DPU2000/1500R/2000R DNP 3.0 AUTOMATION TECHNICAL GUIDE

TG 7.11.1.7-50

Version 2.3
4/04

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Section 1- Introduction

With the introduction of a microprocessor based protective relay, today's relay protection engineer must be familiar with topics outside of traditional relaying schemes. It is intended that the production of this manual will enable the relay engineer to understand the principles of a microprocessor-based relay's inclusion in a substation automation project.

Substation automation is heavily dependent upon integration of the appropriate components to allow reporting of metering and event data. The foundation of a successful automation solution is thorough engineering of a communication system. The Distribution Protection Unit (DPU) is the culmination of intensive design efforts and relaying experience, which combine protective relaying and communication capabilities at an economical price. Through the evolution of protective relays, it was decided that a special manual needed to serve today's power automation specialist.

This manual is intended to give the reader an in-depth explanation of the communication interfaces available with the Distribution Protection Unit. Successful integration of microprocessor based relays like the DPU depends on not just understanding the bits and bytes of a particular protocol. It is the inherent understanding and application of such esoteric topics as physical interfaces, real time control, manufacturer independent device integration, throughput vs. speed of communication, … which influences the success of an automation project.

In many cases the individual performing the SCADA integration is not a relay protection engineer. This manual departs from the standard type of relay manual in that each data type is explained and each bit, byte and word meaning is explained. Several application examples are given within each section. A description of each protocol command is illustrated for the benefit of the user. Appendices are included detailing application notes, which augment the text. An explanation of the product's physical interfaces and the connectivity required is explored in depth. Explanations of register's uses to increase overall throughput are also explored. Throughput is always an issue when the system is commissioned. Understanding ways to improve the system data update is explained.

Several steps are required to permit successful communication between devices:

1. Identification of the hardware components (Section 2).
2. Correct physical connection between devices (Section 3).
3. Correct device configuration of port protocol and operation parameters (Section 4).
4. Generation and interpretation of the protocol command strings (Section 5).
5. Throughput evaluation and troubleshooting tips (Section 6).

The following sections shall explore the following procedures in depth when establishing a communication automation system, utilizing the DPU 2000R.

The DPU, DPU 2000 and DPU 2000R all have networking capabilities. The DPU has the most limited network capabilities whereas the DPU 2000R has the most expansive of connectivity options and array of protocols. Figure 1-1 shows the general look of the units as viewed from the front.

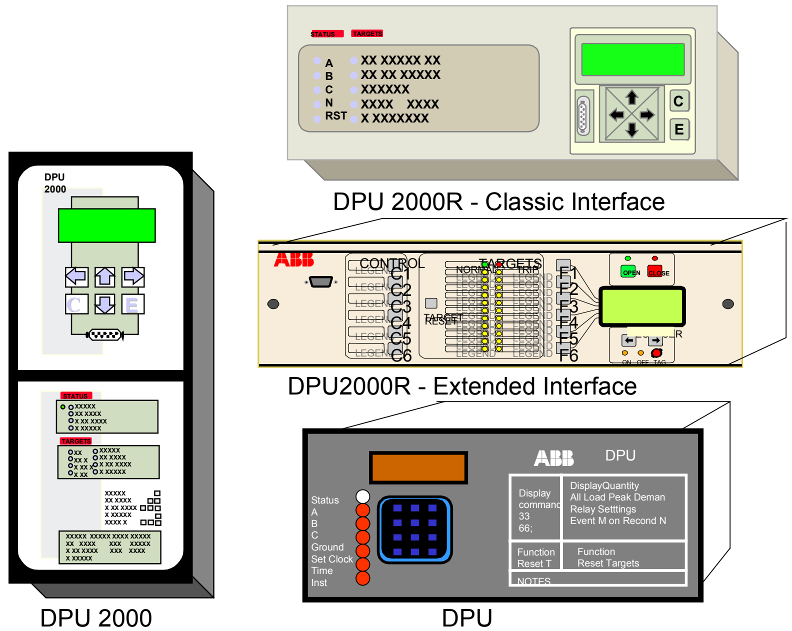


Figure 1-1. Distribution Protection Unit Product Family

The products differentiate themselves as listed in Table 1-1. Table 1-1 lists the available protocols within the relays. Standard Ten Byte is an ABB protocol which is within each of the protective relays. Standard Ten Byte is an asynchronous byte oriented protocol. The programming software (ECP [DOS External Communication Program] and WIN ECP [Windows External Communication Program]) allows configuration of the relay through a port on the units. Standard Ten Byte is available through an RS 232 or RS 485 port on the DPU.

INCOM is an ABB protocol, which is a derivative of Standard Ten Byte. It is a modulated synchronous bit stream using the same commands as in the Standard Ten Byte protocol. INCOM is available on each of the protective relays as indicated within Table 1-1. Its physical interface is proprietary in that the DPU node expects a modulated signal.

Serial Modbus is an industrial de-facto standard protocol, which has been widely embraced by the utility industry. Modbus has two emulation's, RTU, which is a synchronous protocol and ASCII which is an asynchronous protocol. Modbus uses only one command set, but two emulation's. Modbus strengths are that it uses a standard RS 232 or RS 485 interface to interconnect nodes on a network.

Network Modbus is an evolution of Serial Modbus in that it uses Ethernet as the mechanism to transfer the Modbus Serial packets across an Ethernet LAN. It is gaining in popularity in that several protocols and network transmissions may peaceably coexist on a single network cable. Network Modbus (or TCP/IP Modbus) has its own protocol conventions and is not merely initiation of an Ethernet TELNET session over the Local Area Network (LAN).

Modbus Plus is a hybrid protocol refinement of Modbus. Modbus Plus has a proprietary physical interface which is available to device manufacturers through a connectivity program with Groupe Schneider. The interface offers greater speed and communication features than Modbus.

DNP 3.0 is a protocol, which has its roots deep in the utility industry. It is an asynchronous protocol that allows connectivity through a standard RS 232 or RS 485 port. It includes such defined capabilities as file transfer, and timestamping as part of the protocol, which makes it desirable for a utility implementation. UCA is a newly emerging protocol based upon an object oriented device structure. UCA stand for Utility Communication Architecture. Instead of the traditional mindset of data access using address, index terminology, data is retrieved or modified by using predefined "names" to access or modify data. The hardware topology employed for this new protocol is Ethernet (just as that for Network Modbus), however the messaging structure and data access definitions are markedly different. Later sections shall explore the UCA construction from a hardware topology and a software access/control standpoint.

Table 1-1. Protocol Capabilities Listed by Product Type

Product	**Protocol**	**Notes**
DPU	TEXT ASCII COMMAND SCRIPT	Not Addressable RS 232 Only
DPU 2000	Standard Ten Byte	Addressable Front Com, Com 1 and Aux Com
	INCOM	2 Wire (AND SHIELD) Current Injection Physical Interface
	Modbus	RS 232 or RS 485
	DNP 3.0	RS 232 or RS 485
DPU 2000R	Standard Ten Byte	RS 232 or RS 485
	INCOM	2 Wire (AND SHIELD) Current Injection Physical Interface
	Serial Modbus	RS 232 or RS 485
	Modbus Plus	Proprietary Current Injection Physical Interface
	Network Modbus	Ethernet Interface Copper or Fiber Optic
	DNP 3.0	RS 232 or RS 485
	UCA	Ethernet Interface Copper or Fiber Optic
Product	**Protocol**	**Notes**
DPU	TEXT ASCII COMMAND SCRIPT	Not Addressable RS 232 Only

Within this document, only **DNP3.0** protocol shall be covered in depth. Modbus Plus, Modbus (Serial and Network Protocols) Standard 10 Byte, INCOM and UCA shall be explained superficially. If one would need to reference the specific details of Standard Ten Byte or INCOM protocols, please reference the engineering specifications concerning these topics in Appendix B of this document.

Section 2 - Communication Card Identification and Physical Port Characteristics

The communication connector at the front of the unit (near the target LED's) communicates to the ECP or WinECP configuration program. This communication port is referred to as COM 0 and is common to the DPU2000, DPU1500R and DPU2000R. The protocol emulated through this front port is an addressable emulation of Standard 10 Byte Protocol®. With the addition of a communication card option, the unit emulates the protocols described in Table 1-1. The inclusion of optional communication boards enables the rear ports (as shown in Figure 2-2) of their respective units.

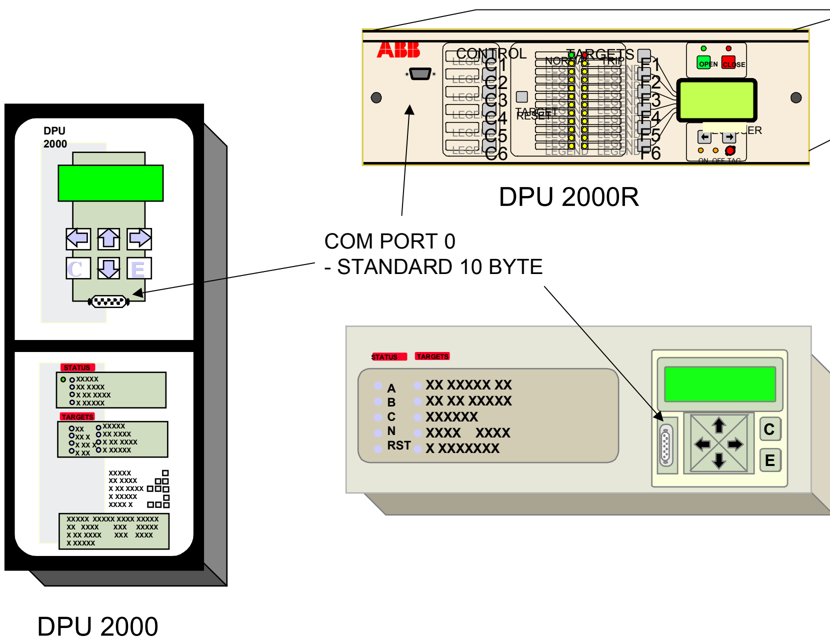


Figure 2-1. COM 0 Port Location

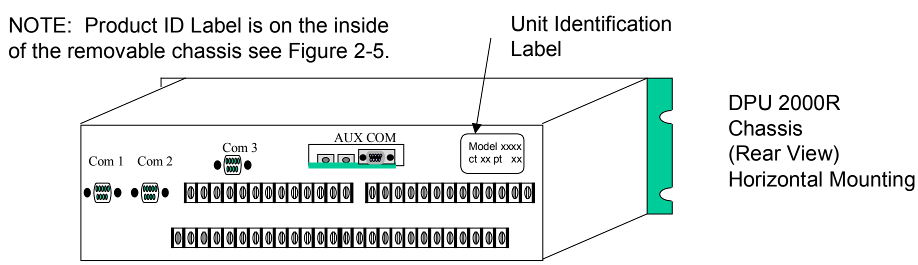
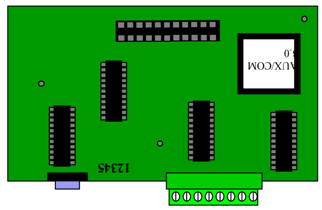
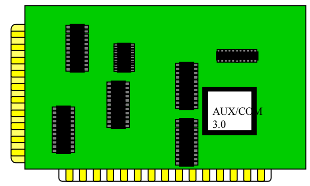


Figure 2-2. Physical Optional Communication Card Port Locations

The DPU2000, DPU1500R, and DPU2000R differ in physical appearance. The communication cards inserted within the unit also differ in form, fit and construction. A typical DPU2000, DPU1500R, and DPU2000R's communication card is illustrated in Figure 2-3 of this document. As shown, the DPU2000R has two physical interface connectors built onto the card. The form factor of these connectors are the industry common DB 9 and "Phoenix® 10 Position" connectors. The "Phoenix® 10 Position" connector has a capacity to land two 18 wire gauge conductors at each position. The DPU2000 has the communication port connectors fixed as part of the chassis. The physical card slot for housing the communication card is marked on the chassis as "COM". The communication card mates with internal connectors allowing electrical and physical connections for the communication card and chassis mounted physical connectors.



DPU1500R/DPU2000R COMMUNICATION CARD (TYPICAL)



DPU2000 COMMUNICATION CARD (TYPICAL)

Figure 2-3. DPU2000 and DPU1500R/DPU2000R Communication Cards

The DPU2000 Communication card is housed within a removable chassis. The communication card mates with edge card connectors located at the front and bottom of the removable chassis. Figure 2-4 illustrates the mounting location of the DPU2000 Communication Card. Figure 2-2 illustrates the communication port locations of the DPU2000, which may be configured to communicate with the protocols described in Section 1 of this document.

The DPU1500R/DPU2000R mates with the unit's main board to enable/disable COM Ports 1,2,3,and AUX COM. The communication cards physical interfaces protrude through the sheet metal back plate housing of the unit and allow for access to the physical connection ports. Figures 2-4 and 2-5 illustrates the location of the communication board assembly.

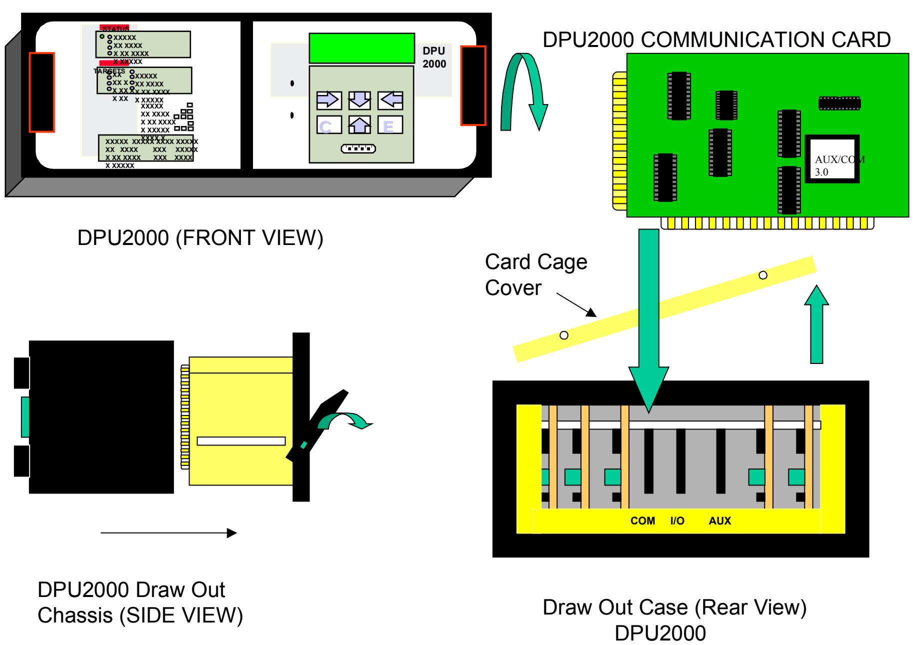


Figure 2-4. Physical Communication Card Location for the DPU2000

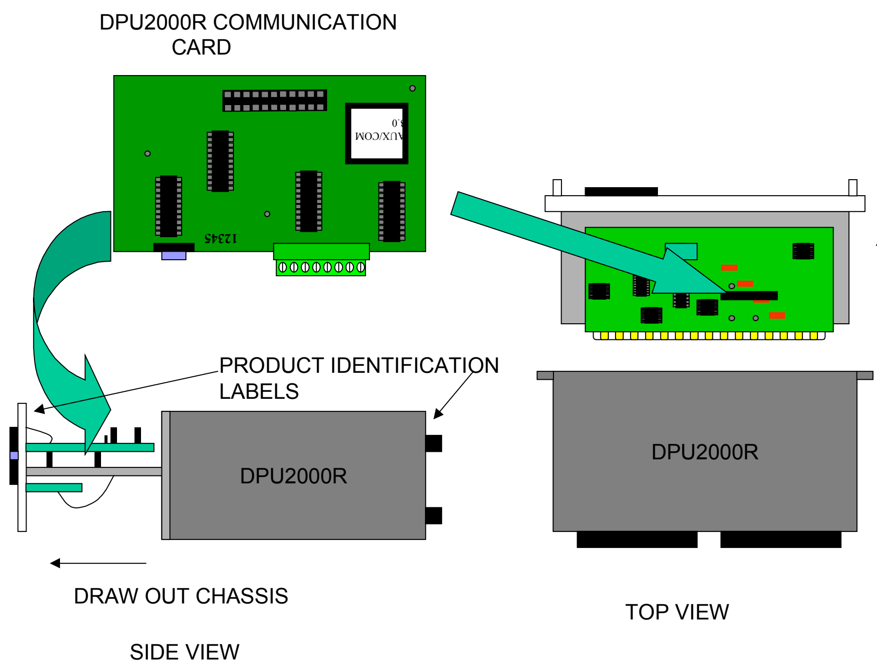


Figure 2-5. Physical Communication Card Location for the DPU1500R/DPU2000R

CAUTION: REMOVAL OF THE DRAW OUT CHASSIS COMPONENTS WILL DE-ENERGIZE THE ELECTRONICS OF THE UNIT THEREBY PREVENTING SYSTEM PROTECTION. EXTREME CARE MUST BE TAKEN WHEN REMOVING THE ELECTRONIC DRAWER FROM THE CHASSIS SINCE ALL PROTECTIVE RELAY FUNCTIONALITY WILL BE TERMINATED.

CAUTION: IF THE UNIT IS UNDER POWER- THE CT's ARE SHORTED INTERNALLY THROUGH THE CHASSIS INERTNAL CONNECTORS. HOWEVER, EXTREME CAUTION MUST BE EXERCISED WHEN REMOVING THE DRAW OUT CASE FROM AN ENERGIZED UNIT. ABB TAKES NO RESPONSIBILITY FOR ACTIONS RESULTING FROM AVOIDANCE OF THIS WARNING AND CAUTION NOTICE.

CAUTION: Sensitive electronic components are contained within the DPU2000 and DPU2000R/DPU1500R units. The individual removing the component boards from the fixed chassis must be grounded to the same potential as the unit. IF THE OPERATOR AND THE CASE ARE NOT CONNECTED TO THE SAME GROUND POTENTIAL, STATIC ELECTRICITY MAY BE CONDUCTED FROM THE OPERATOR TO THE INTERNAL COMPONENTS RESULTING IN DAMAGE TO THE UNIT.

Communication Card Part Number Options

The DPU2000, DPU1500R, and DPU2000R may be ordered with a variety of communication options as listed in Table 2-1. The communication option card installed in the unit is identified by the part number located on the unit or identified through the ECP, WinECP or Front Panel (LCD) interfaces.
The protocols available are:

- STANDARD TEN BYTE® – This is an ABB specific ASCII encoded (asynchronous) 10 byte communication protocol. It allows attainment of all relay parameters. It is the base unit protocol in which configuration programs such as ECP, and WinECP communicate to the DPU2000 or DPU2000R. It is the protocol standard for the COM 0 communication port of the DPU2000 and DPU2000R. Standard 10 Byte does not utilize a proprietary hardware physical interface. Appendix B includes the DPU2000 and DPU2000R/DPU1500R Standard 10 Byte Protocol Document.

- INCOM® – This is an ABB Specific bit oriented (synchronous) protocol. INCOM uses the same commands as Standard Ten Byte, but its inherent bandwidth utilization is far greater than Standard Ten Byte is in that no data encoding is required. INCOM only defined two baud rates 9600 and 1200. INCOM is a proprietary interface in that its physical presentation to the communication medium is dependent upon the baud rate selected. 1200 Baud uses current injection baseband signal presentation, whereas 9600-Baud implements a phase shift frequency in its representation of digital 1 and 0 values. Appendix B includes the DPU2000 and DPU2000R/DPU1500R Standard Ten Byte Protocol document which describes INCOM in further detail.

- DNP 3.0® – This is a Utility industry standard protocol allowing communication between a host and slave devices. DNP 3.0 is a byte oriented (asynchronous) protocol which is physical interface device independent. The protocol allows for time synchronization, and unsolicited event reporting. It is a very popular protocol in utility installations. The discussion of DNP 3.0 protocol is included in this document.

- SPACOM® – This is an ABB Specific byte oriented (asynchronous) protocol common in Europe. It is a Master-Slave protocol which is implemented on a variety of physical interfaces. SPACOM protocol is not covered within this document.

- SERIAL MODBUS® – This is an Industrial standard. The protocol allows a single master device to communicate with several slave devices. It has gained wide acceptance in that a great majority of utility devices incorporate Modbus protocol. Modbus Protocol is physical interface independent. Modbus Protocol has two emulation's RTU (a synchronous bit oriented emulation) and ASCII (an asynchronous byte oriented emulation). The DPU2000 and DPU2000R may be configured for both emulations. The discussion of Modbus protocol is included in this document. Please reference the DPU2000 and DPU2000R Modbus/Modbus Plus Automation Technical Guide TG 7.11.1.7-51 for a discussion of this protocol.

- MODBUS PLUS® – This protocol is also and industrial standard. Modbus Plus allows up to 64 devices to communicate among each using token passing techniques. The Modbus Plus protocol is fast (1 megabaud) and uses several advanced techniques to maximize bandwidth. The physical interface to Modbus Plus is proprietary and regulated by Groupe Schneider. Modbus Plus is the incorporation of Modbus commands on a HDLC®- like protocol using a current injection interface. The discussion of Modbus Plus protocol is not included in this document. Please reference the DPU2000 and DPU2000R Modbus/Modbus Plus Automation Technical Guide TG 7.11.1.7-51 for a discussion of this protocol. **(AVAILABLE ON THE DPU2000R ONLY)**.

- PG&E® – This protocol is a bit oriented asynchronous protocol allowing a Master Device to communicate with several slave devices. PG&E protocol is a Utility protocol. The protocol is not described in this document **(AVAILABLE ON THE DPU2000R ONLY**).

- NETWORK MODBUS – This protocol is derived from the Modbus protocol and is an extension of the protocol on an Ethernet MMS Transport Layer. It is also gaining wide acceptance since it is used frequently with Programmable Logic controllers found commonly in Industrial and Utility applications.

- UCA – This evolving protocol is based upon an Ethernet standard in which each of the elements within the protocol are object oriented. This next step in network protocol architecture allows the device to be self reporting with regard to the protocol objects defined in the device.

The device configuration for the DPU2000 is illustrated in Tables 2-1 and 2-2 illustrating the configuration options. The generic part number for the DPU2000 is 4 8 7 M R X D Z – C S S S Q. Deciphering the part numbers: found on the labels of the unit or obtained through ECP or the Front Panel LCD Interface, allows easy identification of the communication options found on the unit.

Table 2-1. DPU2000 Communication Options

IF PART NUMBER POSITION "Z" IS	THE DPU2000 HAS AN INSTALLED OPTION For unit 4 8 7 M R X D **Z** – C S S S Q (COMMUNICATION PHYSICAL INTERFACE OPTION)
1	RS232 (COM 3) Isolated Port Enabled
2	RS485 (AUX COM PORT) and RS232 (COM 3) Ports Enabled
3	INCOM (AUX COM PORT) Enabled
4	RS485 (AUX COM PORT) Ports Enabled
IF PART NUMBER POSITION "Q" IS	**THE DPU2000 HAS AN INSTALLED OPTION** **For unit** 4 8 7 M R X D C – Z S S S **Q** (COMMUNICATION PHYSICAL INTERFACE OPTION)
0	STANDARD TEN BYTE
1	DNP 3.0
2	SPACOM
4	MODBUS

Table 2-2. DPU2000 Communication Card Matrix for Unit 4 8 7 M R X D Z – C S S S Q

"Z" Digit	"Q" Digit	COM 3	AUX COM RS485	INCOM	IRIG B
1	0	Standard 10 Byte **RS232**			
2	0	Standard 10 Byte **RS232**	Standard 10 Byte		Available
2	1	Standard 10 Byte or DNP 3.0 **RS232**	Standard 10 Byte or DNP 3.0		Available *
2	2	Standard 10 Byte **RS232**	SPACOM		
2	4	Standard 10 Byte or Modbus **RS232**	Standard 10 Byte or Modbus		Available
3	0			Available	Available
4	0		Standard 10 Byte	Available	Available
4	1		DNP 3.0	Available	Available *
4	2		SPACOM		
4	4		Modbus	Available	Available
5	0		Standard 10 Byte		
* NOTE: Must Have Version 4.4 or later for IRIG B availability. Not available on earlier versions.					

The device configuration for the DPU2000R is illustrated in Tables 2-3 and 2-4 illustrating the configuration options. The generic part number for the DPU2000 is 4 8 7 X X X Y Z – X X X X Q. Deciphering the part numbers: found on the labels of the unit or obtained through ECP or the Front Panel LCD Interface, allows easy identification of the communication options found on the unit.

Table 2-3. DPU2000R Communication Options

IF PART NUMBER POSITION "Y" IS	THE DPU 2000R HAS AN INSTALLED OPTION For unit 587 X X X Y Z – X X X X Q (X = Don't Care) (FRONT PANEL INTERFACE OPTION)
0	Horizontal Unit Mounting – NO FRONT PANEL LCD INTERFACE
1	Horizontal Unit Mounting – FRONT PANEL LCD INTERFACE IS INCLUDED
2	Horizontal Enhanced OCI – FRONT PANEL LCD AND PUSHBUTTON INTERFACE INCLUDED
3	Horizontal Enhanced OCI – FRONT PANEL LCD AND PUSHBUTTON INTERFACE INCLUDED with Hot Line Tagging.
5	Vertical Unit Mounting – NO FRONT PANEL LCD INTERFACE
6	Vertical Unit Mounting – FRONT PANEL LCD INTERFACE IS INCLUDED
7	Vertical Enhanced OCI – FRONT PANEL LCD AND PUSHBUTTON INTERFACE INCLUDED
8	Vertical Enhanced OCI – FRONT PANEL LCD AND PUSHBUTTON INTERFACE INCLUDED with Hot Line Tagging.

IF PART NUMBER POSITION "Z" IS	**THE DPU 2000R HAS AN INSTALLED OPTION** **For unit** 587 X X X Y **Z** – X X X X Q (X = Don't Care) (COMMUNICATION PHYSICAL INTERFACE OPTION)
0	RS 232 (COM 1) Non-isolated Port is active on the unit
1	RS 232 (COM 2) Isolated Port Only is active on the unit (SEE NOTE)
2	RS 485 (AUX COM PORT) and RS 232 (COM 3) Ports on Option Card.
3	INCOM (AUX COM PORT) and RS 485 (AUX COM PORT) Ports on Option Card
4	INCOM (AUX COM PORT) and RS 485 (AUX COM PORT) Ports on Option Card
5	RS 485 (AUX COM PORT) Port On Option Card
6	Modbus Plus Port (COM 3) on the Option Card
7	Modbus Plus (COM 3) and RS 485 (AUX COM PORT) on the Option Card
8	RS 485 (COM 3) and RS 485 (AUX COM PORT) Ports on the Option Card
E	Ethernet Fiber Optic and Copper Option Card
	NOTE: * = If the option denoted in part number position "Y" is a 0 or 5, the COM 2 port is enabled. If the option denoted in part number position "Y" is a 1 or 5 the COM 2 Port is enabled.
IF PART NUMBER POSITION "Q" IS	**THE DPU 2000R HAS AN INSTALLED OPTION** **For unit** 587 X X X Y Z – X X X X **Q** (X = Don't Care) (COMMUNICATION PHYSICAL INTERFACE OPTION)
0	STANDARD TEN BYTE
1	DNP 3.0
2	SPACOM
3	PG&E
4	SERIAL MODBUS /NETWORK MODBUS PLUS/MODBUS PLUS (Depending on hardware interface selected in Position Z)
6	UCA
7	NETWORK MODBUS AND UCA

Table 2-4. DPU1500R Communication Options

IF PART NUMBER POSITION "Y" IS	**THE DPU1500R HAS AN INSTALLED OPTION** **For unit** 5 7 7 X X X **Y** Z – X X X X Q (X = Don't Care) (FRONT PANEL INTERFACE OPTION)
0	Horizontal Unit Mounting – No front panel LCD interface.
1	Horizontal Unit Mounting – Front panel LCD interface is included.
5	Vertical Unit Mounting – No front panel LCD interface.
6	Vertical Unit Mounting – Front panel LCD interface is included.
IF PART NUMBER POSITION "Z" IS	**THE DPU1500R HAS AN INSTALLED OPTION** **For unit** 5 7 7 X X X Y **Z** – X X X X Q (X = Don't Care) (COMMUNICATION PHYSICAL INTERFACE OPTION)
0	RS232 (COM 1) Non-Isolated Port is active on the unit.
1	RS232 (COM 2) Isolated Port Only is active on the unit. (SEE NOTE)
2	RS485 (AUX COM PORT) and RS232 (COM 3) Ports on Option Card.
3	INCOM (AUX COM PORT) and RS485 (AUX COM PORT) Ports on Option Card.
4	INCOM (AUX COM PORT) and RS485 (AUX COM PORT) Ports on Option Card.
5	RS485 (AUX COM PORT) Port On Option Card.
	NOTE: * = If the option denoted in part number position "Y" is a 0 or 5, the COM 2 port is enabled, if the option denoted in part number position "Y" is a 2 or 6 the COM 2 Port is disabled.
IF PART NUMBER POSITION "Q" IS	**THE DPU1500R HAS AN INSTALLED OPTION** **For unit** 5 7 7 X X X Y Z – X X X X **Q** (X = Don't Care) (COMMUNICATION PHYSICAL INTERFACE OPTION)
0	STANDARD TEN BYTE
1	DNP 3.0
4	Modbus (Depending on hardware interface selected in Position Z)

Table 2-5. DPU2000R Communication Card Matrix for Unit 5 8 7 X X X Y Z – X X X X Q

"Z" Digit	"Q" Digit	COM 1 RS 232	COM 2 RS 232	COM 3	AUX COM	INCOM	IRIG B
0	0	Note 1	Standard 10 Byte				
1	0	Note 1		Standard 10 Byte **RS 232**			
2	0	Note 1		Standard 10 Byte **RS 232**	Standard 10 Byte **RS 485**		AVAILABLE
2	1	Note 1		Standard 10 Byte or DNP 3.0 **RS 232**	Standard 10 Byte or DNP 3.0 **RS 485**		AVAILABLE (NOTE 3)
2	2	Note 1		Standard 10 Byte **RS 232**	SPACOM **RS 485**		
2	4	Note 1		Standard 10 Byte or Modbus **RS 232**	Standard 10 Byte or Modbus **RS 485**		AVAILABLE
3	0	Note 1				AVAILABLE	AVAILABLE
4	0	Note 1			Standard 10 Byte **RS 485**	AVAILABLE	AVAILABLE
4	1	Note 1			DNP 3.0 **RS 485**	AVAILABLE	AVAILABLE (NOTE 3)
4	2	Note 1			SPACOM **RS 485**		
4	4	Note 1			Modbus **RS 485**	AVAILABLE	AVAILABLE
5	0	Note 1			Standard 10 Byte **RS 485**		
6	4	Note 1	Standard 10 Byte	Modbus Plus			
7	4	Note 1		Modbus Plus	Standard 10 Byte **RS 485**		
8	0	Note 1		Standard 10 Byte **RS 485**	Standard 10 Byte **RS 485**		AVAILABLE
8	1	Note 1		Standard 10 Byte or DNP 3.0 **RS 485**	Standard 10 Byte or DNP 3.0 **RS 485**		AVAILABLE (NOTE 3)
8	4	Note 1		Standard 10 Byte or Modbus **RS 485**	Standard 10 Byte or Modbus **RS 485**		AVAILABLE
E	4	Note 1			Network Modbus **Ethernet Copper or Ethernet Fiber Optic**		
E	6	Note 1			UCA **Ethernet Copper or Ethernet Fiber Optic**		
E	7	Note 1			UCA or Network Modbus **Ethernet Copper or Ethernet Fiber Optic** Note 2		

NOTE 1: Enabled Standard 10 Byte if Digit "Y" is 0 or 5. Front Panel Interface not included. Unavailable if Digit "Y" is 1, 2, 3, 4, 6, 7, or 8.
NOTE 2: Only one port Copper or Fiber Optic is enabled, both protocols co-exist on the same medium.
NOTE 3: Requires DNP Chipset AUX0XX1 version 4.4 or later to enable the IRIG B via the AUX COM PORT.

The visual identification of a DPU1500R/DPU2000R communication card is completed through visual inspection of the card component location and of the part number of the base printed circuit board as illustrated in Table 2-6.

Table 2-6. DPU1500R/DPU2000R Communication Card Matrix

"Z" Digit	Raw Circuit Board Part Number	Components To Look For
1	COMM 485 PCB 613709-005 REV0	Parts near black 9 pin 232 connector are populated
2	2000R AUX COM 613708-005 REV0	Parts in middle of board are not populated –2 DC/DC Converters (U1 & U8)
3	AUX COM 613708-005 REV0	Only parts in middle of board – no DC/DC Converters, has Transformer T2
4	AUX COM 613708-005 REV0	Parts near black 9 pin 232 connector are not populated – only 1 DC/DC Converter (U1)
5	COMM 485 PCB 613709-005 REV0	Parts near green connector are populated
6	MODBUS COMM PCB 613720-002 REV1	RS-485 option parts NOT populated (area inside dotted border)
7	MODBUS COMM PCB 613720-002 REV1	Fully populated
8	AUX & AUX 613755-002 REV0	Fully populated
E	PRIME/ETHERNET/UCA 613850-T1	--

Table 2-7. DPU1500R Communication Card Matrix for Unit 5 7 7 X X X Y Z – X X X X Q

"Z" Digit	"Q" Digit	COM 1 RS232	COM 2 RS232	COM 3	AUX COM RS485	INCOM	IRIG B
0	0	Note 1	Standard 10 Byte				
1	0	Note 1		Standard 10 Byte **RS232**			
2	0	Note 1		Standard 10 Byte **RS232**	Standard 10 Byte		Available
2	1	Note 1		Standard 10 Byte <u>or</u> DNP 3.0 **RS232**	Standard 10 Byte <u>or</u> DNP 3.0		Available (NOTE 2)
2	4	Note 1		Standard 10 Byte or Modbus **RS232**	Standard 10 Byte or Modbus		Available
3	0	Note 1				Available	Available
4	0	Note 1			Standard 10 Byte	Available	Available
4	1	Note 1			DNP 3.0	Available	Available (NOTE 2)
4	4	Note 1			Modbus	Available	Available
5	0	Note 1			Standard 10 Byte		

NOTE 1- Available if Digit "Y" is 0 or 5.Front Panel Interface not included. Unavailable if Digit "Y" is 1 or 6.
NOTE 2 – Available if version chipset AUX 0XX1 Version 4.4 is used. Unavailable for earlier versions.

Unit Communication Card Verification

There are several ways to identify the communication cards inserted in the DPU2000 or DPU2000R/DPU1500R units. Some of the methods require the unit to be powered up. Other methods require the unit to be taken out of service.

To identify the unit part number of the present DPU2000 or DPU2000R/DPU1500R, the following steps may be executed to facilitate unit identification.

1. With the unit energized, if the unit has a Classic Front Panel LCD (Refer to Tables 2-1 through 2-4 inclusive for identification) Interface:

    1. Depress the "E" Key.
    2. Depress the Arrow Down Key "↓" once to highlight the SETTINGS field. Depress the "E" Key.
    3. Depress the Arrow Down Key "↓" twice to highlight the UNIT INFORMATION field. Depress the "E" key.
    4. The Serial Number and Catalog Number shall be displayed.

    If the unit has the Enhanced OCI Front Panel Interface, (Refer to Tables 2-1 through 2-4 inclusive for identification).

    1. While viewing the metering menu, depress the F1 <MENU> function key.
    2. Depress the F2 MAIN MENU function key.
    3. Depress the F6 <PAGE DOWN> function key to view the remaining menu selections.
    4. Depress the F4 Unit Information Function key to view the UNIT INFORMATION. Since all the information cannot be displayed on the screen, depress the F6 <PAGE DOWN> key to display all UNIT INFORMATION.
    5. Depress the F1 Function Key, five times to return to the metering screen.

    If the Unit does not have a Front Panel LCD Interface (Refer to Tables 2-1 through 2-4 inclusive for identification) and the user has DOS ECP or if the user wishes not to use the unit's Front Panel LCD Interface:

    1. Start ECP.
    2. Select the appropriate communication parameters so that the personal computer attached to the DPU2000 or DPU2000R will communicate via the null modem cable connection. (See Figure 3-3 or Figure 3-4)
    3. Depress enter to allow attachment of the unit.
    4. The Serial Number and Catalog Number shall be displayed.

    If the Unit does not have a Front Panel LCD Interface (Refer to Tables 2-1 through 2-4 inclusive for identification) and the user has WINECP or if the user wishes not to use the unit's Front Panel Interface:

    1. Start WINECP.
    2. Depress the "DIRECT ACCESS" selection button presented in the pop-up window.
    3. Depress the "CONNECT" option selection presented within the pop-up window.
    4. Select the "HELP" Menu option at the top right-hand section of the menu bar.
    5. Select the Drag-Down Menu item "UNIT INFORMATION".
    6. A pop-up window shall appear with the Serial Number and Catalog Number.

2. At the back of the DPU2000, DPU1500R or the DPU2000R chassis, in the left-hand lower section of the unit, a label shall appear indicating the serial number and model number of the unit. It should match the data presented in the ECP, WinECP or Front Panel Interface (FPI) Menus. If it does not, please contact the factory.

3. As a final check, if the DPU2000, DPU1500R or DPU2000R can be powered-down or if protection can be interrupted, loosen the front panel screws at the front of the unit. Remove the product component drawer from the chassis. Face the front panel interface, and rotate the board so that the semiconductor components are directly visible. On the backside of the metal panel supporting the Front Panel Interface, a label shall be available indicating the serial number and model number. These numbers should match those obtained in steps 1 and 2. If they do not, please contact the factory.

Section 3 - DPU2000, DPU1500R and DPU2000R Device Connectivity

Communication between devices is only possible through connectivity of the units through a physical media interface. There are two physical interface types on a DPU2000R and a DPU2000. Table 3-1 lists the characteristics for each of the port types. Those physical interfaces are:

- RS232 (isolated and non-isolated)
- RS485 (isolated)

Table 3-1. Physical Interface Options

	DPU1500R/2000R	DPU2000	Notes
COM 0	RS232 Non Isolated	RS232 Non Isolated	Front Port Standard 10 Byte
COM 1	RS232 Non Isolated		Standard 10 Byte Only
COM 2	RS232 Non Isolated		Standard 10 Byte Only
COM 3	RS232 Isolated/RS485 Isolated or Modbus Plus	RS232 Isolated	DPU2000R – Communication Option Card Determines Physical Interface
AUX COM	RS485 (Isolated) and/or INCOM or 10 Base T/10 Base FL Ethernet	RS485 (Isolated) and/or INCOM	Physical Interface Dependent on Communication Option Card Interface Selected

RS232 Interface Connectivity

RS232 is perhaps the most utilized and least understood communication interface in use. RS232 is sometimes misinterpreted to be a protocol; it is in fact a physical interface. A physical interface is the hardware and network physical media used to propagate a signal between devices. Examples of physical interfaces are RS232 serial link, printer parallel port, current loop, V. 24, IEEE® Bus… Examples of network media are, twisted copper pair, coaxial cable, free air…

RS232 gained widespread acceptance due to its ability to connect to another RS232 device or modem. A modem is a device, which takes a communication signal and modulates it into another form. Common forms of modems include telephone, fiber optic, microwave, and radio frequency. Modem connectivity allows attachment of multiple devices on a communication network or allows extension of communication distances in a network with two nodes. Physical connection of two devices or more than two devices require differing approaches. Figure 3-2illustrates a topology using two devices (point to point topology). Figure 3-3 illustrates a multi-drop topology between many nodes. RS232 was designed to allow two devices to communicate without using intermediate devices.

Port Isolation

Network installation within a substation requires special considerations. A substation environment is harsh in that high levels of electromagnetic interference are present. Additional ground currents are present in such installations. RS232 is an unbalanced network in that all signals are referenced to a common ground. On longer cable runs, the potential of the signals at the sending device can be significantly lower than at the receiving end due to electrical interference and induced ground current. This increases with long runs of cable and use of unshielded cable. ABB's Substation Automation and Protection Division recommends the length of RS232 cable be less than 10 feet (3 meters) for an un-isolated port and that the cable be shielded. Internal to a typical device, the RS232 transceivers are referenced to the electronic components internal ground. Any electrical interference could be coupled through the chip set and fed back to the device. Typical isolation ratings of a non-isolated port could be as low as 1 volt. Such a port could allow electrical feedback of noise to the electronics for any signal interference over 1 volt.

Coms 0 through 2 on DPU/TPU/GPU units are non-isolated. However an RS232 implementation on COM 3 uses opto-isolation technology which increases electrical isolation from the port to the devices internal circuitry to 2.3 kV. It is highly desirable to utilize this port in connection to devices in longer cable runs and dedicated communication networks. RS232 isolated ports are limited in connection distance for a maximum of fifty feet. Additionally, the AUX COM RS 485 port is optically isolated. An example of IED isolation is shown in Figure 3-1.

Optically isolated ports offer the advantages of port isolation which are usually found in more expensive installations using external optic technology.

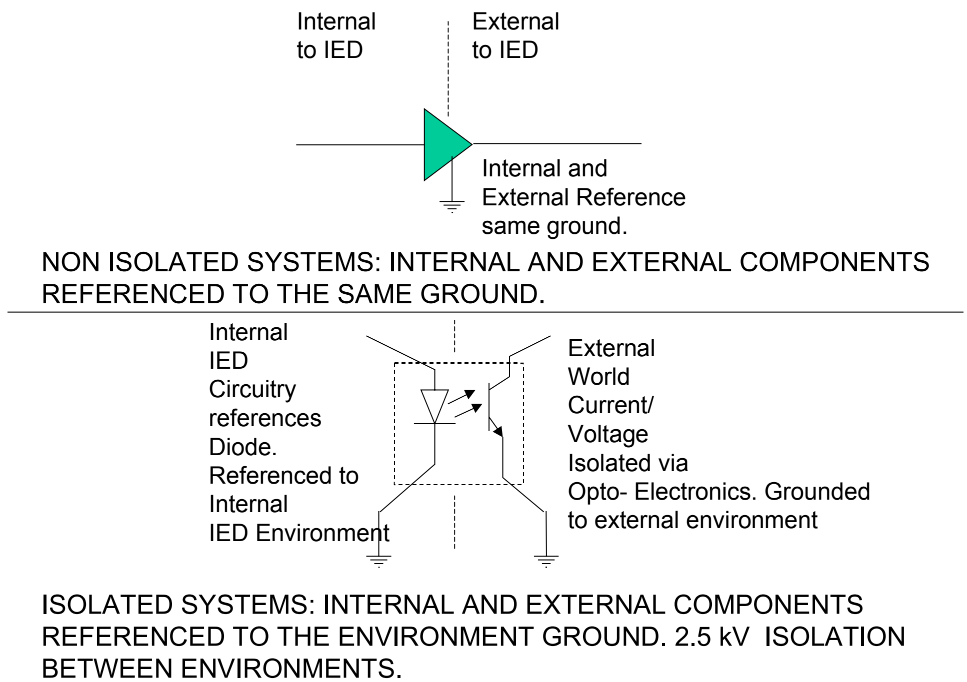


Figure 3-1. Optical Port Isolation Example

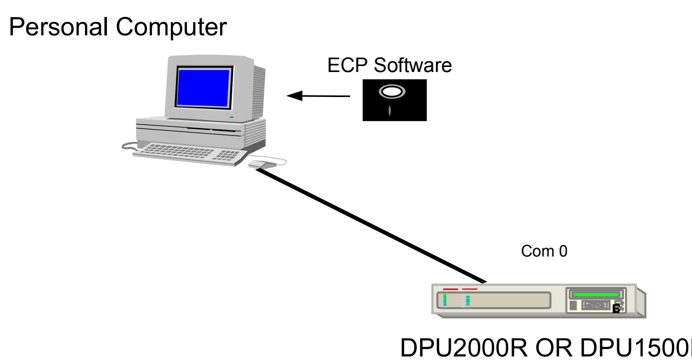


Figure 3-2. Point to Point Architecture Using RS232

RS232 Handshaking Defined

Handshaking is the ability of the device to control the flow of data between devices. There are two types of "handshaking", hardware and software. Hardware handshaking involves the manipulation of the RTS (Request to Send) and CTS (Clear to Send) card control signal lines allowing data communication direction and data flow rates to be controlled by the DTE device. Also the flow is controlled by the DTR (Data Terminal Ready) signal which allows the DCE operation.

Software handshaking involves the data flow control by sending specific characters in the data streams. To enable transmission, the XON character is transmitted. To disable reception of data, the transmitting device sends an XOFF character. If the XOFF character is imbedded within the data stream as information, the receiving node automatically turns off. This is the main weakness of software handshaking, inadvertent operation due to control characters being imbedded within data streams. Software handshaking is usually used in printer control.

The DPU2000, DPU1500R and DPU2000R devices do not incorporate handshaking, therefore, the control lines may be ignored as illustrated in Figure 3-4. However, some PC software utilizes handshaking, thus the port on the personal computer may require a special hardware configuration of the cable to the port. Consult with the software vendor to determine RS232 control and buffering requirements and the need for signal jumpers required in RS232 cabling.

The ports on the DPU/TPU/GPU have been tested for operation up to a speed of 19,200 baud. 19,200 baud is the typical data rate applicable for the operation of an asynchronous communication connection over RS232 without the use of additional timing lines.

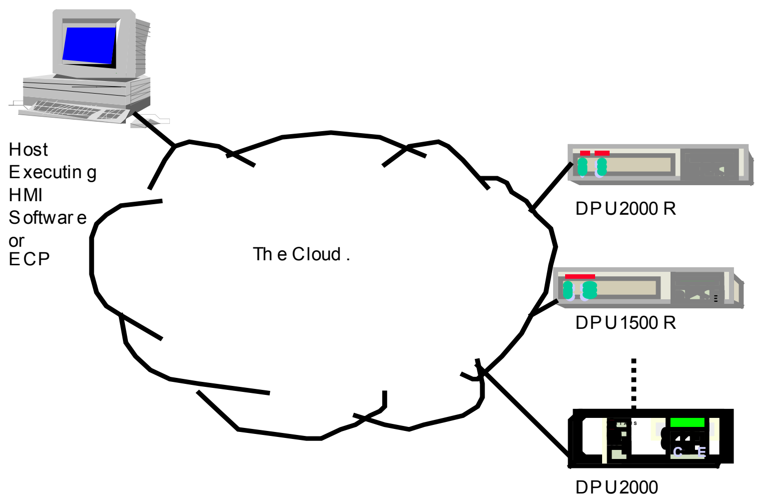


Figure 3-3. Multi-Drop Topology Using RS232

RS232 Cable Connectivity

A cable diagram is illustrated in Figure 3-4 and 3-5. Figure 3-4 shows the direction of communication signal transmission and the gender of the connectors used in constructing a communication cable. It is important to realize that the Enhanced Panel OCI Com 0 port offers a DCE Port, whereas the traditional Front Panel Interface offers a DTE Port. Take care to use the proper cable for communication connectivity as illustrated.

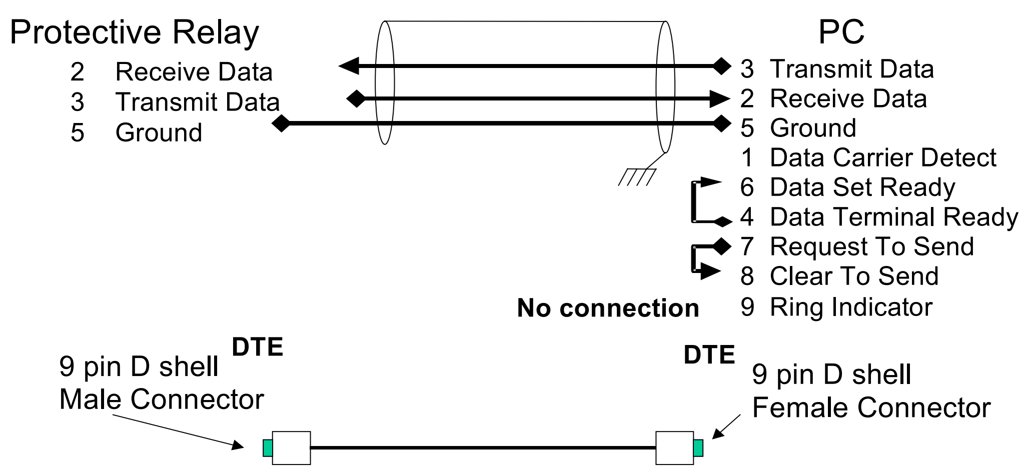


Figure 3-4. 9 Pin RS232-DTE-DTE Connector – Classic DPU

An RS232 interface was designed to simplify the interconnection of devices. Definition of terms may demystify issues concerning RS232 interconnection. Two types of RS232 devices are available, DTE and DCE. DTE stands for **D**ata **T**erminal **E**quipment whereas DCE stands for **D**ata **C**ommunication **E**quipment. These definitions categorize whether the device originates/receives the data (DTE) or electrically modifies and transfers data from location to location (DCE). Personal Computers are generally DTE devices while line drivers/modems/converters are DCE devices. DPU/TPU/GPU devices have RS232 DTE implementation. Generally, with a few exceptions, a "straight through cable" (a cable with each pin being passed through the cable without jumping or modification) will allow a DTE device to communicate to a DCE device.

Connection of a PC to a DPU2000, DPU1500R, or DPU2000R requires cable modification since the interconnected devices are both DTE. The same cabling would be utilized if one would connect two DCE devices. The classifications of DTE/DCE devices allow the implementers to determine which device generates the signal and which device receives the signal. Studying Figure 3-4, Pins 2 and 3 are data signals, pin 5 is ground whereas pins 1,6,7,8,9 are control signals. The arrows illustrate signal direction in a DTE device. The DPU2000, DPU1500R and DPU2000R series of protective devices do not incorporate hardware or software “handshaking”. If a host device has an RS232 physical interface with a DB 25 connector, reference Figure 3-5 for the correct wiring interconnection.

Note the Enhanced Front Panel Interface Port 0 uses a straight through cable illustrated in Figure 3-4a. The Classic Interface Port 0 uses a “Null Modem” cable illustrated in Figure 3-4.

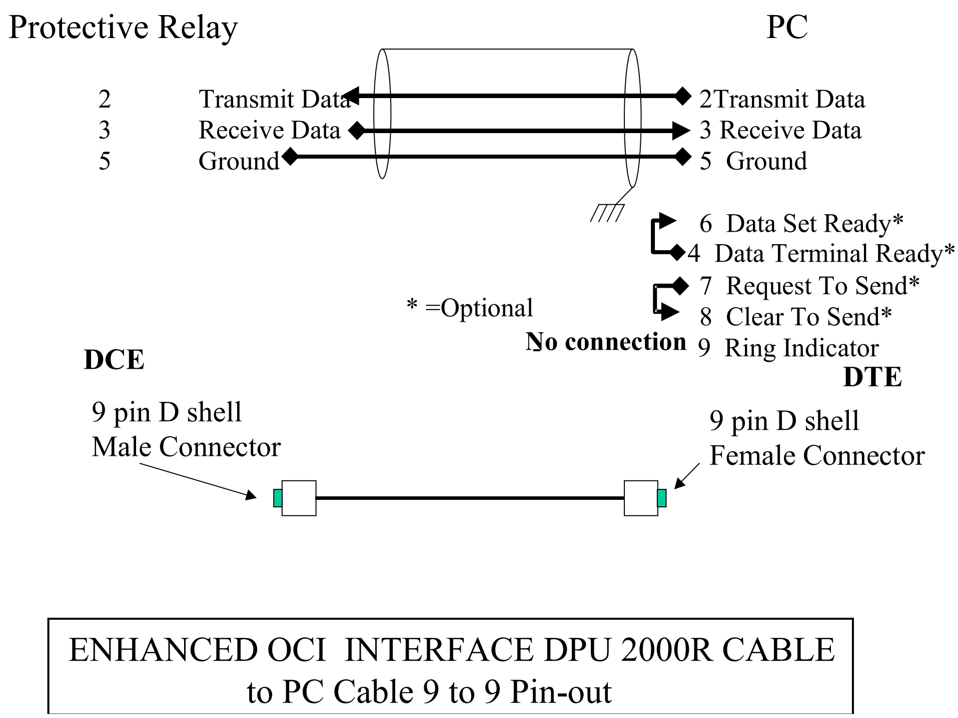


Figure 3-4A. Enhanced OCI DPU2000R DB 9 RS232 Cable Diagram

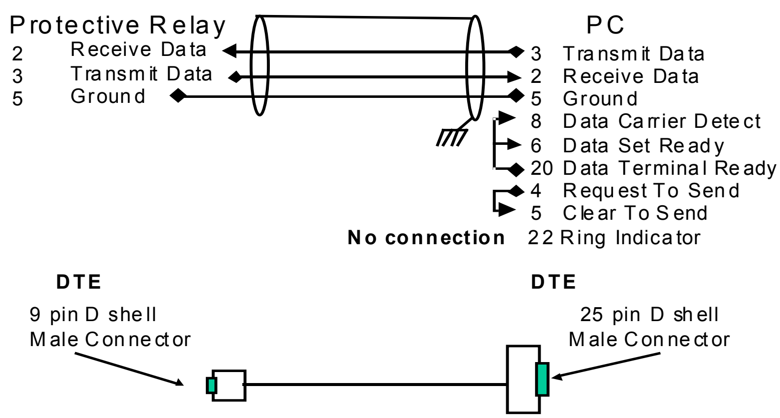


Figure 3-5. Connection of a DB 25 Connector to a DPU2000, DPU1500R or DPU2000R

RS485 Device Connectivity with the DPU2000 and DPU2000R

RS485 is one of the more popular physical interfaces in use today. It was developed as an enhancement of the RS422 physical interface. Its inherent strength is its ability to transmit a message over a twisted pair copper medium of 3000 feet in length. An RS485 interface is able to transmit and receive a message over such a distance because it is a balanced interface. That is, it does not reference the signal to the system's electrical ground, as is the case in an RS232 interface. RS485 references the communication voltage levels to a pair of wires isolated from system ground. Depending on the manufacturer's implementation, isolation may be optical or electronic. RS485 has two variants, two wires and four-wire. In the two-wire format, communication occurs over one single wire pair. In four-wire format, communication occurs over two wire pairs, transmit and receive. The two-wire format is the most common in use. The DPU2000, DPU1500R and DPU2000R support half duplex two-wire format only. The RS485 port is also optically isolated to provide for 3000 V of isolation.

The RS485 network supported and recommended by ABB requires the use of three conductor shielded cable. Suggested RS485 cable and the respective manufacturer's wire numbers are:

- ALPHA 58902
- Belden 9729
- Belden 9829
- Carol 58902

ABB does not support deviations from the specified cables. The selected cable types listed are of the type which have the appropriate physical and electrical characteristics for installation in substation environments.

A multi-drop RS485 connection is illustrated in Figure 3-3. Three wires, Positive (Terminal 9), Negative (Terminal 8) and Ground (Terminal 10). RS485 requires a termination resistor at each end of the communication cable. The resistance shall be from 90 to 120 ohms. Additionally, depending upon the RS485 physical interface converter used, a pull-up and pull-down resistor may be added to bias the line to decrease the amount of induced noise coupled onto the line when no communications are occurring. Internal to the DPU2000, DPU1500R and DPU2000R are jumpers which when inserted in the proper position (as referenced in Figure 3-6), bias the line by inserting the proper pull-up, pull-down, and termination resistors. To configure the Jumpers J6, J7, and J8, execute the following procedure:

- Face the front of the DPU2000 and DPU2000R and loosen the two knurled screws at the front of the unit.
- Grasp the two handles at the front of the unit and pull it towards you. The DPU2000 and DPU2000R has make before break contacts in the CT connectors. Powering down the unit need not be done when performing this step.
- Refer to Figure 3-6 illustrating the placement of J6, J7 and J8. J6 inserts a 120 ohm resistor between transmit and receive lines. J7 and J8 inserts a pull-up and pull-down resistor. The IN position inserts the associated resistor in to the circuit. The OUT position removes the resistor from the circuit.
- Insert the DPU2000 and DPU2000R unit into the chassis.
- Tighten the knurled screws at the front of the unit.
- It is advisable to place a sticker on the front of DPU2000, DPU1500R and DPU2000R indicating that it is a terminated end of line unit.

CAUTION: Removal of the chassis will <u>not</u> allow for relay protection by the DPU2000/DPU2000R. Backup protection must be enabled via alternate devices to insure line protection.

The following example illustrates an interconnection of the DPU2000 and DPU2000R with a host device through a UNICOM physical interface connection using a 3-wire connection method. It should be noted that the RS485 design on ABB relay products incorporates isolation. That is, the RS485 ground is electrically isolated from the internal circuitry thereby assuring minimal interference from the extreme noise environments found in a substation. Care should be used when installing an RS485 communication network. The recommended configuration must be followed as shown in Figure 3-6, 3-7, 3-8, and 39. Jumpers J6, J7, and J8 should be inserted to provide termination and pull-up at the DPU2000 and DPU2000R end. Although not shown, a 120 ohm resistor should be inserted between the TX/RX + and TX/RX- pairs to provide for termination at the transmission end.

If a Type 8 board is used and termination is required on the COM 3, implementation of the RS485 performs the previously described steps substituting J16, J17, and J18 for jumpers J6, J7, and J8.

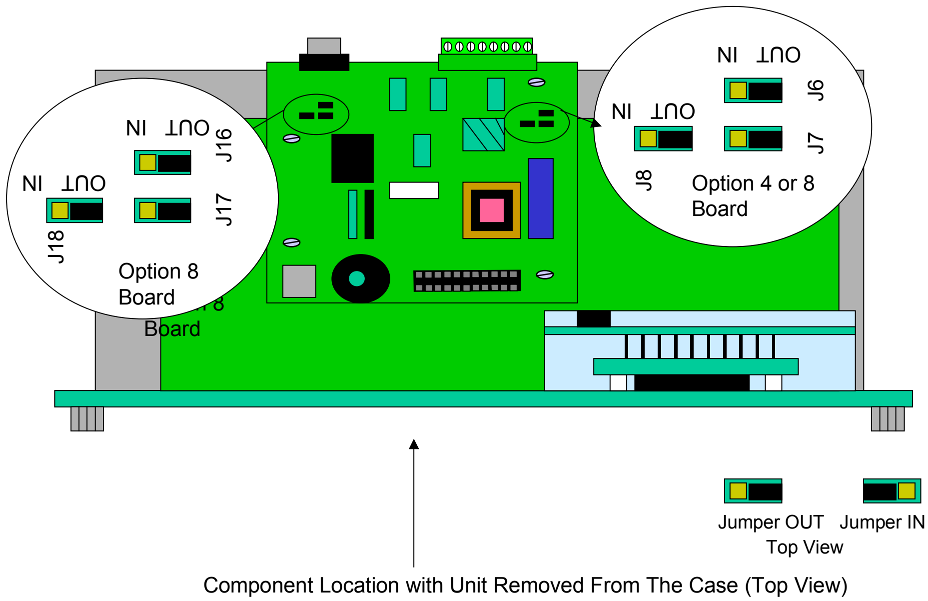


Figure 3-6. Location of RS485 Resistor Configuration Jumpers in the DPU2000R/DPU1500R

The following example illustrates an interconnection of the DPU2000, DPU1500R and DPU2000R with a host device through a UNICOM physical interface connection using a 3-wire connection method. It should be noted that the RS485 design on ABB relay products incorporates isolation. That is, the RS485 ground is electrically isolated from the internal circuitry thereby assuring minimal interference from the extreme noise environments found in a substation. Care should be used when installing an RS485 communication network. The recommended configuration must be followed as shown in Figures 3-7 and 3-8. Jumpers J6, J7, and J8 should be inserted to provide termination and pull-up at the DPU2000, DPU1500R and DPU2000R end. Although not shown, a 120 ohm resistor should be inserted between the TX/RX + and TX/RX- pairs to provide for termination at the transmission end.

The DPU2000R Type 8 card allows for an RS 485 connection on COM 3. ABB offers an accessory affording easy connection to a DPU2000R for an inline connection on an RS 485 network. The connector 602133-009 when attached to a COM 3 port on a TYPE 8 card converts the DB 9 female connector to a 9 conductor PHOENIX connector allowing easy connection to inline multidrop RS 485 nodes. Please contact your local ABB Distributor or Representative for additional product and pricing information.

Topology Diagram for RS485 Multi-Drop Architecture - if jumpers are inserted on end units providing for proper termination.

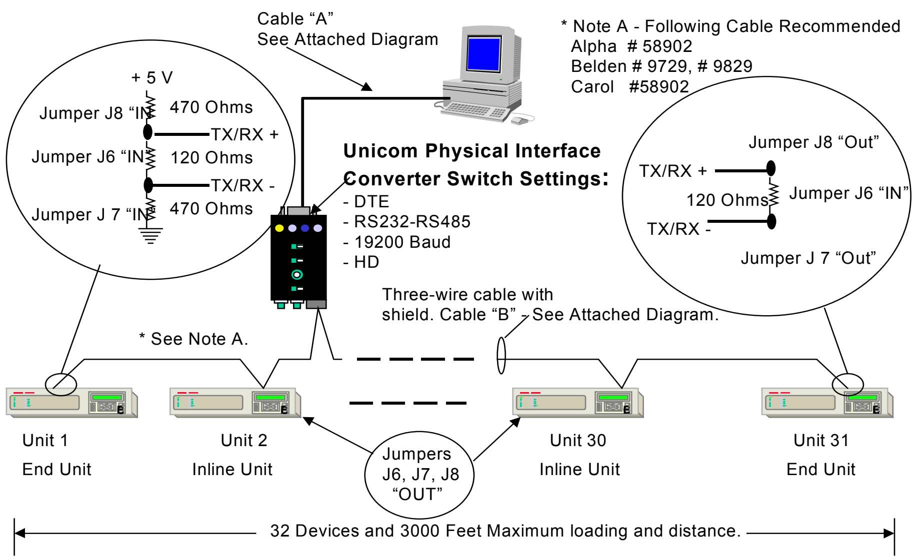


Figure 3-7. RS485 Topology Configuration for the DPU2000R

Topology Diagram for RS485 Multi-Drop Architecture - if external resistors are installed providing proper termination.

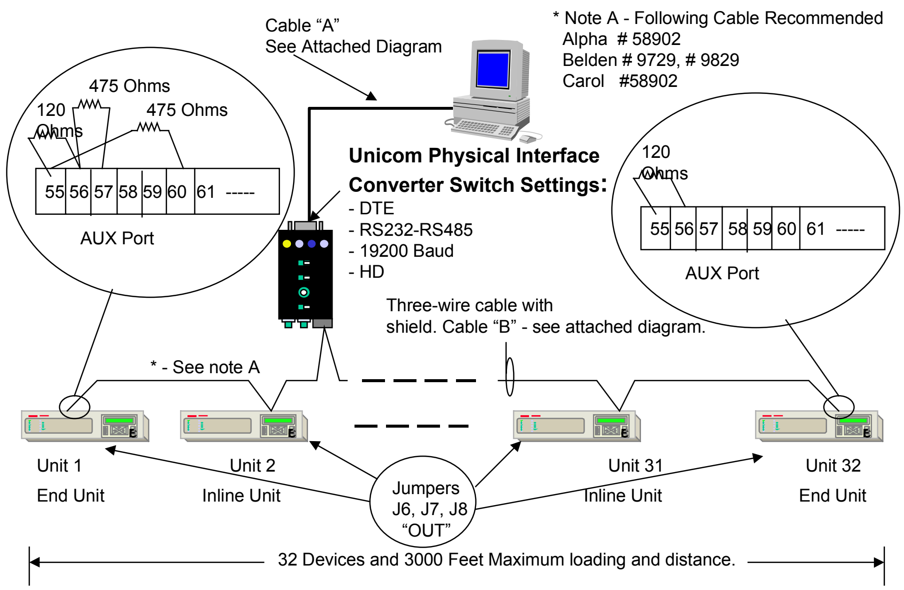


Figure 3-8. Alternate External Resistor Placement for the DPU2000R

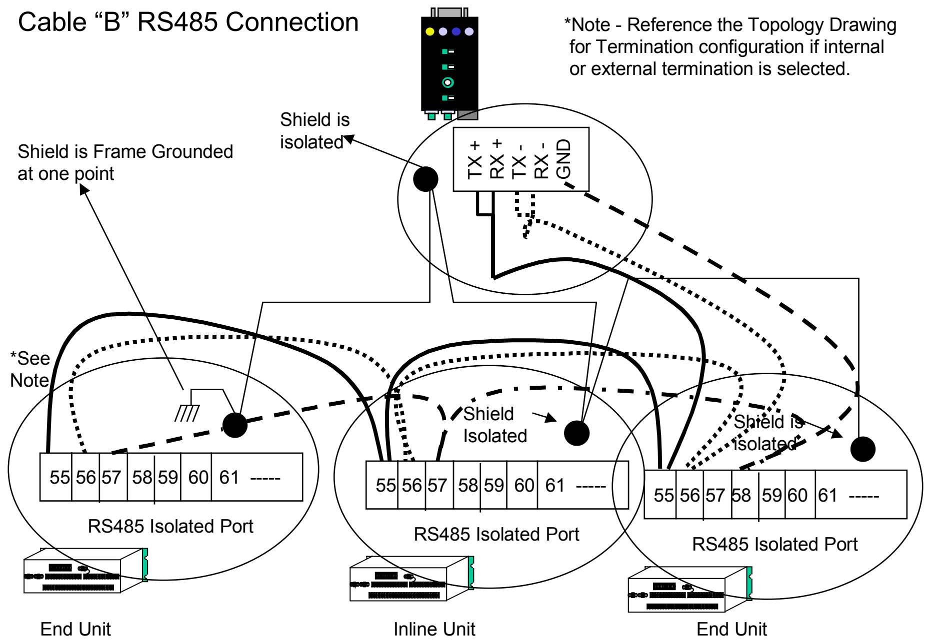


Figure 3-9. RS485 Communication Cabling (DPU2000R)

The DPU2000 has the two wire RS485 communication connectivity terminals located in a different position than that for the DPU2000R/DPU1500R. Table 3-2 lists the AUX COM connector signal assignments for the DPU2000.

Table 3-2. DPU2000 AUX COM Signal Assignments

Pin Number	Pin Definition
65	IRIG B Minus
66	IRIG B Plus
67	INCOM
68	INCOM
69	+5 VDC (100 mA max)
70	RESERVED
71	RESERVED
72	RS485 Common /(Return)
73	RS485 Minus
74	RS485 Plus

Therefore, connection of several DPU2000 units on a communication network would yield the wiring as depicted in Figure 3-10. DPU2000 and DPU2000R units may be interconnected on the same network as long as this signal position difference is noted and signal polarity is followed.

IMPORTANT: Each unit must be daisy chained as illustrated in Figure 3-9. NO intermediate taps or connectors shall be inserted in the network.

Also note that the entire network is grounded at one point. If "Non" isolated devices are inserted in the network, review the installation with the IED manufacturer so as to not introduce ground loops in the network.

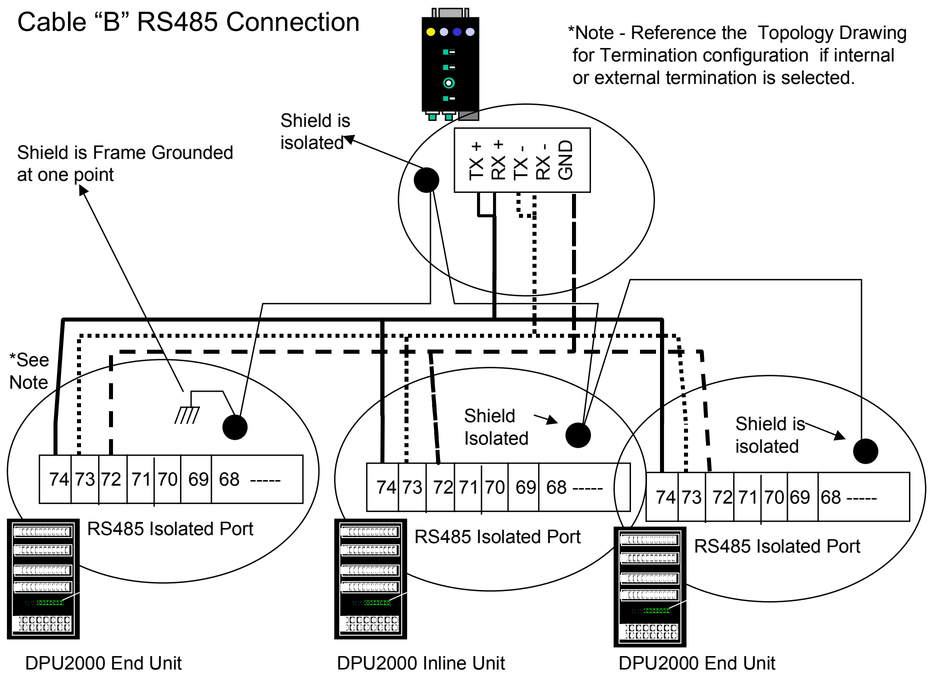


Figure 3-10. DPU2000 RS485 Wiring Diagram

Section 4 - DPU2000 and DPU2000R Device Parameterization

Establishing DPU2000, DPU1500R and DPU2000R communication depends upon correct parameterization of the communication menus within the unit. Parameterization may occur via the unit's front panel interface of through ECP (External Communication Program) or WinECP (Windows External Communication Program). Modbus, Modbus Plus and DNP require certain parameterizations. Even COM 0 requires certain parameterization to communication with the configuration program.

COM 0 Port (Front Port Configuration)

In order to attach a configuration program to the DPU2000, DPU1500R, or DPU2000R, the correct parameters must be set up within the unit. The supported parameters are listed in Table 4-1 below. The protocol for the unit is addressable Standard 10 Byte. To view the communication port parameters it is advised that they should be viewed via the unit's front panel interface. If the DPU2000, DPU1500R, or DPU2000R does not have a front panel interface, the parameters should be marked on the front panel sticker with the port's parameters.

The keystrokes required for visualizing the communication port parameters from the Classic front panel interface are:

1. Depress the "E" pushbutton.
2. Depress the "↓" key once to select the SETTINGS Menu and then depress the "E" pushbutton.
3. Depress the "E" pushbutton to select the SHOW SETTINGS Menu selection.
4. Depress the "↓" key six times to select the COMMUNICATIONS Menu and then depress the "E" pushbutton.
5. Under the SHOW COM SETTINGS MENU, the following shall be displayed for the Front Panel RS232 port (FP).
   - ❑ Unit Node Address (Address displayed in HEX)
   - ❑ FP RS 232 Baud
   - ❑ FP RS 232 Frame

The keystrokes required for visualizing the communication port parameters from the Enhanced OCI front panel interface are:

1. Depress the F1 <MENU> pushbutton.
2. Depress the F2 <MAIN MENU> pushbutton.
3. Depress the F3 <SHOW SETTINGS> pushbutton.
4. Depress the F4 <COMMUNCIATION> pushbutton.

Other parameters shall be shown. The parameters listed shall vary in accordance with the communication card inserted within the unit. However, the FP displayed parameters must match with the parameters configured in the Standard Ten Byte Section of the WinECP package.

One may change parameters via the front panel interface. The selections for each parameter required in Front Panel Port configuration is shown in Table 4-1.

Table 4-1. DPU2000, DPU1500R, and DPU2000R COM Port 0 Front Panel Interface Parameters

Option	Selection	Notes
Unit Node Address	1 to FFF (1 = default setting)	1 to 2048 decimal node address
FP RS232 Baud	300	Selectable Baud Rates for the Standard Ten Byte Front Panel Port.
	1200	
	2400	
	4800	
	9600 (default setting)	
FP RS232 Frame	N – 8 – 1 (default setting)	No Parity 8 Data Bits 1 Stop Bit
	N – 8 – 2	No Parity 8 Data Bits 2 Stop Bits

Modification of the Front Panel Parameter settings is accomplished via the following keystrokes:

1. From the Metering Menu depress the "E" key.
2. Depress the "↓" key once to select the SETTINGS Menu and then depress the "E" pushbutton.
3. Depress the "↓" key once to select the SHOW SETTINGS Menu selection. Depress the "E" pushbutton.
4. Depress the "↓" key seven times to select the COMMUNICATIONS Menu and then depress the "E" pushbutton.
5. Enter the unit's password, one digit at a time. The default password is four spaces. Depress the "E" pushbutton once.
6. The CHANGE COMMUNICATION SETTINGS Menu shall be displayed. With the cursor at the Unit Address field, depress "E". The unit address can be modified. The address selected in this field will configure the address for the entire node. Use the "↓" and "↑" arrow keys to select the password digit entry. Use the "→" and "←" keys to select the digit to configure. Depress "E" to save the digits. Depress "C" to return to the Root Menu.
7. Once returned to the Main Menu, depress the "↓" key once to select the FRONT RS232 BAUD RATE Menu and then depress the "E" pushbutton. The selections for the menu are listed in Table 4-1. Use the "→" and "←" keys to select the baud rates for the port. Depress "E" to select the entry. Depress "C" to return to the Root Menu.
8. Once returned to the Main Menu, depress the "↓" key once to select the FRONT RS232 FRAME Menu and then depress the "E" pushbutton. The selections for the menu are listed in Table 4-1. Use the "→" and "←" keys to select the baud rates for the port. Depress "E" to select the entry. Depress "C" to return to the Root Menu.
9. To Save the selections configured in the previous steps depress the "C" pushbutton. A query will be presented to the operator "Enter YES to save settings <NO>". Use the "→" and "←" keys to select the option YES and depress "E" to save the settings.

If one has an Enhanced Operator Interface on a DPU 2000R, the following procedure allows for the modification and the viewing of the COM 0 port parameters.

1. Depress F1 <MENU>
2. Depress F2 <MAIN MENU>
3. Depress F3 <SHOW SETTINGS MENU>
4. Depress F6 <PAGE DOWN>
5. Depress F4 <COMMUNICATION MENU>
6. The selections for UNIT ADDRESS, and FP RS 232 Baud, as well as FP RS 232 Framing is visible.

To change the settings for the front panel port, follow the following keystroke sequence for the Enhanced Version of the DPU 2000R.

1. Depress F1 <MENU>
2. Depress F2 <MAIN MENU>
3. Depress F4 <CHANGE SETTINGS MENU>
4. Depress F6 <PAGE DOWN>
5. Depress F5 <COMMUNICATION MENU>
6. Enter the PASSWORD using the F2, F3, and F4 keys. The default password is four spaces.
7. Depress F6 to enter the password. If it is accepted, one shall be able to change the following parameters:
   F2 UNIT ADDRESS
   F3 FP RS 232 BAUD
   F4 FR RS 232 FRAME
8. Once the appropriate parameters have been entered for the DPU 2000R, then depress F6 END OF COMM to enter the screen to save the parameters.
9. Depress F1 <ESC>. One shall be prompted for SAVE SETTINGS? Depressing F4 – YES, F5 NO.

If the unit does not have a front panel interface, it is advisable that the communication port parameters be marked on the front of the unit. If the parameters are not known, please contact ABB Technical Support to obtain the procedure to determine the parameters or take the unit out of service and reset the port parameters.

Figure 4-1 illustrates the parameterization screen in WinECP which must be parameterized allowing communication between the configuration unit and the DPU2000, DPU1500R or DPU2000R.

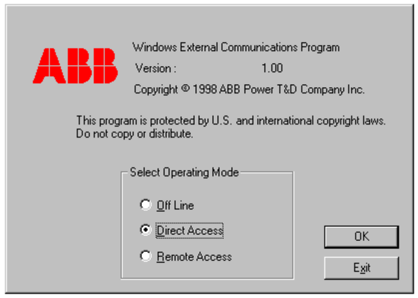


Figure 4-1. Initial WinECP Communication Configuration Screen

A direct connect is selected in this instance allowing retrieval and configuration of the relay parameters. Once the OK button is depressed, the screen shown in Figure 4-2 is presented to the operator.

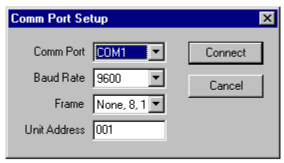


Figure 4-2. Communication Port Setup Screen

The selections in WinECP are illustrated in Table 4-2. The settings must agree with those configured in the DPU2000 and DPU2000R/DPU1500R.

Table 4-2. WinECP Communication Port Settings

Option	Selection	Notes
COM PORT	COM 1	Personal Computer Port Selection for ECP to DPU2000 and DPU2000R/DPU1500R connection.
	COM 2	
	COM 3	
	COM 4	
BAUD RATE	**300**	Baud Rates Offered for DPU 2000/2000R connection to the WinECP RS232 port connection.
	1200	
	2400	
	4800	
	9600 (default setting)	
	19200	
Frame	**None – 8 – 1 (default setting)**	No Parity 8 Data Bits 1 Stop Bit
	None – 8 – 2	No Parity 8 Data Bits 2 Stop Bits
	Even – 8 – 1	Even Parity 8 Data Bits 1 Stop Bit
	Odd – 8 – 1	Odd Parity 8 Data Bits 1 Stop Bit
	Even – 7 – 1	Even Parity 7 Data Bits 1 Stop Bit
	None – 7 – 2	Even Parity 7 Data Bits 2 Stop Bits
	Odd – 7 – 1	Odd Parity 7 Data Bits 1 Stop Bit
Unit Address	1 – FFF (1 = Default)	Unit Address in HEX
NOTE : Bold indicates Selections Supported by WinECP and DPU2000/DPU2000R/DPU1500R		

COM Port 1 Option Settings (DPU1500R or DPU2000R Only) [Catalog 587 XXX00-XXX0 or 587 XXX50-XXX0] or [Catalog 577 XXX00-XXX0 OR 577 XXX50-XXX0]

If the unit does not have a front panel interface, the rear port is on the DPU1500R/DPU2000R is active. The Configuration screens through WinECP are shown in Figure 4-3 for reference. The communication options may not be configured via the front panel interface since this port is only active if the unit does not have a front panel communication port interface (see Section 3 of this document for further information). The communication protocol supported on this port is Standard Ten Byte Only.

Table 4-3 illustrates the port configuration options available for this COM Port 1. Figure 4-3 illustrates the WinECP screen used to configure Communication Port 1 in the DPU1500R or DPU2000R.

Table 4-3. COM Port 1 and COM Port 2 WinECP Port Setting Options

Option	Selection	Notes
BAUD RATE	300	Com Port Baud Rate Selections Via WinECP
	1200	
	2400	
	4800	
	9600 (default setting)	
	19200	
	38400	
Frame	None – 8 – 1 (default setting)	No Parity 8 Data Bits 1 Stop Bit
	None – 8 – 2	No Parity 8 Data Bits 2 Stop Bits
	Even – 8 – 1	Even Parity 8 Data Bits 1 Stop Bit
	Odd – 8 – 1	Odd Parity 8 Data Bits 1 Stop Bit
	Even – 7– 1	Even Parity 7 Data Bits 1 Stop Bit
	None – 7 – 2	Even Parity 7 Data Bits 2 Stop Bits
	Odd – 7 – 1	Odd Parity 7 Data Bits 1 Stop Bit

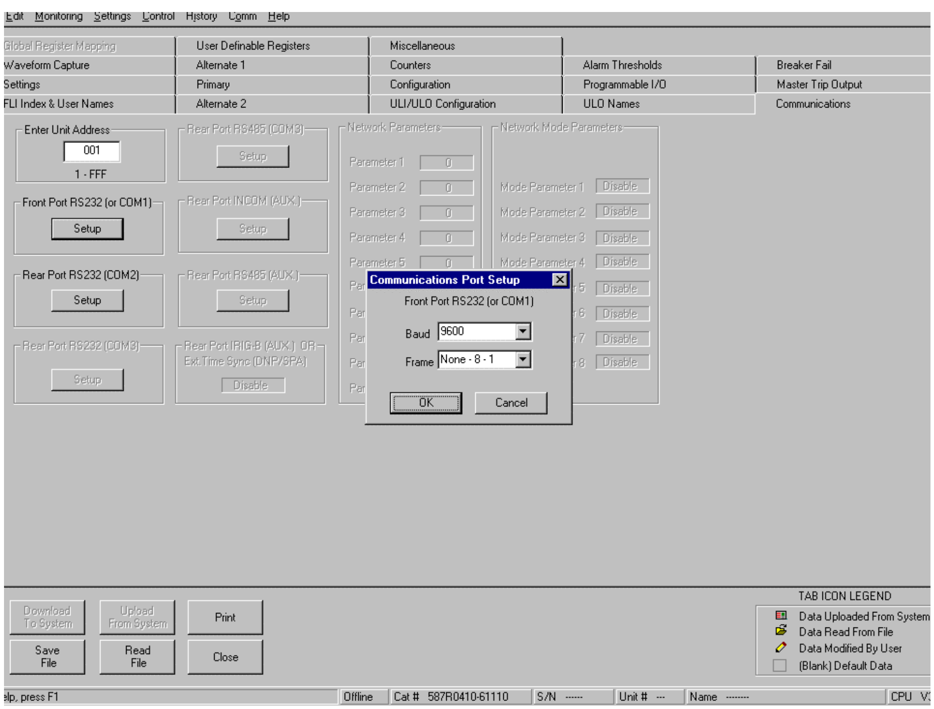


Figure 4-3. COM Port 1 WinECP Setting Screen

COM Port 2 Option Settings (DPU1500R or DPU2000R Only) [Catalog 587 XXXX0-XXX0 or 587 XXXX6-XXX4] or [Catalog 577 XXXX0-XXX0]

There are two option boards, which enable communication port 2 for the DPU2000R/DPU1500R. Figure 4-4 illustrates the configuration screen for the COM Port 2 options when viewed on WinECP.

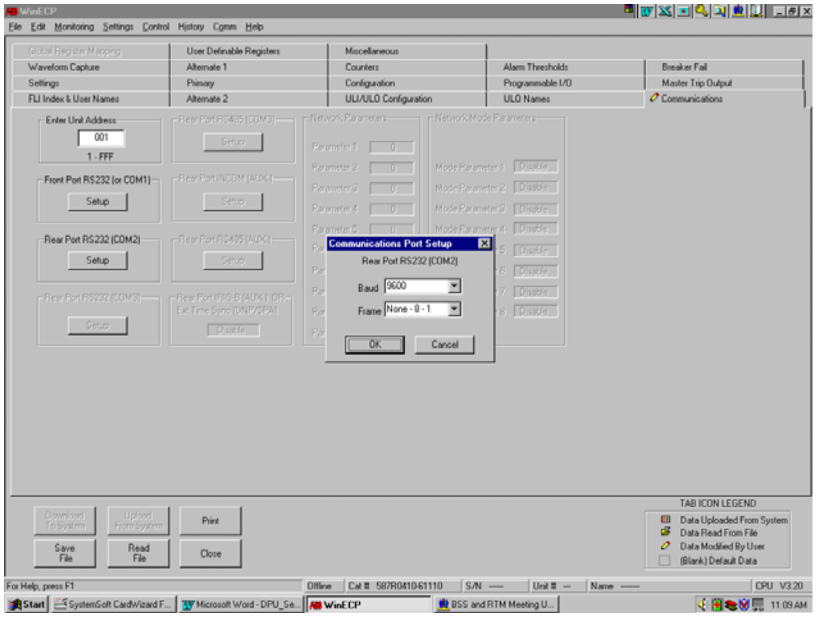


Figure 4-4. WinECP COM Port 2 Communication Screen

The options for configuration are listed in Table 4-3.

COM Port 3 and AUX COM Configuration

The DPU2000, DPU1500R, and DPU2000R share the same commonality in that two rear ports may be available depending upon the hardware inserted in the units. The configuration techniques vary in that the configuration depends upon the protocol included on the board itself. Figure 4-5 lists the combinations for the DPU2000R. Figure 4-6 lists the communication option combinations for the DPU2000. IRIG B time synchronization is not covered in this guide since the DNP 3.0 boards do not support IRIG B time synchronization. Figure 4-7 lists the option for the DPU1500R.

Catalog Number Select Option 587R041[ ]	- 6101[ ]	REAR PORT ASSIGNMENTS: COM 1 NON ISOLATED RS-232 With Display	COM 1 NON ISOLATED RS-232 Without Display*	COM 2 NON ISOLATED RS-232	COM 3 ISOLATED RS-232 unless noted	AUX. PORTS RS-485 ISOLATED	INCOM ISOLATED	IRIG-B
0	0		ABB Ten Byte	ABB Ten Byte				
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®or ABB Ten Byte See Note #	Modbus®or ABB Ten Byte See Note #		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	
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®or ABB Ten Byte (RS-485) See Note #	Modbus®or ABB Ten Byte See Note #		IRIG-B

Figure 4-5. DPU2000R Communication Capability Chart

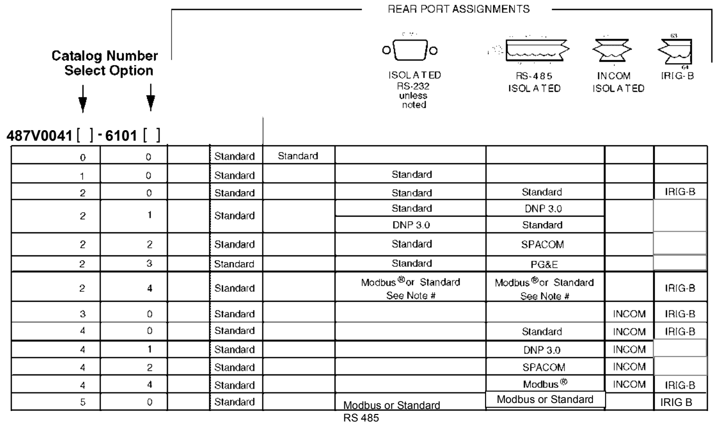


Figure 4-6. DPU2000 Communication Capability Chart

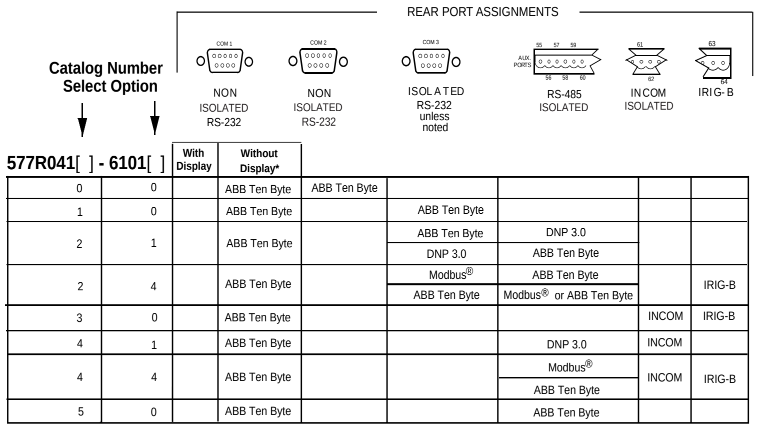


Figure 4-7. DPU1500R Communication Capability Chart

DNP 3.0 Configuration of COM 3 and AUX COM Port

The DPU2000, DPU1500R, and DPU2000R allow one of the available communication ports to be configured as DNP 3.0. If the unit has more than one port, it is configured as Standard Ten Byte. The configuration parameters supported for Baud Rate and Frame configuration as listed in Table 4-4.

Table 4-4. Valid Parameter Selection for Standard Ten Byte and DNP 3.0 Protocols

PROTOCOL SELECTED	BAUD RATE SELECTIONS	FRAME SELECTIONS
DNP 3.0	300,1200, 2400, 4800, 9600, 19200	• Even Parity, 8 Data Bits, One Stop Bit • No Parity, 8 Data Bits, One Stop Bit • Odd Parity, 8 Data Bits, One Stop Bit • No Parity, 8 Data Bits, Two Stop Bits
Standard Ten Byte	300,1200, 2400, 4800, 9600, 19200	• Odd Parity, 7 Data Bits, One Stop Bit • Odd Parity, 7 Data Bits, Two Stop Bits • Even Parity, 7 Data Bits, One Stop Bit • Even Parity, 7 Data Bits, Two Stop Bits • Even Parity, 8 Data Bits, One Stop Bit • No Parity, 8 Data Bits, One Stop Bit • Odd Parity, 8 Data Bits, One Stop Bit • No Parity, 8 Data Bits, Two Stop Bits

DPU2000, DPU1500R and DPU2000R DNP 3.0 Communication Port Parameters and Mode Parameters must be configured correctly to allow communication with a host unit connected with it. The host parameters must match with the DNP 3.0 parameters configured in the DPU2000 or DPU2000R. Failure to do so will result in erratic or no communication between the host device and the attached nodes. The definition of the parameters follows:

“Parameter 1” is the inter-character gap timeout in milli-seconds. Must be greater than 0 and less than 255 milli-seconds. If the default value of zero is specified for this parameter, then a value of 10 milli-seconds is used. If an inter-character gap timeout occurs during a frame read, then the frame will be deemed corrupted, and discarded. This timeout value must be large enough to accommodate the maximum expected inter-character delays generated by the host computer, yet as small as possible to maximize throughput.

"Parameter 2" is the data link layer primary timeout in deci-seconds (tenth's of seconds). This timeout is activated whenever the DPU1500R, 2000, or 2000R is acting as a DLC primary, i.e. when the DPU1500R, 2000, or 2000R is transmitting a data frame with a DLC confirm or the DPU1500R, 2000, or 2000R is transmitting a reset link frame. The timeout is not used for unconfirmed data frames or when the DPU1500R, 2000, or 2000R is acting as secondary and transmitting ACK, NACK, or other secondary frames. If this parameter is set to the default value of zero, then a timeout value of 100 (1 second) is used.

This parameter is also used to set the upper limit of the delay used for collision recovery. If a collision is detected, i.e. data is received from the RS485 line at the time the DPU1500R, 2000, or 2000R is prepared to transmit, then the DPU1500R, 2000, or 2000R will delay for some random period of time less than or equal to the primary timeout value specified by this parameter. The seed of the random number generator used to randomize the collision delay is set to the unit address, so that probability of collisions with other DPU1500R, 2000, or 2000R's on the same RS485 line will be reduced.

"Parameter 3" is the number of data link layer primary retries. Can range from 0 through 255. Default is zero which eliminates retries, regardless of the setting of "Parameter 2".

"Parameter 4" is the minimum delay in milli-seconds after frame receive before a data link level frame can be transmitted. If this parameter is set to the default value of zero then a delay of 30 milli-seconds is used. This value must be increased to at least 200 milli-seconds when the DPU1500R, 2000, or 2000R is being used with the Applied Systems Engineering DNP test set on the IBM PC. Failure to increase this timeout will cause the DNP test set to ignore part or all of transmissions from the DPU1500R, 2000, or 2000R.

"Parameter 5, 6, 7, and 8" specify which points are to be included in a class scans. The full set of points is divided into several groups and the operator can specify from the front panel which of the groups are to be activated so that they will be returned when the host asks for a class data scan. The default values, zero for all of these parameter bytes, causes only group zero to be returned for all class scans. To force all scan groups to be returned parameters 5, 6, 7, and 8 should be set to 254, 255, 255 and 255 respectively. These parameters disable data return only for class scans (any class, 0 or integrity, 1, 2, or 3). All of the defined points are accessible via a read command without regard to the settings of parameter bytes 5, 6, 7, and 8. Reference Section 5 for examples for parameterizing the GROUPS for Class scans.

"Parameter 9” has a default value of zero. FOR DNP VERSION 4.3 and EARLIER - This parameter can be used to specify the frequency in minutes (0 to 255) that the relay will set the “time synchronization required from master” bit. Normally, (with the default value) this occurs every 60 minutes after a DNP OBJECT 50 OR 52 time synch command is received from the master. This bit is initially set one minute after a System Reset.

FOR DNP VERSION 4.4 and LATER - This parameter is used in conjunction with the EXTERNAL TIME SYNCHRONIZATION PARAMETER available for configuation using the Front Panel Interface or WIN ECP. Please reference the IRIG B configuration section present in this manual for proper configuration of this parameter to enable network (DNP 3.0 external time synch.), IRIG B (external Time Synch) or no time synch.

"Parameter 10" is presently reserved for use by ABB and should be left at the default value of 0.

The group designation for binary inputs, counters, and analog inputs is given in the point list below and listed under the column heading Scan Type. Use the designated Parameter Value to disable group zero output, or enable output of any of the other groups for a class scan. Since the front panel operator interface takes the input in decimal, add the parameter values together to enable multiple groups in one parameter byte. The mapping of the parameter bytes is as follows:

Table 4-5. Class Masking Table for DNP 3.0

Group Number (Scan Type)	Parameter Byte	Parameter Value	(Except for group 0, set to enable)
-----------	-----------	-----------	----------------------------
0	5	1	**(1 = enabled, 0 = disabled)**
1	5	2	
2	5	4	
3	5	8	
4	5	16	
5	5	32	
6	5	64	
7	5	128	
8	6	1	
9	6	2	
10	6	4	
11	6	8	
12	6	16	
13	6	32	
14	6	64	
15	6	128	
16	7	1	
17	7	2	
18	7	4	
19	7	8	
20	7	16	
21	7	32	
22	7	64	
23	7	128	
24	8	1	
25	8	2	
26	8	4	
27	8	8	
28	8	16	
29	8	32	
30	8	64	
31	8	128	

"Mode Parameter 1" indicates data link layer confirms. If value is not zero then confirmation at the data link layer is enabled. This means that "User Data With Confirm" and ACK will be used for all user data transmissions from the DPU2000 to the host. If this parameter is set to the default value of disabled then "Unconfirmed User Data" frames will be used for all user data transmissions to the host.

"Mode Parameter 2" indicates application level confirms. If the value is not zero then confirmation at the application layer is enabled. This means that the "CON" confirmation bit will be set in the application control byte of all response headers sent by the DPU2000 to the host. The host is expected to respond with application level confirmation messages. Application level retries by the DPU2000 are not supported and no retry attempts will be made if the host does not respond with a confirmation frame. If the host does not respond with a confirmation frame as expected, no special action is taken, i.e., the lack of a user level confirmation is ignored by the DPU2000. Note that this also means the event is not cleared from DPU storage, and will be transmitted again upon receipt of another event scan or read operation. If this parameter is set to the default value of disabled, then the "CON" confirmation bit will not be set in the application control byte of response headers sent by the DPU2000 to the host and no confirmation frames will be expected from the host. In this case, events are cleared from DPU storage upon transmission, and may potentially be lost due to transmission errors.

"Mode Parameter 3" indicates protocol selection for the serial ports. If the value is zero or disabled, then the RS232 port uses the INCOM 10 byte ASCII protocol and the RS485 port uses DNP 3.0 protocol. If the mode parameter 3 value is one or enabled then the protocol selections for each port are swapped are reversed.

“Mode Parameter 4" indicates RTS/CTS handshaking for the RS232 serial port. This parameter is ignored unless protocol the relay contains a communications card with both RS232 and RS485 ports. If “disabled” this parameter causes the RS232 port to be set for constant carrier. “Enabling” this parameter enables RST/CTS handshaking. Presently handskaking via leased line modems is only supported by the DNP 3.0 protocol.

"Mode Parameter 5” enables/disables automatic resetting of sealed-in binary points, once their corresponding DNP events have been reported. The default value of “Disable” prevents them from being reset, until explicitly requested via either a control request from the DNP Binary Control point 26, or the ECP program, or a System Reset.

Mode Parameter 6 “ enables/ disables the rapid analog reporting mechanism of analog points for a CLASS 3 Scan. This parameter is used with the MISCELLANEOUS PARAMETERS screen to enable time reporting of the UDR (User Definable Register) configured points. Please reference the UDR configuration section to configure the RAPID ANALOG REPORTING FEATURE.

“Mode Parameters 7 and 8" are presently reserved for use by ABB and should be left at their default values of “Disable”.

Figure 4-8. COM 3 Port Parameterization for DNP 3.0

The communication ports for DNP 3.0 may be configured via WinECP. The configuration screens appear the same as shown in Figure 4-8 above. The DNP 3.0 configuration procedure if one is to perform the steps through the Front Panel Interface is listed as such:

Modification of the Front Panel Parameter settings is accomplished via the following keystrokes:

1. From the metering screen depress the “E” key.
2. Depress the “↓” key once to select the SETTINGS Menu and then depress the “E” pushbutton.
3. Depress the “↓” key once to select the CHANGE SETTINGS Menu selection. Depress the “E” pushbutton.
4. Depress the “↓” key seven times to select the COMMUNICATIONS Menu and then depress the “E” pushbutton.

5. Enter the unit's password, one digit at a time. The default password is four spaces. Depress the "E" pushbutton once.
6. The CHANGE COMMUNICATION SETTINGS Menu shall be displayed. With the cursor at the Unit Address field, depress "E". The unit address can be modified. The address selected in this field will configure the address for the entire node. Use the "↓" and "↑" arrow keys to select the password digit entry. Use the "→" and "←" keys to select the digit to configure. Depress "E" to save the digits. Depress "C" to return to the Root Menu.
7. Once returned to the Main Menu, depress the "↓" key four times to select the RP RS 232 BAUD RATE (SEE NOTE 1) Menu and then depress the "E" pushbutton. The selections for the menu are listed in Table 4-1. Use the "→" and "←" keys to select the baud rates for the port. Depress "E" to select the entry. Depress "C" to return to the Root Menu.
8. Once returned to the Main Menu, depress the "↓" key once to select the RP RS 232 FRAME (SEE NOTE 2) Menu and then depress the "E" pushbutton. The selections for the menu are listed in Table 4-1. Use the "→" and "←" keys to select the baud rates for the port. Depress "E" to select the entry. Depress "C" to return to the Root Menu.
9. Once returned to the Main Menu, depress the "↓" key once to select the RP RS 485 BAUD RATE (SEE NOTE 3) Menu and then depress the "E" pushbutton. The selections for the menu are listed in Table 4-1. Use the "→" and "←" keys to select the baud rates for the port. Depress "E" to select the entry. Depress "C" to return to the Root Menu.
10. Once returned to the Main Menu, depress the "↓" key once to select the RP RS 485 FRAME (SEE NOTE 4) Menu and then depress the "E" pushbutton. The selections for the menu are listed in Table 4-1. Use the "→" and "←" keys to select the baud rates for the port. Depress "E" to select the entry. Depress "C" to return to the Root Menu.
11. Once returned to the Main Menu, depress the "↓" key once to select the RP IRIG B selection. IRIG B is not supported via DNP 3.0. If this selection is enabled, the unit shall allow time synchronization via the DNP 3.0 Network. Please refer to Section 5 to review TIME SYNCHRONIZATION procedures via DNP 3.0.
12. Once returned to the Main Menu, depress the "↓" key once to select the PARAMETER 1 (Inter Character Gap Timeout) Menu and then depress the "E" pushbutton. The selections for this field may range from 0 to 255. Use the "→" and "←" keys to select appropriate entry for PARAMETER 1 as described above. Depress "E" to select the entry. Depress "C" to return to the Root Menu.
13. Once returned to the Main Menu, depress the "↓" key once to select the PARAMETER 2 (Data Link Layer Timeout) Menu and then depress the "E" pushbutton. The selections for this field may range from 0 to 255. Use the "→" and "←" keys to select appropriate entry for PARAMETER 2 as described above. Depress "E" to select the entry. Depress "C" to return to the Root Menu.
14. Once returned to the Main Menu, depress the "↓" key once to select the PARAMETER 3 (Data Link Primary Retries) Menu and then depress the "E" pushbutton. The selections for this field may range from 0 to 255. Use the "→" and "←" keys to select appropriate entry for PARAMETER 3 as described above. Depress "E" to select the entry. Depress "C" to return to the Root Menu.
15. Once returned to the Main Menu, depress the "↓" key once to select the PARAMETER 4 (Transmit Delay) Menu and then depress the "E" pushbutton. The selections for this field may range from 0 to 255. Use the "→" and "←" keys to select appropriate entry for PARAMETER 4 as described above. Depress "E" to select the entry. Depress "C" to return to the Root Menu.
16. Once returned to the Main Menu, depress the "↓" key once to select the PARAMETER 5 (CLASS SCAN MASK) Menu and then depress the "E" pushbutton. The selections for this field may range from 0 to 255. Use the "→" and "←" keys to select appropriate entry for PARAMETER 5 as described above. Depress "E" to select the entry. Depress "C" to return to the Root Menu.
17. Once returned to the Main Menu, depress the "↓" key once to select the PARAMETER 6 (CLASS SCAN MASK) Menu and then depress the "E" pushbutton. The selections for this field may range from 0 to 255. Use the "→" and "←" keys to select appropriate entry for PARAMETER 6 as described above. Depress "E" to select the entry. Depress "C" to return to the Root Menu.
18. Once returned to the Main Menu, depress the "↓" key once to select the PARAMETER 7 (CLASS SCAN MASK) Menu and then depress the "E" pushbutton. The selections for this field may range from 0 to 255. Use the "→" and "←" keys to select appropriate entry for PARAMETER 7 as described above. Depress "E" to select the entry. Depress "C" to return to the Root Menu.
19. Once returned to the Main Menu, depress the "↓" key once to select the PARAMETER 8 (CLASS SCAN MASK) Menu and then depress the "E" pushbutton. The selections for this field may range from 0 to 255. Use

the "→" and "←" keys to select appropriate entry for PARAMETER 8 as described above. Depress "E" to select the entry. Depress "C" to return to the Root Menu.

20. Once returned to the Main Menu, depress the "↓" key once to select the PARAMETER 9 (Time Synchronization Frequency Request) Menu and then depress the "E" pushbutton. The selections for this field may range from 0 to 255. Use the "→" and "←" keys to select appropriate entry for PARAMETER 9 as described above. Depress "E" to select the entry. Depress "C" to return to the Root Menu. NOTE: THE IRIG B SELECTION PRESENT ON THE CONFIGURATION PAGE (REFERENCE Figure 4-8) MUST BE SET TO "ENABLED –CC" OR "ENABLED-MMM" FOR THE TIME SYNCHRONIZATION TO OPERATE USING THE DNP 3.0 TIME OBJECTS 50 OR 52.
21. Once returned to the Main Menu, depress the "↓" key one time to select the MODE PARAMETER 1 Menu item (Data Link Layer Confirm with ACK) and then depress the "E" pushbutton. The selections for this field are enable and disable. Use the "→" and "←" keys to select appropriate entry for MODE PARAMETER 1 as described above. Depress "E" to select the entry. Depress "C" to return to the Root Menu.
22. Once returned to the Main Menu, depress the "↓" key once to select the MODE PARAMETER 2 (Application Layer Level with ACK Confirm) Menu item and then depress the "E" pushbutton. The selections for this field are enable and disable. Use the "→" and "←" keys to select appropriate entry for MODE PARAMETER 2 as described above. Depress "E" to select the entry. Depress "C" to return to the Root Menu.
23. Once returned to the Main Menu, depress the "↓" key once to select the MODE PARAMETER 3 (Set RS 232 Port to DNP 3.0) Menu item and then depress the "E" pushbutton. The selections for this field are enable and disable. Use the "→" and "←" keys to select appropriate entry for MODE PARAMETER 3 as described above. Depress "E" to select the entry. Depress "C" to return to the Root Menu.
24. Once returned to the Main Menu, depress the "↓" key once to select the MODE PARAMETER 4 (Enable RTS/CTS Handshaking) Menu item and then depress the "E" pushbutton. The selections for this field are enable and disable. Use the "→" and "←" keys to select appropriate entry for MODE PARAMETER 4 as described above. Depress "E" to select the entry. Depress "C" to return to the Root Menu.
25. Once returned to the Main Menu, depress the "↓" key once to select the MODE PARAMETER 5 (Auto Reset of Sealed Points on a Read) Menu item and then depress the "E" pushbutton. The selections for this field are enable and disable. Use the "→" and "←" keys to select appropriate entry for MODE PARAMETER 5 as described above. Depress "E" to select the entry. Depress "C" to return to the Root Menu. NOTE: POINTS ARE RESET ON A "CLASS 3, CLASS 0, OBJECT1, OR OBJECT 2 "DATA SCAN. LATCHED DATA POINTS ARE RESET UPON A READ IF THIS PARAMETER IS ENABLED. A MANUAL RESET OR RESET VIA AN OBJECT 12 INDEX 26 IS REQUIRED TO RESET THESE POINTS IF MODE PARAMETER IS DISABLED.
26. Once returned to the Main Menu, depress the "↓" key once to select the MODE PARAMETER 6 (Class 3 Analog User Definable Register Reporting) Menu item and then depress the "E" pushbutton. The selections for this field are enable and disable. Use the "→" and "←" keys to select appropriate entry for MODE PARAMETER 6 as described above. Depress "E" to select the entry. Depress "C" to return to the Root Menu. If Mode Parameter 6 is ENABLED, UDR's will be reported in a Class 3 scan. If Mode Parameter 6 is DISABLED, no reporting occurs. Please reference Section 5 of this manual for additional configuration instructions for complete parameterization for Analog CLASS 3 reporting.
27. To Save the selections configured in the previous steps depress the "C" pushbutton. A query will be presented to the operator "Enter YES to save settings <NO>". Use the "→" and "←" keys to select the option YES and depress "E" to save the settings.

NOTE 1: If the DUAL RS485 Board (Option 8) is selected, the query shall be modified as: RS485 – 1 Baud. If the hardware does not support COM 3, this query shall be omitted.
NOTE 2: If the DUAL RS485 Board (Option 8) is selected, the query shall be modified as RS485 – 1 Frame. If the hardware does not support COM 3, this query shall be omitted.
NOTE 3: If the DUAL RS485 Board (Option 8) is selected, the query shall be modified to RS485 – 2 Baud.
NOTE 4: If the DUAL RS485 Board (Option 8) is selected, the query shall be modified to RS485 – 2 Frame.

If one has a DPU2000R with the enhanced Front Panel OCI interface, modification of the Front Panel Parameter settings is accomplished via the following keystrokes:

1. From the metering screen depress the "F1" key to view the MENU selection.
2. Depress the "F2" key to view the MAIN MENU selection.

3. Depress the “F4” key to view the CHANGE SETTINGS selection.
4. Depress the “F6” <PG DWN> selection to view the remaining menu selections.
5. Depress the “F5” COMMUNICATE SETTINGS pushbutton to view the communication settings.
6. Enter the unit’s password, one digit at a time. The “F5” Change Character selection moves the cursor right to change the selected digit of the password. If the cursor indicator (a ∧ beneath the character) is at the last digit, depressing the “F5” function key shall place the cursor indicator at the first digit of the password field. The “F2” shall display the next character in a list (move up the list) whereas “F3” shall display the previous character to place in the field (move down the list). Depress “F6” to accept the password entered in the field. THE DEFAULT PASSWORD IS FOUR SPACES. IT IS IMPORTANT THAT THE USER CHANGE THE PASSWORD TO PREVENT UNAUTHORIZED ACCESS TO MENU OPTIONS.
7. Depress the F1 UNIT ADDR function key to change the unit address of the IED. This unit address is in hexadecimal. A submenu shall be displayed allowing the operator to cursor through the menu. Depress the “F3” function key to cursor through the unit address digit positions. Depress the “F4” + function key to increase the address digit. Depress the “F5” – function key to decrease the address digit. Depress the “F6” ENTER function key to enter the password in the device. Depress the “F1” function key to return to the Main Menu.
8. A menu shall be displayed. Depress the “F3 Key to view the FP RS 232 BAUD RATE Menu. The selections for the menu are listed in Table 4-1. Use the “F4” and “F5” keys to select the baud rates for the port. Depress “F6” to select the entry. Depress “F1” to return to the Root Menu.
9. Depress the “F4” key once to select the FP RS 232 FRAME Menu. The selections for the menu are listed in Table 4-1. Use the “F4” and “F5” keys to select the baud rates for the port. Depress “F6” to select the entry. Depress “F1” to return to the Root Menu.
10. Once returned to the Main Menu, depress the “F5” key once to select the RP RS 232 BAUD RATE (SEE NOTE 1) Menu. The selections for the menu are listed in Table 4-1. Use the “F4” and “F5” keys to select the baud rates for the port. Depress “F6” to select the entry. Depress “F1” to return to the Root Menu.
11. To View the next menu selections, depress the “F6” <PG DN> key to select the next set of configuration options.
12. Depress the “F2” key once to select the RP RS 232 FRAME (SEE NOTE 2) Menu. The selections for the menu are listed in Table 4-1. Use the “F4” and “F5” keys to select the baud rates for the port. Depress “F6” to select the entry. Depress “F1” to return to the Root Menu.
13. Once returned to the Main Menu, depress the “F3” key once to select the RP RS 485 BAUD RATE (SEE NOTE 3) Menu. The selections for the menu are listed in Table 4-1. Use the “F4” and “F5” keys to select the baud rates for the port. Depress “F6” to select the entry. Depress “F1” to return to the Root Menu.
14. Depress the “F4” key once to select the RP RS 485 FRAME (SEE NOTE 4) Menu. The selections for the menu are listed in Table 4-1. Use the “F4” and “F5” keys to select the baud rates for the port. Depress “F6” to select the entry. Depress “F1” to return to the Root Menu.
15. Once returned to the Main Menu, depress the “F5” key once to select the RP IRIG B selection. IRIG B is not supported via DNP 3.0. If this selection is enabled, the unit shall allow time synchronization via the DNP 3.0 Network. Please refer to SECTION 5 to review TIME SYNCHRONIZATION procedures via DNP 3.0.
16. To View the next menu selections, depress the “F6” <PG DN> key to select the next set of configuration options.
17. Once returned to the Main Menu, depress the “F2” key once to select the PARAMETER 1 (Inter Character Gap Timeout) Menu. The selections for this field may range from 0 to 255. Use the “F4” and “F5” keys to select appropriate entry for PARAMETER 1 as described above. Depress “F6” to select the entry. Depress “F1” to return to the Root Menu.
18. Once returned to the Main Menu, depress the “F3” key once to select the PARAMETER 2 (Data Link Layer Timeout) Menu. The selections for this field may range from 0 to 255. Use the “F4” and “F5” keys to select appropriate entry for PARAMETER 2 as described above. Depress “F6” to select the entry. Depress “F1” to return to the Root Menu.
19. Once returned to the Main Menu, depress the “F4” key once to select the PARAMETER 3 (Data Link Primary Retries) Menu. The selections for this field may range from 0 to 255. Use the “F4” and “F5” keys to select appropriate entry for PARAMETER 3 as described above. Depress “F6” to select the entry. Depress “F1” to return to the Root Menu.
20. Once returned to the Main Menu, depress the “F5” key once to select the PARAMETER 4 (Transmit Delay) Menu. The selections for this field may range from 0 to 255. Use the “F4” and “F5” keys to select appropriate entry for PARAMETER 4 as described above. Depress “F6” to select the entry. Depress “F1” to return to the Root Menu.
21. To View the next menu selections, depress the “F6” <PG DN> key to select the next set of configuration options.

22. Once returned to the Main Menu, depress the “F2” key once to select the PARAMETER 5 (CLASS SCAN MASK) Menu. Use the “F4” and “F5” keys to select appropriate entry for PARAMETER 5 as described above. To View the next menu selections, depress the “F6” <PG DN> key to select the next set of configuration options.
23. Once returned to the Main Menu, depress the “F3” key once to select the PARAMETER 6 (CLASS SCAN MASK) Menu. Use the “F4” and “F5” keys to select appropriate entry for PARAMETER 6 as described above. To View the next menu selections, depress the “F6” <PG DN> key to select the next set of configuration options.
24. Once returned to the Main Menu, depress the “F4” key once to select the PARAMETER 7 (CLASS SCAN MASK) Menu. Use the “F4” and “F5” keys to select appropriate entry for PARAMETER 7 as described above. To View the next menu selections, depress the “F6” <PG DN> key to select the next set of configuration options.
25. Once returned to the Main Menu, depress the “F5” key once to select the PARAMETER 8 (CLASS SCAN MASK) Menu. Use the “F4” and “F5” keys to select appropriate entry for PARAMETER 8 as described above. To View the next menu selections, depress the “F6” <PG DN> key to select the next set of configuration options.
26. To View the next menu selections, depress the “F6” <PG DN> key to select the next set of configuration options.
27. Once returned to the Main Menu, depress the “F2” key once to select the PARAMETER 9 (Time Synchronization Frequency Request) Menu. Use the “F4” and “F5” keys to select appropriate entry for PARAMETER 8 as described above. To View the next menu selections, depress the “F6” <PG DN> key to select the next set of configuration options.
28. Once returned to the Main Menu, depress the “F3” key one time to select the MODE PARAMETER 1 Menu item (DATA LINK LAYER CONFIRM WITH ACK). Use the “F4” and “F5” keys to select appropriate entry for MODE PARAMETER 1 as described above. To View the next menu selections, depress the “F6” <PG DN> key to select the next set of configuration options.
29. Once returned to the Main Menu, depress the “F4” key once to select the MODE PARAMETER 2 (APPLICATION LAYER LEVEL WITH ACK CONFIRM.) Menu. Use the “F4” and “F5” keys to select appropriate entry for MODE PARAMETER 2 as described above. To View the next menu selections, depress the “F6” <PG DN> key to select the next set of configuration options.
30. Once returned to the Main Menu, depress the “F5” key once to select the MODE PARAMETER 3 (SET RS 232 PORT TO DNP 3.0) Menu. Use the “F4” and “F5” keys to select appropriate entry for MODE PARAMETER 3 as described above. To View the next menu selections, depress the “F6” <PG DN> key to select the next set of configuration options.
31. To View the next menu selections, depress the “F6” <PG DN> key to select the next set of configuration options.
32. Once returned to the Main Menu, depress the “F2” key once to select the MODE PARAMETER 4 (ENABLE RTS/CTS HANDSHAKING) Menu. Use the “F4” and “F5” keys to select appropriate entry for MODE PARAMETER 4 as described above. To View the next menu selections, depress the “F6” <PG DN> key to select the next set of configuration options.
33. Once returned to the Main Menu, depress the “F3” key once to select the MODE PARAMETER 5 (AUTO RESET OF SEALED POINTS ON A READ) Menu. Use the “F4” and “F5” keys to select appropriate entry for MODE PARAMETER 2 as described above. To View the next menu selections, depress the “F6” <PG DN> key to select the next set of configuration options.
34. To Save the selections configured in the previous steps depress the “F1” pushbutton. A query will be presented to the operator “Save settings ”. Use the “F3” and “F4” keys to select the proper option to save the settings.

NOTE 1: If the DUAL RS485 Board (Option 8) is selected, the query shall be modified as: RS485 – 1 Baud. If the hardware does not support COM 3, this query shall be omitted.

NOTE 2: If the DUAL RS485 Board (Option 8) is selected, the query shall be modified as RS485 – 1 Frame. If the hardware does not support COM 3, this query shall be omitted.

NOTE 3: If the DUAL RS485 Board (Option 8) is selected, the query shall be modified to RS485 – 2 Baud.

NOTE 4: If the DUAL RS485 Board (Option 8) is selected, the query shall be modified to RS485 – 2 Frame.

DNP 3.0 Configuration of IRIG B or External Time Synchronization Configuration and Wiring

Although not a protocol, IRIG B time synchronization is included on the communication cards within the DPU2000, DPU 1500R and DPU2000R. The following section describes the theory, connection and configuration options present within the aforementioned IEDs.

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/GPU/GPU2000/R relays (herein referred to as an IED) offer IRIG B time synchronization capabilities.

Figure 4-9 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.

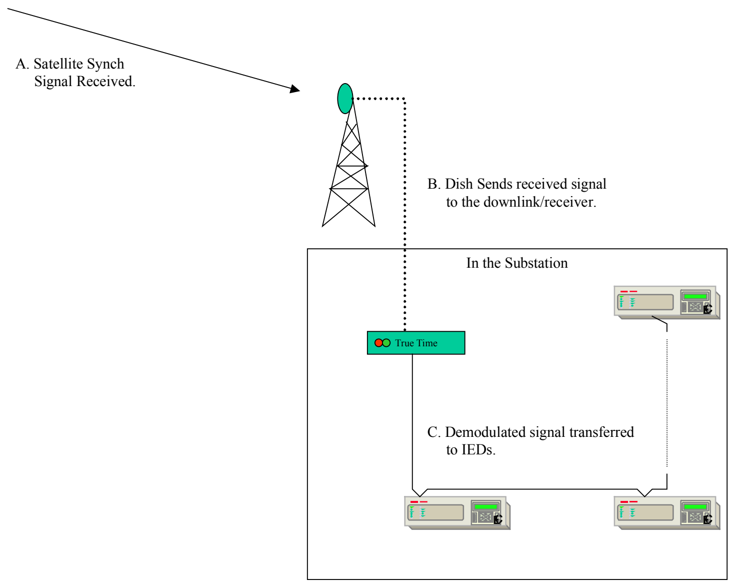


Figure 4-9. Typical IRIG B Architecture

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 4-10. 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.

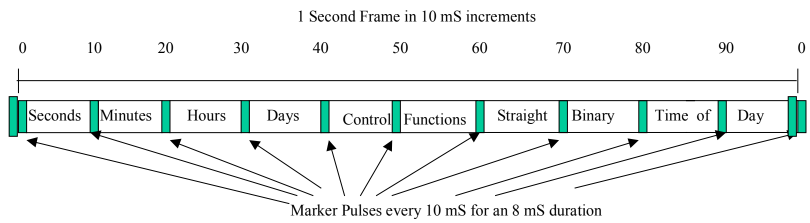


Figure 4-10. IRIG B Frame Construction

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/GPU/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 GPU/GPU/DPU2000/2000R 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 Tables 4-6 and 4-7. Generally, two types of protective relays do not offer IRIG B, units without a communication card, and units with Modbus Plus communication cards. Prior to the release of VERSION 4.4 DNP chipsets, DNP 3.0 was not available on the DPU Distribution Protection units. With the addition of the new silicon chipsets to the existing communication card hardware, DNP shall be available for configuration and use within the IED.

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/GPU/GPU2000R 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 4-11. The DPU/GPU2000(R) and DPU1500R use pins 65 and 66 as illustrated in Figure 4-12.

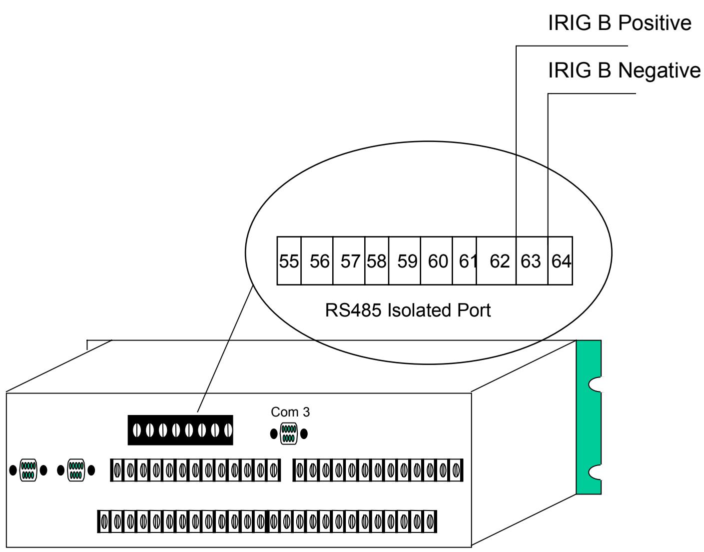


Figure 4-11. DPU/TPU/GPU2000R and DPU1500R IRIG B Connector Placement

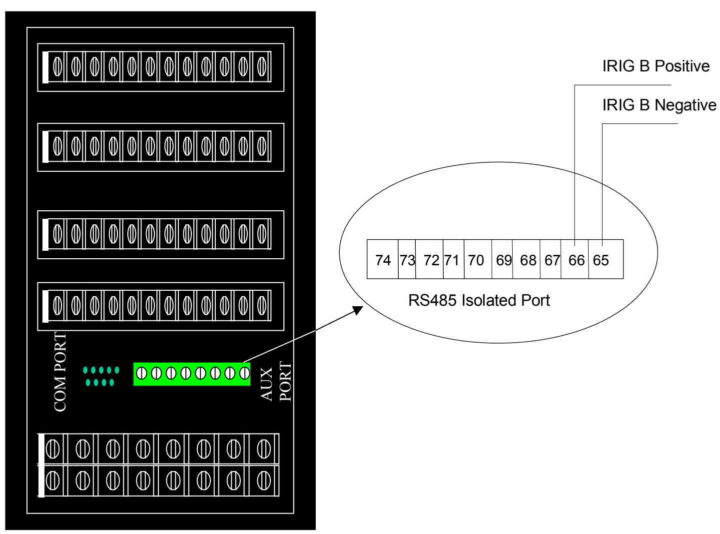


Figure 4-12. DPU/TPU2000 IRIG B Connector Placement

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 4-13.

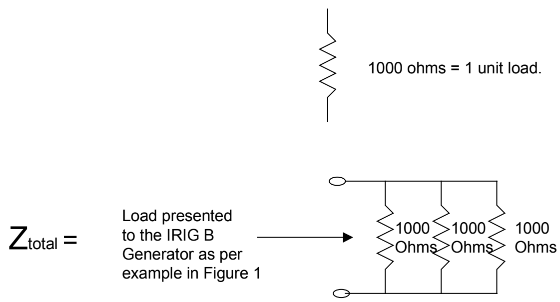
If the input impedance of each DPU/GPU/GPU2000/R is measured at its IRIG B connection, the impedance would be 1000 ohms. Each IRIG B input requires less than one mA to drive it. The required voltage must be no less than 5 VDC.

Calculating the load impedance presented to the IRIG B source generator is illustrated in Figure 4-13. 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 4-13 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 4-13. Load Impedance Calculation

The calculated load impedance for the architecture presented in Figure 4-13 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 daisychain interconnection of three units is illustrated in Figure 4-14.

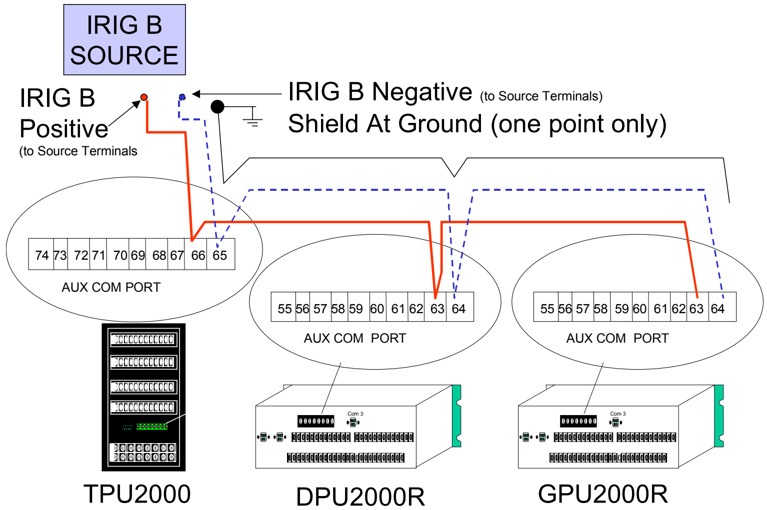


Figure 4-15. Pin to Pin Illustration of ABB Protective Daisychain Link for IRIG B

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. There are two configuration methods for IRIG B.

PRIOR TO VERSION 4.4 DNP 3.0 the configuration of the parameters for DNP 3.0 protocol time synchronization are as follows (Versions 3.3 and earlier do not support IRIG B time synchronization. Only DNP Network Time Synchronization is supported):

1. Start WINECP from the operating system for the appropriate device being configured.
2. Highlight the Change Settings Menu.
3. Highlight and Select the Communications Menu to display the screen as illustrated in Figure 4-15.
4. Scroll down to the field “ IRIG B”. Depress the enter key and select the “ENABLE” selection. Two selections are displayed, ENABLE-mmm or ENABLE-cc. If (IRIG B cc) is selected then all times received from the DPU or TPU will be in the Hour:Minute:Second:Hundreds of Seconds format. If (IRIGB mmm) is selected then all times will be transmitted as an unsigned long word where the most significant bit is set to 1 and the remainder of the long word will represent the total milli-seconds for the day.

   Example: The following (IRIGB mmm) time is received from the GPU2000R:

   82C6F096, where hour contains 82, minute contains C6 etc.

   This would represent the following time in hours minutes seconds milliseconds:

   12:56:13:150
5. Return from the menu item.
6. Download the changed selections to the attached unit.

The unit is now synchronized to the time source. All events shall be time stamped to the common time source. The protective relays may also be configured for selected timestamping from the front panel MMI of units which are equipped with a front panel interface.

If VERSION 4.4 DNP 3.0 is resident within the DPU 2000, 2000R or 1500R, the configuration procedure differs than from that listed above since event time stamping may occur from three different sources (External protocol time synch, IRIG B time synch, or IED clock source). The following procedure must be followed:

1. Reference Table 4-6 as illustrated below for the type of time synchronization required for the protocol used, (NO TIME SYNCHRONIZATION, EXTERNAL TIME SYNCHRONIZATION)
2. Start WINECP from the operating system for the appropriate device being configured.
3. Highlight the Change Settings Menu.
4. Highlight and Select the Communications Menu.
5. Select the field " REAR PORT IRIG B (AUX)/EXT. TIME SYNCH. DNP/SPA" as illustrated in FIGURE Y-Y".Access the selection pull-down menu and select the selection for the time synchronization required as listed in Table 4-6. Three selections are displayed, Disable, ENABLE-mmm or ENABLE-cc. If (IRIGB cc) is selected then all times received from the DPU or TPU will be in the Hour:Minute:Second:Hundreds of Seconds format. If (IRIGB mmm) is selected then all times will be transmitted as an unsigned long word where the most significant bit is set to 1 and the remainder of the long word will represent the total milli-seconds for the day.

Example: The following (IRIGB mmm) time is received:

82C6F096, where hour contains 82, minute contains C6 etc.

This would represent the following time in hours minutes seconds milliseconds:

12:56:13:150

7. Select the field corresponding to PARAMTER 9. Enter the appropriate value as indicated in Table 4-6 for the time synchronization required.
8. Return from the menu item.
9. Download the changed selections to the attached unit.

Table 4-6. Time Synchronization Options and Configuration Values

Time Synchronization Method	WINECP External Time Synch (SPA/DNP) Value	Parameter 9 Value
NONE	DISABLE	0
IRIG B	ENABLE –cc Or ENABLE- mmm	255
DNP 3.0 Object 50/52 DNP 3.0 network time synchronization	ENABLE –cc Or ENABLE- mmm	0 <= Value<= 254 Note: 0 Value is default and sets synch time to 60 minutes.

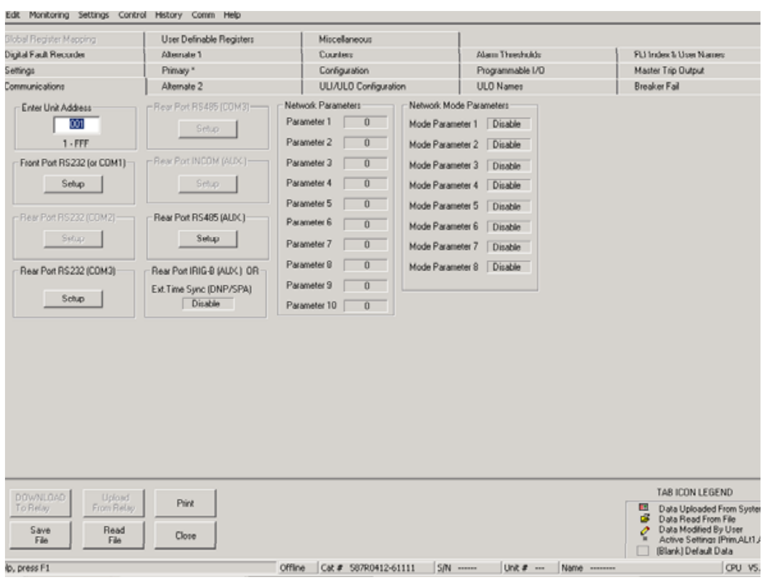


Figure 4-15. Communication Card Configuration Screen

Section 5 – DNP 3.0 Profile Description

The DPU2000, DPU1500R and DPU2000R has been one of the first IED's incorporating DNP 3.0 in their protective relay. Although the DNP implementation is not specifically Level II, it incorporates LEVEL I, LEVEL II, and LEVEL III commands. DNP 3.0 in the DPU2000, DPU1500R, and DPU2000R is a robust implementation allowing the following capabilities:

- Acquisition of Metering Data
- Contact Test Functionality
- Forcing Capabilities
- Status Reporting of Point Force/Unforce Status
- Function Status Reporting
- Counter Acquisition
- Fault Record Reporting
- Operation (Event) Record Reporting
- Alarm Reporting
- User Register Group Reporting
- Class Data Reporting
- Class Point Masking
- Function Enabled Status Reporting
- Time Synchronization Through DNP 3.0

The DPU2000, DPU1500R, and DPU2000R does not support Unsolicited Response (or Report By Exception as referred to by some). This new DNP 3.0 Profile document lists the supported commands in a format more conducive to that specified in the DNP 3.0 Subset Definitions Document. It is recommended that the reader consult the text titled:

> GE HARRIS® DISTRIBUTED NETWORK PROTOCOL – DNP 3.0 BASIC 4 DOCUMENT SET – Part Number 994-0007 dated July 30, 1995 REV. 3

The device protocol tables follow:

Table 5-1 provides a Device Profile Information in the standard format defined in the DNP 3.0 Subset Definitions Document. The table, in combination with the Implementation Table (Table 5-2) provided and the Point Lists provided in this user document should provide complete application implementation details for the DPU2000R/DPU2000 DNP environment.

Table 5-1. DPU2000/2000R/1500R Device Profile Definition

DNP V3.0 **DEVICE PROFILE DOCUMENT** (Also see the DNP 3.0 Implementation Table in Section 5, beginning on page 44.)	
Vendor Name: **ABB Inc.** **Substation Automation and Protection Division**	
Device Name: **Distribution Protection Unit**	
Highest DNP Level Supported: For Requests: **Level 2** (Since the implementation preceded the level definitions as of now the implementation lacks certain level 2 functionalities as noted below) For Responses: **Level 2** (See the note above)	Device Function: as **Slave**
Notable objects, functions, and/or qualifiers supported in addition to the Highest DNP Levels Supported (the complete list is described in the attached table): **For static data requests, in addition to qualifier code 06 (no range), qualifier codes 00 and 01 (start-stop), and 17 and 28 (index) are supported. For requests made with qualifiers 17 and 28, responses will also include qualifier codes 17 or 28.** **16-bit and 32-bit Analog Change Events with Time may be requested** **The read function code for Object 50 (Time and Date), variation 1, is supported.** Notable objects, functions, and/or qualifiers **NOT** supported that are **required** for LEVEL 2 DNP Levels **For Binary Input Change requests, (Object 2), Analog Change Event request (Object 32) and Class Data Scans (Object 60) qualifier codes 07 and 08 (limited quantity) are not supported.** **The event reporting is sorted by points and then with in each point sorted chronologically.**	
Maximum Data Link Frame Size (octets): Transmitted: **292** Received: **292**	Maximum Application Fragment Size (octets): Transmitted: **2048** Received: **2048**
Maximum Data Link Re-tries: ⊗ **Configurable from 0 to 255 (Using Parameter 3)**	Maximum Application Layer Re-tries: ⊗ **None**
Requires Data Link Layer Confirmation: ☐ Never ☐ Always ☐ Sometimes ⊗ **Configurable (Using Mode Parameter) Enable/Disable Data Link Layer Confirmation as Always or Never**	

DNP V3.0
DEVICE PROFILE DOCUMENT
(Also see the DNP 3.0 Implementation Table in Section 5, beginning on page 44.)

Requires Application Layer Confirmation:

☐ Never
☐ Always
☐ When reporting Event Data (Slave devices only)
☐ When sending multi-fragment responses (Slave devices only)
☐ Sometimes
⊗ **Configurable (Using Mode Parameter) Enable/Disable Application Layer Confirmation as Always or Never**

Timeouts while waiting for:

Data Link Confirm:	☐ None	☐ Fixed at ____	☐ Variable	⊗ **Configurable. Using Parameter**
Complete Appl. Fragment:	⊗ **None**	☐ Fixed at ____	☐ Variable	☐ Configurable
Application Confirm:	⊗ **None**	☐ Fixed at ____	☐ Variable	☐ Configurable
Complete Appl. Response:	⊗ **None**	☐ Fixed at ____	☐ Variable	☐ Configurable

Others: Inter-character Delay, Minimum turn around time for responses configurable. Request for Write Time - Interval configurable.

Sends/Executes Control Operations:

WRITE Binary Outputs	⊗ **Never**	☐ Always	☐ Sometimes	☐ Configurable
SELECT/OPERATE	☐ Never	⊗ **Always**	☐ Sometimes	☐ Configurable
DIRECT OPERATE	☐ Never	⊗ **Always**	☐ Sometimes	☐ Configurable
DIRECT OPERATE - NO ACK	☐ Never	⊗ **Always**	☐ Sometimes	☐ Configurable
Count > 1	⊗ **Never**	☐ Always	☐ Sometimes	☐ Configurable
Pulse On	☐ Never	☐ Always	⊗ **Sometimes**	☐ Configurable
Pulse Off	☐ Never	☐ Always	⊗ **Sometimes**	☐ Configurable
Latch On	☐ Never	☐ Always	⊗ **Sometimes**	☐ Configurable
Latch Off	☐ Never	☐ Always	⊗ **Sometimes**	☐ Configurable
Queue	⊗ **Never**	☐ Always	☐ Sometimes	☐ Configurable
Clear Queue	⊗ **Never**	☐ Always	☐ Sometimes	☐ Configurable

Execution of Pulse On, Pulse Off, Latch On, and Latch Off depend upon the data point being operated upon.

Reports Binary Input Change Events when no specific variation requested:

☐ Never
⊗ **Only time-tagged**
☐ Only non-time-tagged
☐ Configurable to send both, one or the other (attach explanation)

Reports time-tagged Binary Input Change Events when no specific variation requested:

☐ Never
⊗ **Binary Input Change With Time**
☐ Binary Input Change With Relative Time
☐ Configurable (attach explanation)

Sends Unsolicited Responses:

⊗ **Never**
☐ Configurable
☐ Only certain objects
☐ Sometimes (attach explanation)
☐ ENABLE/DISABLE UNSOLICITED Function codes supported

Sends Static Data in Unsolicited Responses:

⊗ **Never**
☐ When Device Restarts
☐ When Status Flags Change

No other options are permitted.

DNP V3.0 **DEVICE PROFILE DOCUMENT** (Also see the DNP 3.0 Implementation Table in Section 5, beginning on page 44.)	
Default Counter Object/Variation: ☐ No Counters Reported ☐ Configurable (attach explanation) ⊗ **Default Object 20** **Default Variation: 2** ☐ Point-by-point list attached	Counters Roll Over at: ☐ No Counters Reported ☐ Configurable (attach explanation) ☐ 16 Bits ☐ 32 Bits ⊗ **Other Value: 9999** ☐ Point-by-point list attached
Sends Multi-Fragment Responses: ⊗ **Yes** ☐ No	

DNP V3.0 Implementation Table

Table 5-2 identifies which object variations, function codes, and qualifiers the DPU2000/2000R/1500R supports in both request messages and in response messages. Note that while the DPU2000/2000R/1500R may parse many object variations, it will respond to the request variations identified below with entries in the response column. The shaded areas represent functionality beyond that required by a DNP Level 2 device. Also note that the unit does not respond to qualifier codes 07 and 08 for all the objects with the exception of object 50.

Table 5-2. DNP 3.0 Object/Variations Supported for the DPU2000/2000R/1500R

OBJECT			REQUEST (DPU2000/2000R/1500R will parse)		RESPONSE (DPU2000/2000R/1500R will respond with)	
Object No.	**Variation No**	**Description**	**Function Codes (dec)**	**Qualifier Codes (hex)**	**Function Codes (dec)**	**Qualifier Codes (hex)**
1	0	Binary Input – Any Variation	1 (read)	00, 01(start-stop) 06 (no range) 17, 28 (index)		
1	1	Binary Input	1 (read)	00, 01(start-stop) 06 (no range) 17, 28 (index)	129(response)	00, 01(start-stop) 17, 28 (index)
1	2 (default)	Binary Input with Status	1 (read)	00, 01(start-stop) 06 (no range) 17, 28 (index)	129(response)	00, 01(start-stop) 17, 28 (index)
2	0	Binary Input Change – Any Variation	1 (read)	06 (no range)		
2	1	Binary Input Change without Time	1 (read)	06 (no range)	129(response)	17, 28 (index)
2	2 (default)	Binary Input Change with Time	1 (read)	06 (no range)	129(response)	17, 28 (index)
10	0	Binary Output Status – Any Variation	1 (read)	00, 01(start-stop) 06 (no range) 17, 28 (index)		
10	2 (default)	Binary Output Status	1 (read)	00, 01(start-stop) 06 (no range) 17, 28 (index)	129(response)	00, 01(start-stop) 17, 28 (index)
12	1	Control Relay Output Block	3 (select) 4 (operate) 5 (direct op) 6 (dir. op, noack)	00, 01(start-stop) 17, 28 (index)	129(response)	echo of request
20	0	Binary Counter – Any Variation	1 (read) 7 (freeze) 8 (freeze noack)	00, 01(start-stop) 06 (no range) 17, 28 (index)		

OBJECT			REQUEST (DPU2000/2000R/1500R will parse)		RESPONSE (DPU2000/2000R/1500R will respond with)	
Object No.	**Variation No**	**Description**	**Function Codes (dec)**	**Qualifier Codes (hex)**	**Function Codes (dec)**	**Qualifier Codes (hex)**
20	2 (default)	16-Bit Binary Counter	1 (read) 7 (freeze) 8 (freeze noack)	00, 01(start-stop) 06 (no range) 17, 28 (index)	129(response)	00, 01(start-stop) 17, 28 (index)
20	6	16-Bit Binary Counter without Flag	1 (read) 7 (freeze) 8 (freeze noack)	00, 01(start-stop) 06 (no range) 17, 28 (index)	129(response)	00, 01(start-stop) 17, 28 (index)
21	0	Frozen Counter – Any Variation	1 (read)	00, 01(start-stop) 06 (no range) 17, 28 (index)		
21	2	16-Bit Frozen Counter	1 (read)	00, 01(start-stop) 06 (no range) 17, 28 (index)	129(response)	00, 01(start-stop) 17, 28 (index)
21	6 (default)	16-Bit Frozen Counter with time of freeze	1 (read)	00, 01(start-stop) 06 (no range) 17, 28 (index)	129(response)	00, 01(start-stop) 17, 28 (index)
21	10	16-Bit Frozen Counter without Flag	1 (read)	00, 01(start-stop) 06 (no range) 17, 28 (index)	129(response)	00, 01(start-stop) 17, 28 (index)
30	0	Analog Input – Any Variation	1 (read)	00, 01(start-stop) 06 (no range) 17, 28 (index)		
30	1	32-Bit Analog Input	1 (read)	00, 01(start-stop) 06 (no range) 17, 28 (index)	129(response)	00, 01(start-stop) 17, 28 (index)
30	2 (default)	16-Bit Analog Input	1 (read)	00, 01(start-stop) 06 (no range) 17, 28 (index)	129(response)	00, 01(start-stop) 17, 28 (index)
30	3	32-Bit Analog Input without Flag	1 (read)	00, 01(start-stop) 06 (no range) 17, 28 (index)	129(response)	00, 01(start-stop) 17, 28 (index)
30	4	16-Bit Analog Input without Flag	1 (read)	00, 01(start-stop) 06 (no range) 17, 28 (index)	129(response)	00, 01(start-stop) 17, 28 (index)
32	0	Analog Change Event – Any Variation	1 (read)	06 (no range)		
32	3	32-Bit Analog Change Event with Time	1 (read)	06 (no range)	129(response) 130(unsol. resp)	17, 28 (index)
32	4 (default)	16-Bit Analog Change Event with Time	1 (read)	06 (no range)	129(response) 130(unsol. resp)	17, 28 (index)
50	0	Time and Date	1 (read) 2 (write)	06 (no range) 07 (no range)		
50	1 (default)	Time and Date	1 (read) 2 (write)	06 (no range) 07 (no range)	129(response)	00, 01(start-stop) 17, 28 (index)
52	1	Time Delay Fine			129(response)	00, 01(start-stop) 17, 28 (index)
60	0	Class 0, 1, 2, and 3 Data	1 (read)	06 (no range)		
60	1	Class 0 Data	1 (read)	06 (no range)		
60	2	Class 1 Data	1 (read)	06 (no range)		
60	3	Class 2 Data	1 (read)	06 (no range)		
60	4	Class 3 Data	1 (read)	06 (no range)		
80	1	Internal Indications	2 (write)	00 (start-stop) (index must =7)		
No Object (function code only)			13 (cold restart)			
No Object (function code only)			14 (warm restart)			

OBJECT			REQUEST (DPU2000/2000R/1500R will parse)		RESPONSE (DPU2000/2000R/1500R will respond with)	
Object No.	**Variation No**	**Description**	**Function Codes (dec)**	**Qualifier Codes (hex)**	**Function Codes (dec)**	**Qualifier Codes (hex)**
No Object (function code only)			23 (delay meas)			

(Default variations are responded when variation 0 is requested and/or in class 0, 1, 2, or 3 scans.)

Internal Indication (IIN) Field Data Returns

DNP 3.0, is a protocol which includes status bytes within a data transfer frame. The decode of the defined bits within the protocol are defined in Figure 5-1. The DPU2000 and DPU2000R supports all the bits as defined in the protocol. However the definition of when the defined bits are given as a reference to the operator.

The IIN field is useful to determine if Class Data is available, or if commands have been accepted or if diagnostics and the device are operational.

First byte, Bit 4 - Time-synchronization required, set at power up, cleared by host.
First byte, Bit 5 - Outputs offline - always zero.
Second byte, Bit 5 - Configuration corrupt - always zero.
First byte, Bit 6 - Device Trouble - set if any of the following binary inputs are true.

Table 5-3. Trouble Bit 6 Instance Occurrence Definitions

Description
Self Test Status
DSP ROM Failure
DSP Internal RAM Failure
DSP External RAM Failure
DSP +/-5V Failure
DSP +/-15V Failure
DSP +5V Failure
DSP Comm. Failure
ADC Failure
CPU RAM Failure
CPU EPROM Failure
CPU NVRAM Failure
CPU EEPROM Failure

IIN CODE FORMAT

Bit 0 = All Stations Message
Bit 1 = Class 1 Data
Bit 2 = Class 2 Data
Bit 3 = Class 3 Data
Bit 4 = Time Synch Required from Master
Bit 5 = Digital Output Point(s) in LOCAL
Bit 6 = Device Trouble
Bit 7 = Device Restart

OCTET 1

Bit 7	Bit 6	**Bit 5**	**Bit 4**	Bit 3	Bit 2	Bit 1	Bit 0

Bit 0 = RESERVED
Bit 1 = Requested Object(s) Unknown
Bit 2 = Qualifier, Range, or Data Invalid
Bit 3 = Event Buffers Overflowed
Bit 4 = Request Understood/Command Processing
Bit 5 = Current Configuration Corrupt
Bit 6 = RESERVED (Always 0)
Bit 7 = RESERVED (Always 0)

OCTET 2

Bit 7	Bit 6	**Bit 5**	**Bit 4**	Bit 3	Bit 2	Bit 1	Bit 0

Figure 5-1. DNP 3.0 Device IIN Bit Definition Assignment

Binary Input Points (224 Indices Defined)

Binary Input Points are reported a variety of ways using Object 1 (Single Bit Binary Data with or without status reporting) or Object 2 (Single Bit Binary Input Change with or without status/time reporting).

If the point as defined in Table 5-4.

Table 5-4. Binary Input Index Definition Table

Binary Input Points
Static (Steady-State) Object Number: **1**
Change Event Object Number: **2**
Request Function Codes supported: **1 (read)**
Static Variation reported when variation 0 requested: **1 (Binary Input without status)**
Change Variation reported when variation 0 requested: **2 (Binary Input without status)**
NOTE: For Static points the response for variation 0 is configurable

Point I.D.	Name/Description	Default[1] Change Event Assigned Class (1, 2, 3 or none)	Scan Group	
0	Contact Input Status Changed (obj 1 only)	None	@	0
1	Local Settings Change (obj 1 only)	None	@	0
2	Remote Edit Disabled (obj 1 only)	None	@	5
3	Alternate Settings Group 1 Enabled (obj 1 only)	None	@	0
4	Alternate Setting Group 2 Enabled (obj 1 only)	None	@	0
5	Fault Record Logged (obj 1 only)	None	@	0
6	Power was Cycled (obj 1 only)	None	@	0
7	One/More Unreported Operations (obj 1 only)	None	@	0
8	Local Operator Interface Action (obj 1 only)	None	@	0
9	0 = Wye, 1 = Delta (obj 1 only)	None	@	5
10	0 = KWhr 1 = MWhr (obj 1 only)	None	@	5
11	52a Input Enabled - from Input Tab	3		3
12	52b Input Enabled - from Input Tab	3		0
13	43a - Reclose Function Enabled	3		3

Binary Input Points
Static (Steady-State) Object Number: **1**
Change Event Object Number: **2**
Request Function Codes supported: **1 (read)**
Static Variation reported when variation 0 requested: **1 (Binary Input without status)**
Change Variation reported when variation 0 requested: **2 (Binary Input without status)**
NOTE: For Static points the response for variation 0 is configurable

Point I.D.	Name/Description	Default[1] Change Event Assigned Class (1, 2, 3 or none)	Scan Group	
14	PH3 - Phase Torque Control Enabled	3		4
15	GRD - Ground Torque Control Enabled	3		4
16	SCC - Spring Charging Input Enabled	3		5
17	79S - Single Shot Reclose Input Enabled **(See Point 127 for 79M Multi-Shot Reclosing)**	3		4
18	TCM - Trip Coil Monitor Input Enabled	3		3
19	50-1 - 1st Inst. Unit Torque Control	3		4
20	50-2 - 2nd Inst. Unit Torque Control	3		4
21	50-3 - 3rd Inst. Unit Torque Control	3		4
22	ALT1 - Alternate 1 Settings Enabled	3		4
23	ALT2 - Alternate 2 Settings Enabled	3		4
24	ECI1 - Event Capture 1 Enabled	3		5
25	ECI2 - Event Capture 2 Enabled	3		5
26	WCI - Waveform Capture Enabled	3		5
27	ZSC - Zone Sequence Coord. Enabled	3		5
28	OPEN - Trip Contact Initiated	3		4
29	CLOSE - Close Contact Initiated	3		4
30	46TC - Neg. Sequence Control Enabled	3		4
31	TRIP - Output Contact Energized	3		6
32	CLOSE - Output Contact Energized	3		6
33	ALARM - Self Check Alarm Energized	3		6
34	27 - Under Voltage Trip	3	**(L)**	7
35	46 - Negative Sequence Overcurrent Trip	3	**(L)**	7
36	50P1 - Phase Inst. Overcurrent Trip	3	**(L)**	7
37	50N1 - Neutral Inst. Overcurrent Trip	3	**(L)**	7
38	50P2 - Phase Inst. Overcurrent Trip	3	**(L)**	7
39	50N2 - Neutral Inst. Overcurrent Trip	3	**(L)**	7
40	50P3 - Phase Inst. Overcurrent Trip	3	**(L)**	7
41	50N3 - Neutral Inst. Overcurrent Trip	3	**(L)**	7
42	51P - Phase Time Overcurrent Trip	3	**(L)**	7
43	51N - Neutral Time Overcurrent Trip	3	**(L)**	7
44	59 - Over Voltage Trip	3	**(L)**	7
45	67P - Direct. Overcurrent Trip (pos seq)	3	**(L)**	7
46	67N - Direct. Overcurrent Trip (neg seq)	3	**(L)**	7
47	81S - Frequency Shed (1st stage)	3	**(L)**	7
48	81R - Frequency Restore (1st stage)	3	**(L)**	7
49	PATA - Phase A Target Alarm Energized	3		6
50	PBTA - Phase B Target Alarm Energized	3		6
51	PCTA - Phase C Target Alarm Energized	3		6

Binary Input Points
Static (Steady-State) Object Number: **1**
Change Event Object Number: **2**
Request Function Codes supported: **1 (read)**
Static Variation reported when variation 0 requested: **1 (Binary Input without status)**
Change Variation reported when variation 0 requested: **2 (Binary Input without status)**
NOTE: For Static points the response for variation 0 is configurable

Point I.D.	**Name/Description**	**Default[1] Change Event Assigned Class (1, 2, 3 or none)**	**Scan Group**	
52	TCFA - Trip Coil Failure Alarm Energized	3		3
53	TCC - Tap Changer Cutout Energized	3		9
54	79DA - Reclosing Disabled Alm Energized	3		6
55	PUA - Pick Up Alarm Energized	3		9
56	79LOA - Recloser Lock Out Alm Energized	3		9
57	BFA - Breaker Failure Alarm Energized	3	**(L)**	3
58	PDA - Phs Demand Current Alm Energized	3		9
59	NDA - Neut Demand Current Alm Energized	3		9
60	BFUA - Blown Fuse Alarm Energized	3		9
61	KSI - KSI Summation Alarm Energized	3		9
62	79CA-1 - Recloser Counter Alm 1 Energized	3		9
63	HPFA - High Power Factor Alm Energized	3		9
64	LPFA - Low Power Factor Alm Energized	3		9
65	OCTC - O/C Trip Counter Alm Energized	3		9
66	50-1D - 1st Inst O/C Dis. Alm Energized	3		10
67	50-2D - 2nd Inst O/C Dis. Alm Energized	3		10
68	STC - Settings Table Chg Alm Energized	3		10
69	ZSC - Zone Sequence Coord. Energized	3		10
70	PH3-D - PHS O/C Disabled Alm Energized	3		10
71	GRD-D - GRD O/C Disabled Alm Energized	3		10
72	32PA - 67P Pickup Alarm Energized	3		9
73	32NA - 67N Pickup Alarm Energized	3		9
74	27-3P - Phase Under Voltage Trip	3	**(L)**	7
75	VarDA - 3PHS Kvar Demand Alm Energized	3		9
76	79CA-2 - Recloser Counter Alm 2 Energized	3		9
77	TRIPA - Single Pole Trip (phase A)	3	**(L)**	10
78	TRIPB - Single Pole Trip (phase B)	3	**(L)**	10
79	TRIPC - Single Pole Trip (phase C)	3	**(L)**	10
80	52a Input Closed	3	**(D) (N)**	11
81	52b Input Closed	3	**(D) (N)**	11
82	43a Input Closed	3	**(D) (N)**	11
83	Input 1 Input Closed	3		11
84	Input 2 Input Closed	3		11
85	Input 3 Input Closed	3		11
86	Input 4 Input Closed	3		11
87	Input 5 Input Closed	3		11
88	Input 6 Input Closed	3	**(N)**	11
89	Input 7 Input Closed	3	**(N)**	11

Binary Input Points
Static (Steady-State) Object Number: **1**
Change Event Object Number: **2**
Request Function Codes supported: **1 (read)**
Static Variation reported when variation 0 requested: **1 (Binary Input without status)**
Change Variation reported when variation 0 requested: **2 (Binary Input without status)**
NOTE: For Static points the response for variation 0 is configurable

Point I.D.	Name/Description	Default[1] Change Event Assigned Class (1, 2, 3 or none)	Scan Group	
90	Input 8 Input Closed (NOTE : INPUT 6 ON DPU 1500)	3		11
91	Input 9 Input Closed	3	**(D) (N)**	11
92	Input 10 Input Closed	3	**(D) (N)**	11
93	Input 11 Input Closed	3	**(D) (N)**	11
94	Input 12 Input Closed	3	**(D) (N)**	11
95	Input 13 Input Closed	3	**(D) (N)**	11
96	Fault Rec Stat (bit 0) 0=Wye, 1=Delta (obj 2 only)	1		12
97	Fault Rec Stat (bit 1) 0=Fault, 1=Event (obj 2 only)	1		12
98	67P - Direct. Overcurrent Trip (pos seq)	3		4
99	67N - Direct. Overcurrent Trip (neg seq)	3		4
100	ULI 1 - User Logical 1 Enabled	3		13
101	ULI 2 - User Logical 2 Enabled	3		13
102	ULI 3 - User Logical 3 Enabled	3		13
103	ULI 4 - User Logical 4 Enabled	3		13
104	ULI 5 - User Logical 5 Enabled	3		13
105	ULI 6 - User Logical 6 Enabled	3		13
106	ULI 7 - User Logical 7 Enabled	3		13
107	ULI 8 - User Logical 8 Enabled	3		13
108	ULI 9 - User Logical 9 Enabled	3		13
109	CRI - Clear Recloser Counter Energized	3		4
110	ULO 1 - User Logical 1 Enabled	3		14
111	ULO 2 - User Logical 2 Enabled	3		14
112	ULO 3 - User Logical 3 Enabled	3		14
113	ULO 4 - User Logical 4 Enabled	3		14
114	ULO 5 - User Logical 5 Enabled	3		14
115	ULO 6 - User Logical 6 Enabled	3		14
116	ULO 7 - User Logical 7 Enabled	3		14
117	ULO 8 - User Logical 8 Enabled	3		14
118	ULO 9 - User Logical 9 Enabled	3		14
119	PVArA - Positive 3 PHS Kvar Alarm Energized	3		9
120	NVArA - Negative 3 PHS Kvar Alarm Energized	3		9
121	LOADA - Load Current Alarm Energized	3		9
122	81O-1 - Over Frequency (1^{st} Stage)	3	**(L)**	7
123	81O-2 - Over Frequency (2^{nd} Stage)	3	**(L)**	7
124	81S-2 - Over Frequency Shed (2^{nd} Stage)	3	**(L)**	7
125	81R-2 - Over Frequency Restore (2^{nd} Stage)	3		7
126	CLTA - Cold Load Timer Alarm Energized	3		9
127	79M – Multi-Shot Reclose Input Enabled	3		4

Binary Input Points
Static (Steady-State) Object Number: **1**
Change Event Object Number: **2**
Request Function Codes supported: **1 (read)**
Static Variation reported when variation 0 requested: **1 (Binary Input without status)**
Change Variation reported when variation 0 requested: **2 (Binary Input without status)**
NOTE: For Static points the response for variation 0 is configurable

Point I.D.	Name/Description	Default[1] Change Event Assigned Class (1, 2, 3 or none)	Scan Group	
128	LOCAL - Local Supervisory Control	3	**(R)**	2
129	SBA - Slow Breaker Alarm	3	**(R)**	2
130	ARCI - Automatic Reclose Inhibited**	3	**(R)**	26
131	TARC - Initiate Trip and Auto Reclose**	3	**(R)**	26
132	SEF TC - Sensitive Earth Fault Torque Control**	3	**(R)**	26
133	Ext BFI - External Breaker Fail Indicate**	3	**(R+)**	26
134	BFI - Breaker Fail Inidicate**	3	**(R+)**	26
135	UDI - User Display Input**	3		26
136	25 - Synch Check Function**	3	**(R+)**	26
137	25 BYPASS - Synch Check Function Bypass**	3	**(R+)**	26
138	TGT - Target LED's Reset**	3	**(R)**	26
139	SIA - Seal In Alarms Reset**	3	**(R)**	26
140	Pwatt1 - Positive Watt Alarm 1 Energized**	3		26
141	Pwatt2 - Positive Watt Alarm 2 Energized**	3		26
142	SEF - Sensitive Earth Fault Alarm Trip**	3	**(L)(R)**	26
143	BZA - Bus Zone Alarm **	3		26
144	BF TRIP - Breaker Fail Trip**	3	**(L) (R+)**	26
145	BF RETRIP - Breaker Fail Retrip**	3	**(L) (R+)**	26
146	32P-2 - Phase Directionality Alarm**	3	**(L) (R+)**	26
147	32N-2 - Neutral Directionality Alarm**	3	**(L) (R+)**	26
148	25 - In Synchronism**	3	**(L) (R+)**	26
149	79V - Recloser Velocity Enabled**	3		26
150	ReCLin - Recloser In **	3		26
151	59G - Voltage Zero Sequence Overvoltage Alarm**	3	**(L)**	26
152	LO1 - Latching Output 1**	3	**(R+)**	28
153	LO2 - Latching Output 2**	3	**(R+)**	28
154	LO3 - Latching Output 3**	3	**(R+)**	28
155	LO4 - Latching Output 4**	3	**(R+)**	28
156	LO5 - Latching Output 5**	3	**(R+)**	28
157	LO6 - Latching Output 6**	3	**(R+)**	28
158	LO7 - Latching Output 7**	3	**(R+)**	28
159	LO8 - Latching Output 8**	3	**(R+)**	28
160	79ON - Hot Hold Tagging On**	3	**(R+)**	28
161	79OFF - Hot Hold Tagging Off**	3	**(R+)**	28
162	79TAG - Hot Hold Tagging Tagged**	3	**(R+)**	28
163	59-3 - 3 phase OV	3		7
164	47- Neg Seq OV	3		7
165	21P-1 - ZONE1 OC	3		7

Binary Input Points
Static (Steady-State) Object Number: **1**
Change Event Object Number: **2**
Request Function Codes supported: **1 (read)**
Static Variation reported when variation 0 requested: **1 (Binary Input without status)**
Change Variation reported when variation 0 requested: **2 (Binary Input without status)**
NOTE: For Static points the response for variation 0 is configurable

Point I.D.	Name/Description	Default[1] Change Event Assigned Class (1, 2, 3 or none)	Scan Group	
166	21P-2 - ZONE2 OC	3		7
167	21P-3 - ZONE3 OC	3		7
168	21P-4 - ZONE4 OC	3		7
169	50-3D - Instantaneous Disabled Alarm	3	**(E)**	29
170	OCI Control Button C1	3	**(O+)**	29
171	OCI Control Button C2	3	**(O+)**	29
172	OCI Control Button C3	3	**(O+)**	29
173	OCI Control Button C4	3	**(O+)**	29
174	OCI Control Button C5	3	**(O+)**	29
175	OCI Control Button C6	3	**(O+)**	29
176	TripT - Trip Target	3	**(E)**	29
177	NTA - Neutral Trip Target	3	**(E)**	29
178	TimeT - Time OC Trip Target	3	**(E)**	29
179	InstT - Instantaneous OC Trip Target	3	**(E)**	29
180	NegSeqT - Negative Sequence Trip Target	3	**(E)**	29
181	FreqT - Frequency Trip Target	3	**(E)**	29
182	DirT - Directional Trip Target	3	**(E)**	29
183	VoltT - Voltage Trip Target	3	**(E)**	29
184	DistT - Distance Trip Target	3	**(E)**	29
185	SEFT - Sensitive Earth Trip Target	3	**(E)**	29
186	ULO10 - User Logical Out 10	3	**(E)**	29
187	ULO11 - User Logical Out 11	3	**(E)**	29
188	ULO12 - User Logical Out 12	3	**(E)**	29
189	ULO13 - User Logical Out 13	3	**(E)**	29
190	ULO14 - User Logical Out 14	3	**(E)**	29
191	ULO15 - User Logical Out 15	3	**(E)**	29
192	ULO16 - User Logical Out 16	3	**(E)**	29
193	HBHL - Hot Bus Hot Line	3	**(E)**	29
194	HBDL - Hot Bus Dead Line	3	**(E)**	29
195	DBHL - Dead Bus Hot Line	3	**(E)**	29
196	DBDL - Dead Bus Dead Line	3	**(E)**	29
197	46A - Trip 46A	3	**(E)**	29
198	46A (L) - Trip 46A Latched	3	**(E)**	29
199	LIS1 - Latch In Set 1	3	**(E)**	29
200	LIS2 - Latch In Set 2	3	**(E)**	29
201	LIS3 - Latch In Set 3	3	**(E)**	29
202	LIS4 - Latch In Set 4	3	**(E)**	29
203	LIS5 - Latch In Set 5	3	**(E)**	29

Binary Input Points
Static (Steady-State) Object Number: **1**
Change Event Object Number: **2**
Request Function Codes supported: **1 (read)**
Static Variation reported when variation 0 requested: **1 (Binary Input without status)**
Change Variation reported when variation 0 requested: **2 (Binary Input without status)**
NOTE: For Static points the response for variation 0 is configurable

Point I.D.	Name/Description	Default[1] Change Event Assigned Class (1, 2, 3 or none)	Scan Group	
204	LIS6 - Latch In Set 6	3	**(E)**	29
205	LIS7 - Latch In Set 7	3	**(E)**	29
206	LIS8 - Latch In Set 8	3	**(E)**	29
207	LIR1 - Latch In Reset 1	3	**(E)**	29
208	LIR2 - Latch In Reset 2	3	**(E)**	29
209	LIR3 - Latch In Reset 3	3	**(E)**	29
210	LIR4 - Latch In Reset 4	3	**(E)**	29
211	LIR5 - Latch In Reset 5	3	**(E)**	29
212	LIR6 - Latch In Reset 6	3	**(E)**	29
213	LIR7 - Latch In Reset 7	3	**(E)**	29
214	LIR8 - Latch In Reset 8	3	**(E)**	29
215	TR_SET - Set Hot Line Tag function	3	**(O+)**	29
216	TR_RST - Reset Hot Line Tag function	3	**(O+)**	29
217	ULI10 - User Logical Input 10	3	**(E)**	29
218	ULI11 - User Logical Input 11	3	**(E)**	29
219	ULI12 - User Logical Input 12	3	**(E)**	29
220	ULI13 - User Logical Input 13	3	**(E)**	29
221	ULI14 - User Logical Input 14	3	**(E)**	29
222	ULI15 - User Logical Input 15	3	**(E)**	29
223	ULI16 - User Logical Input 16	3	**(E)**	29
224	46A_TC - 46A Torque Control	3	**(E)**	29
225	LOCAL D – Local Remote Switch Status	3	**(S)**	29*
226	SW SET – Retentive Switch Set Control Active	3	**(S)**	30
227	SHIFT A – Status Of TEST A Ring Shift Register	3	**(S)**	30
228	SHIFT B - Status Of TEST B Ring Shift Register	3	**(S)**	30
229	PRIMSETTACTIVE – Primary Settings Status Indicator	3	**(S)**	30
230	ALT1SETTACTIVE – Alternate 1 Setting Status Indicator	3	**(S)**	30
231	ALT2SETTACTIVE - Alternate 1 Setting Status Indicator	3	**(S)**	30
232	SHIFT_A1 – TEST A is in Stage 1 of Test Procedure.	3	**(S)**	30
233	SHIFT_A2 – TEST A is in Stage 2 of Test Procedure	3	**(S)**	30
234	SHIFT_A3 – TEST A is in Stage 3 of Test Procedure	3	**(S)**	30
235	SHIFT_A4 – TEST A is in Stage 4 of Test Procedure	3	**(S)**	30
236	SHIFT_B1 – TEST B is in Stage 1 of Test Procedure.	3	**(S)**	30
237	SHIFT_B2 – TEST B is in Stage 2 of Test Procedure	3	**(S)**	30
238	SHIFT_B3 – TEST B is in Stage 3 of Test Procedure	3	**(S)**	30
239	SHIFT_B4 – TEST B is in Stage 4 of Test Procedure	3	**(S)**	30

Binary Input Points
Static (Steady-State) Object Number: **1**
Change Event Object Number: **2**
Request Function Codes supported: **1 (read)**
Static Variation reported when variation 0 requested: **1 (Binary Input without status)**
Change Variation reported when variation 0 requested: **2 (Binary Input without status)**
NOTE: For Static points the response for variation 0 is configurable

Point I.D.	Name/Description	Default[1] Change Event Assigned Class (1, 2, 3 or none)	Scan Group

NOTES:
@ = DPU2000R only
(L) = Latched or Seal In Status Point – Reset via Object 12 Index 12 or via WinECP or Front Panel Interface [See Communication Section 4.0 Mode Parameter 5]
(D) = DPU2000 Only
(N) = Not Available In 1500R
(R) = DPU2000R
(R+) = DPU2000R Firmware Version 4.10 or later
(R++) = DPU 2000R Firmware Version 4.23 with DNP 3.0 Version Firmware 3.7 or later.
(O+) = OCI Front Panel Interface with Firmware Version 5.20 and DNP3.0 Version Firmware 4.5 or later.
(E) = DPU2000R with Firmware Version 5.20
(S) = DPU 2000R with Firmware Version 6.0 only

DNP Control (152 Indices Defined)

The explanation of DNP 3.0 control theory in relation to an ASE Test Set simulator follows. The discussion is not to be host device centric but to be protocol centric. The commands discussed relate to the parameterization of the ASE Test Set.

The ASE DOS Test Set has a standard list of DNP 3.0 commands. DNP 3.0 is an object based protocol upon which different functions are defined. The DNP 3.0 protocol is defined by GE Harris® and a protocol document Titled Distributed Network Protocol DNP 3.0 Basic 2 Document Set Part Number 994-0007 Revision 03 described the command set. Reference Table 5-5 for Control Indices.

Control Functions and Objects Defined

DNP 3.0 defines two objects for discrete point data access/control. The defined Objects are:

Object 10 - Binary Output Status
Supporting Control Operation READ (Function 01)
Object 12- Binary Output Control
Supporting Control Operations SELECT (Function 03)
OPERATE (Function 04)
DIRECT OPERATE (Function 05)
DIRECT OPERATE NO ACK (Function 06)

It should be noted that the standard ASE Object Command SBO Relay OUT uses functions 03 and 04 to complete the control functionality.

It should also be noted that the standard ASE Default List of DNP 3.0 commands uses 8 bit (single octet) range identifiers as a default. Thus Object 12 Variant 1 is intended to use a range qualifier of 17x when performing control functionality.

The use of Binary Output Control (Object 12) shall be explained within this application note. To perform the desired control functions with the ASE Test Set, the following information is required for initiation of communications to a DPU2000/DPU2000R. ASE uses the description SBO Relay Out to denote control functionality.

Source	100	
Destination	1	
Object	12	
Variant	1	(Required for Object 12 Control)
Qualifier	17x	(HEX) (Single Byte Range Argument)
Range	1	(Single Control Type)

Single Control Point Configuration

The ASE Test Set offers additional parameters that must be specified for control operation. Although multiple functions may be controlled via a DNP 3.0 command, this application note shall only deal with single point control. Depressing the Range button on the ASE Test Set and selecting the Single Point Control, a window shall be displayed requesting:

Index (Refer to Table 5-1 for the desired function)

Control Code Configuration

The second set of parameters which must be specified for control are particular to the control object 12. The specified control arguments required for in the Relay parameters field of the test set is:

Control Code	
Count	(Number of Times Control operation is to be executed)
Length of Pulse ON (in mS)	(Length of Pulse Control ON)
Length of Pulse OFF (in mS)	(Length of Pulse Control OFF)
Status	(DPU2000/DPU2000R this argument is always = 0)

The Pulse Control OFF argument is useful when the count is greater than 1. The Pulse ON and Pulse OFF time creates a pulse train duration useful for execution of specific consecutive timed events.

The control codes are defined in DNP 3.0 as per the bit pattern as outlined in Figure 5-2. The following permutations are as such:

00 (hex)	NULL Control (Cancels the Control Operation Depending on the Control function)
01 (hex)	Momentary Pulse ON (Duration = Pulse ON Value Field)
02 (hex)	Momentary Pulse OFF (Duration = Pulse OFF Value Field)
03 (hex)	Latch ON (Set Control Value to ON until reset or Latch OFF)
04 (hex)	Latch OFF (Set Control Value to OFF until reset of Latch ON)
81 (hex)	Trip Designation with Momentary On (Paired Point Operation)
41 (hex)	Close Designation with Momentary Off (Paired Point Operation)

Each of the above control functions included in Table 5-1 shall be explained using single point control are reviewed in the following sections. **It is noted that the NULL CONTROL CODE is not supported and sending such a control code shall generate a returned message that the request is not accepted. This does not affect the operation of the relay.**

Bit 7	Bit 6			Bit 3	Bit 2	Bit 1	Bit 0

Trip = 01
Close = 10
For Control Code Bits

0000 = Null Operation
0001 = Pulse On (for the specific On Time)
0010 = Pulse Off (for the specific Off Time)
0011 = Latch On
0100 = Latch Off

- The control code for Trip would be 41x (hex)
- The control code for Close would be 81x (hex)

Figure 5-2. DNP Control Field Bit Designation

The following sections explain the control operations for each of the aforementioned grouping of points. The supported objects and variants for each of the DPU2000/DPU2000R control types are listed in DPU2000/DPU2000R Implementation of the DNP 3.0 User Guide Revision 3.0.

Paired Point Operation

Several indices are configured as paired points. Paired point operation, as per the DNP 3.0 definition operates with the TRIP (81x) and CLOSE (41x) commands. Paired Point implementation occurs with the following groups.

Physical Output Test Control
Trip Operate Control
Reset Element Control
User Logical Control

Several Groups of data have a PAIRED POINT operation implementation with respect to control codes TRIP 81x and CLOSE 41x. Each point in a PAIRED POINT IMPLEMENTATION group operates as such:

EVEN POINT NUMBER: If a TRIP Command is sent to this point the corresponding function is energized (for example, trip physical output [index 0], Output 1 [index 2], or ULO 1 [index 14]). If a CLOSE command is sent to an even index, the next corresponding function [odd paired index] is energized (for example, spare [index 1], Output 2 [index 3] or ULO 2 [index 15]). The groups described as being paired points shall have the odd index- even index point pairing.

ODD POINT NUMBER: If a CLOSE Command (41x) is sent to an ODD index, the defined operation shall occur as the index is defined in Table 5-1. If a TRIP (81x) command is sent, the command shall be accepted but ignored.

The advantage of a PAIRED POINT implementation is that some legacy host devices perform trip and close on the same point index. The PAIRED POINT implementation allows ABB protective relays to provide superior automation control via DNP 3.0 with a wide variety of host implementations.

PAIRED POINT index implementation is not configurable from the operator or from the host device.

Physical Output Test Control (Index 0 Through 9)

Physical Output Control is provided for DPU2000/DPU2000R test. ABB DNP 3.0 implementation allows for pulsing of the output contacts for test. The output may be pulsed on for a duration of 300 mS. Control Index points 0 through 9 allow for a single pulse of the selected point. The supported control operations are as follows for the aforementioned points. **PAIRED POINT operation is implemented.**

Even Numbered Control Points (0,2,4,6,8)

Control Code	01 (Momentary On)
	03 (Latch On)
	81 (Trip)
	41 (Close)
	All other Control Codes are accepted. No action results.
Count	All counts other than 1 execute the command once.
Length of Pulse ON	A number 1 or greater pulses the output for 300 mS.
Length of Pulse OFF	Field Value is ignored.
Status	Field Value is ignored.

Odd Numbered Control Points (1,3,5,7,9)

Control Code	01 (Momentary On)
	03 (Latch On)
	41 (Close)
	All other Control Codes are accepted. No action results.
Count	All counts other than 1 execute the command once.
Length of Pulse ON	A number 1 or greater pulses the output for 300 mS.
Length of Pulse OFF	Field Value is ignored.
Status	Field Value is Ignored.

Trip Operate Control (Index 10-11 and 24-25)

The Trip Operate Control index operates only with the trip control argument. Since the DPU2000/DPU2000R has only the ability to trip a breaker, (Closing is only possible via a manual operation via a mimic panel switch). **PAIRED POINT operation is implemented.** The following are accepted control codes for single point control:

Control Code	81x (Trip)
	41x (Close)
	03x (Latch ON)
	04x (Latch OFF)
Count	Count of 1 is supported only all others execute once.
Length of Pulse ON	The entry in this field determines the pulse duration.
Length of Pulse OFF	Field Value is ignored.
Status	Field Value is ignored.

The DPU allows paired point operation for index points 11 and 12. As illustrated above, both a trip command (81 hex) or a close command (41 hex) produces a trip operation on this singular index.

Reset Element Control (Index 12 Through 13 and 26)

The DPU2000/DPU2000R allows for resetting latched points via a DNP command (Supervisory Control). Targets, Alarms, and Demand values may also be reset. **PAIRED POINT operation is implemented.**

The control block for the RESET ELEMENT CONTROL functions are:

Even Numbered Control Points (12)

Control Code	01 (Momentary On)
	03 (Latch On)
	04 (Latch Off)
	81 (Trip)
	41 (Close)
	All other Control Codes are accepted. No action results.
Count	All counts other than 1 execute the command once.
Length of Pulse ON	A number 1 or greater pulses the output for 300 mS.
Length of Pulse OFF	Field Value is ignored 0.
Status	Field Value is ignored 0.

Odd Numbered Control Points (13)

Control Code	01 (Momentary On) 03 (Latch On) 04 (Latch Off) 41 (Close) All other Control Codes are accepted. No action results.
Count	All counts other than 1 execute the command once.
Length of Pulse ON	A number 1 or greater for Code 01 is accepted. otherwise the field is ignored.
Length of Pulse OFF	Field Value is ignored 0.
Status	Field Value is ignored 0.

Several Object 1 and 2 digital status points are “seal In” or commonly referred to as “latched”. The reset procedure may be performed by a manual reset, reset via a network read (by setting Mode Parameter 5 to enabled) or by using index 26 with the parameters as follows:

Control Point (26)

Control Code	01 (Momentary On) 03 (Latch On) 04 (Latch Off) 41 (Close) All other Control Codes are accepted. No action results.
Count	All counts other than 1 execute the command once.
Length of Pulse ON	A number 1 or greater for Code 01 is accepted. otherwise the field is ignored.
Length of Pulse OFF	Field Value is ignored 0.
Status	Field Value is ignored 0.

ULO “Soft Point” Control (Index 14 Through 22) and (Index 144 Through 150)

The DPU has a variety of ULI/ULO control capabilities within the unit. ABB offers various application notes covering applications in which ULO/ULI control is desirable. The ABB DPU2000R Distribution Protection Unit 1MRA587219-MIB (IB 7.11.1.7-4) Manual (REV B) has a detailed explanation of such capabilities listed in Section 6. Soft Point Control may be linked to various DPU2000/DPU2000R elements, Physical Output and timer capabilities. The DPU2000/DPU2000R allows for the ULO (User Logical Output) elements to be controlled via DNP 3.0 **PAIRED POINT operation is implemented.** DPU1500R does not have logic (ULO/ULI capabilities).

Valid control parameterization accepted to perform these capabilities are as follows:

Even Numbered Control Points (14,16,18, 20, 22)

Control Code	01 (Momentary On) 03 (Latch On) 04 (Latch Off) 81 (Trip) 41 (Close) All other Control Codes are accepted. No action results.
Count	1 to 512
Length of Pulse ON	1 to 65,535
Length of Pulse OFF	If the count is 1 this field is ignored else the number in this field, 1 to 65,535 determines the OFF time duty cycle.
Status	Field Value is ignored 0

Odd Numbered Control Points (15,19, 21, 23)

Control Code	01 (Momentary On)

	03 (Latch On)
	04 (Latch Off)
	41 (Close)
	All other Control Codes are accepted. No action results.
Count	1 to 512
Length of Pulse ON	1 to 65,535
Length of Pulse OFF	If the count is 1 this field is ignored else the number in this field, 1 to 65,535 determines the OFF time duty cycle.
Status	Field Value is ignored 0

Force Logical Input Configuration

The DPU2000/DPU2000R/Dpu1500R has a default configuration of Force Logical Input bits. Forcing these bits on or off enables or disables the function associated with the function bits. The DPU ECP (External Configuration Program) allows reassignment of the default functions as listed in Table 5-1.

The DPU2000/DPU2000R have the capability of automation configuration to a generic Logical Input bit. These bits are generic in nature and can be mapped via ECP (External Communication Program) or WinECP (Windows External Communication Program). Mapping of the values occurs as such:

1. From ECP or WinECP select the menu item “FLI Index and User Name” selection.
2. A list of default mappings are shown as in Figure 5-3 (ECP Screen) In this case the user is viewing the screen in ECP as shown in the <u>CHANGE SETTINGS</u> Screen.
3. The default list corresponds to the Logical Input mapping of Logical Inputs (hereto referred as LI) as illustrated in Table 5-5.
4. If one would wish to change the relay protective function element mapped to the specific LI, depress the “ENTER” key. The display in Figure 5-4 shall be displayed.

5. The user would then scroll down the list and highlight the element desired to be mapped to the specific LI within the edited list.
6. Depress the “ENTER” key to map the selected element into the table.

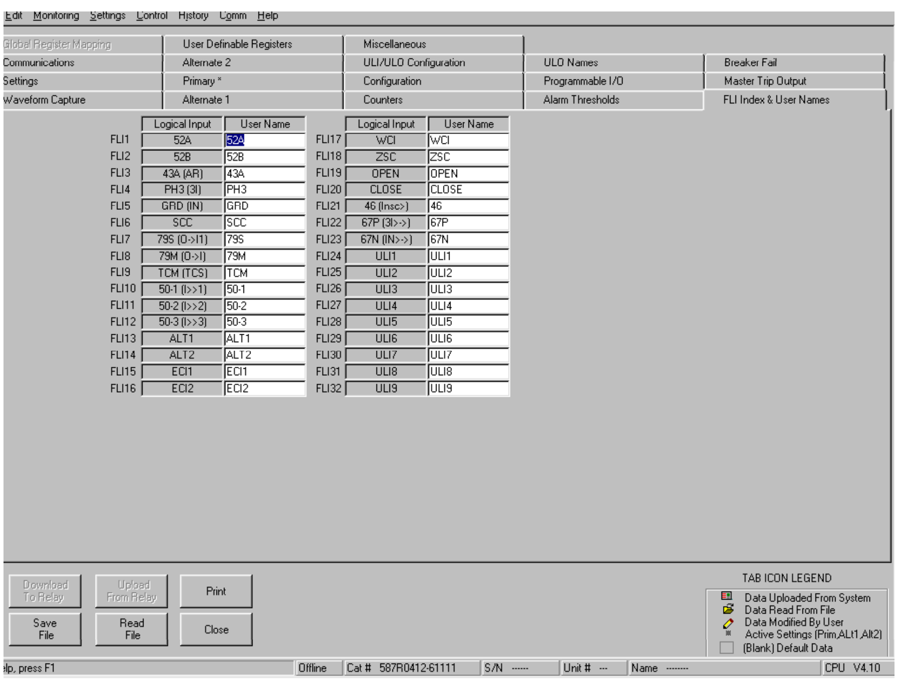


Figure 5-3. WINECP Default FLI Logical Input List

Table 5-5. ECP Default Correlation to Forced Logical Input Bit Map

FLI Number	Description	User Name	FLI Number	Description	User Name
FLI 01	Relay Status	52a	FLI 17	Initiate Close Output	CLOSE
FLI 02	Relay Status	52b	FLI 18	Event Capture Initiate	ECI 1
FLI 03	Reclosing Enable	43a	FLI 19	Event Capture Initiate	ECI 2
FLI 04	Trip Coil Monitor	TCM	FLI 20	Waveform Capture Initate	WCI
FLI 05	Ground Protection Overcurrent 51N/50N-1/50N-2 Enable	GRD	FLI 21	Negative Sequence Time Overcurrent Enable	46
FLI 06	Phase Protection Overcurrent 51P/50P-1/50P-2 Enable	PH3	FLI 22	Positive Sequential Directional Control Time Overcurrent Enable	67P
FLI 07	Phase & Ground Instantaneous Level 1 Enable	50-1	FLI 23	Negative Sequence Directional Control Ground Overcurrent Enable	67N
FLI 08	Phase & Ground Instantaneous Level 2 Enable	50-2	FLI 24	User Logical Input 1	ULI 1
FLI 09	Phase & Ground Instantaneous Level 3 Enable	50-3	FLI 25	User Logical Input 2	ULI 2
FLI 10	Alternate Relay Setting 1	ALT 1	FLI 26	User Logical Input 3	ULI 3
FLI 11	Alternate Relay Setting 2	ALT 2	FLI 27	User Logical Input 4	ULI 4
FLI 12	Zone Sequence Control	ZSC	FLI 28	User Logical Input 5	ULI 5
FLI 13	Spring Charging Contact	SCC	FLI 29	User Logical Input 6	ULI 6
FLI 14	Single Shot Reclosing Enable	79S	FLI 30	User Logical Input 7	ULI 7
FLI 15	Multi Shot Reclosing Enable	79M	FLI 31	User Logical Input 8	ULI 8
FLI 16	Initiate Trip Output	OPEN	FLI 32	User Logical Input 9	ULI 9

The usefulness of this feature cannot be understated. Each one of these functions can be forced via a network control. Programming need not be done to allow for function control via a network. If the relaying feature “RECLOSING” were to be enabled, the bit FLI 03 could be forced to an “ON” condition via the network control. If a desired control function were to be controlled via the network, then ECP mapping would have to be configured as per Figure 5-4.

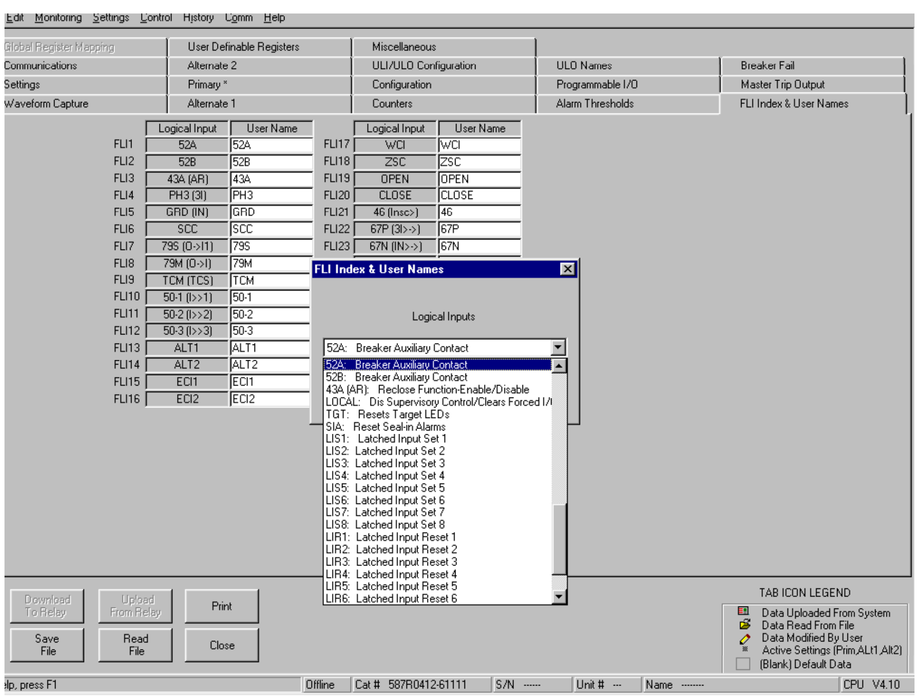


Figure 5-4. WINECP Forced Logical Input Mapping Screen

Point Forcing Control Functionality (Index 32 Through 137)

The DPU2000/DPU2000R allows forcing of the following control points:

Logical Inputs
Physical Inputs
Physical Outputs

Traditionally, network or supervisory operation of control points was determined to be a special operation. As a safeguard to unintended operator control initiation ABB's implementation of forcing functionality has specifically required certain steps to be performed within the DNP 3.0 protocol for a supervisory operation to occur.

Additionally, when the operator has executed a force function, a visual indication is initiated on the faceplate of the relay. When no element is forced, the NORMAL LED at the front of the relay is illuminated in a solid green color. When any element is forced within the relay, the NORMAL LED flashes at a rate of one second energized and one second extinguished. The NORMAL LED shall continue to flash until no elements are forced within the DPU2000/DPU2000R.

Supervisory Forcing control points are implemented in a odd-even arrangement. As per Table 5-5, even points are designated as STATUS whereas odd points are designated as UNFORCE. The descriptions of their functionality is as follows:

Control Code	03 (Latch On)
	04 (Latch Off)
	All other Control Codes are accepted. No action results.
Count	All counts other than 1 execute the command once.
Length of Pulse ON	1
Length of Pulse OFF	Field Value is ignored 0.
Status	Field Value is ignored 0.

A write of the control code 03x "LATCH ON" forces the point to a state of 1. A write of the control code 04x "LATCH OFF" forces the point to a state of 0. A force of the point allows control by the operator or supervisory host. If the point is forced, any logic capabilities configured in the DPU2000/DPU2000R/1500R are overridden by the supervisory control established via DNP 3.0. The forced index control shall be forced until the point is "UNFORCED".

To "UNFORCE" a control point, the following control code parameterization is required.

Control Code	01 (Momentary On)
	02 (Momentary Off)
	03 (Latch On)
	04 (Latch Off)
	81x (Trip)
	82x (Trip Off)
	41x (Close)
	42x (Close Off)
Count	All counts other than 1 execute the command once.
Length of Pulse ON	1
Length of Pulse OFF	Field Value is ignored unless 02 or 82 code is used. 1
Status	Field Value is ignored 0.

When the code is "UNFORCED" control is restored to the configured logic in the DPU2000/DPU2000R.

The list of DNP 3.0 Object 10 and 12 indicies are listed in Table 5-6.

"C" Pushbutton Control Using DNP Control Commands (Index 138 Through 143)

The DPU 2000R Enhanced OCI Front Panel Interface allows control of internal points. Traditionally, network or supervisory operation of control points was wired to an external pushbutton or pistol grip control device (torque control). The Enhanced OCI interface placed six control keys numbered C1 through C6 on the front panel interface. The state of the keys operates as such:

If the "C" key is configured as a maintained Control key, the following occurs during a pushbutton operation.

- When the control pushbutton is depressed, the state of the internal memory location is toggled from its present state to its inverted state. The inverted state is then stored and maintained in the relay.

If the "C" key is configured as a momentary Control key, the following occurs during a pushbutton operation:

- When a control pushbutton is depressed, the state of the internal memory location is pulsed for a single time for one machine execution state (thus creating a momentary one shot logical pulse). The status of "1" is placed in the memory for that execution state. During the next execution state, a status of "0" is placed in the memory location.

When one performs a DNP 3.0 control operation to pulse this control operation, the same action is performed as if an operator was physically depressing the physical "C" key on the DPU 2000R front panel interface. Thus the control command and the pushbutton can be thought to be "WIRE OR-ED".

If any control code is sent via an OBJECT 12 control cycle, the action is the same as described above even though the defined DNP 3.0 code is otherwise. The DPU 2000R interprets the code as a pushbutton action and performs the action as such. All DNP control codes are executed as a momentary action resulting in the status being transferred to the internal function as a maintained or momentary state interpreted in the DPU 2000R.

Accepted control codes are:

Control Code	01 (Momentary On)
	02 (Momentary Off)
	03 (Latch On)
	04 (Latch Off)
	81 (Trip)
	41 (Close)
	All other Control Codes are accepted. No action results.
Count	All counts other than 1 execute the command once.
Length of Pulse ON	1
Length of Pulse OFF	Field Value is ignored 0
Status	Field Value is ignored 0

It must be stressed that since control is occurring on the mapped element via a "C" key, a control action on the individual element may not be effectuated since the overriding elemental control state is determined by the logic attached to that element in its internal scan status.

Hot Line Tagging Element Control Using DNP Control Commands (Index 151 Through 152)

A write of the control code to index 151 sets the Hot Line Tag –SET control to enabled and latched. A write of the control code to index 152 RESETS the Hot Line Tag to disabled and unlatched. This action occurs regardless of the definition of the DNP 3.0 control action.

Accepted parameterization is as follows.

Control Code	01 (Momentary On)

	02 (Momentary Off)
	03 (Latch On)
	04 (Latch Off)
	81x (Trip)
	82x (Trip Off)
	41x (Close)
	42x (Close Off)
Count	All counts other than 1 execute the command once.
Length of Pulse ON	1
Length of Pulse OFF	Field Value is ignored unless 02 or 82 code is used.
Status	Field Value is ignored 0

The DPU 2000/DPU 2000R allows assignment of a LOCAL/SUPERVISORY function to a Physical Input. The mapping is accomplished via ECP or WIN ECP. When the Physical Input is asserted (logical state 1), the DPU 2000/DPU 2000R is in a LOCAL STATE. During a changeover to a LOCAL STATE control, the DPU 2000/DPU 2000R will place all forced points (those points from index 32 through 137) into an unforced or “NORMAL” state. The GREEN NORMAL LED located on the faceplate of the DPU 2000/DPU 2000R will cease flashing. The function will return to that state prior to the force or in the case of physical input physical output control, user logical input or user logical output, to the state of the logic executed within the DPU 2000/DPU 2000R.

When the DPU 2000/DPU 2000R is in the LOCAL STATE, all network control commands via the DNP 3.0 protocol or ECP/WIN ECP terminals shall be rejected. Network control of Object 12 indicies cannot occur.

Table 5-6. Binary Output Control Indices

Binary Output Status Points
Object Number: **10**
Request Function Codes supported: **1 (read)**
Default Variation reported when variation 0 requested: **2 (Binary Output Status)**
Control Relay Output Blocks
Object Number: **12**
Request Function Codes supported: **3 (select), 4 (operate), 5 (direct operate), 6 (direct operate, no acknowledge)**

Point I.D.	Name/Description	Notes	Supported Control Relay Output Block Fields	Scan Group
0	Trip Contact operate test	1	Trip, Close, Pulse ON, Pulse OFF, Latch ON, Latch OFF	
1	Close Contact operate test	1,4	Trip, Close, Pulse ON, Pulse OFF, Latch ON, Latch OFF	
2	Output 1 Contact operate test	1	Trip, Close, Pulse ON, Pulse OFF	0
3	Output 2 Contact operate test	1	Trip, Close, Pulse ON, Pulse OFF	0
4	Output 3 Contact operate test	1	Trip, Close, Pulse ON, Pulse OFF	1
5	Output 4 Contact operate test	1	Trip, Close, Pulse ON, Pulse OFF	1
6	Output 5 Contact operate test	1	Trip, Close, Pulse ON, Pulse OFF	1
7	Output 6 Contact operate test	1	Trip, Close, Pulse ON, Pulse OFF	1
8	Output 7 Contact operate test	1,4	Trip, Close, Pulse ON, Pulse OFF	1
9	Output 8 Contact operate test	1,4	Trip, Close, Pulse ON, Pulse OFF	1
10	Trip operate command	1	Trip, Close, Pulse ON, Pulse OFF, Latch ON, Latch OFF	1
11	Close operate command	1	Trip, Close, Pulse ON, Pulse OFF, Latch ON, Latch OFF	1

Binary Output Status Points
Object Number: **10**
Request Function Codes supported: **1 (read)**
Default Variation reported when variation 0 requested: **2 (Binary Output Status)**
Control Relay Output Blocks
Object Number: **12**
Request Function Codes supported: **3 (select), 4 (operate), 5 (direct operate), 6 (direct operate, no acknowledge)**

Point I.D.	Name/Description	Notes	Supported Control Relay Output Block Fields	Scan Group
12	Reset Alarms/Target LEDs	1	Trip, Close, Pulse ON, Pulse OFF, Latch ON, Latch OFF	1
13	Reset Peak and Minimum Demand Currents	1	Trip, Close, Pulse ON, Pulse OFF, Latch ON, Latch OFF	1
14	ULO1 Output Energize	1	Trip, Close, Pulse ON, Pulse OFF, Latch ON, Latch OFF	8
15	ULO2 Output Energize	1	Trip, Close, Pulse ON, Pulse OFF, Latch ON, Latch OFF	8
16	ULO3 Output Energize	1	Trip, Close, Pulse ON, Pulse OFF, Latch ON, Latch OFF	8
17	ULO4 Output Energize	1	Trip, Close, Pulse ON, Pulse OFF, Latch ON, Latch OFF	8
18	ULO5 Output Energize	1	Trip, Close, Pulse ON, Pulse OFF, Latch ON, Latch OFF	8
19	ULO6 Output Energize	1	Trip, Close, Pulse ON, Pulse OFF, Latch ON, Latch OFF	8
20	ULO7 Output Energize	1	Trip, Close, Pulse ON, Pulse OFF, Latch ON, Latch OFF	8
21	ULO8 Output Energize	1	Trip, Close, Pulse ON, Pulse OFF, Latch ON, Latch OFF	8
22	ULO9 Output Energize	1	Trip, Close, Pulse ON, Pulse OFF, Latch ON, Latch OFF	8
23	Reserved		Reserved	NONE
24	Trip Operate Command (Duplicate of Point 10)	1	Trip, Close, Pulse ON, Pulse OFF, Latch ON, Latch OFF	1
25	Close Operate Command - Independently of Reclose (43A)	1	Trip, Close, Pulse ON, Pulse OFF, Latch ON, Latch OFF	1
26	Reset Seal In Points	1	Trip, Close, Pulse ON, Pulse OFF, Latch ON, Latch OFF	16
27	Reserved		Reserved	16
28	Reserved		Reserved	16
29	Reserved		Reserved	16
30	Reserved		Reserved	16
31	Reserved		Reserved	16
32	Forced Logical Input 1 - status (52a)	3	Latch ON, Latch OFF	16
33	Forced Logical Input 1 - unforce (52a)	3	Trip, Close, Pulse ON, Pulse OFF, Latch ON, Latch OFF	16
34	FLI 2 - status (52b)	3	Latch ON, Latch OFF	16
35	FLI 2 - unforce (52b)	3	Trip, Close, Pulse ON, Pulse OFF, Latch ON, Latch OFF	16
36	FLI 3 - status (43A)	3	Latch ON, Latch OFF	16
37	FLI 3 - unforce (43A)	3	Trip, Close, Pulse ON, Pulse OFF, Latch ON, Latch OFF	16
38	FLI 4 - status (PH3)	3	Latch ON, Latch OFF	16
39	FLI 4 - unforce (PH3)	3	Trip, Close, Pulse ON, Pulse OFF, Latch ON, Latch OFF	16

Binary Output Status Points
Object Number: **10**
Request Function Codes supported: **1 (read)**
Default Variation reported when variation 0 requested: **2 (Binary Output Status)**
Control Relay Output Blocks
Object Number: **12**
Request Function Codes supported: **3 (select), 4 (operate), 5 (direct operate), 6 (direct operate, no acknowledge)**

Point I.D.	Name/Description	Notes	Supported Control Relay Output Block Fields	Scan Group
40	FLI 5 - status (GRD)	3	Latch ON, Latch OFF	16
41	FLI 5 - unforce (GRD)	3	Trip, Close, Pulse ON, Pulse OFF, Latch ON, Latch OFF	16
42	FLI 6 - status (SCC)	3	Latch ON, Latch OFF	16
43	FLI 6 - unforce (SCC)	3	Trip, Close, Pulse ON, Pulse OFF, Latch ON, Latch OFF	16
44	FLI 7 - status (79S)	3	Latch ON, Latch OFF	16
45	FLI 7 - unforce (79S)	3	Trip, Close, Pulse ON, Pulse OFF, Latch ON, Latch OFF	16
46	FLI 8 - status (79M)	3	Latch ON, Latch OFF	16
47	FLI 8 - unforce (79M)	3	Trip, Close, Pulse ON, Pulse OFF, Latch ON, Latch OFF	16
48	FLI 9 - status (7CM)	3	Latch ON, Latch OFF	16
49	FLI 9 - unforce (TCM)	3	Trip, Close, Pulse ON, Pulse OFF, Latch ON, Latch OFF	16
50	FLI 10 - status (50-1)	3	Latch ON, Latch OFF	16
51	FLI 10 - unforce (50-1)	3	Trip, Close, Pulse ON, Pulse OFF, Latch ON, Latch OFF	16
52	FLI 11 - status (50-2)	3	Latch ON, Latch OFF	16
53	FLI 11 - unforce (50-2)	3	Trip, Close, Pulse ON, Pulse OFF, Latch ON, Latch OFF	16
54	FLI 12 - status (50-3)	3	Latch ON, Latch OFF	16
55	FLI 12 - unforce (50-3)	3	Trip, Close, Pulse ON, Pulse OFF, Latch ON, Latch OFF	16
56	FLI 13 - status (ALT1)	3	Latch ON, Latch OFF	16
57	FLI 13 - unforce (ALT1)	3	Trip, Close, Pulse ON, Pulse OFF, Latch ON, Latch OFF	16
58	FLI 14 - status (ALT2)	3	Latch ON, Latch OFF	16
59	FLI 14 - unforce (ALT2)	3	Trip, Close, Pulse ON, Pulse OFF, Latch ON, Latch OFF	16
60	FLI 15 - status (ECI1)	3	Latch ON, Latch OFF	16
61	FLI 15 - unforce (ECI1)	3	Trip, Close, Pulse ON, Pulse OFF, Latch ON, Latch OFF	16
62	FLI 16 - status (ECI2)	3	Latch ON, Latch OFF	16
63	FLI 16 - unforce (ECI2)	3	Trip, Close, Pulse ON, Pulse OFF, Latch ON, Latch OFF	16
64	FLI 17 - status (WCI)	3	Latch ON, Latch OFF	16
65	FLI 17 - unforce (WCI)	3	Trip, Close, Pulse ON, Pulse OFF, Latch ON, Latch OFF	16
66	FLI 18 - status (ZSC)	3	Latch ON, Latch OFF	16
67	FLI 18 - unforce (ZSC)	3	Trip, Close, Pulse ON, Pulse OFF, Latch ON, Latch OFF	16
68	FLI 19 - status (OPEN)	3	Latch ON, Latch OFF	16
69	FLI 19 - unforce (OPEN)	3	Trip, Close, Pulse ON, Pulse OFF, Latch ON, Latch OFF	16
70	FLI 20 - status (CLOSE)	3	Latch ON, Latch OFF	16
71	FLI 20 - unforce (CLOSE)	3	Trip, Close, Pulse ON, Pulse OFF,	16

Binary Output Status Points
Object Number: **10**
Request Function Codes supported: **1 (read)**
Default Variation reported when variation 0 requested: **2 (Binary Output Status)**
Control Relay Output Blocks
Object Number: **12**
Request Function Codes supported: **3 (select), 4 (operate), 5 (direct operate), 6 (direct operate, no acknowledge)**

Point I.D.	Name/Description	Notes	Supported Control Relay Output Block Fields	Scan Group
			Latch ON, Latch OFF	
72	FLI 21 - status (46)	3	Latch ON, Latch OFF	16
73	FLI 21 - unforce (46)	3	Trip, Close, Pulse ON, Pulse OFF, Latch ON, Latch OFF	16
74	FLI 22 - status (67P)	3	Latch ON, Latch OFF	16
75	FLI 22 - unforce (67P)	3	Trip, Close, Pulse ON, Pulse OFF, Latch ON, Latch OFF	16
76	FLI 23 - status (67N)	3	Latch ON, Latch OFF	16
77	FLI 23 - unforce (67N)	3	Trip, Close, Pulse ON, Pulse OFF, Latch ON, Latch OFF	16
78	FLI 24 - status (ULI 1)	3	Latch ON, Latch OFF	16
79	FLI 24 - unforce (ULI 1)	3	Trip, Close, Pulse ON, Pulse OFF, Latch ON, Latch OFF	16
80	FLI 25 - status (ULI 2)	3	Latch ON, Latch OFF	16
81	FLI 25 - unforce (ULI 2)	3	Trip, Close, Pulse ON, Pulse OFF, Latch ON, Latch OFF	16
82	FLI 26 - status (ULI 3)	3	Latch ON, Latch OFF	16
83	FLI 26 - unforce (ULI 3)	3	Trip, Close, Pulse ON, Pulse OFF, Latch ON, Latch OFF	16
84	FLI 27 - status (ULI 4)	3	Latch ON, Latch OFF	16
85	FLI 27 - unforce (ULI 4)	3	Trip, Close, Pulse ON, Pulse OFF, Latch ON, Latch OFF	16
86	FLI 28 - status (ULI 5)	3	Latch ON, Latch OFF	16
87	FLI 28 - unforce (ULI 5)	3	Trip, Close, Pulse ON, Pulse OFF, Latch ON, Latch OFF	16
88	FLI 29 - status (ULI 6)	3	Latch ON, Latch OFF	16
89	FLI 29 - unforce (ULI 6)	3	Trip, Close, Pulse ON, Pulse OFF, Latch ON, Latch OFF	16
90	FLI 30 - status (ULI 7)	3	Latch ON, Latch OFF	16
91	FLI 30 - unforce (ULI 7)	3	Trip, Close, Pulse ON, Pulse OFF, Latch ON, Latch OFF	16
92	FLI 31 - status (ULI 8)	3	Latch ON, Latch OFF	16
93	FLI 31 - unforce (ULI 8)	3	Trip, Close, Pulse ON, Pulse OFF, Latch ON, Latch OFF	16
94	FLI 32 - status (ULI 9)	3	Latch ON, Latch OFF	16
95	FLI 32 - unforce (ULI 9)	5	Trip, Close, Pulse ON, Pulse OFF, Latch ON, Latch OFF	16
96	Forced Phy. Input 1 - status (IN1)	5	Latch ON, Latch OFF	16
97	Forced Phy. Input 1 - unforce (IN1)	5	Trip, Close, Pulse ON, Pulse OFF, Latch ON, Latch OFF	16
98	FPI 2 - status (IN2)	5	Latch ON, Latch OFF	16
99	FPI 2 - unforce (IN2)	5	Trip, Close, Pulse ON, Pulse OFF, Latch ON, Latch OFF	16
100	FPI 3 - status (IN3)	5	Latch ON, Latch OFF	16
101	FPI 3 - unforce (IN3)	5	Trip, Close, Pulse ON, Pulse OFF, Latch ON, Latch OFF	16
102	FPI 4 - status (IN4)	5	Latch ON, Latch OFF	16

Binary Output Status Points
Object Number: **10**
Request Function Codes supported: **1 (read)**
Default Variation reported when variation 0 requested: **2 (Binary Output Status)**
Control Relay Output Blocks
Object Number: **12**
Request Function Codes supported: **3 (select), 4 (operate), 5 (direct operate), 6 (direct operate, no acknowledge)**

Point I.D.	Name/Description	Notes	Supported Control Relay Output Block Fields	Scan Group
103	FPI 4 - unforce (IN4)	5	Trip, Close, Pulse ON, Pulse OFF, Latch ON, Latch OFF	16
104	FPI 5 - status (IN5)	5	Latch ON, Latch OFF	16
105	FPI 5 - unforce (IN5)	5	Trip, Close, Pulse ON, Pulse OFF, Latch ON, Latch OFF	16
106	FPI 6 - status (IN6)	5	Latch ON, Latch OFF	16
107	FPI 6 - unforce (IN6)	5	Trip, Close, Pulse ON, Pulse OFF, Latch ON, Latch OFF	16
108	FPI 7 - status (IN7)	3	Latch ON, Latch OFF	16
109	FPI 7 - unforce (IN7)	3	Trip, Close, Pulse ON, Pulse OFF, Latch ON, Latch OFF	16
110	FPI 8 - status (IN8)	3	Latch ON, Latch OFF	16
111	FPI 8 - unforce (IN8)	3	Trip, Close, Pulse ON, Pulse OFF, Latch ON, Latch OFF	16
112	FPI 9 - status (IN9)	4	Latch ON, Latch OFF	16
113	FPI 9 - unforce (IN9)	4	Trip, Close, Pulse ON, Pulse OFF, Latch ON, Latch OFF	16
114	FPI 10 - status (IN10)	4	Latch ON, Latch OFF	16
115	FPI 10 - unforce (IN10)	4	Trip, Close, Pulse ON, Pulse OFF, Latch ON, Latch OFF	16
116	FPI 11 - status (IN11)	4	Latch ON, Latch OFF	16
117	FPI 11 - unforce (IN11)	4	Trip, Close, Pulse ON, Pulse OFF, Latch ON, Latch OFF	16
118	FPI 12 - status (IN12)	4	Latch ON, Latch OFF	16
119	FPI 12 - unforce (IN12)	4	Trip, Close, Pulse ON, Pulse OFF, Latch ON, Latch OFF	16
120	FPI 13 - status (IN13)	4	Latch ON, Latch OFF	16
121	FPI 13 - unforce (IN13)	4	Trip, Close, Pulse ON, Pulse OFF, Latch ON, Latch OFF	16
122	Forced Phy. Output 1 - status (OUT1)	5	Latch ON, Latch OFF	16
123	Forced Phy. Output 1 - unforce (OUT1)	5	Trip, Close, Pulse ON, Pulse OFF, Latch ON, Latch OFF	16
124	FPO 2 - status (OUT2)	5	Latch ON, Latch OFF	16
125	FPO 2 - unforce (OUT2)	5	Trip, Close, Pulse ON, Pulse OFF, Latch ON, Latch OFF	16
126	FPO 3 - status (OUT3)	5	Latch ON, Latch OFF	16
127	FPO 3 - unforce (OUT3)	5	Trip, Close, Pulse ON, Pulse OFF, Latch ON, Latch OFF	16
128	FPO 4 - status (OUT4)	5	Latch ON, Latch OFF	16
129	FPO 4 - unforce (OUT4)	5	Trip, Close, Pulse ON, Pulse OFF, Latch ON, Latch OFF	16
130	FPO 5 - status (OUT5)	5	Latch ON, Latch OFF	16
131	FPO 5 - unforce (OUT5)	5	Trip, Close, Pulse ON, Pulse OFF, Latch ON, Latch OFF	16
132	FPO 6 - status (OUT6)	5	Latch ON, Latch OFF	16
133	FPO 6 - unforce (OUT6)	5	Trip, Close, Pulse ON, Pulse OFF,	16

Binary Output Status Points
Object Number: **10**
Request Function Codes supported: **1 (read)**
Default Variation reported when variation 0 requested: **2 (Binary Output Status)**
Control Relay Output Blocks
Object Number: **12**
Request Function Codes supported: **3 (select), 4 (operate), 5 (direct operate), 6 (direct operate, no acknowledge)**

Point I.D.	Name/Description	Notes	Supported Control Relay Output Block Fields	Scan Group
			Latch ON, Latch OFF	
134	FPO 7 - status (OUT7) - future DPU2000 pt.	4	Latch ON, Latch OFF	16
135	FPO 7 - unforce (OUT7) - future DPU2000 pt.	4	Trip, Close, Pulse ON, Pulse OFF, Latch ON, Latch OFF	16
136	FPO 8 - status (OUT8) - future DPU2000 pt.	4	Latch ON, Latch OFF	16
137	FPO 8 - unforce (OUT8) - future DPU2000 pt.	4	Trip, Close, Pulse ON, Pulse Off, Latch On, Latch Off	16
138	C1 – Pushbutton Control	6	Trip, Close, Pulse ON, Pulse OFF, Latch ON, Latch OFF	29
139	C2 – Pushbutton Control	6	Trip, Close, Pulse ON, Pulse OFF, Latch ON, Latch OFF	29
140	C3 – Pushbutton Control	6	Trip, Close, Pulse ON, Pulse OFF, Latch ON, Latch OFF	29
141	C4 – Pushbutton Control	6	Trip, Close, Pulse ON, Pulse OFF, Latch ON, Latch OFF	29
142	C5 – Pushbutton Control	6	Trip, Close, Pulse ON, Pulse OFF, Latch ON, Latch OFF	29
143	C6 – Pushbutton Control	6	Trip, Close, Pulse ON, Pulse OFF, Latch ON, Latch OFF	29
144	ULO10 – User Logical Output Control	7	Trip, Close, Pulse ON, Pulse OFF, Latch ON, Latch OFF	29
145	ULO11 – User Logical Output Control	7	Trip, Close, Pulse ON, Pulse OFF, Latch ON, Latch OFF	29
146	ULO12 – User Logical Output Control	7	Trip, Close, Pulse ON, Pulse OFF, Latch ON, Latch OFF	29
147	ULO13 – User Logical Output Control	7	Trip, Close, Pulse ON, Pulse OFF, Latch ON, Latch OFF	29
148	ULO14 – User Logical Output Control	7	Trip, Close, Pulse ON, Pulse OFF, Latch ON, Latch OFF	29
149	ULO15 – User Logical Output Control	7	Trip, Close, Pulse ON, Pulse OFF, Latch ON, Latch OFF	29
150	ULO16 – User Logical Output Control	7	Trip, Close, Pulse ON, Pulse OFF, Latch ON, Latch OFF	29
151	HLT_SET – Hot Line Tagging Set	7	Trip, Close, Pulse ON, Pulse OFF, Latch ON, Latch OFF	29
152	HLT_RST – Hot Line Tagging Reset	7	Trip, Close, Pulse ON, Pulse OFF, Latch ON, Latch OFF	29

NOTE:

1. When paired, this function operates on the next (even numbered) point in the table. When unpaired it operates on the selected point.
2. Function must be mapped to one of the output relays in order for this function to operate.
3. DPU2000R Point Only
4. DPU2000 Point Only
5. DPU1500R/DPU2000R Only

6. DPU 2000R with Version 5.20 Firmware and Version 4.5 DNP Only
7. DPU 2000R with Version 5.20 Firmware

Counter Access (15 Elements Defined)

Counters may be accessed via Object 20 or frozen via Object 21. The DPU2000 and DPU2000R allow for access of several counter values including those associated with:

- Kiloamperes Symmetrical
- Breaker Operations
- Reclose Operations

Counters may be read, written, or frozen. The frozen counter objects require an explicit freeze request from the host. Each freeze request will capture one sample of the related static counter up to a maximum of 32 samples. A DNP read request for a frozen counter will return all frozen samples for each point specified in the read request in ascending time order. Once read, further read requests for a point will not return frozen data for the previously read counter until another freeze request occurs.

Table 5-7 lists the index list of the counters defined for the DPU2000/DPU2000R.

Table 5-7. Counter Index Assignment

Binary Counters
Static (Steady-State) Object Number: **20**
Request Function Codes supported: **1 (read), 7 (freeze), 8 (freeze noack), 9 (freeze and clear), 10 (freeze and clear, noack)**
Static Variation reported when variation 0 requested: **2 (16-Bit Binary Counter with Flag)**
Change Event Variation reported when variation 0 requested: **none – not supported**

Frozen Counters
Static (Steady-State) Object Number: **21**
Request Function Codes supported: **1 (read)**
Static Variation reported when variation 0 requested: **6 (16-Bit Frozen Binary with Flag and Timestamp)**
Change Event Variation reported when variation 0 requested: **none – not supported**

Point I.D.	Name/Description	Change Event Assigned Class (1, 2, 3 or none)	Scan Groups[2]
0	KSI Sum A Counter	None	15
1	KSI Sum B Counter	None	15
2	KSI Sum C Counter	None	15
3	Overcurrent Trip Counter	None	15
4	Breaker Operations Counter	None	15
5	Reclose Counter 1	None	15
6	1st Reclose Counter	None	15
7	2nd Reclose Counter	None	15
8	3rd Reclose Counter	None	15
9	4th Reclose Counter	None	15
10	Reclose Counter 2	None	15

Analog Input Index Designation (129 Elements Defined)

The DPU2000 and DPU2000R has 129 data elements assigned to Analog Input objects. The types of data retrievable via the analog input data objects are:

- Metering Data
- Demand Data
- Peak Demands
- Minimum Demands
- Fault Data
- Operation (Relay Event Record Data)
- User Definable Register Data

Object 30 and Object 32 reads the Analog Input Data referenced above.

Metering Data (Index 0 Through 42, 91 Through 96 and 129)

Metering data is retrieved in a straightforward manner. The definition of the data is given as 32 or 16 bit data types. All metering values are in primary units. If one wishes to scale and redefine the range of the returned data, User Definable Registers (Indices 97 through 128).

Metering Data is static in nature and is retrieved via variants 1 through 4 depending upon the data type assigned to the value (16 or 32 bit data).

Demand Data (Index 43 to 54)

Peak and minimum demands are continuously monitored and any change in value or associated time mark are recorded as an event. These events are only collected/reported if the Group Number (enabled via Parameter 5,6,7, and 8 settings as explained in the port configuration sequence) is enabled.

If indices 43 to 54 are accessed via static data objects (Object 30), then the current demand reading is returned. If indices 43 through 54 are accessed via event change objects (Object 32), then the data returned indicated either a minimum or peak demand reading between accesses. If a peak demand or minimum demand is calcuated, its value is reported as a change event object (oject 32) or a Class 3 object. A calculated average demand is reported as an object 30 or as a Class 0 index point.

The host may retrieve these events via an analog event scan or class scans (as explained on page 69). A maximum of 768 events may be stored for reporting to the host. An event, (one value with time stamp) is any change in any one of the peak or minimum values. Upon power-up, any non-zero peak or minimum value will be returned to the host.

Demand Values (indices 43 through 54) are calculated until reset by the host. The reset index for demand values is available through object 12 index 13 as listed in Table 5-7.

Fault Record (Index 58 Through 86) and Operation Record (Index 87 Through 89) Retrieval

As shown in Figure 5-5, the DPU2000 and DPU2000R support fault record and operation data retrieval through DNP 3.0. Each time a fault is recorded within the DPU2000 or DPU2000R, it is stored in an internal buffer. Up to 32 fault records may be stored in the unit's buffer. If more than 32 faults are recorded, the first fault is overwritten in the buffer (internal to the DPU2000/DPU2000R). This internal buffer is different from the DNP 3.0 storage buffer. A total of 768 events (including those of digital changes, demands, faults, and operations), may be stored in the DNP queue. If more than 768 events accumulate in the DNP 3.0 storage buffer, then the IIN buffer overflow bit shall be set. If the indices for points are read using a static object/qualifier combination, no points shall be reported and the host shall receive a flag notification that the point is offline. Fault indices 58 through 86. Fault types are reported in Index 59 and are listed in Table 5-8A.

Operation Records also operate using the same principle as described for fault records. However, if the firmware/hardware platform of the DPU is version 4.99 or earlier, then 128 operation records may be stored in the

DPU2000/DPU2000R buffer. If more than 128 operation records are stored in the DPU's internal buffer, then the first record in the buffer is overwritten. The same rules regarding the DNP 3.0 buffer apply to the operation records.

FI the DPU firmware/hardware platform is version 5.20 or later, 255 operation records are maintained in the internal buffer. If the buffer is full (255 records stored) and a new fault occurs, then the oldest fault is overwritten in the buffer.

Each operation is recorded and stamped via a unique message number. Table 5-8 lists the unique operation number (Index 89) assigned to each operation. As with the Event Records, Operation Records are only reported to the host on an event object or Class 2 Object poll. The indices for Operations Record reporting must be enabled via Parameters 5, 6, 7, and 8 as described on page 73.

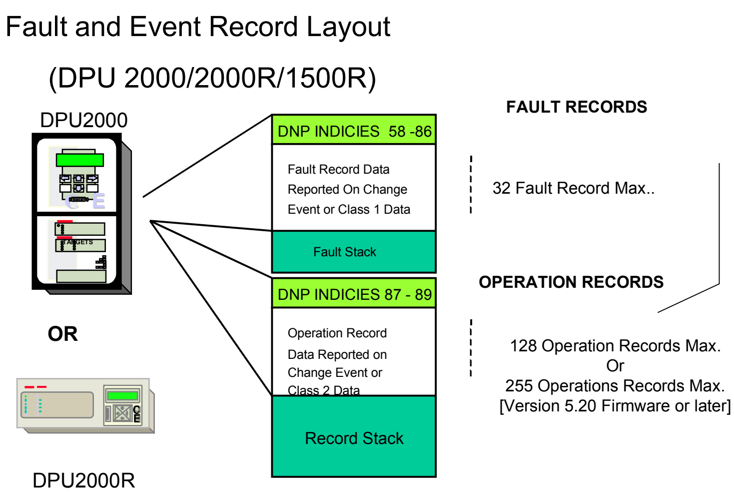


Figure 5-5. Fault Record/Event Record Data Format

Table 5-8. Event Record Definition Type

Operation Record Type (Index 89 code definition)	
Operation Number	**Definitions**
00	51P Trip
01	51N Trip
02	50P-1 Trip
03	50N-1 Trip
04	50P-2 Trip
05	50N-2 Trip
06	50P-3 Trip
07	50N-3 Trip
08	67P Trip (DPU2000/R)
09	67N Trip (DPU2000/R)
10	46 Trip
11	27-1P Alarm
12	59 Alarm (DPU2000/R)
13	79V Block
14	81S-1 Trip (DPU2000/R)
15	81R-1 Restore (DPU2000/R)
16	81V Block (DPU2000/R)
17	TOC Pickup-No Trip
18	27-3P Alarm
19	SEF Trip
20	External Trip
21	External Close

Operation Record Type (Index 89 code definition)	
22	Breaker Opened
23	Breaker Closed
24	Open Trip Contact
25	Recloser Lockout
26	Direct Trip
27	Direct Close
28	MDT Close
29	External Trip and ARC
30	Reclose Initiated
31	CB Failed to Trip
32	CB Failed to Close
33	CB Pops Open
34	CB Pops Closed
35	CB State Unknown
36	CB Stuck Closed
37	Ext. Trip CB Stuck
38	Springs Discharged
40	Manual Trip
41	Manual Close
42	Ground TC Enabled
43	Ground TC Disabled
44	Phase TC Enabled
45	Phase TC Disabled
46	Primary Set Active
47	Alt 1 Set Active
48	Alt 2 Set Active
49	Zone Step
50	Recloser Enabled
51	Recloser Disabled
52	Zone Sequence Enabled
53	Zone Sequence Disabled
54	50P/N-1 Disabled
55	50P/N-2 Disabled
56	50P/N-3 Disabled
57	50P/N-1 Enabled
58	50P/N-2 Enabled
59	50P/N-3 Enabled
60	81S-2 Trip (DPU2000/R)
61	81R-2 Restore (DPU2000/R)
62	81O-1 Overfrequency (DPU2000/R)
63	81O-2 Overfrequency (DPU2000/R)
70	Blown Fuse Alarm
71	OC Trip Counter
72	Accumulated KSI
73	79 Counter 1 Alarm
74	Phase Demand Alarm
75	Neutral Demand Alarm
76	Low PF Alarm
77	High PF Alarm
78	Trip Coil Failure
79	kVAR Demand Alarm
80	79 Counter 2 Alarm
81	Pos kVAR Alarm
82	Neg. kVAR Alarm
83	Load Alarm
84	Cold Load Alarm
85	Pos Watt Alarm 1
86	Pos Watt Alarm 2

Operation Record Type (Index 89 code definition)	
87	32P Trip (DPU2000/R)
88	32N Trip (DPU2000/R)
90	Event Capture #1
91	Event Capture #2
92	Waveform Capture
93	BFT Operation (DPU2000/R)
94	RETRIP Operation (DPU2000/R)
95	Ext. BFI Enabled (DPU2000/R)
96	Ext. BFI Disabled (DPU2000/R)
97	BFI Enabled (DPU2000/R)
98	BFI Disabled (DPU2000/R)
100	ROM Failure
101	RAM Failure
102	Self Test Failed
103	EEPROM Failure
104	BATRAM Failure
105	DSP Failure
106	Control Power Fail
107	Editor Access
128	Springs Charged
129	Springs Discharged
130	79S Input Enabled
131	79S Input Disabled
132	79M Input Enabled
133	79M Input Disabled
134	TCM Input Closed
135	TCM Input Opened
136	ALT 1 Input Enabled
137	ALT 1 Input Disabled
138	ALT 2 Input Enabled
139	ALT 2 Input Disabled
140	Ext Trip Enabled
141	Ext Trip Disabled
142	Event Cap 1 Init
143	Event Cap 1 Reset
144	Event Cap 2 Init
145	Event Cap 2 Reset
146	Wave Cap Init
147	Wave Cap Reset
148	Ext Close Enabled
149	Ext Close Disabled
150	52a Closed
151	52a Opened
152	52b Closed
153	52b Opened
154	43a Closed
155	43a Opened
156	46 Unit Enabled
157	46 Unit Disabled
158	67P Unit Enabled (DPU2000/R)
159	67P Unit Disabled (DPU2000/R)
160	67N Unit Enabled (DPU2000/R)
161	67N Unit Disabled (DPU2000/R)
162	ULI1 Input Closed (DPU2000/R)
163	ULI1 Input Opened (DPU2000/R)
164	ULI2 Input Closed (DPU2000/R)
165	ULI2 Input Opened (DPU2000/R)
166	ULI3 Input Closed (DPU2000/R)

Operation Record Type (Index 89 code definition)	
167	ULI3 Input Opened (DPU2000/R)
168	ULI4 Input Closed (DPU2000/R)
169	ULI4 Input Opened (DPU2000/R)
170	ULI5 Input Closed (DPU2000/R)
171	ULI5 Input Opened (DPU2000/R)
172	ULI6 Input Closed (DPU2000/R)
173	ULI6 Input Opened (DPU2000/R)
174	ULI7 Input Closed (DPU2000/R)
175	ULI7 Input Opened (DPU2000/R)
176	ULI8 Input Closed (DPU2000/R)
177	ULI8 Input Opened (DPU2000/R)
178	ULI9 Input Closed (DPU2000/R)
179	ULI9 Input Opened (DPU2000/R)
180	CRI Input Closed
181	CRI Input Opened
182	ARC Blocked
183	ARC Enabled
184	TARC Opened
185	SEF Enabled
186	SEF Disabled
187	User Display Input On
188	User Display Input Off
189	25 Enabled (DPU2000/R)
190	25 Disabled (DPU2000/R)
191	Lines Synced
192	Line Sync Lost
193	CB Slow
194	Local Enabled
195	Local Disabled
196	25 Bypass Enabled (DPU2000/R)
197	25 Bypass Disabled (DPU2000/R)
198	25 Synch Failed (DPU2000/R)
199	Catalog Number Update
200	Reserved
201	Reserved
202	Reserved
203	Reserved
204	Reserved
205	Reserved
206	Reserved
207	Reserved
208	Reserved
209	Reserved
210	Reserved
211	Reserved
212	Reserved
213	Reserved
214	Reserved
215	59G Alarm (DPU2000R)
216	TGT Enabled (DPU2000R)
217	TGT Disabled (DPU2000R)
218	SIA Enabled (DPU2000R)
219	SIA Disabled (DPU2000R)
220	LIS Asserted (DPU2000R)
221	LIR Asserted (DPU2000R)
222	LIS Deasserted (DPU2000R)
223	LIR Deasserted (DPU2000R)
224	LO Asserted (DPU2000R)

Operation Record Type (Index 89 code definition)	
225	LO Deasserted (DPU2000R)
226	TR_SET Asserted (DPU2000R)
227	TR_RST Asserted (DPU2000R)
228	TR_SET Deasserted (DPU2000R)
229	TR_RST Deasserted (DPU2000R)
230	TR_ON Asserted (DPU2000R)
231	TR_OFF Asserted (DPU2000R)
232	TR_TAG Asserted (DPU2000R)
233	59-3P Alarm (DPU2000R)
234	47 Alarm (DPU2000R)
235	21P-1 Zone 1 Trip (DPU2000R)
236	21P-2 Zone 2 Trip (DPU2000R)
237	21P-3 Zone 3 Trip (DPU2000R)
238	21P-4 Zone 4 Trip (DPU2000R)

Table 5-8A. Fault Record Definition Type

Fault Record Type (Index 59 code Definition)	
00	51P
01	51N
02	50P-1
03	50N-1
04	50P-2
05	50N-2
06	50P-3
07	50N-3
08	67P (DPU2000 and DPU2000R)
09	67N (DPU2000 and DPU2000R)
10	46
11	81 (DPU2000 and DPU2000R)
12	Zone Step
13	ECI-1
14	ECI-2
15	SEF (SE models)

User Definable Registers (Indices 97 Through 128)

Many DNP 3.0 hosts may follow differing levels of implementation. Some hosts may accept 16 bit objects, but they may only interpret 12 bit data types. ABB allows scaling of this data to various data lengths. The procedure to configure these User Definable Registers is detailed on page 84 of this document.

The data may also be packed to ensure that a group of data is returned upon a poll of the specific analog data types.

Analog Data Index Definition (129 Indices Defined)

Table 5-9 lists the Analog data retrievable via DNP 3.0. All analog data except for the data in the User Definable Register area index 97 through 128 [Group 24 Class 0] reported in primary units.

Table 5-9. Analog Input Index Designation

Analog Input Points
Static (Steady-State) Object Number: **30**
Change Event Object Number: **32**
Request Function Codes supported: **1 (read)**
Static Variation reported when variation 0 requested: **2 (16-Bit Analog Input)**
Change Event Variation reported when variation 0 requested: **2 (16-Bit Analog Change Event w/o Time)**

Point I.D.	Item	Description	Assigned Class (1, 2, 3 or none)	Scan Group
0	Ia (Load Currents)	16 Bits (See Note 2)	None	17
1	Ia Angle	16 Bits (See Note 2)	None	17
2	Ib	16 Bits (See Note 2)	None	17
3	Ib Angle	16 Bits (See Note 2)	None	17
4	Ic	16 Bits (See Note 2)	None	17
5	Ic Angle	16 Bits (See Note 2)	None	17
6	In	16 Bits (See Note 2)	None	17
7	In Angle	16 Bits (See Note 2)	None	17
8	Iavg	16 Bits (See Note 2)	None	17
9	KVan (Mag) (*1000)	32 Bits (See Note 3)	None	17
10	KVan (Ang) (See point 91 for KVab)	16 Bits (See Note 2)	None	17
11	KVbn (Mag) (*1000)	32 Bits (See Note 3)	None	17
12	KVbn (Ang)	16 Bits (See Note 2)	None	17
13	KVcn (Mag) (*1000)	32 Bits (See Note 3)	None	17
14	KVcn (Ang)	16 Bits (See Note 2)	None	17
15	KWan	32 Bits (See Note 3)	None	18
16	KWbn	32 Bits (See Note 3)	None	18
17	KWcn	32 Bits (See Note 3)	None	18
18	KW3	32 Bits (See Note 3)	None	18
19	KVARan	32 Bits (See Note 3)	None	18
20	KVARbn	32 Bits (See Note 3)	None	18
21	KVARcn	32 Bits (See Note 3)	None	18
22	KVAR3	32 Bits (See Note 3)	None	18
23	KWHra	32 Bits (See Note 3)	None	18
24	KWHrb	32 Bits (See Note 3)	None	18
25	KWHrc	32 Bits (See Note 3)	None	18
26	KWHr3	32 Bits (See Note 3)	None	18
27	KVARHra	32 Bits (See Note 3)	None	18
28	KVARHrb	32 Bits (See Note 3)	None	18
29	KVARHrc	32 Bits (See Note 3)	None	18
30	KVARHr3	32 Bits (See Note 3)	None	18
31	I0	16 Bits (See Note 2)	None	19
32	I0 Angle	16 Bits (See Note 2)	None	19
33	I1	16 Bits (See Note 2)	None	19
34	I1 Angle	16 Bits (See Note 2)	None	19
35	I2	16 Bits (See Note 2)	None	19
36	I2 Angle	16 Bits (See Note 2)	None	19
37	KV1 (*1000)	32 Bits (See Note 3)	None	19
38	KV1 Angle	16 Bits (See Note 2)	None	19
39	KV2 (*1000)	32 Bits (See Note 3)	None	19
40	KV2 Angle	16 Bits (See Note 2)	None	19
41	Frequency (*100)	16 Bits (See Note 2)	None	17
42	Power Factor (*100) Signed, two's comp + = Leading - = Lagging	16 Bits (See Note 2)	None	17
43	Demand Ia (Load Currents) (see Note 1)	16 Bits (See Note 2)	3	20
44	Demand Ib (see Note 1)	16 Bits (See Note 2)	3	20
45	Demand Ic (see Note 1)	16 Bits (See Note 2)	3	20
46	Demand In (see Note 1)	16 Bits (See Note 2)	3	20
47	Demand Kwan (see Note 1)	32 Bits (See Note 3)	3	20
48	Demand KWbn (see Note 1)	32 Bits (See Note 3)	3	20
49	Demand KWcn (see Note 1)	32 Bits (See Note 3)	3	20
50	Demand KW3 (see Note 1)	32 Bits (See Note 3)	3	20

Analog Input Points
Static (Steady-State) Object Number: **30**
Change Event Object Number: **32**
Request Function Codes supported: **1 (read)**
Static Variation reported when variation 0 requested: **2 (16-Bit Analog Input)**
Change Event Variation reported when variation 0 requested: **2 (16-Bit Analog Change Event w/o Time)**

Point I.D.	Item	Description	Assigned Class (1, 2, 3 or none)	Scan Group
51	Demand KVARan (see Note 1)	32 Bits (See Note 3)	3	20
52	Demand KVARbn (see Note 1)	32 Bits (See Note 3)	3	20
53	Demand KVARcn (see Note 1)	32 Bits (See Note 3)	3	20
54	Demand KVAR3 (see Note 1)	32 Bits (See Note 3)	1	20
55	Fault Type (element)	16 Bits (See Note 4)	1	21
56	Fault Record Reclose Seq (bits 0-3)	16 Bits (See Note 4) 1 = Reclose Seq 1 2 = Reclose Seq 2 3 = Reclose Seq 3 4 = Reclose Seq 4 5 = Lockout	1	21
57	Fault Record Active Set (bits 4-7)	16 Bits (See Note 4) 1 = Primary 2 = Alt 1 Settings 3 = Alt 2 Settings	1	21
58	Fault Number	16 Bits (See Note 4)	1	21
59	Ia (Fault Currents)	16 Bits (See Note 4)	1	21
60	Ib	16 Bits (See Note 4)	1	21
61	Ic	16 Bits (See Note 4)	1	21
62	In	16 Bits (See Note 4)	1	21
63	Ia Angle	16 Bits (See Note 4)	1	22
64	Ib Angle	16 Bits (See Note 4)	1	22
65	Ic Angle	16 Bits (See Note 4)	1	22
66	In Angle	16 Bits (See Note 4)	1	22
67	Zero Seq **I** (Mag)	16 Bits (See Note 4)	1	22
68	Pos Seq **I** (Mag)	16 Bits (See Note 4)	1	22
69	Neg Seq **I** (Mag)	16 Bits (See Note 4)	1	22
70	Zero Seq **I** (Ang)	16 Bits (See Note 4)	1	22
71	Pos Seq **I** (Ang)	16 Bits (See Note 4)	1	22
72	Neg Seq **I** (Ang)	16 Bits (See Note 4)	1	22
73	KVab/KVan (Mag) (*1000)	16 Bits (See Note 4)	1	21
74	KVbc/KVbn (Mag) (*1000)	16 Bits (See Note 4)	1	21
75	KVca/KVcn (Mag) (*1000)	16 Bits (See Note 4)	1	21
76	Vab/Van (Ang)	16 Bits (See Note 4)	1	22
77	Vbc/Vbn (Ang)	16 Bits (See Note 4)	1	22
78	Vca/Vcn (Ang)	16 Bits (See Note 4)	1	22
79	Pos Seq V (Mag)	16 Bits (See Note 4)	1	22
80	Neg Seq V (Mag)	16 Bits (See Note 4)	1	22
81	Pos Seq V (Ang)	16 Bits (See Note 4)	1	22
82	Neg Seq V (Ang)	16 Bits (See Note 4)	1	22
83	Fault location (*10)	16 Bits (See Note 4)	1	21
84	Fault impedance, real part (*1000)	32 Bits (See Note 4)	1	21
85	Breaker Operate Time (*1000)	32 Bits (See Note 4)	1	22
86	Relay Operate Time (*1000)	32 Bits (See Note 4)	1	22
87	Operation message #	16 Bits (See Note 4)	2	23
88	Operation Value (if any)	16 Bits (See Note 4)	2	23
89	Operation Number	16 Bits (See Note 4)	2	23
90	KVab (Mag) (*1000)	32 Bits (See Note 3)	None	17

Analog Input Points
Static (Steady-State) Object Number: **30**
Change Event Object Number: **32**
Request Function Codes supported: **1 (read)**
Static Variation reported when variation 0 requested: **2 (16-Bit Analog Input)**
Change Event Variation reported when variation 0 requested: **2 (16-Bit Analog Change Event w/o Time)**

Point I.D.	Item	Description	Assigned Class (1, 2, 3 or none)	Scan Group
91	KVab (Ang)	16 Bits (See Note 2)	None	17
92	KVbc (Mag) (*1000)	32 Bits (See Note 3)	None	17
93	KVbc (Ang)	16 Bits (See Note 2)	None	17
94	KVca (Mag) (*1000)	32 Bits (See Note 3)	None	17
95	KVca (Ang)	16 Bits (See Note 2)	None	17
96	I Scale Factor	16 Bits (See Note 2) 0 or 1 -> 1 10 -> 10	None	21
97	User Register 1	16 Bits (See Note 2)	None	24
98	User Register 2	16 Bits (See Note 2)	None	24
99	User Register 3	16 Bits (See Note 2)	None	24
100	User Register 4	16 Bits (See Note 2)	None	24
101	User Register 5	16 Bits (See Note 2)	None	24
102	User Register 6	16 Bits (See Note 2)	None	24
103	User Register 7	16 Bits (See Note 2)	None	24
104	User Register 8	16 Bits (See Note 2)	None	24
105	User Register 9	16 Bits (See Note 2)	None	24
106	User Register 10	16 Bits (See Note 2)	None	24
107	User Register 11	16 Bits (See Note 2)	None	24
108	User Register 12	16 Bits (See Note 2)	None	24
109	User Register 13	16 Bits (See Note 2)	None	24
110	User Register 14	16 Bits (See Note 2)	None	24
111	User Register 15	16 Bits (See Note 2)	None	24
112	User Register 16	16 Bits (See Note 2)	None	24
113	User Register 17	16 Bits (See Note 2)	None	24
114	User Register 18	16 Bits (See Note 2)	None	24
115	User Register 19	16 Bits (See Note 2)	None	24
116	User Register 20	16 Bits (See Note 2)	None	24
117	User Register 21	16 Bits (See Note 2)	None	24
118	User Register 22	16 Bits (See Note 2)	None	24
119	User Register 23	16 Bits (See Note 2)	None	24
120	User Register 24	16 Bits (See Note 2)	None	24
121	User Register 25	16 Bits (See Note 2)	None	24
122	User Register 26	16 Bits (See Note 2)	None	24
123	User Register 27	16 Bits (See Note 2)	None	24
124	User Register 28	16 Bits (See Note 2)	None	24
125	User Register 29	16 Bits (See Note 2)	None	24
126	User Register 30	16 Bits (See Note 2)	None	24
127	User Register 31	16 Bits (See Note 2)	None	24
128	User Register 32	16 Bits (See Note 2)	None	24
129	3-Phase Volt - Amps	16 Bits (See Note 2)	None	25
130	W Power Factor	16 Bits (See Note 2,5,6)	None	27
131	Uw Power Factor Status	16 Bits (See Note 2,5,6)	None	27
132	I0 Zero Sequence Measured	32 Bits (See Note 2,5,6)	None	27
133	I0 Zero Sequence Angle Measured	16 Bits (See Note 2,5,6)	None	27
134	V0 Zero Sequence Measured	32 Bits (See Note 2,5,6)	None	27
135	V0 Zero Sequence Angle Measured	16 Bits (See Note 2,5,6)	None	27
136	V0 Zero Sequence Calculated	32 Bits (See Note 2,5,6)	None	27

Analog Input Points
Static (Steady-State) Object Number: **30**
Change Event Object Number: **32**
Request Function Codes supported: **1 (read)**
Static Variation reported when variation 0 requested: **2 (16-Bit Analog Input)**
Change Event Variation reported when variation 0 requested: **2 (16-Bit Analog Change Event w/o Time)**

Point I.D.	Item	Description	Assigned Class (1, 2, 3 or none)	Scan Group
137	V0 Zero Sequence Angle Calculated	16 Bits (See Note 2,5,6)	None	27
138	Fault Distance (Km or Mi)	16 Bits (See Note 2,5,6)	None	27
139	Voltage Differential Magnitude	32 Bits (See Note 2,5,6)	None	27
140	Voltage Differential Angle	16 Bits (See Note 2,5,6)	None	27
141	Synch Check Slip Frequency	16 Bits (See Note 2,5,6)	None	27

NOTE:

1. If Static data is read (Object 30) then the current demand data is returned. If Event Read data is placed in the buffer, then the peak demand (Load) and minimum demand (Load) values are returned for class or object data.
2. 16 Bit data returned as per object request.
3. 32 Bit Data returned.
4. Event and Fault Data Returned only on a change event detection (Object 32). No data is available as static (Object 30)
5. Added in Version 3.4 which requires flash executive 4.02 or later for feature incorporation.
6. DPU 2000R ONLY

Class Data Parameterization

The DPU2000, DPU1500R and DPU2000R supports Class Data. All elements described in Tables 5-4, 5-5 and 5-8 are reported in a Class 0 scan. A Class 0 scan is sometimes referred to as an integrity scan. Others refer to a class 1, 2, 3, 0 scan as an integrity scan. Figures 5-6 through 5-9 explain the method to enable Class data reporting via enabling of group information.

A summary explanation of DNP 3.0 Class Reporting Data is as follows:

- Class 0 — All Static Data
- Class 1 — Fault Record Data (Digital Input Points 96, 97 and Analog Input Points 55-86) Groups 12, 21, 22 or a combination enabled thereof.
- Class 2 — Operation Records (Analog Input Points 87 through 89) Group 23 enabled.
- Class 3 — Minimum and Maximum Demand Data (Analog Input Points 43 through 54) Status Point Information (Digital Input Points 1 through 95, and 98 through 1-162)

It should be noted that only Class 3 (Object 60 Variant 3) Digital Points may be masked to provide a reduced amount of data returned between integrity scans. It is a reliable method of obtaining change of state data within the DPU2000, DPU1500R and DPU2000R.

Parameter 5 Class Data Configuration

Upper Byte Used for Class Data Masking

Lower Byte Used for Class Data Selection

	Bit 7	Bit 6	**Bit 5**	**Bit 4**	Bit 3	Bit 2	Bit 1	Bit 0

Bit 0 = 0 = Group 0 data reported = value = 0
Bit 1 = 1 = Group 1 data reported = value = 2
Bit 2 = 1 = Group 2 data reported = value = 4
Bit 3 = 1 = Group 3 data reported = value = 8
Bit 4 = 1 = Group 4 data reported = value = 16
Bit 5 = 1 = Group 5 data reported = value = 32
Bit 6 = 1 = Group 6 data reported = value = 64
Bit 7 = 1 = Group 7 data reported = value = 128

To enable all Groups parameter must be set to 254.

Parameter 5 - If Bit 0 = 1 Group 0 Disabled

Parameter 5 - If Bit 0 = 0 Group 0 Enabled

Parameter 5 - If Bit 1 - 7 = 1 Group 1 to 7 Enabled. If 0 then corresponding group Disabled

Figure 5-6. Parameter 5 DNP 3.0 Group Mask

Parameter 6 Class Data Configuration

Upper Byte Used for Class Data Masking

Lower Byte Used for Class Data Selection

	Bit 7	Bit 6	**Bit 5**	**Bit 4**	Bit 3	Bit 2	Bit 1	Bit 0

Bit 0 = 1 = Group 8 data reported = value = 1
Bit 1 = 1 = Group 9 data reported = value = 2
Bit 2 = 1 = Group 10 data reported = value = 4
Bit 3 = 1 = Group 11 data reported = value = 8
Bit 4 = 1 = Group 12 data reported = value = 16
Bit 5 = 1 = Group 13 data reported = value = 32
Bit 6 = 1 = Group 14 data reported = value = 64
Bit 7 = 1 = Group 15 data reported = value = 128

To enable all Groups parameter must be set to 255.

Parameter 6 - If Bit 0 - 7 = 1 Group 8 to 15. If 0 then corresponding group Disabled.

Figure 5-7. Parameter 6 Group Mask

Parameter 7 Class Data Configuration

Upper Byte Used for Class Data Masking

Lower Byte Used for Class Data Selection

	Bit 7	Bit 6	**Bit 5**	**Bit 4**	Bit 3	Bit 2	Bit 1	Bit 0

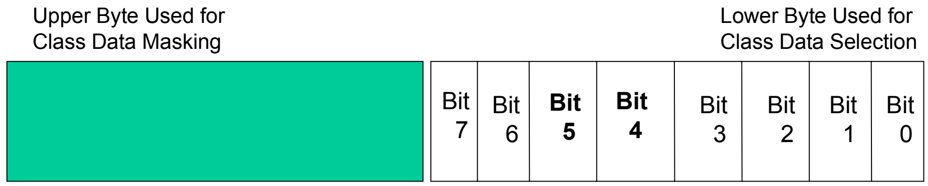
Bit 0 = 1 = Group 16 data reported = value = 1
Bit 1 = 1 = Group 17 data reported = value = 2
Bit 2 = 1 = Group 18 data reported = value = 4
Bit 3 = 1 = Group 19 data reported = value = 8
Bit 4 = 1 = Group 20 data reported = value = 16
Bit 5 = 1 = Group 21 data reported = value = 32
Bit 6 = 1 = Group 22 data reported = value = 64
Bit 7 = 1 = Group 23 data reported = value = 128

To enable all Groups parameter must be set to 255.

Parameter 7 - If Bit 0 - 7 = 1 Group 16 to 23. If 0 then corresponding group Disabled.

Figure 5-8. Parameter 7 Group Mask

Parameter 8 Class Data Configuration



Bit 0 = 1 = Group 24 data reported= value = 1
Bit 1 = 1 = Group 25 data reported = value = 2
Bit 2 = 1 = Group 26 data reported = value = 4
Bit 3 = 1 = Group 27 data reported = value = 8
Bit 4 = 1 = Group 28 data reported = value = 16
Bit 5 = 1 = Group 29 data reported = value = 32
Bit 6 = 1 = Group 30 data reported = value = 64
Bit 7 = 1 = Group 31 data reported = value = 128
To enable all Groups parameter must be set to 255.

Parameter 8 - If Bit 0 - 7 = 1 Group 24 to 31. If bit is 0 then corresponding group Disabled.

Figure 5-9. Parameter 8 Group Mask

EXAMPLE
If Groups 0, 1, 27 and 28 were to be enabled and all other points were to be disabled. What would be the calculated parameters for PARAMETERS 5, 6, 7, and 8.

SOLUTION
Parameter 5 = Group 0 Enabled + Group 1 Enabled + Group 2 Disabled + Group 3 Disabled + Group 4 Disabled + Group 5 Disabled + Group 6 Disabled + Group 7 Disabled

Parameter 5 = 0 + 2+ 0+0+0+0+0+0

Parameter 5 = 2
Parameter 6 = 0 (Nothing selected for these groups)
Parameter 7 = 0 (Nothing selected for these groups)

Parameter 8 = Group 24 Disabled + Group 25 Disabled + Group 26 Disabled + Group 27 Enabled + Group 28 Enabled + Group 29 Disabled + Group 30 Disabled + Group 31 Disabled

Parameter 8 = 0 + 0+ 0+16+8+0+0+0

Parameter 8 = 24.

Thus in the setup communication parameter configuration screen Parameters 5, 6, 7, and 8 would be configured with the values 2,0,0, and 24.

It must be noted that regardless of the order of points given in the group enable parameterization, class data for a given class will be returned in the order defined in the parameter byte assignment configuration table. More than one object may be contained in the response to accommodate various data types and variations required to satisfy the request.

Group Point Display Masking

Host databases requires correct and complete configuration of data points in order for group data retrieval. The following table will enable to configure the amount of points required for database configuration if certain groups are enabled (VERSION 3.7)

Group Number	Object 1 Data Points	Object 10 Data Points	Object 20 Data Points	Object 30 Data Points
0	9	2	0	0

Group Number	Object 1 Data Points	Object 10 Data Points	Object 20 Data Points	Object 30 Data Points
1	14	0	0	0
2	2	0	0	0
3	5	0	0	0
4	15	0	0	0
5	8	0	0	0
6	7	0	0	0
7	26	0	0	0
8	0	9	0	0
9	19	0	0	0
10	9	0	0	0
11	16	0	0	0
12	2 * OBJECT 2 ONLY	0	0	0
13	9	0	0	0
14	9	0	0	0
15	0	0	11	0
16	0	106	0	0
17	0	0	0	23
18	0	0	0	16
19	0	0	0	10
20	0	0	0	12
21	0	0	0	14 (OBJECT 32 ONLY)
22	0	0	0	19 (OBJECT 32 ONLY)
23	0	0	0	3 (OBJECT 32 ONLY)
24	0	0	0	32
25	0	0	0	1
26	22	0	0	0
27	0	0	0	12
28	11	0	0	0
29	0	0	0	0
30	0	0	0	0
31	0	0	0	0

Class 3 Data Masking

DNP 3.0 is a powerful protocol designed for utility applications. However, the amount of data must be efficiently managed so that fast updates to the host may occur. A common method to acquire vast amounts of data is to configure a host to perform an integrity scan initially (request Class 1, 2, 3, and 0 Data) and then perform Class 3 scans. The host shall update its database in that Class 3 data shall only return the data, which has changed from the previous, scan to the present scan. Each implementer determines the time duration between Class Scans. When a sufficient period of time elapses, the host would then execute an integrity scan. The host would then update its own database and verify the integrity of its own records. Integrity scans can occur as frequently as every 5 minutes or as infrequently as every 1 hour. Each host has its own capabilities and the designer of the automation system designs the polling interval to suit the application.

ABB relays incorporate a method to decrease the amount of data reported upon a change event poll. If the group has been enabled, all points in that group are returned for a class. If the amount of data required on a Class 3 poll is less than that on a Class 0 or integrity poll, Event Masking is a method to de-select points within a Class 3 request poll.

The method to perform event masking is described as such:

Events generated for Binary Input points can be masked to minimize the amount of data returned on a Class 3 scan. As of release v3.2, all Binary Input points with point index 11 or greater generate change events. Point index 96 and 97 generate Class 1 events, all other binary events are Class 3 and may be masked. The masking must be set up using the ABB provided External Communications Program - ECP.

The Communication Configuration Settings are accessed via the Miscellaneous Settings item on the Change Settings Menu. The Binary Input Event Masks are contained in Settings 1 to 9; by default they are all zero - enabled. This causes all events to be reported (provided their Scan Group is enabled). They can be disabled by changing all of these Communication Configuration Settings to have all bits set (65535).

The masks for individual points can be determined from the Table 5-10 below. The left half of the table specifies which Settings Word applies for each group of 16 points. By dividing the point index by 16 and checking the remainder in the right half of the table the mask value for each individual point index can be determined.

Table 5-10. Class 3 Event Masking Settings

Point Index Range	Comm. Configuration Settings		Point Index Remainder
	Setting Word	Mask Value	
0-15	1	1	0
16-31	2	2	1
32-47	3	4	2
48-63	4	8	3
64-79	5	16	4
80-95	6	32	5
96-111	7	64	6
112-127	8	128	7
128-143	9	256	8
		512	9
		1024	10
		2048	11
		4096	12
		8192	13
		16384	14
		32768	15

Example 1: To mask out the Binary Event for the Breaker Failure Alarm (BFA) - point index 57, perform the following steps:

a. Divide 57 by 16, to get a remainder of 9.
b. Look up the entries for 57 and 9 in the left and right halves of the table, respectively.
c. This tells us that Communication Configuration Setting 4 should be set to 512 to mask out this event.

Example 2: To mask out multiple Binary Events, for the 50P3 and 50N3 Functions (point indexes 40 and 41) first follow the procedure from example 1, then perform the following steps:

a. The steps in example 1 establish that both points are in Communication Configuration Setting 3 and that the values are 256 and 512 for point index 40 and 41, respectively.
b. To mask off both points we need only to add the two values together to get 768.

Users who have DNP software versions prior to v3.2 may want to limit the number of points reported via the Class 3 Binary Input changes for compatibility with those other versions. For versions v2.0 through v2.8 only point index 11 was reported as a Class 3 Binary Input event. For versions v2.9 and v3.0, the Class 3 Binary Input events were limited to point index 11 and the points marked as “sealed-ins”. The table below shows the Communication Configuration Settings to restrict event reporting to those points if using a relay with v3.2 or later software.

Setting Word	v2.0 - v2.8 Value	v2.9 - v3.0 Values
1	63487	63487
2	65535	65535
3	65535	3
4	65535	65022
5	65535	64511
6	65535	65535
7	65535	65535
8	65535	50175
9	65535	65534

NOTE: In all cases, events are not reported unless the specified Scan Group (or Scan Type) is enabled. Thus, a disabled Scan Group also effectively masks all Class 3 events generated by points in that group.

The Sample DNP Event Masking Worksheet (on the next page) shows how the values for masking all events that are not available on the DNP v3.0 software were determined.

DNP Event Masking Worksheet (sample)

		Communications Configurable Setting #										
Value$_{10}$	**Value$_{Hex}$**	1	2	3	4	5	6	7	8	9	10	11
1	0x0001	0	16	32	x 48	64	80	96	112	128	144	160
2	0x0002	1	17	33	49	65	81	97	113	129	145	161
4	0x0004	2	18	x 34	50	66	82	98	114	130	146	162
8	0x0008	3	19	x 35	51	67	83	99	115	131	147	163
16	0x0010	4	20	x 36	52	68	84	100	116	132	148	164
32	0x0020	5	21	x 37	53	69	85	101	117	133	149	165
64	0x0040	6	22	x 38	54	70	86	102	118	134	150	166
128	0x0080	7	23	x 39	55	71	87	103	119	135	151	167
256	0x0100	8	24	x 40	56	72	88	104	120	136	152	168
512	0x0200	9	25	x 41	x 57	73	89	105	121	137	153	
1024	0x0400	10	26	x 42	58	x 74	90	106	x 122	138	154	
2048	0x0800	x 11	27	x 43	59	75	91	107	x 123	139	155	
4096	0x1000	12	28	x 44	60	76	92	108	x 124	140	156	
8192	0x2000	13	29	x 45	61	77	93	109	x 125	141	157	
16384	0x4000	14	30	x 46	62	78	94	110	126	142	158	
32768	0x8000	15	31	x 47	63	79	95	111	127	143	159	
	(step 2)	***2048***	***0***	***65532***	***513***	***1024***	***0***	***0***	***15360***	***0***	***0***	***0***
Totals	65535 ***(step 3)***	***63487***	***65535***	***3***	***65022***	***64511***	***65535***	***65535***	***50175***	***65535***	***65535***	***65535***
Totals	***(step 4)***	***0xF7FF***	***0xFFFF***	***0x0003***	***0xFDFE***	***0xFBFF***	***0xFFBF***	***0xFFFF***	***0xC3FF***	***0xFFFF***	***0xFFFF***	***0xFFFF***

- Entries in the table indicate DNP Point numbers.
- The Communications Configurable Setting #s in the column headings show which setting contains the masks for the indicated DNP points.
- The leftmost columns contain the mask value for each row of DNP points in decimal and hexidecimal.

Steps:

1. Mark (with an x) each point that should have event reporting enabled.

2. Proceeding one column at a time, total the values corresponding to the marked points.
3. Calculate the mask value by subtracting the value from step 2 from 65535.
4. The step 3 results have been converted to hexidecimal format (optional).
5. Enter the results from step 3 in the ECP program for the specified Communications Configurable Settings.

DNP Event Masking Worksheet

Communications Configurable Setting #

$Value_{10}$	**$Value_{Hex}$**	1	2	3	4	5	6	7	8	9	10	11
1	0x0001	0	16	32	48	64	80	96	112	128	144	160
2	0x0002	1	17	33	49	65	81	97	113	129	145	161
4	0x0004	2	18	34	50	66	82	98	114	130	146	162
8	0x0008	3	19	35	51	67	83	99	115	131	147	163
16	0x0010	4	20	36	52	68	84	100	116	132	148	164
32	0x0020	5	21	37	53	69	85	101	117	133	149	165
64	0x0040	6	22	38	54	70	86	102	118	134	150	166
128	0x0080	7	23	39	55	71	87	103	119	135	151	167
256	0x0100	8	24	40	56	72	88	104	120	136	152	168
512	0x0200	9	25	41	57	73	89	105	121	137	153	
1024	0x0400	10	26	42	58	74	90	106	122	138	154	
2048	0x0800	11	27	43	59	75	91	107	123	139	155	
4096	0x1000	12	28	44	60	76	92	108	124	140	156	
8192	0x2000	13	29	45	61	77	93	109	125	141	157	
16384	0x4000	14	30	46	62	78	94	110	126	142	158	
32768	0x8000	15	31	47	63	79	95	111	127	143	159	
Totals 65535												
Totals	0xFFFF											

- Entries in the table indicate DNP Point numbers.
- The Communications Configurable Setting #s in the column headings show which setting contains the masks for the indicated DNP points.
- The leftmost columns contain the mask value for each row of DNP points in decimal and hexidecimal.

Time Synchronization

Although, required for a Level 2 implementation, the DPU2000 and DPU2000R allow for Time Synchronization via the DNP 3.0 communication network. Time Synchronization must be enabled if the value in Parameter 9 is other than 0. The procedure for Time Synchronization is covered in the DNP Texts referenced within this document. The procedure to perform time synchronization is included here for the benefit of the reader.

1. The Master station sends a Delay Measurement Response request to the relay (Object 52 Variant 1 or 2 in reference to fine or coarse time). The Master records the time of the transmission of the first bit of the first byte of the request.
2. The relay receives the first bit of the first byte of the Delay Measurement Request at the time the RTU RECEIVE TIME (the local time in the relay).
3. The relay transmits the first bit of the first byte of the response to the Delay Measurement request at time RTU SEND TIME. The response contains the fine or coarse (as defined by Variant 1 or 2 of Object 52 as defined in the DNP 3.0 specification) TIME DELAY object, with the time in his object equal to the "turn around time [time of send/receive and relay response] of the host communicating to the relay.
4. The Master Station receives the first bit of the first byte of the relay's response at the time the Master Receive Time is recorded by the host as the response input.
5. The Master Station can now calculate the one way propagation delay = (Master Send Time - Master Receive Time - "turn around time")/2
6. The master now transmits the first bit of the first byte of a WRITE COMMAND at time of send. The Write request contains the calculated value of the actual host time plus the calculated delay time. This is the time the relay will be set to including delay. The Write command shall be Object 50 variant 2 as defined by the DNP 3.0 protocol.

When the relay receives the time synchronize write command, the relay is Synchronized. IT MUST BE REMEMBERED THAT THE IRIG –B SELECTION MUST BE ENABLED IN THE IED “AND” PARAMETER 9 SHOULD BE PARAMETERIZED FOR A TIME INTERVAL FOR SETTING THE “IIN NEET TIME” BIT.

According to the specification of DNP 3.0, if all delay times for all devices receiving commands on the network are the same, the host may send a broadcast command which is address FFFF hexadecimal.

Rapid Analog Reporting

The ABB DPU 2000/2000R does not incorporate analog deadbanding. In order to improve DNP 3.0 response,an alternate method of performing rapid access of DNP 3.0 metering values has been developed. Since no metering values are returned in the CLASS 1, 2, or 3 scans, all metering data must be obtained by performing a CLASS 0, or Object 30. An alternate means has been incorporated in which up to 32 UDR (User Definable Registers) may be reported in a CLASS 3 scan on a timed basis. If the DPU has not been read by a Class 3 scan within that time interval, the analog UDR data register is overwritten and the new value is reported. Figure 5-9E illustrates the method to calculate the Miscellaneous Communicaiton Parameters to enable the Rapid Analog Reporting Feature.

The method to configure the DPU2000R is as follows:

1. GROUP 31 (User Definable Registers) must be enabled via Communication Parameter 8. Reference Section 4 of this manual for an explanation of this procedure.
2. Mode Parameter 6 must be enabled to allow the DPU2000/2000R to periodically report the User Definable Registers on a timed Basis. Section 4 of this manual describes the means to configure the communication configuration screen.
3. Select the Micellaneous Tab in WIN ECP to access the screen to configure the UDR Analog Reporting feature. The screen is shown in Figure 5-9A. Select the submenu selection “Set Communications Config” to access the screen to parameterize the device. The Analog Reporting Configuration process may only be accomplished via WIN ECP. The process may not be accomplished via the FRONT PANEL INTERFACE. Parameters 17,18, and 19 are available to parameterize this feature. Access the sub window configuration screen by “clicking” over the field to be configured. Figure 5-9B shows the subwindow available for configuration.
4. Enable the specific UDR registers as per the prodedure illustrated in Figures 5-9 C and 5-9 D. Miscellaneous Setting parameter 17 and 18 selects the register to report to the host. It must be emphasized that if the specific bit is set to a value of “1” the specific UDR will not be reported on a timed basis. If the specific bit is set to a value of “0” then the specific UDR will be reported on a timed basis to the requesting host device.

5. The rate as to how often the UDR registers are placed in the CLASS 3 reporting buffer (thereby setting the CLASS 3 bit) is configured in the Miscellaneous Setting 19. The value written in this parameter is from 1 to 32763 and reflects the number of seconds by which UDR's are placed in the CLASS 3 data reporting mechanism. If the CLASS 3 data is not scanned within the configured time window, the values are overwritten. It should be noted that time stamping of the analog CLASS 3 data does not occur. In other words, no matter how long it takes the master station before the IED is scanned, there will only be one set of UDR registers to be reported and the time of reporting will NOT be reported as part of the CLASS 3 scan data returned to the host.
6. Refer to the next section titled REGISTER SCALING AND RE-MAPPING AND USER DEFINABLE REGISTER (UDR) CONFIGURATION PROCESS, for configuring the data format for the requested CLASS 3 reported information.

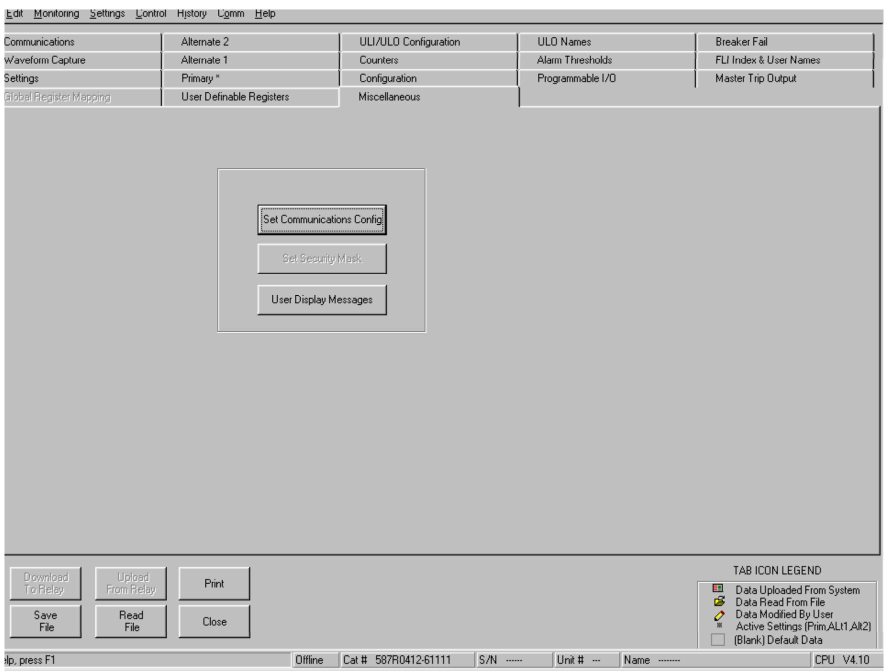


Figure 5-9A. Miscellaneous Setting Screen

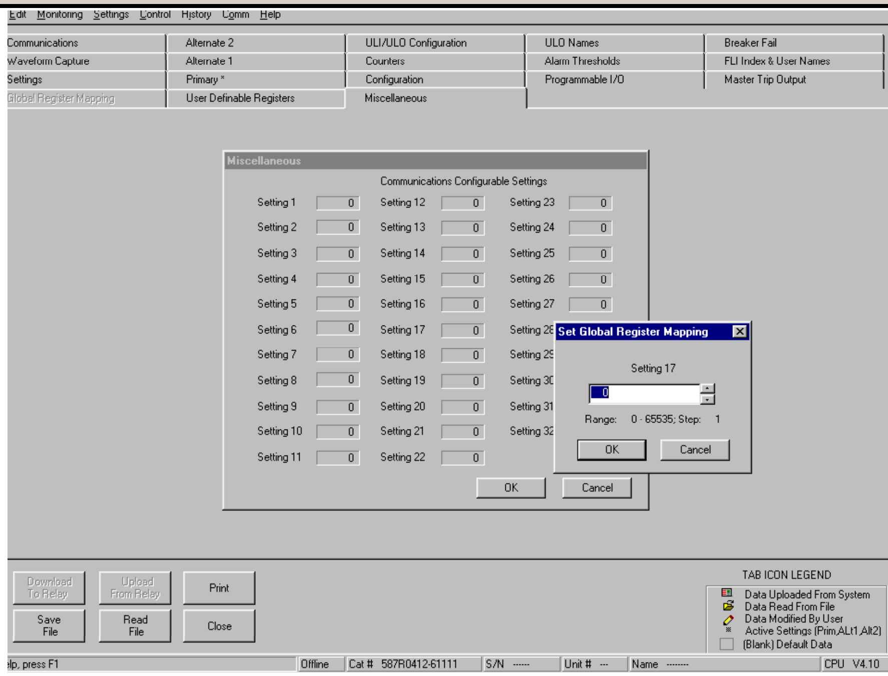


Figure 5-9B. Miscellaneous Parameter Configuration Subscreens

Miscellaneous Communication Configurable Settings-Setting 17

Bit 15	Bit 14	**Bit 13**	**Bit 12**	Bit 11	Bit 10	Bit 9	Bit 8	Bit 7	Bit 6	**Bit 5**	**Bit 4**	Bit 3	Bit 2	Bit 1	Bit 0

Bit 0 = 0 = UDR 17 data not reported	value = 1
Bit 1 = 0 = UDR 18 data not reported	value = 2
Bit 2 = 0 = UDR 19 data not reported	value = 4
Bit 3 = 0 = UDR 20 data not reported	value = 8
Bit 4 = 0 = UDR 21 data not reported	value = 16
Bit 5 = 0 = UDR 22 data not reported	value = 32
Bit 6 = 0 = UDR 23 data not reported	value = 64
Bit 7 = 0 = UDR 24 data not reported	value = 128
Bit 8 = 0 = UDR 25 data not reported	value = 256
Bit 9 = 0 = UDR 26 data not reported	value = 512
Bit 10= 0 = UDR 27 data not reported	value = 1,024
Bit 11= 0 = UDR 28 data not reported	value = 2,048
Bit 12 = 0 = UDR 29 data not reported	value = 4,096
Bit 13 = 0 = UDR 30 data not reported	value = 8,192
Bit 14 = 0 = UDR 31 data not reported	value = 16,384
Bit 15 = 0 = UDR 32 data not reported	value = 32,768

EXAMPLE:

IF UDR's 17,23 and 27 were to be included in a Class 3 scan:

65535 - 1 - 64 - 1024=
Setting = 64446

Figure 5-9C. Miscellaneous Parameter 17 Setting

Miscellaneous Communication Configurable Settings-Setting 18

Bit 15	Bit 14	**Bit 13**	**Bit 12**	Bit 11	Bit 10	Bit 9	Bit 8	Bit 7	Bit 6	**Bit 5**	**Bit 4**	Bit 3	Bit 2	Bit 1	Bit 0

Bit 0 = 0 = UDR 1 data not reported	value = 1
Bit 1 = 0 = UDR 2 data not reported	value = 2
Bit 2 = 0 = UDR 3 data not reported	value = 4
Bit 3 = 0 = UDR 4 data not reported	value = 8
Bit 4 = 0 = UDR 5 data not reported	value = 16
Bit 5 = 0 = UDR 6 data not reported	value = 32
Bit 6 = 0 = UDR 7 data not reported	value = 64
Bit 7 = 0 = UDR 8 data not reported	value = 128
Bit 8 = 0 = UDR 9 data not reported	value = 256
Bit 9 = 0 = UDR 10 data not reported	value = 512
Bit 10= 0 = UDR11 data not reported	value = 1,024
Bit 11= 0 = UDR 12 data not reported	value = 2,048
Bit 12 = 0 = UDR 13 data not reported	value = 4,096
Bit 13 = 0 = UDR 14 data not reported	value = 8,192
Bit 14 = 0 = UDR 15 data not reported	value = 16,384
Bit 15 = 0 = UDR 16 data not reported	value = 32,768

EXAMPLE:

IF UDR's 1 through 5 were to be included in a Class 3 scan:

65535 - 1 -2 - 4 -8 - 16=
Setting = 65472

Figure 5-9D. Miscellaneous Parameter 18 Setting

EXAMPLE

Miscellaneous Communication Parameter

Setting 17 = 64446
Setting 18 = 65472
Setting 19 = 5

UDR's 1,2,3,4,5, 17,23 and 27 are reported in a CLASS 3 SCAN (IIN BIT SET) every 5 seconds.

Figure 5-9D. Example Continued

Register Scaling and Re-Mapping and User Definable Register (UDR) Configuration Process

In the evolution of SCADA hosts, different capabilities have been implemented in conjunction with a protocol's implementation. Some SCADA manufacturers have limited the range of numbers accepted at the host level. Other SCADA manufacturers have reserved alternate definitions of most significant bit placement. Still, other SCADA manufacturers have restricted the amount of commands, which a host may send over a network.

ABB's implementation of Register Scaling and Re-Mapping is one method of dealing with certain restrictions or limitations of a SCADA host's protocol implementation. For example, if a host device only accepts numbers from a value of 0 to 4095 (12 bit unipolar) or –2047 to + 2048, how can that host device interpret the Van (Voltage a to neutral) in the DPU2000 which reports the value as a number from 0 to +4,294,967,295 (32 bit number)? The answer is that one of the devices must take the 32 bit data and scale it into a format usable by the other device. Many hosts share this limitation and are unable to undertake the mathematical machinations to scale the data value. The ABB DPU2000 and 2000R permits scaling of its own internal data. The procedure is straightforward in that a simple configuration screen is presented to the operator and menu of choices is selected to complete the configuration procedure.

Re-mapping is especially instrumental in increasing network throughput by allowing all information to be accessed via one network transaction. Within the DPU2000 and 2000R, multitudes of values are available for retrieval via a network connection. However, different protocols require that each group of information can only be accessed via a single network query. Thus if three different groups of information are required via the network, three network accesses must occur. However, if the information is re-mapped to a single memory area in the relay, only one network access need be undertaken to gather the data. Network throughput is increased. Register scaling and re-mapping is common to all ABB DPU2000, DPU1500R, and 2000R relays. The Register Scaling and Re-Mapping procedure is the same for DNP/Modbus/Modbus Plus/Standard Ten Byte Protocols. DNP uses this method to improve overall network throughput in reporting analog data in a CLASS 3 scan.

DPU2000, DPU1500R, and DPU2000R protective relays provide for scaling and re-mapping functionality. The DPU does not support this capability. Figure 5-6 illustrates the example of re-mapping Van to one of 32 possible Modbus register locations. The example table configuration entries are shown in the Figure 5-13. A definition of each configuration entry and mathematically derived configuration examples follow.

DPU2000, DPU1500R and DPU2000R Internal Operation

The DPU2000, DPU1500R, and DPU2000R reads the raw analog values received from the CT and PT physical connections. The microprocessor-based relay then converts the analog values to a raw digital numeric value from the relay's internal Analog to Digital Converter (A/D) hardware platform. The conversion of the voltage and current readings is not complete. The DPU2000 and DPU2000R microprocessor then takes the raw converted value and performs a mathematical calculation providing a numeric value which is displayed on the relay's front panel MMI or through network accesses.

A protection engineer would recognize the terms as such:

PRIMARY VALUES – the metering values displayed on the protective relay's front panel interface. [Primary Units]

SECONDARY VALUES – the current or voltage received by the CT or PT attached to the unit. [Secondary Units]

SCALED VALUES – the value received by the host device (or calculated by the IED and transmitted to the host) through the communication interface.

The mathematical calculations involved require the CT Phase, CT Neutral, and PT ratios in order to convert the raw A/D to an understandable value, displayed on the front panel MMI or available for access via a network connection. Thus, the information Van (Voltage A to Neutral), is displayed on the front panel MMI is in converted format (not raw A/D readings), and the data received via the Modbus/Modbus Plus Registers (40265 and 40266) is reported in Volts in a 32 bit representation. The maximum value able to be physically metered by the relay is dependent upon the DPU2000/2000R and the ratio of the PT and CT's used. The CT and PT values are entered into the DPU through ECP/WinECP in the Configuration Settings Menu illustrated in Figure 5-11.

However, life as we know it, is not perfect. Many SCADA hosts are unable to interpret the 32-bit value received over a network. What can be done? ABB's answer is to provide for a fill-in-the-blanks method of scaling. This method takes the interpreted value and provides for DIVISOR SCALING (taking the MMI/network register values and dividing by a constant) or a RATIO SCALING (taking the MMI values/network register values, PT Ratios, CT Ratios and Full SCALE Metered Readings) and transform it into a raw scaled value depending on the minimum/maximum value the SCADA system can interpret. The SCADA system must then receive the mathematical value and perform its own internal calculations so that the data may be displayed to the operator which mirrors that displayed on the relay's front panel. The front panel interface and metering screens in ECP/WinECP display the values in primary units.

TYPICAL SCALING EXAMPLE

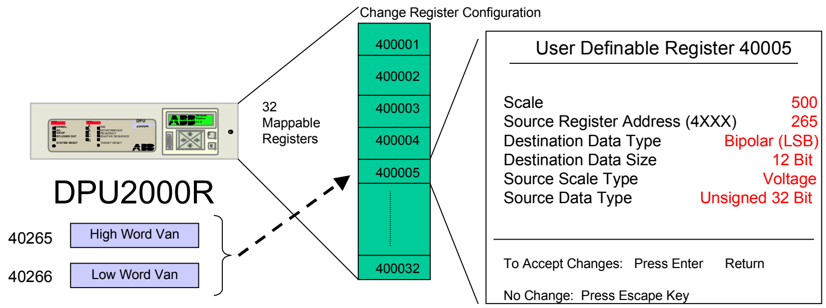


Figure 5-10. Register Scaling Methodology

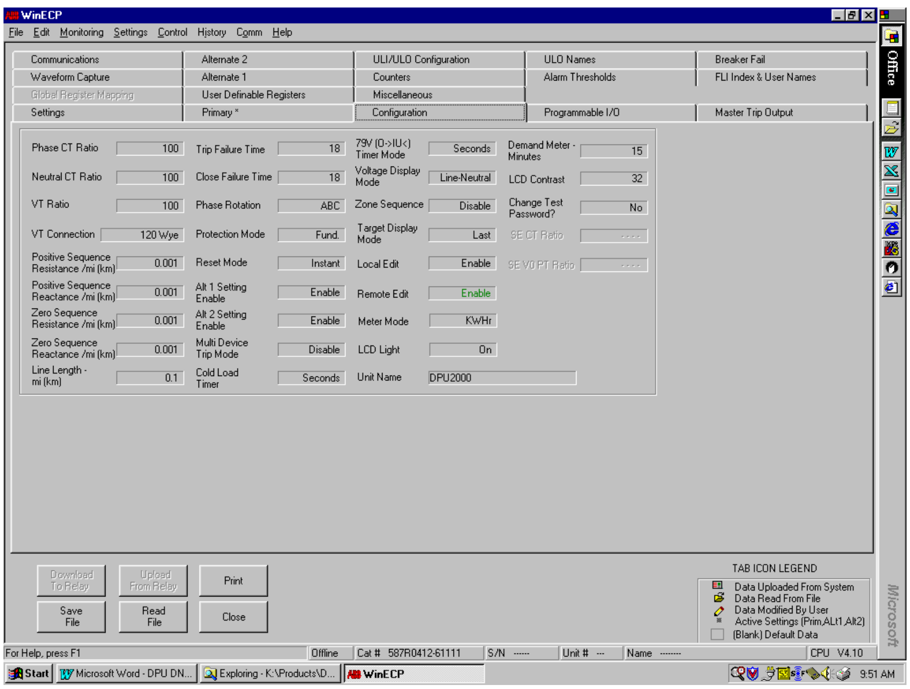


Figure 5-11. Change Configuration Settings Menu Illustrating CT and VT Configuration

ABB Data Type Definitions

All definitions within this guide shall be based upon bits or registers. Since the ABB concept of Register Scaling and Remapping is based upon the Modbus Protocol, it is essential to understand Modbus Protocol even when providing Register Scaling and Remapping for DNP, Modbus Plus or Standard Ten Byte Protocols.

For example, Modbus requires all register values to be reported in 16 bit portions (1 word). Two registers may be combined to form numeric representations for IEEE notations, long signed (a number from –2,147,483,648 to +2,147,483,647) or unsigned numbers (a number from 0 to +4,294,967,295). If a value is requested in the short form (a number from –128 to +127, or 0 to 255), 16 bits will be returned as a response to the host's request, but the number will be within the range of an 8 bit integer.

msb	lsb	msb	lsb
Word Data MSW		Word Data LSW	
Byte 0	Byte 1	Byte 2	Byte 3

Register Offsets of Signed/Unsigned Long

Word Data	
Byte 0	Byte 1

Register Offsets of Signed /Unsigned Integers

0	Byte Data
Byte 0	Byte 1

Register Offsets of Signed/Unsigned Short

ASCII Char	ASCII Char
Byte 0	Byte 1

Register Offsets of ASCII Characters

The DPU2000 and DPU2000R support the following data return types:

- Unsigned Short - 8 bits - 1 byte in 1 word - Range 0 to 255
- Signed Short - 8 bits - 1 byte in 1 word - Range -128 to +127
- Unsigned - 16 bits - 2 bytes in 1 word - Range 0 to + 65,535
- Signed - 16 bits - 2 bytes in 1 word - Range -32,768 to 32,767
- Unsigned Long - 32 bits - 4 bytes in 2 words - Range 0 to +4,294,967,295
- Signed Long - 32 bits - 4 bytes in 2 words - Range -2,147,483,648 to +2,147,483,647
- ASCII - 16 bits - 2 bytes in 1 word 2 characters per register (Reference Appendix A)

The tables contained within this document reference the above definitions and give the cadence of bytes or words as:

- MSB Most Significant Byte
- LSB Least Significant Byte
- MSW Most Significant Word
- LSW Least Significant Word
- msb Most Significant Bit
- lsb Least Significant Bit

Register Scaling Investigated

Within ECP and WinECP, the Change Settings Mode must be entered. A selection titled “Register Configuration” will appear to the operator. Within ECP, a screen as depicted in Figure 5-12 appears allowing configuration of any of the 32 available registers.

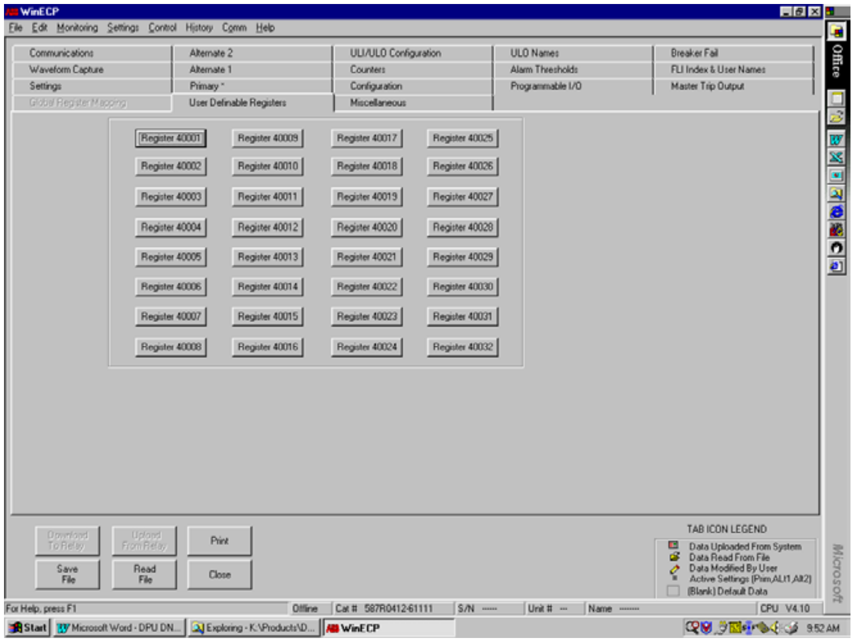


Figure 5-12. User Definable Register Configuration Screen

When using the ABB ECP Relay configuration program or the ABB WinECP Relay configuration program, the following menu items must be selected for each of the 32 mappable and scalable entries. The scaled register addresses are resident in Modbus addressing format from Register 40001 through 40032 defined for UDRI through 32. The following fields must be configured to perform scaling correctly:

Table 5-11. Register Scaling Queries

ECP QUERY	QUERY SELECTIONS
SCALING METHOD	UNIPOLAR
	NEGATIVE UNIPOLAR
	BIPOLAR
	OFFSET BIPOLAR
DESTINATION REGISTER JUSTIFICATION (Selectable with Scaling Method)	LSB (Least Significant Bit)
	MSB (Most Significant Bit)
DESTINATION REGISTER SIZE	16 Bits
	12 Bits
	8 Bits
	4 Bits
	2 Bit
SOURCE REGISTER ADDRESS	257 – XXXX Reference Table 5-13
SOURCE REGISTER TYPE	16 Bits Signed

	16 Bits Unsigned
	32 Bits Signed
	32 Bits Unsigned
SOURCE SCALE RANGE	1 – 65535
SOURCE SCALE TYPE	CURRENT
	VOLTAGE
	POWER
	NORMAL
	REMAINDER

Figure 5-13 illustrates the ECP configuration which appears before the operator upon configuration of each of the User Definable Registers (UDR). Using the computer's arrow keys to select the field, and depressing the space bar shall allow configuration of the fields within this popup menu screen.

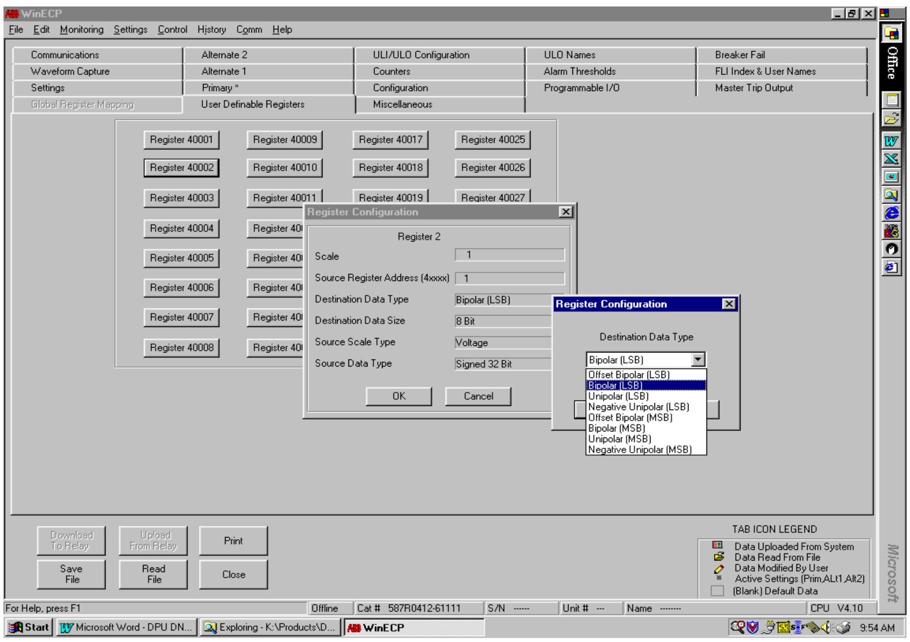


Figure 5-13. Popup Menu Configuration Screen for Data Type Register Selections

Scaling Option and Destination Register Length Options Explained

The source data may be scaled from a 32 bit or 16 bit value from the relay to a 16,12, 8, 4,or 1, bit scale of the value which is sent to a destination register. The scaling, minimum and maximum values sent to the destination register are listed in the table below.

Table 5-12. Min/Max Ranges for Scaled Numbers Depending Upon Scale Option and Bit Length Selected

SCALE OPTION	16 Bit Scale		12 Bit Scale		8 Bit Scale		4 Bit Scale		2 Bit Scale	
	min	max	min	max	min	max	min	max	min	max
Offset Bipolar	0	65535	0	4095	0	255	0	15	0	4
Bipolar	-32768	32767	-2048	2047	-128	127	-8	7	-1	2
Unipolar	0	65535	0	4095	0	255	0	15	0	4
Negative Unipolar	0	65535	0	4095	0	255	0	15	0	4

The above table lists the maximum and minimum values reported to a host in the scaled format. Figure 5-12 illustrates the value correlation between the scale bit minimum and maximum numbers reported to the host versus the unscaled values generated by the DPU2000 and 2000R.

Within following discussions of scaling parameters, it should be remembered that the bit scale shall be referred to as the quantity "N" which is used extensively for the final scaled value calculation. N shall be a value of 16,12,8,4, or 2, which corresponds to the Bit Scale type referred to in Table 5-12.

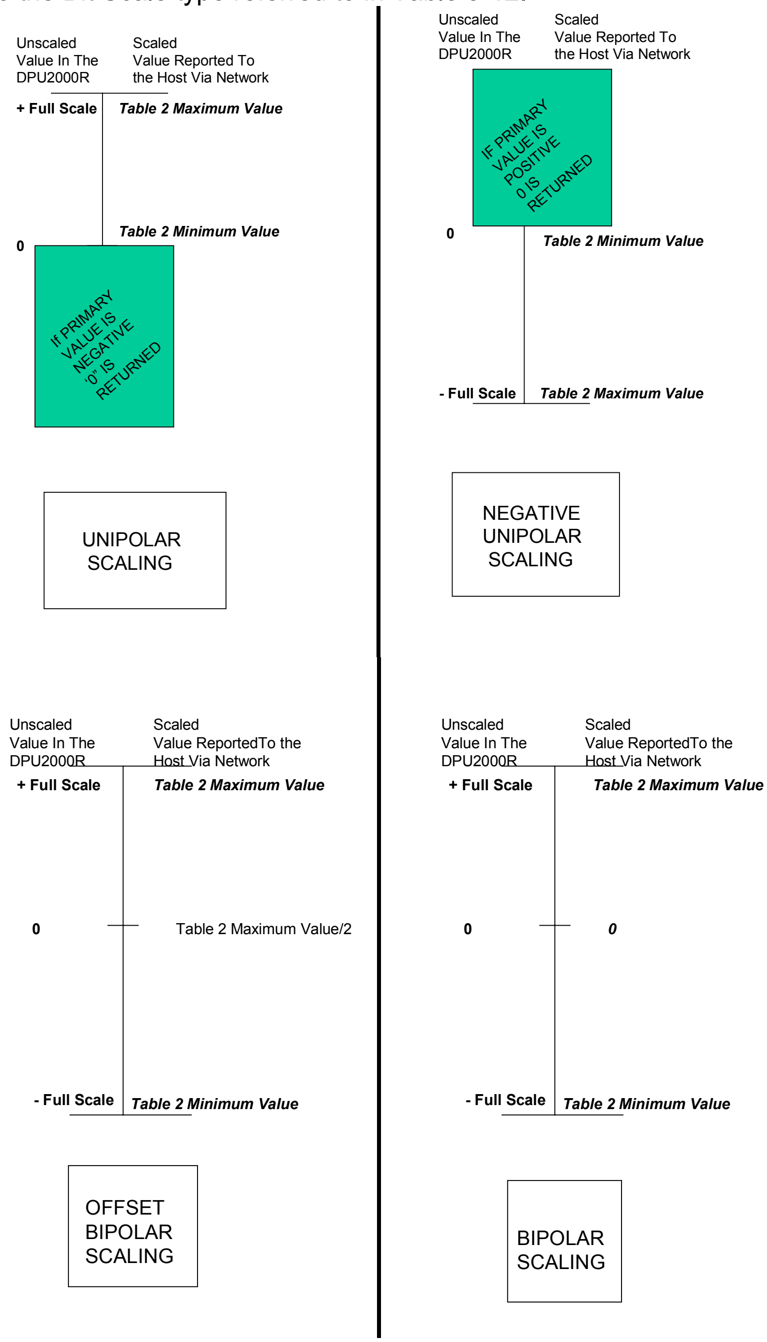


Figure 5-14. Relationship Between Scaled and Unscaled Formats for Offset Bipolar, Bipolar, Unipolar, and Negative Unipolar Scaling Selection in the DPU2000 and 2000R

If one were to mathematically compute the minimum and maximum values as described above in Table 5-12 and relate the values to the unscaled full scale + and full scale – values, the following equations would result from the analysis.

Data Type Definitions **Value Ranges**

EQUATION 1:
Offset Bipolar — (0 to $+2^{N}-1$) where 0 = -FS, $2^{N-1}-1$ = 0 and $2^{N}-1$ = +FS
EQUATION 2:
Bipolar — (-2^{N-1} to + $2^{N-1}-1$) where -2^{N-1} = -FS, 0 = 0 and $2^{N-1}-1$ = +FS
EQUATION 3:
Unipolar — (0 to $2^{N}-1$) where 0 = 0 and $2^{N}-1$ = +FS (If Primary Value is Negative 0 is returned)

EQUATION 4:
Negative Unipolar — (0 to $2^{N}-1$) where 0 = 0 and $2^{N}-1$ = -FS (If Primary Value is Positive, 0 is returned)

NOTE: for the above equations “N” = the amount of bits selected for scaling (i.e. 16, 12, 8, 4, 1)

Destination Register Length Justification Options Explained

Modbus has one definition, but its definition has been interpreted differently by various protocol implementers. This presents a special challenge to the automation engineer. For example, some host device implementations count the first address as address zero whereas other implementers count the first address as address 1 and internally shift the address to offset it by 1 to account for the baseline format.

Another interpretation has been that of most significant bit and least significant bit justification. Two selections are possible for the query DESTINATION BIT JUSTIFICATION. Selections as per Table 5-11 and Figure 5-13 are MSB and LSB. Figure 5-15 illustrates the bit definition and bit padding for the DESTINATION BIT JUSTIFICATION field selection and DESTINATION REGISTER SIZE query.

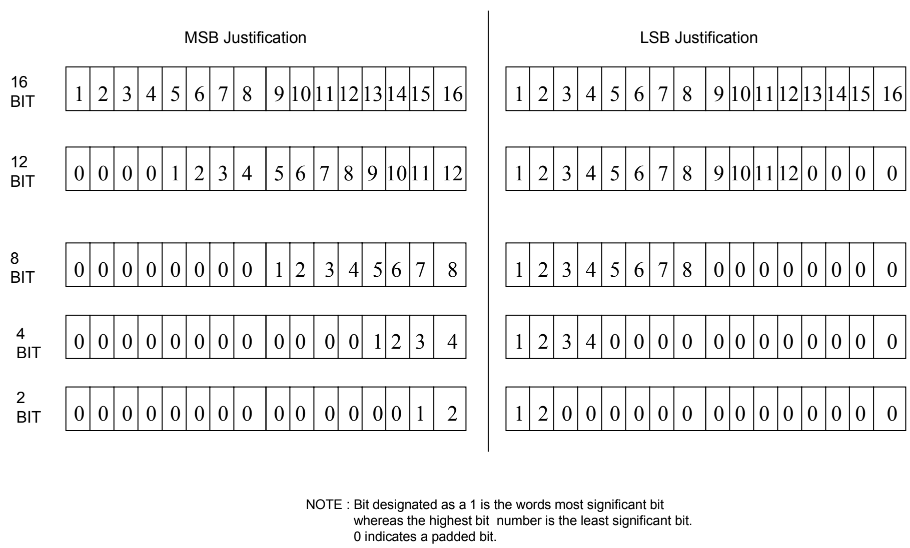


Figure 5-15. Bit Justification Notation

An investigation of Figure 5-15 illustrates that register justification shifts the data to the left of the right of the register. If the reported data for example is to be reported as 1 after scaling, the internal Modbus presentation to the host shall be 0001 hex in 12 bit MSB justification format and 0010 in the 12 bit LSB justification format. In both cases Bit 12 is set to represent the number 1, however the reported data to the host is shifted accordingly depending upon the hosts interpretation of the DNP 3.0 data.

Source Register Address and Source Register Type Explained

The Source register address is the root address number of any accepted and valid DPU2000 or DPU2000R address listed within this Automation Technical Guide. For example, if one wished to map the Voltage a to neutral value from its Modbus address at Register 265, the entry within the SOURCE REGISTER query would be 265. The leading 40 designation (or 4X as some refer to it as) is not required.

Within this Automation Technical Guide several designations are given for the source data type. Each value reported within a 4X Register has a separate designation. Example data type designations available for scaling and re-mapping are as follows:

Unsigned Short	Register	40257	Current Phase A	16 Bit Register Unsigned
Signed Short	Register	40335	Power Factor	16 Bit Register Signed
Unsigned Long	Registers	40265		
		40266	Voltage Phase A	32 Bit Double Register Unsigned
Signed Long	Registers	40283		
		40284	kWatts Phase A	32 Bit Double Register Signed

The query field may contain any of the above four register types for data transfer.

Table 5-13. Register Scaling and Remapping Quantities and Associated Indexes

ECP Source Register Address Entry	Item	Description
158	Phase CT Ratio	Unsigned 16 Bit
159	Neutral Ratio	Unsigned 16 Bit
160	PT Ratio	Unsigned 16 Bit
161	Power Fail Timestamp Year	Unsigned Integer 16 Bit 1900<=Range<= 2100
162	Power Fail Timestamp Month	Unsigned Integer 16 Bit 1<=Range<=12
163	Power Fail Timestamp Day	Unsigned Integer 16 Bit 1<=Range<=31
164	Power Fail Timestamp Hours	Unsigned Integer 16 Bit 0<=Range<=23
165	Power Fail Timestamp Minutes	Unsigned Integer 16 Bit 0<=Range<=59
166	Power Fail Timestamp Seconds	Unsigned Integer 16 Bit 0<=Range<=59
167	Power Fail Timestamp Hundredths of Seconds	Unsigned Integer 16 Bit 0<=Range<99
168	Power Fail Timestamp Fail Type	Unsigned Integer 16 Bit 1 = DC
169	Power Fail Timestamp Machine State	Unsigned Integer 16 Bit 0 = Circuit Breaker Closed 1 = Picked Up 2 = Circuit Breaker Tripping 3 = Circuit Breaker Failed to Open 4 = Circuit Breaker Open 6 = Circuit Breaker Open 7 = Circuit Breaker Failed to Open 8 = Control Switch Trip Fail 9 = Circuit Breaker State Unknown
170	Fast Status Bit 0 - 5 Division Code (Lsb) Bit 6 Reserved Bit 7 Reserved Bit 8 Reserved Bit 9 Unreported Operation	Unsigned 16 Bit 00 0101 = 07 HEX) Reserved Reserved Reserved 1 = Unreported Record

ECP Source Register Address Entry	Item	Description
	Record Bit 10 - 15 Reserved	 Reserved
171	Fast Status Bit 0 - 5 Reserved (Lsb) Bit 6 Reserved Bit 7 Reserved Bit 8 Reserved Bit 9 Reserved Bit 10 -15 Product ID (Msb)	Unsigned Integer 16 Bit Reserved Reserved Reserved Reserved Reserved 00 1110 = 0E HEX left justified
172	Last Comm Port Error	Unsigned Integer 0 = Modbus Plus (Type 6 or 7 Card Only DPU2000R) 1 = INCOM 2 = RS 232 3 = RS 485
173	Last Comm Error Command	Unsigned Integer/Word Byte Decode If Modbus or Modbus Plus, register contains Modbus Command. If INCOM or Standard Ten Byte, register contains Command + Subcommand in upper lower byte decode.
174	Last Comm Error Register Request	Unsigned Integer Last Requested Address on Comm error read/write request.
175	Last Comm Error Type	Unsigned Integer 1 = Invalid Password 2 = Checksum Error 3 = Block/Register Range Invalid 4 = Block/Register attempted to be accessed invalid 5 = Range of data attempted to be accessed invalid 6 = Invalid Data 7 = Settings being edited elsewhere in unit or remote edit disabled 8 = A write to one setting group attempted while actively editing another. 9 = Breaker State Invalid 10 = Data entered is below minimum value 11 = Data entered is above maximum allowed 12 = Data entered is out of step 32 = Reference Type or File Number Invalid 33 = Too many registers for Modbus Protocol 34 = Invalid Function Code 35 = Invalid Record Control
176	Control Mask If Write Error	Unsigned Integer Control Mask 1 Write Mask (MSW)
177	Control Mask If Write Error	Unsigned Integer Control Mask 1 Write Mask (LSW)
178	Control Mask If Write Error	Unsigned Integer Control Mask 2 Write Mask (MSW)
179	Control Mask If Write Error	Unsigned Integer Control Mask 2 Write Mask (LSW)
257	Ia Magnitude	Unsigned 16 Bit
258	Ia Angle	Unsigned 16 Bit
259	Ib Magnitude	Unsigned 16 Bit
260	Ib Angle	Unsigned 16 Bit
261	Ic Magnitude	Unsigned 16 Bit
262	Ic Angle	Unsigned 16 Bit

ECP Source Register Address Entry	Item	Description
263	In Magnitude	Unsigned 16 Bit
264	In Angle	Unsigned 16 Bit
265	Van Magnitude	Unsigned 32 Bit
267	Van Angle	Unsigned 16 Bit
268	Vbn Magnitude	Unsigned 32 Bit
270	Vbn Angle	Unsigned 16 Bit
271	Vcn Magnitude	Unsigned 32 Bit
273	Vcn Angle	Unsigned 16 Bit
274	Vab Magnitude	Unsigned 32 Bit
276	Vab Angle	Unsigned 16 Bit
277	Vbc Magnitude	Unsigned 32 Bit
279	Vbc Angle	Unsigned 16 Bit
280	Vca Magnitude	Unsigned 32 Bit
282	Vca Angle	Unsigned 16 Bit
283	Kwatts (Phase A)	Signed 32 Bit
285	Kwatts (Phase B)	Signed 32 Bit
287	Kwatts (Phase C)	Signed 32 Bit
289	Kwatts (Three Phase)	Signed 32 Bit
291	Kvars (Phase A)	Signed 32 Bit
293	Kvars (Phase B)	Signed 32 Bit
295	Kvars (Phase C)	Signed 32 Bit
297	KVArs (Three Phase)	Signed 32 Bit
299	Kwatt Hours (Phase A)	Signed 32 Bit
301	Kwatt Hours (Phase B)	Signed 32 Bit
303	Kwatt Hours (Phase C)	Signed 32 Bit
305	Kwatt Hours (Three Phase)	Signed 32 Bit
307	Kwatt Hours (Phase A)	Signed 32 Bit
309	Kwatt Hours (Phase B)	Signed 32 Bit
311	Kwatt Hours (Phase C)	Signed 32 Bit
313	KVArHrs 3 Phase	Signed 32 Bit
315	Zero Sequence Current Magnitude (Computed)	Unsigned 16 Bit
316	Zero Sequence Current Angle (Computed)	Unsigned 16 Bit
317	Positive Sequence Current Magnitude	Unsigned 16 Bit
318	Positive Sequence Current Angle	Unsigned 16 Bit
319	Negative Sequence Current Magnitude	Unsigned 16 Bit
320	Negative Sequence Current Angle	Unsigned 16 Bit
321	Positive Sequence Voltage Magnitude	Unsigned 32 Bit
323	Positive Sequence Voltage Angle	Unsigned 16 Bit
324	Negative Sequence Voltage Magnitude	Unsigned 32 Bit
326	Negative Sequence Angle	Unsigned 16 Bit
327	Frequency	Unsigned 16 Bit (Multiplier = 100)
328	Power Factor Bit 0 = PF Bit 1 = PF Bit 2 = PF Bit 3 = PF Bit 4 = PF Bit 5 = PF Bit 6 = PF	Unsigned 16 Bit Decode Power Factor (LSByte lsb) (X 100) Power Factor Power Factor Power Factor Power Factor Power Factor Power Factor (MS Bye msb)

ECP Source Register Address Entry	Item	Description
	Bit 7 = Sign Bit 8 = Lead/Lag Bit 9 = Reserved Bit 10 = Reserved Bit 11 = Reserved Bit 12 = Reserved Bit 13 = Reserved Bit 14 = Reserved Bit 15 = Reserved	0 = Positive 1 = Negative 0 = Leading 1 = Lagging Reserved Reserved Reserved Reserved Reserved Reserved Reserved
329	Zero Sequence Current Magnitude (Measured)	Unsigned 32 Bit
331	Zero Sequence Current Angle (Measured)	Unsigned 16 Bit
332	Zero Sequence Voltage Magnitude (Measured)	Unsigned 32 Bit
334	Zero Sequence Voltage Angle (Measured)	Unsigned 16 Bit
335	Power Factor Value	Signed 16 Bit (Multiplier = 100)
336	Power Factor Direction	Unsigned 16 Bit – 1 = Lagging 0 = Leading
337	Kvars 3 Phase	Unsigned 32 Bit
339	Fault Distance	Unsigned 16 Bit
340	Vbus to Vline Voltage Difference	Unsigned 32 Bit
342	Vbus to Vline Angle Difference	Unsigned 16 Bit
385	Demand Ia Magnitude	Unsigned 16 Bit
386	Demand Ib Magnitude	Unsigned 16 Bit
387	Demand Ic Magnitude	Unsigned 16 Bit
388	Demand In Magnitude	Unsigned 16 Bit
389	Demand Kwatts Phase A	Unsigned 32 Bit
391	Demand Kwatts Phase B	Unsigned 32 Bit
393	Demand Kwatts Phase C	Unsigned 32 Bit
395	Demand Kwatts 3 Phase	Unsigned 32 Bit
397	Demand Kvars Phase A	Unsigned 32 Bit
399	Demand Kvars Phase B	Unsigned 32 Bit
401	Demand Kvars Phase C	Unsigned 32 Bit
403	Demand Kvars 3 Phase	Unsigned 32 Bit
513	Peak Demand Current Phase A	Unsigned Integer 16 Bits
514	Peak Demand Current Phase A Year	Most Significant Byte 8 Bits 00<= Range<= 99
	Peak Demand Current Phase A Month	Least Significant Byte 8 Bits 00<= Range<= 12
515	Peak Demand Current Phase A Day	Most Significant Byte 8 Bits 00<= Range<= 31
	Peak Demand Current Phase A Hour	Most Significant Byte 8 Bits 00<= Range<= 23
516	Peak Demand Current Phase A Minute	Most Significant Byte 8 Bits 00<= Range<= 59
517	Peak Demand Current Phase B	Unsigned Integer 16 Bits
	Peak Demand Current Phase B Year	Most Significant Byte 8 Bits 00<= Range<= 99
518	Peak Demand Current Phase B Month	Least Significant Byte 8 Bits 00<= Range<= 12
	Peak Demand Current Phase B Day	Most Significant Byte 8 Bits 00<= Range<= 31
519	Peak Demand Current Phase B Hour	Least Significant Byte 8 Bits

ECP Source Register Address Entry	Item	Description
		00<= Range<= 23
	Peak Demand Current Phase B Minute	Most Significant Byte 8 Bits 00<= Range<= 59
521	Peak Demand Current Phase C	Unsigned Integer 16 Bits
522	Peak Demand Current Phase C Year	Most Significant Byte 8 Bits 00<= Range<= 99
	Peak Demand Current Phase C Month	Least Significant Byte 8 Bits 00<= Range<= 12
523	Peak Demand Current Phase C Day	Most Significant Byte 8 Bits 00<= Range<= 31
	Peak Demand Current Phase C Hour	Most Significant Byte 8 Bits 00<= Range<= 23
524	Peak Demand Current Phase C Minute	Most Significant Byte 8 Bits 00<= Range<= 59
525	Peak Demand Current Neutral	Unsigned Integer 16 Bits
526	Peak Demand Current Neutral Year	Most Significant Byte 8 Bits 00<= Range<= 99
	Peak Demand Current Neutral Month	Least Significant Byte 8 Bits 00<= Range<= 12
527	Peak Demand Current Neutral Day	Most Significant Byte 8 Bits 00<= Range<= 31
	Peak Demand Current Neutral Hour	Most Significant Byte 8 Bits 00<= Range<= 23
528	Peak Demand Current Neutral Minute	Most Significant Byte 8 Bits 00<= Range<= 59
529	Kwatt Hours Phase A Peak Demand	Signed 32 Bit
531	Peak Demand Kwatt Hours Phase A Year	Most Significant Byte 8 Bits 00<= Range<= 99
	Peak Demand Kwatt Hours Phase A Month	Least Significant Byte 8 Bits 00<= Range<= 12
532	Peak Demand Kwatt Hours Phase A Day	Most Significant Byte 8 Bits 00<= Range<= 31
	Peak Demand Kwatt Hours Phase A Hour	Most Significant Byte 8 Bits 00<= Range<= 23
533	Peak Demand Kwatt Hours Phase A Minute	Most Significant Byte 8 Bits 00<= Range<= 59
534	Kwatt Hours Phase B Peak Demand	Signed 32 Bit
536	Peak Demand Kwatt Hours Phase B Year	Most Significant Byte 8 Bits 00<= Range<= 99
	Peak Demand Kwatt Hours Phase B Month	Least Significant Byte 8 Bits 00<= Range<= 12
537	Peak Demand Kwatt Hours Phase B Day	Most Significant Byte 8 Bits 00<= Range<= 31
	Peak Demand Kwatt Hours Phase B Hour	Most Significant Byte 8 Bits 00<= Range<= 23
538	Peak Demand Kwatt Hours Phase B Minute	Most Significant Byte 8 Bits 00<= Range<= 59
539	Kwatt Hours Phase C Peak Demand	Signed 32 Bit
541	Peak Demand Kwatt Hours Phase C Year	Most Significant Byte 8 Bits 00<= Range<= 99
	Peak Demand Kwatt Hours Phase C Month	Least Significant Byte 8 Bits 00<= Range<= 12
542	Peak Demand Kwatt Hours Phase C	Most Significant Byte 8 Bits

ECP Source Register Address Entry	Item	Description
	Day	00<= Range<= 31
	Peak Demand Kwatt Hours Phase C Hour	Most Significant Byte 8 Bits 00<= Range<= 23
543	Peak Demand Kwatt Hours Phase C Minute	Most Significant Byte 8 Bits 00<= Range<= 59
544	Kwatt Hours 3 Phase Peak Demand	Signed 32 Bit
546	Peak Demand Kwatt Hours 3 Phase Year	Most Significant Byte 8 Bits 00<= Range<= 99
	Peak Demand Kwatt Hours 3 Phase Month	Least Significant Byte 8 Bits 00<= Range<= 12
547	Peak Demand Kwatt Hours 3 Phase Day	Most Significant Byte 8 Bits 00<= Range<= 31
	Peak Demand Kwatt Hours 3 Phase Hour	Most Significant Byte 8 Bits 00<= Range<= 23
548	Peak Demand Kwatt Hours 3 Phase Minute	Most Significant Byte 8 Bits 00<= Range<= 59
549	KVAR Hours Phase A Peak Demand	Signed 32 Bit
551	Peak Demand KVAR Hours Phase A Year	Most Significant Byte 8 Bits 00<= Range<= 99
	Peak Demand KVAR Hours Phase A Month	Least Significant Byte 8 Bits 00<= Range<= 12
552	Peak Demand KVAR Hours Phase A Day	Most Significant Byte 8 Bits 00<= Range<= 31
	Peak Demand KVAR Hours Phase A Hour	Most Significant Byte 8 Bits 00<= Range<= 23
553	Peak Demand KVAR Hours Phase A Minute	Most Significant Byte 8 Bits 00<= Range<= 59
554	KVAR Hours Phase B Peak Demand	Signed 32 Bit High Order Word MSW
556	Peak Demand KVAR Hours Phase B Year	Most Significant Byte 8 Bits 00<= Range<= 99
	Peak Demand KVAR Hours Phase B Month	Least Significant Byte 8 Bits 00<= Range<= 12
557	Peak Demand KVAR Hours Phase B Day	Most Significant Byte 8 Bits 00<= Range<= 31
	Peak Demand KVAR Hours Phase B Hour	Most Significant Byte 8 Bits 00<= Range<= 23
558	Peak Demand KVAR Hours Phase B Minute	Most Significant Byte 8 Bits 00<= Range<= 59
559	KVAR Hours Phase C Peak Demand	Signed 32 Bit
561	Peak Demand KVAR Hours Phase C Year	Most Significant Byte 8 Bits 00<= Range<= 99
	Peak Demand KVAR Hours Phase C Month	Least Significant Byte 8 Bits 00<= Range<= 12
562	Peak Demand KVAR Hours Phase C Day	Most Significant Byte 8 Bits 00<= Range<= 31
	Peak Demand KVAR Hours Phase C Hour	Most Significant Byte 8 Bits 00<= Range<= 23
563	Peak Demand KVAR Hours Phase C Minute	Most Significant Byte 8 Bits 00<= Range<= 59
564	KVAR Hours 3 Phase Peak Demand	Signed 32 Bit
566	Peak Demand KVAR Hours 3 Phase Year	Most Significant Byte 8 Bits 00<= Range<= 99
	Peak Demand KVAR Hours 3 Phase Month	Least Significant Byte 8 Bits 00<= Range<= 12

ECP Source Register Address Entry	Item	Description
567	Peak Demand KVAR Hours 3 Phase Day	Most Significant Byte 8 Bits 00<= Range<= 31
	Peak Demand KVAR Hours 3 Phase Hour	Most Significant Byte 8 Bits 00<= Range<= 23
568	Peak Demand KVAR Hours 3 Phase Minute	Most Significant Byte 8 Bits 00<= Range<= 59
641	Minimum Demand Current Phase A	Unsigned Integer 16 Bits
642	Minimum Demand Current Phase A Year	Most Significant Byte 8 Bits 00<= Range<= 99
	Minimum Demand Current Phase A Month	Least Significant Byte 8 Bits 00<= Range<= 12
643	Minimum Demand Current Phase A Day	Most Significant Byte 8 Bits 00<= Range<= 31
	Minimum Demand Current Phase A Hour	Most Significant Byte 8 Bits 00<= Range<= 23
644	Minimum Demand Current Phase A Minute	Most Significant Byte 8 Bits 00<= Range<= 59
645	Minimum Demand Current Phase B	Unsigned Integer 16 Bits
646	Minimum Demand Current Phase B Year	Most Significant Byte 8 Bits 00<= Range<= 99
	Minimum Demand Current Phase B Month	Least Significant Byte 8 Bits 00<= Range<= 12
647	Minimum Demand Current Phase B Day	Most Significant Byte 8 Bits 00<= Range<= 31
647	Minimum Demand Current Phase B Hour	Most Significant Byte 8 Bits 00<= Range<= 23
648	Minimum Demand Current Phase B Minute	Most Significant Byte 8 Bits 00<= Range<= 59
649	Minimum Demand Current Phase C	Unsigned Integer 16 Bits
650	Minimum Demand Current Phase C Year	Most Significant Byte 8 Bits 00<= Range<= 99
	Minimum Demand Current Phase C Month	Least Significant Byte 8 Bits 00<= Range<= 12
651	Minimum Demand Current Phase C Day	Most Significant Byte 8 Bits 00<= Range<= 31
	Minimum Demand Current Phase C Hour	Most Significant Byte 8 Bits 00<= Range<= 23
652	Minimum Demand Current Phase C Minute	Most Significant Byte 8 Bits 00<= Range<= 59
653	Minimum Demand Current Neutral	Unsigned Integer 16 Bits
654	Minimum Demand Current Neutral Year	Most Significant Byte 8 Bits 00<= Range<= 99
	Minimum Demand Current Neutral Month	Least Significant Byte 8 Bits 00<= Range<= 12
655	Minimum Demand Current Neutral Day	Most Significant Byte 8 Bits 00<= Range<= 31
	Minimum Demand Current Neutral Hour	Most Significant Byte 8 Bits 00<= Range<= 23
656	Minimum Demand Current Neutral Minute	Most Significant Byte 8 Bits 00<= Range<= 59
657	Kwatt Hours Phase A Minimum Demand	Signed 32 Bit
659	Minimum Demand Kwatt Hours Phase A Year	Most Significant Byte 8 Bits 00<= Range<= 99

ECP Source Register Address Entry	Item	Description
659	Minimum Demand Kwatt Hours Phase A Month	Least Significant Byte 8 Bits 00<= Range<= 12
	Minimum Demand Kwatt Hours Phase A Day	Most Significant Byte 8 Bits 00<= Range<= 31
660	Minimum Demand Kwatt Hours Phase A Hour	Most Significant Byte 8 Bits 00<= Range<= 23
661	Minimum Demand Kwatt Hours Phase A Minute	Most Significant Byte 8 Bits 00<= Range<= 59
662	Kwatt Hours Phase B Minimum Demand	Signed 32 Bit
664	Minimum Demand Kwatt Hours Phase B Year	Most Significant Byte 8 Bits 00<= Range<= 99
	Minimum Demand Kwatt Hours Phase B Month	Least Significant Byte 8 Bits 00<= Range<= 12
665	Minimum Demand Kwatt Hours Phase B Day	Most Significant Byte 8 Bits 00<= Range<= 31
	Minimum Demand Kwatt Hours Phase B Hour	Most Significant Byte 8 Bits 00<= Range<= 23
666	Minimum Demand Kwatt Hours Phase B Minute	Most Significant Byte 8 Bits 00<= Range<= 59
667	Kwatt Hours Phase C Minimum Demand	Signed 32 Bit High Order Word MSW
669	Minimum Demand Kwatt Hours Phase C Year	Most Significant Byte 8 Bits 00<= Range<= 99
	Minimum Demand Kwatt Hours Phase C Month	Least Significant Byte 8 Bits 00<= Range<= 12
670	Minimum Demand Kwatt Hours Phase C Day	Most Significant Byte 8 Bits 00<= Range<= 31
	Minimum Demand Kwatt Hours Phase C Hour	Most Significant Byte 8 Bits 00<= Range<= 23
671	Minimum Demand Kwatt Hours Phase C Minute	Most Significant Byte 8 Bits 00<= Range<= 59
672	Kwatt Hours 3 Phase Minimum Demand	Signed 32 Bit
674	Minimum Demand Kwatt Hours 3 Phase Year	Most Significant Byte 8 Bits 00<= Range<= 99
	Minimum Demand Kwatt Hours 3 Phase Month	Least Significant Byte 8 Bits 00<= Range<= 12
675	Minimum Demand Kwatt Hours 3 Phase Day	Most Significant Byte 8 Bits 00<= Range<= 31
	Minimum Demand Kwatt Hours 3 Phase Hour	Most Significant Byte 8 Bits 00<= Range<= 23
676	Minimum Demand Kwatt Hours 3 Phase Minute	Most Significant Byte 8 Bits 00<= Range<= 59
677	KVAR Hours Phase A Minimum Demand	Signed 32 Bit
679	Minimum Demand KVAR Hours Phase A Year	Most Significant Byte 8 Bits 00<= Range<= 99
	Minimum Demand KVAR Hours Phase A Month	Least Significant Byte 8 Bits 00<= Range<= 12
680	Minimum Demand KVAR Hours Phase A Day	Most Significant Byte 8 Bits 00<= Range<= 31
	Minimum Demand KVAR Hours Phase A Hour	Most Significant Byte 8 Bits 00<= Range<= 23

ECP Source Register Address Entry	Item	Description
681	Minimum Demand KVAR Hours Phase A Minute	Most Significant Byte 8 Bits 00<= Range<= 59
682	KVAR Hours Phase B Minimum Demand	Signed 32 Bit High Order Word MSW
684	Minimum Demand KVAR Hours Phase B Year	Most Significant Byte 8 Bits 00<= Range<= 99
	Minimum Demand KVAR Hours Phase B Month	Least Significant Byte 8 Bits 00<= Range<= 12
685	Minimum Demand KVAR Hours Phase B Day	Most Significant Byte 8 Bits 00<= Range<= 31
	Minimum Demand KVAR Hours Phase B Hour	Most Significant Byte 8 Bits 00<= Range<= 23
686	Minimum Demand KVAR Hours Phase B Minute	Most Significant Byte 8 Bits 00<= Range<= 59
687	KVAR Hours Phase C Minimum Demand	Signed 32 Bit
689	Minimum Demand KVAR Hours Phase C Year	Most Significant Byte 8 Bits 00<= Range<= 99
	Minimum Demand KVAR Hours Phase C Month	Least Significant Byte 8 Bits 00<= Range<= 12
690	Minimum Demand KVAR Hours Phase C Day	Most Significant Byte 8 Bits 00<= Range<= 31
	Minimum Demand KVAR Hours Phase C Hour	Most Significant Byte 8 Bits 00<= Range<= 23
691	Minimum Demand KVAR Hours Phase C Minute	Most Significant Byte 8 Bits 00<= Range<= 59
692	KVAR Hours 3 Phase Minimum Demand	Signed 32 Bit
694	Minimum Demand KVAR Hours 3 Phase Year	Most Significant Byte 8 Bits 00<= Range<= 99
	Minimum Demand KVAR Hours 3 Phase Month	Least Significant Byte 8 Bits 00<= Range<= 12
695	Minimum Demand KVAR Hours 3 Phase Day	Most Significant Byte 8 Bits 00<= Range<= 31
	Minimum Demand KVAR Hours 3 Phase Hour	Most Significant Byte 8 Bits 00<= Range<= 23
696	Minimum Demand KVAR Hours 3 Phase Minute	Most Significant Byte 8 Bits 00<= Range<= 59
769	Unreported Operation Counter	Unsigned Integer 16 Bits 0<=Range<=9999
770	Unreported Fault Counter	Unsigned Integer 16 Bits 0<=Range<= 9999
771	KSIA	Unsigned 16 Bit 0 – 9999 Kiloamps Symmetrical Ia – Current existing when breaker opened on Phase A.
772	KSIB 0 – 9999	Unsigned 16 Bits 0 – 9999 Kiloamps Symmetrical Ib – Current existing when breaker opened on Phase B.
773	KSIC 0 – 9999	Unsigned 16 Bits 0 – 9999 Kiloamps Symmetrical Ic – Current existing when breaker opened on Phase C.

ECP Source Register Address Entry	Item	Description
774	Overcurrent Trip Counter	Unsigned 16 Bits 0 – 9999
775	Total Breaker Operations	Unsigned 16 Bits 0 – 9999
776	Recloser Counter 1	Unsigned 16 Bits 0<=Range<=9999
777	Recoser Counter 2	Unsigned 16 Bits 0<=Range<= 9999
778	First Reclose Counter 0 – 9999	Unsigned 16 Bits 0 – 9999
779	Second Reclose Counter 0 – 9999	Unsigned 16 Bits 0 – 9999
780	Third Reclose Counter 0 – 9999	Unsigned 16 Bits 0 – 9999
781	Fourth Reclose Counter 0 – 9999	Unsigned 16 Bits 0 – 9999
897	Logical Output Bit 0 = 67N (lsb) Bit 1 = 67P Bit 2 = 59 Bit 3 = 51N Bit 4 = 51P Bit 5 = 50N-3 Bit 6 = 50P-3 Bit 7 = 50N-2 Bit 8 = 50P-2 Bit 9 = 50N-1 Bit 10 = 50P-1 Bit 11 = 46 Bit 12 = 27-1P Bit 13 = ALARM Bit 14 = TRIP Bit 15 = CLOSE	Unsigned Integer 16 Bits Neg Seq. Dir Ground Time Overcurrent Enabled Pos Seq. Dir Phase Time Overcurrent Enabled Overvoltage Element Enabled Time Ground Overcurrent Function Enabled Time Phase Overcurrent Function Enabled Level 3 Phase Inst. Overcurrent Function Enabled Level 3 Neutral Inst. Overcurrent Function Enabled Level 2 Phase Inst. Overcurrent Function Enabled Level 2 Neutral Inst. Overcurrent Function Enabled Level 1 Phase Inst. Overcurrent Function Enabled Level 1 Neutral Inst. Overcurrent Function Enabled Negative Sequence Time Overcurrent Function Enabled Single Phase Undervoltage Enabled Alarm DPU in Alarm DPU is Tripping Breaker DPU is Closing Breaker (msb)
898	Logical Output Bit 0 = 79CA Bit 1 = KSI Bit 2 = BFUA Bit 3 = NPDA Bit 4 = PPDA Bit 5 = BFA Bit 6 = 79LOA Bit 7 = PUA Bit 8 = 79DA Bit 9 = TCC Bit 10 = TCFA Bit 11 = PCTA Bit 12 = PBTA Bit 13 = PATA Bit 14 = 81R Bit 15 = 81S	Unsigned Integer 16 Bits Recloser Counter Alarm (1 or 2) (lsb) Kiloamp Summation Alarm Blown Fuse Alarm Neutral Current Demand Alarm Phase Current Demand Alarm Breaker Fail Alarm Recloser Lockout Alarm Pickup Alarm Recloser Disabled Alarm Tap Changer Cutoff Contact (Recloser Active) Trip Circuit Failure Alarm Phase C Target Alarm Phase B Target Alarm Phase A Target Alarm Over Frequency Restore Over Frequency Shed
899	Logical Output Bit 0 = TRIP B Bit 1 = TRIP A	Unsigned Integer 16 Bits Phase B Trip Alarm Phase A Trip Alarm

ECP Source Register Address Entry	Item	Description
	Bit 2 = 79 CA-2	Recloser Counter 2 Alarm
	Bit 3 = VarDA	Phase Kilovar Demand Alarm
	Bit 4 = 27-3P	Three Phase Undervoltage Alarm
	Bit 5 = 32NA	Neg. Sequence Zone Neutral Pickup Alarm
	Bit 6 = 32PA	Pos. Sequence Zone Phase Pickup Alarm
	Bit 7 = GRD-D	Ground Control Disabled Alarm
	Bit 8 = PH3-D	Phase Control Disabled Alarm
	Bit 9 = ZSC	Zone Sequence Coordination Enabled Indicator
	Bit 10 = STC	Settings Table Changed Alarm
	Bit 11 = 50-2D	Phase Inst.Overcurrent Disabled Energized Alarm
	Bit 12 = 50-1D	Phase Inst. Overcurrent Disabled Energized Alarm
	Bit 13 = OCTC	Overcurrent Trip Counter Energized Alarm
	Bit 14 = LPFA	Low Power Factor Alarm
	Bit 15 = HPFA	High Power Factor Alarm
900	Logical Output	Unsigned Integer 16 Bits
	Bit 0 = 81R1 **(L)**	Freq. Load Restoration Module 1 Activated
	Bit 1 = 81 S1 **(L)**	Freq. Load Shed Module 1 Activated
	Bit 2 = 67 N **(L)**	Neg. Sequence Supervised Dir. Time Overcurrent Trip Alm
	Bit 3 = 67 P **(L)**	Pos. Sequence Supervised Dir Time Overcurrent Trip Alm
	Bit 4 = 59 **(L)**	Single Phase Overcurrent Alarm
	Bit 5 = 51N **(L)**	Neutral Time Overcurrent Trip Alarm
	Bit 6 = 51P **(L)**	Phase Time Overcurrent Trip Alarm
	Bit 7 = 50N-3 **(L)**	Neutral Instantaneous Trip Seal In Level 3 Alarm
	Bit 8 = 50P-3 **(L)**	Phase Instantaneous Trip Seal In Level 3 Alarm
	Bit 9 = 50N-2 **(L)**	Neutral Instantaneous Trip Seal In Level 2 Alarm
	Bit 10 = 50P-2 **(L)**	Phase Instantaneous Trip Seal In Level 2 Alarm
	Bit 11 = 50N-1 **(L)**	Neutral Instantaneous Trip Seal In Level 1 Alarm
	Bit 12 = 50P-1 **(L)**	Phase Instantaneous Trip Seal In Level 1 Alarm
	Bit 13 = 46 **(L)**	Neg. Seq. Time Overcurrent Trip Seal In Alarm
	Bit 14 = 27-1 **(L)**	Single Phase Undervoltage Alarm
	Bit 15 = TRIPC	Phase C Trip Alarm
901	Logical Output	Unsigned Integer 16 Bits
	Bit 0 = NVArA	Negative 3 Phase Kilovar Alarm
	Bit 1 = PVAra	Positive 3 Phase Kilovar Alarm
	Bit 2 = ULO 9	User Logical Output 9 Energized
	Bit 3 = ULO 8	User Logical Output 8 Energized
	Bit 4 = ULO 7	User Logical Output 7 Energized
	Bit 5 = ULO 6	User Logical Output 6 Energized
	Bit 6 = ULO 5	User Logical Output 5 Energized
	Bit 7 = ULO 4	User Logical Output 4 Energized
	Bit 8 = ULO 3	User Logical Output 3 Energized
	Bit 9 = ULO 2	User Logical Output 2 Energized
	Bit 10 = ULO 1	User Logical Output 1 Energized
	Bit 11 = TRIP C **(L)**	Phase C Trip Alarm
	Bit 12 = TRIP B **(L)**	Phase B Trip Alarm
	Bit 13 = TRIP A **(L)**	Phase A Trip Alarm
	Bit 14 = 27-3P **(L)**	Phase Undervoltage Alarm
	Bit 15 = 81O-1	Overfrequency Alarm Module 1 Setting Exceeded Alarm
902	Logical Output	Unsigned Integer 16 Bits
	Bit 0 = LOADA (msb)	Load Current Alarm
	Bit 1 = 81O1	Overfrequency Alarm Module 1 Setting Exceeded Alarm
	Bit 2 = 81O2	Overfrequency Alarm Module 2 Setting Exceeded

ECP Source Register Address Entry	Item	Description
		Alarm
	Bit 3 = 81S2	Frequency Shed Module 2 Setting Exceeded Alarm
	Bit 4 = 81R2	Frequency Restore Module 2 Setting Exceeded Alarm
	Bit 5 = 81O2	Overfrequency Alarm Module 2 Setting Exceeded Alarm
	Bit 6 = 81S2	Frequency Shed Module 2 Setting Exceeded Alarm
	Bit 7 = 81R2	Frequency Restore Module 2 Setting Exceeded Alarm
	Bit 8 = CLTA	Cold Load Timer Alarm
	Bit 9 = WATT 1	Positive Watt Alarm 1
	Bit 10 = WATT 2	Positive Watt Alarm 2
	Bit 11 = 79CA **(L)**	Recloser Counter Exceeded Alarm
	Bit 12 = 79CA-2 **(L)**	Recloser Counter 2 Exceeded Alarm
	Bit 13 = SEF **(L)**	Sensitive Earth Fault Alarm
	Bit 14 = SEF	Sensitive Earth Fault Alarm
	Bit 15 = BZA W/O SEF (lsb)	Bus Zone Alarm Without Sensitive Earth Fault
903	Logical Output	Unsigned Integer 16 Bits
	Bit 0 = BFT	Breaker Failure Trip Alarm
	Bit 1 = ReTrip	Breaker Failure Retrip Alarm
	Bit 2 = BFT **(L)**	Breaker Failure Trip Alarm
	Bit 3 = ReTrip **(L)**	Breaker Failure Retrip Alarm
	Bit 4 = 32P-2	Phase Power Directional Alarm
	Bit 5 = 32N-2	Neutral Power Directional Alarm
	Bit 6 = 32P-2 **(L)**	Phase Power Directional Alarm
	Bit 7 = 32N-2 **(L)**	Neutral Power Directional Alarm
	Bit 8 = BFA **(L)**	Breaker Failure Alarm
	Bit 9 = 25 **(L)**	Synch Check Condition Sensed
	Bit 10 = 25	Synch Check Condition Sensed
	Bit 11 = SBA	Slow Breaker Alarm
	Bit 12 = 79V	Block Voltage On Reclose Fault
	Bit 13 = Rclin	Recloser In
	Bit 14 = Reserved	Reserved
	Bit 15 = Reserved	Reserved
905	Logical Input	Unsigned Integer 16 Bits
	Bit 0 = 52a	Breaker Status 1 = Closed 0 = Open
	Bit 1 = 52b	Breaker Status Inverted
	Bit 2 = 43a	Reclosing Function Status
	Bit 3 = PH3	Phase Control Enabled
	Bit 4 = GRD	51N/50N-1/50N-2 Enabled
	Bit 5 = SCC	Spring Charging Contact Input Enabled
	Bit 6 = 79s	Single Shot Reclosing Enabled
	Bit 7 = 79m	Multiple Shot Reclosing Enabled
	Bit 8 = TCM	Trip Coil Monitoring Enabled
	Bit 9 = 50-1	50P-1 and 50N-1 Inst. Overcurrent Protection Enabled
	Bit 10 = 50-2	50P-2 and 50P-2 Inst. Overcurrent Protection Enabled
	Bit 11 = 50-3	50P-3 and 50P-3 Inst. Overcurrent Protection Enabled
	Bit 12 = ALT1	Alternate Settings 1 Enabled
	Bit 13 = ALT2	Alternate Settings 2 Enabled
	Bit 14 = ECI2	Event Capture 2 Enabled
	Bit 15 = ECI1	Event Capture 1 Enabled
906	Logical Input	Unsigned Integer 16 Bits
	Bit 0 = WCI	Waveform Capture Initiate Enabled

ECP Source Register Address Entry	Item	Description
	Bit 1 = ZSC Bit 2 = OPEN Bit 3 = CLOSE Bit 4 = 46 Bit 5 = 67P Bit 6 = 67N Bit 7 = ULI 1 Bit 8 = ULI 2 Bit 9 = ULI 3 Bit 10 = ULI 4 Bit 11 = ULI 5 Bit 12 = ULI 6 Bit 13 = ULI 7 Bit 14 = ULI 8 Bit 15 = ULI 9	Zone Sequence Coordination Enabled Control Switch to Open Breaker Enabled Control Switch to Close Breaker Enabled Negative Seq. Time Overcurrent Enabled Positive Seq. Dir. Controlled Phase Overcurrent Enabled Negative Seq. Dir. Controlled Phase Overcurrent Enabled User Logical 1 Bit Enabled User Logical 2 Bit Enabled User Logical 3 Bit Enabled User Logical 4 Bit Enabled User Logical 5 Bit Enabled User Logical 6 Bit Enabled User Logical 7 Bit Enabled User Logical 8 Bit Enabled User Logical 9 Bit Enabled
907	Logical Input Bit 0 = CRI Bit 1 = ARCI Bit 2 = TARC Bit 3 = SEFTC Bit 4 = EXTBFI Bit 5 = BFI Bit 6 = UDI Bit 7 = 25 Bit 8 = 25By Bit 9 = LOCAL Bit 10 = TGT Bit 11 = SIA Bit 12 = Reserved Bit 13 = Reserved Bit 14 = Reserved Bit 15 = Reserved	Unsigned Integer 16 Bits Reclose and Overcurrent Counters Cleared Automatic Reclose Inhibited Trip and Automatic Reclose and Intiated Sensitive Earth Fault Torque Control External Starter Input Energized Breaker Fail Trip Logic Initated User Display Interface Message Sent to Device Synch Check Enabled Synch Check Bypassed Local Control Only when = 1 Target Reset Seal In Alarm Reserved Reserved Reserved Reserved
908	Logical Input Reserved	Unsigned Integer 16 Bits Reserved
909	Logical Input Reserved	Unsigned Integer 16 Bits Reserved
910	Logical Input Reserved	Unsigned Integer 16 Bits Reserved
911	Logical Input Reserved	Unsigned Integer 16 Bits Reserved
912	Logical Input Reserved	Unsigned Integer 16 Bits Reserved
913	Bit 0 = Reserved Bit 1 = Reserved Bit 2 = Reserved Bit 3 = Reserved Bit 4 = Reserved Bit 5 = Reserved Bit 6 = Reserved Bit 7 = Reserved Bit 8 = OUT 6 Bit 9 = OUT 5 Bit 10 = OUT 4	Unsigned Integer 16 Bits

ECP Source Register Address Entry	Item	Description
	Bit 11 = OUT 3 Bit 12 = OUT 2 Bit 13 = OUT 1 Bit 14 = CLOSE Bit 15 = TRIP	
914	Bit 0 = Reserved Bit 1 = Reserved Bit 2 = Reserved Bit 3 = Reserved Bit 4 = Reserved Bit 5 = IN 8 Bit 6 = IN 7 Bit 7 = IN 6 Bit 8 = IN 5 Bit 9 = IN 4 Bit 10 = IN 3 Bit 11 = IN 2 Bit 12 = IN 1 Bit 13 = Reserved Bit 14 = Reserved Bit 15 = Reserved	Unsigned Integer 16 Bits
915	Forced Bits Bit 0 = Reserved Bit 1 = Reserved Bit 2 = Reserved Bit 3 = Reserved Bit 4 = Reserved Bit 5 = IN 8 Bit 6 = IN 7 Bit 7 = IN 6 Bit 8 = IN 5 Bit 9 = IN 4 Bit 10 = IN 3 Bit 11 = IN 2 Bit 12 = IN 1 Bit 13 = Reserved Bit 14 = Reserved Bit 15 = Reserved	Unsigned Integer 16 Bits
916	Forced Bit State Bit 0 = Reserved Bit 1 = Reserved Bit 2 = Reserved Bit 3 = Reserved Bit 4 = Reserved Bit 5 = IN 8 Bit 6 = IN 7 Bit 7 = IN 6 Bit 8 = IN 5 Bit 9 = IN 4 Bit 10 = IN 3 Bit 11 = IN 2 Bit 12 = IN 1 Bit 13 = Reserved Bit 14 = Reserved Bit 15 = Reserved	Unsigned Integer 16 Bits
917	Forced Bit Status	Unsigned Integer 16 Bits

ECP Source Register Address Entry	Item	Description
	Bit 0 = Reserved Bit 1 = Reserved Bit 2 = Reserved Bit 3 = Reserved Bit 4 = Reserved Bit 5 = Reserved Bit 6 = Reserved Bit 7 = Reserved Bit 8 = OUT 6 Bit 9 = OUT 5 Bit 10 = OUT 4 Bit 11 = OUT 3 Bit 12 = OUT 2 Bit 13 = OUT 1 Bit 14 = CLOSE Bit 15 = TRIP	
918	Output Select Status Bit 0 = Reserved Bit 1 = Reserved Bit 2 = Reserved Bit 3 = Reserved Bit 4 = Reserved Bit 5 = Reserved Bit 6 = Reserved Bit 7 = Reserved Bit 8 = OUT 6 Bit 9 = OUT 5 Bit 10 = OUT 4 Bit 11 = OUT 3 Bit 12 = OUT 2 Bit 13 = OUT 1 Bit 14 = CLOSE Bit 15 = TRIP	Unsigned Integer 16 Bits
919	Logical Input Select Status Bit 0 = FLI 32 Bit 1 = FLI 31 Bit 2 = FLI 30 Bit 3 = FLI 29 Bit 4 = FLI 28 Bit 5 = FLI 27 Bit 6 = FLI 26 Bit 7 = FLI 25 Bit 8 = FLI 24 Bit 9 = FLI 23 Bit 10 = FLI 22 Bit 11 = FLI 21 Bit 12 = FLI 20 Bit 13 = FLI 19 Bit 14 = FLI 18 Bit 15 = FLI 17	Unsigned Integer 16 Bits
920	Logical Input Select Status Bit 0 = FLI 16 Bit 1 = FLI 15 Bit 2 = FLI 14 Bit 3 = FLI 13 Bit 4 = FLI 12	Unsigned Integer 16 Bits

ECP Source Register Address Entry	Item	Description
	Bit 5 = FLI 11 Bit 6 = FLI 10 Bit 7 = FLI 9 Bit 8 = FLI 8 Bit 9 = FLI 7 Bit 10 = FLI 6 Bit 11 = FLI 5 Bit 12 = FLI 4 Bit 13 = FLI 3 Bit 14 = FLI 2 Bit 15 = FLI 1	
921	Logical Input Force Status Bit 0 = FLI 32 Bit 1 = FLI 31 Bit 2 = FLI 30 Bit 3 = FLI 29 Bit 4 = FLI 28 Bit 5 = FLI 27 Bit 6 = FLI 26 Bit 7 = FLI 25 Bit 8 = FLI 24 Bit 9 = FLI 23 Bit 10 = FLI 22 Bit 11 = FLI 21 Bit 12 = FLI 20 Bit 13 = FLI 19 Bit 14 = FLI 18 Bit 15 = FLI 17	Unsigned Integer 16 Bits
922	Logical Input Force Status Bit 0 = FLI 16 Bit 1 = FLI 15 Bit 2 = FLI 14 Bit 3 = FLI 13 Bit 4 = FLI 12 Bit 5 = FLI 11 Bit 6 = FLI 10 Bit 7 = FLI 9 Bit 8 = FLI 8 Bit 9 = FLI 7 Bit 10 = FLI 6 Bit 11 = FLI 5 Bit 12 = FLI 4 Bit 13 = FLI 3 Bit 14 = FLI 2 Bit 15 = FLI 1	Unsigned Integer 16 Bits

Source Scale Range and Source Scale Type Selections Explained

Scaling is determined by a simple formula depending upon the SCALE TYPE, FULL SCALE/SCALE FACTOR, SCALING OPTION, and DESTINATION LENGTH, values.

Most quantities defined within Table 5-13 is classified by being a Current Value, Voltage Value, or Power Value. If one of these aforementioned scale types are selected, the value in the FULL SCALE/SCALE FACTOR field is designated as the maximum value of the unscaled source value. If the source value is above the configured FULL SCALE/SCALE FACTOR field value, the maximum value (as shown in Table 5-12) will be reported as the destination register scaled value.

The values within the relay may be scaled by an integer factor if a normal or remainder scaling type is selected. If one of aforementioned selections are within the FULL SCALE/SCALE FACTOR selection field then the selection is automatically the scale factor.

The allowable values for the FULL SCALE/SCALE FACTOR field are from 1 to 65535. This is equivalent to the secondary quantities and the relationship to the primary quantities being scaled as per said formulas below. (which should be familiar to those of you who are "old" transducer engineers.)

If one of the voltage, current, or power SCALE TYPES are selected, then one or more of the following CT /PT ratio values must be known to compute the destination scaled value. The quantities which must be known to compute the equations for scaling are:

158:	Unsigned Short	Phase CT (CT)
159:	Unsigned Short	Neutral CT Ratio (CT)
160:	Unsigned Short	PT Ratio (PT)

The values may be viewed from the ECP/WinECP program as illustrated in Figure 5-11.

IF OFFSET BIPOLAR CURRENT IS SELECTED

EQUATION 5:

Register Value = $(2^{N-1} * \text{Source Value} / [FS * CT\ Ratio]) + 2^{N-1} - 1$

IF OFFSET BIPOLAR VOLTAGE IS SELECTED

EQUATION 6:

Register Value = $(2^{N-1} * \text{Source Value} / [FS * PT\ Ratio]) + 2^{N-1} - 1$

IF OFFSET BIPOLAR POWER IS SELECTED

EQUATION 7:

Register Value = $(2^{N-1} * \text{Source Value} / [FS * CT\ Ratio * PT\ Ratio]) + 2^{N-1} - 1$

IF NORMAL SCALING IS SELECTED

EQUATION 8:

Register Value = Source Value / Scale (NOTE : INTEGER DIVISION OCCURS, USE REMAINDER SCALING TO GET THE MODULUS OF THE DIVISION)

IF REMAINDER SCALING IS SELECTED

EQUATION 9:

Register Value = Remainder of [Source Value/Scale] (commonly referred to as the modulus function).

IF BIPOLAR CURRENT IS SELECTED

EQUATION 10:

Register Value = $(2^{N-1} * \text{Source Value} / [FS * CT\ Ratio])$

IF BIPOLAR VOLTAGE IS SELECTED

EQUATION 11:

Register Value = $(2^{N-1} * \text{Source Value} / [FS * PT\ Ratio])$

IF BIPOLAR POWER IS SELECTED

EQUATION 12:

Register Value = $(2^{N-1} * \text{Source Value} / [FS * CT\ Ratio * PT\ Ratio])$

One should notice that if equations 5, 6, 7, 10, 11, or 12 are used, the SCALE entry shown in Figure 5-13, refers to the full scale value referenced in the equations. If equations 8 or 9 are used, the SCALE entry shown in Figure 5-13 refers to the Scale divisor denominator as referenced.

DPU2000 and 2000R User Definable Register Defaults

The DPU2000 and 2000R contains User Definable Register default mappings as shown in Table 5-14 below. It should be noted that the register shall saturate at the maximum values computed and shown in Table 5-13. The maximum saturation value can be computed to be 2N-1 where N is the register size in bits.

Table 5-14. Default Scaling and Remapping Register Assignments

User Definable Register	Register Type (Bits)	Start Register (Bits/Type)	FS or Scale (Type)	Description
1: INDEX 97	Unipolar (16,LSB)	129 (16/Unsigned)	1 (Normal)	Relay Status
2: INDEX 98	Offset Bipolar (12,LSB)	257 (16/Unsigned)	10 (Current)	Load Current A
3: INDEX 99	Offset Bipolar (12,LSB)	259 (16/Unsigned)	10 (Current)	Load Current B
4: INDEX 100	Offset Bipolar (12,LSB)	261 (16/Unsigned)	10 (Current)	Load Current C
5: INDEX 101	Offset Bipolar (12,LSB)	265 (32/Unsigned)	150 (Voltage)	Voltage VAN
6: INDEX 102	Offset Bipolar (12,LSB)	268 (32/Unsigned)	150 (Voltage)	Voltage VBN
7: INDEX 103	Offset Bipolar (12,LSB)	271 (32/Unsigned)	150 (Voltage)	Voltage VCN
8: INDEX 104	Offset Bipolar (12,LSB)	289 (32/Signed)	3000 (Power)	3 Phase Watts
9: INDEX 105	Offset Bipolar (12,LSB)	297 (32/Signed)	3000 (Power)	3 Phase VARs
10: INDEX 106	Offset Bipolar (12,LSB)	283 (32/Signed)	1000 (Power)	Phase A Watts
11: INDEX 107	Offset Bipolar (12,LSB)	285 (32/Signed)	1000 (Power)	Phase B Watts
12: INDEX 108	Offset Bipolar (12,LSB)	287 (32/Signed)	1000 (Power)	Phase C Watts
13: INDEX 109	Offset Bipolar (12,LSB)	291 (32/Signed)	1000 (Power)	Phase A VARs
14: INDEX 110	Offset Bipolar (12,LSB)	293 (32/Signed)	1000 (Power)	Phase B VARs
15: INDEX111	Offset Bipolar (12,LSB)	295 (32/Signed)	1000 (Power)	Phase C VARs
16: INDEX 112	Unipolar (16,LSB)	158 (16/Unsigned)	1 (Normal)	Phase CT Ratio
17: INDEX 113	Unipolar (16,LSB)	160 (16/Unsigned)	1 (Normal)	PT Ratio
18: INDEX 114	Offset Bipolar (12,LSB)	263 (16/Unsigned)	10 (Current)	Load Current N
19: INDEX 115	Unipolar (16,LSB)	305 (32/Signed)	10000 (Normal)	+3 Phase kWatthours (high)
20: INDEX 116	Unipolar (16,LSB)	305 (32/Signed)	10000 (Remainder)	+3 Phase kWatthours (Low)
21: INDEX 117	Neg Unipolar (16,LSB)	305 (32/Signed)	10000 (Normal)	-3 Phase kWatthours (High)

22: INDEX 118	Neg Unipolar (16,LSB)	305 (32/Signed)	10000 (Remainder)	-3 Phase kWatthours (Low)
23: INDEX 119	Unipolar (16,LSB)	313 (32/Signed)	10000 (Normal)	+3 Phase kVARhours (High)
24: INDEX 120	Unipolar (16,LSB)	313 (32/Signed)	10000 (Remainder)	+3 Phase kVARhours (Low)
25: INDEX 121	Neg Unipolar (16,LSB)	313 (32/Signed)	10000 (Normal)	-3 Phase kVARhours (High)
26: INDEX 122	Neg Unipolar (16,LSB)	313 (32/Signed)	10000 (Remainder)	-3 Phase kVARhours (Low)
27: INDEX 123	Unipolar (16,LSB)	327 (16/Unsigned)	1 (Normal)	System Frequency
28: INDEX 124	Undefined	Undefined	Undefined	Undefined
29: INDEX 125	Undefined	Undefined	Undefined	Undefined
30: INDEX 126	Undefined	Undefined	Undefined	Undefined
31: INDEX 127	Undefined	Undefined	Undefined	Undefined
32: INDEX 128	Undefined	Undefined	Undefined	Undefined

An explanation of some of the above default mappings are offered as a guide to understanding the scaling methodology implementation. Figure 5-16 illustrates the scaling procedure for Indicies 98 through 100. Registers 257, 259, and 261 (as detailed in Table 5-14) contain the MMI reported current values to be remapped and re-scaled to 12 bit Offset Bipolar Values.

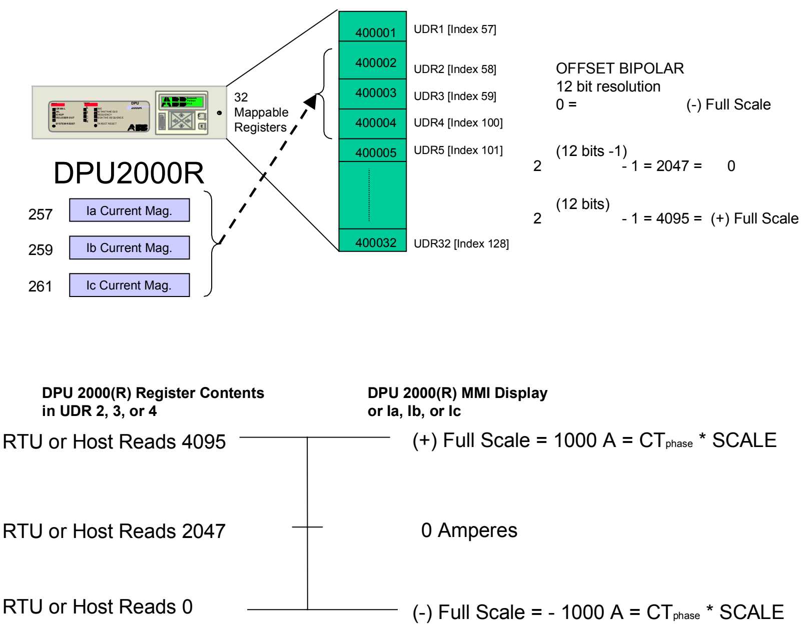


Figure 5-16. Register Scaling Default Example

The mathematics to determine the reported value to the host is illustrated in Figure 5-17 and using Equation 5 above using offset bipolar scaling.

Full Scale = **10**
CT Ratio (Current Calculation) = **100:1** (as per the default screen shown in Figure 5-17)
Source Value Location = **259** [neglect the leading 4] **16 Bit Value Signed**
Calculate the 12 bit scaled reading when the DPU2000R indicates 5A for Ia.

$$((2^{(12\ bits\ -1)} * 5Amps\ Primary)/(10 * 100)) + (2^{(12\ bits\ -1)} - 1) = 3071\ counts.$$

Thus Equation 7 illustrates that a current of 5A displayed on the MMI shall indicate a count of 3071 reported to the SCADA Host when UDR2 [Index 98] is read. The SCADA host shall then interpret it and display it on its host screen as 5 A.

Perhaps another example shall suffice. The DPU2000/2000R also meters voltages. The next example illustrates the scaling which occurs for the default registers 40005, 40006, and 40007. Figure 5-11 shows the scale algorithm application for scaling to an Offset Bipolar 12 bit number.

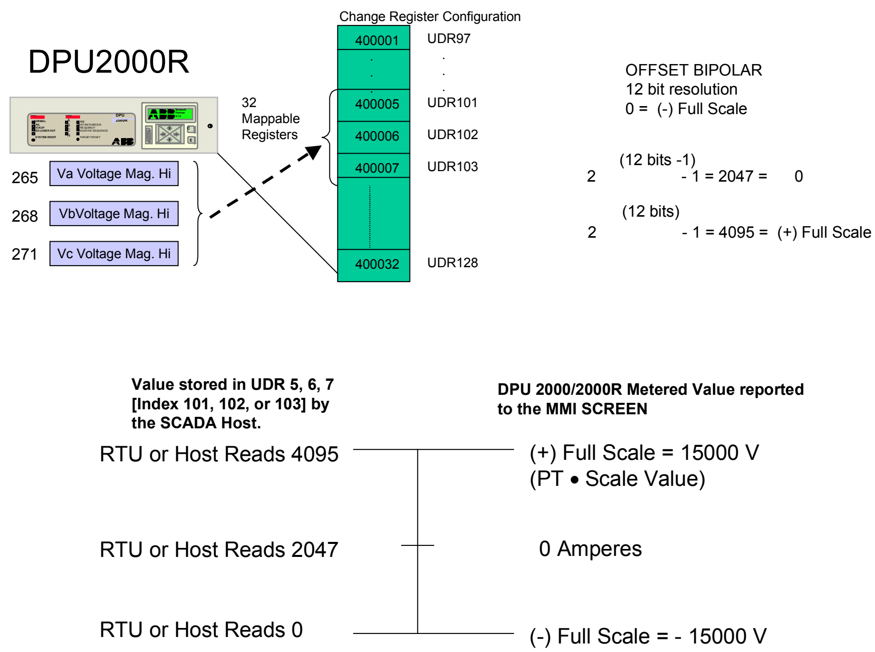


Figure 5-17. Scaling Example for Voltage Mapped Registers

The values used for this example are:

Full Scale = **500**
PT Ratio (Voltage Calculation) = **100:1**
Source Value Location = **265** [neglect the leading 4] **32 Bit Value Unsigned**

Using Equation 6 the following results when calculating the numeric value reported to the SCADA host when register 40005, 40006 or 40007 is accessed.

$$((2^{(12\text{ bits }-1)} * 11884\text{Volts Primary})/(500 * 100)) + (2^{(12\text{ bits }-1)} - 1) = 3699.562\text{ counts}$$

$$1622.562 \quad + \quad 2047 = 3699$$

When the front panel MMI reads 11884 V, a value of 3699 is reported to the SCADA host.

One final example is illustrated for transferring values from different areas in the protective relay to the default table. Such values as Relay status (located in Register 40129 and transferred to 40001), Phase CT ratio (used by the SCADA host to provide for scale conversion located in Register 40158 and transferred to 40016), PT ratio (used by the SCADA host to provide for scale conversion in Register 40160 and transferred to 40017), and system frequency (located in Register 40027).

The transfer of registers to a block is accomplished by using equation 8 and providing a scale factor of 1. Thus the contents of the source register are divided by 1 and transferred to the User Definable Register Table. It is important that the scale type of 16 be used to ensure the transfer is not scaled.

Section 6 - DNP 3.0 Communication Troubleshooting

DNP 3.0 is a very involved protocol. Many individuals when troubleshooting the network lack the appropriate tools to view the communication strings passed between the host and the DPU2000/2000R/1500R. The most common issues, which arise when commissioning a DNP 3.0 network, are as follows:

1. Improper host/DPU2000 or DPU2000R parameterization. Most individuals when setting the mode parameters select the defaults. Perhaps the most trouble is that the host has parameters for response in excess of those expected of the IED. The most critical parameter causing communication malfunction is device timeout (Parameter 4). Other issues are that all data is enabled via Groups. It is recommended that the device timeout parameter be maximized until communication occurs between the host. The value can be decreased later to efficiently tune communication speeds. Decrease Parameters 5,6,7, and 8 to 0,0,0,0. Thus enabling Group 0. Thus the minimum of data is transmitted upon a class or event request, thus allowing for network tuning.
2. Improper RS232 or RS485 cabling. Refer to Section 3 of this document.
3. Selecting a physical interface converter which cannot support DNP 3.0 communications. Additionally, some converters require additional configuration to set the data transfer on a RD line instead of RTS/CTS handshaking.
4. Improper Host Addressing. Remember, the DPU2000 and DPU2000R's address is in HEX.

It is imperative that a complete understanding of the protocol exists by the implementor. It is recommended that the DNP 3.0 Texts be consulted (GE-HARRIS DNP 3.0 manual is especially beneficial). Several Websites are also available such as:

www.demandside.org
www.dnp.org
www.trianglemicroworks.com

It is also recommended that a communication analyzer package be available. One of many which has been used in the process is manufactured by Applied System Engineering of Sunnyvale, CA. The ASE DNP 3.0 test set allows (depending upon the model selected), the user to decode command strings between the devices, allow the test set to be a slave device, and/or allow the test set to be a host device.

Many hosts also offer these same capabilities with respect to datascope or communication analyzer features. Some even offers communication string decodes capabilities.

A Table of DPU2000R response rates is given illustrating the throughput for executing DNP 3.0 commands in several scenarios using Class Scan data retreival. Table 6-1 lists the following reponse times per the DPU2000R using Version 3.1 DNP 3.0 firmware and Version 3.06 CPU executive flash firmware.

Table 6-1. DNP Performance Results – V3.1

	Comm Param Settings					Msg Length		Timing (msec)				
Device	5	6	7	8	Scan Type	Req Size	Resp Size	Request	Turn around	Response	Total	Notes
DPU2000R	254	255	255	255	CLASS 0	18	1269	17.7	132-154	1299	1448-1470 (4)	
					CLASS 1	18	17	17.6	56	16.6*	89 (1)	
					CLASS 1	18	17	17.6	32	16.6*	64-65 (3)	
					CLASS 2	18	127	17.7	120	127	265 (1)	a
					CLASS 2	18	17	17.7	32	16.6	65 (3)	
					CLASS 2	18	17	17.7	45	16.6	78 (1)	
					CLASS 3	18	8477	17.7	194	9148	9360	a
					CLASS 3	18	17	17.7	34	16.6	65-66 (4)	
					CLASS 1,2,3	24	166	24	221	169	414	a
					CLASS 1,2,3	24	17	24	574	16.6	614	
					CLASS 1,2,3	24	17	24	32	16.6	72 (2)	
					CLASS 1,2,3,0	18	1269	17.7	130	1311	1459	b
					CLASS 1,2,3,0	18	1269	17.7	148	1311	1477	b
					CLASS 1,2,3,0	18	1269	17.7	130	1311	1459	b
					CLASS 1,2,3,0	27	1269	27	133	1299	1459 (3)	c

NOTES:

Tests were performed with v3.06 CPU Software

a-Change events included in the response
b-Variation 0 (zero) to request all classes
c-Variation 1, 2, 3, and 4 used to request all classes

Revision History

For the benefit of the reader, the DPU2000 and DPU2000R communication firmware revision history is provided:

Software History:

V2.0 - Base Version
V2.1 - Changes binary event reporting for 52A closed from point #80 to point 11. This means that the event and it's corresponding static value is associated with a logical input rather than a physical input. This will allow DNP to correctly access the data on the DPU2000R.
V2.2 - Support for front panel control of class scan results by grouping points in list.
- Ignore error returns from INCOM commands used to operate relays.
- The communication parameters were rearranged to move some of the binary flags to the mode bit parameters.
- An additional pair of trip/close points has been added. This duplicates the original pair except that the close function is not dependent on the status of 43A.
- The initial time sync request has been delayed until one (1) minute after reset to permit communications between the CPU and Aux Com to be completely established.

V2.3 - Implement the INCOM ten byte ASCII protocol as used with the ECP program. Allow front panel selection of protocols for RS232 and RS485. Modifies the choice of the qualifier/index byte in returned data. To reduce output data volumes, the range qualifier is used where possible for static data returns.
- Addressing problems that prevented using a Unit Address above 15 (00F hex) have been corrected.

V2.4 - Provides capability for communications via the Aux Com RS232 port using switched carrier (RTS/CTS), as needed for PECO system.
- Corrected definition of User Logical Output (ULOx) points as Binary Outputs. These points now contain the status of the ULOx points not the last change-of-state message sent to the DPU.

V2.6 - Corrected handling of "spare" points when performing DNP group scans.
- Added address checking for 10-Byte protocol. Previously, units with DNP responded to any 10-Byte commands regardless of address.
- Corrected problems with decoding global address (x'FFFF') when communicating with DNP master station.

V2.8 - The thirty-two 16-bit User Definable (Modbus) Registers have been added as static analog points (97 to 128 on the DPU and 319 to 350 on the TPU). This provides user scaleable analog points to circumvent the 32-bit processing limitations of the Harris D20 RTU. These additional points are processed as signed analogs.
- Numerous performance enhancements have reduced the worst case turnaround for DNP requests to approximately 350 msec on the DPU. Typical response for most requests is less than 200 msec.
- The control logic was revised to detect busy conditions and support multiple concurrent operations. This fixes the problems with ULO3.
- Collection of fault records by DNP is delayed until the fault distance calculation is completed.
- The processing of spare points has been corrected.
- The Application Layer Headers are now properly built when all the qualifier code requests "all" objects.

V2.9 - Support added for new Auxillary Communications Card (Type 8) with two RS485 ports.
- Additional control point added for "Reset all Seal Ins".
- Additional class 3 digital event points added (see list at end of Binary Input Points).
- Additional analog point for 3 phase volt-amps.

V3.0- Corrected processing of control requests as per DNP Basic 4 Document Set.
- Automatically reset seal-in points after they have been reported by DNP, depending on the status of Mode Parameter 5.
- Added DNP support for Forced I/O points (Logical Inputs and Physical Inputs/Outputs)
- Added event masking for Binary Input events.
- Changed default qualifier for DPU on a Class scan from x'18' to x'17'.
- Added Binary Input points 128 and 129.
- Prevented accumulation of Class 2 or 3 changes for points not enabled via Scan Groups or the Binary Input Event Masking.
- Performance enhancements added to reduce the turn-around time when requesting class 1, 2 or 3 data.

V3.1- Note: this is an internal (ABB only release), the following features are all included in the V3.2 release
- Provided Binary Event (change) reporting for most Binary Input points as indicated in documentation. Binary changes for sealed-in points are now limited to current state reporting (i.e., a seal-in must be reset before another "set" event will be reported).
- Added capability to configure the period for requesting time synchronization from the master via Parameter 9.
- Added performance improvements secondary rear port (non-DNP port) to enhance communications with ECP program.

V3.2- Add support for running with the CPU clock stopped (required for final manufacturing tests).
- Revise start-up processing to support revisions to Motorola processor used in Aux. Com boards.

V3.3- Revised changes to handle CPU clock stopped.

V3.4- Added Binary Inputs 130-162 for DPU2000R v4.02 and v4.10.
- Added Analog Inputs 130-141 for DPU2000R v4.02 and v4.10.
- Updated point tables to indicate points that are unique to the DPU2000, DPU2000R and DPU1500R relays.
- Revised Scan Group number for Analog Inputs 15-18 from 17 to 18.

V3.7- Add UDR Analog Reporting
- Add 59-3, 47, and 21P-1, 2, 3, 4

V4.3- Added Modbus document reference to DNP Message Formats section.
- Added Binary Controls 138 – 152.
- Added Binary Outputs 138 – 152.
- Added Binary Inputs 169 – 224.
- Added note ('…refer to Software Version Spec. …') at the end of Software History section of appendix.

Appendix A - ASCII CODE

Decimal Value	Hexadecimal Value	Control Character	Character
0	00	NUL (CTRL @)	Null
1	01	SOH (CTRL A)	
2	02	STX (CTRL B)	
3	03	ETX (CTRL C)	
4	04	EOT (CTRL D)	
5	05	ENQ (CTRL E)	
6	06	ACK (CTRL F)	
7	07	BEL (CTRL G)	Beep
8	08	BS (CTRL H)	Backspace
9	09	HT (CTRL I)	Tab
10	0A	LF (CTRL J)	Line-feed
11	0B	VT (CTRL K)	Cursor home
12	0C	FF (CTRL M)	Form-feed
13	0D	CR (CTRL N)	Carriage Return (Enter)
14	0E	SO (CTRL O)	Shift Out
15	0F	SI (CTRL P)	Shift In
16	10	DLE	Data Link Escape
17	11	DCI	
18	12	DC2	
19	13	DC3	
20	14	DC4	
21	15	NAK	
22	16	SYN	
23	17	ETB	
24	18	CAN	
25	19	EM	
26	1A	SUB	
27	1B	ESC	
28	1C		Cursor right
29	1D		Cursor left
30	1E		Cursor up
31	1F		Cursor down
32	20		Space
33	21		!
34	22		“
35	23		#
36	24		$
37	25		%
38	26		&
39	27		‘
40	28		(
41	29		(
42	2A		*
43	2B		+
44	2C		,
45	2D		-
46	2E		.
47	2F		/
48	30		0
49	31		1
50	32		2
51	33		3

52	34	4
53	35	5
54	36	6
55	37	7
56	38	8
57	39	9
58	3A	
59	3B	
60	3C	<
61	3D	
62	3E	>
63	3F	?
64	40	@
65	41	A
66	42	B
67	43	C
68	44	D
69	45	E
70	46	F
71	47	G
72	48	H
73	49	I
74	4A	J
75	4B	K
76	4C	L
77	4D	M
78	4E	N
79	4F	O
80	50	P
81	51	Q
82	52	R
83	53	S
84	54	T
85	55	U
86	56	V
87	57	W
88	58	X
89	59	Y
90	5A	Z
91	5B	[
92	5C	\
93	5D	]
94	5E	^
95	5F	_
96	60	`
97	61	a
98	62	b
99	63	c
100	64	d
101	65	e
102	66	f
103	67	g
104	68	h
105	69	i
106	6A	j
107	6B	k
108	6C	l
109	6D	m
110	6E	n

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<tr><td>117</td><td>75</td><td>u</td></tr>
<tr><td>118</td><td>76</td><td>v</td></tr>
<tr><td>119</td><td>77</td><td>w</td></tr>
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<tr><td>121</td><td>79</td><td>y</td></tr>
<tr><td>122</td><td>7A</td><td>z</td></tr>
<tr><td>123</td><td>7B</td><td>{</td></tr>
<tr><td>124</td><td>7C</td><td>|</td></tr>
<tr><td>125</td><td>7D</td><td>}</td></tr>
<tr><td>126</td><td>7E</td><td>~</td></tr>
<tr><td>127</td><td>7F</td><td>DEL</td></tr>
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Appendix B - Standard 10-Byte Protocol Document for DPU2000/2000R/1500R

RC-1097/01, Revision 17.0

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1 Document Revision History

Rev	Date	Author	Notes
4.00	05/29/96	DAH	ER No. 960045
5.00	04/14/99	DAH	Revised document's format to reflect current ABB documentation format. Changed document name to reflect addition of 1500R to the DPU Series of relays. Modified commands for the DPU1500R Protocol Command Set.
6.00	11/99	CWH	Revised document and added 59G, 67N, and 3V0 enhancements for the DPU2000R 4.10 release .
7.00	04/10/01	KEB	Add 47, 47*, 3ph_59, and 3ph_59* to logical outputs in 3 0 7 Command
8.0	04/29/01	Vab	Added 21P-1/2/3/4 and 21P-1*/2*/3*/4*. Added appendix A for protocol change details for V5.0 DPU2000R.
9.0	07/12/01	Vs	Added C1 – C6 and 9 Targets Alarms for Logical Outputs in Block 6, offset 52 for cmd 3 1 1
10.0	10/12/01	KEB	Add Support for C1-C6 and DPU200R rel Ver 5.10.
11.0	03/11/02	Vab	Added Table of Figures & Table of Contents. Consolidated multiple definitions into tables for logical inputs, input bit assignments, and output bit assignments. Added 3-0-9 command for Clear Records, reserved for future use.
11.1	04/01/03	Vab	Added SEFT to bit 8, offset 50, for 3-1-1 command.
12.0	04/01/03	Vab	Updated for V5.20 DPU2000R logical i/o & operation record additions. Company name was 'ABB Automation Inc.'.
13.0	04/01/03	Vab	Added REMOTE-D for V5.30 DPU2000R.
14.0	04/04/03	JSC	Added new operations records for capturing information on 065 error. Also Added 3 – 1 – 4, 3 – 1 – 5, and 3 – 1 – 6 commands
15.0	07/24/03	Vab	Changes for V5.40 DPU. Added logical inputs: SWSET, SHIFTA, & SHIFTB. Added logical outputs: PRI-ON, ALT1-ON, ALT2-ON, SHIFTA-1, SHIFTA-2, SHIFTA-3, SHIFTA-4, SHIFTB-1, SHIFTB-2, SHIFTB-3, SHIFTB-4.
16.0	07/28/03	VS	In 8.2.1.1.7 BLK 6: PHYSICAL and LOGICAL INPUT/OUTPUT BLOCK : Offset 50 was changed to 52 and offset 52 changed to 56 on p 30
17.0	01/19/2004	VAB	Added note ('DFR commands found in extended Modbus register set') to 3 14 n commands (waveform capture) section.

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3 Table of Figures

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5 Introduction

5.1 Purpose

The purpose of this protocol document is to define the valid commands for the DPU Series of relays. The words transmit and receive in each command description, are with respect to the relay.

This DPU Series Protocol Command Set document is intended for ABB personnel and customers.

5.2 Scope

This DPU Series Protocol Command Set document will depict the manner in which a three-byte INCOM protocol is translated to a 10-byte RS-232 protocol. This document defines the communication commands required for the following product models: DPU2000, DPU2000R and DPU1500R. The first three characters of the DPU's catalog number identifies the model. For a DPU2000 they are 484 or 487. For a DPU2000R they are 587 or 687. For a DPU1500R they are 577. Features that are specific to only one unit model or variation of that model will be noted throughout this document.

Starting with V5.0 DPU2000R, appendix A lists the protocol changes between box versions.

6 Protocol Translation

The commands are spelt out in a 10-byte RS-232 protocol or a 3-byte INCOM protocol. It will be easy to understand the commands in a 33-bit INCOM context and then translate the protocol to a 10-byte RS-232 protocol. The protocol messages are of two types - command and data.

Command Message (33 bit INCOM)

	S	S	C/D	Inst	Cmd	Subcmd	Address	BCH	S
Bit	1	2	3	4 to 7	8 to 11	12 to 15	16 to 27	28 to 32	33

Figure 2 - Command Message (33-bit INCOM)

Data Message (33 bit INCOM)

	S	S	C/D	Data 1	Data 2	Data 3	BCH	S
Bit	1	2	3	4 to 11	12 to 19	20 to 27	28 to 32	33

Figure 3 - Data Message (33-bit INCOM)

6.1 Command Message

An INCOM command message can be represented in a 10 byte RS-232 protocol as shown in Figure 4 below.

Command Message (10 byte RS-232)

	STX	C/D	Inst	Cmd	SCmd	Addr Lo	Addr Mid	Addr Hi	CS Lo	CS Hi
Byte	1	2	3	4	5	6	7	8	9	10

Figure 4 - Command Message (10 byte RS 232)

The address bytes, Addr Lo, Addr Mid, and Addr Hi, are a 3 digit hex address. The checksum is 256 minus the sum of the ASCII characters in bytes 1 to 8. CS Lo is the low byte and CS Hi is the high byte of the checksum.

Example (3 4 1 command with a unit address of 001)

STX	=	hex 02	=	use 2 -->	Start of transmission
C/D	=	hex 31	=	ASCII 1 -->	Command type of message
Inst	=	hex 33	=	ASCII 3 -->	Instruction byte
Cmd	=	hex 34	=	ASCII 4 -->	Command byte
SCmd	=	hex 31	=	ASCII 1 -->	Subcommand byte
Addr Lo	=	hex 31	=	ASCII 1 -->	Unit address low byte
Addr Mid	=	hex 30	=	ASCII 0 -->	Unit address mid byte
Addr Hi	=	hex 30	=	ASCII 0 -->	Unit address high byte
CS Lo	=	hex 34	=	ASCII 4 -->	Checksum low byte
CS Hi	=	hex 46	=	ASCII F -->	Checksum high byte

Checksum = 256 - (STX + C/D + Inst + Cmd + SCmd + Addr Lo + Addr Mid + Addr Hi)

256 - (2 + 1 + 3 + 4 + 1 + 1 + 0 + 0) = F4

6.2 Data Message

An INCOM data message can be represented in a 10 byte RS-232 protocol as follows:

Data Message (10 byte RS-232)

	STX	C/D	D1 Lo	D1 Hi	D2 Lo	D2 Hi	D3 Lo	D3 Hi	CS Lo	CS Hi
Byte	1	2	3	4	5	6	7	8	9	10

Figure 5 - Data Message (10 byte RS-232)

Where D1 Lo is the low nibble of the first data byte and D1 Hi is the high nibble of the first data byte, D2 Lo is the low nibble of the second data byte and D2 Hi is the high nibble of the second data byte, and D3 Lo is the low nibble of the third data byte and D3 Hi is the high nibble of the third data byte.

The checksum is 256 minus the sum of the ASCII characters in bytes 1 to 8. CS Lo is the low byte and CS Hi is the high byte of the checksum.

Example (3 data bytes, ASCII characters 4, 8, and 7)

STX	=	hex 2 -->	Start of transmission
C/D	=	hex 0 -->	Data type of message
D1 Lo	=	hex 4 -->	Data 1 low byte
D1 Hi	=	hex 3 -->	Data 1 high byte
D2 Lo	=	hex 8 -->	Data 2 low byte
D2 Hi	=	hex 3 -->	Data 2 high byte
D3 Lo	=	hex 7 -->	Data 3 low byte
D3 Hi	=	hex 3 -->	Data 3 high byte
CS Lo	=	hex 2 -->	Checksum low byte
CS Hi	=	hex E -->	Checksum high byte

The three data bytes translate to:
Data 1 = 34 --> ASCII 4
Data 2 = 38 --> ASCII 8
Data 3 = 37 --> ASCII 7

Checksum = 256 - (STX + C/D + D1L + D1H + D2L + D2H + D3L + D3H)
256 - (2 + 0 + 4 + 3 + 8 + 3 + 7 + 3) = E2

7 Transmission and Reception Convention

To acknowledge successful receipt of a message, an ACK is transmitted. The three byte message packet is 0x000013. For an unsuccessful reception, ie. a checksum error or an error in command processing, a NACK is transmitted. The three byte message packet is 0x100013.

The commands for the relay can be categorized into three basic types according to the response that is expected by the master. When a command or data is received, the relay must acknowledge if the reception was successful.

7.1 Simple Commands

A simple command directs the relay to perform specific actions. After the successful completion of these actions, the relay transmits an ACK as seen below.

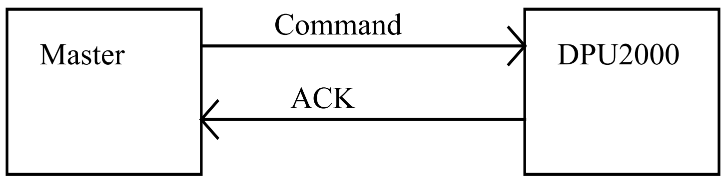

Figure 6 - Simple Command Communication Flow

7.2 Upload Data

This type of command requests the relay to transmit specific data. The proper transmission of this data is the relay acknowledgement of this type of command as seen in Figure 7 below.

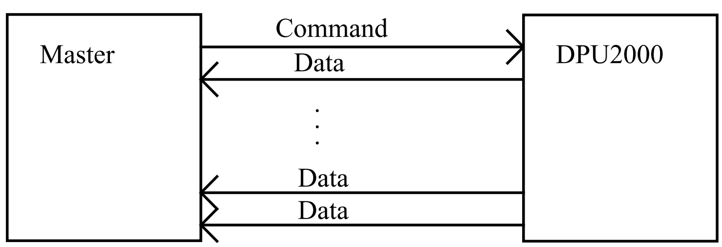

Figure 7 - Upload Data Communication Flow

7.3 Download Data

These commands edit the relay data. The relay responds with an ACK after the successful receipt of each data message packet. This can be seen in Figure 8 below.

Message Packet Checksum: This checksum is different than the checksum associated with every INCOM message packet. The value of the checksum is contained in a two byte integer and is the summation of all

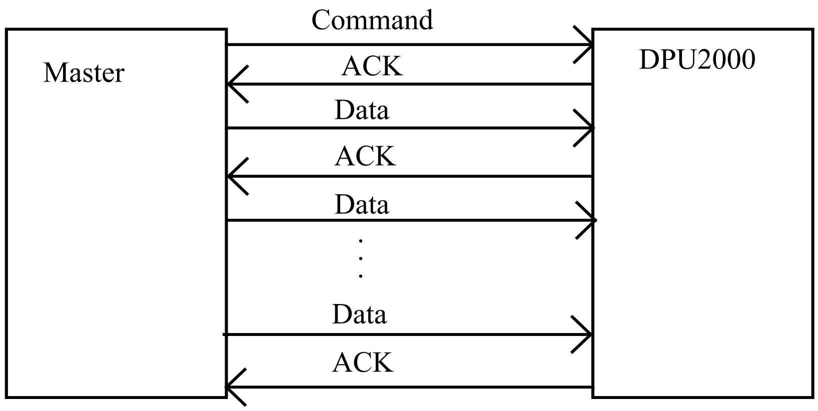

Figure 8 - Download Data Communication Flow

message bytes (1/1 + 1/2 + 1/3 + 2/1 + 2/2 + ...) for the command. The only exception is that the checksum message bytes are not included in the summation.

Example (3 3 1 command): (values are hex equivalent of the ASCII)

1/1 = hex 05	3/1 = hex 44
1/2 = hex 31	3/2 = hex 00
1/3 = hex 04	3/3 = hex 00
2/1 = hex 00	4/1 = hex 00
2/2 = hex 01	4/2 = hex 00 <-- checksum high byte
2/3 = hex 44	4/3 = hex C3 <-- checksum low byte

8 Command Set Summary

Inst	Cmd	Subcmd	Definition
3	0	n	Status Commands
3	1	n	Register Data Acquisition Command
3	2	n	
3	3	n	Transmit Settings Commands
3	4	n	Transmit Settings Commands
3	5	n	Transmit Meter/Record Commands
3	6	n	Load Profile Commands
3	7	n	
3	8	n	
3	9	n	Relay Commands
3	10	n	Receive Edit Buffer Commands
3	11	n	Receive Edit Buffer Commands
3	12	n	
3	13	n	Programmable Curve Commands
3	14	n	Waveform Capture Commands
3	15	n	Reserved for Factory

8.1 Transmit Status "N" Commands (3 0 n)

N	Definition
0	Transmit Fast Status
1	Reserved
2	Unit Information
3	Reserved for RCVDALL
4	Unreported Record Status
5	Reset Alarms/Target LEDs
6	Reset Max/Min Demand Currents
7	Logical Input/Output Status
8	Reset Relay Status Flag

8.1.1 Transmit Fast Status (3 0 0)

This command will cause the relay to respond with one data message with the format shown below:

byte 3 |byte 2 |byte 1
ST2 ST1 L T4 T3 T2 T1 T0|P5 P4 P3 P2 P1 P0 A3 A2 | A1 A0 D5 D4 D3 D2 D1 D0

D5 D4 D3 D2 D1 D0 => Division Code. RTD division code is 5 (000101)
A3 A2 A1 A0 => A0 - If this bit is set, one or more Unreported Operations have occurred.
A1 => Reserved
A2, A3 => Reserved
P5 P4 P3 P2 P1 P0 => Product ID. (DPU2000 series = 001110)
T2 T1 T0 => Reserved
T4 T3 => Reserved
L => Local Operator interface action. (Future implementation)
ST2 ST1 => Corporate standard status bits. (Future implementation)

8.1.2 Unit Information (3 0 2)

This command will cause the relay to transmit data messages containing catalog number and the software version.

1/1-5/3	Catalog Number (15 characters)
6/1	CPU Software Version high byte (*100)
6/2	CPU Software Version low byte (bit 0-14 version number *100, bit 15 1=non released software version)
6/3	DSP Software Version (*10)

7/1	Front Panel Software Version (*10)
7/2	Rear Communication Software version (*10)
7/3	Serial Number most significant high byte
8/1	Serial Number most significant low byte
8/2	Serial Number least significant high byte
8/3	Serial Number least significant low byte

8.1.3 RCVDALL (3 0 3)

- Reserved -

8.1.4 Unreported Record Status (3 0 4)

This command will respond with the number of unacknowledged operation and fault records.

To mark the record as being reported, a 3 6 8 command will retrieve the oldest unreported fault record and decrement the unreported fault record counter by one.

Likewise, a 3 6 9 command will retrieve the oldest unreported operations record and decrement the unreported fault record counter by one.

Msg byte	Definition
1/1	Relay Status (see command 3 4 1, msg 1/1)
1/2	Command + Subcommand = 0x04
1/3	Total Number of Messages = 4
2/1	Unreported Fault Record Count byte
2/2	Unreported Operation Record Count byte
2/3	Spare
3/1	Spare
3/2	Spare
3/3	Spare
4/1	Spare
4/2	Spare
4/3	Spare

8.1.5 Reset Alarms/Target LEDs (3 0 5)

The targets, alarms and relay status flag (see command 3 4 1 msg 2/1) will be reset on the relay. After the relay receives this command it will transmit an ACK/NACK based on the completion of the command.

8.1.6 Reset Max/Min Demand Currents (3 0 6)

This command will reset the Max/Min demand current values along with their time tags. After the relay receives this command it will transmit an ACK/NACK based on the completion of the command.

8.1.7 Show logical Input/Ouput Status (3 0 7)

This command displays the binary value of the logical input and output table for the present state of the unit.

Bit = 0, Input Disabled/Output Not Energized.
Bit = 1, Input Enabled/Output Energized.
Outputs denoted with '*' are sealed in until cleared.

8.1.7.1 DPU2000 Logical I/O

DPU2000 Logical Inputs Include: "TCM", "GRD", "PH3", "50-1", "50-2", "50-3", "ALT1", "ALT2", "ZSC", "SCC", "79S", "79M", "OPEN", "CLOSE", "ECI1", “ECI2", "WCI", "46", "67P", "67N", "ULI1", "ULI2", "ULI3", "ULI4", "ULI5", "ULI6", "ULI7", "ULI8", "ULI9", "CRI", "UDI".

DPU2000 Logical Outputs Include: "TRIP", "CLOSE", "ALARM", “BFA", "TCFA", "79LOA", "TCC", "PUA", "51P", "51N", "46", "50P-1", "50N-1", "50P-2", "50N-2", "50P-3", "50N-3", "PATA", "PBTA", "PCTA", "67P", "67N", "81S-1", "81R-1", "81O-1", "27-1P", "59", "79DA", "79CA1", "OCTC", "KSI", "PDA", "NDA", "PVArA", "NVArA", "LOADA",

"50-1D", "LPFA", "HPFA", "ZSC", "50-2D", "BFUA", "STCA", "PH3-D", "GRD-D", "27-3P", "VarDA", "79CA2", "TRIPA", "TRIPB", "TRIPC", "27-1P*", "46*", "50P-1*", "50N-1*", "50P-2*", "50N-2*", "50P-3*", "50N-3*", "51P*", "51N*", "59*", "67P*", "67N*", "81S-1*", "81R-1*", "81O-1*", "27-3P*", "TRIPA*", "TRIPB*", "TRIPC*", "ULO1", "ULO2", "ULO3", "ULO4", "ULO5", "ULO6", "ULO7", "ULO8", "ULO9", "81O-2", "81S-2", "81R-2", "81O-2*", "81S-2*", "81R-2*", "CLTA", "PWatt1", "PWatt2", "79CA1*", "79CA2*", "BFA*".

8.1.7.2 DPU2000R Logical I/O

DPU2000R Logical Inputs Include: "52A", "52B", "43A", "TCM", "GRD", "PH3", "50-1", "50-2", "50-3", "ALT1", "ALT2", "ZSC", "SCC", "79S", "79M", "OPEN", "CLOSE", "ECI1", "ECI2", "WCI", "46", "67P", "67N", "ULI1", "ULI2", "ULI3", "ULI4", "ULI5", "ULI6", "ULI7", "ULI8", "ULI9", "CRI", "ARCI", "TARC", "SEF" (*Sensitive Earth Model*), "EXTBF", "BFI", "UDI", "25"(*Synch Check Model*), "25By"(*Synch Check Model*). The following logical inputs are available in CPU versions greater than 1.92: "LOCAL", "TGT", "SIA". The following logical inputs are available in CPU version greater than 4.02 (2.01 for PTH): “LIS1”, “LIS2 “,“LIS3”, “LIS4 “, “LIS5”, “LIS6 “, “LIS7”, “LIS8“, “LIR1”, “LIR2”, “LIR3”, “LIR4 “, “LIR5”, “LIR6 “, “LIR7”, “LIR8”, “TR_SET”, “TR_RST”.

DPU2000R Logical Outputs Include: "TRIP", "CLOSE", "ALARM", “BFA", "TCFA", "79LOA", "TCC", "PUA", "51P", "51N", "46", "50P-1", "50N-1", "50P-2", "50N-2", "50P-3", "50N-3", "PATA", "PBTA", "PCTA", "67P", "67N", "81S-1", "81R-1", "81O-1", "27-1P", "59", "79DA", "79CA1", "OCTC", "KSI", "PDA", "NDA", "PVArA", "NVArA", "LOADA", "50-1D", "LPFA", "HPFA", "ZSC", "50-2D", "BFUA", "STCA", "PH3-D", "GRD-D", "32PA", "32NA", "27-3P", "VarDA", "79CA2", "TRIPA", "TRIPB", "TRIPC", "27-1P*", "46*", "50P-1*", "50N-1*", "50P-2*", "50N-2*", "50P-3*", "50N-3*", "51P*", "51N*", "59*", "67P*", "67N*", "81S-1*", "81R-1*", "81O-1*", "27-3P*", "TRIPA*", "TRIPB*", "TRIPC*", "ULO1", "ULO2", "ULO3", "ULO4", "ULO5", "ULO6", "ULO7", "ULO8", "ULO9", "81O-2", "81S-2", "81R-2", "81O-2*", "81S-2*", "81R-2*", "CLTA", /* V1.40 */ "PWatt1", "PWatt2", "79CA1*", "79CA2*".

The following were added to CPU V1.60: "SEF*"(*Sensitive Earth Model*), "SEF"(*Sensitive Earth Model*), "BZA", "BFT", "ReTrp", "BFT*", "ReTrp*".

The following were added to CPU V1.80: "32P-2", "32N-2", "32P-2*", "32N-2*", "BFA*".

The following were added to CPU V1.93: “25*"(*Synch Check Model*), "25"(*Synch Check Model*), "SBA".

The following were added to CPU V3.20: “79V"and "RClin". The following were added to CPU V4.10 (2.10 for PTH): “59G”,”59G*”, “LO1”, “LO2”,”LO3”,”LO4”,”LO5”,”LO6”,”LO7”,”LO8”, “TR_ON”,”TR_OFF”,”TR_TAG”.

The following were added to CPU V5.0: ”59-3p”, ”59-3p*”, ”47”,”47*”,”21P-1”,”21P-1*”,”21P-2”,”21P-2*”,”21P-3”,”21P-3*”,”21P-4”,”21P-4*”.

The following were added to CPU V5.1: “C1”, “C2”, “C3”, “C4”, “C5”, “C6”,”TRIPT”, “NTA”, “TIMET”, “INSTT”, “NEGSEQT”, “FREQT”, “DIRT”, “VOLTT”, “DISTT”, “SEFT”, “50-3D”.

8.1.7.3 DPU1500R Logical I/O

DPU1500R Logical Inputs Include: "52A", "52B", "43A", "TCM", "GRD", "PH3", "50-1", "50-2", "50-3", "ALT1", "ALT2", "ZSC", "SCC", "79S", "79M", "OPEN", "CLOSE", "ECI1", "ECI2", "WCI", "46", "CRI", "ARCI", "TARC", "SEF" (*Sensitive Earth Model*), "UDI", "LOCAL", "TGT", "SIA".

DPU1500R Logical Outputs Include: "TRIP", "CLOSE", "ALARM", “BFA", "TCFA", "79LOA", "TCC", "PUA", "51P", "51N", "46", "50P-1", "50N-1", "50P-2", "50N-2", "50P-3", "50N-3", "PATA", "PBTA", "PCTA", "27-1P", "79DA", "79CA1", "OCTC", "KSI", "PDA", "NDA", "PVArA", "NVArA", "LOADA", "50-1D","LPFA", "HPFA", "ZSC", "50-2D", "BFUA", "STCA", "PH3-D", "GRD-D", "27-3P", "VarDA", "79CA2", "TRIPA", "TRIPB", "TRIPC", "27-1P*", "46*", "50P-1*", "50N-1*", "50P-2*", "50N-2*", "50P-3*", "50N-3*", "51P*", "51N*", "27-3P*", "TRIPA*", "TRIPB*", "TRIPC*", "CLTA", "PWatt1", "PWatt2", "79CA1*", "79CA2*", "SEF*"(*Sensitive Earth Model*), "SEF"(*Sensitive Earth Model*), "BZA", "BFA*", "SBA", “79V" and "RClin".

8.1.7.4 Logical I/O Bit Definitions

Byte-Bit	Output	Input	Byte-Bit	Output	Input
1-7	TRIP	52a	2-7	50N2	TCM
1-6	CLOSE	52b	2-6	50P3	50-1
1-5	ALARM	43a	2-5	50N3	50-2
1-4	27	PH3	2-4	51P	50-3

1-3	46	GRD	2-3	51N	ALT1
1-2	50P1	SCC	2-2	59	ALT2
1-1	50N1	79S	2-1	67P	ECI1
1-0	50P2	79M	2-0	67N	ECI2

Byte-Bit	Output	Input	Byte-Bit	Output	Input
3-7	81S-1	WCI	4-7	PUA	ULI2
3-6	81R-1	ZSC	4-6	79LOA	ULI3
3-5	PATA	OPEN	4-5	BFA	ULI4
3-4	PBTA	CLOSE	4-4	PPDA	ULI5
3-3	PCTA	46	4-3	NPDA	ULI6
3-2	TCFA	67P	4-2	BFUA	ULI7
3-1	TCC	67N	4-1	KSI	ULI8
3-0	79DA	ULI1	4-0	79CA-1	ULI9

Byte-Bit	Output	Input	Byte-Bit	Output	Input
5-7	HPFA	CRI	6-7	GRD-D	25By
5-6	LPFA	ARCI	6-6	32PA	LOCAL
5-5	OCTC	TARC	6-5	32NA	TGT
5-4	50-1D	SEF	6-4	27-3P	SIA
5-3	50-2D	EXTBFI	6-3	VarDA	LIS1
5-2	STC	BFI	6-2	79CA-2	LIS2
5-1	ZSC	UDI	6-1	TRIPA	LIS3
5-0	PH3-D	25	6-0	TRIPB	LIS4

Byte-Bit	Output	Input	Byte-Bit	Output	Input
7-7	TRIPC	LIS5	8-7	50N3*	LIR5
7-6	27*	LIS6	8-6	51P*	LIR6
7-5	46*	LIS7	8-5	51N*	LIR7
7-4	50P1*	LIS8	8-4	59*	LIR8
7-3	50N1*	LIR1	8-3	67P*	TR_SET
7-2	50P2*	LIR2	8-2	67N*	TR_RST
7-1	50N2*	LIR3	8-1	81S-1*	ULI10
7-0	50P3*	LIR4	8-0	81R-1*	ULI11

Byte-Bit	Output	Input	Byte-Bit	Output	Input
9-7	81O-1*	ULI12	10-7	ULO4	
9-6	27-3P*	ULI13	10-6	ULO5	
9-5	TRIPA*	ULI14	10-5	ULO6	
9-4	TRIPB*	ULI15	10-4	ULO7	
9-3	TRIPC*	ULI16	10-3	ULO8	
9-2	ULO1	46A TC	10-2	ULO9	
9-1	ULO2		10-1	PVArA	
9-0	ULO3		10-0	NVArA	

Byte-Bit	Output	Input	Byte-Bit	Output	Input
11-7	LOADA		12-7	CLTA	
11-6	81O-1		12-6	PWatt1	
11-5	81O-2		12-5	PWatt2	
11-4	81S-2		12-4	79CA1*	
11-3	81R-2		12-3	79CA2*	
11-2	81O-2*		12-2	SEF*	
11-1	81S-2*		12-1	SEF	
11-0	81R-2*		12-0	BZA	

Byte-Bit	Output	Input	Byte-Bit	Output	Input
13-7	BFT		14-7	BFA*	
13-6	RETRIP		14-6	25*	
13-5	BFT*		14-5	25	

13-4	RETRIP*		14-4	SBA	
13-3	32P-2		14-3	79V	
13-2	32N-2		14-2	RClin	
13-1	32P-2*		14-1	59G	
13-0	32N-2*		14-0	59G*	

Byte-Bit	Output	Input	Byte-Bit	Output	Input
15-7	LO1		16-7	TR_ON	
15-6	LO2		16-6	TR_OFF	
15-5	LO3		16-5	TR_TAG	
15-4	LO4		16-4	59-3ph	
15-3	LO5		16-3	59-3ph*	
15-2	LO6		16-2	47	
15-1	LO7		16-1	47*	
15-0	LO8		16-0	50-3D	

Byte-Bit	Output	Input	Byte-Bit	Output[note1]	Input
17-7	21P-1	not	18-7	not	not
17-6	21P-1*	applicable,	18-6	applicable,	applicable,
17-5	21P-2	no more	18-5	no more	no more
17-4	21P-2*	logical input	18-4	logical input	logical input
17-3	21P-3	bytes are	18-3	bytes are	bytes are
17-2	21P-3*	available.[note 1]	18-2	available[note 1]	available.[note 1]
17-1	21P-4		18-1		
17-0	21P-4*		18-0		

NOTE: SEF and SEF* are available in DPU2000R and DPU1500R Sensitive Earth models only.

Note 1: Do NOT use this command for future expansion of logical outputs or logical inputs. Use the appropriate 3-1-1 command in place of 3-0-7. 3-0-7 will eventually be replaced by command 3-1-1.

Msg byte	Definition
1/1	Relay Status (see command 3 4 1, msg 1/1)
1/2	Command + Subcommand = 0x07
1/3	Total Number of Messages = 13
2/1	Logical Output byte1
2/2	Logical Output byte2
2/3	Logical Output byte3
3/1	Logical Output byte4
3/2	Logical Output byte5
3/3	Logical Output byte6
4/1	Logical Output byte7
4/2	Logical Output byte8
4/3	Logical Output byte9
5/1	Logical Output byte10
5/2	Logical Output byte11
5/3	Logical Output byte12
6/1	Logical Output byte13
6/2	Logical Output byte14
6/3	Logical Output byte15
7/1	Logical Output byte16
7/2	Logical Input byte1
7/3	Logical Input byte2
8/1	Logical Input byte3
8/2	Logical Input byte4
8/3	Logical Input byte5
9/1	Logical Input byte6
9/2	Logical Input byte7
9/3	Logical Input byte8

10/1	Logical Input byte9
10/2	Logical Input byte10
10/3	Logical Input byte11
11/1	Logical Input byte12
11/2	Logical Input byte13
11/3	Logical Input byte14
12/1	Logical Input byte15
12/2	Logical Input byte16
12/3	Logical Output byte 17
13/1	Logical Output byte 18
13/2	Checksum High Byte
13/3	Checksum Low Byte

8.1.8 Reset Relay Status (3 0 8)

The relay status flag (see command 3 4 1 msg 2/1) will be reset on the relay. After the relay receives this command it will transmit an ACK/NACK based on the completion of the command.

8.1.9 Clear Records (3 0 9)

- This is reserved for future use for Clear Records -

8.2 Register Data "N" Command (3 1 n)

N	Definition
0	Reserved for repeat 3 1 n
1	Register Based Communication Command
2	Transmit Modbus™ Extended Register Set Command
3	Receive Modbus™ Extended Register Set Command
4	Not Used
5	Not Used
6	Process Modbus™ command

8.2.1 Transmit Register Based Data Set (3 1 1)

NOTE: **The register based command, 3-1-1, is available in DPU2000R and DPU1500R, all block and offset register data refers to DPU2000R and DPU1500R models**.

Data Byte	Definition	
1/1	Block Number	(0-255)
1/2	Offset Number	(0-255)
1/3	Number of Bytes to Retrieve (Num Bytes)	(1-132)

Msg Byte	Definition
1/1	Relay Status Byte Bit 7: Control Power Cycled Bit 6: New Fault Recorded Bit 5: Alternate 2 Settings Active Bit 4: Alternate 1 Settings Active Bit 3: Remote Edit Disable Bit 2: Local Settings Changed Bit 1: Contact Input Chnaged Bit 0: Selftest Status
1/2	Command + Subcommand = 11
1/3	Total Number of Messages (TotalMsg = 1+(Num Bytes/3))
2/1	Data Byte Block Number, Offset Number
2/2	Data Byte Block Number, Offset Number + 1
2/3	Data Byte Block Number, Offset Number + 2
.	.
.	.
.	.
TotalMsg/1	Data Byte Block Number, Offset Number + NumBytes - 3
TotalMsg/2	Data Byte Block Number, Offset Number + NumBytes - 2
TotalMsg/3	Data Byte Block Number, Offset Number + NumBytes - 1

Data Type Definitions	Value Ranges
Unsigned Byte	(0 to 255)
Signed Byte	(-128 to 127)
Unsigned Short	(0 to 65,535)
Signed Short	(-32,768 to 32,767)
Unsigned Long	(0 to 4,294,967,295)
Signed Long	(-2,147,483,648 to 2,147,483,647)

Note: Data Byte Order follows the Low Addres-High Byte, High Address -Low Byte Convention.

8.2.1.1 Register Based Communication Definitions

8.2.1.1.1 BLK 0: SYSTEM STATUS/CONFIGURATION BLOCK

Block Offset	Data Size	Scale	Description
Offset 0:	Unsigned Word		Relay Status Bit 15-11: Spare Bit 10: New Minimum DemandValue Bit 9: New Peak Demand Value Bit 8: New Operation Recorded Bit 7: Control Power Cycled Bit 6: New Fault Recorded Bit 5: Alternate 2 Settings Active Bit 4: Alternate 1 Settings Active Bit 3: Remote Edit Disable Bit 2: Local Settings Changed Bit 1: Contact Input Changed Bit 0: Selftest Status
Offset 2:	Unsigned Long		Diagnostic Status Flag Bit 31-16: Spare Bit 15: DSP COP FAILURE Bit 14: DSP +5V FAILURE Bit 13: DSP +/-15V FAILURE Bit 12: DSP +/-5V FAILURE Bit 11: DSP ADC FAILURE Bit 10: DSP EXT RAM FAILURE Bit 9: DSP INT RAM FAILURE Bit 8: DSP ROM FAILURE Bit 7: Spare Bit 6: Spare Bit 5: Spare Bit 4: Spare Bit 3: CPU EEPROM FAILURE Bit 2: CPU NVRAM FAILURE Bit 1: CPU EPROM FAILURE Bit 0: CPU RAM FAILURE
Offset 6:	Unsigned Word		Relay Configuration Bit 15-2: Spare Bit 2: 0=V(line-neutral), 1=V(line-line) Bit 1: 0=kWhr/kVarhr, 1=MWhr/MVarhr Bit 0: 0= Wye PT, 1=Delta PT
Offset 8:20	Char String		Catalog Number
Offset 28:	Unsigned Short	100	CPU Software Version Number
Offset 30:	Unsigned Short	10	Analog/DSP Software Version Number
Offset 32:	Unsigned Short	10	Front Panel Controller Software Version Number
Offset 34:	Unsigned Short	10	Auxillary Communication Software Version Number
Offset 36:	Unsigned Long	1	Serial Number
Offset 40:	18 Char String		Unit Name

8.2.1.1.2 BLK 1: RMS LOAD CURRENT/ANGULAR VALUES BLOCK

Block Offset	Data Size	Scale	Description
Offset 0:	Unsigned Word	1	Load Current-A
Offset 2:	Unsigned Word	1	Load Current-A Angle
Offset 4:	Unsigned Word	1	Load Current-B
Offset 6:	Unsigned Word	1	Load Current-B Angle
Offset 8:	Unsigned Word	1	Load Current-C
Offset 10:	Unsigned Word	1	Load Current-C Angle
Offset 12:	Unsigned Word	1	Load Current-N
Offset 14:	Unsigned Word	1	Load Current-N Angle
Offset 16:	Unsigned Long	1	Voltage VAN
Offset 20:	Unsigned Word	1	Voltage VAN Angle

Offset 22:	Unsigned Long	1	Voltage VBN
Offset 26:	Unsigned Word	1	Voltage VBN Angle
Offset 28:	Unsigned Long	1	Voltage VCN
Offset 32:	Unsigned Word	1	Voltage VCN Angle
Offset 34:	Unsigned Long	1	Voltage VAB
Offset 38:	Unsigned Word	1	Voltage VAB Angle
Offset 40:	Unsigned Long	1	Voltage VBC
Offset 44:	Unsigned Word	1	Voltage VBC Angle
Offset 46:	Unsigned Long	1	Voltage VCA
Offset 50:	Unsigned Word	1	Voltage VCA Angle
Offset 52:	Signed Long	1	kWatts A
Offset 56:	Signed Long	1	kWatts B
Offset 60:	Signed Long	1	kWatts C
Offset 64	Signed Long	1	3 Phase kWatts
Offset 68:	Signed Long	1	kVars A
Offset 72:	Signed Long	1	kVars B
Offset 76:	Signed Long	1	kVars C
Offset 80	Signed Long	1	3 Phase kVars
Offset 84:	Signed Long	1	kWatt Hours A
Offset 88:	Signed Long	1	kWatt Hours B
Offset 92:	Signed Long	1	kWatt Hours C
Offset 96	Signed Long	1	kWatt Hours 3 Phase
Offset 100:	Signed Long	1	kVar Hours A
Offset 104:	Signed Long	1	kVar Hours B
Offset 108:	Signed Long	1	kVar Hours C
Offset 112	Signed Long	1	kVar Hours 3 Phase
Offset 116:	Unsigned Word	1	Load Current Zero Sequence
Offset 118:	Unsigned Word	1	Load Current Zero Sequence Angle
Offset 120:	Unsigned Word	1	Load Current Positive Sequence
Offset 122:	Unsigned Word	1	Load Current Positive Sequence Angle 1
Offset 124:	Unsigned Word	1	Load Current Negative Sequence
Offset 126:	Unsigned Word	1	Load Current Negative Sequence Angle
Offset 128:	Unsigned Long	1	Voltage 1 Magnitude
Offset 132:	Unsigned Word	1	Voltage 1 Angle
Offset 134:	Unsigned Long	1	Voltage 2 Magnitude
Offset 138:	Unsigned Word	1	Voltage 2 Angle
Offset 140:	Unsigned Word	100	System Frequency
Offset 142	Unsigned Word		Power Factor Bit 15-9: Not used Bit 8: 0=Positive, 1=Negative Bit 7: 0=Leading, 1=Lagging Bit 6-0: Power Factor Value (x100)
Offset 144:	Unsigned Long	1	Current Sens Earth Mag
Offset 148:	Unsigned Word	1	Current Sens Earth Angle
Offset 150:	Unsigned Long	1	3V0/Vbus Mag
Offset 154:	Unsigned Word	1	3V0/Vbus Ang
Offset 156:	Signed Word	100	Power Factor
Offset 158:	Unsigned Word		Power Factor Status Bits 15-1: Not used Bit 0: 0=Leading, 1=Lagging
Offset 159:	Unsigned Word	1	Reserved
Offset 160:	Unsigned Word	1	Reserved
Offset 161:	Unsigned Word	1	3V0 Mag (calculated)
Offset 162:	Unsigned Word	1	3V0 Ang (calculated)

8.2.1.1.3 BLK 2: RMS DEMAND CURRENT/REAL and REACTIVE POWER VALUES BLOCK

Block Offset	Data Size	Scale	Description
Offset 0:	Unsigned Short	1	Demand Current-A
Offset 2:	Unsigned Short	1	Demand Current-B
Offset 4:	Unsigned Short	1	Demand Current-C
Offset 6:	Unsigned Short	1	Demand Current-N
Offset 8:	Signed Long	1	Demand kWatts-A
Offset 12:	Signed Long	1	Demand kWatts-B
Offset 16:	Signed Long	1	Demand kWatts-C
Offset 20:	Signed Long	1	3 Phase Demand Watts
Offset 24:	Signed Long	1	Demand kVars-A
Offset 28:	Signed Long	1	Demand kVars-B
Offset 32:	Signed Long	1	Demand kVars-C
Offset 36:	Signed Long	1	3 Phase Demand Vars

8.2.1.1.4 BLK 3: RMS PEAK DEMAND CURRENT/REAL and REACTIVE POWER VALUES and TIME STAMPS BLOCK

Block Offset	Data Size	Scale	Description
Offset 0:	Unsigned Word	1	Peak Demand Current-A
Offset 2:	Unsigned Byte		Peak Demand Current-A Year
Offset 3:	Unsigned Byte		Peak Demand Current-A Month
Offset 4:	Unsigned Byte		Peak Demand Current-A Day
Offset 5:	Unsigned Byte		Peak Demand Current-A Hour
Offset 6:	Unsigned Byte		Peak Demand Current-A Minute
Offset 7:	Unsigned Byte		Spare
Offset 8:	Unsigned Word	1	Peak Demand Current-B
Offset 10:	Unsigned Byte		Peak Demand Current-B Year
Offset 11:	Unsigned Byte		Peak Demand Current-B Month
Offset 12:	Unsigned Byte		Peak Demand Current-B Day
Offset 13:	Unsigned Byte		Peak Demand Current-B Hour
Offset 14:	Unsigned Byte		Peak Demand Current-B Minute
Offset 15:	Unsigned Byte		Spare
Offset 16:	Unsigned Word	1	Peak Demand Current-C
Offset 18:	Unsigned Byte		Peak Demand Current-C Year
Offset 19:	Unsigned Byte		Peak Demand Current-C Month
Offset 20:	Unsigned Byte		Peak Demand Current-C Day
Offset 21:	Unsigned Byte		Peak Demand Current-C Hour
Offset 22:	Unsigned Byte		Peak Demand Current-C Minute
Offset 23:	Unsigned Byte		Spare
Offset 24:	Unsigned Word	1	Peak Demand Current-N
Offset 26:	Unsigned Byte		Peak Demand Current-N Year
Offset 27:	Unsigned Byte		Peak Demand Current-N Month
Offset 28:	Unsigned Byte		Peak Demand Current-N Day
Offset 29:	Unsigned Byte		Peak Demand Current-N Hour
Offset 30:	Unsigned Byte		Peak Demand Current-N Minute
Offset 31:	Unsigned Byte		Spare
Offset 32:	Signed Long	1	Peak Demand KWatts-A
Offset 36:	Unsigned Byte		Peak Demand KWatts-A Year
Offset 37:	Unsigned Byte		Peak Demand KWatts-A Month
Offset 38:	Unsigned Byte		Peak Demand KWatts-A Day
Offset 39:	Unsigned Byte		Peak Demand KWatts-A Hour
Offset 40:	Unsigned Byte		Peak Demand KWatts-A Minute
Offset 41:	Unsigned Byte		Spare
Offset 42:	Signed Long	1	Peak Demand KWatts-B
Offset 46:	Unsigned Byte		Peak Demand KWatts-B Year
Offset 47:	Unsigned Byte		Peak Demand KWatts-B Month
Offset 48:	Unsigned Byte		Peak Demand KWatts-B Day
Offset 49:	Unsigned Byte		Peak Demand KWatts-B Hour

Offset 50:	Unsigned Byte		Peak Demand KWatts-B Minute
Offset 51:	Unsigned Byte		Spare
Offset 52:	Signed Long	1	Peak Demand KWatts-C
Offset 56:	Unsigned Byte		Peak Demand KWatts-C Year
Offset 57:	Unsigned Byte		Peak Demand KWatts-C Month
Offset 58:	Unsigned Byte		Peak Demand KWatts-C Day
Offset 59:	Unsigned Byte		Peak Demand KWatts-C Hour
Offset 60:	Unsigned Byte		Peak Demand KWatts-C Minute
Offset 61:	Unsigned Byte		Spare
Offset 62:	Signed Long	1	3 Phase Peak Demand KWatts
Offset 66:	Unsigned Byte		3 Phase Peak Demand KWatts Year
Offset 67:	Unsigned Byte		3 Phase Peak Demand KWatts Month
Offset 68:	Unsigned Byte		3 Phase Peak Demand KWatts Day
Offset 69:	Unsigned Byte		3 Phase Peak Demand KWatts Hour
Offset 70:	Unsigned Byte		3 Phase Peak Demand KWatts Minute
Offset 71:	Unsigned Byte		Spare
Offset 72:	Signed Long	1	Peak Demand KVars-A
Offset 76:	Unsigned Byte		Peak Demand KVars-A Year
Offset 77:	Unsigned Byte		Peak Demand KVars-A Month
Offset 78:	Unsigned Byte		Peak Demand KVars-A Day
Offset 79:	Unsigned Byte		Peak Demand KVars-A Hour
Offset 80:	Unsigned Byte		Peak Demand KVars-A Minute
Offset 81:	Unsigned Byte		Spare
Offset 82:	Signed Long	1	Peak Demand KVars-B
Offset 86:	Unsigned Byte		Peak Demand KVars-B Year
Offset 87:	Unsigned Byte		Peak Demand KVars-B Month
Offset 88:	Unsigned Byte		Peak Demand KVars-B Day
Offset 89:	Unsigned Byte		Peak Demand KVars-B Hour
Offset 90:	Unsigned Byte		Peak Demand KVars-B Minute
Offset 91:	Unsigned Byte		Spare
Offset 92:	Signed Long	1	Peak Demand KVars-C
Offset 96:	Unsigned Byte		Peak Demand KVars-C Year
Offset 97:	Unsigned Byte		Peak Demand KVars-C Month
Offset 98:	Unsigned Byte		Peak Demand KVars-C Day
Offset 99:	Unsigned Byte		Peak Demand KVars-C Hour
Offset 100:	Unsigned Byte		Peak Demand KVars-C Minute
Offset 101:	Unsigned Byte		Spare
Offset 102:	Signed Long	1	3 Phase Peak Demand KVars
Offset 106:	Unsigned Byte		3 Phase Peak Demand KVars Year
Offset 107:	Unsigned Byte		3 Phase Peak Demand KVars Month
Offset 108:	Unsigned Byte		3 Phase Peak Demand KVars Day
Offset 109:	Unsigned Byte		3 Phase Peak Demand KVars Hour
Offset 110	Unsigned Byte		3 Phase Peak Demand KVars Minute
Offset 111:	Unsigned Byte		Spare

8.2.1.1.5 BLK 4: RMS MINIMUM DEMAND CURRENT/REAL and REACTIVE POWER VALUES and TIME STAMPS BLOCK

Block Offset	Data Size	Scale	Description
Offset 0:	Unsigned Word	1	Minimum Demand Current-A
Offset 2:	Unsigned Byte		Minimum Demand Current-A Year
Offset 3:	Unsigned Byte		Minimum Demand Current-A Month
Offset 4:	Unsigned Byte		Minimum Demand Current-A Day
Offset 5:	Unsigned Byte		Minimum Demand Current-A Hour
Offset 6:	Unsigned Byte		Minimum Demand Current-A Minute
Offset 7:	Unsigned Byte		Spare
Offset 8:	Unsigned Word	1	Minimum Demand Current-B
Offset 10:	Unsigned Byte		Minimum Demand Current-B Year
Offset 11:	Unsigned Byte		Minimum Demand Current-B Month
Offset 12:	Unsigned Byte		Minimum Demand Current-B Day
Offset 13:	Unsigned Byte		Minimum Demand Current-B Hour

Offset 14:	Unsigned Byte		Minimum Demand Current-B Minute
Offset 15:	Unsigned Byte		Spare
Offset 16:	Unsigned Word	1	Minimum Demand Current-C
Offset 18:	Unsigned Byte		Minimum Demand Current-C Year
Offset 19:	Unsigned Byte		Minimum Demand Current-C Month
Offset 20:	Unsigned Byte		Minimum Demand Current-C Day
Offset 21:	Unsigned Byte		Minimum Demand Current-C Hour
Offset 22:	Unsigned Byte		Minimum Demand Current-C Minute
Offset 23:	Unsigned Byte		Spare
Offset 24:	Unsigned Word	1	Minimum Demand Current-N
Offset 26:	Unsigned Byte		Minimum Demand Current-N Year
Offset 27:	Unsigned Byte		Minimum Demand Current-N Month
Offset 28:	Unsigned Byte		Minimum Demand Current-N Day
Offset 29:	Unsigned Byte		Minimum Demand Current-N Hour
Offset 30:	Unsigned Byte		Minimum Demand Current-N Minute
Offset 31:	Unsigned Byte		Spare
Offset 32:	Signed Long	1	Minimum Demand KWatts-A
Offset 36:	Unsigned Byte		Minimum Demand KWatts-A Year
Offset 37:	Unsigned Byte		Minimum Demand KWatts-A Month
Offset 38:	Unsigned Byte		Minimum Demand KWatts-A Day
Offset 39:	Unsigned Byte		Minimum Demand KWatts-A Hour
Offset 40:	Unsigned Byte		Minimum Demand KWatts-A Minute
Offset 41:	Unsigned Byte		Spare
Offset 42	Signed Long	1	Minimum Demand KWatts-B
Offset 46:	Unsigned Byte		Minimum Demand KWatts-B Year
Offset 47:	Unsigned Byte		Minimum Demand KWatts-B Month
Offset 48:	Unsigned Byte		Minimum Demand KWatts-B Day
Offset 49:	Unsigned Byte		Minimum Demand KWatts-B Hour
Offset 50:	Unsigned Byte		Minimum Demand KWatts-B Minute
Offset 51:	Unsigned Byte		Spare
Offset 52:	Signed Long	1	Minimum Demand KWatts-C
Offset 56:	Unsigned Byte		Minimum Demand KWatts-C Year
Offset 57:	Unsigned Byte		Minimum Demand KWatts-C Month
Offset 58:	Unsigned Byte		Minimum Demand KWatts-C Day
Offset 59:	Unsigned Byte		Minimum Demand KWatts-C Hour
Offset 60:	Unsigned Byte		Minimum Demand KWatts-C Minute
Offset 61:	Unsigned Byte		Spare
Offset 62:	Signed Long	1	3 Phase Minimum Demand KWatts
Offset 66:	Unsigned Byte		3 Phase Minimum Demand KWatts Year
Offset 67:	Unsigned Byte		3 Phase Minimum Demand KWatts Month
Offset 68:	Unsigned Byte		3 Phase Minimum Demand KWatts Day
Offset 69:	Unsigned Byte		3 Phase Minimum Demand KWatts Hour
Offset 70:	Unsigned Byte		3 Phase Minimum Demand KWatts Minute
Offset 71:	Unsigned Byte		Spare
Offset 72:	Signed Long	1	Minimum Demand KVars-A
Offset 76:	Unsigned Byte		Minimum Demand KVars-A Year
Offset 77:	Unsigned Byte		Minimum Demand KVars-A Month
Offset 78:	Unsigned Byte		Minimum Demand KVars-A Day
Offset 79:	Unsigned Byte		Minimum Demand KVars-A Hour
Offset 80:	Unsigned Byte		Minimum Demand KVars-A Minute
Offset 81:	Unsigned Byte		Spare
Offset 82:	Signed Long	1	Minimum Demand KVars-B
Offset 86:	Unsigned Byte		Minimum Demand KVars-B Year
Offset 87:	Unsigned Byte		Minimum Demand KVars-B Month
Offset 88:	Unsigned Byte		Minimum Demand KVars-B Day
Offset 89:	Unsigned Byte		Minimum Demand KVars-B Hour
Offset 90:	Unsigned Byte		Minimum Demand KVars-B Minute
Offset 91:	Unsigned Byte		Spare
Offset 92:	Signed Long	1	Minimum Demand KVars-C

Offset 96:	Unsigned Byte		Minimum Demand KVars-C Year
Offset 97:	Unsigned Byte		Minimum Demand KVars-C Month
Offset 98:	Unsigned Byte		Minimum Demand KVars-C Day
Offset 99:	Unsigned Byte		Minimum Demand KVars-C Hour
Offset 100:	Unsigned Byte		Minimum Demand KVars-C Minute
Offset 101:	Unsigned Byte		Spare
Offset 102:	Signed Long	1	3 Phase Minimum Demand KVars
Offset 106:	Unsigned Byte		3 Phase Minimum Demand KVars Year
Offset 107:	Unsigned Byte		3 Phase Minimum Demand KVars Month
Offset 108:	Unsigned Byte		3 Phase Minimum Demand KVars Day
Offset 109:	Unsigned Byte		3 Phase Minimum Demand KVars Hour
Offset 110:	Unsigned Byte		3 Phase Minimum Demand KVars Minute
Offset 111:	Unsigned Byte		Spare

8.2.1.1.6 BLK 5: COUNTERS BLOCK

Overcurrent Trip Counters A, B, C, and N are available in DPU2000R with Recloser Curve Software option, catalog numbers XXXXXXXX-XXX2X or XXXXXXXX-XXX3X.

Block Offset	Data Size	Scale	Description
Offset 0:	Unsigned Short	1	Operations Counter
Offset 2:	Unsigned Short	1	Fault Counter
Offset 4:	Unsigned Short	1	Sum of Fault Currents, A
Offset 6:	Unsigned Short	1	Sum of Fault Currents, B
Offset 8:	Unsigned Short	1	Sum of Fault Currents, C
Offset 10:	Unsigned Short	1	Overcurrent Trip Counter
Offset 12:	Unsigned Short	1	Breaker Operations Counter
Offset 14:	Unsigned Short	1	Recloser Counter 1
Offset 16:	Unsigned Short	1	Stage 1 Reclose Counter
Offset 18:	Unsigned Short	1	Stage 2 Reclose Counter
Offset 20:	Unsigned Short	1	Stage 3 Reclose Counter
Offset 22:	Unsigned Short	1	Stage 4 Reclose Counter
Offset 24:	Unsigned Short	1	Recloser Counter 2
Offset 26:	Unsigned Short	1	Overcurrent Trip Counter A
Offset 28:	Unsigned Short	1	Overcurrent Trip Counter B
Offset 30:	Unsigned Short	1	Overcurrent Trip Counter C
Offset 32:	Unsigned Short	1	Overcurrent Trip Counter D

8.2.1.1.7 BLK 6: PHYSICAL and LOGICAL INPUT/OUTPUT BLOCK

Block Offset	Data Size	Description				
Offset 0:	Unsigned Long	Logical Output 0-31				
			Bit 31:	TRIP	Bit 15:	81S (2000R)
			Bit 30:	CLOSE	Bit 14:	81R (2000R)
			Bit 29:	ALARM	Bit 13:	PATA
			Bit 28:	27-1P	Bit 12:	PBTA
			Bit 27:	46	Bit 11:	PCTA
			Bit 26:	50P-1	Bit 10:	TCFA
			Bit 25:	50N-1	Bit 9:	TCC
			Bit 24:	50P-2	Bit 8:	79DA
			Bit 23:	50N-2	Bit 7:	PUA
			Bit 22:	50P-3	Bit 6:	79LOA
			Bit 21:	50N-3	Bit 5:	BFA
			Bit 20:	51P	Bit 4:	PPDA
			Bit 19:	51N	Bit 3:	NPDA
			Bit 18:	59 (2000R)	Bit 2:	BFUA
			Bit 17:	67P (2000R)	Bit 1:	KSI
			Bit 16:	67N (2000R)	Bit 0:	79CA
Offset 4:	Unsigned Long	Logical Output 32-63				
			Bit 31:	HPFA	Bit 15:	TRIPC
			Bit 30:	LPFA	Bit 14:	27-1P*
			Bit 29:	OCTC	Bit 13:	46*
			Bit 28:	50-1D	Bit 12:	50P-1*

			Bit 27:	50-2D	Bit 11:	50N-1*
			Bit 26:	STC	Bit 10:	50P-2*
			Bit 25:	ZSC	Bit 9:	50N-2*
			Bit 24:	PH3-D	Bit 8:	50P-3*
			Bit 23:	GRD-D	Bit 7:	50N-3*
			Bit 22:	32PA (2000R)	Bit 6:	51P*
			Bit 21:	32NA (2000R)	Bit 5:	51N*
			Bit 20:	27-3P	Bit 4:	59* (2000R)
			Bit 19:	VarDA	Bit 3:	67P* (2000R)
			Bit 18:	79CA-2	Bit 2:	67N* (2000R)
			Bit 17:	TRIPA	Bit 1:	81S1* (2000R)
			Bit 16:	TRIPB	Bit 0:	81R1* (2000R)
Offset 8:	Unsigned Long	Logical Output 64-95				
			Bit 31:	81O1* (2000R)	Bit 15:	LOADA
			Bit 30:	27-3P*	Bit 14:	81O1 (2000R)
			Bit 29:	TRIPA*	Bit 13:	81O2 (2000R)
			Bit 28:	TRIPB*	Bit 12:	81S2 (2000R)
			Bit 27:	TRIPC*	Bit 11:	81R2 (2000R)
			Bit 26:	ULO1 (2000R)	Bit 10:	81O2 (2000R)
			Bit 25:	ULO2 (2000R)	Bit 9:	81S2 (2000R)
			Bit 24:	ULO3 (2000R)	Bit 8:	81R2 (2000R)
			Bit 23:	ULO4 (2000R)	Bit 7:	CLTA
			Bit 22:	ULO5 (2000R)	Bit 6:	Watt1
			Bit 21:	ULO6 (2000R)	Bit 5:	Watt2
			Bit 20:	ULO7 (2000R)	Bit 4:	79CA*
			Bit 19:	ULO8 (2000R)	Bit 3:	79CA-2*
			Bit 18:	ULO9 (2000R)	Bit 2:	SEF*
			Bit 17:	PVArA	Bit 1:	SEF
			Bit 16:	NVArA	Bit 0:	BZA w/out SEF
Offset 12:	Unsigned Long	Logical Output 96-127				
			Bit 31:	BFT (2000R)	Bit 15:	LO1
			Bit 30:	ReTrip (2000R)	Bit 14:	LO2
			Bit 29:	BFT* (2000R)	Bit 13:	LO3
			Bit 28:	ReTrip* (2000R)	Bit 12:	LO4
			Bit 27:	32P-2 (2000R)	Bit 11:	LO5
			Bit 26:	32N-2 (2000R)	Bit 10:	LO6
			Bit 25:	32P-2* (2000R)	Bit 9:	LO7
			Bit 24:	32N-2* (2000R)	Bit 8:	LO8
			Bit 23:	BFA*	Bit 7:	TR_ON
			Bit 22:	25* (2000R)	Bit 6:	TR_OFF
			Bit 21:	25 (2000R)	Bit 5:	TR_TAG
			Bit 20:	SBA	Bit 4:	59-3p (DPU2000R)
			Bit 19:	79V	Bit 3:	59-3p* (DPU2000R)
			Bit 18:	RClin	Bit 2:	47 (DPU2000R)
			Bit 17:	59G	Bit 1:	47* (DPU2000R)
			Bit 16:	59G*	Bit 0:	50-3D
Offset 16:	Unsigned Long	Logical Input 0-31				
			Bit 31:	52a	Bit 15:	WCI
			Bit 30:	52b	Bit 14:	ZSC
			Bit 29:	43a	Bit 13:	OPEN
			Bit 28:	PH3	Bit 12:	CLOSE
			Bit 27:	GRD	Bit 11:	46
			Bit 26:	SCC	Bit 10:	67P (2000R)
			Bit 25:	79s	Bit 9:	67N (2000R)
			Bit 24:	79m	Bit 8:	ULI1 (2000R)
			Bit 23:	TCM	Bit 7:	ULI2 (2000R)
			Bit 22:	50-1	Bit 6:	ULI3 (2000R)
			Bit 21:	50-2	Bit 5:	ULI4 (2000R)
			Bit 20:	50-3	Bit 4:	ULI5 (2000R)

			Bit 19:	ALT1	Bit 3:	ULI6 (2000R)
			Bit 18:	ALT2	Bit 2:	ULI7 (2000R)
			Bit 17:	ECI1	Bit 1:	ULI8 (2000R)
			Bit 16:	ECI2	Bit 0:	ULI9 (2000R)
Offset 20:	Unsigned Long	Logical Input 32-63				
			Bit 31:	CRI	Bit 15:	LIS5(2000R)
			Bit 30:	ARCI	Bit 14:	LIS6(2000R)
			Bit 29:	TARC	Bit 13:	LIS7(2000R)
			Bit 28:	SEF TC	Bit 12:	LIS8(2000R)
			Bit 27:	EXTBFI (2000R)	Bit 11:	LIR1(2000R)
			Bit 26:	BFI (2000R)	Bit 10:	LIR2(2000R)
			Bit 25:	UDI	Bit 9:	LIR3(2000R)
			Bit 24:	25 (2000R)	Bit 8:	LIR4(2000R)
			Bit 23:	25By (2000R)	Bit 7:	LIR5(2000R)
			Bit 22:	LOCAL	Bit 6:	LIR6(2000R)
			Bit 21:	TGT	Bit 5:	LIR7(2000R)
			Bit 20:	SIA	Bit 4:	LIR8(2000R)
			Bit 19:	LIS1(2000R)	Bit 3:	TR_SET(2000R)
			Bit 18:	LIS2(2000R)	Bit 2:	TR_RST(2000R)
			Bit 17:	LIS3(2000R)	Bit 1:	
			Bit 16:	LIS4(2000R)	Bit 0:	
Offset 24:	Unsigned Long	Logical Input 64-95 (Reserved)				
Offset 28:	Unsigned Long	Logical Input 96-127 (Reserved)				
Offset 32:	Unsigned Short	Physical Output				
			Bit 15:	Reserved	Bit 7:	OUT6
			Bit 14:	Reserved	Bit 6:	OUT5
			Bit 13:	Reserved	Bit 5:	OUT4
			Bit 12:	Reserved	Bit 4:	OUT3
			Bit 11:	Reserved	Bit 3:	OUT2
			Bit 10:	Reserved	Bit 2:	OUT1
			Bit 9:	Reserved	Bit 1:	CLOSE (Reserved)
			Bit 8:	Reserved	Bit 0:	TRIP
Offset 34:	Unsigned Short	Physical Input				
			Bit 15:	Reserved	Bit 7:	IN5
			Bit 14:	Reserved	Bit 6:	IN4
			Bit 13:	Reserved	Bit 5:	IN3
			Bit 12:	Reserved	Bit 4:	IN2
			Bit 11:	Reserved	Bit 3:	IN1
			Bit 10:	IN8 (2000R) IN6 (1500R)	Bit 2:	Reserved
			Bit 9:	IN7 (2000R)	Bit 1:	Reserved
			Bit 8:	IN6 (2000R)	Bit 0:	Reserved
Offset 36:	Unsigned Short	Forced Physical Inputs Normal State Mask 0=Normal state, 1=Normal state override or return to Normal state				
			Bit 15:	Reserved	Bit 7:	IN5
			Bit 14:	Reserved	Bit 6:	IN4
			Bit 13:	Reserved	Bit 5:	IN3
			Bit 12:	Reserved	Bit 4:	IN2
			Bit 11:	Reserved	Bit 3:	IN1
			Bit 10:	IN8 (2000R) IN6 (1500R)	Bit 2:	Reserved
			Bit 9:	IN7 (2000R)	Bit 1:	Reserved
			Bit 8:	IN6 (2000R)	Bit 0:	Reserved
Offset 38:	Unsigned Short	Forced Physical Inputs Forcing State Mask If Forced Physical Inputs Normal State Mask bit is set then 0=Forcing Reset state or Open, 1=Forcing Set state or Close				
			Bit 15:	Reserved	Bit 7:	IN5
			Bit 14:	Reserved	Bit 6:	IN4
			Bit 13:	Reserved	Bit 5:	IN3

Bit 12:	Reserved	Bit 4:	IN2
Bit 11:	Reserved	Bit 3:	IN1
Bit 10:	IN8 (2000R) IN6 (1500R)	Bit 2:	Reserved
Bit 9:	IN7 (2000R)	Bit 1:	Reserved
Bit 8:	IN6 (2000R)	Bit 0:	Reserved

Offsets 36 and 38, two 16 bit words, Forced Physical Inputs Normal State mask and Forced Physical Inputs Forcing State mask, indicate which inputs to force and the state to which they are being forced. If the bit specific to an input is reset in the Normal State mask then all input operations for that input will proceed according to normal logical conditions. If the Normal State mask bit specific to an input is set then all input operations for that input will be ignored and the Forcing State mask will be utilized to force the input condition indicated by the Forcing State mask.

Offset 40: Unsigned Short Forced Physical Outputs Normal State Mask
0=Normal state, 1=Normal state override or return to Normal state

Bit 15:	Spare	Bit 7:	OUT6
Bit 14:	Spare	Bit 6:	OUT5
Bit 13:	Spare	Bit 5:	OUT4
Bit 12:	Spare	Bit 4:	OUT3
Bit 11:	Spare	Bit 3:	OUT2
Bit 10:	Spare	Bit 2:	OUT1
Bit 9:	Reserved	Bit 1:	CLOSE (Reserved)
Bit 8:	Reserved	Bit 0:	TRIP

Offset 42: Unsigned Short Forced Physical Outputs Forcing State Mask
If Forced Physical Outputs Normal State Mask bit is set then
0=Forcing Reset state or De-Assert, 1=Forcing Set state or Assert

Bit 15:	Spare	Bit 7:	OUT6
Bit 14:	Spare	Bit 6:	OUT5
Bit 13:	Spare	Bit 5:	OUT4
Bit 12:	Spare	Bit 4:	OUT3
Bit 11:	Spare	Bit 3:	OUT2
Bit 10:	Spare	Bit 2:	OUT1
Bit 9:	Reserved	Bit 1:	CLOSE (Reserved)
Bit 8:	Reserved	Bit 0:	TRIP

Offsets 40 and 42, two 16 bit words, Forced Physical Outputs Normal State mask and Forced Physical Outputs Forcing State mask, indicate which outputs to force and the state to which they are being forced. If the bit specific to an output is reset in the Normal State mask then all output operations for that output will proceed according to normal logical conditions. If the Normal State mask bit specific to an output is set then all output operations for that output will be ignored and the Forcing State mask will be utilized to force the output condition indicated by the Forcing State mask.

Offset 44: Unsigned Long Forced Logical Inputs Normal State Mask
0=Normal state, 1=Normal state override or return to Normal state

Bit 31:	FLI31	Bit 15:	FLI15
Bit 30:	FLI30	Bit 14:	FLI14
Bit 29:	FLI29	Bit 13:	FLI13
Bit 28:	FLI28	Bit 12:	FLI12
Bit 27:	FLI27	Bit 11:	FLI11
Bit 26:	FLI26	Bit 10:	FLI10
Bit 25:	FLI25	Bit 9:	FLI09
Bit 24:	FLI24	Bit 8:	FLI08
Bit 23:	FLI23	Bit 7:	FLI07
Bit 22:	FLI22	Bit 6:	FLI06
Bit 21:	FLI21	Bit 5:	FLI05
Bit 20:	FLI20	Bit 4:	FLI04
Bit 19:	FLI19	Bit 3:	FLI03
Bit 18:	FLI18	Bit 2:	FLI02
Bit 17:	FLI17	Bit 1:	FLI01
Bit 16:	FLI16	Bit 0:	FLI00

Offset 48: Unsigned Long Forced Logical Inputs Forcing State Mask

If Forced Logical Inputs Normal State Mask bit is set then
0=Forcing Reset state or Open, 1=Forcing Set state or Close

Bit 31:	FLI31	Bit 15:	FLI15
Bit 30:	FLI30	Bit 14:	FLI14
Bit 29:	FLI29	Bit 13:	FLI13
Bit 28:	FLI28	Bit 12:	FLI12
Bit 27:	FLI27	Bit 11:	FLI11
Bit 26:	FLI26	Bit 10:	FLI10
Bit 25:	FLI25	Bit 9:	FLI09
Bit 24:	FLI24	Bit 8:	FLI08
Bit 23:	FLI23	Bit 7:	FLI07
Bit 22:	FLI22	Bit 6:	FLI06
Bit 21:	FLI21	Bit 5:	FLI05
Bit 20:	FLI20	Bit 4:	FLI04
Bit 19:	FLI19	Bit 3:	FLI03
Bit 18:	FLI18	Bit 2:	FLI02
Bit 17:	FLI17	Bit 1:	FLI01
Bit 16:	FLI16	Bit 0:	FLI00

Offsets 44 and 48, four 32 bit words, the Forced Logical Inputs Normal State mask and Forced Logical Inputs Forcing State mask, indicate which inputs to force and the state to which they are being forced. If the bit specific to an input is reset in the Normal State masks then all input operations for that input will proceed according to normal logical conditions. If the Normal State mask bit specific to an input is set in the Normal State masks then all input operations for that input will be ignored and the Forcing State mask will be utilized to force the input condition indicated by the Forcing State mask.

Offset 52: Unsigned Long Logical Output 128 – 159 (DPU2000R only, out_stat_4)

Bit 31:	21P-1	Bit 15:	TimeT
Bit 30:	21P-1*	Bit 14:	InstT
Bit 29:	21P-2	Bit 13:	NegSeqT
Bit 28:	21P-2*	Bit 12:	FreqT
Bit 27:	21P-3	Bit 11:	DirT
Bit 26:	21P-3*	Bit 10:	VoltT
Bit 25:	21P-4	Bit 9:	DistT
Bit 24:	21P-4*	Bit 8:	SEFT
Bit 23:	C1	Bit 7:	ULO 10
Bit 22:	C2	Bit 6:	ULO 11
Bit 21:	C3	Bit 5:	ULO 12
Bit 20:	C4	Bit 4:	ULO 13
Bit 19:	C5	Bit 3:	ULO 14
Bit 18:	C6	Bit 2:	ULO 15
Bit 17:	TripT	Bit 1:	ULO 16
Bit 16:	NTA	Bit 0:	HBHL

Offset 56: Unsigned Long Logical Output 160 – 191 (DPU2000R only, out_stat_5)

Bit 31:	HBDL	Bit 15:	
Bit 30:	DBHL	Bit 14:	
Bit 29:	DBDL	Bit 13:	
Bit 28:	46A	Bit 12:	
Bit 27:	46A*	Bit 11:	
Bit 26:	REMOTE_D	Bit 10:	
Bit 25:		Bit 9:	
Bit 24:		Bit 8:	
Bit 23:		Bit 7:	
Bit 22:		Bit 6:	
Bit 21:		Bit 5:	
Bit 20:		Bit 4:	
Bit 19:		Bit 3:	
Bit 18:		Bit 2:	
Bit 17:		Bit 1:	
Bit 16:		Bit 0:	

8.2.2 Transmit Modbus ™ Extended Register Set Command (3 1 2)

NOTE: The Modbus™ register based command, 3-1-2, is available in DPU2000R series, CPU V1.80 and above and DPU1500R. See Modbus/Modbus Plus Protocol Document for 6X Register Definitions.

Data Byte	Definition
1/1	Address High Byte (Use 6XXXX-60000)
1/2	Address Low Byte
1/3	Number of **WORDS** (2 byte quantities) to Retrieve (1-65)

Msg Byte	Definition
1/1	Relay Status Byte Bit 7: Control Power Cycled Bit 6: New Fault Recorded Bit 5: Alternate 2 Settings Active Bit 4: Alternate 1 Settings Active Bit 3: Remote Edit Disable Bit 2: Local Settings Changed Bit 1: Contact Input Chnaged Bit 0: Selftest Status
1/2	Command + Subcommand = 12
1/3	Total Number of Messages
2/1	Data Word 0 High Byte
2/2	Data Word 0 Low Byte
2/3	Data Word 1 High Byte
3/1	Data Word 1 Low Byte
.	.
.	.
.	.
TotalMsg/1	Data Word n Low Byte (or could be spare used to fill out last message)
TotalMsg/2	Checksum High Byte
TotalMsg/3	Checksum Low Byte

8.2.3 Receive Modbus ™ Extended Register Set Command (3 1 3)

NOTE: The Modbus™ register based command, 3-1-2, is available in DPU2000R series, CPU V1.80 and above and DPU1500R. See Modbus/Modbus Plus Protocol Document for 6X Register Definitions.

Data Byte	Definition
1/1	Address High Byte (Use 6XXXX-60000)
1/2	Address Low Byte
1/3	Number of **WORDS** (2 byte quantities) to Write (1-65)
2/1	Data Word 0 High Byte
2/2	Data Word 0 Low Byte
2/3	Data Word 1 High Byte
3/1	Data Word 1 Low Byte
.	.
.	.
.	.
TotalMsg/1	Data Word n Low Byte (or could be spare used to fill out last message)
TotalMsg/2	Checksum High Byte
TotalMsg/3	Checksum Low Byte

8.2.4 Receive Modbus ™ Extended Register Set Command (3 1 6)

NOTE: The Modbus™ register based command, 3-1-2, is available in DPU2000R series, CPU V1.80 and above and DPU1500R. See Modbus/Modbus Plus Protocol Document for 6X Register Definitions.

Data Byte	Definition
1/1	Number of messages, starting from message 2 on.
1/2	0

1/3	0
2/1	Modbus RTU Query 1st byte
2/2	Modbus RTU Query 2nd byte
2/3	Modbus RTU Query 3rd byte
3/1	Modbus RTU Query ….
.	.
.	.
.	.
TotalMsg/1	Modbus RTU Query Last byte – CRC Hi
TotalMsg/2	Checksum High Byte
TotalMsg/3	Checksum Low Byte

Note: the total Number of bytes sent must be a multiple of 3. If the 'Checksum Low Byte' does not fall into TotalMsg/3 then fill in with 0 until you get to TotalMsg/3. Ex if 'Checksum Low Byte' falls into TotalMsg/1 then TotalMsg/2 and TotalMsg/3 would each be set to 0. Any Modbus™ query that is supported in the Modbus™ protocol document for the DPU2000R can be sent using this INCOM command.

8.3 Transmit Buffer "33N" Commands (3 3 n)

N	Definition
0	Reserved for repeat 3 3 n
1	Communications Settings
2	Counter Settings
3	Master Trip Output Assignment
4	Breaker Fail Settings

8.3.1 Transmit Communications Settings (3 3 1)

Low byte consists of bits 0 through 7.
High byte consists of bits 8 through 15.

Port configuration byte
- bit 0-3 = port baud rate
  - where 0 = 300, 1 = 1200, 2 = 2400, 3 = 4800, 4 = 9600, 5 = 19200, 6 = 38400
- bit 4-5 = parity (0=None, 1=Odd, 2=Even)
- bit 6 = number of data bits (0=seven,1=eight)
- bit 7 = number of stop bits (0=one,1=two)

Valid Frame Combinations: EVEN 7 1, ODD 7 1, NONE 8 1, EVEN 8 1, ODD 8 1, NONE 8 2, NONE 7 2

Msg byte	Definition
1/1	Relay Status (see command 3 4 1, msg 1/1)
1/2	Command + Subcommand = 0x31
1/3	Total Number of Messages = 9
2/1	Unit Address high byte
2/2	Unit Address low byte
2/3	Front Panel RS232 configuration byte
3/1	Rear Panel RS232 or INCOM configuration byte
3/2	Rear Panel RS485 configuration byte
3/3	Rear Panel IRIG byte 0=Disable; 1=Enable-cc, time stamp HH:MM:SS.cc; 2=Enable-mmm, time stamp HH:MM:SS.mmm
4/1	Spare
4/2	Spare
4/3	Aux Port Parameter 1 byte (0-255)
5/1	Aux Port Parameter 2 byte (0-255)
5/2	Aux Port Parameter 3 byte (0-255)

5/3	Aux Port Parameter 4 byte (0-255)
6/1	Aux Port Parameter 5 byte (0-255)
6/2	Aux Port Parameter 6 byte (0-255)
6/3	Aux Port Parameter 7 byte (0-255)
7/1	Aux Port Parameter 8 byte (0-255)
7/2	Aux Port Parameter 9 byte (0-255)
7/3	Aux Port Parameter 10 byte (0-255)
8/1	Aux Port Parameter Mode byte (0-255)
	Bit 0: Par Mode 1 (0=Disable, 1=Enable)
	Bit 1: Par Mode 2 (0=Disable, 1=Enable)
	Bit 2: Par Mode 3 (0=Disable, 1=Enable)
	Bit 3: Par Mode 4 (0=Disable, 1=Enable)
	Bit 4: Par Mode 5 (0=Disable, 1=Enable)
	Bit 5: Par Mode 6 (0=Disable, 1=Enable)
	Bit 6: Par Mode 7 (0=Disable, 1=Enable)
	Bit 7: Par Mode 8 (0=Disable, 1=Enable)
8/2	Spare
8/3	Spare
9/1	Spare
9/2	Checksum high byte
9/3	Checksum low byte

8.3.2 Transmit Counter Settings (3 3 2)

NOTE: Overcurrent Trip Counters A, B, C, and N are available with Recloser Curve Software option, catalog numbers XXXXXXXX-XXX2X or XXXXXXXX-XXX3X. In DPU2000 series, CPU V1.41 or higher is required for the Recloser Curve Software option.

Low byte consists of bits 0 through 7.
High byte consists of bits 8 through 15.

Msg byte	Definition
1/1	Relay Status (see command 3 4 1, msg 1/1)
1/2	Command + Subcommand = 0x32
1/3	Total Number of Messages = 15
2/1	KSI Sum A Counter high byte (0-9999)
2/2	KSI Sum A Counter low byte
2/3	KSI Sum B Counter high byte (0-9999)
3/1	KSI Sum B Counter low byte
3/2	KSI Sum C Counter high byte (0-9999)
3/3	KSI Sum C Counter low byte
4/1	Over Current Trip Counter high byte (0-9999)
4/2	Over Current Trip Counter low byte
4/3	Breaker Operations Counter high byte (0-9999)
5/1	Breaker Operations Counter low byte
5/2	Reclose Counter 1 high byte (0-9999)
5/3	Reclose Counter 1 low byte
6/1	1^{st} Reclose Counter high byte (0-9999)
6/2	1^{st} Reclose Counter low byte
6/3	2^{nd} Reclose Counter high byte (0-9999)
7/1	2^{nd} Reclose Counter low byte
7/2	3^{rd} Reclose Counter high byte (0-9999)
7/3	3^{rd} Reclose Counter low byte
8/1	4^{th} Reclose Counter high byte (0-9999)
8/2	4^{th} Reclose Counter low byte
8/3	Reclose Counter 2 high byte (0-9999)
9/1	Reclose Counter 2 low byte
9/2	Overcurrent Trip A Counter high byte (0-9999), (DPU2000/R)
9/3	Overcurrent Trip A Counter low byte
10/1	Overcurrent Trip B Counter high byte (0-9999) , (DPU2000/R)
10/2	Overcurrent Trip B Counter low byte

10/3	Overcurrent Trip C Counter high byte (0-9999) , (DPU2000/R)
11/1	Overcurrent Trip C Counter low byte
11/2	Overcurrent Trip N Counter high byte (0-9999) , (DPU2000/R)
11/3	Overcurrent Trip N Counter low byte
12/1	SPARE
12/2	SPARE
12/3	SPARE
13/1	SPARE
13/2	SPARE
13/3	SPARE
14/1	SPARE
14/2	SPARE
14/3	SPARE
15/1	SPARE
15/2	Checksum high byte
15/3	Checksum low byte

8.3.3 Transmit Master Trip Output Assignment (3 3 3)

NOTE: In DPU2000 series, CPU V1.70 or higher is required.

Msg/Byte	Definition		
1/1	Relay Status (see command 3 4 1, msg 1/1)		
1/2	Command + Subcommand = 0x33		
1/3	Total Number of Messages = 5		
2/1	Master Trip Assignment, Byte 1		
		Bit 0:	SPARE
		Bit 1:	SPARE
		Bit 2:	SPARE
		Bit 3:	SPARE
		Bit 4:	SPARE
		Bit 5:	SPARE
		Bit 6:	SPARE
		Bit 7:	SPARE
2/2	Master Trip Assignment, Byte 2		
		Bit 0:	SPARE
		Bit 1:	SPARE
		Bit 2:	SPARE
		Bit 3:	SPARE
		Bit 4:	SPARE
		Bit 5:	SPARE
		Bit 6:	SPARE
		Bit 7:	SPARE
2/3	Master Trip Assignment, Byte 3		
		Bit 0:	67P (DPU2000 and DPU2000R)
		Bit 1:	67N (DPU2000 and DPU2000R)
		Bit 2:	46
		Bit 3:	SPARE
		Bit 4:	SPARE
		Bit 5:	SPARE
		Bit 6:	SPARE
		Bit 7:	SPARE
3/1	Master Trip Assignment, Byte 4		
		Bit 0:	50N-1
		Bit 1:	50N-2
		Bit 2:	50N-3
		Bit 3:	51N
		Bit 4:	50P-1
		Bit 5:	50P-2
		Bit 6:	50P-3

		Bit 7: 51P
3/2	Spare	
3/3	Spare	
4/1	Spare	
4/2	Spare	
4/3	Spare	
5/1	Spare	
5/2	Checksum, high byte	
5/3	Checksum, low byte	

8.3.4 Transmit Breaker Fail Settings (3 3 4)

NOTE: In DPU2000 series, CPU V1.70 or higher is required. This command is NOT available in the DPU1500R series.

Msg/Byte	Definition
1/1	Relay Status (see command 3 4 1, msg 1/1)
1/2	Command + Subcommand = 0x34
1/3	Total Number of Messages = 7
2/1	Enable (1=ON, 0=OFF)
2/2	BFT Pickup Time Delay (high byte) (0.00 to 10.00 sec. In 0.01 sec. Steps)
2/3	BFT Pickup Time Delay (low byte)
3/1	BFT Drop Time Delay (0.0 to 10.0 cycles in 0.25 steps)
3/2	BFT Starters
	Bit 0: External input
	Bit 1: Phase Level Detector
	Bit 2: Neutral Level Detector
3/3	ReTrip Pickup Time Delay (high byte) (0.00 to 10.00 sec. In 0.01 sec. Steps)
4/1	ReTrip Pickup Time Delay (low byte)
4/2	ReTrip Drop Time Delay (0.0 to 10.0 cycles in 0.25 steps)
4/3	ReTrip Starters
	Bit 0: External input
	Bit 1: Phase Level Detector
	Bit 2: Neutral Level Detector
5/1	Phase Level Detector Pickup (5 to 100% of 51P in 5% steps)
5/2	Neutral Level Detector Pickup (5 to 100% of 51N in 5% steps)
5/3	Spare
6/1	Spare
6/2	Spare
6/3	Spare
7/1	Spare
7/2	Checksum, high byte
7/3	Checksum, low byte

8.4 Transmit Buffer "3-4-N" Commands (3 4 n)

N	Definition
0	Reserved for repeat 3 4 n
1	Input Select and Index Tables
2	Programmable Input Negated AND Table
3	Programmable Input AND/OR Table
4	Programmable Input User Defined Input Names
5	Programmable Output Select Table
6	Programmable Output AND/OR Table
7	Programmable Output User Defined Output Strings
8	Primary Relay Settings
9	Alternate 1 Relay Settings
10	Alternate 2 Relay Settings
11	Configuration Settings
12	Counter Settings
13	Alarm Settings
14	Real Time Clock
15	Programmable Output Delays

8.4.1 Transmit Programmable Input Select and Index (3 4 1)

Bit Position:	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
DPU2000:	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
DPU2000R:	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	C6	C5	C4	C3	C2	C1
DPU1500R:	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Bit Position:	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
DPU2000:	IN12	IN13	IN5	IN6	IN7	IN8	IN11	IN1	52A	52B	43A	IN10	IN2	IN9	IN4	IN3
DPU2000R:	FB8	FB7	IN5	IN6	IN7	IN8	FB6	IN1	FB5	FB4	FB3	FB2	IN2	FB1	IN4	IN3
DPU1500R:	N/A	N/A	IN5	N/A	N/A	IN6	N/A	IN1	N/A	N/A	N/A	N/A	IN2	N/A	IN4	IN3

Figure 9 – Physical Input Mapping

Programmable Input Definitions

Physical Input: The opto-isolated binary input that allows external control by physically wiring the input terminals of the relay. Physical inputs are labeled (IN1, IN2, IN3, …, 43A, 52A, 52B).

Logical Input: An input equated by the boolean combination of the physical inputs. These inputs are used by the relay's state machine and control subroutines. Logical Inputs are labeled (PH3, GRD, TCM, …). See protocol document paragraph 4.1 for additional labels.

Active Open: This defines the type of connection from the physical input or inputs and means the physical state of the opto-isolator's logic is inverted. Example: if the voltage across IN1's terminals equals zero, then the boolean equation will evaluate this term as a logical one. Likewise, when a volatge is applied to IN1, the boolean equation will evaluate this term as a logical zero.

Active Closed: This defines the type of connection from the physical input or inputs and means that the physical state of the opto-isolator's logic is the non-inverted. Example: if a voltage is applied across IN1's terminals, then the boolean equation will evaluate this term as a logical one. Likewise, when a volatge is applied to IN1, the boolean equation will evaluate this term as a logical zero.

Example of a boolean input equation:

Logical Ored Physical

50-1 = IN1 + IN2 + IN3

Logical ANDed Physical

GRD = IN1 * IN2 * IN3

Input Select:
The physical inputs are associated with a bit mask to determine which inputs are used when resolving the logical input's boolean equation. If the appropriate bit is set, the term will be included as part of the equation. Likewise, a cleared bit indicates that the physical input term will be ignored.

The bit assignment mask for the physical inputs are as follows:

0 = IN3, 1 = IN4, 2 = IN9, 3 = IN2, 4 = IN10, 5 = 43A, 6 = 52B, 7 = 52A, 8 = IN1, 9 = IN11, 10 = IN8, 11 = IN7, 12 = IN6, 13 = IN5, 14 = IN13, 15 = IN12.

Negated AND Input:
This is a bit mask that indicates if a selected input is inverted based on the active open or closed state. The bit mask uses the same associated physical inputs pattern as in the Input Select data.

AND/OR Select:
The combination of the physical inputs' state used to resolve the boolean equation allows for the algebraic ANDing or Oring of all of the selected physical inputs.

User Definable Names:
Physical inputs, IN1 – IN13, have memory allocated for an eight character (NULL is implied in character 9) user definable strings.

Four protocol commands are required to view or change the relay's programmable input setting tables. The command order for viewing these tables can be retrieved in any sequence, but when the settings are sent to the relay, the commands must be sent in the following sequence:

3 11 1: Recieve Programmable Input Select and Index data.
3 11 2: Recieve Programmable Negated AND Input data.
3 11 3: Recieve Programmable Input AND/OR Select data.
3 11 4: Recieve Programmable Input User Defined Name data.

Up to 29 logical inputs may selected at any one time. The protocol document refers to these generic logical inputs as INPUT1 – INPUT29.

Example:
We want the PH3 logical input to be the combination of the physical inputs IN4 AND NOT IN3 AND ALT1 logical input to be the combination of the physical inputs IN1 OR IN3 OR NOT IN5.

PH3 = IN4 * !IN3
ALT1 = IN1 + IN3 + !IN5

First, generic inputs must be selected to setup the logic equation and for this case INPUT3 is used for PH3 and INPUT8 is used for ALT1. Note, any inputs 1-29 could be valid selections. The data values required for these selections use the the INDEX table defined in the protocol document in section 4.1 and 11.1.

Command	Msg/byte	HexData	Comment
3 11 1	5/1	0xFF	No physicals selected for INPUT3 Input Select high byte
3 11 1	5/2	0xFA	Selects IN3 and IN4 bits for INPUT3 Input Select low byte
3 11 1	5/3	0x03	Assigning PH3 offset to INPUT3 for Input Index
3 11 1	10/1	0xB7	Selects IN1 and IN5 bits for INPUT8 Input Select high byte
3 11 1	10/2	0xF7	Selects IN3 bit for INPUT8 Input Select low byte
3 11 1	10/3	0x03	Assigning ALT1 offset to INPUT8 for Input Index
3 11 2	4/1	0xFF	No physical's logic inverted for INPUT3 Negated AND Input high byte
3 11 2	4/2	0xF7	Inverts IN3's logical state for INPUT3 Negated AND Input low byte
3 11 2	7/3	0xBF	Inverts IN5's logical state for INPUT8 Negated AND Input high byte
3 11 2	8/1	0xFF	No physical's logic inverted for INPUT8 Negated AND Input low byte

3 11 3	3/1	0x00	Boolean combination of INPUT3 selected
3 11 3	3/2	0x00	physical logic are ANDed, all other
3 11 3	3/3	0x00	INPUT1,2,4-29 are Ored together
3 11 3	4/1	0x04	

Bit = 0, Physical Input is selected.
Bit = 1, Physical Input is not selected.
Low byte consists of bits 0 through 7.
High byte consists of bits 8 through 15.
Index byte is the offset into the DPU's logical input structure.

Logical Input List for DPU2000 – Requires matrix (29 x 16) to allow user to map 29 Logical Inputs to 13 Physical Inputs plus "43A", "52A", and "52B". Logical Inputs include: "TCM", "GRD", "PH3", "50-1", "50-2", "50-3", "ALT1", "ALT2", "ZSC", "SCC", "79S", "79M", "OPEN", "CLOSE", "ECI1", "ECI2", "WCI", "46", "67P", "67N", "ULI1", "ULI2", "ULI3", "ULI4", "ULI5", "ULI6", "ULI7", "ULI8", "ULI9", "CRI", "UDI".

Logical Input List for DPU2000R – Requires matrix (29 x 16) to allow user to map 29 Logical Inputs to 8 Physical Inputs plus 8 Feedback Inputs. Logical Inputs include: "52A", "52B", "43A", "TCM", "GRD", "PH3", "50-1", "50-2", "50-3", "ALT1", "ALT2", "ZSC", "SCC", "79S", "79M", "OPEN", "CLOSE", "ECI1", "ECI2", "WCI", "46", "67P", "67N", "ULI1", "ULI2", "ULI3", "ULI4", "ULI5", "ULI6", "ULI7", "ULI8", "ULI9", "CRI", "ARCI", "TARC", "SEF" (*Sensitive Earth Model*), "EXTBF", "BFI", "UDI", "25"(*Synch Check Model*), "25By"(*Synch Check Model*). The following logical inputs are available in CPU versions greater than 1.92: "LOCAL", "TGT", "SIA". The following logical inputs are available in CPU version greater than 4.02 (2.01 for PTH): LIS1, LIS2, LIS3, LIS4, LIS5, LIS6, LIS7, LIS8, LIR1, LIR2, LIR3, LIR4, LIR5, LIR6, LIR7, LIR8, TR_SET, TR_RST.

Logical Input List for DPU1500R – Requires matrix (29 x 6) to allow user to map 29 Logical Inputs to 6 Physical Inputs. Logical Inputs include: "52A", "52B", "43A", "TCM", "GRD", "PH3", "50-1", "50-2", "50-3", "ALT1", "ALT2", "ZSC", "SCC", "79S", "79M", "OPEN", "CLOSE", "ECI1", "ECI2", "WCI", "46", "CRI", "ARCI", "TARC", "SEF" (*Sensitive Earth Model*), "UDI", "LOCAL", "TGT", "SIA".

Table 2 below has the complete listing of Logical Input Offsets and their respective definitions.

Table 2-Logical Input Definitions

Index	Logical Input	Definition
00	52A	Breaker Position – Closed or Open per breaker
01	52B	Breaker Position – Open or Closed opposite of breaker
02	43A	Reclose Function – Enabled or Disabled
03	PH3	Phase Torque Control
04	GRD	Ground Torque Control
05	SCC	Spring Charging Contact
06	79S	Single Shot Reclosing
07	79M	Multi Shot Reclosing
08	TCM	Trip Coil Monitoring
09	50-1	Enables instantaneous over-currents: 50P-1, 50N-1
10	50-2	Enables instantaneous over-currents: 50P-2, 50N-2
11	50-3	Enables instantaneous overcurrents: 50P-3, 50N-3
12	ALT1	Enables ALT1 settings
13	ALT2	Enables ALT2 settings
14	ECI1	Event Capture Initiate - data recorded in fault record
15	ECI2	Event Capture Initiate – data recorded in fault record
16	WCI	Waveform Capture Initiate
17	ZSC	Zone Sequence Co-ordination
18	Open	Initiate a circuit breaker Trip
19	Close	Initiate a circuit breaker Close
20	46	Enables 46 protective function
21	67P	Enables 67P protective function (DPU2000/R)
22	67N	Enables 67N protective function (DPU2000/R)
23	ULI1	User Logical Input – asserts ULO1 (DPU2000/R)
24	ULI1	User Logical Input – asserts ULO1 (DPU2000/R)
25	ULI1	User Logical Input – asserts ULO1 (DPU2000/R)
26	ULI1	User Logical Input – asserts ULO1 (DPU2000/R)
27	ULI1	User Logical Input – asserts ULO1 (DPU2000/R)
28	ULI1	User Logical Input – asserts ULO1 (DPU2000/R)
29	ULI1	User Logical Input – asserts ULO1 (DPU2000/R)
30	ULI1	User Logical Input – asserts ULO1 (DPU2000/R)
31	ULI1	User Logical Input – asserts ULO1 (DPU2000/R)
32	CRI	Counter Reset Input – resets all over-current and recloser counters
33	ARCI	Timed reclose block
34	TARC	Initiate Trip and Automatic Reclose
35	SEF	Enables Sensitive Earth Fault
36	EXTBFI	External Starter Input (DPU2000/R)
37	BFI	Breaker Fail Initiate (DPU2000/R)
38	UDI	User-defined Display Input
39	25	Enables Synchronism Check function (DPU2000/R)
40	25 BYP	Synchronism Check Bypass
41	LOCAL	Local enable
42	TGT	Resets target alarms and target LEDs
43	SIA	Resets seal-in alarms
44	LIS1	Set #1 Latching Logical I/O
45	LIS2	Set #2 Latching Logical I/O
46	LIS3	Set #3 Latching Logical I/O
47	LIS4	Set #4 Latching Logical I/O
48	LIS5	Set #5 Latching Logical I/O
49	LIS6	Set #6 Latching Logical I/O
50	LIS7	Set #7 Latching Logical I/O
51	LIS8	Set #8 Latching Logical I/O
52	LIR1	Reset #1 Latching Logical I/O
53	LIR2	Reset #2 Latching Logical I/O
54	LIR3	Reset #3 Latching Logical I/O

Index	Logical Input	Definition
55	LIR4	Reset #4 Latching Logical I/O
56	LIR5	Reset #5 Latching Logical I/O
57	LIR6	Reset #6 Latching Logical I/O
58	LIR7	Reset #7 Latching Logical I/O
59	LIR8	Reset #8 Latching Logical I/O
60	TR_SET	Set Hot-Line-Tag function
61	TR_RST	Reset Hot-Line-Tag function
62	ULI 10	User Logical Input 10
63	ULI 11	User Logical Input 11
64	ULI 12	User Logical Input 12
65	ULI 13	User Logical Input 13
66	ULI 14	User Logical Input 14
67	ULI 15	User Logical Input 15
68	ULI 16	User Logical Input 16
69	46A TC	46A Torque Control Input
70	SWSET	Logical Input that on rising edge will switch enabled settings groups
71	SHIFTA	Rising Edge Trigger for Barrel Shifter A
72	SHIFTB	Rising Edge Trigger for Barrel Shifter B

Example : if message 2/1 = hex 24
2/2 = hex 11
2/3 = hex 4

Then I/O word is 00100100 00010001 hex 2411. All of these outputs are mapped onto GND (04 offset). Note the Physical Inputs are translated using the physical input table below.

In the example IN3, IN10, IN8 and IN5 are selected for GND. The AND/OR selection and enable disable mapping is selected with commands 3 11 3 and 3 11 2.

Msg byte	Definition
1/1	Relay Status (Note: the relay status is cleared by the 3 0 8 command) Bits that are set to 1 is an indication the condition exists. Bit 0 : SelfTest Status Bit 1 : Contact Input Status changed Bit 2 : Local Settings Change Bit 3 : Remote Edit Disabled. Bit 4 : Alternate Settings Group 1 Active. Bit 5 : Alternate Setting Group 2 Active. Bit 6 : Fault Record Logged. Bit 7 : Power was Cycled
1/2	Command + Subcommand = 0x41
1/3	Total Number of Messages = 31
2/1	INPUT1 high byte (per bits 0-7 in Figure 9, on page 159)
2/2	INPUT1 low byte (per bits 8-15 in Figure 9, on page 159)
2/3	INPUT1 index byte (per Table 2, on page 162)
3/1	INPUT2 high byte
3/2	INPUT2 low byte
3/3	INPUT2 index byte
4/1	INPUT3 high byte
4/2	INPUT3 low byte
4/3	INPUT3 index byte
5/1	INPUT4 high byte
5/2	INPUT4 low byte
5/3	INPUT4 index byte
6/1	INPUT5 high byte
6/2	INPUT5 low byte
6/3	INPUT5 index byte

7/1	INPUT6 high byte
7/2	INPUT6 low byte
7/3	INPUT6 index byte
8/1	INPUT7 high byte
8/2	INPUT7 low byte
8/3	INPUT7 index byte
9/1	INPUT8 high byte
9/2	INPUT8 low byte
9/3	INPUT8 index byte
10/1	INPUT9 high byte
10/2	INPUT9 low byte
10/3	INPUT9 index byte
11/1	INPUT10 high byte
11/2	INPUT10 low byte
11/3	INPUT10 index byte
12/1	INPUT11 high byte
12/2	INPUT11 low byte
12/3	INPUT11 index byte
13/1	INPUT12 high byte
13/2	INPUT12 low byte
13/3	INPUT12 index byte
14/1	INPUT13 high byte
14/2	INPUT13 low byte
14/3	INPUT13 index byte
15/1	INPUT14 high byte
15/2	INPUT14 low byte
15/3	INPUT14 index byte
16/1	INPUT15 high byte
16/2	INPUT15 low byte
16/3	INPUT15 index byte
17/1	INPUT16 high byte
17/2	INPUT16 low byte
17/3	INPUT16 index byte
18/1	INPUT17 high byte
18/2	INPUT17 low byte
18/3	INPUT17 index byte
19/1	INPUT18 high byte
19/2	INPUT18 low byte
19/3	INPUT18 index byte
20/1	INPUT19 high byte
20/2	INPUT19 low byte
20/3	INPUT19 index byte
21/1	INPUT20 high byte
21/2	INPUT20 low byte
21/3	INPUT20 index byte
22/1	INPUT21 high byte
22/2	INPUT21 low byte
22/3	INPUT21 index byte
23/1	INPUT22 high byte
23/2	INPUT22 low byte
23/3	INPUT22 index byte
24/1	INPUT23 high byte
24/2	INPUT23 low byte
24/3	INPUT23 index byte
25/1	INPUT24 high byte
25/2	INPUT24 low byte
25/3	INPUT24 index byte
26/1	INPUT25 high byte
26/2	INPUT25 low byte

26/3	INPUT25 index byte
27/1	INPUT26 high byte
27/2	INPUT26 low byte
27/3	INPUT26 index byte
28/1	INPUT27 high byte
28/2	INPUT27 low byte
28/3	INPUT27 index byte
29/1	INPUT28 high byte
29/2	INPUT28 low byte
29/3	INPUT28 index byte
30/1	INPUT29 high byte
30/2	INPUT29 low byte
30/3	INPUT29 index byte
31/1	spare
31/2	Checksum high byte
31/3	Checksum low byte

8.4.2 Transmit Programmable Input Negated AND Input (3 4 2)

Negated Programmable Input data transferred from relay to PC.

Bit = 0, Enabled when input is opened.
Bit = 1, Enabled when input is closed.
Low byte consists of bits 0 through 7.
High byte consists of bits 8 through 15.

Msg byte	Definition
1/1	Relay Status (see command 3 4 1, msg 1/1)
1/2	Command + Subcommand = 0x42
1/3	Total Number of Messages = 21
2/1	INPUT1 high byte (per bits 8-15 in Figure 9, on page 159)
2/2	INPUT1 low byte (per bits 0-7 in Figure 9, on page 159)
2/3	INPUT2 high byte
3/1	INPUT2 low byte
3/2	INPUT3 high byte
3/3	INPUT3 low byte
4/1	INPUT4 high byte
4/2	INPUT4 low byte
4/3	INPUT5 high byte
5/1	INPUT5 low byte
5/2	INPUT6 high byte
5/3	INPUT6 low byte
6/1	INPUT7 high byte
6/2	INPUT7 low byte
6/3	INPUT8 high byte
7/1	INPUT8 low byte
7/2	INPUT9 high byte
7/3	INPUT9 low byte
8/1	INPUT10 high byte
8/2	INPUT10 low byte
8/3	INPUT11 high byte
9/1	INPUT11 low byte
9/2	INPUT12 high byte
9/3	INPUT12 low byte
10/1	INPUT13 high byte
10/2	INPUT13 low byte
10/3	NPUT14 high byte
11/1	INPUT14 low byte
11/2	INPUT15 high byte
11/3	INPUT15 low byte

12/1	INPUT16 high byte
12/2	INPUT16 low byte
12/3	INPUT17 high byte
13/1	INPUT17 low byte
13/2	INPUT18 high byte
13/3	INPUT18 low byte
14/1	INPUT19 high byte
14/2	INPUT19 low byte
14/3	INPUT20 high byte
15/1	INPUT20 low byte
15/2	INPUT21 high byte
15/3	INPUT21 low byte
16/1	INPUT22 high byte
16/2	INPUT22 low byte
16/3	INPUT23 high byte
17/1	INPUT23 low byte
17/2	INPUT24 high byte
17/3	INPUT24 low byte
18/1	INPUT25 high byte
18/2	INPUT25 low byte
18/3	INPUT26 high byte
19/1	INPUT26 low byte
19/2	INPUT27 high byte
19/3	INPUT27 low byte
20/1	INPUT28 high byte
20/2	INPUT28 low byte
20/3	INPUT29 high byte
21/1	INPUT29 low byte
21/2	Checksum high byte
21/3	Checksum low byte

8.4.3 Transmit Programmable Input AND/OR Select (3 4 3)

Bit = 0, Selected inputs are Ored together.
Bit = 1, Selected inputs are ANDed together.

Bit	Logical Input
0	INPUT1
1	INPUT2
.	
.	
.	
27	INPUT28
28	INPUT29
29	not used reserved for 52A
30	not used reserved for 52B
31	not used reserved for 43A

Msg byte	Definition
1/1	Relay Status (see command 3 4 1, msg 1/1)
1/2	Command + Subcommand = 0x43
1/3	Total Number of Messages = 3
2/1	Programmable input AND/OR selection bits 24-31
2/2	Programmable input AND/OR selection bits 16-23
2/3	Programmable input AND/OR selection bits 8-15
3/1	Programmable input AND/OR selection bits 0-7
3/2	Checksum high byte
3/3	Checksum low byte

8.4.4 Transmit Programmable User Defined Input Names (3 4 4)

User definable 8 char input strings. Byte 9 is an implied NULL.

Msg byte	Definition
1/1	Relay Status (see command 3 4 1, msg 1/1)
1/2	Command + Subcommand = 0x44
1/3	Total Number of Messages = 37
2/1-4/2	IN1 Character String 8 bytes
4/3-7/1	IN2 Character String 8 bytes
7/2-9/3	IN3 Character String 8 bytes
10/1-12/2	IN4 Character String 8 bytes
12/3-15/1	IN5 Character String 8 bytes
15/2-17/3	IN6 Character String 8 bytes
18/1-20/2	IN7 Character String 8 bytes (DPU2000 and DPU2000R)
20/3-23/1	IN8 Character String 8 bytes (DPU2000 and DPU2000R)
23/2-25/3	IN9 Character String 8 bytes (DPU2000)
26/1-28/2	IN10 Character String 8 bytes (DPU2000)
28/3-31/1	IN11 Character String 8 bytes (DPU2000)
31/2-33/3	IN12 Character String 8 bytes (DPU2000)
34/1-36/2	IN13 Character String 8 bytes (DPU2000)
36/3-37/1	Spare Input Strings
37/2	Checksum high byte
37/3	Checksum low byte

8.4.5 Transmit Programmable Output Select (3 4 5)

Bit Position:	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
DPU2000:	N/A	N/A	N/A	N/A	N/A	N/A	Out8	Out7	Out1	Out2	Out3	Out5	Out4	Out6	Close	Trip
DPU2000R:	FB8	FB7	FB6	FB5	FB4	FB3	FB2	FB1	Out1	Out2	Out3	Out5	Out4	Out6	N/A	Trip
DPU1500R:	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Out1	Out2	Out3	Out5	Out4	Out6	N/A	Trip

Figure 10 – Physical Output Mapping

Bit = 0, Physical Output is selected.
Bit = 1, Physical Output is not selected.
Least significant low byte consists of bits 0 through 7.
Least significant high byte consists of bits 8 through 15.
Most significant low byte consists of bits 16 through 23.
Most significant high byte consists of bits 24 through 31.

Table 3-Programmable Bit Assignments for Outputs

Bit	Logical Output Assigned
0	TRIP (Fixed)
1	CLOSE (Fixed DPU2000, mapping NOT permitted by DPU2000R or DPU1500R)
2	OUTPUT 1
3	OUTPUT 2
4	OUTPUT 3
5	OUTPUT 4
6	OUTPUT 5
7	OUTPUT 6
8	OUTPUT 7
9	OUTPUT 8
10	OUTPUT 9
11	OUTPUT 10
12	OUTPUT 11
13	OUTPUT 12
14	OUTPUT 13
15	OUTPUT 14
16	OUTPUT 15
17	OUTPUT 16
18	OUTPUT 17
19	OUTPUT 18
20	OUTPUT 19
21	OUTPUT 20
22	OUTPUT 21
23	OUTPUT 22
24	OUTPUT 23
25	OUTPUT 24
26	OUTPUT 25
27	OUTPUT 26
28	OUTPUT 27
29	OUTPUT 28
30	OUTPUT 29
31	OUTPUT 30

Msg byte	Definition
1/1	Relay Status (see command 3 4 1, msg 1/1)
1/2	Command + Subcommand = 0x45
1/3	Total Number of Messages = 21
2/1	Contact OUT6 most significant high byte (bits assigned per Table 3, page 168)
2/2	Contact OUT6 most significant low byte
2/3	Contact OUT6 least significant high byte
3/1	Contact OUT6 least significant low byte
3/2	Contact OUT4 most significant high byte
3/3	Contact OUT4 most significant low byte
4/1	Contact OUT4 least significant high byte
4/2	Contact OUT4 least significant low byte
4/3	Contact OUT5 most significant high byte
5/1	Contact OUT5 most significant low byte
5/2	Contact OUT5 least significant high byte
5/3	Contact OUT5 least significant low byte
6/1	Contact OUT3 most significant high byte
6/2	Contact OUT3 most significant low byte
6/3	Contact OUT3 least significant high byte
7/1	Contact OUT3 least significant low byte
7/2	Contact OUT2 most significant high byte

7/3	Contact OUT2 most significant low byte
8/1	Contact OUT2 least significant high byte
8/2	Contact OUT2 least significant low byte
8/3	Contact OUT1 most significant high byte
9/1	Contact OUT1 most significant low byte
9/2	Contact OUT1 least significant high byte
9/3	Contact OUT1 least significant low byte
10/1	Contact OUT7 most significant high byte (DPU2000) DPU2000R FB1 most significant high byte
10/2	Contact OUT7 most significant low byte (DPU2000) DPU2000R FB1 most significant low byte
10/3	Contact OUT7 least significant high byte (DPU2000) DPU2000R FB1 least significant high byte
11/1	Contact OUT7 least significant low byte (DPU2000) DPU2000R FB1 least significant low byte
11/2	Contact OUT8 most significant high byte (DPU2000) DPU2000R FB2 most significant high byte
11/3	Contact OUT8 most significant low byte (DPU2000) DPU2000R FB2 most significant low byte
12/1	Contact OUT8 least significant high byte (DPU2000) DPU2000R FB2 least significant high byte
12/2	Contact OUT8 least significant low byte (DPU2000) DPU2000R FB2 least significant low byte
12/3	DPU2000R FB3 most significant high byte
13/1	DPU2000R FB3 most significant low byte
13/2	DPU2000R FB3 least significant high byte
13/3	DPU2000R FB3 least significant low byte
14/1	DPU2000R FB4 most significant high byte
14/2	DPU2000R FB4 most significant low byte
14/3	DPU2000R FB4 least significant high byte
15/1	DPU2000R FB4 least significant low byte
15/2	DPU2000R FB5 most significant high byte
15/3	DPU2000R FB5 most significant low byte
16/1	DPU2000R FB5 least significant high byte
16/2	DPU2000R FB5 least significant low byte
16/3	DPU2000R FB6 most significant high byte
17/1	DPU2000R FB6 most significant low byte
17/2	DPU2000R FB6 least significant high byte
17/3	DPU2000R FB6 least significant low byte
18/1	DPU2000R FB7 most significant high byte
18/2	DPU2000R FB7 most significant low byte
18/3	DPU2000R FB7 least significant high byte
19/1	DPU2000R FB7 least significant low byte
19/2	DPU2000R FB8 most significant high byte
19/3	DPU2000R FB8 most significant low byte
20/1	DPU2000R FB8 least significant high byte
20/2	DPU2000R FB8 least significant low byte
20/3	Spare
21/1	Spare
21/2	Checksum high byte
21/3	Checksum low byte

8.4.6 Transmit Programmable Output AND/OR Select (3 4 6)

Bit = 0, Selected inputs are Ored together.
Bit = 1, Selected inputs are ANDed together.
Index byte is the offset into the DPU's logical output structure.

Logical Output List for DPU2000 – Requires matrix (32 x 8) to allow user to map 32 Logical Outputs to 8 Physical Outputs. NOTE: first two logicals, ***TRIP*** and ***CLOSE*** are fixed (bits 0 and 1), user is not permitted to remove these from the list.

Logical Outputs include: “TRIP”, “CLOSE”, “ALARM”, “BFA”, “TCFA”, “79LOA”, “TCC”, “PUA”, “51P”, “51N”, “46”, “50P-1”, “50N-1”, “50P-2”, “50N-2”, “50P-3”, “50N-3”, “PATA”, “PBTA”, “PCTA”, “67P”, “67N”, “81S-1”, “81R-1”, “81O-1”, “27-1P”, “59”, “79DA”, “79CA1”, “OCTC”, “KSI”, “PDA”, “NDA”, “PVArA”, “NVArA”, “LOADA”, “50-1D”, “LPFA”, “HPFA”, “ZSC”, “50-2D”, “BFUA”, “STCA”, “PH3-D”, “GRD-D”, “32PA”, “32NA”, “27-3P”, “VarDA”, “79CA2”, “TRIPA”, “TRIPB”, “TRIPC”, “27-1P*”, “46*”, “50P-1*”, “50N-1*”, “50P-2*”, “50N-2*”, “50P-3*”, “50N-3*”, “51P*”, “51N*”, “59*”, “67P*”, “67N*”, “81S-1*”, “81R-1*”, “81O-1*”, “27-3P*”, “TRIPA*”, “TRIPB*”, “TRIPC*”, “ULO1”, “ULO2”, “ULO3”, “ULO4”, “ULO5”, “ULO6”, “ULO7”, “ULO8”, “ULO9”, “81O-2”, “81S-2”, “81R-2”, “81O-2*”, “81S-2*”, “81R-2*”, “CLTA”, “Pwatt1”, “Pwatt2”, “79CA1*”, “79CA2*”, “BFA*”.

Logical Output List for DPU2000R – Requires matrix (31 x 14) to allow user to map 31 Logical Outputs to 6 Physical Outputs plus 8 Feedback Outputs. NOTE: first logical, ***TRIP*** is fixed, user is not permitted to remove Trip logical from the list. Also note, since the ***CLOSE*** logical is specific to DPU2000, mapping of this logical (located at bit 1) is NOT permissible. Logical Outputs include: “TRIP”, “CLOSE”, “ALARM”, “BFA”, “TCFA”, “79LOA”, “TCC”, “PUA”, “51P”, “51N”, “46”, “50P-1”, “50N-1”, “50P-2”, “50N-2”, “50P-3”, “50N-3”, “PATA”, “PBTA”, “PCTA”, “67P”, “67N”, “81S-1”, “81R-1”, “81O-1”, “27-1P”, “59”, “79DA”, “79CA1”, “OCTC”, “KSI”, “PDA”, “NDA”, “PVArA”, “NVArA”, “LOADA”, “50-1D”, “LPFA”, “HPFA”, “ZSC”, “50-2D”, “BFUA”, “STCA”, “PH3-D”, “GRD-D”, “32PA”, “32NA”, “27-3P”, “VarDA”, “79CA2”, “TRIPA”, “TRIPB”, “TRIPC”, “27-1P*”, “46*”, “50P-1*”, “50N-1*”, “50P-2*”, “50N-2*”, “50P-3*”, “50N-3*”, “51P*”, “51N*”, “59*”, “67P*”, “67N*”, “81S-1*”, “81R-1*”, “81O-1*”, “27-3P*”, “TRIPA*”, “TRIPB*”, “TRIPC*”, “ULO1”, “ULO2”, “ULO3”, “ULO4”, “ULO5”, “ULO6”, “ULO7”, “ULO8”, “ULO9”, “81O-2”, “81S-2”, “81R-2”, “81O-2*”, “81S-2*”, “81R-2*”, “CLTA”, /* V1.40 */ “Pwatt1”, “Pwatt2”, “79CA1*”, “79CA2*”. The following were added to CPU V1.60: “SEF*”(*Sensitive Earth Model*), “SEF”(*Sensitive Earth Model*), “BZA”, “BFT”, “ReTrp”, “BFT*”, “ReTrp*”. The following were added to CPU V1.80: “32P-2”, “32N-2”, “32P-2*”, “32N-2*”, “BFA*”.

The following were added to CPU V1.93: “25*”(*Synch Check Model*), “25”(*Synch Check Model*), “SBA”.

The following were added to CPU V3.20: “79V”and “Rclin”, “59G”,”59G*”, “LO1”, lO2”, ”LO3”, ”LO4”, ”LO5”, ”LO6”, ”LO7”, ”LO8”, “TR_ON”, ”TR_OFF”, ”TR_TAG”.

The following were added to CPU V5.0: 59-3P, 59-3P*, 47, 47*, 21P-1, 21P-1*, 21P-2, 21P-2*, 21P-3, 21P-3*, 21P-4, 21P-4*.

Logical Output List for DPU1500R – Requires matrix (31 x 6) to allow user to map 31 Logical Outputs to 6 Physical Outputs. NOTE: first logical, ***TRIP*** is fixed, user is not permitted to remove Trip logical from the list. Also note, since the ***CLOSE*** logical is specific to DPU2000, mapping of this logical (located at bit 1) is NOT permissible. Logical Outputs include: “TRIP”, “CLOSE”, “ALARM”, “BFA”, “TCFA”, “79LOA”, “TCC”, “PUA”, “51P”, “51N”, “46”, “50P-1”, “50N-1”, “50P-2”, “50N-2”, “50P-3”, “50N-3”, “PATA”, “PBTA”, “PCTA”, “27-1P”, “79DA”, “79CA1”, “OCTC”, “KSI”, “PDA”, “NDA”, “PVArA”, “NVArA”, “LOADA”, “50-1D”,”LPFA”, “HPFA”, “ZSC”, “50-2D”, “BFUA”, “STCA”, “PH3-D”, “GRD-D”, “27-3P”, “VarDA”, “79CA2”, “TRIPA”, “TRIPB”, “TRIPC”, “27-1P*”, “46*”, “50P-1*”, “50N-1*”, “50P-2*”, “50N-2*”, “50P-3*”, “50N-3*”, “51P*”, “51N*”, “27-3P*”, “TRIPA*”, “TRIPB*”, “TRIPC*”, “CLTA”, “Pwatt1”, “Pwatt2”, “79CA1*”, “79CA2*”, “SEF*”(*Sensitive Earth Model*), “SEF”(*Sensitive Earth Model*), “BZA”, “BFA*”, “SBA”, “79V” and “Rclin”.

See Table 4 below for a complete listing of Logical Output Offsets and respective definitions.

Table 4-Logical Output Indices & Definitions

Index	Logical Output	Definitions
00	TRIP	Fixed Trip
01	CLOSE	Fixed Close
02	ALARM	Self Check Alarm
03	27-1P	Single Phase Under Voltage
04	46	Negative Sequence Overcurrent
05	50P-1	Phase Inst. Overcurrent
06	50N-1	Neutral Inst. Overcurrent
07	50P-2	Phase Inst. Overcurrent
08	50N-2	Neutral Inst. Overcurrent
09	50P-3	Phase Inst. Overcurrent
10	50N-3	Neutral Inst. Overcurrent
11	51P	Phase Time Overcurrent
12	51N	Neutral Time Overcurrent
13	59	Over Voltage
14	67P	Directional Overcurrent (pos seq)
15	67N	Directional Overcurrent (neg seq)
16	81S-1	Frequency Shed (First stage)
17	81R-1	Frequency Restore (First stage)
18	PATA	Phase A Target
19	PBTA	Phase B Target
20	PCTA	Phase C Target
21	TCFA	Trip Circuit Fail
22	TCC	Tap Changer Cutout
23	79DA	Recloser Disable
24	PUA	Pickup
25	79LOA	Recloser Lockout
26	BFA	Breaker Fail
27	PDA	Phase Peak Demand
28	NDA	Neutral Peak Demand
29	BFUA	Blown Fuse
30	KSI	KiloAmp Summation
31	79CA-1	Reclose Counter1
32	HPFA	High Power Factor
33	LPFA	Low Power Factor
34	OCTC	Overcurrent Trip Counter
35	50-1D	50-1 Element Disable
36	50-2D	50-2 Element Disable
37	STCA	Setting Table Change
38	ZSC	Zone Sequence
39	PH3-D	Phase Torque Control Disable
40	GRD-D	Neutral Torque Control Disable
41	32PA	Directional Pickup (pos seq)
42	32NA	Directional Pickup (neg seq)
43	27-3P	3 Phase Under Voltage
44	VarDA	Var Demand
45	79CA-2	Reclose Counter2
46	TRIPA	Single Pole Trip Phase A
47	TRIPB	Single Pole Trip Phase B
48	TRIPC	Single Pole Trip Phase C
49	27-1P*	Single Phase Under Voltage
50	46*	Negative Sequence Overcurrent
51	50P-1*	Phase Inst. Overcurrent
52	50N-1*	Neutral Inst. Overcurrent
53	50P-2*	Phase Inst. Overcurrent
54	50N-2*	Neutral Inst. Overcurrent
55	50P-3*	Phase Inst. Overcurrent
56	50N-3*	Neutral Inst. Overcurrent
57	51P*	Phase Time Overcurrent
58	51N*	Neutral Time Overcurrent
59	59*	Over Voltage
60	67P*	Directional Overcurrent (pos seq)
61	67N*	Directional Overcurrent (neg seq)
62	81S-1*	Frequency Shed (First stage)
63	81R-1*	Frequency Restore (First stage)
64	81O-1*	Over Frequency (First stage)
65	27-3P*	3 Phase Under Voltage
66	TRIPA*	Single Pole Trip Phase A

Index	Logical Output	Definitions
67	TRIPB*	Single Pole Trip Phase B
68	TRIPC*	Single Pole Trip Phase C
69	ULO1	User Logical Output 1
70	ULO2	User Logical Output 2
71	ULO3	User Logical Output 3
72	ULO4	User Logical Output 4
73	ULO5	User Logical Output 5
74	ULO6	User Logical Output 6
75	ULO7	User Logical Output 7
76	ULO8	User Logical Output 8
77	ULO9	User Logical Output 9
78	PVArA	Positive Var
79	NVArA	Negative Var
80	LOADA	Load Current
81	81O-1	Over Frequency (First Stage)
82	81O-2	Over Frequency (2nd Stage)
83	81S-2	Frequency Shed (2nd Stage)
84	81R-2	Frequency Restore (2nd Stage)
85	81O-2*	Over Frequency (2nd Stage)
86	81S-2*	Frequency Shed (2nd Stage)
87	81R-2*	Frequency Restore (2nd Stage)
88	CLTA	Cold Load Timer
89	Pwatt1	Positive Watt Alarm 1
90	Pwatt2	Positive Watt Alarm 2
91	79CA1*	Recloser Counter 1 Alarm
92	79CA2*	Recloser Counter 2 Alarm
93	SEF*	Sensitive Earth Fault Trip
94	SEF	Sensitive Earth Fault Trip
95	BZA	Bus Zone Alarm
96	BF Trip	Breaker Fail Trip
97	BF Retrip	Breaker Fail Re-Trip
98	BF Trip*	Breaker Fail Trip
99	BF Retrip*	Breaker Fail Re-Trip
100	32P	Phase Directionality Alarm
101	32N	Neutral Directionality Alarm
102	32P*	Phase Directionality Alarm
103	32N*	Neutral Directionality Alarm
104	BFA*	Breaker Failure Alarm
105	25*	In Synchronism
106	25	In Synchronism
107	SBA	Slow Breaker Alarm
108	79V	Recloser
109	Rclin	Recloer init
110	59G	V0 Over Voltage
111	59G*	V0 Over Voltage seal-in
112	LO1	Latching output1
113	LO2	Latching output2
114	LO3	Latching output3
115	LO4	Latching output4
116	LO5	Latching output5
117	LO6	Latching output6
118	LO7	Latching output7
119	LO8	Latching output8
120	TR_ON	Hot Hole Tagging On
121	TR_OFF	Hot Hole Tagging Off
122	TR_TAG	Hot Hole Tagging Tagged
123	59-3P	3 Phase Over Voltage
124	59-3P*	3 Phase Over Voltage Seal-in
125	47	Neg Seq Over Voltage
126	47*	Net Seq Over Voltage Seal-in
127	50-3D	50-3 Element Disable
128	21P-1	Fwd Reach Zone 1 Distance Alarm
129	21P-1*	Fwd Reach Zone 1 Distance Seal-in Alarm
130	21P-2	Fwd Reach Zone 2 Distance Alarm
131	21P-2*	Fwd Reach Zone 2 Distance Seal-in Alarm
132	21P-3	Fwd Reach Zone 3 Distance Alarm
133	21P-3*	Fwd Reach Zone 3 Distance Seal-in Alarm
134	21P-4	Fwd Reach Zone 4 Distance Alarm

Index	Logical Output	Definitions
135	21P-4*	Fwd Reach Zone 4 Distance Seal-in Alarm
136	C1	Control Button 1
137	C2	Control Button 2
138	C3	Control Button 3
139	C4	Control Button 4
140	C5	Control Button 5
141	C6	Control Button 6
142	TripT	Trip Target
143	NTA	Neutral Target
144	TimeT	Time Target
145	InstT	Inst Target
146	NeqSeqT	Negative Seq Target
147	FreqT	Frequency Target
148	DirT	Direction Target
149	VoltT	Volt Target
150	DistT	Distance Target
151	SEFT	Sensitve Earth Fault Target
152	ULO 10	User Logical Output 10
153	ULO 11	User Logical Output 10
154	ULO 12	User Logical Output 10
155	ULO 13	User Logical Output 10
156	ULO 14	User Logical Output 10
157	ULO 15	User Logical Output 10
158	ULO 16	User Logical Output 10
159	HBHL	Hot Bus – Hot Line
160	HBDL	Hot Bus – Dead Line
161	HBHL	Hot Bus – Hot Line
162	HBDL	Hot Bus – Dead Line
163	46A	Negative Sequence Overcurrent, percentage pickup
164	46A*	Negative Sequence Overcurrent, percentage pickup
165	REMOTE_D	Remote Disable
166	PRI-ON	Primary Settings Active
167	ALT1-ON	ALT1 Settings Active
168	ALT2-ON	ALT2 Settings Active
169	SHIFTA-1	Barrel Shift-A Output No. 1
170	SHIFTA-2	Barrel Shift-A Output No. 2
171	SHIFTA-3	Barrel Shift-A Output No. 3
172	SHIFTA-4	Barrel Shift-A Output No. 4
173	SHIFTB-1	Barrel Shift-B Output No. 1
174	SHIFTB-2	Barrel Shift-B Output No. 2
175	SHIFTB-3	Barrel Shift-B Output No. 3
176	SHIFTB-4	Barrel Shift-B Output No. 4

NOTE: SEF, SEF*, and BZA logical outputs are available in Sensitive Earth model only. Also, * indicates sealed in outputs.

Msg byte	Definition
1/1	Relay Status (see command 3 4 1, msg 1/1)
1/2	Command + Subcommand = 0x46
1/3	Total Number of Messages = 13
2/1	spare (bits 24-31)
2/2	spare (bits 16-23)
2/3	Programmable output AND/OR selection bits 8-15
3/1	Programmable output AND/OR selection bits 0-7
3/2	OUTPUT1 index byte (index per Table 4, page 171)
3/3	OUTPUT2 index byte
4/1	OUTPUT3 index byte
4/2	OUTPUT4 index byte
4/3	OUTPUT5 index byte
5/1	OUTPUT6 index byte
5/2	OUTPUT7 index byte
5/3	OUTPUT8 index byte
6/1	OUTPUT9 index byte
6/2	OUTPUT10 index byte

6/3	OUTPUT11 index byte
7/1	OUTPUT12 index byte
7/2	OUTPUT13 index byte
7/3	OUTPUT14 index byte
8/1	OUTPUT15 index byte
8/2	OUTPUT16 index byte
8/3	OUTPUT17 index byte
9/1	OUTPUT18 index byte
9/2	OUTPUT19 index byte
9/3	OUTPUT20 index byte
10/1	OUTPUT21 index byte
10/2	OUTPUT22 index byte
10/3	OUTPUT23 index byte
11/1	OUTPUT24 index byte
11/2	OUTPUT25 index byte
11/3	OUTPUT26 index byte
12/1	OUTPUT27 index byte
12/2	OUTPUT28 index byte
12/3	OUTPUT29 index byte
13/1	OUTPUT30 index byte
13/2	Checksum high byte
13/3	Checksum low byte

8.4.7 Transmit Programmable Output User Defined Strings (3 4 7)

User definable 8 char output strings. Byte 9 is an implied NULL

Msg byte	Definition
1/1	Relay Status (see command 3 4 1, msg 1/1)
1/2	Command + Subcommand = 0x47
1/3	Total Number of Messages = 37
2/1-4/2	OUT1 Character String 8 bytes
4/3-7/1	OUT2 Character String 8 bytes
7/2-9/3	OUT3 Character String 8 bytes
10/1-12/2	OUT4 Character String 8 bytes
12/3-15/1	OUT5 Character String 8 bytes
15/2-17/3	OUT6 Character String 8 bytes
18/1-20/2	OUT7 Character String 8 bytes (DPU2000)
20/3-23/1	OUT8 Character String 8 bytes (DPU2000)
23/2-25/3	Spare Character String 8 bytes
26/1-28/2	Spare Character String 8 bytes
28/3-31/1	Spare Character String 8 bytes
31/2-33/3	Spare Character String 8 bytes
34/1-36/2	Spare Character String 8 bytes
36/3-39/1	Spare Character String 8 bytes
39/2	Checksum high byte
39/3	Checksum low byte

8.4.8 Transmit Relay Settings (3 4 x)

(3 4 8) = Primary Settings
(3 4 9) = Alternate 1 Settings
(3 4 10) = Alternate 2 Settings

Low byte consists of bits 0 through 7.
High byte consists of bits 8 through 15.

The following functions are available in the DPU1500R: 51P, 50P-1, 50P-2, 50P-3, 46, 51N, 50N-1, 50N-2, 50N-3, 79 and 27.

8.4.8.1 Standard ANSI Curves for DPU2000 and DPU2000R

Table 5 – ANSI Curve Selection Type I

Index	Overcurrent Curve
0	Extremely Inverse
1	Very Inverse
2	Inverse
3	Short Time Inverse
4	Definite Time
5	Long Time Extremely Inverse
6	Long Time Very Inverse
7	Long Time Inverse
8	Recloser Curve
9	User Curve 1
10	User Curve 2
11	User Curve 3

Table 6 – ANSI Curve Selection Type II

Index	Overcurrent Curve
0	Extremely Inverse
1	Very Inverse
2	Inverse
3	Short Time Inverse
4	Definite Time
5	Long Time Extremely Inverse
6	Long Time Very Inverse
7	Long Time Inverse
8	Recloser Curve
9	Disable
10	User Curve 1
11	User Curve 2
12	User Curve 3

Table 7 – ANSI Curve Selection Type III

Index	Overcurrent Curve
0	Disable
1	Standard
2	Inverse
3	Definite Time
4	Short Time Inverse
5	Short Time Extremely Inverse
6	User Curve 1
7	User Curve 2
8	User Curve 3

8.4.8.2 Recloser Curves for DPU2000 and DPU2000R

NOTE: Catalog Numbers XXXXXXXX-XX2XX and XXXXXXXX-XX3XX use the following curve types for 51P, 50P-1, 51N, and 50N-1 functions. Also, in addition to the Time Dial fields, include 51P, 50P-1, 51N and 50N-1 Minimum Response fields.

Table 8 – Recloser Curve (51P)

Index	Recloser Curve
0	A
1	B
2	C
3	D
4	E
5	K
6	N
7	R
8	W
9	User Curve 1
10	User Curve 2
11	User Curve 3

Table 9 – Recloser Curve (51N)

Index	Recloser Curve
0	2
1	3
2	8
3	8*
4	8+
5	9
6	11
7	Disable
8	User Curve 1
9	User Curve 2
10	User Curve 3

Table 10 – Recloser Curve (50P-1)

Index	Recloser Curve
0	Disable
1	A
2	B
3	C
4	D
5	E
6	K
7	N
8	R
9	W
10	User Curve 1
11	User Curve 2
12	User Curve 3

Table 11 – Recloser Curve (50N-1)

Index	Recloser Curve
0	Disable
1	2
2	3
3	8
4	8*
5	8+
6	9
7	11
8	User Curve 1
9	User Curve 2
10	User Curve 3

8.4.8.3 IEC Curves for DPU2000R

NOTE: The following curves are available in IEC DPU2000R, Catalog Number 687XXXXX-XXXXX. All IEC type curves except Definite Time Curves, use Time Multipliers in place of Time Dials.

Table 12 – IEC Curve Selection Type I

Index	Overcurrent Curve
0	Extremely Inverse
1	Very Inverse
2	Inverse
3	Long Time Inverse
4	Definite Time
5	User Curve 1
6	User Curve 2
7	User Curve 3

Table 13 – IEC Curve Selection Type II

Index	Overcurrent Curve
0	Disable
1	Extremely Inverse
2	Very Inverse
3	Inverse
4	Long Time Inverse
5	Definite Time
6	User Curve 1
7	User Curve 2
8	User Curve 3

Table 14 – IEC Curve Selection Type III

Index	Overcurrent Curve
0	Disable
1	Standard
2	Definite Time
3	User Curve 1
4	User Curve 2
5	User Curve 3

8.4.8.4 ANSI/IEC Curves for DPU1500R

NOTE: All IEC type curves, use Time Multipliers in place of Time Dials.

Table 15 – 1500R Curve Selection Type I

Index	Overcurrent Curve
0	Extremely Inverse
1	Very Inverse
2	Inverse
3	Short Time Inverse
4	Definite Time
5	Long Time Extremely Inverse
6	Long Time Very Inverse
7	Long Time Inverse
8	Recloser Curve
9	IEC Extremely Inverse
10	IEC Very Inverse
11	IEC Inverse
12	IEC Long Time Inverse
13	User Curve 1
14	User Curve 2
15	User Curve 3

Table 16 – 1500R Curve Selection Type II

Index	Overcurrent Curve
0	Extremely Inverse
1	Very Inverse
2	Inverse
3	Short Time Inverse
4	Definite Time
5	Long Time Extremely Inverse
6	Long Time Very Inverse
7	Long Time Inverse
8	Recloser Curve
9	Disable
10	IEC Extremely Inverse
11	IEC Very Inverse
12	IEC Inverse
13	IEC Long Time Inverse
14	User Curve 1
15	User Curve 2
16	User Curve 3

Table 17 – 1500R Curve Selection Type III

Index	Overcurrent Curve
0	Disable
1	Standard
2	Inverse
3	Definite Time
4	Short Time Inverse
5	Short Time Extremely Inverse
6	User Curve 1
7	User Curve 2
8	User Curve 3

8.4.8.5 79-X Select Bit Pattern for DPU2000/2000R/1500R

Table 18 – 79 Lockout & Enable/Disable Bit Pattern

Bit	Function Low byte (bits 0-7): 0=No Lockout/Disable, 1=Enabled High byte (bits 8-15): 0=Enable, 1=Lockout
0, 8	50N-1
1, 9	50N-2
2, 10	50N-3
3, 11	51N
4, 12	50P-1
5, 13	50P-2
6,14	50P-3
7,15	Reserved

Msg byte	Definition
1/1	Relay Status (see command 3 4 1, msg 1/1)
1/2	Command + Subcommand = (Prim = 0x48, Alt1 = 0x49, Alt2 = 0x4a)
1/3	Total Number of Messages = 36
2/1	51P Curve Select byte (Type I or Recloser)
2/2	51P Pickup Amps byte (1-12Amp *10, 0.2-2.4Amp *50)
2/3	51P Time dial(1-10 *20)/delay byte(0-10 * 20) IEC Curve 51P Time Multiplier (.05-1.00 *200)
3/1	50P-1 Curve Select byte (Type III or Recloser)
3/2	50P-1 Pickup X byte (0.5-20 *10)
3/3	50P-1 Timedial (1-10 *10)/delay(0-9.99 *100) high byte IEC Curve –50P-1 Time Multiplier (.05-1.00 *200)
4/1	50P-1 Timedial/delay low byte
4/2	50P-2 Select byte (0=Disable, 1=Enable)
4/3	50P-2 Pickup X byte (0.5-20 *10)
5/1	50P-2 Timedelay high byte (0-9.99 *100)
5/2	50P-2 Timedelay low byte
5/3	50P-3 Select byte (0=Disable, 1=Enable)
6/1	50P-3 Pickup X byte (0.5-20 *10)
6/2	46 Curve Select byte (Type II)
6/3	46 Pickup Amps byte (1-12Amp *10, 0.2-2.4Amp *50)
7/1	46 Time dial(1-10 *20)/delay byte(0-10 * 20) IEC Curve –46 Time Multiplier (.05-1.00 *200)
7/2	51N Curve Select byte (Type II or Recloser)
7/3	51N Pickup Amps byte (1-12Amp *10, 0.2-2.4Amp *50)
8/1	51N Time dial(1-10 *20)/delay byte(0-10 * 20) IEC Curve –51N Time Multiplier (.05-1.00 *200)
8/2	50N-1 Curve Select byte (Type III or Recloser)
8/3	50N-1 Pickup X byte (0.5-20 *10)
9/1	50N-1 Timedial/delay high byte (1-10 *10, 0-9.99 *100) IEC Curve –50N-1 Time Multiplier (.05-1.00 *200)
9/2	50N-1 Timedial/delay low byte
9/3	50N-2 Select byte (0 = Disable, 1 = Enable) Sensitive Earth Model (0=Disable, 1=Standard, 2=SEF, 3=Directional SEF)
10/1	50N-2 Pickup X byte (0.5-20 *10)
10/2	50N-2 Timedelay high byte (0-9.99 *100) SEF or Directional SEF Selects – 50N-2 Time Delay (0.5 to 180.0)*200
10/3	50N-2 Timedelay low byte
11/1	50N-3 Select byte (0=Disable, 1=Enable)
11/2	50N-3 Pickup X byte (0.5-20 *10)
11/3	79 Reset Time byte (3-200)
12/1	79-1 Select high byte (Lockout Type)
12/2	79-1 Select low byte (Enable Type)

12/3	79-1 Open Interval Time high byte (0.1 – 200 *10, 2001 = Lockout) Sensitive Earth Model (0.1 to 1800 *10, 18001=Lockout)
13/1	79-1 Open Interval Time low byte
13/2	79-2 Select high byte (Lockout Type)
13/3	79-2 Select low byte (Enable Type)
14/1	79-2 Open Interval Time high byte (0.1 – 200 *10, 2001 = Lockout) Sensitive Earth Model (0.1 to 1800 *10, 18001=Lockout)
14/2	79-2 Open Interval Time low byte
14/3	79-3 Select high byte (Lockout)
15/1	79-3 Select low byte (Enable)
15/2	79-3 Open Interval Time high byte (0.1 – 200 *10, 2001 = Lockout) Sensitive Earth Model (0.1 to 1800 *10, 18001=Lockout)
15/3	79-3 Open Interval Time low byte
16/1	79-4 Select high byte (Lockout Type)
16/2	79-4 Select low byte (Enable Type)
16/3	79-4 Open Interval Time high byte (0.1 – 200 *10, 2001 = Lockout) Sensitive Earth Model (0.1 to 1800 *10, 18001=Lockout)
17/1	79-4 Open Interval Time low byte
17/2	79-5 Select high byte (Lockout Type)
17/3	79-5 Select low byte (Enable Type)
18/1	79-5 Open Interval Time high byte (always lockout)
18/2	79-5 Open Interval Time low byte
18/3	79 Cutout Time byte (1 –201) (201 = Disable)
19/1	Cold Load Time byte (1 –254) (255 = Disable)
19/2	2 Phase Voting byte (0=Disable, 1=Enable)
19/3	67P Select byte (0=Disable, 1=Enable, 2=Lockout)
20/1	67P Curve Select byte (Type I)
20/2	67P Pickup Amps byte (1-12Amp *10, 0.2-2.4Amp *50)
20/3	67P Time dial(1-10 *20)/delay(0-10 * 20) byte IEC Curve –67P Time Multiplier (.05-1.00 *200)
21/1	67P Torque Angle byte (0-355 /5)
21/2	67N Select byte (0=Disable, 1=Enable Neg Polar, 2=Enable Zero Polar, 3=Lockout Neg Polar, 4=Lockout Zero Polar) Sensitive Earth Model (0=Disable, 1=Enable-Neg Sequence, 2=Lockout-Neg Sequence, 5=Enable-Pos Sequence, 6=Lockout Pos Sequence)
21/3	67N Curve Select byte (Type I)
22/1	67N Pickup Amps byte (1-12Amp *10, 0.2-2.4Amp *50)
22/2	67N Time dial(1-10 *20)/delay(0-10 * 20) byte IEC Curve –67N Time Multiplier (.05-1.00 *200)
22/3	67N Torque Angle byte (0-355 /5)
23/1	81 Select byte (0=Disable,1=81-1, 2=81-2, 3=Special)
23/2	81s-1 Pickup Frequency high byte (60hz: 56-64 *100, 6401=Disable, 50hz: 46-54 *100, 5401=Disable)
23/3	81s-1 Pickup Frequency low byte
24/1	81s-1 Timedelay high byte (0.08-9.98 *100)
24/2	81s-1 Timedelay low byte
24/3	81r-1 Pickup Frequency high byte (60hz: 56-64 *100, 6401=Disable 50hz: 46-54 *100, 5401=Disable)
25/1	81r-1 Pickup Frequency low byte
25/2	81r-1 Timedelay high byte (0-999)
25/3	81r-1 Timedelay low byte
26/1	81v Voltage Block high byte (40-200)
26/2	81v Voltage Block low byte
26/3	27 Select byte (0=Disable, 1=Enable)
27/1	27 Pickup Voltage high byte (10-200)
27/2	27 Pickup Voltage low byte
27/3	27 Timedelay byte (0-60)
28/1	79v Select byte (0=Disable, 1=Enable)
28/2	79v Pickup Voltage high byte (10-200)

28/3	79v Pickup Voltage low byte
29/1	79v Timedelay byte (4-200)
29/2	59 Select byte (0=Disable, 1=Enable)
29/3	59 Pickup Voltage high byte (70-250)
30/1	59 Pickup Voltage low byte
30/2	59 Timedelay byte (0-60)
30/3	51 P Minimum Response (0 – 60 cycles)
31/1	51 N Minimum Response (0 – 60 cycles)
31/2	50 P-1 Minimum Response (0 – 60 cycles)
31/3	50 N-1 Minimum Response (0 – 60 cycles)
32/1	Unit Configuration byte bit 0 : neutral tap range if bit 7 is 0 use range: 0=1-12A, 1=0.2-2.4A if bit 7 is 1 use range: 0=0.5-6.0A, 1=0.2-2.4A bit 1 : phase tap range if bit 7 is 0 use range: 0=1-12A, 1=0.2-2.4A if bit 7 is 1 use range: 0=1-12A, 1=0.5-6.0A bit 2 : frequency range (0=60Hz, 1=50Hz) bit 3 : cold load timer mode (0=seconds, 1=minutes) bit 4 : user definable curves (0=disabled, 1=enabled) bit 5 : recloser curves (0=disabled, 1=enabled) bit 6 : Version Select (0=ANSI, 1=IEC) bit 7 : phase & neutral tap ranges (0=1-12 and 0.2-2.4, 1=1-12, 0.2-2.4 and 0.5-6.0)
32/2	81s-2 Pickup Frequency high byte (60hz: 56-64 *100, 6401=Disable 50hz: 46-54 *100, 5401=Disable)
32/3	81s-2 Pickup Frequency low byte
33/1	81s-2 Timedelay high byte (0.08-9.98 *100)
33/2	81s-2 Timedelay low byte
33/3	81r-2 Pickup Frequency high byte (60hz: 56-64 *100, 6401=Disable 50hz: 46-54 *100, 5401=Disable)
34/1	81r-2 Pickup Frequency low byte
34/2	81r-2 Timedelay high byte (0-999)
34/3	81r-2 Timedelay low byte
35/1	Sensitive Earth Model – SEF Torque Angle (0-355 /5)
35/2	Sensitive Earth Model – SEF 50N-2 Pickup mA high byte (.005-.060 *2000)
35/3	SEF 50N-2 Pickup mA low byte
36/1	Sensitive Earth Model- Neutral Cold Load (1-254)(255= Disable)
36/2	Checksum high byte
36/3	Checksum low byte

8.4.9 Transmit Configuration Settings (3 4 11)

Low byte consists of bits 0 through 7.
High byte consists of bits 8 through 15.

Msg byte	Definition
1/1	Relay Status (see command 3 4 1, msg 1/1)
1/2	Command + Subcommand = 0x4b
1/3	Total Number of Messages = 23
2/1	Phase CT Ratio high byte (1-999 DPU2000, 1-2000 DPU2000R/1500R)
2/2	Phase CT Ratio low byte
2/3	Neutral CT Ratio high byte (1-999 DPU2000, 1-2000 DPU2000R)
3/1	Neutral CT Ratio low byte
3/2	VT Ratio high byte (1-999 DPU2000, 1-2000 DPU2000R/1500R)
3/3	VT Ratio low byte
4/1	VT Connection high byte (0=69V Wye,1=120V Wye, 2=120V Delta, 3=208V Delta, 4=69V Wye 3V0 I, 5=120V Wye 3V0 I)

4/2	VT Connection low byte
4/3	Positive Sequence Reactance high byte (1-4 *1000)
5/1	Positive Sequence Reactance low byte
5/2	Positive Sequence Resistance high byte (1-4 *1000)
5/3	Positive Sequence Resistance low byte
6/1	Zero Sequence Reactance high byte (1-4 *1000)
6/2	Zero Sequence Reactance low byte
6/3	Zero Sequence Resistance high byte (1-4 *1000)
7/1	Zero Sequence Resistance low byte
7/2	Distance in Miles high byte (0.1-50 *10) IEC Version (0.1-200 *10) km
7/3	Distance in Miles low byte
8/1	Trip Failure Time high byte (5-60)
8/2	Trip Failure Time low byte
8/3	Close Failure Time high byte (18-999)
9/1	Close Failure Time low byte
9/2	Phase Rotation high byte (0=ABC, 1=ACB)
9/3	Phase Rotation low byte
10/1	Configuration Flag high byte
10/2	Configuration Flag low byte bit 0: Protection Mode (0=Fund, 1=RMS) bit 1: Reset Mode (0=Instant, 1=Delayed) bit 2: Zone Sequence (0=Disabled, 1=Enabled) bit 3: Target Display Mode (0=Last, 1=All) bit 4: Local Edit (0=Disabled, 1=Enabled) bit 5: Remote Edit (0=Disabled, 1=Enabled) bit 6: WHr/VarHr Mtr Mode (0=KWHr, 1=MWHr) bit 7: LCD Light (0=Timer, 1=On) bit 8: Multi Device Trip (0=Disabled, 1=Enabled) bit 9: VCN Special Mode (0=Normal, 1=Inverted) bit10: Cold Load Timer Mode(0=Seconds, 1=Minutes) bit11: IEC Mode Bit, Not supported as of V1.70, Reserved bit 12: 79V Timer Mode(0= sec., 1= min.) bit 13: Voltage Display Mode(0= Vln, 1= Vll) bit 14: Password Viewer (0= Disable, 1= Enable)
10/3	ALT 1 Setting Enable high byte(0=Disable, 1=Enable)
11/1	ALT 1 Setting Enable low byte
11/2	ALT 2 Setting Enable high byte(0=Disable, 1=Enable)
11/3	ALT 2 Setting Enable low byte
12/1	Demand Time Constant high byte
12/2	Demand Time Constant low byte (0=5 min, 1=15 min, 2=30 min, 3=60 min)
12/3	Sensitive Earth CT Ratio high byte (1-2000), (DPU2000R/1500R)
13/1	Sensitive Earth CT Ratio low byte
13/2-18/1	Unit Name character 1-15
18/2	OCI configuration byte (0 = disable, 1 = enable) Bit 0: OCI Control Button Bit 1: Breaker Control Button Bits 2 – 7: reserved for future use
18/3	Sensitive Earth V0 PT Ratio high byte (1-2000) , (DPU2000R/1500R)
19/1	Sensitive Earth V0 PT Ratio low byte
19/2	Spare
19/3	Spare
20/1	LCD Contrast Adjustment high byte(0-63)
20/2	LCD Contrast Adjustment low byte
20/3	Relay Password character 1
21/1	Relay Password character 2
21/2	Relay Password character 3
21/3	Relay Password character 4
22/1	Test Password character 1

22/2	Test Password character 2
22/3	Test Password character 3
23/1	Test Password character 4
23/2	Checksum high byte
23/3	Checksum low byte

8.4.10 Transmit Counter Settings (3 4 12)

NOTE: This command is used in DPU2000 versions prior to CPU V1.41.
Low byte consists of bits 0 through 7.
High byte consists of bits 8 through 15.

Msg byte	Definition
1/1	Relay Status (see command 3 4 1, msg 1/1)
1/2	Command + Subcommand = 0x4c
1/3	Total Number of Messages = 9
2/1	KSI Sum A Counter high byte(0-9999)
2/2	KSI Sum A Counter low byte
2/3	KSI Sum B Counter high byte(0-9999)
3/1	KSI Sum B Counter low byte
3/2	KSI Sum C Counter high byte(0-9999)
3/3	KSI Sum C Counter low byte
4/1	Overcurrent Trip Counter high byte(0-9999)
4/2	Ovecurrent Trip Counter low byte
4/3	Breaker Operations Counter high byte(0-9999)
5/1	Breaker Operations Counter low byte
5/2	Reclose Counter 1 high byte(0-9999)
5/3	Reclose Counter 1 low byte
6/1	1st Reclose Counter high byte(0-9999)
6/2	1st Reclose Counter low byte
6/3	2nd Reclose Counter high byte(0-9999)
7/1	2nd Reclose Counter low byte
7/2	3rd Reclose Counter high byte(0-9999)
7/3	3rd Reclose Counter low byte
8/1	4th Reclose Counter high byte(0-9999)
8/2	4th Reclose Counter low byte
8/3	Reclose Counter 2 high byte(0-9999)
9/1	Reclose Counter 2 low byte
9/2	Checksum high byte
9/3	Checksum low byte

8.4.11 Transmit Alarm Settings (3 4 13)

Low byte consists of bits 0 through 7.
High byte consists of bits 8 through 15.

Msg byte	Definition
1/1	Relay Status (see command 3 4 1, msg 1/1)
1/2	Command + Subcommand = 0x4d
1/3	Total Number of Messages = 13
2/1	KSI Summation Alarm Threshold high byte (1-9999,10000=Disables)
2/2	KSI Summation Alarm Threshold low byte
2/3	Overcurrent Trip Counter Alarm high byte (1-9999,10000=Disables)
3/1	Overcurrent Trip Counter Alarm Threshold low byte
3/2	Reclosure Counter 1 Alarm high byte (1-9999,10000=Disables)
3/3	Reclosure Counter 1 Alarm Threshold low byte
4/1	Phase Demand Alarm high byte (1-9999,10000=Disables)
4/2	Phase Demand Alarm low byte
4/3	Neutral Demand Alarm high byte (1-9999,10000=Disables)
5/1	Neutral Demand Alarm low byte
5/2	Low PF Alarm high byte (0.5-1.0 *100, 101=Disables)

5/3	Low PF Alarm low byte
6/1	High PF Alarm high byte (0.5-1.0 *100, 101=Disables)
6/2	High Pf Alarm low byte
6/3	Reclosure Counter 2 Alarm high byte (1-9999,10000=Disables)
7/1	Reclosure Counter 2 Alarm Threshold low byte
7/2	3 Phase kVAR Alarm high byte (10-99990 /10,10000=Disables)
7/3	3 Phase kVAR Alarm Threshold low byte
8/1	Load Current Alarm high byte (1-9999,10000=Disables)
8/2	Load Current Alarm low byte
8/3	Positive kVAR Alarm high byte (10-99990 /10,10000=Disable)
9/1	Positive kVAR Alarm low byte
9/2	Negative kVAR Alarm high byte (10-99990 /10,10000=Disable)
9/3	Negative kVAR Alarm high byte
10/1	Pos Watt Alarm 1 high byte (1-9999, 10000=Disable)
10/2	Pos Watt Alarm 1 low byte
10/3	Pos Watt Alarm 2 high byte (1-9999, 10000=Disable)
11/1	Pos Watt Alarm 2 low byte
11/2	Spare
11/3	Spare
12/1	Spare
12/2	Spare
12/3	Spare
13/1	Spare
13/2	Checksum high byte
13/3	Checksum low byte

NOTE: Positive Watt Alarm 1 and Positive Watt Alarm 2 units are displayed in either KWhr or MWhr according to bit 6 of Configuration Flag (Command 3 4 11, message 10/2). If bit is set to one, use MWhr, if bit is zero, use KWhr.

8.4.12 Transmit Real Time Clock (3 4 14)

Msg byte	Definition
1/1	Relay Status (see command 3 4 1, msg 1/1)
1/2	Command + Subcommand = 0x4e
1/3	Total Number of Messages = 4
2/1	Hours byte (0-23)
2/2	Minutes byte (0-59)
2/3	Seconds byte (0-59)
3/1	Day byte (0-31)(0=Clock shutdown)
3/2	Month byte (1-12)
3/3	Year byte (0-99)
4/1	Spare
4/2	Checksum high byte
4/3	Checksum low byte

8.4.13 Transmit Programmable Output Delays (3 4 15)

Msg Byte	Definition
1/1	Relay Status (see command 3 4 1, msg 1/1)
1/2	Command + Subcommand = 0x4f
1/3	Total Number of Messages = 8
2/1	OUT 6 delay high byte (0.00-60, DPU2000 and 0.00-250, DPU2000R/1500R, *100)
2/2	OUT 6 delay low byte
2/3	OUT 4 delay high byte (0.00-60, DPU2000 and 0.00-250, DPU2000R/1500R, *100)
3/1	OUT 4 delay low byte
3/2	OUT 5 delay high byte (0.00-60, DPU2000 and 0.00-250, DPU2000R/1500R, *100)
3/3	OUT 5 delay low byte
4/1	OUT 3 delay high byte (0.00-60, DPU2000 and 0.00-250, DPU2000R/1500R, *100)
4/2	OUT 3 delay low byte
4/3	OUT 2 delay high byte (0.00-60, DPU2000 and 0.00-250, DPU2000R/1500R, *100)
5/1	OUT 2 delay low byte

5/2	OUT 1 delay high byte (0.00-60, DPU2000 and 0.00-250, DPU2000R/1500R, *100)
5/3	OUT 1 delay low byte
6/1	OUT 7 delay high byte (0.00-60, DPU2000)
6/2	OUT 7 delay low byte
6/3	OUT 8 delay high byte (0.00-60, DPU2000)
7/1	OUT 8 delay low byte
7/2	Spare
7/3	Spare
8/1	Spare
8/2	Checksum high byte
8/3	Checksum low byte

8.5 Transmit Buffer “35N” Commands (3 5 n)

When n=0 then the previous Receive Number command would define the number “N”. Otherwise this command would take the number “N” defined by the subcmd field (1 – 15).

N	Definition
0	Repeat last command
1	Show Load Metered Data
2	Show Demand Metered Data
3	Show Maximum Peak Demand Metered Data
4	Show Minimum Peak Demand Metered Data
5	Show Load Meter Data
6	Show Average Load Current
7	Show Quick 3-Phase Meter Data
8	Send First Fault Record
9	Send Next Fault Record
10	Send First Fault Summary Record
11	Send Next Fault Summary Record
12	Send First Operation Record
13	Send Next Operation Record
14	Breaker Status (including contact inputs)
15	Power Fail Data

8.5.1 Show Load Metered Data (3 5 1)

Msg byte	Definition
1/1	Relay Status Command (see command 3 4 1, msg 1/1)
1/2	Command + Subcommand = 0x51
1/3	Total Number of Messages = 35
2/1	Aux. Status byte Bit 0 : 0 = Wye, 1 = Delta Bit 1 : 0 = kWhr 1 = Mwhr Bit 2 : 0= V(line-neutral) , 1= V(line-line)
2/2	IA Hi byte (Load Currents)
2/3	IA Lo byte
3/1	IA Angle Hi byte
3/2	IA Angle Lo byte
3/3	IB Hi byte
4/1	IB Lo byte
4/2	IB Angle Hi byte
4/3	IB Angle Lo byte
5/1	IC Hi byte
5/2	IC Lo byte
5/3	IC Angle Hi byte
6/1	IC Angle Lo byte
6/2	IN Hi byte
6/3	IN Lo byte
7/1	IN Angle Hi byte
7/2	IN Angle Lo byte
7/3	Kvan/Kvab (Mag) Hi byte (*100)
8/1	Kvan/Kvab (Mag) Lo byte
8/2	Kvan/Kvab (Ang) Hi byte
8/3	Kvan/Kvab (Ang) Lo byte
9/1	KVbn/KVbc (Mag) Hi byte (*100)
9/2	KVbn/KVbc (Mag) Lo byte
9/3	KVbn/KVbc (Ang) Hi byte
10/1	KVbn/KVbc (Ang) Lo byte
10/2	KVcn/Kvca (Mag) Hi byte (*100)
10/3	KVcn/Kvca (Mag) Lo byte

11/1	KVcn/Kvca (Ang) Hi byte
11/2	KVcn/Kvca (Ang) Lo byte
11/3	Kwan Hi byte
12/1	Kwan Mid byte
12/2	Kwan Lo byte
12/3	KWbn Hi byte
13/1	KWbn Mid byte
13/2	KWbn Lo byte
13/3	KWcn Hi byte
14/1	KWcn Mid byte
14/2	KWcn Lo byte
14/3	KW3 Hi byte
15/1	KW3 Mid byte
15/2	KW3 Lo byte
15/3	KVARan Hi byte
16/1	KVARan Mid byte
16/2	KVARan Lo byte
16/3	KVARbn Hi byte
17/1	KVARbn Mid byte
17/2	KVARbn Lo byte
17/3	KVARcn Hi byte
18/1	KVARcn Mid byte
18/2	KVARcn Lo byte
18/3	KVAR3 Hi byte
19/1	KVAR3 Mid byte
19/2	KVAR3 Lo byte
19/3	KWHra Hi byte
20/1	KWHra Mid byte
20/2	KWHra Lo byte
20/3	KWHrb Hi byte
21/1	KWHrb Mid byte
21/2	KWHrb Lo byte
21/3	KWHrc Hi byte
22/1	KWHrc Mid byte
22/2	KWHrc Lo byte
22/3	KWHr3 Hi byte
23/1	KWHr3 Mid byte
23/2	KWHr3 Lo byte
23/3	KVARHra Hi byte
24/1	KVARHra Mid byte
24/2	KVARHra Lo byte
24/3	KVARHrb Hi byte
25/1	KVARHrb Mid byte
25/2	KVARHrb Lo byte
25/3	KVARHrc Hi byte
26/1	KVARHrc Mid byte
26/2	KVARHrc Lo byte
26/3	KVARHr3 Hi byte
27/1	KVARHr3 Mid byte
27/2	KVARHr3 Lo byte
27/3	I0 Hi byte
28/1	I0 Lo byte
28/2	I0 Angle Hi byte
28/3	I0 Angle Lo byte
29/1	I1 Hi byte
29/2	I1 Lo byte
29/3	I1 Angle Hi byte
30/1	I1 Angle Lo byte
30/2	I2 Hi byte

30/3	I2 Lo byte
31/1	I2 Angle Hi byte
31/2	I2 Angle Lo byte
31/3	KV1 Hi byte (*100)
32/1	KV1 Lo byte
32/2	KV1 Angle Hi byte
32/3	KV1 Angle Lo byte
33/1	KV2 Hi byte (*100)
33/2	KV2 Lo byte
33/3	KV2 Angle Hi byte
34/1	KV2 Angle Lo byte
34/2	Frequency Hi byte (*100)
34/3	Frequency Lo byte
35/1	Power Factor bit 0-6 : Power factor value (*100) bit 7 : 0 = Leading, 1 = Lagging
35/2	Spare
35/3	Spare

8.5.2 Show Demand Metered Data (3 5 2)

Msg byte	Definition
1/1	Relay Status (see command 3 4 1, msg 1/1)
1/2	Command + Subcommand = 0x52
1/3	Total Number of Messages = 12
2/1	Aux. Status byte (see command 3 5 1, msg 2/1)
2/2	Demand Ia Hi byte (Load Currents)
2/3	Demand Ia Lo byte
3/1	Demand Ib Hi byte
3/2	Demand Ib Lo byte
3/3	Demand Ic Hi byte
4/1	Demand Ic Lo byte
4/2	Demand In Hi byte
4/3	Demand In Lo byte
5/1	Demand Kwan Hi byte
5/2	Demand Kwan Mid byte
5/3	Demand Kwan Lo byte
6/1	Demand KWbn Hi byte
6/2	Demand KWbn Mid byte
6/3	Demand KWbn Lo byte
7/1	Demand KWcn Hi byte
7/2	Demand KWcn Mid byte
7/3	Demand KWcn Lo byte
8/1	Demand KW3 Hi byte
8/2	Demand KW3 Mid byte
8/3	Demand KW3 Lo byte
9/1	Demand KVARan Hi byte
9/2	Demand KVARan Mid byte
9/3	Demand KVARan Lo byte
10/1	Demand KVARbn Hi byte
10/2	Demand KVARbn Mid byte
10/3	Demand KVARbn Lo byte
11/1	Demand KVARcn Hi byte
11/2	Demand KVARcn Mid byte
11/3	Demand KVARcn Lo byte
12/1	Demand KVAR3 Hi byte
12/2	Demand KVAR3 Mid byte
12/3	Demand KVAR3 Lo byte

8.5.3 Show Maximum Peak Demand Metered Data (3 5 3)

Msg byte	Definition
1/1	Relay Status (see command 3 4 1, msg 1/1)
1/2	Command + Subcommand = 0x53
1/3	Total Number of Messages = 32
2/1	Aux. Status byte (see command 3 5 1, msg 2/1)
50	Peak Dem Ia Hi byte (Load Currents)
50	Peak Dem Ia Lo byte
3/1	Peak Dem Ia time yy
50	Peak Dem Ia time mn
50	Peak Dem Ia time dd
4/1	Peak Dem Ia time hh
50	Peak Dem Ia time mm
50	Peak Dem Ib Hi byte
5/1	Peak Dem Ib Lo byte
50	Peak Dem Ib time yy
50	Peak Dem Ib time mn
6/1	Peak Dem Ib time dd
50	Peak Dem Ib time hh
50	Peak Dem Ib time mm
7/1	Peak Dem Ic Hi byte
50	Peak Dem Ic Lo byte
50	Peak Dem Ic time yy
8/1	Peak Dem Ic time mn
50	Peak Dem Ic time dd
50	Peak Dem Ic time hh
9/1	Peak Dem Ic time mm
50	Peak Dem In Hi byte
50	Peak Dem In Lo byte
10/1	Peak Dem In time yy
50	Peak Dem In time mn
50	Peak Dem In time dd
11/1	Peak Dem In time hh
50	Peak Dem In time mm
50	Peak Dem Kwan Hi byte
12/1	Peak Dem Kwan Mid byte
50	Peak Dem Kwan Lo byte
50	Peak Dem Kwan time yy
13/1	Peak Dem Kwan time mn
50	Peak Dem Kwan time dd
50	Peak Dem Kwan time hh
14/1	Peak Dem Kwan time mm
50	Peak Dem KWbn Hi byte
50	Peak Dem KWbn Mid byte
15/1	Peak Dem KWbn Lo byte
50	Peak Dem KWbn time yy
50	Peak Dem KWbn time mn
16/1	Peak Dem KWbn time dd
50	Peak Dem KWbn time hh
50	Peak Dem KWbn time mm
17/1	Peak Dem KWcn Hi byte
50	Peak Dem KWcn Mid byte
50	Peak Dem KWcn Lo byte
18/1	Peak Dem KWcn time yy
50	Peak Dem KWcn time mn
50	Peak Dem KWcn time dd
19/1	Peak Dem KWcn time hh
50	Peak Dem KWcn time mm

50	Peak Dem KW3 Hi byte
20/1	Peak Dem KW3 Mid byte
50	Peak Dem KW3 Lo byte
50	Peak Dem KW3 time yy
21/1	Peak Dem KW3 time mn
50	Peak Dem KW3 time dd
50	Peak Dem KW3 time hh
22/1	Peak Dem KW3 time mm
50	Peak Dem KVARan Hi byte
50	Peak Dem KVARan Mid byte
23/1	Peak Dem KVARan Lo byte
50	Peak Dem KVARan time yy
50	Peak Dem KVARan time mn
24/1	Peak Dem KVARan time dd
50	Peak Dem KVARan time hh
50	Peak Dem KVARan time mm
25/1	Peak Dem KVARbn Hi byte
50	Peak Dem KVARbn Mid byte
50	Peak Dem KVARbn Lo byte
26/1	Peak Dem KVARbn time yy
50	Peak Dem KVARbn time mn
50	Peak Dem KVARbn time dd
27/1	Peak Dem KVARbn time hh
50	Peak Dem KVARbn time mm
50	Peak Dem KVARcn Hi byte
28/1	Peak Dem KVARcn Mid byte
50	Peak Dem KVARcn Lo byte
50	Peak Dem KVARcn time yy
29/1	Peak Dem KVARcn time mn
50	Peak Dem KVARcn time dd
50	Peak Dem KVARcn time hh
30/1	Peak Dem KVARcn time mm
50	Peak Dem KVAR3 Hi byte
50	Peak Dem KVAR3 Mid byte
31/1	Peak Dem KVAR3 Lo byte
50	Peak Dem KVAR3 time yy
50	Peak Dem KVAR3 time mn
32/1	Peak Dem KVAR3 time dd
32/2	Peak Dem KVAR3 time hh
32/3	Peak Dem KVAR3 time mm

8.5.4 Show Minimum Peak Demand Metered Data (3 5 4)

Substitute minimum peak for maximum peak and this command is the same as the Show Maximum Peak Demand Metered Data command (3 5 3), except for byte 2 of message 1. The command + subcommand (Msg 1/byte 2) is 0x54, not 0x53.

8.5.5 Show Load Metered Data (3 5 5)

Msg byte	Definition
1/1	Relay Status (see command 3 4 1, msg 1/1)
1/2	Command + Subcommand = 0x55
1/3	Total Number of Messages = 4
2/1	Aux. Status byte (see command 3 5 1, msg 2/1)
2/2	a high byte (Load Currents)
2/3	Ia (low byte)
3/1	Ib (high byte)
3/2	Ib (low byte)
3/3	Ic (high byte)
4/1	Ic (low byte)
4/2	In (high byte)

4/3	In (low byte)

8.5.6 Show Average Load Current (3 5 6)

Msg byte	Definition
1/1	Relay Status (see command 3 4 1, msg 1/1)
1/2	Command + Subcommand = 0x56
1/3	Total Number of Messages = 2
2/1	Aux. Status byte (see command 3 5 1, msg 2/1)
2/2	Iavg (high byte)
2/3	Iavg (low byte)

8.5.7 Show Quick 3-Phase Meter (3 5 7)

Msg byte	Definition
1/1	Relay Status (see command 3 4 1, msg 1/1)
1/2	Command + Subcommand = 0x57
1/3	Total Number of Messages = 4
2/1	Aux. Status (see command 3 5 1, msg 2/1)
2/2	Iavg (high byte)
2/3	Iavg (low byte)
3/1	KW3 Hi byte
3/2	KW3 Mid byte
3/3	KW3 Lo byte
4/1	KVAR3 Hi byte
4/2	KVAR3 Mid byte
4/3	KVAR3 Lo byte

8.5.8 Send First Fault Record (3 5 8)

Table 19 - Codes for Fault Element Type

Fault Element Type	Message Number
51P	0
51N	1
50P-1	2
50N-1	3
50P-2	4
50N-2	5
50P-3	6
50N-3	7
67P (DPU2000 & DPU2000R)	8
67N (DPU2000 & DPU2000R)	9
46	10
81 (DPU2000 & DPU2000R	11
Zone Step	12
ECI-1	13
ECI-2	14
SEF (for SE model)	15

Table 20 - Active Settings and Reclose Sequence Definitions

Value	Definition
0x11	Primary-1
0x12	Primary-2
0x13	Primary-3
0x14	Primary-4
0x15	Primary-Lockout
0x21	Alternate 1-1
0x22	Alternate 1-2
0x23	Alternate 1-3
0x24	Alternate 1-4
0x25	Alternate 1-Lockout
0x41	Alternate 2-1
0x42	Alternate 2-2
0x43	Alternate 2-3
0x44	Alternate 2-4
0x45	Alternate 2-Lockout

Msg byte	Definition
1/1	Relay Status (see command 3 4 1, msg 1/1)
1/2	Command + Subcommand = 0x58
1/3	Total Number of Messages = 27
2/1	Fault Type (element) (Table 19, p. 191)
2/2	Active Set and Reclosing Sequence byte (Table 20, p. 192) bit 0-3 : 1=1, 2=2, 3=3, 4=4, 5=L bit 4-7 : 1=Prim, 2=Alt1, 4=Alt2
2/3	Fault Number (high byte)
3/1	Fault Number (low byte)
3/2	Year
3/3	Month
4/1	Day
4/2	Hours or Most significant high byte millisec time since midnight
4/3	Minutes or Most significant low byte millisec time since midnight
5/1	Seconds or Least significant high byte millisec time since midnight
5/2	Hundredths of seconds or Least significant low byte millisec time since midnight, see note below.
5/3	IA Hi byte (/i_scale see msg 8/2)
6/1	IA Lo byte
6/2	IB Hi byte (/i_scale see msg 8/2)
6/3	IB Lo byte
7/1	IC Hi byte (/i_scale see msg 8/2)
7/2	IC Lo byte
7/3	IN Hi byte (/i_scale see msg 8/2)
8/1	IN Lo byte
8/2	Current Scale (0,1 : i_scale=1, 10 : i_scale=10)
8/3	Spare
9/1	Ia Angle (Hi byte)
9/2	Ia Angle (Lo byte)
9/3	Ib Angle (Hi byte)
10/1	Ib Angle (Lo byte)
10/2	Ic Angle (Hi byte)
10/3	Ic Angle (Lo byte)
11/1	In Angle (Hi byte)
11/2	In Angle (Lo byte)
11/3	Zero Seq I (Mag) Hi byte (/i_scale see msg 8/2)
12/1	Zero Seq I (Mag) Lo byte
12/2	Pos Seq I (Mag) Hi byte (/i_scale see msg 8/2)

12/3	Pos Seq I (Mag) Lo byte
13/1	Neg Seq I (Mag) Hi byte (/i_scale see msg 8/2)
13/2	Neg Seq I (Mag) Lo byte
13/3	Zero Seq I (Ang) Hi byte
14/1	Zero Seq I (Ang) Lo byte
14/2	Pos Seq I (Ang) Hi byte
14/3	Pos Seq I (Ang) Lo byte
15/1	Neg Seq I (Ang) Hi byte
15/2	Neg Seq I (Ang) Lo byte
15/3	Kvab/Kvan (Mag) Hi byte (*100)
16/1	Kvab/Kvan (Mag) Lo byte (*100)
16/2	KVbc/KVbn (Mag) Hi byte (*100)
16/3	KVbc/KVbn (Mag) Lo byte (*100)
17/1	Kvca/KVcn (Mag) Hi byte (*100)
17/2	Kvca/KVcn (Mag) Lo byte (*100)
17/3	Vab/Van (Ang) Hi byte
18/1	Vab/Van (Ang) Lo byte
18/2	Vbc/Vbn (Ang) Hi byte
18/3	Vbc/Vbn (Ang) Lo byte
19/1	Vca/Vcn (Ang) Hi byte
19/2	Vca/Vcn (Ang) Lo byte
19/3	Pos Seq KV (Mag) Hi byte (*100)
20/1	Pos Seq KV (Mag) Lo byte
20/2	Neg Seq KV (Mag) Hi byte (*100)
20/3	Neg Seq KV (Mag) Lo byte
21/1	Pos Seq V (Ang) Hi byte
21/2	Pos Seq V (Ang) Lo byte
21/3	Neg Seq V (Ang) Hi byte
22/1	Neg Seq V (Ang) Lo byte
22/2	Fault location (high byte) (*10)
22/3	Fault location (low byte)
23/1	Fault impedance, real part (high byte) (*1000)
23/2	Fault impedance, real part |
23/3	Fault impedance, real part |
24/1	Fault impedance, real part (low byte)
24/2	Breaker Operate Time (high byte) (*1000)
24/3	Breaker Operate Time |
25/1	Breaker Operate Time |
25/2	Breaker Operate Time (low byte)
25/3	Relay Operate Time (high byte) (*1000)
26/1	Relay Operate Time |
26/2	Relay Operate Time |
26/3	Relay Operate Time (low byte)
27/1	Record Status (high byte)
27/2	Record Status (low byte) bit 0 : 0 = Wye Connection , 1 = Delta Connection bit 1 : 0 = Fault , 1 = Event Capture
27/3	Spare

If no fault data entry is present then send all 0s for 2/1 through 27/3.

NOTE: If IRIG is enabled using Enable-mmm option in Communications Command, then the most significant bit of the hour byte will be set to indicate that the four time bytes (Hours, Minutes, Seconds, and Hundreths of Seconds should be combined to form a long value indicating the time in milliseconds since midnight.

8.5.9 Send Next Fault Record (3 5 9)

Same format as (3 5 8) except Msg 1/2 = 0x59.

8.5.10 Send First Fault Summary Record (3 5 10)

Msg byte	Definition
1/1	Relay Status (see command 3 4 1, msg 1/1)
1/2	Command + Subcommand = 0x5a
1/3	Total Number of Messages = 8
2/1	Fault Type (element) (Table 19, p. 191)
2/2	Active Set and Reclosing Sequence byte bit 0-3 : 1=Prim, 2=Alt1, 4=Alt2 bit 4-7 : 1=1, 2=2, 3=3, 4=4, 5=L
2/3	Fault Number (high byte)
3/1	Fault Number (low byte)
3/2	Year
3/3	Month
4/1	Day
4/2	Hours or Most significant high byte millisec time since midnight
4/3	Minutes or Most significant low byte millisec time since midnight
5/1	Seconds or Least significant high byte millisec time since midnight
5/2	Hundredths of seconds or Least significant low byte millisec time since midnight, see note in command 3 5 8.
5/3	IA Hi byte (/i_scale see msg 8/2)
6/1	IA Lo byte
6/2	IB Hi byte (/i_scale see msg 8/2)
6/3	IB Lo byte
7/1	IC Hi byte (/i_scale see msg 8/2)
7/2	IC Lo byte
7/3	IN Hi byte (/i_scale see msg 8/2)
8/1	IN Lo byte
8/2	Current Scale (0,1 : i_scale=1, 10 : i_scale=10)
8/3	Spare

If no fault data entry is present then send all 0s for 2/1 through 8/3.

8.5.11 Send Next Fault Summary Record (3 5 11)

Same format as (3 5 10) except Msg 1/2 = 0x5b.

8.5.12 Send First Operations Record (3 5 12)

Table 21 - Operation Record Definitions

Index	Operation Record Description
0	51P Trip
1	51N Trip
2	50P-1 Trip
3	50N-1 Trip
4	50P-2 Trip
5	50N-2 Trip
6	50P-3 Trip
7	50N-3 Trip
8	67P Trip
9	67N Trip
10	46 Trip
11	27-1P Alarm
12	59 Alarm
13	79V Block
14	81S-1 Trip
15	81R-1 Restore
16	81V Block

Index	Operation Record Description
17	TOC Pickup-No Trip
18	27-3P Alarm
19	SEF Trip
20	External Trip
21	External Close
22	Breaker Opened
23	Breaker Closed
24	Open Trip Contact
25	Recloser Lockout
26	Direct Trip
27	Direct Close
28	MDT Close
29	Ext. Trip and ARC
30	Reclose Initiated
31	CB Failed To Trip
32	CB Failed To Close
33	CB Pops Open
34	CB Pops Closed
35	CB State Unknown
36	CB Stuck Closed
37	Ext. Trip CB Stuck
38	Springs Discharged
39	- reserved for future use -
40	Manual Trip
41	Manual Close
42	Ground TC Enabled
43	Ground TC Disabled
44	Phase TC Enabled
45	Phase TC Disabled
46	Primary Set Active
47	Alt1 Set Active
48	Alt2 Set Active
49	Zone Step
50	Recloser Enabled
51	Recloser Disabled
52	Zone Seq Enabled
53	Zone Seq Disabled
54	50P/N-1 Disabled
55	50P/N-2 Disabled
56	50P/N-3 Disabled
57	50P/N-1 Enabled
58	50P/N-2 Enabled
59	50P/N-3 Enabled
60	81S-2 Trip
61	81R-2 Restore
62	81O-1 Overfreq.
63	81O-2 Overfreq
64	CloseFailed/NoSync
65	LBLL
66	LBDL
67	DBLL
68	DBDL
69	SOFTWARE ERROR
70	Blown Fuse Alarm
71	OC Trip Counter
72	Accumulated KSI
73	79 Counter1 Alarm
74	Phase Demand Alarm

Index	Operation Record Description
75	Neutral Demand Alm
76	Low PF Alarm
77	High PF Alarm
78	Trip Coil Failure
79	kVAR Demand Alarm
80	79 Counter2 Alarm
81	Pos. kVAR Alarm
82	Neg. kVAR Alarm
83	Load Alarm
84	Cold Load Alarm
85	Pos. Watt Alarm 1
86	Pos. Watt Alarm 2
87	32P Trip
88	32N Trip
89	- reserved for future use -
90	Event Capture #1
91	Event Capture #2
92	Waveform Capture
93	BFT Operation
94	ReTrip Operation
95	Ext. BFI Enabled
96	Ext. BFI Disabled
97	BFI Enabled
98	BFI Disabled
99	- reserved for future use -
100	ROM Failure
101	RAM Failure
102	Self Test Failed
103	EEPROM Failure
104	BATRAM Failure
105	DSP Failure
106	Control Power Fail
107	Editor Access
108	System Reboot Init.
109	Interrupt Overlap
110	DSP COP Status
111	System Booting
112	- reserved for future use -
113	- reserved for future use -
114	- reserved for future use -
115	Suprvsr Stack Pointer
116	User Stack Pointer
117	Task Control Block
118	Stack Base
119	Task Address
120	- reserved for future use -
121	- reserved for future use -
122	- reserved for future use -
123	- reserved for future use -
124	- reserved for future use -
125	- reserved for future use -
126	- reserved for future use -
127	- reserved for future use -
128	Springs Charged
129	Springs Discharged
130	79S Input Enabled
131	79S Input Disabled
132	79M Input Enabled

Index	Operation Record Description
133	79M Input Disabled
134	TCM Input Closed
135	TCM Input Opened
136	ALT1 Input Enabled
137	ALT1 Input Disabled
138	ALT2 Input Enabled
139	ALT2 Input Disabled
140	Ext Trip Enabled
141	Ext Trip Disabled
142	Event Cap1 Init
143	Event Cap1 Reset
144	Event Cap2 Init
145	Event Cap2 Reset
146	Wave Cap. Init
147	Wave Cap. Reset
148	Ext Close Enabled
149	Ext Close Disabled
150	52a Closed
151	52a Opened
152	52b Closed
153	52b Opened
154	43a Closed
155	43a Opened
156	46 Unit Enabled
157	46 Unit Disabled
158	67P Unit Enabled
159	67P Unit Disabled
160	67N Unit Enabled
161	67N Unit Disabled
162	ULI1 Input Closed
163	ULI1 Input Opened
164	ULI2 Input Closed
165	ULI2 Input Opened
166	ULI3 Input Closed
167	ULI3 Input Opened
168	ULI4 Input Closed
169	ULI4 Input Opened
170	ULI5 Input Closed
171	ULI5 Input Opened
172	ULI6 Input Closed
173	ULI6 Input Opened
174	ULI7 Input Closed
175	ULI7 Input Opened
176	ULI8 Input Closed
177	ULI8 Input Opened
178	ULI9 Input Closed
179	ULI9 Input Opened
180	CRI Input Closed
181	CRI Input Opened
182	ARC Blocked
183	ARC Enabled
184	TARC Input Opened
185	SEF Enabled
186	SEF Disabled
187	User Display On
188	User Display Off
189	Sync Check Enabled
190	Sync Check Disabled

Index	Operation Record Description
191	Lines Synced
192	Line Sync Lost
193	CB Slow To Trip
194	Supervisory Disable
195	Supervisory Enabled
196	Sync Bypass Enabled
197	Sync Bypass Disable
198	Failed to Sync
199	Catalog Nmbr Updtd
200	- reserved for future use -
201	- reserved for future use -
202	- reserved for future use -
203	- reserved for future use -
204	- reserved for future use -
205	- reserved for future use -
206	- reserved for future use -
207	- reserved for future use -
208	- reserved for future use -
209	- reserved for future use -
210	- reserved for future use -
211	- reserved for future use -
212	- reserved for future use -
213	- reserved for future use -
214	- reserved for future use -
215	59G Alarm
216	TGT Enabled
217	TGT Disabled
218	SIA Enabled
219	SIA Disabled
220	LIS Asserted
221	LIR Asserted
222	LIS Deasserted
223	LIR Deasserted
224	LO Asserted
225	LO Deasserted
226	TR_SET Asserted
227	TR_RST Asserted
228	TR_SET Deasserted
229	TR_RST Deasserted
230	TR_ON Asserted
231	TR_OFF Asserted
232	TR_TAG Asserted
233	59-3P Alarm
234	47 Alarm
235	21P-1 Zone 1 Trip
236	21P-2 Zone 2 Trip
237	21P-3 Zone 3 Trip
238	21P-4 Zone 4 Trip
239	ULI10 Input Closed
240	ULI10 Input Opened
241	ULI11 Input Closed
242	ULI11 Input Opened
243	ULI12 Input Closed
244	ULI12 Input Opened
245	ULI13 Input Closed
246	ULI13 Input Opened
247	ULI14 Input Closed
248	ULI14 Input Opened

Index	Operation Record Description
249	ULI15 Input Closed
250	ULI15 Input Opened
251	ULI16 Input Closed
252	ULI16 Input Opened
253	46A Trip
254	46A Unit Enabled
255	46A Unit Disabled
256	Not applicable!! **Note** – the operation record index can not be greater than 255.

Msg byte	Definition
1/1	Relay Status (see command 3 4 1, msg 1/1)
1/2	Command + Subcommand = 0x5c
1/3	Total Number of Messages = 5
2/1	Year
2/2	Month
2/3	Day
3/1	Hours or Most significant high byte millisec time since midnight
3/2	Minutes or Most significant low byte millisec time since midnight
3/3	Seconds or Least significant high byte millisec time since midnight
4/1	Hundredths of seconds or Least significant low byte millisec time since midnight, see note in command 3 5 8.
4/2	Message Number
4/3	Value (if any) Hi byte
5/1	Value (if any) Lo byte
5/2	Operation Number (high byte)
5/3	Operation Number (low byte)

If the operation entry doesn't exist then send 0's in all the bytes 2/1 through 5/3.

8.5.13 Send Next Operations Record (3 5 13)

Same format as (3 5 12) except Msg 1/2 = 0x5d.

8.5.14 Breaker Status (Including I/O Status) (3 5 14)

Input status bit 0=opened, 1=closed.
Output status bit 0=de-energized, 1=energized.

Msg byte	Definition
1/1	Relay Status (see command 3 4 1, msg 1/1)
1/2	Command + Subcommand = 0x5e
1/3	Total Number of Messages = 3
2/1	Contact Input Status (high byte) Bit 0 – Input 6 (DPU2000 and DPU2000R) Bit 1 – Input 7 (DPU2000 and DPU2000R) Bit 2 – Input 8 (DPU2000 and DPU2000R) or Input 6 (DPU1500R) Bit 3 – Input 9 (DPU2000) Bit 4 – Input 10 (DPU2000) Bit 5 – Input 11 (DPU2000) Bit 6 – Input 12 (DPU2000) Bit 7 – Input 13 (DPU2000)
2/2	Contact Input Status (low byte) Bit 0 – 52a (DPU2000) Bit 1 – 52b (DPU2000) Bit 2 – 43a (DPU2000)

Bit 3 – Input 1
Bit 4 – Input 2
Bit 5 – Input 3
Bit 6 – Input 4
Bit 7 – Input 5

2/3 Self Test Status (high byte)
Bit 0 – DSP ROM
Bit 1 – DSP Internal RAM
Bit 2 – DSP External RAM
Bit 3 – DSP +/-5V
Bit 4 – DSP +/-15V
Bit 5 – DSP +5V
Bit 6 – DSP Comm. Failure
Bit 7 – ADC Failure

3/1 Self Test Status (low byte)
Bit 0 – CPU RAM
Bit 1 – CPU EPROM
Bit 2 – CPU NVRAM
Bit 3 – CPU EEPROM
Bit 4 –
Bit 5 –
Bit 6 –
Bit 7 –

3/2 Output Contact Status (high byte)
Bit 0 – Output 7 (DPU2000)
Bit 1 – Output 8 (DPU2000)

3/3 Output Contact Status (low byte)
Bit 0 – Trip
Bit 1 – Close (DPU2000)
Bit 2 – Output 1
Bit 3 – Output 2
Bit 4 – Output 3
Bit 5 – Output 4
Bit 6 – Output 5
Bit 7 – Output 6

8.5.15 Power Fail Data (3 5 15)

Msg byte	Definition
1/1	Relay Status (see command 3 4 1, msg 1/1)
1/2	Command + Subcommand = 0x5f
1/3	Total Number of Messages = 4
2/1	Year
2/2	Month
2/3	Day
3/1	Hour
3/2	Minute
3/3	Second
4/1	Hundredths of second
4/2	Power Fail Type Bit 0: DC Control Bit 1: +5/+15V
4/3	Breaker Status (state)

8.6 Load Profile/Record Commands (3 6 n)

N	Definition
0	Define Load Profile Settings
1	Start Load Profile Data Accumulation
2	Freeze Load Profile Data
3	Report Load Profile Header-All
4	Report Next Load Profile Data Block
5	Retransmit Last Load Profile Data Block
6	Report Load Profile Header-Last
8	Report Oldest Unreported Fault Record
9	Report Oldest Unreported Operations Record

8.6.1 Load Profile Settings (3 6 0)

Reserved for user configuration.

8.6.2 Accumulate Load Profile Data (3 6 1)

Start load profile data collection.

8.6.3 Freeze Load Profile Data (3 6 2)

Stop load profile data collection.

8.6.4 Report Load Profile Data Header (All Data) (3 6 3)

This command is used to initialize the unit to report the entire contents of the accumulated load profile.

Msg byte	Definition
1/1	Relay Status (see command 3 4 1, msg 1/1)
1/2-4/1	Report Column (1-9) Attribute Number
4/2	spare
4/3-9/3	Unit Id Name (16 chars)
10/1-11/2	Time Tag of the first Block reporting (5 bytes :yy,mn,dd,hh,mm in order)
11/3	spare
12/1-12/2	Report Column 1 Attribute Scale (high, low byte)
12/3-17/3	Report Column (2-9) Attribute Scale

Attr#	Description	Dynamic Scale
0	Demand kW-A	122
1	Demand kW-B	122
2	Demand kW-C	122
3	Demand kVar-A	122
4	Demand kVar-B	122
5	Demand kVar-C	122
6	Van	10
7	Vbn	10
8	Vcn	10
9	Demand kW-3P	367
10	Demand kVar-3P	367
11	Demand Ia	1
12	Demand Ib	1
13	Demand Ic	1
14	Vab	10
15	Vbc	10
16	Vca	10

8.6.5 Report Next Load Profile Data Block (3 6 4)

Msg byte	Definition
1/1	Demand Interval (5/15/30/60 Mins)
1/2-1/3	Record # (a number starting from 1 to #of blocks)
2/1	Total Number Data Bytes (1 through 126)
2/2-3/3	Time Tag of the first Block (5 bytes : hh,mm,dd,mn,yy in order) **NOTE**: Different than command 363 time stamp
4/1-45/3	Data Blocks (up to 126 bytes of data)

Each data block is a two-byte word that has the following bit configuration:

bit 0-13:	data values
bit 14:	sign bit (1=multiply bits 0-13 by –1)
bit 15:	scale bit (0=multiply bits 0-13 by 1, 1=multiply bits 0-13 by attribute scale)

Example: Report column 1 is profiling attribute #0 (Demand kW-A) and has a dynamic scale = 122

Data word	Binary pattern	Scale	Reported value
8,000	0001111101000000	1	8,000 kW
24,384	0101111101000000	-1	-8,000 kW
16,776	0100000011000100	122	23,912 kW
49,384	1100000011000100	-122	-23,912 kW

To obtain the reported value column from the data word, a listing for a C routine should look as follows:

```
long int  ConvertData(unsigned short ,unsigned short );
long int                report_value;
unsigned short int      data_word;

report_value = ConvertData( data_word ,attribute_scale);
{
        int scale=1;

        if ( data_word & 0x4000 ) /* is sign bit set ? */
        {
           scale = -1;
        }

        if ( data_word & 0x8000 ) /* is scale bit set ? */
        {
           scale *= attribute_scale;
        }

        return( (data_word & 0x3fff) * scale );
}
```

8.6.6 Retransmit the Last Load Profile Data Block (3 6 5)

Same as Report Next Load Profile Data Block except it’s the previous data sent.

8.6.7 Report Load Profile Data Header(Last Data) (3 6 6)

This command is used to initialize the unit to report the entire contents of the accumulated load profile.

8.6.8 Oldest Unreported Fault Record (3 6 8)

This command will report the oldest unreported fault record. The 3 0 4 command can be issued to determine how many unreported records exist in units queue. The issuance of the 3 6 8 command will decrement the counter by one record.

Unreported Command byte (0=Get Oldest Unreported, 1= Get Last Reported)

Data Byte	Definition
1/1	Unreported Command Byte
1/2	Unreported Command Byte (Duplicate)
1/3	Unreported Command Byte (Triplicate)

Msg Byte Definition

Same format as (3 5 8) except Msg 1/2 = 0x68.

8.6.9 Oldest Unreported Operations Record (3 6 9)

This command will report the oldest unreported operations record. The 3 0 4 command can be issued to determine how many unreported records exist in units queue. The issuance of the 3 6 9 command will decrement the counter by one record.

Unreported Command byte (0=Get Oldest Unreported, 1= Get Last Reported)

Data Byte	Definition
1/1	Unreported Command Byte
1/2	Unreported Command Byte (Duplicate)
1/3	Unreported Command Byte (Triplicate)

Msg Byte Definition

Same format as (3 5 12) except Msg 1/2 = 0x69.

8.7 Miscellaneous Commands (3 9 n)

N	Definition
0	Trip Command
1	Close Command
2	Energize Output Contact Command
3	Set/Reset Output Contacts Command
4	Close Command-Independent of 43A
5	Set Forced Physical Inputs Command
6	Forced Logical Inputs Information
7	Forced Physical Outputs Command

8.7.1 Trip Command (3 9 0)

The TRIP command will be issued to the DPU. This command has a data message that contains the Password and a command verification code for trip. NOTE: To issue the trip command, the DPU2000 must be in the CLOSED state, 52A closed and 52B opened.

Msg byte	Definition
1/1	Most significant high byte of password
1/2	Most significant low byte of password
1/3	Least significant high byte of password
2/1	Least significant low byte of password
2/2	spare
2/3	Command + Subcommand = 0x90

8.7.2 CLOSE Command (3 9 1)

The CLOSE command will be issued to the DPU. This command has a data message that contains the Password and a command verification code for Close. NOTE: To issue the close command, the DPU2000 must be in the OPEN state and the 43A input must be asserted, 52A opened, 52B closed and 43A closed.

Msg byte	Definition
1/1	Most significant high byte of password
1/2	Most significant low byte of password
1/3	Least significant high byte of password
2/1	Least significant low byte of password
2/2	spare
2/3	Command + Subcommand = 0x91

8.7.3 Energize Output Contact Command (3 9 2)

The test output contact command would be issued to the DPU. This command has a data message that contains the Password and a command verification code and a 16-bit word indicating which contacts should be closed.

The output contact will be a momentary closure for the time period specified in the configuration menu for trip failure time.

Msg byte	Definition
1/1	Most significant high byte of password
1/2	Most significant low byte of password
1/3	Least significant high byte of password
2/1	Least significant low byte of password
2/2	spare
2/3	Command + Subcommand = 0x92
3/1	Output Contact State (high byte) Bit 0 – OUT7 (DPU2000) Bit 1 – OUT8 (DPU2000) Bit 2-7 – Spare
3/2	Output Contact State (low byte) Bit 0 – TRIP Bit 1 – CLOSE (DPU2000)

		Bit 2 – OUT1
		Bit 3 – OUT2
		Bit 4 – OUT3
		Bit 5 – OUT4
		Bit 6 – OUT5
		Bit 7 – OUT6
3/3	Output Contact State Confirmation (high byte)	
		Bit 0 – OUT7 (DPU2000)
		Bit 1 – OUT8 (DPU2000)
		Bit 2-7 – Spare
4/1	Output Contact State Confirmation (low byte)	
		Bit 0 – TRIP
		Bit 1 – CLOSE (DPU2000)
		Bit 2 – OUT1
		Bit 3 – OUT2
		Bit 4 – OUT3
		Bit 5 – OUT4
		Bit 6 – OUT5
		Bit 7 – OUT6
4/2	Checksum high byte	
4/3	Checksum low byte	

8.7.4 Set/Reset Output Contacts Command (3 9 3)

This command allows for the assertion/deassertion of the ULO1-9 logical outputs. It also provides the means to reset the sealed in logical output contacts. Outputs denoted with '*' are sealed in and can only be reset.

Bit = 0, Output Not Energized/No Change in Status.
Bit = 1, Output Energized/Change in Status.

Bit	Output Byte1	Output Byte2	Output Byte3
7	27*	51P*	27-3P*
6	46*	51N*	TRIPA*
5	50P-1*	59* (DPU2000/R)	TRIPB*
4	50N-1*	67P* (DPU2000/R)	TRIPC*
3	50P-2*	67N* (DPU2000/R)	ULO1 (DPU2000/R)
2	50N-2*	81S-1* (DPU2000/R)	ULO2 (DPU2000/R)
1	50P-3*	81R-1* (DPU2000/R)	ULO3 (DPU2000/R)
0	50N-3*	81O-1* (DPU2000/R)	ULO4 (DPU2000/R)

Bit	Output Byte4	Output Byte5	Output Byte6
7	ULO5 (DPU2000/R)	79CA1*	25* (DPU2000R w/Synch Check)
6	ULO6 (DPU2000/R)	79CA2*	59G* (DPU2000R)
5	ULO7 (DPU2000/R)	SEF* (SE Models, DPU2000R/1500R)	59-3p* (DPU2000R)
4	ULO8 (DPU2000/R)	BFT* (DPU2000/R)	47* (DPU2000R)
3	ULO9 (DPU2000/R)	RETRIP* (DPU2000/R)	21P-1* (DPU2000R)
2	81O-2* (DPU2000/R)	32P-2* (DPU2000/R)	21P-2* (DPU2000R)
1	81S-2* (DPU2000/R)	32N-2* (DPU2000/R)	21P-3* (DPU2000R)
0	81R-2* (DPU2000/R)	BFA*	21P-4* (DPU2000R)

Bit	Output Byte7	Output Byte8
7		
6		
5		
4		
3		
2		
1		

0

Example: To Send a command to clear 27-3P* and set ULO4 the following command bytes should be issued:

Set/Reset Output Byte3 = 01 hex
Status Change Output Byte3 = 81 hex

This allows a change to occur for outputs in bit position 7 and 0. Note you can only clear "*" outputs.

Msg byte	Definition
1/1	Most significant high byte of password
1/2	Most significant low byte of password
1/3	Least significant high byte of password
2/1	Least significant low byte of password
2/2	Spare
2/3	Command + Subcommand = 0x93
3/1	Set/Reset Output Byte 1
3/2	Set/Reset Output Byte 2
3/3	Set/Reset Output Byte 3
4/1	Set/Reset Output Byte 4
4/2	Set/Reset Output Byte 5
4/3	Set/Reset Output Byte 6
5/1	Set/Reset Output Byte 7
5/2	Set/Reset Output Byte 8
5/3	Spare
6/1	Spare
6/2	Spare
6/3	Spare
7/1	Status Change Output Byte 1
7/2	Status Change Output Byte 2
7/3	Status Change Output Byte 3
8/1	Status Change Output Byte 4
8/2	Status Change Output Byte 5
8/3	Status Change Output Byte 6
9/1	Status Change Output Byte 7
9/2	Status Change Output Byte 8
9/3	Spare
10/1	Spare
10/2	Spare
10/3	Spare
11/1	Spare
11/2	Checksum high byte
11/3	Checksum low byte

8.7.5 CLOSE Command (3 9 4)

The CLOSE command will be issued to the DPU. This command has a data message that contains the Password and a command verification code for Close. NOTE: To issue the close command, the DPU2000 must be in the OPEN state (independent of 43A input).

Msg byte	Definition
1/1	Most significant high byte of password
1/2	Most significant low byte of password
1/3	Least significant high byte of password
2/1	Least significant low byte of password
2/2	spare
2/3	Command + Subcommand = 0x94

8.7.6 Force Physical Input (3 9 5)

This command is available in DPU2000R and DPU1500R.

This command is issued to the unit and contains a data message that indicates the Password and a command verification code plus two 16 bit words, Normal State mask and Forcing State mask, which indicate which inputs to force and the state to which they are being forced. If the bit specific to an input is reset in the Normal State mask then all input operations for that input will proceed according to normal logical conditions. If the Normal State mask bit specific to an input is set then all input operations for that input will be ignored and the Forcing State mask will be utilized to force the input condition indicated by the Forcing State mask.

Msg byte	Definition
1/1	Most significant high byte of password
1/2	Most significant low byte of password
1/3	Least significant high byte of password
2/1	Least significant low byte of password
2/2	Spare
2/3	Command + Subcommand = 0x95
3/1	high byte of Change state mask
3/2	low byte of Change state mask
3/3	high byte of Normal state mask
4/1	low byte of Normal state mask
4/2	high byte of Forcing state mask
4/3	low byte of Forcing state mask
5/1	Spare
5/2	Spare
5/3	Spare
6/1	Spare
6/2	Checksum high byte
6/3	Checksum low byte

Change State mask (Bit definition):
0 = No change, 1 = Associated input is defined by the states in the Normal and Forcing masks. Refer to Figure 11 (p. 214) for the bit assignments.

Normal State mask (Bit definition):
0 = Normal State, 1 = Normal State over ride. Refer to Figure 11 (p. 214) for the bit assignments.

Forcing State mask (Bit definition):
0 = Forcing Reset state, 1 = Forcing Set State. Refer to Figure 11 (p. 214) for the bit assignments.

8.7.7 Force Logical Input (3 9 6)

This command is available in DPU2000R and DPU1500R.

This command is issued to the unit and contains a data message that indicates the Password and a command verification code plus four 32 bit words, the Normal State masks and Forcing State masks, which indicate which inputs to force and the state to which they are being forced. If the bit specific to an input is reset in the Normal State masks then all input operations for that input will proceed according to normal logical conditions. If the Normal State mask bit specific to an input is set in the Normal State masks then all input operations for that input will be ignored and the Forcing State mask will be utilized to force the input condition indicated by the Forcing State mask.

Msg byte	Definition
1/1	Most significant high byte of password
1/2	Most significant low byte of password
1/3	Least significant high byte of password
2/1	Least significant low byte of password
2/2	Spare
2/3	Command + Subcommand = 0x96
3/1	Most significant high byte of 1st unsigned long word Change state mask
3/2	Most significant low byte of 1st unsigned long word for Change state mask
3/3	Least significant high byte of 1st unsigned long word Change state mask
4/1	Least significant low byte of 1st unsigned long word for Change state mask
4/2	Most significant high byte of 1st unsigned long word for Normal State mask
4/3	Most significant low byte of 1st unsigned long word for Normal State mask

5/1	Least significant high byte of 1st unsigned long word for Normal State mask
5/2	Least significant low byte of 1st unsigned long word for Normal State mask
5/3	Most significant high byte of 1st unsigned long word for Forcing State mask
6/1	Most significant low byte of 1st unsigned long word for Forcing State mask
6/2	Least significant high byte of 1st unsigned long word for Forcing State mask
6/3	Least significant low byte of 1st unsigned long word for Forcing State mask
7/1	Spare
7/2	Spare
7/3	Spare
8/1	Spare
8/2	Checksum high byte
8/3	Checksum low byte

Both unsigned long words for the Change State mask, the Normal State mask and the Forcing State mask, break down as follows for the DPU2000R and DPU1500R:

Bits 31:FLI31	Bits 23:FLI23	Bits 15: FLI15	Bits 07: FLI07
Bits 30:FLI30	Bits 22:FLI22	Bits 14: FLI14	Bits 06: FLI06
Bits 29:FLI29	Bits 21:FLI21	Bits 13: FLI13	Bits 05: FLI05
Bits 28:FLI28	Bits 20:FLI20	Bits 12: FLI12	Bits 04: FLI04
Bits 27:FLI27	Bits 19:FLI19	Bits 11: FLI11	Bits 03: FLI03
Bits 26:FLI26	Bits 18:FLI18	Bits 10: FLI10	Bits 02: FLI02
Bits 25:FLI25	Bits 17:FLI17	Bits 09: FLI09	Bits 01: FLI01
Bits 24:FLI24	Bits 16:FLI16	Bits 08: FLI08	Bits 00: FLI00

8.7.8 Force Physical Output Contact Command (3 9 7)

This command is available in DPU2000R and DPU1500R.

This command is issued to the unit and contains a data message that indicates the Password and a command verification code plus two 16 bit words, Normal State mask and Forcing State mask, which indicate which outputs to force and the state to which they are being forced. If the bit specific to an output is reset in the Normal State mask then all output operations for that output will proceed according to normal logical conditions. If the Normal State mask bit specific to an output is set then all output operations for that output will be ignored and the Forcing State mask will be utilized to force the output condition indicated by the Forcing State mask.

Msg byte	Definition
1/1	Most significant high byte of password
1/2	Most significant low byte of password
1/3	Least significant high byte of password
2/1	Least significant low byte of password
2/2	Spare
2/3	Command + Subcommand = 0x97
3/1	high byte of Change state mask
3/2	low byte of Change state mask
3/3	high byte of Normal state mask
4/1	low byte of Normal state mask
4/2	high byte of Forcing state mask
4/3	low byte of Forcing state mask
5/1	Spare
5/2	Spare
5/3	Spare
6/1	Spare
6/2	Checksum high byte
6/3	Checksum low byte

Change State mask (Bit definition):
0 = No change, 1 = Associated input is defined by the states in the Normal and Forcing masks. Refer to Figure 13 (p. 218) for the bit assignments.

Normal State mask (Bit definition):

0 = Normal State, 1 = Normal State over ride. Refer to Figure 13 (p. 218) for the bit assignments.

Forcing State mask (Bit definition):
0 = Forcing Reset state, 1 = Forcing Set State. Refer to Figure 13 (p. 218) for the bit assignments.

8.8 Receive Buffer "N" Commands (3 10 n)

N	Definition
0	Reserved for repeat 3 10 n
1	Communications Settings
2	Counter Settings
3	Master Trip Output Assignment
4	Breaker Failure Settings

8.8.1 Receive Communications Settings (3 10 1)

Low byte consists of bits 0 through 7.
High byte consists of bits 8 through 15.

Port configuration byte
bit 0-3 = port baud rate (0=300,1=1200,2=2400,3=4800, 4=9600,5=19200,6=38400)
bit 4-5 = parity (0=None, 1=Odd,2=Even)
bit 6 = number of data bits (0=seven, 1=eight)
bit 7 = number of stop bits (0=one, 1=two)

Msg byte	Definition
1/1	Most significant high byte of password
1/2	Most significant low byte of password
1/3	Least significant high byte of password
2/1	Least significant low byte of password
2/2	Spare
2/3	Command + Subcommand = 0xa1
3/1	Unit Address high byte
3/2	Unit Address low byte
3/3	Front Panel RS232 configuration byte
4/1	Rear Panel RS232 or INCOM configuration byte
4/2	Rear Panel RS485 configuration byte
4/3	Rear Panel IRIG byte (0=Disable; 1=Enable-cc, time stamp reporting will be HH:MM:SS.cc; 2=Enable-mmm, time stamp reporting will be HH:MM:SS.mmm)
5/1	Spare
5/2	Spare
5/3	Aux Port Parameter 1 byte (0-255)
6/1	Aux Port Parameter 2 byte (0-255)
6/2	Aux Port Parameter 3 byte (0-255)
6/3	Aux Port Parameter 4 byte (0-255)
7/1	Aux Port Parameter 5 byte (0-255)
7/2	Aux Port Parameter 6 byte (0-255)
7/3	Aux Port Parameter 7 byte (0-255)
8/1	Aux Port Parameter 8 byte (0-255)
8/2	Aux Port Parameter 9 byte (0-255)
8/3	Aux Port Parameter 10 byte (0-255)
9/1	Aux Port Parameter Mode byte (0-255) Bit 0: Par Mode 1 (0=Disable, 1=Enable) Bit 1: Par Mode 2 (0=Disable, 1=Enable) Bit 2: Par Mode 3 (0=Disable, 1=Enable) Bit 3: Par Mode 4 (0=Disable, 1=Enable) Bit 4: Par Mode 5 (0=Disable, 1=Enable) Bit 5: Par Mode 6 (0=Disable, 1=Enable) Bit 6: Par Mode 7 (0=Disable, 1=Enable) Bit 7: Par Mode 8 (0=Disable, 1=Enable)
9/2	Spare
9/3	Spare

10/1	Spare
10/2	Checksum high byte
10/3	Checksum low byte

8.8.2 Receive Counter Settings (3 10 2)

NOTE: Overcurrent Trip Counters A, B, C, and N are available with Recloser Curve Software option, catalog numbers XXXXXXXX-XXX2X or XXXXXXXX-XXX3X. In DPU2000 series, CPU V1.41 or higher is required for the Recloser Curve Software option.

Msg byte	Definition
1/1	Most significant high byte of password
1/2	Most significant low byte of password
1/3	Least significant high byte of password
2/1	Least significant low byte of password
2/2	Spare
2/3	Command + Subcommand = 0xa2
3/1	KSI Sum A Counter high byte(0-9999)
3/2	KSI Sum A Counter low byte
3/3	KSI Sum B Counter high byte(0-9999)
4/1	KSI Sum B Counter low byte
4/2	KSI Sum C Counter high byte(0-9999)
4/3	KSI Sum C Counter low byte
5/1	Over Current Trip Counter high byte (0-9999)
5/2	Over Current Trip Counter low byte
5/3	Breaker Operations Counter high byte (0-9999)
6/1	Breaker Operations Counter low byte
6/2	Reclose Counter 1 high byte (0-9999)
6/3	Reclose Counter 1 low byte
7/1	1st Reclose Counter high byte (0-9999)
7/2	1st Reclose Counter low byte
7/3	2nd Reclose Counter high byte (0-9999)
8/1	2nd Reclose Counter low byte
8/2	3rd Reclose Counter high byte (0-9999)
8/3	3rd Reclose Counter low byte
9/1	4th Reclose Counter high byte (0-9999)
9/2	4th Reclose Counter low byte
9/3	Reclose Counter 2 high byte (0-9999)
10/1	Reclose Counter 2 low byte
10/2	Overcurrent Trip A Counter high byte (0-9999), (DPU2000/R)
10/3	Overcurrent Trip A Counter low byte
11/1	Overcurrent Trip B Counter high byte (0-9999), (DPU2000/R)
11/2	Overcurrent Trip B Counter low byte
11/3	Overcurrent Trip C Counter high byte (0-9999), (DPU2000/R)
12/1	Overcurrent Trip C Counter low byte
12/2	Overcurrent Trip N Counter high byte (0-9999), (DPU2000/R)
12/3	Overcurrent Trip N Counter low byte
13/1	SPARE
13/2	SPARE
13/3	SPARE
14/1	SPARE
14/2	SPARE
14/3	SPARE
15/1	SPARE
15/2	SPARE
15/3	SPARE
16/1	SPARE
16/2	Checksum high byte
16/3	Checksum low byte

8.8.3 Receive Master Trip Output Assignment (3 10 3)

NOTE: DPU2000 series requires CPU version 1.70 and above.

Msg/Byte	Definition		
1/1	Most significant high byte of password		
1/2	Most significant low byte of password		
1/3	Least significant high byte of password		
2/1	Least significant low byte of password		
2/2	Spare		
2/3	Command + Subcommand = 0xa3		
3/1	Master Trip Assignment, Byte 1		
		Bit 0:	SPARE
		Bit 1:	SPARE
		Bit 2:	SPARE
		Bit 3:	SPARE
		Bit 4:	SPARE
		Bit 5:	SPARE
		Bit 6:	SPARE
		Bit 7:	SPARE
3/2	Master Trip Assignment, Byte 2		
		Bit 0:	SPARE
		Bit 1:	SPARE
		Bit 2:	SPARE
		Bit 3:	SPARE
		Bit 4:	SPARE
		Bit 5:	SPARE
		Bit 6:	SPARE
		Bit 7:	SPARE
3/3	Master Trip Assignment, Byte 3		
		Bit 0:	67P (DPU2000 and DPU2000R)
		Bit 1:	67N (DPU2000 and DPU2000R)
		Bit 2:	46
		Bit 3:	SPARE
		Bit 4:	SPARE
		Bit 5:	SPARE
		Bit 6:	SPARE
		Bit 7:	SPARE
4/1	Master Trip Assignment, Byte 4		
		Bit 0:	50N-1
		Bit 1:	50N-2
		Bit 2:	50N-3
		Bit 3:	51N
		Bit 4:	50P-1
		Bit 5:	50P-2
		Bit 6:	50P-3
		Bit 7:	51P
4/2	Spare		
4/3	Spare		
5/1	Spare		
5/2	Spare		
5/3	Spare		
6/1	Spare		
6/2	Checksum, high byte		
6/3	Checksum, low byte		

8.8.4 Breaker Failure Settings (3 10 4)

NOTE: This command is NOT available in DPU1500R. DPU2000 series requires CPU version 1.70 and above.

Msg/Byte Definition

1/1	Most significant high byte of password
1/2	Most significant low byte of password
1/3	Least significant high byte of password
2/1	Least significant low byte of password
2/2	Spare
2/3	Command + Subcommand = 0xa4
3/1	Enable (1=ON, 0=OFF)
3/2	BFT Pickup Time Delay (high byte)
3/3	BFT Pickup Time Delay (low byte)
4/1	BFT Drop Time Delay
4/2	BFT Starters Bit 0: External input Bit 1: Phase Level Detector Bit 2: Neutral Level Detector
4/3	ReTrip Pickup Time Delay (high byte)
5/1	ReTrip Pickup Time Delay (low byte)
5/2	ReTrip Drop Time Delay
5/3	ReTrip Starters Bit 0: External input Bit 1: Phase Level Detector Bit 2: Neutral Level Detector
6/1	Phase Level Detector Pickup (5 to 100% of 51P)
6/2	Neutral Level Detector Pickup (5 to 100% of 51N)
6/3	Spare
7/1	Spare
7/2	Spare
7/3	Spare
8/1	Spare
8/2	Checksum, high byte
8/3	Checksum, low byte

8.9 Receive Edit Buffer "N" Commands (3 11 n)

N	Definition
0	Reserved for Repeat
1	Programmable Input Select and Index Tables
2	Programmable Input Negated AND Table
3	Programmable Input AND/OR Table
4	Programmable Input User Defined Input Names
5	Programmable Ouptut Select Table
6	Programmable Output AND/OR Table
7	Programmable Output User Defined Output Names
8	Primary Relay Settings
9	Alternate 1 Relay Settings
10	Alternate 2 Relay Settings
11	Configuration Settings
12	Counter Settings
13	Alarm Settings
14	Real Time Clock
15	Programmable Output Delays

8.9.1 Receive Programmable Input Select and Index (3 11 1)

Bit Position:	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
DPU2000:	IN3	IN4	IN9	IN2	IN10	43A	52B	52A	IN1	IN11	IN8	IN7	IN6	IN5	IN13	IN12
DPU2000R:	IN3	IN4	FB1	IN2	FB2	FB3	FB4	FB5	IN1	FB6	IN8	IN7	IN6	IN5	FB7	FB8
DPU1500R:	IN3	IN4	N/A	IN2	N/A	N/A	N/A	N/A	IN1	N/A	IN6	N/A	N/A	IN5	N/A	N/A

Figure 11 – Physical Input Index

Bit = 0, Physical Input is selected.
Bit = 1, Physical Input is not selected.
Low byte consists of bits 0 through 7.
High byte consists of bits 8 through 15.
Index byte is the offset into the DPU's logical input structure.

Logical Input List for DPU2000 – Requires matrix (29 x 16) to allow user to map 29 Logical Inputs to 13 Physical Inputs plus "43A", "52A", and "52B". Logical Inputs include: "TCM", "GRD", "PH3", "50-1", "50-2", "50-3", "ALT1", "ALT2", "ZSC", "SCC", "79S", "79M", "OPEN", "CLOSE", "ECI1", "ECI2", "WCI", "46", "67P", "67N", "ULI1", "ULI2", "ULI3", "ULI4", "ULI5", "ULI6", "ULI7", "ULI8", "ULI9", "CRI", "UDI".

Logical Input List for DPU2000R – Requires matrix (29 x 16) to allow user to map 29 Logical Inputs to 8 Physical Inputs plus 8 Feedback Inputs. Logical Inputs include: "52A", "52B", "43A", "TCM", "GRD", "PH3", "50-1", "50-2", "50-3", "ALT1", "ALT2", "ZSC", "SCC", "79S", "79M", "OPEN", "CLOSE", "ECI1", "ECI2", "WCI", "46", "67P", "67N", "ULI1", "ULI2", "ULI3", "ULI4", "ULI5", "ULI6", "ULI7", "ULI8", "ULI9", "CRI", "ARCI", "TARC", "SEF" (*Sensitive Earth Model*), "EXTBF", "BFI", "UDI", "25"(*Synch Check Model*), "25By"(*Synch Check Model*). The following logical inputs are available in CPU versions greater than 1.92: "LOCAL", "TGT", "SIA", The following logical inputs are available in CPU version greater than 4.02 (2.01 for PTH): LIS1, LIS2, LIS3, LIS4, LIS5, LIS6, LIS7, LIS8, LIR1, LIR2, LIR3, LIR4, LIR5, LIR6, LIR7, LIR8, TR_SET, TR_RST.

Logical Input List for DPU1500R – Requires matrix (29 x 6) to allow user to map 29 Logical Inputs to 6 Physical Inputs. Logical Inputs include: "52A", "52B", "43A", "TCM", "GRD", "PH3", "50-1", "50-2", "50-3", "ALT1", "ALT2", "ZSC", "SCC", "79S", "79M", "OPEN", "CLOSE", "ECI1", "ECI2", "WCI", "46", "CRI", "ARCI", "TARC", "SEF" (*Sensitive Earth Model*), "UDI", "LOCAL", "TGT", "SIA".

Refer to Table 2 on page 162 for the complete listing of Logical Input Offsets and their respective definitions.

Msg byte	Definition
1/1	Most significant high byte of password

1/2	Most significant low byte of password
1/3	Least significant high byte of password
2/1	Least significant low byte of password
2/2	Spare
2/3	Command + Subcommand = 0xb1
3/1	INPUT1 high byte
3/2	INPUT1 low byte
3/3	INPUT1 index byte
4/1	INPUT2 high byte
4/2	INPUT2 low byte
4/3	INPUT2 index byte
5/1	INPUT3 high byte
5/2	INPUT3 low byte
5/3	NPUT3 index byte
6/1	INPUT4 high byte
6/2	INPUT4 low byte
6/3	INPUT4 index byte
7/1	INPUT5 high byte
7/2	INPUT5 low byte
7/3	INPUT5 index byte
8/1	INPUT6 high byte
8/2	INPUT6 low byte
8/3	INPUT6 index byte
9/1	INPUT7 high byte
9/2	INPUT7 low byte
9/3	INPUT7 index byte
10/1	INPUT8 high byte
10/2	INPUT8 low byte
10/3	INPUT8 index byte
11/1	INPUT9 high byte
11/2	INPUT9 low byte
11/3	INPUT9 index byte
12/1	INPUT10 high byte
12/2	INPUT10 low byte
12/3	INPUT10 index byte
13/1	INPUT11 high byte
13/2	INPUT11 low byte
13/3	INPUT11 index byte
14/1	INPUT12 high byte
14/2	INPUT12 low byte
14/3	INPUT12 index byte
15/1	INPUT13 high byte
15/2	INPUT13 low byte
15/3	INPUT13 index byte
16/1	INPUT14 high byte
16/2	INPUT14 low byte
16/3	INPUT14 index byte
17/1	INPUT15 high byte
17/2	INPUT15 low byte
17/3	INPUT15 index byte
18/1	INPUT16 high byte
18/2	INPUT16 low byte
18/3	INPUT16 index byte
19/1	INPUT17 high byte
19/2	INPUT17 low byte
19/3	INPUT17 index byte
20/1	INPUT18 high byte
20/2	INPUT18 low byte
20/3	INPUT18 index byte

21/1	INPUT19 high byte
21/2	INPUT19 low byte
21/3	INPUT19 index byte
22/1	INPUT20 high byte
22/2	INPUT20 low byte
22/3	INPUT20 index byte
23/1	INPUT21 high byte
23/2	INPUT21 low byte
23/3	INPUT21 index byte
24/1	INPUT22 high byte
24/2	INPUT22 low byte
24/3	INPUT22 index byte
25/1	INPUT23 high byte
25/2	INPUT23 low byte
25/3	INPUT23 index byte
26/1	INPUT24 high byte
26/2	INPUT24 low byte
26/3	INPUT24 index byte
27/1	INPUT25 high byte
27/2	INPUT25 low byte
27/3	INPUT25 index byte
28/1	INPUT26 high byte
28/2	INPUT26 low byte
28/3	INPUT26 index byte
29/1	INPUT27 high byte
29/2	INPUT27 low byte
29/3	INPUT27 index byte
30/1	INPUT28 high byte
30/2	INPUT28 low byte
30/3	INPUT28 index byte
31/1	INPUT29 high byte
31/2	INPUT29 low byte
31/3	INPUT29 index byte
32/1	Spare
32/2	Checksum high byte
32/3	Checksum low byte

8.9.2 Receive Programmable Input Negated AND (3 11 2)

Bit = 0, Enabled when input is opened.
Bit = 1, Enabled when input is closed.
Low byte consists of bits 0 through 7.
High byte consists of bits 8 through 15.

Msg byte	Definition
1/1	Most significant high byte of password
1/2	Most significant low byte of password
1/3	Least significant high byte of password
2/1	Least significant low byte of password
2/2	spare
2/3	Command + Subcommand = 0xb2
3/1	INPUT1 high byte
3/2	INPUT1 low byte
3/3	INPUT2 high byte
4/1	INPUT2 low byte
4/2	INPUT3 high byte
4/3	INPUT3 low byte
5/1	INPUT4 high byte
5/2	INPUT4 low byte
5/3	INPUT5 high byte

6/1	INPUT5 low byte
6/2	INPUT6 high byte
6/3	INPUT6 low byte
7/1	INPUT7 high byte
7/2	INPUT7 low byte
7/3	INPUT8 high byte
8/1	INPUT8 low byte
8/2	INPUT9 high byte
8/3	INPUT9 low byte
9/1	INPUT10 high byte
9/2	INPUT10 low byte
9/3	INPUT11 high byte
10/1	INPUT11 low byte
10/2	INPUT12 high byte
10/3	INPUT12 low byte
11/1	INPUT13 high byte
11/2	INPUT13 low byte
11/3	INPUT14 high byte
12/1	INPUT14 low byte
12/2	INPUT15 high byte
12/3	INPUT15 low byte
13/1	INPUT16 high byte
13/2	INPUT16 low byte
13/3	INPUT17 high byte
14/1	INPUT17 low byte
14/2	INPUT18 high byte
14/3	INPUT18 low byte
15/1	INPUT19 high byte
15/2	INPUT19 low byte
15/3	INPUT20 high byte
16/1	INPUT20 low byte
16/2	INPUT21 high byte
16/3	INPUT21 low byte
17/1	INPUT22 high byte
17/2	INPUT22 low byte
17/3	INPUT23 high byte
18/1	INPUT23 low byte
18/2	INPUT24 high byte
18/3	INPUT24 low byte
19/1	INPUT25 high byte
19/2	INPUT25 low byte
19/3	INPUT26 high byte
20/1	INPUT26 low byte
20/2	INPUT27 high byte
20/3	INPUT27 low byte
21/1	INPUT28 high byte
21/2	INPUT28 low byte
21/3	INPUT29 high byte
22/1	INPUT29 low byte
22/2	Checksum high byte
22/3	Checksum low byte

8.9.3 Receive Programmable Input AND/OR Select (3 11 3)

Bit = 0, Selected inputs are Ored together.
Bit = 1, Selected inputs are ANDed together.

Msg byte	Definition
1/1	Most significant high byte of password
1/2	Most significant low byte of password

1/3	Least significant high byte of password
2/1	Least significant low byte of password
2/2	spare
2/3	Command + Subcommand = 0xb3
3/1	Programmable input AND/OR selection bits 24-31
3/2	Programmable input AND/OR selection bits 16-23
3/3	Programmable input AND/OR selection bits 8-15
4/1	Programmable input AND/OR selection bits 0-7
4/2	Checksum high byte
4/3	Checksum low byte

Bit	Logical Input
50	INPUT1
50	INPUT2
	.
	.
	.
50	INPUT28
50	INPUT29
50	not used reserved for 52A
50	not used reserved for 52B
50	not used reserved for 43A

8.9.4 Receive Programmable Input User Defined Strings (3 11 4)

User definable 8 chars input strings. Byte 9 is an implied NULL

Msg byte	Definition
1/1	Most significant high byte of password
1/2	Most significant low byte of password
1/3	Least significant high byte of password
2/1	Least significant low byte of password
2/2	spare
2/3	Command + Subcommand = 0xb4
3/1-5/2	IN1 Character String 8 bytes
5/3-8/1	IN2 Character String 8 bytes
8/2-10/3	IN3 Character String 8 bytes
11/1-13/2	IN4 Character String 8 bytes
13/3-16/1	IN5 Character String 8 bytes
16/2-18/3	IN6 Character String 8 bytes
19/1-21/2	IN7 Character String 8 bytes (DPU2000/2000R)
21/3-24/1	IN8 Character String 8 bytes (DPU2000/2000R)
24/2-26/3	IN9 Character String 8 bytes (DPU2000)
27/1-29/2	IN10 Character String 8 bytes (DPU2000)
29/3-32/1	IN11 Character String 8 bytes (DPU2000)
32/2-34/3	IN12 Character String 8 bytes (DPU2000)
35/1-37/2	IN13 Character String 8 bytes (DPU2000)
37/3-38/1	spares
38/2	Checksum high byte
38/3	Checksum low byte

8.9.5 Receive Programmable Output Select (3 11 5)

NOTE: Feedback terms are available in DPU2000R, CPU version 1.60 and above.

Bit Position:	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
DPU2000:	Trip	Close	Out6	Out4	Out5	Out3	Out2	Out1	Out7	Out8	N/A	N/A	N/A	N/A	N/A	N/A
DPU2000R:	Trip	N/A	Out6	Out4	Out5	Out3	Out2	Out1	FB1	FB2	FB3	FB4	FB5	FB6	FB7	FB8
DPU1500R:	Trip	N/A	Out6	Out4	Out5	Out3	Out2	Out1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Figure 13 – Physical Output Index

Programmable Output data transferred from PC to relay.

Bit = 0, Physical Output is selected.
Bit = 1, Physical Output is not selected.
Least significant low byte consists of bits 0 through 7.
Least significant high byte consists of bits 8 through 15.
Most significant low byte consists of bits 16 through 23.
Most significant high byte consists of bits 24 through 31.

Msg byte	Definition
1/1	Most significant high byte of password
1/2	Most significant low byte of password
1/3	Least significant high byte of password
2/1	Least significant low byte of password
2/2	spare
2/3	Command + Subcommand = 0xb5
3/1	Contact OUT6 most significant high byte
3/2	Contact OUT6 most significant low byte
3/3	Contact OUT6 least significant high byte
4/1	Contact OUT6 least significant low byte
4/2	Contact OUT4 most significant high byte
4/3	Contact OUT4 most significant low byte
5/1	Contact OUT4 least significant high byte
5/2	Contact OUT4 least significant low byte
5/3	Contact OUT5 most significant high byte
6/1	Contact OUT5 most significant low byte
6/2	Contact OUT5 least significant high byte
6/3	Contact OUT5 least significant low byte
7/1	Contact OUT3 most significant high byte
7/2	Contact OUT3 most significant low byte
7/3	Contact OUT3 least significant high byte
8/1	Contact OUT3 least significant low byte
8/2	Contact OUT2 most significant high byte
8/3	Contact OUT2 most significant low byte
9/1	Contact OUT2 least significant high byte
9/2	Contact OUT2 least significant low byte
9/3	Contact OUT1 most significant high byte
10/1	Contact OUT1 most significant low byte
10/2	Contact OUT1 least significant high byte
10/3	Contact OUT1 least significant low byte
11/1	Contact OUT7 most significant high byte (DPU2000) DPU2000R FB1 most significant high byte
11/2	Contact OUT7 most significant low byte (DPU2000) DPU2000R FB1 most significant low byte
11/3	Contact OUT7 least significant high byte (DPU2000) DPU2000R FB1 least significant high byte
12/1	Contact OUT7 least significant low byte (DPU2000) DPU2000R FB1 least significant low byte
12/2	Contact OUT8 most significant high byte (DPU2000) DPU2000R FB2 most significant high byte
12/3	Contact OUT8 most significant low byte (DPU2000) DPU2000R FB2 most significant low byte
13/1	Contact OUT8 least significant high byte (DPU2000) DPU2000R FB2 least significant high byte
13/2	Contact OUT8 least significant low byte (DPU2000) DPU2000R FB2 least significant low byte
13/3	DPU2000R FB3 most significant high byte
14/1	DPU2000R FB3 most significant low byte
14/2	DPU2000R FB3 least significant high byte

14/3	DPU2000R FB3 least significant low byte
15/1	DPU2000R FB4 most significant high byte
15/2	DPU2000R FB4 most significant low byte
15/3	DPU2000R FB4 least significant high byte
16/1	DPU2000R FB4 least significant low byte
16/2	DPU2000R FB5 most significant high byte
16/3	DPU2000R FB5 most significant low byte
17/1	DPU2000R FB5 least significant high byte
17/2	DPU2000R FB5 least significant low byte
17/3	DPU2000R FB6 most significant high byte
18/1	DPU2000R FB6 most significant low byte
18/2	DPU2000R FB6 least significant high byte
18/3	DPU2000R FB6 least significant low byte
19/1	DPU2000R FB7 most significant high byte
19/2	DPU2000R FB7 most significant low byte
19/3	DPU2000R FB7 least significant high byte
20/1	DPU2000R FB7 least significant low byte
20/2	DPU2000R FB8 most significant high byte
20/3	DPU2000R FB8 most significant low byte
21/1	DPU2000R FB8 least significant high byte
21/2	DPU2000R FB8 least significant low byte
21/3	Spare
22/1	Spare
22/2	Checksum high byte
22/3	Checksum low byte

8.9.6 Receive Programmable Output AND/OR/Index (3 11 6)

Bit = 0, Selected outputs are Ored together.
Bit = 1, Selected outputs are ANDed together.
Index byte is the offset into the DPU's logical output structure.

Logical Output List for DPU2000 – Requires matrix (32 x 8) to allow user to map 32 Logical Outputs to 8 Physical Outputs. NOTE: first two logicals, ***TRIP*** and ***CLOSE*** are fixed (bits 0 and 1), user is not permitted to remove these from the list. Logical Outputs include: "TRIP", "CLOSE", "ALARM", "BFA", "TCFA", "79LOA", "TCC", "PUA", "51P", "51N", "46", "50P-1", "50N-1", "50P-2", "50N-2", "50P-3", "50N-3", "PATA", "PBTA", "PCTA", "67P", "67N", "81S-1", "81R-1", "81O-1", "27-1P", "59", "79DA", "79CA1", "OCTC", "KSI", "PDA", "NDA", "PVArA", "NVArA", "LOADA", "50-1D", "LPFA", "HPFA", "ZSC", "50-2D", "BFUA", "STCA", "PH3-D", "GRD-D", "32PA", "32NA", "27-3P", "VarDA", "79CA2", "TRIPA", "TRIPB", "TRIPC", "27-1P*", "46*", "50P-1*", "50N-1*", "50P-2*", "50N-2*", "50P-3*", "50N-3*", "51P*", "51N*", "59*", "67P*", "67N*", "81S-1*", "81R-1*", "81O-1*", "27-3P*", "TRIPA*", "TRIPB*", "TRIPC*", "ULO1", "ULO2", "ULO3", "ULO4", "ULO5", "ULO6", "ULO7", "ULO8", "ULO9", "81O-2", "81S-2", "81R-2", "81O-2*", "81S-2*", "81R-2*", "CLTA", "Pwatt1", "Pwatt2", "79CA1*", "79CA2*", "BFA*".

Logical Output List for DPU2000R – Requires matrix (31 x 14) to allow user to map 31 Logical Outputs to 6 Physical Outputs plus 8 Feedback Outputs. NOTE: first logical, ***TRIP*** is fixed, user is not permitted to remove Trip logical from the list. Also note, since the ***CLOSE*** logical is specific to DPU2000, mapping of this logical (located at bit 1) is NOT permissible. Logical Outputs include: "TRIP", "CLOSE", "ALARM", "BFA", "TCFA", "79LOA", "TCC", "PUA", "51P", "51N", "46", "50P-1", "50N-1", "50P-2", "50N-2", "50P-3", "50N-3", "PATA", "PBTA", "PCTA", "67P", "67N", "81S-1", "81R-1", "81O-1", "27-1P", "59", "79DA", "79CA1", "OCTC", "KSI", "PDA", "NDA", "PVArA", "NVArA", "LOADA", "50-1D", "LPFA", "HPFA", "ZSC", "50-2D", "BFUA", "STCA", "PH3-D", "GRD-D", "32PA", "32NA", "27-3P", "VarDA", "79CA2", "TRIPA", "TRIPB", "TRIPC", "27-1P*", "46*", "50P-1*", "50N-1*", "50P-2*", "50N-2*", "50P-3*", "50N-3*", "51P*", "51N*", "59*", "67P*", "67N*", "81S-1*", "81R-1*", "81O-1*", "27-3P*", "TRIPA*", "TRIPB*", "TRIPC*", "ULO1", "ULO2", "ULO3", "ULO4", "ULO5", "ULO6", "ULO7", "ULO8", "ULO9", "81O-2", "81S-2", "81R-2", "81O-2*", "81S-2*", "81R-2*", "CLTA", /* V1.40 */ "Pwatt1", "Pwatt2", "79CA1*", "79CA2*". The following were added to CPU V1.60: "SEF*"(*Sensitive Earth Model*), "SEF"(*Sensitive Earth Model*), "BZA", "BFT", "ReTrp", "BFT*", "ReTrp*". The following were added to CPU V1.80: "32P-2", "32N-2", "32P-2*", "32N-2*", "BFA*".

The following were added to CPU V1.93: "25*"(*Synch Check Model*), "25"(*Synch Check Model*), "SBA".

The following were added to CPU V3.20: "79V"and "Rclin","59G","59G*", "LO1", LO2", "LO3", "LO4", "LO5", "LO6", "LO7", "LO8", "TR_ON","TR_OFF","TR_TAG".

The following were added to CPU V5.0: 59-3P, 59-3P*, 47, 47*, 21P-1, 21P-1*, 21P-2, 21P-2*, 21P-3, 21P-3*, 21P-4, 21P-4*.

Logical Output List for DPU1500R – Requires matrix (31 x 6) to allow user to map 31 Logical Outputs to 6 Physical Outputs. NOTE: first logical, ***TRIP*** is fixed, user is not permitted to remove Trip logical from the list. Also note, since the ***CLOSE*** logical is specific to DPU2000, mapping of this logical (located at bit 1) is NOT permissible. Logical Outputs include: “TRIP”, “CLOSE”, “ALARM”, “BFA”, “TCFA”, “79LOA”, “TCC”, “PUA”, “51P”, “51N”, “46”, “50P-1”, “50N-1”, “50P-2”, “50N-2”, “50P-3”, “50N-3”, “PATA”, “PBTA”, “PCTA”, “27-1P”, “79DA”, “79CA1”, “OCTC”, “KSI”, “PDA”, “NDA”, “PVArA”, “NVArA”, “LOADA”, “50-1D”,”LPFA”, “HPFA”, “ZSC”, “50-2D”, “BFUA”, “STCA”, “PH3-D”, “GRD-D”, “27-3P”, “VarDA”, “79CA2”, “TRIPA”, “TRIPB”, “TRIPC”, “27-1P*”, “46*”, “50P-1*”, “50N-1*”, “50P-2*”, “50N-2*”, “50P-3*”, “50N-3*”, “51P*”, “51N*”, “27-3P*”, “TRIPA*”, “TRIPB*”, “TRIPC*”, “CLTA”, “Pwatt1”, “Pwatt2”, “79CA1*”, “79CA2*”, “SEF*”(*Sensitive Earth Model*), “SEF”(*Sensitive Earth Model*), “BZA”, “BFA*”, “SBA”, “79V” and “Rclin”.

Refer to Table 4, on page 171, for a complete listing of Logical Output Offsets and their respective definitions.

Msg byte	Definition
1/1	Most significant high byte of password
1/2	Most significant low byte of password
1/3	Least significant high byte of password
2/1	Least significant low byte of password
2/2	spare
2/3	Command + Subcommand = 0xb6
3/1	spare (bits 24-31)
3/2	spare (bits 16-23)
3/3	Programmable output AND/OR selection bits 8-15
4/1	Programmable output AND/OR selection bits 0-7
4/2	OUTPUT1 index byte
4/3	OUTPUT2 index byte
5/1	OUTPUT3 index byte
5/2	OUTPUT4 index byte
5/3	OUTPUT5 index byte
6/1	OUTPUT6 index byte
6/2	OUTPUT7 index byte
6/3	OUTPUT8 index byte
7/1	OUTPUT9 index byte
7/2	OUTPUT10 index byte
7/3	OUTPUT11 index byte
8/1	OUTPUT12 index byte
8/2	OUTPUT13 index byte
8/3	OUTPUT14 index byte
9/1	OUTPUT15 index byte
9/2	OUTPUT16 index byte
9/3	OUTPUT17 index byte
10/1	OUTPUT18 index byte
10/2	OUTPUT19 index byte
10/3	OUTPUT20 index byte
11/1	OUTPUT21 index byte
11/2	OUTPUT22 index byte
11/3	OUTPUT23 index byte
12/1	OUTPUT24 index byte
12/2	OUTPUT25 index byte
12/3	OUTPUT26 index byte
13/1	OUTPUT27 index byte
13/2	OUTPUT28 index byte
13/3	OUTPUT29 index byte
14/1	OUTPUT30 index byte
14/2	Checksum high byte
14/3	Checksum low byte

Bit	Logical Output
50	TRIP
50	CLOSE (This bit available for mapping in DPU2000 only)
50	OUTPUT1
50	OUTPUT2
.	
.	
.	
50	OUTPUT29
50	OUTPUT30

8.9.7 Receive Programmable Output User Defined Names (3 11 7)

User definable 8 char output strings. Byte 9 is an implied NULL.

Msg byte	Definition
1/1	Most significant high byte of password
1/2	Most significant low byte of password
1/3	Least significant high byte of password
2/1	Least significant low byte of password
2/2	spare
2/3	Command + Subcommand = 0xb7
3/1-5/2	OUT1 Character String 8 bytes
5/3-8/1	OUT2 Character String 8 bytes
8/2-10/3	OUT3 Character String 8 bytes
11/1-13/2	OUT4 Character String 8 bytes
13/3-16/1	OUT5 Character String 8 bytes
16/2-18/3	OUT6 Character String 8 bytes
19/1-21/2	OUT7 Character String 8 bytes (DPU2000)
21/3-24/1	OUT8 Character String 8 bytes (DPU2000)
24/2-26/3	Spare Character String 8 bytes
27/1-29/2	Spare Character String 8 bytes
29/3-32/1	Spare Character String 8 bytes
32/2-34/3	Spare Character String 8 bytes
35/1-37/2	Spare Character String 8 bytes
37/3-40/1	Spare Character String 8 bytes
40/2	Checksum high byte
40/3	Checksum low byte

8.9.8 Receive Relay Settings (3 11 x)

(3 11 8) = Primary Settings
(3 11 9) = Alternate 1 Settings
(3 11 10) = Alternate 2 Settings
Low byte consists of bits 0 through 7.
High byte consists of bits 8 through 15.

The following functions are available in the DPU1500R: 51P, 50P-1, 50P-2, 50P-3, 46, 51N, 50N-1, 50N-2, 50N-3, 79 and 27.

8.9.8.1 Standard ANSI Curves for DPU2000 and DPU2000R

Refer to Table 5 (p. 175), Table 6 (p. 175), and Table 7 (p. 175) for the Curve Select assignments.

8.9.8.2 Recloser Curves for DPU2000 and DPU2000R

NOTE: Catalog Numbers XXXXXXXX-XX2XX and XXXXXXXX-XX3XX use the following curve types for 51P, 50P-1, 51N, and 50N-1 functions. Also, in addition to the Time Dial fields, include 51P, 50P-1, 51N and 50N-1 Minimum Response fields.

Refer to Table 8 (p. 176), Table 9 (p. 176), Table 10 (p. 176), and Table 11 (p. 177) for the Curve Select assignments.

8.9.8.3 IEC Curves for DPU2000R

NOTE: The following curves are available in IEC DPU2000R, Catalog Number 687XXXXX-XXXXX. All IEC type curves except Definite Time Curves, use Time Multipliers in place of Time Dials.

Refer to Table 12 (p. 177), Table 13 (p. 177), and Table 14 (p. 177) for the Curve Select assignments.

8.9.8.4 ANSI/IEC Curves for DPU1500R

NOTE: All IEC type curves, use Time Multipliers in place of Time Dials.

Refer to Table 15 (p. 178), Table 16 (p. 178), and Table 17 (p. 178) for the Curve Select assignments.

8.9.8.5 79-X Select Bit Pattern for DPU2000/2000R/1500R

Refer to Table 18 (p. 179) for the 79 lockout and enable/disable bit pattern assignments.

Msg byte	Definition
1/1	Most significant high byte of password
½	Most significant low byte of password
1/3	Least significant high byte of password
2/1	Least significant low byte of password
2/2	spare
2/3	Command + Subcommand = (Prim=0xb8, Alt1=0xb9, Alt2=0xba)
3/1	51P Curve Select byte (Type I or Recloser)
3/2	51P Pickup Amps byte (1-12Amp *10, 0.2-2.4Amp *50)
3/3	51P Time dial (0.05-1*200)/delay byte(0-10 *20)
	IEC Curve –51P Time Multiplier (.05-1.00 *200)
4/1	50P-1 Curve Select byte (Type III or Recloser)
4/2	50P-1 Pickup X byte (0.5-20 *10)
4/3	50P-1 Timedial (1-10*10)/delay (0-9.99*100)high byte
	IEC Curve –50P-1 Time Multiplier (.05-1.00 *200)
5/1	50P-1 Timedial/delay low byte
5/2	50P-2 Select byte (0=Disable, 1=Enable)
5/3	50P-2 Pickup X byte (0.5-20 *10)
6/1	50P-2 Timedelay high byte (0-9.99 *100)
6/2	50P-2 Timedelay low byte
6/3	50P-3 Select byte (0=Disable, 1=Enable)
7/1	50P-3 Pickup X byte (0.5-20 *10)
7/2	46 Curve Select byte (Type II)
7/3	46 Pickup Amps byte (1-12Amp *10, 0.2-2.4Amp *50)
8/1	46 Time dial(1-10 *20)/delay byte(0-10 * 20)
	IEC Curve –46 Time Multiplier (.05-1.00 *200)
8/2	51N Curve Select byte (Type II or Recloser)
8/3	51N Pickup Amps byte (1-12Amp *10, 0.2-2.4Amp *50)
9/1	51N Time dial(1-10 *20)/delay byte(0-10 * 20)
	IEC Curve –51N Time Multiplier (.05-1.00 *200)
9/2	50N-1 Curve Select byte (Type III or Recloser)
9/3	50N-1 Pickup X byte (0.5-20 *10)
10/1	50N-1 Timedial(1-10*10)/delay(0-9.99*100)high byte
10/2	50N-1 Timedial/delay low byte
10/3	50N-2 Select byte (0=Disable, 1=Enable)
	Sensitive Earth Model (0=Disable, 1=Standard, 2=SEF, 3=Directional SEF)
11/1	50N-2 Pickup X byte (0.5-20 *10)
11/2	50N-2 Timedelay high byte (0-9.99 *100)
	SEF or Directional SEF Selects – 50N-2 Time Delay (0.5 to 180.0)*200
11/3	50N-2 Timedelay low byte
12/1	50N-3 Select byte (0=Disable, 1=Enable)
12/2	50N-3 Pickup X byte (0.5-20 *10)

12/3	79 Reset Time byte (3-200)
13/1	79-1 Select high byte (Lockout Type)
13/2	79-1 Select low byte (Enable Type)
13/3	79-1 Open Interval Time high byte (0.1 – 200 *10, 2001 = Lockout) Sensitive Earth Model (0.1 to 1800 *10, 18001=Lockout)
14/1	79-1 Open Interval Time low byte
14/2	79-2 Select high byte (Lockout Type)
14/3	79-2 Select low byte (Enable Type)
15/1	79-2 Open Interval Time high byte (0.1 – 200 *10, 2001 = Lockout) Sensitive Earth Model (0.1 to 1800 *10, 18001=Lockout)
15/2	79-2 Open Interval Time low byte
15/3	79-3 Select high byte (Lockout)
16/1	79-3 Select low byte (Enable)
16/2	79-3 Open Interval Time high byte (0.1 – 200 *10, 2001 = Lockout) Sensitive Earth Model (0.1 to 1800 *10, 18001=Lockout)
16/3	79-3 Open Interval Time low byte
17/1	79-4 Select high byte (Lockout Type)
17/2	79-4 Select low byte (Enable Type)
17/3	79-4 Open Interval Time high byte (0.1 – 200 *10, 2001 = Lockout) Sensitive Earth Model (0.1 to 1800 *10, 18001=Lockout)
18/1	79-4 Open Interval Time low byte
18/2	79-5 Select high byte (Lockout Type)
18/3	79-5 Select low byte (Enable Type)
19/1	79-5 Open Interval Time high byte (always lockout)
19/2	79-5 Open Interval Time low byte
19/3	79 Cutout Time byte (1 –201) (201 = Disable)
20/1	Cold Load Time byte (1 –254) (255 = Disable)
20/2	2 Phase Voting byte (0=Disable, 1=Enable)
20/3	67P Select byte (0=Disable, 1=Enable, 2=Lockout)
21/1	67P Curve Select byte (Type I)
21/2	67P Pickup Amps byte (1-12Amp *10, 0.2-2.4Amp *50)
21/3	67P Time dial(1-10 *20)/delay(0-10 * 20) byte IEC Curve –67P Time Multiplier (.05-1.00 *200)
22/1	67P Torque Angle byte (0-355 /5)
22/2	67N Select byte (0=Disable, 1=Enable, 2=Lockout) Sensitive Earth Model (0=Disable, 1=Enable-Neg Sequence, 2=Lockout-Neg Sequence, 5=Enable-Pos Sequence, 6=Lockout Pos Sequence)
22/3	67N Curve Select byte (Type I)
23/1	67N Pickup Amps byte (1-12Amp *10, 0.2-2.4Amp *50)
23/2	67N Time dial(1-10 *20)/delay(0-10 * 20) byte IEC Curve –67N Time Multiplier (.05-1.00 *200)
23/3	67N Torque Angle byte (0-355 /5)
24/1	81 Select byte (0=Disable,1=81-1,2=81-2,3=Special)
24/2	81s-1 Pickup Frequency high byte (60hz: 56-64 *100, 6401=Disable 50hz: 46-54 *100, 5401=Disable)
24/3	81s-1 Pickup Frequency low byte
25/1	81s-1 Timedelay high byte (0.08-9.98 *100)
25/2	81s-1 Timedelay low byte
25/3	81r-1 Pickup Frequency high byte (60hz: 56-64 *100, 6401=Disable 50hz: 46-54 *100, 5401=Disable)
26/1	81r-1 Pickup Frequency low byte
26/2	81r-1 Timedelay high byte (0-999)
26/3	81r-1 Timedelay low byte
27/1	81v Voltage Block high byte (40-200)
27/2	81v Voltage Block low byte
27/3	27 Select byte (0=Disable, 1=Enable)
28/1	27 Pickup Voltage high byte (10-200)
28/2	27 Pickup Voltage low byte
28/3	27 Timedelay byte (0-60)

29/1	79v Select byte (0=Disable, 1=Enable)
29/2	79v Pickup Voltage high byte (10-200)
29/3	79v Pickup Voltage low byte
30/1	79v Timedelay byte (4-200)
30/2	59 Select byte (0=Disable, 1=Enable)
30/3	59 Pickup Voltage high byte (70-250)
31/1	59 Pickup Voltage low byte
31/2	59 Timedelay byte (0-60)
31/3	51 P Minimum Response (0 – 60 cycles)
32/1	51 N Minimum Respons (0 – 60 cycles)
32/2	50 P-1 Minimum Response (0 – 60 cycles)
32/3	50 N-1 Minimum Response (0 – 60 cycles)
33/1	Unit Configuration byte(for transmit only)
33/2	81s-2 Pickup Frequency high byte (60hz: 56-64 *100, 6401=Disable 50hz: 46-54 *100, 5401=Disable)
33/3	81s-2 Pickup Frequency low byte
34/1	81s-2 Timedelay high byte (0.08-9.98 *100)
34/2	81s-2 Timedelay low byte
34/3	81r-2 Pickup Frequency high byte (60hz: 56-64 *100, 6401=Disable 50hz: 46-54 *100, 5401=Disable)
35/1	81r-2 Pickup Frequency low byte
35/2	81r-2 Timedelay high byte (0-999)
35/3	81r-2 Timedelay low byte
36/1	Sensitive Earth Model – SEF Torque Angle (0-355 /5)
36/2	Sensitive Earth Model – SEF 50N-2 Pickup mA high byte (10-400)/2
36/3	Sensitive Earth Model – SEF 50N-2 Pickup mA low byte
37/1	Sensitive Erth Model neutral cold load time(1-254)(255= disable)
37/2	Checksum high byte
37/3	Checksum low byte

8.9.9 Receive Configuration Settings (3 11 11)

Low byte consists of bits 0 through 7.
High byte consists of bits 8 through 15.

Msg byte	Definition
1/1	Most significant high byte of password
½	Most significant low byte of password
1/3	Least significant high byte of password
2/1	Least significant low byte of password
2/2	spare
2/3	Command + Subcommand = 0xbb
3/1	Phase CT Ratio high byte (1-999 DPU2000, 1-2000 DPU2000R/1500R)
3/2	Phase CT Ratio low byte
3/3	Neutral CT Ratio high byte (1-999 DPU2000, 1-2000 DPU2000R)
4/1	Neutral CT Ratio low byte
4/2	VT Ratio high byte (1-999 DPU2000, 1-2000 DPU2000R/1500R)
5/1	VT Connection high byte
5/2	VT Connection low byte (0=69V Wye, 1=120V Wye, 2=120V Delta, 3=208V Delta, 4=69V Wye 3V0 I, 5=120V Wye 3V0 I)
5/3	Positive Sequence Reactance high byte (1-4 *1000)
6/1	Positive Sequence Reactance low byte
6/2	Positive Sequence Resistance high byte (1-4 *1000)
6/3	Positive Sequence Resistance low byte
7/1	Zero Sequence Reactance high byte (1-4 *1000)
7/2	Zero Sequence Reactance low byte
7/3	Zero Sequence Resistance high byte (1-4 *1000)
8/1	Zero Sequence Resistance low byte
8/2	Distance in Miles high byte (0.1-50 *10)
8/3	Distance in Miles low byte

9/1	Trip Failure Time high byte(5-60)
9/2	Trip Failure Time low byte
9/3	Close Failure Time high byte(18-999)
10/1	Close Failure Time low byte
10/2	Phase Rotation high byte (0=ABC, 1=ACB)
10/3	Phase Rotation low byte
11/1	Configuration Flag high byte
11/2	Configuration Flag low byte
	bit 0: Protection Mode (0=Fund, 1=RMS)
	bit 1: Reset Mode (0=Instant, 1=Delayed)
	bit 2: Zone Sequence (0=Disabled, 1=Enabled)
	bit 3: Target Display Mode (0=Last, 1=All)
	bit 4: Local Edit (0=Disabled, 1=Enabled)
	bit 5: Reserved (Remote Edit, 0=Disabled, 1=Enabled)
	bit 6: WHr/VarHr Mtr Mode (0=KWHr, 1=MWHr)
	bit 7: LCD Light (0=Timer, 1=On)
	bit 8: Multi Device Trip (0=Disabled, 1=Enabled)
	bit 9: VCN Special Mode (0=Normal, 1=Inverted)
	bit10: Cold Load Timer Mode(0=Seconds, 1=Minutes)
	bit11: Reserved
	bit 12: 79V Timer Mode (0= sec., 1=min.)
	bit 13: Voltage Display Mode (0= vln, 1=Vll)
	bit 14: Reserved
11/3	ALT 1 Setting Enable high byte(0=Disable,1=Enable)
12/1	ALT 1 Setting Enable low byte
12/2	ALT 2 Setting Enable high byte(0=Disable,1=Enable)
12/3	ALT 2 Setting Enable low byte
13/1	Demand Time Constant high byte
13/2	Demand Time Constant low byte (0=5 min, 1=15 min, 2=30 min, 3=60 min)
13/3	Sensitive Earth CT Ratio high byte (1-2000)
14/1	Sensitive Earth CT Ratio low byte
14/2-19/1	Unit Name character 1-15
19/2	OCI configuration byte (0 = disable, 1 = enable)
	Bit 0: OCI Control Button
	Bit 1: Breaker Control Button
	Bits 2 – 7: reserved for future use
19/3	Sensitive Earth V0 PT Ratio high byte (1-2000)
20/1	Sensitive Earth V0 PT Ratio low byte
20/2	Spare
20/3	Spare
21/1	LCD Contrast Adjustment high byte(0-63)
21/2	LCD Contrast Adjustment low byte
21/3	Relay Password character 1
22/1	Relay Password character 2
22/2	Relay Password character 3
22/3	Relay Password character 4
23/1	Test Password character 1
23/2	Test Password character 2
23/3	Test Password character 3
24/1	Test Password character 4
24/2	Checksum high byte
24/3	Checksum low byte

8.9.10 Receive Counter Settings (3 11 12)

NOTE: This command is used in versions prior to CPU V1.41.
Low byte consists of bits 0 through 7.
High byte consists of bits 8 through 15.

Msg byte	Definition

1/1	Most significant high byte of password
½	Most significant low byte of password
1/3	Least significant high byte of password
2/1	Least significant low byte of password
2/2	spare
2/3	Command + Subcommand = 0xbc
3/1	KSI Sum A Counter high byte
3/2	KSI Sum A Counter low byte
3/3	KSI Sum B Counter high byte
4/1	KSI Sum B Counter low byte
4/2	KSI Sum C Counter high byte
4/3	KSI Sum C Counter low byte
5/1	Over Current Trip Counter high byte
5/2	Over Current Trip Counter low byte
5/3	Breaker Operations Counter high byte
6/1	Breaker Operations Counter low byte
6/2	Reclose Counter 1 high byte
6/3	Reclose Counter 1 low byte
7/1	1st Reclose Counter high byte
7/2	1st Reclose Counter low byte
7/3	2nd Reclose Counter high byte
8/1	2nd Reclose Counter low byte
8/2	3rd Reclose Counter high byte
8/3	3rd Reclose Counter low byte
9/1	4th Reclose Counter high byte
9/2	4th Reclose Counter low byte
9/3	Reclose Counter 2 high byte
10/1	Reclose Counter 2 low byte
10/2	Checksum high byte
10/3	Checksum low byte

8.9.11 Receive Alarm Settings (3 11 13)

Low byte consists of bits 0 through 7.
High byte consists of bits 8 through 15.

Msg byte	Definition
1/1	Most significant high byte of password
½	Most significant low byte of password
1/3	Least significant high byte of password
2/1	Least significant low byte of password
2/2	spare
2/3	Command + Subcommand = 0xbd
3/1	KSI Summation Alarm Threshold high byte (1-9999,10000=Disables)
3/2	KSI Summation Alarm Threshold low byte
3/2	Overcurrent Trip Counter Alarm Threshold high byte (1-9999,10000=Disables)
4/1	Overcurrent Trip Counter Alarm Threshold low byte
4/2	Reclosure Counter 1 Alarm Threshold high byte (1-9999,10000=Disables)
4/3	Reclosure Counter 1 Alarm Threshold low byte
5/1	Phase Demand Alarm high byte (1-9999,10000=Disables)
5/2	Phase Demand Alarm low byte
5/3	Neutral Demand Alarm high byte (1-9999,10000=Disables)
6/1	Neutral Demand Alarm low byte
6/2	Low PF Alarm high byte (0.5-1.0 *100, 101=Disables)
6/3	Low PF Alarm low byte
7/1	High PF Alarm high byte (0.5-1.0 *100, 101=Disables)
7/2	High Pf Alarm low byte
7/3	Reclosure Counter 2 Alarm Threshold high byte (1-9999,10000=Disables)
8/1	Reclosure Counter 2 Alarm Threshold low byte
8/2	3 Phase kVAR Alarm Threshold high byte (10-99990 /10,10000=Disables)

8/3	3 Phase kVAR Alarm Threshold low byte
9/1	Load Current Alarm high byte (1-9999,10000=Disables)
9/2	Load Current Alarm low byte
9/3	Positive kVAR Alarm high byte (10-99990 /10,10000=Disable)
10/1	Positive kVAR Alarm low byte
10/2	Negative kVAR Alarm high byte (10-99990 /10,10000=Disable)
10/3	Negative kVAR Alarm high byte
11/1	Pos Watt Alarm 1 high byte (1-9999, 10000=Disable)
11/2	Pos Watt Alarm 1 low byte
11/3	Pos Watt Alarm 2 high byte (1-9999, 10000=Disable)
12/1	Pos Watt Alarm 2 low byte
12/2	Spare
12/3	Spare
13/1	Spare
13/2	Spare
13/3	Spare
14/1	Spare
14/2	Checksum high byte
14/3	Checksum low byte

NOTE: Positive Watt Alarm 1 and Positive Watt Alarm 2 units are displayed in either KWhr or MWhr according to bit 6 of Configuration Flag (Command 3 4 11, message 10/2). If bit is set to one, use MWhr, if bit is zero, use KWhr.

8.9.12 Receive Real Time Clock (3 11 14)

Msg byte	Definition
1/1	Most significant high byte of password
½	Most significant low byte of password
1/3	Least significant high byte of password
2/1	Least significant low byte of password
2/2	spare
2/3	Command + Subcommand = 0xbe
3/1	Hours byte (0-23)
3/2	Minutes byte (0-59)
3/3	Seconds byte (0-59)
4/1	Day byte (0-31) (0= Clock Shutdown)
4/2	Month byte (1-12)
4/3	Year byte (0-99)
5/1	spare
5/2	Checksum high byte
5/3	Checksum low byte

8.9.13 Receive Programmable Output Delays (3 11 15)

Msg Byte	Definition
1/1	Most significant high byte of password
½	Most significant low byte of password
1/3	Least significant high byte of password
2/1	Least significant low byte of password
2/2	Spare
2/3	Command + Subcommand = 0xbf
3/1	OUT 6 delay high byte
3/2	OUT 6 delay low byte
3/3	OUT 4 delay high byte
4/1	OUT 4 delay low byte
4/2	OUT 5 delay high byte
4/3	OUT 5 delay low byte
5/1	OUT 3 delay high byte
5/2	OUT 3 delay low byte
5/3	OUT 2 delay high byte
6/1	OUT 2 delay low byte

6/2	OUT 1 delay high byte
6/3	OUT 1 delay low byte
7/1	OUT 7 delay high byte (DPU2000)
7/2	OUT 7 delay low byte
7/3	OUT 8 delay high byte (DPU2000)
8/1	OUT 8 delay low byte
8/2	Spare
8/3	Spare
9/1	Spare
9/2	Checksum high byte
9/3	Checksum low byte

8.10 Programmable Curve Commands (3 13 n)

n	Definition
0	Repeat Last Command
1	Receive Curve Parameters
2	Receive First Curve Data Set
3	Receive Next Curve Data Set
4	Receive Curve Pointer Table
5	Show Curve Parameters
6	Show Curve Data Set
7	Show Curve Pointer Table

8.10.1 Receive Curve Parameters (3 13 1)

For the unit to receive the curve data the following sequence of commands must be issued:

3 13 1 (Curve parameters)
3 13 2 (8 Alpha-Beta segments) block 0
3 13 3 (8 Alpha-Beta segments) block 1
3 13 3 (8 Alpha-Beta segments) block 2
3 13 3 (8 Alpha-Beta segments) block 3
3 13 3 (8 Alpha-Beta segments) block 4
3 13 3 (8 Alpha-Beta segments) block 5
3 13 3 (8 Alpha-Beta segments) block 6
3 13 4 (60 pointer offsets)

Data Byte	Definition
1/1	Most significant high byte of password
½	Most significant low byte of password
1/3	Least significant high byte of password
2/1	Least significant low byte of password
2/2	Spare
2/3	Command + Subcommand = 0xd1
3/1	Programmable curve number
3/2	Coefficient A (high byte)
3/3	Coefficient A |
4/1	Coefficient A |
4/2	Coefficient A (low byte)
4/3	Coefficient B (high byte)
5/1	Coefficient B |
5/2	Coefficient B |
5/3	Coefficient B (low byte)
6/1	Coefficient C (high byte)
6/2	Coefficient C |
6/3	Coefficient C |
7/1	Coefficient C (low byte)
7/2	Coefficient P (high byte)
7/3	Coefficient P |
8/1	Coefficient P |
8/2	Coefficient P (low byte)
8/3	Spare
9/1	Spare
9/2	Checksum (high byte)
9/3	Checksum (low byte)

8.10.2 Receive First Curve Data Set (3 13 2)

Data Byte	Definition
1/1	Most significant high byte of password
½	Most significant low byte of password

1/3	Least significant high byte of password
2/1	Least significant low byte of password
2/2	Spare
2/3	Command + Subcommand = 0xd2
3/1	Programmable curve number
3/2	Segment 0: Endrange (high byte)
3/3	Segment 0: Endrange (low byte)
4/1	Segment 0: Alpha (high byte)
4/2	Segment 0: Alpha |
4/3	Segment 0: Alpha |
5/1	Segment 0: Alpha (low byte)
5/2	Segment 0: Beta (high byte)
5/3	Segment 0: Beta |
6/1	Segment 0: Beta |
6/2	Segment 0: Beta (low byte)
6/3-9/3	Segment 1 (same as segment 0)
10/1-13/1	Segment 2 (same as segment 0)
13/2-16/2	Segment 3 (same as segment 0)
16/3-19/3	Segment 4 (same as segment 0)
20/1-23/1	Segment 5 (same as segment 0)
23/2-26/2	Segment 6 (same as segment 0)
26/3-29/3	Segment 7 (same as segment 0)
30/1	Spare
30/2	Checksum (high byte)
30/3	Checksum (low byte)

8.10.3 Receive Next Curve Data Set (3 13 3)

Same format as (3 13 2).

8.10.4 Receive Curve Pointer Table (3 13 4)

Data Byte	Definition
1/1	Most significant high byte of password
1/2	Most significant low byte of password
1/3	Least significant high byte of password
2/1	Least significant low byte of password
2/2	Spare
2/3	Command + Subcommand = 0xd4
3/1	Programmable curve number
3/2	Pointer offset 0
3/3	Pointer offset 1
4/1	Pointer offset 2
4/2	Pointer offset 3
4/3	Pointer offset 4
5/1	Pointer offset 5
5/2	Pointer offset 6
5/3	Pointer offset 7
6/1	Pointer offset 8
6/2	Pointer offset 9
6/3	Pointer offset 10
7/1	Pointer offset 11
7/2	Pointer offset 12
7/3	Pointer offset 13
8/1	Pointer offset 14
8/2	Pointer offset 15
8/3	Pointer offset 16
9/1	Pointer offset 17
9/2	Pointer offset 18
9/3	Pointer offset 19

10/1	Pointer offset 20
10/2	Pointer offset 21
10/3	Pointer offset 22
11/1	Pointer offset 23
11/2	Pointer offset 24
11/3	Pointer offset 25
12/1	Pointer offset 26
12/2	Pointer offset 27
12/3	Pointer offset 28
13/1	Pointer offset 29
13/2	Pointer offset 30
13/3	Pointer offset 31
14/1	Pointer offset 32
14/2	Pointer offset 33
14/3	Pointer offset 34
15/1	Pointer offset 35
15/2	Pointer offset 36
15/3	Pointer offset 37
16/1	Pointer offset 38
16/2	Pointer offset 39
16/3	Pointer offset 40
17/1	Pointer offset 41
17/2	Pointer offset 42
17/3	Pointer offset 43
18/1	Pointer offset 44
18/2	Pointer offset 45
18/3	Pointer offset 46
19/1	Pointer offset 47
19/2	Pointer offset 48
19/3	Pointer offset 49
20/1	Pointer offset 50
20/2	Pointer offset 51
20/3	Pointer offset 52
21/1	Pointer offset 53
21/2	Pointer offset 54
21/3	Pointer offset 55
22/1	Pointer offset 56
22/2	Pointer offset 57
22/3	Pointer offset 58
23/1	Pointer offset 59
23/2	Spare
23/3	Spare
24/1	Spare
24/2	Spare
24/3	Spare
25/1	Spare
25/2	Spare
25/3	Spare
26/1	Spare
26/2	Checksum (high byte)
26/3	Checksum (low byte)

8.10.5 Send Curve Parameters (3 13 5)

For the unit to receive the curve data the following sequence of commands must be issued:

3 13 5 (Curve parameters)
3 13 6 (8 Alpha-Beta segments) block 0
3 13 6 (8 Alpha-Beta segments) block 1
3 13 6 (8 Alpha-Beta segments) block 2

3 13 6 (8 Alpha-Beta segments) block 3
3 13 6 (8 Alpha-Beta segments) block 4
3 13 6 (8 Alpha-Beta segments) block 5
3 13 6 (8 Alpha-Beta segments) block 6
3 13 7 (60 pointer offsets)

Data Byte	Definition
1/1	Curve Number
1/2	Curve Number
1/3	Curve Number

Msg Byte	Definition
1/1	Relay Status (see command 3 4 1, msg 1/1)
1/2	Command + Subcommand = 0xd5
1/3	Total Number of Messages = 8
2/1	Coefficient A (high byte)
2/2	Coefficient A |
2/3	Coefficient A |
3/1	Coefficient A (low byte)
3/2	Coefficient B (high byte)
3/3	Coefficient B |
4/1	Coefficient B |
4/2	Coefficient B (low byte)
4/3	Coefficient C (high byte)
5/1	Coefficient C |
5/2	Coefficient C |
5/3	Coefficient C (low byte)
6/1	Coefficient P (high byte)
6/2	Coefficient P |
6/3	Coefficient P |
7/1	Coefficient P (low byte)
7/2	Spare
7/3	Spare
8/1	Spare
8/2	Checksum (high byte)
8/3	Checksum (low byte)

8.10.6 Send Curve Data Set (3 13 6)

Data Byte	Definition
1/1	Programmable curve number
½	Block number
1/3	Programmable curve number + Block number

Msg Byte	Definition
1/1	Relay Status (see command 3 4 1, msg 1/1)
½	Command + Subcommand = 0xd6
1/3	Total Number of Messages = 29
2/1	Programmable curve number
2/2	Block number
2/3	Segment 0: Endrange (high byte)
3/1	Segment 0: Endrange (low byte)
3/2	Segment 0: Alpha (high byte)
3/3	Segment 0: Alpha |
4/1	Segment 0: Alpha |
4/2	Segment 0: Alpha (low byte)
4/3	Segment 0: Beta (high byte)
5/1	Segment 0: Beta |
5/2	Segment 0: Beta |
5/3	Segment 0: Beta (low byte)

6/1-9/1	Segment 1 (same as segment 0)
9/2-12/2	Segment 2 (same as segment 0)
12/3-15/3	Segment 3 (same as segment 0)
16/1-19/1	Segment 4 (same as segment 0)
19/2-22/2	Segment 5 (same as segment 0)
22/3-25/3	Segment 6 (same as segment 0)
26/1-29/1	Segment 7 (same as segment 0)
29/2	Checksum (high byte)
29/3	Checksum (low byte)

8.10.7 Send Curve Pointer Table (3 13 7)

Data Byte	Definition
1/1	Programmable curve number
½	Programmable curve number
1/3	Programmable curve number

Msg Byte	Definition
1/1	Relay Status (see command 3 4 1, msg 1/1)
½	Command + Subcommand = 0xd7
1/3	Total Number of Messages = 25
2/1	Programmable curve number
2/2	Pointer offset 0
2/3	Pointer offset 1
3/1	Pointer offset 2
3/2	Pointer offset 3
3/3	Pointer offset 4
4/1	Pointer offset 5
4/2	Pointer offset 6
4/3	Pointer offset 7
5/1	Pointer offset 8
5/2	Pointer offset 9
5/3	Pointer offset 10
6/1	Pointer offset 11
6/2	Pointer offset 12
6/3	Pointer offset 13
7/1	Pointer offset 14
7/2	Pointer offset 15
7/3	Pointer offset 16
8/1	Pointer offset 17
8/2	Pointer offset 18
8/3	Pointer offset 19
9/1	Pointer offset 20
9/2	Pointer offset 21
9/3	Pointer offset 22
10/1	Pointer offset 23
10/2	Pointer offset 24
10/3	Pointer offset 25
11/1	Pointer offset 26
11/2	Pointer offset 27
11/3	Pointer offset 28
12/1	Pointer offset 29
12/2	Pointer offset 30
12/3	Pointer offset 31
13/1	Pointer offset 32
13/2	Pointer offset 33
13/3	Pointer offset 34
14/1	Pointer offset 35
14/2	Pointer offset 36
14/3	Pointer offset 37

15/1	Pointer offset 38
15/2	Pointer offset 39
15/3	Pointer offset 40
16/1	Pointer offset 41
16/2	Pointer offset 42
16/3	Pointer offset 43
17/1	Pointer offset 44
17/2	Pointer offset 45
17/3	Pointer offset 46
18/1	Pointer offset 47
18/2	Pointer offset 48
18/3	Pointer offset 49
19/1	Pointer offset 50
19/2	Pointer offset 51
19/3	Pointer offset 52
20/1	Pointer offset 53
20/2	Pointer offset 54
20/3	Pointer offset 55
21/1	Pointer offset 56
21/2	Pointer offset 57
21/3	Pointer offset 58
22/1	Pointer offset 59
22/2	Spare
22/3	Spare
23/2	Spare
23/3	Spare
23/2	Spare
24/3	Spare
24/2	Spare
24/3	Spare
25/1	Spare
25/2	Checksum (high byte)
25/3	Checksum (low byte)

8.11 Waveform Capture Commands (3 14 n)

The waveform capture feature was replaced by the digital fault recorder (DFR) feature in V5.20 DPU2000R. There for the 3 14 n commands are not supported in V5.20 DPU2000R and later versions. Refer to the extended Modbus register set (i.e. INCOM commands 3-1-2, 3-1-3, and 3-1-6) for the digital fault recorder feature.

N	Definition
0	Define waveform capture settings
1	Show waveform capture settings
2	Start waveform data accumulation
3	Stop waveform data accumulation
4	Report waveform record data headers
5	Fetch first block of a record
6	Fetch next block of a record
7	Retransmit last block of a record
8	Fetch Acquistion Status

8.11.1 Define Waveform Capture Settings (3 14 0)

Note the trigger sources are logically OR'ed together.

Example: if 3/1 is Hex 07; trigger on 50N-1 or 50N-2 or 50N-3 pickup. The capture is 8 cycles of waveform with 32 samples per cycle. We then have 7 inputs each of 8 cycles capture. The inputs are Ia, Ib, Ic, In, VA, Vb, and Vc . The data is sent from thr DPU in quarter cyle records, that is 32/4 samples per analog variable.

Data Byte	Definition
1/1	Most significant high byte of password
1/2	Most significant low byte of password
1/3	Least significant high byte of password
2/1	Least significant low byte of password
2/2	Spare
2/3	Command + Subcommand = 0xe0
3/1	Trigger source (byte 1) Bit 0: 50N-1 Bit 1: 50N-2 Bit 2: 50N-3 Bit 3: 51N Bit 4: 50P-1 Bit 5: 50P-2 Bit 6: 50P-3 Bit 7: 51P
3/2	Trigger source (byte 2) Bit 0: 67P (DPU2000 and DPU2000R) Bit 1: 67N (DPU2000 and DPU2000R) Bit 2: 46 Bit 3: 27 Bit 4: 59 (DPU2000 and DPU2000R) Bit 5: 79 Bit 6: 81S (DPU2000 and DPU2000R) Bit 7: 81R (DPU2000 and DPU2000R)
3/3	Trigger source :reserved (byte 3) Bit 0: Trip issued signal Bit 1: Breaker open Bit 2: External (WCI) Bit 5: 59G Bit 6 : 32P (DPU2000 and DPU2000R) Bit 7 : 32N (DPU2000 and DPU2000R)
4/1	Trigger source:reserved (byte 4)
4/2	Trigger position(qtr cycle): 0 to 255 (for 64 qtr cycle record)

0 to 128 (for 32 qtr cycle records)
0 to 64 (for 16 qtr cycle records)
0 to 32 (for 8 qtr cycle records)

4/3 Mode/Record Size
bit 0,1: 00 = 8 rec of 8 qtr cycle record
01 = 4 rec of 16 qtr cycle records
Table 3 = 2 rec of 32 qtr cycle records
11 = 1 rec of 64 qtr cycle records
bit 6 : Single Shot Mode (0=off, 1=on)
bit 7 : Append Record Mode (0=off, 1=on)

5/1 Spare
5/2 Checksum (high byte)
5/3 Checksum (low byte)

8.11.2 Report Waveform Capture Settings (3 14 1)

Data Byte	Definition
1/1	Relay Status (see command 3 4 1, msg 1/1)
1/2	Command + Subcommand = 0xe1
1/3	Total Number of Messages = 9
2/1 – 6/3	Unit ID Name (15 characters)
7/1	Trigger source (byte 1) Bit 0: 50N-1 Bit 1: 50N-2 Bit 2: 50N-3 Bit 3: 51N Bit 4: 50P-1 Bit 5: 50P-2 Bit 6: 50P-3 Bit 7: 51P
7/2	Trigger source (byte 2) Bit 0: 67P (DPU2000 and DPU2000R) Bit 1: 67N (DPU2000 and DPU2000R) Bit 2: 46 Bit 3: 27 Bit 4: 59 (DPU2000 and DPU2000R) Bit 5: 79 Bit 6: 81S (DPU2000 and DPU2000R) Bit 7: 81R (DPU2000 and DPU2000R)
7/3	Trigger source (byte 3) Bit 0: Trip issued signal Bit 1: Breaker open Bit 2: External (WCI) Bit 5: 59G Bit 6 : 32P (DPU2000 and DPU2000R) Bit 7 : 32N (DPU2000 and DPU2000R)
8/1	Trigger source (byte 4)
8/2	Trigger position
8/3	Mode/Record Size bit 0,1: 00 = 8 rec of 8 qtr cycle record 01 = 4 rec of 16 qtr cycle records

Table 3 = 2 rec of 32 qtr cycle records
11 = 1 rec of 64 qtr cycle records
bit 6 : Single Shot Mode (0=off, 1=on)
bit 7 : Append Record Mode (0=off, 1=on)

9/1 Spare
9/2 Checksum (high byte)
9/3 Checksum (low byte)

8.11.3 Arm Waveform Data Accumulation (3 14 2)

Start Waveform data collection.

8.11.4 Disarm Waveform Data Accumulation (3 14 3)

Stop Waveform data collection.

8.11.5 Report Waveform Record Data Headers (3 14 4)

Msg Byte	Definition
1/1	Relay Status (see command 3 4 1, msg 1/1)
1/2	Command + Subcommand = 0xe4
1/3	Total Number of Messages = 38
2/1 – 6/3	Unit ID Name (15 characters)
7/1	Record 0: Trigger position
7/2	Record 0: Year
7/3	Record 0: Month
8/1	Record 0: Date
8/2	Record 0: Hours or Most significant high byte millisec time since midnight
8/3	Record 0: Minutes or Most significant low byte millisec time since midnight
9/1	Record 0: Seconds or Least significant high byte millisec time since midnight
9/2	Record 0: Hundredths of seconds or Least significant low byte millisec time since midnight, see note in command 3 5 8.
9/3	Record 0: Voltage Scale High byte
10/1	Record 0: Voltage Scale Low byte
10/2	Record 0: Mode/Record Size bit 0,1 :00 = 8 rec of 8 qtr cycle record 01 = 4 rec of 16 qtr cycle records Table 3 = 2 rec of 32 qtr cycle records 11 = 1 rec of 64 qtr cycle records bit 6 : Single Shot Mode (0=off, 1=on) bit 7 : Append Record Mode (0=off, 1=on)
10/3	Record 0: Spare
11/1 – 14/3	Record 1 (same as record 0)
15/1 – 18/3	Record 2 (“)
19/1 – 22/3	Record 3 (“)
23/1 – 26/3	Record 4 (“)
27/1 – 30/3	Record 5 (“)
31/1 – 34/3	Record 6 (“)
35/1 – 38/3	Record 7 (“)

8.11.6 Fetch First Block of a Record (3 14 5)

Data Byte	Definition
1/1	Record number (0 to 7)
1/2	Record number(Duplicate)
1/3	Record number(Triplicate)

Msg Byte	Definition
1/1	Relay status (see command 3 4 1, msg 1/1)
1/2	Command + Subcommand = 0xe5
1/3	Total Number of Messages = 34
2/1	Record number
2/2	Block number
2/3	Sample 0: Ia (high byte)
3/1	Sample 0: Ia (low byte)
3/2	Sample 0: Ib (high byte)
3/3	Sample 0: Ib (low byte)
4/1	Sample 0: Ic (high byte)

4/2	Sample 0: Ic (low byte)
4/3	Sample 0: In (high byte)
5/1	Sample 0: In (low byte)
5/2	Sample 0: Va (high byte)
5/3	Sample 0: Va (low byte)
6/1	Sample 0: Vb (high byte)
6/2	Sample 0: Vb (low byte)
6/3	Sample 0: Vc (high byte)
7/1	Sample 0: Vc (low byte)
7/2 – 11/3	Sample 1 data
12/1 – 16/2	Sample 2 data
16/3 – 21/1	Sample 3 data
21/2 – 25/3	Sample 4 data
26/1 – 30/2	Sample 5 data
30/3 – 35/1	Sample 6 data
35/2 – 39/3	Sample 7 data
40/1	Phase scale (high byte)
40/2	Phase scale (low byte)
40/3	Neutral scale (high byte)
41/1	Neutral scale (low byte)
41/2	Input status (high byte). See Figure 11 (p. 214) for bit assignments.
41/3	Input status (low byte)
42/1	Output status byte
42/2	Miscellaneous status byte Bit 0: Trip Bit 1: Breaker failure Bit 2 : Bit 3 : Bit 4 : 32P Fault (DPU2000 and DPU2000R) Bit 5 : 32N Fault (DPU2000 and DPU2000R) Bit 6 : 32P Pickup (DPU2000 and DPU2000R) Bit 7 : 32N Pickup (DPU2000 and DPU2000R)
42/3	Pickup status (high byte) Bit 0: 50N-1 Bit 1: 50N-2 Bit 2: 50N-3 Bit 3: 51N Bit 4: 50P-1 Bit 5: 50P-2 Bit 6: 50P-3 Bit 7: 51P
43/1	Pickup status (low byte) Bit 0: 67P (DPU2000 and DPU2000R) Bit 1: 67N (DPU2000 and DPU2000R) Bit 2: 46 Bit 3: 27 Bit 4: 59 (DPU2000 and DPU2000R) Bit 5: 79 Bit 6: 81S (DPU2000 and DPU2000R) Bit 7: 81R (DPU2000 and DPU2000R)
43/2	Fault status (high byte) Format same as 42/3
43/3	Fault status (low byte) Format same as 43/1

8.11.7 Fetch Next Block of a Record (3 14 6)

Same message format as (3 14 5)

8.11.8 Retransmit Last Block of a Record (3 14 7)

Same message format as (3 14 5)

8.11.9 Fetch Acquisition Status (3 14 8)

Msg Byte	Definition
1/1	Relay status (see command 3 4 1, msg 1/1)
1/2	Command + Subcommand = 0xe8
1/3	Total Number of Messages = 32
2/1	Mode/Record Size
	bit 0,1 :00 = 8 rec of 8 qtr cycle record
	01 = 4 rec of 16 qtr cycle records
Table 3	= 2 rec of 32 qtr cycle records
	11 = 1 rec of 64 qtr cycle records
	bit 6 : Single Shot Mode (0=off, 1=on)
	bit 7 : Append Record Mode (0=off, 1=on)
2/2	Records Remaining (single shot mode)
2/3	State of Accumulation (0=running,1=stopped)

9 Appendix A – Revision History Detail

The goal of this appendix is to detail the protocol document changes such that this appendix could "stand on its own". In other words only a copy of the appendix is necessary to understand what changed in the protocol. The protocol changes are sectioned by the version of the box. Each section references this document's revisions that apply.

9.1 DPU2000R version 5.0, protocol document revisions 7.0 to 8.0

Cmd	Msg Byte	Old Definition	New Definition
3 0 8		Logical Output (byte-bit) 16-4 : no definition 16-3 : no definition 16-2 : no definition 16-1 : no definition 17-7 : no definition 17-6 : no definition 17-5 : no definition 17-4 : no definition 17-3 : no definition 17-2 : no definition 17-1 : no definition 17-0 : no definition	 59-3ph 59-3ph* 47 47* 21P-1 21P-1* 21P-2 21P-2* 21P-3 21P-3* 21P-4 21P-4*
	12/3	Spare	Logical Output byte 17
	13/1	Spare	Logical Output byte 18
3 1 1	Blk 6, offset 12	 Bit 4: no definition Bit 3: no definition Bit 2: no definition Bit 1: no definition Bit 0: no definition	 Bit 4: 59-3p Bit 3: 59-3p* Bit 2: 47 Bit 1: 47* Bit 0: spare
	Offset 50	Does not exist	Logical Outputs 128 – 159 Bits 24-31: 21P-1/2/3/4 and 21P-1*/2*/3*/4*
	Offset 52	Does not exist	Logical Outputs 160 – 191 Not defined.
3 4 6		Output Offset Index: 123 – 135 do not exist	123: 59-3 124: 59-3* 125: 47 126: 47* 127: spare 128: 21P-1 129: 21P-1* 130: 21P-2 131: 21P-2* 132: 21P-3 133: 21P-3* 134: 21P-4 135: 21P-4*
3 5 12		Operation Message Number: 216 – 232 are missing, 233 – 238 do not exist.	 233: 59-3P Alarm 234: 47 Alarm 235: 21P-1 Zone 1 Trip 236: 21P-2 Zone 2 Trip 237: 21P-3 Zone 3 Trip 238: 21P-4 Zone 4 Trip
3 9 3		Output byte 6: Bit 5: LO1 Bit 4: LO2	Output byte 6: Bit 5: 59-3P* Bit 4: 47*

Cmd	Msg Byte	Old Definition	New Definition
		Bit 3: LO3 Bit 2: LO4 Bit 1: LO5 Bit 0: LO6 Output byte 7: Bit 7: LO7 Bit 6: LO8 Bit 5: TR_ON Bit 4: TR_OFF Bit 3: TR_TAG.	Bit 3: 21P-1* Bit 2: 21P-2* Bit 1: 21P-3* Bit 0: 21P-4* Output byte 7: Bits 7 – 3 are not used; undefined.
3 11 6		Output Offset Index: 123 – 135 do not exist	123: 59-3 124: 59-3* 125: 47 126: 47* 127: spare 128: 21P-1 129: 21P-1* 130: 21P-2 131: 21P-2* 132: 21P-3 133: 21P-3* 134: 21P-4 135: 21P-4*

9.2 DPU2000R version 5.10, protocol document revisions 9.0 to 11.1

Cmd	Msg Byte	Old Definition	New Definition
3 0 7		Logical Output (byte-bit) 16-0 : no definition	 50-3D
3 0 9		- Does not exist -	Clear Records
3 1 1	BLK 6 Offset 12 Offset 50	 Bit 0: Spare Bit 8-23 Spare	 50-3D Bit 8 SEFT Bit 9 TimeT Bit 10 VoltT Bit 11 DirT Bit 12 FreqT Bit 13 NegSeqT Bit 14 InstT Bit 15 TimeT Bit 16 NTA Bit 17 TripT Bit 18 C6 Bit 19 C5 Bit 20 C4 Bit 21 C3 Bit 22 C2 Bit 23 C1
3 4 1	Fig. 8	Figure 8 – Physical Input Mapping Bits 16 – 31 do not exist.	 Bit 16: C1 Bit 17: C2 Bit 18: C3

Cmd	Msg Byte	Old Definition	New Definition
			Bit 19: C4 Bit 20: C5 Bit 21: C6 Bits 22 – 31: N/A
3 4 1	Table 1	List of logical input definitions	Created Table 1 – Logical Input Definitions
3 4 5	Table	List of bit assignments for outputs	Created Table – Programmable Bit Assignments for Outputs
3 4 6	Table 2	<u>Index</u> 136 – 151: not defined	 136: C1 137: C2 138: C3 139: C4 140: C5 141: C6 142: TripT 143: NTA 144: TimeT 145: InstT 146: NegSeqT 147: FreqT 148: DirT 149: VoltT 150: DistT 151: SEFT
3 4 8(9,10)		4 sets of Curve Selection lists.	Created 4 sets of Curve Selection tables.
3 4 11	18/2	Spare	OCI configuration byte (0=disable, 1=enable) Bit 0: OCI Control Button Bit 1: Breaker Control Button Bits 2 – 7: reserved for future use
3 5 8	Table 4 & 5	List of Fault Record Messages List of reclose sequence definitions	Table 4 – Codes for Fault Element Type. Table 5 – Active Setting & Reclose Sequence Definitions
3 11 8(9,10)		4 sets of Curve Selection lists.	Refer to the Curve Selection tables found under the 3 4 8(9,10) command.
3 11 11	19/2	Spare	OCI configuration byte (0=disable, 1=enable) Bit 0: OCI Control Button Bit 1: Breaker Control Button Bits 2 – 7: reserved for future use

9.3 DPU2000R version 5.20, protocol document revision 12.0

Cmd	Msg Byte	Old Definition	New Definition
3 1 1	BLK 6 Offset 50 Offset 52	 Bit 0-7 Spare Bit 31-27 Spare	 Bit 7 ULO 10 Bit 6 ULO 11 Bit 5 ULO 12 Bit 4 ULO 13 Bit 3 ULO 14 Bit 2 ULO 15 Bit 1 ULO 16 Bit 0 HBHL Bit 31 HBDL

Cmd	Msg Byte	Old Definition	New Definition
			Bit 30 DBHL Bit 29 DBDL Bit 28 46A Bit 27 46A*
3 4 1		Table 1 – Logical Input Definitions Indicies 62 to 69 are not defined.	 62: ULI 10 63: ULI 11 64: ULI 12 65: ULI 13 66: ULI 14 67: ULI 15 68: ULI 16 69: 46A TC
3 4 6		Table 3 – Logical Output Indicies & Definitions Indicies 152 – 164 are not defined.	 152: ULO 10 153: ULO 10 154: ULO 10 155: ULO 10 156: ULO 10 157: ULO 10 158: ULO 10 159: HBHL 160: HBDL 161: DBHL 162: DBDL 163: 46A 164: 46A*
3 5 12		Operation Record message and definitions list	Table 20 - Operation Record Definitions Added definitions for the following indices: 19, 64 – 69, 95 – 98, 108 – 111, and 139 – 256.
3 14 n		The waveform capture feature is supported in all versions of the DPU.	The waveform capture feature is not supported in V5.20 DPU2000R and later versions.

9.4 DPU2000R version 5.30, protocol document revision 13.0

Cmd	Msg Byte	Old Definition	New Definition
3 1 1	BLK 6 Offset 52	 Bit 26 Spare	 Bit 26 REMOTE_D
3 4 6		Table 3 – Logical Output Indices & Definitions 165: Not defined	Table 3 – Logical Output Indices & Definitions 165: REMOTE_D

9.5 DPU2000R version 5.40, protocol document revision 15.0

Cmd	Msg Byte	Old Definition	New Definition
	Table 1 - Logical Input Definition	<u>Indicies</u> 70: not defined 71: not defined 72: not defined	<u>Indicies</u> 70: SWSET 71: SHIFTA 72: SHIFTB
	Table 3 - Logical Output	<u>Indicies</u> 166 - 176: not defined	<u>Indicies</u> 166: PRI-ON 167: ALT1-ON

Cmd	Msg Byte	Old Definition	New Definition
	Indices & Definition		168: ALT2-ON 169: SHIFTA-1 170: SHIFTA-2 171: SHIFTA-3 172: SHIFTA-4 173: SHIFTB-1 174: SHIFTB-2 175: SHIFTB-3 176: SHIFTB-4