CANplus® 640c Control Panel Operation Manual

October 2018

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1 Important Safety and Emissions Information

1.1 Safety Symbols

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

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

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

ADDITIONAL IMPORTANT INFORMATION

1.2 Safety Instructions

Please read and follow all safety instructions.

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.

LOFA 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.

The specifying Original Equipment Manufacturer (OEM) and/or installer of any LOFA 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.

LOFA products are not designed for, or intended for use on, applications requiring explosive proof components. Further, LOFA products are not designed for, or intended for application within, hazardous or explosive environments.

The installer of this LOFA product is solely responsible for ensuring that all OSHA, ANSI, CE, or other applicable standards are met with respect to LOFA panel applicability, machine guarding, general safety guidelines, labeling, and warnings.

The installer of this LOFA panel and/or LOFA harness is responsible for the correct sizing and integration of a suitable fuse/breaker on the un-switched DC circuit supplying power to the LOFA panel.

Only trained and qualified persons may perform installation, testing, service, or repair work on the LOFA product.

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.

Please refer to www.LOFA.net for details on LOFA Industries, LLC warranty policies.

LOFA Industries, LLC has provided this document as a reference. We try to keep this document updated with the latest information regarding your LOFA product. However, changes do occur and LOFA reserves the right to make changes to the design of the LOFA products and supporting documentation without notice.

1.3 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 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 keyswitch malfunction. The panel key/lever switch should always be used as the primary engine shutdown method.

1.4 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.

1.5 Exhaust Emissions Compliance Disclaimer

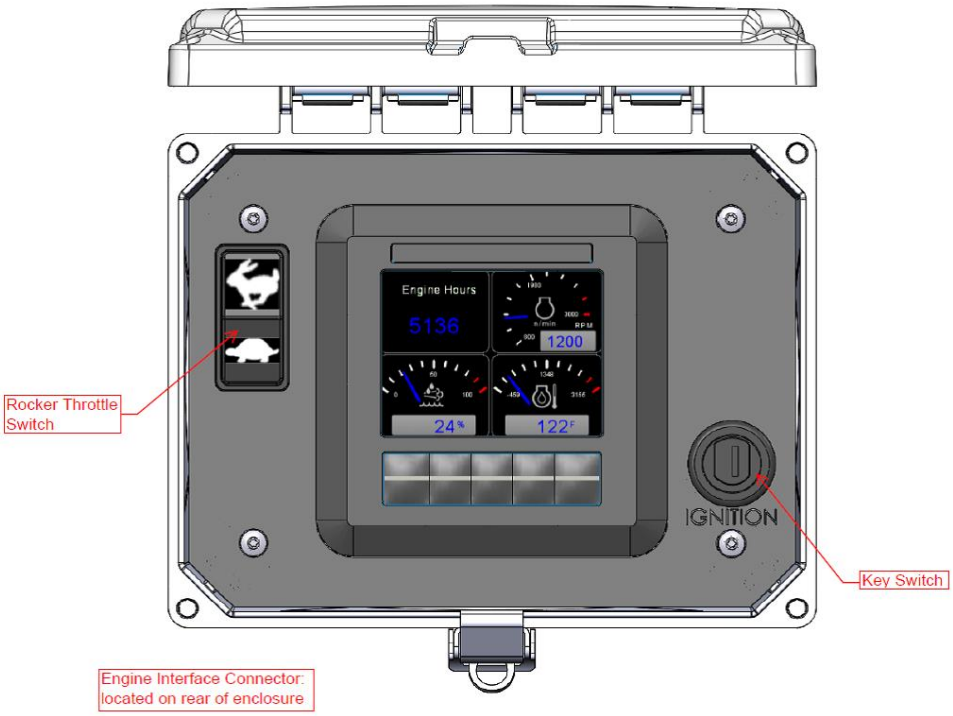
This panel is equipped with operator-programmable parameters. The engine/machine as a function of the emissions system can/could initiate, via the engine ECU (engine control unit), certain required emissions operations such as regeneration of the DPF (diesel particulate filter), or other emissions system 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 as a result of starting or stopping the engine/machine during any ECU initiated emissions event.

2 Overview

The LOFA CP640c control panel is an economical platform for EPA Tier 3, EPA Tier 4 (interim), and EPA Tier 4 electronically governed diesel engines. Graphical gauge pages or a single large analog gauge are displayed on the 3.5-inch diagonal LCD. Virtually any SAE J1939 parameter reported by the ECU (Engine Control Unit) can be displayed including, but not limited to: RPM, coolant temperature, oil pressure, engine hours, voltage, exhaust emissions system state, and diagnostic codes. The backlit display is clearly readable in both bright sunlight as well as total darkness and housed in a rugged IP66 rated housing. The CP640c can optionally include three (3) bright LEDs to indicate Faults, Warnings, and Emission-Related Alerts.

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. Active fault conditions are displayed in plain language on popup messages and can be viewed in the fault list. Various diagnostic screens allow detailed investigation of the CAN bus data stream.

All diagnostic and emissions related messages displayed on the CP640c are generated by the engine ECU or other attached devices. The operator must be familiar with the engine manufacturer ECU messages and icons in order to react accordingly with respect to emissions compliance, service, and diagnostic message response.


Rocker Throttle Switch
Engine Hours
5136
1200
24%
122F
IGNITION
Key Switch
Engine Interface Connector: located on rear of enclosure

3 Display

The CANplus® display is a robust, sunlight viewable 3.5” QVGA color display with five (5) integrated backlit buttons housed in a rugged, water-tight IP66 rated enclosure. The five soft keys simplify and enhance the user interface by providing a configurable auditory beep and 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. It can be easily configured to customer preference, including gauge type (analog or digital), gauge arrangements, gauge size, units, and language.

Different software versions may have slightly different displays.

3.1 Adjusting Lighting and Contrast

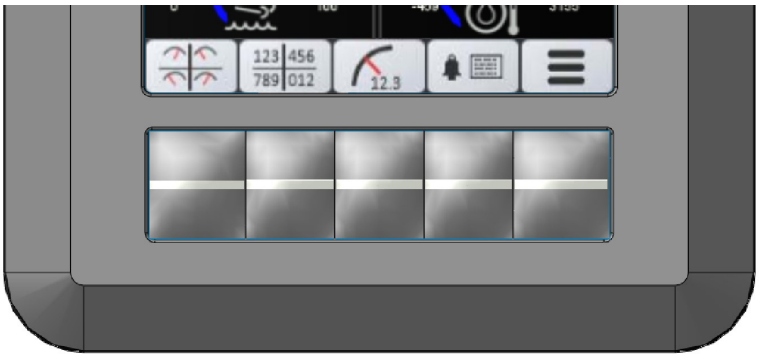
Pressing button 5 (the right-hand button) when there is no menu bar opens the lighting and contrast menu bar. The display has a number of back-lighting levels allowing the display to be read in the dark. The level is adjusted by pressing buttons 1 (decrease) or button 2 to (increase) illumination. Contrast is adjusted in the same manner using buttons 3 and 4.

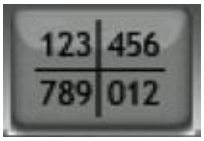
The display adjusts the contrast with ambient temperature. Manual contrast adjustments are only necessary with extreme climate change.

The menu is exited by pressing button 5. The lighting and contrast settings are retained after the unit is powered off.

3.2 Button Bar

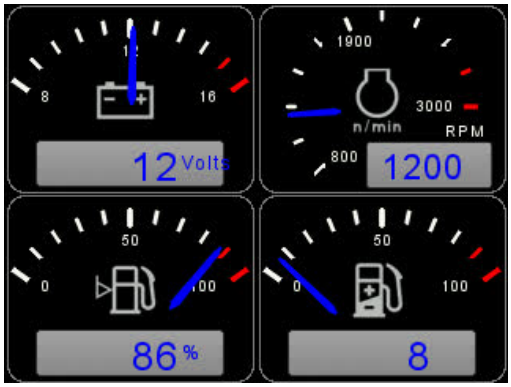
Pressing any of the first four (4) soft keys on the display will prompt the button bar key function legend to appear at the bottom of the display above the keys. The button bar will show an icon above the button which corresponds to its current function.



Button 1	Button 2	Button 3	Button 4	Button 5
				
Analog Gauge Pages	**Digital Gauge Pages**	**Single Analog Gauge**	**Active Alarm Page**	**Menus**
Repeated presses cycle through the four pages of analog gauges	Repeated presses cycle through the four pages of digital gauges	Repeated presses cycle through the available digital gauges	Displays active alarms including plain language description	Opens Menus

3.3 Analog Gauge Pages

Analog Gauge Pages provide four (4) independently configurable pages of analog gauges. To enable Analog Gauge Pages, press any of the first four (4) buttons to show the top level button bar and then press button 1 to cycle through the pages.

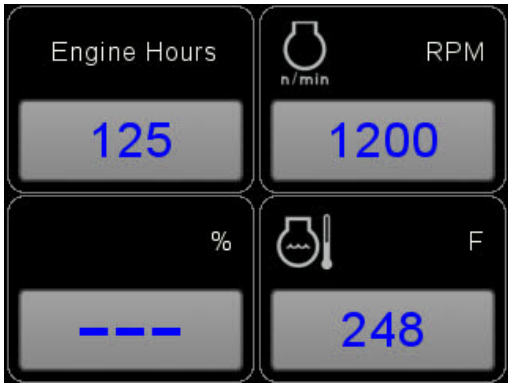


Some items like Engine Hours are displayed as a digital value even on Analog Gauge Pages.

All sixteen (16) gauges may be configured to create an application-specific view of data. With Tech or Admin level access, the four (4) analog gauge pages can be configured using the menu Configuration > Display > Gauges > Quad Gauge Pages.

3.4 Digital Gauge Pages

Digital Gauge Pages display the same data as the Analog Gauge Pages but in digital only format. To enable Digital Gauge Pages, press any of the first 4 buttons to show the top level button bar and then press button 2 to cycle through the pages.



The sixteen (16) gauges are the same for Analog and Digital Gauge Pages. Adjustments in either Analog Gauge Pages or Digital Gauge Pages affect the same gauge in the other mode.

3.5 Single Analog Gauge

Single Analog Gauge uses the entire display for a single large analog gauge. This mode is enabled by pressing any of the first 4 buttons to show the top-level button bar and then press button 3 to cycle through the available gauges. The active displayed gauge is stored when power is removed (see Preferred Screen Store).

3.6 Active Alarms

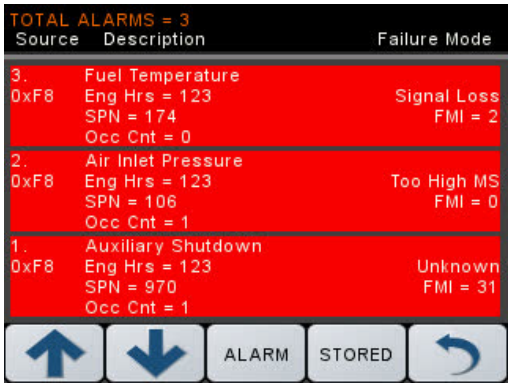
When an active alarm is received, a flashing popup window is overlaid on the current screen when an active alarm is received. The popup includes a plain language description in addition to the standard SPN/FMI (Suspect Parameter Number/Failure Mode Indicator) pair defined by the SAE J1939 standard. Additionally,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

Standard J1939 abbreviations are used for alarms. MS = Most Severe, MOD = Moderately Severe, LS = Least Severe.

3.7 Alarm List

The Alarm List is accessed by pressing any button while an alarm popup is displayed or by pressing any of the first 4 buttons to show the button bar and then button 4. Alarms not yet acknowledged are shown in white on red 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 as long as 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.



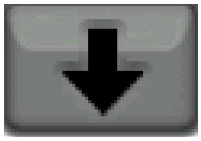
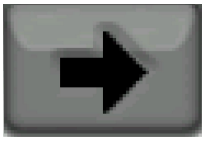
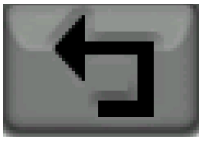
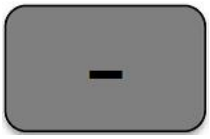
Only active faults are displayed in the alarm list. Once a fault is corrected it is automatically removed from the list. To view previously active faults press the ”STORED” button.

3.8 Service Timers

The CP640c display provides sixteen (16) service timers to alert the operator of required maintenance. The time interval for each timer can be adjusted in increments of ten (10) hours. A popup message is displayed after the display 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 pump-related parameters. All sixteen (16) service timers can be monitored via wireless telemetry.

3.9 Menus

The menu pages can be accessed by pressing and holding button 5. After one (1) second, the top-level menu page will 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**
				
Sroll Up	Scroll Down	[Intentionally Blank]	Go into Selected Submenu	Return to Previous Menu
				
		Decrement Value or Previous Selection	Increment Value or Next Selection	

The menus pages can also be accessed by pressing and holding the optional Rotary Control using LOFA’s RotaryPlus™ technology:

- Push and hold the rotary for one (1) second to open menus main page
- Move down through the menu choices with clockwise rotations

- Move up through the menu choices with counter clockwise rotations
- Select menus, options, and entries by pushing in the rotary knob (click)
- Increase numerical entries with clockwise rotations
- Decrease numerical entries with counter clockwise rotations
- Pushing in the rotary knob twice quickly (double click) backs up to the previous menu
- At any time, pushing and holding the rotary for one (1) second causes the display to completely back out of the menu mode showing the main gauges

3.9.1 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 particular item to be available for displaying.

Black = User
Green = Tech
Red = Admin

Display

- Language
- Units
  - Distance
  - Pressure
  - Volume
  - Temperature
- Button Beep ON/OFF
- Gauges
  - Quad Gauge Pages (configure which gauges will be displayed)
    - 1-4
  - Voltmeter - 12V/24V

System

- Restore Defaults (recall factory defaults)
- Import Config (import a new configuration file from the USB port)
- Export Config (export current configuration to a file on the USB port)
- PINs (see section 3.9.2)
  - Elevate Access Level
  - Entry - On/Off
  - Change
- CAN bus
  - TSC1 Address (panel sends the TSC1 messages from this CAN address)
  - Panel Address (CAN address for the panel)
  - CM1 Address (panel sends the CM1 messages from this CAN address)
  - Config Address (panel address for Config program)
- Engine Type
- Engine Specific Settings
- Date and Time
- About

Throttle

- Min / Idle / Max RPM
- Switch/Rotary
  - Increments
  - Max Change Per Second
- Autoramp (see section 4.5)
  - RPM Settings
    - Intermediate
    - Run
  - Time Profile
    - Warm Up
    - Ramp to Intermediate
    - Ramp to Run
    - Ramp to Cooldown
    - Cooldown

Telemetry

- Status
- Address (CAN address for the telemetry device)

Service Timers

- Timers 1-16 (each timer is listed separately)
  - Hours remaining
  - Reset

Tier 4 Control

- Inhibit - OFF/ON (inhibit Regenerations)
- Request Force (request a Force Regeneration; depending on conditions, ECU may not honor)
- Status (database Viewer for Tier 4 related status messages from the ECU)

Database Viewer

3.9.2 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 CP640c supports up to three (3) independent PINs that are configurable. The standard LOFA 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 Tech or Admin levels, use the Elevate Access Level menu 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. 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.

PIN Change

PINs can be changed via the Menu by selecting Configuration > System > PIN Settings > PIN Change.

The PIN being changed is the PIN for the current access level. Example: At 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 Tech of 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 was entered. If 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 key is turned off. When the key is turn back to the ON position, the access level reverts back to User and follows the Menu PIN Required setting.

4 Manual Operation

1. Ensure that the Auxiliary Engine Stop (if fitted) is not activated.
2. Turn the keyswitch to the run position.
3. Turn the keyswitch clockwise to the start position and hold until the engine successfully starts.
4. Release keyswitch.

If the engine fails to start, the keyswitch must be returned to the off position prior to subsequent start attempts.

The ECU will not preheat unless conditions warrant. If necessary, starting the engine may be attempted by turning the key to the start position without waiting for preheat to expire.

4.1 Throttle Control

Throttle operation is determined by the type of throttle operator(s) installed along with the configured values of:

- Minimum Requested RPM
- Idle RPM
- Intermediate RPM
- Run RPM
- Maximum Requested RPM

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. 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 to NOT set the panel’s Minimum Requested RPM below the ECU’s minimum RPM or above the ECU’s maximum RPM.

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 CP640c 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.

The panel's Minimum Requested RPM and Maximum Requested RPM can be configured using the CANplus® Suite Software, or via menus within the display (if enabled by PIN). See Configuration section for more information.

4.2 Ramp Throttle

The standard Ramp Throttle uses a momentary rocker switch to adjust the requested engine speed. All throttle requests are sent directly to the engine using CAN throttle control.

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 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 continue to increase (ramp) until the maximum speed is achieved.
- Pressing and releasing the turtle icon decreases the speed by the switch increment value (default = 25 RPM).
- Pressing and holding the turtle icon causes the speed to decrease (ramp) until the minimum speed is achieved.
- The CP640c will smoothly ramp the RPM up and down using the Max RPM change / s value (500 default). This value can be changed in the Throttle » Switch/Rotary » Max Change / s menu.

4.3 Rotary Throttle Control

The optional Digital Rotary Throttle uses a rotary switch to simulate the operation of a throttle. When the engine is first started, the requested engine speed is always Idle RPM. Turning the throttle knob clockwise increases the requested engine speed by the switch/rotary increment value (default = 50 RPM). Turning the throttle knob counter-clockwise decreases the requested engine speed.

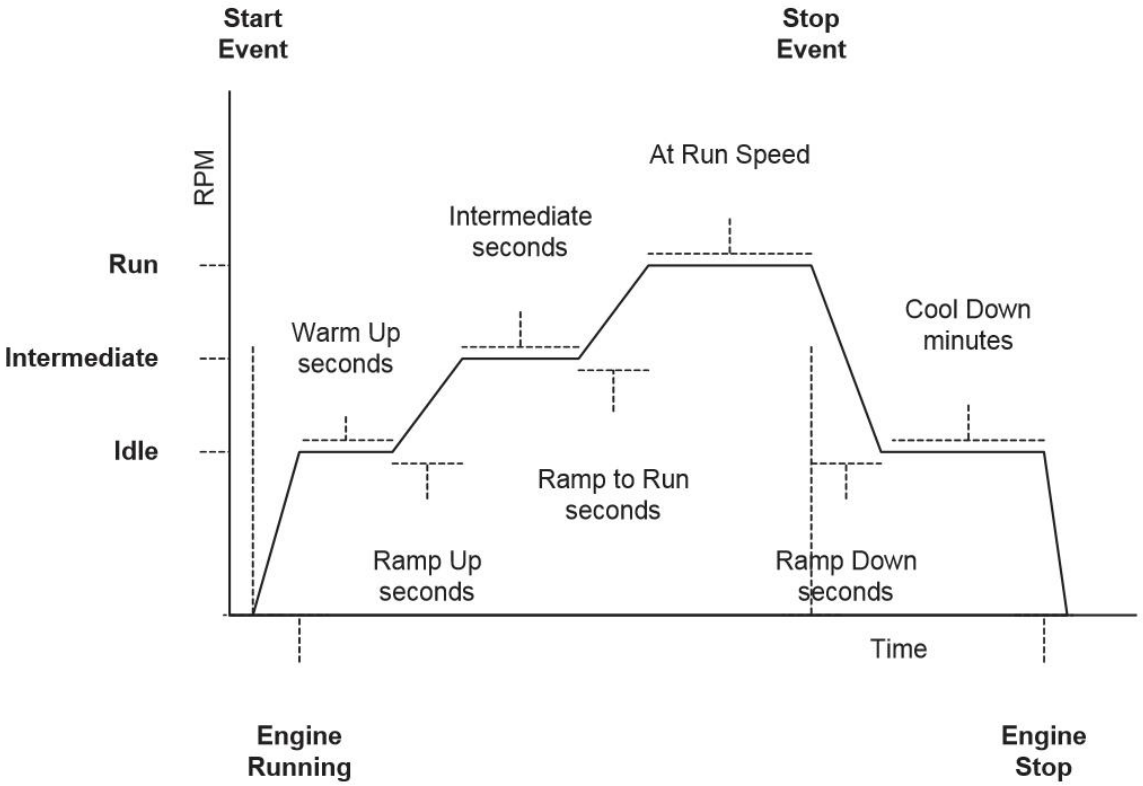
4.4 Stopping the Engine

To stop the engine simply turn the key to the "OFF"' position. Do not use the Auxiliary Engine Stop (if fitted) to stop the engine under normal conditions.

4.5 Autoramp™

The optional Autoramp™ feature allows the use of configurable warm up and cooldown profiles to help protect engines and other assets such as plumbing, or to insure proper ramp up and down of pressure or flow.

The Autoramp™ feature uses the configurable Autoramp™ RPM and time profiles. The following diagram shows the settings and the relationship to each other.



Idle RPM	Selects the RPM the control system will request for idle speed. If the engine is started, it will always begin running at Idle speed.
Intermediate RPM	Selects the RPM the control system will request for intermediate speed. Intermediate speed is a specific speed point that the engine will pause at during the ramping up cycle. The Intermediate speed pause duration is configurable in the Autoramp > Time Profile menu. The intermediate speed can be used to prime pump or charge lines during the optional automatic ramp operation.
Run RPM	Selects the RPM the control system will request for run speed. The run speed is the normal operating speed.

The minimum engine speed is controlled by the ECU. Requesting a lower speed causes the engine to run at the ECU minimum speed. RPM limits are configured into the panel to limit the requested speed. Changing the panel's Minimum Requested RPM and Maximum Requested RPM requires a Tech Level Password or higher to access those settings. Those values can also be adjusted using the CANplus® Configuration Suite.

If an Intermediate RPM is not desired, it can be set to the same speed as Idle RPM and also setting Ramp Up s (seconds) to zero (0) seconds (see Ramp Profile).

Intermediate and Run RPM settings are only applicable during the optional automatic ramp operation and have no affect when the panel is manually started.

To utilize the optional Autoramp™ feature, the Autoramp™ RPM and Time setting must be configured. Once configured, turn the key to the ON position from the OFF position without cranking the engine. With the engine off, press and release the Autoramp™ switch at the top right of the control panel. After releasing the switch, the Autoramp™ LED will start blinking, and the panel will automatically start the engine. The panel will follow the configured Autoramp™ RPM and time profiles until the Run Speed is achieved, at which point, the LED will turn solid green.

Once the LED stays solid green, the engine's RPM can be adjusted as desired. Once the job is complete, pressing the Autoramp™ switch will cause the Autoramp™ LED to blink again and the panel to automatically ramp the engine down following the configured RPM and time profiles. When the Cooldown period is over, the panel will automatically shut down the engine and the LED will turn off.

5 Configuration

The CP640c has been preloaded with factory default 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:

1. Display Menu
2. LOFA CANplus® Software Suite and LOFA CANplus® Config kit
3. LOFA CANplus® Software Suite and a USB drive

5.1 Display Menu

Most commonly, accessible parameters can be changed on-site 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 section 3.9.1 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.

5.2 LOFA CANplus® Software Suite and LOFA CANplus® Config kit

In situations where multiple units must be reconfigured, or in the case of a single unit which requires complete reconfiguration, it is recommend to use the CANplus® Software Suite, which is LOFA's proprietary configuration software. 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. The latest update can be found at http://www.lofa.net/updates/.

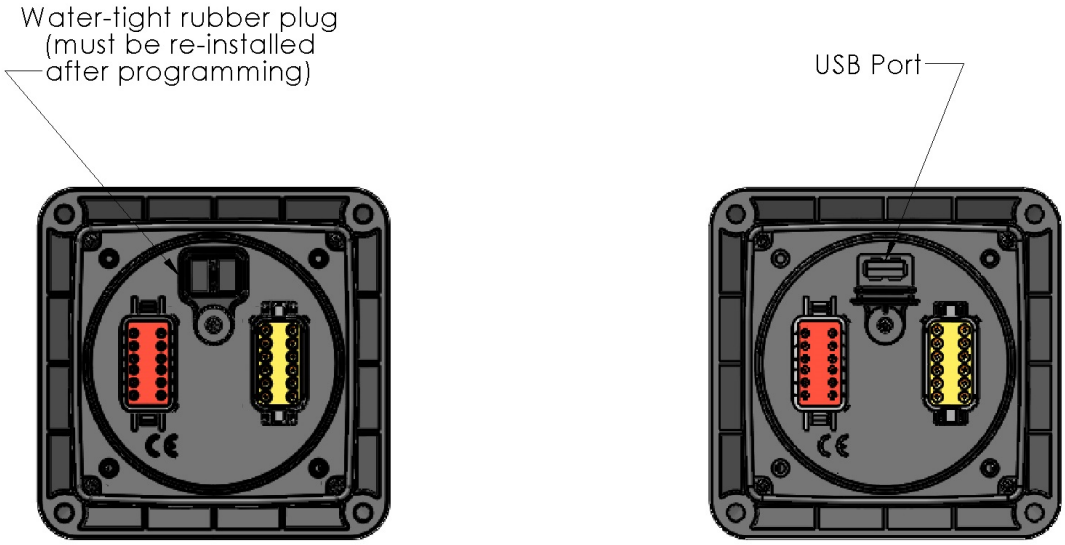
The LOFA CANplus® Config kit (LOFA part number 010-6750-01) includes:

1. An adapter harness that connects to the panels engine interface connector
2. An AC power supply
3. 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 insures proper operation during configuration read or writes). A demonstration video that shows how to use the CANplus® Config kit and the software suite can be viewed at http://www.lofa.net/product-support/videos/.

5.3 LOFA CANplus® Software Suite and a USB drive

The CP640c introduces the ability to import and export configurations using a USB drive avoiding the need to purchase and have onsite a LOFA CANplus® Config kit as well as disconnecting the panel from the engine. The panels USB port can be accessed by simply removing the four (4) front faceplate screws. The USB port location is shown below protect by a water-tight rubber plug.



Install the USB drive in the panel's USB port. The current configuration can be exported by going to System > Export Config. To import a new configuration, the menu access level must be at the Tech or Admin level (see section 3.9.2 Access Levels). A new configuration is imported by going to System > Import Config. New configuration changes take effect immediately. Therefore, the engine should not be running when importing a new configuration.

When finished with exporting of importing configurations, remove the USB drive, reinstall the protective water-tight rubber plug, and secure the faceplate with the four (4) screws.

6 Miscellaneous

6.1 Emissions System Functionality

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.

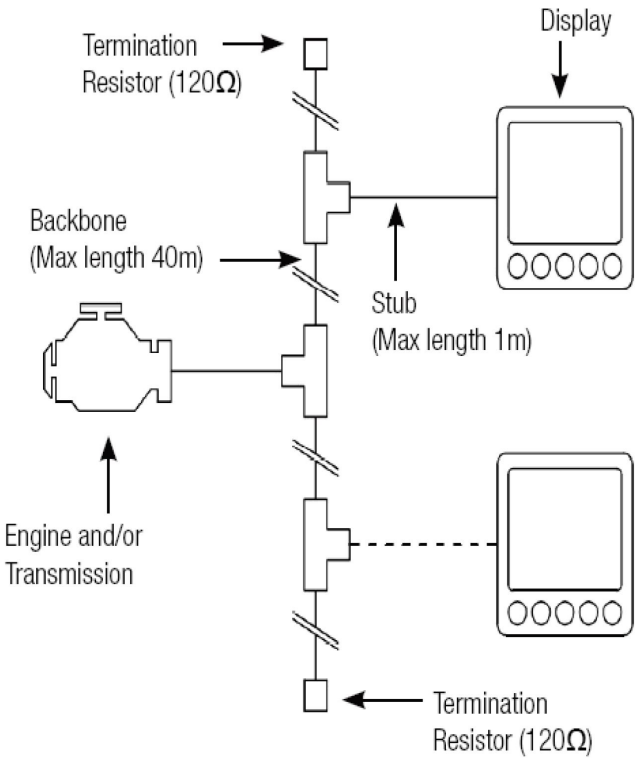
CAUTION Carefully read and understand the engine manufacturer owner/operator manual. Your engine manufacturer provides specific information regarding the exhaust emission system of your engine. This information is maintenance, procedural, and safety related. Failure to exactly follow the engine manufacturer 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 LOFA 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.

6.2 CP640c Panel Wiring

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

6.2.1 Typical J1939 Wiring Topology



6.2.2 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 on the facing page.

6.2.3 Sealed Connectors

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

LOFA does not recommend using dielectric grease or sealant with sealed connectors. These chemicals may cause seal damage and allow water entry. Use LOFA provided cavity plugs to seal the connector if wires are removed.

6.2.4 Unsealed Connectors

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

Pin	Signal Description	Direction	Notes
A	Preheat In/Out	In/Out	10A Maximum Output
B	Battery Supply	In	Connect direct to battery '+' via 30A Fuse
C	Ground	N/A	Connect direct to battery '-'
D	Starter	Out	10A Maximum
E	Ground	N/A	Connect direct to battery '-'
F	CAN Shield	N/A	
G	ECU/Solenoid	Out	10A Maximum
H	Temperature Sender	In	Resistive
J	Alternator Excitation	Out	5A Maximum
K	Tach	In	Alternator or single ended mag-pickup
L	No Connect	N/A	
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 390Ω resistor
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

Table 1. Engine Harness Connection

LOFA does not recommend using sealant with unsealed connectors. Sealant traps moisture in the connector and encourages corrosion.

6.2.5 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 inch (25 mm) of any connector in order to avoid seal distortion allowing moisture to enter the connector.

6.3 Engine Starter Excitation Connection

6.3.1 Starter Relay

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

LOFA provides suitable heavy duty relays and generic starter relay wiring kits in both 12v and 24V; please contact your LOFA reseller for more information.

6.3.2 Battery Circuit Requirements

Improper wiring can cause electrical noise, 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 30A maximum fused power circuit must be provided for the control system. LOFA 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.

6.3.3 Battery Positive Connection

The electronic control system operates on either a 12 VDC or 24 VDC electrical systems. The unswitched battery positive connection to the control system is made at the weather proof 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 30A fused dedicated circuit reduces the possibility of system damage.

Disconnecting the battery while the engine is running may result in damage to electrical components. When using a battery disconnect switch, LOFA recommends using a 2 pole switch to disconnect both the battery and alternator output.

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

6.3.4 Voltage Drop

If control system voltage drops below 6 volts for more than one tenth of a second, the control system may reset causing the self-test to reactivate. Resetting the control system is equivalent to quickly turning the keyswitch to off and back to run without starting the engine. Voltage drops can be caused by a discharged battery, transients from external equipment, improper wire sizes, faulty wiring or nearby lightning strikes.

6.3.5 Suppression of Voltage Transients (Spikes)

The installation of voltage transient suppression at the transient source is required. LOFA 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. Refer to the illustration for 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.

6.3.6 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.

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 keyswitch 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.

6.4 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 Battery Circuit Requirements)
Faulty control system	Repair or replace control system

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

Possible Cause	Possible Remedy
Engine Stop LED illuminated	Correct ECU 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)
Display configuration problem	Reset display using Restore Defaults
CAN failure	Check CAN (see Testing CAN)
ECU not sending data	Repair or replace ECU

Display shows Bad Device

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

6.4.1 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.

6.4.2 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. This test procedure helps identify the problem location.

1. Disconnect the battery.
2. Identify the engine diagnostic plug. Connect an ohmmeter across the CAN pins of the diagnostic plug.
3. A reading of 60±5Ω indicates both ends of the bus are correctly terminated and the bus is intact.
4. A reading of 120±10Ω indicates only one end of the bus is terminated. (Note: The CP640c has switchable termination via software. Please see CAN bus settings in the Tech menus for more information.)

   An ohmmeter reading of around 120Ω indicates the bus to the terminator in the panel is complete and the problem is between the panel and the engine terminator.

   An open circuit ohmmeter reading indicates the bus to the engine terminator is complete and the problem is between the panel and the diagnostic plug.
5. Reinstall the terminator resistor and reconnect the battery.

   If the ECU diagnostic tool is available, use it to verify the ECU is transmitting CAN data. Refer to ECU documentation to identify and correct the error.

   If another panel is available for testing, replace the panel to determine if the error is in the panel.

6.5 Diagnostic Trouble Codes (DTC)

CAN Diagnostic Trouble Codes are a pair of numbers; the SPN and FMI. The SPN indicates the faulting subsystem and the FMI identifies the type of failure.

6.5.1 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 ECU documentation for supported SPNs. Table 2 on the next page describes some example SPNs.

6.5.2 FMI

FMI codes are defined by SAE J1939-71. Refer to ECU documentation for correct interpretation of FMI codes for a specific SPN. Table 3 on page 29 describes each FMI.

SPN	Description
51	Throttle Position
91	Accelerator Pedal Position
94	Fuel Delivery Pressure
98	Engine Oil Level
100	Engine Oil Pressure
110	Engine Coolant Temperature
111	Coolant Level

Table 2. Example SPN

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	
thru	Reserved for future assignment
30	
31	Not available or condition exists

Table 3. FMI Descriptions