ENGINEERING TEST REPORT

Vehicular Repeater
Model No.: MOBEXCOM DVRS VHF
FCC ID: LO6-DVRSVHF

Applicant:

Futurecom Systems Group Inc.
3277 Langstaff Road
Concord, Ontario
Canada, L4K 5P8

Tested in Accordance With

Federal Communications Commission (FCC)
47 CFR, Parts 2 and 90 (Subpart I)

UltraTech's File No.: FSG-059FCC90

This Test report is Issued under the Authority of Tri M. Luu, Professional Engineer, Vice President of Engineering UltraTech Group of Labs Date: August 14, 2006	
Report Prepared by: Dharmajit Solanki Issued Date: August 14, 2006	Tested by: Hung Trinh, EMI/RFI Technician Test Dates: July 9 & 10, 2006

- *The results in this Test Report apply only to the sample(s) tested, and the sample tested is randomly selected.*
- *This report must not be used by the client to claim product endorsement by NVLAP or any agency of the US Government.*

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EXHIBIT 1. SUBMITTAL CHECK LIST

Annex No.	Exhibit Type	Description of Contents	Quality Check (OK)
--	Test Report	• Exhibit 1: Submittal check lists • Exhibit 2: Introduction • Exhibit 3: Performance Assessment • Exhibit 4: EUT Operation and Configuration during Tests • Exhibit 5: Summary of test Results • Exhibit 6: Measurement Data • Exhibit 7: Measurement Uncertainty • Exhibit 8: Measurement Methods	OK
1	Test Setup Photos	Radiated Emission Setup Photos	OK
2	External Photos of EUT	External Photos	OK
3	Internal Photos of EUT	Internal Photos	OK
4	Cover Letters	• Letter from Ultratech for Certification Request • Letter from the Applicant to appoint Ultratech to act as an agent	OK
5	Attestation Statements	Attestation Letter	OK
6	User Manual	User's Manual	OK
7	RF Exposure	RF Exposure Booklet	OK

EXHIBIT 2. INTRODUCTION

2.1. SCOPE

Reference:	FCC Parts 2 and 90
Title:	Code of Federal Regulations (CFR) Title 47 - Telecommunication, Parts 2 and 90 (Subpart I).
Purpose of Test:	To gain FCC Class II Permissive Change Acceptance for Radio operating in the frequency band 136-174 MHz (12.5 kHz and 25 kHz Channel Spacing)
Test Procedures:	Both conducted and radiated emissions measurements were conducted in accordance with American National Standards Institute ANSI C63.4 - 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.
Environmental Classification:	Commercial, Industrial or Business

2.2. RELATED SUBMITTAL(S)/GRANT(S)

None.

2.3. NORMATIVE REFERENCES

Publication	Year	Title
FCC CFR Parts 0-19, 80-End	2005	Code of Federal Regulations – Telecommunications
ANSI C63.4	2003	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
CISPR 22 & EN 55022	2003 2003	Limits and Methods of Measurements of Radio Disturbance Characteristics of Information Technology Equipment
CISPR 16-1	2003	Specification for Radio Disturbance and Immunity measuring apparatus and methods

EXHIBIT 3. PERFORMANCE ASSESSMENT

3.1. CLIENT INFORMATION

APPLICANT	
Name:	Futurecom Systems Group Inc.
Address:	3277 Langstaff Road Concord, Ontario Canada L4K 5P8
Contact Person:	Mr. Adam Kolanski Phone #: 905-660-5548 Fax #: 905-660-1380 Email Address: adamk@futurecom.com

MANUFACTURER	
Name:	Futurecom Systems Group Inc.
Address:	3277 Langstaff Road Concord, Ontario Canada L4K 5P8
Contact Person:	Mr. Adam Kolanski Phone #: 905-660-5548 Fax #: 905-660-1380 Email Address: adamk@futurecom.com

3.2. EQUIPMENT UNDER TEST (EUT) INFORMATION

The following information (with the exception of the Date of Receipt) has been supplied by the applicant.

Brand Name:	Futurecom Systems Group Inc.
Product Name:	Vehicular Repeater
Model Name or Number:	MOBEXCOM DVRS VHF
Type of Equipment:	Non-broadcast Radio Communication Equipment
External Power Supply:	None
Primary User functions of EUT:	To provide extended portable radio coverage
Transmitting/Receiving Antenna Type:	Non-Integral

3.3. EUT'S TECHNICAL SPECIFICATIONS

TRANSMITTER	
Equipment Type:	Mobile
Intended Operating Environment:	Commercial, industrial or business environment
Power Supply Requirement:	13.8 Vdc
RF Input Power Rating:	0 dBm
RF Output Power Rating:	• 20 watts max. • 1 watt min.
Operating Frequency Range:	136-174 MHz
RF Output Impedance:	50 Ohms
Channel Spacing	12.5 kHz and 25 kHz
Occupied Bandwidth (99%):	• 9.8 kHz (12.5 kHz Channel Spacing) • 14.8 kHz (25 kHz Channel Spacing)
Emission Designation:	• 11K0F3E and 11K0F1E (12.5 kHz Channel Spacing) • 16K0F3E and 16K0F1E (25 kHz Channel Spacing)
Antenna Connector Type:	TNC Female
Antenna Description:	Omnidirectional antenna : The Antenna Gain Limit is 2.15 dBi

* For an average case of commercial telephony, the Necessary Bandwidth is calculated as follows:

For FM Voice Modulation:

Channel Spacing = 12.5 KHz, D = 2.5 KHz max., K = 1, M = 3 KHz
B_n = 2M + 2DK = 2(3) + 2(2.5)(1) = **11 KHz**
Emission designation: 11K0F3E

Channel Spacing = 25 KHz, D = 5 KHz max., K = 1, M = 3 KHz
B_n = 2M + 2DK = 2(3) + 2(5)(1) = **16 KHz**
Emission designation: 16K0F3E

3.4. LIST OF EUT'S PORTS

Port Number	EUT's Port Description	Number of Identical Ports	Connector Type	Cable Type (Shielded/Non-shielded)
1	Transmitter	1	TNC Female	Terminated with 50 Ohm load
2	Receiver	1	TNC Female	Terminated with 50 Ohm load
3	DC Input	1	6-pin Circular	Non-shielded
4	USB	1	4-pin Circular	Shielded
5	Mobile Radio	1	20-pin Circular	Shielded
6	AUX	1	9-pin Circular	Shielded

3.5. ANCILLARY EQUIPMENT

None.

3.6. GENERAL TEST SETUP

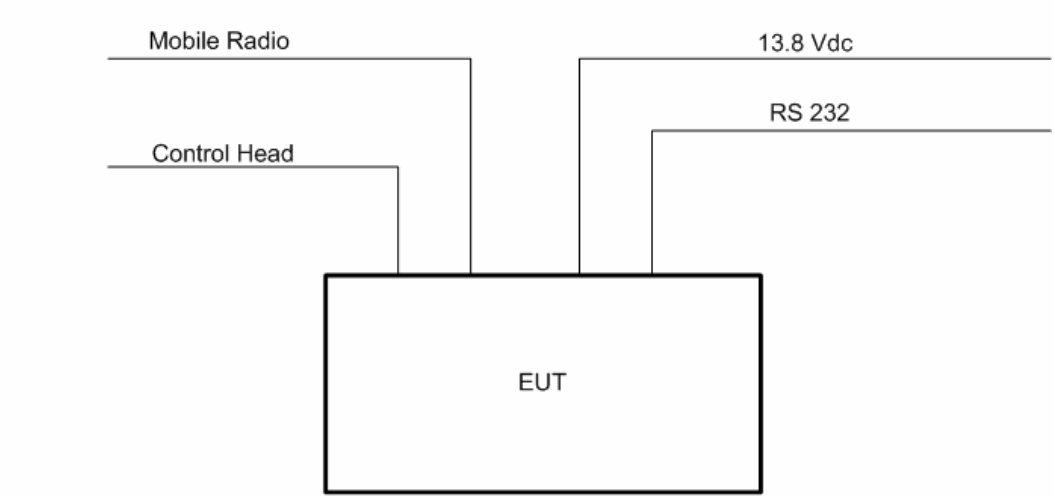

EXHIBIT 4. EUT OPERATING CONDITIONS AND CONFIGURATIONS DURING TESTS

4.1. CLIMATE TEST CONDITIONS

The climate conditions of the test environment are as follows:

Temperature:	21°C
Humidity:	51%
Pressure:	102 kPa
Power input source:	13.8 Vdc

4.2. OPERATIONAL TEST CONDITIONS & ARRANGEMENT FOR TEST SIGNALS

Operating Modes:	The transmitter was operated in a continuous transmission mode with the carrier modulated as specified in the Test Data.
Special Test Software:	Testing software provided by the manufacturer to configure different test configurations.
Special Hardware Used:	N/A
Transmitter Test Antenna:	The EUT is tested with the transmitter antenna port terminated to a 50 Ohms RF Load.

Transmitter Test Signals	
Frequency Band(s):	136-174 MHz
Frequency(ies) Tested: (Near lowest and near highest frequencies in the frequency range of operation.)	136 MHz; 155 MHz & 174 MHz
RF Power Output (measured maximum output power):	20 Watts High & 1 Watt Low
Normal Test Modulation:	Unmodulated, FM Voice (analog & digital)
Modulating signal source:	External

EXHIBIT 5. SUMMARY OF TEST RESULTS

5.1. LOCATION OF TESTS

All of the measurements described in this report were performed at Ultratech Group of Labs located in the city of Oakville, Province of Ontario, Canada.

- Radiated Emissions were performed at the Ultratech's 3-10 TDK Semi-Anechoic Chamber situated in the Town of Oakville, province of Ontario. This test site been calibrated in accordance with ANSI C63.4, and found to be in compliance with the requirements of Sec. 2.948 of the FCC Rules. The descriptions and site measurement data of the Oakville 3-10 TDK Semi-Anechoic Chamber has been filed with FCC office (FCC File No.: 31040/SIT 1300B3) and Industry Canada office (Industry Canada File No.: IC2049-1). Last Date of Site Calibration: June 20, 2006.

5.2. APPLICABILITY & SUMMARY OF EMC EMISSION TEST RESULTS

FCC Section(s)	Test Requirements	Applicability (Yes/No)
2.1053, 2.1057 & 90.210	Transmitter Radiated Emission - Field Strength of Harmonic/Spurious Emissions	Yes

5.3. MODIFICATIONS INCORPORATED IN THE EUT FOR COMPLIANCE PURPOSES

None

EXHIBIT 6. MEASUREMENTS, EXAMINATIONS & TEST DATA FOR EMC EMISSIONS

6.1. TEST PROCEDURES

This section contains test results only. Details of test methods and procedures can be found in Exhibit 8 of this report

6.2. MEASUREMENT UNCERTAINTIES

The measurement uncertainties stated were calculated in accordance with requirements of UKAS Document NIS 81 with a confidence level of 95%. Please refer to Exhibit 7 for Measurement Uncertainties.

6.3. MEASUREMENT EQUIPMENT USED

The measurement equipment used complied with the requirements of the Standards referenced in the Methods & Procedures ANSI C63.4 and CISPR 16-1.

6.4. ESSENTIAL/PRIMARY FUNCTIONS AS DECLARED BY THE MANUFACTURER

The essential function of the EUT is to provide portable radio users greater communication range by repeating signals through the vehicle's mobile radio to the dispatch centre. The Vehicular Repeater connects to an existing mobile radio and a control head. The mobile radio provides demodulated mobile audio signal to the repeater and receives demodulated repeater audio signal from the repeater. Therefore, the repeater thus allows local RF repeat operation. It also locally transmits mobile radio received signal and allows the mobile radio to retransmit signals locally received by the repeater from portable radios.

6.5. TRANSMITTER SPURIOUS/HARMONIC RADIATED EMISSIONS [§§ 90.208 & 90.210]

6.5.1. Limits

Emissions shall be attenuated below the mean output power of the transmitter as follows:

FCC Rules	Frequency Range	Attenuation Limit (dBc)
90.210(b)	10 MHz to Lowest frequency of the radio to 10th harmonic of the highest frequency of the radio	43+10*log(P) or -13 dBm
90.210(d)	10 MHz to Lowest frequency of the radio to 10th harmonic of the highest frequency of the radio	50+10*log(P) or -20 dBm or 70 dBc whichever is less

6.5.2. Method of Measurements

The spurious/harmonic ERP measurements are using substitution method specified in Exhibit 8, Section 8.1 of this report and its value in dBc is calculated as follows:

(1) If the transmitter's antenna is an integral part of the EUT, the ERP is measured using substitution method.
(2) If the transmitter's antenna is non-integral and diverse, the lowest ERP of the carrier with 0 dBi antenna gain is used for calculation of the spurious/harmonic emissions in dBc:
Lowest ERP of the carrier = EIRP – 2.15 dB = Pc + G - 2.15 dB = Pc dBm (conducted) + 0 dBi – 2.15 dB
(3) Spurious /harmonic emissions levels expressed in dBc (dB below carrier) are as follows:

ERP of spurious/harmonic (dBc) = ERP of carrier (dBm) – ERP of spurious/harmonic emission (dBm)

6.5.3. Test Equipment List

Test Instruments	Manufacturer	Model No.	Serial No.	Frequency Range
Spectrum Analyzer	Rohde & Schwarz	FSEK20/B4/B21	834157/005	9 kHz – 40 GHz
RF Amplifier	Com-Power	PA-102		1 MHz to 1 GHz, 30 dB gain nominal
Microwave Amplifier	Hewlett Packard	HP 83017A		1 GHz to 26.5 GHz, 30 dB nominal
Biconilog Antenna	EMCO	3142	10005	30 MHz to 2 GHz
Dipole Antenna	EMCO	3121C	8907-434	30 MHz – 1 GHz
Horn Antenna	EMCO	3155	9701-5061	1 GHz – 18 GHz
Horn Antenna	EMCO	3155	9911-5955	1 GHz – 18 GHz
RF Signal Generator	Hewlett Packard	HP 83752B	3610A00457	0.01 – 20 GHz

6.5.4. Test Data

Remarks:

- There was no difference in spurious/harmonic emissions on pre-scans for all different modulations. Therefore, the rf spurious/harmonic emissions in this section would be performed without modulation and it shall represent for all different modulations required.
- The RF spurious/harmonic emission characteristics for narrow band and wide band operation are indistinguishable. Therefore, the following radiated emissions were performed at 12.5 kHz channel spacing (narrow band) operation, and the results were compared with the more stringent limit of 50+10*log(P in Watts) for the worst-case.
- The radiated emissions were performed with high power setting at 3 meters distance to represents the worst-case test configuration.

6.5.4.1. Lowest Frequency (136 MHz)

Fundamental Frequency: 136 MHz
RF Output Power: 43 dBm
Limit: -(50+10*log(20.32)) = - 63 dBc
Frequency Test Range: 30 MHz – 2 GHz

Frequency (MHz)	E-Field @3m (dBμV/m)	ERP measured by Substitution Method (dBm)	(dBc)	EMI Detector (Peak/QP)	Antenna Polarization (H/V)	Limit (dBc)	Margin (dB)	Pass/ Fail
680	61.21	-40.00	-83.0	Peak	V	-63.00	-20.0	Pass
680	61.30	-39.91	-82.9	Peak	H	-63.00	-19.9	Pass
816	68.28	-35.20	-78.2	Peak	V	-63.00	-15.2	Pass
816	66.22	-37.26	-80.3	Peak	H	-63.00	-17.3	Pass
1360	63.22	-39.74	-82.7	Peak	V	-63.00	-19.7	Pass
1360	60.60	-42.36	-85.4	Peak	H	-63.00	-22.4	Pass

The emissions were scanned from 30 MHz to 2 GHz at 3 meters distance and all emissions within 20 dB below the limits were recorded.

6.5.4.2. Middle Frequency (155 MHz)

Fundamental Frequency: 155 MHz
RF Output Power: 43 dBm
Limit: -(50+10*log(20.14)) = - 63 dBc
Frequency Test Range: 30 MHz – 2 GHz

Frequency (MHz)	E-Field @3m (dBμV/m)	ERP measured by Substitution Method (dBm)	(dBc)	EMI Detector (Peak/QP)	Antenna Polarization (H/V)	Limit (dBc)	Margin (dB)	Pass/ Fail
775	66.33	-37.15	-80.2	Peak	V	-63.0	-17.2	Pass
775	64.10	-39.38	-82.4	Peak	H	-63.0	-19.4	Pass

The emissions were scanned from 30 MHz to 2 GHz at 3 meters distance and all emissions within 20 dB below the limits were recorded.

6.5.4.3. Highest Frequency (174 MHz)

Fundamental Frequency:	174 MHz
RF Output Power:	43 dBm
Limit:	-(50+10*log(20.32)) = - 63 dBc
Frequency Test Range:	30 MHz – 2 GHz

The emissions were scanned from 30 MHz to 2 GHz at 3 meters distance and all emissions found were more than 20 dB below the limits.

EXHIBIT 7. MEASUREMENT UNCERTAINTY

The measurement uncertainties stated were calculated in accordance with the requirements of NIST Technical Note 1297 and NIS 81 (1994)

7.1. RADIATED EMISSION MEASUREMENT UNCERTAINTY

CONTRIBUTION (Radiated Emissions)	PROBABILITY DISTRIBUTION	UNCERTAINTY (± dB)	
		3 m	10 m
Antenna Factor Calibration	Normal (k=2)	±1.0	±1.0
Cable Loss Calibration	Normal (k=2)	±0.3	±0.5
EMI Receiver specification	Rectangular	±1.5	±1.5
Antenna Directivity	Rectangular	+0.5	+0.5
Antenna factor variation with height	Rectangular	±2.0	±0.5
Antenna phase center variation	Rectangular	0.0	±0.2
Antenna factor frequency interpolation	Rectangular	±0.25	±0.25
Measurement distance variation	Rectangular	±0.6	±0.4
Site imperfections	Rectangular	±2.0	±2.0
Mismatch: Receiver VRC Γ_1 = 0.2 Antenna VRC Γ_R = 0.67(Bi) 0.3 (Lp) Uncertainty limits 20Log(1±$\Gamma_1\Gamma_R$)	U-Shaped	+1.1 -1.25	±0.5
System repeatability	Std. Deviation	±0.5	±0.5
Repeatability of EUT		-	-
Combined standard uncertainty	Normal	+2.19 / -2.21	+1.74 / -1.72
Expanded uncertainty U	Normal (k=2)	+4.38 / -4.42	+3.48 / -3.44

Calculation for maximum uncertainty when 3m biconical antenna including a factor of k = 2 is used:

$U = 2u_c(y) = 2x(+2.19) = +4.38$ dB And $U = 2u_c(y) = 2x(-2.21) = -4.42$ dB

EXHIBIT 8. MEASUREMENT METHODS

8.1. RADIATED POWER MEASUREMENTS (ERP & EIRP) USING SUBSTITUTION METHOD

8.1.1. Maximizing RF Emission Level (E-Field)

(a) The measurements was performed with full rf output power and modulation.
(b) Test was performed at listed 3m open area test site (listed with FCC, IC, ITI, NVLAP, ACA & VCCI).
(c) The transmitter under test was placed at the specified height on a non-conducting turntable (80 cm height)
(d) The BICONILOG antenna (20 MHz to 1 GHz) or HORN antenna (1 GHz to 18 GHz) was used for measuring.
(e) Load an appropriate correction factors file in EMI Receiver for correcting the field strength reading level

Total Correction Factor recorded in the EMI Receiver = Cable Loss + Antenna Factor
E (dBuV/m) = Reading (dBuV) + Total Correction Factor (dB/m)

(f) Set the EMI Receiver and #2 as follows:

Center Frequency:	test frequency
Resolution BW:	100 kHz
Video BW:	same
Detector Mode:	positive
Average:	off
Span:	3 x the signal bandwidth

(g) The test antenna was lowered or raised from 1 to 4 meters until the maximum signal level was detected.
(h) The transmitter was rotated through 360^{o} about a vertical axis until a higher maximum signal was received.
(i) The test antenna was lowered or raised again from 1 to 4 meters until a maximum was obtained. This level was recorded.
(j) The recorded reading was corrected to the true field strength level by adding the antenna factor, cable loss and subtracting the pre-amplifier gain.
(k) The above steps were repeated with both transmitters' antenna and test receiving antenna placed in vertical and horizontal polarization. Both readings with the antennas placed in vertical and horizontal polarization shall be recorded.
(l) Repeat for all different test signal frequencies

8.1.2. Measuring the EIRP of Spurious/Harmonic Emissions using Substitution Method

(a) Set the EMI Receiver (for measuring E-Field) and Receiver #2 (for measuring EIRP) as follows:

Center Frequency:	equal to the signal source
Resolution BW:	10 kHz
Video BW:	same
Detector Mode:	positive
Average:	off
Span:	3 x the signal bandwidth

(b) Load an appropriate correction factors file in EMI Receiver for correcting the field strength reading level

Total Correction Factor recorded in the EMI Receiver = Cable Loss + Antenna Factor
E (dBuV/m) = Reading (dBuV) + Total Correction Factor (dB/m)

(c) Select the frequency and E-field levels obtained in the Section 8.2.1 for ERP/EIRP measurements.
(d) Substitute the EUT by a signal generator and one of the following transmitting antenna (substitution antenna):
- ♦ DIPOLE antenna for frequency from 30-1000 MHz or
- ♦ HORN antenna for frequency above 1 GHz }.

(e) Mount the transmitting antenna at 1.5 meter high from the ground plane.
(f) Use one of the following antenna as a receiving antenna:
- ♦ DIPOLE antenna for frequency from 30-1000 MHz or
- ♦ HORN antenna for frequency above 1 GHz }.

(g) If the DIPOLE antenna is used, tune it's elements to the frequency as specified in the calibration manual.
(h) Adjust both transmitting and receiving antenna in a VERTICAL polarization.
(i) Tune the EMI Receivers to the test frequency.
(j) Lower or raise the test antenna from 1 to 4 meters until the maximum signal level was detected.
(k) The transmitter was rotated through 360^{o} about a vertical axis until a higher maximum signal was received.
(l) Lower or raise the test antenna from 1 to 4 meters until the maximum signal level was detected.
(m) Adjust input signal to the substitution antenna until an equal or a known related level to that detected from the transmitter was obtained in the test receiver.
(n) Record the power level read from the Average Power Meter and calculate the ERP/EIRP as follows:

P = P1 - L1 = (P2 + L2) – L1 = P3 + A + L2 - L1
EIRP = P + G1 = P3 + L2 - L1 + A + G1
ERP = EIRP – 2.15 dB
Total Correction factor in EMI Receiver # 2 = L2 – L1 + G1

Where:	P:	Actual RF Power fed into the substitution antenna port after corrected.
	P1:	Power output from the signal generator
	P2:	Power measured at attenuator A input
	P3:	Power reading on the Average Power Meter
	EIRP:	EIRP after correction
	ERP:	ERP after correction

(o) Adjust both transmitting and receiving antenna in a HORIZONTAL polarization, then repeat step (k) to (o)
(p) Repeat step (d) to (o) for different test frequency
(q) Repeat steps (c) to (j) with the substitution antenna oriented in horizontal polarization.
(r) Actual gain of the EUT's antenna is the difference of the measured EIRP and measured RF power at the RF port. Correct the antenna gain if necessary.

Figure 2

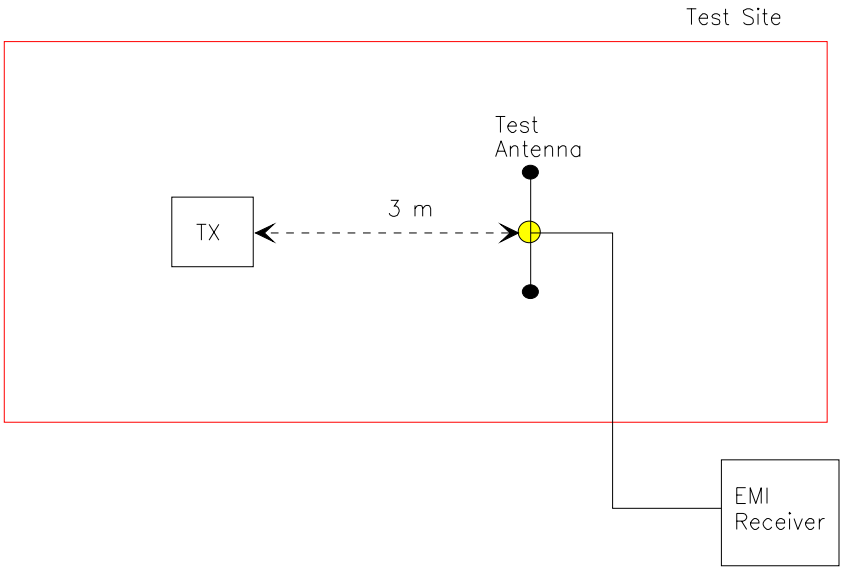

Figure 3