RMS Omega technologies

TLG1-Probe Developer Guide

Version 1.0

Contents

Summary

This document details the commands that can be transmitted/received from the Bluetooth enabled tyre and pressure measuring probe, hereafter called the probe.

For detailed information about how to use the probe, refer to the *TL-G1 Probe User Guide*.

The probe contains a Bluetooth transceiver that presents itself to a PC as a serial device. The serial device can be connected using the following settings:

Type	**Setting**
Baud Rate	9600
Data Bits	8
Parity	None
Start Bits	1
Stop Bits	1

Bluetooth Connection

The probe can connect to any Bluetooth enabled PC or mobile device. The probe device will display on the PC as **Pneu Logic Probe Dnnnnnn** where **nnnnnn** is a six character string. When selected the service supplied by the probe device is **Tyre Probe on Pneu Logic Probe Dnnnnnn** this is a serial port and can connect to any serial terminal program when a pairing is made. You may be requested to enter a PIN. The PIN has been factory set to **1234**.

The data from the probe is transmitted via the bluetooth in 10 Bit ASCII Text Format and allows the full range of the A/D module to be utilised and for the data to be viewed in a terminal program as ASCII data, the data is transmitted in the following format:

Name	**Measurements**
Command	<varies>
Thousands	decimal number 0 - 9 (30 - 39 hex)
Hundreds	decimal number 0 - 9 (30 - 39 hex)
Tens	decimal number 0 - 9 (30 - 39 hex)
Units	decimal number 0 - 9 (30 - 39 hex)
Terminator	<cr> (0D Hex)

Enhanced Operation

The Bluetooth enabled probe contains a number of enhancements that are not available in the RF version of the probe. These enhancements allow commands to be sent to the probe to change various options and to query the state or readings from the probe.

A - Stable Reading Time

This command allows the Tread Depth and Pressure stability time to be set or viewed in units of 10ms. The stability time is the time that the reading must be stable before it will be transmitted.

The format of the command is as shown below, note that **nnn** is in unit of 10ms.

Cmd	Description	Probe Response
A	View Stable Reading Times	ATnnn APnnn
AT	View Tread Depth Time	ATnnn
AP	View Pressure Time	APnnn
ATnnn	Set Tread Depth Time	
APnnn	Set Pressure Depth Time	

AUTOSENSE - Bluetooth Module Type Auto-Detect [V5.04 or Newer Firmware Only]

This command allows the probe to automatically detect the type of Bluetooth module which has been fitted during manufacture. Once the module has been detected the settings are written into EEPROM and this mode is no longer needed. To speed up the boot-up time of the probe this command can be used to disable the auto-detect. All probes have the auto-detect feature disabled after manufacture by default. It is recommended, however, that the auto-detect be turned back on before servicing as changes to the bluetooth could cause the probe to stop working if the mode is disabled.
The format of the command is as shown below, where n is 0 = **OFF**, 1=**ON**;

Cmd	Description	Probe Response
AUTOSENSE=	View Current Setting	AUTOSENSE=n
AUTOSENSE=0	Disable Auto-Detect	-
AUTOSENSE=1	Enable Auto-Detect	-

B - Battery Voltage Reading

This command transmits the battery voltage reading for the internal probe battery. The battery voltage can be calculated using the formula in *Reading Battery Voltage (B): on page 15.*

Cmd	Description	Probe Response
B	View Battery Voltage	Bnnnn

B2DELAY - Bluetooth Start-up Delay {V5.04 or Newer Firmware Only}

This command can be used to alter the allowed time for the Bluetooth to start-up. The default setting is "03" (3 seconds). If necessary the time can be altered between 1 and 250 seconds.

NOTE: When setting the time the command needs a minimum of 2 characters for the set time. For example; To set to 5 seconds use 'B2DELAY=05'.

Cmd	Description	Probe Response
B2DELAY=	View Current Setting	B2DELAY=n
B2DELAY=nn	Set Delay in seconds (1 to 250 seconds)	-

D - Device Number

This command allows the device number of the probe to be viewed. The device number presented to the Pc is **Trans-Logik Dnnnnnn** where nnnnnn is a six character string.

Cmd	Description	Probe Response
D	View Device Number	Dnnnnnn

NOTE: In firmware V5.01+ the Device ID data is used to form part of the transmitted Bluetooth ID. i.e. **Trans-Logik<SPACE><MODEL><DEVICE ID> (See MODEL Command)**

E - User EEPROM Data

This command allows the OEM developer to store and retrieve system information onto the probe. The command allows up to 8 data strings of 16 characters.

The OEM developer can read and write the user data strings using the commands below.

Cmd	Description	Probe Response
ER	Read all user data	ER1<data> ER2<data> ER3<data> ER4<data> ER5<data> ER6<data> ER7<data> ER8<data>
ERn	Read the specified user data where n = 1 to 8	Ern<data>
EWn<data>	Write user data where n = 1 to 8	

H - 'H' Register [V4.04 or Newer Firmware Only]

The **H** register is a 32-bit register for storing and setting the extended configuration details of the probe. This register can be read from or written to using the **H** command. Only the first 29 bits can be accessed by the user. Currently, only 2 of the 29 available H register locations are used, the remaining are reserved for future use:

H1 - 1/32" Measurement Mode

The probe now supports taking tread measurements in 1/32 of an inch. This feature can be enabled by setting the H1 register to **1**. This feature only works if the probe is calibrated and the measurement mode is set to **inches**. When setting the H1 register you must set tread measurement mode to **Actual** and back into 'Inched' mode before taking readings. Setting H1 back to '0' will re-enable the use of decimal inches. **1/32** can also be set using the **UTS** command and the H1 register is automatically set. However, to use decimal inches (UTI) again the H1 register must be cleared.

For more information please see the H register details in the table below.

H2 - Bluetooth Compatibility Mode

Some Bluetooth devices such as the Symbol PDA do not fully support the enhanced power saving features of this probe and sometimes struggle to connect to the probes Bluetooth. Bluetooth Compatibility Mode has now been introduced, which disables some of the power saving features to allow reliable connection to these devices. Setting the H2 register to **1** will enable compatibility mode and setting to **0** will turn off compatibility mode. Please be aware that turning this mode on will increase overall power consumption and slightly reduce the battery life of the probe. You should only use this mode if you are experiencing connection problems with the normal Bluetooth mode.

This mode only functions on the 105 model probes. 105a, 105b & 105T models use a different bluetooth module so this mode does not apply.

Cmd	Description	Probe Response
H	View Current 'H' Register	H1,<data> H2,<data> etc.....H29<-data>
H1,<data>	Configure H1 Register;	
	Inch Measurement Mode:	
	0 = Decimal Inches	-
	1 = 1/32 inches	-
H2,<data>	Configure H2 Register;	
	Bluetooth Compatibility Mode	
	0 = OFF, 1 = ON	-
H3.....H29	TBA	

I - Idle Timer

This command allows the user to set the **Idle Timer** time in minutes. The idle timer is used by the probe to shut down the probe if there has been no activity for **x** minutes. Setting the idle timer to **0** will disable the idle timer.

Cmd	Description	Probe Response
I	View Current Idle Time	Innn
Innn	Set Idle Time	-
I0	Disable Idle Timer	-

L - Operation Counter

This command allows the user to view how many measurement operations have been performed. This feature is useful to determine the service interval of the unit. The count is output as a hexadecimal number (for example, **DA** is 218 operations).

Cmd	Description	Probe Response
LT	View Tread Operations	Lnnnn
LP	View Pressure Operations	Lnnnn
LTC	Reset Tread Counter	-
LPC	Reset Pressure Counter	-

M - Mains Voltage Reading

This command transmits the voltage reading for the external power supply connected to the probe. The voltage can be calculated using the following formula. (1/76) * nnnn

Cmd	Description	**Probe Response** (Type 3)
M	View Main Supply Voltage	Mnnnn

MODEL

Probe Model Type [V5.01 or Newer Firmware Only] This command allows the probe model type to be read. Command usage, where n is the model code:

Cmd	Description	Probe Response
MODEL=	View Current Setting	MODEL=n
Or		
MODEL=?	View Current Setting	MODEL=n

Model Codes:

- D - 30mm, pressure, V2.0 Bluetooth
- B - 30mm, pressure, V2.1 Bluetooth
- L - 30mm, pressure, V4.0 BLE Bluetooth
- T - 30mm, NO pressure, V2.1 Bluetooth
- V - 16mm, pressure, V2.1 Bluetooth
- M - 16mm, NO pressure, V2.1 Bluetooth
- O - 16mm, NO pressure, V4.0 BLE Bluetooth

Note: In firmware V5.01+ the MODEL data is used to form part of the transmitted Bluetooth ID. For example, **Trans-Logik<SPACE><MODEL><DEVICE ID> (See D Command)**

N - "One-Click" Mode Feature

This command controls the **One-Click** mode feature and enables you to turn the feature on or off as desired.

Cmd	Description	Probe Response
NTE	Enable One-Click Mode	-
NTD	Disable One-Click Mode	-
NT?	View One-Click Mode setting	Ntn (E=enabled, D=disabled)

P - Pressure Reading

This command transmits the Pressure reading for the probe. The value nnnn will vary based on the units of measurement selected, if **Actual A/D** Readings then nnnn will represent the voltage detected at the Pressure Sensor and will be a whole number. If any other measurement, PSI or BAR, is selected then nnnn will be a decimal number (i.e. 0.166).

Cmd	Description	Probe Response
P	View Pressure Reading	Pnnnn

R - Report Type

This command allows the probe's report type to be set/viewed. The report type can be set from 0 to 3 as follows:

- 0 = 8 bit Binary Format
- 1 = 8 bit Text Format
- 2 = 10 bit Binary Format
- 3 = 10 bit Text Format (This is the default setting for most uses)

Cmd	Description	**Probe Response** (Type 3)
R	View Report Type	Rnnnn
Rn	Set Report Type	

T - Tread Depth Reading

This command transmits the Tread Depth reading for the probe. The value **nnnn** will vary based on the units of measurement selected, if **Actual A/D** Readings then **nnnn** will represent the voltage detected at the Tread Depth Sensor and will be a whole number. If any other measurement, mm or inches, is selected then nnnn will be a decimal number (for example, 16.00).

Cmd	Description	Probe Response
T	View Tread Depth Reading	Tnnnn

U - Units of Measurement

This command allows the probe's units of measurements to be viewed or changed. The units of measurement can be changed for both the **Tread Depth** and **Pressure** readings, the units allowed are as follows:

Cmd	Description
A	Actual A/D Readings
M	Tread reading in mm
I	Tread reading in inches (Refer to 'H' register section for more information)
P	Pressure reading in PSI
B	Pressure reading in BAR

For the mm/inches PSI/BAR units of measurement to operate correctly the probe must be re- calibrated with two references for the **Tread Depth** (0 and 16mm) and **Pressure** (0 and 100 PSI) using the X command. If these references and report types are not set then the probe will revert to **Actual A/D Readings**.

Cmd	Description	Probe Response
U	View units of measurement	UTn
		Upn
UTA	Set Tread Depth to Actual	-
UTM	Set Tread Depth to mm	-
UTI	Set Tread Depth to inches (Refer to 'H' register section for more information)	-
UPA	Set Pressure to Actual	-
UPP	Set Pressure to PSI	-
UPB	Set Pressure to BAR	-
UPK	Set Pressure to kPa {V5.11 or newer firmware only}	-

V - Software Version

This command transmits the Version number of the software running on the probe.

Cmd	Description	Probe Response
V	View Software VersionVxx.yy (dd-mm-yy)	Dnnnnnn

W - Watchdog [V4.07beta Only]

This command allows the systems integrator to add a Bluetooth link watchdog function to their software. The default setting is for the **Watchdog** to be disabled, and when enabled the watchdog time is set to 10 seconds. If the **Watchdog** is not reset within that time then the Bluetooth link is dropped and the probe is shutdown to conserve power.

When a valid watchdog enable/reset command is received the probe responds with the current time, in seconds, left to run on the watchdog, before resetting the time back to 10 seconds. The WT command will enable/reset the watchdog without resetting the Idle timeout, if set. The Wt1 command will enable/reset the watchdog and also reset the Idle timeout.
Please note that this command is case sensitive.

Cmd	**Description**	**Probe Response** (Type 3)
WT	Enable/Reset the watchdog	Wnnnn
WT1	Enable/Reset the watchdog / Reset the Idle Timeout	Wnnnn
W0	Disable the watchdog	-
WS	Shutdown the Probe	-

X - Recalibrate

This command allows the user to view or re-calibrate the probe's internal references that are used in the calculations for the units of measurements. The internal references that can be viewed or re-calibrated are as follows:

1. Idle Tread Depth level
2. Idle Pressure Level
3. 0mm Tread Depth Reading
4. 16mm Tread Depth Reading
5. 0 PSI Pressure Reading
6. 100 PSI Pressure Reading

Cmd	**Description**	**Probe Response**
X	View internal References	X[1]nnnn
		X[2]nnnn
		X[3]nnnn
		X[4]nnnn
		X[5]nnnn
		X[6]nnnn
X1	Set Idle Tread Depth level	-
X2	Set Idle Pressure level	-
X3	Set 0mm Tread Depth level	-
X4	Set 16mm Tread Depth level	-
X5	Set 0 PSI Pressure level	-
X6	Set 100 PSI Pressure level	-
XC	Clear values in X3 to X6	-

Calibration

To use the probe in either mm, inches, PSI or BAR measurement modes the probe must first be set to **Report Type 3** and then calibrated. To calibrate, the probe must be given 4 calibration values. These 4 values are:

- Tread measurement at 0mm (X3 Value)
- Tread Measurement at 16mm (X4 Value)
- Pressure measurement at 0 PSI (X5 Value)
- Pressure measurement at 100 PSI (X6 Value)

The typical calibration procedure is as follows:

Pre-Calibration:

- Set to **Report Type 3** (Command: R3).
- Set tread units to **Actual** (Command: UTA).
- Set pressure units to **Actual** (Command: UPA).

Calibrating tread:

1. Using the flat end of the calibration block (supplied with kit) set the tread depth needle to **0mm** by pushing the nose of the probe fully flat upon the block.
2. Set X3 value (**Command: X3**).
3. Wait a couple of seconds then release the tread depth needle back to its fully extended position.
4. Using the **16mm** end of the calibration block (supplied with kit) set the tread depth needle to **16mm** by pushing the nose of the probe fully flat upon the top of the block and the needle inside the **16mm** deep hole.
5. Set X4 value (**Command: X4**).
6. Wait a couple of seconds then release the tread depth needle back to its fully extended position.

Calibrating pressure:

1. Using atmospheric pressure as **0PSI** set the pressure to **0PSI** by ensuring the pressure inlet is vented to atmosphere and there is no pressure applied to the probe.
2. Set X5 value (**Command: X5**).
3. Using a known **100PSI** pressure set the pressure value by applying the **100 PSI** air pressure to the inlet of the probe.
4. Set X6 value (**Command: X6**).
5. Wait a couple of seconds then release the air pressure and allow the inlet to vent to atmosphere.

Select Measurement Units:

1. Select the tread measurement units (mm, inches, 1/32") (**Command: UTM or UTI or UTS**).
2. Select the pressure measurement units (PSI, BAR) (**Command: UPP or UPB**).

The probe is now calibrated for taking measurements.

Understanding Analogue Data Values

The probe measures the analogue signals for **Tread Depth**, **Tyre Pressure**, **Battery Voltage**, **Battery Temperature** and **DC Input Voltage**. These signals are fed through a 10-bit ADC and returned to the user as a value. This document describes how these values can be interpreted into usable data.

The ADC uses the regulated supply voltage of 3.3V as its reference and the value returned represents a ratio of the 3.3V. In 10-bit mode the value is between 0 and 1024 (where 0=0V and 1024=3.3V) and in 8-bit mode the value is between 0 and 256 (0=0V and 256=3.3V).

Reading Tread Depth (T):

The tread depth can be returned by the probe using the "T" command. Alternatively this data is automatically sent when the probe is taking tread depth measurements. When using "Actual" mode the data value can be interpreted as follows;

To determine the tread depth in actual measurements 2 references are required. For ease of use we use 0mm and 16mm (Setting Block). The data values need to be read with the tread needle set at these distances. For the 0mm the needle is pushed into the probe until the nose is on a flat surface. For the 16mm the setting block can be used to push the needle in until the nose is flat to the top of the setting block. These values are then known as your calibration data.

The tread depth sensor on the probe is effectively linear, so the calculation for tread is:

$$Mt = (T0 - Vr) \div \left(\frac{T0 - T16}{16} \right)$$

Where:

Mt = Measured Tread Reading (mm)
T16 = Value read at 16mm (Lower Reference)
T0 = Value read at 0mm (Upper Reference)
Vr = Value read for the measured tread

Reading Tyre Pressure (P):

The tyre pressure can be returned by the probe using the **P** command. Alternatively this data is automatically sent when the probe is taking pressure measurements. When using **Actual** mode the data value can be interpreted as follows;

To determine the tyre pressure in actual measurements 2 references are required. For ease of use we use 0PSI {Atmospheric 0} and 100PSI. The data values need to be read with the pressure inlet at these values. These values are then known as your calibration data.
The pressure sensor on the probe is effectively linear, so the basic calculation for pressure is:

$$Mp = (Vr - P0) \div \left(\frac{P100 - P0}{100} \right)$$

Where:
- Mp = Measured Pressure Reading (PSI)
- P100 = Value read at 100PSI (Upper Reference)
- P0 = Value read at 0PSI [Atmospheric 0] (Lower Reference)
- Vr = Value read for the measured pressure

However, a small non-linear anomaly is present when the pressure is below 7PSI (approx). At pressures below 7PSI (including the 0PSI), the output of the pressure sensor displays a negative curve, which makes the 0PSI reference lower than you would expect from a truly linear output. If using the equation above, this causes an inaccuracy in the calculated pressure by up to ±2% getting worse the further from 100PSI the measured pressure is. At between 70 and 130 PSI this inaccuracy is typically less than ±0.5%. As the majority of commercial tyres are to be inflated between 70 & 130 PSI, and due to the fact that traditional standard needle gauges are only accurate to ±3%, this inaccuracy is deemed acceptable in most general applications.

If more accurate pressure measurements are required the non-linear output will have to be compensated for. Upon testing numerous probes it was found the error found for the "0" value was an average of 1.8% (0.018) lower than it would be if the output was truly linear. Using this error to recalculate the pressure readings increases the accuracy to less than ±1% deviation throughout the 10-150PSI range. This **Error Percentage (Ep)** can then be used to compensate for the error when taking pressure measurements regardless of the calibration data used. To calculate the pressure with error correction use:

$$Mp = (Vr - P0) \div \left(\frac{P100 - (P0 + ((P100 - P0) \times Ep))}{100} \right)$$

Where:
- Mp = Measured Pressure Reading (PSI)
- P100 = Value read at 100PSI (Upper Reference)
- P0 = Value read at 0PSI [Atmospheric 0] (Lower Reference) Ep = Error (0.018)
- Vr = Value read for the measured pressure

Note: When using **Report Type 3** and unit measurement modes, (such as PSI or BAR) further error compensation is not required. When transmitting measurements in units error compensation is included.

Reading Battery Voltage (B):

The probe's internal battery voltage can be returned by the probe using the **B** command. The data value can be interpreted as follows:

10-bit operation:

$$Vb = \frac{(3.3 \times Vr)}{1024} \div 0.6803 \quad \text{or:} \quad \frac{0.003222656 \times Vr}{0.6803}$$

8-bit operation:

$$Vb = \frac{(3.3 \times Vr)}{256} \div 0.6803 \quad \text{or:} \quad \frac{0.012890625 \times Vr}{0.6803}$$

Where:
Vb = Internal Battery Voltage (VDC)
Vr = Value read for the measured voltage

Note: For correct operation of the probe the internal battery voltage should be above 3.5vDC. Anything below this and the probe could begin to return false measurements or loose the Bluetooth connection. A typical fully charged battery is around 4.1 to 4.3vDC.

Reading Input Voltage (M):

The probe's input charging voltage can be returned by the probe using the "M" command. The data value can be interpreted as follows;

10-bit operation:

$$Vm = \frac{(3.3 \times Vr)}{1024} \div 0.2481 \quad \text{or:} \quad \frac{0.003222656 \times Vr}{0.2481}$$

8-bit operation:

$$Vm = \frac{(3.3 \times Vr)}{256} \div 0.2481 \quad \text{or:} \quad \frac{0.012890625 \times Vr}{0.2481}$$

Where:
Vm = Input charging voltage (VDC)
Vr = Value read for the measured voltage

Note: For correct operation of the probe the input charge voltage needs to be between 8.0 and 14.vDC.

Reading Battery Temperature (C):

The probe's internal battery temperature can be returned by the probe using the **C** command. The data value can be interpreted using the following table:

Temperature	**-40°C**	**-20°C**	**0°C**	**10°C**	**20°C**	**30°C**	**40°C**	**50°C**
Data (10-bit)	994	928	784	682	569	457	356	271
Data (8-bit)	249	232	196	171	142	114	89	68

NOTE: The minimum temperature for fast charging is 10°C and the maximum temperature for fast charging is 40°C.

Useful Tips

Below are a few useful tips to help reduce problems and make the application software as user friendly as possible:

1. When first connecting to the probe it is a good idea to first perform a **Device ID (D)** command to verify the connection and that the probe is functioning correctly. After a 'D' command the probe should return the Device ID of the probe.
2. After first connecting to the probe check that the correct **Report Type (R)** is set for your application. For most applications and for unit measurement modes this is 3. Having this incorrectly set will result in incorrectly formatted data which may cause issues with the application software.
3. After first connecting to the probe check that the **Stable Timers (AT and AP)** are set to a value within suitable range. The default is for both timers is1000ms (100). The recommended minimum setting is 400ms (40). A setting outside 400-1000ms (40-100) is not recommended and may adversely affect the operation of the probe.
4. If connection problems are experienced with the Bluetooth, enable **Bluetooth Compatibility Mode (H2)**, if the probe supports it. Note that only 105 model probes with V4.04 or newer firmware support this mode. Models 105a, 105b and 105T use a different bluetooth module which does not need this mode.
5. Connection issues with newer hardware and operating systems such as Windows 8 can often be resolved by disabling authentication or encryption. With Windows 8 or 8.1 it is also recommended that the probe connection is managed in the **Control Panel >> Devices and Printers** dialog box rather than the **Bluetooth** section of the **PC Settings App**.
6. To prevent your software from sending unsupported commands which an older version probe can not understand it is recommended that the **Firmware Version (V)** be read from the probe to determine compatibility and any unused commands be blocked or disabled.
   E.g. Firmwares below V4.04 do not support the **Log Counter (L)** command.
   E.g. 'UTS' is not supported for firmwares below V4.07beta.

   Command Compatibility Summary:

Firmware Revision	Compatible Commands
All	A, B, C, D, E, I, M, P, R, T, U*, V, X
V2.09+	N, lower case commands
V4.04+	H1, H2, L
V4.07beta(+)	W**, UTS
V5.01+	MODEL
V5.04+	AUTOSENSE, B2DELAY
V5.11	UPK

* All U commands except UTS
** W command in V4.07 ONLY

7. Make full use of the battery voltage and temperature measurement capability. It is often useful to the probe's user to see what state the battery is in. Low battery indication and unsuitable charging environment indication are useful extras.
   The probe should not be used if the battery drops below 3.6V.
   The probes battery should not be charged if it outside 0°C - 35°C.