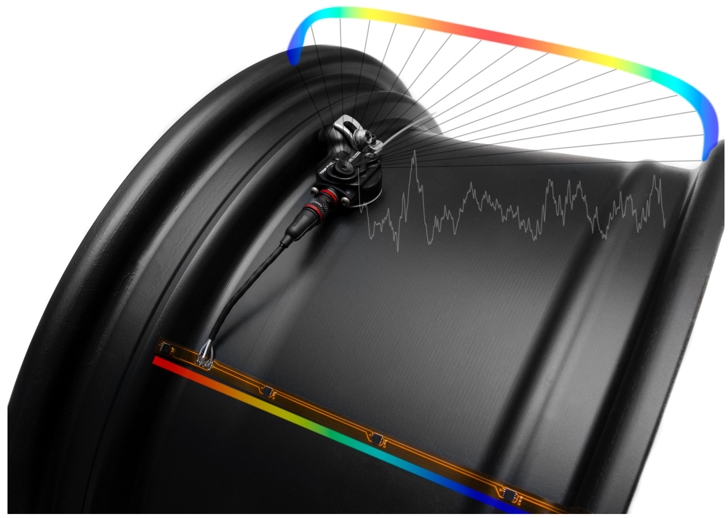
The IZZE-RACING R&D Tire Temperature and Pressure Monitoring System consists of small, lightweight, wheel-mounted sensor and an equally small receiver with a built-in pressure transducer for high-accuracy gauge pressure measurements.

The pressure sensor is specifically designed to measure Contact Patch Load Variation (CPLV) using a high-speed (1000Hz), high-accuracy, ultra-sensitive (0.1mBar) pressure transducer, thus capable of modal and CPLV analysis on track, where it matters.

The sensor simultaneously measures the lateral temperature distribution of the inner tire carcass with an ultra-wide 16-channel infrared sensor, wheel temperature distribution with up to 8 equally-spaced temperature sensors, and relative humidity, providing invaluable tire data for motorsport and R&D applications.



SPECIFICATIONS – TTPMS SENSOR

Pressure, Range (Absolute)	0 to 5000 mBar
Pressure, Accuracy / Res.	±10 mBar, 0.1 mBar
Internal Temp., Range	-40 to 150˚C
Internal Temp., Accuracy / Res.	±0.5˚C, 0.1˚C
Wheel Temp., Range	-40 to 150˚C
Wheel Temp., Accuracy / Res.	±0.5˚C, 0.1˚C
Infrared Temp., Range	-20 to 300˚C
Infrared Temp., Accuracy / Res.	±3.0˚C, 0.1˚C
Update Rate at Speed (IR)	1.0 Hz
Update Rate at Speed (Pressure)	1000 Hz
Operating Temperature Range*	0 to 135˚C
Relative Humidity, Range	0 to 100%
Relative Humidity, Accuracy / Res.	±2%, 0.1%
Battery Life (typ)	10 active hours
RF Center Frequency	902 - 928 MHz
RF Output Power	0.16 mW
Wireless Range, Open Space	> 50 m

*Will survive brief temperature excursions < 150˚C

SPECIFICATIONS – RECEIVER

Voltage Input	5 to 16 V
Supply Current	30 mA
Temperature Range	-20 to 85˚C
Max No. of Sensors	120 (30 / corner)
RF Center Frequency	902 – 928 MHz
Sensitivity (typ)	-110 dBm

MECHANICAL SPECS – SENSOR

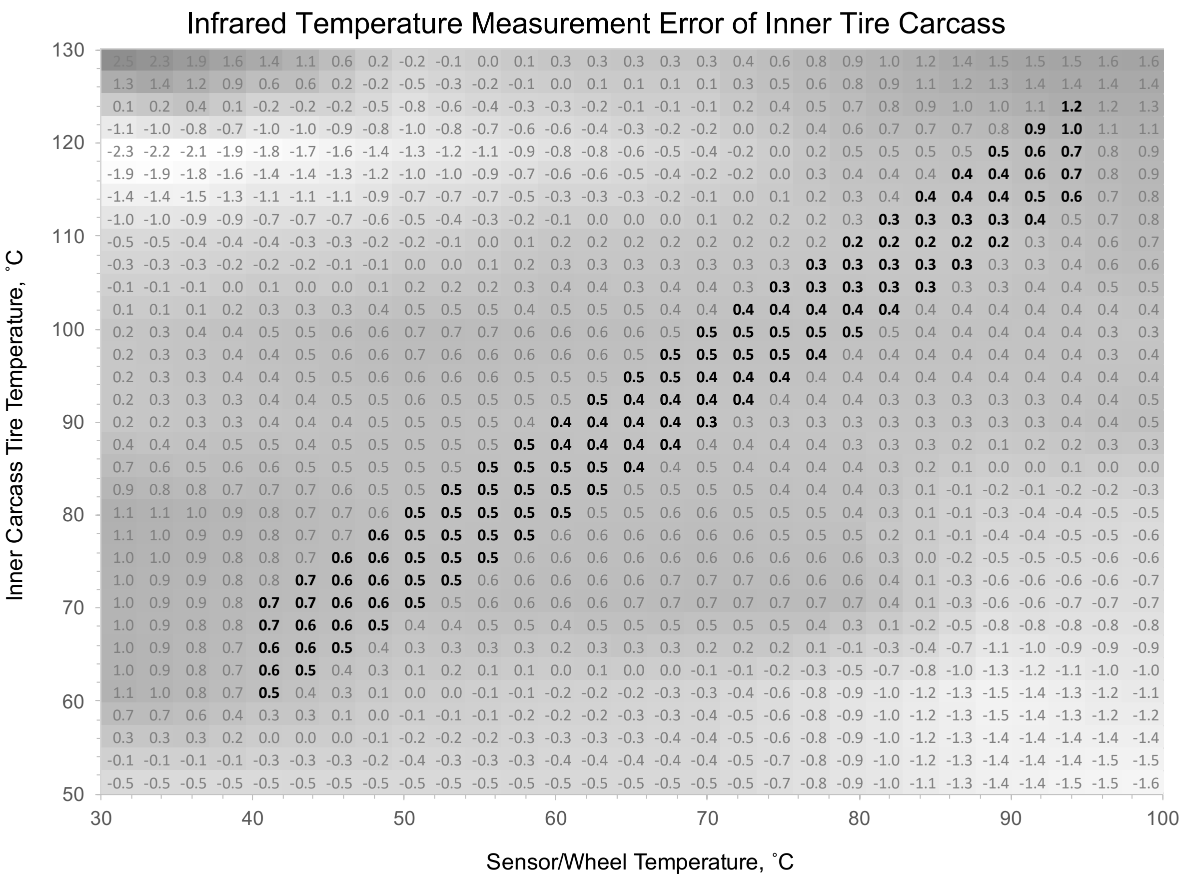
Weight	24 ± 1g
Material	7075-T6
Max. Centrifugal Accel.	2000G (SF = 3)
L x W x H (max)	61 x 32 x 18 mm
Protection Rating	IP61

MECHANICAL SPECS – RECEIVER

Weight	18 ± 1g
Material	6061-T6
L x W x H (max)	50.5 x 35.5 x 8 mm
Protection Rating	IP65

INFRARED TEMPERATURE ACCURACY:

- A proprietary calibration (W-REC-V2 S/N > 00680) accounts for multiple variables (infrared radiation, wheel temperature, pressure, sensor temperature, spatial distribution, etc.) to achieve class-leading temperature accuracy for internal tire carcass temperature measurement:



Test Conditions: 1.0 – 3.5 bar, air, 20-50% humidity, infrared channels 5 to 12

* **Bold** = Typical operating region

	IR CH 1–4 (inside)	IR CH 5–12 (central)	IR CH 13–16 (outside)
Average Error	+0.9˚C	+0.5˚C	+0.5˚C

CAN SPECIFICATIONS – RECEIVER

Standard	CAN 2.0A, ISO-11898	
Bit Rate	1 Mbit/s (adjustable)	
Byte Order	Big-Endian / Motorola	
Data Conversion	0.1 mBar per bit, +3000 offset	HS Pressure
	1 integer per bit	SN, TC,
	1 dBm per bit	RSSI
	1mV per bit	Battery Voltage
	1 mBar per bit	Pressure
	0.1˚C per bit, -100˚C offset	Temperature
	0.1 % per bit	Rel. Humidity
	(all variables unsigned except RSSI and HS Pressure)	
Base CAN ID (defaults)	LF, RF, LR, RR: 0x424, 0x42A, 0x430, 0x436	
Termination	None	

WIRING SPECS – RECEIVER:

Wire	M22759/32-26, DR25
Cable Length	500 mm
Connector	None

Supply Voltage, V_s	Red
Ground	Black
CAN +	Blue
CAN -	White

CAN MESSAGE STRUCTURE – RECEIVER:

CAN ID: 0x424 (LF) / 0x42A (RF) / 0x430 (LR) / 0x436 (RR)

Serial Number		Battery Voltage		HS Pressure		Gauge Pressure	
Byte 0 (MSB)	Byte 1 (LSB)	Byte 2 (MSB)	Byte 3 (LSB)	Byte 4 (MSB)	Byte 5 (LSB)	Byte 6 (MSB)	Byte 7 (LSB)

CAN ID: 0x425 (LF) / 0x42B (RF) / 0x431 (LR) / 0x437 (RR)

Infrared Temp, CH 1		Infrared Temp, CH 2		Infrared Temp, CH 3		Infrared Temp, CH 4	
Byte 0 (MSB)	Byte 1 (LSB)	Byte 2 (MSB)	Byte 3 (LSB)	Byte 4 (MSB)	Byte 5 (LSB)	Byte 6 (MSB)	Byte 7 (LSB)

CAN ID: 0x426 (LF) / 0x42C (RF) / 0x432 (LR) / 0x438 (RR)

Infrared Temp, CH 5		Infrared Temp, CH 6		Infrared Temp, CH 7		Infrared Temp, CH 8	
Byte 0 (MSB)	Byte 1 (LSB)	Byte 2 (MSB)	Byte 3 (LSB)	Byte 4 (MSB)	Byte 5 (LSB)	Byte 6 (MSB)	Byte 7 (LSB)

CAN ID: 0x427 (LF) / 0x42D (RF) / 0x433 (LR) / 0x439 (RR)

Infrared Temp, CH 9		Infrared Temp, CH 10		Infrared Temp, CH 11		Infrared Temp, CH 12	
Byte 0 (MSB)	Byte 1 (LSB)	Byte 2 (MSB)	Byte 3 (LSB)	Byte 4 (MSB)	Byte 5 (LSB)	Byte 6 (MSB)	Byte 7 (LSB)

CAN ID: 0x428 (LF) / 0x42E (RF) / 0x434 (LR) / 0x43A (RR)

Infrared Temp, CH 13		Infrared Temp, CH 14		Infrared Temp, CH 15		Infrared Temp, CH 16	
Byte 0 (MSB)	Byte 1 (LSB)	Byte 2 (MSB)	Byte 3 (LSB)	Byte 4 (MSB)	Byte 5 (LSB)	Byte 6 (MSB)	Byte 7 (LSB)

CAN ID: 0x429 (LF) / 0x42F (RF) / 0x435 (LR) / 0x43B (RR)

Transmission Count, per 1K		RSSI		Sensor Temperature		Relative Humidity	
Byte 0 (MSB)	Byte 1 (LSB)	Byte 2 (MSB)	Byte 3 (LSB)	Byte 4 (MSB)	Byte 5 (LSB)	Byte 6 (MSB)	Byte 7 (LSB)

CAN ID: 0x43C (LF) / 0x442 (RF) / 0x448 (LR) / 0x44E (RR)

Wheel Temp, WT1		Wheel Temp, WT2		Wheel Temp, WT3		Wheel Temp, WT4	
Byte 0 (MSB)	Byte 1 (LSB)	Byte 2 (MSB)	Byte 3 (LSB)	Byte 4 (MSB)	Byte 5 (LSB)	Byte 6 (MSB)	Byte 7 (LSB)

CAN ID: 0x43D (LF) / 0x443 (RF) / 0x449 (LR) / 0x44F (RR)

Wheel Temp, WT5		Wheel Temp, WT6		Wheel Temp, WT7		Wheel Temp, WT8	
Byte 0 (MSB)	Byte 1 (LSB)	Byte 2 (MSB)	Byte 3 (LSB)	Byte 4 (MSB)	Byte 5 (LSB)	Byte 6 (MSB)	Byte 7 (LSB)

* The base CAN ID (0x424) is adjustable

BASE CAN ID PROGRAMMING – RECEIVER:

To modify the wireless receiver's base CAN ID, bit rate, or emissivity mode, send the following CAN message at 1Hz for at least 10 seconds and then reset the receiver by disconnecting power for 5 seconds. For more details and options, refer to the Appendix.

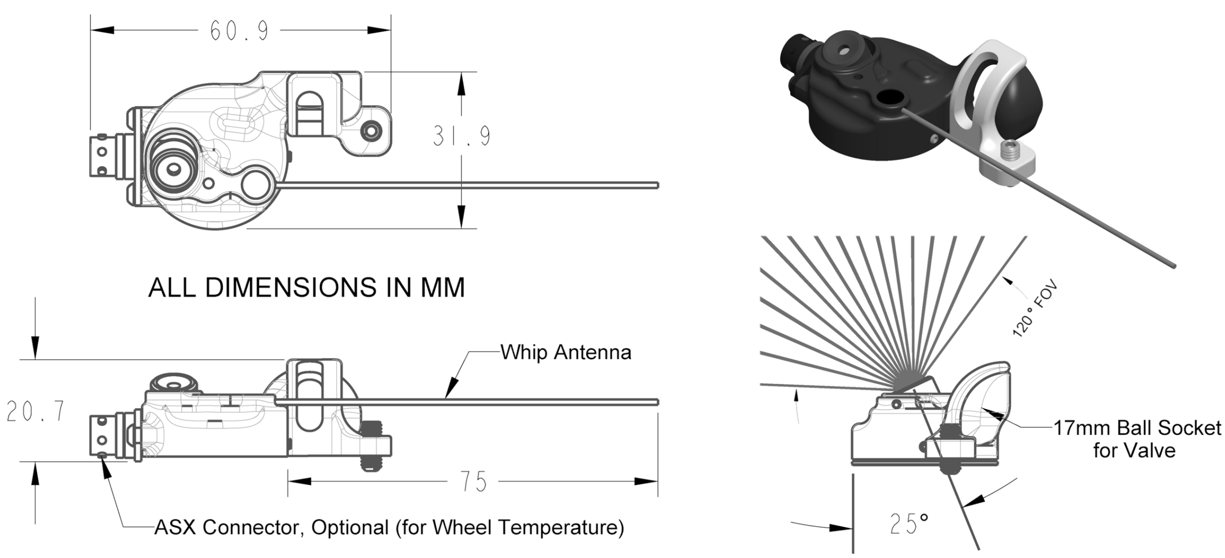
CAN ID = Base ID (Default = 0x406)

Programming Constant		New CAN Base ID (11-bit)		Sensor Assignment	Bit Rate	Emissivity	
Byte 0 (MSB)	Byte 1 (LSB)	Byte 2 (MSB)	Byte 3 (LSB)	Byte 4	Byte 5	Byte 6	Byte 7
30000 = 0x7530		1 = 0x001 ⋮ 2047 = 0x7FF		1 = Default 2 = Custom	1 = 1 Mbit/s 2 = 500 kbit/s 3 = 250 kbit/s 4 = 100 kbit/s	1 = Default 2 = Custom	0

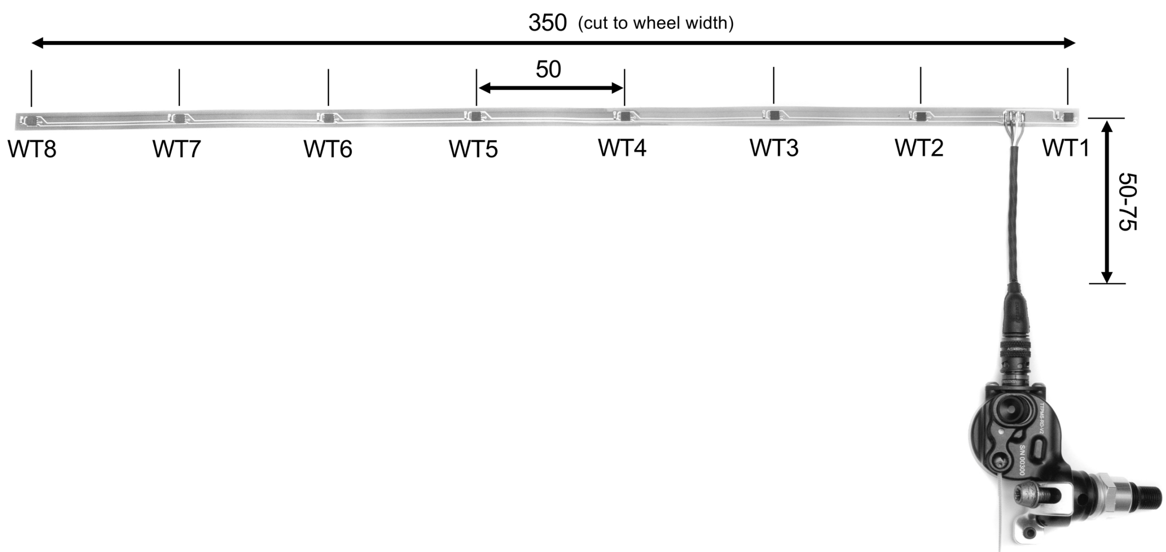
CAN messages should only be sent to the receiver during the configuration sequence.
DO NOT continuously send CAN messages to the receiver.

DIMENSIONS:

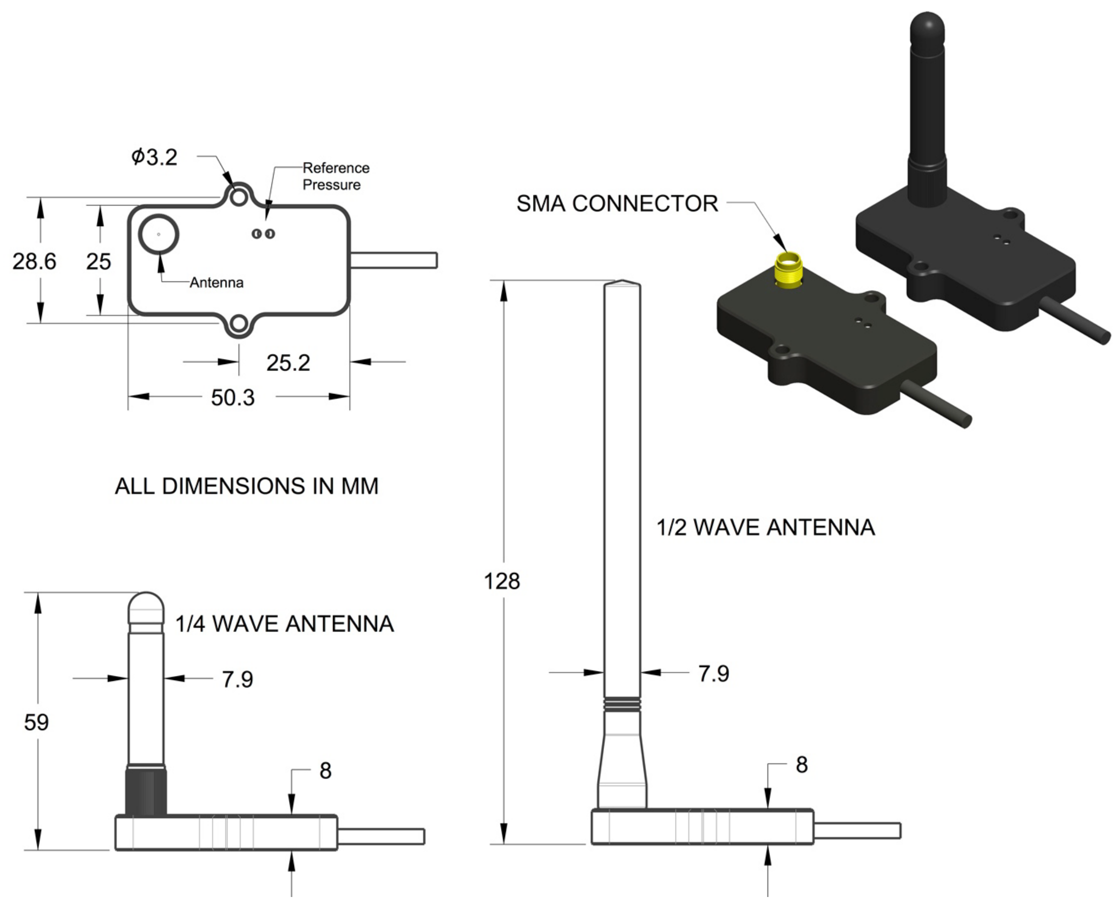
R&D TTPMS Sensor, TTPMS-RD-V2



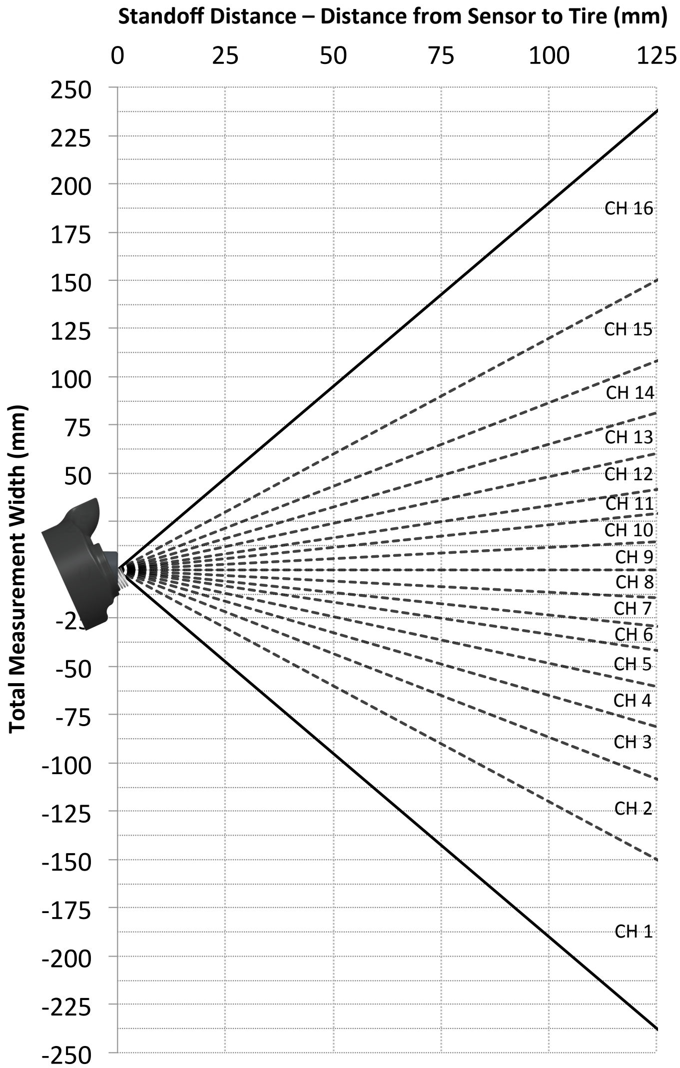
R&D TTPMS Wheel Temperature Strip



R&D TTPMS Receiver, W-REC-V2



120˚ Field-of-View, Spatial Mapping of Temperature Channels:



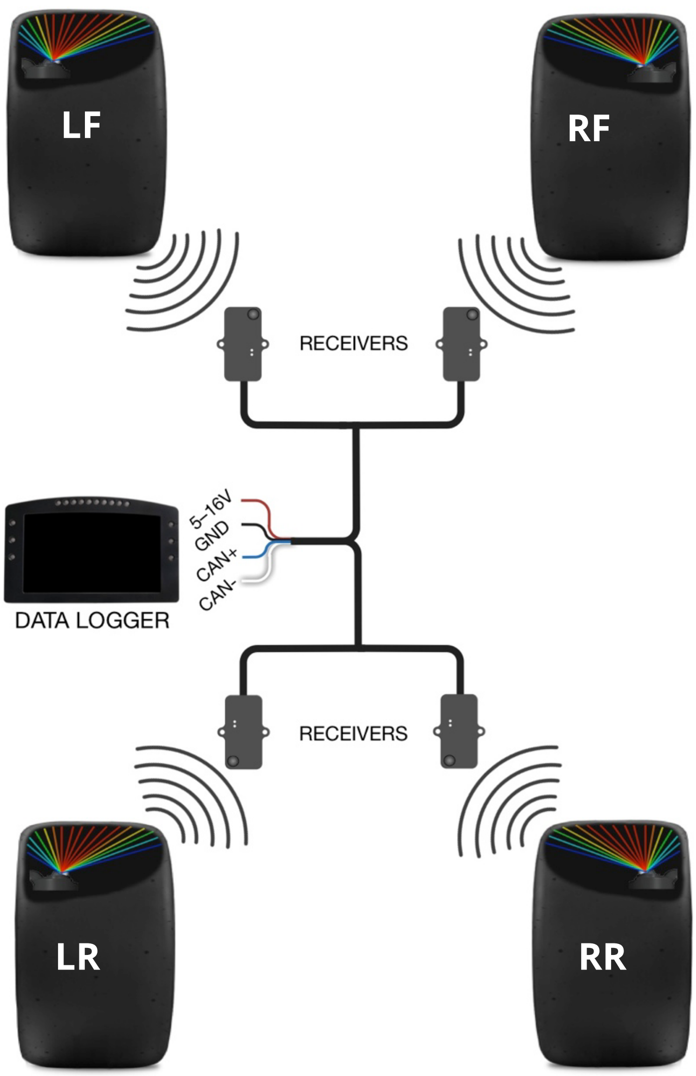
CAD model available with temperature channel rays

TRANSMISSION RATE:

State	Criteria	Data	Update Period
Uninflated or Cold	P_{gauge} < 250mBar T_{sensor} < 5˚C	None	N/A (sleeping)
Inflated	P_{gauge} > 250mBar	Pressure, Humidity	240 seconds
Inflated & Heated	P_{gauge} > 250mBar T_{sensor} > 40˚C	Pressure, Humidity	10 seconds
Inflated & ΔP *	P_{gauge} > 250mBar ΔP_{gauge} > 10mBar	HS Pressure, Infrared	1ms (pressure), 1s (IR temp), 4s (WT)
Rotation *	Wheel movement	HS Pressure, Infrared	1ms (pressure), 1s (IR temp), 4s (WT)

* 40 second overrun before switching to lower state / longer update period

SYSTEM LAYOUT:



- Each corner requires a dedicated receiver and frequency given the RF bandwidth
- Sensors are assigned to specific corners/receivers with dedicated Network ID's and Frequencies

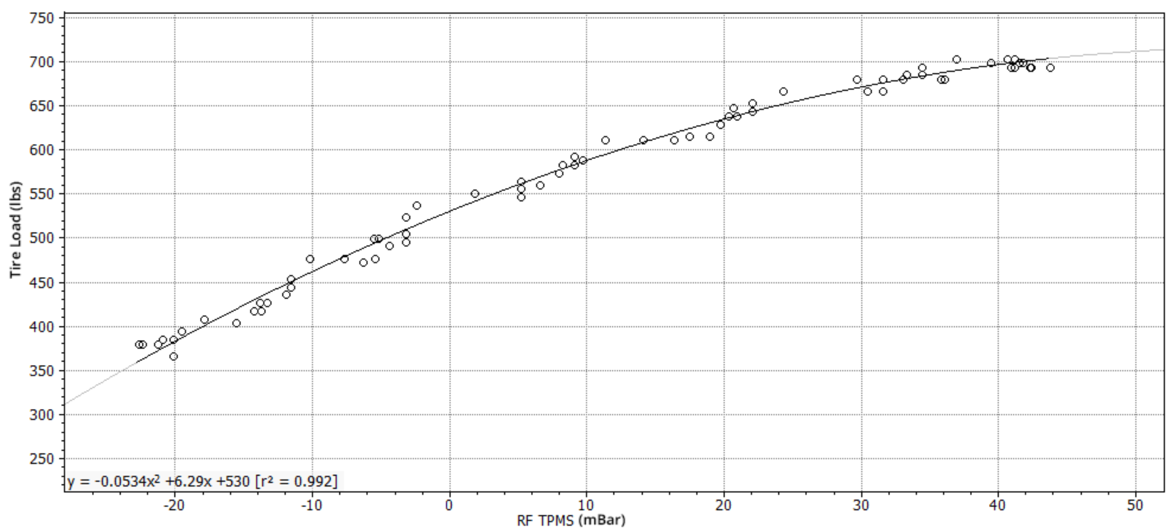
FUNCTION – HIGH-SPEED PRESSURE

When a tire is loaded or unloaded, its internal volume changes. The change in volume results in a change in pressure; accordingly, a tire's change in vertical load at the contact patch is proportional to a change in internal pressure. This change in volume/pressure is minute and so the sensor has an ultra-sensitive 24-bit pressure transducer in order to achieve a high level of sensitivity (e.g., N/mBar).

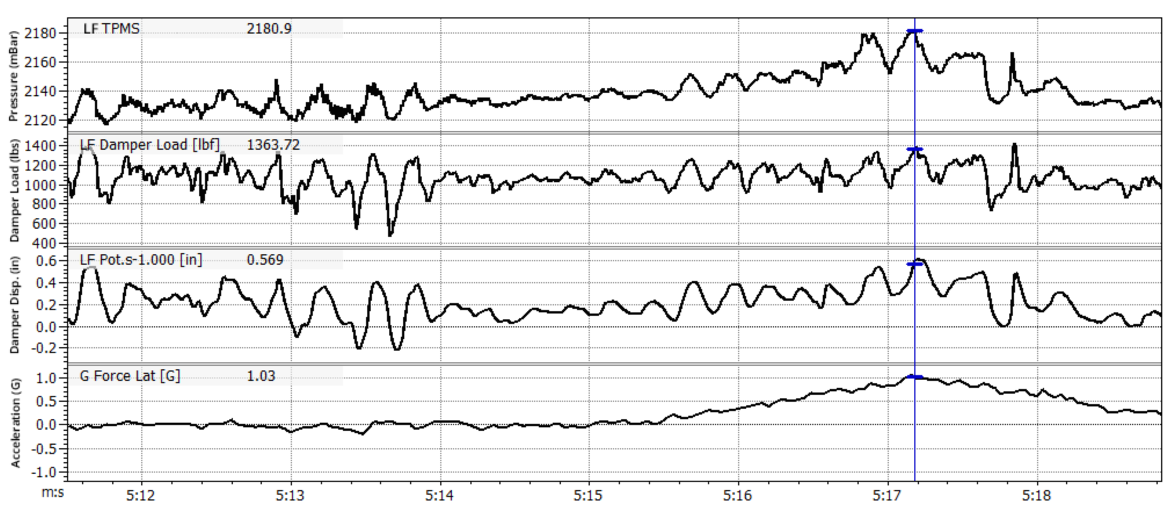
The main purpose of the High-Speed Tire Pressure Sensor is to measure Contact Patch Load Variation (CPLV) on track and to validate shaker rig data.

SAMPLE DATA – HIGH-SPEED PRESSURE

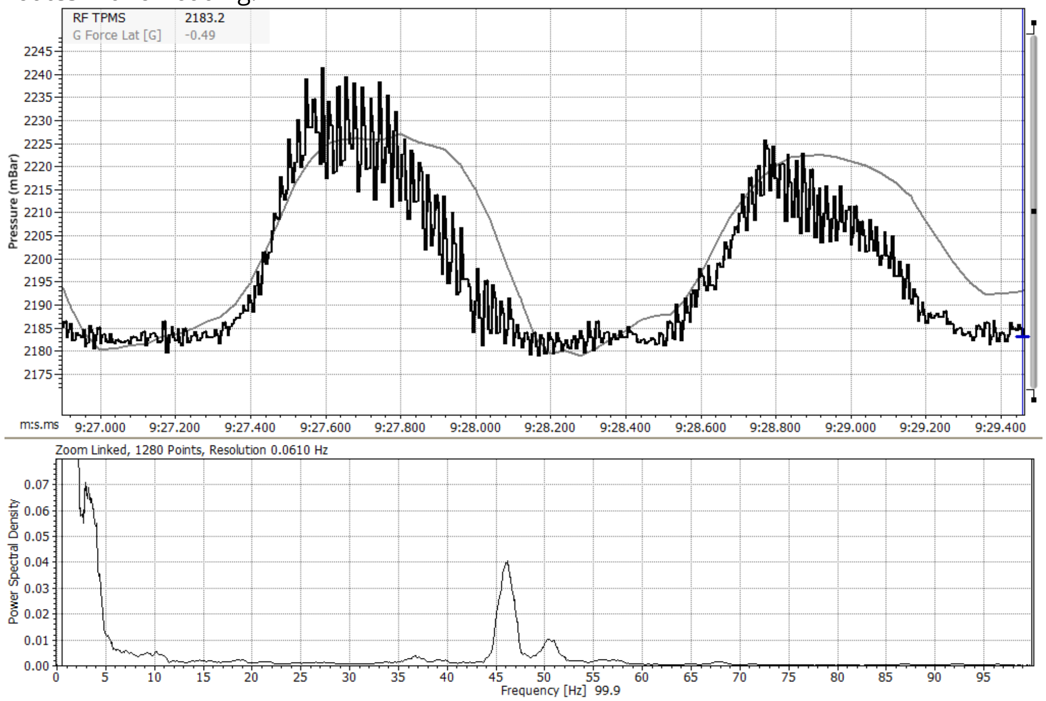
Representative tire load vs. pressure profile. Profile will vary with tire dimensions and construction.



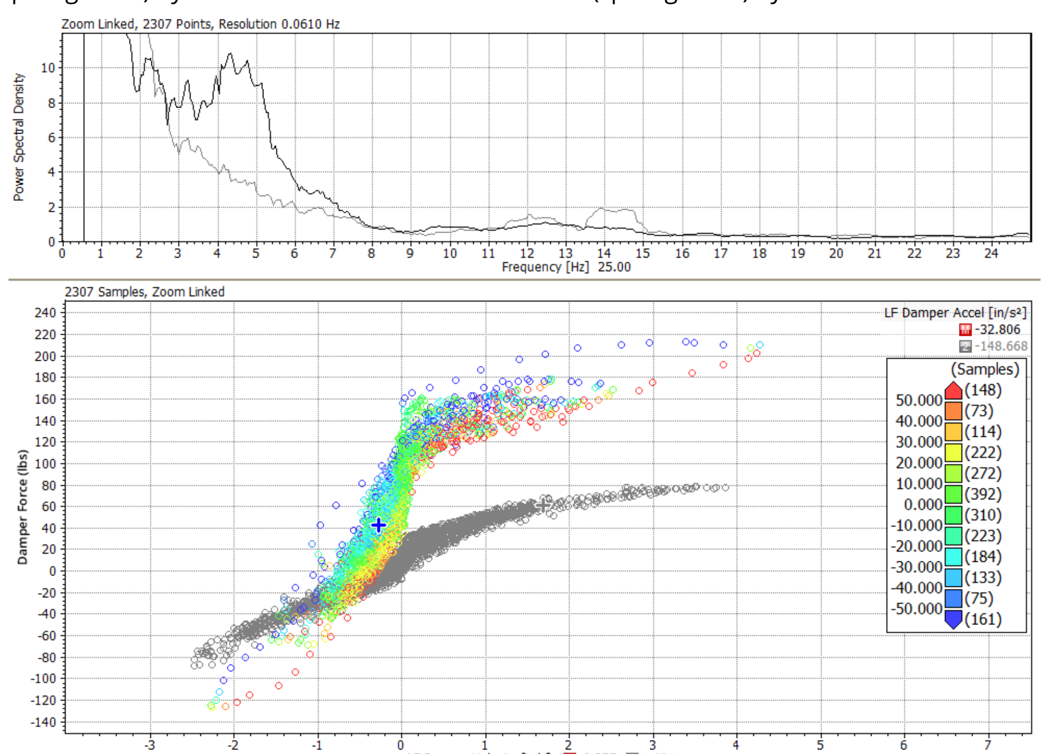
Similitude between tire pressure, damper load (strain gauge), damper displacement, and lateral accel.



Excitation of the first tire natural mode at 46Hz; CPLV increases with loading, reducing mechanical grip, and then attenuates with unloading.



Comparison of two damper curves and resultant change in CPLV (PSD). Increase in damping reduces CPLV at 14Hz (unsprung mass) by 60% but increases CPLV from 3-6Hz (sprung mass) by 280%.



ADDITIONAL INFORMATION:

- Battery life depends on a multitude of operating conditions but will typically reach 10 active hours.
  - The sensor is fitted with a serviceable battery.
    - Carefully pry PEEK cap with flathead, alternating positions until wiggles free
    - Trim battery (TLH-2450/P) terminals to 4mm length, insert battery
    - Replace PEEK cap with arch cutout lined up with hole/ASX connector
- The maximum recommended sensor temperature is 120˚C for utmost reliability and battery life, but transient temperature excursions up to 150˚C are survivable.
- To avoid dropped packets, the average Received Signal Strength Indication (RSSI) should be no less than -90dBm.
- Do not wash the TTPMS sensors – keep dry.

PART NUMBERS:

Part No.	Description
TTPMS-RD-V2	R&D TTPMS Sensor
W-REC-V2	R&D TTPMS Receiver
AV-STD-49	Standard TTPMS Sensor Valve

APPENDIX

A.1 – BASIC RECEIVER PROGRAMMING:

To modify the wireless receiver's base CAN ID, sensor assignment mode, bit rate, or emissivity, send the following CAN message at 1Hz for at least 10 seconds and then reset the receiver by disconnecting power for 5 seconds.

CAN ID = Base ID (Default = 0x424)

Programming Constant		New CAN Base ID (11-bit)		Sensor Assignment	Bit Rate	Emissivity	
Byte 0 (MSB)	Byte 1 (LSB)	Byte 2 (MSB)	Byte 3 (LSB)	Byte 4	Byte 5	Byte 6	Byte 7
30000 = 0x7530		1 = 0x001 ⋮ 2047 = 0x7FF		1 = Default 2 = Custom	1 = 1 Mbit/s 2 = 500 kbit/s 3 = 250 kbit/s 4 = 100 kbit/s	1 = Default 2 = Custom	

CAN messages should only be sent to the receiver during the configuration sequence.
DO NOT continuously send CAN messages to the receiver.

A.2 – RECEIVER NETWORK, NODE ID, and RF FREQUENCY:

- The receiver's Network, Node ID, and Radio Frequency (from 868 to 930MHz) may be changed in order to communicate with another set of TTPMS sensors.

CAN MESSAGE for PROGRAMMING NETWORK, NODE ID, and RF FREQUENCY:

CAN ID = Base ID (Default = 0x424)

Programming Constant		Network ID	Node ID	Radio Frequency			
Byte 0 (MSB)	Byte 1 (LSB)	Byte 2	Byte 3	Byte 4 (MSB)	Byte 5 (LSB)	Byte 6	Byte 7
20020 = 0x4E34		0 = 0x00 ⋮ 255 = 0xFF	0 = 0x00 ⋮ 255 = 0xFF	Decimal Value x 10^5 Hz (ex: 9155 = 915,500,000 Hz)		0 = 0x00	0 = 0x00

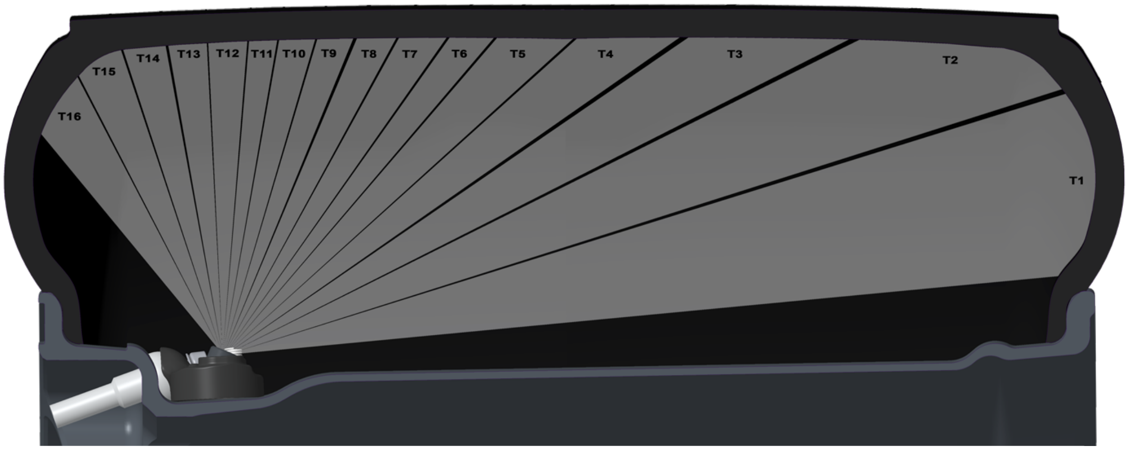
A.3 – ADVANCED EMISSIVITY ADJUSTMENT:

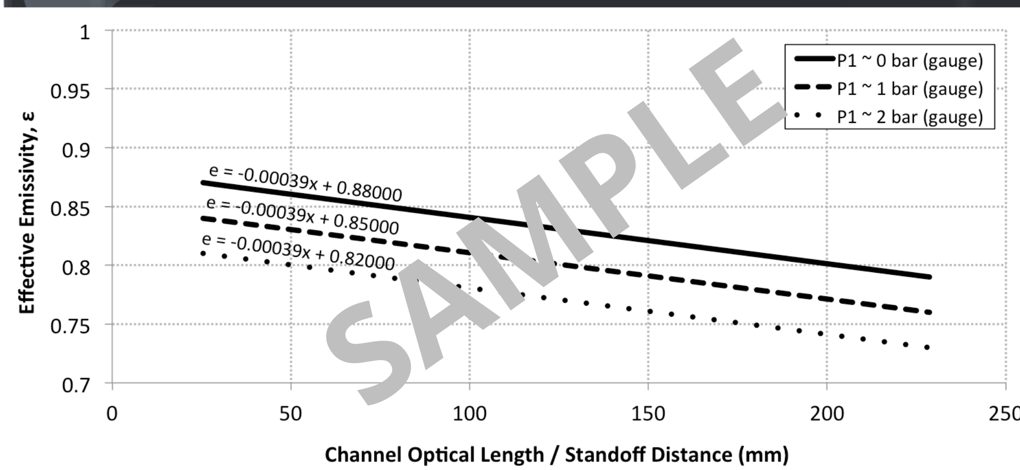
Long-wave infrared radiation attenuates with increasing optical distance / standoff distance, increasing pressure, and changes with gas mixtures. The *effective emissivity* for each infrared temperature channel is adjustable in order to compensate for attenuation and, therefore, achieve utmost temperature accuracy when necessary.

- The *effective emissivity* decreases with increasing optical distance, as quantified in the sample chart below. As shown in the sample model, the first couple infrared temperature channels have much longer optical distances than the other channels; therefore, the *effective emissivity* will be lower for the first couple channels in order to compensate for the longer optical distance.
- The *effective emissivity* decreases with increasing pressure, as shown in the sample chart below for air (low-humidity). The sensitivity to pressure will depend on the gas mixture but is typically significant in one bar increments.
- This behavior is inherent for *all infrared radiometry measurements*, not just this sensor.
- Example:

Pressure = 2 bar, $T1_{\text{Optical Length}}$ = 270mm, $T12_{\text{Optical Length}}$ = 100mm

$\varepsilon_{T1} \approx -0.00039 \times 270\text{mm} + 0.82 \approx 0.71$, $\varepsilon_{T12} \approx -0.00039 \times 100\text{mm} + 0.82 \approx 0.78$





CAN MESSAGE for PROGRAMMING EMISSIVITY:

- "Emissivity" (Byte 5 in Section A.1) must be set to "Custom" (i.e., Byte 5 = 2) in order to activate custom emissivity assignments.

CAN ID = Base ID (Default = 0x424)

Programming Constant		ε, T1	ε, T2	ε, T3	ε, T4	ε, T5	ε, T6
Byte 0 (MSB)	Byte 1 (LSB)	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
20030 = 0x4E3E		.01 = 0x01 ⋮ 1.0 = 0x64	.01 = 0x01 ⋮ 1.0 = 0x64	.01 = 0x01 ⋮ 1.00 = 0x64	.01 = 0x01 ⋮ 1.00 = 0x64	.01 = 0x01 ⋮ 1.00 = 0x64	.01 = 0x01 ⋮ 1.00 = 0x64

CAN ID = Base ID (Default = 0x424)

Programming Constant		ε, T7	ε, T8	ε, T9	ε, T10	ε, T11	ε, T12
Byte 0 (MSB)	Byte 1 (LSB)	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
20031 = 0x4E3F		.01 = 0x01 ⋮ 1.0 = 0x64	.01 = 0x01 ⋮ 1.0 = 0x64	.01 = 0x01 ⋮ 1.00 = 0x64	.01 = 0x01 ⋮ 1.00 = 0x64	.01 = 0x01 ⋮ 1.00 = 0x64	.01 = 0x01 ⋮ 1.00 = 0x64

CAN ID = Base ID (Default = 0x424)

Programming Constant		ε, T13	ε, T14	ε, T15	ε, T16	ε, Default	
Byte 0 (MSB)	Byte 1 (LSB)	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
20032 = 0x4E40		.01 = 0x01 ⋮ 1.0 = 0x64	.01 = 0x01 ⋮ 1.0 = 0x64	.01 = 0x01 ⋮ 1.00 = 0x64	.01 = 0x01 ⋮ 1.00 = 0x64	.76 = 0x4C DO NOT CHANGE	