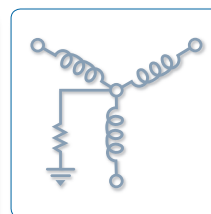
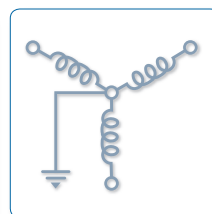
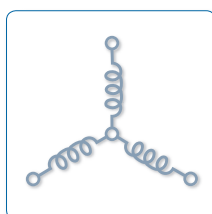
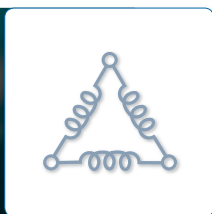




DSP-OHMNI V.2

HIGH RESISTANCE
GROUNDING SYSTEM



unparalleled protection



Instruction Manual C-429EM,
DSP-OHMNI V.2, Revised April 2012

IMPORTANT



Each DSP module is carefully inspected before packed in a specially designed carton. The unit should be examined immediately upon receipt. If damage or indication of rough handling is apparent, a claim should be filed without delay with the transport company. I-Gard should be notified promptly if replacements for damaged goods are necessary. If units received are not to be installed immediately they should be stored in their original containers in an area free of dust and moisture.

The DSP-OHMNI Version 2 offers added features and versatility than previous versions. It is important to note that Version 2 modules are NOT compatible with Version 1 modules and vice versa. All Version 2 modules are labeled and identified by indicating either V2 or Version 2.

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1 INTRODUCTION

High-Resistance-Grounding is becoming more prevalent in industrial and commercial electrical power systems. As the need for reliable and stable power increases the inconvenience of unwanted downtime in processing, robotics and data service also become more critical and costly.

Single Ground Faults in motors and equipment are common and will cause interruption of service in Solidly Grounded systems. HRG prevents this event from happening by limiting the fault current to a sustainable level for an indefinite time.

The DSP-OHMNI system will provide the user with an Alarm and indication of the location of the fault using a combination of voltage and current measurements.

In some applications, however, it is desirable to clear any fault on the system when it occurs with fire prevention or protection of sensitive equipment being the main concern rather than continuity of service. e.g. petro-chemical, grain handling. In this case, in addition to fault indication the DSP-OHMNI can be programmed up to Trip the breakers associated with the fault with or without adjustable Time Delay.

The DSP-OHMNI system is designed to detect the event of a single fault and signal an alarm condition and point to the affected branch or feeder. Thus maintenance can be immediately alerted to the problem and an operator dispatched to locate the fault to isolate it promptly. The DSP-OHMNI system can assist in locating the fault with a pulsing fault location circuit that modulates the current in the fault circuit. This allows the operator to identify and locate the fault location through the branch circuit which is carrying fault current by using a portable clamp-on current probe connected to an ordinary ammeter (DMM) meter.

Additionally, the DSP-OHMNI has two TRIP modes of operation. It can be set up to control circuit breakers to TRIP on the occurrence of a single fault with or without time delay, or if the Feeder Circuit Ground Fault current exceeds 100A on two (Phase to ground to Phase) faults. (This can only occur when two faults exist since the current on a single fault cannot exceed the Grounding Resistor Rate current) the DSP-OHMNI can then be set up to selective second ground fault trip on a priority basis to protect the critical feeder. Because two circuits will be involved it is possible to prioritize which circuit will be interrupted by a priority setting. This ensures that only the least important circuit is interrupted.

Where it is important to protect sensitive equipment, the DSP-OHMNI can be setup to TRIP the faulted Feeder Module on the first fault, with, or without, time delay (up to 99 hours). The Alarm Level is normally set at 50% (default) of the system maximum ground current, however with the DSP-OHMNI Version 2 system other Alarm Levels between 10% and 90% may be set as desired.

The DSP-OHMNI system consists of a number of modules that are mounted on a 35mm DIN rail typically located in a control compartment of switchgear. The modules are connected together through 20-conductor standard ribbon cable. A panel-mounted Display module provides a human interface to the system allows set-up and control.

There are four DSP modules as follows:

- DSP-DM Display Module
- DSP-DPS Power Supply
- DSP-DSM System Module
- DSP-DFM Feeder Module

Additionally there are other optional modules

- DSP-DRM Grounding Resistor Monitor
- DSP-DLM Data Logging Module
- DSP-CA Cable Adapter
- DSP-CAS Cable Adapter with on/off switch

The Display Module is a panel-mounted enclosure designed for flush mounting in a door. It is connected by a ribbon cable to the Power Supply unit. The DSP-DM display indicates faulted phase, total system leakage current, feeder branch current level and provides other information such as priority settings and Resistor setting etc. It is used to set-up the system and provide manual control of the pulse location system. The DSP-DM also provides MODBUS RTU communications through a RS-485 network to external information systems.

The POWER Supply unit DSP-DPS is a DIN rail-mounted modular unit constructed with an ABS enclosure and provides +5V, +12V and -12V regulated power to all of the modules through the front ribbon cables. It is capable of operation with a wide range of input voltage supplies from 100V to 240V ac without selection of any jumpers or switches. It can also operate when supplied with DC voltage from 125V to 250V DC. The Alarm Relay contacts are also located on this unit.

The System Module monitors the system line-to-ground voltages through a standard I-Gard Corp. DDR2 voltage sensor unit. It determines if there is voltage unbalance in the system and the level of ground fault current in the grounding resistor by measuring the voltage displacement of the neutral from ground, without any connection to the Neutral Grounding Resistor. It also signals phase indication to the DSP-DM Display.

The Feeder Modules (DSP-DFM) measure the fault current level in the branch circuits that are protected. This module uses standard I-Gard zero sequence current sensors Type TxA or Rx-yA. It is equipped with a form C 10A output Relay that can be used for breaker control. The DSP-DFM detects two fault levels. Firstly it detects the single fault, which creates a System Alarm condition, and secondly through a priority level system it provides breaker control to disconnect the least important circuit breaker in the event of a second fault occurrence providing continuity of supply to the critical feeder. Through the setup of the DSP-DM Display, DSP-DFM is automatically set to the same Alarm level as that of the System Module during Feeder Module Setup.

Note: If the Alarm level is changed in the System Module (or the System Module has been changed) then it may be necessary to Setup the DSP-FM modules afterwards.

The DSP-DRM module is used to monitor the integrity of the neutral grounding resistor for change of resistance and/or open circuit condition. It is installed in the same line-up of modules as the rest of the DSP-OHMNI system with ribbon cable jumpers. The DSP-DRM uses external I-Gard zero sequence current sensors and a NGRS Resistor sensor which provide voltage and current at the Neutral Grounding grounding resistor. The DSP-DRM uses the same Alarm system as the rest of the DSP-OHMNI system. See Section 12 for detailed information.

In order to capture event information, a data logging module type DSP-DLM has been designed to enhance the standard last-fault event indication. This module may be inserted anywhere in the DFM line-up with ribbon cable connections. The module includes a real-time clock to signal the event time and date of each event captured. Events captured are Loss of DDR-2 phase(s), Bus Fault, Feeder Fault, Feeder Trip and NGR fault for both Trip-on-First-Fault, and Trip-on-second- fault setups. The DSP-DLM date stamps the events according to the time and date set up on the DSP-DM during the system set-up.

The Cable Adapter Modules DSP-CA and DSP-CAS are used when two or more DSP-OHMNI systems are to prioritize in main-tie-main systems for example. These modules convert the ribbon cable conductors involved to shielded cable for connection to the other DSP-OHMNI systems. The DSP-CAS is equipped with solid state switches to allow connection only when the input terminals of this unit are shorted (normally by a tie breaker contact for example).

Communications is provided by a 4-wire RS-485 network connection from a jack located at the rear of the DSP-DM Display module. The communications protocol supported is MODBUS RTU, which is a master/slave system with selectable baud rates from 4800 to 19200 (default 4800). The DSP supports the MODBUS function Read Holding Registers only, without exception support. Additionally it will support remote RESET using the Force Coil function.

2 APPLICATION

The DSP system is used in conjunction with I-Gard, Voltage Sensor Unit Type DDR2. The DDR2 matches the DSP-DSM input circuits to the system voltage. The DDR2 types available are catalogued as follows:

Part #	Description	Certification
DDR2-1	Standard DDR2 for 120 V system Recommended for applications on medium voltage systems, installed on the secondary of three (3) "Y-Y" connected Voltage Transformers.	CSA & UL
DDR2-1-SO1	Special 120V system with harmonic filter compatible with SIGMA & DRM	
DDR2-2	Standard DDR2 for 240 Vs system	
DDR2-2-SO1	Special 183V system	
DDR2-2-SO6	Special 240V system with harmonic filter compatible with SIGMA & DRM	
DDR2-2-SO5	Special 288V system	
DDR2-4	Standard DDR2 for 480 V system	
DDR2-4-SO1	Special 415V system	
DDR2-4-SO2	Special 400V system	
DDR2-4-SO3	Special 340V system	
DDR2-4-SO4	Special 380V system	
DDR2-4-SO5	Special 400V system with harmonic filter	
DDR2-4-SO6	Special 380V system with harmonic filter compatible with SIGMA & DRM	
DDR2-4-SO7	Special 480V system with harmonic filter compatible with SIGMA & DRM	
DDR2-6	Standard DDR2 for 600 V system	
DDR2-6-SO1	Special 525V system	
DDR2-6-SO3	Special 600V system with harmonic filter	Available Upon Request Please note that: • These models should be fused on the high voltage side. • There is no insulation between High voltage and Low Voltage, therefore may not be installed inside a low voltage section of the switch gear.
DDR2-6-SO6	Special 600V system with harmonic filter compatible with SIGMA & DRM	
DDR2-6-SO2	Special 690V system	
DDR2-6-SO4	Special 690V system with harmonic filter	
DDR2-6-SO7	Special 690V system with harmonic filter compatible with SIGMA & DRM	
DDR2-12	Standard DDR2 for 1.2 kV system with harmonic filter compatible with SIGMA & DRM	
DDR2-24	Standard DDR2 for 2.4 kV system with harmonic filter compatible with SIGMA & DRM	
DDR2-41	Standard DDR2 for 4.1 kV system with harmonic filter compatible with SIGMA & DRM	
DDR2-60	Standard DDR2 for 6 kV system with harmonic filter compatible with SIGMA & DRM	
DDR2-72	Standard DDR2 for 7.2 kV system with harmonic filter compatible with SIGMA & DRM	

Table #1: DDR2 types.

The DDR2 provides output voltages $V_{AG'}$, $V_{BG'}$, V_{CG} that are proportional to the phase to ground voltage and also voltage V_{NG} that is proportional to the neutral resistor voltage. (i.e. Total leakage/fault current of the system)

On large systems provision is usually made to ground the system using a current-limiting resistance (I-Gard Type OHMNI-PM). On ungrounded systems there is always leakage capacitance to ground from each line. Re-striking ground faults may cause an excessive build up of line to ground voltage due to this capacitance. It may be stabilized with the addition of a grounding resistance, thus preventing costly breakdown of insulation.

The OHMNI-PM is connected between ground and the Neutral (star) point of the transformer on Wye systems. On Delta systems an artificial neutral device (I-Gard Type DDAI) is required to provide a Neutral (star point). Both OHMNI-PM and DDAI devices are selected for appropriate current 'let-through', i.e.: The current, which will flow to ground, if there is a direct short from line to ground (on any one phase).

NOTE: A good Rule-of-Thumb for Resistor current selection is 1 ampere per 2000KVA, if no surge capacitors are on the system, and 1 ampere per 1000KVA with surge capacitors.

DDAI and OHMNI-PM devices are available with UL Listing for continuous currents of 1 ampere to 10 amperes and up to 600 Volts for most systems. Other Voltages and ratings are available upon request. For further information regarding the use of these devices refer to:

Instruction Manual Type DDAI Artificial Neutrals	C-430EM
Instruction Manual Type DDR2 Alarm Resistor Units	C-440EM
Instruction Manual Type OHMNI-PM Neutral Grounding Resistors	C-450EM
Instruction Manual type CA(S) Modules	C-415EM

3 INSTALLATION

A typical installation will include for each power source (transformer/generator) 1 DSP-DM, 1 DSP-DPS, 1 DSP-DSM, 1 DSP-DRM, 1 DSP-DLM and a number of DSP-DFM Feeder Modules as required with 1 for each branch protected. Additionally there will be a DSP-OHMNI-PM pulsing resistor to ground the system. A voltage-sensing resistor DDR2 is required for the DSP-DSM input, as well as one current sensor for each DSP-DFM for current detection. See Table 3.1 for typical requirements.

TABLE 3.1 SYSTEM MODULE REQUIREMENTS

Catalog Number	Description	No Required/System
DSP-DM	Display Module	1
DSP-DPS	Power Supply	1
DSP-DSM	System Voltage Module	1
DSP-DFM	Feeder Module	As required 1/ Circuit
OHMNI-PM	Pulse Equipped Resistor	1
DDR2	Voltage Sensing Resistor	1
DDAI	Artificial Neutral	Required only for delta system
TxA or Rx-yA	Toroidal Current Sensor	1/Feeder Module

TABLE 3.2 OPTIONAL MODULES

Catalog Number	Description	No Required/System
DSP-DRM	Resistor Monitor	1
DSP-DLM	Logging Module	1

TABLE 3.3. STANDARD RIBBON CABLES

Length	Function	Catalog Number
365cm (12ft)	DSP-DM to DSP-DPS	DRC-365
150cm (5ft)	DSP-DM to DSP-DPS	DRC-150
5cm (2 in.)	Module to Module connection	RC-3
30cm (12 in.)	Module to Module connection	RC-30

DSP modules are mounted on a 35mm DIN Rail generally located at the rear wall of a switchgear compartment. They should be mounted side by side and connected with 20-conductor ribbon cable in a daisy chain configuration. This applies to the DSP-DPS, DSP-DSM and DSP-DFM modules only.

DSP (Outline Dimensions). Care should be taken not to over tighten the 8-32 nuts used to retain the DSP-DM

It will be necessary to provide a reliable power source (which is not interrupted by operation of the DSP output contacts) for control power. The supply should be in the range of 120V to 240V ac, 50/60Hz or 125V dc up to 250V, The control supply must be fused by a 1 Ampere fuses as shown in Fig. 4.1 (Connection Diagram).

4 WIRING

No. 14 or No. 16 switchboard wire is used for all current sensor, control and DDR2 connections, which need not be shielded. 4-wire shielded cable should be used for the serial communications, however. A typical wiring schematic is shown in Figure 4.1a. It is recommended to use twisted pair for wiring from the secondary of the zero sequence current sensors (TxA) to the DSP-DFM.

Sensor wiring is not generally limited by length and may be up to a kilometer without degradation of performance, since the sensor is a current source. Sensor wiring should be run in separate conduit from Power wiring. The recommended sensor wiring connections are shown in Figure 4.2. Two twisted wires should be run from each sensor X1 and X2 as indicated to prevent cross coupling between Modules. If existing wiring does not allow this connection because of common connection at X2 as has been common in some installations, then the G terminals of the DSP-DFM modules should be connected as shown in Figure 4.3.

Ribbon cables are available in different lengths as shown in Table 3.2. For other lengths contact I-GARD. The DRC-cable from the DSP-DM to the DSP-DPS, apart from being different in length, also differs in the orientation of the connector. This allows the cable to be run easily from the DSP-DM towards the DSP-DPS power supply. The RC-cables are used for Module to Module connections and are short in length. Note the orientation of the plug as marked on the DSP-DM display module. If a second row of modules is installed on another DIN rail, the last module on the right can be connected to the last module on the right on the second row using the RC-30 cable. Either slot can be used on the DSP-DFM feeder modules for connection.

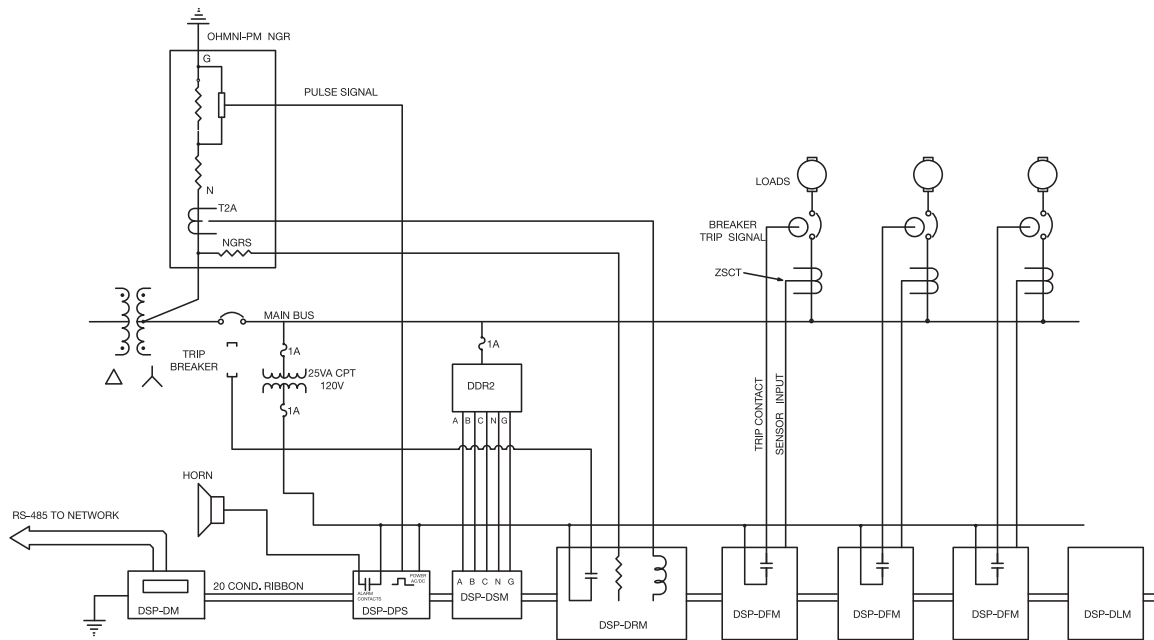


Figure 4.1a Typical One-Line Installation - Unit Substation

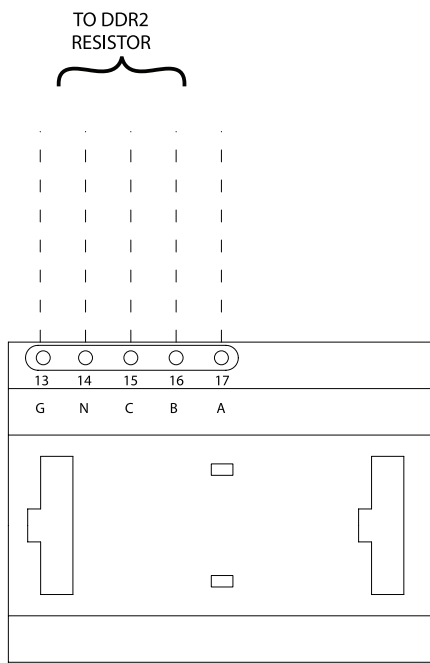


Figure 4.1b System Module DSP-DSM Wiring

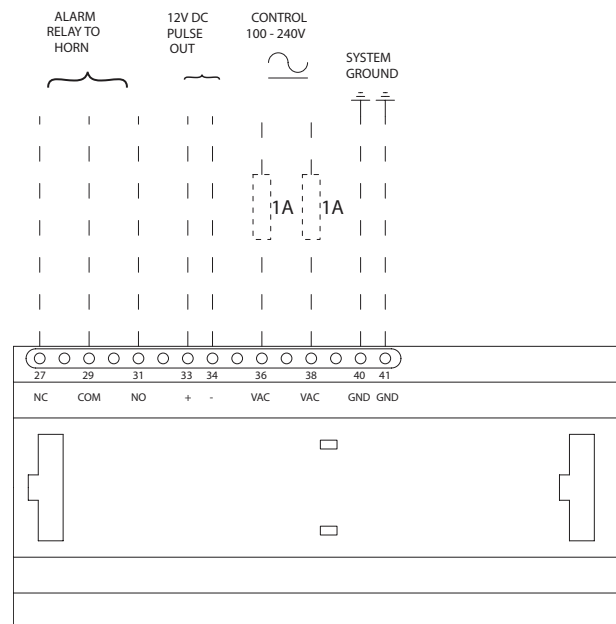


Figure 4.1c Power Supply DSP-DPS Wiring

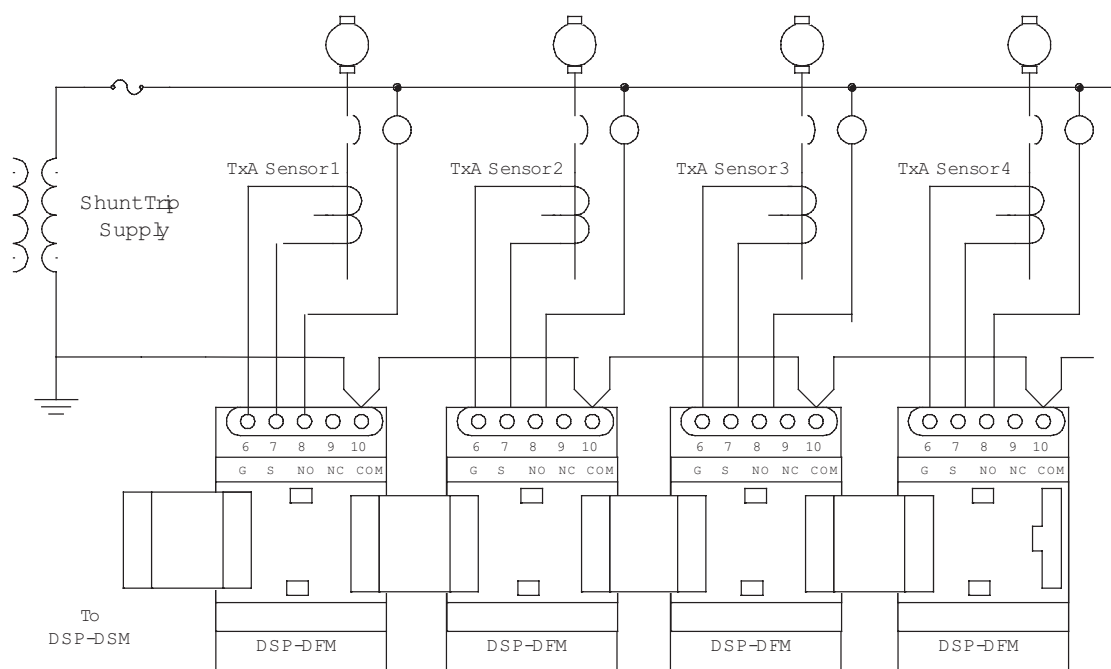


Figure 4.2 Preferred Feeder Module DSP-DFM Wiring

NOTE: For Main-Tie-Main systems and multiple sources with tie breakers the priority buses can be joined together with the use of I-Gard devices DSP-CAS and DSP-CA Modules. The DSP-CA module converts ribbon cable to an 8-conductor shielded cable for this purpose. The DSP-CAS does the same thing except that it includes an electronic switch to make or break the connections when the tie breakers are closed or open. The two modules are DIN rail mounted similar to the other DSP modules in 70mm wide housing. See information on DSP-CA(S) in manual C-415EM for typical wiring.

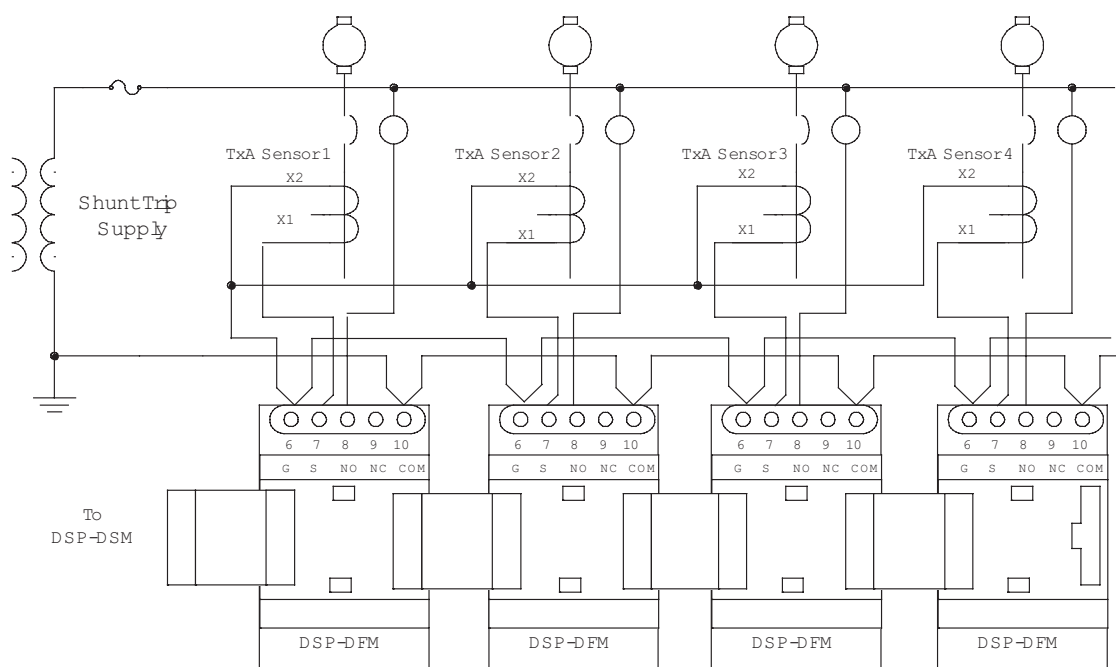


Figure 4.3 Alternative Sensor Wiring

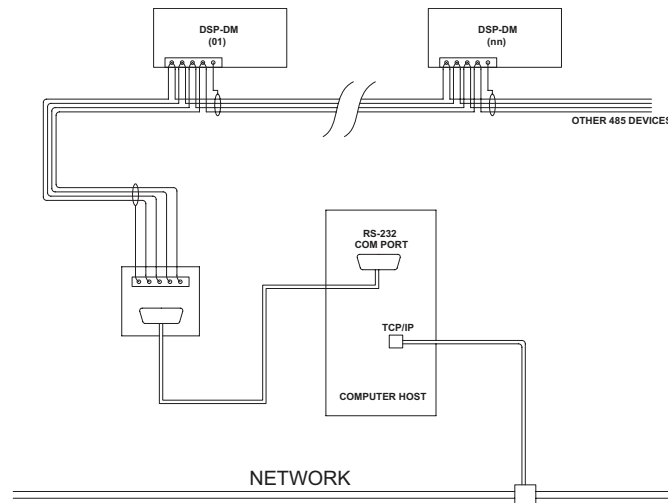


Figure 4.4 Typical 4-wire Communications Connection.

The RS-485 cable shield should be grounded at the ground terminal provided on the 5-pin jack as shown in Figure 4.4, which shows a typical installation with a local computer and LAN.

Communications may be supported as a node in an existing MODBUS network or may be connected through a standard RS-485 to RS-232 converter to a PC with supporting software.

NOTE: the user must supply software to read the registers of the DSP-OHMNI system.

The Alarm contacts are available at the DSP-DPS as a Form C type and should be connected to operate a horn or other means to alert an operator to the fact that a fault has occurred on the HRG system. The contacts are rated at 10A, 240VAC Resistive.

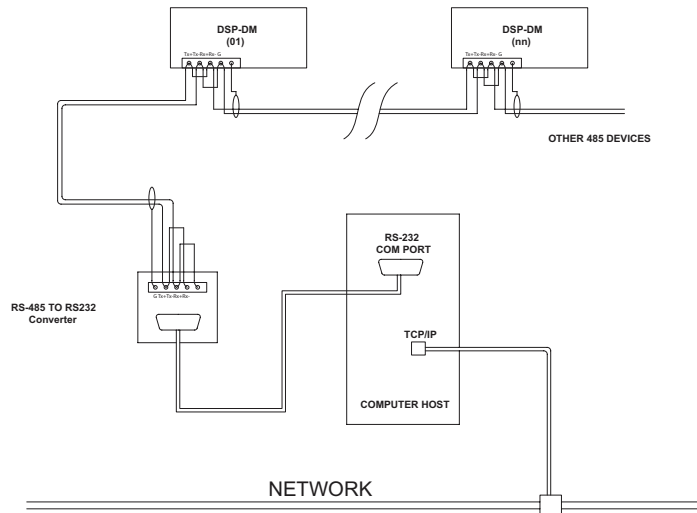


Figure 4.5 Alternative two-wire connection for RS-485.

Communications wiring may be 2-wire or 4-wire but must use shielded cable with low capacitance. Wire lengths up to 2000 metres can generally be used without the need for termination resistors.

Figures 4.4 and 4.5 show typical RS-485 arrangements with a RS-485/RS-232 converter and a host PC connected to a LAN.

5 PULSING FAULT LOCATION

For Fault location the DSP system is equipped with Pulse modulation for the ground current to locate the fault more readily. Pulse current is provided at the DSP-DPS (+) and (-) terminals, which may be directly connected to the Pulse Relay in the DSP-OHMNI-PM. It is important to observe the polarity of the connection. This 12V wiring need not be shielded but should be 14 or 16 AWG switchboard wire for durability.

Following successful installation of the DSP system and connection of the control voltage, the DSP-DM display module should indicate a Green NORMAL light and the screen should show the following message.



Figure 5.1 Home Screen

This is the Home Screen, Screen1, which is the NORMAL starting screen after RESET is pressed. Various messages may modify this screen following an event such as a fault, loss of fuse, or during pulsing to provide some diagnostic information.

If the following screen appears and the local Alarm sounds, then most likely the DDR2 resistor is not energized or connected.

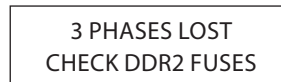


Figure 5.2 Alarm Screen

6 SETUP

Password

On a new installation some simple set-up is required with at least Maximum System Current (NGR set-up) and Feeder Modules being set prior to use of the equipment. Optional settings are Communications and Pulse Control. On a new installation some simple set-up is required with at least Maximum System Current (NGR set-up) and Feeder Modules being set prior to use of the equipment. Optional settings are Communications and Pulse Control. At the HOME screen (only) Press SETUP to enter the Setup Mode. First of all, the user will be prompted for a 4-digit password with the following screen:

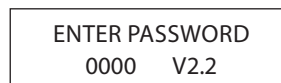


Figure 6.1 Password Request

Use the (arrow) ▼▲◀▶ navigation keys to change the password to 8421, which will always be the default (backdoor) password, should the user password be forgotten.

Following operation of the ENTER key, the user will be asked if a change in password is required. At this point the user can enter a new 4-digit password to prevent unauthorized changes to the system.



Figure 6.2 Password Change



Figure 6.3 Password changed

In this case the new password is 0123

If the wrong password is entered, or not known, the user can still have access to the Self-Test Functions of the system and will be taken there directly, by-passing the system setup when ENTER is pressed

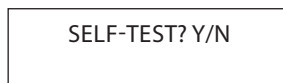


Figure 6.4 Wrong Password Entered Message

Enter the Set-Up Mode press SETUP when the Home screen or Alarm Screen is showing (SETUP will not enter from any other screens). If confused at any point, press RESET and the Home Screen (or Alarm Screen - if a fault has occurred) will be shown. Figure 6.5 shows the first set-up screen that will be encountered – COMMS set-up mode. The DSP-OHMNI is normally shipped with a 9600 Baud setup.



Figure 6.5 Communications Set-up

If the RS-485 connection is not used, then press ENTER to skip to the next set-up, otherwise press ◀ to move the flashing cursor to select Y (for Yes) and press ENTER. The communications screen will appear similar to Figure 6.6. The screen will show the set-up presently in use, or the default as shown.



Figure 6.6 Communications Set-up

The DSP system must be identified by an address number from 01 to 32, to distinguish between it and other MODBUS devices that may be connected on the same RS-485 network. If only one device is used then it will typically be set to 01, which is the default value. (Ensure that no other device has the same I/D setting on the RS-485 network or data will not be valid). To change the number, use the ▲▼ arrows to increase/decrease the digit under the flashing cursor and ▶◀ to change digits.

When a desired number has been entered press ENTER to change the Baud Rate setting if required. The present rate will be shown. Press ▲ to select another setting. Only three baud rates are provided (4800, 9600 and 19.2K).

Keep pressing the ▲ button and the selection will simply scroll through the three settings until ENTER is pressed to finalize the Communications Set-up and show the screen of Figure 6.8. Select Y to enter this set-up or ENTER to move to Feeder Module Set-up. Note: The setting must be saved. If this is the only setting being changed then the user must press ENTER to skip the following setup until the SAVE screen is presented As in Figure 6.7

SAVE CHANGES Y/N

Figure 6.7 Save Setup Screen

Select Yes or No using the ►◀ keys and press ENTER to Save.

Resistor Set-up

a) Request

SETUP NGR? Y/N

b) Setup

IG CURRENT A 05
 SET TO NGR 1-16A

Figure 6.8 Grounding Resistor Set-up

The next screen following Communications is the Grounding Resistor Setting. This setting must be set according to the current limiting value of the grounding Resistor of the HRG system. The default value is 1A. To change the number, use the ▲▼ arrows to increase/decrease the digit under the flashing cursor and ►◀ to change digits.

The final value must be between 01 and 16 for 1-16A range. Press ENTER when completed.

HOWEVER THE VALUES WILL REPEAT EVERY 16 TIMES, E.G. IF THE VALUE 17 IS ENTERED THE ACTUAL SETTING WILL BE 01 AGAIN.

The selected NGR value must be saved as in Figure 6.7

Alarm Level Setting

Pressing ENTER after the NGR Setup will take the user to the Alarm Level Setup. The screen shows two settings. The upper line indicates a variable Setting, which can be selected with the ▲▼ keys, while the lower line indicates the present setting. The user may select from 10% to 90% of the Neutral Voltage displacement as a threshold in 10% increments.

ALARM LEVEL 60%
 PRESENT LVL. 50%

Figure 6.9 Alarm Level Setting

The user selects a new level if desired and presses ENTER. The lower line will change to agree with the selection if successful. The DSP-OHMNI is normally shipped with 50% level selected. Changing this value will require the user to setup the Feeder Modules afterwards, since they are not automatically updated to the new Alarm Level. This will require use of the next setup procedure. If a new Feeder Module has been installed at a later date it will have to be setup also so that the system is consistent.

Note: to check Alarm Level of Feeder Modules use the Self-Test Feeder Module Procedure. See below.
 The selected NGR value must be saved as in Figure 6.7

Feeder Module Set-up

Following the OHMNI-PM set-up the display prompts for Feeder Module Set-up. Select Y to enter the Feeder Module setup screen as shown in Figure 6.10 (b).

SETUP FM? Y/N

Figure 6.10 Feeder Module Set-up Request.

Select Yes to enter the Setup as follows:

FEEDER SEL	01
TRIP SELECT	◀

Figure 6.11 Feeder Module Selection, IDENT and Type selection.

After installation of Feeder Modules they must be given identification numbers from 01 to 50 (maximum) so that the Display unit can determine which module it is talking to. Each module must have a different number. To change the number, use the ▲▼ arrows to increase/decrease the digit under the flashing cursor and ►◀ to change digits.

The Display module is the master module and is constantly sending requests for data from each feeder module from 1 to 50. The Feeder Modules compare the request I/D with their own I/D to decide whether or not they are being asked for data. If the I/D is the same then that Feeder Module replies with Current, Priority and Status information to the master Display Module. Therefore it is very important that there are not two modules in the chain with the same I/D number after setup. The Feeder Select program checks for duplicate I/D when ENTER is pressed following an entry of FEEDER SEL xx. If an existing I/D is detected, the screen will indicate as in Figure 6.12.

I/D IN USE	01
TRIP ON PRIOR	00

Figure 6.12 I/D Check indication

In this case the user must enter a different I/D number before proceeding further. The user is allowed another chance to enter a valid I/D number before the cursor moves to 2ND FLT/1ST FLT TRIP type selection. This permits the TRIP and Priority of previously set modules to be changed while retaining the same I/D number. Also there most likely be duplicate I/D numbers prior to the first setup. These will be overwritten by the setup procedure.

Note also if a duplicate I/D number has been selected, that the ACCEPTED result could still be obtained with the result that there will be two or more modules with the same I/D. If the FEEDER SELF TEST is performed these duplicates will not respond when the TEST button is pushed.

CAUTION! IT IS ENTIRELY POSSIBLE FOR THE USER TO ENTER A NUMBER OUTSIDE THE RANGE 01 TO 50 AND THE SYSTEM WILL ACCEPT IT WITHOUT WARNING, DATA WILL NOT BE COLLECTED FROM SUCH MODULES, ALTHOUGH THEY WILL CONTINUE TO PROVIDE FAULT PROTECTION.

Typically, the numbers will be in the sequence 01, 02, 03, 04.... but they can be in any order physically. The Display Module does not discriminate the physical position of the modules in the chain. The identification number, however, must be known for each feeder circuit since the Display does not support the use of Text Labelling to identify circuits. Note: This can be done with user-provided software from the RS-485 network if required.

FEEDER SEL	01
TRIP 2 ND FLT	---

a) Trip 2nd Fault (default)

FEEDER SEL	01
TRIP 1 ST DELAY	--

b) Trip on 1st fault

Figure 6.13 FM Setup Selection TRIP function

When the I/D is selected, the Feeder Module must be setup to define TRIP Operation. This allows the normal TRIP on 2nd Fault only or TRIP on the Occurrence of a single ground fault as required. The default mode is to TRIP on 2nd Fault. As indicated in Figure 6.13(a). Pressing ◀ will toggle between TRIP on 1st Fault and TRIP on 2nd Fault.

FEEDER SEL	01
TRIP 2ND FLT	05

Figure 6.14 TRIP on 2nd Fault priority 5

Press ENTER for selection of either Mode of TRIP operation and enter at the cursor position, the DELAY (in minutes or hours) OR the PRIORITY level for the Feeder being set up.

The range of priority numbers ranges from 00 to 15 with 0 being a lower priority than 15. In the case of Priority numbers it is OK to use the same number more than once unlike the I/D numbers, so that, for example, unimportant circuits can all be set to 00 and the critical feeder set to priority 15.

NOTE: It is possible to exceed the range of 00-15 and enter priority numbers above 15 but the priority will not be increased and will roll over after 15 to become 00 again. To avoid confusion, the priorities should be kept within the range 00 to 15 only.

The range of DELAY numbers is from 00 to 99 representing the delay for First-Fault tripping in minutes or hours with 00 representing instantaneous TRIP operation (100 ms).

When the desired PRIORITY or DELAY for a given I/D number has been selected, press ENTER. You will then be prompted with the screen of Figure 6.15

PUSH FM BUTTON
AND THEN ENTER

Figure 6.15 Feeder Module Set-up

At this point select the DSP-FM module that is to have the I/D that was set-up, and press the TEST button on that module. The red FAULT light will turn on to indicate the received I/D signal. (No need to hold button)

Press ENTER to complete the process. The DSP-DM will display either of the following messages depending on whether or not the setup was successful.

FM ACCEPTED CONTINUE	FM NOT ACCEPTED CONTINUE
-------------------------	-----------------------------

a) Feeder Module Successful

b) Set-up Not Successful

Figure 6.16

Should the DFM not be accepted please inspect the connections to the DSP-DFM a ribbon cable connector may be loose and is preventing the DM to properly communicate with the DFM. another case may be that the feeder module is a V2 module, should the condition persist please contact technical support at i-Gard.

Press ► to exit the screen and the DSP-DM will allow the user to set-up more Feeder Modules with screen 6.17 a) and b)

FM ACCEPTED ANOTHER? Y/N

Figure 6.17 DSP-DM allows further Feeder Module set-up

FM NOT ACCEPTED ANOTHER? Y/N

Figure 6.18 If previous set-up had not been successful

Pulse Setup

If more Feeder Modules need to be set-up then select Y and ENTER to repeat, or if not select N and ENTER (or RESET) to exit the Feeder Module Set-up and enter the PULSE Set-up. The Pulse set-up screen allows the pulsing mode for fault location to be changed for different frequencies and mode of operation. The screens of Figure 6.19 and 6.20 are shown.

SETUP PULSE? Y/N

Figure 6.19 Pulse Set-up Request

PULSE INVRT?	OFF
FREQ 0 LOCK?	OFF

Figure 6.20 Pulse Mode Set-up

Select Y to enter the Pulse Set-up Screen which looks like Figure 6.19 which will show the existing set-up of the PULSE module (which resides in the DSP-DSM module, which must be installed for this set-up) settings with the cursor flashing at the Inverted mode ON/OFF setting. Press ◀ to toggle the setting ON or OFF as required (see PULSE Module operation in section 7).

Invert / NORMAL

The output from the DSP-DPS module is connected to a solid state relay. Normally (non Inverted operation) the output from the '+' and '-' terminals of the DSP-DPS module is zero prior to any pulsing operation, and the relay is OFF. If Inverted mode is selected, then this voltage is 12V dc. And the relay is, therefore, energized continuously. The choice of NORMAL or INVERTED operation depends on how the Grounding Resistor current is connected. If the Grounding resistor consists of two series or two parallel resistors (one main resistor and one pulse resistor) with the pulse resistor to be switched in and out by a solid state relay then the following two options exist.

Pulse Up current

Pulsing upwards means to increase current from IGmax 5A to IGmax 10A, for example. In this case the pulse resistor is normally OFF and the INVRT OFF would be selected. Pulsing would then change the current to a higher level from 5A to 10A alternating when a 100% fault exists.

Pulse Down current

Pulsing downwards means to reduce the current from IGmax 5A to IGmax 2.5A, for example. In this case the pulse resistor will be Normally ON and thus the INVRT ON mode would have to be selected. This will mean that the solid state relay will be ON when the system is normal (no fault) and will open when pulsing is started thus reducing current.

DSP-OHMNI-PM grounding resistors require the Inverter to be ON, in order to operate at the current rating indicated on the name plate.

See Diagram 6.21 for examples of both series and parallel connected resistor arrangements.

NOTE: the INVRTed mode is the mode used with the standard OHMNI-PM resistors as supplied by I-GARD.

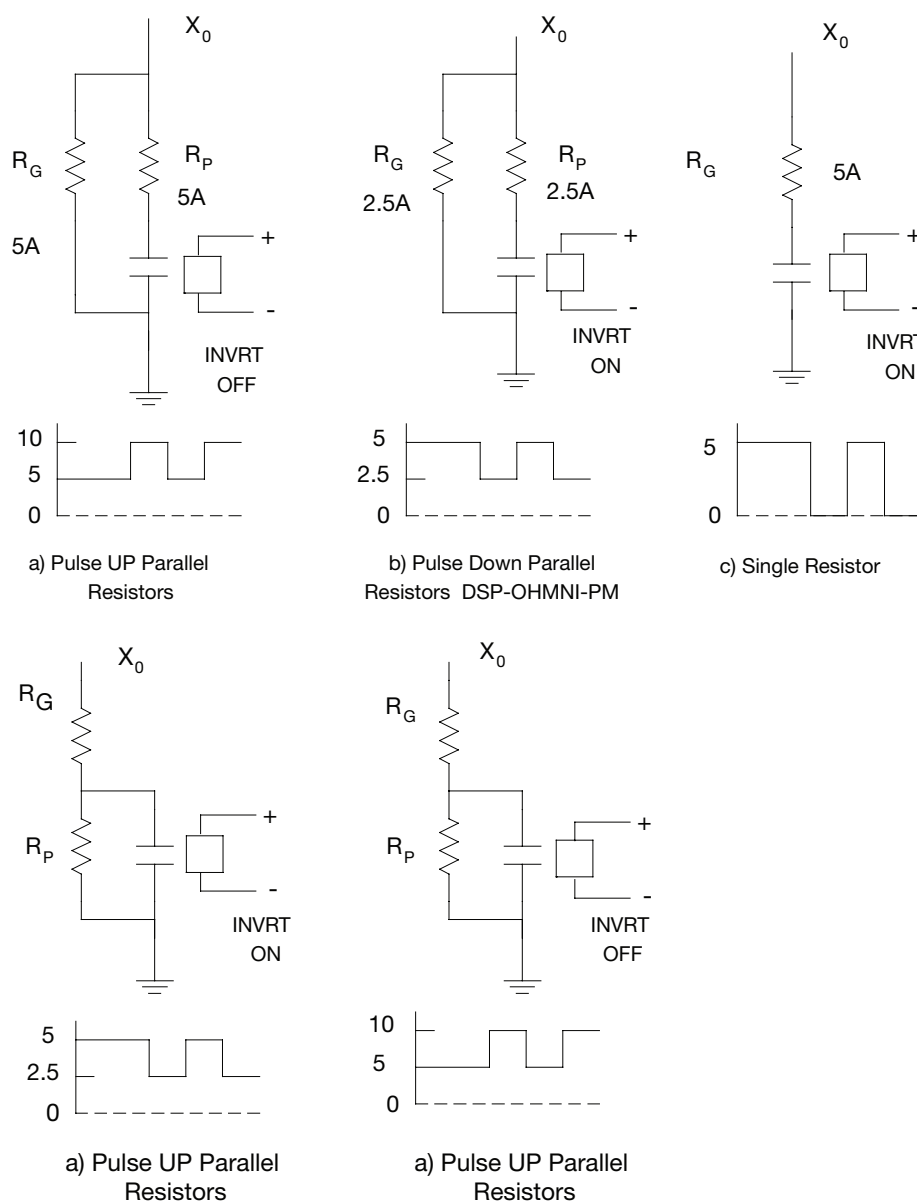


Figure 6.21 Typical Examples of Pulse Circuit Connection

Press ENTER when the selection is chosen. The cursor will then move to the FREQUENCY position. Press ▲▼ to select a pulse frequency from 0 to 9 with frequency increasing with the number selected. It is not important to know exactly the frequency selected, however, Table 6.1. Indicates the frequency for each setting.

TABLE 6.1 PULSING FREQUENCY SELECTION

Select	0	1	2	3	4	5	6	7	8	9
Freq Hz.	1.0	1.25	1.50	1.75	.2.00	.2.25	2.50	2.75	3.00	3.25

Press ENTER after a value has been selected and the cursor moves to the interLOCK position. The interlock prevents pulsing from occurring when there is no fault on the system. Press ◀ to toggle ON or OFF and then ENTER to complete the Pulse set-up. It is recommended to operate the DSP-OHMNI system with the Lock ON.

NOTE: It is not necessary to Save the Pulse Setup since it is already saved in the System Module

For the next Setup the user will then be presented with the option to change the operation of the MUTE function. The MUTE button normally disables the Alarm Relay and the local Beeper Alarm when pressed to following a fault. However, the designer might use the Alarm Relay for some other function, for example another contactor or cooling fan operation of the Neutral grounding resistors. In this case it is undesirable to MUTE the relay. For this reason the operator may choose to disallow the MUTE button to change the state of the Alarm Relay.

ALARM RELAY Y/N

Figure 6.22 Alarm relay Setup

Selection of 'Y' provides the option selection screen of Figure 6.22.

MUTE ALARM RLY
ENABLED

Figure 6.23 Alarm relay Options

The default is with the Alarm Relay MUTE control Enabled to allow Silence control of an external Horn system. Pressing ◀ button will toggle the ENABLED to DISABLED. The DISABLED position is used to defeat the MUTE switch operation of the Alarm Relay and allow it to be used for other purposes which depend on whether or not the system is in a Faulted condition.

NOTE: This does not affect the local Beeper function which will still continue to be MUTED by the MUTE button.

If a DSP-DLM Logging Module is installed the user will be asked if a clock setup should be performed with the following screen.

SET CLOCK? Y/N

Figure 6.24 Clock Setup

If the user selects Yes then the screen shows the present clock setting

CHANGE TIME
 02:05:25 PM TUE

Figure 6.25 Time Adjust

Pressing ENTER stops the clock and allows the user to change the time, am/pm and day of the week using the ▲▼ keys to change each digit individually. With single digits preceded with a leading zero

Pressing ENTER again presents the Date Change Screen to indicate the present setting.

CHANGE DATE
 08/12/09

Figure 6.26 Date Adjust

Using the ▲▼ keys the settings may be changed to the correct date, according to the day/month/year format, with single digits preceded with a leading zero

Pressing ENTER once when completed saves the new setting and exits the Clock Setup

CLEAR RECORD Y/N

Figure 6.27 Clearing EEPROM Record

At this point, the user is presented with the option of clearing the last event stored in the logging module with the screen. The user, if required, may select Yes to remove the last event from the list of events stored in the DSP-DLM Log Module. This will only remove one record at a time.

CLEAR ALL Y/N

Figure 6.28 Clearing EEPROM completely

Following CLEAR RECORD the user is presented with the option of clearing the entire list of events. The screen shown will be presented. If Yes is selected then the record list is cleared.

After a short delay the screen will change to indicate that the process. Is complete with the following message

CLEAR

Figure 6.29 EEPROM Cleared

That completes the set-up. At this point you may be presented with the option of saving the values changed or not with the screen of Figure 6.30.

SAVE CHANGES Y/N

Figure 6.30 Save Screen

NOTE: You may not see this screen. If no changes were made in the set-up, or changes were made to the Feeder Module set-up or the Pulse Set-up, it will not appear. This is because those changes are actually saved in the DSP-DFM and DSP-DSM respectively. The changes selected will be saved in non-volatile EEPROM memory until the next time the set-up is changed and re-saved.

NOTE: There are no Setup requirements for the DSP-DRM NGR Monitor if installed.

Press ENTER after selecting Y/N in the SAVE mode.

At this point the user is asked if SELF-TEST is desired with screen of Figure 6.31.

SELF-TEST? Y/N

Figure 6.31 Self-Test Prompt

The user can just press ENTER to ignore and return to the Home Screen, or select Y ENTER to perform Self-Test on the system. See Self-Test section for details.

7 OPERATION

Normally with an un-faulted system and recent RESET, the Display Module will display the Normal Home screen of Figure 7.1 with a green NORMAL light on the front panel of the DSP-DM and no Alarm. The System Module will indicate a green NORMAL light and the DSP-DFM modules will show no light indication at all. The DSP-DPS supply will also indicate POWER with a green light when power is supplied to it. The yellow PULSE light may, or may not, be ON, depending on whether, or not, the INVERTed mode of operation has been selected for the pulse operation, if a DSP-OHMNI-PM Neutral Grounding Resistor is used, it is recommended to have the INVERTer ON. If the Inverted Mode is selected the Pulse Relay will be normally energized and will de-energize with each pulse. The PULSE light will indicate when the pulse relay is energized. In the Normal pulse mode, the light will be OFF and will light with each pulse. The Display Module will indicate the Normal Home screen as in Figure 7.1.

I-GARD RESISTORS
HRG SYSTEM OK

Figure 7.1 Normal Home Screen

Pressing ► takes the user to the Screen 2 which shows the total system ground current I_g as a percentage of the maximum ground current allowed by the grounding Resistor as this current is proportional to the voltage displacement of the Neutral from Ground. Also indicated is the ALARM setting for the system as a percentage of the system let-through current. (NGR maximum approximately) As a reference, the setting for the Maximum Ground current is shown as IG max (5A in the example of Figure 7.2) The IGmax (Neutral Grounding Resistor Let-through) current must agree with that of the Neutral Grounding Resistor of the system. If it does not then the OHMNI-PM set-up must be repeated. ALARM level may be adjusted as required although the usual 50% default value is generally used.

IG SYSTEM A =10%
100%(IGmax) =05A

Figure 7.2 System leakage current I_g

NOTE this screen can only be seen when the system does not have a fault as will be seen.

Press ► again to view Screen 3 which is the Feeder Module screen in Figure 7.3 below. It allows the user to examine the status of the installed DSP-DFM modules. Feeder Modules are identified by their I/D numbers from 1 to 50 and may be scrolled through with the ▲▼ keys. Priority settings can be observed (10 in this case) and Ground Current I_{Gf} for the Feeder is displayed as a percentage of the maximum Ground Current of the System. A reading of "--" would represent a direct short to ground for the Feeder while 00% represents no current leakage at all. STATUS is indicated as well which shows whether or not the Feeder Module is OK (leakage below 50%), FLT (faulted) leakage greater than 50% or TRP (Tripped) which may happen if a second fault caused current in the sensor to exceed 100A for 200ms or more.

FDR 01 PRIOR 10
 I_{Gf} 07% STAT OK

Figure 7.3. Feeder Current I_{Gf}

Only those DSP-DFM modules that have valid I/D settings will indicate successfully. All others will indicate as though they were not installed with blank characters in the display fields.

NOTE: to identify which DSP-DFM is which, if not sure, the user can push the I/D/TEST button on each DSP-DFM until the Status indicator on the Feeder Screen shows 'TST'. This will be the FM selected and the I/D can be read on this screen.

If the First-Fault TRIP function was selected in the Setup Mode, then the Feeder Modules will indicate with a screen similar to Figure 7.4

FDR 01 FF DLY 01
 I_{Gf} 07% STAT OK

Figure 7.4 First Fault example

Press ► to move to the next screen. This is the Pulsing Control Screen. It appears as in Figure 7.5.

PULSE ON/OFF ←
 PULSING OFF →

Figure 7.5 Pulse Control

This screen is only used to turn on the Pulsing System for fault location. It will cause the OHMNI-PM Grounding Resistor value to be modulated to permit readings to be easily detected on portable current probes. Pulsing is toggled ON and OFF with the ◀ button. The bottom line of the display indicates the Status of the Pulsing Module. It should change to ON when pulsing is ON. Note: If the Pulsing cannot be turned ON, it could be because the InterLOCK setting has been set to ON in the Pulse Set-up. In this case Pulsing cannot be turned ON unless there is an actual fault on the system. This can be easily changed in the Set-up configuration.

Faults can be located easily with the use of a flexcore sensor (i-GARD type TS-SENSOR). Following Feeder fault identification, faults may be traced by following the feeder circuits downstream with a multimeter.

The flexcore sensor is wrapped around the feeder cable/duct and if a pulse is detected on the Ammeter (DMM), then the circuit being tested is faulted and the detection process can be moved further down to a lower branch circuit. In this way the fault can be safely isolated and removed.

If Pulsing is selected ON, then it will remain ON until turned OFF again or RESET is pressed. The Home screen will remind the Operator that pulsing is ON with the screen of Figure 7.6.

PULSING ON
HRG SYSTEM OK

Figure 7.6 New Home screen indicates Pulsing ON

12V DC Pulse current is sent from the DSP-DPS '+' and '-' terminals to the DSP-OHMNI-PM Neutral Grounding Resistor to energize the solid-state relay in the OHMNI-PM to modulate the Ground Fault Current (if any).

When finished with the Pulse operation press ► to exit and return to the Home Screen.

8 ALARM INDICATIONS

If a fault greater than the Alarm Level setting develops somewhere on the system, or the (optional) DSP-DRM Resistor monitor detects a Neutral Grounding Resistor Failure, an Alarm is declared by the System Module. This causes several events to occur as follows:

LED indications

- DSP-DM display module green NORMAL changes to red ALARM
- DSP-DSM system module red ALARM light
- DSP-DFM Fault Indication is enabled to provide indication if Fault is detected by Feeder Module (Fault may not be detected by a Feeder Module - if it is on the Main Bus for example)

Alarms

- DSP-DRM red light (NGR FAULT) lights.
- Alarm Relay (Form C) on DSP-DPS will operate to energize customers' alarm device (Horn etc.)
- A local beeper will sound in the DSP-DM to indicate the fault

The Alarms both local and external can be cancelled by the MUTE button, which is actually the ▼ key in all screens. Once cancelled the Alarm will remain OFF until about an hour after the last button has been pressed on the keypad of the DSP-DM when it will resume if an Alarm condition still exists. RESET will also cancel the MUTE effect. The MUTE control of the alarm relay contacts may be disabled (See Setup Mode in Section 9) to allow use of the ALARM contacts in the DSP-DPS power supply to be used for other purposes than an audible horn (Fans for example). However, the MUTE in that case would still silence the local Beeper.

Display

The Home screen will change to an Alarm Screen which will indicate which phase is faulted, and the branch circuit that is affected, with a screen similar to that of Figure 8.1.

FAULT PHASE A
FEEDER 01 IG 67%

Figure 8.1 Alarm Screen

The faulted Feeder is identified by I/D number. The Total System Current IG will indicate the system current as determined by the voltage from the DDR2 Voltage sensor unit (See 2.1 above). Note this may not be exactly the same as the Feeder Current Igf that is indicated in the Feeder Module Screen since the sum of all leakages will not necessarily be the same as that of one particular Feeder branch.

Feeder fault information can be determined by pressing ► to move to the Feeder Screen. The Faulted Feeder (if any) can be located by scrolling with ▲▼ keys to the faulted one. The current reading Igf relating to that feeder

is shown. It should exceed 50%. The FLT status will also confirm that this is the faulted circuit. In addition, there will be an Alarm Indication on the faulted Feeder Module which is indicated by a continuous red LED.

In the case of TRIP on First-Fault, the LED indicator light on the DSP-DFM (Feeder module) will be flashing.

When the system is faulted, it then becomes necessary to determine the source of the fault. In some cases this might be known problem but if the fault is not quickly identified, then the risk is that a second fault may develop and cause shutdown of one of the breakers. To locate the fault easily the Pulse system can be turned on using ► to enter the Pulse Control screen.

If no Feeder Faults are identified the Display Module will indicate BUS FAULT as in Figure 8.2 to indicate this special situation. In this case the probability is that there is a fault upstream of the current sensors and usually indicates a fault in the main transformer or bus duct which supplies the switchgear.

FAULT PHASE A
 BUS FAULT IG 67%

Figure 8.2 Bus Fault

This screen may be observed under other situations as well. For example if a fault develops on a faulty DSP-DFM or the Module is missing or a Feeder has no protection on it at all, the same indication will result. Another situation might be on a main-tie-main system with two DSP systems and a fault develops on one side of the gear. The DSP-DM on the other side will indicate Alarm with a BUS FAULT if the tie is closed since it does not 'see' any DSP-DFM on its side with a fault. One other case for this condition is that the Feeder Module that is faulted (red-light on) is not set up with an I/D an priority setting.

9 SELF – TEST

Basic functionality testing of the system can be done without interrupting circuit breakers. To enter the Test the operator must be in the Home Screen and without a fault on the system at the time. Press SETUP button. Using the ENTER key press it 11 (eleven) times until the SELF-TEST screen is reached, Select Y and ENTER to access the Self-Test. The operator is prompted with the TEST SYSTEM test as in Figure 9.1

TEST SYSTEM?
 Y/N

Figure 9.1 System-Test Prompt

To check the SYSTEM Module DSP-DSM, select Y and ENTER otherwise just push ENTER to move to the Feeder Module Test.

If the SYSTEM was selected when ENTER is pressed, the Red Alarm lights on System Module and Display Module will light and both the local and remote Alarm devices will sound. Check that the MUTE button silences the Alarms effectively.

The prompt figure 9.2 for Feeder Module DSP-DFM automatically appears at this time. Select Y or ENTER to perform the Feeder Module Test. Pressing ENTER will return the display to the Home Screen.

TEST FEEDER? Y/N

Figure 9.2 Prompt for Feeder Test

The second line of the display will indicate that it is ready for a Feeder Module Test with the screen of Figure 9.3.

TEST FEEDER? Y/N
FM NO.

Figure 9.3 Feeder Module Test

At this point the operator may press any DSP-DFM TEST button and if the DSP-DFM (Feeder Module) be operational in optimal condition, the Display will respond with the I/D number of the selected Feeder Module and acknowledges with "OK" as in the example of Figure 9.4

Note that the Alarm Level Setting for the DSP-DFM Module selected is shown. This may not be the same necessarily as that of the System Module. To synchronize the Feeder Module with the System Module it will be necessary to enter the Setup for the Feeder Modules and re-program the module.

NOTE: The Alarm Levels need not all be set to the same value but it is usually desirable to do so.

TEST FEEDER? Y/N
FM 05 OK ALM 50%

Figure 9.4 Test Result

Press any other Feeder TEST button to check other modules similarly.

Press ENTER to leave the Self-Test and return to the Home Screen.

10 EVENTS

Standard (No DSP-DLM module)

When a fault occurs sufficient to cause an alarm the event is recorded along with the fault current level and location so that it can be checked on the DSP-DM display module, even if the fault has disappeared. This can be seen on the Home screen which indicates an event with a message as in Figure 10.1.

I-GARD
FAULT CLEARED ←

Figure 10.1 Event Notification

To observe what event occurred press ◀ as indicated and hold to read the data. The display will show the type of fault, phase faulted and the branch location if any. For example Figure 10.2 shows a typical Feeder Fault that was momentary.

FAULT PHASE A
FEEDER 03 IG 78%

Figure 10.2 Momentary Feeder Fault Example

The following Events are supported:

Type of Event	Interpretation	Possible Cause
Bus Fault	Fault occurred which was not identified by any Feeder Module	a) Fault upstream in duct or transformer
		b) Fault in unprotected Feeder branch
Phase Loss	Loss of a phase on the DDR2 resistor	Fuse Open
3- Phases Lost	No power on DDR2 resistor unit	Power Disconnected
Feeder Fault	Fault occurred on identified Feeder	Ground Fault on Feeder

The event will remain until superseded by another fault, which will rewrite over the previous data. The data is volatile and will be cleared on a power interruption or operation of the RESET button.

11 DSP-DLM LOGGING MODULE

If a Logging Module is installed the clock in requires to be setup for correct time and date; This is performed when the system is being set up through the DSP-DM.

The logging function is part of the DSP-DM Display software which is constantly scanning the System Module and the Feeder Modules status to determine if a TRIP, Feeder Fault, System Fault or NGR Fault occurs that was not there previously. If any of these conditions occurs then the following procedure takes place:

Event information is compiled along with the new Record Number, time and date in a register
Register information is stored in non-volatile EEPROM memory.

The module will capture the status of the events and stamp both; the time and the date information to the event.

The DSP-DLM will not indicate the fault levels however. Also the fault must exist for at least 0.5 seconds to be recorded completely particularly with regard to phase indication due to delays in the System Module response.

NOTE: The DSP-DLM will not capture faults that occur while the DSP-DLM is being read, therefore the user must exit the Log Mode to capture further events. RS-485 Communications will also stop during the time that the Log Module is being read. Protection, however, during an Alarm and a Trip operation the DSP-DLM does not interrupt communications.

When an event occurs, and is cleared, the screen will signal the presence of an event with a ◀ left arrow at the lower, right hand end of the screen.

Type of Interpretation Event/Display	Possible Cause	
BUS FAULT	Fault occurred which was not identified by any Feeder Module DSP-DFM I/D not setup	Fault upstream in duct or transformer Fault in unprotected Feeder branch
PHASE LOSS	Loss of a phase on the DDR2 resistor	Fuse Open
3- PHASES LOST	No power on DDR2 resistor unit	Power Disconnected
FAULT PHASE FEEDER NO x	Fault occurred on identified Feeder	Ground Fault on Feeder
FEEDER TRIP 1st or 2nd Fault	Feeder Module Tripped* on either b) TRIP on single fault mode selected- one fault exists	Two faults exist

*Does not display the faulted Phase

The Display will indicate the Record number in the top-left corner of the read-out along with the fault type and time of occurrence in hour:min:sec am/pm format.

Figure 11.1 Fault/Time logged event

10 FAULT PHASE B
03:04:09 PM

To get the date and further information press ◀ to read more.

Release ◀ to return to Fault/Time information. To exit the DSP-DLM press ENTER or RESET

FEEDER 01
07/10/09 TUE

The Display will always show the last event when the module is first selected, however to read previous events, press ▲▼ keys to review them. Up to 99 events can be stored before the EEPROM rolls over to start at 01 again. The ▼ key will step backwards in event number through the entire 99 events (even if some are cleared) but the ▲ key will only allow the user to scroll through Events 1 to n (where n is the latest event).

NOTE: To quickly get back to the latest event press ENTER to exit the module and then ◀ key again to get back in.

12 DSP-DRM Resistor Monitor

The I-Gard DSP-DRM is Neutral Grounding Resistor (NGR) monitor relay. In distribution systems employing High Resistance Grounding the DSP-DRM protects against abnormal resistance values of the Neutral Grounding Resistor (NGR).

The DSP-DRM is specifically designed for a variety of system voltages and Neutral Grounding Resistors (NGR)

The DSP-DRM is designed to be used with an i-Gard zero sequence current sensor Type TxA or Rx-YA and a NGRS-XX Resistor Sensor installed with a Neutral Grounding Transformer sized for a Let Through Current according to the specifications of the system in which it will be installed.

The DSP-DRM monitors the NGR using one of two methods, a Measurement mode of operation where the NGR resistance is measured using the leakage current through the NGR and a Continuity mode of operation where the continuity of the NGR is checked used when the leakage current is too low (below 1% of the maximum let through current) for the measurement mode to accurately gauge the resistance of the NGR.

In the Measurement mode of operation used when the combination of current through the CT and neutral-to-ground voltage indicates that the resistance of the NGR has increased to more than 150% of its nominal value or has decreased to less than 66% of its nominal value. If these limits are exceeded, the DSP-DRM will indicate an NGR failure and trip within 3.5 seconds. A fast response is necessary as failure of the NGR implies that there is limited ground fault protection on the system. It also ensures fast tripping when a transformer is energized and the resistor is faulty.

By measuring the leakage values of current and voltage the DSP-DRM recognizes when the resistance of the NGR cannot be measured accurately. If the NGR current is less than 1% of the Let-Through Current the DRM integrity monitor detects whether the NGR resistance is present or the NGR has failed such that it presents an open circuit.

In the event that the NGR opens completely when the DSP-DRM is in the Measurement mode described above, the appearance of the open circuit will cause the DSP-DRM to switch from the Measurement mode to the Continuity mode described above. The Continuity mode will recognize that the NGR circuit is open and indicate of an NGR failure within 3.5 to 10 seconds.

DSP-DRM Installation (See Figure 17.8 DSP-DRM Connections)

The DSP-DRM is designed to be used with an I-Gard Type TxA Sensor and a NGRS-XX Resistor Sensor installed inside a Neutral Grounding Resistor sized to limit ground fault current.

The Let-through Current measured by the zero sequence current sensor will be the vector sum of any leakage currents or charging currents normally in the system and any ground fault currents that may be present.

The DSP-DRM measures the current through the NGR, the transformer neutral-to-ground voltage and the Neutral Grounding Resistor resistance. The relay compares the measured values with the value of the NGR set in the DSP OHMNI Setup, and provides relay outputs and LED indications when an abnormal condition is detected.

Note: The connection of the NGRS-XX resistor should be as direct as possible to the X0 point of the transformer in order to include the conductor between this point and the N terminal of the NGR Resistor within the zone of protection.

The DSP-DRM system is matched to the System voltage by means of a fully rated NGRS. Neutral-to-ground voltage is measured by means of the NGRS-XX Resistor Sensor, connected between the NGR's connection to the transformer neutral (X0) and the relay's NGRS input terminal. (XX refers to the voltage of the system) The NGRS-XX Sensing Resistor is used by the DSP-DRM as part of a comparator to monitor the NGR resistance. The NGRS-XX Sensing Resistor contains a voltage suppressor which limits its output voltage to a safe level in the event of disconnection of the resistor and the DSP-DRM.

When the NGR current measured by the zero sequence current sensor is above 1% of the NGR Let-Through Current setting, an NGR fault will be detected if the measured current and voltage indicates that the NGR resistance has increased to more than 150% or has decreased to less than 66% of its nominal value.

When the zero sequence current sensor output current is below 1% of the NGR Let-Through Current setting, the DSP-DRM simply monitors the NGR resistance for continuity, i.e. whether, or not, the NGR is open, or presents some resistance.

The DSP-DRM has one Form C output relay which can be used to give a door/panel mounted or remote indication of an NGR Fault.

DSP-DRM Operation with DSP-OHMNI system

A DSP-DRM module must be present in the lineup of Feeder Modules In order to monitor the system ground resistor. If the NGR is good then Pressing ► until the screen shows NGR condition results in the NGR OK Indication. The 'LOW V' indication may or may not be seen. It depends on the voltage that is measured across the NGR grounding resistor. Normally this voltage will be low or zero in the absence of a ground fault. If sufficient NGR voltage develops then the DSP-DRM will begin to monitor the resistance Value of the NGR and signal out-of-tolerance if necessary. Measurement of the actual resistance of the NGR depends on the existence of at least 1% of NGR rated voltage otherwise LOW V is indicated. If this is displayed then the DSP-DRM will only monitor the NGR for continuity i.e. not open circuit.

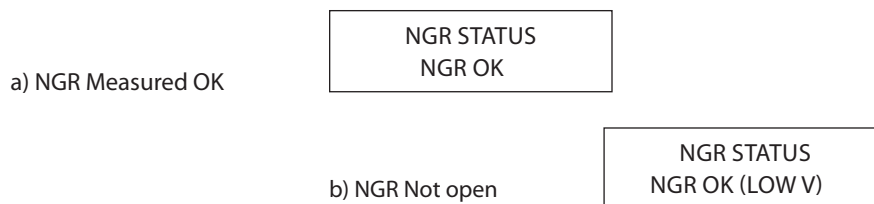


Figure 12.1 NGR Status Good Resistor

If the NGR resistor fails open then the display will indicate. Failure of the resistor with the fail screen shown.



Figure 12.2 NGR Fault

If a DSP-DRM is not connected the following message will be reported



Figure 12.3 DSP-DRM not connected

Pressing ENTER will terminate the Setup and Self-Test and The HOME screen will be returned.



If the DSP is left in the Setup Mode it will not gather information on the system, however Feeder protection will still be effective. If the DSP is left accidentally in the Setup Mode it will reset Automatically after a period of approximately 1 hour.

13 MAINTENANCE AND TESTING



Due to the solid state design and the use of sealed components, it is not necessary to service the DSP other than occasionally dusting with a damp cloth or vacuum cleaner during regular switchboard maintenance.

To test the DSP it will normally be sufficient to use the SELF-TEST procedure (as described in section 9).

To test the system in the field involves placing a ground fault on one of the lines. This should only be performed with the permission of the owner and by qualified individuals using proper techniques, to ensure safety to plant, equipment and personnel.

 DANGER 	
Hazard of Electrical Shock, Burn or Explosion	
All installation, servicing and testing referred to in this manual must be performed by qualified personnel. All power should be disconnected prior to removing covers or enclosures and where live conductors may otherwise be exposed.	
Failure to observe these precautions may result in death or severe personal injury and damage to equipment .	
Before placing an intentional ground fault on the power system, check that a fault does not already exist. Any test ground fault equipment must be rated for full system voltage and be fused for protection.	

A complete test of the system can be accomplished with the connection of a resistive fault between one of the three lines and ground at a location downstream of one of the Feeder current sensors. This simple test will identify the integrity of sensor, Feeder Module circuits, connections, communications, System Module operation, DDR2 resistor OHMNI-PM resistor and Pulsing without causing a Trip to occur on any of the breakers. The only thing it will not test is the priority of the double-fault trip process. For this two such resistors would be required, with resistor value low enough to provide more than the 100A trip current required for the selective second ground fault tripping.

 DANGER 	
Never use a piece of wire to create a test fault. It is possible that the protection may not be operational due to mis-wiring or other problems and cannot clear the fault current resulting in a serious arcing situation which may severely damage the equipment and cause injury or death.	

Secondary injection testing is possible using low current sources to test the Feeder Modules. It is recommended to use currents of 1/1000 of the expected circuit current through the zero sequence current sensor. Because there are interlocking signals from the System Module that prevent Feeder Module Trip and Indication, then it is necessary to either apply a voltage to the N-G terminals of the system module, or simply pull one of the DDR2 fuses to drive the System Module into the Alarm Condition thus enabling the Feeder Modules to provide indication and Digital Trip functionality.

NOTE: Should the injection current induced during this procedure exceed 100mA then the Feeder Module will trip on the Analog backup circuit without any indication at all.

14 SERVICE

I-Gard offers comprehensive training, commissioning and inspection assistance by trained engineers. For assistance in installation, setup or testing please call I-Gard toll free at 1-888-737-4787 (1-888-RESISTR)

There are no user-serviceable parts in the DSP, therefore all service should be referred to qualified factory representatives, other than direct replacement of entire Modules to I-Gard. Please visit the I-Gard website for information regarding field service representatives in your area. (www.i-gard.com)

NOTE: Please ensure that proper authorisation is obtained from I-Gard before returning the equipment.

15 COMMUNICATIONS

Installation

To allow communications to a remote terminal or network, a 4-wire RS-485 communications jack is provided at the rear of the DSP-DM Display Module. The 5-pin connector supplied has screw terminals and allows disconnection without breaking the RS-485 daisy chain. A ground connection is supplied for grounding the shield of the 4-wire cable. The protocol supported is MODBUS RTU. The baud rate can be changed in the DSP-DM set-up to 4800, 9600 or 19200 as desired. The frame set-up is 8 bit, No Parity and 1 Stop Bit. The I/D number for the DSP-DM must be entered in the set-up within the range of 1 to 32. Cable should be standard 4-wire with two twisted-pairs ideally, and a grounding shield for electro-magnetic coupling protection. The shield of the cable between nodes should not be continuously grounded, but each section of cable should be grounded at GND pin of J3. When installing cable, avoid star connections and make connections flow from node to node. Cable length of 1-2 kilometres or more should be easily accommodated.

DSP MODBUS output structure

Two functions are supported

Read Holding Register (03)

Set Coil (05)

There are 156 registers available, which can be accessed by an external host system. This document summarizes the format and function of these registers.

The request from the master is always 8 bytes long and are as shown in Table 15.1.

Unit I/D	Function	Starting Address		No. of Registers requested		CRC	
		High	Low	High	Low	High	Low
01	03	00	01	00	02	nn	nn

TABLE 15.1 MODBUS RTU STANDARD 8 BYTE HOLDING REGISTER READ FUNCTION (03)

All bytes are in hexadecimal. Numbers above are, for example, a request for 2 registers only, starting from address 01. CRC checksum is 16 bit CRC as described in MODBUS information. The high bytes are not used in any requests.

If successful the DSP will return the message shown in Table 15.2.

Unit I/D	Function	No. of bytes	Data 1		Data 2		CRC	
			High	Low	High	Low	High	Low
01	03	04	00	nn	00	nn	nn	nn

TABLE 15.2 RETURNED INFORMATION STRUCTURE FOR HOLDING REGISTER REQUEST

Register contents are shown in Tables 15.5 to 15.8 as follows.

NOTE: Register number is shown in decimal but must be sent in hexadecimal form in the request.

The only write functions presently supported in the DSP system are RESET control and PULSE ON/OFF which will require the use of Set Coil function in MODBUS. The format for Setting is as shown in Figure 15.3

Unit I/D	Function	Coil Address		Force Coil		CRC	
		High	Low	High	Low	High	Low
01	05	00	00	ff	00	nn	nn

TABLE 15.3 REQUEST TO WRITE TO SET A BIT ON A REGISTER (MODBUS FORCE COIL)

In this case there will only be two 'coils' (actually DSP functions)

'Coil' No	Name	Force Coil Data	
00	Reset	ff00 =on	0000=off
01	Pulse	ff00 =on	0000=off

The response of Table 15.4 will confirm the request

Unit I/D	Function	Coil Address		Force Coil		CRC	
		High	Low	High	Low	High	Low
01	05	00	00	ff	00	nn	nn

TABLE 15.4 RETURNED INFORMATION FROM DSP FOLLOWING A FORCE BIT REQUEST

Which is just an echo of the request.

The registers can be read either one at a time or in a continuous block up to a maximum of 100 registers at a time.

There are times when the DSP processor will not be able to respond to a request since it is busy with other tasks and no response will be returned. For this reason it is recommended to request the maximum number of registers used by the system in a single request. Since the DSP is set up to 50 current registers, 50 Status registers and 50 Priority registers followed by the System function registers, it is best to read the data with three consecutive requests.

NOTE: that the DSP will not respond to requests if the DSP-DM is in the SETUP mode.

The Feeder Module currents Igf values are contained in the first 50 registers as follows. The values range from 0x00 to 0xff although maximum for a first fault condition will be 0x64 or 100%. Table 13.5 lists the register addresses in the MODBUS convention.

Register No	Contents	Format	Register No.	Contents	Format
40001	Feeder 1 Igf	0x00nn	40026	Feeder 26 Igf	0x00nn
40002	Feeder 2 Igf		40027	Feeder 27 Igf	
40003	Feeder 3 Igf		40028	Feeder 28 Igf	
40004	Feeder 4 Igf		40029	Feeder 29 Igf	
40005	Feeder 5 Igf		40030	Feeder 30 Igf	
40006	Feeder 6 Igf		40031	Feeder 31 Igf	
40007	Feeder 7 Igf		40032	Feeder 32 Igf	
40008	Feeder 8 Igf		40033	Feeder 33 Igf	
40009	Feeder 9 Igf		40034	Feeder 34 Igf	
40010	Feeder 10 Igf		40035	Feeder 35 Igf	
40011	Feeder 11 Igf		40036	Feeder 36 Igf	
40012	Feeder 12 Igf		40037	Feeder 37 Igf	
40013	Feeder 13 Igf		40038	Feeder 38 Igf	
40014	Feeder 14 Igf		40039	Feeder 39 Igf	
40015	Feeder 15 Igf		40040	Feeder 40 Igf	
40016	Feeder 16 Igf		40041	Feeder 41 Igf	
40017	Feeder 17 Igf		40042	Feeder 42 Igf	
40018	Feeder 18 Igf		40043	Feeder 43 Igf	
40019	Feeder 19 Igf		40044	Feeder 44 Igf	
40020	Feeder 20 Igf		40045	Feeder 45 Igf	
40021	Feeder 21 Igf		40046	Feeder 46 Igf	
40022	Feeder 22 Igf		40047	Feeder 47 Igf	
40023	Feeder 23 Igf		40048	Feeder 48 Igf	
40024	Feeder 24 Igf		40049	Feeder 49 Igf	
40025	Feeder 25 Igf		40050	Feeder 50 Igf	

TABLE 15.5 FEEDER MODULE GROUND CURRENT ADDRESSES

Feeder Module Status is represented by five valid states as follows:

0x00	=	OK
0x01	=	Faulted feeder
0x02	=	Feeder Tripped
0x03	=	Test Button pushed
0x0f	=	Not available

The registers following return two bytes – The first byte is always 0x00 with the second returning status in hexadecimal as above.

Register No.	Contents		Register No.	Contents	
	Function	Format		Function	Format
40051	Feeder 1 Status	0x00nn	40076	Feeder 26 Status	0x00nn
40052	Feeder 2 Status		40077	Feeder 27 Status	
40053	Feeder 3 Status		40078	Feeder 28 Status	
40054	Feeder 4 Status		40079	Feeder 29 Status	
40055	Feeder 5 Status		40080	Feeder 30 Status	
40056	Feeder 6 Status		40081	Feeder 31 Status	
40057	Feeder 7 Status		40082	Feeder 32 Status	
40058	Feeder 8 Status		40083	Feeder 33 Status	
40059	Feeder 9 Status		40084	Feeder 34 Status	
40060	Feeder10 Status		40085	Feeder 35 Status	
40061	Feeder 11 Status		40086	Feeder 36 Status	
40062	Feeder 12 Status		40087	Feeder 37 Status	
40063	Feeder 13 Status		40088	Feeder 38 Status	
40064	Feeder 14 Status		40089	Feeder 39 Status	
40065	Feeder 15 Status		40090	Feeder 40 Status	
40066	Feeder16 Status		40091	Feeder 41 Status	
40067	Feeder 17 Status		40092	Feeder 42 Status	
40068	Feeder 18 Status		40093	Feeder 43 Status	
40069	Feeder 19 Status		40094	Feeder 44 Status	
40070	Feeder 20 Status		40095	Feeder 45 Status	
40071	Feeder 21 Status		40096	Feeder 46 Status	
40072	Feeder 22 Status		40097	Feeder 47 Status	
40073	Feeder 23 Status		40098	Feeder 48 Status	
40074	Feeder 24 Status		40099	Feeder 49 Status	
40075	Feeder 25 Status		40100	Feeder 50 Status	

TABLE 15.6 FEEDER MODULE STATUS ADDRESSES

Register No.	Contents		Register No.	Contents	
	Function	Format		Function	Format
40101	Feeder 1 Priority	0x00nn	40126	Feeder 26 Priority	0x00nn
40102	Feeder 2 Priority		40127	Feeder 27 Priority	
40103	Feeder 3 Priority		40128	Feeder 28 Priority	
40104	Feeder 4 Priority		40129	Feeder 29 Priority	
40105	Feeder 5 Priority		40130	Feeder 30 Priority	
40106	Feeder 6 Priority		40131	Feeder 31 Priority	
40107	Feeder 7 Priority		40132	Feeder 32 Priority	
40108	Feeder 8 Priority		40133	Feeder 33 Priority	
40109	Feeder 9 Priority		40134	Feeder 34 Priority	
40110	Feeder10 Priority		40135	Feeder 35 Priority	
40111	Feeder 11 Priority		40136	Feeder 36 Priority	
40112	Feeder 12 Priority		40137	Feeder 37 Priority	
40113	Feeder 13 Priority		40138	Feeder 38 Priority	
40114	Feeder 14 Priority		40139	Feeder 39 Priority	
40115	Feeder 15 Priority		40140	Feeder 40 Priority	
40116	Feeder16 Priority		40141	Feeder 41 Priority	
40117	Feeder 17 Priority		40142	Feeder 42 Priority	
40118	Feeder 18 Priority		40143	Feeder 43 Priority	
40119	Feeder 19 Priority		40144	Feeder 44 Priority	
40120	Feeder 20 Priority		40145	Feeder 45 Priority	
40121	Feeder 21 Priority		40146	Feeder 46 Priority	
40122	Feeder 22 Priority		40147	Feeder 47 Priority	
40123	Feeder 23 Priority		40148	Feeder 48 Priority	
40124	Feeder 24 Priority		40149	Feeder 49 Priority	
40125	Feeder 25 Priority		40150	Feeder 50 Status	

TABLE 15.7 FEEDER MODULE PRIORITY ADDRESSES

Register	Function	Format	Description
40151	System IG current	0x00nn	nn = 0-100% Total System leakage current IGt
40152	System Status	0x00nn	Nn
			01 = Normal no fault
			10 = A phase low
			20 = B phase low
			40 = C phase low
			70 = All phases low
			82 = A phase faulted
			84 = B phase faulted
			88 = C phase faulted
40153	Pulse setup	0x00nn	nn lower byte is a composite byte upper nibble is Mode of operation while lower nibble of nn is pulse frequency 0 – 9.
			nn
			0n = Normal, interlock OFF
			1n = Inverted, interlock OFF
			2n= Normal , interlock ON
			3n=Inverted, interlock ON
40154	Pulse Status	0x000n	n
			0=Pulsing OFF
			1=Pulsing ON
40155	Alarm Level	0x000n	n
			1 = 10% of NGR current maximum
			2 = 20%
			3 = 30%
			4 = 40%
			5 = 50%
			6 = 60%
			7 = 70%
			8 = 80%
			9 = 90%
40156	NGR Status	0x00nn	nn
			00 = NGR OK Voltage Good
			01 = NGR fail Voltage Good
			10 = NGR OK Voltage Low
			11 = NGR fail Voltage Low

Table 15.8 System Function Registers

16 SPECIFICATIONS

Power Requirements DSP-DPS	100-240V, 50/60Hz or DC, 25VA	
Maximum Ratings DSP-DPS		
Control voltage	250V AC/DC	
Dielectric		
Relay contacts to chassis	1500V rms. for 1 minute	
Control terminals to chassis	1500V rms. for 1 minute	
DC output maximum rating	22W max for +5, +12 and 12V supplies	
Settings DSP-DSM System Module		
Alarm Level Pickup	10% to 90% in 10% increments of system Ground Current IG	
Pulse Set-up		
Pulse Rates		
0 to 9 Setting in 0.25Hz increments	1.0,1.25,1.50,1.75, 2.0, 2.25, 2.50, 2.75, 3.0, 3.25Hz.	
Pulse Modes	Normal, Inverted	
Pulse Interlock	Normal, Interlocked with Fault Detect.	
Pulse Output current	0.5A @ 12V DC	
DSP-DFM		
Ground Current Settings IG	1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16A	
Trip Level Current	100A	
Trip Level Delay	10xP +200mS (Where P=Priority setting)	
Priority Levels	0 – 15 (16 settings)	
Contact Ratings		
DSP-DFM Trip Contacts	Form C SPDT	10 amperes, 240V AC resistive
	8A 24V DC	
DSP-DPS Alarm Contacts	Form C SPDT	8 amperes, 240V AC resistive
	8A 24V DC	
DSP-DPS Pulse output	DC Source	100 milliamperes, 12V dc maximum
Performance		
DSP-DFM		
Maximum No. of Modules	50	
Pickup accuracy	±10% of system let-through current	
Trip Level accuracy	±10A	
Trip Delay Trip on 2nd Fault		
Digital Trip delay	200mS+(10 x priority*) mS	(e.g. if priority is 5 then 200 +5x10=250mS)
*the priority factor only applies if the two faults occur at the same instant otherwise the delay will be simply 200mS		
Analog Backup delay	1 Sec.	
Trip Delay on 1st Fault		
Minimum Setting (00 position)	Fixed 0.1 Sec.	
Adjustable	01 to 99 minutes	
DSP-DSM		
Alarm Level Accuracy	±10% of IG	
Meter accuracy	±10% of IG	
Note: Accuracy based on single resistance fault, at nominal line voltage, without system capacitance.		

DSP-DLM	
Maximum No of events	99
Minimum Capture Time	0.5 Sec.
DSP-DRM	
NGR Acceptable Range	66% to 150% of nominal value
Minimum Voltage Value	1% of maximum NGR voltage
Contacts	1 Form C 10A @240VAC, 8A 24V DC

General

Temperature Range:	
Operating temperature	0°C-+50°C

Standards

CSA File number	LR65287
ULListed file number	E232710
CE	

Dimensions	See Fig. 17 (next)
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I-GARD RESERVES THE RIGHT TO CHANGE SPECIFICATIONS OF ITS PRODUCTS WITHOUT NOTICE.

17 OUTLINE DIMENSIONS

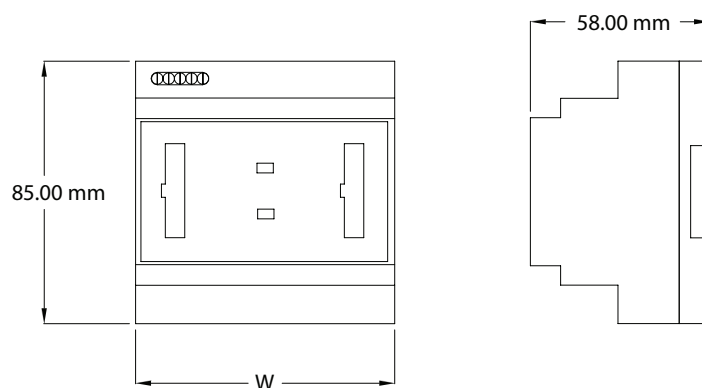


Figure 17.1 shows typical Dimensional details of the Polymeric enclosures used for the modules. All have the same cross-section dimensions but with different widths W as shown.

Module	W
DSP-DFM	35mm (1.377 in.)
DSP-DLM	35mm (1.377 in.)
DSP-DSM	70mm (2.755 in.)
DSP-DPS	155mm (6.102 in.)
DSP-DRM	155mm (6.102 in.)
DSP-CAS	70mm (2.755 in.)
DSP-CA	70mm (2.755 in.)

Figure 17.1 DIN Rail Mounted Modules

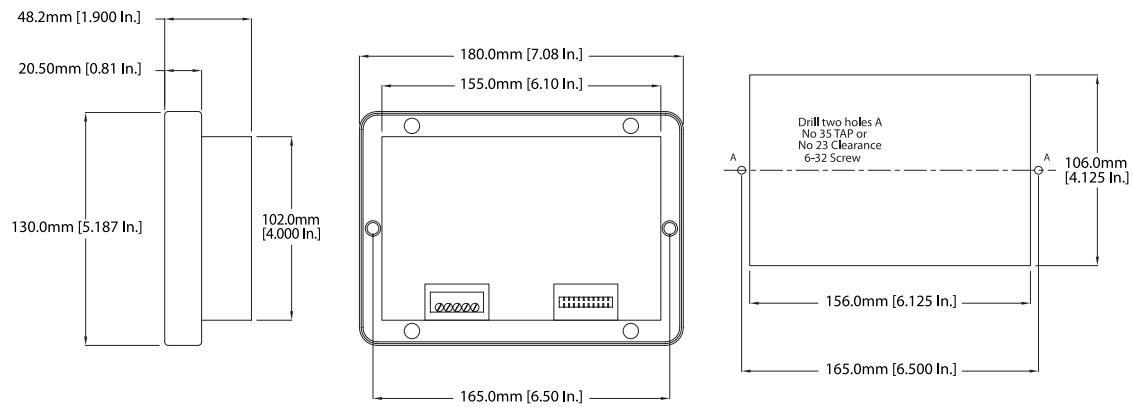


Figure 17.2 DSP-DM Display Module with cut-out detail

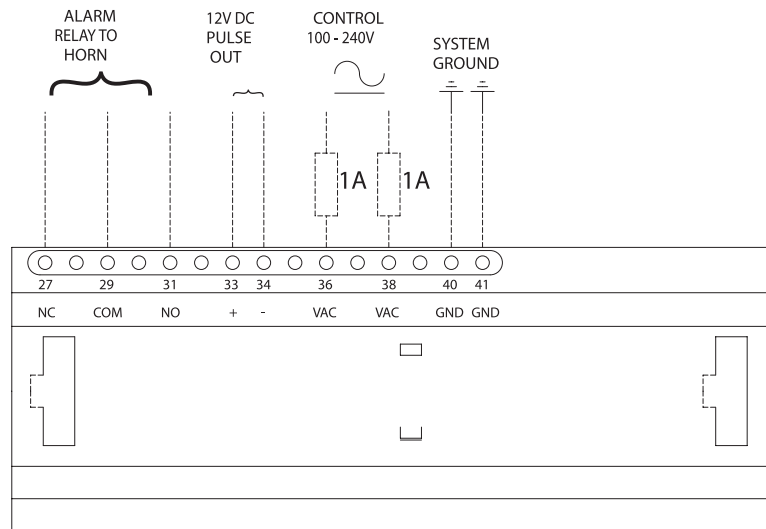


Figure 17.3 DSP-DPS Power Supply Connections

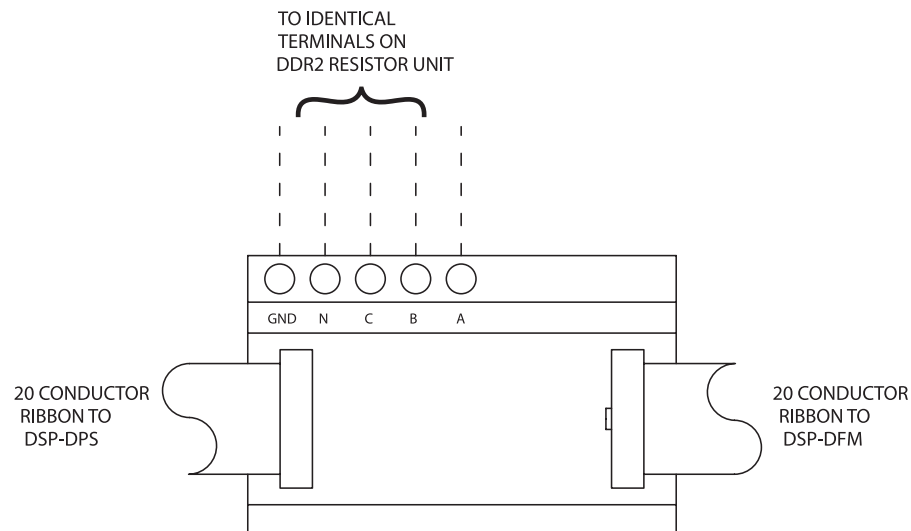


Figure 17.4 DSP-DSM System Module Connection

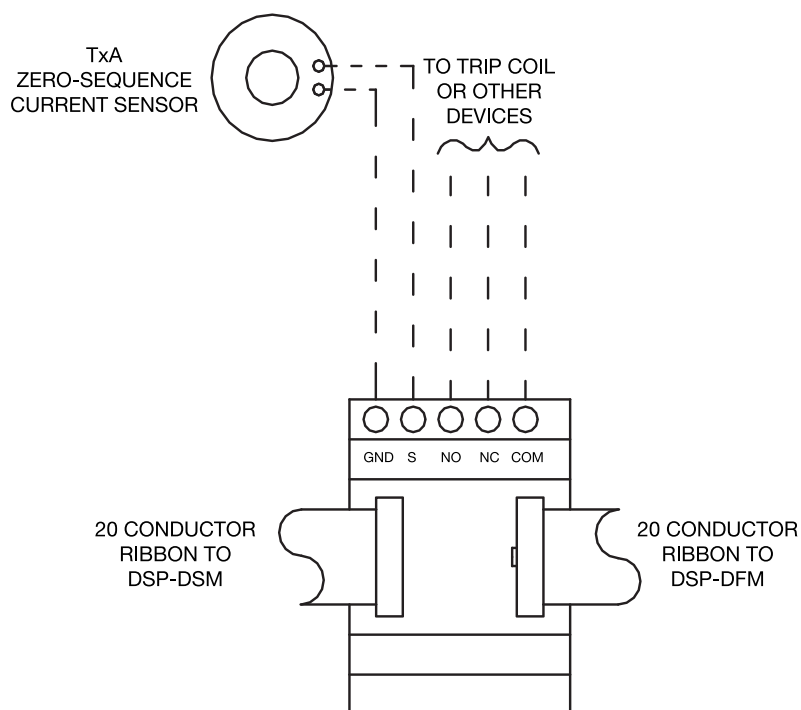


Figure 17.5 DSP-DFM Feeder Module Connection

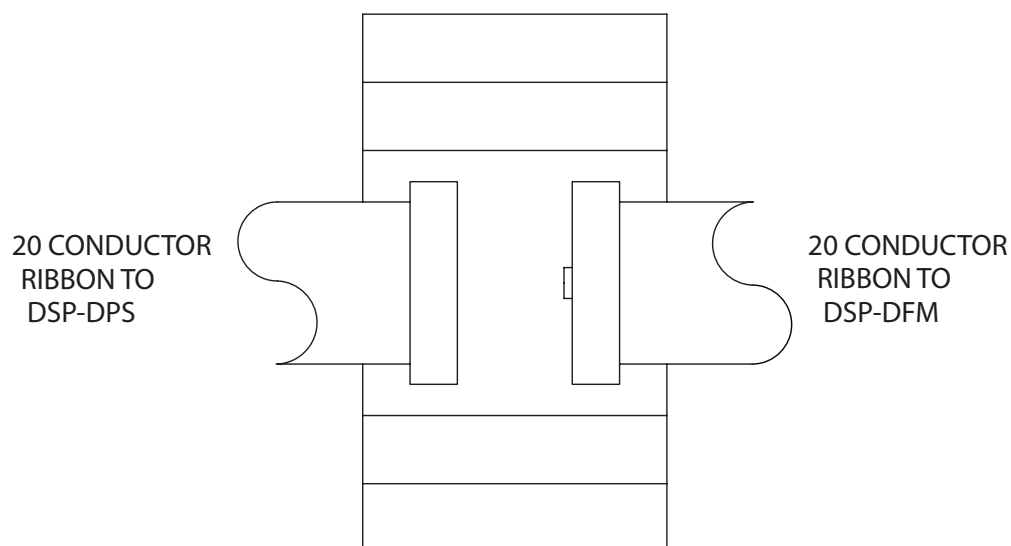


Figure 17.6 DSP-DLM Logging Module Connections

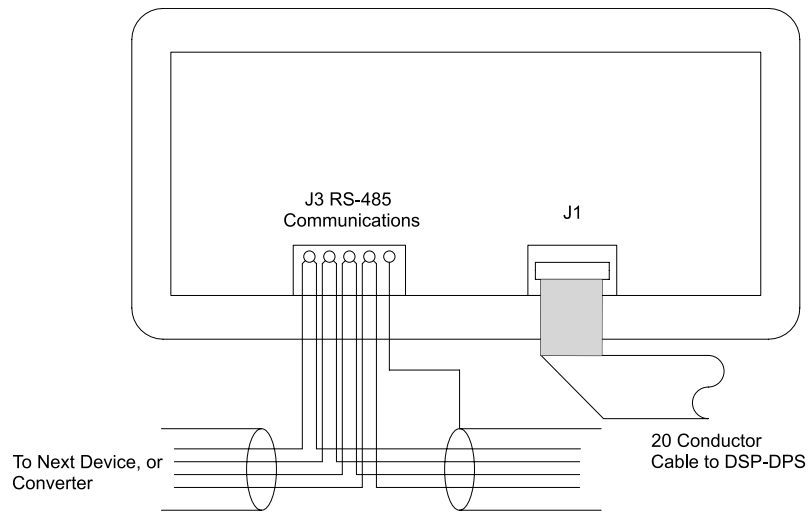


Figure 17.7 DSP-DM Display Module Connections

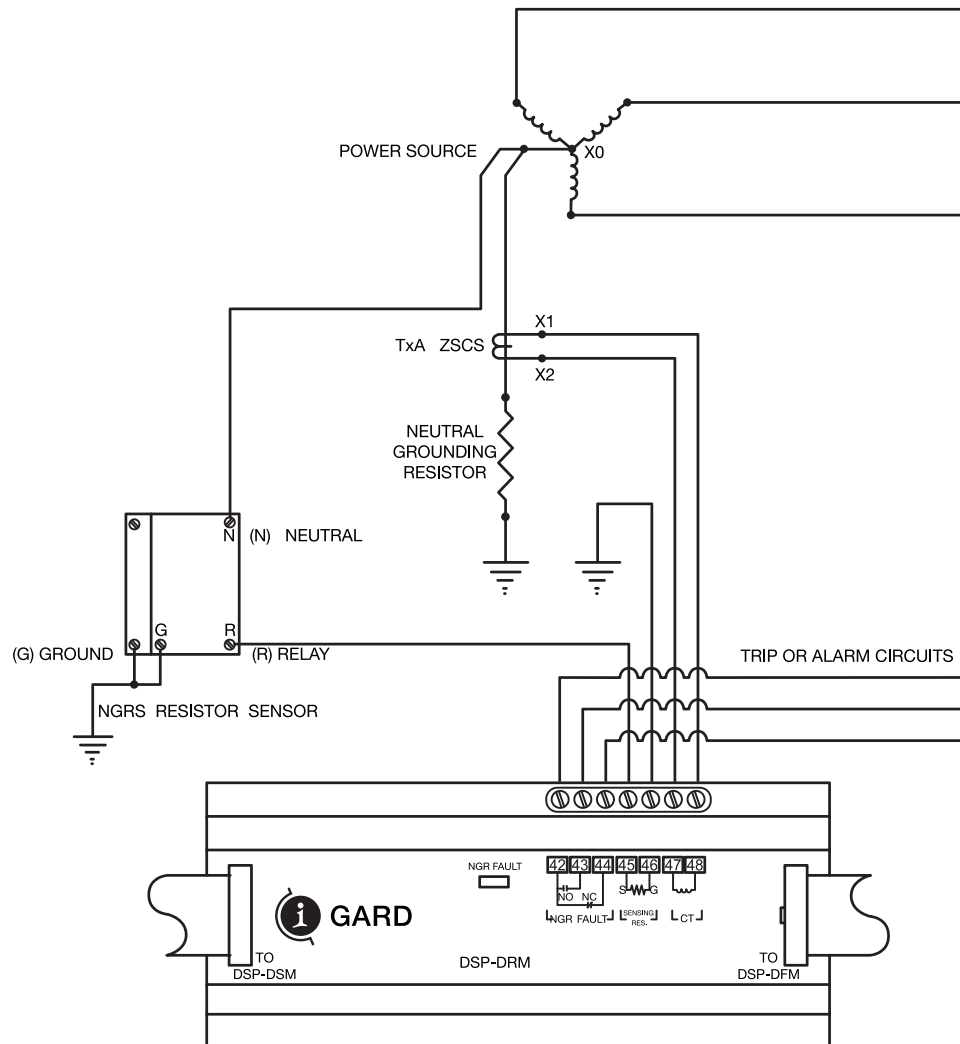


Figure 17.8 Typical DSP-DRM Installation Connections

18 I-GARD PRODUCTS

These are some of the I-Gard Products. For more information or for a complete list of them, please contact I-Gard



FALCON
Optical Arc
Protection System



VIA
Voltage Alarm Indicator



mGARD
Ground Fault
Relay



STOPLIGHT
High Resistance
Grounding System



GEMINI
High Resistance
Grounding System



SLEUTH
High Resistance
Grounding System



FUSION
High Resistance
Grounding System



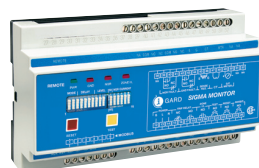
SENTINEL
High Resistance
Grounding System



MGFR
Ground Fault
Relay



DSP OHMNI
High Resistance
Grounding System



SIGMA
Ground Fault Relay
Resistor Monitor



GCHK-100
Mining Relay

unparalleled protection



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