GenStart
Standby Generator Controller

Version 1.08

Flight Systems Inc.

www.flightsystems.com
Introduction and Product Description

The GenStart standby controller is an affordable but reliable option to replace obsolete controls, newer generation controls, or just to add additional functionality such as remote access and remote notifications. The GenStart controller is NFPA 110 compliant, compact, affordable, user programmable and will replace a broad range of existing controls. User profiles are available for some applications and more are being developed. Custom programming may be available for your application.

The daylight-readable backlit character display provides status information and all parameters can be accessed from the front panel with a 6-button dual purpose keypad. The keypad provides navigation in setup mode and generator control in run mode.

With the use of the GenConnect software you can create, save and upload profiles that greatly simplify the installation process. Included with the software installation are sample profiles that provide a good starting point when replacing specific controls. Connecting to the GenStart controller can be done by direct connection through USB or a network connection via the optional GenStart modems. For more information on connectivity, refer to the GenConnect Software Manual.
8 Channel Digital Input
Switched to ground

Settings:
Active Open
Active Closed

Options:
0-Disabled
1-Air Damper
2-Charger Failure
3-High Engine Temp
4-Low Engine Temp
5-Low Fuel Pressure
6-Low Fuel Level
7-Low Oil Level
8-Low Oil Pressure
9-Low Coolant
10-Emergency Stop
11-Basin Rupture
12-Fuel Leak
13-Remote Start

4 Channel Analog Input
With constant current driver for resistive sensors.
(0-2500 ohms)

Settings:
Current (2-20mA)
Offset
Span
Low Alarm
Pre Low Alarm
Pre High Alarm
High Alarm

Options:
0-Disabled
1-Oil Temp
2-Oil Pressure
3-Coolant Temp
4-Coolant Level
5-Fuel Pressure
6-Fuel Level
7-User Input 1
8-User Input 2

3 Phase Voltage and Current Input
Settings:
CT Ratio
Over Current
Low Voltage
High Voltage
Low Frequency
High Frequency

Options:
Single Phase A-N
Single Phase A-B
3 Phase (4 wire)

Real Time Clock
With programmable self exercise

Settings:
Date and Time
Exercise Interval
Exercise Time

4 Programmable NO Relays
Options:
0-Disabled
1-Start Solenoid
2-Fuel Solenoid
3-Pre Heat
4-Field Flash
5-Not In Auto
6-System Ready
7-Transfer Ready
8-Shutdown Alarm
9-Idle Control
10-Shutdown Solenoid

Power Input 7-36VDC
Settings:
Low Cranking voltage
Low Battery Voltage
High Battery Voltage

RPM Input 20-20kHz
Settings:
Crank Disconnect RPM
Under Speed
Over Speed

*See Accessories and Connectivity options for RS485
**CAN port is for future development only
Main Controls and Display

Generator Control

Mode of Operation

Analog channel 1

Analog channel 2

Analog channel 3

Analog channel 4

Silence/Reset audible alarm.
Press once to silence, press again to reset.

Emergency Stop

Scroll display left when in AUTO or MANUAL mode.

Scroll display right when in AUTO or MANUAL mode.

Indicates that more information is available. Use LEFT and RIGHT arrow keys to scroll

Press Crank to start generator when in Manual mode.

Navigation and Setup

Displays the current selection

Indicates that more options are available

Indicates that more options are available

Increase the value of the currently selected parameter.

Parameter value

Press ESC to escape without saving the current settings

Scroll left through available options

Scroll right through available options

Decrease the value of the currently selected parameter.
Installing the included sensors is recommended to eliminate errors in calibrating for existing sensors. For more information on setting up analog sensors, refer to the Calibration section of this manual (page 8). In some applications the oil pressure transducer and coolant temperature sensor may be connected to an existing analog gauge. It is not necessary to remove these sensors to install new ones. Do not attempt to connect an analog input of the GenStart to any existing wiring! The GenStart controller uses a programmable constant current source to drive resistive sensors and connecting these inputs to any external voltage could produce false readings or damage the controller. The default profile for the GenStart has analog input 1 assigned to oil pressure and analog input 2 assigned to coolant temperature. Analog inputs 3 and 4 are disabled. To add additional sensors refer to the calibration section of this manual.

- **Oil Pressure** - Locate the oil pressure transducer at or just above the oil filter. If there is no available port for installing the new sensor and you wish to keep the existing transducer, install a T at the oil pressure port. Apply thread sealant and install the new transducer.

- **Coolant Temperature** - For most applications there are several plugs installed on the engine block for installing sensors. Be sure to avoid installing the coolant temperature sensor at the intake or anywhere near the exhaust manifold. Locate a plug on the engine block for coolant and select the correct bushing for your application. Do not use thread sealant of any kind as it may interfere with the sensor ground. If you have not drained the coolant from the engine, take the necessary precautions as you will lose some coolant removing the plug and installing the new sensor.

**Wiring**

All connections should be made using #18 AWG except for the relay connections. Proper wire gauge should be selected for your application. Using stranded wire, strip approximately ¼ inch of insulation from the wire so that it fully inserts into the clamp and tighten the binding screw.

**Digital Inputs** - All digital inputs are clearly labeled on the left side of the GenStart controller. They have been programmed for a common set of faults, however they can be reassigned for other functions from the SETTINGS menu as well as their polarity (NO/NC). For the default settings, any unused input should be left open. All digital inputs are switched to ground.

1. Emergency Stop - Normally open external emergency stop switch.
2. Low Fuel - Normally open low fuel level switch.
3. High Engine Temperature - Normally open high temperature switch.
4. Low Engine Temperature - Normally open low temperature switch.
5. Low Oil Level - Normally open oil level switch.
7. Low Coolant Level - Normally open low coolant level switch.
8. Remote Start - Connect to a normally open contact from the transfer switch or other utility monitoring equipment. Grounding input 8 will activate remote start when in AUTO.
**Analog Inputs** - Connect analog input 1 to the oil pressure transducer. You can ground the remaining terminal of the oil pressure transducer to battery ground, chassis, or analog return on analog input 6. Connect analog input 2 to the temperature sensor. The temperature sensor uses the engine block as a ground so no further wiring is necessary. The default setup is labeled on the left side of the GenStart controller.

1. Oil Pressure - Calibrated for the included VDO pressure transducer (0-80psi).
   
   **Calibration = 16mA, Preset VDO FSI Oil (positive slope)**
   
   - Pre Low Oil Pressure 15psi
   - Low Oil Pressure 10psi

2. Coolant Temperature - Calibrated for the included VDO thermistor (38-300°F).
   
   **Calibration = 2mA, Preset VDO FSI TEMP (negative slope)**
   
   - Low Coolant Temperature 35°F
   - Pre Low Coolant Temp 40°F
   - Pre High Coolant Temp 190°F
   - High Coolant Temperature 205°F

3. Disabled
4. Disabled

**3 Phase Current Input** - The 3 phase current input is monitored based on the voltage configuration setting from the SETTINGS menu. Setting the stator configuration to single phase A-N (default), the controller will only monitor phase A for over current. Setting for A-B will monitor inputs A and B, and setting to 3 phase (4 wire) will monitor inputs A,B, and C. The default CT ratio is set to 500:1.

1. Phase A input - Current Transformer (500:1)
2. Phase A Return
3. Phase B input - Current Transformer (500:1)
4. Phase B Return
5. Phase C input - Current Transformer (500:1)
6. Phase C Return

**3 Phase Stator Input** - The 3 phase stator voltage input is monitored based on the voltage configuration setting from the SETTINGS menu. Setting the stator configuration to disabled will disable crank disconnect voltage, over/under frequency, over/under voltage, and over current. It is recommended that at a minimum the stator configuration is set to single phase A-N (default). Frequency and crank disconnect voltage is derived from phase A to neutral in any configuration. Setting the stator to single phase A-B will display the sum of both inputs but will monitor over and under voltage from each input to neutral. A setting of 3 phase (4 wire) will monitor over and under voltage from each phase to neutral. **At the time of writing this manual, 3 phase delta is not supported by the software.**

   - Stator Configuration - Single Phase A-N
   - Crank Disconnect Voltage 75 VAC
   - Under Voltage 100 VAC
   - Over Voltage 140 VAC

1. Voltage Phase A - Connect sensing wire to phase A on main stator.
2. Voltage Phase B - Open or phase B on main stator.
3. Voltage Phase C - Open or phase C on main stator.
4. Neutral - Must be connected to neutral on main stator.
RS485 Communications Port - The GenStart controller is a Modbus slave device and no configuration is necessary. See Accessories and connectivity options.

**External 120 ohm terminating resistor may be required from terminal A to terminal B.**
1. RS485 Shield - Connect twisted pair shield only at one end.
2. RS485 B - Connect to terminal B of Modbus Master.
3. RS485 A - Connect to terminal A of Modbus Master.

CAN Communications Port - *For future development only, contact Flight Systems for details.*
1. CAN Shield
2. CAN High
3. CAN Low

Main Power Connector / Relay Outputs - Refer to the default wiring diagrams for connecting the relay outputs. The default configuration is listed below and other options are available in the relay configuration option from the SETTINGs menu.
1. Common Alarm - Dry contact A for external alarm.
2. Common Alarm - Dry contact B for external alarm.
3. Relay 1 - Configured for transfer ready signal.
4. Relay 1 - Configured for transfer ready signal.
5. Relay 2 - Fuel Solenoid*
6. Relay 2 - Connect to battery power for fuel solenoid.
7. Relay 3 - Pre Heat* Active during delay before engine start and cranking.
8. Relay 3 - Power or ground for pre heat.
9. Relay 4 - Start Solenoid*
10. Relay 4 - Connect to battery power for start solenoid.
11. Battery - Power for GenStart controller, connect to battery positive.
12. Ground - System ground for GenStart controller, connect to battery negative.

*Relays can switch to ground or to battery voltage. External diodes should be installed for inductive loads*

RPM Input - Use shielded twisted pair to connect a mag pickup, tach generator, or R-terminal to the RPM input. The shield should only be connected at the controller. It is very important to set the MPU configuration for your application. Failure to properly set the pulses per revolution could result in starter or ring gear damage as well as incorrect RPM readings. The MPU configuration is available from the SETTINGs menu. Default settings are listed below.

- MPU Configuration - 168 pulses per revolution
- Crank Disconnect 400 RPM
- Under Speed 1700 RPM
- Over Speed 2100 RPM

1. Shield - Connect shield for twisted pair.
2. RPM Return - Ground for RPM input (common to system ground).
3. RPM Input - Connect to mag pickup, R-terminal, or tach generator.

Testing Your Configuration
After you have reviewed the user profile it is recommended that you do a test run in MANUAL mode. Refer to the Sequence of Operation and Running in Manual sections of this manual. Start and run the generator in manual to confirm that crank disconnect and analog readings are correct. Allow enough time for the generator to run the system delays and get to normal operating conditions to test for false alarms. Shutdown by returning to the OFF mode and set the controller for AUTO. Ground the remote start input to simulate a request from the transfer switch and confirm all settings are correct.
**Main Menu**

**SETTINGS** - While in OFF mode press the ESC key to enter the main menu. Use the LEFT and RIGHT arrows to scroll through the options available. Select SETTINGS and press ENTER.

When prompted to enter PIN, enter the default PIN 1000. The PIN can only be changed using the GenConnect software included with the GenStart controller. If you enter the incorrect PIN you will immediately be returned to the main menu screen.

Options:
- Digital Inputs - Select Channel - Polarity, Function
- Analog Inputs - Select Channel - Function, Gain, Offset, Span, Low Alarm, PreLow Alarm,
  PreHigh Alarm, High Alarm
- Current Config - CT Ratio, Over Current
- Voltage Config - Stator Configuration, Crank Disconnect, Under Voltage Alarm, Over Voltage Alarm,
  Under Frequency Alarm, Over Frequency Alarm
- MPU Config - Calibration, Crank Disconnect, Underspeed, Overspeed
- Relay Config - Select Channel - Function
- Delay Config - Engine Start, Crank Duration, Crank Cycles, Crank Rest, Alarm Bypass,
  Cooldown, Transfer Ready
- Set Clock - Date and Time
- Set Exercise - Interval, Day of Week, Time of Day, Duration
- Calibration - Gain Offset, Gain Span, Battery, Current, Voltage *calibration is set from factory

**EVENT HISTORY** - The last 50 events are stored in non volatile memory and will not be erased by removing power to the controller. Events are listed most recent first and will overwrite the oldest entry after 50 events are stored. Events include pre alarms, shutdown alarms and exercise functions. While in OFF mode, press ESC to enter the main menu and select Event History, then press ENT. Use the left and right buttons to select View History or Clear History and press ENT. Use the UP and DOWN buttons to view the event history.

**TERMINAL** - The terminal application is used for debugging and setting up devices connected to the Modbus of the GenStart controller. Note that entering the terminal application will cease all communication on the Modbus and USB ports so external devices may indicate a communication failure until you exit the terminal application. Press ENT to enable the terminal application and ESC to exit.
Calibration

Analog Inputs
New for version 1.08 and later, analog inputs are calibrated by entering 10 calibration points of resistance and actual value. Values must be entered in decending order from maximum to minimum value. Resistance readings can be entered in decending order (positive slope) or ascending order (negative slope). The current source will automatically be adjusted based on the maximum resistance value. Included with the software, are tables for some common sensors. To select a preset sensor, click "Load" on the desired channel. A dialog box will open and navigate to the folder labeled "SENSORS". Select the desired sensor and click open. The calibration points will be loaded as well as the sensor function and the current setting in mA. See the diagrams below for examples of the default VDO oil pressure transducer and VDO temperature sender.

The default oil pressure transducer is a positive slope. Both resistance and value are entered in decending order. The function has been set to oil pressure and the current adjusted to 16mA based on a maximum resistance of 185 ohms.

The default coolant temperature sensor has a negative slope. Values are entered in decending order and resistance is entered in ascending order. The function is set to Coolant Temp and the current has been adjusted to 2 mA based on a maximum resistance of 2700 ohms.

System Calibration
The system calibration includes constants for the programmable current (offset and span), battery voltage, AC current, and AC voltage. These settings have been set from factory and should not need adjusted. Calibration for the current driver can be set using the GenConnect software. For correct calibration procedures, see the Manual section of the GenConnect software. AC voltage offsets are automatically set everytime the a value is stored in the calibration settings. To display correct stator voltage, increase or decrease the constant for that phase. The constant represents a decimal number that the raw ADC value is calculated with to display real world readings. For example, if the raw ADC value of phase A is 1090 and the actual voltage is 120VAC, the calibration value should be (.110).
Sequence of Operation

Off Mode
On initial power up the controller will default to OFF mode or Reset. In OFF mode all alarms are cleared, generator and engine monitoring are disabled and sensor power is disabled. To switch modes, use the LEFT and RIGHT arrow keys for AUTO and MANUAL. Press the ESC button to enter SETUP. See page 7 for details on the Main Menu. While in OFF mode, the screen will display serial communication information (USB and RS485).

Auto Mode
Auto mode is enabled by pressing the LEFT arrow key while in the OFF position. Switching to auto mode will enable power for the analog sensors and enable constant alarms. This mode will also enable remote start and self exercise functions as setup in the user profile. Press the DOWN arrow to return to OFF mode or use the LEFT and RIGHT arrows to scroll through the main display options. Pressing the ESC key at any time will activate the Emergency Stop function. You must return to the OFF position before switching to MANUAL.

IMPORTANT! RPM and voltage crank disconnects must be configured for this function to work properly.

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<tr>
<td>Analog Channel 4</td>
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</table>

Manual Mode
Manual mode is enabled by pressing the RIGHT arrow key while in the OFF position. This will disable the low power mode and allow you to force the generator into a start condition. Press and hold the ENTER key to enable the start solenoid. If crank disconnect on RPM or voltage has been properly set up, the crank will disengage automatically. Otherwise, you must release the ENTER key to disengage the starter. As with AUTO mode, pressing ESC will activate the Emergency Stop function and the LEFT and RIGHT arrows will scroll through the main display options.

Alarms
In the event of an alarm condition, the main screen will default to an alarm notification screen, the internal alarm will sound and the backlight will begin flashing. Pressing the UP arrow will silence the alarm and if the alarm is not a shutdown event, return the display to the main screen. Pressing alarm silence again will clear the active alarm. If the alarm is set for shutdown, you must clear the alarm by returning to the OFF position. The last 50 events are stored in the EVENT HISTORY, most recent listed first.
Running in Manual Mode

1. Manual - While in OFF mode, press the right arrow or MANUAL button to enable MANUAL mode. The pre-heat relay is enabled if configured and all alarms are enabled except low oil pressure and voltage. Do not leave the controller unattended in manual as it will cause excessive drain on the battery when not running. It is recommended that you verify all readings are correct in manual mode before enabling AUTO mode.

2. Manual Start - Press and hold Crank(ENT) to engage the start solenoid, field flash, and fuel solenoid relay. Pre-heat will remain active during cranking. If the RPM calibration and crank disconnect settings are configured properly, the start solenoid will disengage automatically. Otherwise you must release the Crank button upon start up to disengage the start solenoid.

3. Running in Manual - After RPM and/or voltage exceed crank disconnect values the mode indicator will change to "Running in Manual". The alarm bypass delay and transfer ready delay will begin to time out. You can use the RIGHT and LEFT arrows to scroll through the main display. After the alarm bypass delay expires, oil pressure and voltage alarms will be enabled. The Transfer Ready relay will be active after the transfer ready delay expires.

4. Shutdown - To shut down from manual mode, press the Off button. The generator will shut down without delay and return to the OFF or reset mode.

**IMPORTANT! Before switching to AUTO you MUST have the RPM calibration(flywheel teeth), RPM disconnect and Voltage disconnect configured properly to prevent damage to generator.**

Default Settings:

RPM Calibration = 168 Pulses Per Revolution
RPM Crank Disconnect = 400 RPM
Voltage Crank Disconnect = 75 VAC A-N
Running in Auto Mode

1. **Standby** - While in OFF mode press the left arrow or AUTO button to enable AUTO mode. It is very important that RPM calibration and RPM crank disconnect or voltage crank disconnect are set correctly for this function to work properly. Please review these settings before attempting to run in AUTO. It is recommended that you do a manual test first to confirm RPM and voltage readings are correct.

2. **Enable Auto Start** - Grounding the remote start input or enabling the self exercise function will begin the time delay before engine start (default is 10 seconds) and activate the pre-heat relay (if enabled). After the delay expires, the controller will attempt to start the generator. Removing the remote start signal at this time will immediately return the controller to standby without delay.

3. **Auto Crank** - During cranking, the GenStart controller will monitor stator voltage and RPM for crank disconnect. The controller will try to start the generator for the number of cycles, time on and time off, as set in the user profile. Default settings are 5 attempts at 5 seconds on and 10 seconds off before faulting on overcrank. The controller will test for low cranking voltage during the crank cycle.

4. **Running in AUTO** - After crank disconnect by either stator voltage or RPM, the alarm bypass delay and transfer ready delay begin to time out. The mode indicator will change to Running in AUTO or Self Exercise depending on the start condition. Preheat, Start Solenoid and Field Flash are disabled and all alarms except oil pressure and voltage are enabled. Removing the remote start signal will immediately shut down the generator and return to standby without delay. 15 seconds before transfer ready, Idle Control will be active and the controller will start to monitor voltage and frequency.

5. **Cooldown** - After the alarm bypass delay expires, both oil pressure and voltage alarms are enabled. Removing the remote start signal before the transfer ready delay expires will immediately shut down the generator. If the transfer ready delay has expired, removing the remote start signal will disable the transfer ready relay and begin the cooldown cycle for the duration set in the user profile. Self exercise does not require a cooldown cycle and upon completion of a successful exercise, an event will be stored in the event history and a notification message is generated for RS485 devices.

6. **Return To Auto** - Upon completion of the exercise cycle or cooldown the controller will return to standby and wait for the next exercise or remote start condition. The controller will continue to monitor constant alarms.
Accessories and Connectivity

Cellular Notifications and Remote Access

Modbus to Wifi Remote Annunciator

Wifi Modem and Wifi Annunciator
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<td>Pre-High User Input 1</td>
<td>Alarm</td>
<td>X</td>
<td></td>
<td>X</td>
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<tr>
<td>36</td>
<td>Pre-Low User Input 1</td>
<td>Alarm</td>
<td>X</td>
<td></td>
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</tr>
<tr>
<td>37</td>
<td>Pre-High User Input 2</td>
<td>Alarm</td>
<td>X</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>38</td>
<td>Pre-High User Input 2</td>
<td>Alarm</td>
<td>X</td>
<td></td>
<td>X</td>
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<td>39</td>
<td>Over Crank</td>
<td>Shutdown</td>
<td>X</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>40</td>
<td>Exercise Complete</td>
<td>Notification</td>
<td>X</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Technical Assistance, Repair, Warranty

Technical Assistance - If you require technical assistance during installation or operation of the GenStart controller, please call our Technical Service Department at 717-590-7330 M-F, 8am-5pm ET or email hawk@flightsystems.com.

Repair - Should the GenStart Controller suffer a problem when out of warranty, repair service is available from the manufacturer at reasonable rates. Ship unit to Flight Systems, 207 Hempt Road Mechanicsburg, PA 17050.

Warranty - The GenStart Controller is warranted to be free from defects in materials and workmanship for a period of two years from the date of shipment. FLIGHT SYSTEMS' liability is limited to the repair or replacement of defective product within the warranty period, and does not cover installation or removal costs incurred or possible damage to other equipment (including generator sets and transfer switches) as a result of a malfunction of the GENSTART REPLACEMENT CONTROL. If, in the opinion of FLIGHT SYSTEMS (or its authorized agent), the malfunction of the GENSTART REPLACEMENT CONTROL PANEL was caused by abuse, misuse or improper installation, the warranty claim will be disallowed and established repair rates shall apply.