Product Specification,
NGI Light Bar
Message Center

072-40346 WORKING DRAFT 10

WORKING DRAFT 10
(NOT RELEASED)

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072-40346 Revision Table

REVISION	DATE	DESCRIPTION OF CHANGE
4	11/04/04	Working Draft 4
6	03/17/05	Working Draft 6 - Updates
7-8	05/02/05	Working Draft 7-8 - Bob's additions
9	09/01/06	Shelly's review copy
10	10/19/06	Changes and additions

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1 Introduction

1.1 Purpose and Scope

This document describes the design features of the Light Bar Message Center (LMC). Functional, operational, physical, electrical, and environmental specifications are included.

1.2 How to Use This Specification

Chapter 1, Introduction - Terms, abbreviations, references, etc. used in this document.

Chapter 2, Functional Specification - This chapter describes the LMC's capabilities and functions.

Chapter 3, Message Center Operation - Describes how to use the Message Center.

Chapter 4, Installation

Chapter 5, Electrical Specifications

Chapter 6, Environmental and Reliability Specifications

1.3 Reference Documents

1.3.1 Test Specifications

SAE J1113/1, Version 1995-07, *Electromagnetic Compatibility Measurement Procedures and Limits for Vehicle Components*

SAE J1113/21, Version 1994-10, *Immunity to Electromagnetic Fields, 10 KHz to 18 GHz, Absorber-Lined Chamber*

SAE J1113/41, Version 1995-07, *Limits and Measurement of Radio Disturbance Characteristics of Components and Modules for the Protection of Receivers Used On-Board Vehicles*

SAE J1399, Version 1984-06, *Electric Tachometer Specification*

SAE J1455, Version 1994-08, *Recommended Environmental Practices for Electronic Equipment Design (Heavy Duty Trucks)*

SAE J1812, Version 1996-10, *Functional Performance Status Classification for EMC Immunity Testing*

AMETEK Dixson 079-14193, *AMETEK Dixson Test Specification, Heavy Vehicle*

1.3.2 Interface Specifications

SAE J1939 - *Recommended Practice for a Serial Control and Communications Vehicle Network*

1.4 Regulatory Agencies

Federal Motor Vehicle Safety Standards (FMVSS)

1.5 Abbreviations and Definitions of Terms Used in This Document

- **Buzzer** - A device that provides audible feedback to the user
- **ECU** - *Electronic Control Unit*, a status and control device designed to oversee the operation of a particular vehicular subsystem such as the engine, transmission, emissions, air conditioning, anti-skid brake system, etc.
- **Ground** - Any point that is referenced to the battery ground terminal. This may be a stud provided near the instrumentation for this purpose or an unpainted hardware surface (nut, bolt, chassis, etc.) behind the dash.
- **LC** - *Liquid Crystal*, as in LC display
- **LCD** - *Liquid Crystal Display*
- **LED** - *Light-Emitting Diode*. All light sources in the LMC System are LEDs.
- **LMC** - *Light Bar Message Center*
- **NGI** - *Next Generation Instrumentation*
- **NGI Bus** - An internal and proprietary communications bus used to send power, ground, and data from the LMC to gauges and displays
- **Panel** - Panel and bezel in which the modules are mounted
- **Vehicle Data Bus** - A pair of wires that is connected to various parts of the vehicle and that allows those parts to communicate with each other
- ⇓ - The “Down” switch on the light bar
- ⇒ - The “Right” switch on the light bar

2 Functional Specification

The LMC oversees the operation of the entire instrumentation system. It contains the following:

- Vehicle data bus input/output receivers and drivers
- NGI Bus
- Internal power regulators and backlight control
- Seven analog inputs, eleven switched inputs, and two switched outputs
- Two pushbutton switches
- An audible annunciator
- Eighteen telltales
- System initialization and diagnostics
- Message Center

Responding to messages on the vehicle data bus and to discrete inputs, the LMC drives the telltales, Message Center, and any connected NGI gauge appropriately. In addition to vehicle data bus inputs, the LMC accepts analog and switch inputs to display temperature, pressure, fluid levels, and switch-sensed conditions.

2.1 Description

The following sections refer to Figure 2-1.

2.1.1 Vehicle Data Bus Input/Output

The vehicle data bus is a two-wire bus located in the vehicle. It is used by the electronic control units (ECUs) connected to it to send and receive information such as speed, distance, current engine conditions, and other data. The LMC is connected to the vehicle data bus and uses data from it to drive NGI modules.

The LMC complies with SAE J1587 and/or SAE J1939 specifications.

2.1.2 NGI Bus Driver

The NGI bus is a pair of wires that originates at the LMC; it carries data from the LMC to the NGI modules through NGI cable assemblies. The NGI bus is brought outside the LMC housing on two six-pin connectors that are wired in parallel.

Caution: The NGI bus is a proprietary data bus designed to control NGI modules. It is not designed to control or power non-NGI modules devices. Doing so can adversely affect the operation of the NGI System, reduce its reliability, or cause permanent damage to the system.

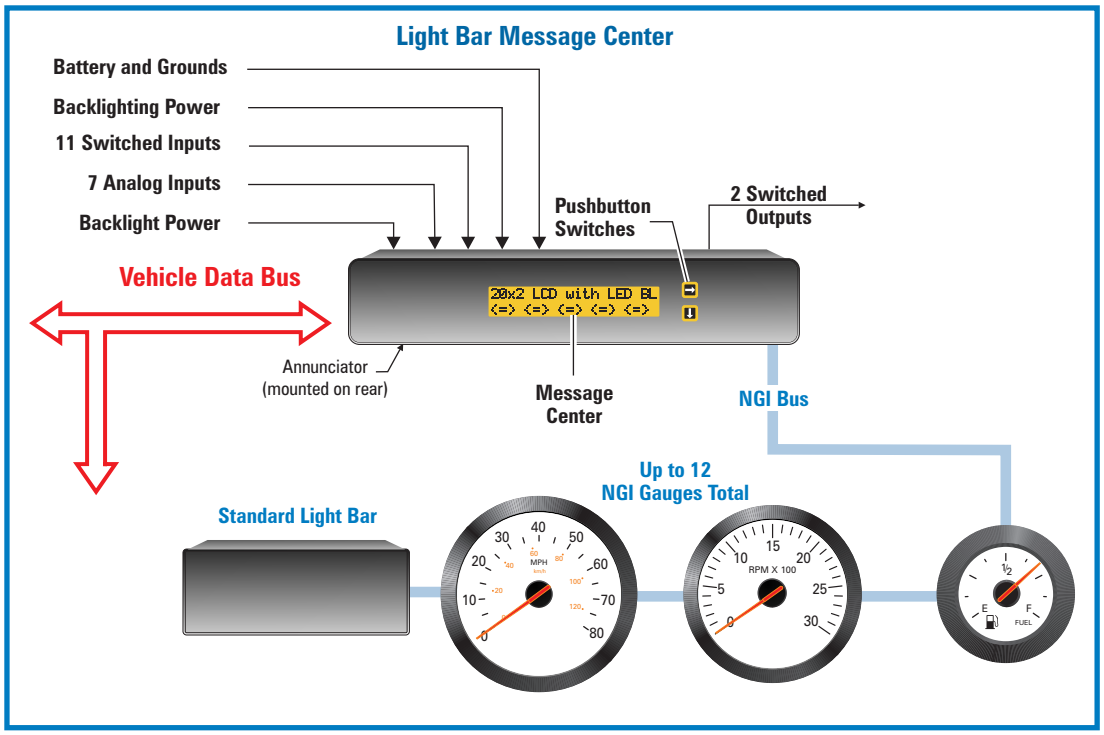

Figure 2-1 *LMC Block Diagram*

The LMC can support up to 12 NGI gauges through the NGI Bus. In the case of multiple display gauges, each pointer counts as one gauge. Thus, for example, the NGI Bus can support two 4-in-1 gauges, one 3-in-1 gauge, and one single-display gauge.

Standard, 16-telltale NGI light bars can also be connected to the NGI Bus, but doing so will decrease the total number of gauges that can be supported. Please call AMETEK for more information.

2.1.3 Internal Power Regulators

The LMC power inputs are:

- Battery +
- Ignition (Battery + available when the ignition is on)
- Ground
- Backlighting power source and ground

The LMC filters out transients (see Table 5-3 on page 5-3) on these lines and generates regulated DC voltages for internal and NGI Bus use. An internal switching regulator provides power to the Message Center, telltales, and gauges.

2.1.4 Backlight Control

The backlighting for the gauges and the Message Center is controlled by the dashlight dimmer control as follows:

- If the backlight voltage input falls below 10 percent of the battery voltage, the LMC will turn the gauge backlighting off and the Message Center backlighting to maximum intensity (daylight conditions).
- As the backlight input level increases to 100 percent of battery voltage, the LMC will increase the gauge and Message Center backlighting minimum to maximum intensity.
- If the backlight voltage input rises above 10 percent of the battery voltage, the LMC will turn the gauge backlighting to minimum brightness and the Message Center backlighting to minimum intensity.

2.1.5 Analog Inputs

The LMC accepts up to seven analog inputs. These are inputs from temperature, pressure, and fluid level sensors whose outputs vary continuously as a function of the monitored parameter. Valid inputs range from zero to 6,400 ohms. Reduced ranges, offset ranges, and input linearization can be configured by the factory to meet most any need below 6,400 ohms. Please consult AMETEK for application assistance.

Valid input ranges:

- **Resistance** - zero to 6,400 ohms
- **Voltage** - ???

The customer specifies the input voltage or resistance for each analog input.

2.1.6 Switched Inputs

The LMC accepts 11 switched inputs, all configured at the factory to customer specifications. Each one can be either Active High or Active Low, and each can be configured to control any of the telltales. Please consult AMETEK for application assistance.

- Active High - pulled up?
- Active Low - Grounded (voltage threshold?)

2.1.7 Switched Outputs

The LMC provides two outputs. When active, each can sink up to XX mA.

2.1.8 Audible Annunciator

The LMC contains an audible annunciator that can be used to alert the driver of a condition that requires his attention (low air or oil pressure, overheating, etc.)

The annunciator is a software-driven, miniature piezo-electric device with a pitch of 2 kilohertz. Its emitted sound level is 85 dB minimum when measured 10 cm from the rear of the LMC housing.

2.1.8.1 Annunciator Options

The annunciator's on- and off-times are controlled by the LMC; the following parameters can be customized at the factory if specified at time of order:

- **Custom Buzzer Events** - For example, a headlight-on reminder, or buzzer test during power-up initialization
- **On-Off Duration and Timing** - Duty cycle, pattern, repetition rate

2.1.9 Pushbutton Switches

The LMC contains two illuminated pushbutton switches with tactile feedback. Among other things, the switches let the user:

- Select displays
- Acknowledge messages
- Scroll through diagnostic messages
- Perform diagnostic tests
- Reset the trip odometers
- Configure and set display options

Throughout this specification, the switch with the right-pointing arrow (⇒) is called the "Right switch", and the switch with the down-pointing arrow (⇓) is called the "Down switch". The LMC monitors the switch positions and can detect not only that a switch is being pressed, but the duration of the press as well.

2.1.10 Telltales

The LMC contains 18 telltales, each illuminated by a red, green, amber, blue, or white LED. Each time the ignition is switched on, all telltales turn on for three seconds and then indicate the actual state of their respective inputs.

All telltales turn off promptly and without fade. A light baffle prevents light spill-over to adjacent telltales.

2.1.10.1 Telltale Brightness Control

Normally the telltales light at maximum brightness; however, their brightness can be varied by the dimmer control if desired. This feature can be enabled if specified by the customer at time of order. The turn signal and high beam indicator brightness can be controlled independent of the other telltales.

2.1.10.2 Activation

Each telltale can be activated as follows:

- **Directly Switched Input** - The input goes directly to the telltale and is not modified by the LMC. When the input is active, the telltale is on and vice versa.
- **LMC-Modified Input** - A discrete analog or switched input that the LMC modifies in some way.

  One example of this is a "Low Fuel Level" telltale. When the analog input from the fuel level sensor reaches a predetermined value (usually when the fuel level drops to 1/8 tank), the LMC turns on the telltale.

  In another example, the LMC monitors a switched input and applies hysteresis to it to eliminate the effects of fuel or water slosh.

  A third example is based on an internal timing function. For example, the SCU can turn a seatbelt icon on each time the ignition is switched on and automatically turn it off some predetermined number of seconds later.
- **Data Bus Messages** - The LMC turns a telltale on and off based on messages it receives from the vehicle data bus. Examples of this are low oil pressure and high coolant temperature.
- Based on a combination of the preceding.

The customer specifies the following for each telltale:

- **Position, Color, and Symbol Design** - The symbol can be specified by the customer, ISO 7000, or other published standard.
- **Activation Method** - Directly switched, LMC-modified, data bus message, or combination
- **Active State** - Low or high
- **System Initialization Pattern** - How the telltales appear when the ignition key is turned on (i.e., all at once, alternating checkerboard pattern, marquee, etc.)
- **Brightness Control**

2.1.11 Message Center

The Message Center is a backlit, positive-mode, liquid crystal display (LCD) with amber backlighting. The LCD contains two 20-character lines, and each character consists of a 5×7-dot matrix. The Message Center operates from –40 to +85 C, and its brightness can be varied by the dashlight dimmer control.

2.2 Operation

2.2.1 LMC Start-Up

Turning the ignition on:

- Activates the Message Center
- Starts the initialization sequence (see Figure 2-2), providing the user with a quick visual check of LMC and gauge operation
- Positions gauge pointers to zero
- Displays the main screen

Note - *If any warning messages are active, the LMC will display them (and the user can acknowledge them by pressing either switch) before displaying the main screen.*

2.2.2 LMC Shutdown

2.2.2.1 Normal Shutdown

If the ignition is switched off while the battery voltage is in the normal range of 9.0 to 16.0 volts (18 to 32 volts on a 24-volt system), the LMC positions all pointers to zero and goes into a stand-by state that uses minimal power.

In the stand-by state, pressing either pushbutton turns the Message Center on and displays the odometer and hourmeter for 15 seconds. After that, the LMC returns to its stand-by state. Pressing either switch again restarts the 15-second display period. Turning the ignition off also clears all stored messages and fault codes.

2.2.2.2 Over/Under-Voltage Shutdown

If the battery voltage input to the LMC drops below 9 volts or exceeds 16 volts (18 volts and 32 volts in a 24-volt configuration), the LMC will immediately disconnect itself from the battery input. The pointers of any connected NGI gauges will stop at their last position, and the Message Center and all telltales will turn off. When the battery voltage input returns to the normal range, the LMC will reset itself and continue normal operation.

Note - *If the battery voltage drops low enough when the starter is engaged, the System may repeat the sequence when the power returns to normal.*

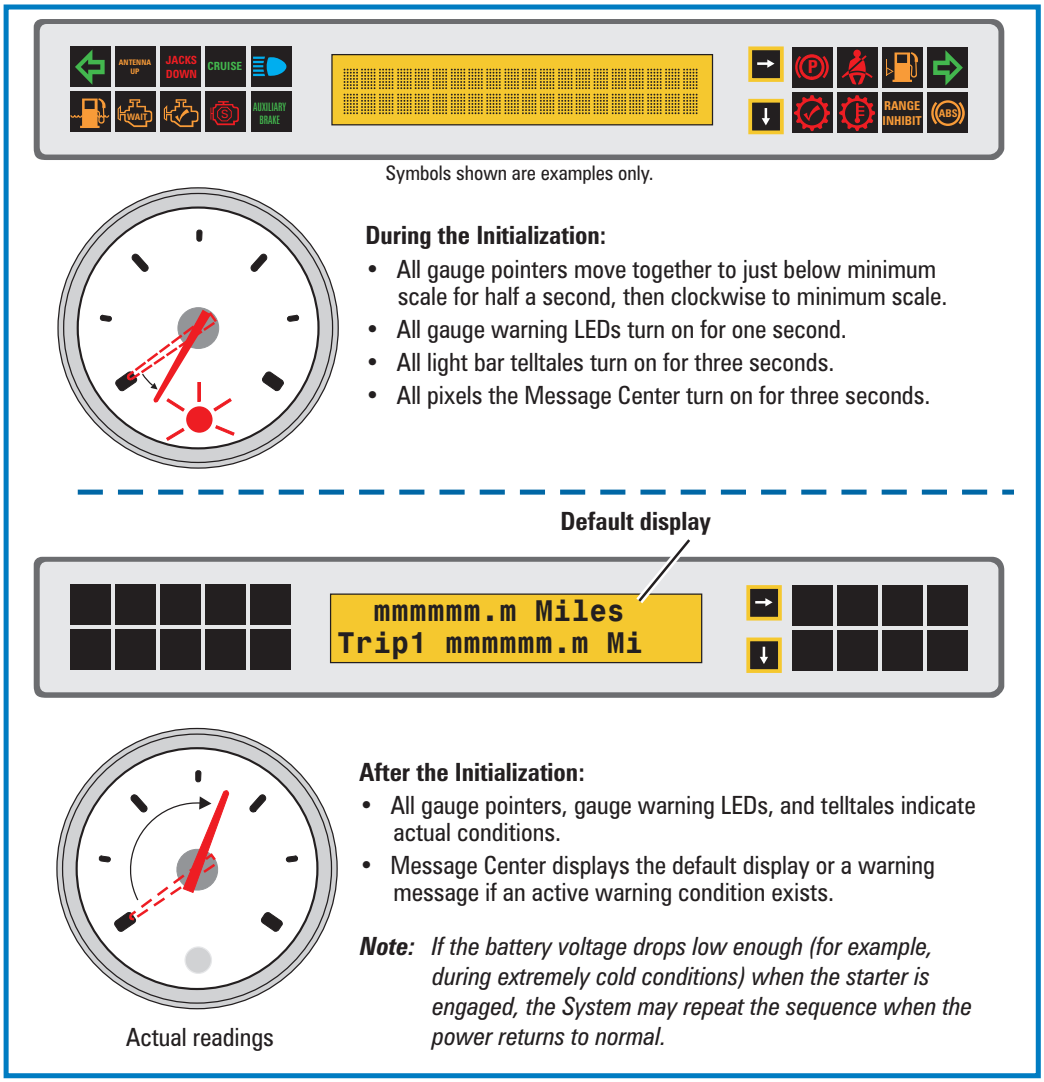

Figure 2-2 *System Initialization Sequence*

2.2.3 Main Display

The main display (*displays* are also referred to as *screens* in this document) is the one that is shown during normal vehicle operation. The user can assign any of the four information screens to the main display.

The user can switch from one information screen to the next while the vehicle is moving; however, he can only change the contents of those screens while the park brake is on.

The LMC remembers which of the four information screens was the main screen each time the ignition is switched off, and displays that screen the next time the ignition is switched on.

Table 2-3 list display items that can be assigned.

DISPLAY ITEM	APPEARANCE
Road Speed	`Speed nnnn MPH`
Tachometer	`Tach nnnn RPM`
Oil Pressure	`Oil nnn PSI`
Coolant Temperature	`Engine nnn degF`
Battery Voltage	`Battery nn.n Volts`
Transmission Oil Temperature	`Trans nnn degF`
Turbo Boost	`Turbo nn.n PSI`
Outside Air Temperature	`Air Temp nnn degF`
Engine Load	`Eng Load nnn %`
Engine Hours	`Enginennnnnn.n Hours`
Average Fuel Economy	`Fuel Ave nn.n mpg`
Instantaneous Fuel Economy	`Fuel Inst nn.n mpg`
Fuel Remaining	`Fuel Left nnnn Miles`
Trip 1 Distance	`Trip1 nnnnnn.n Miles`
Trip 2 Distance	`Trip2 nnnnnn.n Miles`
Odometer	`nnnnnn.n Miles`
Heading	`Heading XX`
Note - *"n" indicates a number, X indicates a letter.*	

Table 2-3 *Configurable Screen Contents*

2.2.3.1 Primary Information Screen

The Primary Information screen contains a vehicle odometer on the top line. The top line cannot be changed, but the user can modify the bottom line to show other vehicle information.

Should the battery be disconnected and later reconnected, the main display will revert to the Primary Information screen consisting of the odometer on the top line and whatever display item was in the bottom line.

2.2.3.2 Secondary Screens

Three secondary screens are available, all of whose top and bottom lines are configurable by the user when the park brake is on.

2.2.4 Odometer

The user can display miles or kilometers; the choice is made in the Setup mode. The odometer functions as follows:

- **Range** - 0 to 9999999.9
- **Factory Setting** - 0
- **Leading Zeros** - suppressed
- **Rollover** - None. After 9999999.9, the LMC freezes the odometer value.
- **Resettable** - no

The vehicle odometer value is not resettable. The LMC calculates, stores, and displays the odometer value using one of the following methods:

- Direct from the vehicle databus
- Calculated by the LMC using a speed integration method
- Calculated by the LMC using a match method

The customer specifies the desired method at time of order.

2.2.4.1 Direct from Databus

The LMC displays the total vehicle distance (TVD) value broadcast by the Engine ECU on the vehicle data bus.

2.2.4.2 Speed Integration Method

The LMC calculates the odometer value by integrating vehicle speed data over time as follows:

1. When the ignition is switched on, the LMC retrieves the current odometer value stored in its microprocessor.
2. Every 100 milliseconds it then calculates a new current odometer value using speed data from the data bus.
    a. If speed data is lost, the LMC continues to update the odometer for eight seconds using the last known vehicle speed.

b. If no data is present after eight seconds, the LMC freezes the display.

3. It updates the display every half second.
4. It stores the current value every 20 miles when the vehicle speed is over 5 MPH.
5. It stores the current value every 0.1 mile when the vehicle speed is less than 5 MPH, and every time the ignition is switched off.

2.2.4.3 Match Method

When the ignition is switched on, the LMC retrieves the stored odometer value and compares it with the TVD on the vehicle data bus. If the two are within 0.2 miles of each other, the LMC displays the value and increments it every tenth mile thereafter using distance tick marks from the vehicle data bus. Every tenth mile and every time the ignition is switched off, the SCU stores the current odometer value.

Various options exist to deal with cases where the values do not match. These should be discussed with AMETEK.

2.2.5 Standard Access Screens

The standard access screens include the trip information and fuel economy screens and are shown in Figure 3-4 on page 3-5. These screens are available to the driver when the vehicle is moving.

2.2.5.1 Travel Distance and Time

Two independent trip counters are available. Each displays travel distance and time, and each can be reset without affecting the other.

- **Range -** 0 to 99999.9 miles
- **Leading Zeros -** suppressed
- **Rollover -** None. The display freezes at the maximum displayable value until reset.
- **Resettable -** yes

Trip odometer values are calculated using the current odometer reading. A trip distance is the current total vehicle distance minus the total vehicle distance when the trip odometer was last reset.

The LMC stores the distance and time values so they will not be lost when the ignition switch is turned off or when the battery is disconnected.

2.2.5.2 Fuel Economy Display

Two fuel economy-related screens are available and the user can switch between them while the vehicle is moving.

- **Fuel Remaining** - Provides an estimate of remaining fuel
- **Fuel Economy** - Provides an average fuel consumption rate

Both values are reset by the user, normally after refueling.

2.2.5.2.1 Fuel Remaining

The Fuel Remaining screen shows the estimated distance before refueling is recommended. The LMC calculates and displays the percent of fuel remaining in the tank every 10 seconds until the value drops below 12.5%. At that time, the LMC will display **`Low Fuel`**.

2.2.5.2.2 Fuel Economy

The Fuel Economy screen shows the average rate of fuel consumption in miles per gallon. When system is configured to display metric units, the LMC displays Fuel Economy in terms of liters used per hundred kilometers (**`lhk`**).

2.2.6 Engine Hours

The Engine Hours display shows total engine hours.

- **Range -** 0 to 99999 hours
- **Factory Setting -** 0
- **Leading Zeros -** suppressed
- **Rollover -** none
- **Resettable -** no

Each time the ignition is switched on and every 10 seconds thereafter, the LMC requests Total Engine Hours data from the Engine ECU and displays the value received. The LMC stores the last value it received so it will not be lost when the ignition switch is turned off or when the battery is disconnected. When Engine Hours must be displayed while the ignition is off, the LMC displays the stored value.

If the LMC does not receive any Total Engine Hours values during the current ignition cycle, it displays the last value it received.

If the LMC has never received a Total Engine Hours value, it will display 0. When the maximum displayable value is attained, the display freezes at that value.

Note - *Various other engine parameters can be displayed in addition to Engine Hours. The choice is made by the customer at time of order.*

2.2.7 Service Reminder Display

The Service Reminder display reminds the user when the next service is due, or how far beyond the service alarm period the vehicle has been driven.

The user can choose a service alarm period or he can turn off the service display completely.

2.2.7.1 How the Service Reminder Function Works

Eighteen preset service alarm periods (or service intervals) ranging from 3,000 to 20,000 miles in 1,000-mile increments are available. If the LMC has been configured

for kilometers, the service interval values are displayed in kilometers. The Service Reminder is enabled and set to 15,000 miles at the factory.

When the Service Reminder is displayed, the LMC shows:

- The distance remaining until service is due; or,
- The distance overdue for service, if the vehicle is driven beyond the desired interval; or,
- Service Alarm Is Turned Off

It is up to the user to determine the service interval and to reset the counter after the vehicle has been serviced. See 3.2.4 on page 3-6 for additional information.

2.2.8 Diagnostic Function

The Diagnostic function lets the user display messages (pop-ups) and fault codes the LMC has received during the current ignition-on cycle. These are discussed in Section 2.3 starting on page 2-13.

2.2.9 Self-Test Function

The Self-Test function is a service aid that provides the following tests:

- **Auto Self-Test** - This lets the user quickly check the operation of the LMC and any attached NGI modules simultaneously.
- **Manual Test** - The manual test lets the user select and test each telltale and attached NGI module separately.
- **Software Version Display** - This lets the user display the version and configuration numbers of the LMC's firmware.

2.2.9.1 Auto Self-Test

During Auto Self-Test, all pointers, gauge LEDs, and telltales operate simultaneously and without user intervention. For three seconds, the Message Center displays what the pointers and telltales should be doing. Pointers are tested at minimum scale, mid-scale, and maximum scale. The Auto Self-Test loops continually until the user terminates it.

2.2.9.2 Manual Test

The Manual Test helps isolate instrumentation problems by allowing the user to activate and test telltales and attached NGI gauges individually. It works in phases by sending pre-determined data to the selected telltale or NGI gauge and displaying what each phase is doing. If the telltale or gauge responds correctly, it indicates that the data path between the LMC and the telltale or gauge is good and that the telltale or gauge is responding correctly to LMC data.

The Manual Test cannot verify the integrity of analog, switched, or vehicle data bus inputs to the LMC microprocessor, nor can it verify the integrity of the inputs to telltales that are normally controlled by direct switched connections.

2.2.10 Software Version Display

This part of the Diagnostic function displays the version number of the software with which the LMC microprocessor has been programmed. The number will be displayed until the user terminates it.

2.2.11 Setup Menu

A Setup menu lets the user customize certain parts of the display system. Using the ⇒ and ⇓ switches, the user can:

- Switch the Message Center display between English and metric units
- Choose what to display in the bottom line in the primary display
- Choose what to display in both lines of the second, third, and fourth customizable displays
- Calibrate the compass module if one installed

2.3 Real-Time Warning Messages and Fault Codes

2.3.1 LMC Warning Messages (Pop-Ups)

When the LMC detects a condition that requires user notification, it displays a text warning message. Such messages are also called “pop-ups” because they replace whatever is currently being displayed. It handles pop-ups in the following manner:

- A pop-up will be displayed as long as the ignition is on and the condition that triggered it is active.
- If the trigger condition goes inactive for 30 consecutive seconds, the LMC will store the pop-up and return the display to its previous condition.
- The LMC can store up to 30 pop-ups during the current ignition cycle. If more than 30 messages are acknowledged, the oldest one is deleted.
- All pop-ups are cleared each time the ignition is switched off.
- Pop-ups can be accompanied by the audible alarm if specified at time of order.

Table 2-1 on page 2-15 lists typical pop-ups and associated parameters.

2.3.1.1 LMC Warning Message Priorities

The LMC assigns a priority number to every warning message. The higher the number, the higher the priority. Higher priority messages will be displayed before lower priority messages. Warning messages of a given priority will override (but not delete) a warning message having a lower priority. Typical priority assignments are listed in Table 2-2 on page 2-16.

2.3.1.2 Acknowledging an LMC Warning Message

When an LMC warning message first appears, it is considered unacknowledged. At this point, the user can:

- **Do nothing** - If the user does nothing, the LMC will continue to display the pop-up until its trigger condition goes inactive. When that happens, the LMC stores the message for later recall, and the pop-up will not reappear unless its trigger condition goes active again. If a trigger condition with a higher priority occurs, it will override the current message.
- **Acknowledge the message** by pressing either switch while the pop-up is displayed. The LMC will then dismiss the message, store it for later recall, and silence the annunciator if it is on. If another unacknowledged pop-up exists, the LMC will display it; otherwise, the LMC will display the main display.
- **Press and hold ⇓ for three seconds** - This will return the Message Center to the main display; however, if the triggering condition still exists, the pop-up will reappear.
- **Turn the ignition off** - This will clear all stored messages.

Note - *The wording of pop-ups and the annunciator state, if different from that shown in Table 2-1, can be specified at time of order.*

WARNING MESSAGE (POP-UP) TEXT	ACTIVATION (PGN, SA, SPN, FMI)	CLEAR CONDITIONS	ANNUN-CIATOR
Low Front Air	Analog input to LMC Active at 65 PSI or less	Front air >70 psi	Yes
Low Rear Air	Analog input to LMC Active at 65 PSI or less	Rear air >70 psi	Yes
ABS Fault	ABS Control Status bits 2 & 1 ≠ 00; or, ABS Control Status timed out	ABS input high	No
Stop Engine	65226, 0, any, any and Stop Lamp Status ON	Fault inactive for 30 seconds	Yes
High Coolant Temp	65226, 0, 110, 0	Fault inactive for 30 seconds	Yes
Trans Over Temp	65272, 3, 177, 0 (Temperature >250 F)	Fault inactive for 30 seconds	No
Low Oil Pressure	65226, 0, 100, 1	Fault inactive for 30 seconds	Yes
Chect Engine	65226, 0, any, any and Amber Warn Lamp Status ON	Fault inactive for 30 seconds	Yes
Check Transmission	65226, 3, any, any and Amber Warn Lamp Status ON	Fault inactive for 30 seconds	No
Transmission J1939 Communication Fault	Electronic Transmission Controller #2 PGN not received for 5 seconds	PGN #2 not timed out	No
Park Brake ON Trans Not In Neutral	Park Brake ON AND transmission not in neutral	Park Brake OFF or transmission in neutral	No
Low Fuel	Analog input to LMC; 12% or less fuel detected	Fuel level >25%	No
Water in Fuel	65279, 0, 97, –	SPN 97 OFF	No
No J1939 Data Bus Communication	No J1939 data for 5 seconds	J1939 message received	No
No J1587 Data Bus Communication	No J1587 data for 5 seconds	J1939 message received	No
Overdue For Service	LMC calculation	Reset by user	No

Table 2-1 *Typical Warning Messages and Associated Parameters*

MESSAGE DESCRIPTION	TYPICAL PRIORITY LEVEL
Loss-of-Data Messages	These override all other messages
NGI Warning Messages	28 - 17
Reserved	16, 15, 14
Odometer	13
Trip 1	12
Trip 2	11
Engine Hours	10
Reserved	9, 8
Diagnostics	7
Acknowledged Warning Messages	6 - 1

Table 2-2 *Typical Message Priorities*

2.3.2 Fault Codes

When a device (or ECU) attached to the vehicle data bus detects a fault, it can place an active fault code on the vehicle data bus. The fault code contains the device ID code of the device that detected the fault along with a specific failure code (for example, Engine ECU—low oil pressure). The LMC does not display fault codes as they occur, but stores them for later viewing.

The LMC maintains an internal list that can contain up to 16 fault codes. By pressing ⇓ while in the Diagnostic Function (described in Figure 3-6 on page 3-9), the user can cycle through and view the active fault codes one-at-a-time. If the list is empty, the LMC displays **`No Fault Codes`**. The internal list is cleared each time the ignition is switched off.

The LMC updates the internal list continuously as follows:

- The LMC will store a fault code when the condition that causes it first occurs; however, it will not be displayed at the actual time of the event.
- When more than 16 fault codes are active, the LMC will flash **`Fault Codes`** at a one-Hertz rate to indicate the overflow condition.
- If a fault code condition goes inactive while it is being displayed, it is dropped from the list as soon as anything else is displayed.
- If a new fault code condition occurs while the list is being viewed, it is immediately added to the list, but it may not be displayed until the list is scrolled through a second time.

Note - *The display order may change each time the list is viewed if fault codes have been added or dropped.*

2.4 Additional Fault Indications

The LMC System will give the indications in Table 2-3 if it detects a problem with associated sensors, wiring, or other system inputs.

INDICATION	TYPE OF PROBLEM
A gauge's pointer goes to zero or full scale and its warning LED flashes rapidly.	This indicates a sensor output is outside the range for which the LMC has been configured.
A gauge's pointer goes to zero and its warning LED flashes slowly.	The gauge is not receiving any data from the LCM. The problem could be inside or outside the LMC System.

Table 2-3 *Additional Fault Indications*

2.4.1 Data Out-Of-Range Indication

The LMC is configured at the factory with specific parameters for each gauge. One of these parameters is the gauge's valid input range. If the input (voltage or resistance) to the LMC for a particular gauge falls outside the valid input range, the LMC flashes the gauge's warning LED and positions the gauge pointer according:

- If the pointer deflection increases as that gauge's sensor output increases, the LMC will position the pointer to minimum scale for an out-of-range low condition, and to full scale for an out-of-range high condition.
- If the pointer deflection is inversely related to the gauge's sensor output, the LMC will position the pointer to maximum scale for an out-of-range low condition.

  Example: When the fuel tank is full, the fuel level sensor resistance is minimum and the pointer deflection in the Fuel Level gauge is maximum; when the fuel tank is empty, the sensor resistance is maximum and the pointer deflection is minimum.

2.4.2 Loss-of-Data Indication

When a gauge does not receive data from the LMC for 15 or more seconds, the gauge flashes its warning LED about once per second and positions its pointer to minimum scale.

3 Message Center Operation

The LMC provides several functions. The functions are accessible during particular conditions. Table 3-1 identifies the conditions and lists the available functions.

CONDITION	WHAT THE USER CAN DO
Ignition Off	View odometer/hourmeter screens
Ignition On and Park Brake Off	Switch among the four information screens Display and reset Trip Information screens Display and reset Fuel Economy screens
Ignition On and Park Brake On	Display engine hour screen Configure, display, and reset the Service Reminder Display stored messages and fault codes Enter the Setup mode Select English or metric units Configure bottom line of Primary Information screen Configure top and bottom lines of the other three (secondary) information screens Calibrate optional compass module

Table 3-1 *Message Center States and Functions*

3.1 Ignition-Off State

When the ignition is off, the LMC operates as shown in Figure 3-1.

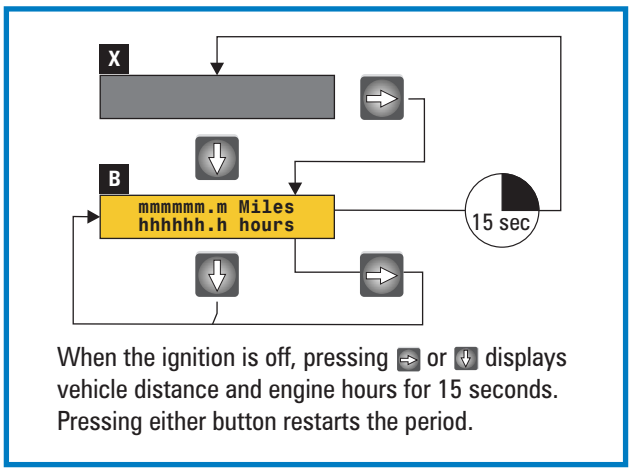

Figure 3-1 *Ignition-Off State*

3.2 Ignition-On State

Turning on the ignition places the LMC into an Ignition-On state. This mode begins with a 3-second initialization period during which all LCD segments are activated. Three seconds later, the LMC displays any messages that may exist (usually none, since all messages were cleared when the ignition was last turned off). This is followed by the main display.

The main display remains until one of the following occurs:

- The ignition is switched off; or,
- The ⇒ switch is pressed, allowing the user to select a different information screen for the main display; or,
- The ⇓ switch is pressed and released, allowing the user to see the standard access screens (Section3.2.2 on page 3-5).

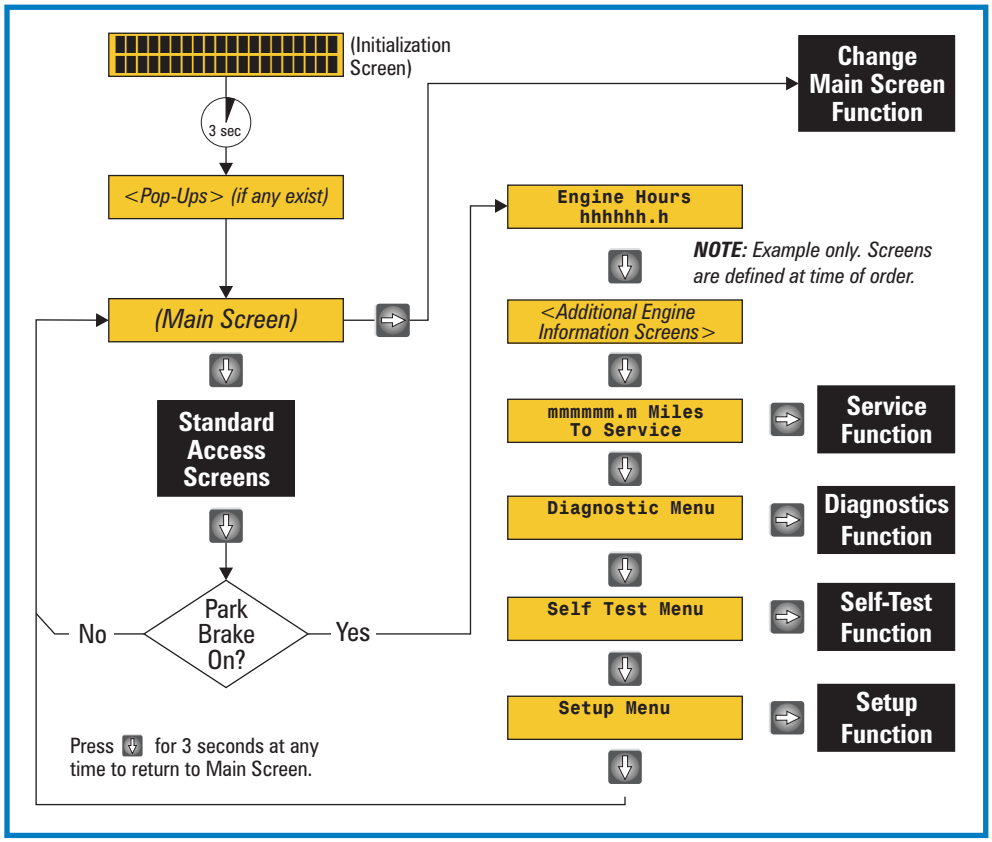

Figure 3-2 *Ignition-On State*

3.2.1 Main Display Selection Function

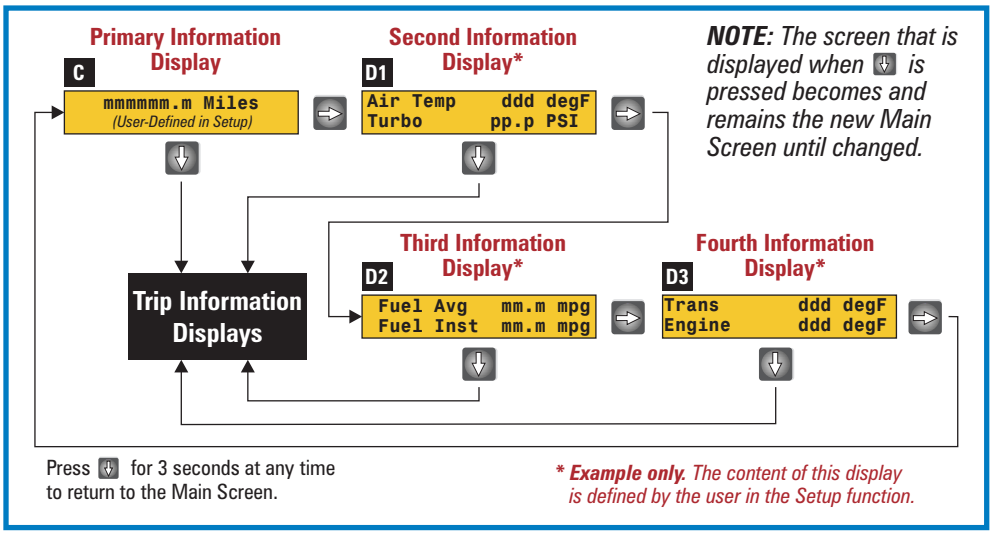

Figure 3-3 *Main Display Selection Function*

This section along with Figure 3-3 shows only how the user selects which of the information screens becomes the main screen. Changing the actual contents of an information screen is described in Section 3.3 on page 3-13.

To select display a different information screen:

1. If the main screen is not being displayed, press and release ⇓ until it (Screen C, or Screen D1 through D3 in Figure 3-3) appears.
2. Press and release ⇒ to enter the Main Display Selection function.
3. Do one of the following:
   a. Press and release ⇒ to scroll through the information screens; or,
   b. Press and release ⇓ to accept the currently displayed information screen and exit the function; or,
   c. Press and hold ⇓ for three seconds to exit the function and return to the main display.

3.2.2 Standard Access Screens

Standard Access screens are available whenever the ignition is on.

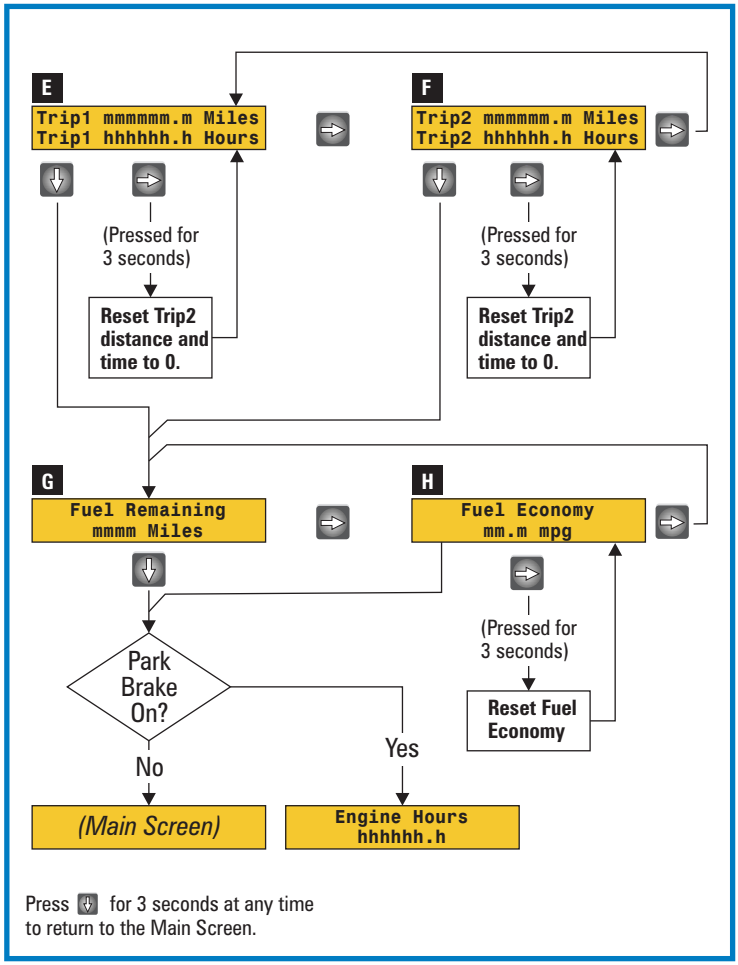

Figure 3-4 *Standard Access Screens*

3.2.2.1 Trip Information Displays

The Trip Information displays consists of two independently trip odometers and hourmeters. When **`Trip Information`** is displayed, do one of the following:

- Press ⇒ to alternate between Trip 1 (Screen E) and Trip 2 (Screen F); or,
- Press and hold ⇒ for three seconds to reset the distance and time of the current display to zero; or,
- Press ⇓ to display Fuel Remaining (or Fuel Economy) information; or,
- Press and hold ⇓ for three seconds to exit the function and return to the main display.

3.2.2.2 Fuel Economy Display

When the Fuel Economy display is active, do one of the following (see Figure 3-4 on page 3-5):

- Press and release ⇒ to alternate between the Fuel Remaining screen (Screen G) and the Fuel Economy screen (Screen H); or,
- Press and hold ⇒ for three seconds to zero the Fuel Economy display. From that point, the LMC will display dashes until enough fuel has been used and enough distance has been traveled to allow it to calculate a reasonable value; or,
- If the park brake is off, press and release ⇒ while **`Fuel Economy`** is displayed to return to the main display; or,
- If the park brake is on, press and release ⇓ while Fuel Economy is displayed to access additional modes; or,
- Press and hold ⇓ for three seconds to return to the main display.

The Fuel Remaining value is updated every 10 seconds.

The LMC calculates and displays the percent of fuel remaining until it drops below 12%. At that time, the LMC displays **`Low Fuel`**.

When system is set to display metric units, the LMC displays **`lhk`** indicating liters per hundred kilometers.

3.2.3 Engine Hours Display

The Engine Hours display shows total engine-on time (see Figure 3-2 on page 3-3. The data comes from the Engine ECU and is not resettable. When **`Engine Hours`** is displayed, do one of the following:

- Press and release ⇓ to display the Service Reminder function; or,
- Release the park brake or press and hold ⇓ for three seconds to return to the main display.

Note - *Pressing ⇒ has no effect.*

3.2.4 Service Reminder Function

The Service Reminder function allows the user view the current service interval, change its value, or turn the service reminder off completely. See Figure 3-5 on page 3-7.

3.2.4.1 Viewing the Current Service Alarm Setting

To see which service alarm setting is in effect:

1. With the park brake on, press and release ⇓ until the Miles To Service screen appears.

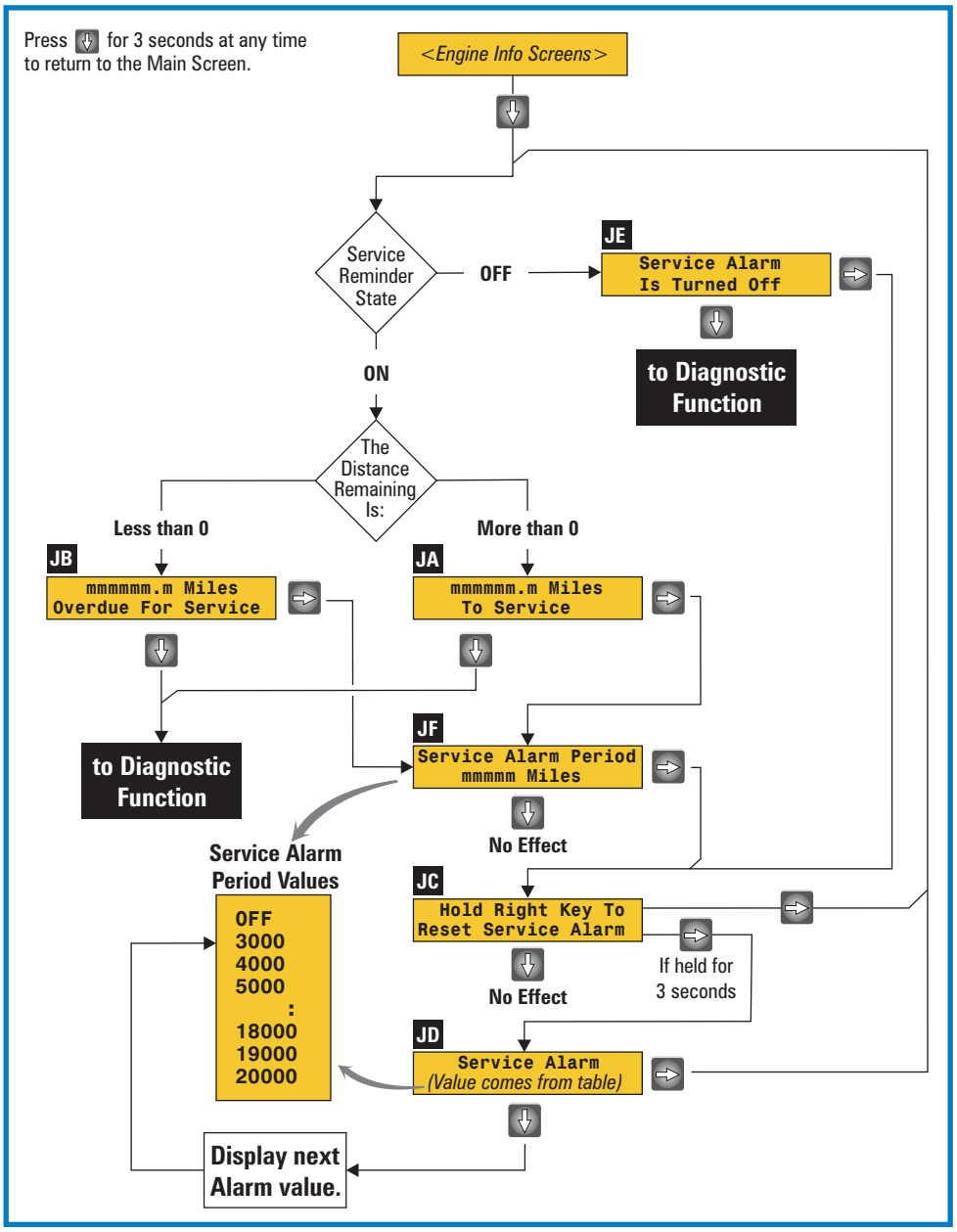

Figure 3-5 *Service Reminder Function*

2. Press and release ⇓ . The LMC will display either the Overdue For Service screen (Screen JB) or the Miles to Service screen (Screen JA), or **`Service Alarm Is Turned Off`** (Screen JE), depending upon actual conditions.
3. Press ⇒ once. The LMC will display **`Service Alarm Period`** on the top line and its value on the bottom line (Screen JF).

3.2.4.2 Changing the Service Alarm Value

1. Perform the steps in Section 3.2.4.1.
2. When the Service Alarm Period screen appears (Screen JF), press and release ⇒ . The LMC will display **`Hold RIGHT Key To`** on the top line and **`Reset Service Alarm`** on the bottom line (Screen JC).
3. Do one of the following:
   a. Press and hold ⇒ for three seconds to select a different alarm period. The LMC beep and will flash the current service alarm value on the bottom line (Screen JD).
   b. Press and release ⇓ to scroll through the service alarm values.
4. While the desired alarm period (or **`OFF`**) flashes, do one of the following:
   a. To accept the displayed value and return to the beginning of the function, press and release ⇒ twice.
   b. To return to the main display without changing the value of the service alarm period, either release the park brake or press and hold ⇓ for three seconds.

Note - *Pressing and releasing ⇓ at this point has no effect.*

3.2.4.3 Resetting the Service Reminder

This operation is very similar to changing the Service Alarm Value described in Section 3.2.4.2.

1. Perform the steps in Section 3.2.4.1.
2. When the Service Alarm Period screen appears (Screen JF), press and release ⇒ . The LMC will display **`Hold RIGHT Key To`** on the top line and **`Reset Service Alarm`** on the bottom line (Screen JC).
3. Press and release ⇒ to reset the counter to zero and return to the beginning of the function.
4. Do one of the following:
   a. Press and release ⇓ to exit the Service Reminder function and advance to the Diagnostic function; or,
   b. Release the park brake or press and hold ⇓ for three seconds to return to the main display.

3.2.5 Diagnostic Function

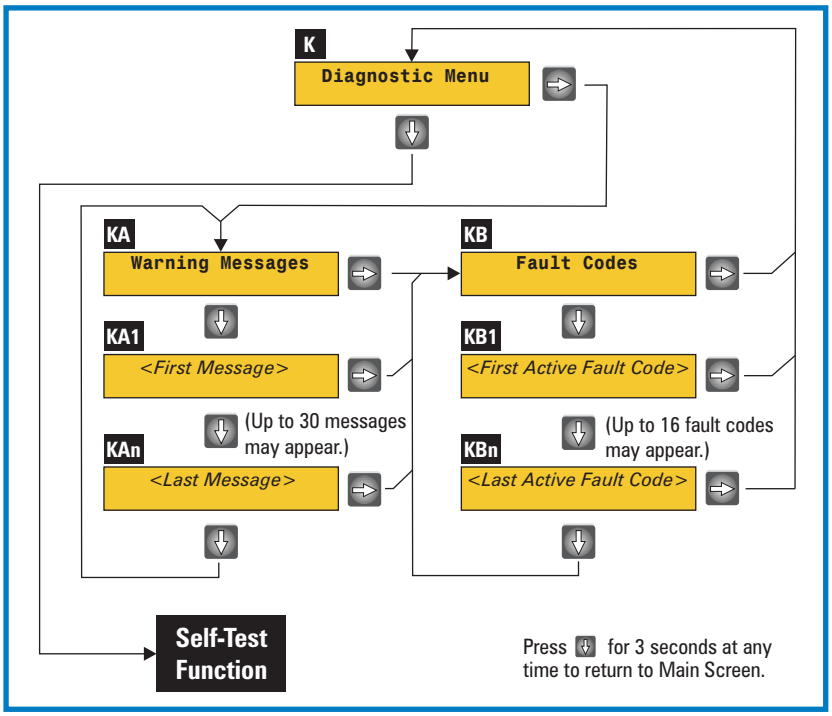

Figure 3-6 *Diagnostic Function*

3.2.5.1 Viewing Stored Warning Messages

To view stored warning messages:

1. Navigate to the Diagnostic menu.
2. When the LMC displays **`Diagnostic Menu`**, press and release ⇒ . The LMC will display **`Warning Messages`**.
3. Do one of the following (see Figure 3-6):
   a. Press and release ⇓ to scroll through the stored messages. If none exist, the LMC will display **`No Warning Messages`**.

Note - *Up to 30 messages are stored during the current ignition cycle, and switching the ignition off will clear the messages.*

   b. At any time, press and release ⇒ to view the messages; or,
   c. Press and release ⇒ twice to return to the diagnostic menu screen; or,

d. Release the park brake or press and hold ⇓ for three seconds to exit the function and return to the main display.

Typical warning messages are listed in Table 2-1 on page 2-15.

3.2.5.2 Viewing Fault Codes

To view stored fault codes:

Navigate to the Diagnostic menu.

1. When the LMC displays **`Diagnostic Menu`**, press and release ⇒ two times. The LMC will display **`Fault Codes`**.
2. Do one of the following (see Figure 3-6):

   a. Press and release ⇓ to scroll through the stored fault codes. If none exist, the LMC will display **`No Fault Codes`**.

Note - *Up to 16 fault codes are stored during the current ignition cycle, and switching the ignition off will clear them.*

   b. At any time, press and release ⇒ to view fault codes; or,

   c. Press and release ⇒ twice to return to the diagnostic menu screen; or,

   d. Release the park brake or press and hold ⇓ for three seconds to exit the function and return to the main display.

3.2.6 Self-Test Function

The Self-Test function consists of an automated test, a manual test, and a software version display. Refer to Figure 3-7. When **`Self Test Menu`** is displayed, the user can:

- Press and release ⇒ to scroll through the Auto SelfTest, Manual Selftest, and SW Version screens; or,
- Press and release ⇓ to exit the function and advance to the Setup Function; or,
- Release the park brake or press and hold ⇓ for three seconds to exit the function and return to the main display.

3.2.6.1 Auto Self-Test

To run the Auto Self-Test, press ⇓ when **`Auto SelfTest`** is displayed. The LMC will continuously cycle through the process shown in Screens LB, LC, and LD in Figure 3-6.

To stop the Auto Self-Test, press and release ⇒ , release the park brake, or press and hold ⇓ for three seconds.

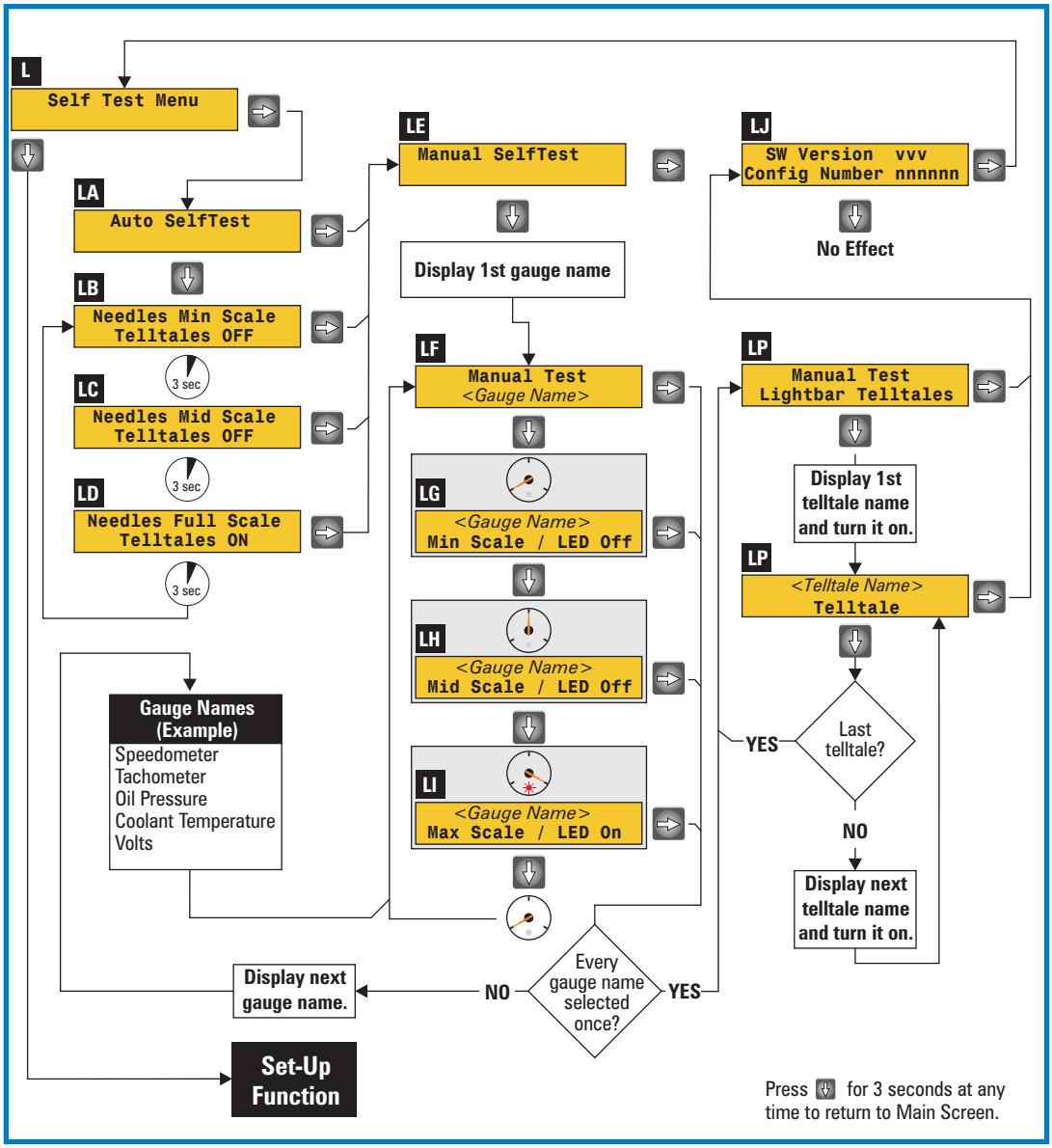

Figure 3-7 *Self-Test Function*

3.2.6.2 Manual Self-Test

To run the Manual Self-Test:

1. Navigate to the Self-Test function. **`Self Test Menu`** will be displayed.
2. Press and release ⇒ . The LMC will display **`Manual SelfTest`**.
3. Press and release ⇓ . The LMC will display **`Manual Test`** on the top line and the name of the first NGI module for which it is configured on the bottom line (i.e. either some gauge name or **`Light bar Telltales`**).
4. Press and release ⇓ . If a gauge name was displayed, the LMC will display that gauge's name on the top line, **`Min Scale / LED Off`** on the bottom line, and will position that gauge's pointer to minimum scale.
5. Observe the designated gauge. Its pointer should be at minimum scale and its LED should be off.
6. Press and release ⇓ . The LMC will position that gauge's pointer to middle scale and change the bottom line to **`Mid Scale / LED Off`**.
7. Observe the designated gauge. Its pointer should be at middle scale and its LED should be off.
8. Press and release ⇓ . If an NGI gauge name was displayed, the LMC will display that gauge's name on the top line, **`Max Scale / LED ON`** on the bottom line, position that gauge's pointer to maximum scale and turn its LED on.
9. Observe the designated gauge. Its pointer should be at minimum scale and its LED should be off.
10. Do one of the following:
    a. Press and release ⇓ to repeat the test on the same gauge; or,
    b. Press and release ⇒ to perform the test on the next configured gauge. When all configured gauges have been tested, the LMC will display **`Light bar Telltales`**.

Note - *Pressing and releasing ⇒ at any point during a test will exit that test and advance to the next configured gauge.*

11. When **`Light bar Telltales`** is displayed:
12. Press and release ⇓ . The LMC will display a telltale name and light that telltale.
13. Observe the telltale and verify it is on.
14. Do one of the following:
    a. Press and release ⇓ to check each telltale as previously described; or,

b. Press and release ⇒ to exit the Manual Self-Test and display the Software Version Screen; or,

c. Release the park brake or press and hold ⇓ for three seconds to exit the test and return to the main display.

3.3 Setup Function

The Setup function lets the user switch between displaying English units and metric units. It also lets the user configure the bottom line of the Primary Information display, and in both lines of the secondary (second, third, and fourth) information displays. See Figure 3-8.

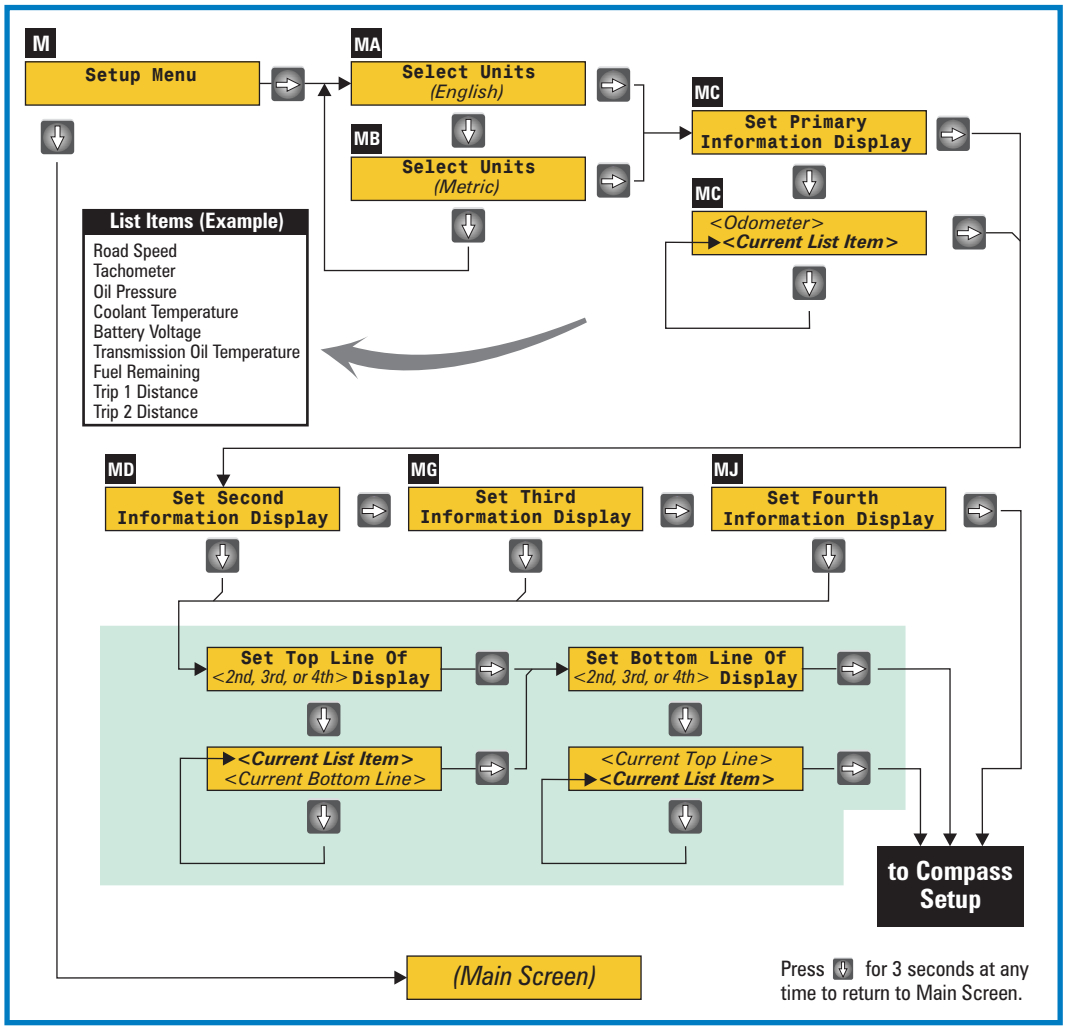

Figure 3-8 *Setup Function*

3.3.1 Switching Between English and Metric Displays

1. From the main screen, press and release ⇓ until **Setup Menu** is displayed.
2. Press and release ⇒ twice. **Select Units** will appear in the top line while the bottom line flashes **ENGLISH** (or **METRIC**).
3. Press and release ⇓ to alternate between English and metric units of measurement.
4. While the desired unit of measurement is flashing, press and release ⇒ to select the flashing unit of measurement. **Set Primary** will appear on the top line and **Information Display** will appear on the bottom line. At this point, the Message Center switches to the new units of measurement.
5. Do one of the following:
   a. If you are finished with the Setup function, press and release ⇒ repeatedly until the main screen appears; or,
   b. Release the park brake or press and hold ⇓ for three seconds to exit the function without change the units of measurement and return to the main display.

3.3.2 Changing the Contents of the Four Information Screens

This section explains how to change the contents of the four information screens. For information on how to assign one of these screens to the main display, please refer to Section 3.2.1 on page 3-4.

1. From the main screen, press and release ⇓ until **Setup Menu** is displayed.
2. Press and release ⇒ twice. **Set Primary** and **Information Display** will appear on the top and bottom lines respectively.
3. To change the bottom line:
   a. Press and release ⇓ . The Primary Information screen will appear and the bottom line will flash.
   b. Press and release ⇓ repeatedly until the desired information item flashes.
   c. When the desired information item flashes, press and release ⇒ to accept it and advance to the Set Second Information Display screen.
4. To advance to the next information screen without changing anything, press and release ⇒ .
5. Repeat the process for each screen and line.

3.4 Optional Compass Set-Up

The compass setup function allows the user to calibrate the compass module (if one is installed) and set a factor that tells the LMC the declination at the current vehicle location. See Figure 3-9.

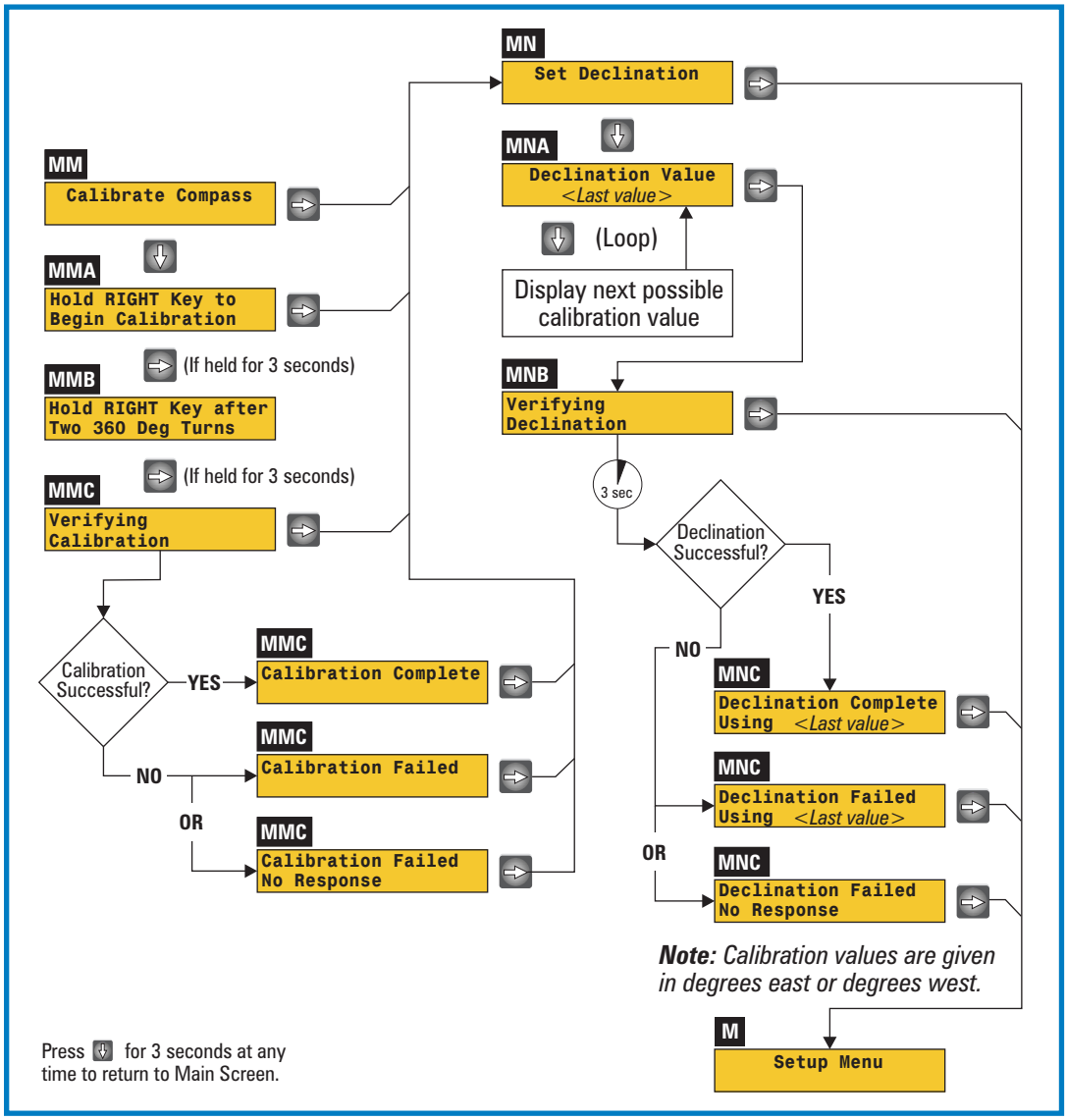

Figure 3-9 *Optional Compass Set-Up*

3.4.1 Calibrating the Compass (Optional Equipment)

Once calibrated, it is rarely necessary to recalibrate it. If the compass is obviously incorrect at several locations, follow this procedure to recalibrate it (also shown in Figure 3-9 on page 3-15).

NOTE: *Calibrating the compass near power transmission lines, radio transmitters, or other strong magnetic or electromagnetic fields can result in miscalibration.*

1. When **`Setup Menu`** is displayed, press and release ⇒ until **`Calibrate Compass`** is displayed.
2. Press ⇓ to begin the calibration process. When **`Hold RIGHT Key to Begin Calibration`** appears, press and hold ⇒ at least three seconds.
3. Perform Steps 3a and 3B within the next three minutes:
   a. Release the Park Brake and drive the vehicle two complete 360° turns (direction does not matter).
   b. After stopping the vehicle, press and hold ⇒ at least three seconds.
4. The system will verify the calibration process and display the results:
   a. **`Calibration Complete`** - No problems were detected.
   b. **`Calibration Failed, No Response`** - The system received no data from the Compass Module. The vehicle should be serviced to determine the cause. The system checks for about five seconds before making this determination.
   c. **`Calibration Failed`** - Appears if it took longer than three minutes to make the two turns, display, and/or accept a calibration value. This message can also appear if the calibration was performed in the presence of a strong magnetic or electromagnetic field. In such cases, the system will display and use the value that was in effect when at the start of the Setup routine.
5. When the calibration results are displayed:
   a. Pressing ⇒ while the park brake is disengaged will terminate the Setup mode and return the system to the default display.
   b. Setting the park brake and then pressing ⇒ enables the Set Declination function.

3.4.2 Setting the Compass Declination (Optional Equipment)

The compass reading can be modified to allow for different declination value depending upon the vehicle's location. This is done by locating the vehicle's current position on a map provided with the compass module, reading the declination value for that location along the top of the map, and entering that value in the Set Declination function as follows:

1. Locate the vehicle's current position on the map.
2. Find the nearest declination line (the curved blue lines or the somewhat straighter red lines) having a declination factor at the top of the map (for example, 12°W, or 0, 18°E).
3. Follow this line to the top of the map and make a note of its declination value.
4. From the Setup Menu screen, press and release ⇒ six times to display the Calibrate Compass screen.
5. Press ⇒ again to display the Set Declination screen.
6. Perform Steps 5a through 5C within the next three minutes:
   a. Press ⇓. The current declination value will appear.
   b. To accept this value, press ⇒; or,
   c. To change and accept another value, press ⇓ repeatedly until the desired value appears, then press ⇒ to accept it.
7. The system will verify the declination process and display the results:
   a. **`Declination Complete, using`** < *value* > - No problems were detected.
   b. **`Declination Failed, No Response`** - The system received no data from the Compass Module. The vehicle should be serviced to determine the cause. The system checks for about five seconds before making this determination.
   c. **`Declination Failed, using`** < *value* > - Appears if it took longer than three minutes to display and/or accept a declination value. In this case, the system will display and use the value that was in effect when at the start of the Setup routine.
8. While the declination results are being displayed, press ⇒ to return to the Setup Menu screen.

4 Installation

4.1 Mounting the Light Bar

Light Bar dimensions and panel cutout sizes are shown in Figure 4-1.

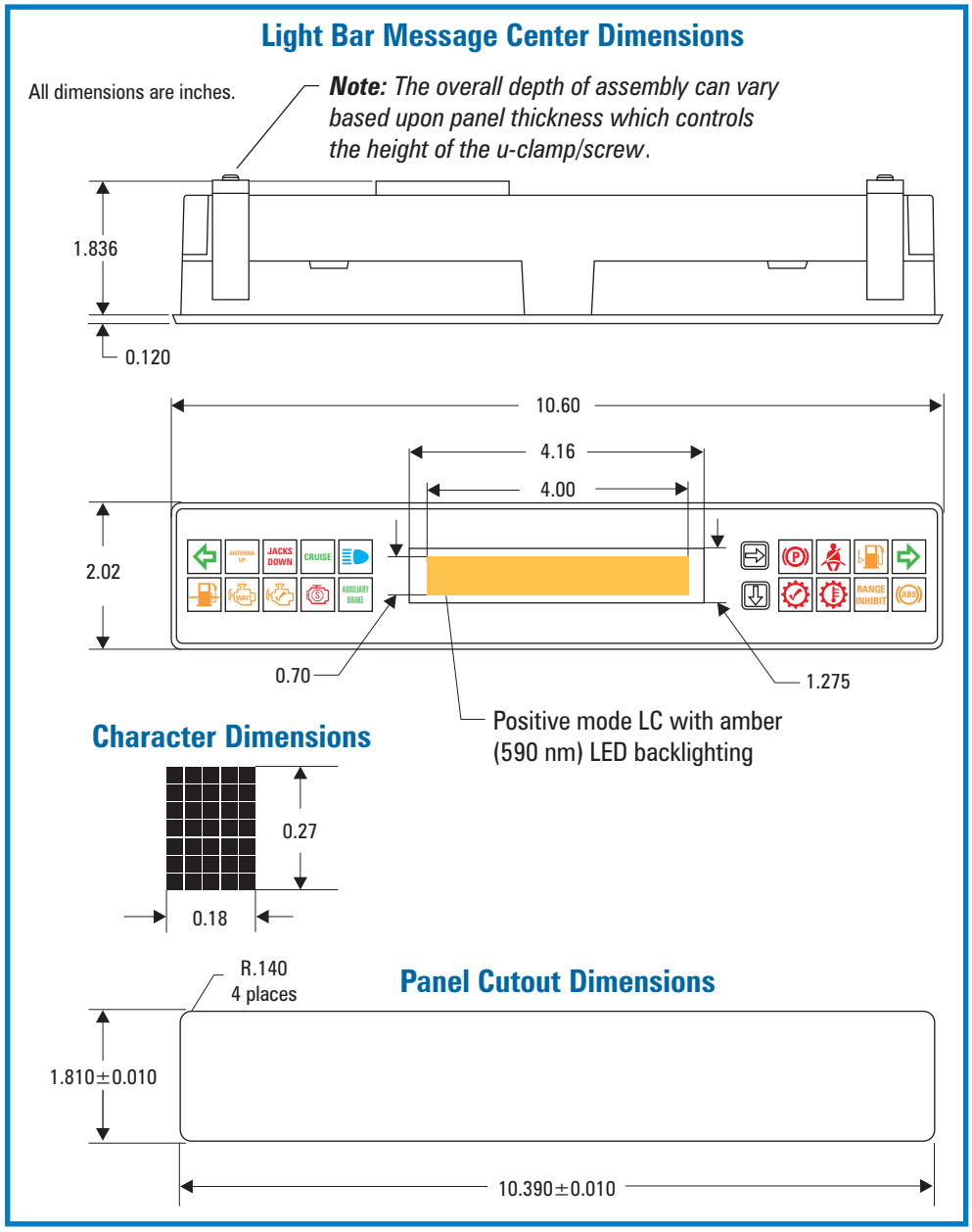

Figure 4-1 *Mounting the Lightbar*

4.2 Panel Wiring

Typical panel wiring is shown in Figure 4-2. Connections to the vehicle wiring harness are shown in red. The NGI Bus Cable Assemblies (shown in blue) are used when attaching NGI modules to the LMC.

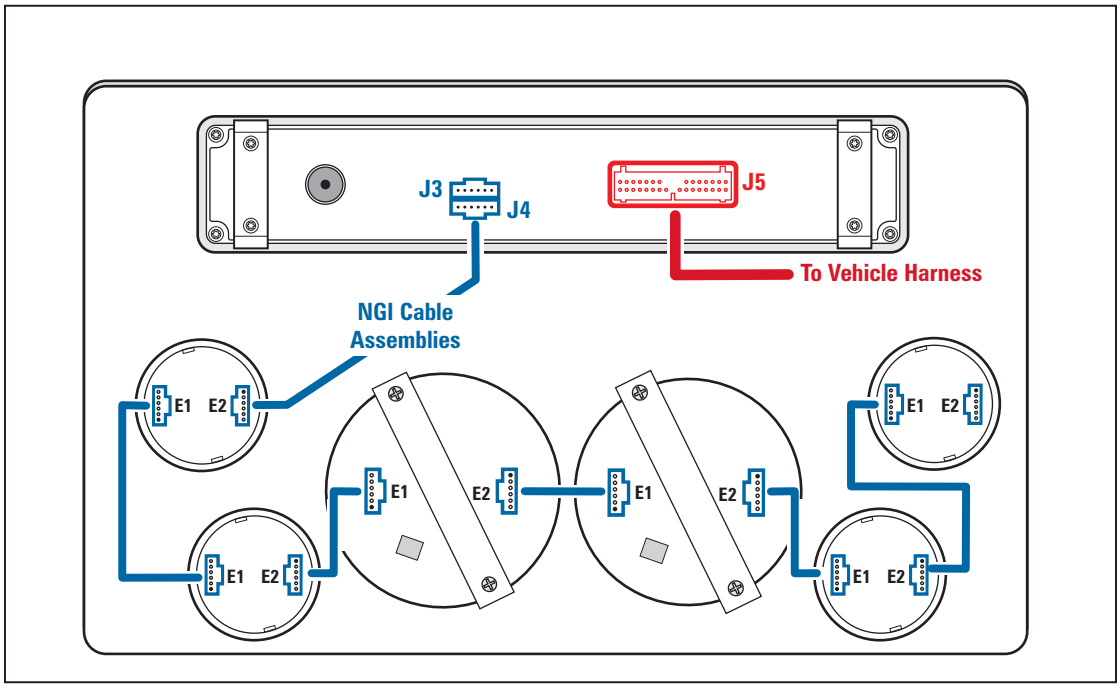

Figure 4-2 *Typical Panel Wiring*

5 Electrical Specification

5.1 Electrical Connections

LCM Front View

Indicator Name	Indicator Position	Signal Name, or (PGN, SA, SPN, FMI)	Input Pin (J5)	Dimming Control	Switch Level (+ Volts)	Hysteresis (Volts	Cleaning Current	Active with Ignition Off
Left Turn	R1C1	Left Turn	5	TT_DIM	5.0 to 5.83	1.66 to 5.83	N/A	Yes
Antenna Up	R1C2	Active Low 4	16	LB-OE	4.18 to 1.42	1.47 to 5.33	18 mA	No
Jacks Down	R1C3	Active Low 3	15	LB-OE	4.18 to 1.42	1.47 to 5.33	18 mA	No
Cruise	R1C4	65265, 0, 595		LB_OE				No
High Beam	R1C5	High Beam	12	TT_DIM	5.0 to 7.9	1.66 to 5.83	N/A	Yes
Park Brake	R1C6	Active Low 2	9	LB_OE	4.18 to 1.42	1.47 to 5.33	18 mA	Yes
Seat Belt	R1C7	Active Low 1	8	LB_OE	4.18 to 1.42	1.47 to 5.33	18 mA	No
Low Fuel	R1C8			LB_OE				No
Right Turn	R1C9	Right Turn	4	TT_DIM	5.0 to 7.9	1.66 to 5.83	N/A	Yes
Water in Fuel	R2C1	65279, 0 97		LB_OE				No
Wait to Start	R2C2	65252, 0 1081		LB_OE				No
Check Engine	R2C3	65226, 0, -, -		LB_OE				No
Stop Engine	R2C4	65226, 0, -, -		LB_OE				No
Auxiliary Brake	R2C5	61440, 15 or 41, 520, -		LB_OE				No
ABS	R2C6	ABS	11	N/A	3.0 to 3.3	No	30 mA	No
Check Trans	R2C7	65226, 8, -, -		LB_OE				No
Trans Temp	R2C8	65272, 8, 177, -		LB_OE				No
Range Inhibit	R2C9	65098, 3, 1851		LB_OE				No

Parameter Name	Parameter Range	Input Range	Input Pin (J5)	Signal Name
Battery Volts	9 to 36 volts	1.26 to 5.02 volts		Battery Monitor
Fuel	Empty to Full	240 to 33 ohms	22	Analog 1
Forward Air Pressure	0 to 150 PSI	33 to 240 ohms	23	Analog 2
Rear Air Pressure	0 to 150 PSI	33 to 240 ohms	24	Analog 3
Ambient Air Temperature				

TBD

J5 Mating Connector Manufacturer Part Numbers

Connector: JAE IL-AG5-30S-D3C1
Pins: JAE IL-AG5-C1-5000

TBD

NGI Bus Connectors (E1, E2, E4 and E5)

Pin 1:	NGI Power (+7.6 VDC)
Pin 2:	NGI Ground
Pin 3:	NGI Bus positive (+)
Pin 4:	NGI Bus negative (–)
Pin 5:	Backlight Ground
Pin 6:	Backlight Power

Figure 5-1 *Electrical Connections*

5.2 Input Power Requirements

PARAMETER	MINIMUM	TYPICAL	MAXIMUM
Battery Input Voltage	9.0 volts	14.0 volts	16.0 volts
Battery Input Current		0.5 amperes	2 amperes
Ignition Input Voltage	5.0 volts	14.0 volts	16.0 volts
Ignition Input Current		0.01 amperes	9.04 amperes
Panel Lamp Input Voltage	0		16.0 volts
Panel Lamp Input Current		<1 milliampere	10 milliamperes

Table 5-1 *Input Power Requirements*

5.3 Electrical Transient Test Parameters

CHARACTERISTIC	REFERENCE	CONDITIONS
Load Dump (12V)	SAE J1455, Sec. 4.11.2.2.1	R_{SOURCE}: 0.4 ohms Voltage: $14+86e^{(-t/0.4)}$ Number of pulses: 5 Interval: 10 seconds
Inductive Switching (12V)	SAE J1455, Sec. 4.11.2.2.1	R_{SOURCE}: 20 ohms Voltage: $14+600e^{(-t/0.001)}$ Number of pulses: 10 positive & 10 negative Interval: 1 second
Mutual Coupling (12V)	SAE J1455, Sec. 4.11.2.2.1	R_{SOURCE}: 50 ohms Voltage: $14+300e^{(-t/0.000015)}$ Number of pulses: 10 positive & 10 negative; Interval: 1 second
Electrostatic Discharge (Handling, Non-Operating)	SAE J1455, Sec. 4.11.2.2.1	$V_{APPLIED}$: ±15KV Network: 150 pF, 150 ohms Number of pulses: 3 positive & 3 negative; Air discharge applied to each connector pin with system ground tied to ESD source ground.
Electrostatic Discharge (In Vehicle, Operating)	SAE J1455, Sec. 4.11.2.2.1	$V_{APPLIED}$: ±15KV Normal operating configuration; Tested all accessible parts

Table 5-2 *Transient Test Parameters*

SIGNAL (J5 PIN NUMBER)	LOAD DUMP	INDUCTIVE SWITCHING		MUTUAL COUPLING		ELECTROSTATIC DISCHARGE	
		(+)	(–)	(+)	(–)	Operating	Non-Operating
(1) Active High 1	✓	✓	✓	✓	✓	✓	✓
(2) Active High 2	✓	✓	✓	✓	✓	✓	✓
(3) Active High 3	✓	✓	✓	✓	✓	✓	✓
(4) Right Turn	✓	✓	✓	✓	✓	✓	✓
(5) Left Turn	✓	✓	✓	✓	✓	✓	✓
(6) Panel Lamps	✓	✓	✓	✓	✓	✓	✓
(7) Panel Lamp Ground				✓	✓	✓	✓
(8) Active Low 1				✓	✓	✓	✓
(9) Active Low 2				✓	✓	✓	✓
(10) Ignition	✓	✓	✓	✓	✓	✓	✓
(11) ABS				✓	✓	✓	✓
(12) High Beam	✓	✓	✓	✓	✓	✓	✓
(13) Battery	✓	✓	✓	✓	✓	✓	✓
(14) Ground							
(15) Active Low 3				✓	✓	✓	✓
(16) Active Low 4				✓	✓	✓	✓
(17) Output Switch 1		✓	✓	✓	✓	✓	✓
(18) Output Switch 2		✓	✓	✓	✓	✓	✓
(19) Analog 5				✓	✓	✓	✓
(20) Analog 6				✓	✓	✓	✓
(21) Analog 7				✓	✓	✓	✓
(22) Analog 1				✓	✓	✓	✓
(23) Analog 2				✓	✓	✓	✓
(24) Analog 3				✓	✓	✓	✓
(25) Analog 4				✓	✓	✓	✓
(26) Analog Ground				✓	✓	✓	✓
(27) J1708 (+)				✓	✓	✓	✓
(28) J1708 (–)				✓	✓	✓	✓
(29) J1939 (+)				✓	✓	✓	✓
(30) J1939 (–)				✓	✓	✓	✓

Table 5-3 *Transient Testing Matrix*

5.4 Serial Data Compliance

All serial data communications in the System comply with the following specifications:

- **SAE J1708/1587** - SAE J1708 Appendix A (physical layer) and SAE J1587 (protocol)
- **SAE J1939** - SAE J1939/11 (physical layer) and SAE J1939/21 CAN 2.0B Extended Frame Format (protocol)
- **NGI Serial Communication Link** - EIA RS-485 (physical layer) and NGI Serial Communications Protocol Specification and Message Definition (AMETEK Dixson Specification 079-14232 (protocol)

5.5 Signal Application Matrix

Table 5-3 shows which electrical transient tests were performed on each input pin of connector J5. A grayed-out area in a particular column indicates the test was not performed on the signal in that row.

5.6 ABS

The ABS input is conditioned and operates the ABS telltale through a hardwired connection. It is also applied to the microprocessor to enable detection of specific conditions. The ABS input is compatible with WABCO revision D brake controllers and has the following characteristics:

- A 470-ohm pull-up to ignition voltage (15 milliamperes minimum current when active)
- The ABS telltale will be on when the controller pulls the input signal below 3.5 volts. This complies with the requirements for the self-conducting mode of the controller that indicates a loss of power.
- An inactive ABS input will be pulled above 6.5 volts when the load is 3,000 ohms or greater.
- The ABS indicator will not light with 8 milliamperes of leakage into the ABS controller.
- The ABS indicator will not flicker when the 500-microsecond test pulse occurs (every 14 seconds).
- The input will not source current when the ignition is off.

To prevent a flash when the ABS controller goes into the self-conducting mode, the telltale will turn off immediately when the ignition is turned off.

5.7 Voltage Regulation Characteristics

CHARACTERISTIC	REFERENCE	TEST CONDITIONS
Normal Operation	SAE J1455, Sec. 4.11.1.1.1	Minimum: 9 volts Maximum: 16 volts
Cold Cranking	SAE J1455, Sec. 4.11.1	Voltage Variation: 5.2 to 7.8 volts Frequency: 4 Hertz Duration: 1 minute
Reverse Polarity	SAE J1455, Sec. 4.11.1	Voltage: –24 volts Duration: 1 minute Voltage: –50 volts Duration: 1 minute
Jump Start	SAE J1455, Sec. 4.11.1	Voltage: 48 volts Duration: 5 minutes
Series Charging	SAE J1455, Sec. 4.11.1	Voltage: 50.6 volts Duration: 5 minutes
Power Interruption		Battery: 1 ms off, 40 Hertz Ignition: 100 ms off, 2 Hertz
Ground Differential		Tested vehicle serial communication with ±2 volt differential on Battery ground.
Input Short Circuit		Backlighting, switched-to-Battery, switched-to-ground, J1708, and analog inputs shorted to ground and power.
Sneak Paths		With ignition off, tested for voltage or current feedback on connector pins.

Table 5-4 *Voltage Regulation Characteristics*

5.8 Electromagnetic Interference Characteristics

CHARACTERISTIC	REFERENCE	TEST CONDITIONS
EMC Susceptibility	SAE J1113/21 SAE J1812	Functional Status Classification: B (10 KHz to 1 GHz) Performance Requirements: L3 (100 v/m) - Region II L2 (80 v/m) - Region II L1 (50 v/m) - Region I
EMC Radiated Emissions	SAE J1113/41 Sec. 8 and 9	Performance Class: 3 10 KHz to 1 GHz

Table 5-5 *Electromagnetic Interference Characteristics*

6 Environmental and Reliability Specifications

6.1 Environmental Specifications

CHARACTERISTIC	REFERENCE SPEC	CONDITIONS
Thermal Cycle	SAE J1455 Sec. 4.1.3.1	Temperature Limits: –40 to +85 C 12 eight-hour cycles Duration: 96 hours (4 days) Voltage: 16 volts
Thermal Shock	SAE J1455 Sec. 4.1.3.2	Temperature Limits: –40 to +85 C 24 Cycles, 2 hours hot, 2 hours cold Duration: 4 days Voltage: Day 1 = 9 volts Day 2 = 13.8 volts Day 3 = 16 volts Day 4 = 9 volts
Humidity	SAE J1455 Sec. 4.2	95% RH,15 to 38 C Temperature Range: –40 to+85 C Frost: every third cycle at –40 C Duration: 20 eight-hour cycles (7 days) Voltage: 16 volts
Mechanical Vibration		Random Acceleration Frequency Range: 5 to 500 Hertz Power Spectral Density Level: 0.0635 G^2/Hz, 5 to 100 Hz, 3db roll-off to 500 Hz Test Level: 4.0 G Duration: 3 hours each plane (X, Y, Z)
Operating Shock	MIL-STD 202F Method 213B Test Condition J	Three shocks in each direction in each axis, 18 shocks total Peak Value: 30 G Duration: 11 ms Waveform: half-sine Velocity Change: 6.8 feet per second
Dust		Portland Cement Dust Concentration: 0.88 g/m Duration: 24 hours
Splash	SAE J1455 Sec. 4.4	Window cleaner, wax, detergent, water

Table 6-1 *Environmental Specifications*

PARAMETER	SPECIFICATION
Gauge Accuracy	±2 percent of range
System Accuracy	±2 percent of range
Fuel Gauge System Accuracy	Empty: –9% to 0% of range Full: 0 to +9% of range

Table 6-2 *Reliability and Accuracy Specifications*

6.2 Serviceability

The instrumentation maximizes serviceability. No specialized tools are required to install or remove the components from the vehicle. None of the individual modules are serviceable at the field or dealer level. If a component is deemed defective, it is simply replaced.

To help verify the operational status of individual components, the instrumentation includes diagnostics that can be used at the user or dealer level. These are described in detail in Chapter 3.

END OF DOCUMENT