

User guide

TMD4903/TMG4903 EVM

**TMD4903/TMG4903 Light-To-Digital Color Ambient Light Sensor
With Proximity Detection, Gesture Detection, Mobeam®, and Remote Control**



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TMD4903/TMG4903 Sensor

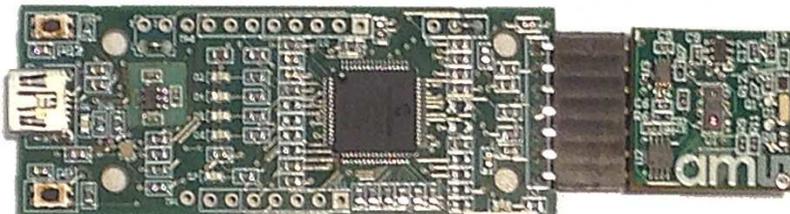
The TMD4903 features ambient light and color (RGB) sensing, proximity detection and IRBeam optical pattern generator capable of mobeam™ barcode emulation and IR remote control. In addition, the TMG4903 supports 2D and 3D gesture detection.



Initial hardware setup

The software should be installed prior to connecting any hardware to the computer. Follow the instructions found in the Quick Start Guide (QSG). This will load the control software and graphical user interface (GUI).

The hardware consists of the EVM Controller, the TMD4903 or TMG4903 evaluation daughterboard and a USB interface cable and a USB Flash Drive. When the USB cable is connected the green LED should light momentarily indicating that power is being received via the USB interface, and the motherboard processor is running. If the green LED does not flash, check the USB cable connections; unplug the USB cable and try again. If the green LED still does not flash, check the PC for USB error messages.





1 Establishing basic functionality

The software should be started using the TMx4903 desktop icon or by double clicking the GestureSensor.exe file from the installation directory. The default installation directory, depending on the device and the operating system you are using, is:

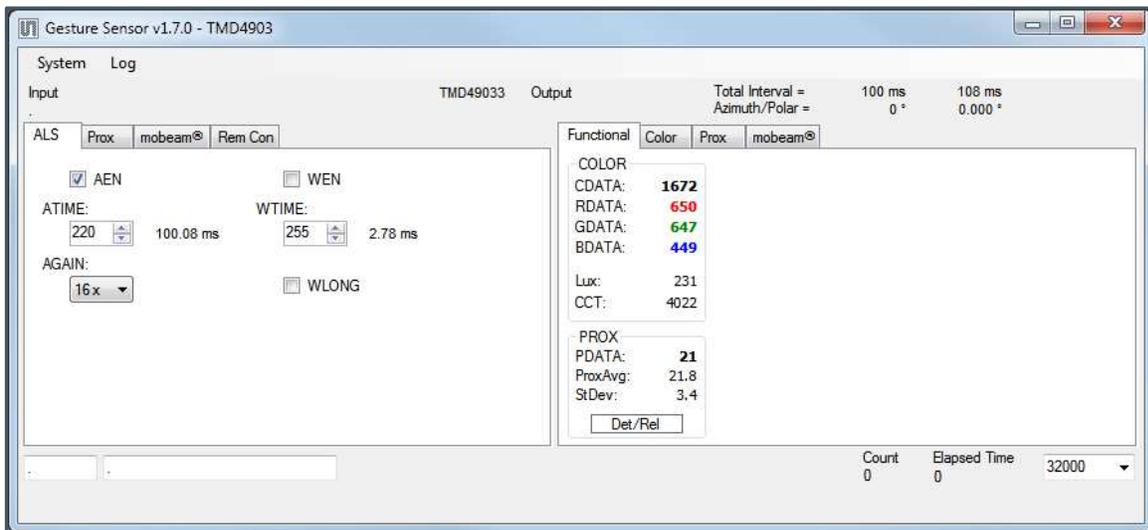
C:\Program Files\ams\TMx4903_EVM (Windows 32 bit operating systems)

C:\Program Files (x86)\ams\TMx4903_EVM (Windows 64 bit operating systems)

A different install path may be selected by the user. When started, two windows will open on the PC. The top window, or Parent Window (PW), is not typically needed and may be placed out of the way. The bottom window, or Child Window (CW), is the main user interface and should be positioned on the screen for easy access. Clicking on the red “X” on the PW will close both windows and terminate the application. Clicking on the red “X” on the CW will close only the CW.

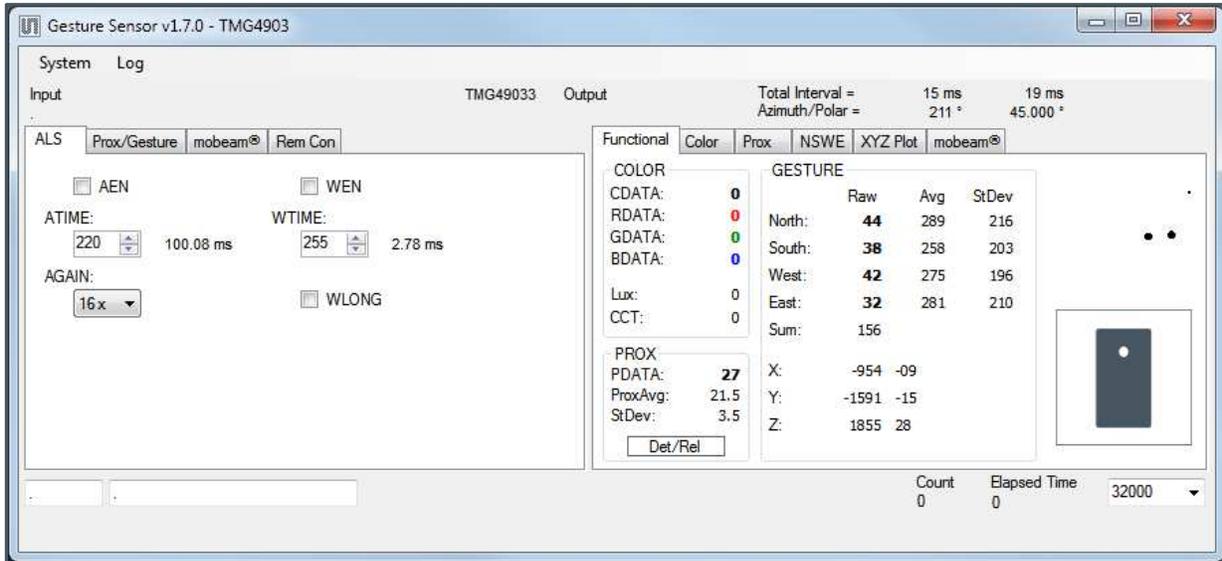


The “ALS” tab on the left side and the “Functional” tab on the right side of the child window will be selected by default. On the right tab, the Prox numbers will be changing, showing that the proximity function is active. Placing your hand approximately 4 inches (100mm) above the sensor causes the proximity readings to change, increasing as your hand approaches. The image below shows the window for a TMD4903 sensor. The Color values will vary as your hand moves over the sensor.





The next image shows the child window for a TMG4903 sensor. The color sensor is not enabled by default for this device, so the Color numbers will not change. The Prox values will change as your hand approaches the sensor and the Gesture numbers and images will change as your hand moves across the sensor from left to right or top to bottom.



The balance of this document identifies and describes the controls available on the different tabs of the TMx4903 EVM application. The TMD4903/TMG4903 datasheet and QSG are included in the installation directory to be used in combination with this user document. In addition, application notes may be found and technical support may be requested on the ams website, www.ams.com.



2 TMx4903 EVM graphical user interface (GUI)

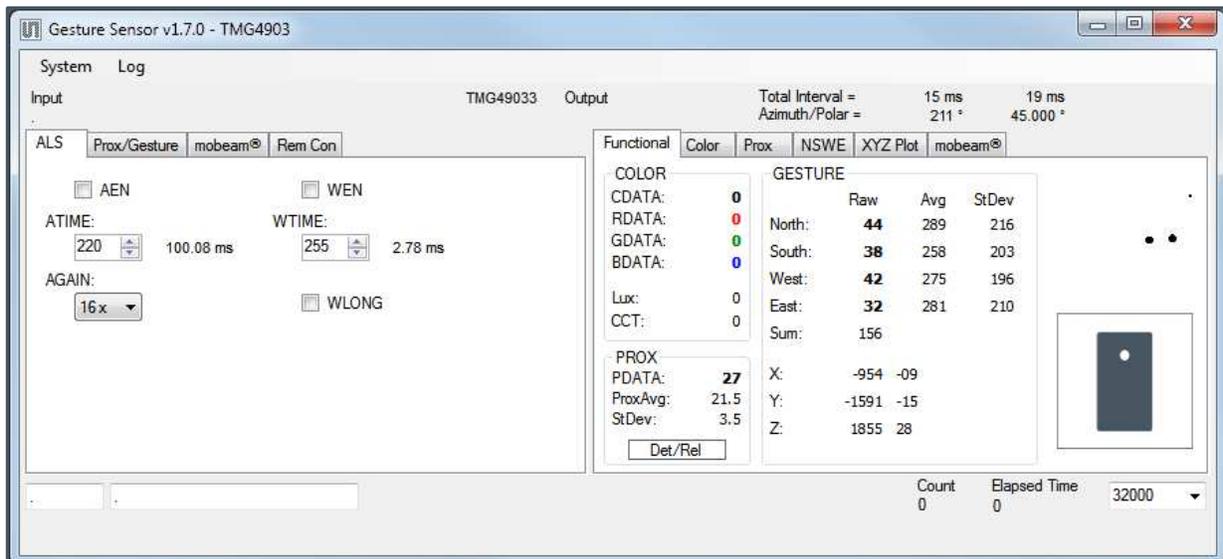
2.1 Software overview

On initialization the software displays two windows – a smaller “Gesture Sensor” window and a larger window containing controls pertinent to the device connected.

If “No Devices” appears, verify that the daughterboard is connected to the motherboard properly. If “No_HID” appears, verify the USB cable is connected. A green LED on the motherboard lights momentarily when the USB cable is connected to the system. The “Reset” button on the screen can be pressed, or the software can be restarted, to reinitialize the device.



The Child Window contains the user interface with control buttons, fields, selection boxes and output values for the identified device connected. Tabs are used to make control and evaluation of specific device functions easy. For the TMG4903 device the initial display screen is shown:





The window for the TMD4903 is similar, but none of the controls or tabs related to the Gesture functionality are present.

This window has inputs organized on the left, and outputs organized on the right. Values for register variables may be set using multiple techniques. ALS and Prox (or Prox/Gesture) input tabs are used to evaluate the device by allowing the user to adjust certain settings. The Functional output tab displays the results of any adjusted settings. Other tabs provide graphical methods to display color and prox data as well as additional demonstration and test features for evaluation.

The values shown in this document will not exactly match a user's system but the basic window and controls should be identical. This document will identify the usage and operation of these items in detail.

Always visible along the bottom is a section containing logging controls and status information:



1. Text entered here is appended to the default file name and stored in the log file. The file name contains the Part Name and address shown in the large "Gesture Sensor" window, an underscore "_" and the text entered. The default, if nothing is entered, is a period (".").
2. Secondary comment box. Text entered here is also appended to the log file name and stored in the log. The default, if nothing is entered, is a period (".").

Sample:

TMD4903Cx39_A-B-C_1-2-3_Log.csv

— From GestureSensor.exe

— From User Input

3. Count of samples in the log buffer. When that number reaches the limit selected in #5, the system will show a file dialog to save the log in a named file.
4. The elapsed time since the beginning of logging data.
5. The number of log samples collected before log entry is written to the log file.



2.1.1 Top-Level menus

At the top of the window there are two pull-down menus labeled “System”, and “Log”. The System menu controls the “Power On” function of the device and the Log menu is used to control the logging function.

2.1.1.1 System Menu

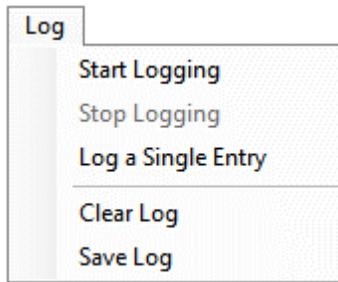
The System Menu provides access to the Power On function.



When the **Power On (PON)** item is checked, the device will function as configured by the remaining controls. When this item is unchecked, the device enters a low-power idle state.

2.1.1.2 Log Menu

The Log menu is used to control the logging function and to save the log data to a file. Log data is accumulated in memory until it is discarded or written to a data file.



Click **Start Logging** to start the logging function. Each time the program polls the ALS and Prox information from the device, it will create a new log entry showing the raw data values, the calculated lux value, the values of various control registers, and the values entered by the user into the text fields near the bottom right corner of the window.

Click **Stop Logging** to stop the logging function. Once logging is stopped, the data can be written to a file, or you can continue collecting additional data by clicking Start Logging again.

The **Log a Single Entry** command, will cause logging to be start, collect one single entry, and immediately stop again. This function is not available when logging is already running.

Click **Clear Log** to discard any data that has already been collected. If there is data in memory, which has not been saved to disk, this function will display a prompt asking if you to verify that it is OK to discard the data. If the log is running when this function is clicked, the log will continue running after the existing data is discarded.

Click **Save Log** to save the collected log data to a data file. This will stop the logging function, if it is active, and display a file dialog box for you to specify where to store the logged data. The default file name, as described above, will be displayed, but you may change the file name if you wish.



2.1.2 Input side, “ALS” tab

Simple commonly used controls exist for the ALS functionality and the wait time between samples.

ALS

AEN WEN

ATIME: 220 100.08 ms WTIME: 255 2.78 ms

AGAIN: 16x WLONG

ALS/Color sensor

- **AEN** – This checkbox controls the ALS Enable. Check this box to enable the ALS/Color function and uncheck it to disable the function.
- **ATIME** – This box controls the time of the ALS/Color integration cycle. A value of 255 represents the shortest integration time (2.78 ms) and a value of 0 represents the longest integration time (711.68 ms). The actual time associated with the register setting is displayed immediately to the right of the box.
- **AGAIN** – This control allows the user access to the ALS Gain settings. The gain amplifies the ADC signal to increase sensitivity. The gain options include 1x, 4x, 16x and 64x and are selected from the list box when the down arrow is clicked.

NOTE: The saturation level of the device is partially dependent on the integration time. Digital saturation occurs when the ADC output registers overflow. Digital saturation is reached at 65,535, thus the full-scale output of the TMx4903 is 65,535 (16-bits). If the integration time is set less than 177.92 ms (ATIME = 192), however, the dynamic range of the device will be limited to the following:

ATIME <= 192, Saturation = 65,535

ATIME > 192, Saturation = ((256 - ATIME) x 1024) – 1

By default, the TMx4903 EVM application will enable the ALS/Color function for the TMD4903 and disable it for TMG4903.

Wait time

The Wait Time register controls the time between ALS/Color cycles.

- **WEN** – Enables the wait function. If this box is checked, a wait time will be inserted between each ALS/Color cycle. If it is not checked, a new ALS/Color cycle will begin immediately after the end of the previous cycle.



- **WTIME** – Controls the length of the ALS wait time. The time is calculated the same as the ATIME register, where 255 is the shortest time and 0 is the longest. The actual time associated with the register setting is displayed immediately to the right of the box. This displayed time does not reflect the 12x factor when WLONG is selected.
- **WLONG** – This bit extends the wait time by a factor of 12x. When this bit is set, a WTIME value of 255 represents 33.36 ms while WTIME = 0 represents 8.54016 seconds.

By default, the TMx4903 EVM application does not enable the wait function.

2.1.3 Input side, “Prox” or “Prox/Gesture” Tab

Proximity controls are common to both the TMD4903 and the TMG4903. Controls for gesture-related fields are present only for the TMG4903 device.

TMD4903

TMG4903

Prox Controls

The following fields control prox-related functions and are present for both TMD4903 and TMG4903.

- **PEN** – This checkbox enables the proximity function. Uncheck this box to disable the function.
- **PTIME** – This field controls the *rate* at which prox cycles occur. Unlike ATIME which controls the time between the end of one ALS cycle and the beginning of the next, PTIME controls the time between the beginnings of each cycle. PTIME = 0 represents the shortest rate (2.78 ms), and PTIME = 255 represents the longest rate (711.68 ms). The actual time associated with the register setting is displayed immediately to the right of the box.
- **PPULSE** – This field controls the maximum number of pulses used for each prox cycle. To avoid saturating the prox sensor, the Automatic Pulse Control (APC) feature of the device may reduce the number of pulses in real-time. The maximum number of pulses selected, which is one more than the value in the register (PPULSE = 0 → 1 pulse), is displayed immediately to the right of the box.
- **PMASK** – Each of these four bits masks the associated prox diode out of the PDATA value. The displayed PDATA value represents the average value of all of the enabled prox diodes. If all of the diodes are disabled, the prox result will always be 0.



Prox Detect and Release Thresholds

There are two sliders below the prox controls labelled Prox Release Threshold and Prox Detect Threshold. These fields are not directly mapped to any hardware. They implement a software-only demonstration of a Detect/Release function. When the average value of the last 32 prox cycles exceeds the Prox Detect Threshold, the Det/Rel box on the Functional Output tab turns red. When the prox average subsequently falls below the Prox Release Threshold, the Det/Rel box is changed back to white.

Prox/Gesture Controls

There are a series of controls which are common to both the prox and gesture functions. These fields are present for both TMD4903 and TMG4903.

- **PGPULSE_LEN** – This field controls the length of each of the pulses in a prox or gesture cycle. The available pulse lengths are 4, 8, 16 and 32 μ s and are selected from the list box when the down arrow is clicked.
- **PGGAIN** – This field controls the prox/gesture gain. The gain amplifies the ADC signal to increase sensitivity. The gain options include 1x, 2x, 4x and 8x and are selected from the list box when the down arrow is clicked.
- **PGLDRIVE** -- Configures the nominal LED current linearly in steps of 20mA (actual current depends on factory-configuration of LED drive strength). The minimum and maximum current settings are 10 mA and 310 mA respectively. The actual drive current associated with the register setting is displayed immediately below the box.
- **OFFSET** – There are four offset registers; one for each of the prox/gesture diodes. Each offset register may be programmed with a value in the range of -255 to 255.

Gesture-Only Controls

The controls which are specific to the gesture function appear only for the TMG4903 device.

- **GEN** – Enables the gesture mode. When this box is checked, the device is able to enter gesture mode. When the box is unchecked, gesture mode is disabled.
- **GTIME** – Controls the rate at which gesture cycles occur when gesture mode is active. GTIME must be configured to be longer than the time settings in the GPULSE and PGPULSE_LEN fields. GTIME is specified in steps of 88 μ s. A value of 0 is the shortest setting (88 μ s) and a value of 255 is the longest setting (22.5 ms). The actual time associated with the register setting is displayed immediately to the right of the box.
- **GPULSE** – This field controls the number of pulses used for each gesture cycle. The number of pulses selected, which is one more than the value in the register (GPULSE = 0 \rightarrow 1 pulse), is displayed immediately to the right of the box.



- **GTHR_IN** – This is the Gesture Entry Threshold. When the gesture mode is enabled, PDATA is compared to this threshold. If PDATA is larger, the device will enter gesture mode.
- **GTHR_OUT** – This is the Gesture Exit Threshold. Once the device has entered gesture mode, it will compare the data from each gesture channel with the exit threshold value. When all of the unmasked channels fall below the exit threshold, the device will exit gesture mode.
- **GTHR_MASK** – These four boxes control which gesture channels will be compared to GTHR_OUT to determine when to exit gesture mode.

2.1.4 Output Side, “Functional” Tab

Color and Proximity fields are common to both the TMD4903 and the TMG4903. Displays for gesture-related fields are present only for the TMG4903 device.

TMD4903

TMG4903

Color/Prox Data

The Color box displays the output register values of the Clear, Red, Green and Blue photodiodes (CDATA, RDATA, GDATA and BDATA respectively).

The calculated Lux and Correlated Color Temperature (CCT) values are displayed below the raw color values.

The Prox indication shows the current prox reading (PDATA), a 32-point rolling average of the PDATA values, and the standard deviation of those 32 prox readings.

The Detect/Release box is a visual indicator of proximity detection. When the prox threshold is exceeded the box will turn red. This is a software-only demonstration function. It is described in more detail in the paragraph named “Prox Detect and Release Thresholds” above.

Gesture-Only Data

Gesture data is only displayed when gesture is enabled and gesture mode is active.



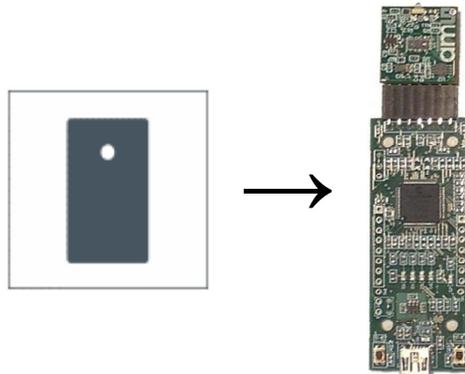
The raw gesture data is presented in three columns. The first column is the raw gesture data for each of the four directional photodiodes. The second and third columns are the average and standard deviation of the most recent 32 gesture points. The “Raw” column contains an additional value; the sum of the four displayed raw values.

The sensor field above the device is divided into a 3D grid. That grid is reported as numeric values on the X, Y and Z plains.

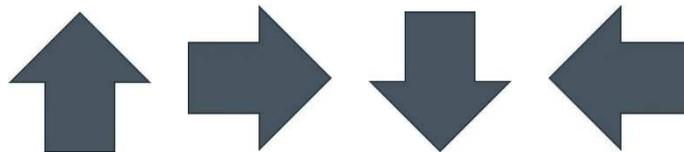
X and Y are reported such that zero is the center point above the device with values moving positive and negative. The first column indicates the first order calculated values and allows for greater granularity. The second column provides an approximate range of -20 to +20 and allows for greater stability within the field.

Z is reported with zero being the closest value to the device. The first column indicates the first order calculated values and allows for greater granularity. The second column provides an approximate range of 0 to +30 and allows for greater stability within the field.

There are 2 graphical displays at the right-hand side of the display. The display in the lower right corner displays detected gestures. In its normal/idle state this display shows a rounded rectangle with a white dot which represents the TMG4903 daughterboard and motherboard oriented so that the daughterboard is pointed away from the user.



When the Gesture Sensor detects a gesture across the device, it will display an indicator based on this orientation of the device. Gestures across the device are displayed as arrows to the left, right, up and down. Long gestures, created by holding a hand above the device are reported as “Button,” “Button Held” and “Button Released”. Approximately 1 second after the end of each gesture, the display will return to its default state.

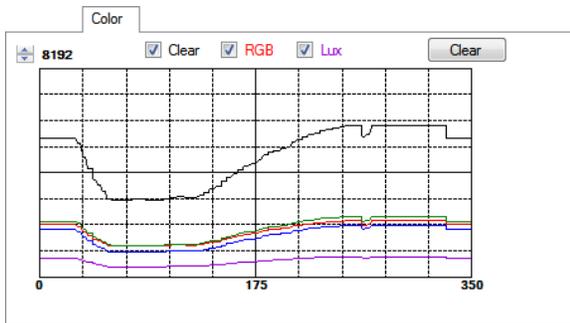




The display on the upper right corner of this tab displays a series of dots which track the motion of a target, or hand, above the TMG4903 device. The size of the dots roughly correspond to the distance from the sensor. The dots will be larger as the detected target approaches the device, and smaller as the target moves away.

2.1.5 Output Side, "Color" Tab

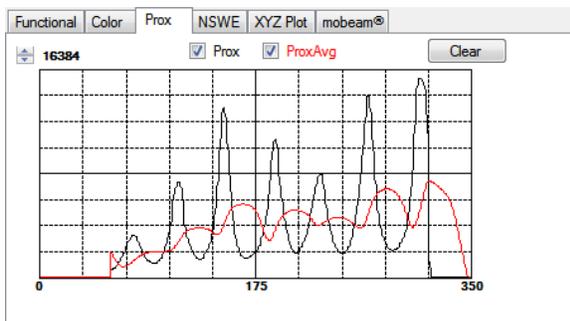
The photodiodes, Lux values can be displayed vs. time on a graph.



To select the data which is displayed, use the checkboxes at the top of the tab. The "Clear" checkbox will display CDATA as a black line. Selecting "RGB" will display RDATA, GDATA and BDATA as red, blue and green lines respectively. If "Lux" is selected, the calculated Lux value will be displayed as a magenta line. The scale of the Y-axis of the plot can be adjusted to any power of 2, from 64 through 65535, by clicking the up and down arrows at the top left corner of the plot. Clicking the "Clear" button will discard the currently displayed data and continue plotting new data as it is collected.

2.1.6 Output Side, "Prox" Tab

The raw proximity data and average data can be displayed vs. time on a graph.

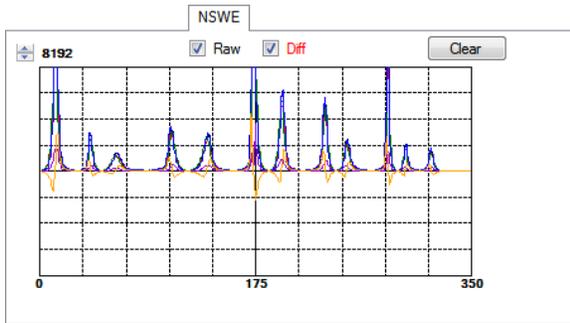




To select the data which is displayed, use the checkboxes at the top of the tab. The “Prox” checkbox will display PDATA as a black line. The “ProxAvg” checkbox will display the average of the previous 32 PDATA points as a red line. The scale of the Y-axis of the plot can be adjusted to any power of 2, from 64 through 16384, by clicking the up and down arrows at the top left corner of the plot. Clicking the “Clear” button will discard the currently displayed data and continue plotting new data as it is collected.

2.1.7 Output Side, “NSWE” Tab

The raw gesture data and the differences between the N/S and W/E channels can be displayed vs. time on a graph.



To select the data which is displayed, use the checkboxes at the top of the tab. The “Raw” checkbox will display North, South, West and East data as black, red, green and blue lines, respectively. The “Diff” checkbox will display the difference between the North and South values (N – S) as a magenta line and the difference between the East and West values (E-W). The scale of the Y-axis of the plot can be adjusted to any power of 2, from 64 through 16384, by clicking the up and down arrows at the top left corner of the plot. Clicking the “Clear” button will discard the currently displayed data and continue plotting new data as it is collected.

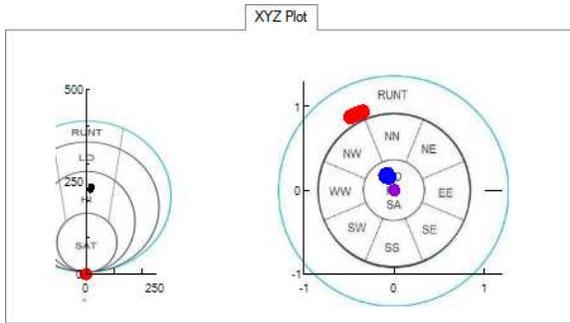
Data is added to this chart only while gesture mode is active. When gesture mode is not active, no new data is added to the chart.

Note that the North, South, West and East data is directly from photo diodes on the TMG4903 device. It is not rotated based on the display.



2.1.8 Output Side, “XYZ Plot: Tab

The XYZ Plot tab shows two separate graphs used to demonstrate the detection of gesture data.



The graph on the left side of this tab represents the angular deviation of the target from the center of the device and the distance of the target from the device. As the target approaches the device (represented by the red dot at the bottom of the plot), the black dot will approach the base of the graph, and as the target moves away from the center of the device, the dot will move away from the vertical axis of the graph.

The graph on the right side of this tab displays the detected target in X, Y and Z space. The device is represented by the magenta dot in the center of the graph. The red dots around the outside of the graph represent the angle from the device to the detected target. The blue dots will show the calculated position of the target in XY space. The relative size of the red and blue dots represent the distance from the target to the device. As the target moves closer, the dots will be smaller. When the target moves away, the dots will grow larger. The directions marked on this graph are aligned in the same orientation described above for gesture detection.

2.1.9 Input Side, “mobeam” Tab

This tab is used to demonstrate the ability of the IRBeam pattern generator to support mobeam™ barcode emulation. The IRBeam pattern generator can support many barcode standards. Only UPC-A and Code39 are demonstrated by the TMx4903 EVM application.

The figure shows a window titled "mobeam" with a control panel. At the top left, there is a checked checkbox for "IBEN". Below it, the "Barcode" section has two radio buttons: "UPC-A" (selected) and "CODE39". To the right of the "CODE39" radio button is a "Code39 Len" field with a numeric value of "12" and up/down arrow buttons. Below the "Barcode" section is a "DIGITS" field containing the text "059280201638". To the right of the "DIGITS" field is a checked checkbox for "Auto-Generate". At the bottom of the window, there are two buttons: "IDLE" and "RUN".

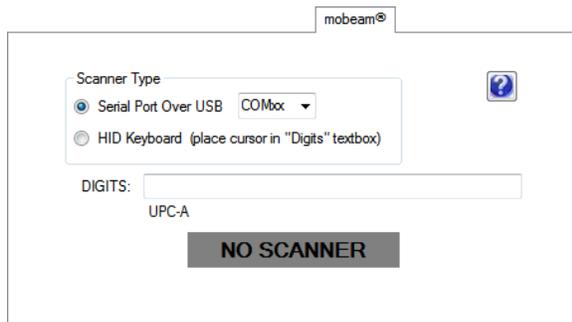
The following fields are used to control the mobeam barcode emulation.



- **IBEN** – Check this box to activate all of the controls on this screen. The gesture functions and the IRBeam pattern generator cannot both function at the same time. When IBEN is checked, the TMx4903 EVM application will automatically disable the gesture function, and if the gesture function is enabled, the application will disable IBEN. If the Prox function is enabled, the TMD4903/TMG4903 device will automatically suspend its operation when the IRBeam pattern generator is running and resume Prox operation as soon as the pattern is complete.
- **UPCA/Code39** – Use this radio button to select the barcode standard to be used.
- **DIGITS** – Enter the digits and/or characters to be encoded into the barcode here. If the Auto-Generate box is checked, the TMx4903 EVM application will automatically generate a random valid code for you. If you enter your own code, the application will verify that the code is valid for the selected standard before running the pattern generator.
- **Auto-Generate** – If you check this box, the application will automatically generate a random valid code each time you press the Run button. If this box is not checked, the application will verify the value entered in the Digits box and use that value to generate the barcode.
- **Code39 Len** – This box is only used if Code39 and Auto-Generate have both been selected. It specifies the number of characters that will be generated for the barcode.
- **RUN/STOP** – When the IRBeam pattern generator is idle, this button is labelled RUN. Pressing the RUN button will start the pattern generator and the button will be changed to STOP. The pattern generator will operate for approximately 12 seconds and then return to the stopped state. Pressing the STOP button will stop the pattern generator and switch the button back to RUN.
- **IDLE/BUSY** – This value indicates whether the IRBeam pattern generator is active. When it is not running, this value will read “IDLE”. It will read “BUSY” while the pattern generator is active.

2.1.10 Output Side, “mobeam” Tab

This tab allows the use of a Motorola Symbol LS2208 handheld scanner to verify the operation of the IRBeam pattern generator mobeam™ emulation functions. Use of this tab is not required in order to use mobeam emulation.



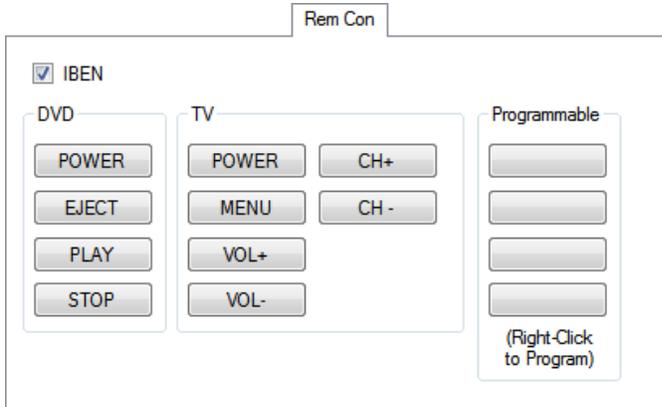
The scanner can be configured to emulate a PC COM port, or a HID keyboard device. You must set the controls on this tab according to your scanner configuration.



- **Serial Port Over USB** – If your scanner is configured to emulate a PC COM port, select this setting and then use the COMxx pull down list to specify which COM port the scanner is using.
- **HID Keyboard** – If your scanner is configured for “HID Keyboard”, select this setting. If this option is selected, you will need to manually click in the DIGITS output box. When a HID Keyboard scanner is used, the barcode results will be placed in ANY textbox that has focus.
- **DIGITS** – When the connected scanner detects a barcode, the resulting code will be displayed in this box. The text immediately below the box will indicate the detected barcode format.
- **Status Box** – The shaded status box is used to display the current status of the scanner. If no scanner is detected, it will read “NO SCANNER”. After a scanned barcode is read, the TMx4903 EVM application will compare the scanned code to the DIGITS field in the Input Side mobeam tab and then indicate in the status box whether the received code matches the transmitted code.

2.1.11 Input Side, “Rem Con” Tab

This tab is used to demonstrate the remote control capability of the IRBeam pattern generator.

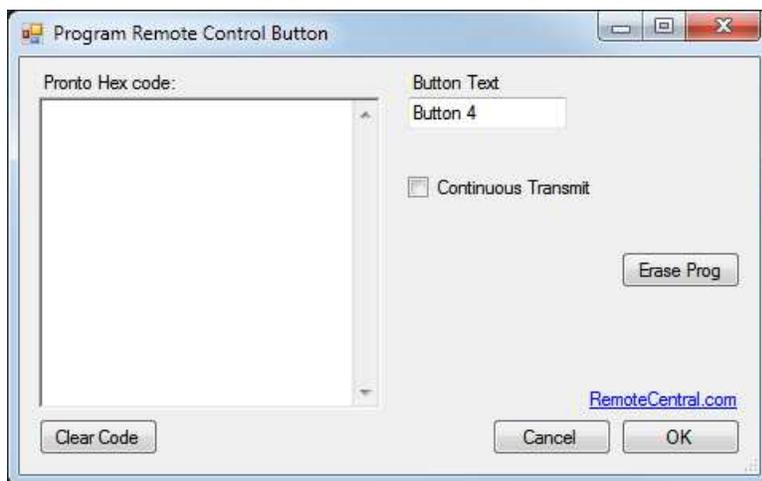


This tab provides several buttons that are pre-programmed to control any certain televisions DVD players. It also provides four buttons which can be programmed to control other devices. The following fields are used to control the remote control functions.

- **IBEN** – Check this box to activate all of the controls on this screen. The gesture functions and the IRBeam pattern generator cannot both function at the same time. When IBEN is checked, the TMx4903 EVM application will automatically disable the gesture function, and if the gesture function is enabled, the application will disable IBEN. If the Prox function is enabled, the TMD4903/TMG4903 device will automatically suspend its operation when the IRBeam pattern generator is running and resume Prox operation as soon as the pattern is complete.
- **DVD buttons** – These buttons are pre-programmed to control certain Samsung DVD players. If you do not have access to one of these players, you can program the Programmable buttons to control your device.



- **TV buttons** – These buttons are pre-programmed to control most Samsung televisions. If you do not have access to one of these televisions, you can program the Programmable buttons to control your device.
- **Programmable buttons** – These 4 buttons can be programmed to control other devices or to access additional functions for the pre-programmed devices. Click on an un-programmed button or Right-Click on any programmable button to access the programming window. Once programmed, clicking on one of these buttons will cause the programmed code to be transmitted.



This window allows you to program remote control codes for the programmable buttons. Buttons are programmed using hex codes. One place to obtain these codes is via the web site <http://www.RemoteCentral.com>. Clicking on the link in the lower right portion of this screen will open your default browser to this site.

- **Pronto Hex code** – Enter (or copy and paste) the hex code for the remote control command in this text box.
- **Clear Code** – Click this button to erase all of the data from the Pronto Hex code box. This button does not erase the button text or change the continuous transmit flag.
- **Button Text** – Enter the text you would like to display on the programmed button. The default text displayed in this field is based on which of the buttons you are programming.
- **Continuous Transmit** – Check this box if the remote control command contains a repeating portion. If you do not check this box, when the programmed button is clicked, the remote command will be transmitted one time. If this box is checked, the repeating portion of the remote command will be transmitted as long as the button remain pressed.
- **Erase Prog** – Click this button to completely clear any programming associated with the programmable button.
- **Cancel** – Click this button to cancel any changes you have made on this screen.



- **OK** – Click this button to complete the programming of the button. The associated button will now transmit the new code whenever it is pressed.

2.1.12 Resources

TMD4903 datasheet

TMG4903 datasheet

Quick Start Guide (QSG)

Designer's Notebooks

For additional information regarding the TMD4903/TMG4903, please refer to the respective datasheet. For information regarding the installation of the TMx4903 EVM host application please refer to the Quick Start Guide.

Designer's Notebooks dealing with various aspects of optical measurement and optical measurement applications are available. All content is available on the ams website www.ams.com