



Protection, control, monitoring and recording functions for AC generators in a single compact package.

Features and Benefits

- High dependability and security
- Extensive self-diagnostic routines
- Redundant power supply
- Adaptive sampling frequency for better protection during startup
- Extensive recording capabilities (last 100 events, three fault reports)
- Oscillography (120 cycles)
- Compact to reduce space requirements
- Modular construction for easy maintenance

Applications

- Any size AC generators driven by steam, gas and hydraulic turbine

Protection and Control

- Stator differential
- 100% stator ground faults
- Current unbalance

Monitoring and Metering

- Negative sequence current
- Third harmonic voltages

User Interfaces

- 16 character LED display, 20 button keypad
- Two RS232 ports



Protection and Control

The DGP is a Digital Generator Protection system for any size of AC generator driven by steam, gas or hydraulic turbine. A high degree of security is provided via extensive self-diagnostics and an optional redundant power supply. Protection features include:

Current Unbalance

The DGP protects the generator from heating caused by current unbalance, using a formula based on the negative sequence component of the stator current. A linear reset allows the machine to cool down, and an alarm function is operated by the negative sequence component.

Stator Differential

High-speed protection during internal phase-to-phase faults and three-phase faults is provided. This function can provide high-speed phase-to-ground protection provided the neutral of the machine is grounded or another machine operating in parallel is grounded.

Anti-Motoring

The DGP includes a one or two-step anti-motoring reverse power function with individual time delay adjustments. One step can be used for sequential tripping of the generator, in which the turbine is tripped first. This step is enabled when closing of turbine inlet valves is indicated by digital input. The trip sequence is then continued when its delay time elapses. The second step is intended to provide backup to the sequential trip. If the sequential trip is not enabled, the two devices can be used as two-step reverse power functions with independent timers.

Ground Overcurrent

This inverse overcurrent function can be used to detect stator ground faults in a high or low resistance grounded generator system.

Time Overcurrent with Voltage Restraint

Protection against prolonged generator contribution to a fault on the system is provided through a time-overcurrent function with voltage restraint, as part of the system backup protection. This function is controlled by a fault detector and a Voltage Transformer Fuse Failure (VTFF) condition.

Stator Ground

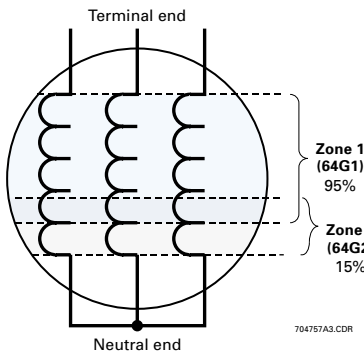
Two overlapping zones provide stator ground fault detection in a high impedance grounded generator system.

Zone 1 uses a fundamental frequency neutral overvoltage to cover about 95% of the stator winding, based on the pickup voltage setting.

Zone 2 is based on comparing the third harmonic voltage at the generator neutral with the total third harmonic voltage generated. This function is designed to cover 15% of the neutral end of the stator windings, and is controlled by fundamental and third harmonic voltage thresholds. Together the two zones cover 100% of the stator windings.

Alternatively, Zone 1 can be used as a generator-bus ground detector in a high-impedance grounded or ungrounded system.

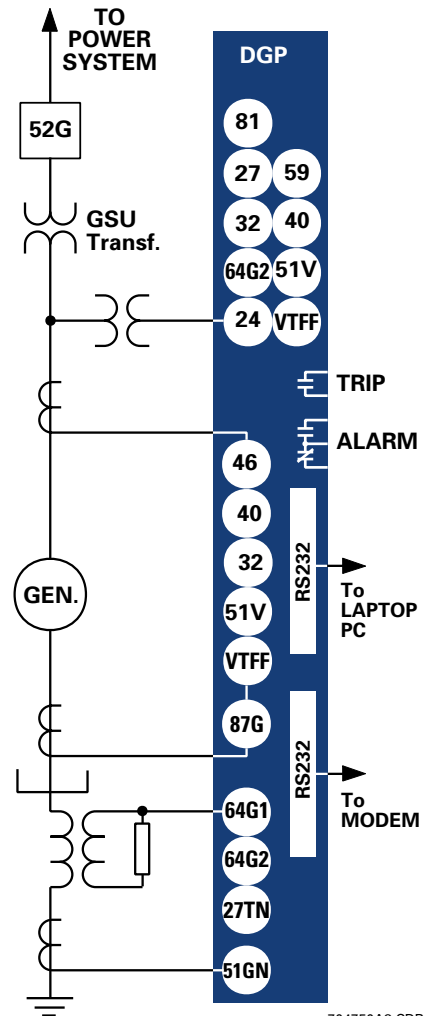
The DGP uses two overlapping zones to detect stator ground faults.



Loss of Excitation

When a synchronous generator loses excitation, it acts as an induction generator: running above normal speed, operating at

Functional Block Diagram



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DEVICE PROTECTION	
87S	Generator differential
46	Current unbalance
40	Loss of excitation
32	Anti-motoring
51V	TOC with voltage restraint
64G	100% stator ground
51GNP	Stator ground overcurrent
27TN	3rd harmonic neutral undervoltage
24	Overexcitation
59	Overvoltage
27P	Undervoltage
81	Over and underfrequency
50/27	Accidental energization
VTFF	Voltage transformer fuse failure

reduced power, and receiving its excitation (vars) from the system. The DGP's loss of excitation function includes two mho characteristics featuring individually adjustable reach, offset, and time delay. The DGP will block this function if it detects a negative sequence voltage, which would indicate a VTFF, or an external VTFF signal.

The first zone mho function can be set to detect severe cases of excitation failure with a short time delay. The second zone mho function can be set to detect all the excitation failure cases with a longer time delay setting. This permits system security during stable power system swing conditions.

Overexcitation Protection

Provided through a Volts/Hertz function with inverse and instantaneous time delay characteristics. The overexcitation protection includes trip and alarm functions computed for each of the three-phase voltages. The trip function incorporates a user-configurable linear reset characteristic to mimic machine cooling.

Over and Undervoltage

The undervoltage function consists of a positive sequence undervoltage with a user-selectable inverse or definite time characteristic. The overvoltage function consists of a positive sequence overvoltage with an inverse characteristic. A linear reset characteristic is incorporated for both functions. The overvoltage function can be used as a backup to the overexcitation. The undervoltage function also provides voltage phase reversal protection.

Over and Underfrequency

Up to four steps of protection are included, each with an adjustable time delay. The steps are controlled by an adjustable positive sequence voltage level.

Voltage Transformer Fuse Failure (VTFF)

When a fuse failure is detected, the DGP will block tripping by the loss of excitation and TOC with voltage restraint functions, as they may continue operating with a loss of AC.

Accidental Energization

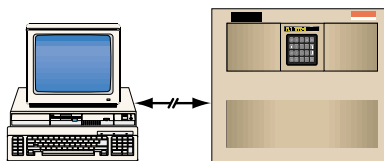
The DGP system uses internal logic to detect accidental energization of the generator.

Configurable I/Os

Two general purpose contact converter inputs allow easy connection of external trip or alarm contacts, permitting use of the event log and configurable outputs of the DGP. An optional input can be configured to disable all protections functions.

Eight configurable output relays, four trip and four alarm, allow the user to select any desired combination of the functions. Output relays can be controlled remotely or locally through a secured authorization or hardwire jumper.

The control functions of the DGP can operate output relays locally or remotely.



Configurable Logic

The DGP allows strategic modification of internal logic to favor either security or dependability. This can be accomplished either by software settings or automatically by a "Generator Offline" contact input. This feature allows disabling of selected functions when the generator is offline and modification of the Accidental Energization logic.

Contact Expansion Unit

The DEC 1000 unit is an intelligent contact expansion unit that provides an additional 11 output relays, five with contacts in 'C'

configuration, and six with normally open contacts. Eleven LEDs indicate operation of contacts, and a reset button tests and resets the unit. Available for "CA" model only.

The DEC 1000 expands the number of outputs controlled by the DGP.



Monitoring and Metering

The DGP features advanced metering and event recording functions which include:

Self-Tests and Diagnostics

Self-test routines are performed during power-up and continue to run in the background during service. Failures are categorized as either a critical or non-critical alarm. Appropriate protective functions are automatically disabled during a critical alarm, helping to maintain the high security of the DGP.

The DGP also has a RELAY TEST menu which facilitates installation by allowing testing of individual protective functions and output relays for the protection system.

Trip Circuit Monitor

This function consists of the Trip Voltage Monitor (TVM) and the Trip Current Monitor (TCM) for up to four trip output contacts. The TVM detects any discontinuity in the external trip circuit and produces a non-critical alarm. The TCM confirms energizing of the trip circuit when a trip is issued by the DGP. To protect the output contacts the TCM may be used to seal-in the trip output as long as trip current is flowing.

Metering

The DGP provides the following metering values:

- Currents (I_a, I_b, I_c)
- Voltages (V_a, V_b, V_c or V_{ab}, V_{bc}, V_{ca})

- Angles of I and V
- Negative sequence current (%I₂)
- Third harmonic voltages (phase/neutral)
- Watts (three-phase)
- Vars (three-phase)
- Frequency
- Contact inputs (status)

The currents, voltages, watts, and vars can be metered as either primary or secondary values to an accuracy of 3%.

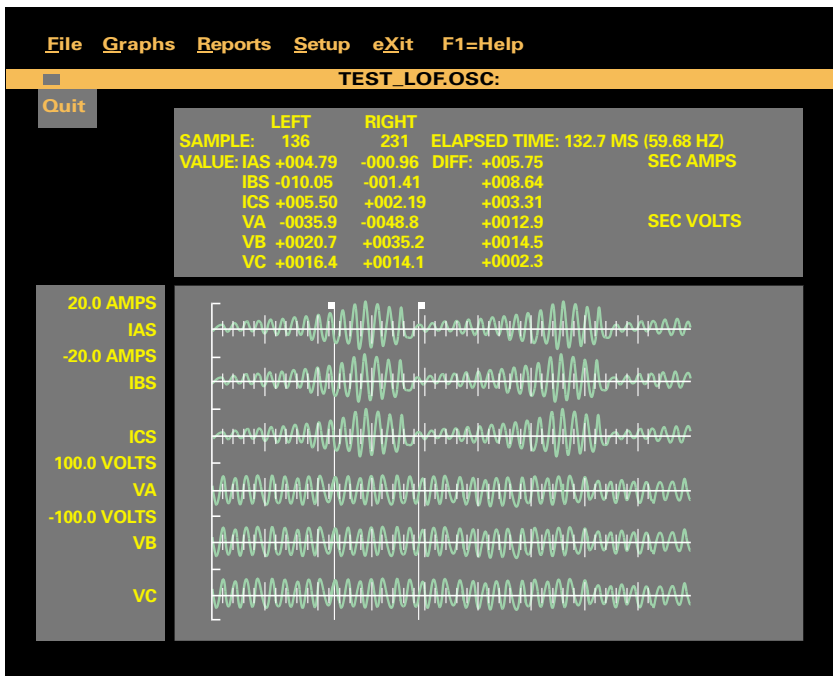
Event Recording

The last 100 events are time tagged in milliseconds and stored in the DGP's memory. Event data is available via the RS232 ports and the optional printer port for analysis.

The DGP stores the last 100 events.

Time	Description
10/29/93 14:40:42.276	*AG TRIP CIRCUIT OPEN ALARM OFF
10/29/93 14:39:54.971	*AG TRIP CIRCUIT OPEN ALARM ON
10/29/93 14:33:35.660	*AG TRIP SIGNAL RESET
10/29/93 14:33:35.660	32.1 OFF
10/29/93 14:33:35.639	32.2 OFF
10/29/93 14:33:34.966	32.1 ON
10/29/93 14:33:31.997	TURBINE INLET VALVE CLOSED
10/29/93 14:33:28.423	GENERATOR OFF LINE
10/29/93 14:33:26.452	*AG TRIP SIGNAL ON
10/29/93 14:33:26.451	32.2 ON
10/29/93 14:27:59.878	GENERATOR ON LINE
10/29/93 14:27:04.968	TURBINE INLET VALVE OPEN
10/29/93 14:26:54.203	*AG TRIP SIGNAL RESET
10/29/93 14:26:54.202	*AG TRIP
10/29/93 14:26:50.911	TURBINE INLET VALVE CLOSED
10/29/93 14:26:47.584	GENERATOR OFF LINE
10/29/93 14:26:42.604	*AG TRIP SIGNAL ON
10/29/93 14:26:42.603	GAGI ON
10/29/93 14:25:44.444	GENERATOR ON LINE
10/29/93 14:25:38.202	TURBINE INLET VALVE OPEN
10/29/93 16:32:31.642	REMOTE - SETTINGS CHANGE DONE
10/29/93 16:32:30.882	REMOTE - SETTINGS CHANGE STARTED

The DGP can store 120 cycles of oscillography.



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Fault Reports

The DGP stores the last three fault reports in its memory. A fault report is generated by any protective function trip or by an externally triggered input.

Oscillography

The DGP can capture and store 120 cycles of oscillography data which can be divided into one, two, or three partitions. Up to 20 pre-fault cycles can be captured. In addition to 12 analog waveforms (currents and voltages) the DGP captures internal logic flags and contact I/O status. The DGP settings at time of capture are also stored as part of the data, along with the fault report.

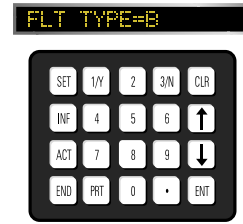
User Interfaces

The 489 allows users ease of access through:

Keypad and Display

A 20 button keypad and a 16 character LED display allow the user easy access to settings and data. Two distinct security passwords limit tampering.

A keypad and display are provided for local user interface.



LED Indicators

Over eighteen LEDs on the front panel provide easy and immediate indication of the phase and fault type. A two-color LED (red and green) is also provided to indicate the relay status.

Communications

Two RS232 serial ports are provided on the DGP, one on the front and one on the rear. The port on the front allows easy local user interface via a laptop computer. The rear port can be used to interface with a remote computer via modem. There are three levels of security password provided for remote communications. For added security, hardware jumpers can disable setting changes and control actions from a computer.

For remote link communications, DGP offers a choice of **GE-MODEM or *ModBus® protocol, each supplied with a copy of GE-LINK remote communication software. In addition to the GE-LINK, a copy of the DGP-DATA software is also supplied with the relay for oscillography data analysis of DGP data.

* ModBus® available with "CA" model only. Requires an optional RS485 to RS232 converter.

** New Windows® version of GE-LINK for ModBus® protocol.

Time Synchronization

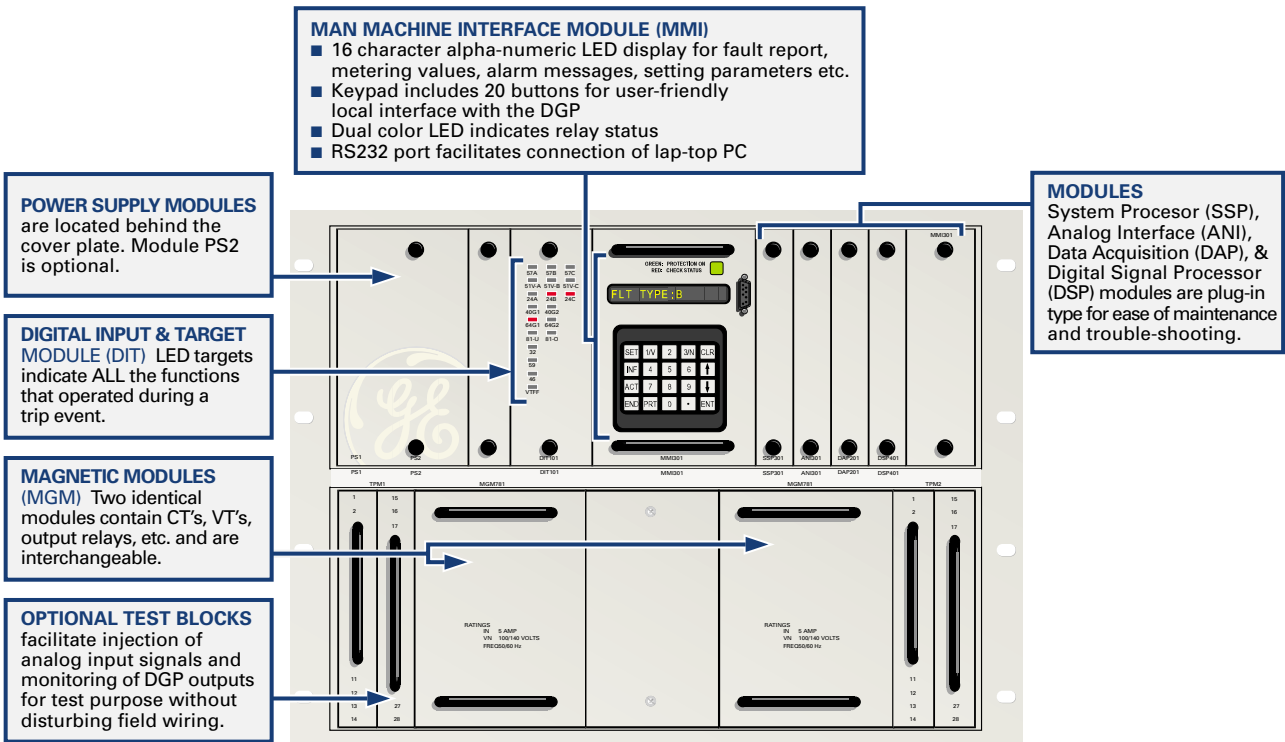
An IRIG-B input is provided for time synchronization via satellite signal.

Drawout Construction

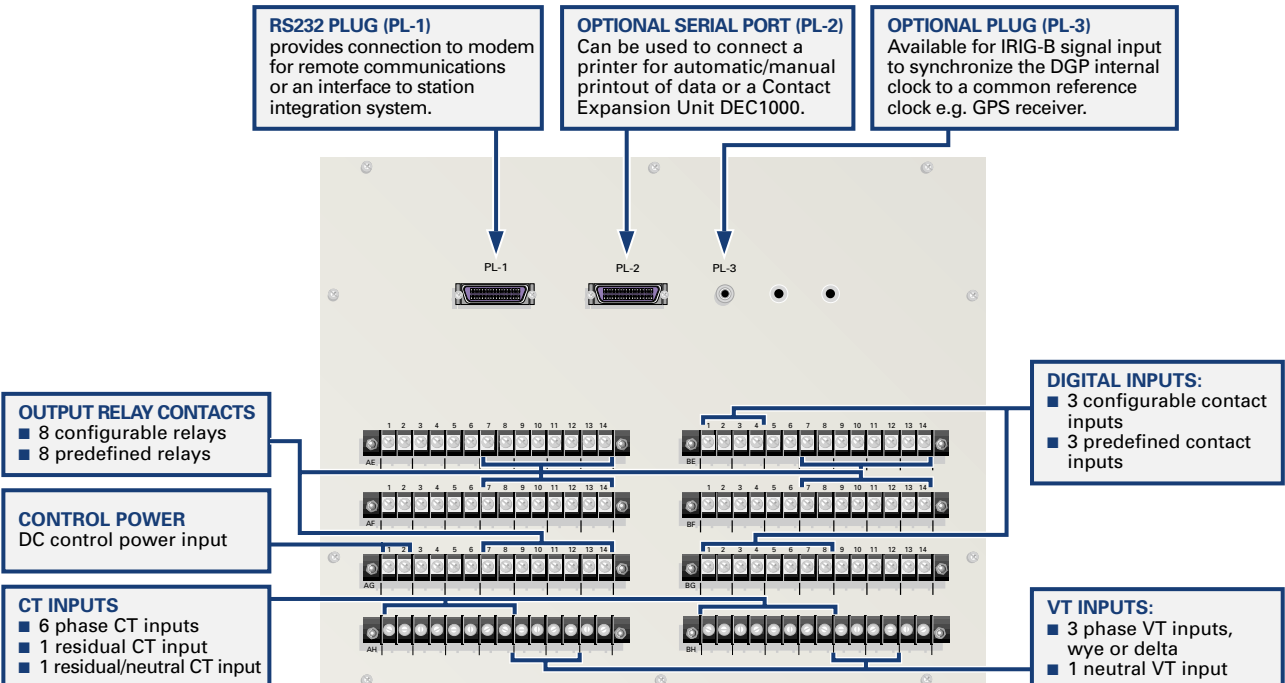
The drawout construction of the DGP case allows for all internal components to be withdrawn from the front of the relay.

Features

Front View

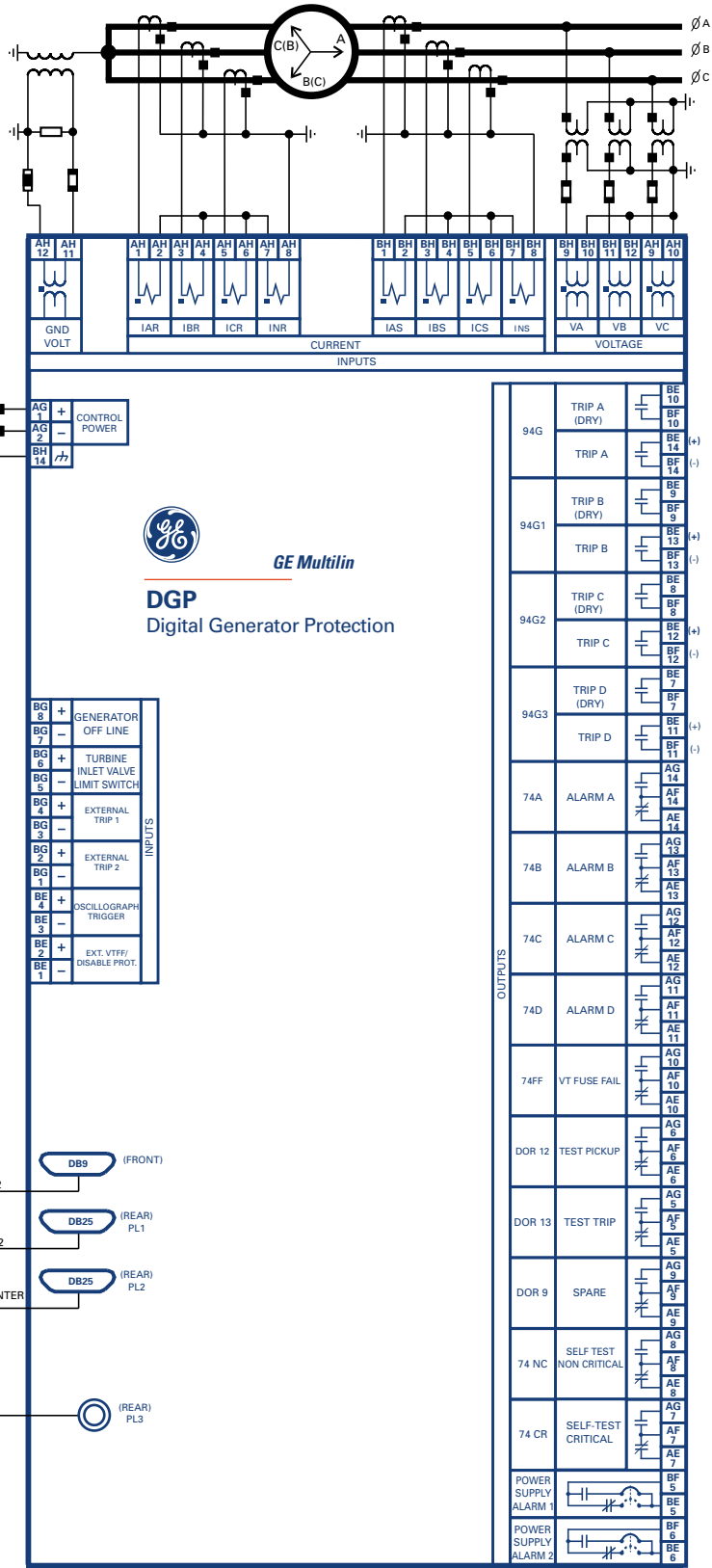


Rear View



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Typical Wiring



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DGP Technical Specifications

PROTECTION		
General differential (87G):		
Differential current pickup:	In = 1 A: 0.04 – 0.2 A	In = 5 A: 0.2 – 1.0 A
% slope factor:	1 – 10	1 – 10
Current unbalance (46A, 46T):		
Neg. seq. current pickup:	0.01 – 0.60 A	0.5 – 2.99 A
Machine constant (46T):	1 – 45	1 – 45
Alarm time delay (46A):	1 – 9 sec	1 – 9 sec
Loss of field (40):		
Zone 1 and Zone 2 center:	12.5 – 300 Ω	2.5 – 60 Ω
Zone 1 and Zone 2 radius:	12.5 – 300 Ω	2.5 – 60 Ω
Zone 1 and Zone 2 timer:	0.01 – 9.99 sec	0.01 – 9.99 sec
Anti-motoring (32-1 & optional 32-2):		
Reverse power:	0.1 – 20.0 W	0.5 – 99.9 W
Time delay:	1 – 120 sec	
Stator ground (64G1 & optional 64G2):		
Neutral OV pickup:	4 – 40 V	
Time delay (for 64G1):	0.1 – 9.9 sec	
Time delay (for 64G2):	0.1 – 9.9 sec	
3rd harmonic neutral undervoltage (27TN):		
U/V setpoint:	0.1 – 9.9 V	
Time delay:	0.5 – 99.9 sec	
Overexcitation, (24T, 24I, 24A):		
V/Hz pickup:	1 – 1.99 PU	
Time factor (24T-inverse):	0.1 – 99.99	
Time delay (instantaneous):	0 – 9.9 sec	
Time delay (24A-alarm):	0 – 9.9 sec	
Rate of reset:	0 – 999 sec	
Undervoltage, optional (27):		
U/V set point:	40 – 120 V	
Time factor:	0.1 – 99.99 sec	
Curve select:	Inverse/definite time	
Overvoltage (59):		
O/V set point:	100 – 225 V	
Time factor:	0.1 – 99.99 sec	
Over and underfrequency, up to four steps (81):		
O/F set point (each step):	45 – 0.79.9 Hz	
U/F set point (each step):	40 – 65 Hz	
Time delay (each step):	0.05 – 99.99 sec	
Time delay (U/F step 1):	0.1 – 999.9 sec	
System Backup (51V):		
Overcurrent pickup:	0.1 – 3.2 A	0.5 – 16 A
Time factor:	0.1 – 99.99 sec	0.1 – 99.99 sec

METERING	
RATINGS	
Nominal frequency:	50 or 60 Hz
Frequency tracking:	30 – 80 Hz
Nominal voltage (phase-phase):	100 – 210 VAC
Rated current:	$I_n = 1$ or 5 A
Maximum permissible current:	
Continuous	$2 \times I_n$
Three sec	$50 \times I_n$
One sec	$100 \times I_n$
Maximum permissible AC voltage:	
Continuous	280 VAC
One min (once per hour)	490 VAC
ACCURACY	
RMS measurements:	± 3%
Phase angle measurements:	± 1°
Frequency measurements:	± 0.01 Hz
Timers:	± 3% of setting
Data time tag resolution:	± 1 ms

POWER SUPPLY	
DC control voltage:	
48 VDC	38.5 – 60 VDC
110/125 VDC	88 – 150 VDC
220/250 VDC	176 – 300 VDC

INPUTS	
BURDENS	
Current circuits:	0.022 Ω, 5° for $I_n = 5$ A 0.12 Ω, 30° for $I_n = 1$ A @ 60 Hz 0.0507 ∠ 4.738
Voltage circuits:	0.30 VA, 60 Hz 0.40 VA, 50 Hz
DC battery:	
Power supply:	19 W with 1 supply 25 W with 2 supplies
For contact converters:	2.5 mA at rated voltage

COMMUNICATIONS	
INTERFACE DATA	
System interface:	DB25, RS232 port – rear panel DB9, RS232 port – front panel IRIG-B port – rear panel (optional) Printer port – rear panel (optional)

OUTPUTS	
CONTACT DATA	
Trip outputs (4 programmable relays, 2 contacts each)	
Trip contacts:	Continuous rating = 3 A Make and carry 30 A per ANSI C37.90 Interrupting = 60 VA inductive, maximum 250 V or 0.5 A
Alarm outputs (4 programmable & 5 predefined relays, 1 contact each)	
Alarm contacts:	Continuous rating = 3 A Make and carry 5 A for 30 sec Interrupting = 60 VA inductive, maximum 250 V or 0.5 A
Trip current monitor sensitivity: 150 mA	
Trip voltage monitor: 38 – 300 VDC	
Digital inputs: 38 – 300 VDC, 1 – 3 mA	

ENVIRONMENTAL	
Ambient temperature range:	
Storage:	-30° C to +70° C
Operation:	-20° C to +55° C
Humidity:	95% without condensation

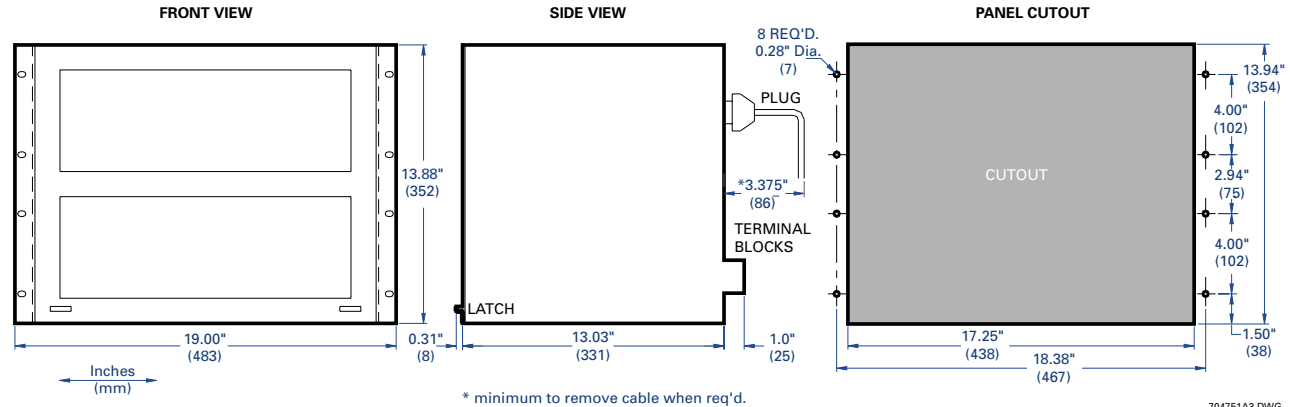
TYPE TESTS	
Insulation test voltage:	2kV 50/60 Hz, one min 2.8kV VDC, one min
Impulse voltage withstand:	5 kV peak, 1.2/50 μsec, 0.5 J
Interference test withstand:	SWC, per ANSI C37.90.1 & IEC 255-5
Vibration test withstand:	IEC255-21-1

PACKAGING	
Net weight:	51 lbs (23 kg)
Dimensions:	
Height:	14" (352 mm) 8 rack units
Width:	19" (484 mm) standard 19" rack
Depth:	14" (356 mm)

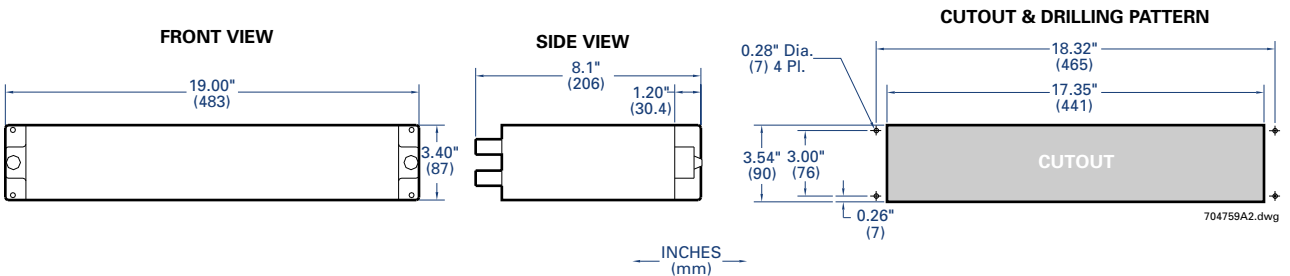
APPROVALS	
UL - UL listed for USA and Canada	

*Specifications subject to change without notice.

Dimensions



DEC1000 Mounting



DGP Guideform Specifications

For an electronic version of the DGP guideform specifications, please visit: www.GEindustrial.com/Multilin/specs, fax your request to 905-201-2098 or email to literature.multilin@indsys.ge.com.



3

Ordering

Note that the DGP relay with special configuration of printer port is required for the DEC1000 to function properly.

DGP	*	*	*	*	*	*	
DGP							Digital Generator Protection
1							1 A rated
5							5 A rated
0							One power supply, 48 VDC
1							One power supply, 110/125 VDC
2							One power supply, 220/250 VDC
3							Two power supplies, 48 VDC
4							Two power supplies, 110/125 VDC
			A				With test blocks, gray case
			B				Without test blocks, gray case
			A				GE-MODEM communication protocol
			B				ModBus® communication protocol (not available with Function Group A/B)
				A			Function Group A } See DGP
				B			Function Group B } Selection Guide*
				C			Function Group C } on the right
					A		Revision level

Optional RS485 to RS232 converter available for use with ModBus® version

DEC 1000A	***	*	00C
DEC			

			Select the three digit code from the DEC Selection Guide† on the right or fill in desired function assignment for the DEC1000 output relays R1-R11 using Table 1 and submit with the order. Codes 001 to 005 are already assigned and are available as described. Any protection function available in the companion DGP relay can be selected for the DEC output relay assignment
		F	Vps = 24 – 48 VDC
		H	Vps = 110 – 250 VDC

*DGP Selection Guide

FUNCTIONS AND FEATURES	FUNCTION GROUP		
	A	B	C
Stator differential 87G	X	X	X
Current unbalance 46	X	X	X
Loss of excitation 40-1, -2	X	X	X
OC – voltage restraint 51V	X	X	X
Stator ground 64G1 (fundamental OV)	X	X	X
Overexcitation 24 (Volts/Hz)	X	X	X
Overvoltage 59	X	X	X
Accidental energization logic	X	X	X
Sequential trip logic	X	X	X
VT fuse failure	X	X	X
Oscillography capture	X	X	X
IRIG-B input	X	X	X
Anti-motoring 32	2 setpoints	1 setpoint	2 setpoints
Stator ground 64G2 (3rd Harm. UV)	X	—	X
Neutral OC 51GN	—	X	X
Undervoltage 27	—	X	X
Stator GND 27TN	—	X	X
Underfrequency 81-U	4 setpoints	2 setpoints	4 setpoints
Overfrequency 81-O	4 setpoints	2 setpoints	2 setpoints
Printer output	X	—	X
DEC1000 compatible	—	—	X
Communication ports	2-RS232	2-RS232	2-RS232

Example: **DGP54BBCA** – DGP rated 5 A, 50/60 Hz, 110/125 VDC redundant power supplies, no built-in test blocks, ModBus® protocol, function group C, revision A.

The following special DGP™ systems are also available. Refer to factory for other special requirements.
DGP***AAA-0101 – Similar to 'AAA' except single voltage-rated digital inputs, special logic for function 51V and separate terminals for power supply inputs.

†DEC Selection Guide

CODE	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11
001	32-2	59	81O1	81-2	81U1	81U2	40	46-2	46-1	32-1	—
002	32-1	64G2	46-1	32-2	64G1	40-1	87G-A	87G-B	87G-C	46-2	40-2
003	87G①	64G②	32-2	51GN	24③	87G①	64G②	32-2	51GN	24③	32-1
004	46T	51V①	59	81O1	81U1	46T	51V①	59	81O1	81U1	40-1
005	46T	51V①	59	64G1	87G①	D13	D14	32-1	—	—	—
③											
③											

①Indicates any phase – A, B, or C ②Indicates any zone – 1 or 2 ③Code assigned by GE