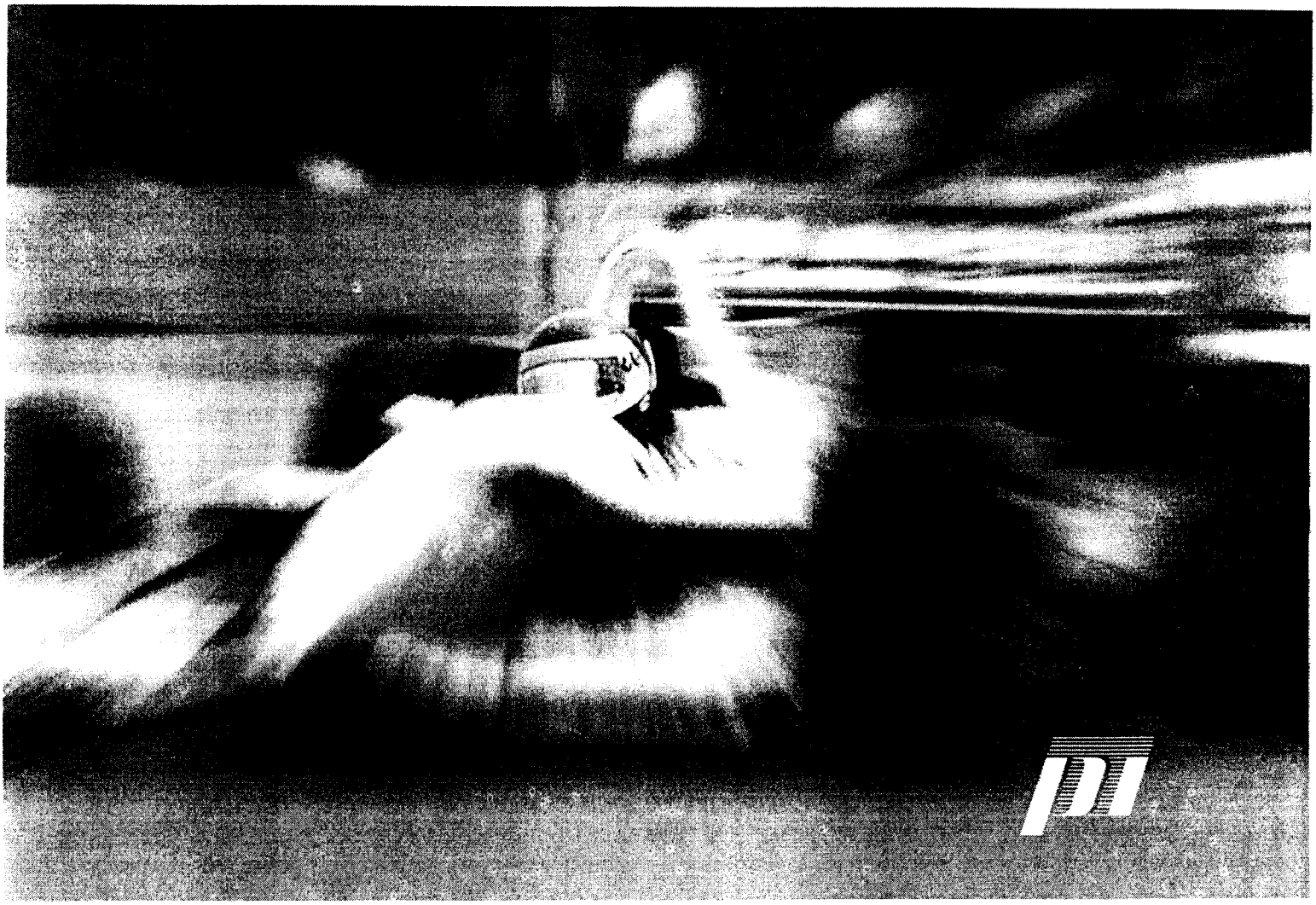
HP Tire Monitoring System

ATION NOTE



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FCC regulations

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation.

If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

Changes or modifications to this device without the express approval of Pi Research Inc. may void the user's authority to use this device.

Contents

Safety information

The Pi Tire Monitoring System (TMS) is designed to be fitted and used with specially modified wheels. Modifications to wheels must only be made by the wheel manufacturers and approved by the relevant motorsport regulatory authorities. Under no circumstances must wheel modifications be carried out by anyone other than the wheel manufacturers.

Pi Research do not take responsibility for use of the Tire Monitoring System when fitted to non-approved modified wheels.

Before using the Tire Monitoring System the engineer(s) responsible for fitting the system should read this application note carefully, and consider the following points.

- Follow the installation instructions provided.
- Use only TMS wheel bolts of the correct length, and Dowty washers supplied by Pi.
- Record the use of each TMS wheel fixture and schedule refurbishment for the end of each season or when a failed transmitter is found.
- Have your wheels and TMS wheel bolts frequently tested for cracks.
- Crack test the TMS wheel bolts before high speed races such as super speedways.
- Check TMS wheel fixtures for signs of the cap moving by checking the paint spot on the joint of the cap and the transmitter case. If there are signs of movement then the TMS wheel fixture should not be used until the cap has been removed, cleaned, resealed, and tightened to the correct torque.
- Remove TMS wheel fixtures from wheels after each race or practice session.
- Store Tire Monitoring System equipment in the protective case supplied.

Introduction

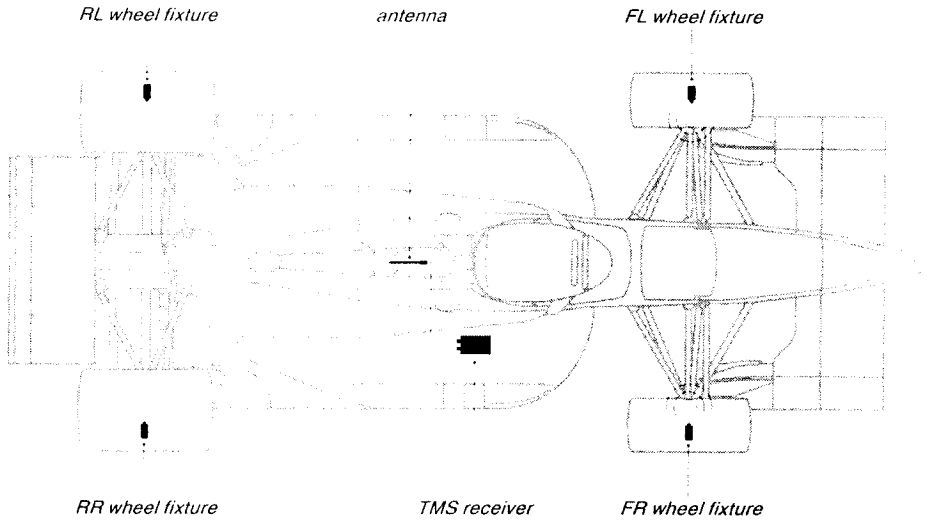
The setup of a high performance race car is very sensitive. The rolling radius of a tire is critical to the ride height and consequently, the aerodynamic performance and balance. The speed at which a car can corner is a function of the lateral and vertical stiffness of the tire, and the physical properties of the tread rubber.

Some of the stiffness is generated by the inflation pressure holding the sidewall in position. It has been calculated that for a typical racecar tire, a 2 PSI change in inflation pressure equates to a 100 lbf/in change in the tire's vertical spring rate.

Changes in vertical spring rate result in a change in the dynamic reactions of the car. If the change in inflation pressure is gradual, then the change in dynamic reaction will be small. If there is a rapid change in pressure the whole tire may fail mechanically with disastrous results.

The Tire Monitoring System is designed to provide early warning of potential tire failure by measuring inflation pressure. The pressure data can be logged or sent to the pits using real-time telemetry equipment to provide lap-by-lap monitoring of tire condition. By careful observation of the data, race engineers can make informed decisions, and avoid potentially dangerous situations.

Tire Monitoring System: Overview



The Tire Monitoring System comprises a car mounted radio receiver and four wheel fixtures (transmitter assemblies).

Transmitter assemblies

Each transmitter is powered by two lithium batteries. To increase battery life, transmission only occurs when wheel motion is detected.

Identification

To ensure that data from other cars is not received, each transmitter is programmed with position information and a unique Team Identification. The receiver is programmed to recognize only one Team Identification.

To make it easier to relate TMS wheel fixtures to wheel position they are color-coded. The following table details the position and color of TMS wheel fixtures.

Wheel positions are as the driver would see the wheels when seated in the car.

Wheel	TMS wheel fixture label	Label color
Rear right	01B-050391-RR	white
Rear left	01B-050391-RL	yellow
Front left	01B-050391-FL	red
Front right	01B-050391-FR	blue

When a new transmitter is fitted to the car, for example during a pit stop, the receiver first learns the Team Identification of the new transmitter before sending pressure data to the logging system.

Pressure data

When wheel motion is detected and the transmitter Team Identification has been learned, inflation pressure data is transmitted every 5 seconds. If the inflation pressure changes by ±1.0 PSI then the pressure data is transmitted every 1.25 seconds until the pressure stabilizes.

As standard, the Tire Monitoring System is set so that if the change in inflation pressure is more than 5 PSI, the receiver waits for a second pressure reading before sending pressure data to the logging system.

This feature can be disabled by a request to Pi Customer Support.

Receivers

Each receiver is programmed to only identify data from wheel fixtures with the same unique Team Identification. The receiver outputs pressure data from the four wheels as an RS-422 serial data stream. In addition to the pressure channels, five debug channels are provided for fault finding: four diagnostic channels and a receiver temperature channel.

For use with data logging systems that do not accept RS-422 data, the TMS receiver outputs pressure data as four 0–5V analog signals.

System requirements

To use the Tire Monitoring System you need one of the following:

- Pi System 3+ programmed with boxcode and ECM driver that supports the Tire Monitoring System.
- Pi System 4+ programmed with boxcode that supports the Tire Monitoring System.
- Pi System 5STAR or Motor Racing Computer (MRC) programmed with customer specific code, and correct communication ports.
- A non-Pi system with four 0–5V analog inputs.

Additionally you need:

- Pi Analysis software that supports the Tire Monitoring System.

You should be familiar with Pi Version 6 software and be able to calibrate a sensor channel.

Pi System looms

From 1996 onwards, Pi System looms have a connector that enables a TMS receiver or an Octal Serial Junction box to be connected directly to the logging system. Communication between the Tire Monitoring System and the LCU (Logging Control Unit) is by an RS-422 data link.

Non-Pi systems

The Pi Tire Monitoring System can be used with non-Pi systems by using the four 0–5V analog outputs instead of the serial communication link. A suitable adapter loom to connect the TMS receiver to the logging system is required. Connector pin details for the TMS receiver are provided in this Application Note.

Installation

Installing the TMS receiver

When installing the TMS receiver:

- select a position where the TMS receiver will not be in constant contact with water, fuel, or oil;
- protect the TMS receiver from vibration by mounting the it using anti-vibration mounts or Velcro®;
- make sure that TMS receiver will not be affected by heat soak;
- try not to position the TMS receiver near sources of electrical interference e.g. ignition coils, plug leads, ECMs, telemetry antennas, and alternators.

The TMS receiver antenna should be mounted so that there is line-of-sight to the wheel fixtures. The best position for the TMS receiver antenna is the roll hoop area of the car. Use the antenna extension loom to position the antenna remotely.

When installing the receiver antenna:

- choose a position for the receiver antenna so that there is line-of-sight from the receiver antenna to each wheel fixture;
- make sure that the receiver antenna is at least 12" (300mm) from other antennas, and
- use the contents of the antenna installation kit to install the antenna.

To install the TMS receiver using Velcro®:

1. Select a suitable location for the TMS receiver.

Make sure that all of the looms that you have to connect to the TMS receiver can reach the selected position.

2. Clean and degrease the selected location and the base of the TMS receiver.
3. Apply the Velcro® to the base of the TMS receiver and to the chassis. Press the TMS receiver firmly and evenly down onto the Velcro® on the chassis.
4. Plug the System and antenna looms into the TMS receiver.

Installing the TMS receiver antenna

Ground planes

The TMS receiver antenna needs a suitable ground plane to operate efficiently. The ground plane is a conductive material placed at the base of the antenna to increase its efficiency.

Generally, the construction and shape of a race car does not allow for a suitable ground plane. To use your Tire Monitoring System effectively you may have to make a suitable ground plane.

Each TMS receiver antenna comes with an installation kit that includes a piece of self-adhesive copper foil which you can use to make a ground plane.

When making a ground plane you should consider the following points:

- The antenna should be mounted in a vertical position in the centre of the ground plane.
- The ground plane should be made as large as is possible within the constraints of the car body work.
- The ground plane must not make electrical contact with any part of the vehicle chassis that is likely to conduct; for example, carbon fibre.

To fit the antenna to a fibre glass body panel:

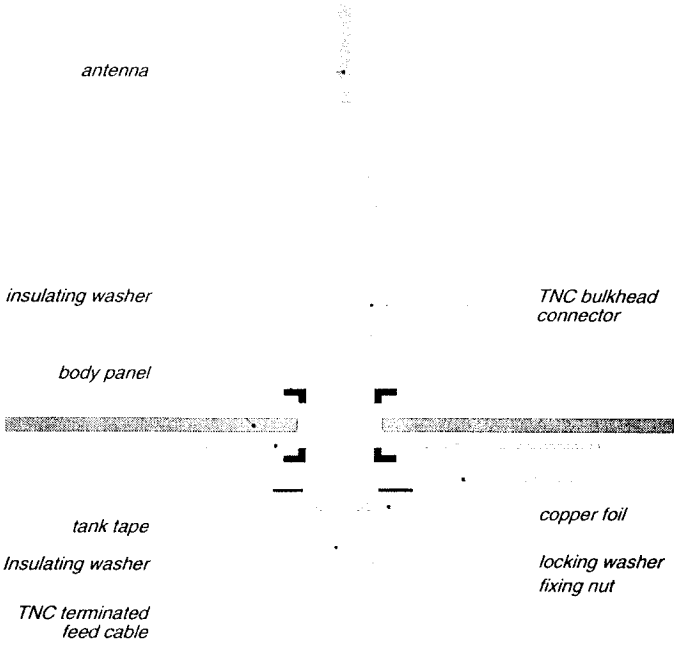
1. Locate a suitable panel that can be removed easily for access to the antenna loom.

As fibre glass is electrically nonconducting, you can stick the copper foil directly to the underside of the panel.

2. Drill a hole in the panel for the insulating washers.
3. Assemble the insulating washers on either side of the panel, and tighten the TNC bulkhead connector, ensuring that it makes electrical contact with the copper foil.

Ensure that the copper foil does not make contact with any part of the chassis that is likely to conduct.

4. Tighten the antenna and antenna feed cable to the bulkhead connector, and refit the panel.



Antenna installation detail

To fit the antenna to carbon fibre chassis panels:

1. Locate a suitable panel that can be removed easily for access to the antenna.
2. Make a bracket from metal or carbon fibre that will hold the antenna vertical. Fix the bracket to the chassis.
3. Stick an insulating layer of 'tank tape' to the underside of the bracket. Make sure that it is of a larger diameter than the copper foil for the ground plane.
4. Stick the copper foil to the underside of the insulating layer.
5. Tighten the TNC connector of the antenna, ensuring that it makes electrical contact with the copper foil.

6. Ensure that the copper foil does not make contact with any part of the chassis that is likely to conduct.
7. Drill a hole in the panel for the antenna to pass through.

Antenna feed loom

If you are going to use your own antenna feed loom, it should be a high quality coaxial cable with a stranded inner core. Pi recommend that you use 50 ohm RG58 coaxial cable.

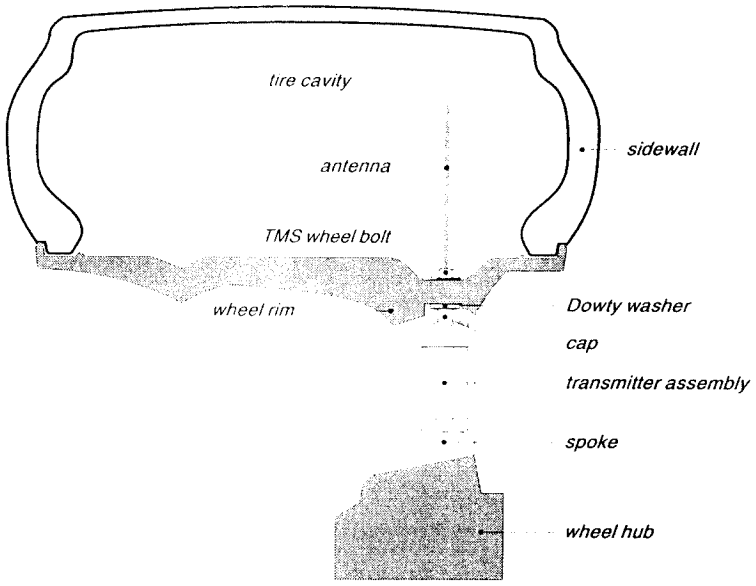
For best results, use crimp TNC connectors at both TMS receiver and antenna ends of the feed cable.

WARNING: It is important that the TNC connectors of the feed loom do not vibrate against any other conducting surfaces such as Lemo connectors or the chassis floor, as this will result in radio frequency noise and a loss of signal.

Fitting TMS wheel fixtures

Each wheel fixture consists of three important components:

- the transmitter assembly,
- a coated Dowty washer, and
- a TMS wheel bolt.



Section through wheel showing typical location of TMS wheel fixture

Each wheel must be specially machined to accept a TMS wheel fixture. Wheels may be supplied fitted with TMS fixtures or you may have to fit them yourself.

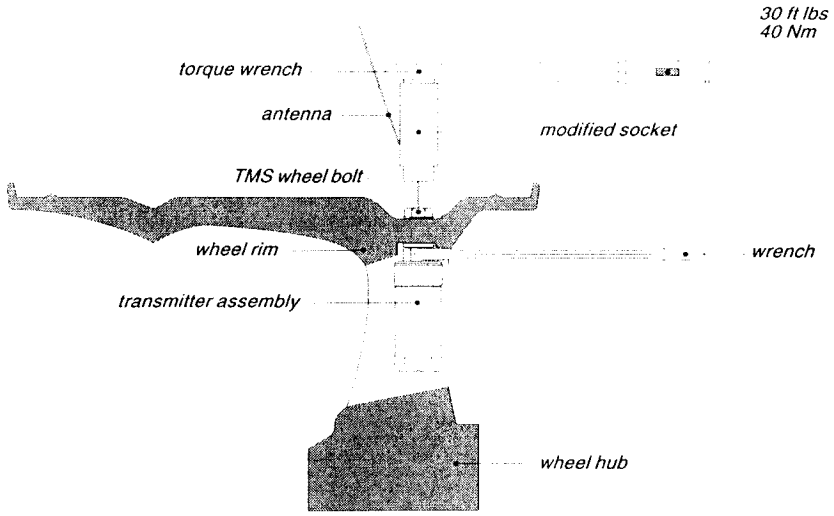
WARNING: The bolt used for the rear wheel may be of a different length than the bolt used for the front wheel—be sure to use the correct bolt. The bolts are color coded. See the table on page 32.

To fit a TMS wheel fixture to a wheel:

1. Remove the tire from the wheel.
2. Thoroughly clean and dry the hole allocated for the TMS wheel fixture.
3. Choose the correct bolt for the thickness of the wheel rim. (See page 32.)
4. Place the wheel bolt into the hole in the wheel rim. The bolt head should be on the tire cavity side of the wheel rim.
5. Make sure that the bolt is clean and free of debris, and place four drops of Loctite® 242 at 90° intervals around the bolt thread.

WARNING: Use only the specially coated Dowty washers available from Pi.

6. Place the 3/8" coated Dowty washer over the antenna so that it sits on top of the transmitter cap. Do NOT use additional washers if the bolt appears to be too long. Check that the correct bolt has been chosen.
7. Choose the correct transmitter for the wheel. Each transmitter is labelled according to its wheel position (FR, FL, RR, and RL).
8. Carefully guide the antenna through the wheel bolt and tighten the transmitter onto the wheel bolt finger-tight.
9. Prevent the cap from rotating using a 1/2" wrench, and tighten the wheel bolt to 30 ft lbs (40 Nm) using an accurate torque wrench fitted with the modified socket.



Tightening a TMS wheel fixture

WARNING: The antenna is exposed and can be easily damaged. The tire should be fitted by starting at a point opposite to the position of the transmitter.

10. Send the wheel to have the tire fitted and balanced.
11. Inflate the tire using dry nitrogen and leave for a minimum of six hours. This time also allows the Loctite® 242 to set.
12. Check the tire for leaks and deflation.
13. If no leaks are found, adjust the inflation pressure to normal working pressure.

Removing and checking TMS wheel fixtures

Wheel fixtures must be removed from wheels after each race or practice. The wheel fixture should be removed also if the transmitter electronics have failed, or there are signs that the cap is loose, or you are returning the unit to Pi Research for repair, replacement, or refurbishment.

Always remove wheel fixtures before cleaning the wheel with high pressure water jets or other cleaning materials as these must not be allowed to enter the fixture through the pressure part in the bolt head.

To remove a TMS wheel fixture from a wheel:

1. Remove the wheel from the car.
2. Deflate the tire and remove the tire from the wheel taking care not to damage the TMS antenna.
3. Prevent the cap from rotating using a 1/2" wrench and undo the wheel bolt.
4. Remove the transmitter assembly.
5. Clean the threads of the wheel bolt to remove any Loctite® 242 using a clean wire brush. Retain the wheel bolt. (Screw it into the transmitter for safe keeping.)
6. Clean the threads of the Transmitter assembly cap to remove any Loctite®. (The method is given in the *Transmitter assembly cap cleaning* section of this Application Note.)
7. Discard the Dowty washer.
8. Always store TMS wheel fixtures in the protective case supplied.

Checking the cap seal

After each practice or race session you should remove the TMS wheel fixture from the wheel and examine the paint spot for signs of the cap loosening.

If the paint spot has cracked then the cap must be removed, cleaned, resealed, and tightened.

To reseal the cap:

1. Carefully remove the cap from the transmitter case.
2. Clean the threads of the cap and transmitter case to remove any Loctite® 242.
3. Apply four drops of Loctite® 242 at 90° intervals around the cap thread, and tighten the cap into the transmitter case finger-tight.
4. Grip the base of the transmitter assembly using a wrench and tighten the cap to 30 ft lbs (40 Nm) using an accurate torque wrench.
5. Remove the old paint mark and apply a small spot of paint to the joint of the cap and transmitter case, and leave the assembly to dry for six hours.

Cleaning the Transmitter assembly cap

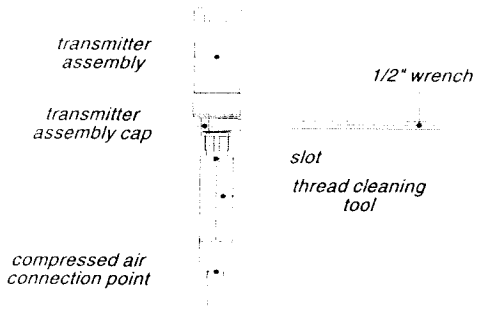
TMS wheel fixture bolts and transmitter assembly caps are manufactured from maraging steel, which has a mild tendency to corrode in a combination of air and water. It is possible that water vapour in compressed air used to inflate tires could cause corrosion of the TMS wheel fixture bolt and the transmitter assembly cap. For this reason Pi recommend that tires are inflated using dry air or dry nitrogen.

Cleaning the threads on the transmitter assembly cap

Use the thread cleaning tool supplied with your TMS kit to clean TMS transmitter assembly cap threads which are corroded or to remove Loctite® 242. Omit steps 2 and 5 in the following list if compressed air is not available.

1. Refer to the section describing *Removing and checking* TMS wheel fixtures and remove the TMS wheel fixture from the wheel.
2. Connect a low pressure compressed air supply to the nozzle end of the thread cleaning tool. Do not turn the compressed air on.

3. Hold the thread cleaning tool in a vice, with the threads on the tool pointing upwards.



Using the thread cleaning tool

4. Carefully feed the antenna of the transmitter assembly into the hole down the center of the thread cleaning tool. Turn the transmitter assembly so that the threads in the cap just catch the threads on the thread cleaning tool.

WARNING: Use compressed air at a pressure less than 20 PSI. Follow all normal precautions for the use of compressed air.

5. If you are using compressed air, turn it on.
6. Fully screw the transmitter assembly onto the thread cleaning tool, taking care that any debris produced falls out of the slot in the thread cleaning tool and not into the body of the transmitter assembly.

NOTE: When turning the transmitter assembly grip the Hexagonal flats at the end, not the body of the transmitter assembly. You can use a 1/2" AF wrench on the transmitter assembly cap to turn the transmitter assembly. Do not over-tighten the transmitter assembly.

Calibration and testing

Calibrating TMS channels

Choosing a channel to calibrate

1. Make sure that you have connected the TMS receiver to your data logging system.

If you are using the four analog outputs of the TMS receiver, decide which channels you are going to use, and plug them into the appropriate inputs of the data logging system.

2. Switch on your computer. Locate and start the Version 6 Setup application.
3. Power your data logging system.
4. Plug the download lead form the computer into the download connector of the data logging system.

If you are using a PiDD the red LED should illuminate to confirm that it is powered.

5. Make sure that you have the car that you want selected and choose "Calibrate LCU Channel..." from the Calibrate menu. The Channel for Calibrating dialog appears.

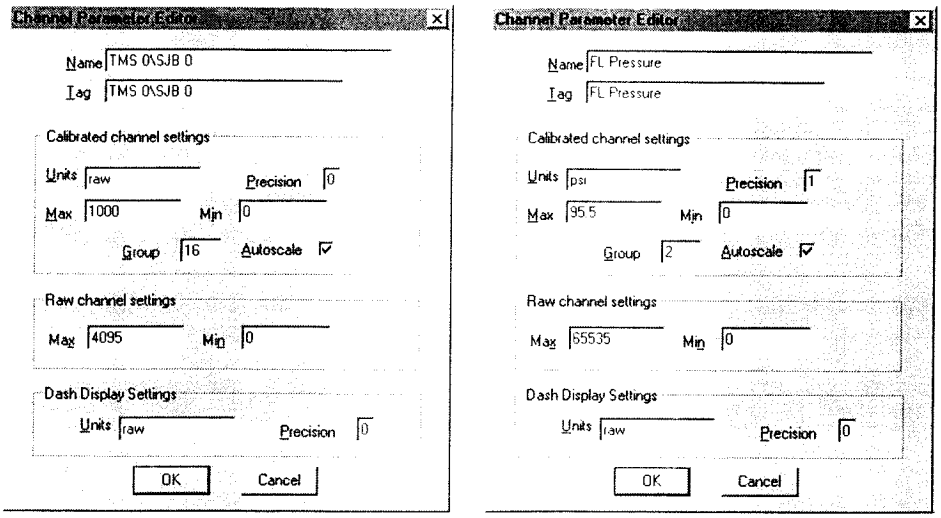
The current car is shown in the title bar of the Setup main window. To quickly change cars, hold Ctrl + Shift and press F1 to F9 for cars 1 to 9.

If you have an MRC or System 5STAR MCU then you can calibrate MRC channels by choosing "Calibrate MRC Channel..." from the Calibrate menu.

6. Choose a channel to calibrate from the Channel for Calibrating dialog. The Calibration window appears.

Changing channel parameters

The first step in calibrating a channel is to change the channel parameters.



Changing channel parameters for RS-422 TMS pressure channels

To change channel parameters:

1. Make sure that the Calibration window is open.
2. Choose "Change Channel Parameters..." from the Calibrate menu. The Channel Parameter Editor dialog appears.
3. Select Name and enter a name for the channel. As you enter the channel name the Tag name changes.

The following table gives details about TMS pressure channels.

Index	Default channel name	Function
SS0	TMS 0\SJB 0	FL pressure
SS1	TMS 1\SJB 1	FR pressure
SS2	TMS 2\SJB 2	RL pressure
SS3	TMS 3\SJB 3	RR pressure

4. Select Units and enter PSI.
5. Set the Precision to one decimal place.
6. Define the measurement range of the sensor by entering a maximum of 95.5 and a minimum of 0 (zero) for the calibrated channel settings.

NOTE: Remember that 95.5 PSI is the value displayed during a fault condition or during learn mode. The inflation pressure measurement range is 0–63.5 PSI.

7. Select Group and enter a group number.

As you calibrate TMS pressure channels give them the same group number.

8. Set the Maximum Raw channel setting to 65535 and the Minimum Raw channel setting to 0 (zero).

Entering calibration points

When you calibrate a sensor channel you define a set of points by specifying x- and y-coordinates. A minimum of two points are required to create a calibration curve. Ideally the calibration should include points close to the maximum and minimum raw values.

Calibration information for RS-422 TMS pressure channels

RS-422 TMS pressure channels require the following channel calibration.

Pressure	y-coordinate	x-coordinate	Function
0 PSI	0	16384 counts	minimum pressure reading
95.5 PSI	95.5	65535 counts	fault condition or learn mode

To enter x- and y-coordinates using the keyboard:

1. Make sure that a Calibration window is open.
2. Ensure that "Manual ADC Count" is checked (✓) in the Calibrate menu.
3. Choose the Ins button or press [Insert]. In the Coordinate Entry dialog, enter the y-coordinate for 0 PSI from the table above.

The Coordinate Entry dialog box reappears requesting an x-coordinate.

4. Enter the x-coordinate for 0 PSI from the table above.
5. Choose the Ins button or press [Insert]. In the Coordinate Entry dialog, enter the y-coordinate for 95.5 PSI from the table above.
6. Enter the x-coordinate for 95.5 PSI from the table above.

To delete a calibration point, highlight it in the Calibration points list, and choose the Del button or press [Delete].

Calibration information for TMS analog voltage channels

If you are using the Tire Monitoring System with a non-Pi System and the four analogue output voltages, then use the following information when calibrating your system.

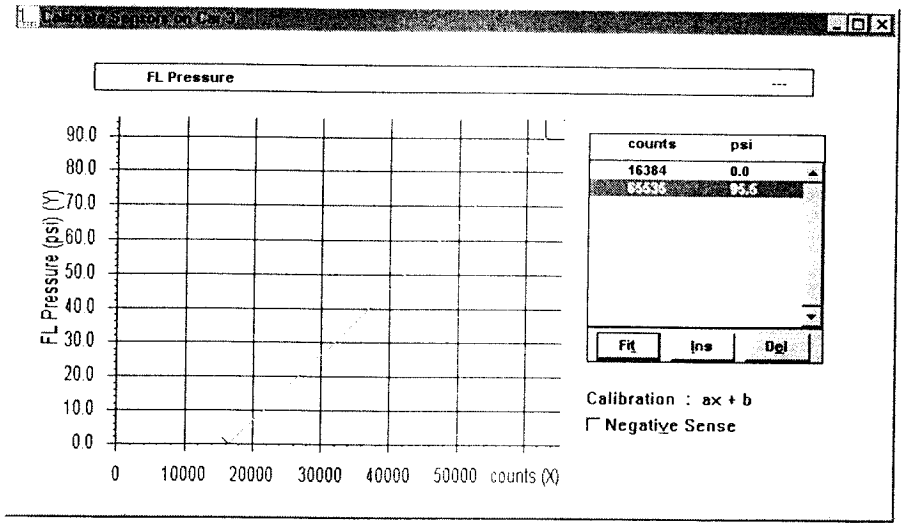
DAC output voltage	Pressure	Function
1.25V	0 PSI	minimum pressure reading
3.75V	63.5 PSI	maximum pressure reading
5V	95.5 PSI	fault condition or learn mode

Calibration curves

The calibration tool is supplied with five calibration curves that can be fitted to your calibration points to define the response of the sensor over the entire measurement range. The TMS pressure channels requires an ax+b calibration.

To fit a calibration curve:

1. Select "Calibration Type" from the Calibrate menu and choose ax+b.
2. Choose the Fit button. The calibration curve is fitted to the calibration points in the calibration graph.



Calibration window for a TMS pressure channel

To save a calibration:

1. Choose "Close" from the control-menu box.
2. Choose Yes to save the calibration and return to the Setup application. Choose No to return to Setup application and make no changes to the calibration.

RS-422 debug channels

The serial data stream from the TMS receiver includes four debug channels that can be used to test the operation of the Tire Monitoring System. The following table gives details about TMS debug channels.

Index	Default channel name	Function	Calibration
SST	SJB Temp	temperature	no calibration
SS4	TMS 4\SJB 4	FL debug	no calibration
SS5	TMS 5\SJB 5	FR debug	no calibration
SS6	TMS 6\SJB 6	RL debug	no calibration
SS7	TMS 7\SJB 7	RR debug	no calibration

The 8-bit temperature message contains temperature data for all four wheel fixtures.

Bit	Wheel fixture	Label color
7, 6	Front Left	red
5, 4	Front Right	blue
3, 2	Rear Left	yellow
1, 0	Rear Right	white

NOTE: The temperature measured is the temperature of the transmitter electronics, not the temperature of the tire.

Temperature ranges are indicated by the following bit states

Bit state	Temperature range
0, 0	less than 104°F (40°C)
0, 1	106°F to 167°F (41°C to 75°C)
1, 0	169°F to 230°F (76 to 110°C)
1, 1	greater than 230°F (110°C)

Testing TMS transmitters

To test a transmitter fitted to a wheel not fitted to a car:

1. Make sure that the TMS receiver is connected and functioning correctly.
2. Power your data logging system.
3. Plug the download lead from the computer into the download connector of the data logging system.
4. Make sure that you have established a communication connection using the Server application.

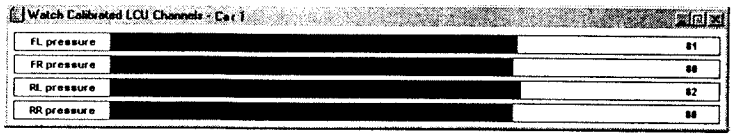
If you are using the PiDD the red LED should illuminate to confirm that it is powered.

5. Make sure that the Server and Setup are connected to the car.

The current car is shown in the title bar of the Setup main window. To quickly change cars, hold (Ctrl) + (Shift) and press (F1) to (F9) for cars 1 to 9.

6. Choose "Watch LCU..." channels from the Connect menu. The Channels for Watching dialog appears.
7. Select your TMS channels.
8. Select the Calibrated option to display channel values in calibrated units.

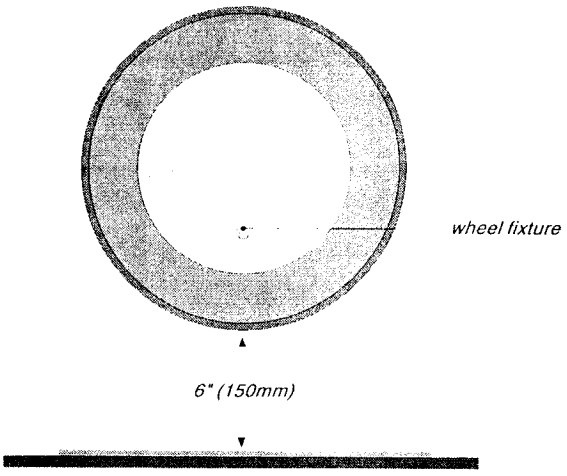
The channels appear in a Watch Calibrated Channels window.



Watching non-learned TMS channels

9. Place a protective mat on the floor.
10. Rotate the wheel until the wheel fixture is close to the floor.
11. Raise the wheel 6" (150mm) keeping the sides at right angles to the floor.
12. Release the wheel and bounce it on the protective mat for 20–30 seconds.

The channel values should read 95.5 PSI for 2 seconds, and then return to a reading of 80 PSI.

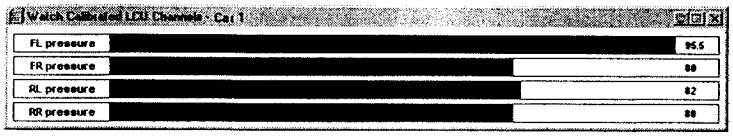


Bouncing a wheel to test transmitter operation

To test a wheel transmitter fitted to the car:

1. Raise the car off the ground and spin the wheel for 20–30 seconds.

The channel values should read 95.5 PSI for 2 seconds, and then return to a reading of 80 PSI.



TMS channel in learn mode

Using the Tire Monitoring System

Pre-race and pre-testing

The Tire Monitoring System is a safety device and therefore should be fitted and treated with care. The environment in which it is designed to work is harsh and it is important that the system is checked frequently. In particular:

- Crack test the TMS wheel bolts before high speed races such as super speedways.
- After each race or practice session, remove all transmitters from their wheels and discard the Dowty washers.
- Send wheels, TMS wheel bolts and transmitter assembly cases for crack testing once or twice each season.
- Balance wheels after fitting TMS wheel fixtures.
- Inflate the tires using dry nitrogen and leave for a minimum of two hours. Check the tires for leaks. If no leaks are found, adjust the inflation pressure to normal working pressure.
- Test the operation of each transmitter before fitting the wheel to the car.

Before fitting transmitters

- Clean all threads to remove debris.
- Renew the coated Dowty washer.
- Use wheel bolts of the correct length.
- Apply the Loctite® 242 at 90° intervals around the thread of the wheel bolt.

Race operation

Single car teams

The TMS receiver is designed to learn about the transmitters from which it is receiving data. With learn mode enabled the receiver takes up to 60 seconds after motion is detected to identify the TMS transmitters and output valid inflation pressure data.

If you are a single car team, then you can request that the learn mode is disabled so that valid inflation pressure data is available as soon as motion is detected. Learn mode can be disabled by a request to Pi Research Customer Support.

Multi-car teams

If you have more than one car fitted with the Tire Monitoring System then the learn mode enables the receiver to learn about the transmitters fitted to its car without interference from other cars in the same team.

Identifying non-learned or failed transmitters

If your Tire Monitoring System is sending data to the logging system using the RS-422 communication link then a non-learned or failed transmitter can be identified by an inflation pressure of 80 PSI.

If your Tire Monitoring System is connected to four analogue input channels then a non-learned or failed transmitter can be identified by an inflation pressure of –32 PSI (0 volts).

Message overlap

There are times when more than one transmitter is transmitting pressure data at the same instant. The TMS receiver is designed to tolerate some overlap of messages. Messages that completely overlap each other are lost. The receiver maintains the last good pressure reading until a complete new message is received.

Running with a failed transmitter

The transmitter is designed as an integral part of the wheel system and is subject to the inflation pressure. If a wheel transmitter fails electronically, use of the wheel may continue until the opportunity arises to change the wheel for one with a functioning TMS transmitter.

Running with the wrong wheel fixture fitted

If you fit a TMS wheel fixture in the wrong position, e.g. you fit the Rear Left (RL) wheel fixture on the rear left wheel, you will still get valid inflation pressure data, but Version 6 will label the channels incorrectly.

Sudden loss of inflation pressure

The TMS receiver is set so that if the inflation pressure changes by more than ±5 PSI the receiver double-checks the value by waiting 1.25 seconds for the next pressure reading before sending pressure data to the logging system.

This feature can be disabled by a request to Pi Customer Support.

Wheel fixture temperature

The transmitter electronics in each TMS wheel fixture have an operating temperature range of between +40°F and +248°F (+10°C and +120°C). Operation outside this range can result in reduced battery life and/or transmitter failure.

Teams engaged in types of racing where wheel temperatures may exceed the upper limit, (such as road circuits) must accept that transmitters could fail, and should make appropriate provision for spare/replacement wheel fixtures.

Specifications

TMS transmitter

Description	Value
Operating voltage	6 volts DC nominal
Voltage source	Lithium batteries
Battery life	50 hours (operating)
	9 months (storage)
Pressure measurement range	0–63.5 PSI
Resolution	0.125 PSI
Accuracy	±1% FSO @ 77–257°F (25–125°C)
Maximum overpressure	120 PSIA
Transmission frequency	355MHz
Transmission range	100 feet (25m) maximum
Temperature range (operating)	+40°F to +248°F (+10°C to +120°C)
(storage)	–4°F to +266°F (–20°C to +130°C)
Weight	3 ounces (85 grams)

TMS receiver

Description	Value
Operating voltage range	10–18V DC
Operating current	10mA
Resolution and accuracy	determined by transmitter
Analogue voltage output	0–5V
Output impedance	470 ohms
Communication interface	balanced RS-422, 9600 baud
Operating temperature range	+50°F to +140°F (+10°C to +60°C)
Weight	5.1 ounces (145 grams)
Environmental	IP65

Receiver connector types

Description	Connector	Mating connector
System connector	AS210-35PN	AS610-35SN
Antenna	TNC	TNC

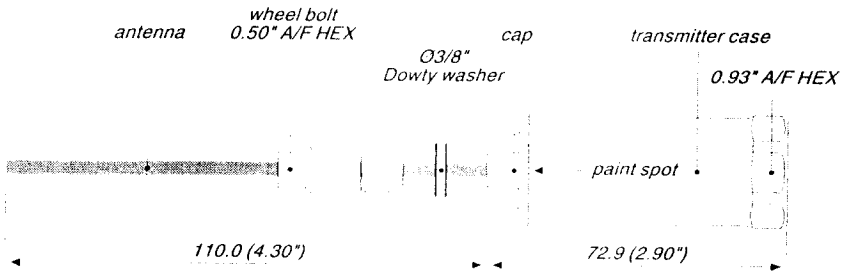
Receiver connector pin details

Pin	Description	Pin	Description
1	Power 0V	8	FL signal 0–5V (not standard Pi installation)
2	Power 9–18V DC	9	FR signal 0–5V (not standard Pi installation)
3	TMS to Pi System (A)†	10	RL signal 0–5V (not standard Pi installation)
4	TMS to Pi System (B)†	11	9600/38400 baud select (not used)
5	Signal 0V	12	Tick in (not used)
6	Pi System to TMS (A)†	13	RR signal 0–5V (not standard Pi installation)
7	Pi System to TMS (B)†		

† According to EIA RS-422 specifications.

Dimensions

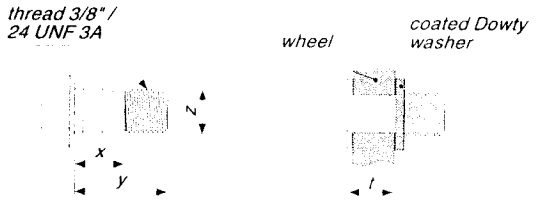
TMS wheel fixture



Dimensions in millimetres and inches

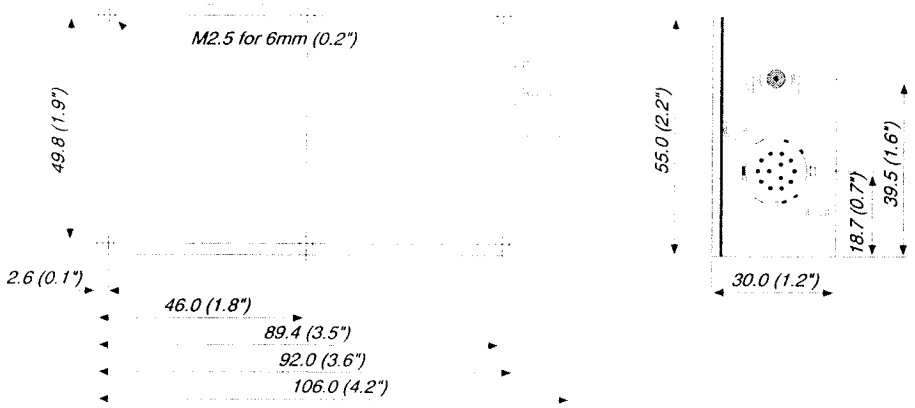
TMS wheel bolts

TMS wheel bolts are available in two lengths, which are shown in the next table. Dimension *t* is the thickness of the wheel material. Dimensions are shown in millimetres and inches.



Part Number	x	y	z	t	Color
10B-050367	13.84(0.545")	22.35(0.880")	9.59(0.374")	10.16 ±0.5(0.4" ± 0.02")	Black
10B-050369	11.30(0.445")	19.81(0.780")	9.59(0.374")	7.62 ±0.5(0.3" ± 0.02")	Green

TMS receiver



Dimensions in millimetres and inches

Parts numbering

HP TMS kit 1 (Part number 30B-050381)

Description	Part number	Quantity
HP TMS wheel fixture (RR)	01B-050391-RR	3
HP TMS wheel fixture (RL)	01B-050391-RL	3
HP TMS wheel fixture (FL)	01B-050391-FL	3
HP TMS wheel fixture (FR)	01B-050391-FR	3
HP TMS receiver	01B-050210	1
TMS long bolt*	10B-050367	12
or TMS short bolt*	10B-050369	12
TMS case and accessories	13B-050395	1

* Selected at time of order.

HP TMS kit 2 (Part number 30B-050382)

Description	Part number	Quantity
HP TMS wheel fixture (RR)	01B-050391-RR	6
HP TMS wheel fixture (RL)	01B-050391-RL	6
HP TMS wheel fixture (FL)	01B-050391-FL	6
HP TMS wheel fixture (FR)	01B-050391-FR	6
HP TMS receiver	01B-050393	1
TMS long bolt*	10B-050367	24
or TMS short bolt*	10B-050369	24
TMS case and accessories	13B-050395	1

* Selected at time of order.

HP TMS receiver kit (Part number 30B-050383)

Description	Part Number	Quantity
HP TMS receiver	01B-050210	1
Car antenna	01A-049085	1
HP TMS Application Note	29B-071223	1
Antenna extension loom	03I-00509	1
Antenna mounting kit	30C-049087	1

HP TMS case and accessories (Part number 13B-050395)

Description	Part Number	Quantity
Car antenna	01A-049085	1
Antenna extension loom	03I-00509	1
TMS custom socket	10B-050256	1
TMS thread cleaning tool	10B-050297	1
TMS sealing ring	10B-050389	50
HP TMS Application Note	29B-071223	1
Antenna mounting kit	30C-049087	1
Loctite® 242 thread lock	32B-0023	1
HP TMS Application Note	29B-071223	1

Refurbishment and repair details

Faulty Tire Monitoring System equipment should be returned to Pi Research. Damaged TMS receivers will be repaired or replaced. Damaged TMS wheel fixtures will be replaced.

Repair and replacement costs for Tire monitoring System equipment are subject to examination of the equipment by Pi Research.

Tire Monitoring System equipment should be returned to Pi Research for refurbishment at the end of each race season.

Contact information

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