Measurement of RF Interference from a Model Motorola Canopy Transciever ISM Band using (3) Different Antenna Configurations

For : Cascade Networks, Inc.
Longview WA

P.O. No. :
Date Received : June 27, 2003
Date Tested : June 30 through July 5, 2003
Test Personnel : Richard E. King
Specification : FCC "Code of Federal Regulations" Title 47 Part 15.247, Subpart C

Test Report By : Richard E. King

Witnessed by :
Brian Magnuson
Cascade Networks, Inc.

Approved By : Raymond J. Klouda
Registered Professional Engineer of Illinois - 44894

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Measurement of RF Emissions from a Motorola Canopy Transciever

1.0 INTRODUCTION:

1.1 Description of Test Item - This document presents the results of tests performed to determine if the Motorola Canopy Transceiver (ISM Band) would meet the FCC requirements when using a Radiowaves Model SEC-5V-120-14 Antenna (120), a Andrew Model P2F-52-N7A Antenna (Dish), or a Radiall /Larson Model R380.700.205 omni-directional antenna (Omni). The test item was designed to transmit in the 5725MHz to 5850MHz band. The tests were performed for Cascade Networks Inc, of Longview, Washington.

1.2 Purpose - The test series was performed to determine if the test item meets the requirements of the radiated RF emission requirements of the FCC "Code of Federal Regulations" Title 47, Part 15, Subpart C, Sections for Intentional Radiators. Testing was performed in accordance with ANSI C63.4-2001.

1.3 Deviations, Additions and Exclusions - There were no deviations, additions to, or exclusions from the test specification during this test series.

1.4 Applicable Documents - The following documents of the exact issue designated form part of this document to the extent specified herein:

- Federal Communications Commission "Code of Federal Regulations", Title 47, Part 15, Subpart C, dated 1 October 2002
- ANSI C63.4-2001, "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"

1.5 Subcontractor Identification - This series of tests was performed by Elite Electronic Engineering Incorporated of Downers Grove, Illinois. The laboratory is accredited by the National Institute of Standards and Technology (NIST) under the National Voluntary Laboratory Accreditation Program (NVLAP). NVLAP Lab Code: 100278-0.

1.6 Laboratory Conditions The temperature at the time of the test was 23°C and the relative humidity was 50%.

2.0 TEST ITEM SETUP AND OPERATION:

The test item is a Motorola Canopy Transciever and external antennas. A block diagram of the test item setup is shown as Figure 1.

2.1 Power Input - The test item was powered with 24VDC from a Motorola model AEC-T4824 Class 2 transformer.

2.2 Grounding - Since the test item was powered with two wires, it was ungrounded during the tests.

2.3 Peripheral Equipment - The test item was submitted with a Panasonic ToughBook laptop.

2.4 Interconnect Cables - The test item was connected to the laptop via a 45 foot long CAT 5 ethernet cable.

2.5 Operational Mode - For all tests the test item and all peripheral equipment were placed on a 80cm high non-conductive stand. The test item and all peripheral equipment were energized.

For all tests, the test item was set to transmit continuously. The tests were performed with the test item transmitting at 5735MHz, 5790MHz and 5840MHz.

3.0 TEST EQUIPMENT:

3.1 Test Equipment List - A list of the test equipment used can be found on Table I. All equipment was calibrated per the instruction manuals supplied by the manufacturer.

3.2 Calibration Traceability Test equipment is maintained and calibrated on a regular basis. All calibrations are traceable to the National Institute of Standards and Technology (NIST).

4.0 REQUIREMENTS, PROCEDURES AND RESULTS:

4.1 Powerline Conducted Emissions

4.1.1 Requirements – Since conducted emissions will be provided by Cascade Networks, no conducted emission measurements were taken.

4.2 Antenna Conducted Emissions Measurements:

4.2.1 Requirements – Per section 15.247(c), in any 100kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by at least 20 dB below that in the 100kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated emissions measurement. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall on the restricted bands, as defined in §15.205(a), must comply with the radiated emission limits specified in §15.209(a) (see§ 15.205(c)).

4.2.2 Procedures – The transmitter was connected to a spectrum analyzer through two 20dB attenuators. The resolution bandwidth was set to 100kHz with a video bandwidth of 1MHz. The maximum meter reading was recorded for the harmonics starting with the 2nd harmonic up to the 6th harmonic. The peak emissions in a 100kHz bandwidth was measured for the low, middle and high channels.

4.2.3 Results: The antenna conducted emissions for the low, middle and high channel are shown on data page 12. As can be seen by the data the test item did meet the emissions limits of 15.247(c).

4.3 Radiated Measurements

4.3.1 Requirements - Per section 15.247(c), in any 100kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by at least 20 dB below that in the 100kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated emissions measurement. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall on the restricted bands, as defined in §15.205(a), must comply with the radiated emission limits specified in §15.209(a) (see§ 15.205(c)).

Paragraph 15.209(a) has the following radiated emission limits:

Frequency MHz	Field Strength (microvolts/meter)	Measurement distance (meters)
0.009-0.490	2400/F(kHz)	300
0.490-1.705	24000/F(kHz)	30
1.705-30.0	30	3
30.0-88.0	100**	3
88.0-216.0	150**	3
216.0-960.0	200**	3
Above 960	500	3

4.3.2 Procedures - Radiated measurements were manually performed in a 32ft. x 20ft. x 14ft. high shielded enclosure. The shielded enclosure prevents emissions from other sources, such as radio and TV stations from interfering with the measurements. All powerlines and signal lines entering the enclosure pass through filters on the enclosure wall. The powerline filters prevent extraneous signals from entering the enclosure on these leads.

The radiated emission tests were performed for the 2nd and 4th harmonics which fall in restricted

bands.

To ensure that maximum emission levels were measured, the following steps were taken:

1) Measurements were made using an average detector and a standard gain horn antenna.
2) To ensure that maximum or worst case, emission levels were measured, the following steps were taken:
   (a) The test item was rotated so that all of its sides were exposed to the receiving antenna.
   (b) Since the measuring antenna is linearly polarized, both horizontal and vertical field components were measured.
   (c) The measuring antenna was raised and lowered for each antenna polarization to maximize the readings.

Photographs of the test item setup with each antenna are presented as Figures 2, 3 and 4.

4.3.3 Results - The radiated emission levels are presented on data pages 13 through 15. As can be seen by the data the test item did meet the emissions limits of 15.247(c).

5.0 CONCLUSIONS:

It was determined that the Cascade Networks, Inc. Motorola Canopy Transciever, did fully meet the emission requirements of the FCC "Code of Federal Regulations" Title 47, Part 15.247, Subpart C, Section 15.205 et seq. for Intentional Radiators, when tested per ANSI C63.4-2001.

6.0 CERTIFICATION:

Elite Electronic Engineering Incorporated certifies that the information contained in this report was obtained under conditions which meet or exceed those specified in the test specifications.

The data presented in this test report pertains to the test item at the test date as operated by Cascade Networks, Inc. personnel. Any electrical or mechanical modification made to the test item subsequent to the specified test date will serve to invalidate the data and void this certification.

7.0 ENDORSEMENT DISCLAIMER:

This report must not be used to claim product endorsement by NVLAP or any agency of the US Government.

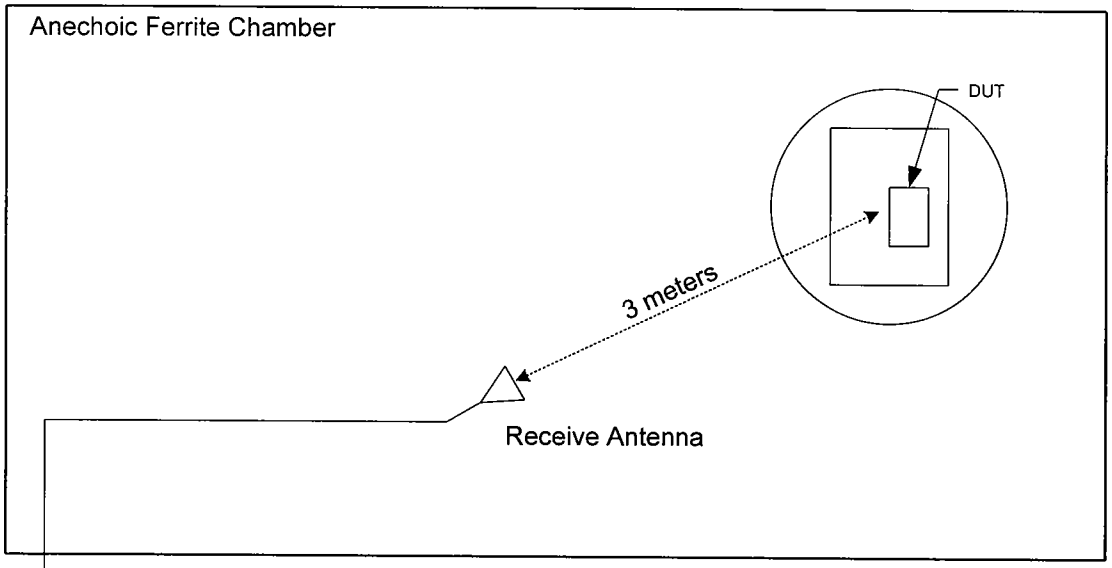
TABLE I: TEST EQUIPMENT LIST

ELITE ELECTRONIC ENG. INC. Page: 1

Eq ID	Equipment Description	Manufacturer	Model No.	Serial No.	Frequency Range	Cal Date	Cal Inv	Due Date
Equipment Type: ACCESSORIES, MISCELLANEOUS								
XOA1	WAVE-TO-COAX ADAPTER	HEWLETT PACKARD	R281A	02119	26.5-65GHZ		NOTE 1	
XOB1	ADAPTER	HEWLETT PACKARD	K281C	10422	18-26.5GHZ		NOTE 1	
XZG3	ATTENUATOR/SWITCH DRIVER	HEWLETT PACKARD	11713A	2421A03059	---		N/A	
Equipment Type: AMPLIFIERS								
APH0	POWER AMPLIFIER	HEWLETT PACKARD	11975A	2304A00322	2-8GHZ		NOTE 1	
APK3	PREAMPLIFIER	AGILENT TECHNOL	8449B	3008A01593	1-26.5GHZ	05/09/03	12	05/09/04
Equipment Type: ANTENNAS								
NHA0	STANDARD GAIN HORN ANTENNA	NARDA	640	---	8.2-12.4GHZ		NOTE 1	
NHE1	STANDARD GAIN HORN ANT. -	NARDA	639	---	12.4-18GHZ		NOTE 1	
NHG0	STANDARD GAIN HORN ANTENNA	NARDA	638	---	18-26.5GHZ		NOTE 1	
NHG1	STANDARD GAIN HORN ANTENNA	NARDA	638	---	18-26.5GHZ		NOTE 1	
NHH0	STANDARD GAIN HORN ANTENNA	NARDA	V637	---	26.5-40GHZ		NOTE 1	
NHH1	STANDARD GAIN HORN ANTENNA	NARDA	V637	---	26.5-40GHZ		NOTE 1	
Equipment Type: ATTENUATORS								
TVC0	VARIABLE ATTENUATOR	HEWLETT PACKARD	R382A	1281	26.5-40GHZ	07/29/02	12	07/29/03
TVD0	VARAIBLE ATTENUATOR	HEWLETT PACKARD	K382A	1066	18-26.5GHZ	07/29/02	12	07/29/03
Equipment Type: CONTROLLERS								
CDR2	COMPUTER, LAP-TOP AUTOMOTI	IBM	600M		300MHZ		N/A	
CMA0	MULTI-DEVICE CONTROLLER	EMCO	2090	9701-1213	---		N/A	
Equipment Type: RECEIVERS								
RAC2	SPECTRUM ANALYZER	HEWLETT PACKARD	85660B	3638A08770	100HZ-22GHZ	02/10/03	12	02/10/04
RACD	RF PRESELECTOR	HEWLETT PACKARD	85685A	3010A01205	20HZ-2GHZ	02/10/03	12	02/10/04
RAE1	SPECTRUM ANALYZER (DCC-CEM	HEWLETT PACKARD	85660A	2209A01336	100HZ-22GHZ	02/06/03	12	02/06/04
RAF4	QUASIPEAK ADAPTER	HEWLETT PACKARD	85650A	2043A00320	0.01-1000MHZ	02/10/03	12	02/10/04
RAH0	FREQUENCY MIXER	HEWLETT PACKARD	11970K	2332A00270	18-26GHZ		N/A	
RAI0	FREQUENCY MIXER	HEWLETT PACKARD	11970A	2332A00292	26-40GHZ	06/02/03	N/A	
Equipment Type: SIGNAL GENERATORS								
GSB0	SWEEP OSCILLATOR	HEWLETT PACKARD	8350B	2309A02104	0.01-40GHZ	06/10/03	12	06/10/04

Eq ID	Equipment Description	Manufacturer	Model No.	Serial No.	Frequency Range	Cal Date	Cal Inv	Due Date
GSBB	TUNING HEAD	HEWLETT PACKARD	83570A	2412A00512	18-26.5GHZ	06/09/03	12	06/09/04
GSBC	TUNING HEAD	HEWLETT PACKARD	83572B	2429A00203	26.5-40GHZ	06/09/03	12	06/09/04

Cal. Interval: Listed in Months I/O: Initial Only N/A: Not Applicable
Note 1: For the purpose of this test, the equipment was calibrated over the specified frequency range, pulse rate, or modulation prior to the test or monitored by a calibrated instrument.



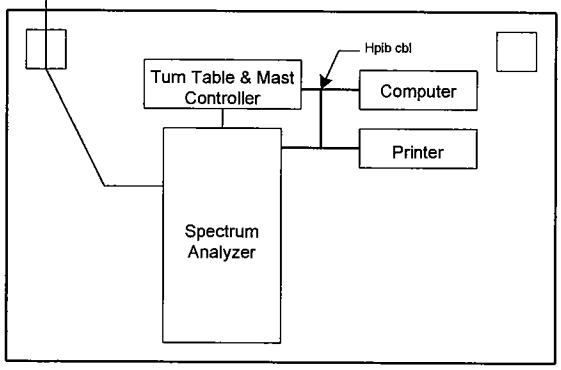
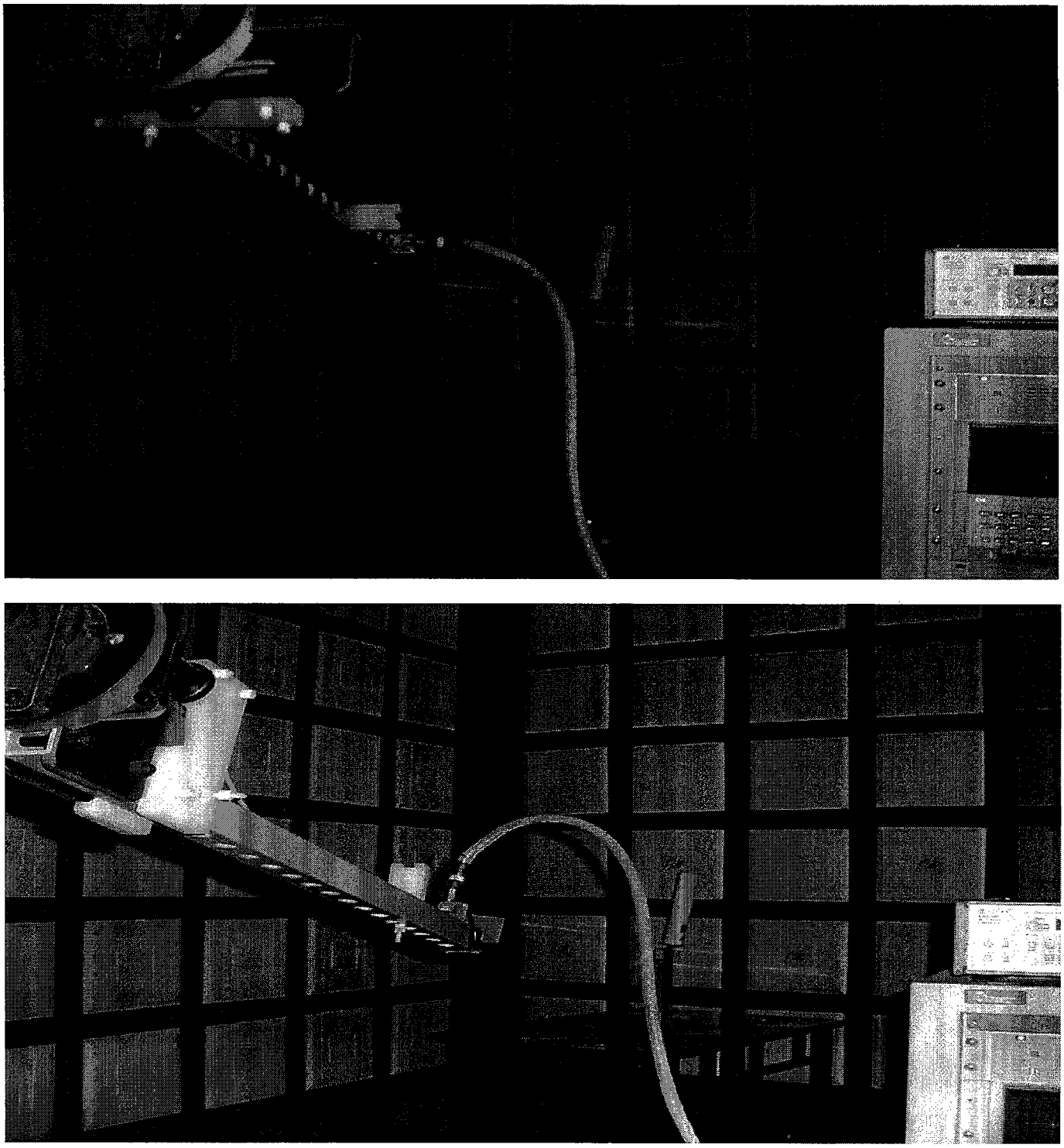


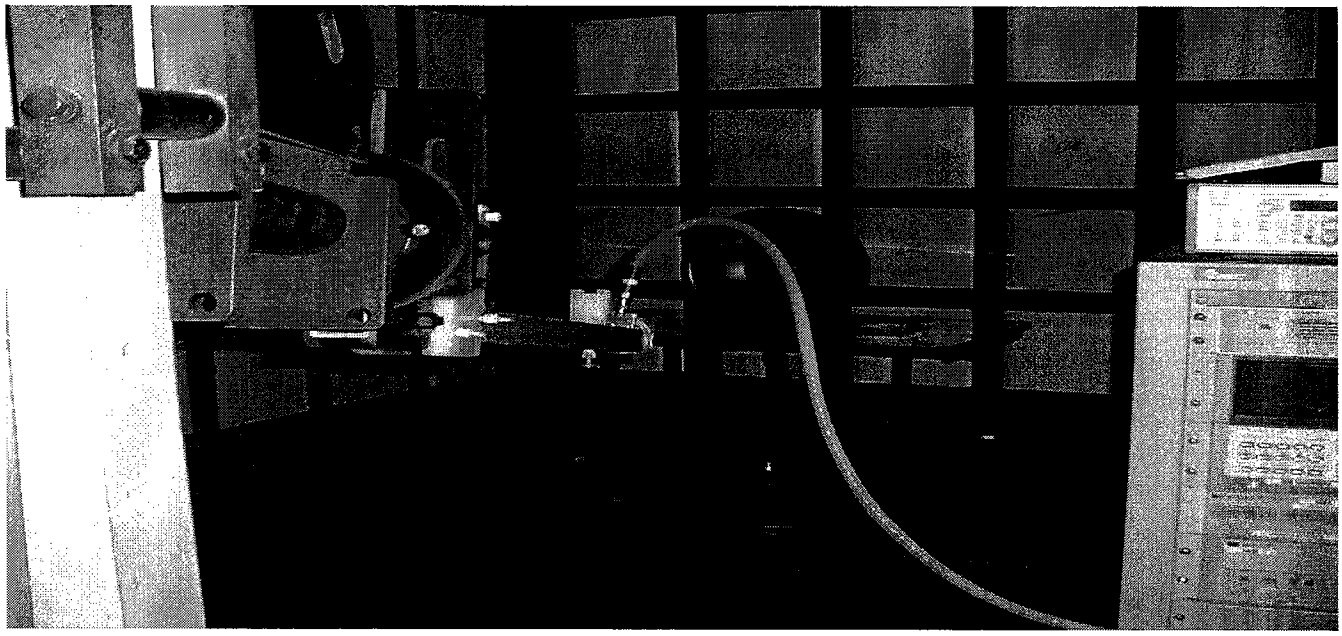
FIGURE 1 BLOCKDIAGRAM OF TEST SETUP

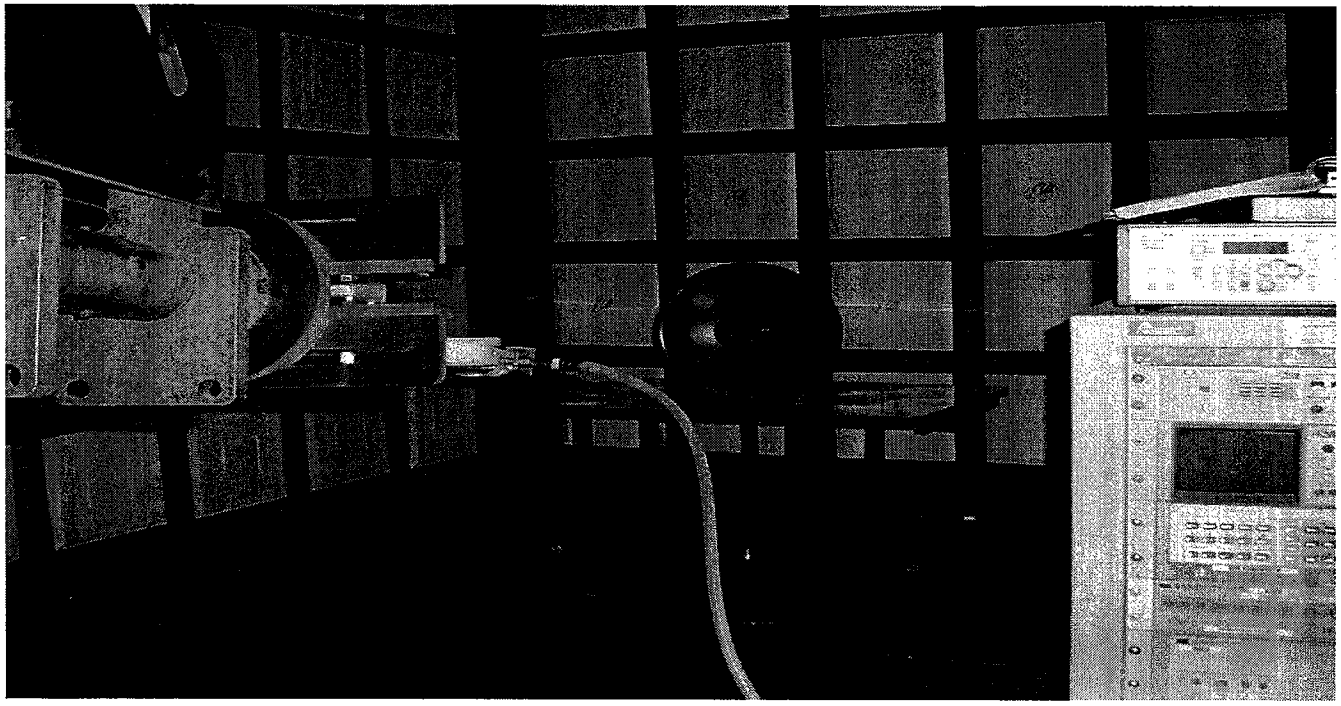
Figure 2



TEST SETUP FOR MEASUREMENT OF RADIATED EMISSIONS 120 ANTENNA

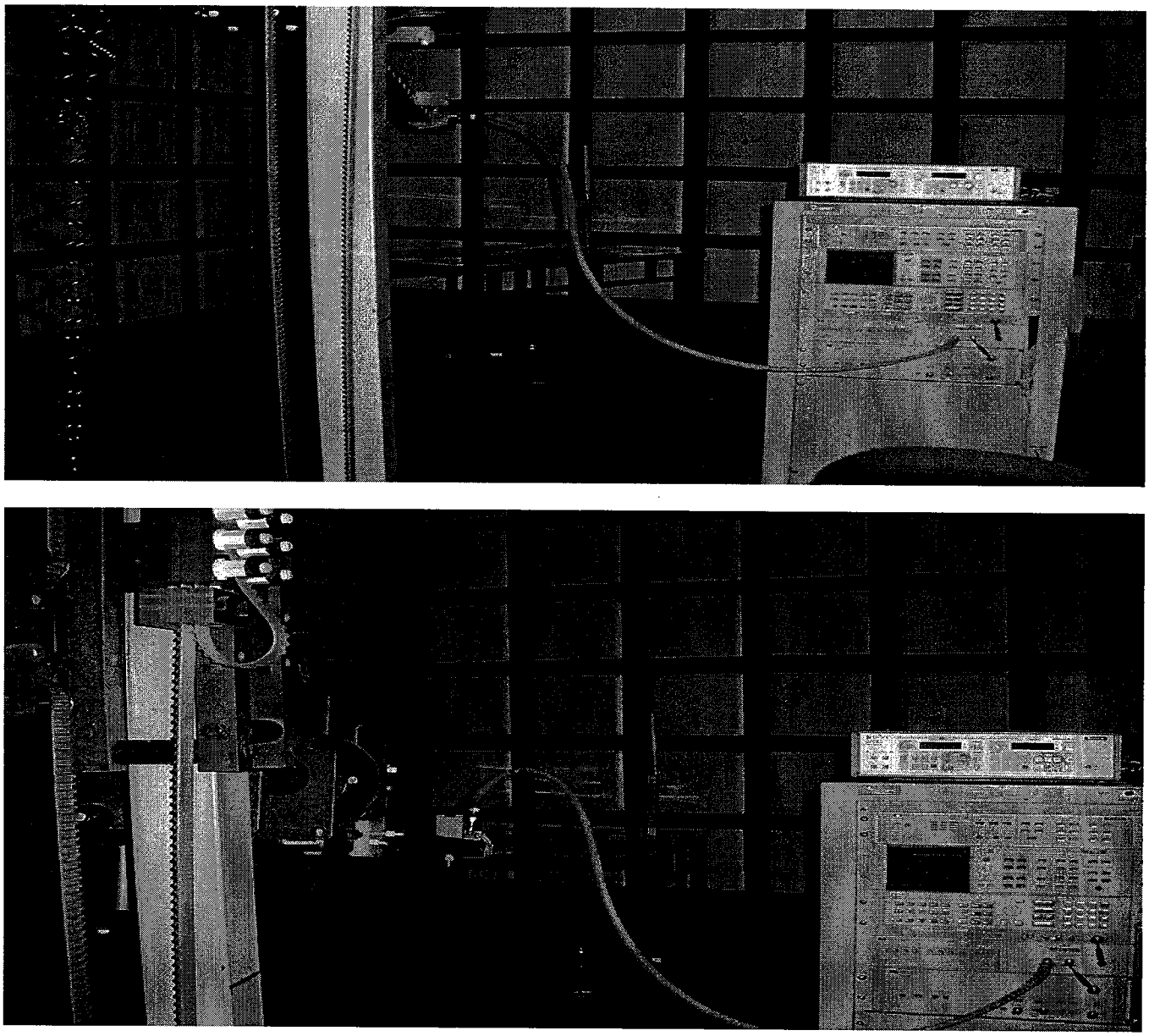
Figure 3





TEST SETUP FOR MEASUREMENT OF RADIATED EMISSIONS DISH ANTENNA

Figure 4



TEST SETUP FOR MEASUREMENT OF RADIATED EMISSIONS OMNI ANTENNA

MANUFACTURER : Cascade Networks
MODEL : Motorola Canopy Transceiver
S/N : None given
SPECIFICATION : FCC-15C Antenna Conducted Emissions
DATE : July 2, 2003
NOTES :

LOW Channel

FREQ MHz	MTR RDG dBm	Amb.	RBW/VBW	Attenuation	TOTAL dBm	LIMIT dBm
5735.0	-23.7		100kHz/1M	40	16.3	
11470.0	-81.3		100kHz/1M	40	-41.3	-3.6
17205.0	-78.2		100kHz/1M	40	-38.2	-3.6
22940.0	-88.6	*	100kHz/1M	40	-48.6	-3.6
28675.0	-89.9	*	100kHz/1M	40	-49.9	-3.6
34410.0	-85.9	*	100kHz/1M	40	-45.9	-3.6

MIDDLE Channel

FREQ MHz	MTR RDG dBm	Amb.	RBW/VBW	Attenuation	TOTAL dBm	LIMIT dBm
5790.0	-22.4		100kHz/1M	40	17.6	
11580.0	-81.6		100kHz/1M	40	-41.6	-2.4
17370.0	-78.1		100kHz/1M	40	-38.1	-2.4
23160.0	-90.1	*	100kHz/1M	40	-50.1	-2.4
28950.0	-86.0	*	100kHz/1M	40	-46.0	-2.4
34740.0	-86.5	*	100kHz/1M	40	-46.5	-2.4

HIGH Channel

FREQ MHz	MTR RDG dBm	Amb.	RBW/VBW	Attenuation	TOTAL dBm	LIMIT dBm
5840.0	-22.9		100kHz/1M	40	17.1	
11680.0	-81.5		100kHz/1M	40	-41.5	-2.9
17520.0	-77.5		100kHz/1M	40	-37.5	-2.9
23360.0	-90.3	*	100kHz/1M	40	-50.3	-2.9
29200.0	-85.4	*	100kHz/1M	40	-45.4	-2.9
35040.0	-86.7	*	100kHz/1M	40	-46.7	-2.9

CHECKED BY: Richard E. King
Richard E. King

MANUFACTURER : Cascade Networks
MODEL : Motorola Canopy Transceiver
ANTENNA : 120
S/N : None given
SPECIFICATION : FCC-15C Radiated Emissions
DATE : July 2, 2003
NOTES : * Indicates that the measurement was taken at 1 meter.
: Otherwise the measurement distance was 3 meters.

LOW Channel

FREQ MHz	ANT POL	MTR RDG dBuV	Amb.	RBW/VBW	Dist. Corr. Fac	ANT FAC	CABLE LOSS	PRE AMP	TOTAL dBuV/m	15.209 LIMIT dBuV/m
11470.0	H	29.2	Amb.	1M/10		34.2	2.5	-34.2	31.7	54.0
	V	28.6	Amb.	1M/10		34.2	2.5	-34.2	31.1	54.0
22940.0	H	20.3	Amb.*	1M/10	-10.5	40.6	0.0	0.0	50.4	54.0
	V	20.3	Amb.*	1M/10	-10.5	40.6	0.0	0.0	50.4	54.0

MIDDLE Channel

FREQ MHz	ANT POL	MTR RDG dBuV	Amb.	RBW/VBW	Dist. Corr. Fac	ANT FAC	CABLE LOSS	PRE AMP	TOTAL dBuV/m	15.209 LIMIT dBuV/m
11580.0	H	28.4	Amb.	1M/10		34.2	2.5	-34.2	30.9	54.0
	V	28.7	Amb.	1M/10		34.2	2.5	-34.2	31.2	54.0
23160.0	H	20.2	Amb.*	1M/10	-10.5	40.6	0.0	0.0	50.3	54.0
	V	20.2	Amb.*	1M/10	-10.5	40.6	0.0	0.0	50.3	54.0

HIGH Channel

FREQ MHz	ANT POL	MTR RDG dBuV	Amb.	RBW/VBW	Dist. Corr. Fac	ANT FAC	CABLE LOSS	PRE AMP	TOTAL dBuV/m	15.209 LIMIT dBuV/m
11680.0	H	28.3	Amb.	1M/10		34.2	2.5	-34.2	30.8	54.0
	V	29.1	Amb.	1M/10		34.2	2.5	-34.2	31.6	54.0
23360.0	H	20.1	Amb.*	1M/10	-10.5	40.6	0.0	0.0	50.2	54.0
	V	20.0	Amb.*	1M/10	-10.5	40.6	0.0	0.0	50.1	54.0

CHECKED BY: Richard E. King
Richard E. King

MANUFACTURER : Cascade Networks
MODEL : Motorola Canopy Transceiver
ANTENNA : Dish
S/N : None given
SPECIFICATION : FCC-15C Radiated Emissions
DATE : July 2, 2003
NOTES : * Indicates that the measurement was taken at 1 meter.
: Otherwise the measurement distance was 3 meters.

LOW Channel

FREQ MHz	ANT POL	MTR RDG dBuV	Amb.	RBW/VBW	Dist. Corr. Fac	ANT FAC	CABLE LOSS	PRE AMP	TOTAL dBuV/m	15.209 LIMIT dBuV/m
11470.0	H	32.9		1M/3M		34.2	2.5	-34.2	35.4	54.0
	V	30.3		1M/3M		34.2	2.5	-34.2	32.7	54.0
22940.0	H	20.1	Amb.*	1M/10	-10.5	40.6	0.0	0.0	50.2	54.0
	V	20.3	Amb.*	1M/10	-10.5	40.6	0.0	0.0	50.4	54.0

MIDDLE Channel

FREQ MHz	ANT POL	MTR RDG dBuV	Amb.	RBW/VBW	Dist. Corr. Fac	ANT FAC	CABLE LOSS	PRE AMP	TOTAL dBuV/m	15.209 LIMIT dBuV/m
11580.0	H	32.7		1M/10		34.2	2.5	-34.2	35.2	54.0
	V	31.3		1M/10		34.2	2.5	-34.2	33.8	54.0
23160.0	H	20.2	Amb.*	1M/10	-10.5	40.6	0.0	0.0	50.3	54.0
	V	20.0	Amb.*	1M/10	-10.5	40.6	0.0	0.0	50.1	54.0

HIGH Channel

FREQ MHz	ANT POL	MTR RDG dBuV	Amb.	RBW/VBW	Dist. Corr. Fac	ANT FAC	CABLE LOSS	PRE AMP	TOTAL dBuV/m	15.209 LIMIT dBuV/m
11680.0	H	31.4		1M/10		34.2	1.4	-34.2	32.8	54.0
	V	30.4		1M/10		34.2	1.4	-34.2	31.8	54.0
23360.0	H	20.1	Amb.*	1M/10	-10.5	40.6	0.0	0.0	50.2	54.0
	V	19.8	Amb.*	1M/10	-10.5	40.6	0.0	0.0	49.9	54.0

CHECKED BY: Richard E. King
Richard E. King

MANUFACTURER : Cascade Networks
MODEL : Motorola Canopy Transceiver
ANTENNA : OMNI
S/N : None given
SPECIFICATION : FCC-15C Radiated Emissions
DATE : July 2, 2003
NOTES : * Indicates that the measurement was taken at 1 meter.
: Otherwise the measurement distance was 3 meters.

LOW Channel

FREQ MHz	ANT POL	MTR RDG dBuV	Amb.	RBW/VBW	Dist. Corr. Fac	ANT FAC	CABLE LOSS	PRE AMP	TOTAL dBuV/m	15.209 LIMIT dBuV/m
11470.0	H	28.2	Amb.	1M/10		34.2	2.5	-34.2	30.7	54.0
	V	28.1	Amb.	1M/10		34.2	2.5	-34.2	30.6	54.0
22940.0	H	20.3	Amb.*	1M/10	-10.5	40.6	0.0	0.0	50.4	54.0
	V	20.2	Amb.*	1M/10	-10.5	40.6	0.0	0.0	50.3	54.0

MIDDLE Channel

FREQ MHz	ANT POL	MTR RDG dBuV	Amb.	RBW/VBW	Dist. Corr. Fac	ANT FAC	CABLE LOSS	PRE AMP	TOTAL dBuV/m	15.209 LIMIT dBuV/m
11580.0	H	31.5	Amb.	1M/10		34.2	2.5	-34.2	34.0	54.0
	V	28.5	Amb.	1M/10		34.2	2.5	-34.2	31.0	54.0
23160.0	H	18.8	Amb.*	1M/10	-10.5	40.6	0.0	0.0	48.9	54.0
	V	20.1	Amb.*	1M/10	-10.5	40.6	0.0	0.0	50.2	54.0

HIGH Channel

FREQ MHz	ANT POL	MTR RDG dBuV	Amb.	RBW/VBW	Dist. Corr. Fac	ANT FAC	CABLE LOSS	PRE AMP	TOTAL dBuV/m	15.209 LIMIT dBuV/m
11680.0	H	28.9	Amb.	1M/10		34.2	2.5	-34.2	31.4	54.0
	V	33.4	Amb.	1M/10		34.2	2.5	-34.2	35.9	54.0
23360.0	H	19.8	Amb.*	1M/10	-10.5	40.6	0.0	0.0	49.9	54.0
	V	18.8	Amb.*	1M/10	-10.5	40.6	0.0	0.0	48.9	54.0

CHECKED BY: Richard E. King
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