



Differential Pressure Charger Installation - Operation - Maintenance Manual

DB1TM



PATENT PENDING



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Table of Contents

Introduction to the DB1	3
DB1-10/20/50 Features	4
Optional Equipment	5
Accessories	5
Factors That Affect the Start-Up of the DB1	6
Factors That Affect the Performance of the DB1	6
Specifications	7
Diagnostics	7
DB1 Charger System Overview	8
DB1 Controller	9
LEDs	9
Interface	9
Alarm Contacts	9

Installation

DB1 Installation	10
Field Wiring Connections	12

Operating Instructions

Preparing for Start-Up	13
Before Starting	20
Starting the DB1	20
Shutting Down the DB1	21
To Test the Charger	22

Maintenance/Trouble Shooting

Trouble Shooting	23
Warranty	27

Introduction to the DB1

The DB1 Differential Pressure Charger is an efficient and reliable alternative to solar panel systems that are used to power electronic instruments on gas pipelines. In applications where a lead acid battery is used to provide high peak power for short burst requirements (such as for wireless communications at remote monitoring sites), the DB1 produces a 12 or 24 volt power output to keep the battery fully charged. The battery's temperature and charge level are continuously monitored and the DB1 produces up to 50 watts to keep it charged.

Unlike solar panels, the DB1 can be installed in almost any location where adequate differential pressure exists, and is unaffected by shade, snow, freezing rain, ice, dust build-up, or birds.

The DB1 battery charger uses the differential pressure developed across a pressure reducing device on natural gas pipelines to run a small turbine-powered Generator. The Generator output can be used to charge a lead acid battery – similar to PGI's Thermo-Electric Chargers (TECs). Unlike the TECs, the DB1 does not consume any natural gas. Power is produced by allowing a small portion of the gas to flow through a turbine, bypassing the pressure reducing device. The amount of gas flow through the DB1 turbine is low relative to the total line flow, and stable, keeping the DB1 transparent to the pressure.

- **Powered by natural gas to 1440 PSIG system pressures**
- **Microprocessor controlled simple start up and diagnostics**
- **Integrated temperature compensated charger with remote battery temperature sensor**
- **User configurable operating characteristics**
- **Status output for remote monitoring**
- **Direct mount (on pipeline) or optional 2" pipe mount**

The pressure reducing device automatically adjusts for the slight decrease in flow resulting when the DB1 runs.

The power generated is micro-processor controlled to provide the ideal temperature compensated battery charging current and voltage to the battery. Internal diagnostics detect possible system problems and the system status can be remotely monitored using the open collector alarm output.

Controlled start-up for the DB1 makes turning the system ON as simple as flipping a switch.

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DB1-10/20/50 Features

- 10, 20, or 50 watts of charging power
- Charge either 12 volt or 24 volt batteries (detected and set by the Controller)
- Input to allow a switch or remote device, such as an External Shut-Down Device (ESD), to disable the system – signal may need to go through a barrier if connected to an intrinsically safe device in the hazardous location (The ESD is a failsafe feature which allows for remote activation/deactivation of the DB1.)
- Temperature compensated charging
- Status LED:
 1. Idle – flash GREEN (*on ¼ sec off for 2 seconds*)
 2. Charging – GREEN
 3. Disabled (ESD) – flash RED (*on ¼ sec off 2 seconds*)
 4. Battery too low to start charger – off
 5. Shutdown – flash RED (*on for ½ sec off for ½ sec*)
- Run/Disable switch
- “Run command” regardless of battery voltage
- Two configurable alarm outputs (open collector) with major and minor levels (Major Alarms disable the Charger, while Minor Alarms simply alert the technician to undesirable conditions which could require service)
 - Lost Generator Communications Link (MAJOR—Non-Latched)
 - Control Valve is Full Open but no RPM Detected (MAJOR—Latched)
 - Control Valve Failed (MAJOR—Latched)
 - Generator RPM or Voltage Output Too High (MAJOR—Latched)
 - Turbine RPM Sensor Failed (MAJOR—Latched)
 - Control Valve Position Sensor Failed (MAJOR—Latched)
 - Controller Switch in Disable Position (MINOR—Non-Latched)
 - Unable to Generate Maximum Power with Control Valve Full Open (MINOR—Latched)
 - ESD Input Detected (MINOR—Non-Latched)
 - Generator Run Time Service Due (MINOR—Latched)
 - Temperature Sensor Failed (MINOR—Non-Latched)
 - Unable to Reach Full Charge (MINOR—Non-Latched)

- Alarm LEDs
 1. No alarm (OFF)
 2. Minor alarm (Warning: DB1 can still function) flash YELLOW
 3. Major alarm (DB1 is shutdown) flash RED (*on ¼ sec, off 1 sec*)
- Event log with battery volts, date, and time stamp (1,000 events)
 - Start time
 - Stop time
 - Alarms
 - Remote shutdown
 - Run/Disable switch was switched
 - Run or Disable commands were turned on and off
 - Cable cut or interface malfunction shutdown. Lost communication link.
- Turbine maintenance log and maintenance timer to track service due
- Safely shutdown turbine if any wires between the Generator and Controller are cut or disconnected – or if the battery is disconnected
- Controller can be wall mounted.

Models

- DB1-10: 10 Watt Max.
- DB1-20: 20 Watt Max.
- DB1-50: 50 Watt Max.

Options

- VCH Option: Carbon Steel Remote Mount Kit
- VSH Option: Stainless Steel Remote Mount Kit

Accessories

- SK-DB1-001 DB1 Monitor Software and Interface Cable
- P8-214-A0 3/4" NPT Pipe Union
- P8-215-C0 1/2" 316SS Ball Valve
- SS-C9E-500-CL 0-2000psi Gauge
- SS-C9E-516-CL 0-300psi Gauge
- SS-C9E-517-CL 0-600psi Gauge
- SS-C9E-518-CL 0-1000psi Gauge

All gauges are 316ss, Liquid Filled, , 1/4" MNPT Center Back Mount, with a 2 ½" Dial.

Factors That Affect Start-Up of the DB1

The DB1 system start-up is dependant upon several factors. What follows is a list of conditions that must be met in order to ensure reliable operation. Failure to meet these conditions will result in failure to start or improper operation. Repeated attempts at start-up may drain the battery voltage to a level below the start-up requirement (10v for a 12v system & 20v for a 24v system).

1. An adequate pressure differential

A minimum pressure differential of 65psig is required to operate the DB1 at 10 watts (85psig to operate at 20 watts or 125psig to operate at 50 watts). The power output will drop as the differential pressure is reduced. The turbine could stall if the differential pressure is less than 50 psig. The maximum inlet pressure is 1440 psig.

2. A properly sized battery

A properly sized battery is necessary to get the optimum performance from the DB1. If the battery is too small, it will drain and charge very quickly. This would lead to short ON/OFF cycling of the DB1 and appreciably reduce battery life.

3. Properly charged battery

A drained battery may not provide enough voltage to allow communication between the Controller and the Generator. If the battery voltage is less than 10 volts for a 12 volt system, or less than 20 volts for a 24 volt system, re-charge or replace the battery, then restart the DB1.

NOTE: It is possible that the battery be “healthy” enough to make the Controller-to-Generator communication, but not strong enough to open the Control Valve, thus rendering the Charger non-functional. Remember, the battery must have at least 10v for a 12v system, and 20v for a 24v system.

Factors That Affect the Performance of the DB1

The DB1 battery charger uses the differential pressure developed across a pressure reducing device on natural gas pipelines to run a small turbine-powered Generator. There must be a **differential pressure** in excess of 65psig between the inlet side and the outlet side of the DB1 to operate at 10 watts (85psig for 20 watts or 125psig for 50 watts). The amount of current that will be generated is directly proportional to the **wattage** of the DB1 (10/20/50 watts). What follows is a list of conditions that will affect these two factors.

1. Differential pressure available to activate turbine.

The Inlet tubing must have a minimum inside diameter of 3/8”, and the Outlet tubing must have a minimum inside diameter of 1/2”.

2. Angle of installation

It is recommended that the DB1 be installed in an upright position. However, if constraints exist, the DB1 may be installed on an angle not to exceed 45° off vertical.

3. Low supply gas pressure

If the supply gas to the DB1 is below 100psig, the charger current output will be reduced as well as the power output.

4. High supply gas pressure

Supply gas higher than 1440 psi will exceed the rated pressure capability of the charger, causing the DB1 to fail.

5. Exposure to extreme cold

Extreme cold may cause icing/freezing in the supply gas which could cause the charger to stall.

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Specifications

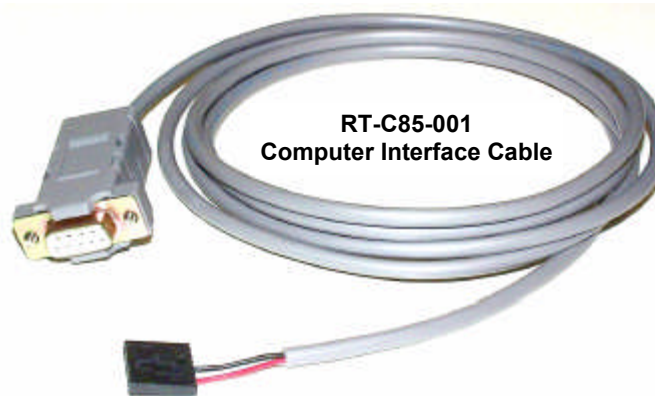
Charger Output	12/24V (temp. comp.) for Lead Acid Batteries
Output Power when Charging.....	10/20/50 Watts continuous at 68°F (20°C) ambient
Remote Battery Temperature Sensor	Silicone diode
Alarm Status & Notification	LED & NPN Open Collector (2), 30V max, 200mA max
Transient Protection.....	Bi-directional TVS 1500 Watts peak pulse power
Battery Short Circuit Protection.....	10 amp PTC Over-Current Protection
Electrical Connections	1/2" Rigid Conduit Opening (2), (Explosion-Proof)
Wire Connections	Terminal Strip w/Screw Clamp, 14 AWG max.
Inlet Gas Supply Pressure	1440psig max.
Gas Flow During Charge Cycle.....	29 scfm @ 10W — 40 scfm @ 20W — 65 scfm @50W
Gas Supply Connections.....	Inlet 3/8" OD SS Tubing, Outlet 3/4" FNPT
Operating Temperature Range	-40°C (-40°F) to 60°C (140°F)
Enclosure	Cast Alum A356-T6, 316 SS NEMA 4X
Mounting Configurations.....	Direct mount or optional 2" pipe mount

Diagnostics

Basic operation of the DB1 can be monitored using the Windows[®] based DB1-Monitor firmware. Typically, each technician who performs service to the DB1, should have access to the diagnostics equipment.

The firmware will monitor the battery voltage, the battery temperature, the charge current, the output voltage, its operating modes, and any error codes.

Detailed operating instructions for the Windows[®] based DB1-Monitor software can be found in the *Operating Instructions* section of this manual.



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DB1 Charger System Overview

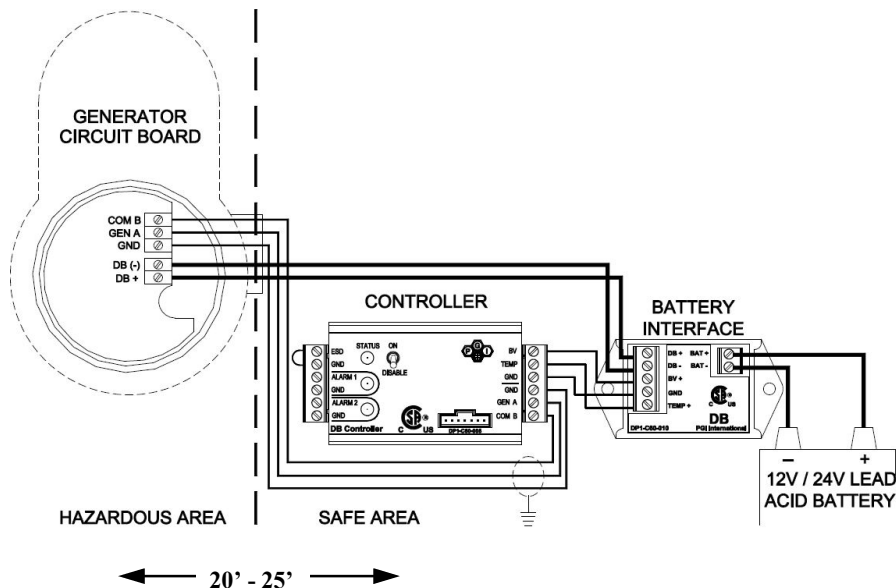
The DB1 system consists of three main components: the Generator, the Controller, and the Battery Interface Module. The Generator shall be installed on or near the pipeline, typically in a division 1 or 2 hazardous location. For this reason the DB1 is constructed in an explosion proof enclosure.

The Controller should be mounted near the battery, in a safe area location.

IMPORTANT!

CONNECTIONS BETWEEN THE GENERATOR AND CONTROLLER MUST BE THROUGH CONDUIT WITH AN EXPLOSION-PROOF WIRE SEAL FITTING AT THE GENERATOR END.

The diagram below shows the interconnecting wires between the Generator and the Controller. The Generator and the Controller each have a microprocessor. By using separate microprocessors, the Generator can monitor itself and the communications link to the Controller, and shut the Control Valve using power from the Generator (until the turbine stops) if necessary. The Generator will monitor the RPM, the charge current, the Control Valve position, and the input voltage while controlling the Valve Motor and the optional Flow Restrictor. All other parameters (battery voltage, battery temperature, External Shut-Down [ESD] input, alarm output, status LEDs) are monitored and managed by the Controller microprocessor. The DB1 can be monitored without removing the cover on the Generator's explosion-proof enclosure. The battery temperature sensor, battery interface field screw terminals, and over-current protection will be provided in a Battery Interface Module mounted as close to the battery as possible.



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DB1 Controller

The Controller toggle switch does not remove power from Controller or the Generator. It simply provides a convenient way to disable the Generator for servicing. The Controller will continue to function when the switch is in the DISABLE position, but the Generator will not be allowed to run or open the Control Valve. If the switch is moved to the DISABLE position while the unit is charging, the Control Valve will be closed and disable charging.

LEDs

The Controller has three (3) LEDs. The top LED, located next to the toggle switch, is the Status LED (Red/Green).

- Idle—the toggle switch is in the ON position, but the Generator is not running: the Status LED will **FLASH GREEN** once every two (2) seconds.
- Charging—Generator is running: the Status LED will be **SOLID GREEN**.
- Shutdown—if the system has been disabled, the Status LED will **FLASH RED** every half second.
- The remaining LEDs will indicate the state of the Alarm Outputs (Red/Yellow).
 - ◊ **FLASH RED**—Major Alarms: DB1 disabled
 - ◊ **FLASH YELLOW**—Minor Alarms: DB1 will continue functioning
- The LEDs will alternately flash RED and YELLOW if major and minor alarm conditions exist simultaneously.



RS-485 Interface between the Generator and Controller

The RS-485 interface between the Generator and Controller was chosen because it allows for a large voltage difference between the Generator ground and the Controller ground. RS-485 has excellent immunity to interference and is commonly used in industrial applications to send communications over long distances.

Alarm Contacts

The open collector Alarm output can be used for remote monitoring of the DB1 health. When the output is “shorted”, the DB1 is healthy. If the alarm circuit is “opened”, the DB1 has either been ‘DISABLED’ or has shutdown, and is not charging the battery. There are several tests performed on the Generator system to detect malfunctions and to safely shutdown the system. If the DB1 shuts down, the battery will continue to power the connected device for a period of time determined by the battery size and device power requirements.

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DB1 Installation

The DB1 must be installed across a pressure reducing device which results in a minimum pressure differential of 65psig between the inlet side and the outlet side for a 10 watt unit (85psig for a 20 watt unit or 125 for a 50 watt unit).

WARNING! WARNING! WARNING! WARNING! WARNING! WARNING!
THE ELECTRICAL CONNECTIONS BETWEEN THE GENERATOR AND THE CONTROLLER/BATTERY INTERFACE MUST BE THROUGH CONDUIT WITH AN EXPLOSION-PROOF WIRE SEAL FITTING AT THE GENERATOR END.
THE CONTROLLER WILL BE MOUNTED NEAR THE BATTERY IN A "SAFE NON-HAZARDOUS LOCATION".
FAILURE TO COMPLY COULD RESULT IN SERIOUS INJURY AND EVEN DEATH.

To ensure optimal performance, it is recommended that the DB1 be installed in an upright position. However, if constraints exist, the DB1 may be installed on an angle not to exceed 45° off vertical.

In order to achieve the necessary flow through the DB1, it is very important that Full Opening Ball Valves be installed at the inlet and outlet. If an existing valve is to be used, be sure to blow-out the valve prior to connecting the tubing. Also, since a new run of tubing may contain small metal shavings which could jam the turbine, it is necessary to blow-out the tubing prior to connecting it to the DB1.

To ensure that the pressure source may not be interrupted (which would disable the DB1), the inlet should be located on the pipeline before any gate valves, as shown below.

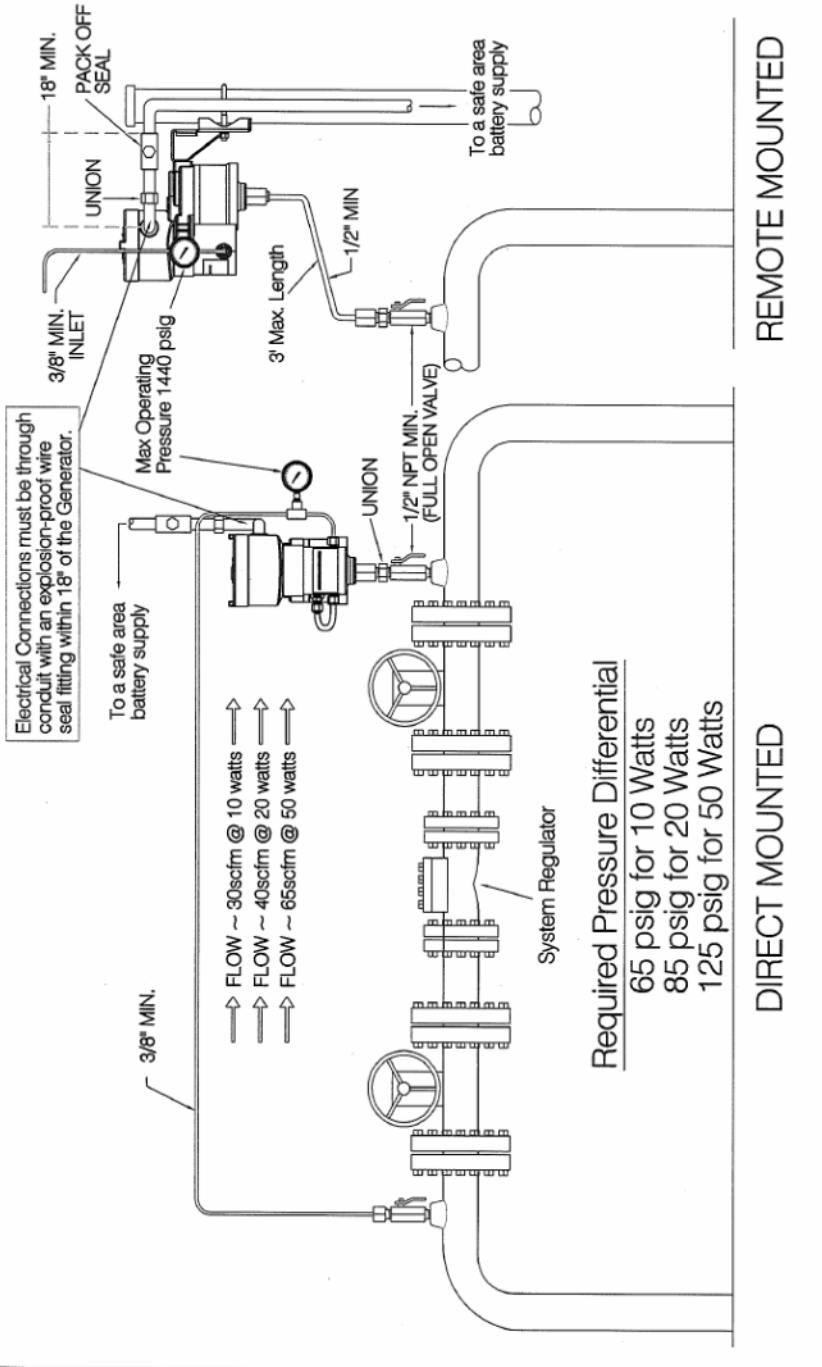
As a means of visual verification that the unit is “seeing” the required input pressure, it is recommended that a pressure gauge adequate for operating conditions be installed as close to the **Inlet** side of the DB1 as possible, as shown below. (See *Accessories* on page 5 of the manual.)

Also, for direct mount systems, it is recommended that a pipe union be installed between the DB1 and the full opening gate valve, as shown below. This will ease removal and re-mounting.

Notes for optimal performance

1. Install the DB1 between two Full Opening Ball Valves.
2. Blow-out any pre-existing Ball Valves prior to connecting the tubing.
3. Blow-out the tubing prior to connecting it to the DB1.
4. The DB1 must see a minimum pressure differential of 65psig between the inlet side and the outlet side for a 10 watt unit (85psig for a 20 watt unit or 125psig for a 50 watt unit).
5. Install the DB1 in an upright position.
6. Use 3/8” minimum tubing on inlet side.
7. Use 1/2” minimum tubing or pipe on outlet side.

Recommended DB1 System Installation



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Field Wiring Connections

A 30' cable and a Battery Interface Module is included to interface the DB1 to the external battery it will keep charged.

The DB1 will not start with a “dead” battery. In order for the DB1 to start, the battery to be used must measure greater than 10v for a 12v system, and greater than 20v for a 24v system.

The Battery Interface Module contains a temperature sensor and over-current protection and should be attached as close to the battery being charged as possible.

Also included is a 30' length of cable to make the Generator-to-Controller connection. The extra length is to be cut off and used to make the Controller-to-Battery Interface Module connection.

These components may also be purchased separately:

Component	Part Number	Cable Specifications
Battery Interface Cable (30 feet)	SS-C85-1553	2 Conductor; 14AWG Unshielded Alpha Wire 1891C SL005 or Equivalent
Generator-Controller-Interface Cable (30 feet)	SS-C85-1468	3 Conductor; 20AWG Shielded Alpha Wire 2413C SL005 Or Equivalent

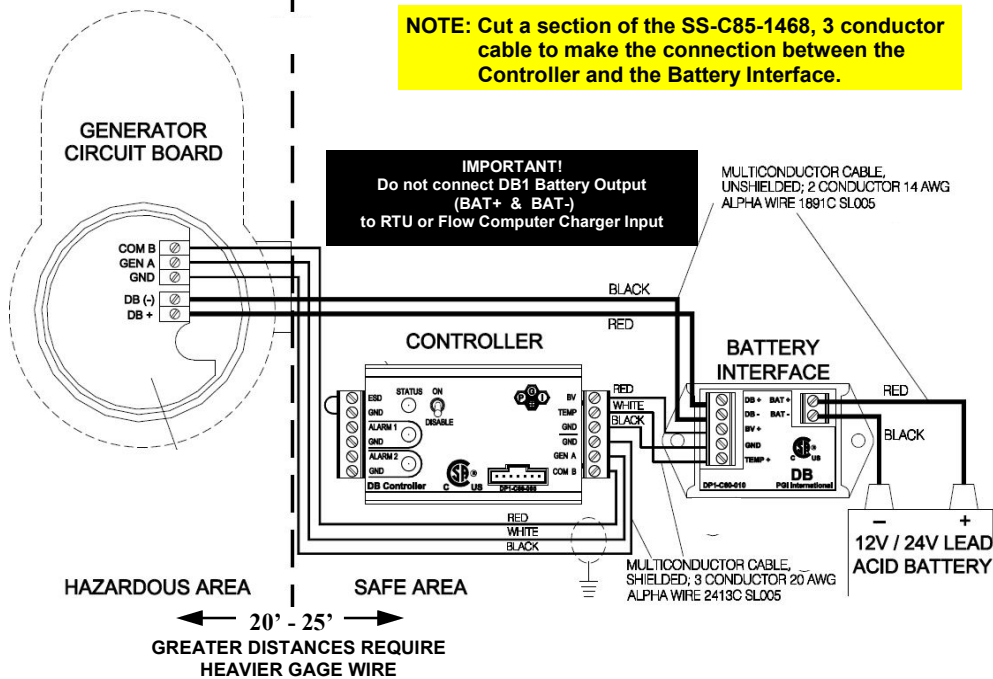
WARNING!

Always have the DB1 Power Switch in the 'DISABLE' position and the battery (+) lead disconnected when making field connections.

WARNING!

Always connect the DB1 side first, then the remote battery.

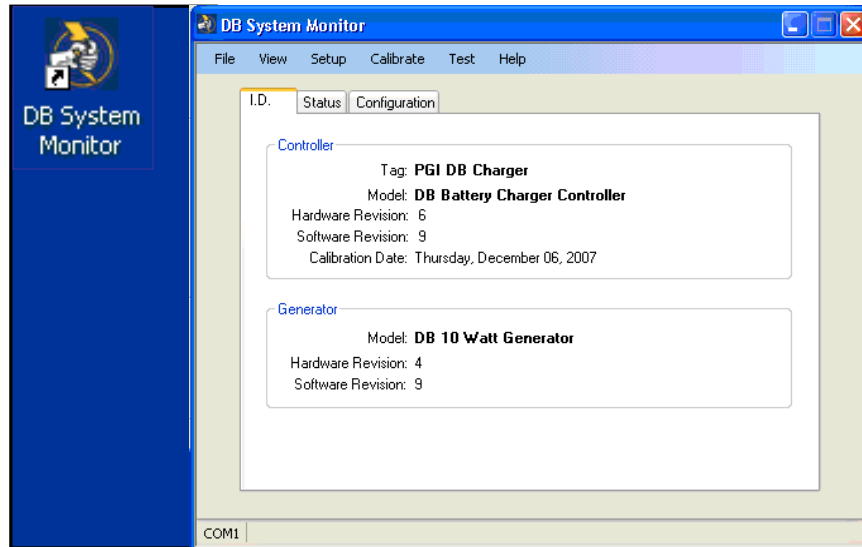
NOTE: Cut a section of the SS-C85-1468, 3 conductor cable to make the connection between the Controller and the Battery Interface.



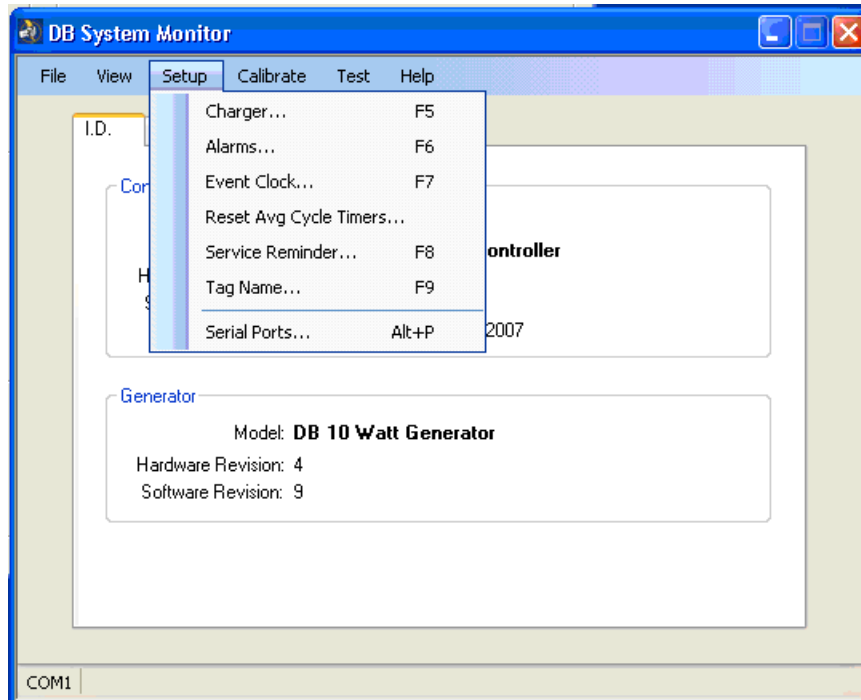
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Preparing for Start-Up

1. Download the DB software and save it to your desktop.
2. Double-click the 'DB Monitor' icon to open the program.



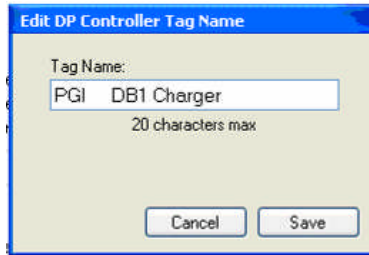
3. If the screen does not appear as shown, click on 'File', then 'Connect'.
4. Click 'Setup' on the menu bar, then click 'Tag Name' or press the F9 key.



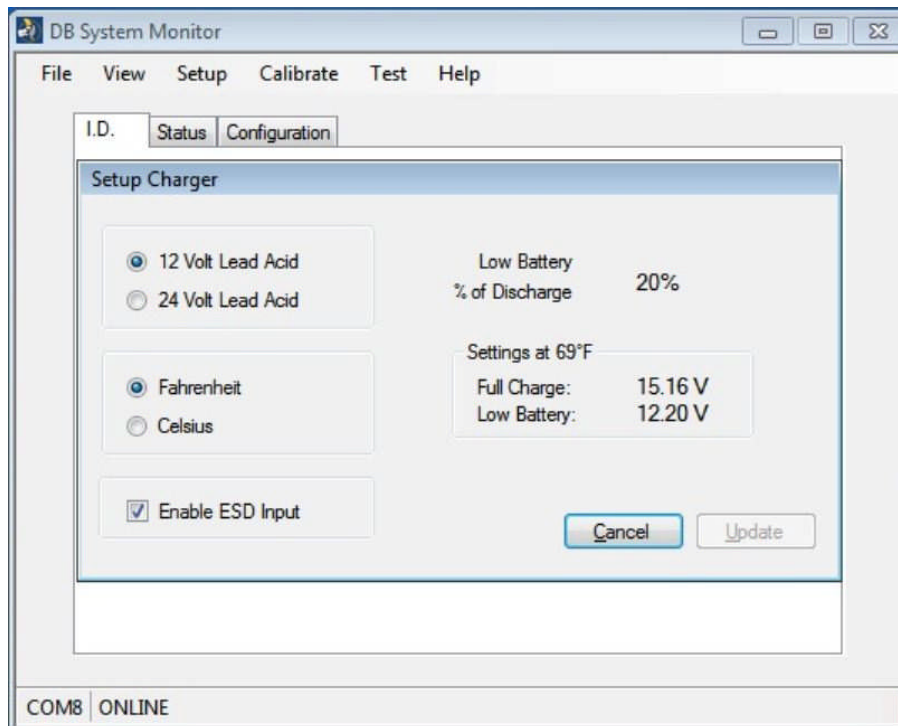
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Preparing for Start-Up (cont'd.)

5. In the text box, type in a unique description of the DB unit (i.e. location, number, etc.), then click 'Save'.



6. Again, on the menu bar, click on 'Setup', as in step 3, then click 'Charger' or press the F5 key.
7. Determine the battery size to be charged and select '12 or 24 Volt Lead Acid'.
8. Select the temperature scale that will be used.
9. If an External Shutdown Device will be used, click the 'Enable ESD Input' box.
10. Click 'Update' to save changes.



Preparing for Start-Up (cont'd.)

12. Again, on the menu bar, click on 'Setup' (as in step 5), then click 'Alarms' or press the F6 key.
13. This screen displays the list of alarms that may be enabled to notify the technician of undesirable conditions. Only those alarms that are enabled will be indicated by the Controller. The image below demonstrates the recommended settings. (i.e. 'Alarm 1' for major alarms and 'Alarm 2' for minor alarms.)

NOTES:

- A major alarm will disable the charger.
- The Alarm LED on the Controller will flash RED to indicate a major alarm.
- A minor alarm is informative, but will not prevent charging.
- The Alarm LED on the Controller will flash YELLOW to indicate a minor alarm.
- Latched alarms require the technician to make repairs and reset the charger to clear the alarm.
- Non-Latched alarms will be cleared automatically after the condition is removed.

Setup Alarms

Major Alarms

Num. **1** **2**

1	<input checked="" type="checkbox"/>	<input type="checkbox"/>	Lost Generator Communications Link (Non-Latched)
2	<input checked="" type="checkbox"/>	<input type="checkbox"/>	Control Valve is Full Open but no RPM Detected (Latched)
3	<input checked="" type="checkbox"/>	<input type="checkbox"/>	Control Valve Failed (Latched)
4	<input checked="" type="checkbox"/>	<input type="checkbox"/>	Generator RPM or Voltage Output Too High (Latched)
5	<input checked="" type="checkbox"/>	<input type="checkbox"/>	Turbine RPM Sensor Failed (Latched)
6	<input checked="" type="checkbox"/>	<input type="checkbox"/>	Control Valve Position Sensor Failed (Latched)

Major alarms will disable the charger when detected. Controller Alarm LED will flash red when an enabled major alarm is detected.

Minor Alarms

Num. **1** **2**

7	<input type="checkbox"/>	<input checked="" type="checkbox"/>	Controller Switch is in Disable Position (Non-Latched)
8	<input type="checkbox"/>	<input checked="" type="checkbox"/>	Unable to Generate Maximum Power with Control Valve Full Open (Latched)
9	<input type="checkbox"/>	<input checked="" type="checkbox"/>	ESD Input Detected (Non-Latched)
10	<input type="checkbox"/>	<input checked="" type="checkbox"/>	Generator Run Time Service Due (Latched)
11	<input type="checkbox"/>	<input checked="" type="checkbox"/>	Temperature Sensor Failed (Non-Latched)
12	<input type="checkbox"/>	<input checked="" type="checkbox"/>	Unable to Reach Full Charge (Non-Latched)

Minor alarms are informative but do not typically prevent charging. The Alarm LEDs flash yellow on the controller if enabled.

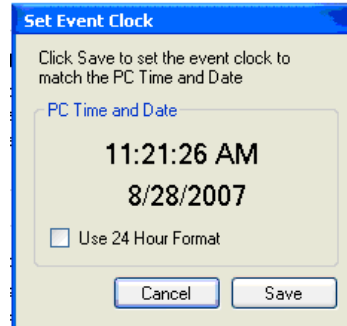
Checked alarms are Enabled
Latched alarms require the operator to make repairs and reset the charger to clear the alarm.
Non-Latched alarms are cleared automatically after the condition is removed.

Cancel Save

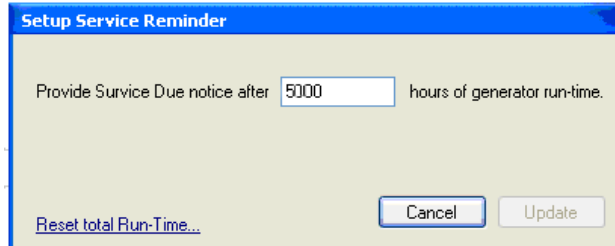
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Preparing for Start-Up (cont'd.)

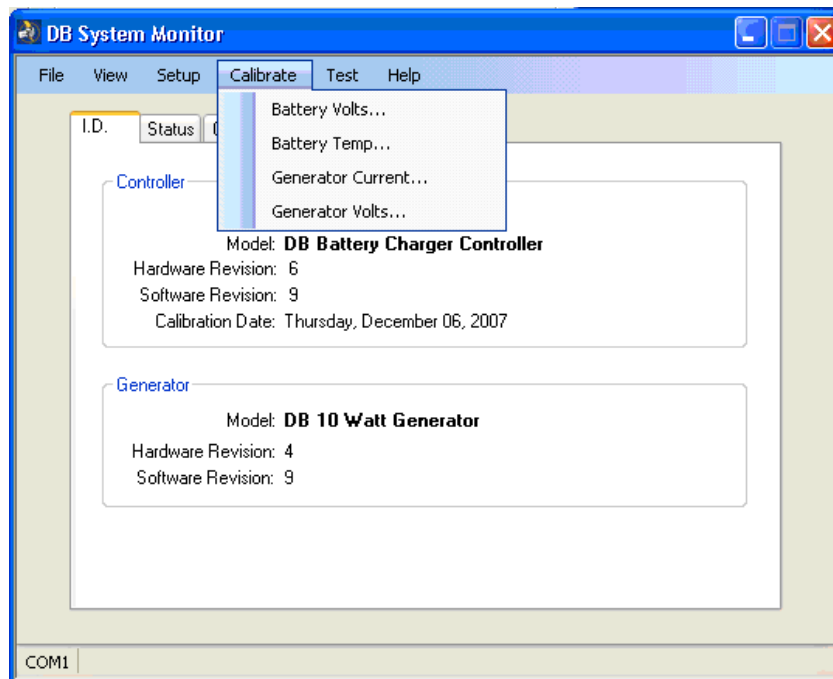
15. Again, on the menu bar, click on 'Setup' (as in step 5), then click 'Event Clock' or press the F7 key.
16. The 'Set Event Clock' box will display the time and date on the PC. Click 'Save' to set the event clock.



17. Once again, on the menu bar, click on 'Setup' (as in step 5), then click 'Service Reminder' or press the F8 key.
18. It is recommended that the Service Reminder be set to 5000 hours.
19. Click 'Update' to save.



20. Now, on the menu bar, click on 'Calibrate', then click 'Battery Volts'.



Preparing for Start-Up (cont'd.)

21. Use a Voltmeter to measure the Actual Battery Voltage and enter that value into the box provided.
22. Click 'Update' to save.

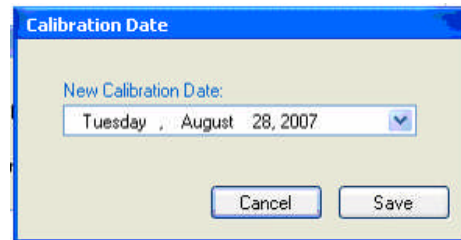
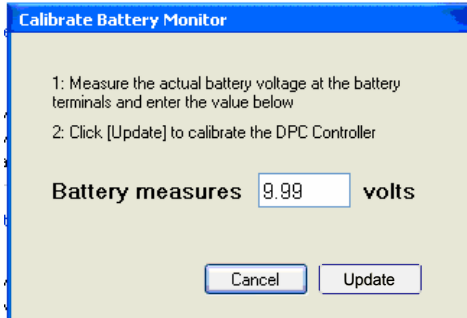
Important!

If the value in the box matches the Voltmeter reading, change the value by 0.01 volt and click 'Update'.

(This will capture and save all the data values. Otherwise, if the Controller is disabled for any reason, the default values will reappear .)

NOTE:

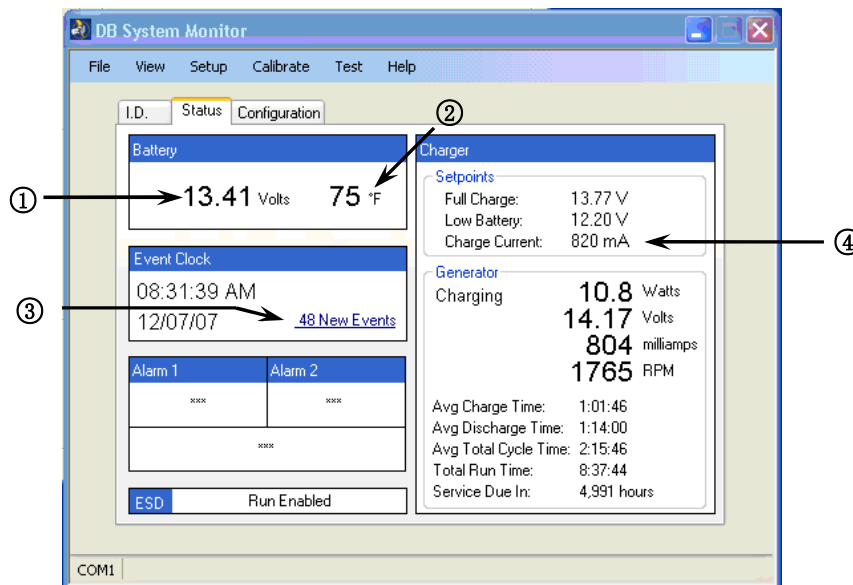
When the Battery Volts value is changed, the Calibration Date will change, as well.



23. Next, click on the 'Status' tab to see the present state of the Generator and Battery.

- In this example, the battery presently has 13.41 volts ① and the battery temperature is 75°F ②.
- To see a chronological list of events, click on '1000 New Events' ③.
- A minor alarm is indicated in the 'Alarm 2' section. Click on the 'Configuration' tab to display the alarm description.

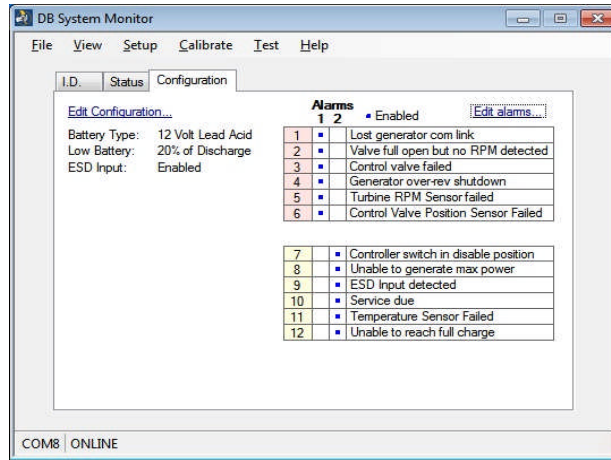
NOTE: When the 'Charge Current' ④ is at zero, the unit has been disabled.



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Preparing for Start-Up (cont'd.)

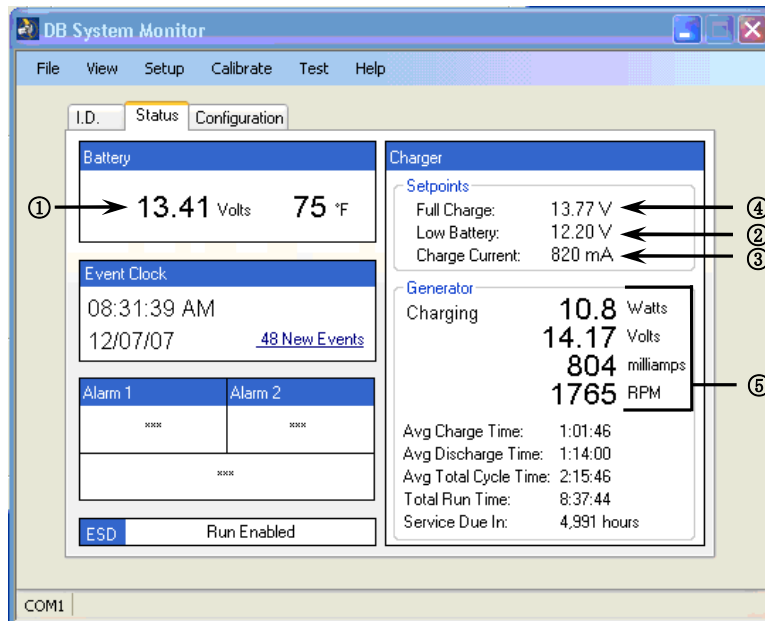
24. The alarm indicated on the 'Status' screen will be highlighted for easy identification.



25. Click back to the 'Status' screen.

When the Power Switch is toggled to the 'ON' position and the battery voltage ① drops below the 'Low Battery' value ②, the Controller will determine the 'Charge Current' ③ necessary to reach the 'Full Charge' value ④. The Generator ⑤ will then attempt to match the calculated 'Charge Current'. The Control Valve will open until the Turbine reaches the speed at which the milliamps produced by the Generator equals the required charge current. The Control Valve will remain open until the 'Full Charge' value is achieved.

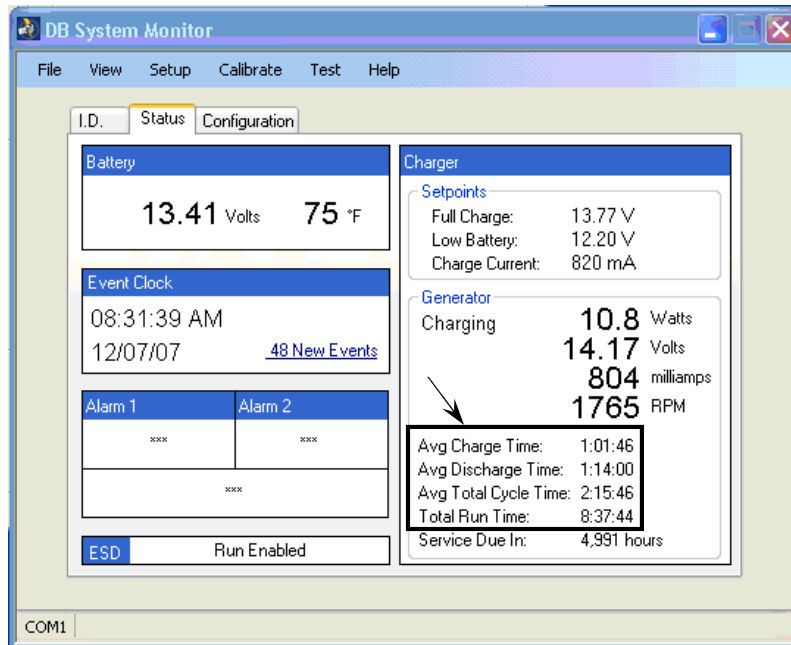
NOTES: 1) The amount of charge delivered to the battery is calculated with consideration to the battery temperature. 2) Conditions may exist that may cause inconsequential fluctuations in the current produced.



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Preparing for Start-Up (cont'd.)

26. The 'Avg. Charge Time', 'Avg. Discharge Time', and 'Avg. Total Cycle Time' are used to calculate the 'Total Run Time' since the last Configuration Update.
NOTE: Data must be compiled over a period of time before calculations can be made.



Operating Instructions

Before starting...

- Check field wiring and all connections.
- Test all connections for gas leaks.

To start the charger . . .

- 1) Connect the Diagnostics Cable from your computer to the Controller.
- 2) Open the Main Shut-Off Valve.
- 3) Toggle the DB1 Power Switch to the ON position.

When the Power Switch is toggled ON, the Controller will determine if the battery needs to be charged. If a charge is needed, the Controller will then determine the charge level necessary and open the Control Valve accordingly. The Control Valve will be held open by the Controller until one of the following conditions occur:

- the Power Switch is toggled to the 'DISABLE' position,
- the battery is fully charged, or
- the internal diagnostics detect a problem with the system.



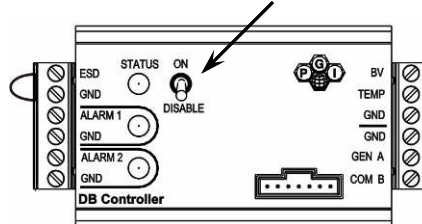
When gas flow is introduced to the DB1, the turbine will begin to spin, generating power. Once the battery has been fully charged, the Controller will close the Control Valve and enter a 'Standby' mode.

The **Diagnostics** section of this manual details how to monitor the Generator and battery condition.

Operation Instructions (cont'd.)

To shut down the charger . . .

Toggle the Power Switch to the 'DISABLE' position. (The Controller will close the Control Valve.)



WARNING! WARNING! WARNING! WARNING! WARNING! WARNING!

Do not perform any service on the DB1 unless the area is known to be non-hazardous.

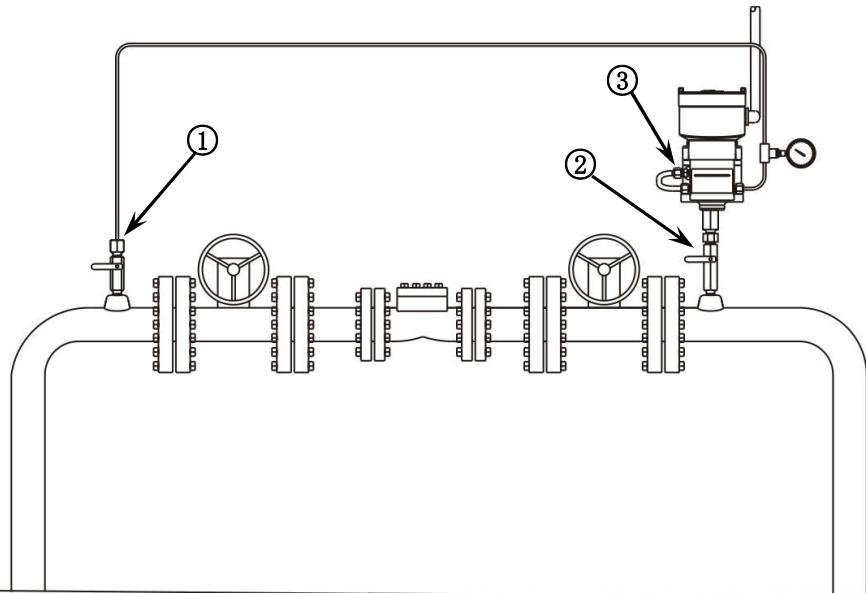
IMPORTANT!

Prior to performing any service to the DB1:

- Toggle the Power Switch to 'DISABLE'.
- Close the supply gas Main Shut-Off Valve. ①
- Close the downstream Outlet Valve. ②
- Purge the DB1 by loosening one of the fitting nuts on the transition tube. ③

WARNING!

The Power Switch must be turned to the 'DISABLE' position **BEFORE** disconnecting the battery. Otherwise the DB1 Control Valve will not close and the DB1 will continue to run.

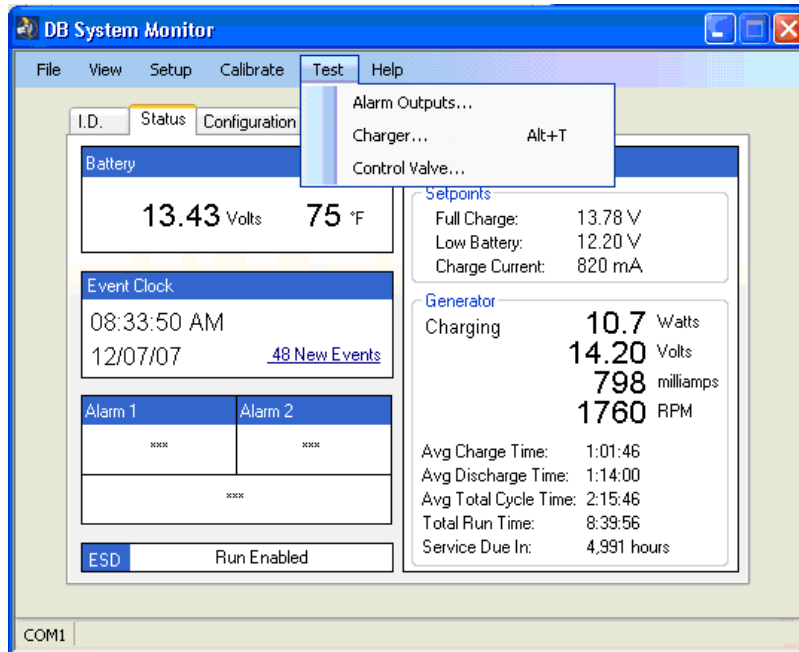


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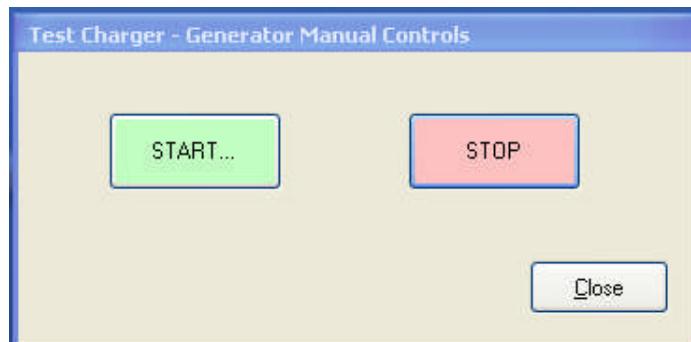
To Test the Charger . . .

To test the Charger regardless of the battery condition, the Test feature may be used:

1. From the DB System Monitor screen, click on 'Test' on the menu bar, then click 'Charger' on the dropdown menu.



2. Click on 'Start' and the Generator will start and continue to run until the battery is at full charge or until stopped manually by clicking on 'STOP'.



Maintenance/Trouble Shooting

The DB1's sturdy construction and a limited number of moving parts equate to high reliability and low maintenance. However, there are variables that occur during normal operation that may affect the life and operation of the DB1.

What follows is a list of components, symptoms and remedies which may occur in the field.

WARNING! WARNING! WARNING! WARNING! WARNING! WARNING!

Do not perform any service on the DB1 unless the area is known to be non-hazardous.

COMPONENT

DB1 Valve

MAINTENANCE

Under normal working conditions:

- the Valve Stem Packing could be depleted or fail
- the Valve Seat could become damaged by the media

TROUBLE SHOOTING

A leak from the Stem area indicates the Valve Stem Packing has been depleted or has failed. This type of leak would create a HAZARDOUS CONDITION.

A leak through the Valve when fully closed indicates damage to the Valve Seat. In this case, the Turbine may continue to run when the Valve is fully closed, although not fast enough to produce current.

REMEDY

Replace the Valve — Service Kit Number SK-DP1-C60-002

COMPONENT

Valve Motor

MAINTENANCE

Under normal working conditions:

- the gears in the Valve Motor may become worn
- the Valve Motor could be affected by a lightning strike or other power surge

TROUBLE SHOOTING

The Valve will not open (or close).

REMEDY

Replace the Valve Motor — Service Kit Number SK-DP1-C60-009

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WARNING! WARNING! WARNING! WARNING! WARNING! WARNING!

Do not perform any service on the DB1 unless the area is known to be non-hazardous.

COMPONENT

Bearing

MAINTENANCE

Under normal working conditions:

- the Bearing could lose its lubrication
- the Bearing could become damaged by dirty supply gas

TROUBLE SHOOTING

If the Bearing is worn, the Turbine will not be able to turn properly, resulting in a noisy and/or vibrating DB1.

REMEDY

Replace the Bearing — Service Kit Number SK-DP1-C50-015

COMPONENT

PC Cards

MAINTENANCE

Under normal working conditions:

- any one of the three electrical components (Generator Board, Controller, or Battery Interface) could become damaged by a lightning strike or other power surge

TROUBLE SHOOTING

Loss of communication between the Controller and the Generator
Will not allow start-up of Generator

REMEDY

Replace the parts — Service Kit Numbers:

Generator Board	SK-SS-C85-1522
Controller Board	SK-DP1-C60-005
Interface	SK-DP1-C60-010

USER NOTES

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USER NOTES

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Warranty

A. Warranty

PGI International warrants that at the time of shipment the products manufactured by PGI International and sold hereunder will be free from defects in material and workmanship, and will conform to the specifications furnished by PGI International.

B. Warranty Adjustment

- 1) If any defect within this warranty appears, Buyer shall notify PGI International immediately.
- 2) PGI International agrees to repair or furnish a replacement for, but not install, any product which within one (1) year from the date of shipment by PGI International shall, upon test and examination by PGI International, prove defective within the above warranty.
- 3) No product will be accepted for return or replacement without the written authorization of PGI International. Upon such authorization, and in accordance with instructions by PGI International, the product will be returned shipping charges prepaid by Buyer. Replacements made under this warranty will be shipped prepaid. All returns must be shipped in the original packaging.

C. Exclusions from Warranty

- 1) THE FOREGOING WARRANTY IS IN LIEU OF AND EXCLUDES ALL OTHER EXPRESSED OR IMPLIED WARRANTIES OR MERCHANTABILITY, OR FITNESS, OR OTHERWISE.
- 2) Components manufactured by any supplier other than PGI International shall bear only the warranty made by the manufacturer of that product, and PGI International assumes no responsibility for the performance or reliability of the unit as a whole. Elastomer seals or **battery packs** that require replacement as a result of normal operation are also excluded.
- 3) In no event shall PGI International be liable for indirect, incidental or consequential damages nor shall the liability of PGI International arising in connection with any products sold hereunder (whether such liability arises from a claim based on contract, warranty, tort or otherwise) exceed the actual amount paid by Buyer to PGI International for the products delivered hereunder.
- 4) The warranty does not extend to any product manufactured by PGI International which has been subjected to misuse, neglect, improper installation or to use in violation of instructions furnished by PGI International.
- 5) The warranty does not extend to or apply to any unit which has been repaired or altered at any place other than PGI International's factory or to service performed by persons not expressly approved by PGI International or to specifications not furnished by PGI International.



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