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1

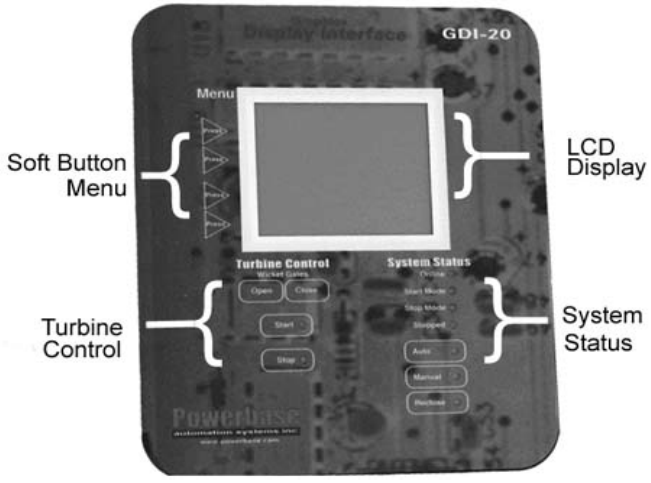
Graphic Display Interface

Introduction

The Graphic Display Interface (GDI-20) is a device that communicates with, and displays information from the various Powerbase™ Modules associated with a **single turbine/generator set.**

The GDI-20 gathers data from all of the Powerbase Modules and displays operation, protection and metering information. The GDI-20 allows the user to view, monitor and control various aspects of the system.

Figure 1-1 Powerbase Graphic Display Interface



GDI-20 Features

GDI-20 Features	
•a menu based device that provides access to each turbine/generator module •displays all monitored alarm/trip and lockout conditions •an LCD display panel offers bright easy to read characters and graphic icons of the system status •large screen area to display multiple system parameters simultaneously	•sealed membrane switches to protect against environmental contamination •Optocom (RS-485) communications bus •provides system status information which includes alarm, trip and lockout conditions as well as RTD data •modifies basic operating parameters such as manual/auto mode, gates/blades position •clearly displays alarm/trip and lockout conditions

The Powerbase Platform

Traditionally, protection and control devices for hydro power generation systems use generic programmable logic controllers (PLCs) or combine control components from several manufacturers. This system requires considerable system integration, and increases hardware and software engineering costs. The cost of developing a PLC based system often exceeds the cost of the control units.

To view a large scale drawing of the Powerbase Platform, please print the following graphics, located on the Powerbase Graphic Display Interface CD-ROM. The drawings are titled as follows:

- Typical Station Communication Overview (station_communications.pdf)
- Single Unit Overview (overview.pdf)

About the Optocom Bus

The are 2 Optocom buses associated with the GDI-20. They are:

- system bus
- global bus

The *system bus* is required on the Powerbase Platform. It transmits and receives data from the GDI-20 *to each of the Powerbase Modules* associated with a single turbine/generator set.

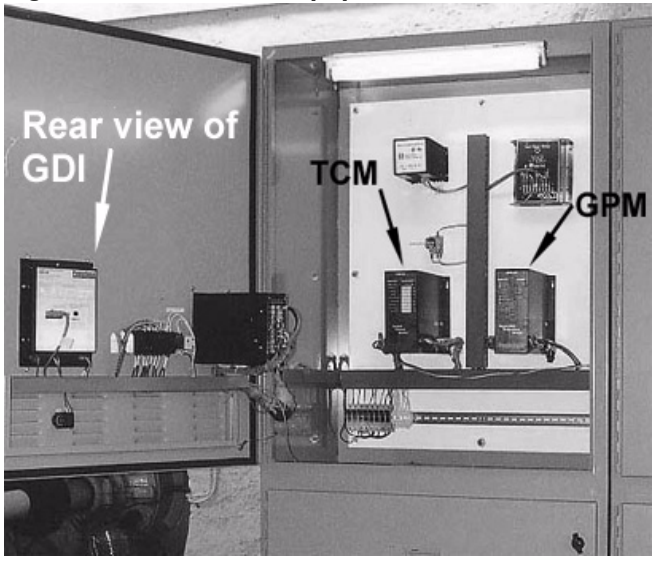
The *global bus* provides communication capabilities to Powerbase Modules that share data with all of the turbine/generator control sets. Global devices include the Powerbase ProSCADA, Water Level Sensors (WRT-20) and the Automatic Telephone Dialer (ATD-20).

The Optocom bus is a RS-485 type bus and optically isolated.

If the system grows, the user can add additional Modules to the global bus structure.

The Modules mount in a standard switchgear cabinet for each turbine/generator set. Connectors on the Modules allows for neat wiring and easy access for maintenance. Figure 1-2 shows a typical installation within a control cabinet.

Figure 1-2 Powerbase Equipment Mounted in a Standard Switchgear Cabinet



The user configures each turbine/generator set by entering specific parameters into the Setup Guide, which runs on a station computer. The setpoints are then downloaded into the Modules. The RS-232 bus enables communications between the station computer and the GDI-20. The system's "expert" software alerts the user to an incorrect parameter value. For more information about the Setup Guide software, refer to the *Powerbase Setup Guide User's Guide*.

About the Powerbase Manuals

All Powerbase guides are organized with the same format to provide you with easy to understand documentation.

Icons

All Powerbase manuals use the same icons to help you operate our products more efficiently and safely.

Note The note icon indicates a further explanation of a key concept.

Tip! The tip icon indicates a short cut to save time.

Caution The caution icon indicates that failing to follow the instructions can damage the equipment.

Danger! The danger icon indicates that failing to follow the instructions will cause injury or death, as well as destroy any equipment.

Glossary

Each Powerbase manual contains a general glossary of terms. These terms include general definitions about hydro power generation as well as specific Powerbase technology. The glossary is found in the final chapter of each manual.

Warranty Information

POWERBASE AUTOMATION SYSTEMS INC. warrants its products against defective materials and workmanship for a period of 12 months from the date of installation or 18 months from the date of shipment by Powerbase, whichever occurs first.

The Warranty is effective from the date of purchase. **POWERBASE AUTOMATION SYSTEMS INC**. will repair or replace, at its option, any product found to be defective (F.O.B. point of manufacturer) during the Warranty period, provided the equipment has been installed, wired, programmed and operated in accordance with the manufacturer's instruction manual included with each unit, and the applicable sections of the Electrical Code.

The Warranty will be invalid if any unauthorized alterations are made to the product, or if the product has been abused or mishandled. Damage due to static discharges will void the Warranty, as will application of voltages or currents outside the specified ratings of the device inputs.

Product Return Procedure

To make a valid warranty claim, you must promptly notify **POWERBASE AUTOMATION SYSTEMS INC.** within the Warranty period and request a Return Goods Authorization (RGA) and complete and return the RGA form. A valid number authorizes the return of this product. This number must appear on all shipping boxes and products must be returned prepaid. Products not returned prepaid or returned without a valid RGA will not be accepted.

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At Powerbase we value your opinion. To help us improve our documentation, please tell us what you like or dislike about our manuals.

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2 Installation

Introduction

The GDI-20 comes fully assembled and ready to be installed. The following parts and materials are included with the GDI-20:

- GDI-20 dimension drawings (refer to Chapter 5 "Technical Information" for a copy of the drawing.)
- 1 global bus connector (user must supply their own cable)
- 1 DB-9 computer cable (CBL-072)
- Power supply cable kit (KIT-012)
- four 4mm (5/32") nuts with lockwashers (attached to the back of the GDI-20)

4 conductor, RJ-11, plug and play cable to connect the Module to the GDI-20 System bus. This cable is available from Powerbase. When ordering this cable, specify the cable length and part # KIT-013.

Tools and Equipment

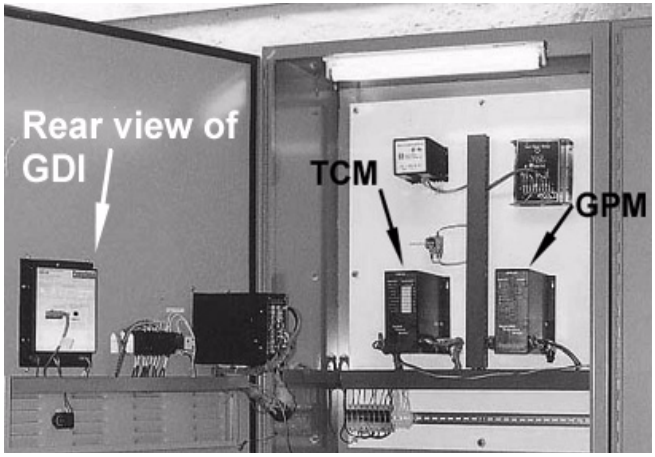
To install and wire the GDI-20, the following tools and equipment are required:

- jigsaw, with metal cutting blade
- drill, 1/4" (6mm) and 3/16"(5mm) (pilot hole size) high speed steel drill bits
- wrench or 3/16" (5mm) nut driver
- masking tape

- flat file
- black marker
- 1” (25mm) plastic lay-in cable trays, or tie wraps and anchors. Double sided adhesive tape may be used to mount the plastic cable tray inside the door.
- shielded, twisted pair wire for the global bus connection. Powerbase recommends 18 gauge or larger for mechanical strength.
- safety goggles

Note The GDI-20 housing protrudes a maximum of 1 3/4” (45mm) into the cabinet space when the cabinet door is closed. When the cabinet door is shut, you must allow some clearance for the GDI-20 and the DB-9 computer cable connection in order to avoid contact with other equipment and wiring inside the cabinet.

Figure 2-1 Correct Cabinet Configuration for GDI-20 and Powerbase Modules



Cutting the Cabinet Door

To mount the GDI-20 in the cabinet door, perform the following steps:

Step 1 Use the supplied drawing to measure and mark the square (which represents the back of the GDI-20) and the four screw holes.

Step 2 Apply masking tape on either side of the cut lines. This prevents scratches on the cabinet door's surface.

Step 3 Drill 4 pilot holes with a 1/4" (6mm) drill bit in all corners of the square. These holes allow you to insert the jigsaw blade to cut out a the square. You may have to use a larger drill bit if your saw blade is wider than 1/4" (6mm).

Step 4 Use a flat file to smooth any rough edges.

Step 5 Set the GDI-20 into the door and fasten with nuts and lock washers. The nuts and lockwashers are attached to the back of the GDI-20.

Connecting the GDI-20

Danger! Before you begin to wire the GDI-20, it is imperative that the cabinet door must be **bonded to earth ground**. Use a ground strap to ground the cabinet to the cabinet housing.

Do not rely on the cabinet door hinges to provide a reliable ground.

Figure 2-2 Back of Cabinet Door

Global Bus Connections

The Global bus allows the SCADA, Water Resource Transmitter (WRT-20) and the Automatic Telephone Dialer (ATD-20) to communicate with each GDI-20 at a power station.

The Global bus can be connected in series or ring. Powerbase recommends a ring configuration. Shielded twisted pair wire is required to connect the Powerbase Modules together.

Note The drain wire of each length of twisted pair wire must be grounded only at one end. This precaution prevents any current from flowing through the shield of the wire in the event of a ground fault.

System Bus Connections

The system bus allows the GDI-20 to communicate with the Powerbase Modules in a single turbine/generator set.

A RJ-11 4 conductor cable plugs into the back of the GDI-20 and connects to the other Powerbase Modules within that cabinet bus. This cable is available from Powerbase. Be sure to specify the cable length and part # KIT-013.

To secure the cable use 1" plastic lay-in cable trays or tie wraps.

Note To ensure the cabinet door opens and closes without causing strain on the cables, allow enough slack so that the cables are not stretched when the door is open or the cables are not too loose when the door is closed. Powerbase suggests that you use a wire loom to bundle the cables.

Power Supply Cable

The power supply cable has three colored wires, green, white and black.

- green - ground
- white - neutral/common connection
- black - fuse holder/AC or DC station supply

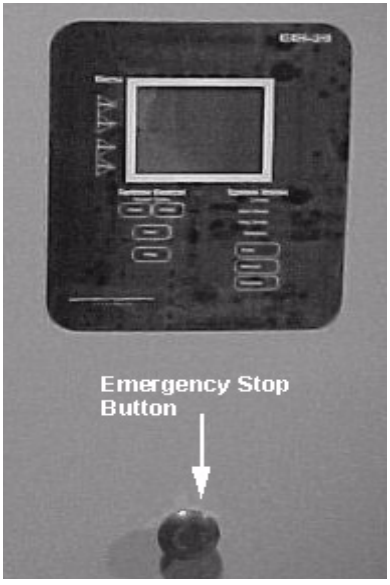
Danger! **Do not ground the wire to the cabinet door.** Use a bonding point, usually located at the back of the cabinet.

The power supply cable plugs into the back of the GDI-20 and connects to the fuse block terminal.

Emergency Stop Button

Powerbase strongly recommends that a normally closed push-to-open Emergency Stop button is installed on the control cabinet under the GDI-20. The normally closed contacts should be wired in series with the HPU dump valve/protection circuits.

Figure 2-3 Emergency Stop Button on Door of Standard Cabinet



Fuses

Powerbase recommends 2A slow-blow fuses for the GDI-20 power supply. We strongly recommend that you use individual fuses for each Module, otherwise when a fuse blows, all the affected Modules go offline, rather than a single Module.

A disconnecting type fuse holder is recommended because it allows the power to be disconnected for any repairs.

Turning on the GDI-20

The GDI-20 does not have a ON/OFF button. Once power is applied, the unit automatically turns on. Once power is established, the GDI-20 displays an initializing screen.

Note The GDI-20 does not need to be connected to any Powerbase Modules to verify that it is **ON**.

All Powerbase Modules should be connected and operational (power applied) in order for the GDI-20 to correctly configure the system. When the GDI-20 is turned on, the screen displays the software version and the Powerbase Modules that are installed in the system.

Cleaning and Care for the GDI-20

The following is a list of tips to clean and maintain the GDI-20:

- don't press the LCD screen.
- keep liquids away from the GDI-20.
- to clean the GDI-20, spray some window cleaner onto a cloth and then wipe the GDI-20.
- do not spray the cleaner directly at the GDI-20, this may damage the GDI-20.
- gently press the soft button menus.
- vacuum the cabinet monthly, especially the top of the cabinet, near the intake vent.
- tighten screws on the GDI-20 monthly.

3 Navigation

Introduction

The Graphic Display Interface (GDI-20) is a display device that communicates with, and displays information from the various Powerbase™ Modules associated with a **single turbine/generator set.**

The GDI-20 is an easy to use menu based device that provides access to all Powerbase Modules. The GDI-20 gathers data from all of the Powerbase Modules and displays all the information in a menu format as well as the systems running status. The GDI-20 allows the user to view, monitor and adjust all aspects of the system.

The GDI-20 uses the Optocom (RS-485) interface bus to connect all of the Powerbase Modules.

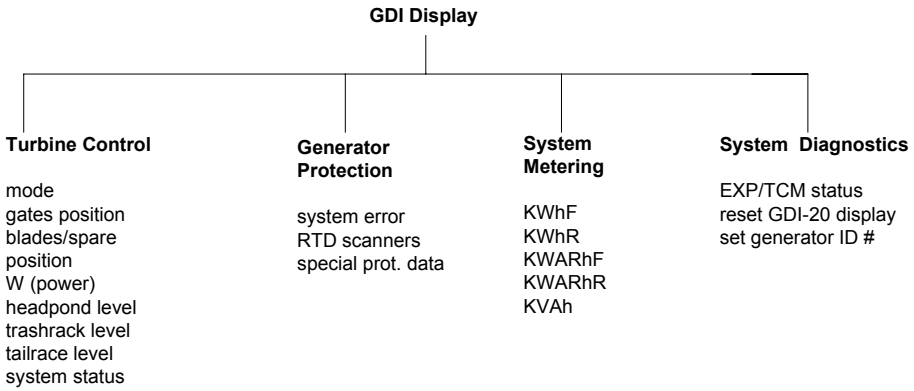
Danger! The control buttons on the GDI-20 can start operational status of the turbine. Before any work is performed on the turbine, generator, or wiring, **the equipment must be locked out.** The turbine could unexpectedly start, causing harm to the user or equipment. For more information about lockout conditions, refer to chapter 4 "Alarms and Trips."

GDI-20 Menus and Submenus

The GDI-20 reads and displays data from the various Powerbase Modules. Each menu is accompanied by a submenu.

Figure 3-1 illustrates the functions of the GDI-20 menus and submenus. The tables throughout this chapter describe in detail the information displayed in each submenu.

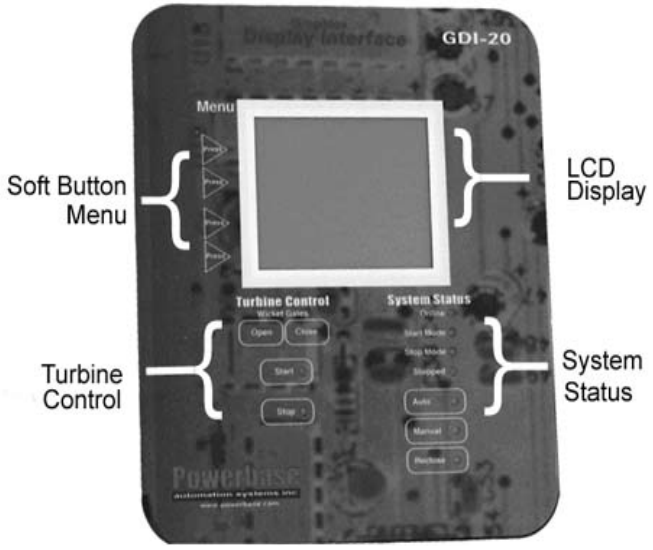
Figure 3-1 GDI-20 Menus and submenus



The GDI-20 is divided into 4 areas:

- LCD display
- soft button menu
- turbine control
- system status

Figure 3-2 Powerbase Graphic Display Interface



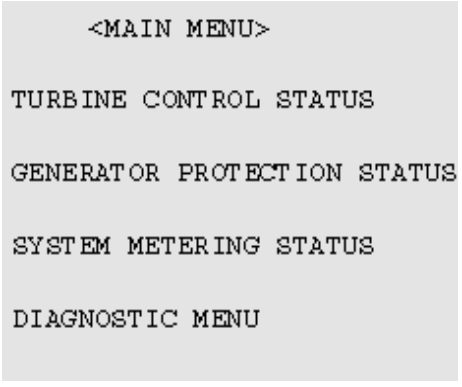
Soft Button Menus

The system menu is located on the left side of the GDI-20 and consists of the following submenus:

- turbine control
- generator protection
- system metering
- system diagnostics
- commissioning mode

To access each menu, press the button located on the left hand side of the screen. A black arrow points to the soft button associated with each function.

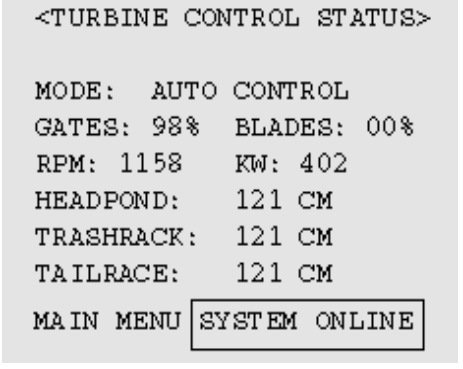
Figure 3-3 GDI-20 Main Menu



Turbine Control Menu

The turbine control menu gathers information from the Turbine Control Module (TCM) and displays the information required to operate the turbine.

Figure 3-4 GDI-20 Turbine Status Menu



The user presses the Turbine Control menu button to scroll through the various settings. Table 3-1 outlines the turbine menu information.

Table 3-5 Turbine Control Status

Display	Description
Mode	Indicates the control status of the turbine. There are 6 different types of modes: **Standby** - Indicates that the system is offline and awaiting a startup command. **Aligning Blades** - For double regulated turbines, the runner blades are aligned to the startup position before the wicket gates are opened. **Starting** - Indicates that the wicket gates are opening from a stand still state. **Manual Set** - Displays the wicket gate setpoints in percentage. The user is free to adjust the gates position using the **Gates Open** and **Gates Close** buttons on the GDI-20. I**ncrease/Decrease Power** (TCM-40 only) - Adjusts the turbine/generator real power setpoint (1% increments) of the generator rating. **Auto Control** - The turbine runs automatically based on the desired headpond level entered by the user. When water levels are too low, the system shuts down. Once water levels return to the startup level, the system automatically restarts. **Stopping** - Indicates the turbine is stopping.
Gates	Displays the percentage that the turbine gates are open. 97% indicates that the gates are 97% open.
Blades/SPARE	Indicates the position of the blades for double regulated machines, or second wicket gate for double wheel Francis turbines.
RPM	Indicates turbine's current revolutions per minute. **This input sensor is required and failing to install it results in a tachometer fail trip.** For more information about a tachometer trip refer to Chapter 4 "Alarms and Trips."
W	Indicates the generator output wattage. Requires a GPM-40 to display the data on the GDI-20.
Headpond	Indicates the level in centimeters of the headpond from the bottom of the water level sensor (WLS). If no sensor is installed, the GDI-20 displays 2 dashes.
Trash Rack	Indicates the level in centimeters of the trashrack from the bottom of the water level sensor (WLS). If no sensor is installed, the GDI-20 displays 2 dashes.
Tailrace	Indicates the level in centimeters of the tailrace from the bottom of the water level sensor (WLS). If no sensor is installed, the GDI-20 displays 2 dashes.
System Status	Indicates the status of the turbine/generator set: •**online mode** - unit is online, breaker closed •**start mode** - unit is moving from standstill to speed no load. •**stop mode** - unit is moving from online to standstill. •**stopped mode** - unit is at standstill

Generator Protection Status Menu

The generator protector status menu gathers information from the Generator Protection Module (GPM-40), the Transformer Protection (TPM-30) and displays the information required to protect the generator from thermal or electrical damage.

Figure 3-6 GDI-20 Protection Menu

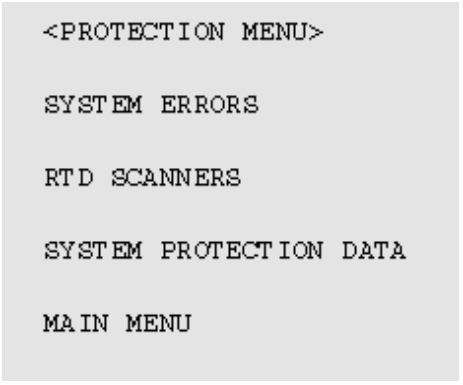


Table 3-7 outlines the protection menu information.

Table 3-7 Protection Menu

Display	Description
System Errors	Displays DPM or GPM errors. Used to reset the last error. Once the reset button is pressed, the last error status displays the message **PROTECTION OK.**
RTD Scanners	Allows the user to view the GPM and DPM RTD status. Each screen displays the temperature and alarm conditions of 10 RTD channels in degrees Celsius. The Transformer Protection Module (TPM) requires a dedicated GDI-20, therefore only TPM and RTDs are displayed in this mode.
System Protection Data	Displays voltage and current information of the DPM and GPM.

Metering Status Menu

The metering status menu displays real time values of produced and consumed energy.

Figure 3-8 GDI-20 System Metering Menu

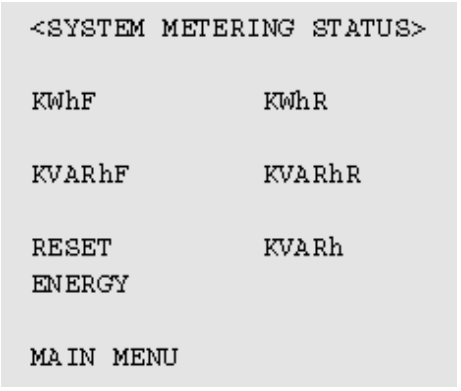


Table 3-9 outlines the metering information.

Note The metering data is derived from the GPM's protection PT/CTs and is not revenue quality.

Table 3-9 GDI-20 Metering Menu

Display	Description
KWhF (Kilowatt Hours Forward)	The amount of energy produced (exported) since the last reset.
KWhR (Kilowatt Hours Reverse)	The amount of energy consumed since the last reset.
KVARhF (Kilovolt Hours Forward)	The amount of reactive energy produced by the generator.
KVARhR (Kilovolt Hours Reverse)	The amount of reactive energy consumed (i.e., heating/lighting loads)
KVAh (Kilovolt-Amp Hours)	The net amount of energy produced, not considering the power factor.

Tip! Press the **Reset Energy** button to reset all of the metering data to zero.

System Diagnostic Menu

The System Diagnostic screen allows the user to access helpful diagnostic functions.

Figure 3-10 System Diagnostic Menu

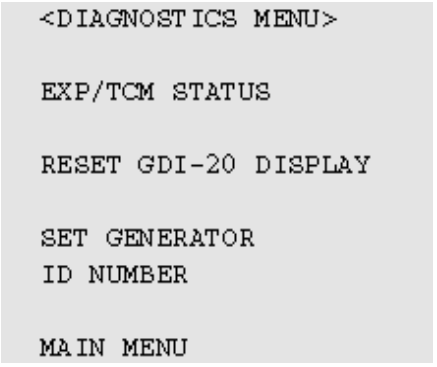


Table 3-11 outlines the diagnostic information.

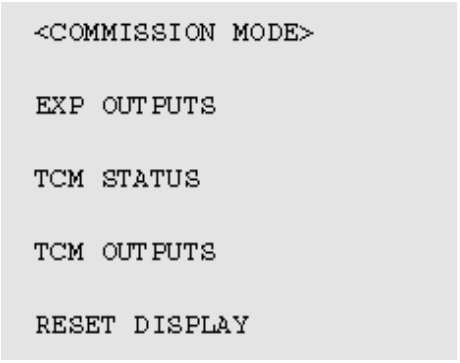
Table 3-11 System Diagnostic Display

Display	Description
EXP/TCM status	Displays the TCM Auto Mode, and the EXP inputs and outputs. The TCM Auto Mode displays the following information: **Tolerance** - **IN** indicates the water level is between the upper and lower limits. **OUT** indicates the water level is outside of the range. **Trend** - Indicates whether the water level is trending towards or away from the setpoint. **Stalled** indicates no change in headpond level. **Level Timer** - Indicates the amount of time that has passed since the last time the water level registered any change. Displayed in minutes. **Change Window** - Indicates how extreme the gate reaction will be for the next change in water level away from the setpoint. The higher the percentage, the more the gates will move. The further out of tolerance, the larger the value. **H.P. Readings** - Indicates an average headpond depth over the past 30 seconds. The GDI-20 displays the last 3 readings, and uses the middle of the 3 readings. The TCM uses the middle and last reading to calculate whether the water level is rising or falling.
Reset GDI-20 Display	Clears the display and resets the screen. An initiating screen appears during a start up sequence. The system performs a self diagnostic check and verifies communication with all Powerbase Modules.
Set Generator ID number	The generator ID number allows communication with up to 8 turbines in a single station. In a single turbine/generator system the ID number must be set to 1. In multiple turbine/generator systems the turbine/generator assigned ID #1 must be connected to the station computer in order to program it with the Powerbase Setup Guide software as well to monitor it with the Powerbase ProSCADA software. Each additional turbine/generator set must be numbered in succession. i.e. Gen. #1 = ID #1, Gen. #2 = ID #2, Gen. #3 = ID# 3.

Commission Mode

The Commission Mode screen is used to test external wiring to the Powerbase Modules.

Figure 3-12 GDI-20 Commission Mode Menu



To access the commission screen, perform the following steps.

Step 1 Set the GDI-20 to the main menu.

Step 2 Use four fingers to press down and hold on all of the soft menu buttons at the same time.

Step 3 Wait until COMMISSION MODE appears on the screen. Select the Module(s) you wish to check.

Note The Commission Mode screen is designed to be difficult to access so that you do not accidently enter the Commission Mode.

Table 3-13 outlines the commission information.

Danger! Use extreme care when operating in the Commission Mode.

Table 3-13 Commission Mode Functions

Display	Description
EXP Outputs TCM Status TCM Outputs	Allows the user to view current input status and toggle ALL digital outputs including excitation and breaker status.
When operating in **Commission Mode**, the following GDI-20 button functions are re-configured as follows: **Gates Open button**- causes hydraulic system to open the gates (until the button is released). **Gates Close button** - causes hydraulic system to close the gates (until the button is released). **Start button** - causes hydraulic system to open blades (until the button is released). **Stop button** - causes hydraulic system to close the blades (until the button is released).	
Reset Display	Resets the display and returns the user to the main menu.

Turbine Control/Wicket Gates (TCM-30/40)

The Turbine Control/Wicket Gates control is located on the left hand side of the GDI-20, below the LCD screen. Table 3-14 outlines the turbine control/wicket gate information.

Table 3-14 Turbine Control/Wicket Gates Display

Display	Description
Wicket Gates Open/Close TCM-30/40	Adjust the position of the wicket gates while the generator is online. In order to adjust the wicket gates, the generator must be in **MANUAL** Mode. Pressing these buttons at any other time, has no effect. 0% indicates the gates are completely closed, while 100% indicates the gates are completely open.
Power setpoint increase/decrease (TCM-40)	The TCM-40 provides the additional function of real power (W) setpoint control. Press the **AUTO** Mode button to toggle between headpond level and power control
Start button	The Turbine Control Module is initiating a start sequence.
Stop button	Initiates a soft shutdown (SSD) of the turbine.

⚠

Caution Powerbase strongly recommends that a series wired, normally closed, push to stop **Emergency Stop** button is installed near the GDI-20 system. The Emergency Stop button should be series wired with the hydraulic dump valve/protection loop circuit.

System Status

The System Status display and buttons are located on the right hand side of the GDI-20, below the LCD screen. Table 3-15 outlines the system status information.

Table 3-15 System Status Display

Status	Description	Display
Online	Indicates the system is operating online, the unit breaker is closed.	Green light. The light turns off when the system is offline.
Start Mode	The system is initiating a start condition.	Green light during synchronizing. Red light is on when the unit breaker is open and the turbine is rotating.
Stop Mode	The system is stopping.	Red light. The light turns off when the system is stopping.
Stopped Mode	The system has stopped.	Red light is on when the turbine is at rest.
Auto Mode Selection #1 (TCM-30/40)	The system automatically adjusts the headpond levels according to the information entered by the user in the Setup Guide.	Yellow light.
Auto Mode Selection # 2 (TCM-40 only)	The system maintains the real power level selected by the user.	Yellow light.

Table 3-15 System Status Display (continued)

Status	Description	Display
Manual Mode (TCM-30/40)	The system maintains the gate position set by the user. The generator stops if the headpond level falls below the minimum level set by the user in the Setup Guide.	Yellow light.
Reclose Mode	Allows the system to automatically restart in the event of most trip conditions. A re-start occurs after the reclose period has elapsed and if the re-start attempt is less than the maximum number of re-start attempts programmed in the Setup Guide. For more information about trips, refer to Chapter 4 “Alarms and Trips.”	Yellow light

4

Alarms and Trips

Introduction

The Powerbase™ Platform is designed to alert the user of alarm, trip, lockout or fault conditions in order to prevent damage to the system.

Before commissioning a system, the user employs the Setup Guide software to enter trip or lockout parameters into the system. This data is saved into the various Powerbase Modules. When the limit of a system parameter is reached, the system automatically alerts the user.

Table 4-1 Condition Definitions

Condition	Definition
Alarm	Acts as a warning to the user about a problem with the system. The problem is not severe enough to shut down or damage the system.
Trip	Occurs when the system exceeds one of the trip parameters set by the user in the Setup Guide. A trip shuts down the system.
Lockout	Warns the user of a fault condition which must be corrected before the user can restart the turbine.
Fault	Warns the user of a condition which must be corrected **before** the user can resume use of the Turbine Control or System Status menu options.

Alarms

An *alarm* acts as a warning to the user about a problem with the system. The problem is not severe enough to shut down or damage the system. An alarm message appears on the screen until the user accepts the alarm. Table 4-2 outlines the types of alarms and their cause(s).

Table 4-2 Alarms

Alarm	Cause(s)	Remedy
Brakes Malfunction	•The generator brakes are not engaging and releasing. •Insufficient hydraulic pressure. •Faulty wiring. •Faulty feedback switch.	•Adjust regulator setting. •Lubricate the mechanism. •Correct any wiring problems and verify that the correct voltage is applied. •Adjust the position of the feedback switch. If the problem continuous, replace the switch.
Cooling Filter	•The water cooling filter is plugged and needs to be cleaned or replaced. •Faulty wiring •Defective switch.	•Clean and re-install the cooling water filter. Replace if necessary. •Correct any wiring problems and verify that the correct voltage is applied. •Replace the filter detection switch.
Dump Valve Not Closed	•The protection equipment is tripped elsewhere in the turbine/generator set. •Blown fuse. •The Emergency Stop button was pushed. •Faulty wiring.	•Check each piece of protection equipment for alarms/trips. •Replace fuse. •**Ensure nobody is working on the equipment**, then pull out the Emergency Stop button. •Check the wiring for the dump valve circuit, especially the wiring around the door hinge. Repeated opening and closing of the door may damage the wires.

Table 4-2 Alarms (continued)

Alarm	Cause(s)	Remedy
EXP-30 Digital Input #1-24	•The EXP-30 Module detects an alarm in the designated input. •An actual alarm condition may exist, as programmed into the EXP-30. •The incorrect information was entered with the Setup Guide software. •Faulty wiring.	•Verify that the sensor or the equipment is properly connected to that input. •Adjust the information with the Setup Guide software and download the new information into the TCM-30/40. •Correct any wiring problems and verify that the correct voltage is applied.
EXP-30 Analog Input #1-3	•The EXP-30 Module detects an alarm condition on the affected input. •The incorrect information was entered with the Setup Guide software. •Faulty wiring.	•Verify that the sensor or the equipment is properly connected to that input. •Adjust the information in the Setup Guide software and download the new information into the TCM-30/40. •Correct any wiring problems and verify that the correct voltage is applied.
Governor Error	•The external governor indicates an alarm. •Faulty wiring. •The incorrect information was entered with the Setup Guide software.	•Correct the alarm on the governor equipment. •Correct any wiring problems and verify that the correct voltage is applied. •If a governor is not installed, ensure that the “governor turbine type” selection in the Setup Guide is **not** selected. If you make changes with the Setup Guide, download the new information into the TCM-30/40.

Table 4-2 Alarms (continued)

Alarm	Cause(s)	Remedy
Headpond Differential	•The water level between the headpond and trashrack sensors has triggered an alarm. •Debris in the trashrack blocks the water intake to the power station. •The incorrect information was entered with the Setup Guide software. •Faulty wiring. •Faulty water sensor.	•Clear debris from the trashrack to improve water flow. •Adjust the high headpond level alarm in the Setup Guide and download the new information into the TCM-30/40. •Correct any wiring problems and verify that the correct voltage is applied. •Adjust the position of the water level sensor. Replace any damaged sensors.
Headpond Level Low	•The water level in the headpond is too low to start the turbine. •The headpond minimum level setpoint in the Setup Guide program is too high. •Faulty sensor.	•Adjust the bypass channels or stop any other turbine(s). •Use the Setup Guide software to adjust the minimum setpoint to a lower level and download the new information into the TCM-30/40. **Ensure that you are allowed to change the levels without violating any conservation agreements or causing flooding to nearby houses/buildings.** •Adjust the position of the water level sensor. Replace any damaged sensors.

Table 4-2 Alarms (continued)

Alarm	Cause(s)	Remedy
High Headpond Level	•The headpond level has reached the maximum setpoint. •Other generators have shut down and do not operate at a high enough power level. •The incorrect information was entered with the Setup Guide software. •Faulty wiring. •Faulty water sensor.	•Ensure that a sufficient amount of water is flowing through or around the power station in order to avoid high levels at the headpond. •Adjust the headpond level alarm in the Setup Guide and download the new information into the TCM-30/40. •Correct any wiring problems and verify that the correct voltage is applied. •Reposition or replace the water sensor.
Low Water Pressure	•The cooling water pressure is too low. •Inlet valves not fully open. •Water filter is plugged. •Defective pressure switch. •Faulty wiring.	•Ensure that all inlet valves are completely open. •Replace filter. •Adjust or replace switch. •Correct any wiring problems and verify that the correct voltage is applied.
No Headpond Sensor	•The headpond sensor does not register a signal. •Power to the WRT is disconnected or a fuse has blown. •Global bus is disconnected from the GDI-20. •Faulty wiring. •Auto Mode is selected when no headpond sensor is installed. •Incorrect jumper setting in WRT.	•Reset the circuit breaker, or replace the fuse. •Unplug the connector for the Global bus back and then plug it back in. •Correct wiring problems, including Global bus and sensor cables. Verify that the correct voltage is applied. •Auto Mode only works when a headpond sensor is installed. If no sensor is installed, use **Manual Mode.** •Adjust the jumper for the headpond sensor to **Enable**.

Table 4-2 Alarms (continued)

Alarm	Cause(s)	Remedy
No Trashrack/Tailrace Sensor	•The trashrack and/or tailrace sensors do not register a signal. •Power to the WRT is disconnect or a fuse has blown. •Global bus is disconnected from the GDI-20. •Faulty wiring •Fault jumper setting in WRT.	•Reset the circuit breaker or replace the fuse. •Unplug the connector for the Global bus back and then plug it back in. •Correct wiring problems, including Global bus and sensor cables. Verify that the correct voltage is applied. •Reposition or replace the water level sensor. •Adjust the jumper for the headpond sensor to **Enable**.
Oil Contamination	•The HPU oil filter is plugged. •Defective pressure switch. •Faulty wiring.	•Adjust or replace the contamination switch. •Check the wiring and verify that the correct voltage is applied.
Shear Pin Broken	•The shear pin is broken. •Faulty wiring. •Incorrect programming of the Setup Guide.	•Replace the shear pin. •Check the wiring and verify that the correct voltage is applied. •Ensure that the “shear pin” selection in the Setup Guide is not selected.
Water Coolant Fault	•The water supply inlet may be shut off. •The cooling water flow switch may be wired incorrectly or is defective. •Insufficient water pressure.	•Check all input valves and filters. •Correct any wiring problems and verify that the correct voltage is applied. •replace any defective switches. •Clean intake filter, make sure the valves are completely open.

Table 4-2 Alarms (continued)

Alarm	Cause(s)	Remedy
Water Maintenance Gate	•The water maintenance gate is not operating correctly. The message may appear during normal operation of the gate. •Opening/closing operation is taking too long. •Faulty limit switches. •Faulty wiring.	•The alarm alerts the user that the gate is in the process of opening or closing. The message disappears when the gate is fully opened/closed. •Check the gate for the correct opening/closing speed. Lubricate if necessary. •Correct any wiring problems and verify that the correct voltage is applied.

Trip Conditions

A *trip* occurs when the system exceeds one of the trip parameters set by the user in the Setup Guide. A trip shuts down the system.

Turbine Control Module Trip Conditions

TCM-30/40 trip or lockout conditions alert the user to specific problems relating to the operation of the turbine. Table 4-3 outlines the trip conditions, the cause, remedy and re-start procedure for each condition.

Table 4-3 Turbine Control Module Trip Conditions

Trip	Cause(s)	Remedy
If you need to make repairs to any of the wires or equipment, refer to the specific User's Guide for detailed instructions.		
Coolant Flow Switch	•No coolant flow was detected at the bearings (Ch. 6, J12). •One of the water supply solenoids may be off. •Flow switches may require repairs or a filter may be blocked in the pipe system.	•Check the flow switches for proper operation such as blocked filters or valves that cannot completely open. •Verify that both the main and auxiliary supply valves are working.

Table 4-3 Turbine Control Module Trip Conditions (continued)

Trip	Cause(s)	Remedy
EXP-30 Analog Input #1-3	•The EXP-30 detects a soft shutdown or an Emergency Shutdown condition. An actual trip condition may exist, as programmed into the EXP-30. •Incorrect EXP-30 programming. •Faulty wiring.	•Check the sensor/equipment that is connected to the input. •Adjust the parameters with the Setup Guide software. Download the new information into the TCM-30/40. •Inspect wiring and connectors for loose or damaged connections. Verify that the correct voltage is applied.
EXP-30 Digital Input #1-24	•The EXP-30 detects a soft shutdown or an Emergency Shutdown condition. An actual trip condition may exist as programmed into the EXP-30. •Incorrect EXP-30 programming. •Faulty wiring.	•Check the sensor/equipment that is connected to the input. •Adjust the parameters with the Setup Guide software. Download the new information into the TCM-30/40. •Inspect wiring and connectors for loose or damaged connections. Verify that the correct voltage is applied.
Gates Below Offline	•The setpoint programmed into the TCM-30/40 with the Setup Guide is too low. •The HPU does not allow the gates to open properly. •Debris stuck in wicket gate.	•Enter a lower value with the Setup Guide software. Download the updated information to the TCM-30/40. •Check the HPU valve connections on the TCM-30/40. •Check the HPU wiring and valve operation. •Check the HPU pressure. •Clear the debris from the gates.

Table 4-3 Turbine Control Module Trip Conditions (continued)

Trip	Cause(s)	Remedy
Generator Overspeed	•The RPM of the generator exceeded the setpoint programmed with the Setup Guide. •The generator breaker failed to close when requested. •Hydraulic problem caused the gates to open to far. •The excitation system shut down.	•Check fuses on the breaker, or any additional hardware (timers, etc.) for the correct operation. •Check that stored energy in the breaker is charged. •Check the HPU wiring and operation. Check the HPU's pressure and valves. •Check fuses and wiring of the excitation system. Also check the brush conditions on the generator.
Headpond Differential	•The water level between the headpond and the trashrack has reached the level which causes a trip. •Debris in the trashrack blocks the intake to the power station. •Incorrect programming. •Faulty water sensor. •Faulty wiring.	•Clear debris from the trashrack. •Adjust the headpond differential trip setpoint with the Setup Guide software. Download the new information into the TCM-30/40. •Reposition or replace the water level sensor. •Inspect wiring and connectors for loose or damaged connections. Verify that the correct voltage is applied.
Headpond Level Low	•The headpond water level is too low to start the turbine.The level entered with the Setup Guide is too high. •The sensor was not set deep enough. •The WRT has not received a signal.	•Adjust the setpoint level with the Setup Guide and download the information into the TCM-30/40. •Adjust the depth of the sensor. Use the GDI-20 to display the level. •If the WRT was recently activated, allow 30 seconds for the WRT to produce a water level update.

Table 4-3 Turbine Control Module Trip Conditions (continued)

Trip	Cause(s)	Remedy
Headpond Sensor Fail	•The headpond sensor does not produce a reading. •No power to the WRT. •Faulty wiring. •The Global bus is disconnected. •Breather tube may be blocked.	•Verify that the LED inside the WRT-20 or WLS-11 is lit. If not, check the fuse. •Inspect indoor and outdoor sensor wires. Replace any damaged wires. •Check for moisture inside the pull boxes. Replace the seals around the lid. If moisture continues to enter the boxes, replace the sensor. •Remove and then plug-in the Global bus connector. •Inspect the breather tube. Replace, if damaged.
Hydraulic Oil Low	•The HPU's oil reservoir level is low. •Faulty wiring/switch.	•Add oil. Allow room in the tank for the cylinder rod volume. When the hydraulic pressure is activated, this prevents the tank from overflowing. •Inspect wiring between the TCM-30/40 and level switch of the HPU. Check the wires in the electrical connector or on the sight glass on the HPU.
Incomplete Sequence	•A function required for starting/stopping the turbine failed to complete within the time allotted.	•Restart the turbine to identify which process is failing to complete a start/stopping sequence.

Expansion Module Trip Conditions

The Expansion Module allows the user to create specific functions that are unavailable with the TCM-30/40. For more information about the Expansion Module, refer to the *Powerbase Expansion Module User's Guide* and the *Powerbase Setup Guide User's Guide.*

Protection Module Trip Conditions

The protection Modules each display the same error messages to alert the user of a trip or lockout condition. These Powerbase Modules include:

- Generator Protection Module (GPM-30)
- Differential Protection Module (DPM-30)

- Transformer Protection Module (TPM-30)

Table 4-4 outlines the trip conditions.

Note Depending on how the user creates system parameters with the Setup Guide software, some conditions can be set as a **lockout** rather than a self-setting trip.

Table 4-4 Protection Module Trip Conditions

Trip	Cause
The trip conditions not listed in this table fall under IEEE Std. 37 102 1995. Refer to the standard located in Chapter 5 "Technical Information" for more information.	
Processor Failure	•Indicates a problem within the processor of the Module. Remove the power fuse for 5 seconds then re-install it.
GPM-30 Initializing	•Wait until the GPM-30 has finished initializing.
GPM-30 is being programmed	•The Module parameters and setpoints are being down-loaded into the GPM-30.
No VA zero crossing signal	•Turbine at zero speed. •Excitation system failure.
Phase 1/2/3 at zero volts	•defective VT fuse.
Phase Rotation Test	•Incorrect phase wiring. Only A-B-C is allowed.
Breaker status false off/on.	•defective breaker status contactor.
Reverse Power	•Indicates the generator begins to draw power from the bus and exceeds the reverse power programmed set-point.
Under Impedance	•Generator V/I less than setpoint.

Table 4-4 Protection Module Trip Conditions (continued)

Trip	Cause
User Trip #1-4	•Indicates an external device signaled a trip condition on the specific User Trip #.
RTD #1-10 Trip	•Indicates the RTD channel # temperature exceeded the programmed setpoint.
GPM-30 Not Calibrated	•Indicates the GPM-30 is no longer calibrated. This condition occurs when the memory backup battery fails. Refer to the *Powerbase Generator Protection Module User's Guide* for more details.
RTD Channel In Alarm/Trip	•Indicates the specified RTD channel has exceeded the setpoint temperature.
User #1-4 Alarm	•Indicates an external device signaled an alarm condition on the specific User Alarm #.

5

Technical Information

Function/User Interface	
•controls all TCM-30/40 user functions from front panel mounted, sealed membrane switch keypad •displays operating status of Powerbase Modules within local switchgear cabinet •LCD graphics panel, 160 X 120 pixels •LCD backlight •LED turbine status indicators	
Isolation/Communications	
•high voltage isolated, optically coupled proprietary Optocom (RS-485) communication interface between Powerbase Modules •1500 VAC high potential test isolation between bus and module •all logic circuits are ground potential	
General	
supply voltage	•world universal; 100 to 240 VAC, 50/60 Hz or 110 VDC to 340 VDC
power supply current	•0.4amp, AC or DC
operating temperature	• -10°C to 50°C, ambient air
storage temperature	• -20°C to 75°C
humidity	•0 to 95% non condensing, conformally coated circuits
EMC/Transient Protection	•meets European EMC directive 1997, including radiated, conducted and immunity to EMC and electrical fast transients (IEC 901 and CISPR 11 and 14)
shipping weight	•less than 2 kg

IEEE Std. 37-102-1995 AC Generator Protection

6. Protection Specification

This clause presents detailed protective arrangements for six generating station configurations.There is a one line diagram for each station configuration.A typical control logic diagram for the unit generator-transformer connection illustrates the combination of protective relays, with their control functions, normally applied in accordance with good engineering practices. The intent of these diagrams is to illustrate one approach for providing protection. The reader can modify the protection provided to meet his particular protective philosophy and reliability requirements. While it is generally agreed that the unit is tripped, steam system is shutdown and auxiliaries are transferred for internal electrical faults, there is no generally agreed on approach for condition items such as volts/hertz, underfrequency, etc. See IEEE Std 502-1985 for further discussion. The protection of combustion turbine generators (CTG) is quite similar to the protection of steam turbine generators. There are, however, certain differences in the design and application of CTGs that may result indifferent protection requirements. Since many CTGs are unmanned stations, control systems provide automatic protection. Figure 6-6 shows the recommended protection for a CTG.

6.1 Protective Arrangements

A number of factors will determine the selection of a protective scheme for 100% stator ground, generator breaker failure and inadvertent energizing. To simplify the one-lines, examples of these schemes were not shown. These protective functions should be applied after considering factors described in the following related subclauses:

- 100% stator ground (4.3.3)
- Generator breaker failure (4.7)
- Inadvertent energizing (5.4)

Due to space restrictions, the figures do not incorporate external timers in all cases. Refer to appropriate clauses within the guide for timer applications.

6.2 Protective Functions

The protective functions noted in the various generating station configurations provide both primary and backup protection for the generating station as well as additional protection schemes which could also be applied. These protective functions are listed below with a reference to the subclause in the text that discusses their application in detail. Also included is a discussion of the various tripping modes used in generating stations.

Table 5-1 Protective Devices

Device	Function	Subclause
21	Distance relay. Backup for system and generator zone phase faults. Device 21 4.6.1 requires a time delay for coordination.	4.6.1
24	Volts/hertz overexcitation protection for the generator and its associated step-up 4.5.4 and auxiliary transformers.	4.5.4
27	Undervoltage relay.	4.3.3.1
32	Reverse-power relay. Motoring protection.	4.5.5
40	Loss of field protection.	4.51
46	Stator unbalanced current protection. Negative sequence relay	4.5.2
49	Stator thermal protection.	4.1
50N	Instantaneous overcurrent relay used as current detector in a breaker failure scheme.	4.7
50/51	Time overcurrent relays with instantaneous element. High-side bank overcurrent relays providing phase-fault protection for unit auxiliary transformer and backup protection for failure of UAT low-side bank breaker.	
50/51GN	Time overcurrent relay with instantaneous element. Primaryand/or backup 4.3.3.1.1 protection for generator ground faults.	4.3.3.1.1
51	Time overcurrent relay. Detection of turn-to-turn faults in generator windings.	4.3.2
51TN1	Time overcurrent relay. Provides backup protection for transmission ground 4.6.2faults when applied to GSU neutral. Protects for ground faults on the unit 4.6.4 auxiliary bus when applied to UAT neutral.	4.6.2
51TN2	Time overcurrent relay when applied to GSU neutral. Protects for faults in the low-side of the UAT 4.6.4 down to the low-side bank breaker when applied to UAT neutral. Provides backup for failure of low-side breaker to trip.y. Provides backup protection for GSU ground faults	4.6.4

Table 5-1 Protective Devices (continued)

Device	Function	Subclause
51 UAT	Time overcurrent relays connected to current transformers in UAT low-side bank breaker. Protects for phase faults on unit auxiliary bus.	4.6.1
51V	Voltage controlled or voltage-restrained time overcurrent relay. Backup for 4.6.1 system and generator zone phase faults.	4.5.4.4
53	Exciter or DC generator relay.	4.5.6
59	Overvoltage protection.	4.3.3
59BG	Zero-sequence voltage relay. Ground fault protection for an ungrounded bus.	
59GN	Voltage relay. Primary ground fault protection for a generator.	4.3.3
60	Voltage balance relay. Detection of blown potential transformer fuses. 5.2.1.1	5.2.1.1
62B	Breaker failure timer.	4.7
63	Fault pressure relay. Detects transformer faults.	4.9.2
64F	Voltage relay. Primary protection for rotor ground faults.	4.4
71	Transformer oil or gas level.	4.9.1
78	Loss of synchronism protection. This protection is optional. Applied when, 4.5.3during a loss of synchronism, the electrical center is in the step-up transformer or in the generator zone. Alternate locations are shown for this protection. A study should be made to determine which location is best for the detection of an out-of-step condition.	4.5.3
81	Frequency relay. Both under frequency and overfrequency protection may 4.5.7 be required.	4.5.7

Table 5-1 Protective Devices (continued)

Device	Function	Subclause
86	Hand-reset lockout auxiliary relay.	
87B	Differential relay used for bus protection.	
87G	Differential relay. Primary phase-fault protection for the generator.	4.3.2
87GN	Differential relay. Sensitive ground-fault protection for the generator.	4.3.3.2
87T	Differential relay. Primary protection for the GSU or UAT transformer. May be used to provide phase fault backup for the generator in some station arrangements. The zone may be extended to cover the generator bus using cts from the generator and Unit Auxiliary Transformer when lowside cts are not available.	
87U	Differential relay for overall unit and transformer.	

6.2.2. Tripping Modes

Table 5-1 is an example of the trip logic for protective devices on a unit generator-transformer. It provides guidance in developing a generator protection trip scheme. Individual trip scheme logic will vary, dependent upon the owner's preference and the capabilities of the prime mover and steam supply system. Where possible, the arrangement of the lockout relays should provide redundancy in both trip paths and trip functions, so that backup relays trip a separate lockout relay from the primary protection. The task associated with applying tripping schemes on generating units should not be underestimated. This effort requires a broad knowledge of the generating unit equipment and its behavior during both normal and abnormal conditions. It would be shortsighted if the only consideration given is to disconnect the generator from the electrical system without taking into consideration the precise manner in which the generating unit can be isolated from the power system for various protective relay operations.

Described below are four common methods for isolating the generator from service following unacceptable abnormal operating conditions or electrical faults.

Simultaneous Tripping—Provides the fastest means of isolating the generator. This tripping mode is used for all internal generator faults and severe abnormalities in the generator protection zone. Isolation is accomplished by tripping at the same time the generator breakers, field breaker, and shutting down the prime mover by closing the turbine valves. Auxiliary loads are

transferred to a standby source. If there exists a potential for significant overspeed condition of the unit, a time delay may be used in the generator breaker trip path. If time delay is used, the effect of this delay on the generator and/or system should be determined.

Generator Tripping—This mode of isolation trips the main generator and field breakers. The scheme does not shut down the prime mover and is used where it may be possible to correct the abnormality quickly, thereby permitting the re-connection of the machine to the system in a short period of time. This protection trips the generator for a power system disturbance, rather than an internal generator faults/abnormalities. This mode can be used if permitted by the type of prime mover, boiler and governor control systems and requires that the unit be capable of quick response following a load rejection.

Unit Separation Tripping—A variation of the generator tripping scheme is one where only the main generator breakers are opened. It is recommended for applications when it is desirable to maintain the unit auxiliary loads connected to the generator. The advantage of this scheme is that the unit can be reconnected to the system with minimum delay. As with the generator tripping scheme, the unit shall be capable of a quick response following a load rejection.

Sequential Tripping—This mode is primarily used for steam turbines when delayed tripping has no detrimental effect on the generating unit. It is generally used to trip the generator for prime mover problems where high speed tripping is not a requirement. When the turbine control system indicates that the turbine has been tripped, tripping of the generator breaker followed by the field breaker is initiated. Inclusion of a reverse-power relay in series with a mechanical signal indicating that the turbine has been tripped provides

security against possible overspeed of the turbine by ensuring that steam flows have been reduced below the amount necessary to produce an overspeeding condition when the generator breakers are tripped. For steam turbine problems this is the preferred mode since it prevents any overspeed of the machine. However, the disadvantage is that there is no trip output for a failure of the turbine control trip indication or reverse-power

relay. If this approach is used, backup protection, in the form of motoring protection, should be provided to assure tripping of the generator main and field breakers in case there is a failure in the sequential trip signal. This mode

should not override the generator switchyard protection that instantaneously opens the generator breaker when a critical electrical fault occurs that might cause serious damage to the generator or switchyard equipment.

Many factors contribute to the decision on the selection of the appropriate tripping scheme. Listed below are several key items:

a) Type of prime mover—diesel/gas engine, gas turbine, steam turbine, or waterwheel

b) Impact of the sudden loss of output power on the electrical system

c) Safety to personnel

d) Operating experience

e) Management of unit auxiliary loads during emergency shutdown

f) Extent of damage or potential damage due to the fault or abnormality

Table 5-1 provides an **example** of the trip function for the unit connected generator. The specific trip logic is dependant upon many factors, including the plant electrical configuration, the operating capability of the turbine and the operational experience of the utility. The trip logic should be designed to minimize the impact of a failure of any protective relay or lockout relay.

6.2.3 Other Generator Tripping Considerations

In large power plants, it is common to use a breaker-and-a-half yard layout with a disconnect on the generator feed. This allows the generator to be taken off-line, the disconnect opened, and the breakers closed to maintain another tie between the main busses. In the early phases of plant construction, it is common to have a ring bus configuration that will later be expanded to a breaker-and-a-half. The ring configuration requires a disconnect switch on the generator feed that can be opened so that the ring can be closed when the generator is off-line. Some engineers have used auxiliary contacts in the motor operator of these disconnect switches to disable some or all of the generator protection when the generator is off-line. While this appears to be a convenient indication of the status of the machine, it can be fooled by abnormal conditions and should be avoided.

6.2.3.1 Maintenance

When the generator is off-line for maintenance, safety rules and procedures may require the generator potential transformers to be racked out and tagged. Also, in some instances, current transformers may be shorted and even the station DC tripping source can be disconnected. The design engineer must be aware of these possibilities when determining the type and location of generator backup and inadvertent energizing protection. The common belief is that if the generator is off-line, the protection is not needed. However, the long list of generators that have been inadvertently energized tends to support the need to have as much of the protection in service as possible even when the machine is off-line.

6.2.3.2 Disconnect Switch

When protective relaying is routinely disabled with auxiliary contacts from the disconnect switch, the following should be carefully considered. Due to contamination, adjustment and linkage problems the auxiliary contacts may not properly close and vital protection can be out of service when needed most. Also, if the auxiliary contacts are located inside the motor operator compartment, they may only follow the motor mechanism and not the actual switch blades. When the motor operator is uncoupled from the switch shaft and the switch is closed manually, the protection will be out of service. Even if the auxiliary stack is mounted so that it follows the disconnect switch operating shaft, it is not considered reliable. Several very serious accidents can be traced directly to using auxiliary contacts to disable protection and this practice is not recommended.

6.2.3.3 Potential Sensitive Relays

Underfrequency relays that depend on potential may misoperate during startup if they are energized from the Underfrequency relays that depend on potential may misoperate during startup if they are energized from the generator voltage transformers. An alternative to using the disconnect switch auxiliary contacts to disable these relays is to use switchyard potential or startup source potential. Electromechanical impedance type relays that use voltage for restraint can generally be adjusted so that there is sufficient spring restraint to keep the relays from misoperating during startup.

6.2.3.4 Control Schemes

Some control schemes use the disconnect switch auxiliary contacts to disable certain boiler trips while the machine is in startup. This is fairly common on coal fired units where it takes a long time to get the machine on line. If a nuisance trip occurs, many hours may be wasted. While it is necessary to be sensitive to the control problems, the generator protection shall not be compromised in the process.

6

Glossary of Terms

Term	Definition
Alarm	Acts as a warlning to the user to a potential problem with the system. The alarm does not shut down the system, but merely warns the user. The alarm limits are lower than the fault limits.
Dam intake	Where the headpond flows into the trashrack.
Fault	Warns the user of a condition which must be corrected **before** the user can resume use of the Turbine Control Module.
Flow rate	The rate and volume of water that passes through the power station. Also known as Flow Discharge.
Governor	Adjusts the water flow to maintain a balance between water input to the turbine and the power or speed (frequency) requirements of the system.
Graphic Display Interface	A device that gathers data from all of the Powerbase Modules and displays the operation, protection and metering information. Usually mounted on a switchgear or control cabinet door.
Gross head	The difference in elevation between the headwater surface (upstream) and the centerline of the turbine runner.

Term	Definition
Head	The appropriate vertical distance between the turbine centerline and the dam intake water level.
Head loss	Not all of the gross head can produce power due to losses when delivering the water into the turbine. Some residual water is needed to discharge water back into the tailrace.
Headpond	A water storage reservoir or area in front of the trashracks. The headpond can also be expressed as a height measurement. For example, "the maximum headpond reading is 212 cm," where the zero level reference is a geographical height above sea level.
Induction generator	Also asynchronous generator, with no excitation system. This type of generator is only used on very large stable electrical grids.
Junction box	A weatherproof chassis that contains electrical connections and splices.
KWhF (kilowatt hours forward)	The amount of energy produced (exported) since the last reset.
KWhR (kilowatt hours reverse)	The amount of energy consumed since the last reset.
KWARhF (kilovolt hours forward)	The amount of reactive energy produced by the generator.
KWARhR (kilovolt hours reverse)	The amount of reactive energy consumed (i.e., heating/lighting loads or generator motor due to condensing mode selection.)
KVAh (kilovolt-amp hours)	The net amount of energy produced, not considering the power factor.
Lockout	Warns the user of a condition which must be corrected **before** the user can select a menu option. The system does not allow the user to restart the system until the condition is corrected.

Term	Definition
Optocom bus	Allows each Powerbase Module to send and receive information throughout the system. It uses a RS-485 network cable. There are two bus systems in the Powerbase Platform: **System bus** - connects individual Powerbase Modules within a single turbine/generator set. **Global bus** - connects ProSCADA (local computer) head sensors and ATD to all turbine/generator sets in a given powerstation.
Penstock	A pipe where water from the headpond enters the turbine.
Programmable logic controllers (PLC)	A device that performs a series of operations based on a custom program dependent on the status of various input and output devices.
Resistance temperature detectors (RTD)	A sensor that monitors the winding temperatures of thermally sensitive devices such as the generator windings The Powerbase system is compatible with 2-3 wire PT-100 RTDs.
ProSCADA	Supervisory control and data acquisition. Windows based software that allows the user to perform or monitor station functions remotely.
Tailrace	Refers to the water level at the output side of the turbine, sometimes called “suction head.”
Trashrack	A gate or set of bars that are located at the entrance to the penstock.
Trend	Information displayed on the GDI screen and refers to the control of the headpond water level. Indicates whether the water level is trending towards or away from the setpoint.

Term	Definition
Trip	A trip shuts down the turbine. A trip with "reclose active" allows the turbine to restart after a number of reclose retries. The number of retries is programmed into the TCM with the Setup Guide software. A trip with lockout does not allow the turbine to start again until the lockout reset is activated. **The user should investigate, and if necessary, make any repairs before restarting the turbine.**
Turbine blades/runners	The vanes connected to the drive shaft of the turbine. Water strikes the vanes and causes them to spin, creating shaft torque.
Wicket gates	Adjustable gates that control the amount of water flowing through the turbine.

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