Instruction Book
DPU2000R
Distribution Protection Unit

1MRA587219-MIB (IB 7.11.1.7-4)

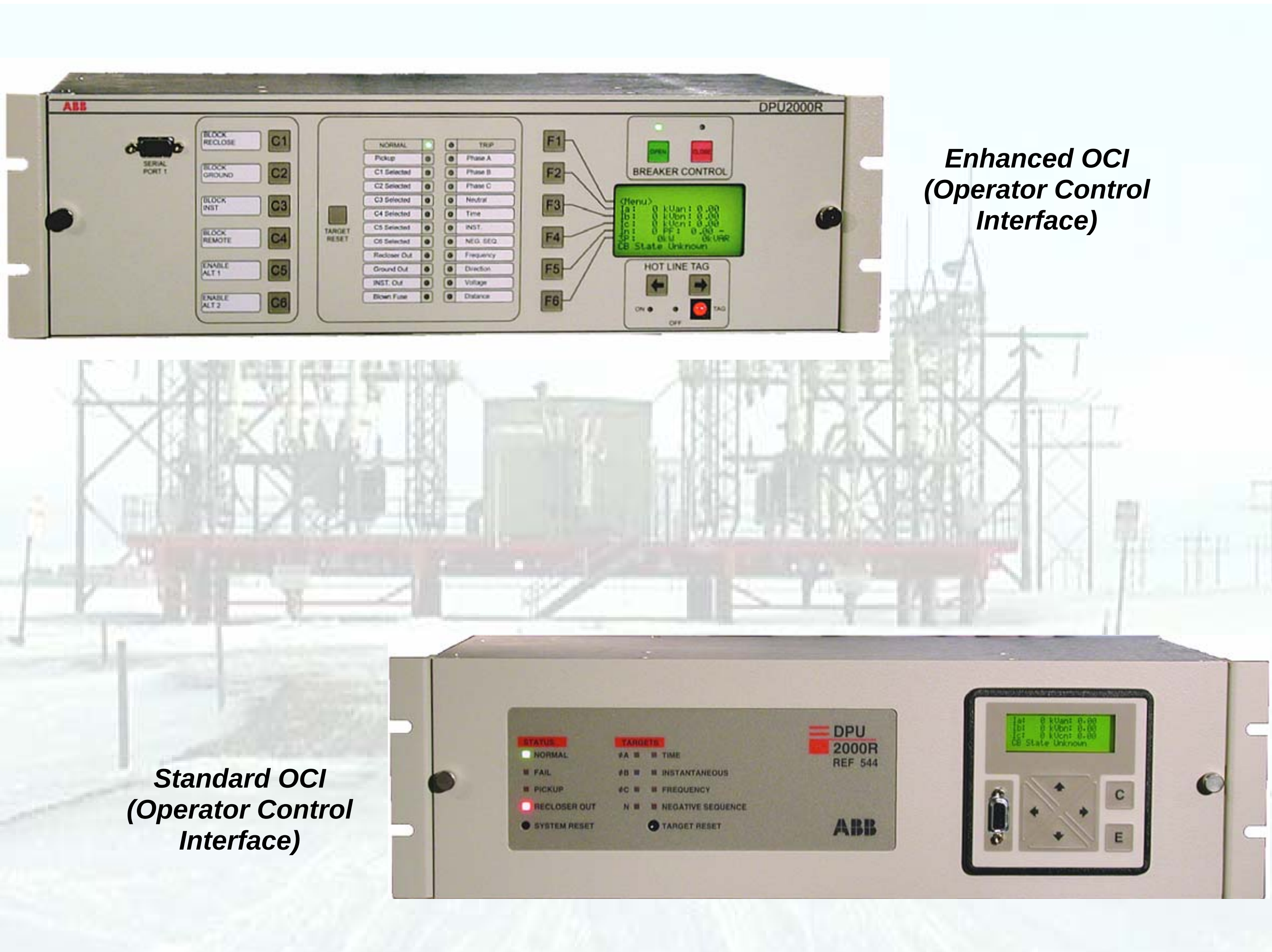


ABB Inc.

Addendum 071709 to DPU2000R IB 7.11.1.7- 4, Issue E

DPU2000R firmware maintenance releases have been issued May 29, 2009, and are available to customers that wish to utilize the improvements and additions the firmware releases entail in their installed DPU2000R units. A DPU2000R can be flash upgraded to the applicable latest maintenance release using the ABB flash programming tool WinFPI. Table A-1 shows the three DPU2000R hardware platforms and the highest CPU firmware version now available that applies per the maintenance releases covered in this addendum. Each hardware platform has a maximum CPU firmware version to which it can be flashed upgraded. A DPU2000R's CPU version can be obtained via the LCD using the Unit Information menu option in the Settings menu for non-Operated Control Interface (OCI) units and Main Menu for OCI units or via WinECP using the status bar located on the bottom of the window. For questions regarding the availability of these features in your particular DPU2000R and flash upgrading, contact your local Regional Technical Manager or call our Customer Support department outside the United States at +1 610 395-7333 or inside the United States at 1 800-634-6005.

Table A-1 DPU2000R Platforms and Applicable CPU Firmware Versions

DPU2000R Hardware Platform	CPU Versions Supported	Most Recent CPU Version
Plated through-hole (PTH)	V1.xx or V2.xx	V2.02
Surface mount technology (SMT)	V3.xx or V4.xx	V4.15
Fast surface mount technology (FSMT)	V5.xx or V6.xx	V6.13

Here are the improvements and enhancements these firmware maintenance releases entail and the DPU2000R platforms to which they are applicable. The applicable section and page number(s) of the Instruction Booklet (IB) are provided in the heading.

Section 1: Sensitive Earth Fault (SEF) Option, 50N-2(I0>2) – Definite Time, page 1-6

The directional SEF option utilizes the zero sequence current measured via the Sensor 5 current input terminals 45 and 46, see Figures 9-5 and 9-6 for connection details, for its operate quantity and the Sensor 5 current angle and zero sequence voltage angle from either the measured Sensor 10 voltage input angle terminals 35 and 36, see Figures 9-5 and 9-6 for connection details, or derived zero sequence voltage with wye-(star-)connected VT's, see Section 2 Configuration Settings on page 2-1 as its polarization quantity.

(Note: In Directional SEF DPU2000R units with CPU firmware V4.13 to V6.12, the polarization quantity utilized the neutral current input Sensor 4 when the Configuration setting "VT Connection" was set to either "69 Wye 3V0 Input" or "120 Wye 3V0 Input" which gave an effective sensitivity of 100 mA, not the 5 mA sensitivity achievable with the current input Sensor 5.)

Section 1: Ground Directional Power Element 32N-2 (I2>-->), page 1-28

When the 32N-2 ground directional power element's Select setting is set to "Enable – Zero Seq", the element utilizes the zero sequence current angle measured via the Sensor 4 current input terminals 47 and 48, see Figure 9-46 for typical connection details, and the zero sequence voltage angle from either the measured Sensor 10 voltage input angle terminals 35 and 36, see Figures 9-5 and 9-6 for connection details, or derived zero sequence voltage with wye-(star-) connected VT's, see Section 2 Configuration Settings on page 2-1, as its polarization quantity.

(Note: In Directional SEF DPU2000R units with CPU firmware V4.13 to V6.12, the polarization quantity utilized the current angle from the current input Sensor 5 when the Configuration setting "VT Connection" was set to either "69 Wye 3V0 Input" or "120 Wye 3V0 Input".)

Section 6: User Logical Inputs/User Logical Outputs, page 6-17

In PTH and SMT platform DPU2000R units with CPU firmware V2.02 and V4.15, respectively, ULO9 will clear as ULO1 through ULO8 are cleared, i.e., whenever its 'Clear ULO' command is issued or its "Connected" same-numbered ULI is disabled.

(Note: In PTH and SMT platform DPU2000R units with CPU firmware <V2.02 and <V4.15, respectively, ULO9 will reset whenever the seal-in alarms are cleared and the unit is reset.)

Section 7: Page 7-6

CPU System Error Codes and Troubleshooting Instructions

The DPU2000R CPU includes embedded self-diagnostics that run continuously and when an error is discovered will lead to a System Error code being displayed on the DPU2000R LCD and the disabling of protection. Table A-2 provides details on the System Error codes that could be displayed on the DPU2000R LCD with suggested course(s) of action a user can take to resolve the error. In any case of such a system error being experienced, contact your local ABB representative to report it so it can be monitored in our quality database.

Table A-2 List of System Error Codes and User Troubleshooting Instructions

System Error	Description	Troubleshoot Instructions
000	No communication between the main processor and the front panel human machine interface (HMI).	1. Is the self-check contact asserted? If yes, re-seat the front panel ribbon cable. If no, verify the monitor chip (U18) is seated in its socket. Report problem to ABB representative, even if problem is fixed. If the problem is not solved, return to factory for repair.
002	Bus error	1. Reset the relay, one time, only. 2. Document the scenario when the problem occurred, if possible. 3. Report problem to the factory, even if problem is fixed.
003	Address error	
010	Un-implemented instruction	
011	Illegal instruction	
065	Stack error	
067	Command Queue error.	

Section 7: Operations Log Listing, page 7-7 to 7-16

In DPU2000R units with CPU firmware V2.02, V4.15 or V6.13, there are additional Operation Records available that indicate operation of available User Logical Outputs and physical outputs which will enhance post-operation diagnostics. These additional records and their descriptions are detailed in Table A-3.

Table A-3 Additional Operation Records Available with CPU V2.02, V4.15 and V6.13

Operations Record Log	Definition
ULOx Closed	User logical output x (where "x" = 1 to 9 for PTH and SMT DPU2000R

	units and "x" = 1 to 16 for FSMT DPU2000R units) is set or enabled.
ULOx Opened	User logical output x (where "x" = 1 to 9 for PTH and SMT DPU2000R units and "x" = 1 to 16 for FSMT DPU2000R units) is cleared or disabled.
TRIP Closed	The programmable Master Trip physical output is energized.
OUT1 Closed	The programmable physical output OUT1 is energized.
OUT2 Closed	The programmable physical output OUT2 is energized.
OUT3 Closed	The programmable physical output OUT3 is energized.
OUT4 Closed	The programmable physical output OUT4 is energized.
OUT5 Closed	The programmable physical output OUT5 is energized.
OUT6 Closed	The programmable physical output OUT6 is energized.
Self-check Closed	The self-check diagnostics physical output ALARM is energized.
TRIP Opened	The programmable Master Trip physical output is de-energized.
OUT1 Opened	The programmable physical output OUT1 is de-energized.
OUT2 Opened	The programmable physical output OUT2 is de-energized.
OUT3 Opened	The programmable physical output OUT3 is de-energized.
OUT4 Opened	The programmable physical output OUT4 is de-energized.
OUT5 Opened	The programmable physical output OUT5 is de-energized.
OUT6 Opened	The programmable physical output OUT6 is de-energized.
Self-check Opened	The self-check diagnostics physical output ALARM is de-energized.

Section 9: Communications Ports, page 9-11

In PTH, SMT and FSMT platform DPU2000R units with CPU firmware V2.02, V4.15 and V6.13, respectively, the unit's clock will not become disabled when a clock edit command of "Day=0" is issued via the IRIG-B port from a clock generator. In PTH, SMT and FSMT DPU2000R units having CPU firmware lower than V2.02, V4.15 and V6.13, respectively, the clock will become disabled whenever a clock generator issues a clock edit command of "Day=0" which some manufacturer's devices do when they are reset. Editing the clock data to "Day=0" via the DPU2000R LCD Change Clock settings menu remains ABB's recommendation of disabling to clock when the unit is not being used to save the clock battery.

Section 10: Digital Fault Recorder (DFR – Waveform Capture), page 10-11

In FSMT DPU2000R units with CPU firmware V6.13, the digital signals identified in Table A-4 will now be available in the Digital Fault Recorder (DFR) COMTRADE files should they operate during a trigger. See the Logical Outputs definitions in Section 6 for details of each logical output.

Table A-4 Additional Operation Records Available with CPU V2.02, V4.15 and V6.13

Logical Output	Definition
BFA	Breaker Failure Alarm driven by Trip Failure Time Configuration setting.
BFT	Breaker Fail to Trip alarm driven by Breaker Failure tab settings.
ReTrip	Re-trip signal driven by the Breaker Failure tab settings.
TCFA	Trip circuit failure alarm based on the status of the TCM logical input.
79DA	Reclosing disabled alarm.
50-1D	First level phase and neutral instantaneous elements disabled alarm.
50-2D	Second level phase and neutral instantaneous elements disabled alarm.
50-3D	Third level phase and neutral instantaneous elements disabled alarm.
ZSC	Zone sequence coordination step alarm.
PH3-D	Phase overcurrent elements disabled alarm.
GRD-D	Ground overcurrent elements disabled alarm.
TRIPA	Phase A trip alarm.
TRIPB	Phase B trip alarm.

TRIPC	Phase C trip alarm.
81O-1	Level 1 overfrequency alarm.
81O-2	Level 2 overfrequency alarm.
CLTA	Cold load timer ‘running’ alarm.
25	Synchronism check element alarm.
59G	Ground overvoltage element alarm.
Prim	Primary settings group activated alarm.
Alt1	Alternate 1 settings group activated alarm.
Alt2	Alternate 2 settings group activated alarm.
81S-2	Level 2 load shed underfrequency element alarm.
81R-2	Level 2 load restoration element alarm.
ULO1	User logical output #1 signal.
ULO2	User logical output #2 signal.
ULO3	User logical output #3 signal.

Section 12: Communications Ports, page 12-4

For FSMT DPU2000R with CPU firmware V6.13 and the DNP3.0 Level 2+ “L” option, the analog dead-banding feature has been enhanced to allow for different band settings for groups of like analog parameters via the 32 User Definable Registers. Table A-5 shows the groups of like analog values and their assigned User Definable Register range.

Table A-5 User Definable Register Definitions for DNP3.0 Analog Dead-banding feature

UDR Group	Group Description	UDR Assignments
I	Load current	1 – 5
II	Load voltage	6 – 12
III	Sequence current	13 – 15
IV	Sequence voltage	16 – 18
V	Watts	19 – 23
VI	VARs	24 – 28
VII	Power factor	29 – 32

Section 12: Option E, page 12-8

For FSMT DPU2000R units with the CPU firmware V6.13 and the Ethernet communications card option, multiple networks will be supported via user programmable gateway setting editable via the Ethernet card’s RS-232 serial communications port and WinECP V4.90.

Addendum to IB 7.11.1.7- 4 – CPU Firmware V5.41 Instructions

The following features have been modified or added and are available in a DPU2000R with CPU firmware version V5.40. One or more of the following features are available only in the Enhanced Operator Control Interface (OCI) option of the DPU2000R Catalog Number 587xxx2x-xxxxx or 587xxx3x-xxxxx, where "x" denotes "not applicable". Any questions regarding the availability of these features in a particular DPU2000R, contact your local Regional Technical Manager or call our Customer Support department at 800-634-6005 or 610-395-7333.

OCI Control Pushbuttons Momentary Operation

In CPU firmware versions V5.40 and higher, the OCI control pushbutton (PB) flexibility has been increased with the implementation of new settings for momentary operation. Presently, the OCI pushbuttons C1 through C6, when enabled, act as maintained switches staying in a fixed position of on or off after being pressed. (Making the control pushbutton act as a momentary switch where it returns to a neutral position is possible, but requires extensive programmable logic.) This feature allows for each control PB to be independently selectable as **Disable**, **Momentary** or **Maintained**, further increasing the flexibility of control operations. In this way, maintained control operations such as block reclosing, block ground or block remote, can be programmed as **Maintained**. The remaining control pushbuttons can be programmed as **Momentary** for applications requiring only a pulse signal, e.g., switching settings groups, resetting latching relays (external and internal) or on/off capacitor bank control. See Application Note AN-A1 for an example of the application of a momentary OCI control PB.

The WinECP Configurations settings screen showing the new OCI control pushbutton settings is shown in Figure A-1 – the settings shown are the factory default settings. Selecting the OCI Front Panel Select button in Configuration settings accesses this screen.

NOTE: An OCI Front Panel Select control pushbutton setting of **Disable** refers only to OCI front panel operation. Remote control operation of the OCI PB's via SCADA can still be accomplished with a Front Panel Select PB setting of **Disable**. To prevent remote control of the OCI control pushbuttons, the logical input LOCAL must be asserted. This control is accomplished by mapping C4 to the logical input LOCAL and selecting it. The control PB C4 would have to be enabled with an Operation setting of **Maintained**.

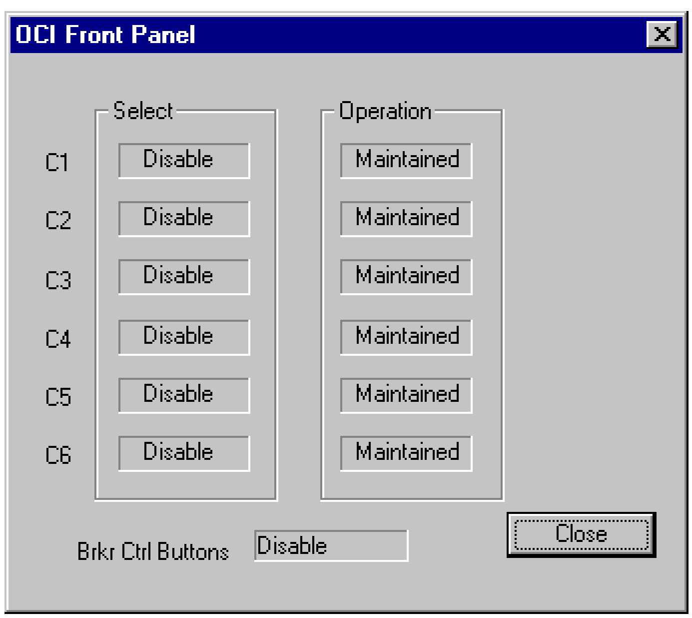


Figure A-1 OCI Front Panel Select Settings

Switch Settings Groups

In DPU2000R firmware V5.40 and higher, the convenience of efficiently transferring from one settings group to another group is available via the logical input **SWSET**. The activation of this logical input drives the DPU2000R to switch from the present active settings group to the next enabled settings group in the order of Primary, Alternate 1 and Alternate 2. This logical input is rising-edge triggered and thus requires only a pulse or momentary input to activate it. The need for external latching relays or internal latching logic mapped to maintain the logical inputs **ALT1** and **ALT2** is eliminated.

The factory default position is Primary settings active. The active settings group is stored in non-volatile memory so that the cycling of control-power will not change that status. Figure A-2 shows the functional block diagram and logic flow for **SWSET**.

NOTE: When selecting this logical input in the Programmable Inputs Map, the logical inputs **ALT1** and **ALT2** must be removed. The logical inputs **ALT1** and **ALT2** take precedence over the logical input **SWSET**.

Logical Inputs

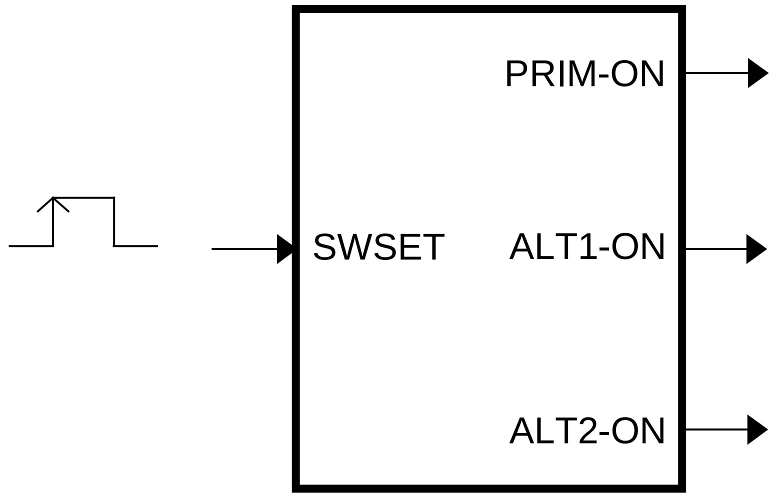
Logical	Description
SWSET	The assertion of this logical input causes the DPU2000R to switch from its present active settings group to the next enabled settings group in the order of Primary, Alternate 1 and Alternate 2. This logical is rising-edge triggered, therefore the control signal should be momentary (pulsed). Should the control signal be of a maintained type, e.g., latching relay, then use the alternate settings groups' dedicated logical inputs **ALT1** and **ALT2**. Figure A-2 shows the function block representation and logic flow for **SWSET**. **NOTE:** When selecting this logical input in the Programmable Inputs Map, the logical inputs **ALT1** and **ALT2** must be removed. The logical inputs **ALT1** and **ALT2** take precedence over the logical input **SWSET**.

Dedicated Logical Outputs for Active Settings Group

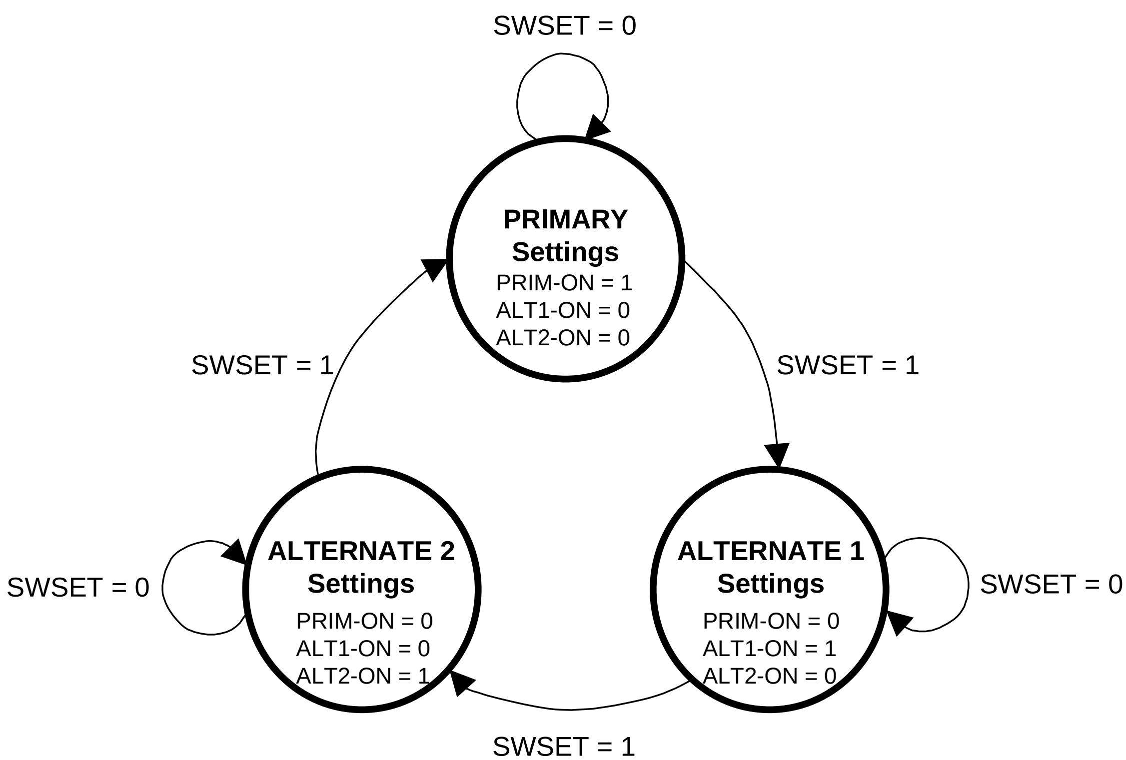
Each of the three settings groups now have a dedicated logical output that when asserted indicates that it is active in CPU firmware versions V5.40 and higher. This offers quick and reliable feedback to ensure the proper switch of settings groups has taken place.

Logical Outputs

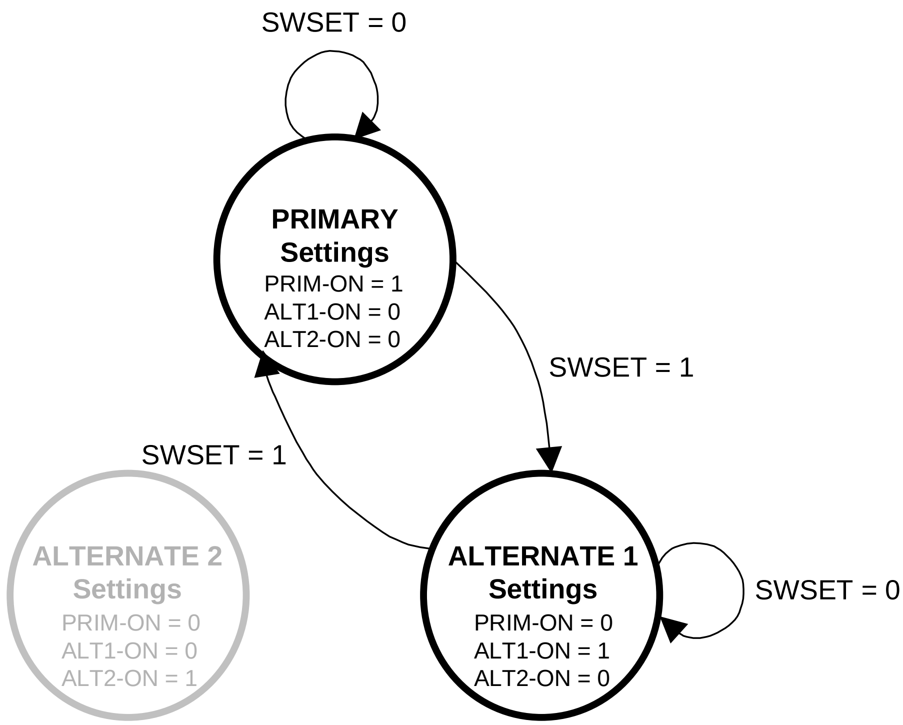
Logical	Description
PRIM-ON	This logical output asserts when Primary settings group becomes active via the assertion of logical input SWSET, both logical inputs ALT1 and ALT2 are de-asserted or both alternate settings groups are disabled in Configuration settings.
ALT1-ON	This logical output asserts when Alternate 1 settings group becomes active via the assertion of the logical input ALT1 or SWSET.
ALT2-ON	This logical output asserts when Alternate 2 settings group becomes active via the logical input ALT2 or SWSET.



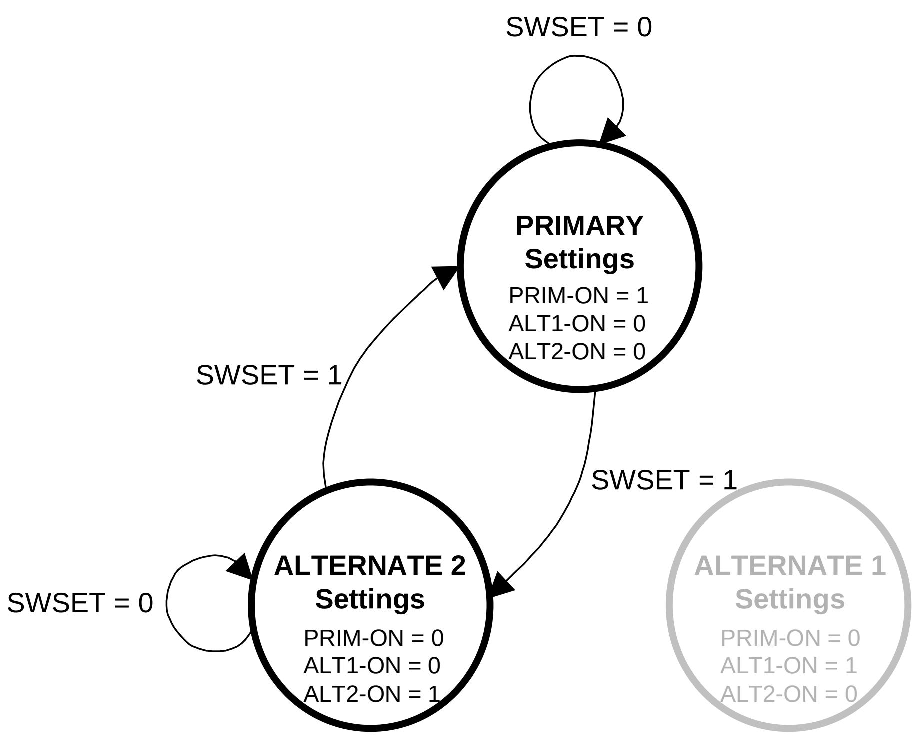
a) functional block



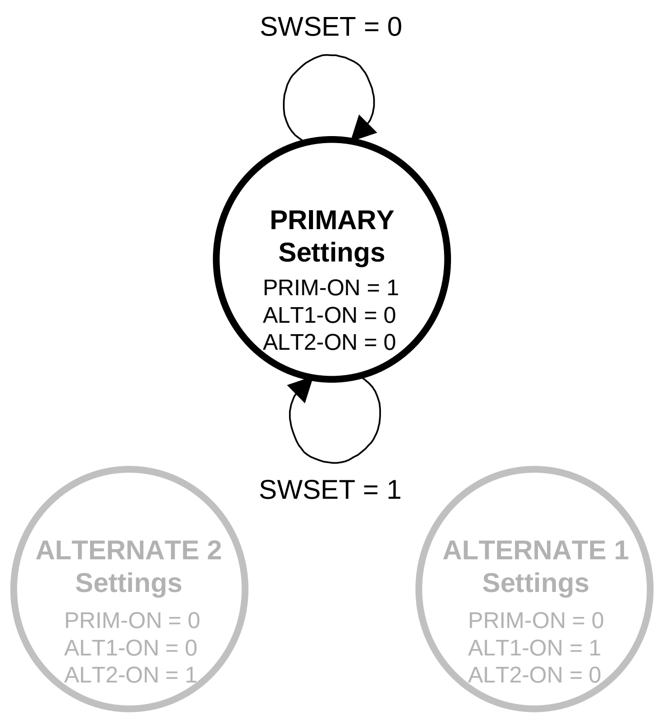
b) state transition diagram ALT1 = Enable, ALT2 = Enable



c) state transition diagram ALT1 = Enable, ALT2 = Disable



d) state transition diagram ALT1 = Disable, ALT2 = Enable



e) state transition diagram ALT1 = Disable, ALT2 = Disable

Figure A-2 SWSET Function Block and State Transition Diagrams

Shift Registers

Two shifting registers, SHIFT_A and SHIFT_B, are now offered for general-purpose use in the programmable logic input and output mapping. Each shift register (Barrel Shifter) is composed of an input and a quantity of outputs selectable by the user as two, three or four. The programming is performed in Configuration settings. The number of outputs is set independently for each shift register with the default for each set at three. Figure A-3 shows the location of the shift register settings in Configuration.

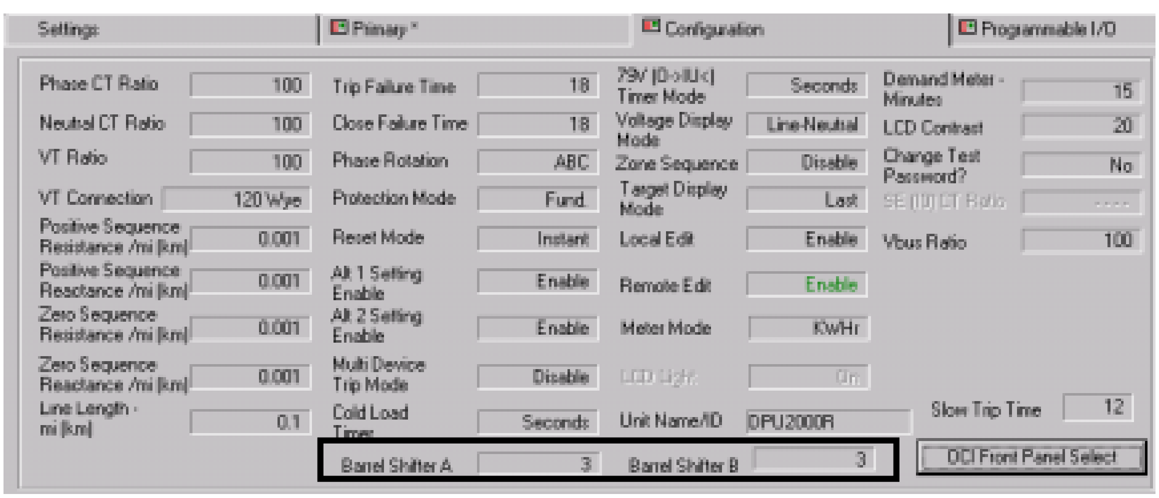


Figure A-3 WinECP Configuration Settings with Shift Registers

Figure A-4 shows the shift register functional block representation and logic flow. The factory default settings will assert the first output of each shift register. The active output is stored in non-volatile memory so that the cycling of control-power will not change that status. See Application Note AN-A2 for an example of applying this function.

Logical Inputs

Logical	Description
SHIFT_A	When asserted, this logical input causes the Shift Register A to energize the next enabled output in the order of 1, 2, 3 and 4. When the last enabled output is reached, another assertion of this logical causes the register to return to the first output.
SHIFT_B	When asserted, this logical input causes the Shift Register B to energize the next enabled output in the order of 1, 2, 3 and 4. When the last enabled output is reached, another assertion of this logical causes the register to return to the first output.

Logical Outputs

Logical	Description
SHIFTA_1	This logical output asserts when Shift Register A is in the first position. This is the factory default position.
SHIFTA_2	This logical output asserts when Shift Register A is in the second position.
SHIFTA_3	This logical output asserts when Shift Register A is in the third position when enabled. See Configuration settings.
SHIFTA_4	This logical output asserts when Shift Register A is in the fourth position when enabled. See Configuration settings.
SHIFTB_1	This logical output asserts when Shift Register B is in the first position. This is the factory default position.
SHIFTB_2	This logical output asserts when Shift Register B is in the second position.
SHIFTB_3	This logical output asserts when Shift Register B is in the third position when enabled. See Configuration settings.
SHIFTB_4	This logical output asserts when Shift Register B is in the fourth position when enabled. See Configuration settings.

Disable OCI Breaker Status LED's

The ability to disable the Breaker Control LED operation, in addition to the breaker control pushbuttons OPEN and CLOSE, is available in CPU firmware versions V5.40 and higher. This is useful in double breaker schemes where the mapped logical inputs 52A and 52B represent a single breaker via the combination of the two. This new selection is added to the OCI Breaker Control setting selections as **Disable** in Configuration settings. The factory default setting is **Disable**.

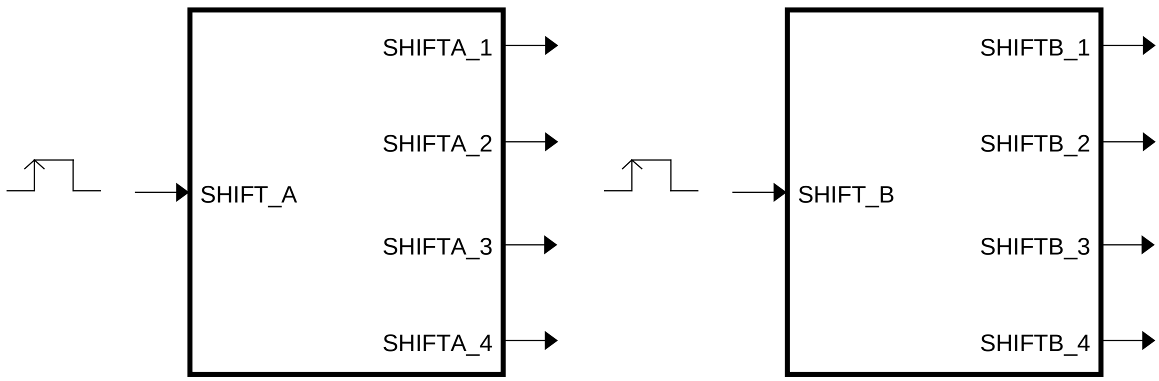
NOTE: In CPU firmware versions less than V5.40, the setting selection of **Disable** yielded the operation of the LED's. That setting, when read by WinECP, will be automatically changed to the setting selection **LEDs Only**.

Phase Targets Operation on Ground Faults

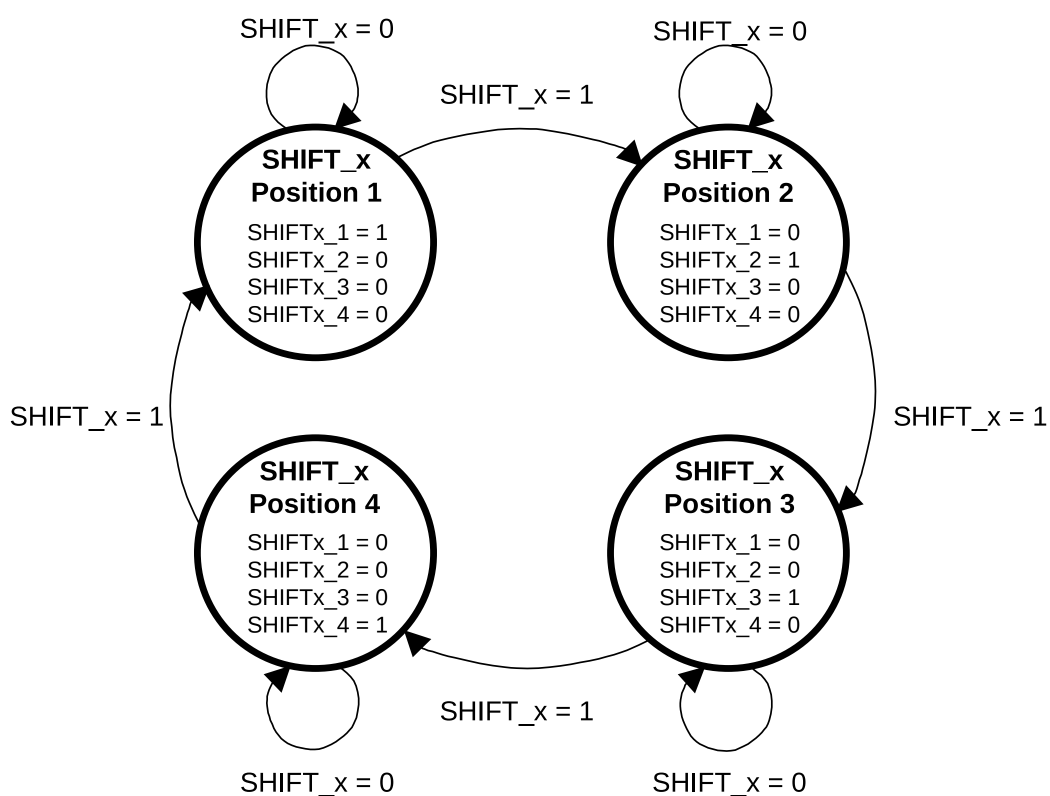
In CPU firmware version V5.40 and higher, the phase current that measure greater than or equal to the 51P or 50P Pickup setting during a ground trip, will have its phase target illuminated. This will assist Operations personnel in identifying and focusing on the specific line(s) to inspect for the fault location.

Logical Outputs

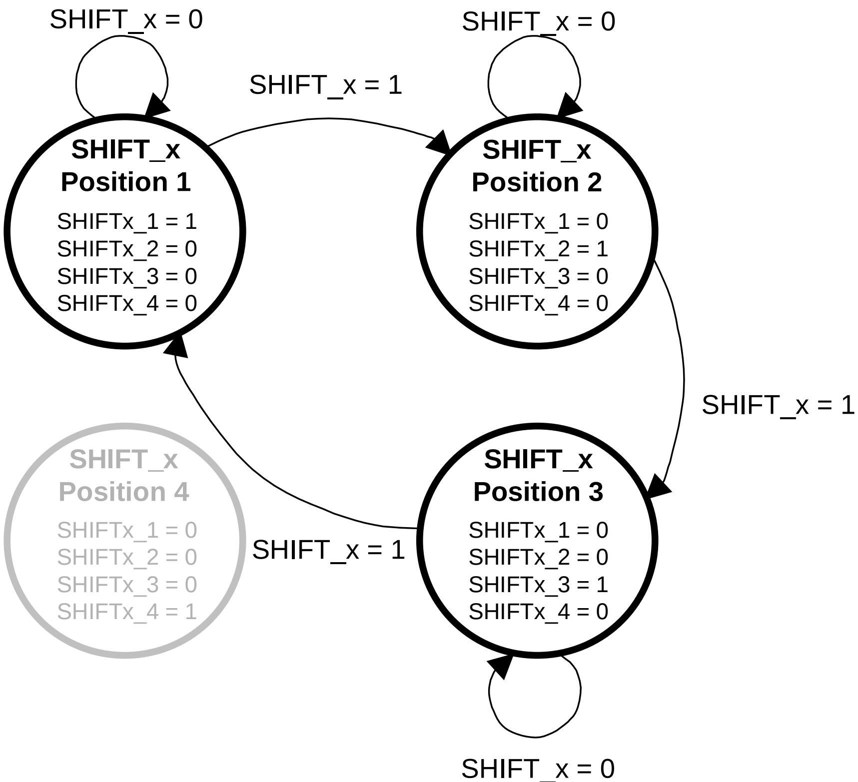
Logical	Description
PATA	This logical output asserts when the phase A current measures above any phase overcurrent pickup and the DPU2000R trips on a phase or ground overcurrent element.
PBTA	This logical output asserts when the phase B current measures above any phase overcurrent pickup and the DPU2000R trips on a phase or ground overcurrent element.
PCTA	This logical output asserts when the phase C current measures above any phase overcurrent pickup and the DPU2000R trips on a phase or ground overcurrent element.



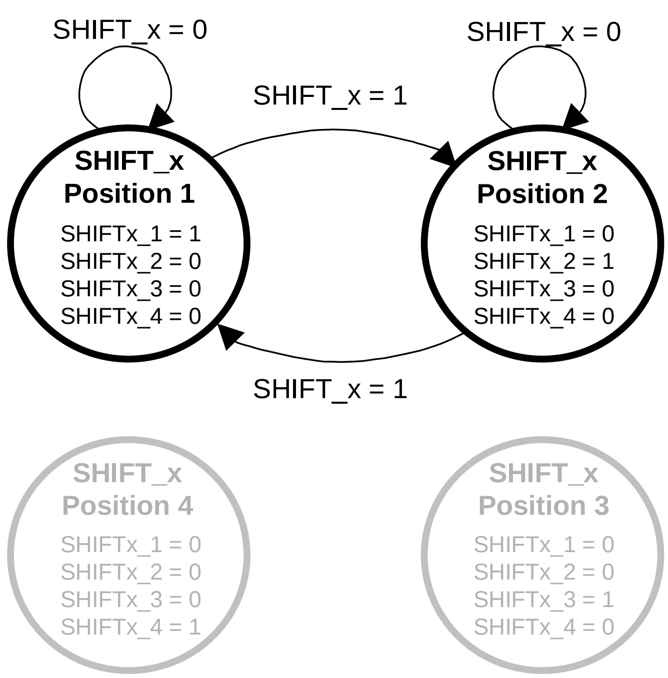
a) function block



b) state transition diagram SHIFT_X = 4 outputs (where x = A or B)



c) state transition diagram SHIFT_X = 3 outputs



d) state transition diagram SHIFT_X = 2 outputs

Figure A-4 Shift Registers (X = A, B) Function Block and State Transition Diagrams

Modbus over TCP/IP Ethernet

ABB has improved upon the capabilities of its 2000R line of protection IEDs in offering Ethernet Modbus capabilities. With this new and state of the art line of communication cards, existing DPU 2000R devices are able to communicate with TCP/IP Modbus Ethernet IED's within today's rapidly changing substation environs. The newly defined Modbus registers for this firmware release V5.40 is shown in Figure A-5. With the addition of Modbus TCP/IP in ABB's DPU 2000R, the IED:

- Responds with the same information as the serial Modbus card when requested by a TCP/IP host. This allows the DPU 2000R to communicate with TCP/IP Modbus capable devices such as IED's, Bridges and protocol translators.
- Uses the same Serial Modbus address map as present users are accustomed for the TCP/IP Modbus Communication Card. Automation data and control capabilities include:
    - Analog Metering
    - Demand Metering Access.
    - Fault Record Access
    - Operation Record Access
    - Modbus Oscillographic Record Access
    - Primary, Alternate Setting Group Access and Configuration
    - Access of IED status information such as Targets, Faults, and Alarms.
    - Diagnostic Data Access
    - Dual Bit Change Detect Element Reporting
    - Latched Element Bit Reporting.
    - Control Capabilities including, Data Element Resets, Trip, Close, Forcing Functions of Logical and Physical Elements.
- Can intercommunicate with up to 4 Modbus client devices simultaneously with rapid data access and response capability.
- The Modbus TCP/IP Ethernet card is a powerful Ethernet server. ABB's Ethernet implementation allows for rapid access of Fault Information and Sequence of Event Records.
- ABB's robust design offers Fiber Optic or Copper connectivity for use in applications where safety and noise immunity are of primary concern.

Hardware Specifications

The ABB ethernet board has two ethernet communication ports:

- 10BaseT port that uses standard CAT5 cable termination
- 10FL fiber-optic port that uses multi-mode fiber-optic cable with ST type connectors.

Both ports have auto-negotiate functionality so that network equipment will not have to be hand configured. Only one port can be active at once. A slide switch that moves from front to back with respect to the relay's front and back is used to select which ethernet port is active. When the slide switch is in the front position the 10FL port is enabled and when it's in the rear the 10BaseT port is enabled. It is recommended that the fiber-optic port be used inside a substation. When a valid fiber-optic link is created the green LED located at the back panel will light.

The ABB ethernet board also has a serial port, COM3 that is not to be connected at all by the end user. This is a development emulation communications port for diagnostics and thus unavailable for end user use.

The ABB ethernet board can be mounted to a 2000R relay the same way other comm boards are mounted.

REGISTER NUMBER	OLD DEFINITION	NEW DEFINITION
00167	Undefined	Primary Set Active
00168	Undefined	ALT1 Set Active
00169	Undefined	ALT2 Set Active
00170	Undefined	SHIFTA – 1
00171	Undefined	SHIFTA – 2
00172	Undefined	SHIFTA – 3
00172	Undefined	SHIFTA – 4
00174	Undefined	SHIFTB – 1
00175	Undefined	SHIFTB – 2
00176	Undefined	SHIFTB – 3
00177	Undefined	SHIFTB – 4
00845	Undefined	Primary Set Active
00846	Undefined	Primary Set Active Momentary
00847	Undefined	ALT1 Set Active
00848	Undefined	ALT1 Set Active Momentary
00849	Undefined	ALT2 Set Active
00850	Undefined	ALT2 Set Active Momentary
00851	Undefined	SHIFTA – 1
008852	Undefined	SHIFTA – 1 Momentary
00853	Undefined	SHIFTA – 2
00854	Undefined	SHIFTA – 2 Momentary
00855	Undefined	SHIFTA – 3
00856	Undefined	SHIFTA – 3 Momentary
00857	Undefined	SHIFTA – 4
00858	Undefined	SHIFTA – 4 Momentary
00859	Undefined	SHIFTB – 1
00860	Undefined	SHIFTB – 1 Momentary
00861	Undefined	SHIFTB – 2
00862	Undefined	SHIFTB – 2 Momentary
00863	Undefined	SHIFTB – 3
00864	Undefined	SHIFTB – 3 Momentary
00865	Undefined	SHIFTB – 4
00866	Undefined	SHIFTB – 4 Momentary
10071	Undefined	SWSET
10072	Undefined	SHIFTA
10073	Undefined	SHIFTB
10653	Undefined	SWSET
10654	Undefined	SWSET Momentary
10655	Undefined	SHIFTA
10656	Undefined	SHIFTA Momentary
10657	Undefined	SHIFTB
10658	Undefined	SHIFTB Momentary
40909-910	ULI12, ULI13, ULI14, ULI15, ULI16, 46A	ULI12, ULI13, ULI14, ULI15, ULI16, 46A & SWSET, SHIFTA, & SHIFTB
40925-926	LBDL, DBLL, DBDL, 46A, 46A*, REMOTE – D	LBDL, DBLL, DBDL, 46A, 46A*, REMOTE – D & Primary Set Active, ALT1 Set Active, ALT2 Set Active, ShiftA – 1, ShiftA – 2, ShiftA – 3, ShiftA – 4, ShiftB – 1, ShiftB – 2, ShiftB – 3, ShiftB – 4

Figure A-5 New Modbus Register Definitions for CPU Firmware V5.40

Reset Mode

In CPU firmware versions lower than V5.40, the Reset Mode setting was internally configured to **Instant** whenever the MDT Mode setting was **Enable** though the setting displayed might have been **Delayed**. This prevented the bus backup DPU2000R's overcurrent elements from ratcheting towards a trip ahead of the feeder breaker's DPU2000R. In CPU firmware versions V5.40 and higher, this dependency has been removed and the Reset Mode setting will operate according to the programmed settings, independent of the MDT Mode setting. In this way, the flexibility of use is increased. See Application Note AN-A3 for an example of where a delayed Reset Mode is desired with a MDT Mode setting of **Enable**.

The following Application Notes assist the user with an understanding of methods to apply the newest features and modifications in the CPU firmware release V5.40.

Application Note AN-A1: Convenient Settings Switching for Maintenance

Using SWSET, operators can easily and confidently switch to the particular settings group for the required maintenance scheduled for that day. The following example shows how this can be accomplished in an Enhanced OCI DPU2000R with CPU firmware V5.40.

Settings Groups Setup

Primary Group:	Normal feeder application.
Alternate 1 Group:	Hot-line work - reclosing disabled and sensitive phase and ground instantaneous elements enabled.
Alternate 2 Group:	Adjacent feeder breaker maintenance – time overcurrent settings raised by a predetermined percentage.

Configuration Settings

C5 Select: Enable
C5 Operation: Momentary

Programmable Inputs Map

SWSET = C5

Programmable Outputs Map

LED3 = PRIM_ON
LED4 = ALT1_ON
LED5 = ALT2_ON

Operation

When either hot-line work or breaker maintenance is required, the local operator can simply activate the desired settings group by pressing the OCI control pushbutton C5, confirming the activation through the appropriately labeled OCI LED. The remote dispatcher can also “press C5” via SCADA DNP3.0 or Modbus protocol and activate the appropriate output for the local personnel.

Application Note AN-A2: Configuration Shifting in Automation System

Changing the entire automation system configuration during testing or other checks can be quickly and easily accomplished using a Shift Register. The following example shows how this can be accomplished in the DPU2000R.

Configuration Settings

Barrel Shifter A: 3
C6 Select: Enable
C6 Operation: Momentary

Programmable Inputs Map

SHIFT_A = C6

Programmable Outputs Map

LED6 = SHIFTA_1
LED7 = SHIFTA_2
LED8 = SHIFTA_3

(The following mappings are optional as Shift Register status can be read via SCADA.)
OUT4 = SHIFTA_1

OUT5 = SHIFTA_2
OUT6 = SHIFTA_3

Operation
With each press of the OCI control pushbutton C6, Shift Register A will energize the next output in the order of 1, 2 and 3. The shift register will, upon the next assertion of its logical input, wrap around to its first output when the maximum enabled output is reached. The operator can confirm the output activation by viewing its appropriately labeled OCI LED. The remote dispatcher can also “press C6” via SCADA DNP3.0 or Modbus protocol and activate the appropriate output for the local personnel.

Application Note AN-A3: Multiple Device Trip with Reset Mode Delayed

In CPU firmware version less than V5.40, enabling the Multiple Device Trip (MDT) Mode automatically set the Reset Mode to **Instant**, regardless of the displayed setting. This was a requirement when applying the DPU2000R in a bus backup protection scheme. The bus DPU2000R MDT mode would be set to **Enable** to prevent it from ratcheting and tripping for a feeder fault before the feeder DPU2000R tripped. The feeder DPU2000R would most likely have its Reset Mode set to **Instant**. With CPU version V5.40 and higher, the Reset Mode setting is independent of the MDT Mode setting. This allows the DPU2000R to be applied on many other schemes such as in double-bus, double-breaker systems. The following example shows how this can be accomplished in the DPU2000R.

For more information regarding the bus breaker backup to feeder breaker protection scheme, refer to the Application Note AN-22 located in Section 13 in the DPU2000R Instruction Booklet, IB 7.11.1.7-4.

Configuration Settings

Multiple Device Trip Mode:	Enable
Reset Mode:	Delayed

Operation
Regardless of the MDT Mode setting of **Enable**, the overcurrent elements will have a delayed reset to better coordinate with upstream electromechanical relays.

Instruction Booklet
1MRA587219–MIB

Issue E July 2002 (IB 7.11.1.7-4)

Manual Revision Note:

7/1/02 Changed issue Version to E and issue date to July 2002 The following features and changes have been incorporated into the DPU2000R relay:

- Pickup Timers and Dropout Timers for all physical outputs and feedbacks are provided.
- Digital Fault Recording (DFR) now provides extended oscillography (from 64 to 256 records of information storage).
- A new oscillographic analysis package is now available – ABB WaveWin – that provides more complete fault analysis, and converts files to COMTRADE
- Ethernet Communications and UCA are now supported: selection type E on the catalogue selection sheet.
- Negative Sequence Function – a 46A has been added in addition to the 46 element.
- For the synch check function 25, the four conditions, DBDL, DBLL, LLDB, and LLLB, have been added to the logical outputs.
- Increased Operations Record size has been increased from 128 to 255.
- The number of ULIs and ULOs has been increased from 8 to 16.
- The pickup levels for the timed overcurrent functions have been reduced to a newer lower level for greater sensitivity.
- The SEF 50N-2 function has the maximum pickup extended to 400 ma. Pickup range is now 5 to 400 ma.
- Memory voltage is now provided for the 21P function that will permit the distance element to trip if the voltage collapses for a three phase fault. Six (6) cycles of memory are provided.

Note:In the past year, a number of other enhancement have been made to the DPU2000R including:

- Enhanced Operator Control Interface (OCI), New relay functions 21P, 47, 59G and 59-3, and Faster flash download of firmware

These are all described within.

2/27/02 Changed issue date to February 2002. Section 6: Added Logical Outputs and Feedback Subsection and 2 figures on pages 6-18 and 6-19. Also incremented figure numbering to remaining figures in the section.

1/24/02 Changed Issue Version to D and issue date to January 2002. Added Section 14 “Operator Control Interface Panel”.

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Introduction

The Distribution Protection Unit 2000R (DPU2000R) is an advanced microprocessor-based relay that protects electrical power subtransmission and distribution systems. Available for 5 or 1 ampere secondary current transformers (CTs), the DPU2000R uses circuit breaker 52a (XO) and 52b (XI) auxiliary contacts for logic input signals. The DPU2000R can be applied with voltage transformers (VTs) connected for operation at 69 or 120 volts AC phase-to-ground (Wye(Star)), 120 volts AC phase-to-phase (Delta or Open Delta with B phase grounded) or 208 volts AC phase-to-phase (Delta). The DPU2000R is packaged in a metal case suitable for conventional flush mounting on a rack panel. The microprocessor-based logic along with the power supply can be totally withdrawn from the case and interchanged with other cases without the need for calibration. All connections to the DPU2000R are made at clearly identified terminals on the rear of the unit. Because of its microprocessor capability, the DPU2000R provides the following features in one integrated package:

- Isolated communication ports for superior noise-free communications
- Password protected settings and controls
- Expanded operating temperature range, from -40° C to $+85^\circ$ C
- Phase time and instantaneous overcurrent protection: 51P (3I>), 50P-1 (3I>>1), 50P-2 (3I>>2), 50P-3 (3I>>3)
- Ground time and instantaneous overcurrent protection: 51N (IN>), 50N-1 (IN>>1), 50N-2 (IN>>2), 50N-3 (IN>>3)
- Negative sequence (I_2) time overcurrent protection: 46 (Insc>)
- Multishot reclosing: 79 (O->I)
- Single- and three-phase undervoltage and single-phase overvoltage functions: 27-1P (U<) and 27-3P (3U<)
- Metering: currents, voltages, watts, VARs, watt and VAR hours, power factor, frequency
- Peak demand currents, watts and VARs with time stamp
- Fault locator with estimated distance in miles and fault resistance
- Fault summary and detailed fault records for last 32 trips
- Operations (sequence of events) record for last 128 operations
- Eight (6) user-programmable binary (contact) inputs
- Eight (8) output contacts: six (6) user-programmable
- Three selectable settings tables: Primary, Alternate 1 and Alternate 2
- Cold load pickup function
- Bus breaker backup scheme is easily implemented
- Zone sequence coordination function
- Summation of breaker interrupting duty and breaker operations counter
- Battery backed-up clock maintains date and time during control power interruptions
- Continuous self-diagnostics on power supply, memory elements and microprocessors
- Front RS-232 port and a variety of rear communication port options such as RS-232, RS-485 and Modbus ®
- Optional load profile capability: watts, VARs and voltage for 40, 80 or 160 days
- Optional user-programmable time overcurrent curves
- Optional oscillographic data storage captures 64 cycles of current and voltage waveform data
- Drawout motherboard and power supply from the case and interchange with other cases without the need for calibration

Getting Started

Precautions

Take the following precautions when using the ABB Distribution Protection Unit 2000R:

1. Incorrect wiring may result in damage. Be sure wiring agrees with connection diagram before energizing.
2. Apply only the rated control voltage marked on the unit.
3. High-potential tests are not recommended. If a control wire insulation test is required, fully withdraw the DPU2000R from its case and perform only a DC high-potential test. **Surge capacitors installed in the unit do not allow AC high-potential testing.**
4. Follow test procedures to verify proper operation. To avoid personal shock, use caution when working with energized equipment. Only competent technicians familiar with good safety practices should service these devices.
5. In the event the self-checking function detects a system failure, the protective functions are disabled and the alarm contacts are actuated. Replace the unit as soon as possible.

Password

6. A correct password is required to make changes to the relay settings and to test the output contacts. **The preset factory password is four blank spaces**. Once you have chosen a new password and entered it into the system, access will be denied if the password is forgotten. If you forget the password, contact the factory.

WARNING: **Removal of the relay from the case exposes the user to dangerous voltages. Use extreme care. Do not insert hands or other foreign objects into the case.**

This instruction booklet contains the information to properly install, operate and test the DPU2000R but does not purport to cover all details or variations in equipment, nor to provide for every possible contingency to be met in conjunction with installation, operation or maintenance. Should particular problems arise which are not sufficiently covered for the purchaser's purposes, please contact ABB Inc.

DPU2000R - Quick Start

The purpose of this document is to provide an engineer or technician with all of the necessary information on how to test trip and reclose in a new DPU2000R relay. It will answer all of the questions most frequently asked by users who are not familiar with the relay. It is recommended that the initial tests performed be done according to the Acceptance Test procedure in this instruction manual before attempting to test with operational settings.

Initial Tripping

When right from the factory, mostly all of the protection functions in the DPU2000R are disabled in the Primary Settings. Only the functions 51P (3I>), 50P-1 (3I>>1), 51N (IN>), and 50N-1 (IN>>1) are enabled. The Time Overcurrent elements are set to pick up at 6 amperes and the Instantaneous to trip at 3 times this setting or 18 amperes. Given the default curve (extremely inverse) and time dial (5), 12 Amps rms into one phase and out another should trip the 51P (3I>) in about 16 seconds.

It is not enough that the settings are enabled directly as above, they must also be enabled in the Recloser Trip Functions settings 79-1 (O->I1), 79-2 (O->I2), 79-3 (O->I3), 79-4 (O->I4), and 79-5 (O->I5). Only the functions that are enabled (or set to lockout) can trip the relay during that recloser cycle. That is, only functions enabled (set to lockout) in 79-1 (O->I1)can trip the relay before it's first reclose, only the functions enabled in 79-2 (O->I2) can trip between the first and second reclose, and so on. Elements that are selected "Disable" in any reclose sequence will not operate.

From the factory, only the functions 51P (3I>), 50P-1 (3I>>1), 51N (IN>), and 50N-1 (IN>>1) are enabled in setting 79-1 (O->I1). The 51P (3I>) function is not in the list because it is always enabled. To add to the list in 79-1 (O->I1), a function must first be enabled outside of 79-1 (O->I). The new function will then appear in the 79-1 (O->I1) list as "Disabled" and must be set to "Enable" or "Lockout". The preceding statements are also applicable to all of the other Recloser Trip step settings, 79-2 (O->I2) through 79-5 (O->I5).

Another way to disable (torque control) protection functions is by mapping that function to one of the programmable inputs in the **Programmable Inputs** screen using WinECP. Mapping a function to an input will disable that function if there is no control voltage detected on that input's terminals. An will disable the function when control voltage is detected on that input's terminals.

From the factory, no tripping functions are disabled in this way. The only functions that are mapped to inputs are the 52A (XO), 52B (XI), and 43A (AR) functions which are mapped to IN-1, IN-2, and IN-3 respectively.

Yet another way that a function can be disabled is by deselecting it from the **Master Trip Output** screen. The Master Trip Output allows the user to choose which tripping function will activate the main trip contact and provides a way to separate the different tripping functions among programmable output contacts. From the factory, all tripping functions are mapped to the main trip output.

Reclosing

When the DPU2000R with factory settings is first powered up, the red "Recloser Out" front panel target LED will be lit indicating that the reclosing function is disabled. There are a few different ways that reclosing is defeated in the factory settings. Any one of them is capable of disabling the recloser by itself and must each be taken into account. They are listed here:

1. The 43A (AR) function is mapped with a programmable input IN-3. Enable the recloser by connecting control voltage to IN-3 or by unmapping the 43A (AR) input.

2. The factory settings do not map the CLOSE function to any programmable output. Use WinECP to map CLOSE to OUT-1 or any other output contact.

3. The **79-1 (O->I1) Open Time** setting is initially set to "Lockout". Change this setting to some time interval.

Another thing that can keep the relay from reclosing, regardless of what the settings are, is the way the unit is tested. When the relay is tripped, the breaker status 52A (XO) and 52B (XI) contacts must change state and the fault current must drop to 5% under the lowest pickup within the **Trip Failure Time** setting or the relay will go to Lockout and issue a breaker failure alarm. The breaker status requirement can be bypassed by putting the relay into Functional Test mode (from the Test Menu). In this mode, the relay can ignore the status of the 52A (XO) and 52B (XI) contacts for 15 minutes, unless it is reset.

To stop the fault current, the current source should be configured to turn off when it senses that the trip contact has closed, or, the current could be wired through an A-contact controlled by the breaker. If the current cannot be turned off quickly enough, the **Trip Failure Time** setting (in the Configuration Settings group) can be increased up to 1 second (60 cycles).

There are additional reasons that the DPU2000R relay may not reclose when the relay does not contain only factory settings. Some possible causes are listed here:

1. The function that causes the trip is set to send the relay into "Lockout" within the **79-X (O->IX) Select** setting where **X** can be reclose step 1, 2, 3, 4 or 5.
2. The **79V (O->IU<) Voltage Select** setting is enabled and one of the phase voltages is below the **79V (O->IU<) Pickup** setting.

WARNING: This device is shipped with default passwords. Default passwords should be changed to private passwords at installation. Failure to change each default password to a private password may allow unauthorized access. ABB shall not be responsible for any damage resulting from unauthorized access.

Protective Functions

Protective Elements

The DPU2000R features a combination of protective elements as typically applied in subtransmission and distribution protection schemes. The following text will describe the various elements, their application, and how to set them.

WARNING: This device is shipped with default passwords. Default passwords should be changed to private passwords at installation. Failure to change each default password to a private password may allow unauthorized access. ABB shall not be responsible for any damage resulting from unauthorized access.

Summary of Protective Elements

The following Figure 1-1 summarizes all of the protective elements contained in the DPU2000R, their settings, and factory default settings. See the following text for a complete description of each element.

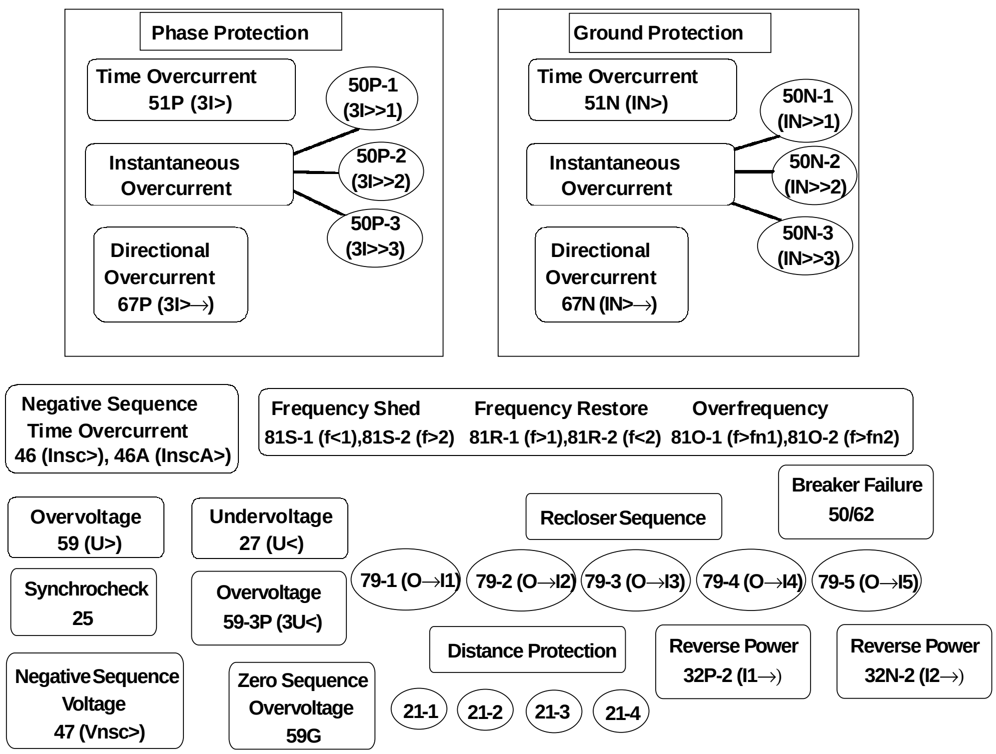


Figure 1-1. DPU2000R Protective Functions

Phase Time Overcurrent Element 51P (3I>)

The phase time overcurrent element, 51P, contained in the DPU2000R is set based on CT secondary current as connected to the phase current inputs; Sensor 1 (Ia), Sensor 2 (Ib), and Sensor 3 (Ic). See Figure 9-4 for a typical connections drawing. Multiple time curves and time dials are available (see Table 1-1) to closely coordinate with other devices in the system. The time-current curves included in the DPU2000R can be found later this section. User programmable curves are available depending on the DPU2000R model ordered (see Section 10 for more details). See Section 12 for help defining the unit model number. The 51P pickup, curve type, and time dial are all set in the Primary, Alternate 1, and Alternate 2 settings groups. For the 51P element to operate the “Trip” contact, it must be selected in the “Master Trip Output” mapping (see “Programmable Master Trip Contact” later in this section). 51P is set by factory default to operate the “Trip” contact.

Table 1-1. 51P (3I>) Characteristics

51N Parameter	Range/Curve	Time Dial	Increment
Pickup for 5 ampere model	0.4 to 12 amperes		0.1 ampere
Pickup for 1 ampere model	0.08 to 2.4 amperes		0.02 ampere
Time Overcurrent Curves **			
ANSI (For Cat. No.	Inverse	1 to 10	0.1
beginning with 587)	Very Inverse	1 to 10	0.1
	Extremely Inverse	1 to 10	0.1
	Long Time Inverse	1 to 10	0.1
	Long Time Very Inverse	1 to 10	0.1
	Long Time Ext. Inverse	1 to 10	0.1
	Short Time Inverse	1 to 10	0.1
	Definite Time	0 to 10	0.1
	Recloser Curve	1 to 10	0.1
IEC (For Cat. No.	Inverse	0.05 to 1.0	0.05
beginning with 687)	Very Inverse	0.05 to 1.0	0.05
	Extremely Inverse	0.05 to 1.0	0.05
	Long Time Inverse	0.05 to 1.0	0.05
	User Prog. Curve #1 ***	1 to 10	0.1
	User Prog. Curve #2 ***	1 to 10	0.1
	User Prog. Curve #3 ***	0 to 10	0.1

** See model number for applicability

*** Optional

See Table 5-1 for the 51P factory default settings.

The 51P and 50P element can be supervised (torque controlled) by mapping the "PH3" logical input to a physical input for external supervision or Logical Output for internal supervision. See the Programmable I/O" Section for programming instructions.

There are two selectable reset modes available for the 51P element. The instantaneous mode is used to coordinate with other instantaneous reset devices such as solid state or microprocessor based relays. In the instantaneous mode the 51P will reset when the current drops below the pickup setting for one half cycle.

The delayed mode simulates the action of an electromechanical induction disk relay. In this mode the 51P reset follows a slow reset characteristic that depends upon the duration of the overcurrent condition and the amount of load current flowing after the event. The reset equations are described later in this section. When the DPU2000R "Multiple Device Trip Mode" (see "Multiple Device Trip Mode" in Section 2) is enabled, the 51P reset characteristic defaults to the instantaneous mode and cannot be set to delayed. The reset mode applies to all time overcurrent elements in the DPU2000R.

Ground Time Overcurrent Element 51N (IN>)

The ground time overcurrent element, 51N, contained in the DPU2000R is based on CT secondary current (I_0) as connected to the ground current input, sensor no. 4. See Figure 9-4, Typical External Connections. Multiple time curves and time dials are available (see Table 1-2) to closely coordinate with other devices in the system. The time-current curves for the DPU2000R are can be found later in this section. User programmable curves are available depending on the DPU2000R model ordered (see Section 10 for programmable curves). See Section 12 for help defining the unit model number. The 51N pickup, curve type, and time dial are all set in the Primary, Alternate 1, and Alternate 2 settings groups. For the 51N element to operate the "Trip" contact, it must be selected in the "Master Trip Output" mapping (see "Programmable Master Trip Contact" later in this section). The 51N element is set by factory default to operate the "Trip" contact.

Table 1-2. 51N (IN>) Characteristics

51P Parameter	Range/Curve	Time Dial	Increment
Pickup for 5 ampere model	0.4 to 12 amperes		0.1 ampere
Pickup for 1 ampere model	0.08 to 2.4 amperes		0.02 ampere
Time Overcurrent Curves **			
ANSI (For Cat. No.	Inverse	1 to 10	0.1
beginning with 587)	Very Inverse	1 to 10	0.1
	Extremely Inverse	1 to 10	0.1
	Long Time Inverse	1 to 10	0.1
	Long Time Very Inverse	1 to 10	0.1
	Long Time Ext. Inverse	1 to 10	0.1
	Short Time Inverse	1 to 10	0.1
	Definite Time	0 to 10	0.1
	Recloser Curve	1 to 10	0.1
IEC (For Cat. No.	Inverse	0.05 to 1.0	0.05
beginning with 687)	Very Inverse	0.05 to 1.0	0.05
	Extremely Inverse	0.05 to 1.0	0.05
	Long Time Inverse	0.05 to 1.0	0.05
	User Prog. Curve #1 ***	1 to 10	0.1
	User Prog. Curve #2 ***	1 to 10	0.1
	User Prog. Curve #3 ***	0 to 10	0.1

** See model number for applicability

*** Optional

See Table 5-1 for the 51N factory default settings.

The 51N element tripping can be enabled or disabled in each step of the reclose sequence. See "Reclosing" later in this section for more details. The 51N element can be supervised ("torque controlled") by mapping the "GRD" logical input to a physical input for external supervision or Logical Output for internal supervision. See "Programmable I/O" in Section 6 for programming instructions.

There are two selectable reset modes available for the 51N element. The instantaneous mode is used to coordinate with other instantaneous reset devices such as solid state or microprocessor based relays. In the instantaneous mode the 51N will reset when the current drops below the pickup setting for one half cycle. The delayed mode simulates the action of an electromechanical induction disk relay. In this mode the 51N reset follows a slow reset characteristic that depends upon the duration of the overcurrent condition and the amount of load current flowing after the event. The delayed reset equations are described later in this section. When the DPU2000R "Multiple Device Trip Mode" (see "Multiple Device Trip Mode" in Section 2) is enabled the 51N reset characteristic defaults to the instantaneous mode and cannot be set to delayed. The reset mode applies to all time overcurrent elements in the DPU2000R.

Phase Instantaneous Overcurrent Element 50P-1 (3I>>1) - Level 1, Low set

The 50P-1 function operates when the level of any phase current exceeds the pickup level. It should be enabled where phase instantaneous tripping is desired. It is typically set equal to or higher than the phase time overcurrent pickup. The pickup level of 50P-1 is set as a multiple of the 51P pickup. The timing of the 50P-1 element varies depending upon which curve is selected (see Table 1-3). The curves can be found later in this section. The 50P-1 pickup, curve type, and time dial are all set in the Primary, Alternate 1, and Alternate 2 settings groups. For the 50P-1 element to operate the "Trip" contact, it must be selected in the "Master Trip Output" mapping (see "Programmable Master Trip Contact" later in this section). The 50P-1 element is set by factory default to operate the "Trip" contact.

Table 1-3. 50P-1 (3I>>1) Characteristics

50P-1 Parameter	Range/Curve	Time Dial	Increment
Pickup	0.5 to 40 x 51P setting	- - -	0.1x
Instantaneous Curves			
	Standard	No Intentional Delay	- - -
	Inverse Instantaneous	1 to 10	0.1
	Short Time Inverse	1 to 10	0.1
	Short Time Ext. Inverse	1 to 10	0.1
	Definite Time	0 to 9.99	0.01

See Table 5-1 for the 50P-1 factory default settings.

The 50P-1 element tripping can be enabled or disabled in each step of the reclose sequence. See "Reclosing" later in this section for more details. It can also be supervised (torque controlled) by mapping the 50-1 logical input to a physical input for external supervision or Feedback I/O for internal supervision. See the "Programmable I/O" Section for programming instructions. When the two phase 50P tripping function is selected, the 50P-1 element trips only when two or three phases exceed the pickup setting and does not operate for single phase faults. This is applicable where instantaneous tripping for single phase to ground faults is not desired (see "Two Phase 50P Tripping" later in this section).

When the circuit breaker is closed by an external source such as a control switch or SCADA, the 50P-1 can be disabled from tripping for a "Cold Load Time". See the "Cold Load Time" also in this section.

Table 1-4. 50P-2 (3I>>2) Characteristics

50P-2 Parameter	Range/Curve	Increment
Pickup	0.5 to 40 x 51P setting	0.1x
Definite Time	0 to 9.99 seconds	0.01 sec.

The 50P-2 element is disabled in the factory default settings.

Phase Instantaneous Overcurrent Element 50P-2 (3I>>2) - Level 2, Mid set

The 50P-2 function operates when the level of any phase current exceeds the pickup level. 50P-2 is used to establish an additional layer of instantaneous overcurrent protection. The pickup level of 50P-2 is set as a multiple of the 51P pickup. The timing of the 50P-2 is set strictly as definite time (see Table 1-4). The 50P-2 pickup is often set higher than the 50P-1 and used to trip faster than the 50P-1 or for recloser Lockout. See "Reclosing" later in this section. The 50P-2 pickup and time delay are all set in the Primary, Alternate 1, and Alternate 2 settings groups. For the 50P-2 element to operate the "Trip" contact, it must be selected in the "Master Trip Output" mapping (see "Programmable Master Trip Contact" later in this section). 50P-2 is set by factory default to operate the "Trip" contact. Note: The 50P-2 element cannot be blocked by the cold load timer.

50P-2 tripping can be enabled or disabled in each step of the reclose sequence. See the "Reclosing" Section for more details. It can also be supervised (torque controlled) by mapping the "50-2" logical input to a physical input for external supervision or feedback I/O for internal supervision. See the "Logical Inputs" Section for programming instructions. When the two phase 50P tripping function is selected, the 50P-2 element trips only when two or three phases exceed the pickup setting and does not operate for single phase faults. See also "Two Phase 50P Tripping" later in this section.

Phase Instantaneous Overcurrent Element 50P-3 (3I>>3) - Level 3, High set

The 50P-3 function operates when the level of any phase current exceeds the pickup level. 50P-3 is typically used to establish high set instantaneous overcurrent protection. The 50P-3 setting is often used to block reclosing at high levels of fault current, or as a level detector supervised by another function within the relay such as the 32. To operate an output relay with the 50P-3 only, a programmable output contact must be mapped to operate on the 50P-3 element only. See the "Programmable I/O" Section for more details. The pickup level of 50P-3 is set as a multiple of the 51P pickup (see Table 1-5). The timing of the 50P-3 is not selectable and trips instantaneously with no intentional time delay. The 50P-3 pickup is set in the Primary, Alternate 1, and Alternate 2 settings groups. For the 50P-3 element to operate the “Trip” contact, it must be selected in the “Master Trip Output” mapping (see “Programmable Master Trip Contact” later in this section). 50P-3 is set by factory default to operate the “Trip” contact.

Table 1-5. 50P-3 (3I>>3) Characteristics

50P-3 Parameter	Range/Curve	Increment
Pickup	0.5 to 40 x 51P setting	0.1x

The 50P-3 element is disabled in the factory default settings.

50P-3 tripping can be enabled or disabled in each step of the reclose sequence. See “Reclosing” later in this section for more details. When the Two Phase 50P tripping function is selected, the 50P-3 element trips only when two or three phases exceed the pickup setting and does not operate for single phase faults. This is applicable where instantaneous tripping for ground faults is not desired. Note: The 50P-3 element cannot be blocked by the cold load timer.

Two Phase 50P (3I>>) Tripping

The Two Phase 50P tripping is used to increase sensitivity and improve clearing time for three phase, phase to phase, and two phase to ground faults on the main section of radial distribution lines. The two phase 50P tripping mode is not sensitive to single phase to ground faults. When the two phase 50P mode is enabled in the Primary, Alternate 1, or Alternate 2 settings groups, the 50P-1, 50P-2, and 50P-3 elements will trip only for two or three phase faults. The 50N-1, 50N-2, and 50N-3 ground instantaneous overcurrent elements will still operate for single phase to ground faults where the ground current exceeds the 50N-1, 50N-2, and 50N-3 pickup settings. Two Phase 50P tripping is disabled in the factory default settings. Refer to Application Note AN-24.

Ground Instantaneous Overcurrent Element 50N-1 (IN>>1) - Level 1, Low set

The 50N-1 function operates when the level of ground current exceeds the pickup level. It is enabled where ground instantaneous tripping is desired. It is typically set equal to or at a higher pickup level than the ground time over current pickup. The pickup level of 50N-1 is set as a multiple of the 51N pickup. The timing of the 50N-1 element varies depending upon which curve is selected (see Table 1-6). The 50N-1 pickup, curve type, and time dial are all set in the Primary, Alternate 1, and Alternate 2 settings groups. For the 50N-1 element to operate the “Trip” contact, it must be selected in the “Master Trip Output” mapping (see “Programmable Master Trip Contact” later in this section). 50N-1 is factory default to operate the “Trip” contact.

Table 1-6. 50N-1 (IN>>1) Characteristics

50N-1 Parameter	Range/Curve	Time Dial	Increment
Pickup	0.5 to 40 x 51N setting		0.1x
Instantaneous Curves			
	Standard Instantaneous	No Intentional Delay	
	Inverse Instantaneous	1 to 10	0.1x
	Short Time Inverse	1 to 10	0.1x
	Short Time Ext. Inverse	1 to 10	0.1x
	Definite Time	0 to 9.99	0.01

See Table 5-1 for the 50N-1 factory default settings.

50N-1 tripping can be enabled or disabled in each step of the reclose sequence. See “Reclosing” later in this section for more details. It can also be supervised (torque controlled) by mapping the 50-1 logical input to a physical input for external supervision or Feedback I/O for internal supervision. See the “Programmable I/O” Section for programming instructions.

When the circuit breaker is closed by an external source such as a control switch or SCADA, the 50N-1 can be disabled from tripping for a “Cold Load Time”. See the “Cold Load Time” Section for more details.

Ground Instantaneous Overcurrent Element 50N-2 (IN>>2) - Level 2, Mid set

The 50N-2 function operates when the level of ground current exceeds the pickup level. 50N-2 is used to establish one more layer of instantaneous overcurrent protection such as a high set instantaneous overcurrent element. If the fault current exceeds the 50N-2 setting, a typical scenario would be to trip faster than the 50N-1 setting, lockout reclosing, or operate an external lockout relay. To operate an external lockout relay with the 50N-2 only, a programmable output contact must be mapped to operate on the 50N-2 element only. See the "Programmable I/O" Section for more details. The pickup level of 50N-2 is set as a multiple of the 51N pickup. The timing of the 50N-2 is set strictly as definite time (see Table 1-7). The 50N-2 pickup and time delay are all set in the Primary, Alternate 1, and Alternate 2 settings groups. For the 50N-2 element to operate the "Trip" contact, it must be selected in the "Master Trip Output" mapping (see Programmable Trip Contact Section). 50N-2 is set by factory default to operate the "Trip" contact. Note: The 50N-2 element cannot be blocked by the cold load timer.

Table 1-7. 50N-2 (IN>>2) Characteristics

50N-2 Parameter	Range/Curve	Increment
Pickup	0.5 to 40 x 51N setting	0.1x
Definite Time	0 to 9.99 seconds	0.01 sec.

The 50N-2 element is disabled in the factory default settings.

50N-2 tripping can be enabled or disabled in each step of the reclose sequence. See "Reclosing" later in this section for more details. It can also be supervised (torque controlled) by mapping the "50N-3" logical input to a physical input for external supervision or Feedback I/O for internal supervision. See the "Programmable I/O" Section for programming instructions.

Sensitive Earth Fault (<u>SEF</u>) Option, 50N-2 (IØ>2) - Definite Time

The Sensitive Earth Fault (SEF) is applicable to systems where all loads are connected line to line **and no neutral or earth current flows unless an earth fault occurs**. (This options is <u>not</u> applicable to 4 wire multigrounded systems.) This feature is included on special SEF DPU2000R models only (see Section 12) and replaces the standard 50N-2 element described earlier. For SEF models a separate SEF current input is provided at Sensor 5 (I_0SEF). This input can be connected residually in series with the standard earth fault CT or it may be connected to a separate window type CT that encloses all three phase conductors. See Table 1-8 for applicable SEF settings.

The analog and digital filtering provide a rejection ratio of third harmonic greater than 50:1 to prevent incorrect operation due to the effects of distribution transformer excitation currents.

For loop schemes or ungrounded systems, a directional SEF model is available (see Section 12). The directional unit is polarized, by a separate V_0 (zero sequence voltage) input (see Figure 9-6). The potential transformers should be connected wye-broken delta. The minimum polarization voltage is 2 volts and the torque angle is set 0 to 355 degrees in 5 degree steps with a sector width of 180 degrees. (Contact factory for availability of 1-volt sensitivity). The SEF 50N-2 tripping can be enabled or disabled in each step of the reclose sequence. See "Reclosing" later in this section for more details. It can also be supervised (torque controlled) by mapping the "SEF" logical input to a physical input for external supervision or Logical Output for internal supervision. See the "Programmable I/O" Section for programming instructions.

Table 1-8. 50N-2 (IN>>2) Sensitive Earth Fault Units

SEF 50N-2 Parameter	Range/Curve	Increment
Pickup	5 mA to 400 mA	0.5mA
Definite Time	0.5 to 180 seconds	0.1 seconds

The SEF 50N-2 is disabled in the factory default settings.

Ground Instantaneous Overcurrent Element 50N-3 (IN>>3) - Level 3, High set

The 50N-3 function operates when the level of ground current exceeds the pickup level. 50N-3 is typically used to establish high set instantaneous overcurrent protection. If the fault current exceeds the 50N-3 setting a typical scenario would be to lockout reclosing or operate an external lockout relay. To operate an external lockout relay with the 50N-3 only, a programmable output contact must be mapped to operate on the 50N-3 element only. This function can also be used as a level detector supervised by some other function such as the 32N. See the "Programmable I/O" Section for more details. The pickup level of 50N-3 is set as a multiple of the 51N pickup (see Table 1-2). The timing of the 50N-3 is not selectable and trips instantaneously with no intentional time delay. The 50N-3 pickup is set in the Primary, Alternate 1, and Alternate 2 settings groups. For the 50N-3 element to operate the "Trip" contact, it must be selected in the "Master Trip Output" mapping (see "Programmable Master Trip Contact" later in this section). 50N-3 is set by factory default to operate the "Trip" contact. 50N-3 tripping can be enabled or disabled in each step of the reclose sequence. See "Reclosing" later in this section for more details. Note: The 50N-3 element cannot be blocked by the cold load timer.

Table 1-9. 50N-3 (IN>>3) Characteristics

50N-3 Parameter	Range/Curve	Increment
Pickup	0.5 to 40 x 51N setting	0.1x

The 50N-3 element is disabled in the factory default settings.

Negative Sequence Time Overcurrent Element 46 (Insc>) and 46A (InscA>)

Protective Element 46 (Insc>)

The negative sequence overcurrent element is used where increased sensitivity for phase to phase faults is desired. In addition to the typical application of feeder protection, this element can also be applied on DPU2000R relays protecting a main bus breaker in medium to large distribution substations. The main DPU2000R would typically be set to provide protection for bus faults and backup protection for a failed feeder relay or breaker. In the case of a medium to larger substation the time and instantaneous overcurrent elements 50/51 in the main DPU2000R must be set well above the combined full load current of all the individual feeders. This slows the response to bus faults and decreases the sensitivity to faults on a single distribution feeder. Since the negative sequence element only looks at the amount of negative sequence current in the system it can be set just above the maximum negative sequence current level produced by single phase load unbalance. The negative sequence element 46 then allows the DPU2000R to react more quickly for phase to phase bus faults.

Multiple time curves and time dials are available (see Table 1-10) to coordinate with other devices in the system. The time-current curves included in the DPU2000R are located later in Section 1. User programmable curves and special Recloser curves are also available depending on the DPU2000R model ordered (see Section 10 for programmable curves). See Section 12 for help defining the unit model number. The 46 pickup, curve type, and time dial are all set in the Primary, Alternate 1, and Alternate 2 settings groups. For the 46 element to operate the "Trip" contact, it must be selected in the "Master Trip Output" mapping (see "Programmable Master Trip Contact" later in this section). The 46 element is set by factory default to operate the "Trip" contact. The 46 element will always initiate reclosing unless the recloser is disabled. See "Reclosing" later in this section for more details.

There are two selectable reset modes available for the 46 element. The instantaneous mode is used to coordinate with other instantaneous reset devices such as solid state or microprocessor based relays. In the instantaneous mode the 46 will reset when the current drops below the pickup setting for one half cycle. The delayed mode simulates the action of an electromechanical induction disk relay. In this mode the 46 reset follows a slow reset characteristic that depends upon the duration of the overcurrent condition and the amount of load current flowing after the event. The reset time equations are available at the end of Section 1. When the DPU2000R "Multiple Device Trip Mode" (see "Multiple Device Trip Mode" in Section 2) is enabled the 46 reset characteristic defaults to the instantaneous mode and cannot be set to delayed. The reset mode when set applies to all time overcurrent elements in the DPU2000R.

Table 1-10. 46 (Insc>) Characteristics

46 Parameter	Range/Curve	Time Dial	Increment
Pickup for 5 ampere model	0.4 to 12 amperes		0.1 ampere
Pickup for 1 ampere model	0.08 to 2.4 amperes		0.02 ampere
Time Overcurrent Curves **			
ANSI (For Cat. No.	Inverse	1 to 10	0.1
beginning with 587)	Very Inverse	1 to 10	0.1
	Extremely Inverse	1 to 10	0.1
	Long Time Inverse	1 to 10	0.1
	Long Time Very Inverse	1 to 10	0.1
	Long Time Ext. Inverse	1 to 10	0.1
	Short Time Inverse	1 to 10	0.1
	Definite Time	0 to 10	0.1
	Recloser Curve	1 to 10	0.1
IEC (For Cat. No.	Inverse	0.05 to 1.0	0.05
beginning with 687)	Very Inverse	0.05 to 1.0	0.05
	Extremely Inverse	0.05 to 1.0	0.05
	Long Time Inverse	0.05 to 1.0	0.05
	User Prog. Curve #1 ***	1 to 10	0.1
	User Prog. Curve #2 ***	1 to 10	0.1
	User Prog. Curve #3 ***	0 to 10	0.1

** See model number for applicability

*** Optional

The 46 element is disabled in the factory default settings.

NOTE: For the DPU relays with firmware Version 5.2X with a current pickup range of 0.4 to 12A, the available setting range for the 46 function are as follows:

If the 51P pickup is set from 0.4 to 6.0A, then the 46 function pickup range is settable from 0.4 to 12A.
If the 51P pickup is set from 6.1 to 12A, then the 46 function pickup range is settable from 1 to 12A.

For relays with a current pickup range of 0.08 to 2.4A, the available setting ranges for the 46 function are as follows:

If the 51P pickup is set from 0.08 to 1.20A, then the 46 function pickup range is from 0.08 to 2.4A.
If the 51P pickup is set from 1.21 to 2.4A, then the 46 function pickup range is from 0.20 to 2.4A.

Protective Element 46A (InscA>)

Table 1-11. Pickup Settings for the 46A Protection Function

Parameter	Units	Min	Max	Default	Step	Range Availability
46A Pickup	% of 51P setting	5%	50%	50%	5%	Only DPU2000R models CPU Flash version 5.20 and greater.

In addition to the negative sequence time overcurrent element 46, a 46A, or negative sequence time overcurrent alarm element is also provided. This element is identical in functionality as the 46 element, however its pickup range is as a percentage of the 51P phase overcurrent setting using all of the available time curves listed on Table 1-11.

This setting flexibility permits the negative sequence overcurrent setting to be independent of the 46 function.

The minimum pickup setting is 5% for both the high tap CT option and the low tap CT option.

Directional Phase Time Overcurrent Element 67P (3I>-->)

The directional phase time overcurrent element 67P, is used to provide time overcurrent protection in one direction of current flow only. This applies to applications of the DPU2000R in parallel subtransmission lines or double ended substations with multiple sources. Multiple time curves and time dials are available (see Table 1-12) to closely coordinate with other devices in the system. The time-current curves included in the DPU000R can be found later in Section 1. User programmable curves and special Recloser curves are available depending on the DPU2000R model ordered (see "User Programmable Curves" in Section 10). See Section 12 for help defining the unit model number. **Note: Only one set of curves is available at any one time, i.e. if Recloser curves were ordered, the ANSI curve set is not included.** The 67P pickup, curve type, time dial, and torque angle are all set in the Primary, Alternate 1, and Alternate 2 settings groups. For the 67P element to operate the "Trip" contact, it must be selected in the "Master Trip Output" mapping (see "Programmable Master Trip Contact" later in Section 1). 67P is factory default to operate the "Trip" contact. The 67P element will always initiate reclosing unless the recloser is disabled. See "Reclosing" later in this section for more details.

Polarizing of the 67P is provided by the positive sequence voltage (V_1) in the system. It is sensitive down to 1 volt AC line to line. If the polarizing voltage drops below this level, the 67P will lose direction and will not trip. The 67P function is achieved by comparing the positive sequence voltage (V_1) to the direction of the positive sequence current (I_1). The torque angle is set 0 to 355 degrees in 5 degree steps (I_1 leading V_1) with a sector width of 180 degrees. See Figure 1-2 for examples of different torque angle settings. It should be noted that when the voltage seen by the relay is at or near the minimum sensitivity point of 1 volt line to line, the set angle may move $\pm$ 10 degrees.

Table 1-12. 67P (3I>-->) Characteristics

67P Parameter	Range/Curve	Time Dial	Increment
Pickup for 5 ampere model	0.4 to 12 amperes		0.1 ampere
Pickup for 1 ampere model	0.08 to 2.4 amperes		0.02 ampere
Time Overcurrent Curves **			
ANSI (For Cat. No.	Inverse	1 to 10	0.1
beginning with 587)	Very Inverse	1 to 10	0.1
	Extremely Inverse	1 to 10	0.1
	Long Time Inverse	1 to 10	0.1
	Long Time Very Inverse	1 to 10	0.1
	Long Time Ext. Inverse	1 to 10	0.1
	Short Time Inverse	1 to 10	0.1
	Definite Time	0 to 10	0.1
	Recloser Curve	1 to 10	0.1
IEC (For Cat. No.	Inverse	0.05 to 1.0	0.05
beginning with 687)	Very Inverse	0.05 to 1.0	0.05
	Extremely Inverse	0.05 to 1.0	0.05
	Long Time Inverse	0.05 to 1.0	0.05
	User Prog. Curve #1 ***	1 to 10	0.1
	User Prog. Curve #2 ***	1 to 10	0.1
	User Prog. Curve #3 ***	0 to 10	0.1
Maximum Torque Angle	0 to 355°		5°

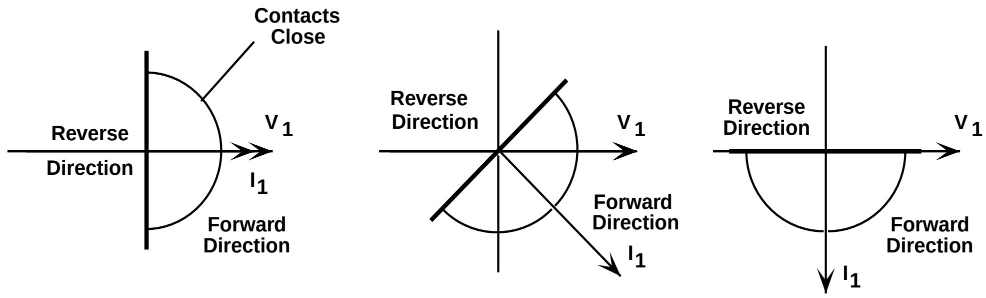
** See model number for applicability
*** Optional

NOTE: For the DPU relays with firmware Version 5.2X with a current pickup range of 0.4 to 12A, the available setting range for the 67P function are as follows:

If the 51P pickup is set from 0.4 to 6.0A, then the 67P function pickup range is settable from 0.4 to 12A.
If the 51P pickup is set from 6.1 to 12A, then the 67P function pickup range is settable from 1 to 12A.

For relays with a current pickup range of 0.08 to 2.4A, the available setting ranges for the 67P function are as follows:

If the 51P pickup is set from 0.08 to 1.20A, then the 67P function pickup range is from 0.08 to 2.4A.
If the 51P pickup is set from 1.21 to 2.4A, then the 67P function pickup range is from 0.20 to 2.4A.



0⁰ Setting　315⁰ Setting　270⁰ Setting

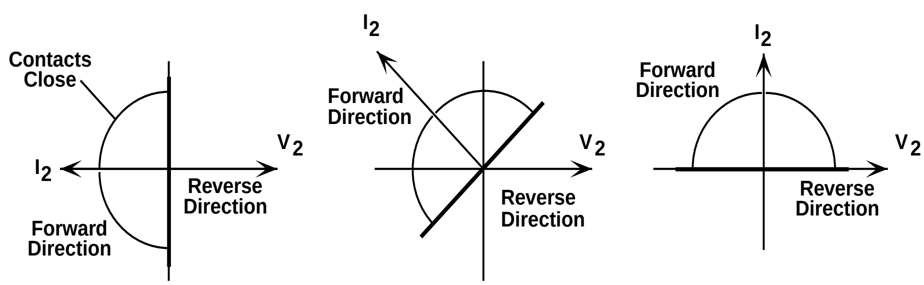
Figure 1-2. 67P Maximum Torque Angles, Example Settings

There are two selectable reset modes available for the 67P element. The instantaneous mode is used to coordinate with other instantaneous reset devices such as solid state or microprocessor based relays. In the instantaneous mode the 67P will reset when the current drops below the pickup setting for one half cycle. The delayed mode simulates the action of an electromechanical induction disk relay. In this mode the 67P reset follows a slow reset characteristic that depends upon the duration of the overcurrent condition and the amount of load current flowing after the event. The reset equations can be fund later in this section. When the DPU2000R "Multiple Device Trip" mode (see "Multiple Device Trip Mode" in Section 2) is enabled the 67P reset characteristic defaults to the instantaneous mode and cannot be set to delayed. The reset mode when set applies to all time overcurrent elements in the DPU2000R.

If the 51P element is not used for phase time overcurrent protection, disable the element in the "Master Trip" mapping (see Programmable Trip Contact Section) and set the pickup level equal to that of the 67P to enhance metering resolution.

Directional Ground Time Overcurrent Element 67N (IN>-->)

The directional ground time overcurrent element 67N, is used to provide time overcurrent protection in one direction of current flow only. This applies to applications of the DPU2000R in parallel subtransmission lines or double ended substations with multiple sources. Multiple time curves and time dials are available (see Table 1-13) to coordinate with other devices in the system. The time-current curves included in the DPU2000R can be found later in this section. User programmable curves and special Recloser curves are available depending on the DPU2000R model ordered (see "User Programmable Curves" in Section 10). See Section 12 for help defining the unit model number. **Note: Only one set of curves is available at any one time, I.E. if Recloser curves were ordered, the ANSI curve set is not included.** The 67N pickup, curve type, time dial, and torque angle are all set in the Primary, Alternate 1, and Alternate 2 settings groups. For the 67N element to operate the "Trip" contact, it must be selected in the "Master Trip Output" mapping (see "Programmable Master Trip Contact" later in this section). 67N is set by factory default to operate the "Trip" contact. The 67N element will always initiate reclosing unless the recloser is disabled. See "Reclosing" later in this section for more details.



180⁰ Setting　135⁰ Setting　90⁰ Setting

Figure 1-3. 67N Maximum Torque Angles, Negative Sequence Polarization and Operate Quantities, Example Settings

Table 1-13. 67N (IN>-->) Characteristics

67N Parameter	Range/Curve	Time Dial	Increment
Pickup for 5 ampere model	0.4 to 12 amperes		0.1 ampere
Pickup for 1 ampere model	0.08 to 2.4 amperes		0.02 ampere
Time Overcurrent Curves **			
ANSI (For Cat. No.	Inverse	1 to 10	0.1
beginning with 587)	Very Inverse	1 to 10	0.1
	Extremely Inverse	1 to 10	0.1
	Long Time Inverse	1 to 10	0.1
	Long Time Very Inverse	1 to 10	0.1
	Long Time Ext. Inverse	1 to 10	0.1
	Short Time Inverse	1 to 10	0.1
	Definite Time	0 to 10	0.1
	Recloser Curve	1 to 10	0.1
IEC (For Cat. No.	Inverse	0.05 to 1.0	0.05
beginning with 687)	Very Inverse	0.05 to 1.0	0.05
	Extremely Inverse	0.05 to 1.0	0.05
	Long Time Inverse	0.05 to 1.0	0.05
	User Prog. Curve #1 ***	1 to 10	0.1
	User Prog. Curve #2 ***	1 to 10	0.1
	User Prog. Curve #3 ***	0 to 10	0.1
Maximum Torque Angle	0 to 355°		5°

** See model number for applicability
*** Optional

NOTE: For the DPU relays with firmware Version 5.2X with a current pickup range of 0.4 to 12A, the available setting range for the 67N function are as follows:

If the 51P pickup is set from 0.4 to 6.0A, then the 67N function pickup range is settable from 0.4 to 12A.
If the 51P pickup is set from 6.1 to 12A, then the 67N function pickup range is settable from 1 to 12A.

For relays with a current pickup range of 0.08 to 2.4A, the available setting ranges for the 67N function are as follows:

If the 51P pickup is set from 0.08 to 1.20A, then the 67N function pickup range is from 0.08 to 2.4A.
If the 51P pickup is set from 1.21 to 2.4A, then the 67N function pickup range is from 0.20 to 2.4A.

Polarizing of the 67N function is provided by the negative sequence voltage (V_2) in the system, or by the zero sequence voltage (V_0) from the WYE connected potential transformers. It is selectable in the relay program. If the DPU2000R relay is connected to an open delta voltage source, then the unit cannot use (V_0) as it is not generated. The relay will then use the negative sequence voltage and calculate the zero sequence voltage for the required polarizing quanitity for the 67N element and the directional SEF function if included.

The directional element 67N function is achieved by comparing the negative sequence or zero sequence voltage to the direction of the zero sequence current (I_0). The torque angle is set 0 to 355 degrees in 5 degree steps (current s leading voltage) with a sector width of 180 degrees. See Figure 1-3 for examples of different angles of maximum reach settings. It should be noted that when the voltage seen by the relay is at or near the minimum sensitivity point of 1 volt line to line, the set angle may move ± 10 degrees.

There are two selectable reset modes available for the 67N element. The instantaneous mode is used to coordinate with other instantaneous reset devices such as solid state or microprocessor based relays. In the instantaneous mode the 67N will reset when the current drops below the pickup setting for one half cycle. The delayed mode simulates the action of an electromechanical induction disk relay. In this mode the 67N reset follows a slow reset characteristic that depends upon the duration of the overcurrent condition and the amount of load current flowing after the event. The reset curves can be found later in this section. When the DPU2000R “Multiple Device Trip” mode (see “Multiple Device Trip Mode” in Section 2) is enabled the 67N reset characteristic defaults to the instantaneous mode and cannot be set to delayed. The reset mode when set applies to all time overcurrent elements in the DPU2000R.

If the 51N element is not used for ground time overcurrent protection, disable the element in the “Master Trip” mapping (see Programmable Trip Contact Section) and set the pickup level equal to that of the 67N to enhance metering resolution.

Timing Curves

Time Overcurrent Curve Equation

ANSI

$$\text{Trip Time} = \left(\frac{A}{M^p - C} + B \right) \times \left(\frac{14n-5}{9} \right)$$

$$\text{Reset Time} = \left(\frac{D}{|1-EM|} \right) \times \left(\frac{14n-5}{9} \right)$$

M = Multiples of pickup current (I/Ipu)
n = Time Dial setting

Table 1-14. Constants for ANSI Time Overcurrent Characteristics

Curve	A	B	C	P	D	E	K	a
Extremely Inverse	6.407	0.025	1	2.0	3	0.998	80.0	2.0
Very Inverse	2.855	0.0712	1	2.0	1.346	0.998	13.5	1.0
Inverse	0.0086	0.0185	1	0.02	0.46	0.998	0.14	0.02
Short Time Inverse	0.00172	0.0037	1	0.02	0.092	0.998		
Short Time Ext. Inv.	1.281	0.005	1	2.0	0.6	0.998		
Long Time Ext. Inv.	64.07	0.250	1	2.0	30	0.998		
Long Time Very Inv.	28.55	0.712	1	2.0	13.46	0.998		
Long Time Inverse	0.086	0.185	1	0.02	4.6	0.998	120.0	1.0
Recloser Curve #8	4.211	0.013	0.35	1.8	3.29	1.5		

Notes:

- The time in seconds for the **Long Time Extremely Inverse** Curve is 10 times that of the Extremely Inverse Curve.
- The time in seconds for the **Long Time Very Inverse** Curve is 10 times that of the Very Inverse Curve.
- The time in seconds for the **Long Time Inverse** Curve is 10 times that of the Inverse Curve.
- The time in seconds for the **Short Time Inverse** Curve is 1/5 times that of the Inverse Curve.
- The time in seconds for the **Short Time Extremely Inverse** Curve is 1/5 times that of the Extremely Inverse Curve.
- See Section 10 for information on optional Recloser curves.

Timing Curves

Time Overcurrent Curve Equation

IEC

$$\text{Trip Time} = \left(\frac{K}{\left[\frac{G}{G_b}\right]^{\alpha} - 1} \right) \times \text{ time multiple}$$

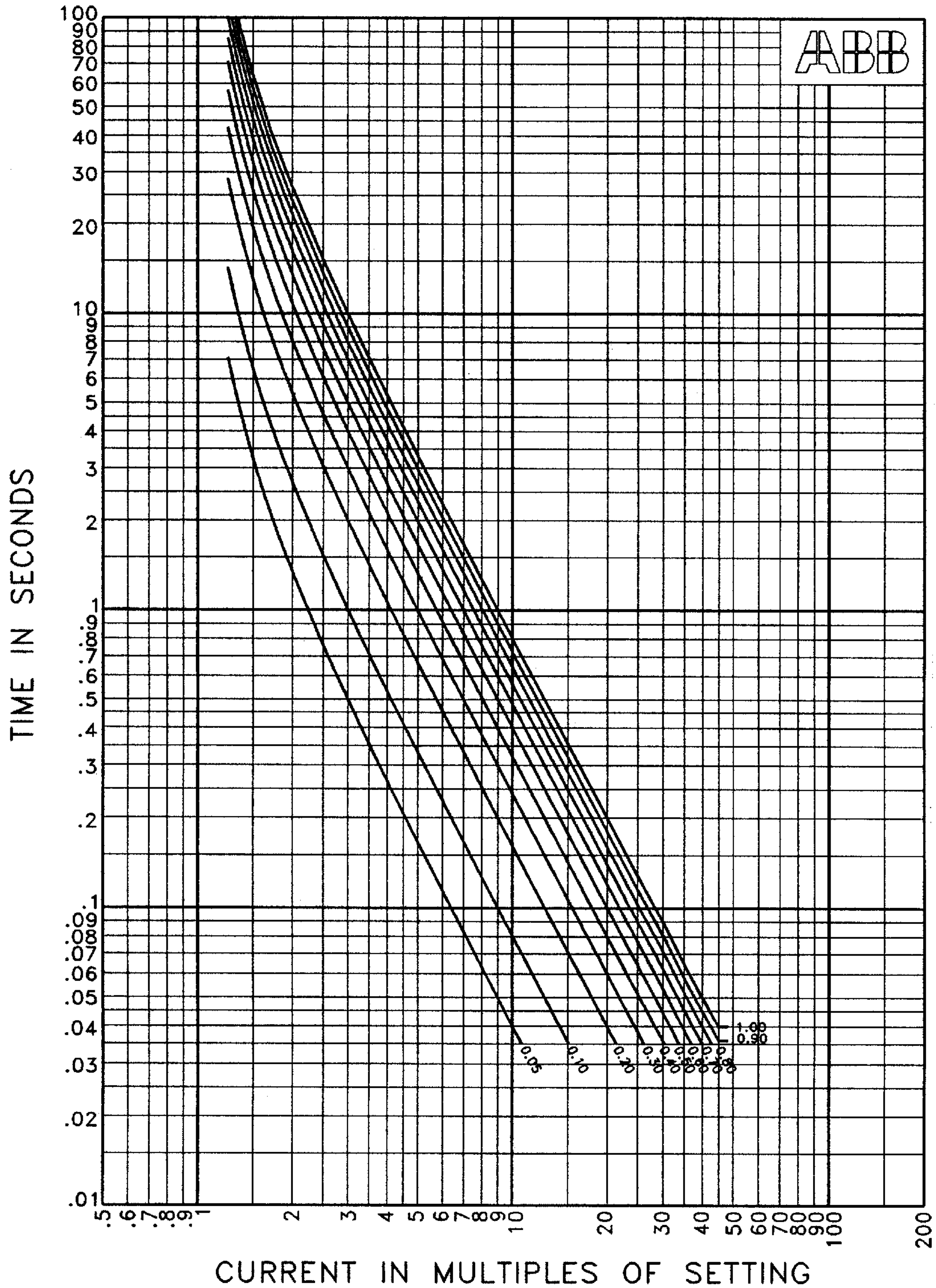
Reset Time = instantaneous

$\left[\frac{G}{G_b}\right]$ = multiples of pickup current

Time multiple range 0.05 to 1.0 in steps of 0.05

Table 1-15. Constants for IEC Time Overcurrent Characteristics

Curve	K	α
Extremely Inverse	80.0	2.0
Very Inverse	13.5	1.0
Inverse	5.14	0.02
Long Time Inverse	122.0	1.0



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IEC EXTREMELY INVERSE

DWG NO 604930 REV 0

Figure 1-4. IEC Extremely Inverse Curve

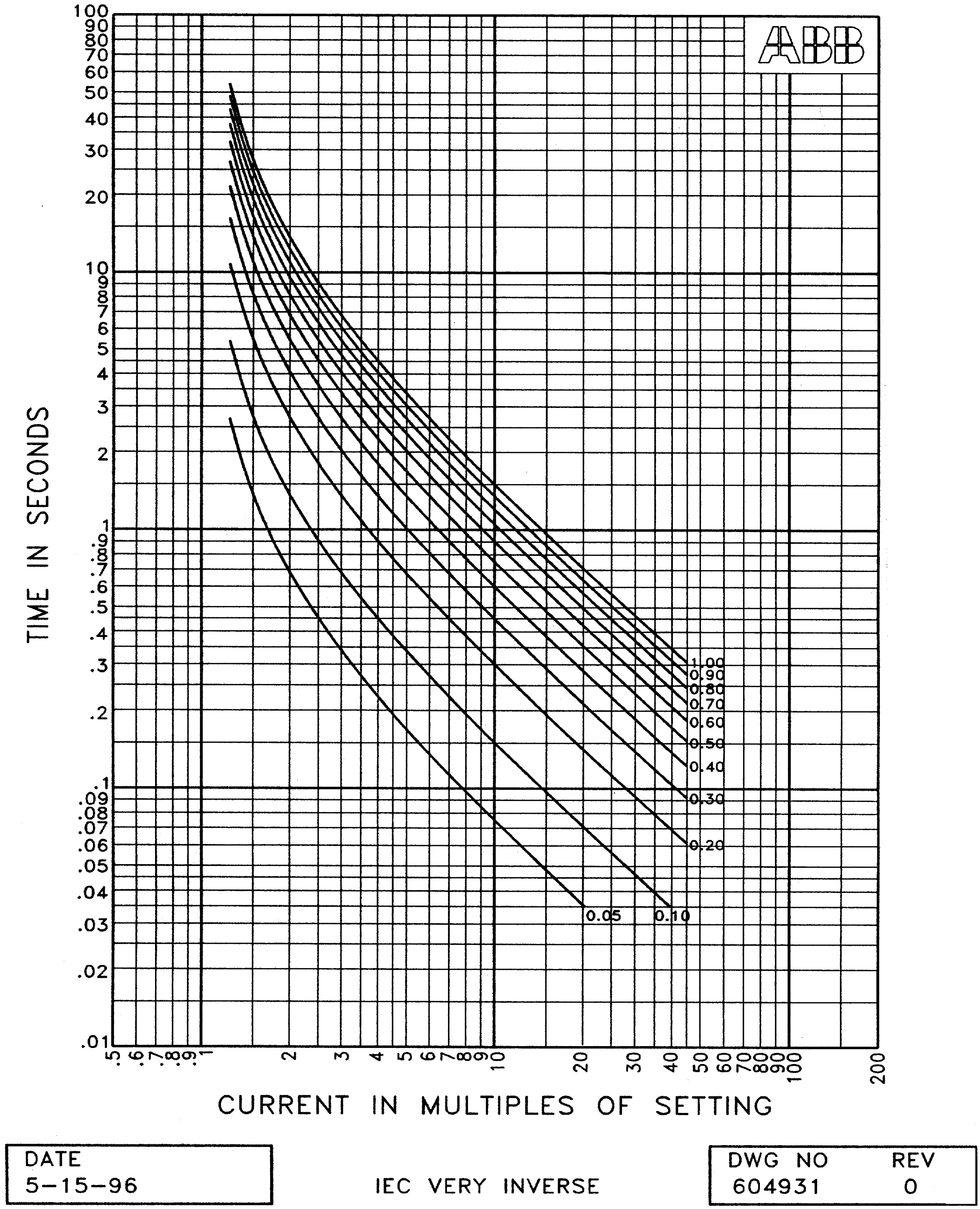


Figure 1-5. IEC Very Inverse Curve

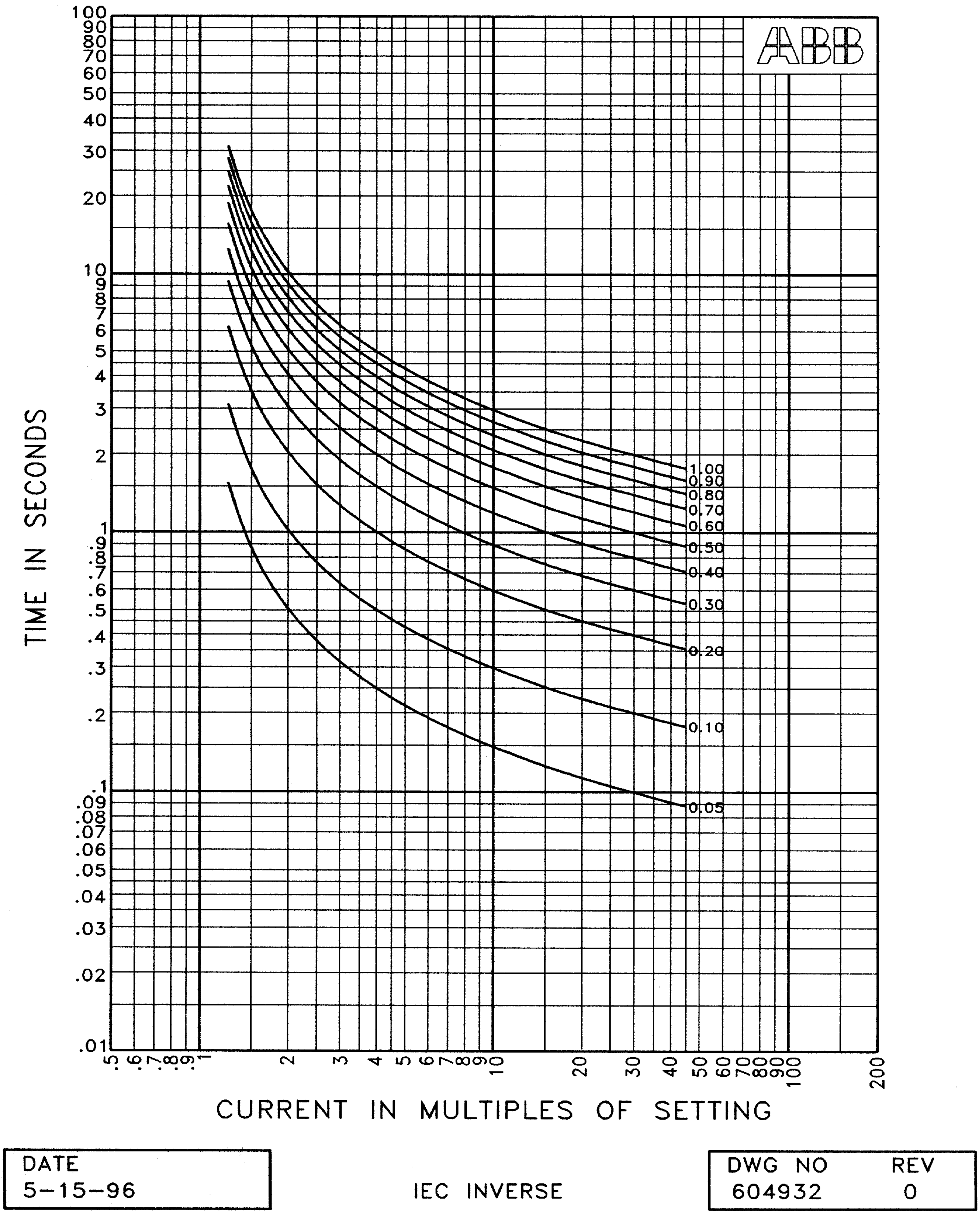


Figure 1-6. IEC Inverse Curve

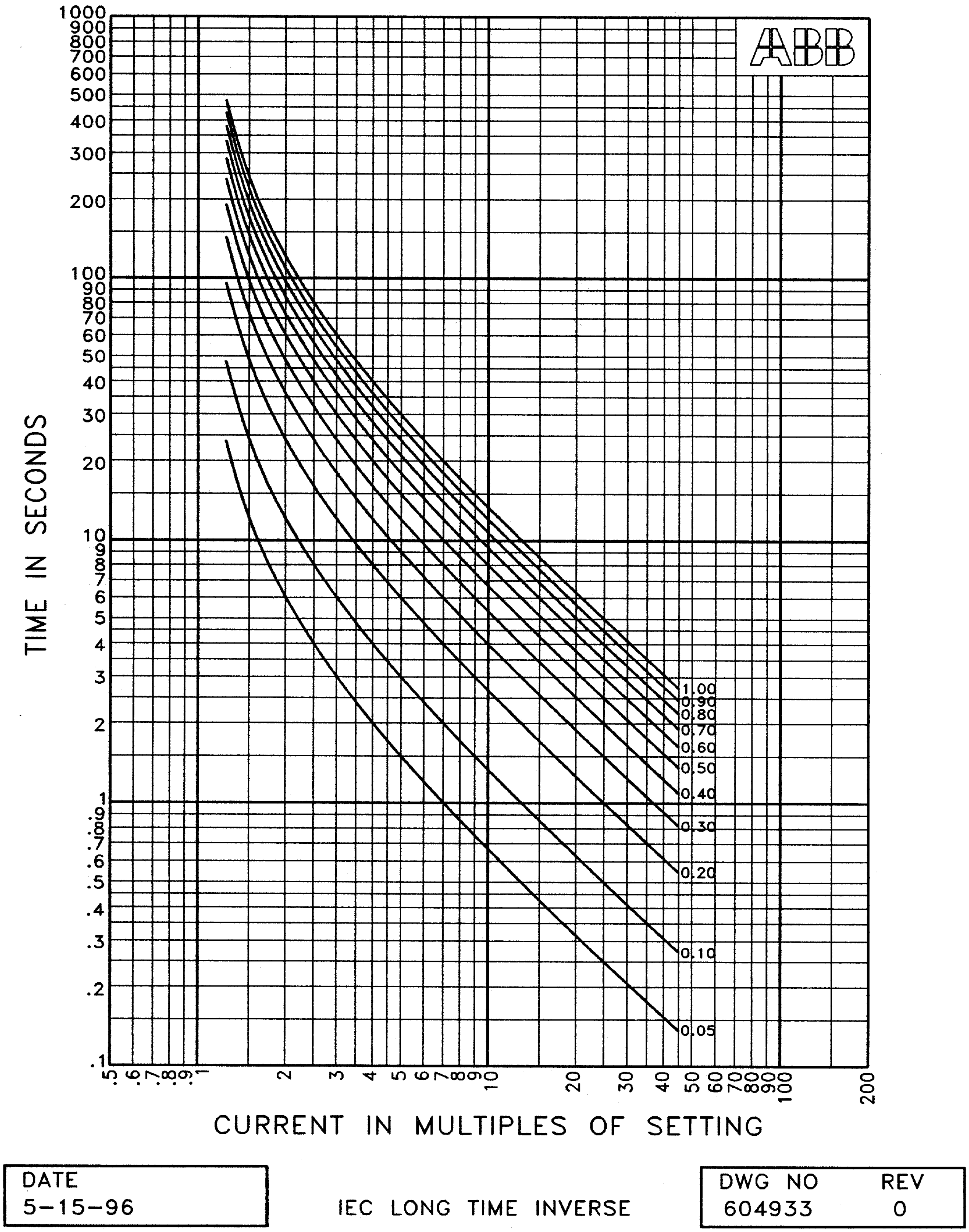


Figure 1-7. IEC Long Time Inverse Curve

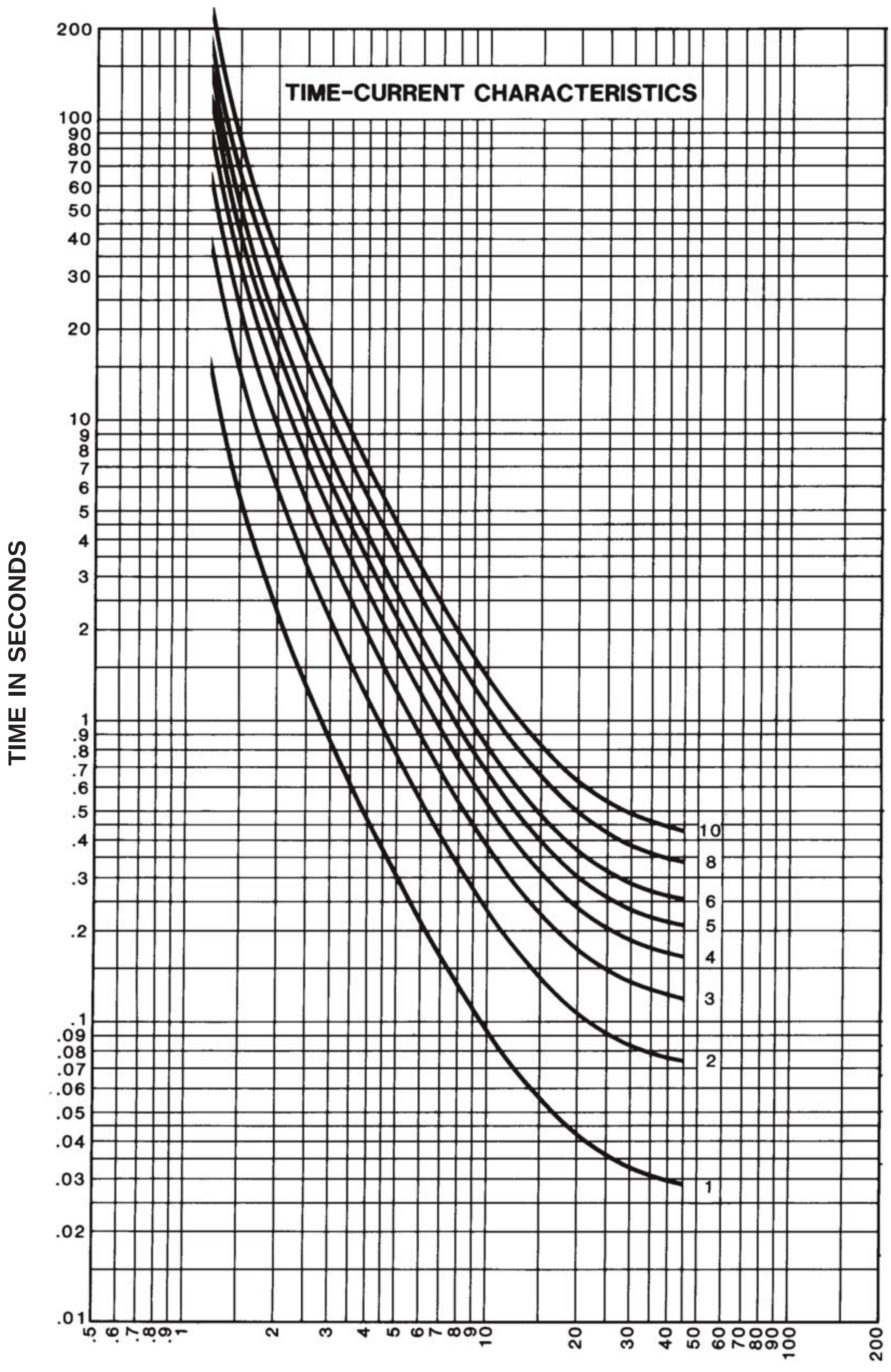


Figure 1-8. Extremely Inverse Curve

DWG. NO. 605842 Rev. 2

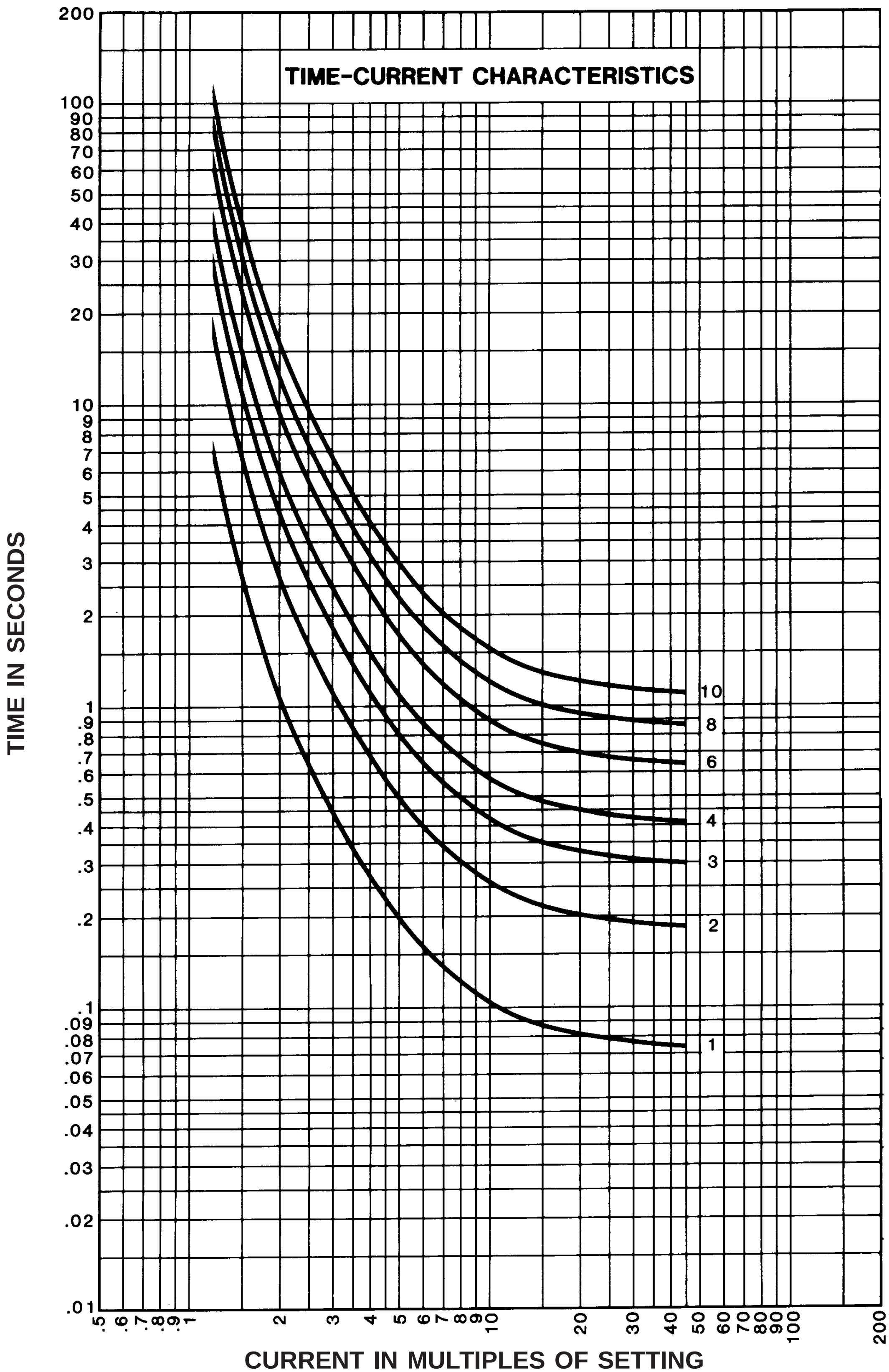


Figure 1-9. Very Inverse Curve

DWG. NO. 605841 Rev. 2

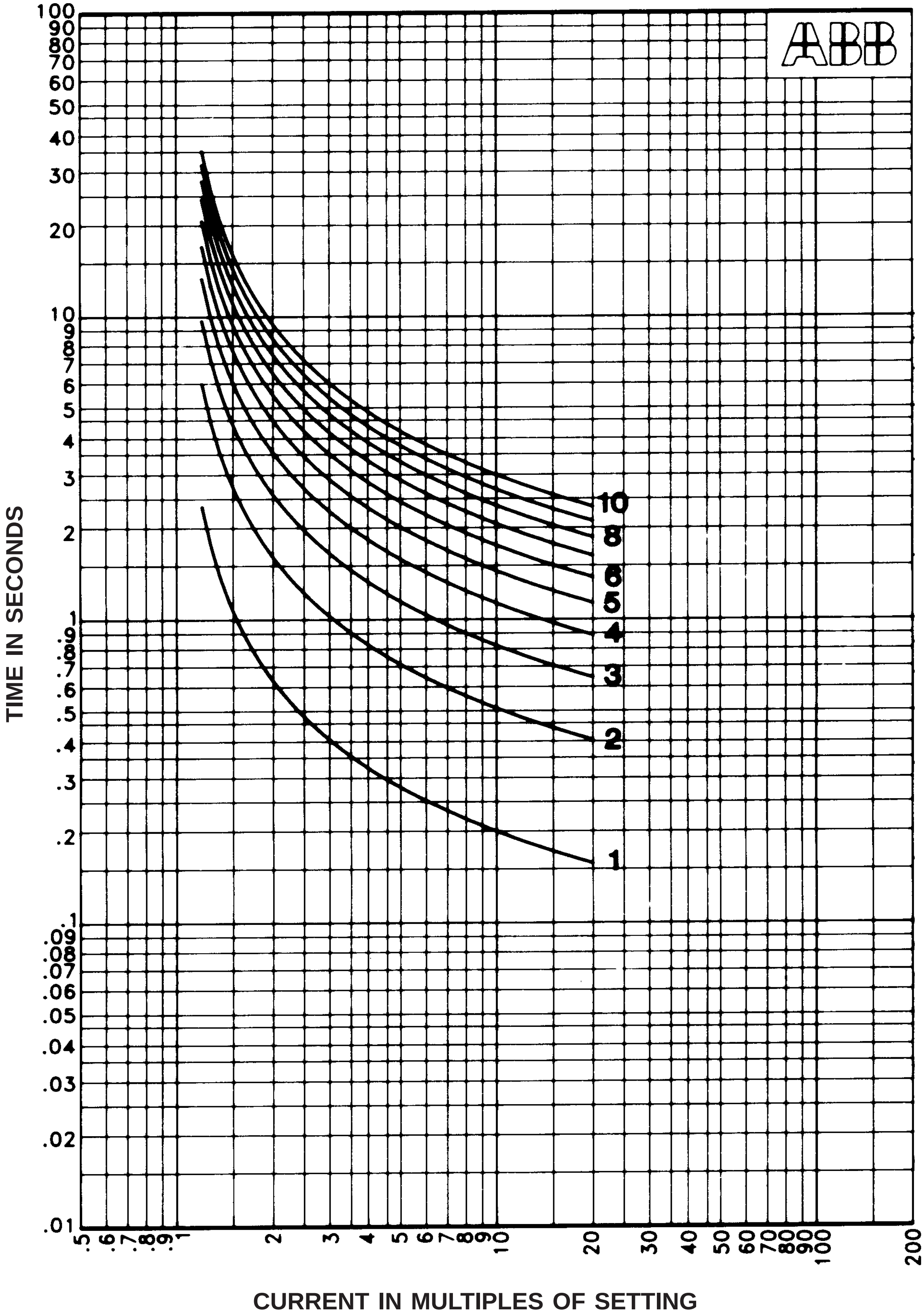


Figure 1-10. Inverse Curve

DWG. NO. 605854 Rev. 0

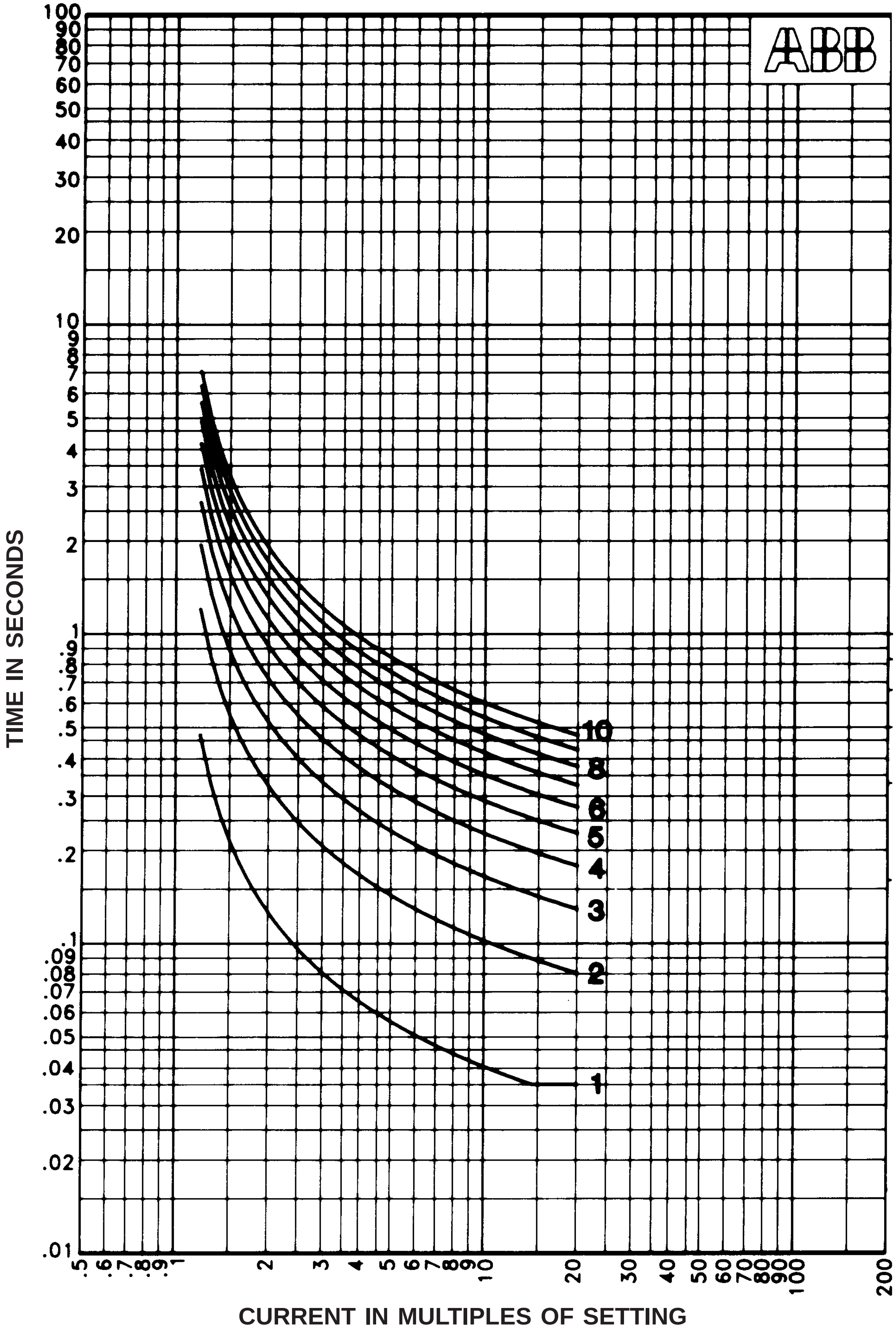


Figure 1-11. Short Time Inverse Curve

DWG. NO. 605855 Rev. 0

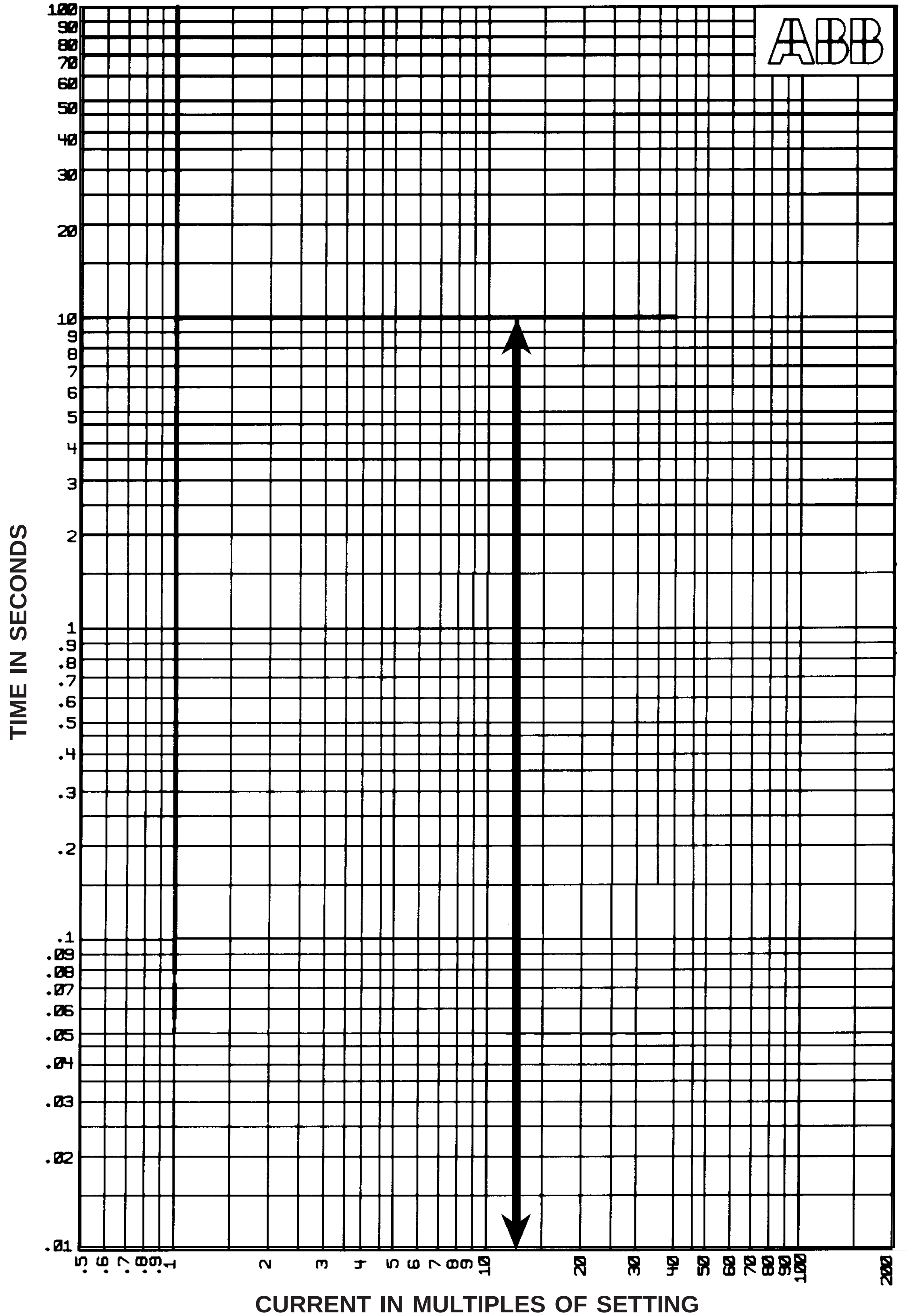


Figure 1-12. Definite Time Curve

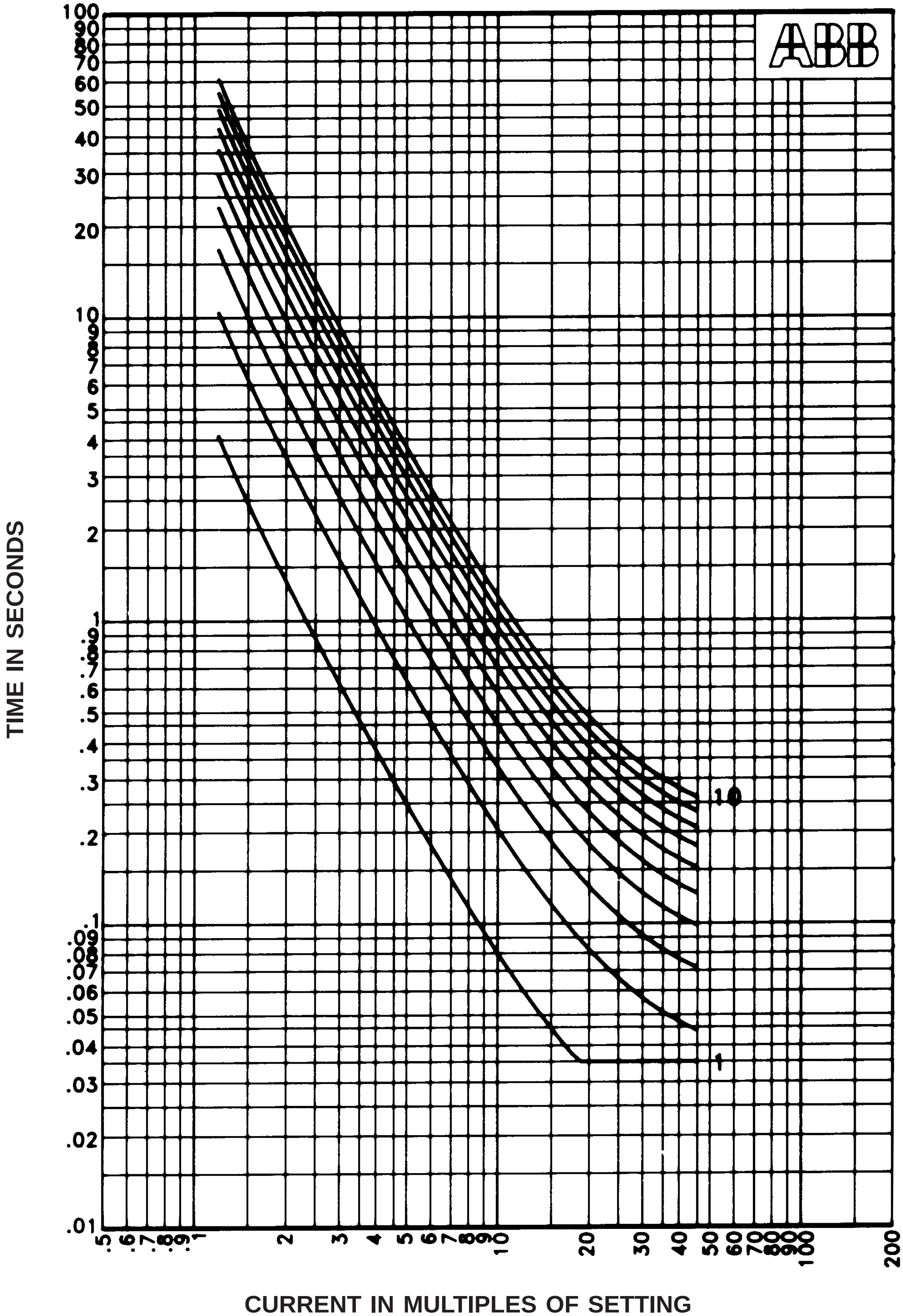


Figure 1-13. Recloser Curve #8

DWG. NO. 605856 Rev. 0

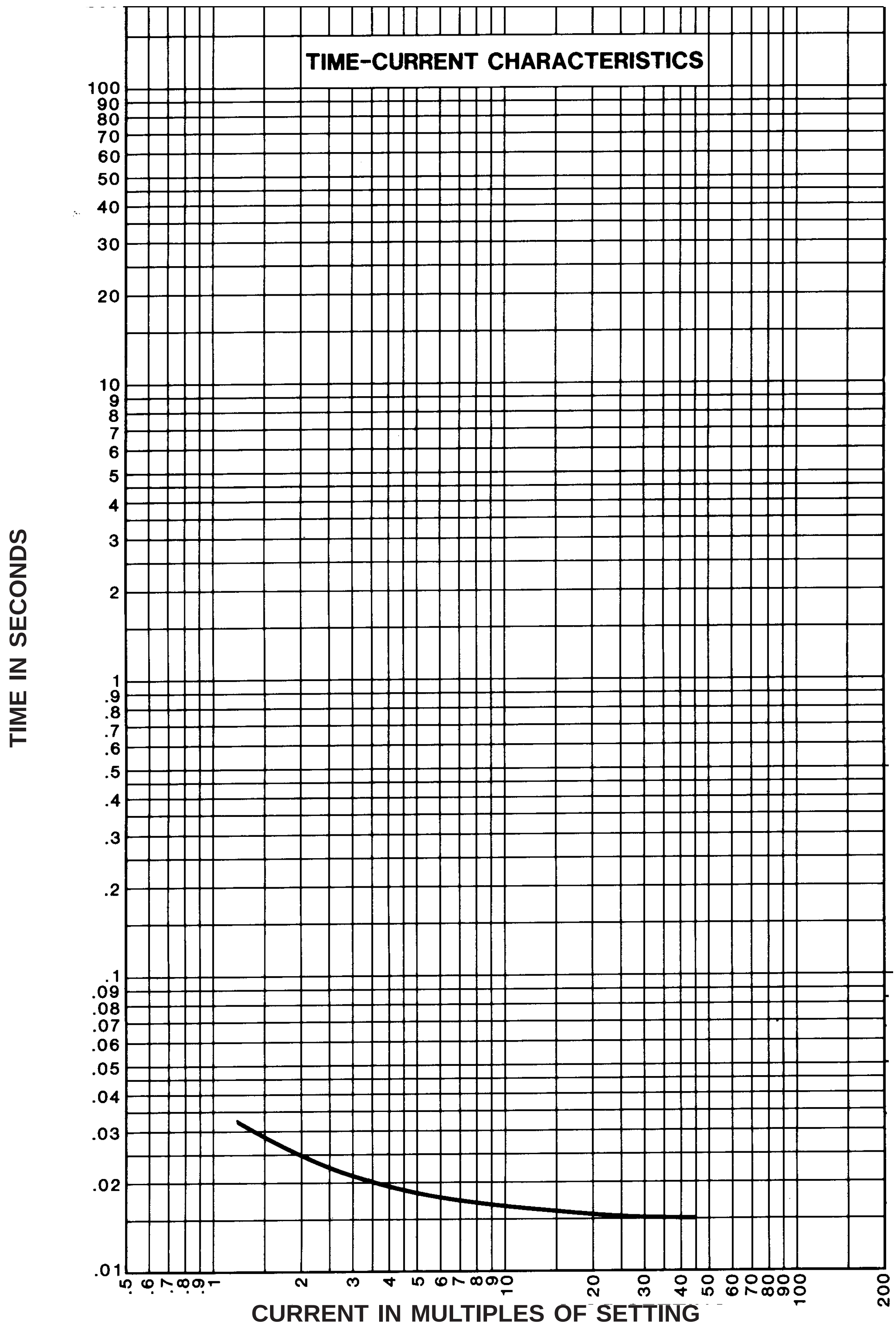


Figure 1-14. Standard Instantaneous Curve DWG. NO. 605845 Rev. 2

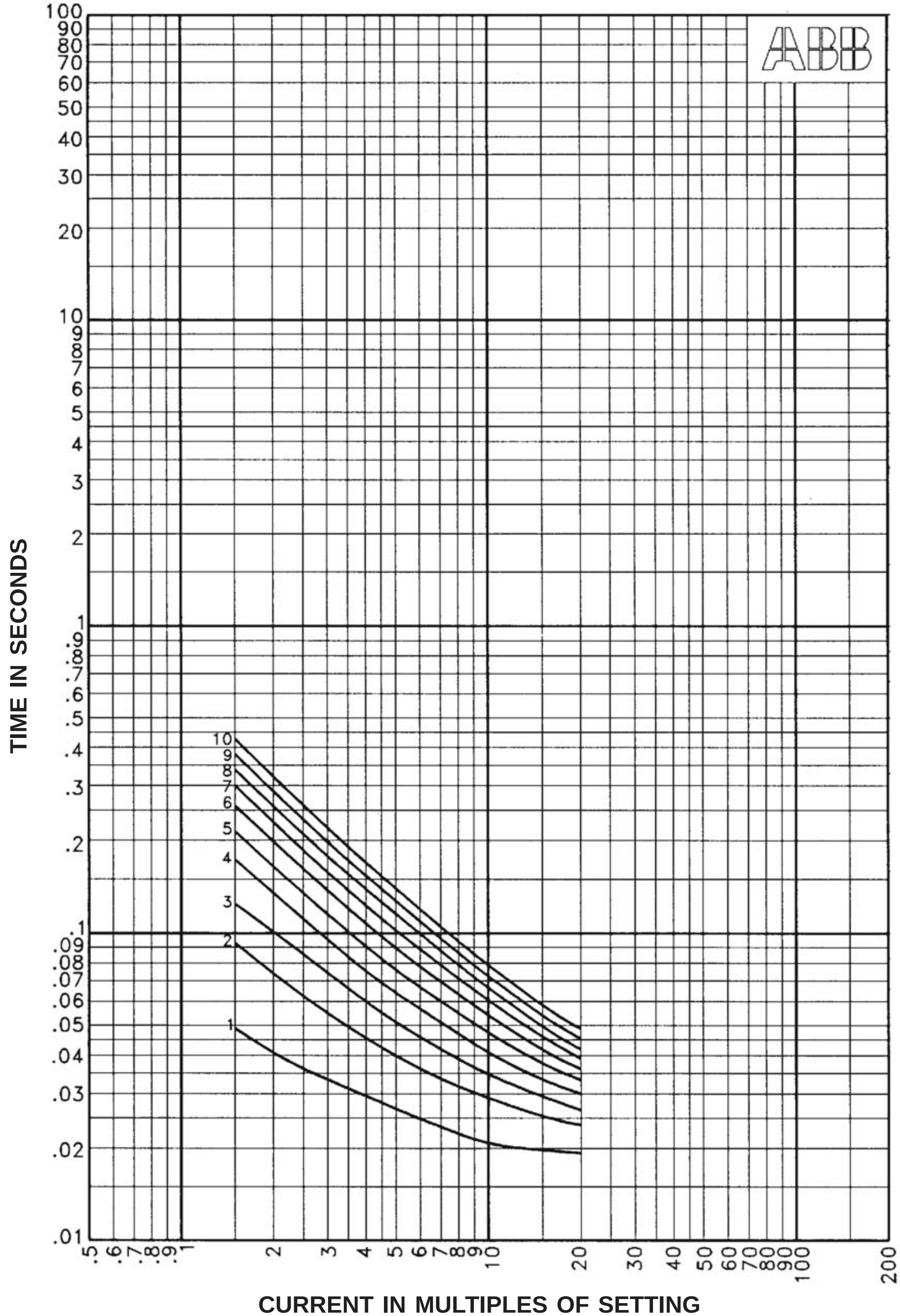


Figure 1-15. Inverse Instantaneous Curve

DWG. NO. 604916 Rev. 0

Phase Directional Power Element 32P-2 (I1>-->)

A phase power directional unit 32P-2 can be used to supervise (torque control) other protective elements within the DPU2000R. In addition, its logical output, 32P-2, can be mapped to a physical output contact (see the Programmable I/O Section) for supervision of external devices. The 32P-2 logical element operation is based upon the torque angle setting defined as the positive sequence current angle compared to the positive sequence voltage angle. The torque angle is set 0 to 355 degrees in 5 degree steps with a sector width of 180 degrees and is the only setting associated with the 32P-2 element. The 32P-2 unit operates **independently** of the 67P element described earlier. It should be noted that if the 32P-2 is used to supervise the 50P units, a minimum of 50 milliseconds time delay on the 50 unit is required for coordination. It should also be noted that when the voltage seen by the relay is at or near the minimum sensitivity point of 1 volt line to line, the set angle may move $\pm$ 10 degrees. 32P-2 is disabled in the factory default settings.

Although the angle setting for the 32P-2 function is independent of the 67P function, the angle setting is defined the same way (I_1 leading V_1) as the 67P function.

Ground Directional Power Element 32N-2 (I2>-->)

A ground power directional unit 32N-2 can be used to supervise (torque control) other protective elements within the DPU2000R. In addition, its logical output, 32N-2, can be mapped to a physical output contact (see the Programmable I/O Section) for supervision of external devices. The 32N-2 logical element operation is based upon the torque angle setting defined as the negative sequence current angle compared to the negative sequence voltage angle. The torque angle is set 0 to 355 degrees in 5 degree steps with a sector width of 180 degrees and is the only setting associated with the 32N-2 element. The 32N-2 unit operates **independently** of the 67N element described earlier. It should be noted that if the 32N-2 is used to supervise the 50N units, a minimum of 50 milliseconds time delay on the 50 unit is required for coordination. It should also be noted that when the voltage seen by the relay is at or near the minimum sensitivity point of 1 volt, the set angle may move $\pm$ 10 degrees. 32N-2 is disabled in the factory default settings.

Although the angle setting for the 32N-2 function is independent of the 67N function, the angle setting is defined the same way (I_2 leading V_2) as the 67N function.

Frequency Load Shed and Restoration Functions 81S, 81R, and 81O

Table 1-16. 81 Descriptions

Module Number	Load Shed and Underfrequency	Load Resoration	Overfrequency
1	81S-1	81R-1	81O-1
2	81S-2	81R-2	81O-2

The DPU2000R provides two independent logical “modules” containing elements for underfrequency load shedding (81S), and overfrequency load restoration (81R) alarming (81O). The logical outputs from these modules can be assigned to physical outputs for tripping and closing of a circuit breaker based on frequency. The 81 function in general is used to shed load on a distribution feeder when the system becomes unstable and the frequency begins to fall. If the stability of the system is sacrificed due to overloading the frequency will generally drop off slowly. The time delay of the under frequency load shed (trip) element can be set to a “toleration” point to allow time for the power system to recover.

The power system frequency is measured from the zero crossing on the Van voltage input for wye connected VT’s and Vab for delta connected VT’s.

The two independent logical frequency modules are provided with separate logical outputs. The outputs for module 1 are 81S-1, 81R-1 and 81O-1. The logical outputs for module 2 are 81S-2, 81R-2 and 81O-2. These outputs become active (logical 1) when the frequency setting has been exceeded for the associated time delay. Both logical outputs will remain active as long as the frequency setting is still exceeded. The one exception to this is in the case where the system voltage is below 81V voltage block setting (see 81V description). The frequency shed outputs 81S-1 and 81S-2, can be assigned to the same trip output contact but set at different frequency thresholds and trip time settings. This provides fast tripping response for severe disturbances and slower trip times for more tolerable system disturbances. For example: Set 81S-1 to sense a slight underfrequency condition and assign a longer time period to it. Set 81S-2 to a lower frequency with a shorter time period. This will allow a longer trip time for slight under frequency conditions and shorter trip time for more severe conditions.

Included in the two modules discussed, are the load restoration elements 81R-1 and 81R-2. These two elements can be used to automatically restore load (close the circuit breaker) after a frequency load shed (81S-1 or 81S-2) trip. The DPU2000R senses a load shed trip by the operation of 81S-1 or 81S-2 **and** by the change of the 52A and 52B breaker auxiliary inputs. Only at this time are the 81R-1 and 81R-2 logical outputs allowed to operate. The 81R function will activate when the frequency rises above the frequency setting and the associated timer expires. If the power system frequency falls back below the 81 setting before expiration of the load restore timer (81R), the timer will reset and begin again when the frequency returns to normal. The 81R logical outputs remain active until a successful breaker close or until the Trip Fail Time expires (see Trip Fail Timer in the Recloser Section for more details). The 81R function is not armed again until the next load shed operation.

Two over frequency elements are also included in the two modules discussed. They are 81O-1 and 81O-2. These logical outputs activate when the frequency rises above the 81R setting and the 81R time delay expires. They can be used to trip the circuit breaker but they do not initiate an automatic restoration.

To apply the DPU2000R to an intertie with local generation, the 81S-1 can be set to provide underfrequency tripping and 81O-2 can be set to provide over frequency protection. These settings provide a "frequency window" when both logical outputs 81S-1 and 81O-2 are assigned to the same output trip contact. The intertie is tripped when the frequency deviates outside the created frequency window.

The hysteresis (or dropout points) for the 81S and 81R logical outputs is 0.02 hertz above the frequency setting. For 81O the hysteresis is 0.02 hertz below the frequency setting.

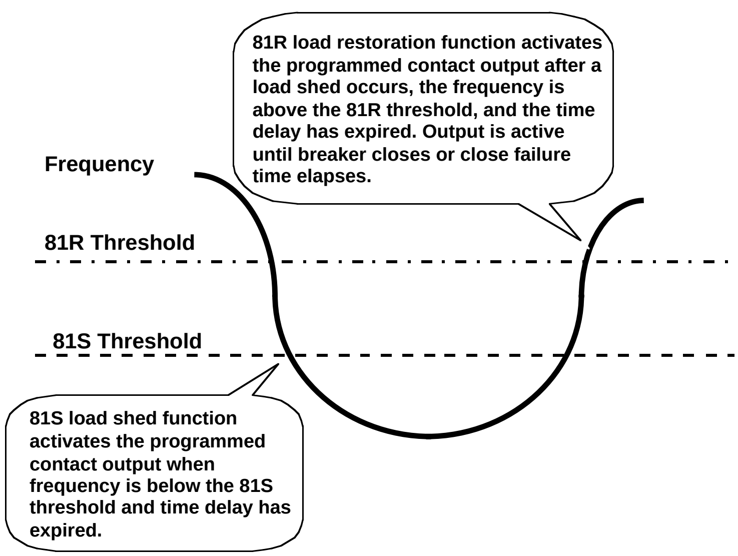


Figure 1-16. 81S and 81R Functions

Table 1-17. 81 Characteristics

81 Parameter	Range	Increment
81S-1,2 Pickup - 60 Hz Model	56 to 64 Hz	0.01
81S-1,2 Pickup - 50 Hz Model	46 to 54 Hz	0.01
81S-1,2 Time Delay	0.08 to 60 seconds	0.01
81R-1,2 Pickup - 60 Hz Model	56 to 64 Hz	0.01
81R-1,2 Pickup - 50 Hz Model	46 to 54 Hz	0.01
81R-1,2 Time Delay	0.0 to 999 seconds	1
81V	40 to 200 volts AC	1

The 81 element is disabled in the factory default settings.

Voltage Block Element 81V

This elements blocks operation of the logical outputs 81S-1 and 81S-2 when the power system voltage is below the 81V setting. For wye connected VT's, Van is used. For delta connected VT's, the voltage is taken from Vab. Operation of the logical outputs is restored when the voltage returns to normal. The 81S-1 or 81S-2 elements will de-activate if they are active at the time when the power system voltage falls below the 81V setting. The range for this setting is from 40 - 200 VAC.

Undervoltage Element 27, Overvoltage Element 59 and 59-3 Element

The undervoltage element is provided for alarm and control purposes when any one phase voltage drops below a preset threshold. Two logical outputs are provided with the 27 element; one for single phase undervoltage, 27-1P, and one for three phase undervoltage, 27-3P. The 27-1P element will operate when any single phase drops below the undervoltage setting. The 27-3P element will operate only when all three phases drop below the undervoltage setting. Both elements are separate and do not operate the "Main Trip" contact. These logical outputs must be mapped to physical outputs if alarming or tripping is desired (see Programmable I/O Section). The 27 element can also be used to supervise (torque control) other protective elements such as the 51P. Mapping the 27 element to the "PH3" logical input via the programmable logic, provides a voltage controlled overcurrent protective function. See the "Programmable I/O" Section for more details.

Table 1-18. 27/59 Characteristics

27/59 Parameter	Range/Curve	Increment
Undervoltage Pickup	10 to 200 VAC	1 volt
Overvoltage Pickup	70 to 250 VAC	1 volt
Time Delay	0 to 60 seconds	1 second

The 27/59 under/overvoltage elements are disabled in the factory default settings.

The overvoltage element, 59, is provided for alarm and control purposes when the system voltage rises above a preset threshold. The overvoltage element 59, is separate from the "Main Trip" contact. The logical output, 59, must be connected to a physical output if alarming or tripping is desired (see Programmable Outputs).

The 27/59 threshold and time delay are set in the Primary, Alternate 1, and Alternate 2 settings groups (Table 1-18). (See the Programmable Outputs Section). The time delay range available for each function is 0 to 60 seconds. If trip times below one second are desired, set the Time Delay to zero and place desired trip time in physical output timers.

Three Phase Overvoltage Element 59-3

Three phase overvoltage protection (Device 59-3), is included as a standard DPU2000R function. This function requires the voltage of all three phases to be at the pick up setting prior for an output to occur making possible faster identification of system voltage problems and equipment problems compared to the single phase 59-1 function.

The setting for the 59-3 element will be the same as presently available for the DPU2000R relay 59 element: namely 70-250 volts in 1.0 volts steps. However, for an output to occur, all three (3) phases must be at or above the setting of the function. The 59-3 threshold and time delay are set in the Primary, Alternate 1, and Alternate 2 settings groups (Table 1-18). Refer tothe programmable outputs section. The time delay range available for the function is 0 to 60 seconds. If trip times below one second are desired, set the Time Delay to zero and enter the desired trip time in the physical output timers.

Zero Sequence Overvoltage Element 59G

A zero sequence overvoltage protection device 59G is included in the DPU2000R relay. This function will detect an overvoltage condition utilizing the V_0 quantity that the relay observes from the potential transformers if they are connected in a WYE configuration. If the relay is contacted to an open delta configuration in which no zero sequence voltage is generated, then the relay will calculate this value using the positive and negative sequence voltage quantities. This setting is programmable in the configuration settings and is dependent on the potential transformer configuration.

Table 1-19. 59G Characteristics

59G Parameter	Range	Increment
V_0 Voltage Pickup	1.0 - 50.0 v	0.5 v
Time Delay	0 to 30 seconds	0.1 second

The 59G function within the relay is normally disabled. Refer to Table 1-19 for the setting parameters for this element. However for an output to occur, the 59G must be enabled with the voltage setting and time delay (if desired) in the Primary, Alternate 1, and Alternate 2 settings groups. The 59G overvoltage element is provided for alarm and control purposes when the zero sequence voltage exceeds the setting level. However, the 59G element is separate from the “Main Trip” contact. The logical output 59G must be connected to a physical output if alarming or tripping is desired (see Programmable Outputs).

Negative Sequence Voltage Element 47

Negative sequence voltage protection (Device 47) is included in the DPU2000R relay. This feature allows the detection of loss of phase or the detection of an unbalanced system without the necessity of current flowing. Benefits include faster identification of blown fuses or an open phase.

Table 1-20. 47 Characteristics

47 Parameter	Range	Increment
V_2 Voltage Pickup	5.0 - 25.0 v	0.5 v
Time Delay	0 to 60 seconds	0.1 second

The 47 negative sequence voltage element is disabled in the factory default settings.

The negative sequence voltage unit (Device 47) will have outputs for alarm indication or sealed-in outputs. This function is separate from the “Main Trip” contact. The logical output, 47, must be connected (mapped) to a physical output if alarming or tripping is desired (see programmable outputs). The default position for the 47 element is disabled.

The 47 threshold and time delay are set in the Primary, Alternate 1, and Alternate 2 settings groups (Table 1-20). Refer to the programmable outputs section. The time delay range available for the function is 0 to 60 seconds. If trip times below one second are desired, set the Time Delay to zero and enter the desired trip time in the physical output timers.

Refer to Table 1-20 for the device 47 characteristics.

Distance Protection Element 21

Two zones of forward (Zone 1 and Zone 2) and two zones of reverse (Zone 3 and Zone 4) phase impedance protection (Device 21) are included as standard in the DPU2000R relay. With this feature, one style of relay may be used on both the high side and low side of certain distribution substations for the application of sub-transmission and feeder protection. This avaiable application of the DPU may also be used for the protection of small and medium size motors where the reverse zones would protect for low excitation.

Two forward zones and two reverse zones of impedance protection are available with a circular characteristic commonly referred to as the MHO circle. In addition, all of the zones have a variable MHO feature insuring protection near the origin of the R-X diagram. The two forward zones will have a maximum reach of 0.1-50.0 ohms. The angle of maximum reach is adjustable from 10.0-90.0 degrees. Time delay is available from 0.0-10 seconds. The two reverse zones will have identical characteristics except the angle of maximum reach will be in the reverse direction with a range of 190.0-270.0 degrees. All zones have optional supervision by the positive sequence current $I_1$with an adjustable current range of 1.0-6.0 amperes. Refer to Table 1-21 for the complete zone settings.

All zones of the 21P element have a voltage memory feature for six (6) cycles. This is important in that if the relay were to observe a close in fault where there was insufficient or no voltage for the distance element to operate due to a voltage collapse, the memory of six cycles of voltage will permit the protective unit to operate. Depending on the settings of other protective elements in the DPU relay, they may also operate for this condition.

For the 1.0 ampere CT DPU2000R relay model, the reaches for all zones are 5 times that of the 5.0 ampere CT model; namely 0.5-250.0 ohms.

All the zone settings are completely independent of each other. The default setting for the 21 element is disabled.

There is a target LED to indicate that a 21 Zone 1, 2, 3, or 4 have produced a pick up status.

Table 1-21. Impedance Characteristics Element 21

21 Parameter	Range	Increment
Zone 1 Impedance 0.4 - 12.0 Amp model 0.08 - 2.4 Amp model Characteristic Angle Time Delay	0.1 to 50.0 ohms 0.5 to 250 ohms 10 - 90 degrees 0.0 - 10.0 sec.	0.1 ohm steps 0.5 ohm steps 0.1 degree steps 0.1 sec. steps
Zone 2 Impedance 0.4 - 12.0 Amp model 0.08 - 2.4 Amp model Characteristic Angle Time Delay	0.1 to 50.0 ohms 0.5 to 250 ohms 10 - 90 degrees 0.0 - 10.0 sec.	0.1 ohm steps 0.5 ohm steps 0.1 degree steps 0.1 sec. steps
Zone 3 Impedance 0.4 - 12.0 Amp model 0.08 - 2.4 Amp model Characteristic Angle Time Delay	-0.1 to -50.0 ohms -0.5 to -250 ohms 190.0 - 270.0 degrees 0.0 - 10.0 sec.	0.1 ohm steps 0.5 ohm steps 0.1 degree steps 0.1 sec. steps
Zone 4 Impedance 0.4 - 12.0 Amp model 0.08 - 2.4 Amp model Characteristic Angle Time Delay	-0.1 to -50.0 ohms -0.5 to -250 ohms 190.0 - 270.0 degrees 0.0 - 10.0 sec.	0.1 ohm steps 0.5 ohm steps 0.1 degree steps 0.1 sec. steps
I_1 Supervision 0.4 - 12.0 Amp model 0.08 - 2.4 Amp model	1.0 - 6.0 amps 0.2 - 1.2 amps	0.1 amp steps 0.02 amp steps

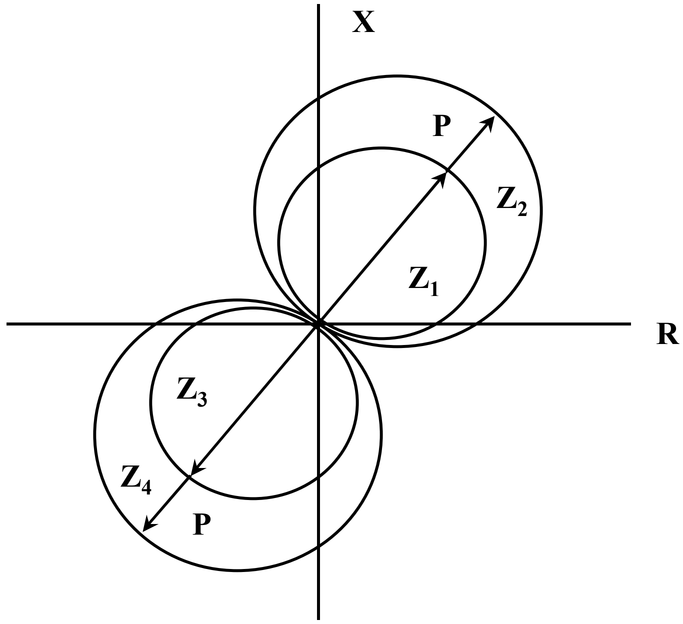


Figure 1-17. Characteristics of the Four Zone Distance Element 21P-1, -2, -3, -4.

Sync Check Function (25)

Application

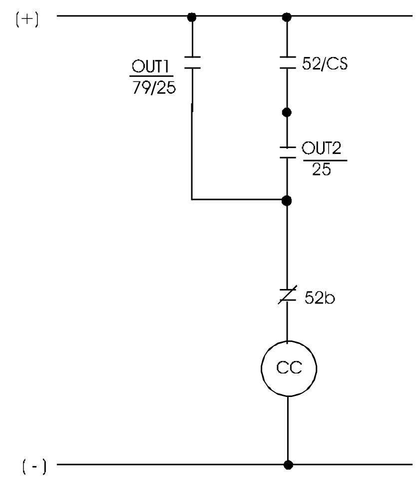
The Sync Check function was developed for application on transmission lines or on distribution lines with a co-generation source. Normally one end of a line would be closed first to energize the line. The sync check dead line setting allows one end to be closed energizing the line. The other end would then require sync check.

The sync check function is intended for application where two parts of a system are to be joined by the closure of a circuit breaker. These lines are interconnected at least at one other point in the system so that even though the voltages on either side of the open circuit breaker are of the same frequency, there may be an angular difference due to load flow throughout the interconnected system. It is usually desirable to close the breaker even though an angular difference exists provided that the difference is not great enough to be detrimental to the system or connected equipment or system stability.

Closing of the breaker is permitted when the phase angle difference, voltage magnitude difference, and slip frequency are within the parameters set by the user.

In conventional sync check relaying, a relatively long time measurement is used to insure that the voltages across the open breaker are in sync. However, this long time delay which may be as long as 10 to 20 seconds, is undesirable if both ends of the line are being reclosed at high speed. If the time delay is shortened, a faster sync check measurement can be made but this may result in reclosing for a non-synchronous condition with slip frequencies that are higher than desired for proper reclosing.

A **slip cut-off** frequency function can allow a high speed sync determination when voltages are in sync without the risk of reclosing if high slip frequencies are actually present. Setting the **slip cutoff frequency** to an acceptable level and the sync time to 0 will assert a synch contact as soon as the line angle reaches the sync window.



Programmable Outputs

	OUT1 OR	OUT2 OR	....
CLOSE	X		
25		X	

Figure 1-18. Typical Sync Check Wiring and Mapping

The sync check function will not provide an output to permit reclosing if no voltage is present on one or both sides of the open breaker. Therefore for applications where Dead Line and/or Dead Bus operation is required, the undervoltage detection functions can be used. Selection can be for one or more of the following supervision conditions:

1. Live Line - Dead Bus
2. Live Bus - Dead Line
3. Dead Line - Dead Bus

Other selections provide for:

Ability to sync to any phase via setting.
Disabling of sync check from the recloser via setting or user input (manual override permission via logical input)
Requiring sync check for manual closing via programmable logic mapping.
Logical output “25” provided. Asserted when synchronism is achieved.

Synchronism Check Settings

The optional synchronism check element, 25, is set based on a secondary voltage and phase angle comparison between the standard connected voltages (terminals 31-34) and the optional voltage input, sensor 10 (terminals 35 and 36). The element can be used to supervise closing in the reclose sequence and/or supervise a manual close by a control switch. See Figure 1-18.

By setting the Reclose Sync Supervision, to Enable during a reclose sequence, the Logical Output CLOSE will not become asserted until the conditions of the 25 element are met. After the open interval timer times out during a reclose sequence, the relay will start a Sync Fail Timer. This timer will continue to decrement until the 25 condition is met. When the 25 condition is met, the relay will issue the CLOSE signal. If the condition is not met within the Sync Fail Time setting, the relay will go to lockout.

To supervise a manual Close operation, the 25 Logical output should be mapped to a separate output contact wired in series with the Control Switch contact. See Figure 1-18.

The following conditions must be met in order to issue the 25 signal.

1) The phase angle difference between the Bus (Sensor 10) Voltage and the selected Line Voltage (Va, Vb, Vc, Vab, Vbc, and Vca) must be less than or equal to the Synchronism Angle setting, **Angle Diff**.

2) The magnitude difference between the Line Voltage and the selected Bus Voltage must be less than or equal to the Voltage Difference setting, **Volt Diff**.(±)

3) Conditions 1 and 2 must be met continuously for a time equal to or greater than the **Synch** setting.

4) The actual slip frequency must be less than the **slip frequency setting**, **Fs**.

5) The 25 Logical Output will be asserted when the 4 conditions above are true.

Other Conditions that could cause the Logical Output 25 to become asserted are:

1) If the Dead Bus - Live Line (DBLL) setting is set to Enable, and the Line Voltage is “Live” based on the live voltage setting, and the selected Bus Voltage is “Dead” based on the dead voltage setting, then the 25 Logical Output will become asserted after the Dead Time timer has timed out.

2) If the Live Bus - Dead Line (LBDL) setting is set to Enable, and the selected Bus Voltage is “Live” based on the live voltage setting, and the Line Voltage is “Dead” based on the dead voltage setting, then the 25 Logical Output will become asserted after the Dead Time timer has timed out.

3) If the Dead Bus- Dead Line (DBDL) setting is set to Enable, and both the Line and Bus Voltages are “Dead” based on the dead voltage setting, then the 25 Logical Output will become asserted after the Dead Time timer has timed out.

4) If the sync - check bypass Logical Input, **25byp**, is mapped to the programmable input table and is true (see Programmable I/O Section), the 25 will become asserted regardless of the system conditions.

The following settings can be found in the Primary, Alt1 and Alt2 settings tables.

Table 1-22. Synchronism Check Characteristics

Setting	***Range***	***Increments***	***Default***
Sync Check Enable ***(Sync Check)***	Enable, Disable		Disable
Dead Bus - Live Line ***(DBLL)***	Enable, Disable		-
Live Bus - Dead Line ***(LBDL)***	Enable, Disable		-
Dead Bus - Dead Line ***(DBDL)***	Enable, Disable		-
Voltage Difference ***(Volt Diff)***	5 to 80 volts	5 volts	-
Angle Difference ***(Angle Diff)***	1 - 90 Degrees	1 degree	-
Synch Time ***(Synch Time)***	0 to 60 sec	.1 sec	-
Slip Cutoff Frequency ***(Slip Freq)***	.005 to 1.000 Hz	.005 Hz	-
Phase Select ***(Phase Select)***	Van Vbn Vcn Vab, Vbc, Vca	-	-
Line/Bus Voltage Dead ***(Dead Volt)***	10 to 150 volt	1 volt	-
Line/Bus Voltage Live ***(Live Volt)***	10 to 150 volt	1 volt	-
Dead Time ***(Dead Time)***	0 to 120 sec	.1 sec	-
Recloser Sync Supervision ***(Reclose)***	Enable, Disable	-	-
Sync Fail Timer ***(Fail Time)***	Disable, 0 - 600 sec	1 sec	-
Breaker Close Time ***(BCT)***	2-15 cyc, disable	cyc	

Note: The SFT will appear if the ***25/79sup*** setting is set to enable.

The gray area in Figure 1-19 shows the area that synchronism will occur. The user must be sure to coordinate the slip frequency setting with the sync time setting and the phase angle setting per the formula that follows. If the sync timer is set too high and the slip frequency is set too high, it is possible to never achieve synchronism. The following equation should be used as a check:

$$\frac{\textbf{Sync Ang}}{\textbf{Sync Time} \times 180} = \text{Max Fs Setting}$$

NOTE: Do not use zero (0) for the sync time for this equation. This would be an undefined value.

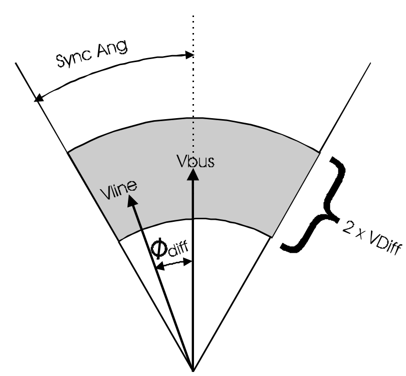


Figure 1-19. Synchronism Area

Another setting in the sync check logic is the **Dead Time**. After the DPU2000R senses a Breaker Open Condition, the Dead Time timer will start. The relay will not check for a sync condition until the **Dead Time** timer has expired.

The logical input, 25, can be supervised via the Programmable Input table by mapping the 25 logical input to a physical input contact. See the "Programmable I/O" Section or Figure 1-19 for more details on Input/Output mapping.

Figure 1-20 shows the logic diagram for the synchronism check function.

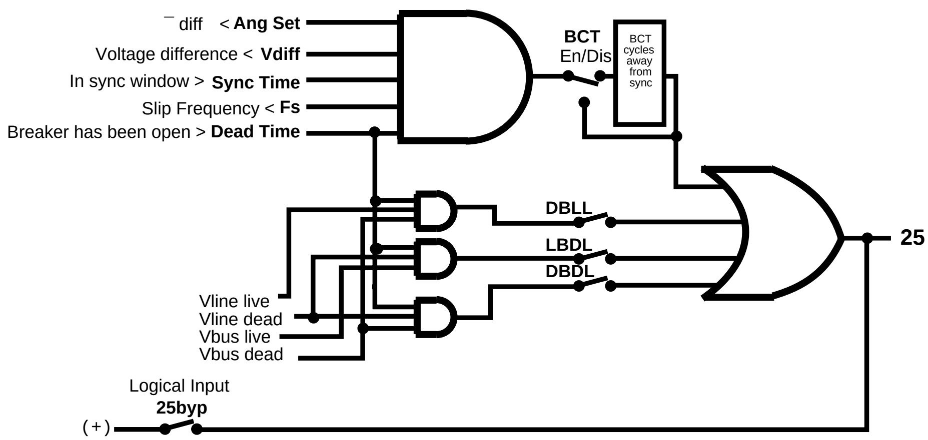


Figure 1-20. Sync Check Logic

Description of Operation

Refer to Figure 1-20. Although the sync check measurement function is constantly running, the sync check logic is activated whenever the DPU2000R determines a circuit breaker open state. There are two paths the logic can take depending on what caused the breaker to open.

Manual Trip

If the breaker was opened but the DPU2000R did not cause it to occur via overcurrent trip, the logical path will follow the manual trip path. In this case the logic checks to see if the “25 Select” setting is enabled. If it is not the logic halts and the DPU2000R MMI display will read “Breaker Opened”. If the “25 Select” setting is enabled, the logic will start a “Dead Timer”. This timer inhibits the assertion of the “25” logical output until the Dead Timer expires. The dead timer can be used when it is not desired to allow reclosing for a period of time even if the system is in sync. Once the dead timer has expired, the “25” logical output is allowed to operate if sync has been achieved. If a no-sync condition exists at this time, the DPU2000R will wait for sync indefinitely. If the circuit breaker is manually closed the logic starts over again. A “Sync Bypass” logical input is provided to override a no-sync condition. This could be used in a SCADA environment where the voltage difference and angular difference are polled by a master operations station and it is determined that a close could be performed safely even though the angle difference or voltage difference is outside the set windows.

Overcurrent Trip Condition

If an overcurrent trip occurs, the DPU2000R recloser will function normally if the “25 Select” setting is disabled or the “Recloser Sync Supervision” setting is disabled. When both of these settings are enabled, the DPU2000R will check for sync before a close is permitted. After the 79-x open time expires the sync check is performed. If a sync condition exists, a close is asserted immediately. If a no-sync condition exists, the DPU2000R will start a “Sync Fail Timer”. If sync is achieved before expiration of this timer, a close is asserted. If sync is not achieved the DPU2000R will switch to lockout upon expiration of the Sync Fail Timer. As described above, a “Sync Bypass” logical input is provided to override a no-sync condition.

External Reclose Initiate 79M / 79S

It is possible to initiate automatic reclosing when the DPU2000R detects an external trip as described earlier. The external reclose logical inputs 79M or 79S can be activated only after the dead timer expires and 79 is enabled via the “79 Select” setting and the 43A logical input. If an external reclose is initiated, the logic will shift to that of an internal trip condition. If the breaker opens again via external trip before the 79 reset time expires, the dead timer will run but will not inhibit the 79M or 79S logical inputs. What this basically means is that the dead timer will inhibit the 79M and 79S inputs for reclose step 79-1 only. Any concurrent reclose steps will not be inhibited.

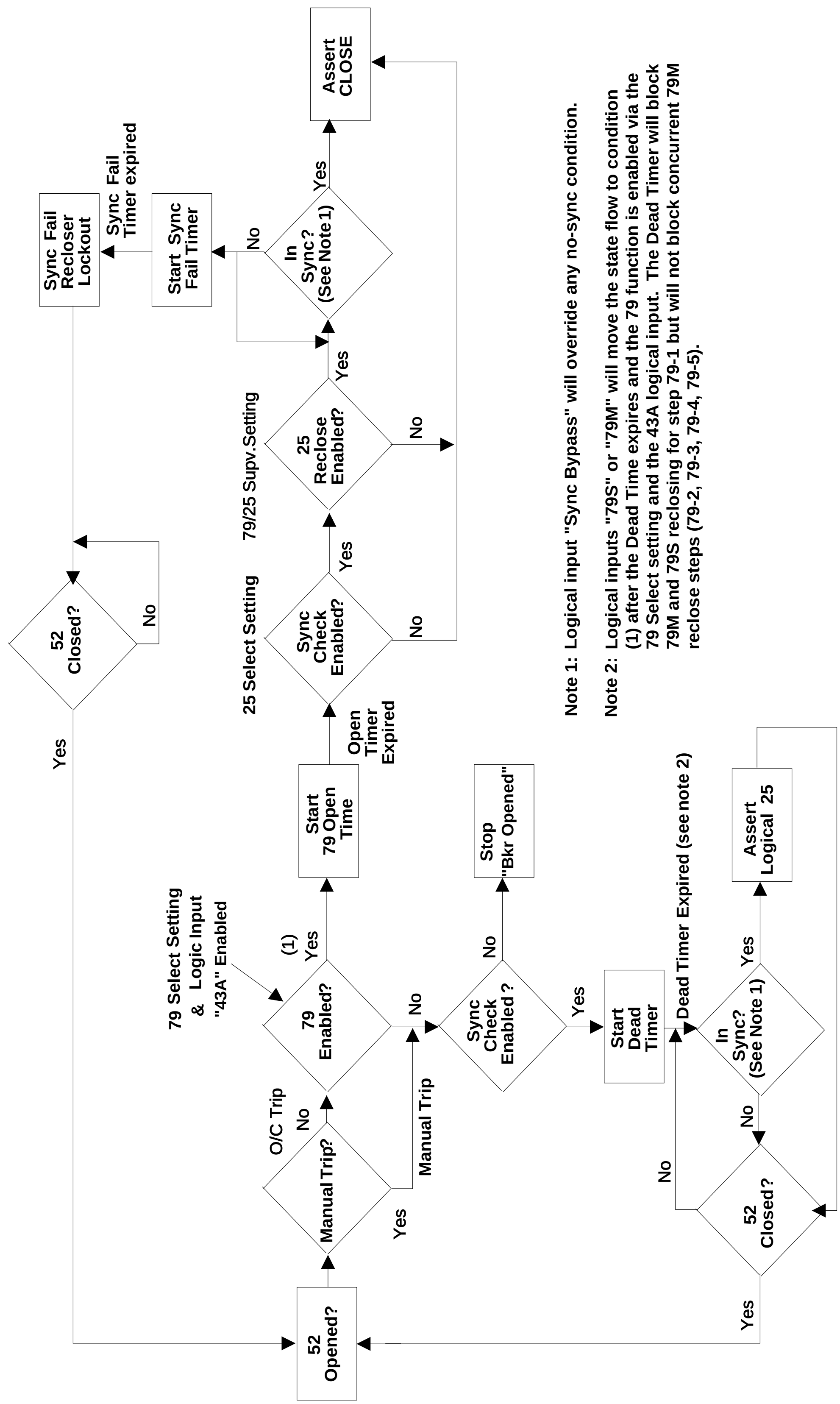


Figure 1-21. Logic Diagram for Synchronism Check Feature

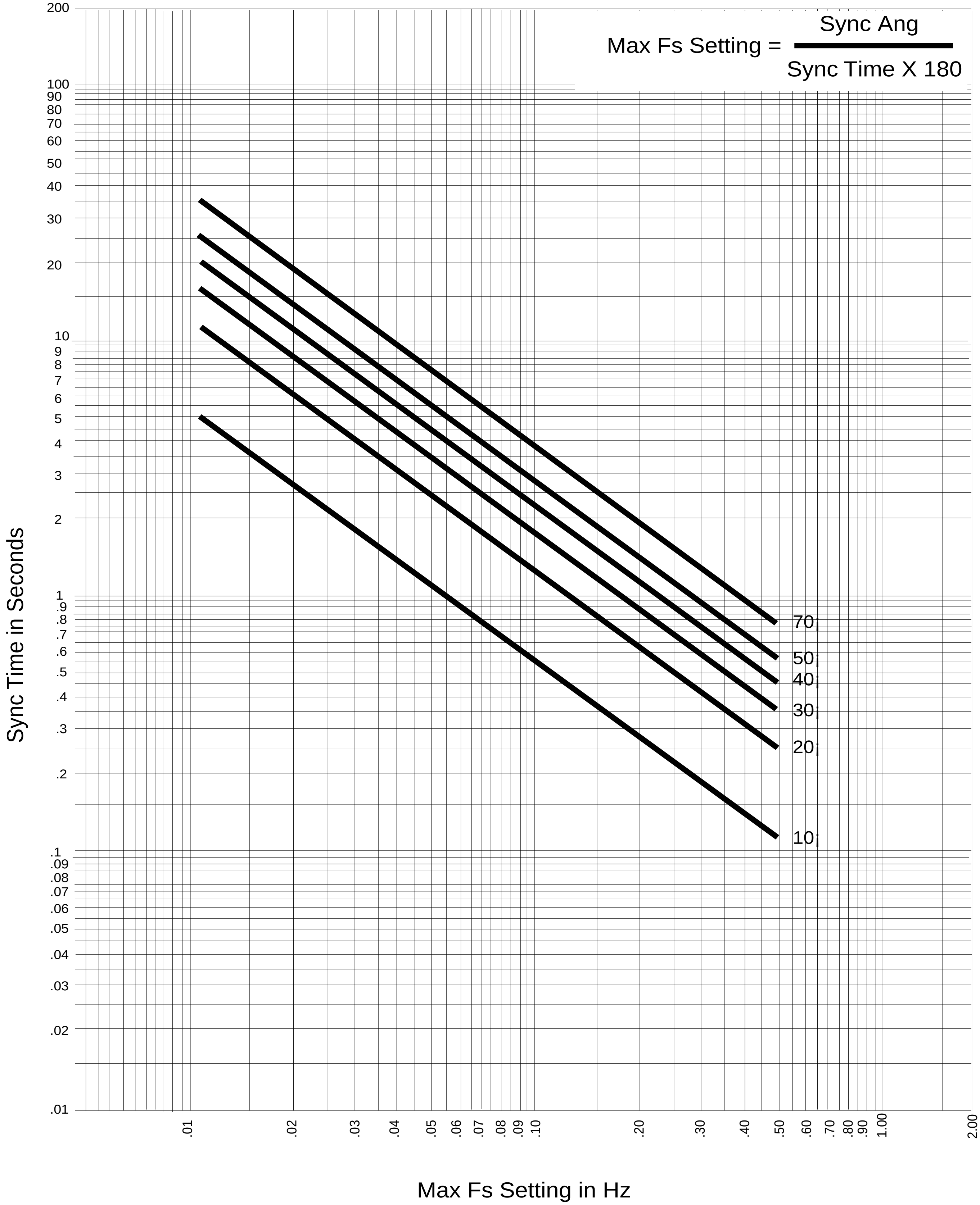


Figure 1-22. Sync Check Maximum Slip Frequency Characteristic

Cold Load Time

The Cold Load timer as set in the Primary, Alternate 1, and Alternate 2 settings groups is used to block unintentional tripping of the 50P-1 and the 50N-1 due to inrush currents seen by the DPU2000R after a manual breaker close. The timer is set from 0 to 254 with a resolution of 1. Select “seconds” or “minutes” in the Configuration Settings (see Section 2). During the cold load time delay period, a logical output, CLTA, is asserted. This logical output can be mapped to a physical output for alarm and control purposes (see Programmable Outputs Section). The cold load timer is operational only after a manual breaker close. It does not operate during a DPU2000R reclose sequence.

The Cold Load Time is disabled in the factory default settings.

A separate Neutral Cold Load Time function is supplied in units with the Sensitive Earth Fault feature.

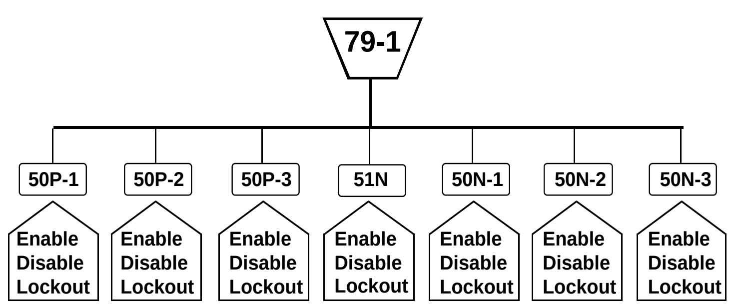
Recloser Function 79 (O->I)

This recloser function, 79, provides automatic reclosing of the circuit breaker after the DPU2000R has tripped due to a fault. The circuit breaker will close after a preprogrammed time delay called “Open Time”. Zero to five recloser steps can be selected and each has its own separate “Open Time” and selection of protective elements, except for 79-5 (step 5). The steps as labeled in the DPU2000R are 79-1 (step 1), 79-2 (step 2), 79-3, (step 3), 79-4 (step 4) and 79-5 (step 5). If the fault persists after the fifth attempt at reclosing, the 79-5 (step 5) will automatically go to lockout. There is no time delay provision for 79-5 as the DPU200R has completed the complete reclosing operation. During each reclose step the protective elements 50P-1, 50P-2, 50P-3, 51N, 50N-1, 50N-2, and 50N-3 can be enabled or disabled from tripping. Each protective element can also be set such that if the element operates, the reclose sequence will be halted and “locked out”. Lockout is a point at which the circuit breaker will remain open after a fault and must be manually closed. These steps can be used to provide high speed reclosing for the first trip and delayed reclosing thereafter. A reset timer runs after a successful circuit breaker reclose (whether automatic or manual) and is used to reset the reclose sequence to 79-1 after its time period expires. If the DPU2000R trips the circuit breaker again before the expiration of the reset time, the reclose sequence will increment one step; I.E. 79-1 to 79-2. The settings as programmed in the 79-2 step will then become active. This incremental stepping occurs until the recloser locks out or successfully recloses. If the reclosing function proceeds to lockout, the circuit breaker must be manually closed.

A red “Recloser Out” target contained on the front panel of the DPU2000R indicates that the recloser function is disabled. The logical input, 43A is used to remotely enable or disable the recloser (I.E. via control switch). If this logical input is not mapped to a physical input (see Programmable I/O Section), the recloser is defaulted to enabled. If the recloser is in the middle of a sequence and the 43A logical input is made inactive the recloser will stop operation. When 43A is returned to the active state, the recloser will be reset to step 79-1. The recloser function can also be disabled by setting 79-1 to lockout.

See Table 5-1 for the 79 factory default settings.

If the single shot recloser is in the middle of the open time or reset time and the recloser is dissabled via the 43A logical input, the recloser will stop operation. When 43A is returned to the active state the recloser will be reset.



Same selections are available for the 79-2, 79-3, and 79-4 recloser functions

Figure 1-23. Recloser Sequence

Lockout

The DPU2000R will lockout reclosing if any one of the following conditions are true:

- A fault persists for the entire reclose sequence.
- The breaker is manually closed and a fault occurs before the reset time expires.
- A Trip output occurs and the fault current is not removed and/or the 52a/52b contacts did not change state before expiration of the Trip Fail Timer (5 to 60 cycles).
- A Close output occurs and the 52a/52b contacts do not change state before the expiration of the Close Fail Timer. If the Circuit Breaker subsequenty closes and trips within the reset time, the recloser will lock out.
- The reclose function is set to lockout after a 50P-1, 50P-2, 50P-3, 51N, 50N-1, 50N-2, or 50N-3 overcurrent trip.
- The voltage block function, 79V, is enabled, the bus voltage is below the 79V setting, and the 79V time delay has expired.

A lockout condition is displayed on the LCD display as "Recloser Lockout". A logical output, 79LOA is also asserted for a lockout condition. The lockout state is cleared when the DPU2000R senses a manual breaker close by the state of the 52a and 52b contacts and the reset timer expires.

Cutout Timer (O->I-CO)

The 79 Cutout Time (79-CO) function allows for the detection of low-level or intermittent faults prior to the resetting of the reclose sequence. At the end of the selected cutout time period, all overcurrent functions are re-enabled based on the 79-1 settings. For example, if the 79 Reset Time is set for ten seconds and the 79 Cutout Time is set for five seconds, the first five seconds after reclosing, the DPU2000R follows the overcurrent function settings for the reclose sequence, but the second five seconds (after the cutout time has expired) it follows the 79-1 settings. The 79-CO setting (in Primary, Alternate 1 or Alternate 2 settings) is enabled by programming a time period from 1 to 200 seconds. When enabled, the 79-CO setting must be less than the 79 Reset Time.

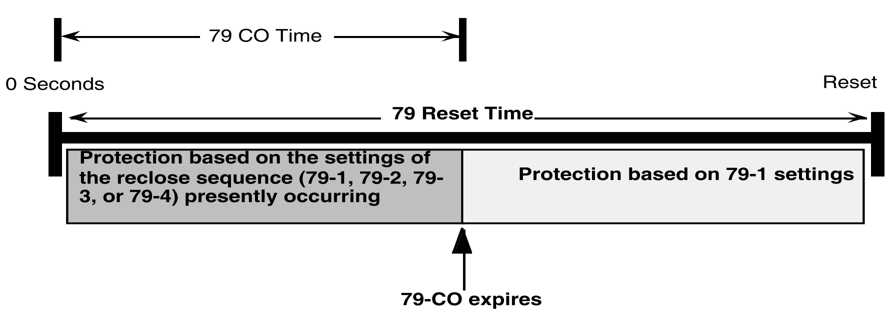


Figure 1-24. 79 Cutout Time

In fuse-saving applications involving large downstream fuses, the 50P and 50N instantaneous functions are set below the fuse curve to detect faults on tapped laterals. These functions are blocked after the first trip in the reclose sequence. The 51P and 51N time overcurrent functions are set above the fuse curve. This results in the upstream protection being less sensitive to an intermittent or low-level fault during the subsequent reclose operations.

If the reset time is too short, the reclosing relay may reset before the fault is detected again. If the reset time is too long, the intermittent or low-level fault is not cleared fast enough by the upstream protective device. In schemes using discrete reclosing relays, blocked instantaneous overcurrent functions are placed back in service only after the reclosing relay has reset. However, the 79-CO function in the DPU2000R re-enables the instantaneous functions at the end of the selected cutout period. Set the time for the 79-CO function according to how long it takes a downstream fuse or other protective device to clear downstream faults. The typical time setting is between 10 and 15 seconds. If an intermittent or low-level fault exists, it will be detected at the end of the 79 CO cutout time period, and the DPU2000R will trip and continue through the reclose sequence until the fault is permanently cleared or lockout is reached. The 79-CO function allows the reset time to be set beyond 60 seconds without jeopardizing sensitivity to intermittent or low-level faults.

Single Shot Reclose Logical Input 79S (O->I1)

The 79S logical input is used to initiate a single shot of reclosing when the circuit breaker is opened by an external source. Logical input 79S must be mapped to a physical input contact for activation by an external device (see Programmable I/O Section). The 43A (recloser enable) logical input must also be active for the 79S function to operate. If 43A is not mapped to a physical input it defaults to enable. The 79S operates as follows:

If the breaker is opened by an external source and the 79S logical input is active, the circuit breaker will close in the 79-1 open time.

If the breaker is opened by an external source and the 79S logical input is not active but is made active after the circuit breaker is opened, the circuit breaker will close in the 79-1 open time.

If the circuit breaker is opened before the reset time expires, 79S will not operate again until the breaker is manually closed back in and the reset time expires.

> The 79S function can be made active or inactive by the mapping a User Logical Output (ULO) to the 79S logical input through the feedback logic (see Programmable I/O Section).
>
> The internal DPU2000R logic only checks the status of the 79S logical input when it detects that the circuit breaker has opened. Once it has determined that the 79S is active, it will initiate the single shot reclose. It doesn't matter if the 79S is toggled or held active.
>
> If the single shot recloser is in the middle of the open time or reset time and the recloser is dissabled via the 43A logical input, the recloser will stop operation. When 43A is returned to the active state the recloser will be reset.

Multi-Shot Reclose Logical Input 79M (O->I)

The 79M logical input is used to initiate multiple shots of reclosing when the circuit breaker is opened by an external source. Logical input 79M must be mapped to a physical input contact for activation by an external device (see Programmable Inputs Section). The 43A (recloser enable) logical input must also be active for the 79M function to operate. If 43A is not mapped to a physical input it defaults to enable. The 79M operates as follows:

If the breaker is opened by an external source and the 79M logical input is active, the circuit breaker will close in the 79-1 open time. If the circuit breaker is opened again by an external source and the reset time has not expired, the recloser will step to 79-2 and the circuit breaker will close (or lockout depending upon the 79-2 programming) in 79-2 time. If the breaker continues to open before the reset time expires, the recloser will continue to increment steps until it reaches the step that locks out. At this point no further reclosing will take place and the circuit breaker must be closed manually.

If the breaker is opened by an external source and the 79M logical input is not active but is made active after the circuit breaker is opened, the circuit breaker will close in the 79-1 open time. If the circuit breaker is opened again by an external source and the reset time has not expired, the recloser will step to 79-2 and the circuit breaker will close (or lockout depending upon the 79-2 programming) in 79-2 time. If the breaker continues to open before the reset time expires, the recloser will continue to increment steps until it reaches the step that locks out. At this point no further reclosing will take place and the circuit breaker must be closed manually.

> The 79M function can be made active or inactive by the mapping a User Logical Output (ULO) to the 79M logical input through the feedback logic (see Programmable Logic Section).

The internal DPU2000R logic only checks the status of the 79M logical input when it detects that the circuit breaker has opened. Once it has determined that the 79M is active, it will initiate the reclose. It doesn't matter if the 79M is toggled or held active.

If the multi-shot recloser is in the middle of a sequence and the 43A logical input is made inactive, the recloser will stop operation. When 43A is returned to the active state the recloser will be reset and at step 79-1.

Voltage Block 79V (O->IU<)

The 79V Voltage Block function blocks reclosing when one or more of the input voltages is below the 79V voltage setting. When the input voltage is restored within the 79V time delay setting, the recloser operation is unblocked and the "open time" will begin. If the voltage is not restored within the 79V time delay setting, the recloser will proceed to lockout. The 79V time delay can be set to count in seconds or minutes. The setting, "79V Time Mode", is made in the Configurations settings (see Section 2). This function is useful in preventing a feeder breaker closure when the bus voltage is lost or below normal. This reduces inrush currents when the voltage to the bus is eventually restored. The settings for the 79V function are listed in Table 1-23. The 79V element is disabled in the factory default settings.

Table 1-23. 79V Characteristics

79V Parameter	Range/Curve	Increment
Voltage	10 to 200 VAC	1 volt
Time Delay	4.0 to 240 seconds	1 sec. (79V time mode: seconds)
Time Delay	4.0 to 240 minutes	1 min. (79V time mode: minutes)

Note: If the voltage is lost or falls below the 79V voltage setting during the open time interval, the open timer will halt. If the voltage is restored before the 79V time delay expires, the open timer will again run. If the voltage is not restored and the 79V time delay expires, the recloser will proceed to lockout.

Recloser Logical Inputs

The following are the programmable logic inputs associated with the recloser.

TARC:	Initiate Trip and Auto Reclose. This input is used to issue a circuit breaker trip and reclose. It is useful in the testing of the circuit breaker trip and close circuits as well as the recloser logic and timing settings. When TARC is a logical 1, a trip and automatic reclose sequence is initiated. If the input is held at a logical 1, the DPU2000R will continue to trip and reclose through the recloser steps (79-1, 79-2, 79-3, etc., see Recloser section for reclosing details). If TARC is pulsed at a logical 1, the trip and auto reclose will only occur once unless TARC is pulsed again. TARC defaults to a logical 0 when not assigned to a physical input or feedback term.
ARCI:	Automatic Reclose Inhibit. This logical input stops the recloser open timer for the time in which it is a logical 1. When ARCI is returned to a logical 0 the open timer will continue where it was stopped. ARCI does not affect the recloser reset timer. ARCI defaults to a logical 0 when not connected to a physical input or feedback term.
43A: (AR)	Recloser Enable. This input is used to supervise the DPU2000R reclosing function. When the 43A input is a logical 1, the DPU2000R recloser is enabled. When 43A is a logical 0, the recloser is disabled. If the recloser is disabled, a red “Recloser Out” target will illuminate on the front of the DPU2000R. 43A defaults to a logical 1 (reclosing enabled) when not assigned to a physical input.
79S: (O->I1)	Single Shot Reclosing. Enables a single shot of reclosing when the DPU2000R determines that an external device has opened the circuit breaker. When 79S is a logical 1, single shot reclosing is enabled. 79S defaults to a logical 0 when not assigned to a physical input or feedback term.
79M: (O->I)	Multi-Shot Reclosing. Enables a multi shot of reclosing when the DPU2000R determines that an external device has opened the circuit breaker. When 79M is a logical 1, multi-shot reclosing is enabled. 79M defaults to a logical 0 when not assigned to a physical input or feedback term.
ZSC:	Enables Zone Sequence Coordination scheme. Allows external supervision of the Zone Sequence scheme. When the ZSC input is a logical 1, zone sequence is enabled. ZSC defaults to a logical 1 if not assigned to a physical input or feedback term. See the Zone Sequence section for more details.
SCC:	Spring Charging Contact. Connect SCC to a physical input to monitor a recloser spring. If the SCC input is a logical 1, a “Spring Charging” event is logged in the operations record. SCC defaults to a logical 0 when not assigned to a physical input or feedback term. SCC only functions when the DPU2000R determines a breaker open state.

Breaker Failure Logic

A stand alone breaker failure trip (BFT) function is provided in the DPU2000R. This allows the DPU2000R to function as a stand alone breaker failure relay or provide internal breaker failure tripping protection. The DPU2000R contains one BFT and one Re-Trip logical output and is designed for application in single breaker schemes. Multiple DPU2000R relays can be used to provide protection on ring bus or breaker-and-a-half arrangements. Figure 1-25 outlines the DPU2000R logic associated with the breaker failure trip function. Both BFT and Re-Trip outputs share the same logic. Both require a Breaker Fail Initiate (BFI) input and a “starter” input. The starter input can be from an internal DPU2000R phase and ground level detector, 52a contact, or a combination of both. The BFT and Re-Trip logical outputs must be mapped to physical outputs for operation (see Programmable I/O Section). The BFI and Starter inputs must be mapped to physical inputs for operation (see Programmable I/O Section). The Breaker Failure Trip settings can only be made by the External Communication Program (ECP) included with the DPU2000R. The settings screen is shown in Figure 1-26.

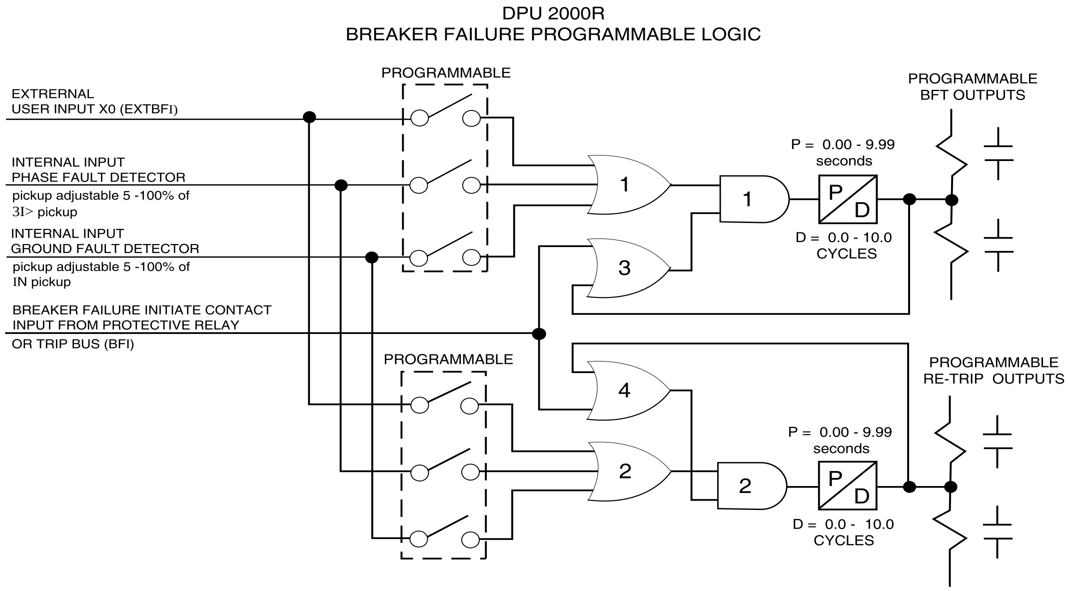


Figure 1-25. Breaker Failure Tripping Logic

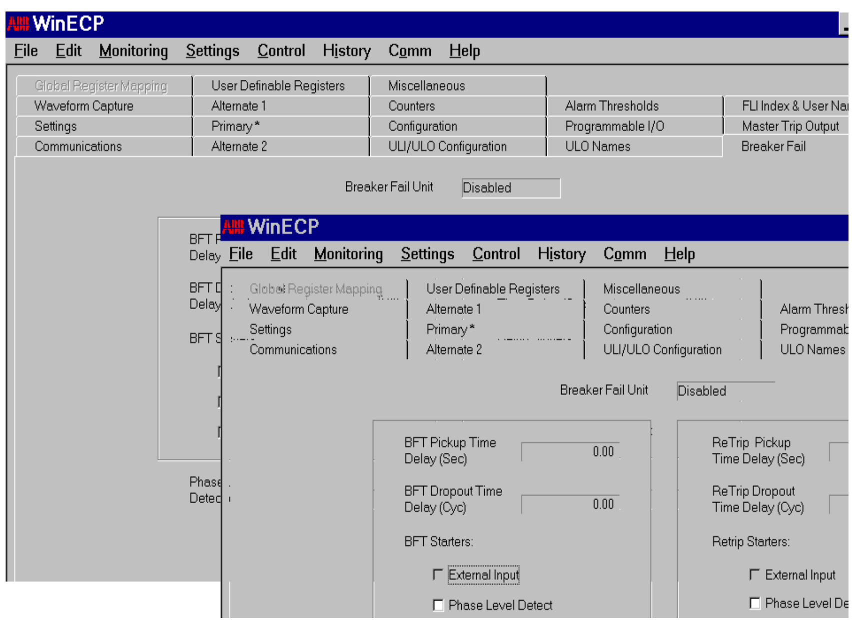


Figure 1-26. Breaker Failure Settings Screen

Alternate Settings Groups

The DPU2000R has three separate and identical selectable settings groups for protective relay functions. These groups are labeled Primary, Alternate 1 and Alternate 2. Use of the three groups provides flexibility to quickly change parameters according to some external conditions. For example, Alternate 1 settings might be used during a High load time while Alternate 2 settings might be used when a storm is pending (and modified instantaneous settings are desired). Other uses might be winter/summer settings or line maintenance settings.

In order to activate these alternate settings groups remotely, the logical inputs ALT1 and ALT2 assigned (in the programmable inputs screen of the Windows External Communications Program - WinECP) to programmable input contacts such as IN1 and IN2 respectively. Once the logic functions are assigned, to IN1 and IN2, they can be wired to electronically controlled switches which can be actuated through SCADA. (Note: The programmable input contacts can also be actuated through one of our various protocol options by simply issuing the proper commands).

The internal logic of DPU2000R will only allow one settings group to be active at a time. When ALT2 is active and an ALT1 input is asserted, ALT2 stays active until the ALT2 input is de-asserted. Only then will the ALT1 settings group become active. Note: there is a 2 cycle time delay that occurs between the settings group change. Protection is never disabled during these changes.

As an example, assign the ALT1 logic function to programmable input IN1 with enabled when closed logic and the ALT2 logic function to programmable input IN2 with enabled when closed logic. Externally wire IN1 to a control switch to be used for Cold Load control and wire IN2 to a control switch to be used for storm settings. If the Cold Load settings (IN1) must have priority over primary settings as well as storm settings (IN2), assign the ALT2 logic function also to programmable input IN1 with enabled when open logic (see Figure 1-16). The logic will force ALT2 to be disabled whenever ALT1 is enabled.

All of the protective elements outlined in the “Protective Elements” Section are available in the Primary, Alternate 1, and Alternate 2 settings groups. All other settings in the relay such as the Configuration settings, Programmable Inputs, Programmable Outputs, etc. are fixed at one group and follow the three protective settings groups. These other settings typically do not change once the relay is set and commissioned.

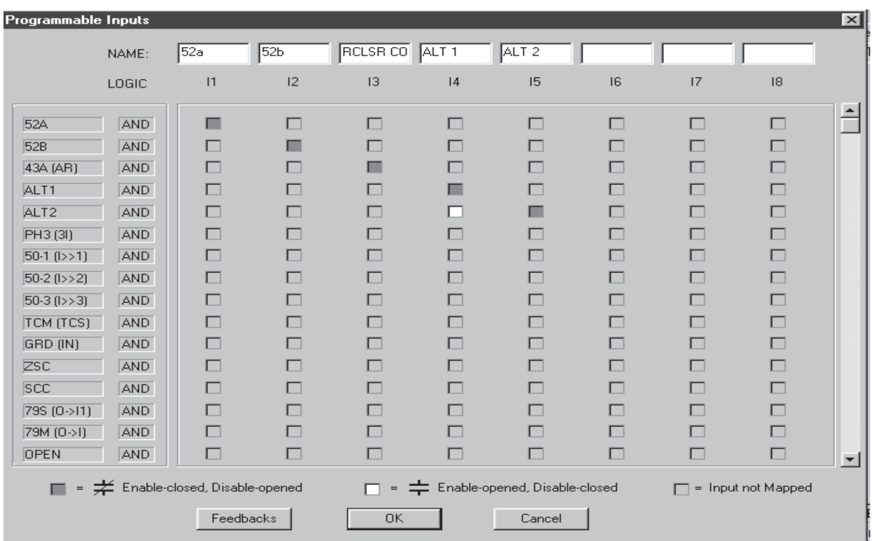


Figure 1-27. Sample Alternate Settings Programmable Input Logic Assignments

Configuration Settings

Phase CT Ratio

Phase current transformer turns ratio. The range is from 1 - 2000 turns.

VT Ratio

Voltage transformer turns ratio. The range is from 1 - 2000 turns.

VT Conn

Must be entered for proper DPU2000R metering and protection.

Options are:
69V Wye
69 Wye - $3V_0$ Input
120V Wye
120 Wye - $3V_0$ Input
120V Open Delta
208V Open Delta

If it is desired that the zero sequence voltage polarization be provided via the separate set of three phase voltage transformers connected in broken delta, then choose the appropriate VT Connection setting of "69 Wye – 3V0 Input", "120 Wye – 3V0 Input", "69 Delta" or "120 Delta". If bus voltage transformers are wired to the DPU2000R as delta or open delta and can not be rewired as wye, then choose the appropriate VT Connection setting, "69 Delta" or "120 Delta", and, if applicable, connect the separate three phase voltage transformers in broken delta for 3V0 polarization.

Important Note: It is imperative that the bus voltage transformers are connected in a wye configuration if deriving 3V0 is desired. See Figure 9-5 in the DPU2000R Instruction Booklet.

Table 2-1. 3V0 Derivation and Metering per VT Connection Setting

VT Connection Option	3V0 Calculation for Configuration "R", "C", "E0", "E1" or "E2"	3V0 Calculation for Configuration "E4", "E5" or "E6"	3V0 Metering for Configuration "R", "C", "E0", "E1" or "E2"	3V0 Metering for Configuration "E4", "E5" or "E6"
69 Wye	Derived	Derived	Derived	Derived
69 Wye – 3V0 Input	Not Applicable	Sensor 10 Input	Not Applicable	Sensor 10 Input
120 Wye	Derived	Derived	Derived	Derived
120 Wye – 3V0 Input	Not Applicable	Sensor 10 Input	Not Applicable	Sensor 10 Input
120 Delta	Fixed at 0 /0°	Sensor 10 Input	Fixed at 0 /0°	Sensor 10 Input
208 Delta	Fixed at 0 /0°	Sensor 10 Input	Fixed at 0 /0°	Sensor 10 Input

Line Impedances

The line impedances are used for fault location purposes. The settings are positive and zero sequence reactance, and positive and zero sequence resistance in primary ohms per mile. The ranges for both resistance and reactance are .001 to 4.00 primary ohms/mi. See the section on "Fault Locator" in Section 7.

Line Length

The line length is used for fault location purposes. The range is from 0.1 to 125 miles. See the section on "Fault Location" in Section 7.

Breaker Trip Fail Timer

The DPU2000R determines a successful trip by the state of the 52a and 52b breaker contacts and the level of input current. The 52a and 52b contacts must indicate an open breaker and the current must have dropped to below 5 percent of the 51P pickup sett Inputing. At the time that the DPU2000R issues a trip, it also starts a "Trip Fail Timer". This timer is used to determine a failed or slow breaker. It is set in the Configuration Setting and is selectable for 5 to 60 cycles in 1 cycle steps. If the timer expires before the DPU2000R determines an open breaker (either or both conditions stated above are met), a Breaker Failure Alarm, BFA, logical output is asserted and the recloser will lockout. If the DPU2000R determines an open breaker within the Trip Fail Time setting, it will reset and re-enable when the breaker is reclosed. The Trip Fail Timer is set by factory default to 18 cycles.

Breaker Close Fail Timer

The DPU2000R determines a successful close by the state of the 52a and 52b breaker contacts. The 52a and 52b contacts must indicate a closed breaker. At the time that the DPU2000R issues a close, it also starts a "Close Fail Timer". This timer is used to determine a failed or slow breaker. It is set in the Configuration Setting and is selectable for 18 to 16000 cycles in 1 cycle steps. If the timer expires before the DPU2000R determines a closed breaker (condition stated above is met), the DPU2000R will halt its automatic reclose or manual close operation and wait for the proper state to appear. If the close failure occurred while the recloser was at a certain reclose step, I.E. 79-3, the DPU2000R will stay at that step until the breaker is finally closed back in. When this occurs, the reset timer will run and the reclose sequence will pickup where it left off. If a subsequent trip occurs, the relay will lock out. If the DPU2000R determines a closed breaker within the Close Fail Time setting, it will reset and re-enable when the breaker is opened. The Close Fail Timer is factory default to 18 cycles.

Close Fail Timer

When a CLOSE command is issued to the DPU2000R with Software Version 1.00 or higher in a "Circuit Breaker Status Indeterminate" state (that is the 52A and 52B contacts inputs read the same value), the DPU2000R will hold the command in memory. This CLOSE command will be executed if the status of the 52A/52B contact inputs become determinate and indicates a "Breaker Open" State. The CLOSE command will not be executed if the status of the 52A/ 52B contact inputs become determinate and indicates a "Breaker Close" state, or if the DPU2000R is reset, or if control power to the DPU2000R is cycled.

Slow Trip Time

At the time the DPU2000R issues a trip, the "Slow Trip Time" timer starts. This timer is used to determine a "sluggish" breaker. This setting is adjustable from 5 to 60 cycles in 1-cycle steps. If the timer expires before the DPU2000R determines an open breaker, a logical output "Slow Breaker" is asserted. If the DPU2000R determines an open breaker within the "Slow Trip Time" setting, it will reset and re-enable when the breaker is reclosed. The Slow Trip Time is set by factory default to 18 cycles.

Phase Rotation

Must be selected for proper sequence calculations for the metering. Options are ABC or ACB. This setting directly affects all directional elements in the relay.

Protection Mode

Select "Fund" if the desired operating quantity for overcurrent protection is the 50 or 60 Hz fundamental current.

Select "RMS" if the desired operating quantity is the unfiltered RMS current which includes the fundamental and all harmonics up to and including 11th harmonic.

Reset Mode

Select "Instant" if the desired overcurrent reset mode is instantaneous.

Select "Delayed" if the desired overcurrent reset mode is delayed as with electromechanical relays. The reset characteristic equations are on page 1-9.

ALT1, ALT2 Setting

The Alternate 1 or Alternate 2 settings tables can be enabled or disabled with this setting. If enabled, the ALT settings will only be active if the logical input ALT1 or ALT2 is mapped via programmable inputs and the logic is "true." See Section 6 for programmable Inputs.

MDT Mode

When the Multiple Device Trip Mode is enabled in the Configuration Settings Table, the DPU2000R's TRIP and CLOSE Output Contacts and Breaker Failure Alarm do not depend on the 52A and 52B contact input status. With this mode enabled, the TRIP output is removed 3 cycles after the fault current drops below 90% of the lowest pickup setting. In the reclose sequence, the open interval timer and subsequent CLOSE output are initiated only if an Overcurrent TRIP Output has occurred and the current has dropped below 90% of the lowest pickup setting within the Trip Failure Time setting.

When the MDT mode is enabled, the lockout state is cleared when either of the following occurs:

1) The 52b contact input is open **and** currents in all three phases are greater than 5% of the 51P pickup setting **and** the reset time has expired.

OR

2) The 52b contact input is open **and** the Targets are reset **and** the reset time has expired.

The 52b contact input is required for the 79S contact input (Single Shot Recloser Input) and the 79M contact input (Multi-Shot Recloser Input) functions to initiate a reclosure when the MDT Mode is enabled. When the MDT Mode is enabled, the Reset Mode is automatically switched to instantaneous.

The MDT mode is disabled in the factory default settings.

Cold Load Time Mode

The cold load time can be either in seconds or minutes. The time itself is set in the primary settings menu. See Section 1 for details on this function.

79V (O->IU<) Time Mode

The 79V time can be either in seconds or minutes. The time itself is set in the primary settings menu. See Section 1 for more details on this function.

Voltage Display Mode

Select “Line-Line” for voltages to be displayed Line to Line.

Select “Line-Neutral” for voltages to be displayed Line to Neutral.

NOTE: All voltages are displayed in kV (Volts X 1000).

Zone Sequence Coordination

The zone sequence coordination function coordinates the instantaneous functions within the reclosing sequence of the upstream and downstream reclosing devices. Applications include fuse-saving schemes for faults that occur beyond the downstream reclosers. Refer to Application Note AN-23.

Enable the ZSC function by (1) enabling it in the Configuration Settings **and** (2) mapping the ZSC logic function to a contact input in the Programmable Inputs screen of the Windows External Communications Program. The 50P-1/50N-1 or 50P-2/50N-2 and 50P-3/50N-3 instantaneous functions in the upstream DPU2000R must be set for a time delay that is equal to or greater than the clearing time of the downstream device. The Reset Time setting of the upstream DPU2000R must also be longer than the longest open interval time of the downstream device.

When the ZSC function is enabled and the DPU2000R senses a fault downstream, the relay increments through its reclose sequence. For example, if the downstream device is activated by a phase to ground fault, the DPU2000R must see a fault current greater in value than the lowest pickup setting of any of the phase overcurrent protective functions.

The zone sequence step occurs when the fault current exceeds the enabled lowest pickup setting and then decreases to less than 90 percent of the setting value before its time delay setting is exceeded. The recloser reset time is displayed when a zone sequence step occurs. All zone sequence coordination steps that occur are logged in the Fault Summary and Fault Record.

Target Display Mode

Select “Last” if the only target desired on the front panel of the relay is the most recent target. If “All” is selected, then all targets will remain displayed since the last target reset.

Local Edit

“Enable” allows settings to be changed via the OCI.

“Disable” disallows setting changes via the OCI.

This setting can only be edited remotely via communications.

Remote Edit

“Disable” disallows setting changes via the communication ports.

This setting can only be changed locally through the OCI.

Meter Mode

Select KWHr or MWHr for kilowatt/kilovar or Megawatt/Megavar metering.

LCD Light

Select “ON” for continuous display.

Select “TIME OUT” to enable the LCD Screen saver. This setting will significantly extend the life of the LCD display. After the Screen saver times out, the user can press any button to activate the LCD display.

Unit ID

Type a 15 character description of the relay.

Demand Meter Constant

Select 5, 15, 30 or 60 minute time constant. Demand currents replicate thermal demand meters. The demand kilowatts and kiloVArs are averaged values that are calculated by using the kilowatt-hours, kiloVArs-hours and the selected time constant.

LCD Contrast

This setting adjusts the brightness of the LCD Display. Adjustable from 0-63 steps of 1 unit. The DPU2000R LCD automatically compensates for change in temperature reducing the need to adjust the default contrast setting for improved legibility.

Change Relay Password

The relay password can be changed via the OCI in the configuration settings menu. Using WinECP, the user can change the relay password when exiting out of the configuration settings menu, select “send settings to unit”, and select “Yes” to change relay password.

Change Test Password

The test password allows access to the actions in the Test Menu and the Operations Menu, see Section 6. The user **cannot** make setting changes with the test password.

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Metering

The DPU2000R contains a complete voltage and current metering package. It also calculates sequence components, real and reactive power flow, power factor, demand, and minimum/maximum values. The proper setting of the Voltage Transformer (VT) and Current Transformer (CT) configurations and ratios are extremely important for proper metering operation. The VT and CT configuration (wye or delta) and ratio settings are contained in the “Configuration Settings” menu (see Section 2). Load magnitudes for kilovolts and current are displayed by default on the LCD display (if applicable). They can also be displayed in the WinECP metering screen. The voltage values displayed are phase to neutral for wye connected VT’s and phase to phase for delta connected VT’s. Voltage Van or Vab for delta VT’s is always shown at 0 degrees and is used as a reference for all other voltage and current phase angles. The calculated sequence voltage components V_1 and V_2 are derived from the line voltages regardless of VT configuration. If a balanced condition is assumed then: In a delta system, the angle of the positive sequence voltage (V_1) leads Vab by 330 degrees. In a wye system the angle of the positive sequence voltage (V_1) equals Van. The metering screen can be used to verify proper and healthy connections to the voltage and current input sensors of the DPU2000R.

The following is a description of all the DPU2000R metering features.

Load Metering

The following load values are contained in the DPU2000R and are accessible via the OCI or WinECP program:
All phase angles are referenced to V_{an} which is set to be zero degrees.

- Phase Currents: Magnitude and Phase Angle (wye or delta connections)
- Ground Current: Magnitude and Phase Angle (wye or delta connections)
- Kilovolts: Magnitude and Phase Angle (wye or delta connections)
- Kilowatts (or Megawatts): Single Phase and Three Phase for wye VT’s and Three Phase for Delta VT’s
- KiloVArs (or MegaVArs): Single Phase and Three Phase for wye VT’s and Three Phase for Delta VT’s
- Kilowatt-hours (or Megawatt-hours): Single Phase and Three Phase for wye VT’s and Three Phase for Delta VT’s
- KiloVAr-hours (or MegaVAr-hours): Single Phase and Three Phase for wye VT’s and Three Phase for Delta VT’s
- Voltage Sequence Components: Magnitude and Phase of Positive Sequence (V_1) and Negative sequence (V_2) voltage
- Current Sequence Components: Magnitude and Phase Angle of Positive Sequence (I_1), Negative Sequence (I_2), and Zero Sequence (I_0) current
- Power Factor
- Frequency

Energy Meter Rollover

The Watt-hour and VAr-hour or Energy meters can be set to display Kilowatt-hours or Megawatt-hours. This setting is made in the “Configuration” Menu (see Man Machine Interface or Windows External Communication Program). Depending on the magnitude of the power flow seen by the DPU2000R and the time period between meter readings, it may be necessary to switch the meter mode to megawatt-hours to avoid energy meter rollover. Meter rollover is the point at which the DPU2000R watt-hour meter has reached its maximum count and returns to zero to begin incrementing again. The roll over point for the energy meters is 6,000,000 kilowatt-hours (kiloVAr-hours) in the Kwhr mode and 2,000,000,000 megawatt-hours (megaVAr-hours) in the Mwhr mode.

The energy meters are capable of reading negative power. If the magnitudes are positive, the meters will increment, if negative they will decrement. Figure 3-1 outlines the metering conventions used in the DPU2000R.

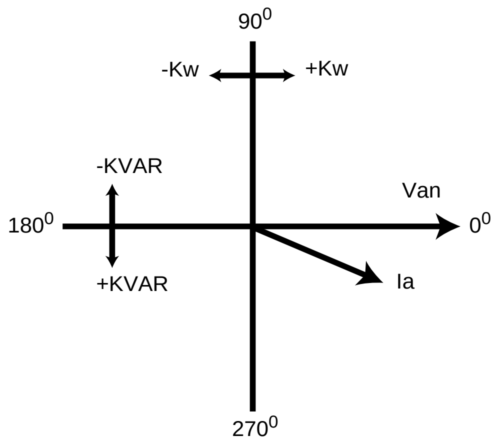


Figure 3-1. Metering Conventions Used in the DPU2000R

The update rate of the energy meters is based on the "Demand Constant" setting (see Demand Meter Section) as set in the "Configurations" settings. The meters will update every 1/15 of the Demand Constant. For example: if the Demand Constant is set to 15 minutes the energy meters will update every 1 minute (15min x 1/15 = 1 min).

The watt-hour and VAr-hour meters can be reset to 0 by the local Operator Control Interface (OCI) only. "Reset Energy Meters" is found in the "Meter" Menu.

Demand Metering

Demand metering is typically used for analysis of equipment loading and system planning. The demand values in the DPU2000R are accessible via the OCI or WinECP program. The following are the measurements taken by the demand meter:

Phase Currents: Magnitude and Phase Angle (wye or delta connections)

Ground Current: Magnitude and Phase Angle (wye or delta connections)

Kilowatts: Single Phase and Three Phase for wye VT's and Three Phase for Delta VT's

KiloVArs: Single Phase and Three Phase for wye VT's and Three Phase for Delta VT's

The demand meter takes a snapshot of the load every 1/15 x Demand Constant minutes. The demand currents are averaged using a $\log_{10}$ function over the period of the Demand Constant Interval to replicate thermal demand ammeters. The demand kilowatts and kiloVArs are averaged values that are calculated by sampling the kilowatt-hours and kiloVAr-hours every "Demand Constant" interval. The Demand Constant interval is a setting made in the "Configuration" settings and is the time period between demand meter updates. Current utility or industrial practice usually dictates the setting of the demand constant interval.

Minimum / Maximum Metering

During each demand interval described above, the DPU2000R also captures and stores minimum and maximum values for the measurements listed below. It functions as a standard minimum / maximum meter given that when a new maximum or minimum value is determined, the old value is replaced. A time stamp is placed with the latest minimum and maximum values. The minimum / maximum meter measures:

Phase Currents: Magnitude and Phase Angle (wye or delta connections)

Ground Current: Magnitude and Phase Angle (wye or delta connections)

Kilowatts: Single Phase and Three Phase for wye VT's and Three Phase for Delta VT's

KiloVArs: Single Phase and Three Phase for wye VT's and Three Phase for Delta VT's

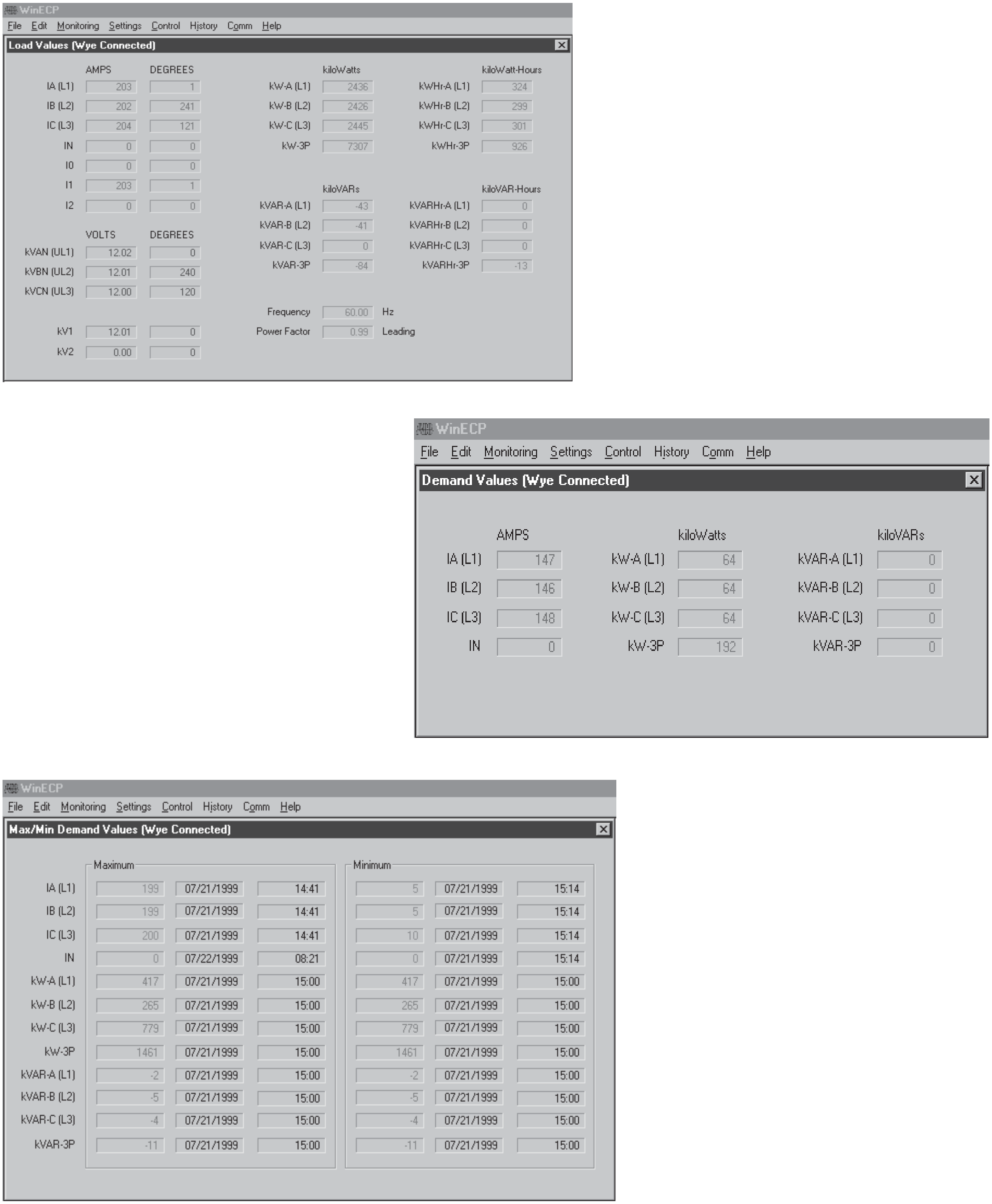
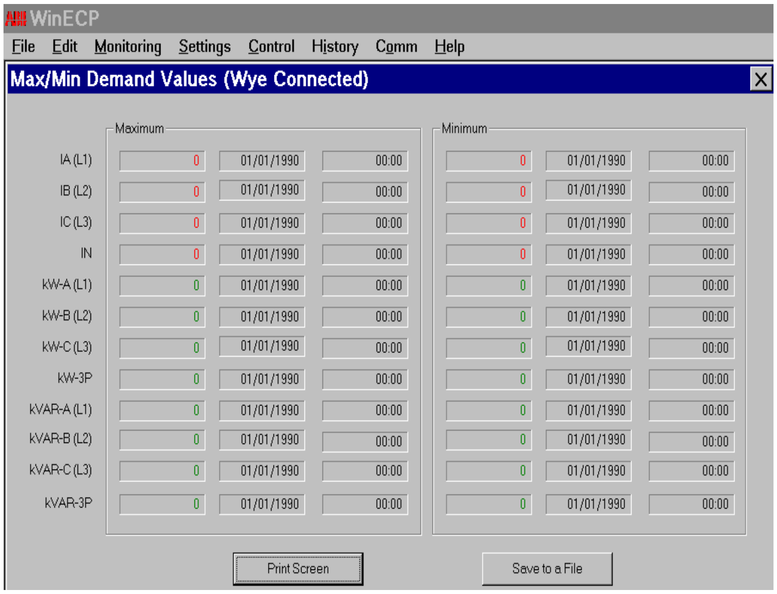


Figure 3-2. WinECP Meter Menus


WinECP
File Edit Monitoring Settings Control History Comm Help
Max/Min Demand Values (Wye Connected)
Maximum
Minimum
IA (L1)
IB (L2)
IC (L3)
IN
kW-A (L1)
kW-B (L2)
kW-C (L3)
kW-3P
kVAR-A (L1)
kVAR-B (L2)
kVAR-C (L3)
kVAR-3P
0
01/01/1990
00:00
Print Screen
Save to a File

Relay Design and Specifications

The DPU2000R design incorporates a 32-bit microprocessor and a 16-bit microprocessor which create a multi tasking environment. The capabilities of these microprocessors allow the DPU2000R to perform many protective and monitoring functions. Figure 4-1 shows a block diagram of the unit.

Processor Specifications

The processing power of the DPU2000R provides a true multitasking environment that combines protection, metering and control. The hardware components of the unit include:

- CPU—20-MHz, 32-bit 68332 Motorola microprocessor
- CPU RAM—64K of temporary storage for CPU
- DSP—a 16-bit analog device digital signal processor handles all analog acquisition and measurement of input parameters. It also performs all arithmetic iterations of the converted digital input signals.
- EEPROM stores all protective function settings.
- 16-bit analog-to-digital (A/D) converter
- FLASH EPROM stores the CPU's programming.
- DSP RAM—16 K of memory provide temporary storage of DSP's arithmetic values.
- Real-time battery backed-up clock

Battery Backed-Up Clock

An internal clock time tags the faults in the Fault Record, events in the Operations Record and values in the Load Profile record. In normal operation, this clock is powered by the DPU2000R. When the DPU2000R is withdrawn from its case, a battery powers the clock. As long as you turn off the battery backed-up clock during prolonged storage, the battery should last the life of the unit. Turn off the battery backed-up clock through the front man-machine interface by entering a “0” for the day. Default state of the clock is off.

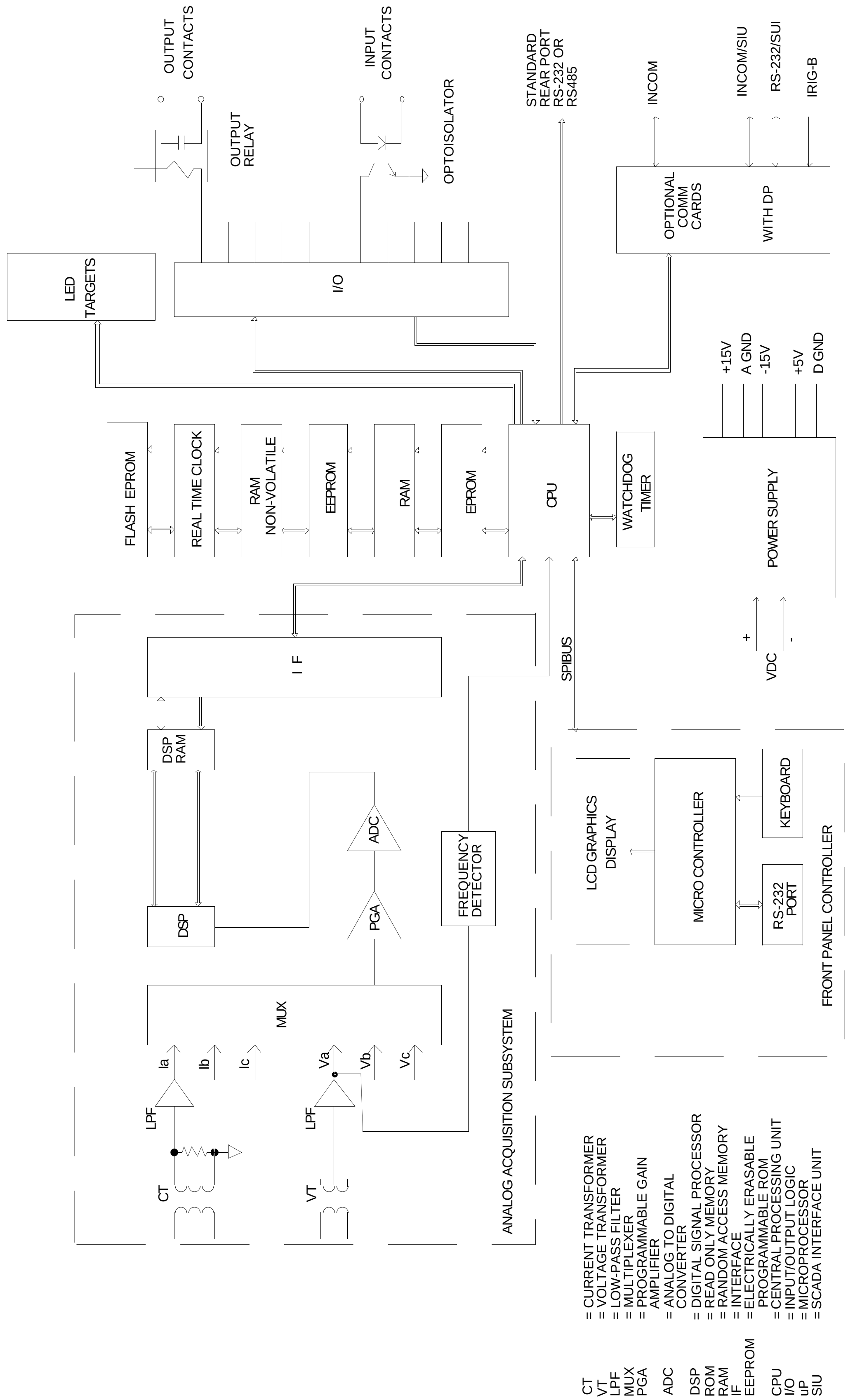


Figure 4-1. DPU2000R Block Diagram

Ratings and Tolerances

The following are the ratings and tolerances of the DPU2000R.

Current Input Circuits

- 5A input rating, 16 A continuous and 450 A for 1 second
- 1A input rating, 3 A continuous and 100 A for 1 second
- Input burden at 0.245 VA at 5 A (1 - 12A range)
- Input burden at 0.014 VA at 1 A (0.2 - 2.4A range)
- Frequency 50 or 60 Hz

Voltage Input Circuit

Voltage ratings based on the VT connection setting.

Burden

- 0.04VA for V(A-N) at 120 Vac

Voltage

- **Wye** Connection: 160V continuous and 480V for 10 seconds
- **Delta** Connection: 260V continuous and 480V for 10 seconds

Contact Input Circuits

- 2.10 VA at 220 Vdc and 250 Vdc
- 0.52 VA at 125 Vdc and 110 Vdc
- 0.08 VA at 48 Vdc
- 0.02 VA at 24 Vdc
- Voltage range 24 to 280 Vdc for 48/110/125/220/250 Vdc
- Voltage range 12 to 140 Vdc for 24 Vdc model

Control Power Requirements

- 48 Vdc model, range = 38 to 58 Vdc
- 110/125/220/250 Vdc models, range = 70 to 280 Vdc
- 24 Vdc model, range = 19 to 39 Vdc

Control Power Burden

- 24 Vdc = 0.7A max @ 19 V
- 48 Vdc = 0.35A max @ 38 V
- 110/125 Vdc = 0.25A max @ 70 V
- 220/250 Vdc = 0.16A max @ 100 V

Output Contact Ratings

125 Vdc	220 Vdc
• 30 A tripping	• 30 A tripping
• 6 A continuous	• 6 A continuous
• 0.25 A break inductive	• 0.1 A break inductive

Operating Temperature

- –40° to + 85° C

Humidity

- Per ANSI 37.90, up to 95% without condensation

Transient Immunity

- Surge withstand capability
  - SWC and fast transient tests per ANSI C37.90.1 and IEC 255-22-1 class III for all connections except comm or AUX ports
  - Isolated comm ports and AUX ports per ANSI C37.90 using oscillatory SWC Test Wave only and per IEC 255-22-1 class III and 255-22-4 class III
  - Impulse voltage withstand test per IEC 255-5
  - EMI test per trial use standard ANSI C37.90.2

Tolerances Over Temperature Range of -20^o C to +55^o C

Function	Pickup	Dropout	Timing (whichever is greater)
51P/51N	±3% of setting	98% of setting	± 7% or +/-- 16 milliseconds
50P/50N	±7% of setting	98% of setting	± 7% or +/-- 16 milliseconds
46/67P	±3% of 51P setting	98% of setting	± 7% or +/-- 16 milliseconds
67N	±3% of 51N setting	98% of setting	± 7% or +/-- 16 milliseconds
27/59/81V/79V	±3% of 51P setting	98% of setting	± 7% or +/-- 16 milliseconds
59G	±3% of setting	98% of setting	± 7% or +/-- 16 milliseconds
47	±3% of setting	98% of setting	± 7% or +/-- 16 milliseconds
21	±3% of setting	98% of setting	± 7% or +/-- 16 milliseconds
81	± 0.01 Hz	± 0.01 Hz	±1 cycle
Ammeter	± 1% of 51P and 51N time overcurrent pickup setting		
Voltmeter	± 1% of VT Connection setting		
Wattmeter	± 2% of full scale		
VARmeter	± 2% of full scale		
Power Meter	± 2% of I xV, 51P pickup setting x VT Connection setting		
Frequency	± 0.01 Hz from 30-90 Hz, at 120 Vac input on Va.		

Dielectric

- 3150 Vdc for 1 second, all circuits to ground except comm ports per IEC 255-5
- 2333 Vdc for 1 second, for isolated communication ports

Weight

- Unboxed 5.36 kg (11.80lbs)
- Boxed 5.67 kg (12.51 lbs)

Interfacing with the Relay

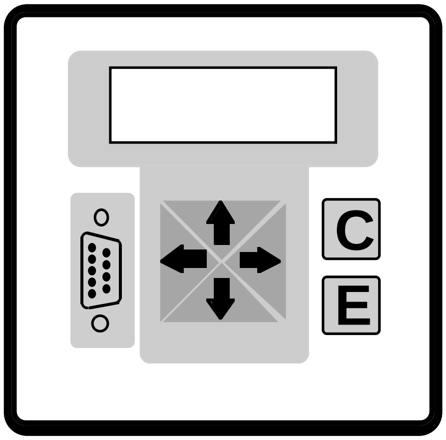


Figure 5-1. OCI Access Panel

Operator Control Interface (OCI)

The operator control interface (OCI) on the front panel consists of an auto temperature compensating graphics LCD, six push-buttons (keys) and twelve LED targets. Press the Enter <E> key to access the Main Menu. Use the ← and → arrow keys to move through the various menus and to change the character value when you enter the alphanumeric password. Use the Enter <E> key to select the desired menu or desired value when you change settings.

Use the ← and → arrow keys to decrease and increase, respectively, setting values or record numbers. Also use them to move from left to right within the password string. If you hold down the right or left arrow key, the setting value slowly changes. If you press the arrow keys repeatedly, the value changes more rapidly.

WARNING: This device is shipped with default passwords. Default passwords should be changed to private passwords at installation. Failure to change each default password to a private password may allow unauthorized access. ABB shall not be responsible for any damage resulting from unauthorized access.

From the default screen, you can use the <C> key to:

If there are no targets

- Hit <C> once within a 5-second window:
  Prompts the user to reset alarms. Hit <C> within 5 seconds to reset alarms. The user will then be prompted to reset seal-ins. Hit <C> within 5 seconds to reset seal-ins.
- Hit <C> two times within a 5-second window:
  Automatically scrolls through demand values.
- Hit <C> three times within a 5-second window:
  Prompts the user to reset Min/Max Demands. Hit <C> within 5 seconds to reset Min/Max Demands.

If there are targets

- Hitting <C> once will prompt the user to clear fault data.
- If <C> is hit again within 5 seconds, fault data will be cleared from the OCI and the user will be prompted to clear target data.
- If <C> is hit again within 5 seconds, targets are cleared and the user will be prompted to clear sealed-in outputs.
- If <C> is hit again, sealed-in outputs will be cleared.

A system reset can be accomplished by simultaneously pressing the <C>, <E> and up-arrow keys. A "System Reset" resets the microprocessor and re-initiates the software program. During a system reset, no stored information or settings are lost. The following displays and menus are available through the OCI:

- Continuous Displays-- shows currents, voltages and which settings table is enabled.
- Post-Fault Display-- shows distance to fault in miles (km) and fault currents for last fault until targets are reset.
- Reclosing Display-- shows open interval or reset time counting down to zero.

Metering Display (Continuous)

Ia:	500	KVan:	13.00
Ib:	500	KVbn:	13.00
Ic:	500	KVcn:	13.00
In:	0	Primary Set	

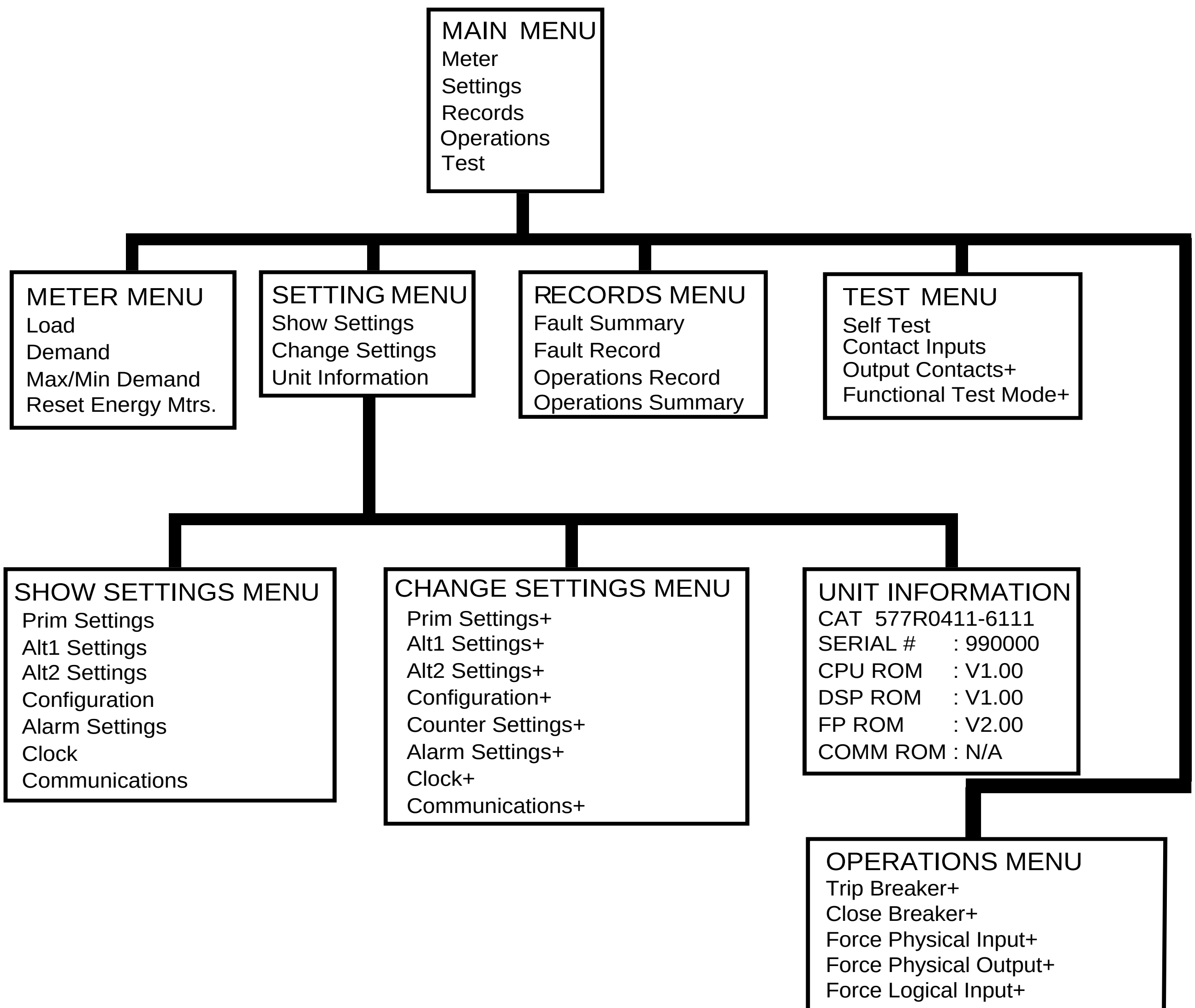
Display After a Fault Interruption

Distance - Km			10.1
Ia:	3320	Ib:	430
ic:	420	In:	3310
	Reset Time		14

Figure 5-2. OCI Displays

Operator Control Interface Menus

Below is an outline of all the menus available through the man-machine interface.



+ Password protected

Figure 5-3. Operator Control Interface Menus

Targets

Twelve Light Emitting Diodes (LED's) called "targets" are provided on the front panel of the DPU2000R for indication of DPU2000R health, overcurrent pickup (current exceeds setting), recloser status, and fault type. Two types of targets called "sealed-in" and "non-sealed in" are available.

Sealed-in targets will remain on even after the condition that has turned them on has been cleared. These type of targets can be reset by depressing the "C" key on the Operator Control Interface (OCI) twice or by pressing the recessed front panel "Target Reset" pushbutton. The target display can be set to "Last" or "All". If they are set to "Last", the latest targets acquired will replace any preceding target information. If set to "All", the all target information is displayed until the Targets a reset. This setting is made in the "Configurations Settings" menu (see Operator Control Interface Section).

Non sealed in targets remain lit only for the time when the condition is present.

The targets and their functionality are listed below.

Normal: Indicates DPU2000R is in normal operating state. If the DPU2000R detects an internal failure the LED will turn off and the Fail LED will turn on. The Normal LED will flash when a logical input or output has been **forced** to an on or off state. The flashing indicate that the DPU2000R is healthy but is in an abnormal operating state (see Operations Menu in Section 8). The Normal LED is a Green non sealed in target.

Fail: Indicates that the DPU2000R has determined a self test failure. The LCD display (if applicable) may indicate an error code at this point. See the Self Testing section for details on error codes. When the Fail LED is lit the unit will usually require service. The Self Check alarm contacts on the rear of the unit will also change state anytime that the Fail LED is lit. The Fail LED is a red non sealed in target.

Pickup: The LED will light for a condition where the input current has exceeded the pickup setting of any of the overcurrent elements (51P, 51N, 50P-1, 50P-2, 50P-3, 50N-1, 50N-2, 50N-3, 46). The Pickup LED is a red non sealed in target.

Recloser Out: Indicates that the reclosing function contained in the DPU2000R is disabled. This LED will light when the logical input 43A is disabled or 79-1 is set to lockout. See the "Recloser" Section for more details. The Recloser Out LED is a red non sealed in target.

ϕA, ϕB, ϕC, N: Indicates the phase or phases faulted. These targets will light after the relay has tripped for a fault. These LED's are all red sealed in targets.

Time: Indicates that a time overcurrent trip has occurred. The time overcurrent elements 51P, 51N, and 46 when tripped will activate the Time target. The Time LED is a red sealed in target.

Instantaneous: Indicates that an instantaneous overcurrent trip has occurred. The instantaneous overcurrent elements 50P-1, 50P-2, 50P-3, 50N-1, 50N-2, and 50N-3 when tripped will activate the Instantaneous target. The Instantaneous LED is a red sealed in target.

Negative Sequence: Indicates that a negative sequence trip has occurred. The negative sequence element 46 when tripped will activate the Negative Sequence target. The Negative Sequence LED is a red sealed in target.

Windows External Communications Program

Use a 9-pin null modem adaptor with a 9-pin RS-232 cable when you connect a PC directly to the DPU2000R (not via modems). When connecting to a modem, simply use a 25-pin to 9-pin RS-232 cable.

If the DPU2000R relay has been provided with the newer enhanced Operator Control Interface (OCI) panel, as discussed in Section14, it is not necessary to use a null modem adapter; rather a conventional 9 pin cable will function. A null modem cable cannot be used for theport located on the front of the OCI panel. For the ports located on the rear of the relay, a null modem cable or adapter is required for communication to the relay.

The application program on this disk has been carefully tested and performs accurately with most IBM-compatible personal computers. If you experience difficulty in using WinECP, use its online helper or contact ABB at (610)395-7333.

WinECP Menus

Below is an outline of all the menus available through the Windows External Communications Program. Many of these menus are the same as those in the man-machine interface (OCI), but some are unique to the WinECP. Tables 5–1 through 5-5 show the specific settings for the DPU2000R.

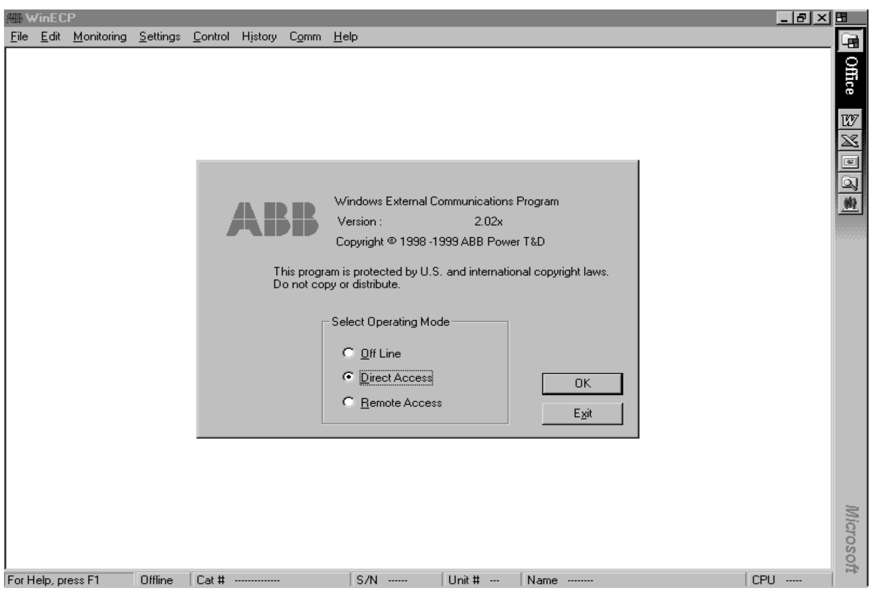


Figure 5-4. WinECP Program Menu

WHAT IS WINECP?

WinECP is an interface program to ABB protective relays. WinECP resides on a PC and communicates to the relay via one of the PC's serial communication ports.

WinECP operates either "on-line" (i.e., communicating with a relay) or "Offline". In the Offline mode, WinECP is not communicating with a relay but with data files which may have been saved from a relay or from a previous WinECP session. WinECP also acts as a "communication bridge" to other software programs and features such as CurveGen, Oscillographics Analysis Tool and Load Profile.

System Requirements

To use WinECP you must have:

Ø Pentium class or better PC
Ø Microsoft Windows 95, Windows 98 or Windows NT
Ø Minimum screen resolution setting of 800x600

This User Guide is intended for use by power utility technicians and engineers and sales persons familiar with ABB protective relays. These users should also be familiar with the PC and use of Windows programs.

INSTALLATION

To install WinECP on your computer's hard drive, follow these steps:

1. Start Microsoft Windows 95 or NT.
2. Place Installation Disk 1 in the floppy diskette drive.
3. From the Start Menu, select Run.
4. Type the letter of the floppy diskette drive where you placed the installation disk, followed by a colon, followed by setup.

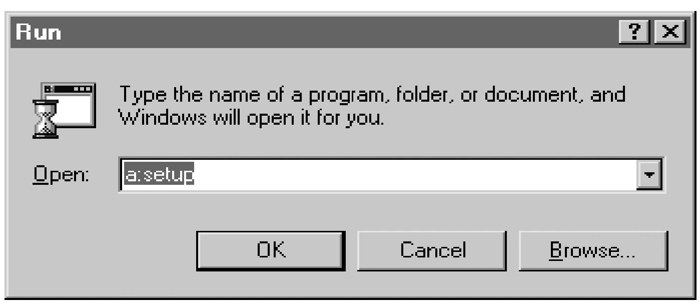


Figure 1

For example, if you placed the diskette in drive b, you would type: b:setup

5. Click OK.
6. Follow the instructions on your computer screen to complete the installation.

The installation program copies the selected application files (WinECP, Oscillographics Analysis Tool and/or FPI) onto your hard drive. The default directory for installation is \ABB Applications.

The installation also creates a Windows Start Programs Menu group called ABB Applications, which contains shortcuts to the applications installed by the WinECP installation program.

STARTING WINECP

To start WinECP, follow these steps:

1. Click Start, Programs.
2. From the list of Programs, highlight ABB Applications, then WinECP, then click on "WinECP".

SELECT OPERATING MODE

The "Select Operating Mode" window is the first screen that appears when you start the WinECP program. From this window, you can choose to work Offline, via Direct Access (the PC is directly connected to the Relay), or via Remote Access (connected through a modem using a dial-up connection).

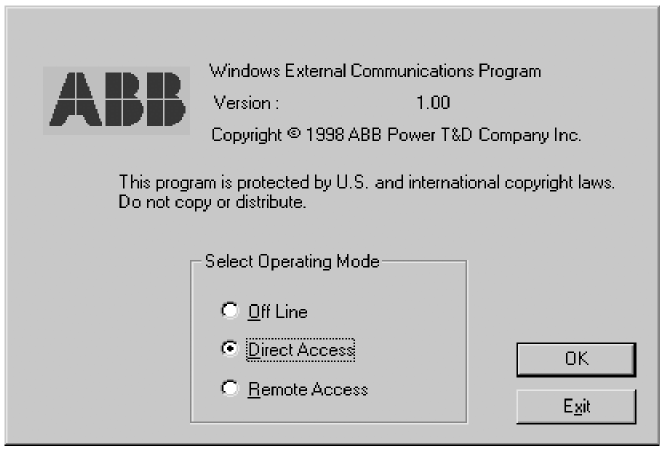


Figure 2

If you select to work Offline, another window appears prompting you to select a relay file or a relay type. (See Figure 3). If you choose to work directly with the relay via Direct Access, a window will appear prompting you to make your Communications Port selections (See Figure 6). If you choose to work with the relay via Remote Access, a window will appear requesting dial-up information (See Figure 7).

Offline

When you select "Offline", you are prompted to select a Relay File or a Relay Type. To use previously saved information, choose "Browse" and select an existing relay file on your hard drive. To generate a new configuration, select a relay type from the drop down list, then choose "Create Catalog Number" to configure the Catalog Number specifications.

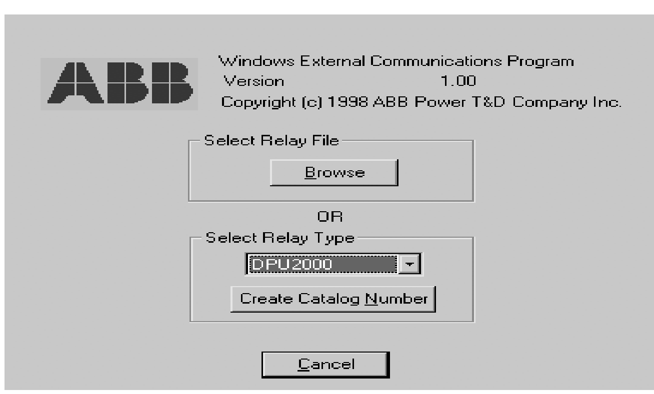


Figure 3

Create Catalog Number

After selecting a relay type and choosing "Create Catalog Number", the following screen appears: (Figure 4) From this screen, you can build the product's catalog number via the editable fields. (NOTE: For additional information regarding catalog numbers, refer to the Ordering Selections page in the Instruction Manual or Descriptive Bulletin.) The Catalog Number can be changed by manually inputting the individual numbers, or by using the drop-down arrow in each field and making the desired selection.

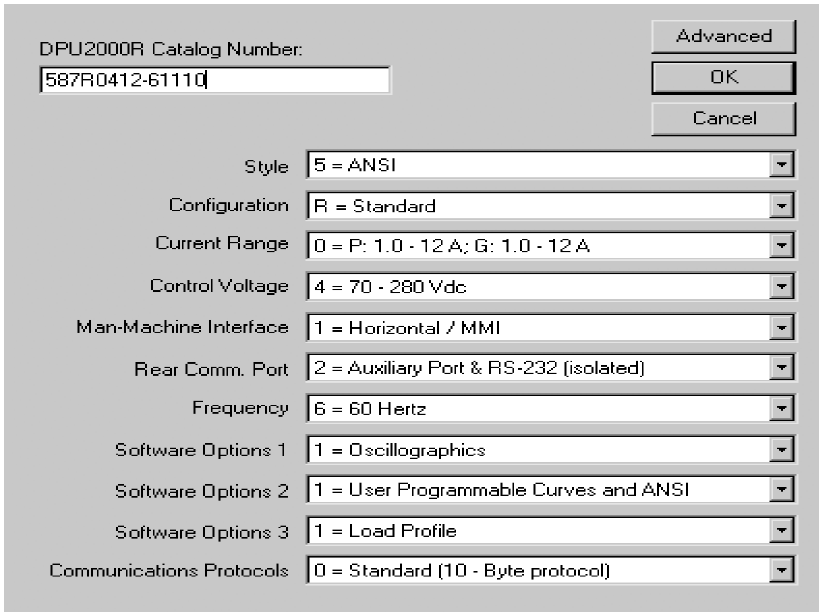


Figure 4

When you have completed your selections in the Create Catalog Number screen, click OK.

Advanced (Version Number)

By clicking the Advanced button in the Create Catalog Number screen, you can select the firmware version number of the relay. Use the drop down arrow that appears in the "Version" window (Figure 5) to choose from a list of Firmware Version Numbers available for the relay type that you have selected. When you have finished making your selection, click OK.

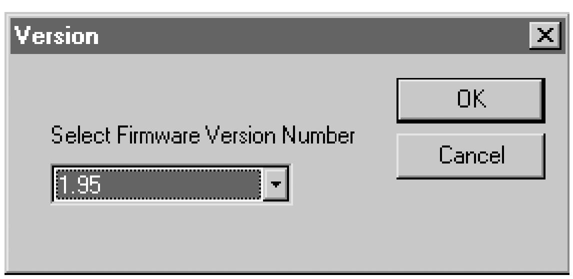


Figure 5

Direct Access

If you wish to connect directly to the relay, select "Direct Access" at the Select Operating Mode dialog (See Figure 2). Make the appropriate selections from the Comm Port Setup dialog that is displayed and then click Connect.

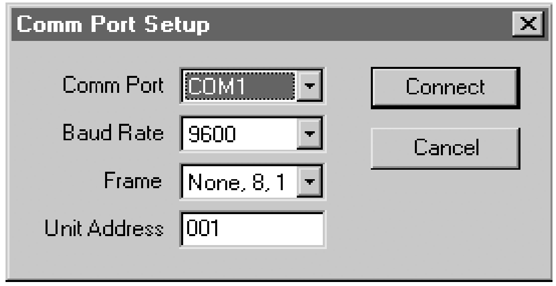


Figure 6

Remote Access

If you wish to connect to a relay remotely (e.g., a relay that is off-site), select "Remote Access" at the Select Operating Mode dialog (See Figure 2). When the Remote Access dialog appears, enter the dialing information (phone number) that will enable the modem to dial into the remote relay.

The Comm Port settings can be configured from within the Remote Access dialog by selecting the drop down arrows next to each item included in "Comm Port Setup". This is the comm port on your computer.

Be sure to select the correct "Dial Mode" for your telephone line, either Tone Dial or Pulse Dial, by clicking once on the button located next to your selection.

You must specify the Unit Address of the remote site relay to which you wish to connect.

If you are connecting to a unit with Code Operated Switch capability, place a checkmark in the box next to "Code Operated Switch (COS)" by clicking once on the box.

When you have completed entering the phone number information (the dialing string), click Dial.

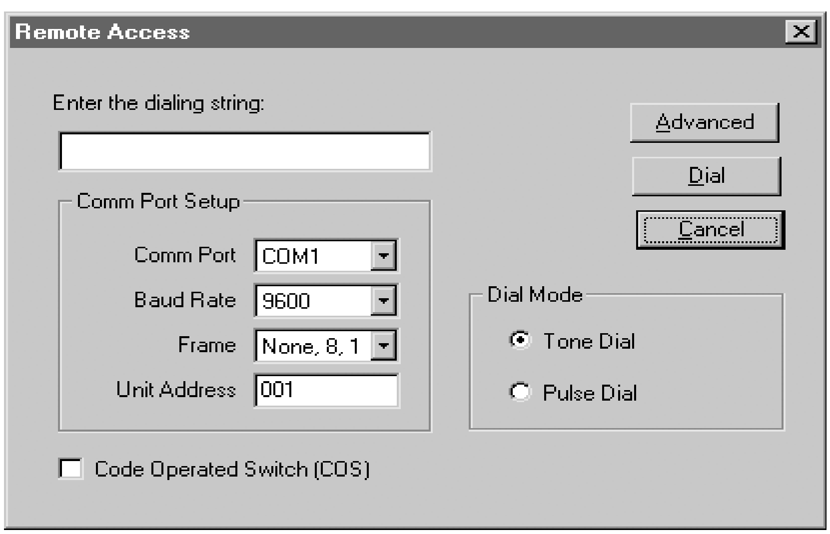


Figure 7

Advanced (Modem Initialization String)

The Modem initialization string has been written to correctly initialize almost all modems. If your modem fails to work and you need to change the modem initialization string, click the Advanced button and enter the appropriate information. (Figure 8) Click OK to return to the Remote Access dialog and initiate the call.

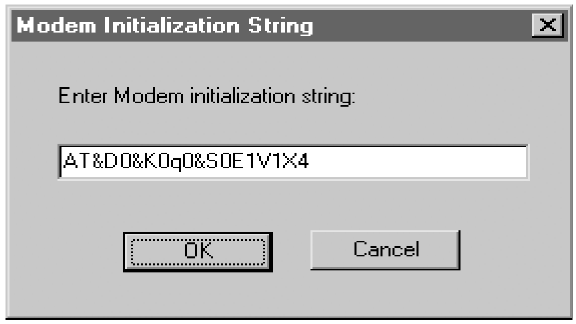


Figure 8

WINECP MAIN WINDOW

After you have established your connection to the relay (Offline, Direct Access or Remote Access), you will be ready to begin utilizing the functions of the WinECP program from within the Main window of WinECP.

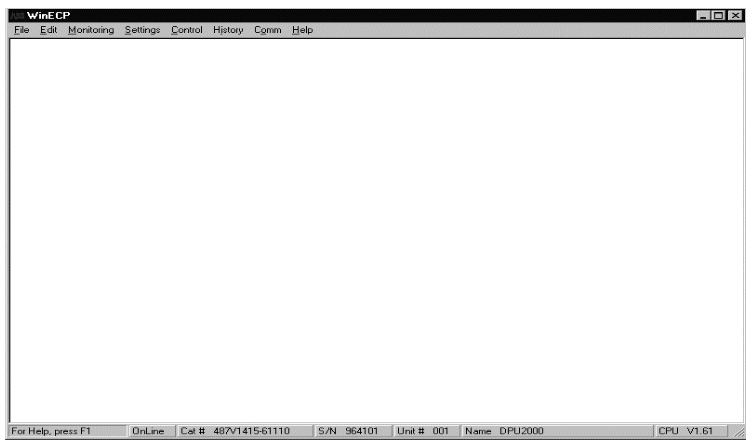


Figure 9

Note: Screen is blank.

Menu Items

The main WinECP window contains the following menu items:

1. File
2. Edit
3. Monitoring
4. Settings
5. Control
6. History
7. Comm
8. Help

Status Bar

The Status Bar appears at the bottom of the main WinECP window. It contains the following information regarding the current connection status to the relay:

1. Help Instructions

NOTE: Full Help capability is still under development and is not included with the WinECP Release 1.00.

2. Connection Type
    a. Online
    b. Offline
3. Catalog Number
4. Serial Number
5. Unit Number
6. Unit Name
7. Firmware Version Number (CPU #)

FILE

From the File menu, you can choose to start a New Session, Import or Export data, open other ABB applications (Oscillographics Analysis Tool or FPI) or Exit the WinECP application.

New Session

1. Click File, New Session.
2. At the prompt, choose Yes to save your current settings to a file on your hard drive, or click No to continue to a new session without saving your current settings. Choose Cancel if you wish to cancel beginning a new session.

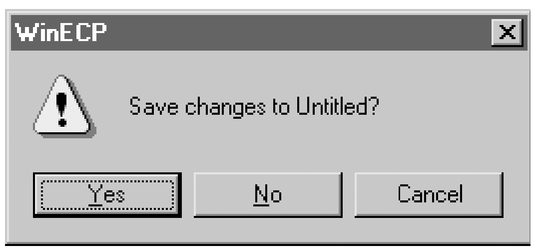


Figure 10

Export

1. Select File, Export.
2. Select the data you wish to save to a file.
    a. Load Profile - When the Save As dialog appears, choose the location where you would like to have the file stored. Assign a name to the file and click Save.
    b. Load Profile All - When the Save As dialog appears, choose the location where you would like to save the file on the computer. Assign a name to the file and click Save.
    c. Oscillographics - When the Waveform Capture Records dialog appears, select the record number you wish to save and click Save to File. When the Save As dialog appears, choose the location where you like to have the file stored.

NOTE: When exporting Oscillographics, the file name is already designated according to the Record Number you choose to save. You can change the default file name by typing in a new name.

When you have verified that the location and file name are correct, click Save.
When the file save has finished, you may either choose another record to save (repeat the above steps) or click Cancel to end the Export Oscillographics process.

d. Program Curves - When the Save As dialog appears, choose the location where you would like to have the file stored. Assign a name to the file and click Save.

When the User dialog appears, select either User1, User2 or User3 and click OK.

Import

1. Select File, Import.
2. Select Program Curves.
3. When the Open dialog appears, select the file you wish to import to the relay and click Open.
4. When the User dialog appears, select either User1, User2, or User3 and click OK.
5. When the Password dialog appears, enter the correct password and click OK.

Oscillographics Analysis Tool

To run the Oscillographics Analysis Tool program, click Osc. Analysis Tool.

NOTE: If you chose not to install Oscillographics Analysis Tool at the time of the initial WinECP installation, you will not be able to access the Oscillographics Analysis Tool software.

FPI

Please note that due to a major change for the design improvement of the DPU2000R relay, existing models with firmware V 4.1X or lower cannot utilize FPI. The relays will not accept the flash in the features provided in the DPU2000R relay with firmware V 5.0 or higher. They cannot be field upgraded. If these features are desired for existing units, contact the factory for details. Only those relays indicating firmware V 5.0 in the relay or a “f” suffix on the nameplate’s serial number will have the features discussed in this instruction book.

Firmware version 5.20 may be installed into relays with V5.1X, but the following enchancements included in this firmware version 5.20 will not be installed into the relay:

- **Pickup and dropout timers for the outputs and feedback in the programmable outputs.**
- **Digital Fault Recorder (DFR) - on some models**
- **Negative sequence overcurrent protection element (46A)**

If the features of the Firmware version 5.20 are desired, the chassis of the relay (main board) must be replaced. Contact ABB, Inc.-Allentown for details including the model number and serial number of the unit.

To run the FPI program, click FPI.

NOTE: If you chose not to install FPI at the time of the initial WinECP installation, you will not be able to access the FPI software.

CAUTION!! Settings saved in the FPI application are not compatible with the WinECP application. You must use WinECP if you wish to save all your Settings prior to downloading new firmware.

Exit

To quit the WinECP application, click Exit.

EDIT

The "Edit" Menu item allows you to copy and paste settings from the Alternate 1, Alternate 2, and Primary settings screens. The copy and paste functions work only with these settings screens, permitting you to copy settings from one screen to another (e.g., from Primary to Alternate 1 or Alternate 2).

NOTE: The copy and paste functions are only enabled when working in the Alternate 1, Alternate 2, and Primary settings screens. They are disabled when you are working on any other settings screen. The "paste" function is enabled only if you have previously selected to "copy" settings from one of these three settings screens.

MONITORING

The monitoring screens periodically poll the relay for data. Select the Monitoring screen whose data you wish to view. Each menu item presents a separate window from which you can view the data as it updates.

To differentiate groups of data, numeric values are shown in differing colors.

To close a Monitoring window, click the "X" in the upper right corner of that window.

Figure 11

NOTE: You must be online with the relay (either via Direct Access or Remote Access) in order to monitor data "live" from the relay.

SETTINGS

From the Settings Menu, you can perform the following functions on one or more tabbed sheets: (Figure 12)

1. Upload from the System - load data into the WinECP program from the relay.
2. Download to the System - load data from the WinECP program to the relay.
3. Save File - save existing data in the WinECP program to a file on your hard drive.
4. Read File - read data into the current Settings sheets from a file on your hard drive.
5. Print - print selected Settings sheets.

Select All/Remove All

From the Settings tab sheet, you can choose to Select All settings if you wish to perform any of the above functions on all or several tabbed sheets.

From the Settings tabbed sheet, click the Select All button. Note that a checkmark is placed in each box on the tabbed sheet. This indicates which data settings you wish to manipulate.

To clear all the checkmarks from the Settings tabbed sheet, click Remove All. Note that all checkmarks are cleared.

You can select or deselect individual settings by clicking once on the checkbox next to the specific setting you wish to change.

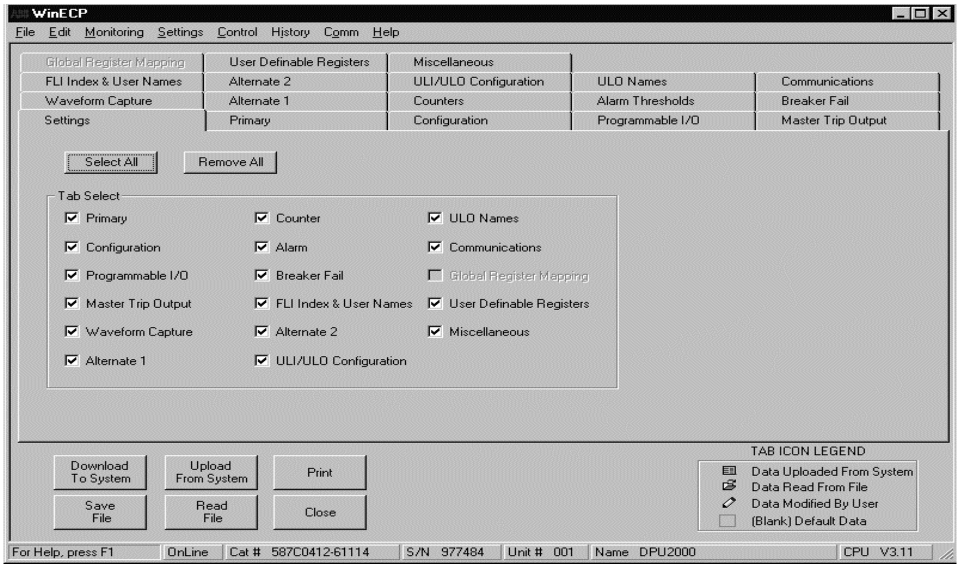


Figure 12

Download to System

To Download data to the relay (must be online), click the Select All button from the main Settings tabbed sheet or select only the checkboxes of those settings you wish to download to the relay.

After selecting the settings sheet(s) you wish to download, click Download to System. Enter the correct password and click OK.

Upload from System

To Upload data from the relay (must be online), click the Select All button from the main Settings tabbed sheet or select only the checkboxes of those settings you wish to upload from the relay.

Click Upload from System.

Save File

To Save data to a file on your hard drive, (online or offline), click the Select All button from the main Settings tabbed sheet or select only the checkboxes of those settings you wish to save to a file.

Click Save File. When the Save As dialog window appears, select a name for the file and the location where the file is to be saved and click Save.

Read File

To Read data from an existing file on your hard drive, (online or offline), click the Select All button from the main Settings tabbed sheet or select only the checkboxes of those settings you wish to read in from a file.

Click Read File. When the Select Relay File window appears, select the relay file you wish to read in and click Open.

Print

To Print data, click Select All from the main Settings tabbed sheet or select only the checkboxes of those settings you wish to print.

Click Print and follow the instructions in the Print dialog window to select your printer, number of copies, etc.

NOTE: You can choose to Download, Upload, Save, Read or Print directly from a Settings tabbed sheet in which you are currently working, in which case only that sheet will be affected.

View/Make Changes to Individual Settings Sheets

1. Click Settings on the menu bar.
2. When the Settings screen appears, click the Primary (or other) tabbed sheet.
3. Note that the Primary sheet now opens and from there you can select from the categories contained on that sheet:

a. Overcurrent
b. Voltage
c. Recloser
d. Directional
e. Frequency
f. Distance
g. Synch Check

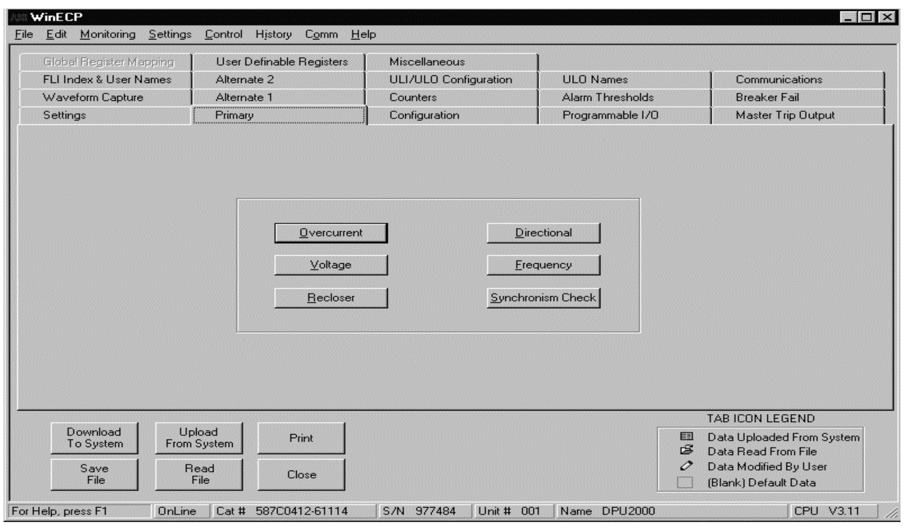


Figure 13

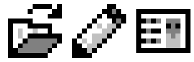
Follow the same guidelines for each tabbed sheet you wish to view, clicking on the appropriate "tab" to bring that sheet to the forefront of the window.

To change data within each tabbed sheet settings category, click on the field whose data you wish to change. When the pop-up window appears, click the arrow to either display a list of items or to change the numeric range of that particular setting.

If the setting you wish to change is a numeric value, you can also enter the desired number by using the numeric keypad on your keyboard.

NOTE: The numeric value you enter manually must fall within the allowable range for that setting. If you enter a value

that is outside of the specified range, you will receive a warning to that effect and will need to correct the value.
As data is manipulated in the tabbed sheets, one of the following icons will appear in the left corner of each tabbed sheet whose data has changed.



= Data has been read in from an existing file
= Data has changed in the tabbed sheet
= Data was successfully downloaded or uploaded to/from the relay

NOTE: If you are in a tabbed sheet and select to Upload/Download, or Read/Save, only that particular tabbed sheet will be affected.

CONTROL

The Control menu provides testing functionality for the relay.

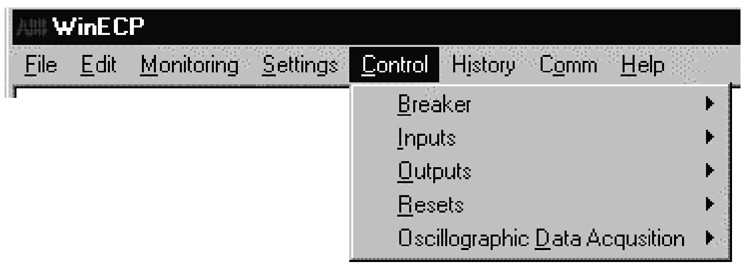


Figure 14

NOTE: You must be connected (online) to a relay in order to conduct testing of the relay through the Control Menu.

NOTE: When a CLOSE command is issued to the DPU2000R with Software Version 1.00 or higher in a "Circuit Breaker Status Indeterminate" state (that is the 52A and 52B contacts inputs read the same value), the DPU2000R will hold the command in memory. This CLOSE command will be executed if the status of the 52A/52B contact inputs become determinate and indicates a "Breaker Open" State. The CLOSE command will not be executed if the status of the 52A/52B contact inputs become determinate and indicates a "Breaker Close" state, or if the DPU2000R is reset, or if control power to the DPU2000R is cycled.

HISTORY

Use the History Menu to view Fault and Operations Records currently stored in the relay. (Figure 13) From this screen, you can select and perform the following functions:

1. Upload
2. Save File
3. Read File
4. Print

Select All/Remove All

You can choose to Select All History records if you wish to perform any of the above functions on all tabbed sheets.

From the History tabbed sheet, click the Select All button. Note that a checkmark is placed in each box on the tabbed sheet. This indicates which data records you wish to manipulate.

To clear all the checkmarks from the History tabbed sheet, click Remove All. Note that all checkmarks are cleared and you can now select individual records by clicking once on the checkbox next to the specific record you wish to use.

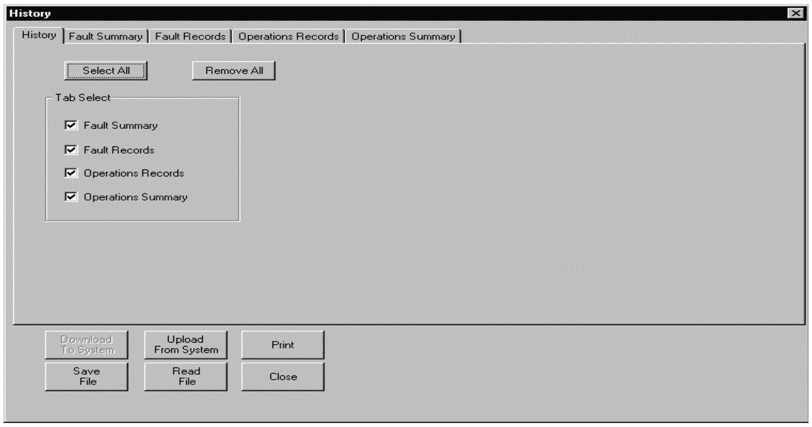


Figure 15

Upload from System

To Upload history data from the relay (must be online), click the Select All button from the History tabbed sheet or select only the checkboxes of the history records you wish to upload from the relay.

Click Upload from System.

Save File

To Save history data to a file on your hard drive after you have Uploaded the data from the relay, click the Select All button from the History tabbed sheet or select only the checkboxes of the history records you wish to save to a file.

Click Save File. When the Save As dialog window appears, select a name for the file and the location where the file is to be saved and click Save.

Read File

To Read history data from an existing file on your hard drive, (online or offline), click the Select All button from the History tabbed sheet or select only the checkboxes of the history records you wish to read in from a file.

Click Read File. When the Select Relay File window appears, select the relay file you wish to read in and click Open.

Print

To Print history data, click Select All from the History tabbed sheet or select only the checkboxes of the history records you wish to print.

Click Print and follow the instructions in the Print dialog window to select your printer, number of copies, etc.

View Individual History Records Sheets

1. Click History on the menu bar.
2. When the History screen appears, click the Fault Summary tabbed sheet. Note that the Fault Summary sheet now opens. You can now choose to Upload, Save File, Read File, Print or Close (History window) directly from this sheet.

NOTE: Remember that if you choose to Upload, Save, Read or Print directly from a History tabbed sheet which you are currently viewing, only that tabbed sheet will be affected.

COMM

Dependent upon your current connection to the relay, you can change the type of connection from the Comm Menu. If you are Offline, you can change to either a Direct or Remote Access connection with a relay.

NOTE: When you select to change to either a Direct or Remote Access connection , you will be prompted to save your current settings (see Figure 10). Click Yes to save your current settings to a file on your hard drive, or click No to establish a new connection without saving your current settings. Click Cancel if you wish to cancel establishing a new connection.

From the Comm Menu, you can also select to change Comm Port settings, set the Unit Address and open the Terminal application.

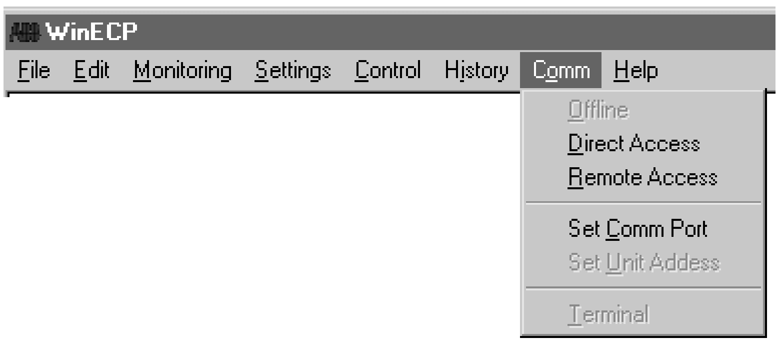


Figure 16

HELP

From the Help Menu item, you can access the Help Topics (currently under development), About WinECP which provides License Agreement, Copyright information, and Unit Information (online only).

Figure 17

Help Topics

NOTE: Complete Help Topics are still under development and are not included with Release V1.00.

For a brief description of the WinECP application, follow these steps:

1. From the menu bar, click Help.
2. Highlight and click Help Topics.
3. Double-click on the "What is WinECP" topic to expand and then double-click on WinECP for a brief description of the application.

About WinECP

About WinECP contains License Agreement information, Copyright information and Version Number. To view the About WinECP information, follow these steps:

1. From the menu bar, click Help.
2. Highlight and click About WinECP.
3. To close the About WinECP window, click OK.

Unit Information

The following unit information is available, during an online session, through the Help Menu item:

a. Product Id
b. Catalog Number
c. CPU Software Version
d. DSP Software Version
e. Front Panel Software Version
f. Rear Comm Software Version
g. Serial Number

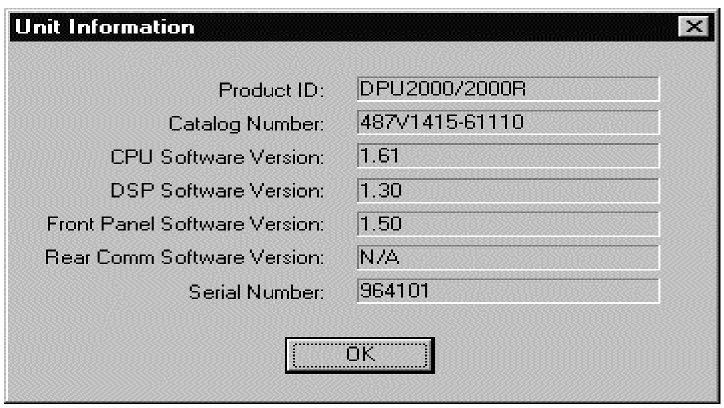


Figure 18

NOTE: Unit Information is only accessible during an online session with the relay.

To access Unit Information (during an online session), follow these steps:

1. From the menu bar, click Help.
2. Highlight and click Unit Information.
3. To close the Unit Information window, click OK.

Table 5-1. Primary, Alternate 1 and Alternate 2 Settings (Password Protected)

Function	Setting	Range	Step Size	Default
51P (3I>)	Curve Selection	See Table 1-1		Extremely Inverse
	Pickup Amps	0.4 to 12 A or 0.08 to 2.4 A	0.1 or 0.02	6.0 or 1.2
	Time Dial/Delay	1.0 to 10.0		5.00
50P-1 (3I>>1)	Curve Selection	See Table 1-3 or Disable		Standard
	Pickup X 51P	0.5 to 40 times 51P pickup setting	0.1	3.00
	Time Dial/Delay	See Table 1-3		-
50P-2 (3I>>2)	Selection	Disable or Enable		Disable
	Pickup X 51P	0.5 to 40 times 51P pickup setting	0.1	-
	Time Delay	0 to 9.99 seconds	0.01	-
50P-3 (3I>>3)	Selection	Disable or Enable		Disable
	Pickup X 51P	0.5 to 40 times 51P pickup setting	0.1	-
46 (Insc>)	Curve Selection	See Table 1-10 or Disable		Disable
	Pickup Amps	0.4 to 12 A or 0.08 to 2.4 A	0.1 or 0.02	-
	Time Dial/Delay	See Table 1-10		-
46A (InscA>)	Curve Selection	See Table 1-10 or Disable		Disable
	% of 51P Pickup	5-50% of 51P pickup	5%	-
	Time Dial/Delay	See Table 1-10		-
51N (IN>)	Curve Selection	See Table 1-2 or Disable		Extremely Inverse
	Pickup Amps	0.4 to 12 A or 0.08 to 2.4 A	0.1 or 0.02	6.0 or 1.2
	Time Dial/Delay	See Table 1-2		5.00
50N-1 (IN>>1)	Curve Selection	See Table 1-6 or Disable		Standard
	Pickup X 51N	0.5 to 40 times 51N pickup setting	0.1	3.00
	Time Dial/Delay	See Table 1-6		-
50N-2 (IN>>2)	Selection	Disable or Enable		Disable
	Pickup X 51N	0.5 to 40 times 51N pickup setting	0.1	-
	Time Delay	0 to 9.99 seconds	0.01	-

Table 5-1. Primary, Alternate 1 and Alternate 2 Settings (Password Protected) (Continued)

Function	*Setting*	*Range*	*Step Size*	*Default*
50N-2 ⊗ (IN>>2)	Select	Disable, Standard, SEF, Directional SEF		Disable
	SEF Pickup Amps ⊗	5 mA to 400 mA	0.5 mA	15 mA
	Delay ⊗	0.5 to 180.0 seconds	0.1	-
	Torque Angle*	0 to 355	5	-
25 **	Select	Enable, Disable	-	Disable
	DB-LL	Enable, Disable	-	-
	LBDL	Enable, Disable	-	-
	DBDL	Enable, Disable	-	-
	Volt Diff	5 to 80 volts	5	-
	Angle Diff	1 - 90 Degrees	1	-
	T Delay	0 to 60 sec.	.1	-
	Slip Freq	.005 to 1.000 Hz	.005	-
	Bkr Cl Time	Disable, 0 to 20 cycles	1	-
	V Phase Sel	Van Vbn Vcn Vab, Vbc, Vca	-	-
	Dead Volt	10 to 150 volt	1	-
	Live Volt	10 to 150 volt	1	-
	Dead Time	0 to 120 sec.	.1	-
	Reclose	Enable, Disable	-	-
	Fail Time	Disable, 0 - 600 sec.	1	-
50N-3 (IN>>3)	Selection	Disable or Enable		Disable
	Pickup X 51N	0.5 to 40 times 51N pickup setting	0.1	-
79 (O->I)	Reset Time	3 to 200 seconds	1	10.00
79-1 (O->I1)	Select	50P-1, 50P-2, 50P-3, 51N, 50N-1, 50N-2, 50N-3 (Enable, Disable, or Lockout for each)		50-P Enable 51-N Enable 50N-1 Enable
	Open Time	0.1 to 200 seconds or Lockout	0.1	Lockout

* Directional SEF Model Only

⊗ SEF Model

** Sync Check Only

Table 5-1. Primary, Alternate 1 and Alternate 2 Settings (Password Protected) (Continued)

79-2 (O->I2)	Select	50P-1, 50P-2, 50P-3, 51N, 50N-1, 50N-2, 50N-3 (Enable, Disable, or Lockout for each)		-
	Open Time	0.1 to 200 seconds or Lockout	0.1	-
79-3 (O->I3)	Select	50P-1, 50P-2, 50P-3, 51N, 50N-1, 50N-2, 50N-3 (Enable, Disable, or Lockout for each)		-
	Open Time	0.1 to 200 seconds or Lockout	0.1	-
79-4 (O->I4)	Select	50P-1, 50P-2, 50P-3, 51N, 50N-1, 50N-2, 50N-3 (Enable, Disable, or Lockout for each)		-
	Open Time	0.1 to 200 seconds or Lockout	0.1	-
79-5 (O->I5)	Select	50P-1, 50P-2, 50P-3, 51N, 50N-1, 50N-2, 50N-3 (Enable, Disable, or Lockout for each)		-
	Open Time	Lockout		-
79-CO (O->I-CO)	Cutout Time	1 to 200 seconds or Disable	1	Disable
Cold Load Time		0 to 254 seconds/minutes or Disable	1	Disable
2-Phase 50P (3I>>)	2Phase 50P Trip	Disable or Enable		Disable
67P (3I>->)	Select	Disable, Enable or Lockout		Disable
	Curve Selection	See Table 1-11		-
	Pickup Amps	0.4 to 12 A or 0.08 to 2.4 A	0.1 or 0.02	-
	Time Dial/Delay	See Table 1-11		-
	Torque Angle	0 to 355°	5	-
67N (IN>->)	Select	Disable, Enable or Lockout*		Disable
	Curve Selection	See Table 1-12		-
	Pickup Amps	0.4 to 12 A or 0.08 to 2.4 A	0.1 or 0.02	-
	Time Dial/Delay	See Table 1-12		-
	Torque Angle	0 to 355°	5	-
81	Select	Disable, Enable 81-1, Enable 81-2		Disable
81S-1 (f<1)	Pickup Hz (load shed)	56 to 64 Hz or 46 to 54 Hz	0.01	-
	Time Delay (shed)	0.08 to 60 seconds	0.01	-
81R-1 (f>1)	Pickup Hz (load restore)	Disable, 56 to 64 Hz, or 46 to 54 Hz	0.01	-
	Time Delay (restore)	0 to 999 seconds	1	-
81S-2 (f<2)	Pickup Hz (load shed)	56 to 64 Hz or 46 to 54 Hz	0.01	-
	Time Delay (shed)	0.08 to 60 seconds	0.01	-
81R-2 (f>2)	Pickup Hz (load restore)	Disable, 56 to 64 Hz or 46 to 54 Hz	0.01	-
	Time Delay (restore)	0 to 999 seconds	1	-
81V (fU<)	Voltage Block	40 to 200 volts AC	1	-

* Disable, Enable-Neg Seq, Lockout-Neg Seq

Table 5-1. Primary, Alternate 1 and Alternate 2 Settings (Password Protected) (Continued)

Function	Setting	Range	Step Size	Default
27 (U<)	Select	Disable or Enable		Disable
	Pickup Volts	10 to 200 volts AC	1	-
	Time Delay	0 to 60 seconds	1	-
79V (O->IU<)	Voltage Select	Disable or Enable		Disable
	Pickup Volts	10 to 200 volts AC	1	-
	Time Delay	4 to 200 seconds	1	-
59 (U>)	Select	Disable or Enable		Disable
	Pickup Volts	70 to 250 volts AC	1	-
	Time Delay	0 to 60 seconds	1	-
59G	Select	Disable or Enable		Disable
	Pickup Volts	1 to 50 volts AC	0.5	40.0
	Time Delay	0 to 30 seconds	.1	1.0
47	Select	Disable or Enable		Disable
	V_2 Pickup Volts	5.0 to 25 volts AC	0.5	10.0
	Time Delay	0 to 60 seconds	1	10.0
21P-1 Forward	Select	Disable or Enable	-	Disable
	Phase Reach	0.1 - 50.0 ohms	.1 ohm	4.0 ohms
	Char Angle	1.0 - 9.0	0.1°	75°
	Time Delay (shed)	0.0 to 10 seconds	0.10	-
	I_0 Suprv*	1.0 to 6.0 amps	0.1	-
21P-2 Forward	Select	Disable or Enable	-	Disable
	Phase Reach	0.1 - 50.0 ohms	.1 ohm	4.0 ohms
	Char Angle	1.0 - 9.0	0.1°	75°
	Time Delay (shed)	0.0 to 10 seconds	0.10	-
	I_0 Suprv*	1.0 to 6.0 amps	0.1	-
21P-3 Reverse	Select	Disable or Enable	-	Disable
	Phase Reach	0.1 - 50.0 ohms	.1 ohm	4.0 ohms
	Char Angle	1.0 - 9.0	0.1°	75°
	Time Delay (shed)	0.0 to 10 seconds	0.10	-
	I_0 Suprv*	1.0 to 6.0 amps	0.1	-
21P-4 Reverse	Select	Disable or Enable	-	Disable
	Phase Reach	0.1 - 50.0 ohms	.1 ohm	4.0 ohms
	Char Angle	1.0 - 9.0	0.1°	75°
	Time Delay (shed)	0.0 to 10 seconds	0.10	-
	I_0 Suprv*	1.0 to 6.0 amps	0.1	-
32P-2 (I1->)	Select	Disable or Enable		Disable
	Torque Angle	0 to 355	5	-
32N-2 (3I->)	Select	Disable or Enable		Disable
	Torque Angle	0 to 355	5	-

*I_0 may be disabled

Table 5-2. Configuration Settings (Password Protected)

Setting	Range	Step Size	Default
Phase CT Ratio	1 - 2000	1	100
VT Ratio	1 - 2000	1	100
VT Connection (VT Conn:)	69 V or 120 V Wye, 69 Wye $3V_0$, 120 Wye $3V_0$, phase to ground; 120 V or 208 V Delta, phase to phase	-	120V Wye
Positive Sequence Reactance/Mile (km) (Pos Seq X/M)	0.001 to 4 Ohms/Mile (km)	0.001	0.001
Positive Sequence Resistance/Mile (km) (Pos Seq R/M)	0.001 to 4 Ohms/Mile (km)	0.001	0.001
Zero Sequence Reactance/Mile (km) (Zero Seq X/M)	0.001 to 4 Ohms/Mile (km)	0.001	0.001
Zero Sequence Resistance/Mile (km) (Zero Seq R/M)	0.001 to 4 Ohms/Mile (km)	0.001	0.001
Line Length	0.1 to 125 miles (km)	0.1	20
Trip Failure Time	5 to 60 cycles	1	18
Close Failure Time	18 to 16,000 cycles, disable	1	18
Phase Rotation (Phase Rotate:)	ABC or ACB	-	ABC
Protection Mode (Prot. Mode:)	Fund. or RMS	-	Fund.
Reset Mode - 51(3I>)/46 (Insc>)	Instant (2 cycles) or Delayed	-	Instant
Alternate 1 Settings (Alt1 Set)	Enable or Disable	-	Enable
Alternate 2 Settings (Alt2 Set)	Enable or Disable	-	Enable
Multiple Device Trip Mode* (MDT)	Disable or Enable	-	Disable
Cold Load Time Mode	Seconds or Minutes	-	Seconds
79V (O->IU<)Time Mode	Seconds or Minutes	-	Seconds
Volt Display	Vln or Vll	-	Vln
Zone Sequence	Disable or Enable	-	Disable
Target Display Mode	Last or All (faults)	-	Last
Remote Edit = (Remote Edit) †	Enable or Disable	-	Enable
Local Edit (Comm Ports Only) ††	Enable or Disable	-	Enable
Meter Mode (WHr Display)	kWHr or MWHr (6 Digits)	-	kWHr
LCD Light	On or Time Out (5 Minutes)	-	On
Unit Identification (ID)	(15 alphanumeric characters)	-	DPU2000R
Demand Meter Constant (Demand Minutes)	5, 15, 30, or 60 minutes	-	15
LCD Contrast	0 to 63	1	16
Change Test Password	4 Alphanumeric characters	-	4 blank spaces
SE CT Ratio ⊗	1 to 2000	1	1
SE V0 PT Ratio ⊗	1 to 2000	1	1
Slow Trip Time (cycles)	5-60	1	12

* When the Multiple Device Trip Mode is enabled, the reset mode automatically goes to Instantaneous setting and cannot be changed.

† Remote edit appears only in MMI display.

††Local edit appears only in the WinECP display.

⊗ SEF model

In the Counter Settings Menu, the user has the option to change the value of the various counters.

Table 5-3. Counter Settings (Password Protected)

Setting	Range	Step Size	Default
KSI Summation A Phase Setting - KSI Sum A (L1)	0 to 9999 kA	1	0
KSI Summation B Phase Setting - KSI Sum B (L2)	0 to 9999 kA	1	0
KSI Summation C Phase Setting - KSI SumC (L3)	0 to 9999 kA	1	0
Overcurrent Trip Counter	0 to 9999	1	0
Breaker Operations Counter	0 to 9999	1	0
79 (O->I) Counter 1	0 to 9999	1	0
79 (O->i) Counter 2	0 to 9999	1	0
1st Reclose Counter (1st Recl) [successful]	0 to 9999	1	0
2st Reclose Counter (2nd Recl) [successful]	0 to 9999	1	0
3rd Reclose Counter (3rd Recl) [successful]	0 to 9999	1	0
4th Reclose Counter (4th Recl) [successful]	0 to 9999	1	0

In the Alarm Settings Menu, the user has the option to set thresholds for various alarms. When the threshold is exceeded, the corresponding logical output is asserted. (See “Programmable I/O” Section).

Table 5-4. Alarm Settings (Password Protected)

Setting	Range	Step Size	Default	Logical Output
KSI Summation	1 to 9999 (kA)	1	Disable	KSI
Over Current Trip Counter	1 to 9999	1	Disable	OCTC
79 (O->I) Counter 1	1 to 9999	1	Disable	79CA1
79 (O->I) Counter 2	1 to 9999	1	Disable	79CA2
Phase Demand Current Alarm	1 to 9999 (A)	1	Disable	PDA
Neutral Demand	1 to 9999 (A)	1	Disable	NDA
Demand 3P-kVar [3-phase kilo VAr alarm] (Dmnd 3P-kVAr)	10 to 99,990 (kVAr)	10	Disable	VarDA
Low PF [power factor alarm]	0.5 to 1.0 (lagging)	0.01	Disable	LPFA
High PF [power factor alarm]	0.5 to 1.0 (lagging)	0.01	Disable	HPFA
Load Current [alarm]	1 to 9999 (A)	1	Disable	LOADA
Positive kVAr [3-phase kiloVAr alarm]	10 to 99,990 (kVAr)	10	Disable	PVArA
Negative kVAr [3-phase KiloVAr alarm]	10 to 99,990 (kVAr)	10	Disable	NVArA
Positive KWatt Alarm 1	1 to 9999	1	Disable	PWatt1
Positive KWatt Alarm 2	1 to 9999	1	Disable	PWatt2

Table 5-5. Communications Settings (Password Protected)

Setting	Range	Default
Unit Address	3 hexadecimal characters (0-9 & A-F)	001
Front RS232 Port:		
Baud Rate	300, 1200, 2400, 4800, 9600	9600
Frame	N,8,1 or N,8,2	N,8,1
Rear Port RS232 :		
Baud Rate*	300, 1200, 2400, 4800, 9600, 19200	9600
Frame	N,8,1; E,8,1; ODD,8,1; N,8,2; E,7,1; ODD,7,1; N,7,2	N,8,1
Rear Port RS485 :		
Baud Rate*	300, 1200, 2400, 4800, 9600, 19200	9600
Frame	N,8,1; E,8,1; ODD,8,1; N,8,2; E,7,1; ODD,7,1; N,7,2	N,8,1
Rear Port INCOM Baud Rate*	1200, 9600	9600
Rear Port IRIG-B Enable*	Disable or Enable	Disable
Network Parameters*	0 to 250	0
Network Modes*	Disable or Enable	Disable

* Check catalog number for available communications port options. Network parameters and network modes are specific settings designed for various SCADA protocols.

In addition to the Tables 5-1 through 5-5, under the “Change Settings” menu, the following settings are also available:

FLI Index and User Names

This allows the user to set up a table of Logical Inputs that can be “forced” via the Operations Menu. See Section 8 for details.

User Logical Output Names

The user has the ability to change the names of “ULO1” through “ULO16”. See Section 6 for details on how to use the User Logical Outputs.

ULI/ULO Configuration

This allows the user to connect or disconnect ULI’s from corresponding ULO’s. The default is all ULI’s connected to ULO’s. See Section 6 for details on ULI/ULOs.

Master Trip Output

The user has the ability to allow only certain protective elements to operate the Master Trip Output Contact (terminals 29 and 30). See Section 6 for more details.

Breaker Fail Settings

This is where all settings for the Breaker Failure Function are done. See Figure 5-5 and Section 1 for more details.

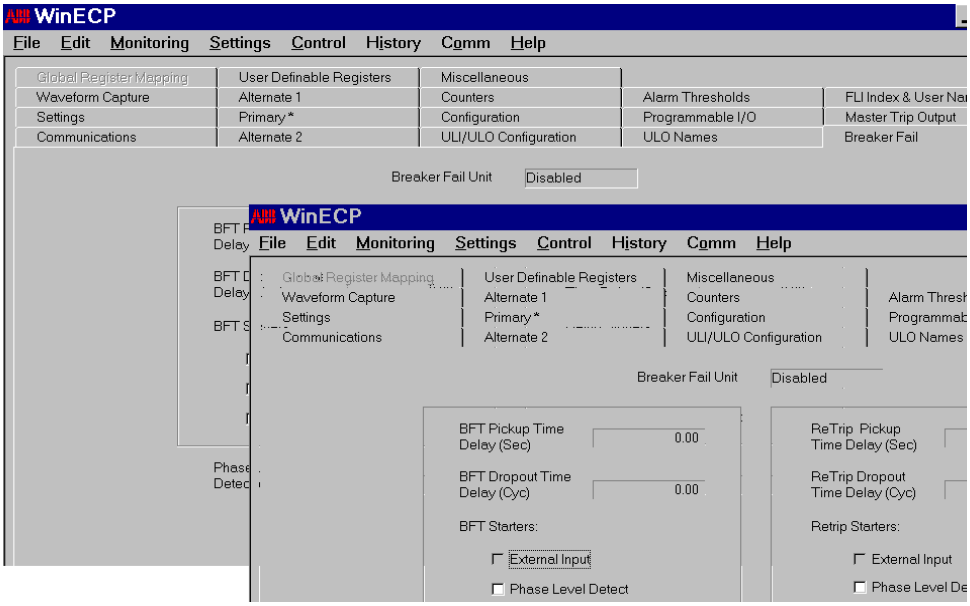


Figure 5-5. DPU External Communications Program Breaker Failure Settings Screen

Global Register Mapping

For use with Modbus Plus™ Communications. Contact Factory for details.

Register Configuration

For use with Modbus/Modbus Plus™ Communications. Contact Factory for details.

Miscellaneous Settings

Under the Miscellaneous Settings Menu, you will find the following:

Communications Configurable Settings-	For use with Modbus/Modbus Plus™ Communications. Contact Factory for details.
Security Mask for Writable 4xxxx Control-	For use with Modbus/Modbus Plus™ Communications. Contact Factory for details.
User Display Message- Programmable Input.	For use with the User Display Input (UDI) The user can type a 4 line message here. When UDI is asserted, this message will blink on the OCI.

Clock

In WinECP, the user can change the relay date and time to the date and time of the PC.

From the MMI, the user can change the relay date and time to the desired setting.

Prolonged Storage of Relay

To preserve the life of the internal battery when the relay is not in service, turn off the clock by entering a “0” for the day.

Programmable Input and Output Contacts

By using the Windows External Communications Program, you can individually program the contact inputs and certain output contacts.

Binary (Contact) Inputs

Binary inputs are either programmable single-ended or programmable double-ended. Single-ended inputs have one terminal connection marked "+" and share a common terminal (# 3) marked "–". Double-ended inputs have two terminal connections, marked "+" and "–". The recognition time for the change in state of an input is two (2) cycles.

Programmable contact inputs with factory default settings include the following:

- 52a (XO) Breaker Position: Breaker Closed (input closed)/Breaker Open (input open)
- 52b (XI) Breaker Position: Breaker Open (input closed)/Breaker Closed (input open)
- 43a (AR) Reclose Function: Enabled (input closed)/Disabled (input opened)

Up to eight user-programmable contact inputs are available. The inputs are programmed via the Windows External Communications Program only. Nine (ten for SEF models) logic functions remain operational (enabled) when not assigned to contact inputs in the Programmable Input Map. These logic functions are: GRD (IN), PH3 (3I), 46 (Insc>), 50-1(I>>1), 50-2 (I>>2), 50-3 (I>>3), TCM (TCS), ZSC and SEF* (IØ >). You must assign the remaining logic functions to contact inputs for those functions to become operational (enabled). The user-programmable inputs can monitor, enable, initiate or actuate the logic functions shown in Table 6-1. The programmable inputs in the table are arranged in the order they appear on the default Programmable Inputs screen.

Figure 6-1 shows the factory default settings for mapping the programmable inputs. The color **red** is used when a closed contact (voltage present) enables the function and the color white is used when an open contact (voltage absent) enables the function. Place the label in the column under the desired contact input's line. For example, based on the factory default settings, you must apply control power to Input 1 to enable logic input contact 52a (XO).

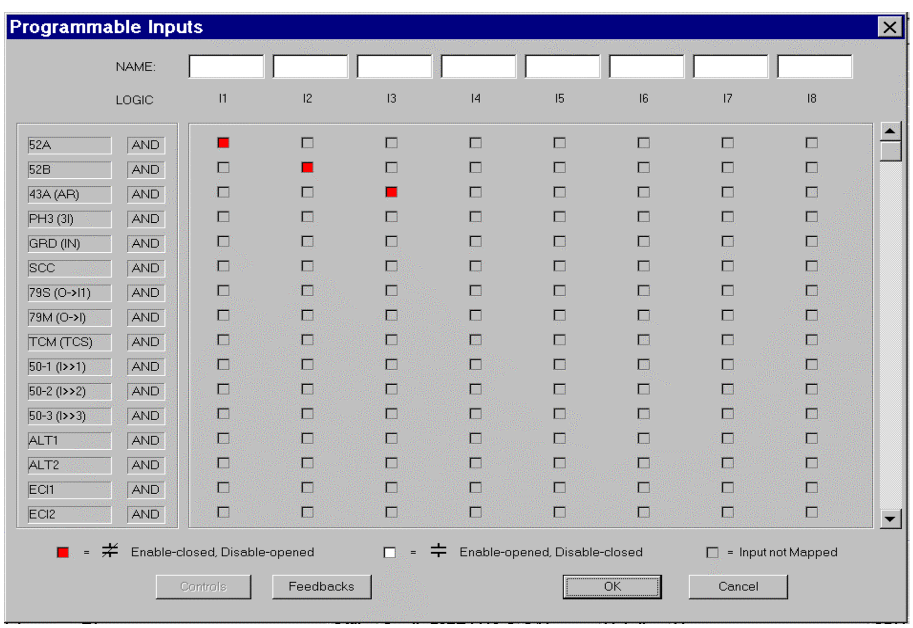


Figure 6-1. Programmable Inputs Screen

Programmable Inputs

Table 6-1: Logical Input Definitions

Abbreviation	Description
——:	Entry not used.
TCM: (TCS)	Trip Coil Monitoring. Assign this to the physical input IN7 or IN8 only to monitor continuity of the circuit breaker coil. See Figure 6-4 for typical trip coil monitoring connections. When input is a logical 1, TCM logic assumes breaker coil continuity. If a logical 0, breaker coil is failed and logical output TCFA (trip circuit failure alarm) is asserted. TCM is only functional when the DPU2000R determines that the breaker is closed. In the MDT mode it is necessary to control the breaker through the DPU2000R since 52a and 52b are ignored and the only way the logic can determine the breaker state is by trip and close signals issued. TCM defaults to a logical 1 (breaker coil healthy) if not assigned to a physical input or feedback term.
GRD: (IN)	Enables 51N/50N-1/50N-2. Use to supervise (torque control) all ground overcurrent protection except 50N-3. When the GRD input is a logical 1, all ground overcurrent protection except 50N-3 is enabled. GRD defaults to a logical 1 (enabled) if not assigned to a physical input or feedback term.
PH3: (3I)	Enables 51P/50P-1/50P-2. Use to supervise (torque control) all phase overcurrent protection except 50P-3. When the PH3 input is a logical 1, all phase overcurrent protection except 50P-3 is enabled. PH3 defaults to a logical 1 (enabled) if not assigned to a physical input or feedback term.
50-1: (I>>1)	Enables 50P-1 & 50N-1. Use to supervise (torque control) phase and ground instantaneous overcurrent protection level 1. When the 50-1 input is a logical 1, phase and ground instantaneous overcurrent protection level 1 is enabled. 50-1 defaults to a logical 1 (enabled) if not assigned to a physical input or feedback term.
50-2: (I>>2)	Enables 50P-2 & 50N-2. Use to supervise (torque control) phase and ground instantaneous overcurrent protection level 2. When the 50-2 input is a logical 1, phase and ground instantaneous overcurrent protection level 2 is enabled. 50-2 defaults to a logical 1 (enabled) if not assigned to a physical input or feedback term.
50-3: (I>>3)	Enables 50P-3 & 50N-3. Use to supervise (torque control) phase and ground instantaneous overcurrent protection level 3. When the 50-3 input is a logical 1, phase and ground instantaneous overcurrent protection level 3 is enabled. 50-3 defaults to a logical 1 (enabled) if not assigned to a physical input or feedback term.
ALT1:	Enables Alternate 1 Settings. When ALT1 is a logical high the Alternate 1 settings are placed into service if Alternate 1 Setting is set to “Enable” in configuration settings. ALT1 defaults to a logical 0 (alternate 1 settings not active) if not assigned to a physical input or feedback term.
ALT2:	Enables Alternate 2 Settings. When ALT2 is a logical high the Alternate 2 settings are placed into service if Alternate 2 Setting is set to “Enable” in configuration settings. ALT2 defaults to a logical 0 (alternate 2 settings not active) if not assigned to a physical input or feedback term.
ZSC:	Enables Zone Sequence Coordination scheme. Allows external supervision of the Zone Sequence scheme. When the ZSC input is a logical 1, zone sequence is enabled. ZSC defaults to a logical 1 (enabled) if not assigned to a physical input or feedback term. See the Section 13 for details on Zone Sequence Coordination.
SCC:	Spring Charging Contact. Connect SCC to a physical input to monitor a recloser spring. If the SCC input is a logical 1, a “Spring Charging” event is logged in the operations record. SCC defaults to a logical 0 (no spring charge event) when not assigned to a physical input or feedback term. SCC only functions when the DPU2000R determines a breaker open state.
79S: (O->I1)	Single Shot Reclosing. Enables a single shot of reclosing when the DPU2000R determines that an external device has opened the circuit breaker. When 79S is a logical 1, single shot reclosing is enabled. 79S defaults to a logical 0 (disabled) when not assigned to a physical input or feedback term. See Section 1 under “Reclosing” for more details.

Table 6-1: Logical Input Definitions (cont).

79M: (O->I)	Multi-Shot Reclosing. Enables a multi shot of reclosing when the DPU2000R determines that an external device has opened the circuit breaker. When 79M is a logical 1, multi shot reclosing is enabled. 79M defaults to a logical 0 (disabled) when not assigned to a physical input or feedback term. See Section 1 under “Reclosing” for more details.
OPEN:	Initiates Trip Output. Assign this input to a physical input for remote opening of the breaker by a control switch. It is recommended this input be used for breaker control when using the MDT mode. When OPEN is a logical 1, a trip is issued at the master trip output. OPEN defaults to a logical 0 (disabled) when not assigned to a physical input or feedback term.
CLOSE:	Initiates Close Output. Assign this input to a physical input for remote closing of the breaker possibly by a control switch. It is recommended this input be used for breaker control when using the MDT mode. When CLOSE is a logical 1, the LOGICAL OUTPUT “CLOSE” is asserted. CLOSE defaults to a logical 0 (disabled) when not assigned to a physical input or feedback term. When a CLOSE command is issued to the DPU2000R with Software Version 1.80 or higher in a “Circuit Breaker Status Indeterminate” state (that is the 52A and 52B contacts inputs read the same value), the DPU2000R will hold the command in memory. This CLOSE command will be executed if the status of the 52A/52B contact inputs become determinate and indicates a “Breaker Open” State. The CLOSE command will not be executed if the status of the 52A/52B contact inputs become determinate and indicates a “Breaker Close” state, or if the DPU2000R is reset, or if control power to the DPU2000R is cycled.
ECI1:	Event Capture Initiate. Assign this input to a physical input to capture events from external devices. When ECI1 is a logical 1, an event called “ECI1” is logged in the operations record. ECI1 defaults to a logical 0 (no event) when not assign to a physical input or feedback term.
ECI2:	Event Capture Initiate. As with ECI1, assign this input to a physical input to capture events from external devices. When ECI2 is a logical 1, an event called “ECI2” is logged in the operations record. ECI1 defaults to a logical 0 (no event) when not assign to a physical input or feedback term.
WCI:	Waveform Capture Initiate. Assign this input to either a physical input or feedback term for initiation of the oscillographic waveform capture. WCI can be used to capture waveform for other devices in the system that do not contain oscillograpic capability. When WCI is a logical 1, the oscillograpic waveform capture is initiated for the number of cycles programmed in the oscillographics settings (see the Oscillographics section). WCI defaults to a logical 0 (no event) when not assigned to a physical input or feedback term.
46: (Insc>)	Enables the 46 Negative Sequence time overcurrent function. Use to supervise (torque control) the negative sequence time overcurrent element. When the 46 input is a logical 1, negative sequence time overcurrent protection is enabled. 46 defaults to a logical 1 (enabled) if not assigned to a physical input or feedback term.
46A: (InscA>)	Enables the 46A Negative Sequence time overcurrent alarm function. Use to supervise (torque control) the negative sequence time overcurrent element. When the 46A input is a logical 1, negative sequence time overcurrent protection is enabled. 46A defaults to a logical 1 (enabled) if not assigned to a physical input or feedback term.
67P: (3I>-->)	Enables the 67P Positive Sequence Directionally Controlled phase time overcurrent function. Use to supervise (torque control) the 67P time overcurrent element. When the 67P input is a logical 1, the 67P time overcurrent protection is enabled. 67P defaults to a logical 1 (enabled) if not assigned to a physical input or feedback term.
67N: (IN>-->)	Enables the 67N Negative Sequence Directionally Controlled ground time overcurrent function. Use to supervise (torque control) the 67N time overcurrent element. When the 67N input is a logical 1, the 67N time overcurrent protection is enabled. 67N defaults to a logical 1 (enabled) if not assigned to a physical input or feedback term.
ULI1-ULI16:	User Logical Inputs 1-16. Input is used to enhance the DPU2000R programmable logic capability. See “Advanced Programmable Logic” later in this section for details. ULIx defaults to a logical 0 (no input) when not assigned to a physical input or feedback term.

Table 6-1: Logical Input Definitions (cont.)

CRI:	Clear Reclose and Overcurrent Counters. Assign this input to a physical input or feedback term to remotely clear the Reclose and Overcurrent Counters. When CRI is a logical 1, the reclose and overcurrent counters are returned to 0. CRI defaults to a logical 0 (no clear) when not assigned to a physical input or feedback term.
UDI:	User Display Input. Assign this input to a physical input to flash a message to the front OCI LCD display. When UDI is a logical 1, a user defined message as preprogrammed using the Windows External Communication Program (WinECP), is displayed along with the LCD default display in 1 second alternating intervals. UDI defaults to a logical 0 (disabled) when not assigned to a physical input or feedback term. This is useful for tagout conditions. The message can be changed using WinECP under "Change Settings", "Miscellaneous Settings".
EXTBFI:	External Starter Input. This input is used to start the breaker failure tripping sequence. See Section 1 under "Breaker Failure Logic". It is typically assigned to the same physical input as the 52a contact. EXTBFI defaults to a logical 0 (no input) when not assigned to a physical input or feedback term.
BFI:	Breaker Fail Initiate. Assign this input to a physical input or feedback term for initiation of the Breaker Failure Trip logic. See Section 1 under "Breaker Failure Logic". It is typically connected to an external protective device with a BFI output contact. BFI defaults to a logical 0 (no input) when not assigned to a physical input or feedback term.
TARC:	Initiate Trip and Auto Reclose. This input is used to issue a circuit breaker trip and reclose. It is useful in the testing of the circuit breaker trip and close circuits as well as the recloser logic and timing settings. When TARC is a logical 1, a trip and automatic reclose sequence is initiated. If the input is held at a logical 1, the DPU2000R will continue to trip and reclose through the recloser steps (79-1, 79-2, 79-3, etc., see Recloser section for reclosing details). If TARC is pulsed at a logical 1, the trip and auto reclose will only occur once unless TARC is pulsed again. TARC defaults to a logical 0 (disabled) when not assigned to a physical input or feedback term.
ARCI:	Automatic Reclose Inhibit. This logical input stops the recloser open timer for the time in which it is a logical 1. When ARCI is returned to a logical 0 the open timer will continue where it was stopped. ARCI does not affect the recloser reset timer. ARCI defaults to a logical 0 (disabled) when not connected to a physical input or feedback term.
52A: (XO)	Breaker Position Input. Assign this input to the physical input that is connected to the circuit breaker 52A auxiliary contact. The DPU2000R requires this input along with the 52B logical input (except when in the MDT mode) to determine circuit breaker states for initiation of circuit breaker close, trip failure, and close failure logical outputs. When 52A is a logical 1 and 52B is a logical 0, the relay logic assumes a closed circuit breaker. When 52A is a logical 0 and 52B is a logical 1, the relay logic assumes an open circuit breaker. If the 52A and 52B are at equal logic states, the DPU2000R will determine a "CB Status Unknown" state as displayed on the front panel OCI LCD display. 52A defaults to a logical 0 when not assigned to a physical input.
52B: (XI)	Breaker Position Input. Assign this input to the physical input that is connected to the circuit breaker 52B auxiliary contact. The DPU2000R requires this input along with the 52A logical input (except when in the MDT mode) to determine circuit breaker states for initiation of circuit breaker close, trip failure, and close failure logical outputs. See 52A for valid breaker operating states. 52B defaults to a logical 0 when not assigned to a physical input.
43A:	Recloser Enable. This input is used to supervise the DPU2000R reclosing function. When the 43A input is a logical 1, the DPU2000R recloser is enabled. When 43A is a logical 0, the recloser is disabled. If the recloser is disabled, a red "Recloser Out" target will illuminate on the front of the DPU2000R. 43A defaults to a logical 1 (enabled) when not assigned to a physical input.
SEF: **SEF Model 0nly**	Sensitive Earth Fault Enable. Enables the sensitive earth fault function (available in Sensitive Earth Fault models only). Use to supervise (torque control) the SEF overcurrent element. When the SEF input is a logical 1, the SEF overcurrent protection is enabled. SEF defaults to a logical 1 (enabled) if not assigned to a physical input or feedback term.

Table 6-1: Logical Input Definitions (cont.)

† 25:	Sync Check enable. This input is used to supervise the Sync Check Element. When this input is a logical 1, Sync Check is enabled. When this input is a logical 0, Sync Check is disabled.
† 25 BYP:	Sync Check Bypass. When this input is a logical 1, the logical output "25" automatically is asserted. When this logical input is a logical 0, then the logical output "25" becomes dependent on relay settings and system conditions.
Local:	When this function is unmapped, or a logical 0, the relay functions normally. When this is set to a logical 1, then the relay will not perform any functions listed in the operations menu via SCADA or any communications program. However, the operations record is always available for use via the OCI.
SIA:	Resets seal-in alarms
TGT:	Resets target LEDs
LIS 1, -8:	Latching Logical Inputs LIS 1,- 8: When this logical input is asserted, the same numbered latching output logical will energize. If asserted when same numbered Latching Input Reset logical is asserted, it is ignored even if the LIR 1, -8 signal is eventually removed. LIS 1, -8 and LIR 1,- 8 are mutually exclusive.
LIR 1, -8:	Reset Latching Logical Inputs LIR 1, - 8. When this logical input is asserted, the same numbered latching output logical will de-energize. If asserted when the same numbered Latching Input Set logical is asserted, it is ignored even if the LIS 1, - 8 are eventually removed. LIR 1, - 8 and LIS 1,- 8 are mutually exclusive.
TR_SET:	Hot Hold Tag Set. When this logical input is asserted, the Hot Hold Tag (HHT) status will transition one state towards the TAG state. If asserted when the HHT reset logical TR_RST is asserted, it will be ignored. If the HHT status is in the TAG state, this assertion will be ignored even if the TR_RST signal is eventually removed. TR_SET and TR_RST are mutually exclusive.
TR_RST:	Hot Hold Tag Reset. When this logical input is asserted, the Hot Hold Tag (HHT) status will transition one state towards the ON state. If asserted when the HHT set logical TR_SET is asserted, it will be ignored. If the HHT status is in the ON state, this assertion will be ignored even if the TR_SET signal is eventually removed. TR_RST and TR_SET are mutually exclusive.

† **Sync Check Model only**

Programming the Binary (Contact) Inputs

Up to 30 attributes can be selected for display on the Programmable Input Map. Use WinECP and follow these steps to program the binary (contact) inputs on the Programmable Input Map screen:

1. From the WinECP Main Menu, select “Settings.”

2. From the Settings Menu, select “Programmable I/O” and then “Programmable Inputs.”

3. The Programmable Input Map screen appears.

4. To change the listing of logical inputs:

   a. Place the mouse arrow on the logical input (leftmost column).
   b. Click to display a list of possible logical inputs.
   c. Scroll through the list until the logical input you want is highlighted.
   d. Click OK to change the contact or click cancel to close the list window without changing the current logical input.

5. To change the logic of a logical input:

   a. Click the logic value of a logical input and it will change.
   b. Click OK to change or cancel to close the logic window without any changes.

6. To change the conditions of a logical input:

   a. Place the mouse arrow on the box across from the contact name and underneath the physical input you want.
   b. Click the box to change color for gray, red or white for deassigned, closed and open logic. Gray, red or white is the same as blank, “C” or “O” logic in DOS ECP.
   c. Click OK to change or cancel to close the status window without any changes.

7. To assign a name to an input:

   a. Click mouse arrow in field above physical input designation.
   b. Click OK to change or cancel to close the input window without any changes.

8. Save your changes.

   a. Return to “Settings Menu”.
   b. Choose “Select All” to save all settings,or “Programmable I/O” to save I/O settings only.
   c. Choose “Download To System” to save change in DPU2000R or “Save To File” to save in a file.

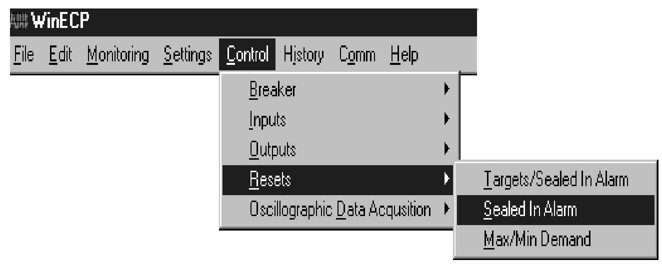
Programmable Outputs

All logical outputs except “ALARM” are a logical 0 when the DPU2000R is in a “the normal” state.

Logical Output Types

The programmable logical outputs (or sometimes called alarms) as listed below can have two different types of outputs for the same function. The first type is a **non-sealed-in** type. This type of logical output will be a logical 1 (logical output asserted) when the condition is present and a logical 0 (logical output de-asserted) when the condition ceases. It is sometimes referred to as a “real time” output. The second type is a **sealed-in** type. This type of logical output will be a logical 1 (logical output asserted) when the condition is present and will remain a logical 1 when the condition ceases. The Sealed-In Outputs are reset by any of the following methods:

1. The front panel OCI “C” (clear) button is depressed once within a 5-second period. The user will eventually be prompted to reset seal-ins. See Section 5 for details.
2. The Sealed In Alarms cam be reset with WinECP by selecting the Control - Resets Menu, and choosing the Sealed In Alarms command. The Sealed In Alarms can be reset individually, or all at once. See Section 8 for more details.
3. Depending on the communications protocol contained in the DPU2000R, a command is issued to reset the individual seal-in outputs or all seal-in outputs.



An example of where seal-in bits are applied: The DPU2000R is connected directly onto a Modbus communications network and a Programmable Logic Controller (PLC) is also on the network. The PLC obtains fault information from the DPU2000R over the Modbus network for certain restoration scheme. If the fault bit, 51P (3I>) for example, sensed by the PLC was a real time bit, the PLC would never see the change. The seal-in bit, 51P* (3I>*) can be used to alert the PLC to a fault even after the fault has extinguished. Once the PLC is finished with the logical output bit 51P* (3I>*), it can reset the bit to a logical 0 via the communication network. This eliminates hard contact wiring between the relay and the PLC and assure that the PLC will always see a fault.

Some of the alarms listed below will have duplicate elements. For example, 50P-1 (3I>>1) and 50P-1***** (3I>>1*). Notice that an asterisk (*****) follows one of the elements. This is the indication of a logical output that is of the seal-in type as described above.

Table 6-2. Logical Output Definitions

Abbreviation	Description
——:	Entry not used.
TRIP:	Breaker Trip Output. This output follows the action of the physical output contact “Trip”. It is activated by all of the overcurrent protective elements that are enabled. TRIP is also activated by the logical input OPEN and operates when the relay is asked to perform a manual circuit breaker trip by either the front panel OCI or remote WinECP program. See Section 1 under “Master Trip Contact Dropout” for details on dropout operation of this logical output.
CLOSE:	Breaker Close Output. This output is used by the DPU2000R recloser as the breaker close output. It must be assigned to the physical output that is connected to the circuit breaker close coil. CLOSE is also activated by the logical input CLOSE and operates when the relay is asked to perform a manual circuit breaker close by either the front panel OCI or remote WinECP program. The CLOSE logical output will become a logical 1 when the DPU2000R issues a CLOSE command. CLOSE will remain a logical 1 until the Close Fail Timer expires or the 52A and 52B contacts indictate that a circuit breaker close state exists.

Table 6-2: Logical Output Definitions (cont).

ALARM:	Self Check Alarm. This output is normally a logical 1, and indicates that the DPU2000R is functioning normally. When the output is a logical 0, the DPU2000R has failed. This output is also linked to the physical "Self Check Alarm" contact and the red front panel "Fail" target.
BFA:	Breaker Failure Alarm. BFA operates when the DPU2000R detects a breaker failed to trip. See Section 2 under "Trip Fail Timer" for details.
BFA*:	Breaker Failure seal-in Alarm. See Logical Output Types section.
TCFA:	Trip Circuit Failure Alarm. TCFA is activated when the DPU2000R determines that the circuit breaker trip coil continuity has been broken. It is directly tied to the operation of the logical input TCM. When TCM is a logical 0, the Trip Circuit Fail Alarm (TCFA) is a logical 1 indicating a trip coil failure.
79LOA: (O->ILO)	Recloser Lockout Alarm. 79LOA operates at any time when the DPU2000R recloser is in the lockout state. When 79LOA is a logical 1, the recloser is in lockout.
TCC:	Tap Changer Cutout Contact. TCC operates when the DPU2000R recloser begins operation and remains active until the last recloser operation is complete (reset time expires or recloser enters lockout state). When TCC is a logical 1, the recloser in the DPU2000R is active. TCC can be used to block a tap changer during fault and recovery operations.
PUA: (I<Is)	Overcurrent Pickup Alarm. PUA operate when any enabled overcurrent element is above its specific pickup level. Since PUA is an OR of all enabled overcurrent elements, it does not distinguish between elements. In other words, it will operate for the lowest set overcurrent element. When PUA is a logical 1, one of the overcurrent elements is above its pickup setting. PUA is instantaneous and ignores any overcurrent timing elements.
51P: (3I>)	Phase Time Overcurrent Trip Alarm. Indicates that the phase time overcurrent element, 51P, has timed out and energized. 51P will be a logical 1 when this occurs.
51P*: (3I>*)	Phase Time Overcurrent Trip Seal-in Alarm. See "Logical Output Types" earlier in this section.
51N: (IN>)	Ground Time Overcurrent Trip Alarm. Indicates that the ground time overcurrent element, 51N, has timed out and energized. 51N will be a logical 1 when this occurs.
51N*: (IN>*)	Ground Time Overcurrent Trip Seal-in Alarm. See "Logical Output Types" earlier in this section.
46: (Insc>)	Negative Sequence Time Overcurrent Trip Alarm. Indicates that the negative sequence time overcurrent element, 46, has timed out and energized. 46 will be a logical 1 when this occurs.
46*: (Insc>*)	Negative Sequence Time Overcurrent Trip Seal-in Alarm. See "Logical Output Types" earlier in this section.
46A: (InscA>)	Negative Sequence Time Overcurrent Alarm. Indicates that the negative sequence time overcurrent element, 46A, has timed out and energized. 46A will be a logical 1 when this occurs.
46A*: (Insc>*)	Negative Sequence Time Overcurrent Seal-in Alarm. See "Logical Output Types" earlier in this section.
50P-1: (3I>>1)	Phase Instantaneous Overcurrent Trip Alarm Level 1 (Low Set Instantaneous). Indicates that the phase instantaneous overcurrent element level 1, 50P-1, has timed out and energized. 50P-1 will be a logical 1 when this occurs.
50P-1*: (3I>>1*)	Phase Instantaneous Overcurrent Trip Seal-in Alarm Level 1 (Low Set Instantaneous). See "Logical Output Types" earlier in this section.
50N-1: (IN>>1)	Ground Instantaneous Overcurrent Trip Alarm Level 1 (Low Set Instantaneous). Indicates that the ground instantaneous overcurrent element level 1, 50N-1, has timed out and energized. 50N-1 will be a logical 1 when this occurs.
50N-1*: (IN>>1*)	Neutral Instantaneous Overcurrent Trip Seal-in Alarm Level 1 (Low Set Instantaneous). See "Logical Output Types" earlier in this section.

Table 6-2: Logical Output Definitions (cont).

50P-2: (3I>>2)	Phase Instantaneous Overcurrent Trip Alarm Level 2 (Mid Set Instantaneous). Indicates that the phase instantaneous overcurrent element level 2, 50P-2, has timed out and energized. 50P-2 will be a logical 1 when this occurs.
50P-2*: (3I>>2*)	Phase Instantaneous Overcurrent Trip Seal-in Alarm Level 2 (Mid Set Instantaneous). See “Logical Output Types” earlier in this section.
50N-2: (IN>>2)	Ground Instantaneous Overcurrent Trip Alarm Level 2 (Mid Set Instantaneous). Indicates that the phase instantaneous overcurrent element level 2, 50N-2, has timed out and energized. 50N-2 will be a logical 1 when this occurs.
50N-2*: (IN>>2*)	Neutral Instantaneous Overcurrent Trip Seal-in Alarm Level 2 (Mid Set Instantaneous). See “Logical Output Types” earlier in this section.
50P-3: (3I>>3)	Phase Instantaneous Overcurrent Trip Alarm Level 3 (High Set Instantaneous). Indicates that the phase instantaneous overcurrent element level 3, 50P-3, has energized. 50P-3 will be a logical 1 when this occurs.
50P-3*: (3I>>3*)	Phase Instantaneous Overcurrent Trip Seal-in Alarm Level 3 (High Set Instantaneous). See “Logical Output Types” earlier in this section.
50N-3: (IN>>3)	Ground Instantaneous Overcurrent Trip Alarm Level 3 (High Set Instantaneous). Indicates that the phase instantaneous overcurrent element level 3, 50N-3, has timed out and energized. 50N-3 will be a logical 1 when this occurs.
50N-3*: (IN>>3*)	Neutral Instantaneous Overcurrent Trip Seal-in Alarm Level 3 (High Set Instantaneous). See “Logical Output Types” earlier in this section.
67P: (3I>-->)	Positive Sequence Supervised Phase Directional Time Overcurrent Trip Alarm. Indicates that the phase directional time overcurrent element, 67P, has timed out and energized. 67P will be a logical 1 when this occurs.
67P*: (3I>-->*)	Positive Sequence Supervised Phase Directional Time Overcurrent Trip Seal-in Alarm. See “Logical Output Types” earlier in this section.
67N: (IN>-->)	Negative Sequence Supervised Ground Directional Time Overcurrent Trip Alarm. Indicates that the ground directional time overcurrent element, 67N, has timed out and energized. 67N will be a logical 1 when this occurs.
67N*: (IN>-->*)	Negative Sequence Supervised Ground Directional Time Overcurrent Trip Seal-in Alarm. See “Logical Output Types” earlier in this section.
PATA: (L1TA)	Phase A Target Alarm. Activates any time the red front panel phase A target LED is illuminated. When PATA is a logical 1, the phase A target LED is lit. If the front panel target LED’s are reset either by the front panel pusbutton “Target Reset” or by the Windows External Communications Program (WinECP) PATA will become a logical 0. This output is useful in remote communications and SCADA applications where faulted phase information is required.
PBTA: (L2TA)	Phase B Target Alarm. Activates any time the red front panel phase B target LED is illuminated. When PBTA is a logical 1, the phase B target LED is lit. If the front panel target LED’s are reset either by the front panel pusbutton “Target Reset” or by the Windows External Communications Program (WinECP) PBTA will become a logical 0. This output is useful in remote communications and SCADA applications where faulted phase information is required.
PCTA: (L3TA)	Phase C Target Alarm. Activates any time the red front panel phase C target LED is illuminated. When PCTA is a logical 1, the phase C target LED is lit. If the front panel target LED’s are reset either by the front panel pusbutton “Target Reset” or by the Windows External Communications Program (WinECP) PCTA will become a logical 0. This output is useful in remote communications and SCADA applications where faulted phase information is required.
81S-1: (f<1)	Frequency Load Shed Trip Module 1. Activates when the system frequency has dropped below the 81S-1 setting and the 81S-1 time delay has expired. 81S-1 does not activate the main trip contact of the DPU2000R. 81S-1 must be mapped to the logical input “OPEN” via the feedback logic for operation of the main trip contact. See the Frequency Load Shed and Restoration section for more details.

Table 6-2: Logical Output Definitions (cont).

81S-1*: (f<1*)	Frequency Load Shed Trip Module 1 Seal-in Alarm. See “Logical Output Types” earlier in this section.
81R-1: (f>1)	Frequency Load Restoration Module 1. Activates when the frequency setting 81R-1 has been met and the 81R-1 time delay has expired. 81R-1 does not activate the logical output “CLOSE”. 81R-1 can be mapped to the logical input “CLOSE” via the feedback logic for operation. 81R-1 will only operate after an 81S-1 under frequency load shed (trip).
81R-1*: (f>1*)	Frequency Load Restoration Module 1 Seal-in Alarm. See “Logical Output Types” earlier in this section.
81O-1: (f>fs1)	Overfrequency Alarm Module 1. Operates when the 81R-1 setting has been exceeded and the 81R-1 time delay has expired.
81O-1*: (f>fs1*)	Overfrequency Seal-in Alarm. See “Logical Output Types” earlier in this section.
81S-2: (f<2)	Frequency Load Shed Trip Module 2. Activates when the system frequency has dropped below the 81S-2 and the 81S-2 time delay has expired. 81S-2 does not activate the main trip contact of the DPU2000R. 81S-2 must be mapped to the logical input “OPEN” via the feedback logic for operation of the main trip contact. See the Frequency Load Shed and Restoration section for more details.
81S-2*: (f<2*)	Frequency Load Shed Trip Module 2 Seal-in Alarm. See “Logical Output Types” earlier in this section.
81R-2: (f>2)	Frequency Load Restoration Module 2. Activates when the frequency setting 81R-2 has been met and the 81R-2 time delay has expired. 81R-2 does not activate the logical output “CLOSE”. 81R-2 can be mapped to the logical input “CLOSE” via the feedback logic for operation. 81R-2 will only operate after an 81S-2 under frequency load shed (trip).
81R-2*: (f>2*)	Frequency Load Restoration Module 2 Seal-in Alarm. See Logical Output Types section.
81O-2: (f>fs2)	Overfrequency Alarm Module 2. Operates when the 81R-2 setting has been exceeded and the 81R-2 time delay has expired.
81O-2*: (f>fs2*)	Overfrequency Seal-in Alarm. See Logical Output Types section.
27-1P: (U<)	Single Phase Undervoltage Alarm. Activates when any phase (or phase pair for delta VT’s) of voltage drops below the 27 undervoltage setting.
27-1P*: (U<*)	Single Phase Undervoltage Seal-in Alarm. See “Logical Output Types” earlier in this section.
59: (U>)	Single Phase Overvoltage Alarm. Activates when any phase (or phase pair for delta VT’s) of rises above the 59 overvoltage setting.
59*: (U>*)	Single Phase Overvoltage Seal-in Alarm. See “Logical Output Types” earlier in this section.
79DA: (O->IDA)	Recloser Disabled Alarm. This logical output operates in conjunction with the red front panel “Recloser Out” target. It becomes a logical 1 when the recloser is disabled either by the 43A logical input or when the 79-1 recloser is set to lockout. It is also set when the HLT functions is in the OFF or TAG position.
79CA1: (O->I-1)	Recloser Counter 1 Alarm. Operates when the recloser has operated beyond the number of counts set in the 79 counter 1 alarm settings.
79CA1*: (O->I-1*)	Recloser Counter 1 Seal-in Alarm. See “Logical Output Types” earlier in this section.
79CA2: (O->I-2)	Recloser Counter 2 Alarm. Operates when the recloser has operated beyond the number of counts set in the 79 counter 2 alarm settings.
79CA2*: (O->I-2*) **Note:**	Recloser Counter 2 Seal-in Alarm. See “Logical Output Types” earlier in this section. Two recloser counter alarms are provided, 79CA1 and 79CA2. They can be set to different thresholds or as typically applied, one can be reset to 0 on a monthly basis and the other on a yearly basis. This way recloser operations can be tracked on a monthly and yearly basis.

Table 6-2: Logical Output Definitions (cont).

OCTC:	Overcurrent Trip Counter Alarm. Activates when the number of overcurrent trip operations has exceeded the Overcurrent Counter Alarm setting.
KSI: (I>TC)	KSI Summation Alarm. Activates when the KSI sum has exceeded the KSI Counter Alarm setting.
PDA:	Phase Current Demand Alarm. Activates when the demand current for any phase has exceeded the Phase Demand Alarm setting. This alarm is based on the incremental demand values and not the instantaneous values as in the load alarms. When the demand value rises above the Phase Demand Alarm setting, a 60 second timer is started. When the timer expires, PDA becomes a logical 1.
NDA:	Neutral Current Demand Alarm. Operates when the demand current for the neutral input has exceeded the Neutral Demand Alarm setting. This alarm is based on the incremental demand values and not the instantaneous values as in the load alarms. When the demand value rises above the Neutral Demand Alarm setting, a 60 second timer is started. When the timer expires, NDA becomes a logical 1.
PVArA:	Positive 3 Phase kiloVAr Alarm. Operates 60 seconds after the positive 3 phase kiloVArs exceed the Positive KiloVAr Alarm setting. When the Positive KiloVAr value rises above the the Positive KiloVAr Alarm setting, a 60 second timer is started. When the timer expires, PVArA becomes a logical 1. If the value drops below the Alarm setting before the 60 second timer expires, the timer will reset.
NVArA:	Negative 3 Phase kiloVAr Alarm. Operates 60 seconds after the negative 3 phase kiloVArs exceed the Negative KiloVAr Alarm setting. When the Negative KiloVAr value rises above the the Negative KiloVAr Alarm setting, a 60 second timer is started. When the timer expires, NVArA becomes a logical 1. If the value drops below the Alarm setting before the 60 second timer expires, the timer will reset.
LOADA:	Load Current Alarm. Operates 60 seconds after any single phase of load current rises above the Load Alarm setting. If the value drops below the Alarm setting before the 60 second timer expires, the timer will reset.
50-1D: (I>>1D)	50-1 Instantaneous Overcurrent Disabled Alarm. Operates when the torque controlled Programmable Input, 50-1, is mapped but not energized. This alarm indicates that the 50P-1 instantaneous unit is disabled form tripping. 50-1D will not operate if the 50P-1 element is disabled in the protective settings.
LPFA:	Low Power Factor Alarm. Operates 60 seconds after the load power factor drops below the Power Factor Alarm setting. If the value drops below the Alarm setting before the 60 second timer expires, the timer will reset.
HPFA:	High Power Factor Alarm. Operates 60 seconds after the power factor rises above the Power Factor Alarm setting. If the value drops below the Alarm setting before the 60 second timer expires, the timer will reset.
ZSC:	Zone Sequence Coordination Enabled Indicator. Operates when the Zone Sequence function is active. ZSC will be a logical 1 when Zone Sequence is enabled in the “Configurations” menu and the ZSC programmable input (see Programmable Inputs section) is not assigned to an input or feedback term. ZSC will also be a logical 1 if the ZSC programmable input is assigned to an input or feedback term and that input or feedback term is energized. If any one of these conditions is not true ZSC will be a logical 0.
50-2D: (I>>2D)	50-2 Instantaneous Overcurrent Disabled Alarm. Operates when the torque control Programmable Input, 50-2, is mapped but not energized. This alarm indicates that the 50P-2 instantaneous unit is disabled form tripping. 50-2D will not operate if the 50P-2 element is disabled in the protective settings.
BFUA:	Blown Fuse Alarm. Operates when the voltage of any phase or phases drops below 7 volts and no 51P or 51N overcurrent pickup condition exists. This Logical Output seals in after a blown fuse condition exists. It must be manually reset via the OCI or WinECP after voltage has been restored.
STCA:	Settings Table Changed Alarm. Activates when ever the “Change Settings” menu is entered via front panel OCI or remote WinECP program.
PH3-D: (3I>D)	Phase Control Disabled Alarm. Operates when the phase torque control logical input PH3 (see Programmable Inputs section) is assigned to a physical input or feedback term and that physical input or feedback term is not energized.
GRD-D: (IN>D)	Ground Control Disabled Alarm. Operates when the ground torque control logical input GRD (see Programmable Inputs section) is assigned to a physical input or feedback term and that physical input or feedback term is not energized.

Table 6-2: Logical Output Definitions (cont).

32PA: (3I-->Is)	67P Zone Pickup Alarm. Operates when the positive sequence current is within the 180 degree torque angle sector as set in the 67P settings. 32PA does not indicate that the 67P overcurrent element is picked up, it indicates only that the positive sequence current is in the angular operating zone. 32PA will not operate if the 67P overcurrent element is disabled. See also "Phase Directional Overcurrent 67P section. For phase power directional supervision of other elements internal or external, use the 32P-2 logical output.
32NA: (IN-->Is)	67N Zone Pickup Alarm. Operates when the negative sequence current is within the 180 degree torque angle sector as set in the 67N settings. 32NA does not indicate that the 67N overcurrent element is picked up, it indicates only that the negative sequence current is in the angular operating zone. 32NA will not operate if the 67N overcurrent element is disabled. See also "Ground Directional Overcurrent 67N. For ground power directional supervision of other elements internal or external, use the 32N-2 logical output.
27-3P: (3U<)	Three Phase Undervoltage Alarm. Activates when all three phases of voltage drop below the 27 undervoltage setting.
27-3P*: (3U<*)	Three Phase Undervoltage Seal-in Alarm. See "Logical Output Types" earlier in this section.
VArDA:	Three Phase kiloVAr Demand Alarm. Operates when the value of the three phase demand VArs exceed the Three Phase Demand Alarm setting. This alarm is based on the incremental demand values and not the instantaneous values as in the load alarms. When the incremental value rises above the VArDA alarm setting, a 60 second timer is started. When the timer expires, VArDA becomes a logical 1.
TRIPA: (TRIPL1)	Phase A Trip Alarm. Operates when the tripping of the DPU2000R main trip contact is caused by a fault on phase A. TRIPA will drop out when the fault current drops below 90% of the lowest set time overcurrent element pickup.
TRIPA*:(TRIPL1*)	Phase A Trip Seal-in Alarm. See "Logical Output Types" earlier in this section.
TRIPB: (TRIPL2)	Phase B Trip Alarm. Operates when the tripping of the DPU2000R main trip contact is caused by a fault on phase B. TRIPB will drop out when the fault current drops below 90% of the lowest set time overcurrent element pickup.
TRIPB*:(TRIPLB*)	Phase B Trip Seal-in Alarm. See "Logical Output Types" earlier in this section.
TRIPC: (TRIPL3)	Phase C Trip Alarm. Operates when the tripping of the DPU2000R main trip contact is caused by a fault on phase C. TRIPC will drop out when the fault current drops below 90% of the lowest set time overcurrent element pickup.
TRIPC*:(TRIPL3*)	Phase C Trip Seal-in Alarm. See "Logical Output Types" earlier in this section.
ULO1-ULO16:	User Logical Outputs1-16. Outputs are used to enhance the DPU2000R programmable logic capability. See "Advanced Programmable Logic" later in this section for details.
CLTA:	Cold Load Timer Alarm. Operates when the cold load timer is in operation. CLTA will become a logical 1 when the Cold Load Timer is counting. When the Cold Load Timer expires, CLTA will become a logical 0.
P Watt1:	Positive Watt Alarm 1. Operates 60 seconds after the positive 3 phase kilowatts exceed the Positive Kilowatt Alarm 1 setting. When the Positive Kilowatt value rises above the the Positive Kilowatt Alarm 1 setting, a 60 second timer is started. When the timer expires, Pwatt1 becomes a logical 1. If the value drops below the Alarm setting before the 60 second timer expires, the timer will reset.
TR_OFF:	Hot Hold Tag "OFF" state. This logical output energizes when the Hot Hold Tag (HHT) status transitions from the TAG state or ON state through an assertion of the HHT logical input TR_RST or TR_SET, respectively. This state represents a condition where only manual closing through the DPU2000R may be initiated. This logical output would be mapped to the logical input 43A through feedback logic to control autoreclosing and mapped to a physical output for local indication of the OFF state.
TR_TAG:	Hot Hold Tag "TAG" state. This logical output energizes when the Hot Hold Tag (HHT) status transitions from the OFF state through an assertion of the HHT logical input TR_SET. This state represents a condition where autoreclosing and manual closing through the DPU2000R may not be initiated. The uniqueness of this state is that the logical output CLOSE is prevented from being energized whenever the HHT status is in the TAG state.
59G (U0>):	Ground Overvoltage. This logical output asserts when the measured ground voltage exceeds its setting threshold for the programmed time delay and remains asserted until the voltage measures below the threshold.

Table 6-2: Logical Output Definitions (cont).

P Watt2:	Positive Watt Alarm 2. Operates 60 seconds after the positive 3 phase kilowatts exceed the Positive Kilowatt Alarm 2 setting. When the Positive Kilowatt value rises above the the Positive Kilowatt Alarm 2 setting, a 60 second timer is started. When the timer expires, Pwatt2 becomes a logical 1. If the value drops below the Alarm setting before the 60 second timer expires, the timer will reset.
Note:	Two positive watt alarm logical outputs are provided, Pwatt1 and Pwatt2. One alarm can be set to a different threshold than the other if desired. An application example: One can be used for alarming purposes and the other for tripping if desired.
BFT:	Breaker Failure Trip. Operates when the stand alone Breaker Failure Trip function in the DPU2000R issues a breaker failure trip. See Section 1 under “Breaker Failure Logic” for details.
BFT*:	Breaker Failure Trip Seal-in Alarm. See “Logical Output Types” earlier in this section.
ReTrp:	Breaker Failure ReTrip. Operates when the stand alone Breaker Failure Trip function in the DPU2000R issues a ReTrip. See Section 1 under “Breaker Failure Logic” for details.
ReTrp*:	Breaker Failure ReTrip Seal-in Alarm. See “Logical Output Types” earlier in this section.
32P-2: (I1-->)	Phase Power Directional Alarm. Operates when the positive sequence current is within the 180 degree torque angle sector as set in the 32P-2 settings.
32P-2*: (I1-->*)	Phase Power Directional Seal-in Alarm. See “Logical Output Types” earlier in this section.
32N-2: (I2-->)	Neutral Power Directional Alarm. Operates when the negative sequence current is within the 180 degree torque angle sector as set in the 32N-2 settings.
32N-2*: (I2-->*)	Neutral Power Directional Seal-inAlarm. See “Logical Output Types” earlier in this section.
25	Sync Check Function. When this is a logical 1, this indicates a Sync Check condition.
25*	Sync Check Seal-In Function. See “Logical Output Types” earlier in this section.
SBA	Slow Breaker Alarm function. This indicates that the “Slow Breaker Time” setting in the configuration settings has expired.SBA: Slow Breaker Alarm function. This indicates that the “Slow Breaker Time” setting in the configuration settings has expired.
I>0:	Sensitive Earth Fault Trip
I>0*:	Sensitive Earth Fault Trip Seal-in Alarm
BZA:	Bus Zone Alarm
79V (O->IU<):	Reclose undervoltage block. When this logical output is asserted, it indicates that the system voltage is less than the 79V setting and the 79 function is suspended. When the system voltage recovers abot the 79V setting for the 79V time delay, this logical output will reset and the 79V will continue.
RClin	Circuit Breaker Close initiate.
LO1,-8:	Latching Logical Outputs ULO 1, -8. The state of this logical output is determined by its same numbered Latching Input Set and Reset logical inputs.
ULO1, -16:	User Logical Outputs 1 – 16 is used to enhance the DPU2000R programmable logic capability. See section on “Programmable Outputs” for details. ULO 1, - 16 defaults to a logical 0.
TR_ON:	Hot Hold Tag “ON” state. This logical output energizes when the Hot Hold Tag (HHT) status transitions from the OFF state through an assertion of the HHT logical input TR_RST. This state represents a condition where autoreclosing and manual closing through the DPU2000R may be initiated. This logical output would be mapped to the logical input 43A through feedback logic to control autoreclosing and mapped to a physical output for local indication of the ON state.

Table 6-2: Logical Output Definitions (cont).

59G* (U0>*):	Ground Overvoltage seal-in alarm. This logical output asserts when the measured ground voltage exceeds its setting threshold for the programmed time delay and remains asserted until seal-in alarms are reset.
47 U2:	Negative Sequence Overvoltage Protection element alarm. Indicates that a negative sequence voltage condition has occurred.. See logical outputs types section.
47 U2*:	Negative Sequence Overvoltage Protection element seal in alarm. Indicates that a negative sequence voltage condition has occurred. 47. See logical outputs types section.
59-3:	Three phase Overvoltage. This logical output asserts when the measured all three phase voltages exceeds its setting threshold for the programmed time delay and remains asserted until the voltages measures below the threshold.
59-3*:	Three phase Overvoltage seal-in alarm. This logical output asserts when the measured phase voltage exceeds its setting threshold for the programmed time delay and remains asserted until seal-in alarms are reset.
21P-1:	Phase Distance element Zone 1. Operates when the 21P-1 setting has been exceeded and the time delay has been expired.
21P-1*:	Phase Distance element Zone 1. Operates when the 21P-1 setting has been exceeded and the time delay has been expired, and seals in the output contact.
21P-2:	Phase Distance element Zone 2. Operates when the 21P-2 setting has been exceeded and the time delay has been expired.
21P-2*:	Phase Distance element Zone 2. Operates when the 21P-2 setting has been exceeded and the time delay has been expired, and seals-in the output contact.
21P-3:	Phase Distance element Zone 3. Operates when the 21P-3 setting has been exceeded and the time delay has been expired.
21P-3*:	Phase Distance element Zone 3. Operates when the 21P-3 setting has been exceeded and the time delay has been expired, and seals in the output contact.
21P-4:	Phase Distance element Zone 4. Operates when the 21P-4 setting has been exceeded and the time delay has been expired.
21P-4*:	Phase Distance element Zone 4. Operates when the 21P-4 setting has been exceeded and the time delay has been expired, and seal-ins the output contact.
DBDL:	Dead bus dead line is a determined setting of the 25 function, and this logical is only asserted when this condition prevails. NOTE: Of the four conditions, (DBDL, DBLL, LBLDL, LBLL), only one of these logicals will assert at a given time.
DBLL:	Dead bus live line is a determined setting of the 25 function, and this logical is only asserted when this condition prevails. NOTE: Of the four conditions, (DBDL, DBLL, LBLDL, LBLL), only one of these logicals will assert at a given time.
LBDL:	Live bus dead line is a determined setting of the 25 function, and this logical is only asserted when this condition prevails. NOTE: Of the four conditions, (DBDL, DBLL, LBLDL, LBLL), only one of these logicals will assert at a given time.
LBLL:	Live bus live line is a determined setting of the 25 function, and this logical is only asserted when this condition prevails. NOTE: Of the four conditions, (DBDL, DBLL, LBLDL, LBLL), only one of these logicals will assert at a given time.

Output Contacts

The relay output contacts are divided into two categories: permanently programmed and user-programmable. Jumpers on the CPU board allow you to choose whether the programmable output contacts are normally open or normally closed.

Permanently Programmed Output Contacts

MASTER TRIP—The trip output contact is actuated by the enabled protective functions. The trip output remains closed until the fault current is removed (less than 5% of the 51P (3I>) and 51N (IN>) pickup settings) and until the 52a (XO) and 52b (XI) contact inputs indicate that the breaker has opened.

If Multiple Device Trip Mode is enabled, the trip output is removed 3 cycles after the fault current drops below 90% of the lowest pickup setting; removal of the trip output is not dependent on the 52a (XO) and 52b (XI) contact inputs.

If Multiple Device Trip Mode is enabled, the open interval timer and subsequent close output are initiated only if an Overcurrent Trip Output has occurred and the current has dropped below 90% of the lowest pickup setting. Initiation of the open interval timer and the subsequent close output is not dependent on the 52a (XO) and 52b (XI) contact inputs.

ALARM—Self-check alarm output contacts, one normally open and one normally closed, change state when control power is applied. Upon a loss of control power or a failure status of a specific self-test, the contacts return to their normal state. A contact must be connected to a local annunciator light or, if available, to a remote terminal unit to indicate the need for relay replacement.

Programmable Master Trip Contact

The DPU2000R contains a “master trip” contact. This output contact is factory set as a type ‘A’ (normally open) contact and is actuated by the protective elements; 51P (3I>), 51N (IN>), 50P-1 (3I>>1), 50P-2 (3I>>2), 50P-3 (3I>>3), 50N-1 (IN>>1), 50N-2 (IN>>2), 50N-3 (IN>>3), and 46 (Insc>). It is possible to set this contact to a B type (normally closed) by removing the DPU2000R from its case and changing jumper J6. It is necessary to remove the metal RF shield covering the output relays. This is done by removing the two phillips screws holding the metal shield in place. Place jumper J6 in “NO” for a normally open contact and “NC” for a normally closed contact.

It is also possible to eliminate any of the above listed protective elements from activating the master trip contact. This can only be performed by the WinECP Select “Master Trip Contact” from “Settings” Menu and place an “X” next to the elements desired to operate the master trip contact and a space next to those not desired. Select “Send Settings” to complete the operation. Figure 6-2 shows a screen capture of the master trip programming.

These settings are useful where certain elements will be programmed to a different output contact (see Programmable I/O Section) for operation of a lockout relay or other auxiliary device.

Figure 6-2. Master Trip Contact Programming Screen

Master Trip Contact Dropout

When the DPU2000R master trip contact operates due to the operation of a protective element such as 51P (3I>), 50P-1 (3I>>1), 50N-1 (IN>>1), etc., the master trip contact will drop out when the fault current on all phases drops to 90% of the lowest set time overcurrent element pickup AND the 52A (XO) and 52B (XI) breaker auxiliary contacts have changed state to the open position. The master trip contact will stay sealed in indefinitely until these cases are met.

Programmable Output Contacts - OUT 1 through OUT 6

Up to six (6) user-programmable output contacts are available. Figure 6-4 shows the Programmable Outputs Menu of the WinECP with some mappings. A solid box means an output contact is mapped.

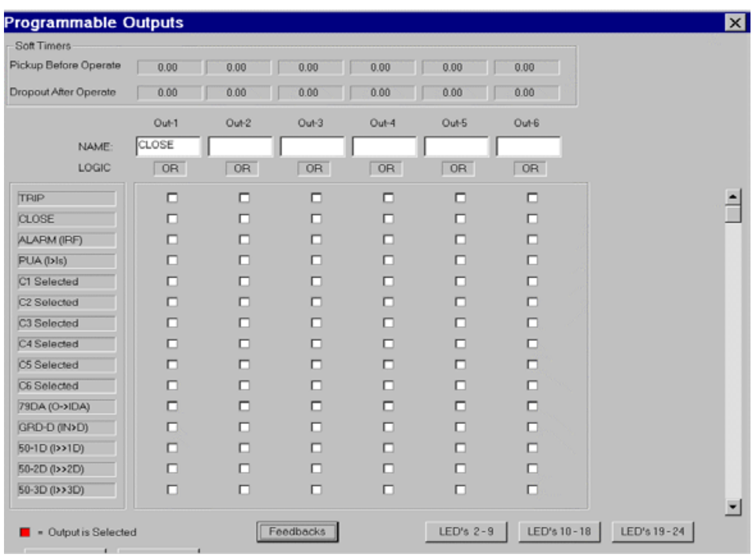


Figure 6-3. Programmable Outputs Screen

OUTPUT TIMERS: Additional time delay can be added to the function by means of the output timers. The time delay interval is adjustable from 0 to 250 seconds in 0.01 steps for both pickup time delay and drop out time delay.

OUTPUT LABELS: Identifying names can be placed under each of the outputs in the screen shown in Figure 6-3.

Advanced Programmable Logic

Introduction

The programmable logic features in the DPU2000R are designed to provide easy to build logic functions. Virtually any desired logic scheme can be accomplished through the advanced programmable I/O features in the relay. This application note explains how to build complex logic schemes in the relay. To describe the various functions, some terms need to be defined:

Physical Inputs

These are hard wired inputs to the relay. Physical Inputs 1 - 5 are "single ended" inputs and require only a positive voltage on its terminals only to denote a HIGH state. Physical Input 6 is "double ended" inputs both positive and negative voltage on its terminals to denote a HIGH state.

Physical Outputs

These are hard wired "dry" output contacts from the relay. There are a total of 6 Physical Outputs on the DPU2000R. The main TRIP output, OUT1, and OUT2 can be configured for normally open or closed.

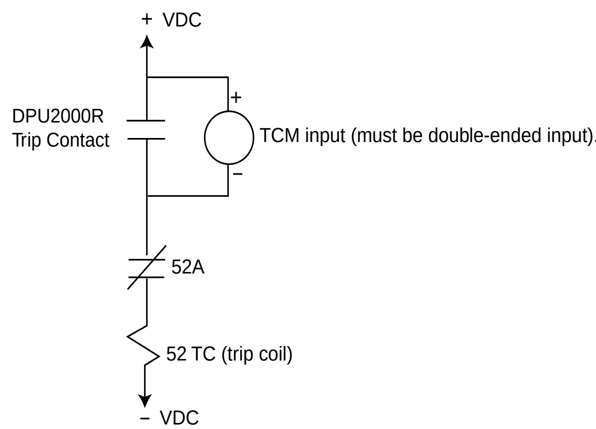


Figure 6-4. Trip Coil Monitoring

Logical Inputs

In the programmable input table in WinECP, the leftmost column lists the Logical Inputs to the relay. Logical Inputs are the protective functions in the relay that can be enabled or disabled via "input mapping". When a Logical Input is true, the function is enabled. When the logic to the Logical Input is false, the function is disabled. A simple example of how logical inputs work is shown below.

Logical Outputs

In the programmable output table in WinECP, the leftmost column lists the Logical Outputs to the relay. Logical Outputs determine the state of a protective functions in the relay. For example, the Logical Output 51P is considered HIGH when the 51P is in the TRIP state. The Logical Output 51P is considered LOW when 51P is dropped out.

User Logical Inputs/User Logical Outputs

User Logical Inputs (ULI's) and User Logical Outputs (ULO's) are variables in the relay to be defined by the user. A ULI is an undefined logical input seen in the relay input map. A ULO is an undefined logical output seen in the relay output map. A ULI in the input map is soft connected to the corresponding ULO in the output map. They can be considered "FEEDFORWARD" logic. When ULI1 goes HIGH, then ULO1 will automatically go HIGH.

However, User Logical Inputs can also be disconnected from its corresponding User Logical Output via the "Change Settings" menu under "ULI/ULO Configuration". In this case, if ULI1 is disconnected from ULO1, and ULI1 goes HIGH, then ULO1 will not be affected. This is used primarily for applications where the user can SET or REST a ULO for some control function. In this case the ULO will act as an S-R Flip Flop. ULO's can be SET or REST via the OCI or through the various communications protocols. When forcing ULO's HIGH or LOW, it is recommended that the ULI-ULO connection be broken. Otherwise the ULI can adversely affect the ULO.

Feedbacks

Feedbacks are similar to ULI/ULO's but are used for Feedback Purposes. When Feedback Output 1 (FBO1) goes HIGH, then Feedback Input 1 (FBI1) will automatically go HIGH.

The above definitions provide building blocks necessary to describe the logic features of the 2000R relays.

Procedure

A logical function can be made from the Programmable Input and Output tables using the following procedure:

Draw a logic diagram fo the function using only AND and OR gates. Any logic gate can have eight or more inputs.

Label the gates as either a Prog. Input or a Prog. Output depending on these rules:

- Any physical input (IN-n contact) must go to a Prog. Input gate.
- Any protection functions must go into a Prog. Output gate.
- Any physical outputs (contact operation) must come from a Prog. Output gate.

Add gates, CONNECTs, and FEEDBACKs to the diagram so that the following rules are followed:

- The output of a Prog. Output gate connects to the input of a Prog. Input gate through a FEEDBACK. See Figure 6-6a.
- The output of a Prog. Input gate can be connected to the input of a Prog. Output by making a CONNECT between the Input gate's ULIk and ULOk. See Figure 6-6b.
- The output of a Prog. Output gate must go to the input another Prog. Output through a FEEDBACK. Prog. Input CONNECT combination. The logic of the added input gate does not matter. See Figure 6-6c.
- The output of a Prog. Input gate must go to the input of another Prog. Input through a CONNECT Prog. Output-FEEDBACK combination. The logic of the added output gate does not matter. See Figure 6-6d.

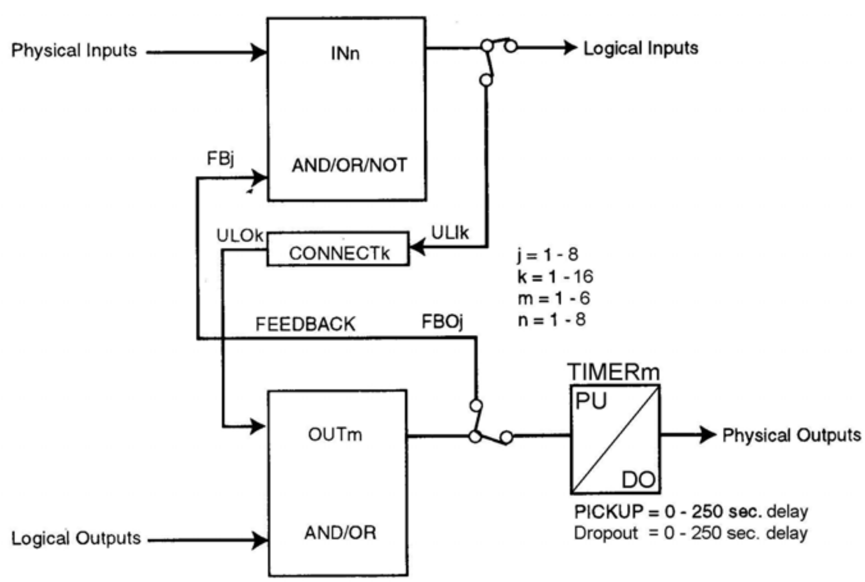


Figure 6-5. 2000R Programmable Logic

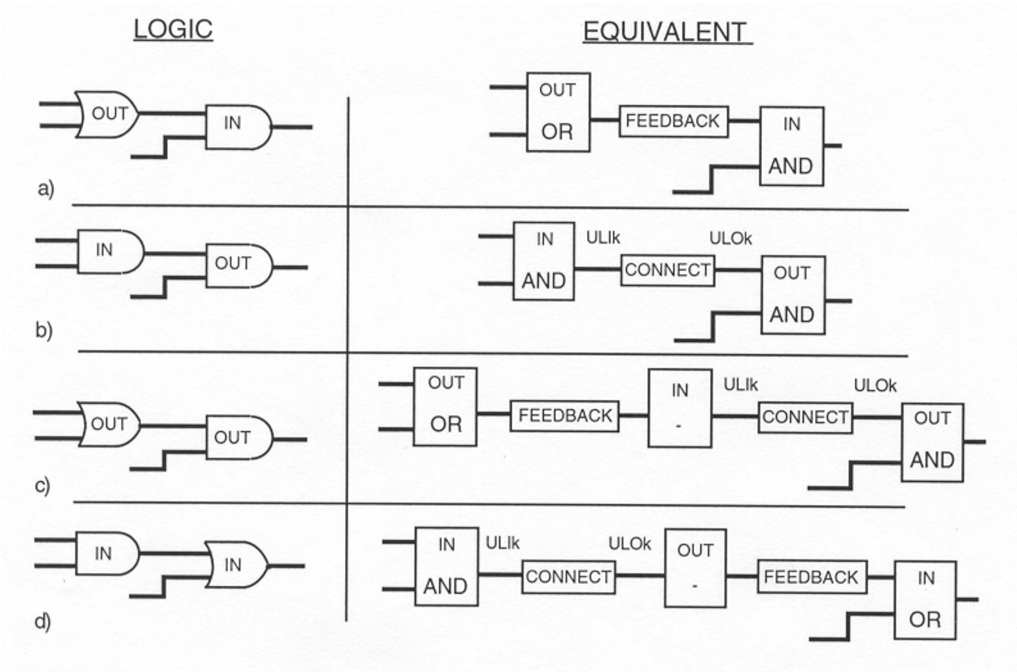


Figure 6-6a, b, c, d. Equivalent Gates

Programming Examples

External Overcurrent Control

1. In this example, the first level of instantaneous 50-1 (I>>1) is enabled ONLY when IN1 is HIGH (has a + voltage) AND IN2 is LOW (no voltage). The Boolean Logic is I1 * I2 = 50-1.

   Also, the 46 (Insc>) function is enabled only when IN1 is HIGH.

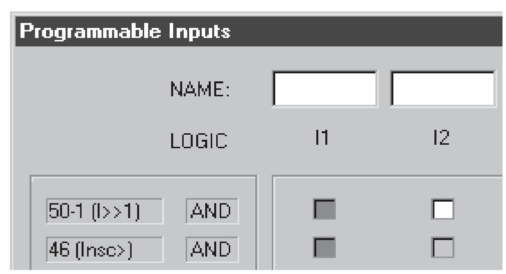


Figure 6-7. Programmable Inputs Screen

52a and 52b

2. In some appplications it is desirable to combine the 52a and the 52b contacts for circuit breaker position indication. This approach is less secure than using separate inputs for the 52a and 52b, but it saves one input for other uses. The following programming example shows how the 52b can be derived from the NOT of 52a. Connect a 52a contact from the breaker to I1.

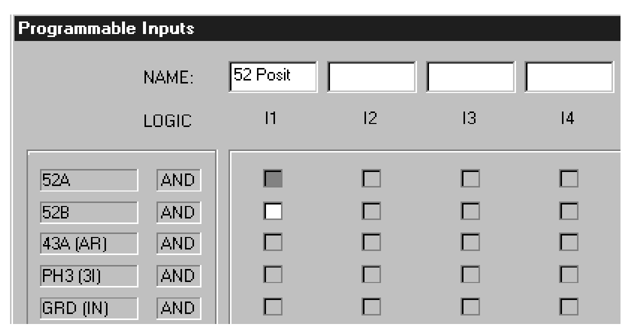


Figure 6-8. 52a and 52b Combined Input Example

Recloser Control

3. The following example shows how to change Setting Groups at the same time the recloser is disabled.

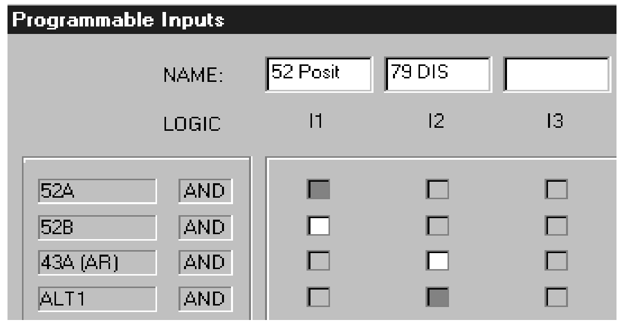


Figure 6-9. ALT1 Settings and 43A Recloser Disable Control Logic

51V

4. If a voltage-controlled overcurrent (51V) function is desired, see the following example. The Boolean Logic OUT2 = 50P-2 (3I>>2) * 27-1P (U<). 50P-2 is a definite time overcurrent element, and output 2 is connected to the trip bus.

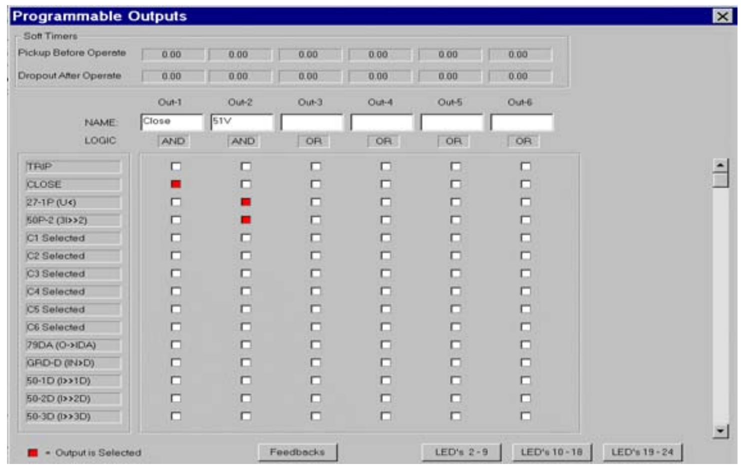


Figure 6-10. 51V Tripping Logic

Ground Torque Control

5. In the following example, the ground relay functions (51N & 50N) will be disabled when I2 and I3 are asserted. I2 can be connected to a panel mounted toggle switch for local control, and I 3 can be connected to an RTU for remote control. When the ground relay is disabled, a message will appear in the OCI display. The Boolean Logic for the User Display Indication (UDI) is I2 + I3 = UDI. The Boolean Logic for the Ground Enable(GRD) is NOT I2 * NOT I3 = GRD; and OUT-1 = GRD-D (Ground Disable Alarm). Notice that GRD-D is the NOT of GRD, so that (by DeMorgan's Theorem) the OUT-2 logic becomes I2 + I3 = GRD-D.

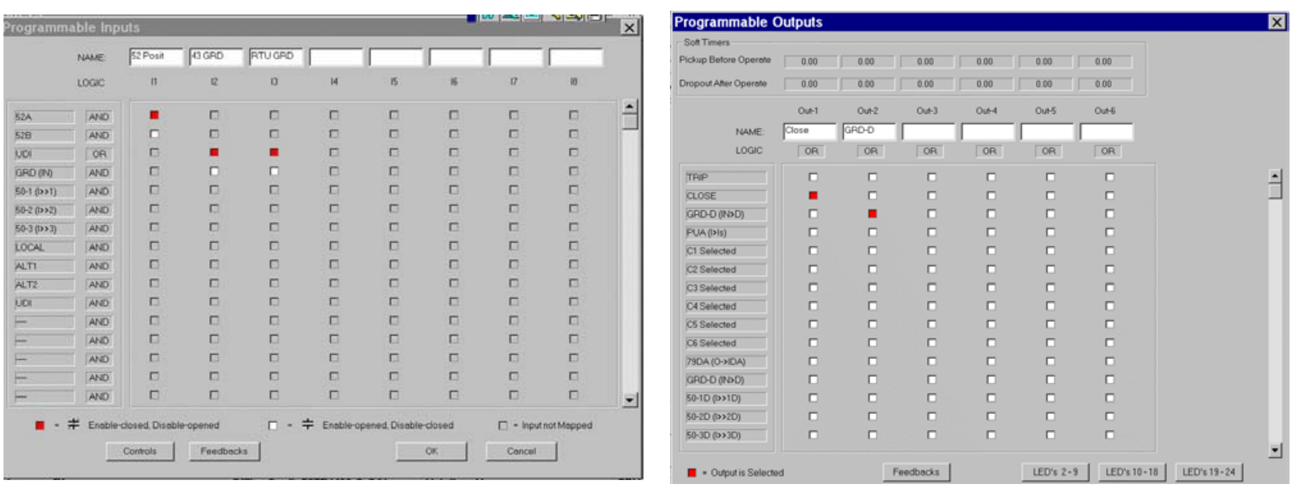


Figure 6-11. Ground Relay Control Logic

Blown Fuse Alarm

6. In this example, the negative sequence overcurrent (46) and the undervoltage (27) elements work together to detect a blown transformer high-side fuse. The Boolean Logic is OUT-2 (blown fuse) = 46 (Insc>) * 27-1P (U<).

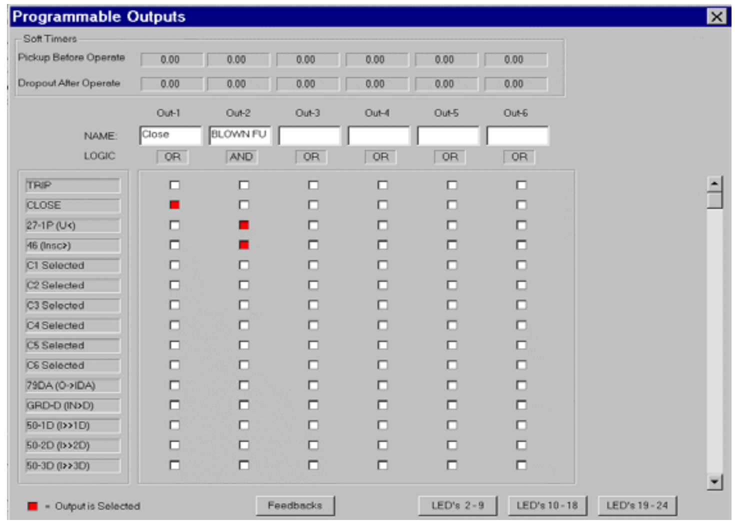


Figure 6-12. Blown Fuse Alarm Logic

Programmable Logic

Latching Logicals

Eight latching logical outputs are included in the list of logical outputs, LO1 – LO8. Each latching logical output becomes set when its same numbered SET latching logical input becomes asserted, e.g. LIS1 for LO1. Each latching logical output becomes reset when its same numbered RESET latching logical input becomes asserted, e.g. LIR1 for LO1. A SET or RESET latching logical input will only be accepted and executed if the same numbered RESET or SET latching logical input is off or de-asserted, respectively.

An application where these latching logicals can be applied is with SCADA RTU control. A RTU with separate contact outputs that are pulsed for “ON” and “OFF” control can have its momentary signals latched by the DPU2000R’s latching logicals and feedback to control the particular function. This saves using many User Logical I/O and Feedback I/O as has been previously required to “latch” a momentary signal.

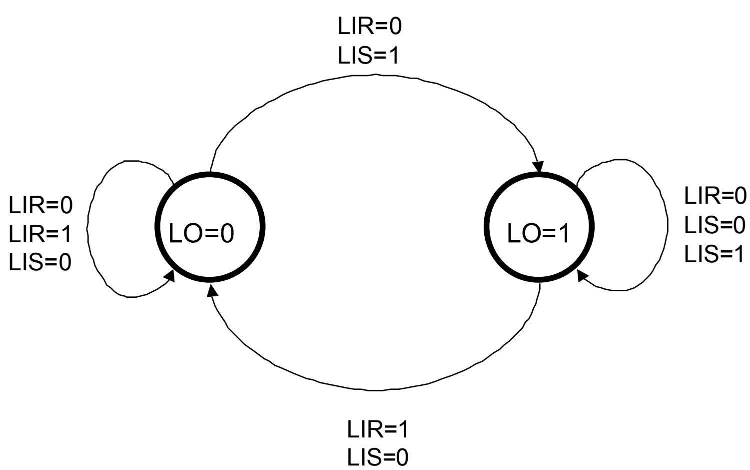


Figure 6-13. Latching Logicals State Diagram

Hot-Hold-Tagging (31TR Emulation) Feature

Through the addition of specific logical inputs and outputs to the programmable mapping, a 31TR switch can now be realized in the DPU2000R providing Hot Hold Tagging operation. The logical inputs are Set and Reset control inputs TR_SET and TR_RST, respectively. The logical outputs TR_ON, TR_OFF and TR_TAG indicate the 31TR position status of on, off and tagged, respectively. Successive on and off cycling of the logical input TR_SET will move the 31TR logical output status in the direction of TR_ON to TR_OFF to TR_TAG. Successive on and off cycling of the logical input TR_RST will change the 31TR logical output status in the direction of TR_TAG to TR_OFF to TR_ON. When in the 31TR on or off state, only its specific logical output is asserted. When in the 31TR tagged state, its specific logical output is asserted and the logical output CLOSE can never be asserted. For a given TR_SET or TR_RST logical input assertion, it will only be accepted and executed if the TR_RST or TR_SET logical input is de-asserted, respectively.

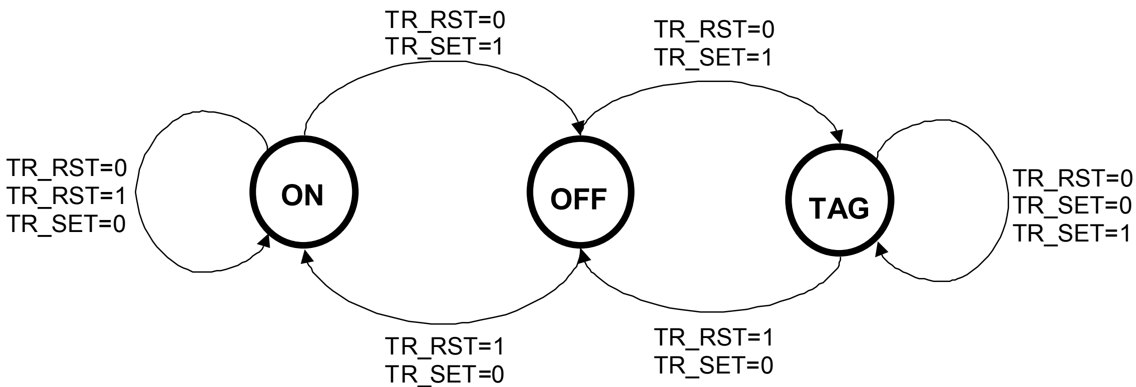
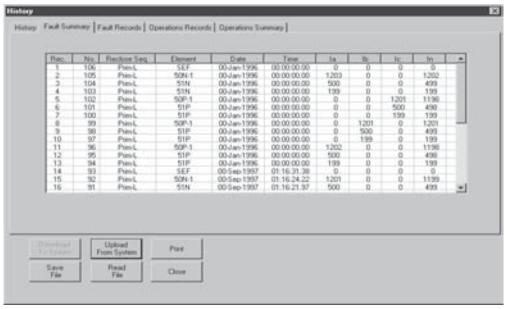


Figure 6-14. Hot Hold Tagging State Diagram

Records



Records Menu

The DPU2000R provides fault and operations records. It also provides a list of records not yet reported.

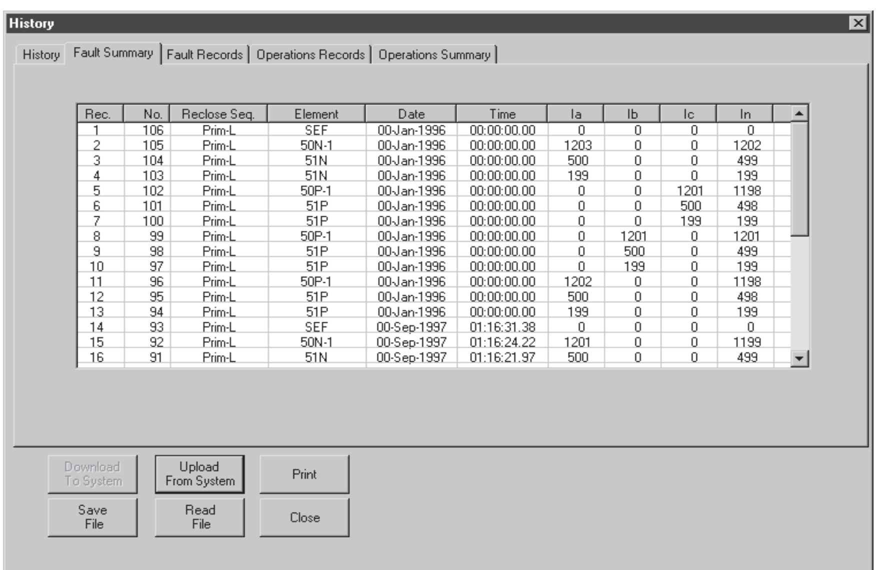
It is possible to only upload the unreported operational and fault records. This is accomplished by using the “unreported” button of the WinECP program The relay will then only retrieve those records that have not been previously reported.

Fault Summary

The DPU2000R provides a summary of the last 32 faults. The Fault Summary includes the:

- Record number (most recent listed first as "1")
- Fault number (numbered in order occurred)
- Enabled settings table and recloser sequence number (1, 2, 3, 4 or L for lockout)
- Tripping element
- Date and time
- Phase and neutral currents (magnitude only)

After a fault, the OCI continuously displays the apparent distance to the fault in miles and the fault currents (magnitude only) until the targets are reset. Save the Fault Summary as a file via WinECP.



Rec.	No.	Reclose Seq.	Element	Date	Time	Ia	Ib	Ic	In
1	106	Prim-L	SEF	00-Jan-1996	00:00:00.00	0	0	0	0
2	105	Prim-L	50N-1	00-Jan-1996	00:00:00.00	1203	0	0	1202
3	104	Prim-L	51N	00-Jan-1996	00:00:00.00	500	0	0	499
4	103	Prim-L	51N	00-Jan-1996	00:00:00.00	199	0	0	199
5	102	Prim-L	50P-1	00-Jan-1996	00:00:00.00	0	0	1201	1198
6	101	Prim-L	51P	00-Jan-1996	00:00:00.00	0	0	500	498
7	100	Prim-L	51P	00-Jan-1996	00:00:00.00	0	0	199	199
8	99	Prim-L	50P-1	00-Jan-1996	00:00:00.00	0	1201	0	1201
9	98	Prim-L	51P	00-Jan-1996	00:00:00.00	0	500	0	499
10	97	Prim-L	51P	00-Jan-1996	00:00:00.00	0	199	0	199
11	96	Prim-L	50P-1	00-Jan-1996	00:00:00.00	1202	0	0	1198
12	95	Prim-L	51P	00-Jan-1996	00:00:00.00	500	0	0	498
13	94	Prim-L	51P	00-Jan-1996	00:00:00.00	199	0	0	199
14	93	Prim-L	SEF	00-Sep-1997	01:16:31.38	0	0	0	0
15	92	Prim-L	50N-1	00-Sep-1997	01:16:24.22	1201	0	0	1199
16	91	Prim-L	51N	00-Sep-1997	01:16:21.97	500	0	0	499

Figure 7-1. Fault Summary Record

Fault Record

The Fault Record contains the last 32 faults. The Fault Record displays one fault at a time and includes the following information:

- Record number
- Fault number
- Reclose sequence number and enabled settings table
- Date and time
- Tripping element
- Apparent distance to the fault in miles
- Fault resistance
- Relay operate time
- Breaker clearing time
- Phase and neutral currents (magnitude and angle)
- Positive, negative and zero sequence currents (magnitude and angle)
- Phase voltages (magnitude and angle)
- Positive and negative sequence voltages (magnitude and angle)

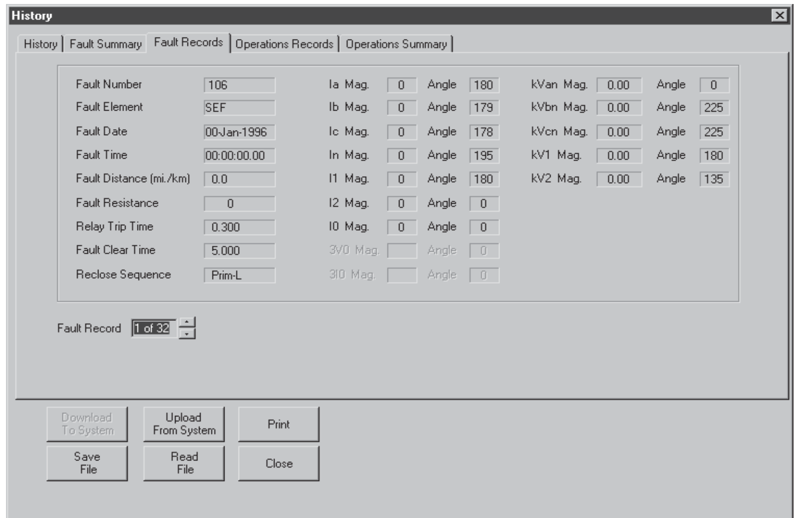


Figure 7-2. Fault Record

Save the Fault Record as a file by using WinECP.

Operations Record

The DPU2000R provides an operations log in which any operation within the relay is recorded. This includes internal operations such as logical tripping elements and relay failures. The operations recorder also logs external events such as settings changes, circuit breaker operations, and logical input operations. During a fault the operations recorder does not know or care what element actually tripped and cleared the fault. It only knows that certain logical element became active and logs them with a time stamp. It is very possible that many elements may be logged for a specific fault but only one was responsible for fault clearing. See the Fault Records for the element responsible for fault clearing. A complete listing of all the possible operations logs is listed along with a description in Table 7-2. For detailed definitions to the actual logical elements 51P (3I>), 27-1P (U<), etc., see the Programmable Outputs Section. It is important to note that the operations record logs only those elements that change state.

Three methods are used to obtain operations information from the DPU2000R.

1. The front panel OCI Main Menu item “Records” is accessed.

2. Operations records can be accessed, viewed, and saved with WinECP. They can be found by in the History Menu by choosing the Operations Records folder.

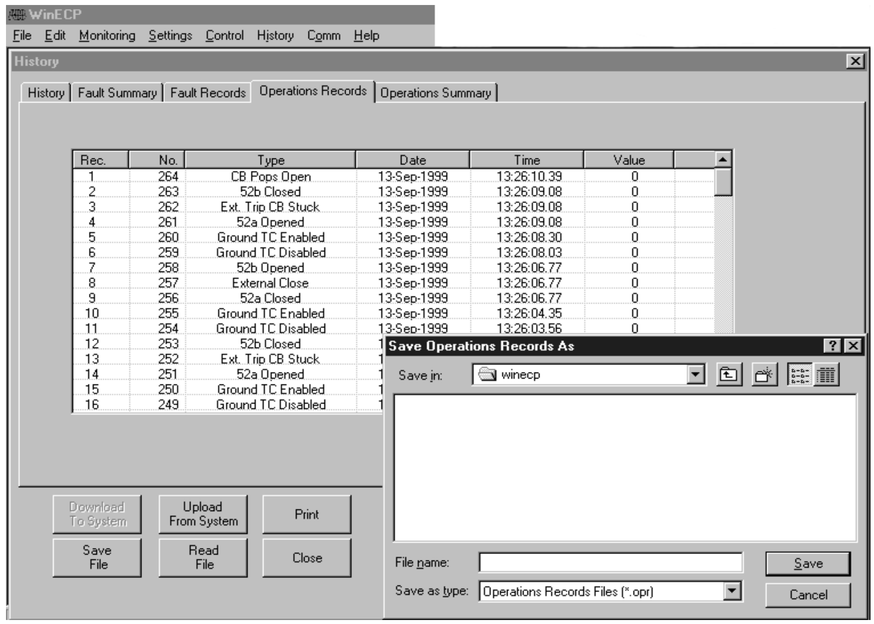


Figure 7-3. Operations Records

3. Depending on the communications protocol contained in the DPU2000R, a command is issued to send the operations records.

As can be seen in Figure 7-3, the operations records may contain a value associated with them. This value is a decimal number that further defines the occurrence. “Editor Access” and “Self Test Failure” logs will include a value. To interpret this number it must first be converted to binary. The binary bit pattern when compared to Table 7-1 will show what occurred. Notice in Table 7-1 that the values for “Editor Access” and “Self Test Failure” mean different things. For example: if the Operations Log records an “Editor Access” with a value of 255 it will not mean the same as a “Self Test Failure” value of 255.

The Operations Record contains the last 255 operations. The Operations Record includes the:

- Record number (most recent listed as "1")
- Operation number (numbered sequentially in order of occurrence)
- Description of the operation
- Date and time of the operation

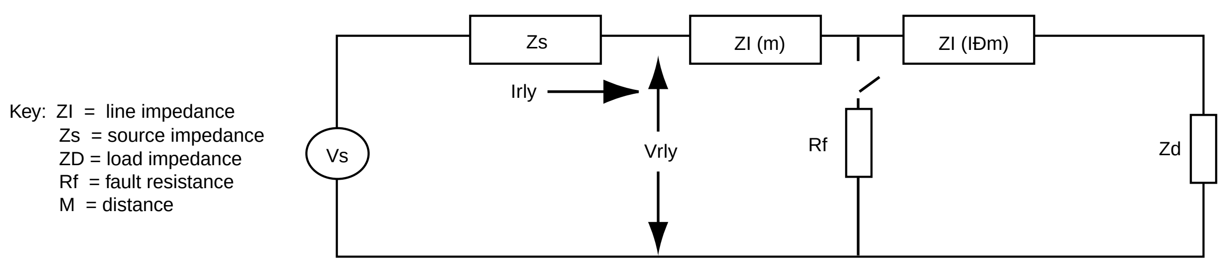
When the operation number reaches 999, the screen resets to 1.

Fault Locator

The DPU2000R fault algorithm is used to calculate estimated fault resistance and apparent distance to the fault. This calculation is performed by comparing the prefault current and voltage to the fault current and voltage and by analyzing the positive and zero sequence reactance per mile. Three to six of 6 cycles of fault current is needed to analyze the fault values. The system parameters are used to estimate the source impedance (known impedance) and source voltage. The fault values are used to estimate the load impedance (estimated impedance) and determine fault type. The known impedance and estimated impedance are used to easily calculate the fault impedance. Once the fault impedance is calculated, the distance to fault can be readily calculated using the fault impedance, the line impedance and the line length.

The Fault algorithm was designed to be used on a homogenous radial distribution line. Therefore, the unit is not intended to be used on a distribution line with many different types of conductors because the algorithm will not be as accurate.

Fault data may not be accurate for a close-into-fault condition where there is no prefault power flow. In the case of closing into a fault during a reclose sequence, the apparent distance to the fault in miles for the first fault appears on the first line of the LCD for the entire reclose sequence. The fault records also display the original fault distance in each record of that reclose sequence. The algorithm for the fault locator is most applicable to a radial feeder.



Self-Test Status

The DPU2000R provides continuous self-testing of its power supply voltages, its memory elements and digital signal processor and its program execution. In the event of a system failure, the protective functions are disabled and the Self-Check Alarm contacts are actuated. Except for a "processor stalled" condition, review the PASS/FAIL status of these self-test elements by using the operator-control interface (OCI). Normal status is indicated by a green NORMAL STATUS light (LED) and system failure is indicated by the red FAIL STATUS light (or by the green NORMAL STATUS light not being lit in the case of a loss of control power).

Self-Test Failures are recorded as a decimal number in the Operations Record. After converting this number to binary, the binary bit pattern indicates the Self-Test Failure or Editor Access Status involved. The 1s in the bit pattern indicate where a failure has occurred. Count from the right of the bit pattern (starting with zero) to the position where a "1" occurs. Compare that bit position with Table 7-1 to reveal the failure. See the examples on page 7-6 for further explanation.

If the self-test fails, the DPU2000R is no longer providing protection. Replace the unit as soon as possible.

Table 7-1. Operations Record Value Information

Bit Position	Self-Test Failure	Editor Access Status	Decimal Value
0	CPU RAM	INTERRUPT LOGGING	1
1	CPU EPROM	REMOTE EDIT DISABLE = 1	2
2	CPU NVRAM	LOCAL EDIT DISABLED = 1	4
3	CPU EEPROM	FRONT MMI EDIT ACTIVE	8
4	MISSING BATTERY	FRONT COMM PORT EDIT ACTIVE	16
5	NOT USED	REAR COMM PORT EDIT ACTIVE	32
6	NOT USED	REAR AUX COMM PORT EDIT ACTIVE	64
7	NOT USED	REAL TIME CLOCK EDITED	128
8	DSP ROM	PROGRAMMABLE I/O EDITED	256
9	DSP INTERNAL RAM	PRIMARY SET EDITED	512
10	DSP EXTERNAL RAM	ALTERNATE1 SETTINGS EDITED	1024
11	DSP ANALOG/DIGITAL CONVERTER	ALTERNATE2 SETTINGS EDITED	2048
12	DSP +/-15, ±12 V POWER SUPPLIES	CONFIGURATION SETTINGS EDITED	4096
13		COUNTER SETTINGS EDITED	8192
14	DSP STALL or +5 V POWER SUPPLY	ALARM SETTINGS EDITED	16384
15	DSP TO CPU COMMUNICATIONS	COMMUNICATIONS SETTINGS EDITED	32768

Examples of bit interpretation are shown below.

Example of a Self-Test Failure

Value : 256 has a binary bit pattern of 0000000100000000 (bit order 15........0)

The 1 is in bit position 8 as you count from the right. This bit position correlates to DSP ROM failure.

Example of an Editor Access

Value : 145 has a binary bit pattern of 0000000010010001 (bit order 15.........0)

The 1s in this bit pattern have the following bit positions and corresponding Editor Access Status:

Bit 0 : Interrupt logging bit (ignore this bit because it will always be set in this example).

Bit 4 : Front communications port initiated the editor access and change.

Bit 7 : Real-time clock settings were changed.

DPU2000R Settings Tables Diagnostics

Three copies of each settings table are stored in a nonvolatile memory device, preventing data loss during control power cycling. When you finish editing any settings table, the changed table's data is transferred from a temporary edit buffer into three separate locations in the nonvolatile memory device.

A background diagnostics task continuously runs a checksum on each copy of the settings tables to verify data consistency. If an invalid copy is detected, the diagnostic task attempts self-correction by transferring a valid copy to the invalid copy location. If this is unsuccessful, the task marks the copy as unusable and switches to the next available copy.

When the DPU2000R detects that all three copies of a settings table are not valid, the diagnostic task adds a self-diagnostic error in the Operations Record, drops the self-check alarm and disables all protective functions. In addition, the Self Test display under the OCI Test Menu shows the current status (PASS or FAIL) for all memory devices.

Operations Log Listing

Listed in Table 7-2 are all of the possible operations records and their descriptions.

Table 7-2. Operations Log Listing

Operations Record Log	Definition
51P Trip	Indicates that the phase time overcurrent element, 51P has timed out and operated. It is possible that this may not have been the actual tripping element.
51N Trip	Indicates that the ground time overcurrent element, 51N has timed out and operated. It is possible that this may not have been the actual tripping element.
50P-1 Trip	Indicates that the phase instantaneous overcurrent element, 50P-1 has timed out and operated. It is possible that this may not have been the actual tripping element.
50N-1 Trip	Indicates that the ground instantaneous overcurrent element, 50N-1 has timed out and operated. It is possible that this may not have been the actual tripping element.
50P-2 Trip	Indicates that the phase instantaneous overcurrent element, 50P-2 has timed out and operated. It is possible that this may not have been the actual tripping element.
50N-2 Trip	Indicates that the ground instantaneous overcurrent element, 50N-2 has timed out and operated. It is possible that this may not have been the actual tripping element.
50P-3 Trip	Indicates that the phase instantaneous overcurrent element, 50P-3 has operated. It is possible that this may not have been the actual tripping element.
50N-3 Trip	Indicates that the ground instantaneous overcurrent element, 50N-3 has operated. It is possible that this may not have been the actual tripping element.
67P Trip	Indicates that the directional phase time overcurrent element, 67P has timed out and operated. It is possible that this may not have been the actual tripping element.
67N Trip	Indicates that the directional ground time overcurrent element, 67N has timed out and operated. It is possible that this may not have been the actual tripping element.
46 Trip	Indicates that the negative sequence time overcurrent element, 46 has timed out and operated. It is possible that this may not have been the actual tripping element.
46A Trip	Indicates that the negative sequence time overcurrent alarm element, 46A has timed out and operated. It is possible that this may not have been the actual tripping element.
27-1P Alarm	Indicates that the single phase undervoltage element, 27-1P, has operated. This log indicates only that the programmable logical output, 27-1P, has operated.
59-1	Indicates that the overvoltage element, 59-1, has operated. This log indicates only that the programmable logical output, 59-1, has operated.
79V Block	Indicates that one or more phases of voltage fell below the 79V threshold setting. Will log a 79V Block only during a reclose operation.
81S-1 Trip	Indicates that the frequency load shed module 1 element, 81S-1, has timed out and operated. This log indicates only that the programmable logical output, 81S-1, has operated.
81R-1 Restore	Indicates that the frequency restoration module 1 element, 81R-1, has timed out and operated. This log indicates only that the programmable logical output, 81R-1, has operated.
81V Block	Indicates that one or more phases of voltage fell below the 81V threshold setting.

Table 7-2. Operations Log Listing (cont.)

27-3P Alarm	Indicates that the three phase voltage element, 27-3P, has operated. This log indicates only that the programmable logical output, 27-3P, has operated.
External Trip	Indicates that the DPU2000R saw the breaker open via the 52A and 52B Programmable Logic inputs, but the relay did not cause the breaker to open.
External Close	Indicates that the DPU2000R saw the breaker close via the 52A and 52B Programmable Logic inputs, but the relay did not cause the breaker to open.
Breaker Opened	Indicates that a “TRIP BREAKER” command was entered from the Operations Menu
Breaker Closed	Indicates that a “CLOSE BREAKER” command was entered from the Operations Menu
Recloser Lockout	Indicates a recloser lockout state. See the Recloser section for details on lockout conditions.
MDT Close	Indicates that a circuit breaker close was issued by the DPU2000R while it was in the MDT mode. See the Multiple Device Trip (MDT) sections for details on MDT tripping.
Ext. Trip & ARC	Indicates that the TARC (Trip and Auto Reclose) logical Input became a logical 1 and the relay went through the reclose cycle.
Ext. Trip CB Stuck	Indicates that the 52A contact opened and the 52B contact closed but current is still flowing through the relay.
Reclose Initiated	Indicates that the DPU2000R has entered into the reclose sequence.
CB Failed to Trip	Indicates the Trip Fail Timer has expired. See Trip Fail Timer in the Recloser section for more details.
CB Failed to Close	Indicates the Close Fail Timer has expired. See Close Fail Timer in the Recloser section for more details.
CB Pops Open	Indicates that the circuit breaker has opened after a CB fail to trip state has occurred. This open state could have occurred when the breaker finally opened (slow breaker) or when manually opened.
CB Pops Closed	Indicates that the circuit breaker has closed after a CB fail to close state has occurred. This could have only occurred external to the DPU2000R or a “Close” command issued via the DPU2000R OCI or WinECP program.
CB State Unknown	Indicates that the 52A and 52B circuit breaker auxiliary contact inputs to the DPU2000R are in an invalid state. See the Programmable Inputs section specifically the 52A and 52B programmable inputs for valid input states.
Grnd. TC Enabled	Indicates that the “GRD” programmable input was asserted and the active ground overcurrent elements enabled. The “GRD” programmable input must be assigned to a physical input or feedback term for this record to appear. It will also appear if the “GRD” logical input is forced Closed in the Operations Menu (see Operations menu section). This record indicates the state of the “GRD” input only.
Grnd. TC Disabled	Indicates that the “GRD” programmable input was de-asserted and the active ground overcurrent elements disabled. The “GRD” programmable input must be assigned to a physical input or feedback term for this record to appear. It will also appear if the “GRD” logical input is forced open in the Operations Menu (see Operations menu section). This record indicates the state of the “GRD” input only.
Phase TC Enabled	Indicates that the “PH3” programmable input was asserted and the active phase overcurrent elements enabled. The “PH3” programmable input must be assigned to a physical input or feedback term for this record to appear. It will also appear if the “PH3” logical input is forced closed in the Operations Menu (see Operations menu section). This record indicates the state of the “PH3” input only.
Phase TC Disabled	Indicates that the “PH3” programmable input was de-asserted and the active phase overcurrent elements disabled. The “PH3” programmable input must be assigned to a physical input or feedback term for this record to appear. It will also appear if the “PH3” logical input is forced open in the Operations Menu (see Operations menu section). This record indicates the state of the “PH3” input only.

Table 7-2. Operations Log Listing (cont.)

Primary Set Active	Indicates that a transition from an Alternate settings group took place and that the Primary settings are active at this point in the record.
Alt 1 Set Active	Indicates that a transition from a Alternate 2 or Primary settings group took place and that the Alternate 1 settings are active at this point in the record.
Alt 2 Set Active	Indicates that a transition from a Alternate 1 or Primary settings group took place and that the Alternate 2 settings are active at this point in the record.
Zone Step	Indicates that a zone sequence coordination operation occurred. See the Zone Sequence Coordination section for details.
Recloser Enabled	Indicates that the "43A" programmable input became asserted or was unmapped to a physical input or feedback term. This record indicates the state of the "43A" input only. This log will appear even if the Recloser is disabled at 79-1 in the active settings group.
Recloser Disabled	Indicates that the 43A programmable input became de-asserted or was mapped to a non active physical input or feedback term. . This record indicates the state of the "43A" input only. This log will appear even if the Recloser is disabled at 79-1 in the active settings group.
Zone Seq. Enabled	Indicates that the programmable input "ZSC" was asserted and the Zone Sequence Coordination function was enabled. This record indicates the state of the "ZSC" input only. This log will appear even if the Zone Sequence Coordination function is disabled in the Configuration settings.
Zone Seq. Disabled	Indicates that the programmable input "ZSC" was de-asserted and the Zone Sequence Coordination function was disabled. This record indicates the state of the "ZSC" input only. This log will appear even if the Zone Sequence Coordination function is disabled in the Configuration settings.
50P/N-1 Disabled	Indicates that the "50-1" programmable input was de-asserted and the active 50P-1 and 50N-1 instantaneous overcurrent elements disabled. The "50-1" programmable input must be assigned to a physical input or feedback term for this record to appear. It will also appear if the "50-1" logical input is forced open in the Operations Menu (see Section 8). This record indicates the state of the "50-1" input only. This log will appear even if the 50P-1 and 50N-1 elements are disabled in the active settings group.
50P/N-2 Disabled	Indicates that the "50-2" programmable input was de-asserted and the active the 50P-2 and 50N-2 instantaneous overcurrent elements disabled. The "50-2" programmable input must be assigned to a physical input or feedback term for this record to appear. It will also appear if the "50-2" logical input is forced open in the Operations Menu (see Section 8). This record indicates the state of the "50-2" input only. This log will appear even if the 50P-2 and 50N-2 elements are disabled in the active settings group.
50P/N-3 Disabled	Indicates that the "50-3" programmable input was de-asserted and the active the 50P-3 and 50N-3 instantaneous overcurrent elements disabled. The "50-3" programmable input must be assigned to a physical input or feedback term for this record to appear. It will also appear if the "50-3" logical input is forced open in the Operations Menu (see Section 8). This record indicates the state of the "50-3" input only. This log will appear even if the 50P-3 and 50N-3 elements are disabled in the active settings group.
50P/N-1 Enabled	Indicates that the "50-1" programmable input was asserted and the active the 50P-1 and 50N-1 instantaneous overcurrent elements enabled. The "50-1" programmable input must be assigned to a physical input or feedback term for this record to appear. It will also appear if the "50-1" logical input is forced open in the Operations Menu (see Section 8). This record indicates the state of the "50-1" input only. This log will appear even if the 50P-1 and 50N-1 elements are disabled in the active settings group.
50P/N-2 Enabled	Indicates that the "50-2" programmable input was asserted and the active the 50P-2 and 50N-2 instantaneous overcurrent elements enabled. The "50-2" programmable input must be assigned to a physical input or feedback term for this record to appear. It will also appear if the "50-2" logical input is forced open in the Operations Menu (see Section 8). This record indicates the state of the "50-2" input only. This log will appear even if the 50P-2 and 50N-2 elements are disabled in the active settings group.
50P/N-3 Enabled	Indicates that the "50-3" programmable input was asserted and the active the 50P-3 and 50N-3 instantaneous overcurrent elements enabled. The "50-3" programmable input must be assigned to a physical input or feedback term for this record to appear. It will also appear if the "50-3" logical input is forced open in the Operations Menu (see Section 8). This record indicates the state of the "50-3" input only. This log will appear even if the 50P-3 and 50N-3 elements are disabled in the active settings group.

Table 7-2. Operations Log Listing (cont.)

81S-2 Trip	Indicates that the frequency load shed module 2 element, 81S-2, has timed out and operated. This log indicates only that the programmable logical output, 81S-2, has operated.
81R-2 Restore	Indicates that the frequency restoration module 1 element, 81R-2, has timed out and operated. This log indicates only that the programmable logical output, 81R-2, has operated.
81O-1 Overfrequency	Indicates that the overfrequency module 1 element, 81O-1, has timed out and operated. This log indicates only that the programmable logical output, 81O-1, has operated.
81O-2 Overfrequency	Indicates that the overfrequency module 2 element, 81O-2, has timed out and operated. This log indicates only that the programmable logical output, 81O-2, has operated.
Blown Fuse Alarm	Indicates that "BFUA" programmable logical output has operated. See the Programmable Outputs section specifically the "BFUA" output for more details.
OC Trip Counter	Indicates that the Overcurrent Trip Counter has exceeded the Overcurrent Trip Counter Alarm setting. See Section 6, specifically the "OCTC" output, for more details.
Accumulated KSI	Indicates that the KSI summation has exceeded the KSI Alarm setting. See Section 6, specifically the "KSI" output, for more details.
79 Counter 1 Alarm	Indicates that the number of reclose operations has exceeded the Reclose Counter 1 Alarm setting. See Section 6, specifically the "79CA1" output, for more details.
79 Counter 2 Alarm	Indicates that the number of reclose operations has exceeded the Reclose Counter 2 Alarm setting. See Section 6, specifically the "79CA2" output, for more details.
Phase Demand Alarm	Indicates that the phase demand current has exceeded the Phase Demand Current Alarm setting. See Section 6, specifically the "PDA" output, for more details.
Neutral Demand Alarm	Indicates that the neutral demand current has exceeded the Neutral Demand Current Alarm setting. See Section 6, specifically the "NDA" output, for more details.
Low PF Alarm	Indicates that the power factor has gone below the Low Power Factor Alarm setting. See the Section 6, specifically the "LPFA" output, for more details.
High PF Alarm	Indicates that the power factor has risen above the High Power Factor Alarm setting. See Section 6, specifically the "HPFA" output, for more details.
Trip Coil Failure	Indicates that the logical input "TCM" indicated a trip coil failure. See Section 6, specifically the "TCM" input.
KVAr Demand Alarm	Indicates that the demand KiloVArs have exceeded the Demand KiloVAr Alarm setting. See Section 6, specifically the "VARDA" output, for more details.
Pos. KVAr Alarm	Indicates that the positive KiloVArs have exceeded the Positive KiloVAr Alarm setting. See Section 6, specifically the "PVArA" output, for more details.
Neg. KVAr Alarm	Indicates that the negative KiloVArs have exceeded the negative KiloVAr Alarm setting. See Section 6, specifically the "NVArA" output, for more details.
Load Alarm	Indicates that the load current has exceeded the Load Current Alarm setting. See Section 6, specifically the "LOADA" output, for more details.
Cold Load Alarm	Logs when the cold load timer is counting down. Also see CLTA logical output description.
Pos Watt Alarm 1	Indicates that the positive kilowatts have exceeded the Positive Kilowatt Alarm 1 setting. See Section 6, specifically the "Pwatt1" output, for more details.
Pos Watt Alarm 2	Indicates that the positive kilowatts have exceeded the Positive Kilowatt Alarm 2 setting. See Section 6, specifically the "Pwatt2" output, for more details.

Table 7-2. Operations Log Listing (cont.)

32P Trip	Indicates that the phase directional power element, 32P-2, has operated. See Section 6, specifically the "32P-2" output, for more details.
32N Trip	Indicates that the ground directional power element, 32N, has operated. See Section 6, specifically the "32N-2" output, for more details.
BFT Operation	Indicates operation of the Breaker Failure Trip (BFT) logical output. See Section 1 under "Breaker Failure Logic" for more details.
ReTrip Operation	Indicates operation of the ReTrip logical output. See Section 1 under "Breaker Failure Logic" for more details.
ROM Failure	Indicates a failure of the DPU2000R Read Only Memory. Contact ABB technical support at this time.
RAM Failure	Indicates a failure of the DPU2000R Random Access Memory. Contact ABB technical support at this time.
Self Test Failed	Indicates a failure of the DPU2000R during the self check procedure. See the servicing section for more details.
EEPROM Failure	Indicates a failure of the DPU2000R Non-Volatile Memory. Contact ABB technical support at this time.
BATRAM Failure	Indicates a failure of the DPU2000R Battery Backed-up Random Access Memory. Contact ABB technical support at this time.
DSP Failure	Indicates a failure of the DPU2000R Digital Signal Processor. Contact ABB technical support at this time.
Control Power Fail	Indicates that the control power has dropped below the control power operating threshold as outlined in the Specifications section
Editor Access	Indicates that a settings change has been made.
Springs Charged	Indicates the state of the Spring Charging Contact, "SCC", programmable input. This record will appear when the "SCC" input transitions from a logical 0 to a logical 1. See Section 6, specifically the "SCC" input, for more details.
Springs Discharged	Indicates the state of the Spring Charging Contact, "SCC", programmable input. This record will appear when the "SCC" input transitions from a logical 1 to a logical 0. See Section 6, specifically the "SCC" input, for more details.
79S Input Enabled	Indicates the state of the single shot reclose ,"79S", programmable input. This record will appear when the "79S" input transitions from a logical 0 to a logical 1. See Section 1 for more details on the 79S function.
79S Input Disabled	Indicates the state of the single shot reclose ,"79S", programmable input. This record will appear when the "79S" input transitions from a logical 1 to a logical 0. See Section 1 for more details on the 79S function.
79M Input Enabled	Indicates the state of the multi shot reclose ,"79M", programmable input. This record will appear when the "79M" input transitions from a logical 0 to a logical 1. See Section 1 for more details on the 79M function.
79M Input Disabled	Indicates the state of the multi shot reclose ,"79M", programmable input. This record will appear when the "79M" input transitions from a logical 1 to a logical 0. See Section 1 for more details on the 79M function.
TCM Input Closed	Indicates the state of the Trip Circuit Monitor,"TCM", programmable input. This record will appear when the "TCM" input transitions from a logical 0 to a logical 1. See Section 6, specifically the "TCM" input, for more details.
TCM Input Opened	Indicates the state of the Trip Circuit Monitor,"TCM", programmable input. This record will appear when the "TCM" input transitions from a logical 1 to a logical 0. See Section 6, specifically the "TCM" input, for more details.
Ext Trip Enabled	Indicates that the programmable input "Open" was asserted. This record indicates the state of the programmable input "Open" only. It does not imply an actual breaker trip.

Table 7-2. Operations Log Listing (cont.)

Ext Trip Disabled	Indicates that the programmable input "Open" was de-asserted.
Event Cap 1 Init	Indicates that the programmable input "ECI1" was asserted and an event capture taken. The data from the event is stored in the Fault Records.
Event Cap 1 Reset	Indicates that the programmable input "ECI1" was de-asserted.
Event Cap 2 Init	Indicates that the programmable input "ECI2" was asserted and an event capture taken. The data from the event is stored in the Fault Records.
Event Cap 2 Reset	Indicates that the programmable input "ECI2" was de-asserted.
Wave Cap Init	Indicates that the programmable input "WCI" was asserted and an oscillographic record stored. The data from the event is stored in the Waveform Capture Records.
Wave Cap Reset	Indicates that the programmable input "WCI" was de-asserted.
Ext Close Enabled	Indicates that the programmable input "Close" was asserted. This record indicates the state of the programmable input "Close" only. It does not imply an actual breaker close.
Ext Close Disabled	Indicates that the programmable input "Close" was de-asserted.
52a Closed	Indicates the state of the programmable logic input "52A". This record indicates the state of the programmable input "52A" only. It does not imply an actual breaker state. The "52A Closed" record indicates that the "52A" logical input was at a logical 1 at the time of the logging.
52a Opened	Indicates the state of the programmable logic input "52A". This record indicates the state of the programmable input "52A" only. It does not imply an actual breaker state. The "52A Opened" record indicates that the "52A" logical input was at a logical 0 at the time of the logging.
52b Closed	Indicates the state of the programmable logic input "52B". This record indicates the state of the programmable input "52B" only. It does not imply an actual breaker state. The "52B Closed" record indicates that the "52B" logical input was at a logical 1 at the time of the logging.
52b Opened	Indicates the state of the programmable logic input "52B". This record indicates the state of the programmable input "52B" only. It does not imply an actual breaker state. The "52B Opened" record indicates that the "52B" logical input was at a logical 0 at the time of the logging.
46 Unit Enabled	Indicates that the programmable input, "46" transitioned from a logical 0 to a logical 1, enabling the negative sequence time overcurrent element if used. This log indicates the state of the "46" input only.
46 Unit Disabled	Indicates that the programmable input, "46" transitioned from a logical 1 to a logical 0, disabling the negative sequence time overcurrent element if used. This log indicates the state of the "46" input only.
67P Unit Enabled	Indicates that the programmable input, "67P" transitioned from a logical 0 to a logical 1, enabling the phase directional time overcurrent element if used. This log indicates the state of the "67P" input only.
67P Unit Disabled	Indicates that the programmable input, "67P" transitioned from a logical 1 to a logical 0, disabling the phase directional time overcurrent element if used. This log indicates the state of the "67P" input only.
67N Unit Enabled	Indicates that the programmable input, "67N" transitioned from a logical 0 to a logical 1, enabling the ground directional time overcurrent element if used. This log indicates the state of the "67N" input only.
67 Unit Disabled	Indicates that the programmable input, "67N" transitioned from a logical 1 to a logical 0, disabling the ground directional time overcurrent element if used. This log indicates the state of the "67N" input only.
ULI1 Input Closed	Indicates that the User Logical Input, ULI1, transitioned from a logical 0 to a logical 1. See Section 6 for more details on User Logical Inputs.
ULI1 Input Opened	Indicates that the User Logical Input, ULI1, transitioned from a logical 1 to a logical 0. See Section 6 for more details on User Logical Inputs.

Table 7-2. Operations Log Listing (cont.)

ULI2 Input Closed	Indicates that the User Logical Input, ULI2, transitioned from a logical 0 to a logical 1. See Section 6 for more details on User Logical Inputs.
ULI2 Input Opened	Indicates that the User Logical Input, ULI2, transitioned from a logical 1 to a logical 0. See Section 6 for more details on User Logical Inputs.
ULI3 Input Closed	Indicates that the User Logical Input, ULI3, transitioned from a logical 0 to a logical 1. See Section 6 for more details on User Logical Inputs.
ULI3 Input Opened	Indicates that the User Logical Input, ULI3, transitioned from a logical 1 to a logical 0. See Section 6 for more details on User Logical Inputs.
ULI4 Input Closed	Indicates that the User Logical Input, ULI4, transitioned from a logical 0 to a logical 1. See Section 6 for more details on User Logical Inputs.
ULI4 Input Opened	Indicates that the User Logical Input, ULI4, transitioned from a logical 1 to a logical 0. See Section 6 for more details on User Logical Inputs.
ULI5 Input Closed	Indicates that the User Logical Input, ULI5, transitioned from a logical 0 to a logical 1. See Section 6 for more details on User Logical Inputs.
ULI5 Input Opened	Indicates that the User Logical Input, ULI5, transitioned from a logical 1 to a logical 0. See Section 6 for more details on User Logical Inputs.
ULI6 Input Closed	Indicates that the User Logical Input, ULI6, transitioned from a logical 0 to a logical 1. See Section 6 for more details on User Logical Inputs.
ULI6 Input Opened	Indicates that the User Logical Input, ULI6, transitioned from a logical 1 to a logical 0. See Section 6 for more details on User Logical Inputs.
ULI7 Input Closed	Indicates that the User Logical Input, ULI7, transitioned from a logical 0 to a logical 1. See Section 6 for more details on User Logical Inputs.
ULI7 Input Opened	Indicates that the User Logical Input, ULI7, transitioned from a logical 1 to a logical 0. See Section 6 for more details on User Logical Inputs.
ULI8 Input Closed	Indicates that the User Logical Input, ULI8, transitioned from a logical 0 to a logical 1. See Section 6 for more details on User Logical Inputs.
ULI8 Input Opened	Indicates that the User Logical Input, ULI8, transitioned from a logical 1 to a logical 0. See Section 6 for more details on User Logical Inputs.
ULI9 Input Closed	Indicates that the User Logical Input, ULI9, transitioned from a logical 0 to a logical 1. See Section 6 for more details on User Logical Inputs.
ULI9 Input Opened	Indicates that the User Logical Input, ULI9, transitioned from a logical 1 to a logical 0. See Section 6 for more details on User Logical Inputs.
ULI10 Input Closed	Indicates that the User Logical Input, ULI10, transitioned from a logical 0 to a logical 1. See Section 6 for more details on User Logical Inputs.
ULI10 Input Opened	Indicates that the User Logical Input, ULI10, transitioned from a logical 1 to a logical 0. See Section 6 for more details on User Logical Inputs.
ULI11 Input Closed	Indicates that the User Logical Input, ULI1, transitioned from a logical 0 to a logical 1. See Section 6 for more details on User Logical Inputs.
ULI11 Input Opened	Indicates that the User Logical Input, ULI1, transitioned from a logical 1 to a logical 0. See Section 6 for more details on User Logical Inputs.

Table 7-2. Operations Log Listing (cont.)

ULI12 Input Closed	Indicates that the User Logical Input, ULI12, transitioned from a logical 0 to a logical 1. See Section 6 for more details on User Logical Inputs.
ULI12 Input Opened	Indicates that the User Logical Input, ULI12, transitioned from a logical 1 to a logical 0. See Section 6 for more details on User Logical Inputs.
ULI13 Input Closed	Indicates that the User Logical Input, ULI13, transitioned from a logical 0 to a logical 1. See Section 6 for more details on User Logical Inputs.
ULI13 Input Opened	Indicates that the User Logical Input, ULI13, transitioned from a logical 1 to a logical 0. See Section 6 for more details on User Logical Inputs.
ULI14 Input Closed	Indicates that the User Logical Input, ULI14, transitioned from a logical 0 to a logical 1. See Section 6 for more details on User Logical Inputs.
ULI14 Input Opened	Indicates that the User Logical Input, ULI14, transitioned from a logical 1 to a logical 0. See Section 6 for more details on User Logical Inputs.
ULI15 Input Closed	Indicates that the User Logical Input, ULI15, transitioned from a logical 0 to a logical 1. See Section 6 for more details on User Logical Inputs.
ULI15 Input Opened	Indicates that the User Logical Input, ULI15, transitioned from a logical 1 to a logical 0. See Section 6 for more details on User Logical Inputs.
ULI16 Input Closed	Indicates that the User Logical Input, ULI16, transitioned from a logical 0 to a logical 1. See Section 6 for more details on User Logical Inputs.
ULI16 Input Opened	Indicates that the User Logical Input, ULI16, transitioned from a logical 1 to a logical 0. See Section 6 for more details on User Logical Inputs.
CRI Input Closed	Indicates that the programmable input Clear Reclose and Overcurrent Counters, “CRI”, transitioned from a logical 0 to a logical 1. See Section 6, specifically the “CRI” input, for more details.
CRI Input Opened	Indicates that the programmable input Clear Reclose and Overcurrent Counters, “CRI”, transitioned from a logical 1 to a logical 0. See Section 6, specifically the “CRI” input, for more details.
ARC Blocked	Indicates that the programmable input Auto Reclose Inhibit, “ARCI”, transitioned from a logical 0 to a logical 1. See Section 6, specifically the “ARCI” input, for more details on “ARCI” operation.
ARC Enabled	Indicates that the programmable input Auto Reclose Inhibit, “ARCI”, transitioned from a logical 1 to a logical 0. See Section 6, specifically the “ARCI” input, for more details on “ARCI” operation.
TARC Opened	Indicates that the programmable input Trip and Auto Reclose, “TARC”, transitioned from a logical 1 to a logical 0. See Section 6, specifically the “TARC” input for more details on “TARC” operation.
TARC Closed	Indicates that the programmable input Trip and Auto Reclose, “TARC”, transitioned from a logical 0 to a logical 1. See Section 6, specifically the “TARC” input for more details on “TARC” operation. Logs when an External Trip and Auto reclose occurred.
⊗ SEF Enabled	Indicates that the Sensitive Earth Fault programmable logic input, “SEF” has transitioned from a logical 0 to a logical 1 enabling the SEF element if used. See the Sensitive Earth Fault section for details on SEF operation.
⊗ SEF Disabled	Indicates that the Sensitive Earth Fault programmable logic input, “SEF” has transitioned from a logical 1 to a logical 0 disabling the SEF element if used. See the Sensitive Earth Fault section for details on SEF operation.
Supervisory Disable	Indicates that the logical input “Local/SupV” has transitioned from a logical 1 to a logical 0.
Supervisory Enabled	Indicates that the logical input “Local/SupV” has transitioned from a logical 0 to a logical 1.

Table 7-2. Operations Log Listing (cont.)

CB Slow to Trip	Indicated that the “Slow Breaker Time” setting in the configuration settings has expired.
†Sync Check Enabled	Indicates that the Sync Check logical input “25” has transitioned from a logical 0 to a logical 1. See Section 1 for more details on Sync Check.
†Sync Check Disabled	Indicates that the Sync Check logical input “25” has transitioned from a logical 1 to a logical 0. See Section 1 for more details on Sync Check.
†Lines Synced	Indicates that the logical output “25 has transitioned from a logical 0 to a logical 1.
†Line Sync Lost	Indicates that the logical output “25” has transitioned from a logical 1 to a logical 0.
†Sync Bypass Enabled	Indicates that the logical input “25 BYP” has transitioned from a logical 0 to a logical 1.
†Sync Bypass Disabled	Indicates that the logical input “25 BYP” has transitioned from a logical 1 to a logical 0.
†Failed to Sync	Logged after a trip and during a reclose sequence, the Sync Fail Timer times out.TOC Pickup - No Trip Indicates that a time overcurrent element pickup up but did not result in a trip output.
SEF Trip	Indicates that a Sensitive EarthFault “SEF” has produced an output. See the Sensitive Earth Fault section for details of SEF operation.
Open Trip Contact	Indicates that an open trip contact exists, or open trip circuit.
CB Stuck Closed	Indicates that the circuit breaker was stuck and failed to open.
Ext. BFI Enabled	Indicates that the Ext. BFI protection was enabled.
Ext. BFT Disabled	Indicates that the Ext. BFI protection was disabled.
BFI Enabled	Indicates that the BFI protection was enabled.
BFI Disabled	Indicates that the BFI protection was disabled.
System Reboot Init.	Indicates that the relay was rebooted.
User Displayed	Indicates that the unit OCI was turned on.
User Displayed Off	Indicates that the unit OCI was turned off.
59-3 P Alarm	Indicates the phase overvoltage element 59-3P element has operated. This indicates only that the programmable logical output 59-3P has operated.
47 Alarm	Indicates the negative sequence voltage element 47 element has operated. This indicates only that the programmable logical output 47 has operated.
21P-1 Trip	Indicates that the phase distance unit zone one 21-1 element has operated. This indicates only that the programmable logical output 21-1 has operated.
21P-2 Trip	Indicates that the phase distance unit zone two 21-2 element has operated. This indicates only that the programmable logical output 21-2 has operated.
21P-3 Trip	Indicates that the phase distance unit zone three 21-3 element has operated. This indicates only that the programmable logical output 21-3 has operated.
21P-4 Trip	Indicates that the phase distance unit zone four 21-4 element has operated. This indicates only that the programmable logical output 21-4 has operated.

⊗ SEF Model only

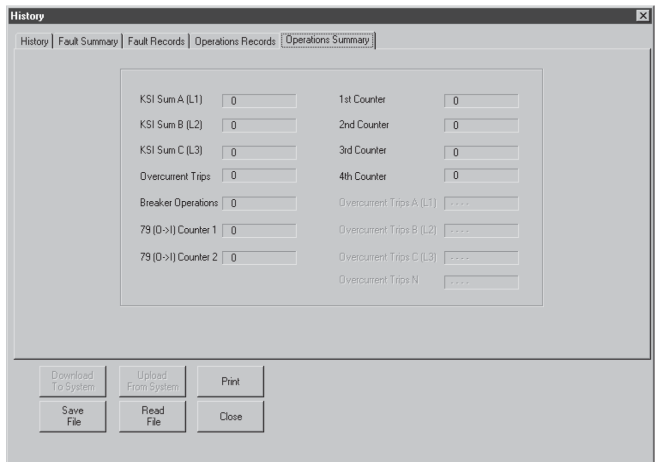
† Sync Check Model only

Table 7-2. Operations Log Listing (cont.)

DBDL	Dead bus dead line is logged when the 25 function is in the unknown state and transitions to the DBDL state.
DBLL	Dead bus live line is logged when the 25 function is in the unknown state and transitions to the DBLL state.
LBDL	Live bus dead line is logged when the 25 function is in the unknown state and transitions to the LBDL state.
LBLL	Live bus live line is logged when the 25 function is in the unknown state and transitions to the LBLL state.

Operations Summary

The Operations Summary includes:



- Summation of breaker interruption duty on a per-phase basis in KSI (thousand symmetrical amperes)
- Number of overcurrent trips
- Total number of reclosures (both counters)
- Number of breaker operations (overcurrent, load current and no load)
- Number of successful reclosings by reclosure sequence number (1st, 2nd, 3rd and 4th)

Save the Operations Summary as a file using WinECP.

Monitoring and Control

The DPU2000R contains a unique feature that allows control, testing, and monitoring of relay functions from the front-panel OCI or WinECP program. It allows monitoring of physical and logical I/O, real-time metering, breaker control (open and close), alarm reset, and state forcing of both physical and logical I/O. All control actions are password protected.

Physical I/O Status

The status of all inputs one through six, outputs one through six, and the Master Trip output is available with WinECP. The Physical I/O Status screen (see Figure 8-1) displays the physical, open/close status of all contact inputs and the energized/de-energized status of all output relays. Use this display to confirm continuity through each optically isolated contact input for both the opened (no voltage applied) and closed (voltage applied) states and to confirm the status of each output relay. Input status is also available through the front-panel OCI by accessing the Test Menu. **Output relay status is not available through the front-panel OCI.**

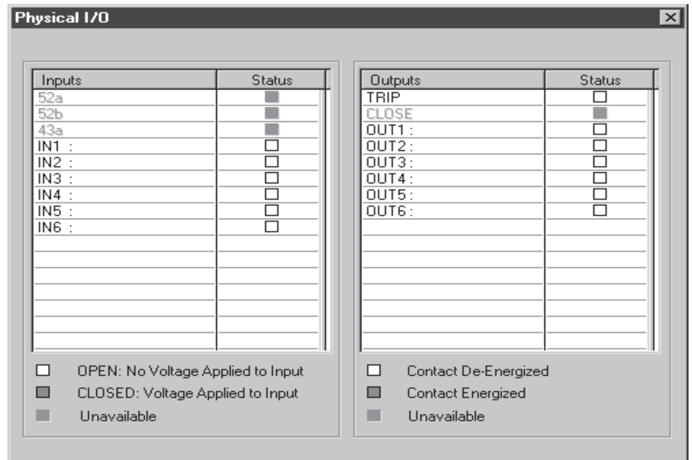


Figure 8-1. Physical I/O Status

Logical Input Status

The Logical Input Status screen (Figure 8-2) displays which functions are enabled or disabled based on the physical input logic. Use this function to verify the actions of programmed logic schemes. With this screen it is possible to view intermediate logic to confirm that the scheme works correctly and produces the desired results. Note that the GRD (3I), PH3 (IN), 46 (Insc>), 50-1 (I>>1), 50-2 (I>>2), 50-3 (I>>3), TCM (TCS), ZSC, and SEF* (IØ >) input functions are enabled by default. Therefore, they need not be mapped to physical inputs in the Programmable Input Logic Map (see Section 6) if it is desired to use them. **This feature is not available through the front-panel OCI.**

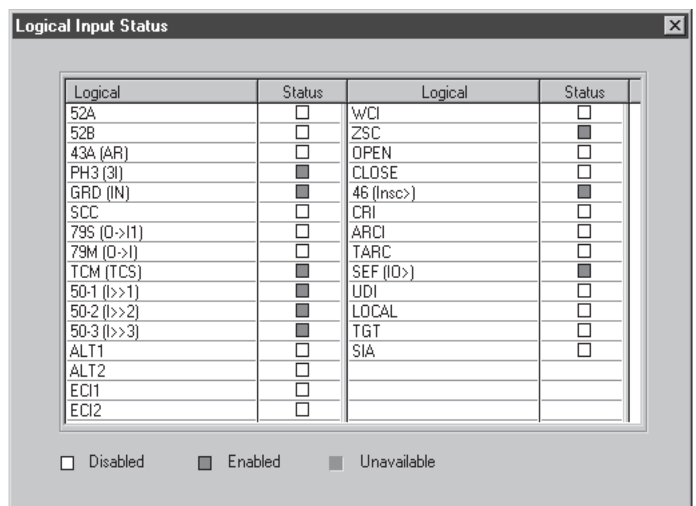
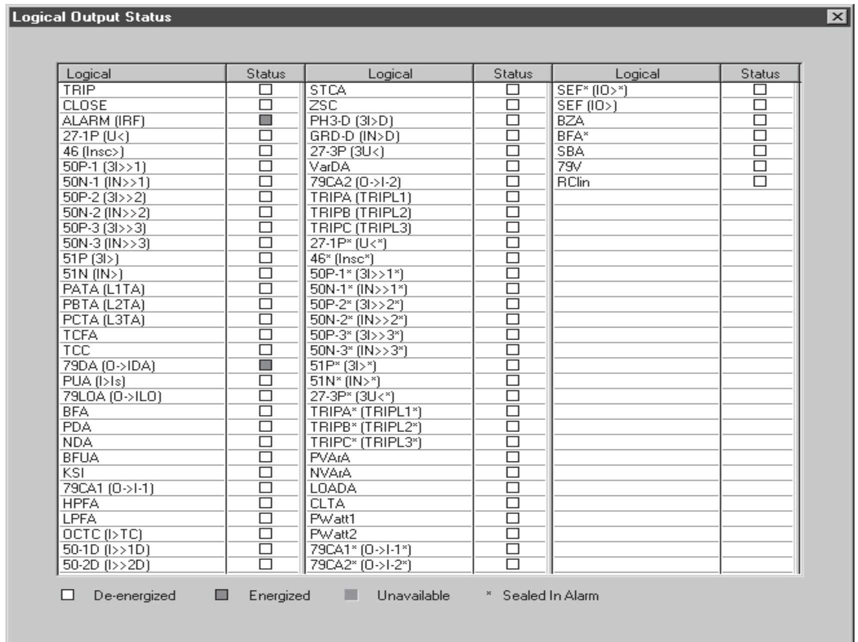


Figure 8-2. Logical Input Status

* SEF model only

Logical Output Status

The logical output status shown in Figure 8-3 displays which output functions are energized and de-energized. Use this display to confirm whether or not the functions are programmed correctly in the Primary, Alternate 1, Alternate 2, Programmable Inputs and Alarm Settings tables. Also use it to check that the settings provide the desired results. **This feature is not available through the front-panel OCI.**


Logical Output Status

Logical	Status	Logical	Status	Logical	Status
TRIP	☐	STCA	☐	SEF* (IO>*)	☐
CLOSE	☐	ZSC	☐	SEF (IO>)	☐
ALARM (IRF)	■	PH3-D (3I>D)	☐	BZA	☐
27-1P (U<)	☐	GRD-D (IN>D)	☐	BFA*	☐
46 (Insc>)	☐	27-3P (3U<)	☐	SBA	☐
50P-1 (3I>>1)	☐	VarDA	☐	79V	☐
50N-1 (IN>>1)	☐	79CA2 (O->I-2)	☐	RClin	☐
50P-2 (3I>>2)	☐	TRIPA (TRIPL1)	☐		
50N-2 (IN>>2)	☐	TRIPB (TRIPL2)	☐		
50P-3 (3I>>3)	☐	TRIPC (TRIPL3)	☐		
50N-3 (IN>>3)	☐	27-1P* (U<*)	☐		
51P (3I>)	☐	46* (Insc*)	☐		
51N (IN>)	☐	50P-1* (3I>>1*)	☐		
PATA (L1TA)	☐	50N-1* (IN>>1*)	☐		
PBTA (L2TA)	☐	50P-2* (3I>>2*)	☐		
PCTA (L3TA)	☐	50N-2* (IN>>2*)	☐		
TCFA	☐	50P-3* (3I>>3*)	☐		
TCC	☐	50N-3* (IN>>3*)	☐		
79DA (O->IDA)	■	51P* (3I>*)	☐		
PUA (I>Is)	☐	51N* (IN>*)	☐		
79LOA (O->ILO)	☐	27-3P* (3U<*)	☐		
BFA	☐	TRIPA* (TRIPL1*)	☐		
PDA	☐	TRIPB* (TRIPL2*)	☐		
NDA	☐	TRIPC* (TRIPL3*)	☐		
BFUA	☐	PVArA	☐		
KSI	☐	NVArA	☐		
79CA1 (O->I-1)	☐	LOADA	☐		
HPFA	☐	CLTA	☐		
LPFA	☐	PWatt1	☐		
OCTC (I>TC)	☐	PWatt2	☐		
50-1D (I>>1D)	☐	79CA1* (O->I-1*)	☐		
50-2D (I>>2D)	☐	79CA2* (O->I-2*)	☐		

☐ De-energized ■ Energized ■ Unavailable * Sealed In Alarm

Figure 8-3. Logical Output Status

Metering Status

The present values of Load, Demand, and Min/Max Demand metering can be viewed in real-time with WinECP and through the front-panel OCI. Use the Monitoring Menu in WinECP, and the Meter Menu on the front-panel OCI. See Section 3 for more information.

Forcing I/O

To aid in DPU2000R commissioning and testing, the state of all Physical Inputs and Outputs, and Logical Inputs can be forced through WinECP or front-panel OCI. This feature can be accessed in WinECP through the Control Menu, and through front-panel OCI through the Operations Menu. When one or more input/output is in the forced condition the "Normal" LED on front panel will blink on and off. All forcing of I/O is password protected. See Figures 8-4 through 8-6.

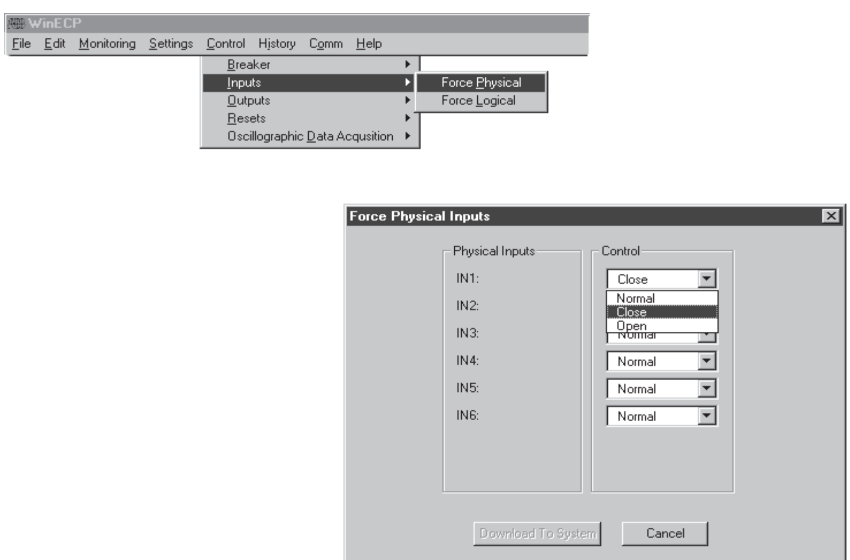


Figure 8-4. Forcing Physical Inputs

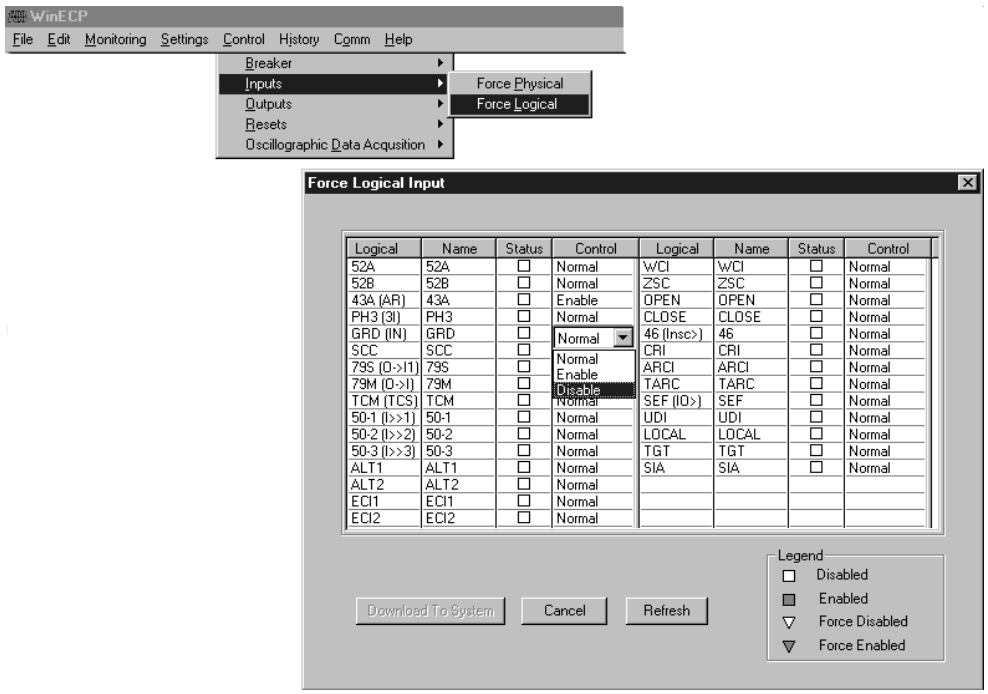


Figure 8-5. Forcing Logical Inputs

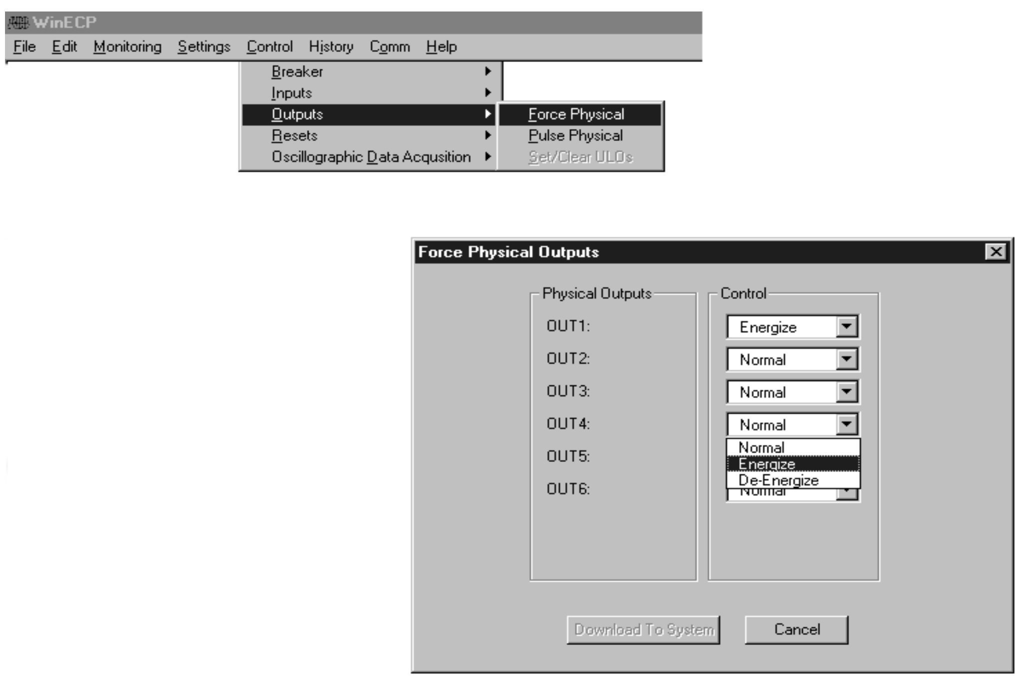


Figure 8-6. Forcing Physical Outputs

Pulsing Physical Outputs

Sometimes it is desired to pulse an output instead of setting it through the Force Physical Output command. In this case, the Pulse Physical Output command can be used. When the output is pulsed, it will stay asserted for approximately 1 second. The Pulse Physical Output command is password protected, and is available through the Control Menu in WinECP, or the Test Menu through the front-panel OCI.

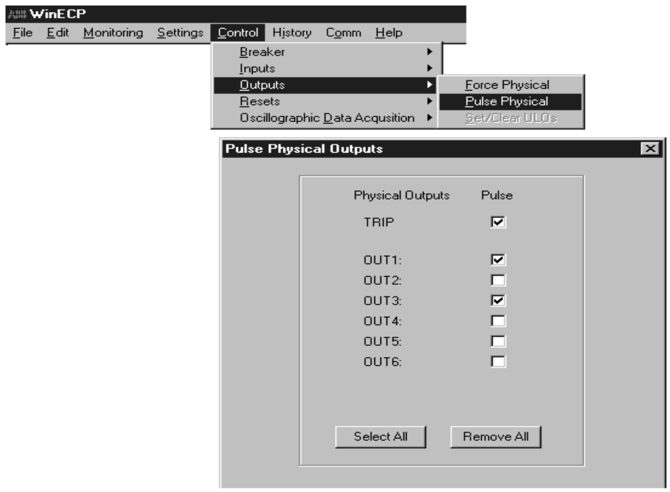


Figure 8-7. Pulse Physical Outputs

Circuit Breaker Open and Close

The circuit breaker can be opened or closed through both WinECP and the front-panel OCI. Use the Control – Breaker Menu in WinECP, and the Operations Menu through the OCI. The Open and Close commands are password protected. See Figure 8-8.

NOTE: When a CLOSE command is issued to the DPU2000R with Software Version 1.00 or higher in a “Circuit Breaker Status Indeterminate” state (that is the 52A and 52B contacts inputs read the same value), the DPU2000R will hold the command in memory. This CLOSE command will be executed if the status of the 52A/52B contact inputs become determinate and indicates a “Breaker Open” State. The CLOSE command will not be executed if the status of the 52A/52B contact inputs become determinate and indicates a “Breaker Close” state, or if the DPU2000R is reset, or if control power to the DPU2000R is cycled.

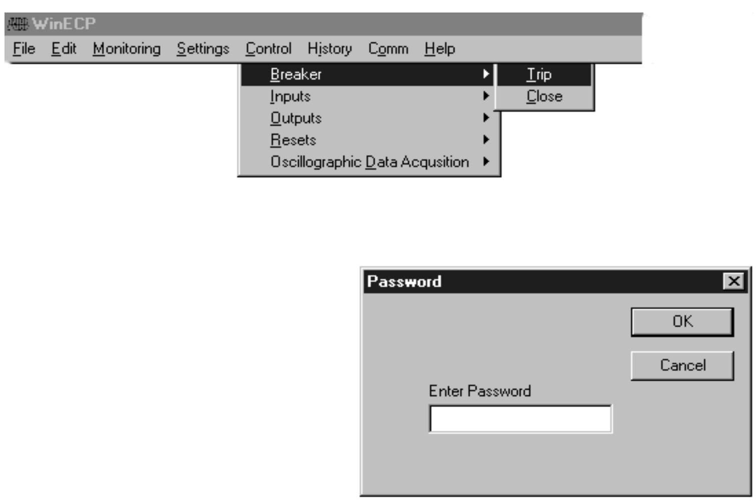


Figure 8-8. Breaker Control

Resets

Certain registers can be reset with WinECP. Targets, Sealed In Alarms, and Min/Max Demand registers can all be reset through the Control-Reset Menu (see Figure 8-9). The Sealed In Alarms can be selectively reset, or can be reset all at once by choosing “De-energize All” (see Figure 8-10). Targets, alarms, and seal-in alarms can also be reset through the front-panel OCI. See page 5-1 in Section 5 for details.

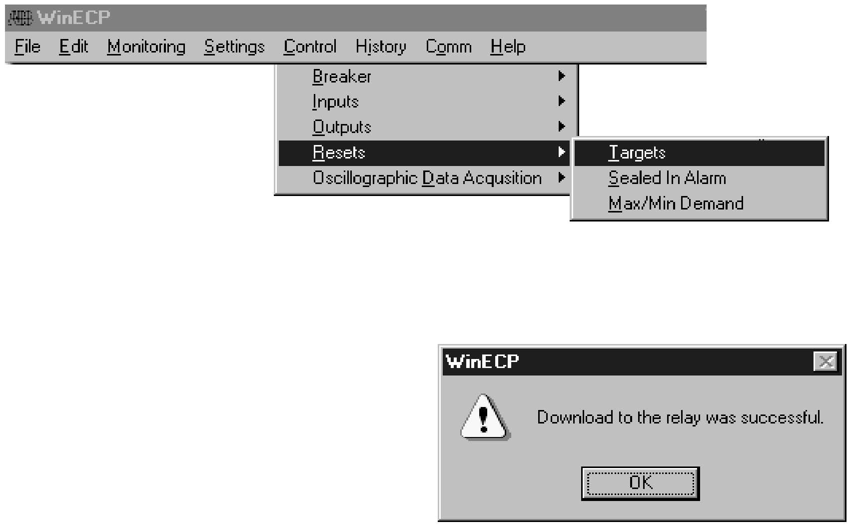


Figure 8-9. Target Reset

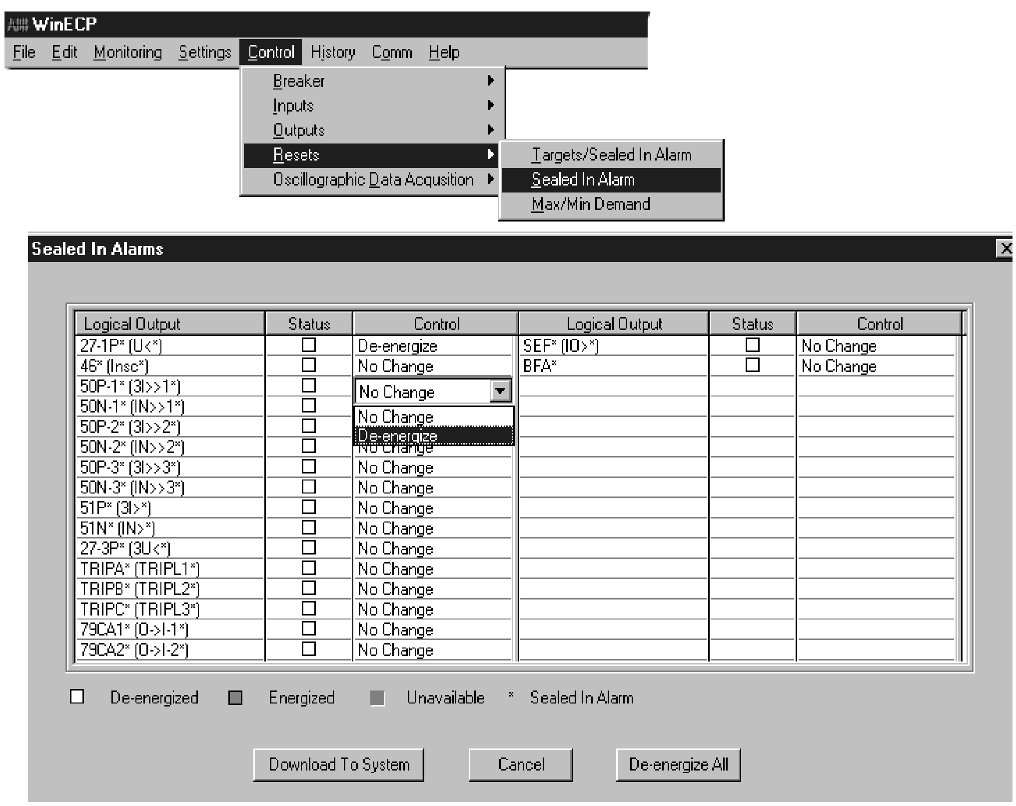


Figure 8-10. Seal-In Alarm Reset

Oscillographic Data Acquisition

Oscillographic data acquisition can be started or stopped with WinECP. Use the Control Menu to start and stop data acquisition (Figure 8-11). The status of the oscillographic data recorder can be viewed through the Monitoring Menu (Figure 8-12). **This feature is not available through the front-panel OCI.**

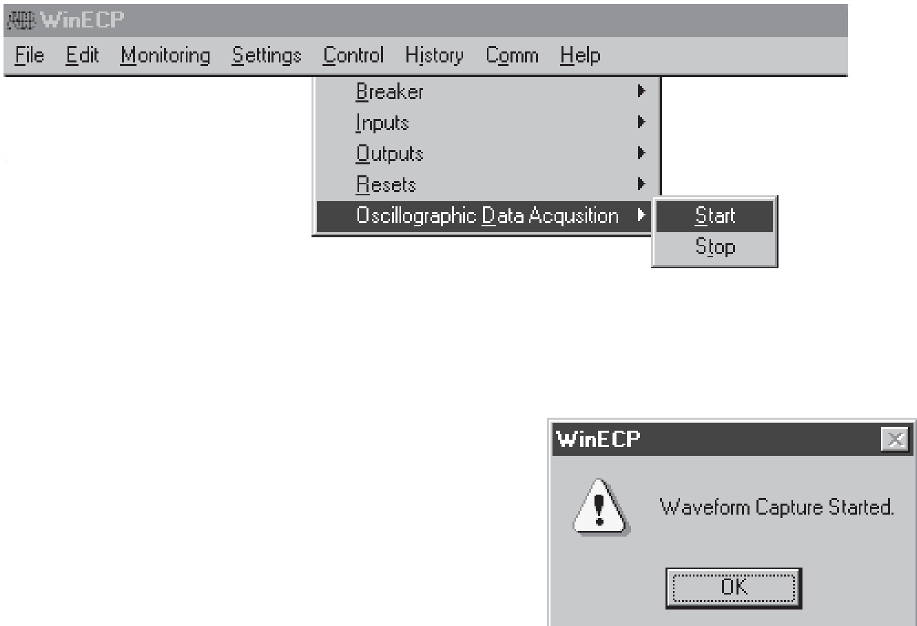


Figure 8-11. Starting Oscillographic Data Acquisition

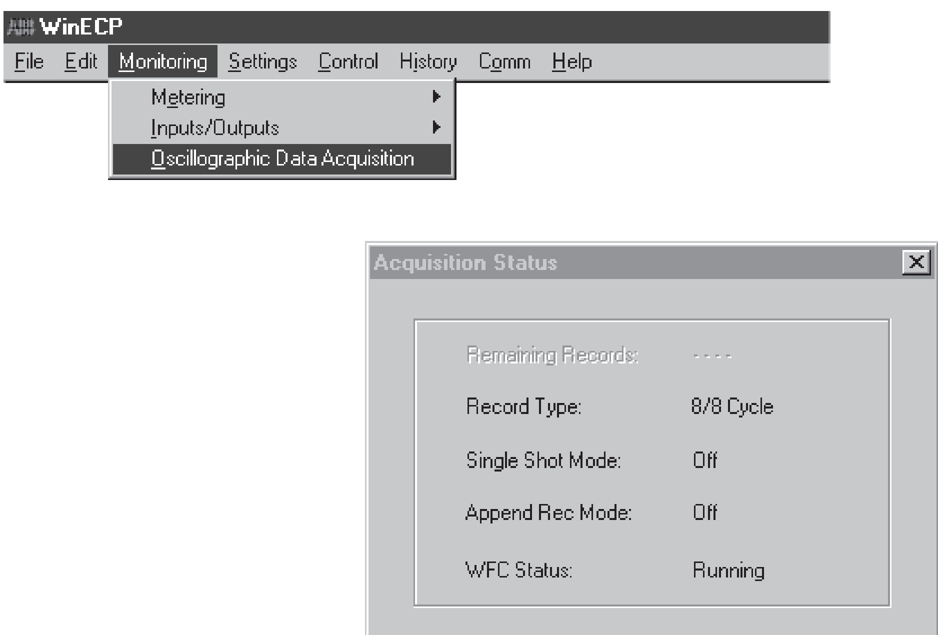


Figure 8-12. Oscillographic Data Acquisition Status

Installation

The DPU2000R unit comes enclosed in a metal case. Follow the instructions and diagrams in this section to install the DPU2000R.

Receipt of the DPU2000R

When you receive the DPU2000R, examine it carefully for shipping damage. If any damage or loss is evident, file a claim at once with the shipping agent and promptly notify the nearest ABB sales office.

Before installing the unit, it is suggested that the following procedures be performed using the OCI:

- Power up the relay. The LEDs should light and a slight clicking sound will be heard.
- Using the arrow keys, go to the Main Menu, scroll to Settings, press <E>, scroll to Unit Information, press <E>. Verify unit information against front panel nameplate.
- Press <C> to return to the Settings Menu, scroll to Show Settings, press <E>. Check default settings against the tables supplied in this manual.
- After checking the default settings, press <C> twice to return to the Main Menu. Scroll to Test and press <E>, at the Self Test selection, press <E>. The unit will self test.
- After performing the self test, press <C> twice to return to the Main Menu. Scroll to Settings and press <E>, in the Settings Menu, scroll to Change Settings and press <E>. In the Settings Menu, scroll to Clock, and set the unit clock.
- Press <E> to enter the correct time and return to the Settings Menu.
- Set the PASSWORD by scrolling to Configuration and press <E>. At the Password prompt, press <E> again. Once in the Change Confi Sett Menu, scroll to Relay Password and enter a password. This will be the main password for entry to the unit. Press <E> to enter the password and return to the Change Confi Sett Menu. Scroll to Test Password, and enter a different password. This password allows low level entry to the Test options of the unit.

WARNING: If the password entered in the Relay Password Section is lost or forgotten, the unit cannot be accessed. If this situation occurs, contact ABB Allentown Technical Support at 1-800-634-6005.

Installing the DPU2000R

The DPU2000R is enclosed in a standard 3U (3 rack units), 19 x 5-inch case designed for rack mounting. Figure 9-2 shows the dimensions of the DPU2000R.

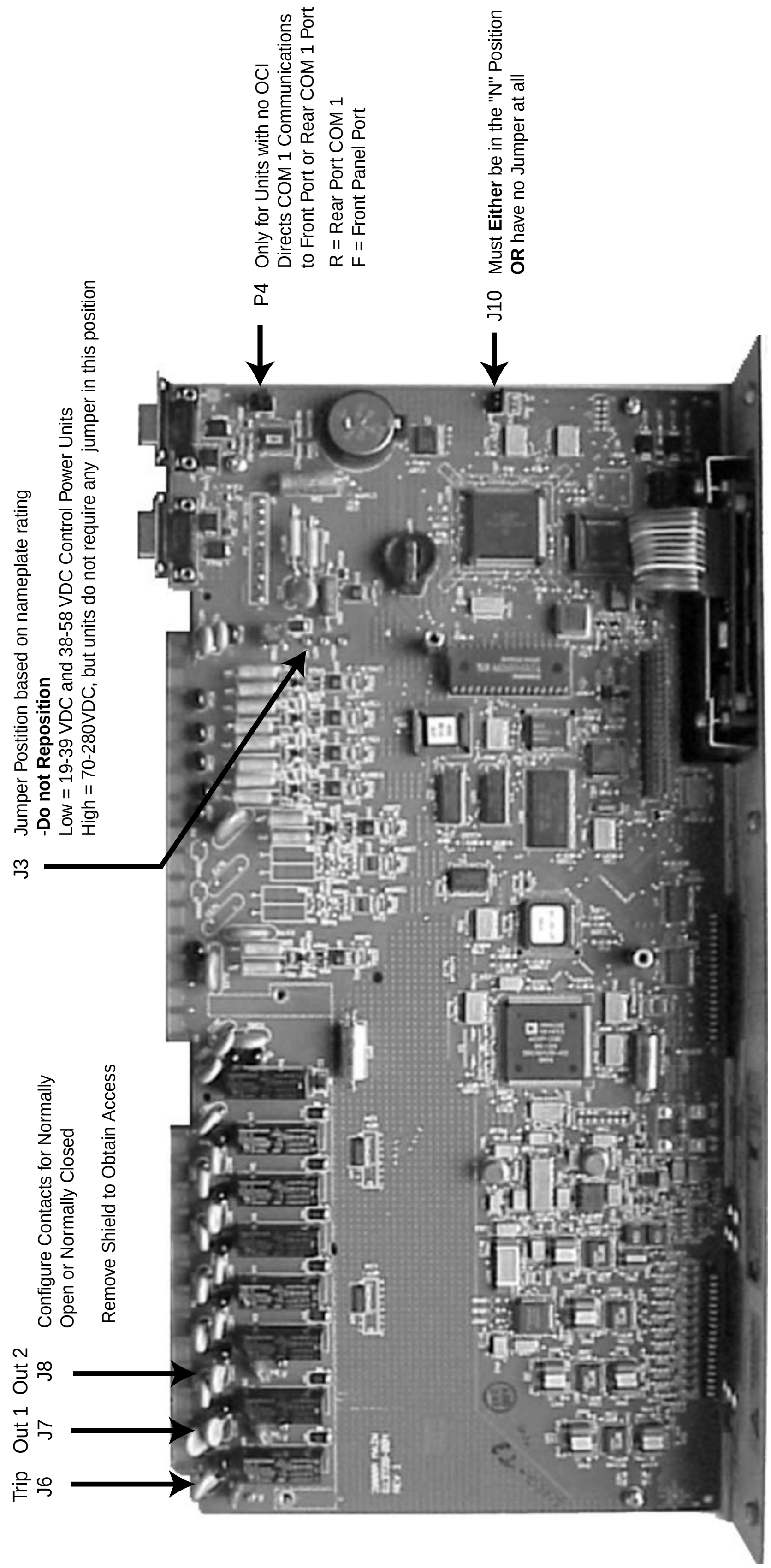


Figure 9-1. Main Circuit Board Jumpers

Case Dimensions (Standard 19" Rack Mount 3 Units High)

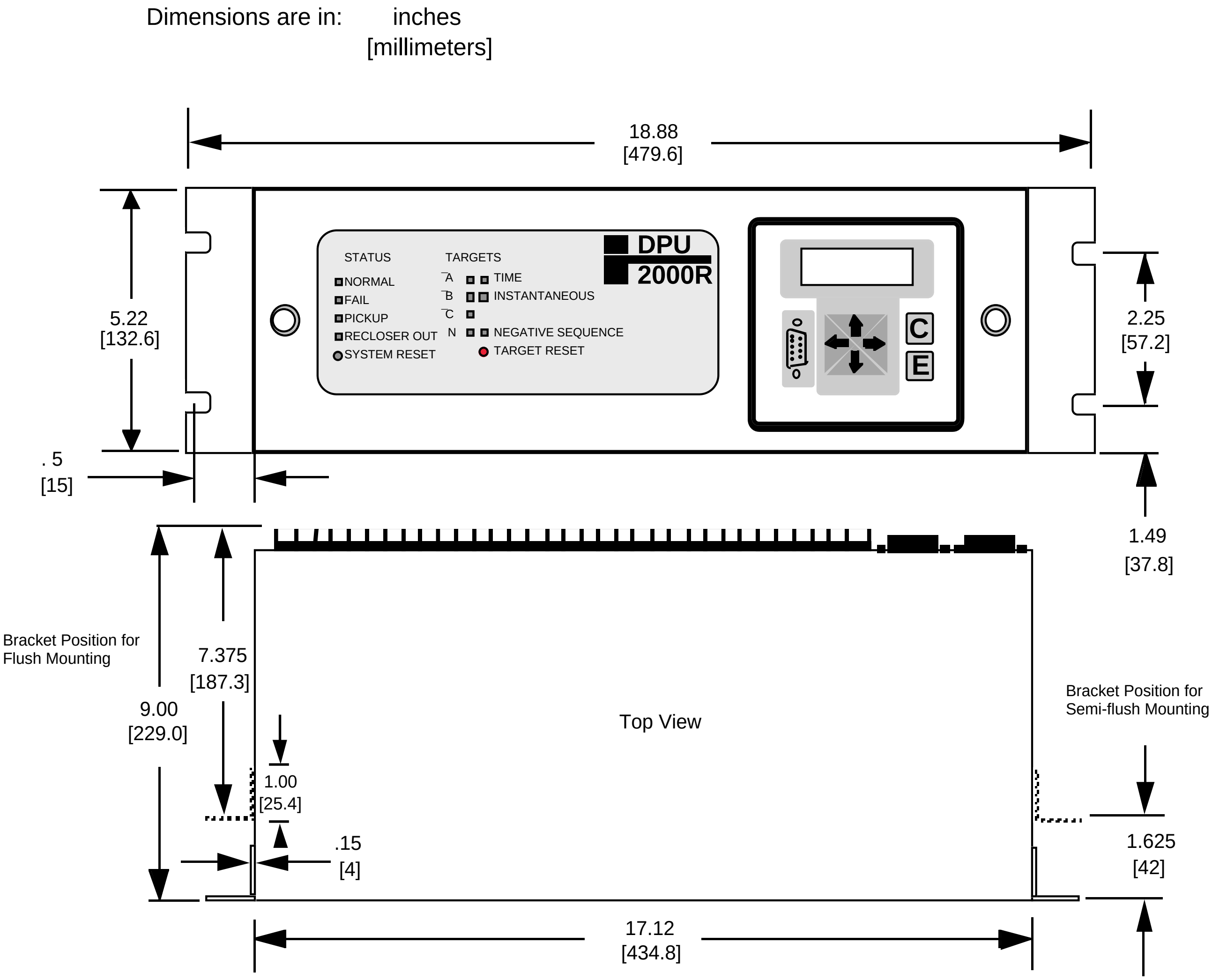


Figure 9-2. Case Dimensions

Panel Mounting Kit

The complete kit will include a bezel, its associated hardware and gasket, as well as a lens cover with its associated hardware. This kit will provide a means for panel mounting and dustproofing.

Ordering Information:

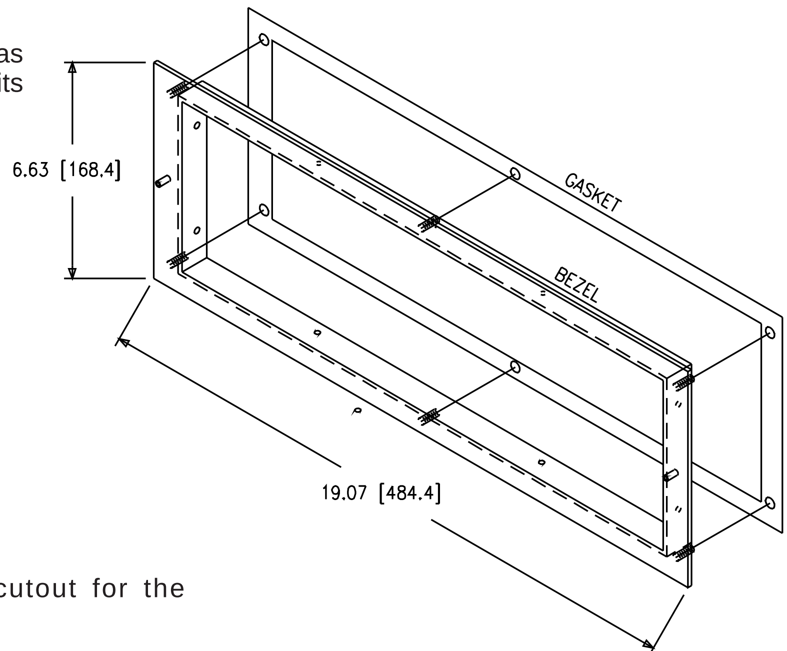
Horizontal Panel Mounting Kit	604513-K1
Vertical Panel Mounting Kit	604513-K2

Spare Parts List:

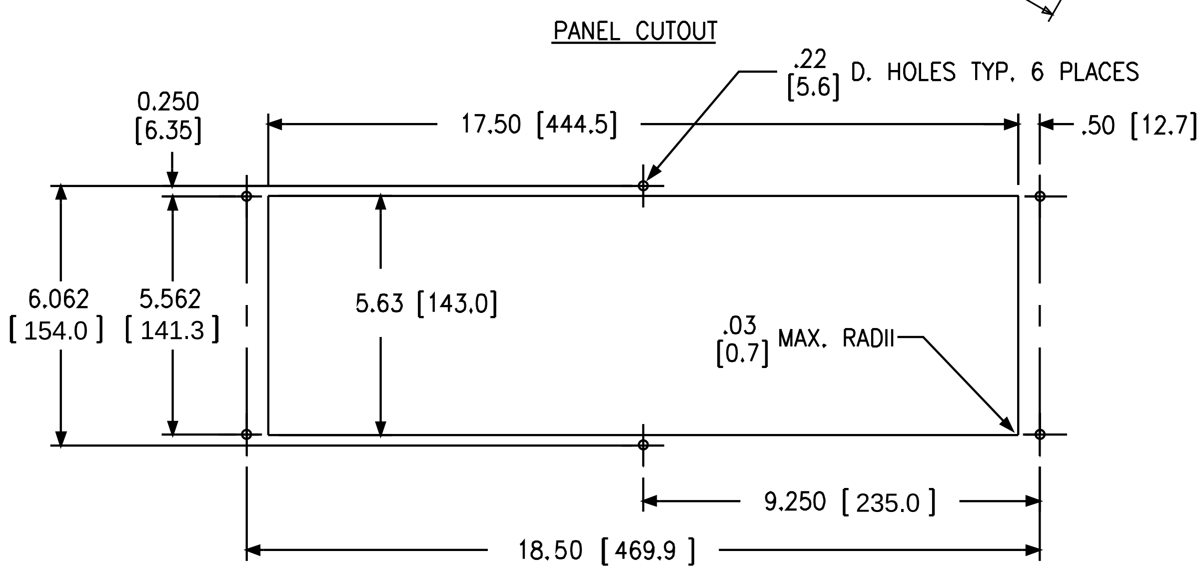
Bezel/gasket assembly only	604513-K3
Horizontal lens cover assembly	613724-K1
Vertical lens cover assembly	613724-K2

Horizontal Mounting

Note: The Bezel Assembly is available as an option for mounting the DPU2000R units in a panel application.

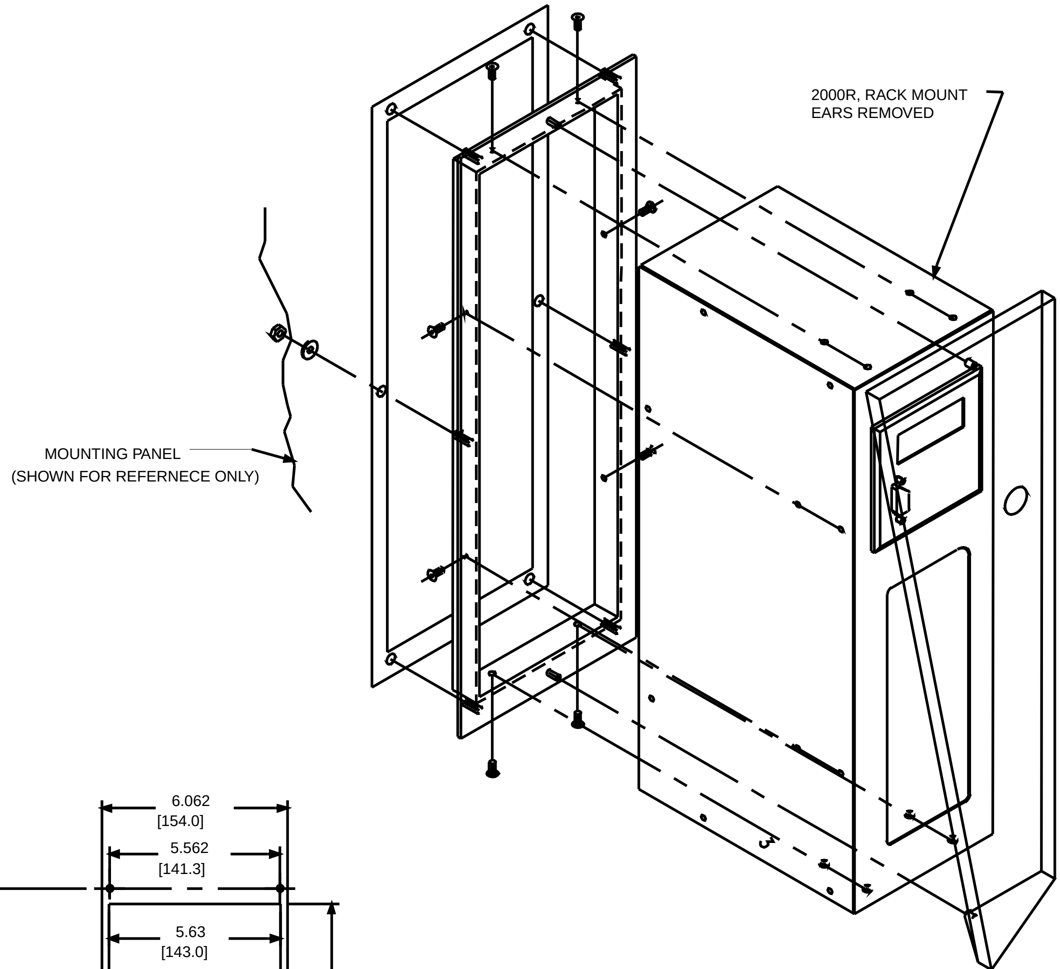


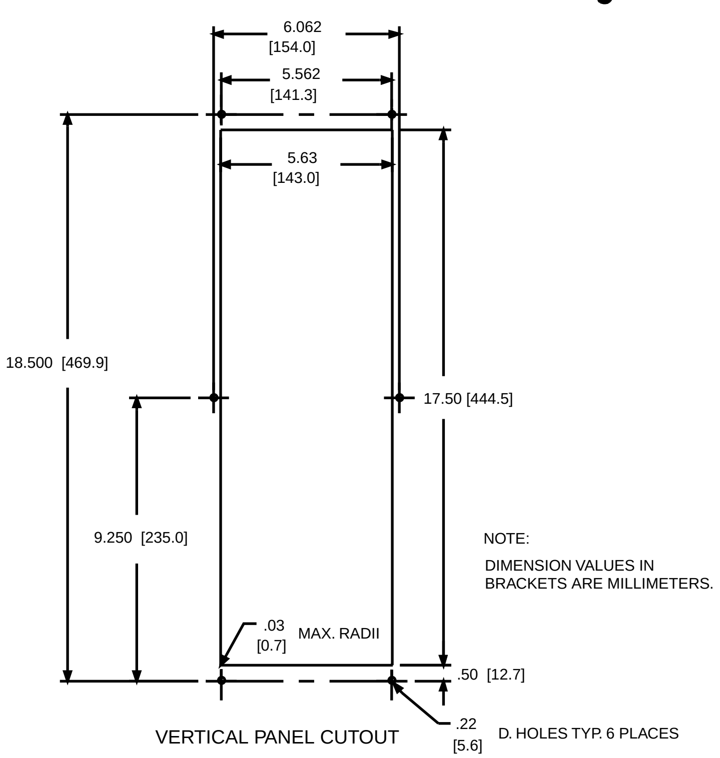
Note: Below is the panel drilling cutout for the DPU2000R unit and the bezel assembly.



NOTE: DIMENSIONS ARE INCHES [MILLIMETERS]

Vertical Mounting





VERTICAL PANEL CUTOUT

Rear Terminal Block Connections

Apply only rated control voltage marked on the front panel of the unit to the positive terminal and the negative terminal. Wire the ground stud on the rear of the case to the equipment ground bus with at least #10 gauge wire. Figure 9-3 shows the rear terminal block layout and numbers.

With exception of the CTs and burden board, you can totally withdraw the DPU2000R from its case.

Use input IN7 or IN8 as a Trip Coil Monitor (TCM) input. When the breaker is closed, a small trace current of 6 milliamperes is passed from the positive terminal through the negative terminal and the trip coil circuit. If an open circuit is detected while the breaker is closed, the Trip Circuit Failure Alarm (TCFA) contacts are actuated and a "Trip Coil Failed" message appears on the OCI display.

Note: On older relays, terminals 35-38 do not exist. This should not have any effect on wiring except for SEF and Sync Check units. For SEF and Sync Check units, the V_0 (or Vline) input should be the highest numbered sensor installed in the unit, which will be sensor 8 on older units and sensor 10 in present production.

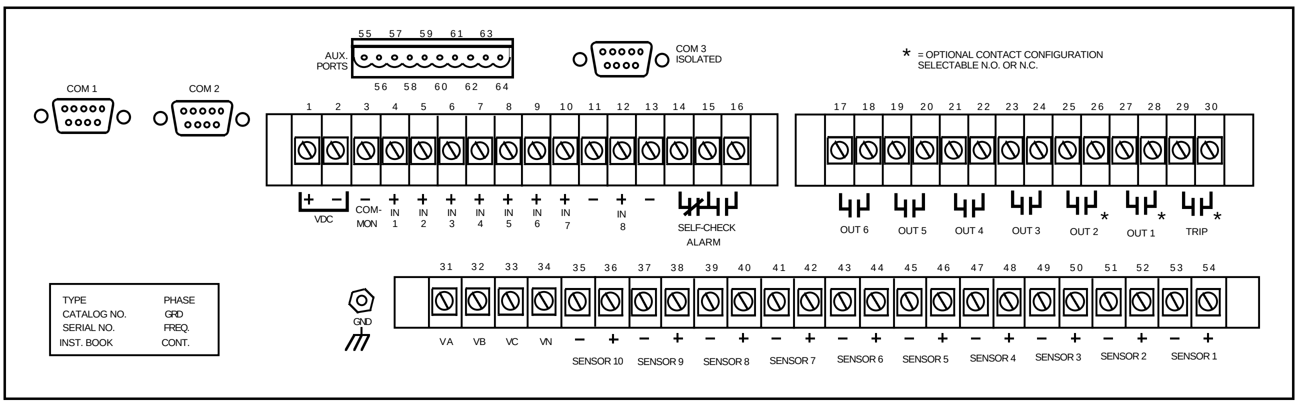


Figure 9-3. Rear Terminal Block

Table 9-1. Minimum Connections

Required Connections	Terminals
Control Voltage Input	Positive: 1, Negative: 2, Common Negative: 3
Current Inputs	IA: 54 & 53; IB: 52 & 51; IC: 50 & 49; IN: 48 & 47
52A (XO) Contact Input	4(+)
52B (XI) Contact Input	5(+)
43A (AR) Contact Input	6(+)
TRIP Output Contact	29 & 30 (N.O./N.C. Jumper #J1)
SELF-CHECK ALARM Output Contacts	15 & 16 N.O.; 14 & 15 N.C. (DPU2000R powered down)
Optional Connections	Terminals
Voltage Inputs	VA: 31; VB: 32; VC: 33; VN: 34

Relay External Connections

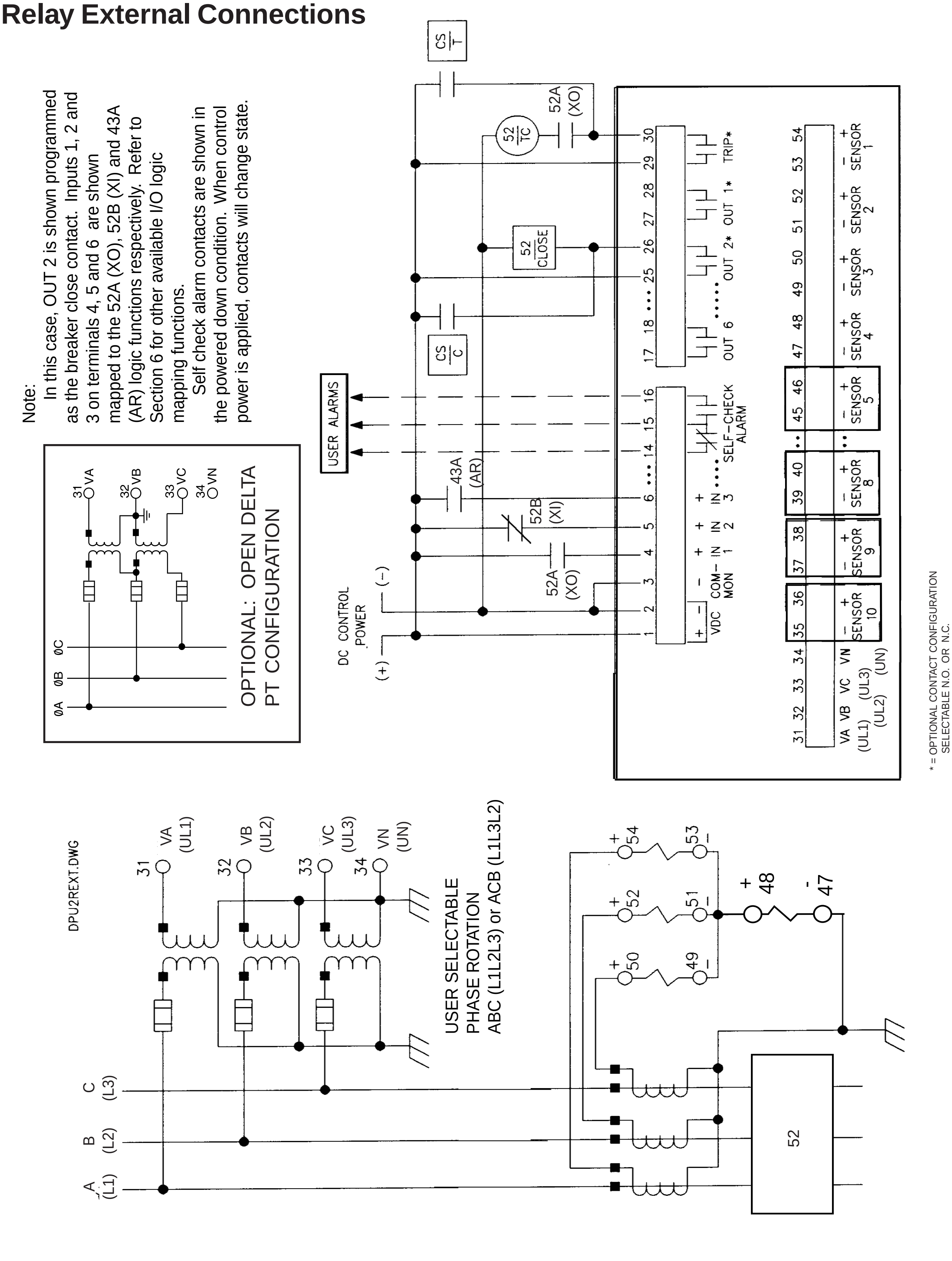


Figure 9-4. Typical External Connections

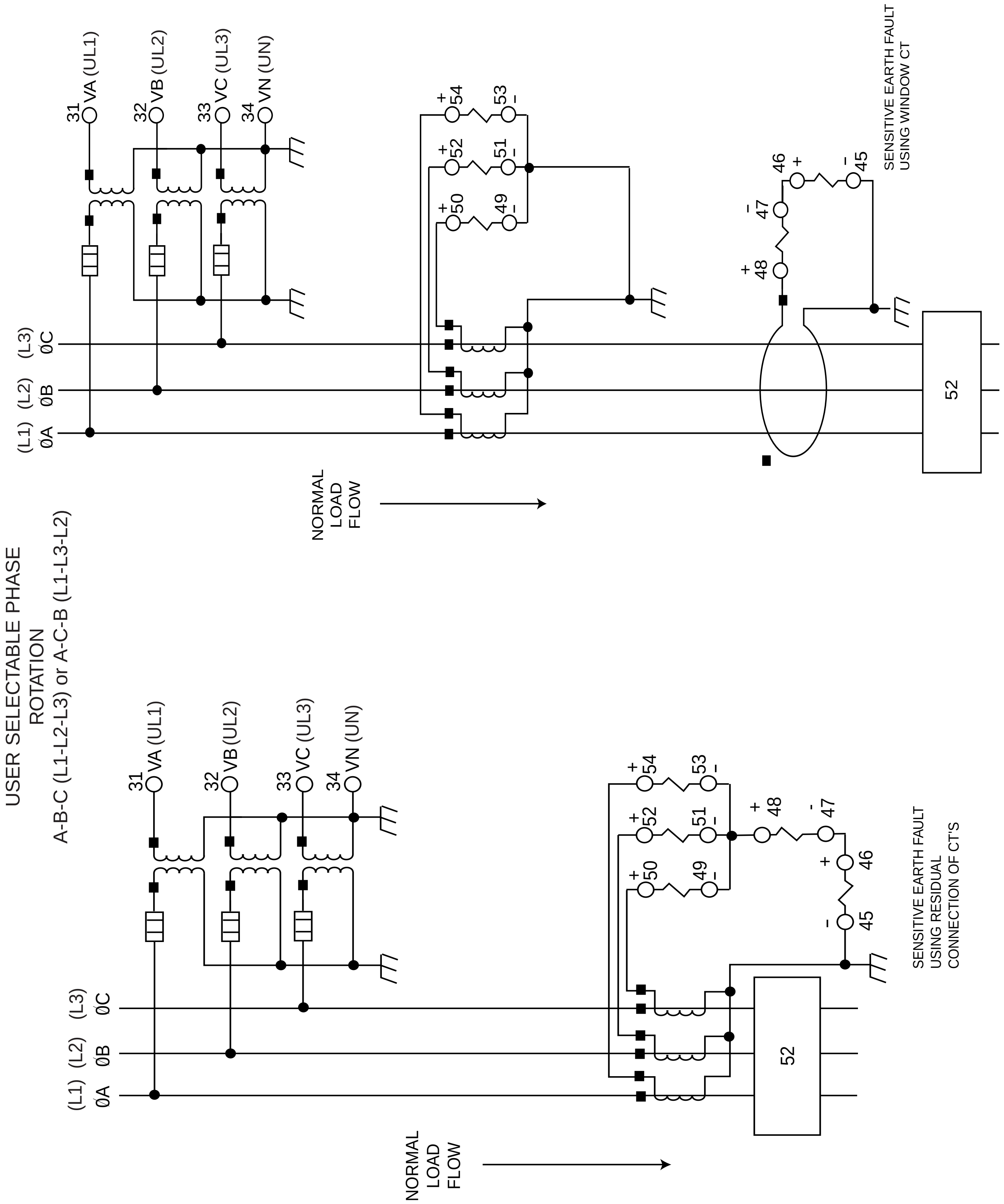


Figure 9-5. Typical Connections for Units with Sensitive Earth Fault Option

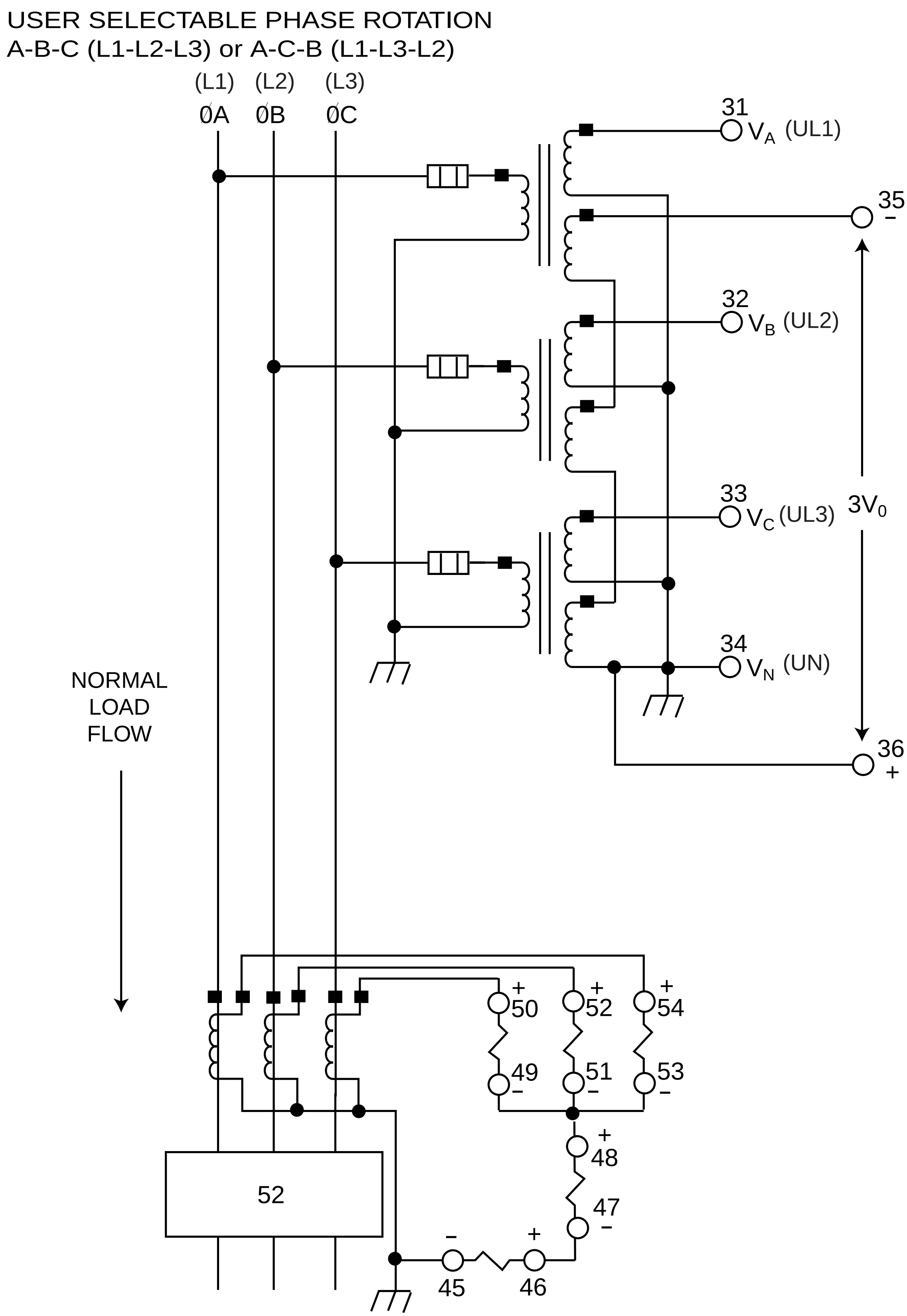
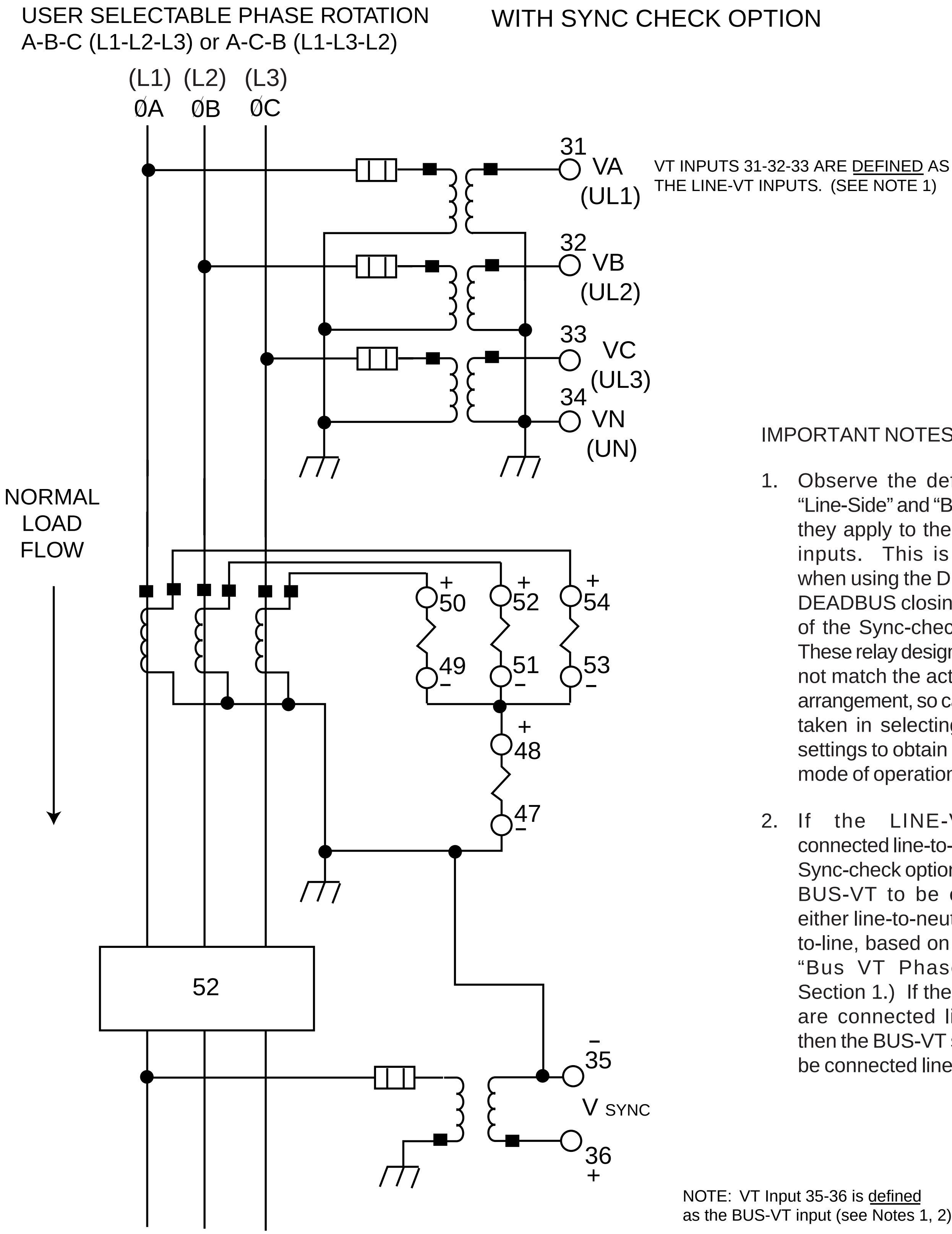


Figure 9-6. Typical VT and CT Connections for Directional Sensitive Earth Fault Units



IMPORTANT NOTES:

1. Observe the definitions of "Line-Side" and "Bus-Side" as they apply to the relay's VT inputs. This is important when using the DEAD-LINE/ DEADBUS closing functions of the Sync-check element. These relay designations may not match the actual system arrangement, so care must be taken in selecting the relay settings to obtain the desired mode of operation.

2. If the LINE-VT's are connected line-to-neutral, the Sync-check option allows the BUS-VT to be connected either line-to-neutral, or line-to-line, based on the setting "Bus VT Phase." (See Section 1.) If the LINE-VT's are connected line-to-line, then the BUS-VT should also be connected line-to-line.

Figure 9-7. Typical Connections with Sync Check Option

Communications Ports

The DPU-2000R has a standard 9-pin RS-232C interface on the front for serial port communications. Connect a 9-pin RS-232C cable and 9-pin null modem adaptor from this port to your personal computer to have direct point-to-point communications using WinECP software provided with the relay. Refer to the External Communications in Section 5 of this manual for the proper communications parameters.

If the DPU2000R relay has been provided with the newer enhanced Operator Control Interface (OCI) panel, as discussed in Section 14, it is not necesary to use a null modem adapter; rather a conventional 9 pin cable will function. A null modem cable cannot be used for the port located on the front of the OCI panel. For the ports located on the rear of the realy, a null modem calbe or adapter is required for communication to the relay.

As an option, one or two serial port terminations can be provided at the rear of the DPU-2000R. This rear port, can be a 9-pin RS-232C, 3-wire RS-485, 2-wire INCOM, IRIG-B or SCADA Interface Unit (SIU) connection. You must refer to the catalog number of the unit shown in the Unit Information menu item to know which rear port option is implemented. The front or rear RS-232C ports can interface with a modem using a straight through cable and a remotely connected computer. The RS-232C ports can also interface directly to a PC with the use of a null modem cable. The RS-232C ports are configured as data terminal equipment.

The DPU-2000R supports various byte-oriented protocols. The command message structure and substructures for these protocols are available upon request. Contact the nearest ABB sales office or ABB at its Allentown, PA factory and request the "Protocol Document" for the unit type (DPU2000R and the specific protocol of interest). The following protocols are available in the DPU-2000R relay:

- STANDARD—ABB 2000 series-specific ASCII oriented 10 byte communication protocol available through all ports
- INCOM®—a two-wire communications system and protocol
- DNP 3.0 (IEC870-5)—a protocol available through the Auxiliary Communications port
- Modbus®—a protocol available through the Auxiliary Communications port
- Modbus Plus™—a token ring network capable of high speed communication (1 Mb/sec)
- UCA—Utility Communications Architecture is an open communications protocol. This allows the DPU2000R relay to be integrated into system solutions.

Pin Connections

The pin connections for the various communications ports are shown in Tables 9-2 and 9-3.

Table 9-2. RS-232 Pin Connections

Pin Number	Pin Number
2	Receive data-Relay receives data through this pin
3	Transmit data-Relay transmits data through this pin
5	Signal ground--Front port and standard rear ports have signal ground tied to the chassis. There is an optional RS-232 rear port where both data and signal ground are fully isolated.

Table 9-3. RS-485, INCOM, SIU and IRIG-B Pin Connections

Pin Number	Pin Number
64	IRIG-B Minus
63	IRIG-B Positive
62	INCOM
61	INCOM
60	+5 VDC at 100 milliamperes
59	Direction minus
58	Direction positive
57	RS-485 common/VDC return
56	RS-485 minus or SIU minus (aux. comm. port)
55	RS-485 positive or SIU positive (aux. comm. port)

RS-485 Port and Communications Card Internal Jumper Positioning

For all communications hardware options with a single RS-485 port, that port is provided at terminals 55(+), 56 (-), and 57 (com). See Table 9-3.

For communications hardware option #8, dual RS485 ports, terminals 55, 56, and 57 are designated RS485 Rear Port #2, and pins 1(+), 2 (-), and 7(com) of the COM3 DB-9 connector represent RS485 Rear Port #1.

The RS485 port on the GPU-2000R has three associated resistors and jumper links that allow insertion or removal of these resistors, depending on the location of the relay in the network. Jumper link J6 on the communications card is for the termination resistor. A termination resistor should be inserted at the first and last devices on the network. Typically J6 would be set for "IN" for the last relay on the RS485 network; and, J6 would be set in the "OUT" position for all other relays in the loop. The first unit on the network, typically an ABB 245X series convertor, has the terminating resistor built-in. For communication hardware option "8," dual RS485 ports, J6 is for Port #2 and a similar jumper, J16 is provided for RS485 Port #1.

Jumper links J7 and J8 insert or remove "pull-up" resistors. These resistors establish a known voltage level on the RS485 bus when no units are transmitting, in order to reduce noise. These jumpers should be set to the "IN" position on only one relay at either end of the RS485 loop. If an ABB communications convertor, catalog series 245X, is used on the network, it has these resistors built-in, and all relays can have J7 and J8 in the out position. For communications hardware option "8", dual RS485 ports, J7 and J8 are for Port #2, and J17 and J18 are for Port #1.

The RS485 cable should be shielded 3 conductor twisted cable. The shield should be grounded at one end of the communications circuit, preferably where the RS485 circuit begins; eg: at the convertor unit. A typical RS485 connection diagram, drawing 604765, is available on request from the factory.

Recommended cables are Alpha #58902, Belden #9729, #9842, #9829 and Carol #58902.

Optional Features

In addition to the protection functions, the DPU2000R has load profile, oscillographic waveform capture and user-programmable curve optional features.

Load Profile

An optional load profile feature records per-phase demand kilowatts, demand kiloVARs and line-to-ground voltages. You can select a 5-, 15-, 30- or 60-minute time interval (Demand Meter Constant) for which the load profile record then contains 13.3, 40, 80 or 160 days of information, respectively (default is 15 minutes and 40 days). The load profile feature requires Wye-connected VTs to accurately measure per-phase kilowatts and kiloVARs for unbalanced loads. For Delta-connected VTs, the load profile feature records three-phase kilowatts and kiloVARs, per-phase and ground demand currents and line-to-line voltages. You can retrieve this load profile data only through the Windows External Communications Program (see page 10-2), which stores the load profile and its header in a comma-delimited ASCII file. You can view this file by using any text editor program (word processor or spreadsheet). The graph in Figure 10-2 is a sample of the type of load profile data analysis that can be performed.

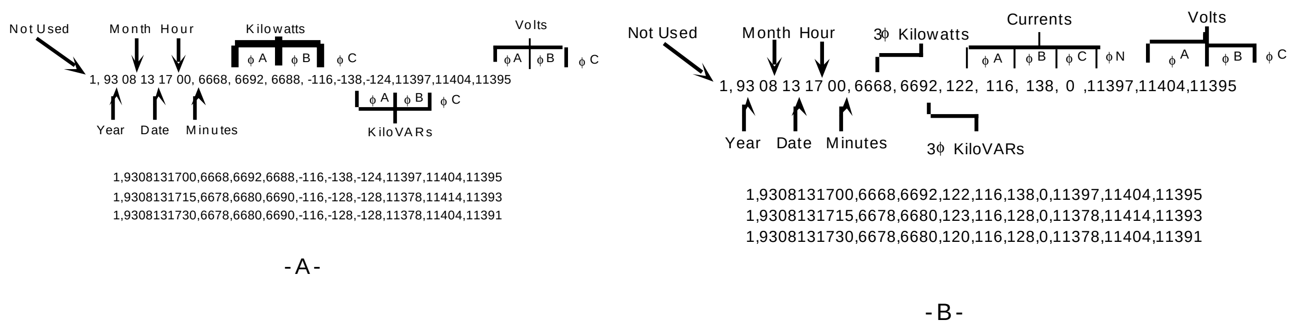


Figure 10-1. Sample Load Profile for (-A-) Wye-Connected VTs and (-B-) Delta-Connected VTs

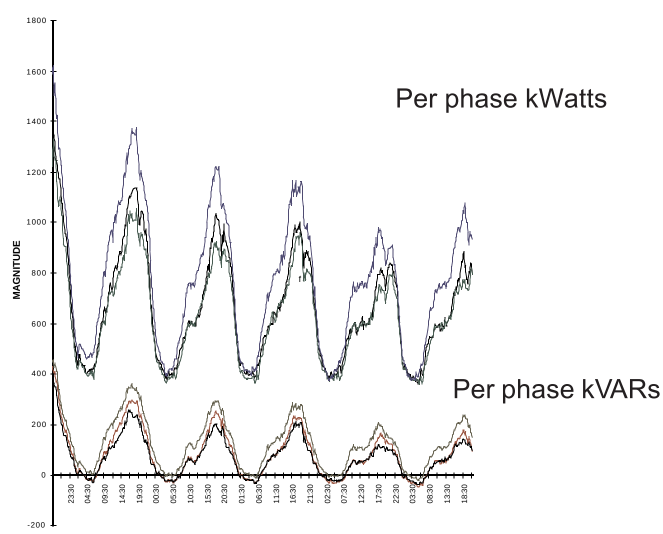


Figure 10-2. Load Profile Analysis

Using the Load Profile Feature

Use WinECP and follow these steps to retrieve and view the optional Load Profile feature information.

1. From the File Menu, choose Export (Figure 10-3). There are two Load Profile options from which to choose. The “Load Profile All ” option will upload all the load profile data that is in the buffer. The “Load Profile” option will only upload the data that has been added to the buffer since the last upload. Choosing this option will reduce the transfer time if data was previously exported.

2. Create a file name in the “Save As” dialog box, and click “Save”. The file will be saved in comma delimited format (.dla).

3. To view the Load Profile data, open the .dla file with a spreadsheet or word processor program. Follow the program manufacturer’s directions for comma delimited data displaying. Many spreadsheet programs, such as Microsoft Excel, have features that allow data to be displayed in graphical form. Consult your spreadsheet’s literature for instructions.

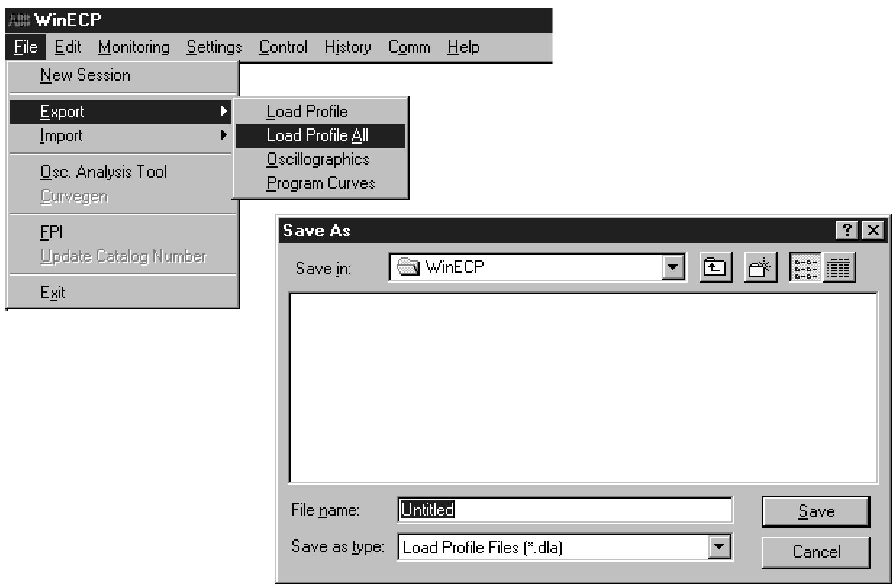


Figure 10-3. Load Profile Data Transfer

Oscillographic Data Storage (Waveform Capture)

NOTE: This waveform capture program, Oscillographic Data Storage, is provided on those DPU2000R relays with firmware version 5.10 or lower.

To enhance disturbance analysis, the DPU2000R can be furnished with optional oscillographic data storage that captures the waveform data for each of the four input currents and three input voltages. The storage capacity is 64 cycles of each waveform. Retrieve the waveform data from the DPU2000R by using the File-Export Menu in the Windows External Communications Program. Fault analysis is enhanced by an Oscillographic Display and Analysis Program that uses a Microsoft® Windows-based Graphical User Interface.

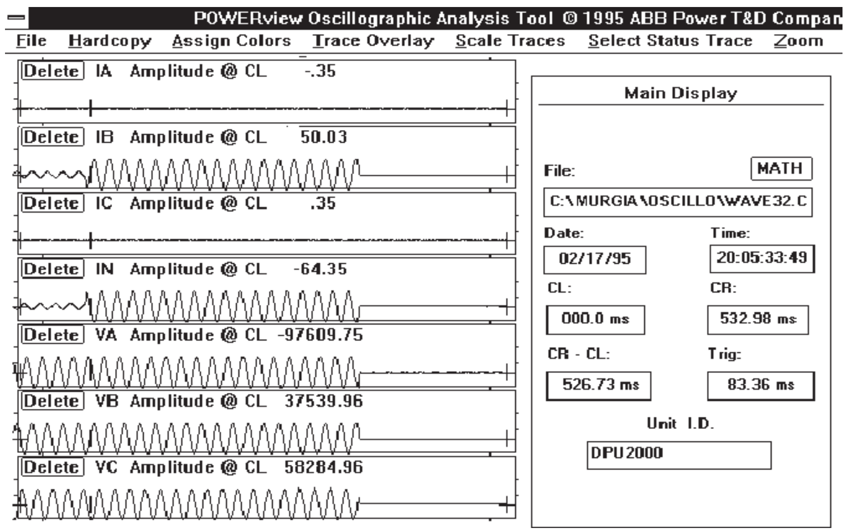


Figure 10-4. Oscillographics Analysis Tool

You can program the DPU2000R to capture eight, four, two or one record(s) containing 8, 16, 32 or 64 cycles of data. Thirty-two points per cycle for each of the seven analog inputs, the 52a (XO) and 52b (XI) contact inputs and numerous protective and logic functions are stored in each waveform record. The capturing of waveform data can be triggered when the trip output is actuated, the breaker is opened or the waveform capture input (WCI) is initiated. You can also program the DPU2000R to trigger the capturing of waveform data on trip of the following functions: 50N-1 (IN>>1), 50P-1 (3I>>1), 50N-2 (IN>>2), 50P-2 (3I>>2), 50N-3 (IN>>3), 50P-3 (3I>>3), 51N (IN>), 51P (3I>), 46 (Insc>), 27 (U<) 59 (U>), 59G (U0>), 81S (f>), 81R (f<), 47 (U_2), and 21 (see Figure 10-3). To provide as many cycles of prefault and fault data as possible, you can program the trigger position at any quarter-cycle within the fault record. The time stamp of a waveform record is captured at the time of trigger.

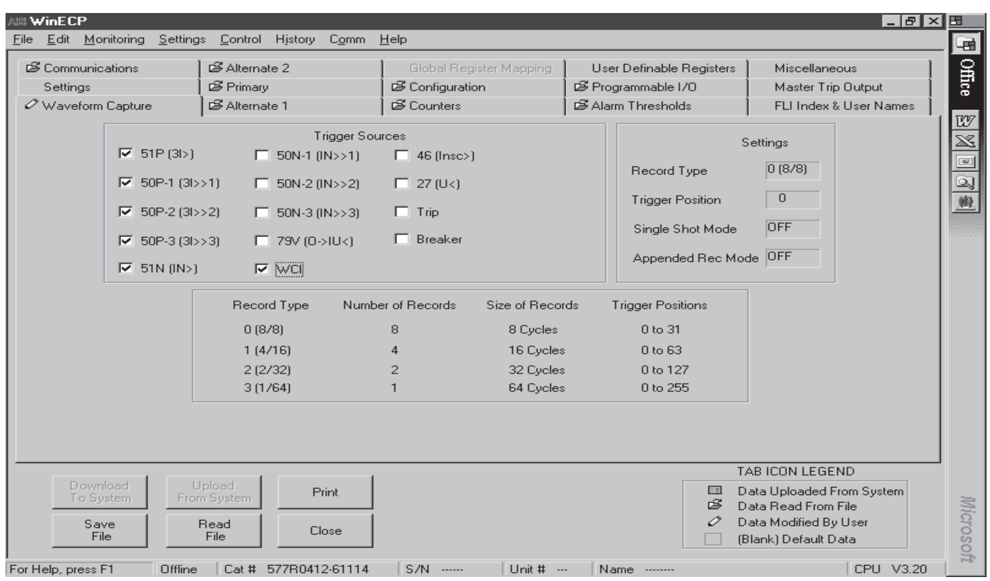


Figure 10-5. Waveform Capture Setting Screen

NOTE: Download the captured waveform records to a file before changing any Waveform Capture setings. Changing settings may lose waveform records. From the factory, Waveform Capture is running, all trigger sources are set to “NO”. The proper sources must be set to “YES” for the capturing of Waveforms.

The Waveform Capture feature also allows the user to choose certain data recording options. In addition to the Trigger Sources, there are four other settings in the Waveform Capture folder. They are Record Type, Trigger Position, Single-Shot Mode, and Append Record Mode. The factory default condition has Oscillographic Data Acquisition set to “ON”.

Record Type:

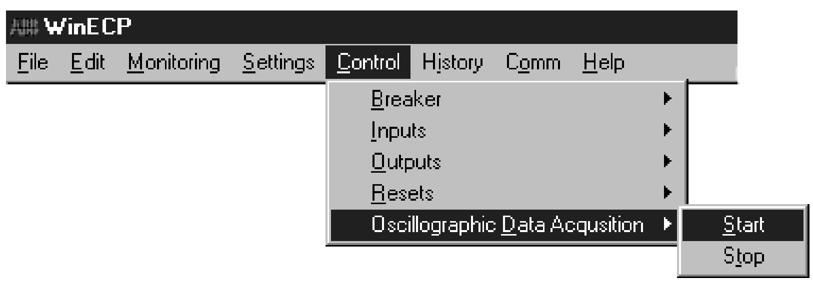
There are four types of records, “0”, “1”, “2”,and “3”. Selecting “0” will yield eight records of eight cycles each. “1” gives four records of sixteen cycles each, “2” gives two records of 32 cycles each, and “3” gives one 64 cycle record.

Trigger Position Setting:

This setting is the amount of pre-event data that will be recorded with each oscillographic record (in quarter cycles). For example, if you wish to have one cycle (4 quarter cycles) of pre-trigger data recorded, choose “4” for the Trigger Position setting.

Single-Shot Mode:

Single-Shot Mode can either be “ON” or “OFF”. When it is “OFF”, the oldest oscillographic record will be over written when the buffer becomes filled. When “ON”, oscillograpic records will be recorded until the buffer is filled to capacity. The buffer size is determined by the Record Type setting chosen (0, 1 ,2, or 3). After the buffer is filled, data acquisition will be stopped. If more data recording is desired, the “Start Oscillographic Data Acquisition” command must be selected from the Control Menu in WinECP.



Append Record Mode:

Append Record Mode can either be “ON” or “OFF”. When it is “ON”, a new record will be generated if a trigger occurs while a previous oscillographic record is being recorded. Append Record mode will only work when the Record Type setting is either 1, 2, or 3.

Saving a Captured Waveform Record

1. Select "Export-Oscillographics" from the File Menu.

2. Select the record you want to save and click “Save To File”. See Figure 10-6.

3. Type the path and filename you want for the record and click “Save”.

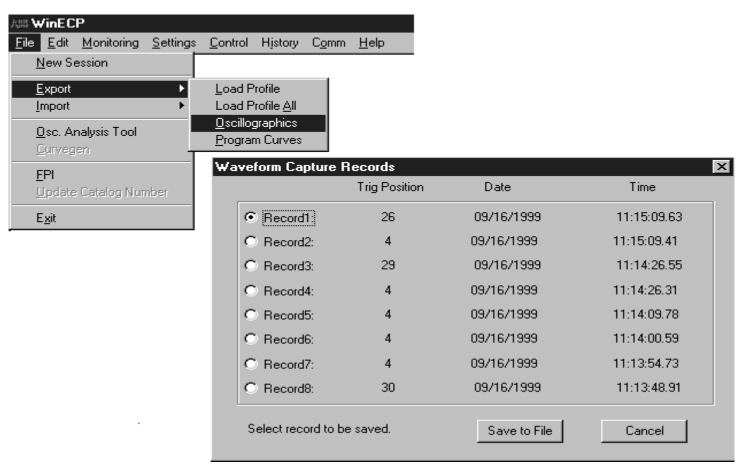


Figure 10-6. Oscillographic Data Exporting

Oscillographic Analysis Tool

ABB's Oscillographic Analysis Tool enhances the fault analysis capabilities of the ABB 2000R Protection Units. The Oscillographic Analysis Tool displays the waveform data captured by these units. Besides all analog wave forms, this program shows digital input/output, pickup, and fault information.

The analog wave forms are displayed simultaneously in individual windows. Each window contains a trigger indicator, a left cursor, and a right cursor. You can move either cursor to any position within the window for that wave form. When you move the cursor in one window, it moves in the other windows as well. Each waveform window can be resized to enhance viewing and can be deleted individually.

The time location of the left and right cursors and the difference in time between the cursors are provided in the Main Display window. Other information in the Main Display window includes the file name from which the waveform records were extracted; the date, time, and trigger position of the sample taken at the Protection Unit; the unit ID number; and the catalog number.

You can overlay an individual analog wave form onto any other analog wave form. For example, you can overlay Va onto Ia to examine the phase relationship.

You can scale all current wave forms with respect to the largest amplitude within that group. This is called the Actual Scale and is the default setting. But you can also scale wave forms with respect to the largest amplitude encountered for that wave form only; this is called the Normalized Scale. The Normalized Scale accentuates noise and other characteristics of the wave form.

A zoom feature allows you to position the left and right cursors within the wave form and then "zoom in" to closely examine that section of the wave form.

System Requirements and Installation

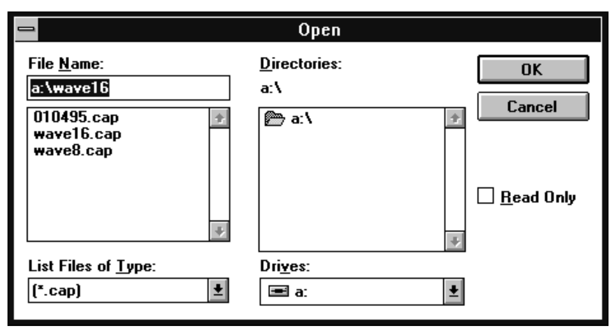
The Oscillographic Analysis Tool installs with WinECP. See Section 5, " Interfacing with the Relay" for more information.

Using the Oscillographic Analysis Tool

The Oscillographic Analysis Tool is a menu-driven program. A parent window contains windows for the analog wave forms and for digital information.

Opening a File

1. Start the Oscillographics Analysis Tool from the File Menu in WinECP.
2. Click on "Continue" at the prompt.
3. Under the File Menu, select "Load Graph Data File".
4. The "Open" window appears. Oscillographic Analysis Tool files are listed as *.CAP files, including the TEST.CAP file. C lick on the file you want and select "OK", or double-click on the filename.



The file loads and the individual analog waveform windows appear.

Analog Display Windows

The analog waveform windows appear within the Main Display window. The Main Display window appears to the right of the analog waveforms and lists the file name, date and time the data was captured at the Protection Unit, and locations of the trigger point and the left and right cursors.

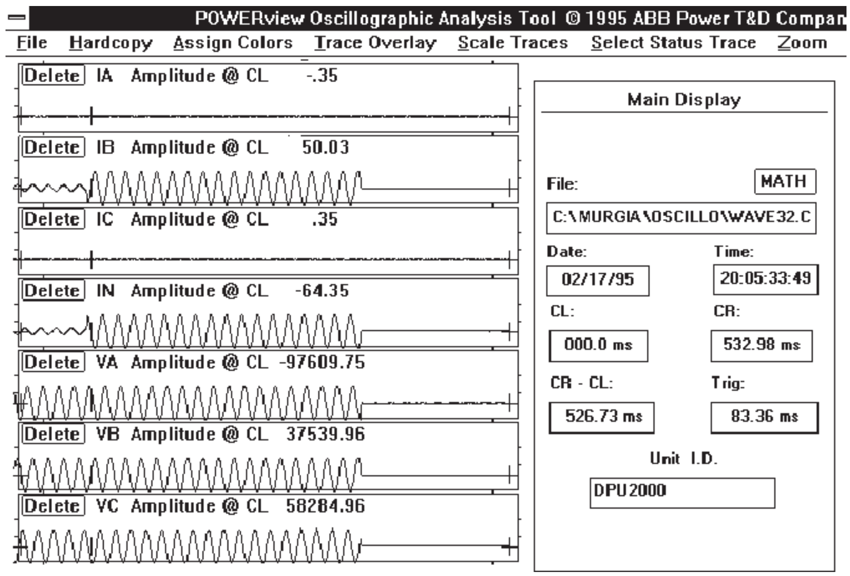


Figure 10-7. Analog Display Window

The left cursor is at the far left side of each analog waveform window, and the right cursor is at the far right side. You can “drag” the cursors by moving the mouse cursor close to the left or right cursors. Hold down the left mouse button while dragging the left or right cursor to the desired position. Release the mouse button.

After you move the left or right cursor, the time value for that cursor changes in the parent window. Also, the cursor position in all the other analog waveform windows mirrors your cursor movement. **The trigger cursor cannot be moved.**

To resize an analog waveform window, move the mouse to the border on that window. A double-headed arrow appears when the mouse is properly positioned. Hold down the left mouse button and drag the window border to the desired position. Release the mouse button.

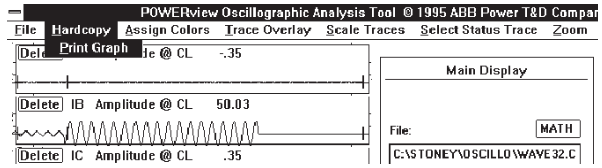
Each analog waveform window can be deleted. Simply click on the DELETE button in the window. That waveform window disappears, and the other waveform windows shift to take up the empty space.

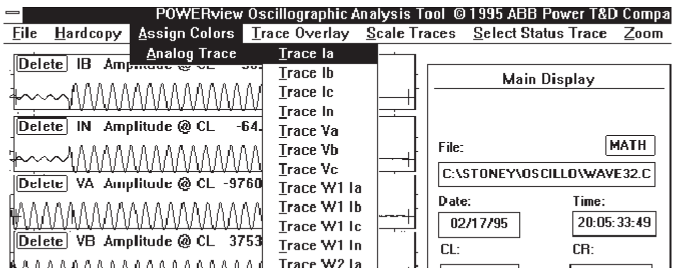
Menu Commands

Each menu on the Oscillographic Analysis Tool parent window has specific features.

Hardcopy Menu

Under the Hardcopy menu is the command "Print Graph." When you want to print a copy of the window(s) you are viewing, select this command.





Assign Colors Menu

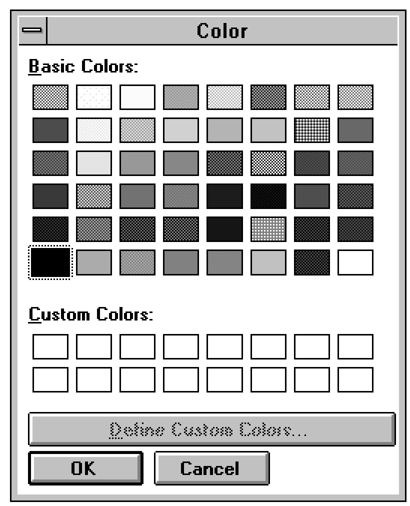
Use this menu to assign colors to the analog wave forms. This is especially helpful when you overlay two wave forms.

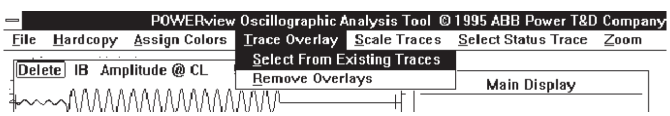
When you select Analog Trace, a list of the analog traces appears.

Click on the trace you want, and a window with color patterns appears. Click on a color and select "OK."

Trace Overlay Menu

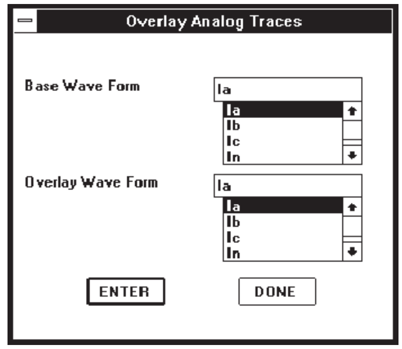
Use the Trace Overlay menu to overlay any analog wave form on any other analog wave form. This way you can directly compare the two. From the Trace Overlay menu, choose "Select From Existing Traces." You can also use this menu to remove overlays.

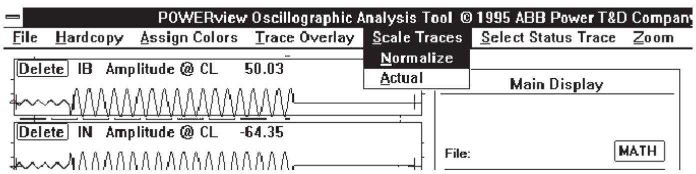




After selecting from the Trace Overlay menu, a window appears that requests you to enter a base trace and an overlay trace. Enter each trace and select “Enter.” The overlay trace appears in the window of the base trace. Enter other traces as you desire, and select “Done” when you are finished.

NOTE: Only one wave form may be overlaid onto any base trace.



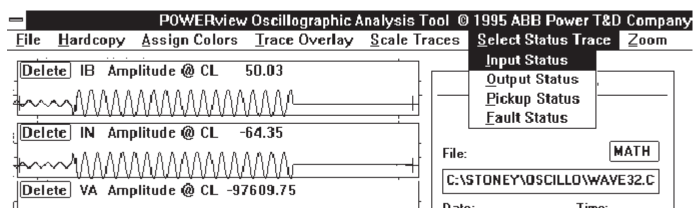


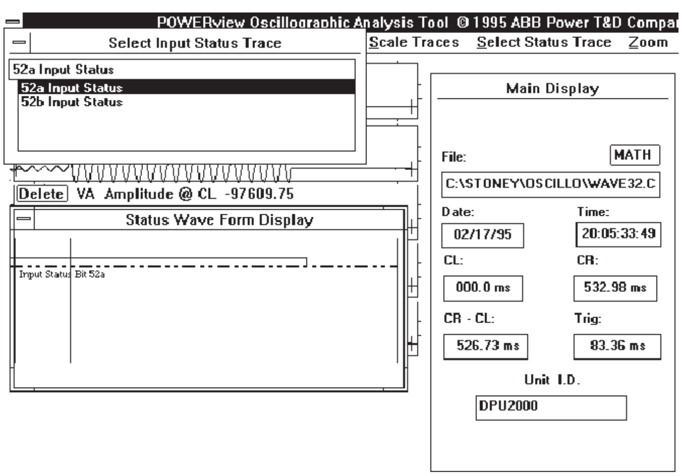
Scale Traces Menu

You can scale analog wave forms to an Actual Scale or a Normalized Scale. Actual Scale shows an analog wave form in relation to the other six wave forms. When you choose Normalized Scale, the wave form is scaled with respect to the largest amplitude for that wave form only. In other words, the peaks expand to fit that individual window. From the Scale Traces menu, select Actual Scale or Normalized Scale. The program launches in Actual Scale.

Select Status Trace Menu

You can present digital input/output, pickup and fault information in a window by using the Select Status Trace menu. Follow these steps to display digital information.

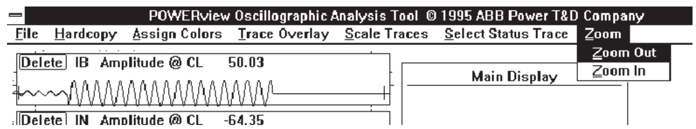




1. Select the digital information you want under the menu.
2. A window appears with a list of the different parameters measured. Double click on the parameters you want. As you double click on a parameter, a digital line appears in the graph window.
3. When you have selected all the parameters you want, click on Done.

Zoom Menu

Zooming in allows you to enlarge a selected portion of the analog wave form. To do this, set the left and right cursors to the desired range. Then select “Zoom In” from the “Zoom” Menu. The portion you selected enlarges. Use “Zoom Out” to return to the original size.



Math Button

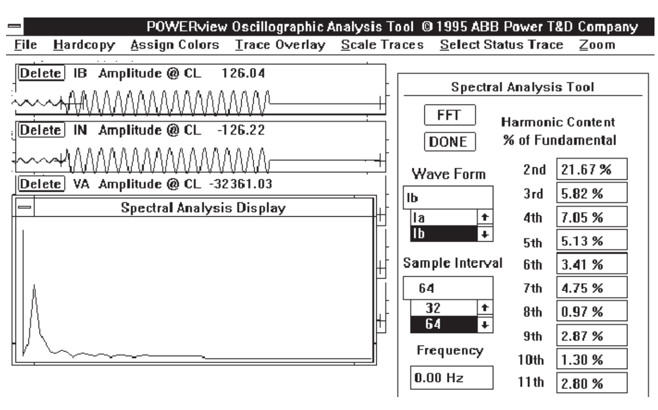
At the top of the Main Display window is a button marked “Math.” Press this button to perform math functions associated with the analog wave forms.

Spectral Analysis

The Spectral Analysis Tool window appears when you click on the Math button. By using this tool, you can create a spectrum window for a selected region of waveform data.

Follow these steps to perform a spectral analysis:

1. Click on the Math button at the top of the Main Display window.
2. The Spectral Analysis Tool window appears.
3. Select the wave form you want by scrolling up or down in the "Wave Form" box. Double-click on the desired wave form. An extended cursor appears in place of the left cursor in the window of the selected wave form. (The default is the uppermost wave form.)
4. Select the desired sample interval by scrolling up or down in the "Sample Interval" box. Double-click on the interval you want. The extended cursor in the waveform window changes size accordingly. (Default = 32 or one cycle for a 50-Hz or 60-Hz wave form.)
5. Move the extended cursor over the section of the wave form on which you want to perform the spectral analysis. Do this by clicking on the left vertical of the cursor and dragging in the waveform window.
6. Click on the FFT (Fast Fourier Transformer) button in the Spectral Analysis Tool window. The Spectral Analysis Display window appears with the generated spectrum. The harmonic content as a percentage of the fundamental (50 or 60 Hz) appears in the Spectral Analysis Tool window for the harmonics (2nd to the 11th).
7. As you wish, move the cursor within the Spectral Analysis Display window by clicking the left mouse button in the region you want. The cursor snaps to that position, and the frequency appears in the "Frequency" box of the Spectral Analysis Tool window.
8. Double-click on the upper left corner of the Spectral Analysis Display window to close it, or click on "Done" in the Spectral Analysis Tool window to remove the Spectral Analysis Display and Spectral Analysis Tool windows.



Customer-Programmable Curves

An external PC-based program, CurveGen, is used to create and program time-current curves for the DPU2000R. With CurveGen you can program time-overcurrent curves other than the ones currently provided in the DPU2000R (see Tables 1-1 and 1-2). You can manipulate the curves in the time and current domains just like any other curve currently programmed into the DPU2000R. CurveGen generates all of the necessary variables for the user-defined curves to be stored in the DPU2000R (i.e. the alpha's, beta's and pointers to the curve table). The method of accomplishing this task is curve definition.

The standard curve entered into the DPU2000R has the form of:

$$t = \left[\left(\frac{A}{M^p - C} \right) + B \right] \left[(14n - 5) / 9 \right]$$

M is the per-unit current above the pickup value
t is total trip time at M
A, p, C and B are variables to be defined.

To define the curve, you must define the variables in this equation. There are two ways to do this:

- Enter variables by hand: With the CurveGen program you can define all four variables by hand. This is designed for users who do not want curves based on already established functions but instead are ready to define curves through mathematical manipulation.
- Determine variables via curve fitting: Define a series of time versus current points and fit them to the standard equation listed above.

With the CurveGen program you can enter these series of time/current points from an already defined curve. CurveGen then fits the four variables to these points. There are two ways to enter these points into the CurveGen program:

- Enter all sampled points by hand. The ability to remove, sort, plot, edit and view points gives you total power over the curve to be generated.
- File entry: CurveGen can also read files with points defined in them. The ability to remove, sort, plot, edit and view points gives you total power over the curve to be generated.

Once all the points are entered, the CurveGen program is cued to fit a standard curve. After A, p, C and B have been determined, you can plot the curve against the points given as well as determine the overall error of the curve versus the plotted points.

After all four variables have been determined, you can generate a linear approximation of the curve. A maximum error criteria must be satisfied before CurveGen can determine the coefficients needed for the DPU2000R. Errors and warnings indicate whether or not the error criteria can be met or if the number of entries in the curve table is above the maximum value allowed.

When the curve tables have been defined by CurveGen, download them into the DPU2000R. When you want a customer-defined curve, select "Export Option" from the File Menu in WinECP.

Digital Fault Recorder (DFR - Waveform Capture)

To enhance the ability to analyze fault and disturbance conditions, an extended oscillographic feature is available in the DPU2000r relay with firmware version 5.20 or higher. This is referred to in this section of the instruction book as DFR - Digital Fault Recording.

The user can select to record any of the analog waveforms available at the analog inputs to the relay from the connected current and voltage transformers. The user selects the triggering sources and also specifies the number of cycles of pre-trigger and post-trigger data to be captured. Digital signals associated with the operation of the protective functions of the relay are also recorded. The data collected is held within the memory elements of the relay until downloaded to a file on your pc. Then a separate Wave Win Program is used to display the waveforms. This analysis program is supplied when the relay is ordered with the waveform capture feature.

Figure 10-8 shows the screen display when you access the Waveform Capture Settings menu item from the WinECP program.

Place an "X" in each box of protective elements that you wish to serve as triggering sources for a waveform capture. The operation of any one of these elements will cause a capture. You may also trigger a capture from an external contact closure by assigning a contact input to programmable input function WCI (See Section 6).

Place an "X" in each box representing the analog input waveforms that you wish to capture.

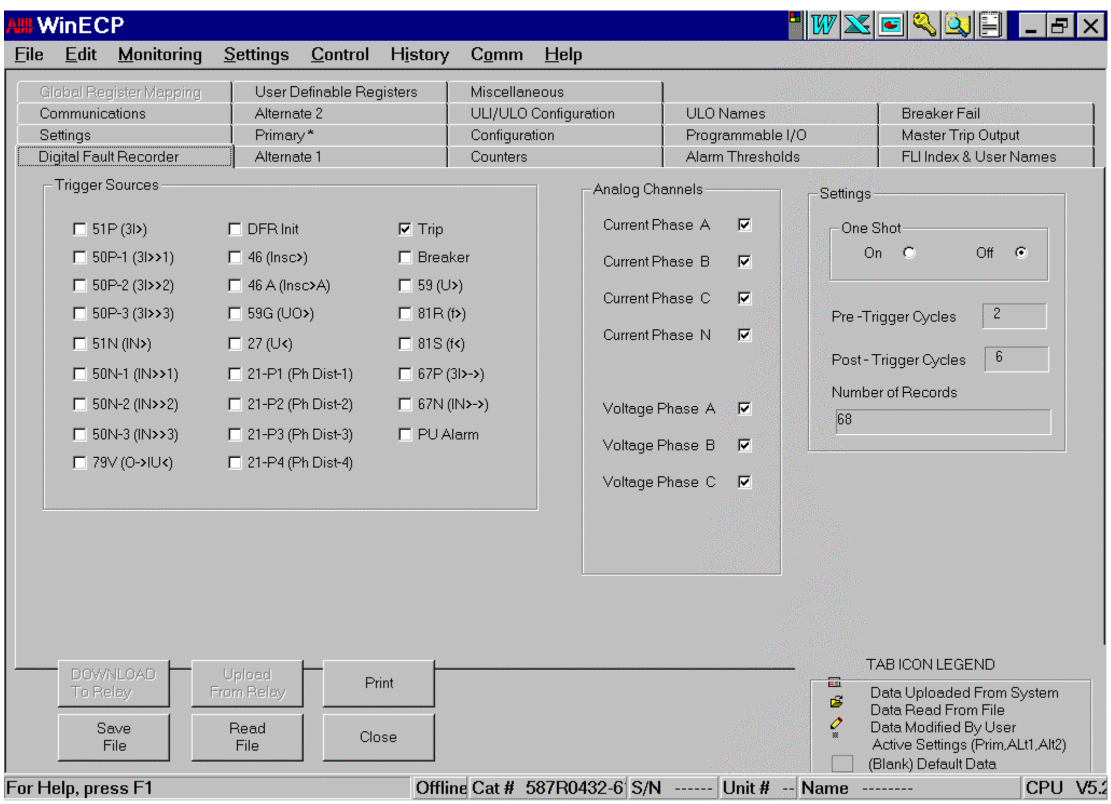


Figure 10-8. Digital Fault Recorder

Record Length and Number of Analog Channels

When the waveform capture feature is installed, there is a specific amount of memory within the DPU2000R that is available for data storage. The following equation defines the relationship between the number of analog channels that can be recorded, the number of power system cycles that can be recorded per record, and the number of reocrds that can be stored.

Record Size = (1 + CH) * (1 + CY)   Where: CH = number of analog channels selected
CY = number of cycles per record

Maximum Number of Records that can be Stored = 6081 / (Record size)

Record size is allocated equally to each event. As an example, if we choose 9 analog channels, and a record length of 60 cycles, then record size is (10*61) = 610, and we have space for 6081/610 = 9 events. A slightly better allocation would be 66 cycles, (10*67) = 670, 6081/670 = still 9 events, but we gain an additional 6 cycles of record length.

Also in this example, in the waveform capture settings we must allocate the 66 cycles to pre-trigger and post-trigger portions. So we might select 4 cycles pre-trigger, and 62 cycles post-trigger. You must allocate at least one cycle to the pre-trigger storage.

Modes of Operation: Single-Shot and Continuous

You must also select the Mode of Operation of the waveform capture. In the One-Shot mode, new events will be captured until the available memory is used up, then no more events will be captured even though a selected trigger source is seen. So it is not truly a one-shot mode, but rather a “several-shot” mode depending on how you have allocated the available memory.

When in the single-shot mode the relay automatically stops data accumulation when the space available has been filled. Important: After the records are transferred to your pc, you must re-initialize the waveform capture function by going into the waveform capture settings and re-sending the settings to the unit again.

In the New-Acquisition or Continuous mode, new events are recorded as triggering events occur, and when the memory is filled, the oldest event will be lost as the new event is recorded. In the Continuous mode, the storage capability is one less than in the single-shot mode, due to the need to record pre-trigger data which is being stored continuously for the “next” event.

Digital Data Capture and Triggering Details

The digital data being stored along with the analog data is stored every quarter cycle. The pickup status of each of the protective functions is stored. The operation of any of the protective functions is stored. And the operation of the Master Trip output, the 52a input, and the Blown Fuse alarm output are recorded.

Once a trigger is received, further triggers are ignored until the complete record has been stored.

Triggers occuring before the pre-trigger buffer is filled are ignored. Triggers are “edge-triggered”; therefore, any event that causes a trigger must be de-asserted and then re-asserted to obtain a second trigger.

Waveform Capture Settings Changes

In order to make a settings change you must go to the Stop/Start Data Accumulation menu item and issue the stop command.

When a new set of waveform capture settings are chosen, the unit takes several seconds to reconfigure, and no events can be captured during this period. Also, no additional change in the waveform capture settings can be made until the reconfiguration has been completed for the intial change. <u>All previous waveform records retained in the memory are lost when the waveform capture settings are changed, therefore they should be downloaded to files on your pc prior to making any changes.</u>

After the new settings are accepted by the unit you must go to the Stop/Start Data Accumulation menu item and issue a start command.

Stop/Start Data Accumulation

The Waveform menu item Start/Stop Data Accum allows the user to enable or disable the waveform capture function. When Stop Data Accumulation is selected, the records already in the memory are retained and no additional records will be taken until the Start Data Accumulation command is initiated.

Important: After making a settings change, or after re-loading your single-shot settings to re-initialize the capture memory, you must re-start the data accumulation.

Transferring a Captured Waveform Record

First under the Waveform menu item, select the Stop/Start Data Accumulation menu item, and press the Stop Waveform Capture button. Then, select the menu item Waveform Records. Select the desired reocrd in the listing shown and then press the Save-Data-Points-to-File button. You will be prompted to enter the desired filename and path.

Comtrade Format

The captured data is in the COMTRADE standard format, therefore the data files that are downloaded to your pc can be displayed by any analysis program that will accept files in this format.

CurveGen Software Release 1.0

PC Requirements

386 processor or higher

Disk Space:

200K in specified Directory

6 MB in Windows/System Directory

Memory:

480K RAM in the lower 640K for setup

Installation

Step 1: While in the windows desktop, insert disk 1 of 2 into drive a:

Step 2: Click on **File.**

Step 3: Click on **Run.**

Step 4: Type **a:\setup** and press enter.

Step 5: Follow the installation instructions.

Step 6: If you encounter errors during the installation, go into your windows/system directory and delete the following files:

0C25.DLL	COMDLG16.DLL	TABCTL.OCX
THREED.OCX	VCFI16.OCX	

Repeat installation from **Step 1**.

Using CurveGen

Click on the CurveGen 1.0 icon to run CurveGen. At this point, the user has two options. Curve coefficients can be calculated by the software by manually entering data points.

The standard equations for timing curves are shown below:

Trip Time (ANSI) = $(A/(M^p\text{-}C)+B) \times ((14n\text{-}5)/9)$
Trip Time (IEC) = $(A/(M^p\text{-}C)+B) \times n$

Where A, B, C and P are the coefficients to be computed and/or entered

n = time dial

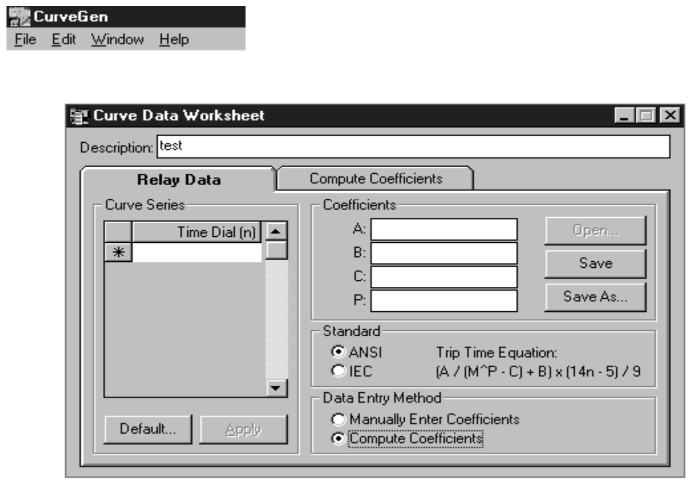
M = Relay current in multiples of tap setting

Computing Coefficients

Step 1: If desired, the user may enter a description in the **Description** field.

Step 2: Under **Standard**, the user should select either **ANS**I curves or **IEC** curves.

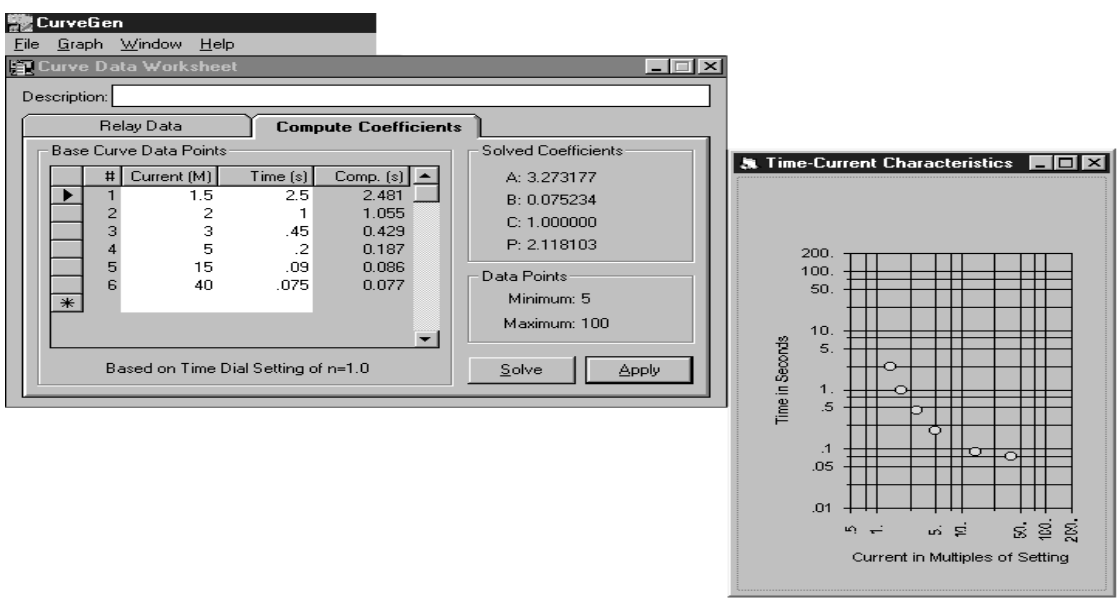
Step 3: Under the **data entry method,** the user should select **Compute Coefficients.** At this point, the **Compute Coefficients Tab** towards the top of the screen should appear. Click this tab.



Step 4: Using the mouse, place the cursor on Row 1, Column 1 (Current M)

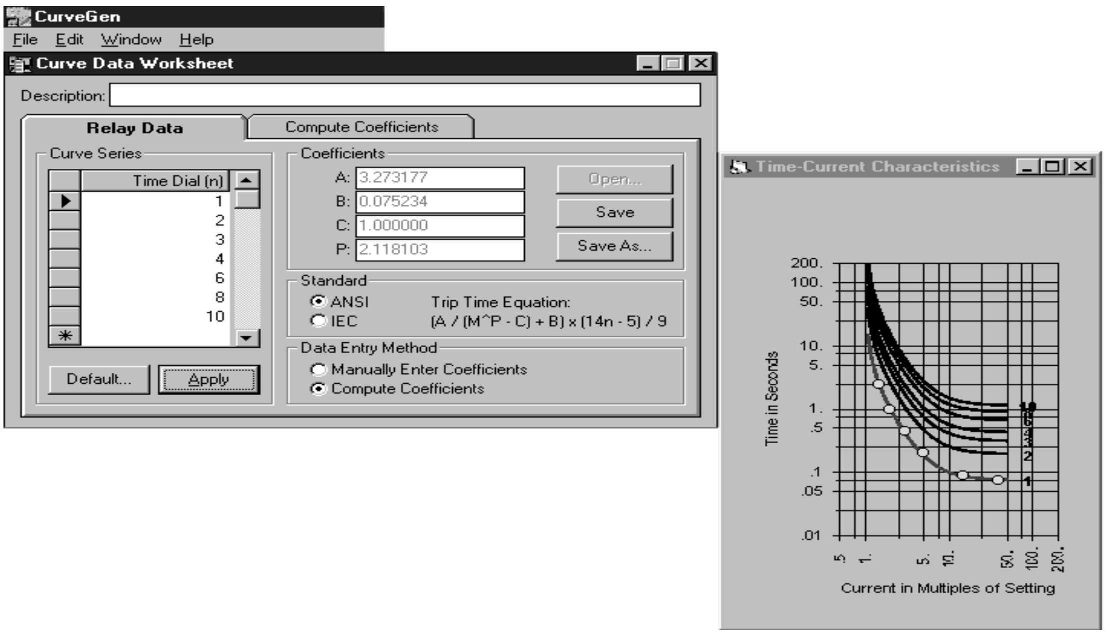
Step 5: Type the desired multiple of tap, M, and press the TAB key. Now type the corresponding time. Press the TAB key again to enter a second point. Continue until at least 5 data points are keyed in (100 points max). Please note that whether you are using ANSI or IEC type curves, the points you enter are equivalent to a time dial of 1.

Step 6: After all points are entered, click on **solve**. The computed coefficients will appear on the screen. In order to see these points on a graph, hit the **Apply** button.



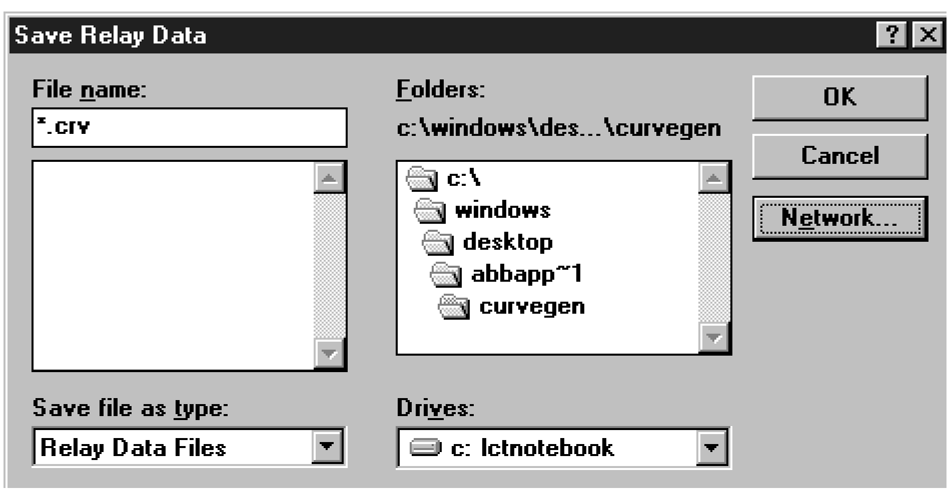
Step 7: Click on the **Relay Data** tab. At this point, you'll see that the coefficients previously calculated appear under **Coefficients**. Under **Curve Series**, select default. Time dial 1 through 10 should appear on the screen for **ANSI** or 0.05 to 1 for **IEC**. Any combination of valid time dials can be used.

Step 8: Select **Apply**. At this point, a graph will appear on the screen. The graph format can be changed by selecting different options under the **Graph** Menu at the top of the screen. The Curves can also be printed for a clearer view.



Step 9: If you are satisfied with the results, select **Save As** under **File** and Type in a filename with a .crv extension. This is the file to be used when downloading curves to your DPU2000R relay.

Step 10: The user also has the ability to save the worksheet. To do this, select **Save Worksheet As** under **File** and type in a filename with a .wrk extension.



Manually Entering Coefficients

Step 1: If desired, the user may enter a description in the **Description** field.

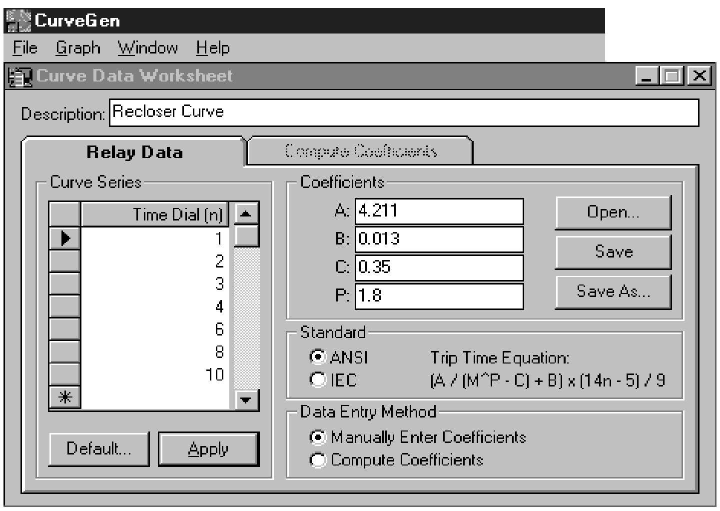
Step 2: Under **Standard,** select **ANSI** or **IEC**.

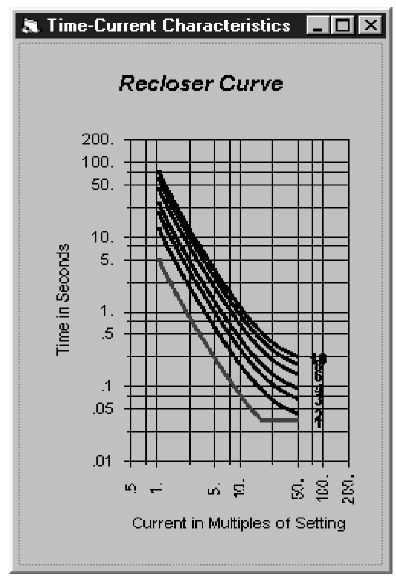
Step 3: Under **Data Entry Method** select **Manually Enter Coefficients**.

Step 4: The user can now enter the known coefficients **A, B, C** and **P**.

Step 5: Under **Curve Series,** select **Default**. Time dial 1 through 10 should appear on the screen for **ANSI** or 0.05 to 1 for **IEC**. Any combination of valid time dials can be used.

Step 6: Select **Apply**. At this point, a graph will appear on the screen. The graph format can be changed by selecting different options under the **Graph** Menu at the top of the screen. The Curves can also be printed for a clearer view.





Step 7: If you are satisfied with the results, select **Save As** under **File** and type in a filename with a .crv extension. This is the file to be used when downloading curves to your DPU2000R relay.

Step 8: the user also has the ability to save the worksheet. To do this select **Save Worksheet As** under **File** and type in a filename with a .wrk extension.

Downloading Curves

By using the File Export, you can send (transmit) curve data that you have created via the CurveGen program from your computer to the DPU2000R. You can also download (receive) curve data from the DPU2000R into your computer for storage and for modification through the CurveGen program.

To transmit or receive curve data, highlight the selection you want and press Enter. Type in the curve's filename (including all directories) and press Enter again. The curve data is sent or retrieved as you selected.

Recloser Curves

This option is offered for those users who have a need for time-current curves that will coordinate with certain time-current curves supplied on Cooper Industries reclosers.

DPU2000R phase overcurrent elements 51P and 50P-1 allow independent selection from curves A, B, C, D, E, K, N, R, W. Ground overcurrent elements 51N and 50N-1 allow selection from curves 2, 3, 8, 8*, 8+, 9, 11.

For each of these curves the DPU2000R provides a Time-Dial selection range of 1 to 10. Time-dial #1 is the closest to the Cooper Industries curve.

The equations for these curves, as implemented in the DPU2000R, follow. Printed copies of the curves are available on request from the factory.

$$t = A / (M ^ P) - C) + B$$

Curve	P	C	A	B	Drawing Number
A	2.307	-1.133	0.2082	-0.002	604900
B	1.782	0.3199	4.229	0.009	604901
C	1.808	0.3800	8.761	0.030	604902
D	2.171	0.1721	5.232	0.001	604903
E	2.183	0.2500	10.77	0.004	604904
N	0.9116	0.4642	0.2856	-0.071	604905
R	0.0022	0.9988	0.0010	-0.134	604906
K	2.012	0.6885	11.98	0	604907
W	1.621	0.3457	15.46	0.056	604908
2	1.849	0.2393	11.42	0.489	604909
3	1.764	0.3799	13.55	0.993	604910
8	1.789	0.4365	1.685	0.158	604911
8*	1.425	0.4426	1.423	-0.008	604912
8+	1.701	0.3667	1.427	-0.004	604913
9	1.035	0.6143	2.760	5.106	604914
11	2.695	-0.6719	21.62	10.68	604915

Equations— Recloser Curves

DPU 2000/2000R

Maintenance and Testing

Because of its continuous self-testing, the DPU2000R requires no routine maintenance. However, you can conduct testing to verify proper operation. ABB recommends that an inoperative unit be returned to the factory for repair. If you need to return a unit, contact your local ABB sales office for a return authorization number.

High-Potential Tests

High-potential tests are not recommended. If a control wire insulation test is required, completely withdraw the DPU2000R from its case and perform only a DC high-potential test.

Withdrawing the DPU2000R from its Case

The DPU2000R can be disassembled to install optional equipment or to change jumper settings of the selectable output contacts, between normally open (NO) and normally closed (NC). Follow these steps to disassemble the unit:

WARNING: Removal of the relay from the case exposes the user to dangerous voltages. Use extreme care. Do not insert hands or other foreign objects into the case.

1. Loosen the knurled screws on the face of the DPU2000R and gently remove the face and attached circuit board by grasping the knurled screws and pulling the unit straight forward. Pulling the board out at an angle or otherwise stressing the board on extraction may damage the unit. Once removed from the case, position the unit face down on a static secured mat.
2. Install the desired options according to the instructions provided with those options. The output relays are on the top-left-rear section of the board (when viewed from the front) under the metal shield. Movable jumper links alongside the output relays set the selectable output contacts to normally open (NO) or normally closed (NC). To access the jumper links it is necessary to remove the shield, which is secured by a screw and 1/4" PCB mounting stud. If an AUX COM board is installed, it will be necessary to remove the board completely, proper ESD precautions taken, to allow access to the shield.
3. To reinstall the unit into the case, carefully align and insert the lips on both sides of the board into the guide rails on the inside walls of the case and gently push the unit straight inward until it fully seats in the case. Secure the knurled screws.

System Verification Tests

Besides continuously monitoring a Self-Check output contact, perform routine hardware tests to verify that the DPU2000R is functioning properly. Run these tests via the OCI or via the communications port and the Windows External Communications Program. The tests are:

1. Confirm pass/fail status of each Self-Check element by using the Test Menu.
2. Confirm continuity of current and voltage through each input sensor by using the Meter Menu.
3. Confirm continuity through each optically isolated contact input for both the opened and closed condition by using the Test Menu.
4. Verify operation of each output contact by using the Test Menu.
5. Confirm that all relay settings are correct by using the Show Settings Menu.
6. Check the Fault and Operation Records for proper sequential operation.

Testing the DPU2000R

When the DPU2000R is in service, its functions depend on the state of the breaker monitored through the 52a (XO) and 52b (XI) contacts. Therefore, to fully test the system, apply a test circuit that simulates circuit breaker operation. Figure 11-1 shows a typical test circuit using a latching relay as the simulated breaker.

A **Breaker Simulator Test Accessory** is available from the factory. Instruction Book IB 7.7.1.7-9 applies to this accessory and is available on request. Catalog numbers: 110/125 Vdc = 200S4004; 48 Vdc = 200S4003; 24 Vdc = 200S4009.

If it is not possible to use a breaker simulator, place the DPU2000R in the Functional Test Mode. This mode allows testing of the programmed overcurrent functions and reclose sequence (when the test current is removed) without simulating the operation of the 52a (XO) and 52b (XI) contacts.

If you do not place the unit in Functional Test Mode and do not connect the 52a (XO) and 52b (XI) contacts during testing, the DPU2000R will go into the Breaker Failure state (and Lockout) on the first test trip.

The DPU2000R stays in the Functional Test Mode for fifteen minutes or until you exit whichever occurs first. Use the “C” key on the OCI to reset the recloser when it is in Lockout in the Test Mode. In the Test Mode the fault sequence is written only to the Operations Record.

The tests described below confirm the relay’s protective capabilities and metering accuracy. Test only those functions that will be enabled when the relay is placed into service. Testing the enabled functions ensures that the relay settings are correct for the desired application. Check the Fault and Operations Records after each test to confirm proper sequential operation of the relay logic.

NOTE: The following test procedures are written from the perspective of using the OCI. You can also use the WinECP to change settings and run the test. See Section 5, "Settings," for basic instructions on using WinECP.

Use a single-phase current test set to confirm continuity through the four current input sensors and the proper operation/settings of 51P (3I>) , 51N (IN>) , 50P-1 (3I>>1) , 50N-1 (IN>>1) , 50P-2 (3I>>2) , 50N-2 (IN>>2) , 50P-3 (3I>>3) , 50N-3 (IN>>3) and 46 (Insc>) functions. Test the phase functions by injecting current into the Ia and Ib input sensors. Test the neutral (ground) functions by injecting current into the Ic and In input sensors. Test the 46 function by injecting current into one phase input sensor (since I_2 = 1/3 Ia when Ib = Ic = 0).

You must have a three-phase current and voltage test set to fully tet the proper operation of the fault locator and the accuracy of the watts, VARs and power factor metering capabilities. (You must have 3-phase current sources, 3-phase voltage sources and a digital timer.)

Use a single-phase voltage test set to confirm the proper operation/settings of the 27 (U<) and 79V (O->IU<) functions.

Properly ground all equipment used in testing.

Tables 11-1 and 11-2 show the factory default settings on which the tests are based. These are the same default settings shown in Tables 5-1 and 5-2.

Table 11-1. Factory Defaults for Testing Primary Settings

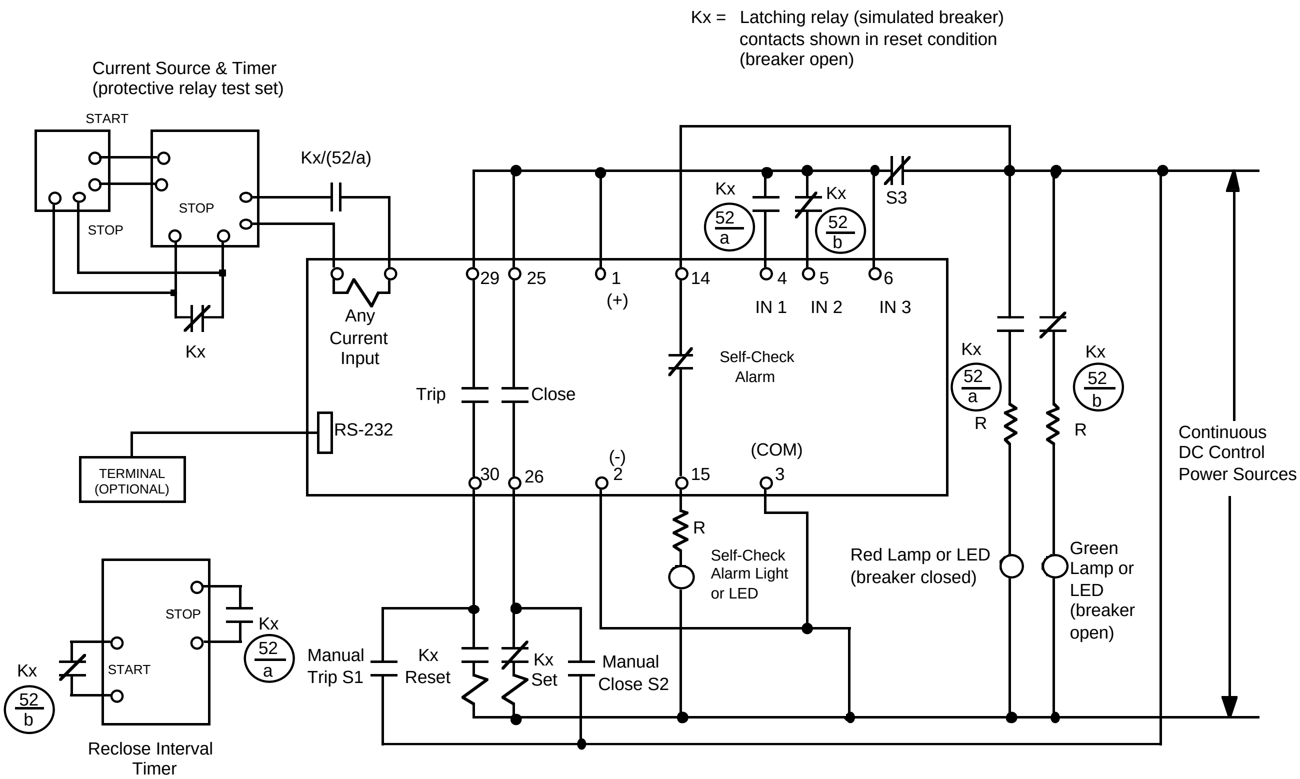
Function	Setting
51P Curve	Ext Inv
51P Pickup A	6.0
51P Time Dial	5.0
50P-1 Curve	Standard
50P-1 PickupX	3.0
50P-2 Select	Disable
50P-3 Select	Disable
46 Curve	Disable
46A Curve	Disable
51N Curve	Ext Inv
51N Pickup A	6.0
51N Time Dial	5.0
50N-1 Select	Standard
50N-1 PickupX	3.0
50N-2 Select	Disable
50N-3 Select	Disable
79 Reset Time	10
79-1 Select	50P-1, 51N, and 50N-1 Enable
79-1 Open Time	LOCK
79 Cutout Time	Disable
Cold Load Time	Disable
2Phase 50P	Disable
67P Select	Disable
67N Select	Disable
21 P-1	Disable
21 P-2	Disable
21 P-3	Disable
21 P-4	Disable
81 Select	Disable
27 Select	Disable
79V Select	Disable
47	Disable
59 Select	Disable
59-3	Disable
59G	Disable
32 P-2 Select	Disable
32 N-2 Select	Disable
25 Select	Disable

Table 11-2. Factory Defaults for Testing Configuration Settings

Function	Setting
Phase CT ratio	100
VT Ratio	100
VT Connection	120 wye
Positive Sequence X/Mi (km)	.001
Positive Sequence R/Mi (km)	.001
Zero Sequence X/Mi (km)	.001
Zero Sequence R/Mi (km)	.001
Line Length Miles (km)	20
Trip Fail Time	18
Close Fail Time	18
Phase Rotation	ABC
Protection Mode (Prot. Mode)	Fund
Reset Mode	Instant
ALT1	Enable
ALT2	Enable
MDT Mode	Disable
Standard Unit (Std. Unit)	Standard
Cold Load Time Mode (C L Time Mode:)	Seconds
Zone Seq Coordination	Disable
Target Mode	Last
Local Edit (Remote Edit)	Enable
Meter Mode (WHr Display)	kWHr
LCD Light	On
Unit ID (ID)	DPU2000R
Demand Meter Constant (Demand Minutes)	15
LCD Contrast	16
Relay Password	[ ] 4 spaces
Test Password	[ ] 4 spaces
CT Ratio ⊗	1
SE V0 PT Ratio ⊗ ⊗	1
Slow Trip Time	12 cycles

⊗ SEF model only

⊗ ⊗ Directional SEF model only



Programmable inputs I1 (52a), I2 (52b) and I3 (43a) must be wired to enable their respective functions and programmed in the Input Mapping screen. Progammable output OUT 2 (Close) must be wired to enable the respective function and programmed in the output mapping screen.

Figure 11-1. Typical Test Circuit

Functional Test Mode (Password Protected)

Use the Functional Test Mode to test programmed overcurrent functions and the reclose sequence (upon removal of test current) without simulating operation of the 52a (XO) and 52b (XI) contact inputs. The DPU2000R stays in Functional Test Mode for fifteen minutes or until you exit, whichever occurs first. Use the <C> key on the OCI to reset the recloser when it is in Lockout in the Test Mode. The OCI display shows the time remaining in the Functional Test Mode (except when the Trip Coil Monitor function has been enabled). The test sequences are written only into the Operations Record.

Verify Self-Checking Test Via OCI

Follow these steps to verify the pass/fail status of each self-check element on the DPU2000R:

1. Connect the proper control power to the unit. Wait for initialization to be complete. The green STATUS LED should be lit and the red RECLOSER OUT LED should also be lit if the recloser is disabled by the active settings table.
2. From the OCI, press “E” to get the Main Menu.
3. Scroll down to “TEST” and press “E.”
4. The first choice is “Self Test,” so press “E.” All elements under the “Self Test” should read “pass.”
5. Press “C” to return to the meter display.

Phase Angle Conventions

For tests that follow, refer to Figure 3-1 for phase angle and metering conventions used in the DPU2000R. In general, all angles are in "degrees leading."

Metering Test

1. Apply 3-phase voltages and currents as shown in Figure 11-2. The values for these are:
   - Ia (L1) = 3.0 A $<$ 0°
   - Ib(L2) = 3.0 A $<$ 240°
   - Ic (L3) = 3.0 A $<$120°
   - Van (UL1) = 120.0 V $<$ 0°
   - Vbn (UL2) = 120.0 V $<$ 240°
   - Vcn (UL3) = 120.0 V $<$ 120°
2. From the OCI Main Menu, press "E" twice to gain access to the Metering Menu.
3. Press "E" on the "Load" choice. The following should be within the ranges listed:
   - Ia (L1) = 300.0 0°$<$ (±6 A; the ±6A was calculated by taking 1% of the product of the pickup setting [6.0 A] x the Phase CT Ratio [100]: .01 x [6.0 x 100] = 6.)
   - Ib (L2) = 300.0 $<$ 240° (±6 A)

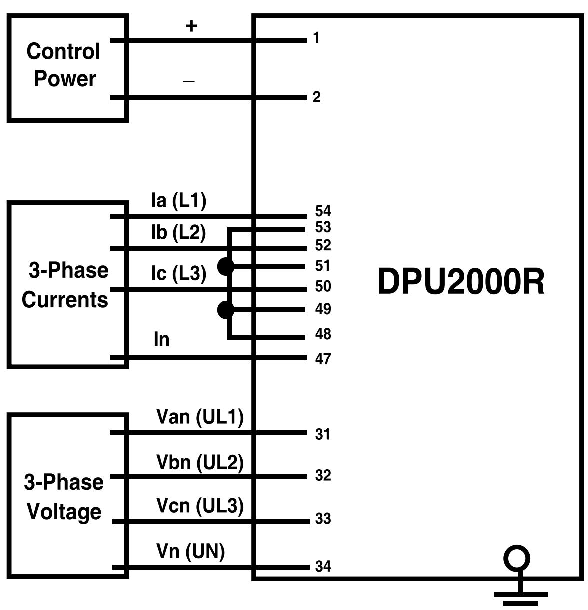


Figure 11-2. Metering Test and Distance Elements

- Ic (L3) = 300.0 $\angle$ 120° (±6 A)
- In = 0.0 (±6 A)
- kVan (UL1) = 12.0 $\angle$ 0° (±0.12 kV)
- kVbn (UL2) = 12.0 $\angle$ 240° (±0.12 kV)
- kVcn (UL3) = 12.0 $\angle$ 120° (±0.12 kV)
- kW-A (L1) = 3600 (±144 kW)
- kW-B (L2) = 3600 (±144 kW)
- kW-C (L3) = 3600 (±144 kW)
- kW-3P = 10800 (±432 kW)
- kVAR-A (L1) = 0 (±144 kW)
- kVAR-B (L2) = 0 (±144 kW)
- kVAR-C (L3) = 0 (±144 kW)
- kVAR-3P = 0 (±432 kW)
- I_0 = 0 (±6 A)
- I_1 = 300 $\angle$ 0° (±6 A)
- I_2 = 0 $\angle$ 0° (±6 A)
- kV_1 = 12.00 $\angle$ 0° (±0.12 kV)
- kV_2 = 0 $\angle$ 0° (±0.12 kV)
- PF = 1.00 Lagging or Leading
- Freq = 60.00 (± 0.01 Hz)

4. Connect the DPU2000R as shown in Figure 11-4. Apply 3.0 A to C (L3)-Phase and the Neutral. Read the current from the Metering Menu as above. The currents Ic and In should be 300.0 ±6 A.

Pickup—Time Overcurrent

Follow these steps to check the time overcurrent of the pickup current.

1. Connect the DPU2000R as shown in Figure 11-3.
2. Apply 5.5 A, gradually increasing the current until the PICKUP LED just lights. This should be within ±3% of the pickup (see Table 11-1) or ±0.18 A (±18.0 A primary). This confirms the continuity and accuracy of phases A (L1) and B (L2).
3. Decrease the input current to 0 and reset targets, if necessary, by pressing the target reset push button.
4. Connect the DPU2000R as shown in Figure 11-4. Repeat Step 2 to confirm the continuity and accuracy of phase C (L3) and Neutral.

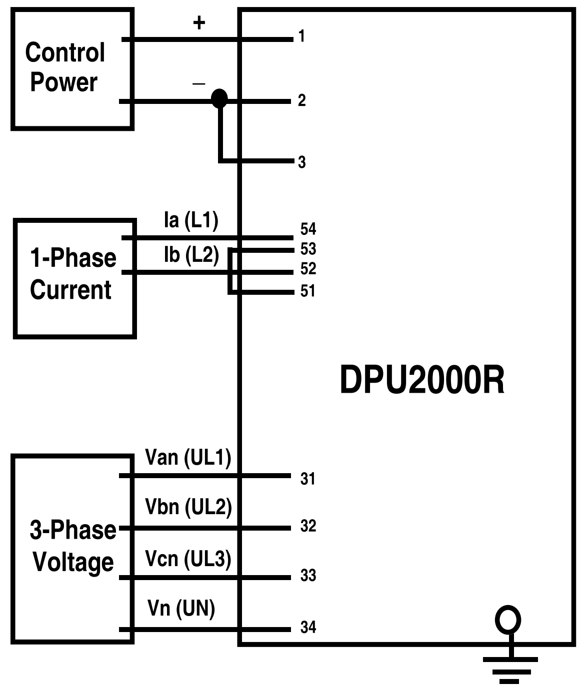


Figure 11-3. Test Circuit for Time Overcurrent, 50P-1 (3I>>1), 2-Phase 50P(3I>>) and 46 (Insc>) Functions

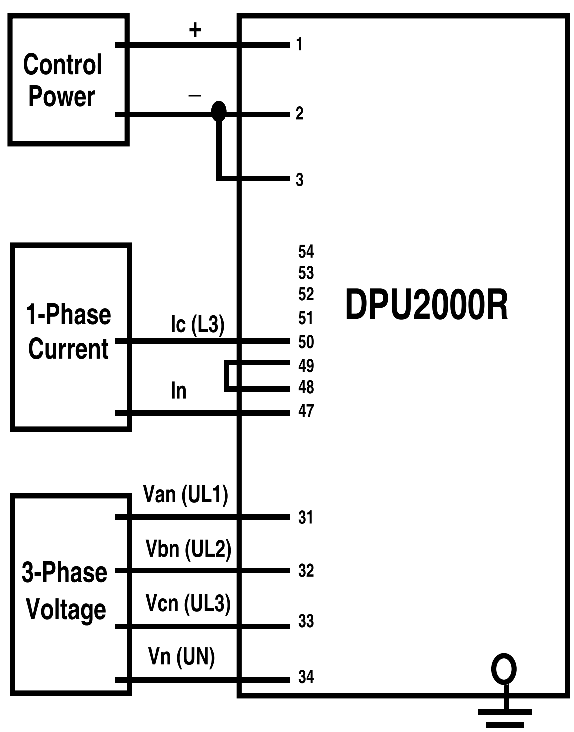


Figure 11-4. Test Circuit for 51N (IN>), 50N-1(IN>>1), 50P-2 (3I>>2), 50N-2 (IN>>2), 50P-3 (3I>>3), 50N-3 (IN>>3) and 2-Phase 50P (3I>>) Functions

5. To confirm the ground pickup, lower the 51N (IN>) setting to 5.0 A. To do this:
   a. Access the settings menu by pressing “E” on the OCI.
   b. Scroll to “Settings.”
   c. Hit “E” and scroll to “Change Settings.”
   d. Hit “E” again to access “Prim Settings.”
   e. Enter the password (four spaces for factory default) and press “E.”
   f. Scroll to “51N Pickup A” and Press “E.”
   g. Press the left arrow key until 5.0 is displayed; hit “E” to accept this value.
   h. Press “C” twice to get out of settings change.
   i. Press right or left arrow key to respond “YES” to the “Save Settings” prompt. Press “E.”
   j. Press “C” until the present metering values are displayed.
6. Apply 4.5 A to the DPU2000R as shown in Figure 11-4. Gradually increase the current until the PICKUP LED just lights. This should be within ±3% of the pickup (5 A). This confirms the ground pickup.
7. Decrease the input current to 0 and reset targets, if necessary, by pressing the target reset push button.
8. Repeat step 5 above to reset the 51N (IN>) pickup to 6.0 amps.

Pickup—Instantaneous Overcurrent

Follow these steps to test the instantaneous overcurrent of the pickup current:

1. To test the 50P-1 (3I>>1) phase instantaneous unit:
   a. Connect the DPU2000R as shown in Figure 11-3.
   b. Apply approximately 85% of the instantaneous pickup current (18 A from Table 11-1) to the relay or 15.3 A.
   c. Gradually increase the current until the INSTANTANEOUS LED lights. This should be ±7% of the setting or ±1.26 A (±126 A primary). This confirms phases A (L1) & B(L2). Targets that should be lit are A (L1), B (L2) and INSTANTANEOUS.
   d. Decrease the input current to 0 and reset targets by pressing the target reset push button.
2. To test the 50N-1 (IN>>1) ground instantaneous unit:
   a. Disable the 50P-1 (3I>>1) function via the “Change Settings”, “Primary Settings” Menus.
   b. Connect the DPU2000R as shown in Figure 11-4.
   c. Apply approximately 85% of the instantaneous pickup current (18 A from Table 11-1) to the relay or 15.3 A.
   d. Gradually increase the current until the INSTANTANEOUS LED lights. This should be ±7% (from Table 11-1) of the setting or ±1.26 A (±126 A primary). Targets N and INSTANTANEOUS should be lit.
   e. Decrease the input current to 0 and reset targets by pressing “C” on the OCI.
3. To test the 50P-2 (3I>>2) phase instantaneous unit:
   a. Enable the 50P-2 (3I>>2) function and disable the 50N-1 (IN>.1) function via the “Change Settings”, “Primary Settings” Menus.
   b. Connect the DPU2000R as shown in Figure 11-3.
   c. Apply approximately 85% of the instantaneous pickup current (18 A from Table 11-1) to the relay or 15.3 A.

d. Gradually increase the current until the INSTANTANEOUS LED lights. This should be ±7% of the setting or ±1.26 A (±126 A primary). Targets C (L3) and INSTANTANEOUS should be lit.

e. Decrease the input current to 0 and reset targets by pressing “C” on the OCI.

4. To test the 50N-2 (IN>>2) ground instantaneous unit

a. Enable the 50N-2 (IN>>2) function and disable the 50P-2 (3I>>2) function via the “Change Settings”, “Primary Settings” Menus.

b. Connect the DPU2000R as shown in Figure 11-4.

c. Apply approximately 85% of the instantaneous pickup current (18 A from Table 11-1) to the relay or 15.3 A.

d. Gradually increase the current until the INSTANTANEOUS LED lights. This should be ±7% of the setting or ±1.26 A (±126 A primary). Targets N and INSTANTANEOUS should be lit.

e. Decrease the input current to 0 and reset targets by pressing “C” on the OCI.

5. To test the 50P-3 (3I>>3) phase instantaneous unit:

a. Enable the 50P-3 (3I>>3) function and disable the 50N-2 function via the “Change Settings”, “Primary Settings” Menus.

b. Connect the DPU2000R as shown in Figure 11-3.

c. Apply approximately 85% of the instantaneous pickup current (18 A from Table *15*) to the relay or 15.3 A.

d. Gradually increase the current until the INSTANTANEOUS LED lights. This should be ±7% of the setting or ±1.26 A (±126 A primary). Targets C (L3) and INSTANTANEOUS should be lit.

e. Decrease the input current to 0 and reset targets by pressing “C” on the OCI.

6. To test the 50N-3 (IN>>3) ground instantaneous unit:

a. Enable the 50N-3 (IN>>3) function and disable the 50P-3 (3I>>3) function via the “Change Settings”, “Primary Settings” Menus.

b. Connect the DPU2000R as shown in Figure 11-4.

c. Apply approximately 85% of the instantaneous pickup current (18 A from Table 11-1) to the relay or 15.3 A.

d. Gradually increase the current until the INSTANTANEOUS LED lights. This should be ±7% of the setting or ±1.26 A (±126 A primary). Targets N and INSTANTANEOUS should be lit.

e. Decrease the input current to 0 and reset targets by pressing “C” on the OCI.

7. To test the 2-Phase 50P (3I>>) Trip function:

a. Enable the 50P-2 (3I>>2) and 2-Phase 50P (3I>>) function via the “Change Settings”, “Primary Settings” Menus.

b. Connect the test set as shown in Figure 11-3.

c. Apply approximately 85% of the instantaneous pickup current (18 A from Table 11-2) to the relay or 15.3 A.

d. Gradually increase the current until the 50P-2 (3I>>2) relay trips. This should be ±7% of the setting or ±1.26 A (±126 A primary). This confirms phases A (L1) & B (L2). Targets A (L1), B (L2) and INSTANTANEOUS should be lit.

e. Decrease the input current to 0 and reset targets by pressing “C” on the OCI.

f. Connect the test set as shown in Figure 11-4, repeat tests c, d and e. This should confirm that the relay does not trip and no INST targets light.

8. Disable the 50P-2 (3I>>2) and the 2-Phase 50P (3I>>) functions via the “Change Settings”, “Primary Settings” Menus. Connect the DPU2000R as shown in Figure 11-4 and map GRD (IN) to an available input (ex: IN4) with logic "C", in the programmable inputs screen. (This will disable the GRD (IN) function.) Apply the fault as in step 2 and confirm that the relay will not trip on 50N-1(IN>>1).

Timing Tests

Follow these steps to test the timing of the DPU2000R:

1. Connect the DPU2000R as shown in Figure 11-5.
2. Apply a fault current of 12 A to the relay. This current is 2x the default pickup current of 6.0 A. The relay should trip between 14.5 and 16.7 seconds (derived from the Extremely Inverse Curve, Figure 1-4, by using the default values in Table 11-1).
3. Apply a fault current of 24 A to the relay (4x the default pickup current). The relay should trip between 3.0 and 3.5 seconds.
4. Apply a fault current of 36 A to the relay (6x the default pickup current). The relay should trip between 1.4 and 1.6 seconds.

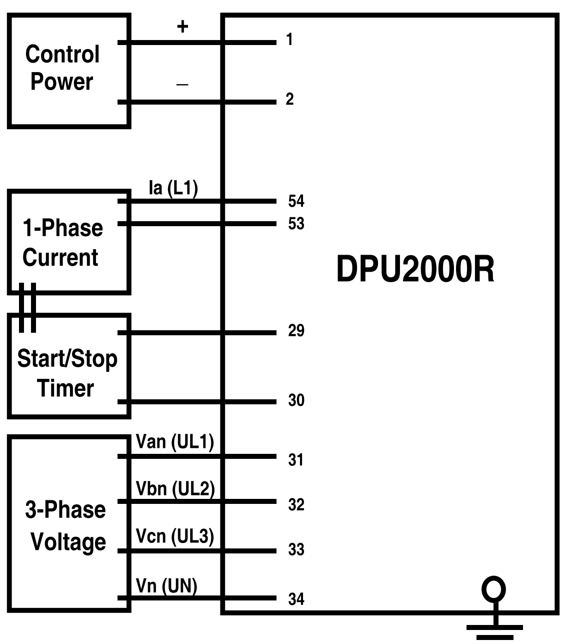


Figure 11-5. Test Circuit for Timing and Recloser Lockout

Directional Testing

Follow these steps to test the directional functions:

1. To test the 67P protective function, enable the directional functions:
   a. Press the "E" key.
   b. Scroll to "Settings" and press "E."
   c. Scroll to "Change Settings" and press "E."
   d. Scroll to "Prim Settings" and press "E."
   e. Enter password (four spaces for default) and press "E."
   f. Scroll down to "67P" and press "E."
   g. Hit right arrow key to change to "Enable" and press "E."
   h. Press "C" twice.
   i Press right arrow key to "Yes" and press "E" to save settings.
   j. The factory default settings are as follows:
      - 67P Curve Extremely Inv
      - 67P Pickup 1.0
      - 67P Time Dial 5
      - Torque Angle 0
   k. Apply the following test values to the circuit, as shown in Figure 11-6:
      - Ia = 5 A $\angle 0^\circ$
      - Ib = 0 A
      - Ic = 0 A
      - In = 5 A $\angle 0^\circ$
      - Van = 10 V $\angle 0^\circ$
      - Vbn = 120 V $\angle 240^\circ$
      - Vcn = 120 V $\angle 120^\circ$
   l. The relay should trip on 67P directional overcurrent between 2.00 and 2.35 seconds (from the Extremely Inverse curve, Figure 1-4). This is indicated by a lit phase target (e.g., A) with no other targets lighting. Check the fault records to confirm the 67P trip.
   m. Reset the targets by pressing "C" on the OCI.
   n. Change the Ia and In angles to 180° and reapply the current.
   o. The relay should not trip on the 67P directional overcurrent.

2. To test the 67N, disable the 67P function and enable the 67N function.
   a. Press the "E" key.
   b. Scroll to "Settings" and press "E."
   c. Scroll to "Change Settings" and press "E."
   d. Scroll to "Prim Settings" and press "E."
   e. Enter the password (four spaces for default) and press "E."

f. Scroll down to “67N” and press “E.”

g. Hit right arrow key to change to “Enable” and press “E.”

h. Press “C” twice.

i. Press right arrow key to “Yes” and press “E” to save settings.

j. The factory default settings are as follows:

- 67N Curve Extremely inv
- 67N Pickup 1.0
- 67N Time Dial 1.0
- Torque Angle 0

k. Apply the following test values to the circuit as shown in Figure 11-6:

- Ia = 5 A ∠180°
- Ib = 0 A
- Ic = 0 A
- In = 5 A ∠180°
- Van = 10 V ∠ 0°
- Vbn = 120 V ∠240°
- Vcn = 120 V ∠120°

l. The relay should trip on 67N directional overcurrent between 0.28 and 0.32 seconds (from the Extremely Inverse curve, Figure 1-4). This is indicated by the N LED lighting with no other targets lit. Check the fault records to confirm the 67N trip.

m. Reset the targets by pressing “C” on the OCI.

n. Change the Ia and In angles to 0° and reapply the current.

o. The relay should not trip on 67N directional overcurrent.

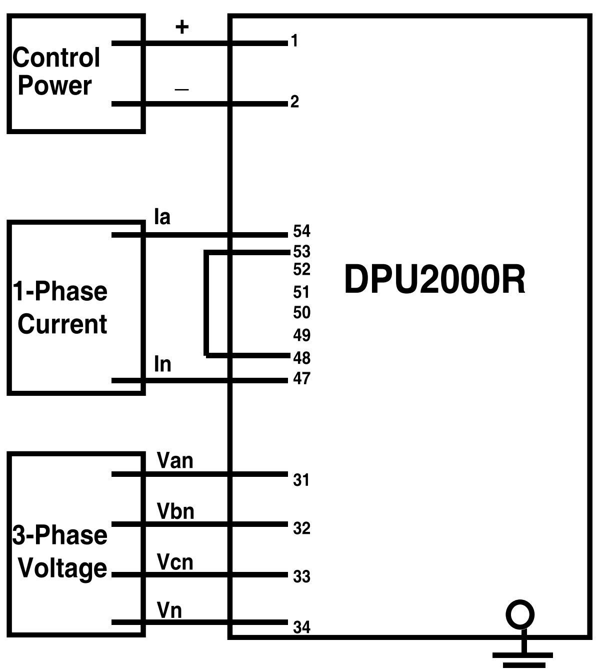


Figure 11-6. Test Circuit for 67P and 67N Functions

Negative Sequence Testing

Follow these steps to test the 46 (Insc>) function:

1. Disable all instantaneous functions - 50P-1 (3I>>1), 50P-2(3I>>2), 50P-3 (3I>>3).

2. Raise the 51P (3I>) Pickup setting to 12A to prevent a 51P (3I>) operation during this test.

3. Set the 46 (Insc>) function according to the following values:
   - Curve: Extremely Inverse
   - Pickup: 3.5A
   - Time Dial: 5.0

4. Apply the following currents as shown in Figure 11-3:
   - Ia (L1) = 12 A $\angle 0°$
   - Ib (L2) = 12 A $\angle 180°$
   - Ic (L3) = 0

   This phase-to-phase fault simulation will produce a two per unit negative-sequence current, 6.9A I_2, (12A x 58% = 6.9A), in the DPU2000R.
   - In = 0

5. In this case, I_2 is determined in the relays as follows:

   $I_2 = 1/3\ (Ia + a^2 I_b + aIc)$

   where:

   $a = 1 \angle 120$

   $a^2 = 1 \angle -120$

   since Ic = 0, then

   $I_2 = 1/3\ (Ia + (1 \angle -120)\ Ib)$

   $= 1/3\ (12 \angle 0 + (1 \angle -120)\ (12 \angle 180)$

   $= 1/3\ (12 \angle 0 + 12 \angle 60)$

   $= 1/3\ (20.7 \angle 30°)$

   $\therefore \quad I_2 = 6.9 \angle 30°$

   therefore, we are at approximately 2x pickup.

6. The relay should trip between 14.3 and 16.3 seconds (from the Extremely Inverse Curve, Figure 1-6) and only the NEGATIVE SEQUENCE LED should light.

Impedance (Distance Element) Testing

1. To enable the 21-1 function through the menu:

   a. Press the ‘E” key.

   b. Scroll to “Settings” and press ‘E”.

   c. Scroll to “Change Settings” and press ‘E”.

   d. Scroll to “Primary Settings” and press “E”.

   e. Enter the password (four spaces for default), and press “E”.

   f. Scroll down to 21-1 Disable and press ‘E”.

   g. Press the right arrow key until 21-1 enable appears and press “E”.

   h. Scroll to the following values and press “E”. Change the values as necessary by pressing the right arrow key. When the values you require are displayed, press “E”.

      - 21-1 select — enable
      - 21-1 Phase reach — 40.0 ohms
      - Characteristic angle — 75 degrees
      - Time Delay — 0.00 seconds
      - I_1 Supervision — Disable or set at 1.0 amp

   i. After changing the values for 21-1, press “C” again.

   j. Use the right arrow key to select “YES” and press “E” to save the new settings.

2. Program an output contact by using the WinECP External Communications Program to detect the 21-1 trip.

3. Verify the 21-1 zone condition by applying the following voltages and currents to the relay at the following phase angle as shown in Figure 1-2.

   - Vab = 120 volts ∠ 0 degrees
   - Vbc = 120 volts ∠ 120 degrees
   - Vca = 120 volts ∠ 240 degrees

   - Ia = 2.5 amps ∠ 0 degrees
   - Ib = 2.5 amps ∠ 120 degrees
   - Ic = 2.5 amps ∠ 240 degrees
   - Phase Angle = 75 degrees current lagging voltage

4. Lower the voltage to 103 volts, and the 21-1 unit should not trip.

5. Lower the voltage to 97 volts, and the 21-1 unit should trip as the impedance reach is inside the circular characteristic.

6. Test the 21-2 unit in the same manner as described above.

7. Test the 21-3 and 21-4 units in the same manner as described above except the phase angle must have 180 degrees added as these two zones are reverse reaching units. Example: Instead of a 75 degree phase shift angle, set the angle for 255 degrees.

Negative Sequence Voltage Testing

1. To enable the 47 function through the menu:
   a. Press the ‘E” key.
   b. Scroll to “Settings” and press ‘E”.
   c. Scroll to “Change Settings” and press ‘E”.
   d. Scroll to “Primary Settings” and press “E”.
   e. Enter the password (four spaces for default), and press “E”
   f. Scroll down to 47. Disable and press ‘E”.
   g. Press the right arrow key until 47 enable appears and press “E”.
   h. Scroll to the following values and press “E”. Change the values as necessary by pressing the right arrow key. When the values you require are displayed, press “E”.
      - 47 select enable
      - 47 Voltage setting 10.0 volts
      - 47 Time delay 0.00 seconds
   i. After changing the values for 47, press “C” again.
   j. Use the right arrow key to select “YES” and press “E” to save the new settings.
2. Program an output contact by using the WinECP External Communications Program to detect the 47 trip.
3. Verify the 47 condition by applying the following voltages and currents to the relay as shown in Figure 1-2.
   - Vab = 120 volts $\angle$ 0 degrees
   - Vbc = 120 volts $\angle$ 120 degrees
   - Vca = 120 volts $\angle$ 240 degrees

   - Ia = 0.0 amps
   - Ib = 0.0 amps
   - Ic = 0.0 amps
4. Lower any two phases to 90 volts, and the 47 device will trip as V_2 will be 10.0 volts. Raise the voltage slightly, and it should not produce a trip.

Undervoltage Testing

1. To enable the 27 function through the menu:
   a. Press the ‘E” key.
   b. Scroll to “Settings” and press ‘E”.
   c. Scroll to “Change Settings” and press ‘E”.
   d. Scroll to “Primary Settings” and press “E”.
   e. Enter the password (four spaces for default), and press “E”.
   f. Scroll down to 27 Disable and press ‘E”.
   g. Press the right arrow key until 27-1 enable appears and press “E”.
   h. Scroll to the following values and press “E”. Change the values as necessary by pressing the right arrow key. When the values you require are displayed, press “E”.
      - 27 select enable
      - 27 Voltage setting 100 volts
      - 27 Time delay 0.00 second
   i. After changing the values for 27, press “C” again.
   j. Use the right arrow key to select “YES” and press “E” to save the new settings.

2. Program an output contact by using the WinECP External Communications Program to detect the 27-1 for a single phase trip; or if a three phase undervoltage condition is to be tested, select on the output contact program 27-3.

3. Verify the 27 condition by applying the following voltages and currents to the relay as shown in Figure 1-2.
   - Vab = 120 volts $\angle$ 0 degrees
   - Vbc = 120 volts $\angle$ 120 degrees
   - Vca = 120 volts $\angle$ 240 degrees

   - Ia = 0.0 amps
   - Ib = 0.0 amps
   - Ic = 0.0 amps

4. Lower any one phase to 100 volts, and the 27-1 device will trip. For a three phase undervoltage test, lower all three phases to 100 volts, and the 27-3 contact output will trip. Raise the voltage slightly, and it should not produce a trip.

Phase Overvoltage Testing

1. To enable the 59 function through the menu:
   a. Press the ‘E” key.
   b. Scroll to “Settings” and press ‘E”.
   c. Scroll to “Change Settings” and press ‘E”.
   d. Scroll to “Primary Settings” and press “E”.
   e. Enter the password (four spaces for default), and press “E”.
   f. Scroll down to 59 disable and press ‘E”.
   g. Press the right arrow key until 59 enable appears and press “E”.
   h. Scroll to the following values and press “E”. Change the values as necessary by pressing the right arrow key. When the values you require are displayed, press “E”.
      - 59 select enable
      - 59 Voltage setting 130 volts
      - 59 Time delay 0.00 seconds
   i. After changing the values for 59, press “C” again.
   j. Use the right arrow key to select “YES” and press “E” to save the new settings.
2. Program an output contact by using the WinECP External Communications Program to detect the 59-1 for a single phase trip; or if a three phase overvoltage condition is to be tested, select on the output contact program 59-3.
3. Verify the 59 condition by applying the following voltages and currents to the relay as shown in Figure 1-2.
   - Vab = 120 volts $\angle$ 0 degrees
   - Vbc = 120 volts $\angle$ 120 degrees
   - Vca = 120 volts $\angle$ 240 degrees

   - Ia = 0.0 amps
   - Ib = 0.0 amps
   - Ic = 0.0 amps
4. Raise any one phase to 130 volts, and the 59-1 device will trip. For a three phase overvoltage test, raise all three phases to 130 volts, and the 59-3 contact output will trip. Lower the voltage slightly, and it should not produce a trip.

Ground Overvoltage Testing

1. To enable the 59G function through the menu:

   a. Press the ‘E” key.
   b. Scroll to “Settings” and press ‘E”.
   c. Scroll to “Change Settings” and press ‘E”.
   d. Scroll to “Primary Settings” and press “E”.
   e. Enter the password (four spaces for default), and press “E”.
   f. Scroll down to 59G disable and press ‘E”.
   g. Press the right arrow key until 59G enable appears and press “E”.
   h. Scroll to the following values and press “E”. Change the values as necessary by pressing the right arrow key. When the values you require are displayed, press “E”.
   - 59G Select enable
   - 59G Voltage setting 10 volts
   - 59G Time delay 0.00 seconds

   i. After changing the values for 59G, press “C” again.
   j. Use the right arrow key to select “YES” and press “E” to save the new settings.

2. Program an output contact by using the WinECP External Communications Program to detect the 59G.

3. Verify the 59G condition by applying the following voltage and currents to the relay as shown in Figure 1-2.
   - Van = 10.0 volts
   - Vbc = 0.0 volts
   - Vca = 0.0 volts

   - Ia = 0.0 amps
   - Ib = 0.0 amps
   - Ic = 0.0 amps

4. Raise the phase to 10 volts, and the 59G device will trip. Lower the voltage slightly, and it should not produce a trip.

Reclosing Sequence Test

Follow these steps to test the reclosing sequence:

1. Change the Primary Settings.
   a. Press the “E” key.
   b. Scroll to “Settings” and press “E.”
   c. Scroll to “Change Settings” and press “E.”
   d. Scroll to “Prim Settings” and press “E.”
   e. Enter the password (four spaces for default) and press “E.”
   f. Scroll down to each of the following and change the value as necessary by using the right arrow key. Verify or change the following PRIMARY settings for this test:

50P-1 (3I>>1) Curve	=	Standard
50P-1 (3I>>1) PickupX	=	1.0
2-Phase 50P (3I>>)	=	Disable
79 (O->I) Reset Time	=	10 seconds
79-1 (O->I1) Select	=	50P-1 (3I>>1), 51N (IN>), 50N-1 (IN>>1) enabled
79-1 (O->I1) Open Time	=	0.3 seconds
79-2 (O->I2) Select	=	50P-1 (3I>>1), 51N (IN>), 50N-1 (IN>>1)enabled
79-2 (O->I2) Open Time	=	10 seconds
79-3 (O->I3) Select	=	50P-1 (3I>>1), 51N (IN>), 50N-1 (IN>>1) enabled
79-3 (O->I3) Open Time	=	15 seconds
79-4 (O->I4) Select	=	50P-1 (3I>>1), 51N (IN>), 50N-1 (IN>>1) enabled
79-4 (O->I4) Open Time	=	15 seconds
79-5 (O->I5) Select	=	50P-1 (3I>>1), 51N (IN>), 50N-1 (IN>>1) enabled
79-5 (O->I5) Open Time	=	LOCKOUT
Trip Fail Time	=	18 cycles

   g. Press “E” when the value you want is displayed.
   h. Press “C” twice.
   i. Press the right arrow key to “Yes” and press “E” to save settings.

2. Set the relay to Functional Test Mode. This eliminates the need for a breaker.
   a. Press the “E” key to access the Main Menu.
   b. Scroll to “Test” and press “E.”
   c. Scroll to “Func. Test Mode” and press “E.”
   d. Enter the password (four spaces for default) and press “E.”
   e. Press right arrow key to “Yes” and press “E.”
   f. The DPU2000R will remain in the Functional Test Mode for 15 minutes, unless reset.

3. Test the Recloser Lockout function.
   a. Connect the DPU2000R as shown in Figure 11-5.
   b. Apply a fault current of 12 A to the relay. Once the relay has tripped, it remains open according to the settings in Step 1f; then the relay should reclose. Be sure the current is removed within the “Trip Fail Time” setting in the configuration settings.
   c. Before the reset time of the relay has expired, apply a subsequent fault current. The relay will trip and reclose.
   d. Continue to apply the fault until Recloser Lockout occurs. This should be on the fourth trip.

Frequency Tests

1. To enable the 81 function through the menus:
   a. Press the “E” key.
   b. Scroll to “Settings” and press “E.”
   c. Scroll to “Change Settings” and press “E.”
   d. Scroll to “Prim Settings” and press “E.”
   e. Enter the password (four spaces for default) and press “E.”
   f. Scroll down to 81 Disable and press “E.”
   g. Press the right arrow key until “81S Enable” appears and press “E.”
   h. Press “C.” Note that additional settings for 81 have been added.
   i. Scroll to the following values and press “E.” Change the value as necessary by pressing the right arrow key. When the value you want is displayed, press “E.”
      - 81 Select 81-1
      - 81S-1 Pickup 60.02 Hz
      - 81S-1 T. Delay 0.10 seconds
      - 81V Block 40 volts
   j. After changing the values for 81, press “C” again.
   k. Use the right arrow key to select “Yes” and press “E” to save the new settings.
2. Program an output contact by using the External Communications Program to detect the underfrequency trip conditions.
3. Verify the underfrequency condition by applying the following voltages to the relay at 60 Hertz.
   - Van = 120.0 0°
   - Vbn = 120.0 240°
   - Vcn = 120.0 120°
4. The relay should trip for an underfrequency condition and light the FREQUENCY target LED on the front panel of the DPU2000R.
5. Reset the frequency target by pressing “C” on the OCI.
6. Change the settings as follows:
   - 81 Select 81-1
   - 81S-1 Pickup 59.95 Hz
   - 81S-1 T. Delay 0.10 seconds
7. Apply the same voltages as in Step 4. The relay should not trip for an underfrequency condition.

Loss of Control Power and Self-Check Alarm Contact Test

Follow these steps to test the loss of control power and the self-check alarm contact:

1. With control power applied to the DPU2000R, check the self-check alarm contact and the STATUS LED. Normal status is indicated by a green LED.
2. Interrupt the control power to the DPU2000R. The self-check contacts should return to their normal state.
3. Reapply control power and check the DPU2000R to see that all settings were properly retained.

New Firmware Installation

Introduction

These instructions give guidance for the installation of the modification/upgrade kit part number UP-587X-xxx. Specific instructions included with any update kit would supersede the instructions given here.

Precautions

To avoid personal shock, use caution when working with energized devices. Only competent technicians familiar with good safety practices should service the relay.

Before you proceed with the update process, you must identify the construction of your unit in order to select the correct floppy disks from the update kit. Details are given in Step 2 of the procedure.

These instructions do not purport to cover all details or variations in equipment, nor to provide for every possible contingency to be met in the installation. If particular problems arise which are not covered sufficiently please contact our Technical Support Group at 800-634-6005, or 610-395-7333, or Fax 610-395-1055.

Should the downloading process be interrupted before completion, a special recovery procedure may be possible for units with surface mount construction. Refer to the procedure "Recovery from Download Failure" given below.

Modification Kit

The modification kit consists of a new External Communications Program floppy disk, a Flash Program Interface (FPI) floppy disk, and two System Application Firmware (SAF) floppy disks (a CPU firmware version for the through-hole-component circuit-board design; and, a CPU firmware version for the surface-mount-component circuit-board design). In Step 2 of the modification procedure you must select the proper SAF disk for the particular unit you are updating. The modification kit will give details on making this identification.

Modification Procedure

1. Establish communications via a computer connected to the front port using your WinECP communications program.
2. Record the serial number, catalog number, and existing versions of firmware Installed in the relay by viewing the Unit Information menu item.

   Important: if the existing CPU version is of the form V1.xx or V2.xx, then select the SAF disk labeled V1.xx or V 2.xx, for "through-hole" designs. If the CPU version is of the form V3.xx, then select the SAF disk labeled V3.xx, for "surface-mount" designs.
3. Download all settings groups, each in turn, to the pc hard drive or a floppy disk.
4. Consider reviewing and saving the information contained in the various records, as these could be lost in the updating process.
5. In order to update the flash memory of the unit, the communication port and the pc must be set to 9600, 8, N, 1. Review, and change your set-up if necessary.
6. Insert the FPI disk into your computer's floppy drive and copy to the hard drive.
7. Remove the FPI disk from the drive, Insert the SAF disk that was selected in Step 2 and copy it to the hard drive. Be sure to check file name (c:\dpuvx_xx.abs)
8. Start the FPI program.
9. At the Monitor Type ? prompt, select appropriate choice and press <**Enter**>. Press **<Enter>** again to start.

10. At the Communications Options screen, install the correct settings. Press **<Enter>.** If all communications settings are correct, the Successful Connection To.... screen appears. Press <**Enter**> to continue. The next screen to appear should be the Main Menu. (If any communications problem exists, the Communications Status screen appears. If this happens, reset the comm settings and recheck your communications cable connections. Then press <**Enter**>.)
11. From the Main Menu screen, select “Update Unit Software” and press <**Enter**>.
12. At the Warning screen, select “Continue with Unit Software Update” and press **<Enter>.**
13. At the Load New Firmware Data screen, type in the correct file name, press <**Enter**>. This will highlight the default action, [Read from Disk]. Press <**Enter**> again.
14. Downloading should begin, and take about 30 minutes to complete. During the process the Target LED’s on the front panel of the relay will blink intermittently and in sequence per the following:

Computer display	Relay LED’s	OCI if present
Monitor Has Been Entered	Phase A (L1) blinks	DPU2000R Monitor
Flash Erase	Phase B (L2) blinks	Flash Memory Erase in Progress
Flash Programming	Phase C (L3) blinks	Flash Memory Download in Progress

15. When complete, the message “Successfully Completed Downloading! Hit Any Key To Return To Main Menu” will appear.
16. Press <**Enter**>. This will cause the systems to reboot and the message “Please Wait While System Reboots”. Then the Main Menu will reappear. Select Quit Program and press <**Enter**>.
17. Load the External Communications Program and establish communications with the relay.
18. Restore all original settings and counters, and verify before placing the relay back in service.

Recovery from Download Failure in Surface Mount Units

Should the downloading process fail you will see an error message. The following procedure can be implemented to retry the downloading:

A. Press the System Reset relay on the front panel of the relay.

B. If the “Fail” and “C” LED’s are on and the “B” LED is flashing, go to step C. If the “A” LED is on, then remove control power from the relay for at least 10 seconds. Then reapply control power. If the “Fail” and “C” LED’s are now on, and the “B” LED is flashing, then go to step C.

C. Continue using the FPI program through the front port of the relay. Go back to the beginning of the program and try to establish communication. You will get “comm error - default settings will be shown”. Hit Enter.

D. The “comm status” screen is displayed.

Do Not select “Re-try to Connect”

Do Not select “Exit - return to DOS”

Hit the ESC key.

E. Select “Update Unit Software”. Do Not select “Recover from Failed Download”. Then select “Continue with Unit Software Update” on the “Warning Message Screen”.

F. If steps A-E are successful you will now be at step 13.

Ordering Information— How to Select a Catalog Number

Communications— Hardware Port Connections and Setup Communications Protocols

Panel Mounting Kits and Dimensions

Spare Parts

Parts and Assemblies

The following table lists the parts and assemblies involved in the DPU2000R

Table 12-1. DPU2000R Parts and Assemblies Table

Part and Assembly Description	Part Number
125-Vdc Power Supply Assembly	613806-K2
48-Vdc Power Supply Assembly	613806-K3
24-Vdc Power Supply Assembly	613806-K1
RS-232 Port Front or Rear Comm 1	613800-T2
RS-232 Card (non isolated Comm 2)	613811-T1
RS-232 Card (isolated Comm 3)	613630-T10
Aux Comm & RS-232 Card (isolated comm 3)	613624-T8
INCOM (isolated)	613624-T6
Aux Comm & INCOM (isolated)	613624-T7
RS-485 (isolated)	613630-T6
Modbus Plus & RS-232 (non isolated comm 2)	613628-T3
Modbus Plus & RS-485 (isolated)	613628-T4
Horizontal Panel Mount Kit	604513-K1
Vertical Panel Mount Kit	604513-K2
Bezel/gasket assembly only	604513-K3
Horizontal lens cover only	613724-K1
Vertical lens cover only	613724-K2

Replacing Power Supplies

To replace an existing power supply with a power supply of the same voltage, simply remove the DPU2000R relay from its case. The power supply board is located on the underside of the relay. Remove the four (4) mounting screws and the two (2) white plastic connectors. Reinstall with new board.

If the user is replacing the power supply with a power supply with a different voltage, follow the above procedure and note the following:

1. When going from a 125 VDC supply to a 48 VDC supply, Jumper J3 on the CPU board should be installed. This jumper should be ordered separately. The part number is 610428-001. On relays with serial numbers ending with an “S”, the existing jumper J3 needs to be moved to the LOW position. This serial number must be read from the back of the relay case.
2. When going from a 48 VDC supply to a 125 VDC supply, Jumper J3 should be removed. On relays with serial numbers ending with an “S”, the existing jumper J3 needs to be moved to the high position. This serial number must be read from the back of the case.
3. When converting from a 24 VDC supply to a 48 or 125 VDC supply or vice versa, the unit MUST be sent back to the factory.

Jumper J3 is located on the CPU Board near the two (2) rear RS-232 ports.

Please note that the unit catalog number will not be modified when changing the power supplies. Therefore, when changing power supply voltages, the sixth digit in the catalog number will be wrong. If the user wants this remedied, please contact the factory.

Panel Mounting Kit

The complete kit will include a bezel, its associated hardware and gasket, as well as a lens cover with its associated hardware. This kit will provide a means for panel mounting and dustproofing.

Ordering Information:

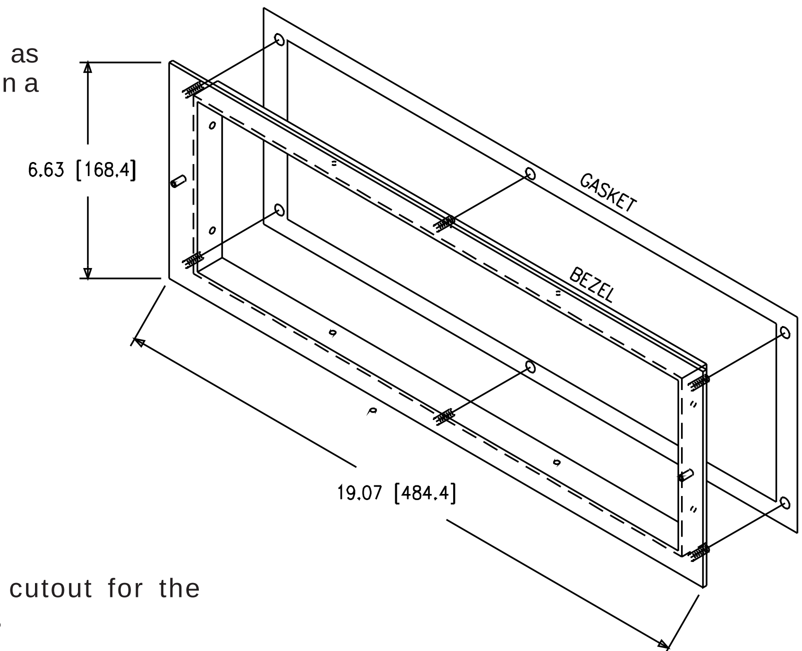
Horizontal Panel Mounting Kit	604513-K1
Vertical Panel Mounting Kit	604513-K2

Spare Parts List:

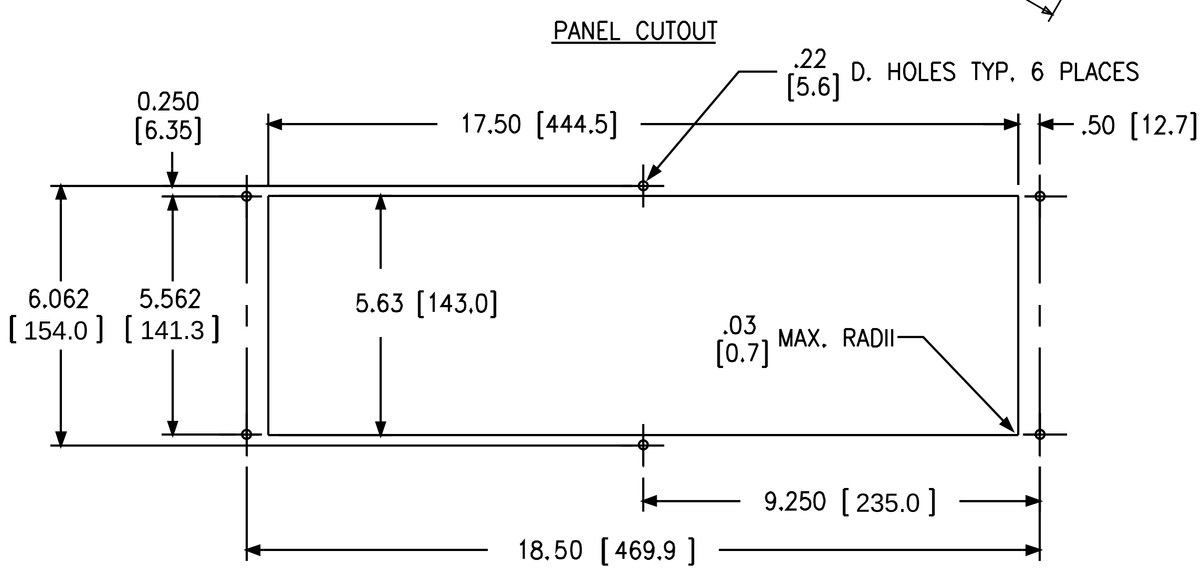
Bezel/gasket assembly only	604513-K3
Horizontal lens cover assembly	613724-K1
Vertical lens cover assembly	613724-K2

Horizontal Mounting

Note: The Bezel Assembly is available as an option for mounting the 2000R units in a panel application.

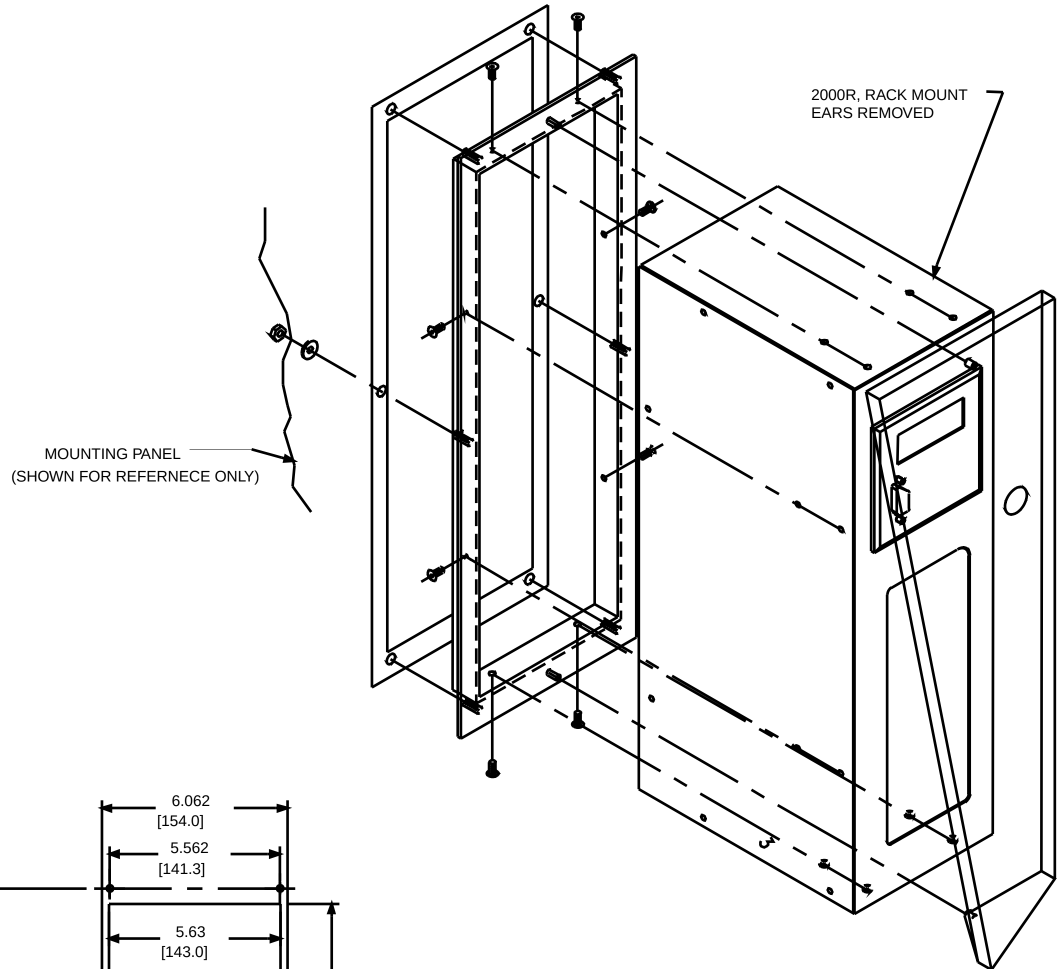


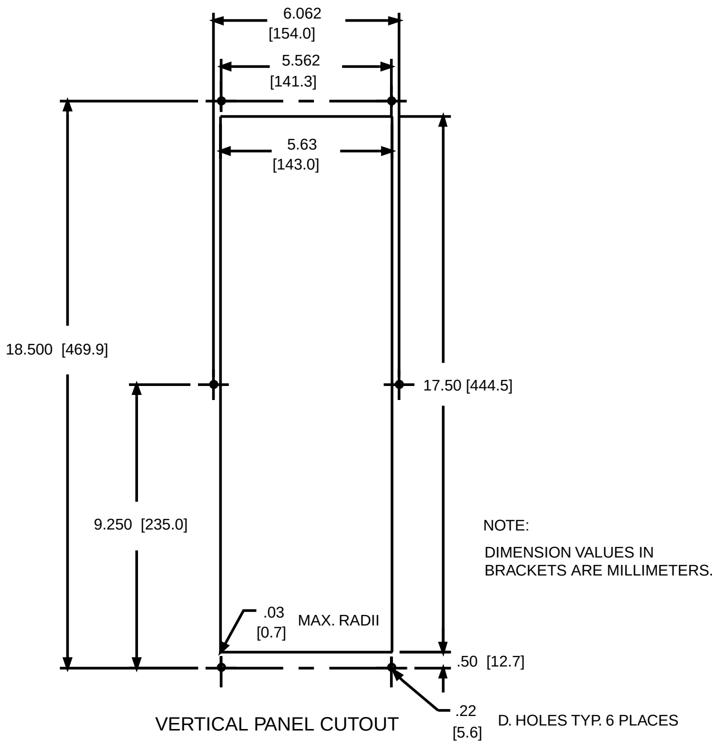
Note: Below is the panel drilling cutout for the DPU2000R unit and the bezel assembly.



NOTE: DIMENSIONS ARE INCHES [MILLIMETERS]

Vertical Mounting





VERTICAL PANEL CUTOUT

Communications Ports

The DPU2000R has a standard 9-pin RS-232C interface on the front for serial port communications. Connect a 9-pin RS-232C cable and 9-pin null modem adaptor from this port to your personal computer to have direct point-to-point communications using WinECP software provided with the relay. Refer to the Windows External Communications in Section 5 of this manual for the proper communications parameters.

If the DPU2000R relay has been provided with the newer enhanced Operator Control Interface (OCI) panel, as discussed in Section 14, it is not necesary to use a null modem adapter; rather a conventional 9 pin cable will function. A null modem cable cannot be used for the port located on the front of the OCI panel. For the ports located on the rear of the realy, a null modem calbe or adapter is required for communication to the relay.

As an option, one or two serial port terminations can be provided at the rear of the DPU2000R. This rear port, can be a 9-pin RS-232C, 3-wire RS-485, 2-wire INCOM, IRIG-B or SCADA Interface Unit (SIU) connection. You must refer to the catalog number of the unit shown in the Unit Information menu item to know which rear port option is implemented. The front or rear RS-232C ports can interface with a modem using a straight through cable and a remotely connected computer. The RS-232C ports can also interface directly to a PC with the use of a null modem cable. The RS-232C ports are configured as data terminal equipment.

The DPU2000R supports various byte-oriented protocols. The command message structure and substructures for these protocols are available upon request. Contact the nearest ABB sales office or ABB at its Allentown, PA factory and request the “Protocol Document” for the unit type (DPU2000R and the specific protocol of interest). The following protocols are available in the DPU2000R relay:

- STANDARD—ABB 2000 series-specific ASCII oriented 10 byte communication protocol available through all ports
- INCOM®—a two-wire communications system and protocol
- DNP 3.0 (IEC870-5)—a protocol available through the Auxiliary Communications port
- Modbus®—a protocol available through the Auxiliary Communications port
- Modbus Plus™—a token ring network capable of high speed communication (1 Mb/sec)
- UCA—Utility Communications Architecture is an open communications protocol. This allows the DPU2000R relay to be integrated into system solutions.

Pin Connections

The pin connections for the various communications ports are shown in Tables 12-2 and 12-3.

Table 12-2. RS-232 Pin Connections

Pin Number	Signal
2	Receive data–Relay receives data through this pin.
3	Transmit data–Relay transmit data through this pin.
5	Signal ground–Front port has signal ground tied to the chassis; rear port signal ground is fully isolated.

Table 12-3. RS-485, INCOM, SIU and IRIG-B Pin Connections

Pin Number	Pin Number
64	IRIG-B Minus
63	IRIG-B Positive
62	INCOM
61	INCOM
60	+5 VDC at 100 milliamperes
59	Direction minus
58	Direction positive
57	RS-485 common/VDC return
56	RS-485 minus or SIU minus (aux. comm. port)
55	RS-485 positive or SIU positive (aux. comm. port)

RS-485 Port

For all communications hardware options with a single RS-485 port, that port is provided at terminals 55(+), 56 (-), and 57 (com). See Table 12-3.

For communications hardware option #8, dual RS485 ports, terminals 55, 56, and 57 are designated RS485 Rear Port #2, and pins 1(+), 2 (-), and 7(com) of the COM3 DB-9 connector represent RS485 Rear Port #1.

The RS485 port on the DPU2000R has three associated resistors and jumper links that allow insertion or removal of these resistors, depending on the location of the relay in the network. Jumper link J6 on the communications card is for the termination resistor. A termination resistor should be inserted at the first and last devices on the network. Typically J6 would be set for “IN” for the last relay on the RS485 network; and, J6 would be set in the “OUT” position for all other relays in the loop. The first unit on the network, typically an ABB 245X series convertor, has the terminating resistor built-in. For communication hardware option “8,” dual RS485 ports, J6 is for Port #2 and a similar jumper, J16 is provided for RS485 Port #1.

Jumper links J7 and J8 insert or remove “pull-up” resistors. These resistors establish a known voltage level on the RS485 bus when no units are transmitting, in order to reduce noise. These jumpers should be set to the “IN” position on only one relay at either end of the RS485 loop. If an ABB communications convertor, catalog series 245X, is used on the network, it has these resistors built-in, and all relays can have J7 and J8 in the out position. For communications hardware option “8”, dual RS485 ports, J7 and J8 are for Port #2, and J17 and J18 are for Port #1.

The RS485 cable should be shielded 3 conductor twisted cable. The shield should be grounded at one end of the communications circuit, preferably where the RS485 circuit begins; eg: at the convertor unit. A typical RS485 connection diagram, drawing 604765, is available on request from the factory.

Recommended cables are Alpha #58902, Belden #9729, #9842, #9829 and Carol #58902.

Communications Settings

Change communications settings via the operator-control interface (OCI) on the front of the DPU2000R or through the WinECP. When you use the OCI, the communications ports are blocked from downloading settings but can still retrieve data. Similarly, when a communications port is downloading new settings, the OCI and other communications ports are blocked from changing or downloading settings but not from retrieving data.

Use the OCI to change all communications settings, such as baud rate, data bits, parity and stop bits. You can change settings locally or remotely. If you use a computer or modem to change the settings, be certain that the communications settings on your equipment match those of the DPU2000R.

Set the communications settings (baud rate, [parity, data bits, stop bits]) for the front and rear ports as follows:

- Front port: 300, 1200, 2400, 4800 or 9600 [n, 8, 1 or n, 8, 2]
- Rear port: 300, 1200, 2400, 4800, 9600 or 19,200 [n, 8, 1 or n, 8, 2 or e, 8, 1 or odd, 8, 1 or e, 7, 1 or n, 7, 2 or odd, 7, 1].

Communication Port Configurations

The 2000R platform provides several variations of communication ports, such as a 9-pin RS-232, RS-485, INCOM™ and Modbus Plus™. Also available is a list of factory supported common communication protocols for networking the unit.

RS-232 ports are available in two different configurations, Isolated and Non-Isolated. Isolated ports provide isolation between the communication port and the rest of the relay.

COM 1 port is configured as a non-isolated port only. Units having an OCI display use the RS-232 port on the front panel as COM 1, thereby permanently disabling the RS-232 port marked COM 1 on the rear of the unit. Units not having an OCI Display permit the user to select, via P4 jumper setting (F=Front, R=Rear), either the front or rear (labeled COM 1) RS-232 connectors to act as COM 1.

COM 2 port is a non-isolated configuration and COM 3 port is an isolated configuration. Refer to the following list of options to select the most suitable configuration.

The 2000R series also features ABB's innovative RS-485 isolated communications capability available when the optional Auxiliary Communication board is installed.   This isolated RS-485 configuration provides superior communication quality recommended for applications in areas of high electrical noise or that require connecting cables longer than 10 feet (3m).

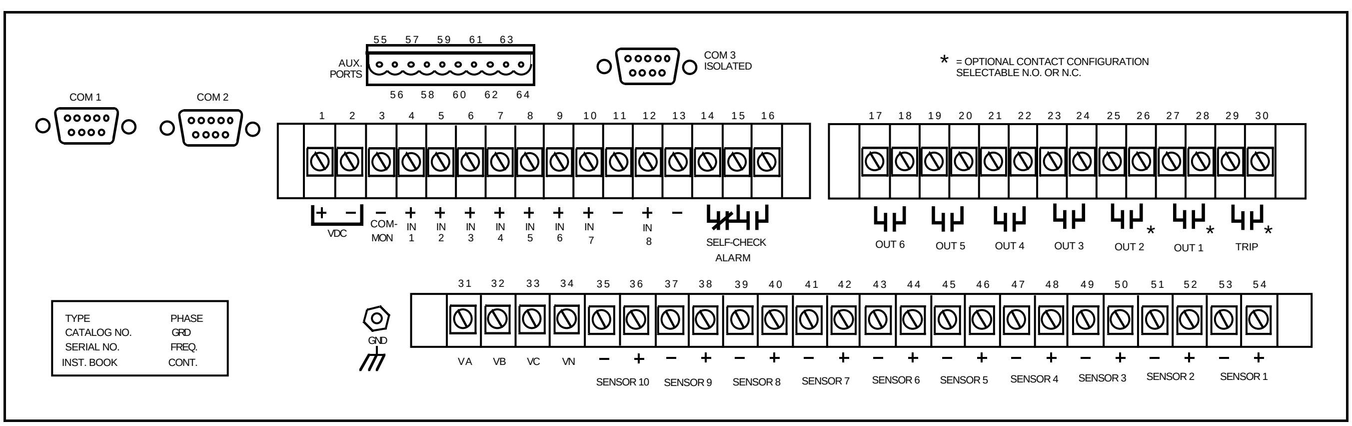


Figure 12-1: Rear Terminal Blocks and Communication Ports

NOTE: Non-isolated RS-232 ports are susceptible to electrical noise. For that reason it is recommended that connecting cables be no longer than 10 feet (3m) when connecting to a non-isolated port. Devices connected to non-isolated ports must have the same ground return as the 2000R unit.

Refer to the Select Communication Options Table when making option selections.

In addition to the standard front or rear non-isolated RS-232 port (COM 1), the following rear communication port options are available:

Option 0

This option provides RS-232 communication via the non-isolated COM 2 port and is suitable only in applications where communication to the unit is local through a direct connection to a PC or remote through an external isolating communication device , such as an RS-232 to fiber optic converter, which is connected to the relay using a short cable.

Options 1 through 8 are provided on an independent communication card installed in the unit.

Option 1

This option provides RS-232 communication via the isolated COM 3 port for transient immunity and isolation and must be used where communication cable lengths are greater than 10 feet (3m) or a common ground is not guaranteed. In general, RS-232 communication is limited to a maximum distance of 50 feet (15m). Aux Com and COM 2 ports are disabled in this configuration.

Option 2

This option provides RS-232 communication via isolated COM 3 port and RS-485 communication via the isolated Aux Com port. The auxiliary port is an isolated RS-485 configuration that supports several communication protocols (*See Communication Protocol Category On Ordering Sheet*). COM 2 ports are disabled in this configuration.

Option 3

This option provides INCOM™ availability, via the INCOM port, in applications where either the Cutler-Hammer INCOM™, or ABB WRELCOM™, network is used. COM 2 and COM 3 ports are disabled in this configuration.

Option 4

This option provides RS-485 communication, via the isolated Aux Com port and INCOM™ availability via the INCOM™ port. In this configuration, the INCOM™ port provides the same functionality as option 3. COM 2 ports are disabled in this configuration.

Option 5

This option provides RS-485 communication via the isolated Aux Com port, and is highly recommended for applications requiring communication over distances of up to 300 feet (100m). This option has an advantage over RS-232 by allowing networking of multiple relays via a simple 3 wire connection. COM 2 and COM 3 ports are disabled in this configuration.

An RS-485 to RS-232 converter can be used to connect the network to an external device such as a modem or a personal computer. Such converters are readily available in the marketplace for computer networking supplies.

Option 6

This option provides a Modbus Plus™ high-speed interface, via the COM 3 port, and RS-232 communication via the non-isolated COM 2 port. The Aux Com port is disabled in this configuration.

Option 7

This option provides a Modbus Plus™ high-speed interface via the COM 3 port, and RS-485 communication via the isolated Aux Com port. The COM 2 port is disabled in this configuration.

Option 8

This option provides dual RS-485 communication via the isolated COM 3 port (DB-9), and Aux Com ports. The COM 2 port is disabled in this configuration.

Option E

This option provides Ethernet with a 10/100 meg twisted pair (RJ45) and 10 meg fiber optic (ST connector).

The pinout for the DB9 port for option 8 is as follows:

Pin	Signal
1	RS485 (+)
2	RS485 (–)
3	Direction (+) RTSA
4	Direction (–) RTSB
7	RS485 COMMON
8	+5VDC at 100ma

Communication Protocols

The Select Options Table shows the communication protocols and the respective hardware port assignments that are currently available.

The "Standard" Protocol

The "Standard" protocol referenced throughout this publication refers to an ABB 2000 series-specific 10 byte ASCII oriented communication protocol. This protocol is standard for COM 1 and is selectable for other rear ports as per the Select Options Table. The 2000 series Windows External Communication Program (WinECP) is provided at no charge with the relay. The protocol document is available on request.

Product specific protocol documents are available from the factory upon request.

DNP 3.0 Protocol

Modbus Protocol

RTU Emulation

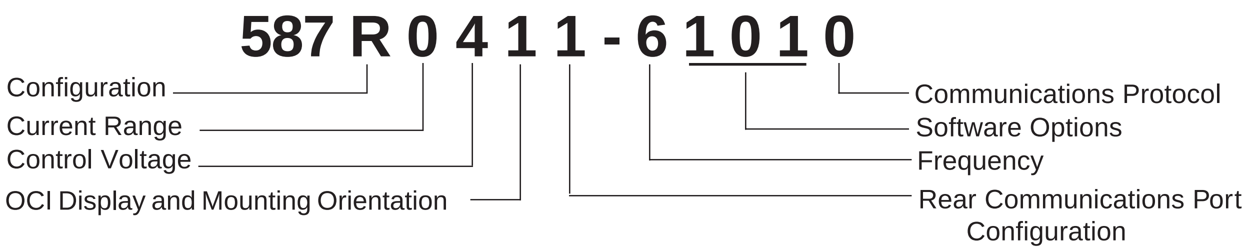
Also available are external RTU Emulation devices that provide a pre-engineered interface between the DPU2000R and a SCADA host. Contact the factory for additional information on the ORION unit.

Modbus Plus™ is a trademark of Modicon, Inc.
Modbus® is a registered trademark of Modicon, Inc.
INCOM™ is a registered trademark of Cutler Hammer Corporation.

Ordering Instructions

The 2000R series of relays have a structured catalog number ordering system. The unit's catalog number is built up from 13 customer-selectable characters. Each character identifies features or functions that can be incorporated into the relay.

Sample Catalog Number



How To Order

Using the Ordering Selection sheet, select those special features or options that are required to adapt the 2000R to your specific application. Create the catalog number, as shown above, by selecting the associated number or letter that refers to the desired feature or option from each category.

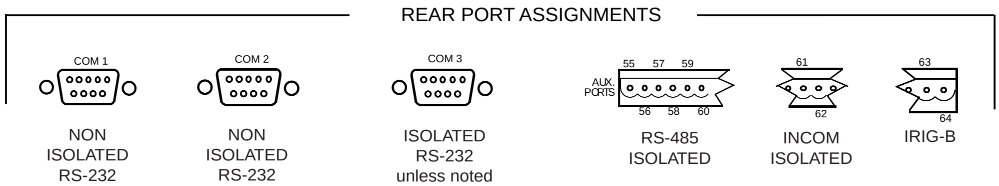
Important: Some of the combinations that can be created from the numbering charts can not be manufactured. Consult factory for feasibility when in doubt.

The table below illustrates all possible hardware configurations for the communication ports and the supported protocols. The Catalog Number Select Option columns list every communication option for which the relays can be configured.

The different protocol variations are outlined under the corresponding communication ports that support them. Select the row containing the protocol combination that best suits your communications requirements and use the corresponding catalog number options to fill in the brackets [ ] of the catalog number.

The auxiliary port labelled IRIG-B receives a demodulated IRIG-B signal for 2000R clock synchronization purposes.

For example, if your system requires DNP 3.0 (IEC870-5) protocol, the ordering catalog number would be 587R041[**2**]-6101[**1**] (4th row), 587R041[**4**]-6101[**1**](10th row) or 587R041[**8**]-6101[**1**](18th row) based on your choice for the second port provided.



Catalog Number Select Option

587 or 687 R041[ ] - 6101[ ]

R041[ ]	6101[ ]	With Display	Without Display* (COM 1, Non isolated RS-232)	COM 2 (Non isolated RS-232)	COM 3 (Isolated RS-232 unless noted)	RS-485 Isolated	INCOM Isolated	IRIG-B
1	0		ABB Ten Byte		ABB Ten Byte			
2	0		ABB Ten Byte		ABB Ten Byte	ABB Ten Byte		IRIG-B
2	1		ABB Ten Byte		ABB Ten Byte DNP 3.0	DNP 3.0 ABB Ten Byte		
2	4		ABB Ten Byte		Modbus® ABB Ten Byte	ABB Ten Byte Modbus®		IRIG-B
3	0		ABB Ten Byte				INCOM	IRIG-B
4	0		ABB Ten Byte			ABB Ten Byte	INCOM	IRIG-B
4	1		ABB Ten Byte			DNP 3.0	INCOM	IRIG-B
4	4		ABB Ten Byte			Modbus®	INCOM	IRIG-B
5	0		ABB Ten Byte			ABB Ten Byte		
6	4		ABB Ten Byte	ABB Ten Byte	Modbus Plus™			
7	4		ABB Ten Byte		Modbus Plus™	ABB Ten Byte		
8	0		ABB Ten Byte		ABB Ten Byte (RS-485)	ABB Ten Byte		IRIG-B
8	1		ABB Ten Byte		ABB Ten Byte (RS 485) DNP 3.0 (RS 485)	DNP 3.0 (RS 485) ABB Ten Byte (RS 485)		
8	4		ABB Ten Byte		Modbus® # ABB Ten Byte (RS-485)	ABB Ten Byte Modbus® #		IRIG-B
E	4					Network Modbus # Ethernet Copper or Ethernet Fiber Optic		
E	6					Network Modbus Ethernet Copper or Ethernet Fiber Optic		
E	7					Network Modbus Ethernet Copper or Ethernet Fiber Optic		

Select Communication Options Table

[ ] An empty selection box indicates communication port is either not provided or is disabled.

Consult factory for availability

DPU2000R Catalog Selection Sheet

		Cat # 587 (ANSI)	R	0	4	1	1	-	6	1	0	1	0
		687 (IEC)	R	0	4	1	1		6	1	0	1	0
Configuration	Standard	R	R	.	.	.	.		.	.	.	.	.
	Standard with Earth Fault Protection	E	.	.	.	.	.		.	.	.	.	.
	Standard with Synchronism Check	C	.	.	.	.	.		.	.	.	.	.
			.	.	.	.	.		.	.	.	.	.
			.	.	.	.	.		.	.	.	.	.
Current Range	**Phase** **Ground**												
	Standard or Non-Directional Sensitive Earth Fault												
	0.4-12A 0.4 -12A	0		0	.	.	.		.	.	.	.	.
	0.4-12A 0.08-2.40A	1		.	.	.	.		.	.	.	.	.
	0.08-2.4A 0.08-2.40A	2		.	.	.	.		.	.	.	.	.
	Directional Sensitive Earth Fault												
	0.4-12A 04-12A	4		.	.	.	.		.	.	.	.	.
	0.4-12A 0.08-2.40A	5		.	.	.	.		.	.	.	.	.
	0.08-2.40A 0.08-2.40A	6		.	.	.	.		.	.	.	.	.
Control Voltage	38-58 VDC	3			.	.	.		.	.	.	.	.
	70-280 VDC	4			4	.	.		.	.	.	.	.
	19-29 VDC	9			.	.	.		.	.	.	.	.
Operator Control Interface (OCI)	Standard OCI, horizontal mounting	1				1	.		.	.	.	.	.
	Enhanced OCI, horizontal mounting	2				.	.		.	.	.	.	.
	Enhanced OCI, with dedicated "Hot-Line-Tag" Recloser Control for horizontal mounting	3				.	.		.	.	.	.	.
	Standard OCI, vertical mounting	6				.	.		.	.	.	.	.
	Enhanced OCI, vertical mounting	7				.	.		.	.	.	.	.
	Enhanced OCI, with dedicated "Hot-Line-Tag" Recloser Control for Vertical mounting	8				.	.		.	.	.	.	.
Rear Communications Port	(Front RS-232 port is standard on all units)												
	RS-232 (isolated) only	1					1		.	.	.	.	.
	RS485 Port (isolated) & RS-232 Port (isolated)	2					.		.	.	.	.	.
	INCOM (isolated)	3					.		.	.	.	.	.
	RS-485 Port (isolated) & INCOM (isolated)	4					.		.	.	.	.	.
	RS-485 (isolated) only	5					.		.	.	.	.	.
	Modbus Plus & RS-232 (non-isolated)	6					.		.	.	.	.	.
	Modbus Plus & RS-485 (isolated)	7					.		.	.	.	.	.
	Two RS-485 Ports (isolated)	8					.		.	.	.	.	.
	Ethernet 10/100 meg twisted pair (RJ45) and 10 meg Fiber Optic (ST connector)	E					.		.	.	.	.	.
Frequency	50 Hertz	5							.	.	.	.	.
	60 Hertz	6							6	.	.	.	.
Software	No Digital Fault Recorder (DFR)	0								.	.	.	.
	Digital Fault Recorder (DFR)	1								1	.	.	.
	No User Programmable Curves	0									0	.	.
	User Programmable Curves	1									.	.	.
	Special Recloser Curves	2									.	.	.
	Special Recloser Curves and User Programmable Curves	3									.	.	.
												.	
	No Load Profile	0										1	
	Load Profile	1											
Communications Protocol	Standard (ABB 10-Byte Protocol – Com Port digits all but 6, 7 & E)	0											0
													.
	DNP 3.0 (Com Port digits 2 or 8)	1											.
	Modbus (Com Port digits 2 or 8)	4											.
	Modbus Plus (Com Port digits 6 or 7)	4											.
	UCA (Com Port digit "E")	6											
	Modbus/UCA (Com Port digit "E")	7											

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Application Note AN-66A

IRIG B Implementation in the DPU/TPU/GPU 2000/R and DPU1500R Units

IRIG B is a time code, which allows devices across the world to synchronize with a common time source to a resolution of one millisecond. IRIG B allows each device to synchronize with the frame received by an IRIG B receiver. ABB's DPU/TPU/GPU 2000/R and DPU1500R relays (herein referred to as an IED) offer IRIG B time synchronization capabilities.

Figure 1 illustrates a typical IRIG B installation. An IRIG B time receiver accepts the RF signal and transforms it into a one-second time synch frame. IEDs in the substation use the one-second time synch frame to govern their internal clocks and event recorders.

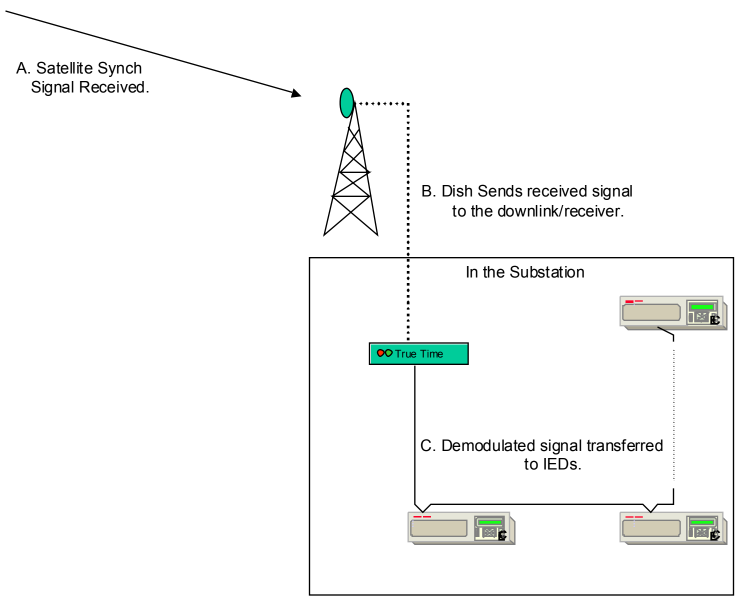


Figure 1. Typical IRIG B Architecture

IRIB B receivers/converters can format the IRIG B synchronization frames as a TTL-level pulse width, Manchester Encoded or Modulated Carrier Frequency signal. TTL-level signals are pulse DC with a voltage range of 0 to 5V. Modulated Carrier Frequency signals are pulse coded AM signals with modulation (tone bursts).

IRIG B is a general designation for time synchronization. There are many subsets to the IRIG B format. These were developed to provide functionality primarily for military applications dealing with missile and spacecraft tracking, telemetry systems, and data handling systems. IRIG B was embraced by the utility industry to answer a need to provide a sequence of events capability between a group of substations. Care must be exercised to match the device demodulating the signal from the satellite (downlink converter) with the IED's requiring specific IRIG B code formats.

DPU/TPU/GPU products support Pulse Width Code (X= 0), whereas, REL 3XX products having an IRIG B Poni Card support Pulse Width Code and Sine Wave Amplitude Modulated, and REL5XX products support Sine Wave Amplitude Modulated IRIG. If the IRIG signal supplied to the device is one in which the attached device cannot decode, the IED shall not synchronize with the signal and IED will not calculate time correctly.

The IRIG B time code has a one-second time frame. Every frame contains 30 bits of Binary Coded Decimal time information representing seconds, minutes, hours, days and a second 17 bit straight binary time-of-day. The frame has internal time markers, which insure time-stamping accuracy to the millisecond. An eight-millisecond frame reference marker appears during the first ten milliseconds of each frame. Another eight-millisecond position identifier appears during the ninetieth millisecond of each one-hundred millisecond period mark. The 30 bit Binary Coded Decimal time data occurs in the first one hundred millisecond of each 1-second frame. Optional control functions are sometimes encoded in the data stream. These functions control deletion commands and allow different data groupings within the synchronization strings. Decoding an IRIG B pulse is quite a complex undertaking. A typical 1-second time frame is illustrated in Figure 2. It is interesting to note that the year is not included within the IRIG B frame. If the Control Function frame (CF) or Straight Binary Time of Day frame (SBT) is not used, the bits defined within those fields are to be set as a string of zeroes and sent to the IED IRIG B receiver.

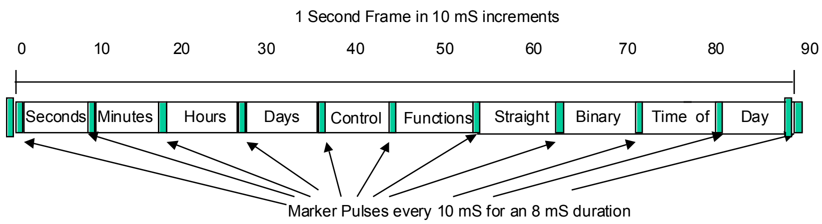


Figure 2. IRIG B Frame Construction

IRIG B is defined for code format sets identified by a three digit format number. Permissible format numbers for the IRIG B subsets are:

IRIG B XYZ Where:
The first field “X” identifies the encoding type of the IRIG B signal. DPU/TPU/GPU products support Pulse Width Code (X= 0), whereas, REL 3XX products having an IRIG B PONI Card support Pulse Width Code and Sine Wave Amplitude Modulated, and REL5XX products support Sine Wave Amplitude Modulated IRIG. Manchester Modulated code was added in IRIG Standard 200-98 Dated May 1998. It is not supported in the ABB protective relay products which are IRIG B capable.

The second field “Y” determines if a carrier is included within IRIG B Data format.

The third field “Z” determines if a combination of the BCD time/Control Function/Straight Binary Time is included within the IRIG B time frame. The inclusion or exclusion of any of the fields may cause errors in receivers not designed for the field’s inclusion/exclusion.

The following combinations may seem daunting, but only a subset of the listed formats are actually defined within the specification.

IF X =
0 = Pulse Width Code
1 = Sine Wave Amplitude Modulated
2 = Manchester Modulated Code

IF Y =
0 = No Carrier
2 =1Khz , 1mS
3 =10Khz, 0.1 mS
4 =100 Khz, 10 mS
5 =1Mhz, 1mS

IF Z=
0 =BCD Time, Control Function, Straight Binary Seconds
1 =Binary Coded Decimal Time, Control Function
2 =Binary Coded Decimal Time
3 =Binary Coded Decimal Time, Straight Binary Seconds

For the TPU/GPU/DPU 2000/2000R products, IRIG B 000 and 002 formats are supported. Consult the IRIG B generator manufacturer so that the correct IRIG B code format is supplied to the receiving devices.

Hardware Configuration

IRIG B time synchronization is available for the products listed in Table 1. Generally, three types of protective relays do not offer IRIG B, units without a communication card, units with Modbus Plus communication cards, and units with DNP 3.0 communication cards.

Table 1. IRIG B Inclusion listed by product part number

DPU 2000 48 X X X X X X 2 – X X X X TPU 2000 488 X X X X X 2 – X X X X
48 X X X X X X 3 – X X X X 488 X X X X X 3 – X X X X
48 X X X X X X 4 – X X X X 488 X X X X X 4 – X X X X

DPU 2000R 587 X X X X 2 – X X X X 0
TPU 2000R 588 X X X X 2 – X X X X 0
587 X X X X 2 – X X X X 2
588 X X X X 2 – X X X X 2
587 X X X X 2 – X X X X 3
588 X X X X 2 – X X X X 4
587 X X X X 2 – X X X X 4
588 X X X X 3 – X X X X 0
587 X X X X 3 – X X X X 0
588 X X X X 4 – X X X X 0
587 X X X X 4 – X X X X 0 588 X X X X 4 – X X X X 2
587 X X X X 4 – X X X X 2
588 X X X X 4 – X X X X 4
587 X X X X 4 – X X X X 4
588 X X X X 8 – X X X X 0
587 X X X X 8 – X X X X 0
588 X X X X 8 – X X X X 2
587 X X X X 8 – X X X X 2
588 X X X X 8 – X X X X 4
587 X X X X 8 – X X X X 4

GPU 2000R 589 X X X X 2 – X X X X 0
589 X X X X 2 – X X X X 4
589 X X X X 3 – X X X X 0
589 X X X X 4 – X X X X 0
589 X X X X 8 – X X X X 0
589 X X X X 8 – X X X X 4

X = Don’t Care

Each of these units uses the AUX COM port located at the rear of the relay to accept the TTL IRIG B signal. The DPU/TPU/GPU 2000R and DPU1500R use Pins 63 and 64 to accept the IRIG B negative polarity and IRIG B positive polarity signals respectively, as illustrated in Figure 3. The DPU/TPU 2000 use pins 65 and 66 as illustrated in Figure 4.

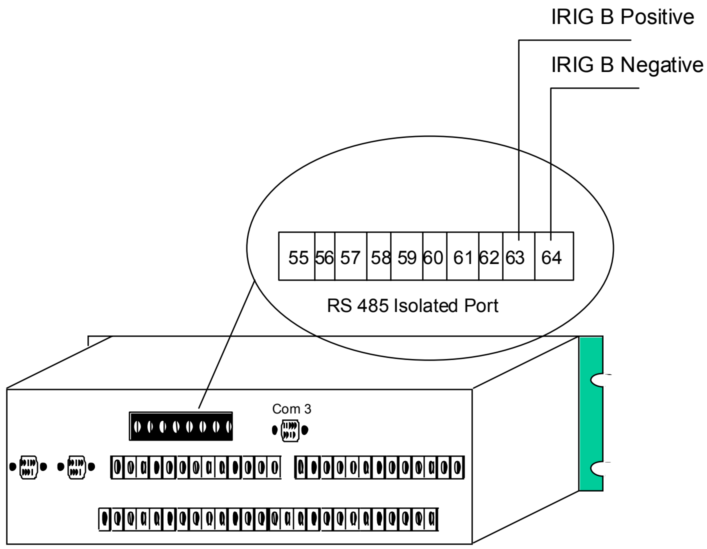


Figure 3. DPU/TPU/GPU 2000R and DPU1500R IRIG B Connector Placement

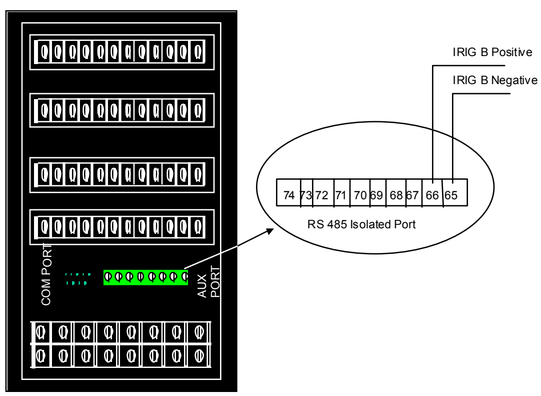


Figure 4. DPU/TPU 2000 IRIG B Connector Placement

ABB's implementation of IRIB B requires that the signal be daisy-chained to each device. Each device in the IRIG B network presents a load to the IRIG B receiver/converter. Daisy-chained inputs are simple parallel circuits. A sample calculation is shown for the example illustrated in Figure 5.

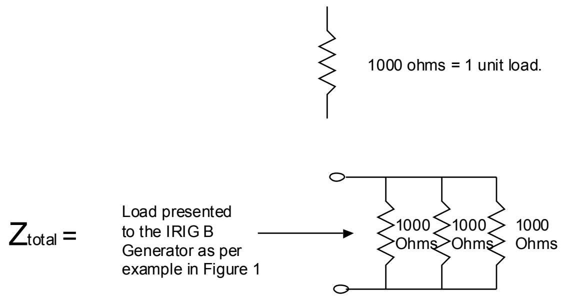
If the input impedance of each DPU/TPU/GPU 2000/R and DPU1500R is measured at its IRIG B connection, the impedance would be 1000 ohms. Each IRIG B input requires less than one mA to drive it.

Calculating the load impedance presented to the IRIG B source generator is illustrated in Figure 5. Each IED load on the IRIG B link presents a parallel impedance to the source. The general equation for parallel impedance is:

$$\frac{1}{Z_{Total}} = \frac{1}{Z_1} + \frac{1}{Z_2} + \frac{1}{Z_3} + \ldots$$

$$I_{Total} = I_1 + I_2 + I_3 + \ldots$$

This impedance equation simplifies to the form in Figure 5 when all IED loads are identical. If the loads are not identical, the general equation listed above must be used to calculate the load.



$Z_{total} = 1/(N*(1/1000))$ where N = number of DPU/GPU/TPU 2000/R Units.

$Z_{total} = 1/(3*(1/1000))$

$Z_{total} = 333.33$ ohms.

Thus the Source must be capable of driving a 333.33 ohm load.

Figure 5. Load Impedance Calculation

The calculated load impedance for the architecture presented in Figure 5 is 333.33 ohms. In this example the IRIG B receiver/converter must be capable of sending a three milli-amp TTL-level signal to a 333.33 ohm load. If the source is not matched with the load impedance, IRIG B will not operate correctly.

The cable recommended to connect the IRIG B devices shall have the following characteristics:

Capacitance: less than 40 pF per foot line to shield
Construction: 2-wire twisted pair shielded with PVC jacket

The maximum lead length of the entire relay is to be no more than 1000 feet. Cable types and vendors recommended and supported by ABB to interconnect the IRIG B devices are:

BELDEN 9841, BELDEN YM29560, or equivalent

An example of the terminal to terminal daisy-chain interconnection of three units is illustrated in Figure 6.

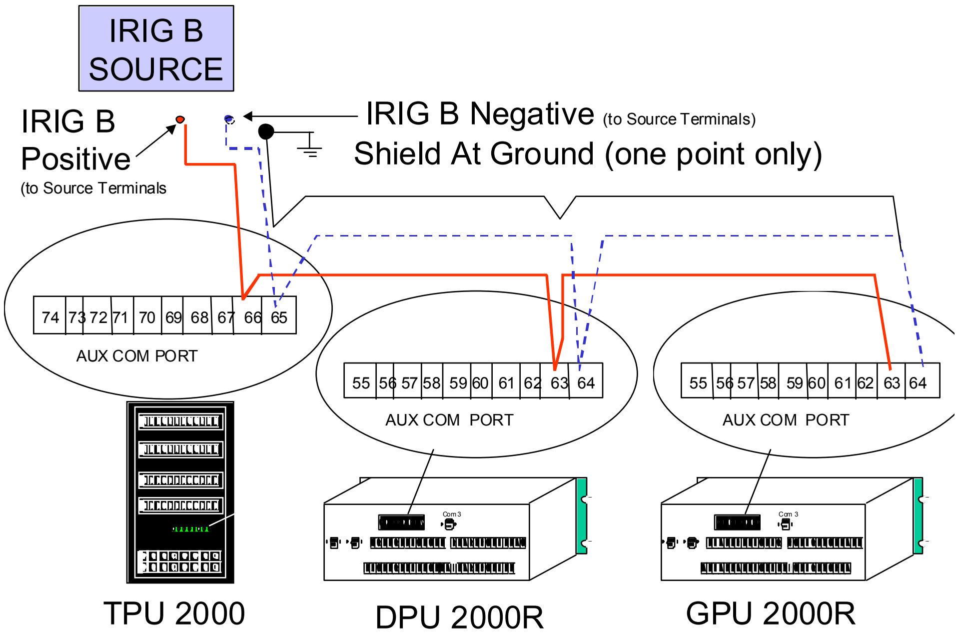


Figure 6. Pin to Pin illustration of ABB Protective Daisy-chain link for IRIG B

Software Configuration

Physical interconnection of the devices is only one part of the procedure to allow IRIG B time stamp. The ABB protective relays must be configured to allow for IRIG B to be enabled. The procedure follows:

1. Start ECP from the DOS operating system for the appropriate device being configured.
2. Highlight the Change Settings Menu.
3. Highlight and Select the Communications Menu.
4. Scroll down to the field “ IRIG B”.
5. Depress the enter key and select the “ENABLE” selection. Two selections are displayed, ENABLE-mmm or ENABLE-cc. ENABLE-mmm will timestamp events and display the millisecond time as a number from 1 to 999. ENABLE-cc will timestamp events and display the millisecond time as a decimal fraction of a second from 1 to 99.
6. Return from the menu item.
7. Download the changed selections to the attached unit.

The unit is now synchronized to the IRIG B time source. All events shall be time stamped to the common IRIG B time source. The protective relays may also be configured for IRIG B time stamping from the front panel MMI of units which are equipped with a front panel interface.

Application Note AN-22

Bus Breaker Backup to Feeder Breaker

The Distribution Protection Unit 1500R/2000R (DPU1500R/2000R) has Multiple Device Trip (MDT) mode capability. When you enable its MDT mode, a DPU1500R/2000R on a bus breaker can be programmed to provide primary protection for the bus and backup protection to feeder breakers. If the relay protecting the feeder fails, the bus breaker DPU1500R/2000R provides isolated backup tripping to the faulted feeder breaker without tripping the bus breaker. Continuity of service will be maintained on all of the unfaulted feeders.

Component Requirements

The DPU1500R/2000R includes the logic and timing elements and the programming flexibility to allow such backup protection with few additional devices:

- DPU1500R/2000R for bus breaker (DPU/B)
- DPU1500R/2000R for each feeder breaker (DPU/Fn*)
- 1 Pickup Auxiliary relay (PA)
- 1 Auxiliary Tripping relay on the bus (Aux/B)
- Auxiliary Self-Check Failure relay (74/Fn*) for each feeder breaker

n* = Number of feeder

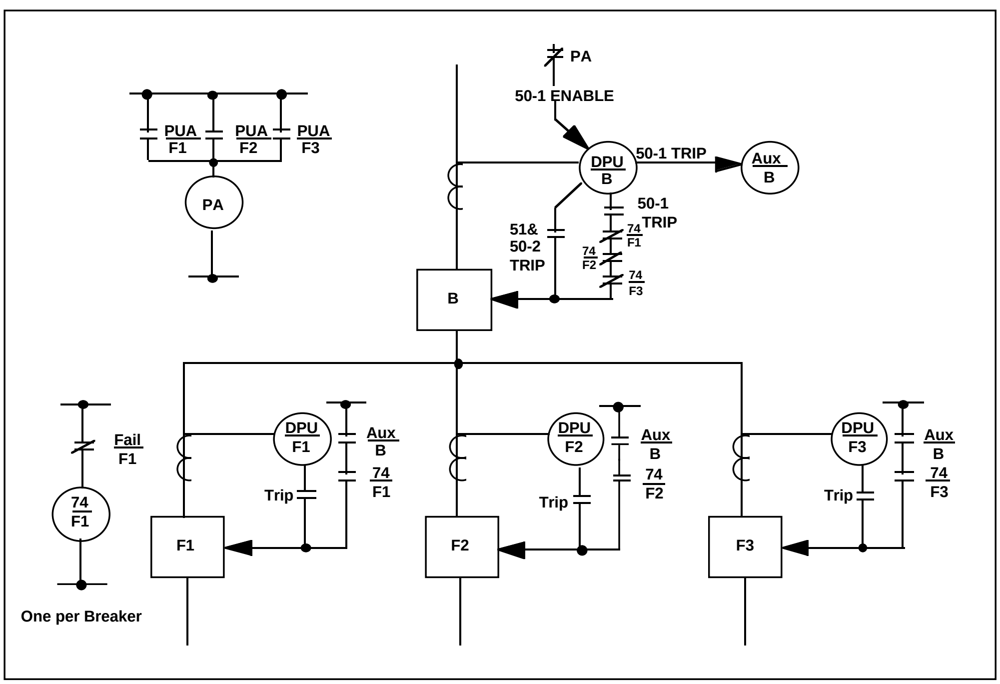


Figure 7. Multiple Device Trip Mode Schematic

Pickup Auxiliary (PA) Relay

During a feeder fault condition, the Pickup Auxiliary high-speed relay disables the 50P-1 and 50N-1 functions of the bus DPU1500R/2000R. This prevents the bus DPU1500R/2000R from tripping the bus breaker before the feeder relay has a chance to clear the fault.

When a feeder DPU1500R/2000R relay goes into pickup, its programmed pickup alarm (PUA) output contact closes. This opens the PA relay output contact, disabling the 50P-1 and 50N-1 functions of the bus DPU1500R/2000R.

The 50P-1 and 50N-1 functions of the bus relay are enabled when there is no pickup condition on any feeder relay or when the relay on the faulted feeder is in a failed state.

Using the Windows External Communications Program (WinECP), map the logical output condition PUA to your desired output contact for each feeder DPU1500R/2000R. Wire all these mapped output contacts to the PA relay (see Figure 8).

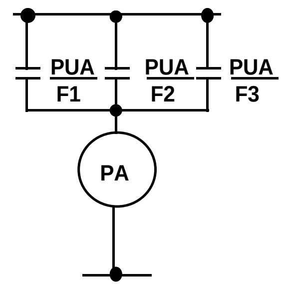


Figure 8. PA Relay

Auxiliary Tripping Relay (Aux/B)

The Aux/B relay allows for DC isolation among the feeder and bus breakers and provides the tripping output necessary to trip the feeder breakers when the feeder relay is in a failed state. If the Aux/B relay fails to trip the feeder breaker, the 51 function of the bus DPU1500R/2000R trips the bus breaker.

Auxiliary Self-Check Failure Relay (74/Fn)

For each feeder DPU1500R/2000R, wire the normally open self-check alarm contact to a 74/Fn auxiliary relay coil. In an energized and normal operating state, the alarming contact is closed. This energizes the 74/Fn relay, opening its normally closed contacts and blocking the DPU1500R/2000R on the bus breaker from tripping the feeder breaker. If the feeder relay fails, the alarm contact opens, the 74/Fn relay becomes de-energized, and the 74/Fn output contact closes, which allows the bus DPU1500R/2000R to trip the feeder breaker.

Setting the MDT Mode on the DPU1500R/2000R

Use the following Windows External Communications Program (WinECP) screens to program the DPU1500R/2000Rs for MDT mode:

- Configuration Settings
- Primary Settings
- Programmable I/O Screen

Programming the Bus DPU1500R/2000R

The bus DPU1500R/2000R provides high-speed tripping for bus faults, and local backup protection for feeder faults not cleared by their primary protective relays. The bus fault protection is accomplished with the 50-1 phase and ground instantaneous elements. A 50 ms time delay is added to coordinate with the blocking signal from the feeder DPUs. This blocking signal is from the pickup alarms (PUA) of each down stream feeder. Each PUA is isolated by an auxiliary relay, PA.

Local backup for feeder faults is accomplished with the 50-2 phase and ground instantaneous elements. A 0.3 second time delay is recommended to coordinate with the down stream feeder instantaneous elements. The 50-2 element should not be used for backup protection with feeder schemes (such as fuse saving schemes) that disable instantaneous elements in a multi-shot recloser sequence.

Follow these steps to program MDT mode on the DPU1500R/2000R on the bus breaker:

1. Enable Multiple Device Trip mode (MDT Mode) in the Configuration Settings.

2. Set the 50P-1 and 50N-1 functions in the Primary Settings table as follows (see Figure 9):

   a. Set the curve to “Definite Time.”

   b. Select the desired pickup.

   c. Set the Time Delay to 0.05 sec.

   d. Disable the 79 reclosing function by setting the 79-1 open time to “Lockout”.

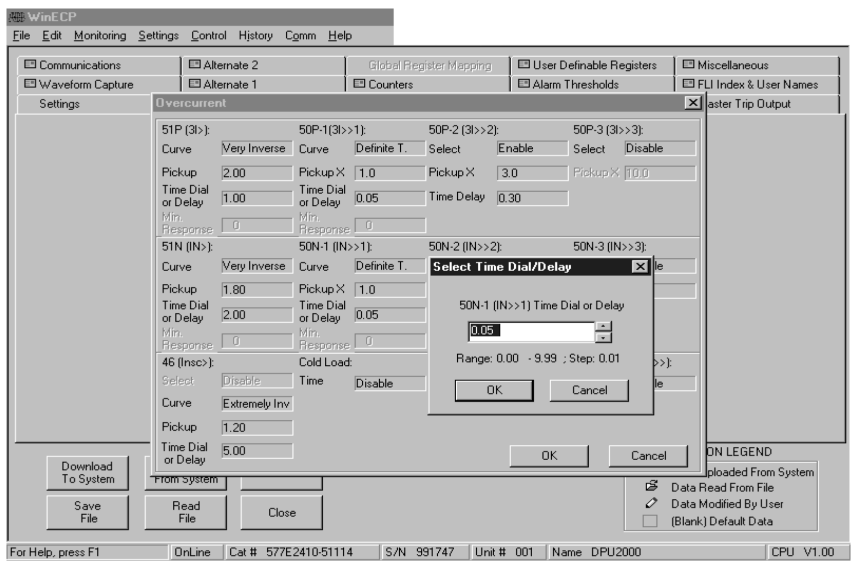


Figure 9. Typical Primary Settings for the Bus DPU1500R/2000R

3. To allow the feeder DPU1500R/2000R relays to control the high-speed instantaneous functions of the bus relay, map the 50-1 element to a physical input in the Programmable Inputs screen (Figure 11). Remove the 50-1 elements from the Master Trip settings and map it to a physical output (Figure 12 and 13). This is required because the 50-1 elements are supervised by the 74 auxiliary relay. Next, wire a normally closed contact from the PA auxiliary relay to the selected physical input on the Bus DPU.

4. The 50-2 provides local backup protection for failed feeder breakers. If this feature is desired, set the time delay in the Primary Settings (Figure 9) to 0.3 seconds. The 50-2 element should not be used for backup with feeder schemes (such as fuse saving schemes) that disable instantaneous elements in any one of the recloser sequences.

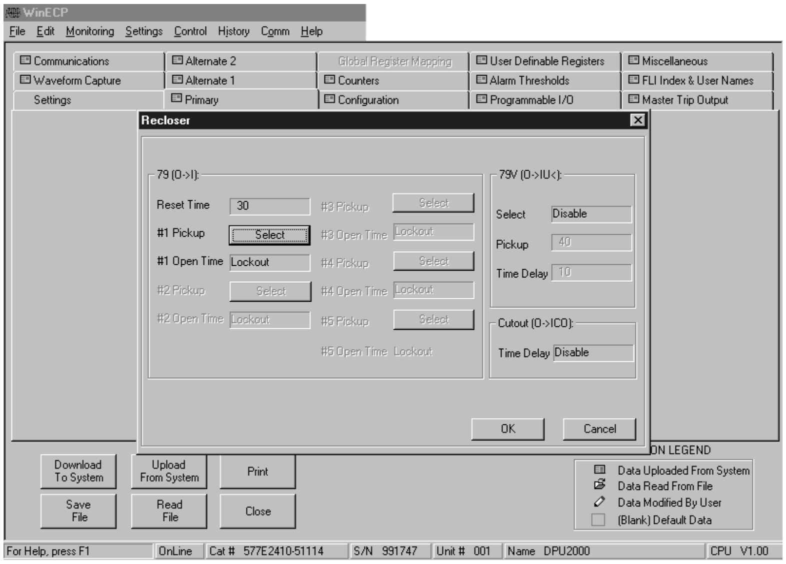


Figure 10. Recloser Settings

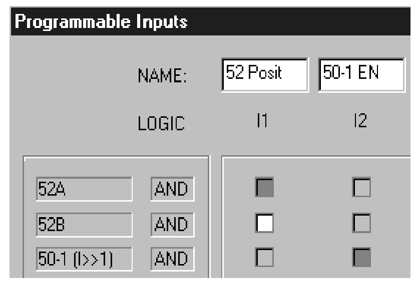


Figure 11. 50-1 Input Control Logic

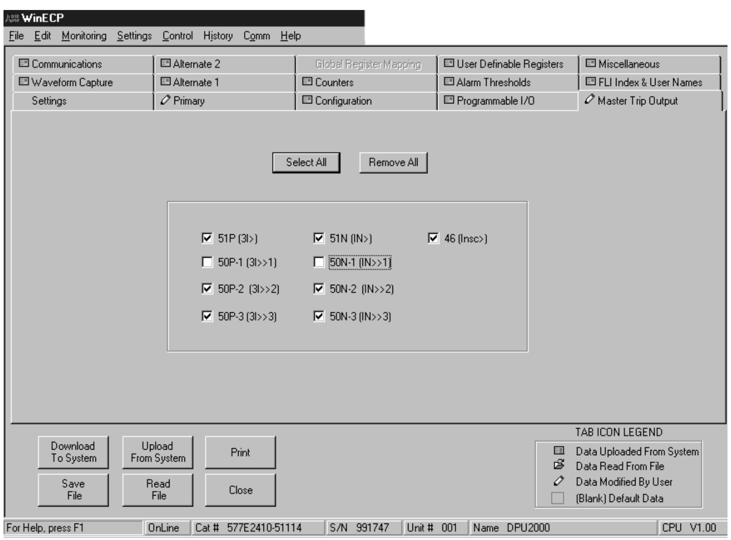


Figure 12. Master Trip Settings

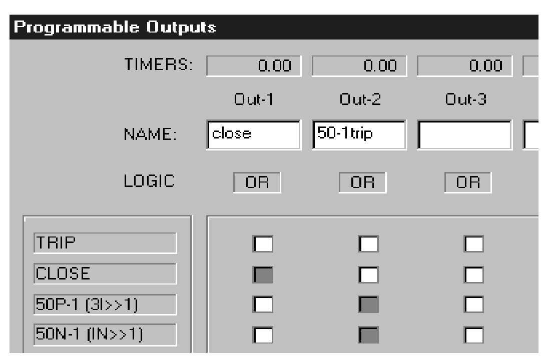


Figure 13. 50-1 Output Logic

Programming the Feeder DPU1500R/2000R

The feeder instantaneous overcurrent relay requires a faster trip response than the bus instantaneous overcurrent relay. When a feeder fault occurs, timing coordination is crucial to allow the feeder relay to trip faster than the bus relay.

1. Set the 50P-1 and 50N-1 functions in the Primary Settings table as follows (see Figure 14):
   a. Set the curve to “Standard Instantaneous”.
   b. Select the desired pickup.
2. At the Programmable Input/Output Screen, map the PUA condition to the desired output. See Figure 15.

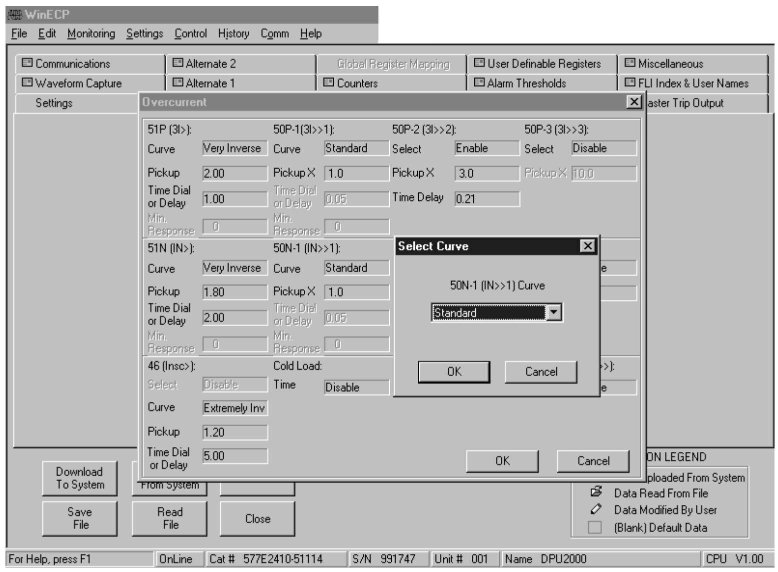


Figure 14. Primary Settings for the Feeder DPU1500R/2000R

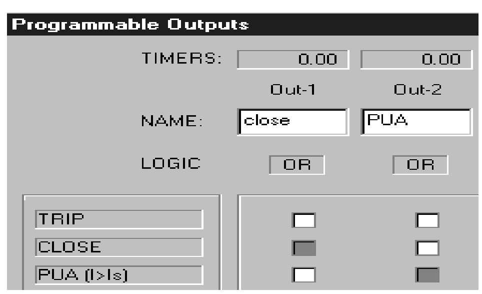


Figure 15. Pickup Alarm Input Logic

Sample Operation

Condition 1. Feeder and Bus DPU1500R/2000R OK: Feeder Fault (see Figure 16).

The pickup alarm (PUA) picks up the pickup auxiliary relay (PA). The PA contact disables the 50-1 functions of the bus DPU1500R/2000R. The feeder relay trips for the fault and recloses after the set open interval time expires.

All auxiliary self-check relays (74/Fn) are picked up, blocking the bus DPU1500R/2000R from tripping the feeder breaker.

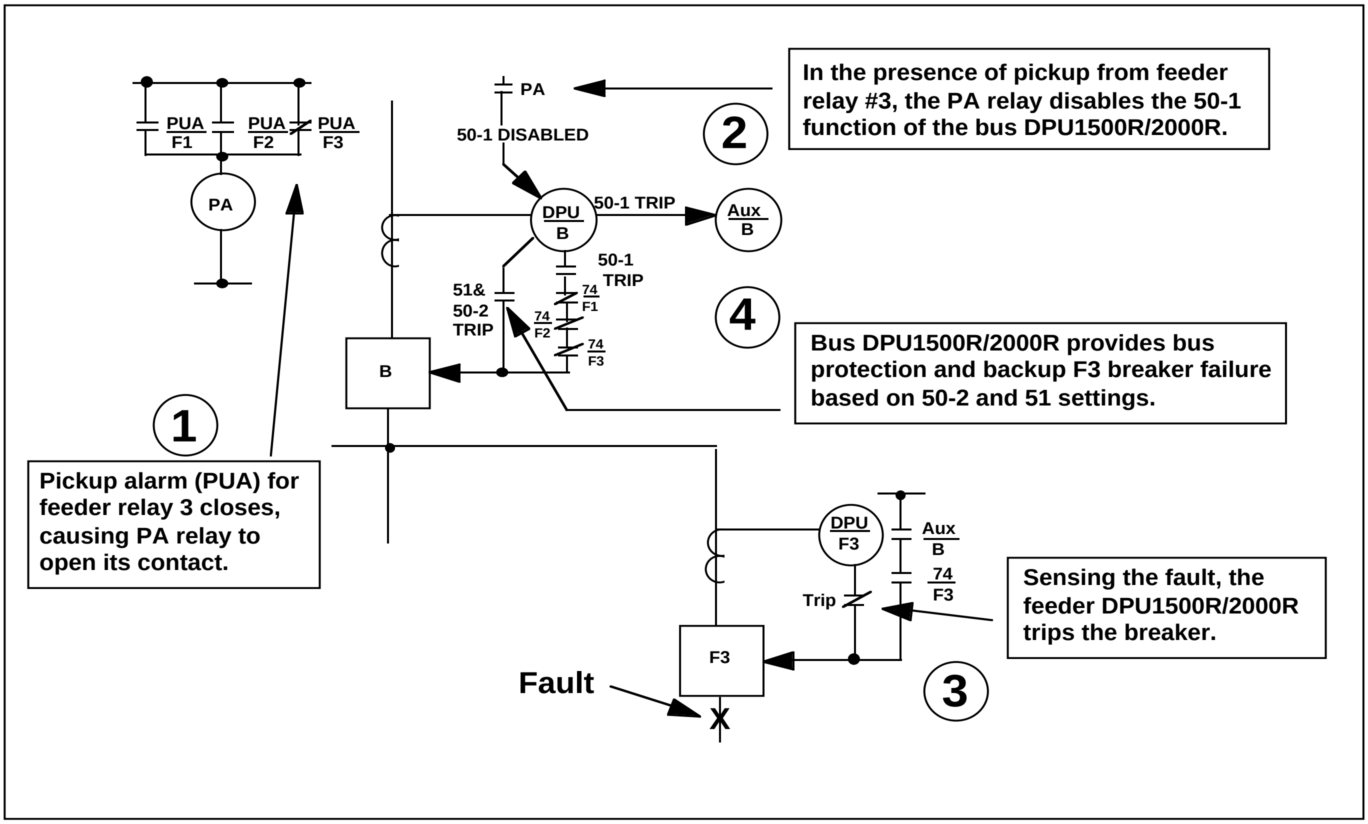


Figure 16. Feeder Fault: Bus and Feeder Relays OK

Condition 2: Feeder and Bus DPU1500R/2000R OK: Bus Fault (see Figure 17).

The pickup auxiliary relay (PA) is not energized, and therefore the 50-1 function of the bus DPU1500R/2000R is enabled. The 50-1 function trips the bus breaker after 0.05 seconds through the closed contacts of the energized (74/Fn) relays.

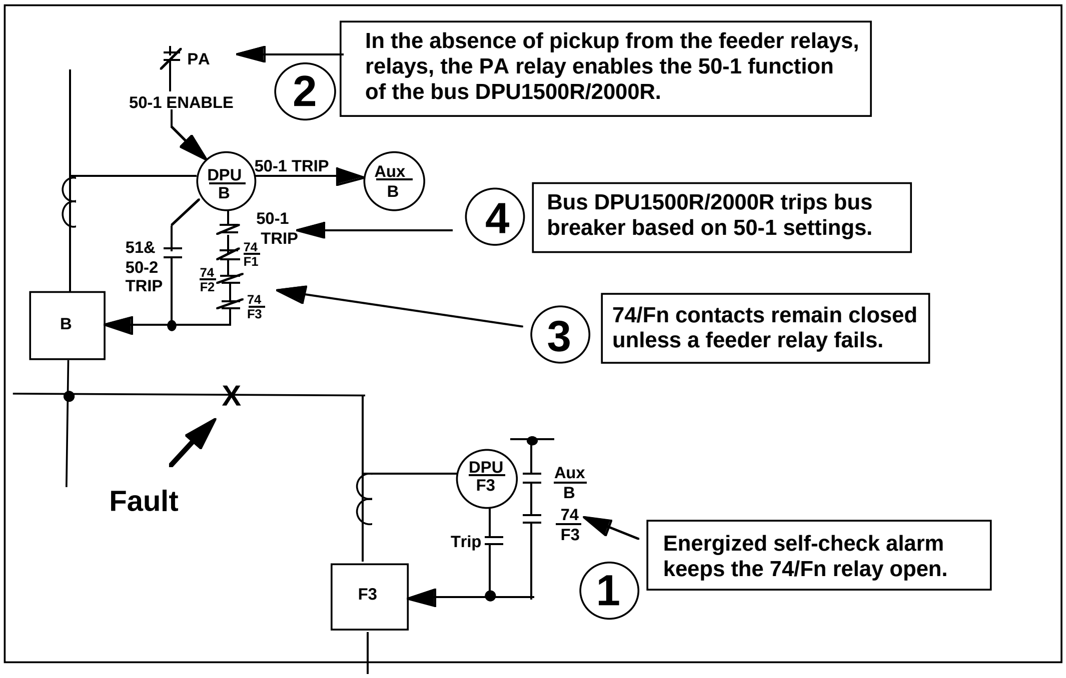


Figure 17. Bus Fault: Bus and Feeder Relays OK

Condition 3: A Feeder DPU1500R/2000R Fails or Is Withdrawn from Its Case: Feeder Fault (see Figure 13).

The self-check alarm contact de-energizes the (74/Fn) relay. The (74/Fn) contact in the feeder trip circuit closes. The PA relay is not energized, thereby enabling the 50-1 functions of the bus DPU1500R/2000R. The bus DPU1500R/2000R's 50-1 functions energize the Aux/B relay, which trips the feeder breaker with no reclosing.

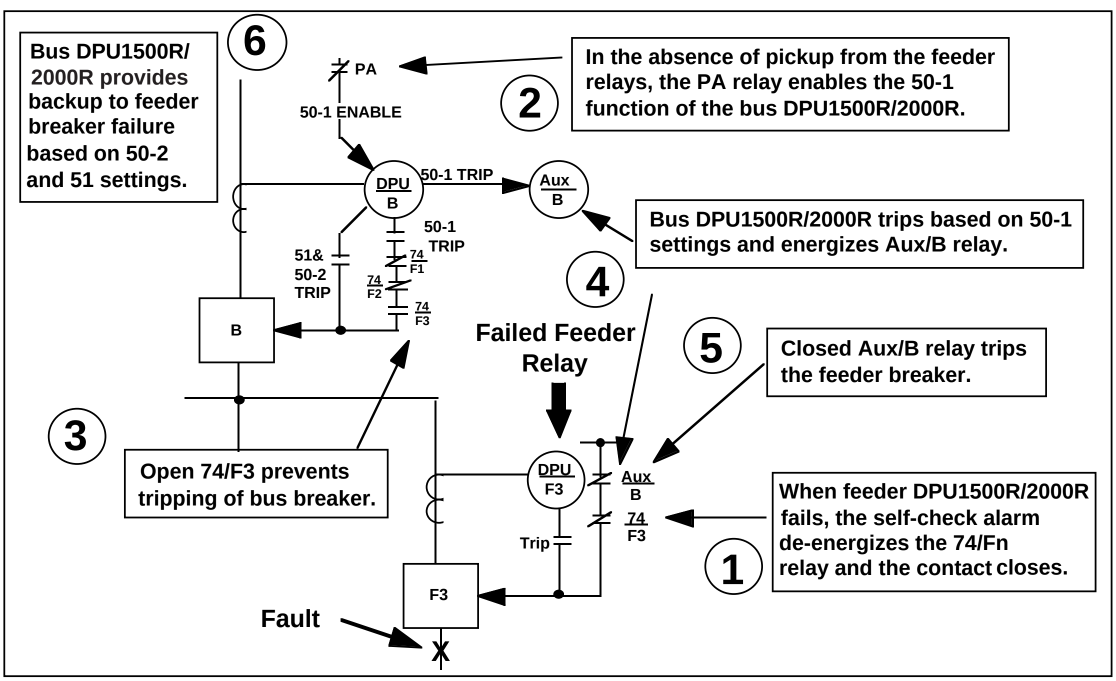


Figure 18. Feeder Fault: Feeder 3 DPU1500R/2000(R) Has Failed

Application Note AN-23

Zone Sequence Coordination

Introduction

In power systems, protection schemes include series combinations of reclosers on medium voltage overhead distribution radial feeder lines. The series combination consists of one or several down-line recloser(s) and a backup substation recloser. This is shown in Figure 195. The down-line and backup reclosers would be set for a typical operating sequence involving two fast or overcurrent trips. The trip times are coordinated so that the substation breaker does not normally operate for faults beyond the down-line device.

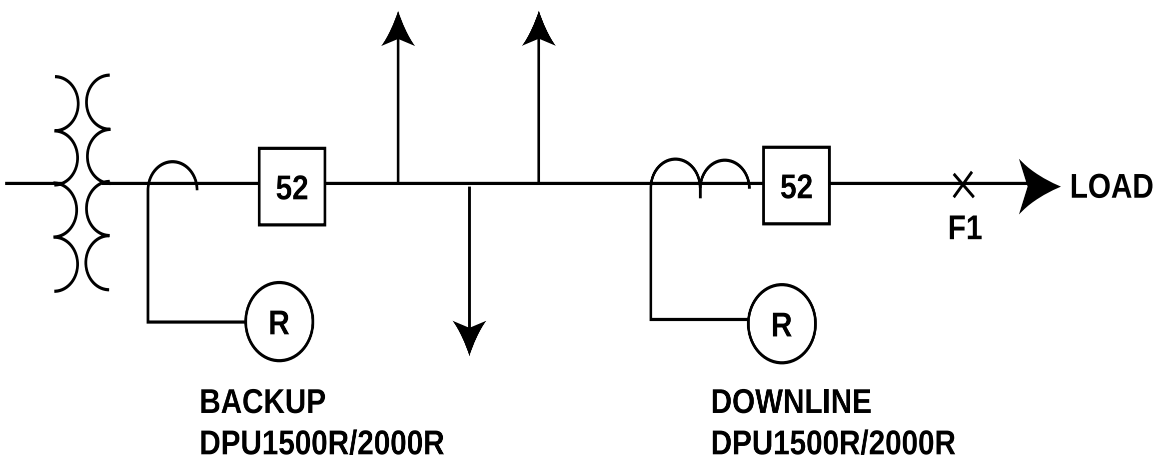


Figure 19. Series Combination of Substation and Down-line Reclosers

Application

If the fault F1 in Figure 19 were a permanent fault and the backup and down-line reclosers were set as described above, the down-line device would trip twice instantaneously and reclose and then begin to time out according to its time overcurrent setting. The backup recloser, however, sensing the same fault current, (series system) but having not tripped due to coordination, will now trip twice on its instantaneous trips since their times are faster than the down-line device's time overcurrent trip; times. The sequence of operations is shown in Figure 20. These undesirable operations of the backup recloser not only interrupts power to more customers than required but also adds unnecessary wear on the mechanisms and contacts. Zone Sequence Coordination (ZSC) is a coordination method that prevents undesirable trips of a backup recloser for a fault beyond a down-line recloser. The DPU1500R/2000R provides the ZSC function in its standard software. The backup DPU1500R/2000R senses the down-line device's interruption of the fault by entering and quickly exiting the 50/50N pickup state without issuing a trip and then advances to the next trip in the reclosing sequence. With the ZSC function enabled in the backup recloser, the down-line device alone will trip for fault F1 while the backup advances its recloser steps to remain coordinated. The correct operations are shown in Figure 21.

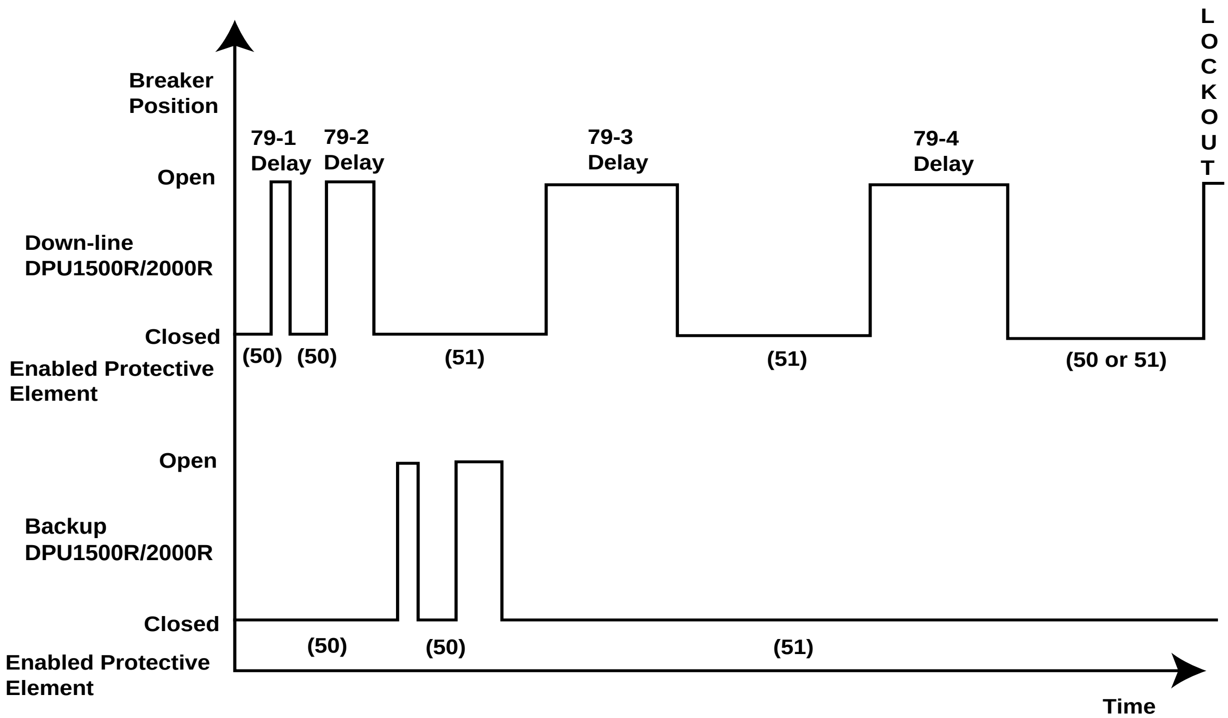


Figure 20. Down-line and Backup Recloser Operations without ZSC

ZSC in the DPU-2000R

You can activate the ZSC feature by running the DPU1500R/2000R Operations software "WinECP." Select **Settings** from the Main Menu and then select **Programmable Inputs**. Get the data from the DPU1500R/2000R and assign ZSC to one of the programmable inputs. Now you can remotely enable or disable the ZSC function via its programmed input terminals. With the relay's rated voltage applied to the ZSC terminals, the function is enabled. Conversely, without rated voltage applied to the ZSC terminals, the function is disabled. The status of the ZSC input terminals can be viewed by selecting **Test** in the main menu and then selecting **Contact Inputs**. The contact input status can be viewed with WinECP and the man-machine interface LCD display. All Zone Sequence Coordination steps are stored in the Operations Record logs.

To ensure correct Zone Sequence Coordination operation, the protection engineer must adhere to the following criteria when setting the relays. Assume the backup DPU1500R/2000R is RELAY #1 and the down-line DPU1500R/2000R is RELAY #2.

1. RELAY #1 must be set for a longer instantaneous time than RELAY #2. The recommended minimum coordination margin is .1 seconds.
2. RELAY #1 time overcurrent settings must be programmed for a longer delay than those of RELAY #2.
3. The 79 reset time of RELAY #1 must be programmed greater than the largest open interval time of RELAY #2.

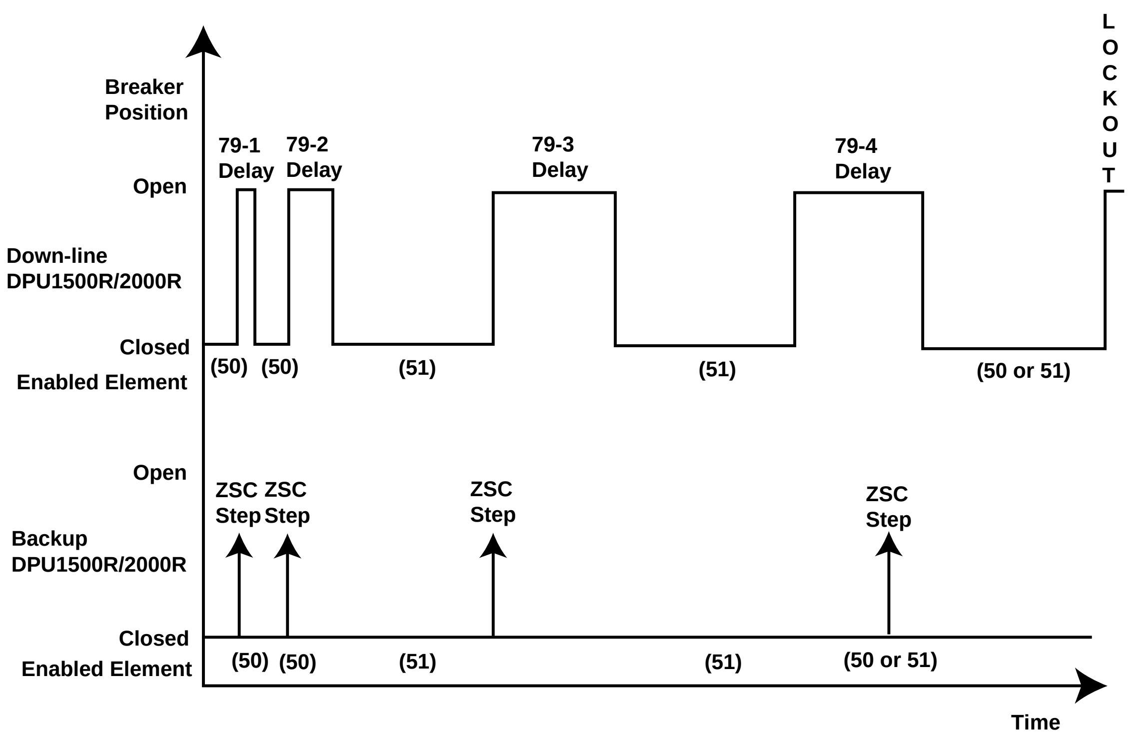


Figure 21. Down-line and Backup Recloser Operations with ZSC

Application Note AN-24

Two-Phase, 50P Tripping

Introduction

The 2 Phase-50P Trip in the DPU1500R/2000R is used to increase sensitivity and improve clearing time for three-phase, phase-to-phase, and two-phase-to-ground faults on the main section of radial distribution lines. The 2 Phase-50P Trip is not sensitive to single-phase-to-ground faults. When the 2 Phase-50P Trip is enabled in the settings table, the 50P-1, 50P-2, and 50P-3 functions will trip only when 2 or 3 phases exceed these trip for phase-to-ground faults when the residual current exceeds the instantaneous 50N-1, 50N-2, or 50N-3 pickup settings.

On distribution lines, the phase and ground instantaneous overcurrent elements are often set very high in order to coordinate with large downstream fuses. When using the DPU1500R/2000R in these applications, the 50N-1 function can be set to coordinate with the large downstream fuses. By enabling the 2 Phase-50P Trip, the 50P-1 function can be set below the 50N-1 pickup setting to increase sensitivity and improve clearing time for three-phase, phase-to-phase, and two-phase-to-ground faults on the main section of the radial feeder.

For example, a 100A downstream fuse may require the upstream 50N-1 pickup setting to be 4000A or more. By enabling the 2 Phase-50P Trip, the 50P-1 function can be set at 2000A. For three-phase, phase-to-phase, and two-phase-to-ground faults greater than 2000A, a 50P-1 instantaneous trip will occur. No 50P-1 trip occurs for single-phase-to-ground faults when the fault current is between 2000 and 4000A. For single--phase-to-ground faults where the current is greater than 4000A, a 50N-1 instantaneous trip will occur.

On manual closing of the circuit, consideration may need to be given to cold load inrush. In the DPU1500R/2000R, the 50P-1, 50P-2, 50N-1, and 50N-2 functions can be delayed from 0 to 200 seconds by the cold load pickup time (CLPT) setting.

Application Note AN-26

Single-Pole Tripping of Distribution Feeders

The DPU1500R/2000R internal logic and programmable outputs are flexible enough to provide single-pole tripping in distribution applications where a group of three single-phase reclosers is used. This scheme requires that the loads be single-phase connected line-to-neutral and provides the benefit of eliminating unnecessary interruptions of the non-faulted phases.

Follow these steps to implement single-pole tripping on the DPU1500R/2000R:

1. Enable Multiple Device Trip Mode in the Configuration Settings.

2. Assign three of the programmable outputs to the Trip A, Trip B, and Trip C attributes.

3. Assign three programmable outputs to the Close attribute for the Phase A, Phase B, and Phase C reclosers.

When the DPU1500R/2000R is in Multiple Device Trip mode, it does not monitor the open-close positions of the interrupting devices. The unit assumes the proper response of the interrupter if the fault current drops below 90% of the pickup setting of each of the active overcurrent elements.

Operation Considerations

When set up for single-pole tripping, the DPU1500R/2000R operates as follows:

- If simultaneous faults occur on two or more phases, the overcurrent trip timing is based on the highest phase current, and all phases with current above pickup are tripped simultaneously.

- If a fault on one phase results in a lockout condition, any subsequent trips on either of the other two phases result in a lockout condition on that phase also. No reclosing occurs.

- If one phase has tripped and is in its open interval timing, a trip on either of the other two phases moves the reclosing program forward one step, and the open interval timing begins again. Both reclosers are closed simultaneously at the end of this new open interval.

  For example, Phase A has tripped and is in its open interval timing based on the 79-1 reclosing sequence. If a trip occurs at this time on Phase C, the reclosing sequence immediately moves to 79-2 and the open interval timer begins again.

Application Note AN-33

Capacitor Bank Protection and Automatic Control Using the Type DPU2000R Intelligent Electronic Device

Introduction

The Distribution Protection Unit, DPU2000R, is designed to provide flexible protective and control elements. Along with these is the ability to create logical control schemes using the internal programmable logic functions. When combined, these two capabilities provide a vast number of possible configurations to suite a particular function not normally associated with a distribution relay. One such function that is possible with the DPU2000R is automatic capacitor bank control. This application note deals in detail with this function.

Application

First needed is the determination of how the capacitor bank control is to operate and which criteria will be used to determine an open and close situation. Capacitor bank controllers normally utilize voltage, VAr, Power Factor, or any combination of these system measurements to determine the capacitor bank commands. The example below will be based on using voltage. Controllers typically do not contain protection. The DPU2000R contains the protective elements necessary for capacitor bank phase and ground overcurrent protection along with the capability to logically control the bank. This allows for the purchase of a single piece of hardware to perform both duties, thus gaining a savings in overall cost.

Figure 22 outlines the Boolean logic associated with this application. The following text will reference this figure. In the following example the DPU2000R three phase undervoltage element, 27-3P, is used to determine a capacitor bank close condition. The overvoltage element, 59, is used to determine a capacitor bank open condition. The 51N* element is used to open the capacitor bank circuit breaker and a control lockout if a ground fault is seen. The asterisk (*) following the 51N function means that it is a sealed-in output and must be either manually reset or reset via remote communications. The bottom line is that this bit will call attention to an abnormal condition and it is up to the user to determine whether a reset of the condition is warranted.

The DPU2000R contains User Logical Input (ULI) and User Logical Output (ULO) functions. A ULI is an undefined logical input seen in the relay input map. A ULO is an undefined logical output seen in the relay output map. A ULI in the input map is soft connected to the corresponding ULO in the output map, I.E. ULI2 is connected to ULO2. This soft connection can be broken by a setting in the DPU2000R. A ULO can act like an S-R flip flop. They are set and reset via the DPU2000R MMI or by remote communications. When a ULO is used in this manner, it is usually necessary to break the soft connection between the ULI and ULO so that an input to the ULI does not affect the operation of the ULO. For example: An “Auto Enable” bit, User Logical Output 6 (ULO6) is used to enable or disable the overall operation of the capacitor bank control. It is set and reset via operator interface to the relay MMI. The operator interface is the only way desired to influence the control. If the soft connection

between ULI6 and ULO6 is not broken, it is possible that a input map programming error could cause undesired operation of ULI6 and ULO6. A text string can be assigned to a ULO making it easier for an operator to understand the functionality that has been assigned to it. Other ULOs are used in this example for transfer of logic signals from the input map to output map. In this case the soft connection needs to remain. In summary, a ULO can be explained as a method of feeding an input signal to the output mapping.

The reverse is true for elements called “feedback terms”. These feedback terms (FBs) are a method of feeding a logical output signal back to the input map. They are also soft connected (I.E. FBO1—FBI1) as with the ULOs but this soft connection cannot be broken. When the ULO and FB terms are combined, it is possible to create programmable logic to perform any number of specific functions.

The three phase undervoltage element, 27-3P, and the three phase overvoltage element, 59, are used to determine capacitor bank state. Each has a maximum time delay of 60 seconds. The DPU2000R also contains output timers. These timers have a maximum setting of 250 seconds (4 minutes) and there is one timer per output contact. When the under/overvoltage timers are combined with the output timers, a maximum time delay of 310 seconds (5.16 minutes) can be obtained. A 5 minute time delay is usually required for capacitor discharge upon a circuit breaker open. In this example, the over/undervoltage elements time delays are set to 60 seconds. The open and close output timers are set to 240 seconds for a total of 300 seconds (5 minutes).

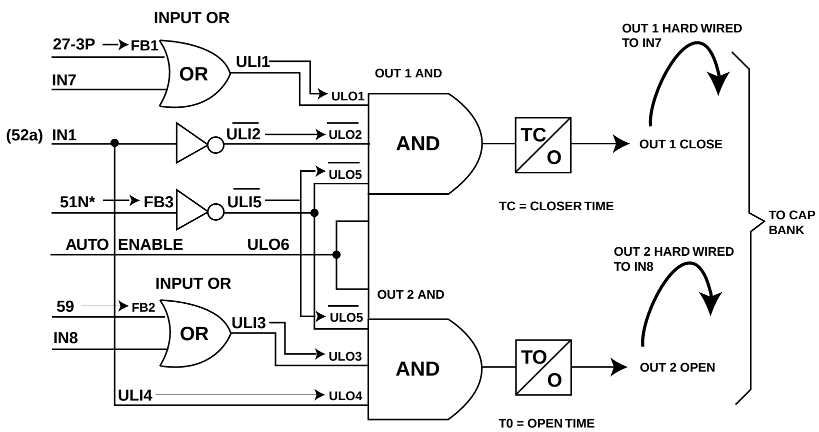


Figure 22. Capacitor Bank Control Logic Control

Capacitor Bank Close Operation

The logic as shown in Figure 21 outlines the scheme operation. When the system voltage falls below the 27-3P threshold for 60 seconds, a logical 1 is output. This logical 1 from 27-3P is fed back to OR1 via feedback 1 (FB1). The output of OR1 is fed forward to AND1 via ULI1—ULO1. Other inputs to AND1 are the inverse of 52a fed forward via ULI2—ULO2, 51N* fed back through FB3, inverted, and fed forward via ULI5—ULO5. An "Auto Enable" bit ULO6 is also part of AND1. The following AND1 conditions must be true before a breaker close can be initiated via timer "TC".

The 27-3P time-out has occurred

The circuit breaker is open indicated by the state of IN1 (52a)

The 51N* has not operated

The Auto Enable ULO6 is On

After the TC timer times out contact OUT1 will close. OUT1 is hardwired to input IN7 which in turn is input to OR1. This is necessary to hold the OUT1 contact closed or seal it in until the circuit breaker has completed its operation as indicated by the input IN1 (52a).

Capacitor Bank Open Operation

When the system voltage rises above the 59 threshold for 60 seconds, a logical 1 is output. This logical 1 from 59 is fed back to OR2 via feedback 2 (FB2). The output of OR2 is fed forward to AND2 via ULI3—ULO3. Other inputs to AND2 are the 52a fed forward via ULI4—ULO4, 51N* fed back through FB3, inverted, and fed forward via ULI5—ULO5. An "Auto Enable" bit ULO6 is also part of AND2. The following AND2 conditions must be true before a breaker close can be initiated via timer "TO".

The 59 time-out has occurred

The circuit breaker is closed indicated by the state of IN1 (52a)

The 51N* has not operated

The Auto Enable ULO6 is On

After the TO timer times out contact OUT2 will close. OUT2 is hardwired to input IN8 which in turn is input to OR2. This is necessary to hold the OUT2 contact closed or seal it in until the circuit breaker has completed its operation as indicated by the input IN1 (52a).

DPU2000R Programmable Logic Configuration

Once the Boolean logic drawing is complete, the DPU2000R input and output maps will require configuration. This can be done by adding the ULI—ULO (feed forward) and feedback mapping to the Boolean drawing. This has been done on Figure 21. After this, transfer the information to the input and output maps.

Figures 23, 24, and 25 show the input and output mapping required for this application. These are actual screen shots of the External Communications Program (ECP) that is required to perform this mapping. ECP is included with the DPU2000R.

Figure 23 shows the input map required for this application. On the top of the map screen are the physical inputs and feedback terms. To the left are the logical inputs and logical AND / OR selections. When a “C” is placed in the map, power is required for that logical input to assert. If an “O” is placed, the inverse is true, no power asserts the input. The “O” map can be used when an inverted signal is necessary. Next to each logical input is the selection of either AND or OR logic. Select each input logic as required. The feedback map is to the right of the physical inputs in the input map screen and should be connected to logical inputs. Remember that the feedback terms come from logical signals in the output map.

```
                              ECP Version 1.89
                  Change Programmable Inputs - unknown unit
        LGC  I1  I2  I3  I4  I5  I6  I7  I8  FB1 FB2 FB3 FB4 FB5 FB6 FB7 FB8

 52A  | AND   O
 52B  | AND   C
 ULI1 | OR                            C       C
 ULI2 | AND   O
 ULI3 | OR                                C       C
 ULI4 | AND   C
 ULI5 | AND                                           O
 GRD  | AND
 ZSC  | AND
 SCC  | AND
 79S  | AND
 79M  | AND
 OPEN | AND
 CLOSE| AND
 ECI1 | AND
 ECI2 | AND
 WCI  | AND
 C = Enable-closed, Disable-opened;  O = Enable-opened, Disable-closed.
 Use UP, DOWN, LEFT, RIGHT arrows, and ENTER. Logic can be AND or OR.
 Press F1 to view/change Input Names. Press ESC to go to Save Screen.
  Press Spacebar for Selections
```

Figure 23. Input Mapping

Figure 24 shows the output map required for this application. On the top of the map screen are the physical outputs, the timers associate with those outputs, and the logical AND / OR selection. To the left are the logical outputs. When an “X” is placed in the map, the that logical output associated with the “X” will energize the output contact to which it is assigned. Press F2 to access the feedback map as shown in Figure 25. Place an “X” in the feedback column for the desired logical output to be fed back and utilized in the input map. Remember that the ULO signals come from the input map unless the soft connection between them has been broken.

```
                         ECP Version 1.89
              Change Programmable Outputs - unknown unit
TIMERS:  240.00   240.00     0.00     0.00     0.00     0.00
       OUT-1    OUT-2    OUT-3    OUT-4    OUT-5    OUT-6
 NAME: Close    Open

 LOGIC  | AND      AND      AND      AND      OR       OR       ___      ___
        |
 TRIP   |
 CLOSE  |
 27-3P  |
 ULO1   |  X
 51N    |
 ULO2   |  X
 ULO3   |           X
 59     |
 ULO4   |           X
 ULO5   |  X        X
 ULO6   |  X        X
 50P-2  |
 50N-2  |
 50P-3  |
 X = Output is selected. LOGIC can be AND or OR. * = Seal In Alarms.
 Use arrows, ENTER for selects. F1 for timers,F2 for Feedbacks. ESC to Exit.
 Press Spacebar for Selections
```

Figure 24. Output Mapping

```
                         ECP Version 1.89
         Change Programmable Feedback Outputs - unknown unit

       FBO-1    FBO-2    FBO-3    FBO-4    FBO-5    FBO-6    FBO-7    FBO-8

 LOGIC  | OR       OR       OR       OR       OR       OR       OR       OR
        |
 TRIP   |
 CLOSE  |
 27-3P  |  X
 ULO1   |
 51N    |                   X
 ULO2   |
 ULO3   |
 59     |          X
 ULO4   |
 ULO5   |
 ULO6   |
 50P-2  |
 50N-2  |
 50P-3  |
 X = Output is selected. LOGIC can be AND or OR. * = Seal In Alarms.
 Use arrows, ENTER for selects. F2 Return to Outputs Screen. ESC to Exit.
 Press Spacebar for Selections
```

Figure 25. Output Feedback Terms

Conclusion

This application is only one of a number that can be created using the DPU2000R protection and control elements along with the programmable logic capabilities. We at ABB Automation Inc. hope that this note will encourage you to investigate the possibilities. If there are any questions regarding this or any other application please contact ABB SAPD technical support at 1-800-634-6005.

Operator Control Interface Panel

Introduction

The new Operator Control Interface (OCI) is designed to give the user greater flexibility to access information from the system than available with the standard operator control interface. The OCI provides the following features:

- Control buttons with access to the DPU's logical inputs
- Breaker control buttons
- 24 target indications for the DPU logical outputs: 22 programmable
- Larger LCD with eight lines to display the DPU menu
- A top level menu of popularly accessed information
- Top level of popularly accessed information
- Hot Line Tag control buttons are available as an optional feature in the new enhanced OCI panel

The enhanced OCI panel and the standard OCI panel are both available in the DPU2000R model. The OCI panel option provided is represented in the catalog number of the DPU2000R relay. The seventh position of the relay catalog number indicates the front panel option.

The four (4) new front panel options available are as follows:

Catalog Option	Operator Control Interface Description
2	Horizontal enhanced OCI panel
3	Horizontal enhanced OCI with Hot Line Tagging
7	Vertical enhanced OCI panel
8	Vertical enhanced OCI with Hot Line Tagging

Shown in Figure 14-1 is the front view of the new OCI panel. The Hot Line Tag illustrated in this figure may or may not be included on the enhanced panel of the DPU2000R relay. This depends on the model number selected.

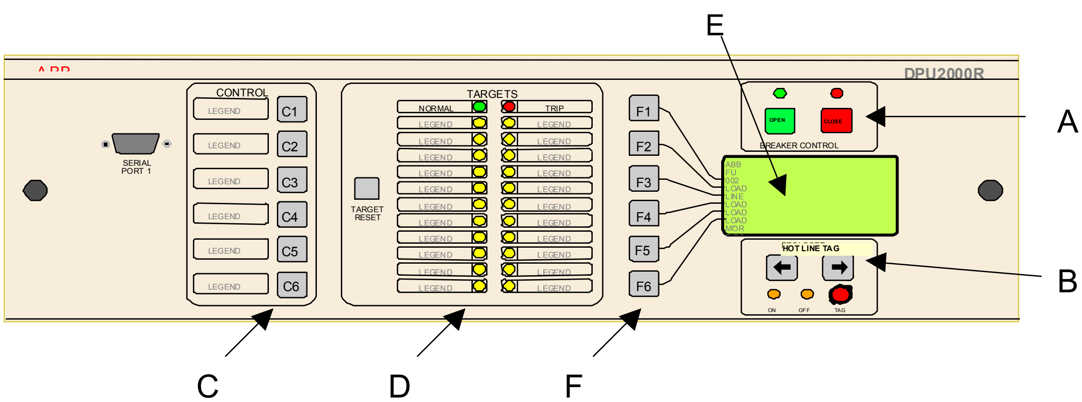


Figure 14-1. Front View of the OCI Enhanced Panel with the Hot Line Tag Feature

A. Pushbutton controls for the breaker
B. Optional "Hot Line Tag" pushbutton control switch
C. Six Control Push Buttons to select/de-select relay functions
D. Expanded Target Information
E. New larger Liquid Crystal Display (LCD) of 8 rows and 21 columns
F. Six Menu Push Buttons serve as hot keys for single-button navigation

Control Buttons

The control buttons are intended to replace the relay's panel buttons. These control buttons give the operator access to the DPU's logical inputs.

De-pressing a control button is analogous to asserting a binary input to the DPU unit.

There are six (6) control buttons labeled C1, C2, C3, C4, C5, and C6. In order to activate the designated function of one of the buttons, it must be held depressed for a minimum of 500 ms. The control button action can be enabled or disabled using the "OCI Control Buttons" settings found in the Configuration settings. The default parameter is disabled. The control button is externally accessible via communications, and it will assert on a negative transition of its access poiint. When the LOCAL logical input is enabled, the control buttons are not accessible via communications.

As previously stated, the six (6) control buttons are analogous to the DPU's binary inputs. As such, the control buttons shall be programmable in the same way as the DPU's programmable Inputs and Feedbacks. The control buttons follow the present close enabled and open enabled logic.

The factory default assignments for the enhanced OCI option without HLT, are shipped as follows with the mylar label inserted:

Control Button	Enhanced OCI Label
C1	Block Reclose
C2	Block Ground
C3	Block Inst
C4	Block Remote
C5	Enable Alt 1
C6	Enable Alt 2

The factory default assignments for the enhanced OCI option with Hot Line Tag are shipped as follows with the mylar label inserted:

Control Button	Enhanced OCI Label
C1	User Display* (see description below)
C2	Block Ground
C3	Block Inst
C4	Block Remote
C5	Enable Alt 1
C6	Enable Alt 2

For OCI version with Hot Line Tag feature, C1 will initiate the display of a user-defined message on the LCD panel. This is because the "BLOCK RECLOSE" function is provided as part of the "Hot Line Tag" functionality.

Mode of operation: Press and release toggles the present state, e.g., if previously "De-selected", factory default condition, then pressing and selecting C1 – 6 will toggle state to "Selected".

The control buttons can be programmed to any of the logical inputs. A new mylar insert can be easily created using word processing or CAD tools, and then inserted. Blank mylars are included with the DPU2000R relay with the enhanced OCI panel. The Word document for typing and printing the customer oriented label identification is supplied with all enhanced OCI relays, or can be obtained from the website, or by contacting ABB Allentown for a copy of the program. Instructions are as follows for creating the new mylar inserts:

1) Type in the desired name using the same type style as used in the default
2) Print on a standard overhead transparency (or print on paper and then create a standard transparency)
3) Cut on the solid lines
4) Slide into the front panel slots

If necessary, re-map to any DPU2000R logical input using WinECP. Refer to Section 6 of this book for details.

Programming of the control buttons to a different function than the default setting can easily be accomplished by using the Win ECP communication software. After establishing communication with the relay or working off line, go to “Settings”: “Programmable I/O”, Display/Edit Programmable Input Map, then select “Controls” at the bottom of the screen to program C1 through C6. The complete library is available for selection. A listing of all of the functions available can be found in this selection. For a complete discussion on the method of programming the control buttons and other functions of the relay, refer to Section 6 of this instruction book.

Table 6-1, Logical Input Definitions on page 6-2 lists all of the available logicals for the new OCI panel control button selections. They are the same input logicals available for all of the programmable inputs.

Circuit Breaker Control Buttons

The circuit breaker control buttons on the enhanced OCI panel are designed to replace the rotary breaker control switch. There are two buttons provided for breaker control: open or close. This feature may be disabled if the user wishes to delete the function. The DPU configuration settings has the parameter to enable or disable the breaker control button. The setting is labeled “Breaker Control Buttons”. The default parameter is disabled.

There are two LED’s on the enhanced OCI panel to indicate the circuit breaker status. The green LED indicates that the circuit breaker is open, and the red LED indicates that the circuit breaker is closed. If the circuit breaker is in a failed state, and there is no receipt of the 52 “a” or “b” switch contacts, the LED’s will blink on and off alternately.

Note: No password is required to operate the circuit breaker, as this feature of the DPU2000R relay is analogous to the standard breaker control switch. Pressing either of the buttons to change the state of the circuit breaker will only require a confirmation query of the F2 function key. If the Hot Line Tag is selected in the ‘tagged position”, the breaker cannot be closed by the relay. However, if the “tagged position” is selected prior to the breaker being opened, then by depressing the green control button with confirmation of function key F2, the circuit breaker will open but cannot be reclosed.

LED Targets

The targets are designed to replace the panel indications. As such, the user may customize the function of the panel indications. The target programmability allows the user to select the function of a particular LED target. There are 24 targets; 22 are programmable for customization by the user. All of the targets are yellow except the T1 target is green for “Normal”; and T13 is red for “Trip”.

The DPU2000R relay with the OCI panel is shipped from the factory with the following default target selection (provided as a Mylar insert in a sleeve, to the left and right of the actual target light):

T1	Normal (green)	T13	Trip (red)
T2	Disabled	T14	Phase A
T3	Pickup	T15	Phase B
T4	C1 Selected	T16	Phase C
T5	C2 Selected	T17	Neutral
T6	C3 Selected	T18	Time
T7	C4 Selected	T19	Instantaneous
T8	C5 selected	T20	Neg. Seq.
T9	C6 selected	T21	Frequency

T10	Recloser Out	T22	Directional
T11	Ground Out	T23	Voltage
T12	Inst. Out	T24	Distance

All target LED's can be programmed to the Control Button inputs C1 to C6, and Targets using the latest version of WinECP.

Inputs: Physical and Logical
Mode of Operation: When input is enabled, the target is light. When input is disabled, the LED is off.
Outputs: Physical and Logical
Mode of Operation: When output is energized (or asserted), the target is lit. When output is de-energized (or de-asserted), the LED is off.

The "C1 Selected" through "C6 Selected" LEDs are provided to let operators know that control button "selections" or "de-selections" have been recognized by the relay.

A new, customized Mylar insert can be created easily by customers using the ABB-provided Word .doc template. This template will be shipped with all enhanced OCI relays. Steps to follow:

1) Type in the desired name using the same type style as used in the default
2) Print on a standard overhead transparency (or print on paper and then create a standard transparency)
3) Cut on the solid lines
4) Slide into the front panel slots.

If necessary, re-map to any DPU2000R logical inputs and outputs to match your new design. Details available in the DPU2000R Instruction Book.

Programming of the LED targets to a different function than the default setting can easily be accomplished by using the Win ECP communication software. After establishing communication with the relay or working off line, the heading under "Settings": and then under "Programmable Outputs" is selected and by clicking on to "Targets", the complete library is available for selection. For a complete discussion on the method of programming the LED targets and other functions of the relay, refer to Section 6 of this instruction book.

Table 6-2, Logical Output Definitions on pages 6-7 through 6-15 lists all of the available logicals for the new OCI panel targets selections. They are the same output logicals available for all of the programmable outputs.

In addition to those logical outputs listed on Table 6-2, there are additional logicals available for target selection as well as any logical output, and are shown in Figure 14-2. These are very recent added logicals and are self explanatory as to their function:

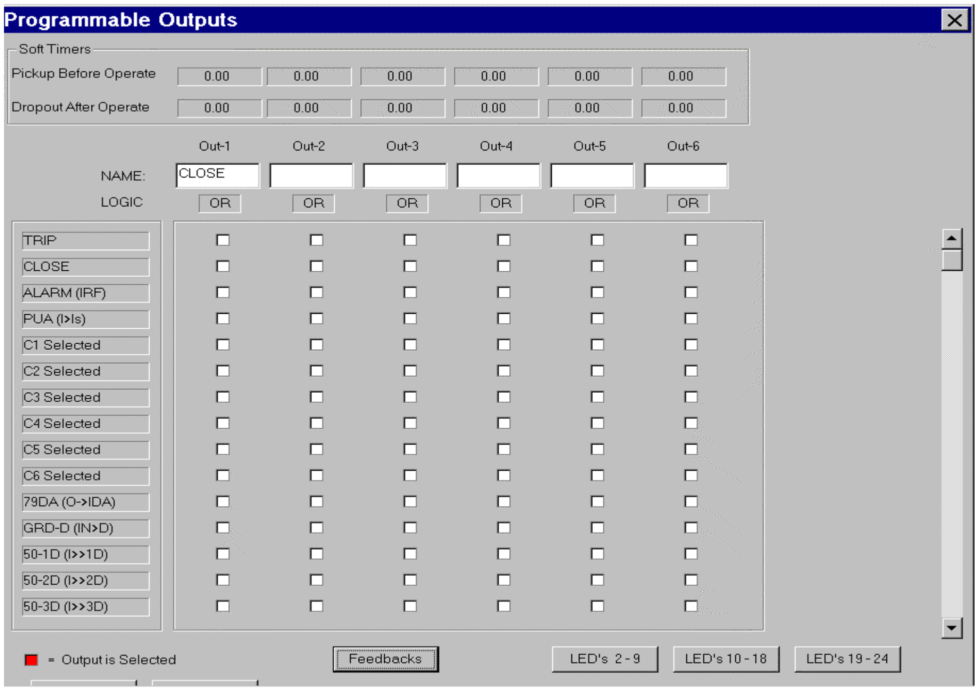


Figure 14-2. Screen Showing Additional Logical Outputs

Hot Line Tagging

For the enhanced OCI with HLT option, the user has access to the Hot Line Tag control buttons on the enhanced OCI panel. This replaces the conventional 31TR control switch. There are two Hot Line Tag control buttons: left arrow and right arrow. The button de-bounce and recognition are identical and the same as the six control buttons C1 – C6. The **on**, **off,** and **tag** panel indication follow the status of the hot-line-tag logical outputs (ON, OFF, TAG) in the conventional DPU2000R. If the enhanced OCI catalog number is without the HLT option, the operation of the HLT's logical inputs is per the normal programmable I/O function.

The right and left arrow HLT buttons are on the enhanced OCI panel. The arrow button shall be treated as enable-closed logic. The Hot Line Tag optional feature has ON or OFF position red LED's, and a magnetic indicator of orange color for the TAGGED position. The arrow keys move the status from one state to another state. There are three HLT indicators: on, off, and tag. The HLT indicators assert per the HLT's logical output status.

The operation of the circuit breaker is restricted as follows per the postiions of the Hot Line Tag assertion and are indicated by the respective LED's:

- ON - Circuit breaker may be operated remotely or locally.
- OFF - Circuit Breaker may only be operated locally.
- TAGGED - Circuit Breaker cannot be operated locally or remotely by any means and is locked in the open position. Operating the left / right arrow keys to either the ON or OFF position will delete this feature.

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