

**Product Specification,
Next Generation
Instrumentation (NGI™)**

072-40337-A

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1 Introduction

1.1 Purpose and Scope

This product specification describes the capabilities of the Next Generation Instrumentation (NGI™) system. It includes standard and optional components and functionality; physical, electrical, and environmental characteristics; and interfacing diagrams. This document is generic and is not specific to any particular installation. Its purpose is to provide the basis for specifying an application-specific instrument system.

1.2 Options and Deviations from Generic Product

Optional configurations, functionality, and cosmetics are listed in each section where applicable, and must be specified at time of order.

1.3 Overview

The NGI System consists of gauge and display modules that provide vehicle speed, engine rpm, and other vehicle operational status to the driver. NGI modules are available as individually mounted, cased-gauges for panel-mounting. NGI technology can also be integrated into one or more clusters. The NGI System operates on a supply from 9 to 30 volts DC and communicates with the vehicle using a combination of discrete analog or switched inputs and/or data from the vehicle data bus. All NGI modules that connect to the vehicle data bus fully comply with the SAE specification for that particular bus.

1.4 How to Use This Specification

Chapter 1, Introduction - Overview, references, common abbreviations, etc. are provided in this chapter.

Chapter 2, Functional Description - Chapter 2 introduces and briefly describes the modules that make up the NGI System, their functions, and how they interconnect with each other.

Chapter 3, Module Specifications - This chapter describes each module in detail, specifying its generic configuration, input capabilities, appearance, and optional configurations.

Chapter 4, Electrical Specifications - Detailed wiring diagrams of NGI modules and their input signal specifications

Chapter 5, Mounting Specifications - Detailed dimensions including mounting hole requirements and removal/reinstallation instructions

Chapter 6, Environmental and Reliability Specifications

1.5 Reference Documents

1.5.1 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*

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

1.5.2 Interface Specifications

SAE J1587, Revision 1996-03 - *Joint SAE/TMC Electronic Data Interchange between Microcomputer Systems in Heavy Duty Vehicle Applications*

SAE J1708 (October 1993) - *Serial Data Communications between Microcomputer Systems in Heavy Duty Vehicle Applications*

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

1.6 Regulatory Agencies

Federal Motor Vehicle Safety Standards (FMVSS)

1.7 Abbreviations and Terminology in This Document

- **AN Display** - *Alphanumeric Display*, a part of the NGI System that provides visual feedback to the user
- **Buzzer** - An audio emitter within the NGI system 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 measures less than two ohms resistance between it and the battery ground terminal when using a properly zeroed ohmmeter on its $\times 1$ range. 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 NGI System are LEDs.
- **MID** - Message Identification, a unit of data on the J1587 public bus
- **Module** - Any gauge or display device connected to the NGI bus
- **NGI** - *Next Generation Instrumentation*
- **NGI Bus** - An internal and proprietary bus within the NGI System that supplies power, ground, backlighting, and data to NGI modules
- **NGI System** - The NGI module complement that makes up the instrumentation
- **Panel** - Panel into which the NGI modules are mounted
- **PID** - Parameter Identification, a unit of data on the J1587 public bus
- **Public Bus** - The communications protocol specified by SAE J1587 or J1939.
- **SCU** - *System Control Unit*, the NGI System's ECU
- **Vehicle Data Bus** - See Public Bus

2 Functional Description

The NGI System collects data from the vehicle data bus, analog sensors, and switches throughout the vehicle and presents the data using gauges, telltales, and other displays. Figure 2-1 shows how the NGI modules interact with each other and with the vehicle.

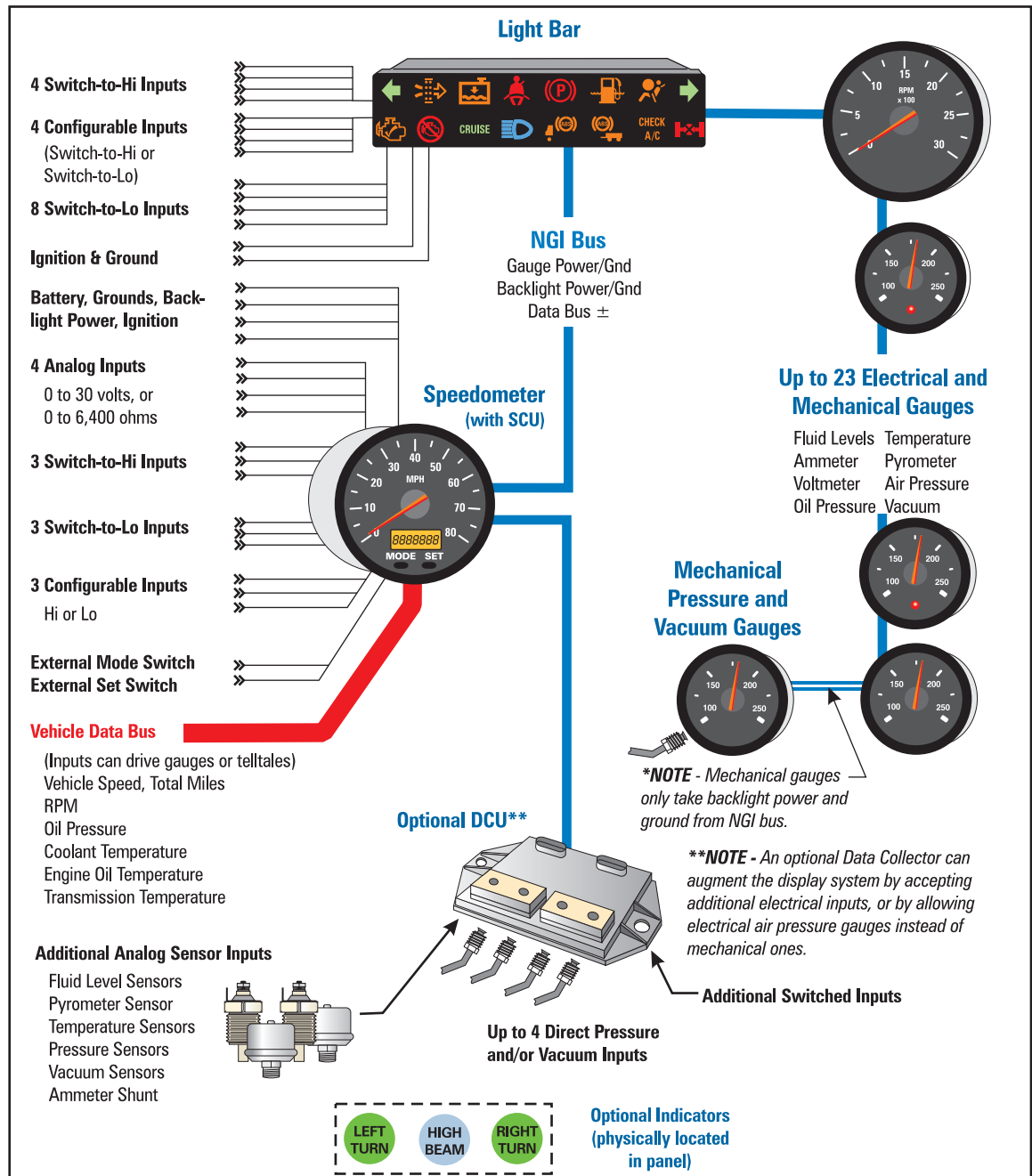


Figure 2-1 Functional Block Diagram

2.1 Vehicle Data Bus

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 SCU is connected to the vehicle data bus and uses data from it to drive NGI modules.

The system complies with SAE J1587/1708 and/or SAE J1939 specifications.

2.2 NGI Bus

The NGI bus is a pair of wires that originates at the SCU; it carries data from the SCU to the NGI modules through NGI cable assemblies. Inside the speedometer, the NGI bus is connected to the speedometer pointer drive electronics and to the Alphanumeric Display. The NGI bus is brought outside the speedometer housing on two six-pin connectors that are wired in parallel. Each NGI module also has a pair of these six-pin NGI connectors to propagate the bus to the next module.

2.3 NGI Cable Assemblies

NGI cable assemblies distribute the NGI bus, module power and ground from the SCU, and module backlighting power and ground from the SCU to all modules. NGI cable assemblies are available in various lengths (see Figure 4-1 on page 4-1). Up to 23 NGI modules can be connected to the NGI bus at one time.

Caution: The NGI bus is a proprietary data bus designed to control NGI modules. Neither it nor the other signals in the NGI cable are designed to control or power non-NGI modules or other customer-supplied equipment. Doing so can adversely affect the operation of the NGI System, reduce its reliability, or cause permanent damage to the system.

2.4 System Control Unit (SCU)

Responding to messages on the vehicle data bus and to discrete inputs, the SCU conditions and processes the external data into data that can drive the NGI modules. The SCU is connected to battery plus, battery ground, battery plus through the ignition switch, and to the vehicle's backlighting power source and ground. The SCU also supplies the power and ground for the NGI modules.

2.4.1 SCU Inputs

In addition to vehicle data bus inputs, the SCU accepts discrete analog and switch inputs to display temperature, pressure, fluid levels, and switch-sensed conditions. A detailed description of all SCU inputs is given in Chapters 3 and 4.

2.4.2 SCU Options

The following SCU options are available:

- **Location** - Can be located inside the tachometer housing, or inside a dedicated housing as a stand-alone module
- **Bus Compatibility** - SAE J1708 and J1939 versions

2.5 Speedometer

The speedometer receives its speed data from an internal connection to the NGI bus. Pointer drive electronics convert the data into stepper motor drive signals to position the speedometer pointer. In standard configurations (see Figure 2-1 on page 2-1), the speedometer also houses the following:

- SCU
- Audible warning device
- Mode and set switches
- Alphanumeric Display

2.5.1 Speedometer Options

The following options are available:

- **Shallow-Depth Case** - If the SCU, mode and set switches, and the Alphanumeric Display are located elsewhere, the speedometer can be housed in a case that is about 1.3 inches shallower than the standard case (see Figure 5-1 on page 5-1).
- **Size** - Available in 3³/₈- or 5-inch formats

2.5.2 Audible Warning Device

Sometimes called the buzzer, the audible warning device is mounted inside the speedometer housing and receives its power and drive signals from the SCU over the NGI bus. The SCU turns the buzzer on when it first displays a warning message and turns it off when the condition causing the warning message no longer exists, or when the user acknowledges the warning message.

2.5.2.1 Buzzer Options

The buzzer's on- and off-times are controlled by the SCU, and the buzzer 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**

2.5.3 Mode and Set Switches

The mode and set switches select which function is displayed by the Alphanumeric Display. They are also used to acknowledge messages, reset the trip odometers, scroll through diagnostic messages, and perform the diagnostic tests described in Section 2.9 on page 2-5.

2.5.3.1 Mode/Set Switch Options

The switches can be remotely mounted if specified at time of order.

2.5.4 Alphanumeric Display

The AN Display is a seven-digit, multi-segment, amber backlit, liquid crystal (LC) display. Connected to and receiving its data from the SCU over the NGI bus, it displays information similar to that shown in Figure 2-2.

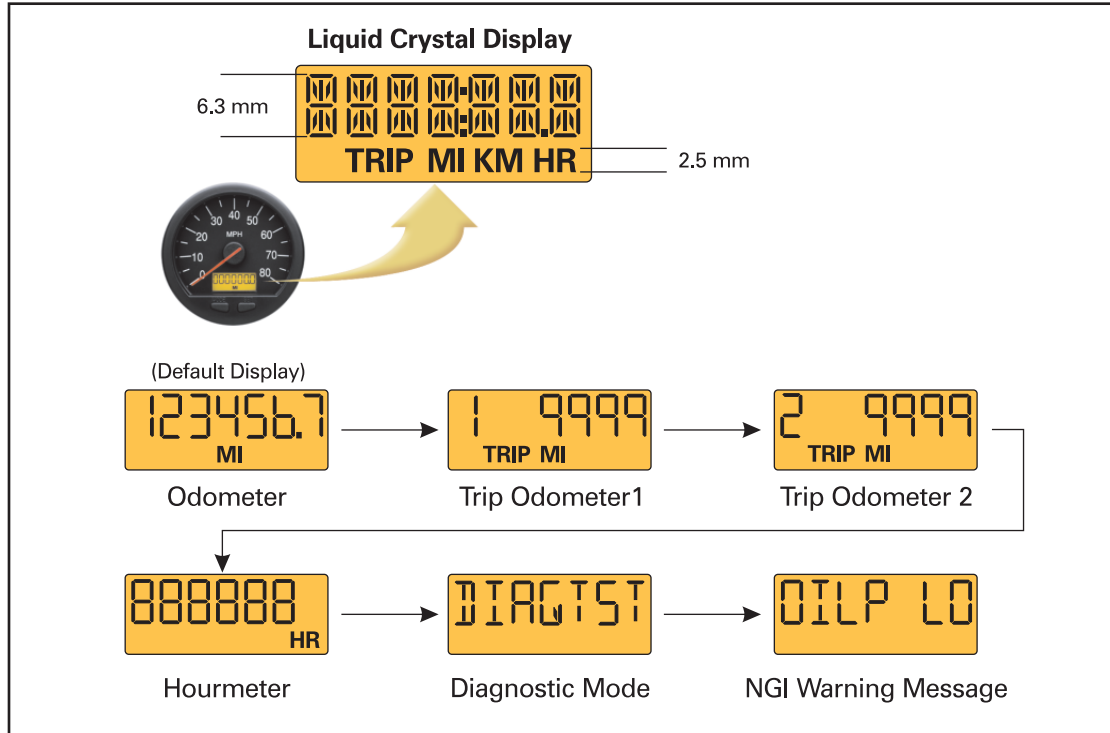


Figure 2-2 Standard Alphanumeric Display Functions

2.6 Electrical Gauges

All electrical gauges are connected to the NGI bus and each one contains a microprocessor that receives pointer position and warning LED data from the SCU. The microprocessor also performs the gauge's initialization (calibration) routine each time power is applied. Electrical gauges include all gauges except mechanical air pressure and vacuum gauges.

2.7 Mechanical Air Pressure Gauges

Mechanical air pressure and vacuum gauges can be used in place of electrical gauges when pressure transducers are not desired or available. These gauges contain a Bourdon tube pointer actuator and connect directly to air pressure or vacuum sources, eliminating the need for a remote data collector. They do not contain warning LEDs, are not calibrated during the power-up initialization, and cannot be manually tested using the mode and set switches. However, because they draw their backlighting power from the NGI bus they are included in the 23-module limitation.

2.8 Light Bars

2.8.1 Standard Light Bar

The standard light bar contains 16 individually controlled telltales, each illuminated by one LED. Internal baffling prevents light spillover to adjacent telltales. The LEDs can be controlled by switched inputs direct to the light bar, or by the SCU over the NGI bus, or both (logical OR).

2.8.2 Light Bar Options

Telltale icons are printed on a decal. No “standard” decal exists, and the layouts shown in this document are only examples. Icon design, color, and placement are unique to each application and decals are manufactured to customer specifications.

Light bars accept a variety of inputs and offer great flexibility in telltale control. Please refer to Section 3.2.9 on page 3-14 for more information about light bar configurations.

2.9 Calibration and Diagnostic Capabilities

2.9.1 Calibration

Each time power is applied to an NGI module, its microprocessor performs an initialization sequence. This provides the user with a quick visual check of its operation, and also calibrates the pointer to the gauge’s zero reference point. The standard power-on initialization sequence is shown in Figure 3-13 on page 3-23.

***Note** - Mechanical pressure gauges do not perform an initialization sequence and have no diagnostic capabilities.*

2.9.2 System Diagnostics

In addition to the power-on initialization and calibration sequence, the NGI System contains menu-driven diagnostic functions. Using the mode and set switches the user can check all modules simultaneously, or select and check individual modules. A fault-polling function displays the most recently stored fault codes.

Each of these capabilities are explained in detail in Chapter 3.

2.9.3 Additional Fault Indications

The NGI System will give the indications in Table 3-1 on page 3-20 (**NO SPEEDO** , **NO HRS** , **NO ODO** , **NO DATA**) if it detects a problem with associated sensors, wiring, or other system inputs.

3 Module Specifications

3.1 General Information

This chapter describes each available module in the NGI System along with its input specifications and options. Warning messages, telltales, and gauge warning LED functionality are also described with their options.

3.1.1 Dial Configurations

Three dial configurations are available:

- **U.S.** - This is the standard configuration. Speed and distance are shown in miles, pressure is shown in pounds per square inch, and temperature is shown in Fahrenheit degrees.
- **NAFTA** - This optional configuration is identical to the standard configuration except speed and distance are shown in kilometers.
- **Metric Option** - In this optional configuration, speed and distance are shown in kilometers, pressure is shown in kiloPascals, and temperature is shown in Celsius degrees.

3.1.2 Parameters Common to All Modules

3.1.2.1 Case Construction, Mounting, and Connectors

Module cases are made of white, high-impact, ABS plastic. All gauges have glass lenses with rubber O-ring seals. Gauge bezels are made of high-impact ABS plastic and are provided with the finishes shown in Figure 3-1 on page 3-4.

All NGI modules mount through the front of the panel. Two-inch gauges have twist-to-lock retaining rings and require no tools to mount. Larger gauges and the light bars are retained by metal U-brackets and Torx-head screws. All display modules have a physical index tab for alignment purposes.

All modules contain two NGI bus receptacles (wired in parallel) that pass the NGI bus through to other NGI modules. All electrical connectors are uniquely polarized to prevent wrong connections and have locking tabs to prevent unintentional separation.

3.1.2.2 Dials and Graphics

Standard dials are black with white graphics as shown in Figure 3-1 on page 3-4. White dials with black or other colored graphics are optional. LEDs provide even backlighting with no hot spots or light leaks, and their brightness can be varied by pulse-width-modulated or variable resistance dash light dimmer controls. Standard backlighting color is amber; other colors (red, blue, green, and white) are optional.

3.1.3 Pointers

Pointers are clear plastic and are foiled to give a "day-glow orange" color. An internal red LED provides hub-to-tip illumination when backlight power is applied. Pointer

hubs are black. All gauge pointers except mechanical air pressure gauge pointers are driven by stepper motors. Standard pointer rotation is 250° clockwise from zero to full scale, with mid-scale at the 12:00 o'clock position. Ranges (zero and full scale values) vary according to the gauge.

3.1.4 Gauge Warning LEDs

All gauges except the speedometer and mechanical pressure gauges contain a red warning LED. When on, warning LEDs are easily visible in daylight, but will not prevent the driver from reading the gauge at night. The LED apertures in the dials are dead-fronted to conceal the LED when off.

3.1.5 Automatic Pointer Re-Zero

All gauges (except mechanical pressure gauges) re-zero their pointers each time power is applied.

3.1.6 Loss-of-Data Indication

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

3.1.7 Data Out-Of-Range Indication

The SCU is programmed at the factory with specific parameters for each gauge. One of these parameters is the valid input range. If the input (voltage or resistance) to the SCU for a particular gauge is out of range, the SCU detects that condition and presents it to the operator by flashing the gauge's warning LED and positioning its pointer to minimum or maximum scale.

On a gauge whose pointer deflection is directly related to the gauge's sensor output (i.e. the greater the input voltage or resistance, the greater the deflection), the SCU 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 SCU 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.

3.1.8 Analog Input Filtering

All analog inputs are filtered to reduce fluctuations in pointer movement. The filter values can be set differently for each input and can range from 0 to 255. This value determines how much filtering is applied to an individual input for both pointer movement and warning devices (gauge warning LED, telltales).

3.1.9 Customer Specifications

The customer provides the following specifications for each gauge when a custom appearance or operation is desired:

- Dial graphics
- Sensor input (vehicle data bus or direct connection to SCU)
- Sensor-out-of-range pointer movement
- Sensor-out-of-range LED operation
- Warning LED turn-on and turn-off points
- Non-linear input curve data
- Input filtering (see Section 3.1.8)

3.1.10 Gauge Options

The following options are configurable at the factory and should be specified by the customer when different from standard product (see Figure 3-1 for illustration):

- **Dial Configuration** - NAFTA or metric
- **Range** - Custom ranges and non-linearity compensation
- **Pointer Sweep** - Custom sweep angles up to 270°
- **Pointer Rotation Direction**
- **Backlight Colors** - Red, green, blue, and white
- **Dial Graphics, Style, Colors** - Background color; arc and tick dimensions, positions, and color; character typeface and color; single or dual scales; logos, icons or other special graphics
- **Bezel Finish** - white, satin chrome, bright chrome, bright gold
- **Bezel Profile** (cross-section cut)
- **Warning LED Color and Activation**

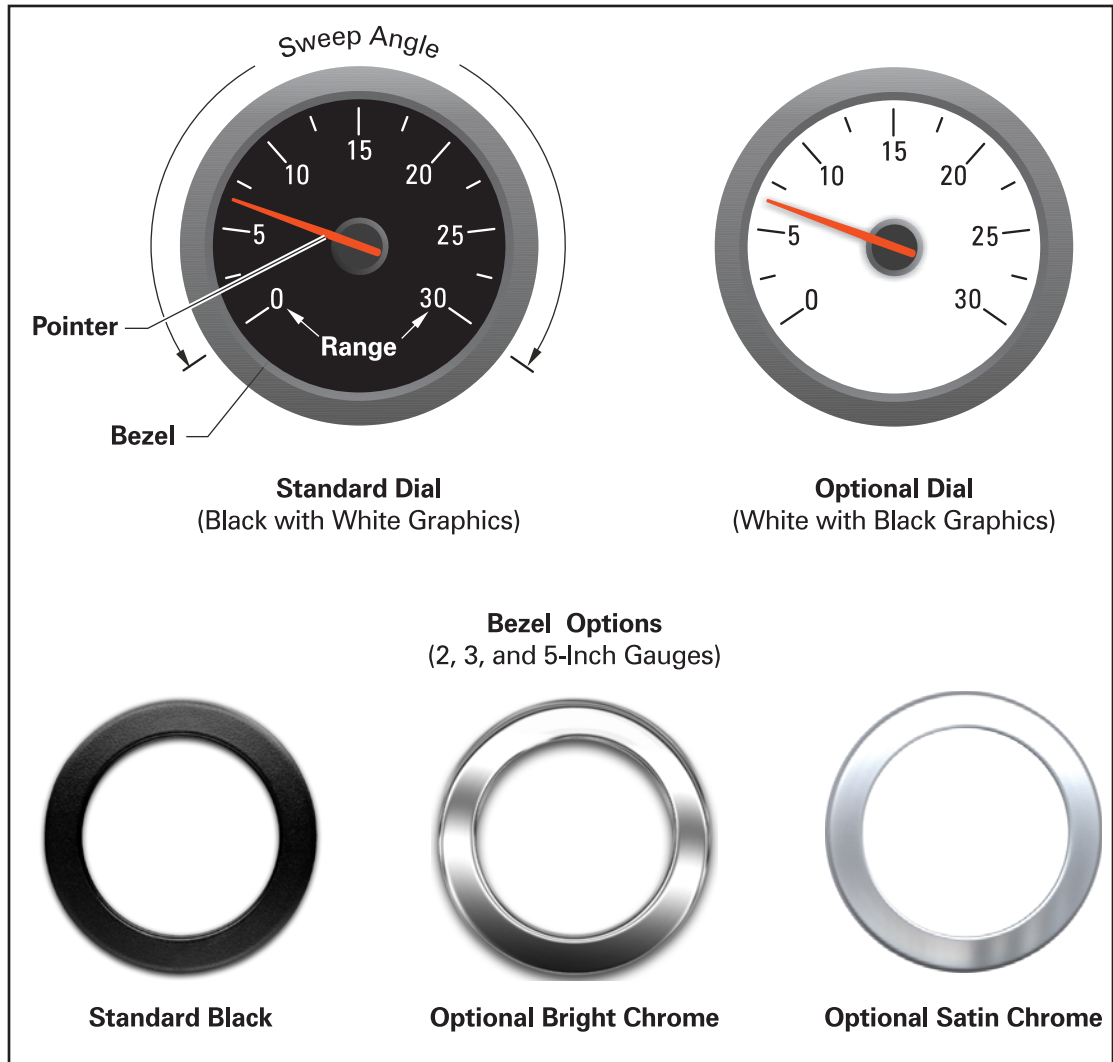


Figure 3-1 Gauge Options

3.2 Available Modules

3.2.1 Speedometers

Speedometers are available in 3³/₈- or 5-inch case diameters. All speed data is received from the vehicle data bus through the SCU.

In standard NGI systems, the speedometer houses the SCU, the AN Display, an audible warning device (i.e., the *buzzer*), and the mode and set switches. Speedometers do not contain warning LEDs.

Dials are shown in Figure 3-2. The standard dial is 0 to 80 MPH with no secondary scale. Dual-scale dials with primary and secondary graduations are available. Special graphics and logos can be specified.

3.2.2 Tachometers

Tachometers are available in 2-, 3³/₈-, or 5-inch case diameters. All engine RPM data is received from the vehicle data bus through the SCU. Tachometers contain a dead-fronted warning LED, but the LED remains off unless otherwise specified. Standard tachometer dials are shown in Figure 3-3.

3.2.3 Pressure Gauges

Oil pressure gauges can receive their data from the vehicle data bus through the SCU. They, and other pressure gauges, can also receive their data from pressure transducers connected to the SCU's analog inputs. In such cases, a converter that converts direct pressure or vacuum into electrical signals or resistance is required

Standard pressure dials are shown in Figure 3-5 on page 3-9 (English) and Figure 3-6 on page 3-10 (metric). Response curves must be specified by the customer at time of order.

The pressure at which the gauge warning LED turns on to indicate low (or high) pressure varies according to the application (for example, oil pressure = 15 psi, air pressure = 65 psi) and is specified by the customer for each pressure gauge.

Mechanical air pressure gauges are also available and do not require any converter. They contain Bourdon tube pointer movements instead of stepper motors, they do not contain warning LEDs, perform no power-on calibration, and cannot be tested using the mode and set switches. They appear identical to other NGI gauges and connect to the NGI bus only to obtain backlight power and ground.

Air pressure fittings (screw-on, press-to-connect, etc.) are specified by the customer.

3.2.4 Temperature Gauges

Temperature gauges receive their data from temperature sensors with discrete analog connections to the SCU, from the vehicle data bus through the SCU, or from the NGI bus through a data converter such as that described in Section 2.9 on page 2-5. Standard English and metric temperature dials are shown in Figure 3-7 on page 3-11.

Standard SCUs accept temperature sensors having a resistance range from 80 to 400K ohms. The desired response must be specified by a resistance curve (see example in Figure 3-10 on page 3-12).

The temperature at which the gauge warning LED turns on to indicate high or low temperature (or both) varies according to the application (water temperature, oil temperature) and is specified by the customer.

3.2.5 Fuel Level Gauge

Fuel level gauges commonly receive their data using a resistive input from a level sensor in the fuel tank connected to one of the SCU's analog inputs. Standard dials are shown in Figure 3-8 on page 3-11. The desired response must be specified by a resistance curve (see example in Figure 3-11 on page 3-13).

When the fuel level sender signal indicates $\frac{1}{8}$ tank or less, the SCU will turn the warning LED on to indicate low fuel. Hysteresis is employed to eliminate erratic indications due to tank slosh.

3.2.6 Voltmeters and Ammeters

Voltmeters can be configured to obtain their data either from the vehicle data bus through the SCU, from an analog input to the SCU, or directly from the SCU. The latter method requires no connector input because the SCU uses the power connection at its input plug to sample the battery voltage. The warning LED is controlled by the SCU and turns on when the voltage drops below 10 volts or rises above 18 volts (below 20 and above 32 volts for 24V systems). Standard dials are shown in Figure 3-8 on page 3-11.

3.2.7 Ammeters

Ammeters receive their inputs through a discrete connection to the SCU. Although they contain warning LEDs controlled by the SCU, the warning LEDs remain off unless otherwise specified. Standard ammeter dials are shown in Figure 3-8 (page 3-11).

3.2.8 Multiple Display Modules

Gauges that display more than one parameter can be specified in $3\frac{3}{8}$ - or 5-inch case diameters to achieve a significant space savings. Such modules must be specified by the customer for parameter indicated, pointer sweep degrees and direction, pointer zero point, and desired graphics. Examples of multiple display modules are shown in Figure 3-4 (page 4).

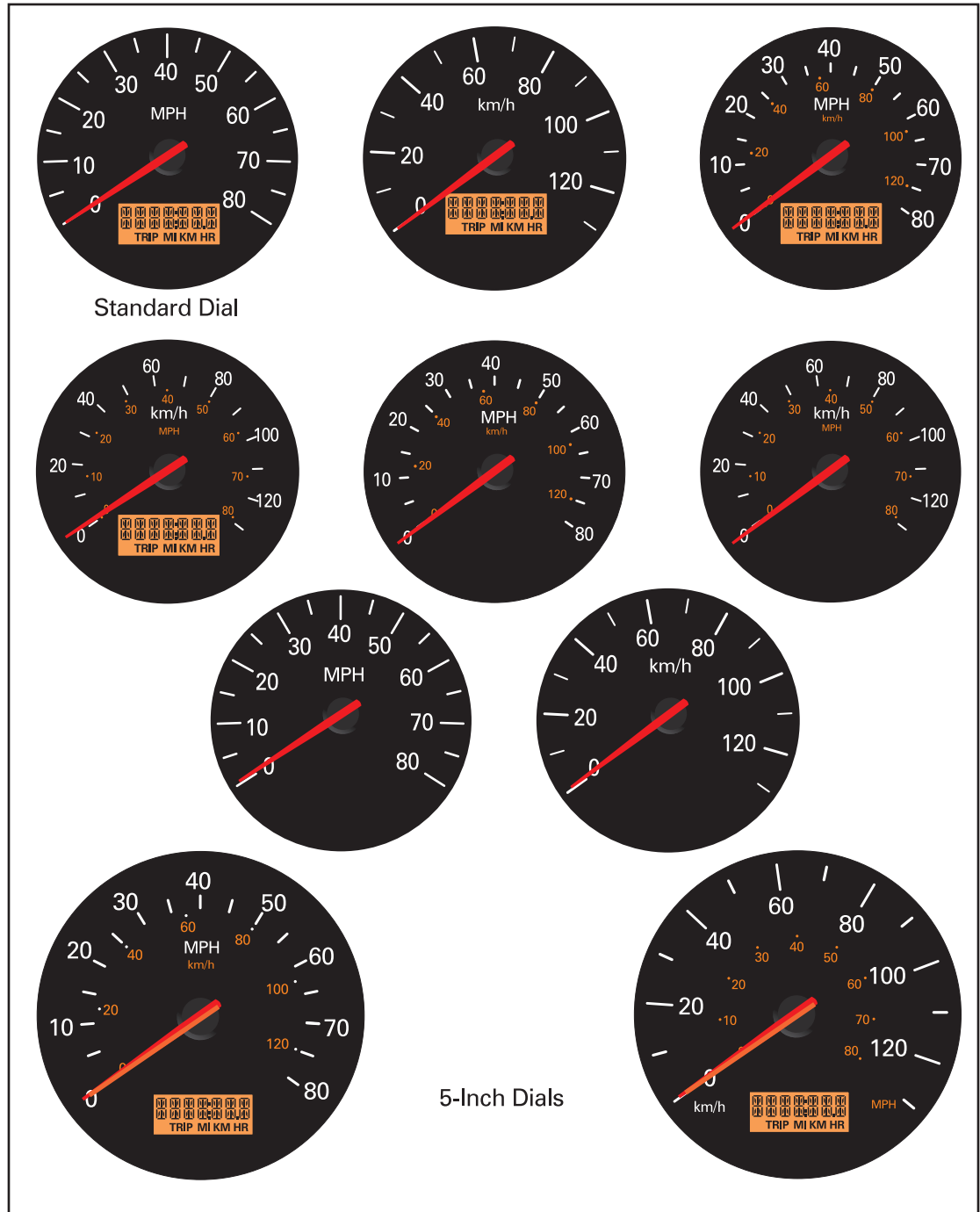


Figure 3-2 Speedometer Dials

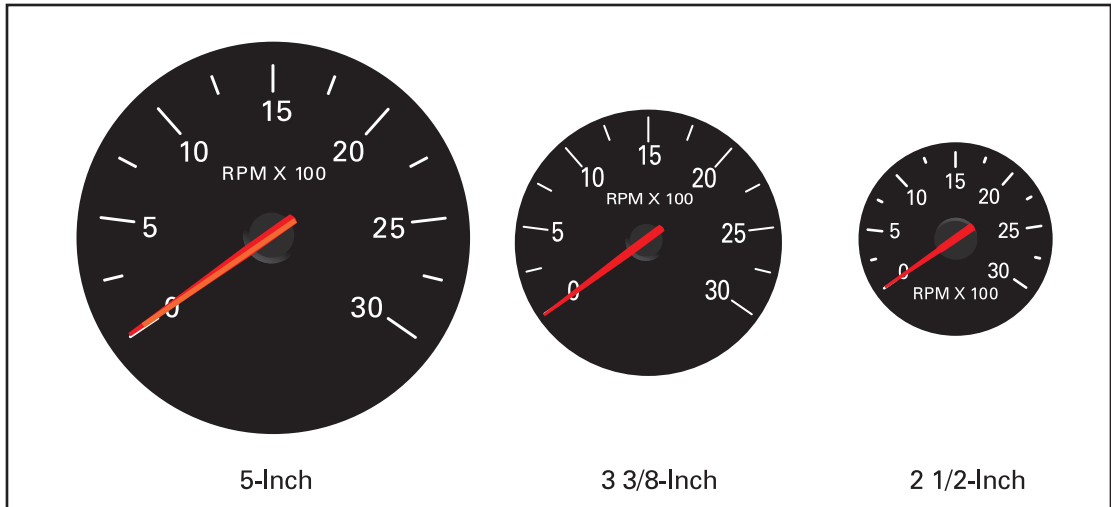


Figure 3-3 Tachometer Dials

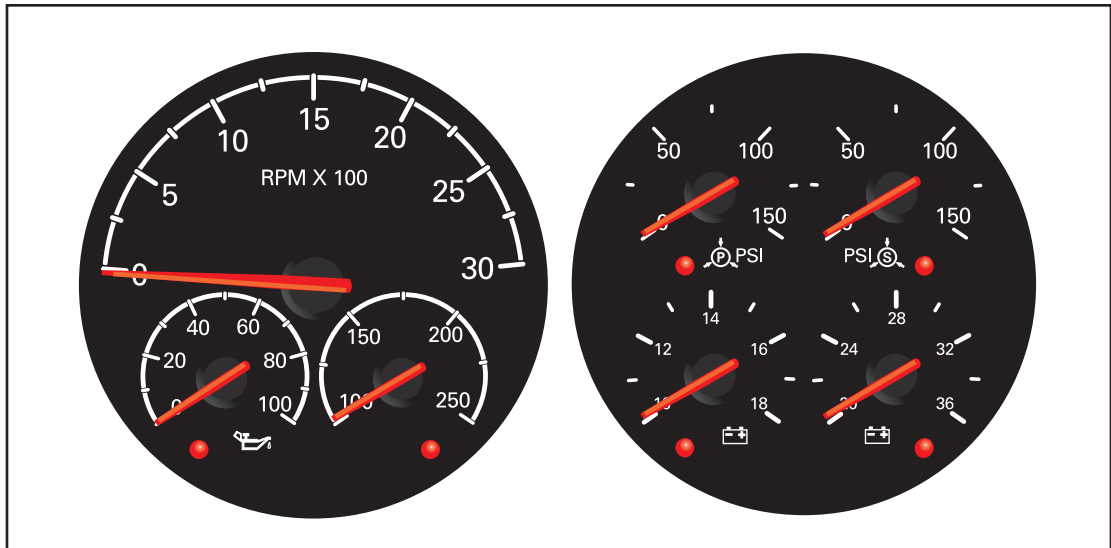


Figure 3-4 Five-Inch Combination Dials

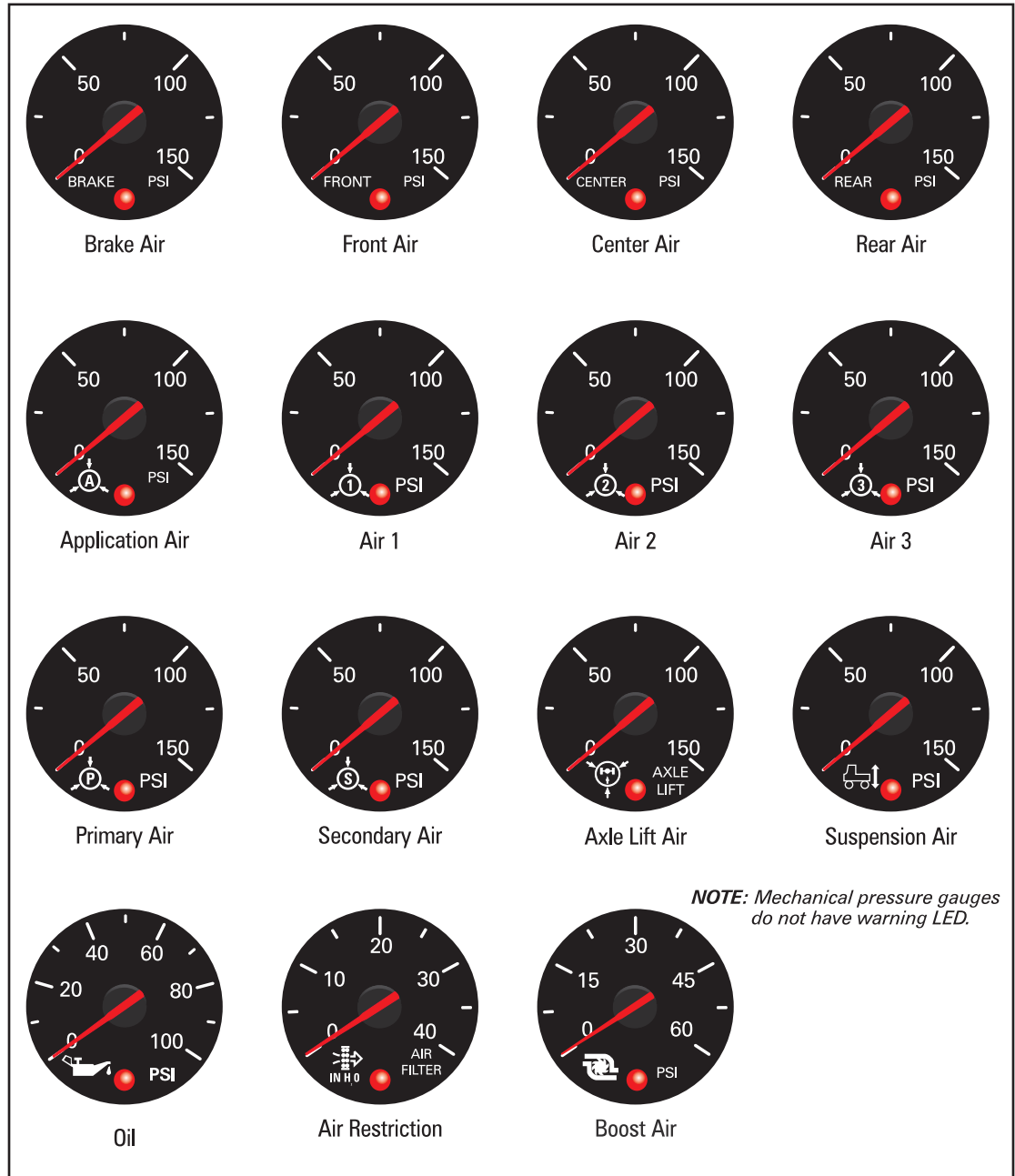


Figure 3-5 English Pressure Dials

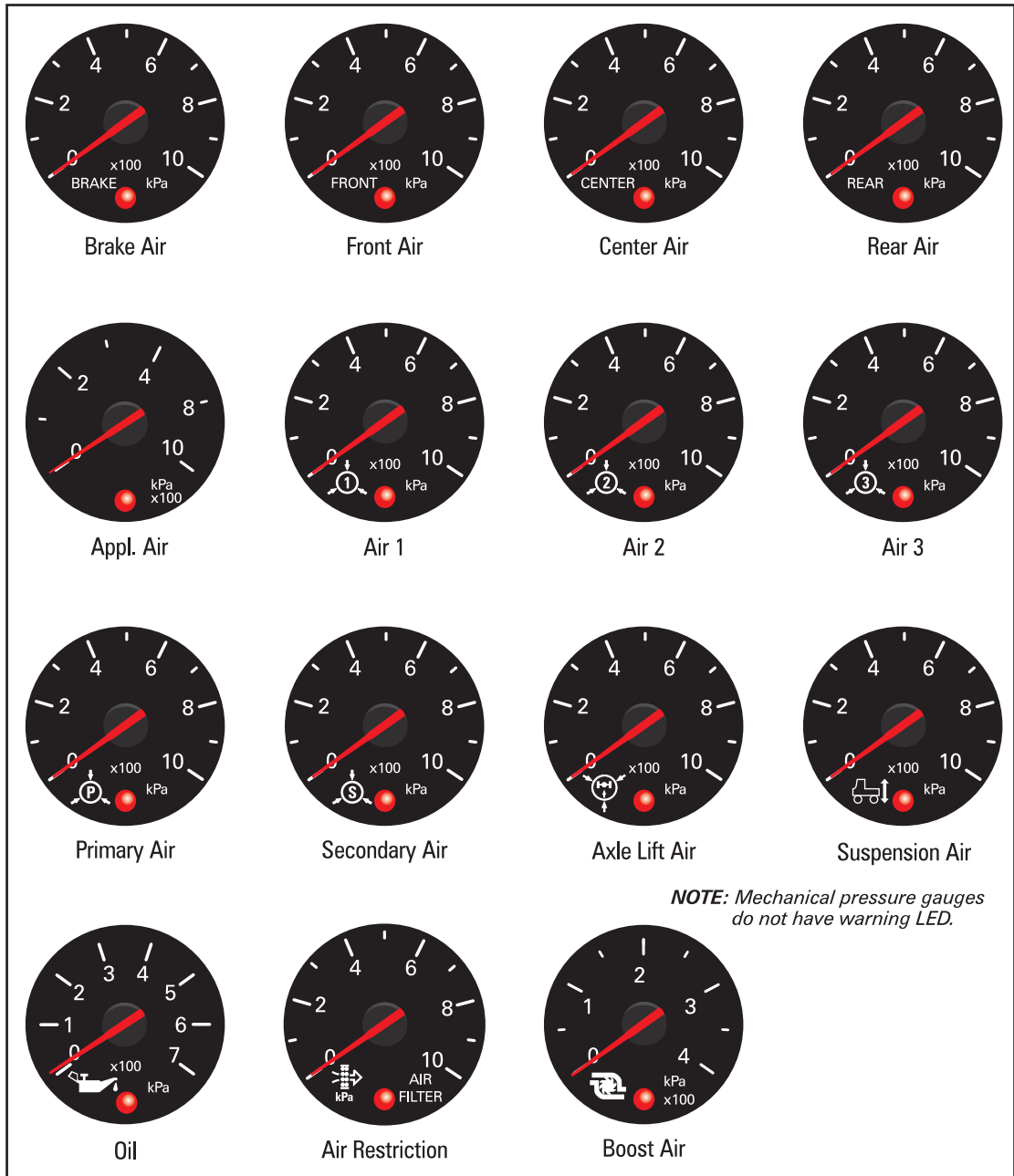


Figure 3-6 Metric Pressure Dials

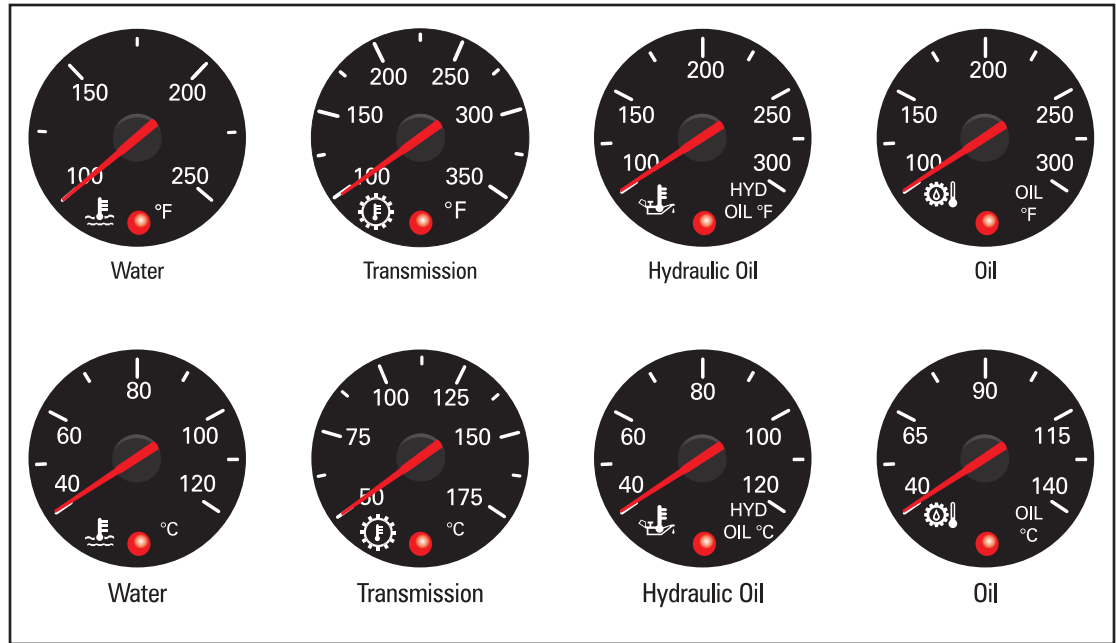


Figure 3-7 Temperature Dials

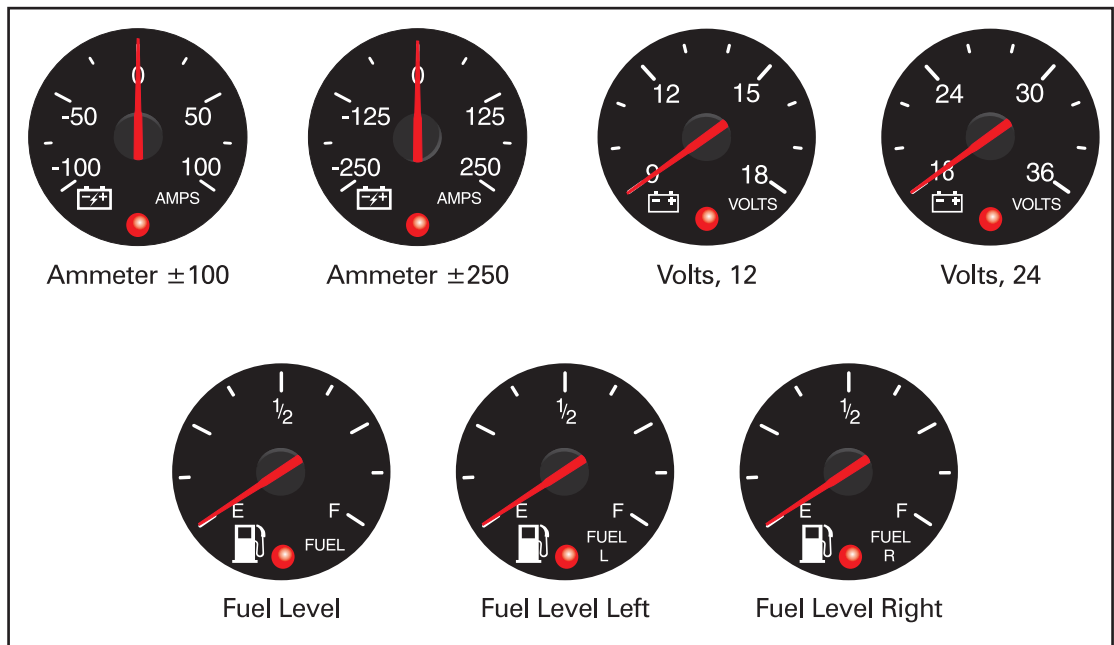


Figure 3-8 Other Standard Dials

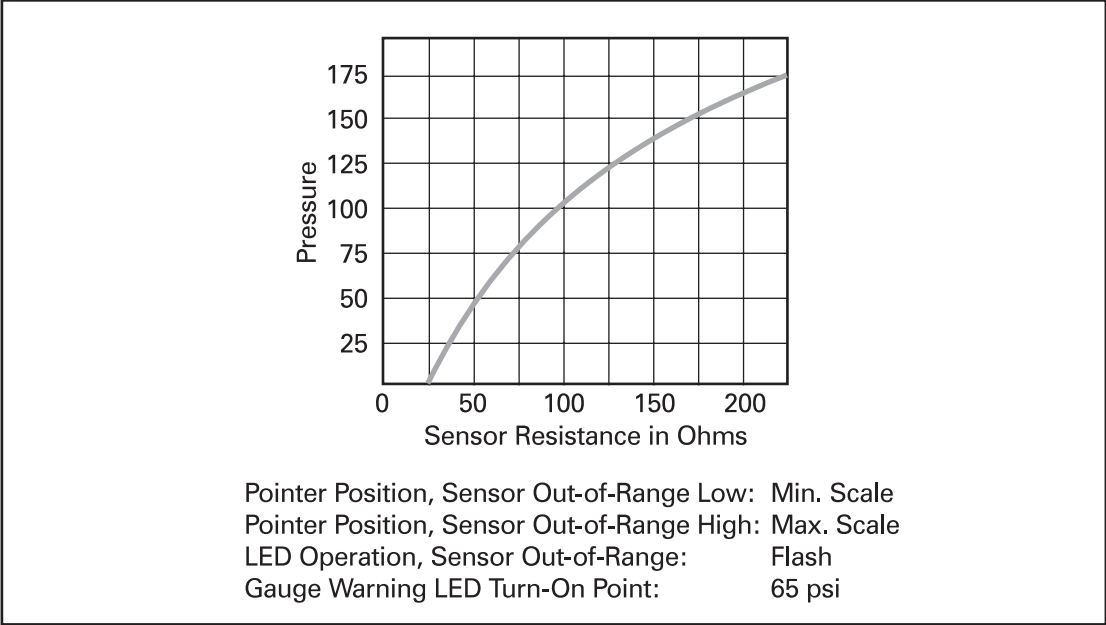


Figure 3-9 Example Pressure Sensor Output Resistance Curve

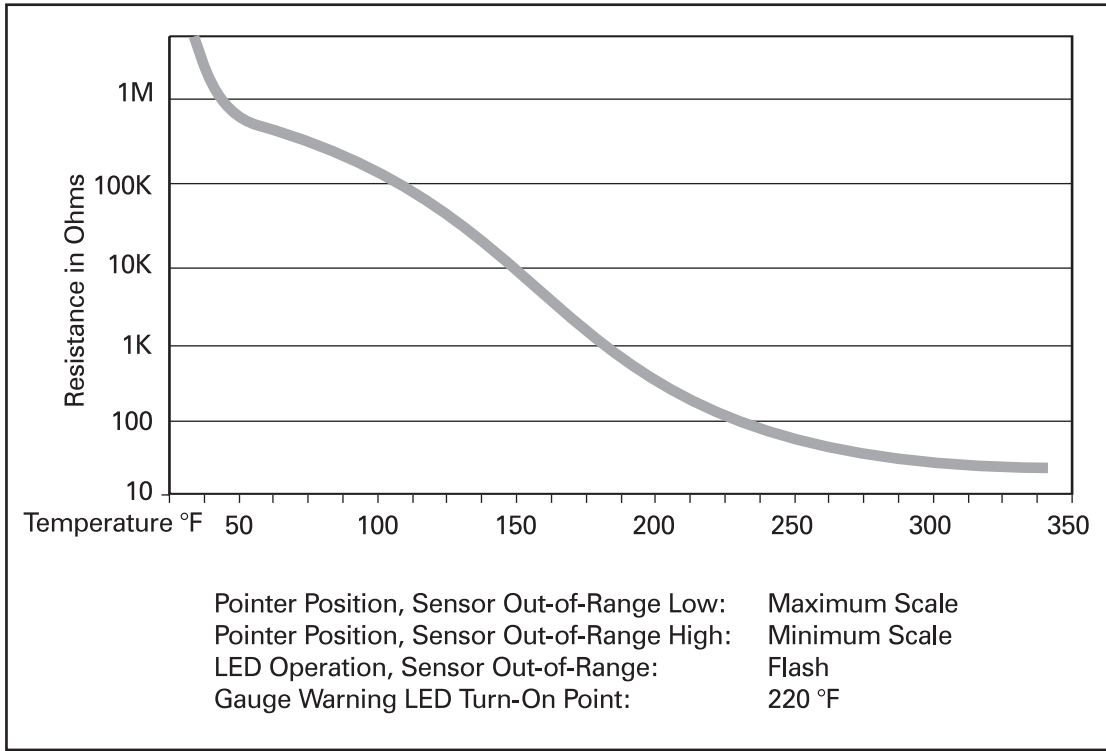


Figure 3-10 Example Temperature Sender Curve

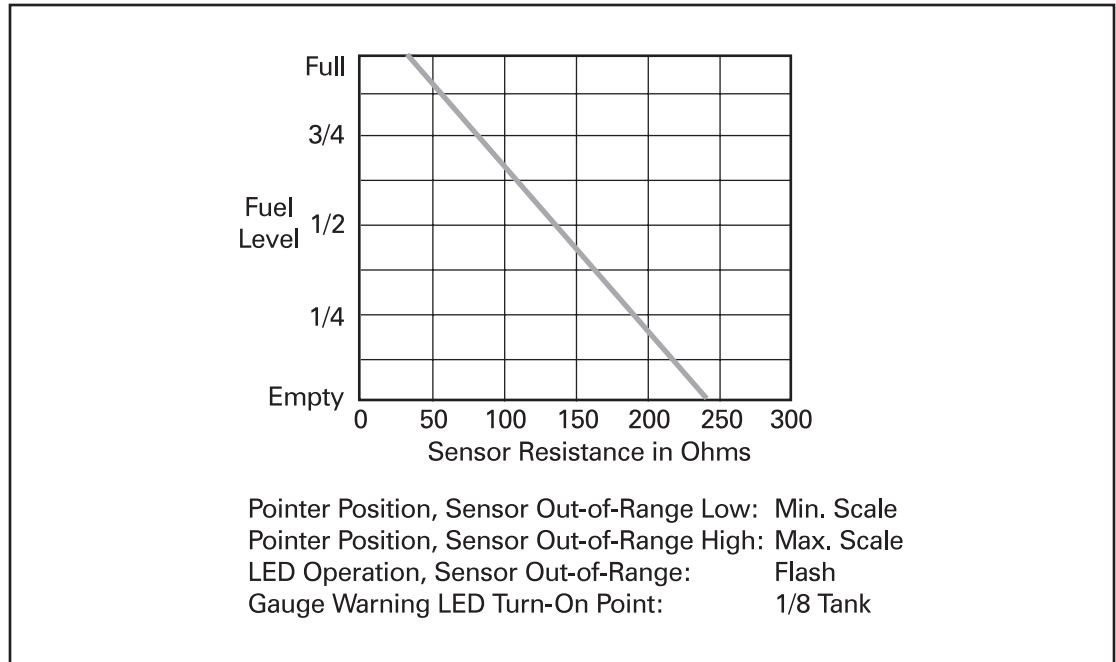


Figure 3-11 Example Resistance Curve from a Fuel Level Sensor

Note - High and low configurable inputs must not be connected at the same time to an individual telltale. Doing so and applying active high and low signals to them simultaneously may damage the unit.

- **SCU-Driven Inputs** - The SCU can control telltales over the NGI bus in any of the following ways:
 - a. Based on messages it receives from the vehicle data bus. Common examples of this are low oil pressure and high coolant temperature.
 - b. Based on discrete analog or switched inputs to the SCU and internal calculations. For example, the SCU can be programmed at the factory to light a Low Fuel telltale when the analog signal from a fuel level sender reaches some predetermined, customer-specified value, or to turn on a Coolant Level telltale when a coolant level switch opens or closes. The SCU can apply hysteresis to the input to eliminate the effects of fuel or water slosh.
 - c. 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 60 seconds later, eliminating the need for a seatbelt continuity switch.
 - d. Based on a combination of the preceding.

The customer specifies the following for the light bar and each telltale:

- Number and physical characteristics (size, shape) of light bars
- Positions, color, and design of each icon
- Control Method: switch input directly to light bar, from SCU, or combination thereof
- Active state for switched inputs to light bar (low, open, or high)
- If the telltale is controlled by the SCU, the data input to the SCU (vehicle data bus, direct switch or analog input, or internally programmed delay)
- Power-on initialization display pattern (all at once, alternating checkerboard pattern, etc.)

3.3 Alphanumeric Display

The AN Display is a backlit, positive-mode liquid crystal display (LCD) located in the speedometer. The following displays and functions can be selected:

- Odometer (default function in standard systems)
- Two Independent Trip Odometers
- Engine Hourmeter
- Diagnostic Test Mode

Unnecessary functions (for example, the odometer and trip odometers in stationary applications) can be disabled at the factory so that they do not appear.

3.3.1 Default Display or Function

The default display or function is that which appears after the power-on initialization sequence is complete and after any unacknowledged messages have been displayed. It is factory-programmed to the customers' specification. If unspecified, the default function is the odometer. The odometer, trip odometer, and hourmeter displays will revert to the default function 15 seconds after the mode switch was last pressed.

3.3.1.1 User-Defined Default Function

This option causes the last selected function to become the default function.

3.3.1.2 Persistency Option

Normally a function is active, or persists, for 15 seconds after the mode or set switch is last pressed. After 15 seconds it is automatically replaced by the default function. The persistency option causes the last selected function to remain active (also through ignition off/on conditions) until the user presses the mode switch, which then returns the display to the default function.

3.3.2 Custom Messages

The wording in these functions and displays cannot be altered. However, the customer can define up to 30 additional messages and the conditions under which they will appear. Each user-defined message can contain up to seven characters and is stored in and controlled by the SCU. A Reset message (see Section 3.3.6.4.3 on page 3-16) is a typical application for custom messages.

3.3.3 Odometer Display and Function

The odometer displays the vehicle odometer without leading zeros and up to **999999.9**, to the nearest tenth. After that, the decimal point is dropped and the display rolls over to **1000000**, continues to **9999999** and then rolls over to **0.0**.

Pressing the set switch while the odometer is displayed toggles the units of distance between miles and kilometers. The selected units of distance will stay set through ignition cycles.

The vehicle odometer value is stored in an EEPROM in the SCU and is not resettable. The value is calculated, stored, and displayed using one of the following methods:

- **Direct from Databus** - The SCU displays the total vehicle distance (TVD) value broadcast by the Engine ECU on the vehicle data bus.
- **Speed Integration Method** - When the ignition is switched on, the SCU retrieves the current odometer value stored in the SCU EEPROM. The SCU then calculates a new current odometer value according to the

formula $D=RT$ and updates the display every half second. Every 20 miles and every time the ignition is switched off, the SCU stores the current odometer value in the EEPROM.

- **Match Method** - When the ignition is switched on, the SCU retrieves the current odometer value from the EEPROM and compares it with the TVD on the vehicle data bus. If the two are within 0.2 miles of each other, the SCU displays the current odometer 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 in the EEPROM.

Various options exist to deal with cases where the values do not match. These should be discussed with AMETEK and it is up to the customer to specify the desired method.

The SCU will display a series of dashes (-----) whenever the odometer function is selected if:

- The SCU fails to store the its odometer reading
- Odometer data is not available from the vehicle
- The engine stops broadcasting TVD

The customer specifies which method to use for calculating the odometer value.

3.3.4 Independent Trip Odometer Display and Function

The NGI System provides two independently resettable and uniquely identified trip odometers (i.e., TRIP 1 and TRIP 2). Each can display up to 9999.9 miles or kilometers and the SCU stores these values in EEPROM. The SCU calculates trip distance for each trip odometer using one of the previously described methods and the value of the trip odometer when it was last reset.

The user resets a trip odometer to zero by pressing the set switch while that trip odometer is displayed.

3.3.5 Hourmeter Display and Function

The hourmeter displays total engine hours. Each time the ignition is switched on and every 10 seconds thereafter, the SCU requests total engine hours data (MID 128, PID 194) from the Engine ECU. The SCU does not store total engine hours, and its value is not resettable. If total engine hours data is not available from the vehicle, the SCU will display a series of dashes (-----) whenever the hourmeter function is selected.

Total engine hours is displayed to the nearest tenth, without leading zeros and up to 9999.9. After that, the display rolls to 0.0.

3.3.6 Other Functions

In addition to the odometer and hourmeter displays and functions, the AN Display has other functions:

- User-Initiated Diagnostics
- Fault and NGI Warning Messages

3.3.6.1 User-Initiated Diagnostic Function

The Diagnostic function allows one to test all display modules (except mechanical pressure gauges) either automatically or manually. Functionality of the diagnostics is shown in Figure 3-15 on page 3-25.

The customer can specify up to five enabling conditions which must be met before the Diagnostic function is enabled. Some examples are: transmission in neutral, park brake applied, engine speed less than 1000 rpm, etc.

3.3.6.1.1 Auto Test

Pressing the set switch while **AUTO** is displayed starts the four-phase Auto Test sequence shown in Figure 3-15 on page 3-25. During each phase, the SCU generates the data for the Alphanumeric Display, gauge pointers, warning LEDs, and telltale control and sends it to the modules over the NGI bus:

- Phase One - **MIN** is displayed, all pointers move in unison to minimum scale, all warning LEDs and telltales are off.
- Phase Two - **MID** is displayed, all pointers move in unison to mid-scale, all warning LEDs remain off, and the odd-numbered telltales turn on.
- Phase Three - **MAX** is displayed, all pointers move in unison to maximum scale, all warning LEDs remain off, the odd-numbered telltales turn off, and the even-numbered telltales turn on.
- Phase Four - **LED** is displayed, all pointers move in unison back to minimum scale, all warning LEDs turn on, and all telltales turn on. At the end of this phase, **AUTO** is displayed.

Pressing the mode or set switch while the Auto Test sequence is active halts the sequence and returns the display to **AUTO**. If the instrumentation passes the Auto Test sequence, all gauges, warning LEDs, and telltales are functioning correctly.

Note - Do not confuse the Auto Test function with the power-up initialization sequence.

3.3.6.2 Manual Test

Pressing the mode switch while **AUTO** is displayed activates (but does not start) the Manual Test function shown in Figure 3-16 on page 3-26 and displays **MANUAL**. The Manual Test function is the same as the Auto Test sequence except that the user can select which modules to test and must press the set switch to move from one phase to the next as follows:

- Use the set switch while **MANUAL** is displayed to select the module to be tested, starting with **SCU**.
- When the desired module's name is displayed, press the set switch to start testing that module or press the mode switch to select a different module.

Press the set switch to step through the test, or press the mode switch to stop the test.

3.3.6.3 Fault Messages

When a device (or ECU) attached to the vehicle data bus detects a fault, it can place an active fault message on the vehicle data bus. The message 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). Each time the SCU receives an active fault message, it automatically displays the device ID code for 12 seconds and then stores it for later recall and viewing. It does not display the specific failure code.

If the set switch is pressed while **FAULTS** is displayed, the SCU will broadcast a fault request message on the vehicle data bus and will display **POLLING** (see Figure 3-15 on page 3-25). Devices connected to the bus will respond by placing their active fault messages on the bus.

After receiving all the active fault messages, the SCU displays their device IDs one-at-a-time in 3-second intervals. Up to 128 device IDs can be displayed. Pressing the mode or set switch during this time exits the Fault mode.

3.3.6.4 NGI Warning Messages

An NGI Warning Message is one that the SCU displays under certain SCU input conditions. The customer specifies the displayed text and defines the input conditions under which it is displayed. The text can be up to seven characters long, and the conditions can be vehicle data bus messages, discrete inputs to the SCU, or a combination of both. NGI Warning Messages can be accompanied by a gauge warning LED, a telltale indication, an audible alert, or any combination as specified by the customer. Examples of NGI Warning Messages are shown in Table 3-1.

NGI WARNING MESSAGE	INPUT CONDITION	ACKNOWLEDGEABLE
AIR1 LO	Switched input to SCU	No
AIR2 LO	Switched input to SCU	No
OIL LO	Vehicle data bus message	No
H2OT HI	Analog input to SCU	Yes
OILT HI	Analog input to SCU	Yes
TRAN HI	Vehicle data bus message	Yes
NO SPDO	SCU detects no speed data for five consecutive seconds	No
NO HRS	SCU detects no engine hour data for 15 consecutive seconds	No
NO ODO	SCU detects no odometer data for 15 consecutive seconds	No
NO DATA	SCU detects no speed, engine hours and odometer data for 15 consecutive seconds	No

Table 3-1 Examples of NGI Warning Messages

3.3.6.4.1 NGI Warning Message Priorities

The SCU assigns a priority from 1 through 28 for everything it displays. The priority determines the order in which something is displayed. The higher the number, the higher the priority. When a condition occurs that results in an NGI Warning Message, the SCU assigns it a priority as well. Items are displayed according to the priority levels shown in Table 3-2.

Loss-of-data messages (**NO SPDO**, **NO HRS**, **NO ODO**, **NO DATA**) do not have a configurable priority and will *override* the NGI Warning Messages if present.

3.3.6.4.2 Unacknowledgable Messages

An unacknowledgable message is one that the driver cannot unacknowledge. Examples are shown in Table 3-1. When an unacknowledgable message appears, the driver can press the Mode switch and scroll through the message list, but he cannot lower the unacknowledgable message's priority by using the Set button. Thirty seconds after the last button press, the unacknowledgable message will reappear.

The customer specifies which messages are unacknowledgable.

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 3-2 Message Priorities

3.3.6.4.3 Acknowledging an NGI Warning Message

When an NGI Warning Message first appears, it is considered *unacknowledged*. At this point, the operator has four options (see Figure 3-17). He can:

- **Silence the buzzer** by pressing the set switch once while the message is displayed.
- **Acknowledge the message** by pressing the set switch a second time while the message is displayed. The SCU will then lower the message's priority to six, and lower the priorities of all previously acknowledged messages by one. If another NGI Warning Message (unacknowledged or acknowledged) exists, it will be displayed; otherwise, the SCU will display the odometer as shown in Figure 3-17.
- **Display the next NGI Warning Message** by pressing the mode switch. If there are no more messages to display, the SCU re-enters the Main Loop and displays the odometer.
- **Do nothing** - If neither the mode nor the set switch has been pressed for 15 seconds, the SCU will display the message with the highest priority. An alternative to this is to have the SCU continuously display the unacknowledged message (see Figure 3-18 on page 3-28). This option must be specified by the customer.

Up to six NGI Warning Messages can be queued. If more than six messages are acknowledged, the oldest one is removed from the queue. Queued messages are retained as long as the SCU receives battery power.

3.3.7 Alphanumeric Display Backlighting

When the dashlights are off, the LCD backlighting is set to a fixed level for best visibility. When the dashlights are on, the backlighting is controlled by the vehicle's dashlight dimming control.

3.4 Audible Warning Device (Buzzer)

The buzzer is a software-driven, miniature piezo-electric device. Its pitch is 2 kilohertz and its emitted sound level is 85 dB minimum measured 10 cm from the rear of the speedometer housing. The buzzer can be controlled by any device on the vehicle data bus, although in standard systems it is controlled by the SCU in response to external events.

3.4.1 Customer-Specified Information for Alphanumeric Display and Buzzer

The customer specifies the following information:

- **NGI Warning Messages (up to 30)** - Text string (up to 7 characters); conditions under which it is displayed; priority; acknowledgeability
- **Other Indications** - Whether an associated gauge warning LED or telltale is on; whether the buzzer sounds when the text string is displayed
- **Diagnostic Function** - Up to five enabling conditions that must be met before this function can be activated
- **User-Defined Default Option** - See Section 3.3.1.1 on page 3-16
- **Persistency Option** - See Section 3.3.1.2 on page 3-16
- **Buzzer Events**, such as whether the buzzer sounds during the power-on initialization sequence
- System response to an NGI Warning Message that has been ignored

3.5 System Operation

Applying battery voltage to the system's ignition input fully activates the system as shown in Figure 3-14 on page 3-24.

The system can be partially activated when the ignition is off by pressing the mode or set switches. This allows one to use the display without an ignition key. The display turns off 10 seconds after the last press of the mode or set switch. Turning the backlighting on activates the display as long as the backlighting remains on.

3.5.1 Power-On Initialization Sequence

Each time ignition power is applied, the system performs the initialization sequence shown in Figure 3-13 (page 3-23). All gauge pointers are automatically re-zeroed and all telltales and gauge warning LEDs momentarily turn on, allowing the user to check their functionality.

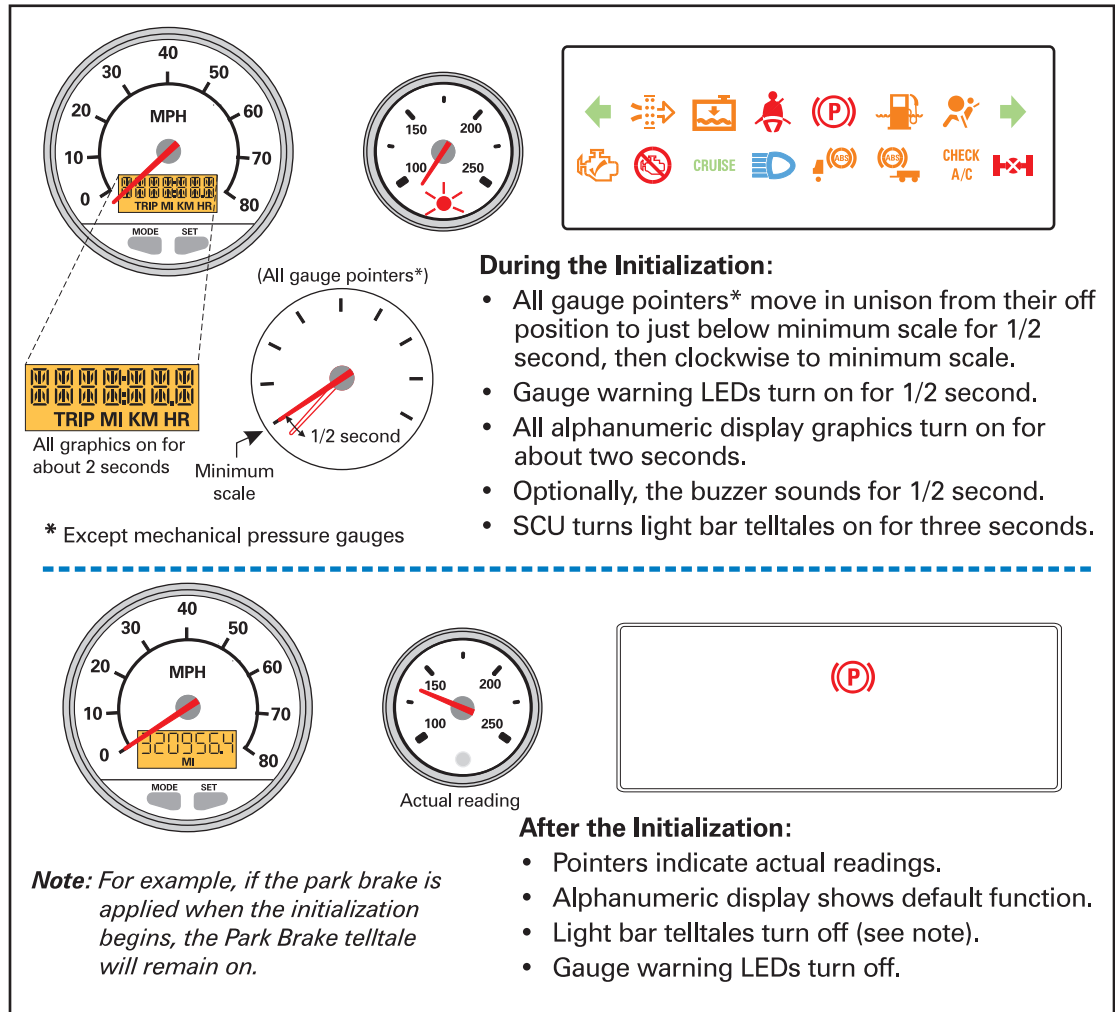


Figure 3-13 Power-On Initialization Sequence

Note - If the battery voltage drops low enough when the starter is engaged, the system may repeat the sequence when the input power comes back up to normal.

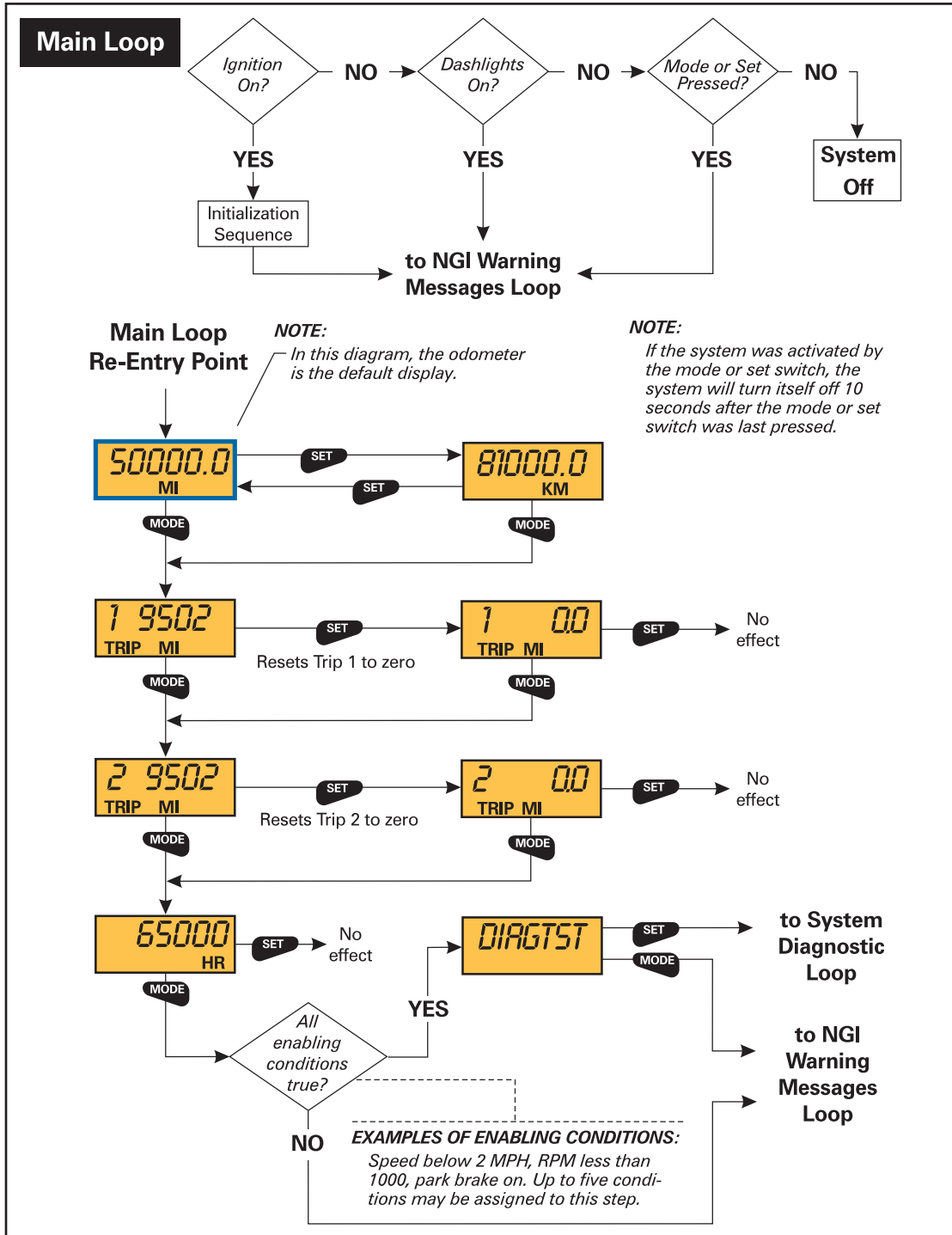


Figure 3-14 Main Loop

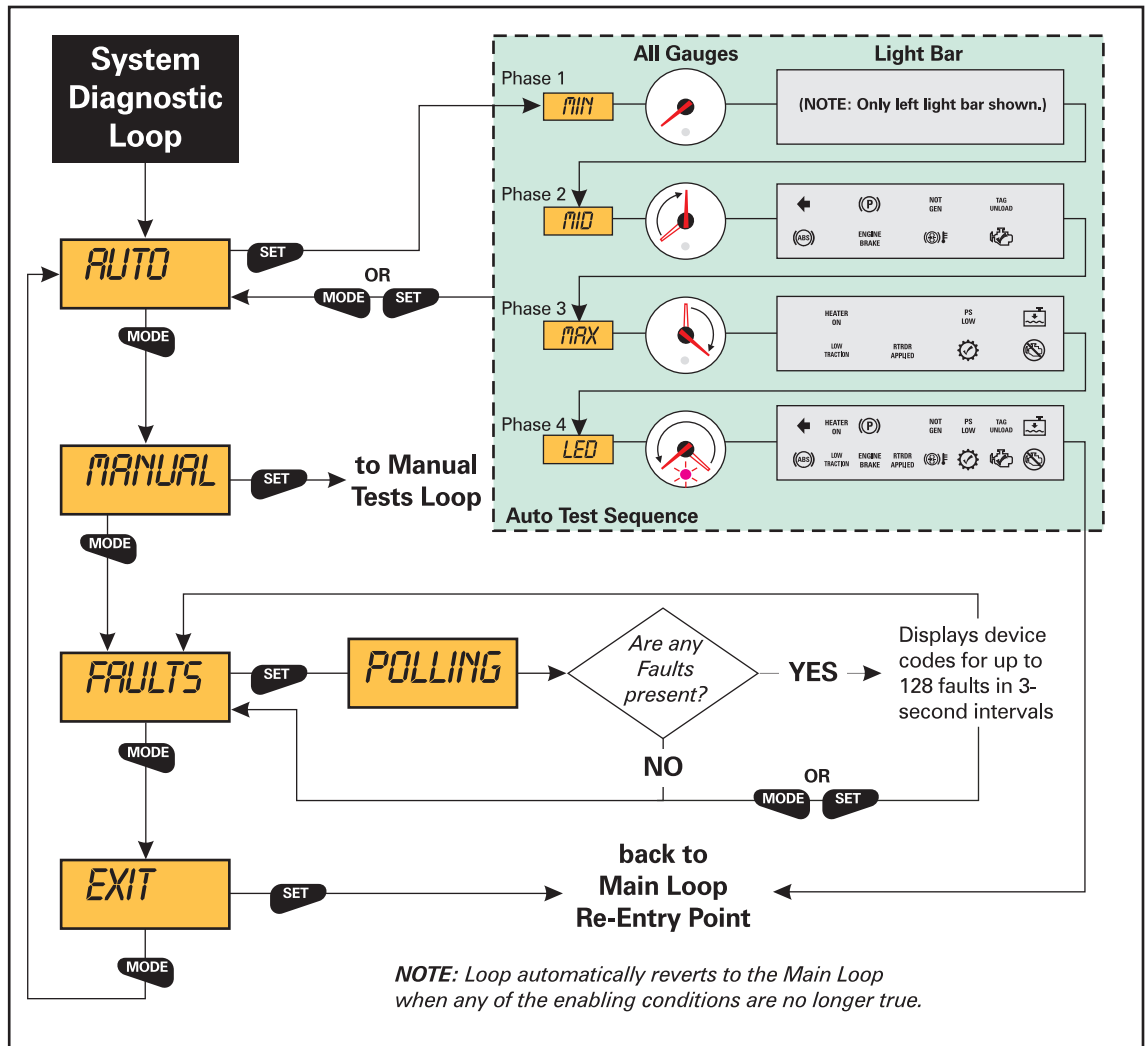


Figure 3-15 Diagnostic Test Loop

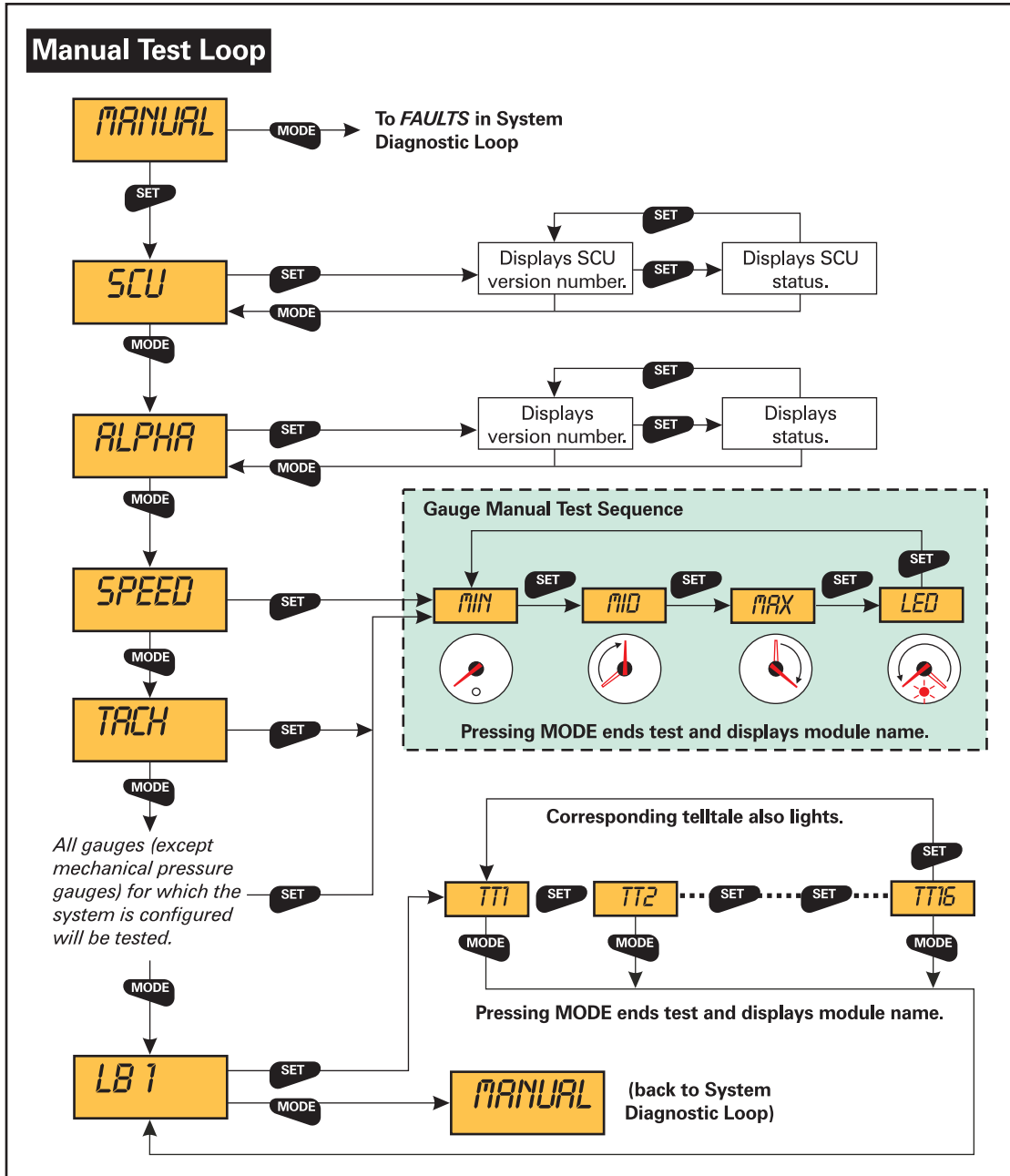


Figure 3-16 Manual Test Loop

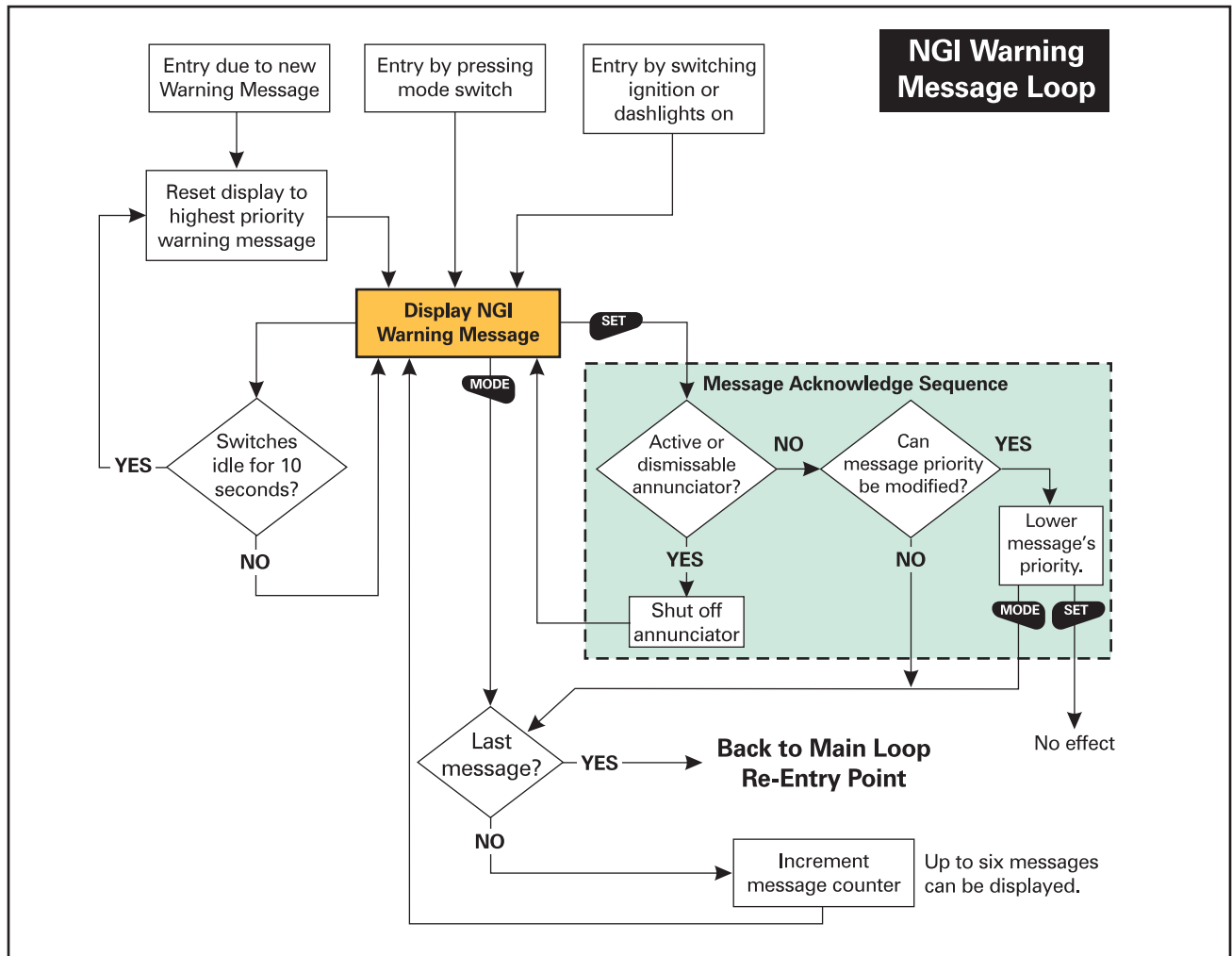


Figure 3-17 NGI Warning Message Loop

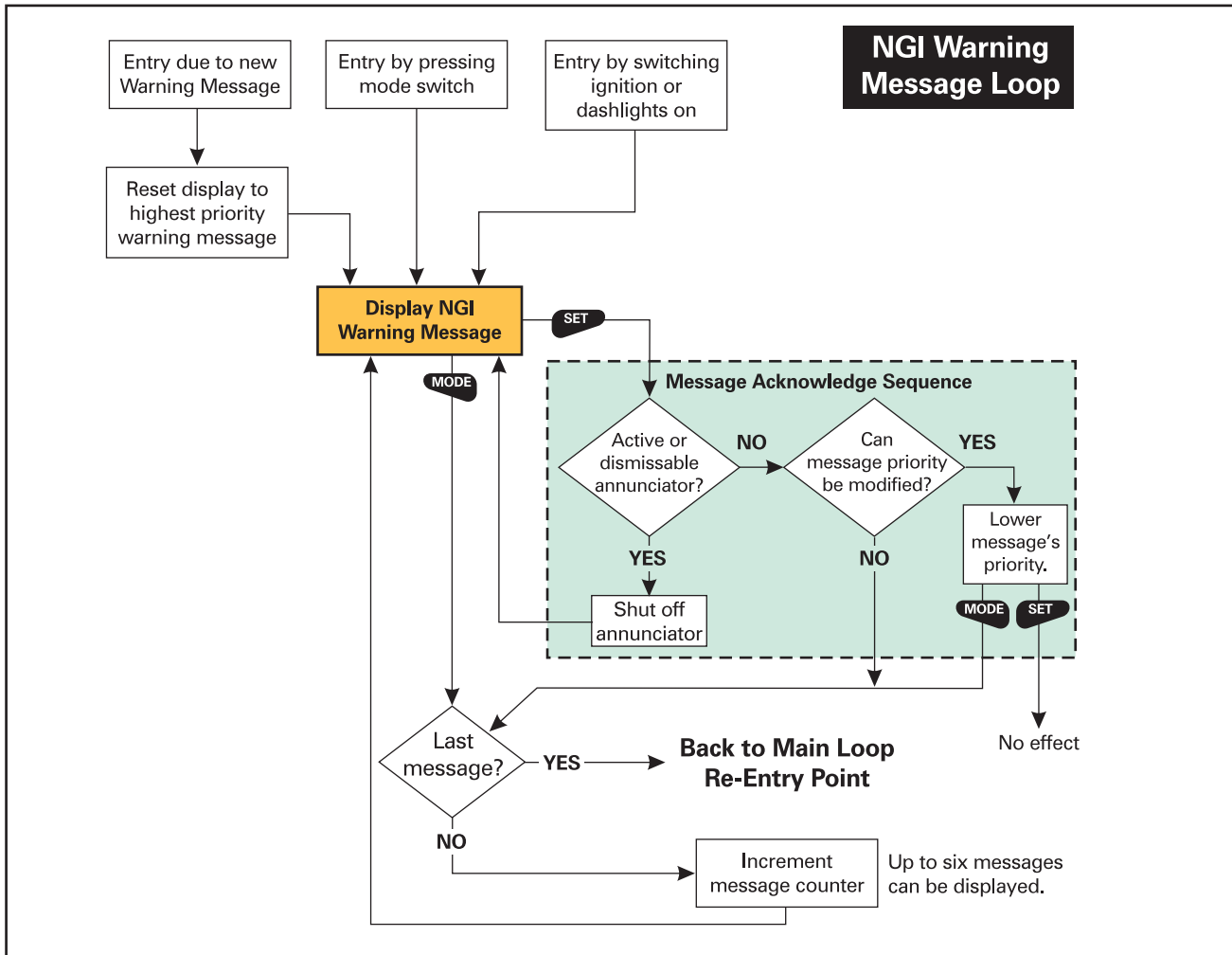


Figure 3-18 NGI Warning Sticky Message Loop

4 Electrical Specifications

4.1 General Panel Wiring

Figure 4-1 illustrates the rear of a panel containing a speedometer with a built-in SCU, tachometer, four 2-inch gauges, Light Bar, and one of many possible connection schemes.

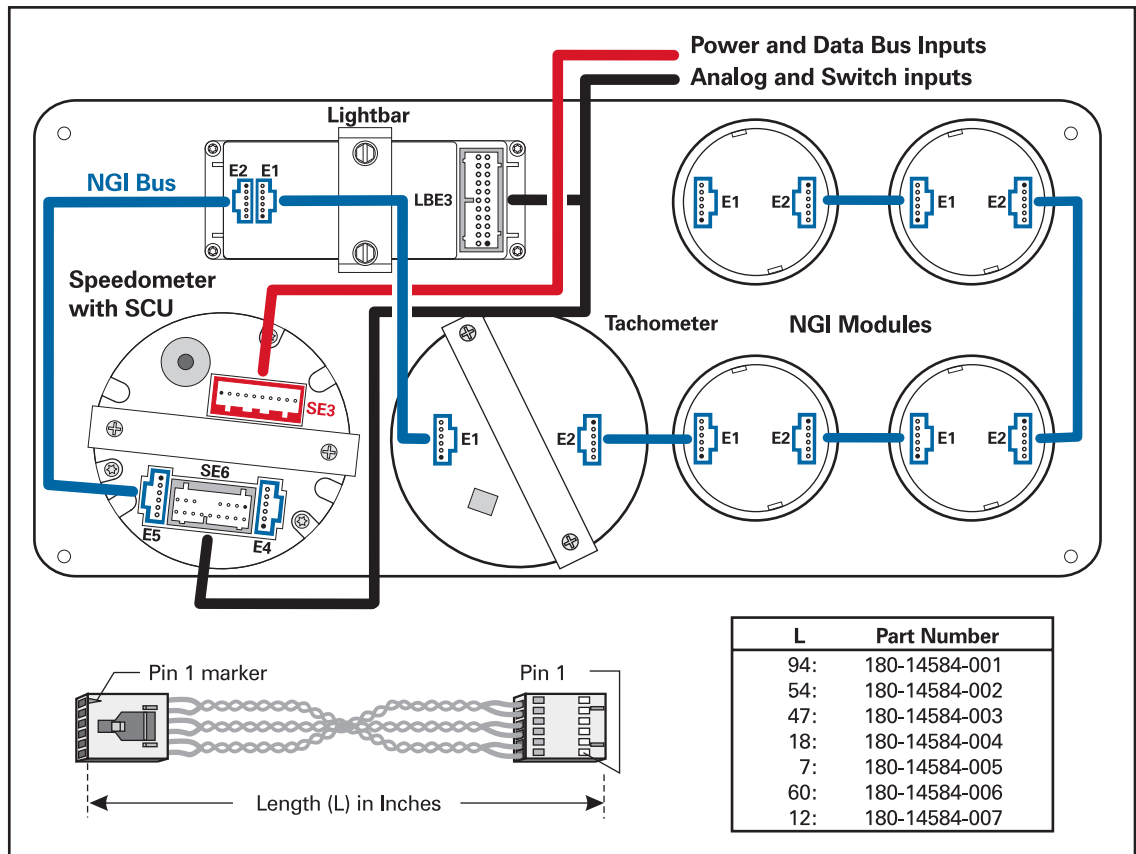


Figure 4-1 Panel Wiring

Connections to the vehicle wiring harness are shown in red. This wiring and its associated connectors are usually supplied by the OEM but can also be ordered from and manufactured by AMETEK Dixon. The NGI Cable assemblies (shown in blue) are part of the NGI System and are supplied by AMETEK Dixon.

4.2 Speedometer/SCU Connections

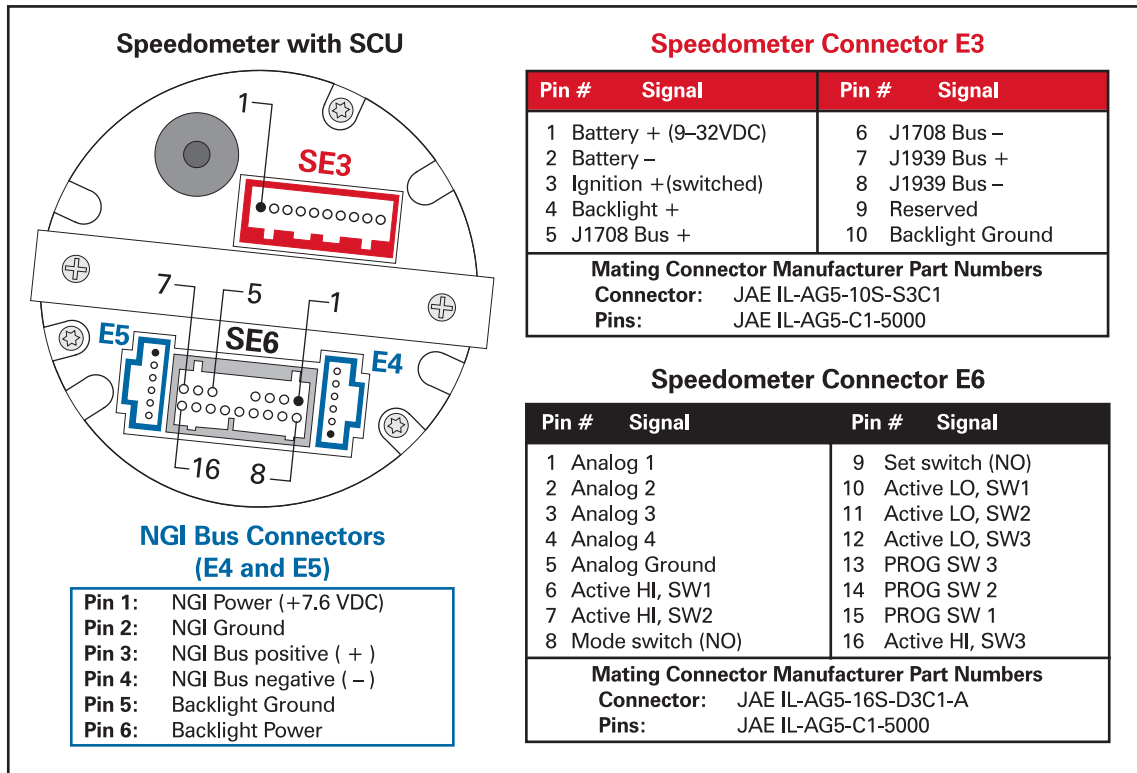


Figure 4-2 SCU Connections

Notes -

- Analog inputs are from temperature sensors, fuel level sensors and other sensors whose outputs vary continuously as a function of the monitored parameter. Valid inputs range from zero to 6,400 ohms, or from 0 to +32 VDC. Reduced ranges, offset ranges, and input linearization can be configured by the factory to meet most any need. Please consult AMETEK Dixson for application assistance.
- Active HI inputs are switched between battery voltage (i.e., between +9 and +32 VDC) and open circuit.
- Active LO inputs are switched between ground and open circuit. Pull-ups are not required. Programmable inputs are configured at the factory as additional active high or active low inputs
- External mode and set switch inputs are active when connected to ground, and inactive when left open. Pull-ups are not required. They replace the mode and set switches when the standard ones are not available or not desired.

4.3 Light Bar Connections

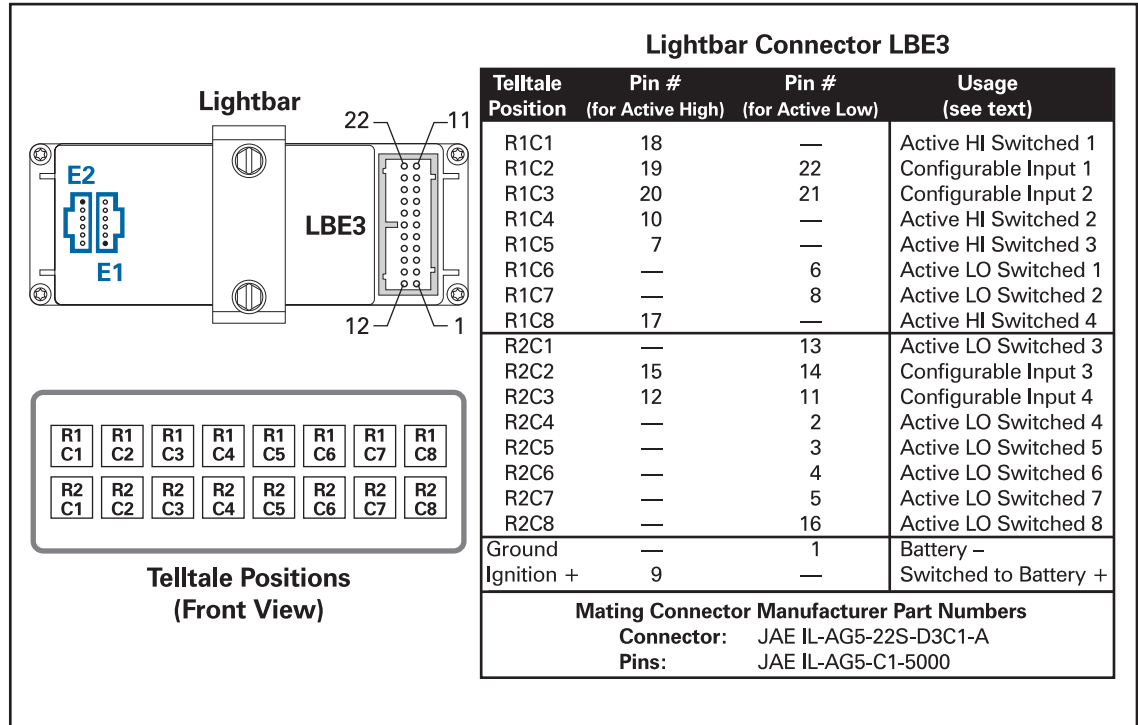


Figure 4-3 Light Bar Connections

ELECTRICAL PARAMETER	SPECIFICATION
Operating voltage	9 to 32 volts DC
Input Voltage Protection (Cold Cranking, Reverse Polarity, Series Charging)	Meets the requirements of SAE J1455 Section 4.11.1
Load Dump, Inductive Switching, Mutual Coupling	Meets the requirements of SAE J1455 Sections 4.11.2.2.1, 4.11.2.2.2, and 4.11.2.2.3
Electromagnetic Conductance (Susceptibility)	Meets the requirements of SAE J1113/21 and SAE J1812
Electromagnetic Conductance (Radiated Emissions)	Meets the requirements of SAE J1113/41 Sections 8, 9
Other electrical transients: conducted noise	Meets the requirements of SAE J1455 and SAE J1113
Electrostatic Discharge (non-operating and operating)	Meets the requirements of SAE J1455 Sections 4.11.2.2.5.1 and 4.11.2.2.5.2

Table 4-1 Electrical Specifications

5 Mounting Specifications

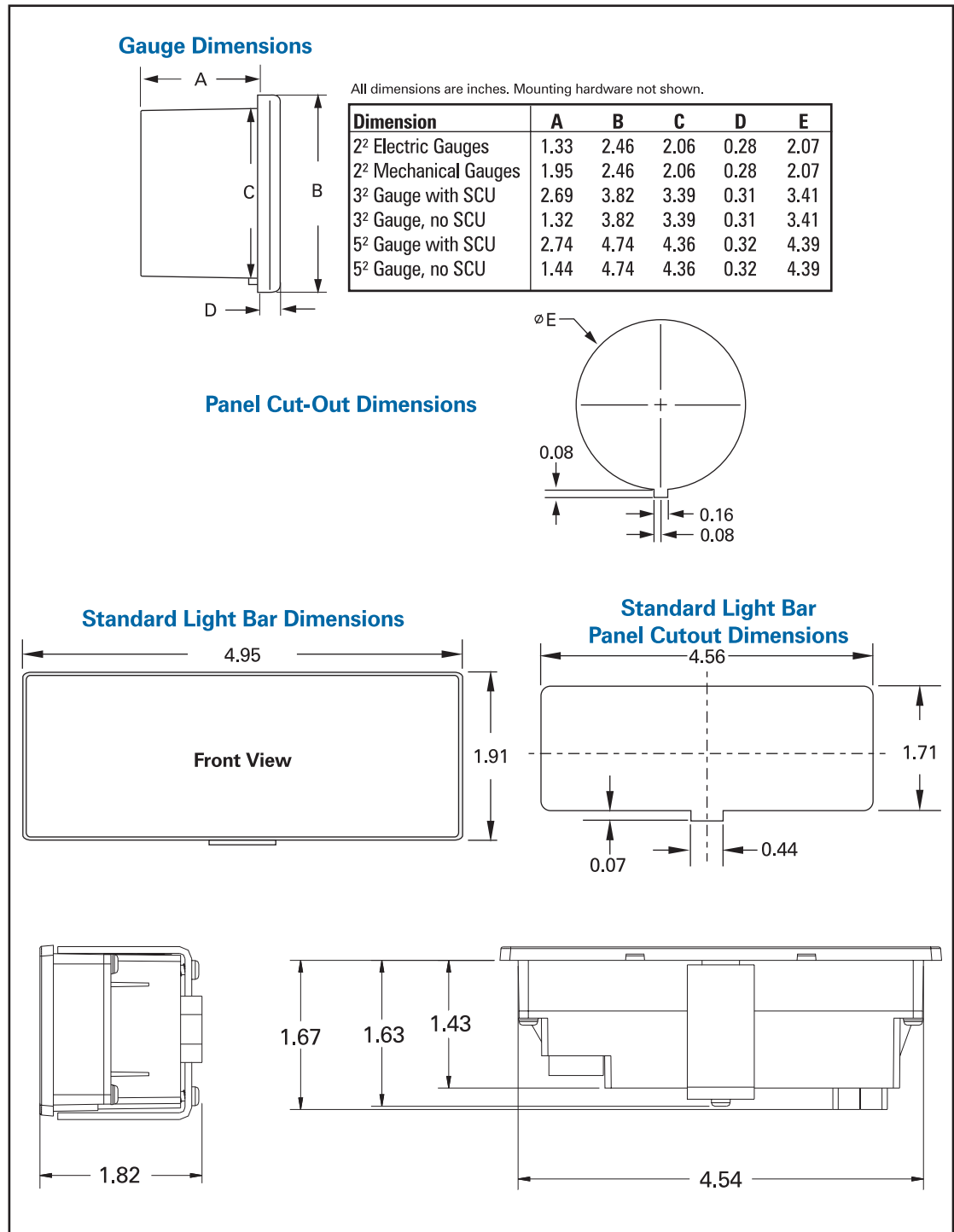


Figure 5-1 Module Dimensions

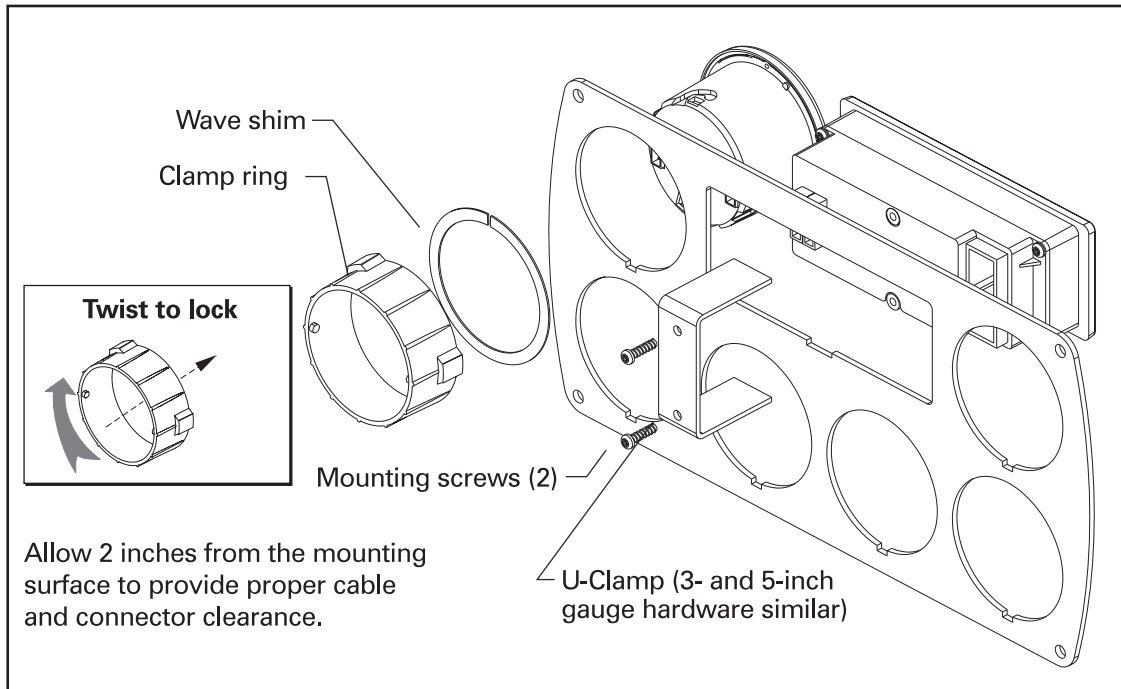


Figure 5-2 Gauge and Light Bar Mounting into Typical Panel

6 Environmental and Reliability Specifications

6.1 Environmental Specifications

ENVIRONMENTAL PARAMETER	SPECIFICATION
Operating and Non-Operating Temperature	-40 to +85C
Thermal Cycling	Meets requirements of SAE J1455, Section 4.1.3.2
Thermal Shock	Meets requirements of SAE J1455, Section 4.1.3.2
Humidity	Meets requirements of SAE J1455, Section 4.2
Mechanical Shock (handling and shipping)	Meets requirements of SAE J1455, Sections 4.10.3.1 and 4.10.2.2
Operating Shock	Meets requirements of MIL-STD-2-2F, Method 213B, Test Condition J
Operating Vibration	0.06354 G ² /Hz, 5 Hz to 2 KHz random
Mechanical Vibration	Meets requirements of SAE J1399, notes 3 and 4
Chemical Splash (soap, wax, coffee, soda)	Meets requirements of SAE J1455, Sections 4.4.1

Table 6-1 Environmental Specifications

6.2 Reliability Specifications

6.2.1 Reliability

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 Specifications

6.3 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 elsewhere in this specification.

END OF DOCUMENT