



Preliminary
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Type MRC2 Multishot Reclosing Relay

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CAUTION

It is recommended that the user of this equipment become acquainted with the information in this instruction leaflet before energizing the relay. Failure to do so may result in injury to personnel or damage to the equipment, and may affect the equipment warranty.

The relay contains static sensitive components. Electrostatic Discharge (ESD) precautions must be practiced when handling printed circuit boards and components. Use of anti-static handling materials and grounding procedures is required.

Before putting relay into service, remove all blocking which may have been inserted for the purpose of securing the parts during shipment. Operate the relay to check the settings and electrical contacts.

The operation of this relay is based on ABB proprietary software, resident-in-memory components. Purchase of this relay includes a restrictive license for the use of any and all programs solely as part of the protective functions. ABB reserves the right to request return of the memory components should the relay no longer be

used as a protective device. The programs may not be copied, transferred or applied to any other device.

1. APPLICATION

The MRC reclosing relay is used for automatic reclosure of ac or dc electrically operated circuit breakers after they have been opened by overcurrent or other protective relay action. The basic style operates with 48 or 125 Vdc, or 120 Vac (50 or 60Hz) input control voltage. The relay may be adjusted to provide several reclosures at predetermined intervals, so that in case the breaker does not remain closed after the first reclosure additional reclosures will be made. The first reclosure usually is an immediate reclosure. System operating experience has shown that the majority of faults are of a temporary nature, such as lightning flashovers, and will not be reestablished after an interruption of the fault current. Consequently, service interruption can be minimized by the use of an immediate reclosure. However, the first reclosure may be delayed if desired.

In case the circuit breaker does not remain closed after the first reclosure, the relay will make additional reclosures at suitably graded intervals. It is common practice to make two additional reclosures, but the relay may be adjusted to make any number up to a total of four reclosures if desired. If the breaker does not remain closed after the final reclosure, the relay goes to "Lockout", and any further attempts at reclosure must be made by manual operation of the external customer control switch. However, if the breaker remains closed after any automatic reclosure, the relay will advance to and stop at the "Home" position, where the relay is in readiness for

All possible contingencies which may arise during installation, operation or maintenance, and all details and variations of this equipment do not purport to be covered by these instructions. If further information is desired by purchaser regarding this particular installation, operation or maintenance of this equipment, the local ABB Power T&D Co. Inc. representative should be contacted.

another cycle of automatic reclosures following the next tripping of the breakers.

For any automatic reclosing application, the underlying factors for breaker interrupting ability should be checked when choosing any particular reclosing cycle. Also, when using immediate first reclosure, it is necessary that the protective relays open their contacts before the breaker contacts make again.

2. CONSTRUCTION

The MRC is a micro-controller-based multishot reclosing relay designed to fit into an FT-22 flexitest case (Figure 1). It monitors an optically-isolated contact inputs, and provides contact outputs using board-mountable, covered relays. Timing, counting and logic are determined by the microcontroller. The relay consists of four printed circuit (pc) modules:

- Bottom I/O Module
- Top I/O Module
- Microcontroller/Display
- Power Supply

2.1 Bottom I/O Module

The Bottom I/O module comprises:

- a. Two opto-isolated inputs that are jumper-selectable for operations with 48 Vdc, 125 Vdc, 250 Vdc, 120 Vac and 240 Vac.
 - 52b input
 - Drive-to-lockout input
- b. Three PC board-mountable relay outputs.
 - Alarm Relay
 - Close Relay
 - Instantaneous Trip Enable Relay

The alarm relay is jumper-selectable for normally open (N.O.) or normally closed (N.C.) alarm contacts. The Close Relay and Instantaneous Trip Enable Relay are not jumper selectable.

2.2 Top I/O Module

The top I/O Module consists of:

- a. Two opto-isolated inputs that are jumper selectable for operations with 48 Vdc, 125 Vdc, 250 Vdc, 120 Vac, and 240 Vac.
 - 52a Input
 - Delayed Reset Input

b. Four PC board-mountable relay outputs

- In Progress Relay
- Lockout Relay
- Failed Reclose Relay
- Load Tap Changer Lockout Relay

The In Progress Relay, Lockout Relay and Failed Reclose Relay are jumper selectable for normally open (N.O.) or normally closed (N.C.) output contacts. The Load Tap Changer Relay has a normally closed (N.C.) contact.

2.3 Microcontroller/Display Module

This module consists of an Intel 87C51FA single chip 8-bit microcontroller with 8K bytes of EPROM program memory, an EEPROM for data retention, a micromonitor IC chip for monitoring the 5 Vdc power supply, the software execution and microcontroller controlled start-up. A 2-line, 16-character per line, liquid crystal display (LCD) with 5 x 7 (dots) character size is used for displaying the sequence of relay operation, including timing and failure mode, as well as settings. There are 5 indication leds: "POWER", "FAILED RECLOSE", "HOME", "LOCKOUT" and "LOAD TAP CHANGER LOCKOUT"; 4 pushbuttons for setting data entries; and 2 reset switches (one FAILED RECLOSE RESET and one DATA SCROLL switch which are externally accessible).

2.4 Power Supply Module

There is an isolated switching power supply, capable of supplying +5 Vdc for microcontroller and surrounding IC logic, -5 Vdc for the LCD display, and 24 Vdc for the output relays.

2.5 Specifications

The MRC conforms to Industry Standards: ANSI C37.90, C37.90.1 and IEC 255.4, 255.5.

a. Inputs

Optically-isolated inputs suitable for 48 Vdc, 125 Vdc, 250 Vdc, 120 Vac, and 240 Vac (see Figure 2).

- 52b input is at terminals 8 and 9
- 52a input is at terminals 19 and 9
- Drive-to-Lockout input is at terminals 7 and 9
- Delayed Reset input is at terminals 20 and 9

b. Outputs

The MRC relay provides the following contact outputs (see Figure 2):

- Close Contact: N.O. contacts, terminals 1 and 2 are used.

NOTE

If the close contacts interrupt inductive loads carrying 0.4 amps or greater, then a zener diode type 1.5KE300 (style number 878A619H07) should be connected in parallel with the interrupted coil to protect the close contacts.

- Instantaneous Trip Enable: N.O. contacts, terminals 3 and 4 are used.
- Monitor Alarm: N.O. or N.C. contacts selectable through a jumper, terminals 5 and 6 are used.
- Load Tap Changer Lockout N.C. contacts, terminals 11 and 12 are used.
- Failed Reclose: N.O. or N.C. contacts selectable through a jumper, terminals 13 and 14 are used.
- Lockout: N.O. or N.C. contacts selectable through a jumper, terminals 15 and 16 are used.
- In-Progress: N.O. or N.C. contacts selectable through a jumper, terminals 17 and 18 are used.

c. Power Supply

Isolated dc/dc with ac and dc source capability. Different styles include 48/125Vdc/120Vac, 240Vac/250Vdc, and 24 Vdc power supplies. Terminals 9 and 10 are used (see Figure 2).

3. OPERATIONS

3.1 Front Panel

The MRC front panel (Figure 3) includes a display for all functions with led indicators, and pushbutton controls.

3.1.1 Front Panel Display

The front panel display has:

- LCD 2-line display with 16 characters per line, for displaying functions and values.

- POWER led which is "ON" for normal, "OFF" or "blinking" for trouble (red). Used as monitor alarm.
- LOCKOUT led (amber).
- FAILED RECLOSE led (amber).
- HOME led (red).
- LOAD TAP CHANGER LOCKOUT led (amber)

3.1.2 Push-Button Operation

- SELECT/RUN push-button.
- LOWER push-button for scrolling functions and values.
- RAISE push-button for scrolling functions and values.
- SET/ENTER push-button for updating values.
- FAILED RECLOSE RESET push-button for external access.
- DATA SCROLL PUSH-BUTTON for external access

3.1.3 Front Panel Settings

See Table I for functions which may be scrolled thru and/or set using the LCD Screen (See Block Diagram, Figure 4).

Maximum cycle timer, cumulative reclosures to lockout and reclose fail timer need to be enabled in order to display them.

3.2 Operating Procedures

- The procedure to change functions and values is as follows (see Figure 3):

NOTE

Functions can be scrolled or changed only when the LCD message shows either "HOME" or "LOCKOUT".

- 1) Push the SELECT/RUN button. "Select Mode" will appear momentarily on the LCD screen. The HOME led goes out if relay is "HOME". The following message appears on the LCD screen:

TABLE 1

FRONT PANEL SETTINGS		MRC DISPLAYED FUNCTIONS	
Function	Value		Factory set to
a. RECLOSURES TO LOCKOUT	0 TO 4	"RECLOSURES "	4
b. FIRST RECLOSE TIMER, sec	0 TO 250	"FIRST RECLOSE "	10
c. SECOND RECLOSE TIMER, sec	0 TO 250	"SECOND RECLOSE "	15
d. THIRD RECLOSE TIMER, sec	0 TO 250	"THIRD RECLOSE "	30
e. FOURTH RECLOSE TIMER, sec	0 TO 250	"FOURTH RECLOSE "	30
f. RESET TIMER, sec	0 to 250	"RESET "	60
g. PAUSE	Yes or No	"PAUSE "	No
h. FAIL RECLOSE ENABLE	Yes or No	"FAIL RECLOSE "	Yes
i. RECLOSE FAIL TIMER, sec	0 to 250	"RECLOSE FAIL "	60
j. INSTANTANEOUS IN RESET	Yes or No	"IT. AT HOME "	No
k. INSTANTANEOUS AFTER FIRST RECLOSURE	Yes or No	"INST AFTER 1ST "	No
l. INSTANTANEOUS AFTER SECOND RECLOSURE	Yes or No	"INST AFTER 2ND "	No
m. INSTANTANEOUS AFTER THIRD RECLOSURE	Yes or No	"INST AFTER 3RD "	No
n. INSTANTANEOUS AFTER FOURTH RECLOSURE	Yes or No	"INST AFTER 4TH "	No
o. INSTANTANEOUS FROM LOCKOUT	Yes or No	"IT FROM LOCKOUT "	No
p. MAX CYCLE ENABLE	Yes or No	"MAX CYCLE "	No
q. MAXIMUM CYCLE TIMER, sec	0 to 999	"MAXIMUM CYCLE "	999
r. FOLLOW BREAKER	Yes or No	"FOLLOW BREAKER "	Yes
s. 52A AVAILABLE, FOR SECURITY	Yes or No	"IS 52a AVAILABLE "	No
t. CUMULATIVE RECLOSURES TO LOCKOUT	Yes or No	"CUMULATIVE LOCK "	No
u. RECLOSURES TO LOCKOUT	0 to 999	"RECLOSURES LOCK "	999
v. POWER UP TO LOCKOUT	Yes or No	"POWER UP TO LOCKOUT"	Yes
w. LIMIT COUNTER	1 to 250	"LIMIT COUNTER "	250
x. BREAKER LIMIT TIMER, min	1 to 250	"LIMIT TIMER "	250
y. BREAKER RECOVERY TIMER, min	1 to 250	"RECOVERY TIMER "	1
z. BREAKER OPERATION	Yes or No	"BREAKER OPERATION"	No

LCD Message



§ Appropriate style number is displayed

For example: Hold down the LOWER button until the RECLOSURES function appears.

- 3) Push the SET/ENTER button. The following message will appear on the LCD screen as long as the SET/ENTER button is held down.

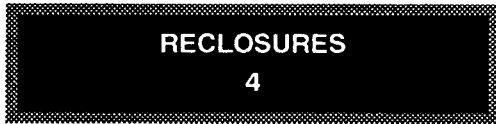
LCD Message



- 2) Scroll through the functions in Table I by pushing either the LOWER or RAISE button.

When the SET/ENTER button is released, the following message will appear on the LCD screen:

LCD Message



- 4) Scroll thru the values by pushing either the LOWER or RAISE button.

Scrolling proceeds at a faster rate by continuing to hold down either the LOWER or RAISE button.

- 5) When the appropriate value is reached (e.g., value = 2), release the LOWER or RAISE button.
 - 6) To restore the original value, press the SELECT/RUN button, until the "VALUE UNCHANGED" message is displayed; then release the SELECT/RUN button. The relay remains in the select mode.
 - 7) Push the SET/ENTER button to enter the value of 2. "VALUE ENTERED" is displayed.
 - 8) Scroll and set other functions/values by pushing either the LOWER or RAISE button until the appropriate function is reached and repeating steps 2 thru 7.
- b. When the functions/values have been reviewed or modified as desired, press the SELECT/RUN button until the "HOME" message is displayed, then release the SELECT/RUN button. If the relay was in the "HOME" state before the "SETTINGS" mode, the "HOME" led will turn ON and the relay will be operational.

LCD Message



- c. While the relay is at HOME or in LOCKOUT, pushing the DATA SCROLL button up allows the following functions to be displayed.

- Accumulated "1ST RECLOSURES"

LCD Message



- Accumulated "2ND RECLOSURES"

LCD Message



- Accumulated "3RD RECLOSURES"

LCD Message



- Accumulated "4TH RECLOSURES"

LCD Message



- "ACCUMULATED LOCK"

LCD Message



- Total Accumulated "Reclosures Left"

LCD Message



Always advance the relay to its original state (HOME or LOCKOUT) by holding the DATA SCROLL button up to make the relay operational again.

4. FUNCTIONS

Upon power-up, the relay performs self-diagnostic routines including dead-man. Detection of a continuing problem will cause the alarm relay to drop out and the MRC relay to be locked out.

Press the SELECT/RUN button on the front panel to enter the select mode, so that the LOWER and RAISE buttons can be used to select a function (see 3.1.3 for functions).

4.1 Lockout

Lockout occurs during any one of the following conditions.

- a. Power up to lockout (when enabled).
- b. The 52b and 52a are at the same state either both open or both closed simultaneously (when 52a option is enabled).
- c. The breaker opens (52b closes) after all programmed reclose attempts have expired.
- d. Failed reclose occurs (when enabled).
- e. Instantaneous trip in lockout is allowed and trip occurs (relay stays in lock out).
- f. Follow breaker (anti-pump) occurs (when enabled).
- g. Maximum cycle is exceeded (when enabled).

When the relay is in lockout, the lockout relay is energized and lockout LED is lit.



4.2 Alarm

Alarm occurs during any of the following conditions:

- a. Loss of power to the relay.
- b. Loss of 5V to the Microcontroller.
- c. Deadman detection, i.e., no pulse is generated by the microcontroller.
- d. Self check failure.

4.3 Timers

4.3.1 Reset Timer

To enable this function, use the select mode and select a value from 0 to 250, in 1-second increments. The reset timer is started when the 52b contacts open. If the breaker remains closed (52b contacts open) for the duration of the reset timer setting, the relay will go to the "HOME" state. The "HOME" led is lit when the relay is in the "HOME" state. If the breaker reopens (52b contacts close), before the reset timer expires, the relay will go to the next reclose attempt or to the "LOCKOUT" state.

4.3.2 PAUSE (Reset Delay)

This is an optically isolated input. When present, re-setting of the MRC relay shall be halted.

To enable this function, use the select mode and select "YES". The Pause is started when the RESET DELAY input is present, and the relay is trying to reset. The Reset Timer is halted and stays in that state until the Reset Delay input is removed before it recloses.

4.3.3 Reclose Timer

The setting ranges are incremented as follows:

<u>Range</u>	<u>Increment</u>
from 0 -1 sec	in 0.01 sec
from 1 - 10 sec	in 0.1 sec
from 10-250 sec	in 1 sec

The reclose timer is started when the 52b contacts close. At the end of the timing cycle, the Close output contact is closed to energize the circuit breaker closing coil. Up to 4 reclose timers are allowed. Setting any reclose timer delays to 0 will initiate an immediate reclose (no intentional delay).

4.3.4 Reclose Fail Timer

To enable this function, use the select mode and answer "YES" to "FAIL RECLOSE". This function is initiated at the end of every RECLOSE timer delay. The "RECLOSE FAIL" timer value is adjustable and may be set (using the SET/ENTER button) from 0 to 250 seconds as follows.

<u>Range</u>	<u>Increment</u>
from 0 -1 sec	in 0.01 sec
from 1 - 10 sec	in 0.1 sec
from 10-250 sec	in 1 sec

If the set time is exceeded before the breaker closes, the relay immediately goes to LOCKOUT. The failed reclose led indicator is lit; in addition, the lockout led lights up and monitor alarm contacts close. To inhibit the RECLOSE FAIL timer, answer "NO" to FAIL RECLOSE enable. While the reclose fail timer is running, the close signal is continually initiated until the breaker closes or the reclose fail timer expires and the relay goes to lockout.

4.3.5 Max Cycle Timer

This function is enabled by answering "YES" and is disabled by answering "NO" in the select mode to MAX CYCLE.

Max Cycle Time is the interval which begins when the first 52b signal is recognized and ends with the relay at "Home" or at "Lockout". 0 to 999 seconds in 1 second increments is used. If the Max Cycle Timer times out, the relay goes to "LOCKOUT, MAX_TIME EXPIRED" which is indicated by the lit lockout light.

4.4 Follow Breaker (or 52b)

This function allows the relay to follow the 52b contacts action. While the relay is timing a reclosure, it checks the 52b contacts for openings. If the 52b contacts open, within a reclosure, the relay starts the "reset" sequence. If the 52b contacts close, within the "reset" sequence, the relay goes to the next reclosure (if more reclosures remain), or to "Lockout". The "Follow Breaker" function, displayed as "FOLLOW BREAKER", is enabled or disabled by answering "YES" or "NO" in the select mode. When this function is enabled, a maximum of 4 trips to "LOCKOUT" are allowed.

4.5 Instantaneous Trip Enable

The instantaneous trip enable function causes the relay to close the instantaneous trip enable contacts and permits instantaneous tripping of the circuit breaker.

This function is enabled or disabled by answering "YES" or "NO" in the select mode.

The instantaneous trip enable contacts can be selected to close in reset, after first reclosure, after second reclosure, after third reclosure, after fourth reclosure, in lockout, and any combination above.

4.6 Power-Up to Lockout/Power to Last State

Power-Up-to-Last-State is selected by answering "NO" in the settings mode and disabled by answering "YES" to Power-Up-to-Lockout. If Power-Up-to-Last-State is selected, then upon loss of power to the relay, the MRC will remember the point in the reclosing sequence. Upon power recovery, the relay will resume the sequence at the point the power was lost.

4.7 Drive to Lockout

This is an optically isolated input. When present it will drive the relay to lockout from anywhere in the sequence.

The relay will stay in "LOCKOUT" unless the drive to lockout input is removed. Then the relay will go through to the reset sequence before going to the "HOME" or "LOCKOUT" state.

4.8 52b and Optionally 52a

Both inputs are optically isolated. The combination provides security relative to breaker position. If both contacts are open or closed for a period of time greater than approximately 0.1 second, the reclosing relay shall go to "LOCKOUT".

This function is enabled by answering "YES" in the settings mode to "IS 52a AVAILABLE", and disabled by answering "NO".

Where only the 52b switch is used for breaker position, the 52a input shall be left open, and the function should be disabled by answering "NO" to "IS 52a AVAILABLE".

4.9 Cumulative Reclosures to Lockout

This function when enabled, allows the relay to be set for "RECLOSURES TO LOCKOUT".

To enable the function, answer "YES" in the select mode. "NO" disables it.

"RECLOSURES LOCK" is a counter that may be set from 1 to 999.

When enabled, this function allows for a preset maintenance counter to start. Each reclosure that occurs decrements the "RECLOSURES LOCK" value.

When the preset number of reclosures has expired, the next trip will force the relay into lockout. The display will read "MAINTAIN BREAKER RELAY LOCKED OUT". at this point, the relay stays in lockout until the "RECLOSURES LOCK" is set higher than 1.

This information is also accessed externally by pushing the lever on the right (or the DATA SCROLL lever) up.

4.10 Breaker Operation

This function when enabled, allows the relay to count the number of breaker operations "LIMIT COUNTER" in a period of time "LIMIT TIMER". If the set values in "LIMIT COUNTER" are reached within a set period of time in "LIMIT TIMER", then the relay does not issue any more reclosures and allows the breaker to recover according to the set value in "RECOVERY TIMER".

To enable this function answer "YES" in the select mode. "NO" disables it.

"LIMIT COUNTER" is adjustable and may be set from 1 to 250.

"LIMIT TIMER" is adjustable and may be set from 1 to 250 minutes in 1 minute increments.

"RECOVERY TIMER" is adjustable and maybe set from 1 to 250 minutes in 1 minute increments.

5. ACCEPTANCE TESTS

5.1 Preliminary Steps

a. Verify that jumpers JMP2, JMP5 on the bottom I/O module, and jumpers JMP12, JMP15 on the top I/O module are in the 125V position.

Locate jumper JMP1 on the bottom I/O module and verify that it is in the normally closed (N.C.) position.

b. Locate jumpers JMP3, JMP4, JMP6, JMP7 on the bottom I/O module and jumpers JMP11, JMP13, JMP14, JMP16 on the top I/O module and verify that they are in the dc position.

c. Make sure to follow step d to drive the MRC relay to a known state such as "HOME" or "LOCKOUT" before proceeding with the acceptance test.

d. Set a variable source to 125 Vdc, then turn off the source and connect it to the relay: the positive lead to terminal 10 and the negative lead to terminal 9. Do not connect terminals 1 and 2 in order to disable the close relay (CR) output.

e. Open the 52b contacts, the Drive-to-Lockout contacts and the RESET DELAY contacts. Turn the relay ON. Wait until the relay goes "HOME".

LCD Message



f. Turn the relay off. Close the 52b contacts. Connect the relay per Figure 6.

g. Turn the relay ON. During this initialization procedure, the POWER led will be OFF and other leds will be ON for approximately one second.

h. At power-up, the MRC relay does a self check (a power check, a dead man check, and a memory check). If the relay passes the self check, then the relay is going to assume the following status.

Led Status

POWER	ON
FAILED RECLOSE	OFF
HOME	OFF
LOCKOUT	ON
LOCKOUT LTC	OFF

Relay Contact Status

Alarm Relay	Open
Close Relay	Open
Instantaneous Trip	
Enable Relay	Open
In Progress	Open
Lockout	Closed
Failed Reclose	Open
Load Tap Changer	
to Lockout	Closed

NOTE Refer to the External Wiring Connections Diagram, in Figure 6, before proceeding further.

Preliminary

5.2 Open 52b Contacts (Breaker Closes)

When contact 52b opens, the reset timer begins.

Led Status

POWER	ON
FAILED RECLOSE	OFF
HOME	OFF
LOCKOUT	ON
LOCKOUT LTC	OFF

LCD Message §



§ Left reading (illustrated by 59 Sec) displayed for the countdown. Right reading (illustrated by 60 Sec) results from the settings function.

LCD Message



Relay Contact Status

Alarm Relay	Open
Close Relay	Open
Instantaneous Trip	
Enable Relay	Open
In Progress	Open
Lockout	Closed
Failed Reclose	Open
Load Tap Changer	Closed

5.2.2 Manually open the 52b contacts (breaker closes).

If the breaker remains closed while the reset timer times out, the relay goes to "HOME".

Relay Contact Status

Alarm Relay	Open
Close Relay	Open
Instantaneous Trip	
Enable Relay	Open
In Progress	Open
Lockout	Closed
Failed Reclose	Open
Load Tap Changer	
to Lockout	Closed

Led Status

POWER	ON
FAILED RECLOSE	OFF
HOME	ON
LOCKOUT	OFF
LOCKOUT LTC	OFF

LCD Message



5.2.1 Close 52b contacts (breaker opens)

While the reset timer is still timing, the relay stays in Lockout.

Led Status

POWER	ON
FAILED RECLOSE	OFF
HOME	OFF
LOCKOUT	ON
LOCKOUT LTC	OFF

Relay Contact Status

Alarm Relay	Open
Close Relay	Open
Instantaneous Trip	
Enable Relay	Open
In Progress	Open
Lockout	Closed
Failed Reclose	Open
Load Tap Changer	Closed

NOTE _____
 When scrolling the functions, refer to Section 3.1.3.

5.3 Reclosing Sequence

With the inputs Drive-to-Lockout and Reset Delay open, MRC stays "HOME" until the 52b contacts close.

NOTE _____
 Verify the "Factory Set To" values below (see also 3.1.3):

5.3.1 Successful Reclosures

Starting with the relay in "HOME" position, close the 52b contacts.

LCD Message



The relay starts the first reclosure.

LCD Message



Open the 52b contacts and leave them open. At the end of the FIRST RECLOSE Timer, the Close Relay is energized and the relay goes to the reset sequence:

LCD Message



- Step 1. The Reset timer times out.
- Step 2. The relay goes "HOME".

LCD Message



- Step 3. The "HOME" led lights up and the "Home" message appears on the LCD screen.

NOTE _____
 Value settings can be checked and/or entered while the relay is in the "LOCKOUT" or "HOME" state.

5.3.2 Four Time Delay Reclosures to Lockout

With the relay in "HOME" state, close the 52b contacts.

LCD Message



The relay starts the first reclosure:

LCD Message



- The first reclosure times out.
- The close relay contacts close.

Open the 52b contacts momentarily, and then close them; the relay starts the second reclosure.

LCD Message



- The second reclosure times out.
- The close relay contacts close.

Open the 52b contacts momentarily, and then close them; the relay starts the third reclosure.

LCD Message

- The third reclosure times out.
- The close relay contacts close.

Open the 52b contacts momentarily, and then close them, the relay starts the fourth reclosure.

LCD Message

- The fourth reclosure times out.
- The close relay contacts close.

Open the 52b contacts momentarily, and then close them; the relay goes to LOCKOUT.

- The Lockout led lights up.
- The "LOCKOUT" message is displayed.

LCD Message**NOTE**

The number of reclosures (0 to 4) and their respective timers (0 to 250 sec.) can be set while the relay is "HOME" or in "LOCKOUT".

5.3.3 Failed Reclose

This function is enabled or disabled by answering "YES" or "NO" (refer to Section 3.1.3).

With the relay in "HOME", close the 52b contacts; the relay starts the first reclosure.

LCD Message

- The first reclosure times out.
- The Close 1 relay contacts close.

Leave the 52b contacts closed; the failed reclose timer starts.

LCD Message

- The fail reclose timer times out, then the relay goes to "LOCKOUT". The "LOCKOUT" led and the "FAILED RECLOSE" led light up. The alarm relay closes. The "FAILED RECLOSE" message is displayed with the "LOCKOUT". The "FAILED RECLOSE" led can be reset by pushing the "FAILED RECLOSE RESET" button.

LCD Message**5.3.4 Lockout for Follow Breaker Option**

Using the Front Panel settings, in Section 3.1.3, enable "FOLLOW BREAKER" by answering "YES".

With the relay starting from the "HOME" position, close the 52b contacts; the relay starts the first reclosure:

LCD Message

Open the 52b contacts before the first reclosure times out; the relay starts to reset.

LCD Message



Close the 52b contacts before the reset timer times out; the relay goes to the second reclosure.

LCD Message



Open the 52b contacts before the fourth reclosure times out; the relay starts to reset.

LCD Message



Open the 52b contacts before the second reclosure times out; the relay starts to reset.

LCD Message



Close the 52b contacts before the reset timer times out; the relay goes to LOCKOUT. The Lockout led turns on, the LOCKOUT relay picks up, and the message "LOCKOUT" is displayed.

LCD Message



Close the 52b contacts before the reset timer times out; the relay goes to the third reclosure.

LCD Message



LCD Message



Open the 52b contacts before the third reclosure times out; the relay starts to reset.

LCD Message



Close the 52b contacts before the reset timer times out; the relay goes to the fourth reclosure.

NOTE

This option is disabled by answering "NO" to "FOLLOW BREAKER" in the select mode.

5.4 Max Cycle

Set the "MAX CYCLE" function to "YES" (for test purposes only), and the MAXIMUM cycle timer to 8 sec.

With the relay at "HOME", close 52b contacts; the relay simultaneously starts the first reclose timer and the "MAXIMUM CYCLE" timer.

- The first reclose timer times down to 1 second, and the relay goes to "LOCKOUT". The "LOCKOUT" led and the "FAILED RECLOSE" led light up. The FAILED RECLOSE relay and the LOCKOUT relay both are energized. The "LOCKOUT" message is followed by the "MAX TIME EXPIRED" message.

LCD Message



Open the 52b contacts and leave them open; the relay will go to reset and then "HOME".

LCD Message



Reset the "FAILED RECLOSE" led by pushing the FAILED RECLOSE reset button.

NOTE

Go to Front Panel Settings (Section 3.1.3) and disable the "MAX CYCLE" function by setting it to "NO".

5.5 Drive-to-Lockout

With the relay at "HOME", close the 52b contacts.

LCD Message



- The First Reclosure Timer starts.

LCD Message



Close the Drive-to-Lockout switch.

- The relay goes to lockout.

LCD Message



Open the Drive-to-Lockout switch.

- The relay starts the Reset sequence.

LCD Message



- If 52b is at the Open position, the relay goes to "HOME".

LCD Message



- If 52b is at Closed position, the relay goes to "LOCKOUT"

5.6 Delayed Reset (Pause)

With the relay at "HOME", close the 52b contacts.

LCD Message



- The First Reclosure timer starts.

LCD Message



Open the 52b contacts.

- The relay starts the reset sequence.

LCD Message



- Before the end of the Reset Timer, close the Delayed Reset input.
- The Reset Delay (Pause) will halt the reset sequence.

LCD Message



- Open the Delayed Reset input, the reset sequence resumes the relay goes "HOME" at the end of the reset sequence.

LCD Message



LCD Message



Connect back the 52a inputs to terminal 19.

- Since the 52b contacts are still open, the relay starts to reset.

LCD Message



The relay goes to "HOME" at the end of the Reset sequence.

LCD Message



5.7 52B-52A Security Check

This function is enabled by answering "YES" in the setting mode to "IS 52a AVAILABLE".

With the relay at "HOME", close the 52b contacts.

LCD Message



- The First Reclosure Timer starts.

LCD Message



To simulate closing the 52a contacts, disconnect the 52a contacts by removing voltage to terminal 19.

- At the end of the First Reclose Timer, the relay goes to "LOCKOUT" because the 52b and 52a are both closed.

LCD Message



NOTE

_____ If the relay does not process the 52a input option, the function "Is 52a AVAILABLE" must be disabled by answering "NO" in the setting mode. To get into the setting mode while the relay is in "LOCKOUT" because of "52b-52a FAILURE."

- either connect back the 52a inputs to terminal 19 and let the relay reset and then go "HOME".
- or turn off the power to the relay first, then while holding the "SELECT/RUN" button turn the power on to the relay back on.

5.8 Power-Up to Last State

The Power-Up-to-Last-State Option is selected by setting the "POWER UP TO LOCKOUT" to "NO".

With the relay in "HOME", close the 52b contact.

LCD Message



- The relay starts the first reclosure.

LCD Message



Turn off the power to the relay somewhere in the middle of the timing sequence.

Restore the power to the relay and observe that the relay resumes the reclosing sequence at the time the power was lost.

Make sure to drive the relay "HOME" by opening the 52b before terminating the test.

5.9 Cumulative Reclosures to Lockout

Enable this option by selecting "YES" to "CUMULATIVE LOCK" in the select mode. Set "RECLOSURES LOCK" to "2".

With the relay at "HOME" trip the breaker (close the 52b).

LCD Message



- The first Reclosure Time starts.

LCD Message



- Open the 52b contacts, the relay starts the re-set sequence.

LCD Message



- Close the 52b contacts before the reset timer times out; the relay goes to the second reclosure.

LCD Message



- Open the 52b contacts before the second reclosure times out, the relay goes to lockout.

The display shows:

LCD Message



To disable this function, go to the Settings mode and set "RECLOSURES LOCK" to "999" and "CUMULATIVE LOCK" to "NO". Then manually reclose the breaker to return "HOME".

5.10 Monitoring Breaker Operations

Enable "BREAKER OPERATIONS" by selecting "YES" in the select mode.

- Set "LIMIT COUNTER" to "3",
- Set "LIMIT TIMER" TO "1 min",
- Set "RECOVERY TIMER" to "1 min".

With the relay at "HOME", close the 52b contacts.

LCD Message



- The first reclosure time starts.

LCD Message



- Open the 52b contacts.
- The relay starts the reset sequence

LCD Message



- Close the 52b contacts before the reset timer times out; the relay goes to the second reclosure.

LCD Message



- Open the 52b contacts before the second reclosure times out; the relay starts to reset.

LCD Message



- Close the 52b contacts before the reset timer times out; the relay goes to the third reclosure.

LCD Message



- Open the 52b contacts before the third reclosure times out; the relay starts to reset.

LCD Message



- Close the 52b contacts before the reset timer times out; the relay goes to the fourth reclosure.

LCD Message



- Open the 52b contacts before the fourth reclosure times out; the relay starts to reset.

LCD Message



- Close the 52b contacts before the reset timer times out; the relay goes to "BREAKER RECOVERY".

LCD Message



- At this point, the relay will not issue any more close relay signals until the "BREAKER RECOVERY" timer expires.

NOTE

Make sure to reset all counters and timers to the appropriate customer settings.

6. INSTALLATION**6.1 Mechanical Installation**

The relays should be mounted on switchboard panels or their equivalent in a location free from dirt, moisture excessive vibration and heat. Mount the relays vertically by means of the four mounting holes on the flanges for semi-flush mounting or by means of the rear mounting stud or studs for projection mounting. Either a mounting stud or the mounting screws may be used for grounding the relay. The electrical connections may be made directly to the terminals by means of screws for steel panel mounting, or with the terminal studs furnished with the relay for thick panel mounting. The terminal studs may be easily removed or inserted by locking two nuts on the stud and then turning the proper nut with a wrench. See Figure 15 for the Outline and Drilling Plan. For detailed FT Case information refer to I.L. 41-076. For mounting hardware information, see Technical Data sheet No. 41-020.



If the relay to be installed has a Power-To-Last-State Option, make sure to use steps a through e in Section 5, ACCEPTANCE TESTS, before connecting all the inputs and outputs of the relay.

6.2 Electrical Wiring

(See Figure 6.)

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Figure	2.	MRC Front Panel	1609C10
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Figure	4.	External Schematic FT-22 Version	1611C69
Figure	5.	Component Location for Bottom I/O Module	1609C78
Figure	6.	Internal Schematic for Bottom I/O Module	1609C84
Figure	7.	Component Location Display/Processor Module	1610C87
Figure	8.	Internal Schematic Display/Processor Module	1610C86
Figure	9.	Component Location Power Supply Module	1610C78
Figure	10.	Internal Schematic Power Supply	1610C77
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Figure	12.	Internal Schematic for Top I/O Module	1609C83
Figure	13.	MRC Mounting in Type FT-21 Case	57D7901
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Figure 1. MRC Reclosing Relay.

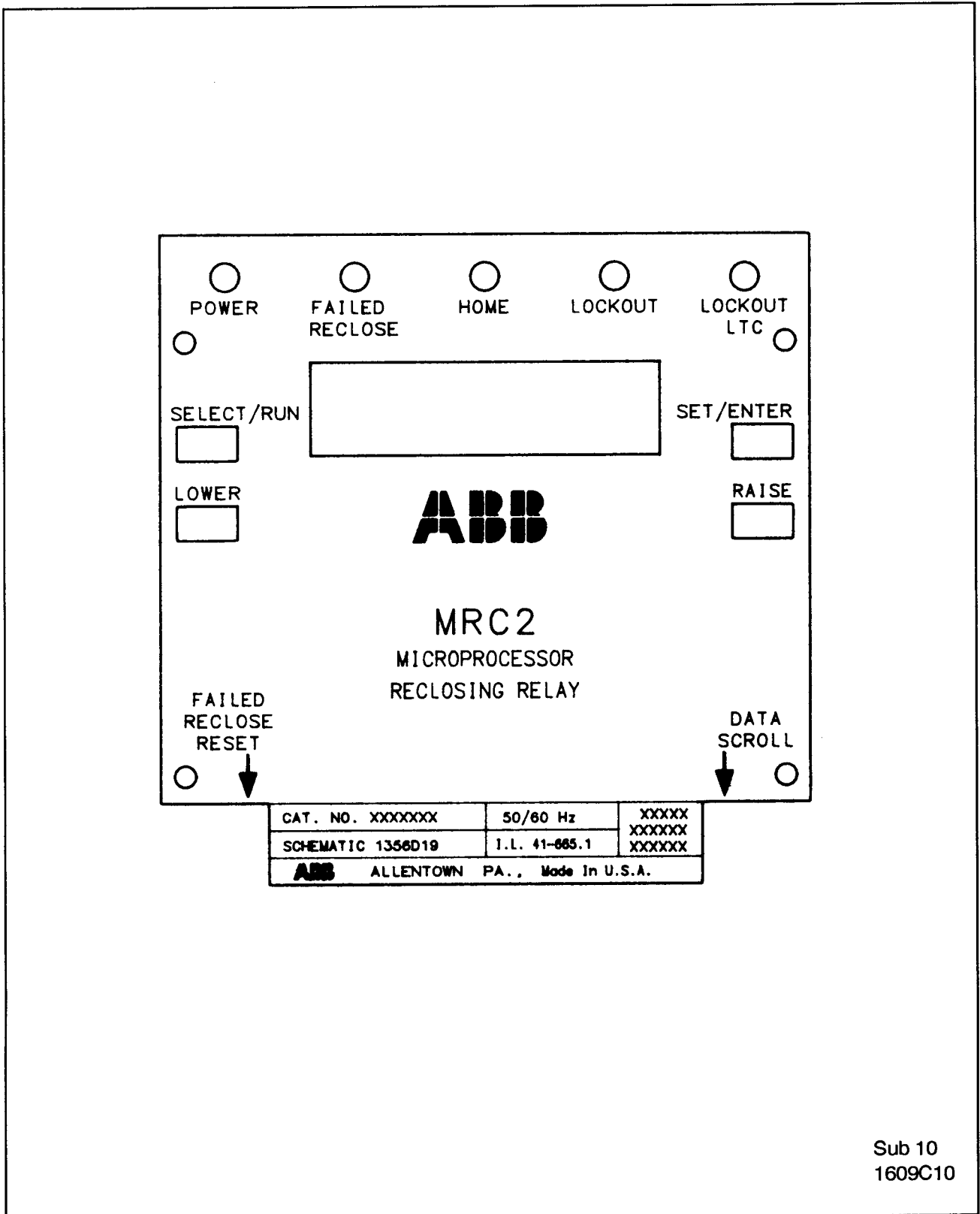
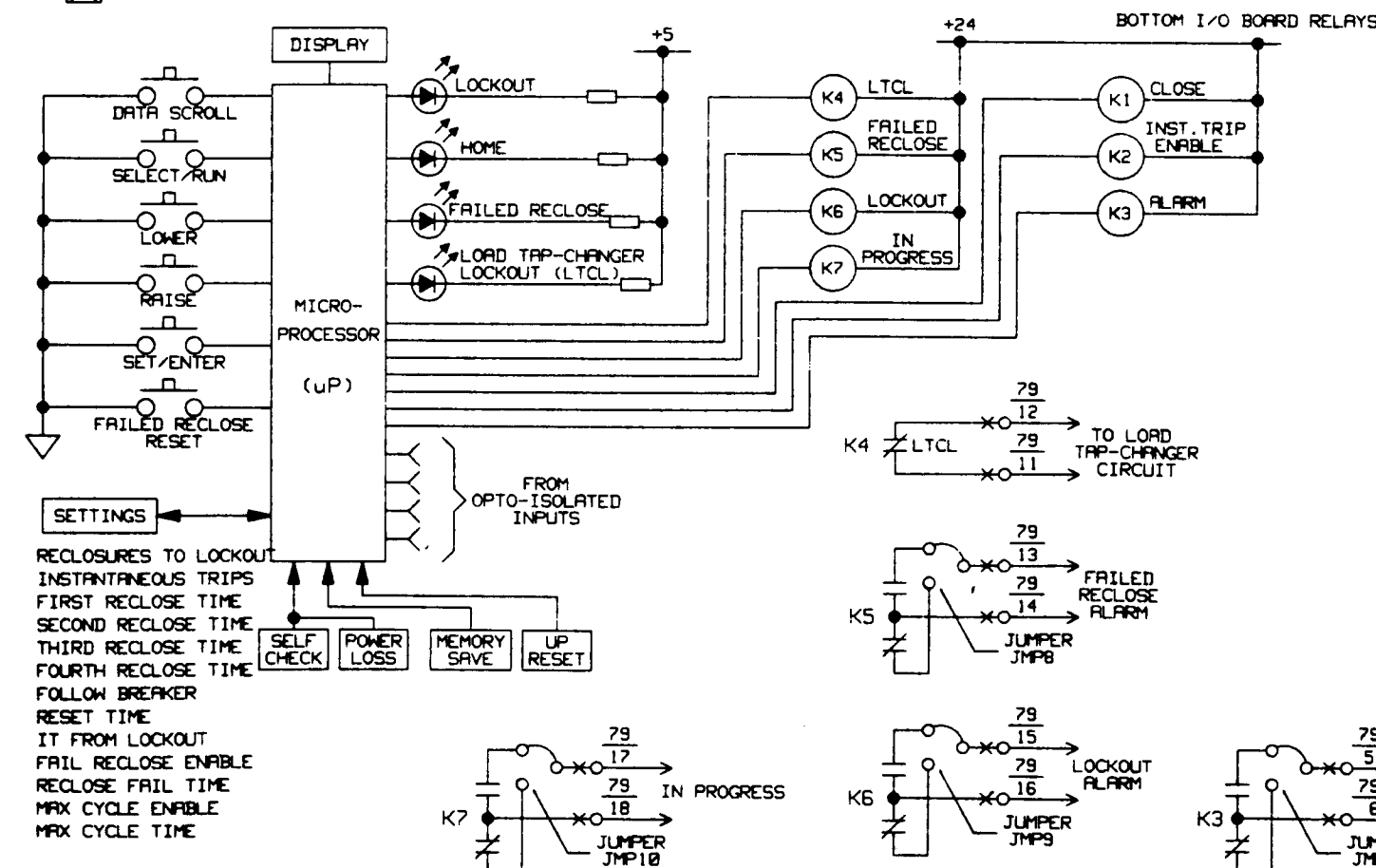
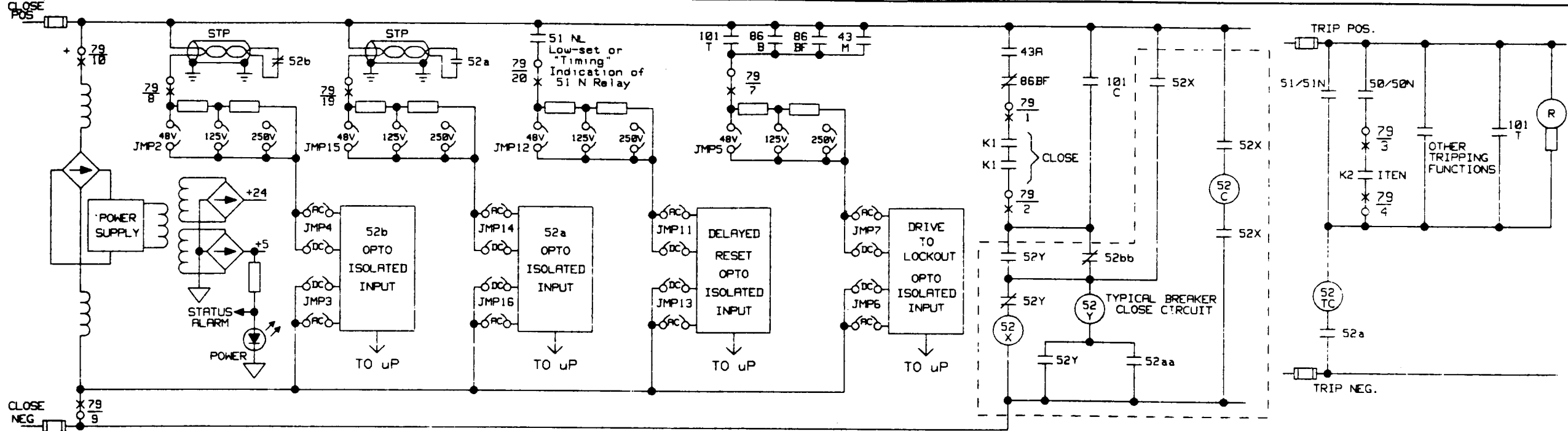


Figure 2. MRC Front Panel.

Sub 10
1609C10



- DEVICE NO.S:**
- 43A - RECLOSER SWITCH (CLOSED IN AUTOMATIC)
 - 50 - PHASE INSTANTANEOUS OVERCURRENT RELAY(S)
 - 50N - GROUND INSTANTANEOUS OVERCURRENT RELAY
 - 51 - PHASE TIME-OVERCURRENT RELAY(S)
 - 51N - GROUND TIME-OVERCURRENT RELAY
 - 51NL - GROUND LOW-SET INSTANTANEOUS OVERCURRENT RELAY, OR "TIMING" OUTPUT OF 51N RELAY
- 52 - CIRCUIT BREAKER**
- 52aa - AUX SW (EARLY CLOSE WHEN BREAKER CLOSES)
 - 52b - AUX SW (CLOSED WHEN BREAKER OPENS)
 - 52bb - AUX SW (EARLY CLOSE WHEN BREAKER OPENS)
 - 52C - CLOSE COIL
 - 52T - TRIP COIL
 - 52X - CLOSE AUX
 - 52Y - ANTI PUMP
- 79 - RECLOSING RELAY, TYPE MRC-22**
- ITEN - INSTANTANEOUS TRIP ENABLE- K2 - NORMALLY PICKED-UP RELAY
 - K1 - CLOSE RELAY
 - K2 - INST. TRIP ENABLE RELAY
 - K3 - ALARM RELAY- K3 - NORMALLY PICKED-UP RELAY
 - K4 - LTCL RELAY
 - K5 - FAILED RECLOSE RELAY
 - K6 - LOCKOUT RELAY
 - K7 - IN PROGRESS RELAY
- 86B - BUS DIFFERENTIAL LOCKOUT RELAY CONTACT**
- 86BF - BREAKER FAILURE LOCKOUT RELAY CONTACT**
- 101 - BREAKER CONTROL SWITCH**
- 101C - CLOSE CONTACT**
- 101T - TRIP CONTACT**
- NOTES:**
1. MRC-22 IS SUITABLE FOR OPERATION WITH ac OR dc POWER INPUT. SEE INSTRUCTION LEAFLET.
 2. ALL CONTACTS ARE SHOWN IN STATE WITH RELAY DEENERGIZED. K2 AND K3 COILS ARE ENERGIZED IN "HOME".
 3. 86BF CAN BE USED TO AVOID POSSIBLE TRIP COIL DAMAGE ONLY WHERE THERE IS A SEPARATE 86BF FOR THIS BREAKER.

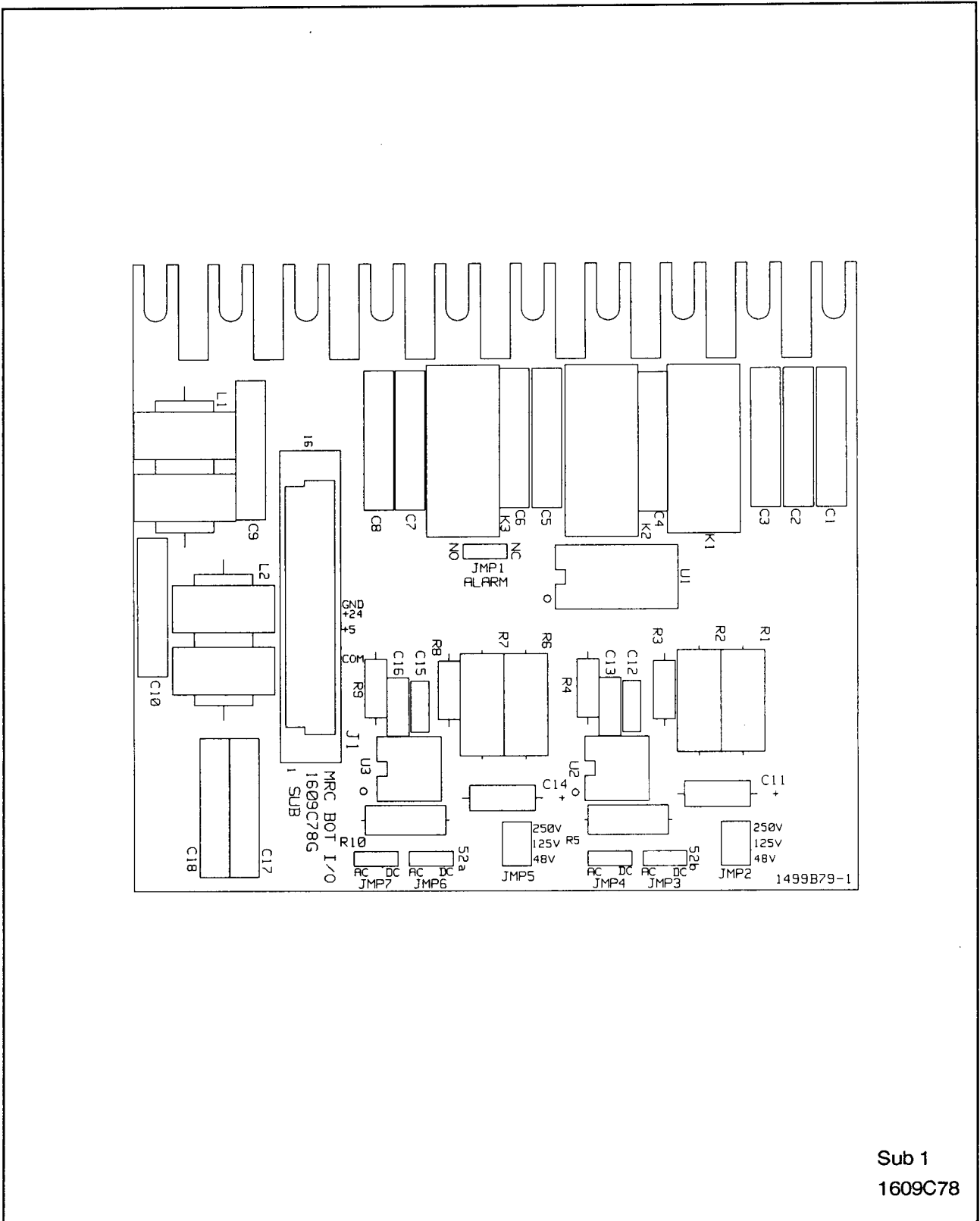


Figure 5. Component Location for Bottom I/O Module

Sub 1
1609C78

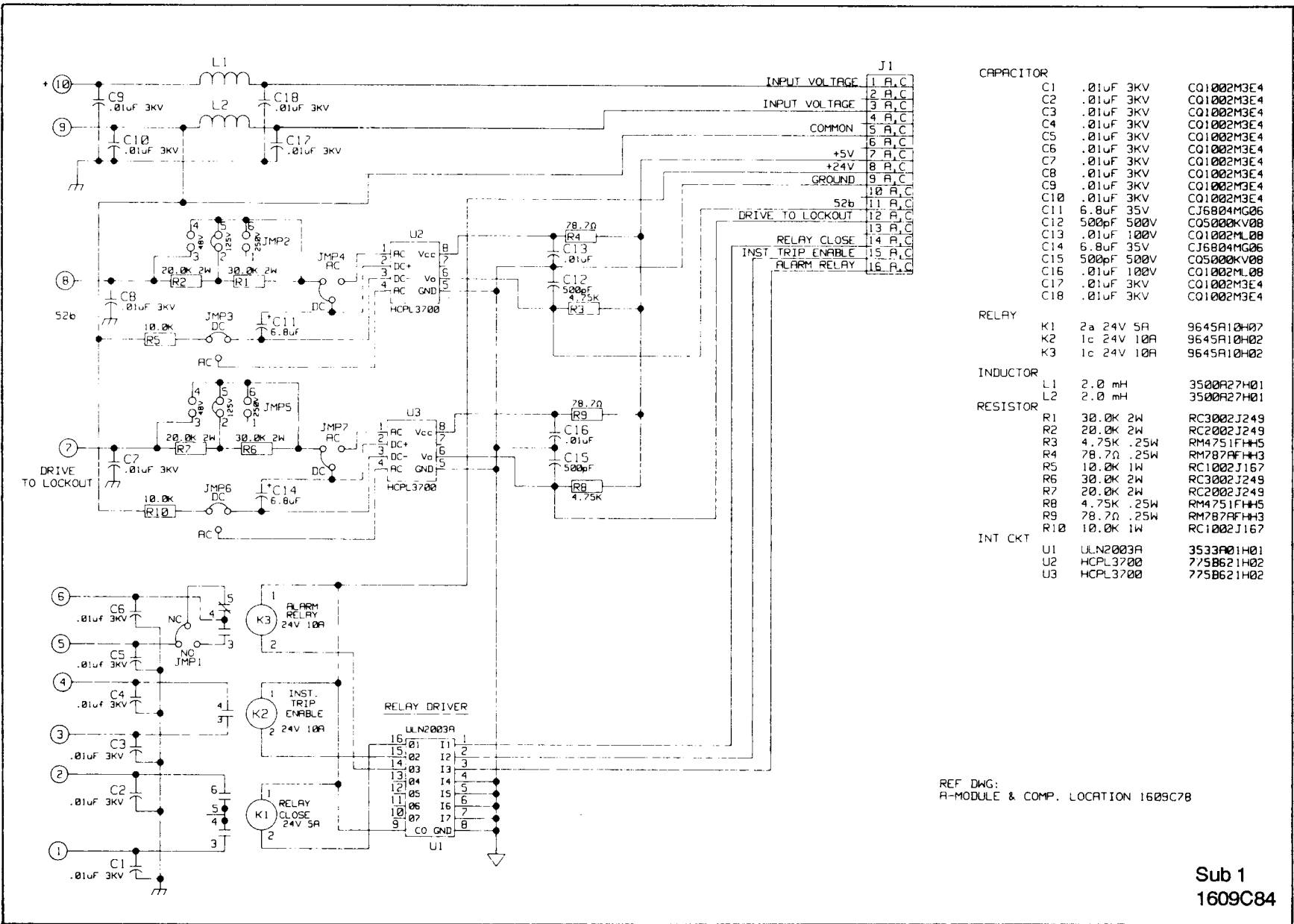
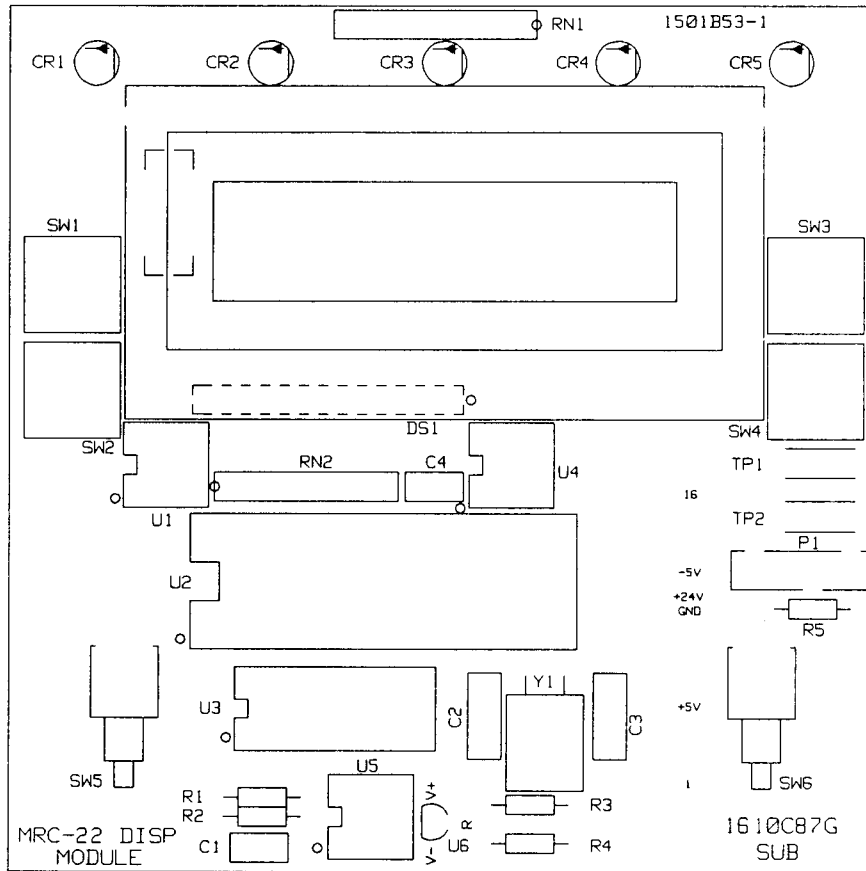
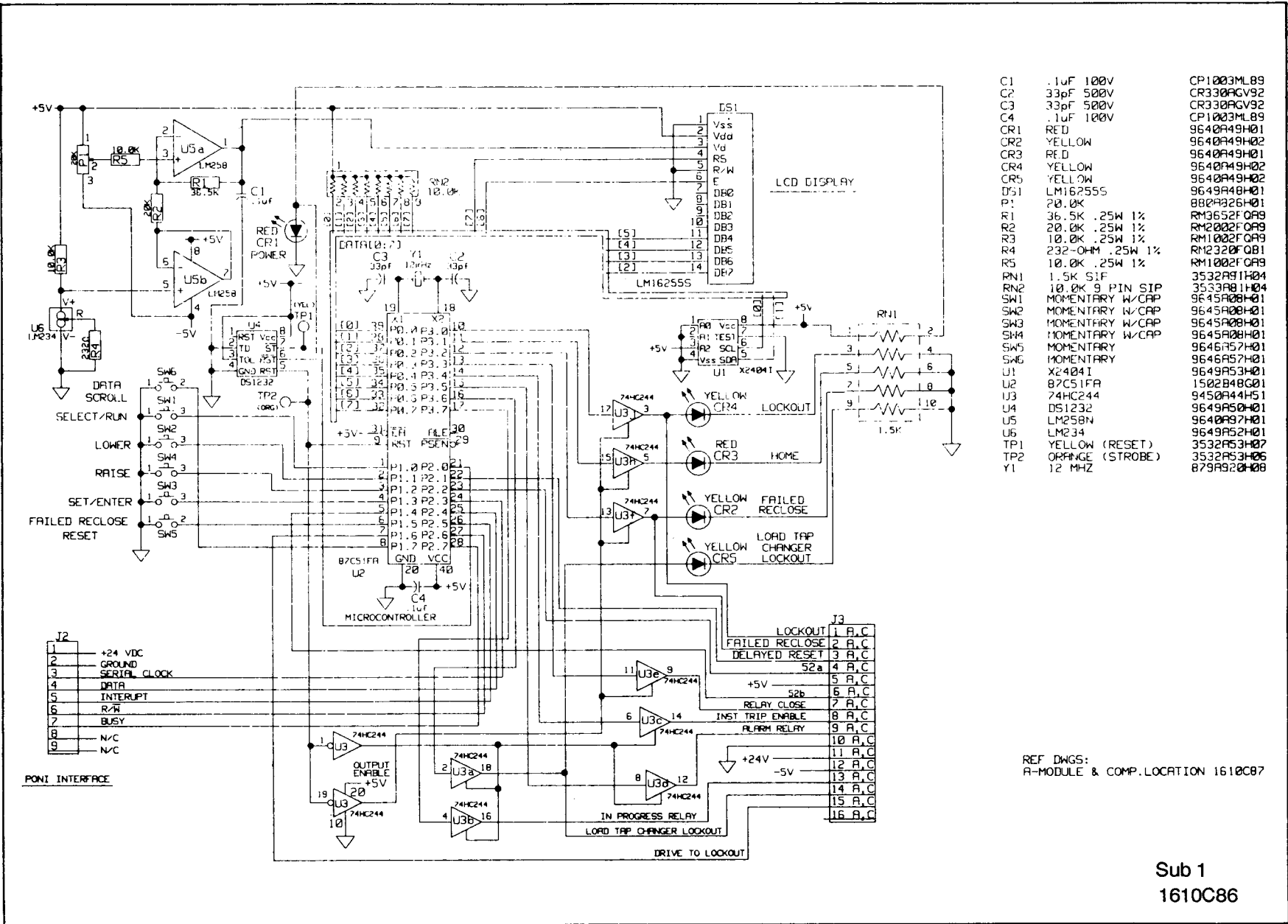


Figure 6. Internal Schematics for Bottom I/O Module



Sub 1
1610C87

Figure 7. Component Location Display/Processor

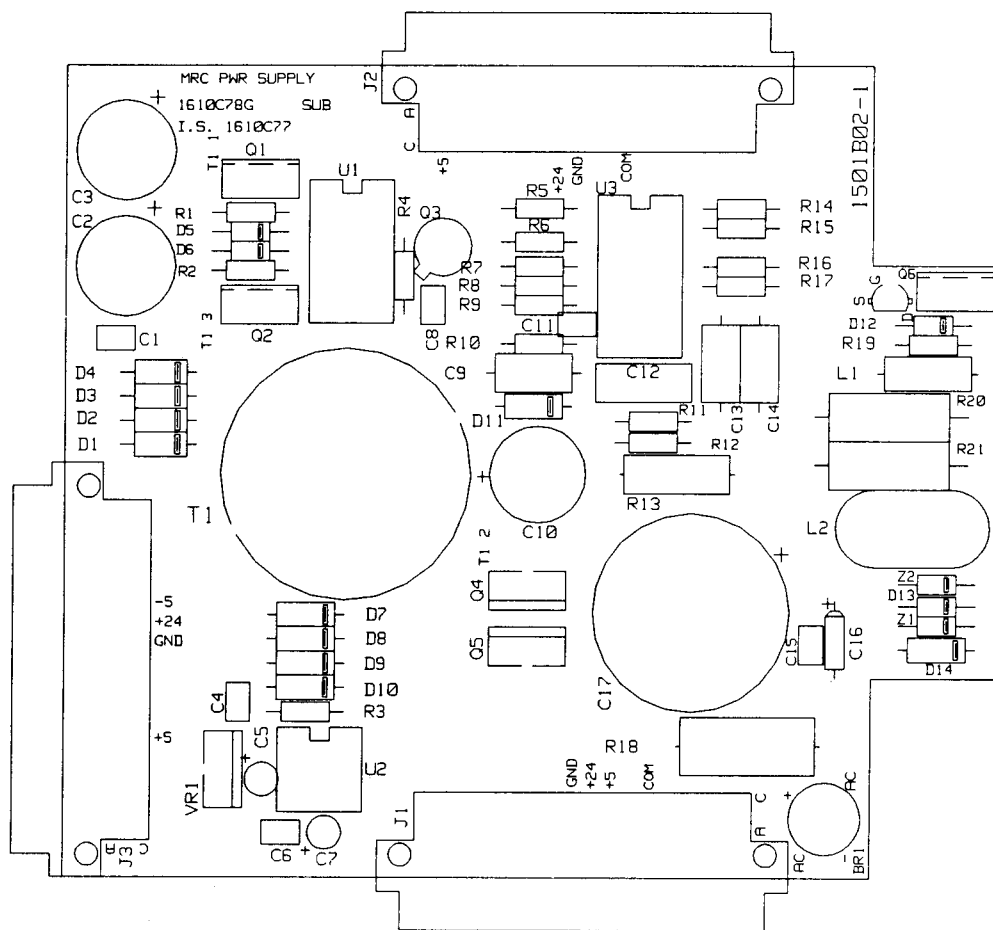


C1	.1uF 100V	CP1003ML89
C2	33pF 500V	CR330AGV92
C3	33pF 500V	CR330AGV92
C4	.1uF 100V	CP1003ML89
CR1	RED	9640A49H01
CR2	YELLOW	9640A49H02
CR3	RED	9640A49H01
CR4	YELLOW	9640A49H02
CR5	YELLOW	9640A49H02
DS1	LM162555	9649A49H01
P1	20.0K	880A926H01
R1	36.5K .25W 1%	RM3652F0A9
R2	20.0K .25W 1%	RM2002F0A9
R3	10.0K .25W 1%	RM1002F0A9
R4	232-OHM .25W 1%	RM2320F0B1
R5	10.0K .25W 1%	RM1002F0A9
RN1	1.5K S1F	3532A91H04
RN2	10.0K 9 PIN SIP	3533A91H04
SW1	MOMENTARY W/CAP	9645A08H01
SW2	MOMENTARY W/CAP	9645A08H01
SW3	MOMENTARY W/CAP	9645A08H01
SW4	MOMENTARY W/CAP	9645A08H01
SW5	MOMENTARY	9646A57H01
SW6	MOMENTARY	9646A57H01
U1	X24041	9649A53H01
U2	87C51FA	1502B48C01
U3	74HC244	9450A44H51
U4	DS1232	9649A50H01
U5	LM259N	9640A97H01
U6	LM234	9649A52H01
TP1	YELLOW (RESET)	3532A53H07
TP2	ORANGE (STROBE)	3532A53H06
Y1	12 MHZ	879A920H08

REF DWGS:
A-MODULE & COMP.LOCATION 1610C87

Sub 1
1610C86

Figure 8. Internal Schematic Display/Processor Module



Sub 1
1610C78

Figure 9. Component Location Power Supply Module

G01 (48/125Vdc/120ac)

C17	150uf 200V	CN1506MPE1
R5	35.7K .25W	RM3572FOA9
R13	1.5K 1W	RC1501J167
R18	36.0K 2W	RC3602J249
R20	5.0K 3W	RW5001F4F8
R21	5.0K 3W	RW5001F4F8
Q6	VN2406M 240V .25A	9641A07H03
T1		1604C87G02
BR1	W06M	3510A67H01

G02 (250Vdc/240ac)

C17	47uf 400V	CN4705MUD5
R5	54.9K .25W	RM5492FOA9
R13	2.43K 50W	RM2431F1J9
R18	200K 1W	RC2003J167
R20	20K 3W	RW2002F4F8
R21	20K 3W	RW2002F4F8
Q6	VN3513L	9641A07H04
T1		1604C87G01
BR1	W06M	3510A67H01

G03 (24Vdc)

C17	150uf 200V	CN1506MPE1
R5	35.7K .25W	RM3572FOA9
R13	1.5K 1W	RC1501J167
R18	5.62K 1/2W	RM5621FH05
R20	2K 3W	RW2001F4F8
R21	2K 3W	RW2001F4F8
Q6	VN2406M 240V .25A	9641A07H03
T1		1604C87G02

CAPACITOR

C1	.1uf 50V
C2	470uf 35V
C3	470uf 35V
C4	.1uf 50V
C5	10uf 25V
C6	.1uf 50V
C7	10uf 25V
C8	.1uf 50V
C9	.047uf 100V
C10	100uf 100V
C11	.01uf 50V
C12	200uf 500V
C13	.047uf 100V
C14	.047uf 100V
C15	.1uf 50V
C16	1.0uf 35V
C17	
DIODE	
D1	1N5817
D2	1N5817
D3	1N5817
D4	1N5817
D5	1N4148
D6	1N4148
D7	1N4934
D8	1N4934
D9	1N4934
D10	1N4934
D11	1N645A
D12	1N4148
D13	1N4148
D14	1N4936
BR1	
ZENER	
Z1	1N964B 13V
Z2	1N964B 13V

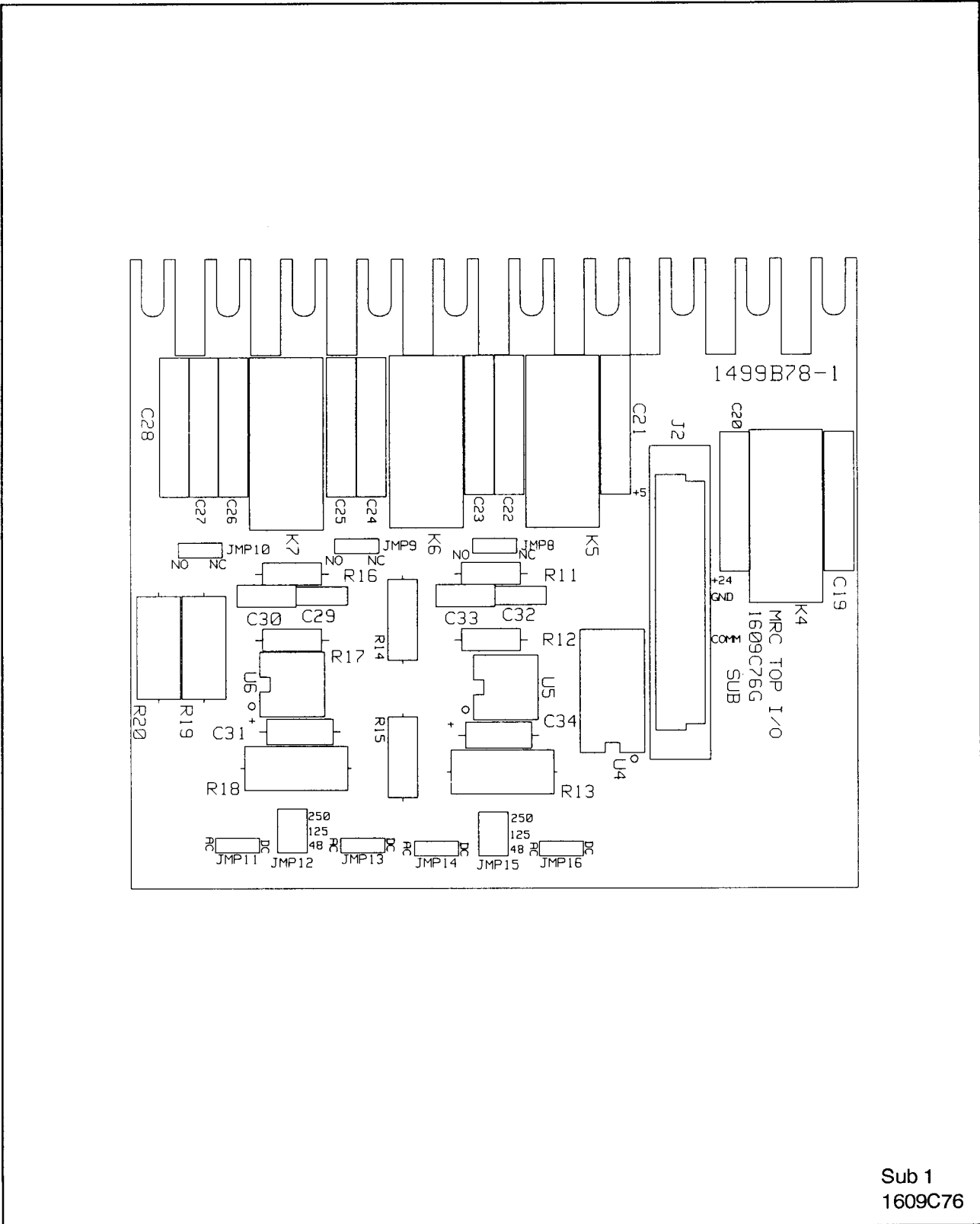
CP1003MH65
CN4706MGD6
CN4706MGD6
CP1003MH65
CW1005ME76
CP1003MH65
CW1005ME76
CP1003MH65
CF4702JL78
CF4702JL78
CN1006MLD5
CP1002MH65
CR2000GV91
CF4702JL78
CF4702JL78
CF4702JL78
CP1003MH65
CJ1004JGAB
*
9648A05H01
9648A05H01
9648A05H01
9648A05H01
9648A05H01
836A920H06
836A920H06
836A920H11
836A920H11
836A920H11
836A920H11
837A692H03
836A920H06
836A920H06
836A920H06
*
862A606H16
862A606H16

RESISTOR

R1	5.11K .25W
R2	5.11K .25W
R3	5.11K .25W
R4	10.0K .25W
R5	
R6	10.0K .25W
R7	10.0K .25W
R8	6.19K .25W
R9	6.19K .25W
R10	6.19K .25W
R11	1.0 OHM .25W
R12	1.0 OHM .25W
R13	
R14	6.19K .25W
R15	5.11K .25W
R16	100 OHM .25W
R17	10.0K .25W
R18	
R19	5.11K .25W
R20	
R21	
INDUCTOR	
L1	39mH
L2	16mH
TRANSISTOR	
Q1	IRF713 350V .9A
Q2	IRF713 350V .9A
Q3	2N2222A
Q6	
Q4	IRF713 350V .9A
Q5	TIP48
XFORMER	
T1	
INT CKT	
U1	MC14013B
U2	ICL756051PA
U3	UC1524AJ
VR1	MC7805CT

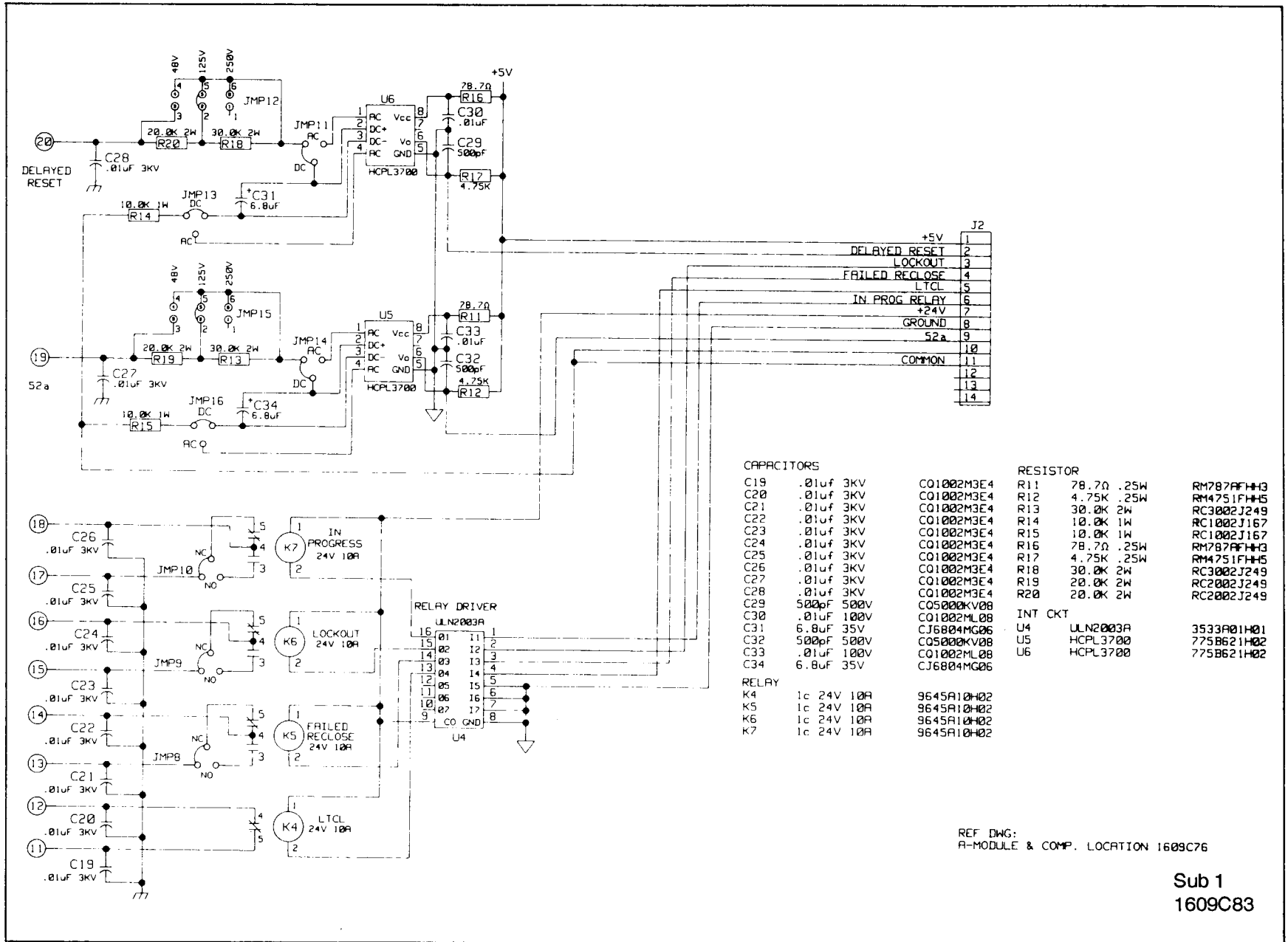
RMS111FQB0
RMS111FQB0
RMS111FQB0
RM1002FOA9
*
RM1002FOA9
RM1002FOA9
RM6191FOB0
RM6191FOB0
RM6191FOB0
RM100BFQB7
RM100BFQB7
*
RM6191FOB0
RMS111FQB0
RM100FOB1
RM1002FOA9
*
RM5111FQB0
*
*
9645A17H01
9645A18H01
9641A07H02
9641A07H02
762A672H15
*
9641A07H02
861A634H02
*
3527A26H06
9649A49H01
3534A92H01
3533A90H01

* = SEE ADJACENT LISTING



Sub 1
1609C76

Figure 11. Component Location Top I/O Module



CAPACITORS		RESISTOR	
C19	.01uF 3KV	R11	78.7Ω .25W
C20	.01uF 3KV	R12	4.75K .25W
C21	.01uF 3KV	R13	30.0K 2W
C22	.01uF 3KV	R14	10.0K 1W
C23	.01uF 3KV	R15	10.0K 1W
C24	.01uF 3KV	R16	78.7Ω .25W
C25	.01uF 3KV	R17	4.75K .25W
C26	.01uF 3KV	R18	30.0K 2W
C27	.01uF 3KV	R19	20.0K 2W
C28	.01uF 3KV	R20	20.0K 2W
C29	500pF 500V		
C30	.01uF 100V		
C31	6.8uF 35V		
C32	500pF 500V		
C33	.01uF 100V		
C34	6.8uF 35V		

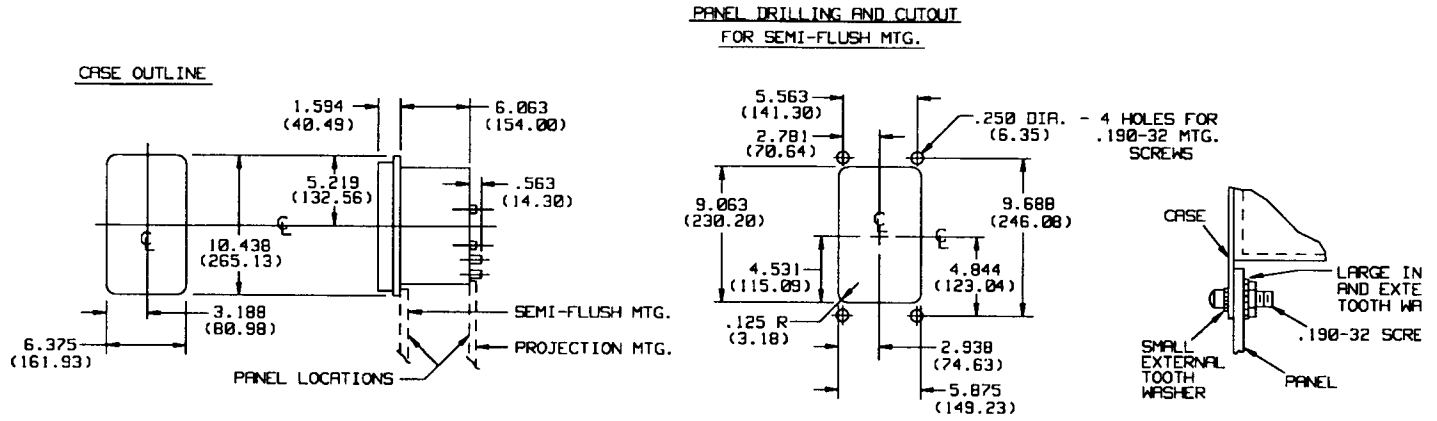
RELAY	
K4	1c 24V 10A 9645A10H02
K5	1c 24V 10A 9645A10H02
K6	1c 24V 10A 9645A10H02
K7	1c 24V 10A 9645A10H02

INT CKT	
U4	ULN2003A 3533A01H01
U5	HCPL3700 7758621H02
U6	HCPL3700 7758621H02

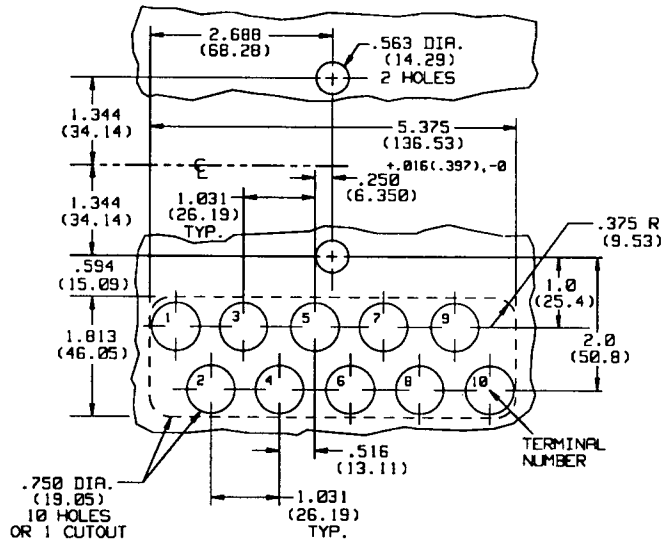
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A-MODULE & COMP. LOCATION 1609C76

Sub 1
1609C83

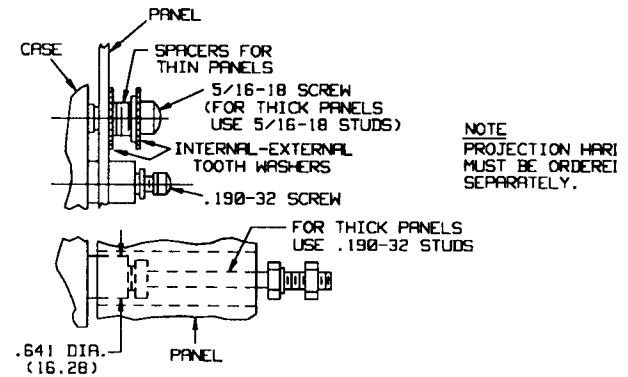
Figure 12. Internal Schematic for Top I/O Module



PANEL DRILLING OR CUTOUT FOR PROJECTION MTG. (FRONT VIEW)



TERMINAL AND MTG. DETAILS FOR PROJECTION MTG.



DIMENSIONS IN INCHES
 DIMENSIONS IN MILLIMETERS:
 305 18
 57D7901

Figure 13. MRC Mounting in Type FT-21 Case.

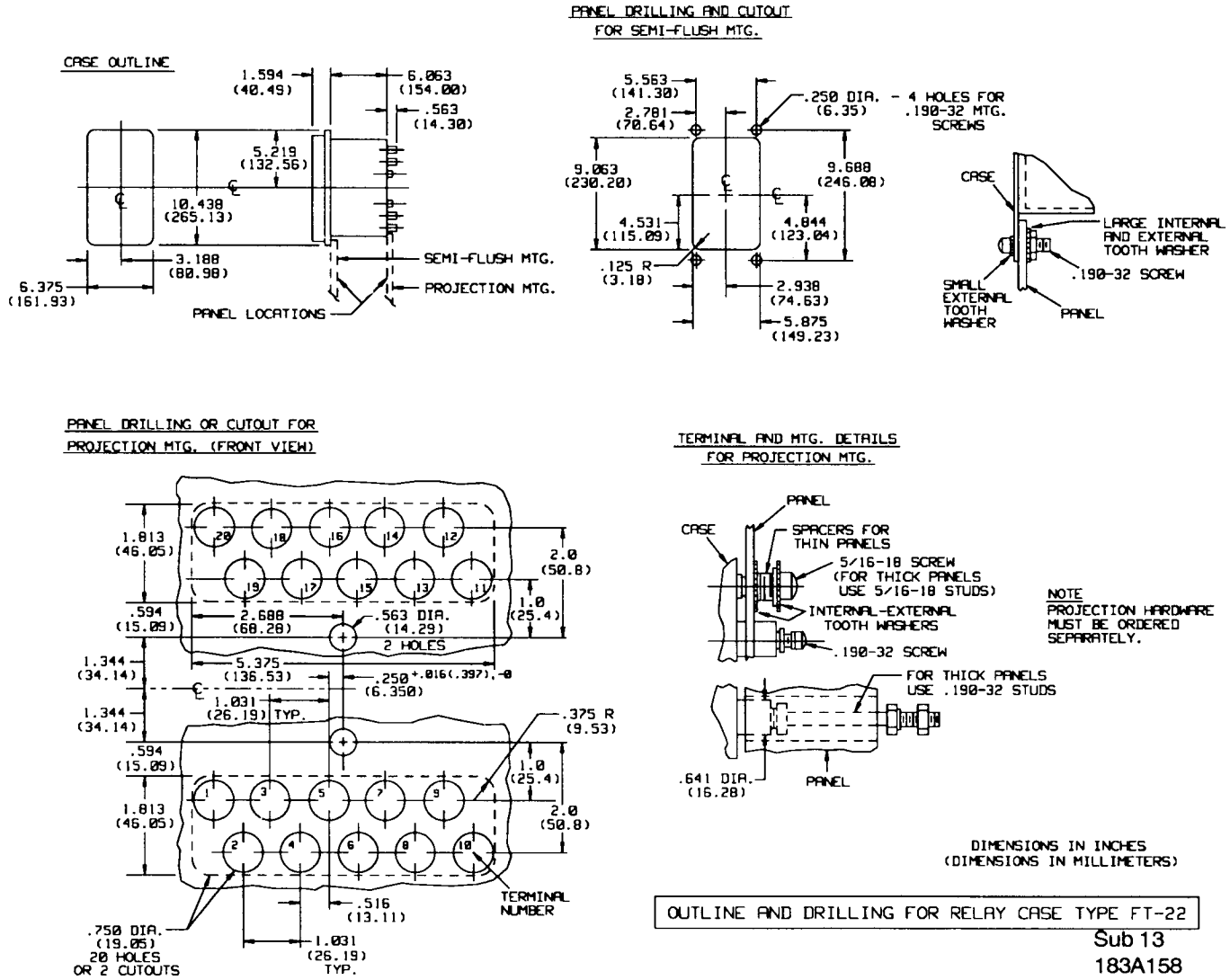


Figure 14. MRC Mounting in Type FT-22 Case.