CANplus® 600 Operation and Troubleshooting

Introduction

The **LOFA™ CANplus™ 600** (CP600™) control panel is an economical platform to monitor and control electronically governed diesel engines. Graphical gauge pages or a single large analog gauge are displayed on the 4.25" diagonal LCD. Virtually any SAE J1939 parameter reported by the ECU (Engine Control Unit) can be displayed including RPM, coolant temperature, oil pressure, engine hours, voltage and diagnostic codes. The transflective, backlit display is clearly readable in both bright sunlight as well as total darkness and housed in a rugged IP67 rated housing. Four optional bright LEDs, controlled directly by the ECU, indicate *Power*, *Preheat*, *Stop* and *Warning* status.
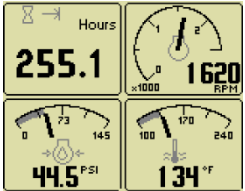
All components are installed in a heavy-duty NEMA 4X polycarbonate enclosure with lockable door and isolation mounting designed to withstand the most extreme industrial applications. When a watertight enclosure is not required, optional AluFlex™ enclosure is a rugged platform with improved high temperature performance.

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 CANbus data stream.

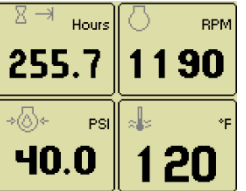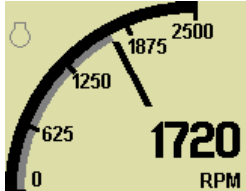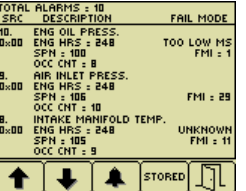Many operating CP600 parameters can be customized using the *Configuration Menu* and the *CANplus Configuration Kit* adds infrequently updated parameters and custom splash screen. Gauge layouts, units of measure, display language and various other parameters such as the full-scale reading of gauges are all adjustable directly with the display.

A context dependent *button bar* is displayed when button from 1 to 4 is pressed indicating the button function. The graphical menu structure uses easily understood icons to indicate the button's current function. The button bar disappears after 5 seconds if no button is pressed or it by pressing the close button.

Button 1	Button 2	Button 3	Button 4	Button 5
Analog Gauge Pages	Digital Gauge Pages	Single Analog Gauge	Active Fault List	Close
Repeated presses cycle through four pages of analog gauges (16 total)	Repeated presses cycle through four pages of digital gauges (16 total)	Repeated presses cycle through available analog gauges	Displays active faults with a plain language description	Closes the button bar

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Throttle Control

The standard *Ramp Throttle* uses a momentary rocker switch to adjust the integral throttle control. All throttle commands are sent directly to the engine using CANbus throttle control. Other throttle options include *Digital Rotary Throttle*, *Two-State Throttle* (Idle/Run) or *Three-State Throttle* (Idle/Intermediate/Run).

Note

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

Service Timers

The CP600 display provides sixteen (16) service timers in 10 hour increments to alert the operator of needed maintenance. A popup message alerts the operator user that service is required after the display self-test is completed. The message can be cleared by pressing any button or will clear automatically after a 5 second delay. The message continues to be displayed at power up until the timer is reset.

Important Note

Most problems with electronically controlled engines can be pinpointed via ECU diagnostic messages.

Use the display or engine diagnostic tool to view fault codes.

The information provided by the CANplus display comes from the CANbus.

The CANplus 600 panel does not control engine operation beyond power control with the keyswitch and speed requests via TSC1 throttle requests

All diagnostic messages displayed are generated by the engine ECU or other attached devices.

Important Operation Information

The information, specifications and illustrations in this publication are based on information available at the time of publication.

All items are subject to change at any time without notice.

Do not operate this product until all operation information is read and understood.

LOFA Industries cannot anticipate every potential hazard. The warnings in this publication do not identify all potential hazards!

Appropriate safety rules and precautions should be followed with any tool, work method or operating procedure.

Failure to follow safe operating procedures could lead to premature failure, product damage, personal injury or death!

Important Maintenance Information

Improper maintenance procedures, tools and materials may cause damage or make the equipment unsafe to operate.

LOFA Industries recommends using replacement parts supplied by LOFA or components with equivalent specifications.

Failure to follow safe maintenance procedures could lead to premature failure, product damage, personal injury or death!

Only persons with appropriate training, skills and tools should perform maintenance and repair.

Do not perform any maintenance or repair on this product until all information is read and understood!

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Operation

Turning the panel key switch to the run position energizes the ECU and displays a splash screen while the display performs a self-test.

Note

A self-test fault is indicated by the display beeping for longer than 1 second or any screen other than the gauge display.

Restore Defaults in the *Configuration Menu* may clear the fault. Contact LOFA Industries for assistance if the problem persists.

After the splash screen disappears, the display shows readings on its virtual gauges. Initially the analog gauges are displayed but the display uses the screen last displayed on subsequent startups (see *Last Screen Store* for details).

If the ECU is preheating when the key switch is turned to the run position, the preheat popup window is displayed. Preheat time varies with atmospheric and engine conditions. The preheat popup window is closed when preheat is complete and the engine can be cranked.

Note

The ECU will not preheat unless conditions warrant.
It may be possible to start the engine before preheat completes.

Turning the key switch to the start position cranks the engine and the switch returns to the run position when released. The key switch is also equipped with a mechanical start locking device to prevent cranking an already running engine. The key switch must be turned to the off position to reset the start locking before the engine can be cranked again.

Throttle Control

The throttle operators installed along with the configured engine speed parameters determines the requested engine speed. The actual engine speed is controlled by ECU and is generally less than the request when the ECU is configured with the typical *droop governor*. Exact engine speed is possible if the ECU is configured with an *isochronous governor*.

Ramp Throttle

The standard *Ramp Throttle* uses a momentary rocker switch to adjust the requested engine speed. When first started, the requested engine speed is *Idle RPM*. Pressing and releasing the rabbit icon 🐰 increases the requested speed by preset interval. Pressing and holding the rabbit icon causes the speed to accelerate to maximum speed within a few seconds. Similarly, pressing the turtle icon 🐢 decreases the requested speed in the same way.

Two-State Throttle

With the optional *Two-State Throttle,* a two position rocker switch selects the desired engine speed. Pressing the rabbit icon 🐰 requests the engine to immediately go to *Run RPM*. Pressing the turtle icon 🐢 requests the engine to immediately go to *Idle RPM*.

Three-State Throttle

The optional *Three-State Throttle* uses a three position rocker switch to add *Intermediate Speed* to the *Run RPM* and *Idle RPM* of the *Two-State Throttle*.

Note

Idle RPM, *Intermediate RPM* and *Run RPM* are adjustable in the configuration menu.
Minimum Requested RPM and *Maximum Requested RPM* are generally only configureable
using the *CANplus Configuration Kit*. See *Configuration* below for more information.
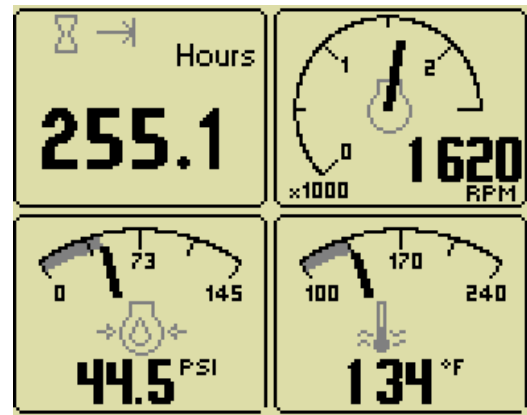
Digital Rotary Throttle

The rotary switch of the optional **Digital Rotary Throttle** simulates a throttle potentiometer. Like the **Ramp Throttle**, the requested engine speed is **Idle RPM** when the engine is started. Turning the throttle knob clockwise increases the requested engine speed. Turning the throttle knob counter-clockwise decreases the requested engine speed. Turning the knob slowly allows fine speed adjustments while turning faster increases the speed increments to get to the desired speed quickly.

The *Rotary Throttle* can be combined with a **Ramp Throttle** or **Three-State Throttle** allowing versatile throttle control. In addition, the push switch of the *Rotary Throttle* can quickly reprogram the **Idle**, **Intermediate** and **Run RPM** setting. After adjusting the engine to the desired speed with the rotary throttle knob, press and hold the knob and then select the switch position to be reprogrammed. After two seconds a popup overlay indicates the speed reprogrammed and the knob can be released.

Note

The **Rotary Throttle** only changes the requested speed in the
intermediate position when used with a **Three-State Throttle**.

CANplus Display

Soft buttons simplify the operator interface by displaying a **button bar** above the buttons when any of the first 4 buttons (buttons 1 to 4 counting from the left) are pressed. Icons on the button bar represent the current function of each button. The button bar disappears after 5 seconds if no further buttons are pressed.

Note

Different software versions may have slightly different displays.

Analog Gauge Pages

Analog Gauge Pages provide four independent pages of analog gauges. *Analog Gauge Pages* are selected by pressing any of the first 4 buttons to show the top level button bar and then pressing button 1 ⊟⊟. The four gauge pages are selected by repeated pressing of button 1.

Default Gauge Pages

| Page 1 | Page 2 | Page 3 | Page 4 |
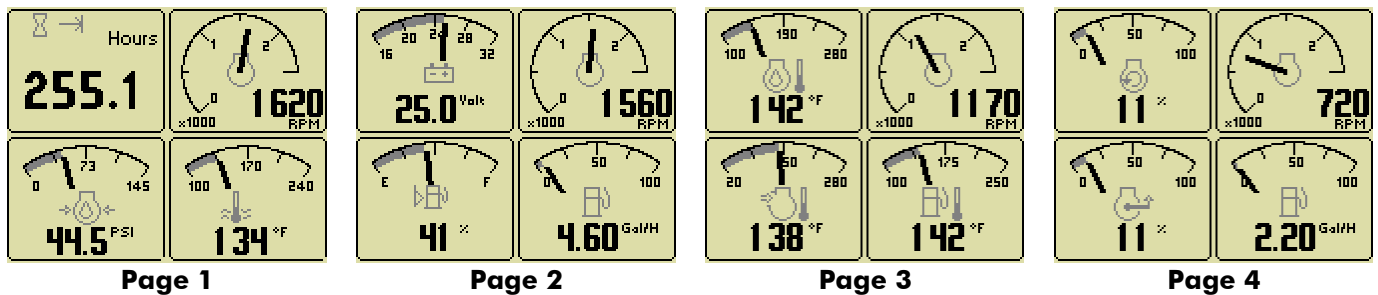
Note

Engine Hours are displayed as a digital value on *Analog Gauge Pages*.
The default gauge pages show 13 selections since the tachometer is the upper right gauge of each page.

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Digital Gauge Pages

Digital Gauge Pages display the same data as the *Analog Gauge Pages* but in digital only format. Digital Gauge Pages are selected by pressing any of the first 4 buttons to show the top level button bar and then pressing button 2 [icon]. The four gauge pages are selected by repeated pressing of button 2.
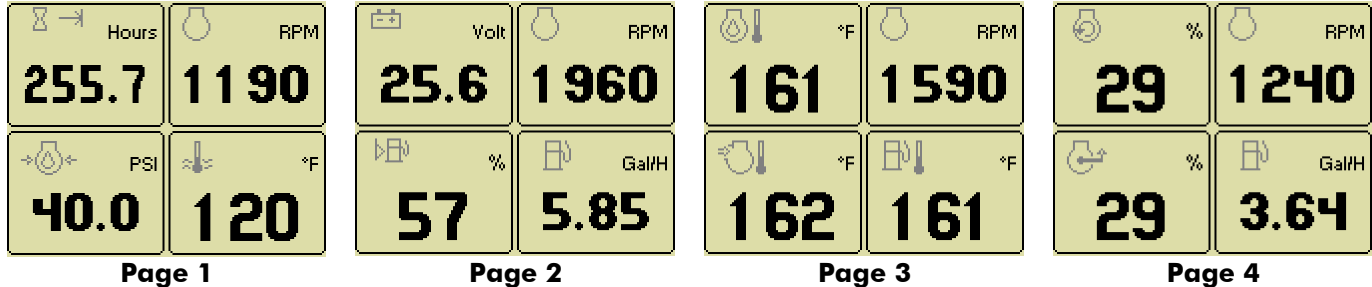
Default Gauge Pages

Hours	RPM	Volt	RPM	°F	RPM	%	RPM
255.7	1190	25.6	1960	161	1590	29	1240
PSI	°F	%	Gal/H	°F	°F	%	Gal/H
40.0	120	57	5.85	162	161	29	3.64

| Page 1	Page 2	Page 3	Page 4

Modifying Gauge Configuration

All 16 gauges may be configured using **Quad Adjust** (disabled by default). When *Quad Adjust* is enabled, the icon for button 5 changes to [icon]. Pressing button 5 opens a new button bar identifying the gauge adjustment functions.

[icon] Top left gauge   [icon] Top right gauge   [icon] Bottom left gauge   [icon] Bottom right gauge   [icon] Exit menu

Successive button presses selects a different gauge for the corresponding gauge. Pressing the exit button closes the *Quad Adjust* menu and saves the page configuration. Selecting a different page allows changes on that page.
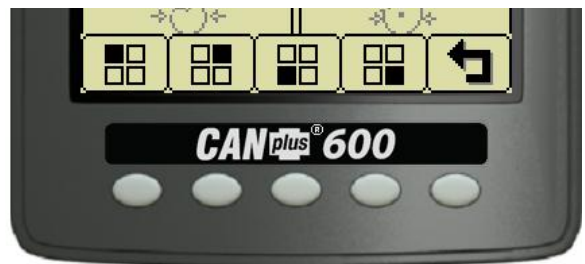
Note

A gauge selection can only appear once per page.
The existing gauge must be moved first to change the location on a page.

Gauge selections are limited to the data being received and parameters monitored.
All possible gauges can be configured in **Demo Mode**.

See **Data Parameters Monitored** for a list of available parameters.

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 pressing button 3 [icon]. The available gauges are selected by repeatedly pressing button 3.

Last Screen Store

The display automatically remembers the selected screen after a few seconds. The display uses the same screen on subsequent power-ups.

Active Faults

When a diagnostic message is received from the CANbus, a flashing popup shows the fault description and the beeper sounds. The fault description along with the SPN-FMI pair, source address, engine hours and the occurrence count are also added to the **Active Fault List**.

Fault Popup	Unacknowledged Fault List	Acknowledged Fault List	No Active Faults
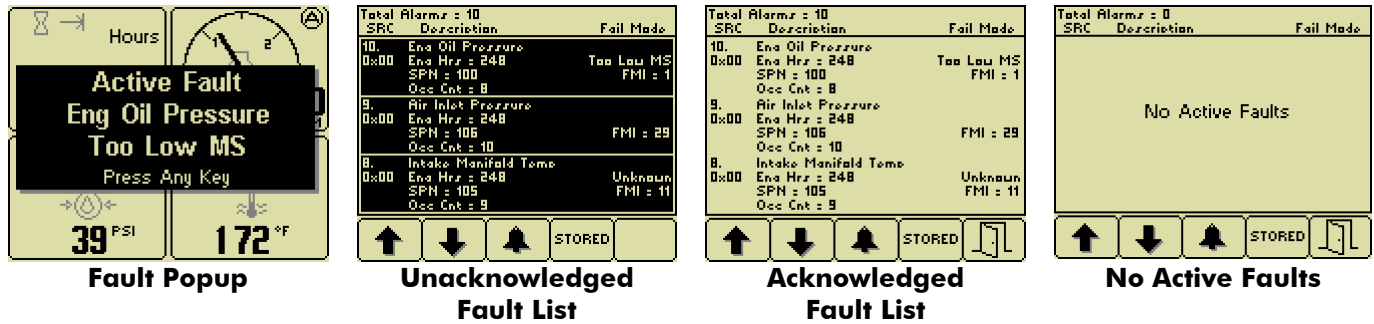
Note

Standard J1939 abbreviations are used for faults.
MS = Most Severe, ***MOD***= Moderately Severe, *LS* = Least Severe.
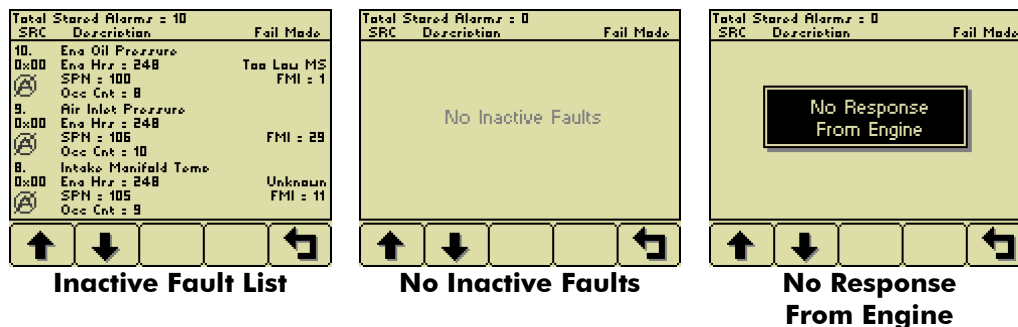
Active Fault List

The *Active Fault List* is accessed by pressing any button while a fault popup is displayed. The fault list is highlighted and the beeper continues until faults are acknowledging by pressing button 3 🔔 . Once acknowledged, the fault list changes to normal text, the beeper is silenced and button 5 becomes available. The most recent fault is displayed at the top of the list and using buttons 1 ⬆ and 2 ⬇ changes fault pages if needed.

An active fault indicator ⊖ is displayed near the upper right corner of the display after the fault list is closed as long as a fault is active. The fault indicator is automatically removed and the fault list is cleared a few seconds after active fault messages stop.

The fault list can be reopened at any time by pressing any of the first 4 buttons and then pressing button 4 ▲⌨ . If there are no active faults, a blank list is displayed with the message *No Active Faults*.

Inactive Faults

Inactive Faults (also called *stored* or *previously active faults*) are history save by the engine ECU and other devices on the CANbus. The fault history from all devices on the CANbus can be read by pressing button 4 [STORED] from the *Active Faults* list. Any inactive faults are displayed with the same information available for active faults. If no stored faults are available, a blank list is displayed with the message *No Inactive Faults*. A popup displays *No Response From Engine* if no J1939 device responds to the inactive fault request.

| Inactive Fault List	No Inactive Faults	No Response From Engine

Note

Inactive faults may be cleared using the engine diagnostic tool.
Some ECUs will automatically clear inactive fault history.

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Adjusting Backlight and Contrast

When no menu bar is shown, pressing button 5 opens the lighting and contrast menu bar. The display backlight is adjusted by pressing buttons 1 [icon] and 2. Contrast is adjusted in the same manner using buttons 3 [icon] and 4.

Display contrast is temperature compensated to avoid adjustments for most temperature changes. The factory defaults can be restored by pressing and holding buttons 1 thru 4 simultaneously.
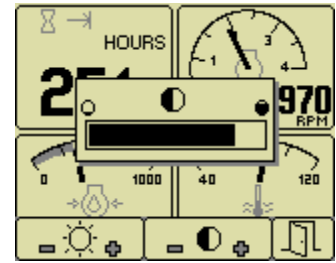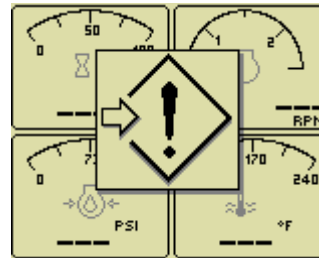
Service Required Popup

Users can set up to sixteen service timers in hours in the Configuration menu. The **Service Required** popup is displayed at power up when one or more service timers has expired. Pressing any button removes the popup. If no button is pressed the popup closes in approximately 5 seconds.
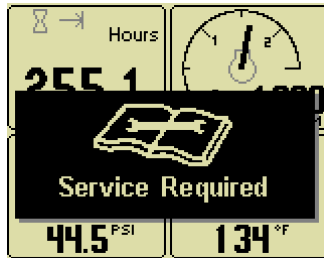
Service Required Popup

Data Communications Failure

Data Communications Failure Icon

The data communications failure icon flashes if the display does not detect J1939 data. Communications failure can be caused by a configuration problem such as incorrect *Engine Source* address or a problem with the CANbus. Normal operation resumes once data is detected and icon disappears.

Configuration

A large number of parameters are configurable to adapt the CP600 panel for a particular application. Most commonly modified parameters can be accessed on the display from the **Configuration Menu**. Infrequently changed parameters and restricted parameters (such as *Maximum RPM*) are normally only accessible using the **CANplus Configuration Kit**.

The Windows® PC program and hardware adapter in the **CANplus Configuration Kit** allows complete access to all panel parameters. The panel configuration can be saved to disk for quick panel configuration and also supports installation of custom splash screens. Please contact LOFA for more information.

Accessing Configuration

The **Configuration Menu** is accessed by pressing and holding button 5 for at least 3 seconds. When *PIN Entry* is enabled, the correct PIN (Personal Identification Number) must be entered to access configuration. The PIN is entered on the popup using the buttons corresponding to the PIN digits.

First digit	Second digit	Third digit	Fourth digit	Enter PIN

Repeated button presses cycles from 0 thru 9 and back to 0. The PIN is entered using button 5 once the PIN is selected. The **Configuration Menu** opens on correct PIN entry or the popup changes to indicate an error if the PIN is incorrect. The display returns to the current gauge a few seconds after an incorrect PIN entry.
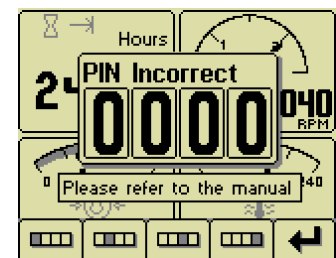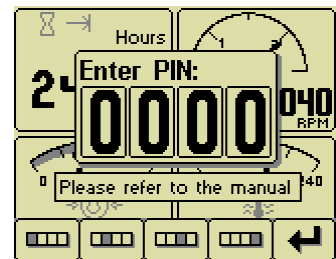
Configuration Menu

Configuration Menu
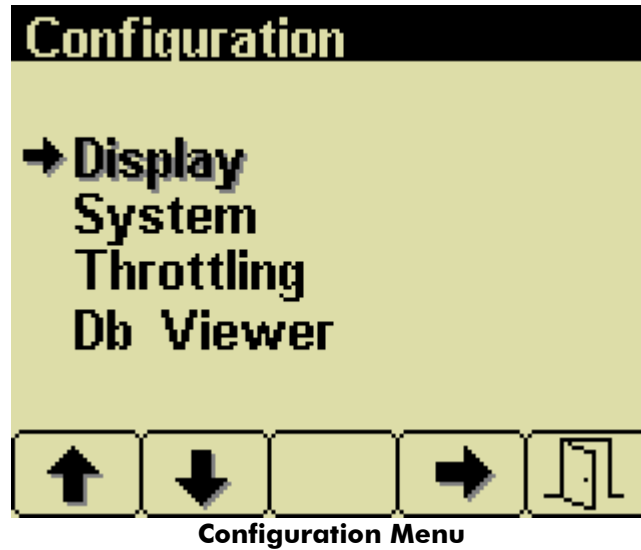
Select configuration submenus

The *Configuration Menu* has four submenus of different parameters and diagnostic information.

Display Menu | **System Menu** | **Throttling Menu** | **Db Viewer**
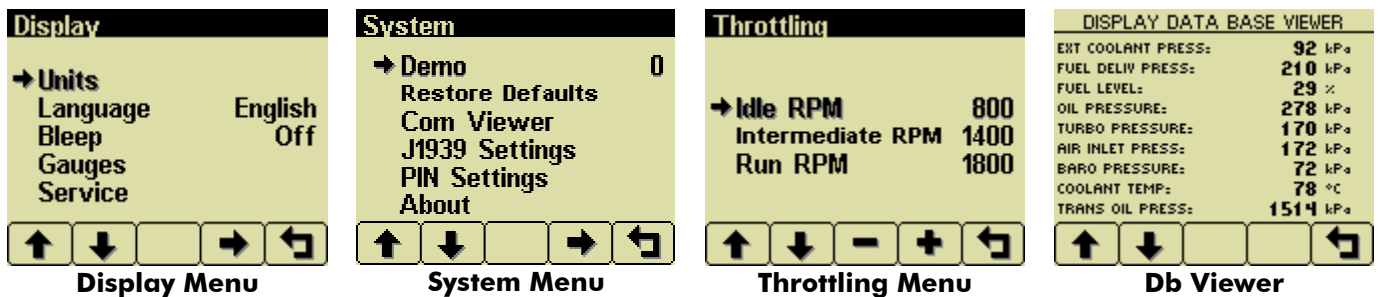
Menu Navigation

The soft buttons use common functions for navigating all menus. The current selection is indicated by bold font and the arrow ➦ icon.

⬆	Move selection up the menu	⬇	Move selection down the menu
➖	Decrease the selected value	➕	Increase the selected value
↩	Return to the previous menu	🚪	Exit the configuration menu

Note

Configuration changes are saved when the menu is closed.
Turning power off before exiting a menu prevents saving changes.

Display Menu
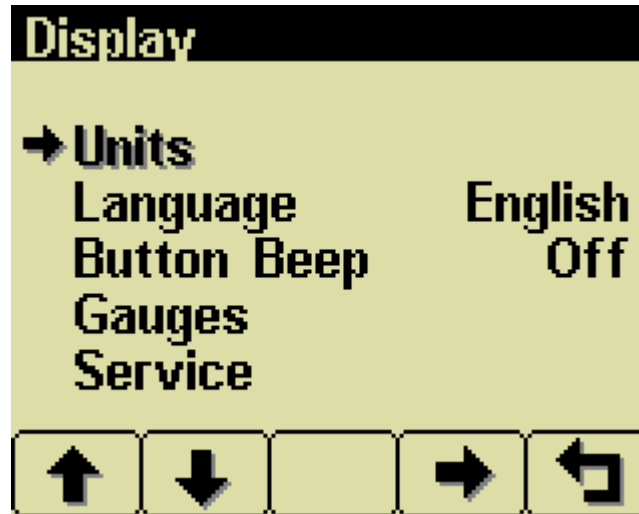
Configure information display

Units Menu
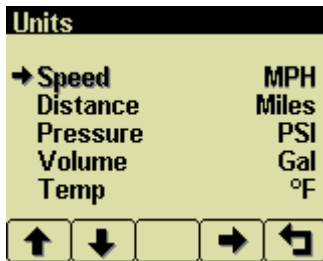
Set display units

Speed MPH (miles per hour, US default)
km/h (kilometers per hour,
metric default)
Kts (knots)

Distance Miles (US default)
km (kilometers, metric default)
NM (nautical miles)

Pressure PSI (pounds per square inch,
US default)
bar (barometric units)
kPa (kilopascals, metric defaults)

Volume Gal (gallons, US default)
IGal (Imperial gallons)
Liters (metric default)

Temp °F (Fahrenheit, US default)
°C (Celsius, metric default)

Language Menu

Set display language

The currently selected language is indicated by the checkmark ☑ icon.

Language English (default)
Svenska (Swedish)
Français, (French Canadian)
Deutsch (German)
Español (Americas Spanish)
Italiano (Italian)
Nederlands (Dutch)
Português (Brazilian Portuguese)
Indonesia (Indonesian)

Button Beep

Enable (*On*, default) or disable (*Off*)

Note

Button Beep setting does not
affect the *Active Fault* beep.

Gauges Menu
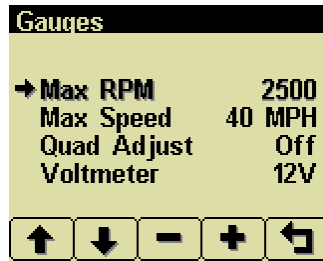
Configures gauge display

Max RPM

Set analog tachometer full scale RPM

RPM	2500 (default), 3000, 3500, 4000, 4500, 5000, 6000, 7000, 8000 or 9000

Note

This only sets the range of the analog gauge.
This does not limit the tachometer digital value
or the maximum engine speed.

Max Speed

Set analog speedometer full scale speed

MPH	15, 20, 25, 30, 35, 40 (default), 45, 50, 55, 60, 70, 75, 80, 85, 95 or 100
km/h	20, 30, 40, 50, 60 (default), 70, 80, 90, 100, 110, 120, 130, 140, 150 or 160
Kts	10, 20, 25, 30, 35 (default), 40, 45, 50, 55, 60, 65, 70, 75, 80 or 85

Note

This only sets the range of the analog gauge.
This does not limit the speedometer digital value.

Quad Adjust

Enable (*On*) or disable (*Off,* default)

Enabling *Quad Adjust* allows the gauge configuration of the *Analog* and *Digital Gauge Pages* to be changed. Disabling *Quad Adjust* prevents accidentally changes.

Voltmeter

Set system voltage

Setting the system voltage sets the analog voltmeter full scale voltage.

Voltmeter	12V (16 V fullscale, default)
	24V (32 V fullscale)

Note

This only sets the range of the analog gauge.
This does not limit the voltmeter digital value.

Service
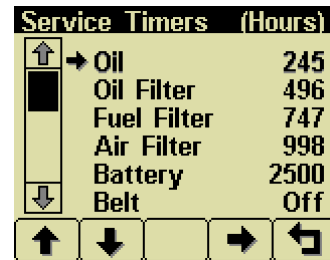
Reset service interval timers
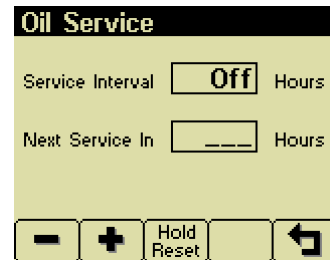
The service interval is adjustable in 10 hour increment starting from *Off* (0, default) using buttons 1 and 2. Holding button 3 [Hold Reset] for approximately 3 seconds resets *Next Service In* using the current service interval and the engine hours.

Note

It is not possible to set service timers if engine hours are not being received by the display.

System Menu
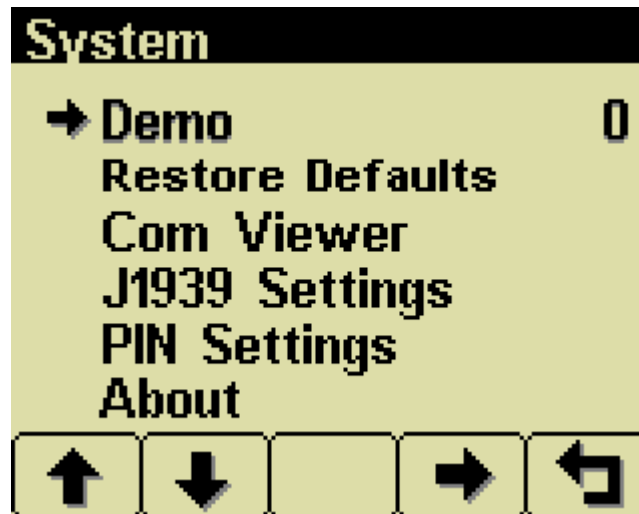
Configure system function

Demo

Select demo mode

Demo Mode generates simulated gauge data to demonstrate display operation. Mode 3 also generates fault messages.

Mode	0 – disabled (default)
	1 – simulate engine and speed
	2 – simulate engine
	3 – Mode 1 with active faults

Note

Demo Mode is automatically disabled when J1939 data is received.

Restore Defaults
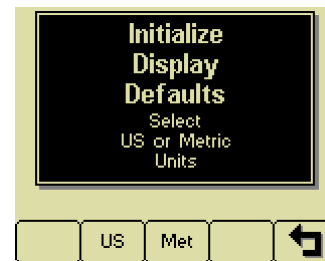
Restore US [US] or metric [Met] defaults

Setting	US	Metric
Max Speed	40 MPH	60 km/h
Speed Units	MPH	km/h
Distance Units	Miles	km
Pressure Units	PSI	kPa
Volume Units	Gal	L
Temperature Units	°F	°C

Common Settings	
Language	English
Button Beep	On
Service Timers	Off
Display Mode	Analog Gauges, default set
Quad Adjust	Off
Demo Mode	0 (disabled)
Engine Source	0 (Engine 1)
Display Address	40
Alarm Filter	Glb (global)
SPN Version	1
Speed Source	Auto
PIN Entry	Off
PIN	1111
Max RPM	2500
Voltmeter	12V (16 V range)

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Com Viewer
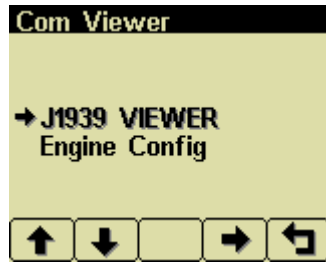
Display raw J1939 data and engine configuration

J1939 Viewer
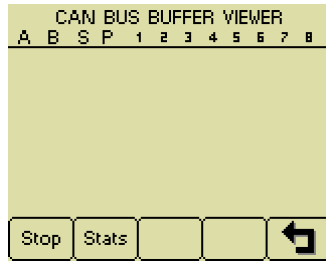
Scrolling display of raw J1939 data

Button 1 [Stop] freezes the scrolling display

Column	Value (hexadecimal)
A and B	*PGN* (Parameter Group Number)
S	source address
P	Priority
1 thru 8	Data bytes
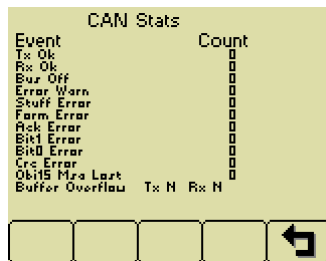
Button 2 [Stats] shows message statistics

Engine Config
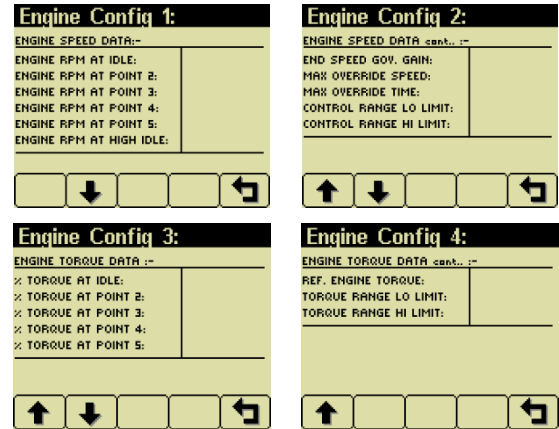
Display engine configuration from ECU

J1939 Settings
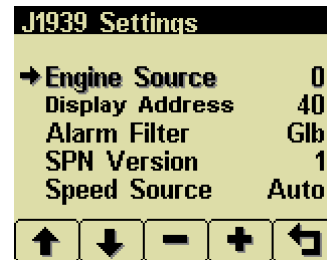
Set J1939 options

Engine Source

Set gauge data engine J1939 address

Each J1939 device has a unique address to identify the data source. Gauge data is only displayed from the engine (Engine 1, address 0, default) and transmission (Transmission 1, address 3, default).

Note

Incorrect Engine Source address will result in limited or no gauge data.

Display Address

Set display J1939 address

The default address (40) will work for most applications.

Note

Incorrect Display Address can result in data collisions on the CANbus.

Alarm Filter

Select alarm filtering

> *Glb* (global, default) – display all faults
> *Src* (source) – display engine and transmission faults

SPN Version

Set SPN (Suspect Parameter Number) conversion version

Version 1 (default), 2 or 3

New J1939 devices use version 4 to send diagnostic messages. Version 4 is automatically detected but decoding must be selected for older devices.

Note

Consult the device supplier to determine the correct SPN conversion method.

Speed Source

Set speedometer source

Speed Source Off (disabled)
Auto (default)
Wheel (SPN 84)
Nav (SPN 517)

Auto uses *Wheel* (SPN 84) if available or *Nav* (SPN 517).

Off disables all speed monitoring.

PIN Settings
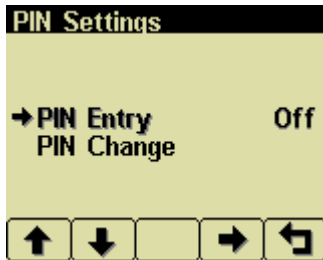
Control configuration access

PIN Entry

Enable (*On*) or disable (*Off*, default)

The current PIN (1111, default) must be entered to enable *PIN Entry*.
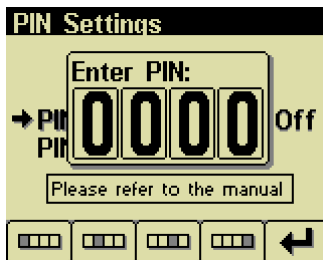
PIN Change
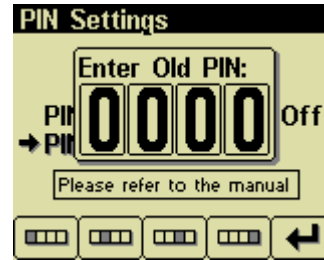
Current PIN prompt
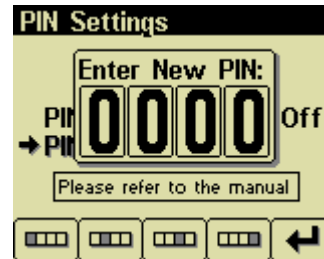
New PIN prompt
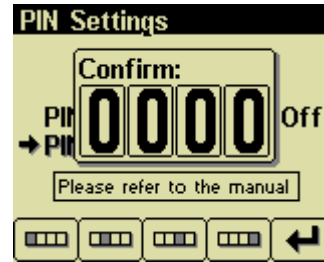
New PIN confirmation prompt
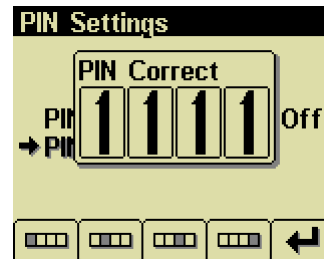
PIN confirmation (if PINs matched)
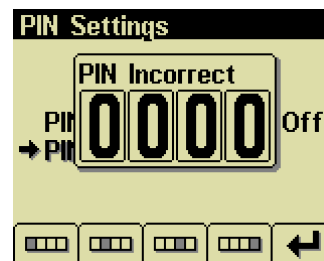
PIN incorrect (old PIN wrong or new PIN mismatch)

Note

A lost PIN can only be cleared using the *CANplus Configuration Kit* or returning the display to LOFA.

About

Display product information

ID/Build	Serial number of the display
EEPROM	Number of EEPROM writes
PART No	Unit part number
VERS	Software version number
CHK	Flash memory checksum
RUN TIME	Display power on time

The checksum is displayed when the calculation completes

Note

The *About* screen will not close until the checksum calculation is complete.

Throttling Menu

Configure throttle control

Idle RPM

Set idle speed requested

Idle RPM (800 RPM default, 10 RPM increment) is the initial speed for *Ramp Throttle* and *Digital Rotary Encoder* as well as the low speed 🐢 for the *Two State* and *Three State Throttle*. Idle can be set to compensate for parasitic loads such as hydraulic pumps or compressors.

Intermediate RPM

Set intermediate speed requested

Intermediate RPM (1400 RPM default, 10 RPM increment) is only used by the *Three State Throttle*.

Run RPM

Set run speed requested

Run RPM (1800 RPM default, 10 RPM increment) is used for the high speed 🐇 of the *Two State* and *Three State Throttle*.

Minimum RPM (optional)

Set minimum speed requested

Minimum RPM (800 RPM default, 10 RPM increment) is the lowest speed the panel will request and limits the minimum configurable speed for *Idle RPM*, *Intermediate RPM* and *Run RPM*. This setting is always available using the *CANplus Configuration Kit* but is optional for the display.

Note
Requesting a lower speed does not override the ECU minimum engine speed.

Maximum RPM (optional)

Set maximum speed requested

Maximum RPM (3000 RPM default, 10 RPM increment) is the highest speed the panel will request and limits the maximum configurable speed for *Idle RPM*, *Intermediate RPM* and *Run RPM*. This setting is always available using the *CANplus Configuration Kit* but is optional for the display.

Note
Requesting a higher speed does not override the ECU maximum engine speed.

Db Viewer


```
DISPLAY DATA BASE VIEWER
EXT COOLANT PRESS:      16.4 PSI
FUEL DELIV PRESS:       30.5 PSI
FUEL LEVEL:               60 %
OIL PRESSURE:           49.2 PSI
TURBO PRESSURE:         29.0 PSI
AIR INLET PRESS:        28.0 PSI
BARO PRESSURE:            14 PSI
COOLANT TEMP:           182 °F
TRANS OIL PRESS:        234 PSI
```

View J1939 monitored data

This diagnostic tool allows viewing all data monitored including items not available on a gauge. All values are displayed in the selected units and updated in real time. Values displayed as **———** are not available from the engine or other device.

Note

The *Db Viewer* is always displayed in English.

General J1939 Wiring Topology

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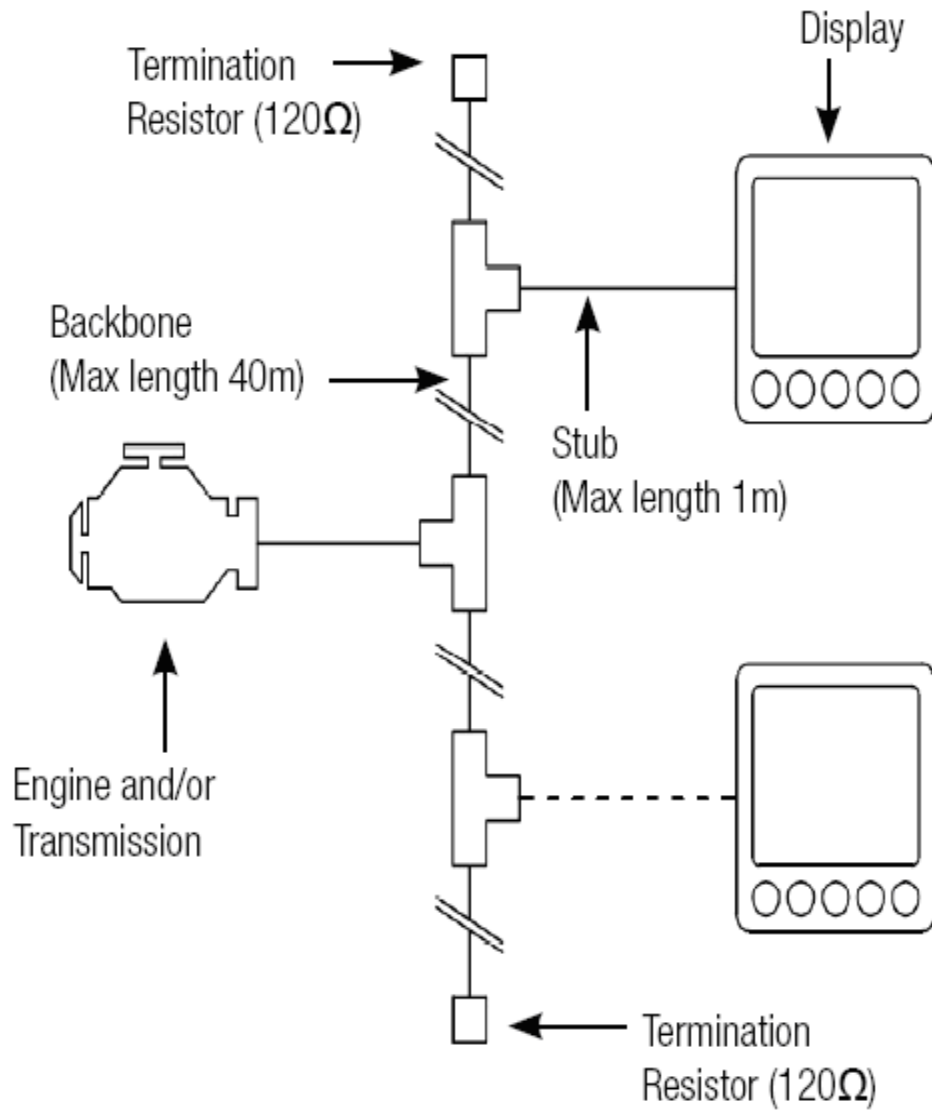
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Harness

Sealed Connectors

The Deutsch sealed weatherproof connector on the panel includes a locking ring which must be turned counter clockwise to separate the connectors. Turn the locking ring clockwise to positively seat the connectors.

Warning!
LOFA does not recommend using dielectric grease or sealant with sealed connectors. These chemicals may cause seal damage and allow water entry.
Make sure the connectors are dry before mating. Mating wet sealed connectors traps moisture in the connector which may lead to corrosion.
Use LOFA provided cavity plugs to seal the connector if any lwires are removed.

Unsealed Connectors

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

Warning!
LOFA does not recommend using adding sealant with unsealed connectors. Sealant added to unsealded connectors traps moisture and encourages corrosion.

Harness Routing

The minimum routing radius of the wiring harnesses should be at least two times the diameter of the wiring harness. Bends within 1 inch (25 mm) of connectors may distort seals and allow moisture into the connector.

Panel Power Connections

The panel 8 to 32 VDC operating range works on either a 12 V or 24 V electrical systems. The panel will reset and reactivate the self-test if the supply voltage drops below 6 volts for more than one tenth of a second. Voltage drops can be caused by a discharged battery, inrush current from external equipment, improper wire sizes or faulty wiring.

Note
Panel power and ground MUST be connected directly to the battery!
Connecting panel power at the starter is NOT SUPPORTED!
Grounding through the engine block or frame members is NOT SUPPORTED!
Over current protection must be provided to protect the circuit from likely faults.

Warning!
Improper wiring can cause electrical noise, unreliable operation and may damage the panel or attached components!
All power connections must be free from foreign material which may interfere with proper connection including paint, rust and grease!
All circuit paths must include over current protection and be capable of carrying any likely fault currents without damage!
Attempting to crank the engine with reversed polarity may damage the panel or connected components!
Disconnecting the battery with the engine running may damage electrical components!

Suppression of Voltage Transients (Spikes)

Warning!

The installation of voltage transient suppression at the transient source is required!

LOFA recommends and follows SAE electrical practices.

Inductive devices such as relays, solenoids and motors generate voltage transients and noise in electrical circuits when switched on and off. Unsuppressed voltage transients exceeding SAE specifications may damage electronic controls.
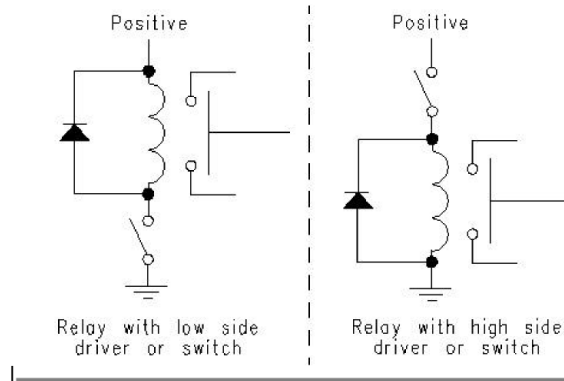
Relays and solenoids with built-in voltage transient suppression diodes are recommended whenever possible. Refer to the illustration for proper installation of diodes when built-in voltage transient suppression is not available.

Inductive devices should be located as far away from the electronic control system as possible. It may also be necessary to add isolation relays to control electric motors to eliminate voltage transients, noise and prevent back feed.

Welding on Equipment with Electronic Controls

Proper welding procedures are required to avoid damage to electronic controls, sensors and associated components. The component should be removed for welding if possible. The following procedure must be used if the component can only be welded in place.

Warning!

**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 welder ground cable as close to the component
being welded as possible 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.

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General Troubleshooting

For additional information, refer to engine manufacturer troubleshooting guide.

No response from starter motor

Possible Cause	Possible Remedy
No battery voltage to starter	Verify wiring and battery connection (power and ground)
Battery discharged	Charge or replace battery, verify alternator charging
Tripped overcurrent protection	Correct fault, replace or reset overcurrent protection
No signal from control system	No power to control system (see *Control System Troubleshooting*)
Defective starter solenoid	Replace starter solenoid
Defective starter motor	Replace starter motor

Engine will crank but not start

Possible Cause	Possible Remedy
Engine not getting fuel	Check fuel level, filter, fuel pump, verify no air in fuel lines
ECU is not functioning	See *Engine Troubleshooting*
Tripped overcurrent protection	Correct fault, replace or reset overcurrent protection
No preheat (cold condition)	See *Preheat Troubleshooting*

Engine runs and shuts down

Possible Cause	Possible Remedy
ECU shutdown	Use display to view ECU diagnostic codes, use ECU diagnostic tool for more detailed information
Circuit overload protection tripped	Correct overload, keep control system from overheating (over 167° F or 75° C)
Voltage transients (spikes)	Add suppressor diodes, protect from nearby lightning strikes, shield induced spikes from other equipment, add electric motor control relay
Defective control system	See *Control System Troubleshooting*

Alternator not charging battery

Possible Cause	Possible Remedy
Broken or slipping alternator drive belt	Adjust or replace alternator drive belt
Alternator not excited	Verify excitation circuit connected, replace faulty regulator
Alternator output not connected	Install charge wire
Alternator not grounded	Clean or add ground connection
Alternator faulty	Replace faulty alternator

Engine Troubleshooting

Note

Most problems with ECU controlled engines can be pinpointed via the ECU diagnostic messages.
Use the display or ECU diagnostic tool to view fault codes.

**All engine state and diagnostic information shown
by the CANplus display is provided from the CANbus.**

**ECU programming determines the response to warnings and failures.
Typically the ECU can be programmed to shutdown, derate or run to failure.**

ECU does not power-up

Possible Cause	Possible Remedy
No power to ECU	Locate reason for lack of power and correct (Circuit overloaded? Failed suppressor diode? Faulty wiring?)
Tripped overcurrent protection	Correct fault, replace or reset overcurrent protection
Faulty ECU	Replace ECU
Optional e-stop engaged	Disengage e-stop

Engine not getting fuel

Possible Cause	Possible Remedy
Empty fuel tank	Fuel engine
Clogged filter	Replace filter
Air in fuel lines	Bleed fuel lines
Low fuel pressure	Replace faulty fuel pump and/or clogged filter
Faulty fuel pump	Replace fuel pump, correct wiring fault (electric fuel pump)

Engine is hard to start in cold conditions

Possible Cause	Possible Remedy
Start attempt before preheat complete	Wait for preheat time to elapse, crank as soon as time elapses
Heater faulty	Replace heater
Heater relay faulty	Replace relay
Preheat control not functioning	Correct wiring, correct ECU configuration
Faulty control system	Repair or replace ECU

Engine produces excessive white smoke after starting

Possible Cause	Possible Remedy
Afterglow not enabled	Reconfigure ECU
Heater faulty	Replace heater
Heater relay faulty	Replace relay
Preheat control not functioning	Correct wiring, correct ECU configuration
Faulty control system	Repair or replace ECU

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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**
CANbus failure	Check CANbus (see **Testing CANbus**)
ECU not sending data	Repair or replace ECU

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.

Testing CANbus

Most information provided to the CANplus display is sent by the ECU via the CANbus. CANbus 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.

Warning!

This test should be completed with the battery disconnected!

Failure to disconnect the battery may cause ECU, panel or test equipment damage!

2. Identify the engine diagnostic plug. Connect an ohmmeter across the CANbus pins of the diagnostic plug.

3. A reading of 60Ω indicates both ends of the bus are terminated and the bus is intact.

4. A reading of 120Ω indicates only one end of the bus is terminated. Identify the CANbus terminator on the engine harness and remove it.

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

    b. An open circuit 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.

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

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

Diagnostic Trouble Codes (DTC)

J1939 Diagnostic Trouble Codes are a pair of numbers; the Suspect Parameter Number (SPN) and Failure Mode Identifier (FMI). The SPN indicates the faulting subsystem and the FMI identifies the type of failure.

Example SPNs

Standard SPN codes are defined by SAE J1939-71. ECUs do not support all standard codes and engine manufacturers may add additional custom SPNs beyond the standard. Refer to ECU documentation for supported SPNs.

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

FMI

FMI codes are defined by SAE J1939-71. Refer to ECU documentation for interpretation of FMI codes for a specific SPN.

FMI	Description
0	Data valid but above normal operational range (most severe)
1	Data valid but below normal operational range (most severe)
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	Root cause not known
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	Data drifted high
21	Data drifted low
22 - 30	Reserved for future assignment
31	Not available or condition exists

Data Parameters Monitored

This table lists the engine and transmission parameters that are monitored via the CANbus. The parameters can be displayed by the user-configurable gauge pages or the single analog gauge. DB is an abbreviation for the internal database which stores all data transmitted from the engine/transmission. The complete database can be accessed on the display via the *Db Viewer* in the Configuration menu.

Icon	SPN	Parameter	Gauge Pages	Single Gauge	Database
		Electrical (Volts or Amps)			
	115	Alternator Current	●	●	●
	167	Alternator Voltage	●	●	●
	158	Battery Voltage, Switched	●	●	●
	168	Electrical Potential	●	●	●
	114	Net Battery Current	●		●
		Fuel (L, Gal, IGal) or (L/h, Gal/h IGal/h) or (km/L, MPG or IMPG)			
	185	Average Fuel Economy	●		●
	1239	Fuel Leakage 1			●
	1240	Fuel Leakage 2			●
	183	Fuel Rate	●	●	●
	184	Instantaneous Fuel Economy	●		●
	182	Trip Fuel	●		●
	1006	Trip Fuel Economy	●		●
	1029	Trip Fuel Rate	●		●
	250	Total Fuel Used			●
		Distance (km, Miles or Nmiles)			
		Distance Remaining	●		●
	245	Total Vehicle Distance	●		●
	244	Trip Distance	●		●
		Pressure (kPa, PSI or bar)			
	107	Air Filter Differential Pressure	●		●
	106	Air Inlet Pressure	●		●
	82	Air Start Pressure	●		●
	1387	Auxiliary Pressure 1	●		●
	108	Barometer Pressure	●		●
	102	Boost Pressure	●	●	●
	123	Clutch Pressure	●		●
	109	Engine Coolant Pressure	●		●
	100	Engine Oil Pressure	●	●	●
	94	Fuel Delivery Pressure	●		●
	164	Injection Control Pressure			●
	157	Injector Metering Rail 1 Pressure	●		●
	156	Injector Metering Rail 2 Pressure	●		●
	127	Transmission Oil Pressure	●	●	●
		Speed (RPM, km/h, MPH or KTS)			
	515	Engine Desired Operating Speed			●
	190	Engine Speed	●	●	●
	161	Input Shaft Speed	●		●
	84 or 517	Wheel or Navigation Vehicle Speed	●		●
	191	Output Shaft Speed	●		●
	103	Turbo 1 Speed	●		●

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Icon	SPN	Parameter	Gauge Pages	Single Gauge	Database
		Percentage (%)			
	91	Acceleration Position	●	●	●
	513	Actual Engine Percent Torque	●	●	●
	111	Coolant Level	●		●
	3719	DPF Soot Load	●		●
	3720	DPF Ash Load			●
	518	Drivers Demand Percent Torque	●		●
	98	Engine Oil Level	●		●
	1639	Estimated Percent Fan Speed	●		●
	96	Fuel Level	●		●
	1761	SCR Catalyst Tank Level	●		●
	51	Throttle Position			●
	92	Torque Use at RPM	●	●	●
		Temperature (°C or °F)			
	172	Air Inlet Temperature	●		●
	441	Auxiliary Temperature 1	●		●
	110	Engine Coolant Temperature	●	●	●
	1136	Engine ECU Temperature			●
	1137	Exhaust Gas Port 1 Temperature			●
	1138	Exhaust Gas Port 2 Temperature			●
	52	Engine Intercooler Temperature	●		●
	175	Engine Oil Temperature	●	●	●
	173	Exhaust Gas Temperature	●	●	●
	174	Fuel Temperature	●	●	●
	105	Intake Manifold Temperature	●	●	●
	177	Transmission Oil Temperature	●	●	●
	1172	Turbo Inlet Temperature	●		●
	176	Turbo Oil Temperature	●		●
		Time (h)			
	3721	DPF Time Since Last Active Regen			●
	247	Total Engine Hours	●		●
	1036	Trip Engine Hours	●		●
		Service Hours			●
		Miscellaneous			
		CANTX Disable			●
	523	Current Gear	●		●
	524	Selected Gear	●		●
	573	Torque Converter Lock-Up Engaged			●

Note

▬▬▬ is displayed if a parameter is not available.

Abbreviations

MPG and *Gal* refers to US gallons   *IMPG* and *IGal* refers to Imperial gallons (UK, Canada, etc.)
Nmiles refers to nautical miles   *KTS* denotes knots

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Glossary

CAN	*Controller Area Network* (also referred to as *CANbus*); serial communications protocol for electronic engines use
DTC	*Diagnostic Trouble Code*; the combination of *SPN* and *FMI* that identifies a specific error
ECU	*Engine Control Unit*; electronic device responsible for controlling and monitoring engine operation, also used to refer to an *Electronic Control Unit*
ECM	*Engine Control Module*; an alternate name for the *ECU*
FMI	*Failure Mode Identifier*; defines the type of failure detected in the subsystem identified by the *SPN*
GPS	*Global Positioning System*; a system of satellites and receiving devices used to compute positions on the earth, used in navigation
ISO	*International Standard Organization*; an international organization working with the United Nations that maintains technology standards for global industry
J1939	SAE engine data protocol using CAN 2.0B
LCD	*Liquid Crystal Display*; a display technology that uses electric fields to align crystals in a special liquid creating a light and dark areas
RS-232	Standard electrical interface for serial communications
RS-485	Standard differential electrical interface for serial communications
SAE	*Society of Automotive Engineers*; professional association of transportation industry engineers that sets most auto-industry standards for the testing, measuring, and designing of automobiles and their components
soft buttons	Push buttons whose function changes according to context
SPN	*Suspect Parameter Number*; a number used to identify a particular element, component or parameter associated with an ECU

Note

Messages and error codes displayed conform to J1939 wherever possible.
Relevant J1939 standards may purchased at http://www.sae.org/standardsdev/groundvehicle/j1939a.htm

Icons displayed conform to ISO standards wherever possible.

Software Release History

1.30

- Initial release

1.36
- Updated available gauges, CANbus parameters database.

1.40
- Update to support configuration program.

Document Revision History

Initial: 24-Jul-2007.
Rev A: 12-Feb-2008.   Clarified text, added throttle operator information, updated configuration information.
Rev B: 27-Feb-2012.   Updated to reflect software updates, clarified language, updated configuration information

Typical Schematic

The following page shows a typical schematic.
Details vary from installation to installation.
See the specific schematics for installation for details.

Typical Connections

Enclosure

Battery
12/24V
Starter
Alternator
Accessory Power

ECU
(Engine Control Unit)

P1 J1

			Typical Connections wire
Preheat Ind	a	a	Preheat Lamp — 18 AWG Tan
Battery+ (30)	B	B	Battery+ (30) — 12 AWG Red
Plug	c	C	Plug
Starter (50)	D	D	Starter (50) — 12 AWG Red/Blk
Ground (31)	E	E	Ground (31) — 14 AWG Black
CAN Shield	f	F	CAN Shield
Accesory (15)	G	G	ECU Power — 14 AWG Purple
Warning Lamp	h	h	Warning Lamp — 18 AWG Yellow/Org
Alternator Accy	j	j	Accessory (15) — 16 AWG Pink/Blk
Plug	k	k	Plug
Plug	l	l	Plug
Plug	m	m	Plug
Plug	n	n	Plug
Stop Lamp	p	p	Stop Lamp — 18 AWG Yellow/Red
Throttle Select	r	r	Throttle Select — 18 AWG Yellow (John Deere Only)
Sensor Return	s	s	Throttle Return — 18 AWG Yellow (John Deere Only)
Plug	t	t	Plug
CAN Low	u	u	CAN Low — 18 AWG Lt Green
CAN High	v	v	CAN High — 18 AWG Yellow
Throttle Up	w	w	Plug
Plug	x	x	Plug

123 18 AWG Tan
109 12 AWG Red
106 12 AWG Red/Blk
107 14 AWG Pink/Blk
114 14 AWG Black
115 14 AWG Pink/Blk
121 18 AWG Yellow/Org
116 16 AWG Pink/Blk
122 18 AWG Yellow/Red
117 18 AWG Yellow
118 18 AWG Yellow
R2 360Ω

CBL2 18 AWG Lt Green / 18 AWG Yellow

Keyswitch
KS1
J2 50, 15, 75, 83, 30
106 12 AWG Red/Blk
107 14 AWG Pink/Blk
109 12 AWG Red

CANplus™ Display
DSP1 J1
1 Power VB+
2 Power VB+
3 RS232 TX+
4 RS232 TX-
5 RS232 RX+
6 RS232 RX+
7 CAN Low
8 CAN High
9 RS485A
10 RS485B
11 Ext Alm (Opt)
12 N/C

101 18 AWG Black
102 18 AWG Pink/Blk
CBL1 18 AWG Lt Green / 18 AWG Yellow
104 18 AWG Yellow
105 18 AWG Lt Blue

CTL1 J5
1 Power
2 RS485B
3 RS485A
4 Ground
5 Spd Up
6 Spare Sw
7 Ground
8

108 18 AWG Pink/Blk
105 18 AWG Lt Blue
104 18 AWG Gray
110 18 AWG Black
111 18 AWG Yellow
112 18 AWG Yellow/Blk
113 18 AWG Black

Throttle Control
RS1 J6
8, 7, 3
J7
112 18 AWG Yellow/Blk
113 18 AWG Black
111 18 AWG Yellow
Throttle Switch

R1 J9
A A
B B
C C
120Ω
SP1 SP2 SP3 SP4

CBL3 18 AWG Yellow / 18 AWG Lt Green

LED Board (Optional)
CTL2 J10
1 Power
2 NC
3 Warning
4 Ground
5 Stop
6 Preheat

119 18 AWG Pink/Blk
121 18 AWG Yellow/Org
120 18 AWG Black
122 18 AWG Yellow/Red
123 18 AWG Tan

Tolerance (Unless Otherwise Noted)
Decimals	INCH	METRIC
0 (X)	N/A	±2 mm
1 (X.X)	±0.1 in	±1 mm
2 (X.XX)	±0.02 in	±0.02 mm
3 (X.XXX)	±0.005 in	N/A
Angle	±5°	

Software License Agreement

This LICENSE AGREEMENT ("Agreement") is made as of the Effective Date noted below by and between **LOFA™ Industries Inc.** ("LOFA"), a Georgia corporation with a principal place of business at 250 Hembree Park Drive, Suite 122, Roswell GA 30076, and Licensee as defined below.

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   (ii) This license is restricted to use with up to one (1) specific identified Licensee Devices; additional devices or products from Licensee require additional licenses.

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   (a) All title and ownership in and to the LOFA Software, LOFA trademarks, and the LOFA-supplied portions of items contained in this Agreement, including all intellectual property rights such as copyright, trade secrets, patents, trade-marks and service marks, shall at all times remain with LOFA and its licensors as appropriate. Should Licensee offer any warranties to third parties on behalf of the Licensee Devices, Licensee must be solely responsible for these warranties.

   (b) Licensee agrees that the techniques, algorithms, ideas, concepts, code, and processes contained in the Materials constitute LOFA's trade secrets and are subject to confidentiality protection. As such, Licensee agrees not to reverse engineer, disassemble or decompile, or otherwise attempt to derive the source code for, or perform cryptographic analysis upon, any Licensed Products to the extent this restriction is permitted by law. To the extent the following prohibition is permitted by law, Licensee is prohibited from creating any Licensee Devices which gives third party proprietary software direct access to any of the following items within the Licensed Products: (i) supported API(s); (ii) security and authentication functionalities; or, (iii) any undocumented internal functionality.

   Licensee agrees to take all reasonable measures to keep confidential the Materials, and protect LOFA's (and its licensor's) rights in the Materials (including, for purposes of this Section, additional hardware, software or information provided. Licensee agrees not to disclose the confidential portions of the Materials to anyone, or copy them, except as permitted under this Agreement.

   (c) Customization of a customer facing page does not grant ownership rights of software

   As used in this Section, the phrase "confidential portions of the Materials" specifically does not include the Runtime elements solely to the extent that such elements are distributed in accordance with this Agreement.

5. **Compliance with Laws.** Licensee must comply with all applicable export, import, or other relevant laws of any applicable jurisdiction. Determination of the applicable law is Licensee's responsibility. Licensee understands that the Licensed Product is cryptographic in nature and therefore the Materials are highly regulated. Licensee is strictly prohibited from exporting, re-exporting or importing the Materials (after initial delivery by LOFA to Licensee), regardless of method (including, for example and not by limitation by use of physical delivery, e-mail, or download from FTP or website, etc.), without first complying with all applicable government use, import, or export laws, rules, regulations, orders, and obtaining any necessary approvals or permits. Obtaining any necessary export or import approval for Licensee Devices and/or the Materials (after initial delivery of the Materials by LOFA to Licensee) is the sole responsibility of Licensee.

6. **Fees.** Licensee fees are referenced in the Purchase Order.

7. **Limited Warranty.** LOFA warrants for a period of thirty (30) days from the first date that it delivers to Licensee the Materials that (a) the Licensed Product(s) will operate in conformity with the material specifications for such item; (b) will be free from material defects; and (c) the media, if any, on which the Licensed Product is furnished will be free from material defects in materials and faulty workmanship under normal use. LOFA's sole liability and Licensee's exclusive remedy for any failure to meet these warranties will be limited to repair or replacement of the defective Materials at LOFA's option and expense.

8. **Warranty Disclaimer.** Except as provided in this Agreement, LOFA transfers the Materials to Licensee on an "as is" basis. The warranties in this Agreement, are in lieu of all other warranties or conditions, and LOFA makes no other warranty, condition or representation of any kind whether express or implied, and LOFA expressly disclaims the implied warranties or conditions of merchantability, merchantable quality, fitness for a particular purpose, infringement and those arising by statute or otherwise in law or from the course of dealing or usage of trade. LOFA does not represent or warrant that the Materials will meet any or all of Licensee's particular requirements, that the operation of the Materials will be error-free or uninterrupted, or that all programming errors in the Licensed Product can be found in order to be corrected. All warranties provided in in this Agreement are solely for the benefit of, and may not be transferred by, Licensee, to any third party.

   (a) **Limits on Scope of Indemnity.** LOFA will have no liability for any infringement arising from (i) the use of the Licensed Product other than as set forth in its accompanying documentation or specifications; (ii) the modification of the Licensed Product; or (iii) the combination or use of the Licensed Product with other software, hardware, items or processes to the extent such infringement is not foreseeable use of the Licensed Product. This Section states LOFA's entire obligation with respect to any claim regarding the intellectual property rights of any third party.

   (b) **Licensee Indemnification Obligation.** Licensee shall indemnify, defend and hold harmless LOFA, its directors, officers, and employees from and against any claim, demand, cause of action, loss, damage, liability suit, proceeding, judgment, or cost (including attorney fees), brought against LOFA which is based on the creation, use or distribution of Licensee Devices to the extent that such suit or proceeding does not arise or result from: (i) LOFA's material breach of any agreement, obligation, representation, warranty or covenant contained in this Agreement; (ii) any wrongful, negligent action or failure to act by LOFA, its employees, agents or independent contractors; or, (iii) any liability for which LOFA is obligated to indemnify Licensee under this Section.

Software License Agreement

9. **Term and Termination.**

   (a) <u>Term.</u> Unless otherwise specified in Exhibit A, the term of this Agreement will commence on the Effective Date and will continue into perpetuity unless otherwise terminated earlier under this Agreement.

   (b) <u>Termination for Cause.</u> Any of the following shall suffice to terminate this Agreement:

      (i) If Licensee materially breaches any term or condition of this Agreement and fails to cure that breach within thirty (30) days after receiving written notice of the breach.

      (ii) This Agreement will terminate automatically without notice and without further action by LOFA in the event Licensee becomes insolvent (i.e., becomes unable to pay its debts in the ordinary course of business as they come due), makes an assignment in violation of this Agreement or makes an assignment for the benefit of creditors or if any other bankruptcy proceedings are commenced by or against Licensee.

   (c) <u>Consequences.</u> Upon the termination of this Agreement for any reason: (i) all rights granted hereunder will automatically revert to LOFA; (ii) Licensee must (A) return to LOFA (or, at LOFA's option, destroy) the originals and all copies of the Materials in Licensee's possession or control; (B) erase any and all of the foregoing from all computer memories and stored Licensee Devices within its possession or control; and (C) provide LOFA with a written statement certifying that it has complied with the foregoing obligations. End use licenses to Licensee Devices for Customers granted by Licensee to Customers prior to termination will survive any such termination.

10. **Limitation of Liability.**

   (a) LICENSEE AGREES THAT ANY LIABILITY ON THE PART OF LOFA FOR BREACH OF THE WARRANTIES CONTAINED HEREIN OR ANY OF THE OTHER PROVISIONS OF THIS AGREEMENT OR ANY OTHER BREACH GIVING RISE TO LIABILITY OR IN ANY OTHER WAY ARISING OUT OF OR RELATED TO THIS AGREEMENT FOR ANY CAUSE OF ACTION WHATSOEVER AND REGARDLESS OF THE FORM OF ACTION (INCLUDING BREACH OF CONTRACT, STRICT LIABILITY, TORT INCLUDING NEGLIGENCE OR ANY OTHER LEGAL OR EQUITABLE THEORY), WILL BE LIMITED TO LICENSEE'S DIRECT DAMAGES IN AN AMOUNT NOT TO EXCEED THE TOTAL AMOUNT PAID TO LOFA BY LICENSEE FOR THE LOFA HARDWARE.

   (b) LICENSEE AGREE THAT IN NO EVENT WILL LOFA BE LIABLE FOR DAMAGES IN RESPECT OF INCIDENTAL, ORDINARY, PUNITIVE, EXEMPLARY, INDIRECT, SPECIAL, OR CONSEQUENTIAL DAMAGES EVEN IF LOFA HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES INCLUDING, BUT NOT LIMITED TO, BUSINESS INTERRUPTION, LOST BUSINESS REVENUE, LOST PROFITS, FAILURE TO REALIZE EXPECTED SAVINGS, ECONOMIC LOSS, LOSS OF DATA, LOSS OF BUSINESS OPPORTUNITY OR ANY CLAIM AGAINST LICENSEE BY ANY OTHER PARTY.

   (c) LICENSEE ACKNOWLEDGES THAT LOFA'S LIMITED LIABILITY EXPRESSED IN THIS AGREEMENT REPRESENTS A MATERIAL BASIS FOR SETTING THE FEES FOR LOFA HARDWARE.

11. **Use of Trademarks.**

   Any and all trademarks and trade names which LOFA uses in connection with the license granted hereunder ("LOFA Marks") are and remain the exclusive property of LOFA. Nothing contained in this Agreement may be deemed to give Licensee any right, title or interest in any LOFA Marks. Subject to notice from LOFA in writing which modifies or cancels such license at LOFA's sole discretion, during the continuance of this Agreement, LOFA hereby grants Licensee a nonexclusive, revocable license to the LOFA Marks for normal advertising, marketing and promotion of Licensee Devices according to guidelines that LOFA may issue from time to time. Licensee must act consistently with LOFA's ownership of the LOFA Marks and may not use LOFA Marks in a disparaging manner. Licensee agrees to use correct trademark notices on advertisements, sales literature, dealer materials, press releases and other marketing materials, which use or display LOFA Marks. Licensee agrees to provide samples of all Licensee's marketing materials and Licensee Devices containing LOFA Marks to LOFA for prior approval. If LOFA rejects any of Licensee's use of LOFA Marks, then the parties may cooperate reasonably in order modify such materials for approval prior to release or use by Licensee. To the extent that LOFA withdraws any portion of the trademark license granted in this subsection, Licensee's obligations under this Section, above, will also terminate if the rights necessary to comply with such obligation are withdrawn.

12. **Interpretation of This Agreement.** This Agreement is the entire Agreement to date between the parties regarding the Materials and supersedes any such prior agreement or communication. Any subsequent waiver or modification of this Agreement, or any part, shall only be effective if reduced to writing and signed by both parties. No delay or failure to enforce any right under this Agreement will be considered a waiver of a party's rights thereafter to enforce each and every right and provision of this Agreement. If any provision of this Agreement is declared by a court of competent jurisdiction to be invalid, illegal, or unenforceable, such provision will be severed from this Agreement and the other provisions will remain in full force and effect. This Agreement will be binding upon, and inure to the benefit of, the successors, heirs and assigns of the parties. Neither Licensee nor Licensee employees, consultants, contractors or agents are agents, employees or joint-venturers of LOFA, nor do they have any authority to bind LOFA by contract or otherwise to any obligation. Licensee agrees not to make any statements that state or imply that LOFA certifies or guarantees Licensee Devices or that Licensee Devices are warranted, tested or approved by LOFA. Dates and times by which either party is required to render performance will be postponed automatically to the extent and for the period of time that such party is prevented from meeting them by reason of any cause beyond its reasonable control. Unless otherwise specifically expressed in this Agreement, the specific business terms and negotiated customisations to this Agreement will be considered confidential ("Business Terms"), and neither party my disclose such information to third parties except as follows: (a) to employees, advisors, financing parties or contractors who are under an obligation of confidentiality to the extent reasonably necessary to conduct business; (b) to the extent that such Business Terms become publicly known through no fault of the parties; (c) to the extent required to comply with any valid law, regulation, statute, or order so long as the non-disclosing party receives reasonable advance notice of such potential disclosure; and (d) to the extent required to enforce, establish, or interpret any right or duty at law or equity with respect to this Agreement.

13. **General.**

   (a) All notices hereunder will be in writing and must be duly given if delivered personally or sent by registered or certified mail, return receipt requested, postage prepaid, to the respective addresses of the parties appearing in this Agreement. Any notice given will be deemed to be received: (i) on the date which it is delivered if delivered personally, (ii) or, if mailed, on the fifth business day next following the mailing thereof. Either party may change its address for notices by giving notice of such change as required in this clause.

   (b) This Agreement, the license rights granted hereunder and the Materials, or any part thereof, may not be assigned or transferred by Licensee, including by operation of law ("Transfer"), without the prior written consent of LOFA. Any such transfer without the prior written consent of LOFA will be ineffective. In any case, any such Transfer absent LOFA's written permission will immediately and automatically terminate this Agreement without further action by LOFA. A change of control of Licensee, whether by sale or issuance of shares (except in the ordinary course of raising capital by public offering), or merger, or otherwise, will be deemed to be an assignment.

   (c) The laws in force in the State of Georgia will govern this Agreement; the parties hereby consent to jurisdiction and venue in the courts of Georgia.

   (d) The provisions in Sections - Licensee's Indemnification, - Ownership, Protection, –Fees - Limited Warranty, - Warranty Disclaimer, -Indemnification, -Term and Termination, Limitation of Liability, - Interpretation of Agreement, and -General (inclusive), remain in force and effect after the termination of this Agreement.

Special License Terms

THE LICENSE GRANTED HEREUNDER IS RESTRICTED SOLELY TO THE OPERATION OF THE LOFA HARDWARE AND FOR NO OTHER PURPOSE. NO SUCH LICENSEE DEVICE INCORPORATING ANY OF THE MATERIALS MAY BE DISTRIBUTED, LICENSED, SOLD, RENTED, OR OTHERWISE PROVIDED TO THIRD PARTIES WITHOUT LOFA'S EXPRESS WRITTEN PERMISSION.

Exhibit B – PRODUCTS/DELIVERABLES

Licensed Product Information

Software codes with product numeric values equal to 001-xxxx-yyyy-zzz; where xxxx, yyyy, and zzz equal (0000...9999).

Software codes qualified under the same numeric regimen detailed above or including the verbal description of "CANPlus™" products and/or the "CANPlus Suite" of products.

Maintenance and Technical

Platform Requirements

   .NET Framework 3.5

Windows® XP, Windows Vista (32/64-bit), Windows 7 (32/64-bit)

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