Guide Form Specification

DGC-2020 Digital Genset Controller

1. General

A flexible, easy to program and operate, microprocessor-based, multifunction generator set controller with the capability to communicate to an engine equipped with analog engine senders or an ECU. It should provide for communications to outside sources via a USB, dial-out/dial-in modem, or an RS-485 connection via Modbus®. The genset controller shall provide the following basic functions as described below: genset start/stop control (local and remote), engine protection, generator protection, generator metering, engine metering, transfer switch control, Windows® based PC software with programmable logic, file management, remote control and monitoring facilities, easy setup and configuration of the controller, and options for automatic synchronizing, additional contact outputs, RS-485 communications, battery backup for the real-time clock, enhanced generator protection, and an internal industrial grade modem. This package must be environmentally hardened to withstand the harshest environments that a genset can be operated within.

2. Start/Stop Control

The genset controller must provide for starting and stopping the genset either manually or automatically. For manual starting, the controller should allow either for a local start control, front-panel mounted pushbutton, or remotely via a contact input or from the PC software. In the automatic mode, the genset controller shall allow for remote starting from an external contact input or from an external start signal that could come from a Modbus control using the optional RS-485 port or from an input from the PC software using the optional onboard modem. Crank disconnect shall have three means for determining the engine has started. These shall be sensing speed from the engine's magnetic pickup, the generator's output voltage, or from the buildup of oil pressure. If one of these methods should fail, the genset controller will automatically revert to the next programmed source and use that for speed sensing. It shall also annunciate the loss of a speed signal.

3. Protection

The genset controller shall provide protection for the engine and generator as well as the loads connected to the generator. There shall be protection that is easily adjustable by the user with threshold settings and time delays as required to adequately protect the genset and connected loads. All functions of the protection package shall be programmable and selectable in the programmable logic portion of the PC software for implementing in to a larger system level control scheme. The engine shall have the following protection offering:

- Engine overspeed
- High coolant temp
- Loss of engine senders
- Low fuel level
- Low oil pressure

The engine protection scheme must also allow warnings to be annunciated to the operator. These shall include all of the engine protection noted above and, in addition to those, it must provide for:

- 3 kW overload thresholds (with single- and three-phase settings for setpoint and hysteresis)
- Active DTCs from the ECU
- Coolant level
- ECU communication failure
- High battery voltage
- High coolant temp
- High fuel level
- Low battery voltage
- Low coolant temperature
- Low fuel level
- Low oil pressure
- Maintenance time
- Weak battery

The generator protection shall provide for multiple setpoints and time delays. The generator protection package shall work in conjunction with the genset control portion and adequately protect the generator while being secure enough to not cause false tripping under normal generator operation during startup and shutdown. This will include underfrequency inhibits for the undervoltage protection and voltage inhibits for the underfrequency protection. The generator protection package must also have provisions for separate single- and three-phase settings to allow the protection to be changed automatically with a contact input indicating the generator configuration from a generator selection switch for gensets used in the rental market. The generator shall have the following protection functions as standard and shall offer optional protection features as noted below:

- Loss of Excitation (40Q)
- Overcurrent (51) – optional
- Overfrequency (81O)
- Overvoltage (59) – two elements
- Reverse power (32)
- Underfrequency (81U)
- Undervoltage (27) – two elements
- Voltage phase imbalance (47) – optional

The overcurrent protection is critical and must have three elements. Each element must have adjustable thresholds, time delays, and a minimum of 17 time current characteristic curves that the user can select from to allow them to choose a time current curve that best replicates the generator's breaker characteristics with a selection. There must also be a selection for an extended time dial range of fixed time up to 7,200 seconds.

All protection functions shall be enabled by the user and will be annunciated via the front panel LCD, the USB port and the PC software, the RS-485 Modbus communications (if equipped), and the internal dial-out modem (if equipped).

4. Event Log

The unit shall have an event log for recording alarms, pre-alarms, engine start-ups, engine shutdowns, modem dial-out attempts, ATS contact inputs, and other entries to assist in the troubleshooting and maintenance of the genset. There shall be 30 entry items, that should record the time/date, and engine run hours of the first occurrence, the last occurrence, and it shall have an occurrence count. In addition, each record shall contain details of the time, date, and engine run hours for the most recent 30 occurrences of that event. Since detailed information is retained for the most recent 30 occurrences for each event record and there are 30 event records, up to 900 specific events shall be recorded. The event log shall be viewable from the front panel or via the PC software. The PC software will allow the user to sort the entries based on the entry type, the first or last occurrence date or time, or the occurrence count. The PC software will also allow the user to download an event file in CSV format to a spreadsheet application.

5. Metering

The genset controller shall monitor the engine and generator portion of the genset. It shall also monitor the bus input sufficiently to indicate the status of the bus. The genset controller shall monitor the following engine parameters:

- Battery voltage
- Coolant temperature
- Engine run time
- Fuel level
- Hours until maintenance is due
- Oil pressure
- RPM
- Various parameters available from the engine ECU via J1939

Engine metering information can be provided via three analog sender inputs (OP, Coolant Temp, Fuel Level), or via an engine's ECU if equipped. The genset controller shall be able to accommodate either method.

The genset controller shall monitor the following generator parameters:

- Apparent power (kVA) total
- Frequency
- Kilowatthours
- Power factor
- Real power (kW) total
- Real power (kW), L-L
- RMS current
- RMS voltage, L-L
- RMS voltage, L-N
- Vars

An automatic phase toggle shall be provided to that allows the user to toggle through the phases at a fixed rate automatically.

The genset controller shall monitor the following bus parameters:

- Frequency
- RMS voltage

6. ATS Control

As a standard feature, the genset controller will have an integrated automatic transfer switch control to allow the genset to monitor the primary power source and automatically start the genset and transfer loads to the genset if the primary source of power gets outside of acceptable voltage and/or frequency levels. Once the primary source of power is returned to normal and stabilized for a period of time, the load will be automatically transferred back to the primary power source.

7. Smart Cool-Down Timer

To conserve fuel, the genset controller must be equipped with a cool-down timer that can recognize when the genset is lightly loaded and will reduce the cool-down time accordingly. This function will be functional when the controller is in the Auto mode and controlled by a remote start signal. Additionally, there shall be a selection to have this function enabled when the unit goes from the Run mode to the Off mode.

8. Contact Inputs

The genset controller shall have 17 contact inputs. One of the inputs shall be dedicated to the Emergency stop function in order to comply with NFPA 110 and the other 16 inputs shall be programmable and selectable in the programmable logic portion of the PC software.

9. Contact Outputs

The genset controller shall have seven contact outputs as standard. There shall be three 30-Adc rated contacts and four 2 Adc rated contacts with an option for eight additional 2 Adc rated contact outputs. The three 30 A rated contacts shall be assigned the functions of crank control, fuel solenoid control, and glow plug (pre-start) control. The use of solid-state outputs is not acceptable. Each contact output shall be programmable and selectable in the programmable logic portion of the PC software.

10. Expandable I/O

The genset controller must be designed to accept additional contact and analog input/output modules to allow for expansion of the capability of the genset controller. These modules can be added on to the genset controller at any time and do not require the controller to be returned to the manufacturer for accepting the modules. The additional inputs and outputs will be mapped and assigned functions in the programmable logic portion of the PC software.

10.1. Contact I/O Module

This module will communicate to the genset controller via SAE J1939 protocol. It will provide 10 additional programmable inputs for use in the genset controller programmable logic. There shall

be 12 4-Adc rated contacts and 12 1-Adc rated contact outputs. All of the contacts outputs shall be form-C, dry type.

10.2. Analog I/O Module

This module will communicate to the genset controller via SAE J1939 protocol. It will provide eight additional programmable analog inputs for use in the genset controller programmable logic. The inputs shall be user selectable for 4 to 20 mA or 0 to 10 Vdc. There shall be two K-type thermocouple inputs and eight RTD inputs. The RTD inputs will be user selectable for 10- or 100-ohm inputs. All of the inputs will provide two over and two under thresholds for protection and tripping based on these analog inputs. There will also be four (4) analog outputs. These will be user selectable for 4 to 20 mAdc or 0 to 10 Vdc output. These outputs can be used to drive external analog meters and can be configured for a wide range of parameters including oil pressure, fuel level, generator voltage, and bus voltage.

11. Load Sharing Module

The genset controller must be capable of accepting the addition of a remote module that allows for kW load sharing. This module should include outputs for controlling the summing point of a voltage regulator and speed governor. It should also have an output for controlling the analog load sharing line of existing gensets. These outputs must be customer selectable for 4 to 20 mAdc or ±10 Vdc. The outputs should be scalable to allow for the compatibility with other load sharing devices. The output selection should be in the PC software. The remote module should communicate information to the genset controller via SAE J1939 protocol. It should also provide Ethernet communications for allowing the pc software to be used to communicate to the genset controller. This module should include provisions for generator sequencing and sharing genset status information via Ethernet. The Load Share Module should also provide for regulation of the generator var/power factor when it is connected to the utility/mains.

12. Packaging

Because of the potentially harsh environments that the genset will be operating in, the genset controller must be very rugged in design. The design of the controller must be such that the printed circuit boards are not exposed to the environment. The printed circuit boards must be fully encapsulated by an epoxy substance that completely submerges the electronic components. Simple conformal coating of the printed circuit boards is not sufficient to meet this requirement. There should also be a back cover to help protect the connections and components of the unit. The dimensions must be 11.77 inches wide by 8.27 inches high by 2.31 inches deep. The front panel of the device must allow for programming of the unit and the menu structure must follow that of the PC software. The front panel will include an LCD good for operation across the entire temperature range of the controller and LED indication of the genset supplying load, alarms, unit Not In Auto, Run, Off, and Auto. Annunciation of shutdowns (alarms) or warnings (pre-alarms) will be done by LED and/or via the front panel LCD. A Shutdown will light a common alarm LED (Red) and the reason for the alarm will be displayed on the LCD. A warning (pre-alarm) will flash the common alarm LED and the pre-alarm message will be displayed on the LCD. The LCD will alternate between the warning message and the metering screen so that the metering information is not obstructed from view. The front panel must be sealed to meet IP54.

13. PC Software

The PC software must allow for easy setup and file transfer. It must allow the user to remotely monitor and control the genset. It must provide a large amount of flexibility and must include programmable logic. The programmable logic must include logic gates for AND, OR, XOR, and NOT functions. It must include a variety of timers bother pickup and dropout. It must include Set and Reset priority latches. There should also be programmable logic to enhance the protection schemes of this device. Configurable Protection shall be provided within the programmable logic that allows the user to select a parameter to be measured and set two over and two under thresholds. The thresholds will be configurable for pre-alarms, alarms, or status only and used by the programmable logic. The programmable logic must be drag-and-drop with point-and-click connection of the various components and allow the user to add labels and change labels for the various inputs/outputs to make the logic scheme understandable.

All function blocks must be incorporated into the logic scheme with connection to the programmable inputs and outputs. Predefined contact input functions like hi/lo line operation and single-/three-phase selection should be provided to make it easy for configuring the genset controller for a rental application. The PC software must have three levels of password protection and allow the user to select the various screens they want to see active at any time.

14. Communications

Because the genset may need to be incorporated into a broader communications network, it needs to have communication capability for USB, RS-485 (optional) using Modbus, an internal industrial-grade modem (optional) with dial-out and dial-in capability, SAE J1939 engine ECU capability (including MTU ADEC, MTU-ECU7, and MTU MDEC Module Type 304 metering) and RS-485 for providing communications to a remote display panel for NFPA 110 indication.

15. Environmental

The genset will be subjected to very harsh environments and must meet severe shock, vibration, and temperature extremes. As a minimum, it will be rated for the following:

- Shock: 15 G
- Temperature: –40 to 70°C (with LCD functional)
- Vibration: 5 G, 52 to 500 Hz

To reduce the possibility of field failures, the genset controller should be HALT tested to evaluate the design of the product and reduce long-term failures that cannot be found without years of operation.

16. Agency Approvals

The digital genset controller will meet the requirements of and/or carry the markings from the following agencies:

- CE
- CSA
- NFPA 110 compatibility

- UL
- UL Class 1, Div. 2 – optional

17. Options

To further add to the functionality of the genset controller, it will need options for auto synchronization that has both anticipatory and phase lock capability. It must have provisions for enhanced generator protection that includes phase overcurrent and phase imbalance protection and an integrated onboard modem with a temperature range equal to that of the main genset controller. There should be an optional remote mounted display panel that communicates the various alarms and warnings required to meet NFPA 110. This device should require only four wires to operate. Two wires should be for communications and two for dc power to the remote panel from the starter batteries of the genset.