Eaton Electrical Predictive Diagnostics

EATON ELECTRICAL

InsulGard™

Startup Procedure

Version 3.0

Revision 1

(January 2006)

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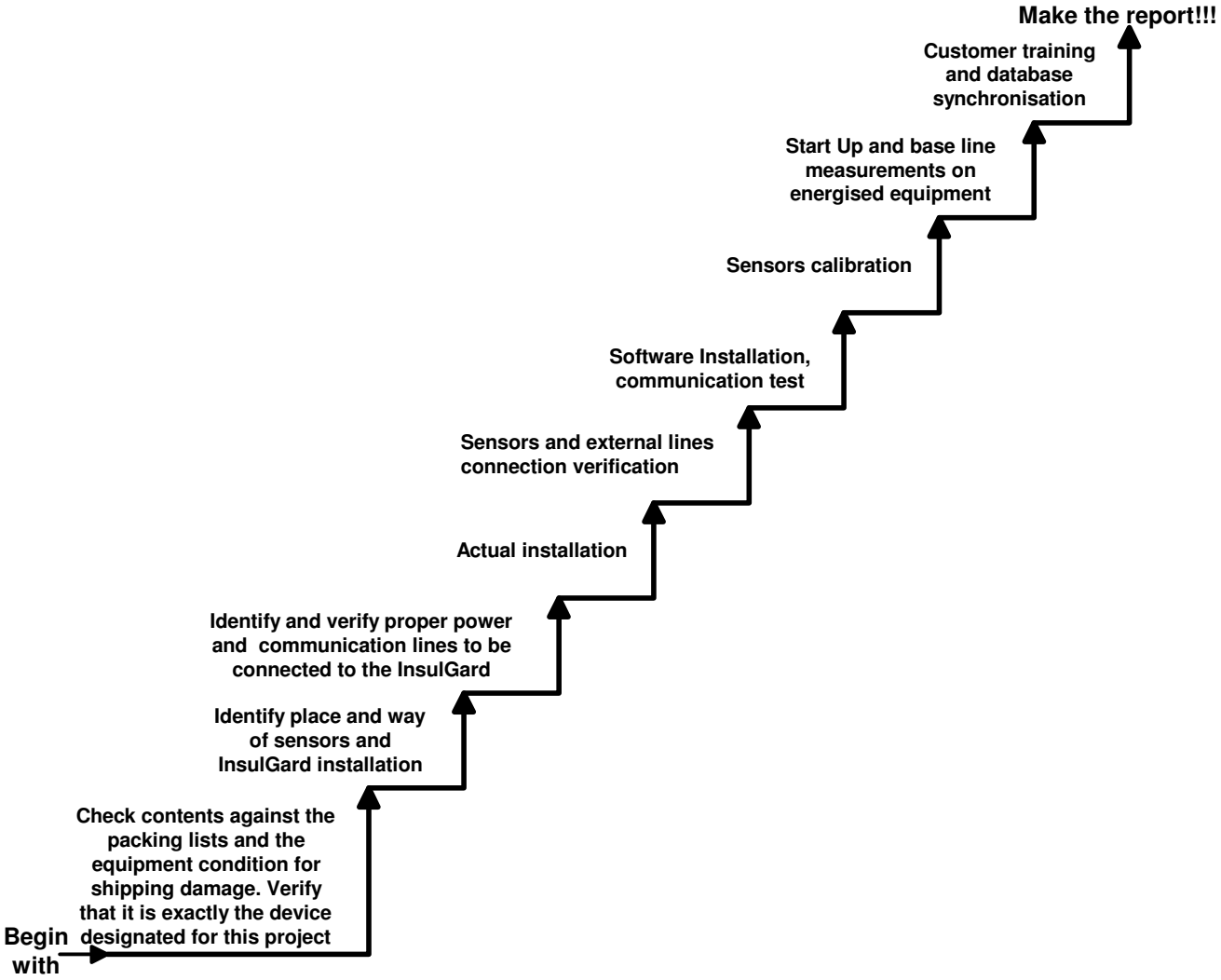
INSTALLATION STAIRCASE



Revision 1.

Some changes are made to the sensors interface board in order to simplify start up procedures eliminating temporal connections to IG during start up. All necessary commutations are done with additional switch located at the bottom of sensor interface board. InsulGard™, revision 1 can be identified by the presence of described switch or by a wiring diagram identification label located on power outlet panel. The label looks like **WD-2-X**. X – identifies real wiring diagram, used for assembly on particular InsulGard™ device.

Note: Changes reflecting new features will be labeled as Rev1 down in the manual!

GETTING READY

The purpose of this manual is to provide guidelines for the quick startup of an InsulGard system. Some of these items need to be done prior to energizing of the machine.

The procedures described below assume that InsulGard and all necessary sensors are installed wired and connected to InsulGard. InsulGard may be shipped in several options on both InsulGard mounting and sensors. Please refer to appropriate installation manuals that are shipped with InsulGard. Be sure that the Insulgard device(s) used are designated for this particular project and to be connected to this particular set of sensors. Insulgard are not interchangeable devices. Switching Insulgard devices can lead to errors and significant reprogramming of database software and Insulgard internal software.

Note1: Some of operations below are to perform on de-energized equipment and some after put it back in service! ALWAYS use appropriate safety practice to ensure safe work!

Note2: The procedures described below are mostly universal for all versions of IPDS sensor (80 pF coupling capacitor). Some procedures differ. Please note below descriptions marked (FOR OLD) that apply for IPDS-15 shipped before 03/01/2004.

Note3: Check that sensors are connected to IG in the sequence: coupling capacitors to the first channels and then RTDs. The table below shows the example of the required sequence for the case of two sets (six coupling capacitors) and nine RTDs. If necessary, reconnect sensors.

CH #	*Sensor*	*CH #*	*Sensor*	*CH #*	*Sensor*
1	*Coupling capacitor Phase A Set1*	*7*	*RTD01*	*13*	*RTD07*
2	*Coupling capacitor Phase B/Set1*	*8*	*RTD02*	*14*	*RTD08*
3	*Coupling capacitor Phase C/Set1*	*9*	*RTD03*	*15*	*RTD09*
4	*Coupling capacitor Phase A/Set2*	*10*	*RTD04*		
5	*Coupling capacitor Phase B/Set2*	*11*	*RTD05*		
6	*Coupling capacitor Phase C/Set2*	*12*	*RTD06*		

Required Items

The following items are required for start up and functionality tests:

Ohmmeter sufficient to measure resistance from 0.5 Ohm to 10 kOhm.

- Laptop computer with Windows operation system and preinstalled InsulGard software.
- Communication cable and RS232/485 converter for InsulGard with RS485 interface. One cable/converter per plant is shipped with InsulGard package.

CHECKING CIRCUIT CONTINUITY

De-energize InsulGard

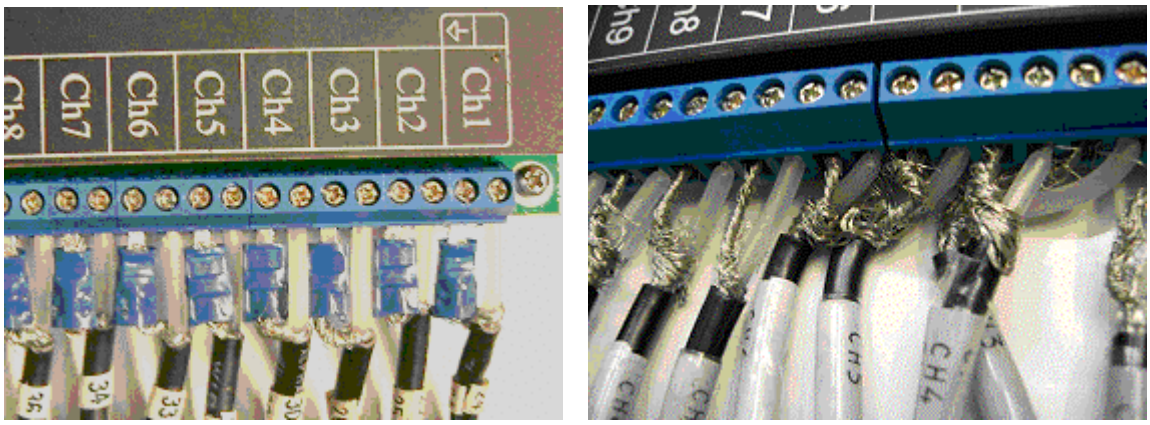
De-energize InsulGard before performing any of the following operations. The best way is to de-energize the power cable coming to InsulGard. Also remove the fuse located on the InsulGard panel.

Checking PD sensors

Provide easy access to InsulGard external connection board. In panel mounted option you need an access to the back of InsulGard, for InsulGard on back panel of mounted in NEMA enclosure you need to disconnect and remove InsulGard itself. Do not forget to disconnect flat ribbon cable from connection board before removing InsulGard.

- Visually verify good connection of coaxial cables to connection board (No

shorts, connections are tight). The pictures in (Figure 1) show an example of good (a.) and inappropriate (b.) connections.



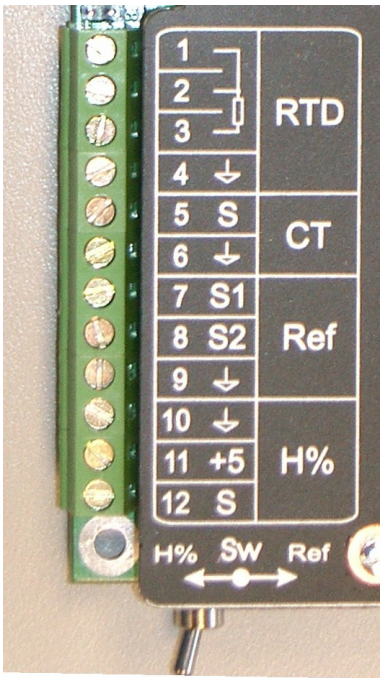
a. ***b.***

Figure 1

- It is a good moment to inspect coax cable terminations to the sensors too. **Verify visually proper coax cable connections to IPDS sensors – switched shield and central wire can't be detected until object energized - too late to change. Verify that wires from RTDs are connected to RTD In side of the RTD PD sensor.**
- Using the Ohmmeter measure resistance of each PD sensor across its terminals on the connection board. The resistance should be close to **1.5kOhm-3kOhm** for each coupling capacitor. **(For Old – 0.2 to 2 ohms).**
- Using an Ohmmeter measure the resistance of the each RTD channel. The resistance should be 0.2 to 2 ohms. Basically it is the resistance of the wire. This can vary installation by installation. However all readings on the same machine should be close to each other.

Checking temperature and load sensors connections

- Using an Ohmmeter measure the resistance between Temperature sensor wires. See Figure below. Resistance between contacts 1 and 2 on the left termination strip should be ~1 Ohm. Resistance between contacts 1 and 3 should be 10-15 Ohm for copper RTD or 100-120 Ohm for platinum RTD.



- Using an Ohmmeter measure the resistance of connected Load (CT) sensor wires. Resistance between contacts 4 and 5 should be ~30-40 Ohm.

Checking InsulGard Power

- Switch On the breaker feeding the InsulGard with fuse still out.
- Check voltage between External Ground and InsulGard ground contacts 1, 2 on left connection strip. Voltage should be zero.
- Check voltage on the Neutral between contacts 1 and 3 – it should be near zero.
- Check line voltage between Line and Neutral contacts 3 and 4 – it should be 115/230 VAC +-10%.
- If insulating transformer is used check ground connections and voltage between Line and Neutral only.

Checking Temperature and Humidity signals

- Depending upon ordered option you may have internal or external T and H% sensors (on a rotating machine the sensors are normally external, on substation - internal). Check that all jumpers are in place on connection board or sensors are properly wired to the board according to the wiring diagram provided.
- Reinstall InsulGard and restore all connections and power the InsulGard up.

- InsulGard should boot up, display Firmware version and start showing parameters on display. Scroll display parameters using top arrow on InsulGard keypad. Check for temperature (***t-XXXX***) and humidity readings (***H-XXXX***). They should reasonably reflect conditions at the point of installation.

CONFIGURATION VERIFICATION

Predictive Diagnostics ships an installation CD with every order. The database is pre-configured for each particular customer and reflects customer's monitored object structure.

If you have already installed InsulGard™ software and have several IG devices, you need to uninstall the existing software through "Control Panel" – "Add/Remove Software". Uninstallation will not destroy any pre-existing data.

Install IG software from newly received CD. This procedure will update the software version and also will install new updated database object structure for your facility. The first time you will run IG software it will add new objects into your existing database.

Important:

If you already had same customer in preexisting data base, software will add this location and object to the database. If your database does not have that customer software will not update your database and you have to remove or rename file "Insulgard.mdb" in "Program Files/Insulgard/Data/" before installation. It is highly recommended to keep separate databases for each customer's location of given customer under different names. Otherwise data base containing multiple objects and multiple locations will grow in size very fast and will slow down even powerful computer.

Establishing Communication to InsulGard from laptop

Certain familiarity with InsulGard software is required to accomplish the described below procedures. Please refer to the respective manuals for the InsulGard and InsulGard software.

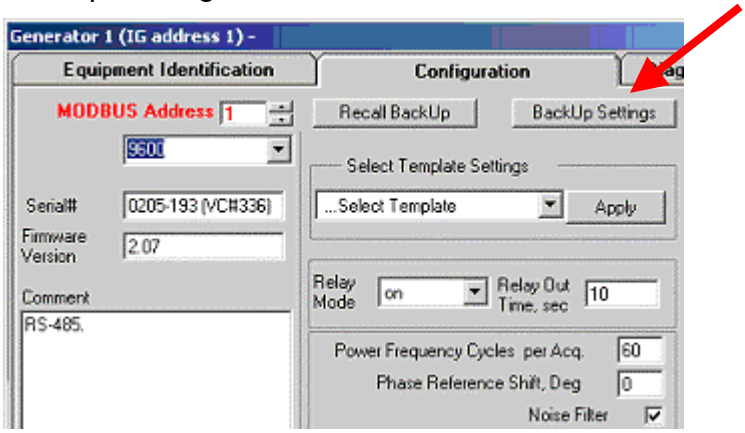
Preparing Configuration

- Connect PC and InsulGard with the provided cable/converter, start InsulGard software and select appropriate object (you may have more then one InsulGard at your facility).
- Click on "Insulgard Set Up button in lower left corner of the software window to get access to the "Configuration" tab. Normally, each device is pre-configured to

the best of our knowledge based on the order and additional information we received. Device setting may be modified by third party facility, if it was an indirect shipment. Or devices assigned for different projects or different locations for the same project could be switched. Verify that the proper Insulgard device has been installed.

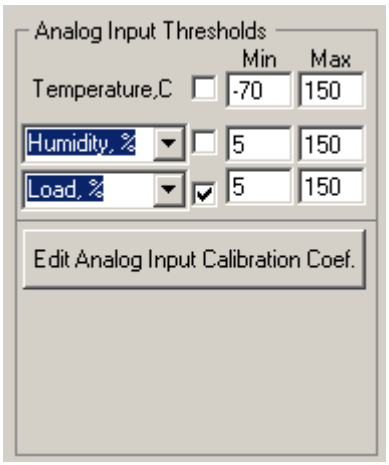
- In “Configuration” Tab check appropriate InsulGard ModBus address and correct communication speed (9600 Baud).

- In the “Communication” Tab set correct COMM port for your PC. You may find your computer COMM port number in Control Panel/System/Device Manager. Ensure established communication by requesting date or number of records from InsulGard. The three settings described above are responsible for communications.
- On the InsulGard Configuration screen store the base configuration file by pressing the “BackUp Setting” Button.



- Press the “Get Settings From Device” button located on the Communication Tab. If downloaded settings do not coincide with data base settings it is an evidence of possible modification by third party or switched InsulGard devices.
- If you have different settings in the device and database software will display warning message and list parameters that are different. Click “Update Database with Device Settings”. Write down the difference – it will help to change settings properly.
- Check for channel activation and names in software device settings. If existing configuration do not match real sensor’s configuration on the monitored object change them according to real sensor’s configuration on the monitored object.
- Press “Backup Setting” on Configuration window.

- Send correct settings by pressing “Send Settings To The Device” button on Configuration window. Make sure that “Edit Analog Input Calibration Coef.” button has not been pressed on Configuration window and the part of this window looks as it shown below.



Set Correct Date and Time

The time and date on the InsulGard is set in Minneapolis Minnesota. Obviously the local time and date must be entered.

1. Go to the Communications Tab of the InsulGard Software.
2. If the time and date on you computer is the same as the local time and date, press the "Apply PC Time" button.
3. Make any changes to the time and date in the Device Time Field to reflect local conditions.
4. Press the "Set Device Time" button.

Erase device memory

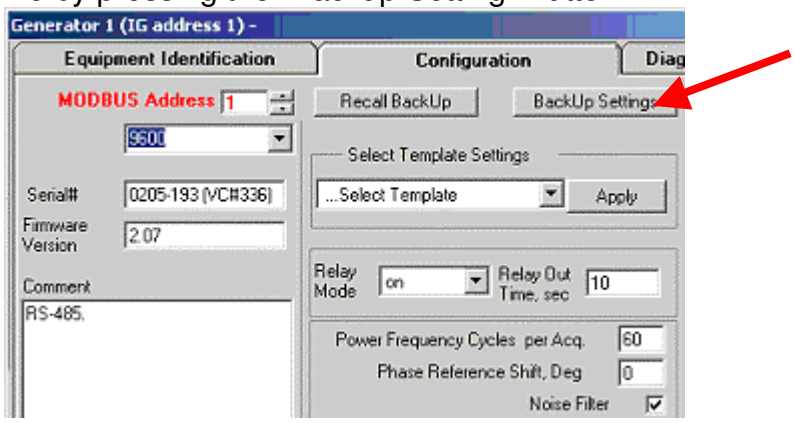
Erase all data stored in the InsulGard by clicking “Erase Device Memory” in upper right corner of the Communication” tab.

CALIBRATION/VERIFICATION

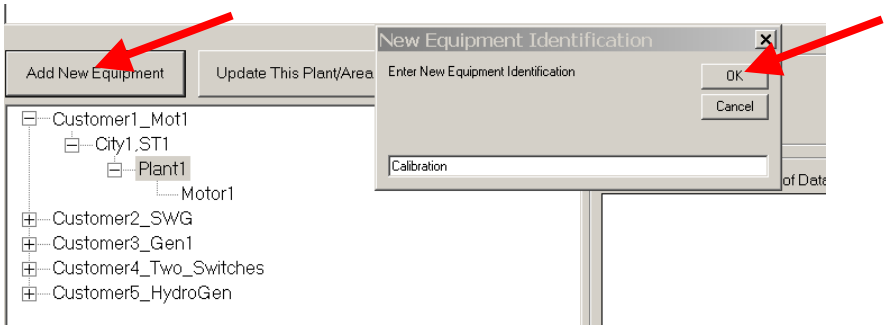
Perform calibration/verification by injecting Pulse Signal to the sensors from a calibrating generator and recording data with InsulGard monitor. It is the only 100% reliable way to verify proper sensors connections and functioning through out the whole InsulGard-Sensors system. Errors like wrong sensor label or connection and inverted connection of RTD PD module can’t be verified with

ohmmeter.

1. Prepare InsulGard for calibration. Be sure that original setting have been saved - on the InsulGard Configuration screen store the base configuration file by pressing the “Backup Setting” Button.

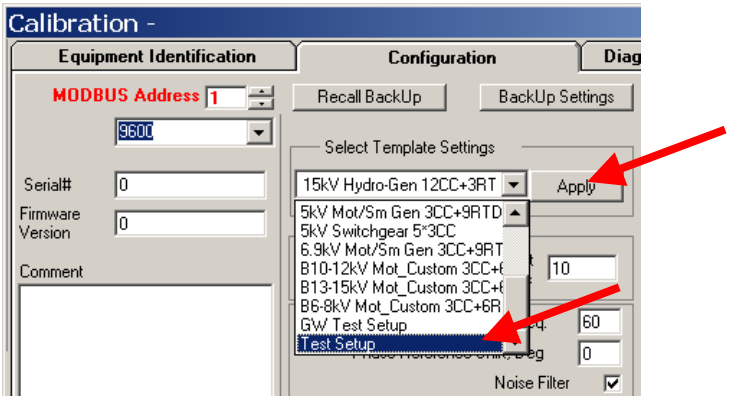


2. Add a dummy “Calibration” object in the same Plant/Area as the actual object.

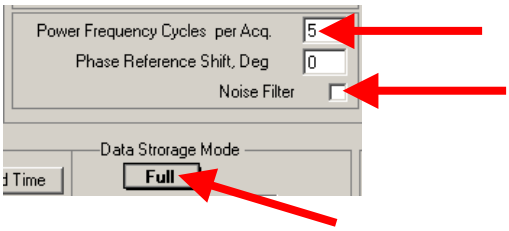


Enter any dummy data in Equipment Identification window.

3. Open configuration window choose and apply “Test setup” template as shown below:

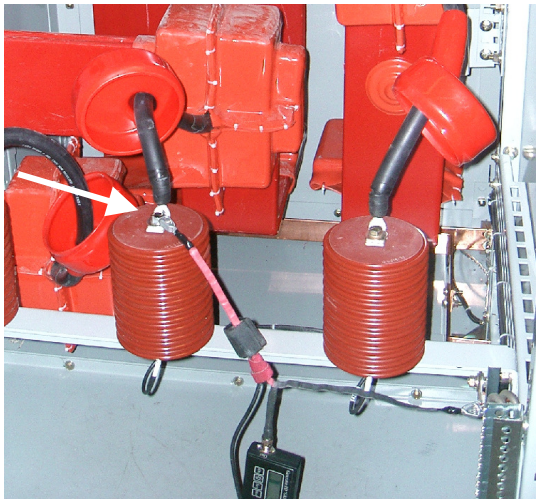


This setup will change Power Frequency Cycles per acquisition to 5 to save time on measurement, uncheck Noise Filter and change Mode from Brief to Full



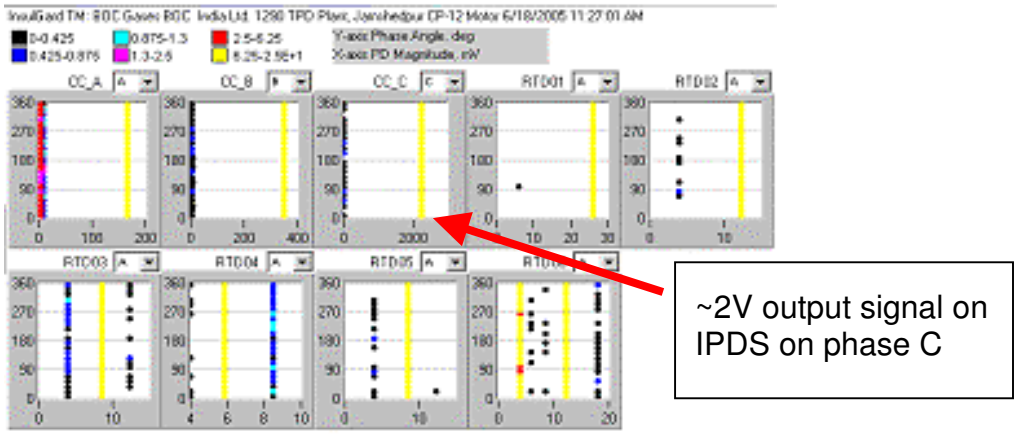
4. If necessary change MODBUS address to same address as in your monitor, you will have to set proper serial port in communication tab also.
5. Send settings by pressing “Send Settings To The Device” button on Configuration window.

6. Use GKI-2 pulse generator to inject pulse in common mode between the HV conductor and ground using cable with alligator clips. Connect the output of the pulse generator between the jumper wire of an IPDS sensor and ground. Make sure the ground connection is as short as possible. It is suitable to connect directly to the closest point on the frame.
   If different from GKI-2 pulse generator used, set the generator pulse parameters: Pulse Magnitude ~10 Volt, Pulse Width – 100 nanoseconds, Pulse repetition rate ~ 1-10 kHz. Magnitude and pulse repetition parameters are not critical. Pulse width should not exceed 500 ns.
   Examples of the generator connection are shown in the Figures below.
   In case of RFCT senor signal should be injected to the feeder terminal

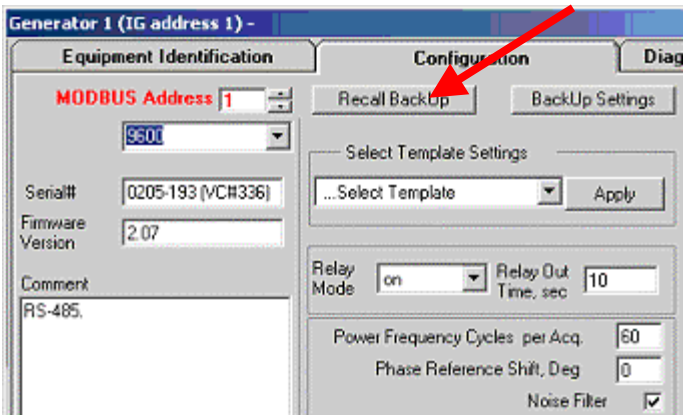


With RTD sensors signal can be injected to one of “RTD In” contacts (except #4) were RTD wires from the stator are terminated.

7. Switch the generator ON and run “Single Measurement” from Communication tab of the InsulGard Software. A measurement is proportional to the number of active channels and will take approximately **1.5 minutes for maximum 15 active channels.**
8. Download data from InsulGard by pressing “Get the Latest Device Records” button located on the Communications Tab. Observe phase-resolved data from this measurement from the Diagnostics and Report Tools screen. An example of expected data is shown in Figure below.



9. Click on Copy button and Paste the picture into the word document for records, write down magnitude measured in channel connected to the sensor under the test. You expect to see higher magnitudes for the sensor where the signal injected and lower magnitudes for the rest of channels reflecting pulse attenuation and crosscoupling. Typical magnitudes for IPDS sensor is ~ 1V, for RFCT with pulse injection to feeder termination is ~0.5 V. Those magnitudes can differ significantly depending on size and number of feeders connected to the termination. This measurement process should be repeated by injecting signals in all sensors. Response for similar sensors and similar geometry should be similar.
10. Remove calibrating generator.
11. Return to the software first window and delete dummy object. Restore monitor setting for the monitored object by recalling settings and sending settings to the device.



12. Erase all data stored in the InsulGard by clicking “Erase Device Memory” in upper right corner of the “Communication” tab.

PROCEDURES ON ENERGIZED MACHINE

At this point all signal cables are connected and the InsulGard is powered up, the motor is running and the Software is installed on the PC. Data base configuration is verified and corresponds to the application.

Setting Phase reference

In order to provide a phase-resolved data, the InsulGard uses a phase reference signal. The Phase Reference signal is an AC voltage signal synchronous with the voltage of the object being monitored and a known constant phase shift to that voltage.

In most of cases power source (115/230 VAC) powering up InsulGard is used for InsulGard synchronization[1]. The device has the internal connection of the power circuit voltage to its synchronization circuitry. This option (default) always works on monitored objects powered from a regular power system (60/50Hz) in the area. Phase shift between power voltage and object high voltage should be determined. The InsulGard allows for automated detection of a phase shift between its power circuit and an external phase reference signal. This procedure is described below.

1. Enter Setup Mode

Enter appropriate password and enter setup.	Press “***Set***” key. ***PSd-***____ will appear on the display. A correct password must be entered, in order to enter the setup mode.

[1] InsulGard has an option to use external synchronization signal. Synchro-signal should be connected to the terminal #8 “Ref” **(#7 Rev 1)**. This option is used in “asynchronous” applications such as variable frequency drive. 60/50 Hz signal component from the channel #1 (should be a coupling capacitor) may serve for this purpose. External synchronization requires appropriate jumper configuration inside InsulGard enclosure and external connection board. Refer to IG user manual for additional information.

Your password is **5421**	Using ↑↓←→ keys enter password and press ***ENTER***. Wait for about 20sec. The first option to appear is the date/time setup. Use the right and left arrow keys (←→) to scroll the setup parameters.

2. Scroll menu to ***PhShiFt***

As default, the device is synchronized from its power source. The device requires a phase shift between the source and the phase-A voltage on the object to be detected. The device can automatically detect phase shift. **Phase shift is the phase between zero crossing of power source voltage and the first correspondent zero crossing of the voltage on the phase A of an object!** **Note: Automatic phase shift detection is incorrect, if any of following has been observed:** **1. IG displayed dashes for several times in the versions 2.00 and higher (bad phase reference signal)** **3. Displayed values range exceeds +/-5^0 (low signal magnitude or high noise).** **4. Any change in displayed phase shift has not been observed.**	Scroll setup parameters until ***PhShiFt*** appears. Press ***Enter*** ***Connections for automatic detection of phase shift in Pre-Revision 1:*** • Temporally disconnect **Humidity signal on the Device input board** (terminal # 12) • Place temporary jumper between terminals 8 ("Ref.") and terminal 12 ("S of H%"). (For Old bring temporally signal from RVS sensor to terminals 6-shield and 12-signal of IG external connection board. Shield is normally brought to terminal 17 and signal to terminal 18 on the terminal strip on the right from IG). ***In Revision 1 set switch in Sensor Interface Board to the right in "Ref" position. This will bring power frequency signal from coupling capacitor in the channel 1 to reference circuitry. You do not need to account for any additional sensor phase shift!*** Press ***Set*** and wait until ***PhSh-XXX*** appears. The device is automatically detecting the required phase shift between power source and the reference signal and displays it. Write down every 15 seconds several readings (>10) that appear on the display and calculate he average value. If this average value is within $\pm 5^0$, setting is correct. If variations are higher – high frequency noise is essential in the reference signal. Press ***Enter*** to save new value, or ***Esc*** to exit without saving. Restore original connections or set switch back to ***"H%"*** position.
Exit Setup	Press ***Esc*** and **SAVinG** will appear

3. **In Pre-Revision 1:**

Take the Phase Shift Number and add 90 degrees to it (this is phase shift of coupling capacitor for 60/50Hz AC voltage). If a result is out the range of 0–360^0, you should subtract from 360^0 in order to get it within the range. *(For Old IPDS Phase Shift number equal to 0^0).*

Example: Reference signal from A phase is used. Automatically detected phase shift is 345^0. Adding +90) = 435^0. Subtracting 360^0 = +75).

In Revision 1:

None of measured phase shift corrections are required, if coupling capacitor from the phase A is connected to the channel #1.

Note: When dealing with InsulGard firmware version 2.07 subtract InsulGard readings from 360 and apply this value in accordance with procedures above.

4. Go to the setup screen on the InsulGard software and enter the phase shift number into the Phase Reference Shift, Deg. field.
5. Go to the Communication Tab and press "Send Settings To Device" Button. This will update the configuration of the InsulGard with the correct phase shift.
6. On the InsulGard Configuration screen store the base configuration file by pressing the “Backup Setting” Button.

Calibration of Load Current Signal

This procedure describes the process to calibration of the load current channel. The InsulGard is calibrated so that load current is expressed in % of full load current.

1. Determine the full load current rating of the machine from the machine nameplate.
2. Determine the load current the machine is currently pulling.
3. Divide the value of Step 2 by Step 1 and multiply by 100. This is the percent of full load current the machine is currently pulling.
4. Enter the set up mode on the InsulGard

Enter appropriate password and enter setup. Your password is **5421**	Press "***Set***" key. ***PSd-____*** will appear on the display. A correct password must be entered, in order to enter the setup mode. Using ↑↓←→ keys enter password and press ***ENTER***. Wait for about 20sec. The first option to appear is the date/time setup. Use the right and left arrow keys (←→) to scroll the setup parameters.

5. The following steps should be used to auto set the % full load current calculated in Step 3.

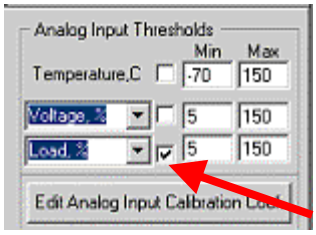
The goal of the procedure is to convert current inputs into meaningful numbers on the display and in database. We recommend using % of rated as a number to represent. You may enter coefficients manually or automatically determine them while setting the device. Automatic procedure is available only from keypad. the current inputs into % of rated value.	Scroll setup parameters until ***CALibr I*** appears. Press ***Enter***. ***InPCoEFF*** will appear. This is the prompt for manual coefficient entering. Use ↑↓ keys and ***CLcCoEFF*** will appear. This is the prompt for automatic detection. If press ***Enter***. in automatic mode ***IPc-000.0*** will appear Use ←→↑↓ keys to enter % of the load current that currently present on the object. Press ***Enter***. The calculated coefficient will be displayed: ***I-XXXX.XX*** Press ***Enter***. When done, press ***Esc***.
Exit Setup	Press ***Esc*** and **SAVinG** will appear

7. Go to the Communication Tab on the InsulGard software and press the "Get Settings From Device Button" to update the current configuration. Accept any differences.
8. On the InsulGard Configuration screen store the base configuration file by pressing the "Backup Setting" Button. To store the current configuration in the backup file.

FINAL STEPS

The final steps involve taking three records of data in the Full Save mode and analyzing the data.

1. Erase any pre-existing data in the device memory by pressing “Erase Device Memory” button in the right top on “Communication” window. It will take about a minute for the device to accomplish.
2. Go to the Configuration Screen and change the Data Storage Mode from "Brief" to "Full".
3. Go to the Communication Tab on the InsulGard software and press the "Send Settings From Device Button" to update the current configuration.
4. On the Communications Tab press the "Single Measurement" Button. This should force the InsulGard to make a measurement. You should see "--------" across the InsulGard Display. This process can take as long as 6 minutes. After finishing measurements InsulGard will return to scrolling mode and will be ready for the next measurement.
5. Repeat step 4 two more times
6. Once all measurements are complete, press the "Read The Latest Device Records" Button on the Communication Tab. This will upload all data to the computer.
7. Go to the Configuration Screen and change the Data Storage Mode from "Full" to "Brief".
8. If load sensor on rotating machine is functioning properly check box next to Load% to suspend InsulGard measurements while machine is out of operation.



9. Go to the Communication Tab on the InsulGard software and press the "Send Settings From Device Button" to update the current configuration.
   Failing to return to Brief mode will lead to storing excessive information in the device memory and wasting flash memory resource.
10. Once all machines are done, analyze the data. E-mail database to EEPD if any questions.

APPENDIX

PD system installation Checklist

General

#	Procedure	Result
1	Unpack InsulGard and sensors, verify packing lists and equipment condition	
2	Verify that it is the system designated for the object. Temporal label on the front panel of an InsulGard shows the object name. SN on the InsulGard should coincide with InsulGard SN in database software for this object.	
3	Identify place and way of sensors installation	
4	Identify InsulGard installation place	
5	Verify proper power designated for the InsulGard – no UPS power, beware of autotransformers, use insulating transformer instead if needed.	
6	Proceed with installation and cable termination	
7	**CHECK EXTERNAL GROUND BEING BROUGHT TO THE INSULGARD ENCLOSURE!**	
8	**CHECK GOOD GROUND OF IPDS SENSORS, CHECK COAX CABLE CONNECTION to IPDS SENSORS for proper signal/shield wire connection**	

Sensors installation verification

1. After connecting RTD wires from stator to RTD PD module (RTD In) verify RTD connection and integrity from RTD Out side of the module (right side)

RTD#	Slot#	Contacts	Resistance
1	1	1 & 2	113.7 Ω
		1 & 3	1.7 Ω
3	4	1 & 2	113.8 Ω
		1 & 3	1.9 Ω
9	17	1 & 2	113.5 Ω
		1 & 3	1.5 Ω
11	20	1 & 2	113.6 Ω
		1 & 3	1.4 Ω
17	33	1 & 2	113.9 Ω
		1 & 3	1.8 Ω
19	36	1 & 2	114.1 Ω
		1 & 3	1.9 Ω

After reconnecting RTD wires to temperature metering verify proper reading on customer's metering system -

2. After terminating coax cables from sensors to an InsulGard check resistance at PD signal termination strip between central wire and shield of the PD sensors coax cables:

InsulGard channel	Default sensor	Result	Remark
1	CCA	3	1-3.5 kOhm
2	CCB	3	1-3.5 kOhm
3	CCC	3	1-3.5 kOhm
4	RTD01	0.5	<2 Ohm
5	RTD02	0.6	<2 Ohm
6	RTD03	0.5	<2 Ohm
7	RTD04	0.7	<2 Ohm
8	RTD05	0.6	<2 Ohm
9	RTD06	0.6	<2 Ohm
10	RFCT (if applicable)	0.6	<2 Ohm
11			
12			
13			
14			
15			
16			Normally N/C

3. Auxiliary sensors.

Auxiliary sensor	Resistance between contacts	Result	Remark
Temperature	1 & 2		<=2 Ohm
Temperature RTD 100 Ohm	2 & 3		100-130 Ohm
Temperature RTD 10 Ohm	2 & 3		10-15 Ohm
Current sensor	4 & 5		30-50 Ohm

4. Switch the breaker on (fuse out).
Check power connections on very right Terminal Strip.

Circuit	Voltage between contacts	Result	Remark
Ground	External Ground & 1, 2		0
Neutral	1 & 3		0
Line	1 & 4		115/230 VAC +-10%

Note: If insulating transformer was utilized for power supply, check voltage between Line and Neutral only.

5. Install InsulGard. Restore connections. Plug fuse in:

From InsulGard front panel verify reasonable reading of the temperature - .

Verify reasonable reading of Humidity% -

(Voltage between contacts 6 and 12 should be in 1-4 V DC range)

This will conclude Installation procedure.

Next step will require software with database installed on a computer

Software installation, communication test

1. Software and database **corresponding to the object** have been installed –
2. Communication with the InsulGard through local port verified –
3. Configuration of the database changed to the actual sensors configuration –
4. Updated configuration uploaded to the InsulGard and saved as Back Up -

Calibration/Verification

Prepare monitor by setting calibration configuration - .

Perform calibration/check of the sensors and InsulGard functionality by injecting signal to every sensor from pulse generator.

InsulGard channel	Sensor	Magnitude recorded by Insulgard	
1	CCA		
2	CCB		
3	CCC		
4	RTD01		
5	RTD02		
6	RTD03		
7	RTD04		
8	RTD05		
9	RTD06		
10	RFCT (if applicable)		
11			
12			
13			
14			
15			

Restore monitor configuration -

Nameplate information

Write down nameplate information for the object -

This conclude installation procedure

On energized equipment perform Start Up operations and Base Line Measurements.

Commissioning

Start Up:

1. Software installed, database corresponds to the object -
2. Phase reference measurement performed, phase calculated in accordance with the manuals, phase shift setting uploaded to the InsulGard -
3. Load channel calibration performed at load - xx%
4. InsulGard memory cleared –

Base Line measurements

1. Base line measurements performed in Full Mode –
2. Data downloaded in database –
3. InsulGard set in Brief Saving mode and left for monitoring -

Customer training

1. Install software to the customer computer –
2. Synchronize databases by copying your database to the customer computer -
3. Train customer to operate InsulGard from his computer –
4. Teach how to transfer data -

Prepare and submit the report