TEST RESULT SUMMARY

FCC PART 15 SUBPART C
Section 15.231(e)

MANUFACTURER'S NAME	Pacific Industrial Co LTD
NAME OF EQUIPMENT	Transmitter for monitoring air pressure and temperature in a vehicle's tires
MODEL NUMBER	**PMV-1001**
MANUFACTURER'S ADDRESS	Godo-cho, Anpachi Gifu, 503-2397 Japan
TEST REPORT NUMBER	W0312
TEST DATE	05 June 2000

According to testing performed at TÜV Product Service Inc, the above-mentioned unit is in compliance with the electromagnetic compatibility requirements defined in FCC Part 15.

It is the manufacturer's responsibility to assure that additional production units of this model are manufactured with identical electrical and mechanical characteristics. Any modifications necessary for compliance made during testing on the above mentioned date(s) must be implemented in all production units for compliance to be maintained.

TÜV Product Service Inc, as an independent testing laboratory, declares that the equipment tested as specified above conforms to the requirements of FCC Part 15.

Date: 30 June 2000

Location: Taylors Falls MN USA

G. S. Jakubowski
Test Engineer

J. T. Schneider
Lead Engineer

Not Transferable

EMC EMISSION - T E S T R E P O R T

Test Report File No.	:	**WC1H031201**	Date of issue:	30 June 2000

Model / Serial No.	:	**PMV-1001 /**
Product Type	:	Transmitter for monitoring air pressure and temperature in a vehicle's tires
Applicant	:	Pacific Industrial Co LTD
Manufacturer	:	Pacific Industrial Co LTD
License holder	:	Pacific Industrial Co LTD
Address	:	Godo-cho, Anpachi
	:	Gifu, 503-2397 Japan
Test Result	:	■ **Positive** ☐ **Negative**
Test Project Number	:	
Reference(s)		**W0312**
Total pages including Appendices		22

TÜV Product Service Inc is a subcontractor to TÜV Product Service, GmbH according to the principles outlined in ISO/IEC Guide 25 and EN 45001.

TÜV Product Service Inc reports apply only to the specific samples tested under stated test conditions. It is the manufacturer's responsibility to assure that additional production units of this model are manufactured with identical electrical and mechanical components. TÜV Product Service Inc shall have no liability for any deductions, inferences or generalizations drawn by the client or others from TÜV Product Service Inc issued reports.

This report is the confidential property of the client. As a mutual protection to our clients, the public and ourselves, extracts from the test report shall not be reproduced except in full without our written approval. This report shall not be used by the client to claim product endorsement by NVLAP or any agency of the US government.

TÜV Product Service Inc and its professional staff hold government and professional organization certifications and are members of AAMI, ACIL, AEA, ANSI, IEEE, NVLAP, and VCCI

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D I R E C T O R Y - EMISSIONS

TÜV PRODUCT SERVICE INC 19333 Wild Mountain Road Taylors Falls MN 55084-1758 Tel: 651 638 0297 Fax: 651 638 0298 Rev.No 1.0

EMISSIONS TEST REGULATIONS :

The emissions tests were performed according to following regulations:

☐ - EN 50081-1 / 1991

☐ - EN 55011 / 1991 ☐ - Group 1 ☐ - Group 2
☐ - Class A ☐ - Class B

☐ - EN 55013 / 1990

☐ - EN 55014 / 1987 ☐ - Household appliances and similar
☐ - Portable tools
☐ - Semiconductor devices

☐ - EN 55014 / A2:1990

☐ - EN 55014 / 1993 ☐ - Household appliances and similar
☐ - Portable tools
☐ - Semiconductor devices

☐ - EN 55015 / 1987

☐ - EN 55015 / A1:1990

☐ - EN 55015 / 1993

☐ - EN 55022 / 1987 ☐ - Class A ☐ - Class B

☐ - EN 55022 / 1994 ☐ - Class A ☐ - Class B

☐ - BS

☐ - VCCI ☐ - Class A ☐ - Class B

■ - FCC Part 15 Subpart C Section 15.231

☐ - AS 3548 (1992) ☐ - Class A ☐ - Class B

☐ - CISPR 11 (1990) ☐ - Group 1 ☐ - Group 2
☐ - Class A ☐ - Class B

☐ - CISPR 22 (1993) ☐ - Class A ☐ - Class B

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Environmental conditions in the lab:

	Actual
Temperature	: 23 °C
Relative Humidity	: 39 %
Atmospheric pressure	: 99 kPa
Power supply system	: 3 VDC

Sign Explanations:

☐ - not applicable
■ - applicable

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Emissions Test Conditions: CONDUCTED EMISSIONS (Interference Voltage)

The *CONDUCTED EMISSIONS (INTERFERENCE VOLTAGE)* measurements were performed at the following test location:

■ - Test not applicable

☐ - Wild River Lab Large Test Site (Open Area Test Site)
☐ - Wild River Lab Small Test Site (Open Area Test Site)
☐ - Oakwood Lab (Open Area Test Site)
☐ - Wild River Lab Screen Room
☐ - New Brighton Lab Shielded Room

Emissions Test Conditions: RADIATED EMISSIONS (Magnetic Field)

The *RADIATED EMISSIONS (MAGNETIC FIELD)* measurements were performed at the following test location:

☐ - Wild River Lab Large Test Site (Open Area Test Site)
☐ - Wild River Lab Small Test Site (Open Area Test Site)
☐ - Oakwood Lab (Open Area Test Site)

at a test distance of :

☐ - 3 meters
☐ - 30 meters

■ - Test not applicable

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Emissions Test Conditions: RADIATED EMISSIONS (Electric Field)

The *RADIATED EMISSIONS (ELECTRIC FIELD)* measurements, in the frequency range of 30 MHz-1000 MHz, were tested in a horizontal and vertical polarization at the following test location :

☐ - Test not applicable

■ - Wild River Lab Large Test Site (Open Area Test Site) – NSA measurements made 6-20-99, due 6-20-00
☐ - Wild River Lab Small Test Site (Open Area Test Site)
☐ - Oakwood Lab (Open Area Test Site)

at a test distance of :

■ - 3 meters
☐ - 10 meters
☐ - 30 meters

Test equipment used :

	Model Number	Manufacturer	Description	Serial Number	Cal Due
■ -	EM-6917B	Electro-Metrics	Biconicalog Antenna	101	9-00
■ -	8566B	Hewlett-Packard	Spectrum Analyzer	2221A01596	11-00
■ -	85662A	Hewlett-Packard	Analyzer Display	2152A03640	11-00
■ -	85650A	Hewlett-Packard	Quasi-Peak Adapter	2811A01127	11-00
■ -	ZHL-1042J	Mini-Circuits	Preamplifier	H072294-11	3-01

All measurement instrumentation is traceable to the National Institute of Standards and Technology (NIST) and is calibrated annually.

Emissions Test Conditions: INTERFERENCE POWER

The *INTERFERENCE POWER* measurements were performed by using the absorbing clamp on the mains and interface cables in the frequency range 30 MHz - 300 MHz at the following test location :

■ - Test not applicable

☐ - Wild River Lab Large Test Site (Open Area Test Site)
☐ - Wild River Lab Small Test Site (Open Area Test Site)
☐ - Oakwood Lab (Open Area Test Site)
☐ - Wild River Lab Screen Room
☐ - New Brighton Lab Shielded Room

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Emissions Test Conditions: RADIATED EMISSIONS (Electric Field)

The *EQUIVALENT RADIATED EMISSIONS* measurements in the frequency range 1 GHz - 3.2 GHz were performed in a horizontal and vertical polarization at the following test location :

■ - Wild River Lab Large Test Site (Open Area Test Site)
☐ - Wild River Lab Small Test Site (Open Area Test Site)
☐ - Oakwood Lab (Open Area Test Site)
☐ - Wild River Lab Screen Room

at a test distance of:

☐ - 1 meters
■ - 3 meters
☐ - 10 meters

☐ **- Test not applicable**

Test equipment used :

	Model Number	Manufacturer	Description	Serial Number	Cal Date
■ -	EM-6917B	Electro-Metrics	Biconicalog Antenna	101	9-00
■ -	8566B	Hewlett-Packard	Spectrum Analyzer	2221A01596	11-00
■ -	85662A	Hewlett-Packard	Analyzer Display	2152A03640	11-00
■ -	85650A	Hewlett-Packard	Quasi-Peak Adapter	2811A01127	11-00
■ -	ZHL-1042J	Mini-Circuits	Preamplifier	H072294-11	3-01

All measurement instrumentation is traceable to the National Institute of Standards and Technology (NIST) and is calibrated annually.

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Equipment Under Test (EUT) Test Operation Mode - Emission tests :

The device under test was operated under the following conditions during emissions testing:

☐ - Standby

☐ - Test program (H - Pattern)

☐ - Test program (color bar)

☐ - Test program (customer specific)

☐ - Practice operation

☐ - Normal Operating Mode

■ - Transmitter on.

Configuration of the device under test:

☐ - See Constructional Data Form in Appendix B - Page B2

■ - See Product Information Form in Appendix B - beginning on Page B3

The following peripheral devices and interface cables were connected during the measurement:

☐ - _____ Type : _____

☐ - _____ Type : _____

☐ - _____ Type : _____

☐ - _____ Type : _____

☐ - _____ Type : _____

☐ - _____ Type : _____

☐ - _____ Type : _____

☐ - _____ Type : _____

☐ - unshielded power cable

☐ - unshielded cables

☐ - shielded cables MPS.No.: _____

☐ - customer specific cables

☐ - _____

☐ - _____

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Emission Test Results:

Conducted emissions 10/150 kHz - 30 MHz

The requirements are ☐ - MET ☐ - NOT MET

Minimum limit margin _____ dB at _____ MHz

Maximum limit exceeding _____ dB at _____ MHz

Remarks: _____

Radiated emissions (magnetic field) 10 kHz - 30 MHz

The requirements are ☐ - MET ☐ - NOT MET

Minimum limit margin _____ dB at _____ MHz

Maximum limit exceeding _____ dB at _____ MHz

Remarks: _____

Radiated emissions (electric field) 30 MHz - 1000 MHz

The requirements are ■ - MET ☐ - NOT MET

Minimum limit margin for fundamental 5 dB at 314.94 MHz

Minimum limit margin for spurious 8 dB at 629.9 MHz

Remarks: The fundamental was measured to be 62.1 dBuV/m (1273 uV/m) in quasi-peak mode compared to a limit of 67.6 dBuV/m (2416 uV/m). The second harmonic was measured to be 38.7 dBuV/m (86 uV/m) in quasi-peak mode compared to an average limit of 47.6 dBuV/m (241.6 uV/m).

Interference Power at the mains and interface cables 30 MHz - 300 MHz

The requirements are ☐ - MET ☐ - NOT MET

Minimum limit margin _____ dB At _____ MHz

Maximum limit exceeding _____ dB At _____ MHz

Remarks: _____

Equivalent Radiated emissions 1 GHz - 3.15 GHz

The requirements are ■ - MET ☐ - NOT MET

Minimum limit margin 16 dB At 1260.1 MHz

Maximum limit exceeding _____ dB At _____ MHz

Remarks: The fourth harmonic was measured to be 37.1 dBuV/m (71.6 uV/m) in peak mode compared to an average limit of 54 dBuV/m (500 uV/m).

DEVIATIONS FROM STANDARD:

None.

GENERAL REMARKS:

The bandwidth of the fundamental must be less than 0.25% of the center frequency, or 787 kHz. Page A5 of A5 shows the bandwidth to be less than 170 kHz. Basically this transmitter sends the signals as described in the following table. The transmission is less than 1 second, and the intervals are greater than 10 seconds.

table 4. Explanation of transmitting

	Typical transmission interval	Minimum number of transmission
Normal	617s	
Pressure alert	14.7s	
Slow puncture alert	14.7s	
High temperature alert	14.7s	16

Note; The time of 1 transmitting frame is about 300ms.

SUMMARY:

The requirements according to the technical regulations are

■ - met

☐ - **not** met.

The device under test does

■ - fulfill the general approval requirements mentioned on page 3.

☐ - **not** fulfill the general approval requirements mentioned on page 3.

Testing Start Date: 05 June 2000

Testing End Date: 05 June 2000

- TÜV PRODUCT SERVICE INC -

J. T. Schneider
Lead Engineer

Tested By:
G. S. Jakubowski

TÜV PRODUCT SERVICE INC 19333 Wild Mountain Road Taylors Falls MN 55084-1758 Tel: 651 638 0297 Fax: 651 638 0298 Rev.No 1.0

Test-setup photo(s):
Conducted emission 10/150 kHz - 30 MHz

Not Applicable

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Test-setup photo(s):
Radiated emission 30 MHz - 3.15 GHz

See Test-Setup Exhibit

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Appendix A

Test Data Sheets

and

Test Setup Drawing(s)

TÜV PRODUCT SERVICE INC 19333 Wild Mountain Road Taylors Falls MN 55084-1758 Tel: 651 638 0297 Fax: 651 638 0298 Rev.No 1.0

TEST SETUP FOR EMISSIONS TESTING

WILD RIVER LAB
Large Test Site

See Test-Setup Exhibit

TÜV PRODUCT SERVICE INC 19333 Wild Mountain Road Taylors Falls MN 55084-1758 Tel: 651 638 0297 Fax: 651 638 0298 Rev.No 1.0

Radiated Electromagnetic Emissions

Test Report #:	W0312 Run 1	**Test Area:**	**LTS 3m**			
Test Method:	**FCC 15 C, Para 15.231(e)**	**Test Date:**	**05-Jun-2000**			
EUT Model #:	**PMV-1001, Type 2 A**	**EUT Power:**	**Internal Battery**			
EUT Serial #:				**Temperature:**	**23**	**°C**
Manufacturer:	**Pacific Industrial Co Ltd**			**Relative Humidity:**	**39**	**%**
EUT Description:	**Tire pressure monitor / transmitter**			**Air Pressure:**		**kPa**
Notes:	**RBW & VBW = 100 kHz below 1 GHz**			**Page:**	**1 of 2**	
	RBW & VBW = 1 MHz above 1 GHz					

FREQ (MHz)	LEVEL (dBuV)	CABLE / ANT / PREAMP (dB) (dB/m) (dB)	FINAL (dBuV/m)	POL / HGT / AZ (m) (DEG)	DELTA1 Denso <1GHz	DELTA2 Denso >1GHz
EUT Nozzle horizontal						
Lines 3 & 4 open						
Maxed						
315.10	62.7 Qp	2.1 / 13.8 / 25.9	52.6	V / 1.7 / 289.0	-15.0	N/A
315.10	71.6 Qp	2.1 / 13.8 / 25.9	61.5	H / 1.0 / 256.0	-6.1	N/A
EUT Nozzle vertical						
Maxed						
315.10	65.3 Qp	2.1 / 13.8 / 25.9	55.2	H / 1.0 / 330.0	-12.4	N/A
315.10	68.0 Qp	2.1 / 13.8 / 25.9	57.9	V / 1.7 / 293.0	-9.7	N/A
EUT Nozzle horizontal						
Lines 3 & 4 jumped						
Maxed						
314.94	72.2 Qp	2.1 / 13.8 / 25.9	62.1	H / 1.0 / 247.0	-5.5	N/A
20dB BW of fundamental = 161.5 kHz (see plot)						
Maxed Harmonics						
629.90	42.4 Qp	2.8 / 19.6 / 26.1	38.7	H / 1.1 / 181.0	-8.9	N/A
944.84	33.9 Qp	3.5 / 22.0 / 25.6	33.8	H / 1.0 / 36.0	-13.8	N/A
1260	33.5 Pk	4.0 / 24.5 / 25.2	37.1	H / 1.0 / 80.0	N/A	-16.9
LAST MEASUREMENT MADE WITH 1 MHZ RBW, 1 MHZ VBW.						
No other significant emissions detected 30-3150 MHz						
End scan 30-3150 MHz						

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Radiated Electromagnetic Emissions

Test Report #:	W0312 Run 1	**Test Area:**	**LTS 3m**			
Test Method:	**FCC 15 C, Para 15.231(e)**	**Test Date:**	**05-Jun-2000**			
EUT Model #:	**PMV-1001, Type 2 A**	**EUT Power:**	**Internal Battery**			
EUT Serial #:				**Temperature:**	**23**	**ºC**
Manufacturer:	**Pacific Industrial Co Ltd**			**Relative Humidity:**	**39**	**%**
EUT Description:	**Tire pressure monitor / transmitter**			**Air Pressure:**		**kPa**
Notes:	**RBW & VBW = 100 kHz below 1 GHz**			**Page:**	**2 of 2**	
	RBW & VBW = 1 MHz above 1 GHz					

FREQ (MHz)	**LEVEL** (dBuV)	**CABLE / ANT / PREAMP** (dB) (dB/m) (dB)	**FINAL** (dBuV/m)	**POL / HGT / AZ** (m) (DEG)	**DELTA1** Denso <1GHz	**DELTA2** Denso >1GHz
********** **MEASUREMENT SUMMARY** **********						
314.94	72.2 Qp	2.1 / 13.8 / 25.9	62.1	H / 1.0 / 247.0	-5.5	N/A
315.10	71.6 Qp	2.1 / 13.8 / 25.9	61.5	H / 1.0 / 256.0	-6.1	N/A
629.90	42.4 Qp	2.8 / 19.6 / 26.1	38.7	H / 1.1 / 181.0	-8.9	N/A
944.84	33.9 Qp	3.5 / 22.0 / 25.6	33.8	H / 1.0 / 36.0	-13.8	N/A
1260	33.5 Pk	4.0 / 24.5 / 25.2	37.1	H / 1.0 / 80.0	N/A	-16.9

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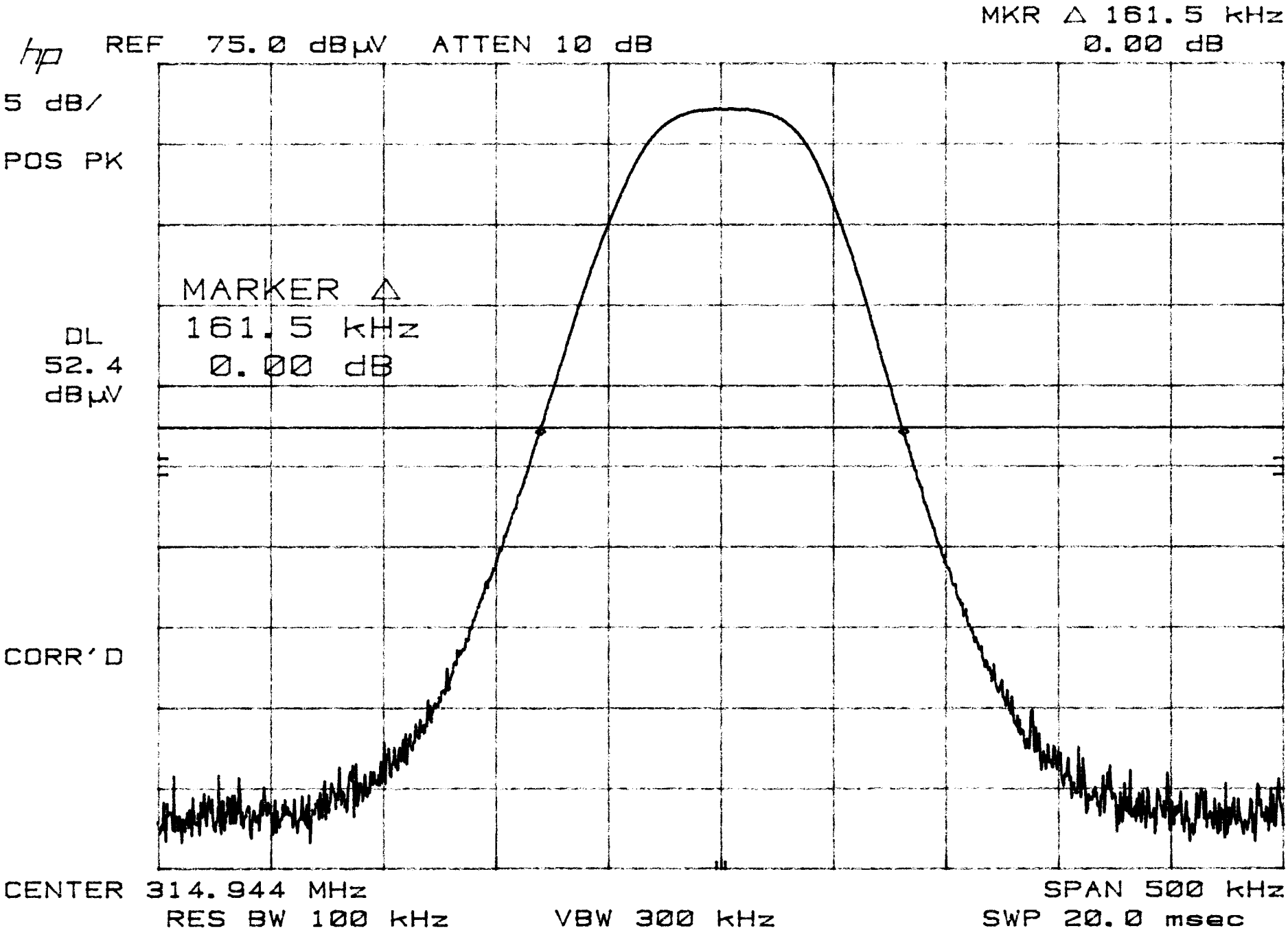
MKR Δ 161.5 kHz
0.00 dB
REF 75.0 dBμV
ATTEN 10 dB
5 dB/
POS PK
MARKER Δ
161.5 kHz
0.00 dB
DL
52.4
dBμV
CORR'D
CENTER 314.944 MHz
SPAN 500 kHz
RES BW 100 kHz
VBW 300 kHz
SWP 20.0 msec

Appendix B

Constructional Data Form

and

Product Information Form(s)

TÜV PRODUCT SERVICE INC 19333 Wild Mountain Road Taylors Falls MN 55084-1758 Tel: 651 638 0297 Fax: 651 638 0298 Rev.No 1.0

Constructional Data Form

Not Applicable

TÜV PRODUCT SERVICE INC 19333 Wild Mountain Road Taylors Falls MN 55084-1758 Tel: 651 638 0297 Fax: 651 638 0298 Rev.No 1.0

Technical Description of the system

Type number

- Transmitter :PMV-1001

Specifications

- Nominal frequency :314.98 MHz obtained by SAW resonator

- Radio frequency output power :67.6 dBuV/m or less
- Type of modulation :F2D
- Power supply
  - Nominal supply voltage :3 VDC
  - Type of battery :One lithium battery
- Antenna :Built-in type (fixed)

Description of the system operation

This system is used for monitoring and indicating about information of air pressure and temperature in vehicle's tires. This transmitter sends to receiver the data that are information of air pressure and temperature in vehicle's tires. The data also include battery voltage and identity code of transmitter. The receiver judges if the data of air pressure and temperature from transmitter are not normal conditions. And then the receiver sends communication signals to a warning lamp through gateway ECU which is an intermediate ECU to divide signals. The warning lamp warns drivers.

Installation in vehicle

The transmitter is installed on tire wheel rim.(see Fig 3.2 Transmitter of installation)

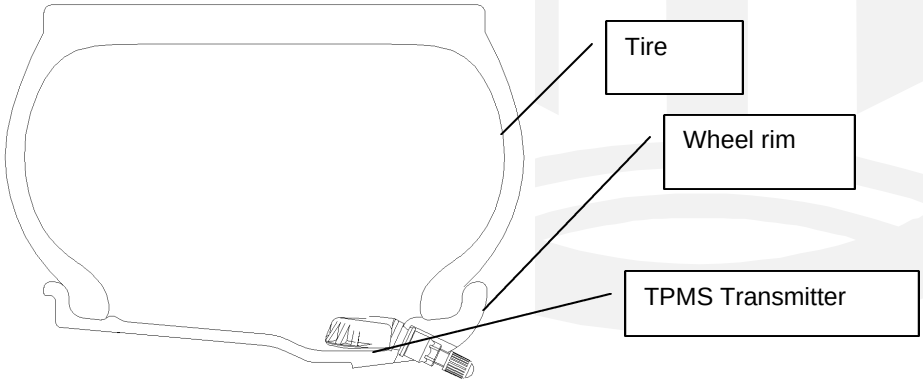

Fig 3.2 Transmitter of installation

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Appendix C

MEASUREMENT PROTOCOL

GENERAL INFORMATION

Measurement Uncertainty

The test system for conducted emissions is defined as the LISN, tuned receiver or spectrum analyzer, and coaxial cable. The test system for radiated emissions is defined as the antenna, the pre-amplifier, the spectrum analyzer and the coaxial cable. These test systems have a measurement uncertainty of ±4.5 dB. The equipment comprising the test systems are calibrated on an annual basis.

Justification

The Equipment Under Test (EUT) is configured in a typical user arrangement in accordance with the manufacturer's instructions. A cable is connected to each available port and either terminated with a peripheral into it's characteristic impedance or left unterminated. When appropriate, the cables are manually manipulated with respect to each other to obtain maximum emissions from the unit.

CONDUCTED EMISSIONS

The final level, expressed in dBµV, is arrived at by taking the reading directly from the EMI receiver. This level is compared directly to the FCC limit.

To convert between dBµV and µV, the following conversions apply:

dBµV = 20(log µV)
µV = Inverse log(dBµV/20)

RADIATED EMISSIONS

The final level, expressed in dBµV/m, is arrived at by taking the reading from the spectrum analyzer (Level dBµV) and adding the antenna correction factor and cable loss factor (Factor dB) to it. This result then has the FCC limit subtracted from it to provide the Delta which gives the tabular data as shown in the data sheets in Attachment B. The amplifier gain is automatically accounted for by using an analyzer offset.

Example:

Frequency (MHz)		Level (dBµV)		Factor & Cable (dB)		Final (dBµV/m)		FCC Limit (dBµV/m)		Delta FCC (dB)
32.21	+	13.9	+	16.3	=	30.2	-	40.0	=	-9.8

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DETAILS OF TEST PROCEDURES

General Standard Information

The test methods used comply with ANSI C63.4-1992 - "Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz."

Conducted Emissions

Conducted emissions on the 60 Hz power interface of the EUT are measured in the frequency range of 450 kHz to 30 MHz. The measurements are performed using a receiver, which has CISPR characteristic bandwidth and quasi-peak detection, and a Line Impedance Stabilization Network (LISN), with 50 Ω/50 µH (CISPR 16) characteristics. Table top equipment is placed on a non-conducting table 80 centimeters above the floor and is positioned 40 centimeters from the vertical ground plane (wall) of the screen room. In some cases, a pre-scan using a spectrum analyzer is initially performed on the units comprising the system under test to locate the highest emissions. If the minimum passing margin appears to be less than 20 dB with a peak mode measurement, the emissions are re-measured using a tuned receiver or spectrum analyzer with quasi-peak and average detection and recorded on the data sheets.

Radiated Emissions

Radiated emissions from the EUT are measured in the frequency range of 30 to 1000 MHz using a spectrum analyzer and appropriate broadband linearly polarized antennas. Measurements between 30 MHz and 1000 MHz are made with 120 kHz/6 dB bandwidth and peak detection and measurements above 1000 MHz are made with a 1 MHz/6 dB bandwidth and peak detection. Table top equipment is placed on a 1.0 X 1.5 meter non-conducting table 80 centimeters above the ground plane. Floor standing equipment is placed directly on the turntable/ground plane. Interface cables that are closer than 40 centimeters to the ground plane are bundled in the center in a serpentine fashion so they are at least 40 centimeters from the ground plane. Cables to simulators/testers (if used in this test) are routed through the center of the table and to a screen room located outside the test area. The antenna is positioned 3 meters horizontally from the EUT. To locate maximum emissions from the test sample the antenna is varied in height from 1 to 4 meters, measurement scans are made with both horizontal and vertical antenna polarizations and the EUT are rotated 360 degrees. Intentional radiators are rotated through three orthogonal axes to determine the attitude that maximizes the emissions.

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