

# LOFA EM500 Operation and Troubleshooting

## Introduction

This document provides general information on LOFA Industries EM500 control systems operation and troubleshooting. The EM500 allows the operator to see the electronically governed diesel engine status at a glance featuring LOFA's powerful First Fault Diagnostics (FFD). After the ECU (Engine Control Unit) pinpoints a failure, FFD stores it in memory and alerts the end user via a single bright LED. FFD directly monitors battery charge and, if reported by the ECU, low oil pressure, high temperature, coolant level, fuel pressure and diagnostic blink code. The microprocessor-based solid-state design uses high power semiconductors instead of outdated electromechanical relays to ensure reliable high current switching.

## Note

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

All engine state information and diagnostic codes displayed by the EM500 are provided by the ECU.

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The EM500's integral throttle control requests the ECU adjust the engine speed via voltage (potentiometer simulation), Pulse Width Modulation (PWM) or CANbus. A single momentary toggle switch adjusts the throttle speed request within the configurable engine speed limits. When teamed with LOFA Auto Start/Stop controls, the EM500's flexible throttle control and configurable throttle ramp time makes an ideal automatic start/stop control system. Alternately, the EM500 can be programmed to operate in dual speed mode via a toggle switch or external input.

Standard VDO Cockpit International analog gauges display current operating parameters reported by the ECU, including RPM, engine temperature and oil pressure. Additional gauges can be installed for other measurements. With the addition of the optional Diagnostic Program Gauge (DPG), virtually any SAE J1939 parameter or diagnostic code can be monitored.

The DPG features a backlit LCD display with three push buttons in a 2" gauge. Additionally, three bright LEDs indicate Preheat, Service Due and Auxiliary input. The LCD is clearly readable in both bright sunlight as well as total darkness. The DPG allows each system to be field configured to suit the customer's unique requirements. After initial configuration, the DPG can be removed in cost sensitive applications.

Some of the EM500 configurable features include:

- Engine brand (Caterpillar, Deutz, John Deere, Perkins, etc.)
- Throttle type (Voltage, PWM or CANbus)
- High idle speed
- Throttle ramp time
- Charge indication mode (lamp input or system voltage)

The standard system terminates to a sealed Deutsch weatherproof plug. This wiring solution offers a robust connection that performs well in harsh environments and allows simplified installation. The design allows efficiently installing custom plug-and-play engine wiring harnesses as well as standard harness extensions.

## **Warning**

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When replacement parts are required, LOFA Industries recommends using replacement parts supplied by LOFA or parts with equivalent specifications.

Failure to heed this warning can lead to premature failure, product damage, personal injury or death.

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## ***Important Safety Information***

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The warnings in this publication are not all inclusive.

LOFA Industries cannot anticipate every potential hazard.

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

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

Only persons with appropriate training, skills and tools should perform these functions.

Improper operation, maintenance or repair of this product can be dangerous and may result in injury or death.

Do not operate or perform any maintenance or repair on this product until all operation, maintenance and repair information is read and understood.

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.

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## Operation

Turning the control system key to the run position starts a self-test which causes all LEDs to illuminate once, the analog gauges (temperature and pressure) to calibrate and energizes the ECU. After self-test, the LEDs indicate the state of the faults they monitor. The normal indication before starting is battery charge in most applications. If the LED is not illuminated at this time it may indicate the inputs are not properly connected.

If the ECU is preheating when the key switch is turned to the run position, the Preheat LED is illuminated. Preheat time varies with atmospheric and engine conditions. After waiting for the Preheat LED to extinguish, the engine is cranked by turning and holding the key switch in the start position until the engine starts.

### Note

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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.

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The key switch is spring loaded to return automatically to the run position when released.

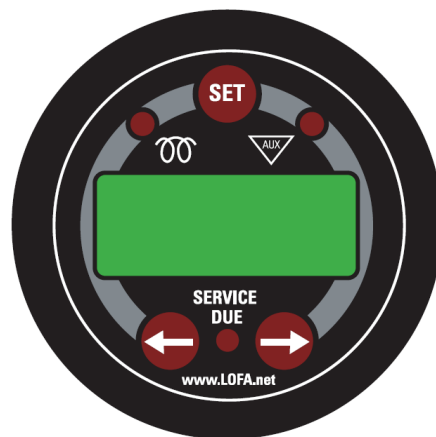
### Note

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The key switch is equipped with a mechanical start locking device. An attempt to re-crank the engine can only be made by turning the key switch to the off position to reset the start locking mechanism.

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## DPG



The DPG features a backlit LCD display with three push buttons in a 2" gauge. Additionally, three bright LEDs indicate Preheat, Service Due and Auxiliary input. The LCD is clearly readable in both bright sunlight as well as total darkness. The DPG allows each system to be field configured to suit the customer's unique requirements. After initial configuration, the DPG can be removed in cost sensitive applications.

When the EM500 powers up the DPG displays a message identifying the hardware version.

LOFA Ind  
HW Rev 0

The differences in hardware primarily affect panel wiring.

After a delay a second message is displayed that identifies the software version installed.

```
SW v1.26
08.11.05
```

The software version affects the features that are available and the display of some items.

**Note**

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The example displays in this manual are from Software Version 1.26.  
Different software versions may have slightly different displays.

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After a delay the display indicates the engine hours are loading and then the ECU reported engine hours.

```
Eng Hrs      After the ECU      Eng Hrs
Loading      responds           610.7h
```

From the Engine Hours (Eng Hours) display, the arrow keys allow switching to view J1939 values (View Values), J1939 faults (View Faults) and back to Engine Hours (Eng Hours).

```
Eng Hrs      →      View      →      View
 610.7h     ←      Values     ←      Faults
      →                                ←
```

**View Values**

Pressing the **SET** button when **View Values** is shown in the display allows viewing the ECU provided J1939 values. A typical fault display is shown

```
Oil Pres
49 psi
```

Pressing either arrow key allows scrolling to the next value. When the last available value is displayed the list loops back around.

The available parameters are Oil Pres, Oil Lvl, Oil Temp, CoolTemp, FuelTemp, FuelRate, FuelPres, Bat Volt, Eng RPM, Set RPM, Load@RPM and Eng Hrs.

**Note**

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Not all parameters are provided by all ECUs.  
If the ECU does not support a value the display shows

```
Oil Lvl
Not Used
```

When all values display **Not Used** the CANbus connection between the panel and ECU has failed.

See **Testing CANbus** to diagnose and repair this problem.

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Set RPM is the RPM the EM500 is requesting from the ECU. All other values are provided by the ECU.

Pressing **SET** while viewing values returns to the **View Values** display.

### **View Faults**

Pressing the **SET** button when **View Faults** is shown in the display allows viewing the ECU provided J1939 faults. When no faults are active the display shows

```
No
Faults
```

A typical fault display is shown

```
SPN  91
FMI   3
```

See the **Diagnostic Codes** section to understand J1939 diagnostic codes. Pressing either arrow key allows scrolling to the next value.

When the last available value is displayed the display shows

```
Last
Fault
```

Press the left arrow to scroll to previous faults or press **SET** to return to the **View Faults** display.

### **View Stored**

Some ECUs support viewing stored faults. Pressing the **SET** button when **View Stored** is shown in the display allows viewing the ECU provided J1939 faults. Pressing either arrow key allows scrolling to the next value. A typical fault display is shown below.

```
SPN  91
FMI   3
```

See the **Diagnostic Codes** section to understand J1939 diagnostic codes.

## **Indicators**



### **Battery LED (Red)**

A solidly illuminated Battery LED indicates a battery charge failure. A battery charge failure may be caused by a faulty alternator, broken drive belt or the alternator not excited. A battery voltage reading of approximately 14 volts on a 12 volt system (28 volts on a 24 volt system) while the engine is running indicates the battery is charging properly. Irregular blinking of the Battery LED may indicate a failing charge circuit. The system can be configured for indication via charge lamp (D+) circuit of the alternator or battery voltage as reported by the ECU.

 **Oil Pressure LED (Red)**

A blinking **Oil Pressure** LED indicates low oil pressure warning reported by the ECU. A solidly illuminated LED indicates the ECU is reporting oil pressure failure.

**Note**

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ECU programming determines the response to warnings and failures.  
Typically the ECU can be programmed to shutdown, derate or run to failure.  
The EM500 only displays ECU reported conditions.

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**Warning**

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Low oil pressure is not an indication of low oil level.

For best possible protection LOFA recommends using  
our solid-state oil level shutdown switch.

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 **Temperature LED (Red)**

A blinking **Temperature** LED indicates high temperature warning reported by the ECU. A solidly illuminated LED indicates the ECU is reporting high temperature failure.

**Note**

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ECU programming determines the response to warnings and failures.  
Typically the ECU can be programmed to shutdown, derate or run to failure.  
The EM500 only displays ECU reported conditions.

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**Warning**

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If the temperature sensor is not in contact with coolant due to  
coolant loss the engine is not protected from overheating.

For best possible protection, LOFA recommends using  
our solid-state coolant level shutdown switch.

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**WATER Coolant Level LED (Red)**

A blinking **Coolant Level** LED indicates a low coolant level warning reported by the ECU. A solidly illuminated LED indicates the ECU is reporting low coolant level failure.

**Note**

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ECU programming determines the response to warnings and failures.  
Typically the ECU can be programmed to shutdown, derate or run to failure.  
Coolant level monitoring is not supported by all engine configurations.  
The EM500 only displays ECU reported conditions.

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### **PSI Fuel PSI LED (Red)**

A blinking *Fuel PSI* LED indicates a fuel pressure warning reported by the ECU. A solidly illuminated LED indicates the ECU is reporting fuel pressure failure.

#### **Note**

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ECU programming determines the response to warnings and failures. Typically the ECU can be programmed to shutdown, derate or run to failure. Fuel pressure monitoring is not supported by all engine configurations. The EM500 only displays ECU reported conditions.

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### **Fault Code LED (Red)**

The *Fault Code* LED displays the blink code as provided by the ECU. Simple diagnostics are provided via a pattern of fast and slow blinks by some ECUs to identify a general error. There is no standard definition of blink codes. Some ECUs only generate blink codes when an input is received. Refer to ECU documentation for correct interpretation of blink codes.

#### **Note**

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Blink codes are not supported by all ECUs. The EM500 only displays ECU reported conditions.

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### **Preheat LED (On DPG)**

A solidly illuminated *Preheat* LED is the system preheat indication. When the LED extinguishes the preheat period is complete and the engine may be cranked.

#### **Note**

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The EM500 only reports when the ECU is requesting preheat. Cold starting aids are not installed in all engine configurations.

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### **Service Due LED (On DPG)**

The *Service Due* LED is illuminated when the ECU output is active. Refer to ECU documentation for service interval and resetting information.

#### **Note**

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Service due indication is not available in all ECUs.

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### **Auxiliary LED (On DPG)**

The *Auxiliary* LED is not currently used.

## Gauges

### Voltmeter

The voltmeter is connected to the key switch accessory terminal. A battery voltage reading of approximately 14 volts on a 12 volt system (28 volts on a 24 volt system) while the engine is running indicates the battery is charging properly.

#### Note

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Failure of panel gauges to read correct values and/or the DPG to display

### Eng Hours Loading

indicates the CANbus connection between the panel and ECU has failed.  
See the troubleshooting section to diagnose and repair this error.

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### Tachometer

The tachometer indicates engine RPM using a frequency signal derived from the ECU. The tachometer is factory calibrated to correctly indicate the engine speed reported by the ECU.

### Oil Pressure Gauge

The oil pressure gauge indicates engine oil pressure derived from the ECU. The oil pressure gauge calibrates each time the panel is energized.

#### Warning

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Low oil pressure is an indication of engine wear, not an accurate indication of low oil level.

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### Coolant Temperature Gauge

The temperature gauge indicates engine coolant temperature derived from the ECU. The temperature gauge calibrates each time the panel is energized.

#### Warning

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If the temperature sensor is not in contact with coolant due to coolant loss  
the gauge will not accurately indicate engine temperature.

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### Additional Gauges

Additional gauges can be added by removing blind covers and installing the gauge. Power connection to the key switch accessory terminal is provided but sender wiring is typically installed by the panel installer.

#### Note

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The EM500 provides constant 12V supply for primary gauges  
(Tachometer, Coolant Temperature and Oil Pressure) even on 24V systems.  
Additional gauges are powered by battery power.

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#### Warning

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Connecting battery power to the gauge power supply will damage the controller board.

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## **Harness**

### ***Sealed Connectors***

The provided Deutsch sealed weather-proof plug includes a grey locking device which must be released to separate the connectors. Press the tab on the connector housing to release the connectors.

#### **Warning**

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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.

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### ***Unsealed Connectors***

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

#### **Warning**

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

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### ***Harness Routing***

The minimum routing of 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.

## **Battery Circuit Requirements**

### ***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 a 15 Amp fuse (12 V or 24 V systems).

Protection for the unswitched battery positive circuit is dependent on specific equipment configuration. The overload protection should not exceed 125% of the sum of all output currents plus 5 Amps for the control system. Powering the control system through dedicated circuits with appropriate overload protection reduces the possibility of system damage.

Circuit breakers are preferred over in-line fuses for circuit protection. Over current protection devices should ideally be located in a central location. If automatic reset circuit breakers are used, consideration of the environment of the breaker is critical and may affect the trip point. The trip point of some circuit breakers can be significantly reduced below the rated trip point if the circuit breaker is exposed to high temperatures.

### **Warning**

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Disconnecting the battery while the engine is running may damage electrical components.

When using a battery disconnect switch, LOFA recommends using a 2 pole switch to disconnect both the battery and alternator output.

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### ***Battery Negative Connection (Grounding)***

### **Warning**

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Improper grounding can cause electrical noise, unreliable operation and may damage the control system or other components. All ground connections must be free from foreign materials, including paint, which may interfere with proper grounding.

A reliable ground must be provided for the control system.  
LOFA recommends the ground connection be made directly to the battery negative.  
Grounding through frame members is not recommended.

All ground paths must be capable of carrying any likely fault currents.

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.

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### **Note**

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

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### ***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 key

switch to off and back to run without starting the engine. Voltage drops can be caused by transients from external equipment, improper wire sizes, faulty wiring or nearby lightning strikes.

## Suppression of Voltage Transients (Spikes)

### Warning

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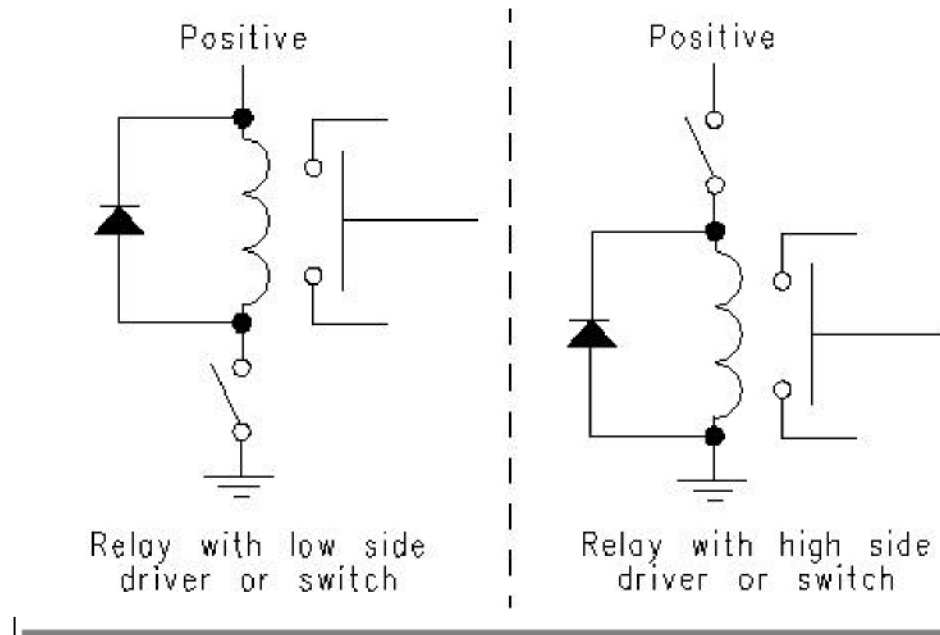
The installation of voltage transient suppression at the transient source is required.

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LOFA follows SAE recommended electrical environment practices.

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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.

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

### **Warning**

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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.

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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.

## 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 <b>Control System Troubleshooting</b> below)
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 (below)
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 DPG 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 185° F/85° C)
Voltage transients (spikes)	Add suppressor diodes, protect from nearby lightening strikes, shield induced spikes from other equipment, add electric motor control relay
Defective control system	See Control System Troubleshooting (below)

### 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 DPG or ECU diagnostic tool to view fault codes.

All engine state information and diagnostic codes displayed by the EM500 are provided by the ECU.

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)

## Preheat Troubleshooting

### 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

## Control System Troubleshooting

### Note

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

All engine state information and diagnostic codes displayed by the EM500 are provided by the ECU.

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

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### 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 above)
Faulty control system	Repair or replace control system

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

Possible Cause	Possible Remedy
Only Battery LED illuminated	Correct battery charge failure (see Battery not charging above)
Only Oil Pressure LED Illuminated	Correct low oil pressure condition, use ECU diagnostics
Only Temperature LED Illuminated	Correct overheating condition, use ECU diagnostics
Only Aux LED Illuminated	Correct fault condition (i.e. coolant level) , use ECU diagnostics
All LEDs illuminate for one second (control system reset)	Add suppressor diodes, protect from nearby lightening strikes, shield induced spikes from other equipment, add electric motor control relay

## 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 EM500 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 EM500 can not display ECU parameters such as engine hours, oil pressure and diagnostic codes. This test procedure helps identify the problem location.

1. Disconnect the battery.

### Warning

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This test should be completed with the battery disconnected!

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

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2. Identify the engine diagnostic plug. Connect an ohmmeter across the CANbus pins of the diagnostic plug.
3. A reading of 120  $\Omega$  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 120  $\Omega$  indicates the bus to the terminator in the panel is complete and the problem is on the harness between the panel and the engine terminator.
  - b. An open circuit ohmmeter reading indicates the bus to the engine terminator is complete and the problem is between the panel and engine harness.
4. A reading of 60 $\Omega$  indicates both end of the bus are terminated and the bus is intact.
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 Codes

ECUs typically report faults via Suspect Parameter Number (SPN) and Fault Mode Indicator (FMI) pair. The SPN indicates the fault and the FMI identifies the precise fault.

### Typical SPNs

Standard SPN codes are defined by SAE J1939-71. Not all standard codes are provided by ECUs. In addition manufacturers may add additional SPN codes. Refer to ECU documentation for complete list of SPN codes.

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 correct interpretation of FMI codes.

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

## **Blink Codes**

Simple diagnostics are sometime provided via a pattern of fast and slow blinks that identify a general error. The Diagnostic Code LED displays the blink code as provided by the ECU. There is no standard definition of blink codes. Refer to ECU documentation for correct interpretation of blink codes.

## **Software Revision History**

### **1.09**

- Until engine hours are reported display `Hours Loading`
- Request engine hours again if no response within 60 seconds (John Deere issue)

### **1.15**

- Bug fixes and enhancements for John Deere and Perkins
- Changed `CODE` entry so left arrow counts down 0, 9, 8, etc.
- Fixed stored error retrieval
- Removed error count from fault menu (shows `Last Fault` after last)
- Changed engine hours message to `Getting Data` if no hours reported

### **1.17**

- Corrected tachometer output to ignore invalid RPM messages

### **1.18**

- `View Stored` removed for CAT Engine
- Maximum valid values for SPNs implemented per J1939
  - `Engine RPM` (SPN 190)
  - `Oil Temp` (SPN 175)
  - `Fuel Rate` (SPN 183)

### **1.19**

- All errors displayed when the SPN is same but FMI differs
- D+ current is on for 60s
- Added `Load@RPM` (SPN513-Actual Engine Percent Torque)
- SPN value checking per SAE J1939
- Removed `Max Operate RPM`
- Removed `Cooldown RPM`
- `View Stored` only if engine RPM is zero
- Added DPG LED power on test
- Added `Reset Settings`
- At switch off DPG is cleared and backlight extinguished
- `View Stored` errors display corrected

### **1.22**

- Engine hours requested every 1 second
- D+ current always on
- Fixed `Reset Settings` bug

### **1.24**

- Memorize Operate RPM by grounding both RPM+ and RPM- for 3 seconds (LEDs blink 3 times to verify)
- Grounding Aux Input for 3 seconds shuts down ECU
- Added Daimler engine type

### **1.26**

- Minimum functional ramp up and down time is 1 second
- Ramp up/down time greater than 5 minutes is fixed
- RPM changes every 100ms during ramp
- RPM-step for reduced to 20 RPM (was 40)
- Default ramp up/down time is 5 seconds
- G/S input reduces the engine rpm to programmed operating rpm if above operate RPM

### **1.30**

- New menu item Message Mode for Deutz
- New menu item TSC1 Priority (3 is default, 8 is off)
- View Values that are not available from the ECU are skipped (jumps to next value)
- Fixed SPN639 error for Perkins engine
- Added values
  - Boost Pressure (SPN 102)
  - Manifold Temp (SPN 105)
  - Turbo Oil Temp (SPN 176)
  - Intraool Temp (SPN 52)
  - Actual Torque (SPN 513)
  - Pedal Position (SPN 91)
  - Trans Oil Level (SPN 124)
  - TransDif Pressure (SPN 126)
  - Trans Oil Pressure (SPN 127)
  - Trans Oil Temp (SPN177)

### **1.31**

- Switch on with G/S grounded starts at minimum RPM (was 0 RPM)

### **1.31b**

- Fixed Aux shutdown bug

## **Document Revision Information**

Initial Release: 22-May-2006.

Revision A: 25-May-2006. Fixed typographic errors. Removed text about reset causing a shutdown.

Revision B: 27-Oct-2006. Fixed typographic errors, added DPG information.

Revision C: 28-Feb-2007. Fixed typographic errors, added software revision history, part number.

## **Typical Schematic**

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

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# 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.

## Standard Terms and Conditions

1. **Definitions.** In this Agreement, unless the context otherwise requires, the following terms shall have the following meanings:
  - (a) **Agreement** shall mean this agreement (as such may be amended from time to time in accordance with the provisions hereof), information sheets and any exhibits, attachments or schedules referenced herein.
  - (b) **LOFA Notices** shall mean all proprietary trademark, patent and copyright notices present in the Materials.
  - (c) **Effective Date** shall mean the date Licensee purchases LOFA hardware and/or software.
  - (d) **Host Device** shall mean the product or device that hosts LOFA software.
  - (e) **New Releases** means material improvements or changes to the LOFA Software that may enhance operating performance. A New Release is signified by an increase in the release number to the left of the first decimal.
  - (f) **Information Sheets** shall mean the attached exhibits which contain specific license terms.
  - (g) **LOFA Software** shall mean a hardware and/or software item listed in **Exhibit B – Products/Deliverables**.
  - (h) **Licensee Device** shall mean the specific LOFA hardware created by or for Licensee combining the LOFA software with the Host Device as identified in **Exhibit A**.
  - (i) **Materials** shall mean all hardware and/or software products and special documentation listed in **Exhibit B – Products/Deliverables**, as well as any standard documentation distributed along with such products.
  - (j) **Runtime** means those portions of the Licensed Products specifically designated as 'runtime' including libraries and sample code.
  - (k) **End User** shall mean the end user of the Licensee Devices.
  - (l) **New Releases and Updates** LOFA may, in its sole discretion, develop any New Releases to LOFA Software; however, LOFA has no obligation to develop, sell, or support New Releases.

## Acceptance of Terms of this Agreement

In order to use the LOFA software referenced herein, you must first agree to the provisions of this Agreement. Use of LOFA software is prohibited without acceptance of all the terms in the Agreement.

## 2. License.

Subject to applicable government export regulations, LOFA grants Licensee a world-wide, non-exclusive, non-transferable, perpetual license subject to limitations as defined below to use, LOFA Software solely for use in the Licensee Device. No such Licensee Device(s) incorporating any of the Materials may be distributed, licensed, sold, rented, or otherwise provided to third parties without the express written permission by LOFA.

## 3. License Restrictions and Conditions.

- Licensee agrees to the following:
- (a) No distribution of licensee devices incorporating the materials without express written permission.
  - (b) This license is restricted to use with up to one (1) specific identified Licensee Devices; additional devices or products from Licensee require additional licenses.

## 4. Ownership, Trade Secrets, Protection.

- (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 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

# Software License Agreement

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.

## 9. **Term and Termination.**

- (a) **Term.** 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) **Termination for Cause.** 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) **Consequences.** 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 may 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.

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- (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 A**

Licensee Information not required

## **Exhibit B – PRODUCTS/DELIVERABLES**

### **Licensed Product Information**

Software codes with product numeric prefixes of 001 through 009 inclusive.

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)