Digital Generator Protection

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

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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.

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.

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.

www.GEindustrial.com/Multilin
The DGP can store 120 cycles of oscillography. The DGP stores the last 100 events. Event data is available via the RS232 ports and the DGP’s memory. Event data is available via the RS232 ports and the DGP’s memory. 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 DGP’s memory. 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.

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 prefault 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.

Communication
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, hardwire 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. In addition to GE-LINK, a copy of the DGP-DATA software is also supplied with the relay for oscillography data analysis of DGP data.

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

**MAN MACHINE INTERFACE MODULE (MMI)**
- 16 character alpha-numeric LED display for fault report, metering values, alarm messages, setting parameters etc.
- Keypad includes 20 buttons for user-friendly local interface with the DGP
- Dual color LED indicates relay status
- RS232 port facilitates connection of lap-top PC

**POWER SUPPLY MODULES**
- are located behind the cover plate. Module PS2 is optional.

**DIGITAL INPUT & TARGET MODULE (DIT)**
- LED targets indicate ALL the functions that operated during a trip event.

**MAGNETIC MODULES**
- (MGM) Two identical modules contain CT’s, VT’s, output relays, etc. and are interchangeable.

**OPTIONAL TEST BLOCKS**
- facilitate injection of analog input signals and monitoring of DGP outputs for test purpose without disturbing field wiring.

Rear View

**RS232 PLUG (PL-1)**
- provides connection to modem for remote communications or an interface to station integration system.

**OPTIONAL SERIAL PORT (PL-2)**
- Can be used to connect a printer for automatic/manual printout of data or a Contact Expansion Unit DEC1000.

**OPTIONAL PLUG (PL-3)**
- Available for IRIG-B signal input to synchronize the DGP internal clock to a common reference clock e.g. GPS receiver.

**OUTPUT RELAY CONTACTS**
- 8 configurable relays
- 8 predefined relays

**CONTROL POWER**
- DC control power input

**CT INPUTS**
- 6 phase CT inputs
- 1 residual CT input
- 1 residual/neutral CT input

**VT INPUTS**
- 3 phase VT inputs, wye or delta
- 1 neutral VT input

**DIGITAL INPUTS:**
- 3 configurable contact inputs
- 3 predefined contact inputs

www.GEindustrial.com/Multilin
Typical Wiring
**DGP Technical Specifications**

### PROTECTION

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>In = 1 A In + 5 A</td>
<td></td>
</tr>
<tr>
<td>General differential (17G):</td>
<td></td>
</tr>
<tr>
<td>Differential current pickup:</td>
<td>0.94 – 0.2 A</td>
</tr>
<tr>
<td>% slope factor:</td>
<td>1 – 10</td>
</tr>
<tr>
<td>Current unbalance (46A, 48):</td>
<td>0.5 – 3.99 A</td>
</tr>
<tr>
<td>Neg. seq. current pickup:</td>
<td>0.01 – 0.60 A</td>
</tr>
<tr>
<td>Machine constant (46T):</td>
<td>1 – 45</td>
</tr>
<tr>
<td>Alarm time delay (46A):</td>
<td>1 – 9 sec</td>
</tr>
<tr>
<td>Loss of field (48):</td>
<td>Zone 1 and Zone 2 center: 12.5 – 300 V</td>
</tr>
<tr>
<td>Zone 1 and Zone 2 radius: 12.5 – 300 V</td>
<td></td>
</tr>
<tr>
<td>Anti-motoring (32-1 &amp; optional 32-2):</td>
<td>0.01 – 9.99 sec</td>
</tr>
</tbody>
</table>

### METERING

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
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</thead>
<tbody>
<tr>
<td>Nominal frequency:</td>
<td>50 or 60 Hz</td>
</tr>
<tr>
<td>Frequency tracking:</td>
<td>30 – 80 Hz</td>
</tr>
<tr>
<td>Nominal voltage (phase-phase):</td>
<td>100 – 210 VAC</td>
</tr>
<tr>
<td>Rated current:</td>
<td>Ieq = 1 or 5 A</td>
</tr>
<tr>
<td>Maximum permissible current:</td>
<td>2 x Ieq</td>
</tr>
<tr>
<td>Minimum permissible AC voltage:</td>
<td>280 VAC</td>
</tr>
<tr>
<td>One min (once per hour)</td>
<td>480 VAC</td>
</tr>
</tbody>
</table>

### POWER SUPPLY

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>DC control voltage:</td>
<td>48 VDC</td>
</tr>
<tr>
<td>110/125 VDC</td>
<td>88 – 150 VDC</td>
</tr>
<tr>
<td>220/250 VDC</td>
<td>176 – 300 VDC</td>
</tr>
</tbody>
</table>

### INFRARED-B port

- IRIG-B port – rear panel (optional)
- DB9, RS232 port – front panel
- DB25, RS232 port – rear panel

### COMMUNICATIONS

- TRUTH & TIME

### CONTACT DATA

- Trip contacts: Continuous rating = 3 A
- Make and carry 3 A per ANSI C37.00
  - Interrupting = 60 VA inductive, maximum 250 V or 0.5 A
- Alarm outputs:
  - 4 programmable & 5 predefined relays, 1 contact each
  - Continuous rating = 3 A
  - Make and carry 3 A for 30 sec
  - Interrupting = 60 VA inductive, maximum 250 V or 0.5 A

### VIBRATION TEST WITHSTAND

- IEC 255-5

### PACKAGING

- UL – UL listed for USA and Canada

### APPROVALS

- Dimensions: 14” (352 mm) 8 rack units
- Width: 19” (484 mm) standard 19” rack
- Depth: 14” (356 mm)

**Environmental**

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ambient temperature range:</td>
<td>Storage: 30°C to 70°C</td>
</tr>
<tr>
<td>Operation: 20°C to 55°C</td>
<td></td>
</tr>
<tr>
<td>Humidity:</td>
<td>95% without condensation</td>
</tr>
</tbody>
</table>

**Type Tests**

<table>
<thead>
<tr>
<th>Specification</th>
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</thead>
<tbody>
<tr>
<td>Insulation test voltage:</td>
<td>2 kV 50/60 Hz, one min</td>
</tr>
<tr>
<td>Impulse voltage withstand:</td>
<td>5 kV peak, 1.2/50 µsec, 0.5 J</td>
</tr>
<tr>
<td>Interference test withstand:</td>
<td>DVC, per ANSI C37.90.1 &amp; IEC 255-5</td>
</tr>
<tr>
<td>Vibration test withstand:</td>
<td>IEC295-21-1</td>
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**Lightning Test Voltage**

- 3 kV 50/60 Hz, one min

**Outputs**

### METERING

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  - Interrupting = 60 VA inductive, maximum 250 V or 0.5 A
- Alarm outputs:
  - 4 programmable & 5 predefined relays, 1 contact each
  - Continuous rating = 3 A
  - Make and carry 3 A for 30 sec
  - Interrupting = 60 VA inductive, maximum 250 V or 0.5 A
- Trip current monitor sensitivity: 190 mA
- Trip voltage monitor: 38 – 300 VDC
- Digital inputs: 38 – 300 VDC, 1 – 3 mA

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<td>Vibration test withstand:</td>
<td>IEC295-21-1</td>
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**Packaging**

- Net weight: 51 lbs (23 kg)
- Dimensions: 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

#### FRONT VIEW

**Dimensions:**

- 19.00” (483)
- 3.40” (87)
- 3.10” (79)
- 13.88” (352)

#### SIDE VIEW

**Dimensions:**

- 8” (203)
- 1.20” (30.4)
- 0.28” (7)

**Panel Cutout:**

- 13.34” (340)
- 4.00” (102)
- 2.04” (51)
- 4.03” (102)

**CUTOUT & DRILLING PATTERN**

- 7047383A REV A

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**DEC1000 Mounting**

#### FRONT VIEW

**Dimensions:**

- 19.00” (483)
- 8.1” (206)

#### SIDE VIEW

**Dimensions:**

- 1.20” (30.4)
- 0.28” (7)

**Cutout & Drilling Pattern**

- 13.34” (340)
- 4.00” (102)
- 2.04” (51)
- 4.03” (102)

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### 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.

### Ordering

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

<table>
<thead>
<tr>
<th>DGP</th>
<th>* * * * *</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Digital Generator Protection</td>
</tr>
<tr>
<td>1</td>
<td>1 A rated</td>
</tr>
<tr>
<td>5</td>
<td>5 A rated</td>
</tr>
<tr>
<td>0</td>
<td>One power supply, 48 VDC</td>
</tr>
<tr>
<td>1</td>
<td>One power supply, 110/125 VDC</td>
</tr>
<tr>
<td>2</td>
<td>One power supply, 220/250 VDC</td>
</tr>
<tr>
<td>3</td>
<td>Two power supplies, 48 VDC</td>
</tr>
<tr>
<td>4</td>
<td>Two power supplies, 110/125 VDC</td>
</tr>
<tr>
<td>A</td>
<td>With test blocks, gray case</td>
</tr>
<tr>
<td>B</td>
<td>Without test blocks, gray case</td>
</tr>
<tr>
<td>A</td>
<td>GE-MODEM communication protocol</td>
</tr>
<tr>
<td>B</td>
<td>ModBus® communication protocol</td>
</tr>
</tbody>
</table>

*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

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.

<table>
<thead>
<tr>
<th>CODE</th>
<th>R1</th>
<th>R2</th>
<th>R3</th>
<th>R4</th>
<th>R5</th>
<th>R6</th>
<th>R7</th>
<th>R8</th>
<th>R9</th>
<th>R10</th>
<th>R11</th>
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<td>002</td>
<td>X</td>
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</table>

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

### DEC Selection Guide

<table>
<thead>
<tr>
<th>CODE</th>
<th>B1</th>
<th>B2</th>
<th>B3</th>
<th>B4</th>
<th>B5</th>
<th>B6</th>
<th>B7</th>
<th>B8</th>
<th>B9</th>
<th>B10</th>
<th>B11</th>
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*Indicates any phase – A, B, or C  †Indicates any zone – 1 or 2  ‡Code assigned by GE

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.

Vps = 24 – 48 VDC

H | Vps = 110 – 250 VDC