A Configuration Record Forms

This Appendix contains photocopy-ready forms for recording the configuration and setting of the M-3430 Generator Protection Relay. The forms can be supplied to field service personnel for configuring the relay, and kept on file for future reference. Examples of the suggested use of these forms are illustrated in Chapter 2, **Application** and Chapter 3, **Operation**.

A copy of the **Relay Configuration Table** (page A-2), discussed in Section 2.2, Configuration, Functions is provided to define and record the blocking inputs and output configuration. For each function; check if **DISABLED** or check the output contacts *to be operated by the function*, and check the inputs designated *to block the function operation.*

The Communication Data & Unit Setup Record Form reproduces the Communication and Setup unit menus. This form records definition of the parameters necessary for communication with the relay, as well as access codes, user logo (identifying) lines, date & time setting, and front panel display operation.

The Functional Configuration Record Form reproduces the Configure Relay menus (including the Setup Relay submenu) accessible via M-3800A IPScom® Communication Software or the optional M-3931 HMI front panel module. For each function or setpoint, refer to the configuration you have defined using the Relay Configuration Table, and circle whether it should be enabled or disabled, the output contacts it will activate, and the inputs that will block its operation.

The Setpoint & Timing Record Form allows recording of the specific values entered for each enabled setpoint or function. The form follows the main menu selections of the relay.

The "AS SHIPPED" data forms illustrate the factory settings.

EXAMPLES:

```
59 #1 PHASE OVERVOLTAGE
disable         enable
```

```
59 #1 RELAY OUTPUT
o8 o7 o6 o5 o4 o3 o2 o1
```

```
59 #1 BLOCK INPUT
fl  i6  i5  i4  i3  i2  i1
```

```
59 #1   PICKUP
_____ Volts
```

```
59 #1   DELAY
_____ Cycles
```

FUNCTION		D	OUTPUTS								fl	INPUTS					
			8	7	6	5	4	3	2	1	fl	6	5	4	3	2	1
21	#1																
	#2																
24 DEF	#1																
	#2																
27	#1																
	#2																
27 TN	#1																
	#2																
32	#1																
	#2																
40	#1																
	#2																
46	DEF																
	INV																
50/27																	
50BF																	
59	#1																
	#2																
59N	#1																
	#2																
60FL																	
81	#1																
	#2																
	#3																
	#4																
87																	
EXT 1																	
EXT 2																	

Check each box applicable : ✓   *(See page A-1 for information on using this table.)*

Legend:

D   disabled   **OUPUTS**   Designated function output(s)

fl   Function blocked by fuse loss   **INPUTS**   Designated function blocking input(s)

Table A-1   Relay Configuration Table

KEY TO INPUT DATA RECORD FORMS

A. All unshaded [   ] screens shown on forms require data inputs. Whatever is in that screen when **ENTER** button is pushed (see Figure A-1) will be installed in the M-3430 relay.

B. All shaded [▓▓▓▓▓▓] screens are either menu screens which have horizontal choices (made with right/left arrows) or screens displaying a result of a choice previously made.

C. Dotted boxes [‾ ‾ ‾ ‾ ‾] enclose screens which bound areas that pressing **ENTER** will permit movement within. In order to move out of one of the dotted boxes it is necessary to either push **EXIT** or make a menu choice change using the Right/Left arrow.

D. The Up/Down arrows only adjust value or letter (lower/upper case) inputs; they do not move within the menus or between menu displays.

E. The Right/Left arrows are used only to make horizontally displayed choices. These can be either menu choices or input value digit choices. The previous choice or location in a menu is highlighted immediately.

F. The **ENTER** button records the setting change and moves down *within* a menu. The operator will notice that after the last menu item, **ENTER** moves to the top of the same menu but does not change menu positions.

G. Pushing **EXIT** at any time will exit the display screen to the last screen containing a horizontal choice. (Return to the preceding menu).
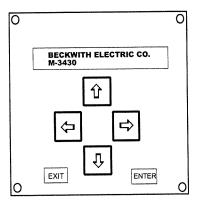

Figure A-1   Human-Machine Interface Module

H. The symbol > or < in a screen indicates additional horizontal menu choices are available in the indicated direction. As previously described, the Right/Left arrows will move the operator to those additional choices.

COMMUNICATION
← COMM setup exit

COM1 SETUP
COM1 com2 com3 com-adr→

COM1 BAUD RATE
← baud_4800 baud_9800

COM2 SETUP
com1 COM2 com3 com_adr→

COM2 BAUD RATE
← baud_4800 baud_9800

COM2 DEAD SYNC TIME
_____ MS

COM2 PROTOCOL
beco2200 MODBUS

COM2 PARITY
none odd even

COM3 SETUP
com1 com2 COM3 com_adr→

COM3 BAUD RATE
← baud_4800 baud_9600

COM3 DEAD SYNC TIME
_____ MS

COM3 PROTOCOL
beco2200 MODBUS

COM3 PARITY
NONE odd even

COMMUNICATION ADDRESS
com1 com2 com3 COM_ADR→

COMMUNICATION ADDRESS
_____

COMM ACCESS CODE
← ACCSS

COMM ACCESS CODE
_____

SETUP UNIT
← comm SETUP exit

SOFTWARE VERSION
VERS sn access number →

SOFTWARE VERSION
D-0032V02.00.13

SERIAL NUMBER
vers SN access number →

SERIAL NUMBER
_____

ALTER ACCESS CODES
vers sn ACCESS number →

ENTER ACCESS CODE
LEVEL#1 level#2 level#3

LEVEL #1
_____

ENTER ACCESS CODE
level#1 LEVEL#2 level#3

LEVEL #2
_____

ENTER ACCESS CODE
level#1 level#2 LEVEL#3

LEVEL #3
_____

USER CONTROL NUMBER
vers sn access NUMBER →

USER CONTROL NUMBER
_____

USER LOGO LINE 1
← LOGO1 logo2 out alrm→

USER LOGO LINE 1
_____

USER LOGO LINE 2
← logo1 LOGO2 out alrm→

USER LOGO LINE 2
_____

CLEAR OUTPUT COUNTERS
← logo1 logo2 OUT alrm→

CLEAR OUTPUT COUNTERS
PRESS ENTER KEY TO CLEAR

CLEAR ALARM COUNTER
← logo1 logo2 out ALRM→

CLEAR ALARM COUNTER
PRESS ENTER KEY TO CLEAR

DATE & TIME
←TIME disp cont okled →

DATE & TIME
01-Jan-2001 12:00:00

DATE & TIME
_____ YEAR

DATE & TIME
JAN feb mar apr may →

DATE & TIME
_____ DATE

DATE & TIME
SUN mon tue wed thu →

DATE & TIME
_____ HOUR

DATE & TIME
_____ MINUTES

DATE & TIME
_____ SECONDS

*Figure A-2 Communication Data & Unit
Setup Record Form (1 of 2)*

LCD DISPLAY BLANKING
← time DISP cont okled→

LCD DISPLAY BLANKING
disable enable

LCD CONTRAST ADJUSTMENT
← time disp CONT okled→

LCD CONTRAST ADJUSTMENT
_____

RELAY OK LED FLASH
←time disp cont OKLED →

RELAY OK LED FLASH
disable enable

CLEAR ERROR CODES
← ERROR diag

CLEAR ERROR CODES
PRESS ENTER KEY TO CLEAR

DIAGNOSTIC MODE
← error DIAG

■ **NOTE**: See Section 6.2, Diagnostic Test Procedures, for more information.

Figure A-2   Communication Data & Unit Setup Record Form (2 of 2)

CONFIGURE RELAYS
← CONFIG stat →

CONFIGURE RELAY
VOLTAGE_RELAY   →

59 #1 PHASE OVERVOLTAGE
disable enable

59 #1 BLOCK INPUT
fl i6 i5 i4 i3 i2 i1

59 #1 RELAY OUTPUT
o8 o7 o6 o5 o4 o3 o2 o1

59 #2 PHASE OVERVOLTAGE
disable enable

59 #2 BLOCK INPUT
fl i6 i5 i4 i3 i2 i1

59 #2 RELAY OUTPUT
o8 o7 o6 o5 o4 o3 o2 o1

59N #1 NEUTRAL OVERVOLT
disable enable

59N #1 BLOCK INPUT
fl i6 i5 i4 i3 i2 i1

59N #1 RELAY OUTPUT
o8 o7 o6 o5 o4 o3 o2 o1

59N #2 NEUTRAL OVERVOLT
disable enable

59N #2 BLOCK INPUT
fl i6 i5 i4 i3 i2 i1

59N #2 RELAY OUTPUT
o8 o7 o6 o5 o4 o3 o2 o1

27 #1 PHASE UNDERVOLTAGE
disable enable

27 #1 BLOCK INPUT
fl i6 i5 i4 i3 i2 i1

27 #1 RELAY OUTPUT
o8 o7 o6 o5 o4 o3 o2 o1

27 #2 PHASE UNDERVOLTAGE
disable enable

27 #2 BLOCK INPUT
fl i6 i5 i4 i3 i2 i1

27 #2 RELAY OUTPUT
o8 o7 o6 o5 o4 o3 o2 o1

27TN #1 NEUTRL UNDERVOLT
disable enable

27TN #1 BLOCK INPUT
fl i6 i5 i4 i3 i2 i1

27TN #1 RELAY OUTPUT
o8 o7 o6 o5 o4 o3 o2 o1

27TN #2 NEUTRL UNDERVOLT
disable enable

27TN #2 BLOCK INPUT
fl i6 i5 i4 i3 i2 i1

27TN #2 RELAY OUTPUT
o8 o7 o6 o5 o4 o3 o2 o1

CONFIGURE RELAY
← CURRENT_RELAY →

46DT NEG SEQ CURRENT DEF
disable enable

46DT BLOCK INPUT
fl i6 i5 i4 i3 i2 i1

46DT RELAY OUTPUT
o8 o7 o6 o5 o4 o3 o2 o1

46IT NEG SEQ CURRENT INV
disable enable

46IT BLOCK INPUT
fl i6 i5 i4 i3 i2 i1

46IT RELAY OUTPUT
o8 o7 o6 o5 o4 o3 o2 o1

87 DIFFERENTIAL CURRENT
disable enable

87 BLOCK INPUT
fl i6 i5 i4 i3 i2 i1

87 RELAY OUTPUT
o8 o7 o6 o5 o4 o3 o2 o1

50/27 INADVERTENT ENRGNG
disable enable

50/27 BLOCK INPUT
fl i6 i5 i4 i3 i2 i1

50/27 RELAY OUTPUT
o8 o7 o6 o5 o4 o3 o2 o1

50BF BREAKER FAILURE
disable enable

50BF BLOCK INPUT
fl i6 i5 i4 i3 i2 i1

50BF RELAY OUTPUT
o8 o7 o6 o5 o4 o3 o2 o1

Figure A-3   Functional Configuration Record Form (1 of 3)

CONFIGURE RELAY
← FREQUENCY_RELAY →

81 #1 FREQUENCY
disable enable

81 #1 BLOCK INPUT
fl i6 i5 i4 i3 i2 i1

81 #1 RELAY OUTPUT
o8 o7 o6 o5 o4 o3 o2 o1

81 #2 FREQUENCY
disable enable

81 #2 BLOCK INPUT
fl i6 i5 i4 i3 i2 i1

81 #2 RELAY OUTPUT
o8 o7 o6 o5 o4 o3 o2 o1

81 #3 FREQUENCY
disable enable

81 #3 BLOCK INPUT
fl i6 i5 i4 i3 i2 i1

81 #3 RELAY OUTPUT
o8 o7 o6 o5 o4 o3 o2 o1

81 #4 FREQUENCY
disable enable

81 #4 BLOCK INPUT
fl i6 i5 i4 i3 i2 i1

81 #4 RELAY OUTPUT
o8 o7 o6 o5 o4 o3 o2 o1

■ **NOTE:** If a function is DISABLED, the input screens for that function will not be displayed.

After the left or right arrow button is used to underline an input or output, the up or down arrow button must be pressed to select the input or output. Upper case letters indicates selection. Only selections in *upper case* will be recorded when **ENTER** is pressed. If no outputs are recorded for a function, that function will be DISABLED.

CONFIGURE RELAY
←VOLTS_PER_HERTZ_RELAY→

24DT #1 VOLTS/HZ DEF
disable enable

24DT #1 BLOCK INPUT
fl i6 i5 i4 i3 i2 i1

24DT #1 RELAY OUTPUT
o8 o7 o6 o5 o4 o3 o2 o1

24DT #2 VOLTS/HZ DEF
disable enable

24DT #2 BLOCK INPUT
fl i6 i5 i4 i3 i2 i1

24DT #2 RELAY OUTPUT
o8 o7 o6 o5 o4 o3 o2 o1

24IT VOLTS/HZ DEF
disable enable

24IT BLOCK INPUT
fl i6 i5 i4 i3 i2 i1

24IT RELAY OUTPUT
o8 o7 o6 o5 o4 o3 o2 o1

CONFIGURE RELAY
←POWER_RELAY→

32 #1 DIRECTIONAL POWER
disable enable

32 #1 BLOCK INPUT
fl i6 i5 i4 i3 i2 i1

32 #1 RELAY OUTPUT
o8 o7 o6 o5 o4 o3 o2 o1

32 #2 DIRECTIONAL POWER
disable enable

32 #2 BLOCK INPUT
fl i6 i5 i4 i3 i2 i1

32 #2 RELAY OUTPUT
o8 o7 o6 o5 o4 o3 o2 o1

CONFIGURE RELAY
←LOSS_OF_FIELD_RELAY→

40 #1 LOSS OF FIELD
disable enable

40 #1 BLOCK INPUT
fl i6 i5 i4 i3 i2 i1

40 #1 RELAY OUTPUT
o8 o7 o6 o5 o4 o3 o2 o1

40 #2 LOSS OF FIELD
disable enable

40 #2 BLOCK INPUT
fl i6 i5 i4 i3 i2 i1

40 #2 RELAY OUTPUT
o8 o7 o6 o5 o4 o3 o2 o1

CONFIGURE RELAY
←PHASE_DISTANCE_RELAY→

21 #1 PHASE DISTANCE
disable enable

21 #1 BLOCK INPUT
fl i6 i5 i4 i3 i2 i1

21 #1 RELAY OUTPUT
o8 o7 o6 o5 o4 o3 o2 o1

21 #2 PHASE DISTANCE
disable enable

21 #2 BLOCK INPUT
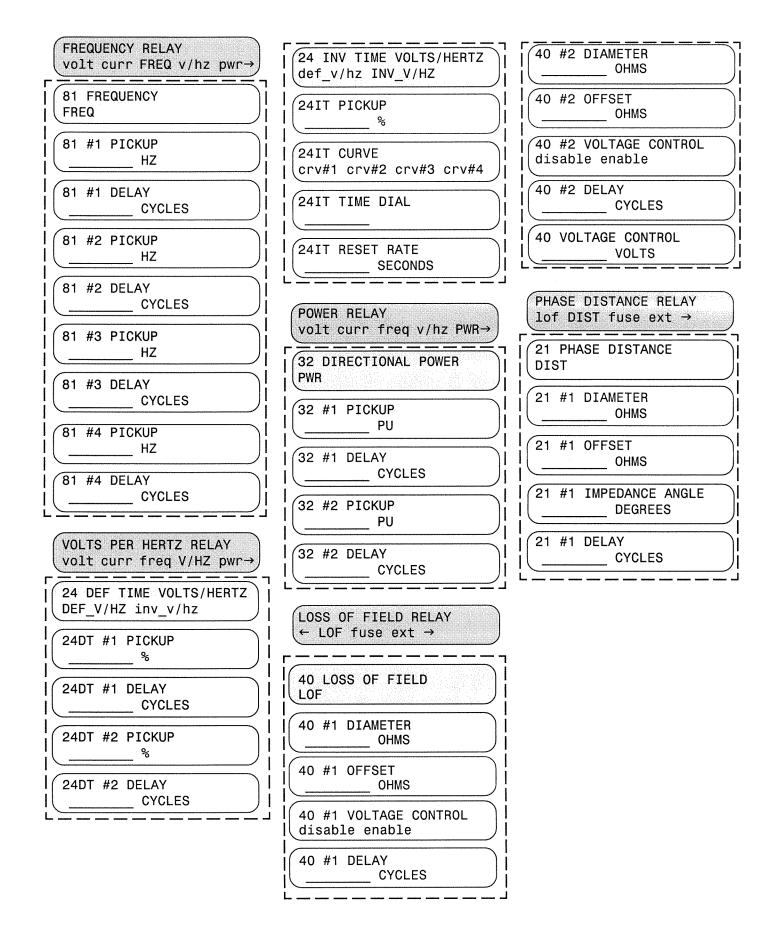fl i6 i5 i4 i3 i2 i1

21 #2 RELAY OUTPUT
o8 o7 o6 o5 o4 o3 o2 o1

CONFIGURE RELAY
←V.T._FUSE_LOSS_RELAY→

60FL V.T. FUSE LOSS
disable enable

60FL BLOCK INPUT
fl i6 i5 i4 i3 i2 i1

60FL RELAY OUTPUT
o8 o7 o6 o5 o4 o3 o2 o1

Figure A-3   Functional Configuration Record Form (2 of 3)

CONFIGURE RELAY
←EXTERNAL_RELAY→

EXT #1 EXTERNAL
disable enable

EXT #1 BLOCK INPUT
fl i6 i5 i4 i3 i2 i1

EXT #1 RELAY OUTPUT
o8 o7 o6 o5 o4 o3 o2 o1

EXT #2 EXTERNAL
disable enable

EXT #2 BLOCK INPUT
fl i6 i5 i4 i3 i2 i1

EXT #2 RELAY OUTPUT
o8 o7 o6 o5 o4 o3 o2 o1

CONFIGURE RELAY
←SETUP_RELAY→

NOMINAL VOLTAGE
VOLT curr vt mag d_ytx →

NOMINAL VOLTAGE
_____ VOLTS

NOMINAL CURRENT
volt CURR vt mag d_ytx→

NOMINAL CURRENT
_____ AMPS

V.T. CONFIGURATION
volt curr VT mag d_ytx→

V.T. CONFIGURATION
line-line line-ground →

V.T. CONFIGURATION
← line-gnd-to-line-line

59/27 MAGNITUDE SELECT
volt curr vt MAG d_ytx→

59/27 MAGNITUDE SELECT
rms dft

DELTA-Y TRANSFORM
volt curr vt mag D_YTX→

DELTA-Y TRANSFORM
disable enable

RELAY SEAL-IN TIME
←SEAL in vt_p vt_n →

RELAY SEAL-IN TIME
_____ CYCLES

ACTIVE INPUT STATE
←seal IN vt_p vt_n→

ACTIVE INPUT OPEN/close
i6 i5 i4 i3 i2 i1

V.T. PHASE RATIO
←seal in VT_P vt_n→

V.T. PHASE RATIO
_____ :1

V.T. NEUTRAL RATIO
←seal in vt_p VT_N→

V.T. NEUTRAL RATIO
_____ :1

C.T. PHASE RATIO
←CT_P ct_n→

C.T. PHASE RATIO
_____ :1

C.T. NEUTRAL RATIO
←ct_p CT_N→

C.T. NEUTRAL RATIO
_____ :1

Figure A-3   Functional Configuration Record Form (3 of 3)

VOLTAGE RELAY
VOLT curr freq v/hz pwr→

59 PHASE OVERVOLTAGE
PHASE_OVER nutrl_over

59 #1 PICKUP
_____ VOLTS

59 #1 DELAY
_____ CYCLES

59 #2 PICKUP
_____ VOLTS

59 #2 DELAY
_____ CYCLES

59N NEUTRAL OVERVOLTAGE
phase_over NUTRL_OVER

59N #1 PICKUP
_____ VOLTS

59N #1 DELAY
_____ CYCLES

59N #2 PICKUP
_____ VOLTS

59N #2 DELAY
_____ CYCLES

27 PHASE UNDERVOLTAGE
←PHASE_UNDER nutrl_undr

27 #1 PICKUP
_____ VOLTS

27 #1 DELAY
_____ CYCLES

27 #2 PICKUP
_____ VOLTS

27 #2 DELAY
_____ CYCLES

■ **NOTE**: If a function is DISABLED,
the input screens for that function will
not be displayed.

27TN NEUTRAL UNDERVOLT
phase_under NUTRL_UNDER

27TN #1 PICKUP
_____ VOLTS

27TN #1 DELAY
_____ CYCLES

27TN #2 PICKUP
_____ VOLTS

27TN #2 DELAY
_____ CYCLES

27TN UNDER VOLT INHIBIT
_____ VOLTS

27TN UNDER POWER INHIBIT
disable enable

CURRENT RELAY
volt **CURR** freq v/hz pwr→

46 NEG SEQ OVERCURRENT
NEG_SEQ diff_over →

46DT PICKUP
_____ %

46DT DELAY
_____ CYCLES

46IT PICKUP
_____ %

46IT TIME DIAL
_____

46IT MAX DELAY
_____ CYCLES

87 DIFFERENTIAL OVERCURR
← neg_seq DIFF_OVER →

87 PICKUP
_____ AMPS

87 SLOPE
_____ %

87 DELAY
_____ CYCLES

50/27 INADVERTENT ENRGNG
← INADVNT_ENG brk_fail

50/27 PICKUP
_____ AMPS

50/27 VOLTAGE CONTROL
_____ VOLTS

50/27 PICKUP DELAY
_____ CYCLES

50/27 DROPOUT DELAY
_____ CYCLES

50BF BREAKER FAILURE
←inadvtnt_eng BRK_FAIL

50BF NEUTRAL ELEMENT
disable enable

50BF NEUTRAL PICKUP
_____ AMPS

50BF PHASE ELEMENT
disable enable

50BF PHASE PICKUP
_____ AMPS

50BF INPUT INITIATE
i6 i5 i4 i3 i2 i1

50BF OUTPUT INITIATE
o8 o7 o6 o5 o4 o3 o2 o1

50BF DELAY
_____ CYCLES

Figure A-4   Setpoint & Timing Record Form (1 of 3)

FREQUENCY RELAY
volt curr FREQ v/hz pwr→

81 FREQUENCY
FREQ

81 #1 PICKUP
_____ HZ

81 #1 DELAY
_____ CYCLES

81 #2 PICKUP
_____ HZ

81 #2 DELAY
_____ CYCLES

81 #3 PICKUP
_____ HZ

81 #3 DELAY
_____ CYCLES

81 #4 PICKUP
_____ HZ

81 #4 DELAY
_____ CYCLES

VOLTS PER HERTZ RELAY
volt curr freq V/HZ pwr→

24 DEF TIME VOLTS/HERTZ
DEF_V/HZ inv_v/hz

24DT #1 PICKUP
_____ %

24DT #1 DELAY
_____ CYCLES

24DT #2 PICKUP
_____ %

24DT #2 DELAY
_____ CYCLES

24 INV TIME VOLTS/HERTZ
def_v/hz INV_V/HZ

24IT PICKUP
_____ %

24IT CURVE
crv#1 crv#2 crv#3 crv#4

24IT TIME DIAL
_____

24IT RESET RATE
_____ SECONDS

POWER RELAY
volt curr freq v/hz PWR→

32 DIRECTIONAL POWER
PWR

32 #1 PICKUP
_____ PU

32 #1 DELAY
_____ CYCLES

32 #2 PICKUP
_____ PU

32 #2 DELAY
_____ CYCLES

LOSS OF FIELD RELAY
← LOF fuse ext →

40 LOSS OF FIELD
LOF

40 #1 DIAMETER
_____ OHMS

40 #1 OFFSET
_____ OHMS

40 #1 VOLTAGE CONTROL
disable enable

40 #1 DELAY
_____ CYCLES

40 #2 DIAMETER
_____ OHMS

40 #2 OFFSET
_____ OHMS

40 #2 VOLTAGE CONTROL
disable enable

40 #2 DELAY
_____ CYCLES

40 VOLTAGE CONTROL
_____ VOLTS

PHASE DISTANCE RELAY
lof DIST fuse ext →

21 PHASE DISTANCE
DIST

21 #1 DIAMETER
_____ OHMS

21 #1 OFFSET
_____ OHMS

21 #1 IMPEDANCE ANGLE
_____ DEGREES

21 #1 DELAY
_____ CYCLES

Figure A-4   Setpoint & Timing Record Form (2 of 3)

V.T. FUSE LOSS RELAY
← lof dist FUSE ext

60FL V.T. FUSE LOSS
FUSE

60FL INPUT INITIATE
i6 i5 i4 i3 i2 i1

60FL DELAY
_____ CYCLES

EXTERNAL RELAY
← lof dist fuse EXT

EXTERNAL
EXT

EXT #1 INPUT INITIATE
i6 i5 i4 i3 i2 i1

EXT #1 DELAY
_____ CYCLES

EXT #2 INPUT INITIATE
i6 i5 i4 i3 i2 i1

EXT #2 DELAY
_____ CYCLES

Figure A-4   Setpoint & Timing Record Form (3 of 3)

COMMUNICATION
← COMM setup exit

SETUP UNIT
← comm SETUP exit

COM1 SETUP
COM1 com2 com3 com-adr

COM1 BAUD RATE
← baud_4800 BAUD_9600

COM2 SETUP
com1 COM2 com3 com_adr

COM2 DEAD SYNC TIME
50 MS

COM2 PROTOCOL
BECO2200 modbus

COM3 SETUP
com1 com2 COM3 com_adr

COM3 DEAD SYNC TIME
50 MS

COM3 PROTOCOL
BECO2200 modbus

COMMUNICATION ADDRESS
com1 com2 com3 COM_ADR

COMMUNICATION ADDRESS
1

COMM ACCESS CODE
← ACCSS

COMM ACCESS CODE
9999

SOFTWARE VERSION
VERS sn access number →

SOFTWARE VERSION
D-0032V02.00.13

SERIAL NUMBER
vers SN access number →

SERIAL NUMBER
XXXX

ALTER ACCESS CODES
vers sn ACCESS number →

ENTER ACCESS CODE
LEVEL#1 level#2 level#3

LEVEL #1
1111

ENTER ACCESS CODE
level#1 LEVEL#2 level#3

LEVEL #2
2222

ENTER ACCESS CODE
level#1 level#2 LEVEL#3

LEVEL #3
9999

USER CONTROL NUMBER
vers sn access NUMBER →

USER CONTROL NUMBER
1

USER LOGO LINE 1
← LOGO1 logo2 out alrm→

USER LOGO LINE 1
BECKWITH ELECTRIC CO.

USER LOGO LINE 2
← logo1 LOGO2 out alrm→

USER LOGO LINE 2
M-3430

CLEAR OUTPUT COUNTERS
← logo1 logo2 OUT alrm→

CLEAR OUTPUT COUNTERS
PRESS ENTER KEY TO CLEAR

CLEAR ALARM COUNTER
← logo1 logo2 out ALRM→

CLEAR ALARM COUNTER
PRESS ENTER KEY TO CLEAR

DATE & TIME
←TIME disp cont okled →

DATE & TIME
01-Jan-2001 12:00:00

DATE & TIME
01 Year

DATE & TIME
JAN feb mar apr may →

DATE & TIME
01 Date

DATE & TIME
SUN mon tue wed thu →

DATE & TIME
01 Hour

DATE & TIME
01 Minutes

DATE & TIME
01 Seconds

Figure A-5   Communication Data & Unit Setup: As Shipped (1 of 2)

```
┌──────────────────────────────┐
│ ┌──────────────────────────┐ │
│ │ LCD DISPLAY BLANKING      │ │
│ │ ← time DISP cont okled→   │ │
│ └──────────────────────────┘ │
│ ┌──────────────────────────┐ │
│ │ LCD DISPLAY BLANKING      │ │
│ │ disable ENABLE            │ │
│ └──────────────────────────┘ │
└──────────────────────────────┘

┌──────────────────────────────┐
│ ┌──────────────────────────┐ │
│ │ LCD CONTRAST ADJUSTMENT    │ │
│ │ ← time disp CONT okled→   │ │
│ └──────────────────────────┘ │
│ ┌──────────────────────────┐ │
│ │ LCD CONTRAST ADJUSTMENT    │ │
│ │ 6000                      │ │
│ └──────────────────────────┘ │
└──────────────────────────────┘

┌──────────────────────────────┐
│ ┌──────────────────────────┐ │
│ │ RELAY OK LED FLASH         │ │
│ │ ←time disp cont OKLED →   │ │
│ └──────────────────────────┘ │
│ ┌──────────────────────────┐ │
│ │ RELAY OK LED FLASH         │ │
│ │ disable ENABLE            │ │
│ └──────────────────────────┘ │
└──────────────────────────────┘

┌──────────────────────────────┐
│ ┌──────────────────────────┐ │
│ │ CLEAR ERROR CODES          │ │
│ │ ← ERROR diag              │ │
│ └──────────────────────────┘ │
│ ┌──────────────────────────┐ │
│ │ CLEAR ERROR CODES          │ │
│ │ PRESS ENTER KEY TO CLEAR  │ │
│ └──────────────────────────┘ │
└──────────────────────────────┘

┌──────────────────────────────┐
│ ┌──────────────────────────┐ │
│ │ DIAGNOSTIC MODE            │ │
│ │ ← error DIAG              │ │
│ └──────────────────────────┘ │
│ ■ NOTE: See Section 6.2, Di- │
│ agnostic Test Procedures, for│
│ more information.            │
└──────────────────────────────┘
```

Figure A-5   Communication Data & Unit Setup: As Shipped (2 of 2)

CONFIGURE RELAYS
← CONFIG stat →

CONFIGURE RELAY
VOLTAGE_RELAY →

59 #1 PHASE OVERVOLTAGE
disable ENABLE

59 #1 BLOCK INPUT
fl i6 i5 i4 i3 i2 i1

59 #1 RELAY OUTPUT
o8 o7 o6 o5 o4 o3 o2 O1

59 #2 PHASE OVERVOLTAGE
DISABLE enable

59N #1 NEUTRAL OVERVOLT
disable ENABLE

59N #1 BLOCK INPUT
fl i6 i5 i4 i3 i2 i1

59N #1 RELAY OUTPUT
o8 o7 o6 o5 o4 o3 o2 O1

59N #2 NEUTRAL OVERVOLT
DISABLE enable

27 #1 PHASE UNDERVOLTAGE
disable ENABLE

27 #1 BLOCK INPUT
FL i6 i5 i4 i3 i2 I1

27 #1 RELAY OUTPUT
o8 o7 o6 o5 o4 o3 o2 o1

27 #2 PHASE UNDERVOLTAGE
DISABLE enable

27TN #1 NEUTRL UNDERVOLT
disable enable

27TN #1 BLOCK INPUT
fl i6 i5 i4 i3 i2 i1

27TN #1 RELAY OUTPUT
o8 o7 o6 o5 o4 o3 o2 o1

27TN #2 NEUTRL UNDERVOLT
DISABLE enable

CONFIGURE RELAY
← CURRENT_RELAY →

46DT NEG SEQ CURRENT DEF
disable ENABLE

46DT BLOCK INPUT
fl i6 i5 i4 i3 i2 i1

46DT RELAY OUTPUT
o8 o7 o6 o5 o4 O3 o2 o1

46IT NEG SEQ CURRENT INV
disable ENABLE

46IT BLOCK INPUT
fl i6 i5 i4 i3 i2 I1

46IT RELAY OUTPUT
o8 o7 o6 o5 o4 o3 o2 O1

87 DIFFERENTIAL CURRENT
disable ENABLE

87 BLOCK INPUT
fl i6 i5 i4 i3 i2 i1

87 RELAY OUTPUT
o8 o7 o6 o5 o4 o3 o2 O1

50/27 INADVERTENT ENRGNG
disable ENABLE

50/27 BLOCK INPUT
fl i6 i5 i4 i3 i2 i1

50/27 RELAY OUTPUT
o8 o7 o6 O5 o4 o3 o2 o1

50BF BREAKER FAILURE
disable ENABLE

50BF BLOCK INPUT
fl i6 i5 i4 i3 i2 i1

50BF RELAY OUTPUT
o8 o7 O6 o5 o4 o3 o2 o1

CONFIGURE RELAY
← FREQUENCY_RELAY →

81 #1 FREQUENCY
disable ENABLE

81 #1 BLOCK INPUT
fl i6 i5 i4 i3 i2 I1

81 #1 RELAY OUTPUT
o8 o7 o6 o5 o4 o3 o2 o1

81 #2 FREQUENCY
DISABLE enable

81 #3 FREQUENCY
DISABLE enable

81 #4 FREQUENCY
DISABLE enable

CONFIGURE RELAY
←VOLTS_PER_HERTZ_RELAY→

24DT #1 VOLTS/HZ DEF
disable ENABLE

24DT #1 BLOCK INPUT
fl i6 i5 i4 i3 i2 I1

24DT #1 RELAY OUTPUT
o8 o7 o6 o5 o4 o3 o2 o1

24DT #2 VOLTS/HZ DEF
DISABLE enable

24IT VOLTS/HZ INV
disable ENABLE

24IT BLOCK INPUT
fl i6 i5 i4 i3 i2 I1

24IT RELAY OUTPUT
o8 o7 o6 o5 o4 o3 o2 o1

A–14   *Figure A-6   Functional Configuration Record Form: As Shipped (1 of 2)*

CONFIGURE RELAY
←POWER_RELAY→

32 #1 DIRECTIONAL POWER
disable ENABLE

32 #1 BLOCK INPUT
fl i6 i5 i4 i3 i2 I1

32 #1 RELAY OUTPUT
o8 o7 o6 o5 o4 o3 o2 O1

32 #2 DIRECTIONAL POWER
DISABLE enable

CONFIGURE RELAY
←LOSS_OF_FIELD_RELAY→

40 #1 LOSS OF FIELD
disable ENABLE

40 #1 BLOCK INPUT
fl i6 i5 i4 i3 i2 I1

40 #1 RELAY OUTPUT
o8 o7 o6 o5 o4 o3 o2 O1

40 #2 LOSS OF FIELD
DISABLE enable

CONFIGURE RELAY
←PHASE_DISTANCE_RELAY→

21 #1 PHASE DISTANCE
disable ENABLE

21 #1 BLOCK INPUT
fl i6 i5 i4 i3 i2 I1

21 #1 RELAY OUPUT
o8 o7 o6 o5 o4 o3 o2 O1

21 #2 PHASE DISTANCE
DISABLE enable

CONFIGURE RELAY
←V.T._FUSE_LOSS_RELAY→

60FL V.T. FUSE LOSS
disable ENABLE

60FL BLOCK INPUT
fl i6 i5 i4 i3 i2 I1

60FL RELAY OUTPUT
o8 o7 o6 o5 o4 o3 o2 O1

CONFIGURE RELAY
←EXTERNAL_RELAY→

EXT #1 EXTERNAL
DISABLE enable

EXT #2 EXTERNAL
DISABLE enable

CONFIGURE RELAY
←SETUP_RELAY→

NOMINAL VOLTAGE
VOLT curr vt mag d_ytx→

NOMINAL VOLTAGE
120 VOLTS

NOMINAL CURRENT
volt CURR vt mag d_ytx→

NOMINAL CURRENT
5.00 AMPS

V.T. CONFIGURATION
volt curr VT mag d_ytx→

V.T. CONFIGURATION
LINE-LINE line-ground →

59/27 MAGNITUDE SELECT
volt curr vt MAG d_ytx→

59/27 MAGNITUDE SELECT
RMS dft

DELTA-Y TRANSFORM
volt curr vt mag D_YTX→

DELTA-Y TRANSFORM
DISABLE enable

RELAY SEAL-IN TIME
← SEAL in vt_p vt_n→

RELAY SEAL-IN TIME
30 CYCLES

ACTIVE INPUT STATE
← seal IN vt_p vt_n→

ACTIVE INPUT OPEN/close
i6 i5 i4 i3 i2 I1

V.T. PHASE RATIO
← seal in VT_P vt_n→

V.T. PHASE RATIO
1.0:1

V.T. NEUTRAL RATIO
←seal in vt_p VT_N→

V.T. NEUTRAL RATIO
1.0:1

C.T. PHASE RATIO
←CT_P ct_n→

C.T. PHASE RATIO
10:1

C.T. NEUTRAL RATIO
←ct_p CT_N→

C.T. NEUTRAL RATIO
10:1

Figure A-6   Functional Configuration Record Form: As Shipped (2 of 2)   **A–15**

VOLTAGE RELAY
VOLT curr freq v/hz pwr→

59 PHASE OVERVOLTAGE
PHASE_OVER nutrl_over →

59 #1 PICKUP
132 Volts

59 #1 DELAY
30 Cycles

59N NEUTRAL OVERVOLTAGE
phase_over NUTRL_OVER →

59N #1 PICKUP
10.0 Volts

59N #1 DELAY
30 Cycles

27 PHASE UNDERVOLTAGE
←PHASE_UNDER nutrl_under

27 #1 PICKUP
108 Volts

27 #1 DELAY
30 Cycles

27TN NEUTRAL UNDERVOLT
←phase_under NUTRL_UNDER

27TN #1 PICKUP
1.2 Volts

27TN #1 DELAY
30 Cycles

27TN UNDER VOLT INHIBIT
200 Volts

27TN UNDER POWER INHIBIT
DISABLE enable

CURRENT RELAY
volt CURR freq v/hz pwr→

46 NEG SEQ OVERCURRENT
NEG_SEQ diff_over →

46DT PICKUP
10%

46DT DELAY
120 Cycles

46IT PICKUP
50%

46IT TIME DIAL
25

46IT MAX DELAY
10,000 Cycles

87 DIFFERENTIAL OVERCURR
neg_seq DIFF_OVER →

87 PICKUP
0.50 Amps

87 SLOPE
25%

87 DELAY
2 Cycles

50/27 INADVERTANT ENERG
←INADVNT_ENG brk_fail →

50/27 PICKUP
3.00 Amps

50/27 VOLTAGE CONTROL
100 Volts

50/27 PICKUP DELAY
120 Cycles

50/27 DROPOUT DELAY
60 Cycles

50BF BREAKER FAILURE
←inadvnt_eng BRK_FAIL

50BF NEUTRAL ELEMENT
disable ENABLE

50BF NEUTRAL PICKUP
1.00 Amps

50BF PHASE ELEMENT
disable ENABLE

50BF PHASE PICKUP
1.00 Amps

50BF INPUT INITIATE
i6 i5 i4 i3 i2 i1

50BF OUTPUT INITIATE
o8 o7 o6 o5 o4 o3 o2 o1

50BF DELAY
30 Cycles

FREQUENCY RELAY
volt curr FREQ v/hz pwr→

81 FREQUENCY
FREQ

81 #1 PICKUP
57.00 Hz

81 #1 DELAY
30 Cycles

Figure A-7   Setpoint & Timing Record Form: As Shipped (1 of 2)

VOLTS PER HERTZ RELAY
volt curr freq V/HZ pwr→

24 DEF TIME VOLTS/HERTZ
DEF_V/HZ inv_v/hz

24DT #1 PICKUP
110%

24DT #1 DELAY
360 Cycles

24 INV TIME VOLTS/HERTZ
def_v/hz INV_V/HZ

24IT PICKUP
105%

24IT CURVE
CRV#1 crv#2 crv#3 crv#4

24IT TIME DIAL
9

24IT RESET RATE
200 Seconds

POWER RELAY
volt freq curr v/hz PWR→

32 DIRECTIONAL POWER
PWR

32 #1 PICKUP
−0.020 PU

32 #1 DELAY
120 Cycles

LOSS OF FIELD RELAY
← LOF dist fuse ext →

40 LOSS OF FIELD
LOF

40 #1 DIAMETER
50.0 Ohms

40 #1 OFFSET
−10.00 Ohms

40 #1 VOLTAGE CONTROL
DISABLE enable

40 #1 DELAY
30 Cycles

PHASE DISTANCE RELAY
← lof DIST fuse ext →

21 PHASE DISTANCE
DIST

21 #1 DIAMETER
50.0 Ohms

21 #1 OFFSET
0.0 Ohms

21 #1 IMPEDANCE ANGLE
85 Degrees

21 #1 DELAY
30 Cycles

V.T. FUSE LOSS RELAY
← lof dist FUSE ext

60FL V.T. FUSE LOSS
FUSE

60FL INPUT INITIATE
FL i6 i5 i4 i3 i2 i1

60FL DELAY
30 Cycles

EXTERNAL RELAY
← lof dist fuse EXT

EXTERNAL
EXT

FUNCTION DISABLED
SEE CONFIGURATION MENU

Figure A-7   Setpoint & Timing Record Form: As Shipped (2 of 2)

A–17

FUNCTION		D	8	7	6	5	4	3	2	1	fl	6	5	4	3	2	1
			O	U	T	P	U	T	S		I	N	P	U	T	S	
21	#1									✓	✓						✓
	#2	✓															
24 DEF	#1						✓										
	#2	✓															
INV										✓							
27	#1									✓	✓						✓
	#2	✓															
27TN	#1									✓							
	#2	✓															
32	#1									✓							✓
	#2	✓															
40	#1									✓	✓						✓
	#2	✓															
46 DEF								✓									
										✓							
50/27						✓											
50BF						✓											
59	#1									✓							
	#2	✓															
59N	#1									✓							
	#2	✓															
60FL					✓												
81	#1									✓							✓
	#2	✓															
	#3	✓															
	#4	✓															
87										✓							
EXT 1		✓															
EXT 2		✓															

Check each box applicable : ✓   *(See page A-1 for information on using this table.)*

Legend:

D   disabled

fl   Function blocked by fuse loss

OUPUTS   Designated function output(s)

INPUTS   Designated function blocking input(s)

Table A-2   M-3430 Configuration As Shipped

B Communications

The M-3430 Generator Protection Relay incorporates three serial ports for intelligent, digital communication with external devices. Equipment such as RTU's, data concentrators, modems, or computers can be interfaced for direct, on-line real time data acquisition and control. Generally, all data available to the operator through the relay's front panel, using the optional M-3931 Human-Machine Interface Module, is accessible through the BECO 2200 data exchange protocol. This protocol document and the BECO 2200 M-3430 database specific protocol document are available from the factory.

The M-3800A IPScom® Communication Software package has been supplied for communication to any IBM compatible computer running under Windows® 3.1 or higher.

The protocol implements serial, byte oriented, asynchronous communication and can be used to fulfill the following communications functions:

- Real time monitoring of line status.

- Interrogation and modification of setpoints.

- Downloading of recorded oscillograph data.

- Reconfiguration of functions.

■ NOTE: The following restrictions apply for MODBUS protocol use:

1) MODBUS protocol is not supported on COM1;

2) Parity is supported on COM3 only, valid selections for COM3 are 8,N,2; 8,O,1 or 8,E,1. COM2 communication must be 8 data, no parity, 2 stop;

3) ASCII mode is not supported (RTU only);

4) Standard baud rates from 300 to 9600 are supported;

5) Only the following MODBUS commands are supported: a- read input register (function 04), b-Force single coil (function 05), c- Preset single register (function 06);

6) MODBUS does not support oscillograph record downloading.

For detailed information on communications, refer to Chapter 4, **Operation (Computers)**.

Communication Ports

The relay has both front and rear panel RS-232 ports and a rear RS-485 port. The front and rear panel RS-232 ports are 9-pin (DB9S) connector configured as DTE (Data Terminal Equipment) per the RS-232C standard. Signals are defined in Table B-1.

The RS-485 port is assigned to the rear panel terminal block pins 1 through 4 (see Figure B-2). This can be configured for RS-485 two-wire or four-wire operation. This port is not suitable for modem use.

Each communication port may be configured to operate at any of the standard baud rates (300, 600, 1200, 2400, 4800, and 9600). The RS-485 port shares the same baud rate with COM2 (or COM1 see Section 5-3).

While the RS-232 communication ports do include some ESD (Electrostatic Discharge) protection circuitry, they are excluded from passing ANSI/IEEE C37.90.1-1989. Beckwith Electric recommends the use of RS-232 to fiber optic converters to avoid any question of surge-withstand capability.

An external termination resistor can be used or Section 5.3 Circuit Board Switches and Jumpers illustrates the placement of an internal terminating resistor jumper that is incorporated in the printed circuit board for the RS-485 channel.

A null modem cable, shown in figure B-1, allows direct connection to a PC (personal computer) if so desired.

CIRCUIT		SIGNAL	COM1	COM2
BB	RX	Receive Data	Pin 2	Pin 2
BA	TX	Transmit Data	Pin 3	Pin 3
CA	RTS	Request-To-Send	Pin 7	Pin 7
CB	CTS	Clear-To-Send	-	Pin 8
CD	DTR	Data Terminal Ready	Pin 4	Pin 4
CF	DCD	Data Carrier Detect	-	Pin 1
AB	GND	Signal Ground	Pin 5	Pin 5
	+15V			Pin 1
	-15V			Pin 9
*±15V (±15%) @ 100mA max.				

Table B-1   Communication Port Signals
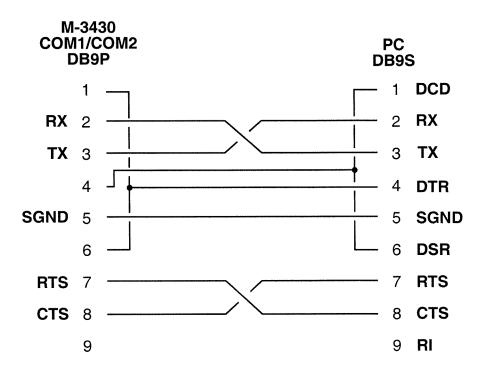
Figure B-1   Null Modem Cable

PC Master

Echo Cancel**

25 pin or
9-25 pin Straight-Through Cable

DYMEC Fiber Optic
Link / Repeater*

DCE
DTE

REP
OFF

T   R

FOC   FOC

FOC   FOC

R   T   R   T   R   T

DCE   DCE   DCE
DTE   DTE   DTE

REP   REP   REP
OFF   OFF   OFF

Slave #1   Slave #2   Slave #3
Address 1   Address 2   Address 3

RS-232   RS-232   RS-232

9-25 pin "Straight-Through" Cables
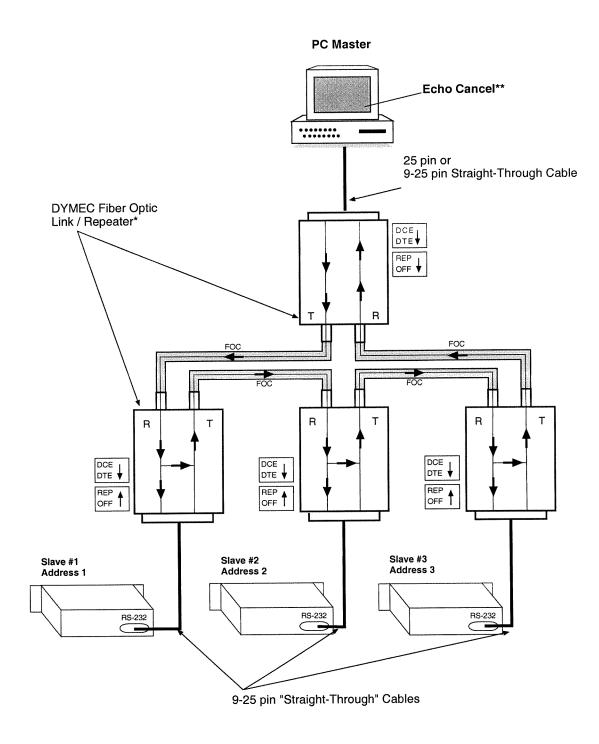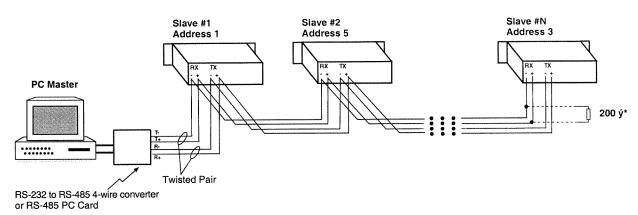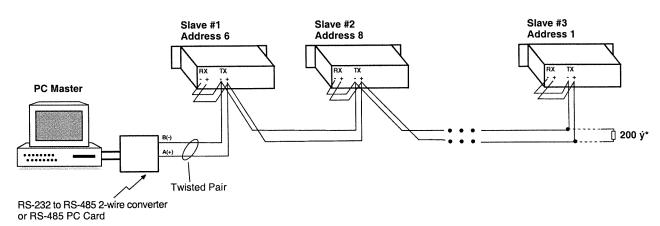
Figure   B-2   RS-232 Fiber Optic Network

RS-485 4-Wire Network

Slave #1
Address 1

Slave #2
Address 5

Slave #N
Address 3

RX   TX

RX   TX

RX   TX

PC Master

200 ÿ*

T-
T+
R-
R+

Twisted Pair

RS-232 to RS-485 4-wire converter
or RS-485 PC Card

RS-485 2-Wire Network

Slave #1
Address 6

Slave #2
Address 8

Slave #3
Address 1

RX   TX

RX   TX

RX   TX

PC Master

200 ÿ*

B(-)
A(+)

Twisted Pair

RS-232 to RS-485 2-wire converter
or RS-485 PC Card

▲ **CAUTION:** Due to the possibility of ground potential difference between units, all units should be mounted in the same rack. If this is not possible, fiber optics with the appropriate converters should be used for isolation.

■ **NOTE:** Each address on the network must be unique. Only the last physical slave on the network should have the termination resistor installed. This may be completed externally or via a dip jumper internal to the unit. See Section 5.3, Circuit Board Switches and Jumpers.

Figure B-3   RS-485 Networks

C Self-Test Error Codes

Error Code	Description
1	
2	Battery backed RAM test fail
3	EEPROM write power-up fail
4	EEPROM read back power-up fail
5	Dual port RAM test fail
6	EEPROM write calibration checksum fail
7	EEPROM write setpoint checksum fail loss of power
8	EEPROM write setpoint checksum fail loss of battery backed RAM
9	DMA checksum/physical block fail
10	
11	DSP external program RAM fail
12	DSP A/D convert fail
13	DSP ground channel fail
14	DSP reference channel fail
15	DSP PGA gain fail
16	DSP DSP<-> HOST interrupt 1 fail
17	DSP DSP -> HOST interrupt 2 set fail
18	DSP DSP -> HOST interrupt 2 reset fail
19	DSP program load fail
20	
21	DSP not running secondary boot code
22	DSP DPRAM pattern test fail
23	EEPROM write verify error
24	BBRAM test error
25	Uninitialized EEPROM

Table C-1   Self-Test Error Codes (page 1 of 2)

Error Code	Description
26	WARNING calibration checksum mismatch warning
27	WARNING setpoint checksum mismatch warning
28	WARNING low battery (BBRAM) warning
29	Supply/mux PGA running test fail
30	
31	Unrecognized INT1 code
32	Values update watchdog fail
33	Abort Error
34	Restart Error
35	Interrupt Error
36	Trap Error
37	
38	
39	
40	
41	
42	
43	
44	Oscillograph buffer overflow
45	Oscillograph buffer underflow
46	Failure of DSP to calculate calibration phasors
47	
48	
49	
50	

Table C-1   Self-Test Error Codes (page 2 of 2)

Error Code	Description
Comm Channel Lock	An incorrect password supplied to the control will result in this error message..
Control in Local Mode	This message indicates the control is being operated locally and serial communication is suspended.
Echo Timeout	This error results if there are problems with the communication link or if the echo cancel function is used incorrectly.
Invalid Data	This error results if incorrect or out-of-range data is entered.
Invalid ID	This message displays when attempting to communicate with a device other than the M-3430.
Invalid Number of Points	This error results if an incompatible version of IPScom® software is used. This is a communication protocol error. Contact Beckwith Electric factory representative.
Invalid Point Number	This error results if an incompatible version of IPScom® software is used. This is a communication protocol error. Contact Beckwith Electric factory representative.
Read Invalid Checksum	This error results if there are problems with the communication link or if the echo cancel function is used incorrectly.
Read Packet Timeout	This error results when communication with the control is lost while attempting to read data to the control.
Response Timeout	This error results when communication with the control is lost while attempting to read data from the control.
Unknown System Error	This error could be caused by a malfunction of control.
User Cancel	This message displays when the escape (ESC) key is pressed.
Write Invalid Checksum	This error results if there are problems with the communication link or if the echo cancel function is used incorrectly.
Write Packet Timeout	This error results when communication with the control is lost while attempting to write data to the control.

Table C-2   IPScom® Error Messages

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D Appendix D – Inverse Time Curves

This Appendix contains the Inverse Time Curve families used for the Volts per Hertz function.

$$t = \frac{.003 * K}{\left(\left(\dfrac{M}{100}\right) - 1\right)^2}$$
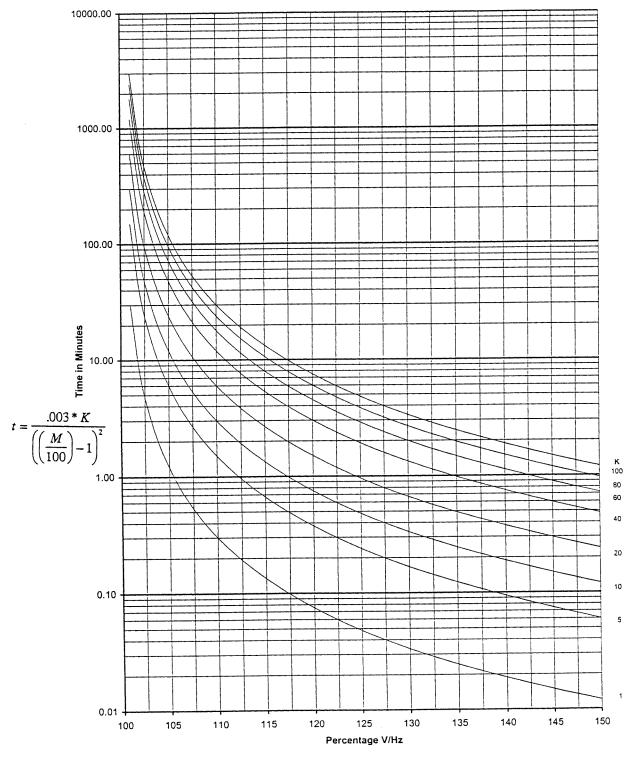
Figure D-1   Volts/Hz (24) Inverse Curve Family #1 (Inverse Square)

$$t = e^{\dfrac{115 + (2.5 * K) - M}{4.8858}}$$
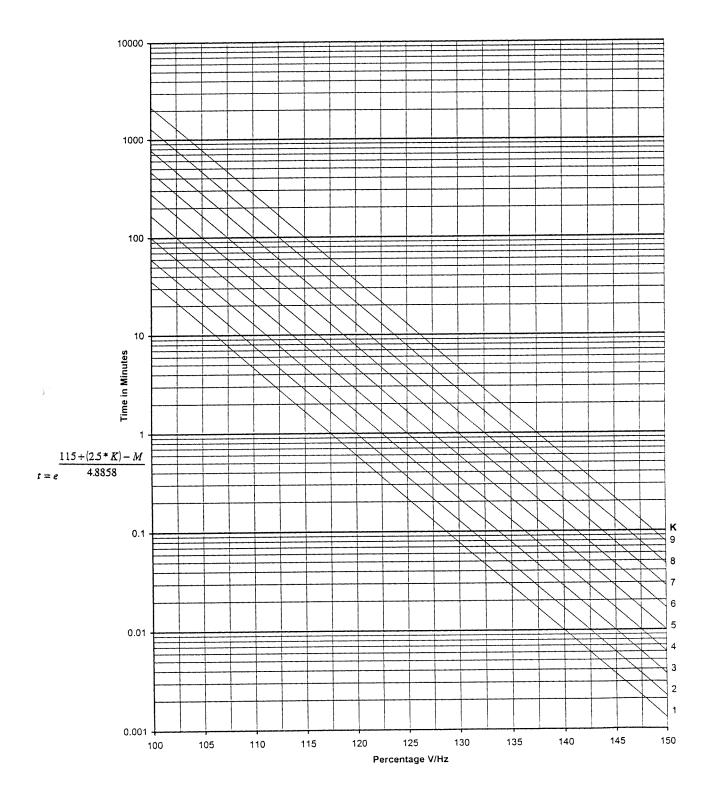
Figure D-2   Volts/Hz (24) Inverse Family Curve #2

$$t = e^{\dfrac{1135 + (25 * K) - M}{3.04}}$$
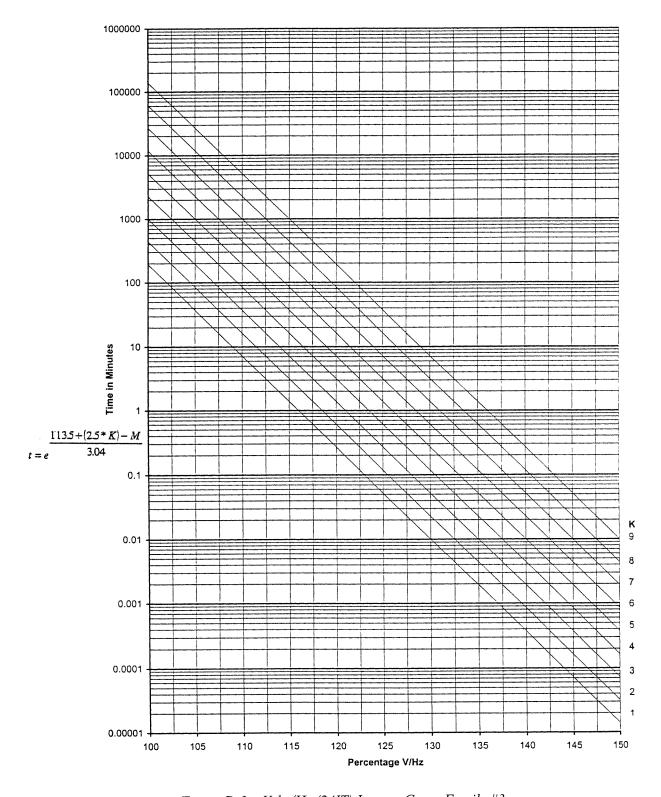
Figure D-3   Volts/Hz (24IT) Inverse Curve Family #3

$$t = e^{\frac{108.75 + (2.5 * K) - M}{2.4429}}$$
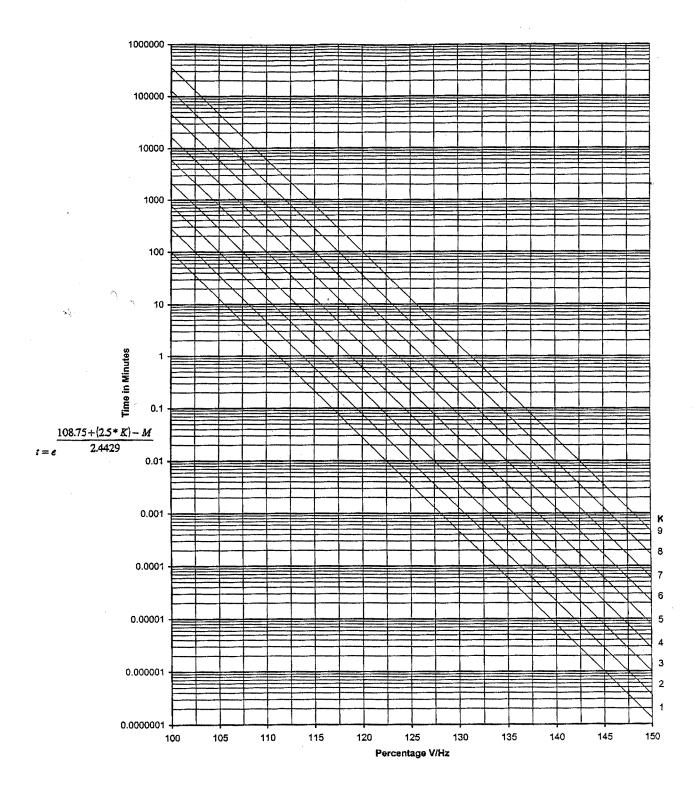
Figure D-4   Volts/Hz (24IT) Inverse Curve Family #4

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1 Introduction

1.1   Instruction Book Contents

This instruction book has six chapters and three appendices.

Chapter 1: Introduction

Chapter One lists M-3430 Generator Protection Relay capabilities, introduces instruction book contents to all readers, and describes accessories.

Chapter 2: Application

Chapter Two is designed for the person or group responsible for application of the relay. It includes functional diagrams and connection diagrams for typical application; describes how to configure the unit (choosing active functions); output contact assignment and input blocking designation; illustrates the definition of system quantities and required equipment characteristics; and describes the individual function settings and oscillograph recorder setup.

This chapter also specifies appropriate forms for recording and communicating the described data to the parties responsible for operation and installation of the relay.

Chapter 3: Operation (Front Panel)

This chapter is designed for the person or group responsible for the operation, direct setting, and configuration of the relay and is limited to installations using the optional M-3931 HMI (Human-Machine Interface) Module. It includes an introduction to the front panel controls, the function and operation of all buttons, characteristics of the display, Targets and Indicators (optional M-3930 Target Module), and the communication ports. It further describes the procedures to input all required data. Included in this chapter is a description of monitoring function status, metering quantities and viewing of target history.

Chapter 4: Operation (Computer)

This chapter is designed for the person or group responsible for the operation and direct setting and configuration of the relay via personal computer, using the IPScom® M-3800A Communications Software package. It includes installation and setup information, procedures necessary to input all required data, and a description of monitoring function status and metering quantities.

Chapter 5: Installation

This chapter contains all the mechanical information required for physical installation, mounting dimensions, equipment ratings, and all external connections. A commissioning checkout procedure is outlined using the HMI option to check the external CT and VT connections. Additional tests which may be desirable at the time of installation are described in Chapter 6, **Testing**.

Chapter 6: Testing

This chapter provides step-by-step test procedures for each function, as well as diagnostic mode procedures and auto-calibration procedure for HMI users.

Appendix A – Configuration Record Forms

This Appendix supplies a set of forms to record and document the data required for proper relay operation.

Appendix B – Communications

This Appendix describes the communications equipment, the protocol used, communication ports, and port signals.

Appendix C - Self-Test Error Codes

This Appendix lists all error codes and their definitions.

Appendix D – Inverse Time Curves

This Appendix contains graphs of the four families of Inverse Time Curves for V/Hz applications.

1.2   M-3430 Generator Protection Relay

M-3430 Generator Protection Relay is a microprocessor-based unit that uses digital signal processing technology to provide fifteen protective relaying functions (see Table 1-1) for generator protection. The relay protects a generator from abnormal voltage and frequency, internal winding faults, system faults, inadvertent energizing, negative sequence current overheating, reverse power, loss-of-field, and overexcitation (V/Hz) disturbances, while also providing loss-of-VT-fuse detection, and breaker failure/flashover protection.

Six input contacts can be programmed to block any relay function and/or to trigger the oscillograph recorder. Any of the functions or the input contacts can be individually programmed to activate any one or more of the eight programmable output contacts.

The internal functions of the relay are listed in Table 1-1. The nomenclature follows the standards of ANSI/IEEE Std. C37.2-1991, Standard Electric Power Systems Device Function Numbers.

FUNCTION	DESCRIPTION
21	Phase Distance (Mho characteristic)
24	Volts/Hz (inverse time and definite time)
27	RMS Undervoltage, 3-Phase
27TN	Third-Harmonic Undervoltage, Neutral Circuit
32	Directional Power, 3-Phase
40	Loss of Field (two-element offset mho)
46	Negative Sequence Overcurrent
50 / 27	Inadvertent Energizing
50BF / 50N	Breaker Failure - Breaker Flashover
59	RMS Overvoltage, 3-phase
59N	RMS Overvoltage, Neutral Circuit or Zero Sequence
60FL	VT Fuse Loss
81	Frequency
87	Phase Differential
External	Outputs triggered by input combination

Table 1-1   Internal Relay Functions

With the optional M-3931 HMI (Human-Machine Interface) Module, the relay will allow local metering of various quantities, including phase, neutral, and sequence voltages and currents, real and reactive power, power factor, and impedance measurements.

The relay provides time-tagged target information for the thirty-two most recent events, as well as self-test, self-calibration and diagnostic capabilities.

With the HMI option, all functions can be set or examined via a local, menu-driven, 2 line by 24-character alphanumeric display.

The function outputs can provide tripping and/or alarm contacts. LEDs (Light Emitting Diodes) are used for the targets to provide visual indication of a function operation. If chosen, the local user interface is provided by front-panel push-buttons and an alphanumeric display. Three serial I/O ports provide remote communication capability.

A switching mode power supply provides the relay with the various power supply voltages required for operation. A redundant power supply is available as an option.

The serial interface ports, COM1 and COM2, are standard 9-pin RS-232C DTE-configured communications ports. The front-panel port, COM1, is used to locally set and interrogate the relay via a portable computer. The second RS-232C port, COM2, is provided at the rear of the unit. An RS-485 communications port, COM3, is also available at the rear terminal block of the relay. Either rear-panel port, COM2 or COM3, can be used to remotely set and interrogate the relay via modem, network or hard-wired serial connection. Detailed information on the use of the relay communications ports is provided in Appendix B, **Communications**, as well as Chapter 4, **Operation (Computer)**.

The unit provides up to 170 cycles of waveform data storage assignable to up to four events with selectable post-trigger delay. Once downloaded, the data can be analyzed using the optional M-3801A IPSplot® Oscillogram Analysis Software package.

M-3800A IPScom® Communications Software

IPScom Communications Software runs on an PC-compatible computer running under Windows® 3.1 or higher, providing remote access to the M-3430 via either direct serial connection or modem. IPScom provides the following communication functions:

- Setpoint interrogation and modification
- Line status real-time monitoring
- Recorded oscillograph data downloading

IPScom also provides remote access to several other Beckwith Electric Integrated Protection Systems.

1.3 Accessories

M-3930 Target Module

The optional target module includes 24 individually labelled **TARGET** LEDs to disaply the operation of relay functions on the front panel. Eight individually labelled **OUTPUT** LEDs will be lit as long as any output contact is picked up.

TARGETS		

OUTPUTS

| OUT 1 ○ | OUT 3 ○ | OUT 5 ○ | OUT 7 ○ |
| OUT 2 ○ | OUT 4 ○ | OUT 6 ○ | OUT 8 ○ |
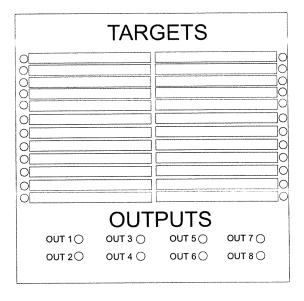
Figure 1-1   M-3930 Target Module

M-3931 HMI (Human-Machine Interface)

The optional HMI module provides the means to interrogate the M-3430 and to input settings, access data, etc. directly from the front of the M-3430 Generator Protection Relay. Figure 1-2 shows the HMI module. HMI operation is described in detail in Section 3.1, Front Panel Controls.
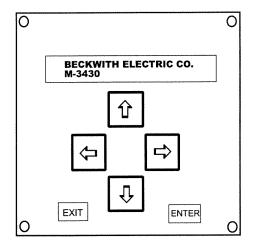

Figure 1-2   M-3931 Human-Machine Interface

M-3801A IPSplot® Oscillograph Analysis Software Package

The IPSplot Oscillograph Analysis Software runs in conjunction with IPScom® software package on any IBM PC-compatible computer, enabling the plotting and printing of waveform data downloaded from the relay.

M-3933 / M-0423 Serial Communications Cable

The M-3933 cable is a 10-foot RS-232 cable for use between the relay's rear-panel (COM2) port and a modem. This cable has a DB25 (25-pin) connector (modem) and a DB9 (9-pin) connector at the relay end.

The M-0423 cable is a 10-foot null-modem RS-232 cable for direct connection between a PC and the relay's front-panel COM1 port or the rear COM2 port. This cable has a DB9 (9-pin) connector at each end.

M-3934 Redundant Low Voltage (24-48 V DC) **Power Supply** or **M-3935 Redundant High Voltage** (110–250 V DC) **Power Supply** is also available.

2 Application

2.1 Introduction

This chapter is designed for the person or group responsible for the application of the M-3430 Generator Protection Relay. This relay is applicable to any high-impedance grounded generator application. Individual relay functions can be programmed to activate any combination of eight output contacts (OUT1–OUT8). Similarly, any relay function can be programmed to be blocked by any of six status inputs (IN1–IN6) or the fuse loss function operation. The relay provides programmable setpoints for each relay function. Most relay functions provide two or more setpoints, each with a magnitude setting and associated time delay.

The chapter is designed to assist in the completion of all relay function designations and usage, assigning output contact usage, relay blocking functions, communication and setup configuration, and the calculation and communication of all necessary setpoints.

This chapter also specifies appropriate forms for recording and communicating these input settings to the parties responsible for operation and installation of the relay.

2.2 System Diagrams
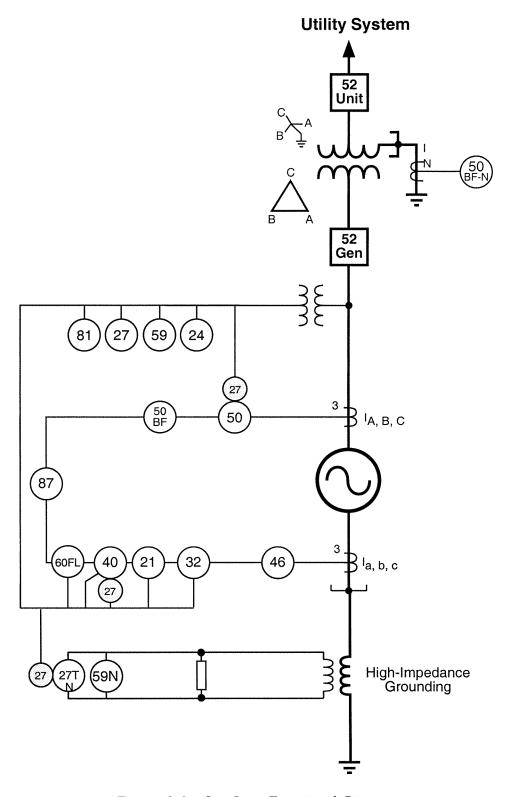
Figure 2-1   One-Line Functional Diagram

① Alternate VT connections
② Required generator breaker status input (52b).
   Contact is closed when generator breaker is open.
   Use unit breaker contact if no generator breaker present.
③ Output contact pairs designated by user.
④ Alarm output can be grouped to a single alarm at
   discretion of user.
⑤ Available control output to supervise other relays
   for VT Fuse Loss can be designated.
⑥ Input contact number is designated by user.

● **WARNING: ONLY dry contacts must be connected**
because these contact inputs are internally wetted.
Application of external voltage on these inputs may result
in damage to the units.

■ **NOTE:** M-3430 current terminal polarity marks (•) indicate
"entering" current direction when primary current is "from"
the generator. If CT connections differ from those shown,
adjust input terminals.

Example of Control / Output Connections

Figure 2-2   Three-Line Connection Diagram

2.3 Configuration

Functions

Configuration of the M-3430 Generator Protection Relay consists of enabling the relay functions to be used in a particular application, designating the output contacts each function will operate, and which status inputs will block the function. The choices include eight programmable output contacts (OUT1–OUT8) and six status inputs (IN1–IN6) plus a block choice for fuse loss logic operation (see Section 2.4, 60FL Fuse Loss for details). Status input IN1 is preassigned to be the 52b breaker(s) status contact. (If a multiple breaker scheme is used, the input IN1 is a series combination of the "52b" contacts.) Additional status inputs (user-chosen) may initiate actions such as Breaker Failure Initiate, Trigger Oscillograph Recorder or Fuse Loss. The status inputs and output contacts should be chosen *before* configuring individual functions. Both can be recorded on the Relay Configuration Table in Appendix A. Outputs 1–6 are form "a" contacts (normally open) and outputs 7 and 8 are form "c" contacts (center tapped "a" and "b" contacts). Output contacts 1–4 contain special circuitry for high-speed operation and pick up about 4 msec faster than contacts 5–8.

The following functions require enable/disable, output, and status input blocking designations:

- 21 Phase Distance #1, #2 ✛
- 24 Volts/Hz: Def Time #1, #2, InvTime
- 27 RMS Undervoltage, 3-Phase #1, #2
- 27TN 3rd Harmonic Undervoltage #1, #2
- 32 Directional Power, 3-Phase #1, #2 ✛
- 40 Loss of Field #1, #2 ✛
- 46 Negative Sequence Overcurrent: Def Time, Inv Time
- 50/27 Inadvertent Energization
- 50BF/50N Breaker Failure
- 59 RMS Overvoltage, 3-Phase #1, #2
- 59N RMS Overvoltage, Neutral #1, #2
- 60FL Fuse Loss
- 81 Frequency #1, #2, #3, #4
- 87 Phase Differential
- External #1, #2

✛ FL (fuse loss) blocking is suggested for these functions where the loss of a fuse may cause mis-operation.

■ **NOTE:** Up to two external functions which perform similarly to internal relay functions can be specified. These external functions will be enabled or disabled, output contacts chosen, and blocking inputs chosen in the configure menu as for the internal functions. The external functions are described in further detail in Section 2.3, External Functions.

```
┌─────────────────────────┐
│ 60FL VT FUSE LOSS       │
│ disable   ENABLE        │
└─────────────────────────┘
```

This designation is required for each relay function. Any disabled function will not accept further output or status input block instructions or settings.

```
┌─────────────────────────┐
│ 60FL BLOCK INPUT        │
│ fl i6 i5 i4 i3 i2 i1    │
└─────────────────────────┘
```

This assigns the blocking of any function with individual "activated" status inputs (up to six) (IN1 = 52b contact). "fl" input for blocking (when designated) is generated internally through the fuse loss logic.

```
┌─────────────────────────┐
│ 60FL RELAY OUTPUT       │
│ o8 o7 o6 o5 o4 o3 o2 o1 │
└─────────────────────────┘
```

This assigns the operation of individual output contacts (up to eight) for the particular relay function. If no output contacts are assigned, the function will be automatically disabled.

System Setup

The system setup consists of defining, for the relay, all pertinent information regarding the system quantities being input. Regardless of the functions enabled or disabled, all of the information shown is required. CT and VT ratios are used only by the IPScom® software program in monitoring and displaying system primary quantities. The screens shown below illustrate operation with the optional M-3931 Human-Machine Interface (HMI) module, and may be accessed by selecting **SETUP RELAY** under the **CONFIGURE RELAYS** menu.

■ **NOTE:** The relay is designed for 50 or 60 Hz operation and for ABC or ACB phase rotation systems. It has been preset at the factory as ordered. These values can be modified with appropriate information and assistance from the factory.

```
NOMINAL VOLTAGE
_____ VOLTS
```

The secondary VT voltage when primary voltage is equal to the rated *generator* voltage. (**V** gen rated ÷ VT ratio) Range = 60–140 V; Increment = 1 V.

```
NOMINAL CURRENT
_____ AMPS
```

The secondary CT current of the phase CTs with rated *generator* current. (**I** gen rated ÷ CT ratio) Range (for both 1 Amp and 5 Amp rated CT's)= 0.50–6.00 A, Increment = 0.01 A.

```
VT. CONFIGURATION
line_line   line_ground→
← line_gnd_to_line_line
```

Indicates VT connection. VT may be configured as line-line, line-ground, or line-ground-to-line-line. Line-Ground-to-Line-Line should be selected only for a VT nominal secondary voltage of 69V (not for 120V). Nominal voltage entered should be line-line nominal voltage, which is √3 times line-ground nominal voltage.

```
59/27 MAGNITUDE SELECT
rms dft
```

When RMS is selected, the magnitude calculation is accurate over a wide frequency range (10 to 90 Hz), and accuracy of the time delay is +20 cycles. When DFT is selected, the magnitude calculation is accurate near 50 or 60 Hz, and timer accuracy is ±30 cycles. RMS is recommended for generator application.

```
DELTA-Y TRANSFORM
disable enable
```

Indicates Generator side Delta/system side Wye step-up transformer connection-used in calculations for 21 Phase Distance backup protection.

```
RELAY SEAL-IN TIME
_____ CYCLES
```

Minimum time for output contact to stay closed to assure proper operation. Range = 2–8160 cycles; Increment = 1.0 cycles

```
ACTIVE INPUT OPEN/close
I6 i5 i4 i3 i2 i1
```

This designates the "active" state for the individual status input. Programming uppercase (see I6) causes the "active" or "operated" condition to be initiated by external contact opening. Otherwise, external contact closure will "activate" the input.

VT PHASE RATIO
_____ : 1

Ratio of the phase VTs. Maximum = 6550.0; Increment = 0.1

VT NEUTRAL RATIO
_____ : 1

Ratio of neutral VT Maximum = 6550.0; Increment = 0.1

CT PHASE RATIO
_____ : 1

Ratio of phase CTs Maximum = 65500; Increment = 1.0

CT NEUTRAL RATIO
_____ : 1

Ratio of neutral CT Maximum = 65500; Increment = 1.0

2.4   Setpoints and Time Settings

The protective functions and their magnitude setting and timing settings are described individually on the following pages:

21 Phase Distance

The phase distance function, designed for system phase fault backup protection, is implemented as a two-zone mho characteristic. Three separate distance elements are implemented to detect AB, BC, and CA fault types. The ranges, increments, and accuracy are shown in Table 2-1. The diameter, offset, system impedance angle (relay characteristic angle), and definite time delay need to be selected for each zone for coordination with the system relaying in the specific application.

When the generator is connected to the system through a delta/wye transformer, proper voltages and currents (equivalent to the high side of the transformer) must be used in order for the relay to see correct impedances for system faults. By enabling the delta/wye transform feature (see Section 2.3, System Setup), the relay can internally consider the 30° phase shift through the delta-wye unit transformer, saving auxiliary VT's. The minimum current sensitivity depends on the reach (diameter and offset) setting. If the current is below the minimum sensitivity current, the impedance displayed is not accurate and should be ignored. This will not cause any relay protection mis-operation.

FUNCTION	SETPOINT RANGE	INCREMENT	ACCURACY
Phase Distance, mho characteristic (21)			
Circle Diameter #1, #2	0.1 to 100.0 Ω (0.5 to 500.0 Ω)	0.1 Ω	±0.1 Ω or 5% (±0.5 Ω or 5%)
Offset #1, #2	-100.0 to 100.0 Ω (-500.0 to 500.0 Ω)	0.1 Ω	±0.1 Ω or 5% (±0.5 Ω or 5%)
Impedance Angle #1, #2	0° to 90°	1°	±1°
Time Delay #1, #2	1 to 8160 cycles	1 cycle	-1 to +3 cycles or ±1%
Values in parentheses apply to 1 Amp CT secondary rating			

Table 2-1   Phase Distance (21) Setpoint Ranges
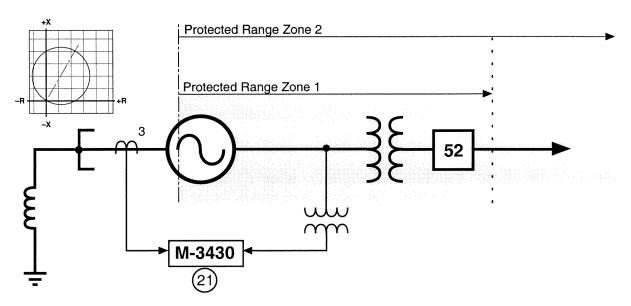
Figure 2-3   Phase Distance (21) Coverage—Neutral-Side CTs
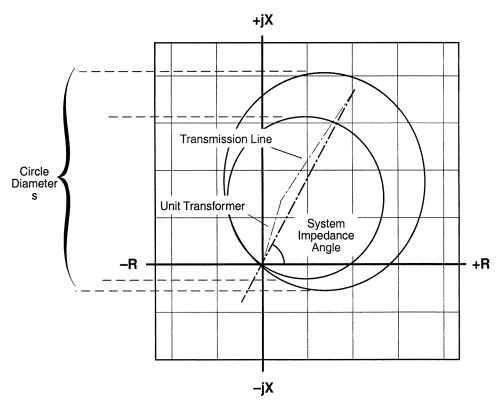
Figure 2-4   Phase Distance (21) Function Applied for System Backup

	Direct-Connected		Delta/Wye Transformer Connected	
	VT Connection		VT Connection	
	L-L or L-G to L-L	**L-G**	**L-L or L-G to L-L**	**L-G**
AB Fault	$\dfrac{V_{AB}}{I_a-I_b}$	$\dfrac{V_A-V_B}{I_a-I_b}$	$\dfrac{V_{BC}-V_{AB}}{(3)I_b}$	$\dfrac{V_B-V_0}{I_b}$
BC Fault	$\dfrac{V_{BC}}{I_b-I_c}$	$\dfrac{V_B-V_C}{I_b-I_c}$	$\dfrac{V_{CA}-V_{BC}}{(3)I_c}$	$\dfrac{V_C-V_0}{I_c}$
CA Fault	$\dfrac{V_{CA}}{I_c-I_a}$	$\dfrac{V_C-V_A}{I_c-I_a}$	$\dfrac{V_{AB}-V_{CA}}{(3)I_a}$	$\dfrac{V_A-V_0}{I_a}$

Table 2-2   CT / VT Scaling

All primary impedances (Z_{PRI}) must be reflected to relay quantities (Z_{SEC}). The primary ohms (Z_{PRI}) on the generator base needs to be multiplied by the ratio of the current transformer ratio (R_C) to the voltage transformer ratio (R_V).

$$Z_{SEC} = Z_{PRI} \times (R_C \div R_V)$$

21 #1 DIAMETER
_____ Ohms

Typically the first zone of protection is set to an impedance value enough in excess of the first external protective section (typically the unit transformer) to assure operation for faults within that protective zone. (See Figure 2-4.) The second #21 zone settings can be set for the second external section of protection on the system (typically transmission Zone 1 distance relays) plus adequate overreach.

21 #1 OFFSET
_____ Ohms

A negative or positive offset can be specified to offset the mho circle from the origin. This offset is usually set at zero.

21 #1 IMPEDANCE ANGLE
_____ Degrees

The impedance angle should be set as closely as possible to the actual impedance angle of the zone being protected.

21 #1 DELAY
_____ Cycles

The time delays are set to coordinate with the primary protection of those overreached zones and, when applicable, with the breaker failure schemes associated with those protective zones.

21 #2 DIAMETER
_____ Ohms

21 #2 OFFSET
_____ Ohms

21 #2 IMPEDANCE ANGLE
_____ Degrees

21 #2 DELAY
_____ Cycles

24 Volts/Hz

The volts-per-hertz function (24) provides overexcitation protection for the generator and unit-connected transformers. This function provides two definite operating time setpoints, four families of inverse time curves widely used in the industry (see Appendix D, **Inverse Time Curves**), and a linear reset rate programmable to match specific machine cooling characteristics. The V/Hz function provides reliable measurement of V/Hz for a frequency range of 2–80 Hz.

The first task in setting this relay function is to determine the desired protective levels and times. This can be accomplished by combining the generator and the associated unit transformer V/Hz limit curves on one graph and simplifying the result into one curve to coordinate with the protection. The curves must be on the same voltage base to be combined on one graph.

An example is shown in Figure 2-5. The manufacturer of the generator and transformer will provide these overexcitation capability limits.

Depending on these characteristics, they can best be matched by one of the four families of inverse time curves, alone or in conjunction with definite time setpoints. Coordination of capabilities and protection is achieved when the time between the relay operation and the capability limit is sufficient for the breakers to open and de-energize the units. This coordination time is read vertically *between* the two curves at any given V/Hz value.

Figure 2-5, Example of Capability and Protection Curves, illustrates a composite graph of generator limits, transformer limits, a chosen inverse time curve, inverse time pickup, and definite time setpoint.

FUNCTION	SETPOINT RANGE	INCREMENT	ACCURACY
Volts/Hz (24)			
Definite Time			
Pickup #1, #2	100% to 200%	1%	± 1%
Time Delay #1*, #2	30 to 8160 cycles	1 cycle	+ 25 cycles
Inverse Time			
Characteristic Curves	Inverse Time #1 – #4		
Pickup	100% – 200%	1%	± 1%
Time Dial: Curve Curve #1	1 to 100 0 to 9	1 0.1	
Reset Rate	1 to 999 sec. (from threshold of trip)	1 sec.	± 3 cycles or 1%
Percent pickup is based on nominal VT secondary voltage and nominal system frequency settings. * *Must be less than the operating time of the inverse time element.*			

Table 2-3   Volts/Hertz (24) Setpoint Ranges
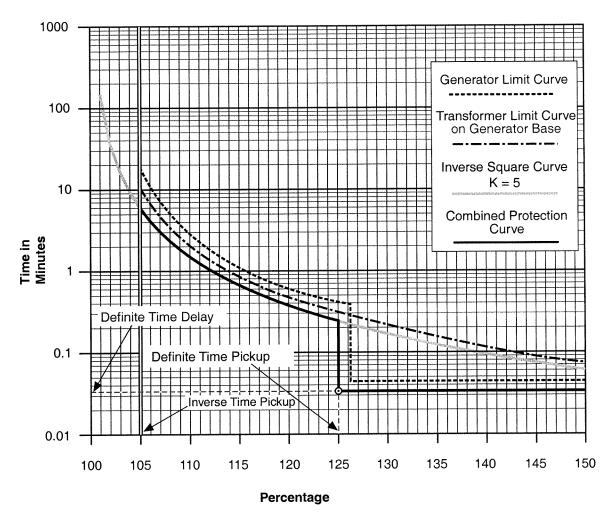
Figure 2-5   Example of Capability and Protection Curves (24)

```
┌─────────────────────────────────┐
│ 24DT #1 PICKUP                  │
│ _____ %                     │
└─────────────────────────────────┘
```

```
┌─────────────────────────────────┐
│ 24DT #1 DELAY                   │
│ _____ Cycles                │
└─────────────────────────────────┘
```

```
┌─────────────────────────────────┐
│ 24DT #2 PICKUP                  │
│ _____ %                     │
└─────────────────────────────────┘
```

```
┌─────────────────────────────────┐
│ 24DT #2 DELAY                   │
│ _____ Cycles                │
└─────────────────────────────────┘
```

```
┌─────────────────────────────────┐
│ 24IT  PICKUP                    │
│ _____ %                     │
└─────────────────────────────────┘
```

```
┌─────────────────────────────────┐
│ 24IT CURVE                      │
│ crv#1 crv#2 crv#3 crv#4         │
└─────────────────────────────────┘
```

```
┌─────────────────────────────────┐
│ 24IT TIME DIAL                  │
│ _____                       │
└─────────────────────────────────┘
```

```
┌─────────────────────────────────┐
│ 24IT RESET RATE                 │
│ _____ Seconds               │
└─────────────────────────────────┘
```

Definite time setpoint #1 establishes the V/Hz level above which the protection operating time will be fixed at the definite time delay #1. (See Figure 2-5.) 100% is equal to nominal voltage at nominal frequency (50/60Hz). See Section 2.3, System Setup.

Delay time setpoint #1 establishes the operation time of the protection for all V/Hz values above the level set by definite time setpoint #1. ■ **NOTE:** Delay time #1 must be less than the operating time of the selected inverse curve at the definite time setpoint #1 V/Hz level.

Definite time setpoint #2 could be programmed to alarm, alerting the operator to take proper control action to possibly avoid tripping (may be used to trip).

Time to operation at any V/Hz value exceeding definite time setting #2.

As shown in Figure 2-5, the pickup value is the V/Hz value (in %) that the chosen inverse curve begins protective operation. Typical value is 105%.

The appropriate curve *family* for this protection application may be selected here. These curves are shown in Appendix D, **Inverse Time Curves**. Note that the operating times are constant above 150% V/Hz values.

The appropriate *curve* in the family is designated by the associated "K" value of the curve. These are shown in Appendix D. If 24DT #1 is enabled, the operating time set here must be greater than the 24DT delay.

After any V/Hz excursion, cooling time must also be taken into account. If the unit should again be subjected to high V/Hz before it has cooled to normal operating levels, damage could be caused before the V/Hz trip point is reached. For this reason, a linear reset characteristic, adjustable to take into account the cooling rate of the unit, is provided. If a subsequent V/Hz excursion occurs before the reset characteristic has timed out, the time delay will pick up from the equivalent point (as a %) on the curve. The value entered here should be the time needed for the unit to cool to normal operating temperature if the V/Hz excursion time was just under the trip time.

27 RMS Undervoltage, 3-Phase

The 27 Undervoltage function may be used to detect any condition causing long-term generator undervoltage.

FUNCTION	SETPOINT RANGE	INCREMENT	ACCURACY
RMS Undervoltage (27)			
Pickup #1, #2	5 to 200 V	1 V	± 0.5 V or ± 0.5%
Time Delay #1, #2	1 to 8160 cycles	1 cycle	+20 cycles or ± 1%
When RMS (total waveform) is selected, timing accuracy is +20 cycles or ± 1%. *When DFT (fundamental rms) is selected, timing accuracy is -1 to +3 cycles or ± 1%.*			

Table 2-4   RMS Undervoltage, 3-Phase (27) Setpoint Range

```
27 # 1 PICKUP
_____ Volts
```

```
27 # 1  DELAY
_____ Cycles
```

```
27 # 2 PICKUP
_____ Volts
```

```
27 # 2  DELAY
_____ Cycles
```

Relay volts are equal to the primary bus voltage divided by the VT ratio.

27TN Third Harmonic Undervoltage, Neutral Circuit

For ground faults near the stator neutral, the third-harmonic (180/150 Hz) neutral undervoltage function (27TN) provides stator ground-fault protection for high-impedance-grounded generator applications. When used in conjunction with the fundamental neutral overvoltage (60/50Hz) function (59N), 100% stator ground-fault protection can be provided. This is illustrated in Figure 2-6. At the choice of the user, the 27TN function is supervised by the positive-sequence phase-undervoltage element (function 27) or forward power flow (function 32) or both to prevent tripping when the generator field is not energized or the unit is not yet synchronized.

The 27TN setting depends on the actual third-harmonic neutral voltage level seen during normal operation of the generator. The setting should be about 50% of the minimum third harmonic voltage observed during various loading conditions. This can be most conveniently measured during commissioning of the relay. Since the relay measures the 3rd harmonic voltage levels and will display those values directly, no additional equipment is required. The undervoltage inhibit setting should be about 80% to 90% of the nominal voltage.

FUNCTION	SETPOINT RANGE	INCREMENT	ACCURACY
Third-Harmonic Undervoltage, Neutral (27TN)			
Pickup #1, #2	0.3 to 20.0 V	0.1 V	±0.5 V
Time Delay #1, #2	1 to 8160 cycles	1 cycle	-1 to +3 cycles or ±1%
Undervoltage Inhibit (positive sequence)	5 to 200 V	1 V	±0.5 V or ±0.5%
Underpower Inhibit	0.002 to 3.000 pu	0.001 pu	±0.002 pu or ±2%

Table 2-5   Third-Harmonic Undervoltage, Neutral Circuit (27TN) Setpoint Ranges
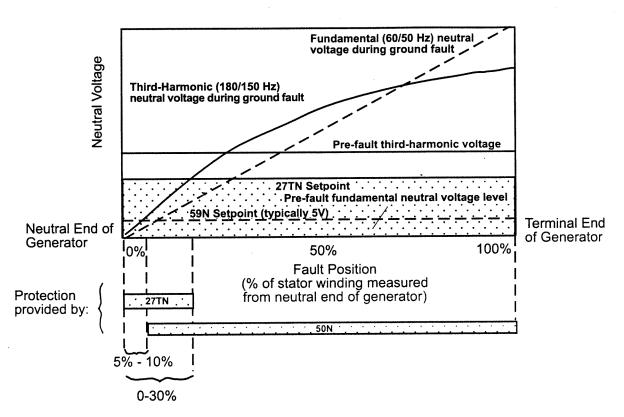
Figure 2-6   Third Harmonic Undervoltage (27TN) Protection Characteristics

```
┌─────────────────────────────┐
│ 27TN #1 PICKUP              │
│                             │
│ _____ Volts             │
└─────────────────────────────┘
```

Relay volts are equal to the primary neutral voltage divided by the grounding transformer ratio. Generally set for approximately 50% of the minimum third harmonic voltage observed during various loading conditions.

```
┌─────────────────────────────┐
│ 27TN #1 DELAY              │
│                             │
│ _____ Cycles            │
└─────────────────────────────┘
```

```
┌─────────────────────────────┐
│ 27TN #2 PICKUP             │
│                             │
│ _____ Volts             │
└─────────────────────────────┘
```

```
┌─────────────────────────────┐
│ 27TN #2 DELAY             │
│                             │
│ _____ Cycles            │
└─────────────────────────────┘
```

```
┌─────────────────────────────┐
│ 27TN UNDER VOLT INHIBIT   │
│                             │
│ _____ Volts             │
└─────────────────────────────┘
```

An inhibit voltage setting is *required* if either 27TN #1 or #2 is enabled. Generally set equal to 80–90% of nominal voltage.

```
┌─────────────────────────────┐
│ 27TN UNDER POWER INHIBIT  │
│ disable ENABLE              │
└─────────────────────────────┘
```

In some generation applications it is desirable to supervise the operation of the 27TN with power flow from the generator. In those applications, enable the 27TN Under Power Inhibit and set at the desired per unit power level.

```
┌─────────────────────────────┐
│ 27TN UNDER POWER INHIBIT  │
│ _____ PU                │
└─────────────────────────────┘
```

The per unit value is based on the nominal current and nominal voltage values input to the relay, and may be set from 0.002 to 3.000 pu.

32   Directional Power, 3-Phase

The directional power function can provide both anti-motoring and overload protection. It provides two power setpoints, each with a magnitude setting and a time delay. The Forward Power direction (power flow to system) is automatically chosen when the pickup setting is positive and the Re- verse Power direction (power flow to generator) is automatically chosen when the pickup setting is negative. The range, as shown is from –3.000 pu to 3.000 pu, where 1.0 pu is equal to the generator MW rating corresponding to the nominal voltage and nominal current.

FUNCTION	SETPOINT RANGE	INCREMENT	ACCURACY
Directional Power, 3-Phase (32)			
Pickup #1, #2	-3.000 to +3.000 pu	0.001 p.u.	±0.002 pu or ±2%
Time Delay #1, #2	1 to 8160 cycles	1 cycle	+16 cycles or ±1%
The per-unit pickup is based on nominal VT secondary voltage and nominal CT secondary current settings.			

Table 2-6   Directional Power, 3-Phase (32) Setpoint Ranges

```
32 #1 PICKUP
_____ PU
```

```
32 #1 DELAY
_____ Cycles
```

```
32 #2 PICKUP
_____ PU
```

```
32 #2 DELAY
_____ Cycles
```

The reverse power pickup setting should be based on the type of prime mover and the losses when the generator is motoring. The settings range from –3.000 pu to 3.000 pu on the generator rated base. (The calculated pu power flow level is based on the Nominal Voltage and Nominal Current setting inputs). Reverse power relays should always be applied with a time delay in order to prevent mis- operation during power swing conditions. Typical time delay settings are 20 to 30 seconds.

If used, forward power settings can be used for overload protection, providing either alarm or tripping or both. The pickup and time delay settings should be based on the capability limit of the generator.

A second reverse power setting can be used for sequential tripping of the generator in which case the associated time delay will be in the range of 2 to 3 seconds.

40 Loss of Field

The loss-of-field function (40) provides protection for a partial or complete loss of field (excitation). A variety of possible settings make the relay very flexible, providing compatibility with existing industry- standard relays.

The loss-of-field function is implemented with two offset mho elements, an undervoltage element (voltage control), and a directional element. The settings for each mho element (diameter, offset, and time delay) are adjusted individually. Voltage control is applied to each mho element individually as desired, but the voltage level setting is common. The common directional unit affects both elements

and is provided to block the relay operation during leading power factor operation or inductive VAr flow into the machine. Its zero sensitivity (torque) line is placed at –13° from the R axis.

The settings of the offset mho elements should be such that the relay detects the loss-of-field condition for any loading while not mis-operating during power swings and fault conditions. Two approaches are widely used in the industry, both of which are supported by the M-3430 Generator Protection Relay. Both approaches require knowledge of the reactances and other parameters of the generator. They are described in Figures 2-7 and 2-8.

FUNCTION	SETPOINT RANGE	INCREMENT	ACCURACY
Loss of Field, offset mho characteristic (40)			
Circle Diameter #1, #2	0.1 to 100.0 Ω (0.5 to 500.0 Ω)	0.1 Ω	±0.1 Ω or 5% (±0.5 Ω or 5%)
Offset #1, #2	-50 to + 50 Ω (-250.0 to 250.0 Ω)	0.1 Ω	±0.1 Ω or 5% (±0.5 Ω or 5%)
Time Delay #1, #2	1 to 8160 cycles	1 cycle	-1 to +3 cycles or ±1%
Voltage Control (positive sequence)	5 to 200 V	1 V	±0.5 V or ±0.5%
Directional Element	Fixed at -13°	--	--
Values in parentheses apply to 1 A CT secondary rating *Voltage control for each zone can be individually enabled.*			

Table 2-7 Loss-of-Field (40) Setpoint Ranges
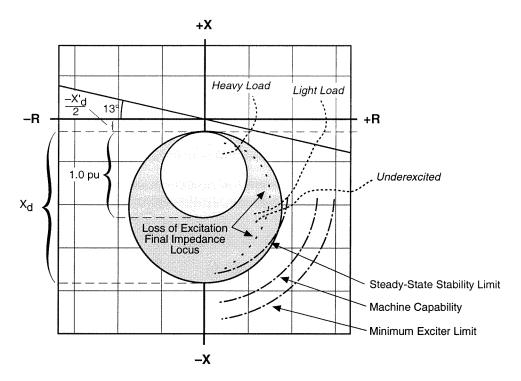
Figure 2-7 Loss-of-Field (40)—Protective Approach 1
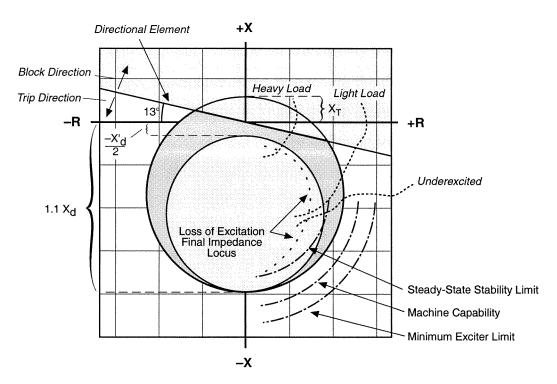
Figure 2-8 Loss-of-Field (40)—Protective Approach 2

```
┌─────────────────────────────┐
│ 40 #1  DIAMETER             │
│ _____ Ohms            │
└─────────────────────────────┘

┌─────────────────────────────┐
│ 40 #1  OFFSET               │
│ _____ Ohms            │
└─────────────────────────────┘

┌─────────────────────────────┐
│ 40#1 VOLTAGE CONTROL        │
│ disable enable              │
└─────────────────────────────┘

┌─────────────────────────────┐
│ 40 #1  DELAY                │
│ _____ Cycles          │
└─────────────────────────────┘

┌─────────────────────────────┐
│ 40 #2  DIAMETER             │
│ _____ Ohms            │
└─────────────────────────────┘

┌─────────────────────────────┐
│ 40 #2  OFFSET               │
│ _____ Ohms            │
└─────────────────────────────┘

┌─────────────────────────────┐
│ 40#2 VOLTAGE CONTROL        │
│ disable enable              │
└─────────────────────────────┘

┌─────────────────────────────┐
│ 40 #2  DELAY                │
│ _____ Cycles          │
└─────────────────────────────┘

┌─────────────────────────────┐
│ 40  VOLTAGE CONTROL         │
│ _____ Volts           │
└─────────────────────────────┘
```

The first approach is shown in Figure 2-7. Here, both of the offset mho elements (#1 and #2) are set with an offset of $-X'_d \div 2$, where X'_d is the direct axis transient reactance of the generator. The diameter of the smaller circle (#1) is set at 1.0 pu impedance on the machine base. This mho element detects loss-of-field from full load to about 30% load. A small time delay (5 to 10 cycles) provides fast protection.

The diameter of the larger circle (#2) is set equal to X_d, where X_d is the direct axis synchronous reactance of the machine. This mho element can detect a loss-of-field condition from almost no load to full load. A time delay of 30 to 60 cycles (#2) should be used in order to prevent possible incorrect operation on stable swings.

■ **NOTE:** Either circle characteristic may be #1 or #2.

The second approach is shown in Figure 2-8. In this approach, one of the mho elements is set with an offset of $-X'_d \div 2$, a diameter of $1.1X_d - (X'_d \div 2)$, and a time delay of 10 to 30 cycles. The second element is set to coordinate with the generator minimum excitation limit and steady-state stability limit.

In order to obtain proper coordination, the offset of this element must be adjusted to be positive. Typically, the offset is set equal to the unit transformer reactance (X_T). The diameter is approximately equal to ($1.1\,X_d + X_T$). A time delay of 30 to 60 cycles would prevent mis-operation on stable swings.

Although the voltage control is common to both zones, either one can be enabled or disabled and is typically set at 80% to 90% of the nominal voltage. The voltage control should be applied after careful study of the system since, depending on the stiffness of the system, the voltage may not be reduced enough to operate the under-voltage element during loss-of-field conditions.

*All primary impedances must be reflected to relay quantities (Z_{SEC}). The primary ohms on the generator base (Z_{PRI}) needs to be multiplied by the **ratio** of the current transformer ratio (R_c) to the voltage transformer ratio (R_v).*

$$Z_{SEC} = [Z_{PRI} \times (R_c \div R_v)]$$

46 Negative Sequence Overcurrent

The Negative Sequence Overcurrent function provides protection against possible rotor overheating and damage due to unbalanced faults or other system conditions which can cause unbalanced three-phase currents in the generator. This function has two separate assignable output contact sets. One output contact set is associated with a definite time pickup value and a definite operating time. These are normally associated with an alarm function. The inverse time operation contact set is usually associated with a trip function and has a detection level and an operating time defined by an $(I_2)^2 t = K$ Time Dial Setting.

The minimum delay for this function is factory set at 12 cycles to avoid nuisance tripping. A maximum time to trip can be set to reduce the operating events for modest imbalances. An important feature that helps protect the generator from damage due to recurring imbalances is a linear reset characteristic: when I_2 decreases below the pickup value, the trip timer takes four minutes to reset from its 100% trip level. Figure 2-9 illustrates the inverse time characteristic of the negative sequence overcurrent function.

The first task of setting this function is to determine the capabilities of the associated machine. As established by ANSI standards, the machine limits are expressed as $(I_2)^2 t = K$. The value of K is established by the machine design and is generally provided on test sheets on the machine. The relay can accommodate any generator size because of the wide range of K settings from 1 to 95. Typical values can be found in ANSI C50.13-1977.

The negative sequence pickup range is from 3% to 100% of the nominal current value input during system setup (see Section 2.3).

This protection must *not* operate for system faults that will be cleared by system relaying. This requires consideration of line protection, bus differential and breaker failure backup protections.

FUNCTION	SETPOINT RANGE	INCREMENT	ACCURACY
Negative Sequence Overcurrent (46)			
Definite Time			
Pickup	3 to 100%	1%	±0.5% of 5 A (±0.5% of 1 A)
Time Delay	1 to 8160 cycles	1 cycle	-1 to +3 cycles or ±1%
Inverse Time			
Pickup	3 to 100%	1%	±0.5% of 5 A (±0.5% of 1 A)
Time Dial Setting	1 to 95	1	±3%
Definite Maximum Time to Trip	600 to 65,500 cycles	1 cycle	-1 to +3 cycles or ±1%
Reset Time (Linear)	4 minutes (from threshold of trip)		
Values in parentheses apply to 1 A CT secondary rating. *Pickup is based on the nominal CT secondary current.*			

Table 2-8   Negative Sequence Overcurrent (46) Setpoint Ranges
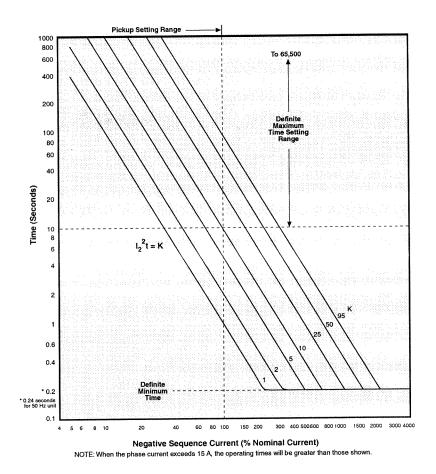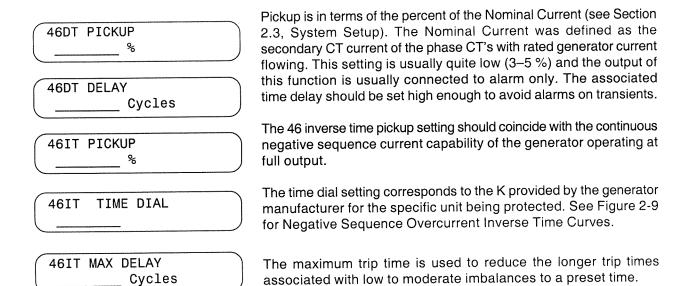
Figure 2-9   Negative Sequence Overcurrent Inverse Time Curves

Pickup is in terms of the percent of the Nominal Current (see Section 2.3, System Setup). The Nominal Current was defined as the secondary CT current of the phase CT's with rated generator current flowing. This setting is usually quite low (3–5 %) and the output of this function is usually connected to alarm only. The associated time delay should be set high enough to avoid alarms on transients.

The 46 inverse time pickup setting should coincide with the continuous negative sequence current capability of the generator operating at full output.

The time dial setting corresponds to the K provided by the generator manufacturer for the specific unit being protected. See Figure 2-9 for Negative Sequence Overcurrent Inverse Time Curves.

The maximum trip time is used to reduce the longer trip times associated with low to moderate imbalances to a preset time.

46DT PICKUP
_____ %

46DT DELAY
_____ Cycles

46IT PICKUP
_____ %

46IT TIME DIAL
_____

46IT MAX DELAY
_____ Cycles

50/27 Inadvertent Energizing

The inadvertent energizing protection function is an overcurrent function supervised by generator terminal bus voltage. Inadvertent or accidental energizing of off-line generators has occurred frequently enough to warrant the use of dedicated protection logic to detect this condition. Operating errors, breaker flashovers, control circuit malfunctions or a combination of these causes have resulted in generators being accidentally energized while off-line. The problem is particularly prevalent on large generators connected through a high voltage disconnect switch to either a ring bus or breaker-and-a-half bus configuration. When a generator is accidentally energized from the power system, it will accelerate like an induction motor. While the machine is accelerating, high currents induced into the rotor can cause significant damage in a matter of seconds. Voltage supervised overcurrent logic is designed to provide this protection (see Figure 2-10).

An undervoltage element (all three phases must be below the pickup) with adjustable pickup and dropout time delay supervise an instantaneous overcurrent tripping. The undervoltage detectors automatically arm the overcurrent tripping when the generator is taken off-line. This undervoltage detector will disable or disarm the overcurrent operation when the machine is put back in service.

FUNCTION	SETPOINT RANGE	INCREMENT	ACCURACY
Inadvertent Energizing (50/27)			
50 Overcurrent			
Pickup	0.50 to 15.00 A (0.10 A to 3.00 A)	0.01 A	± 0.1A or $\pm 2\%$ (± 0.02 A or $\pm 2\%$*)
27 Undervoltage			
Pickup	40 to 130V	1 V	± 0.5V
Pick-up Time Delay	1 to 8160 cycles	1 cycle	-1 to +3 cycles or $\pm 1\%$
Drop-out Time Delay	1 to 8160 cycles	1 cycle	-1 to +3 cycles $\pm 1\%$
Values in parentheses apply to 1 A CT secondary rating			

Table 2-9   Inadvertent Energizing (50/27) Setpoint Ranges
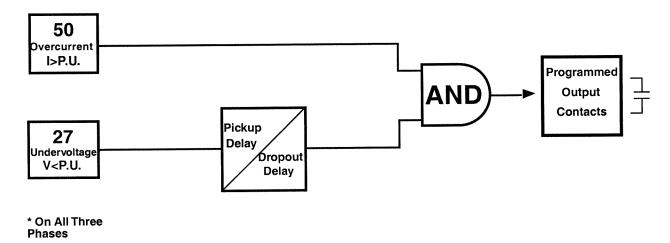
Figure 2-10 Inadvertent Energizing (50/27) Logic Diagram

```
50/27 PICKUP
_____ Amps
```

No coordination is required with other protection since this function is only operational when the generator is off-line. Typical pickup setting is 0.5 amps. (Relay amperes are equal to the primary amperes divided by the CT ratio.)

```
50/27 VOLTAGE CONTROL
_____ Volts
```

The purpose of the undervoltage detector is to determine whether the unit is connected to the system. The voltage level during this accidental energization depends on the system strength. Typical setting is 50%–70% of rated voltage. (Relay volts are equal to primary volts divided by the VT ratio.)

```
50/27 PICKUP DELAY
_____ Cycles
```

The pickup time delay is the time for the unit to operate to *arm* the protection. It must coordinate with other protection for conditions which cause low voltages.

```
50/27 DROPOUT DELAY
_____ Cycles
```

The dropout time delay is the time for the unit to operate to *disarm* the protection when the voltage is increased above the pickup value or the generator is brought on-line.

**50BF Generator Breaker Failure /
HV Breaker Flashover**

The 50BF function actually provides three separate options for operation, all using the same assigned output contacts and status input blocking designated in Section 2.2, **Configuration**. If enabled, the choices of operation are:

50BF-Neutral Element: This instantaneous overcurrent relay is energized from the unit transformer neutral CT. Although it may be used for any desired purpose, this element can provide a contact for use with an existing breaker failure scheme (external to the relay) for the HV unit breaker. This contact, when used in series with a breaker "b" contact, can provide logic for breaker flashover protection.

This operation is chosen by enabling the neutral element, disabling the phase element, and inputting a neutral pickup setting and a one cycle time delay.

50BF-Ph Generator Breaker Failure: When the M-3430 Generator Protection Relay detects an internal fault or an abnormal operating condition, it closes an output contact to trip the generator breaker or the unit HV breaker. When a generator breaker is used, protection is available for the instance where it fails to clear the fault or abnormal condition. Such generator breaker failure protection output contacts must be connected to trip the additional necessary breakers to isolate the generator from the system.

The breaker-failure condition is usually detected by the continued presence of current in any one or more of the phases after a trip has been applied to breaker. However, the current detector (50BF-Ph) may not always give the correct status of the breaker, especially for generator breakers. This is because faults and abnormal operating conditions such as ground faults, overexcitation, over/under frequency, and reverse power may not produce enough current to operate the current detectors. For this reason, the breaker status input 52b contact must be used, in addition to the 50BF-Ph, to provide adequate breaker status indication.

Implementation of the generator breaker failure function is illustrated in Figure 2-11. The breaker failure timer will be started whenever any one of the designated output contacts or the externally programmed breaker failure initiate status input are operated. The timer continues to time if any one of the phase currents are above the 50BF-Ph pickup setting or if the 52b contact indicates the breaker is still closed; otherwise, the timer is reset.

This operation is chosen by disabling the neutral element, enabling the phase element, and inputting a phase pickup setting, initiating inputs and outputs and a time delay setting.

Since current in the generator high side CT which energizes the 50BF protection (I_A, I_B, I_C) might not extinguish concurrently with the breaker opening for faults between the CT location and the generator breaker, a possible area of mis-operation exists. Usually the risk of faults in this limited area is small enough to be ignored but should be considered.

HV Breaker Failure (limited)

The relay's breaker failure function may be used for a unit breaker rather than a generator breaker. It is limited in that it has no fault detector associated with the unit breaker. Output contact operation would occur if any of the initiate contacts close *and* the 52b contact indicated a closed breaker after the set time delay.

This operation is chosen by disabling the neutral element, disabling the phase element, and designating initiating inputs and outputs and a time delay setting.

FUNCTION	SETPOINT RANGE	INCREMENT	ACCURACY
Breaker Failure (50BF)			
Pickup			
Phase Current (50BF-Ph)	0.10 to 10.00 A (0.02 to 2.00 A)	0.01 A	±0.1 A or ±2% (±0.02 A or ±2%)
Neutral Current (50BF-N)	0.10 to 10.00 A (0.02 to 2.00 A)	0.01 A	±0.1 A or ±2% (±0.02 A or ±2%)
Time Delay	1 to 8160 cycles	1 cycle	-1 to +3 cycles or ±1%

Values in parentheses apply to 1 A CT secondary rating.
50BF can be initiated from designated output contacts or status inputs.

Table 2-10   Breaker Failure (50BF) Setpoint Ranges
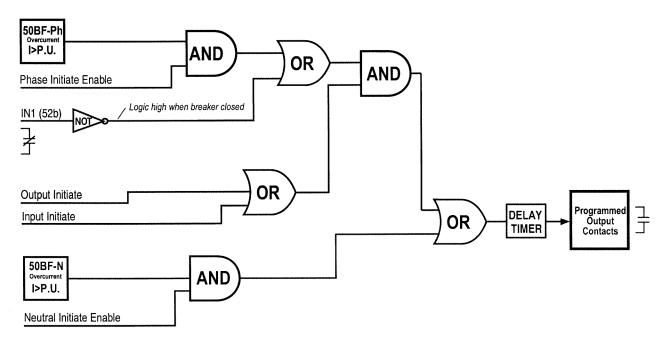
Figure 2-11   Breaker Failure (50BF) Logic Diagram

```
┌─────────────────────────────┐
│  50BF  NEUTRAL  ELEMENT     │
│  enable disable             │
└─────────────────────────────┘
```

If the unit transformer neutral overcurrent element is used in this application, **ENABLE** here, set neutral pickup amps, **DISABLE** the phase element, and set delay time to 1 cycle (no intentional time delay).

```
┌─────────────────────────────┐
│  50BF  NEUTRAL  PICKUP      │
│  _____  Amps             │
└─────────────────────────────┘
```

Relay amps = Primary amps ÷ transformer neutral CT ratio.

```
┌─────────────────────────────┐
│  50BF  PHASE  ELEMENT       │
│  enable disable             │
└─────────────────────────────┘
```

If generator breaker failure function is used in this application, **DISABLE** the neutral element, **ENABLE** here, set phase pickup amps, designate initiating inputs and/or output contacts, and set a time delay.

```
┌─────────────────────────────┐
│  50BF  PHASE  PICKUP        │
│  _____  Amps             │
└─────────────────────────────┘
```

Relay amps = Primary amps ÷ Phase CT ratio.

```
┌─────────────────────────────┐
│  50BF  INPUT  INITIATE      │
│       i6 i5 i4 i3 i2 i1     │
└─────────────────────────────┘
```

Designate the status inputs which will initiate the breaker failure timer (if any).

```
┌─────────────────────────────┐
│  50BF  OUTPUT  INITIATE     │
│  o8 o7 o6 o5 o4 o3 o2 o1    │
└─────────────────────────────┘
```

Designate the outputs that will initiate the breaker failure timer (if any).

```
┌─────────────────────────────┐
│  50BF  DELAY                │
│  _____  Cycles           │
└─────────────────────────────┘
```

For Generator Breaker Failure or HV Breaker Failure use, time delay should be set to allow for breaker operating time plus margin.

For limited HV unit breaker failure protection, **DISABLE** *both* the phase and neutral elements, designate the initiating inputs and/or outputs to initiate the timer, and set a time delay.

59 RMS Overvoltage, 3-Phase

The RMS Overvoltage function is used to provide overvoltage protection for the generator.

The relay provides overvoltage protection functions with two voltage levels and two definite time setpoints, either of which can be programmed to trip the unit or send an alarm.

FUNCTION	SETPOINT RANGE	INCREMENT	ACCURACY
RMS Overvoltage, 3-phase (59)			
Pickup #1, #2	5 to 200 V	1 V	± 0.5 V or ± 0.5%
Time Delay #1, #2	1 to 8160 cycles	1 cycle	+20 cycles or ± 1%
When RMS (total waveform) is selected, timing accuracy is +20 cycles or ±1%. When DFT (fundamental rms) is selected, timing accuracy is -1 to +3 cycles or ±1%.			

```
╭─────────────────────────╮
│  59 #1 PICKUP           │
│  _____ Volts        │
╰─────────────────────────╯

╭─────────────────────────╮
│  59 #1 DELAY            │
│  _____ Cycles       │
╰─────────────────────────╯

╭─────────────────────────╮
│  59 #2 PICKUP           │
│  _____ Volts        │
╰─────────────────────────╯

╭─────────────────────────╮
│  59 #2 DELAY            │
│  _____ Cycles       │
╰─────────────────────────╯
```

Table 2-11   RMS Overvoltage, 3-Phase (59) Setpoint Ranges

This overvoltage function is typically used as an alarm and the trip function is performed by the Volts/Hz relay. Generator capa-

59N   RMS Overvoltage, Neutral Circuit or Zero Sequence

The neutral overvoltage function (59N) provides stator ground-fault protection for high-impedance grounded generators. The 59N function can provide ground fault protection for 90–95% of the stator winding (measured from the terminal end). When used in conjunction with the third-harmonic undervoltage function (27TN), 100% stator ground-fault protection can be provided. (See Section 2.3, 27TN Third-Harmonic Undervoltage, Neutral Circuit, and Figure 2-6.)

The 59N function provides two setpoints. The 59N function responds only to the fundamental frequency component, rejecting all other harmonic components.

FUNCTION	SETPOINT RANGE	INCREMENT	ACCURACY
RMS Overvoltage, Neutral Circuit or Zero Sequence (59N)			
Pickup #1, #2	5.0 to 200.0 V	0.1 V	± 0.5V or ± 0.5%
Time Delay #1, #2	1 to 8160 cycles	1 cycle	-1 to +3 cycles or ± 1%

Table 2-12   RMS Overvoltage, Neutral Circuit or Zero Sequence (59N) Setpoint Ranges

```
59N #1  PICKUP
_____  Volts
```

```
59N #1  DELAY
_____  Cycles
```

```
59N #2  PICKUP
_____  Volts
```

```
59N #2   DELAY
_____  Cycles
```

With typical distribution transformer ratios and a typical minimum setting of 5 volts, this protection is capable of detecting ground faults in about 95% of the generator stator winding from the terminal end.

If grounded-wye to grounded-wye VTs are connected at the machine terminals, the voltage relay must be time coordinated with VT fuses for faults on the transformer secondary winding. If relay time delay for coordination is not acceptable, the coordination problem can be alleviated by grounding one of the secondary phase conductors instead of the secondary neutral. When this technique is used, the coordination problem still exists for ground faults on the secondary neutral. Thus, its usefulness is limited to those applications where the exposure on the secondary neutral to ground faults is small.

Since system ground faults can induce zero sequence voltages at the generator due to transformer capacitance coupling, this relay must coordinate with the system ground fault relaying.

60FL Fuse Loss

Since some functions may inadvertently operate when a VT fuse is blown, provisions are incorporated for both internal and external fuse loss detection. Functions which mis-operate on VT fuse loss such as 40, 21 and 32 can be programmed to disable during a VT fuse-loss condition. The status of the fuses can then be monitored via remote communications or locally if the optional M-3930 Target Module is in service.

For internal detection of a fuse-loss condition, positive and negative sequence quantities are compared. The presence of negative sequence voltage in the absence of negative sequence current is considered to be a fuse loss condition. An additional supervising condition includes a minimum positive sequence voltage to assure VT inputs are being applied to the relay.

A timer, associated with the fuse loss logic, is available. This timer is to assure proper coordination for conditions which may appear as a fuse loss such as secondary VT circuit faults which will be cleared by local low voltage circuit action.

For the specific application where the above logic cannot be considered reliable (such as when current inputs to the relay are not connected, sustained positive sequence current during fault conditions is minimal, or negative sequence currents are not present during fault conditions), provision is made for disabling the 60 Fuse Loss internal logic by not highlighting FL of the 60FL Input Initiate choices. The FL input blocking selection (under **Configure** menu) also should not be highlighted if 60FL blocking is not considered realistic.

Provision is also made to input external status contact(s) of other fuse loss detection protection. These external contacts may be input to any of the input contacts (IN1 to IN6) and programmed to initiate the 60FL function.

FUNCTION	SETPOINT RANGE	INCREMENT	ACCURACY
VT Fuse-Loss Detection, 60FL			
Time Delay	1 to 8160 cycles	1 cycle	-1 to +3 cycles or ± 1%

Table 2-13   Fuse Loss (60FL) Setpoint Ranges

```
┌─────────────────────────────┐
│ 60FL INPUT INITIATE          │
│   FL i6 i5 i4 i3 i2 i1       │
└─────────────────────────────┘

┌─────────────────────────────┐
│ 60FL DELAY                   │
│ _____ Cycles             │
└─────────────────────────────┘
```

The *initiating inputs* are user-designated. The operation of any of the externally-connected contacts (across these relay inputs) will start the associated time delay to the 60FL function operation. Designating FL will initiate this function with the internal logic.

The time delay is to be set to coordinate for conditions which may appear as a fuse loss but will be corrected by other protection (such as a secondary VT circuit fault which will be cleared by local low voltage circuit action).

81 Frequency

The 81 function provides either over frequency or under frequency protection of the generator. It has four independent pickup and time delay settings. The over frequency mode is automatically selected when the frequency setpoint is programmed higher than the base frequency (50 or 60 Hz) and the under frequency mode selected when the setpoint is programmed below the base frequency.

The steam turbine is usually considered to be more restrictive than the generator at reduced frequencies because of possible natural mechanical resonance in the many stages of the turbine blades. If the generator speed is close to the natural frequency of any of the blades, there will be an increase in vibration. Cumulative damage to the blades due to this vibration can lead to cracking of the blade structure.

Typical settings of the 81 function are shown in Figure 2-12. The frequency functions are automatically disabled when the input voltage (positive sequence) is less than about 5 V.

FUNCTION	SETPOINT RANGE	INCREMENT	ACCURACY
Frequency (81)			
Pickup #1, #2, #3, #4	50.00 to 67.00 Hz (40.00 to 57.00 Hz)*	0.01 Hz	± 0.02 Hz
Time Delay #1,#2,#3,#4	2 to 65,500 cycles	1 cycle	-2 to +3 cycles or ± 1%

Pickup accuracy is applied to 60 Hz models at a range of 57 to 63 Hz, and to 50 Hz models at a range of 47 to 53 Hz. Beyond these ranges, the accuracy is ± 0.1 Hz.
*This range applies to 50 Hz nominal frequency models.
Values in parentheses apply to 50 Hz nominal frequency models.

Table 2-14 Frequency (81) Setpoint Ranges
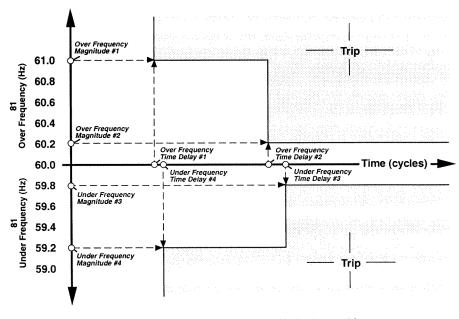
Figure 2-12 Example of Frequency (81) Trip Characteristics

```
/ 81 #1 PICKUP          \
|          _____ Hz     |
\                        /
```

```
/ 81 #1 DELAY           \
|          _____ Cycles |
\                        /
```

```
/ 81 #2 PICKUP          \
|          _____ Hz     |
\                        /
```

```
/ 81 #2 DELAY           \
|          _____ Cycles |
\                        /
```

```
/ 81 #3 PICKUP          \
|          _____ Hz     |
\                        /
```

```
/ 81 #3 DELAY           \
|          _____ Cycles |
\                        /
```

```
/ 81 #4 PICKUP          \
|          _____ Hz     |
\                        /
```

```
/ 81 #4 DELAY           \
|          _____ Cycles |
\                        /
```

These magnitude and time settings describe a curve (as shown in Figure 2-12) to be coordinated with the capability curves of the turbine and generator as well as the system under frequency load-shedding program. These capabilities are given by a description of areas of prohibited operation, restricted time operation, and continuous allowable operation.

The under frequency function is usually connected to trip the machine whereas the over frequency function is generally connected to alarm.

■ **NOTE**: In order to prevent mis-operation during switching transients, the time delay should be set to greater than 5 cycles.
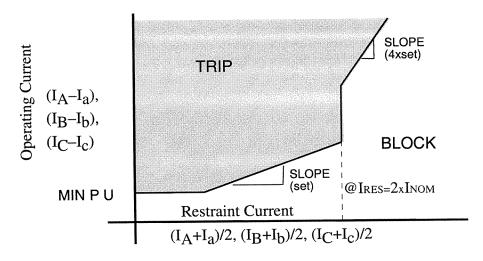
87 Phase Differential

The phase differential function is a percentage differential with an adjustable slope of 1–100%. Although this protection is used to protect the machine from internal winding faults, single phase to ground faults in machines with high impedance grounding may have currents (typically between 3 and 30 primary amps) less than the sensitivity of the differential relay. Turn-to-turn faults are not detected by differential relays because the current into the generator equals out the current. Even though the percentage differential relay is more tolerant of CT errors, all CTs should have the same characteristics and accuracies. To provide restraint for CT saturation at high offset currents, the slope is automatically adjusted (at a restraining current equal to two times nominal current) to four times the slope setting (see Figure 2-13). For very high currents in large generators, the proximity of CTs and leads in different phases can cause unbalanced currents to flow in the secondaries. These currents must be less than the minimum sensitivity of the relay.

FUNCTION	SETPOINT RANGE	INCREMENT	ACCURACY
Phase Differential (87)			
Min Pickup Current	0.20 A to 3.00 A (0.04 A to 0.60 A)	0.01A	±0.10 A or ±5% (±0.02 A or ±5%)
Percent Slope	1 to 100%	1%	±2%
Time Delay	1 to 8160 cycles	1 cycle	-1 to +3 cycles or ±1%

Values in parentheses apply for 1 A CT secondary rating.
When time delay of 1 cycle is selected, the response time is less than 1-1/2 cycles.

Table 2-15   Differential (87) Setpoint Ranges

Where I_A and I_a are generator high side and neutral side currents respectively.

Figure 2-13   Differential Relay (87) Operating Characteristics

87 PICKUP
_____ AMPS

A typical setting is 0.3 amps. (Relay amps = primary amps ÷ CT ratio.)

87 SLOPE
_____ %

A typical setting is 10%.

87 DELAY
_____ Cycles

A typical setting is 1 cycle. If 1 cycle is specified, there is *no* intentional time delay resulting in high speed operation. The output designated should be one of the high-speed outputs (Output 1–4).

External Functions

The M-3430 Generator Protection Relay provides two external functions to allow external device contacts to trip through the relay. These functions expand the capability of the relay by providing additional operating logic and target information for external devices. The *initiating inputs* (any number of *external contacts* may be connected across any of the inputs IN2–IN6*) are then designated to operate the function. The designated *blocking inputs* and *output contacts* are specified in Section 2.3, but are reviewed here for clarity.

*(IN1 is pre-designated as the generator breaker "b" contact.)

FUNCTION	SETPOINT RANGE	INCREMENT	ACCURACY
External Functions			
Time Delay #1, #2	1 to 8160 cycles	1 cycle	-1 to +3 cycles or ±1%

Table 2-16   External Functions Setpoint Ranges

```
EXT # _ INITIATE
        i6 i5 i4 i3 i2 i1
```

```
EXT # _ DELAY
_____ Cycles
```

The *initiating inputs* are user-designated for each enabled external function. The operation of any externally-connected contact (across these inputs) will start the external function operation.

Each enabled external function requires a time delay setting.

For the following example of the setup of an external function, the function is **ENABLED**. The designated initiating contacts as described in Figure 2-14, External Function Example, are IN2 and IN5. The designated blocking status input is IN3, and the designated output contact for the function is OUT6, as described in Section 23, Configuration, Functions.

A time delay setting is also required. The only logical limitation is that the same status input cannot be both a designated initiating input and a designated blocking input. The connection of the external contacts to the inputs is illustrated in Figure 5-2, External Connections and in Table 6-3, Input Contacts.
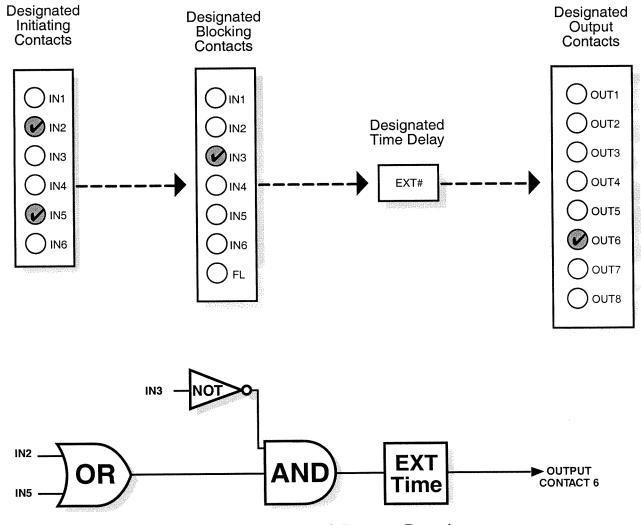
Figure 2-14 External Function Example

2.5   Oscillograph Recorder

The oscillograph recorder provides comprehensive data recording (voltage, current, and status input/output signals) for all monitored waveforms (at 16 samples per cycle). Oscillograph data can be downloaded via the communications ports to any IBM compatible personal computer running the M-3800A IPScom® Communications Software package. Once downloaded, the waveform data can be examined and printed using the optional M-3801 IPSplot® Oscillograph Data Analysis Software package.

The recorder can be triggered manually through serial communication via IPScom or automatically via programmed status inputs (IN1 to IN6) or programmed output contact operation (OUT1 to OUT8). When untriggered, the recorder continuously records waveform data, keeping the data in a buffer memory. The recorder's memory may be partitioned into 1 record of 170 cycles, 2 records of 112 cycles each, 3 records of 84 cycles each, or 4 records of 68 cycles each. When triggered the time stamp is recorded, and the recorder continues recording for a user-defined period (post-trigger delay). The snapshot of the waveform is then moved into memory for later retrieval with IPScom communications software.

■ **NOTE**: If more events or triggers occur before downloading than the number of partitions defined, the oldest data will be overwritten and therefore lost. Data is not retained if power to the unit is lost.

A post trigger delay of 5% to 95% may be specified. After triggering, the recorder will continue to store data for the programmed portion of the total record before rearming for the next record. For example, a setting of 80% will result in a record with 20% pretrigger data and 80% post-trigger data. In most cases, the most significant data to have recorded will occur before the triggering events such as breaker opening or protection operation.

The **OSC TRIG** LED on the front panel will indicate a recorder operation with data available for downloading.

```
╭─────────────────────────────╮
│  RECORDER PARTITIONS         │
│                              │
│  _____                 │
╰─────────────────────────────╯
```

This designates the number of individual records that make up the total recorder capability. The actual length of individual records for different numbers of partitions is given above. Whenever the number of partitions is changed, the Post Trigger Delay is automatically reset to 5%.

```
╭─────────────────────────────╮
│  TRIGGER INPUTS              │
│       i6 i5 i4 i3 i2 i1      │
╰─────────────────────────────╯
```

The trigger inputs designate the input contacts whose operation will trigger the recorder to record an event. Any number can be used and "IN1" is the breaker "b" contact.

```
╭─────────────────────────────╮
│  TRIGGER OUTPUTS             │
│  o8 o7 o6 o5 o4 o3 o2 o1     │
╰─────────────────────────────╯
```

The trigger outputs are the relay output contact sets whose operation will trigger the recorder to record an event.

```
╭─────────────────────────────╮
│  POST TRIGGER DELAY          │
│       _____ %          │
╰─────────────────────────────╯
```

The post trigger delay assigns the amount (%) of the individual data record *occurring after* the trigger. The remaining portion consists of pre-triggering data.

Application for IRIG-B Time Synchronization

The relay can accept a modulated IRIG-B time clock synchronization signal through a BNC connector provided at the rear of unit. The IRIG-B time sychronization information is used to correct the hour, minute, seconds, and milliseconds information. The day of the week, date, month, and year information is still derived from the internal time/date clock.

The relay can display the IRIG-B synchronized time, and this time is used to time-stamp targets and oscillography data. The accuracies are:

• Target Time Stamping: +5 ms typical
• Oscillographic Data Time Stamping: +6 ms typical

When IRIG-B is not connected to the relay, the time information reverts to the internal time clock which has a resolution of one second.

3 Operation (Front Panel)

This chapter provides general information on the use of the optional M-3931 HMI (Human-Machine Interface) Module (front panel controls) to maneuver through the menus, enter values, and set and interrogate the relay.

3.1   Front Panel Controls

The M-3430 Generator Protection Relay has been designed to be set and interrogated locally with the optional HMI. An integral part of this design is the layout and function of the front panel indicators and controls, illustrated in Figure 3-1.

The indicators and controls consist of the alphanumeric display, the up and down arrow buttons, the left and right arrow buttons, and the **EXIT** and **ENTER** buttons. These controls are used by the operator to navigate the system menus and set and interrogate the unit. Detailed information on using these controls is provided in this chapter.

Alphanumeric Display

To assist the operator in setting and interrogating the relay, the unit displays menus which guide the operator to the desired function or setpoint value. These menus consist of two lines. The bottom line lists lower case abbreviations of each menu selection with the current menu selection highlighted by being in uppercase. The top menu line provides a description of the current menu selection.

While the unit is not in use, and has not operated, the user logo lines are displayed until **ENTER** is pressed, at which time the first-level menu is displayed. If the unit has operated, the display cycles through a sequence of screens summarizing the operation status conditions (targets) until **ENTER** is pressed.

Arrow Buttons

The left and right arrow buttons are used to choose among menu selections displayed. When entering values, the left and right arrow buttons are used to select the digit (by moving the cursor) of the displayed setpoint that will be increased or decreased by the use of the up and down buttons.

The up and down arrow buttons only increase or decrease input values or change between upper and lower case inputs. Upper case inputs are active whereas lower case inputs are inactive. If the up or down button is held when adjusting numerical values, the speed of increment or decrement is increased.

EXIT Button

Use the **EXIT** button to exit from a displayed screen to the immediately preceding menu. Any changed setpoint will *not* be saved if the selection is aborted via the **EXIT** button.

ENTER Button

A. The **ENTER** button is used to choose a highlighted menu selection, to replace a setpoint or other programmable value with the currently displayed value, or to select one of several displayed options (such as to **ENABLE** or **DISABLE** a function).

B. The **ENTER** button is also used to move up or down within a menu.

Target/Status Indicators and Controls

The target/status indicators and controls consist of the following LEDs: Power Supply (**PS1** and **PS2**) **RELAY OK**, the Oscillograph Recorder (**OSC TRIG**), **BREAKER CLOSED**, **TARGET**, **DIAGNOSTIC** and **TIME SYNC**

Power Supply (PS1 and PS2) LED.

The green **PS** LED indicator(s) remains illuminated for the appropriate power supply whenever power is applied to the unit and the power supply is operating correctly. Power supply PS2 is available as an option.

RELAY OK LED

The green **RELAY OK** LED is controlled by the microprocessor. A flashing **RELAY OK** LED indicates proper program cycling. The LED can also be programmed to illuminate continuously.

Oscillograph (OSC TRIG) Recorder LED

The **OSC TRIG** LED illuminates to indicate that oscillograph data has been recorded in the unit's memory.

Breaker (BRKR) CLOSED LED

The red **BRKR CLOSED** LED illuminates when the breaker status input (52b) is open.

Target Indicators and Target Reset

Normally, the **24 TARGET** LEDs are not illuminated. Upon operation, LEDs corresponding to the cause(s) of the operation will light and stay illuminated until reset. The eight **OUTPUT** LED's will reflect the present state of the OUT1–OUT8 output contacts. Pressing and releasing the **TARGET RESET** button will momentarily light all LEDs (providing a means to test them) and allows resetting of the **TARGET** LEDs if the condition which caused the operation has been removed. Detailed information about the cause of the last 32 operations is retained in the unit's memory for access through the alphanumeric display via the **VIEW TARGET HISTORY** menu.

Pressing and holding the **TARGET RESET** button displays the present *pickup* status of the functions on the target indicators.

TIME SYNC LED

The green **TIME SYNC** LED illuminates to indicate that the IRIG-B time signal is being received and the internal sychronized with the IRIG-B time signal.

Diagnostic LED (DIAG LED)

The **DIAG** LED flashes upon occurrence of a detectable self-test error. The LED will flash the Error Code Number. For example, for error code 32, the LED will flash 3 times, followed by a short pause, and then 2 flashes, followed by a long pause, and then repeat. For units equipped with the HMI, the Error Code Number is also displayed on the screen.

Accessing Screens

To prevent unauthorized access to the functions, the software has the provision for assigning access codes. If access codes have been assigned, the access code entry screen, will be displayed after

ENTER is pressed from the default message screen. The relay is shipped with the access code feature disabled.

The relay has three levels of access codes. Depending on the access code they hold, users have varying levels of access to the functions.

3 Level 3 access = access to all configuration functions and settings

2 Level 2 access = all level 1 priviledges, plus the ability to change setpoints

1 Level 1 access = read setpoints, monitor status, view target history

Each access code is a user-defined, one- to four-digit number. Access codes are altered by choosing **ALTER ACCESS CODES** menu under **SETUP UNIT** menu. (They can only be altered by a level 3 user.)

▲ **CAUTION**: If the level 3 access code is set to 9999, the access code feature is disabled. When access codes are disabled, the access screens are bypassed, and all users have full access to the relay.

Default Message Screens

When the relay is powered and unattended, user logo lines are displayed. The display automatically returns to the logo screens after exiting from the menu and most other screens after five minutes of unattended operation. A screen blanking feature can be enabled by the user.

If a function has operated and not been reset, it will display the time and date of the operation and automatically cycle through screens for each applicable target. (This sequence is illustrated in Figure 3-2.) In either case, pressing **ENTER** will begin local mode operation, displaying the access code entry screen or, if access codes have been disabled, the first level menu.

Serial Interfaces (COM1, COM2 and COM3)

The serial interface COM1 port (front) and COM2 port (rear) are standard 9-pin RS-232 DTE configured communications ports. The COM1 port will normally be used for local setting and interrogating of the relay via a portable computer running IPScom®. IPScom only supports communications using BECO 2200 protocol. COM1 port protocol is fixed at BECO 2200. An additional COM3 port (RS-485) is available at the rear terminal block. Either the COM2 port or the COM3 port will normally be used for remote setting and interrogation of the relay via a network, direct connection or a permanently wired modem. COM2 and COM3 have the option of setting the protocol to BECO 2200 or MODBUS. While COM1 and COM2 communicates with a fixed 8 bits, no parity and 2 stop bits (8,N,2 standard BECO 2200 settings), COM3 has the option of setting parity (None, odd or even) if configured for MODBUS protocol. Detailed information on the use of the communications ports is provided in Appendix B, **Communications**.

The protocol description document and the communication data base document may be requested from the factory or downloaded from our website at www.beckwithelectric.com.

■ **NOTE:** The following restrictions apply for MODBUS protocol use:

1) MODBUS protocol is not supported on COM1;

2) Parity is supported on COM3 only, valid selections for COM3 are 8,N,2; 8,O,1 or 8,E,1. COM2 communication must be 8 data, no parity, 2 stop;

3) ASCII mode is not supported (RTU only);

4) Standard baud rates from 300 to 9600 are supported;

5) Only the following MODBUS commands are supported: a) read holiding register (function 04), b) Force single coil (function 05), c) Preset single register (function 06);

6) *MODBUS does not support oscillograph record downloading.*

Figure 3-1   Front Panel

Figure 3-2   Screen Message Menu Flow

VOLTAGE RELAY	CURRENT RELAY	FREQUENCY RELAY	VOLTS PER HERTZ RELAY
VOLT curr freq v/hz pwr →	volt CURR freq v/hz pwr →	volt curr FREQ v/hz pwr →	volt curr freq V/HZ pwr →

• 59 Phase Overvoltage
• 59N Neutral Overvoltage
• 27 Phase Undervoltage
• 27TN Neutral Undervolt

• 46 Neg Seq Overcurrent
• 87 Differential Overcurr
• 50/27 Inadvertant Energ
• 50BF Breaker Failure

• 81 Frequency

• 24 Def Time Volts/Hertz
• 24 Inv Time Volts/Hertz

POWER RELAY	LOSS OF FIELD RELAY	PHASE DISTANCE RELAY	V.T. FUSE LOSS RELAY
volt curr freq v/hz PWR →	← LOF dist fuse ext →	← lof DIST fuse ext →	← lof dist FUSE ext →

• 32 Directional Power

• 40 Loss of Field

• 21 Phase Distance

• 60FL V.T. Fuse Loss

EXTERNAL RELAY	CONFIGURE RELAYS	MONITOR STATUS	VIEW TARGET HISTORY
← lof dist fuse EXT →	← CONFIG stat →	← config STAT →	← TARGETS osc_rec →

• External

• Voltage Relay
• Current Relay
• Frequency Relay
• Volts per Hertz Relay
• Power Relay
• Loss of Field Relay
• Phase Distance Relay
• V.T. Fuse Loss Relay
• External Relay
• Setup Relay
   Nominal Voltage
   Nominal Current
   V.T. Configuration
   59/27 Magnitude Select
   Delta-Y Transform
   Relay Seal-In Time
   Active Input State
   V.T. Phase Ratio
   V.T. Neutral Ratio
   C.T. Phase Ratio
   C.T. Neutral Ratio

• Voltage Status
• Current Status
• Frequency Status
• Volts per Hertz Status
• Power Status
• Impedance Status
• In/Out Status
• Voltage Timer
• Current Timer
• Frequency Timer
• Volts per Hertz Timer
• Power Timer
• Loss of Field Timer
• Distance Timer
• Fuse Loss Timer
• External Timer
• Temperature
• Counters
• Time of Last Power Up
• Error Codes
• Checksums

• View Target History
• Clear Target History

OSCILLOGRAPH RECORDER	COMMUNICATION	SETUP UNIT	EXIT LOCAL MODE
← targets OSC_REC →	← COMM setup exit →	← comm SETUP exit →	← comm setup EXIT

• View Record Status
• Clear Records
• Recorder Setup

• COM1 Setup
• COM2 Setup
• COM3 Setup
• Communication Address
• Comm Access Code

• Software Version
• Serial Number
• Alter Access Codes
• User Control Number
• User Logo Line 1
• User Logo Line 2
• Clear Output Counters
• Clear Alarm Counter
• Date & Time
• LCD Display Blanking
• LCD Contrast Adjustment
• Relay OK LED Flash
• Clear Error Codes
• Diagnostic Mode

Figure 3-3   Main Menu Flow

3.2 Initial Setup Procedure/Settings

The relay is shipped with the initial settings as listed in Appendix A, **Configuration Record Forms**. Selected settings that are unique to the application may be recorded on the appropriate record form as calculated from Chapter 2, **Application**.

1. Connect power to the rear power terminals as marked on the rear-panel power supply label and as shown in Figure 5.2, External Connections.

2. Whenever powered up, the relay performs a number of self-tests to ensure its correct operation. During the self-tests, the unit displays "**x**" for each test successfully executed. If all tests are executed successfully, it will briefly display the word **PASS** and then a series of status screens, including the model number, the software version number, the serial number, the date and time as set in the system clock, and the user logo screen. (Figure 3-2 illustrates this sequence of screens.) If any test should fail, an error code will be displayed and the relay will not allow operation to proceed. In such a case, the error code should be noted and the factory contacted. A list of error codes and their descriptions are provided in Appendix C, **Error Codes**.

   Assuming that various voltage functions are enabled, and that there are no voltage inputs connected, various voltage targets will be identified as having operated.

3. If remote communication is used, set the baud rate, address, and other parameters for the communication ports by following the instructions in Section 3.2, Communications Data subsection, or in Chapter 4, **Operation (Computer)**, using M-3800A IPScom® Communications Software. The **COM3** port does not have a separate baud rate setting but uses the setting of **COM2** (or **COM1**: see Section 5.3 Circuit Board Switches & Jumpers).

4. To set up the unit with general information required including altering access codes, clearing output counters, setting date and time, defining user logos, and other adjustments, see Section 3.2, Setup Unit Data subsection.

5. If necessary, calibrate the unit following the calibration procedure detailed in Section 6.3, Auto Calibration. (For units without HMI option, see Section 5.3, Circuit Board Switches & Jumpers.)

■ **NOTE**: The M-3430 Generator Protection Relay has been fully calibrated at the factory using very precise and accurate test equipment. There is no need for recalibration before initial installation. Further calibration is only necessary if a component was changed and will be only as accurate as the test equipment used.

6. Complete the Relay Setup. These settings are described in the **SETUP RELAY** submenu under the **CONFIGURE RELAYS** menu. This is the general system and equipment information required for the operation of the relay. This includes such items as CT and VT ratios, VT configurations, and Nominal values. See Section 3.2, Configure Relays Data subsection.

7. Enable the desired functions under the **CONFIGURE RELAYS** menu. See Section 3.2, Configure Relays Data subsection.

■ **NOTE**: Disabling unused functions improves the response time of the indicators and controls.

8. Enter the desired setpoints for the enabled functions. See Section 3.2, Setpoints and Time Settings subsection.

9. Enter the desired information for the oscillograph recorder. See Section 3.2, Oscillograph Recorder Data subsection.

10. Install the relay and connect the external input and output contacts according to the rear panel terminal block markings as shown in Figure 5.2, External Connections.

Communications Data

To input the data, access the **COMMUNICATION** menu as follows:

1. Press **ENTER** to bring up the main menu.

2. Press the right arrow button until **COMMU-NICATION** appears on the top line of the display.

3. Press **ENTER** to access the **COMMUNICA-TION** menu and begin the data input.

The general information required to complete the input data of this section includes:

- baud rate for **COM1** and **COM2** communication ports (**COM3** uses the same baud rate as **COM2** by default);

- communications address is used to access multiple relays via a multidrop communication line;*

- communications access code is used for communication system security; entering an access code of 9999 disables communication security.

- communication protocol and dead sync time for **COM2** and **COM3**

- parity for **COM3** if **MODBUS** protocol used.

Before entering the communication data in the relay, complete Figure A-2, Communication Data & Unit Setup Record Form in Appendix A, **Configuration Record Forms.**

The relay already contains factory settings for communication data which can be used to familiarize yourself with the Communication menu.

* Individual communication addresses should be between 1 and 200. If addresses in excess of 200 are desired, refer to the protocol description document and the communication database document available from the factory.

Setup Unit Data

To input the data, access the **SETUP UNIT** menu as follows:

1. Press **ENTER** to bring up the main menu.

2. Press the right arrow button until **SETUP UNIT** appears on the top line of the display.

3. Press **ENTER** to access the **SETUP UNIT** menu and begin the data input.

The general information required to complete the input data in this section includes:

- access codes

- control numbers

- date and time

- user logo

- diagnostic mode

- LCD adjustments ✛

- Relay OK LED flash (ENABLE)

✛ *Not available on all units.*

Before entering the setup data, complte Figure A-2, Communication Data & Unit Setup Record Form in Appendix A.

The relay already contains factory settings for setup data which can be used to familiarize yourself with the **SETUP UNIT** menu.

Configure Relay Data

To input the data, access the **CONFIGURE RELAY** menu as follows:

1. Press **ENTER** to bring up the main menu.

2. Press the right arrow button until **CONFIGURE RELAY** appears on the top line of display.

3. Press **ENTER** to access the **CONFIGURE RELAY** menu and begin the data input.

The general information required to complete the input data in this section includes:

- function enable or disable

- output choices (OUT1–OUT8)

- input choices (IN1–IN6), plus fuse loss blockingfor each possible function. Input descriptions are detailed in Section 2.2, Configuration, Functions.

Before entering the **CONFIGURE RELAYS** data, Figure A-3, Functional Configuration Record Form in Appendix A should be completed.

The relay already contains factory settings for configure relays data which can be used to familiarize yourself with the **CONFIGURE RELAYS** menu.

Oscillograph Recorder Data

To input the data, access the **OSCILLOGRAPH RECORDER** menu as follows:

1. Press **ENTER** to bring up the main menu.

2. Press right arrow button until **OSCILLO-GRAPH RECORDER** appears on the top line of the display.

3. Press **ENTER** to access the **OSCILLO-GRAPH RECORDER** menu and begin the data input.

The oscillograph recorder provides comprehensive data recording of all monitored waveforms, storing up to 170 cycles of data. The total record length of 170 cycles may be configured for 1, 2, 3, or 4 event records. The oscillograph recorder is triggered either remotely or via designated status input signals or relay output operations. When untriggered, the recorder continuously records waveform data, keeping the data in buffer memory. When triggered, the recorder continues storing data for a user-defined time period, keeping the most recent records in memory for downloading to a personal computer. If more events or triggers occur than the number of records designated (partitions) before downloading of data, triggering the recorder overwrites the oldest of the event records.

Before entering the oscillograph recorder settings, complete page two of Figure A-4, Setpoint & Timing Record Form in Appendix A, **Configuration Record Forms**.

The relay already contains factory settings for oscillograph recorder data which can be used to familiarize yourself with the **OSCILLOGRAPH RECORDER** menu.

Setpoints and Time Settings

To input the data, access these menus as follows:

1. Press **ENTER** to bring up the main menu.

2. Press the right arrow button until **VOLTAGE RELAY**, the first of the setpoint and time setting menus, appears on the top line of the display.

3. Press **ENTER** to begin the data entry for this menu, or continue pressing the right arrow button until the desired setpoint and time setting menu appears and then press **ENTER** to begin the data input.

The general information required to complete the input data in this section includes individual relay function:

- pickup settings (converted to relay quantities)
- time delay settings
- frequency settings
- time dials
- power level settings (in percent rated)
- impedance diameter in relay ohms for distance and offset settings.

Input descriptions are detailed in Section 2.3, Setpoints and Time Settings. Before entering the setpoint and time settings data, Figure A-4, Setpoint & Timing Record Form in Appendix A, **Configuration Record Forms**, should be completed.

The relay already contains factory settings for setpoint and time settings data which can be used to familiarize yourself with these menus.

3.3 Checkout Status/Metering

The M-3430 Generator Protection Relay has two menu selections concerning monitoring status and reviewing target history. This section describes the operation of these selections.

Monitor Status - Metering

Access the **MONITOR STATUS** menu as follows:

1. Press ENTER to bring up the main menu.

2. Press the right-arrow button until **MONITOR STATUS** appears on the top line of the display.

3. Press ENTER to access the **MONITOR STATUS** menu and begin the monitoring.

Each category listed below is a menu item. Pressing the **ENTER** button moves down within that menu, allowing you to monitor values within that menu category. To exit a specific category and continue to the next menu category, press the **EXIT** button.

The menu categories for monitored values are:

Voltage Status – phase voltages, neutral voltage, 3rd harmonic neutral voltage, positive sequence voltage, negative sequence voltage, zero sequence voltage.

Current Status – phase currents (A-B-C), phase currents (a-b-c), differential current, neutral current, positive sequence current, negative sequence current, zero sequence current.

Frequency Status – frequency

Volts per Hertz Status – volts per hertz

Power Status – real power, reactive power, power factor

Impedance Status – Z_{ab}, Z_{bc}, Z_{ca}, positive sequence impedance

IN/OUT Status – Status of input and output contacts

The following timer status can also be monitored, timers for the inverse time functions are displayed in percentage where 100% corresponds to the full value of the integrating timer.

Volt Timer – 59#1, 59#2, 59N#1, 59N#2, 27#1, 27#2, 27TN#1, 27TN#2

Current Timer – 46DT, 46IT, 46IT Max Delay, 87, 50/27 Pickup, 50/27 Dropout, 50BF

Frequency Timer – 81#1, 81#2, 81#3, 81#4

Volts/Hz Timer – 24DT#1, 24DT#2, 24IT

Power Timer – 32#1, 32#2

LOF Timer – 40#1, 40#2

Distance Timer – 21#1, 21#2

Fuse Loss Timer – 60FL

External Function Timer – #1, #2

Temperature

Counters

Time of Last Powerup

Error Codes

Checksums

View Target History

The **VIEW TARGET HISTORY** menu selection enables the user to review the targets for the previous thirty-two target conditions. A target is triggered whenever an output is operated or closed. The target history for each operation cycles continuously through a sequence of screens until **EXIT** is pressed. A target includes:

- status information which indicates any function which is timing,

- an indication which function(s) have operated and timers expired,

- phase currents at the time of trip and individual phase element information at the time of the trigger, if the operating function was a three phase function,

- input and output status, and

- a time/tag of the trigger. The final selection allows the user to clear all operation history for further target recording.

It should be noted that a second function attempting to operate an output which is already operated will not trigger a new target since no new output has been operated or closed. If the second function operation closes a different, unoperated output, a new target will be triggered.

4 Operation (Computer)

This chapter contains information on configuring and interrogating the M-3430 Generator Protection Relay via a personal computer, using the M-3800A IPScom Communications Software package.

4.1 Installation and Setup (IPScom)

IPScom runs with the Microsoft® Windows™ operating system, version 3.1 or later. IPScom only supports communication via the BECO 2200 protocol.

IPScom is available in the following IBM PC-compatible format:

- one 3.5" double-sided, high-density (DS/HD 1.44 Mb) disk

- available for download from our website at www.beckwithelectric.com

The M-3800A IPScom Communications Software package is not copy-protected and can be copied to a hard disk. For more information on your specific rights and responsibilities, see the licensing agreement enclosed with your software or contact Beckwith Electric.

Hardware Requirements

IPScom will run on any IBM PC-compatible computer that provides at least the following:

- 4 Mb of RAM (Win95) or 8 Mb of RAM (Win98)

- Windows 3.1 or later

- one 3.5" double-sided, high-density (DS/HD 1.44 Mb) disk drive

- one serial (RS-232) communication port

- VGA monitor

- Mouse or pointing device

Recommended, but not required, are the following:

- Math coprocessor

- Windows®-compatible printer

The M-3430 Generator Protection Relay provides three serial communication ports. Two serial in-

terface ports, COM1 and COM2, are standard 9-pin RS-232 DTE-configured ports. The front-panel port, COM1, can be used to locally set and interrogate the relay by computer. The second RS-232 port, COM2, is provided at the rear of the unit. An RS-485 configured port, COM3, is also available at the rear terminal block of the unit. Either port COM2 or COM3 can be used to remotely set and interrogate the relay via a modem, whereas all three may be used for direct serial connection.

■ **NOTE:** The RS-232 standard specifies a maximum cable length of 50 feet for RS-232 connections. Successful operation cannot be guaranteed for cable lengths exceeding this recommendation. Every effort should be made to keep cabling as short as possible. Low capacitance cable is recommended.

In order to use IPScom® to communicate with the relay via a modem, the following must be provided with the unit:

* Hayes-compatible modem (1200, 2400, 4800, or 9600 baud)

* Serial modem cable with 9-pin connector for the system and the applicable connector for the modem

Similarly, the computer must also have access to a Hayes-compatible modem and an appropri-

ate cable. Pin-outs for communication cables are provided in Appendix B, **Communications**.

In order to use IPScom to communicate with the relay via direct serial connection, a serial "null modem" cable is required with a 9-pin connector (DB9P) for the system and an applicable connector for the computer (usually DB9S or DB25S). Pin-outs for a null modem adapter are provided in Appendix B, **Communications**.

Installation

Before you install the IPScom program, make a backup copy of the software disks to work with during installation.

IPScom

Figure 4-1   IPScom Program-Item Icon

IPScom can be run from a hard disk. An installation utility has been provided to make the process easier (see Figure 4-2).
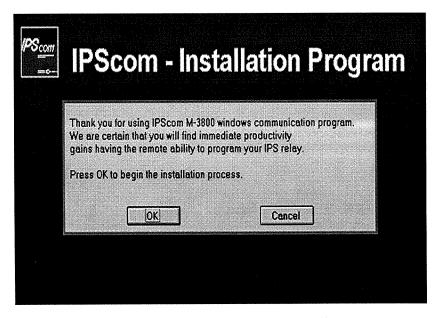
Figure 4-2   IPScom Install Utility Dialog Box

Installing IPScom®

1. Insert the software diskette in your drive.

2. Select "Run" from Start menu

3. Click "browse" and select Drive A or B.

4. Double click on **INSTALL**.

5. Click "OK" button

Installing the Modems

Using IPScom to interrogate, set, or monitor the relay via modem requires both a remote modem connected at the relay location and a local modem connected to the computer with IPScom installed. The local modem can be initialized, using IPScom, by connecting the modem to the computer and choosing the **Comm** menu, then the **Modem** command button, and finally the Initialize command button from the expanded Communications dialog box. This sends an AT command string to the modem. The following steps outline the initialized modem setup procedures.

1. Connecting the modem to the computer:

If the computer has an external modem, connect the computer and modem using a standard RS-232 modem cable between the desired serial port and the modem. If the computer has an internal modem, refer to your modem's instruction book for selecting a communications port.

The Hayes-compatible modem must be attached to (if external) or assigned to (if internal) the same serial port as IPScom. While IPScom can use any of the four serial ports (COM1 through COM4), most computers support only COM1 and COM2.

Connect the modem to the telephone line and turn modem on.

2. Connecting the modem to the relay:

Connect the unit and a Hayes-compatible modem by attaching a standard RS-232 modem cable to the appropriate serial communications port on both the unit and the modem.

Connect the modem to the telephone line and turn modem on.

The modem attached to the unit *must* have the following AT command configuration:

E0	No Echo.
Q1	Don't return result code.
&D3	ON to OFF DTR, hang-up and reset.
&S0	DSR always on.
&C1	DCD ON when detected.
S0=2	Answer on second ring.

The relay does not issue or understand any modem commands. It will not adjust the baud rate and should be considered a "dumb" peripheral. It communicates with 1 start, 8 data, and 1 stop bit.

The following commands *may* also be required at the modem:

&Q6	Constant DTE to DCE speed.
N0	Answer only at specified speed.
\J	Disable serial data rate adjust.
\Q3	Bidirectional RTS/CTS relay.
\N0	Normal mode.
&B1	Fixed serial port rate.
S37	Desired line connection speed.

There is some variation in the AT commands supported by manufacturers of Hayes-compatible modems. Refer to the hardware's user documentation for a list of supported AT commands and for direction in issuing these commands.

Setting Up the Relay for Communications

The initial setup of the relay for communication *must* be completed by direct serial connection (see Section 4.2, **Operation**, Activating Communications) or through the optional M-3931 Human-Machine Interface (HMI) panel.

Factory settings for the communication setup are recorded on the Communication Data & Unit Setup "AS SHIPPED" form located in Appendix A, **Configuration Record Forms**. The default baud rate for all ports is set to 9600, the communication address is set to 1, and the communication access code is set to 9999, disabling security. If IPScom communication is to take place through the relay's COM2 or COM3 port, the controls communication protocol must be set at BECO 2200.

1. To start communication setup program, choose the IPScom icon from the Becoware folder (or folder to which software was installed).

2. Set the communications parameters for the unit:

   a. Set the communications address of the unit to a number not used by any other unit sharing the same modem.

   b. If desired, set the communications access code for secure communications of the remote operation.

   c. If the Baud rate is to be different than the 9600 initial setting, set the baud rate to match that used by both modems.

The baud rate chosen must be supported by the modem and must match the settings for the IPScom Communications Software package.

▲ **CAUTION:** Complete communications capabilities are not available if the unit is in local mode (accessed via the HMI panel). To ensure that the unit is available for complete remote communications after setting or interrogating the system from the front panel, you must exit all menus or press **ENTER** at the **Exit Local Mode** menu to exit local mode.

Multiple Systems Setup

The individual addressing capability of IPScom and the relay allows multiple systems to share a direct or modem connection when connected via a communications-line splitter. As shown in Figure 4-3, one such device enables two to six units to share one communications line.

▲ **CAUTION:** Each unit connected to the communications-line splitter must have a unique communications address. If two or more units share the same address, corrupted communication will result.

Serial Multidrop Network Setup

Individual remote addressing also allows for communications through a serial multidrop network (RS-485). Up to 32 relays can be connected using the same 2-wire or 4-wire communications line.

Appendix B figure B-2 illustrates a RS-232 Fiber Optic network setup and figure B-3 illustrates both a RS-485 4-wire and a 2-wire network.
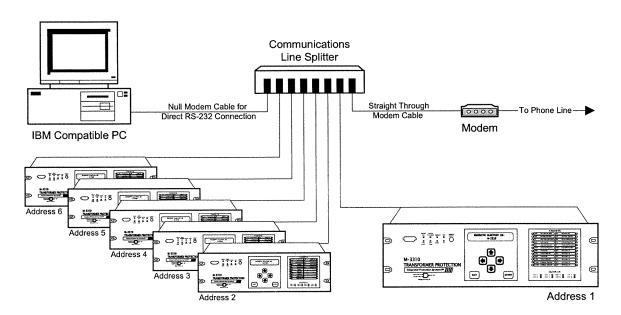
Figure 4-3   Multiple System Addressing Using Communications-Line Splitter

4.2 Operation

Activating Communications

After the relay has been set up, the modems initialized, and IPScom installed, communication is activated as follows:

1. Choose the IPScom® icon from the Becoware folder.

2. The IPScom splash screen is displayed briefly, providing the software version number and copyright information. This information is also available by choosing **About**... from the **Help** menu.

3. Choose the **COMM** menu selection. Complete the appropriate information on the window for the relay to be addressed.
    a. If communication is through a modem, choose the **Modem** command button to expand the communications dialog box. Choose the desired relay location and choose **Dial** button. This action establishes contact and automatically opens the communication to the relay.

    b. If computer is connected through the front port, choose the **Open COM** button. This action establishes communications.

4. Enter valid IPScom command(s) as desired.

5. To end communication when communicating by modem, choose the **Hang Up** command button from the expanded Communication dialog box. To close the communication channel when connected locally, choose **Close COM**.

Overview

When IPScom is run, a menu and status bar is displayed, as shown in Figure 4-5. This section describes each IPScom menu selection and explains each IPScom command in the same order as they are displayed in the software program. For detailed information on each dialog box field (function), refer to Chapter 2, **Application**.

When starting IPScom, the initial menu choices are the **File** menu or the **Comm** menu. The choice specifies whether the operator desires to write to an data file or to communicate directly with the relay.

File Menu

The **File** menu enables the user to create a new data file, open a previously created data file, close, print, and save the file. The IPScom program can also be exited through the **File** menu.

Since IPScom can be used with several Beckwith protection systems in addition to the M-3430 Generator Protection Relay, the format and contents of a file must be established depending on which protective system is being addressed. When not connected to one of the protection systems, using the **New** command, a new file is established with the New Device Profile dialog box (see Figure 4-4). Choosing the **OK** command button, allows the new data file to be named by using the **Save** or **Save As**...commands.

■ **NOTE**: By choosing **New**, unit and setpoint configuration values are based on factory settings specified for the profiled protection system.
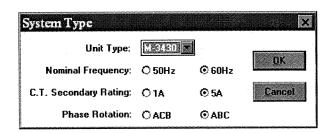
Figure 4-4   New Device Profile Dialog Box

Path: File menu / New command

▢ **COMMAND BUTTONS**

OK   Saves the currently displayed information.

Cancel   Returns you to the IPScom® main window; any changes to the displayed information are lost.

The **Save** and **Save As**... commands allow resaving a file or renaming a file, respectively. The **Open** command allows opening a previously created data file. With an opened data file, use the **Relay... Setup...** menu items to access the setpoint windows.
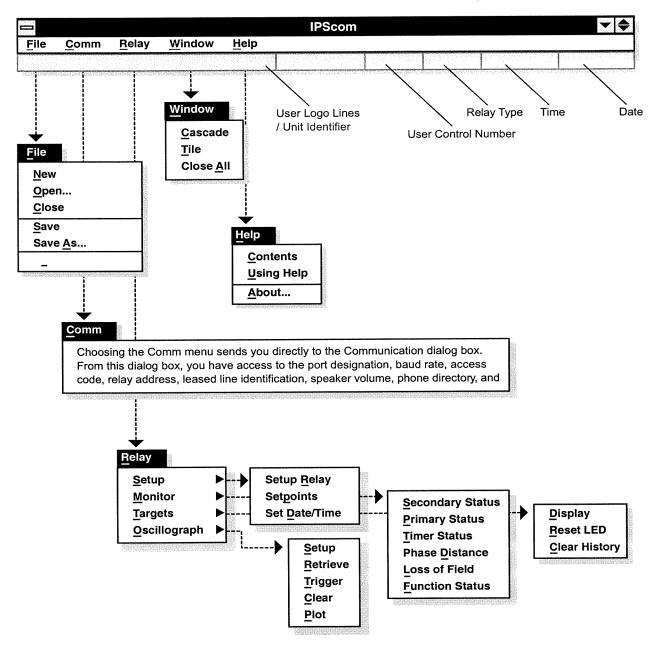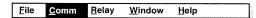
Figure 4-5 IPScom® Menu Selections

If communication can be established with a relay, it is always safer to use the **Relay...Read From** command to update the PC's data file with the relay data. This file now contains the proper system type information, eliminating the need to set the information manually.

The **Print** and **Printer Setup** commands allow user to select printer options and print out all setpoint data from the data file or directly from the relay, if a relay is communicating with the PC.

The **Exit** command quits the IPScom® program.

Comm Menu

| File | **Comm** | Relay | Window | Help |

The Communication dialog box (see Figure 4-6) allows setup of the IPScom® communication data to coordinate with the relay and by choosing the **Modem** button, to establish contact for remote locations. When communicating by way of a fiber optic loop network, echo cancelling is available by checking **Echo Cancel**. This command masks the sender's returned echo.

If communication is established through the modem, the **Initialize** button should be pressed. If communication cannot be established with the default string, the AT&F may be selected to initialize. Following initialization, select an entry from the modem list and press the **Dial** button to dial out.

▲ **CAUTION:** The AT & F command will reset the modem to factory defaults.

If the modem was not used to establish communication (direct connection), press the **Open COM** button to start. If the relay has the communication access code set to 9999 (factory default), a message window will appear showing access level #3 was granted. Otherwise, another dialog box will appear to prompt the user to enter the access code in order to establish the communication. **Close COM** discontinues communication.
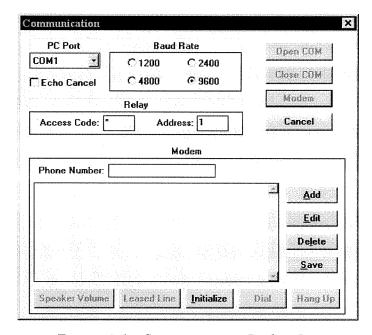
Figure 4-6   Communication Dialog Box
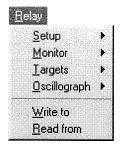
Path: Comm menu

▢ **COMMAND BUTTONS**

Cancel Returns you to the IPScom main window; any changes to the displayed information are lost.

Open COM Initiates contact with the protective system, either by direct serial or modem communication.
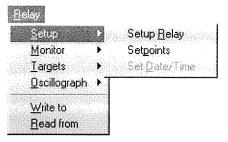
Close COM Breaks communication with the protective system, for both direct serial or modem communication.

Modem Expands Communication dialog box.

Add Displays the Add/Edit dialog box, allowing you to type a protective system's unit identifier, phone number, and address.

Edit Displays the Add/Edit dialog box, allowing you to review and change the user lines (unit identifier), phone number, and communication address of a selected entry.

Delete Deletes a selected entry.

Initialize Allows you to send special setup or other AT commands directly to the modem.

Dial Dials the entry selected from the directory.

Hang Up Ends modem communication.

Relay Menu

The **Relay** menu provides access to the windows used to set, monitor, or interrogate the M-3430. Four submenus are provided: **Setup, Monitor, Targets** and **Oscillograph** as well as two commands, **Write To** and **Read From**.

The **Setup** submenu provides three commands: **Setup Relay, Setpoints**, and **Set Date/Time**. The **Setup Relay** command displays the Setup Relay dialog box (see Figure 4-7) allowing the input of the pertinent information regarding the system on which the relay is installed (see Section 2.2, **Configuration**, System Setup).

SETUP RELAY

Nominal Frequency: 60 Hz   C.T. Secondary Rating: 5 A   Phase Rotation: ABC

Nominal Voltage:	120	60 V ◄		► 140 V
Nominal Current:	5.00	0.50 A ◄		►6.00 A
27/59 Magnitude Select:	○ DFT ◉ RMS			

Input Active State:	6	5	4	3	2	1
	○ Open	○ Open	○ Open	○ Open	○ Open	○ Open
	◉ Close	◉ Close	◉ Close	◉ Close	◉ Close	◉ Close

V.T. Configuration:	◉ Line to Line ○ Line to Ground ○ Line-Ground to Line-Line
Delta-Y Transformer:	○ Enable ◉ Disable

Relay Seal-in Time:	30	2 cycles ◄	► 8160 cycles
V.T. Phase Ratio:	1.0	: 1	1.0 ◄	► 6550.0
V.T. Neutral Ratio:	1.0	: 1	1.0 ◄	► 6550.0
C.T. Phase Ratio:	1	: 1	1 ◄	► 65500
C.T. Neutral Ratio:	1	: 1	1 ◄	► 65500

Save   Cancel

Figure 4-7   Setup Relay Dialog Box

Path: Relay menu / Setup submenu / Setup Relay window

⬜ **COMMAND BUTTONS**

Save   When connected to a protection system, sends the currently displayed information to the unit. Otherwise, saves the currently displayed information.

Cancel   Returns you to the IPScom® main window; any changes to the displayed information are lost.

■ **NOTE:** Checking the inputs for the Active Input Open parameter designates the "operated" state established by an *opening* rather than a closing external contact.

The **Setpoints** command displays the Relay Setpoints dialog box (see Figure 4-8) from which the individual relay function dialog boxes can be accessed. Choosing a Relay function button (#46, for example), will display the corresponding function dialog box (see Figure 4-9).

The Relay Setpoints dialog box gives access to two additional dialog boxes: All Setpoints Table and Configure.
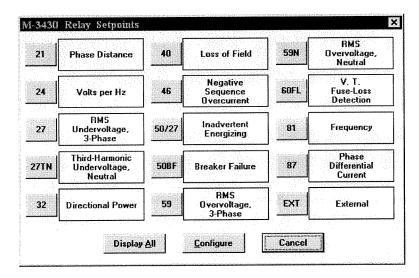
Figure 4-8   Relay Setpoints Dialog Box

Path: Relay menu /   Setup submenu / Setpoints window

☐ **COMMAND BUTTONS**

Display All Opens the All Setpoints Table dialog box.

Configure Opens the Configure dialog box.

Exit Saves currently displayed information and returns you to the IPScom® main window.
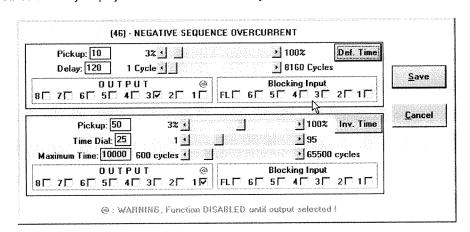
Figure 4-9   Function 46 Setpoint Dialog Box

Path: Relay menu/Setup submenu / Setpoints window/46 command button OR
   46 jump hotspot within All Setpoints Table or Configure dialog

☐ **COMMAND BUTTONS**

Save When connected to a protection system, sends the currently displayed information to the unit. Otherwise, saves currently displayed information and returns you to the point of origin.

Cancel Returns you to previous window; any changes to displayed information are lost.

Choosing the **Display All** command button displays the All Setpoints Table dialog box (see Fig. 4-10). This dialog contains a list of settings for each relay within a single window to allow scrolling through all relay setpoint configuration values. Choosing the **Configure** command displays the Configure dialog box (see Fig. 4-11), which contains a chart of programmed input and output contacts, in order to allow scrolling through all relay output and blocking input configurations. Both dialog boxes (All Setpoint Table and Configure), feature hotspots which allows the user to jump from a scrolling dialog box to an individual relay function dialog box and return to the scrolling dialog box again. All available parameters can be reviewed or changed when jumping to a relay configuration dialog box from either scrolling dialog box
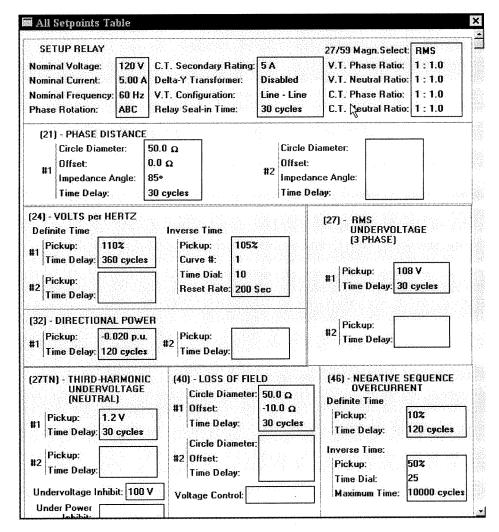
Figure 4-10   All Setpoints Table Dialog Box

Path: Relay menu/Setup submenu /Setpoints window/ Display All command button

JUMP HOTSPOTS

This window provides you with jump hotspots, identified by the hand icon, that take you to each relay dialog box and the Setup Relay dialog box. Exiting these dialog boxes will return you to the All Setpoints Table.

CONTROL MENU

| Close | Returns you to Relay Setpoints dialog box. |
| Move | Allows you to reposition the dialog box. |
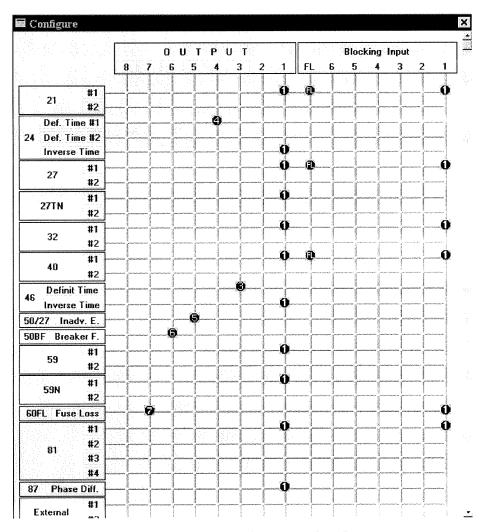
Figure 4-11   Configure Dialog Box

Path: Relay menu / Setup submenu / Setpoints window/ Configure command button

JUMP HOTSPOTS

This window provides you with jump hotspots, identified by the hand icon, that take you to each relay dialog box. Exiting any of these dialog boxes will return you to the Configure dialog box.

CONTROL MENU

Close   Returns you to the Relay Setpoints dialog box.

Move   Allows you to reposition the dialog box.

The **Set Date/Time** command (see Figure 4-12) allows system date and time to be set, or system clock to be stopped. This dialog box also displays an LED mimic to identify when the Time Sync is in use (preventing date/time from being changed by user).
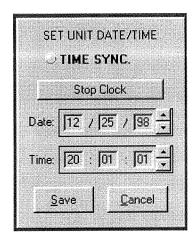
Figure 4-12   Unit Date/Time Dialog Box

Path: Relay menu/ Setup submenu/ Set Date/Time

There is a blue Time Sync LED mimic on this dialog box (the LED is displayed as different shading on a monochrome monitor). When this LED is blue, the relay is synchronized with the IRIG-B signal and the Time field is grayed out, indicating that this field can't be changed. But the Date field can be changed (by editing and pressing **Save**).

When the LED is *not* blue, the relay is not time-synchronized and therefore, both the Date and Time fields can be changed.

The time field in the dialog box is not updated continuously. The time at which the dialog box was opened is the time that is displayed and remains as such. This is true whether the relay is synchronized with the IRIG-B signal or not.

▢ **COMMAND BUTTONS**
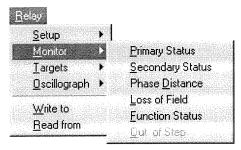
Stop Clock This toggles between start/stop, the relay clock. 'Stop' pauses, 'Start' resumes.

Save When connected to the Protection system, the date and time information on the display is sent to the relay.
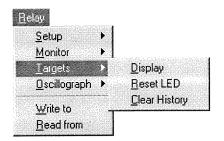
Cancel Returns you to IPScom® main window. Any changes to displayed information are lost.

The **Monitor** submenu provides access for reviewing the present status of the measured and calculated values, other real-time parameters and conditions as well as examining real-time and historical demand metering information (see Section 4.3 **Checkout Status/Metering**). A cascading menu appears, providing several command options as shown below.

The **Targets** submenu provides three command options: **Display**, **Reset LED**, and **Clear History**. The **Display** command displays the **Target Dialog**. This dialog box (see Figure 4-13) provides detailed data on target events, including time, date, function status, phase current values, and IN/OUT contact status at the time of trip. Individually recorded events may be selected within the dialog box and saved into a text file, or printed out with added comments. The **Reset LED** is similar to pushing the **Target Reset** button on the unit itself, and resets current target displayed on the relay. This command does not reset any target history.

The **Clear History** command clears all stored target data.
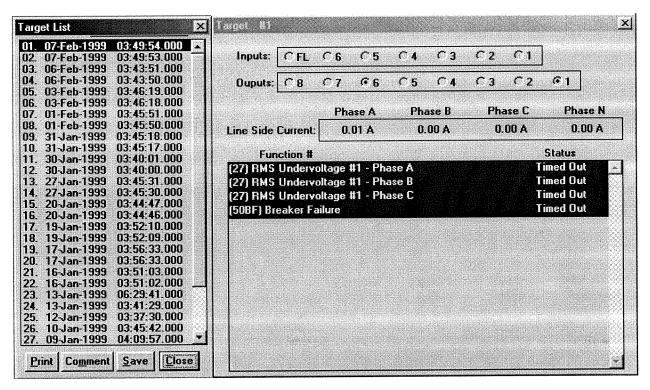
Figure 4-13   Target Dialog Box

Path: Relay menu / Targets submenu / Display window

Time is displayed in milliseconds when the IRIG-B time synchronization is used. When the IRIG-B is not used, the millisecond part of the time stamp reads 000.

▢   **COMMAND BUTTONS**

Comment   Opens comment dialog box for annotation.
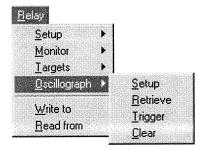
Print   Prints out selected target information, with comment.

Save   Saves selected target information, with comment, as a text file.

Close   Exits the currently displayed dialog box.

■ **NOTE: Comment, Print,** and **Save** command buttons resident in Target dialog box are only available in IPScom version V2.7.0 and after.

The **Oscillograph** submenu allows storing data on selected parameters for review and plotting at a later time. The **Setup** command allows the user to set the number of partitions and triggering designations to be made. The **Retrieve** command downloads and stores collected data to a file; **Trigger** allows the manual triggering of the recorder; **Clear** erases the existing record. Run the optional M-3801A IPSplot® Oscillograph Analysis Software program to view the downloaded oscillograph files.

The **Write To** command is used to write the data to the M-3430 relay. The **Read From** command is used to retrieve the data from the relay to the computer for display.

Window Menu/Help Menu

The **Window** menu enables the positioning and arrangement of any all IPScom® windows so that there is better access to available functions. This feature allows the display of several windows at the same time. Clicking on an inactive window activates that window.

The **Help** menu enables you to look up information about any IPScom menus or commands.

The **About** IPScom Dialog Box (see Figure 4-14) displays IPScom version and development information.
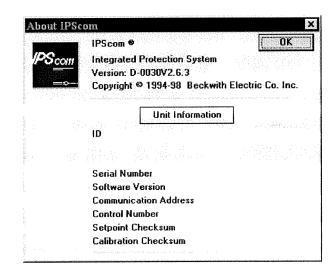
Figure 4-14   About IPScom Dialog Box

Path: Help menu / About... command

⬜ **COMMAND BUTTONS**

   OK   Exits the currently displayed dialog box.

The **Profile Info** allows the user to view or make notations for the relay setpoint data files.

4.3   Checkout Status/Metering
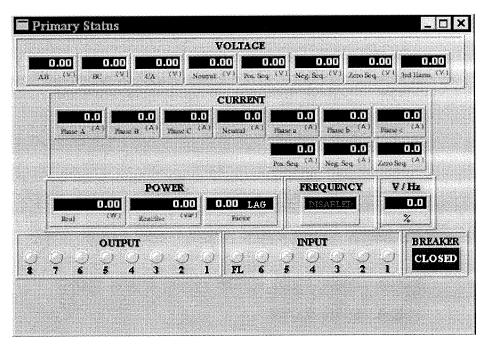
Figure 4-15   Primary Status Dialog Box

Path: Relay menu/ Monitor submenu/ Primary Status window

These are calculated values base on the VT and CT inputs.
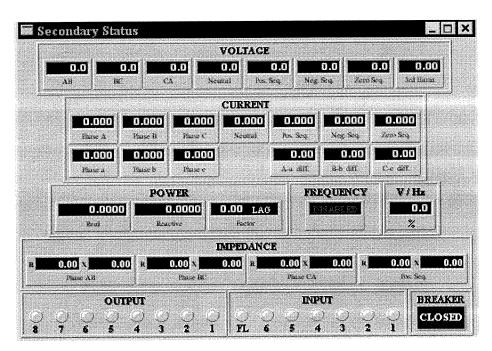
Figure 4-16   Secondary Status Dialog Box

Path: Relay menu / Monitor submenu / Secondary Status window
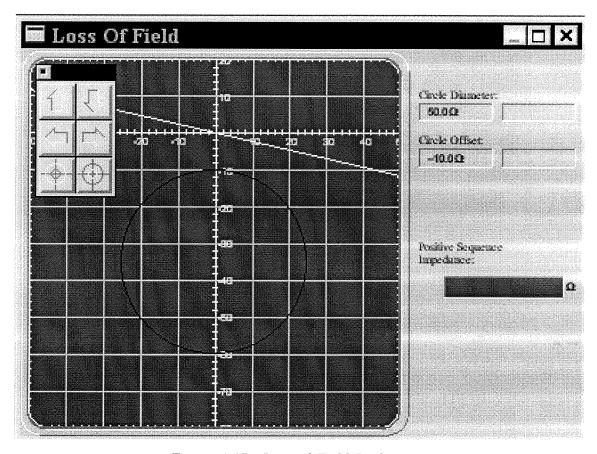
Figure 4-17   Loss of Field Dialog Box

Path: Relay menu / Monitor submenu / Loss of Field window

CONTROL BUTTONS

⬆	Move up the scope window	⬅	Move the scope window to the left
⬇	Move down the scope window	➡	Move the scope window to the right
⊕	Zoom In	⊙	Zoom Out
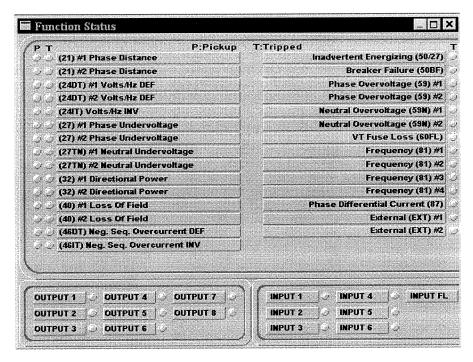
Figure 4-18 Function Status Dialog Box

Path: Relay menu / Monitor submenu / Function Status window

COMMAND BUTTONS

Close Exits the currently displayed dialog box.

4.4 Cautions

System and IPScom® Compatibility

Every attempt has been made to maintain compatibility with previous software versions. In some cases (most notably with older protection systems), compatibility cannot be maintained. If there is any question about compatibility, contact the factory.

System Priority

System conflicts will not occur, as local commands initiated from the front panel receive priority recognition. While the unit is in local mode, communication via the serial ports is suspended. IPScom displays an error message to indicate this fact.

Time and Date Stamping

Time and date stamping of events is only as useful as the validity of the unit's internal clock. Under the **Relay** menu, the **Set Date/Time** command allows you to manually set the unit's clock.

Echo Cancel

The Echo Cancel check box, under the **Comm** menu, should only be used when several relays are connected via a fiber optic loop network. Otherwise, Echo Cancel must *not* be selected or communication will be prevented.

Serial Port Connections

If the serial port is connected to something other than a modem, and an IPScom modem command is executed, the results are unpredictable. In some cases, the computer may have to be reset.

4.5   Keyboard Shortcuts

Keyboard Shortcuts	
SYSTEM KEYS	
These keys can be used within Windows and IPScom®.	
Alt-Tab	To switch between applications.
Ctrl-Esc	To open Task List dialog box or Open Start Menu (Win 95/98).
Ctrl-Tab	To switch between windows within an application.
Arrow Keys	To select an application or group icon.
First Character of Name	To select application or group icon.
Enter	To open selected group or run selected application.
MENU KEYS	
These keys enable you to select menus and choose commands.	
Alt or F10	To select or cancel selection of the Setup menu on the menu bar..
Left Arrow, Right Arrow	To move between menus.
Up Arrow, Down Arrow	To move between commands.
A character key	To choose the menu or command. The underlined character matches the one you type.
Enter	To choose the selected menu name or command.
Esc	To cancel the selected menu name, or to close the open menu.
DIALOG BOX KEYS	
These keys are useful when working in a dialog box.	
Alt-a character key	To move to the option or group whose underlined letter or number matches the one you type.
Arrow Keys	To move highlighted selections within list boxes.
Alt-Down Arrow	To open a list.
Spacebar	To select an item or cancel a selection in a list. Also to select or clear a check box.
Enter	To carry out a command.
Esc or Alt-F4	To close a dialog box without completing the command.

Table 4-1   Windows Keyboard Shortcuts

4.6 IPSutil™ Communications Software
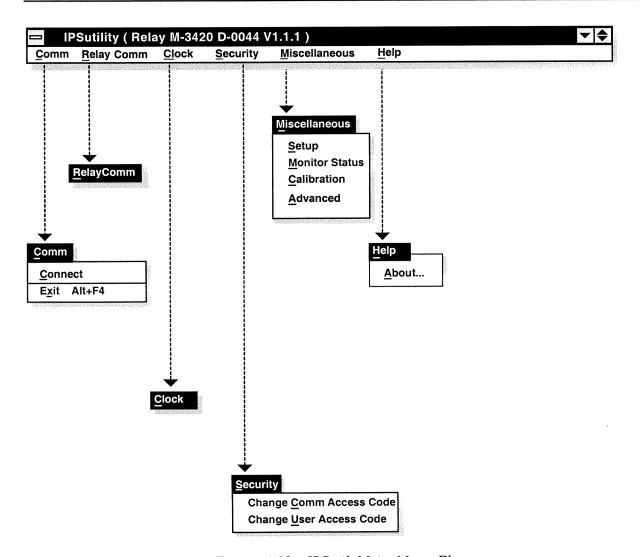
Figure 4-19 IPSutil Main Menu Flow

M-3800 IPSutil™

The IPSutil Communication software package provides communication with the Beckwith Integrated Protection System® (IPS) for setting up the relays. Its main purpose is to aid in setting up IPS relays that are ordered without the optional front panel HMI interface.

● **WARNING: The IPScom® and IPSutil programs are distributed on the same disk. The IPSutil program has the capability of overriding the security parameters set in the relay. It is recommended that you remove the IPSutil program from the IPScom disk and file it separately in a safe place, to be used by authorized people. For convenience, Beckwith Electric has distributed both programs on the same disk.**

Installation and Setup

IPSutil™ runs with the Microsoft® Windows operating system, version 3.1 or above, and is available in the following IBM PC-compatible format:

- one 3.5" double-sided, high-density (DS/HD 1.44 Mb) disk

Hardware Requirements

IPSutil™ will run on any IBM PC-compatible computer that provides at least the following:

- 4 Mb of RAM

- Microsoft® Windows 3.1 or Windows 95

- one 3.5" double-sided, high-density (DS/HD 1.44 Mb) disk drive

- one serial (RS-232) communication port

- VGA monitor

- Mouse or pointing device

Installation

An installation utility has been provided as a part of IPScom and IPSutil programs. After installation, the IPSutil can be run from the hard drive by choosing IPSUTIL.EXE.

System Setup

Connect a null modem cable from COM1 of the relay to the PC serial port. The IPSutil supports COM1 port direct connection only. Modem connection is not supported. IPSutil program is not supported through COM2 or COM3 ports of the relay.

Overview

IPSutil helps in setting up IPS relays which were ordered without the optional front panel HMI interface. Units delivered without HMI's are shipped with a set of factory default settings for various parameters that the end user may wish to change. While the utility program is directed to users that do not have HMI, users of HMI-provided relays can also use IPSutil to set various parameters. When the IPSutil is started, a warning window appears (See Figure 4-20).
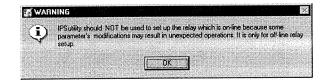
Figure 4-20 Warning message

After you accept the warning, you can access the IPSutil main menu. The following sections describe each IPSutil menu items.

Comm Menu
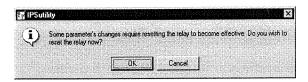
The **Comm** menu allows you to make connections to the relay. This is the first command you must use to access the unit. After you click the **Connect** submenu item, the Communications dialog box appears (See Figure 4-21).

- Select the correct PC communication port where the null modem cable is connected for the relay.

- Select the baud rate of the relay. Factory default is 9600 baud.

- Select the access code resident in the relay. Factory default is 9999.

- Click "**Open COM**" button.

The following message window will appear showing COM opened. Now, the title bar will display the relay model and the software version.

The **Exit** submenu allows you to quit the IP-Sutil™. If the relay was connected, this submenu disconnects the relay. When the relay was connected, if you have made any changes for some parameters (for example, baud rate, phase rotation) the following message window appears.

Relay Comm

When **Relay Comm** command is selected, the Relay Comm Port Settings dialog box appears (See Figure 4-23). It allows you to set the relay communication ports COM1 or COM2/COM3 baud rate. For COM2/COM3, it allows you to set the protocol and dead synch time. Additionally, for COM2 and COM3, if you select MODBUS protocol, the dialog box allows you to enable the parity option.

■ **NOTE:** If COM1 baud rate is changed and the relay is reset, the new baud rate must be used to communicate with COM1

Clock

When the **Clock** command is selected, the "Set Unit Date/Time" dialog box appears (See Figure 4-24). Date and Time can be changed and sent to the relay. This dialog box allows you to start or stop the clock in the relay.

Security Menu

The **Security** Menu allows you to set the communication access code and the level access codes for the relay.

The **Change Access Code** allows you to assign new communication access code to the relay. The range of the access code is 1 to 9999. Note that the access code 9999 is a factory default. See Figure 4-25.

■ **NOTE:** Setting the access code to 9999 disables security.

The **Change Level Access Code** allows you to assign three different levels of access code for the relay functions accessibility. The range of the level access code is 1 to 9999. See Figure 4-26.

▲ **CAUTION:** This submenu allows you to change the relay level access codes.

Miscellaneous Menu

The **Miscellaneous** menu allows you to set and monitor some of the relay parameters.

The **Setup** submenu allows you to change the users Logo information, test outputs, assign communication address and user control number, phase rotation, **OK** LED flash mode in the relay. Note that the highest number used for the communication address is 255 and the highest control number allowed is 9999. See Figure 4-27.

The **Monitor Status** submenu allows you to monitor and clear the error code counters, monitor the check sums, and to view inputs test status. Note that powerloss counter cannot be cleared.

Help Menu

Under **Help** Menu, the **About...** submenu provides you the information on the IPSUtil version numbers.
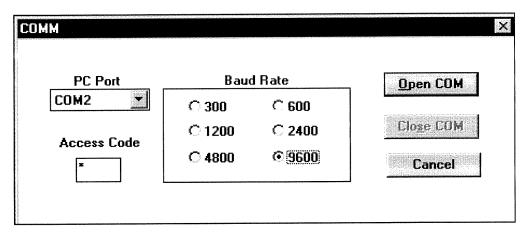
Figure 4-21   Communication Dialog Box

COMMAND BUTTONS

Open com   Initiates communication with the protective system by direct serial communication.

Close com   Discontinues communication with the protective system.

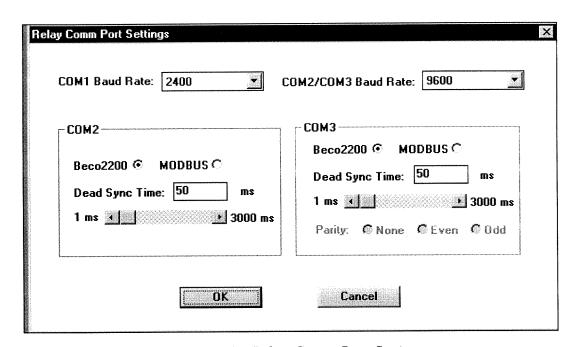**Cancel**   Returns you to the IPSutil™ main window. Any changes to the displayed information are lost.

Figure 4-22   Relay Comm Port Settings

COMMAND BUTTONS

OK   Sends the currently displayed information to the relay.

Cancel   Returns you to the IPSutil main window. Any changes to the displayed information is lost.
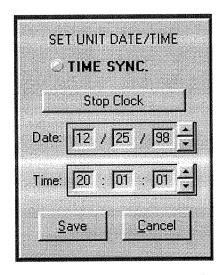
Figure 4-23   Unit Date/Time Dialog Box

COMMAND BUTTONS

Stop Clock   This toggles between start/stop the clock of the relay. The 'Stop' stops the clock in the relay. The 'Start' resumes the clock in the relay.

Save   When connected to the protection system, the date and time information on the display is sent to the relay.

Cancel   Returns you to the IPSutil main window. Any changes to the displayed information is lost.

There is a blue Time Sync LED mimic on this dialog box (the LED is displayed as different shading on a monochrome monitor). When this LED is blue, the relay is synchronized with the IRIG-B signal and the Time field is grayed out, indicating that this field can't be changed. But the Date field can be changed (by editing and pressing **Save**).

When the LED is *not* blue, the relay is not time-synchronized and therefore, both the Date and Time fields can be changed.

The time field in the dialog box is not updated continuously. The time at which the dialog box was opened is the time that is displayed and remains as such. This is true whether the relay is synchronized with the IRIG-B signal or not.

Figure 4-24   Change Communication Access Code Dialog Box

COMMAND BUTTONS

OK   Sends the currently displayed information to the relay.

Cancel   Returns you to the IPSutil™ main window. Any changes to the displayed information is lost.
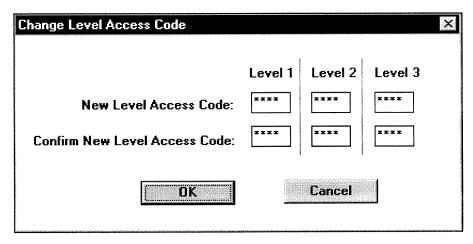
Figure 4-25 Change Level Access Code Dialog Box

COMMAND BUTTONS

OK Sends the currently displayed information to the relay.

Cancel Returns you to the IPSutil main window. Any changes to the displayed information is lost.
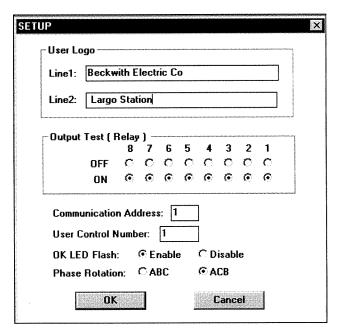
Figure 4-26 Setup Dialog Box

COMMAND BUTTONS

OK Sends the currently displayed information to the relay.

Cancel Returns you to the IPSutil main window. Any changes to the displayed information is lost.

5 Installation

It is suggested the terminal connections illustrated here be transferred to *station* one-line wiring and three-line connection diagrams, *station* panel drawings and *station* DC wiring schematics.
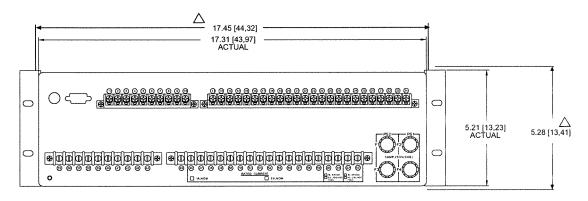
If during the commissioning of the M-3430 Generator Protection Relay, additional tests are desired, Chapter 6, **Testing**, can be consulted.

The operation of the relay, including the initial setup procedure, is described in Chapter 3, **Operation (Front Panel)**, for HMI front panel users and in Chapter 4, **Operation (Computer)**, using a personal computer. Section 3.1, Front Panel Controls, details the front panel controls and Section 3.2, Initial Setup Procedure/Settings,

details the HMI setup procedure. This includes details for entering the communications data, the unit setup data, the configure relays data, the individual setpoints and time settings for each function, and oscillograph recorder setup information. Section 3.3, Checkout Status/Metering, guides the operator through the checkout status procedures including status monitoring and viewing the target history.

5.1 Mechanical/Physical Dimensions
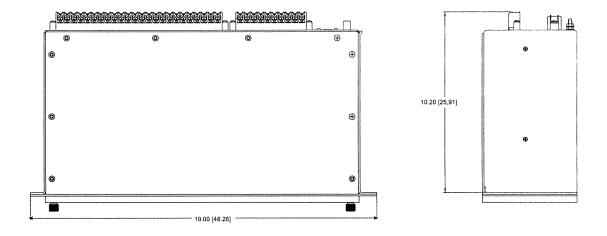
Figures 5-1 through 5-4 contain physical dimensions of the relay that may be required for mounting the unit on a rack.
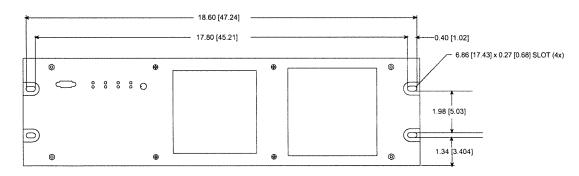
17.45 [44,32]

17.31 [43,97]
ACTUAL

5.21 [13,23]
ACTUAL

5.28 [13,41]

REER VIEW

△ RECOMMENDED CUTOUT WHEN RELAY IS
NOT USED AS STANDARD RACK MOUNT

10.20 [25,91]

19.00 [48.26]

18.60 [47.24]

17.80 [45.21]

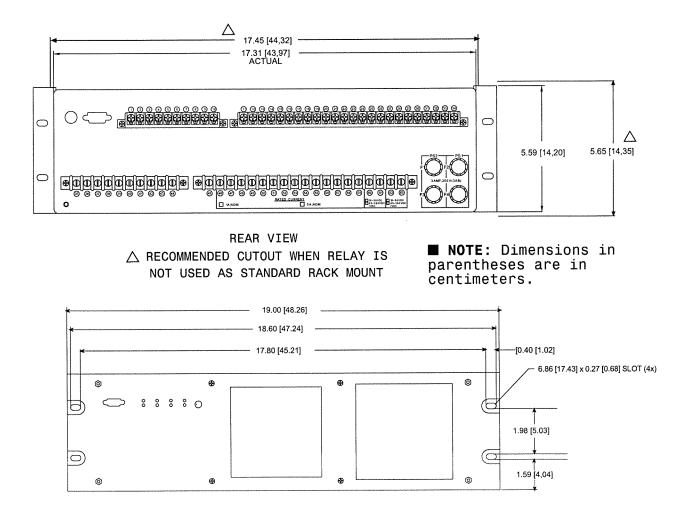0.40 [1.02]

6.86 [17.43] x 0.27 [0.68] SLOT (4x)

1.98 [5.03]

1.34 [3.404]

Horizontal Mount Chassis   ■ **NOTE**: Dimensions in parentheses
are in centimeters.

Figure 5-1   M-3430 Mounting Dimensions – Horizontal Chassis

17.45 [44,32]

17.31 [43,97]
ACTUAL

5.59 [14,20]   5.65 [14,35]

REAR VIEW

△ RECOMMENDED CUTOUT WHEN RELAY IS
NOT USED AS STANDARD RACK MOUNT

■ **NOTE:** Dimensions in
parentheses are in
centimeters.

19.00 [48.26]

18.60 [47.24]

17.80 [45.21]   [0.40 [1.02]

6.86 [17.43] x 0.27 [0.68] SLOT (4x)

1.98 [5.03]

1.59 [4,04]

Vertical Mount Chassis

Figure 5-2   M-3430 Mounting Dimensions – Vertical Chassis

.39

1.91

2.25

.261 Diameter
4 Holes

8.655

Recommended
Panel Cutout
Dimensions

18.21

19.00

2.80

2.80

8.655

*Max. Depth
of Unit:*
10"

6.19

Front View
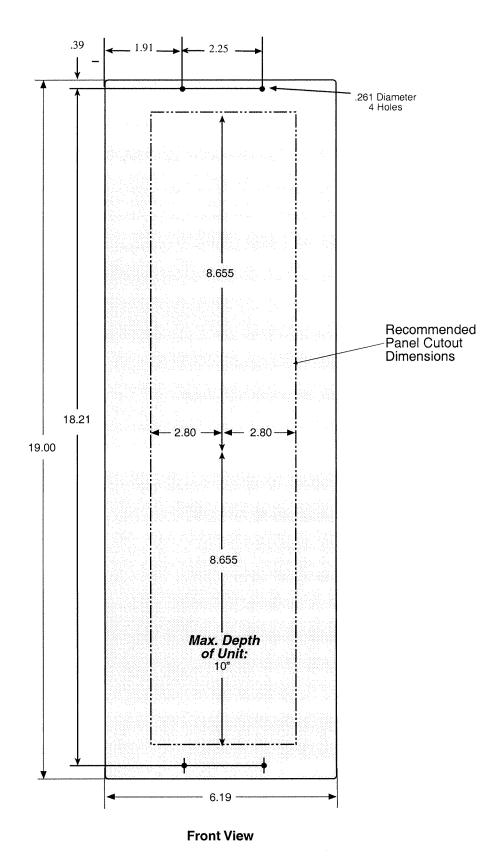
Figure 5-3   (H2) Mounting Dimensions

.75
6.13
1.04
5.56
.261 Diameter
6 Holes

8.655

Recommended
Panel Cutout
Dimensions

18.50

2.80   2.80

20.78

15.56

8.655

7.78

**Max. Depth
of Unit:**
10"

2.60

1.14

7.63

Front View
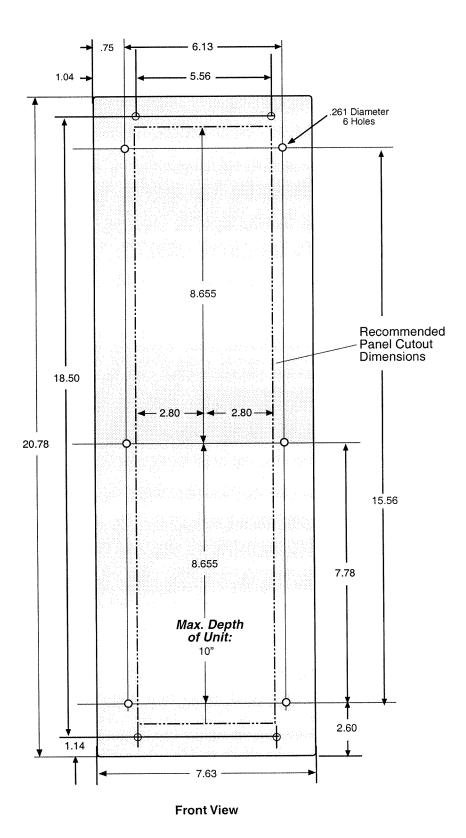
Figure 5-4   (H3) Mounting Dimensions for GE L-2 Cabinet

■ **NOTES:**

Output contacts #1 through #4 are high speed operation contacts.

FIELD GND connection is for future use.

To fulfill UL listing requirements, terminal block connections must be made with No. 12 AWG solid or stranded copper wire inserted in an AMP #324915 (or equivalent) connector and both screws tightened to 8 inch-pounds torque.

ONLY dry contacts must be connected to inputs (terminals 5 through 10 with 11 common) because these contact inputs are internally wetted.

● **WARNING: Application of external voltage on these inputs may result in damage to the units.**
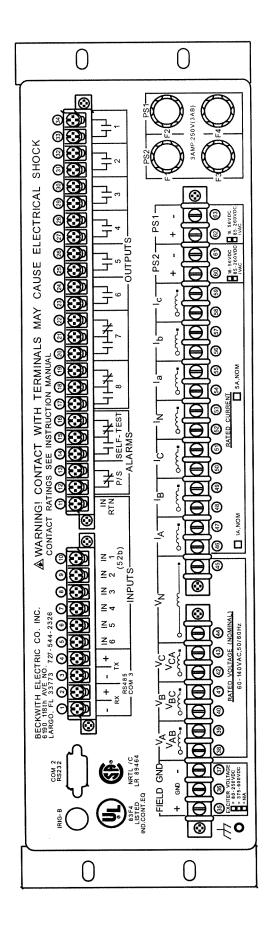
Figure 5-5 External Connections

① Alternate VT connections
② Required generator breaker status input (52b).
   Contact is closed when generator breaker is open.
   Use unit breaker contact if no generator breaker present.
③ Output contact pairs designated by user.
④ Alarm output can be grouped to a single alarm at
   discretion of user.
⑤ Available control output to supervise other relays
   for VT Fuse Loss can be designated.
⑥ Input contact number is designated by user.

● **WARNING: ONLY dry contacts must be connected
because these contact inputs are internally wetted.
Application of external voltage on these inputs may result
in damage to the units.**

■ **NOTE**: M-3430 current terminal polarity marks (•) indicate
"entering" current direction when primary current is "from"
the generator. If CT connections differ from those shown,
adjust input terminals.

Example of Control / Output Connections

Figure 5-6   Three-Line Connection Diagram

5.2 Commissioning Checkout

During field commissioning, check the following to ensure that the CT and VT connections are correct.

1. Press **ENTER**. After a short delay the unit should display:

```
VOLTAGE RELAY
VOLT curr freq v/hz pwr →
```

2. Press the right arrow button until the unit displays:

```
MONITOR STATUS
← config STAT →
```

3. Press **ENTER**. The unit should display:

```
MONITOR VOLTAGE STATUS
VOLT curr freq v/hz pwr →
```

4. Press **ENTER**. The unit should display either V_A, V_B, V_C (line-to-ground connections) or V_{AB}, V_{BC}, V_{CA} (line-to-line connections) or line-ground to line-line connections.

```
PHASE VOLTAGE
AB=    BC=    CA=
```

Compare these voltages with actual measurements using a voltmeter. If there is a discrepancy, check for loose connections to the rear terminal block of the unit. If line-ground to line-line voltage selection is used, the voltages displayed are $\sqrt{3}$ times of the line-to-ground voltages applied.

5. Press **ENTER** to display the Neutral Voltage:

```
NEUTRAL VOLTAGE
_____ Volts
```

The neutral voltage should be near zero volts.

6. Press **ENTER** to display 3rd Harmonic Neutral Voltage:

```
3RD HARMONIC NUTRL VOLT
_____ Volts
```

The 3rd Harmonic Neutral Voltage is usually between 1 V and 10 V.

7. Display positive, negative and zero sequence voltages. Press **ENTER** until the unit displays:

```
POS SEQUENCE VOLTAGE
_____ Volts
```

The positive sequence should be $V_{POS} \approx V_A \approx V_B \approx V_C$ or $V_{AB} \approx V_{BC} \approx V_{CA}$

8. Press **ENTER** until the unit displays:

```
NEG SEQUENCE VOLTAGE
_____ VOLTS
```

The negative sequence voltage should be $V_{NEG} \approx 0$

9. Press **ENTER** until the unit displays:

```
ZERO SEQUENCE VOLTAGE
_____ Volts
```

The zero sequence voltage should be $V_{ZERO} \approx 0$

If the negative sequence voltage shows a high value and the positive sequence voltage is close to zero, the phase sequence is incorrect and proper phases must be reversed to obtain correct phase sequence. If the phase sequence is incorrect, frequency- and power-related functions will not operate properly and the **MONITOR FREQUENCY STATUS** menu will read **LOW VOLT DISABLE**.

If positive, negative and zero sequence voltages are all present, check the polarities of the VT connections and change connections to obtain proper polarities.

10. Press **EXIT** until the unit displays:

```
MONITOR VOLTAGE STATUS
VOLT curr freq v/hz pwr →
```

11. Press the right arrow once until the unit displays:

```
MONITOR CURRENT STATUS
volt CURR freq v/hz pwr →
```

12. Press **ENTER** for the unit to display line currents (Ia, Ib, Ic). The unit should display:

```
PHASE CURRENT
A=      B=      C=
```

Compare these currents with the measured values using a meter. If there is a discrepancy, check the CT connections to the rear terminal block of the unit.

13. Press **ENTER** to display line currents (I_A, I_B, I_C). The unit should display::

```
PHASE CURRENT
a=      b=      c=
```

Compare these currents with the measured values using a meter. If there is a discrepancy, check the CT connections to the rear terminal block of the unit.

14. Press **ENTER** for the unit to display:

```
DIFFERENTIAL CURRENT
A=      B=      C=
```

Differential current should be near zero amps. If a significant amount of differential current is present, check the CT polarities.

15. Press **ENTER** for the unit to display:

```
NEUTRAL CURRENT (IN)
_____ Amps
```

The Neutral current IN should be near zero amps.

16. Press **ENTER** for the unit to display:

```
POS SEQUENCE CURRENT
_____ AMPS
```

The positive sequence current should be $I_{POS} \approx I_A \approx I_B \approx I_C$.

17. Press **ENTER** for the unit to display:

```
NEG SEQUENCE CURRENT
0.0 Amps
```

Negative sequence current should near zero amperes.

18. Press **ENTER** for the unit to display:

```
ZERO SEQUENCE CURRENT
0.0 Amps
```

The zero sequence current should be $I_{ZERO} \approx 0$. If a significant amount of negative or zero sequence current (greater than 25% of I_A, I_B, I_C,) then either the phase sequence or the polarities are incorrect. Modify connections to obtain proper phase sequence and polarities.

19. Press **EXIT** once and the right arrow until the unit displays:

```
MONITOR POWER STATUS
←  POWER imped i/o  →
```

20. Press **ENTER** to display real power and check its sign. The unit should display:

```
REAL POWER
_____ PU
```

The sign should be positive for forward power and negative for reverse power. If the sign does not agree with actual conditions, check the polarities of the three neutral-end CTs and/or the PTs.

21. Press **ENTER** to display:

```
REACTIVE POWER
_____ PU
```

22. Press **ENTER** to display:

```
POWER FACTOR
_____ Lag/Lead
```

5.3   Circuit Board Switches and Jumpers

DIP JUMPER	POSITION	DESCRIPTION
J60	AB	Connects CD signal to COM 2 pin 1 *
	BC	Connects +15V to COM 2 pin 1
J61	Inserted	Connects -15V to COM 2 pin 9
	Removed	Disconnects COM 2 pin 9 *
J58	AB	Receiver continuously enabled
	BC	Receiver disabled while transmitting*
J10	AB	COM3 Termination Resistor inserted
	BC	COM3 Termination Resistor not inserted*
J46	AB	COM 3 shares Baud rate with COM 1
	BC	COM 3 shares Baud rate with COM2*
J5	AB	Demodulated IRIG-B signal TTL Pin 6
	BC	Modulated IRIG-B signal BNC *

*Default setting

Table 5-1   Dip Jumper Settings

SWITCH POSITIONS				DESCRIPTION
1	2	3	4	Switches should not be changed while power is applied to unit
U	X	X	X	Up for dual Pwr Supply, down for single
	X			Not functional on M-3310
X	X	U	U	Run Mode
X	X	U	D	Factory Use only
X	X	D	U	Initialize access codes and communication parameters to default values*
X	X	D	D	Calibrate *,**

*Power down, set switch, then power up. After power up, the RELAY OK LED light remains off and DIAG LED will light when the operation has been satisfactorily completed.

**Power down, adjust, connect reference inputs, power up.

Table 5-2   Dip Switch Settings
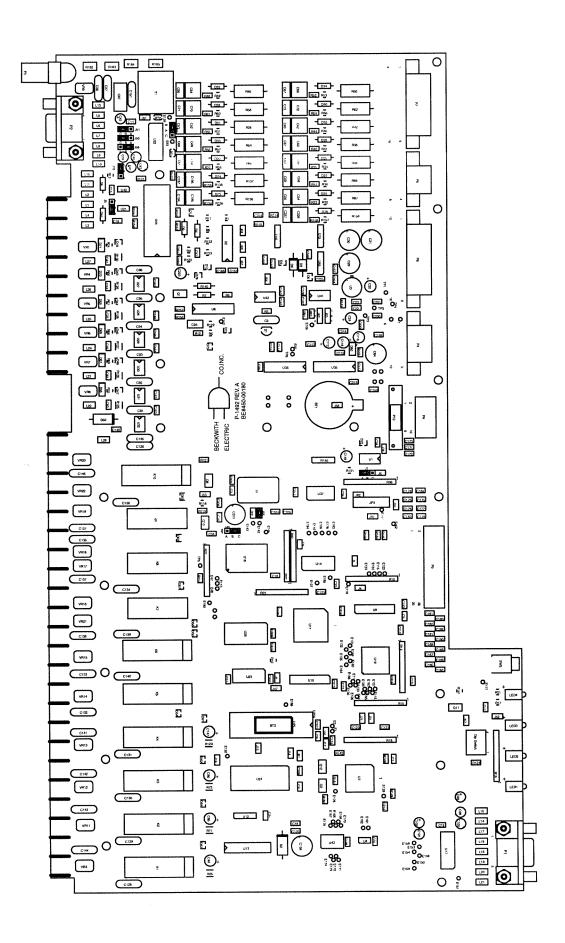
Figure 5-7   M-3430 Circuit Board

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6 Testing

6.1 Equipment/Test Setup

These test procedures are based on the prerequisite that the functions are enabled and have settings as described in Chapter 2, **Application** or "As Shipped" settings in Appendix A, **Configuration Record Forms**. The M-3430 Generator Protection Relay has been calibrated and fully tested at the factory. If calibration is necessary because of a component replacement, follow the auto-calibration procedure detailed in Section 6.3, Auto Calibration Test.

Equipment Required

The following equipment is required to carry out the test procedures:

1. Two Digital Multimeters (DMM) with 10 A current range.

2. 120 V AC or 0 to 125 V dc variable supply for system power.

3. Three-phase independent voltage sources (0 to 250 V) variable phase to simulate VT inputs.

4. Three-phase independent current sources (0 to 25 A) variable phase to simulate CT inputs.

5. Electronic timer accurate to at least 8 ms.

Setup

1. Connect system power to the power input terminals 62 (hot) and 63 (neutral). The relay can be ordered with a nominal input power supply of 110/120/230/240 Vac/110/125/220/250 Vdc or 24/48 Vdc.

■ **NOTE**: The proper power for the relay is clearly marked on the power supply terminals on the rear panel.

2. For each test procedure, connect the voltage and current sources according to the configuration listed in the test procedure and follow the steps outlined. When the testing of one function may cause another function to operate depending on the particular settings, it is recommended the untested function be disabled. Table 6-1, below. illustrates which functions to disable.

FUNCTION BEING TESTED	FUNCTION TO DISABLE													
	21	24	27	27TN	32	40	46	50/27	50BF/50N	59	59N	81	87	60FL
21	■				✓								✓	✓
24		■								✓		✓		✓
27			■			✓				✓				✓
27TN			✓	■							✓			✓
32	✓				■	✓		✓		✓			✓	✓
40	✓		✓		✓	■		✓		✓			✓	✓
46							■		✓				✓	
50/27			✓		✓			■					✓	
50BF/50N								✓	■	✓			✓	
59		✓	✓		✓					■				✓
59N				✓							■			
81		✓										■		✓
87							✓	✓	✓				■	
60FL			✓		✓				✓				✓	■

Table 6-1   Testing Disable Table
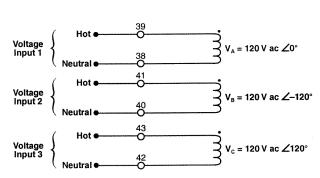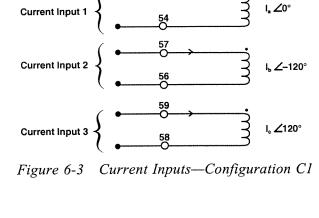
Figure 6-1   Voltage Inputs—Configuration V1

Figure 6-3   Current Inputs—Configuration C1

Figure 6-2   Voltage Inputs—Configuration V2
(open both)
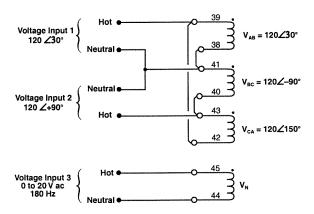

Figure 6-4   Current Inputs—Configuration C2

■ **NOTE**: The phase angles shown here use leading angles as positive and lagging angles as negative. Some manufacturers of test equipment have used lagging angles as positive, such as the Pulsar test set V_A=120 Vac<0°, V_B=120 Vac<120° and V_C=120 Vac<240°. The different phase angles listed here also apply towards the current imputs.

6.2 Diagnostic Test Procedures

The diagnostic procedures perform basic functional tests to verify the operation of the front-panel controls, inputs/outputs, and communication ports. These tests are performed in diagnostic mode, which is entered in the following manner:

1. Press **ENTER** to begin main menu.

2. Press the right arrow button until **SETUP UNIT** appears on the top line of the display.

3. Press **ENTER** to access the **SETUP UNIT** menu.

4. Press the right arrow button until **DIAGNOSTIC MODE** appears in the display.

5. Press **ENTER**. A reset warning appears: **WARNING! PROCESSOR WILL RESET, PRESS ENTER TO CONTINUE.**

6. Press **ENTER**. Unit will reset and **DIAGNOSTIC MODE** will be temporarily displayed, followed by **OUTPUT TEST (RELAY)**. This is the beginning of the diagnostic menu.

The diagnostic menu includes tests for Output, Input, Status LED, Target LED, Button, Display, Display Contrast, COM1/COM2/COM3 Loopback, COM3 (2-wire and 4-wire), Clock, Nominal Frequency, Phase Rotation, and Auto Calibration. The left arrow and right arrow buttons are used to move within the diagnostic menu.

After **EXIT** is pushed, **PRESS ANY KEY TO EXIT DIAGNOSTIC MODE** is displayed.

Output Test (Relay)

The first step in testing the operation of the function outputs is to confirm the positions of the outputs in the unoperated or **OFF** position. This can be accomplished by connecting a DMM (Digital Multimeter) across the appropriate contacts and confirming open (infinite ohms) or closed (zero ohms). The de-energized or **OFF** position for each output is listed in Table 6-2.

RELAY / OUTPUT NUMBER	NORMALLY OPEN CONTACT*	NORMALLY CLOSED CONTACT*
1	33 - 34	-
2	31 - 32	-
3	29 - 30	-
4	27 - 28	-
5	25 - 26	-
6	23 - 24	-
7	21 - 20	21 - 22
8	18 - 17	18 - 19
9 (Self-Test)	15 - 14	15 - 16
10 (Power Supply)	13 - 12	-

* *Normal position of the contact corresponds to the OFF (de-energized) state of the relay.*

Table 6-2   Output Contacts

Following confirmation and verification of output contact positions in the de-energized or **OFF** position, the output status can be turned **ON** in the following manner:

1. Press **ENTER**. The following is displayed:

```
RELAY  NUMBER
       1
```

2. Press **ENTER**. The following is displayed:

```
RELAY  NUMBER  1
OFF  on
```

3. Use the right arrow button to highlight **ON** in upper case letters.

4. Press **ENTER**. The following is displayed:

```
RELAY NUMBER
      1
```

5. The DMM can now be used to verify the position of the output contacts in the operated or **ON** position. The readings should be the opposite of the initial reading above.

6. All outputs should be returned to their initial de-energized or **OFF** positions (**OUTPUT** LEDs will go out when each output is turned off) before pushing **EXIT** to return to the **DIAGNOSTIC MODE** menu.

Choose output numbers 2 through 8 by using the up and down arrow buttons to turn all relays or outputs to the energized or **ON** position. Note that when each output is turned on, the appropriate red **OUTPUT** LED turns on and stays on.

Input Test (Status)

The **INPUT TEST** menu enables the user to determine the status of the individual status inputs. Individual inputs can be selected by its number using the up-arrow and down-arrow buttons. The status of the input will then be displayed.

INPUT NUMBER	COMMON TERMINAL	TERMINAL
1 (52b)	11	10
2	11	9
3	11	8
4	11	7
5	11	6
6	11	5

Table 6-3   Input Contacts

1. When **OUTPUT TESTS (RELAY)** is displayed, press the right arrow button until the following is displayed:

```
INPUT TEST (STATUS)
output INPUT led target →
```

2. Press **ENTER**. The following is displayed:

```
INPUT NUMBER
      1
```

3. Press **ENTER**. The following is displayed:

```
INPUT NUMBER 1
CIRCUIT OPEN
```

4. Connect **IN COM** terminal (terminal #11) to **IN1** terminal (terminal #10). See Table 6-3. This will test the input contact operation *and* the external wiring to the input contacts. The following is immediately displayed:

```
INPUT NUMBER 1
CIRCUIT CLOSED
```

Alternatively, if this specific input is being used in this application and the external wiring is complete, the external status input contact can be manually closed.

5. Disconnect **IN COM** terminal (terminal #11) from **IN1** terminal (terminal #10). The following is immediately displayed:

```
INPUT NUMBER 1
CIRCUIT OPEN
```

6. Press **ENTER**. The following is displayed:

```
INPUT NUMBER
      1
```

7. Use the up arrow button to go to the next input. Repeat the procedure using the contacts as shown in Table 6-3. When finished, press **EXIT** to return to the **DIAGNOSTIC MODE** menu.

Status LED Test

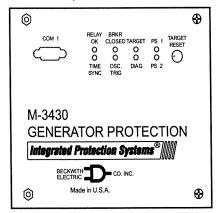The **STATUS LED TEST** menu enables the user to check the front panel LEDs individually.

Figure 6-5   Status LED Panel

1. When **INPUT TESTS (STATUS)** is displayed, press the right arrow button until the following is displayed:

```
STATUS LED TEST
output input LED target →
```

2. Press **ENTER**. LED #1 (**RELAY OK**) lights and the following is displayed:

```
STATUS LED TEST
led 1 = on
```

3. Repeat step 2 for the LEDs shown in Figure 6-5, except the PS1 and PS2 indicators. These constantly monitor the power supply.

4. Press **EXIT** to return to the **DIAGNOSTIC MODE** menu.

Target LED Test

The **TARGET LED TEST** menu allows the user to check the M-3930 Target Module LEDs individually.
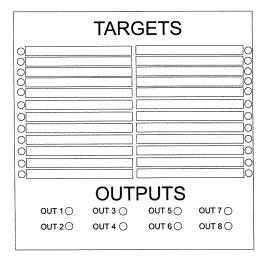
Figure 6-6   M-3930 Target Module Panel

1. When **STATUS LED TEST** is displayed, press the right arrow button until the following is displayed:

```
TARGET LED TEST
output input led TARGET →
```

2. Press **ENTER**. LED #1 lights and the following is displayed:

```
TARGET LED TEST
LED NUMBER 1 = ON
```

3. Repeat step 2 for each LED shown in Figure 6-6. When all LEDs have been tested, press **EXIT** to return to the **DIAGNOSTIC MODE** menu. Pressing the **TARGET RESET** button on the front panel also provides a simultaneous test for all **TARGET** LEDs during regular relay operation (not operational in diagnostic mode).

Expanded I/O Test

1. When **TARGET LED TEST** is displayed, press right arrow button until the following is displayed:

```
EXPANDED I/O TEST
← EX_IO button disp cont →
```

2. Press **ENTER**. Unit will display:

```
EXPANDED RELAY NUMBER
           1
```

3. Press **ENTER**. Unit will display:

```
EXPANDED RELAY NUMBER 1
off on
```

Button Test

The **BUTTON TEST** menu selection allows the user to check the M-3931 HMI Module buttons. As each button is pressed, its name is displayed.
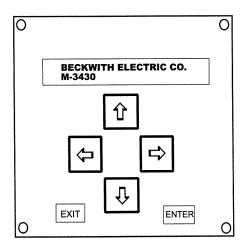

Figure 6-7   M-3931 Human-Machine Interface Module

1. When the **TARGET LED TEST** is displayed, press the right arrow button until the following is displayed:

```
BUTTON TEST
←ex_io BUTTON disp cont →
```

2. Press **ENTER**. The following is displayed:

```
BUTTON TEST
ENTER
```

3. Press each button for test.

■ **NOTE: EXIT** button will exit from this test, so it should be tested last. If it is pushed before this test sequence is completed, the test may will be stopped, but may be restarted by pushing **ENTER**. Notice the word **EXIT** is displayed temporarily before the test sequence is exited.

Display Test

The **DISPLAY TEST** menu selection enables the user to check the display. This test cycles through varying test patterns until **EXIT** is pressed.

1. When **BUTTON TEST** is displayed, press the right arrow button until the following is displayed:

```
DISPLAY TEST
←ex_ io button DISP cont →
```

2. Press **ENTER**. The unit will display a sequence of test characters until **EXIT** is pushed.

3. After the test has cycled through completely, press **EXIT** to return to the **DIAGNOSTIC MODE** menu.

Display Contrast Test

(*not applicable with fluorescent displays*)

The **DISPLAY CONTRAST** menu allows the user to adjust the contrast of the display. The contrast adjustment may be varied from a minimum of 100 (greatest contrast with background) to a maximum of 4000 (least contrast with background).

1. When **DISPLAY TEST** is displayed, press the right arrow button until the following is displayed:

```
DISPLAY CONTRAST TEST
←ex_io button disp CONT →
```

2. Press **ENTER**. The following is displayed:

```
CONTRAST CONTROL
        2000
```

3. The left and right arrow buttons are used to underline one digit of the four-digit setting. Only one digit will be underlined at a time, signifying which is the one which can be increased (using the up arrow) or decreased (using the down arrow). When the appropriate setting is shown (the contrast is automatically and immediately adjusted to the value shown on the screen), press **ENTER**.

4. Press **EXIT** to return to the **DIAGNOSTIC MODE** menu.

COM1/COM2/COM3 Loopback Test

The **COM1** and **COM2 LOOPBACK TEST** menu allows the user to check the front panel RS-232C port. A loopback plug is required for this test. **COM2 LOOPBACK TEST** menu checks the rear panel RS-232C port.

■ **NOTE**: The loopback plug required consists of a DB9P connector (male) with pin 2 (RX) connected to pin 3 (TX) and pin 7 (RTS) connected to pin 8 (CTS). No other connections are necessary.

1. When **DISPLAY CONTRAST** is displayed, press the right arrow button until the following is displayed:

    ```
    COM1 LOOPBACK TEST
    COM1 com2 com3 clock →
    ```

2. Press **ENTER**. The following is displayed:

    ```
    COM1 LOOPBACK TEST
    CONNECT LOOPBACK PLUG
    ```

3. Connect the loop-back plug to **COM1**, the front panel RS-232C connector.

4. Press **ENTER**. After the test, the following is displayed:

    ```
    COM1 LOOPBACK TEST
    PASS
    ```

5. Press **EXIT** to return to the **DIAGNOSTIC MODE** menu.

6. When **COM1 TEST** is displayed, press the right arrow button until **COM2 TEST** appears and repeat steps 1 through 5 for **COM2**.

COM3 Test (2-Wire)

The COM3 test allows the user to check operation of the COM3 port. A PC with terminal emulation software installed is required for this test.

1. When **COM3 LOOPBACK TEST 4WIRE** is displayed, press the right arrow button until the following is displayed:

    ```
    COM3 ECHO TEST 2WIRE
    ← com1 com2 COM3 clock →
    ```

2. Press **ENTER**. The following is displayed:

    ```
    COM3 ECHO TEST
    IDLING...
    ```

3. On the rear of the unit, connect a PC to the relay at terminals 3 (-) and 4 (+) via an RS-485 converter set for 2 wire operation. See Figure 6-8 for diagram.
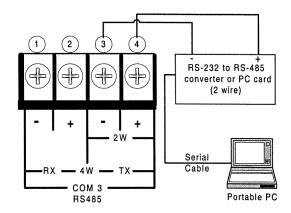

Figure 6-8   2-Wire Testing

4. Set the following PC communications parameters:

    Baud Rate: 9600
    Parity: None
    Data Bits: 8
    Stop Bits: 1
    Duplex: Half

5. Open the terminal emulator program on the PC and open the **COM** port for the RS-485 converter.

6. Press a key on the PC keyboard. Verify that the character pressed shows temporarily on the display of the relay and appears on the PC monitor.

7. When communications has been verified, press **EXIT**. The following is displayed:

    ```
    COM3 ECHO TEST 2WIRE
    -DONE-
    ```

8. Close the COM port on the PC and exit the terminal emulator program.

COM3 Test (4-Wire)

■ **NOTE:** This test is only applicable for units that have the RS-485 4-wire option installed.

The **COM3 LOOPBACK TEST 4WIRE** allows the user to test the RS-485 rear terminal connections for proper operation.

1. When **DISPLAY TEST** is displayed, press the right button until the following is displayed:

```
COM3 LOOPBACK TEST 4WIRE
← com1 com2 COM3 clock →
```

2. Press **ENTER**. The following will be displayed:

```
COM3 LOOPBACK TEST 4WIRE
CONNECT LOOPBACK PLUG
```

3. On the rear of the unit, connect a jumper from terminal 1 to terminal 3 and from terminal 2 to terminal 4. See Figure 6-9 for diagram.
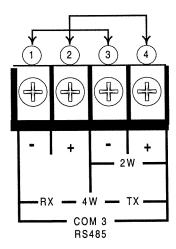

Figure 6-9   4-Wire Testing

4. Press **ENTER**. The following is displayed:

```
COM3 LOOPBACK TEST
19200 pass....
```

5. Press **ENTER** to test each of the baud rates. When all baud rates have been tested, press **ENTER**. The following will be displayed:

```
COM3 LOOPBACK TEST
-DONE-
```

Clock Test

1. When **COM3 ECHO TEST 4WIRE** is displayed, press the right arrow button until the following is displayed:

```
CLOCK TEST
com1 com2 com3 CLOCK →
```

2. Press **ENTER**. A display similar to the following is shown:

```
CLOCK TEST
03-JAN-1998 09:00:00.000
```

3. Press **ENTER** again to toggle the clock. If the clock is running, it will stop. If the clock has stopped, it will start. The clock stop case is shown below.

```
CLOCK TEST
-CLOCK START-
```

4. Press **ENTER** and verify that the relay clock is running. A display similar to the following is shown with the seconds counting.

```
CLOCK TEST
03-JAN-1998 09:00:35.000
```

5. Press **ENTER** again to stop the clock. The following will be displayed:

```
CLOCK TEST
-CLOCK STOP-
```

6. Press **ENTER** and verify that the relay clock has stopped. A display similar to the following will be shown, with the seconds stopped:

```
CLOCK TEST
03-JAN-1998 09:00:35.000
```

■ **NOTE:** When the relay's clock has stopped, the seconds will be displayed as 80.

7. Repeat steps 2 and 3 to restart the clock.

■ **NOTE:** If the unit is removed from service or is without power for long periods of time, the clock should be stopped to preserve battery life.

Nominal Frequency

▲ **CAUTION**: Changing these settings may result in erroneous operation of your system! *Before any attempts to adjust nominal frequency, contact Beckwith Electric Co.*

```
NOMINAL FREQUENCY
← FREQ phase        →
```

Phase Rotation

ABC or ACB phase rotation sequence can be chosen or set here. Check your order to verify phase rotation setting.

```
PHASE ROTATION
← FREQ phase        →
```

Auto Calibration

Refer to the following Section 6.3, Auto Calibration, for more information on that function.

```
AUTO CALIBRATION
← CAL factory
```

Factory Use Only

This function is provided to permit access by factory personnel.

```
FACTORY USE ONLY
← cal FACTORY
```

Exiting Diagnostic Mode

From anywhere in the menu, press **EXIT**. Unit will display:

```
PRESS EXIT TO
EXIT DIAGNOSTIC MODE
```

Pressing **EXIT** at this time will cause the unit to exit from **Diagnostic Mode**, and cycle through **Power On Self Test** screens.

6.3 Auto Calibration Procedure

The M-3430 Generator Protection Relay has been fully calibrated at the factory. There is no need to recalibrate the unit prior to initial installation. Further calibration is only necessary if a component was changed, or if a unit originally ordered as 60 Hz will be operated at 50 Hz.

For units without an HMI, see Section 5-3, Circuit Board Switches and Jumpers for dipswitch settings for auto calibration.

1. When **PHASE ROTATION** is displayed, press the right arrow button until the following is displayed:

   ```
   AUTO CALIBRATION
   clock led CAL factory
   ```

2. Press **ENTER**. The following is displayed:

   ```
   CONNECT REFERENCE INPUTS
   PRESS ENTER TO CALIBRATE
   ```

3. Connect $V_A=V_B=V_C=V_N$ = 120.0 Vac, ±.01 Vac at <0° phase and $I_a=I_b=I_c=I_A= I_B=I_C=I_N$=5.00*, ±.01A at <0°. For 1 Amp CTS, use 1.00 Amp ±0.002. *1 Amp for 1A rated unit. Connections are indicated in Figures 6.8 and 6.9.

■ **NOTE**: The phase angle difference between voltage and current input source should be 0° ±0.05°, and an accurate low-distortion source should be used. (THD less than 1%.) Resolution = 1°.

4. Press **ENTER**. While the unit is calibrating, the unit will display **WAIT**. When the calibration is complete, the unit will display **DONE**.

5. The calibration can be verified by reading the status (see the **MONITOR STATUS** menu and Monitor Status/Metering in Section 3.3, Checkout Status/Metering).

$V_A=V_B=V_C=V_N$=120 V $V_1=V_2=0$ V_0=120V

$I_A=I_B=I_C=I_N$=5A* $I_1=I_2=0$ I_0=5 A*

$I_a=I_b=I_c$=5A*   P=1 puQ=0.0 pu

Power Factor=1.0

$I_{diffa} = I_{diffb} = I_{diffc} = 0$

where subscript 0, 1, and 2 represent zero, positive, and negative sequence quantities respectively.
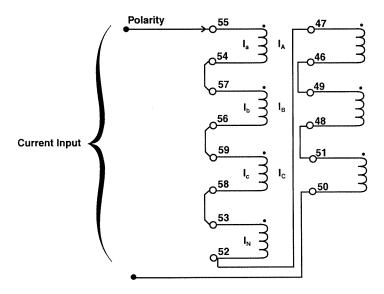
6. Remove the calibration source inputs.

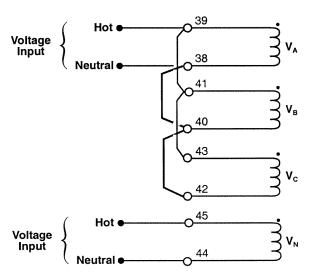*Figure 6-10   Current Input Configuration*

Figure 6-11   Voltage Input Configuration

6.4 Functional Test Procedures

This section details the test quantities, inputs and procedures for testing each function of the M-3430 Generator Protection Relay. The purpose is to confirm the function's designated output operation, the accuracy of the magnitude pickup settings, and the accuracy of time delay settings. Whereas the first test described, "Power On Self Test," does not require electrical quantity inputs all other functional tests require inputs and the necessary connection configurations as shown.

In all test descriptions, a process for calculating input quantities to test the actual settings of the function will be given if needed. In many test cases, it will be necessary to disable other functions not being tested at the time. This action is to prevent the operation of multiple functions with one set of input quantities, which could cause confusion of operation of outputs or timers. The complete description of the method to disable/enable functions may be found in detail in Section 3.2, Configure Relay Data or Chapter 4, **Operation (Computer)**. The complete description of the method to install setting quantities, may also be found in detail in Section 3.2, Setpoints and Time Settings or Chapter 4, **Operation (Computer)**.

It is desirable to *confirm* or check the actual settings of the individual functions of the M-3430 before beginning the testing. Use the **FUNCTION-AL CONFIGURATION RECORD FORM** and the **SETPOINT AND TIMING RECORD FORM** found in Appendix A for recording settings.

The tests are described in this section in ascending function number order as in Chapter 2, **Application**. Depending on which functions are to be tested at a given time, an order may be determined with the aid of Table 6-1, Testing Disable Table, which may result in the fewest changes in connections and disable/enable operations.

During the lifetime of the relay, testing of individual functions (due to changes in application settings) will be more likely than an overall testing routine. An index of the individual test procedures is illustrated at the beginning of this chapter.

■ **NOTE:** Care must be taken to reset or enable any functions that have been changed from their intended application settings before quitting the test procedures. Note that after a function is disabled, both output arrangements and blocking input designations must be reestablished.

Many options for test sequences and methods are possible. As an example, the operation of the output contacts can be tested along with the operation of the LEDs in the Diagnostic Test Procedures. If desired, during the Functional Test Procedures, the closure of the output contacts may again be confirmed with the LED and function operation.

If timer quantities are to be checked, the timer must be activated by the appropriate output contacts. The contact pin numbers are enumerated in Table 6-2, Output Contacts.

It is suggested that copies of the following be made for easy referral during test procedures:

Input Configurations - page 6-3

Output Contact Numbers - page 6-5

Relay Configuration Table - page A-2

Setpoint & Time Record Form - pages A-8, 9

Power On Self Tests

VOLTAGE INPUTS: none

CURRENT INPUTS: none

1. Apply proper power to the power input terminals: 60 (HOT) and 61 (NEUTRAL).

2. The unit will display:

```
POWER ON SELFTESTS
XXXXXXXxxxxxxxx
```

3. All LEDs will light simultaneously, for about 1 sec. The **POWER** and **RELAY OK** LEDs will remain lit; the rest of the LEDs will turn off, except for LEDs distinguishing trip conditions (ie, F27 under-voltage). These should be disabled if necessary.

The unit will display:

```
POWER ON SELFTESTS
PASS            →
```

The model number:

```
BECKWITH ELECTRIC CO.
M-3430
```

```
BECKWITH ELECTRIC CO.
D-0024XX.XX.XX
```

where "xx.xx-xx" signifies the software revision;

```
BECKWITH ELECTRIC CO.
Serial Number XXX
```

where "xxx" signifies the unit serial number.

The **POWER** LED(s) will turn on. The **RELAY OK** LED will flash (or stay on as programmed in the setup menu) and the **BREAKER CLOSED** LED will remain on. The power on self-test ends with the system date and time and the default logo, and then presents the default screens. These are the target history screens when a trip has occurred, which will have occurred if the voltage and frequency relays are enabled, but there is no input voltage.

21 Phase Distance (#1 or #2), Line to Ground

VOLTAGE INPUTS:	Configuration V1		
CURRENT INPUTS:	Configuration C1		
TEST SETTINGS	Diameter	P ohms	(0.1 to 100)
	Offset	O ohms	(-100 to +100)
	Impedance Angle	A Degrees	(0 to 90)
	Time Delay	D cycles	(1 to 8160)
	Programmed Outputs	Z OUT	(1 to 8)

Function 87, 60FL	Disable
DELTA-Y Transform	Disable
VT Configuration	Line-Ground
Function 21 #1 or #2	Disable

■ **NOTE:** It would be efficient to disable the function with the higher "reach" (Diameter plus Offset) setting first (lower current) and test the lower "reach" setting operation. Since the higher reach setting operation can be tested without disabling the lower setting, the 21 functions will be enabled when the tests are complete.

1. Disable functions as shown. See Section 3.2, Configure Relay Data, for procedure.

2. Confirm settings to be tested.

3. Connect inputs in Configuration V1 and C1 designated above. See Section 6.1, Equipment/Test Setup for configurations.

4. The level of current at which operation is to be expected for an individual setting is as follows:
   a. Define "Reach" as **R ohms = (P ohms + O ohms)** offset, **O**, usually set at zero ohms
   b. Define "Current " as **I = (Selected Voltage ÷ R ohms)**. The voltage level may be selected based on the desired test current level.

5. Set the three phase voltages V_A, V_B, and V_C to the **Selected Voltage** value from step 4.

6. Set the phase angle between the voltage and current inputs at **A** degrees (from setting above).

7. Hold the **TARGET RESET** button in and slowly increase the three-phase currents on the input until the appropriate **21 #_ PHASE DISTANCE** LED light goes on or the pickup indicator operates on the computer target screen. The level should be equal to "**I**" calculated in step 4 with the resulting impedance ±0.1 ohms or 5%. Release the target reset button and decrease the **INPUT CURRENTS** and the **OUTPUT** LED will go out. Press **TARGET RESET** button to remove targets.

8. With output contacts (**Z**) being connected to the timer, apply approximately 110% of the current (**I**) found in step 4 and start timing. The contacts will close after **D** cycles within −1 to +3 cycle.

9. If testing is complete, enable any functions disabled for this test. If other tests are to be completed, check the proper functions to disable for the next test and proceed from this point.

21 Phase Distance (#1 or #2), Line to Line

VOLTAGE INPUTS:	**Configuration V2**		
CURRENT INPUTS:	**Configuration C1**		
TEST SETTINGS	Diameter	**P ohms**	**(0.1 to 100)**
	Offset	**O ohms**	**(-100 to +100)**
	Impedance Angle	**A Degrees**	**(0 to 90)**
	Time Delay	**D cycles**	**(1 to 8160)**
	Programmed Outputs	**Z OUT**	**(1 to 8)**

Function 87, 60FL	**Disable**
DELTA-Y Transform	**Disable**
VT Configuration	**Line-Line**
Function 21 #1 or #2	**Disable**

■ **NOTE**: It would be efficient to disable the function with the higher "reach" (Diameter plus Offset) setting first (lower current) and test the lower "reach" setting operation. Since the higher reach setting operation can be tested without disabling the lower setting, the 21 functions will be enabled when the tests are complete.

1. Disable functions as shown. See Section 3.2, Configure Relay Data, for procedure.

2. Confirm settings to be tested.

3. Connect inputs in Configuration V2 and C1 designated above. See Section 6.1, Equipment/Test Setup for configurations.

4. The level of current at which operation is to be expected for an individual setting is as follows:

   a. Define "Reach" as **R ohms = (P ohms + O ohms)** offset, **O**, usually set at zero ohms

   b. Define "Current " as **I = ((Selected Voltage/   ) ÷ R ohms)**. The voltage level may be selected based on the desired test current level.

5. Set the three phase-voltages V_A, V_B, and V_C to the **Selected Voltage** value from step 4.

6. Set the phase angle between the voltage and current inputs at **(A-30°)** degrees (from setting above).

7. Hold the **TARGET RESET** button in and slowly increase the three-phase currents on the input until the appropriate **21 #_ PHASE DISTANCE** LED light goes on, or the pickup indicator operates on the computer target screen. The level should be equal to **"I"** calculated in step 4 with the resulting impedance ±0.1 ohms or 5%. Release the target reset button and decrease the **INPUT CURRENTS** and the **OUTPUT** LED will go out. Press **TARGET RESET** button to remove targets.

8. With output contacts (**Z**) being connected to the timer, apply approximately 110% of the current (**I**) found in step 4 and start timing. The contacts will close after **D** cycles within −1 to +3 cycle.

9. If testing is complete, enable any functions disabled for this test. If other tests are to be completed, check the proper functions to disable for the next test and proceed from this point.

24 Volts Per Hertz Definite Time (#1 or #2)

VOLTAGE INPUTS:	**Configuration V1**		
CURRENT INPUTS:	**None**		
TEST SETTINGS:	**Definite Time Pickup**	**P %**	**(100 to 200)**
	Time Delay	**D**	**(30 to 8160)**
	Programmed Outputs	**Z OUT**	**(1 to 8)**
	Function 24DT #1 or 2[1]	**Disable**	
	Function 24IT	**Disable**	

1. Disable functions as shown. Refer to Section 3.2, **Configure Relays Data**, for procedures.

2. Confirm settings to be tested.

3. Connect voltage input in Configuration V1 designated above. Refer to Section 6.4, Input Configurations, for configurations.

4. The volts/Hz pickup level of a percentage setting of nominal frequency (50 or 60Hz) is Definite Time Pickup **P** % ÷ 100 times **Nominal Voltage**, see example below. The Nominal Values have been programmed in the system setup data described in Section 2.2, **Configuration,** and are recorded on the **COMMUNICATION & UNIT SETUP RECORD FORM**. Test voltage levels may be at any percentage of Nominal Voltage. Choose 4 or 5 test levels and calculate the voltage level for each. 150% V/Hz ÷ 100 x 120 =180 volts (*Pickup (P) setting divided by 100, multiplied by Nominal Voltage equals voltage level*)

5. **Voltage Pickup Test:** Apply voltage to phase A of the relay at a level 10% lower than pickup level calculated in step 4. Press and hold the **TARGET RESET** button, and slowly increase the voltage on phase A until the **24DT DEF TIME VOLTZ/HZ** LED illuminates or the pickup indicator operates on the computer target screen. The level of operation will be **P** ±1%. Release the **TARGET RESET** button and decrease phase A voltage to 10% below the pickup voltage and the **OUTPUT** LED will go out. Press the **TARGET RESET** button to remove targets. This test may be repeated for each of the other 2 phase voltages.

6. **Frequency Pickup Test:** Apply voltage to phase A of the relay at the Nominal Voltage level. Press and hold the **TARGET RESET** button, and slowly decrease the frequency of phase A until the **24DT DEF TIME VOLTZ/HZ** LED illuminates or the pickup indicator operates on the computer target screen. The level of operation will be **P** ±1%. Release the **TARGET RESET** button and increase phase A frequency to 1% above the pickup frequency and the **OUTPUT** LED will extinguish. Press the **TARGET RESET** button to remove targets. This test may be repeated for each of the other 2 phases. 60 ÷ 150% V/Hz ÷ 100 = 40Hz (**Nominal Frequency** *Pickup (P) setting times 100 equals frequency level*)

7. **Timer Test:** With output contacts (**Z**) connected to the timer, apply the calculated voltage from step 4 on phase A and start timing. The operating time will be **D** cycles within +25 cycles. Repeat this step for all test levels chosen. The tested points verify the operation of the function.

8. If testing is complete, enable any functions disabled for this test. If further testing is desired, check the proper functions to disable for the next test and continue from this point.

---

[1] *Only the function being tested should be enabled, the other disabled.*

24 Volts Per Hertz Inverse Time

VOLTAGE INPUTS:	**Configuration V1**		
CURRENT INPUTS:	**None**		
TEST SETTINGS:	**Inverse Time Pickup**	**P %**	**(100 to 150)**
	Inverse Time Curve	**C**	**(1 to 4)**
	Time Dial	**TD**	**(1 to 100)**
	Reset Rate	**R**	**(1-999)**
	Programmed Outputs	**Z OUT**	**(1 to 8)**
	Function 24DT#1 & 2	**Disable**	

1. Disable functions as shown. Refer to Section 3.2, **Configure Relays Data,** for procedures.

2. Confirm settings to be tested.

3. Connect voltage input in Configuration V1 designated above. Refer to Section 6.4, **Input Configurations,** for configurations.

4. The volts/Hz pickup level of a percentage setting of nominal frequency (50 or 60Hz) is Definite Time Pickup **P %** ÷ 100 times **Nominal Voltage,** see example below. The Nominal Values have been programmed in the system setup data described in Section 2.2, **Configuration,** and are recorded on the **COMMUNICATION & UNIT SETUP RECORD FORM.**

150% V/Hz	÷ 100	x 120	=180 volts
Pickup (**P**) setting	divided by100	times **Nominal Voltage**	equals voltage level

5. Test voltage levels may be at any percentage of Nominal Voltage that are a minimum of 5% higher than the selected pickup percentage, **P** %. It is suggested to choose 4 or 5 test levels and calculate the voltage level and operating time from the table below for each.

6. **Time Test:** With output contacts (**Z**) connected to the timer, apply the calculated voltage from step 4 on phase A and start timing. Operating time will be as calculated in step 5 ±*1%.* Repeat this step for all chosen test levels. The curve portion extending lower than **P** % V/Hz values are inactive and can be ignored.

$t = \dfrac{.003 * K}{\left(\left(\dfrac{M}{100}\right) - 1\right)^2}$	$t = e^{\frac{115 + (2.5 \times TD) - V/Hz}{4.8858}}$	$t = e^{\frac{113.5 + (2.5 \times TD) - V/Hz}{3.04}}$	$t = e^{\frac{108.75 + (2.5 \times TD) - V/Hz}{2.4429}}$
Curve 1	**Curve 2**	**Curve 3**	**Curve 4**

t= time in minutes
TD = Time Dial Setting
V/Hz in percent (%)

7. **Reset Rate Test:** If it is desired to test the reset rate, begin timing when the input voltage is reduced below pickup value. Pressing and holding the **TARGET RESET** button, stop timing when **24IT INV. TIME VOLTS/HZ** LED extinguishes. The time will be the Reset Rate (**R**) within ±3 cycles or ±1%.

8. If testing is complete, enable any functions disabled for this test. If further testing is desired, check the proper functions to disable for the next test and continue from this point.

■ **NOTE:** If re-testing is required, the unit should be powered down or wait the duration of the programmed Reset of the timer.

27 Positive Sequence Undervoltage

VOLTAGE INPUTS:	**Configuration V1**		
CURRENT INPUTS:	**None**		
TEST SETTINGS:	**Undervoltage Pickup**	**P volts**	**(5 to 140)**
	Undervoltage Inhibit	**U volts**	**(5 to 140)**
	Time Delay	**D cycles**	**(1 to 8160)**
	Programmed Outputs	**Z OUT**	**(1 to 8)**
	Function 81U	**Disable**	

1. Disable functions as shown. Refer to Section 3.2, Configure Relay Data, for procedures.

2. Confirm settings to be tested. Be sure the Undervoltage Inhibit is set to a lower value than the Undervoltage Pickup to prevent the function from being disabled.

3. Connect voltage input in Configuration V1 designated above. Refer to Section 6.4, Input Configurations, for configurations.

4. Set 3-phase Voltage Inputs at 1.2 x **P** volts at the Nominal Frequency.

5. *Pickup Test:* Press and hold the **TARGET RESET** button, and slowly decrease 3-phase voltages until the **27 POS SEQ. UNDERVOLT** LED illuminates or the pickup indicator operates on the computer target screen. The level of operation will be **P** volts ±0.5V or ±5%. Release the **TARGET RESET** button and increase the 3-phase voltages to 1.2 x **P** volts and the **OUTPUT** LED will go out. Press **TARGET RESET** button to remove targets.

6. *Undervoltage Inhibit Test:* Slowly decrease the 3-phase voltages until the **27 POS SEQ. UNDERVOLT LED** extinguishes. The level will be **U** volts ±0.5 volts. Steps 6 and 7 may be repeated for each of the other 2 phase voltages.

7. *Time Test:* With output contacts (**Z**) connected to the timer, reduce phase voltages to approximately 50% of **P** volts and start timing. The operating time will be **D** cycles within -1 or +3 cycles or ±1%.

8. If testing is complete, enable any functions disabled for this test. If further testing is desired, check the proper functions to disable for the next test and continue from this point.

27TN Neutral Undervoltage (3rd Harmonic) (#1 or #2)

VOLTAGE INPUTS:	**Configuration V2**		
CURRENT INPUTS:	**None**		
TEST SETTINGS:	Neutral Undervoltage	**N Volts**	**(0.3 to 20)**
	Time Delay	**D cycles**	**(1 to 8160)**
	Undervoltage Inhibit (Positive Sequence)	**U Volts**	**(5 to 200)**
	Programmed Outputs	**Z OUT**	**(1 to 8)**
	Function 27, 59N, 60FL 27TN #1 or #2	**Disable Disable**	

■ **NOTE**: It would be efficient to disable the 27TN function with the lower pickup setting first and test the higher setting operation. Since the higher setting operation can be tested without disabling the lower setting, the 27TN functions will be enabled when the tests are complete.

1. Disable functions as shown. See Section 3.2, Configure Relay Data, for procedure.

2. Confirm settings to be tested.

3. Connect inputs in Configuration V2 designated above. See Section 6.1, Equipment/Test Setup for configurations.

4. Set Voltage Input 3 at (1.2 x **N** volts), 180 Hz. Set Voltage Inputs 1 & 2 at (1.2 x **U** volts), 60Hz.

5. *Pickup Test.* Press and hold the **TARGET RESET** button, and slowly decrease input 3 voltage until the **27TN NEUT UNDERVOLTAGE LED** light goes on or the pickup indicator operates on the computer target screen. The level of operation will be (**N**) volts ± 0.15V. Release the target reset button and increase the voltage to (1.2 x **N** volts) and the **OUTPUT** LED's will go out. Press **TARGET RESET** button to remove targets.

6. *Timer Test.* With output contacts (**Z**) connected to the timer, reduce input to approximately 50% of **N** volts and start timing. The operating time will be **D** cycles within –1 to +3 cycles.

7. *Undervoltage Inhibit Test.* Slowly decrease the voltage inputs 1 and 2 until the **27TN NEUT UNDERVOLTAGE** light goes out or pickup indicator operates on the computer target screen. The level will be **U** volts ±0.5 V. (This step is appropriate for both 27TN #1 or #2.)

8. If testing is complete, enable any functions disabled for this test. If other tests are to be completed, check the proper functions to disable for the next test and proceed from this configuration.

32 Directional Power, 3 Phase (#1, #2), Line to Ground

VOLTAGE INPUTS: Configuration V1

CURRENT INPUTS: Configuration C1

TEST SETTINGS:	Pickup	P pu	(-3.000 to +3.000)
	Time Delay	D cycles	(1 to 8160)
	Programmed Outputs	Z OUT	(1 to 8)

Function 87, 60FL	Disable
Function 32 #1 or #2	Disable
VT Configuration	Line-Ground

■ **NOTE:** It would be efficient to disable the function with the lower pickup setting first and test the higher setting operation. Since the lower setting operation can be tested without disabling the higher setting, the 32 functions will be enabled when the tests are complete.

1. Disable functions as shown. See Section 3.2, Configure Relay Data, for procedure.

2. Confirm settings to be tested.

3. Connect inputs in Configuration V1 and C1 designated above. See Section 6.1, Equipment/Test Setup for configurations.

4. The level of current at which operation is to be expected for and individual power setting is as follows: Multiply the PU pickup value (**P** above) by the **Nominal Current** previously input to the relay. This value is described in Section 2.2, Configuration and should be recorded on Figure A-2, Communication Data and Unit Setup Record Form.

5. Set the 3-phase voltages to the **Nominal Voltage**. Press and hold the **TARGET RESET** button, and slowly increase the three-phase currents until the **32 #_ DIRECTIONAL POWER** LED light goes on or the pickup indicator operates on the computer target screen. For negative or reverse power flow direction, the phase angle of the phase current is set at 180 degrees from the respective phase voltages. The level of operation will be equal to that calculated in step 4; ± 2% or ±0.0015pu. Release the target reset button and decrease the currents and the **OUTPUT** LED will go out. Press **TARGET RESET** button to remove targets.

6. With output contacts (**Z**) connected to the timer, apply approximately 110% of the pickup current and start timing. The contacts will close after **D** cycles within +16 cycles.

7. If testing is complete, enable any functions disabled for this test. If other tests are to be completed, check the proper functions to disable for the next test and proceed from this configuration.

32 Directional Power, 3 Phase (#1, #2), Line to Line

VOLTAGE INPUTS:	Configuration V2		
CURRENT INPUTS:	Configuration C1		
TEST SETTINGS:	Pickup	P pu	(-3.000 to +3.000)
	Time Delay	D cycles	(1 to 8160)
	Programmed Outputs	Z OUT	(1 to 8)
	Function 87, 60FL	Disable	
	Function 32 #1 or #2	Disable	
	VT Configuration	Line-Line	

■ **NOTE:** It would be efficient to disable the function with the lower pickup setting first and test the higher setting operation. Since the lower setting operation can be tested without disabling the higher setting, the 32 functions will be enabled when the tests are complete.

1. Disable functions as shown. See Section 3.2, Configure Relay Data, for procedure.

2. Confirm settings to be tested.

3. Connect inputs in Configuration V1 and C1 designated above. See Section 6.1, Equipment/Test Setup for configurations.

4. The level of current at which operation is to be expected for and individual power setting is as follows: Multiply the PU pickup value (**P** above) by the **Nominal Current** previously input to the relay. This value is described in Section 2.2, Configuration and should be recorded on Figure A-2, Communication Data and Unit Setup Record Form.

5. Set the phase voltages to the **Nominal Voltage**. Press and hold the **TARGET RESET** button, and slowly increase the three phase currents (–30° angle for each phase) until the **32 #_ DIRECTIONAL POWER LED** light goes on or the pickup indicator operates on the computer target screen. For negative or reverse power flow direction, the phase angle of the phase current is set at 180 degrees out of phase. The level of operation will be equal to that calculated in step 4; ±2% or ±0.0015 pu. Release the target reset button and decrease the currents and the **OUTPUT** LED will go out. Press **TARGET RESET** button to remove targets.

6. With output contacts (**Z**) connected to the timer, apply approximately 110% of the pickup current and start timing. The contacts will close after **D** cycles within +16 cycles.

7. If testing is complete, enable any functions disabled for this test. If other tests are to be completed, check the proper functions to disable for the next test and proceed from this configuration.

40 Loss of Field (#1 or #2)

VOLTAGE INPUTS:	Configuration V1		
CURRENT INPUTS:	Configuration C1		
TEST SETTINGS:	Diameter	**F ohms**	(0.1 to 100)
	Offset	**O ohms**	(-50 to +50)
	Time Delay	**D cycles**	(1 to 8160)
	Programmed Output<u>s</u>	**Z OUT**	(Z = 1 to 8)

Function 87, 60FL, 32	**Disable**
Function 40 Volt Control	**Disable**
Function 40 #1 or #2	**Disable**
VT Configuration	**Line-Ground**

■ **NOTE:** It would be efficient to disable the function with the higher "reach" (diameter minus offset) setting first (lower current) and test the lower "reach" setting operation. Since the higher setting operation can be tested without disabling the lower setting, the 40 functions will be enabled when the tests are complete.

1. Disable functions as shown. See Section 3.2, Configure Relay Data, for procedure.

2. Confirm settings to be tested.

3. Connect inputs in Configuration V1 and C1 designated above. See Section 6.1, Equipment/Test Setup for configurations.

4. The level of current at which operation is to be expected for an individual setting is as follows:
   a. Define "reach" as **R ohms = (F - O) ohms** where **O** is usually negative.
   b. Define "trip current" as **I = (Selected Voltage ÷ R ohms**. The voltage level may be selected based on the desired test current level.
   c. Define "offset current" as **IO = (Selected Voltage ÷ O ohms)**.

5. Set the phase voltages V_A, V_B, and V_C to the **Selected Voltage** value from step 4.

6. Set the phase angle between the voltage and current inputs to 90° (current leading voltage).

7. Press and hold the **TARGET RESET** button, and slowly increase the phase currents until the appropriate 40 #_ **LOSS OF FIELD** LED light goes on or the pickup indicator operates on the computer target screen. The level will be equal to "I" calculated in step 4 with the resulting impedance within ±0.1 ohms or ±5%. *If the offset is negative, continue to increase the current until the LED light goes out. The level will be equal to "IO" calculated in step 4 with the resulting offset impedance within ±0.1 ohms or ±5%.* Release **TARGET RESET** button and decrease the currents and the **OUTPUT** LED will go out. Press **TARGET RESET** button to reset targets.

8. If testing is complete, enable any functions disabled for this test. If other tests are to be completed, check the proper functions to disable for the next test and proceed from this configuration.

   (For proper testing, I < 3 x CT rating)

40 Loss of Field (#1 or #2)

VOLTAGE INPUTS:	Configuration V2		
CURRENT INPUTS:	Configuration C1		
TEST SETTINGS:	Diameter	F ohms	(0.1 to 100)
	Offset	O ohms	(-50 to +50)
	Time Delay	D cycles	(1 to 8160)
	Programmed Outputs	Z OUT	(Z = 1 to 8)
	Function 87, 60FL, 32	Disable	
	Function 40 Volt Control	Disable	
	Function 40 #1 or #2	Disable	
	VT Configuration	Line-Line	

■ **NOTE**: It would be efficient to disable the function with the higher "reach" (diameter minus offset) setting first (lower current) and test the lower "reach" setting operation. Since the higher setting operation can be tested without disabling the lower setting, the 40 functions will be enabled when the tests are complete.

1. Disable functions as shown. See Section 3.2, Configure Relay Data for procedure.

2. Confirm settings to be tested.

3. Connect inputs in Configuration V2 and C1 designated above. See Section 6.1, Equipment/Test Setup for configurations.

4. The level of current at which operation is to be expected for an individual setting is as follows:
   a. Define "reach" as **R ohms = (F - O) ohms** where **O** is usually negative.
   b. Define "trip current" as **I = ((Selected Voltage/) ÷ R ohms)**. The voltage level may be selected based on the desired test current level.
   c. Define "offset current" as **IO = (Selected Voltage ÷ O ohms).**

5. Set the phase voltages V_A, V_B, and V_C to the **Selected$\sqrt{3}$Voltage** value from step 4.

6. Set the phase angle between the voltage and current inputs to 60° (current leading voltage).

7. Press and hold the **TARGET RESET** button, and slowly increase the phase currents until the appropriate **40 #_ LOSS OF FIELD** LED light goes on or the pickup indicator operates on the computer target screen. The level will be equal to "**I**" calculated in step 4 with the resulting impedance within ±0.1 ohms or ±5%. *If the offset is negative, continue to increase the current until the LED light goes out. The level will be equal to "IO" calculated in step 4 with the resulting offset impedance within ±0.1 ohms or ±5%.* Release **TARGET RESET** button and decrease the currents and the **OUTPUT** LED will go out. Press **TARGET RESET** to reset targets.

6. If testing is complete, enable any functions disabled for this test. If other tests are to be completed, check the proper functions to disable for the next test and proceed from this configuration.

   (For proper testing, I < 3 x CT rating)

46 Negative Sequence Overcurrent Definite Time

	VOLTAGE INPUTS:	Configuration V1*		
	CURRENT INPUTS:	Configuration C1 (MODIFIED)		
	TEST SETTINGS:	Pickup Def Time	P %	(3 to 100)
		Time Delay	D cycles	(1 to 8160)
		Programmed Ouputs	Z OUT	(1 to 8)
		Function 87	Disable	
		Function 46 Inv Time	Disable	

■ **NOTE:** Although no voltage input is required for the testing of the 46 function, it is suggested that Nominal Volts be applied to restrain the functions which use both voltage and current inputs for operation. If other functions (such as Function 21 Phase Distance) operate during these tests, they will need to also be disabled for the test and re-enabled after the tests are complete.

1. Disable functions as shown. See Section 3.2, Configure Relay Data, for procedure.

2. Confirm settings to be tested.

3. Connect inputs in Configuration V1 and C1 (MODIFIED) designated above. The modification to C1 (See Section 6.1, Equipment/Test Setup for configuration) is to exchange Current input 2 and 3. (B Ø current = input 3 and CØ current = input 2).

4. The level of current at which operation is to be expected for an individual setting is: Pickup current = (**P%** ÷ 100) x (**Nominal Current**) where the Nominal Values have been programmed in the system setup data described in Section 2.2, Configuration and should be recorded on Figure A-2, Communication Data and Unit Setup Record Form.

5. Set the phase voltages V_A, V_B, and V_C to the **Nominal Voltage** value from step 4. Press and hold the **TARGET RESET** button, and slowly increase the phase currents until the appropriate **46 #_NEG SEQUENCE OVERCURRENT** LED light goes on or the pickup indicator operates on the computer target screen. The level will be equal to pickup current calculated in step 4 ±0.5%. Release **TARGET RESET** button and decrease the currents and the **OUTPUT** LED will go out. Press **TARGET RESET** button to reset targets.

6. With output contacts (**Z**) being connected to the timer, apply current of at least (**1.1 x pickup**) amps and start timing. The contacts will close after **D** cycles within −1 to +3 cycles.

7. If testing is complete, enable any functions disabled for this test. If other tests are to be completed, check the proper functions to disable for the next test and proceed from this point.

   (For proper testing, I < 3 x CT rating)

46 Negative Sequence Overcurrent Inverse Time

VOLTAGE INPUTS: Configuration V1*

CURRENT INPUTS: Configuration C1 (MODIFIED)

TEST SETTINGS:			
	Pickup Inv Time	P %	(3 to 100)
	Time Dial Setting	K	(1 to 95)
	Maximum Trip Time	D cycles	
	Programmed Ouputs	Z OUT	(1 to 8)
	Function 87	Disable	
	Function 46 DEF Time	Disable	

■ **NOTE:** Although no voltage input is required for the testing of the 46 function, it is suggested that Nominal Volts be applied to restrain the functions which use both voltage and current inputs for operation. If other functions (for instance Function 21 Phase Distance) operate during these tests, they will need to also be disabled for the test and enabled after the tests are complete.

1. Disable functions as shown. See Section 3.2, Configure Relay Data, for procedure.

2. Confirm settings to be tested.

3. Connect inputs in Configuration V1 and C1 (MODIFIED) designated above. The modification to C1 (See Section 6.1, Equipment/Test Setup for configuration) is to exchange Current input 2 and 3. (Phase B current = input 3 and Phase C current = input 2).

4. The current pickup level at a percentage setting is: Pickup current = (**P%** ÷ 100) x (**Nominal Current**) where the Nominal Values have been programmed in the system setup data described in Section 2.2, Configuration and are recorded on the COMMUNICATION & UNIT SETUP RECORD FORM.

5. Test levels may be chosen at any percentages of Nominal Current which are a minimum of 5% higher than the pickup percentage, **P%**. (Suggest 4 or 5 test levels chosen and calculated in amps.)

6. Set the three phase voltages V_A, V_B, and V_C to the **Nominal Voltage** value from step 4.

7. With output contacts (**Z**) connected to the timer, apply current equal to the chosen test levels calculated in step 5 and start timing. The operating time will be as read from Figure 2-13, Negative Sequence Current in % of Pickup Setting for the % current and appropriate **K** (Time Dial) setting or the maximum trip time (whichever is faster). Repeat this step for all test levels chosen. The Figure 2-13 curve portion extending to lower than **P%** current values are inactive and can be ignored. The tested points verify the operating times of the function.

8. If it is desired to test the reset time, begin timing immediately when the input current is reduced below the pickup value. Pressing and holding the **TARGET RESET** button, stop timing when the **TARGET** LED goes out. The time should be approximately 4 minutes.

9. If testing is complete, enable any functions disabled for this test. If other tests are to be completed, check the proper functions to disable for the next test and proceed from this point.

■ **NOTE:** If retesting is required, the unit should be powered down or wait 4 minutes before the next test to assure complete resetting of the timer.

(For proper testing, I < 3 x CT rating)

50/27 Inadvertent Energizing

VOLTAGE INPUTS: Configuration V1

CURRENT INPUTS: Configuration C2

TEST SETTINGS:	50 Pickup	**P** Amps	(0.5 to 15)
	27 Pickup	**V** Volts	(40 to 130)
	Pick-up Time Delay	**D** Cycles	(1 to 8160)
	Drop-out Time Delay	**T** Cycles	(1 to 8160)
	Programmed Outputs	**Z** OUT	(1 to 8)
	Function 27, 87, 50BF	**Disable**	

1. Disable functions as shown. See Section 3.2, Configure Relay Data, for procedure.

2. Confirm settings to be tested.

3. Connect inputs in Configuration V1 and C2 designated above. See Section 6.1, Equipment/Test Setup.

4. ***Testing:***

   - **50 Overcurrent Test:** Set Voltage inputs at zero volts, (after a minimum time of **D** cycles) hold the **TARGET RESET** button in and slowly increase the Phase A current (Input 1) until the **50/27 Inadvertent Energizing** LED light goes on or the pickup indicator operates on the computer target screen. The level of operation will be (**P**) amps ±0.1 A or ±2%.

   - **27 Undervoltage Test:** If desired, the dropout time delay (**T**) can be set to its minimum value for this test. Press and hold the **TARGET RESET** button, and slowly increase the voltage input (Continuing current input in a.). Wait at least **T** cycles between each voltage change. The **50/27** LED will go out at **V** volts ±0.5 Volts.

   - **27 Pick-up Delay Test:** Reduce input voltage to Zero volts and start timing. The operating time to close will be **Y** cycles within −1 to +3 cycles.

   - **27 Drop-out Delay Test:** Increase current by one (1) amp and then with output contacts (**Z**) connected to the timer, apply approximately 110% of **V** volts (pickup setting) and start timing. The operating time to open will be **T** cycles within −1 to +3 cycles.

5. If testing is complete, enable any functions disabled for this test. If other tests are to be completed, check the proper functions to disable for the next test and proceed from this configuration.

50BF/50N Breaker Failure

VOLTAGE INPUTS:	**Configuration V1**		
CURRENT INPUTS:	**Configuration C2**		
TEST SETTINGS:	**50BF-Ph Pick-up**	**P Amps**	**(0.1 to 10)**
	50BF-N Pick-up	**N Amps**	**(0.1 to 10)**
	Time Delay	**D cycles**	**(1 to 8160)**
	Breaker Failure Initiate	**B OUT**	**(1 to 8)**
		INPUTS I	**(1 to 6)**
	Programmed Outputs	**Z OUT**	**(1 to 8)**
	Function 87	**Disable**	

■ **NOTE:** Although no voltage input is required for the testing of the 50BF function, it is suggested that Nominal Volts be applied to restrain the functions which use both voltage and current inputs for operation. If other functions (for instance Function 21 Phase Distance) operate during these tests they will need to also be disabled for the test and re-enabled after the tests are complete.

1. Disable functions as shown. See Section 3.2, Configure Relay Data, for procedure.

2. Confirm settings to be tested.

3. Connect inputs in Configuration V1 and C2 designated above. See Section 6.1, Equipment/Test Setup. Testing 50BF-N operation: **50BF-N ENABLED, 50BF-Ph DISABLED**, Pickup setting = **N** amps, Time delay setting = 1 cycle.

4. Press and hold the **TARGET RESET** button, and slowly increase current input 3 until the **50BF BREAKER FAILURE** LED light goes on or the pickup indicator operates on the computer target screen. The current level of operation will be **(N)** amps ±0.1 amps or ±2%. Release the **TARGET RESET** button and decrease the current and the **OUTPUT** LED will go out. Press **TARGET RESET** button to reset targets.

5. With output contacts **(Z)** connected to the timer, input approximately 110% of **N** amps and start timing. The operating time will be less than 4 cycles. Reduce input 3 current to 0 amps. Testing 50BF-Ph Generator Breaker Failure operation: **50BF-N DISABLED, 50BF-Ph ENABLED**, 50BF Pickup Setting = **P** amps, Time delay setting = **D** cycles.

4. Initiate operation by externally shorting any ONE set of contacts **(I)** IN shown above. Short IN 1 (connect contacts 10 & 11) to simulate 52b contact closure (breaker open). Alternatively, the external contact may be operated if all connections are made.

5. Press and hold the **TARGET RESET** button, and slowly increase current input 3 until the **50BF BREAKER FAILURE** LED light goes on or the pickup indicator operates on the computer target screen. The current level of operation will be **(P)** amps ±0.1 amps or ±2%. Release the **TARGET RESET** button and decrease the current and the **OUTPUT** LED will go out. Press **TARGET RESET** button to reset targets.

6. With output contacts **(Z)** connected to the timer, apply approximately 110% of **P** amps and start timing. The operating time will be **D** cycles within −1 to +3 cycles. Reduce input 3 current to 0 amps. Testing HV Breaker Failure operation: 50BF-N DISABLED,50BF-Ph DISABLED,Time delay set = **D** cycles.

7. Disconnect 52b contact input (M-3430 terminal #10). With output contacts **(Z)** connected to the timer, initiate operation by externally shorting any ONE set of contacts **(I)** IN above. The operating time will be **D** cycles within −1 to +3 cycles.

8. If testing is complete, enable any functions disabled for this test. If other tests are to be completed, check the proper functions to disable for the next test and proceed from this configuration.

59 RMS Overvoltage, 3-Phase (#1 or #2)

VOLTAGE INPUTS:	Configuration V1		
CURRENT INPUTS:	None		
TEST SETTINGS:	Pickup	P Volts	(5 to 200)
	TimeDelay	D cycles	(1 to 8160)
	Programmed Outputs	OUT Z	(1 to 8)
	Functions 60FL, 24	Disable	
	Function 59 #1 or #2	Disable*	

■ **NOTE:** If 59 #1 and 59 #2 have different pickup settings, it would be efficient to disable the one with the lower setting first and test the higher setting operation. The lower setting operation could then be tested without disabling the higher setting.

1. Disable functions as shown. See Section 3.2, Configure Relay Data, for procedure.

2. Confirm settings to be tested.

3. Connect inputs in Configuration V1 designated above. See Section 6.1, Equipment/Test Setup for configuration. Set Voltages = Nominal voltage

4. Press and hold the **TARGET RESET** button, and slowly increase the input voltages on phase A until **PHASE OVERVOLTAGE 59 #_** LED light goes on or the pickup indicator operates on the computer target screen. The level should be equal to **P** volts ±0.5 V. Release the **TARGET RESET** button and decrease the input voltages to nominal voltage and the **OUTPUT** LED will go out. Press **TARGET RESET** button to reset targets.

5. With output contacts (**Z**) being connected to the timer, apply (**P+1**) Volts on phase A and start timing. The contacts will close after **D** cycles within 20 cycles.

6. If testing is complete, enable any functions disabled for this test. If other tests are to be completed, check the proper functions to disable for the next test and proceed from this point.

59N RMS Overvoltage, Neutral Circuit or Zero Sequence (#1 or #2)

VOLTAGE INPUTS:	See Below		
CURRENT INPUTS:	None		
TEST SETTINGS:	Pickup	**P Volts**	(5 to 200)
	Time Delay	**D cycles**	(1 to 8160)
	Programmed Ouput<u>s</u>	**Z OUT**	(1 to 8)

Function 27TN	**Disable**
Function 59 #1, #2	**Disable**
Function 59N #1 or #2	**Disable**

■ **NOTE:** If function 59 settings are greater than the 59N setting being tested, it is not necessary to disable.

■ **NOTE**: If 59N #1 and 59N #2 have different pickup settings, it would be efficient to disable the one with the lower setting first and test the higher setting operation. The lower setting operation could then be tested without disabling the higher setting.

1. Disable functions as shown. See Section 3.2, Configure Relay Data, for procedure.

2. Confirm settings to be tested.

3. Connect voltage input to terminal numbers 44 and 45.

4. Press and hold the **TARGET RESET** button, and slowly increase the input voltage V_N until **59N#_ NEUTRAL OVERVOLTAGE** LED light goes on or the pickup indicator operates on the computer target screen. The level should be equal to **P** volts ±0.5 V. Release the **TARGET RESET** button and decrease the input voltage and the **OUTPUT** LED will go out. Press **TARGET RESET** button to reset targets.

5. With output contacts (**Z**) connected to the timer, apply (**P**+1) Volts and start timing. The contacts will close after **D** cycles within –1 to +3 cycles.

6. If testing is complete, enable any functions disabled for this test. If other tests are to be completed, check the proper functions to disable for the next test and proceed from this point.

60 FL VT Fuse Loss Detection

VOLTAGE INPUTS:	Configuration V1		
CURRENT INPUTS:	Configuration C1		
TEST SETTINGS:	Time Delay	D Cycles	(1 to 8160)
	Programmed Outputs	Z OUT	(1 to 8)
	Function 27, 87, 32	Disable	

■ **NOTE:** It is necessary for "FL" to be designated as an initiating input (See 2.3 Setpoints and Time Settings - 60FL) before this function can be tested.

1. Disable functions as shown. See Section 3.2, Configure Relay Data, for procedure.

2. Confirm settings to be tested.

3. Connect inputs in Configuration V1 and C1 designated above. See Section 6.1, Equipment/Test Setup for configurations.

4. Adjust the three-phase voltage source to Nominal volts, and the three-phase current source to Nominal amps.

5. With output contacts (**Z**) connected to the timer, remove the A phase voltage input and start timing. The operating time will be **D** cycles within −1 to +3 cycles and the **60FL V.T. FUSE LOSS** LED and the output **Z** LED will light or the pickup indicator operates on the computer target screen.

6. Reconnect the phase A voltage and press **TARGET RESET** button to reset targets.

7. Repeat steps 5 and 6 for phases B and C.

8. If testing is complete, enable any functions disabled for this test. If other tests are to be completed, check the proper functions to disable for the next test and proceed from this configuration.

81 Frequency (#1, #2, #3, #4)

VOLTAGE INPUTS:	Configuration V1	
CURRENT INPUTS:	None	

TEST SETTINGS:

Pickup	**P Hz**	(40.00 to 67.00)
Time Delay	**D cycles**	(2 to 65,500)
Programmed Outputs	**Z OUT**	(1 to 8)
Function 24, 60FL	Disable	
Function 81 #1, 2, 3, 4	Disable	

■ **NOTE:** It would be efficient to disable the functions with the settings nearest to nominal frequency first (testing over or under-frequency functions).

1. Disable functions as shown. See Section 3.2, Configure Relay Data for procedure.

2. Confirm settings to be tested.

3. Connect inputs in Configuration V1 designated above. See Section 6.1, Equipment/Test Setup for configuration.

4. Set the voltages V_A, V_B, and V_C to Nominal voltage (Nominal Frequency). For overfrequency testing, press and hold the **TARGET RESET** button, and slowly increase the frequency on the input voltage(s) until the appropriate **81 #_ FREQUENCY** LED light goes on or the pickup indicator operates on the computer target screen. The level will be equal to **P** Hz ±0.02 Hz. Return to nominal input frequency and **OUTPUT** LEDs will go out. Press **TARGET RESET** button to reset targets. For underfrequency testing, decrease the input frequency and return to nominal after operation.

5. With output contacts (**Z**) being connected to the timer, apply (**P**+ or − 0.5) Hz and start timing. The contacts will close after **D** cycles within −1 to +3 cycles or ±1%

6. Complete the testing for all 81 functions by repeating the appropriate steps for each one.

7. If testing is complete, enable any functions disabled for this test. If other tests are to be completed, check the proper functions to disable for the next test and proceed from this point.

87 Phase Differential

VOLTAGE INPUTS: Configuration V1*

CURRENT INPUTS: Configuration C3 (See opposite page)

TEST SETTINGS:	Minimum Pickup	P Amps	(0.2 to 3.0)
	Percent Slope	S %	(1 to 100)
	Time Delay	D cycles	(1 to 8160)
	Programmed Outputs	Z OUT	(Z = 1 to 8)
	Function 46, 50BF	Disable	

■ **NOTE**: Although no voltage input is required for the testing of the 87 function, it is suggested that Nominal Volts be applied to restrain the functions which use both voltage and current inputs for operation. If other functions (for instance Function 21 Phase Distance) operate during these tests they will need to also be disabled for the test and enabled after the tests are complete.

1. Disable functions as shown. See Section 3.2, Configure Relay Data, for procedure.

2. Confirm settings to be tested.

3. Connect inputs in Configuration V1 and C3 as designated above. See Section 6.1, Equipment/Test Setup for configuration V1 and next page for configuration C3.

4. Minimum Pickup Test: Set $I_a = 0$ Amps (input 1); press and hold the **TARGET RESET** button, and slowly increase I_A (input 2) until the **87 DIFFERENTIAL CURRENT** LED light goes on or the pickup indicator operates on the computer target screen. The current level of operation will be equal to **P** amps ±0.1A or ±5%. Release the **TARGET RESET** button and decrease the current and the **OUTPUT** LED's will go out. Press **TARGET RESET** button to reset targets. Each phase may be tested individually or I_A and I_a may be exchanged.

5. Timer Check: With output contacts connected to the timer, apply at least 10% higher I_A (input 2) current than the minimum pickup level and start timing. The contacts will close after **D** cycles within –1 to +3 cycles. When Time Delay is set at 1 cycle, the relay operates in less than $1-\frac{1}{2}$ cycles.

6. Slope Test: Define any number of testing points desirable to verify the trip curve. Choosing any values for I_a (input 1), calculate the expected operating current I_A (input 2) according to the following:

(I_A-I_a) Difference in currents	> is greater than	(I_A+I_a) sum of the currents	x times	Slope/100 the per unit slope	÷2 ÷ 2

or $I_A = [(1+K) \div (1-K)] \times I_a$ where $K = S \div 200$ and where **S** is % slope input above.

■ **NOTE**: For tests above the restraint current $\{(I_A+I_a)/2\}$ value of 2X Nominal Current; use a slope % value equal to 4 times the input slope value(s) for these computations.

With I_a (input 1) and I_A (Input 2) set at the chosen value, press and hold the **TARGET RESET** button and slowly increase either current until the **87 DIFFERENTIAL CURRENT** LED light goes on or the pickup indicator operates on the computer target screen. The current level of operation will equal I_A within ±0.1A or ±1% slope calculation. Release the **TARGET RESET** button and decrease the larger current and the output LED will go out. Press **TARGET RESET** button to reset targets. Note that the difference current must be greater than minimum pickup current for proper operation.

7. If testing is complete, enable any functions disabled for this test. If other tests are to be completed, check the proper functions to disable for the next test and proceed from this configuration.
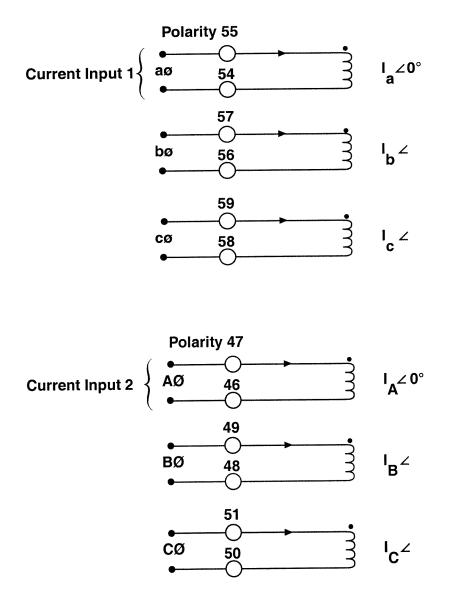
Polarity 55

Current Input 1 {

aø   54 $I_a \angle 0°$

57
bø   56 $I_b \angle$

59
cø   58 $I_c \angle$

Polarity 47

Current Input 2 {

AØ   46 $I_A \angle 0°$

49
BØ   48 $I_B \angle$

51
CØ   50 $I_C \angle$

Figure 6-12   Current Configuration C3

External Functions (#1 OR #2)

    VOLTAGE INPUTS: None

    CURRENT INPUTS: None

    TEST SETTINGS: Time Delay   **D Cycles** **(1 to 8160)**

            Programmed Outputs **Z OUT**   **(1 to 8)**

            Initiating Inputs   **IN**   **(1 to 6)**

1. Confirm initiating input numbers.

2. With output contacts (**Z**) connected to the timer, either short out input terminals designated or actually close external initiating contacts (one at a time) and start timing. The operating time will be **D** cycles within −1 to +3 cycles and the **EXTERNAL FUNCTION #** _ LED and Output **Z** LED's will light or the pickup indicator operates on the computer target screen.

3. To test the designated blocking inputs, hold the **TARGET RESET** button in and short (see step 2) input terminals (one at a time) designated as blocking inputs. The **EXTERNAL FUNCTION #_** LED will go out.

4. Open initiating contact and press **TARGET RESET** button between contact closures to remove targets.

5. Repeat for each designated external triggering contact.

6. If testing is complete, enable any functions disabled for this test. If other tests are to be completed, check the proper functions to disable for the next test and proceed from this configuration.