CANplus™

CP1000 & CP750-E

Control Panel Operation Manual

9M02-1000-A401-EN

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Revision History

VERSION	DATE	NOTES
1.0	12/2019	
B	12/2020	Document rebranded and contact information updated
C	03/2021	Corrections
D	07/2021	Added Icon Appendix
E	08/2021	Added CANplus Control features and QR-Assist™
F	11/2021	Added telemetry and Bluetooth
G	11/2022	VFD, Manufacturing Info, Saved Configs, Auto Antifreeze
H	02/2023	Machine Learning
J	10/2023	VFD Programming, Key switch behavior change, USB protective door
K	01/24	Multi-Pump, Added CP750-E to consolidate the 2

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2 Important Safety and Emissions Information

2.1 Safety Notation

This manual uses the following conventions to present IMPORTANT SAFETY INFORMATION to you. Please read and follow ALL SAFETY INSTRUCTIONS.

	WARNING
	IMPORTANT AND URGENT SAFETY INFORMATION – A HAZARD THAT WILL, IF NOT AVOIDED, CAUSE SERIOUS INJURY OR LOSS OF LIFE.

	CAUTION
	IMPORTANT SAFETY INFORMATION – A HAZARD THAT MIGHT CAUSE SERIOUS INJURY OR LOSS OF LIFE.

Note: Additional Important Information

2.2 Safety Instructions

Please read and follow all safety instructions.

	CAUTION
	THIS DOCUMENT MUST BE COMPLETELY READ AND UNDERSTOOD PRIOR TO INSTALLING, TESTING OR OPERATING THE EQUIPMENT DESCRIBED WITHIN. FURTHER, THIS DOCUMENT MUST BE RETAINED FOR CURRENT AND FUTURE USERS OF THIS EQUIPMENT. FAILURE TO STRICTLY FOLLOW THE WARNINGS AND DANGERS PRESENTED WITHIN THIS DOCUMENT COULD RESULT IN DAMAGE TO EQUIPMENT, DAMAGE TO PROPERTY, BODILY INJURY OR DEATH.

	CAUTION
	CANPLUS PRODUCTS ARE NOT DESIGNED OR APPROVED FOR USE AS CRITICAL COMPONENTS OF ANY SAFETY DEVICE OR SYSTEM THAT IS INTENDED TO PREVENT BODILY INJURY, PROTECT LIFE OR PREVENT PROPERTY DAMAGE.

	CAUTION
	THE SPECIFYING ORIGINAL EQUIPMENT MANUFACTURER (OEM) AND/OR INSTALLER OF ANY CANPLUS PANEL IS RESPONSIBLE FOR ALL SAFETY LABELING AND OPERATOR EDUCATION REGARDING THE SAFE OPERATION OF THIS PANEL AND THE OPERATION OF THE SPECIFIC MACHINE THAT THIS PANEL IS INSTALLED UPON, INCLUDING CONFORMANCE TO EXHAUST EMISSIONS REGULATIONS.

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⚠	CAUTION
	CANPLUS PRODUCTS ARE NOT DESIGNED FOR, OR INTENDED FOR USE ON, APPLICATIONS REQUIRING EXPLOSIVE PROOF COMPONENTS. FURTHER, CANPLUS PRODUCTS ARE NOT DESIGNED FOR, OR INTENDED FOR APPLICATION WITHIN, HAZARDOUS OR EXPLOSIVE ENVIRONMENTS.

⚠	CAUTION
	THE INSTALLER OF THIS CANPLUS PRODUCT IS SOLELY RESPONSIBLE FOR ENSURING THAT ALL OSHA, ANSI, CE OR OTHER APPLICABLE STANDARDS ARE MET WITH RESPECT TO CANPLUS PANEL APPLICABILITY, MACHINE GUARDING, GENERAL SAFETY GUIDELINES, LABELING AND WARNINGS.

⚠	CAUTION
	THE INSTALLER OF THIS CANPLUS PANEL AND/OR CANPLUS HARNESS IS RESPONSIBLE FOR THE CORRECT SIZING AND INTEGRATION OF A SUITABLE FUSE/BREAKER ON THE UNSWITCHED DC CIRCUIT SUPPLYING POWER TO THE CANPLUS PANEL.

⚠	CAUTION
	ONLY TRAINED AND QUALIFIED PERSONS MAY PERFORM INSTALLATION, TESTING, SERVICE OR REPAIR WORK ON THE CANPLUS PRODUCT.

Note: The seller hereby expressly disclaims all warranties, either expressed or implied, including any implied warranty of merchantability or fitness for a particular purpose, and neither assumes nor authorizes any other person to assume for it any liability in connection with the sale of such products.

2.3 Auxiliary Engine Stop Disclaimer

This panel or harness may include an optional Auxiliary Engine Stop feature. Please note that the Auxiliary Engine Stop feature is NOT intended to function as the machine/equipment Emergency Stop or to be purposed as an Emergency Stop for safety purposes. The machine manufacturer must provide a separate Emergency Stop switch to meet safety mandates or emergency machine shutdown functionality. The sole design intent of the Auxiliary Engine Stop feature is to provide for engine shutdown in the event of a malfunction. The panel's off button should always be used as the primary engine shutdown method.

General Emissions Disclaimer

This panel may include provision(s) for operator input such as FORCE REGENERATION, INHIBIT REGENERATION, INTERLOCK, and others specific to US and International emissions regulations. Responsibility for emissions-related inputs and compliance with emissions regulations is solely that of the owner and/or operator of the machine/engine on which this panel is connected.

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2.4 Exhaust Emissions Compliance Disclaimer

This panel is equipped with operator-programmable parameters. The engine/machine as a function of the emissions system can/could initiate, via the engine ECU (Engine Control Unit), certain required emissions operations such as regeneration of the DPF (Diesel Particulate Filter), or other emissions system maintenance, while the engine is running. The owner/operator of the engine/machine is solely responsible for any adverse effects or damage to the engine, engine emissions system or other damage that could occur because of starting or stopping the engine/machine during any ECU initiated emissions event.

3 Overview

The CANplus CP1000 & CP750-E control panels are a manual and auto-start platform for EPA Tier 3, EPA Tier 4 (interim), EPA Tier 4 and EU Stage V electronically governed diesel or natural gas engines. It can also control mechanically governed diesel engines. Additionally starting with firmware version 2.03, the panel can control Variable Frequency Drives (VFD) enabling electrically powered applications. The CP1000 is the big brother of the CP750-E. The CP1000 has more inputs and outputs and has two additional “Dashboard” buttons to the left of the Rabbit and Turtle buttons. This user manual will use the word “panel” to describe both versions and will specifically state when there is significant difference between the two.

All components are installed in a heavy-duty, vibration-isolated metal enclosure designed to withstand the most extreme industrial applications. External weather-resistant switches and controls facilitate convenient operator inputs/controls.

The Graphical quad-gauge pages are displayed on the 4.3” diagonal WQVGA (480x272 pixels) LCD. Virtually any SAE J1939 parameter reported by the ECU (Engine Control Unit) can be displayed, including, but not limited to the following: RPM, coolant temperature, oil pressure, engine hours, voltage, exhaust emissions system state and diagnostic codes. When utilized with a VFD, the panel can display Output Voltage, Frequency, Current, Power Factor as well as others. The backlit display is clearly readable in both bright sunlight and total darkness and is housed in a rugged IP66 rated housing. The panel has three bright LEDs to indicate Faults and Warnings, Emission-Related Alerts and Autostart active. The Panel has five display keys that are associated with the dynamic Display Key bar as well as eight control buttons.

The panel features advanced automatic start/stop control which can meet almost any requirement. Building on the functionality of the CP750 series platform, this next generation panel offers many new start/stop modes using a very powerful, yet easily configured Event Manager, which can start or stop based on any of the eight digital inputs, six 4-20 mA analog transducer inputs, Real Time Clock, or combinations of date/time and analog or digital inputs. With the use of a transducer, the panel has a “cruise control” feature that automatically throttles the engine or motor to maintain a configurable level. The panel can be configured to use any one of the transducer inputs for the maintain/cruise control feature, regardless of whether that input is also being used as a start or stop event.

The panel optionally offers local Machine Learning enabling it to learn the normal operation of an application by looking at multiple inputs from sensors, engines, and VFDs. The panel will then monitor and display status with CANplus IQ gauges. The panel will alert to warning and shutdown conditions that are outside the norm for the learned application.

Active fault conditions are displayed in plain language on popup messages include the source of the fault. In this case, the source of the fault message is the Engine ECU. If the panel is the source, the popup will say Active Panel Fault. The faults can also be viewed in the fault list. The popup also includes the dynamic fault QR-Assist code, which can be scanned for more detail information on the fault (See the QR-Assist section). To expedite the resolution of engine issues, it is highly effective to reach out to the original equipment manufacturer (OEM) or the Engine Distributor.

All diagnostic and emissions-related messages generated by the engine ECU, VFD, or other attached devices are displayed by the panel. The operator should be familiar with the engine manufacturer ECU and VFD messages and icons to react accordingly with respect to emissions compliance, service, and diagnostic message response.

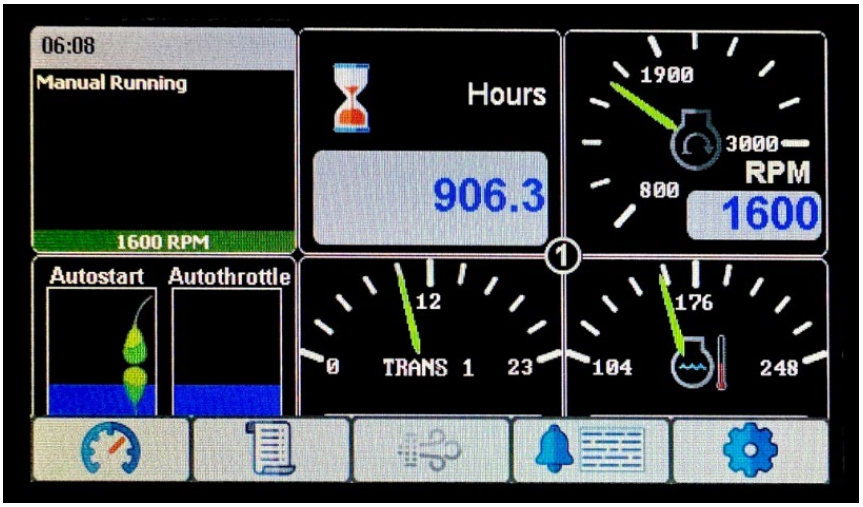
4 Display

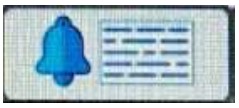
The CANplus display is a robust, sunlight-viewable 4.3" WQVGA color display with five integrated backlit display buttons and eight large control buttons housed in a rugged, water-tight IP66 rated enclosure. The five display keys simplify and enhance the user interface by providing positive tactile feedback when pressed. The display can show virtually any SAE J1939 parameter reported by the ECU, including RPM, engine temperature, oil pressure and diagnostic codes; as well as VFD-related parameters. It can be easily configured to customer preference, including gauge type (analog or digital), gauge arrangements, gauge size, units, and language.

Note: Different software versions may have slightly different displays.

4.1 Button Bar

Pressing any of the first five soft keys on the display will prompt the "button bar" key function legend to appear at the bottom of the display above the keys. The button bar will show an icon above the button which corresponds to its current function, as shown below.



Button 1	Button 2	Button 3	Button 4	Button 5
				
Analog Gauge Pages	Database Viewer	Emissions Control	Alarm Page	Menus
Each press cycles through the four pages of analog gauges	Displays the Database Viewer	Displays Emission Control menus	Displays active alarms including plain language description	Opens Menus

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4.2 Gauge Pages

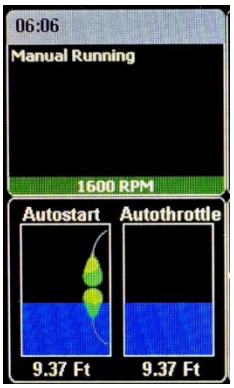
There are four independently configurable pages of analog gauges. To change Gauge Pages, press any of the first four buttons to show the top-level button bar and then press button 1 to cycle through the pages. The current page is indicated by the number in the center of the screen, as shown below.

Note: Some items like Engine Hours are displayed only as a digital value.

All 16 gauges may be configured to create an application-specific view of the data. With Tech or Admin level access, the four pages of gauges can be configured using the following menu: **Configuration → Display → Gauges → Quad Gauge Pages**.

4.3 Status and Autostart Gauge

To the left of the configurable gauges are the Status gauge (top left) and the Autostart gauge (bottom left), as shown below.



The Status gauge shows the status of many of the emissions-related features as well as date, time, and signal strength.

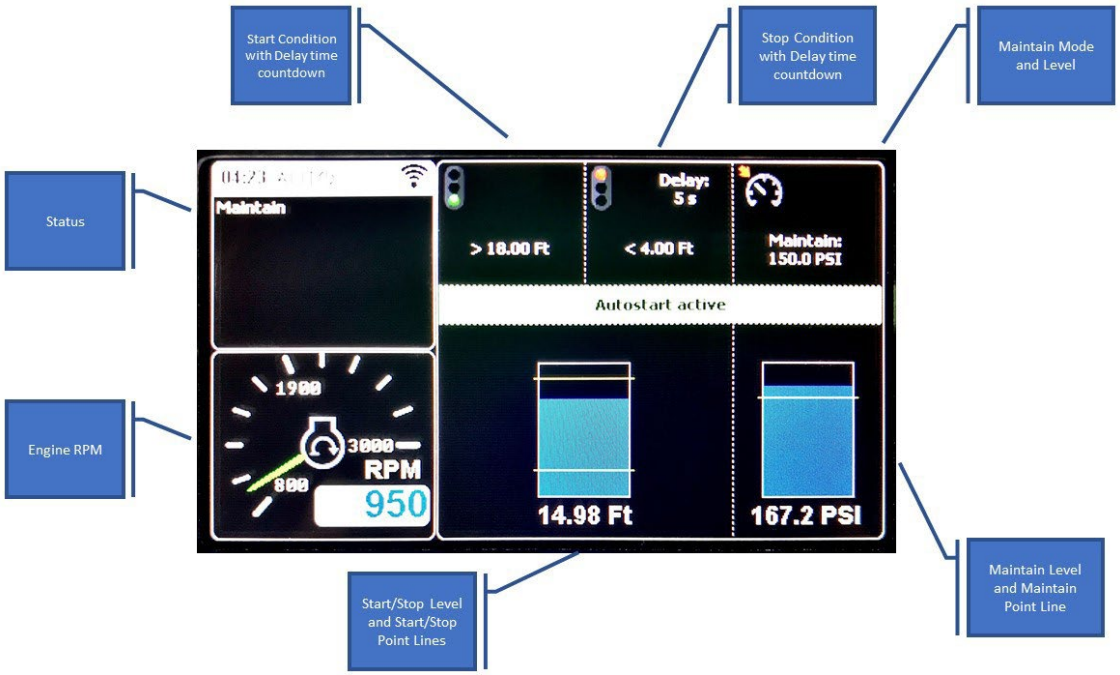
The Autostart gauge shows the start and stop events or levels on the left and the maintain/cruise control level on the right.

4.4 Autostart and Throttling Dashboards

4.4.1 Autostart

Click here to view the Autostart dashboard video.

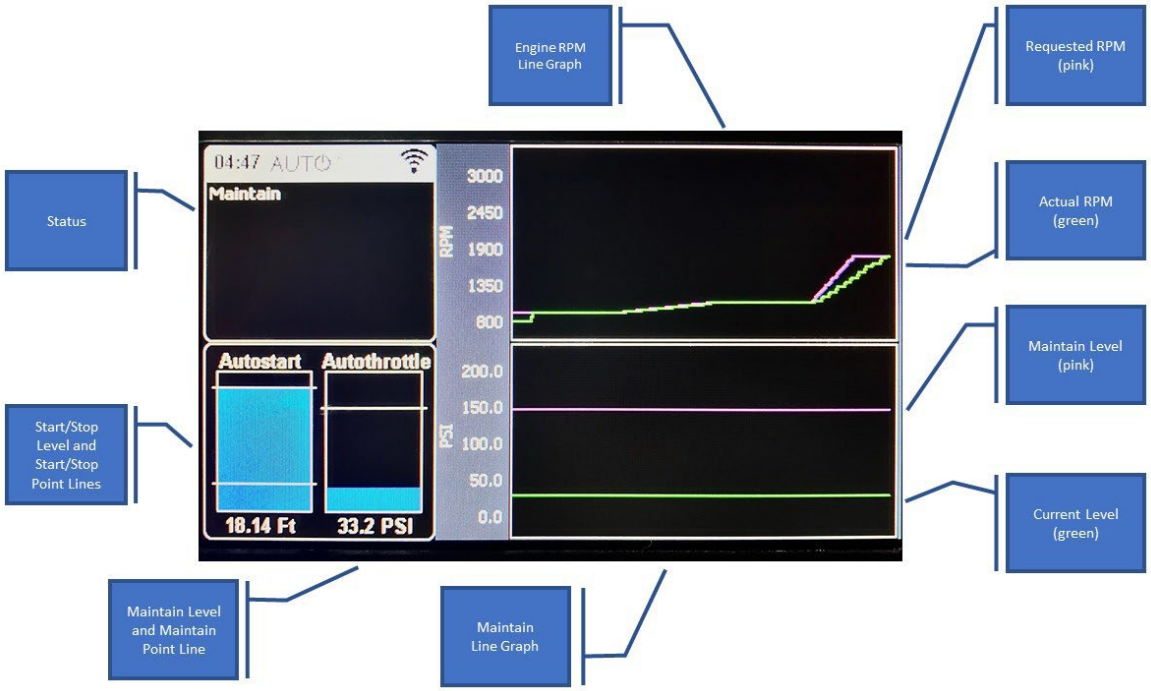
When the Dashboard-1 button  is pressed on a CP1000, the display will change to the full screen Autostart dashboard, as shown below. On a CP750-E, this dashboard is available on the thru the Quick Access button 



When the Dashboard-1 button is pressed again, the display will revert to the gauge page. On a CP750-E, the gauge page can be displayed by pushing any display button and then pressing the left most button.

4.4.2 Throttling

When the Dashboard-2 button  is pressed, the display will change to the dashboard, as shown below. On a CP750-E, this dashboard is available on the thru Quick Access button  .



Pressing the Dashboard-2 button again will cause the display to revert to the gauge page. On a CP750-E, the gauge page can be displayed by pushing any display button and then pressing the left most button.

4.5 Active Alarms

When an active alarm is received, a flashing popup window is overlaid on the current screen. The popup includes a plain language description in addition to the standard SPN/FMI (Suspect Parameter Number/Failure Mode Indicator) pair defined by the SAE J1939 standard. Additionally, if enabled, the beeper sounds as an audible cue.

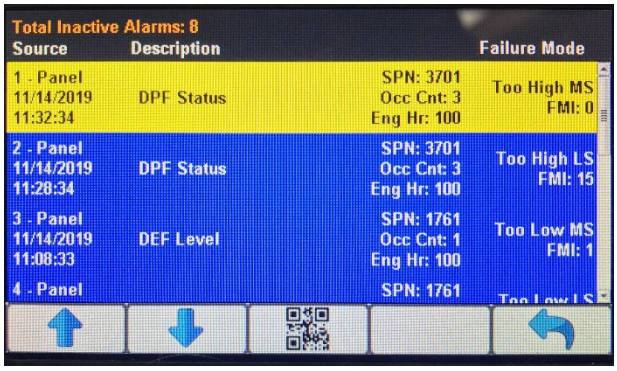
Note: Standard J1939 abbreviations are used for alarms, as follows:

MS = Most Severe
MOD = Moderately Severe
LS = Least Severe

4.6 Alarm List

The Alarm List is accessed by pressing any button while an alarm popup is displayed or by pressing any of the first four buttons to show the button bar and then button 4. Alarms not yet acknowledged are shown in white text on a red background, while acknowledged alarms are shown in white on black. The list also indicates when the alarm occurred if engine hours are available. The most recent alarm is displayed at the top of the list. The list can be scrolled using buttons 1 and 2 and alarms acknowledged by pressing button 3. The Alarm List can be closed by pressing button 5 once the alarms are acknowledged.

An alarm indicator is displayed near the upper right corner of the display if alarms are active. The indicator and alarm messages in the list are automatically removed when the alarm has not been received for a few seconds.



Once an alarm is silenced using the center display button, a QR-code icon will appear on this button. This button provides access to the Equipment Fault Code Diagnostic Information system. Pressing this button again displays a QR-code specific to this alarm. The QR-code can be scanned using the camera on most smart phones. When scanned, the phone will give an option to automatically jump to the RemoteIQ™ Fault website. The website will automatically pull up the details for this fault and list possible remedies.

Note: Only active faults are displayed in the alarm list. Once a fault is corrected, it is automatically removed from the list. To view previously active faults, press the “File Cabinet” button.

4.7 Service Timers

The panel's display provides 16 service timers to alert the operator of required maintenance. The time interval for each timer can be adjusted in increments of 10 hours. A popup message is displayed after completion of the display's self-test if a timer (or timers) has expired, alerting the user that service is required. The message is displayed on each power-up until the elapsed timer is disabled or reset. The service timers can have their respective names customized to monitor engine and machine-related parameters. All 16 service timers can be monitored via wireless telemetry.

4.8 Menus

The menu pages can be accessed by pressing button 5. The top-level menu page will then appear. From there the functions of the five display buttons change to allow navigation and selecting and modifying parameters.

Button 1	Button 2	Button 3	Button 4	Button 5
 Scroll Up	 Scroll Down	[Intentionally Blank]	 Go into Selected Submenu	 Return to Previous Menu
		 Decrement Value or Previous Selection	 Increment Value or Next Selection	

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Menu Tree

The menu tree is shown below. Some menus items are suppressed based on the access level currently allowed. The color of the text in the tree indicates the minimum access level required for this item to be available for displaying.

Blue = User

Green = Tech

Red = Admin

Display

- Language
- Units
  - Distance
  - Pressure
  - Volume
  - Temperature
- Gauges
  - Quadrant Page 1-4
    - Top Left
    - Top Right
    - Bottom Left
    - Bottom Right
- Power Timeout

System Setup

- Configurations & Updates
- Restore Defaults
- Set Date & Time
  - Import Configuration
  - Export Configuration
  - Saved Configurations
  - Load Firmware
  - OTA Update
  - Bootloader Update
  - BLE Firmware Update
  -
- PINs
  - Elevate Access Level
  - Change
  - Entry Off/On
- Engine
- Engine Specific Settings
  - Starter
    - Running Threshold
    - Max Starter On (s)
    - Min Starter On (ms)

        - Dropout RPM
        - Restart Delay (s)
        - Restart Attempts
    - Mechanical Engines
        - Calibrate Tach
        - Actuator Setup
        - Preheat
            - Mode
            - Duration
            - After Glow
            - Enabled During Cranking
    - Engine Data Sources
        - Tachometer
        - Engine Hours
        - Coolant Temp
        - Oil Pressure
    - Yanmar
    - CAT / Perkins
- About
- Logging
- Manufacturer Info
- Import License
- License Viewer

Emission Control

- Request Force Regen
- Inhibit Regen Disable/Enable

Throttle

- Minimum RPM
- Idle RPM
- Maximum RPM
- Switch/Rotary
    - Switch RPM
    - Increment
    - Rotary RPM
    - Increment
    - Max RPM
    - Change / sec

Autostart

- Behavior
    - Operation
        - High → Low
        - Low → High
    - Start-Stop With
        - Dual Switch, Single Switch, Transducer, Transducer w/ Backup Switches,Scheduler Only, Timed Run, Cycle Run, Single Start/Stop, Remote Control, Pressure Washer
    - Start Enable Delay (s)
    - Stop Enable Delay (s)

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- Maintain Transducer
  - Maintain Function
    - Disable
    - Low → High
    - High → Low
  - Auto Throttle Input
    - Transducer 1,2,3,4,5,6
  - Target Point
  - Throttle Aggressiveness
  - Error Operation
    - Controlled Stop, Immediate Stop, Go to Run, Derate

- Ramp Profile
  - RPM Settings
    - Intermediate RPM
    - Run RPM
  - Time Profile
    - Warm Up Time (s)
    - Ramp Up (s)
    - Intelligent Intermediate
    - Intermediate (s)
    - Ramp to Run (s)
    - Ramp Down (s)
    - Cool Down (s)
- Transducer
  - Autostart Trigger
    - Autostart Trigger
      - Transducer 1, 2, 3, 4, 5, 6
    - High Set Point
    - Low Set Point
  - Setup
    - Transducer 1-6
      - Low Warning Alarm
      - Low Shutdown Alarm
      - High Warning Alarm
      - High Shutdown Alarm
      - Type & Range
- Scheduler
  - Method
    - Allowed Times, Disabled, Override
  - Schedule A-P
    - Days of the Week
    - Start Time hh:mm
    - Stop Time hh:mm
- Timed Run
  - Default Time hh:mm
  - Switch Adjustment hh:mm
- Cycle Time
  - Default State
    - Stopped, Running

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- Run Time hh:mm
- Stop Time hh:mm

- Auto Battery Recharge
  - Auto Battery Enabled
    - Off/On
  - Recharge Run Speed
  - Enable Delay (m)
  - Recharge Time (m)
  - Delay Between Recharge (m)
  - Low Battery Threshold (V)
- Auto Antifreeze
  - Enable
  - Run Speed
  - Delay (m)
  - Run Time (m)

Input / Output Setup

- Outputs
  - Output Events
    - Alarm Output
    - At Speed Output
  - Aux Out 1-4, Low Side Out 11-14, High Side Out 1-2
    - Armed When
      - Always, Never, Autostart, Manual Start
    - Engine Condition
      - Always, Stopped, Running
    - Active When
    - Running Ignore Delay (s)
    - Enable Delay (s)
    - Disable Delay (s)
- Inputs
  - Event Manager
    - Oil Pressure
    - Coolant Temp
    - Fuel Level
    - Battery Voltage
    - Engine Speed
  - Aux Switch 1-6
    - Armed When
      - Always, Never, Autostart, Manual Start
    - Engine Condition
      - Always, Stopped, Running
    - Switch Type
    - Engine Stop
      - Controlled Stop, Immediate Stop, Go to Run, Derate
    - Running Ignore Delay (s)
    - Enable Delay (s)
    - Disable Delay (s)
    - SPN

        - FMI
        - LED Select
            - Red, Amber
        - LED Flash Rate
            - Slow, Fast, Solid

Communications

- CAN bus Settings
  - TSC1 Address
  - Panel Address
  - CM1 Address
  - Interlock Address
  - Config Address
  - Termination
- Modbus
  - Baud
  - Parity
  - Address
  - VFD Model
- Telemetry
  - Cell Status
  - GPS Status
  - Geofence Setup
- Bluetooth
  - Pair New Device
  - Status
  - Delete Bonds

Machine Learning

- Machine Learning
  - Disabled/Enabled
- Settings
  - Suction Pressure
    - Alarms
      - Disabled/Enabled
    - Warning Threshold (%)
    - Fault Threshold (%)
  - Discharge Pressure
    - Alarms
      - Disabled/Enabled
    - Warning Threshold (%)
    - Fault Threshold (%)
  - Delta Pressure
    - Alarms
      - Disabled/Enabled
    - Warning Threshold (%)
    - Fault Threshold (%)
  - Flow Meter
    - Alarms
      - Disabled/Enabled

        - Warning Threshold (%)
        - Fault Threshold (%)
    - Fuel Rate
        - Alarms
            - Disabled/Enabled
        - Warning Threshold (%)
        - Fault Threshold (%)
    - Engine Load
        - Alarms
            - Disabled/Enabled
        - Warning Threshold (%)
        - Fault Threshold (%)
    - VFD Percent Load
        - Alarms
            - Disabled/Enabled
        - Warning Threshold (%)
        - Fault Threshold (%)
    - VFD Power Factor Angle
        - Alarms
            - Disabled/Enabled
        - Warning Threshold (%)
        - Fault Threshold (%)
    - VFD Output Current
        - Alarms
            - Disabled/Enabled
        - Warning Threshold (%)
        - Fault Threshold (%)
    - VFD Torque
        - Alarms
            - Disabled/Enabled
        - Warning Threshold (%)
        - Fault Threshold (%)
- Setup
    - Suction Transducer
        - Trans 1, 2, 3, 4, 5, 6, Disabled
    - Discharge Transducer
        - Trans 1, 2, 3, 4, 5, 6, Disabled
    - Flow Meter
        - Trans 1, 2, 3, 4, 5, 6, Pulse, Disabled
    - Minimum RPM
    - Maximum RPM
    - Settling Time (Seconds)
    - Learning Time (Seconds)
    - Start auto learning phase
        - Overview – Screen
        - Learning Status – Screen
        - Learning Results – Screen
- Warning Alarm
    - Armed When

        - Never, Autostart, Manual Start, Always
    - Engine/Motor Condition
        - Running, Always, Stopped
    - Engine/Motor Stop
        - Ignore, Derate, Go to Run
    - Running Ignore Delay (Seconds)
    - Enable Delay (Seconds)
    - Disable Delay (Seconds)
    - Data Loss Fault
        - Off/On
- Shutdown Alarm
    - Armed When
        - Never, Autostart, Manual Start, Always
    - Engine/Motor Condition
        - Running, Always, Stopped
    - Engine/Motor Stop
        - Ignore, Derate, Go to Run
    - Running Ignore Delay (Seconds)
    - Enable Delay (Seconds)
    - Data Loss Fault
- Status - Screen

4.8.1 Access Levels

The available menu items are dependent upon the current access level. The current access level is shown in the upper right corner while in the menus. The panel supports up to three independent PINs that are configurable. The standard CANplus configuration has the following PINs settings:

- User = 1000
- Tech = 1111
- Admin = 2222
- Menu PIN Required = OFF
- Elevate Access Level

When the panel is turned on, the access level reverts to the User level. To gain access to the Tech or Admin levels, use the Elevate Access Level menu, as follows: **Configuration → System → PIN Settings → Elevate Access Level.**

The panel will prompt for a PIN input. User, Tech, or Admin level access will be granted based on which PIN is entered. For example, if the Tech level PIN is entered, Tech level access will be granted, and similarly if Admin or User level PINs are entered. If the entered PIN does not match User, Tech, or Admin, then "Incorrect PIN" is displayed, and the access level reverts to User.

Once elevated, the access level stays in effect until the panel is turned off or the display times out (see display Power Timeout).

4.9 PIN Change

PINs can be changed via the Menu as follows: Configuration → System → PIN Settings → PIN change.

The PIN that is changed is the PIN for the current access level. For example, at the User level, only the User PIN can be changed. To change the Tech PIN, use the Elevate Access Level menu and enter the correct Tech PIN. Then go to the PIN Change menu to change the Tech PIN.

- Menu PIN Required OFF
  - Accessing the menu is allowed with no PIN input required
  - Only User access level items are displayed
  - Use the Elevate Access Level menu to access the Tech or Admin menu items
- Menu PIN Required ON
  - PIN is required to access the menu
  - User, Tech, or Admin level access will be granted based on which PIN is entered. If the PIN does not match the User, Tech, or Admin PIN, then the panel will display "Invalid PIN"

Once an access level is granted, that level is retained until the display is power-cycled or the display times out (see display Power Timeout).

When the turns back on, the access level reverts to User and follows the Menu PIN Required setting.

4.10 Quick Access Menu

The Quick Access Menu can be opened by pressing the menu control button  . This menu contains commonly accessed menu items. All access levels open this menu, and it is not affected by the Menu PIN Required setting. The following is the Quick Access Menu tree:

- Start-Stop with

- Operation
- Maintain Function
- Language
- Distance units
- Pressure units
- Volume units
- Temperature units
- High Set Point
- Low Set Point
- Target Point
- Autostart Dashboard

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5 Engine or VFD Setup

5.1 Engine Setup

Setting up the panel for a particular engine can be done through the menus. However, some engines require changes to multiple parameters, see section 4.3 and 4.4

5.2 VFD Setup

The panel can also control a Variable Frequency Drive (VFD) allowing electric-motor powered applications. A VFD is analogous to an engine's ECU. Instead of the panel commanding the ECU, which controls the engine, the panel commands the VFD, which controls the electric motor. Once setup for a VFD, the panel's operation is the same as an engine. To set up the panel for VFD control, navigate to **System → Engine Type** menu using an Admin level access and select VFD from the list. The next step is to select the specific VFD that is being used.

The panel communicates with the VFD over Modbus. Still with Admin level access, navigate to the **Communications → Modbus** menu and select the VFD model from the list. If the VFD being used is not listed, contact Cattron Sales to request the addition. The final step in this menu, is to verify the Modbus parity, baud rate, & stop bit match VFD settings. Next, Navigate to **System → Throttling** menu and verify the panel's max RPM matches the max RPM of the motor. The motor's max RPM can typically be found on the motor's information plate.

Referring to the VFD's user manual, verify or set the following items in the VFD

- Max frequency (50/60)
- Motor RPM
- Speed control source set to Modbus
- Ramp time to 0s or as low as possible.
    - The Panel will control ramp time using its settings (see Ramp Profile section 6.4.5)

Starting with version 2.06, the panel can directly configure some VFDs eliminating the, sometimes complicated, manually set up of a VFD. VFD's that support direct configuration have "Auto-Config" to the right of their name. Navigate to **Communications → Modbus à Motor** Settings at set the following items.

- Motor Frequency (50/60)
- Motor Speed (RPM)
- Motor Current
- Motor Voltage
- Motor Horse Power (HP)

Once configured, the electric motor can be started, stopped, and changes made to the RPMs exactly as if it was an engine.

5.3 Electronically Governed Engines

All of the following panel menu actions described in this section require Admin-level privileges.

To configure the panel to a particular engine, first go to the **System → Engine** Type menu and select the appropriate engine.

Some engines require additional configurations. After selecting the engine type, check to see if the engine selected needs additional configurations by navigating to the **System → Engine** Specific Settings menu. If the engine selected is listed, enter that sub-menu to configure the additional parameters. If the selected engine is not in the list, no further configurations are required.

Finally, set the Minimum, Idle and Maximum RPMs in the Throttling Menu.

5.4 Mechanically Governed Engines

All of the following panel menu actions described in this section require Admin-level privileges.

To configure the panel for a mechanical engine, first go to the **System → Engine** Type menu and select the mechanical engine. Next, navigate to the **System → Engine Specific Settings → Mechanical Engines** menu.

The following steps should be performed in order:

1. Calibrate the tachometer by selecting Calibrate Tach.
    a. With the engine at idle, measure the RPM using a photo-tachometer or handheld tachometer. Better RPM accuracy is achieved if the engine is allowed to warm up.
    b. Enter the measured RPM into the panel while the engine is still running at the measured RPM.
2. Mount the Actuator.
    a. Select the Actuator Setup menu and then Mounting and Setup.
    b. The actuator can now be physically mounted to the engine. The display buttons can be used to Extend or Retract the actuator as needed to ensure full travel of the throttle arm.
3. Use the Extend or Retract controls to adjust the throttle arm to its Minimum point and select Set Min Travel Point on the panel. The engine does not need to be running.
4. Use the Extend or Retract controls to adjust the throttle arm to its Maximum point and select Set Max Travel Point on the panel. The engine does not need to be running.
5. Crank up the engine. Better RPM accuracy is achieved if the engine is allowed to warm up before proceeding.
6. Select Start Calibration.
7. Finally, set the Minimum, Idle and Maximum RPMs in the Throttling Menu.

6 Manual Operation

Use the following steps for manual operation:

1. Ensure that the Auxiliary Engine Stop (if fitted) is not activated.
2. Turn the key switch to the run position.
3. Press and hold the Run button.
4. Release button when engine or electric motor starts.

6.1 Throttle Control

The ECU determines how the engine responds to the throttle requests and will not allow the engine speed to fall below the ECU minimum RPM or go above the ECU maximum RPM. The ECU minimum and maximum RPM values are determined by the ECU "payload" and typically require the engine manufacturer's configuration tool to adjust them. The ECU will honor RPM requests that are above the ECU's minimum RPM as well as RPM requests that are below the ECU's maximum RPM.

Therefore, to avoid confusion, it is best not to set the panel's Minimum Requested RPM below the ECU's minimum RPM or set the panel's Maximum Requested RPM above the ECU's maximum RPM.

For example, the panel's Minimum Requested RPM is set to 800 RPM, yet the ECU payload defines the engine minimum speed to be 900 RPM. In this case, the engine will not run at 800 RPM despite the control panel requesting a lower engine speed. The ECU will ignore all RPM requests that are below 900 RPM, resulting in a minimum speed of 900 RPM.

6.2 Ramp Throttle

The standard Ramp Throttle uses the rabbit and turtle buttons to adjust the requested engine or motor speed. All throttle requests are sent directly to the engine using CAN throttle control or over Modbus to the VFD

> Note: Throttle control requires CAN throttling to be enabled in the ECU. CAN throttling is also known as Torque Speed Control or TSC1.

When first started, the requested engine or motor speed is Idle RPM.

- Pressing and releasing the rabbit icon increases the speed by the switch/rotary increment value (default = 50 RPM)
- Pressing and holding the rabbit icon causes the speed to increase (ramp) until the maximum speed is achieved
- Pressing and releasing the turtle icon decreases the speed by the switch increment value (default = 50 RPM)
- Pressing and holding the turtle icon causes the speed to decrease (ramp) until the minimum speed is achieved
- The panel will smoothly ramp the RPM up and down using the Max RPM change / s value (default = 500). This value can be changed in the Throttle → Switch/Rotary → Max Change / s menu.

6.3 Rotary Throttle Control

The optional Digital Rotary Throttle uses a rotary switch to simulate the operation of a throttle. When the engine or motor is first started, the requested speed is always Idle RPM. Turning the throttle knob clockwise

increases the requested speed by the switch/rotary increment value (default = 10 RPM). Turning the throttle knob counterclockwise decreases the requested speed.

6.4 Stopping the Engine or Motor

To stop the engine or motor, simply press the “OFF” button. The speed will be reduced in a control fashion and then the engine or motor will be stopped. Pressing the button for more than 3 seconds will cause the engine or motor to be stopped immediately. Do not use the Auxiliary Stop (if fitted) or the key switch to stop the engine or motor under normal conditions.

7 CANplus Machine Learning*

7.1 Introduction

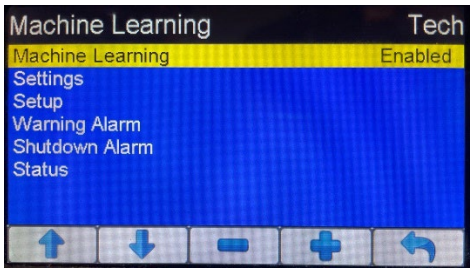
The panel offers local Machine Learning. All learning, analysis, monitoring, and alerting are performed directly by the panel. Telemetry is not required. The panel will learn the normal operation of an application by looking at multiple inputs from sensors, engines, and VFDs. The learning stage only takes minutes and once done, alarm levels for warnings and faults are automatically set. The panel will then monitor all the learned parameters. The status is shown on the display with CANplus IQ gauges. Any alarms that occur are sent out on the CAN bus and telemetry if installed.

7.2 Getting Started

Please see the Technical White Papers using the links below

- CANplus Best Practices – Getting the Most out of your CANplus Machine Learning
- CANplus Machine Learning Trouble Shooting

The pumping application should be setup and running as desired meaning that the suction, pressure, flow, lift, etc. are all operating as desired. At this point, the panel is first configured for Machine Learning. Navigate, with a TECH level access, to the Machine Learning menu and enabling it.



The next step is to configure which inputs are to be used for the Suction input, Discharge input, Flow input, Vibration 1, 2, 3. Navigate to Input/Output Setup -> Inputs -> Pump Parameters

Suction Transducer – Selections (Transducer 1, 2, 3, 4, 5, 6, Disabled)
Discharge Transducer - Selections (Transducer 1, 2, 3, 4, 5, 6, Disabled)
Flow Meter - Selections (Transducer 1, 2, 3, 4, 5, 6, Pulse, Disabled)
Vibration sensor – Selections (Transducer 1, 2, 3, 4, 5, 6, Disabled)

Navigate to the Machine Learning → Setup menu.

Minimum RPM - (RPM)

The applications operational minimum RPM, which could be higher than idle
Example: At idle, the pump is unable to maintain enough suction to lift the water the required amount. The application requires 1000 RPMs to properly lift the water and maintain operation. Therefore, Machine Learning's Minimum RPM should be set to no lower than 1000.

Maximum RPM - Setting (RPM)

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The applications operational maximum RPM, which could be lower than the pump/engines max RPM
Example: Due to other limitations, the pump would generate to much discharge pressure at the engine's or pump's max RPM of 3000. This application's max RPM is 2500. Therefore, the Machine Learning's Maximum RPM should be set to no higher than 2500.

Settling Time - (Seconds)

Default is 30 seconds
The time the panel waits after an RPM change before the learning starts at the new RPM
This value should be set to a long enough time for the system to stabilize.
This value affects the overall learning time. A conservatively long setting time will ensure the system is stable but will make the overall learning time longer. However, an aggressively short time will decrease the overall learning time but could lead to less accurate learning of the application if the system is not yet stable.

Learning Time - (Seconds)

Default is 15 seconds
The time the panel learns the behavior at each RPM stage
This value affects the overall learning time. A conservatively long learning time will ensure most accurate learning of the application but make the overall learning time longer. However, an aggressively short time will lower the overall learning time but could lead to less accurate learning of the application.

7.3 Learning Phase

Once the Machine Learning has been configured, the learning phase can be started. The pump must be running in Manual mode. Once running in Manual mode, select "Start auto learning phase". The Machine Learning wizard steps thru the process starting with an Overview Screen, which has the estimated time and says the following

This process will automatically control the engine/motor speed while it learns the expected runtime values. Please ensure the setup is working as expected and the correct sensors and speed range are selected before starting. Starting a new learning process will remove the previous learned values

The next screen is the Learning Status screen, which shows time remaining for the learning process. The Learning Status screen can be left to view gauges and other information as desired. Navigating back to the Start auto learning phase will then provide updated status information.

After the learning phase is complete, the Learning Results screen appears, which shows what inputs were learned and the details of the learning. During the learning phase, if there is no data, erratic data, or too constant (too small of range for the data) that input data will be discarded, and the status screen will show the input as Invalid. The screen will show the input as Disabled if that input is disabled in the settings menu.

7.4 Input Enabled/Disabled, Warning and Fault Thresholds

Now that the application has been learned, each Input (see list below) can be enabled or disable in the **Machine Learning → Settings** menu. The Warning and Fault thresholds can also be viewed. These thresholds are automatically determined during the learning phase. However, they can be individually changed in the settings menu as desired. Engine and VFD parameters may not be available on all engines or VFDs. If a

particular parameter is not available, its lack of availability will automatically be recognized during the learning phase.

Machine Learning Inputs:

Flow, Suction, Discharge, Delta Pressure (Discharge minus Suction) across the pump

Vibration

Engine Fuel Rate, Load (Torque)

VFD Percent Load, Power Factor Angle, Output Current, Torque

7.5 Warning and Fault Alarms Settings

Finally, in the Machine Learning Settings menu, The Warning and Fault Alarms can be configured. Below is the Warning Alarm menu with descriptions. The Shutdown Alarm menu is similar.

Warning Alarm

Armed When - Selections (Never, Autostart, Manual Start, Always)

The mode the panel must be in for the Alarm to be enabled

Engine/Motor Condition - Selections (Running, Always, Stopped)

The condition of the engine/motor must be in for the Alarm to be enabled

Engine/Motor Stop - Selections (Ignore, Derate, Go To Run)

What condition the engine/motor should go to when the Alarm happens

Running Ignore Delay - (Seconds)

Default is 60 seconds

The number of seconds after the engine/motor starts running before the Alarm is enabled

Enable Delay - (Seconds)

Default is 30 seconds

The number of seconds the Alarm condition must be true before the Alarm occurs.

Example: If the Alarm condition occurs for only 10 seconds and this delay is set to 30 seconds, the Alarm will not occur.

Disable Delay - (Seconds)

Default is 5 seconds

The number of seconds the Alarm condition must remain False before the Alarm will be cancelled.

Example: If the Alarm condition briefly goes False for 10 seconds and this delay is set to 30 seconds, the Alarm will not be cancelled.

Data Loss Fault - Selections (Off/On)

If the panel detects the data for this input is lost or invalid, an alarm will occur if set to On.

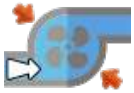
Example: If the suction transducer is unplugged from the panel, an alarm will occur if set to On.

7.6 CANplus IQ Gauges

The current Machine Learning status and values can be viewed on the IQ Gauges.

The IQ gauge is divided into 5 ranges. Green is the normal range. The gauge will show the parameter is as expected when its needle is pointing straight up. The needle will deviate to left as parameter is less than the normal and the right when it is more than the norm. As the parameter deviates more and more from the normal, it will cross over into the yellow region. If it remains in the region for more than the configured Warning Enable Delay (default is 30 seconds), a Warning Alarm will occur if enabled. If it continues to deviate even more, the needle will swing into the red region. If it remains in the red region for more than the configured Shutdown Enable Delay (default is 30 seconds), a Shutdown Alarm will occur if enabled.

The following table shows all the icons used with the IQ gauges .

Icon	Description
	Pump Flow
	Pump suction (flow arrow on the suction side of the pump)
	Pump Discharge (flow arrow on the discharge side of the pump)
	Pump Delta Pressure (flow arrow on suction and discharge sides of the pump)
	Vibration
	Engine Fuel Rate
	Engine load Torque

Icon	Description
	VFD Percent Load
	VFD Power Factor Angle
	VFD Output Current
	VFD Torque

8 Autostart Operation

8.1 Prerequisites

The panel can start and stop the engine or motor based on external triggers and/or timed schedules.

Note: It is important to note that the engine or motor may start without warning or notice.

The panel is equipped with an Autostart warning alarm.

- It is SOLELY the responsibility of the owner/installer/operator to provide warning labels, visible warnings and audible warnings to notify the operator of an impending start-up
- ALWAYS use lock-out/tag-out procedures prior to performing ANY service or configuration operations
- DO NOT configure operator programmable features while the panel is in “AUTO” mode (green Autostart light is illuminated)

8.2 Enabling Autostart

To place the panel in Autostart mode, turn the key switch clockwise to the ON position and press the AUTO button. The Autostart ICON will illuminate, indicating the panel is in the Autostart mode. CAN bus values will show “- - -” since the ECU is not energized at this time. The display will power down after two minutes to reduce battery drain but the Autostart light will stay illuminated. The power-down time can be adjusted through Display, under the Display menu with an Admin level access. When the selected start condition occurs, the control panel will power up and attempt to start the engine or motor after sounding the Autostart warning alarm. When the engine or motor has successfully started, the panel will control the speed following the configurable throttle control profile (see the Ramp Profile section). The flexible throttle profile includes various speeds and times for a variety of scenarios. When a stop condition exists, the panel will reduce the speed as per the throttle profile and stop the engine or motor. If the configured start condition returns before the shutdown process is complete, the engine or motor will not stop but rather will return to the required speed.

⚠	WARNING
	AUTOMATIC START/STOP WARNING! WHEN THE AUTOSTART MODE IS ACTIVE AND A START CONDITION EXISTS, THE PANEL WILL START IMMEDIATELY! DO NOT CONFIGURE THE PANEL WHEN THE AUTOSTART MODE IS ACTIVE! ALWAYS USE LOCK-OUT/TAG-OUT PROCEDURES WHEN SERVICING AUTOSTART EQUIPMENT!

8.3 Autostart Menu

The panel has two switch inputs dedicated for use as Autostart inputs. The transducer input can also be selected to control a start/stop set point.

8.4 Behavior

The following links to videos show how to set up the panel for sample applications:

Click here to view Dual Float Empty.

Click here to view Transducer with Backup Switches.

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8.4.1 Configuring Operation

Configuring Autostart begins with selecting the desired behavior. The two choices are as follows:

1. High to low, examples:
   - High water level to low water level
   - High pressure to low pressure
   - High temperature to low temperature
2. Low to high, examples:
   - Low water level to high water level
   - Low pressure to high pressure
   - Low temperature to high temperature

8.4.2 Configuring Start and Stop Events

The next step is to define the start and stop events. The choices are as follows:

- Single switch
- Cycle Run
  - Start upon entering Autostart modes
  - Stops after x minutes
  - Restarts after y minutes
- 2-State, Single Switch
  - Manually started and stopped
  - Switched input toggles between idle (open) and Intermediate RPM (closed)
- Remote Control
  - Start and stop via switch
  - Throttle up and down via two other switches
  - Single start/stop
- Dual switch
  - Start and stop via dual (high and low) switches
- Transducer
  - Start and stop via transducer level
    - Transducer with backup switches
      - Start and stop via transducer level
      - Switches as backup start and stop if there is a transducer failure
    - Scheduler
    - Timed run
      - Manually started
      - Automatically stopped by countdown timer
      - Can maintain a level while running

The following table describes the Start/Stop events when behavior operation is set to “High to Low” (switches/floats are normally open):

Start/Stop Events	Engine or Motor Starts When	Engine or Motor Stops When
Single Switch	SW1 is closed	SW1 is open
Dual Switch	SW1 and SW2 are both closed	SW1 and SW2 are both open
Transducer	Input is above high set point	Input is below low set point
Transducer with Backup Switches	Input is above high set point; Dual Switch mode if Transducer fault is detected	Input is below low set point; Dual Switch mode if Transducer fault is detected

Start/Stop Events	Engine or Motor Starts When	Engine or Motor Stops When
Scheduler	Date and Time occurs	Date and Time occurs
Timed Run	Autostart switch pressed	Timer expires

The following table describes the Start/Stop events when behavior operation is set to "Low to High" (switches/floats are normally open):

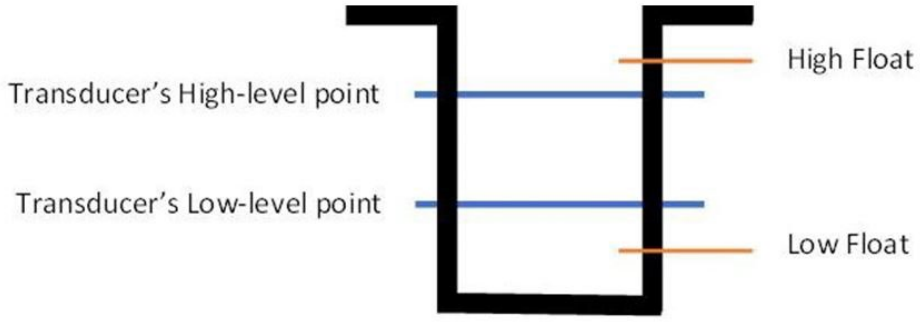
Start/Stop Events	Engine or Motor Starts When	Engine or Motor Stops When
Single Switch	SW1 is open	SW1 is closed
Dual Switch	SW1 and SW2 are both open	SW1 and SW2 are both closed
Transducer	Input is below low set point	Input is above high set point
Transducer with Backup Switches	Input is below low set point; Dual Switch mode if Transducer fault is detected	Input is above high set point; Dual Switch mode if Transducer fault is detected
Scheduler	Date and Time occurs	Date and Time occurs
Timed Run	Autostart switch pressed	Timer expires

8.4.2.1.1 Transducer Fault Detection using Backup Switches

When configured and equipped with transducer and back up switches, the panel will use the transducer to determine the primary start and stop events. The switches are used to detect transducer faults; when a fault is detected, the panel will automatically adjust to use the switches to detect the start and stop events. The panel will alert to the fault, but normal operation will continue with the exception that the switches will be used instead of the faulty transducer.

For proper operation and fault detection, the switches must be configured such that the high-switch opens/closes at a level above the transducer's high-level point and the low-switch opens/closes at a level below the transducer's low-level point, as illustrated in the fluid pumping example diagram below.

As an example, consider the following situation. When pumping fluid, the setup should be like the following diagram. Typically, floats function as an Open switch when not floating and a Closed switch when floating.



Faults

Transducer Level	Low-Level Switch	High-Level Switch	Result
Above Low-Level Point	Open	—	Transducer is within normal operating range, but value is incorrect (too high) because low-level float should be closed
Below High-Level Point	—	Closed	Transducer is within normal operating range, but value is incorrect (too low) because high-level float is closed
Out of Range (Low)	—	—	Transducer value is below the normal operating range (severe)
Out of Range (High)	—	—	Transducer value is above the normal operating range (severe)

8.4.3 Configuring the Transducer

With a transducer connected, the panel can be configured to throttle the engine or motor to maintain a specific transducer level much like a car's cruise control. If this cruise control feature is desired, the Maintain Transducer Level should be set to Enabled.

The other choice is to Disable the Maintain Transducer Level, which follows the Ramp Profile described in the Ramp Profile section.

The transducer's cruise control function can be independently set to either Low to High or High to Low.

Function	Throttles Up When	Throttle Down When
Low to High	Input is below the target point	Input is above the target point
High to Low	Input is above the target point	Input is below the target point

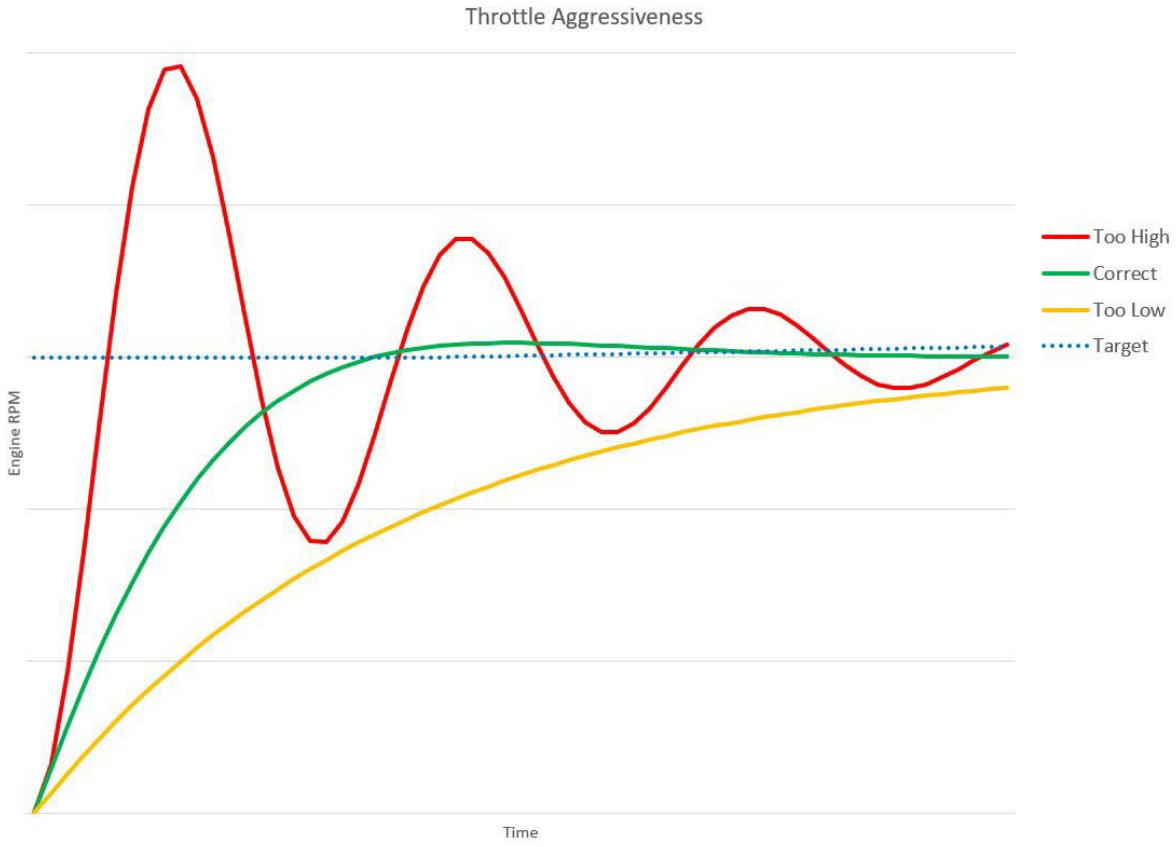
To see or change the transducer target point, go to the **Autostart → Maintain Transducer Level → Target Point** menu.

Some applications are slow to respond to throttle changes while others are fast. An analogy is a car's cruise control and how the car reacts going downhill or uphill. Going downhill, a car will quickly speed up when just a little more throttle is applied. In this case, the throttle adjustment should be less aggressive. On the other hand, a car going uphill will speed up slowly and therefore needs more aggressive throttling. To adjust how quickly the control panel ramps the throttle up or down for a particular application, go to the **Autostart → Behavior → Maintain Transducer Level → Throttle Aggressiveness** menu. The higher the number, the more aggressive or quicker the control panel ramps the throttle up or down to maintain the level.

When adjusting the Throttle Aggressiveness, it is best to understand how responsive the system is to changes. Like the analogy of the car going downhill, a small water tank with a large pump is an example of a system that will respond quickly to changes when throttling the water level. Alternatively, a large tank with a small pump will respond more slowly.

The following figure demonstrates the responsiveness of a system to adjustments in Throttle Aggressiveness. A fast-responding system will need a lower aggressiveness value. Otherwise, the RPMs will overshoot and undershoot the target value as depicted in the graph by the red "Too High" throttle aggressiveness line. Ideally, the RPM should quickly ramp up and home in on a small RPM range to maintain the target value as

depicted in the graph by the green “Correct” throttle aggressiveness line. However, if the gain is set too low, the RPM may never get to the proper range to maintain the target value as depicted in the graph by the yellow “Too Low” throttle aggressiveness line. The full screen Throttling Line Graph (see the Throttling section) can be utilized to observe the behavior to determine if the throttling aggressiveness is correct.



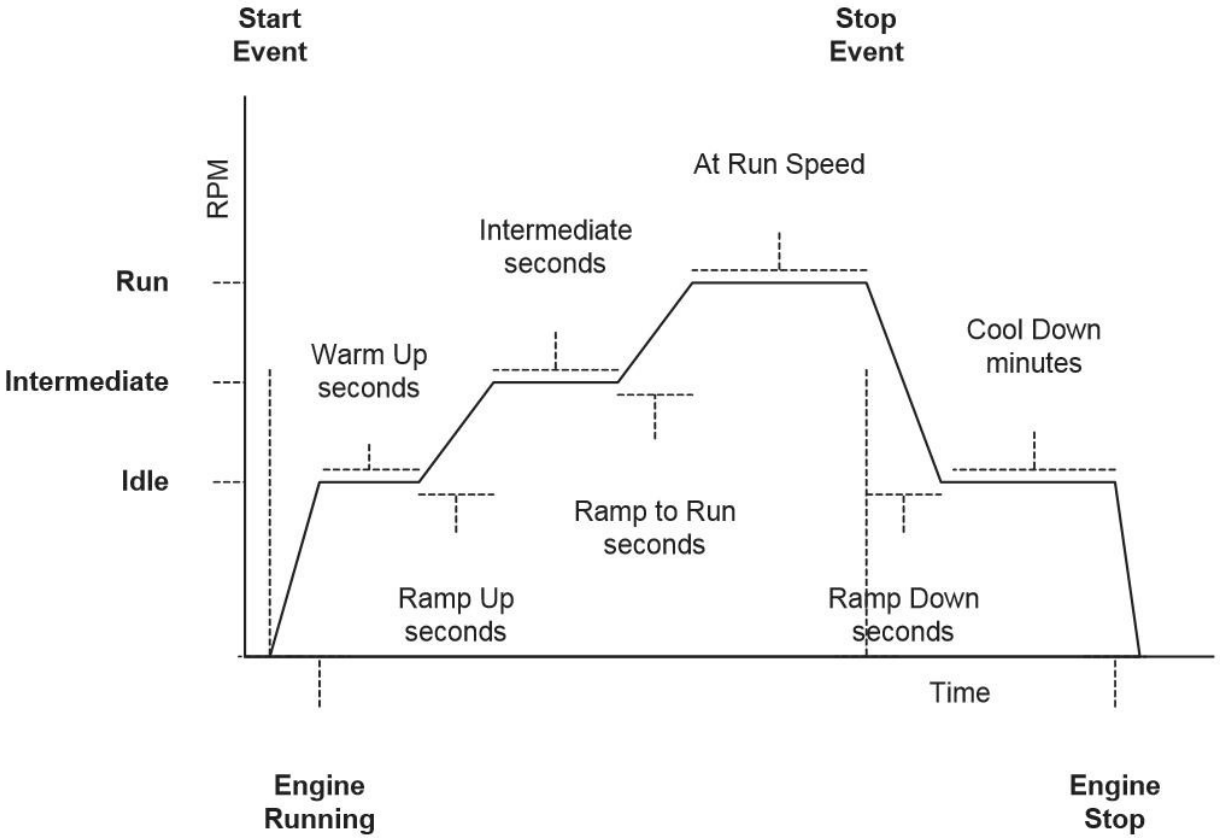
8.4.4 Configuring Start and Stop Delays

In situations where start or stop conditions may be met briefly, repeated start/stop cycles should be avoided. Two settings allow a delay to be added before a specific input condition is recognized. An example of such use is where a float switch is installed in choppy water. The float switch may repeatedly open and close based on the water’s surface waves. Rather than repeated start and stop cycles, it is better to wait for the float switch to be continuously closed for a specified duration before the start or stop event is declared.

The Start and Stop Delays can be configured by going to the **Autostart → Behavior → Start Delay or Stop Delay** menu.

8.4.5 Ramp Profile

The Auto ramp profile allows the use of configurable warm up and cool down profiles to help protect the equipment and other assets such as plumbing, or to ensure proper ramp up and down of pressure or flow. An example is shown below.



Setting	Description
Idle RPM	Selects the RPM that the control system will request for idle speed. If the engine or motor is started, it will always begin running at Idle speed.
Intermediate RPM	Selects the RPM that the control system will request for intermediate speed. Intermediate speed is a specific speed point at which the engine or motor will pause during the ramping up cycle. The intermediate speed can be used to prime a pump or charge lines.
Run RPM	Selects the RPM that the control system will request for run speed. The run speed is the normal operating speed. If the Maintain Transducer Level "cruise control" is enabled, the control panel will dynamically throttle the engine or motor to maintain the level using the Run RPM as the max.
Warm Up Time	The time (in seconds) the engine or motor will stay at the Idle RPM after starting.
Ramp to Intermediate Time	The time (in seconds) the engine or motor will take to ramp from the Idle RPM to the Intermediate RPM.
Intermediate Time	The time (in seconds) the engine or motor will stay at the Intermediate RPM.
Ramp to Run Time	The time (in seconds) the engine or motor will take to ramp from the Intermediate RPM to the Run RPM. If the Maintain Transducer Level is enabled, the panel will not ramp to the Run RPM but will start throttling the engine or motor to maintain the level.
Ramp to Cooldown Time	The time (in seconds) the engine or motor will take to ramp from the Run RPM to the Cooldown RPM.
Cooldown Time	The time (in minutes) the engine or motor will stay at the Cooldown RPM before shutting down engine or motor

Instead of a time-based system, the ramp profile can wait for an event to occur before Ramping to Run. These events can be one of the following, for example:

- Pump is primed

8.5 Transducers

The transducers can be configured for Autostart levels, scaled values, units of measure for setup and display, calibration, warning, and fault levels.

8.5.1 Autostart Triggers

The low and high Autostart trigger levels can be set via the **Autostart → Transducer → Autostart Triggers** menu.

8.5.2 Setup

There are a few parameters that must be configured for proper operation of the transducer. These configurations can be set via the **Autostart → Transducer → Setup** menu.

- Type and Range
  - 4 mA Scaled Value
    - Value in setup units represented by a 4-mA reading

  - 20 mA Scaled Value
    - Value in setup units represented by a 20-mA reading
  - Setup Units
    - Units used to setup the 4 mA and 20 mA scaled values
  - Display Units
    - Units that are displayed on the gauges
  - Calibration Zero Offset
    - Offset to calibrate the 4-mA value (plus or minus 5%)
- Low Warning Alarm
  - Value in display units that will generate a Low warning
- Low Shutdown Alarm
  - Value in display units that will generate a Low shutdown
- High Warning Alarm
  - Value in display units that will generate a High warning
- High Shutdown Alarm
  - Value in display units that will generate a High shutdown

8.6 Scheduler

Setting the "Start/Stop with" to be "Scheduler Only" causes the engine or motor to be started and stopped based on the schedule defined by the **Autostart → Behavior → Start/Stop with → Scheduler Only** menu.

Next, set the Scheduler Method to Override by going to the **Autostart → Scheduler → Method** menu. Using the Override method will override any Autostart settings.

The Scheduler mode starts and stops the engine or motor based on time and date. Up to 16 unique scheduled run cycles can be configured offering multiple run cycles per day, and those run cycles can differ depending on the day of the week.

The Scheduler has another method called Allowed Times. Unlike the Override method, this method marries the Autostart setting with the Scheduler, allowing the AutoStart to only occur during the allowed times. For example, with this method the panel can be configured to only AutoStart on Mondays, Wednesdays, and Fridays between the times of 12:00 p.m. and 3:00 p.m. Up to 16 unique allowed times can be configured.

8.7 Timed Run

The Timed Run mode allows for a manually initiated start with the stop event being automatically triggered based on running time. This mode allows the operator to walk away from a running system knowing that it will automatically stop after a predetermined amount of time. There are no automatic restarts in this mode. All starts are manually initiated by pressing the Autostart switch.

8.8 Auto Battery Recharge

The panel can be configured to monitor the battery and crank up the engine to recharge the battery once the battery voltage falls to a configured level. To enable and configure this feature with Tech or Admin level access, navigate to **Autostart→ Auto Battery Recharge**

- Auto Battery Enabled
  - Off/On
- Recharge Run Speed
  - The speed that the engine will run at during the recharging
- Enable Delay (m)
  - How long the battery must be at or below the voltage threshold before the recharging is

started

- Recharge Time (m)
  - How long the engine runs to recharge the battery
- Delay Between Recharge (m)
  - How long to wait between recharge cycles
- Low Battery Threshold (V)
  - The battery voltage the battery must be at or below to start a recharge

8.9 Auto Antifreeze

The panel can be configured to periodically run to prevent fluid in the system pipes from freezing. To enable and configure this feature with Tech or Admin level access, navigate to **Autostart→ Auto Antifreeze**

- Auto Antifreeze Enabled
  - Off/On
- Antifreeze Run Speed
  - The speed that the engine or motor will run to prevent fluid from freezing
- Antifreeze Delay (m)
  - How long to wait between antifreeze cycles
- Antifreeze Run time (m)
  - How long the engine or motor will run to prevent fluid from freezing

9 Multi-Pump Control

9.1 Introduction

In conjunction with Autostart, the panel can control up to five other CANplus controllers over Modbus. This capability is targeted for jobs that require multiple pumps. For example:

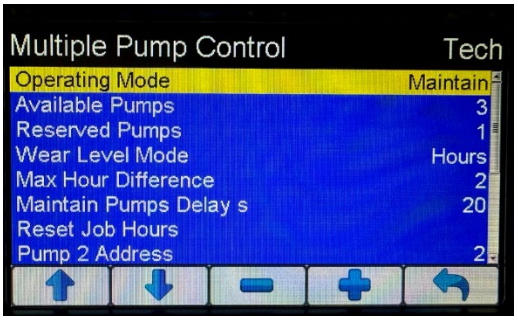
- A job might require pumps to start when a reservoir is full
  - A controller can be configured to Autostart when a connected float is active
- However, the job might require two pumps running in parallel to achieve the required flow
  - The Controller panel can be configured to automatically control both pumps to work synchronously together. Both starting and stopping
  - Both pumps would go to their own configured Run speed
- The job might also require a 3rd pump as a backup in case one pump goes down.
  - The Controller panel can be configured to only have two pumps running at a time and keep the 3rd as a reserve. If one pump fails, it will automatically bring up the 3rd pump.
- The job might further require that all the pumps rotated into operation so that the total job-hours is spread across all three pumps
  - The Controller panel can be configured to monitor engine hours of all the pumps and when the job hours of any pump is more than a configured amount (example 50 hours), that pump will be stopped and the pump with the least number of job hours will be started.
  - Alternatively, the Controller panel can be configured to alternate pumps each time a start event occurs (Lead-Lag).

9.2 Setup

A multiple pump set up consists of a Controller panel and 1 to 5 Peripheral panels. Start and Stop sensors or switches and sensors used to maintain a certain level, pressure, or flow; all are connected to the Controller panel. The Controller panel uses ModBus connections to command the Peripheral panels to start, stop, or change speed.

The Multiple Pump Control menu can be accessed from the top menu with Tech level access.

There are three Operating Modes:



- Disabled
  - Multiple Pump Control is disabled
  - All Peripheral Panels should be set to disabled
- Synchronized Running
  - Pumps will start and stop at the same time
  - Pump will run at their configured Run speed, which can be different
- Maintain
  - For use when a certain level (flow, depth, pressure…) is to maintained
  - Pumps will start and stop as needed to maintain the set level.
  - Only the Controller panel should have its Maintain set to Low→High or High→Low. The Peripheral panels should have their Maintain mode set to Disabled

Only the Controller panel should be set to Synchronized Running or Maintain modes. The other Peripheral panels' operating modes should be set to Disabled

Available Pumps is the total number of pumps including the Controller

Reserved Pumps is the total number of pumps that should be held in reserved

In the Introduction example, the total number of pumps is 3 (1 Controller and 2 Peripherals) with 1 of the 3 pumps being held in reserve at all times

Wear Level Mode is mode used to balance the usage. Choices are Hours (will change pumps based on job hours) or Lead-Lag (will alternate pumps every starting event)

Max Hour difference is how many hours the Controller panel will use to determine when to shut down one pump and bring up another. This setting is not used when Lead-Lag is set as the Wear Leveling Mode.

Maintain Pump Delay is the number of seconds that the controller will wait when bring up another pump. This time gives the system time to stabilize. When the time has elapsed and the maintain point has still not been achieved, the Controller panel will bring up another pump.

The Controller panel will select one of the pumps to be the Maintain pump, which may or may not be the pump that the Controller panel is physically attached to. When the selected Maintain pump reaches its Run speed and still unable to achieve or maintain the level, pressure, or flow; the Controller panel will wait the duration of time set as the Maintain Pump Delay before bringing an additional pump online. That additional pump will then ramp to its Run speed. The Maintain pump will then adjust its speed accordingly. The process repeats until finally the Maintain pump is able to lower its speed to maintain the level, pressure, or flow.

Similarly in a reverse fashion; if the Maintain pump ramps itself down to idle and stays their for the Maintain Pump Delay duration, one of the additional pumps will be ramped down and shut down. This process repeats until the Maintain pump is able to raise its speed above idle.

Reset Job Hours is used at the beginning of the job once the pumps are plumbed and ready to begin operation. Ensure that the displays of all the Peripheral panels are on and that all panels, including the Controller panel, have valid engine hours. The Controller panel uses this command to collect the engine hours from all the engines in use to establish the Job Hours for each engine. Example using the introduction synchronous example that had 3 pumps with 1 in reserved with Max Hour Difference set to 50:

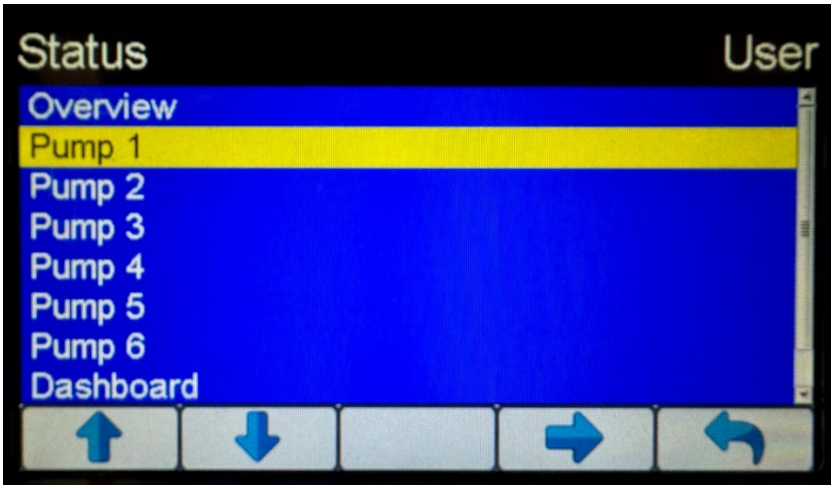
- Pump Engine 1 is at 550 hours
- Pump Engine 2 is at 50
- Pump Engine 3 is at 250
- Job hour 0 starts at these points
- Pump Engine 1 & 2 are started
- 50 job hours later,
    - Pump Engine 1 is at 600 hours
    - Pump Engine 2 is at 100
    - Pump Engine 3 is still at 250
    - Pump Engine 1 is shut down
    - Pump Engine 2 keeps running
    - Pump Engine 3 is started
- 50 more job hours later for a total of 100 job hours

    - Pump Engine 1 is still at 600 hours
    - Pump Engine 2 is now at 150
    - Pump Engine 3 is still at 300
    - Pump Engine 2 is shut down
    - Pump Engine 1 is started back again
    - Pump Engine 3 keeps running
- 50 more job hours later for a total of 150 job hours
    - Pump Engine 1 is now at 650 hours
    - Pump Engine 2 is still at 150
    - Pump Engine 3 is now at 350
    - Pump Engine 3 is shut down
    - Pump Engine 2 is started back again
    - Pump Engine 1 keeps running
- At this time, each Pump Engine will have run for 100 job hours

Pump Address 2—6 are the Modbus addresses that each panel should be set. Each address must be unique.

9.3 Multiple Pump Status and Dashboard

On the Controller panel, the status of the individual Peripheral panels can be viewed in the menus Multi Pump Control → Status or using the Custom Menu button



The Multiple Dashboard can be viewed by selecting Dashboard. On a CP1000, pressing Dashboard[2] button twice will also bring up this dashboard.

*Patented or Patent Pending www.cattron.com/resources/cattron-patents

10 CANplus Control

The panel has expanded throttle capabilities, which provides users with more options to control electronically governed engines, electrical motors, or mechanically governed engines when equipped with the Cattron Throttle Actuator.

CANplus Control Throttling Options:

- Dynamic Throttling*
- Pause at Run speed*
- Throttle by Maintain Point*
- Controlled Off
- Linear Throttling
- Auto/Manual mode Toggle
- Momentary Rabbit/Turtle Keys
- Auto ramp
- Autostart
- Auto throttle Maintain Point

10.1 Dynamic Throttling

Configurable throttle increments for up to 10 rpm ranges

Click here for a video showing Setup and Demonstration or go to https://youtu.be/uhce0nqn8xM

10.2 Pause at Run speed

at Run Speed Single press and hold to ramp to the configurable run RPM and pause to allow throttling adjustments from that point

Click here for a video showing Setup and Demonstration or go to https://youtu.be/j6WimkphzsY

10.3 Throttle by Maintain Point

Throttle by Maintain Point Live adjustments of the maintain point using the rabbit and turtle buttons

Click here for a video showing Setup and Demonstration or go to https://youtu.be/MSitdFR5pkU

10.4 Controlled Off

Controlled Off Single click to ramp the engine or motor down automatically and smoothly to idle and shut it off

Pressing the OFF button for 3 seconds, will cause the engine or motor to immediately shutdown

Click here for a video showing Setup and Demonstration or go to https://youtu.be/-vGmPeS2mdc

10.5 Linear Throttling

Linear Throttling Allows an external device to control the throttle using a 4-20 mA input

Click here for a video showing Setup and Demonstration or go to https://youtu.be/3HILfk1TSV8

*Patented or Patent Pending www.cattron.com/resources/cattron-patents

10.6 Auto/Manual mode Toggle

Auto/Manual Mode Toggle allows switching between modes without shutdown the engine or motor

10.7 Momentary Rabbit/Turtle Keys

Momentary Rabbit/Turtle Keys Throttle adjustment via momentary rocker switch

10.8 Autoramp

Autoramp Configurable seven-stage RPM profile

10.9 Autostart

Configurable start and stop events for AutoStart switch inputs, 4-20 mA transducer (level, pressure, flow, etc.), 24x7 schedule run and countdown-to-off timer

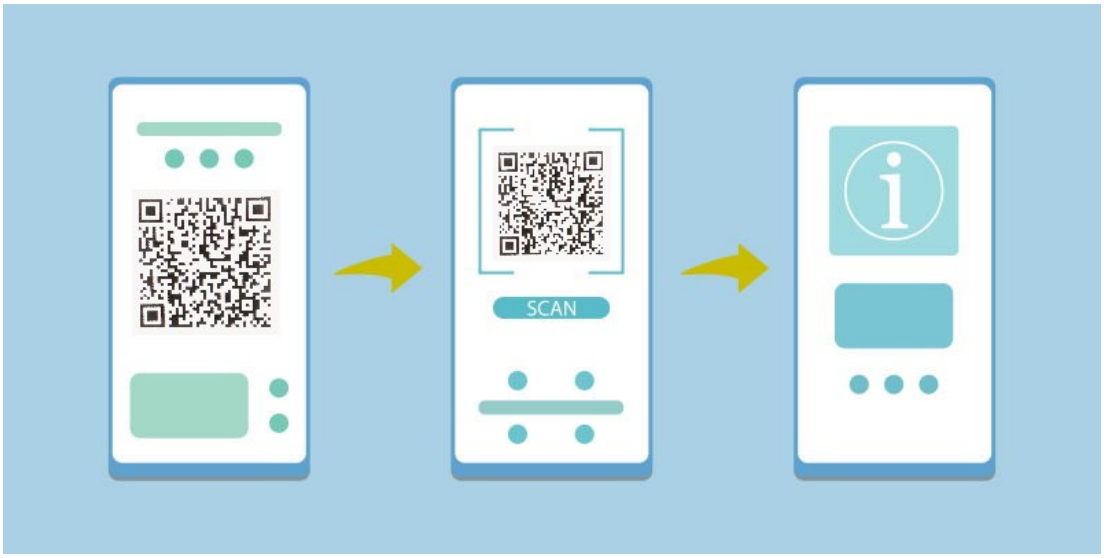
10.10 Autothrottle Maintain Point

Configurable 4-20 mA transducer and pulse flow meter target values to dynamically throttle the engine or motor to maintain a level

11 QR-Assist™*

The panel has built-in QR-Assist technology that dynamically generates a diagnostic QR-Code that is tied to diagnostic trouble codes for the Panel, Engine, VFD, Pump, or Machine. In addition to the trouble code itself, the dynamically generate QR Codes also contain valuable details about the machine at the time the trouble code occurs. Scanning this code with a typical smart phone automatically links to RemoteIQ QR-Assist website, which displays the details of the issue along with helpful trouble-shooting steps. Scan the code below for an example or Click here for a video showing Setup and Demonstration or go to https://youtu.be/00rD_Q8CWag

Some SPN/FMI combinations are proprietary codes. SPN/FMI combinations can easily be added by contacting support.lofa@cattron.com.



*Patented or Patent Pending www.cattron.com/resources/cattron-patents

12 Configuration and Manufacturing Info

The panel has been preloaded with factory default configurations, or optionally a custom OEM-specific configuration, to ensure easy start-up and commissioning. To support the diversity of applications, the control panel is easily configured on demand. Accessing configurable settings can be accomplished in three ways:

- Display Menu
- CANplus Customizer Software Suite and CANplus Config Kit
- CANplus Customizer Software Suite and a USB drive

When finished with exporting or importing configurations, remove the USB drive and reinstall the dirt and dust rubber plug.

12.1 Display Menu

Most commonly accessible parameters can be changed onsite or in a facility by navigating the display using the soft keys to find the appropriate menu page and data field. The available menu items are dependent upon the current access level (see the Menu Tree section for available menu items). Easy to follow menu navigation diagrams are located throughout the user manual and accompany each section which describes a configurable operation or setting.

12.2 CANplus Customizer Software Suite and CANplus Config Kit

In situations where multiple units must be reconfigured, or in the case of a single unit which requires complete reconfiguration, using the CANplus Customizer Software Suite, which is proprietary configuration software, is highly recommended. The software suite is meticulously maintained and regularly updated. These free updates include software enhancements and new functionality, and they ensure compatibility with evolving technologies. Please see the Resources section at

- https://www.cattron.com/products/canplus/canplus-cp1000/
- https://www.cattron.com/products/canplus/canplus-cp750-e/.

The CANplus Config Kit (Part Number 010-6750-01) includes the following:

- An adapter harness that connects to the panel's engine interface connector
- An AC power supply
- A USB to CAN bus hardware adapter

With this kit, a panel's configuration can be read from the panel or written to the panel via CAN bus. During read or write operations, the panel must be the only CAN bus device. Using the included adapter harness ensures proper operation during configuration read or writes.

12.3 CANplus Customizer Software Suite and a USB Drive

The panel has ability to import and export configurations using a USB drive, avoiding the need to purchase and have onsite a CANplus Config Kit as well as the need to disconnect the panel from the engine. The panel's USB port is located on the front of the panel. It is recommended that the dirt and dust rubber plug be inserted into the USB port when this port is not in use. Newer panels, have a spring-loaded door to protect the USB port from dirt and dust. Additionally, the port can be used to charge a phone if desired.

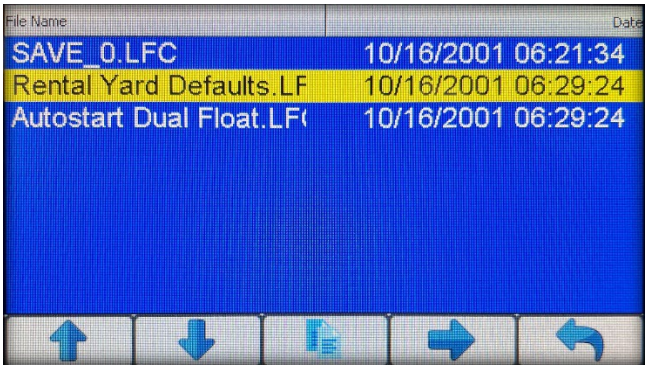
Install the USB drive in the panel's USB port. The current configuration can be exported by going to the **System → Export Config**. menu. To import a new configuration, the menu access level must be at the Tech or Admin level (see the Access Levels section). A new configuration is imported by going to the **System → Import Config**. menu. New configuration changes take effect immediately. Therefore, the engine should not be running when importing a new configuration.

12.4 Saved Configurations

The panel can save up to 10 configurations. Any of these configurations can be loaded to be the operational configuration. Changing and importing configurations requires a Tech or Admin level PIN (see the Access Levels section).

12.4.1 Import Configurations for storage

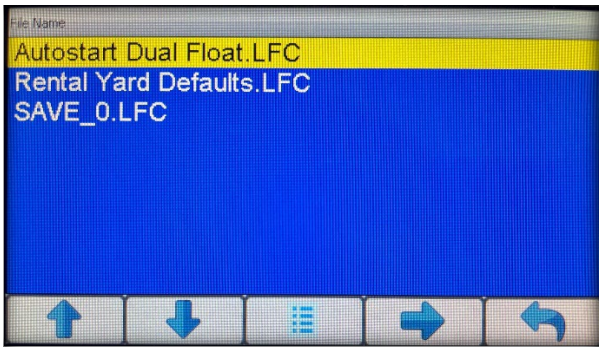
Use the Customizer software to create the desired configurations and save them to a USB drive. Place the drive in the panel's USB port and with Tech or Admin level access, navigate to **System → Import Configurations**. Use the display buttons to select the file to copy to the panel's storage. Pressing the middle display button  will copy the file to the panel's storage. Repeat for any other files



12.4.2 Loading a Saved Configuration to be the Operational configuration

To make a saved configuration be the operational configuration, navigate to **System → Saved Configurations**.

Use the display buttons to select the desired file. Pressing the middle display button  will make that configuration the panel's operational configuration.



12.5 Manufacturer Info

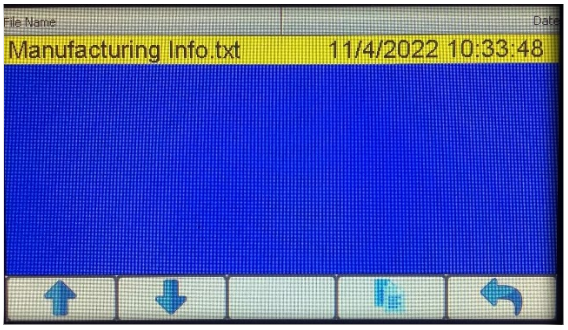
The panel can store additional manufacturing information. Importing Manufacturer information requires an Admin level PIN (see the Access Levels section).

12.5.1 Creating the Manufacturer Info file

Create a plain text file using a PC save it to a USB drive. The text in the file is limited to 4098 characters.

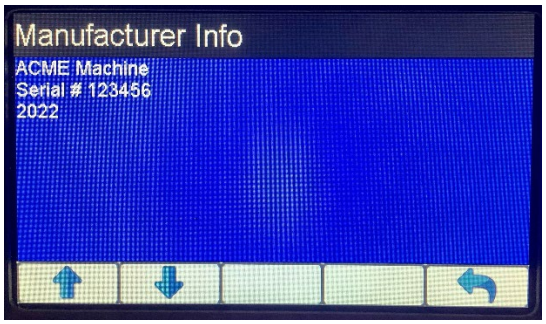
12.5.2 Importing the Manufacturer Info file

Place the drive in the panel's USB port and with Admin level access, navigate to **System → Import Manufacturer Info**. Use the display buttons to select the file to copy to the panel's storage. Pressing the 4th display button  will copy the file to the panel's storage. Repeat for any other files



12.5.3 Viewing the Manufacturer Info

The stored Manufacturer Info can be displayed with all access levels by navigating to System → Manufacturer Info



13 Firmware Update

The panel utilizes a USB drive and its USB front USB port to update the application firmware.

13.1 Updating via USB Drive

13.1.1 Preparation

Copy the update file into the root directory of an empty USB stick, which has been formatted with FAT32.

13.1.2 Procedure

Verify that the unit is turned on. Insert the USB Stick into the USB Port of the unit and navigate to the **System → Configurations & Updates** menu. The panel will show the available update files that are currently on the drive. After selecting the appropriate file, the update process will begin. There will be on-screen information during the update process. The update process may take a few minutes to complete.

14 Miscellaneous

14.1 Emissions System Functionality

Note: GENERAL EMISSIONS DISCLAIMER This panel may include provision(s) for operator input such as FORCE REGENERATION, INHIBIT REGENERATION, INTERLOCK, and others specific to US and International emissions regulations. Responsibility for emissions-related inputs and compliance with emissions regulations is solely that of the owner and/or operator of the machine/engine or motor on which this panel is connected.

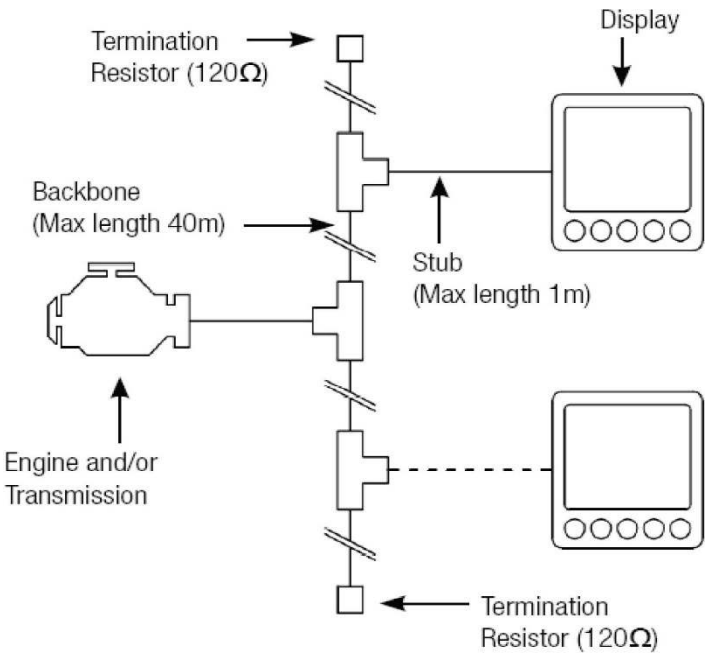
	CAUTION
	CAREFULLY READ AND UNDERSTAND THE ENGINE MANUFACTURER OWNER/OPERATOR MANUAL. YOUR ENGINE MANUFACTURER PROVIDES SPECIFIC INFORMATION REGARDING THE EXHAUST EMISSION SYSTEM OF YOUR ENGINE. THIS INFORMATION IS MAINTENANCE, PROCEDURAL AND SAFETY RELATED. FAILURE TO EXACTLY FOLLOW THE ENGINE MANUFACTURER INSTRUCTIONS AND SCHEDULES COULD POTENTIALLY RESULT IN HARM OR INJURY TO YOU AND/OR OTHERS. FURTHER, FAILURE TO EXACTLY FOLLOW THE ENGINE MANUFACTURER INSTRUCTIONS AND SCHEDULES COULD RESULT IN DAMAGE TO YOUR ENGINE AND/OR EQUIPMENT.

The CANplus display reports emissions messages received from the engine ECU. Depending on the received message, icons or symbols may be displayed on the screen. Some messages/icons are displayed as an overlay (inhibit symbol shown at left). Other symbols/icons may cover most of the screen. The operator MUST respond to the indications on the display following engine manufacturer recommended procedures/actions. Please note that indications shown by the display may vary with respect to engine manufacturer and may vary between engine models from the same manufacturer.

14.2 panel Panel Wiring

Most electronically governed engine installations include a harness with a built-in J1939 backbone. Use twisted shielded pair with a drain wire for CAN wiring terminated with 120 Ω resistors at each end. The maximum length for the CAN bus is 131 ft (40 m) and stubs should not exceed 39 in (1 m) in length.

14.2.1 Typical J1939 Wiring Topology



14.2.2 Engine Harness Connector

Connection to the engine is provided by a Deutsch/TE 21 pin connector (Part Number HDP24-24-21PE). The mating connector is Deutsch/TE (Part Number HDP26-24-21SE).

Signals are shown in Table 1.

Table 1: Engine Harness Connection

Pin	Signal Description	Direction	Notes
A	Preheat Out	Out	10 A Maximum Output
B	Battery Supply	In	Connect direct to battery '+' via 30 A Fuse
C	Sender Return	In	Connect to Sender ground or as close as possible
D	Starter	Out	10 A Maximum
E	Ground	N/A	Connect direct to battery '-'
F	CAN Shield	N/A	
G	ECU/Solenoid	Out	10 A Maximum
H	Temperature Sender	In	Resistive
J	Alternator Excitation	Out	5 A Maximum
K	Tach	In	Alternator or single ended mag-pickup
L	Aux Out	Out	Low-side output (Bluetooth options only)
M	Auxiliary Switch 2	In	Ground Input
N	Temperature Switch	In	Ground Input
P	Oil Pressure Sender	In	Resistive
R	Throttle Switch	In	Connected to 'S' via 390 Ω resistor

Pin	Signal Description	Direction	Notes
S	Throttle Switch Return	Out	
T	Oil Pressure Switch	In	Ground Input
U	CAN Low	In/Out	J1939
V	CAN High	In/Out	J1939
W	Auxiliary Switch 1	In	Ground Input
X	Fuel Sender	In	Resistive

14.2.3 Sealed Connectors

The provided Deutsch sealed weather-proof plug includes a locking ring device which must be turned counterclockwise to separate the connectors. To positively seat the connectors, the locking ring is turned clockwise.

	CAUTION
⚠	CATTRON DOES NOT RECOMMEND USING DIELECTRIC GREASE OR SEALANT WITH SEALED CONNECTORS. THESE CHEMICALS MAY CAUSE SEAL DAMAGE AND ALLOW WATER ENTRY. USE CATTRON PROVIDED CAVITY PLUGS TO SEAL THE CONNECTOR IF WIRES ARE REMOVED.

14.2.4 Unsealed Connectors

For unsealed connectors exposed to the elements, Cattron recommends using dielectric grease to protect the contacts.

	CAUTION
⚠	CATTRON DOES NOT RECOMMEND USING SEALANT WITH UNSEALED CONNECTORS. SEALANT TRAPS MOISTURE IN THE CONNECTOR AND ENCOURAGES CORROSION.

14.2.5 Harness Routing

The minimum routing radius of the wiring harnesses should be at least two times the diameter of the wiring harness. Bends should be avoided within 1 in (25 mm) of any connector to avoid seal distortion allowing moisture to enter the connector.

14.3 Engine Starter Excitation Connection

14.3.1 Starter Relay

General Starter Relay Specifications		
Minimum Starter Relay (Continuous) Rating	60 A @ 12 V	30 A @ 24 V
Maximum Starter Relay Excitation Current Draw	5 A @ 12 V	3 A @ 24 V

Cattron provides suitable heavy-duty relays and generic starter relay wiring kits in both 12 V and 24 V; please contact sales@cattron.com for more information

14.3.2 Battery Circuit Requirements

	CAUTION

*Patented or Patent Pending www.cattron.com/resources/cattron-patents

⚠	IMPROPER WIRING CAN CAUSE ELECTRICAL NOISE OR UNRELIABLE OPERATION AND MAY DAMAGE THE CONTROL SYSTEM OR OTHER COMPONENTS. ALL POWER CONNECTIONS MUST BE FREE FROM FOREIGN MATERIALS, INCLUDING PAINT, WHICH MAY INTERFERE WITH PROPER CONNECTION. A RELIABLE 30 A MAXIMUM FUSED POWER CIRCUIT MUST BE PROVIDED FOR THE CONTROL SYSTEM. CATTRON RECOMMENDS THE POWER CONNECTION BE MADE DIRECTLY TO THE BATTERY WITH THE FUSE ELECTRICALLY CLOSE TO THE BATTERY. GROUNDING THROUGH FRAME MEMBERS IS NOT RECOMMENDED. ALL CIRCUIT PATHS MUST BE CAPABLE OF CARRYING ANY LIKELY FAULT CURRENTS WITHOUT DAMAGE. DO NOT REVERSE THE BATTERY POLARITY. ATTEMPTING TO CRANK THE ENGINE WHEN THE POLARITY OF THE BATTERY CONNECTIONS IS REVERSED MAY DAMAGE THE CONTROL SYSTEM.

14.3.3 Battery Positive Connection

The electronic control system operates on either 12 VDC or 24 VDC electrical systems. The unswitched battery positive connection to the control system is made at the weatherproof connector. The control system provides switched positive battery protected by solid-state MOSFETs. These outputs include integral protection against overloads and short circuits.

Powering the control system through a 30 A fused dedicated circuit reduces the possibility of system damage.

⚠	CAUTION
	DISCONNECTING THE BATTERY WHILE THE ENGINE IS RUNNING MAY RESULT IN DAMAGE TO ELECTRICAL COMPONENTS. WHEN USING A BATTERY DISCONNECT SWITCH, CATTRON RECOMMENDS USING A TWO POLE SWITCH TO DISCONNECT BOTH THE BATTERY AND ALTERNATOR OUTPUT.

Note: A maximum of three ring terminals should be connected to a power stud to ensure integrity of the connection. The use of more than three terminals can cause the connection to become loose.

14.3.4 Voltage Drop

If control system voltage drops below 6 V for more than 0.1 s, the control system may reset, causing the self-test to reactivate. Voltage drops can be caused by a discharged battery, transients from external equipment, improper wire sizes, faulty wiring, or nearby lightning strikes.

14.3.5 Suppression of Voltage Transients (Spikes)

⚠	CAUTION
	THE INSTALLATION OF VOLTAGE TRANSIENT SUPPRESSION AT THE TRANSIENT SOURCE IS REQUIRED. CATTRON FOLLOWS SAE RECOMMENDED ELECTRICAL ENVIRONMENT PRACTICES.

Inductive devices such as relays, solenoids and motors generate voltage transients and noise in electrical circuits. Unsuppressed voltage transients can exceed SAE specifications and damage electronic controls.

Relays and solenoids with built-in voltage transient suppression diodes are recommended whenever possible. Ensure the proper installation of diodes when built-in voltage transient suppression is not available.

Locate inductive devices as far as possible from the components of the electronic control system. When using electric motors, it may also be necessary to add isolation relays to eliminate voltage transients, noise and prevent back feed.

14.3.6 Welding on Equipment with Electronic Controls

Proper welding procedures should be observed to avoid damage to electronic controls, sensors, and associated components. The component should be removed for welding when possible.

The following procedure must be followed if the component must be welded while installed on equipment with electronic controls. This procedure will minimize the risk of component damage.

	CAUTION DO NOT GROUND THE WELDER TO ELECTRICAL COMPONENTS SUCH AS THE CONTROL GROUND OR SENSORS. IMPROPER GROUNDING CAN CAUSE DAMAGE TO ELECTRICAL COMPONENTS. CLAMP THE GROUND CABLE FROM THE WELDER TO THE COMPONENT BEING WELDED. PLACE THE CLAMP AS CLOSE AS POSSIBLE TO THE WELD TO REDUCE THE POSSIBILITY OF DAMAGE.

1. Stop the engine. Turn the key switch to the OFF position.
2. Disconnect the negative battery cable from the battery.
3. Open any installed battery disconnect switch.
4. Unplug the control system if possible.
5. Connect the welding ground cable as close as possible to the area to be welded.
6. Protect the wiring harness from welding debris and spatter.
7. Use standard welding methods to weld the materials.

14.4 Control System Troubleshooting

Control system does not perform self-test

Possible Cause	Possible Remedy
Tripped overcurrent protection	Correct fault, replace or reset overcurrent protection
Faulty connection to battery	Correct battery connections (see the Battery Circuit Requirements section)
Faulty control system	Repair or replace control system

Control system performs normal self-test, engine or motor cranks, runs and shuts down

Possible Cause	Possible Remedy
Engine Stop LED illuminated	Correct ECU or FVD stop condition, use ECU diagnostics

Display does not display data

Possible Cause	Possible Remedy
Display lost power	Turn on key, verify display plugged into harness
Engine Source address incorrect	Change Engine Address in Configuration
Display Address incorrect	Change Display Address to 40 (default)

Possible Cause	Possible Remedy
Display configuration problem	Reset display using Restore Defaults
CAN failure	Check CAN (see the Testing CAN section)
ECU not sending data	Repair or replace ECU

Display shows Bad or Corrupt Configuration

Possible Cause	Possible Remedy
Configuration file does not match firmware version	Reload configuration file from the config program with matching version

14.4.1 Testing a Warning or Shutdown

Shutdown simulation with ECU controlled engines requires using the ECU diagnostic tool. Refer to the diagnostic tool documentation to simulate a warning or shutdown.

14.4.2 Testing CAN

Most information provided to the CANplus display is sent by the ECU via the CAN bus. CAN is an international data bus used to support SAE J1939. If this connection is broken or improperly terminated, the CANplus display cannot show ECU parameters such as engine hours, oil pressure and diagnostic codes. The following test procedure helps identify the problem location:

1. Disconnect the battery and the panel
2. Connect an ohmmeter across the green and yellow CAN pins (pins u & v) of the D21 connector.
3. A reading of near 0 ohms indicates the other end of the bus is not correctly terminated or not intact.
4. A reading of 120±10 Ω indicates the other end of the bus is terminated correctly and that the panel's software configurable termination resistor should be turned on.
5. A reading of 60±5 Ω indicates that the bus is already terminated at both ends and that the panel's software configurable termination resistor should be turned off.

Note: The panel has switchable termination via software. Please see the CAN bus settings in the Tech or Admin menus for more information.

14.5 Diagnostic Trouble Codes (DTC)

CAN Diagnostic Trouble Codes be a pair of numbers, the SPN (Suspect Parameter Number) and the FMI (Failure Mode Indicator). The SPN indicates the faulting subsystem, and the FMI identifies the type of failure.

14.5.1 Typical SPNs

Standard SPN codes are defined by SAE J1939-71. Not all standard codes are provided by ECUs. Manufacturers may add additional SPN codes beyond the codes identified in J1939-71. Refer to the ECU documentation for supported SPNs. Table 2 describes some example SPNs.

Table 2: Example SPN

SPN	Description
51	Throttle Position
91	Accelerator Pedal Position
94	Fuel Delivery Pressure

SPN	Description
98	Engine Oil Level
100	Engine Oil Pressure
110	Engine Coolant Temperature
111	Coolant Level

14.5.2 FMI

FMI codes are defined by SAE J1939-71. Refer to the ECU documentation for correct interpretation of the FMI codes for a specific SPN. Table 3 describes each FMI.

Table 3: FMI Descriptions

FMI	Description
0	Data valid but above normal operational range
1	Data valid but below normal operational range
2	Data erratic, intermittent or incorrect
3	Voltage above normal or shorted high
4	Voltage below normal or shorted low
5	Current below normal or open circuit
6	Current above normal or grounded circuit
7	Mechanical system not responding properly
8	Abnormal frequency, pulse width or period
9	Abnormal update rate
10	Abnormal rate of change
11	Failure mode not identifiable
12	Bad intelligent device or component
13	Out of calibration
14	Special instructions
15	Data valid but above normal operational range (least severe)
16	Data valid but above normal operational range (moderately severe)
17	Data valid but below normal operational range (least severe)
18	Data valid but below normal operational range (moderately severe)
19	Received network data in error
20 through 30	Reserved for future assignment
31	Not available or condition exists

15 Certifications

15.1 FCC Part 15 Certification

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

	WARNING
	15.1.1.1 CHANGES OR MODIFICATIONS NOT EXPRESSLY APPROVED BY THE PARTY RESPONSIBLE FOR COMPLIANCE COULD VOID THE USER'S AUTHORITY TO OPERATE THE EQUIPMENT.

Note: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

—Reorient or relocate the receiving antenna.

—Increase the separation between the equipment and receiver.

—Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.

—Consult the dealer or an experienced radio/TV technician for help.

This equipment uses the following Antennas and may not be used with other antenna types or with antennas of higher gain:

Mfg.: Pegasus Wireless Products

Type: Dipole

Gain: 3 dBi

This equipment complies with FCC RF Exposure requirements and should be installed and operated with a minimum distance of 20 cm between the radiator and any part of the human body.

15.2 Industry Canada Certification

Note: These statements are required to be listed in both English and French Languages.

This device complies with Industry Canada license-exempt RSS standard(s). Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes : (1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

Under Industry Canada regulations, this radio transmitter may only operate using an antenna of a type and maximum (or lesser) gain approved for the transmitter by Industry Canada. To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (e.i.r.p.) is not more than that necessary for successful communication.

Conformément à la réglementation d'Industrie Canada, le présent émetteur radio peut fonctionner avec une antenne d'un type et d'un gain maximal (ou inférieur) approuvé pour l'émetteur par Industrie Canada. Dans le but de réduire les risques de brouillage radioélectrique à l'intention des autres utilisateurs, il faut choisir le type d'antenne et son gain de sorte que la puissance isotrope rayonnée équivalente (p.i.r.e.) ne dépasse pas l'intensité nécessaire à l'établissement d'une communication satisfaisante.

This equipment complies with the ICES RF radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with a minimum distance of 20 cm between the radiator and any part of the human body.

Cet équipement est conforme aux limites d'exposition aux radiations ICES définies pour un environnement non contrôlé . Cet équipement doit être installé et utilisé à une distance minimale de 20 cm entre le radiateur et une partie de votre corps.

16 Technical Support

For remote and communication control systems support, parts and repair, or technical support, visit us online at: www.cattron.com/contact.

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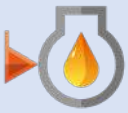
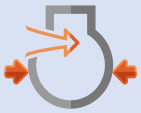
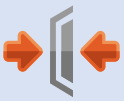
17 Icons Glossary

17.1 Gauge Icons

Icon	SPN	Description
	94	Fuel Pressure
	96	Fuel Level
	98	Engine Oil Level
	100	Engine Oil Pressure
	106	Inlet Air Pressure
	109	Engine Coolant Pressure
	110	Engine Coolant Temperature
	111	Engine Coolant Level
	123	Clutch Pressure
	127	Transmission Oil Pressure
	168	Battery Voltage
	172	Inlet Air Temperature

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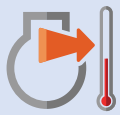
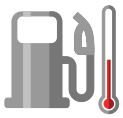
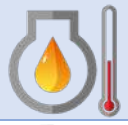
Icon	SPN	Description
	173	Exhaust Gas Temperature
	174	Fuel Temperature
	175	Engine Oil Temperature
	177	Transmission Oil Temperature
	183	Fuel Consumption Rate
	190	Engine Speed
	247	Total Engine Hours
	1761	SCR Fluid Level
	3719	Soot Percentage
	3720	Ash Percentage

17.2 Status Gauge Icons

NOTE: Not all engine templates use the icons on this page. Icon requirements are defined by the engine manufacture.

Icon	Description
	Preheat Active / Wait to Start

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Icon	Description
	Regeneration Needed
	Low SCR Fluid
	High Exhaust Temperatures Active
	Regeneration Inhibited by Panel or other reasons
	Regeneration Needed - Most Severe
	Regeneration Needed - Least Severe
	Aftertreatment Fault - Lease Severe
	Aftertreatment Fault - Intermediate Severe
	Aftertreatment Fault - Most Severe
	Engine Derate Active
	Stop Engine
	Check Engine

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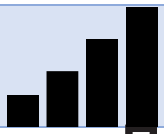
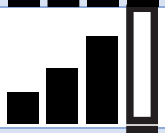
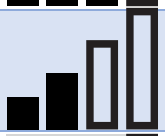
17.3 Status Bar Icons

Icon	Description
	BLE - Device Connected
	BLE - Device Disconnected
	Cellular - Excellent Connection
	Cellular - Good Connection
	Cellular - Moderate Connection
	Cellular - No Signal
	Cellular - Poor Connection
	Cellular - Searching
	Cloud - Connected
	Cloud - Disconnected
	GPS - Excellent
	GPS - Good
	GPS - Moderate

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Icon	Description
	GPS - Poor
	GPS - No Fix / NA
AUTO™	Autostart Active

17.4 Autostart Dashboard Icons

Icon	Description
	AutoStart - AutoStart Switch Active
	AutoStart - AutoStart Switch Inactive
	AutoStart - Maintain Throttle Mode
	AutoStart - Start Event Requirements
	AutoStart - Stop Event Requirements

17.5 Menu Icons

Icon	Description
	Action - Acknowledge Alarms
	Action - Enter Submenu
	Action - Exit Current Menu

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Icon	Description
	Action - Navigate Down
	Action - Navigate Up
	Action - Request Stored Alarms
	Navigation - Alarms Page
	Navigation - Database Viewer
	Navigation - Emissions Menu
	Navigation - Select Gauge Page / Rotate Gauge Pages
	Navigation - Settings Menu