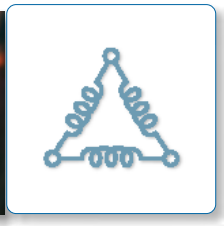
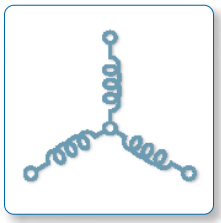
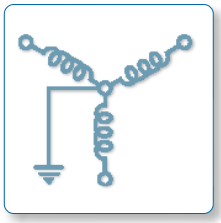
GARD

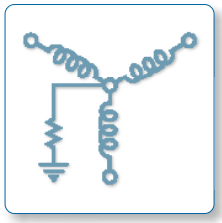
Unparalleled Protection

DSP-OHMNI









ABOUT I-GARD

I-Gard's commitment to electrical safety provides both industrial and commercial customers with the products needed to protect their electrical equipment and the people that operate them.

As the only electrical-safety focused company whose product portfolio includes neutral grounding resistors, high-resistance grounding systems and optical arc mitigation, we take pride in our technologies that reduce the frequency and impact of electrical hazards, such as arc flash and ground faults.

For those customers who have purchased from us over the last 30 years, you know us for the quality and robustness of our products, our focus on customer service and technical leadership. We build on this foundation by investing in developing new products in electrical safety education by actively participating in the IEEE community programs on technical and electrical safety standard, and working with local universities at discovering new technologies. We remain unrelenting in our goal of improving electrical safety in the workplace.

Our commitment to excellence is validated by long-standing relationships with industry leaders in fields as diverse as petroleum and gas, hospitals, automotive, data centers, food processing, aerospace, water and waste water plants, and telecommunications. We provide our customers with the product and application support required to ensure that their electrical distribution system is safe and reliable.

TABLE OF CONTENTS

1. INTRODUCTION

High resistance grounding (HRG) 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 offers service continuity by limiting the ground fault current to a sustainable level for an indefinite time.

I-Gard's DSP-OHMNI is an HRG system designed to provide service continuity using a Neutral Grounding Resistor, a voltage alarm unit and a ground fault relay to detect the event of a single ground fault, signal an alarm condition and display the affected phase and/or feeder using programmable voltage and current measurements.

The DSP-OHMNI system also allows the operator to identify the precise fault location using an integrated pulsing module available in the OHMNI-PM or OHMNI-PM-RM resistor to modulate the current in the fault circuit which can be detected using a portable clamp-on current probe (TS-SENSOR) connected to an ordinary ammeter (DMM) meter. Thus, maintenance can be immediately alerted and an operator dispatched to locate the fault to isolate it promptly.

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 to trip the breakers associated with the fault with or without adjustable 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 system other alarm levels between 10% and 90% may be set as desired.

Additionally, the DSP-OHMNI has two TRIP modes. 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 rated 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.

The DSP-OHMNI system consists of a voltage sensor unit (DDR2), a Neutral Grounding Resistor (OHMNI-PM or OHMNI-PM-RM) and a ground fault relay (DSP-DSYS) which includes a panel mounted touchscreen display module (DSP-TDM) and two 35mm DIN rail mounted modules (DSP-DPS & DSP-DSM) typically located inside the control compartment of a switchgear. The modules are connected together using 20 pins-conductor standard ribbon cables. The panel-mounted touchscreen display module (DSP-TDM) is a Human Interface Device (HID) that allows set-up and control of the system. Optional 35mm Din Rail mountable modules are available for specific applications.

Standard DSP-OHMNI Components:
- DDR2 voltage alarm unit
- OHMNI-PM or OHMNI-PM-RM resistor
- (DSP-DSYS)
- DSP-TDM (Touchscreen Display Monitor)
- DSP-DPS Power Supply Module
- DSP-DSM Sytem Module
- DSP-DCM Communication Module

DSP-OHMNI Optional Modules (35 mm Din Rail):
- DSP-DRM Resistor Monitoring
- DSP-DFM Feeder Module
- DSP-ADM Arc Detection Module
- DSP-CA Cable Adaptor
- DSP-CAS Cable Adaptor with on/off switch

1.1 STANDARD DSP-OHMNI COMPONENTS

The DDR2 is a voltage alarm unit used for line-to-ground-voltage measurements of three phase power systems. The DDR2 alarm unit may be used on wye connected resistance grounded systems or delta connected systems using an artificial neutral with a neutral grounding resistor.

The OHMNI-PM is a neutral grounding resistor used to limit the ground fault current to a safe level (typically 5A or 10A) for an indefinite time. The resistor is available for 480V & 600V systems and can be equipped with optional resistance monitoring components (sensing resistor & ZSCS) becoming an OHMNI-PM-RM. Both models includes an integrated pulsing module to modulate the current in the fault circuit which can be detected by a portable clamp-on current probe (TS-SENSOR) connected to an ordinary ammeter (DMM) meter.

The DSP-TDM is a panel-mounted touchscreen display designed for flush mounting in a door. The DSP-TDM 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 provides manual control of the pulse location system. The DSP-TDM also provides MODBUS RTU communications through a RS-485 network and MODBUS TCP communications through a Ethernet network to external information systems. The module includes a real-time clock to signal the event time and date of each event captured (up to 1000 events). 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-TDM date stamps the events according to the time and date set up on the system set-up.

The DSP-DPS is a 35mm Din Rail mountable power supply module used to provide +5V, +12V and -12V regulated power to all of the modules and also provides 10A, 240 VAC resistive Form C alarm relay contacts to operate a horn or other means of alarm to alert the operator . The DSP-DPS operates on a wide range of AC input voltage supplies from 100V to 240V AC without selection of any jumpers or switches and can also operate on a wide range of DC input voltage supplies from 125V to 250V DC.

The DSP-DSM is a 35mm Din Rail mountable system module used to monitor the systems line-to-ground voltages through the DDR2 voltage alarm 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-TDM Display.

1.2 OPTIONAL DSP-OHMNI MODULES (35MM DIN RAIL MOUNTABLE)

The DSP-DRM is the resistor monitoring module used to monitor the integrity of the neutral grounding resistor (NGR) for change of resistance and/or open circuit condition. This module must be installed following the system module (DSP-DSM) in the 35mm Din Rail line-up of the DSP-OHMNI system. The DSP-DRM uses external I-Gard zero sequence current sensors and a NGRS sensing resistor which provide voltage and current measurements of the neutral grounding resistor to the (DSP-DSM). The DSP-DRM uses the same alarm system as the rest of the DSP-OHMNI system.

The DSP-DFM is the feeder module which can be included in the DSP system to 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-TDM touchscreen display, DSP-DFM is automatically set to the same alarm level as that of the system module during feeder module set-up. This module should be mounted following the DSP-DRM module in the 35mm Din Rail line-up.

Note: If the alarm level is changed in the system module (or the system module has been changed) then it may be necessary to set-up the DSP-DFM modules afterwards.

The DSP-ADM is an arc detection module that uses air pressure and/or light sensing transducers to continuously monitor up to 21 possible fault sources and offer a first line of defense in the arc detection feature of the DSP-OHMNI system. It is used to provide protection against arc flash hazards by lowering the incident energy level to safer values protecting both, personnel and equipment, from severe damages. This module should be installed following the DSP-DFMs in the 35mm Din Rail line-up.

The DSP-CA and DSP-CAS are cable adapter modules used when two or more DSP-OHMNI systems are connected in double ended main-tie-main application. The DSP-CA and DSP-CAS are equipped with solid state switches to allow connection only when the input terminals of one of these units are shorted (normally by a tie breaker contact) following an outage of one of the power sources. The main breaker on the outage side will open and the tie breaker will close (through key interlock or other controls) allowing power to be supplied from the ''live'' side to the ''dead'' side to maintain service and priority allocations to both DSP systems. These modules should be installed at the end of the 35mm Din Rail line-up.
Communications is provided by Ethernet connection and a 4-wire RS-485 network connection from a jack located at the side of the DSP-TDM touchscreen display module. The communications protocol supported is MODBUS TCP and MODBUS RTU, which is a master/slave system with selectable baud rates from 9600 to 256000 (default 57600). The DSP supports the MODBUS function read holding registers only, without exception support.

2. APPLICATION

The DSP system is used in conjunction with I-Gard's 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 and DRM	CSA & UL
DDR2-2	Standard DDR2 for 240 Vs system	CSA & UL
DDR2-2-SO1	Special 183V system	CSA & UL
DDR2-2-SO6	Special 240V system with harmonic filter compatible with SIGMA & DRM	CSA & UL
DDR2-2-SO5	Special 288V System	CSA & UL
DDR2-4	Standard DDR2 for 480 V system	CSA & UL
DDR2-4-SO1	Special 415V system	CSA & UL
DDR2-4-SO2	Special 400V system	CSA & UL
DDR2-4-SO3	Special 340V system	CSA & UL
DDR2-4-SO4	Special 380V system	CSA & UL
DDR2-4-SO5	Special 400V system with harmonic filter	CSA & UL
DDR2-4-SO6	Special 380V system with harmonic filter compatible with SIGMA & DRM	CSA & UL
DDR2-4-SO7	Special 480V system with harmonic filter compatible with SIGMA & DRM	CSA & UL
DDR2-6	Standard DDR2 for 600 V system	CSA & UL
DDR2-6-SO1	Special 525V system	CSA & UL
DDR2-6-SO3	Special 600V system with harmonic filter	CSA & UL
DDR2-6-SO6	Special 600V system with harmonic filter compatible with SIGMA & DRM	CSA & UL
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	

Table 1: DDR2 Types

The DDR2 provides output voltages VAG, VBG, VCG that are proportional to the phase to ground voltage and also voltage VNG that is proportional to the neutral resistor voltage (i.e. total leakage/fault current of the system).

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 600V 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 CA(S) Modules	C-415EM

3. INSTALLATION

A typical installation will include for each power source (transformer/generator) 1 DSP-TDM, 1 DSP-DCM, 1 DSP-DPS, 1 DSP-DSM, 1 DSP-DRM 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 2 for typical requirements.

Catalogue Number	Description	Number Required/System
DSP-TDM	Touchscreen Display Module	1 (part of DSP-DSYS/V2)
DSP-DCM	Communication Module	1 (part of DSP-DSYS/V2)
DSP-DPS/V2	Power Supply	1 (part of DSP-DSYS/V2)
DSP-DSM/V2	System Voltage Module	1 (part of DSP-DSYS/V2)
OHMNI-PM	Pulse Equipped Resistor	1
DDR2	Voltage Sensing Resistor	1

Table 2: System Module Requirements

Catalogue Number	Description	Number Required /System
DDAI	Artificial Neutral	Required only for delta system
DSP-DFM/V2	Feeder Module	As required 1/circuit(feeder)
TxA or Rx-yA	Toroidal Current Sensor	1/feeder module
DSP-ADM	Arc Detection Module	1 required for arc detection application
DSP-CA	Cable adapter module	1 required for Main-Tie-Main applications
DSP-CAS	Cable adapter module (switch)	1 required for Main-Tie-Main applications

Table 3: Optional Modules

Length	Function	Catalogue Number
5cm (2 in.)	Module to Module connection	RC-3
30cm (12 in.)	Module to Module connection	RC-30

Table 4: Standard Ribbon Cables

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-TDM.

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. 5 (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. A typical wiring schematic is shown in Figure 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 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 3.

Ribbon cables are available in different lengths as shown in Table 4. For other lengths contact I-Gard. 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-TDM touchscreen 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.

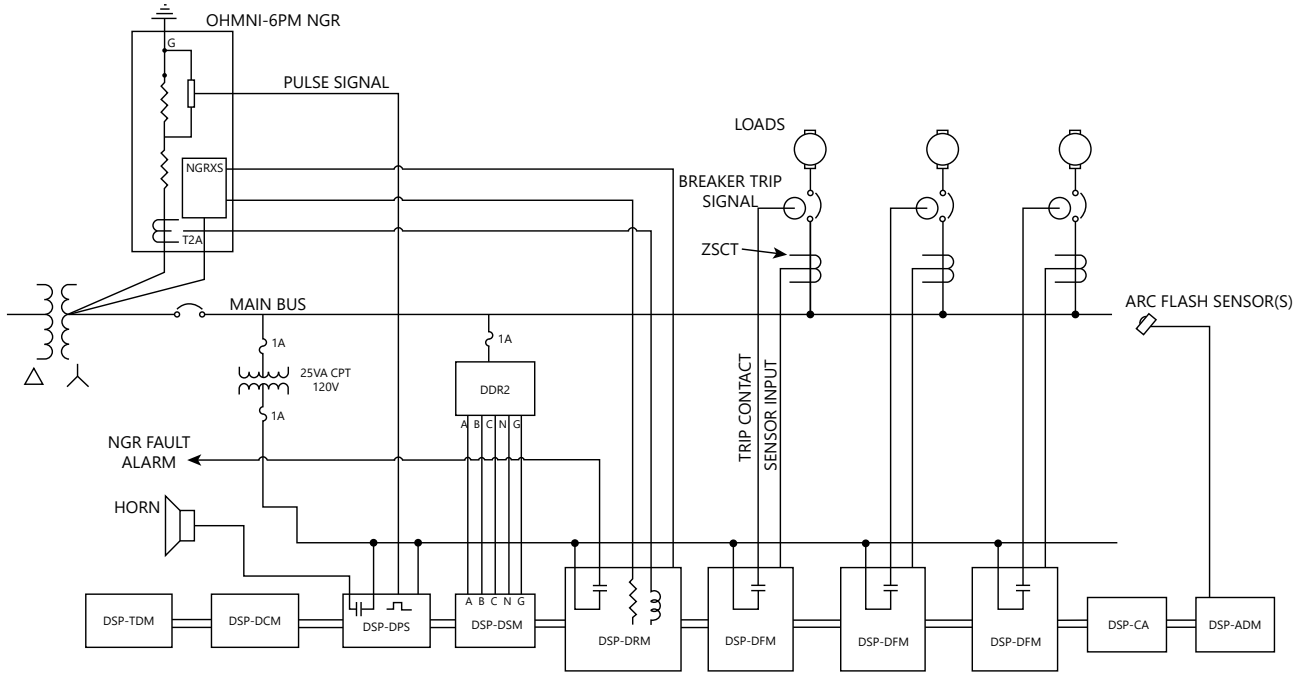


Figure 1a: Typical One-Line Installation - Unit Substation

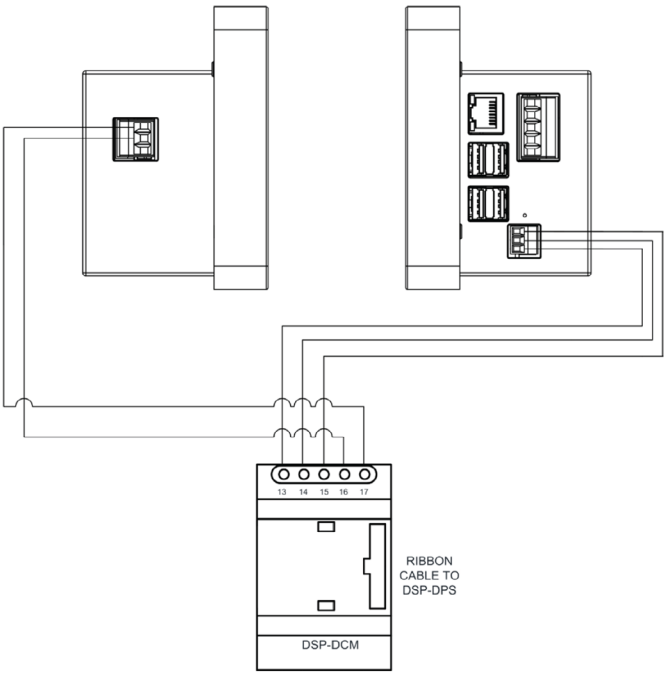


Figure 1b: DSP-DCM Wiring

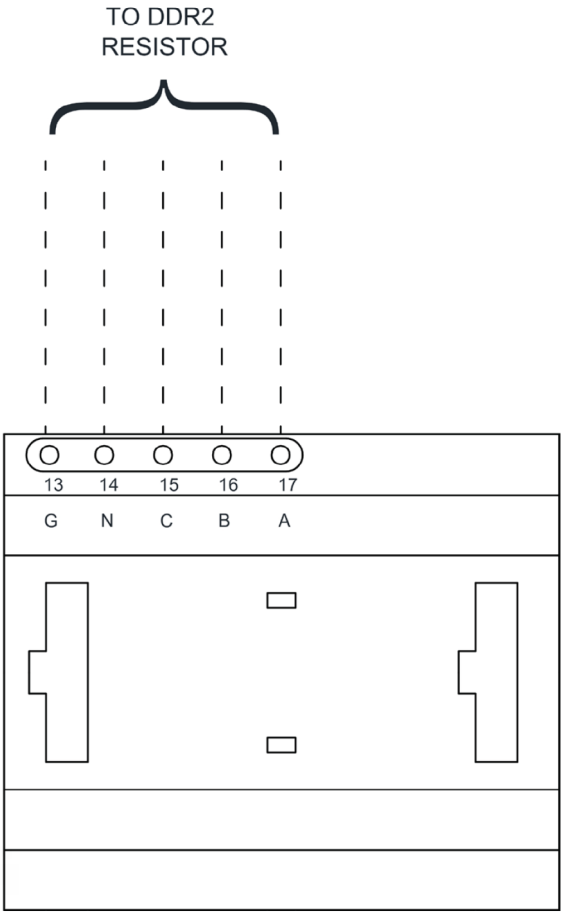


Figure 1c: System Module DSP-DSM Wiring

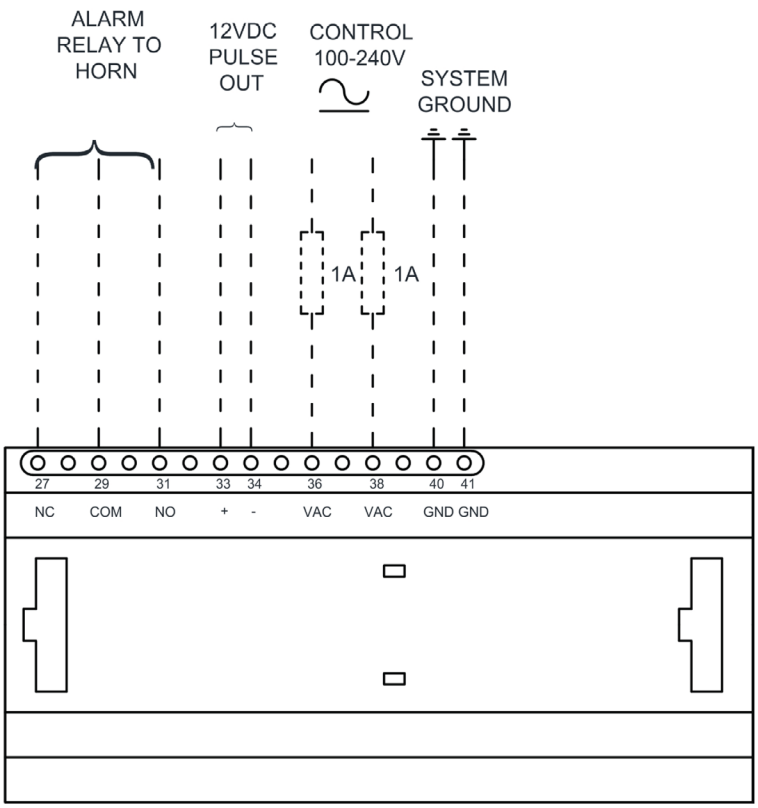


Figure 1d: Power Supply DSP-DPS Wiring

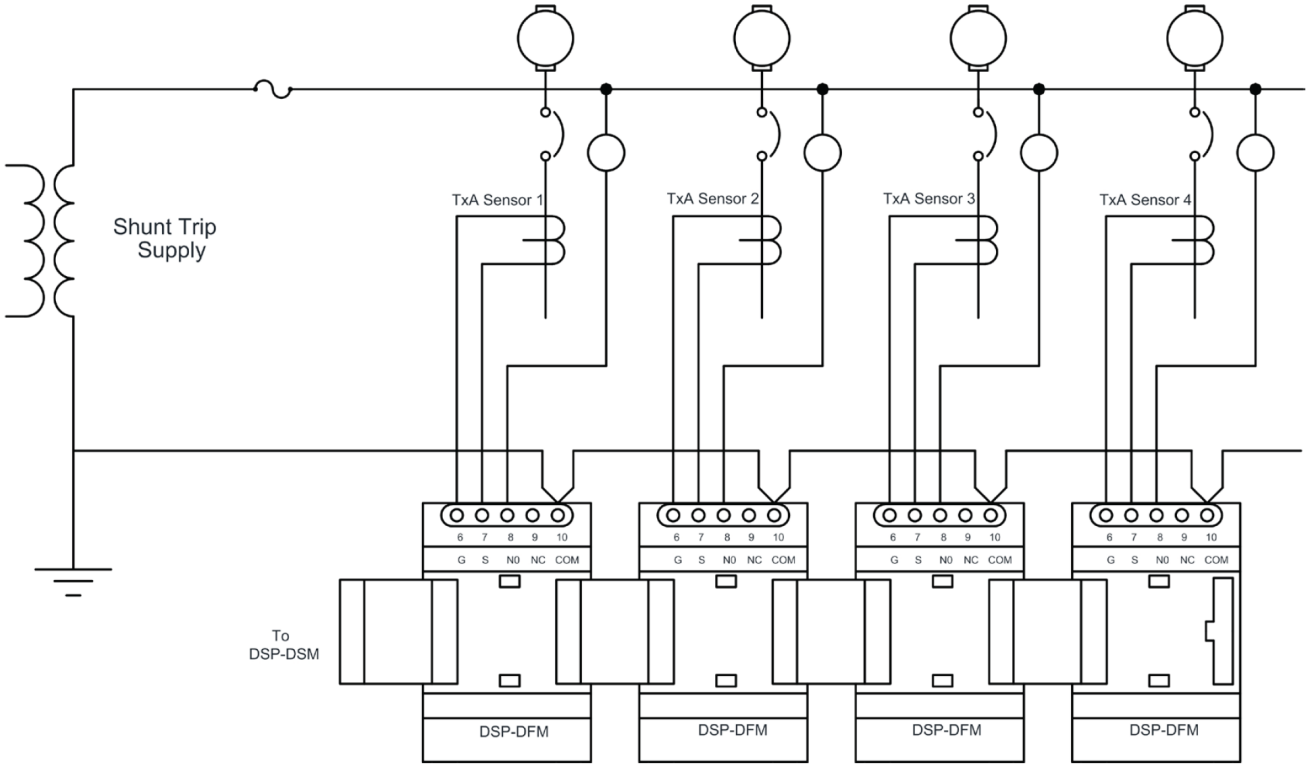


Figure 2: Preferred Feeder Module DSP-DFM Wiring

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-CA(S) and DSP-CA modules. The DSP-CA module converts ribbon cable to an 8-conductor shielded cable for this purpose. The DSP-CA(S) 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.

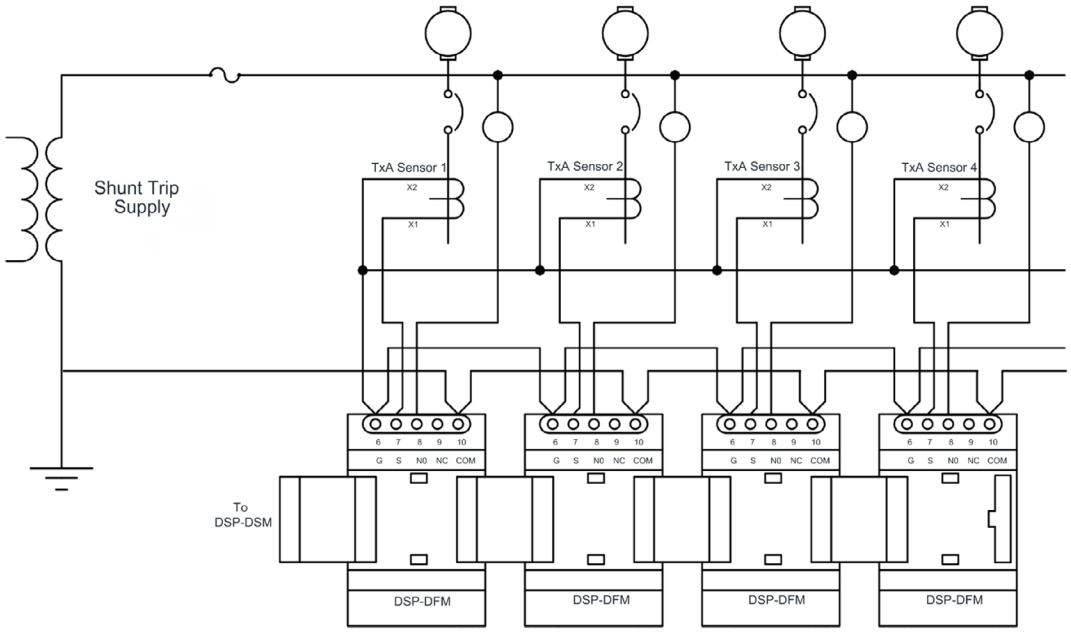


Figure 3: Alternative Sensor Wiring

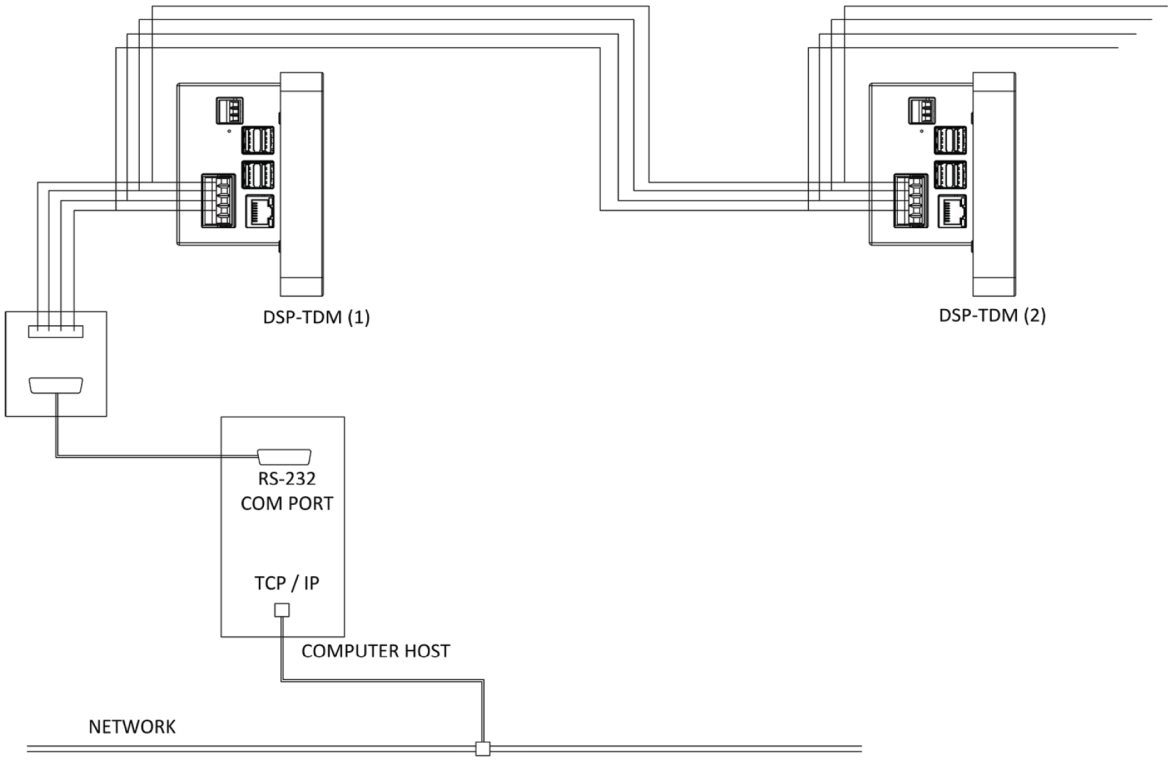


Figure 4: Typical 4-wire Communications Connection

The RS-485 cable shield should be grounded at the ground terminal provided on the 5–pin jack as shown in Figure 4, 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, 240V AC resistive.

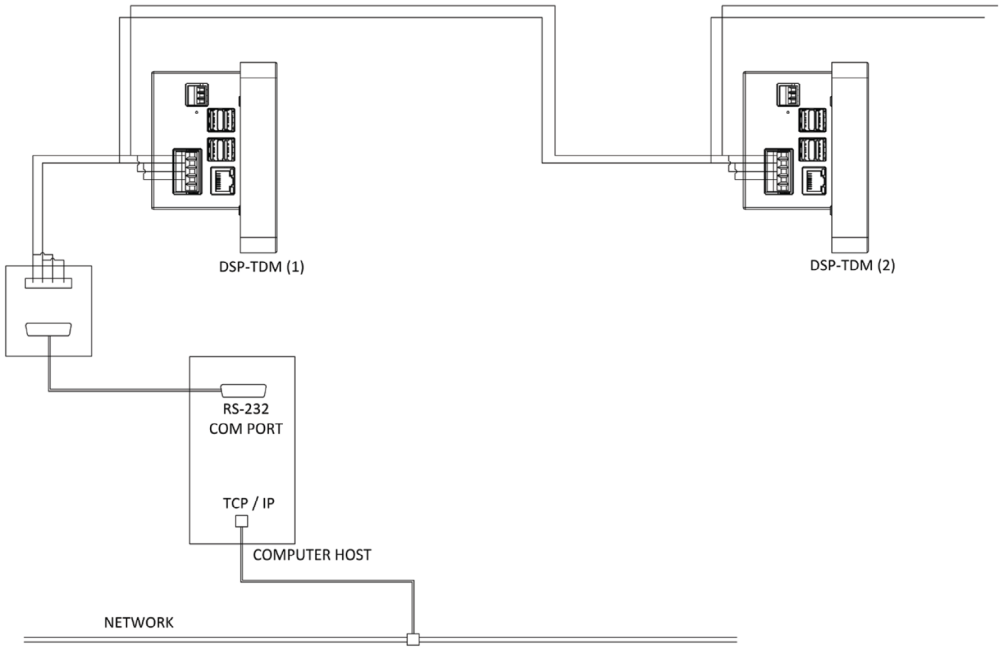


Figure 5a: Alternative 2-wire connection for RS-485

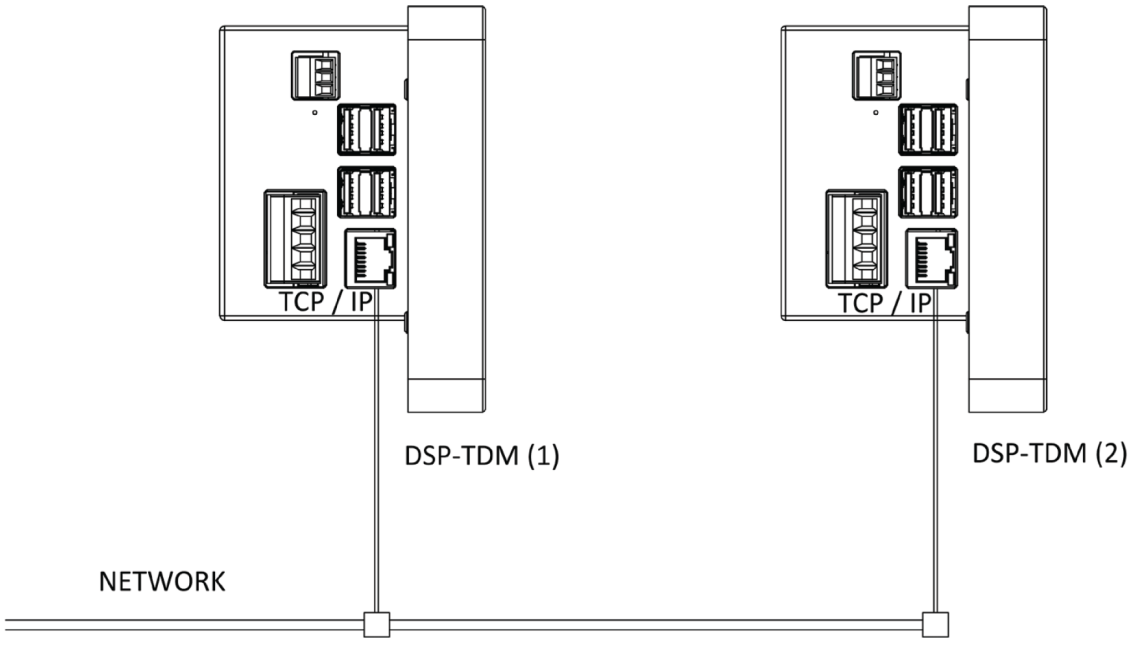


Figure 5b: TCP/IP Connection

Communications wiring may be 2-wire or 4-wire but must use shielded cable with low capacitance. Wire lengths up to 2000 meters can generally be used without the need for termination resistors. Figures 4, 5a and 5b show typical RS-485 arrangements with a RS-485/RS-232 converter and a host PC connected to a LAN.

4.1 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.

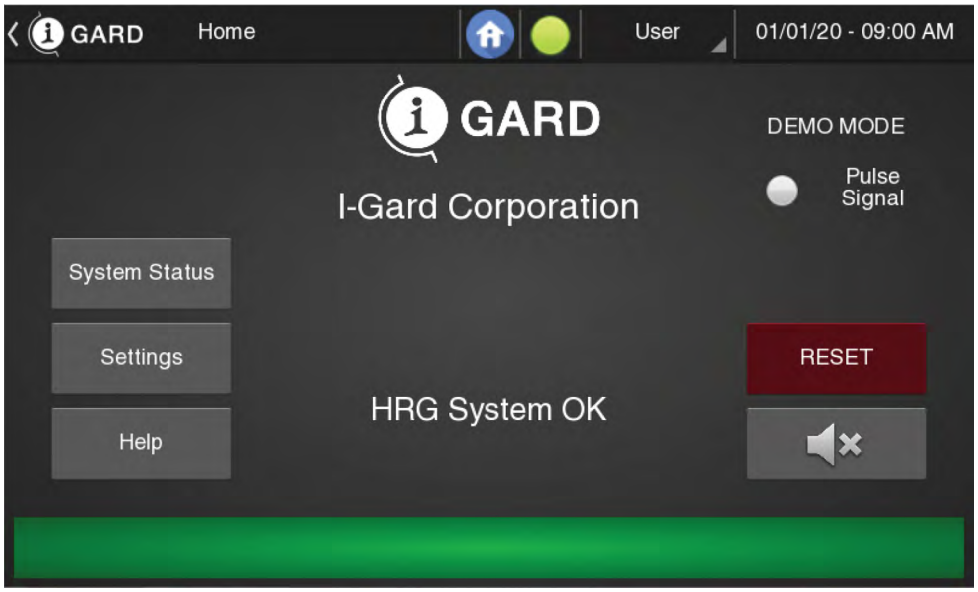


Figure 6: Home Screen

This is the home screen, which is the NORMAL starting screen after RESET is pressed. Various messages may modify this screen following an event such as a phase fault, loss of fuse, or during pulsing to provide some diagnostic information. If the following screen appears and the local alarm sounds, then the DDR2 resistor is likely not energized or connected.

Figure 7: Alarm Screen

5. SETUP

5.1 SETTINGS

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 press SETTINGS to enter the settings screen.

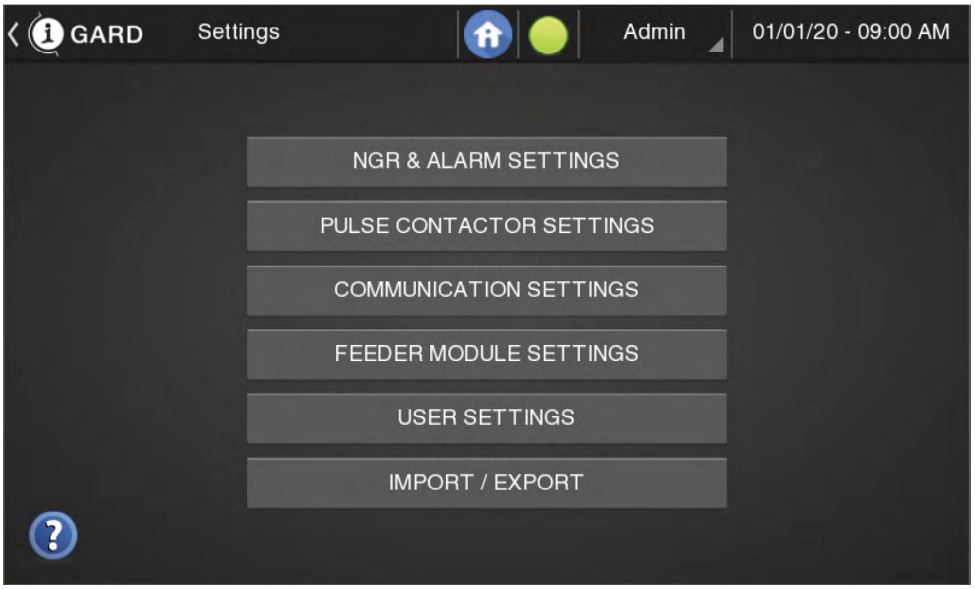
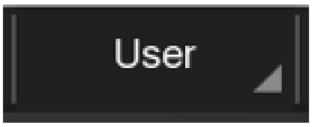


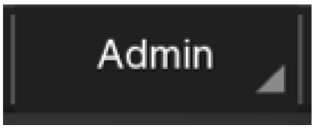
Figure 8: Settings Page

This page gives access to make changes to system settings. Some settings sub-pages require Administrative permission to access.

There are two modes of operation: Administrative and User. To have access to all the settings, it is necessary to log in the Admin mode. To change between modes, just choose the mode on the drop box on the title:



or



When enter on the Admin mode, a password will be required. The default password is 8421, which will always be the backdoor password, should the user password be forgotten. It is recommended to change this password.

5.2 PASSWORD

To change the password enter Admin mode, and from the HOME screen,
press Settings ▸ User Settings ▸ Set password

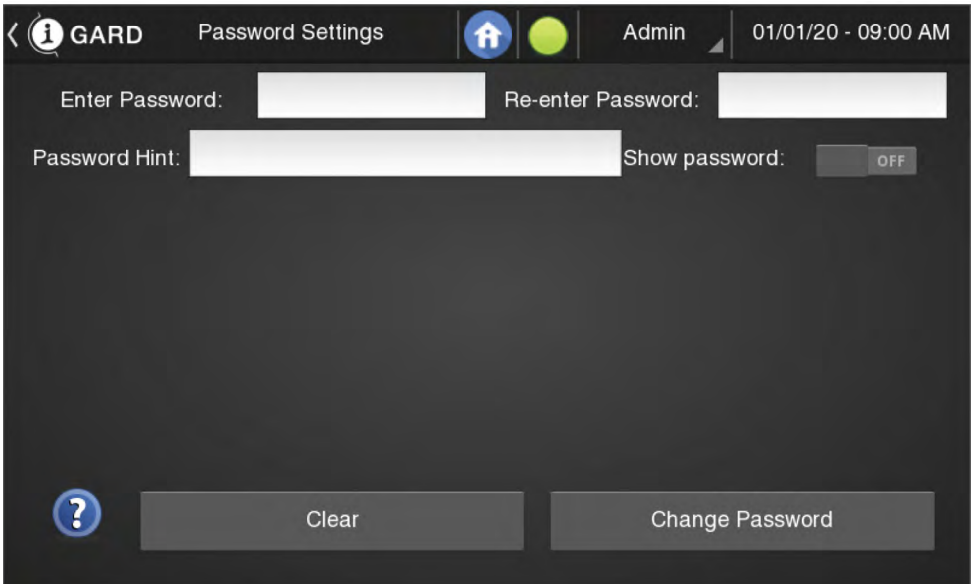


Figure 9: Password Settings Page

Enter the new password and press Change Password. The password must be only numbers up to 8 characters. The device will return to the User mode after save the data. It is possible to set a Password Hint to help to remember the password in the future.

5.3 COMMUNICATION

To change the communication settings, enter Admin mode, and from the HOME screen, press Settings, then press Communication Settings

On this screen, you have the options to configure both MODBUS: RTU and TCP.

Figure 10: Communications Set-up MODBUS TCP

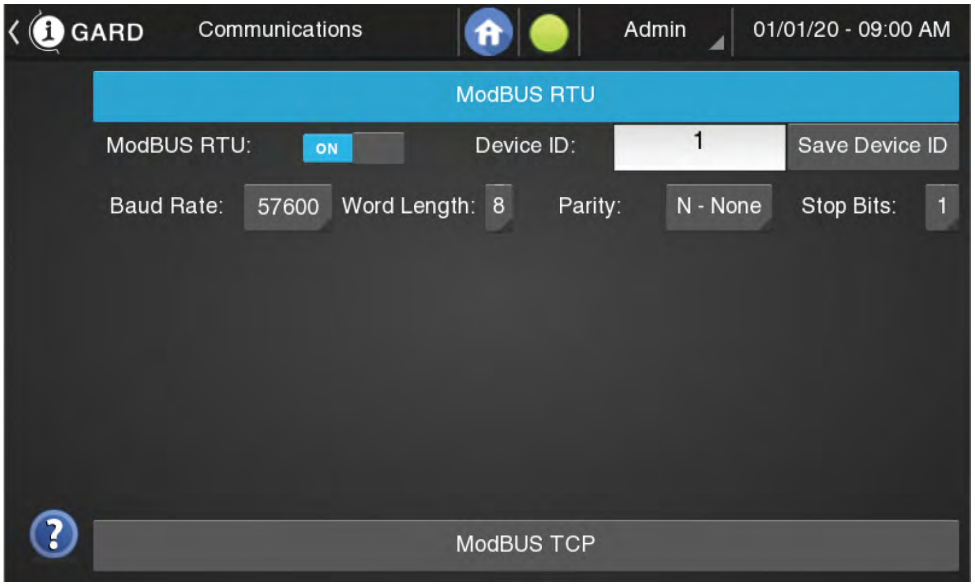


Figure 11: Communications Set-up MODBUS RTU

Figure 10 shows the first set-up screen that will be encountered – COMMS set-up mode. The DSP-OHMNI is normally shipped with a 57600 Baud setup.

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 MODBUS 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 MODBUS network or data will not be valid). In order to change the number, select the field and enter the desired number. Then, press Save Device ID.

5.4 NGR & ALARM SETTINGS

To change the NGR & Alarm Setttings enter in the Admin mode, and from the HOME screen, press Settings ▸NGR and Alarm Settings.

6. ALARM SETTINGS

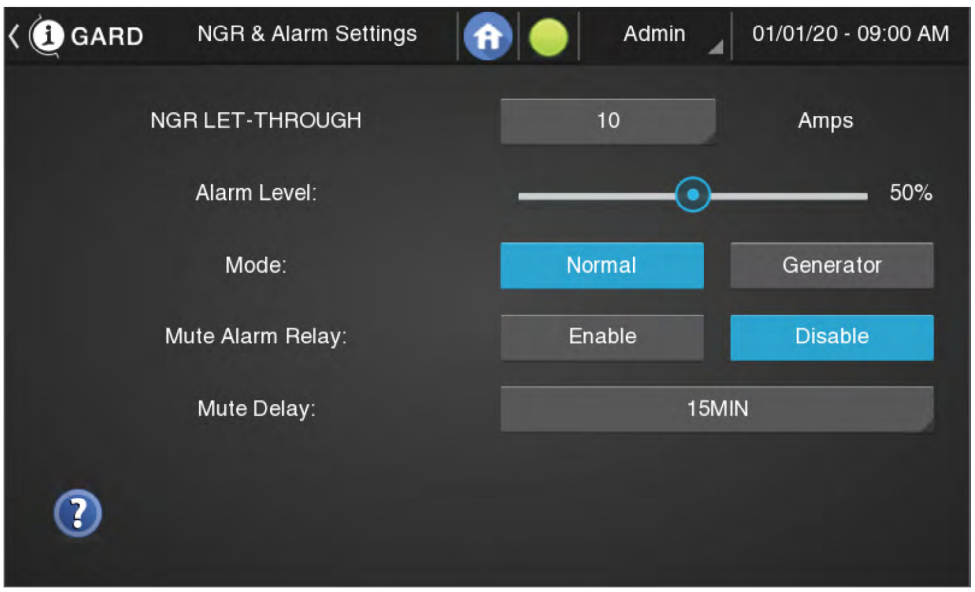


Figure 12: Grounding Resistor Set-up

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, select the value on the drop box. The final value must be between 01 and 16 for 1-16A range.

6.1 ALARM LEVEL SETTING

The user may select from 10% to 90% of the neutral voltage displacement as a threshold in 10% increments.

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.

GENERATOR mode should be used when the DSP is installed on a standby switchboard that provides control power to the DSP so that it is always on and it is desired to suppress the "CHECK DDR2 FUSES" alarm that would normally exist when the bus is de-energized.

Normally on the occurrence of an alarm when the MUTE button is pressed, the DSP-DPS general alarm relay (Form C contact on terminals 27, 29, 31) is reset and the local annunciator is muted. This is the operation when the MUTE ALARM setting is ENABLED. The default setting for the MUTE ALARM is ENABLED.

When the MUTE ALARM setting is DISABLED, then on the occurrence of an alarm when the MUTE button is pressed, the DSP-DPS general alarm relay (Form C contact on terminals 27, 29, 31) is not reset but the local annunciator is still muted. This setting is typically chosen when the general alarm relay is being monitored by a building automation system, for instance.

After MUTE is pressed, the system will be MUTED until the Mute Delay Time is reached. Once reached, the system will be UNMUTED.

6.2 FEEDER MODULE SET-UP

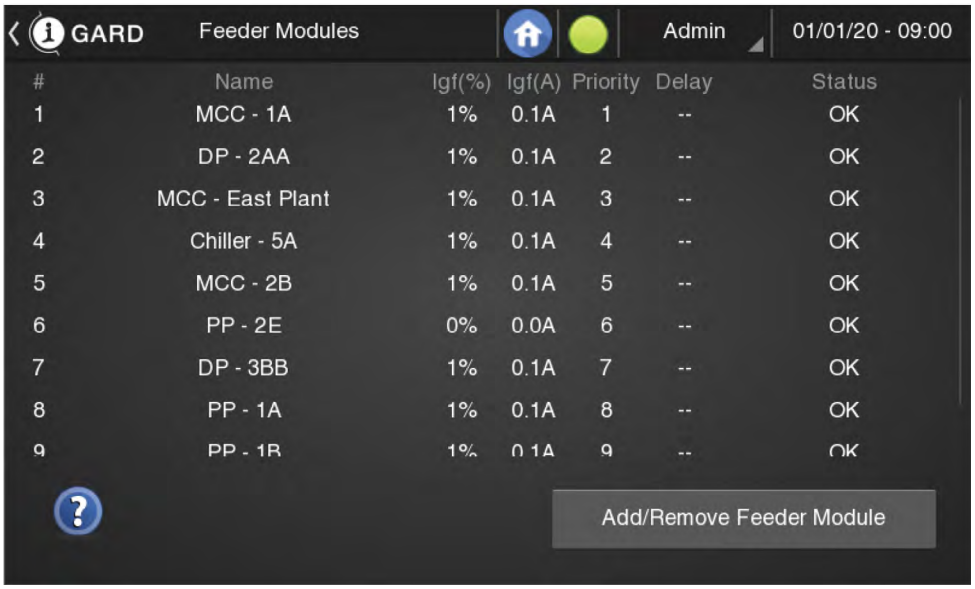


Figure 13: Feeder Module Status Page

To setup the Feeder Modules, enter Admin mode, and from the HOME screen, press Settings ▸ FEEDER MODULE SETTINGS.

Figure 13 shows the current feeder module configurations. Scroll to see all the feeders.

To change the Feeder Configuration, press Add/Remove Feeder Module.

Select the ID number to enter the set-up as follows:

Figure 14: 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 touchscreen display module can determine which module it is talking to. Each module must have a different number.

The touchscreen display module is the master module and is constantly sending requests for data from each feeder module. 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.

In the case of 2 feeders with the same number, the user must enter a different I/D number before proceeding further. The user is given the opportunity 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. There will likely be duplicate I/D numbers prior to the first setup and these will be overwritten by the set-up procedure.

Note: If a duplicate I/D number has been selected, 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.

DANGER

Caution! It is 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 touchscreen display module does not discriminate the physical position of the modules in the chain.
If a feeder module is configured to a particular I/D number, it must also have a defined TRIP setting. The trip mode must either be TRIP on 2nd fault or TRIP on first fault. The default is TRIP on 2nd fault. Click the trip mode drop down to change the trip mode to TRIP on 1st fault. Each feeder module must be given a trip mode setting as either TRIP on 1st fault or TRIP on 2nd fault. It is possible to have a DSP sytem where some feeder modules are programmed to TRIP on 1st fault and some programmed to TRIP on 2nd fault.

The feeder module PRIORITY setting is set if it is TRIP on 2nd fault and DELAY setting is set if it is TRIP on 1st fault.

The priority numbers range 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. 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 DELAY numbers range from 00 to 99 representing the delay for first-fault tripping in minutes or hours with 00 representing instantaneous TRIP operation (100 ms).

When all the fields for a given I/D number have been filled, press Program Feeder Module. You will then be prompted with the screen of Figure 15.

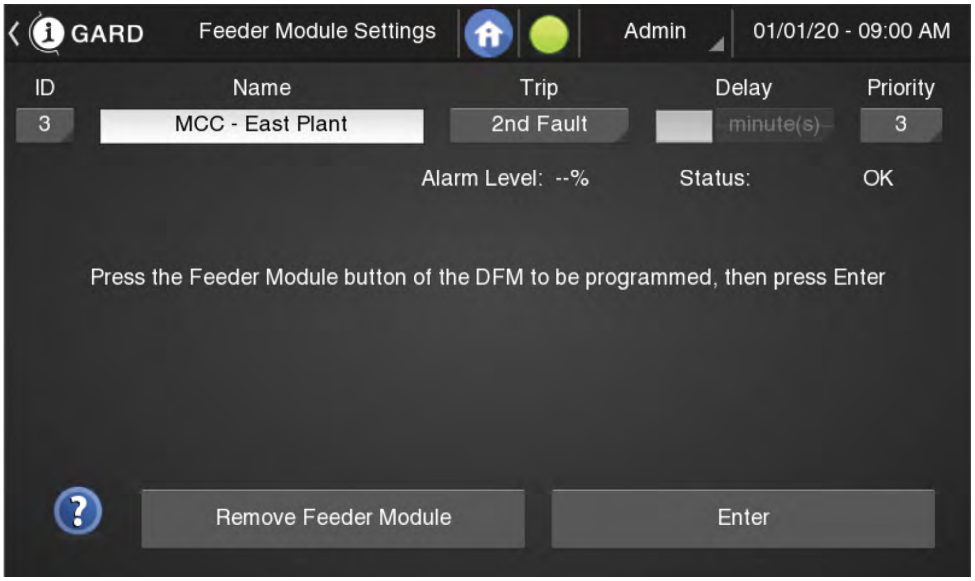


Figure 15: Feeder Module Set-up

At this point, select the DSP-DFM module intended to have the I/D that was set-up, and press the TEST button on that module. The red FAULT light will blink to indicate the received I/D signal (no need to hold button). Press ENTER to complete the process. If the setup of the DSP-DFM is successful then the DSP-TDM will display the message in Figure 16.

Should the DSP-DFM not be accepted, inspect the connections to the DSP-DFM as a ribbon cable connector may be loose and could be preventing the DSP-TDM from properly communicating with the DFM.

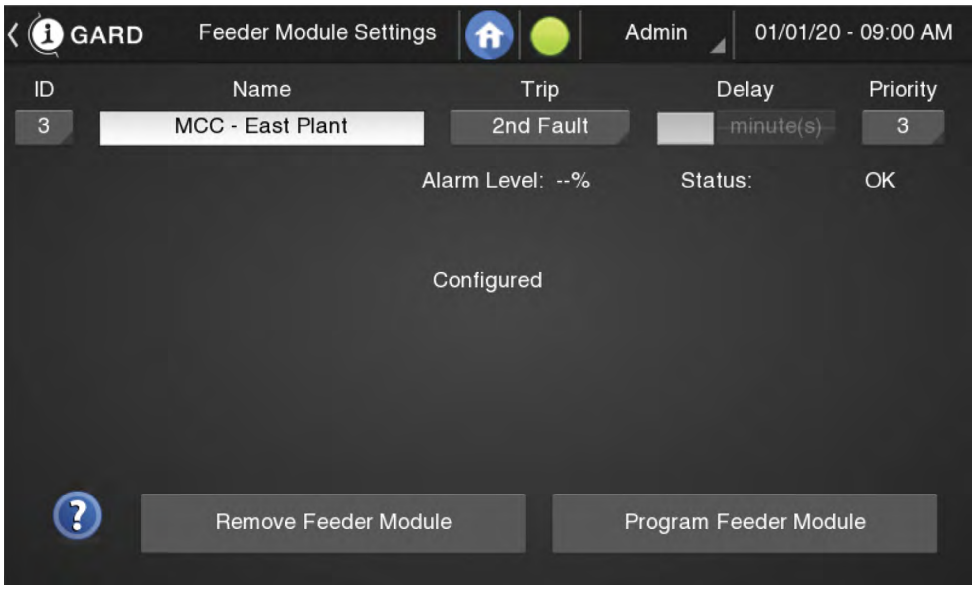


Figure 16: Feeder Module Successful

6.3 PULSE SETUP

To setup Pulsing Settings, enter Admin mode, and from the HOME screen, press Settings ▸ PULSE CONTACTOR SETTINGS.

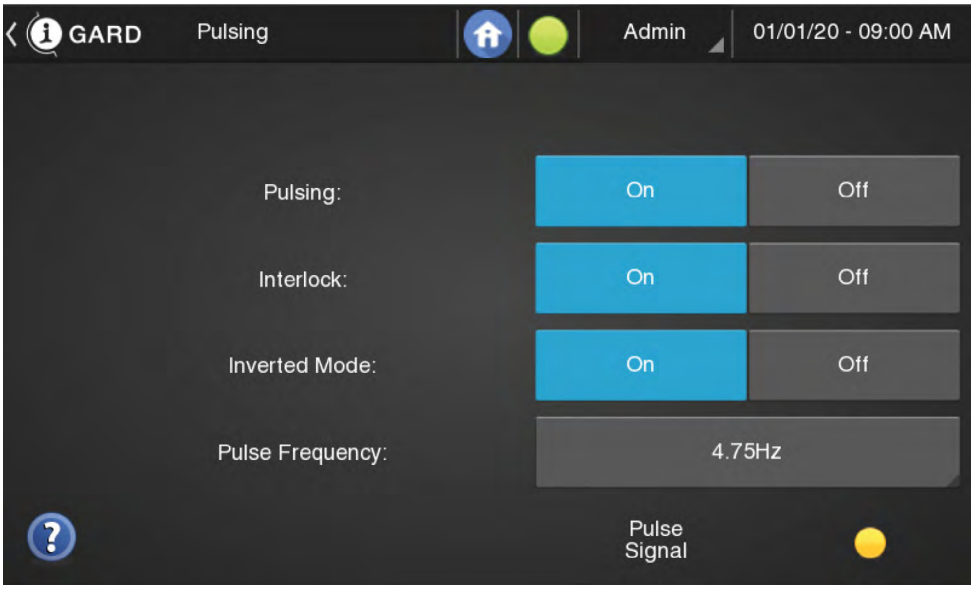


Figure 17: Pulse Settings Page

The pulse set-up screen allows the pulsing mode for fault location to be changed for different frequencies and mode of operation. This screen will show the present PULSE settings. The pulse feature resides in the DSP-DPS. See section 7 for more details.

6.4 INVERTED MODE

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 ON, then this voltage is 12V DC and therefore the relay is energized continuously. The choice of ON or OFF 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; for example, from IGmax 5A to IGmax 10A. In this case the pulse resistor is normally OFF and the Inverted Mode 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 current; for example, from IGmax 5A to IGmax 2.5A. In this case, the pulse resistor will be normally ON and thus the Inverted Mode ON mode would have to be selected. This means 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 Figure 18 for examples of both series and parallel connected resistor arrangements.

Note: INVERTED mode is the mode used with the standard OHMNI-PM resistors as supplied by I-Gard.

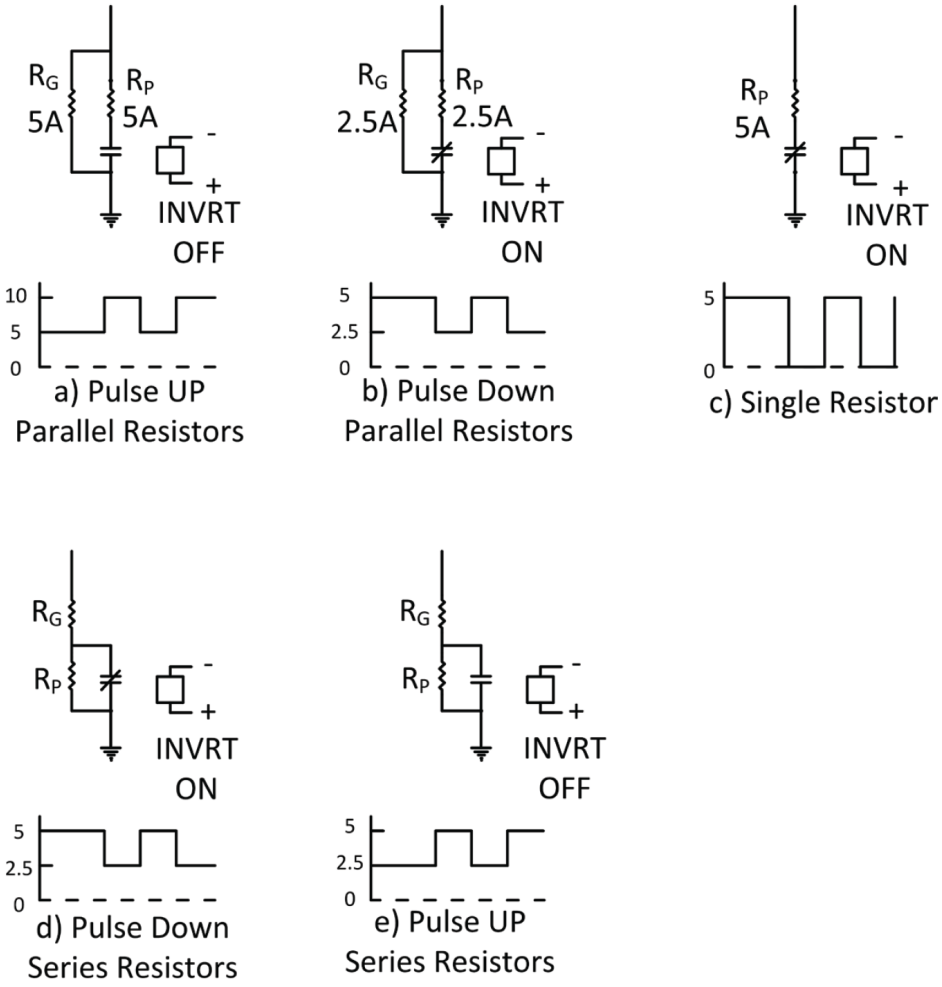


Figure 18: Typical Examples of Pulse Circuit Connection

Pulse Frequency: Press the drop down button to select a pulse frequency from 1Hz to 3.25Hz. It is not important to know exactly the frequency selected, however, Table 5 indicates the frequency for each setting.

Freq Hz.	1.00	1.25	1.5	1.75	2.00	2.25	2.50	2.75	3.00	3.25

Table 5: Pulsing Frequency Selection

6.5 INTERLOCK

The interlock prevents pulsing from occurring when there is no fault on the system. Press to toggle ON or OFF to complete the pulse set-up. It is recommended to operate the DSP-OHMNI system with the lock ON.

6.6 CLOCK SETTINGS

To setup the Pulsing Settings enter in the Admin mode, and from the HOME screen, press Settings ▸ USER SETTINGS ▸ Set Date and Time

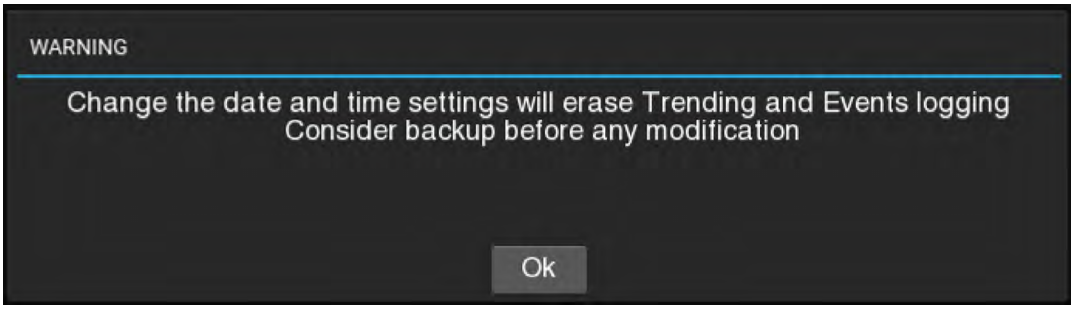


Figure 19: Change of Date/Time Settings Warning

After pressing Ok, you can see the current time and date, the format and the field to change the date and time.

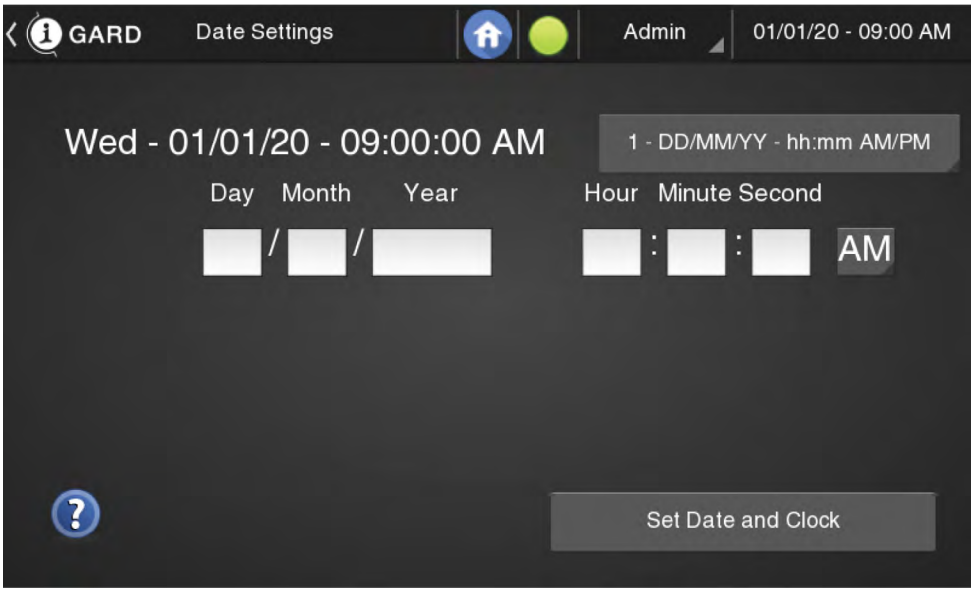


Figure 20: Date Settings Page

After filling all the fields, press Set Date and Clock.

7. OPERATION

Normally with an un-faulted system and a recent RESET, the display module will display the normal home screen of Figure 21 with a green NORMAL indicator on the front panel of the DSP-TDM 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 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 touchscreen display module will indicate the normal home screen as in Figure 21.

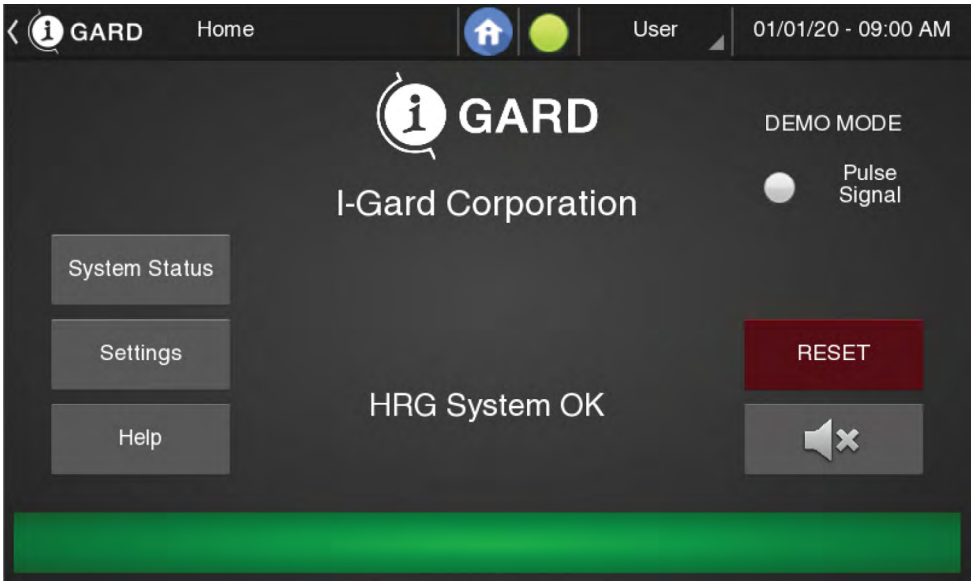


Figure 21: Normal Home Screen

Pressing System Status takes the user to the screen which shows the total system ground current IG 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 22) 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.

Press FEEDER MODULE STATUSES to view the feeder module screen in Figure 22 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. Priority settings can be observed and ground current IGf 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 0% represents no current leakage at all. STATUS is also indicated which shows whether or not the feeder module is OK (leakage below 50%), Fault (faulted) leakage greater than 50% or Trip (Tripped) which may happen if a second fault caused current in the sensor to exceed 100A for 200ms or more.

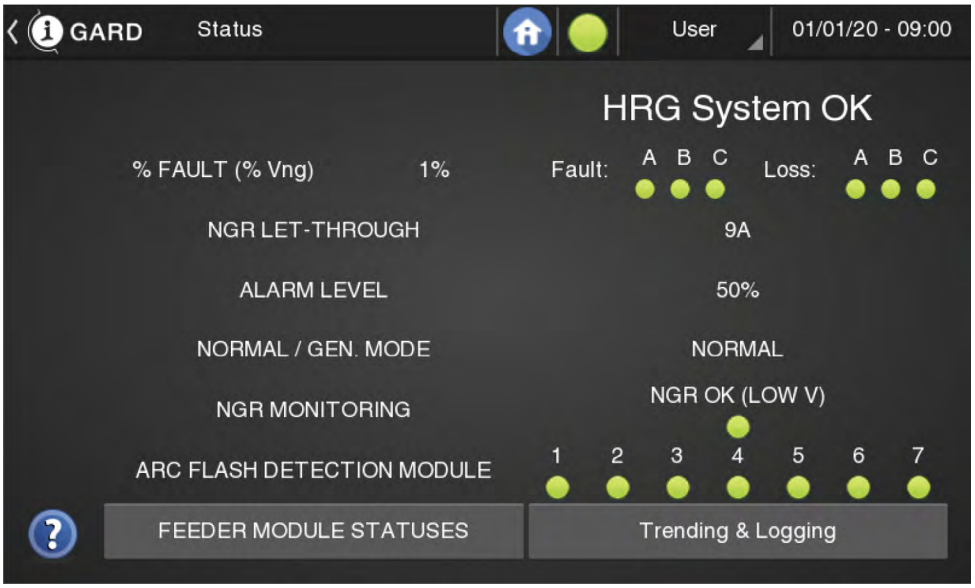


Figure 22: System Leakage Current I_g

Figure 23: 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 status NOT DETECTED.

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 'Test' in blue. This will be the DSP-DFM selected and the I/D can be read on this screen.

7.1 PULSING

When a fault occurs, it is possible to start and stop Pulsing from the Home Screen by pressing the Activate Pulsing button.

Figure 24: Home Screen When In Feeder Fault

To verify the Pulsing configuration press Settings ▸ PULSE CONTACTOR SETTINGS.

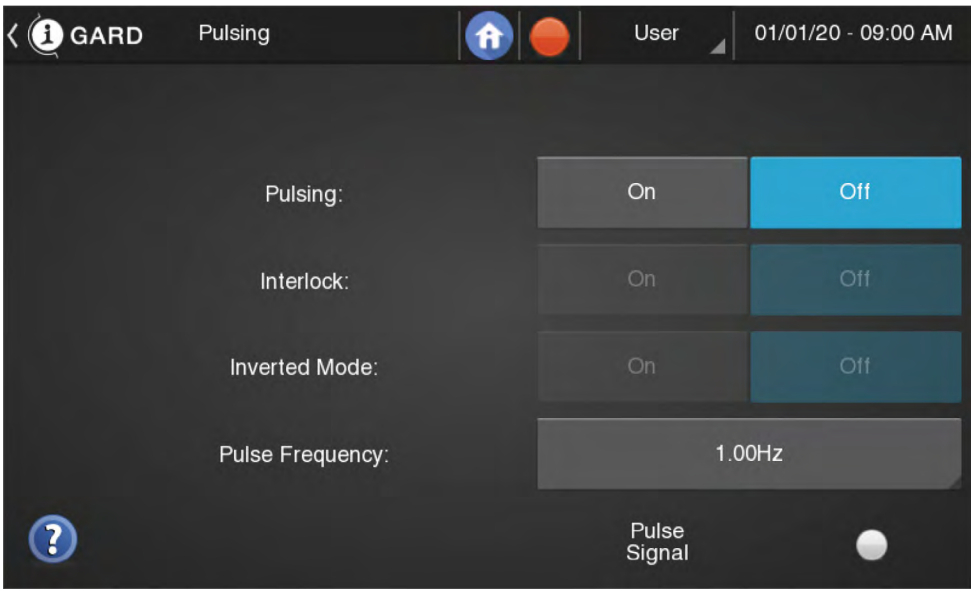


Figure 25: Activate Pulsing from Pulse Settings Page

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 buttons. The bottom line of the display indicates the status of the pulsing module. It should change the indicator color. 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.

In User mode, the commands Interlock and Inverted Mode are blocked. Enter Admin mode to change this 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. 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 has a Pulse signal indicator to remind the operator that pulsing is ON with the screen of Figure 26.

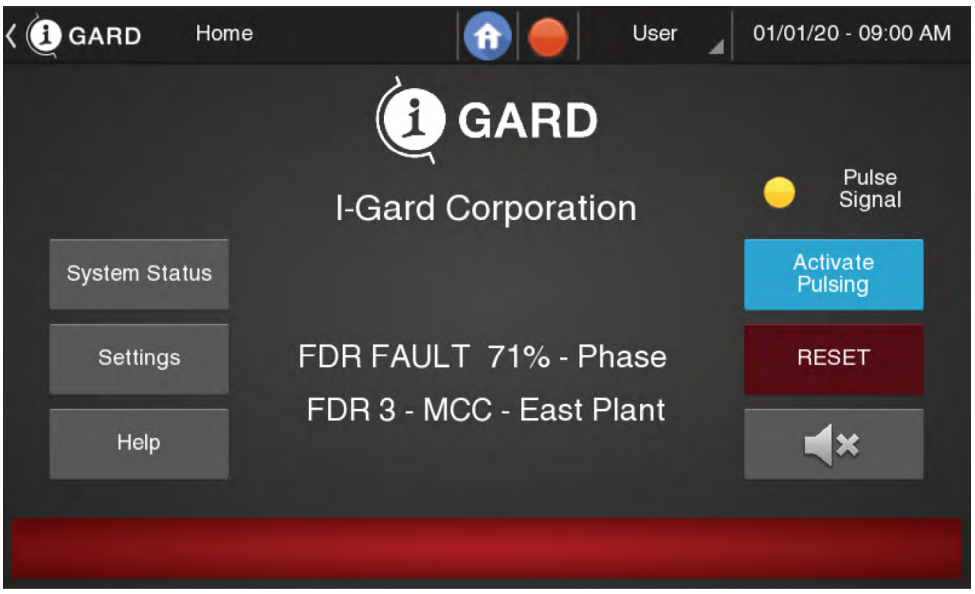


Figure 26: New Home Screen indicates Pulsing ON

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 the home button to exit and return to the home screen.

7.2 ALARM INDICATIONS

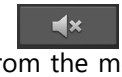
If a fault greater than the alarm level setting develops somewhere on the system, or the (optional) DSP-DRM resistor monitor detects a neutral grounding resistor failure, an alarm is declared by the system module. Alarms are annunciated in three ways:

- **LED INDICATIONS**

  - DSP-DSM system module red ALARM light
  - DSP-DFM fault indication is enabled to provide indication if fault is detected by feeder module (the faul may not be detected by a feeder module. For example, if it is on the main bus it won't be detected).

- **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-TDM to indicate the fault.

The alarms both local and external can be cancelled by the MUTE button, which is the  key on the Home screen. Once cancelled, the alarm will remain off until the MUTE Delay times out from the moment of the last initiation of the MUTE command, and if an alarm condition still exists. RESET will also cancel the MUTE effect. The MUTE control of the alarm relay contacts may be disabled 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 that indicates which phase is faulted, and the branch circuit that is affected. See Figure 27 for example.

Figure 27: Alarm Screen

The faulted feeder is identified by I/D number and name. The total system current IG will indicate the system current as determined by the voltage from the DDR2 voltage sensor unit . 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 "System Status" ▸ Feeder Module Statuses to move to the feeder screen. The faulted feeder (if any) can be located by scrolling to the faulted one.

The current reading Igf relating to that feeder is shown. It should exceed 50%. The FAULT 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 is necessary to determine the source of the fault. In some cases this might be a 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 easily locate the fault, the pulse feature can be activated from the PULSE CONTACTOR SETTINGS page if the partial ground fault current is not above the alarm threshold; or if is above the threshold an "Activate Pulsing" button will appear on the home screen.

If no feeder faults are identified, the touchscreen display module will indicate BUS FAULT as in Figure 26 to indicate this unique 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.

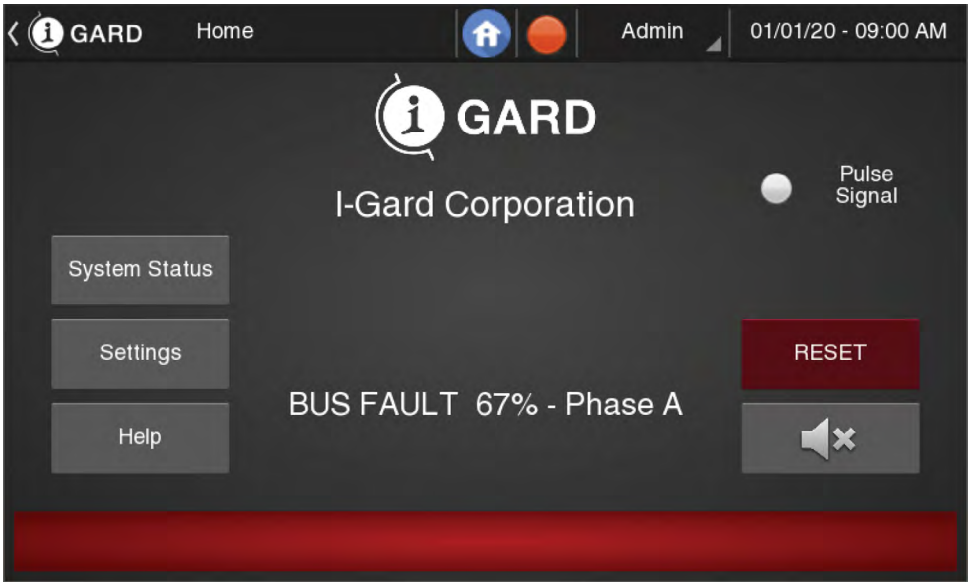


Figure 28: Bus fault

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-TDM 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 as priority setting.

7.3 EVENTS AND LOGGING

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-TDM touchscreen 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 30.

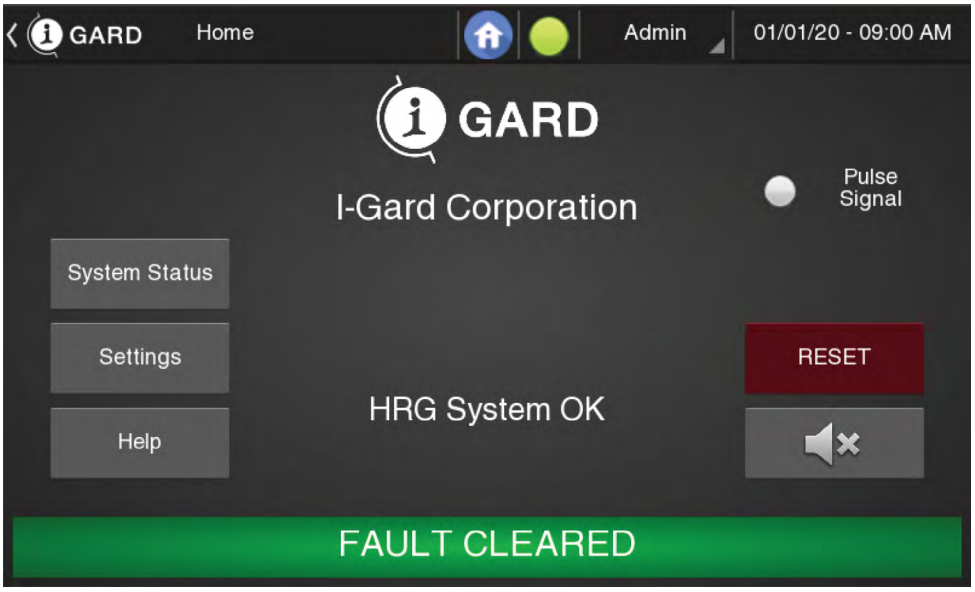


Figure 29: Event Notification

To observe what event occurred, press System Status ▸ Trending and Logging. The touchscreen display will show the type of fault, phase faulted and the branch location if any.

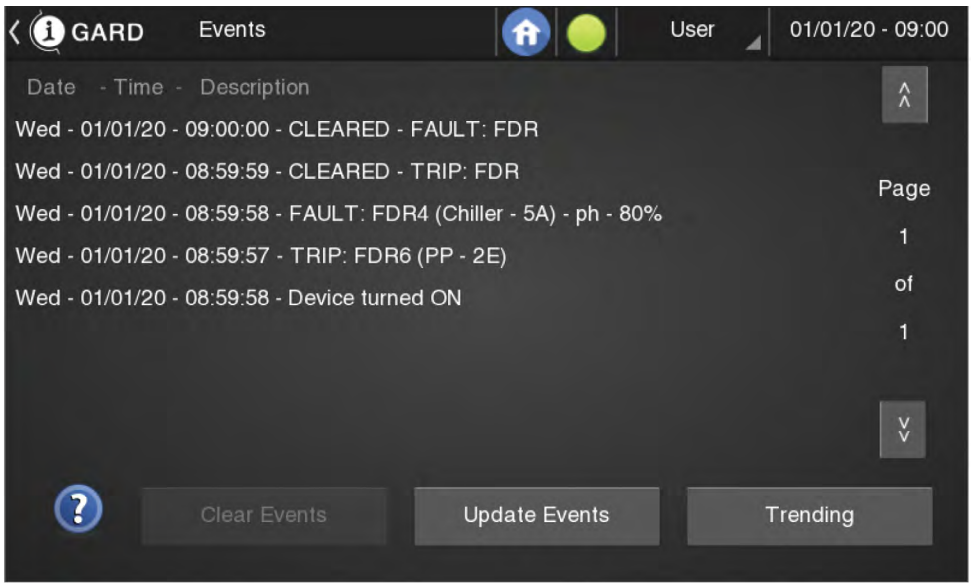


Figure 30: Momentary Feeder Fault Example

The logging function is part of the DSP-TDM 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 occur, 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 system 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-TDM will not capture faults that occur while the DSP-TDM is initializing

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.

The following events are supported:

Error/Fault	Device	Event Message
No Comm.	DSP-DCM	Communication Error
ARC Flash Detection	DSP-ADM	ARC FAULT: INPUT
Bus Loss 3ph - Normal	DSP-DSM	BUS LOSS - 3 phases
Bus Loss 3ph - Generator	DSP-DSM	BUS LOSS - Generator Mode
Bus Loss 1 or 2 phases	DSP-DSM	Bus Loss - ph
Trip	DSP-DFM	TRIP: FDR # (FEEDER NAME)
Feeder Fault	DSP-DFM	Fault: FDR # (FEEDER NAME) - ph-%
Bus Fault	DSP-DSM	BUS FAULT - ph %
NGR Fault	DSP-DRM	NGR FAULT

Table 6: Fault Message List

Up to 1000 events can be stored before the EEPROM rolls over to start at 01 again.

7.4 DSP-DRM RESISTOR MONITOR

The I-Gard DSP-DRM is a neutral grounding resistor (NGR) monitor relay. In distribution systems, employing high resistance grounding the DSP-DRM protects against abnormal resistance values of the NGR.

The DSP-DRM is specifically designed for use in system voltages of up to 5kV.

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 5% 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 is 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 5% 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.

7.5 DSP-DRM INSTALLATION (SEE FIGURE 45 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 NGR 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 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 NGR 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.

7.6 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 ok then the STATUS page shows NGR MONITORING NGR OK. 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 5% 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 or short circuit.

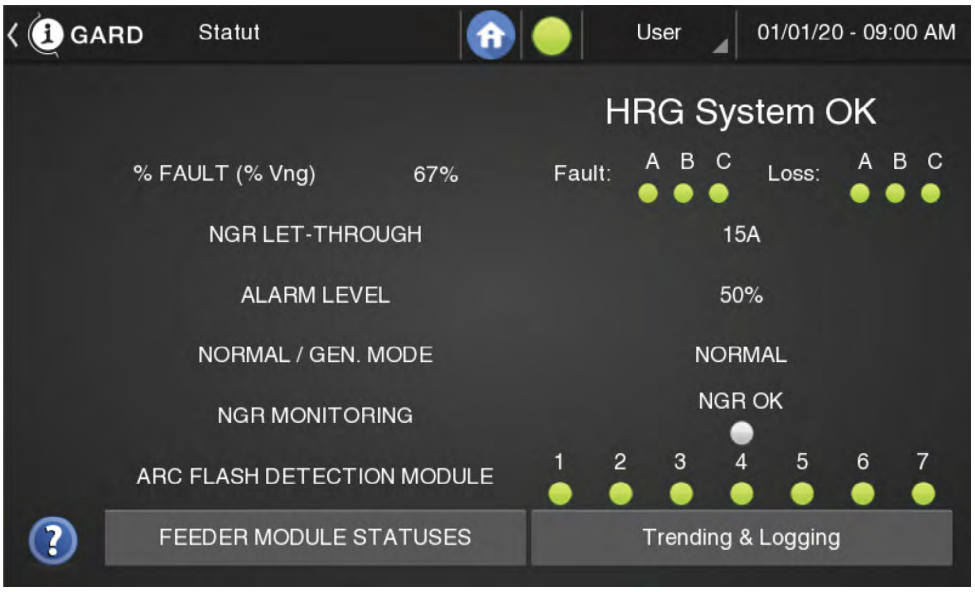


Figure 31: NGR Measured Ok

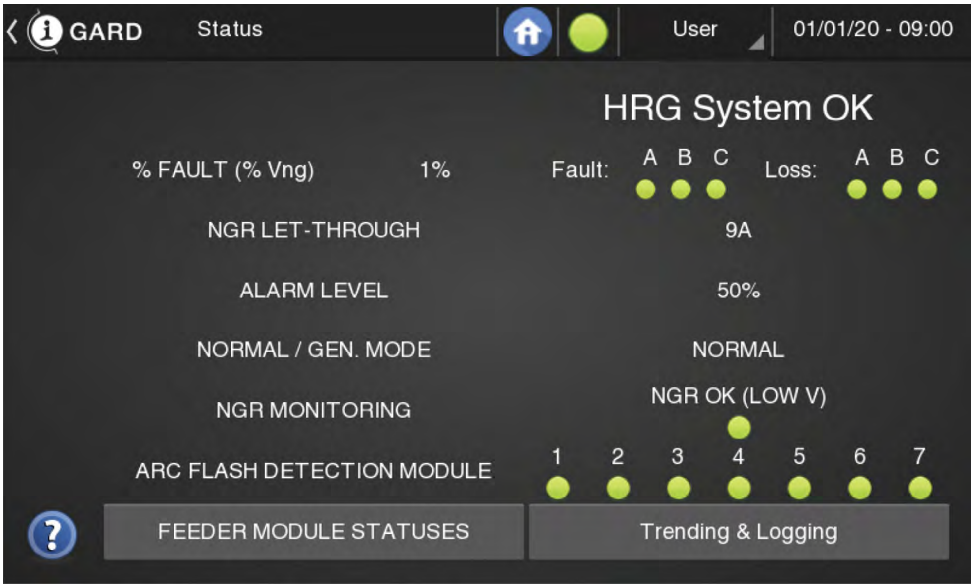


Figure 32: NGR Status Good Resistor

The health of the NGR is monitored. If the NGR becomes open or shorted this is an NGR FAULT. Such a fault is annunciated as shown in Figure 33 below.

Figure 33: NGR Fault

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

Figure 34: DSP-DRM Not Connected

Pressing ENTER will terminate the set-up and self-test and the HOME screen will be returned. If the DSP is left in the set-up mode, it will not gather information on the system, however feeder protection will still be effective. If the DSP is left accidentally in the set-up mode it will reset automatically after a period of approximately 1 hour.

7.7 DSP-ADM ARC DETECTION MODULE

The I-Gard DSP-ADM is an ARC detection module that uses air pressure and/or light sensing transducers to continuously monitor up to 21 sensors through up to seven channels. It offers a first line of defense in the arc detection feature of the DSP-OHMNI system. The DSP-ADM is used to provide protection against arc flash hazards in lowering the incident energy level to safer values protecting both personnel and equipment from severe damages. This module should be installed following the DSP-DFM or DSP-DLM (if resent) in the 35 mm DIN Rail line-up.

The DSP-ADM is designed to be used with:

- SENSOR L1 point light sensors
- SENSOR F1 modified point sensor with fiber optic tail
- SENSOR iPS2 or 1PS4 pressure arc sensors

The DSP-ADM monitors the area to be protected for flashes of light and for air pressure waves caused by arc flashes. When any of the sensors identifies such an incident, the internal Form C contact transfers. This signal is then use to trip the breaker interrupting energy to the circuit.

The DSP-ADM (Arc Detection Module) requires the DSP-OHMNI to have firmware of 2.20 or higher.

7.8 DSP-ADM INSTALLATION (SEE FIGURE 46)

The DSP-ADM is designed to be mounted in the DSP-OHMNI module array after (to the right of) the DSP-DFM feeder modules. The RC-3 ribbon cable supplies power to the DSP-ADM and allows communication to the main DSP-OHMNI system.

Up to seven of each of three styles of sensors can be connected to the DSP-ADM module. One of each sensor is assigned to one of seven channels as indicated in the table below.

Sensor Type	Connection Points	Channel
SENSOR L1 or F1 point light sensor	RTN 52-51	1
SENSOR L1 or F1 point light sensor	RTN 50-49	2
SENSOR L1 or F1 point light sensor	RTN 48-47	3
SENSOR L1 or F1 point light sensor	RTN 46-45	4
SENSOR L1 or F1 point light sensor	RTN 44-43	5
SENSOR L1 or F1 point light sensor	RTN 42-41	6
SENSOR L1 or F1 point light sensor	RTN 40-39	7
SENSOR FO fiber optic sensor	Optic 1	1
SENSOR FO fiber optic sensor	Optic 2	2
SENSOR FO fiber optic sensor	Optic 3	3
SENSOR FO fiber optic sensor	Optic 4	4
SENSOR FO fiber optic sensor	Optic 5	5
SENSOR FO fiber optic sensor	Optic 6	6
SENSOR FO fiber optic sensor	Optic 7	7
SENSOR iPS2/iPS4 pressure sensor	34	1
SENSOR iPS2/iPS4 pressure sensor	33	2
SENSOR iPS2/iPS4 pressure sensor	32	3
SENSOR iPS2/iPS4 pressure sensor	31	4
SENSOR iPS2/iPS4 pressure sensor	30	5
SENSOR iPS2/iPS4 pressure sensor	29	6
SENSOR iPS2/iPS4 pressure sensor	28	7

Table 7: List of Sensors for DSP-ADM

The internal Form C contact terminals NO 1, COM 2, NC 3 provide the output signal to the energy interruption circuit. This contact operates on signals from the sensors independently from the balance of the DSP-OHMNI system.

7.9 DSP-ADM SETUP

The DSP-ADM does not require any setup on the DSP-TDM touchscreen display module.

7.10 DSP-ADM OPERATION WITH DSP-OHMNI SYSTEM

A DSP-ADM module must be present in the lineup to monitor for arc flash incidents. The actual DSP-ADM trip is independent of other DSP-OHMNI functions but the DSP-ADM status can be viewed from the DSP-TDM touch-screen display module.

To view the status of the DSP-ADM, navigate to the STATUS page. Examples are shown in the figures 55 below. The DSP-ADM status line shows the statuses for each of the seven channels. When a channel is marked green its status is ok. When a channel is marked red it indicates that an arc flash was detected for this channel. If the channels are all grey then there is no DSP-ADM installed in the DSP lineup.

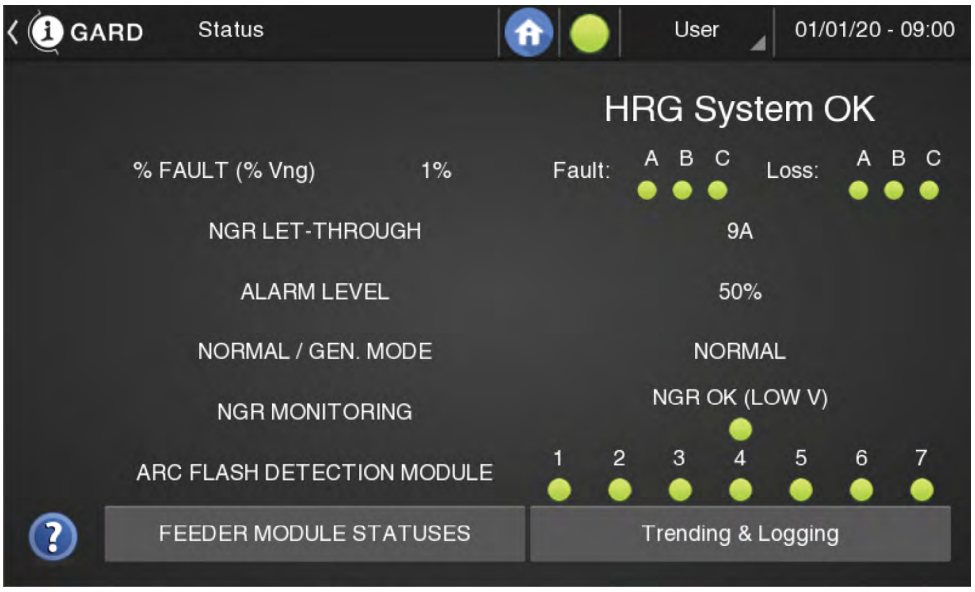


Figure 35: Arc Detection Module status page when no DSP-ADM is present

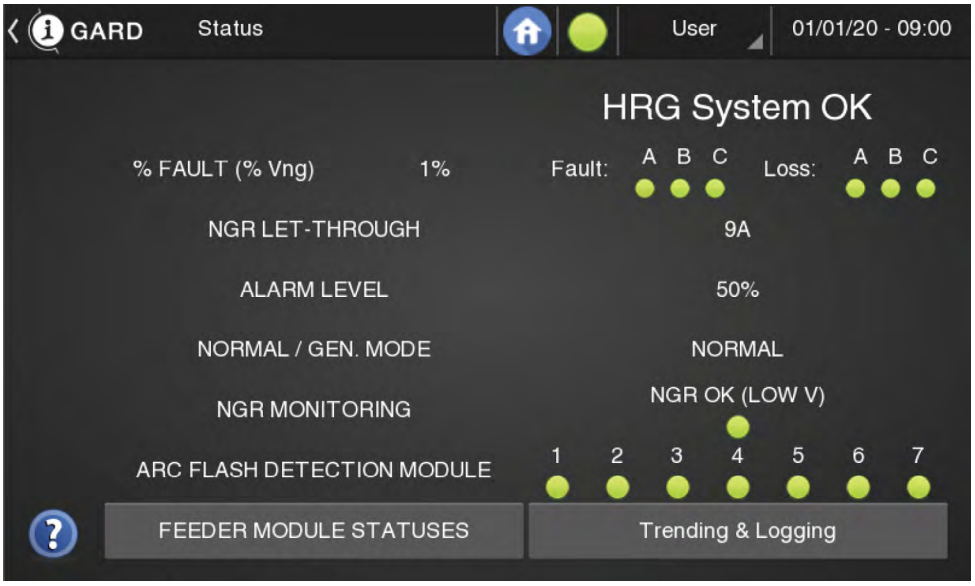


Figure 36: Arc Detection Module status page with DSP-ADM present and no alarms active

7.11 ARC DETECTION MODULE

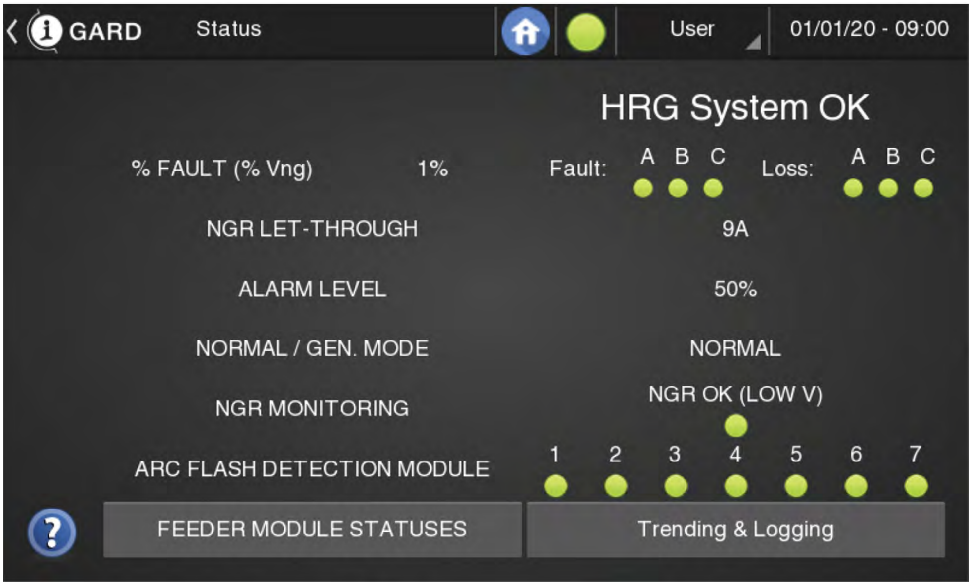


Figure 37: Arc Detection Module status page with DSP-ADM present and flash alarm shown on channel 1

7.12 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.

Service

I-Gard offers comprehensive training, commissioning and inspection assistance by qualified engineers. For assistance with installation, set-up 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 at www.i-gard.com for information regarding field service representatives in your area.

Note: Please ensure that proper authorization is obtained from I-Gard before returning any equipment.

8. COMMUNICATIONS

8.1 INSTALLATION

To allow communications to a remote terminal or network, a 4-wire RS-485 communications jack and Ethernet connector are provided at the side of the DSP-TDM touchscreen 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-TDM set-up from 9600 to 256000 as desired. The frame set-up is 5 to 8 bit, parity NONE, EVEN, ODD, MARK or SPACE and 1, 1.5 or 2 stop bits. The I/D number for the DSP-TDM must be entered in the set-up within the range of 1 to 255. Cable should be standard 4-wire with two twisted-pairs 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 kilometers or more should be easily accommodated.

8.2 DSP MODBUS OUTPUT STRUCTURE

Two functions are supported: Read Holding Register (03) and 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 8 below.

UNIT I/D	FUNCTION	STARTING ADDRESS		3 OF REGISTERED REG.		CRC	
01	03	High	Low	High	Low	High	Low
		00	01	00	02	nn	nn

Table 8: 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 check sum 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 9 below.

UNIT I/D	FUNCTION	# OF BYTES	Data 1		DATA 2		CRC		
01	03	04	High	Low	High	Low	Low	High	Low
			00	nn	00	nn	nn	nn	nn

Table 9: Returned Information Structure for Holding Register Request

Register contents are shown in Tables 13 to 16.

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 Table 8.

UNIT I/D	FUNCTION	COIL ADDRESS		FORCE COIL		CRC	
01	05	High	Low	High	Low	High	Low
		00	00	ff	00	nn	nn

Table 10: 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	
0	Reset	ff00=on	0000=off
1	Reset	ff00=on	0000=off

Table 11: Write Register Information

The response of Table 12 will confirm this request:

UNIT I/D	FUNCTION	COIL ADDRESS		FORCE COIL		CRC	
01	05	High	Low	High	Low	High	Low
		00	00	ff	00	nn	nn

Table 12: Returned Information from DSP Following a Force Bit 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: The DSP will not respond to requests if the DSP-TDM 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 8 lists the register addresses in the MODBUS convention.

REGISTER NO.	CONTENTS	FORMAT
40001	Feeder 1 I gf	0x00 nn
40002	Feeder 2 I gf	
40003	Feeder 3 I gf	

Table 13: 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 following registers return two bytes – The first byte is always 0x00 with the second returning status in hexadecimal as above.

REGISTER NO	CONTENTS	
	FUNCTION	FORMAT
40051	Feeder 1 Status	0x00 nn
40052	Feeder 2 Status	
40053	Feeder 3 Status	

Table 14: Feeder Module Status Addresses

REGISTER NO	CONTENTS	
	FUNCTION	FORMAT
40101	Feeder 1 Priority	0x00nn
40102	Feeder 2 Priority	

Table 15: 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 16: System Function Registers

9. SPECIFICATIONS

Power Requirements DSP-DPS	100-240V, 50/60Hz or DC, 25V A
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 I_G
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 detection
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 +5 x10= 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 second
Trip Delay on 1st Fault	
Minimum Setting (00 position)	Fixed 0.1 second
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-DRM

NGR Acceptable Range	66% to 150% of nominal value
Minimum Voltage Value	1% of maximum NGR voltage
Contacts	1 Form C 10A @240V AC, 8A 24V DC

DSP-ADM

Channels	Up to Seven
Sensors	Three styles, Up to one of each per channel.
Contacts	1 Form C NO 8A @240V AC, 8A 24V DC NC 0.35A @240V AC, 0.35A 24V DC

GENERAL

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

STANDARDS

CSA File Number	LR65287
ULListed File Number	E232710
CE	
Dimensions	See Fig. 37

Note: I-Gard reserves the right to change specifications of products without notice.

10. OUTLINE DIMENSIONS

Figure 38 shows typical dimensional details of the polymeric enclosures used for the modules. All have the same cross-section dimensions but with different widths as shown.

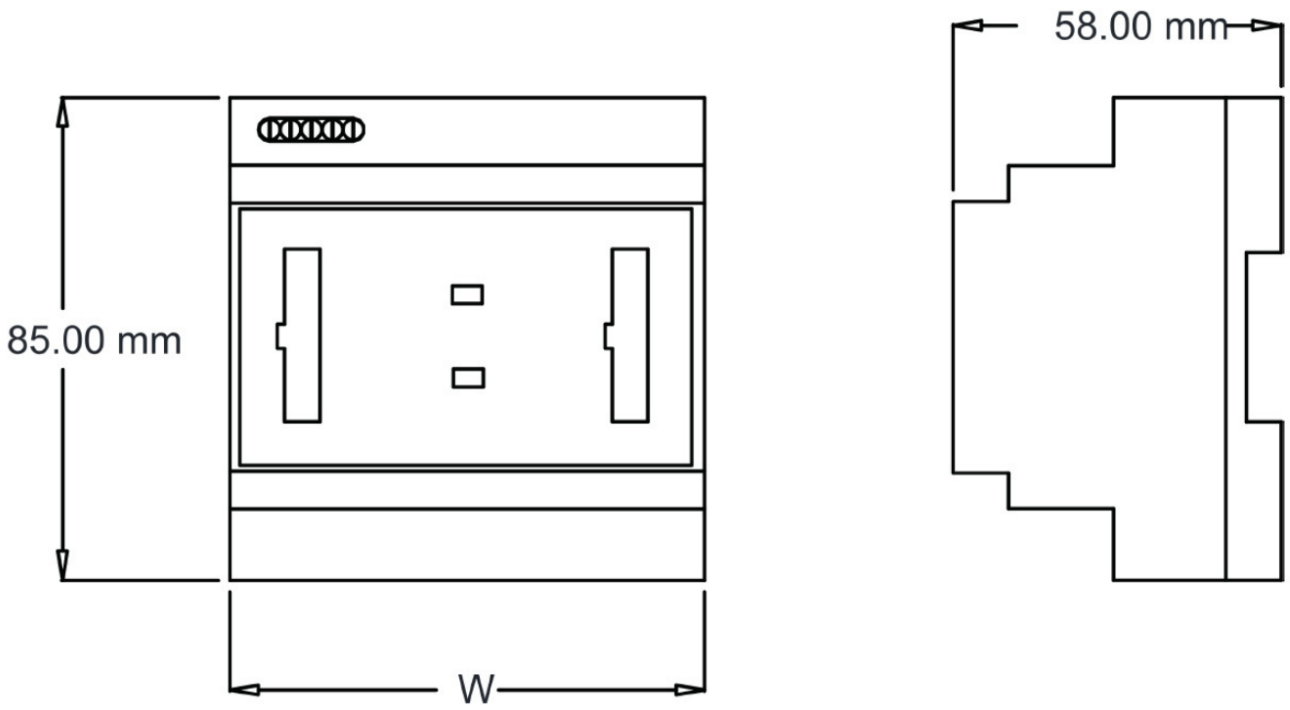


Figure 38: DIN Rail Mounted Modules

MODULE	WIDTH
DSP-DFM	35mm (1.377 in.)
DSP-DSM	70mm (2.755 in.)
DSP-DPS	155mm (6.102 in.)
DSP-DRM	155mm (6.102 in.)
DSP-DCM	70mm (2.755 in.)
DSP-CAS	70mm (2.755 in.)
DSP-CA	70mm (2.755 in.)
DSP-ADM	155mm(6.102 in.)

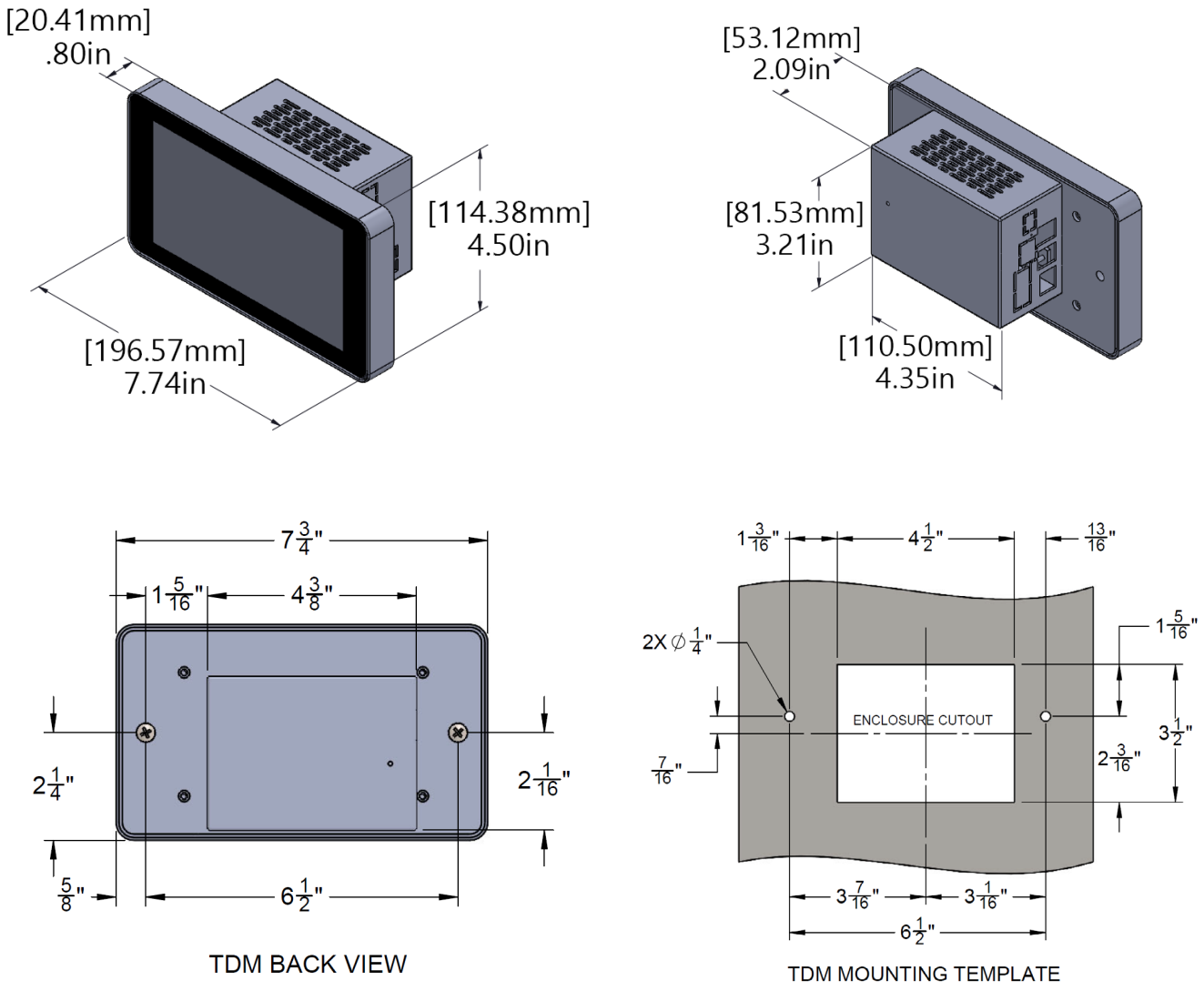


Figure 39: DSP-TDM Touchscreen Display Module dimensions

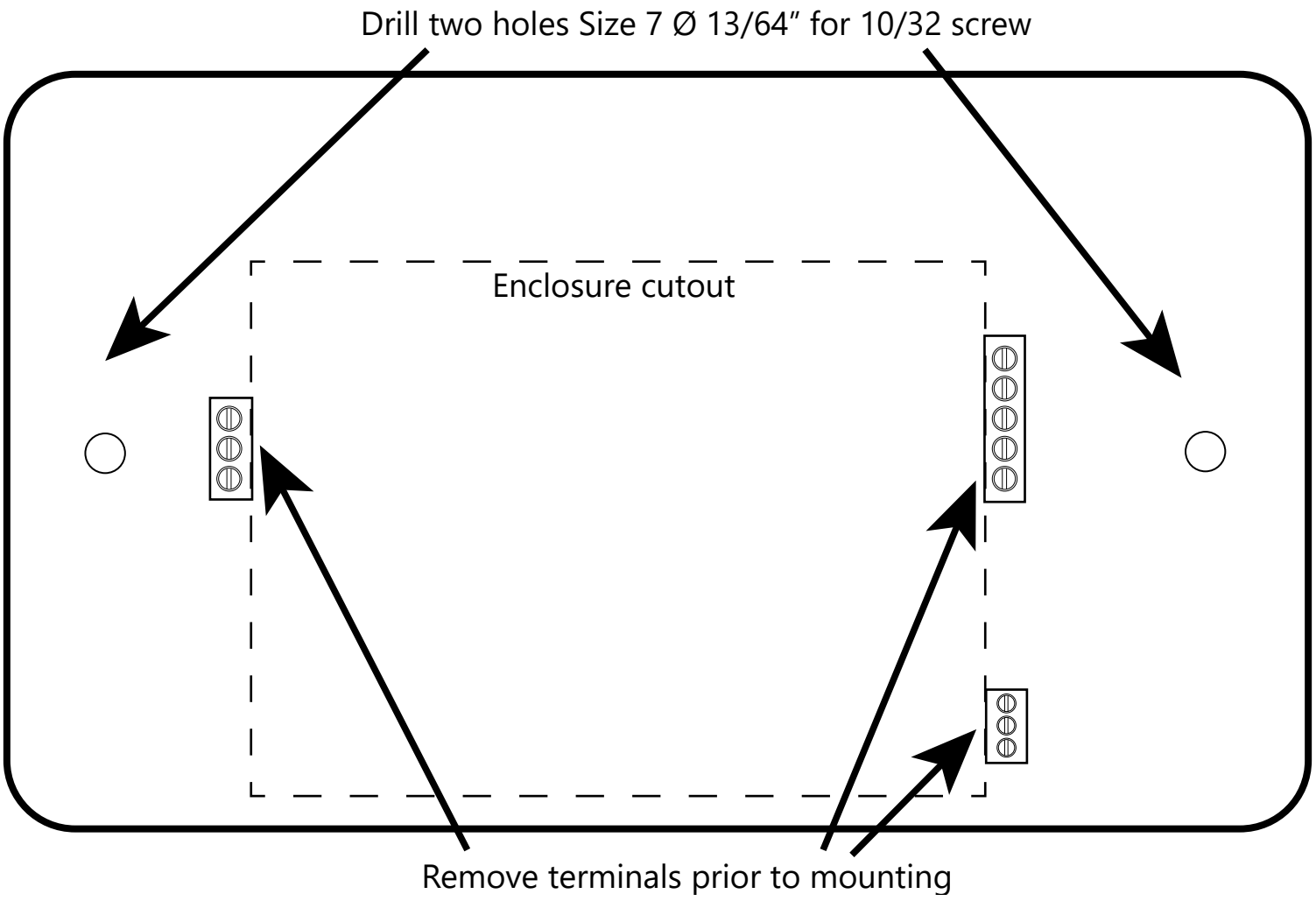


Figure 40: DSP-TDM Touchscreen Display Module Template real size to cutout

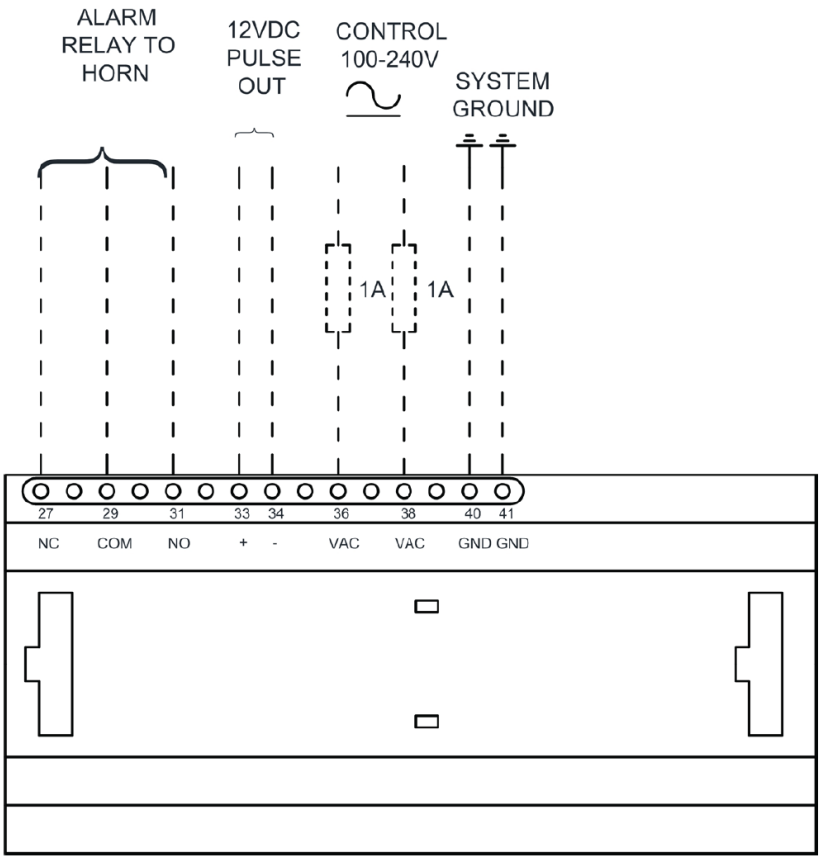


Figure 41: DSP-DPS Power Supply Connections

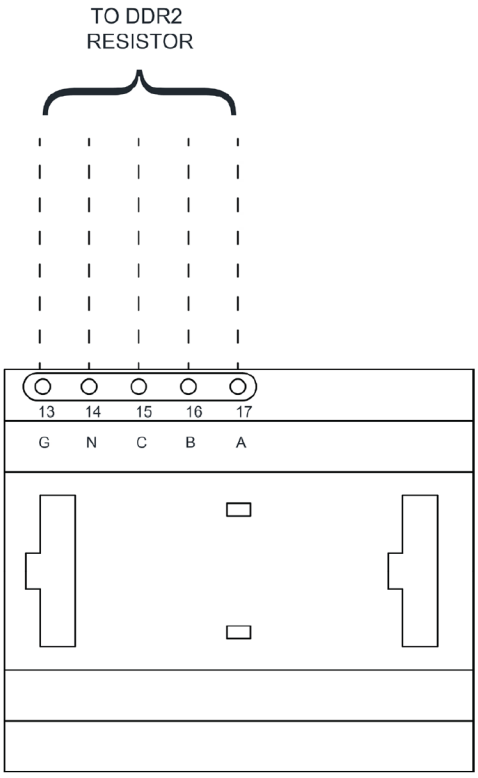


Figure 42: DSP-DPS System Module Connection

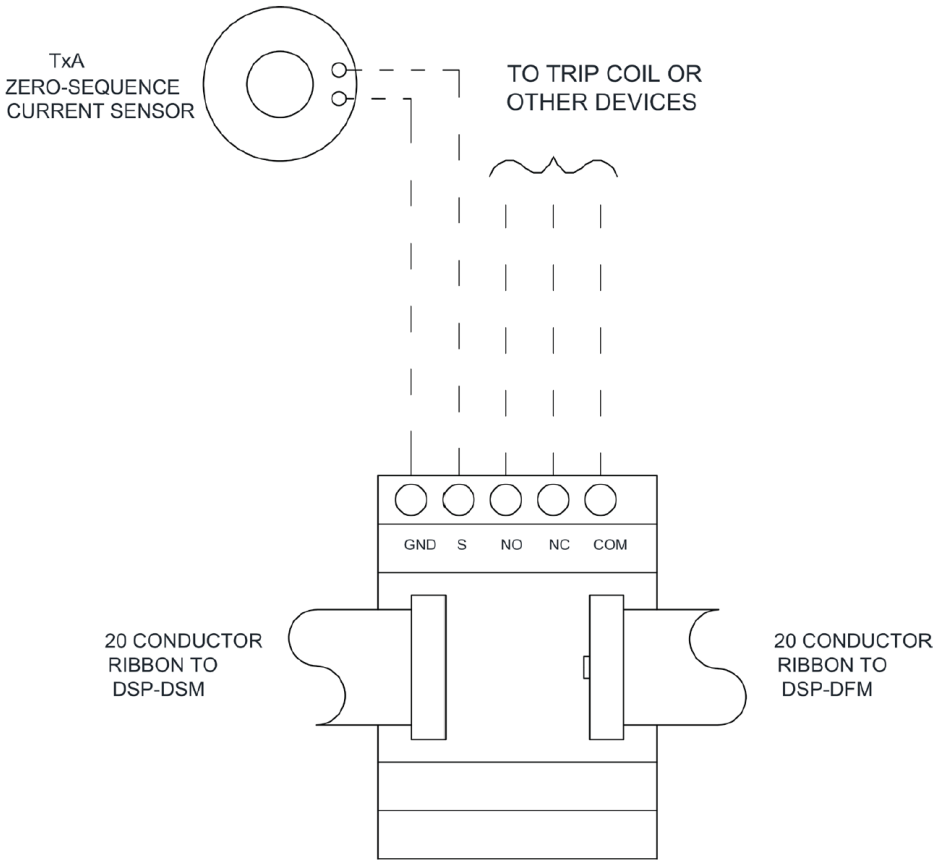


Figure 43: DSP-DFM Feeder Module Connection

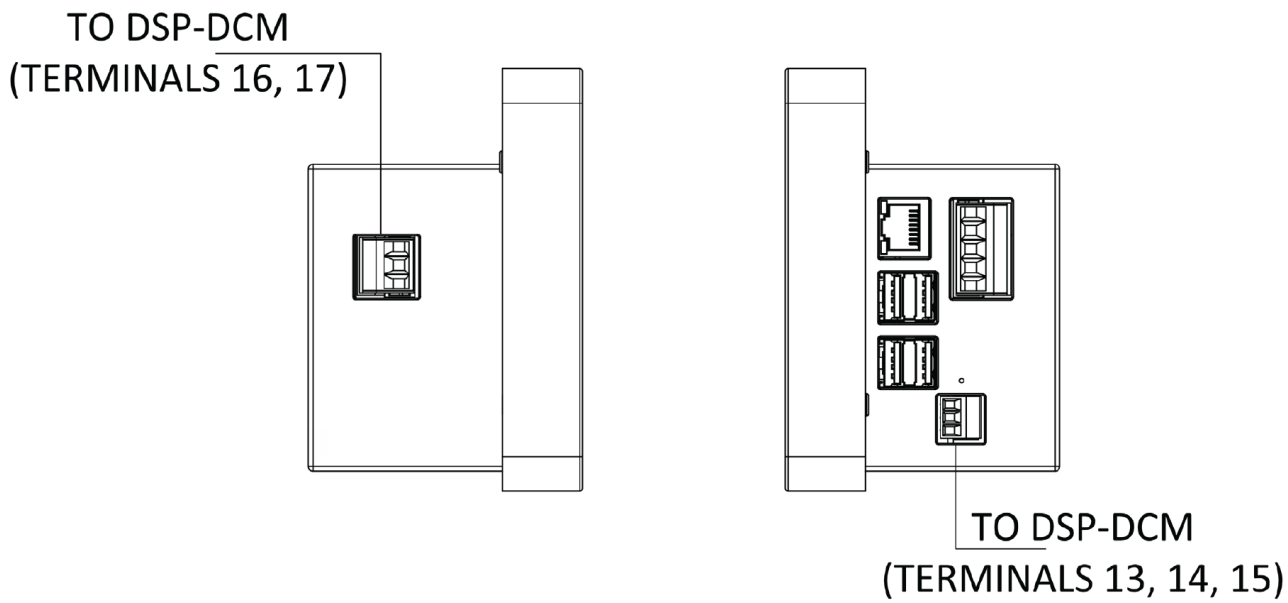


Figure 44: DSP-TDM Touchscreen Display Module Connections

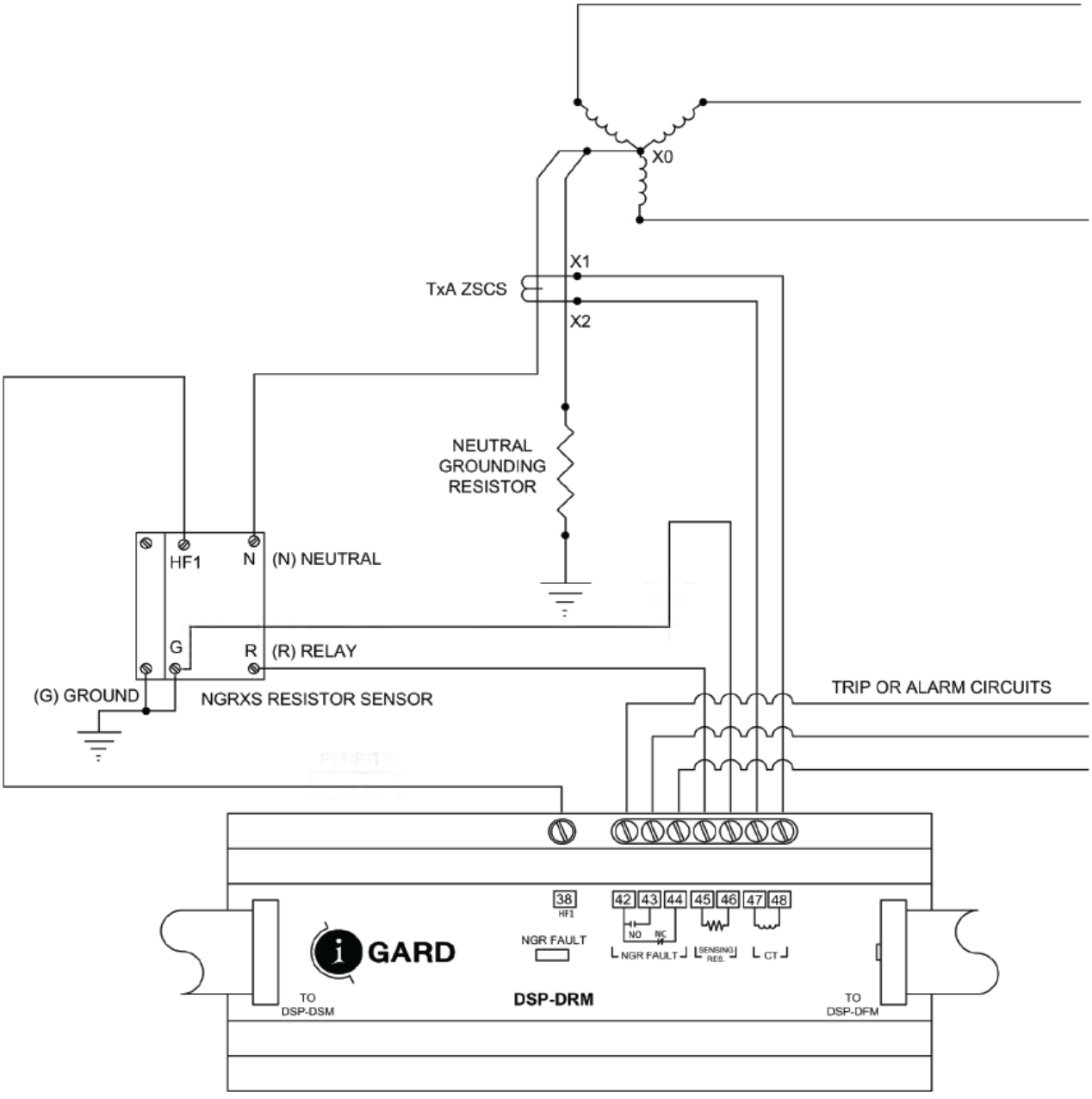


Figure 45: Typical DSP-DRM Installation Connections

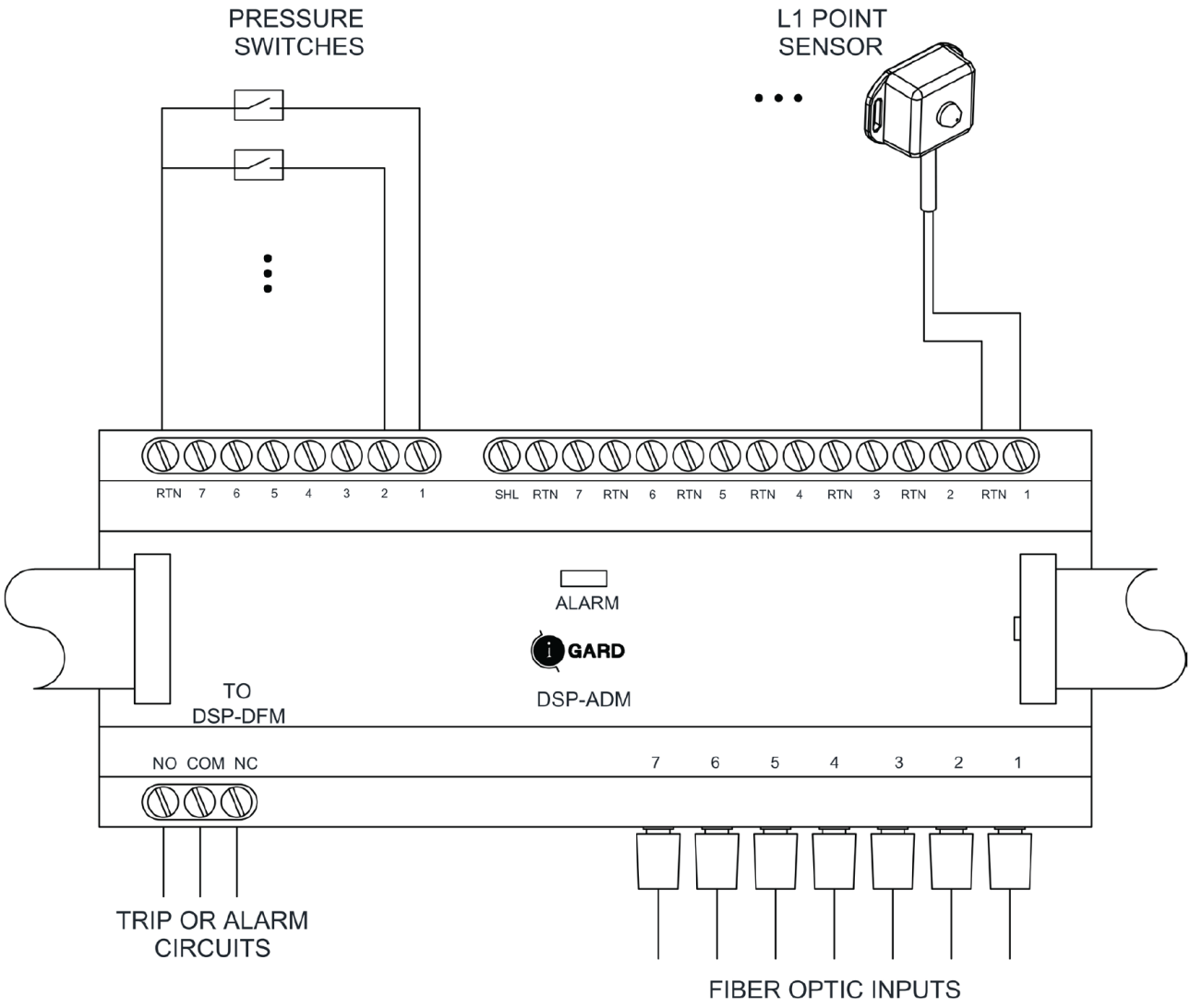


Figure 46: DSP-ADM Arc Detection Module Connections

11. HOW TO VIDEOS

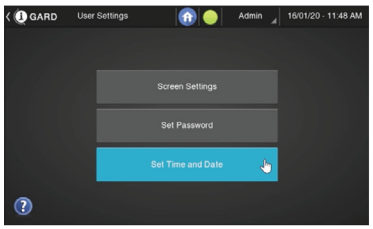
This series of videos provides step-by-step answers to commonly asked questions about DSP-TDM touchscreen display module operation. Click on the video titles below to be redirected to each video on www.i-gard.com or, scan the QR code to be directed to the video on your smartphone.

How to Enter Admin Mode

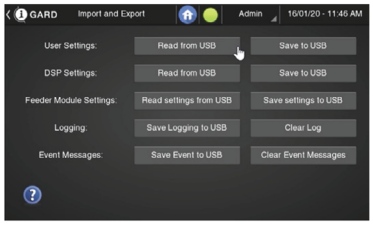
How to Configure MODBUS TCP

How to Edit Alarm Settings

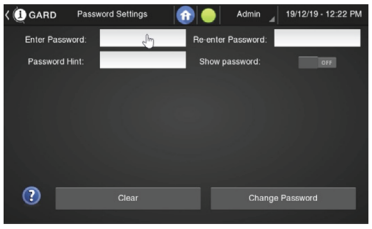
How to Set Date and Time



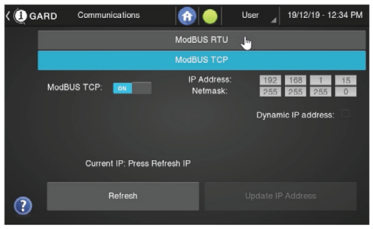
How to Import and Export



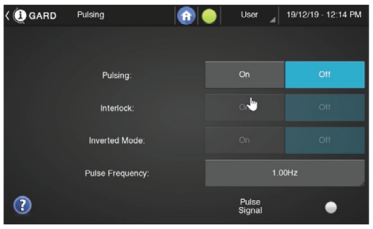
How to Set Password



How to Configure MODBUS RTU



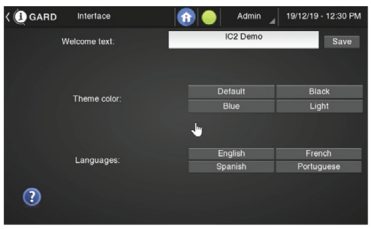
How to Activate Pulsing



How to Configure Feeder Modules

How to Read and Interpret System Status

[How to Change Operating Language](#)



[How to Identify Feeder Modules](#)

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