



**XD-16 Digital Universal Dash Display  
User Manual**

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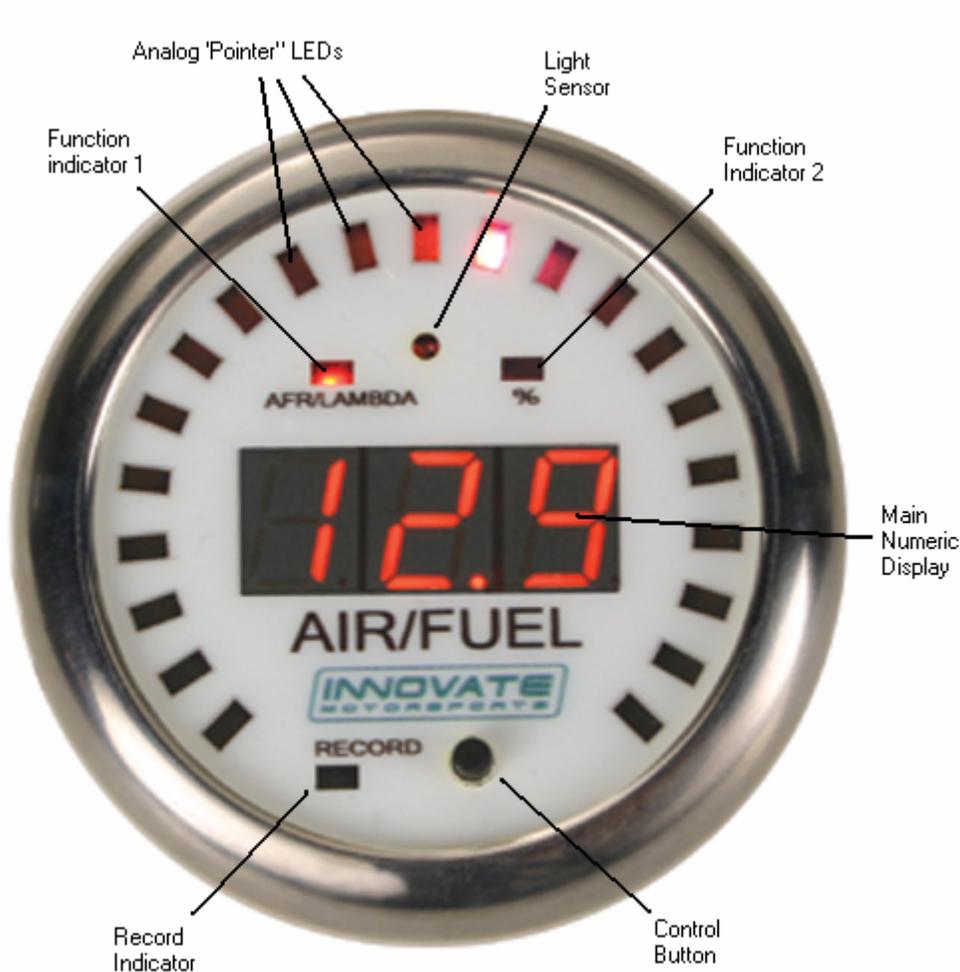
# 1. Overview

The XD-16 is a programmable digital display used as dash mounted instrument for the Innovate Motorsports sensor devices. The XD-16 fits into a standard 52mm (2-1/16") gauge hole. Multiple XD-16's can be daisy-chained to build an entire programmable dash. XD-16 gauge faces can be user customized. The XD-16 can also be used to initiate and control recording on the LM-1 or other Innovate Recording devices, can initiate free air calibration for Innovate Motorsports wideband controllers and indicate wideband controller status. In addition the XD-16 can be programmed to hold minimum/maximum values of the displayed channel and provide warnings/alerts depending on programmable warn conditions.

# 2. The XD-16 Device

The XD-16 set contains the following parts:

## *The XD-16 Module*



## **2.1. Identifying the user interface features of the XD-16**

The analog pointer LED's (21 total) act as a digital needle. The range and individual colors of this "needle" is freely programmable.

The Function indicators 1 and 2 are used to indicate between % display (heater warm-up or O2 content) when the XD-16 is programmed as AFR/Lambda display (default). When used to display other channels, the indicators can be used to indicate the sign of the displayed value. By using the indicators as sign display (positive or negative) one of the three numerical displays is not wasted to show a '-' sign. This functionality is programmable.

The main numeric display shows the numeric value of the displayed channel. When the XD-16 is used as AFR/Lambda display it will also show the status of the wideband controller.

The light sensor allows the XD-16 to adjust its brightness to the light level of the environment. At night the full on display would be much too bright and would interfere with the operation of the vehicle. During sunlight the XD-16 will go to maximum brightness to allow readability.

The Control Button is used to control various aspects of the XD-16 and attached wideband controller or recording device like the LM-1.

The record indicator will blink when a LM-1 or other Innovate Motorsports recording product is attached and actively recording.

## **2.2. Included cables and devices**

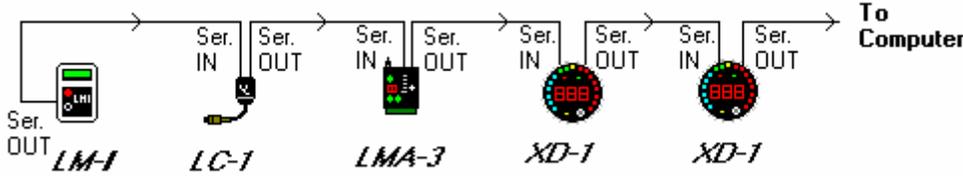
1. XD-16 to LM-1 cable (Mini-DIN 8 to female 2.5mm Stereo). Use with patch cable (#3 below).
2. XD-16 to Computer cable (male 2.5mm Stereo to DB-9)
3. Male 2.5mm Stereo to male 2.5mm Stereo cable
4. XD-16 Terminator plug (single male 2.5mm Stereo plug)
5. XD-16 Mounting bracket, studs and nuts
6. CD with manual and programming software

## **3. Mounting and Connecting the XD-16**

1. If not using a commercial gauge pod, cut a 52mm hole into the intended dash location.
2. Insert and mount the XD-16 and mount it with the included mounting bracket, leaving the XD-16 cables in the back accessible.
3. Connect the RED wire from the back of the XD-16 to a switched 12V source in your car. A switched 12V source goes on as soon as the ignition on the car is on or the engine runs. Make sure the connection is fused with at least a 2A fuse.
4. If connecting to a LM-1, connect the "XD-16 to LM-1 cable" to the LM-1's Serial Port. Plug the 2.5mm male stereo end into the XD-16 Serial IN port (female 2.5 mm socket marked "IN").
5. If connecting to an LC-1 or LMA-3, connect the male 2.5mm Stereo to male 2.5mm Stereo cable between the Serial OUT port of the LC-1 or the Serial OUT of the LMA-3 to the Serial IN port of the XD-16.

- If using a computer to datalog or download LM-1 data, connect the XD-16 to Computer cable between the Serial OUT port of the XD-16 and the computer's serial port.

The following diagram show how to connect multiple Innovate Motorsports devices to form a logging and display chain. The example chain consists of a LM-1, a LC-1, a LMA-3 and 2 XD-16's. In this case the chain has 12 channels (6 from LM-1, 1 from LC-1 and 5 from LMA-3).



## 4. Using the XD-16

When the XD-16 powers up it will go briefly through a sequence where it lights up all its LEDs. This is a function and diagnostic test. Holding down the Control button during power-up will continue to light up all LEDs until the button is released.

### 4.1. Displayed functions when using XD-16 as AFR/Lambda display

#### 1. Sensor Warm-up

**H56**

For example, this would indicate that the heater is warmed up to 56%. The Function Indicator 2 is lit.

#### 2. Heater Calibration

**HC2**

The last digit is the count-down of the heater calibration.

#### 3. Free air calibration in process

**CAL**

When shown steady, free air calibration is in progress. If blinking and not going away after 5 seconds, the LM-1 requests a free air calibration as happens after a heater calibration.

Blinking CAL can also happen if the control button is pressed rapidly 3 times. Pressing it then again, initiates a free air calibration. If this is unintentionally pressed, the CAL request goes away after 5 seconds.

#### 4. Normal Operation

**123**

With function indicator 1 lit this shows AFR.

#### 5. Normal Operation very lean mixture or free air

Switching between  and 

Shows the free air content of the gas the sensor sees.

## 5. No Connection detected

If the display shows:



The XD-16 cannot receive data from the LM-1 or other devices. Check the cables.

## 4.2. Button Functions

### 1. Start/Stop Recording

Press the Control button once to start recording. The Record indicator light will blink.  
Press the Control button again once to stop recording. The Record indicator will switch off.

### 2. Clear Recording Memory of LM-1

Press and hold the Control button until  for Reset shows.

### 3. Review Min/Max hold

Press the Control button twice rapidly. The XD-16 will show the last minimum value indicated. Note that the XD-16 will remember the minimum value even if power is switched off.  
Minimum value is indicated by alternating between:



and the minimum value stored.

Holding the Control button down for a few seconds while this is displayed will reset the minimum value.

Press the Control button instead only briefly will show the maximum value indicated. It is indicated by alternating between:



and the maximum value stored.

Press the Control button again briefly to return to normal operation.  
Holding the Control button down for a few seconds while this is displayed will reset the maximum value.

### 3. Initiating a free air calibration

Press the Control button three times rapidly. The display will show a blinking:



If the button was press accidentally three times, wait for 5 seconds. The XD-16 will return to normal display mode.

Pressing the Control button while the blinking CAL is displayed will initiate a free air calibration on ALL connected wideband devices.

## **5. Programming the XD-16**

You will need:

1. XD-16 to Computer cable (male 2.5mm Stereo to DB-9)
2. XD-16 Terminator plug (single male 2.5mm Stereo plug)
3. A laptop computer
4. When powered by the car, the ignition of the car must be on to power the XD-16. Alternatively you can power the XD-16 with a suitable power source between 8V and 25V. A normal 9V battery can be used to power the XD-16.

### ***5.1. Installing the LM Programmer Software***

Put the included CD in your CD-drive on your computer and follow the instructions on screen. The Software will be installed including pre-set directories for log-data and downloaded software. The LM Installer also puts entries for the LM Software in the Start-Menu of your computer under the heading 'Innovate!'.

The following items will be installed on your hard-drive

1. LM Programmer Version 3.0  
This is used to program the XD-16
2. LogWorks  
This is a comprehensive datalogging and analysis package to download and analyze engine data recorded with Innovate devices. It also allows real-time logging and display.  
LogWorks allows to program the relationship between sensor voltages recorded by the LM-1 or LMA-3 and the indicated values. This relationship will be programmed into the XD-16 for the selected channel/input.
3. This manual (XD-16 Manual)
4. The LogWorks Manual  
Describes how to use LogWorks for datalogging and engine analysis.
5. The RPM converter (LMA-2) Manual  
Describes how to operate and use the LMA-2 RPM converter and how to connect different engine sensors. Used for LM-1 users.
6. The current firmware for the XD-16
7. An example datalog file

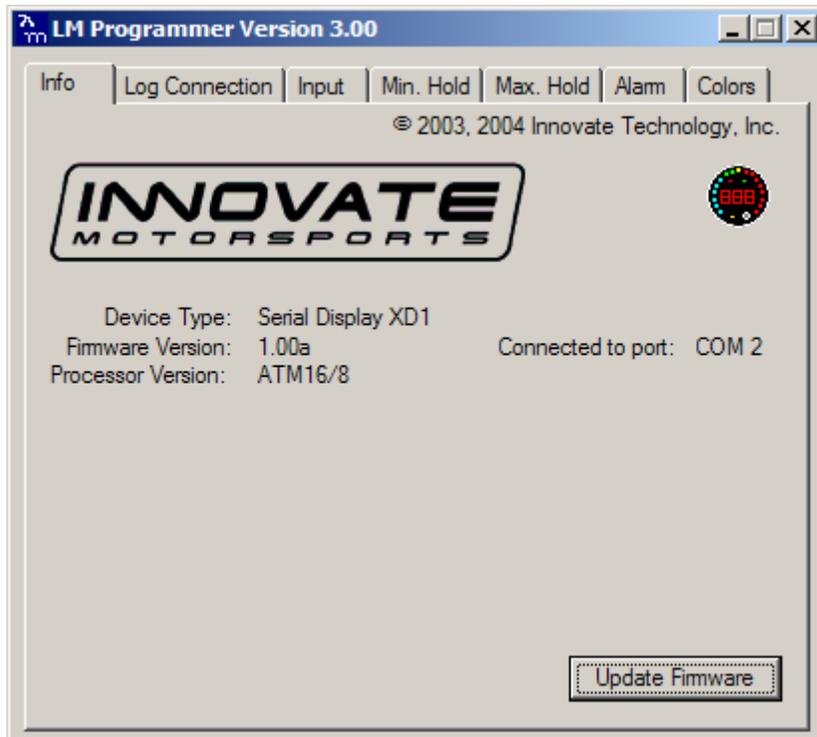
### ***5.2. Setting up the used inputs in LogWorks.***

Make sure the input channels to be used by the XD-16 are correctly programmed in LogWorks as they would show up on the LogWorks screen. Refer to the LogWorks manual for details. When programming the XD-16 the current real time settings of LogWorks are used to program the XD-16.

### 5.3. Connecting the XD-16 device to the computer

1. Connect the Serial OUT connection with the included 2.5mm stereo to DB-9 cable to a serial port on your laptop.
2. Connect the terminator plug (2.5mm male plug with no cable) into the Serial IN connection of the XD-16.

Start the LM-Programmer software. The screen should look like this:



### 5.4. Updating the Firmware

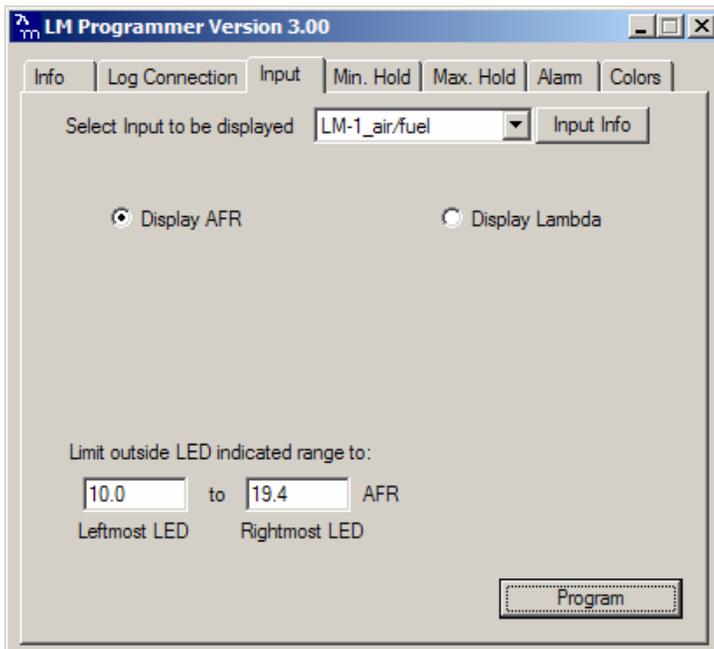
Click the 'Update Firmware' in the main page to upgrade to the latest *firmware* for the XD-16. Firmware for the XD-16 has the extension dld. You can also download the latest firmware and software (LM Programmer and Demo) from the Innovate! Motorsports web-site at

<http://www.tuneyouengine.com>

If your computer crashes during a firmware upgrade, the XD-16 has a recovery mechanism where it will be able to retry the download again and not be disabled by half loaded firmware. Switch the XD-16 off and on again and then try to restart the LM Manager software. The recovery mechanism is designed to be able to recover 99.9% of the time. While we don't anticipate this occurring, it is possible that the XD-16 will not recover correctly and may need to be serviced at our factory. If you suspect this is the case, contact Innovate support.

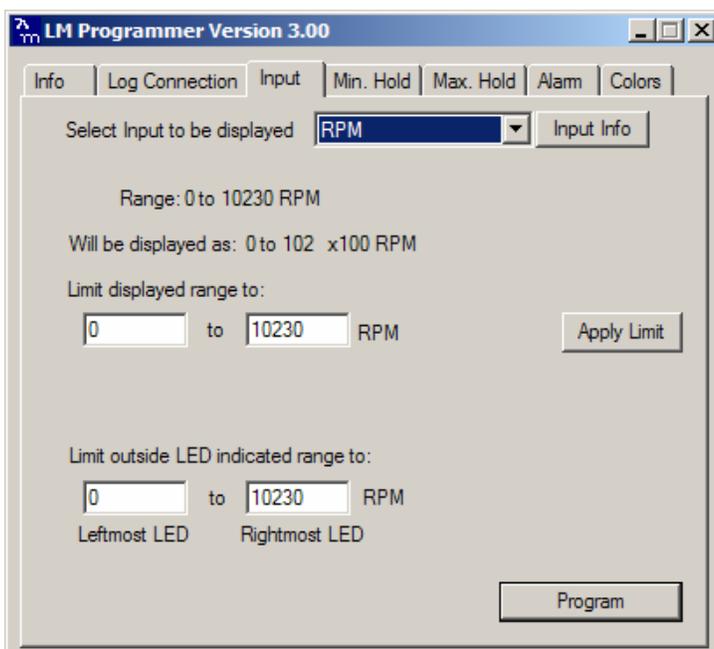
## 5.5. Selecting the display channel

Click on the Input Tab at the top of the window. The following screen will appear:

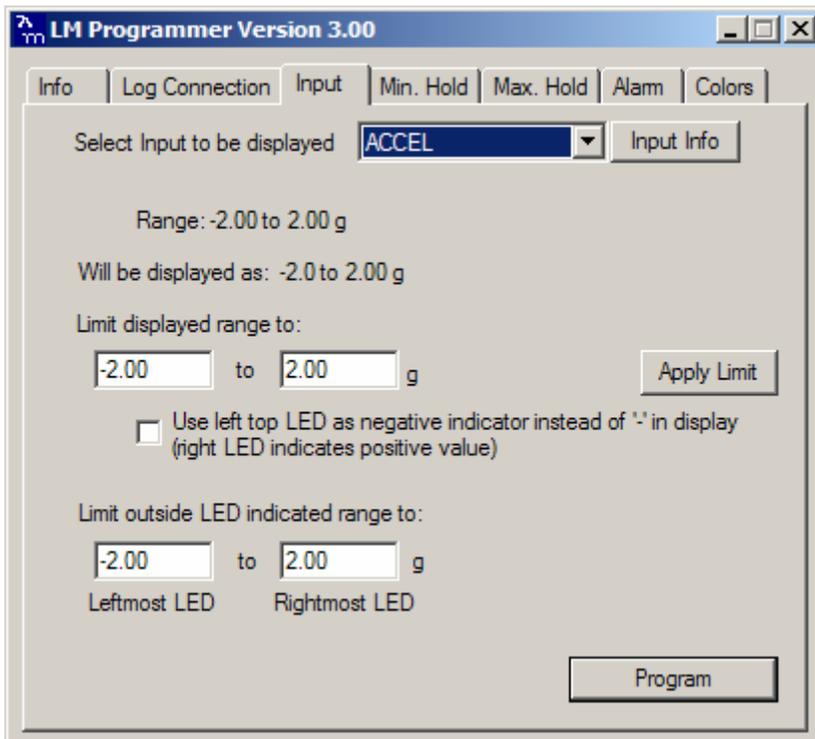


You can select the input channel to display, whether Lambda or AFR is displayed (when selecting a wideband Lambda/AFR channel) and also you can set the range of the analog 'needle' LEDs. Press the program button when you are finished.

**If you select something other than a Lambda/AFR channel you will first need to connect all your MTS devices or LM-1 to LogWorks and complete a real-time log. LogWorks compiles channel information through this process. Exit LogWorks and reconnect to LM Programmer. The list of available devices/channels will now be selectable from the 'Input' tab. If you select something other than a Lambda/AFR channel, the display will change to:**



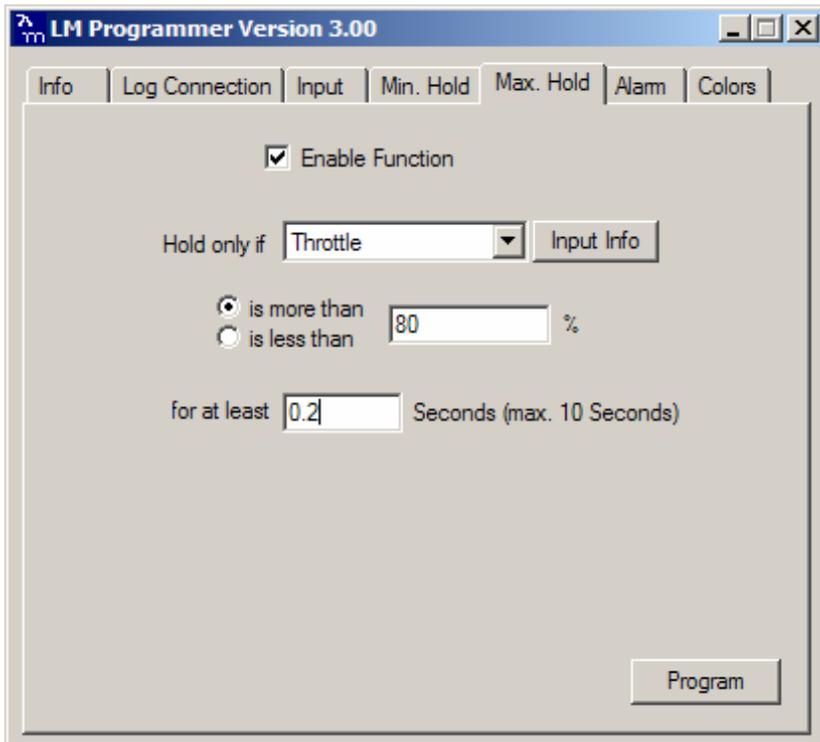
As you can see here, the display will indicate in 100 RPM. This might be too coarse for many applications. The limit is there because the XD-16 can only display 3 digits. By applying a limit (for example to 0...9990 RPM the XD-16 can display the RPM in multiples of 10 RPM. If a channel is selected that has both positive and negative values, a different screen will show:



This allows you to use the Indicator 1 and 2 LEDs as negative value indicators to preserve the 3-digit resolution of the XD-16.

### ***5.6. Programming the Min/Max hold functions***

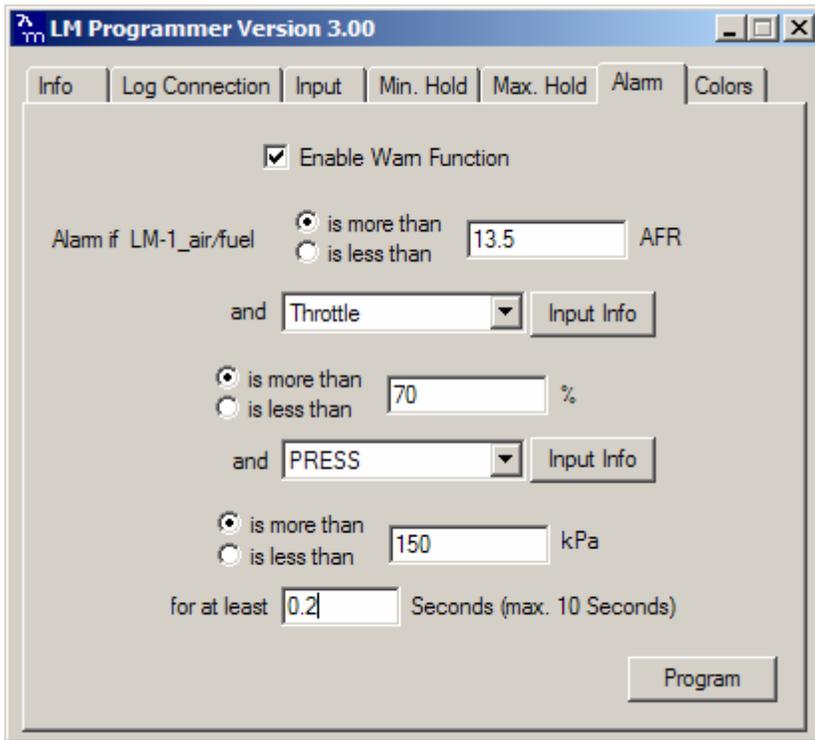
Click on the Min. Hold or Max. Hold Tab on the top of the window. The following screen will show up:



Programming the Min or Max hold function should be pretty self evident. You can enable the function. You can also make the hold function depending on another channel. In this example the Max hold function will be programmed so that the leanest AFR is only stored during WOT operation and only if the condition persists for more than 0.2 seconds. In this case AFR was used as input and you don't want to store the leanest AFR during closed throttle where the injectors cut off. Any channel can be programmed as dependency. You can program any minimum persist time between 0 and 10 seconds.

### ***5.7. Programming the Warning/Alarm function***

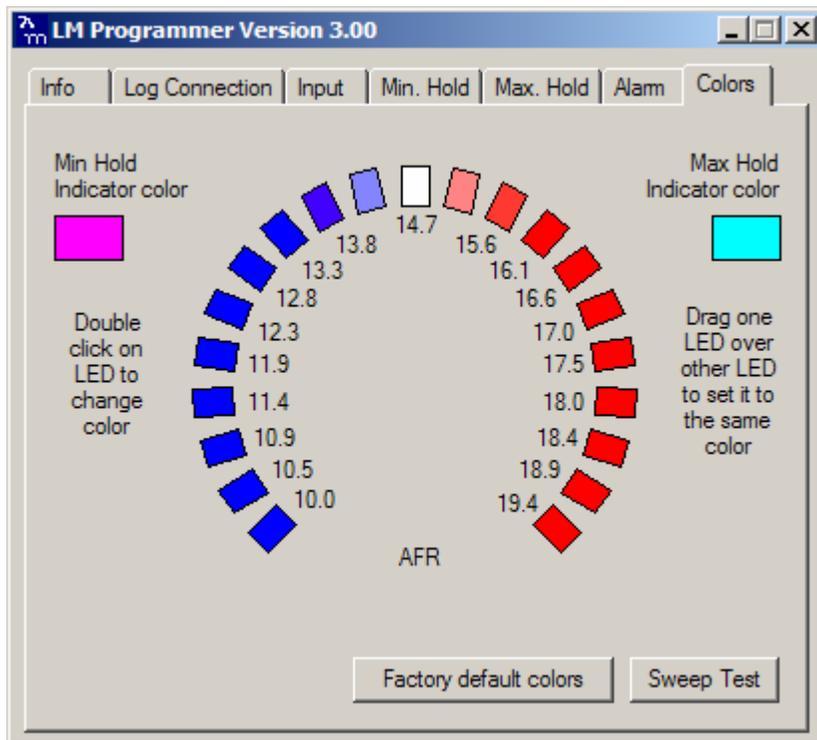
Click on the Alarm tab on the top of the screen.



Again, the programming is very similar to the Min/Max hold programming as described in 4.6. Except here the Alarm condition can be programmed to be dependent on two other channels and time. During an Alarm the XD-16 will flash the indicated value and the analog needle LEDs at maximum brightness until the Alarm condition goes away.

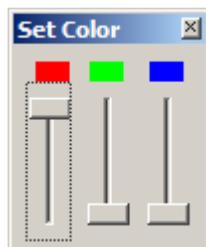
## 5.8. Programming the Analog 'needle' colors

Click on the Colors tab.



This shows the current color settings for all the 21 LEDs plus the indicator colors used when reviewing Min/Max hold.

To change the color of an individual LED, double-click with your mouse on the LED to change. The following dialog box will show up:



The currently selected LED is also highlighted.

By changing the sliders for red, green and blue any color out of a set of 32767 colors can be created. Any color can be created by mixing red, green and blue light at varying ratios. The XD-16 can be programmed for 32 different values for each red, green and blue. And  $32 \times 32 \times 32$  is 32768. But black (all off) is hardly used. While moving the sliders the simulated LED on the screen changes color and also the appropriate LED on the XD-16 at the same time. Because computer screens use a different technology to create colors than the XD-16, the actual colors on the XD-16 can be different than the screen colors.

With the sweep test button the XD-16 will sweep through all LEDs from left to right to give you an indication on how the color scheme you programmed will look in real life.

To change multiple LEDs to the same color, just program one LED. Then drag this LED over the other LEDs you want to program to the same color.

## 6. Changing the gauge face of the XD-16

When you use the XD-16 to display different channels than AFR or Lambda, you very likely want to change the gauge face. As the LM-1/MTS system can be programmed for any 0..5V sensor, the possibilities are endless. Because not every possible use can be anticipated, the XD-16 is designed to allow user customization.

### 6.1. Installing the new gauge face

1. Lay the XD-16 face down on a table and remove the three Phillips screws from the outside rim of the back plate.
2. Carefully lift out the back plate with the electronics package from the bezel.
3. Laying the electronics package on its back, first place the gauge face followed the glass and bezel. **\*Be sure to remove protective film from the gauge face. This can be done easily with a piece of scotch tape.** Make sure every piece is positioned correctly on the button shaft.
4. Carefully flip the complete assembly and line up the screw hole of the bezel with the screw hole of the back plate ensuring that everything slides into the bezel correctly.
5. Holding the assembly together with one hand, test the operation of the button and as necessary, adjust by rotating bezel, glass, and gauge face.
6. Reinstall the 3 Phillips screws.



## 6.2. Create a custom label

### Note:

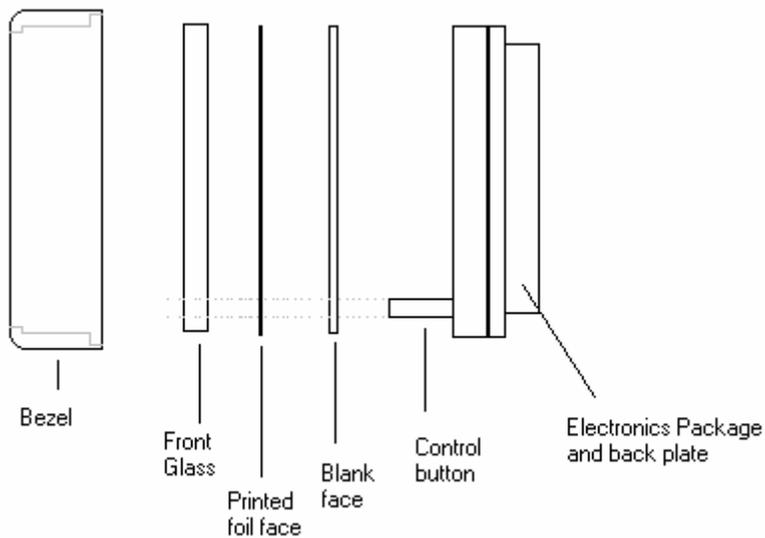
To customize you will need to use a blank white gauge face (supplied with every XD-16).

Innovate Motorsports will provide downloadable .pdf file templates for the most common sensors at: [www.innovatemotorsports.com](http://www.innovatemotorsports.com).

Print these templates on clear overhead foil suitable for your printer. Any stationary store carries those. Depending whether you use an inkjet or laser printer, different foils will be needed.

1. Exacto™ knife or razor blade (or scissors)
2. Piece of plywood or sturdy cardboard as cutting background. (Do not use the kitchen table).
3. A 1/8" hole punch. Leather equipment stores or horse tack stores carry those.
4. A small Phillips screw-driver.
5. Blank white XD-16 face (included)

## 6.3. Assembly sequence of the XD-16 with foil face



## Appendix A: Specifications

Supply voltage range	8V to 25V
Current draw	< 600 mA *
Weight	3oz / 82g
Serial port speed	19.2 kb
Max serial port cable length	15 ft.

\* Current draw depends on outside brightness and number of LED segments lit.

## Revision History

### **1.0 – 2/5/05**

Initial release

### **1.1- 3/16/05**

Corrected misc. errata.

### **1.2- 4/11/05**

Corrected section 2.2

### **1.3 – 2/06/06**

Added XD-16 information