User Manual

Allen-Bradley

# Combination Generator Control Module

Catalog Numbers 1407-CGCM

Allen-Bradley • Rockwell Software

Rockwell Automation

# Important User Information

Read this document and the documents listed in the additional resources section about installation, configuration, and operation of this equipment before you install, configure, operate, or maintain this product. Users are required to familiarize themselves with installation and wiring instructions in addition to requirements of all applicable codes, laws, and standards.

Activities including installation, adjustments, putting into service, use, assembly, disassembly, and maintenance are required to be carried out by suitably trained personnel in accordance with applicable code of practice.

If this equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

In no event will Rockwell Automation, Inc. be responsible or liable for indirect or consequential damages resulting from the use or application of this equipment.

The examples and diagrams in this manual are included solely for illustrative purposes. Because of the many variables and requirements associated with any particular installation, Rockwell Automation, Inc. cannot assume responsibility or liability for actual use based on the examples and diagrams.

No patent liability is assumed by Rockwell Automation, Inc. with respect to use of information, circuits, equipment, or software described in this manual.

Reproduction of the contents of this manual, in whole or in part, without written permission of Rockwell Automation, Inc., is prohibited.

Throughout this manual, when necessary, we use notes to make you aware of safety considerations.

**WARNING:** Identifies information about practices or circumstances that can cause an explosion in a hazardous environment, which may lead to personal injury or death, property damage, or economic loss.

**ATTENTION:** Identifies information about practices or circumstances that can lead to personal injury or death, property damage, or economic loss. Attentions help you identify a hazard, avoid a hazard, and recognize the consequence.

**IMPORTANT** Identifies information that is critical for successful application and understanding of the product.

Labels may also be on or inside the equipment to provide specific precautions.

**SHOCK HAZARD:** Labels may be on or inside the equipment, for example, a drive or motor, to alert people that dangerous voltage may be present.

**BURN HAZARD:** Labels may be on or inside the equipment, for example, a drive or motor, to alert people that surfaces may reach dangerous temperatures.

**ARC FLASH HAZARD:** Labels may be on or inside the equipment, for example, a motor control center, to alert people to potential Arc Flash. Arc Flash will cause severe injury or death. Wear proper Personal Protective Equipment (PPE). Follow ALL Regulatory requirements for safe work practices and for Personal Protective Equipment (PPE).

This manual contains new and updated information. Changes throughout this revision are marked by change bars, as shown to the right of this paragraph.

## New and Updated Information

This table contains the changes made to this revision.

| Topic | Page |
|---|---|
| Updated the dimension diagrams | 14 |
| Updated the Configuration Messaging section | 129 |
| Added information for the Network status indicator | 164 |
| Added information for the Module status indicator | 165 |
| Updated the Get Attributes All (service code 0x01) table for Identity Object Instance 1 | 198 |
| Updated the Get Attributes All (service code 0x01) table for Identity Object Instance 2 | 199 |
| Added a Device Status for Identity Object Instance 2 | 199 |
| Updated the Certification information in the Agency Certifications table | 210 |

# Notes:

## Appendix B
## CGCM Unit Math Models



## Appendix C
## Additional ControlNet Network Information



## Appendix D
## Specifications



## Appendix E
## Detailed CGCM Unit Tag Descriptions



## Appendix F
## Configuration Record Worksheet



## Index

The information in this manual applies to the 1407-CGCM module, Series D, Revision A, with host firmware revision 4.25 and ControlNet firmware revision 1.07. The manual notes differences with earlier versions of the product where they occur.

## Additional Resources

These documents contain additional information concerning related products from Rockwell Automation.

| Resource | Description |
|---|---|
| Safety Guidelines for the Application, Installation and Maintenance of Solid State Controls, publication SGI-1.1 | Describes some important differences between solid-state equipment and hard-wired electromechanical devices. |
| ControlNet Coax Media Planning and Installation, publication CNET-IN002 | Provides installation procedures for the ControlNet network. |
| Logix5000™ Controllers Common Procedures, publication 1756-PM001 | Provides information about RSLogix™ 5000 software. |
| CGCM Release Notes, publication 1407-RN001 | Provides information on compatible RSLogix 5000 software versions and ControlLogix® controller firmware revisions. |
| Industrial Automation Wiring and Grounding Guidelines, publication 1770.4.1. | Provides general guidelines for installing a Rockwell Automation industrial system. |
| Product Certifications website, http://www.ab.com | Provides declarations of conformity, certificates, and other certification details. |

You can view or download publications at http://www.rockwellautomation.com/literature/. To order paper copies of technical documentation, contact your local Allen-Bradley distributor or Rockwell Automation sales representative.

# Notes:

# General Information

## Introduction

The Combination Generator Control Module (CGCM unit) is a microprocessor-based control and protection device. The CGCM unit is designed to integrate with a Logix family programmable controller to provide generator control, protection and synchronization functions. Programmability of system parameters, regulation settings, and protective functions enable the CGCM unit to be used in a wide range of applications.

## Functions

The following sections outline the functions of the unit.

### Generator Regulation and Control Functions

This list contains the generator regulation and control functions:

- Four excitation control modes
- Automatic voltage regulation (AVR)
- Manual or field current regulation (FCR)
- Power factor (PF)
- Reactive power (VAR)
- Soft start voltage buildup with an adjustable ramp in AVR and FCR control modes
- Over-excitation (OEL) and under-excitation (UEL) limiting in AVR, VAR, and PF control modes
- Under-frequency compensation (Volts/Hertz)
- Line drop compensation
- Auto-tracking between operating modes and between redundant CGCM units
- Automatic transfer to a back-up CGCM unit in redundant systems
- Generator paralleling with reactive droop compensation or cross-current (reactive differential) compensation
- Generator paralleling with real power load sharing
- Synchronizing for one or two circuit breakers

## Generator Protection Functions

This list contains the generator protection functions:

- Loss of excitation current (40)
- Over-excitation voltage (59F)
- Generator over-voltage (59)
- Generator under-voltage (27)
- Loss of sensing (60FL)
- Loss of permanent magnet generator (PMG/Excitation power) (27)
- Reverse VAR (40Q)
- Over-frequency (81O)
- Under-frequency (81U)
- Reverse power (32R)
- Rotating diode monitor
- Phase rotation error (47)
- Generator over-current (51)

## Metering Functions

This list contains the metering functions:

- Voltage
- Current
- Frequency
- Real Power
- Apparent Power
- Reactive Power
- Power Factor
- Real Energy (kWh)
- Apparent Energy (kVAh)
- Reactive Energy (kVARh)
- Controller Excitation Current and Voltage
- Diode Monitor Ripple Level
- Load Share Error
- Synchronization Parameters

## Inputs

This list contains the inputs for the CGCM unit:

- Single-phase or 3-phase true rms generator voltage sensing
- Single-phase dual bus or 3-phase single bus voltage sensing
- 3-phase generator current sensing (1 or 5 A nominal)
- Single-phase cross current loop 1 or 5 A current transformer (CT) input
- Auxiliary ±10V DC input providing remote control of the setpoints
- DC power input

## Outputs

This list contains the outputs for the CGCM unit:

- Pulse-width modulated output power stage rated at 15 A
- Discrete redundancy relay output
- Discrete fault output driver
- Load sharing connection for use with the Allen-Bradley Line Synchronization Module (1402-LSM) or compatible hardware

## Communication Interfaces

The CGCM unit has these three communication ports:

- Redundant ControlNet connector
- RS-232 port for dedicated communication with a redundant CGCM
- RS-232 port for factory configuration and test (not for customer use)

# Notes:

# Installation

## Mounting Requirements

This equipment is intended for use in a Pollution Degree 2 Industrial Environment, in over-voltage Category II applications (as defined by IEC publication 60664-1). Because the units contain a heat sink, they must be mounted vertically. Any other mounting angle reduces the heat dissipation capabilities of the units, possibly leading to premature failure of critical components. The unit can be mounted anywhere that the ambient temperature does not exceed the rated environmental conditions or clearance requirements. The clearance requirements for the CGCM unit are:

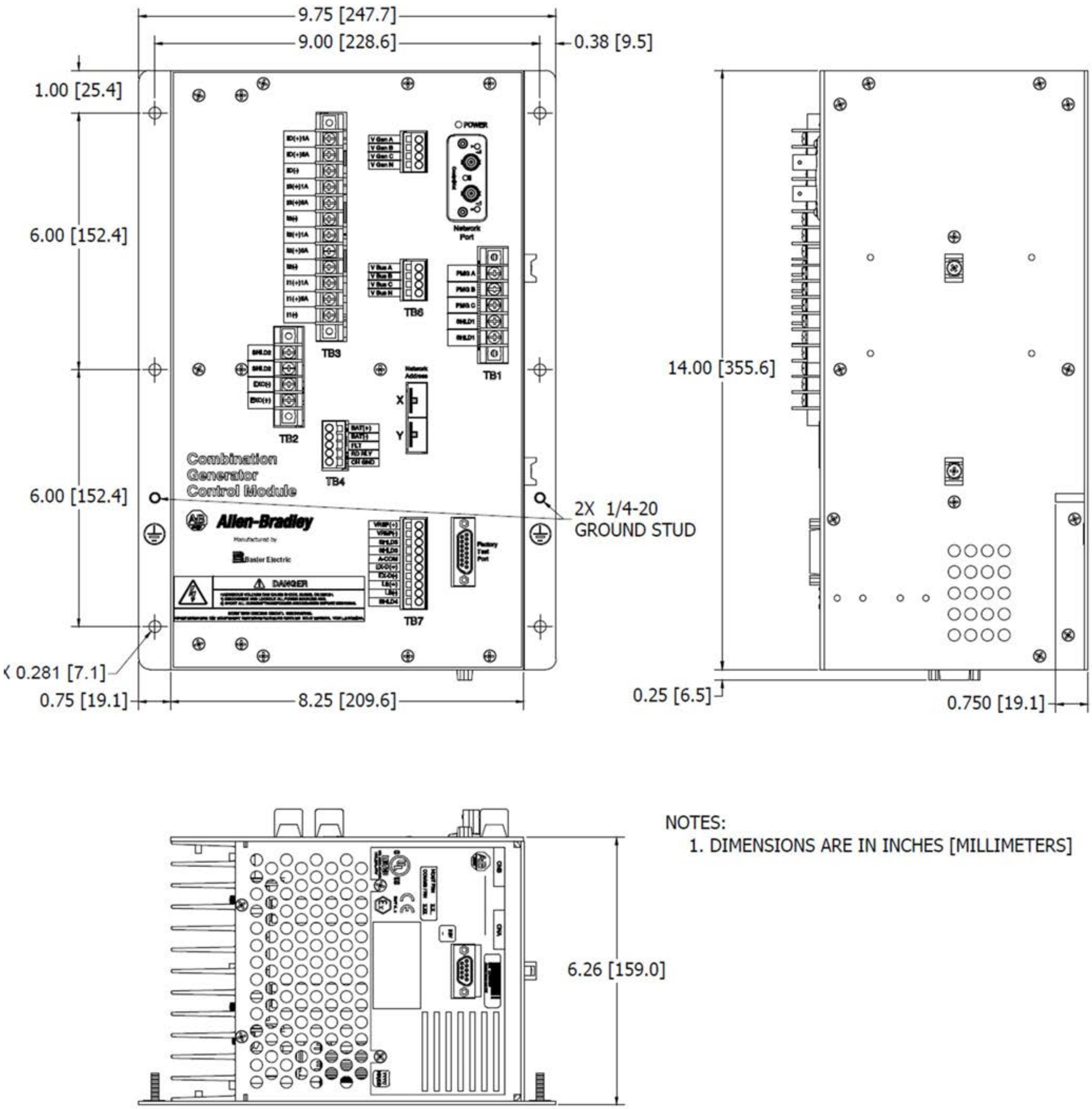
- 63.5 mm (2.5 in.) of clearance is required on both sides of the unit when mounted.
- 101.6 mm (4 in.) of clearance is required above and below the unit when mounted.

Overall dimensions for the unit are shown in CGCM Unit Overall Dimensions on page 14.

**WARNING:** Explosion Hazard

- Substitution of components can impair suitability for Class I, Division 2.
- Do not replace components or disconnect equipment unless power has been switched off or the area is known to be non-hazardous.
- Do not connect or disconnect components unless power has been switched off or the area is known to be non-hazardous.
- This product must be installed in an enclosure. All cables connected to the product must remain in the enclosure or be protected by conduit or other means.
- All wiring must comply with N.E.C. article 501-4(b).

**Figure 1 - CGCM Unit Overall Dimensions**



## Electrical Connections

The CGCM unit's connections are dependent on the application and excitation scheme. All inputs or outputs cannot be used in a given installation. Incorrect wiring can result in damage to the unit.

Connect the CGCM unit's terminals with copper wire rated for a minimum of 600V. General appliance wire rated for minimum temperatures of 105 °C (221 °F) is acceptable. All wire must be copper. Select circuit conductors based on good design practice.

The wire gauge range listed in the Terminal Block Label Description table indicates the physical capabilities of the connector.

The CGCM unit's terminals are on the front, bottom, and right panel of the unit. The nine-pin connector on the bottom of the unit is used for communication between CGCM units in a redundant system. Suggested torque for terminal screws is 1 N•m (9 lb•in).

Refer to pages 17…34 for typical connection diagrams.

Terminals to be used as landing points for shielded wires are provided on several terminal strips. Shield terminals with the same name are internally connected together but are not connected to protective earth or any internal unit circuitry.

**Table 1 - Terminal Block Label Description**

| Terminal Block | Wire Gauge Range | Label | Description |
|---|---|---|---|
| TB1 | 2.6…2.1 $mm^2$ (10…12 AWG) | PMG A | Phase A excitation power supply |
| | | PMG B | Phase B excitation power supply (three phase only) |
| | | PMG C | Phase C excitation power supply |
| | | SHLD1 | Shield 1 landing points are tied together but are not connected internally to protective earth or other unit circuitry |
| | | SHLD1 | |
| TB2 | | SHLD2 | Shield 2 landing points are tied together but are not connected internally to protective earth or other unit circuitry |
| | | SHLD2 | |
| | | EXC(-) | Excitation output negative |
| | | EXC(+) | Excitation output positive |

**Table 1 - Terminal Block Label Description**

| Terminal Block | Wire Gauge Range | Label | Description |
|---|---|---|---|
| TB3 | 2.6…2.1 $mm^2$ (10…12 AWG) | ID(+)1 A | 1 A cross-current compensation CT input |
| | | ID(+)5 A | 5 A cross-current compensation CT input |
| | | ID(-) | Cross-current compensation CT common input |
| | | I3(+)1 A | 1 A phase C CT input |
| | | I3(+)5 A | 5 A phase C CT input |
| | | I3(-) | Phase C CT common input |
| | | I2(+)1 A | 1 A phase B CT input |
| | | I2(+)5 A | 5 A phase B CT input |
| | | I2(-) | Phase B CT common input |
| | | I1(+)1 A | 1 A phase A CT input |
| | | I1(+)5 A | 1 A phase A CT input |
| | | I1(-) | Phase A CT common input |
| TB4 | 1.6…1.0 $mm^2$ (14…18 AWG) | BAT(+) | 24V DC control power input |
| | | BAT(-) | 24V DC control power return |
| | | FLT | Open collector fault output |
| | | RD RLY | Open collector output for redundancy relay |
| | | CH GND | Chassis ground |
| TB5 | | V Gen A | Phase A generator voltage input |
| | | V Gen B | Phase B generator voltage input |
| | | V Gen C | Phase C generator voltage input |
| | | V Gen N | Neutral generator voltage input |
| TB6 | | V Bus A | Phase A bus voltage input(1) |
| | | V Bus B | Phase B bus voltage input(1) |
| | | V Bus C | Phase C bus voltage input |
| | | V Bus N | Neutral bus voltage input |
| TB7 | 1.6…1.0 $mm^2$ (14…18 AWG) | VREF(+) | Remote setpoint adjust input |
| | | VREF(-) | Remote setpoint adjust input return |
| | | SHLD3 | Shield 3 landing points are tied together but are not connected internally to protective earth or other unit circuitry |
| | | SHLD3 | |
| | | A-COM | Analog common |
| | | EX-D(+) | Excitation enable input |
| | | EX-D(-) | Excitation enable return |
| | | LS(+) | Real power load sharing input |
| | | LS(-) | Real power load sharing return |
| | | SHLD4 | Shield 4 landing point is not connected internally to protective earth or other unit circuitry |

(1) When used in a dual breaker configuration, Bus A voltage input is wired from V Bus A to V Bus N and Bus B is wired from V Bus B to V Bus N.

## Excitation Power

Excitation power is wired to the PMG terminals, whether connected to the generator output (Shunt Excited) or to a PMG. Connect shunt excited inputs with a voltage transformer (VT).

PMG inputs are on TB1 and are labeled PMG A, PMG B, and PMG C, illustrating their respective phase relationships. Single-phase excitation power must be connected to terminals PMG A and PMG C. Twisted, shielded cabling is required for the PMG inputs.

Refer to the wiring diagrams below.

**Figure 2 - Excitation Power Connections, 3-phase PMG**

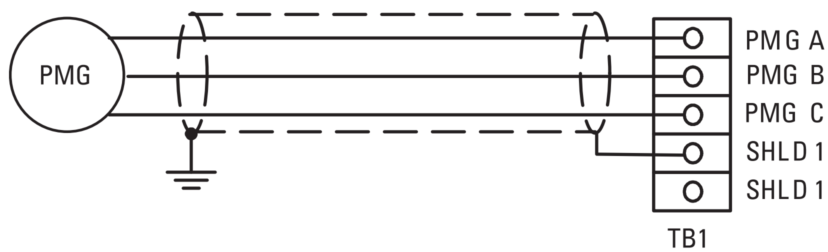



**Figure 3 - Excitation Power Connections, Single-phase PMG**

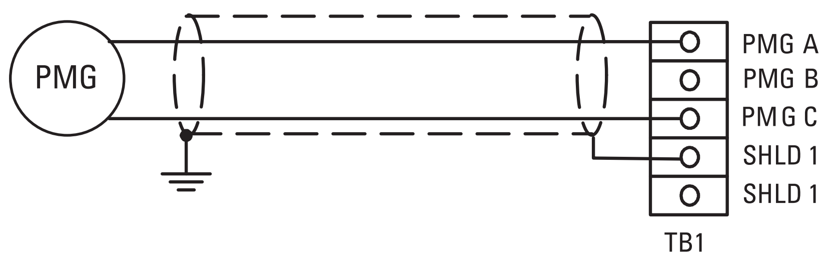



**Figure 4 - Excitation Power Connections, Single-phase Shunt**

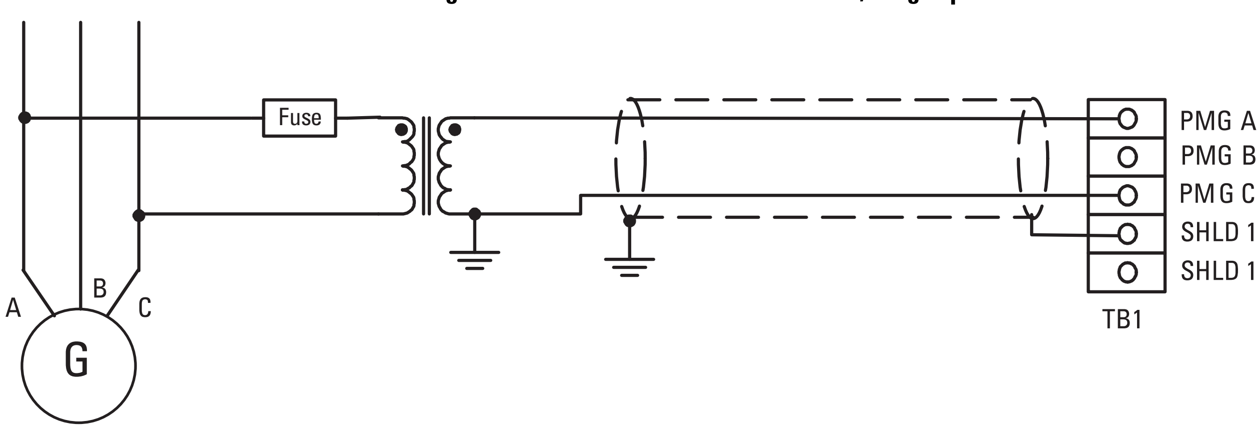


**Figure 5 - Excitation Power Connections, 3-phase Shunt**

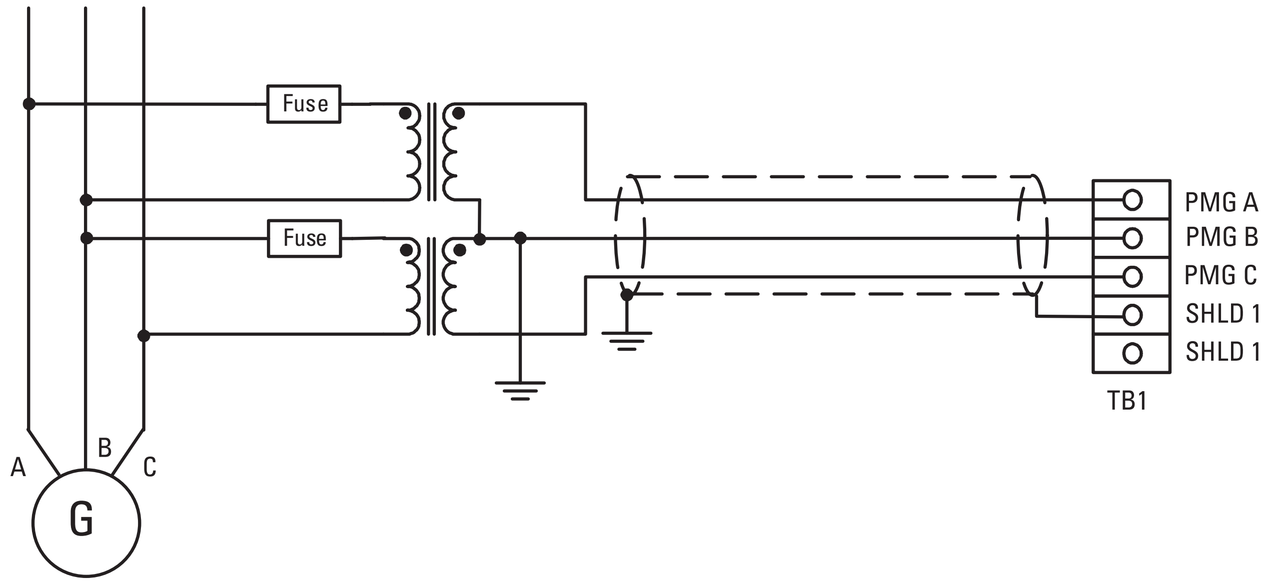
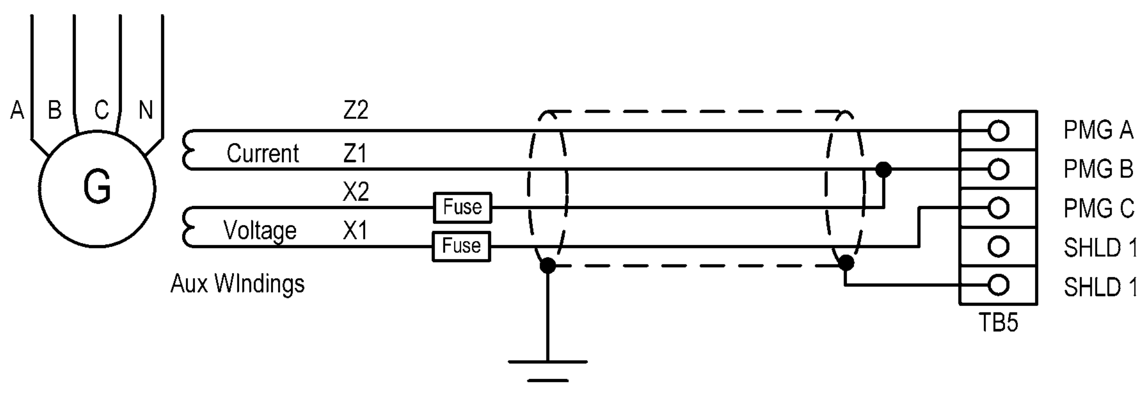



**Figure 6 - Excitation Power Connections, AREP Generator**

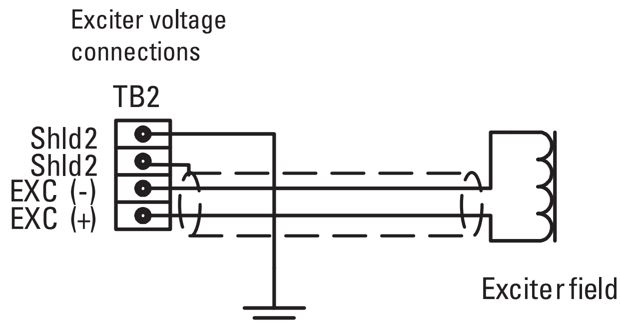
**TIP** This diagram is based on a Leroy Somer 300 kW AREP (auxiliary winding regulation excitation principle) machine. Details can differ on other machines.



## Excitation Output

The excitation outputs are on TB2 and are labeled EXC(+) and EXC(-). Twisted, shielded cabling is required for the excitation outputs.

**Figure 7 - Excitation Output Connections, Non-redundant CGCM**



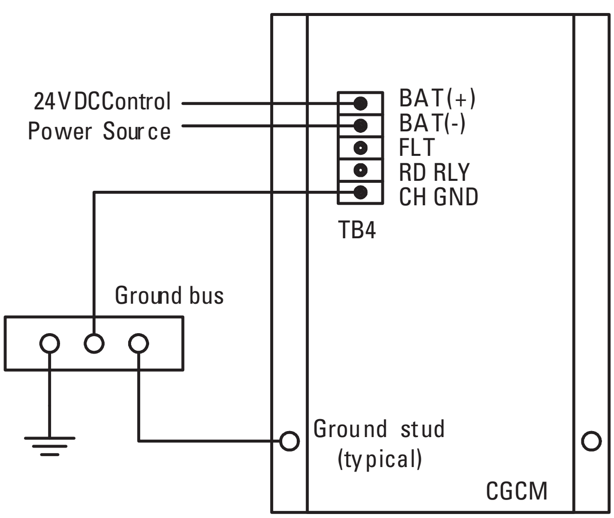

When the redundancy function is used, three or four external flyback diodes in series must be placed across the generator field winding.

Refer to the redundancy wiring diagrams on pages 31…32.

## Control Power

The 24V DC control power inputs are on TB4 and are labeled BAT(+) and BAT(-).

**Figure 8 - Control Power and Chassis Ground Connections**



## Chassis Ground

The terminal labeled CH GND, on TB4, is the chassis ground. Ground studs are also provided on the lower part of the mounting flanges and are internally connected to the CH GND terminal. Connect chassis ground to earth ground with minimum 2.6 $mm^2$ (10 AWG) copper wire attached to either stud on the lower part of either side of the unit and to the CH GND terminal with 1.6 $mm^2$ (14 AWG) copper wire. When installed in a system with other CGCM units, use a separate lead to the ground bus from each unit.

## AC Voltage and Current Sensing

The CGCM unit supports generator and bus voltage sensing and generator current sensing.

### *Generator and Bus Voltage Sensing*

CGCM units accept single-phase or 3-phase generator and bus voltage sensing input with nominal voltages of 120 or 208V AC.

Refer to Terminal Block Label Description on page 15 for possible wiring configurations.

The terminals found on TB5 provide connections for generator voltage sensing and are labeled V GEN A, V GEN B, V GEN C, and V GEN N. The terminals found on TB6 provide connections for bus voltage sensing and are labeled V BUS A, V BUS B, V BUS C, and V BUS N. The connection examples below show typical connections for various generator and bus connection schemes.

The CGCM unit supports these generator connection schemes:

- Single-phase
- Delta or Two-transformer Open Delta
- Three-wire Wye
- Four-wire Wye

The CGCM supports these bus connection schemes:

- Single-phase
- Delta or Two-transformer Open Delta
- Three-wire Wye
- Four-wire Wye
- Dual Breaker, Single-phase only

### *Generator Current Sensing*

CGCM units provide 3-phase AC current sensing with provisions for 1 A and 5 A nominal sensing ranges. The inputs for 3-phase current sensing are on TB3. The ID (+) and ID (-) terminals are used for systems connected in a cross-current compensation system.

### *Voltage and Current Sensing Connection Examples*

The following examples depict typical connections of voltage (also called potential) transformer (VTs) and current transformers (CTs) to the CGCM unit for various bus and generator power system configurations. These diagrams do not show all connections to the CGCM unit, nor are they intended to show all possible wiring combinations. For assistance in wiring a CGCM unit in a power system configuration not shown below, please contact Rockwell Automation.

**Figure 9 - Voltage and Current Connection for Two (or three) Transformer Delta Bus and Two (or three) Transformer Delta Generator System**

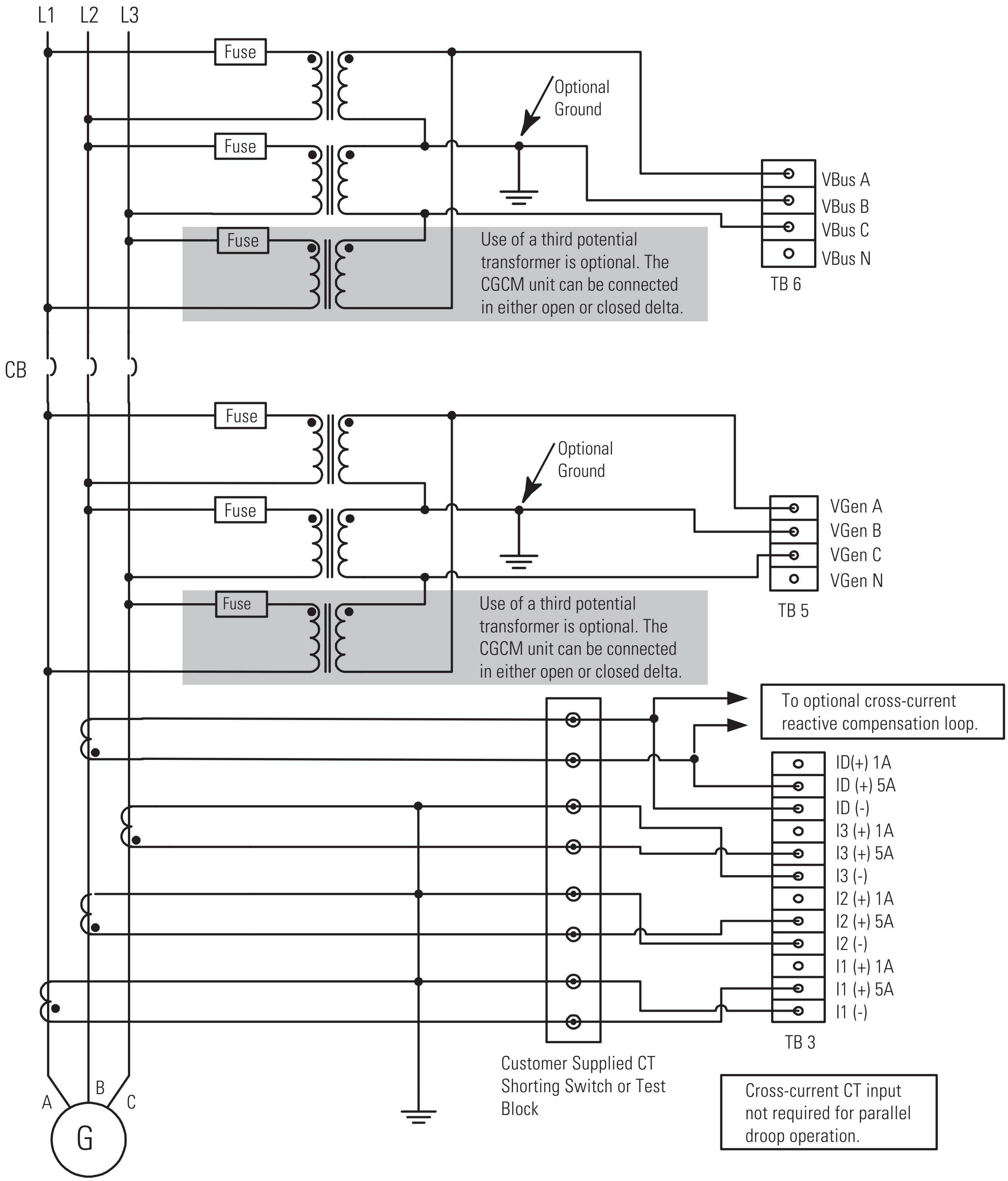


**Figure 10 - Voltage and Current Connection for Four-wire Wye Bus and Four-wire Wye Generator System with Grounded Neutral**

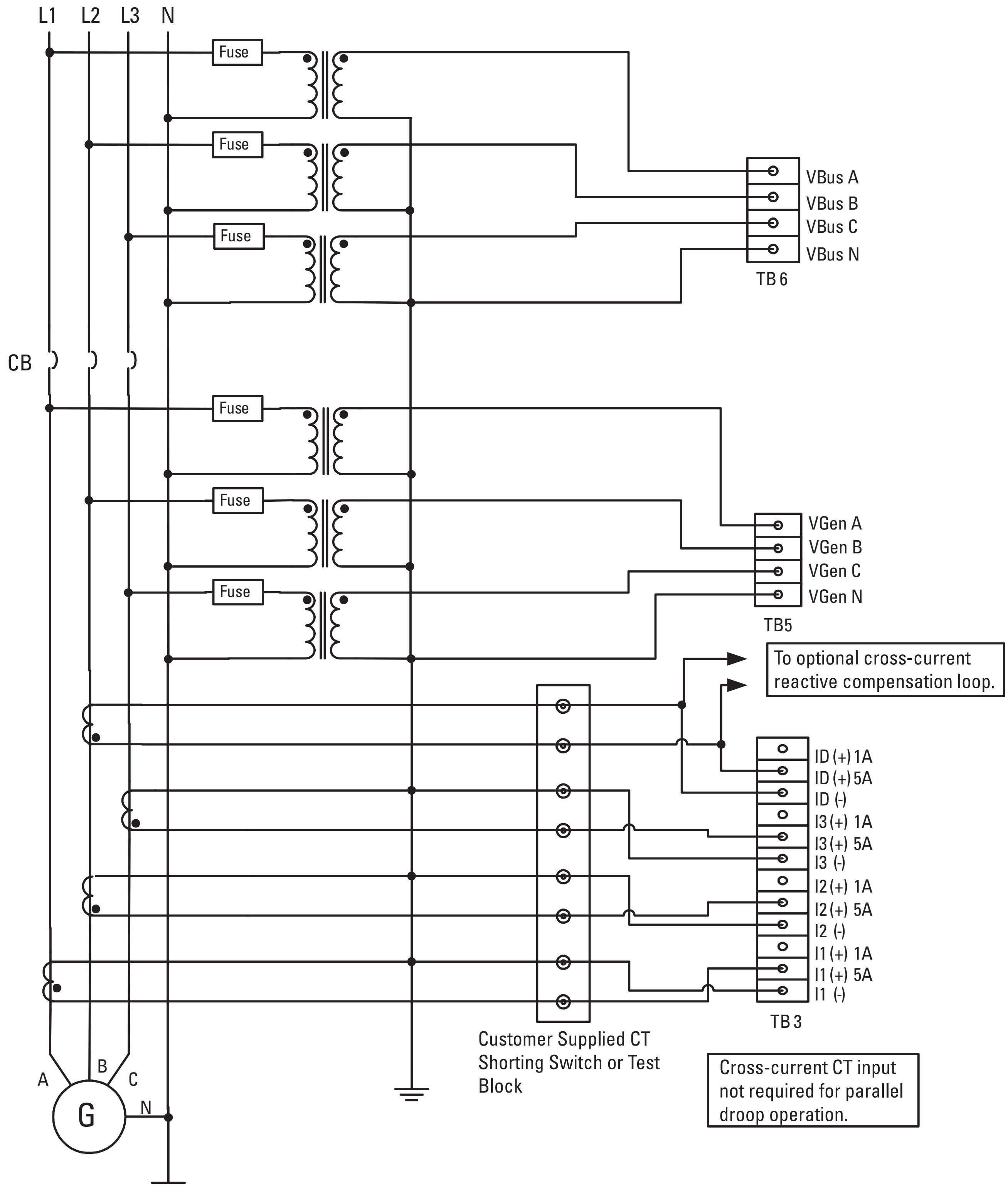


**Figure 11 - Voltage and Current Connection for Four-wire Wye Bus and Two (or three) Transformer Delta Generator System**

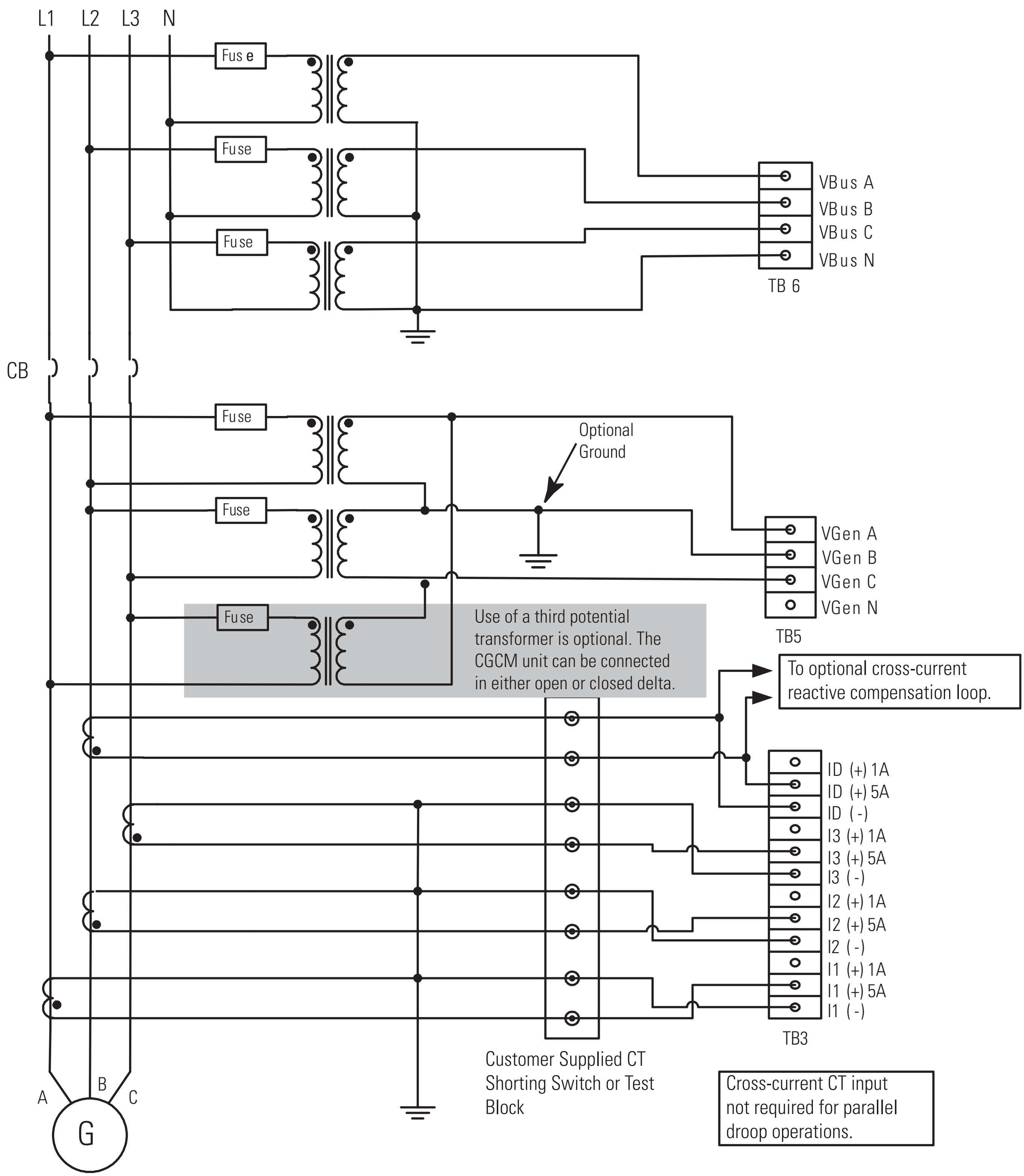


**Figure 12 - Voltage and Current Connection for Two (or three) Transformer Delta Bus and Four-wire Wye Generator System**

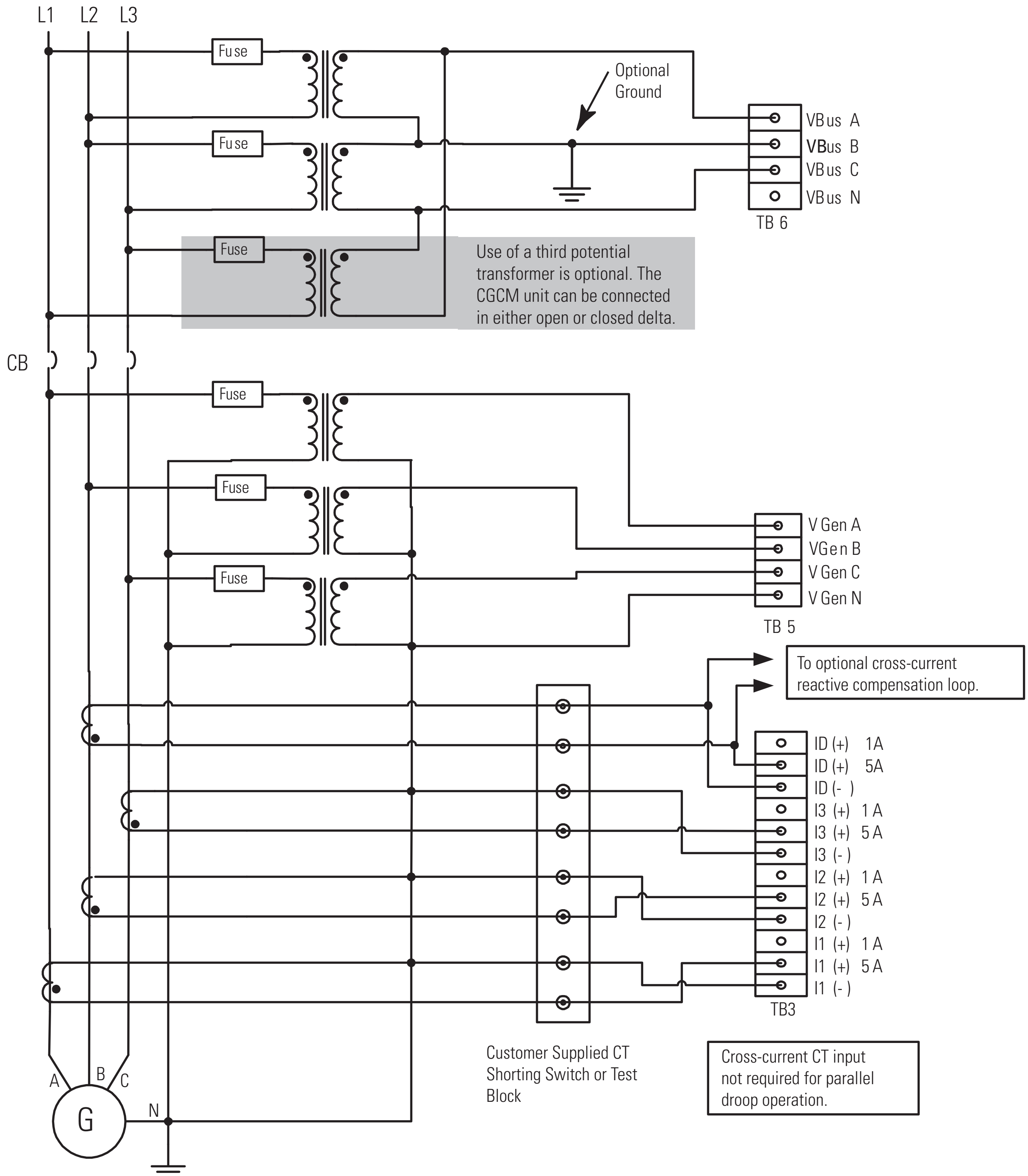


**Figure 13 - Voltage and Current Connection for Three-wire Wye Bus and Four-wire Wye Generator System with Grounded Neutral**

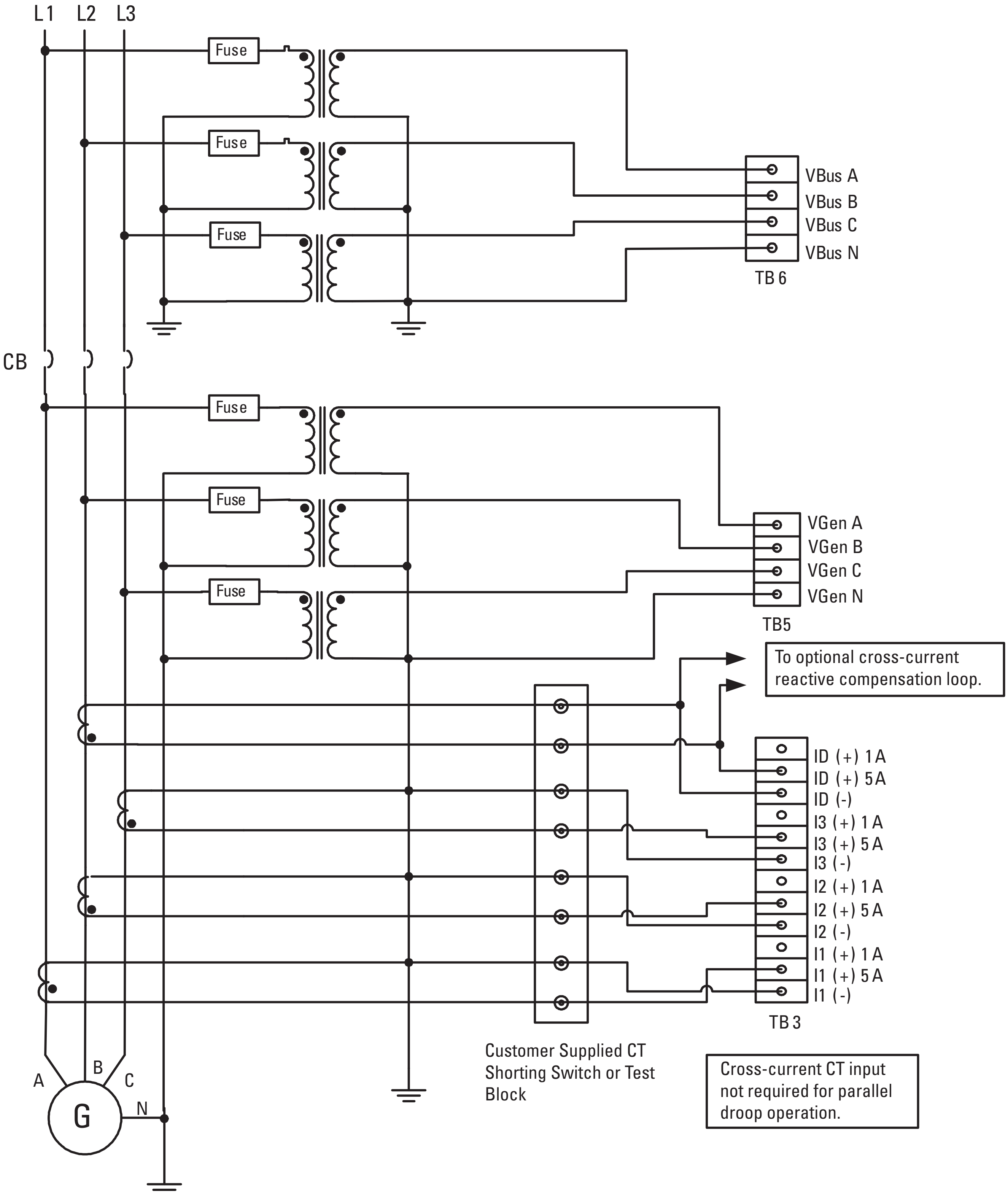


**Figure 14 - Voltage and Current Connection for Dual Breaker Bus and Two (or three) Transformer Delta Generator System**

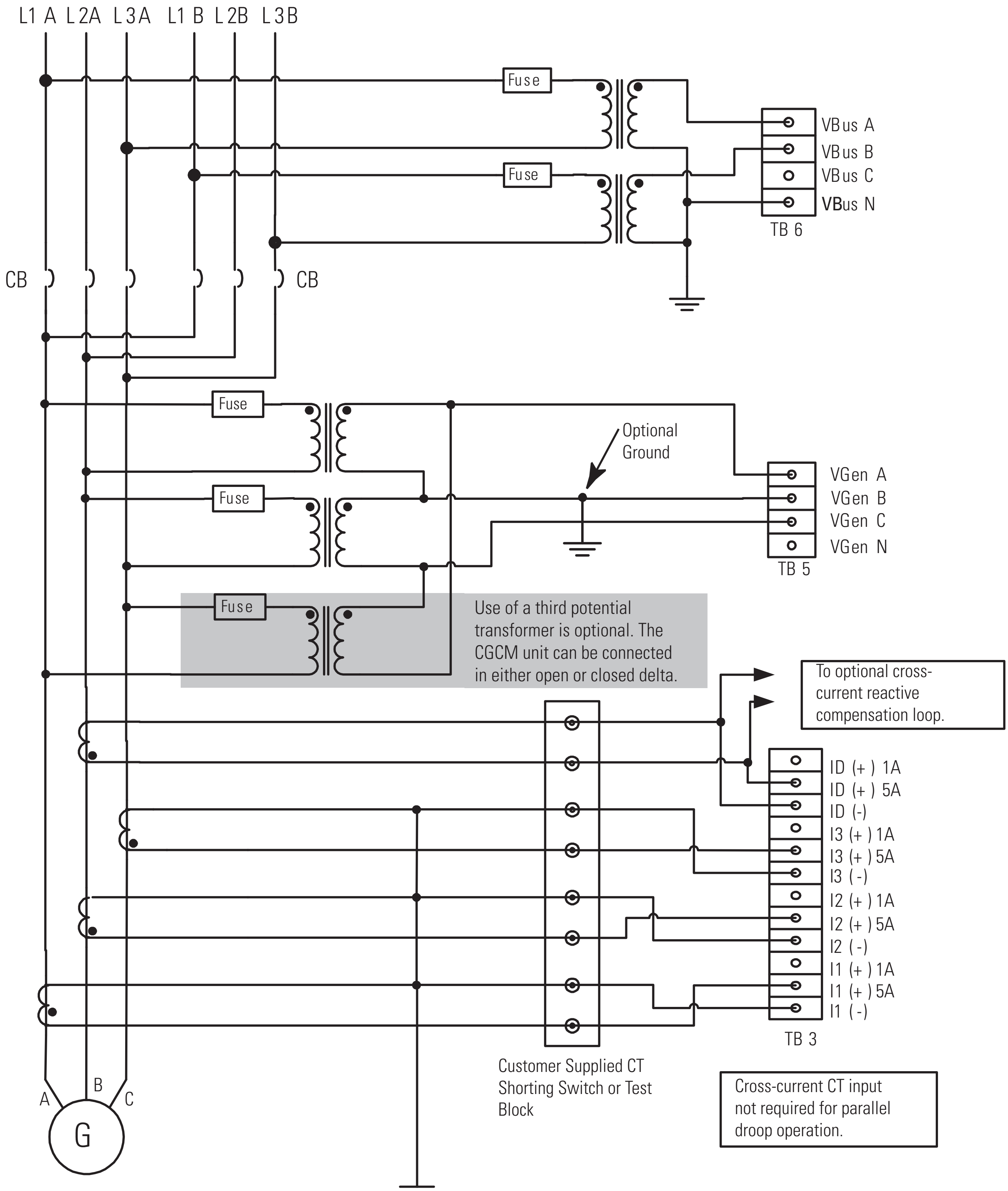


**Figure 15 - Voltage and Current Connection for Dual Breaker Bus and Four-wire Wye Generator System**

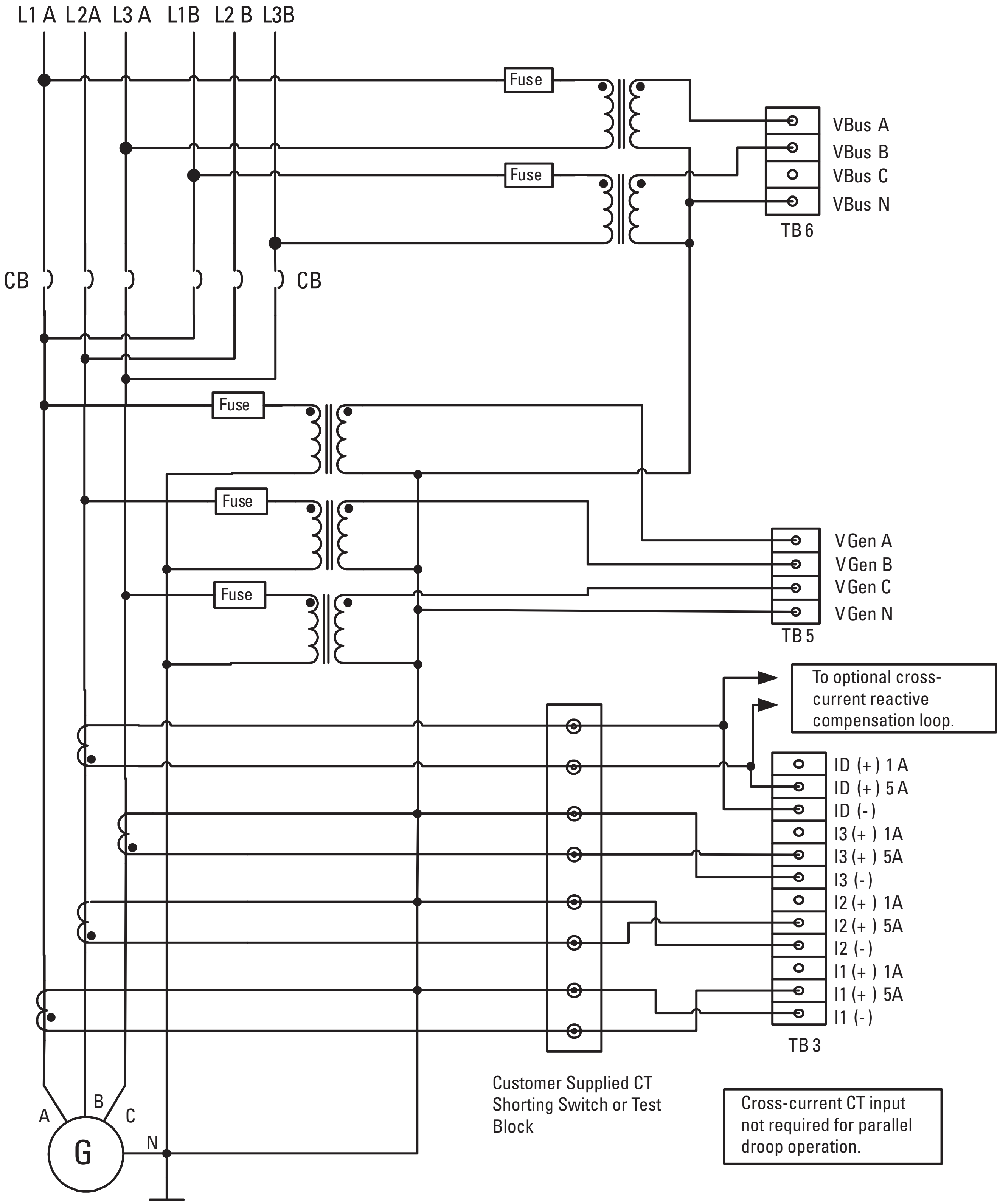


**Figure 16 - Voltage and Current Connection for Single Phase Bus and Single-phase Generator System**

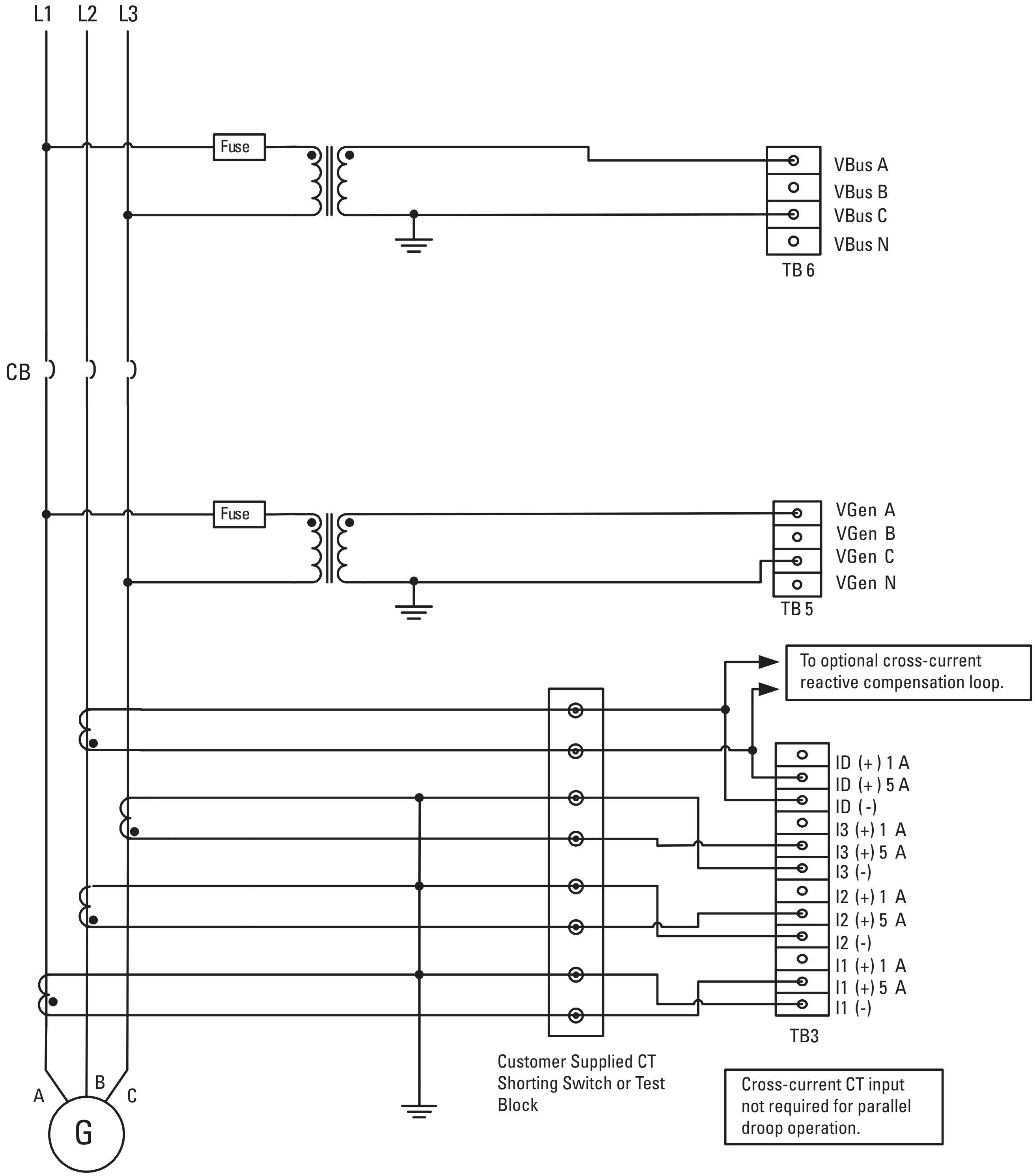
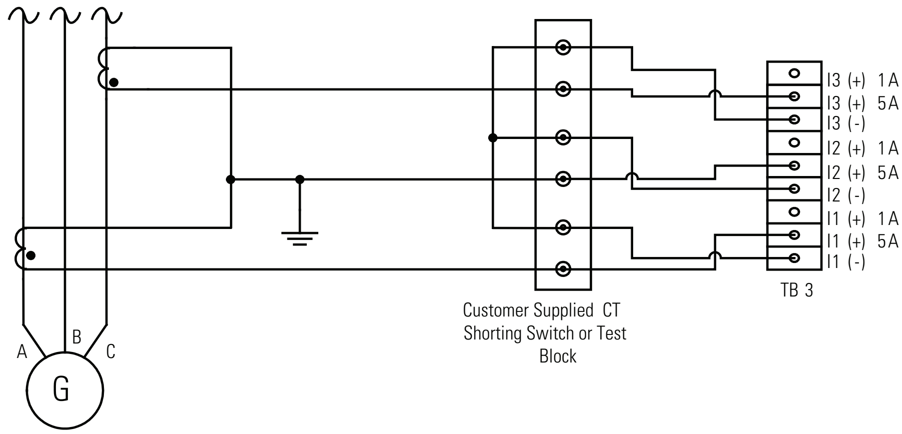


**Figure 17 - Current Connections for 3-phase Delta Generator with Two CTs**

The connections shown in this diagram can be used if only two CTs are available in the generator circuit. Two CTs can be used only with a three-wire delta generator. The circuit shown in this diagram can be substituted for the CT connections shown in Figures 9, 11, 14, and 16.




## Auxiliary Input

The auxiliary input is a +/- 10V DC input. The auxiliary input terminals are on TB7 and are labeled VREF(+) and VREF(-). SHLD3 is provided for landing the cable shield. Twisted, shielded cabling is required for the VREF connections.

## Remote Excitation Enable Input

The remote excitation enable input is a 24V DC input. The remote excitation enable input terminals are on TB7 and are labeled EX-D(+) and EX-D(-).

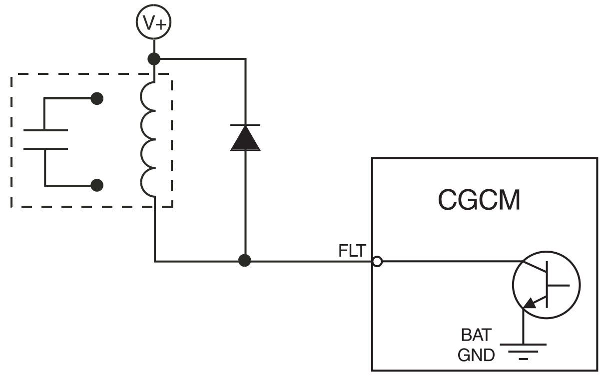
## Discrete Outputs

There are two types of discrete outputs: fault relay outputs and redundancy relay outputs.

### Fault Relay Output

The fault relay output is an open-collector sinking output. The fault relay output terminals are on TB4 and are labeled FLT. The following illustration shows a typical connection.

**Figure 18 - Typical Fault Relay Connection**




### Redundancy Relay Output

The redundancy relay output is an open-collector sinking output. The redundancy relay output terminals are on TB4 and are labeled RD RLY. The following figures illustrate typical redundancy connections.

**Figure 19 - Typical Redundancy Voltage Sensing Connection Diagram**

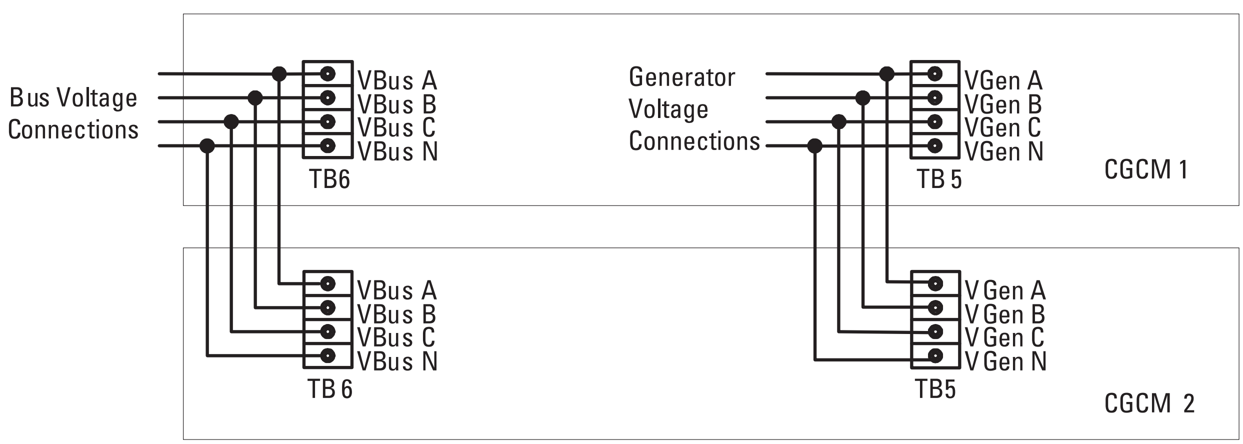


**Figure 20 - Typical Redundancy Current Sensing Connection Diagram**

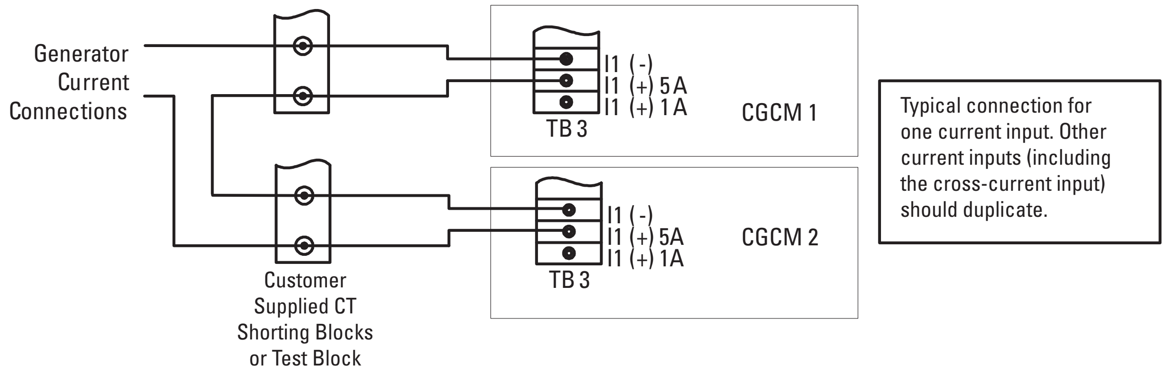



**Figure 21 - Typical Redundancy Excitation Power Connection Diagram**

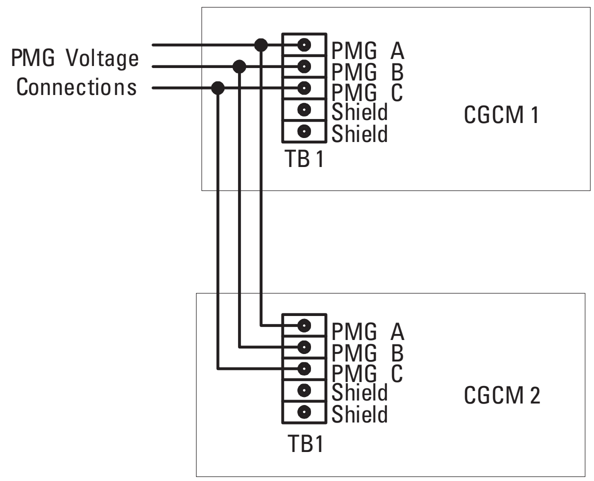
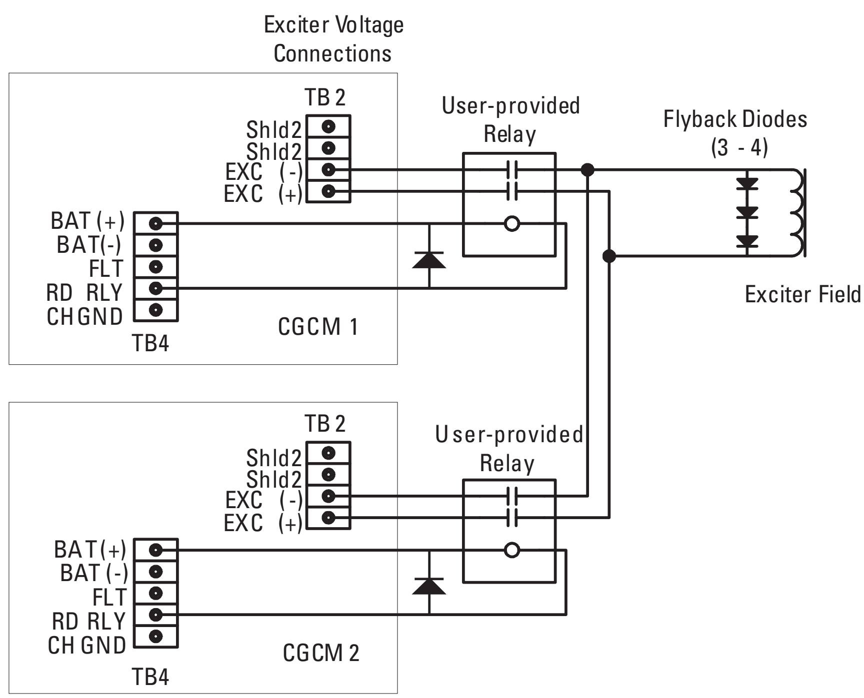


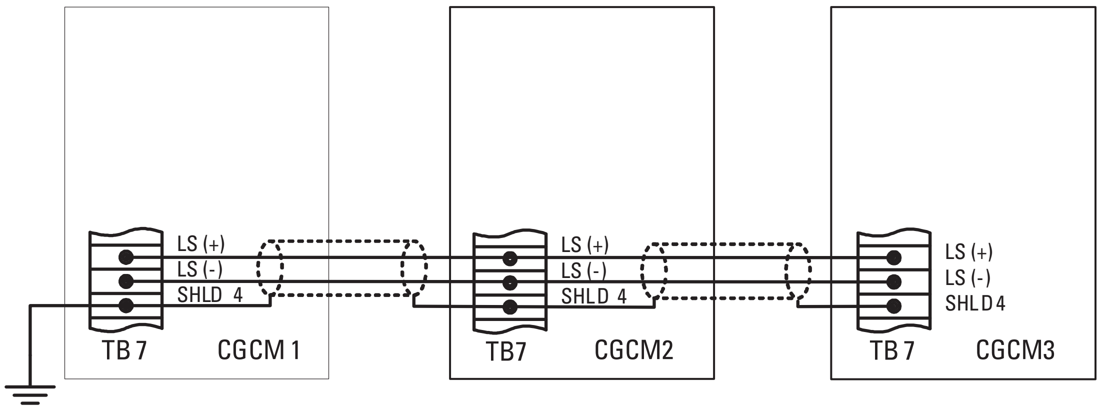

**Figure 22 - Typical Redundancy Relay Connection Diagram**



## Real-power Load Sharing

The load sharing terminals connect to a 0…5V DC, internally powered circuit. The load sharing terminals are on TB7 and are labeled LS(+) and LS(-). Terminal SHLD4 is provided to land the cable shield. Twisted, shielded cabling is required for the load sharing connections.

**Figure 23 - Real-power Load Sharing**




## Cross-current Compensation

The Cross-current (reactive differential) Compensation Connection Diagram on page 34 shows a typical connection diagram for three paralleled generators using the 5 A sensing input range on the AC current input.

Make connections with 2.6 mm (10 AWG) copper wire for CT inputs.

The resistance of the cross-current CT wiring must be as low as possible. A loop resistance less than 10% of the internal cross -current burden resistance of 1.0 Ω[1] enables cross-current operation with negligible voltage droop. If the CCCT loop resistance must be higher, adjust the CCCT gain or increase the cross-current burden resistance. You can do those things by adding external resistance to each CGCM unit in the loop.

The cross-current compensation terminals are on TB3 and are labeled ID(-) and ID(+). One and five ampere range terminals are provided.

(1) Series C devices have internal 1 Ω resistor. Earlier devices can require an external resistor.

**Figure 24 - Cross-current (reactive differential) Compensation Connection Diagram**

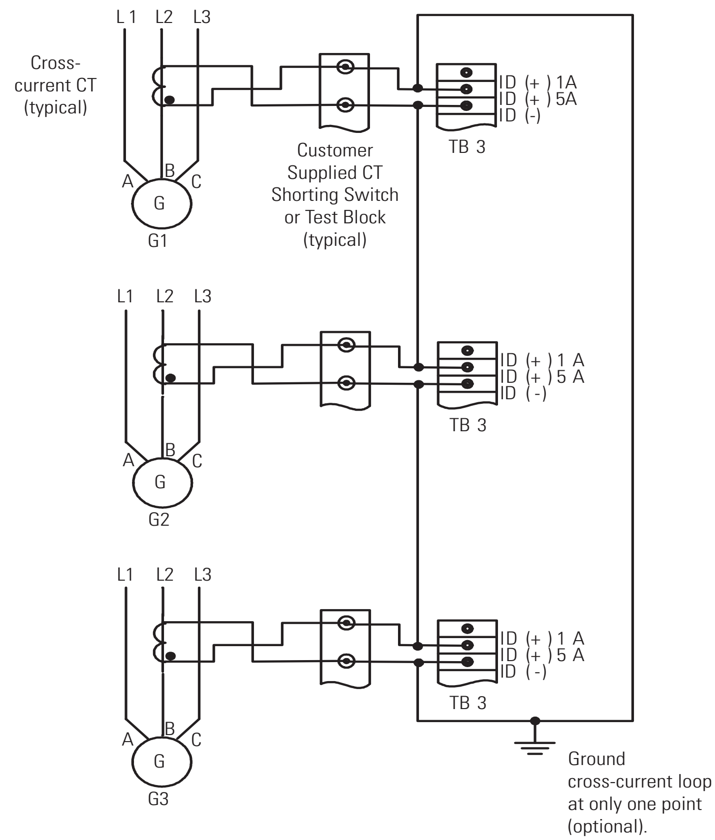
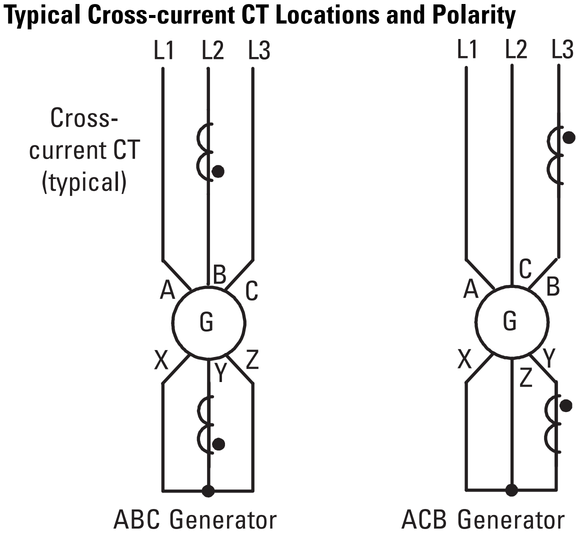



**Figure 25 - Typical Cross-current CT Locations and Polarity**



## Communication Connectors and Settings

There are three ports on the unit: the factory calibration port, the redundancy port (COM1), and the ControlNet network port.

### *Factory Calibration Port*

The factory calibration port is not intended for use by anyone other than qualified factory representatives.

### *Redundancy Port (COM1)*

The DB-9 female connector on the bottom side of the CGCM unit is used for communication with another CGCM unit when operating in a redundant system configuration. Use a null modem cable for this connection.

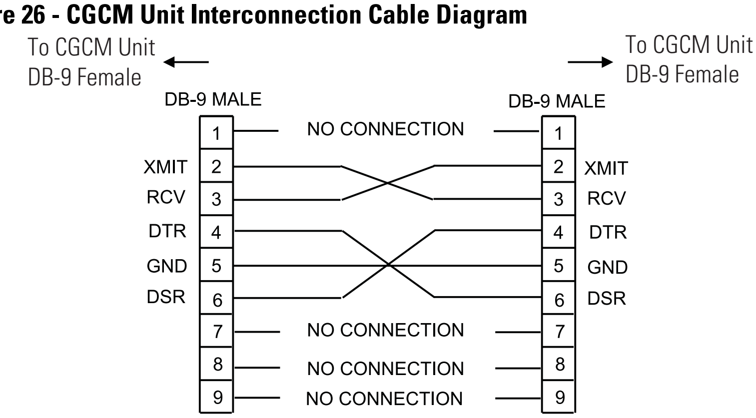
See CGCM Unit Interconnection Cable table for connector pin numbers, functions, names, and signal directions.

The cable pin-out is illustrated in the CGCM Unit Interconnection Cable Diagram.

**Table 2 - CGCM Unit Interconnection Cable**

| Pin | Name | Description | Function |
|---|---|---|---|
| 1 | | Not used | |
| 2 | XMIT | Transmit | Sends serial data from CGCM unit |
| 3 | RCV | Receive | Receives serial data from CGCM unit |
| 4 | DTR | Data terminal ready | Receives a signal that the sending unit is operational |
| 5 | GND | Ground | Provides the ground signal |
| 6 | DSR | Data set ready | Sends a signal that the CGCM unit is operational |
| 7, 8, 9 | | Not used | |

**Figure 26 - CGCM Unit Interconnection Cable Diagram**



### *ControlNet Network Port*

Two ControlNet tap cables and channel labels are included with the 1407-CGCM unit.

If redundancy is desired, use both connectors. Otherwise, you can use either connector.

You can use the mounting fasteners provided on the right-hand side of the unit chassis to fasten the tap cables. Minimum bend radius for the ControlNet tap cables is 38 mm (1.5 in.). Take care not to kink or pinch the ControlNet tap cable or bend it more sharply than the minimum radius. Panduit HLM-15RO hook-and-loop wraps are recommended for securing the tap cable to chassis mounts.

Use the thumbwheel switches on the front of the CGCM unit to set the ControlNet network node address (MAC ID).

For installation procedures, please refer to ControlNet Coax Media Planning and Installation, publication CNET-IN002.

# CGCM Unit Operation

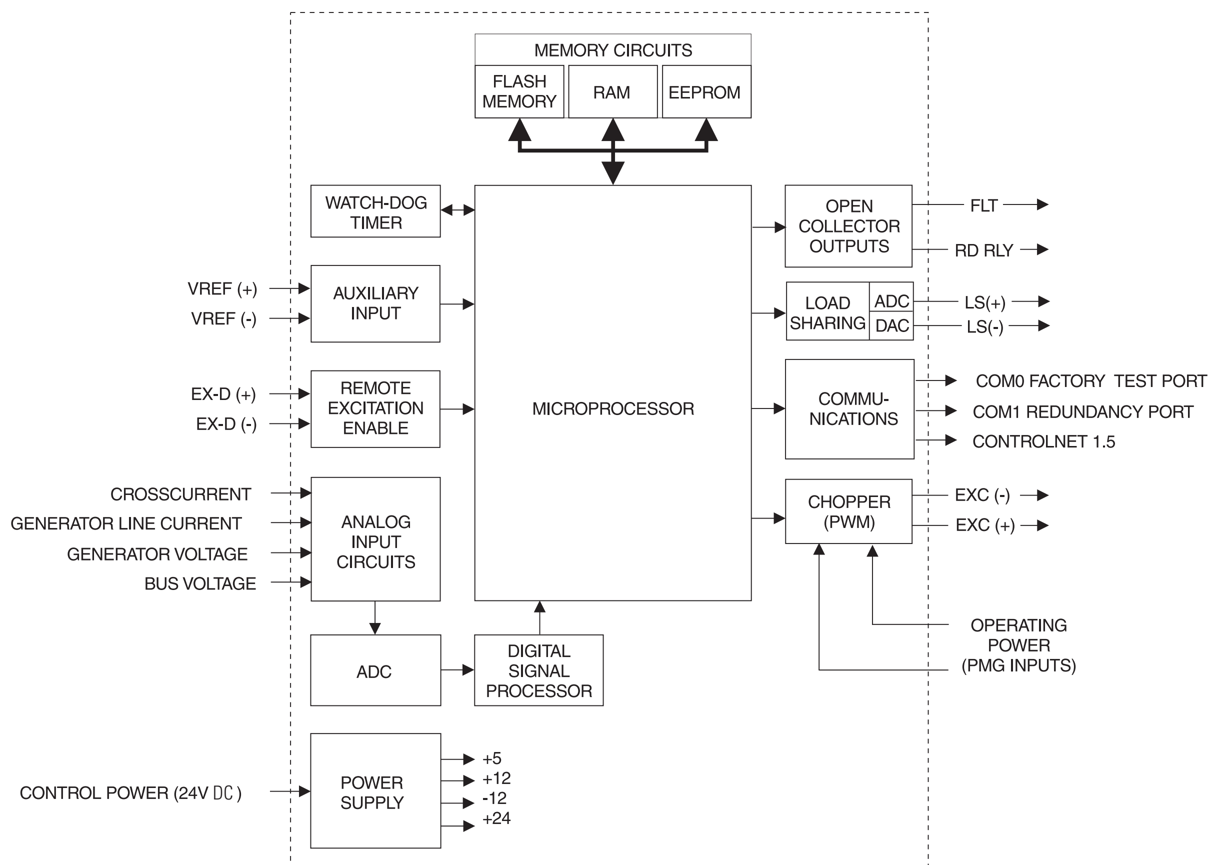
This section provides a operational description of the CGCM unit's functions. The CGCM unit incorporates hardware inputs and outputs, software inputs and outputs to a Logix family programmable controller, configuration settings, and its internal control algorithms to provide the regulation, synchronizing, and protection functions described in this section.

For information on configuring the CGCM unit, see Chapter 4, Configuration.

For further information on the software interface between the CGCM unit and its host Logix programmable controller, see Chapter 6, CGCM Unit Software Interface.

The Simplified Block Diagram provides a functional block diagram for the CGCM unit.

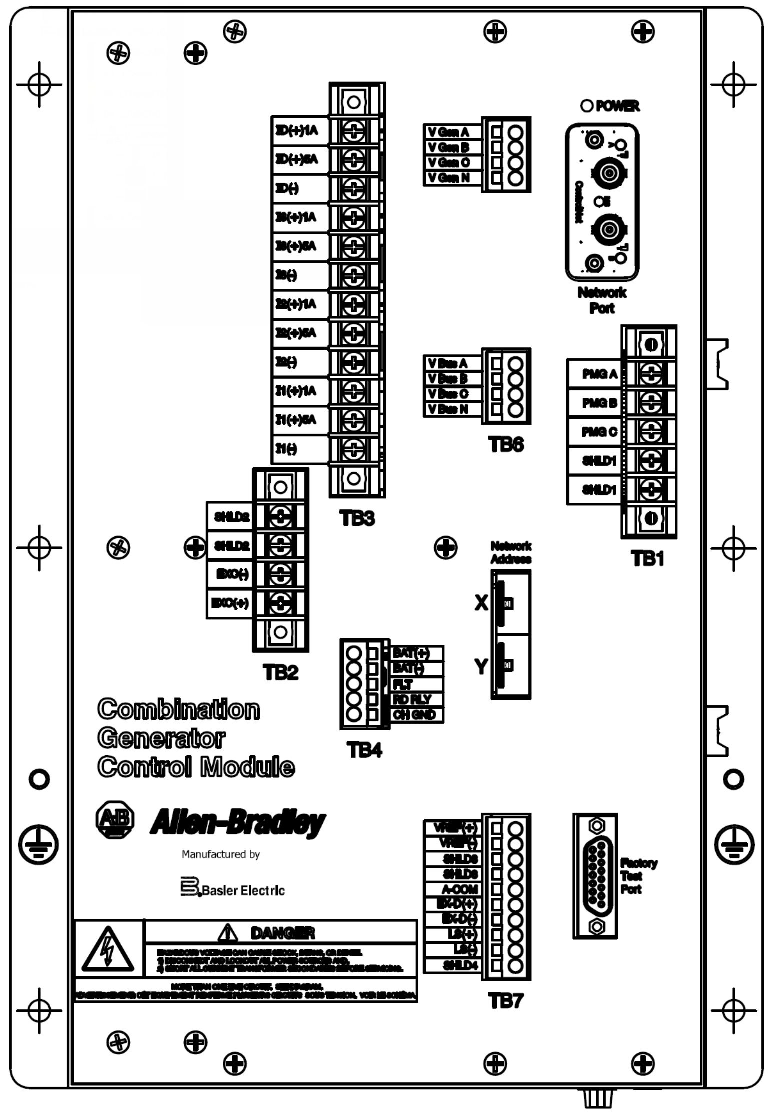
**Figure 27 - Simplified Block Diagram**



## Inputs and Outputs

The figure below shows the front panel layout of the CGCM unit. Input and output connections are made through the terminal blocks TB1…TB7.

**Figure 28 - Front Panel Layout**




### Analog Inputs

The CGCM unit provides a number of analog inputs for use in the regulation and control of stand-alone and paralleled generator systems. Each of the inputs is outlined below.

#### *Generator Voltage Sensing Inputs*

The CGCM unit senses generator voltage through voltage transformers (VTs) installed across the generator output leads.

The CGCM unit uses voltages measured through the generator voltage sensing inputs for generator voltage, VAR and/or power factor regulation, kW and kVAR load sharing, synchronization, metering, and protection. The inputs accept signals with up to 40% Total Harmonic Distortion (THD) and are connected for single-phase and 3-phase applications. The generator voltage inputs are internally scaled by the CGCM unit according to its transformer configuration settings.

Generator voltage sensing inputs are labeled V Gen A, V Gen B, V Gen C, and V Gen N.

### *Bus Voltage Sensing Inputs*

Voltages measured through the bus voltage sensing inputs are used for generator to bus synchronizing. The CGCM unit senses bus voltage through VTs. Depending upon the number of busses and the type of synchronizing required, there is one or two sets of bus sensing transformers. If dual bus synchronizing is required, the sensing transformer configuration is limited to single-phase. In a single breaker system the inputs are connected in either single-phase or 3-phase configurations. The inputs accept signals with up to 40% THD. The bus voltage inputs are internally scaled by the CGCM unit according to its transformer configuration settings.

Bus voltage sensing inputs are labeled V Bus A, V Bus B, V Bus C, and V Bus N.

### *Generator Line Current*

The CGCM unit senses generator current through current transformers installed on the generator output leads.

Current measured through the line current inputs is used for metering purposes, regulating generator vars, regulating generator PF, real power load sharing, and for protection purposes; and is required for operation in AVR Droop, PF, and VAR operating modes. Line current inputs are galvanically isolated via CTs internal to the CGCM unit. The CGCM unit accepts either 1 A or 5 A current inputs wired to the corresponding input. Line current inputs are labeled I1(+)1 A, I1(+)5 A, I1(-), and so forth.

### *Cross-current*

The CGCM unit senses reactive differential current through properly connected current transformers typically installed on the B-phase output leads of each paralleled generator.

See Typical Cross-current CT Locations and Polarity on page 34 for more information.

Line current inputs are galvanically isolated via CTs internal to the CGCM unit. The CGCM unit accepts either 1 A or 5 A current inputs. The cross-current input terminals are labeled ID(+)5A, ID(+)1A, and ID(-).

### *Auxiliary Input*

This input is an analog voltage (-10…10V DC), and provides a means to remotely adjust the regulation point of the generator. Resistive isolation is provided through the use of differential amplifiers.

The auxiliary input terminals are labeled VREF(+) and VREF(-).

## Power Inputs

The unit has two types of power inputs: control power inputs and excitation power inputs.

### *Control Power Input*

The CGCM unit operates from a nominal 24V DC supply connected to the control power inputs. The control power input is diode-protected to protect against equipment damage due to improper polarity of the applied power.

The control power inputs are labeled BAT(+) and BAT(-).

### *Excitation Power Input*

The CGCM unit accepts either 3-phase or single phase excitation power. Excitation power can be obtained from the generator or the utility via shunt excitation (SE) or from the generator prime mover via a Permanent Magnet Generator (PMG).

See Chapter 2 for details on connections for SE or PMG operation.

The excitation power input terminals are labeled PMG A, PMG B, and PMG C.

## Discrete Inputs - Remote Excitation Enable

The remote excitation enable input is a 24V DC input. When 24V DC is applied to the input, CGCM unit excitation is permitted.

| | |
|---|---|
| **IMPORTANT** | For generator excitation to occur, excitation must be enabled in software, an active ControlNet connection must be present, and a 24V DC signal must be applied to the remote excitation enable input. |

The remote excitation enable input terminals are labeled EX-D(+) and EX-D(-).

## Analog Outputs

The unit has two types of analog outputs: excitation output and real power load sharing.

### *Excitation Output*

The CGCM unit Pulse Width Modulated (PWM) power stage provides DC generator exciter field current. The excitation power stage is designed to accommodate up to 125V DC (nominal) field voltages.

Refer to Excitation Control Modes on page 44 for a description of operation.

Care must be taken that the field resistance does not allow more than 15 A DC to flow continuously at rated field voltage.

Minimum resistance for common voltages is given in Appendix D.

The CGCM unit excitation output is equipped with a high-speed circuit for detecting a shorted output. The excitation output is clamped at a very low level when a low impedance connection is detected. The CGCM unit indicates that the clamp is active by setting Spare2 bit in the Scheduled Read Data Table. The Spare2 bit indication is reset by either setting the tag SoftwareExcEN = 0 or by cycling the control power to the CGCM unit.

Note that a loss of ControlNet network communication with the host Logix controller causes the CGCM unit to automatically shutdown generator excitation.

The excitation output terminals are labeled EXC(+) and EXC(-).

### *Real-power Load Sharing*

Real-power load sharing terminals are provided to allow two or more CGCM units or other compatible generator control devices (such as the Line Synchronization Module, catalog number 1402-LSM) to load the generators under their control such that the same per unit output is developed by each generator.

Load sharing terminals are labeled LS(+) and LS(-).

### Discrete Outputs

The CGCM unit provides two discrete open collector outputs, the fault output and the redundancy relay output. These are sinking type outputs internally connected to the control power BAT(-) supply. They are intended to drive a user-supplied relay connected between the control power BAT(+) supply and the applicable discrete output terminal.

#### *Fault Output*

The fault output can be used to annunciate a fault via a user-supplied relay. The user chooses, from a predetermined list, the conditions for this output. The fault output is labeled FLT.

The fault enable output tags in the Output table determine which faults activate the fault relay output.

#### *Redundancy Relay Output*

The redundancy relay output is used to transfer excitation of the generator from the primary CGCM unit to the redundant CGCM unit in dual unit systems. The redundancy relay output is labeled RD RLY.

## Communication

The CGCM unit provides three communication ports along with software inputs and outputs.

### Com 0 Factory Test Port

Not for customer use. This port is used to calibrate the CGCM unit during factory testing.

### Com 1 Redundancy Port

The redundancy port lets one CGCM unit communicate with its partner CGCM unit in a redundant system, letting the partner unit auto-track the primary unit's control modes.

### ControlNet Network Port

The version 1.5 ControlNet network port is used to interface with a Logix family programmable logic controller. Through this port, RSLogix 5000 software facilitates setting CGCM unit configuration parameters. Control, metering, and protection settings are communicated to the CGCM unit by using this port. The CGCM unit firmware is flash programmable through this port.

### Software Inputs and Outputs

Your Logix family host programmable controller must include the hardware and communication interfaces with the generator, prime mover, power system, and balance of plant that are not specifically included in the CGCM unit module. The software interface between the CGCM unit and its host controller is made via the ControlNet software interface. The specific interface consists of several assembly instances, or data tables.

- The Input (Scheduled Read) table provides time-critical status and fault parameters, and control commands, from the CGCM unit to the host Logix controller.
- The Output (Scheduled Write) table provides time-critical enable commands, selection commands, and setpoints from the host controller to the CGCM unit.
- The Unscheduled Read table provides non time critical metering data from the CGCM unit to the host controller.
- The Unscheduled Write table provides a means to adjust selected gains and (in firmware revision 3.*x* or later) energy counter presets while excitation is enabled.
- The Configuration table contains the basic CGCM unit configuration parameters and is automatically transferred from the host controller to the CGCM unit on powerup and at other times when excitation is not enabled.

Refer to Chapter 6, CGCM Unit Software Interface, for more detailed information on the CGCM unit software interface.

## Operational Functions

The following sections describe the operational functions of the CGCM unit. The functions include the following:

- Excitation Control Modes
- Limiting Functions
- Protection Functions
- Synchronizing
- Real-power Load Sharing
- Metering
- Redundancy
- Watchdog Timer

## Excitation Control Modes

The CGCM unit controls the DC excitation current of the generator exciter based on a number of factors, including the following:

- The selected control mode
- The configuration of the CGCM unit including gains
- Measured generator voltage and current
- The applicable setpoint or setpoints
- The value of the Auxiliary Input
- Various limiting functions

The CGCM unit offers several modes of regulation that are selected and activated by using the software interface to the host Logix programmable controller. An active ControlNet network connection must exist with the host Logix controller for any regulation mode to be active.

The CGCM unit automatically shuts down excitation if one of these faults occurs:

- Overexcitation voltage
- Reverse VAR
- Logix controller fault

### *Gains*

The CGCM unit regulates excitation current by using a proportional, integral, and derivative (PID) control algorithm. The regulatory response of the CGCM unit is determined by your gain settings. The gains for each mode include the following:

- Proportional Gain Kp – determines the basic response to changes in generator voltage
- Integral gain Ki – speeds the return to steady state voltage after a disturbance
- Derivative gain Kd – speeds the initial regulator response to a disturbance
- Overall gain Kg – adjusts the coarse loop gain of the regulator
- Auxiliary Gain – adjusts the effect of the auxiliary input on the regulator output

Please refer to Chapter 4, CGCM Unit Configuration, for more detailed information.

### *Field Current Regulation Mode (FCR)*

FCR mode provides manual control of the excitation current. In FCR mode, the CGCM unit measures and controls its field excitation current output to maintain the commanded field current setpoint. The FCR feedback loop includes adjustable proportional, integral, and derivative gains. In FCR mode, automatic voltage control, reactive power control, power factor control, over-excitation limiting, and under-excitation limiting are disabled. To activate FCR mode:

- the gains must be set.
- FCR mode must be selected (tag **AVR_FCR_Select** = 1).
- the desired setpoint must be written to the **FCRSetpt** tag.
- excitation enabled (tag **SoftwareExcEn** = 1).
- remote Excitation Enable On (discrete input).

### *Automatic Voltage Regulation Mode (AVR)*

AVR mode provides automatic control of the excitation current. In AVR mode, the CGCM unit controls field excitation current output to maintain the commanded generator voltage setpoint. The AVR feedback loop includes adjustable proportional, integral, and derivative gains. To activate AVR mode:

- the metering VTs must be properly connected and configured.
- the AVR gains must be set.
- AVR mode must be selected (tag **AVR_FCR_Select** = 0).
- the desired setpoint must be written to the **AVRSetpt** tag.
- excitation enabled (tag **SoftwareExcEn** = 1).
- remote Excitation Enable On (discrete input).
- for constant voltage control, droop must be disabled (tag **V_DroopEn** = 0).

### *Droop (reactive current compensation)*

Droop (reactive current compensation) is a method of controlling reactive current when a generator is connected in parallel with another energy source. Droop adjusts the generator voltage in proportion to the measured generator reactive power. The CGCM unit calculates reactive power by using the 3-phase generator voltage and current sensing inputs. The droop adjustment represents the percent reduction from the generator voltage setpoint when the generator produces reactive power corresponding to rated generator kVA.

To activate droop:

- the metering CTs and generator VTs must be properly connected and configured.
- the desired droop setpoint must be written to the **V_DroopSetpt** tag.
- excitation enabled (tag **SoftwareExcEn** = 1).
- remote Excitation Enable On (discrete input).
- the CGCM unit must be in AVR mode (tag **AVR_FCR_Select** = 0).
- droop must be enabled (**V_DroopEn** tag = 1).
- droop must be selected (**Droop_CCC_Select** tag = 0).
- automatic reactive power control must be disabled (tag **PF_VAR_En** = 0).

### *Cross-current Compensation*

Cross-current compensation (reactive differential compensation) is a method of connecting multiple generators in parallel to share reactive load. Cross-current compensation requires the connection of an additional CT into the cross-current compensation input. The CGCM unit operates in a stand-alone application without the cross-current inputs connected.

The cross-current compensation method of reactive load sharing is possible with other controllers of similar type. Cross-current compensation monitors the ID current, V GEN A, and V GEN C inputs to adjust the excitation level. A gain adjustment is provided to allow tuning of the cross current control. Cross-current compensation is configured and controlled by using the software interface to the Logix controller.

To activate cross-current compensation:

- the generators must be connected in parallel.
- the cross-current CT and generator VTs must be properly connected.
- the desired cross-current gain must be written to the **CrossCurrentGain** tag.
- excitation enabled (tag **SoftwareExcEn** = 1).
- remote Excitation Enable On (discrete input).
- the CGCM unit must be in AVR mode (tag **AVR_FCR Select** = 0).
- droop must be enabled (**V_DroopEn** tag = 1).
- cross-current compensation must be selected (**Droop_CCC_Select** tag = 1) (and **KVAR_LS_En** tag = 1 for firmware rev. 2.*x*).

When cross-current compensation is disabled or control power is removed from the unit, the cross-current input terminals ID(+) and ID(-) are internally connected together through a very small impedance.[1]

(1) For series B devices, the input terminals are not connected together when control power is removed.

### *Auxiliary Input Regulation Adjustment*

The auxiliary input provides a means to remotely adjust the regulation point of the generator. This analog voltage (-10…10V DC) input signal changes the setpoint of the selected operating mode by one percent of the applicable rated value for each volt applied (positive or negative), multiplied by the auxiliary gain setting for AVR/FCR or VAR/PF.

Refer to Chapter 4 for more information.

Auxiliary input gain settings range from -99…99. If the gains are set to zero, the auxiliary input is inactive.

A typical use for this input is with a Power System Stabilizer where adjusting the regulation point of the generator can increase system stability during power system kW swings.

### *Line-drop Compensation*

Line-drop compensation adjusts generator voltage proportional to generator load. Line-drop compensation can be used to maintain voltage at a load that is at a distance from the generator. Generator output reactive current is used to increase the generator voltage with increasing load, based on the user configurable line-drop compensation factor. Line-drop compensation is adjustable from 0…10% of the voltage setpoint in 0.1% steps, which represents the percent voltage change at rated generator current. Line-drop compensation cannot be used with droop or cross-current compensation.

### *Power Factor Regulation Mode (PF)*

In PF mode, the CGCM unit controls field excitation current output to maintain the commanded power factor setpoint. The CGCM unit uses the measured generator voltages and currents to calculate power factor. The PF feedback loop includes adjustable proportional and integral gains. To activate PF mode:

- the metering CTs and VTs must be properly connected and configured.
- the PF mode gains must be set.
- the desired power factor setpoint must be written to the **PFSetpt** tag.
- excitation enabled (tag **SoftwareExcEn** = 1).
- remote Excitation Enable On (discrete input).
- the CGCM unit must be in AVR mode (tag **AVR_FCR_Select** = 0).
- droop must be enabled (**V_DroopEn** tag = 1).
- droop must be selected (**Droop_CCC_Select** tag = 0).
- automatic reactive power control must be enabled (tag **PF_VAR_En** = 1).
- power factor control must be selected (tag **PF_VAR_Select** = 0).

### *Reactive Power Regulation Mode (VAR)*

In VAR mode, the CGCM unit controls field excitation current output to maintain the commanded reactive power setpoint. The CGCM unit uses the measured generator voltages and currents to calculate reactive power. The VAR feedback loop includes adjustable proportional and integral gains. To activate VAR mode:

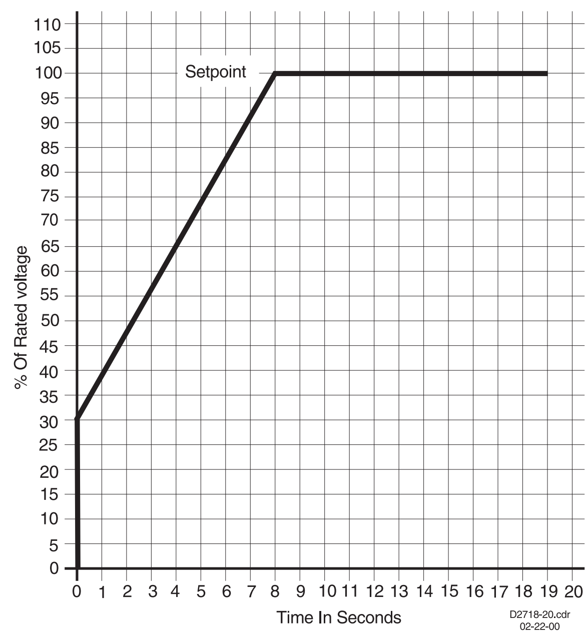
- the metering CTs and VTs must be properly connected and configured.
- the VAR mode gains must be set.
- the desired reactive power setpoint must be written to the **VARSetpt** tag.
- excitation enabled (tag **SoftwareExcEn** = 1).
- remote Excitation Enable On (discrete input).
- the CGCM unit must be in AVR mode (tag **AVR_FCR_Select** = 0).
- droop must be enabled (**V_DroopEn** tag = 1).
- droop must be selected (**Droop_CCC_Select** tag = 0).
- automatic reactive power control must be enabled (tag **PF_VAR_En** = 1).
- VAR control must be selected (tag **PF_VAR_Select** = 1).

### *Soft Start Mode*

CGCM unit Soft Start mode provides for an orderly build-up of generator voltage from residual to the voltage setpoint in the desired time with minimal overshoot. When the system is in Soft Start mode, the CGCM unit adjusts the voltage reference based on the Soft Start Initial Voltage and Soft Start Time.

The Soft Start Voltage Reference illustration is a graph for the voltage reference showing soft start initial voltage at 30%, soft start time at 8 seconds.

**Figure 29 - Soft Start Voltage Reference**



If the generator is not up to speed when the soft start begins, the voltage increases but only to the level determined by Volts/Hz limiting. When the unit is operating in FCR mode, soft start operates as it does in the AVR mode, with the field current, rather than the generator voltage, being the controlled parameter.

To activate soft start mode:

- the Soft Start Initial Voltage (tag **SoftStart_InitLevel**) and Soft Start Time (tag **SoftStartTime**) parameters must be set.
- excitation enabled (tag **SoftwareExcEn** = 1).
- remote Excitation Enable On (discrete input).
- FCR mode not active (tag **AVR_FCR_Select** = 0).
- engine idle bit is set (tag **EngineIdle** = 1).

### *Internal Tracking*

The CGCM unit provides a tracking function between the non-active modes of operation and the active mode of operation, to minimize the potential for instability that can occur when switching from one mode to another. There are two settings you can configure. The internal tracking rate defines the time constant of a first-order filter through which the CGCM unit matches the non-active modes with the active mode and is scaled in seconds. The time for the tracking function to settle out after a step change in the operating setpoint is approximately four times the internal tracking rate setting.

The internal tracking delay setting adjusts the delay of the tracking function to prevent a non-active mode from being adjusted into an undesirable condition. For example, with AVR mode active, if the generator sensing VT fails open, the excitation output goes to a full-on state. Applying a tracking delay reduces the likelihood of this undesirable operating point being transferred to a new operating mode.

### *Traverse Rates*

You can control the speed at which the CGCM unit switches from one regulation mode to another by configuring traverse rates for each regulation mode. These settings define the rate at which the system changes to the new setpoint when the mode changes. At the instant the mode is changed, the regulator begins changing its operating point from the internal tracking setpoint to the new mode's setpoint at a rate determined by the new mode's traverse rate.

Please refer to Chapter 4 for information on scaling and units of the traverse rate settings.

Increasing a traverse rate causes the regulator output to change more slowly. A value of 200 seconds is a special case that causes the CGCM unit to hold the existing regulator output until the new setpoint is adjusted to become equal to or pass through the previous mode's setpoint.

The tag **SetptTraverseActive** = 1 when the CGCM unit is traversing between the internal tracking setpoint and the new operating mode's setpoint. The tag = 0 when the operating point has completed traversing to the new mode's setpoint. This tag is used by the host Logix controller to determine when the new mode has taken control.

## Limiting Functions

This section discusses the different types of limiting functions the CGCM unit provides.

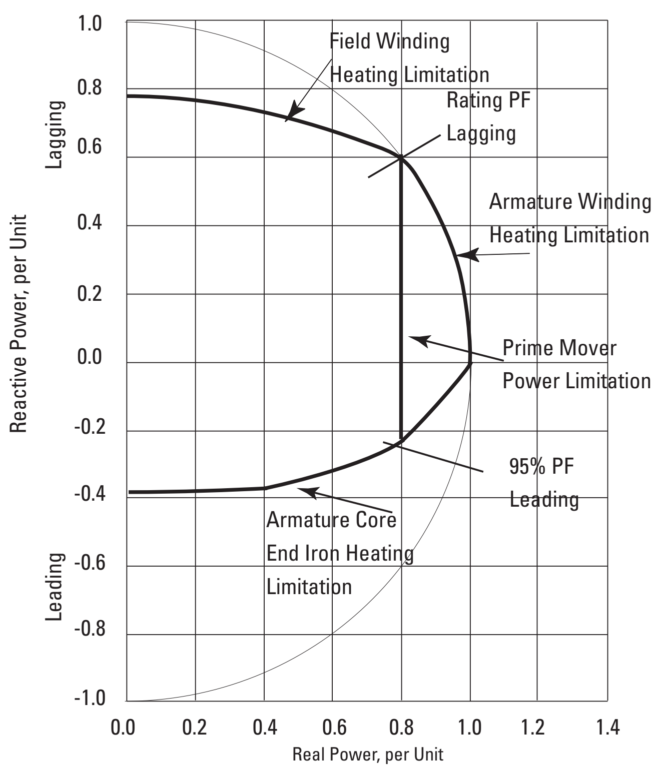
- Volts/Hertz Limit
- Over-excitation Limit
- Under-excitation Limit

### *Generator Capability Curve*

The generator capability curve graphically depicts the combinations of real and reactive power a generator is able to produce (or absorb, in the case of reactive power) without damage caused by overheating. The CGCM unit provides a number of limiting functions designed to maintain operation within safe areas of the generator capability curve.

A typical generator capability curve is shown in the following illustration.

**Figure 30 - Typical Generator Capability Curve**



### *Volts/Hertz Limit*

Volts/Hertz limiting acts to reduce the generator output voltage by an amount proportional to generator frequency. This is done to protect the generator from overheating and reduce the impact on the prime mover when adding a large load.

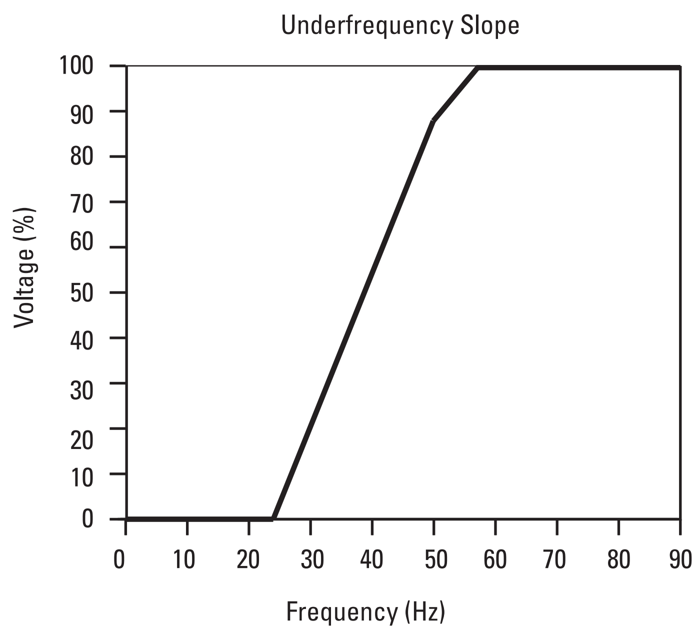
When the generator frequency drops, the voltage setpoint is automatically adjusted by the CGCM unit so that generator voltage follows the under-frequency slope.

The CGCM unit provides two configurable knee frequencies and two configurable slopes that allow the user to define the Volts/Hz characteristic. The slopes are expressed in PU Volts / PU Hertz. For a nominal 60 Hz, 120V system, a slope of one corresponds to 2V per Hz. The generator output voltage is maintained at the configured level for any frequency at or above the configured knee frequency up to 90 Hz. Excitation is inhibited when the frequency is at or below the 10 Hz cutoff frequency.

The Under-frequency Slope and Knee Voltages graph shows a typical Volts/Hz characteristic as displayed in the RSLogix 5000 software CGCM unit configuration screen.

Volts/Hertz limiting is automatically enabled in AVR mode and limits the voltage increase in Soft Start mode.

**Figure 31 - Under-frequency Slope and Knee Voltages**



### *Over-excitation Limit*

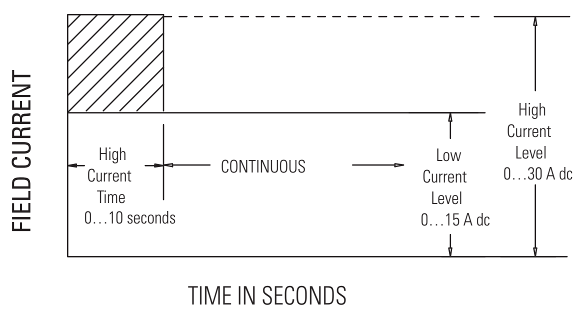
Over-excitation limiting (OEL) operates in all modes except FCR. The CGCM unit senses and limits the field current to prevent field overheating. When the limit is reached, the limiter function overrides AVR, VAR, or Power Factor modes to limit field current to the preset level. OEL operates in the area above the Field Winding Heating Limitation curve in the generator capability curve.

The generator operates in one of two different states, offline or online. The generator is offline when it is operating in a constant-voltage mode. The CGCM unit is considered online if any of these modes are enabled:

- Droop (reactive power) compensation
- Cross current compensation
- Line drop compensation

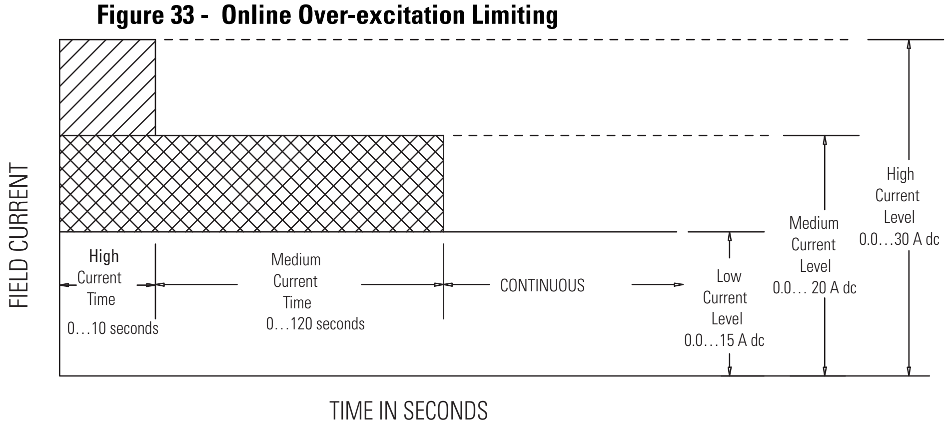
Two OEL current levels, high and low, are defined for offline operation as shown in the graph below. The generator can operate continuously at or below the low OEL current level and for a time at the high OEL current level that you configure.

**Figure 32 - Offline Over-excitation Limiting**




Three OEL current levels, high, medium, and low are defined for online operation as shown in the graph below. The high and medium current levels can be maintained only for time periods you define. The generator can operate continuously at or below the low OEL current level.

**Figure 33 - Online Over-excitation Limiting**



The CGCM unit also uses two counters, the reset counter and the time limit counter. The counters are used to prevent excessive heating of the exciter field that can be a result of repeated over-excitation. The time limit counter monitors the duration of an over-excitation condition. The reset counter counts backward from either the high OEL time setting or the sum of the high and medium OEL times, depending on the value of the time limit counter.

If, during an OEL cycle, excitation current returns below the low current value, the reset counter begins counting backwards from its present value. If it reaches zero, the time limit counter is reset to zero and a new OEL cycle can then occur.

If the reset counter does not reach zero before the excitation current rises above the low current value, the time limit counter begins counting where it stopped when the excitation current last fell below the low current value. If the time limit counter is greater than the programmed high OEL time, the excitation current is limited to the medium current value. This prevents repeated cycling of the exciter field at its highest possible current value.

When the excitation current exceeds the OEL limit, the OEL alarm tag OEL_Active = 1. In FCR mode, OEL limiting is not active although the tag is set. This tag is in the Scheduled Read table. The OEL function meets ANSI/IEEE C50.13.

### *Under-excitation Limit*

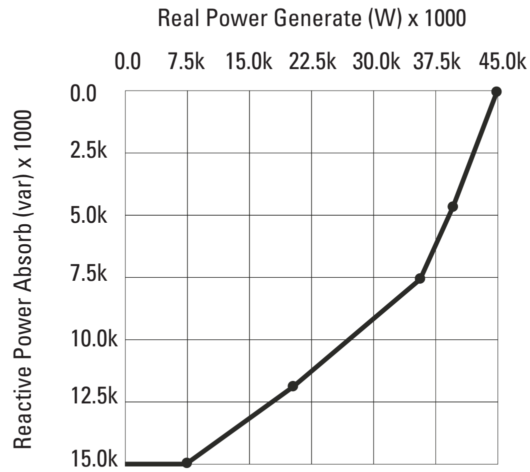
Under-excitation limiting (UEL) operates in all modes except FCR mode. UEL senses the leading var input of the generator and limits any further decrease in excitation to prevent loss of synchronization and excessive end-iron heating during parallel operation. UEL operates in the area below the Armature Core End Iron Heating Limitation curve in the generator capability curve.

**TIP** The UEL function is not designed to prevent the loss of excitation function from operating.

A customizable UEL limiting curve is defined by a piecewise linear curve specified by five points you select as shown in the Typical UEL Limiting Curve diagram.

Generator is operating in the area of its characteristic curve below the UEL curve, when the excitation current is less than the UEL curve, the UEL alarm tag **UEL_Active** = 1. In FCR mode, UEL limiting is not active although the tag is set. This tag is in the Scheduled Read table.

**Figure 34 - Typical UEL Limiting Curve**




## Protection Functions

The CGCM unit detects the fault conditions listed and described below. Faults detected by the CGCM unit are communicated to the host Logix programmable controller. Fault flags are communicated in the Scheduled Read table. A fault flag is latched until the host controller resets it. The host Logix controller can reset all CGCM unit faults by setting the tag FltReset = 1 once the fault condition is cleared.

The CGCM unit automatically shuts down excitation if one of these faults occurs:

- Overexcitation voltage
- Reverse VAR
- Logix controller fault

Fault conditions can also be configured to activate the CGCM unit fault relay output. Once configured, the CGCM unit fault relay operates independently of the host Logix controller program (including Controller Run/Program mode).

Refer to Chapter 4 for information on configuring the fault relay operation.

### *CGCM Protection Capabilities*

The protective functions in the CGCM unit are time-proven and designed to provide a high degree of reliability, repeatability, longevity, and accuracy. The CGCM unit is designed to meet or exceed applicable CE standards, but was not tested to all standards that many North American utilities use to define utility grade protection. However, the CGCM unit does possess many of the features that define utility grade protection.

The CGCM unit can be used as primary protection in applications not requiring utility grade protection or in utility applications where the authority having jurisdiction has approved the CGCM unit for use as primary protection. In applications requiring utility grade protection, where the local authority has not evaluated or approved the CGCM unit, the CGCM unit can be used for secondary protection in conjunction with a primary protection system.

#### *Loss of Excitation Current (40)*

The CGCM unit activates this fault when excitation current metered by the CGCM unit falls below the user specified loss of excitation current setpoint for more than the user defined delay time. In a redundant CGCM unit system, excitation is disabled and a transfer to the secondary controller occurs. If this fault occurs, tag **LossExcFlt** = 1 in the Scheduled Read table. This fault is inhibited during voltage build and when soft start is active.

#### *Over-excitation Voltage (59F) (field over-voltage)*

When the field voltage rises above the level you specified for more than a set amount of time, a field over-voltage annunciation occurs. Once the field voltage drops below the threshold, the field over-voltage timer is reset. If this fault occurs, the CGCM unit shuts down excitation and sets tag **OvrExcFlt** = 1 in the Scheduled Read table.

#### *Generator Over-voltage (59)*

When the generator voltage rises above the level you specified for more than a set amount of time, a generator over-voltage annunciation occurs. Once the generator voltage drops below the threshold, the generator over-voltage timer is reset. If this fault occurs, tag
**Ovr_V_Flt** = 1 in the Scheduled Read table.

#### *Generator Under-voltage (27)*

When the generator voltage falls below the level you specified for more than a set amount of time, a generator under-voltage annunciation occurs. Once the generator voltage rises above the threshold, the generator under-voltage timer is reset. This function is disabled during soft start timing or when the **EngineIdle** tag is set. If this fault occurs, tag **Undr_V_Flt** = 1 in the Scheduled Read table.

### *Loss of Sensing (60FL)*

For three-wire and four-wire sensing, Loss of Sensing detection is based on the logical combination of several conditions. They include these conditions:

1. The average positive sequence voltage is greater than 8.8% of the AVR setpoint.
2. The negative sequence voltage is greater than 25% of the positive sequence voltage.
3. The negative sequence current is less than 17.7% of the positive sequence current.
4. The positive sequence current is less than 1% of rated current for 0.1 seconds.
5. The generator positive sequence voltage is less than 8.8% of the AVR setpoint.
6. The positive sequence current is less than 200% of the rated current for 0.1 seconds.

The three phase loss of sensing is expressed by this logical formula:

Loss of Sensing = ((1 and 2) and (3 or 4)) or (5 and 6)

For single-phase sensing, Loss of Sensing is detected when the following conditions exist in the proper logical combination.

1. The average generator terminal line-to-line voltage is less than 70% of the AVR setpoint.
2. The positive sequence current is less than 200% of the rated current.
3. The negative sequence current is less than or equal to 17.7% of the positive sequence current.
4. The positive sequence current is less than 1% of rated current for 0.1 seconds.

The single phase loss of sensing is expressed by this logical formula:

Loss of Sensing = ((1 and 2) and (3 or 4))

The time delay for this function is fixed at 0.1 seconds during normal operation and increased to 1.0 seconds during soft start operation. Loss of Sensing is disabled when the excitation current is less than the Loss of Excitation setpoint. If this fault occurs, tag **LossSensingFlt** = 1 in the Scheduled Read table.

### *Loss of Excitation Power (PMG) (27)*

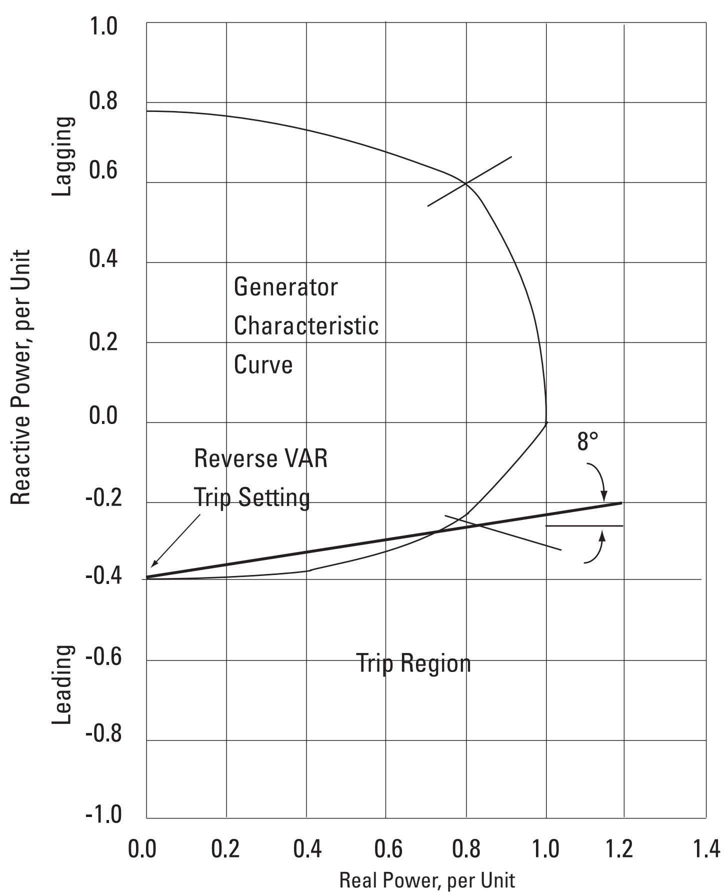
If voltage to the PMG excitation power inputs falls below 10V AC for approximately 400 ms or more, a Loss of Excitation power fault occurs. When single phase PMG is selected, the CGCM unit senses phases A and C for this function. This function is disabled when Shunt excitation is selected, the **EngineIdle** tag is set, or the host Logix controller is in Program mode. If this fault occurs, tag **LossPMGFlt** = 1 in the Scheduled Read table.

### *Reverse VAR (40Q)*

When the Reverse VAR level exceeds the characteristic curve for an amount of time you set, a Reverse VAR fault occurs. The characteristic curve is a line that begins at the pickup setting you defined at zero real power and extends toward positive reactive power at an angle of 8°. Once the VARs increase above the threshold, the Reverse VAR fault timer is reset. If this fault occurs, the CGCM unit shuts down excitation and sets tag **RevVARFlt** = 1 in the Scheduled Read table.

The Reverse VAR Characteristic graph shows more details.

**Figure 35 - Reverse VAR Characteristic**



### *Over-frequency (81O)*

When generator frequency exceeds the over-frequency setpoint for a specified amount of time, a definite time over-frequency fault occurs. Once the frequency drops below the threshold, the over-frequency fault timer is reset. If this fault occurs, tag **OvrFreqFlt** = 1 in the Scheduled Read table.

### *Under-frequency (81U)*

When generator frequency drops below the under-frequency setpoint for a specified amount of time, a definite time under-frequency fault occurs. This function is disabled during soft start timing, when no voltage is present on the generator voltage sensing inputs, or when the **EngineIdle** tag is set. Once the frequency rises above the threshold, the under-frequency fault timer is reset. If this fault occurs, tag **UndrFreqFlt** = 1 in the Scheduled Read table.

### *Reverse Power Protection (32R)*

When generator reverse power exceeds the reverse power setting for a specified amount of time, a reverse power fault occurs. Once the reverse power drops below 95% of the threshold, the reverse power fault timer is reset. If this fault occurs, tag **RevPwrFlt** = 1 in the Scheduled Read table.

### *Rotating Diode Failure*

The Rotating Diode Monitor is capable of detecting one or more open or shorted diodes in the generator's rotor. If a failed diode is detected, a fault occurs.

The CGCM unit monitors specific harmonic components present in the field current. The frequency of the harmonics is proportional to the system frequency and the ratio between the main and exciter field poles.

For example, during normal operation at 60 Hz, a 3-phase exciter bridge produces a ripple current frequency of 1080 Hz.

1080 Hz = 6 * 60Hz * (12 exciter poles / 4 main poles)

A shorted diode produces increased ripple current at 1/6 of the normal ripple frequency or 180 Hz. Similarly, an open diode shows increased current at 1/3 of the normal ripple frequency or 360 Hz. The CGCM unit senses harmonics in the 1/6 and 1/3 harmonic levels to provide protection for these conditions.

When the ripple current at one of these frequencies exceeds the applicable user specified threshold, a timer is started. Once the time delay is exceeded, a rotating diode fault occurs. If the ripple current falls below the threshold (configured as percent of measured excitation current) before the timer expires, the timer is reset. If this fault occurs, tag **RotDiodeFlt** = 1 in the Scheduled Read table.

The Rotating Diode fault is inhibited if the field current is less than 1.5 A DC or if the generator frequency is outside the range of 45…70 Hz.

### *Phase Rotation Fault (47)*

The CGCM unit calculates the negative sequence voltage of the 3-phase generator voltage sensing input. When the generator phase rotation is opposite to the wiring rotation you configured, the level of the generator negative sequence voltage increases to approximately 100%. The pickup value for this function is fixed at 66%. When the pickup value is exceeded, timing is started. After a one second delay a phase rotation fault is indicated. A phase rotation fault is also indicated when a phase loss condition occurs. If this fault occurs, tag **PhRotFlt** = 1 in the Scheduled Read table.

### *Generator Over-current (51/51V)*

A generator over-current fault occurs when generator current exceeds the generator over-current function's setpoint. You configure over-current protection by selecting a time characteristic curve, an over-current setpoint, a time dial setting and a voltage restraint setpoint. The over-current function meets ANSI/IEEE C37.112.

See Appendix A for a list of available curves and more detail.

If this fault occurs, tag **Ovr_I_Flt** = 1 in the Scheduled Read table.

## Synchronizing

The CGCM unit monitors the generator and bus voltage sensing inputs to provide synchronization between the generator and either of two buses. The CGCM unit provides voltage, phase and frequency error parameters, and a breaker close permissive signal, to its host Logix controller. This lets the controller control the prime mover, achieve phase synchronization, and voltage matching.

The CGCM unit can also provide synchronization between two busses by measuring appropriate synchronization parameters. For synchronizing between two busses, substitute the term second bus for generator in the discussions that follow.

When synchronizing a system between systems with differing metering configurations, the synchronization configuration must account for any phase shift or voltage differences between the two systems. For example, when synchronizing a three-wire (delta) generator to four-wire (wye) bus system, the synchronization configuration must take into account the 30° phase shift between line-to-line and line-to-neutral voltage.

*Synchronizing Connection Schemes*

The CGCM unit provides information that its host Logix controller uses to synchronize the generator output voltage, frequency, and phase to a reference power system, or bus. 3-phase, dual bus, and single-phase connection schemes are described below.

- 3-phase

  In this scheme, the 3-phase output of the generator and all three phases of the reference system are connected to the CGCM unit. This lets the CGCM unit match voltage, frequency, phase, and phase rotation of the generator to the reference system. The 3-phase scheme provides the CGCM unit with the most power system data, allowing it to perform the most thorough synchronization.

  To enable a 3-phase connection, the user selects the Generator and Bus VT Configurations as two-transformer open-delta, three-wire wye or four-wire wye.

  When synchronizing delta systems, the CGCM unit uses line-to-line voltage for voltage, frequency and phase matching. When synchronizing wye systems, the CGCM unit uses line-to-line voltage for voltage and frequency matching, and line-to-neutral voltage for phase matching.

- Dual Bus

  The CGCM unit has the ability to synchronize a generator to either one of two reference busses. The CGCM unit supports this by monitoring one line-to-line phase of the two reference busses. The user must select the appropriate bus for synchronization. It is not possible to synchronize to two different busses at the same time. For dual-bus synchronization, the 3-phase output of the generator and a single phase from each reference bus are connected to the CGCM unit. This lets the CGCM unit match voltage, frequency, and phase, but not phase rotation of the generator to the reference system.

  However, the CGCM unit verifies that the generator output phase rotation matches the user-configured selection of ABC or ACB.

  To enable the dual-bus mode, select the Bus VT Configuration as Dual Breaker.

- Single-phase

  The CGCM unit is also capable of synchronizing where only a single line-to-line input is available from the generator or bus. This is the case for single-phase systems or in systems where only one phase has a transformer connected for synchronizing purposes. The CGCM unit can perform no phase rotation check on the generator output with single-phase generator voltage sensing. The reference bus connection can be either single or 3-phase.

To enable single-phase synchronizing, select the Generator VT Configuration as Single-phase.

### *Configurable Synchronization Parameters*

The CGCM unit provides a number of configurable settings to facilitate synchronizing between systems with different voltages and metering configurations.

Please refer to Chapter 4 for more information.

### *Initiating Synchronization*

Prior to performing synchronization, the host controller must initialize tags in the Output table to their appropriate values as described below.

- Automatic Synchronization

  The host controller sets the **AutoSyncEn** tag to enable the synchronizer to compute error and correction tags in the software interface for control of the synchronization bus voltage, frequency, and phase. When the synchronizing conditions are met, the CGCM unit sets the proper close breaker tag.
  - Dual bus: The CGCM unit performs synchronization by using the generator bus inputs and the active bus inputs.
  - Dead bus: If dead bus closure is enabled, the CGCM unit sets the close breaker tag when the generator frequency and voltage are within the configured dead bus limits.

| IMPORTANT | Prior to Host FRN 4.9, regardless of the setting of the **DeadbusGenFreqLoLimit** parameter, the CGCM unit disables synchronization when the generator frequency is below 45 Hz. |
|---|---|

    When the CGCM unit senses that all three (one for single phase setup) bus voltages are less than 10% of the configured voltage and frequency is less than 20 Hz, it sets the Dead Bus Synchronizing mode tag. The CGCM unit does not calculate voltage or frequency error signals during Dead Bus mode.
  - Phase rotation (3-phase connection only): If the bus and generator are opposite in phase rotation, synchronization fails. The CGCM unit continually checks phase rotation match when synchronization is active.
- Permissive Synchronization

  The host controller sets the **PermissiveSyncEn** tag to enable Permissive Synchronization mode. This mode is the same as Automatic Synchronizing mode except that the CGCM unit does not compute error and correction tags. The CGCM unit sets the proper close breaker tag when the synchronizing conditions are met.

- Check Synchronization

  The host controller sets the **CheckSyncEn** tag to enable Check Synchronization mode. This mode is the same as the Automatic Synchronization mode except the CGCM unit does not set a close breaker tag. This mode is useful for testing the system.
- Initiate Synchronization

  The host Logix controller sets the **InitiateSync** tag to begin the synchronization process. This tag must remain set during the entire process. If the initiate synchronization tag is reset, the CGCM unit terminates the synchronization process. Similarly, a write of the Unscheduled Write table terminates an active synchronization process.

  The Initiate Synchronization tag enables the operation of the selected Synchronizing mode. The host controller must select one and only one of the three modes described above before or at the same time as the Initiate Synchronization tag. If none are enabled, the CGCM unit sets the undefined Synchronization mode error flag. If more than one of these inputs is enabled, the CGCM unit sets the conflict error flag. In either case, synchronization fails and the CGCM unit sets the synchronization failure flag.

### *Synchronizing Error Calculation*

When Synchronization is active, the CGCM unit computes synchronizing errors as follows.

$$\text{Voltage Match Error} = 100 \times \frac{\text{Bus Voltage} - \text{Generator Voltage}}{\text{Bus Voltage}}$$

$$\text{Frequency Match Error} = \text{Bus Frequency} - \text{Generator Frequency}$$

$$\text{Phase Match Error} = \text{Bus Voltage Phase Angle in Degrees} - \text{Generator Voltage Phase Angle in Degrees}$$

### *Synchronizing Control Software Interface*

When synchronization is active, the CGCM unit adjusts the values of the Scheduled Read table tags as described below.

- Voltage Match Error as computed above
- Frequency Match Error as computed above
- Phase Match Error as computed above
- Voltage Raise and Lower tags, which are set when the voltage match error is above or below, respectively, the voltage acceptance window as defined by the configured synchronizing voltage high and low limits
- Frequency Raise and Lower tags, which are set when the frequency match error is above or below, respectively, the frequency acceptance window as defined by the configured synchronizing frequency high and low limits
- Phase Raise and Lower tags, which are set when the phase match error is above or below, respectively, the phase acceptance window as defined by the configured synchronizing phase high and low limits
- The applicable Close Breaker tag, which is set when the voltage match error, frequency match error and phase match error have all remained continuously within their respective acceptance windows for the configured acceptance window delay time

## Real-power Load Sharing

The real-power load sharing function lets two or more CGCM units or other compatible generator control devices (such as the Line Synchronization Module, bulletin number 1402-LSM) to load the generators under their control such that the same per unit output is developed by each generator. A 0…5V DC signal is developed proportional to the per unit kW output of the generator and fed to the load sharing terminals through an internal resistor. The configurable full-scale voltage corresponds to the rated generator kilowatts. The load sharing output is updated every 50 ms.

The load sharing terminals are connected in parallel (plus to plus, minus to minus) with other compatible devices. If the CGCM unit's generator is more heavily loaded than the others, its developed load share voltage is higher, and current flows out of the CGCM unit and into other devices on the network. A more lightly loaded generator results in a lower load share voltage and current flowing into the CGCM unit.

The direction and magnitude of current flow is used to develop the Load Share Error value the CGCM unit makes available to the host logic controller. The host logic controller program can use this value to control the prime mover governor and balance generator output with others in the system.

The CGCM unit exhibits two rate of change features, Limit and Rate, that work together to protect against an unstable system.

Limit defines the maximum per unit load share error reported to the host controller.

Rate defines the maximum change in the load share error per CGCM unit update cycle, expressed in percent of rated kilowatts per second. For example, if a change of load of 50% is required and the rate set for 10% per second, the change takes 5 seconds to complete. The CGCM unit has an internal relay that isolates the load share circuit whenever the function is not active or when control power is not present.

| | |
|---|---|
| **IMPORTANT** | Series B units do not isolate when control power is lost. An external relay must be used. |

## Metering

The CGCM unit provides true RMS metering based on voltage and current samples obtained from the current and voltage inputs. All monitored parameters are derived from these values. Accuracy is specified as a percentage of full scale, at 25 °C (77 °F) across the frequency range of the controller, at unity power factor. Metered parameters are communicated to the host Logix programmable controller via the Unscheduled Read table.

The Metered Parameter Accuracy table lists all metered parameters and their accuracy.

3-phase generator side metering is independent of the Synchronization mode in one or two breaker schemes. In the two-breaker scheme, single-phase bus side metering is provided only for the selected bus.

Refer to the Specifications, Appendix D, for information on metering accuracy. Refer to Power System Sign Conventions on page 66 for the sign convention of power and current values.

### *Metered Parameters*

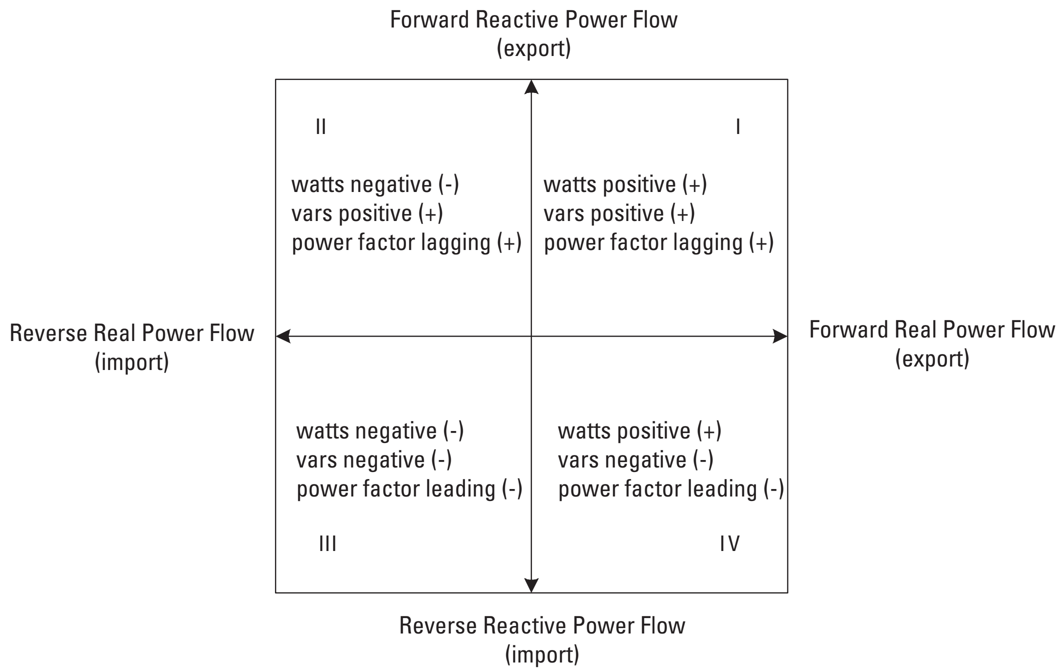
The CGCM unit provides the following metered parameters. The collection of metering data is dependent on the metering wiring mode selected, for example, single-phase, open-delta, four-wire wye, and three-wire wye.

**Table 3 - Metered Parameter Accuracy**

| Metered Parameter | Metering Wiring Mode | | | | |
|---|---|---|---|---|---|
| | Single-phase | Delta | Three-wire Wye | Four-wire Wye | Dual-bus |
| Gen Voltages, 3, L-L | CA | AB, BC, CA | AB, BC, CA | AB, BC, CA | - |
| Gen Voltage, avg, L-L | Yes (=CA) | Yes | Yes | Yes | - |
| Gen Voltages, 3, L-N | N/A | N/A | N/A | A, B, C | - |
| Gen Voltage, avg, L-N | N/A | N/A | N/A | Yes | - |
| Gen Currents, 3 | A, B, C | A, B, C | A, B, C | A, B, C | - |
| Gen Current, avg | Yes | Yes | Yes | Yes | - |
| Gen Kilowatts, 3 | N/A | N/A | N/A | A, B, C | - |
| Gen Kilowatts, total | Yes | Yes | Yes | Yes | - |
| Gen kVA, 3 | N/A | N/A | N/A | A, B, C | - |
| Gen kVA, total | Yes | Yes | Yes | Yes | - |
| Gen kVAR, 3 | N/A | N/A | N/A | A, B, C | - |
| Gen kVAR, total | Yes | Yes | Yes | Yes | - |
| Gen Power Factor, 3 | N/A | N/A | N/A | A, B, C | - |
| Gen Power Factor, avg | Yes | Yes | Yes | Yes | - |
| Gen Frequency | Yes | Yes | Yes | Yes | - |
| Excitation Current | Yes | Yes | Yes | Yes | - |
| Gen Kilowatt Hours | Yes | Yes | Yes | Yes | - |
| Gen kVAR Hours | Yes | Yes | Yes | Yes | - |
| Gen kVA Hours | Yes | Yes | Yes | Yes | - |
| Diode Ripple Level | Yes | Yes | Yes | Yes | - |
| Load Share Error | Yes | Yes | Yes | Yes | - |
| Voltage Match Error | (1) | (1) | (1) | (1) | (1) |
| Sync Phase Error | (1) | (1) | (1) | (1) | (1) |
| Sync Frequency Error | (1) | (1) | (1) | (1) | (1) |
| Bus Voltages, 3, L-L | CA | AB, BC, CA | AB, BC, CA | AB, BC, CA | N/A |
| Bus Voltage, avg, L-L | Yes (=CA) | Yes | Yes | Yes | Yes |
| Bus Voltages, 3, L-N | N/A | N/A | N/A | A, B, C | N/A |
| Bus Voltage, avg, L-N | N/A | N/A | N/A | Yes | N/A |
| Bus A Frequency | Yes | Yes | Yes | Yes | Yes |
| Bus B Frequency | N/A | N/A | N/A | N/A | Yes |
| Gen Phase Rotation | N/A | Yes | Yes | Yes | Yes |
| Bus Phase Rotation | N/A | Yes | Yes | Yes | N/A |

(1) Results updated only while Synchronization is active (tag **InitiateSync** = 1).

**Figure 36 - Power System Sign Conventions**




## Redundancy

The CGCM unit is capable of being used in a Redundant mode that provides automatic transfer of control to a second CGCM unit. In a redundant configuration, the host Logix programmable controller is primarily responsible for sensing power system conditions that require a transfer of control. The CGCM unit also can initiate a transfer of control in case of certain CGCM unit failures.

The CGCM unit is equipped with two hardware provisions designed to support redundancy, the redundancy communication port and the redundancy relay output.

### *Redundancy Communication Port*

The redundancy ports of the partner CGCM units are connected together by means of a null modem cable. The redundancy communication channel is used to exchange tracking information from the primary to the secondary CGCM unit to support a bumpless transfer. In addition, the secondary CGCM unit can sense a failure in the primary CGCM unit via this communication channel to facilitate an automatic transfer of control.

If a loss of communication between redundant CGCM units occurs, the primary CGCM unit remains primary and the secondary CGCM unit switches to primary also. Because in this state both units are supplying current to the field, the host Logix programmable controller must be programmed to take corrective action (for example disable excitation to one CGCM unit) when this condition occurs.

### *Redundancy Relay Output*

The redundancy relay output is energized (sinks current) when the CGCM unit is in Primary mode. If the CGCM unit experiences a failure or operates in Secondary mode, the redundancy output is de-energized. The output is used to energize your relay that connects excitation output of the primary CGCM unit to the generator field.

When the excitation outputs from two CGCM units are connected through relays to the generator exciter field, you must place flyback diodes across the generator field winding to provide a path for exciter current during a transfer. To prevent errors in field current measurement, place three or four diodes in series. If fewer diodes are used, the field current splits between the external diode and the internal circuitry and prevent the current measurement circuit from sensing the total field current.

### *Redundancy Operation*

CGCM units in a redundant system must both be connected to the generator and bus VTs and the generator and cross-current CTs, as applicable. Connect the units excitation outputs through the relays you provide to the generator exciter field. In addition, properly connect the redundancy communication cable and verify that the CGCM unit configurations match.

CGCM units used in a redundant configuration are normally designated as primary and secondary, depending on the order in which the host controller enables excitation. With excitation disabled, each CGCM unit starts out in a Secondary mode. When the host controller enables excitation on the first CGCM unit, it checks for tracking information on the redundancy communication channel. If no tracking information is received, the CGCM unit switches to Primary mode. When the host controller subsequently enables excitation on the secondary CGCM unit, it begins receiving tracking information and remains in Secondary mode. The primary CGCM unit indicates its status by setting the **Spare1** tag in the software interface to the host controller.

If the primary CGCM unit fails or if its excitation is disabled, it stops sending tracking data on the redundancy communication channel. When the secondary senses a loss of tracking data it automatically switches to Primary mode and takes over-excitation control. It remains primary until the host controller disables its excitation.

Once the primary and secondary CGCM unit roles have been established by the host controller, they remain in their respective modes indefinitely. You can force a transfer by disabling excitation on the primary unit. This causes the secondary unit to sense a loss of tracking information, switch to Primary mode, and take over-excitation control.

Following a transfer, if the original failed primary CGCM unit is repaired and returned to service, it detects tracking information from the primary unit and remain in Secondary mode. In this state it is capable of taking over if the primary unit fails.

In a typical redundant CGCM unit application, the host Logix controller determines the generator's offline or online status by monitoring the status of the generator breaker. When operating offline, the CGCM unit normally regulates generator voltage in AVR mode. The host controller monitors generator voltage and other conditions. If those conditions indicate a failure of the primary unit the host controller initiates a transfer by disabling excitation to the primary unit. The secondary unit senses the loss of tracking information from the primary unit, designate itself the primary, energize its redundancy relay output and take over-excitation control.

When operating online, that is with the generator breaker closed and the generator operating in parallel with other generators or the power grid, the CGCM unit normally operates in VAR or PF mode to regulate reactive power flow. The host controller monitors generator conditions as in the offline condition and initiates a transfer to the secondary CGCM unit as appropriate. When operating online, the generator voltage is relatively fixed; therefore the host controller can monitor a different set of conditions, such as over-excitation or under-excitation.

Host controller operation is dependent on user-provided logic programming.

These events cause a CGCM unit to stop communicating to the backup:
- A fault of the digital signal processor
- A loss of redundant communication
- A watchdog time-out
- A loss of ControlNet communication

### *Redundancy Tracking*

The CGCM unit provides a tracking function between the secondary and primary CGCM units in a redundant system, to reduce the potential for instability that can occur when transferring control between the two units. Two settings you configure are provided. The redundant tracking rate defines the rate at which the primary CGCM unit matches the output of the secondary CGCM unit with its own output and is scaled in seconds per full-scale excursion of the excitation output.

The redundant tracking delay setting adjusts the delay of the tracking function to prevent the secondary CGCM unit output from being adjusted into an undesirable condition. For example, with AVR mode active in the primary CGCM unit, if the generator sensing VT fails open the excitation output goes to a full-on state. Applying a tracking delay reduces the likelihood of this undesirable operating point to be transferred to the secondary CGCM unit when it takes over control.

## Watchdog Timer

A watchdog timer time-out is an indication that the CGCM unit is not capable of executing the proper instructions, including those required to energize the fault output. When the Watchdog Timer times out, the CGCM unit removes excitation from the system, the CGCM unit internal microprocessor is reset, and the output relays (fault and redundancy) are disabled.

# Notes:

# CGCM Unit Configuration

## Introduction

This section provides a generic set-up and verification procedure for power generation systems by using the CGCM unit and RSLogix 5000 software. The various configuration parameters required to customize the device to a specific application are presented. Because every application is unique, read this section carefully and make sure that the configuration entries are appropriate for the system being implemented.

For additional information on RSLogix 5000 software, see Logix5000 Controllers Common Procedures, publication 1756-PM001.

## Overview of the Configuration Process

Follow these steps when you use the RSLogix 5000 software to configure the CGCM unit.

1. Gather the necessary equipment and information.
2. Create a new module.
3. Enter configuration for the module.
4. Edit configuration for a module when changes are needed.

## Preparation

Appendix F provides a table for recording configuration settings. It is suggested that you make a copy of Appendix F, use it to record the setup for each unit, and retain these records for future reference.

This generator information is needed to configure the CGCM unit:

- Rated frequency
- Rated voltage
- Rated current
- Rated real power
- PMG rated voltage
- Full-load exciter field voltage
- No-load exciter field voltage
- Full-load exciter field current
- Generator direct access transient time constant $T'_{do}$
- Generator exciter field time constant $T_e$
- Number of main and exciter field poles

- Generator capability curve
- Generator decrement curve

Consult with the generator manufacturer to be sure that you have the correct data.

### Record System Parameters

Verify and record system information and generator information required for configuration of the CGCM unit. Typically this information can be obtained from the generator nameplate, manufacturer's data sheets, and system electrical drawings.

### Equipment Required

You need a suitable personal computer running RSLogix 5000 software. The software is used to configure the CGCM unit for desired operation. RSLogix 5000 software contains a device profile that provides a user interface to the CGCM unit configuration.

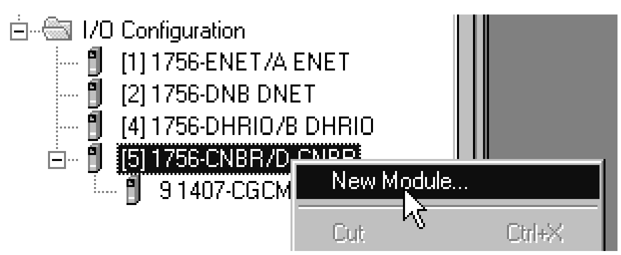
Refer to the CGCM Release Notes, publication 1407-RN001, for information on compatible RSLogix 5000 software versions and ControlLogix controller firmware revisions.

## Create a New Module in the ControlLogix Controller

Follow these steps to create a new module in the ControlLogix controller with RSLogix 5000 software.

| | |
|---|---|
| **IMPORTANT** | You must be offline when you create a new module. |

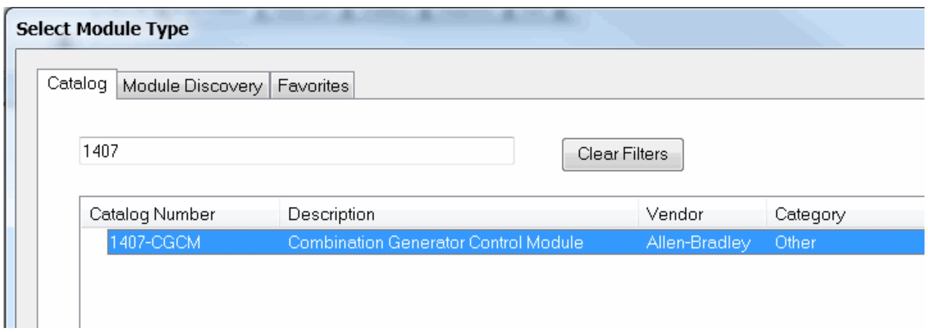
1. Under I/O Configuration, right-click 1756-CNB(R) and choose New Module from the menu.

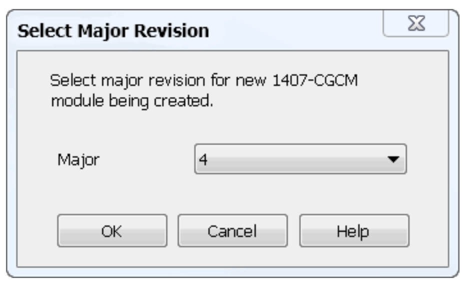



The Select Module Type dialog box appears. Add the CGCM unit as a ControlNet module under the 1756-CNB(R) ControlNet Bridge module in the controller.

2. Select 1407-CGCM, click Create, and then in the Select Major Revision dialog box, enter the Major Revision of the host firmware (for example 4 where the host firmware revision is 4.*x* or 2 where the host firmware is revision 2.*x*).

| IMPORTANT | You must enter the correct Major Revision at this time. Do not change the Major Revision number once the module is created. If you need to change it at a later time, you must delete the module and configure a new module. |
|---|---|



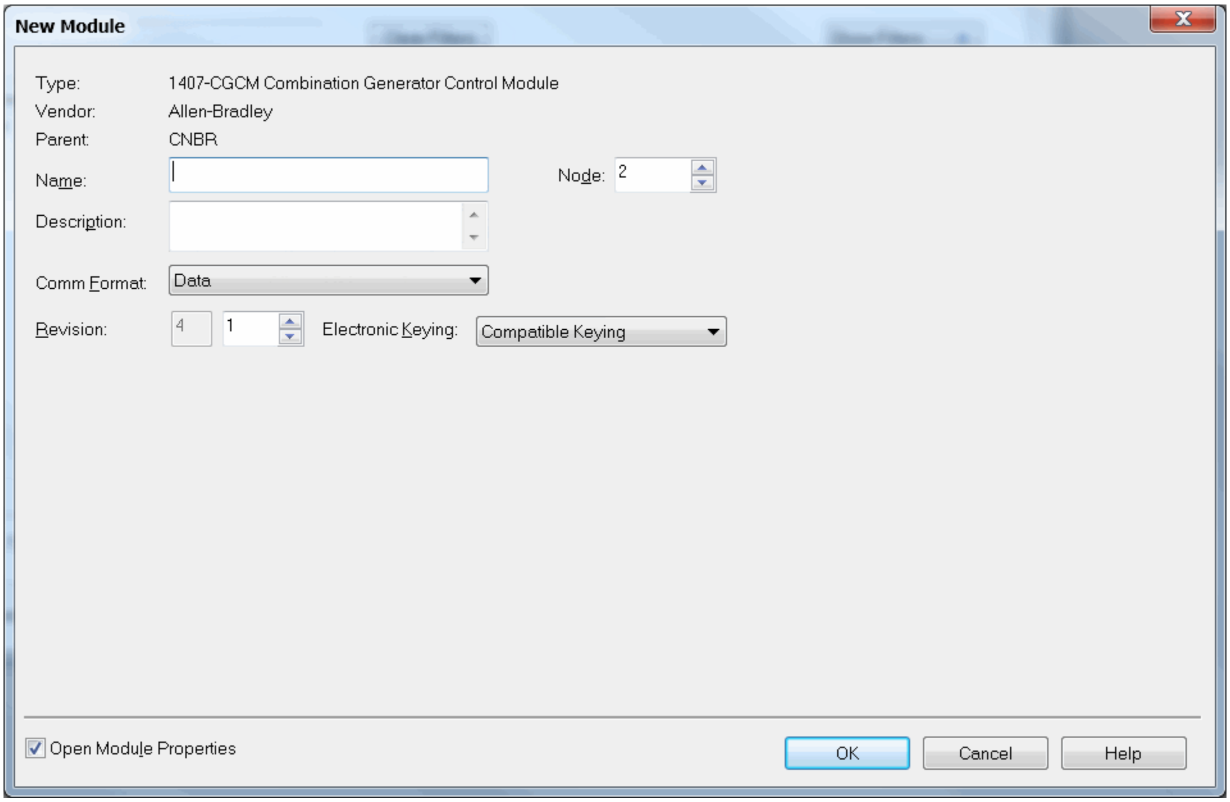

3. Click OK.

   The Module Properties dialog box appears.

4. Enter a Name for the module, its ControlNet Node address, and its Revision (the minor revision number, for example 25 where the host firmware revision is 4.25).

5. Select an Electronic Keying mode to suit your application needs and click Finish.

**TIP** Alternately, you can click Next to begin configuring the CGCM unit at this point. Refer to the configuration tabs description below.




Once you have added the module, you must schedule the connection to the CGCM unit with RSNetWorx for ControlNet software.

## Electronic Keying

**ATTENTION:** Be extremely cautious when using the disable keying option; if used incorrectly, this option can lead to personal injury or death, property damage or economic loss.

Although the CGCM unit does not physically reside in a ControlLogix chassis, electronic keying provides protection against module mismatch.

You must choose one of these keying options for the CGCM unit during module configuration:

- Exact match - all of the parameters described below must match or the inserted module rejects a connection to the controller

- Compatible module - a unit with host firmware major revision 3 or 4 functions as a unit with host firmware major revision 2 if so configured when the new module is created
- Disable keying - the inserted module does not reject a connection to the controller

An I/O module that is connected in a ControlLogix system compares the following information for itself to that of the original configuration:

- Vendor
- Product type
- Catalog number
- Major revision

This feature can prevent the inadvertent operation of a control system if a CGCM unit is replaced with an incompatible unit.

## Device Setup

You must configure the CGCM unit for the unit to function. Configuration tabs in the module set-up screen divide the required information into sub-categories. Evaluate the system and generator information to determine the appropriate configuration settings and use the configuration tabs to enter the settings.

**TIP** Some screens shown in this document can vary slightly from the RSLogix 5000 software that is currently provided. Please review each screen carefully.

### Applying the Configuration to the CGCM Unit

The configuration tabs provide a simple way for you to enter and edit CGCM unit configuration parameters. Changes you make to the configuration are not always immediately sent to the unit. The configuration data is stored in two controller tags in the ControlLogix controller, the Configuration tag and the Unscheduled Write tag.

Refer to Chapter 6 for details on these data tags.

The Unscheduled Write tag contains the parameters from the Gain tab along with the Line Drop Voltage Compensation from the Voltage tab. The Configuration tag contains all other CGCM unit configuration parameters.

Configuration data from the Configuration tag is written automatically to the CGCM unit only when excitation is not enabled and one of two following conditions occur:

- A connection is first established to the CGCM unit
- You change the configuration with the configuration tabs

The Unscheduled Write data tag must be written to the CGCM unit by using a message instruction in the controller program.

Refer to Chapter 6 for more information on the program interface for CGCM unit configuration.

## Configuration Tabs

Input the initial settings (parameters) to match your system application for each of the configuration tabs as shown in the following paragraphs. Review the settings and click OK when complete.

Descriptions for the configuration tabs labeled General, Connection, and Module Info are provided in Logix5000 Controllers Common Procedures, publication 1756-PM001.

Each tab contains four action buttons at the bottom of the tab. These buttons function as follows:

- OK - Accepts the entered values for each screen and returns the user to the previous screen.
- Cancel - Exits the screen and returns the values to their previous values.
- Apply - Applies the current settings without leaving the screen.
- Help - Accesses the help menu.

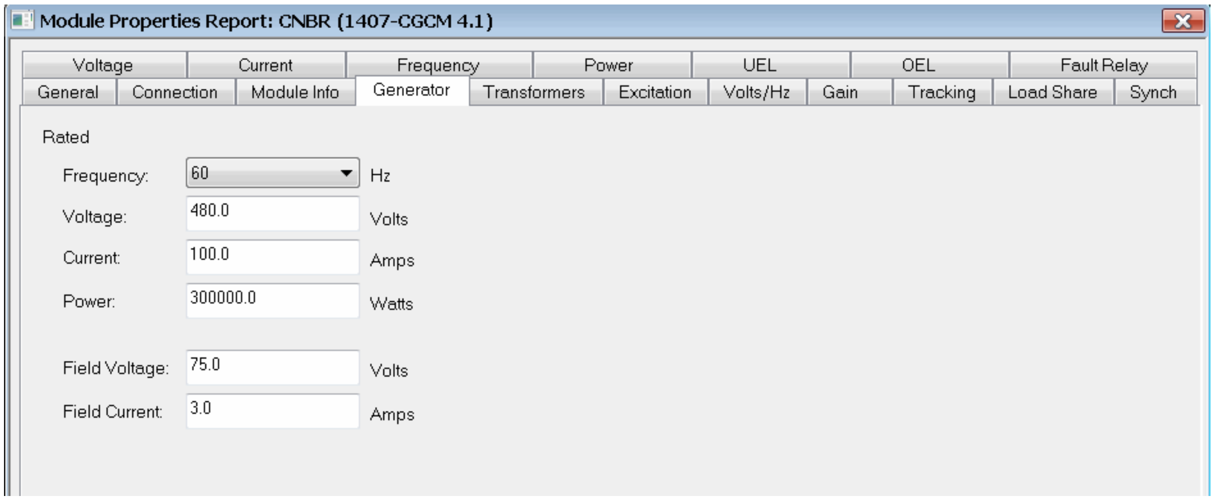
RSLogix 5000 software performs configuration data checking as specified by the limits shown in the data tables. The data checking verifies that the entry is within range for the device, however, it does not verify that it is reasonable for the application. You must be sure that the entry is reasonable for the specific application. If you enter an out-of range parameter in a Configuration tab, a message box reports the error and the appropriate limits.

Refer to Chapter 6 for information on the limits specified by the data tables.

**WARNING:** Data limit checking does not ensure values are appropriate for the application.

*Generator Tab*

The Generator tab is used to configure the unit to the design ratings of the generator. Enter the generator’s nameplate ratings in the appropriate fields of the Generator tab.




Rated Frequency - Sets the generator's rated frequency in Hz. Sets the value of tag **GenRatedFreq** in the Configuration table.

Rated Voltage - Sets the generator's rated line-to-line voltage in volts AC. Sets the value of tag **GenRated_V** in the Configuration table.

Rated Current - Sets the generator's rated current in amperes AC. Sets the value of tag **GenRated_I** in the Configuration table.

Rated Power - Sets the generator's rated power in Watts. Sets the value of tag **GenRated_W** in the Configuration table.

Rated Field Voltage - Sets the generator exciter's rated field voltage while the generator is operating at rated voltage, kW, and kVAR. Sets the value of tag **GenRatedExcV** in the Configuration table.

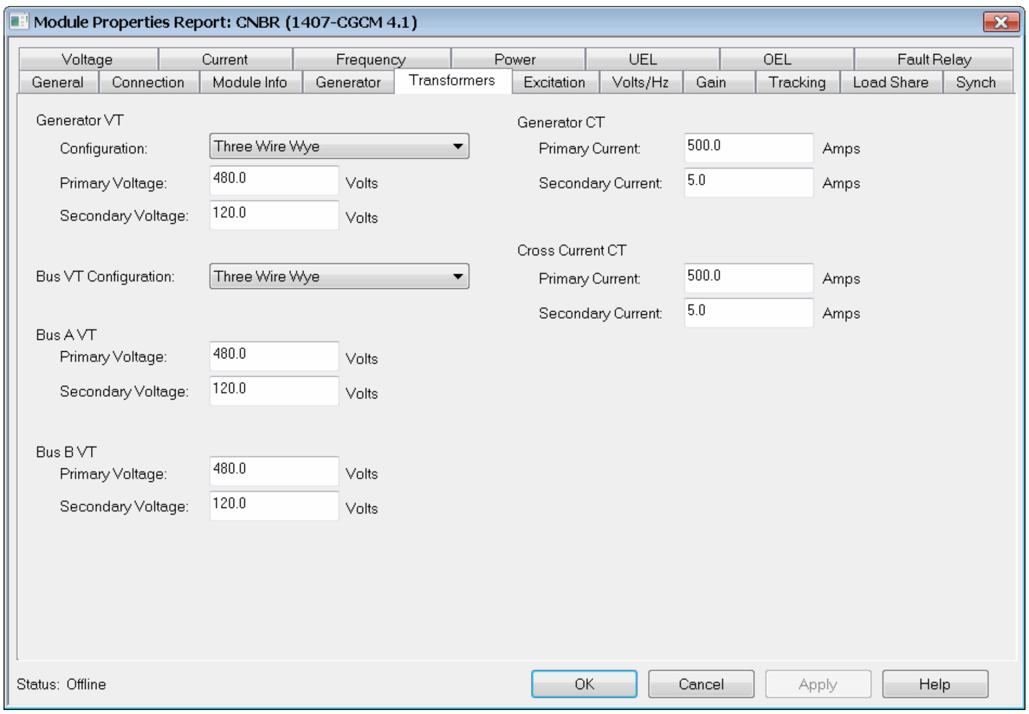
Rated Field Current - Sets the generator exciter's rated field current, in amperes DC. This is the current that must be supplied to the exciter while the generator is operating at rated voltage, kW, and kVAR. Sets the value of tag **GenRatedExcI** in the Configuration table.

### *Transformers Tab*

The Transformers tab is used to match the unit with the configuration of the generator voltage and current sensing transformers. To configure the Transformer tab, you must know the system wiring configuration. The settings entered in the Transformers tab must correspond to the actual wiring configuration.

Please refer to Chapter 2, Installation, for information on various wiring configurations.

Please refer to the VT and CT manufacturer's data for assistance in entering the correct primary and secondary voltages.




- Generator VT Configuration - The generator VT configuration selections are (1) single-phase, (2) two-transformer open delta, (3) three-wire wye, and (4) four-wire wye. Use the two-transformer open delta setting for any delta configuration. This parameter is stored in the tag **GenVT_Config** in the configuration table.
- Generator VT Primary Voltage - The primary voltage rating of the generator voltage transformer is stored in tag **GenVT_Pri_V** in the configuration table.
- Generator VT Secondary Voltage - The secondary voltage rating of the generator voltage transformer connected to V Gen A, V Gen B, and V Gen C, (and V Gen N for wye configurations) of the CGCM unit. This parameter is stored in tag **GenVT_Sec_V** in the configuration table.

- Bus VT Configuration - The bus VT configuration selections are (1) single-phase, (2) two-transformer open delta, (3) three-wire wye, (4) four-wire wye, and (5) dual breaker. This parameter is stored in the tag **BusVT_Config** in the configuration table. For applications that require synchronizing to one of two busses, dual breaker must be selected.
- Bus A VT Primary Voltage - The primary voltage rating of the bus voltage transformer is stored in tag **BusA_VT_Pri_V** in the configuration table.
- Bus A VT Secondary Voltage - The secondary voltage rating of the bus voltage transformer connected to V Bus A, V Bus B, and V Bus C (and V Gen N for wye configurations) of the CGCM unit. This parameter is stored in tag **BusA_VT_Sec_V** in the configuration table.
- Bus B VT Primary Voltage - The primary voltage rating of the second bus voltage transformer when dual breaker bus VT configuration is selected. This parameter is stored in tag **BusB_VT_Pri_V** in the configuration table.
- Bus B VT Secondary Voltage - The secondary voltage rating of the second bus voltage transformer connected to V Bus B, and V Bus N of the CGCM unit. This parameter is stored in tag **BusB_VT_Sec_V** in the configuration table.

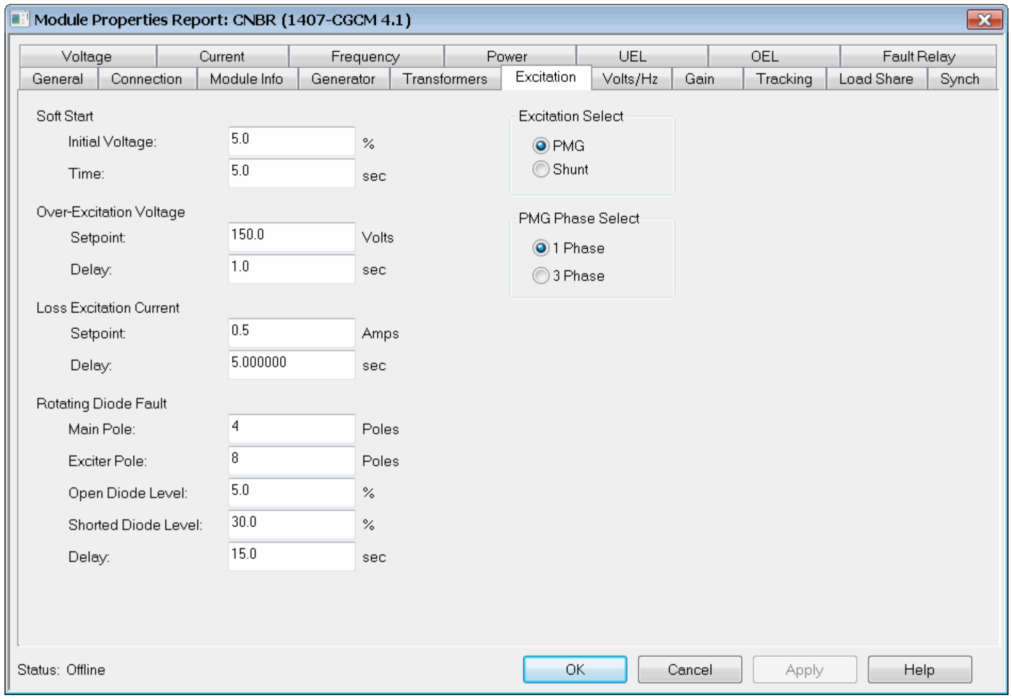
  The Bus B VT settings are used only by the CGCM unit if the Bus VT configuration selection is dual breaker.
- Generator CT Primary Current - Is the primary current rating of the generator current transformers. This parameter is stored in tag **GenCT_Pri_I** in the configuration table.
- Generator CT Secondary Current - The secondary current rating of the generator current transformers connected to the CGCM unit's terminals I1, I2, and I3. This parameter is stored in tag **GenCT_Sec_I** in the configuration table.
- Cross Current CT Primary Current - The primary current rating of the cross current generator current transformer. This parameter is stored in tag **CCCT_Pri_I** in the configuration table. It is used for monitoring generator reactive current in paralleling applications.
- Cross Current CT Secondary Current - The secondary current rating of the cross current generator current transformer connected to the CGCM unit terminals ID (+) and ID (-).This parameter is stored in tag **CCCT_Sec_I** in the configuration table. It is used for monitoring generator reactive current in paralleling applications.

**EXAMPLE** As an example, consider a generator rated at 12,470V and 450 A. VTs with ratios of 100:1 and CTs with ratios of 500:5 are used. The appropriate settings for this configuration are:

- Generator VT Primary Voltage = 12,000
- Generator VT Secondary Voltage = 120
- Generator CT Primary Current = 500
- Generator CT Secondary Current = 5

### *Excitation Tab*

The Excitation tab is used to configure the unit's settings related to operation and protection of the exciter.




- Soft Start Initial Voltage - The generator voltage setpoint that is applied immediately after enabling the CGCM unit excitation output. This parameter is stored in tag **SoftStart_InitLevel** in the Configuration table. Its value is a percentage of the nominal generator rated voltage. Take care to set this parameter higher than the generator residual voltage.
- Soft Start Time - The desired time to ramp up from the Soft Start Initial Voltage to the nominal generator output voltage. This parameter is stored in tag **SoftStartTime** in the Configuration table and is expressed in seconds.
- Over-excitation Voltage Setpoint - Establishes the over-excitation voltage setpoint used by the CGCM unit. This setpoint is stored in tag **OvrExcV_Setpt** in the configuration table and scaled in volts.
- Over-excitation Time Delay - Establishes the time to annunciate a fault once the over-excitation voltage setpoint has been exceeded. This setpoint is stored in tag **OvrExcV_TimeDly** in the configuration table and scaled in seconds.

**TIP** Coordinate the Over-excitation voltage setpoint and time delay settings with the OEL function settings to protect the exciter from overheating while avoiding nuisance tripping from normal field forcing during transient conditions.

- Loss of Excitation Current Setpoint - Establishes the level of excitation current that is considered to be a minimum needed to maintain generator synchronization when in parallel with other power sources such as a utility grid. This setpoint is stored in tag **LossExc_I_Setpt** in the configuration table and scaled in amperes. Excitation current in excess of the loss of excitation current setpoint enables loss of sensing protection.
- Loss of Excitation Current Delay - Establishes the amount of time in seconds that the excitation current must be continually below the Loss of Excitation Current Setpoint before the CGCM unit annunciates a loss of excitation fault. This setpoint is stored in tag **LossExc_I_TimeDly** in the configuration table
- Rotating Diode Fault Main Pole - Indicates the number of poles of the main field of the generator. Stored in tag **MainPole** in the configuration table.
- Rotating Diode Fault Exciter Pole – Indicates the number of poles of the exciter field of the generator. Stored in tag **ExciterPole** in the configuration table.
- Rotating Diode Fault Open Diode Level - Establishes the percent ripple at which the rotating diode monitor alarm turns on when an open diode condition occurs. This parameter is stored in tag **OpenDiodeMonitorLevel** in the configuration table and is expressed in percent of maximum ripple current.
- Rotating Diode Fault Shorted Diode Level - Establishes the percent ripple at which the rotating diode monitor alarm turns on in the event a shorted diode condition occurs. Tag **ShortedDiodeMonitorLevel** in the configuration table stores this value, expressed in percent of maximum ripple current.

- Rotating Diode Fault Delay - Establishes the time duration that the ripple current must be at or above the fault level before the CGCM unit annunciates a rotating diode fault. Tag **DiodeMonitorTimeDelay** in the configuration table stores this value, expressed in seconds.

**TIP** Refer to Chapter 5 for more information on configuring rotating diode protection parameters.

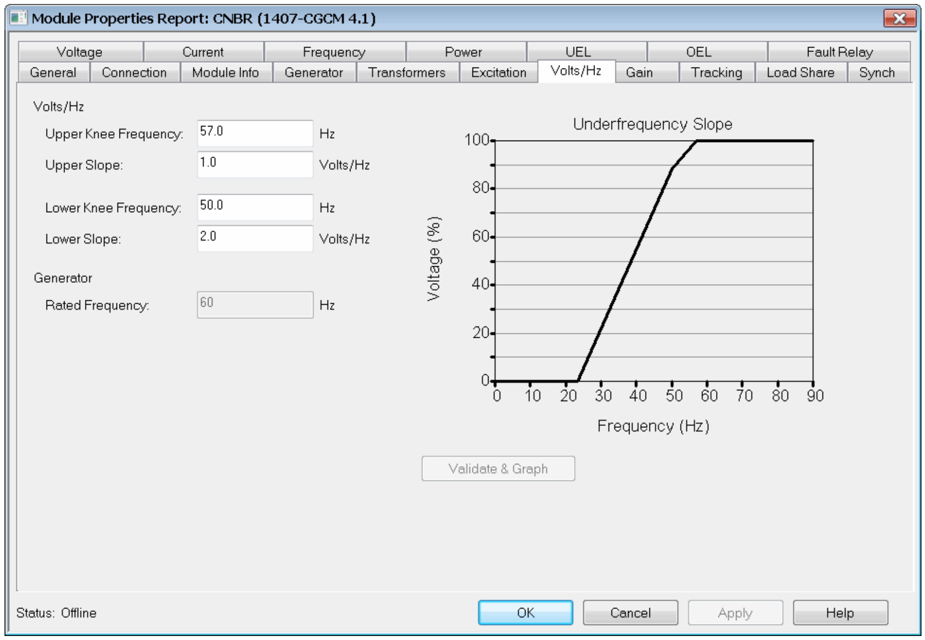
- Excitation Select – Selects the excitation power source. This parameter is stored in the Boolean tag **PMG_Shunt_Select** in the Configuration table. In this tag, 0 = PMG, 1 = Shunt. Select PMG to enable the loss of PMG sensing. Select Shunt for obtaining excitation power from the generator's terminals and for systems using series boost.
- PMG Phase Select – Establishes whether the excitation power source to the CGCM unit is single or 3-phase, to assure correct operation of the loss of PMG sensing function. This parameter is stored in the Boolean tag **PMG_1Ph_3Ph_Select** in the Configuration table. In this tag, 0 = single phase, 1 = 3-phase.

**Related Parameters:**

- Over-excitation voltage protection – Over-excitation limiting (OEL) configuration parameters
- GenRated_V

### *Volts/Hz Tab*

The Volts/Hz tab is used to configure the unit's settings related to operation of the Volts/Hz compensation function. The parameters define a curve, which determines the Volts/Hz response.




- Volts per Hertz Upper Knee Frequency - Establishes the frequency at which the V/Hz characteristic starts to reduce the generator voltage as a function of generator frequency. Tag **VperHz_HiKneeFreq** in the configuration table stores this value, expressed in Hertz. The upper knee frequency must be greater than the lower knee frequency.
- Volts per Hertz Upper Slope - Establishes the rate at which the V/Hz characteristic reduces the generator voltage as a function of generator frequency between the upper and lower knee frequencies. Tag **VperHz_HiSlope** in the configuration table stores this value, expressed as a number that reflects per unit change in voltage for each per unit change in frequency.
- Volts per Hertz Lower Knee Frequency - Establishes the frequency at which the V/Hz characteristic starts to reduce the generator voltage at the lower slope rate as a function of generator frequency. Tag **VperHz_LoKneeFreq** in the configuration table stores this value, expressed in Hertz. The lower knee frequency must be less than the upper knee frequency.
- Volts per Hertz Lower Slope - Establishes the rate at which the V/Hz characteristic reduces the generator voltage as a function of generator frequency below the Lower Knee Frequency setting. Tag **VperHz_LoSlope** in the configuration table stores this value, expressed as a number that reflects per unit change in voltage for each per unit change in frequency.

- The Validate and graph button becomes active when a parameter has been changed. When clicked, the V/Hz curve established by the knee and slope values is plotted in the Volts/Hz tab.

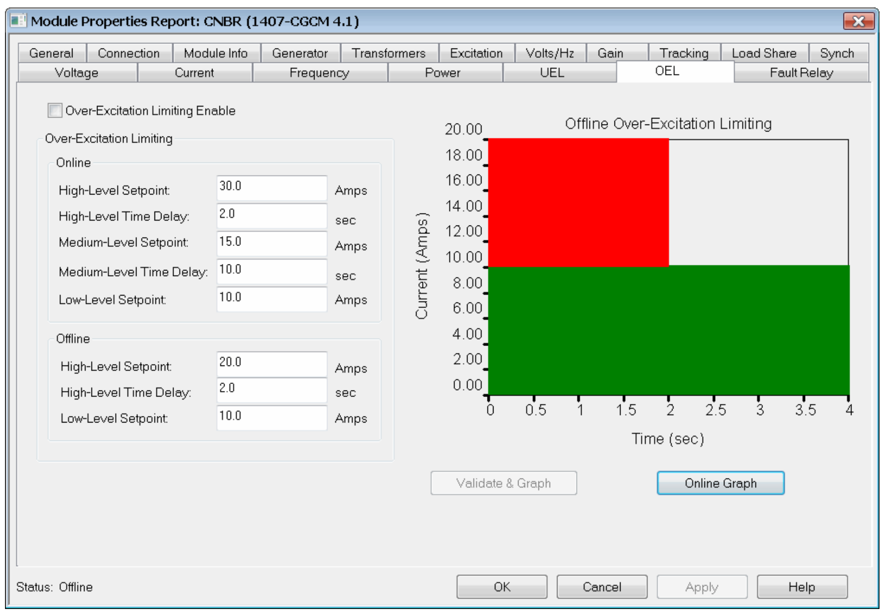
**Related Parameters:**

- GenRated_V
- GenRatedFreq

### *OEL Tab*

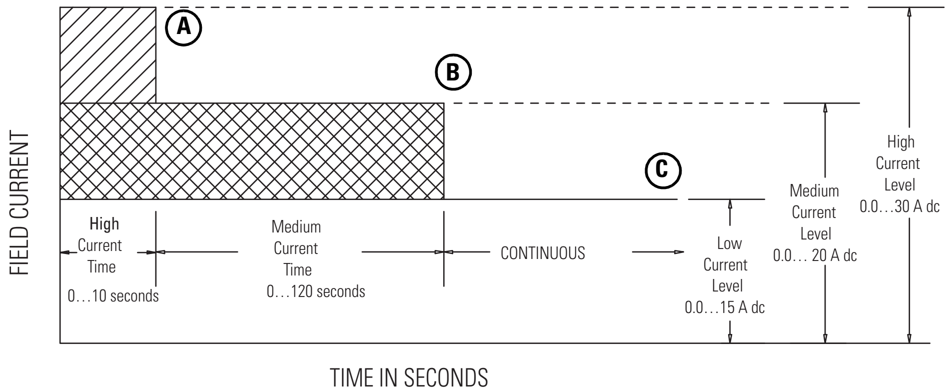
The OEL tab is used to configure the unit's settings related to operation of the Over-excitation Limiting (OEL) function. The values entered in this tab establish the thresholds and time delays that determine the behavior of the over-excitation limiting function. See the generator manufacturer's data sheets for information such as, exciter full-load and forcing current for setting both online and offline conditions.

Refer to Chapter 3 for more information on the operation of the OEL function.



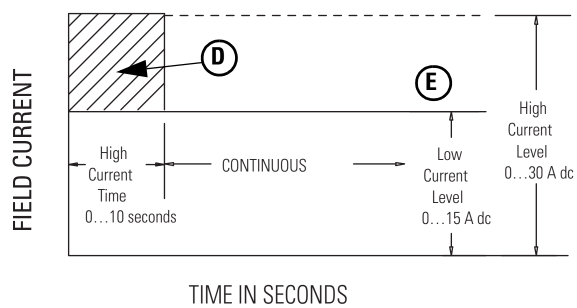

- Over-excitation Limiting Enable – Select this check box to enable over-excitation limiting. Tag **OEL_En** in the configuration table stores this parameter. In addition to selecting the check box, which sets the **OEL_En** tag in the configuration table, the **OEL_En** tag in the Output (Scheduled Write) Data table must also be set to enable this function. In Series B deices with firmware revision 3.3 or earlier, the OEL limiter operates if either box is checked or the **OEL_En** tag in the Output (Scheduled Write) Data table is set.
- The tags listed below determine the points shown in the OEL configuration diagrams below. These tags are in the configuration table and are set by the like-named fields in the OEL tab. They are expressed as amperes and seconds, respectively.

**Figure 37 - Online OEL Configuration**




- Point A is defined by tags **OEL_OnlineHiSetpt** and **OEL_OnlineHiTimeDly**
- Point B is defined by **OEL_OnlineMedSetpt** and **OEL_OnlineMedTimeDly**
- Point C is defined by **OEL_OnlineLoSetpt**

**Figure 38 - Offline OEL Configuration**




- Point D is defined by **OEL_OfflineHiSetpt** and **OEL_OfflineHiTimeDly**
- Point E is defined by **OEL_OfflineLoSetpt**

- Online/Offline graph button - Toggles to show online or offline OEL characteristics. The graph pictorially represents the OEL settings.
- Validate and Graph button – Updates the graph in the OEL tab after entering new values.

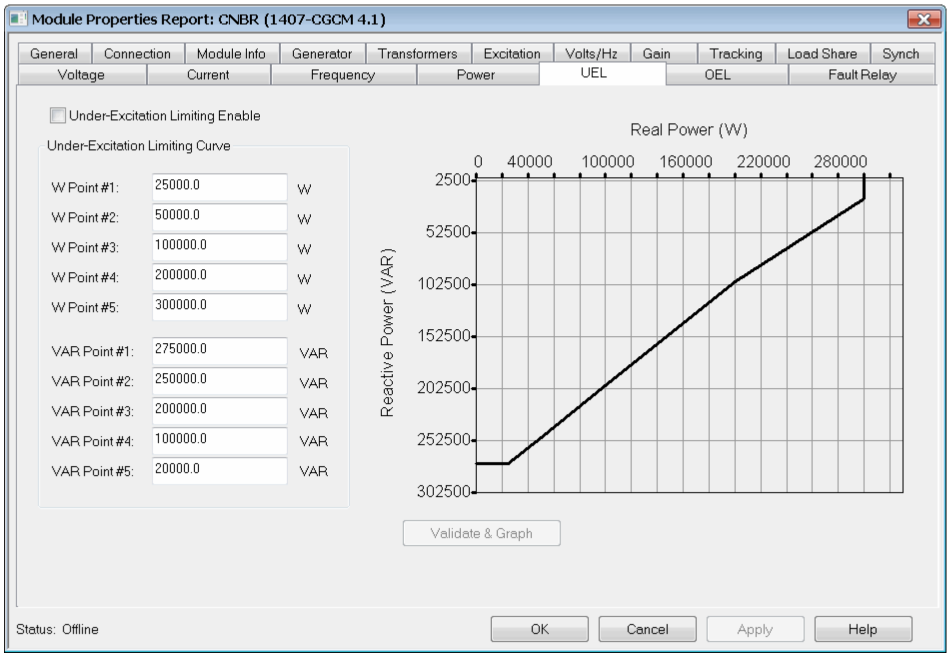
**Related Parameters**

- **GenRatedExcI**
- **OEL_En** tag in the Output table

### *UEL Tab*

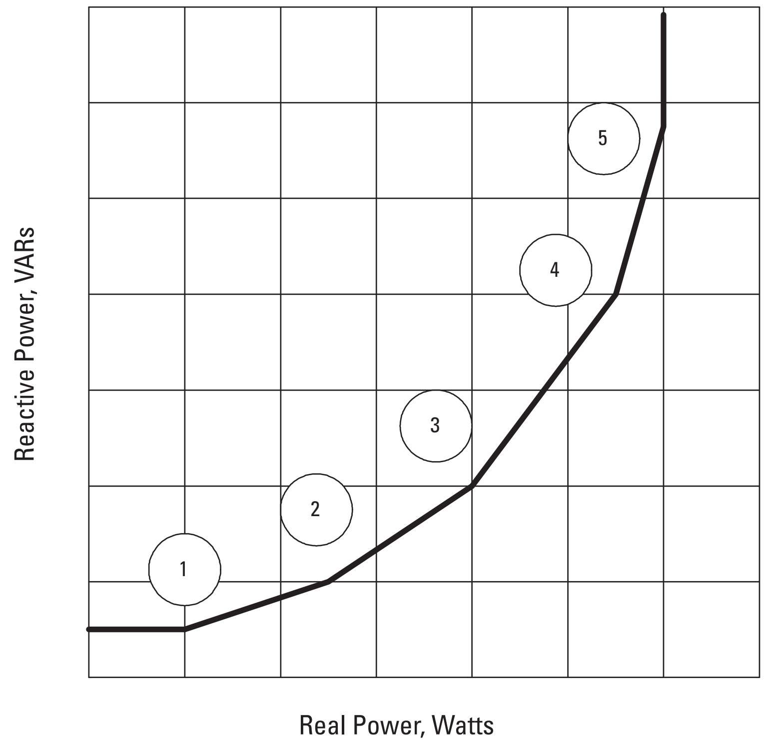
The UEL tab is used to configure the unit's settings related to operation of the Under-excitation Limiting (UEL) function. The values entered in this tab establish break points in a piecewise linear curve that defines the characteristic curve for this function. See the generator manufacturer's data for the proper setting information.

Refer to Chapter 3 for more information on the operation of the UEL function.




- Under-excitation Limiting Enable – Select this check box to enable over-excitation limiting. Tag **UEL_En** in the configuration table stores this parameter. In addition to selecting the check box, which sets the **UEL_En** tag in the configuration table, the **UEL_En** tag in the Output (Scheduled Write) Data table must also be set to enable this function. In Series B deices with firmware revision 3.3 or earlier, the UEL limiter operates if either the enable box is checked or the **UEL_En** tag in the Output (Scheduled Write) Data table is set.

- The tags listed below determine the points shown in the UEL configuration diagrams below. These tags are in the configuration table and are set by the like-named fields in the UEL tab. VAR values are actually negative, indicating leading. Configure the VAR and Watt tags with increasing real power values in point 1 through point *x*. These tags define the curve breakpoints. As shown, the curve continues horizontally left from point 1 and vertically up from point 5. The tags are expressed in Watts or VARs respectively.




  - Point 1 is defined by tags **UEL_Curve_W_Pt1** and **UEL_Curve_VAR_Pt1**
  - Point 2 is defined by tags **UEL_Curve_W_Pt2** and **UEL_Curve_VAR_Pt2**
  - Point 3 is defined by tags **UEL_Curve_W_Pt3** and **UEL_Curve_VAR_Pt3**
  - Point 4 is defined by tags **UEL_Curve_W_Pt4** and **UEL_Curve_VAR_Pt4**
  - Point 5 is defined by tags **UEL_Curve_W_Pt5** and **UEL_Curve_VAR_Pt5**
- Validate and Graph button – Updates the graph in the UEL tab after entering new values.

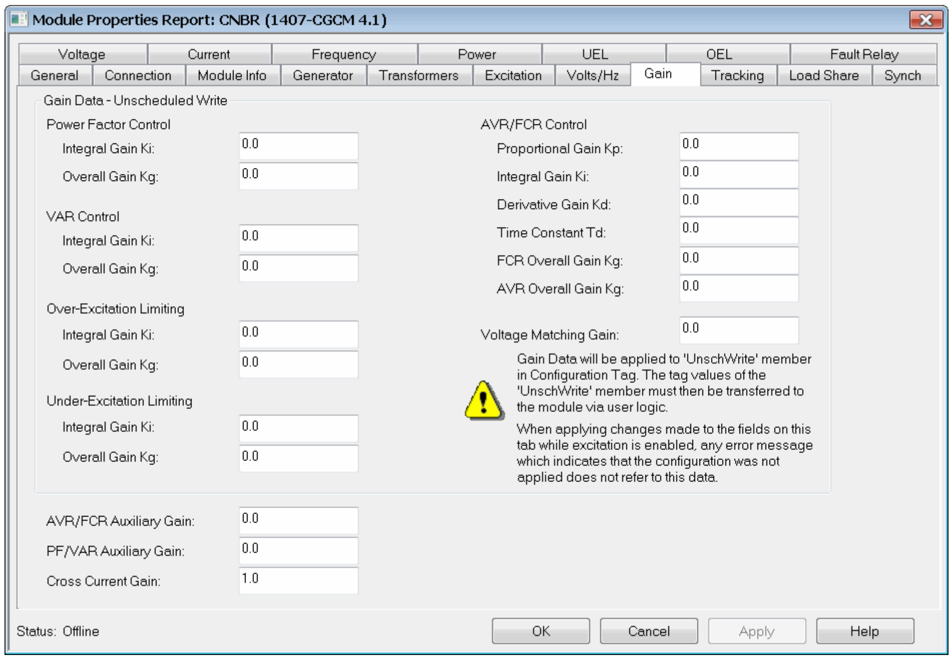
**Related Parameters**

- **UEL_En** tag in the Output table

### *Gain Tab*

The Gain tab is used to configure the unit's gain parameters necessary for the operation of the excitation control. Except as otherwise noted, gain parameters are unitless.

Appendix B provides additional information regarding the mathematical models used in the unit.




The parameters in the Gain tab are stored in the Unscheduled Write table and are not automatically written to the unit.

Refer to Chapter 6 for a discussion of user programming necessary to transfer these parameters.

### AVR/FCR Control

The AVR/FCR gains determine the response of the main control loop of the voltage regulation function. The PID calculator software available in the Tools folder on the RSLogix 5000 software installation CDs can be used to assist in determining appropriate initial AVR gain settings for Kp, Ki, Kd, and Kg. These settings can be fine tuned during system startup.

Please refer to Chapter 5 for more information on tuning the regulator gains.

- Proportional Gain Kp - Sets the proportional gain, which determines the characteristic of the dynamic response to changes in generator voltage. If the transient response has too much overshoot, decrease Kp. If the transient response is too slow, with little or no overshoot, then increase Kp. The tag **AVR_FCR_Kp** in the Unscheduled Write table stores this parameter.
- Integral Gain Ki – Sets the integral gain. If the time to reach steady state is too long, increase Ki. The tag **AVR_FCR_Ki** in the Unscheduled Write table stores this parameter.
- Derivative Gain Kd – Sets the derivative gain. To improve the transient response to a step change, increase Kd. If there is too much jitter in the steady-state voltage, decrease Kd. The tag **AVR_FCR_Kd** in the Unscheduled Write table stores this parameter.
- Time Constant Td - The filtering time constant, Td, is used to remove the noise effect on the numerical differentiation. The tag **AVR_FCR_Td** in the Unscheduled Write table stores this parameter, expressed in seconds.
- FCR Overall Gain Kg - Sets the overall gain of the voltage regulator in FCR mode. It determines the characteristic of the dynamic response to a change in the CGCM unit output current. The tag **FCR_Kg** in the Unscheduled Write table stores this parameter.
- AVR Overall Gain Kg – Sets the overall gain of the voltage regulator in AVR mode. It determines the characteristic of the dynamic response to a change in the voltage of the generator. The tag **AVR_Kg** in the Unscheduled Write table stores this parameter.
- Voltage Matching Gain – This parameter is not used. Set to zero. The tag **V_Match_Gain** in the Unscheduled Write table stores this parameter.

### Power Factor Control

The Power Factor Control gains determine the response of the power factor control loop for the voltage regulation function when in PF mode. These settings can be adjusted during system startup.

Please refer to Chapter 5 for more information on tuning the power factor control gains.

- Integral Gain Ki - Sets the integral gain. Generally if the time to reach steady state is too long, increase Ki. The tag **PF_Ki** in the Unscheduled Write table stores this parameter.
- Overall Gain Kg - Sets the overall gain, which determines the characteristic of the dynamic response to changes in power factor. If the transient response has too much overshoot, decrease Kg. If the transient response is too slow, with little or no overshoot, then increase Kg. The tag **PF_Kg** in the Unscheduled Write table stores this parameter.

### VAR Control

The VAR Control gains determine the response of the VAR control loop for the voltage regulation function when in VAR mode. These settings can be adjusted during system startup.

Please refer to Chapter 5 for more information on tuning the VAR control gains.

- Integral Gain Ki - Sets the integral gain. Generally if the time to reach steady state is too long, increase Ki. The tag **VAR_Ki** in the Unscheduled Write table stores this parameter.
- Overall Gain Kg - Sets the overall gain, which determines the characteristic of the dynamic response to changes in VARs. If the transient response has too much overshoot, decrease Kg. If the transient response is too slow, with little or no overshoot, then increase Kg. The tag **VAR_Kg** in the Unscheduled Write table stores this parameter.

### Over-excitation Limiting

The OEL gains determine the response of the OEL control loop for the voltage regulation function when OEL is active. These settings can be adjusted during system startup.

Please refer to Chapter 5 for more information on tuning the OEL control gains.

- Integral Gain Ki - Sets the integral gain. If the time to reach steady state is too long, increase Ki. The tag **OEL_Ki** in the Unscheduled Write table stores this parameter.
- Overall Gain Kg - Sets the overall gain, which determines the characteristic of the dynamic response when OEL is active. If the transient response has too much overshoot, decrease Kg. If the transient response is too slow, with little or no overshoot, then increase Kg. The tag **OEL_Kg** in the Unscheduled Write table stores this parameter.

### Under-excitation Limiting

The UEL gains determine the response of the UEL control loop for the voltage regulation function when UEL is active. These settings can be adjusted during system startup.

Please refer to Chapter 5 for more information on tuning the UEL control gains.

- Integral Gain Ki - Sets the integral gain. If the time to reach steady state is too long, increase Ki. The tag **UEL_Ki** in the Unscheduled Write table stores this parameter.
- Overall Gain Kg - Sets the overall gain, which determines the characteristic of the dynamic response when UEL is active. If the transient response has too much overshoot, decrease Kg. If the transient response is too slow, with little or no overshoot, then increase Kg. The tag **UEL_Kg** in the Unscheduled Write table stores this parameter.

### Other Gains

The remaining three gains are stored in the Configuration table and can only be written to the CGCM unit when excitation is disabled.

Please refer to Chapter 6 for more information.

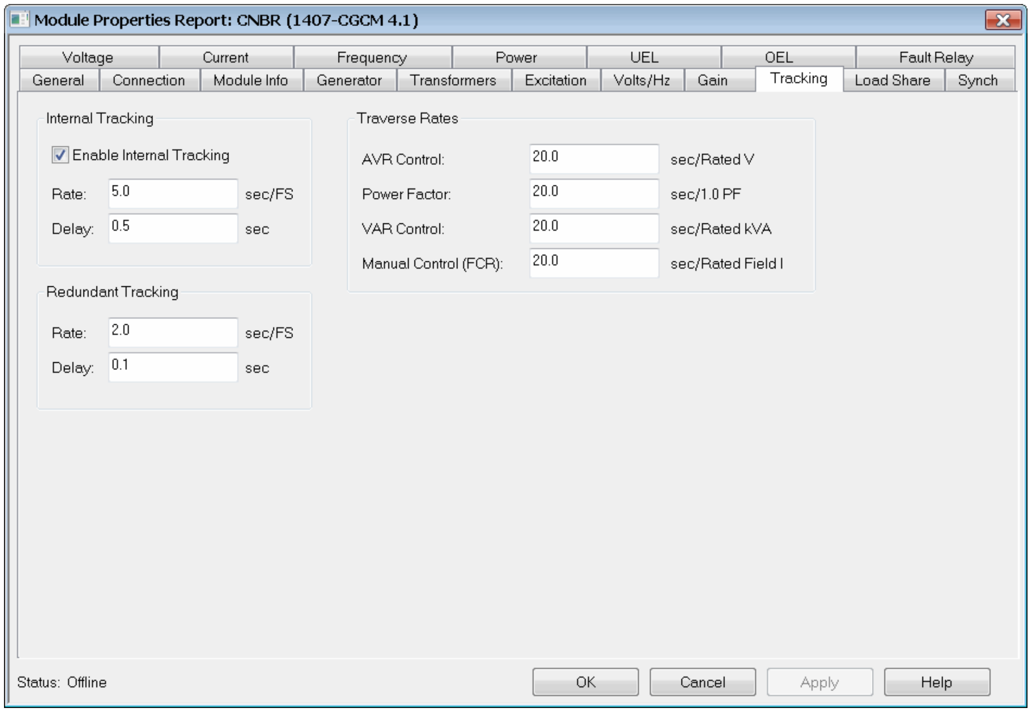
- AVR/FCR Control Auxiliary Gain - Sets the influence of the auxiliary input on the AVR/FCR operating setpoint. The units are percent of rated generator voltage or excitation field current, as applicable, per auxiliary input volt. The tag **AVR_FCRAuxGain** in the Configuration table stores this parameter.
- PF/VAR Auxiliary Gain - Sets the influence of the auxiliary input on the VAR/PF operating setpoint. The units for the var controller are percent of rated generator KVA. For PF control, the units are 0.01 PF per volt. A setting of 5 results in the regulated PF being changed by 0.05 for each volt applied to the auxiliary input. The tag **PF_VARAuxGain** in the Configuration table stores this parameter.
- Cross-current Gain - sets the gain of the cross-current input. The measured cross-current value is multiplied by this setting. This setting determines the change in voltage setpoint expressed in percent of rated voltage for a change in kVARs equal to the rated generator kVA. This parameter adjusts the characteristic of VAR sharing between machines connected in the cross-current compensation method of VAR sharing. A setting of 5, for example, results in the voltage setpoint being changed by 5% of rated voltage for a change in kVARs equal to the rated kVA. The tag **CrossCurrentGain** in the Configuration table stores this parameter.

### Related Parameters

- GenRated_V
- GenRated_I
- GenRatedExcI

### *Tracking Tab*

The Tracking tab is used to configure the unit's internal and redundant tracking parameters. Enter the internal tracking, redundant tracking, and traverse rates in the appropriate fields of the Tracking tab.

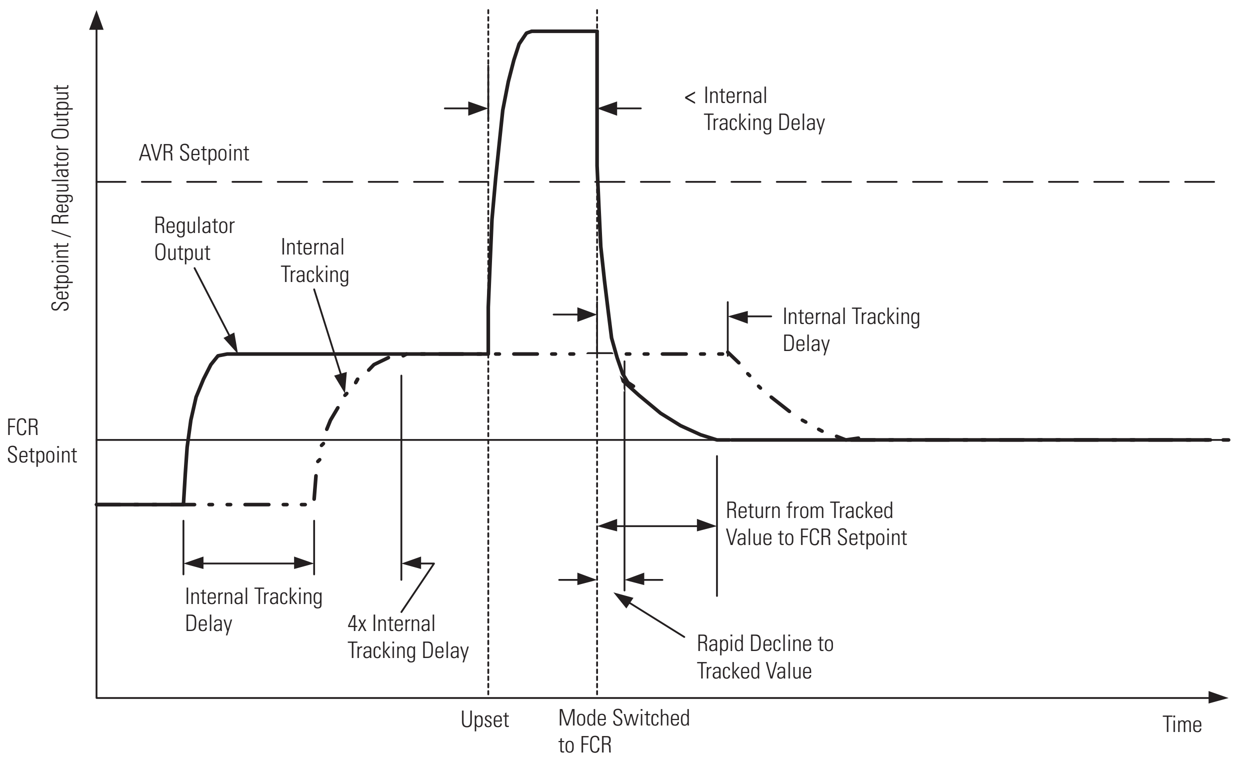



**Internal Tracking**

- Enable internal tracking - This checkbox sets the Boolean tag **Internal_Tracking_En** in the Configuration data table. When the value of this tag is 1, internal tracking between voltage regulating modes is enabled and the Traverse Rates are enabled. If the tag value is 0, both the Traverse Rates and tracking between regulation modes is disable.
- Internal Tracking Rate - This setting changes the rate at which the internal tracking function matches the non-active excitation control modes to the active excitation control mode. This sets the value of the **InternalTrackRate** tag in the Configuration table, expressed in seconds.
- Internal Tracking Delay - This setting adjusts the delay in the internal tracking function. This sets the value of the **InternalTrackDelay** tag in the Configuration table, expressed in seconds. Its purpose is to reduce the likelihood that the short-term response of the active regulating mode to an upset is transferred to a new mode of operation when the mode is switched. If the internal tracking delay is too short, the transient response to an upset is transferred to the new operating mode. Conversely, if the tracking delay is set too long, there is a risk of an old operating point being transferred to the new operating mode, resulting in an undesirable bump.

An example of how these parameters affect tracking is shown in the Internal Tracking graph. In this example, a loss of sensing causes a full-scale regulator output. The internal tracking delay permits FCR mode to begin operation at the output level prior to the loss of sensing.

**Figure 39 - Internal Tracking**




Increasing the internal tracking rate makes the tracking function less responsive to changes in the regulator output by reducing the slope of the tracking function. Increasing the tracking delay offsets the tracking response to the right in the figure. In the example above, if the internal tracking delay were reduced, it is likely that the FCR mode setpoint has started at full regulator output, and recovery to the desired operation has been delayed.

### Redundant Tracking

**TIP** Redundant tracking is enabled whenever two CGCM units are configured in a Redundant mode and both are operational. Redundant tracking parameters have no effect on a CGCM that is not part of a redundant pair.

- Redundant Tracking Rate - This setting adjusts the rate at which the tracking function of the redundant CGCM unit matches its regulator operating point to that of the active CGCM unit. This sets the value of the **RedndtTrackRate** tag in the Configuration table, expressed in seconds per full-scale excursion of the regulator output from zero to the rated generator field current.

- Redundant Tracking Delay - This setting adjusts the delay in the redundant tracking function. This sets the value of the **RedndtTrackDelay** tag in the Configuration table, expressed in seconds. Its purpose is to reduce the likelihood that the short-term response of the active CGCM unit's Regulating mode to an upset will be transferred to the back-up CGCM unit when it becomes primary.

The redundant tracking function performs in a similar fashion to the internal tracking example above. Increasing the redundant tracking rate makes the tracking function less responsive to changes in the regulator output by reducing the slope of the tracking function. Increasing the tracking delay offsets the tracking response to the right in the figure.

### Traverse Rates

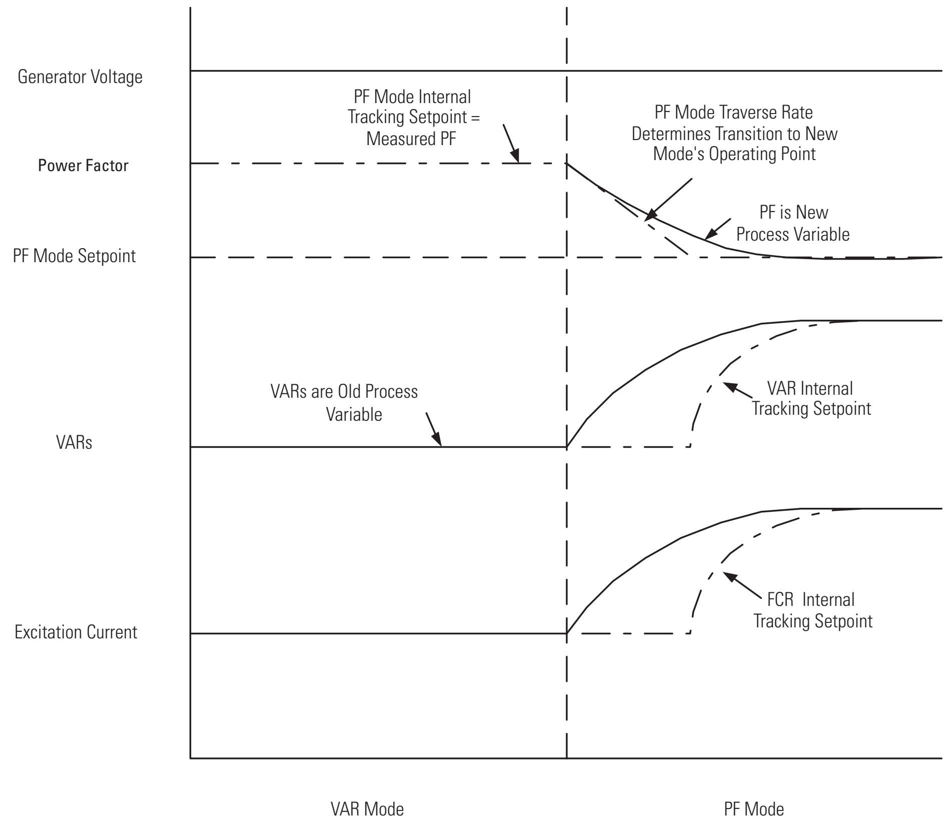
These parameters adjust how fast the regulator changes its operating point from one setpoint, the tracking value, to another when changing regulator operating modes. In general, the lower the rate, the faster the regulator operating point changes. A value of 200 puts the regulator in Hold mode and prevents the field current from changing when the Regulator Operating mode is changed.

Please refer to Chapter 3 for more information.

- AVR Control Traverse Rate – Sets tag **AVR_Traverse_Rate** in the Configuration table. This parameter determines the time measured in seconds for the setpoint to move from zero to the rated generator voltage. It determines how fast the regulator changes the voltage setpoint from the tracking value to the operating setpoint when the Regulator Operating mode changes to AVR.
- Power Factor Traverse Rate - Sets tag **PF_Traverse_Rate** in the Configuration table. This parameter determines the time measured in seconds for the PF setpoint to move from 0.50 lagging to 0.50 leading or vice versa. It determines how fast the regulator changes the power factor setpoint from the tracking value to the operating setpoint when the Regulator Operating mode changes to PF.
- VAR Control Traverse Rate - Sets tag **VAR_Traverse_Rate** in the Configuration table. This parameter determines the time measured in seconds for the setpoint to move from zero to the rated generator KVA. It determines how fast the regulator changes the VAR setpoint from the tracking value to the operating setpoint when the Regulator Operating mode changes to VAR.
- Manual Control (FCR) Traverse Rate - Sets tag **FCR_Traverse_Rate** in the Configuration table. This parameter determines the time measured in seconds for the setpoint to move from zero to the rated exciter current. It determines how fast the regulator changes the field current setpoint from the tracking value to the operating setpoint when the Regulator Operating mode changes to FCR.

The following diagram shows the function of internal tracking and traverse rates on a switch from VAR to PF operating modes.

**Figure 40 - Internal Tracking and Traverse Rates**

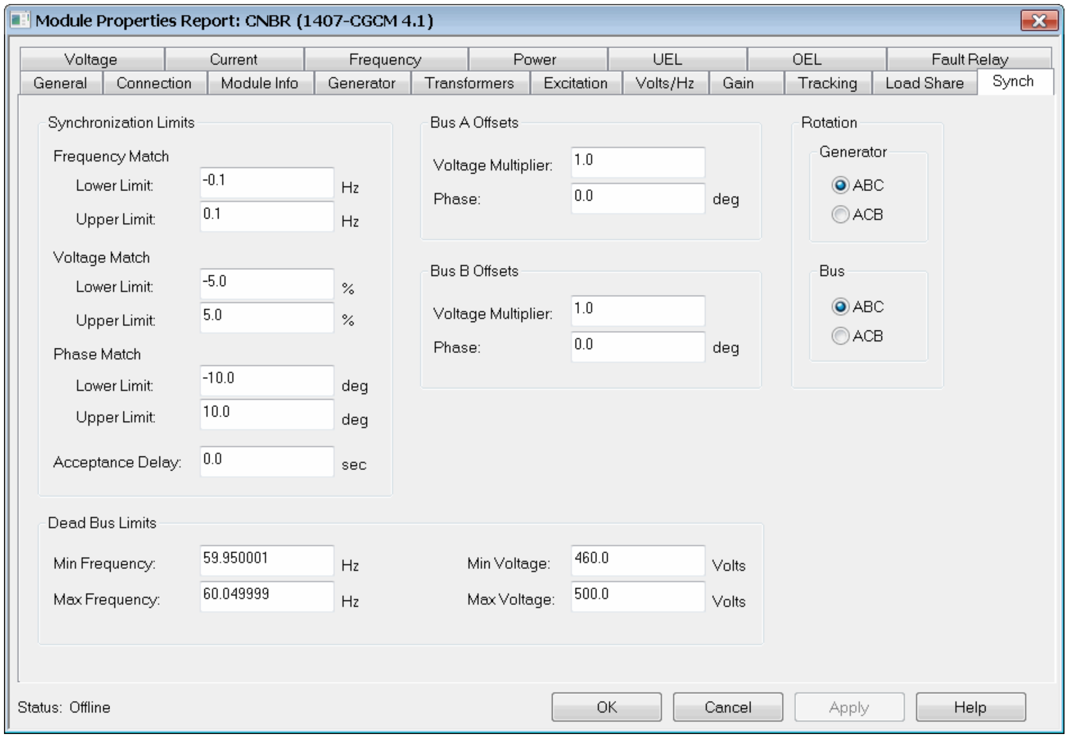



## Related Parameters

- Internal tracking – **GenRatedExcI**
- Traverse rates – **GenRated_V, GenRated_I, GenRatedExcI**

### *Synch Tab*

The Synch tab is used to configure the unit's parameters related to the synchronizing function of the CGCM unit.




**Synchronization Limits**

- Frequency Match - Establishes the acceptance window for frequency matching, defined by Configuration table tags **SyncFreqLoLimit** and **SyncFreqHiLimit**. These tags are set by using the Lower Limit and Upper Limit fields in the Synch tab and are expressed in Hertz.
- Voltage Match - Establishes the acceptance window for voltage matching, defined by Configuration table tags **SyncV_LoLimit** and **SyncV_HiLimit**. These tags are set by using the Lower Limit and Upper Limit fields in the Synch tab and are expressed in percent of rated generator voltage.
- Phase Match - Establishes the acceptance window for phase matching, defined by Configuration table tags **SyncPhLoLimit** and **SyncPhHiLimit**. These tags are set by using the Lower Limit and Upper Limit fields in the Synch tab and are expressed in degrees.
- Acceptance Delay - Establishes the time that all sync parameters must be continuously within their respective acceptance windows to permit closing the breaker. The Configuration table tag **SynchAcceptDly** stores this value, expressed in seconds.

**Bus A Offsets**

- Voltage multiplier - Establishes a factor by which the Bus A voltage is scaled during synchronization. It can be used to compensate for transformer ratio differences between the generator and bus voltages. For example, if the generator nominal voltage is 4160V and the nominal Bus A voltage is 12,480V (each measured line-to-line), a voltage multiplier value of 0.333 permits voltage matching during synchronization. Configuration table tag **BusA_V_Scaler** stores this parameter.
- Phase - Establishes an offset angle added to the measured Bus A phase angle. It can be used to compensate for phase shift across transformers or between delta and wye connected systems.

  As an example, consider the system shown in Voltage and Current Connection for Four-wire Wye Bus and Two (or three) Transformer Delta Generator System on page 24.

  When a generator with three-wire (delta) metering is synchronized to a bus with four-wire (wye) metering, set the phase offset to 30° to compensate for the 30° lag between the delta and wye systems. Configuration table tag **BusA_PhOffset** stores this parameter, expressed in degrees.

**Bus B Offsets**

- Voltage multiplier - Establishes a factor by which the Bus B voltage is scaled during synchronization. It can be used to compensate for transformer ratio differences between the generator and bus voltages. Configuration table tag **BusB_V_Scaler** stores this parameter.
- Phase - Establishes an offset angle added to the measured Bus B phase angle. It can be used to compensate for phase shift across transformers or between delta and wye connected systems. Configuration table tag **BusB_PhOffset** stores this parameter, expressed in degrees.

  **TIP** The Bus A examples also apply to Bus B.

**IMPORTANT** Table 4 provides a guide for adjusting phase offset for wiring configurations shown in Chapter 2, Installation. Other wiring configurations are possible. It is your responsibility to determine and verify phase offset values for wiring configurations that are not depicted in this manual.

**Table 4 - Phase Offset Guide**

| Generator | Bus | Phase Shift Offset in CGCM Synch Tab |
|---|---|---|
| Single phase (line-to-line) | Dual breaker (line-to-neutral) | -30 |
| Single phase (line-to-line) | Four-wire wye | -30 |
| Open delta | Dual breaker (line-to-neutral) | -30 |
| Open delta | Four-wire wye | -30 |
| Three-wire wye | Dual breaker (line-to-line) | -60 |
| Three-wire wye | Dual breaker (line-to-neutral) | -30 |
| Three-wire wye | Four-wire wye | -30 |
| Four-wire wye | Dual breaker (line-to-line) | -30 |
| Four-wire wye | Single (connected line-to-line) | 30 |
| Four-wire wye | Open delta | 30 |
| Four-wire wye | Three-wire wye | 30 |

### Dead Bus Limits

The dead bus limits define the acceptance windows for generator frequency and voltage used by the CGCM unit when closing the breaker into a dead bus. The following Configuration tab fields specify the acceptance windows. These fields set the related tags in the Configuration table.

- Min Frequency - Tag **DeadbusGenFreqLoLimit,** expressed in Hertz
- Max Frequency - Tag **DeadbusGenFreqHiLimit**
- Min Voltage - Tag **DeadbusGenV_LoLimit,** expressed in volts
- Max Voltage - Tag **DeadbusGenV_HiLimit**

| IMPORTANT | Prior to Host FRN 4.9, regardless of the setting of the **DeadbusGenFreqLoLimit** parameter, the CGCM unit disables synchronization when the generator frequency is below 45 Hz. |
|---|---|

### Rotation

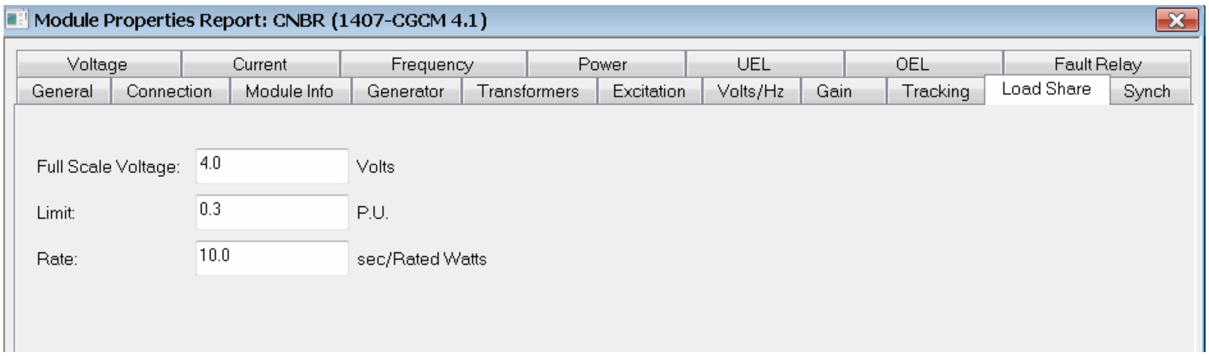
- Generator – Specifies the generator phase rotation. Configuration table tag **GenRotABC_ACB_Select** stores this value. 0 = ABC, 1 = ACB
- Bus – Specifies the bus phase rotation. Configuration table tag **BusRotABC_ACB_Select** stores this value. 0 = ABC, 1 = ACB

### Related Parameters

- **GenVT_Config**
- **BusVT_Config**
- GenRated_V

### *Load Share Tab*

The Load Share tab is used to configure the unit's parameters related to the real power load sharing function of the unit.



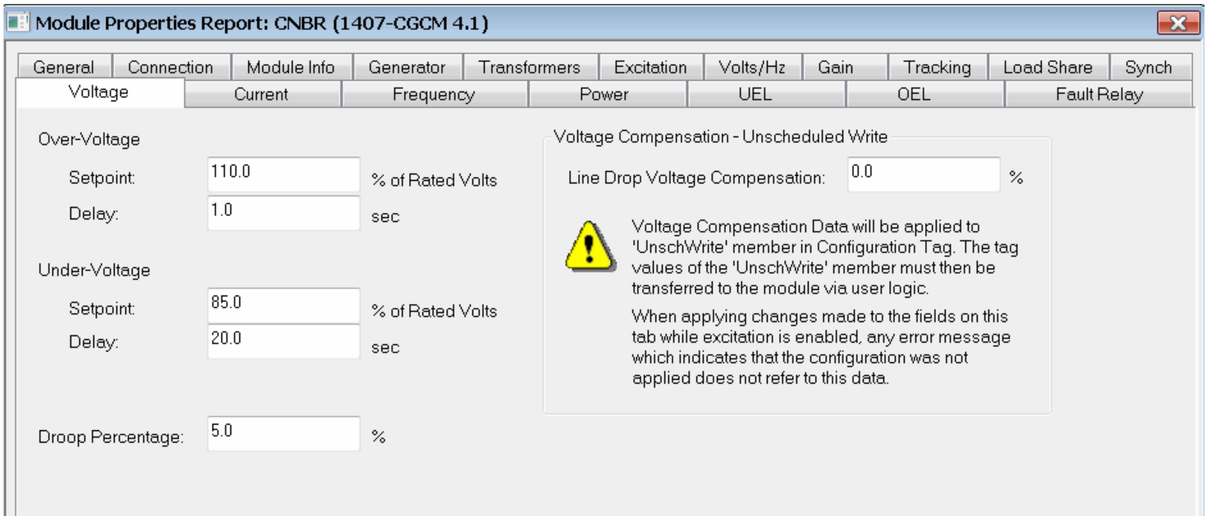

- Full Scale Voltage - Sets the load share output voltage when the generator is producing rated real power. The tag **LS_FS_V** in the configuration table stores this value, expressed in volts.
- Limit - Sets the maximum per unit load share error reported to the host controller. The tag **LSLimit** in the configuration table stores this value, expressed in per unit power.
- Rate - Sets the maximum change in the load share error per CGCM unit update cycle. The tag **LSRate** in the configuration table stores this value, expressed in seconds per rated watts.

**Related Parameters**

- **GenRated_W**

### *Voltage Tab*

The Voltage tab is used to configure the unit's parameters related to the voltage protection and compensation functions.




**Over-voltage**

- Setpoint - Establishes the over-voltage setpoint used by the CGCM unit. This setpoint is stored in tag **Ovr_V_Setpt** in the configuration table and scaled in per cent rated generator volts.
- Delay - Establishes the time the generator voltage must be above the over-voltage setpoint before the CGCM unit annunciates an over-voltage fault. This setpoint is stored in tag **Ovr_V_TimeDly** in the configuration table and scaled in seconds.

**Under-voltage**

- Setpoint - Establishes the under-voltage setpoint used by the CGCM unit. This setpoint is stored in tag **Undr_V_Setpt** in the configuration table and scaled in per cent rated generator volts.
- Delay - Establishes the time the generator voltage must be below the under-voltage setpoint before the CGCM unit annunciates an under-voltage fault. This setpoint is stored in tag **Undr_V_TimeDly** in the configuration table and scaled in seconds.

**Compensation Settings**

- Droop Percentage - Establishes the voltage droop level at rated load when operating in Voltage Droop (reactive current compensation) mode. This setting determines the change in voltage setpoint expressed in percent of rated voltage. A setting of 5, for example, results in the voltage setpoint being changed by 5% of rated voltage for a change in kVARs equal to the rated kVA. The tag **V_DroopSetpt** in the Configuration table stores this parameter.
- Line Drop Voltage Compensation - Establishes the output voltage increase at rated current. Tag **LineDropComp** in the Configuration table stores this parameter.

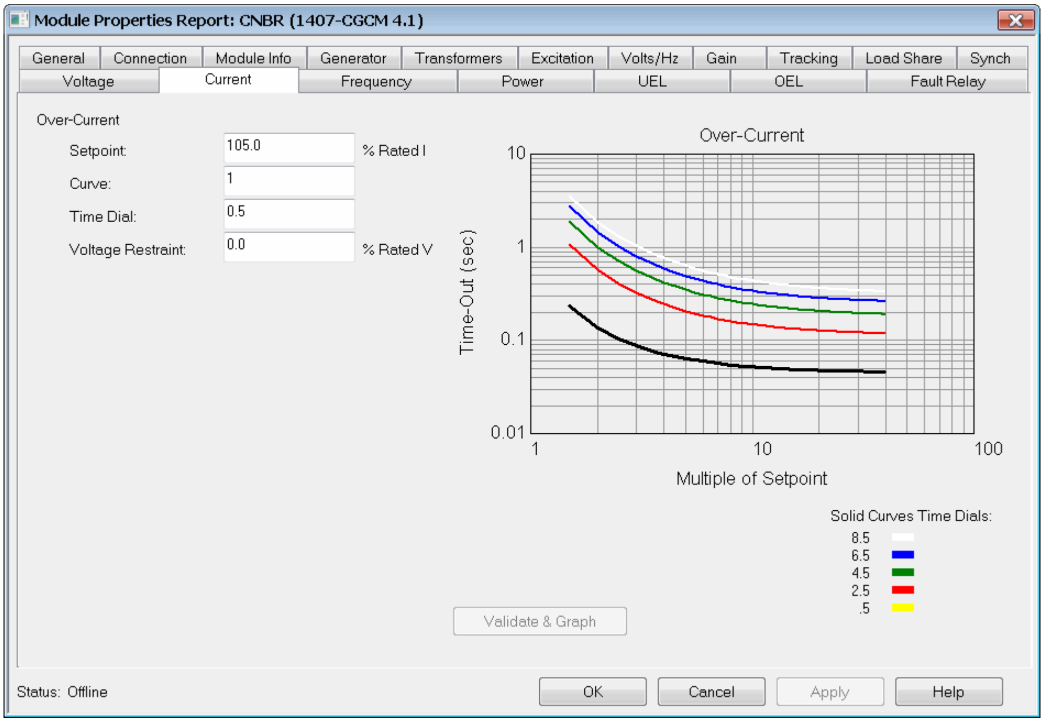
**Related Parameters**

- GenRated_V
- GenRated_I
- GenRated_W
- SoftStartTime
- EngineIdle

## Current Tab

The Current tab is used to configure the CGCM unit parameters related to the over-current protection function.

Refer to Appendix A for more information on setting the parameters in the Current tab as well as the available time over-current characteristic curves.




**Over-current**

- Setpoint - Establishes the over-current threshold. When the generator current exceeds this threshold, the CGCM unit starts timing toward a trip based on the selected over-current curve, voltage-restraint setting, and time dial setting. **Tag Ovr_I_Setpt** stores this parameter, expressed in percent of rated generator current.
- Over-current Curve - Selects the time over-current characteristic curve that are used by the over-current function of the CGCM unit. Tag **Ovr_I_Curve** stores this parameter.
- Over-current Time Dial – Selects a particular curve from the family of curves contained in the selected over-current characteristic curve. Tag **Ovr_I_TimeDial** stores this parameter.
- Over-current Voltage Restraint Setpoint - This setting establishes the generator voltage threshold below which the CGCM unit automatically reduces the selected time over-current setpoint. Tag **Ovr_I_VrestSetpt** stores this value, expressed as a percent of rated generator voltage. The over-current setpoint is reduced to the same percentage as the voltage restraint threshold.

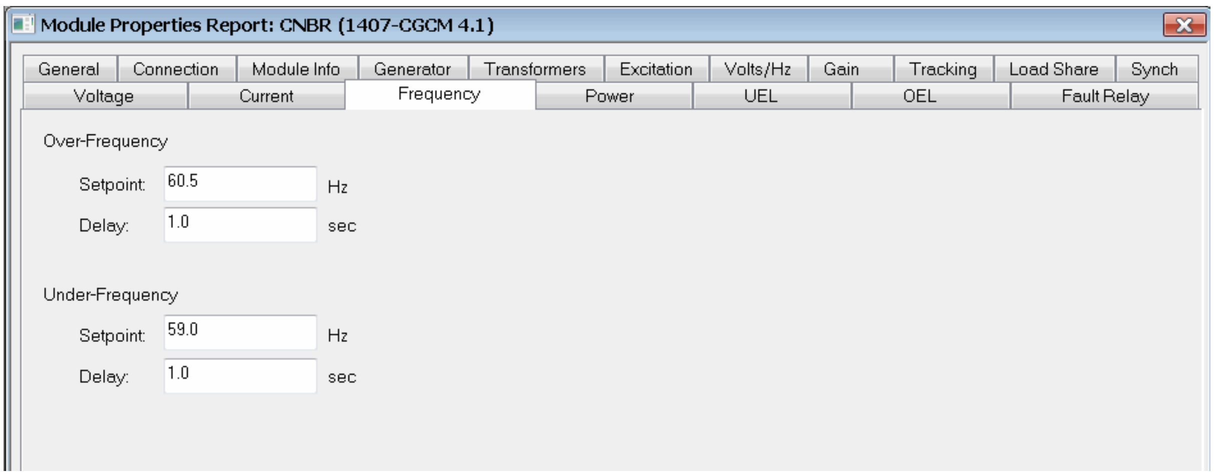
- Validate and graph button – Updates the graph shown on the Current tab to display the selected over-current characteristic curve. The specific curve selected by the over-current time dial setting is displayed in black.

**Related Parameters**

- GenRated_I
- GenRated_V

### *Frequency Tab*

The Frequency tab is used to configure the CGCM unit parameters related to the over-frequency and under-frequency protection functions.



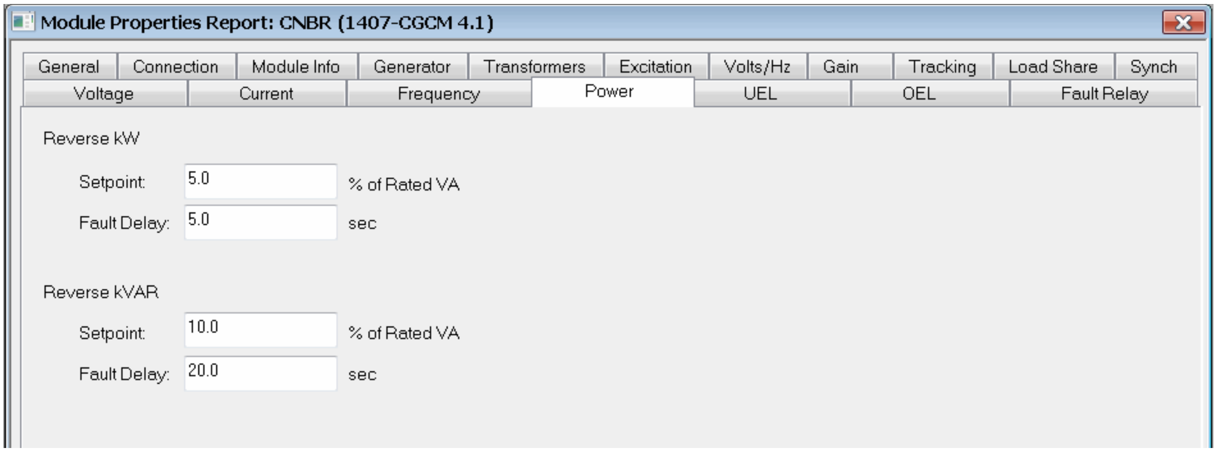

- Over-frequency Setpoint - Establishes the generator over-frequency setpoint. The tag **OvrFreqSetpt** in the configuration table stores this parameter, expressed in Hz.
- Over-frequency Delay - Establishes the amount of time in seconds that the frequency must be above the over-frequency setpoint before the CGCM unit annunciates the fault. This parameter is stored in tag **OvrFreqTimeDly** in the configuration table.
- Under-frequency Setpoint - Establishes the generator under-frequency setpoint. The tag **UndrFreqSetpt** in the configuration table stores this parameter, expressed in Hz.
- Under-frequency Delay - Establishes the amount of time in seconds that the frequency must be below the under-frequency setpoint before the CGCM unit annunciates the fault. This parameter is stored in tag **UndrFreqTimeDly** in the configuration table.

**Related Parameters**

- EngineIdle
- SoftStartTime

### *Power Tab*

The Power tab is used to configure the unit's parameters related to reverse power and reverse reactive power protection. A higher setpoint value corresponds to larger reverse power or VAR flow before a fault is declared.



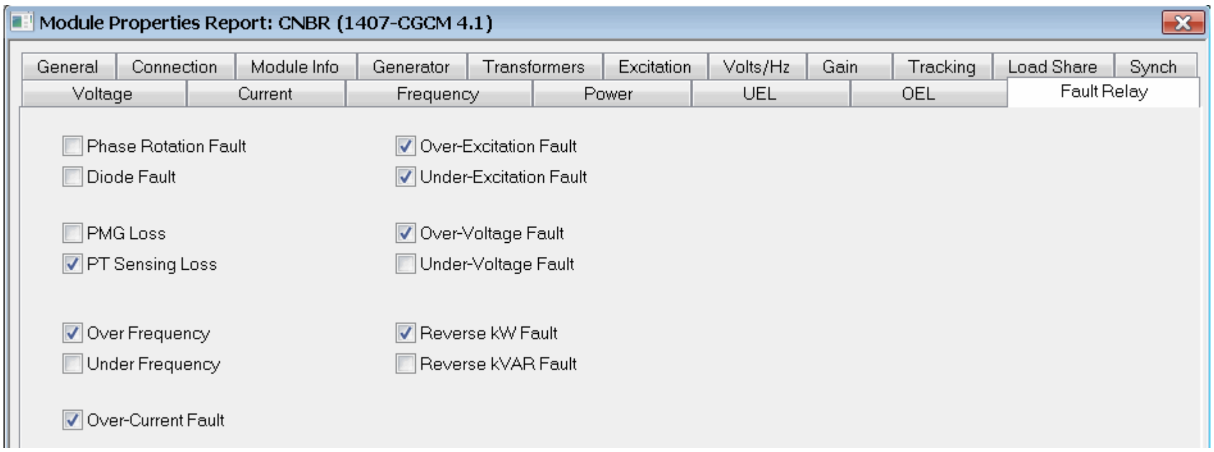

- Reverse kW Setpoint - Establishes the generator reverse kW setpoint in percent of rated VA. The tag **Rev_kW_Setpt** stores this value in the configuration table.
- Reverse kW Fault Delay - Establishes the amount of time in seconds that the reverse kW must be above the reverse kW setpoint before the CGCM annunciates the fault. This parameter is stored in tag **Rev_kW_TimeDly** in the configuration table.
- Reverse kVAR Setpoint - Establishes the generator reverse kVar setpoint in percent of rated VA. The tag **Rev_kVAR_Setpt** stores this value in the configuration table.
- Reverse kVAR Fault Delay - establishes the amount of time in seconds that the reverse kVAR must be above the reverse kVAR setpoint before the CGCM unit annunciates the fault. This parameter is stored in tag **Rev_kVAR_TimeDly** in the configuration table.

**Related Parameters**

- GenRated_V
- GenRated_I

### *Fault Relay Tab*

The Fault Relay tab is used to configure the unit's parameters related to the fault relay output. Checking the box enables the fault output for that particular fault. The fault output relay operates when a selected fault occurs if the fault output is enabled, and the corresponding fault tag in the Output (Scheduled Write) Data table is set. In Series B devices with firmware revision 3.4 or earlier, the fault relay operates if either the enable box is checked or the corresponding fault tag in the Output (Scheduled Write) Data table is set.




**Related Parameters**

- Fault output enable tags in the Output table

# Notes:

# CGCM Unit Startup

## Introduction

This chapter provides a suggested set of steps that the user can follow in commissioning a CGCM system. This assumes that you have:

- evaluated the system design needs.
- selected a suitable instrument wiring arrangement.
- followed recommended installation procedures.
- configured the RSLogix 5000 software and programmed the host Logix controller.
- configured the ControlNet network.
- performed the initial configuration of the CGCM unit.

This suggested procedure is a basic guide that can be altered to suit the needs of your particular installation.

For additional information on how to perform specific steps, refer to Chapter 3, CGCM Unit Operation, and Chapter 4, CGCM Unit Configuration. If errors are encountered during startup, refer to Chapter 7, Troubleshooting.

## Safety

**WARNING:** Only qualified personnel, following accepted safety procedures, can install, wire and service the CGCM unit and its associated components. Before beginning any work, disconnect all sources of power and verify that they are de-energized and locked out. Failure to follow these instructions can result in personal injury or death, property damage or economic loss.

**WARNING:** Never open a current transformer (CT) secondary circuit with primary current applied. Wiring between the CTs and the CGCM unit must include a shorting terminal block in the CT secondary circuit. Shorting the secondary with primary current present lets you remove other connections if needed. An open CT secondary with primary current applied produces a hazardous voltage, which can lead to personal injury, death, property damage or economic loss.

**ATTENTION:** Electrostatic discharge can damage integrated circuits or semiconductors. Follow these guidelines when you handle the module.

Touch a grounded object to discharge static potential.

- Wear an approved wrist strap-grounding device.
- Do not open the module or attempt to service internal components.
- If available, use a static safe workstation.
- When not in use, keep the module in its static shield bag.

## Recommended Equipment

You need the following equipment to help in the startup of the CGCM unit.

### Programming Terminal

A suitable programming terminal (typically a notebook personal computer) with RSLinx, RSLogix 5000, and RSNetWorx for ControlNet software is required. The programming terminal must be equipped with a suitable interface to support communication with the Logix controller. A typical communication interface can be a ControlNet network interface card (catalog number 1784-PCC) and its cable.

### Two-channel Chart Recorder or Other Suitable Data Recording Method

A two-channel recorder or other suitable method is recommended for the verification procedure. Chart recorder connections vary depending on the test being performed.

### Test Current and Voltage Source

An appropriately calibrated 3-phase voltage and 3-phase current source is recommended to simulate generator and system power conditions at known operating points of interest. These can be connected to the CGCM VT and CT input terminals in place of system VT and CT instruments.

**WARNING:** Never open a current transformer (CT) secondary circuit with primary current applied. Wiring between the CTs and the CGCM unit must include a shorting terminal block in the CT secondary circuit. Shorting the secondary with primary current present lets you remove other connections if needed. An open CT secondary with primary current applied produces a hazardous voltage, which can lead to personal injury, death, property damage or economic loss.

## Recommended Start-up Procedure

Perform the static and dynamic redundancy tests described below.

Perform recommended start-up procedures on each unit when commissioning redundant CGCM systems. Remove control power from the other CGCM unit prior to start-up procedures.

### Initial Checkout

Follow these steps to perform the initial checkout.

1. Inspect physical installation of the CGCM unit and associated hardware.
2. Inspect all related CGCM unit wiring interconnections.
3. Verify that grounding wiring is correctly installed and that CT wiring has been correctly installed by using shorting terminal blocks or test switches you provided.
4. Verify that all safety related measures have been properly taken; such as locking and tagging out power interconnections and prime mover capability.

### Apply Power to the CGCM Unit (24V DC)

Follow these steps to apply power to the CGCM unit.

1. Apply control power (24V DC) to the unit.
2. Verify that following the CGCM unit's initial power self test, the ControlNet media status indicators flash and then become solid green.

## Verify the ControlNet Network Connection

Follow these steps to verify the ControlNet network connection.

1. Use the RSWho function of RSLinx software to browse and confirm the CGCM unit is on the ControlNet network.
2. Verify the CGCM unit's firmware revision is the same or later than indicated on the firmware revision label.
3. Use RSLogix 5000 software to confirm that the CGCM unit's connection status is good and that the communication logic (MSG instructions) is executing properly.
4. Verify that scheduled and unscheduled data communication is updating by viewing changing data in the controller tag database.

## Statically Test CGCM System Redundancy Operation

These steps apply only for CGCM units configured in a redundant pair.

1. Connect a suitable load to the excitation output terminals of the CGCM units through redundancy relays you provide.
2. Enable excitation in FCR mode with an FCR setpoint greater than the loss of field current setpoint.
3. Verify that only one CGCM unit is the primary by observing the status of the **Spare1** tag in the Input table, the state of the primary CGCM unit's redundancy relay output, and the exciter field output current.
4. Disable excitation on the primary CGCM unit by removing the hardware excitation enable input, or clearing the software excitation enable tag, or removing the ControlNet connections, or removing 24V DC control power from the primary CGCM unit.
5. Verify that the back-up CGCM unit has become the primary by observing the status of its **Spare1** tag in the Input table, the state of its CGCM unit's redundancy relay output, and the exciter field output current.

## Simulate AC Gen and Bus Inputs and Verify Metered Parameters

Follow these steps to simulate the AC Gen and Bus inputs and verify the metered parameters.

1. Disconnect Generator VT and CT inputs, and Bus VT inputs, in a manner that lets you verify as much of the system wiring as practical.

   Ideally, this is done at the VTs for voltage inputs and at the CT shorting blocks for the CT inputs (after suitably shorting the CTs).
2. Apply known signals to each of the VT and CT inputs by using the test current and voltage source.

   This can be done one at a time or simultaneously depending upon the source available.
3. Observe the scheduled and unscheduled data returned to the controller from the CGCM unit with RSLogix 5000 software.
4. Verify that the metered values correctly reflect the simulated signal inputs.

   If errors are found, make the necessary wiring or configuration corrections.

## Static Tests of Protective Functions

These tests can be performed to verify the applicable protective functions of the CGCM unit. These tests can require the use of the test current and voltage source. Some tests can require a load on the CGCM unit's exciter output. This load can be either the generator exciter field or a simulated load.

### *Loss of Excitation Current (40)*

Follow these steps to test that the Loss of Excitation current function is working properly.

1. Connect a suitable load to the excitation output terminals of the CGCM unit.
2. Set the loss of field current setpoint to a level that causes an alarm.
3. Enable excitation in FCR mode with an FCR setpoint less than the loss of field current setpoint.
4. Verify that a field loss alarm is annunciated following the expected delay by viewing the appropriate controller tag.
5. Reset the loss of field setpoint to the desired level.

### *Over-excitation Voltage (59F)*

Follow these steps to test that the Over-excitation voltage function is working properly.

1. Connect a suitable load to the excitation output terminals of the CGCM unit.
2. Decrease the field over-excitation voltage setpoint to a level that causes an alarm.
3. Enable excitation in FCR mode with an FCR setpoint that produces a field voltage higher than the over-excitation voltage setpoint.
4. Verify that a field over-excitation voltage alarm is annunciated following the expected delay.
5. Reset the field over-excitation voltage setpoint to the desired level.

### *Generator Over-voltage (59)*

Follow these steps to test that the Generator Over-voltage function is working properly.

1. Set the generator over-voltage setpoint to a level that causes an alarm.
2. Apply simulated generator voltage signals by using the test voltage source.
3. Adjust the simulated generator voltage to exceed the generator over-voltage setpoint.
4. Verify that a generator over-voltage alarm is annunciated following the expected delay.
5. Reset the generator over-voltage setpoint to the desired level.

### *Generator Under-voltage (27)*

Follow these steps to test that the Generator Under-voltage function is working properly.

1. Connect a suitable load to the excitation output terminals of the CGCM unit.
2. Increase the generator under-voltage setpoint to a level that causes an alarm.
3. Enable excitation in FCR mode.
4. Clear the **EngineIdle** tag in the controller tag database.
5. Apply simulated generator voltage signals by using the test voltage source.
6. Adjust the simulated generator voltage below the generator under-voltage setpoint.

7. Verify that a generator under-voltage alarm is annunciated following the expected delay.
8. Reset the generator under-voltage setpoint to the desired level.

### *Loss of Sensing (60FL)*

Follow these steps to test that the Loss of Sensing function is working properly.

1. Connect a suitable load to the excitation output terminals of the CGCM unit.
2. Enable excitation in FCR mode with an FCR setpoint greater than the loss of field current setpoint.
3. Apply simulated generator voltage signals by using the test voltage source.
4. Adjust the AVR setpoint equal to the simulated generator average line-to-line voltage.
5. Switch the CGCM unit from FCR to AVR mode.
6. Reduce one or more generator VT sensing inputs to less than 30% of the AVR setpoint.

| | |
|---|---|
| **IMPORTANT** | During this step excitation output increases to the OEL limiting setpoint (if configured) or the maximum output. Exercise caution so that no damage occurs to the CGCM, exciter field or simulated load. |

7. Verify that a generator loss of sensing alarm is annunciated following the expected delay.

### *Loss of Permanent Magnet Generator (PMG/Excitation Power) (27)*

This fault is enabled only when PMG excitation is selected and excitation is enabled. If shunt excitation is selected, skip these steps.

Follow these steps to test that the Loss of Permanent Magnet Generator function is working properly.

1. Verify that PMG excitation is selected and that PMG phase select is correctly set to single- or 3-phase.
2. Connect a suitable load to the excitation output terminals of the CGCM unit.
3. Enable excitation in FCR mode with an FCR setpoint greater than the loss of field current setpoint.
4. Remove one or more generator PMG supply leads to the CGCM unit.
5. Verify that a generator loss of PMG alarm is annunciated following the expected delay.

### *Reverse VAR (40Q)*

Follow these steps to test that the Reverse VAR function is working properly.

1. Apply simulated generator voltage and current signals by using the test current and voltage source.
2. Adjust the simulated reactive power until it exceeds the reverse VAR setting in the negative direction.
3. Verify that a generator reverse VAR alarm is annunciated following the expected delay.

### *Over-frequency (81O)*

Follow these steps to test that the Over-frequency function is working properly.

1. Apply simulated generator voltage signals by using the test voltage source.
2. Adjust the simulated generator voltage frequency until it exceeds the over-frequency setpoint.
3. Verify that a generator over-frequency alarm is annunciated following the expected delay.

### *Under-frequency (81U)*

Follow these steps to test that the Under-frequency function is working properly.

1. Connect a suitable load to the excitation output terminals of the CGCM unit.
2. Enable excitation in FCR mode.
3. Clear the **EngineIdle** tag in the controller tag database.
4. Apply simulated generator voltage signals by using the test voltage source.
5. Adjust the simulated generator frequency below the under-frequency setpoint.
6. Verify that an under-frequency alarm is annunciated following the expected delay.

### *Reverse Power (32R)*

Follow these steps to test that the Reverse Power function is working properly.

1. Apply simulated generator voltage and current signals by using the test current and voltage source.
2. Adjust the simulated real power until it exceeds the reverse power setting in the negative direction.
3. Verify that a generator reverse kW alarm is annunciated following the expected delay.

### *Rotating Diode Monitor*

Test this function after the generator is operating.

See Diode Monitor set-up procedures on page 124.

#### *Phase Rotation Error (47)*

Follow these steps to test that the Phase Rotation Error function is working properly.

1. Apply simulated generator voltage signals by using the test voltage source, opposite to the configured phase rotation.
2. Adjust the simulated generator voltage to the rated generator voltage.
3. Verify that a phase rotation fault alarm is annunciated following the expected delay.

#### *Generator Over-current (51)*

Follow these steps to test that the Generator Over-current function is working properly.

1. Apply simulated generator voltage and current signals by using the test current and voltage source.
2. Adjust the simulated generator voltage to rated generator voltage.
3. Adjust the current above the desired test trip time point on the selected over-current curve.
4. Verify that a generator over-current alarm is annunciated following the expected delay.

   The delay is a function of the curve, time dial selections, voltage restraint settings, and the simulated generator current and voltage applied.
5. Repeat as desired to verify various points on the characteristic curve selected.

#### *Reconnect All Permanent Connections*

Following all static testing, reconnect all permanent connections that were temporarily removed. These connections can include VT and CT input connections, excitation power, and exciter field connections.

Refer to the system installation and wiring documentation.

## Operational Testing of the CGCM Unit's Functions

These tests can be performed to verify the applicable operational functions of the CGCM unit. These tests are performed with the generator and prime mover fully functional. These steps are assumed to be performed in order, so that the conditions at the end of one step exist at the beginning of the next step.

During the following tests, the response of the AVR or FCR modes of operation can be determined by creating a step change in the voltage setpoint. Increasing and decreasing the voltage setpoint creates the step change. The typical change in setpoint is between 1% and 10%. Observe the resulting generator response. Observe the voltage overshoot and settling time and adjust the following gain settings to obtain the desired performance.

A typical test is to operate the generator at nominal voltage. With a chart recorder (or suitable voltage-recording device) monitoring the generator's output voltage, initiate a change in the setting. If the transient response observed has too much overshoot, reduce the Kp value. If the overshoot is small and the response is too slow increase the Kp value. Increasing the Ki value decreases the time required to reach steady state. To improve the transient response to a step change, increase $K_d$. If there is too much jitter in the steady-state output, decrease $K_d$. Because all of these terms impact the characteristic response, it is necessary to balance all three to obtain the desired generator response.

### *Start the Generator*

Follow these steps when starting the generator.

1. Verify the appropriate measures have been taken to allow rotation of the prime mover and generator without applying excitation.
2. Disable the excitation enable inputs to the CGCM unit.
3. Start and accelerate the prime mover to synchronous speed.

### *Verify and Apply PMG Power*

Follow these steps to verify and apply PMG power.

1. Rotate the generator at rated speed.
2. Measure the PMG voltage and compare with generator manufacturer's data to be sure PMG voltage is as expected.
3. Apply the PMG supply voltage at the CGCM unit's PMG input terminals.

### *Verify and Adjust FCR Operation*

Follow these steps to verify and adjust the FCR operation.

1. Select the FCR mode of operation.
2. Set the FCR setpoint to the generator manufacturer's specified no-load exciter field current.
3. Enable the CGCM unit's excitation.
4. Monitor the generator exciter field current, exciter field voltage, and generator voltage.

5. Verify that the configured soft start occurs and the generator voltage increases to near the specified rated output voltage.
6. Adjust the FCR setpoint and verify that the metered field current responds as desired.
7. Adjust gains as required to achieve the desired result.

### *Verify Metered Voltages and Phase Rotation*

Follow these steps to verify metered voltages and phase rotation.

1. Observe the reported phase rotation for the generator.
2. Confirm that the metered rotation matches the configured rotation and that no phase rotation fault exists.
3. Measure the VT inputs at the CGCM unit's VT input terminals and verify that they are correct for the selected wiring configuration.
4. Verify that the phase, line, and average voltages reported in the CGCM unit's controller tags are as expected for the selected configuration.

### *Verify and Adjust AVR Mode Operation (constant voltage)*

Follow these steps to verify and adjust the AVR mode operation.

1. Adjust the AVR setpoint to the generator rated voltage.
2. Select Constant Voltage mode by disabling reactive compensation (droop).
3. Select the AVR mode of operation.
4. Monitor the generator exciter field current and generator voltage.
5. Verify that the metered generator voltage is near the rated output voltage setpoint entered previously.
6. Adjust the AVR setpoint and verify the metered voltage responds as desired.

   Adjust gains as required to achieve the desired result.
7. Disable excitation and allow the generator voltage to collapse.
8. With the AVR mode of operation still selected, enable excitation and verify the configured soft start is performed and the generator voltage increases to the AVR setpoint.

### *Verify CGCM Unit Redundancy Operation (when applicable)*

Follow these steps to verify the CGCM unit's redundancy operation.

1. Determine which CGCM unit is the primary of the redundant pair by monitoring the Spare1 tag in the Input table.
2. Disable excitation on the primary CGCM unit by removing the hardware excitation enable input, or clearing the software excitation enable tag, or removing the ControlNet connections, or removing 24V DC control power from the primary CGCM unit.
3. Verify that control transfers to the back-up CGCM unit and that its status is now primary

## Test Synchronization

Synchronization testing is performed by using external independent metering equipment connected directly to the main leads at the circuit breaker. This test verifies that the CGCM unit properly synchronizes the generator to the reference bus.

### *Generator Breaker in Test Position*

Follow these steps to test synchronization when the generator breaker is in the test position.

1. Verify the generator main circuit breaker is in a test position that prevents the breaker from closing when the CGCM unit issues a close command.
2. Observe the generator voltage, bus voltage, frequencies, and phase synchronization by using independent metering equipment.
3. Initiate synchronization in the CGCM unit.
4. Confirm that the CGCM unit reports appropriate error signals and issues a close command when appropriate as indicated by independent metering equipment.

### *Generator Breaker in Normal Position*

Follow these steps to test synchronization when the generator breaker is in the normal position.

1. Place the generator main circuit breaker into the normal position that enables the breaker to close when the CGCM unit issues a close command.
2. Select manual load control for the prime mover.
3. Select Voltage Droop mode for the CGCM unit.
4. Initiate synchronization.

5. Confirm that the CGCM unit reports appropriate error signals and issues a close command when appropriate.

## Verify Applicable Automatic Operating Modes

The CGCM unit has these automatic operating modes:

- Droop (reactive current compensation) Operation
- Cross Current (reactive differential compensation) Operation
- VAR Control
- PF Control
- Real Power Load Sharing Operation

### *Droop (reactive current compensation) Operation*

Perform this test with the generator operating in parallel with a large power source that is maintaining constant voltage. You could also use one or more additional generators.

Follow these steps to test Droop operation.

1. Adjust the prime mover to maintain constant real power.
2. Adjust the voltage setpoint with the CGCM unit in Voltage Droop mode.
3. Monitor the reactive power and verify that the measured reactive power changes by the expected amount.

| | |
|---|---|
| **EXAMPLE** | If the droop setpoint is 5%, and the voltage setpoint is changed by 1%, the expected change in reactive power is 20% of rated kVA. |

### *Cross Current (reactive differential compensation) Operation*

Perform this test with the generator operating in parallel with a large power source that is maintaining constant voltage. You could also use one or more additional generators.

Follow these steps to test the cross current operation.

1. Safely disconnect the cross-current loop (reactive differential inter-connection) with parallel machines.

   The cross-current CT for the generator under test must remain connected to its CGCM unit.
2. Adjust the prime mover to produce a constant power of approximately 25% of rated output with the voltage control in AVR Droop mode.

3. Change the mode of operation to cross-current compensation.
4. Adjust the voltage setpoint.
5. Monitor the reactive power and verify that the measured reactive power changes by the expected amount.

   For example, if the cross-current compensation gain is 5%, and the voltage setpoint is changed by 1%, the expected change in reactive power is 20% of rated kVA.
6. Repeat the same test on each machine.
7. Reconnect the cross-current loop.
8. Connect two or more machines in parallel (not connected to an infinite source) and apply a load.
9. Verify that the generator voltage does not decrease and the reactive power is shared among the machines.

### *VAR Control*

Perform this test with the generator operating in parallel with a large power source that is maintaining constant voltage.

Follow these steps to test the VAR control operation.

1. Place the voltage control in Droop mode.
2. Adjust the prime mover to produce a constant power of approximately 25% of rated output.
3. Verify that the VAR setpoint is adjusted to the produced VARs.

   In the following step, be prepared to transfer back to AVR Droop mode if the excitation increases or decreases suddenly.
4. Transfer to VAR Control mode.
5. Adjust the VARs to 30% of the rated VA value.
6. Monitor the exciter field current and metered VARs to determine performance during the following step.
7. Perform a 5% step of the VAR setpoint and observe the response of the automatic VAR control.
8. Adjust gains as required to achieve the desired result, and run the test again.

### *PF Control*

Perform this test with the generator operating in parallel with a large power source that is maintaining constant voltage.

Follow these steps to test the PF control operation.

1. Place the voltage control in Droop mode.
2. Adjust the prime mover to produce a constant power of approximately 25% of rated output.
3. Verify that the PF setpoint is adjusted to the measured PF.

   Be prepared to transfer back to AVR Droop mode if the excitation increases or decreases suddenly.
4. Transfer to PF Control mode.
5. Monitor the exciter field current and metered PF to determine performance during the following step.
6. Perform a 0.10 step of the PF setpoint and observe the response of the automatic PF control.

   Adjust gains as required to achieve the desired result, and run the test again.

### *Real Power Load Sharing Operation*

Perform this test with two machines connected in parallel.

Follow these steps to test the Real Power Load Sharing operation.

1. Place one prime mover in constant-speed control, and the other in manual load control (typically droop).
2. Adjust the load to a reasonably balanced condition by adjusting the speed setpoint of the droop machine.
3. Enable the real load sharing function on both machines.
4. Switch the droop machine to constant speed control and observe the real power and load share error reported from the CGCM unit on each machine.
5. Verify that the real power balances between the two generators as required and that the load share error from each CGCM unit approaches zero.
6. Adjust load share rate and limit as required to provide stable load share operation.

## Verify Operation of Limiter Functions and Diode Monitor

Perform the following tests to verify Limiter Functions and Diode Monitor operation.

### *Volts/Hz Operation*

Perform this test with the generator operating unloaded in Constant Speed mode and constant voltage AVR mode.

Follow these steps to test the Volts/Hz operation.

1. With the generator circuit breaker open, adjust the prime mover speed down to just above the configured V/Hz upper knee frequency.

   Verify that the voltage remains constant.
2. Adjust the prime mover speed down to below the configured V/Hz upper knee frequency.

   Verify the voltage decreases at the configured upper slope rate.
3. Adjust the prime mover speed down to below the configured V/Hz lower knee frequency.

   Verify the voltage decreases at the configured lower slope rate.

### *Under-excitation Limiting (UEL) Operation*

Perform this test with the generator operating in parallel (droop or PF/VAR control) with a large power source that is maintaining constant voltage.

Follow these steps to test the UEL operation.

1. Disable the UEL function.
2. Set the online under-excitation limit for 5% VARs into the generator.
3. Adjust the VARs into the generator for 15% at 25% load to create an under-excited condition
4. Enable the UEL function.

   This creates a step change into the UEL limit.
5. Observe the response of the excitation current reported by the CGCM unit.
6. Adjust the UEL gains as required to obtain the desired stable response.
7. Verify stable performance of the UEL by testing the machine from 25…100% real power loading while under excited.
8. Increase the excitation above the UEL limit.
9. Return the UEL settings to the values determined for the application.

### *Over-excitation Limiting (OEL) Operation*

Perform this test with the generator operating unloaded in Constant Speed mode and constant voltage AVR mode.

Follow these steps to test the OEL operation.

1. Enable the OEL function.
2. Determine the field current required to reach 105% of the rated generator voltage.
3. Set the offline OEL high and low setpoints for a value equal to the field current determined above.
4. Set the voltage setpoint to rated generator voltage.
5. Enable excitation.
6. Set the voltage setpoint to 110% of the rated output.
7. Verify that the generator maximum voltage remains at approximately 105% and that the OEL Active tag = 1.
8. Observe the response of the excitation current reported by the CGCM unit.
9. Adjust the OEL gains as required to obtain the desired stable response.
10. Return the AVR setpoint to the rated output level.
11. Return the OEL settings to the values determined for the application.

### *Diode Monitor*

Perform this test with the generator operating in any mode.

Follow these steps to test the Diode Monitor operation.

1. Input the number of main poles and exciter poles.
2. Determine the normal percent ripple by observing the ExcRipple tag value.
3. Find the highest percent ripple while operating the generator and prime mover through the normal operating range.
4. Set the Open Diode Level to a value that is three times the highest normal percent ripple found above.

   The multiplier can be varied from 2…5 to adjust the trip margin. Reducing the multiplier could result in nuisance EDM open diode indications.

5. Set the Shorted Diode Level to a value that is 50 times the highest normal percent ripple found above.

   The multiplier can be varied from 40…70 to adjust the trip margin. Regardless of the calculated value, the level has a maximum value of 70. Reducing the multiplier could result in nuisance EDM shorted diode indications.

6. Set the EDM time delays as desired.
7. Disable excitation and shut down the prime mover.
8. Disconnect one diode to create an open diode condition.
9. Start the prime mover, enable excitation and verify that the CGCM unit annunciates an open diode fault.
10. Disable excitation and shut down the prime mover.
11. Reconnect the diode disconnected above.
12. Start the prime mover, enable excitation and verify that the CGCM unit no longer annunciates an open diode fault.

## Document Configuration Parameter and Wiring Changes

When all tests have been performed and all adjustments are complete, use the configuration record to document the installed configuration. Use the system design documentation to clearly identify any required changes made to CGCM unit's related wiring.

See Appendix F for the configuration record.

# Notes:

# CGCM Unit Software Interface

## Introduction

This chapter provides information on communicating with the CGCM unit by using the ControlNet network. It discusses scheduled and unscheduled messaging between the ControlLogix controller and the CGCM unit and touches briefly on the user program communication interface.

The Summary of Data Tables on page 128 provides an overview of the module-defined Data Types that are created in the ControlLogix controller when a CGCM unit is created.

Other tables display the content and format of the Data Types in greater detail.

### CGCM Unit Firmware Revision Considerations

Controller tags are created when a CGCM unit is added to the ControlLogix controller project. The module-defined data type depends on the major firmware revision selected. If you need to change the major firmware revision in the ControlLogix project you must delete the CGCM unit from the controller I/O configuration and install it again with the correct firmware revision selected.

In revision 3.*x* and later the size of the Unscheduled Write data type was increased from 64 bytes to 76 bytes.

Use the <CGCM>.C.UnschWrite controller tag as the source tag for the unscheduled write with either firmware revision (where <CGCM> is the name of the CGCM unit in the controller I/O configuration). The data in this tag is accessed by using the Gain and Voltage tabs in the module properties dialog box. Set the length of the unscheduled write message to 64 bytes for firmware revision 2.*x* and 76 bytes for revision 3.*x* and later.

If an unscheduled write with length of 76 bytes is attempted to a CGCM unit with firmware revision 2.*x*, the message returns an error due to the data size mismatch.

## CGCM Unit Data Table Summary

This table summarizes what information the data tables provide.

**Table 5 - Summary of Data Tables**

| Data Table Name | Firmware Revision | Data Access(2) | Module-defined Data Type | Ass'y Instance | Size (Bytes) | Message Type(2) | Write permitted with Excitation Enabled? | Refer to Page |
|---|---|---|---|---|---|---|---|---|
| Input (Scheduled Read) | N/A | R | AB:1407_CGCM:I:0 | 2 | 76 | S | N/A | 134 |
| Output (Scheduled Write) | 2.*x* | W | AB:1407_CGCM:O:0 | 1 | 56 | S | Y | 138 |
| | 3.*x*/4.*x* | | AB:1407_CGCM:O:1 | | | | | |
| Unscheduled Read | 2.*x* | R | AB:1407_CGCM: Unscheduled_Read | 5 | 172 | U | N/A | 142 |
| | 3.*x*/4.*x* | | AB:1407_CGCM: Unscheduled_Read3 | | | | | |
| Unscheduled Write | 2.*x* | W | AB:1407_CGCM: Unscheduled_Write | 6 | 64 | U | Y | 144 |
| | 3.*x*/4.*x* | | AB:1407_CGCM: Unscheduled_Write3 | | 76 | | | |
| Configuration | 2.*x* | R/W | AB:1407_CGCM:C:0 | 4 | 344 | S (W)<br>U (R) | N | 147 |
| | 3.*x*/4.*x*(1) | | AB:1407_CGCM:C:1 | | | | | |

(1) Series C units with ControlNet Daughter Card firmware revision 1.09 or later and Series D units have an additional instance that can be used to access this data. The assembly instance is 7 and the size is 352. This instance eliminates the need for the user to deal with internal bytes used by RSLogix software.

(2) S = Scheduled, U = Unscheduled, W = Write, R = Read.

## CGCM Unit User Program Interface

The CGCM unit and the ControlLogix controller transfer data through five controller tags based on the module-defined data types listed in the Summary of Data Tables.

When the CGCM unit is added into the RSLogix 5000 software project, RSLogix 5000 software creates the five module defined data types. In addition, four controller tags are created by using these data types:

- **[CGCM_Module_Name]:C**, the Configuration tag
- **[CGCM_Module_Name]:C.UnschWrite**, the Unscheduled Write tag
- **[CGCM_Module_Name]:O**, the Output or Scheduled Write tag
- **[CGCM_Module_Name]:I**, the Input or Scheduled Read tag

When the Configuration tag is created, a set of default values are assigned. These default values do not always reflect the configuration parameters necessary for operation of your application.

Refer to Chapter 4 for information on configuring the CGCM unit with the RSLogix 5000 software module configuration dialog boxes.

In addition to the module configuration interface, the data in the Configuration and Unscheduled Write tags can be accessed by reading and writing elements of the tags in the user program.

| | |
|---|---|
| **IMPORTANT** | RSLogix 5000 software performs data range checks on configuration data entered into the module configuration screens. This does not ensure that data is appropriate for the application. No data range checking is performed on configuration data that is modified by the user program. Out-of-range configuration data is not accepted by the CGCM unit and a communication error results. |

If you wish to monitor the content of the Unscheduled Read data type in the user program, you must create a tag with data type AB:1407_CGCM:Unscheduled_Read and create logic in the user program to initiate unscheduled read messages to the CGCM unit.

## Configuration Messaging

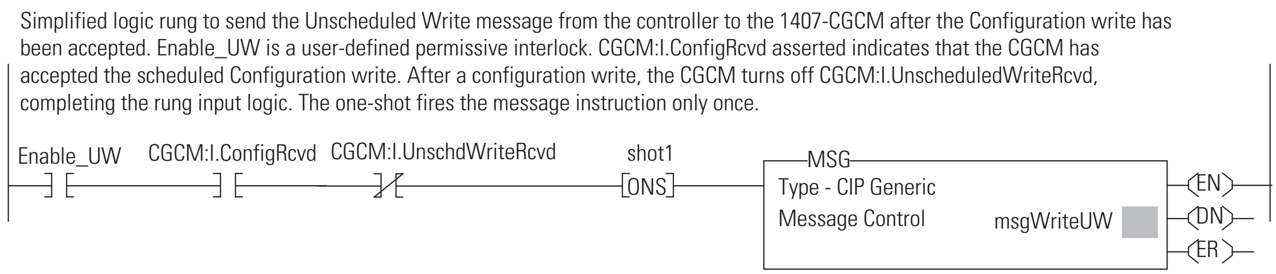
The CGCM unit is not configured when power is applied. Before the CGCM unit can operate, use the ControlLogix controller to configure the unit. There are two parts to the module configuration and a two-step process that transfers the configuration into the CGCM unit. The follow are the two parts of the configuration data:

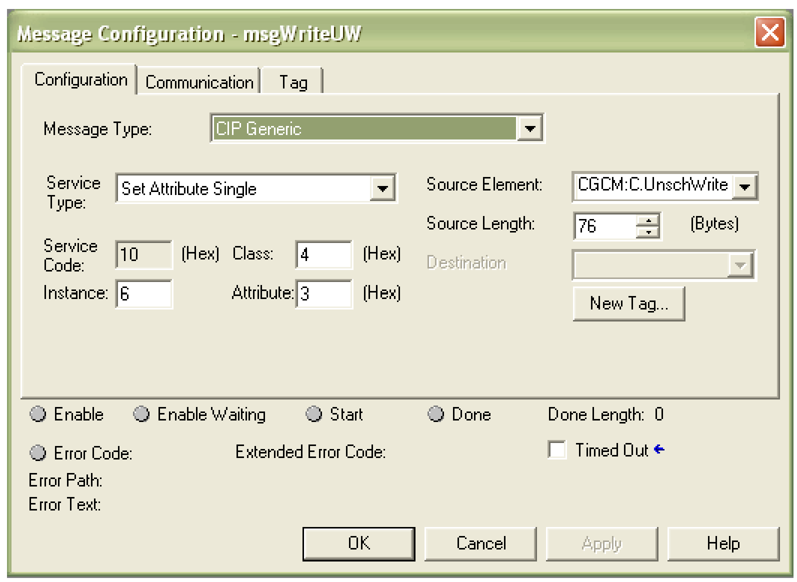
- Configuration data table: The configuration parameters for the CGCM unit are stored in the controller in the Configuration Data Table on page 145.
- Unscheduled Write data table: Voltage regulator gain and voltage compensation parameters are stored in the Unscheduled Write Data Table on page 143.

The controller automatically writes the Configuration data table to the CGCM unit. The user program controls the write of the Unscheduled Write data. The two-step configuration process is described in the Connection Behavior during Configuration section on page 130.

### *Unscheduled Write Message Logic*

This sample ladder diagram rung provides an example of message control for writing the Unscheduled Write data table to the CGCM unit.




| | |
|---|---|
| **IMPORTANT** | The user is responsible for initiating all unscheduled messaging through the user program. |

| | |
|---|---|
| **IMPORTANT** | The message length can be 64 bytes, which avoids writing the kWh, kVARh, and kVAh presets. |

### *Connection Behavior during Configuration*

The CGCM unit operates with an active Class 1 connection with a ControlLogix programmable controller that you programmed and configured. The Class 1 connection is made through the module profile. The CGCM unit controls the state of two bits in the Input data table to interact with the controller during configuration:

- ConfigRcvd - indicates that a valid Configuration write is accepted by the CGCM unit
- UnschdWriteRcvd - indicates that a valid Unscheduled Write message is accepted by the CGCM unit

Two types of connection-related services are involved in the configuration of the CGCM unit:

- Forward Open - When a connection is first established, for instance when the module profile is first configured or the CGCM unit is powered on, a Forward Open service is executed. The ConfigRcvd and UnschdWriteRcvd bits initial states are de-asserted. The controller writes the Configuration data table automatically, and when the CGCM unit accepts this write, the ConfigRcvd bit is set. When the ConfigRcvd bit is set, the user program logic rung that controls the Unscheduled Write message is enabled. When the CGCM unit accepts the Unscheduled Write, the UnschdWriteRcvd bit is set.
- A Null Forward Open is executed when all these conditions are met:
  - A connection is already established.
  - A change to the Configuration or Unscheduled Write data tables is made in the module profile tabs.
  - Appy or OK is clicked.

  The controller attempts to write the Configuration automatically. If excitation is enabled, the configuration write is rejected. If excitation is not enabled, the CGCM unit accepts a valid configuration write. Regardless of excitation status, the CGCM unit de-asserts the UnschedWriteRcvd bit during the execution of a Null Forward Open. This action re-enables the user program logic rung that controls the Unscheduled Write message. When the CGCM unit accepts the Unscheduled Write, the UnschdWriteRcvd bit is set.

With the UnschedWriteRcvd bit asserted, the CGCM unit begins processing Scheduled Write (Output) data and is ready for normal operation based on configuration and outputs received. The CGCM unit ignores any Scheduled Write (Output) data if the UnschedWriteRcvd bit is not asserted.

### *Configuration Summary*

These are the configuration changes to the CGCM unit.:

- The CGCM unit accepts Configuration data only when excitation is disabled and all configuration data is in the correct range.
- The CGCM unit accepts Unscheduled Write data regardless of the excitation state provided that all Unscheduled Write data is in the correct range.

### Operating Interfaces

In normal operation, the ControlLogix controller and the CGCM unit share operating data through scheduled and unscheduled ControlNet network messaging.

The overall functions and detailed content of the CGCM unit data tables are described in the next section.

## CGCM Unit Data Tables

The tables in this section show the content and organization of the CGCM Unit data tables.

### Terms

These terms are used in the following tables:

- Spare - Unused now, can be available for future use. If read, spares are zero value. If written, spare data is ignored by the CGCM unit.
- Reserved - Used internally by CGCM unit. If read, reserve data can be any value. If written, reserved data is ignored by the CGCM unit.
- Generator - Generator output point.
- Bus - Indicates the synchronizing reference point.
- Bus A - Indicates either a three phase reference bus, or the first single phase reference bus.
- Bus B - If used, the second single phase reference bus.

## Abbreviations

The standard abbreviations shown below are used in the data table names for the assembly object table data names.

| Abbreviation | Definition | Abbreviation | Definition |
|---|---|---|---|
| Ack | Acknowledge | Lo | Low |
| Aux | Auxiliary | LS | Load Share |
| Avg | Average | Max | Maximum |
| AVR | Automatic Voltage Regulator | Med | Medium |
| Brkr | Breaker | Min | Minimum |
| CCC | Cross Current Compensation | OEL | Over-excitation Limiting |
| CCCT | Cross Current Compensation Transformer | Out | Output |
| Comp | Compensation | Ovr | Over |
| Config | Configuration | PF | Power Factor |
| CT | Current Transformer | Ph | Phase |
| Dly | Delay | PMG | Permanent Magnet Generator |
| En | Enable | Pri | Primary |
| Ened | Enabled | PU | Per Unit |
| Err | Error | Pwr | Power |
| Exc | Excitation | Rcvd | Received |
| FCR | Field Current Regulator | Redndt | Redundant |
| Flt | Fault | Resvd | Reserved |
| Freq | Frequency | Rev | Reverse |
| FS | Full Scale | Rot | Rotation |
| Gen | Generator | Sec | Secondary |
| Hi | High | Setpt | Setpoint |
| Hrs | Hours | Sync | Synchronization |
| Hz | Hertz | Td | Derivative Time Constant |
| I | Current | UEL | Under-excitation Limiting |
| Init | Initial | Undr | Under |
| k | Kilo | Unschd | Unscheduled |
| Kd | Derivative gain | V | Voltage |
| Kg | Overall gain | VA | Volt Amps |
| Ki | Integral gain | VAR | Volt Amps Reactive |
| Kp | Proportional gain | VT (or PT) | Voltage (Potential) Transformer |
| Lim | Limit | W | Watt |

## Assembly Object Properties

The CIP Assembly Object (Class 0x04) provides assembly instances, attributes and services that facilitate data transfer between the CGCM unit and the ControlLogix controller. Specific assembly object properties are listed with each data table below.

## Input Data Table (scheduled read)

The Input data table contains time-critical status data read from the CGCM unit by the ControlLogix controller.

Data in this Controller Tag is automatically read by the host controller from the unit at the scheduled update rate whenever a connection between the two exists. This occurs independently of the user program. The Input data table can also be read by using unscheduled messaging.

### *Data Type*

The Input data table is automatically created by using module-defined data type AB:1407_CGCM:I:0.

### *Assembly Object Instance 2 - Input Data Table (Scheduled Read)*

The Get Attributes Single service for instance 1 of the Assembly Object can access the following information.

**Table 6 - Get Attributes Single (Service Code 0x0E)**

| Name | Attribute ID | Data Type | Value |
|---|---|---|---|
| Data | 3 | UINT | See Scheduled Read Data Table |
| Size | 4 | UINT | 76 |

### *Configuration Checking*

No range checking is performed on the Input data table.

**Table 7 - Scheduled Read Data Table**

| Byte | Size in Bytes | Type | Bits | Tag Name | Description-+ | Units | Range |
|---|---|---|---|---|---|---|---|
| 0 | 4 | DINT | 0…7 | Status_32_bit | Connect Status | | |
| 4 | 1 | Bool | 0 | RevVARFlt | Reverse kVAR Fault | - | 0=Inactive, 1=Active |
| | | Bool | 1 | RevPwrFlt | Reverse kW Fault | | |
| | | Bool | 2 | OvrExcFlt | Over-excitation Fault | | |
| | | Bool | 3 | Ovr_I_Flt | Over-current Fault | | |
| | | Bool | 4 | Undr_V_Flt | Under-voltage Fault | | |
| | | Bool | 5 | Ovr_V_Flt | Over-voltage Fault | | |
| | | Bool | 6 | UndrFreqFlt | Under-frequency Fault | | |
| | | Bool | 7 | OvrFreqFlt | Over-frequency Fault | | |

**Table 7 - Scheduled Read Data Table**

| Byte | Size in Bytes | Type | Bits | Tag Name | Description-+ | Units | Range |
|---|---|---|---|---|---|---|---|
| 5 | 1 | Bool | 0 | CGCM_Flt | CGCM Internal Fault | - | 0=Inactive, 1=Active |
| | | Bool | 1 | LossExcFlt | Loss of Excitation Current Fault | | |
| | | Bool | 2 | OEL_Active | Over-excitation Limiting Active | | |
| | | Bool | 3 | UEL_Active | Under-excitation Limiting Active | | |
| | | Bool | 4 | LossSensingFlt | VT Sensing Loss | | |
| | | Bool | 5 | LossPMGFlt | PMG Loss | | |
| | | Bool | 6 | RotDiodeFlt | Rotating Diode Fault | | |
| | | Bool | 7 | PhRotFlt | Phase Rotation Fault | | |
| 6 | 1 | Bool | 0 | BusRot_ABC_ACB | Rotation Bus | - | 0=ABC, 1=ACB |
| | | Bool | 1 | GenRot_ABC_ACB | Rotation Generator | | |
| | | Bool | 2 | FltOut | Output Active Fault | | 0=Inactive, 1=Active |
| | | Bool | 3 | ExcOut | Excitation Out Enabled | | 0=Disabled, 1=Enabled |
| | | Bool | 4 | PF_VAR_Selection | Power Factor/VAR Selection | | 0=PF, 1=VAR |
| | | Bool | 5 | PF_VAR_Control_Ened | Power Factor/VAR Control Enabled | | 0=Disabled, 1=Enabled |
| | | Bool | 6 | AVR_FCR_Selection | AVR/FCR Control Selection | | 0=AVR, 1=FCR |
| | | Bool | 7 | FLTResetAck | Reset Acknowledge Fault | | 0=No, 1=Yes |
| 7 | 1 | Bool | 0 | BusV_Present | Bus Voltage Present | - | 0=False, 1=True |
| | | Bool | 1 | GenV_Present | Generator Voltage Present | | |
| | | Bool | 2 | PhRotMatch | Phase Rotation Match | | |
| | | Bool | 3 | V_Match | Voltage Match | | |
| | | Bool | 4 | FreqMatch | Frequency Match | | |
| | | Bool | 5 | PhMatch | Phase Match | | |
| | | Bool | 6 | CGCMInControl | CGCM Control | | 0=No, 1=Yes |
| | | Bool | 7 | Spare1 | CGCM is active in a redundant pair | | 0=False, 1=True |
| 8 | 1 | Bool | 0 | Activebus_A_B | Bus A/B Active | - | 0=Bus A, 1=Bus B |
| | | Bool | 1 | Raise_V | Raise Voltage | | 0=False, 1=True |
| | | Bool | 2 | Lower_V | Lower Voltage | | |
| | | Bool | 3 | Raise_Freq | Raise Frequency | | |
| | | Bool | 4 | Lower_Freq | Lower Frequency | | |
| | | Bool | 5 | Raise_Ph | Raise Phase | | |
| | | Bool | 6 | Lower_Ph | Lower Phase | | |
| | | Bool | 7 | SyncFailure | Synchronization Failure | | |

**Table 7 - Scheduled Read Data Table**

| Byte | Size in Bytes | Type | Bits | Tag Name | Description-+ | Units | Range |
|---|---|---|---|---|---|---|---|
| 9 | 1 | Bool | 0 | AutoSync | Auto Synchronization Enabled | - | 0=Disabled, 1=Enabled |
| | | Bool | 1 | CheckSync | Check Synchronization Enabled | | |
| | | Bool | 2 | PermissiveSync | Permissive Synchronization Enabled | | |
| | | Bool | 3 | UndefinedSyncMode | Undefined Synchronization Mode | | 0=No, 1=Yes |
| | | Bool | 4 | SyncModeConflict | Synchronization Mode Conflict | | |
| | | Bool | 5 | SyncDeadBus | Dead Bus Synchronization | | |
| | | Bool | 6 | CloseBusA_Brkr | Close Bus A Breaker | | 0=Don't Close, 1=Close |
| | | Bool | 7 | CloseBusB_Brkr | Close Bus B Breaker | | |
| 10 | 1 | Bool | 0 | Spare2 | Indicates when the excitation output short circuit protection is active. | - | 0 = Inactive 1 = Active |
| | | Bool | 1 | FreqLessThan10Hz | Frequency Less Than 10 Hz | | 0=False, 1=True |
| | | Bool | 2 | Spare3 | | | |
| | | Bool | 3 | SetptTraverseActive | Traverse Setpoint Active | | 0=Setpoint, 1=Traverse |
| | | Bool | 4 | ShortedRotDiodeFlt | Rotating Diode Shorted Fault | | 0=Inactive, 1=Active |
| | | Bool | 5 | OpenRotDiodeFlt | Rotating Diode Open Fault | | |
| | | Bool | 6 | HardwareExcEned | Hardware Excitation Enabled | | 0=Disabled, 1=Enabled |
| | | Bool | 7 | SoftwareExcEned | Software Excitation Enabled | | |
| 11 | 1 | Bool | 0 | ConfigRcvd | Configuration Received | - | 0=False 1=True |
| | | Bool | 1 | UnschdWriteRcvd | Unscheduled Write Received | | |
| | | Bool | 2 | Spare6 | | | |
| | | Bool | 3 | Spare7 | | | |
| | | Bool | 4 | Spare8 | | | |
| | | Bool | 5 | kVAR_LS_Active | kVAR Load Share Active | | 0=Inactive 1=Active |
| | | Bool | 6 | Spare9 | | | |
| | | Bool | 7 | kW_LS_Active | kW Load Share Active | | 0=Inactive 1=Active |
| 12 | 4 | Real | N/A | Total_kW | Total kW | kW | -3E+09…3E+09 |
| 16 | 4 | Real | N/A | LS_Err | Load Share Error | % | |
| 20 | 4 | Real | N/A | kW_LS_Input_V | kW Load Share Input Voltage | Volts | |
| 24 | 4 | Real | N/A | kW_PU_Load | kW Load Per Unit | - | 0…5 |
| 28 | 4 | Real | N/A | kW_AnalogPU_Load | kW Analog Value Per Unit | - | 0…1 |
| 32 | 4 | Real | N/A | kVAR_LS_InputV | kVAR Load Share Input Voltage | Volts | 0…1 |
| 36 | 4 | Real | N/A | kVAR_PU_load | kVAR Load Per Unit | - | |
| 40 | 4 | Real | N/A | kVAR_AnalogPU_Load | kVAR Analog Value Per Unit | - | 0…1 |
| 44 | 4 | Real | N/A | AvgLLGenV | Average Generator LL Voltage | Volts | 0…30,000 |

**Table 7 - Scheduled Read Data Table**

| Byte | Size in Bytes | Type | Bits | Tag Name | Description-+ | Units | Range |
|---|---|---|---|---|---|---|---|
| 48 | 4 | Real | N/A | V_MatchErr | Voltage Match Error | %V | -100…100 |
| 52 | 4 | Real | N/A | FreqMatchErr | Frequency Match Error | Hz | -90…90 |
| 56 | 4 | Real | N/A | PhMatchErr | Phase Match Error | Deg | -180…180 |
| 60 | 4 | Real | N/A | GenFreq | Generator Frequency | Hz | 10…90 |
| 64 | 4 | Real | N/A | BusFreq | Active Bus Frequency | Hz | 10…90 |
| 68 | 4 | Real | N/A | Spare10 | | - | |
| 72 | 4 | Real | N/A | Spare11 | | - | |

## Output (scheduled write) Data Table

The Output data table contains time-critical command and setpoint data written to the CGCM unit by the ControlLogix controller.

Data in this Controller Tag is automatically written by the host controller to the unit at the scheduled update rate whenever a connection between the two exists. This occurs independently of the user program. The Output data table can also be read and written by using unscheduled messaging. An unscheduled write message is not accepted if there is a scheduled connection active.

### *Data Type*

The Output data table is automatically created by using module-defined data type AB:1407_CGCM:O:0 (Revision 2.*x*) or AB:1407_CGCM:O:1 (Revision 3.*x* or 4.*x*).

### *Assembly Object Instance 1 - Output Data Table (scheduled write)*

The Get Attributes Single service for instance 1 of the Assembly Object can access the following information:.

**Table 8 - Get Attributes Single (service code 0x0E)**

| Name | Attribute ID | Data Type | Value |
|---|---|---|---|
| Data | 3 | UINT | See Output (scheduled write) Data Table, Assembly Instance 1 |
| Size | 4 | UINT | 56 |

The Set Attributes Single service for instance 1 of the Assembly Object can access the following information.

**Table 9 - Set Attributes Single (service code 0x10)**

| Name | Attribute ID | Data Type | Value |
|---|---|---|---|
| Data | 3 | UINT | See Output (scheduled write) Data Table, Assembly Instance 1 |

**TIP** Set Attribute Single is supported for this instance only when there is no scheduled connection to it. Otherwise it returns the error CI_GRC_BAD_OBJ_MODE.

### *Configuration Checking*

No range checking is performed on the Output data table.

### *Data Table*

**Table 10 - Output (scheduled write) Data Table, Assembly Instance 1**

| Byte | Size in Bytes | Type | Bits | Tag Name | Description | Units | Range |
|---|---|---|---|---|---|---|---|
| 0 | 1 | Bool | 0 | RevVARFltOutEn | Reverse VAR Fault Output Enable | - | 0=Disabled, 1=Enabled |
| | | Bool | 1 | RevPwrFltOutEn | Reverse Power Fault Output Enable | | |
| | | Bool | 2 | OvrExcFltOutEn | Over-excitation Fault Output Enable | | |
| | | Bool | 3 | Ovr_I_FltOutEn | Over-current Fault Output Enable | | |
| | | Bool | 4 | Undr_V_FltOutEn | Under-voltage Fault Output Enable | | |
| | | Bool | 5 | Ovr_V_FltOutEn | Over-voltage Fault Output Enable | | |
| | | Bool | 6 | UndrFreqFltOutEn | Under-frequency Fault Output Enable | | |
| | | Bool | 7 | OvrFreqFltOutEn | Over-frequency Fault Output Enable | | |
| 1 | 1 | Bool | 0 | Spare1 | | - | - |
| | | Bool | 1 | LossExcFltOutEn | Loss Excitation Fault Output Enable | | 0=Disabled, 1=Enabled |
| | | Bool | 2 | OEL_En | Over-excitation Limiting Enable | | |
| | | Bool | 3 | UEL_En | Under-excitation Limiting Enable | | |
| | | Bool | 4 | LossSensingFltOutEn | Loss Sensing Fault Output Enable | | |
| | | Bool | 5 | LossPMGFLtOutEn | Loss Permanent Magnet Generator Fault Output Enable | | |
| | | Bool | 6 | RotDiodeFltOutEn | Rotation Diode Fault Output Enable | | |
| | | Bool | 7 | PhRotFltOutEn | Phase Rotation Fault Output Enable | | |

**Table 10 - Output (scheduled write) Data Table, Assembly Instance 1**

| Byte | Size in Bytes | Type | Bits | Tag Name | Description | Units | Range |
|---|---|---|---|---|---|---|---|
| 2 | 1 | Bool | 0 | Spare2 | | - | - |
| | | Bool | 1 | Spare3 | | | |
| | | Bool | 2 | EngineIdle | Engine Idle | | 0=False, 1=True |
| | | Bool | 3 | Spare4 | | | |
| | | Bool | 4 | PF_VAR_Select | Power Factor/VAR Select | | 0=PF, 1=VAR |
| | | Bool | 5 | PF_VAR_En | Power Factor/VAR Enable | | 0=Disabled, 1=Enabled |
| | | Bool | 6 | AVR_FCR_Select | Automatic Voltage Regulator/Field Current Regulator Select | | 0=AVR, 1=FCR |
| | | Bool | 7 | FltReset | Fault Reset | | 0=De-assert, 1=Assert |
| 3 | 1 | Bool | 0 | AutoSyncEn | Auto Synchronization Enable | - | 0=Disabled, 1=Enabled |
| | | Bool | 1 | CheckSyncEn | Check Synchronization Enable | | |
| | | Bool | 2 | PermissiveSyncEn | Permissive Synchronization Enable | | |
| | | Bool | 3 | Spare5 | | | |
| | | Bool | 4 | Spare6 | | | |
| | | Bool | 5 | Bus A_B_Select | Bus A/B Select | | 0=Bus A, 1=Bus B |
| | | Bool | 6 | DeadBusClosureEn | Dead Bus Closure Enable | | 0=Disabled, 1=Enabled |
| | | Bool | 7 | InitiateSync | Initiate Synchronization | | 0=Inactive, 1=Active |
| 4 | 1 | Bool | 0 | Clear_kW_Hrs (Rev. 2.*x*)<br>Set_kW_Hrs (Rev. 3.*x* or later) | Set/Clear kW Hours | | 0=De-assert, 1=Assert |
| | | Bool | 1 | Clear_kVAR_Hrs (Rev. 2.*x*)<br>Set_kVAR_Hrs (Rev. 3.*x* or later) | Set/Clear kVAR Hours | | |
| | | Bool | 2 | Clear_kVA_Hrs (Rev. 2.*x*)<br>Set_kVA_Hrs (Rev. 3.*x* or later) | Set/Clear kVA Hours | | |
| | | Bool | 3 | Spare7 | | | |
| | | Bool | 4 | Droop_CCC_Select | Droop/Cross Current Compensation Select | | 0=Droop, 1=CCC |
| | | Bool | 5 | V_DroopEn | Voltage Droop Enable | | 0=Disabled, 1=Enabled |
| | | Bool | 6 | Spare8 | | | |
| | | Bool | 7 | SoftwareExcEn | Software Excitation Enable | | 0=Disabled, 1=Enabled |

**Table 10 - Output (scheduled write) Data Table, Assembly Instance 1**

| Byte | Size in Bytes | Type | Bits | Tag Name | Description | Units | Range |
|---|---|---|---|---|---|---|---|
| 5 | 1 | Bool | 0 | Spare9 | | - | - |
| | | Bool | 1 | Spare10 | | | |
| | | Bool | 2 | Spare11 | | | |
| | | Bool | 3 | Spare12 | | | |
| | | Bool | 4 | kVAR_LS_BridgeEn | kVAR Load Share Bridge Enable | | 0=Disabled, 1=Enabled |
| | | Bool | 5 | kVAR_LS_En | kVAR Load Share Enable | | |
| | | Bool | 6 | kW_LS_BridgeEn | kW Load Share Bridge Enable | | |
| | | Bool | 7 | kW_LS_En | kW Load Share Enable | | |
| 6 | 1 | Bool | 0…7 | Spare13_20 | | - | - |
| 7 | 1 | Bool | 0…7 | Spare21_28 | | - | - |
| 8 | 4 | Real | N/A | AVRSetpt | Automatic Voltage Regulator Setpoint | Volts | 85…30,000 |
| 12 | 4 | Real | N/A | FCRSetpt | Field Current Regulator Setpoint | Adc | 0…15 |
| 16 | 4 | Real | N/A | PFSetpt | Power Factor Setpoint | PF | -0.5…0.5 |
| 20 | 4 | Real | N/A | VARSetpt | VAR Setpoint | VARS | -1E+07…1E+07 |
| 24 | 4 | Real | N/A | kWLSOutV | kW Load Share Output Voltage | Volts | |
| 28 | 4 | Real | N/A | kWAnalogTargetPUValue | kW Analog Target Value Per Unit | - | |
| 32 | 4 | Real | N/A | kWDigitalTargetPUValue | kW Digital Target Value Per Unit | - | |
| 36 | 4 | Real | N/A | kVAR_LS_OutV | kVAR Load Share Output Voltage | Volts | |
| 40 | 4 | Real | N/A | kVARAnalogTargetPUValue | kVAR Analog Target Value Per Unit | - | |
| 44 | 4 | Real | N/A | kVARDigitalTargetPUValue | kVAR Digital Target Value Per Unit | - | |
| 48 | 4 | Real | N/A | Spare13 | | - | |
| 52 | 4 | Real | N/A | Spare14 | | - | |

## Unscheduled Read Data Table

The Unscheduled Read data table contains metering and other non time-critical status data read from the CGCM unit by the ControlLogix controller.

Data in this Controller Tag is read by the host controller from the unit by using unscheduled messaging controlled by the user program.

### *Data Type*

The Unscheduled Read data table must be created by the user by using module-defined data type AB:1407_CGCM:Unschduled_Read (Revision 2.*x*) or AB:1407_CGCM:Unscheduled_Read3 (Revision 3.*x* or 4.*x*).

### *Unscheduled Read Data Table*

The Get Attributes Single service for instance 5 of the Assembly Object can access the following information.

**Table 11 - Get Attributes Single (service code 0x0E)**

| Name | Attribute ID | Data Type | Value |
|---|---|---|---|
| Data | 3 | UINT | See Unscheduled Read Data Table, Assembly Instance 5 |
| Size | 4 | UINT | 172 |

The Set Attributes Single service is not supported for instance 5.

### *Configuration Checking*

No range checking is performed on this data table.

### *Energy Metering Considerations*

Energy metering values (kW_Hrs, kVAR_Hrs, and kVA_Hrs) are provided using a REAL data type. Values are expressed in a 32-bit floating-point format with a precision of 7 digits. The table lists the theoretical range of a REAL value.

The energy values accumulate when the average generator line current is no less than 1% of generator rated current. The limit that can be represented by an energy tag is expressed by the following formulas:

$$kVA\_Hrs\ Limit = 8{,}338{,}600 \cdot rated\ kVA \cdot (\%\ of\ rated\ load)$$

$$kW\_Hrs\ Limit = 8{,}338{,}600 \cdot rated\ kW \cdot (\%\ of\ rated\ load)$$

$$kVAR\_Hrs\ Limit = 8{,}338{,}600 \cdot rated\ kVAR \cdot (\%\ of\ rated\ load)$$

When the energy tag value reaches (8,388,600 * rated kVA * % of rated load) and the unit is still providing the same load level or less, the value will not update.

For instance, a 30 MVA machine operating at 10% load will yield an energy tag limit of :

(8,338,600 * .1 * 30000) = 25,015,800,000 kVAh, or 2.50158 x $10^{10}$ kVAh

When the energy tag value exceeds 8,338,600, rounding of the value begins to occur.

The energy values are not retentive. When the 1407-CGCM unit powers up or re-establishes a connection with the controller, the energy presets in the Unscheduled Write table are written to the energy metering values.

## *Data Table*

**Table 12 - Unscheduled Read Data Table, Assembly Instance 5**

| Byte | Size in Bytes | Type | Tag Name | Description | Units | Range |
|---|---|---|---|---|---|---|
| 0 | 4 | Real | AvgPF | Average Power Factor | PF | -1…1 |
| 4 | 4 | Real | PhA_PF | Phase A Power Factor | | |
| 8 | 4 | Real | PhB_PF | Phase B Power Factor | | |
| 12 | 4 | Real | PhC_PF | Phase C Power Factor | | |
| 16 | 4 | Real | Total_kVA | Total kVA | kVA | 0…3E+09 |
| 20 | 4 | Real | PhA_kVA | Phase A kVA | | |
| 24 | 4 | Real | PhB_kVA | Phase B kVA | | |
| 28 | 4 | Real | PhC_kVA | Phase C kVA | | |
| 32 | 4 | Real | PhA_kW | Phase A kW | kW | -3E+09…3E+09 |
| 36 | 4 | Real | Ph_B_kW | Phase B kW | | |
| 40 | 4 | Real | PhC_kW | Phase C kW | | |
| 44 | 4 | Real | Total_kVAR | Total kVAR | kVAR | |
| 48 | 4 | Real | PhA_kVAR | Phase A kVAR | | |
| 52 | 4 | Real | PhB_kVAR | Phase B kVAR | | |
| 56 | 4 | Real | PhC_kVAR | Phase C kVAR | | |
| 60 | 4 | Real | Avg_I | Average Current | A | 0…60,000 |
| 64 | 4 | Real | PhA_I | Phase A Current | | |
| 68 | 4 | Real | PhB_I | Phase B Current | | |
| 72 | 4 | Real | PhC_I | Phase C Current | | |
| 76 | 4 | Real | PhAB_GenV | Phase AB Generator Voltage | V | 0…30,000 |
| 80 | 4 | Real | PhBC_GenV | Phase BC Generator Voltage | | |
| 84 | 4 | Real | PhCA_GenV | Phase CA Generator Voltage | | |
| 88 | 4 | Real | AvgLN_GenV | Average LN Generator Voltage | | |
| 92 | 4 | Real | PhA_GenV | Phase A Generator Voltage | | |
| 96 | 4 | Real | PhB_GenV | Phase B Generator Voltage | | |
| 100 | 4 | Real | PhC_GenV | Phase C Generator Voltage | | |
| 104 | 4 | Real | AvgLL_BusV | Average LL Bus A Voltage | | |
| 108 | 4 | Real | PhAB_BusV | Phase AB Bus A Voltage | | |
| 112 | 4 | Real | PhBC_BusV | Phase BC Bus A Voltage | | |
| 116 | 4 | Real | PhCA_BusV | Phase CA Bus A Voltage | | |
| 120 | 4 | Real | AvgLN_BusV | Average LN Bus A Voltage | | |
| 124 | 4 | Real | PhA_BusV | Phase A Bus A Voltage | V | 0…30000 |
| 128 | 4 | Real | PhB_BusV | Phase B Bus A Voltage | | |
| 132 | 4 | Real | PhC_BusV | Phase C Bus A Voltage | | |
| 136 | 4 | Real | BusB_V | Bus B Voltage | | |
| 140 | 4 | Real | Exc_V | Excitation Voltage | | 0 200 |

**Table 12 - Unscheduled Read Data Table, Assembly Instance 5**

| Byte | Size in Bytes | Type | Tag Name | Description | Units | Range | |
|---|---|---|---|---|---|---|---|
| 144 | 4 | Real | Exc_I | Excitation Current | Amps | 0 | 15 |
| 148 | 4 | Real | ExcRipple_I (Rev.2.x)<br>ExcRipple (Rev. 3.x) | Excitation Ripple Current | Amps/% | 0 | 15 |
| 152 | 4 | Real | kW_Hrs | kW Hours | kWh | $-3.04 * 10^{38}$ | $3.04 * 10^{38}$ |
| 156 | 4 | Real | kVAR_Hrs | kVAR Hours | kVARh | $-3.04 * 10^{38}$ | $3.04 * 10^{38}$ |
| 160 | 4 | Real | kVA_Hrs | kVA Hours | kVAh | 0 | $3.04 * 10^{38}$ |
| 164 | 4 | Real | V_AdjustOffset | Voltage Adjust Offset | % | -10 | 10 |
| 168 | 2 | INT | Spare | | | | |
| 170 | 2 | INT | Resvd | Reserved | | | |

## Unscheduled Write Data Table

The Unscheduled Write data table contains gains and other configuration parameters, that can be written to the CGCM unit by the ControlLogix controller regardless of the excitation state.

Data in this Controller Tag is written by the host controller to the unit by using unscheduled messaging controlled by the user program.

### *Data Type*

The Unscheduled Write data table is automatically created by using the appropriate module-defined data type depending on the CGCM unit firmware revision.

### *Assembly Object Instance 6 - Unscheduled Write Data Table*

The Get Attributes Single service for instance 6 of the Assembly Object can access the following information.

**Table 13 - Get Attributes Single (service code 0x0E)**

| Name | Attribute ID | Data Type | Value |
|---|---|---|---|
| Data | 3 | UINT | See Unscheduled Write Data Table, Assembly Instance 6 |
| Size | 4 | UINT | CGCM firmware 2.x = 64<br>CGCM firmware 3.x or 4.x = 72 |

The Set Attributes Single service for instance 6 of the Assembly Object can access the following information.

**Table 14 - Set Attributes Single (service code 0x10)**

| Name | Attribute ID | Data Type | Value |
|---|---|---|---|
| Data | 3 | UINT | See Unscheduled Write Data Table, Assembly Instance 6 |

### *Configuration Checking*

When an unscheduled write is received, the CGCM unit verifies that individual parameters are within the range indicated in the table below (for example, perform range checking). If an out-of-range parameter is detected, the CGCM unit ignores all data in the unscheduled write in the message instruction. The CGCM unit does not perform application checking (is a value suitable for the particular application) or dependency checking (is a value reasonable based on other values entered).

### *Data Table*

Although the Unscheduled Write tag is contained in the Configuration tag in the Logix controller tags, the Unscheduled Write must be read back from the CGCM unit independently.

**Table 15 - Unscheduled Write Data Table, Assembly Instance 6**

| Byte | Size in Bytes | Type | Tag Name | Description | Units | Range | Error Code |
|---|---|---|---|---|---|---|---|
| 0 | 4 | Real | LineDropComp | Line Drop Compensation | % | 0…10 | 1 |
| 4 | 4 | Real | AVR_FCR_Kp | Automatic Voltage Regulator/Field Current Regulator Proportional Gain | - | 0…1000 | 2 |
| 8 | 4 | Real | AVR_FCR_Ki | Automatic Voltage Regulator/Field Current Regulator Integral Gain | - | 0…1000 | 3 |
| 12 | 4 | Real | AVR_FCR_Kd | Automatic Voltage Regulator/Field Current Regulator Derivative Gain | - | 0…1000 | 4 |
| 16 | 4 | Real | AVR_FCR_Td | Automatic Voltage Regulator/Field Current Regulator Derivative Time Constant | - | 0…1000 | 5 |
| 20 | 4 | Real | AVR_Kg | Automatic Voltage Regulator Overall Gain | - | 0…1000 | 6 |
| 24 | 4 | Real | FCR_Kg | Field Current Regulator Overall Gain | - | 0…1000 | 7 |
| 28 | 4 | Real | PF_Kg | Power Factor Overall Gain | - | 0…1000 | 8 |
| 32 | 4 | Real | PF_Ki | Power Factor Integral Gain | - | 0…1000 | 9 |
| 36 | 4 | Real | VAR_Kg | VAR Overall Gain | - | 0…1000 | 10 |
| 40 | 4 | Real | VAR_Ki | VAR Integral Gain | - | 0…1000 | 11 |
| 44 | 4 | Real | OEL_Kg | Over-excitation Limiting Overall Gain | - | 0…1000 | 12 |
| 48 | 4 | Real | OEL_Ki | Over-excitation Limiting Integral Gain | - | 0…1000 | 13 |
| 52 | 4 | Real | UEL_Kg | Under-excitation Limiting Overall Gain | - | 0…1000 | 14 |
| 56 | 4 | Real | UEL_Ki | Under-excitation Limiting Integral Gain | - | 0…1000 | 15 |
| 60 | 4 | Real | V_Match_Gain | Voltage Match Gain | - | 0…1000 | 16 |

**Table 15 - Unscheduled Write Data Table, Assembly Instance 6**

| Byte | Size in Bytes | Type | Tag Name | Description | Units | Range | Error Code |
|---|---|---|---|---|---|---|---|
| 64 | 4 | Real | kWHoursPreset | kW Hours Preset | | $-1 \times 10^{12} \ldots 1 \times 10^{12}$ | 17 |
| 68 | 4 | Real | kVARHoursPreset | kVAR Hours Preset | | $-1 \times 10^{12} \ldots 1 \times 10^{12}$ | 18 |
| 72 | 4 | Real | kVAHoursPreset | kVA Hours Preset | | $0 \ldots 1 \times 10^{12}$ | 19 |

Message size depends on the unit's firmware revision. 64 (FRN 2.*x*) or 76 (FRN 3.*x* or later) byte Message size from CNET to CGCM (Written to the CGCM unit).

**TIP** The last three elements are present only in the CGCM unit host firmware revision 3.*x* or later.

## Configuration Data Table

The Configuration data table contains configuration parameters, which are automatically written to the CGCM unit by the ControlLogix controller when a connection is first established or when the user changes parameters in the RSLogix 5000 software module configuration dialog boxes and clicks the Apply or OK buttons. The CGCM unit accepts only Configuration data if all parameters are within range and excitation is disabled.

### *Data Type*

The Configuration data table is automatically created by using module-defined data type AB:1407_CGCM:C:0 for firmware revision 2.*x* or AB:1407_CGCM:C:1 for firmware revision 3.*x*. This tag does not show the first four bytes of the data table.

Unscheduled reads and writes of the Configuration data table are supported. If you wish to perform unscheduled reads or writes, you must create a user-defined data type and (tags based on it) that begins with a four-byte pad (for example, a DINT element) followed by the remaining tags in the AB:1407_CGCM:C:0 (or C:1) module-defined data type. You can do this in RSLogix 5000 software by highlighting the tags in the module-defined data type definition, choosing Copy from the Edit menu, selecting the element after the pad in the user-defined data type and choosing Paste from the Edit menu.

In host firmware revision 3.4 and later, the configuration is also available by using assembly instance 7. Instance 7 does not require the four-byte pad described above.

| **IMPORTANT** | Writing the CGCM unit's configuration with unscheduled messaging is not recommended. We recommend using only scheduled configuration messaging sent when the connection is opened or the module configuration is edited in RSLogix 5000 software. |
|---|---|

### *Assembly Object Instance 4 - Configuration Data Table*

The Get Attributes Single service for instance 4 of the Assembly Object can access the following information.

**Table 16 - Get Attributes Single (service code 0x0E)**

| Name | Attribute ID | Data Type | Value |
|---|---|---|---|
| Data | 3 | UINT | See Unscheduled Configuration Read/Write Data Table, Assembly Instance 4 |
| Size | 4 | UINT | 344 |

The Set Attributes Single service for instance 6 of the Assembly Object can access the following information.

**Table 17 - Set Attributes Single (service code 0x10)**

| Name | Attribute ID | Data Type | Value |
|---|---|---|---|
| Data | 3 | UINT | See Unscheduled Configuration Read/Write Data Table, Assembly Instance 4 |

| **IMPORTANT** | Use of this service is not recommended. See the note above. |
|---|---|

### *Configuration Checking*

When configuration data is received, the CGCM unit verifies that individual parameters are within the minimum and maximum values indicated in the table below (for example, perform range checking). If an out-of-range parameter is detected, the CGCM unit enters a configuration fault mode and ignores all data in the configuration write. The Connection tab in the module configuration dialog box in RSLogix 5000 software displays an error code corresponding to the first offending configuration parameter. The CGCM unit **does not** perform any application checking (for example, is a value suitable for the particular application) or dependency checking (for example, is a value reasonable based on other values entered).

### *Data Table*

**Table 18 - Unscheduled Configuration Read/Write Data Table, Assembly Instance 4**

| Byte | Size in Bytes | Type | Bits | Tag Name | Description | Units | Range | Error Code |
|---|---|---|---|---|---|---|---|---|
| 0 | 1 | SINT | N/A | Space Reserved for Logix controller Revision Configuration Number | | | | |
| 1 | 3 | SINT | N/A | Pad Bytes Reserved for Logix controller Usage | | | | |
| 4 | 1 | Bool | 0 | RevVARFltOutEn | Reverse VAR Fault Output Enable | - | 0=Disabled, 1=Enabled | |
| | | Bool | 1 | RevPwrFltOutEn | Reverse Power Fault Output Enable | | | |
| | | Bool | 2 | OvrExcFltOutEn | Over-excitation Fault Output Enable | | | |
| | | Bool | 3 | Ovr_I_FltOutEn | Over-current Fault Output Enable | | | |
| | | Bool | 4 | Undr_V_FltOutEn | Under-voltage Fault Output Enable | | | |
| | | Bool | 5 | OvrVFltOutEn | Over-voltage Fault Output Enable | | | |
| | | Bool | 6 | UndrFreqFltOutEn | Under-frequency Fault Output Enable | | | |
| | | Bool | 7 | OvrFreqFltOutEn | Over-frequency Fault Output Enable | | | |
| 5 | 1 | Bool | 0 | Spare1 | | - | - | |
| | | Bool | 1 | Loss_Exc_Flt_Out_En | Loss Excitation Fault Output Enable | | 0=Disabled, 1=Enabled | |
| | | Bool | 2 | OEL_En | Over-excitation Limiting Enable | | | |
| | | Bool | 3 | UEL_En | Under-excitation Limiting Enable | | | |
| | | Bool | 4 | LossSensingFltOutEn | Loss Sensing Fault Output Enable | | | |
| | | Bool | 5 | LossPMGFltOutEn | Loss Permanent Magnet Generator Fault Output Enable | | | |
| | | Bool | 6 | RotDiodeFltOutEn | Rotating Diode Fault Output Enable | | | |
| | | Bool | 7 | PhRotFltOutEn | Phase Rotation Fault Output Enable | | | |
| 6 | 1 | Bool | 0 | BusRotABC_ACB_Select | Bus Rotation ABC/ACB Select | - | 0=ABC, 1=ACB | |
| | | Bool | 1 | GenRotABC_ACB_Select | Generator Rotation ABC/ACB Select | | 0=ABC, 1=ACB | |
| | | Bool | 2 | Spare2 | | | | |
| | | Bool | 3 | PMG_Shunt_Select | PMG/Shunt Select | | 0=PMG, 1=Shunt | |
| | | Bool | 4 | Spare3 | | | | |
| | | Bool | 5 | Spare4 | | | | |
| | | Bool | 6 | Internal_Tracking_En | Internal Tracking Enable | | 0=Disabled, 1=Enabled | |
| | | Bool | 7 | PMG_1Ph_3PhSelect | PMG Single Phase/Three Phase Select | | 0=1Ph, 1=3Ph | |

**Table 18 - Unscheduled Configuration Read/Write Data Table, Assembly Instance 4**

| Byte | Size in Bytes | Type | Bits | Tag Name | Description | Units | Range | Error Code |
|---|---|---|---|---|---|---|---|---|
| 7 | 1 | Bool | 0…7 | Spare5_12 | | - | - | |
| 8 | 4 | Real | N/A | GenVT_Pri_V | Generator Voltage Transformer Primary Voltage | V | 1…30,000 | 1. |
| 12 | 4 | Real | N/A | GenVT_Sec_V | Generator Voltage Transformer Secondary Voltage | V | 1…240 | 2 |
| 16 | 4 | Real | N/A | BusA_VT_Pri_V | Bus A Voltage Transformer Primary Voltage | V | 1…30,000 | 3 |
| 20 | 4 | Real | N/A | BusA_VT_Sec_V | Bus A Voltage Transformer Secondary Voltage | V | 1…240 | 4 |
| 24 | 4 | Real | N/A | BusB_VT_Pri_V | Bus B Voltage Transformer Primary Voltage | V | 1…30,000 | 5 |
| 28 | 4 | Real | N/A | BusB_VT_Sec_V | Bus B Voltage Transformer Secondary Voltage | V | 1…240 | 6 |
| 32 | 4 | Real | N/A | GenCT_Pri_I | Generator Current Transformer Primary Current | A | 1…60,000 | 7 |
| 36 | 4 | Real | N/A | GenCT_Sec_I | Generator Current Transformer Secondary Current | A | 1…5 | 8 |
| 40 | 4 | Real | N/A | CCCT_Pri_I | Cross Current Compensation Transformer Primary Current | A | 1…60,000 | 9 |
| 44 | 4 | Real | N/A | CCCT_Sec_I | Cross Current Compensation Transformer Secondary Current | A | 1…5 | 10 |
| 48 | 2 | INT | N/A | GenVT_Config | Generator Voltage Transformer Configuration | - | 1…4 | 11 |
| 50 | 2 | INT | N/A | BusVT_Config | Bus Voltage Transformer Configuration | - | 1…5 | 12 |
| 52 | 4 | Real | N/A | GenRated_W | Generator Rated Power | W | 0…1E+09 | 13 |
| 56 | 4 | Real | N/A | GenRated_V | Generator Rated Voltage | V | 85…30,000 | 14 |
| 60 | 4 | Real | N/A | GenRated_I | Generator Rated Current | A | 10…60,000 | 15 |
| 64 | 4 | Real | N/A | GenRatedFreq | Generator Rated Frequency | Hz | 50…60 | 16 |
| 68 | 4 | Real | N/A | GenRatedExcV | Generator Rated Excitation Voltage | V | 1…200 | 17 |
| 72 | 4 | Real | N/A | GenRatedExcI | Generator Rated Excitation Current | A | 0.1…15 | 18 |
| 76 | 4 | Real | N/A | LS_FS_V | Load Share Full Scale Voltage | V | 0…4 | 19 |
| 80 | 4 | Real | N/A | LSRate | Load Share Rate | s | 0…100 | 20 |
| 84 | 4 | Real | N/A | LSLimit | Load Share Limit | P.U. | 0…1 | 21 |
| 88 | 4 | Real | N/A | SyncFreqHiLim | Synchronization Frequency High Limit | Hz | -2…2 | 22 |
| 92 | 4 | Real | N/A | SyncFreqLoLim | Synchronization Frequency Low Limit | Hz | -2…2 | 23 |

**Table 18 - Unscheduled Configuration Read/Write Data Table, Assembly Instance 4**

| Byte | Size in Bytes | Type | Bits | Tag Name | Description | Units | Range | Error Code |
|---|---|---|---|---|---|---|---|---|
| 96 | 4 | Real | N/A | SyncV_HiLim | Synchronization Voltage High Limit | %V | -25…25 | 24 |
| 100 | 4 | Real | N/A | SyncV_LoLim | Synchronization Voltage Low Limit | %V | -25…25 | 25 |
| 104 | 4 | Real | N/A | SyncPhHiLim | Synchronization Phase High Limit | Deg | -45…45 | 26 |
| 108 | 4 | Real | N/A | SyncPhLoLim | Synchronization Phase Low Limit | Deg | -45…45 | 27 |
| 112 | 4 | Real | N/A | SyncAcceptDly | Synchronization Accept Delay | s | 0…10 | 28 |
| 116 | 4 | Real | N/A | DeadbusGenFreqLoLim | Deadbus Generator Frequency Low Limit | Hz | 40…70 | 29 |
| 120 | 4 | Real | N/A | DeadbusGenFreqHiLim | Deadbus Generator Frequency High Limit | Hz | 40…70 | 30 |
| 124 | 4 | Real | N/A | DeadbusGenV_LoLim | Deadbus Generator Voltage Low Limit | V | 85…30,000 | 31 |
| 128 | 4 | Real | N/A | DeadbusGenV_HiLim | Deadbus Generator Voltage High Limit | V | 85…30,000 | 32 |
| 132 | 4 | Real | N/A | BusA_PhOffset | Bus A Phase Offset | Deg | -180…180 | 33 |
| 136 | 4 | Real | N/A | BusA_V_Scaler | Bus A Voltage Scaler | - | 0…30,000 | 34 |
| 140 | 4 | Real | N/A | BusB_PhOffset | Bus B Phase Offset | Deg | -180…180 | 35 |
| 144 | 4 | Real | N/A | BusB_V_Scaler | Bus B Voltage Scaler | - | 0…30,000 | 36 |
| 148 | 4 | Real | N/A | VperHz_HiKneeFreq | Volts per Hz Upper Knee Frequency | Hz | 15…90 | 37 |
| 152 | 4 | Real | N/A | VperHz_HiSlope | Volts per Hz Upper Slope | PUV /PUHz | 0…3 | 38 |
| 156 | 4 | Real | N/A | VperHz_LoKneeFreq | Volts per Hz Low Knee Frequency | Hz | 15…90 | 39 |
| 160 | 4 | Real | N/A | VperHz_LoSlope | Volts per Hz Low Slope | PUV /PUHz | 0…3 | 40 |
| 164 | 4 | Real | N/A | V_DroopSetpt | Voltage Droop Setpoint | % | -30…30 | 41 |
| 168 | 2 | INT | N/A | OvrExcV_Setpt | Over-excitation Voltage Setpoint | Volts /100 | 100…20,000 | 42 |
| 170 | 2 | INT | N/A | OvrExcV_TimeDly | Over-excitation Voltage Time Delay | s/100 | 10…3000 | 43 |
| 172 | 2 | INT | N/A | Ovr_V_Setpt | Over-voltage Setpoint | %/100 | 10000…14000 | 44 |
| 174 | 2 | INT | N/A | Ovr_V_TimeDly | Over-voltage Time Delay | s/100 | 10…30,000 | 45 |
| 176 | 2 | INT | N/A | Undr_V_Setpt | Under-voltage Setpoint | %/100 | 6000…10,000 | 46 |
| 178 | 2 | INT | N/A | Undr_V_TimeDly | Under-voltage Time Delay | s/100 | 10…30,000 | 47 |
| 180 | 2 | INT | N/A | OpenDiodeMonitorLevel | Open Diode Monitor Level | %/100 | 0…10,000 | 48 |
| 182 | 2 | INT | N/A | ShortedDiodeMonitorLev el | Shorted Diode Monitor Level | %/100 | 0…10,000 | 49 |
| 184 | 2 | INT | N/A | DiodeMonitorTimeDly | Diode Monitor Time Delay | s/100 | 10…30,000 | 50 |
| 186 | 2 | INT | N/A | MainPole | Main Pole | Poles | 2…24 | 51 |

**Table 18 - Unscheduled Configuration Read/Write Data Table, Assembly Instance 4**

| Byte | Size in Bytes | Type | Bits | Tag Name | Description | Units | Range | Error Code |
|---|---|---|---|---|---|---|---|---|
| 188 | 2 | INT | N/A | ExciterPole | Exciter Pole | Poles | 2…24 | 52 |
| 190 | 2 | INT | N/A | Rev_kW_Setpt | Reverse kW Setpoint | %/100 | 100…10,000 | 53 |
| 192 | 2 | INT | N/A | Rev_kW_TimeDly | Reverse kW Time Delay | s/100 | 10…30,000 | 54 |
| 194 | 2 | INT | N/A | Rev_kVAR_Setpt | Reverse kVAR Setpoint | %/100 | 100…10,000 | 55 |
| 196 | 2 | INT | N/A | Rev_kVAR_TimeDly | Reverse kVAR Time Delay | s/100 | 10…3000 | 56 |
| 198 | 2 | INT | N/A | OvrFreqSetpt | Over-frequency Setpoint | Hz/100 | 3000…7000 | 57 |
| 200 | 2 | INT | N/A | OvrFreqTimeDly | Over-frequency Delay | s/100 | 10…30,000 | 58 |
| 202 | 2 | INT | N/A | UndrFreqSetpt | Under-frequency Setpoint | Hz/100 | 3000…7000 | 59 |
| 204 | 2 | INT | N/A | UndrFreqTimeDly | Under-frequency Delay | s/100 | 10…30,000 | 60 |
| 206 | 2 | INT | N/A | Ovr_I_Setpt | Over-current Setpoint | %/100 | 1000…32,000 | 61 |
| 208 | 2 | INT | N/A | Ovr_I_TimeDly | Over-current Time Delay | Time dial setting /100 | 0…990 | 62 |
| 210 | 2 | INT | N/A | Ovr_I_Curve | Over-current Curve | - | 1…17 | 63 |
| 212 | 2 | INT | N/A | Ovr_I_VrestSetpt | Over-current Voltage Restraint Setpoint | %/100 | 0…20,000 | 64 |
| 214 | 2 | INT | N/A | Spare13 | | - | - | 65 |
| 216 | 2 | INT | N/A | LossExc_I_Setpt | Loss Excitation Current Setpoint | A/100 | 10…1500 | 66 |
| 218 | 2 | INT | N/A | LossExc_I_TimeDly | Loss Excitation Current Delay | s/100 | 10…990 | 67 |
| 220 | 4 | Real | N/A | UEL_Curve_W_Pt1 | Under-excitation Limiting Curve Power Point 1 | W | 0…1E+09 | 68 |
| 224 | 4 | Real | N/A | UEL_Curve_W_Pt2 | Under-excitation Limiting Curve Power Point 2 | W | 0…1E+09 | 69 |
| 228 | 4 | Real | N/A | UEL_Curve_W_Pt3 | Under-excitation Limiting Curve Power Point 3 | W | 0…1E+09 | 70 |
| 232 | 4 | Real | N/A | UEL_Curve_W_Pt4 | Under-excitation Limiting Curve Power Point 4 | W | 0…1E+09 | 71 |
| 236 | 4 | Real | N/A | UEL_Curve_W_Pt5 | Under-excitation Limiting Curve Point 5 | W | 0…1E+09 | 72 |
| 240 | 4 | Real | N/A | UEL_Curve_VAR_Pt1 | Under-excitation Limiting VAR Point 1 | VARs | 0…1E+09 | 73 |
| 244 | 4 | Real | 0…7 | UEL_Curve_VAR_Pt2 | Under-excitation Limiting VAR Point 2 | VARs | 0…1E+09 | 74 |
| 248 | 4 | Real | 0…7 | UEL_Curve_VAR_Pt3 | Under-excitation Limiting VAR Point 3 | VARs | 0…1E+09 | 75 |
| 252 | 4 | Real | 0…7 | UEL_Curve_VAR_Pt4 | Under-excitation Limiting VAR Point 4 | VARs | 0…1E+09 | 76 |
| 256 | 4 | Real | 0…7 | UEL_Curve_VAR_Pt5 | Under-excitation Limiting VAR Point 5 | VARs | 0…1E+09 | 77 |
| 260 | 4 | Real | 0…7 | OEL_OnlineHiSetpt | Over-excitation Online High Setpoint | A | 0…9999 | 78 |

**Table 18 - Unscheduled Configuration Read/Write Data Table, Assembly Instance 4**

| Byte | Size in Bytes | Type | Bits | Tag Name | Description | Units | Range | Error Code |
|---|---|---|---|---|---|---|---|---|
| 264 | 4 | Real | N/A | OEL_OnlineHiTimeDly | Over-excitation Online High Time Delay | s | 0…60 | 79 |
| 268 | 4 | Real | N/A | OEL_OnlineMedSetpt | Over-excitation Online Medium Setpoint | A | 0…9999 | 80 |
| 272 | 4 | Real | N/A | OEL_OnlineMedTimeDly | Over-excitation Online Medium Time Delay | s | 0…120 | 81 |
| 276 | 4 | Real | N/A | OEL_OnlineLoSetpt | Over-excitation Online Low | A | 0…9999 | 82 |
| 280 | 4 | Real | N/A | OEL_OfflineHiSetpt | Over-excitation Offline High Setpoint | A | 0…9999 | 83 |
| 284 | 4 | Real | N/A | OEL_OfflineHiTimeDly | Over-excitation Offline High Time Delay | s | 0…10 | 84 |
| 288 | 4 | Real | N/A | OEL_OfflineLoSetp | Over-excitation Offline Low Setpoint | A | 0…9999 | 85 |
| 292 | 4 | Real | N/A | AVR_Traverse_Rate | AVR Traverse Rate | s | 0…200 | 86 |
| 296 | 4 | Real | N/A | FCR_Traverse_Rate | FCR Traverse Rate | s | 0…200 | 87 |
| 300 | 4 | Real | N/A | VAR_Traverse_Rate | VAR Traverse Rate | s | 0…200 | 88 |
| 304 | 4 | Real | N/A | PF_Traverse_Rate | PF Traverse Rate | s | 0…200 | 89 |
| 308 | 4 | Real | N/A | Softstart_InitLevel | Soft Start Initial Level | % | 0…90 | 90 |
| 312 | 4 | Real | N/A | SoftStartTime | Soft Start Time | s | 1…7200 | 91 |
| 316 | 4 | Real | N/A | InternalTrackRate | Internal Track Rate | s/FS | 1…80 | 92 |
| 320 | 4 | Real | N/A | InternalTrackDly | Internal Track Delay | s | 0…8 | 93 |
| 324 | 4 | Real | N/A | RedndtTrackRate | Redundant Track Rate | s/FS | 1…80 | 94 |
| 328 | 4 | Real | N/A | RedndtTrackDly | Redundant Track Delay | s | 0…8 | 95 |
| 332 | 4 | Real | N/A | CrossCurrentGain | Cross Current Gain | - | -30…30 | 96 |
| 336 | 4 | Real | N/A | AVR_FCRAuxGain | AVR/FCR Auxiliary Gain | - | -99…99 | 97 |
| 340 | 4 | Real | N/A | PF_VARAuxGain | Power Factor/VAR Auxiliary Gain | - | -99…99 | 98 |

# Notes:

# Troubleshooting

This chapter lists suggested diagnostic and corrective action procedures for a variety of common generator system malfunctions. If the suggested actions do not resolve the anomaly, please contact Rockwell Automation technical support. Information on Rockwell Automation support can be found on the back cover.

This chapter does not include procedures to diagnose or correct issues related to the basic communication between the CGCM unit and its host Logix controller.

For assistance in diagnosing ControlNet network communication issues, please refer to ControlNet Coax Media Planning and Installation, publication CNET-IN002.

**Table 19 - Excitation Control - FCR**

| Symptom | Most Likely Cause | Diagnostic Action | Corrective Action |
|---|---|---|---|
| No excitation current output | Excitation is not enabled | Check excitation enable (hardware and software) and FCR select | Correct Logix controller logic or I/O as required |
| | Wiring error | Check wiring for excitation enable, excitation current output, fuses open, grounding, and PMG/supply | Correct wiring as required |
| | No supply/PMG power | Measure Voltage at CGCM unit PMG/supply input terminals | Correct supply anomaly if insufficient voltage is measured |
| Excitation output is less than setpoint | FCR not selected/enabled | Check excitation enable (hardware and software) and FCR select | Correct Logix controller logic or I/O as required |
| | Wiring error | Check wiring for excitation enable, excitation current output, fuses open, grounding, and PMG/supply | Correct wiring as required |
| | Insufficient supply power | Measure Voltage at CGCM unit PMG/supply input terminals | Correct supply anomaly if insufficient voltage is measured |
| | Field resistance too great | Disconnect field current outputs at CGCM unit and measure load resistance | Correct/verify load resistance is within CGCM unit capability |
| | Gain mis-adjusted | Check gains entered into CGCM unit configuration | Calculate/adjust as required |

**Table 19 - Excitation Control - FCR**

| Symptom | Most Likely Cause | Diagnostic Action | Corrective Action |
|---|---|---|---|
| Excitation output is greater than setpoint | FCR not selected/enabled | Check excitation FCR select | Correct Logix controller logic or I/O as required |
| | Wiring error | Check wiring for excitation current output, fuses open, grounding, and PMG/supply | Correct wiring as required |
| | Gain mis-adjusted | Check gains entered into CGCM unit configuration | Calculate/adjust as required |
| Excitation is erratic/unstable | Gain mis-adjusted | Check gains entered into CGCM unit configuration | Calculate/adjust as required |
| | Wiring error | Check wiring for excitation enable, excitation current output, fuses open, grounding, and PMG/supply | Correct wiring as required |

**Table 20 - Excitation Control - AVR**

| Symptom | Most Likely Cause | Diagnostic Action | Corrective Action |
|---|---|---|---|
| No excitation current output | Excitation is not enabled | Check excitation enable (hardware and software) and AVR select | Correct Logix controller logic or I/O as required |
| | Wiring error | Check wiring for excitation enable, excitation current output, VT inputs, fuses open, grounding, and PMG/supply | Correct wiring as required |
| | No supply/PMG power | Measure Voltage at CGCM unit PMG / supply input terminals | Correct supply anomaly if insufficient voltage is measured |

**Table 20 - Excitation Control - AVR**

| Symptom | Most Likely Cause | Diagnostic Action | Corrective Action |
|---|---|---|---|
| Voltage output is less than setpoint | AVR not selected/enabled | Check excitation enable (hardware and software) and AVR select | Correct Logix controller logic or I/O as required |
| | Wiring error | Check wiring for excitation enable, excitation current output, VT inputs, fuses open, grounding, and PMG/supply | Correct wiring as required |
| | Insufficient supply power | Measure Voltage at CGCM unit PMG/supply input terminals | Correct supply anomaly if insufficient voltage is measured |
| | | Measure generator residual voltage (shunt excitation) | If less than 10V AC, consult generator manufacturer's documentation and flash the generator field |
| | Generator not up to rated speed | Check generator speed | Increase generator speed to rated speed |
| | | | Correct condition preventing rated speed from being attained |
| | Field resistance too great | Disconnect field current outputs at CGCM unit and measure load resistance | Correct/verify load resistance is within CGCM unit capability |
| | Gain mis-adjusted | Check gains entered into CGCM unit configuration | Calculate/adjust as required |
| | Excitation limiting active | Check OEL active input | Correct OEL configuration or change operating point |
| | Droop compensation is driving down the voltage | Check Droop Enable | Adjust/disable droop compensation |

**Table 20 - Excitation Control - AVR**

| Symptom | Most Likely Cause | Diagnostic Action | Corrective Action |
|---|---|---|---|
| Voltage output is greater than setpoint | AVR not selected / enabled | Check excitation AVR select | Correct Logix controller logic or I/O as required |
| | Wiring error | Check wiring for excitation current output, VT inputs, fuses open, grounding, and PMG/supply | Correct wiring as required |
| | Gain mis-adjusted | Check gains entered into CGCM unit configuration | Calculate / adjust as required |
| | Excitation limiting active | Check UEL active input | Correct UEL configuration or change operating point |
| | Droop compensation is driving up the voltage | Check Droop Enable | Adjust/disable droop compensation |
| Voltage is erratic or unstable | Gain mis-adjusted | Check gains entered into CGCM unit configuration | Calculate / adjust as required |
| | Wiring error | Check wiring for excitation current output, VT inputs, fuses open, grounding, and PMG/supply | Correct wiring as required |
| | Prime mover is unstable | Check prime mover governor operation | Correct as required |
| | Excitation limiting active | Check UEL/OEL active input | Correct UEL/OEL configuration or change operating point |

**Table 21 - Reactive Power Control - PF**

| Symptom | Most Likely Cause | Diagnostic Action | Corrective Action |
|---|---|---|---|
| Power Factor not at PF setpoint | PF not enabled | Check input tag **PF_Ened** | If not enabled, select appropriate modes of operation to enable PF mode |
| | Gain misadjusted | Observe response of PF to changes in PF setpoint | If a response is slow, increase gain |
| | Diode failure | Use diode monitor if previously configured or measure/check diodes | Replace as required |
| | Excitation limiting active | Check UEL/OEL active input | Correct UEL/OEL configuration or change operating point |
| Power Factor unstable/erratic | Gain misadjusted | Observe response of PF to changes in PF setpoint | Adjust until a stable response is observed |
| | Wiring Error | Check stability in other control mode such as Droop | If stable in other mode, see above. Otherwise, check field output wiring and VT/CT input wiring |

**Table 22 - Reactive Power Control - VAR**

| Symptom | Most Likely Cause | Diagnostic Action | Corrective Action |
|---|---|---|---|
| VARs not at VAR setpoint | VAR not enabled | Check input tag **VAR_Ened** | If not enabled, select appropriate modes of operation to enable VAR mode |
| | Gain misadjusted | Observe response of VAR to changes in VAR setpoint | If a response is slow, increase gain |
| | Diode failure | Use diode monitor if previously configured or measure/check diodes | Replace as required |
| | Excitation limiting active | Check UEL/OEL active input | Correct UEL/OEL configuration or change operating point |
| VARs unstable/erratic | Gain misadjusted | Observe response of VAR to changes in VAR setpoint | Adjust until a stable response is observed |
| | Wiring Error | Check stability in other control mode such as Droop | If stable in other mode, see above. Otherwise, check field output wiring and VT/CT input wiring |

**Table 23 - Compensation Modes - Droop**

| Symptom | Most Likely Cause | Diagnostic Action | Corrective Action |
|---|---|---|---|
| Voltage does not change with changes in reactive load while not connected to the grid | Droop not selected/active | Check tag **Droop_Ened** | If not active, check/correct logic for mode selection |
| | Cross current mode is enabled/selected | Check **Droop_CCCT_Select** tag | If active, check/correct logic for mode selection |
| | Metering error | See Metering troubleshooting | See Metering troubleshooting |
| Reactive power does not change with adjustments to the voltage setpoint while connected to the grid | Droop not selected/active | Check tag **Droop_Ened** | If not active, check/correct logic for mode selection |
| | PF or VAR control enabled/selected | Check tag **PF_VAR_Control** | If active, check/correct logic for mode selection |
| | Metering error | See Metering troubleshooting | See Metering troubleshooting |
| Voltage and / or reactive load is unstable when operating in droop | AVR Gains misadjusted | Check voltage stability when operating isolated from load and if possible in constant voltage control | Calculate/correct AVR gains if required |
| | Metering error | See Metering trouble shooting | See Metering trouble shooting |

**Table 24 - Compensation Modes - Cross Current**

| Symptom | Most Likely Cause | Diagnostic Action | Corrective Action |
|---|---|---|---|
| VARs share but not equally; even when the system load changes | Gain mis-adjustment | Check CCCT Gain | Correct as required |
| | CT or input impedance mismatch | Verify CT selection and measure input impedance to each AVR | Correct or replace CTs as required. Add resistors as required to match AVR input resistance |
| VARs do not share at all and when a voltage adjust is made, nothing happens | Cross current mode is not enabled/selected | Check **Droop_CCCT_Select** tag and **kVAR_LS-En** tag | If not active, check/correct logic for mode selection |
| | Gain misadjustment | Check CCCT Gain | Correct as required |
| | Wiring error | Measure voltage at ID+/- terminal and adjust reactive power/voltage | Correct wiring as required if voltage signal from CCCT circuit is not observed |

**Table 24 - Compensation Modes - Cross Current**

| Symptom | Most Likely Cause | Diagnostic Action | Corrective Action |
|---|---|---|---|
| VARs do not share at all and when a voltage adjust is made, reactive power transfers to/ from the machine | Cross current mode is not enabled/selected | Check **Droop_CCCT_Select** tag | If not active, check/correct logic for mode selection |
| | Wiring error | Measure voltage at ID+/- terminal and adjust reactive power/voltage | Correct wiring as required if voltage signal from CCCT circuit is not observed |
| | Gain mis-adjustment | Check CCCT Gain | Correct as required |
| VARs transfer opposite from one generator to another | CT polarity or differential circuit wiring error | Verify CT polarity on each generator by disconnecting differential circuit and operating on cross-current control | Correct CT polarity and differential circuit wiring as needed |
| VARs share but are unstable | Gain mis-adjustment | Check CCCT Gain | Correct as required |

**Table 25 - Compensation Modes - Line Drop**

| Symptom | Most Likely Cause | Diagnostic Action | Corrective Action |
|---|---|---|---|
| Voltage does not change with changes in reactive load while not connected to the grid | Line Drop not active | Check tag **LineDropComp** | If not active, check/correct logic for mode selection |
| | Metering error | See Metering troubleshooting | See Metering troubleshooting |
| Voltage is unstable | AVR Gains misadjusted | Check voltage stability when operating isolated from load and if possible in constant voltage control | Calculate/correct AVR gains if required |
| | Metering error | See Metering troubleshooting | See Metering troubleshooting |

**Table 26 - Limiting Modes - UEL**

| Symptom | Most Likely Cause | Diagnostic Action | Corrective Action |
|---|---|---|---|
| VARs absorbed exceed the programmed UEL limit (UEL does not limit/activate) | UEL not enabled | Check tag **UEL_En** and configuration | Correct logic or configuration as required |
| | UEL Gain misadjusted | Force into UEL | Adjust gains as required |
| | UEL not configured | Check UEL curve intercepts against reactive capability curve | Correct as required |
| | Metering error | See Metering troubleshooting | See Metering troubleshooting |
| Excitation is unstable when UEL is active | UEL Gain misadjusted | Force into UEL | Adjust gains as required |

**Table 27 - Limiting Modes - OEL**

| Symptom | Most Likely Cause | Diagnostic Action | Corrective Action |
|---|---|---|---|
| Excitation Current exceeds the programmed OEL limit (OEL does not limit/activate) | OEL not enabled | Check tag **OEL_En** and configuration | Correct logic or configuration as required |
| | OEL Gain misadjusted | Force into OEL | Adjust gains as required |
| | OEL not configured | Check OEL settings against generator excitation requirements / limits | Correct as required |
| | Metering error | See Metering troubleshooting | See Metering troubleshooting |
| Excitation is unstable when OEL is active | OEL Gain misadjusted | Force into OEL | Adjust gains as required |

**Table 28 - Real Power Load Sharing**

| Symptom | Most Likely Cause | Diagnostic Action | Corrective Action |
|---|---|---|---|
| Units do not share load | Load share lines not properly connected | Measure voltage at each LS+/- terminal. Verify voltage represents PU load | Re-connect LS lines |
| | | Open LS terminals; apply a load, measure LS voltage.<br>Voltage equals (kW/Rated kW)*LSFSVoltage | If Voltage not correct, replace CGCM unit after verifying configuration settings |
| | Load sharing not enabled | Check output tag kW_LS_EN is set and input tag kW_LS_ACTIVE is true | If Loadsharing must be disabled no anomaly is present, otherwise correct loadsharing logic for tag kW_LS_En |
| | CGCM unit not properly configured | Check configuration parameters are properly set. Refer to Load Share tab, Chapter 4 | Input correct configuration parameters |
| | Wiring errors cause CGCM unit to not meter kW properly | Check kW indication from CGCM unit against second meter for accurate kW indication | Correct wiring errors |
| | Governor not responding to load share error | Observe that load share error is being received from CGCM unit in host controller | Correct anomaly in Host controller if a valid load share error is received |
| Units do not share load equally: one unit increases the other unit decreases | Load share lines connected with polarity reversed | Observe that load share error is being received from CGCM unit in host controller and error polarity is correct | Correct polarity on LS lines |

**Table 28 - Real Power Load Sharing**

| Symptom | Most Likely Cause | Diagnostic Action | Corrective Action |
|---|---|---|---|
| Units do not share load equally: units both change together | Series 2 CGCM unit on network is powered down and load share lines connected | Verify CGCM unit is firmware revision earlier than 3.3 | Replace with Series 3.*x* CGCM unit when available |
| | | | Add relay to disconnect load share lines on power down |
| | Load share full scale voltage configurations do not match | Check full load voltage configuration in each load share device | Set full load voltage same in all load share devices |
| | Governor error | Check governor for use of LS error from CGCM unit | Correct governor |

**Table 29 - Synchronizing**

| Symptom | Most Likely Cause | Diagnostic Action | Corrective Action |
|---|---|---|---|
| No close indication from CGCM unit | Phase not matched | Observe Phase match tag during synchronization | If phase match indicated, check close command tag. If no phase match indicated, check phase match error |
| | | Observe phase error reported by CGCM unit during synchronization | If no phase error is reported by CGCM unit, correct wiring and verify appropriate Synchronization mode is active |
| | | | If phase error reported, verify governor is responding to CGCM unit reported error |
| | Close output from CGCM unit not being examined | Monitor Close breaker tag from CGCM unit | If close indication received, check use of tag. If no close indication, check match errors |
| | Frequency not matched | Observe frequency match tag during synchronization | If frequency match indicated, check close command tag. If no frequency match indicated, check frequency match error |
| | | Observe frequency error, generator frequency, and selected bus frequency reported by CGCM unit during synchronization | If no frequency error is reported by CGCM unit, correct wiring and verify appropriate Synchronization mode is active |
| | | | If frequency error reported, verify governor is responding to CGCM unit reported error |
| | Sync parameter configuration incorrect | Observe configured synchronization limits, VT input configuration, and generator rated entries | Correct any errors in the configuration entries |

**Table 29 - Synchronizing**

| Symptom | Most Likely Cause | Diagnostic Action | Corrective Action |
|---|---|---|---|
| No close indication from CGCM unit (cont.) | Voltage not matched | Observe voltage match tag during synchronization | If voltage match indicated, check close command tag. If no voltage match indicated, check voltage match error |
| | | Observe voltage error, generator voltage, and selected bus voltage reported by CGCM unit during synchronization | If no voltage error is reported by CGCM unit correct wiring and verify appropriate Synchronization mode is active |
| | | | If voltage error is reported, verify voltage setpoint to CGCM unit is being adjusted appropriately to provide voltage correction |
| Close indication from CGCM unit when sync parameters not met | Configuration errors | Observe VT and Bus offset configuration parameters to verify they reflect the desired/expected VT wiring | Correct configuration to match expected VT wiring |
| | Wiring errors | Adjust manually such that test equipment (reference) indicates synchronism, the observe diagnostics above. This information can be used to determine most likely wiring error. Voltage not matched, verify PT wiring and VT ratios are correct. Phase or frequency not matched; verify phase rotation and polarity of VT wiring | Correct VT wiring |

## Metering

If there is a difference between the metering data reported by the CGCM unit and a reference meter, verify the metering used to determine CGCM unit malfunction is being correctly used and in calibration.

**Table 30 - Metering**

| Symptom | Most Likely Cause | Diagnostic Action | Corrective Action |
|---|---|---|---|
| Voltage does not read correctly | Configuration errors | Observe VT configuration and rotation parameters and to verify they reflect desired/expected VT wiring | Correct configuration to match expected VT wiring |
| | Wiring errors | Observe each LL, phase, average voltage, and rotation indication. Indicated rotation matches configured rotation. LL voltage (and LN if applicable) indicated if all low or high indicate ratio error, if one or two are low or high indicate polarity, grounding, or disconnection | Correct phase rotation, polarity, grounding, or fusing as applicable |
| | | Measure signal at CGCM unit terminals | If voltage indicated corresponds to measured value, correct VT wiring. If voltage indicated does not correspond to measured voltage, see configuration errors. If configuration is correct, replace CGCM unit |

**Table 30 - Metering**

| Symptom | Most Likely Cause | Diagnostic Action | Corrective Action |
|---|---|---|---|
| Current does not read correctly | Configuration errors | Observe CT configuration parameters and to verify they reflect desired/ expected CT ratios | Correct configuration to match expected CT wiring |
| | Wiring errors | Observe each phase, and average current indication. Each phase current indicated is approximately equal and the average represents the average of the three. If all low or high indicate ratio error, if one or two are low or high indicate polarity, grounding, or disconnection | Correct phase rotation, polarity, or grounding, as applicable. Confirm the correct CT inputs are used |
| | | Measure signal at CGCM unit terminals | If current indicated corresponds to measured value, correct CT wiring. If current indicated does not correspond to measured current, see configuration errors. If configuration is correct, replace CGCM unit |
| KW does not read correctly | CT Wiring error | See Current troubleshooting above. Observe kVA indicated. If kVA and voltage are correct, verify CT phase rotation | See Current troubleshooting above |
| | VT wiring error | See Voltage troubleshooting above. Then observe kVA indicated. If kVA and voltage are correct, see CT wiring troubleshooting | See Voltage troubleshooting above |
| kVAR does not read correctly | CT Wiring error | See Current troubleshooting above. Observe kVA indicated. If kVA and voltage is correct, verify CT phase rotation | See Current troubleshooting above |
| | VT wiring error | See Voltage troubleshooting above. Then observe kVA indicated. If kVA and voltage are correct, see CT wiring troubleshooting | See Voltage troubleshooting above |

## Communication

The ControlNet Network Status indicators indicate the state of the ControlNet network connected to the BNC connectors. If more than one state is present, the status indicators always reflect the highest priority status present on the network. The following tables describe the status indicator states and the priority of each status indicator.

**Table 31 - ControlNet A and ControlNet B Status (Series C and earlier units)**

| Status Indicator State | Priority | How to View | Cause |
|---|---|---|---|
| Both steady off | 1 (highest) | View together | Reset or no power |
| Both steady red | 2 | | Failed to link interface to ControlNet network |
| Alternating red and green | 3 | | Self testing |
| Alternating red | 4 | | Bad node configuration (such as duplicate ControlNet network address) |
| Steady off | 5 | View independently | Channel disabled or not supported |
| Flashing red and green | 6 | | Invalid link configuration |
| Flashing red | 7 | | Link fault or no frames received |
| Flashing green | 8 | | Temporary channel error or listen only |
| Steady green | 9 (lowest) | | Normal operation |

**TIP** A test sequence is performed on this status indicator during startup.

**Table 32 - Network Status Indicator (A, B) (Series D units)**

| Status Indicator | Status Indicator State | Description |
|---|---|---|
| A and B | Off | Not online/No power |
| | Flashing Red (1 Hz) | Incorrect node configuration, duplicated MAC ID |
| | Alternating Red/Green | Self test of bus controller |
| | Red | Fatal event or faulty unit |
| A or B | Off | Channel is disabled |
| | Alternating Red/Green | Invalid link cofiguration |
| | Flashing Green (1 Hz) | Temporary errors (node self corrects) or node is not configured to go online |
| | Green | Normal operation |
| | Flashing Red (1 Hz) | Media fault or no other nodes on the network |

**Table 33 - Module Status Indicator (MS) (Series D units)**

| Status Indicator State | Description |
|---|---|
| Off | No power |
| Green | Operating in normal condition, controlled by a scanner in Run state |
| Flashing Green (1 Hz) | The module is not configured, or the scanner in idle state |
| Red | Unrecoverable faults, EXCEPTION, or Fatal event |
| Flashing Red (1 Hz) | Recoverable faults, MAC ID has been changed after initialization |

## Redundancy

**Table 34 - Redundancy**

| Symptom | Most Likely Cause | Diagnostic Action | Corrective Action |
|---|---|---|---|
| Both CGCM units operate as primary (both provide excitation to the generator) | Serial cable not properly connected | Disable excitation to one CGCM unit | If excitation turns off as commanded (one remaining CGCM operating), repair / replace cable. If both CGCM units continues to excite, replace CGCM units |
| | | Connect personal computer by using hyperterminal or similar application to verify communication output from CGCM unit redundancy comm port | If communication exists, see above. If no communication output exists, replace CGCM unit |
| One or both CGCM units will not operate as primary | Faulty wiring | Measure excitation enable input to CGCM unit that will not act as primary | Verify voltage is applied to excitation enable input terminal |
| | | Check operation of external relay and associated wiring for redundancy relay and output | Correct excitation redundancy relay operation |
| | | Check wiring of excitation +/- output from CGCM unit | Correct excitation output wiring |
| | Logix controller error | Check output to excitation enable input (hardware and software) | Correct logic as required |
| | | Check logic to redundancy relay (if applicable) | Correct logic as required |
| | One CGCM unit has failed or is not configured properly | Troubleshoot as non-redundant CGCM unit | Correct or replace as needed |

# Protection

**Table 35 - Protection**

| Symptom | Most Likely Cause | Diagnostic Action | Corrective Action |
|---|---|---|---|
| Loss of excitation current (40) | Wiring error | Check excitation output wiring | Correct wiring as required |
| | Gains mis-adjusted | Check AVR gains | Calculate/adjust gains as required |
| Over-excitation voltage (59F) | Wiring error | Check excitation output wiring | Correct wiring as required |
| | Gains mis-adjusted | Check AVR gains | Calculate/adjust gains as required |
| | OEL limit exceeded | Check OEL operation | Correct as required |
| Generator over-voltage (59) | Rapid loss of large load | | |
| | Gains mis-adjusted | Check AVR gains | Calculate/adjust gains as required |
| Generator under-voltage (27) | Over load | | |
| | Wiring error | Check VT wiring. See Voltage metering trouble shooting | Correct wiring as required |
| Loss of sensing (60FL) | Fuse open | Check VT fuses | Replace as required |
| | Wiring error | Check for open connections and phase rotation reversal | Correct wiring as required |
| Loss of permanent magnet generator (PMG/Excitation power) (27) | Supply circuit breaker trip/fuse open | Check PMG supply. Measure with voltmeter at CGCM unit PMG input terminals | Correct/replace PMG input protection as required |
| | Wiring error | Check PMG supply. Measure with voltmeter at CGCM unit PMG input terminals | Correct wiring as required |
| | PMG failure | Check PMG supply. Measure with voltmeter at CGCM unit PMG input terminals | Repair as required |
| | Incorrect configuration | Check single-phase versus 3-phase selection | Correct as required |
| Reverse var (40Q) | Under-excitation | Check UEL configuration if required, | Correct as required |
| | Incorrect operating mode selected | Check selected operating mode for operating requirements | Select as appropriate |
| Over-frequency (81O) | Governor error | | Correct as required |
| Under-frequency (81U) | Governor error | | Correct as required |
| Reverse power (32R) | Governor error | | Correct as required |

**Table 35 - Protection**

| Symptom | Most Likely Cause | Diagnostic Action | Corrective Action |
|---|---|---|---|
| Rotating diode monitor | Failed diode | Remove and test diodes | Replace diode |
| | Incorrect configuration | Confirm test / set up of diode monitor parameters with active parameters | Correct as required |
| | Insufficient number of fly back diodes installed | Check number of external flyback diodes installed at CGCM excitation output if required | Install as required |
| Phase rotation error (47) | Wiring error | See troubleshooting voltage metering | Correct wiring as required |
| Generator over-current (51) | Fault or large load condition | | |
| | Incorrect configuration | Check configuration | Correct as required |

# Notes:

# Time Over-current Characteristic Curves

## General

The CGCM unit time over-current protection function provides time/current characteristic curves that closely emulate most of the common electromechanical, induction disk relays manufactured in North America. To further improve relay coordination, selection of integrated reset or instantaneous reset characteristics is also provided.

## Curve Specifications

Timing Accuracy (all 51 functions) within ±5% or ±1½ cycles (F/R response) or -1½ +3 cycles (A response), whichever is greater for time dial settings of D greater than 0.1 and multiples of 2...40 times the pickup setting but not over 150 A for 5 A CT units or 30 A for 1 A CT units.

Sixteen inverse time functions and one fixed time function can be selected. Characteristic curves for the inverse and definite time functions are defined by the following equations.

**Figure 41 - Equation 1**

$$T_T = \frac{A \cdot D}{M^N - C} + B \cdot D + K$$

**Figure 42 - Equation 2**

$$T_R = \frac{R \cdot D}{\left|M^2 - 1\right|}$$

- TT = Time to trip when M = 1
- TR = Time to reset if relay is set for integrating reset when M < 1. Otherwise, reset is 50 ms or less
- D =T IME DIAL setting (0.0…9.9)
- M = Multiple of PICKUP setting (0…40)
- A, B, C, N, K = Constants for the particular curve
- R = Constant defining the reset time.

These equations comply with IEEE Standard C37.112-1996.

The 51P and 51N Time Characteristic Curve Constants table lists the time characteristic curve constants.

**Table 36 - 51P and 51N Time Characteristic Curve Constants**

| Curve Selection | Curve Name | Trip Characteristic Constants | | | | | Reset |
|---|---|---|---|---|---|---|---|
| | | A | B | C | N | K | R |
| 1 | S, Short Inverse | 0.2663 | 0.03393 | 1.000 | 1.2969 | 0.028 | 0.5000 |
| 2 | S2, Short Inverse | 0.0286 | 0.02080 | 1.000 | 0.9844 | 0.028 | 0.0940 |
| 3 | L1, Long Inverse | 5.6143 | 2.18592 | 1.000 | 1.000 | 0.028 | 15.750 |
| 4 | L2, Long Inverse | 2.3955 | 0.00000 | 1.000 | 0.3125 | 0.028 | 7.8001 |
| 5 | D, Definite Time | 0.4797 | 0.21359 | 1.000 | 1.5625 | 0.028 | 0.8750 |
| 6 | M, Moderately Inverse | 0.3022 | 0.12840 | 1.000 | 0.5000 | 0.028 | 1.7500 |
| 7 | I, Inverse Time | 8.9341 | 0.17966 | 1.000 | 2.0938 | 0.028 | 9.0000 |
| 8 | Inverse Time | 0.2747 | 0.10426 | 1.000 | 0.4375 | 0.028 | 0.8868 |
| 9 | V, Very Inverse | 5.4678 | 0.10814 | 1.000 | 2.0469 | 0.028 | 5.5000 |
| 10 | V2, Very Inverse | 4.4309 | 0.09910 | 1.000 | 1.9531 | 0.028 | 5.8231 |
| 11 | Extremely Inverse | 7.7624 | 0.02758 | 1.000 | 2.0938 | 0.028 | 7.7500 |
| 12 | E2, Extremely Inverse | 4.9883 | 0.01290 | 1.000 | 2.0469 | 0.028 | 4.7742 |
| 13 | Standard Inverse | 0.01414 | 0.00000 | 1.000 | 0.0200 | 0.028 | 2.0000 |
| 14 | B, Very Inverse ($I^2t$) | 1.4636 | 0.00000 | 1.000 | 1.0469 | 0.028 | 3.2500 |
| 15 | Extremely Inverse ($I^2t$) | 8.2506 | 0.00000 | 1.000 | 2.0469 | 0.028 | 8.0000 |
| 16 | Long Time Inverse ($I^2t$) | 12.1212 | 0.00000 | 1.000 | 1.0000 | 0.028 | 29.0000 |
| 17 | Fixed Time | 0.0000 | 1.00000 | 1.000 | 0.0000 | 0.028 | 1.0000 |

## Time Over-current Characteristic Curve Graphs

The following illustrations show the characteristic curves of the CGCM. Equivalent time dial settings were calculated at a value of five times pickup.

The Characteristic Curve Cross-Reference table cross-references each curve to existing electromechanical relay characteristics.

**Table 37 - Characteristic Curve Cross-Reference**

| Curve | Curve Name | Page | Similar To |
|---|---|---|---|
| 1 | S, Short Inverse | 173 | ABB CO-2 |
| 2 | S2, Short Inverse | 174 | GE IAC-55 |
| 3 | L, L1, Long Inverse | 175 | ABB CO-5 |
| 4 | L2, Long Inverse | 176 | GE IAC-66 |
| 5 | D, Definite Time | 177 | ABB CO-6 |
| 6 | M, Moderately Inverse | 178 | ABB CO-7 |
| 7 | I, I1 Inverse Time | 179 | ABB CO-8 |
| 8 | I2 Inverse Time | 180 | GE IAC-51 |
| 9 | V, V1 Very Inverse | 181 | ABB CO-9 |
| 10 | V2, Very Inverse | 182 | GE IAC-53 |
| 11 | E, E1 Extremely Inverse | 183 | ABB CO-11 |
| 12 | E2, Extremely Inverse | 184 | GE IAC-77 |
| 13 | A Standard Inverse | 185 | BS, IEC Standard Inverse |
| 14 | B, Very Inverse (It) | 186 | BS, IEC Very Inverse ($I^2t$) |
| 15 | Extremely Inverse ($I^2t$) | 187 | BS, IEC Extremely Inverse ($I^2t$) |
| 16 | Long Time Inverse | 188 | BS, IEC Long Time Inverse |
| 17 | Fixed Time | N/A | N/A |

## Time Dial Setting Cross-reference

Although the time characteristic curve shapes have been optimized for each relay, time dial settings of the CGCM unit are not identical to the settings of electromechanical induction disk over-current relays.

The Characteristic Curve Cross-reference table on page 172 helps you convert the time dial settings of induction disk relays to the equivalent setting for the CGCM unit.

### *Using Table*

Cross-reference table values were obtained by inspection of published electromechanical time current characteristic curves. The time delay for a current of five times tap was entered into the time dial calculator function for each time dial setting. The equivalent CGCM unit time dial setting was then entered into the cross-reference table.

If your electromechanical relay time dial setting is between the values provided in the table, it will be necessary to interpolate (estimate the correct intermediate value) between the electromechanical setting and the factory setting.

The CGCM unit has a maximum time dial setting of 9.9. The CGCM unit's equivalent time dial setting for the electromechanical maximum setting is provided in the cross reference table even if it exceeds 9.9. This allows interpolation as noted above.

CGCM unit time-current characteristics are determined by a linear mathematical equation. The induction disk of an electromechanical relay has a certain degree of non linearity due to inertial and friction effects. For this reason, even though every effort has been made to provide characteristic curves with minimum deviation from the published electromechanical curves, slight deviations can exist between them.

In applications where the time coordination between curves is extremely close, we recommend that you choose the optimal time dial setting by inspection of the coordination study.

**Table 38 - Characteristic Curve Cross-reference**

| Curve | Equivalent To | Page | Electromechanical Relay Time Dial Setting | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 0.5 | 1.0 | 2.0 | 3.0 | 4.0 | 5.0 | 6.0 | 7.0 | 8.0 | 9.0 | 10.0 | 11.0 |
| | | | Factory Equivalent Time Dial Setting | | | | | | | | | | | |
| 1 | ABB CO-2 | 173 | 0.3 | 0.8 | 1.7 | 2.4 | 3.4 | 4.2 | 5.0 | 5.8 | 6.7 | 7.7 | 8.6 | 9.7 |
| 3 | ABB CO-5 | 175 | 0.4 | 0.8 | 1.5 | 2.3 | 3.3 | 4.2 | 5.0 | 6.0 | 7.0 | 7.8 | 8.8 | 9.9 |
| 5 | ABB CO-6 | 177 | 0.5 | 1.1 | 2.0 | 2.9 | 3.7 | 4.5 | 5.0 | 5.9 | 7.2 | 8.0 | 8.9 | 10.1 |
| 6 | ABB CO-7 | 178 | 0.4 | 0.8 | 1.7 | 2.5 | 3.3 | 4.3 | 5.3 | 6.1 | 7.0 | 8.0 | 9.0 | 9.8 |
| 7 | ABB CO-8 | 179 | 0.3 | 0.7 | 1.5 | 2.3 | 3.2 | 4.0 | 5.0 | 5.8 | 6.8 | 7.6 | 8.7 | 10.0 |
| 9 | ABB CO-9 | 181 | 0.3 | 0.7 | 1.4 | 2.1 | 3.0 | 3.9 | 4.8 | 5.7 | 6.7 | 7.8 | 8.7 | 9.6 |
| 11 | ABB CO-11 | 183 | 0.3 | 0.7 | 1.5 | 2.4 | 3.2 | 4.2 | 5.0 | 5.7 | 6.6 | 7.8 | 8.5 | 10.3 |
| 8 | GE IAC-51 | 180 | 0.6 | 1.0 | 1.9 | 2.7 | 3.7 | 4.8 | 5.7 | 6.8 | 8.0 | 9.3 | 10.6 | |
| 10 | GE IAC-53 | 182 | 0.4 | 0.8 | 1.6 | 2.4 | 3.4 | 4.3 | 5.1 | 6.3 | 7.2 | 8.4 | 9.6 | |
| 2 | GE IAC-55 | 174 | 0.2 | 1.0 | 2.0 | 3.1 | 4.0 | 4.9 | 6.1 | 7.2 | 8.1 | 8.9 | 9.8 | |
| 4 | GE IAC-66 | 176 | 0.4 | 0.9 | 1.8 | 2.7 | 3.9 | 4.9 | 6.3 | 7.2 | 8.5 | 9.7 | 10.9 | |
| 12 | GE IAC-77 | 184 | 0.5 | 1.0 | 1.9 | 2.7 | 3.5 | 4.3 | 5.2 | 6.2 | 7.4 | 8.2 | 9.9 | |

## Voltage Restraint

In Voltage Restraint mode, when the generator voltage is between 100% and 25% of nominal voltage, the CGCM unit automatically reduces the selected over-current setpoint linearly according to this formula:

> Adjusted over-current setpoint = original over-current setpoint * generator voltage / voltage restraint setpoint

The range of the voltage restraint setpoint is 0…200%. A setting of zero disables the voltage restraint.

**Figure 43 - Time Characteristic Curve S, S1 Short Inverse, 99…1369 (similar to ABB CO-2)**

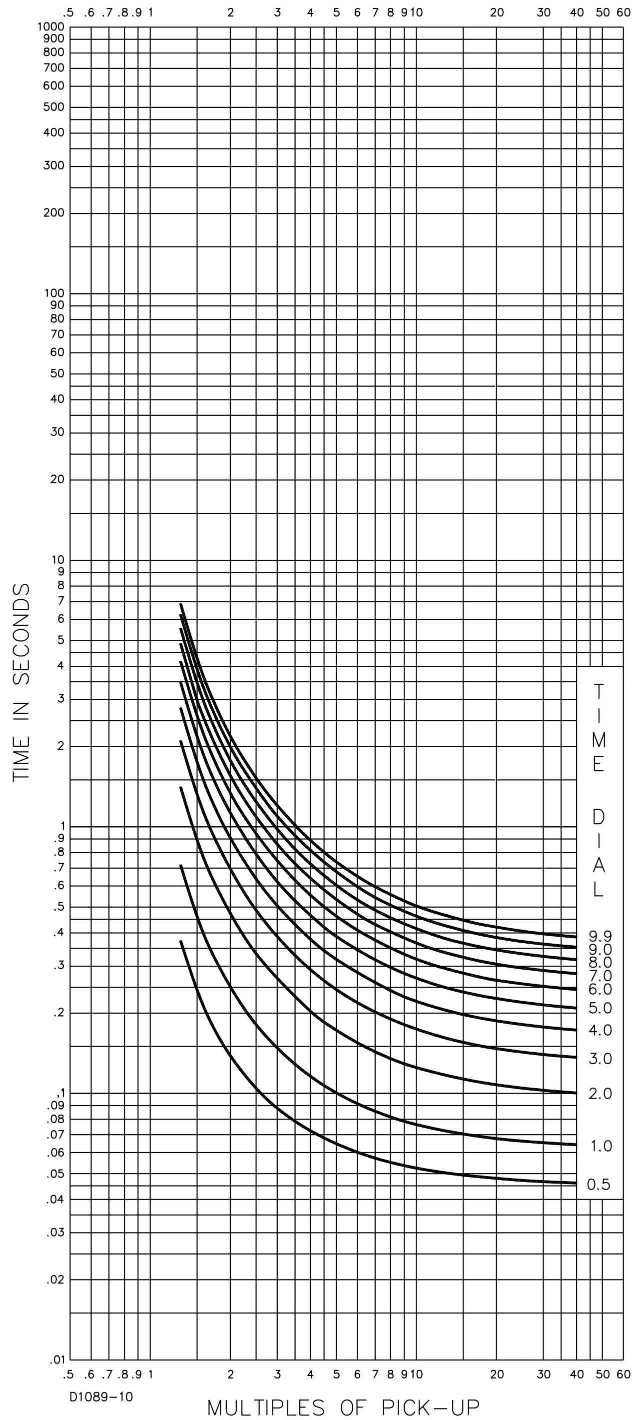


**Figure 44 - Time Characteristic Curve S2, Short Inverse, 99…1595 (similar to GE IAC-55**

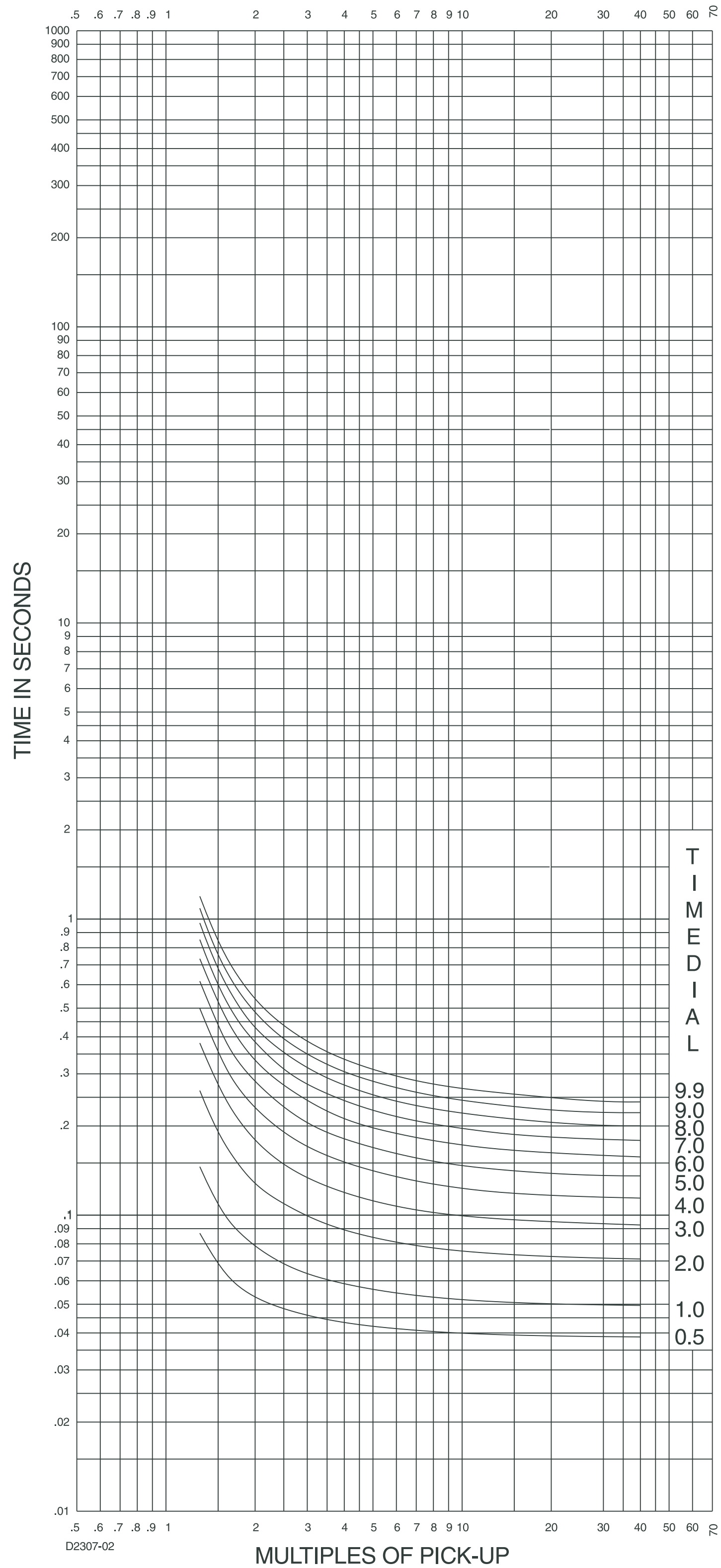


**Figure 45 - Time Characteristic Curve L, L1, Long Inverse, 9 9…1370 (similar to ABB-CO5)**

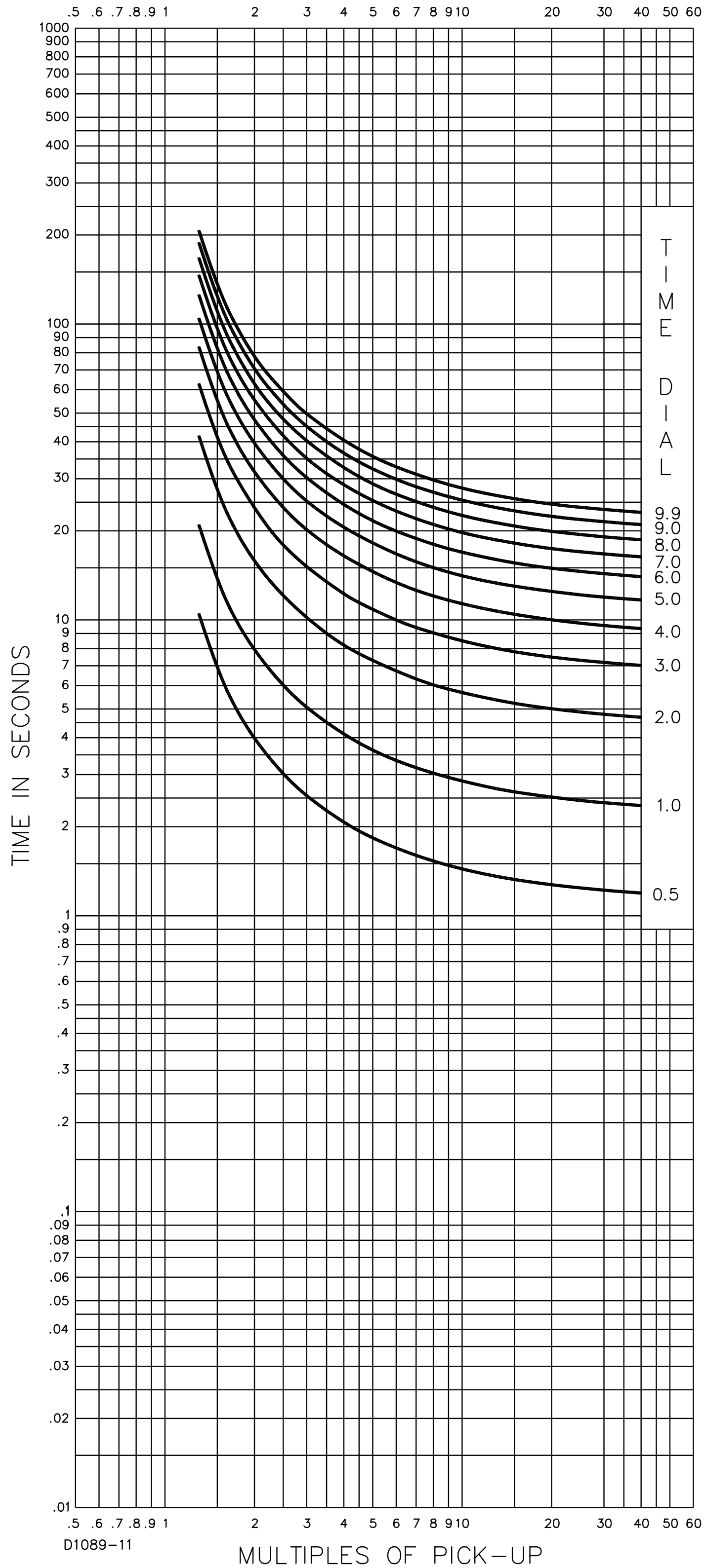


**Figure 46 - Time Characteristic Curve L2, Long Inverse, 99…1594 (similar to GE IAC-66)**

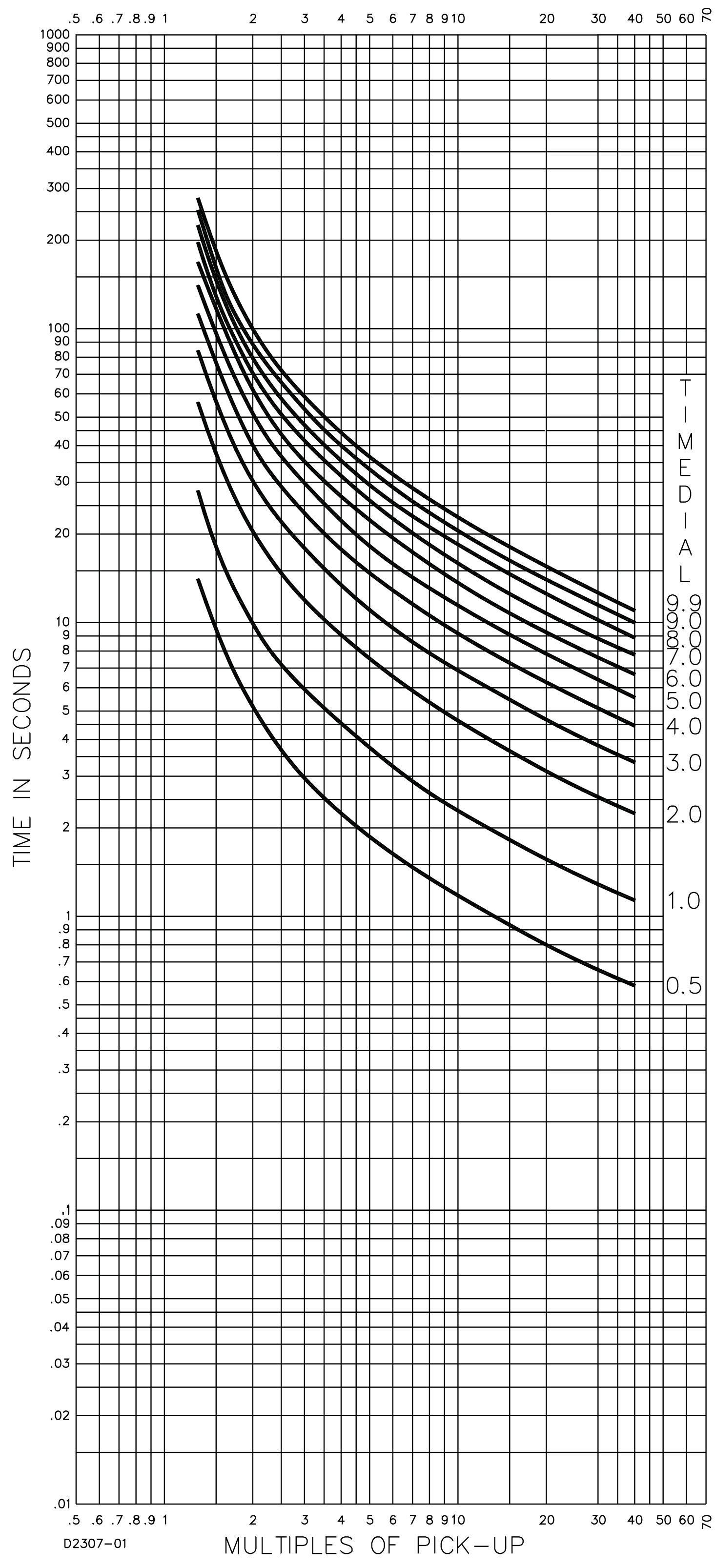


**Figure 47 - Time Characteristic Curve D, Definite Time, 99…1371 (similar to ABB-CO6)**

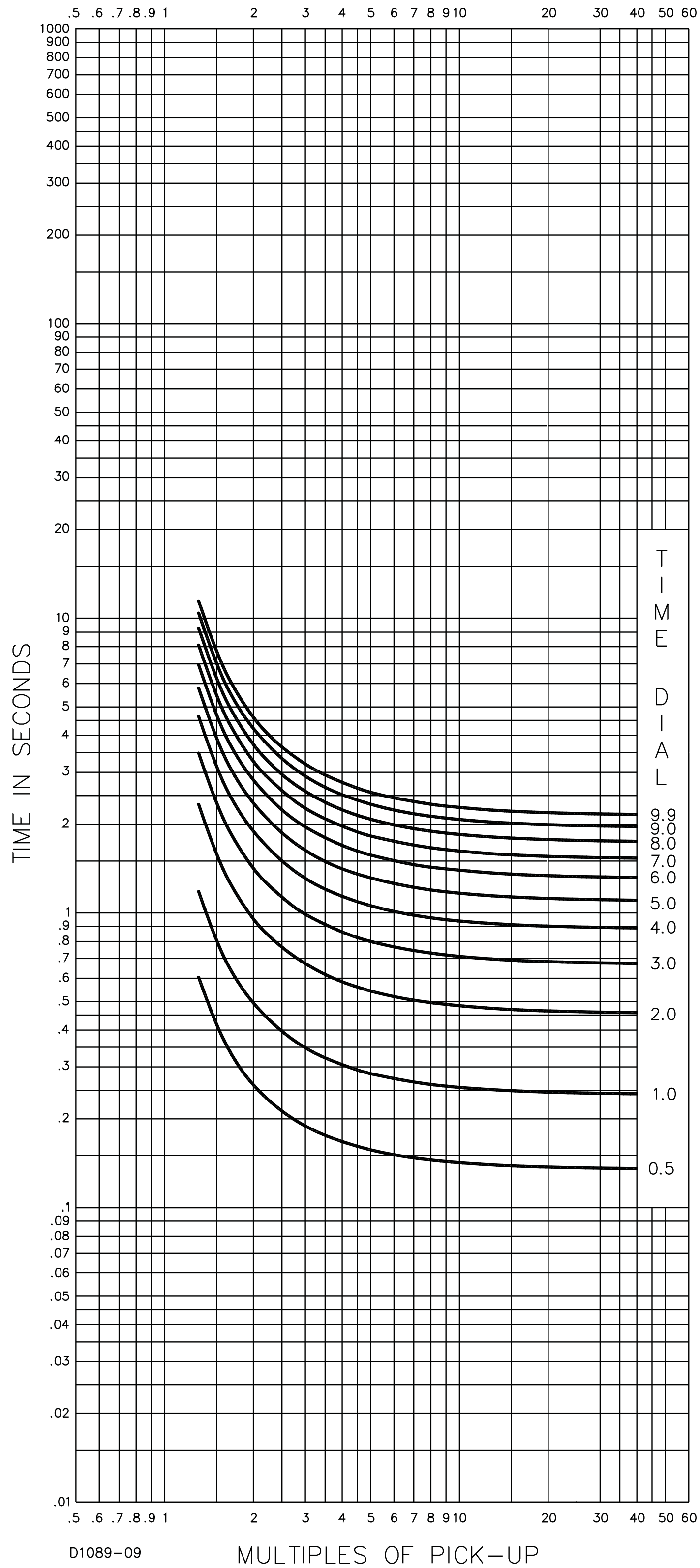


**Figure 48 - Time Characteristic Curve M, Moderately Inverse, 99…1372 (similar to ABB CO-7)**

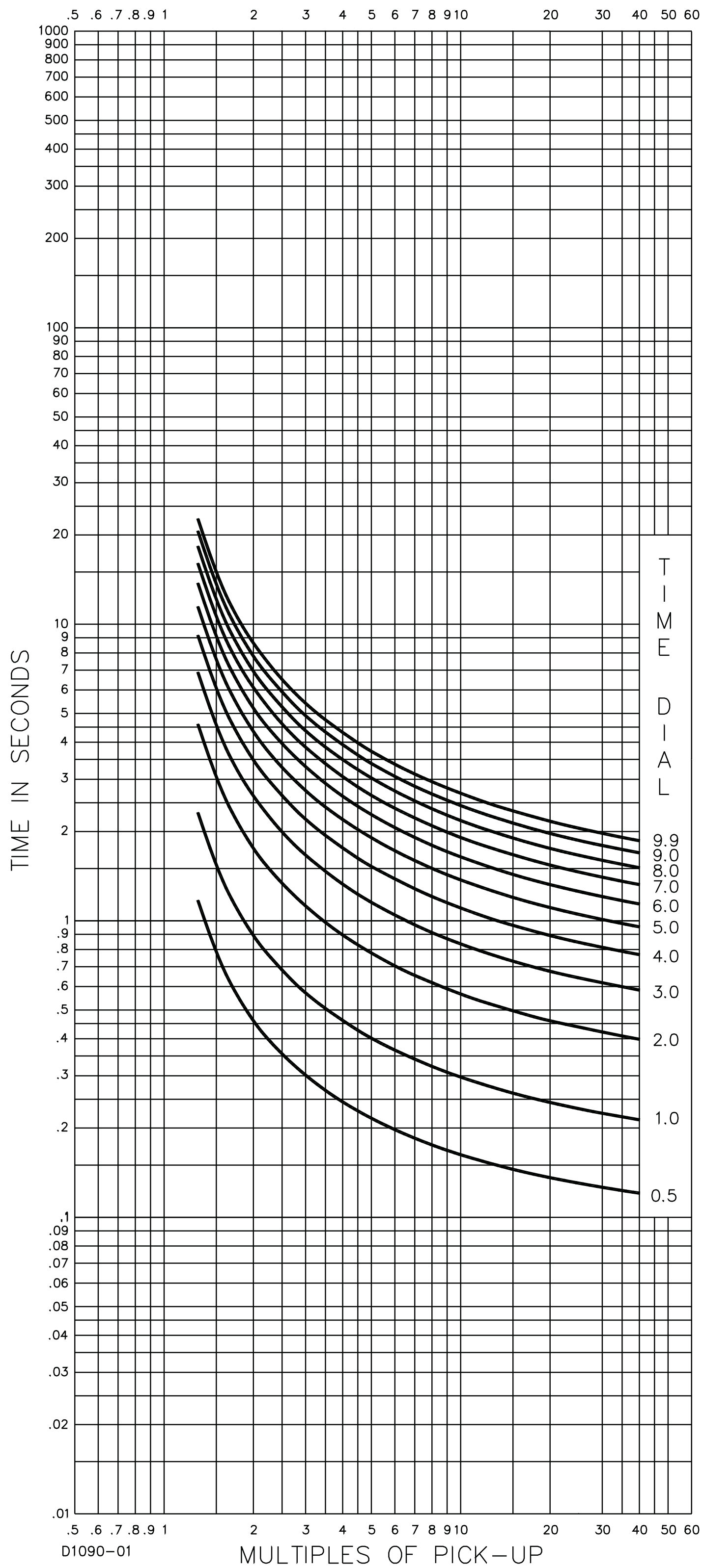


**Figure 49 - Time Characteristic Curve I, I1 Inverse Time, 99…1373 (similar to ABB CO-8)**

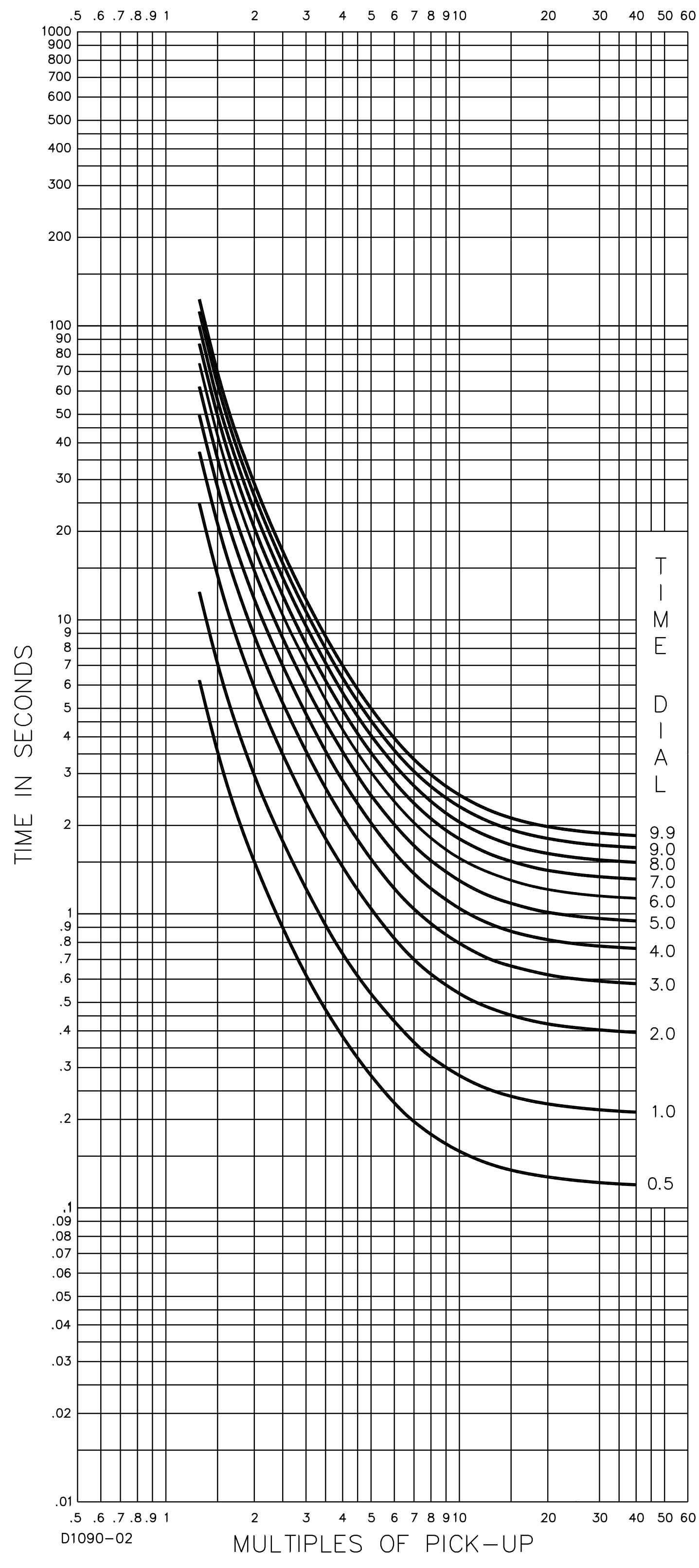


**Figure 50 - Time Characteristic Curve I2, Inverse Time, 99…1597 (similar to GE IAC-51)**

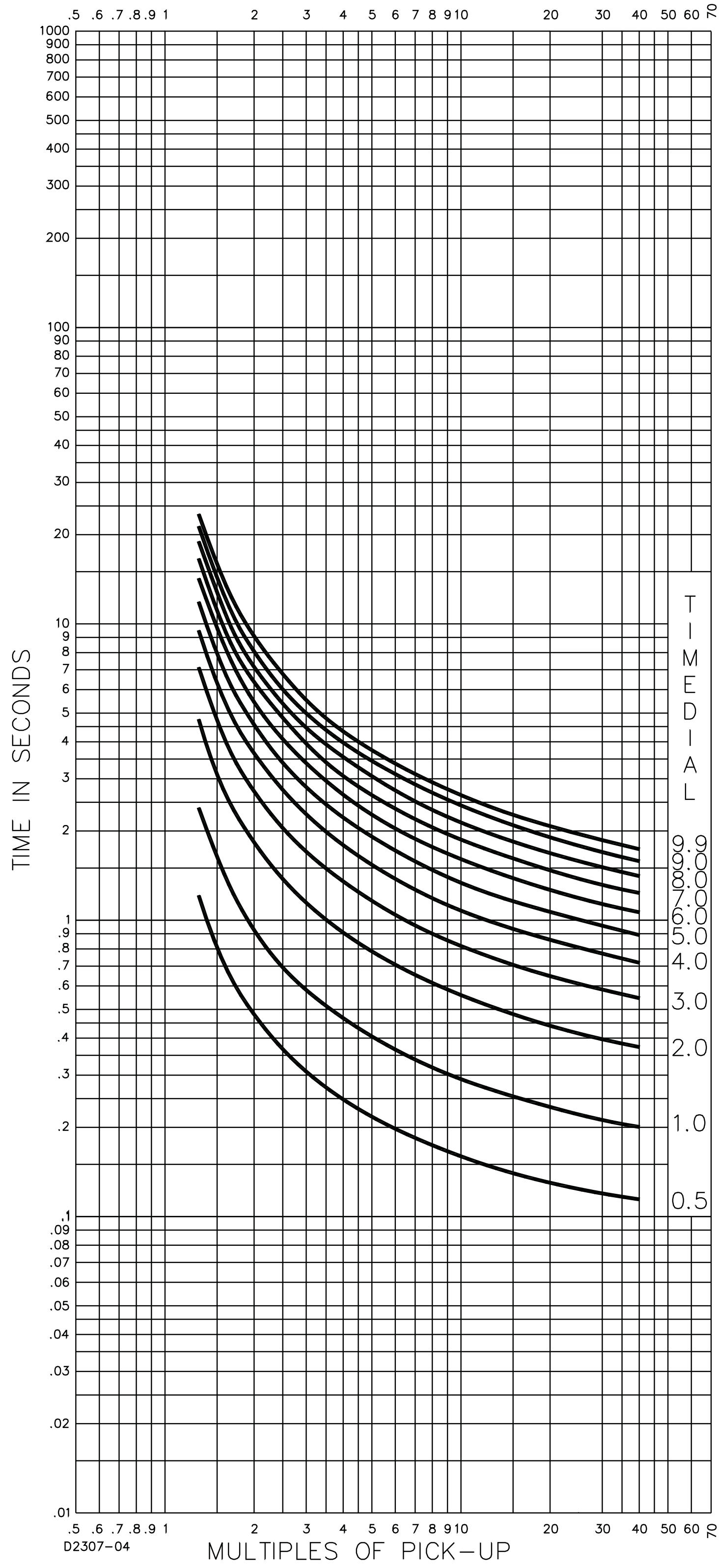


**Figure 51 - Time Characteristic Curve V, V1, Very Inverse, 99…1374 (similar to ABB CO-9)**

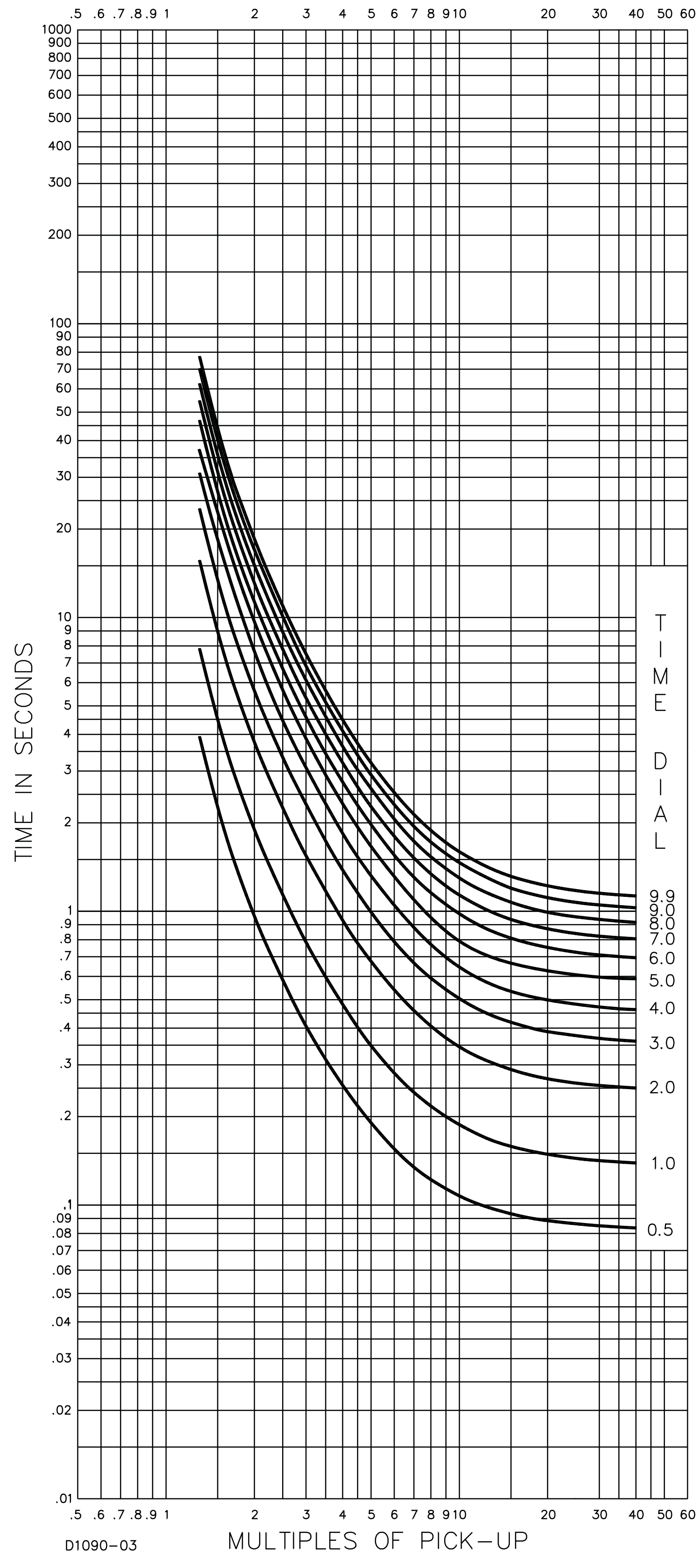


**Figure 52 - Time Characteristic Curve V2, Very Inverse, 99…1596 (similar to GE IAC-53)**

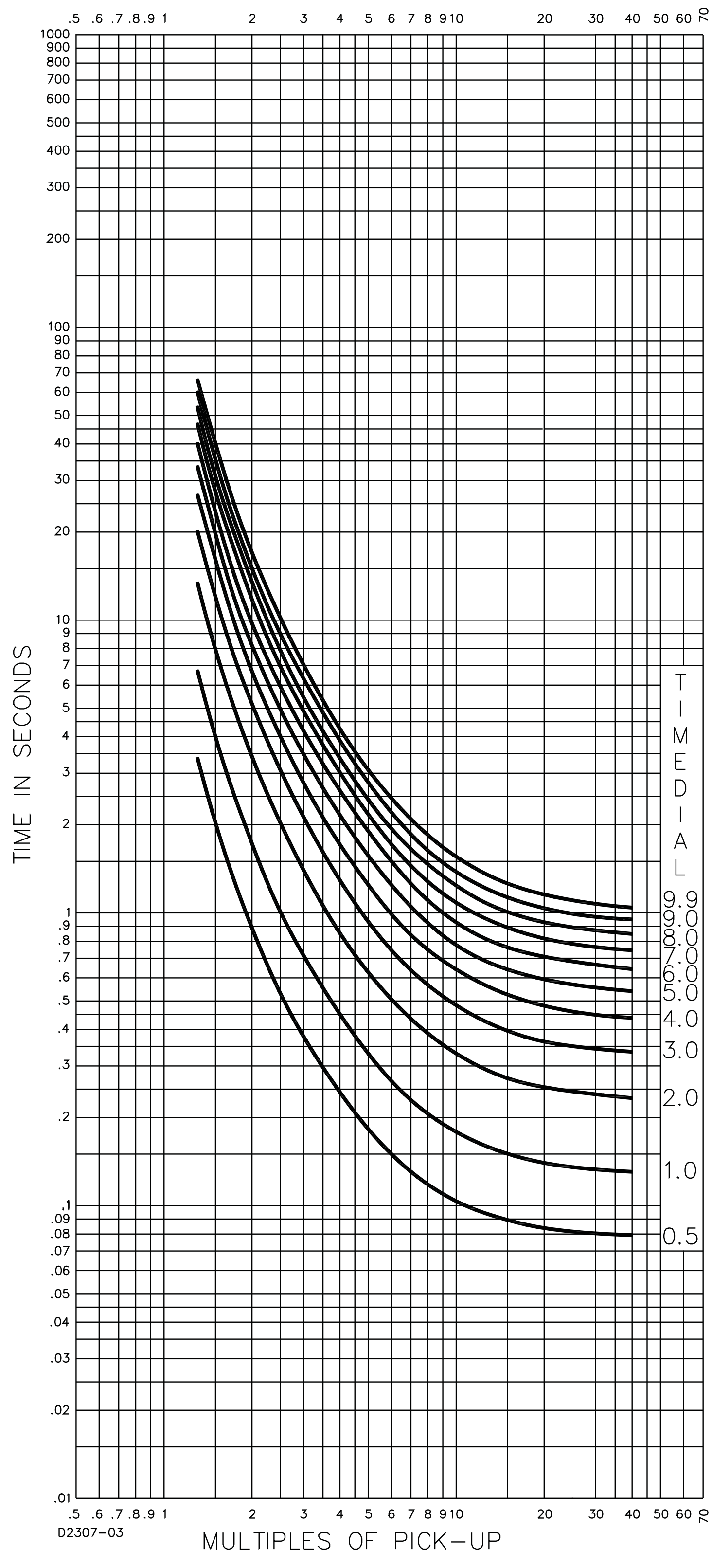


**Figure 53 - Time Characteristic Curve E, E1, Extremely Inverse, 99…1375 (similar to GE IAC-11)**

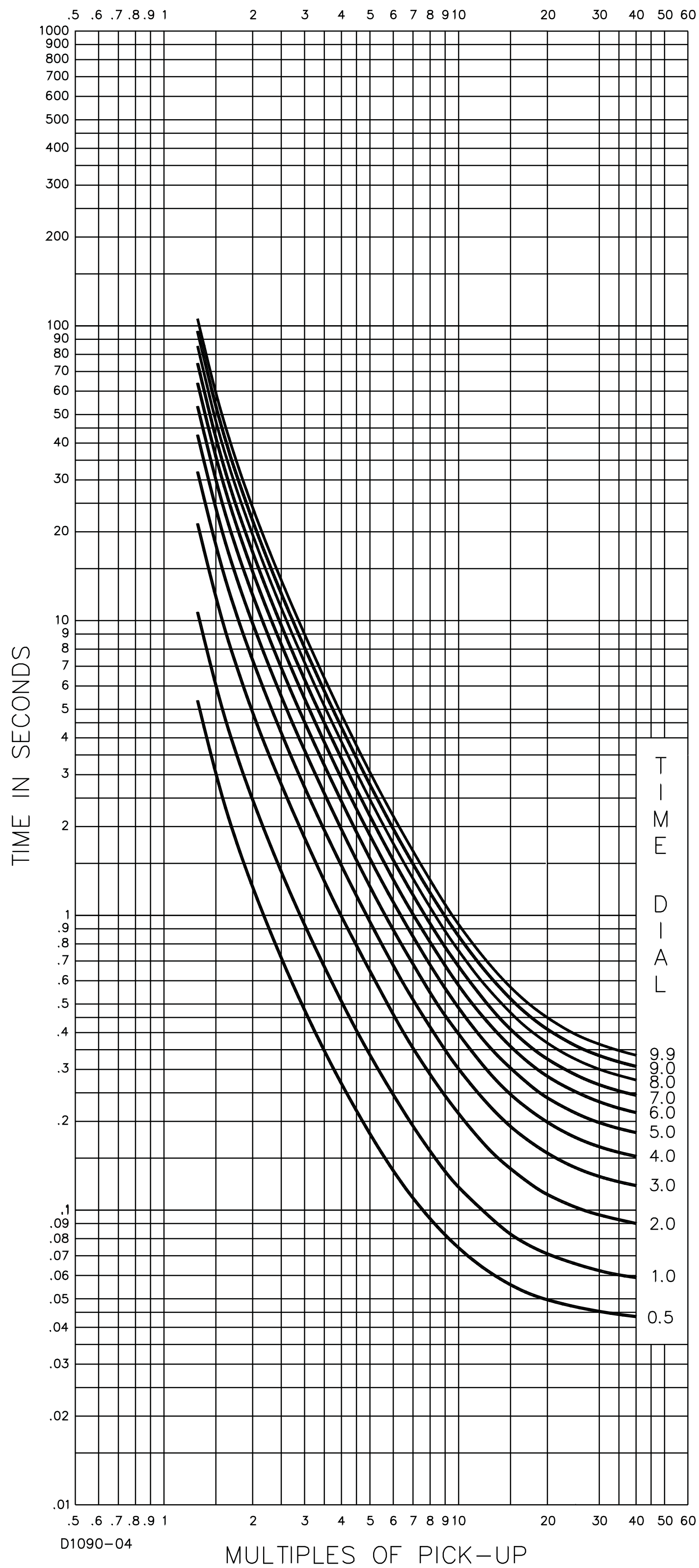


**Figure 54 - Time Characteristic Curve E2, Extremely Inverse, 99…1598 (similar to GE IAC-77)**

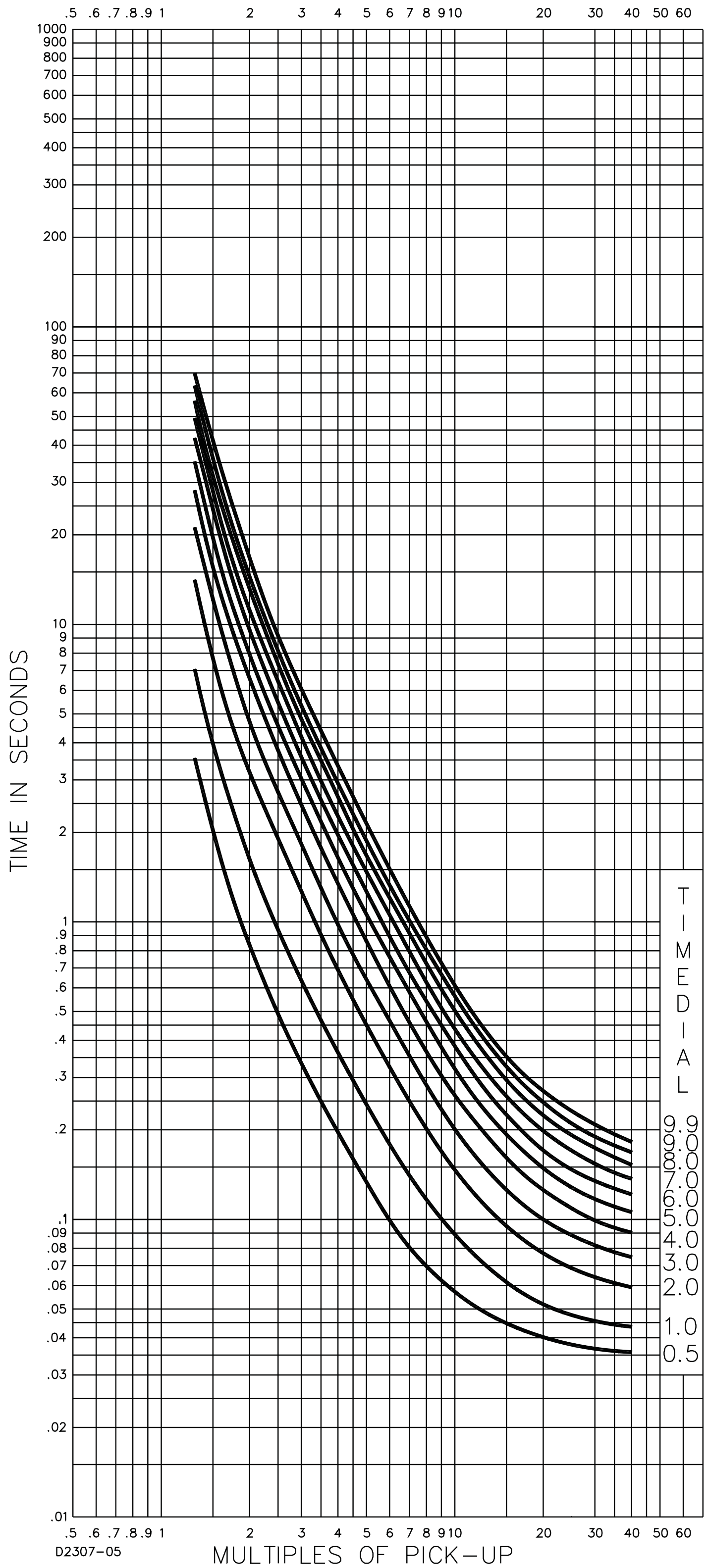


**Figure 55 - Time Characteristic Curve A, Standard Inverse, 99…1621**

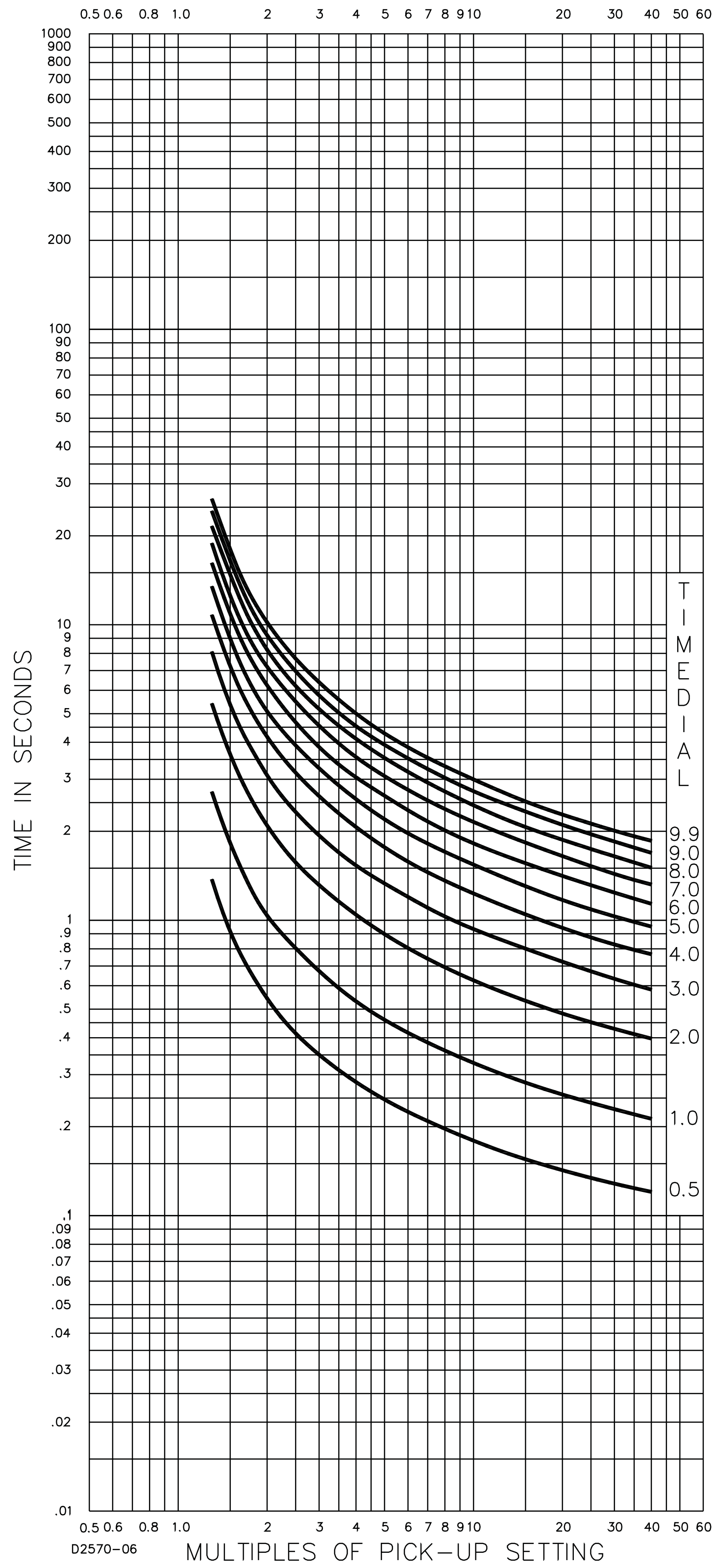


**Figure 56 - Time Characteristic Curve B, Very Inverse, 99…1376**

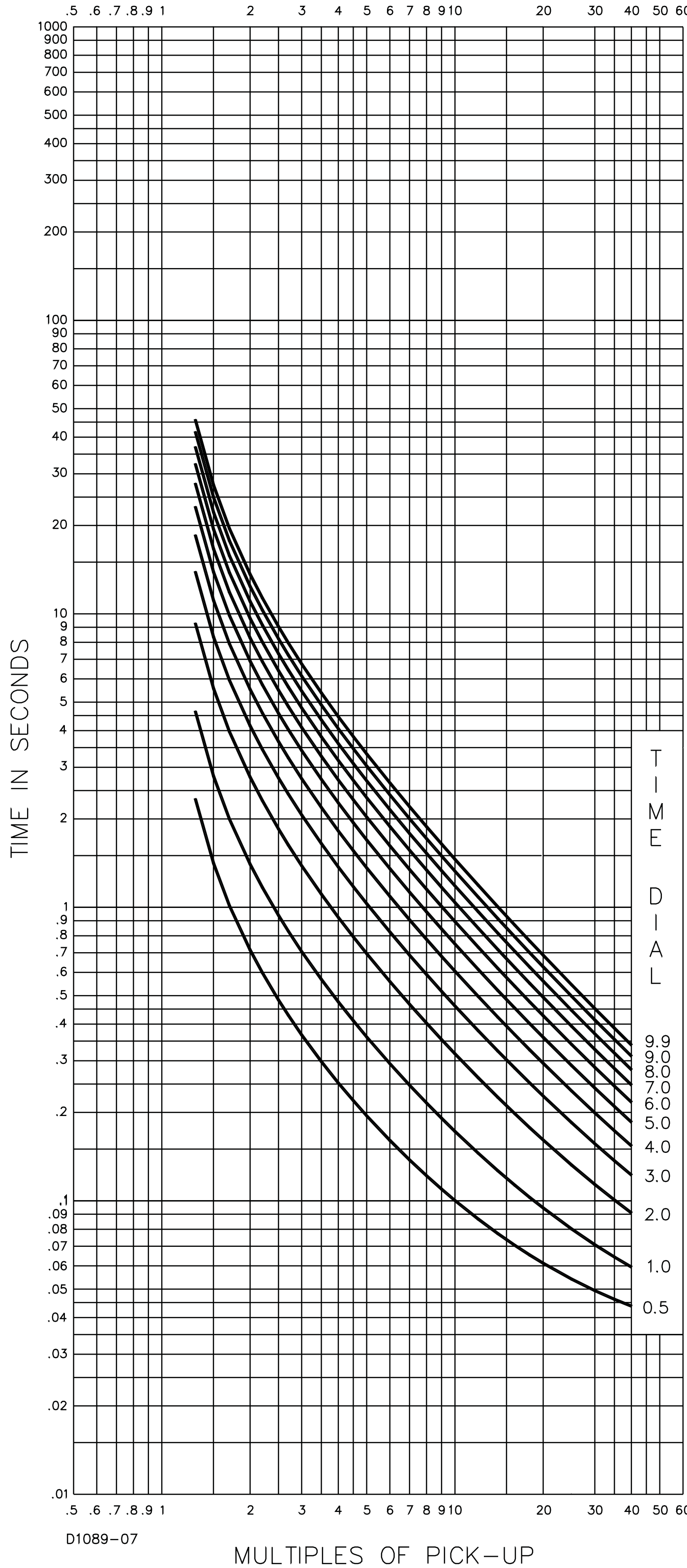


**Figure 57 - TIme Characteristic Curve C, Extremely Inverse, 99…1377**

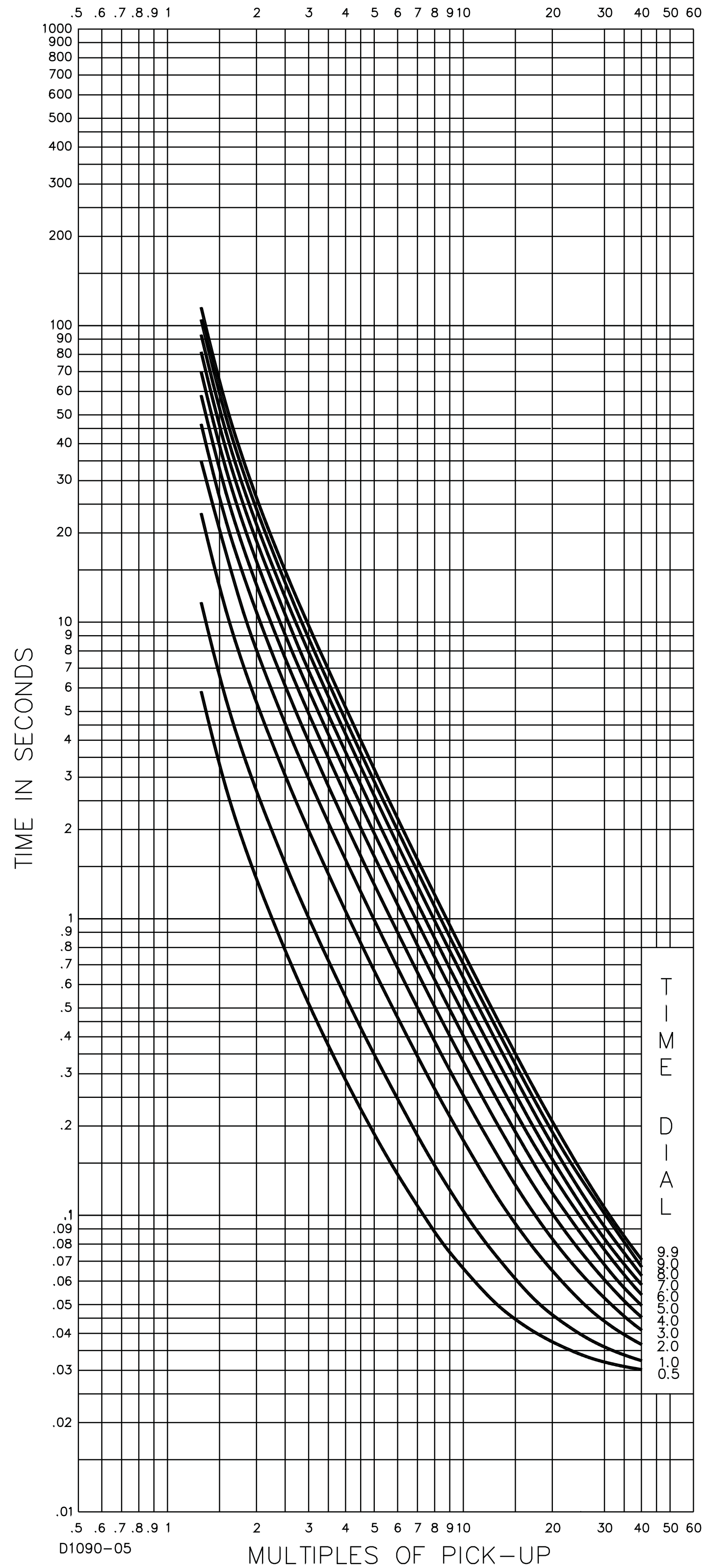
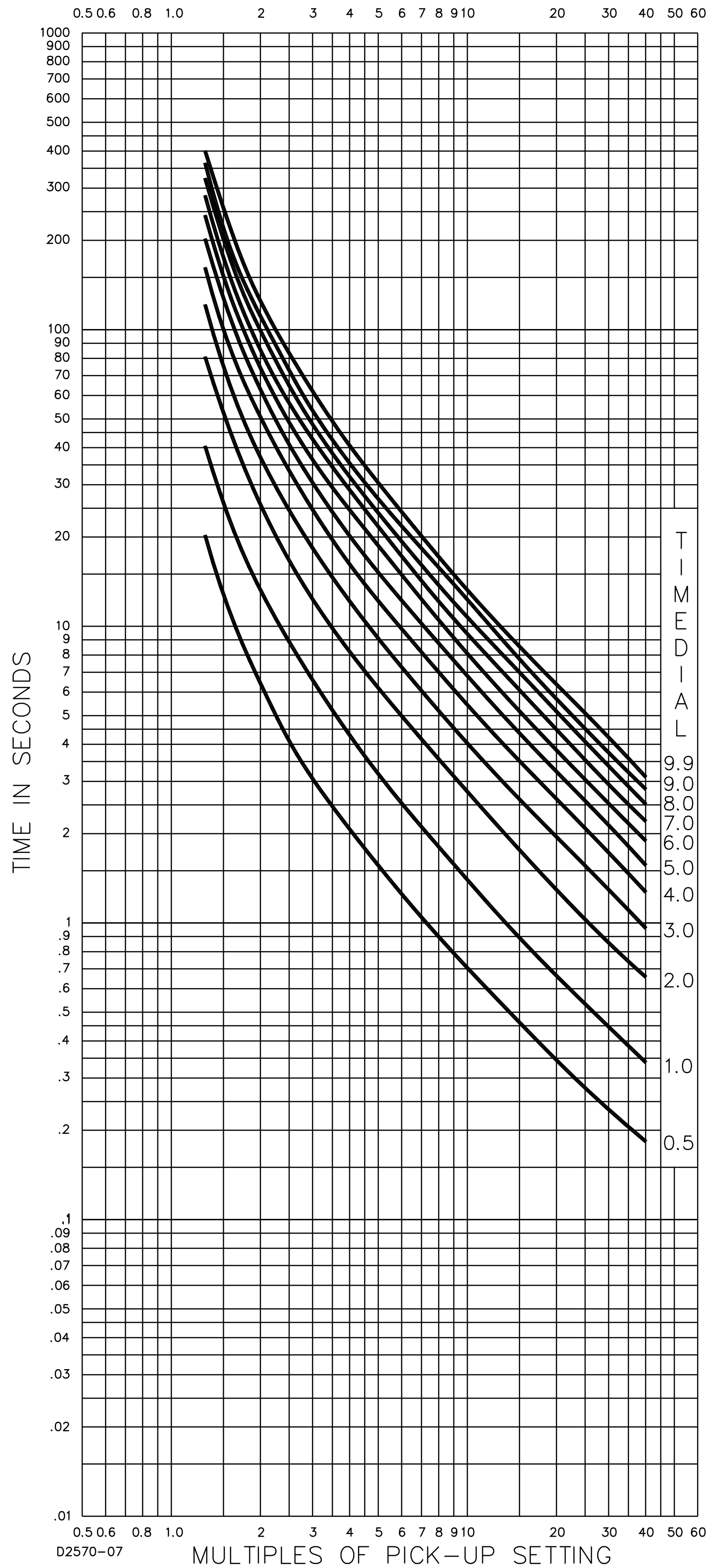


**Figure 58 - Time Characteristic Curve G, Long Time Inverse, 99…1622**



# CGCM Unit Math Models

## Introduction

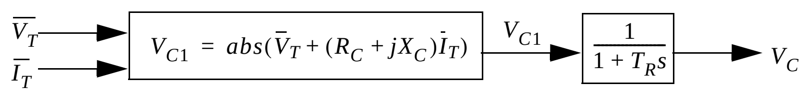
This appendix contains the mathematical model of the CGCM unit's excitation systems.

The rotating rectifier model is based on the type AC8B model available in the reference Computer Models for Representation of Digital-Based Excitation Systems in the IEEE Transactions on Energy Conversion September, 1996, Vol. 11, No. 3. This paper was prepared by the Digital Excitation Task Force of the Equipment Working Group, and jointly sponsored by the Performance and Modeling Working Group of the Excitation System Subcommittee.

## Synchronous Machine Terminal Voltage Transducer and Load Compensator Model

The CGCM unit implements the load compensation by using the vector sum of the magnitudes of the terminal voltage and of the terminal current. The model provided in IEEE Standard 421.5-1992 for terminal voltage transducers and load compensators can be used to model this function in the CGCM unit's system as shown in the following equation.

**Figure 59 - Terminal Voltage and Load Compensation Elements**




The values used in this model can be derived from the CGCM settings as follows:

$R_C = 0$ (Resistive load compensation not available)

$X_C = [1 - (1 - DRP/100))^2]^{1/2}$

$T_R = 5$ ms

where DRP is the percent droop programmed into the CGCM unit, values range from -30…30.

# Voltage Regulator

The Per-unit Block Diagram for Rotating Rectifier Excitation System shows the model of the CGCM excitation system used with a brush-type rotating exciter.

The rotating exciter parameters are not included in this discussion because they are the responsibility of the exciter manufacturer. $V_P$ is the input from the power source for the excitation system.

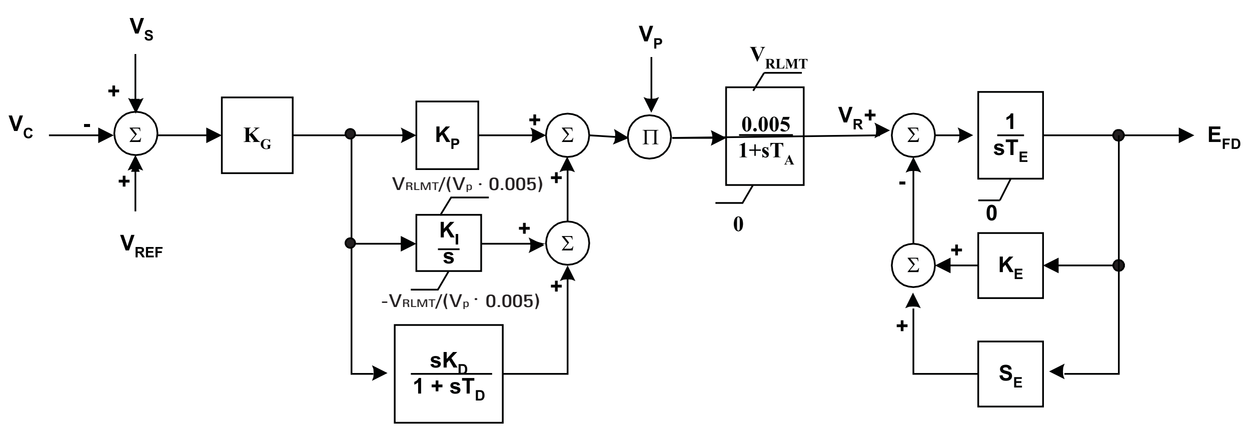
A typical value for $T_A$ is 0. The forcing limit $V_{RLMT}$ is related to the power-input voltage ($V_P$) to the CGCM and the exciter field voltage ($V_R$) as follows:

$V_{RLMT} = 1.4*V_P / V_R$

The gain $K_G$ is used for compensating variations in system configuration such as power input voltage. The per unit base of the parameters $V_P$ and $V_R$ is the nominal exciter field voltage at no load.

The PID gains $K_P$, $K_I$, and $K_D$ are custom designed for the best performance for each generator/exciter system. These continuous time gains are changed to discrete and implemented in the CGCM digital controller. The PID gains can be obtained from the PID Calculator software available from Rockwell Automation.

**Figure 60 - Per-unit Block Diagram for Rotating Rectifier Excitation System**



## VAR/Power Factor Controller

The VAR/PF controller is a summing point type controller and makes up the outside loop of a two-loop system. This controller is implemented as a slow PI type controller. The voltage regulator forms the inner loop and is implemented as a fast PID controller.

The model of the CGCM VAR and power factor controller is shown in Per-unit Block Diagram for Var Controller and Per-unit Block Diagram for PF Controller, respectively. Non-windup limit ($V_{CLMT}$) is used for bounding the VAR/PF controller output voltages ($V_Q$ and $V_{PF}$).

**Figure 61 - Per-unit Block Diagram for Var Controller**

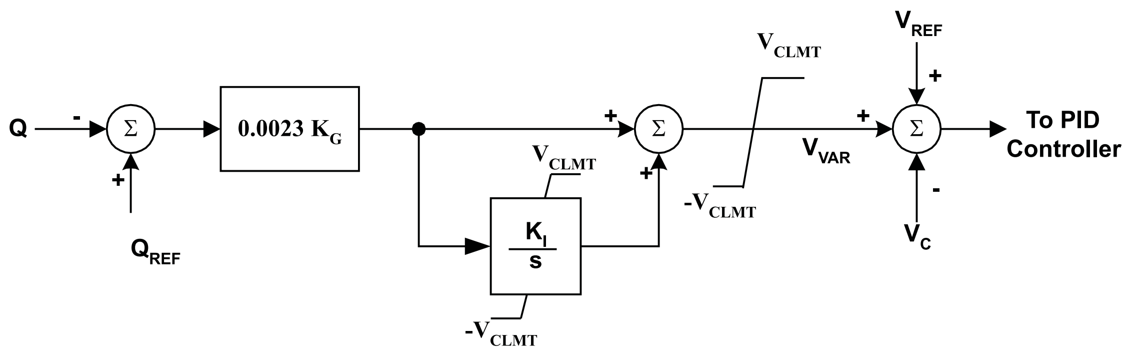
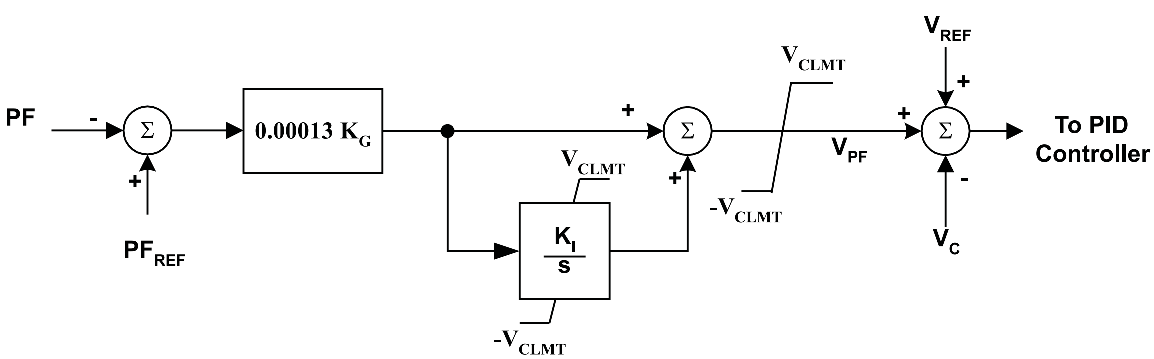



**Figure 62 - Per-unit Block Diagram for PF Controller**




## Limiters

Both the over-excitation limiter (OEL) and the under-excitation limiter (UEL) in this implementation are of the summed limiter type as opposed to takeover type.

Per-unit Block Diagram for Under-excitation Limiter shows the model of the CGCM under-excitation limiter. The UEL makes up the outer loop and the voltage regulator makes up the inner loop. The UEL uses a PI type controller.

The operating characteristics are designed to mimic the characteristics of the limiter on the P-Q plane. The desired UEL curve is generated based on the user input points.

Typical UEL reference is illustrated in Under-excitation Limiter Reference.

**Figure 63 - Per-unit Block Diagram for Under-excitation Limiter**

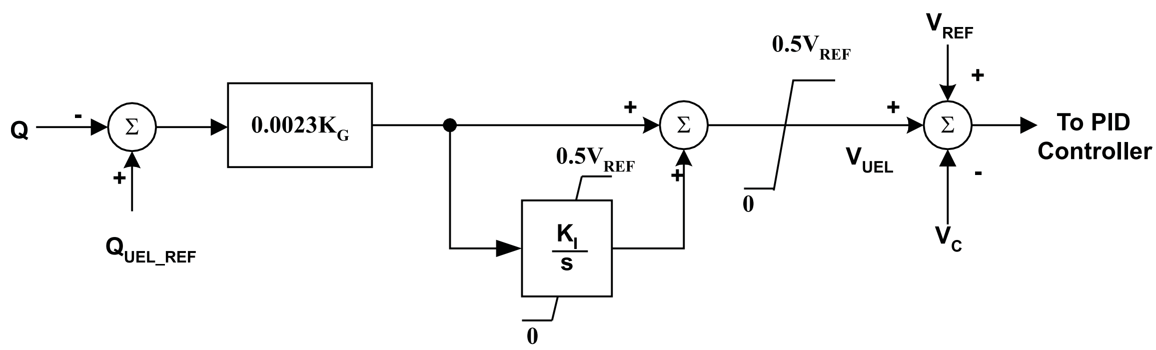
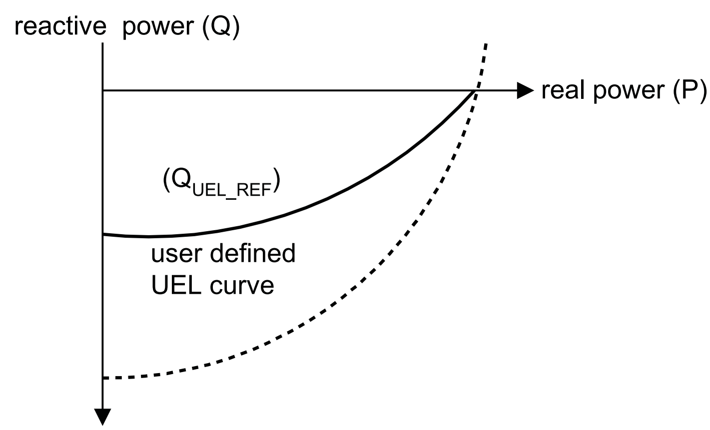



**Figure 64 - Under-excitation Limiter Reference**




Per-unit Block Diagram for Over-excitation Limiter shows the model of the CGCM over-excitation limiter (OEL). The OEL makes up the inner loop of the voltage regulator and uses a PI type controller. In this control scheme the actual field current is compared with a reference field current. The operating characteristics are designed to mimic the field current short-time overload capability given in ANSI standard C50.13-1977. The reference field current is calculated based on the user input parameters as shown in Over-excitation Limiter Reference.

**Figure 65 - Per-unit Block Diagram for Over-excitation Limiter**

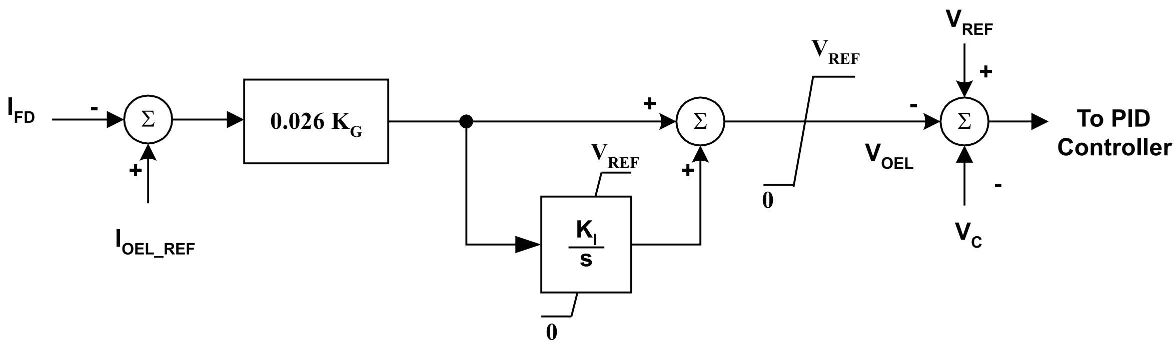
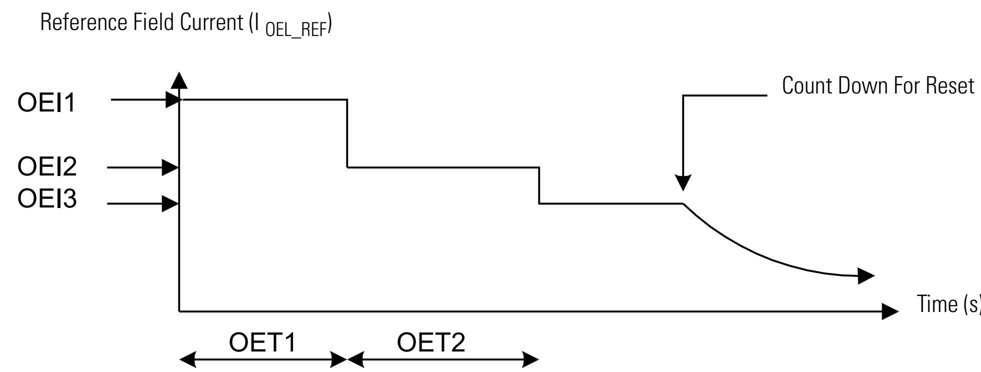



**Figure 66 - Over-excitation Limiter Reference**

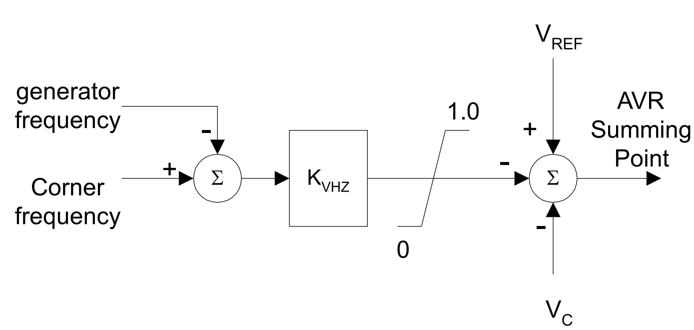



## V/Hz Limiter

V/Hz limiter is designed to protect the generator and step-up transformer from damage due to excessive magnetic flux resulting from low frequency operation and/or over-voltage.

V/Hz limiter has been designed with an adjustable slope ($K_{V/HZ}$) from flat to 3 pu V/Hz. When the system is in an under-frequency condition, the voltage reference is adjusted by the amount calculated based on two programmable parameters, the corner frequency and the V/Hz slope. Its mathematical model is shown in V/Hz Limiter.

**Figure 67 - V/Hz Limiter**

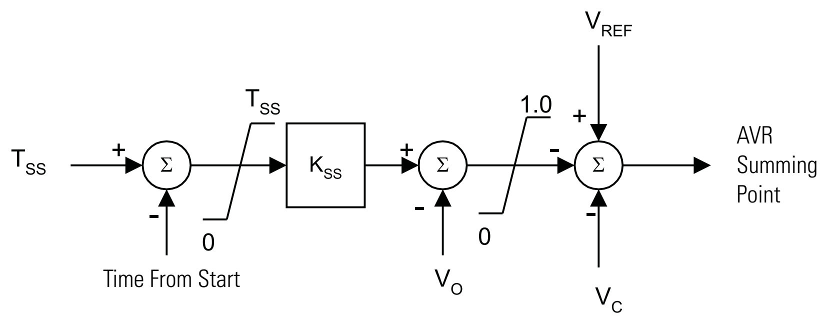


## Soft Start Control

The soft start control function is provided to cause orderly build-up of terminal voltage from the residual voltage to the rated voltage in desired time with minimal overshoot. In CGCM units, the fast dynamic response is used while the voltage reference is adjusted based on the elapsed time. When the system is under start-up condition, the voltage reference is adjusted by the amount calculated based on two programmable parameters, initial soft start voltage level ($V_O$) and desired time ($T_{SS}$) to build up to the rated voltage. Its mathematical model is shown in Soft Start Control. The soft start gain ($K_{SS}$) is calculated by using this formula.

$$K_{SS} = (V_{REF} - V_O) / T_{SS}$$

**Figure 68 - Soft Start Control**



## Field Current Regulator

Per-unit Block Diagram for Rotating Rectifier Excitation System shows the model of the CGCM field current regulator used with a brush-type rotating exciter. $V_P$ is the input from the power source for the excitation system.

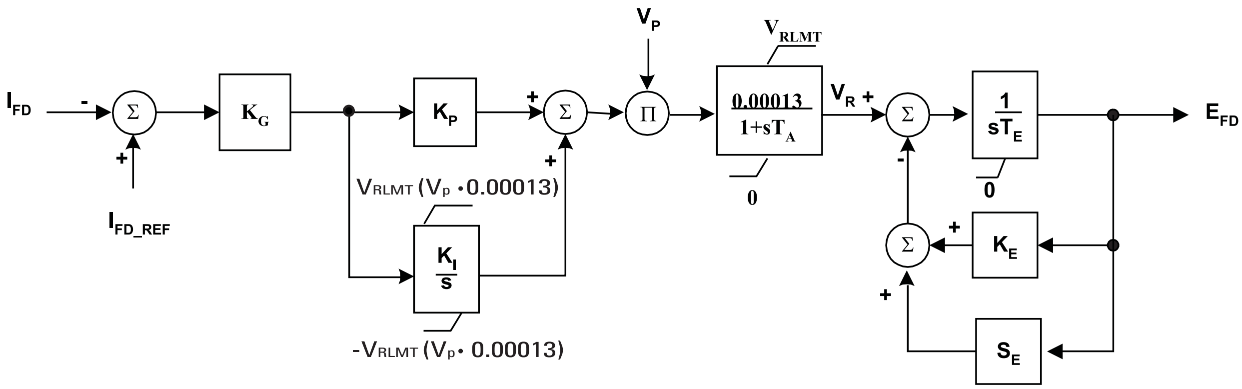
Typical value for $T_A$ is 0. The forcing limit $V_{RLMT}$ is related to the power-input voltage ($V_P$) to the CGCM, the exciter field voltage ($V_R$) and the programmed gain ($K_G$) in this equation.

$$V_{RLMT} = 1.4*V_P / V_R$$

The gain $K_G$ is used for compensating variations in system configuration dependent gains such as power input voltage.

The PI gains $K_P$ and $K_I$ are the same as the PI gains $K_P$ and $K_I$ for the voltage regulator. The PID gains can be obtained from the PID Calculator software available from Rockwell Automation.

**Figure 69 - Per-unit Block Diagram for Rotating Rectifier Excitation System**



# Notes:

# Additional ControlNet Network Information

## ControlNet Application Objects

In addition to the standard adapter class ControlNet core objects, the CGCM unit also supports these application specific objects:

- Identity Object
- Assembly Object

### Data Types

The ControlNet and Logix controller data types used by the CGCM unit assembly objects are shown in the table below.

**Table 39 - ControlNet Data Types Table**

| | |
|---|---|
| BOOL | Boolean |
| SINT | 8-bit (byte) value |
| USINT | 8-bit unsigned value |
| INT | 16-bit signed value |
| UINT | 16-bit unsigned value |
| DINT | 32-bit signed value |
| UDINT | 32-bit unsigned value |
| REAL | 32-bit floating point value |

All data is stored in Little Endian format (least significant byte first). This is assumed for all data and structure formats described in this document that do not have the storage format specifically defined.

All integers and double integers are displayed in decimal.

### Identity Object (class code 0x01)

The Identity Object is used to provide identification information about the device.

### Identity Class Instance (instance 0)

Instance 0 of any ControlNet object represents the class itself.

The Get Attributes All service for instance 0 of the Identity Object returns the following information.

**Table 40 - Get Attributes All (service code 0x01)**

| Name | Attr ID | Data Type | Value |
|---|---|---|---|
| Revision | 1 | UINT | 1 |
| Max Instance | 2 | UINT | 2 |
| Max ID Number of Class Attributes | 6 | UINT | 0 |
| Max ID Number of Instance Attributes | 7 | UINT | 0 |

### Identity Object Instance 1 (CGCM device instance)

Instance 1 of the Identity Object represents the CGCM device.

The Get Attributes All service for instance 1 of the Identity Object returns the following information.

**Table 41 Get Attributes All (service code 0x01)**

| Name | Attr ID | Data Type | Value |
|---|---|---|---|
| Vendor Id | 1 | UINT | 1 (AB) |
| Device Type | 2 | UINT | 115 or 0x73 (Rockwell Automation Misc) |
| Product Code | 3 | UINT | 59 or 0x03B |
| Revision | 4 | USINT[2] | Major, Minor (example 4, 25) |
| Status | 5 | WORD | See Table 41 Device Status |
| Serial Number | 6 | UDINT | Unique device serial number-factory assigned |
| Product Name | 7 | CHAR[] | CGCM Host - Series C and earlier units<br>1407-CGCM - Series D units |

### *Identity Object Instance 2 (communication module device instance)*

Instance 2 of the Identity Object represents the ControlNet communication module (Series D units) or daughter card (DC) in Series C and earlier CGCM units.

The Get Attributes All service for instance 2 of the Identity Object returns the following information.

**Table 42 Get Attributes All (service code 0x01)**

| Name | Attr ID | Data Type | Value |
|---|---|---|---|
| Vendor Id | 1 | UINT | 1(AB) - Series C and earlier<br>90 or 0x5A (HMS Industrial Networks) - Series D |
| Device Type | 2 | UINT | 12 or 0x0C (Rockwell Automation Misc.)<br>43 or 0x2B (Generic Device, keyable) |
| Product Code | 3 | UINT | 55 or 0x37 |
| Revision (Major, Minor) | 4 | USINT[2] | Major, Minor (example 1,11) |
| Status | 5 | WORD | See Table 41 Device Status |
| Serial Number | 6 | UDINT | Unique device serial number |
| Product Name | 7 | CHAR[] | '1407-CGCM-DC' - Series C or earlier<br>ControlNet - Series D |

**Table 43 Device Status**

| Bits | Name | Notes |
|---|---|---|
| 0 | Module Owned | |
| 1 | (reserved) | |
| 2 | Configured[(1)] | |
| 3 | (reserved) | |
| 4... 7 | Extended Device Status:<br>Value: Meaning:<br>0000b Unknown<br>0010b Faulted I/O Connection<br>0011b No I/O connection established<br>0100b Nonvolatile configuration bad<br>0110b Connection in Run mode<br>0111b Connection in Idle mode | |
| 8 | Set for minor recoverable faults | |
| 9 | Set for minor unrecoverable faults | |
| 10 | Set for major recoverable faults | |
| 11 | Set for major unrecoverable faults | |
| 12… 15 | (reserved) | |

(1) This bit shows if the product has other settings than 'out-of-box'. The value is set to true if the configured attribute in the application object is set and/or the module's NV storage is changed from default.

### *Reset Service Code*

The Reset service for instance 1 of the Identity Object requests that a CGCM unit's communication reset be performed. If excitation is enabled, the request is denied. If excitation is not enabled, the request is accepted. If a reset is accepted, the CGCM unit resets the entire CGCM unit and communication with the Logix controller is lost. After the reset is complete, the CGCM unit automatically starts communicating and is immediately ready for normal operation based on its previous configuration data.

The following recognized ControlNet General Response Codes are used in response to the reset request.

**Table 44 - Reset (service code 0x05)**

| Response | Value | Meaning |
|---|---|---|
| Object State Conflict | 0x0C | A reset cannot be performed (excitation enabled) |

## Assembly Object (class code 0x04)

The Assembly Object is used to provide application specific information about a device.

### *Assembly Class Instance (instance 0)*

Instance 0 of any ControlNet object represents the class itself.

The Get Attributes Single service for instance 0 of the Assembly Object can access the following information.

**Table 45 - Get Attributes Single (service code 0x0E)**

| Name | Attr ID | Data Type | Value |
|---|---|---|---|
| Revision | 1 | UINT | 2 |
| Max Instance | 2 | UINT | 6 |

### *Assembly Object Instance 1 through Instance 6*

Refer to Chapter 6 for a discussion of Assembly Instance 1…6 and their related attributes and services.

# Specifications

The CGCM unit's electrical and physical characteristics are listed in the following tables.

## Control Power

| Supply | Burden |
|---|---|
| 18…32V DC (24V DC nom)<br>(The device is to be powered by a 24V Nominal Battery or 24V DC Power Supply with ATEX certification.) | 30 W |
| AC ripple, max | 50%, 50…120 Hz |

## Excitation Power

| Source | Phases | Wiring Configuration | Voltage | Frequency | VA (max) |
|---|---|---|---|---|---|
| PMG(1) | Single-phase | PMG-A and PMG-C | Min 56 Vrms<br>Max 300 Vrms | Min 50 Hz<br>Max 342 Hz | 3070 |
| PMG | 3-phase | Floating wye | Min 56Vrms L-L<br>Max 300 Vrms L-L | Min 50 Hz<br>Max 342 Hz | 3070 |
| SE(2) | Single-phase | PMG-A and PMG-C | Min 56Vrms<br>Max 300 Vrms | Min 50 Hz<br>Max 342 Hz | 3070 |
| SE | 3-phase | Floating wye | Min 56Vrms L-L<br>Max 300 Vrms L-L | Min 50 Hz<br>Max 342 Hz | 3070 |
| SE | 3-phase | Grounded wye<br>(grounded neutral) | Min 56Vrms L-L<br>Max 300 Vrms L-L | Min 50 Hz<br>Max 342 Hz | 3070 |
| SE | 3-phase | Floating delta | Min 56Vrms L-L<br>Max 300 Vrms L-L | Min 50 Hz<br>Max 342 Hz | 3070 |
| SE | 3-phase | Open delta, floating | Min 56Vrms L-L<br>Max 300 Vrms L-L | Min 50 Hz<br>Max 342 Hz | 3070 |

(1) PMG = Permanent Magnet Generator.

(2) SE = Separately Excited.

## Generator Voltage Sensing

| Phase | Wiring Configurations | Grounded Connection Available | Voltage Range for Specified Accuracy | Frequency Range for Specified Accuracy |
|---|---|---|---|---|
| Single-phase | V Gen A and V Gen C | No | Min 57 Vrms<br>Max 150 Vrms | Min 20 Hz<br>Max 90 Hz |
| Three-phase | Floating wye | No | Min 99 Vrms L-L<br>Max 208 Vrms L-L | Min 20 Hz<br>Max 90 Hz |
| Three-phase | Grounded wye (grounded neutral) | Yes | Min 99 Vrms L-L<br>Max 208 Vrms L-L | Min 20 Hz<br>Max 90 Hz |
| Three-phase | Open delta, grounded B phase | Yes | Min 99 Vrms L-L<br>Max 208 Vrms L-L | Min 20 Hz<br>Max 90 Hz |

**IMPORTANT** Voltage sensing burden is < 1VA per phase.

**TIP** For all wiring configurations, the minimum voltage sensing threshold is 2V AC typical. Maximum voltage withstand limit is 360V AC. These limits are provided for reference only. Metering accuracy applies only when operating in the range specified for voltage and frequency in the table above for the specified wiring configuration.

## Generator Current Sensing

| Attribute | 1407-CGCM |
|---|---|
| Type | 3-phase plus cross current compensation input. |
| Frequency | 50/60 Hz |
| Range | 1 A or 5 A max continuous |
| Burden | < 0.1 VA per phase for metering CTs<br>< 2.5 VA per phase for cross-current inputs |
| Cross-current compensation entity parameters<br>ID(+) 1 A<br>ID(+) 5 A<br>ID(-) | Ui = 12 V<br>Ci = 14.1 nF<br>Ii = 5 AAC<br>Li = 1.5 μH |

## Bus Voltage Sensing

| Phase | Wiring Configurations | Grounded Connection Available | Voltage | Frequency |
|---|---|---|---|---|
| Single-phase | V Bus A and V Bus C | No | Min 57 Vrms<br>Max 150 Vrms | Min 20 Hz<br>Max 90 Hz |
| Three-phase | Floating wye | No | Min 99 Vrms L-L<br>Max 208 Vrms L-L | Min 20 Hz<br>Max 90 Hz |
| Three-phase | Grounded wye (grounded neutral) | Yes | Min 99 Vrms L-L<br>Max 208 Vrms L-L | Min 20 Hz<br>Max 90 Hz |
| Three-phase | Open delta, grounded B phase | Yes | Min 99 Vrms L-L<br>Max 150 Vrms L-L | Min 20 Hz<br>Max 90 Hz |

## Auxiliary Input

| Attribute | 1407-CGCM |
|---|---|
| Range | -10…10V DC |
| Input impedance | 20 k Ω |

## Communication Ports

| Attribute | 1407-CGCM |
|---|---|
| ControlNet network | ControlNet 1.5 interface |
| Redundancy port | DB9 Connector, 9600 bps, 8N1 (For redundant CGCM unit use only.) |
| Factory port | DB15 Connector, 9600 bps, 8N1 (Not for customer use.) |

## Remote Excitation Enable Input

| Attribute | 1407-CGCM |
|---|---|
| Voltage rating | 24V DC nom |
| Input impedance | 5.6K Ω |
| Logical high voltage, min | 18V DC |
| Logical low voltage, max | 5V DC |

## Open Collector Outputs (fault relay and redundancy relay)

| Attribute | 1407-CGCM |
|---|---|
| Voltage rating | 24V DC nom |
| Voltage range | 18…30V DC |
| Rated current, max | 500 mA |

## Field Output

| Attribute | | 1407-CGCM |
|---|---|---|
| Continuous voltage | | 32, 63, 125V DC (1) |
| Continuous current | | 15 A DC |
| 10-second forcing voltage | | 50, 100, or 200V DC |
| 10-second forcing current | | 30 A DC |
| Field resistance, min | 32V DC<br>63V DC<br>125V DC | 2.13 Ω<br>4.2 Ω<br>8.3 Ω |

(1) Available output voltage is dependent on magnitude of excitation power input voltage.

## Regulation

The following modes are used to regulate the CGCM unit.

### *AVR Operating Mode*

- Accuracy: ±0.25% over the load range at rated power factor and constant generator frequency.
- Steady State Stability: ±0.1% at constant load and generator frequency.
- Temperature Drift: The maximum error due to temperature drift will be 0.005% of full scale per degrees Celsius for voltage and current measurements and 0.010% of full scale per degree Celsius for watt and VAR measurements.
- V/Hz Characteristic: Slope from 0 to 3PU is adjustable in 0.1PU increments. Two knees and two slopes are available.
- Response Time: < 1 cycle.

### *FCR Operating Mode*

- Accuracy: ±1% of rated current.

### *VAR Operating Mode*

- Accuracy: ±0.4% of the nominal VA rating at the rated frequency.

### *Power Factor Mode*

- Accuracy: ±0.02% of the PF setpoint for the real power between 10…100% at the rated frequency.

## Parallel Compensation

| Attribute | 1407-CGCM |
|---|---|
| Modes | Reactive Droop<br>Reactive Differential (cross-current) |
| Droop adjust range | 0…30% |
| Accuracy | ±0.3% of rated cross current input current |
| Line-drop compensation range | 0…10% of rated voltage in 0.1% increments |

## Loss of Excitation

| Attribute | Range | Increment |
|---|---|---|
| Pickup | 0.1…15 A | 0.1 A |
| Time delay | 0.1…9.9 s | 0.1 s |

## Over-excitation Voltage Protection

| Attribute | Range | Increment |
|---|---|---|
| Pickup | 1…200V DC | 1V DC |
| Time delay | 0.1…30 s | 0.1 s |

## Over-current Protection

| Attribute | Range | Increment | Accuracy |
|---|---|---|---|
| Pickup | 10…320% of rated generator current | 1% | ±2% rated current |
| Time delay | Characteristic inverse per ANSI C50.13 configurable | 0.1 s | |

## Under-voltage Protection

| Attribute | Range | Increment | Accuracy |
|---|---|---|---|
| Pickup | 60…100% of rated generator voltage | 1% | ±2% rated voltage |
| Time delay | 0.1…300 s | | ±0.1 s |

## Over-voltage Protection

| Attribute | Range | Increment | Accuracy |
|---|---|---|---|
| Pickup | 100…140% of rated generator voltage | 1% | ±2% rated voltage |
| Time delay | 0.1…300 s | | ±0.1 s |

## Loss of Sensing Protection

| Attribute | 1407-CGCM |
|---|---|
| Pickup | See text description in Operation section of the manual for this item |
| Time delay | 0.1 s for normal operation, 1 s during soft start |

## Loss of PMG

| Attribute | 1407-CGCM |
|---|---|
| Pickup | < 10V AC single-phase,<br>< 50V AC 3-phase or an imbalance greater than 20% |
| Response time | < 400 ms |

## Reverse VAR

| Attribute | Range | Increment | Accuracy |
|---|---|---|---|
| Time delay | 0.10…300 s | 0.10 s | ±0.1 s |

## Over/Under-frequency

| Attribute | Range | Increment | Accuracy |
|---|---|---|---|
| Pickup | 30…70 Hz | 0.01 Hz | ±2% Hz |
| Time delay | 0.10…300 s | 0.10 s | ±0.1 s |

## Reverse Power

| Attribute | Range | Increment | Accuracy |
|---|---|---|---|
| Pickup | 1…100% of rated generator VA | 1% | ±0.5% rated VA |
| Time delay | 0.10…300 s | 0.10 s | ±0.1 s |

## Rotating Diode Monitor - Range

| Attribute | 1407-CGCM |
|---|---|
| Number of generator poles | 0…24 |
| Number of brushless exciter poles | 0…24 |
| Increment | 2 |
| Fault time delay (applies to both open and shorted diode conditions) | 0.1…300 s |

## Rotating Diode Monitor - Open and Shorted Diode Inhibit Levels

| Attribute | 1407-CGCM |
|---|---|
| Field current | < 1.5 A DC |
| Generator frequency | < 45 Hz |
| Generator frequency | >70 Hz |

## Phase Rotation Check

| Attribute | Range | Accuracy |
|---|---|---|
| Pickup | 67% of rated voltage | ±2% of rated voltage |
| Time delay | 1 s | ±0.1 s |

## Soft Start Function

| Attribute | 1407-CGCM |
|---|---|
| Soft start initial voltage | 0…90% of rated voltage in 1% increments |
| Soft start time | 1…7200 s in 1 s increments |

## Voltage Matching

| Attribute | 1407-CGCM |
|---|---|
| Accuracy | Generator rms voltage is matched with the rms bus voltage to within ±0.5% of the generator voltage. |

## Over-excitation Limiting - Online

| Attribute | High Limiting | Medium Limiting | Low Limiting |
|---|---|---|---|
| Pickup range | 0…30.0 A DC | 0…20.0 A DC | 0…15 A DC |
| Pickup increment | 0.1 A DC | 0.1 A DC | 0.1 A DC |
| Time range | 0…60 s | 0…120 s | Continuous |
| Time increment | 1 s | 1 s | |
| Response time | < 3 cycles | | |

## Over-excitation Limiting - Offline

| Attribute | Range | Increment |
|---|---|---|
| Pickup | 0…15 A DC | 0.1 A DC |
| Time delay | 0…10 s | 1 s |

## Under-excitation Limiting

| Attribute | 1407-CGCM |
|---|---|
| Real power | 0…100% kW for each of 5 points |
| Reactive power | 0…100% kvar for each of 5 points |

## Manual Excitation Control

| Attribute | 1407-CGCM |
|---|---|
| Range | 0…15.0 A DC |
| Increment | 0.1 A DC |

## Metering

| Attribute | Range | Accuracy |
|---|---|---|
| Generator voltage | 57…208V AC | 0.2% (50/60 Hz) |
| Generator current | 0…5 A AC | 0.2% (50/60 Hz) |
| Generator frequency | 10…90 Hz | ±0.05 Hz |
| Bus voltage | 57…208V AC | < 0.2% (50/60 Hz) |
| Bus frequency | 10…90 Hz | ±0.05% |
| Phase angle | ±180° | ±1.0° |
| Field voltage | 0…200V DC | ±1.25 V or ±1.0% (whichever is greater) |
| Field current | 0…30 A AC | ±0.15 A or ±1.0% (whichever is greater) |
| Power factor | -0.5…0.5 | <0.4% of actual PF |
| Power - real and reactive | 0…200% of nom | <0.4% of rated kVA |
| Load share | Resolution: 0.1% of full scale voltage | |
| Load Share entity parameters<br>LS(+)<br>LS(-) | Ui = 0…5 V<br>Ci = 101 nF<br>Ii = 111 ÂµA<br>Li = 0 | |

# Environment

| Attribute | 1407-CGCM |
|---|---|
| Temperature, operating | -20…70 °C (-4…158 °F) |
| Temperature, storage | -40…85 °C (-40…185 °F) |
| Humidity, operating | 5…95% (noncondensing) |
| Shock, operating | 30 g |
| Shock, nonoperating | 50 g in 3 perpendicular planes |
| Vibration, operating | 10 … 500 Hz, 5.0 g / 0.015 in. max (p-p)<br>2 hours each axis |
| Dielectric strength | Tested per IEEE 421.3 |
| Salt fog | Tested per MIL-STD-810E, Method 509.3 |

# Agency Certifications

| Region(1), (2), (3), (4) | Certification / Compliance | Standard |
|---|---|---|
| USA and Canada | Class I, Zone 2,<br>AEx [ic] nA IIC T4, Ex [ic] nA IIC T4 Gc | UL60079-0 6th Edition / CSA60079-0:11<br>UL60079-11 6th Edition / CSA60079-11:11<br>UL60079-15 4th Edition / CSA60079-15:12 |
| | Class I, Division 2, Groups A, B, C, or D<br>UL File E220640 | ANSI/ISA 12.12.01-2013 / CSA C22.2 No. 213-M1987 |
| Europe | Ex II 3G Ex [ic] nA IIC Gc (DEMKO 14 ATEX 1230U)<br>IECEx UL 14.0018U | EN 60079-0:2012<br>EN 60079-11:2012<br>EN 60079-15:2010<br>EN ISO/IEC-80079-34:2011 |
| | CE Compliance | EN 60947-1: Low voltage switch and control gear requirements<br>EN 50081-2: Electromagnetic compatibility emissions<br>EN 61000-4-2: Electromagnetic compatibility immunity<br>EN 61000-4-2: ESD Immunity<br>ENV 50204: Radiated immunity (Pulse)<br>EN 61000-4-3: Radiated immunity (Continuous)<br>EN 61000-4-4: Fast transient immunity<br>EN 61000-4-5: Surge immunity<br>EN 61000-4-6: Conducted immunity<br>EN 61000-4-8: Power frequency magnetic field<br>EN 55011: Conducted emissions/ Radiated emissions<br>EN 61000-4-11: Line related tests |

(1) Mount this equipment in an EN 60079-15 certified enclosure with a minimum ingress protection of IP54 (as defined in EN 60529) and used in an environment of not more than Pollution Degree 2 (as defined in EN 60664-1) when applied in Zone 2 environments.

(2) Transient protection limiting transients to 140% of rated voltage must be provided.

(3) The device is to be powered by a 24V Nominal Battery or 24V DC Power Supply with ATEX certification.

(4) Use wire rated to 105 °C (221 °F) minimum.

## Physical Characteristics

| Attribute | 1407-CGCM |
|---|---|
| Width | 247.7 mm (9.75 in.) |
| Height | 355.6 mm (14.00 in.) |
| Depth | 209.6 mm (8.25 in.) |
| Weight | 7.7 kg (17 lb) |
| Heat dissipation | 3.1 kW max |

# Notes:

# Detailed CGCM Unit Tag Descriptions

## Generator Parameters and Configuration Status

This section describes the generator parameters and configuration status input and output tags for the CGCM unit.

### Inputs to the CGCM Unit

- **GenVT_Pri_V** – This tag defines the rated primary voltage for the Generator potential transformers.
- **GenVT_Sec_V** – This tag defines the rated secondary voltage for the Generator potential transformers.
- **BusA_VT_Pri_V** - This tag defines the rated primary voltage for the BusA potential transformers.
- **BusA_VT_Sec_V** - This tag defines the rated secondary voltage for the BusA potential transformers.
- **BusB_VT_Pri_V** - This tag defines the rated primary voltage for the BusB potential transformers.
- **BusB_VT_Sec_V** - This tag defines the rated secondary voltage for the BusB potential transformers.
- **GenCT_Pri_I** – This tag defines the rated primary current for the Generator current transformers.
- **GenCT_Sec_I –** This tag defines the rated secondary current for the Generator current transformers.
- **CCCT_Pri_I** – This tag defines the rated primary current for the cross-current transformers.
- **CCCT_Sec_I –** This tag defines the rated secondary current for the cross-current transformers.
- **GenVT_Config** – This tag defines the wiring configuration of the generator system.
- **BusVT_Config** – This tag defines the wiring configuration of the bus system.
- **GenRated_W** – This tag defines the rated power for the Generator.
- **GenRated_V –** This tag defines the rated voltage for the Generator.
- **GenRated_I** – This tag defines the rated current for the Generator.
- **GenRatedFreq** – This tag defines the rated frequency for the Generator.
- **GenRatedExcV** – This tag defines the rated excitation voltage for the Generator.
- **GenRatedExcI –** This tag defines the rated excitation current for the Generator.

- **PMG_Shunt_Select -** This tag selects whether the CGCM unit receives power-input voltages from the generator's terminals (shunt) or from a permanent magnet generator (PMG). If PMG is selected, then the information for the PMG Phase Select parameter must be provided.
- **PMG_1Ph_3PhSelect –** This tag configures whether the PMG power applied to the CGCM unit is single or 3-phase.

### Outputs from the CGCM Unit

- **ConfigRcvd** – This tag reports whether a valid Configuration has been received from the host Logix controller. A 1 indicates a valid configuration. This bit must be a 1 to allow scheduled data transfers to occur.
- **UnschdWriteRcvd** – This tag reports whether a valid Unscheduled Write has been received from the host Logix controller. This bit must be a 1 to allow scheduled data transfers to occur.

## General Excitation Control Modes

This section describes the excitation control modes inputs and outputs for the CGCM unit.

### Inputs to the CGCM Unit

- **SoftwareExcEn** – This tag is controlled by the host Logix controller, and if set to 1, provides one of the necessary conditions for the field excitation to be enabled.

### Outputs from the CGCM Unit

- **Internal_Tracking_En** - When this tag is set to 1 the CGCM unit enables internal tracking between the various regulating modes.
- **InternalTrackRate** - This tag configures the rate at which the tracking mode of the CGCM unit matches the non-active excitation control modes to the active excitation control mode.
- **InternalTrackDly** - This tag changes the initial delay of the tracking function of the CGCM unit to prevent the Tracking mode from adjusting the non-active modes into an undesirable condition. For example, while the unit is operating in AVR mode the sensing VT fails to open. If the CGCM unit's Tracking mode were allowed to instantly track the full-on condition created by the loss of sensing, the transfer to the CGCM unit's Manual mode results in an undesirably high generator voltage even when operating in FCR mode. Adding a tracking delay enables the unit to transfer to a different Regulating mode without letting the CGCM unit follow into a potentially undesirable operating point.

- **HardwareExcEned** – This tag reports the state of the Excitation Input [EX-D(+), EX-D(-) terminals on Terminal Block TB7]. Field excitation is disabled when this bit is in a 0 state.
- **SoftwareExcEned** – This tag reports the state of the SoftwareExcEn tag.
- **ExcOut** – This tag reports the state the CGCM unit is commanding the excitation output to take.
- **SetptTraverseActive** - This tag indicates when the CGCM unit is traversing between an internal tracking setpoint establish by the internal tracking function and the final setpoint provided by the schedule write data. Traversing occurs when switching from the active Regulation mode and any of the other regulating modes.

# AVR Mode

This section describes the AVR mode inputs and outputs for the CGCM unit.

## AVR Mode Inputs to the CGCM Unit

The AVR mode contains these inputs:

- **AVR_FCR_Select –** This tag lets you select AVR or FCR control.
- **AVRSetpt –** This tag sets the desired voltage setpoint for operation in the AVR control mode.
- **AVR_FCR_Kp -** This tag sets the Proportional Gain parameter for AVR and FCR control modes.
- **AVR_FCR_Ki –** This tag sets the Integral Gain parameter for AVR and FCR control modes.
- **AVR_FCR_Kd -** This tag sets the Derivative Gain parameter for AVR and FCR control modes.
- **AVR_FCR_Td –** This tag sets the filtering Time Constant for AVR and FCR control modes.
- **AVR_Kg -** This tag lets you adjust coarse loop gain and overall gain of the AVR operating mode. It also determines the characteristic of the dynamic response to a change in the voltage of the generator.
- **AVR_Traverse_Rate -** This parameter determines the time measured in seconds for the setpoint to move from zero to the rated generator voltage. If determines how fast the regulator changes the voltage setpoint from the tracking value to the operating setpoint when the Regulator Operating mode changes to AVR.
- **AVR_FCRAuxGain -** This tag lets you  to adjust the overall gain of the auxiliary input's control on the AVR/FCR operating mode. The units for this are percent of nominal per volt. A setting of one results in the controlled parameter being changed by one percent of the nominal value for each volt applied to the auxiliary input.

### AVR Mode Outputs from the CGCM Unit

The AVR mode has one output.

- **AVR_FCR_Selection –** This tag reports the selection of AVR or FCR control (see **AVR_FCR_Select**).

## FCR Mode

This section describes the FCR mode inputs and outputs for the CGCM unit.

### FCR Mode Inputs to the CGCM Unit

The FCR mode has these inputs:

- **AVR_FCR_Select –** This tag lets you select AVR or FCR control.
- **FCRSetpt -** This tag sets the desired field current setpoint for operation in the FCR control mode.
- **AVR_FCR_Kp -** This tag sets the Proportional Gain parameter for AVR and FCR control modes
- **AVR_FCR_Ki -** This tag sets the Integral Gain parameter for AVR and FCR control modes.
- **AVR_FCR_Kd -** This tag sets the Derivative Gain parameter for AVR and FCR control modes.
- **AVR_FCR_Td –** This tag sets the filtering Time Constant for AVR and FCR control modes.
- **FCR_Kg -** This tag lets you adjust coarse loop gain and overall gain of the FCR operating mode. It also determines the characteristic of the dynamic response to a change in the CGCM unit's output current.
- **FCR_Traverse_Rate -** This parameter determines the time measured in seconds for the setpoint to move from zero to the rated exciter current. It determines how fast the regulator changes the field current setpoint from the tracking value to the operating setpoint when the Regulator Operating mode changes to FCR.
- **AVR_FCRAuxGain -** This tag lets you adjust the overall gain of the auxiliary input's control on the AVR/FCR operating mode. The units for this are percent of nominal per volt. A setting of one results in the controlled parameter being changed by one percent of the nominal value for each volt applied to the auxiliary input.

### FCR Mode Outputs from the CGCM Unit

The FCR mode has one output.

- **AVR_FCR_Selection –** This tag reports the selection of AVR or FCR control (see **AVR_FCR_Select**).

# Power Factor Mode

This section describes the Power Factor mode inputs and outputs for the CGCM unit.

## Inputs to the CGCM Unit

The Power Factor mode has these inputs:

- **PF_VAR_Select –** This tag lets you select PF or VAR control.
- **PF_VAR_En –** When this tag is set to 1, the CGCM unit uses the PF_VAR_Select tag to determine its control mode. When this tag is set to 0, the CGCM unit uses the AVR_FCR_Select tag to determine its control mode.
- **PFSetpt -** This tag sets the desired power factor setpoint for operation in the PF control mode.
- **PF_Kg -** This tag lets you adjust coarse loop gain and overall gain of the power factor controller. It also determines the characteristic of the dynamic response to a change in the power factor of the generator.
- **PF_Ki -** This tag lets you adjust the integral gain of the power factor controller. This tag determines the characteristic of the dynamic response to a change in the power factor setting.
- **PF_Traverse_Rate -** This parameter determines the time measured in seconds for the PF setpoint to move from 0.50 lagging to 0.50 leading or vice versa. It determines how fast the regulator changes the power factor setpoint from the tracking value to the operating setpoint when the Regulator Operating mode changes to PF.
- **PF_VARAuxGain -** This tag lets you adjust the overall gain of the auxiliary input’s control on the VAR/PF operating modes. The units for the var controller are percent of nominal per volt. A setting of one results in the controlled parameter being changed by one percent of the nominal value for each volt applied to the auxiliary input. For PF control, the units are 0.01PF per volt. A setting of 5 results in the regulated PF being changed by 0.05 for each volt applied to the auxiliary input.

## Outputs from the CGCM Unit

The Power Factor mode has these outputs:

- **PF_VAR_Selection** - This tag reports the selection of PF or VAR control (see **PF_VAR_Select**).
- **PF_VAR_Control –** This tag reports your selection of PF/VAR or AVR/FCR mode.

## VAR Mode

This section describes the VAR mode inputs and outputs for the CGCM unit.

### Inputs to the CGCM Unit

The VAR mode has these inputs.

- **PF_VAR_Select –** This tag lets you select PF or VAR control.
- **PF_VAR_En -** When this tag is set to 1, the CGCM unit uses the PF_VAR_Select tag to determine its control mode. When this tag is set to 0, the CGCM unit uses the AVR_FCR_Select tag to determine its control mode.
- **VARSetpt -** This tag sets the desired kVAR setpoint for operation in the VAR control mode.
- **VAR_Kg -** This tag lets you adjust coarse loop gain and overall gain of the power factor controller. It also determines the characteristic of the dynamic response to a change in the power factor of the generator.
- **VAR_Ki -** This tag lets you adjust the integral gain of the VAR controller. It also determines the characteristic of the dynamic response to a change in the VAR setting.
- **VAR_Traverse_Rate -** This parameter determines the time measured in seconds for the setpoint to move from zero to the rated generator KVA. It determines how fast the regulator changes the VAR setpoint from the tracking value to the operating setpoint when the Regulator Operating mode changes to VAR.
- **PF_VARAuxGain -** This tag lets you adjust the overall gain of the auxiliary input's control on the VAR/PF operating modes. The units for the var controller are percent of nominal per volt. A setting of one results in the controlled parameter being changed by one percent of the nominal value for each volt applied to the auxiliary input. For PF control, the units are 0.01PF per volt. A setting of 5 results in the regulated PF being changed by 0.05 for each volt applied to the auxiliary input.

### Outputs from the CGCM Unit

The VAR mode has these outputs:

- **PF_VAR_Selection** - This tag reports the selection of PF or VAR control (see **PF_VAR_Select**).
- **PF_VAR_Control –** This tag reports your selection of PF/VAR or AVR/FCR mode.

## Excitation Control Features

This section describes the excitation control features.

### Soft Start Inputs to the CGCM Unit

- **SoftStart_InitLevel** - This tag configures the generator voltage that is generated immediately after enabling the CGCM unit. This parameter is based on a percentage of the nominal generator voltage.
- **SoftStartTime** - This tag configures the time it takes to go from the Soft Start Initial Voltage to the nominal generator voltage.

### Droop (Reactive Current Compensation) Inputs to the CGCM Unit

- **Droop_CCC_Select** – If Droop is enabled, this tag selects CCC when set to 1 or Droop when set to 0.
- **V_DroopEn** – This tag configures whether Droop is enabled
- **V_DroopSetpt** - This tag configures the amount of voltage droop that is experienced during paralleling generator applications.

### Under-frequency Limit Inputs to the CGCM Unit

- **VperHz_HiKneeFreq** - The Knee Frequency tag configures the frequency at which the V/Hz characteristic starts to reduce the generator voltage as a function of generator frequency.
- **VperHz_HiSlope** - The Upper Slope tag configures the rate at which the V/Hz characteristic reduces the generator voltage as a function of generator frequency. The steeper the slope the faster the prime mover is unloaded and smaller the frequency variations are experienced during load applications.
- **VperHz_LoKneeFreq** - The Knee Frequency tag configures the frequency at which the V/Hz characteristic starts to reduce the generator voltage as a function of generator frequency.
- **VperHz_LoSlope** - The Lower Slope tag configures the rate at which the V/Hz characteristic reduces the generator voltage as a function of generator frequency after the Lower Knee Frequency is exceeded.

### Cross-current Compensation Inputs to the CGCM Unit

- **Droop_CCC_Select** – If Droop is enabled, this bit selects CCC when set to 1 or Droop when set to 0.
- **CrossCurrentGain** - This setting lets you adjust the gain of the cross current input. The actual value measured by the cross current input is multiplied by this setting. It can be used to improve the var sharing between machines connected in cross current.

## Over-excitation Limit Inputs to the CGCM Unit

- **OEL_En** – Setting this tag enables the Over-excitation Limiting function.
- **OEL_Kg** - This tag lets you adjust the proportional gain of the Over-excitation limiter. It also determines the response of the limiter to an Over-excitation event.
- **OEL_Ki** - This tag lets you adjust coarse loop gain and overall gain of the Over-excitation limiter. This tag determines the characteristic of the dynamic response to an Over-excitation event.
- **OEL_OnLineHiSetpt** – This tag sets the high current level for the online over-excitation limiting function. The CGCM unit's over-excitation limiter limits excitation current at this level. Operation at this level is allowed for a time no longer than programmed in the OEL_OnLineHiTimeDly tag.
- **OEL_OnLineHiTimeDly** – This tag sets the amount of time the online over-excitation limiting function lets the unit operate at the excitation current level programmed in the OEL_OnLineHiSetpt tag.
- **OEL_OnLineMedSetpt** - This tag sets the medium current level for the online over-excitation limiting function. Operation at this level is allowed for a time no longer than programmed in the OEL_OnLineMedTimeDly tag.
- **OEL_OnLineMedTimeDly** – This tag sets the amount of time the online over-excitation limiting function lets the unit operate at the excitation current level programmed in the OEL_OnLineMedSetpt tag.
- **OEL_OnLineLoSetpt** - This tag sets the low current level for the online over-excitation limiting function. Operation at this level is allowed continuously.
- **OEL_OffLineHiSetpt** – This tag sets the high current level for the offline over-excitation limiting function. The CGCM unit's over-excitation limiter limits excitation current at this level. Operation at this level is allowed for a time no longer than programmed in the OEL_OffLineHiTimeDly tag.
- **OEL_OffLineHiTimeDly** - This tag sets the amount of time the offline over-excitation limiting function lets the unit operate at the excitation current level programmed in the OEL_OffLineHiSetpt tag.
- **OEL_OffLineLoSetpt** - This tag sets the low current level for the offline over-excitation limiting function. Operation at this level is allowed continuously.

## Over-excitation Limit Outputs from the CGCM Unit

- **OEL_Active** – This tag is set to 1 when the exciter is operating in the Over-excitation Limiting mode.

## Line-drop Compensation Inputs to the CGCM Unit

- **LineDropComp** - This tag configures the amount of voltage droop that is experienced during paralleling generator applications.

## Under-excitation Limit Inputs to the CGCM Unit

- **UEL_En** - Setting this tag enables the Under-excitation Limiting function.
- **UEL_Kg** - This tag lets you adjust the proportional gain of the Under-excitation limiter. It also determines the response of the limiter to an Under-excitation event. Increasing this term increases the speed of the response of the limiter.
- **UEL_Ki** - This tag lets you adjust coarse loop gain and overall gain of the Under-excitation limiter. This tag determines the characteristic of the dynamic response to an Under-excitation event.
- **UEL_Curve_W_Pt1** – This tag is used as the Watt coordinate in the first Watt, VAR coordinate pair, that, in combination with four other Watt, VAR coordinate pairs, lets you enter an Under-excitation Limiting curve.
- **UEL_Curve_W_Pt2** – This tag is used as the Watt coordinate in the second Watt, VAR coordinate pair, that, in combination with four other Watt, VAR coordinate pairs, lets you enter an Under-excitation Limiting curve.
- **UEL_Curve_W_Pt3** - This tag is used as the Watt coordinate in the third Watt, VAR coordinate pair, that, in combination with four other Watt, VAR coordinate pairs, lets you enter an Under-excitation Limiting curve.
- **UEL_Curve_W_Pt4** - This tag is used as the Watt coordinate in the fourth Watt, VAR coordinate pair, that, in combination with four other Watt, VAR coordinate pairs, lets you enter an Under-excitation Limiting curve.
- **UEL_Curve_W_Pt5** - This tag is used as the Watt coordinate in the fifth Watt, VAR coordinate pair, that, in combination with four other Watt, VAR coordinate pairs, lets you enter an Under-excitation Limiting curve.
- **UEL_Curve_VAR_Pt1** - This tag is used as the VAR coordinate in the first Watt, VAR coordinate pair, that, in combination with four other Watt, VAR coordinate pairs, lets you enter an Under-excitation Limiting curve.
- **UEL_Curve_VAR_Pt2** - This tag is used as the VAR coordinate in the second Watt, VAR coordinate pair, that, in combination with four other Watt, VAR coordinate pairs, lets you enter an Under-excitation Limiting curve.
- **UEL_Curve_VAR_Pt3** - This tag is used as the VAR coordinate in the third Watt, VAR coordinate pair, that, in combination with four other Watt, VAR coordinate pairs, lets you enter an Under-excitation Limiting curve.

- **UEL_Curve_VAR_Pt4** - This tag is used as the VAR coordinate in the fourth Watt, VAR coordinate pair, that, in combination with four other Watt, VAR coordinate pairs, lets you enter an Under-excitation Limiting curve.
- **UEL_Curve_VAR_Pt5** - This tag is used as the VAR coordinate in the fifth Watt, VAR coordinate pair, that, in combination with four other Watt, VAR coordinate pairs, lets you enter an Under-excitation Limiting curve.

### Under-excitation Limit Outputs from the CGCM Unit

- **UEL_Active** – This tag is set to 1 when the exciter is operating in the Under-excitation Limiting mode.

## Protection

This section describes the protection tags for the CGCM unit.

### General Protection Inputs to the CGCM Unit

- **FltReset** – This tag is used by the host Logix controller to indicate to the CGCM unit that it has observed the fault condition reported by the CGCM unit, and wants the fault condition reset.

### General Protection Outputs from the CGCM Unit

- **FltOut** – This tag indicates that one of the configured protection faults has gone active.
- **FltResetAck** – This tag reports to the host Logix controller that the activation of the FltReset tag has been received by the CGCM unit, and the protective fault has been cleared.

### Loss of Excitation Inputs to the CGCM Unit

- **LossExcFltOutEn** - When this tag is a 1 in the configuration, and a Loss of Excitation Fault occurs (as defined by the LossExc_I_Setpt tag), the Fault Relay is energized. When this tag is a 0 in the configuration, a Loss of Excitation Condition has no effect on the Fault Relay.
- **LossExc_I_Setpt** - This tag configures the level of the CGCM unit's DC output current that is considered to be a minimum needed to maintain generator synchronization when in parallel with other power sources such as a utility grid.
- **LossExc_I_TimeDly** - This tag configures the amount of time the CGCM unit's excitation is below the Loss of Excitation Current Setpoint before the CGCM unit trips the generator off line by opening the generator breaker.

## Loss of Excitation Outputs from the CGCM Unit

- **LossExcFlt** - This tag is used to communicate the occurrence of a Loss of Excitation Fault to the host Logix controller. When this tag is a 1, it indicates that a fault has occurred. The tag is latched until the host Logix controller resets it by setting the FltReset tag.

## Shorted Excitation Output from the CGCM Unit

- **Spare2** - Indicates when the excitation output short circuit protection is active. When this tag is a 1, it indicates that a shorted output exists and the excitation current output has been clamped to a very low level. The tag is reset by either setting the tag SoftwareExcEN = 0 or by cycling the control power to the CGCM unit.

## Over-excitation Voltage Inputs to the CGCM Unit

- **OvrExcFltOutEn** - When this tag is a 1 in the configuration, and an Over-excitation Fault occurs (as defined by the OvrExcV_Setpt tag), the Fault Relay is energized. When this tag is a 0 in the configuration, an Over-excitation Condition has no effect on the Fault Relay.
- **OvrExcV_Setpt** - This tag configures the over-excitation voltage setpoint that the CGCM unit uses to recognize when an over-excitation condition is present. When the condition occurs, the CGCM unit starts timing toward a trip based on the Over-excitation Time Delay.
- **OvrExcV_TimeDly** - This tag configures the time to trip the unit once the over-excitation voltage setpoint has been exceeded.

## Over-excitation Voltage Outputs from the CGCM Unit

- **OvrExcFlt** - This tag is used to communicate the occurrence of an Over-excitation Fault to the host Logix controller. When this tag is a 1, it indicates that a fault has occurred. The tag is latched until the host Logix controller resets it by setting the FltReset tag.

## Generator Over-voltage Inputs to the CGCM Unit

- **Ovr_V_FltOutEn** – When this tag is a 1 in the configuration, and an Over-voltage Fault occurs (as defined by the Ovr_V_Setpt tag), the Fault Relay is energized. When this tag is a 0 in the configuration, an Over-voltage Condition has no effect on the Fault Relay.
- **Ovr_V_Setpt** – This tag configures the generator over-voltage setpoint that the CGCM unit recognizes an over-voltage condition is present and starts timing to trip based on the Over-voltage Time Delay.
- **Ovr_V_TimeDly** - This tag configures the time to shutdown the unit once the generator Over-voltage Setpoint has been exceeded.

## Generator Over-voltage Outputs from the CGCM Unit

- **Ovr_V_Flt** – This tag is used to communicate the occurrence of an Over-voltage Fault to the host Logix controller. When this tag is a 1, it indicates that a fault has occurred. The tag is latched until the host Logix controller resets it by setting the FltReset tag.

## Inputs to the CGCM Unit

- **Undr_V_FltOutEn** - When this tag is a 1 in the configuration, and an Under-voltage Fault occurs (as defined by the Undr_V_Setpt tag), the Fault Relay is energized. When this tag is a 0 in the configuration, an Under-voltage Condition has no effect on the Fault Relay.
- **Undr_V_Setpt** - This tag configures the generator under-voltage setpoint that the CGCM unit uses to recognize an under-voltage condition. When the condition occurs, the CGCM unit starts timing toward a trip.
- **Undr_V_TimeDly** - This setting establishes the time to trip the unit once the generator Under-voltage Setpoint has been exceeded.
- **EngineIdle** – Setting this tag to 1 enables Soft Start mode and disables the under-frequency, under-voltage, and Loss of PMG protections until the generator is at rated speed.

## Generator Under-voltage Outputs from the CGCM Unit

- **Undr_V_Flt** - This tag is used to communicate the occurrence of an Under-voltage Fault to the host Logix controller. When this tag is a 1, it indicates that a fault has occurred. The tag is latched until the host Logix controller resets it by setting the FltReset tag.

## Loss of Sensing Inputs to the CGCM Unit

- **LossSensingFltOutEn** - When this tag is a 1 in the configuration, and a Loss of Sensing Fault occurs the Fault Relay is energized. When this tag is a 0 in the configuration, a Loss of Sensing Condition has no effect on the Fault Relay.

## Loss of Sensing Outputs from the CGCM Unit

- **LossSensingFlt** - This tag is used to communicate the occurrence of a Loss of Sensing Fault to the host Logix controller. When this tag is a 1, it indicates that a fault has occurred. The tag is latched until the host Logix controller resets it by setting the FltReset tag.

## Loss of Operating Power Inputs to the CGCM Unit

- **LossPMGFltOutEn** - When this tag is a 1 in the configuration, and a Loss of PMG Fault occurs the Fault Relay is energized. When this tag is a 0 in the configuration, a Loss of PMG Condition has no effect on the Fault Relay.

## Loss of Operating Power Outputs from the CGCM Unit

- **LossPMGFlt** - This tag is used to communicate the occurrence of a Loss of PMG Fault to the host Logix controller. When this tag is a 1, it indicates that a fault has occurred. The tag is latched until the host Logix controller resets it by setting the FltReset tag.

## Reverse VAR Inputs to the CGCM Unit

- **RevVARFltOutEn** - When this tag is a 1 in the configuration, and a Reverse VAR Fault occurs (as defined by the Rev_kVAR Setpt tag), the Fault Relay is energized. When this tag is a 0 in the configuration, an Over-voltage Condition has no effect on the Fault Relay.
- **Rev_kVAR_Setpt** - This tag configures the generator reverse kVAR setpoint at which the CGCM unit recognizes a reverse kVAR (loss of excitation) condition is present and starts timing to trip based on the Reverse kVAR fault Delay setting.
- **Rev_kVAR_TimeDly** - This tag configures the time to shutdown/annunciate once the generator reverse kVAR setpoint has been exceeded.

## Reverse VAR Outputs from the CGCM Unit

- **RevVARFlt** - This tag is used to communicate the occurrence of a Reverse VAR Fault to the host Logix controller. When this tag is a 1, it indicates that a fault has occurred. The tag is latched until the host Logix controller resets it by setting the FltReset tag.

## Definite Time Over-frequency Inputs to the CGCM Unit

- **OvrFreqFltOutEn** - When this tag is a 1 in the configuration, and an Over-frequency Fault occurs (as defined by the OvrFreqSetpt tag), the Fault Relay is energized. When this tag is a 0 in the configuration, an Over-frequency Condition has no effect on the Fault Relay.
- **OvrFreqSetpt** - This tag configures the generator over-frequency setpoint at which the CGCM unit recognizes an over-frequency condition is present and starts timing to trip based on the Over-frequency Time Delay.
- **OvrFreqTimeDly** - This tag configures the time to shutdown/annunciate once the generator Over-frequency Setpoint has been exceeded.

## Definite Time Over-frequency Outputs from the CGCM Unit

- **OvrFreqFlt** - This tag is used to communicate the occurrence of an Over-frequency Fault to the host Logix controller. When this tag is a 1, it indicates that a fault has occurred. The tag is latched until the host Logix controller resets it by setting the FltReset tag.

## Definite Time Under-frequency Inputs to the CGCM Unit

- **UndrFreqFltOutEn** - When this tag is a 1 in the configuration, and an Under-frequency Fault occurs (as defined by the UndrFreqSetpt tag), the Fault Relay is energized. When this tag is a 0 in the configuration, an Under-frequency Condition has no effect on the Fault Relay.
- **UndrFreqSetpt** - This tag configures the generator under-frequency setpoint at which the CGCM unit recognizes an under-frequency condition is present and starts timing to trip based on the Under-frequency Time Delay.
- **UndrFreqTimeDly** - This tag configures the time to shutdown/annunciate once the generator Under-frequency Setpoint has been exceeded.
- **EngineIdle –** Setting this tag to 1 disables the under-frequency, under-voltage and Loss of PMG protections until the generator is at rated speed.

## Definite Time Under-frequency Outputs from CGCM

- **UndrFreqFlt** - This tag is used to communicate the occurrence of an Under-frequency Fault to the host Logix controller. When this tag is a 1, it indicates that a fault has occurred. The tag is latched until the host Logix controller resets it by setting the FltReset tag.

## Reverse Power Protection Inputs to the CGCM Unit

- **RevPwrFltOutEn** - When this tag is a 1 in the configuration, and a Reverse Power Fault occurs (as defined by the Rev_kW_Setpt tag), the Fault Relay is energized. When this tag is a 0 in the configuration, a Reverse Power Condition has no effect on the Fault Relay.
- **Rev_kW_Setpt** - This tag configures the generator reverse kW setpoint at which the CGCM unit recognizes a reverse power condition is present and starts timing to trip based on the Reverse kW fault Delay setting.
- **Rev_kW_TimeDly** - This tag configures the time to shutdown/annunciate once the generator reverse kW setpoint has been exceeded.

## Reverse Power Protection Outputs from the CGCM Unit

- **RevPwrFlt** - This tag is used to communicate the occurrence of a Reverse Power Fault to the host Logix controller. When this tag is a 1, it indicates that a fault has occurred. The tag is latched until the host Logix controller resets it by setting the FltReset tag.

## Rotating Diode Monitor Inputs to the CGCM Unit

- **RotDiodeFltOutEn** - When this tag is a 1 in the configuration, and a Shorted or Open Rotating Diode Fault occurs, the Fault Relay is energized. When this tag is a 0 in the configuration, a these conditions has no effect on the Fault Relay.
- **OpenDiodeMonitorLevel** - This tag sets the percent ripple at which the rotating diode monitor alarm announces when an open diode condition occurs.
- **ShortedDiodeMonitorLevel** - This tag sets the percent ripple at which the rotating diode monitor alarm announces when a shorted diode condition occurs.
- **DiodeMonitorTimeDly** - This tag sets the amount of time the CGCM unit takes before the CGCM unit announces the rotating diodes have an anomaly.
- **MainPole** - This tag sets the number of poles of the main field of the generator.
- **ExciterPole** - This tag sets the number of poles of the exciter field of the generator.

## Rotating Diode Monitor Outputs from the CGCM Unit

- **RotDiodeFlt** - This tag is used to communicate the occurrence of a Shorted or Open Rotating Diode Fault to the host Logix controller. When this tag is a 1, it indicates that a fault has occurred. The tag is latched until the host Logix controller resets it by setting the FltReset tag.
- **ShortedRotDiodeFlt** – This tag indicates that a Shorted Rotating Diode Fault caused the RotDiodeFlt tag to be set.
- **OpenRotDiodeFlt** - This tag indicates that an Open Rotating Diode Fault caused the RotDiodeFlt tag to be set.

## Phase Rotation Check Inputs to the CGCM Unit

- **PhRotFltOutEn** - When this tag is a 1 in the configuration, and a Phase Rotation Fault occurs the Fault Relay is energized. When this tag is a 0 in the configuration, a Phase Rotation Fault has no effect on the Fault Relay.

### Phase Rotation Check Outputs from the CGCM Unit

- **PhRotFlt** - This tag is used to communicate the occurrence of a Phase Rotation Fault to the host Logix controller. When this tag is a 1, it indicates that a fault has occurred. The tag is latched until the host Logix controller resets it by setting the FltReset tag.

### Generator Over-current Inputs to the CGCM Unit

- **Ovr_I_FltOutEn** - When this tag is a 1 in the configuration, and an Over-current Fault occurs (as defined by the Ovr_I_Setpt tag), the Fault Relay is energized. When this tag is a 0 in the configuration, an Over-current Condition has no effect on the Fault Relay.
- **Ovr_I_Setpt** - This tag configures the threshold that the CGCM unit uses to recognize when a generator over-current condition exists When the condition occurs, the CGCM unit starts timing toward a trip based on the selected over-current curve and time dial.
- **Ovr_I_TimeDial** – This tag configures the tripping time in relationship to the magnitude of the actual current applied to the CGCM unit.
- **Ovr_I_Curve** - This tag configures the time over-current characteristic curve that is used by the over-current function of the CGCM unit.
- **Ovr_I_VrestSetpt** - This tag lets the timed over-current characteristic to be modified based on the amount of generator voltage applied to the CGCM unit. If the generator voltage drops, indicating a close in fault to the generator, the generator voltage decays and the available fault current can be less. This parameter shifts the characteristic curve in such a manner as to compensate for the reduction of available fault current.

### Generator Over-current Outputs to the CGCM Unit

- **Ovr_I_Flt** - This tag is used to communicate the occurrence of an Over-current Fault to the host Logix controller. When this tag is a 1, it indicates that a fault has occurred. The tag is latched until the host Logix controller resets it by setting the FltReset tag.

## Synchronizing

This section describes the synchronizing inputs and outputs for the CGCM unit.

### Synchronizing Inputs to the CGCM Unit

- **AutoSyncEn** – This tag is used to configure the CGCM unit to perform Auto-Synchronization. This is one of three synchronization modes, each selected by their respective tag. Only one can be active (1) or the SyncModeConflict tag is activated and the synchronization fails (indicated by SyncFailure tag).

- **CheckSyncEn** – This tag is used to configure the CGCM unit to perform Check Synchronization. This is one of three synchronization modes, each selected by their respective tag. Only one can be active (1) or the SyncModeConflict tag is activated and the synchronization fails (indicated by SyncFailure tag).
- **PermissiveSyncEn** – This tag is used to configure the CGCM unit to perform Permissive Synchronization. This is one of three synchronization modes, each selected by their respective tag. Only one can be active (1) or the SyncModeConflict tag is activated and the synchronization fails (indicated by SyncFailure tag).
- **InitiateSync** – Setting this tag causes the CGCM unit to begin a synchronization sequence. This bit must stay set throughout the synchronization or the sequence is terminated.
- **SyncFreqHiLim** – This tag sets the upper limit frequency (in Hz) that is considered acceptable for a synchronization of two busses.
- **SyncFreqLoLim** – This tag sets the lower limit frequency (in Hz) hat is considered acceptable for a synchronization of two busses.
- **SyncV_HiLim** - This tag sets the upper limit voltage (in percentage) that is considered acceptable for a synchronization of two busses.
- **SyncV_LoLim** - This tag sets the lower limit voltage (in percentage) that is considered acceptable for a synchronization of two busses.
- **SyncPhHiLim** - This tag sets the upper limit phase (in degrees) that is considered acceptable for a synchronization of two busses.
- **SyncPhLoLim** - This tag sets the lower limit phase (in degrees) that is considered acceptable for a synchronization of two busses.
- **SyncAcceptDly** - This tag configures the time delay that is required to allow for breaker closing. This setting is based on the time the frequency, voltage and phase angle of the generator, and bus have been matched.
- **BusRotABC_ACB_Select** – This tag is used to configure the reference bus rotation sequence.
- **GenRotABC_ACB_Select** – This tag is used to configure the generator bus rotation sequence.
- **DeadBusGenFreqLoLim** - This tag configures the minimum frequency that must be present on the generator to allow the breaker to close under a Dead Bus condition.
- **DeadBusGenFreqHiLim** - This tag configures the maximum frequency that must be present on the generator to allow the breaker to close under a Dead Bus condition.
- **DeadBusGenV_LoLim** - This tag configures the minimum voltage that must be present on the generator to allow the breaker to close under a Dead Bus condition.
- **DeadBusGenV_HiLim** - This tag configures the maximum voltage that must be present on the generator to allow the breaker to close under a Dead Bus condition.
- **DeadBusClosureEn** – Setting this tag to 1 lets the generator achieve breaker closure with a dead bus.

- **BusA_PhOffset** - This tag configures a phase angle added to the measured bus A phase angle. It is used to compensate for phase shift across sensing transformers.
- **BusA_V_Scaler** - This tag configures a multiplier by which the measured bus A voltage is multiplied. It is used to compensate for ratio error across sensing transformers.
- **BusB_PhOffset** - This tag configures a phase angle added to the measured bus B phase angle. It is used to compensate for phase shift across sensing transformers.
- **BusB_V_Scaler** - This tag configures a multiplier by which the measured bus B voltage is multiplied. It is used to compensate for ratio error across sensing transformers.
- **BusA_B_Select** – This tag selects which reference bus the CGCM unit attempts to synchronize to.
- **V_Match** Gain-This tag sets the Proportional Gain parameter for Voltage Matching mode

## Synchronizing Outputs from the CGCM Unit

- **SyncDeadBus** - This tag indicates all conditions have been to allow a DeadBus synchronization
- **AutoSync** – This tag follows the AutoSyncEn tag setting in the Scheduled Write tag.
- **CheckSync** - This tag follows the CheckSyncEn tag setting in the Scheduled Write tag.
- **PermissiveSync** - This tag follows the PermissiveSyncEn tag setting in the Scheduled Write tag.
- **SyncFailure** – This tag indicates that the synchronization attempt failed.
- **UndefinedSyncMode** – This tag indicates that a synchronization was initiated when none of the synchronization modes were asserted.
- **SyncModeConflict** – This tag indicates that more than one Synchronization mode was selected.
- **BusRot_ABC_ACB** – This tag reports the rotation sequence of the reference bus in three phase metering. In single phase metering, these bits reflect the configuration value.
- **GenRot_ABC_ACB** – This tag reports the rotation sequence of the generator bus in three phase metering. In single phase metering, these bits reflect the configuration value.
- **PhRotMatch** – This tag reports that the phase rotation between the two busses to be synchronized matches, and is acceptable for synchronizing.
- **V_Match** - This tag reports that the voltage difference between the two busses is within the configured acceptable range.
- **FreqMatch** - This tag reports that the frequency difference between the two busses is within the configured acceptable range.

- **PhMatch** - This tag reports that the phase difference between the two busses is within the configured acceptable range.
- **V_MatchErr** – This tag reports the percentage difference in voltage between the two busses to be synchronized.
- **FreqMatchErr** – This tag reports the difference in frequency between the two busses to be synchronized.
- **PhMatchErr** – This tag reports the phase difference between the two busses to be synchronized.
- **CloseBusA_Brkr** – When this tag is 1, it indicates that synchronization has reached a status where it is acceptable to close the breaker to Bus A.
- **CloseBusB_Brkr** – When this tag is 1, it indicates that synchronization has reached a status where it is acceptable to close the breaker to Bus B.
- **Raise_V** – This tag indicates to the host Logix controller that the synchronizing bus has a lower voltage level than that of the reference bus.
- **Lower_V –** This tag indicates to the host Logix controller that the synchronizing bus has a lower voltage level than that of the reference bus.
- **Raise_Freq -** This tag indicates to the host Logix controller that the synchronizing bus is producing voltage at a frequency lower than that of the reference bus.
- **Lower_Freq -** This tag indicates to the host Logix controller that the synchronizing bus is producing voltage at a frequency higher than that of the reference bus
- **Raise_Ph -** This tag indicates to the host Logix controller that the synchronizing bus is producing a voltage that is between 0 and 180 degrees behind the reference bus.
- **Lower_Ph -** This tag indicates to the host Logix controller that the synchronizing bus is producing a voltage that is between 0 and 180 degrees ahead of the reference bus.
- **ActiveBusA_B** – This tag provides feedback as to which reference bus is being monitored.

## Load Sharing

This section describes the load sharing inputs and outputs for the CGCM unit.

### Load Sharing Inputs to the CGCM Unit

- **kVAR_LS_BridgeEn** – This tag is reserved for future use.
- **kVAR_LS_En** – This tag is reserved for future use: must be set to 1 in conjunction with kW-LS-EN tag in Rev. 2.x.
- **kW_LS_BridgeEn** – When this tag is set to 1, the CGCM unit uses the value of kw_AnalogTargetPUValue as the kW Load Share setpoint to provide appropriate bias to the analog units connected to the LS lines.
- **kW_LS-EN** -When this tag is set to 1 the CGCM unit enables the kilowatt load share function.

- **kW_LS_OutV** – This tag sets the voltage that the CGCM unit attempts to output from the load-sharing terminals.
- **kVAR_LS_OutV** – This tag is reserved for future use.
- **LS_FS_V** - This tag sets the voltage the load share output reaches when the generator is producing 1 p.u. kVA. The base for this calculation is the calculated generator kVA.
- **LSRate** - This tag configures the time required for the load share output to change the per unit amount defined above.
- **LSLimit** - This tag configures the amount of per unit change allowed in the load share output per unit of time defined below.
- **KWAnalogTargetPUValue** – The value of this tag is used to provide the bias to the load share lines when the kW_LS_BridgeEN tag is set to 1.
- **KWDigitalTargetPUValue** – This tag is reserved for future use.
- **KVARAnalogTargetPUValue** – This tag is reserved for future use.
- **KVARDigitalTargetPUValue** – This tag is reserved for future use.

## Load Sharing Outputs from the CGCM Unit

- **kVAR_LS_Active** – This tag is reserved for future use.
- **kW_LS_Active** - This tag follows the kW_LS_En tag setting in the Scheduled Write tag.
- **LS_Err** – This tag reports the load share error that is the difference between the kW_LS_OutV and the kW_LS InputV.
- **kW_LS_InputV** – This tag reports the voltage present at the load-sharing terminals.
- **kW_PU_Load** - This tag reports the total p.u. kVA being produced by the active phases of the generator. The base for this calculation is the configured generator kVA.
- **kW_AnalogPU_Load** – This tag reports the value of the voltage present at the load share terminals divided by the configured full scale voltage. It represents the system per unit load.
- **kVAR_LS_InputV** - The product of the RMS magnitude of the reactive portion of the differential current flowing in the input CT and the generator terminal voltage is computed. The product is divided by the rated kVA to determine the reported value for this tag.
- **kVAR_PU_Load** - This tag reports the total p.u. kVAR being produced by the active phases of the generator. The base for this calculation is the configured generator kVA.
- **kVAR_AnalogPU_Load** – This tag reports the difference between the KVAR_PU_Load and the kVAR_LS_inputV.

## Metering

This section describes the metering inputs and outputs for the CGCM unit.

### Metering Inputs to the CGCM Unit

- **Set_kW_Hrs –** When this tag is set to a 1, the kW_Hrs counter is set to 0 in versions 2.*x*. In host firmware revision 3.*x* and later, the value of the tag kWHoursPreset is loaded into the counter.
- **Set_kVAR_Hrs –** When this tag is set to a 1, the kVAR_Hrs counter is set to 0 in versions 2.*x*. In host firmware revision 3.*x* and later, the value of the tag kVARHoursPreset is loaded into the counter.
- **Set_kVA_Hrs –** When this tag is set to a 1, the kVA_Hrs counter is set to 0 in versions 2.*x*. In host firmware revision 3.*x* and later, the value of the tag kVAHoursPreset is loaded into the counter.
- **kwHoursPreset** - This value is loaded into the kW_hrs counter when Set_kW_Hrs is asserted.
- **kVARHoursPreset** - This value is loaded into the kVAR_hrs counter when Set_kW_Hrs is asserted.
- **kVAHoursPreset** - This value is loaded into the kVA_hrs counter when Set_kW_Hrs is asserted.

### Metering Outputs from the CGCM Unit

- **AvgPF**- This tag reports the Average Power Factor of the active phases of the generator.
- **PhA_PF –** This tag reports the Power Factor associated with Generator Phase A.
- **PhB_PF –** This tag reports the Power Factor associated with Generator Phase B.
- **PhC_PF -** This tag reports the Power Factor associated with Generator Phase C.
- **Total_kVA -** This tag reports the Total kVA being produced by the active phases of the generator.
- **PhA_kVA -** This tag reports the kVA being produced by Generator Phase A.
- **PhB_kVA -** This tag reports the kVA being produced by Generator Phase B.
- **PhC_kVA -** This tag reports the kVA being produced by Generator Phase C.
- **Total_kW -** This tag reports the Total kW being produced by the active phases of the generator.
- **PhA_kW -** This tag reports the kW being produced by Generator Phase A.
- **PhB_kW -** This tag reports the kW being produced by Generator Phase B.
- **PhC_kW -** This tag reports the kW being produced by Generator Phase C.

- **Total_kVAR** - This tag reports the Total kVARs being produced by the active phases of the generator.
- **PhA_kVAR** - This tag reports the kVARs being produced by Generator Phase A.
- **PhB_kVAR** - This tag reports the kVARs being produced by Generator Phase B.
- **PhC_kVAR** - This tag reports the kVARs being produced by Generator Phase C.
- **Avg_I** - This tag reports the Average Current of the active phases of the generator.
- **PhA_I**- This tag reports the current in Generator Phase A.
- **PhB_I**- This tag reports the current in Generator Phase B.
- **PhC_I**- This tag reports the current in Generator Phase C.
- **AvgLLGenV** - This tag reports the Average Line-to-Line Voltage of the active phases of the generator.
- **PhAB_GenV** - This tag reports the Line-to-Line Voltage between Generator Phases A and B.
- **PhBC_GenV** - This tag reports the Line-to-Line Voltage between Generator Phases B and C.
- **PhCA_GenV** - This tag reports the Line-to-Line Voltage between Generator Phases C and A.
- **AvgLN_GenV** - This tag reports the Average Line-to-Neutral Voltage of the active phases of the generator**.**
- **PhA_GenV** - This tag reports the Voltage from Generator Phase A to Neutral.
- **PhB_GenV** - This tag reports the Voltage from Generator Phase B to Neutral.
- **PhC_GenV** - This tag reports the Voltage from Generator Phase C to Neutral.
- **AvgLL_BusV** - This tag reports the Average Line-to-Line Voltage of the active phases of the bus.
- **PhAB_BusV** - This tag reports the Line-to-Line Voltage between Bus Phases A and B.
- **PhBC_BusV** - This tag reports the Line-to-Line Voltage between Bus Phases B and C.
- **PhCA_BusV** - This tag reports the Line-to-Line Voltage between Bus Phases C and A.
- **AvgLN_BusV** - This tag reports the Average Line-to-Neutral Voltage of the active phases of the bus.
- **PhA_BusV** - This tag reports the Voltage from Bus Phase A to Neutral.
- **PhB_BusV** - This tag reports the Voltage from Bus Phase B to Neutral.
- **PhC_BusV** - This tag reports the Voltage from Bus Phase C to Neutral.
- **BusB_V** – Reference Bus voltage for the B reference in a dual breaker scenario.

- **Exc_V-** This tag reports the Excitation Voltage.
- **Exc_I –** This tag reports the Excitation Current.
- **ExcRipple –** This tag reports the Ripple Current component of the Excitation Current.
- **kW_Hrs –** This tag reports the cumulative kWHours produced by the Generator.
- **kVAR_Hrs –** This tag reports the cumulative kVARHours produced by the Generator.
- **kVA_Hrs –** This tag reports the cumulative kVAHours produced by the Generator.
- **GenFreq –** This tag reports the Generator frequency.
- **BusFreq –** This tag reports the Bus frequency.
- **V_AdjustOffset** – This tag reports the voltage on the VREF terminals of the CGCM unit.
- **BusV_Present** - This tag indicates if there is voltage present on the reference bus.
- **GenV_Present** - This tag indicates if generator voltage is being developed.
- **FreqLessThan10Hz** - This tag indicates that the generator frequency is less than 10 Hz.

## Redundancy

This section describes the redundancy inputs and outputs for the CGCM unit.

### Redundancy Inputs to the CGCM Unit

- **RedndtTrackRate -** This tag configures the rate at which the Tracking mode of the redundant CGCM units matches the primary CGCM unit's active excitation control mode
- **RedndtTrackDly -** This tag changes the initial delay of the tracking function of the redundant CGCM unit to prevent the Tracking mode from adjusting the non-active modes into an undesirable condition. For example, while the unit is operating in AVR mode, the sensing VT fails to open. If the redundant CGCM unit Tracking mode were allowed to instantly track the full-on condition created by the loss of sensing, the transfer to the redundant CGCM unit in an undesirably high generator voltage. Adding a tracking delay enables the unit to transfer to a redundant CGCM unit without letting the redundant CGCM unit follow into a potentially undesirable operating point.

## Redundancy Outputs from the CGCM Unit

- **CGCM_Flt** - This tag indicates, if the CGCM unit is still capable, that the CGCM unit has a detected an internal failure.
- **CGCMInControl** - This tag indicates that the CGCM unit has hardware and software excitation enabled.
- **Spare1** - When operating in Redundant mode, this tag indicates the CGCM unit has assumed the role of primary and is providing excitation to the generator.

# Configuration Record Worksheet

We suggest you use these charts to record the initial configuration settings of the CGCM unit for each generator. Please make a copy of this appendix for each generator to be controlled. After entering the data and settings, keep this information for future reference.

Refer to Chapter 4 for more information on configuration of the CGCM unit.

## Generator Information

| Parameter | Units | Generator data |
|---|---|---|
| Generator manufacturer and serial number | N/a | |
| Rated frequency | Hz | |
| Rated voltage | V AC | |
| Rated current | A AC | |
| Rated power | W | |
| PMG rated voltage | V AC | |
| Rated field voltage | V DC | |
| No-load exciter field voltage | V DC | |
| Rated field current | A DC | |
| Exciter maximum forcing current | A DC | |
| Generator direct access transient time constant $T'_{do}$ | s | |
| Generator exciter field time constant $T_e$ | s | |

In addition, these generator characteristic curves provide information helpful in configuring specific functions:

- Reactive capability curve
- Generator decrement curves
- Contact the generator manufacturer for this information.

# CGCM Unit Configuration Settings

**Table 46 - Generator Tab**

| Parameter | Units | Setting |
|---|---|---|
| Rated frequency | Hz | |
| Rated voltage | V AC | |
| Rated current | A AC | |
| Rated power | kW | |
| Rated field voltage | V DC | |
| Rated field current | A DC | |

**Table 47 - Transformers Tab**

| Parameter | Units | Setting |
|---|---|---|
| Generator VT configuration | N/A | |
| Generator VT primary voltage | V AC | |
| Generator VT secondary voltage | V AC | |
| Bus VT configuration | N/A | |
| Bus A VT primary voltage | V AC | |
| Bus A VT secondary voltage | V AC | |
| Bus B VT primary voltage | V AC | |
| Bus B VT secondary voltage | V AC | |
| Metering CT primary current | A AC | |
| Metering CT secondary current | A AC | |
| Cross Current CT primary current | A AC | |
| Cross Current CT secondary current | A AC | |

**Table 48 - Excitation Tab**

| Parameter | Units | Setting |
|---|---|---|
| Soft start initial voltage | % | |
| Soft start time | s | |
| Excitation select | PMG or shunt | |
| PMG phase select | Single or three | |
| Loss of excitation current setpoint | A DC | |
| Loss of excitation current delay | s | |
| Rotating diode fault open diode level | % ripple | |
| Rotating diode fault delay | s | |
| Rotating diode fault shorted diode level | % ripple | |
| Number of main poles | N/A | |
| Number of exciter poles | N/A | |

**Table 49 - Volts/Hz Tab**

| Parameter | Units | Setting |
|---|---|---|
| V/Hz upper knee frequency | Hz | |
| V/Hz upper slope | p.u. V / p.u. Hz | |
| V/Hz lower knee frequency | Hz | |
| V/Hz lower slope | p.u. V / p.u. Hz | |

**Figure 70 - Under-frequency Slope and Knee Voltages**

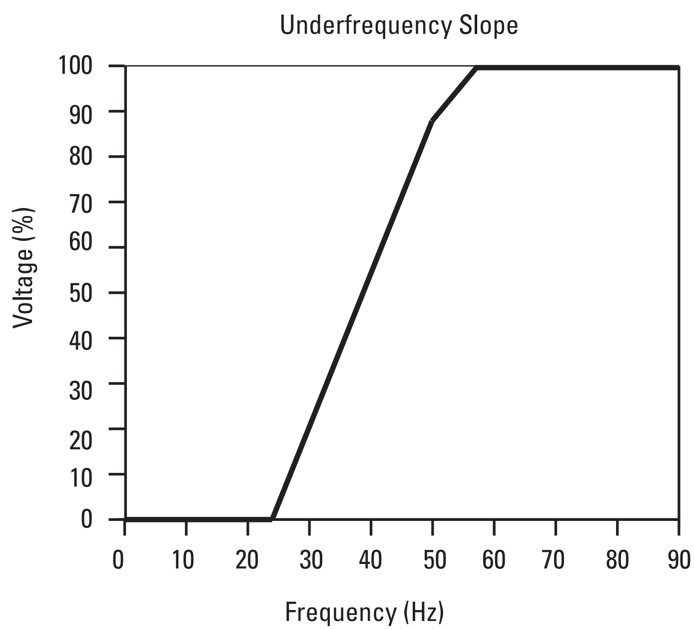


**Table 50 - Over-excitation Limiting (OEL) Tab**

| Parameter | Units | Setting |
|---|---|---|
| Online high-level setpoint | A DC | |
| Online high-level time delay | s | |
| Online medium-level setpoint | A DC | |
| Online medium-level time delay | s | |
| Online low-level setpoint | A DC | |
| Offline high-level setpoint | A DC | |
| Offline high-level time delay | s | |
| Offline low-level setpoint | A DC | |

**Figure 71 - Offline Over-excitation Limiting**

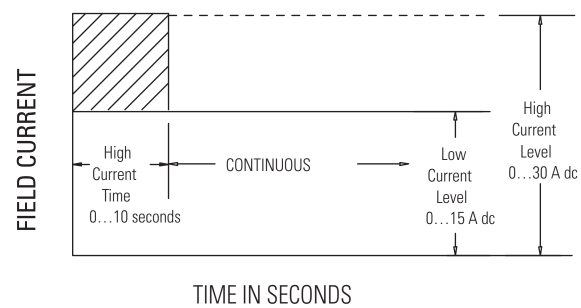



**Figure 72 - Online Over-excitation Limiting**

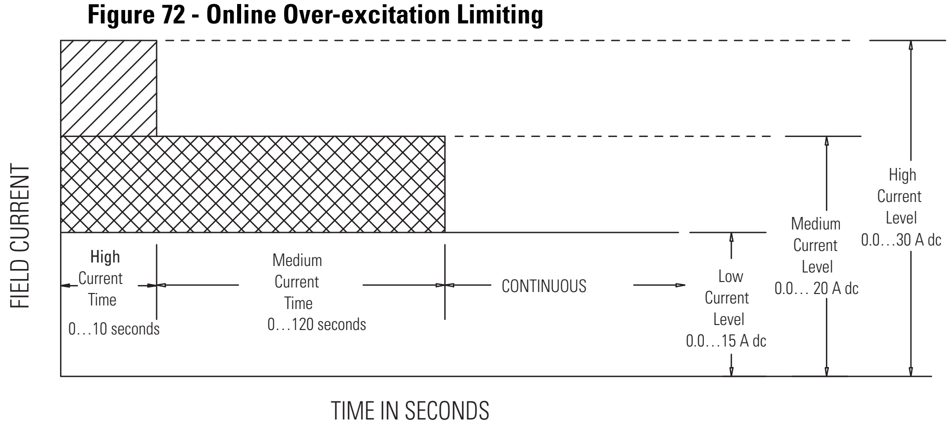


**Table 51 - Under-excitation Limiting (UEL) Tab**

| Parameter | Units | Setting |
|---|---|---|
| UEL Curve kW point #1 | kW | |
| UEL Curve kW point #2 | | |
| UEL Curve kW point #3 | | |
| UEL Curve kW point #4 | | |
| UEL Curve kW point #5 | | |
| UEL Curve kvar point #1 | kvar | |
| UEL Curve kvar point #2 | | |
| UEL Curve kvar point #3 | | |
| UEL Curve kvar point #4 | | |
| UEL Curve kvar point #5 | | |

**Figure 73 - Typical UEL Limiting Curve**

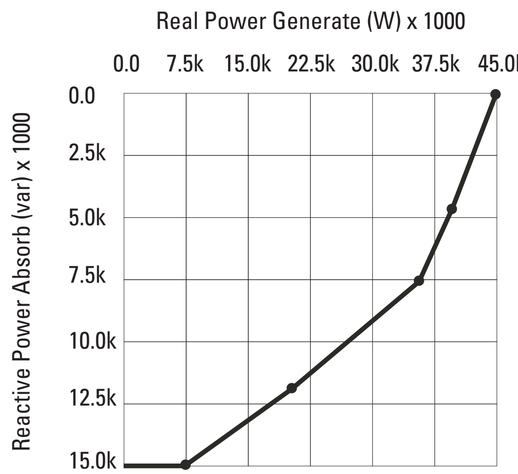


**Table 52 - Gain Tab**

| Parameter | Setting |
|---|---|
| Power factor integral gain Ki | |
| Power factor overall gain Kg | |
| Var integral gain Ki | |
| Var overall gain Kg | |
| OEL integral gain Ki | |
| OEL proportional gain Kg | |
| UEL integral gain Ki | |
| UEL proportional gain Kg | |
| AVR control proportional gain Kp | |
| AVR control integral gain Ki. | |
| AVR control derivative gain Kd | |
| Time constant Td | |
| FCR overall gain Kg | |
| AVR control overall gain Kg | |
| AVR control voltage matching gain | |
| AVR/FCR control auxiliary gain | |
| PF/Var auxiliary gain | |
| Cross current gain | |

**Table 53 - Tracking Tab**

| Parameter | Units | Setting |
|---|---|---|
| Internal tracking rate | s / full scale | |
| Internal tracking delay | s | |
| Redundant tracking rate | s / full scale | |
| Redundant tracking delay | s | |
| AVR control traverse rate | | |
| Power factor traverse rate | | |
| Var control traverse rate | | |
| Manual control (FCR) traverse rate | | |

**Table 54 - Sync Tab**

| Parameter | Units | Setting |
|---|---|---|
| Frequency match lower limit | Hz | |
| Frequency match upper limit | Hz | |
| Voltage match lower limit | % | |
| Voltage match upper limit | % | |
| Phase match lower limit | deg | |
| Phase match upper limit | deg | |
| Acceptance delay | s | |
| Bus A voltage multiplier | N/A | |
| Bus A offsets phase | deg | |
| Bus B voltage multiplier | N/A | |
| Bus B offsets phase | deg | |
| Dead bus minimum frequency | Hz | |
| Dead bus maximum frequency | Hz | |
| Dead bus minimum voltage | V AC | |
| Dead bus maximum voltage | V AC | |
| Generator phase rotation | ABC / ACB | |
| Bus phase rotation | ABC / ACB | |

**Table 55 - Load Share Tab**

| Parameter | Units | Setting |
|---|---|---|
| Full Scale Voltage Vdc | | |
| Limit | | |
| Rate | | |

**Table 56 - Voltage Tab**

| Parameter | Units | Setting |
|---|---|---|
| Over-voltage Setpoint (percent of rated) | % | |
| Over-voltage Time Delay | s | |
| Under-voltage Setpoint (percent of rated) | % | |
| Under-voltage Time Delay | s | |
| Over-excitation Voltage Setpoint | V DC | |
| Over-excitation Time Delay | s | |
| Droop Percentage | % | |
| Line Drop Voltage Compensation | % | |

**Table 57 - Current Tab**

| Parameter | Units | Setting |
|---|---|---|
| Over-current Setpoint. | % | |
| Over-current Curve | | |
| Over-current Time Dial | | |
| Over-current Voltage Restraint Setpoint | % | |

**Table 58 - Frequency Tab**

| Parameter | Units | Setting |
|---|---|---|
| Over-frequency Setpoint | Hz | |
| Over-frequency Delay | s | |
| Under-frequency Setpoint | Hz | |
| Under-frequency Delay | s | |

**Table 59 - Power Tab**

| Parameter | Units | Setting |
|---|---|---|
| Reverse kW Setpoint | % | |
| Reverse kW Fault Delay | s | |
| Reverse kvar Setpoint | % | |
| Reverse kvar Fault Delay | s | |

## A



## C



## D



## E

# Notes:

## Rockwell Automation Support

Rockwell Automation provides technical information on the Web to assist you in using its products. At http://www.rockwellautomation.com/support you can find technical and application notes, sample code, and links to software service packs. You can also visit our Support Center at https://rockwellautomation.custhelp.com/ for software updates, support chats and forums, technical information, FAQs, and to sign up for product notification updates.

In addition, we offer multiple support programs for installation, configuration, and troubleshooting. For more information, contact your local distributor or Rockwell Automation representative, or visit http://www.rockwellautomation.com/services/online-phone.

### Installation Assistance

If you experience a problem within the first 24 hours of installation, review the information that is contained in this manual. You can contact Customer Support for initial help in getting your product up and running.

| | |
|---|---|
| United States or Canada | 1.440.646.3434 |
| Outside United States or Canada | Use the Worldwide Locator at http://www.rockwellautomation.com/rockwellautomation/support/overview.page, or contact your local Rockwell Automation representative. |

### New Product Satisfaction Return

Rockwell Automation tests all of its products to help ensure that they are fully operational when shipped from the manufacturing facility. However, if your product is not functioning and needs to be returned, follow these procedures.

| | |
|---|---|
| United States | Contact your distributor. You must provide a Customer Support case number (call the phone number above to obtain one) to your distributor to complete the return process. |
| Outside United States | Please contact your local Rockwell Automation representative for the return procedure. |

## Documentation Feedback

Your comments will help us serve your documentation needs better. If you have any suggestions on how to improve this document, complete this form, publication RA-DU002, available at http://www.rockwellautomation.com/literature/.

Rockwell Automation maintains current product environmental information on its website at http://www.rockwellautomation.com/rockwellautomation/about-us/sustainability-ethics/product-environmental-compliance.page.

Rockwell Otomasyon Ticaret A.Ş., Kar Plaza İş Merkezi E Blok Kat:6 34752 İçerenköy, İstanbul, Tel: +90 (216) 5698400

**www.rockwellautomation.com**

**Power, Control and Information Solutions Headquarters**

Americas: Rockwell Automation, 1201 South Second Street, Milwaukee, WI 53204-2496 USA, Tel: (1) 414.382.2000, Fax: (1) 414.382.4444
Europe/Middle East/Africa: Rockwell Automation NV, Pegasus Park, De Kleetlaan 12a, 1831 Diegem, Belgium, Tel: (32) 2 663 0600, Fax: (32) 2 663 0640
Asia Pacific: Rockwell Automation, Level 14, Core F, Cyberport 3, 100 Cyberport Road, Hong Kong, Tel: (852) 2887 4788, Fax: (852) 2508 1846