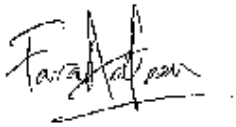
# TEST REPORT
# FROM
# RFI GLOBAL SERVICES LTD

Test of: A M Bromley Ltd.
TMS10 Tyre Pressure Transmitter

To: FCC Part 15.231

**Test Report Serial No:**
RFI/MPTE2/RP46858JD01A

**Supersedes Test Report Serial No:**
RFI/MPTE1/RP46858JD01A

| | |
|---|---|
| **This Test Report Is Issued Under The Authority Of Richard Jacklin, Operations Director:**  | |
| **Tested By: Fara Razally**  | **Checked By: Tony Henriques**  |
| **Report Copy No: PDF001** | |
| **Issue Date: 10 January 2005** | **Test Dates: 23 November 2004** |

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**Test of:** A M Bromley Ltd.
TMS10 Tyre Pressure Transmitter
**To:** FCC Part 15.231

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## 1. Client Information

| | |
|---|---|
| **Company Name:** | A M Bromley Ltd. |
| **Address:** | West Road House<br>26a West Road<br>Buxton<br>Derbyshire<br>SK17 6HF |
| **Contact Name:** | Ms M Bromley |

# 2. Equipment Under Test (EUT)

The following information (with the exception of the Date of Receipt) has been supplied by the client:

## 2.1. Identification of Equipment Under Test (EUT)

| | |
|---|---|
| **Brand Name:** | Tyre Pressure Transmitter |
| **Model Name or Number:** | TMS10 |
| **Serial Number:** | S0425[1]; S0422[2] |
| **FCC ID Number:** | SUYTMS10 |
| **Country of Manufacture:** | UK |
| **Date of Receipt:** | 23 November 2004 |

[1]*Sample set to operate normally i.e. transmitting approximately every 300m seconds*
[2]*Sample set to operate continuously to facilitate testing*

## 2.2. Description of EUT

The equipment under test is a transmitter intended to operate as part of a tyre pressure monitoring system.

## 2.3. Modifications Incorporated in EUT

During the course of testing the EUT was not modified.

## 2.4. Additional Information Related to Testing

| | | | |
|---|---|---|---|
| **Power Supply Requirement:** | Integral 3 VDC lithium manganese battery supply | | |
| **Intended Operating Environment:** | Vehicular | | |
| **Equipment Category:** | Mobile (fitted inside vehicle tyre) | | |
| **Type of Unit:** | Transmitter | | |
| **Interface Ports:** | Not Applicable | | |
| **Transmit Frequency Range:** | 433.92 MHz, Single Frequency | | |
| **Transmit Channels Tested:** | **Channel ID** | **Channel Number** | **Channel Frequency (MHz)** |
| | N/A | N/A | 433.92 |
| **Occupied Bandwidth** | 80.9 kHz | | |

## 2.5. Support Equipment

No support equipment was used to exercise the EUT during testing.

# 3. Methods and Procedures

| | |
|---|---|
| **Reference:** | FCC Part 15 Subpart C: 2003 (Section 15.231) |
| **Title:** | Code of Federal Regulations, Part 15 (47CFR15)<br>Radio Frequency Devices. |
| **Comments:** | A description of the test facility used for this test is on file with, and has been accepted by, the Federal Communications Commission as required by Section 2.948 of Federal Rules. |
| **Purpose of Test:** | To determine whether the equipment complied with the requirements of the specification for the purposes of certification. |

The methods and procedures used were as detailed in:

ANSI/TIA-603-B-2002
Land Mobile Communications Equipment, Measurements and performance Standards

ANSI C63.2 (1987)
Title: American National Standard for Instrumentation - Electromagnetic noise and field strength.

ANSI C63.4 (2003)
Title: American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz.

ANSI C63.5 (1988)
Title: American National Standard for the Calibration of antennas used for Radiated Emission measurements in Electromagnetic Interference (EMI) control.

ANSI C63.7 (1988)
Title: American National Standard Guide for Construction of Open Area Test Sites for performing Radiated Emission Measurements.

CISPR 16-1: (1999)
Title: Specification For Radio Disturbance and Immunity Measuring Apparatus and Methods. Part 1: Radio Disturbance and Immunity Measuring Apparatus.

DA00-705 (2000)
Title: Filing and Frequency Measurement Guidelines for Frequency Hopping Spread Spectrum Systems.

## 3.1. Definition of Measurement Equipment

The measurement equipment used complied with the requirements of the standards referenced in the Methods & Procedures section above. Appendix 1 contains a list of the test equipment used.

## 4. Deviations from the Test Specification

None.

# 5. Operation of the EUT During Testing

## 5.1. Operating Conditions

The EUT was tested in a normal laboratory environment.

During testing, the EUT was powered by an integral 3 VDC battery supply.

## 5.2. Operating Modes

The EUT was tested in the following operating modes, unless otherwise stated:

For measurements of Transmission Duration and Silent Period and Duty Cycle: Normal operating mode i.e. transmitting approximately every 300m seconds.

For all other measurements: Continuous modulated transmission.

## 5.3. Configuration and Peripherals

The EUT was tested in the following configuration:

Standalone.

# 6. Summary of Test Results

| Range of Measurements | Specification Reference | Port Type | Compliancy Status |
|---|---|---|---|
| Transmitter Fundamental Fieldstrength | C.F.R. 47 FCC Part 15: 2003 Section 15.231(e) | Antenna | Complied |
| Transmitter 20 dB Bandwidth | C.F.R. 47 FCC Part 15: 2003 Section 15.231(c) | Antenna | Complied |
| Transmitter Transmission Duration and Silent Period | C.F.R. 47 FCC Part 15: 2003 Section 15.231(e) | Antenna | Complied |
| Transmitter Radiated Spurious Emissions | C.F.R. 47 FCC Part 15: 2003 Section 15.231(b)(e) & 15.209 | Antenna | Complied |

## 6.1. Location of Tests

All the measurements described in this report were performed at the premises of
RFI Global Services Ltd, Ewhurst Park, Ramsdell, Basingstoke, Hampshire, RG26 5RQ, England.

# 7. Measurements, Examinations and Derived Results

## 7.1. General Comments

7.1.1. This section contains test results only.

7.1.2. Measurement uncertainties are evaluated in accordance with current best practice. Our reported expanded uncertainties are based on standard uncertainties, which are multiplied by an appropriate coverage factor to provide a statistical confidence level of approximately 95%. Please refer to Section 8 for details of measurement uncertainties.

# 8. Test Results

## 8.1. Transmitter Fundamental Fieldstrength Section 15.231(e)

8.1.1. The EUT was configured as for radiated emissions testing as described in Section 9 of this report.

8.1.2. Tests were performed to identify the maximum fieldstrength of the fundamental frequency.

**Results:**

**Highest Peak Level:**

| Frequency (MHz) | Antenna Polarity | Level (dBμV/m) | Limit (dBμV/m) | Margin (dB) | Result |
|---|---|---|---|---|---|
| 433.92 | Horiz. | 64.9 | 92.9 | 28.0 | Complied |

**Highest Average Level:**

| Frequency (MHz) | Antenna Polarity | Level (dBμV/m) | Limit (dBμV/m) | Margin (dB) | Result |
|---|---|---|---|---|---|
| 433.92 | Horiz. | 62.8* | 72.9 | 10.1 | Complied |

**Note: As the EUT employs pulsed operation (whose pulse train exceeds 0.1 seconds), the average level of the fundamental was found by measuring the peak level of the fundamental and correcting it with the calculated duty cycle correction factor of -2.1 dB using the procedure detailed in ANSI C63.4-2003 Annex H.4 j).*

*This was calculated as follows:*

*Duty cycle = on time/100 milliseconds or period (whichever is the lesser)*

*On time =78.36 milliseconds (calculated from Duty Cycle plot DC01)*

*Duty cycle = 78.36/100 milliseconds (as period is >100 milliseconds as shown in Duty Cycle plot DC02)*

*Duty cycle = 0.7836 or 78.36%*

*To obtain correction factor in dB i.e. to correct the peak reading to the average value of the emission in dB:*
*20 x log (0.7836) = -2.1 dB*

**Test of:** **A M Bromley Ltd.**
**TMS10 Tyre Pressure Transmitter**
**To:** **FCC Part 15.231**

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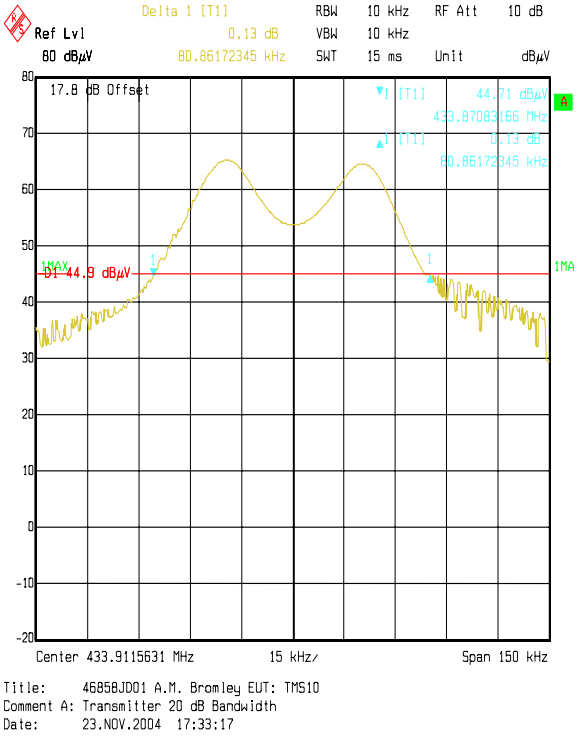
## 8.2.Transmitter 20 dB Bandwidth: Section 15.231(c)

8.2.1. The EUT was configured as for 20 dB bandwidth measurements as described in Section 9 of this report.

8.2.2. Tests were performed to identify the 20 dB bandwidth.

| Transmitter 20 dB Bandwidth (MHz) | Limit (MHz) | Margin (MHz) | Result |
|---|---|---|---|
| 0.0809 | 1.0848* | 1.0039 | Complied |

** Calculated based on a fundamental frequency of 433.92 MHz*



## 8.3.Transmitter Transmission Duration and Silent Period: Section 15.231(e)

8.3.1. The EUT was configured as for transmission duration and silent period measurements as described in Section 9 of this report.

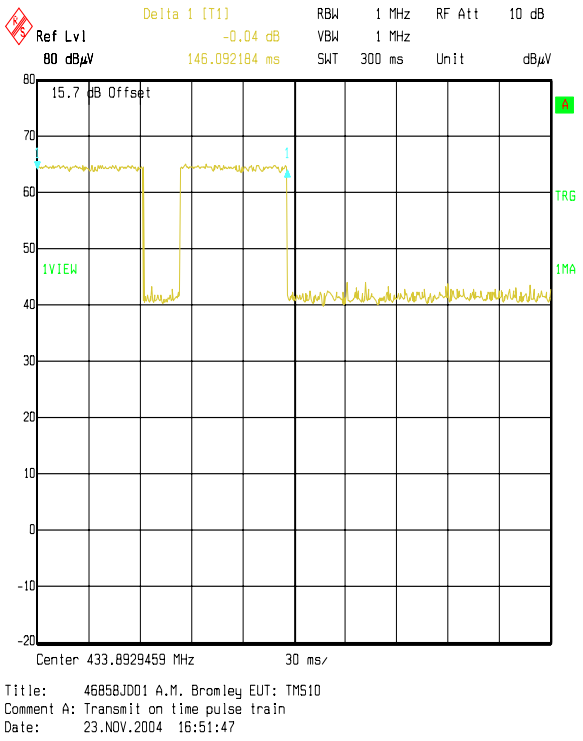
8.3.2. Tests were performed to determine the transmission duration and silent period time of the transmitter.

| Duration Time (seconds) | Limit (seconds) |
|---|---|
| 0.146 | 1 |

| Silent Period (seconds) | Limit (seconds) |
|---|---|
| >300 | ≥10* |

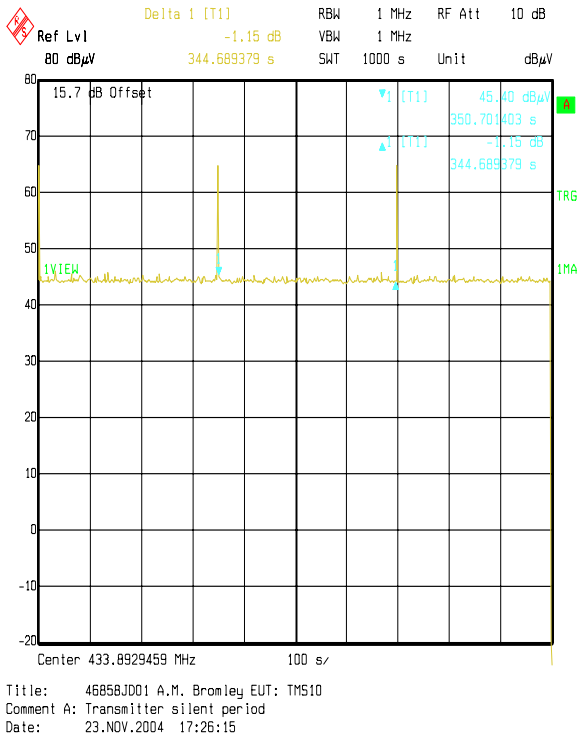
**>30 x transmission duration but in no case less than 10 seconds*

**Transmission Duration**




Title: 46858JD01 A.M. Bromley EUT: TMS10
Comment A: Transmit on time pulse train
Date: 23.NOV.2004 16:51:47

**Silent Period**




Title: 46858JD01 A.M. Bromley EUT: TMS10
Comment A: Transmitter silent period
Date: 23.NOV.2004 17:26:15

## 8.4. Transmitter Radiated Emissions: Section 15.231(b) (e) & Section 15.209

### 8.4.1. Electric Field Strength Measurements: 30 to 1000 MHz

8.4.1.1. The EUT was configured as for radiated emissions testing as described in Section 9 of this report.

8.4.1.2. Tests were performed to identify the maximum radiated spurious emissions levels.

**Results:**

| Frequency (MHz) | Antenna Polarity | Average Level (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Result |
|---|---|---|---|---|---|
| 867.855 | Horiz. | 51.1* | 52.9 | 1.8 | Complied |

**Note: As the EUT employs pulsed operation (whose pulse train exceeds 0.1 seconds), the average level of the emission was found by measuring the peak level of the emission and correcting it with the calculated duty cycle correction factor of -2.1 dB using the procedure detailed in ANSI C63.4-2003 Annex H.4 j).*

*This was calculated as follows:*

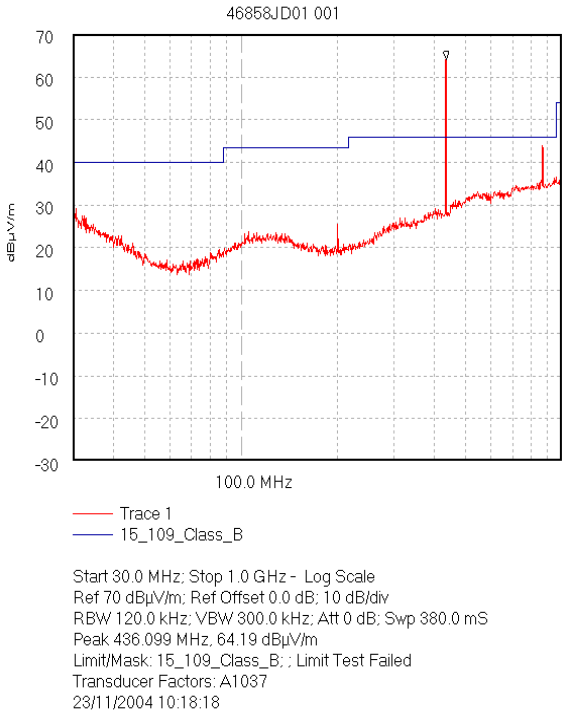
*Duty cycle = on time/100 milliseconds or period (whichever is the lesser)*

*On time =78.36 milliseconds (calculated from Duty Cycle plot DC01)*

*Duty cycle = 78.36/100 milliseconds (as period is >100 milliseconds as shown in Duty Cycle plot DC02)*

*Duty cycle = 0.7836 or 78.36%*

*To obtain correction factor in dB i.e. to correct the peak reading to the average value of the emission in dB:*
*20 x log (0.7836) = -2.1 dB*




*Note: The above plot is a pre-scan and for indication purposes only. It shows an emission at 436.099 MHz, this is the fundamental transmission frequency.*

## 8.4.2. Electric Field Strength Measurements: 1.0 to 4.5 GHz

### Highest Peak Level:

| Frequency (GHz) | Antenna Polarity | Detector Level (dBμV) | Antenna Factor (dB) | Cable Loss (dB) | Actual Level (dBμV/m) | Limit (dBμV/m) | Margin (dB) | Result |
|---|---|---|---|---|---|---|---|---|
| 1.301785 | Horiz. | 22.2 | 21.7 | 0.9 | 44.8 | 74.0 | 29.2 | Complied |

### Highest Average Level:

| Frequency (GHz) | Antenna Polarity | Detector Level (dBμV) | Antenna Factor (dB) | Cable Loss (dB) | Actual Level (dBμV/m) | Limit (dBμV/m) | Margin (dB) | Result |
|---|---|---|---|---|---|---|---|---|
| 1.301785 | Horiz. | 20.1 | 21.7 | 0.9 | 42.7* | 54.0 | 11.3 | Complied |

**Note: As the EUT employs pulsed operation (whose pulse train exceeds 0.1 seconds), the average level of each emission was found by measuring the peak level of the emission and correcting them with the calculated duty cycle correction factor of -2.1 dB using the procedure detailed in ANSI C63.4-2003 Annex H.4 j).*

*This was calculated as follows:*

*Duty cycle = on time/100 milliseconds or period (whichever is the lesser)*

*On time =78.36 milliseconds (calculated from Duty Cycle plot DC01)*

*Duty cycle = 78.36 /100 milliseconds (as period is >100 milliseconds as shown in Duty Cycle plot DC02)*

*Duty cycle = 0.7836 or 78.36%*

*To obtain correction factor in dB i.e. to correct the peak reading to the average value of the emission in dB:*
*20 x log (0.7836) = -2.1 dB*

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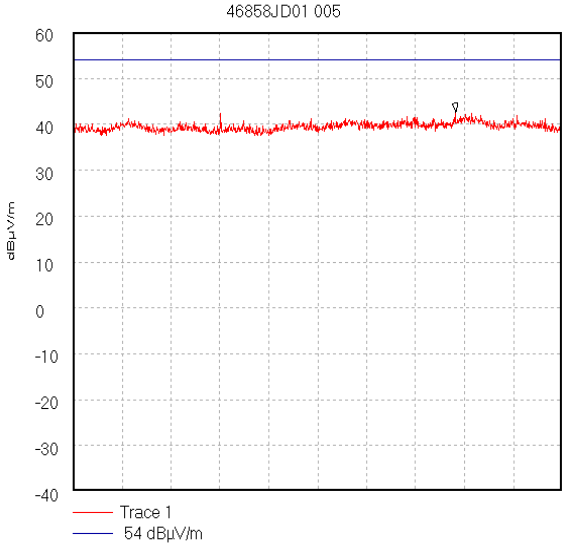
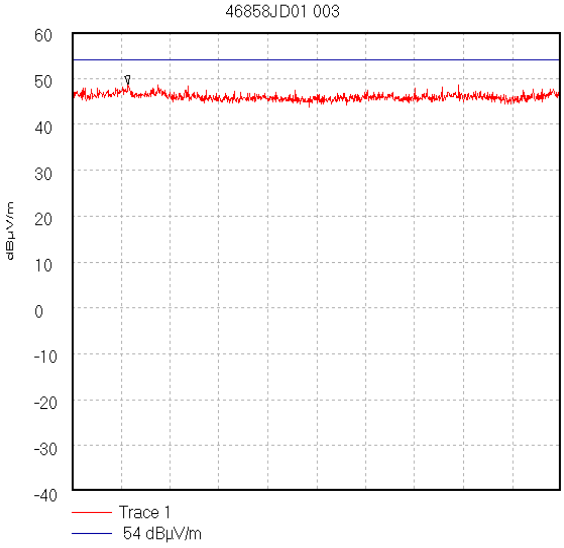
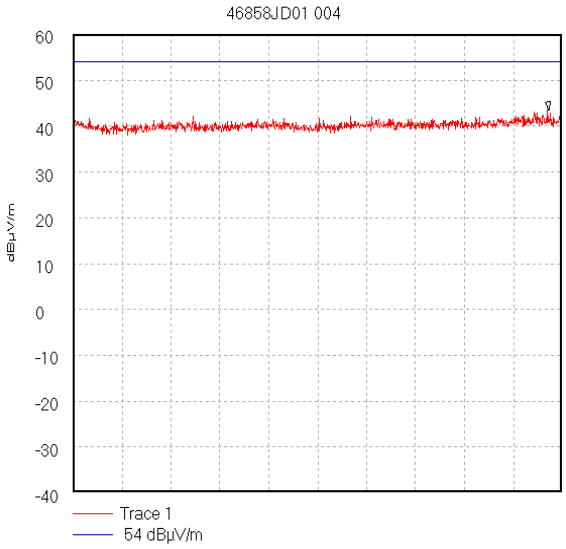
## Transmitter Radiated Emissions: Section 15.231(b) (e) & Section 15.209 (Continued)




Start 1.0 GHz; Stop 2.0 GHz
Ref 60 dBµV/m; Ref Offset 0.0 dB; 10 dB/div
RBW 1000.0 kHz; VBW 1.0 MHz; Att 0 dB; Swp 20.0 mS
Peak 1.782 GHz, 42.56 dBµV/m
Display Line: 54 dBµV/m; ; Limit Test Passed
Transducer Factors: 1 to 2
23/11/2004 11:46:55




Start 2.0 GHz; Stop 4.0 GHz
Ref 60 dBµV/m; Ref Offset 0.0 dB; 10 dB/div
RBW 1000.0 kHz; VBW 1.0 MHz; Att 0 dB; Swp 20.0 mS
Peak 2.229 GHz, 48.65 dBµV/m
Display Line: 54 dBµV/m; ; Limit Test Passed
Transducer Factors: 2 to 4
23/11/2004 11:21:17




Start 4.0 GHz; Stop 4.5 GHz
Ref 60 dBµV/m; Ref Offset 0.0 dB; 10 dB/div
RBW 1000.0 kHz; VBW 1.0 MHz; Att 0 dB; Swp 20.0 mS
Peak 4.486 GHz, 43.45 dBµV/m
Display Line: 54 dBµV/m; ; Limit Test Passed
Transducer Factors: 4_to_6_GHz
23/11/2004 11:38:56

*Note: these plots are pre-scans and for indication purposes only. For final measurements, see accompanying tables.*

**Test of:** **A M Bromley Ltd.**
**TMS10 Tyre Pressure Transmitter**
**To:** **FCC Part 15.231**

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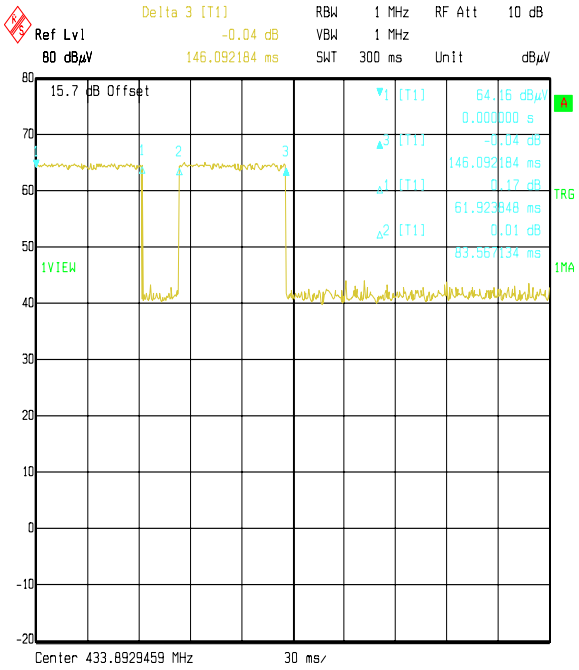
## Transmitter Radiated Emissions (Continued)

## Duty Cycle Plots

### DC01

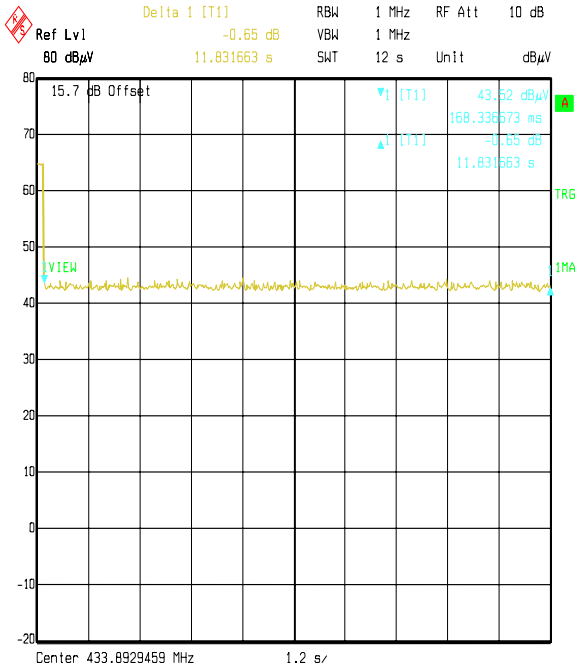
### Transmit On Time




Title: 46858JD01 A.M. Bromley EUT: TMS10
Comment A: Transmit on time pulse train
Date: 23.NOV.2004 16:57:33

### DC02

### Number of transmissions in a 12 s Period




Title: 46858JD01 A.M. Bromley EUT: TMS10
Comment A: Transmitter silent period
Date: 23.NOV.2004 17:02:52

# 9. Measurement Methods

## 9.1. Radiated Emissions

Radiated emissions measurements were performed in accordance with the standard, against appropriate limits for each detector function.

Initial measurements covering the entire measurement band in the form of swept scans in a shielded enclosure were performed in order to identify frequencies on which the EUT was generating interference. This determined the frequencies on which the EUT should be re-measured in full on the open area test site. In order to minimise the time taken for the swept measurements, a Peak detector was used in conjunction with the appropriate detector IF measuring bandwidth (see table below). Repetitive scans were performed to allow for emissions with low repetition rates.

The initial scans were performed using an antenna height of 1.5 m and a measurement distance of 3 m. Following the initial scans, graphs were produced giving an overview of the emissions from the EUT plotted against the appropriate specification limit. Any emission within 20 dB of the limit were then measured on the open area test site, except in cases where the noise floor was within 20 dB of the limit, in these cases the highest point of the noise floor was measured.

In either case the measurement was made at the appropriate distance using a measuring receiver using a peak detector across the entire frequency range.

For the final measurements the EUT was arranged on a non-conducting turn table on a standard test site compliant with ANSI C63.4-2003 Clause 5.4.

All measurements on the open area test site were performed using broadband antennas.

On the open area test site, at each frequency where a signal was to be measured, the trace was maximised by rotating a turntable through 360°. The angle at which the maximum signal was observed was locked out. For frequencies below 1000 MHz the test antenna was varied in height between 1 m and 4 m in order to further maximise the target emission.

For frequencies above 1000 MHz where a horn antenna was used, height searching was performed to locate the optimal height of the horn with respect to the EUT. At this point the horn was locked off and the turntable was again rotated through 360° to maximise the target signal. It should be noted that the received signal from the EUT would diminish very quickly after it exits the beam width of the horn antenna, for this reason it may not be necessary to fully height search with the horns.

At this point, any signals found to be between the limit and a level 6 dB below it were further maximised by changing the configuration of the EUT, e.g. re-routing cables to peripherals and moving peripherals with respect to the EUT.

Scans were performed to the upper frequency limits as stated in Section 15.33

The final field strength was determined as the indicated level in dBμV plus cable loss and antenna factor.

## Radiated Emissions (Continued)

The test equipment settings for radiated emissions measurements were as follows:

| Receiver Function | Initial Scan | Final Measurements Below 1 GHz | Final Measurements Above 1 GHz |
|---|---|---|---|
| Detector Type: | Peak | Peak* | Peak* |
| Mode: | Max Hold | Not applicable | Max Hold |
| Bandwidth: | (120 kHz < 1 GHz)<br>(1 MHz > 1 GHz) | 120 kHz | 1 MHz |
| Amplitude Range: | 100 dB | 100 dB | 100 dB |
| Step Size: | Continuous sweep | Not applicable | Not applicable |
| Sweep Time: | Coupled | Not applicable | Not applicable |

** Corrected to average levels using the procedure detailed below.*

## Duty Cycle Correction factor procedure

As the EUT employs periodic operation the average level of emission was found by measuring the peak level of the emission and correcting it with the duty cycle correction factor, which was obtained as follows:

The EUT (in its normal operating mode) was switched on, transmitting its pulse train continuously. A spectrum analyzer was set to the transmitter carrier frequency with its Resolution Bandwidth (RBW) set wide enough to encompass all significant spectral components, an RBW of 1 MHz was used. The Video Bandwidth was set to 1 MHz. The frequency span was set to 0 Hz. The sweep time was set to a period long enough to capture the entire Transmit On Time pulse. The Transmit On Time pulsewidths were measured and a plot taken.

The sweep time was then extended to cover a period in excess of 100 ms to demonstrate whether or not the pulse train exceeded 100 ms. A sweep time of 12 s was used. A plot of this was taken.

If the pulse train was less than 100 ms, including blanking intervals, the duty cycle was calculated by averaging the sum of the pulse widths over one complete pulse train. If the pulse train exceeded 100 ms, the duty cycle was calculated by averaging the sum of the pulsewidths over the 100 ms width with the highest average value. The duty cycle is the value of the sum of the pulse widths in one period (or 100 ms), divided by the length of the period (or 100 ms) i.e. Duty cycle = on time/100 milliseconds or period (whichever is the lesser).

To obtain the duty cycle correction factor in dB i.e. to correct the peak reading to the average value of the emission in dB the following formula was used:

*Correction factor in dB = 20 x log (Duty cycle in linear terms)*

## 9.2. Transmitter 20 dB Bandwidth

The EUT and spectrum analyser was configured as for transmitter radiated emissions measurements.

To determine the occupied bandwidth, a resolution bandwidth of 10 kHz was used, which is greater than 1% of the 20 dB bandwidth. A video bandwidth of a least the same value was used. The analyser was set for a maximum hold scan to capture the profile of the signal. The peak level was then determined and set as the 0 dB reference point. A reference line was drawn 20 dB below this 0 dB reference point. The bandwidth was determined at the points where the 20 dB reference crossed the profile of the emission.

## 9.3. Transmitter Transmission Duration and Silent Period

The EUT and spectrum analyser was configured as for transmitter radiated emissions measurements.

To determine the transmission duration and silent period time of the transmitter, a spectrum analyser was set to the transmitter carrier frequency with its Resolution Bandwidth (RBW) set wide enough to encompass all significant spectral components, an RBW of 1 MHz was used. The Video Bandwidth was set to 1 MHz. The frequency span was set to 0 Hz.

The sweep time was set to a period long enough to capture the entire Transmit On Time pulse. The Transmit On Time pulsewidth was measured and a plot taken.

In order to determine the silent period the sweep time was then extended to cover a period in excess of 30 times the duration of the transmission or at least 10 seconds whichever was the greater. A sweep time of 1000 seconds was used. A plot of this was taken.

## 10. Measurement Uncertainty

10.1. No measurement or test can ever be perfect and the imperfections give rise to error of measurement in the results. Consequently, the result of a measurement is only an approximation to the value of the measurand (the specific quantity subject to measurement) and is only complete when accompanied by a statement of the uncertainty of the approximation.

10.2. The expression of uncertainty of a measurement result allows realistic comparison of results with reference values and limits given in specifications and standards.

10.3. The uncertainty of the result may need to be taken into account when interpreting the measurement results.

10.4. The reported expanded uncertainties below are based on a standard uncertainty multiplied by an appropriate coverage factor, such that a confidence level of approximately 95% is maintained. For the purposes of this document “approximately” is interpreted as meaning “effectively” or “for most practical purposes”.

| Measurement Type | Range | Confidence Level (%) | Calculated Uncertainty |
|---|---|---|---|
| Occupied Bandwidth | N/A | 95% | +/- 0.12 % |
| Radiated Spurious Emissions | 30 MHz to 1000 MHz | 95% | +/- 5.26 dB |
| Radiated Spurious Emissions | 1 GHz to 40 GHz | 95% | +/- 1.78 dB |

10.5. The methods used to calculate the above uncertainties are in line with those recommended within the various measurement specifications. Where measurement specifications do not include guidelines for the evaluation of measurement uncertainty, the published guidance of the appropriate accreditation body is followed.

## Appendix 1. Test Equipment Used

| RFI No. | Instrument | Manufacturer | Type No. | Serial No. |
|---|---|---|---|---|
| A031 | Horn Antenna | Eaton | 91889-2 | 557 |
| A028 | Horn Antenna | Eaton | 91888-2 | 304 |
| A259 | Bilog Antenna | Chase | CBL6111 | 1513 |
| M003 | Spectrum Monitor | Rohde & Schwarz | EZM | 883 580/008 |
| M028 | Spectrum Analyser | Rohde & Schwarz | FSB | 860 001/009 (RU);<br>860 161/007 (DU) |
| M044 | Receiver | Rohde & Schwarz | ESVP | 891 845/026 |
| M127 | Spectrum Analyser | Rohde & Schwarz | FSEB 30 | 842 659/016 |
| S201 | Site 1 | RFI | 1 | |
| S202 | Site 2 | RFI | 2 | S202-15011990 |

**NB** In accordance with UKAS requirements, all the measurement equipment is on a calibration schedule.

## Appendix 2. Test Configuration Drawings

This appendix contains the following drawings:

| Drawing Reference Number | Title |
|---|---|
| DRG\46858JD01\EMIRAD | Test configuration for measurement of radiated emissions. |

**Test of:** **A M Bromley Ltd.**
**TMS10 Tyre Pressure Transmitter**
**To:** **FCC Part 15.231**

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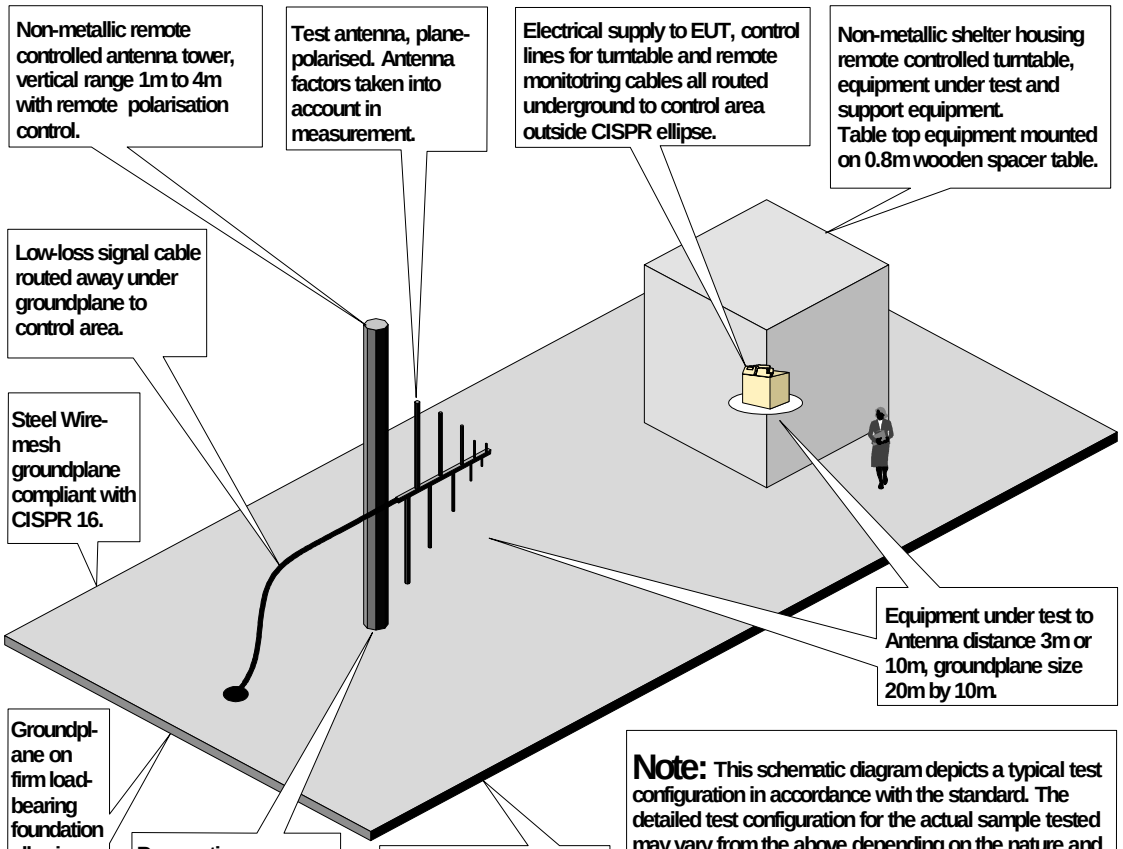
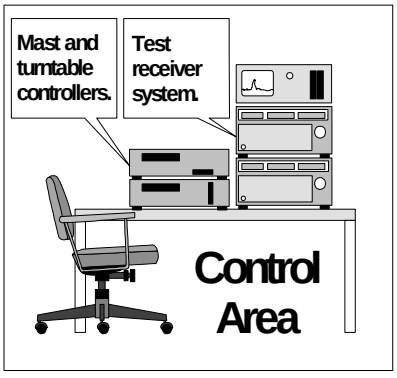
**DRG\46858JD01\EMIRAD**




**Note:** This schematic diagram depicts a typical test configuration in accordance with the standard. The detailed test configuration for the actual sample tested may vary from the above depending on the nature and operation of the EUT.
The test site used by RFI is nominally at ground level.
All electrical cables run underground.
All other dimensions in accordance with the standard.

## Test Configuration For Radiated Emissions Measurements

**Reflection-free area: >60m by 52m (CISPR ellipse)**
**Groundplane Earthed**
**Control room outside CISPR ellipse**



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