Performance Certification to EMC Directive

Normative Standard: **EN61000-6-2, EN 61000-6-3: 2007**

Test Unit Description and Serial Number:

TFT EP0306: JOYSTICK OPERATOR STATION WITH VALVE POSITION CONTROL

S/N: EMI PROTOTYPE

Test Report # 3162
Dates of Test: 09-19-2011 through 09-22-2011
Test Laboratory:

Midwest EMI Associates, Inc.
Electromagnetic Interference Laboratory
21234 W. Commercial Drive
Mundelein, Illinois 60060

EN 61000-6-3 EMISSIONS

TEST METHOD	LIMITS
IEC 61000-6-3 Am 1:2007 (Cispr 11) Radiated Emissions	B
IEC 61000-6-3 Am 1:2007 (Cispr 11) Conducted Emissions (DC Power Supply)	B

EN 61000-6-2 IMMUNITY

TEST METHOD		LEVEL
EN 61000-4-2 Cons Ed 1.2:2009 Electrostatic Discharge Test	2, 4, 6 and 8 kV Air Discharge 2, 4 and 6 kV Contact Discharge	A
EN 61000-4-3 Ed. 3.0: 2009 Radiated Immunity Test	10 V/M (10 V/M minimum) 1000 Hz, 80% AM modulation, 900 MHz, 100% AM, 200 Hz, Square Wave, 30-1000, 1.4-2.0 GHz, 2.0-2.7 GHz (reduced level)	A
EN 61000-4-4 Ed. 2.0: 2004-07 Electrical Fast Transients	.5, 1 and 2 kV Line to Line, Line to Ground	A
EN 61000-4-5 Ed. 2.0: 2006 Electrical Surge Test	.5 and 1 kV Line to Line	A
EN 61000-4-6 Ed. 2.2: 2009 Conducted Immunity	10 V RMS Common Mode	A
EN 61000-4-8: 2001-03 Magnetic Immunity	30 A/M Min (800 A/M Applied) Three Axes	A

Performance Level:

- A- During testing, normal performance occurs within the specification limits.
- B- During testing, temporary degradation, or loss of function or performance occurs that is self recovering without operator intervention.
- C- During testing, temporary degradation, or loss of function or performance occurs that requires operator intervention or system reset.
- D- Degradation or loss of function that is not recoverable occurs due to damage to equipment, components, software, or to loss or corruption of data.

Report by: George Bowman
Midwest EMI Associates
Narte Certified Engineer, EMC-000738NE

MEMBER CHICAGO & NORTHERN ILLINOIS

Nemko Accredited ELA

ACIL

Midwest EMI Associates, Inc.
Electromagnetic Interference Laboratory
21234 W. Commercial Drive
Mundelein, Il 60060

Midwest EMI Associates Test Service
Report No. 3162

CE

Test Specifications

Cispr 11 B Conducted and Cispr 11 B Radiated Emissions
EN 61000-4-2 Electrostatic Discharge Test
EN 61000-4-3 Radiated Susceptibility Test
EN 61000-4-4 Transient Susceptibility Test
EN 61000-4-5 Surge Susceptibility Test
EN 61000-4-6 Conducted Immunity Test
EN 61000-4-8 Magnetic Immunity Test

Test Device: **TFT EP0306: JOYSTICK OPERATOR STATION WITH VALVE POSITION CONTROL**

Serial Number: **EMI PROTOTYPE**

Conducted For:
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Technical Data Taken by and
Report Written by:

George A. Bowman

George Bowman
Midwest EMI Associates

NARTE Certified Engineer, EMC-000738NE

Approved By:

Mr. Steve J. Ferry
Design Engineer
Task Force Tips, Inc.

1.0 PURPOSE:

The purpose of this test sequence is to qualify the compliance of the TFT EP0306: JOYSTICK OPERATOR STATION WITH VALVE POSITION CONTROL to the IEC 61000-6-2 and 61000-6-3 commercial standards. This report covers testing to the testing to Cispr 11B Conducted and Cispr 11B Radiated Emissions, EN 61000-4-2 Electrostatic Discharge test, EN 61000-4-3 radiated susceptibility test, EN 61000-4-4 fast transient test, EN 61000-4-5 surge test, EN 61000-4-6 conducted susceptibility test and EN 61000-4-8 magnetic immunity test. This unit is purely battery operated from a 12 volt battery.

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2.0 TEST FACILITY:

All susceptibility testing was performed on the indoor three-meter site located at Midwest EMI Associates, 21234 W. Commercial Drive, Mundelein, Illinois 60060. Some testing utilized the screened room facility. The personnel access door measures 36" by 82" as shown in the attached room diagram, Figure A. Each power lead is filtered by a low-pass line filter. This interference filter provides substantially more insertion loss than that required for testing. The shielded room has within it a steel table with a copper ground plane (36"W X 72"L X 1/16"D thick) that is attached to the wall of the cage and is 3 feet off the floor of the cage, and has a DC resistance of less than 2.5 milliohms, complying with Military Standards 461. It also has a movable wooden table of 80 cm. height for CISPR testing. Power, which is available, consists of 120/230 VAC, 50/60 Hz.

Referring to Figure A, the major parts of the room which are used during testing are the interference filter which provides protection against external conducted signals, the screened viewing window which allows visual access to the device under test, AC line capacitors which properly terminate the line and neutral leads, and various antennas used for radiated emissions testing. The positions at which the device may be placed are identified in Figure A.

3.0 DESCRIPTION OF TEST SAMPLE:

The Joystick Operator Station with Valve Position Control system consists of a redesigned Y4E-JS joystick operator station and modified Y7010 Valve Interface Box. Task Force Tips project EP0306 replaces the Y5113-B circuit board that is a part of the current Joystick Operator Station (Y4E-JS) with the Y5114 circuit board. The Y5920 circuit board which is a part of the Y7010 Valve Interface Box subassembly was previously certified under Task Force Tips project EP0426 as indicated in CERT0012. In this test the Y5920 has been modified to include the addition of a 3-pin connector to interface with an analog voltage position feedback from a valve actuator manufactured by KZCo, Inc.

The redesign of the Y4E-JS Joystick Operator Station modifies the finished good to read an analog voltage from a slide potentiometer to control the valve position and provides LEDs on a membrane switch for current valve position information. The membrane switch also contains two dome switches to control Oscillate and Park/Stow of a Task Force Tips monitor and two additional dome switches capable of custom functionality for future expansion. The updated Joystick Operator Station also powers and receives input from an analog joystick and converts the analog value received from the joystick to a directional command that is transmitted via the RS-485 communication wires to a Task Force Tips monitor.

The updated Valve Interface Box attaches to a KZCo valve actuator via a 6-pin connector that includes two control wires and 3 wires that connect to a potentiometer internal to the actuator for valve position feedback. The Y5920 receives the commanded valve position from the Joystick Operator Station and positions the valve based on the scaling of a RS-485 command containing a valve position value and reading the voltage from the potentiometer on the KZCo actuator.

The KZCo valve and actuator are not a part of this certification because Task Force Tips has no control over the manufacturing of a standard off-the-shelf product manufactured by a third-party.

EMI SCREENED ROOM RADIATED SUSCEPTIBILITY CONFIGURATION

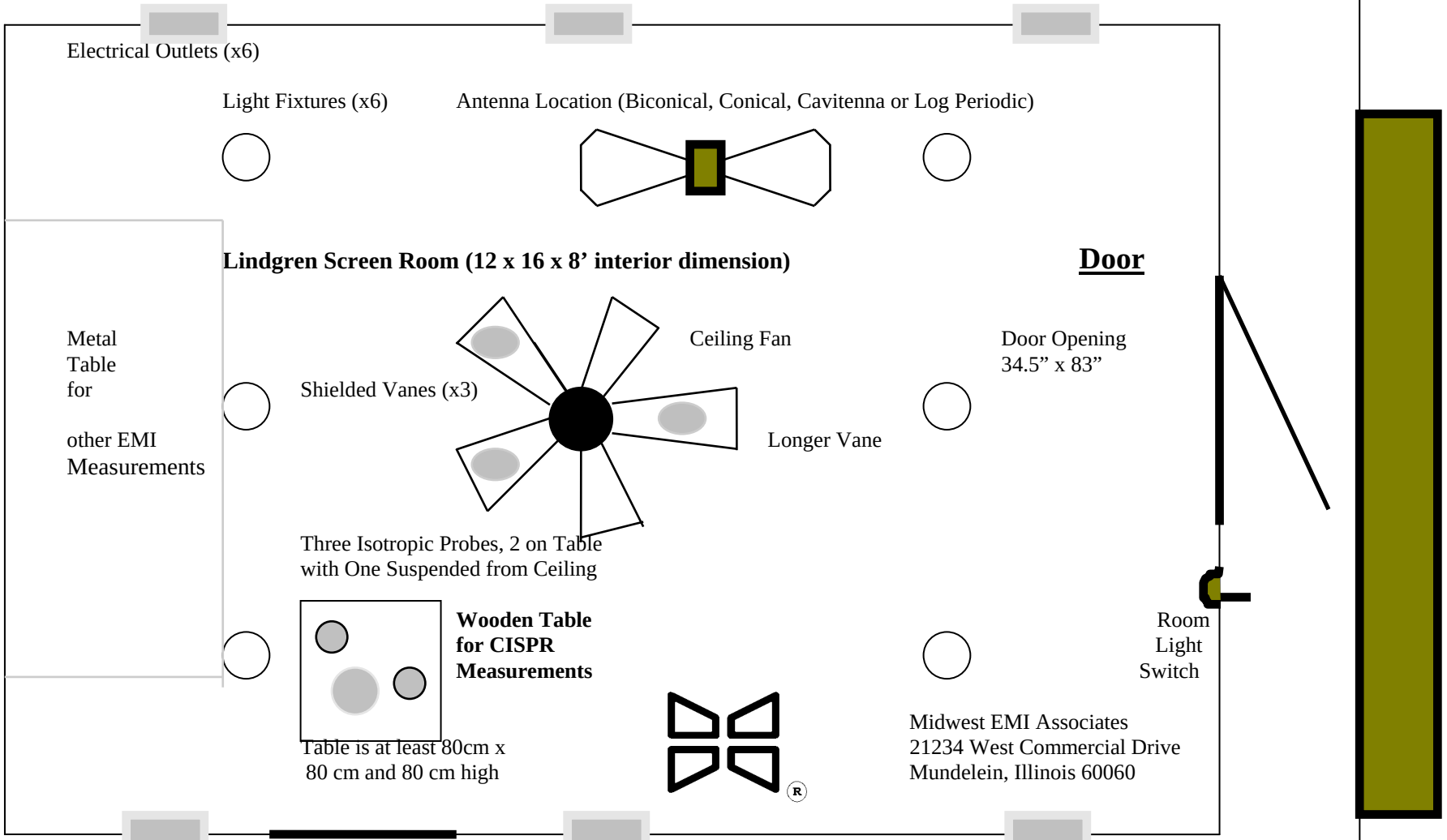


Figure A

Mundelein, IL 60060
42.237732, -88.046751
Housing : Single Story
Height : 20.0 feet
Obstructed : False

	Channels
A:	13.1, 20.1, 66.1
B:	2.1, 5.1, 7.1, 7.1, 9.1, 11.1, 26.1, 32.1, 38.1, 39.1, 44.1, 50.1, 60.1, 62.1

Ambient Signals at Midwest EMI Associates

Note: Channel numbers displayed adjacent to the map are those shown in the "Channel" column in the stations table.

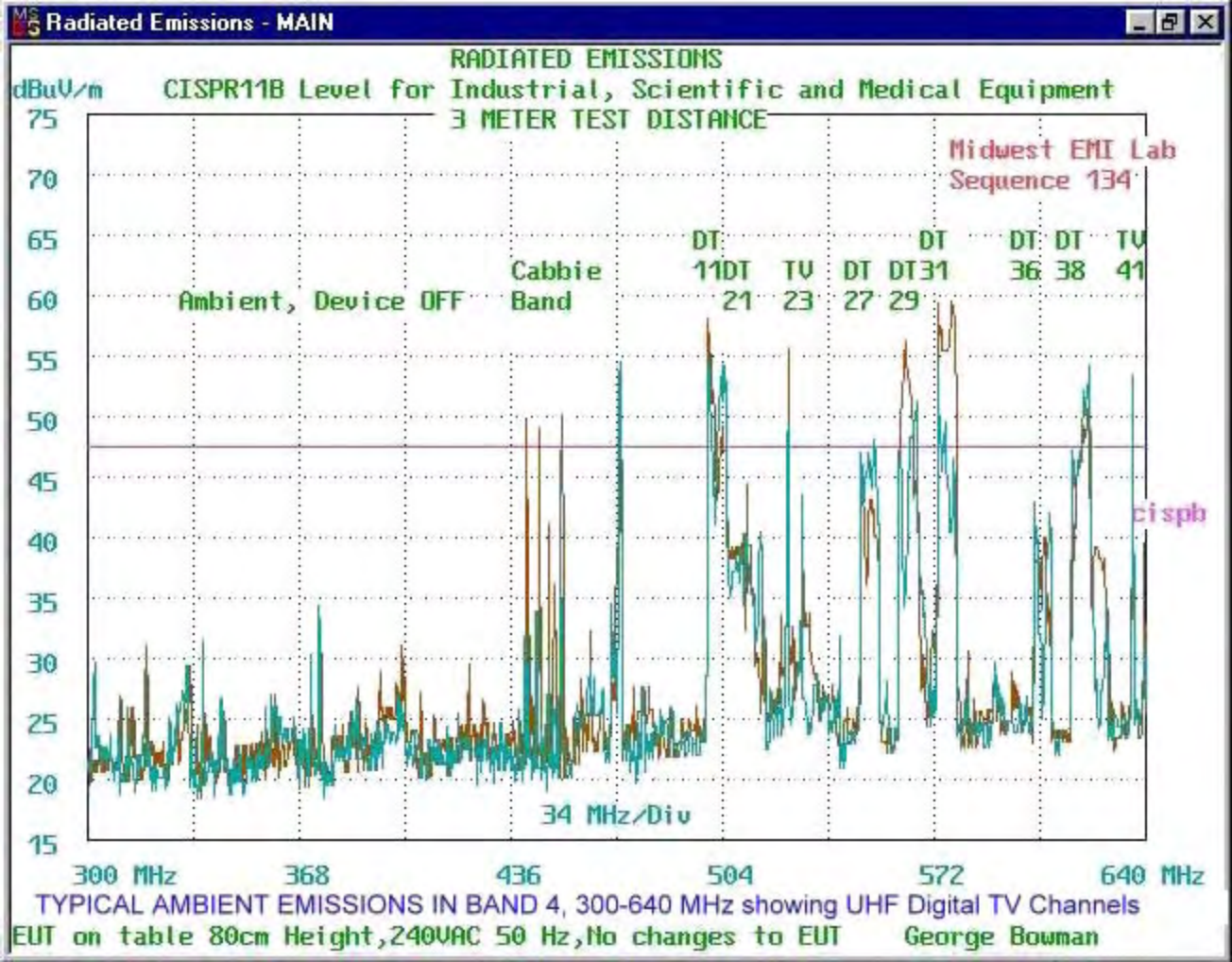
The map shows the distribution of stations around your address. When installing an antenna, you should point your antenna or align your antenna's rotor system to point in the direction of the stations of interest.* The compass arrow in the lower left can help match the orientations on the "Stations" page to the map: the compass arrow shows the direction of magnetic North. Orientations start at 0° (North) and increase clockwise to 360° (North again). So, North-East is 45°, South-East is 135°, etc.

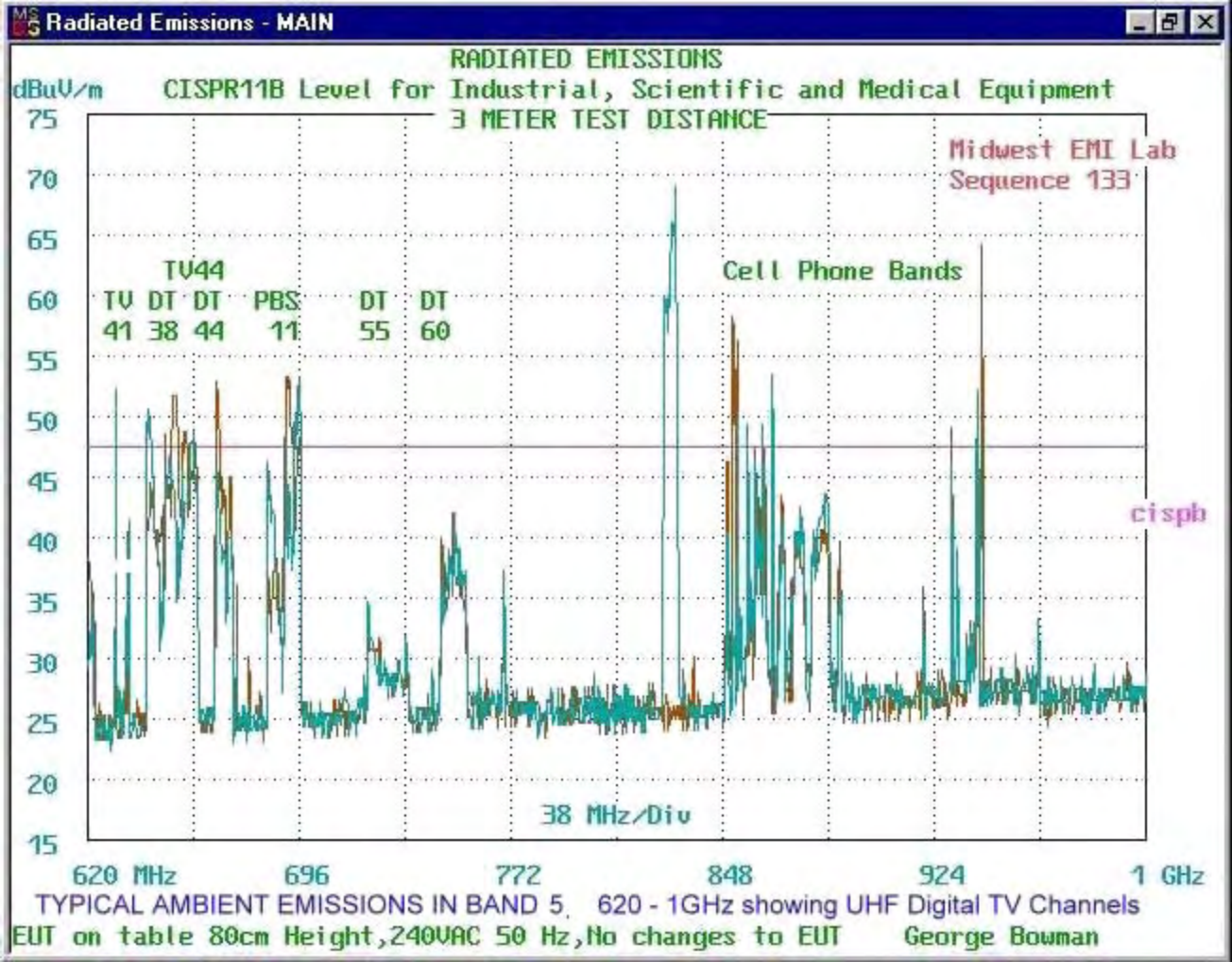
You can see the alignment information and channel numbers for a new location by dragging the center icon or double-clicking on a new location. The Stations page will also be updated with new stations, antenna type recommendations and other information.

*Alignment is not necessary for antennas coded as "multidirectional".

Television Stations

	Channels
A:	13.1, 20.1, 41, 66.1
B:	2.1, 5.1, 7.1, 7.1, 9.1, 11.1, 23, 26.1, 32.1, 34, 38.1, 39.1, 44.1, 50.1, 60.1, 62.1
C:	57


Radiated Emissions - MAIN
RADIATED EMISSIONS
dBuV/m
CISPR11B Level for Industrial, Scientific and Medical Equipment
3 METER TEST DISTANCE
Midwest EMI Lab
Sequence 134
DT
11
DT
21
TV
23
DT
27
DT
29
DT
31
DT
36
DT
38
TV
41
Cabbie
Band
Ambient, Device OFF
cispb
75
70
65
60
55
50
45
40
35
30
25
20
15
34 MHz/Div
300 MHz
368
436
504
572
640 MHz
TYPICAL AMBIENT EMISSIONS IN BAND 4, 300-640 MHz showing UHF Digital TV Channels
EUT on table 80cm Height,240VAC 50 Hz,No changes to EUT
George Bowman


Radiated Emissions - MAIN
RADIATED EMISSIONS
dBuV/m
CISPR11B Level for Industrial, Scientific and Medical Equipment
3 METER TEST DISTANCE
Midwest EMI Lab
Sequence 133
TV44
TV DT DT PBS DT DT
41 38 44 11 55 60
Cell Phone Bands
cispb
75
70
65
60
55
50
45
40
35
30
25
20
15
38 MHz/Div
620 MHz
696
772
848
924
1 GHz
TYPICAL AMBIENT EMISSIONS IN BAND 5, 620 - 1GHz showing UHF Digital TV Channels
EUT on table 80cm Height,240VAC 50 Hz,No changes to EUT George Bowman

FCC Digital Television Allocations in Illinois

Call Sign	Facility ID No.	Community	State	Current DTV Channel	Current NTSC Channel	Tentative Channel Designation
WXFT-TV	60539	AURORA	IL	59	60	50
WYZZ-TV	5875	BLOOMINGTON	IL	28	43	28
WSIU-TV	4297	CARBONDALE	IL	40	8	8
WCIA	42124	CHAMPAIGN	IL	48	3	48
WICD	25684	CHAMPAIGN	IL	41	15	41
WEIU-TV	18301	CHARLESTON	IL	50	51	50
WBBM-TV	**9617**	**CHICAGO**	**IL**	**3**	**2**	**11**
WCIU-TV	**71428**	**CHICAGO**	**IL**	**27**	**26**	**27**
WCPX	**10981**	**CHICAGO**	**IL**	**43**	**38**	**43**
WFLD	**22211**	**CHICAGO**	**IL**	**31**	**32**	**31**
WGN-TV	**72115**	**CHICAGO**	**IL**	**19**	**9**	**19**
WLS-TV	**73226**	**CHICAGO**	**IL**	**52**	**7**	**7**
WMAQ-TV	**47905**	**CHICAGO**	**IL**	**29**	**5**	**29**
WSNS-TV	**70119**	**CHICAGO**	**IL**	**45**	**44**	**45**
WTTW	**10802**	**CHICAGO**	**IL**	**47**	**11**	**47**
WYCC	**12279**	**CHICAGO**	**IL**	**21**	**20**	**21**
WAND	70852	DECATUR	IL	18	17	18
WBUI	16363	DECATUR	IL	22	23	22
WRBU	57221	EAST ST. LOUIS	IL	47	46	47
WIFR	4689	FREEPORT	IL	41	23	23
WSIL-TV	73999	HARRISBURG	IL	34	3	34
WSEC	70536	JACKSONVILLE	IL	15	14	15
WGBO-TV	12498	JOLIET	IL	53	66	38
WWTO-TV	998	LASALLE	IL	10	35	10
WMEC	70537	MACOMB	IL	21	22	21
WTCT	67786	MARION	IL	17	27	17
WQAD-TV	73319	MOLINE	IL	38	8	38
WQPT-TV	5468	MOLINE	IL	23	24	23
WPXS	40861	MOUNT VERNON	IL	21	13	21
WUSI-TV	4301	OLNEY	IL	19	16	19
WAOE	52280	PEORIA	IL	39	59	39
WEEK-TV	24801	PEORIA	IL	57	25	25
WHOI	6866	PEORIA	IL	40	19	19
WMBD-TV	42121	PEORIA	IL	30	31	30
WTVP	28311	PEORIA	IL	46	47	46
WGEM-TV	54275	QUINCY	IL	54	10	10
WQEC	71561	QUINCY	IL	34	27	34
WTJR	4593	QUINCY	IL	32	16	32
WHBF-TV	13950	ROCK ISLAND	IL	58	4	4
WQRF-TV	**52408**	**ROCKFORD**	**IL**	**42**	**39**	**42**
WREX-TV	**73940**	**ROCKFORD**	**IL**	**54**	**13**	**13**
WTVO	**72945**	**ROCKFORD**	**IL**	**16**	**17**	**16**
WCFN	42116	SPRINGFIELD	IL	53	49	13

3.2 POWER REQUIREMENT:

The primary power supplied to the test sample was a 12 or 24 volt battery.

3.3 GROUNDING:

No grounding was supplied to the test sample since it is battery operated.

3.4 RADIATED CONFIGURATION:

The test sample was oriented so that the area exhibiting the greatest amount of radiation was facing the antenna that was the front of the device.

3.5 TEST SAMPLE OPERATION:

The device was operated in its controlling or active movement mode during the test.

4.0 DISPOSITION OF TEST SAMPLE:

Upon completion of the test, the test sample was returned to the sponsor group.

5.0 REFERENCES:

ANSI 63.4 (2003), "American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 Hz to 40 GHz"

IEC61326-1 (2006), "Electrical equipment for measurement, control and laboratory use - EMC requirements - Part 1: General requirements:

CISPR 22 ED. 5.2 B:2006,"Information technology equipment - Radio disturbance characteristics - Limits and methods of measurement"

EN 61000-6-1 (2005-03), "Electromagnetic compatibility (EMC) - Part 6: Generic standards - Section 1: Immunity for residential, commercial and light-industrial environments"

EN 61000-6-2 (2005-01), "Electromagnetic compatibility (EMC) - Part 6-2: Generic standards - Immunity for industrial environments"

EN 61000-6-3 (2006-07), "Electromagnetic compatibility (EMC) - Part 6: Generic standards - Section 3: Emission standard for residential, commercial and light-industrial environments"

EN 61000-6-4 (1997-01), "Electromagnetic compatibility (EMC) - Part 6: Generic standards - Section 4: Emission standard for industrial environments"

IEC 60601-1-2 (2007-03), "Medical Electrical Equipment, Part 1: General requirements for safety. 2. Collateral Standard: Electromagnetic compatibility – requirements and tests"

Mil Std 461E, Part 4 "Electromagnetic Emission and Susceptibility Requirements for the Control of Electromagnetic Interference"

Federal Communications Commission Document MP-4 "FCC method Measurement of Radio Noise Emissions from Computing Devices"

VDE 0871 through 877 European documents

Current IEC Standards 61000-4-1 through 61000-4-11 and IEC Standard "Medical Electrical Equipment Part 1, General Requirements for Safety" issued by TC62A

EN55011, 2004-06, "Limits and Methods of Measurement of Radio Disturbance Characteristics of Industrial, Scientific and Medical (ISM) Radio-frequency Equipment"

CISPR Publication Number 16-1, (2003-10) Edition 1.1, "Specification for Radio Disturbance and Immunity Measuring Apparatus and Methods, Part 1, Radio Disturbance and Immunity Measuring Apparatus, 1998

MDS-201-0004, "Electromagnetic Compatibility Standard for Medical Devices", 1979

IEC 50 (161), "International Electrotechnical Vocabulary, Chapter 161, Electromagnetic Compatibility"

6.0 GENERAL INFORMATION:

A diagram of the EMI facility and test equipment used is shown in the Appendices to this manual. The spectrum analyzer and other equipment are calibrated periodically by using their manufacturers' services.

6.1 TEST PROCEDURES:

The test limits for CISPR and IEC test configurations are located at the end of the various appendices for convenience. All test results and procedures are shown in the Appendices. Hereinafter, the equipment under test will be referred to as the E.U.T. or by its full description.

6.2 TEST DESCRIPTIONS:

All procedures below not referenced by individual protocol ("MEMI-XXX") numbers fall under the master EMI protocol, MEMI-7 "Electromagnetic Interference". Presently commercial devices are tested to 1 GHz per international convention for emissions and susceptibility.

The possible range of tests that could have application either domestically or internationally are listed below along with applicable protocol numbers. The references supplied provide information on how to perform the test. CISPR 11 & 22, Military Standard 462, and EN 61000 part 4 series are used as references for all procedures.

Midwest EMI assumes no liability for the performance of designs in the field derived from these protocols and the recommended criteria of acceptability. Midwest EMI will perform these tests as a service exclusively and will make every effort to assure the data is presented accurately and that the testing is uniformly applied per standards but we cannot guarantee to our customers that the product will gain acceptance by the market. In particular for life sustaining equipment, Midwest EMI recommends that a larger base of tests be performed to gain an accurate understanding of product performance.

6.2.1 **Appendix A1 (CISPR Conducted Emissions)** - Limits are plotted for FCC or CISPR requirements for Level B emissions. *Recommended criterion of acceptability is that A or B Level emissions are passed.*

6.2.2 **Appendix B1 (CISPR Radiated Emissions)** - Limits are plotted for FCC or CISPR requirements for Level B emissions. For some equipment this may include electric and VDE style magnetic emissions. *Criterion of acceptability for Europe is that A or B level emissions must be passed.*

6.2.3 **Appendix C (EN61000-4-4 Fast Transients)** - Limits for EN 60601-1-2 and FDA Reviewer's Guide compliance are 2 KV common and 1 KV differential applied to the power cables and .5 KV applied to peripheral cables. *The criterion of acceptability is that there should be no permanent degradation in performance with the stress applied that is not recoverable automatically.*

6.2.4 **Appendix D (Radiated Susceptibility-EN 61000-4-3)** - Limits are 3 - 10 V/M from 10 KHz to 1 GHz per EN 61000-4-3. For this class of product the immunity of the device must exceed the 3 V/M requirement to meet the IEC 60601-1-2 requirements. *The criterion of acceptability is that there should be no degradation in performance or hardware failure when the EUT is exposed to any level lower and including the limit. In all cases the device must fail safely or it is rejected.*

6.2.5 **Appendix E (EN 61000-4-5 Surge Immunity Test) -** Recommended limits are 2 KV common mode and 1 KV differential mode at angles of 0, 90, 180, and 270 degrees. Ten repetitions at each condition are applied to the EUT. *The criterion of acceptability is no failure, serious malfunction or alarm may occur that is not self-recovered in 5 seconds.*

6.2.6 **Appendix F (EN 61000-4-6 Conducted Immunity Test)** Conducted bulk energy is applied via a voltage coupler to power leads and peripheral cables longer than 3 meters. This test is invasive in that the power line is preconditioned to allow the RF voltage to be applied to all leads of the equipment under test. It is also applied to peripheral cables using the similar coupler of the CS114 test except at a higher intensity typically. *The criterion of acceptability is that no malfunction occurs up to and including the 3 or 10 V RMS limit.*

6.2.7 **Appendix G (EN 61000-4-2 ESD Test)** – The EUT is exposed to high intensity electrostatic pulses up to 8 kV air or 4 kV contact discharge. *The criterion of passing this test is no adverse malfunction that is not self-recovering within 5 seconds of the termination of the pulse.*

6.2.8 Appendix H (EN 61000-4-8 Magnetic Immunity Test) – The EUT is exposed to high level magnetic fields of up to 10 Gauss. *The criterion of passing this test is no adverse malfunction during application of the fields.*

6.3 SPECTRUM ANALYZER CHARACTERISTICS:

This facility uses a type TEK 2756P/TEK 2712 automated spectrum analyzer and an HP Omnibook 900 measuring system. The 6 dB impulse bandwidth settings and wideband correction factors are listed below:

TEK 2756P Analyzer

Bandwidth Setting		Wideband 6dB Bandwidth		Correction Factor		Factor Applied	
3	MHz	3.028	MHz	-9.623	dB	-10	dB
1	MHz	915.0	KHz	.7716	dB	0	dB
.1	MHz	116.4	KHz	18.68	dB	20	dB
10	KHz	9.96	KHz	40.03	dB	40	dB
1	KHz	926	Hz	60.67	dB	60	dB
.1	KHz	96	Hz	80.35	dB	80	dB
10	Hz	10	Hz	100	dB	100	dB

TEK 2712 Analyzer (Dual Analyzers in Use)

Bandwidth Setting		Wideband 6dB Bandwidth		Correction Factor		Factor Applied	
5	MHz	4.92	MHz	-13.84	dB	-14	dB
1	MHz	.932	KHz	.6117	dB	0	dB
.3	MHz	.31	KHz	10.173	dB	10.5	dB
120	KHz	119	KHz	Cispr Required Bandwidth			
9	KHz	8.48	KHz	41.43	dB	41	dB
3	KHz	3300	Hz	49.63	dB	50.5	dB
1	KHz	860	Hz	61.31	dB	60	dB
200	Hz	200	Hz	73.98	dB	74	dB

For test purposes, the correction factors are chosen to be at the nearest 20dB increment.

6.4 Certificates of Calibration

All certificates of calibration are maintained in a binder located at Midwest EMI Associates and are available for inspection. The present expiration dates of certified calibration by our manufacturers are:

a)	Tek2756P Spectrum Analyzer	BO20224	26 Sep 12
b)	Wavetek 2520A RF Generator	0222011	30 Sep 12
c)	Carver TFM-35 250 W/Ch. Audio Amp	3097104	1 Jun 01
d)	ENI RF Power Amplifier (525LA)	367	N/A
e)	ENI RF Power Amplifier (2100L)	129	N/A
f)	Eaton 15100B Power Amplifier	1529-07090	24 Sep 12
g)	Tektronix TDS 420 Oscilloscope	B021212	24 Sep 12

h)	EMCO 3109 Power Biconical (1/3/10 Meters)	9011-2504	17 Sep 12
i)	EMCO 3101 Power Conical	9007-3450	7 Nov 93 (1/3m)
j)	EMCO 6502 Active Loop	1038	18 Sep 12
k)	EMCO 3301B Active E Field	9009-3044	19 Sep 12
l)	EMCO 3147 Wide Range Log Periodic	9102-1019	23 Sep 12
m)	EMCO 3107B Power E Field	9310-2435	N/A
m)	Amplifier Research FM1000	12456	N/A
n)	Amplifier Research FP1000	60701	21 Sep 12
o)	Amplifier Research FP1000	60488	3 Sep 12
p)	IFI EFS-4 E Field Susceptibility	39883	14 Sep 12
	(Holladay 3004EX with HSE405 Probe)		
q)	IFI LMT-B Light Modulator	1117-B	N/A
r)	IFI EFS-1 E Field Susceptibility	245738	1 Feb 99
s)	Solar 6741-1 RF Current Probe	911308	N/A
t)	Fluke 45 True RMS Voltmeter	**EJ574714013**	24 Sep 12
u)	Schaffner NSG 433 ESD Gun	107	
	and Contact Discharge Adapter	402-664/0	30 Sep 12
v)	Solar Loop Sensor 7334-1	----------	N/A
w)	Solar Loop Sensor 9311-1	931101	N/A
x)	Solar RF Coupler 7415-3	906016	N/A
y)	Solar Line Impedance Stabilization Network	8028-50-TS-24-BNC	N/A
z)	Solar VDE Filter Network	8907-250-TS-24-BP	N/A
aa)	Ohmic Instrument BET-300-ADL	522	25 Sep 12
ab)	Werlatone C1795 Dir. Coupler	3442	30 Sep 12
ac)	Solar Current Injection Probe Type 9108-1N	935012	N/A
ad)	Tektronix TR 503B Tracking Generator	B011216	25 Sep 12
ae)	Acme 2KVA Isolation Transformer	T-3-53042-S	N/A
af)	Xentek Extreme Isolation Transformer Model 5410 (2 in use)		
ag)	Tektronix P6202 RF Probe	------	N/A
ah)	Staco Power Variac Type 3PN2210 (0-140VAC) 3.1KVA		N/A
ai)	Helmholtz Coil Stepdown Xfrmr-Chicago Xfrmer Type P-6492		N/A
aj)	Goldstar Signal Generator Mod FG-2002c	201621	25 Sep 12
ak)	Holladay Magnetic Field Probe Model HI-3624	83957	15 Sep 12
al)	Tektronix 2712 Spectrum Analyzer (Quasipeak)	B022520	24 Sep 12
am)	Voltec PM100 Power Analyzer	AA04/8495	25 Sep 12
an)	EMCO 3142 Biconilog Antenna	1052	1 Sep 12
ao)	Haefely P90.1 EN 61000-4-4 Fast Transient Tester	083 593-14	19 Sep 12
ap)	Hewlett Packard 3400A AC Voltmeter	1218A14443	24 Sep 12
aq)	Amplifier Research FP2031 Isotropic Probe	18309	5 Sep 12
ar)	Haefely 250 600/00 (61000-4-5 Surge Tester)	583 334-05	19 Sep 12
as)	Fischer CISPR 14 Absorbing Clamp type F-201	235	7 Sep 12

at)	Fischer IEC 801-6 Transducer	165	23 Sep 12
au)	Solar 9123-1N Current Clamp	956015	23 Sep 12
av	Fischer IC 801-6 CDN FCC-801-M3-25	95	7 Sep 12
aw)	Tektronix 2712 Spectrum Analyzer (Quasipeak)	B022981	24 Sep 12
ax)	C. C. Moore Automated Mast Assembly Model DAPM4/6		N/A
ay)	C. C. Moore Automated Turntable Model DTT-4	N/A	
az)	Antenna Research LPB2520	1152	20 Sep 12
ba)	Behlman Power Pass 50 Hz AC Source (50, 60, 400 Hz)	0005	N/A
bb)	California Instruments WP1251 AC Source (50, 60 Hz)	N/A	
bc)	Plitron Extreme Toroidal Isolation Transformers (2)		
bd)	Edmund Scientific Thermometer/Hygrometer	None	N/A
be)	Coaxial Bird Pads (x2) 8306-030-N3DBNone	30 Sep 12	
bf)	High Current Source, Associated Research 3030D	A140006	25 Sep 12
bg)	California Instruments 5001ix High Power Source	HK52945	25 Sep 12
bh)	Line Leakage tester, Associated Research 510L 130007	25 Sep 12	
bi)	Hipot Tester, Associated Research 3570D	090595	25 Sep 12
bh)	GAASfet Preamplifier	None	30 Sep 12
bi)	Ametek Tachometer Model 1726	R035292	24 Sep 12
bj)	Bird Attenuator (x2), 75 Watt, 75-A-MFN-10	R035290	30 Sep 12
bk)	Tek 495P Opt 5/7	B020147	30 Sep 12
bl)	Amplifier Research FP2036 (.5-5Ghz)		04 Sep 12

7.0 CONCLUSION OF RADIO FREQUENCY INTERFERENCE EMISSIONS AND SUSCEPTIBILITY TESTS:

The TFT EP0306: JOYSTICK OPERATOR STATION WITH VALVE POSITION CONTROL was evaluated for all tests in the configuration requested by the sponsor group for compliance with the diagnostic instruments standards, IEC 61000-6-2 and IEC 61000-6-3:2007. The configuration requested was that of the packaged unit system in an orientation that exercised the remote control/joystick activation function.

The prototype required a change as summarized below. After the change was added, the device was fully functional and showed the joystick was controlling properly and the display was properly indicating the state of the valve at all times.

Changes

The sponsor group added a low pass filter to the encoder controlling the valve position indicator.

Typical Test Configuration

APPENDIX A1

FCC/VDE CONDUCTED EMISSIONS TEST

(EN55011, EN55022, EN55014)

1.0 PURPOSE:

The purpose of this test sequence is to perform compliance testing to FCC and VDE conducted emissions specifications. The test is always performed in a shielded enclosure with a Line Impedance Stabilization Network (LISN).

2.0 INTERIOR SHIELDED ROOM DESCRIPTION:

The 12.5' by 16.5' Lindgren indoor shielded room test site is situated in a 1250 sq. ft. building located at Midwest EMI Associates, 21234 W. Commercial Drive, Mundelein Illinois. This room has a solid steel exterior and copper interior with a blackened screen for visualization of the device under test. The Line Impedance Stabilization Network is bonded to a wall of the enclosure very near to the floor but in such a manner that its terminals are 40 centimeters off the floor. For both FCC and VDE tests, the LISN network has an approved low pass prefilter to permit proper measurement down to 10 kHz. In addition, if the EUT requires 220 VAC power, a Behlman Passport is provided capable of 1350 watts, 50 Hz. The LISN has applied to it a standard three terminal 120VAC IEC plug termination. If the plug style is different, then either a mating connector, a very short alligator clip network, or an equivalent length standard IEC cord is provided. In this case, the 220 VAC cord was used.

3.0 CONFIGURATION AND OPERATION OF TEST SAMPLE:

3.1 POWER REQUIREMENT:

The **TFT EP0306: JOYSTICK OPERATOR STATION WITH VALVE POSITION CONTROL** was operated in its normal mode using 12 VDC battery power.

3.2 GROUNDING:

Any possible alternate ground provided for the test sample was interrupted by the linoleum floor upon which the sample was placed and which situates the test sample 10 cm. above the floor of the lab area. The main ground for the test sample is established by connection of the third wire to a LISN located remotely in the screened room. The EMC receiver, a Tektronix 2712, is located outside the screen room and is grounded with a two inch copper strap at the rear of the instrument and a 2 AWG welding cable at the front of the instrument. The EMC receiver and all measurement equipment including computers are otherwise isolated from the room using a Plitron extreme isolation transformer.

3.3 CONDUCTED CONFIGURATION:

In conducted tests, the test sample was oriented on the metal floor at a 40 cm. height over the ground plane to satisfy Cispr 11 or 22 B level test criterions. The LISN was terminated directly with a brick wall 10 kHz rolloff filter that provides 20 dB attenuation to the signal going to the spectrum analyzer. All calibration data is maintained in files inside the computer running the analyzer via the GPIB bus. Data was read and plotted in PEAK mode using the capabilities of the Tek 2756P.

3.4 TEST SAMPLE OPERATION:

All test measurements were made with the unit in its normal measuring mode after a 3-minute power up period.

3.5 LIMITS OF ACCEPTANCE:

The general procedures are dictated in the individual protocols listed such as ANSI 63.4, FCC Part 15, CISPR 11, and CISPR 22. The limits for FCC rules presently are given in Part 15.109 of 47 CFR 1 (10-9-1990) Edition of the Federal Code of Regulations. For convenience these limits are plotted on the graphs and in registered in tabulated data.

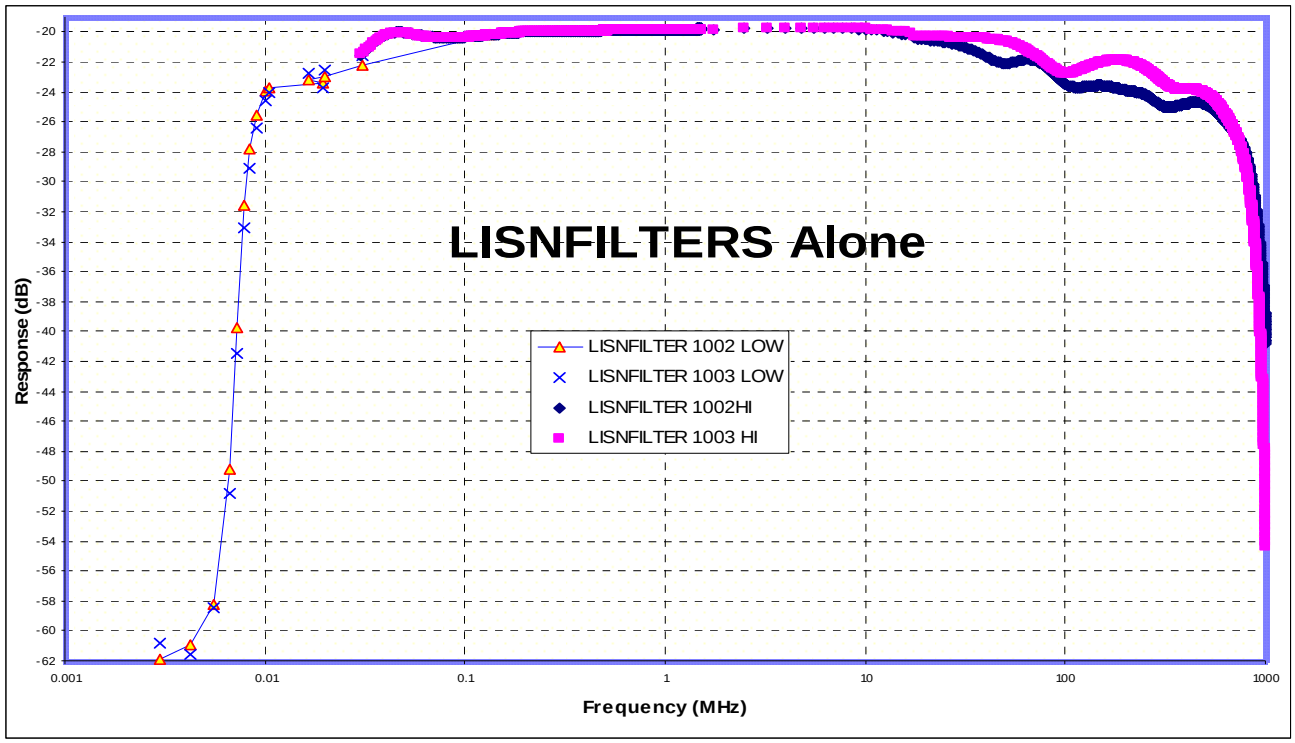
VDE LIMITS

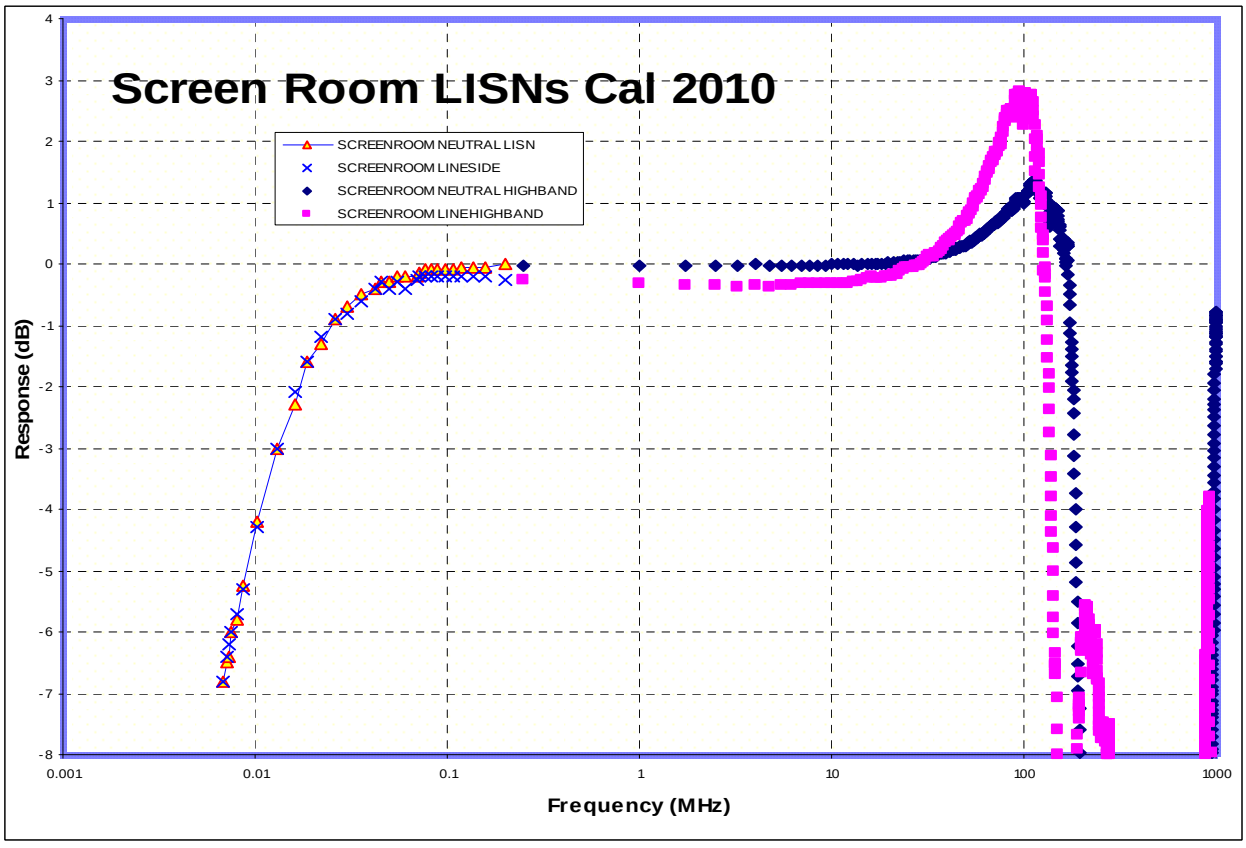
For CISPR 11 (EN55011), 22 (EN55022) or 14 (EN55014) B level conducted compliance starting at 150 kHz the allowed level is 66 dBuV and decreases at a linear rate with the log of frequency to 56 dBuV at 500 kHz. From 500 kHz to 5 MHz the allowed level is 56 dBuV, and 60 dBuV from 5 MHz to 30 MHz at the LISN mains.

3.6 CALIBRATION DATA:

The results of the latest recalibration of the LISN's are contained on the next page over the range of 1 kHz to 1 MHz. The LISN is isolated from the spectrum analyzer by two 10-dB pads on either side of a five-pole rolloff filter. The insertion loss of each LISN has been compared and calibrated to that of a perfect LISN whose response is also shown.

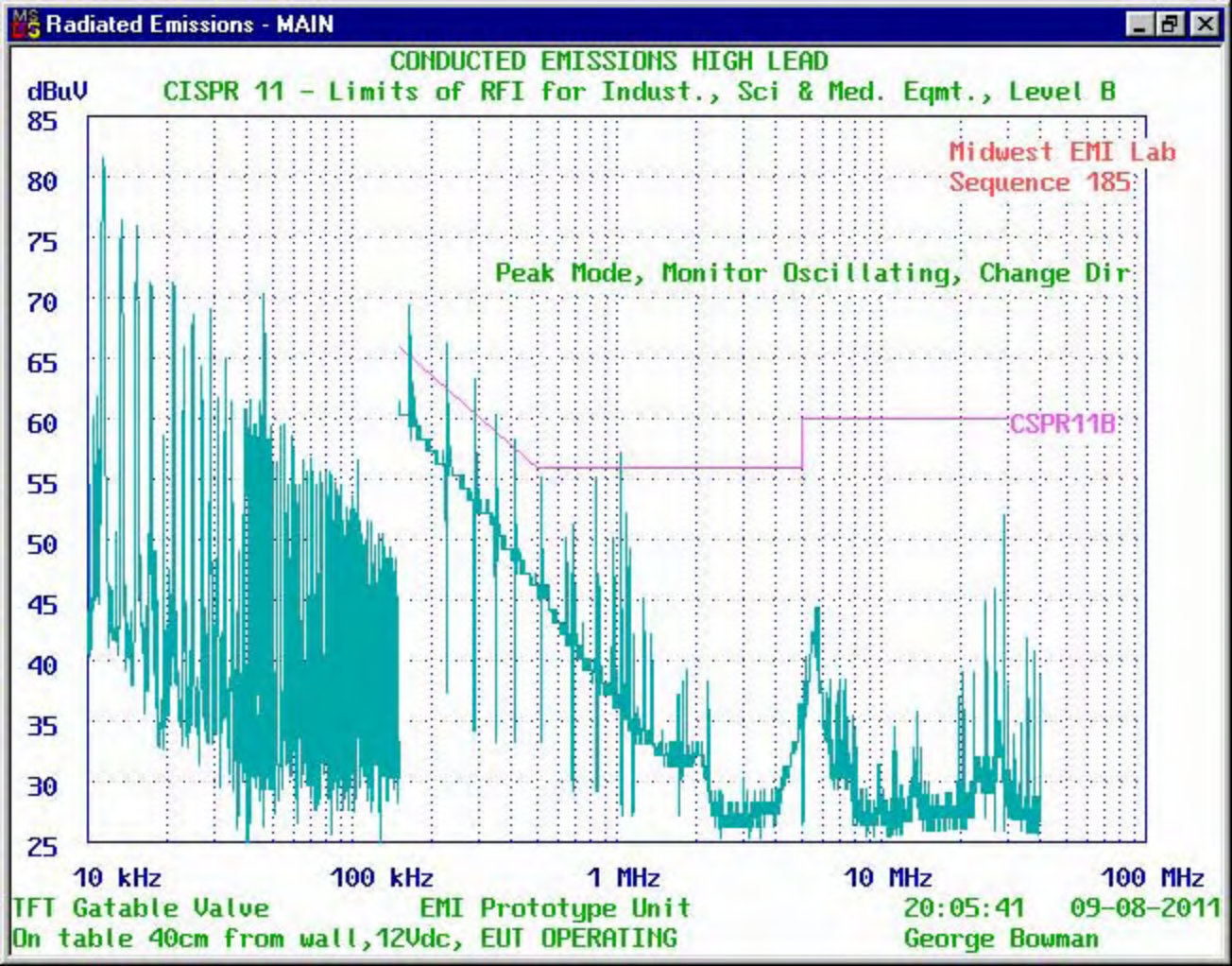
In the range higher than 1 MHz up to 100 MHz the characteristic of each LISN is flat with an insertion loss of no greater than 3 dB. In all cases the deviation from the perfect LISN response has been compensated for in a computer correction table file (approximately 150 points). The actual lower end of LISN response used for substantiation of customer data is 10 kHz.


LISNFILTERS Alone
LISNFILTER 1002 LOW
LISNFILTER 1003 LOW
LISNFILTER 1002HI
LISNFILTER 1003 HI
Response (dB)
Frequency (MHz)
-20
-22
-24
-26
-28
-30
-32
-34
-36
-38
-40
-42
-44
-46
-48
-50
-52
-54
-56
-58
-60
-62
0.001
0.01
0.1
1
10
100
1000


Screen Room LISNs Cal 2010
SCREENROOM NEUTRAL LISN
SCREENROOM LINESIDE
SCREENROOM NEUTRAL HIGHBAND
SCREENROOM LINEHIGHBAND
Response (dB)
Frequency (MHz)
4
3
2
1
0
-1
-2
-3
-4
-5
-6
-7
-8
0.001
0.01
0.1
1
10
100
1000

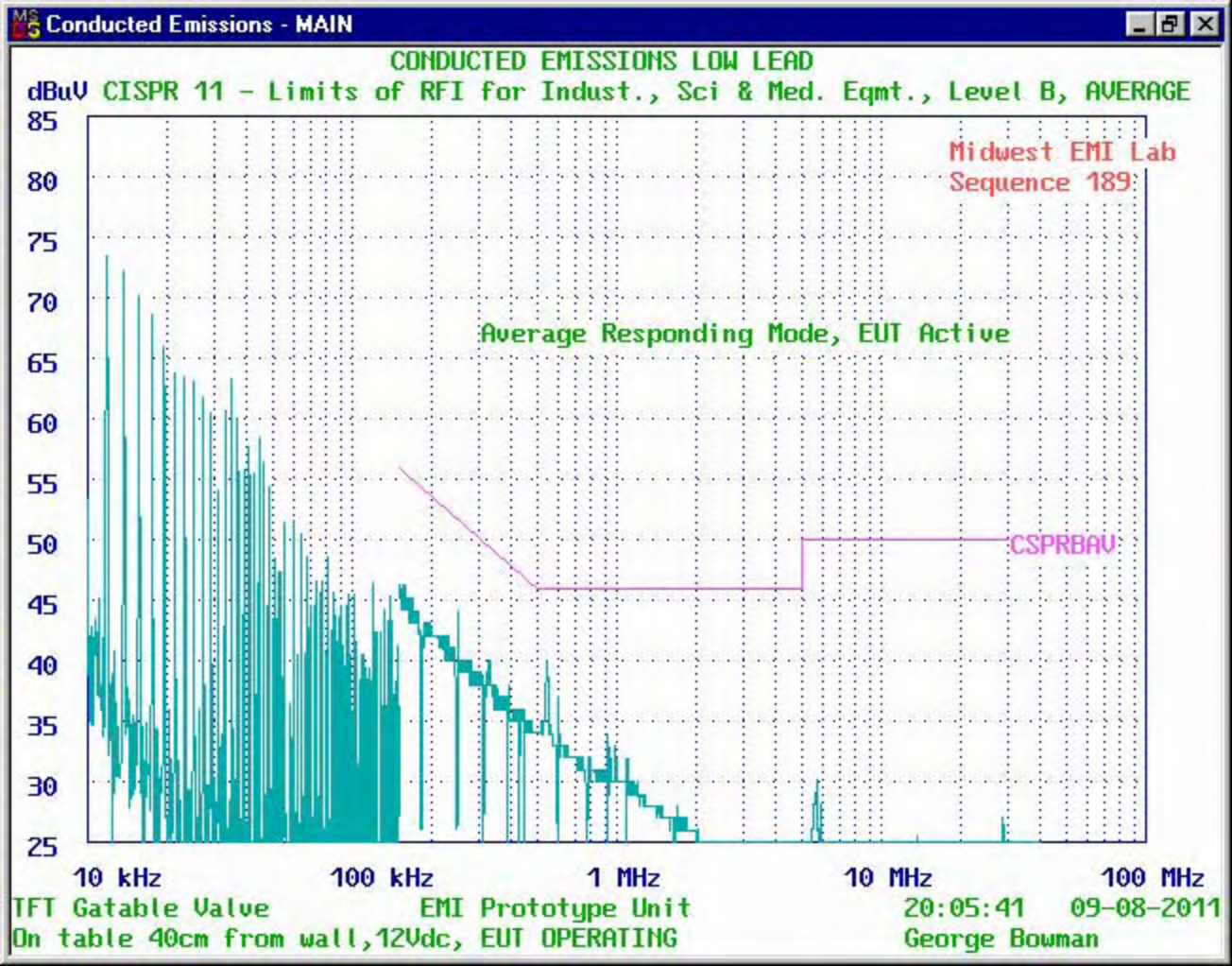
4.0 CONCLUSION OF RADIO FREQUENCY INTERFERENCE EMISSIONS TESTS:

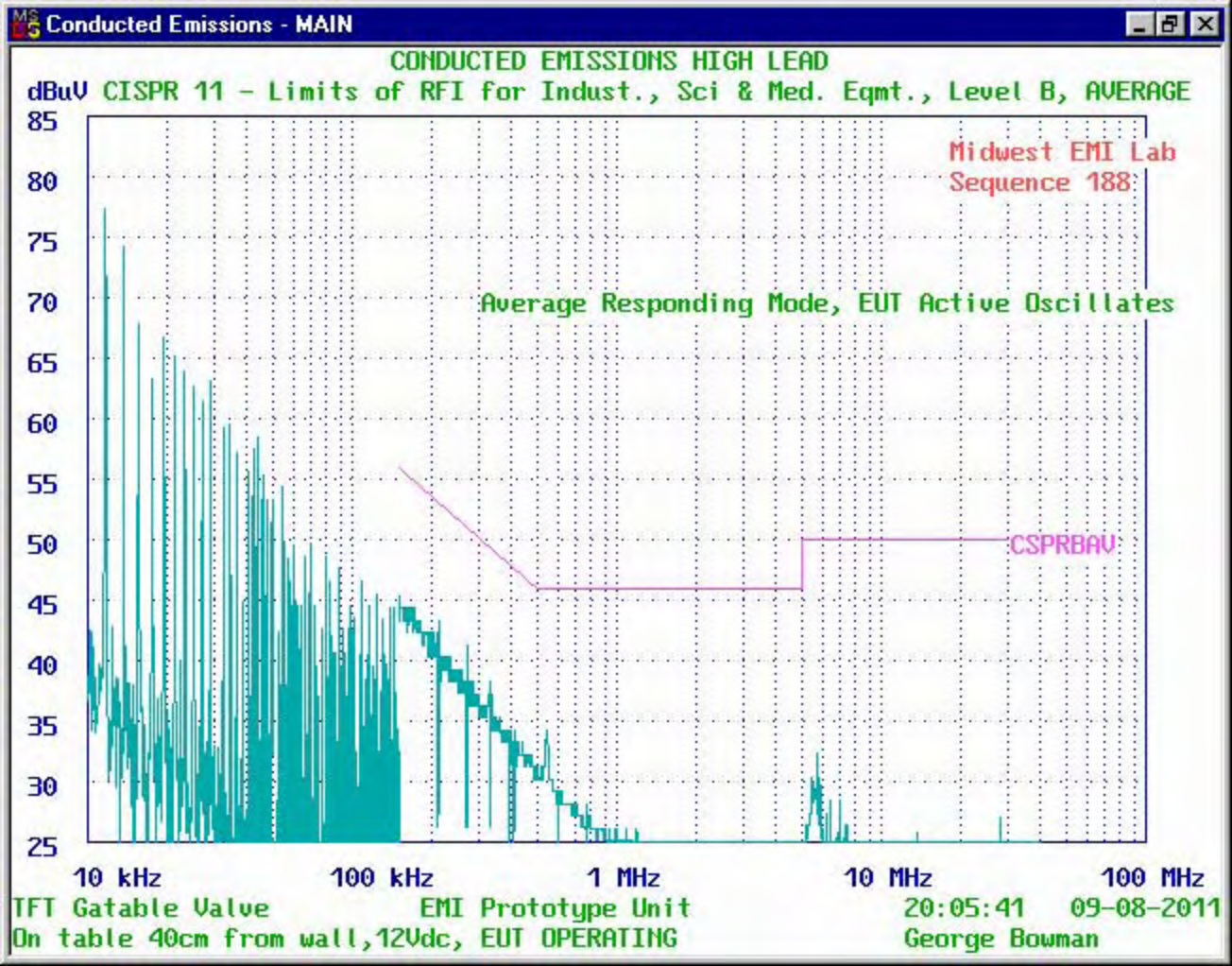
The TFT EP0306: JOYSTICK OPERATOR STATION WITH VALVE POSITION CONTROL was measured for its conducted emissions per EN61000-6-3 for DC operated devices. After measuring the system in average and peak modes, the EUT achieved the Cispr B level without further changes. Peak emissions on the line and neutral leads were equivalent.


Radiated Emissions - MAIN
CONDUCTED EMISSIONS HIGH LEAD
dBuV
CISPR 11 - Limits of RFI for Indust., Sci & Med. Eqmt., Level B
Midwest EMI Lab
Sequence 185
Peak Mode, Monitor Oscillating, Change Dir
CSPR11B
85
80
75
70
65
60
55
50
45
40
35
30
25
10 kHz
100 kHz
1 MHz
10 MHz
100 MHz
TFT Gatable Valve
EMI Prototype Unit
20:05:41
09-08-2011
On table 40cm from wall,12Vdc, EUT OPERATING
George Bowman


Radiated Emissions - MAIN
CONDUCTED EMISSIONS LOW LEAD
CISPR 22 - Limits of RFI for ITEl Switch & Ctrl, Level B
dBuV
0.303
73.6
Midwest EMI Lab
Sequence 212
EUT OPERATING
CSPRB
85
80
75
70
65
60
55
50
45
40
35
30
25
30 kHz/Div
150 kHz
210
270
330
390
450 kHz
TFT Gatable Valve
EMI Prototype Unit
20:05:41
09-08-2011
On table 40cm from wall,12Vdc, EUT OPERATING
George Bowman


Conducted Emissions - MAIN
CONDUCTED EMISSIONS LOW LEAD
dBuV
CISPR 11 - Limits of RFI for Indust., Sci & Med. Eqmt., Level B
Midwest EMI Lab
Sequence 199
Low Lead, Quasi Peak, EUT oscillating
CISPR11B
85
80
75
70
65
60
55
50
45
40
35
30
25
30 kHz/Div
150 kHz
210
270
330
390
450 kHz
TFT Gatable Valve
EMI Prototype Unit
20:05:41
09-08-2011
On table 40cm from wall,12Vdc, EUT OPERATING
George Bowman


Conducted Emissions - MAIN
CONDUCTED EMISSIONS LOW LEAD
dBuV CISPR 11 - Limits of RFI for Indust., Sci & Med. Eqmt., Level B, AVERAGE
Midwest EMI Lab
Sequence 189
Average Responding Mode, EUT Active
CSPRBAV
85
80
75
70
65
60
55
50
45
40
35
30
25
10 kHz
100 kHz
1 MHz
10 MHz
100 MHz
TFT Gatable Valve
EMI Prototype Unit
20:05:41
09-08-2011
On table 40cm from wall,12Vdc, EUT OPERATING
George Bowman


Conducted Emissions - MAIN
CONDUCTED EMISSIONS HIGH LEAD
dBuV CISPR 11 - Limits of RFI for Indust., Sci & Med. Eqmt., Level B, AVERAGE
Midwest EMI Lab
Sequence 188
Average Responding Mode, EUT Active Oscillates
CSPRBAV
85
80
75
70
65
60
55
50
45
40
35
30
25
10 kHz
100 kHz
1 MHz
10 MHz
100 MHz
TFT Gatable Valve
EMI Prototype Unit
20:05:41 09-08-2011
On table 40cm from wall,12Vdc, EUT OPERATING
George Bowman

SHEET 1 CSPR11B CONDUCTED QUASI-PEAK REPORT
Low Lead
CISPR 11 - Limits of RFI for Indust., Sci & Med. Eqmt., Level B
TIME: 20:05:41 Midwest EMI
DATE: 09-08-2011 Associates
TEST ITEM: TFT Gatable Valve
SERIAL NUMBER: EMI Prototype Unit Sequence Number: 199
COMMENTS: On table 40cm from wall,12Vdc, EUT OPERATING
TEST PERFORMED BY: George Bowman

Peak Freq. (kHz)	Peak Interfer. (dBuV)	Quasi-peak Freq. (kHz)	Quasi-peak Interfer. (dBuV)	Spec. Level (dBuV)
184.2	*59.596*	*183.72*	*59.297*	*64.294*
200.4	*58.851*	*192.12*	*58.573*	*63.594*
219	*58.144*	*217.98*	*60.445*	*62.857*
237.6	*58.839*	*226.02*	*57.642*	*62.180*
262.2	*56.732*	*261.36*	*57.432*	*61.361*
292.8	*55.724*	*285.36*	*56.726*	*60.445*
323.4	*54.717*	*311.04*	*55.420*	*59.619*
351.6	*53.811*	*346.56*	*55.112*	*58.925*
376.2	*53.506*	*363.9*	*53.209*	*58.363*
401.4	*52.902*	*396.06*	*54.203*	*57.824*
431.4	*52.297*	*416.94*	*52.699*	*57.226*
447.6	*51.894*	*461.28*	*54.492*	*56.920*

SHEET 1 CSPRB CONDUCTED QUASI-PEAK REPORT
High Lead
CISPR 22 - Limits of RFI for ITE, Switch & Ctrl, Level B
TIME: 20:05:41 Midwest EMI
DATE: 09-08-2011 Associates
TEST ITEM: TFT Gatable Valve
SERIAL NUMBER: EMI Prototype Unit Sequence Number: 213
COMMENTS: On table 40cm from wall,12Vdc, EUT OPERATING
TEST PERFORMED BY: George Bowman

Peak Freq. (kHz)	Peak Interfer. (dBuV)	Quasi-peak Freq. (kHz)	Quasi-peak Interfer. (dBuV)	Spec. Level (dBuV)
36.7608	*66.046*	*36.761*	*54.994*	*77.680*
42.21475	*62.429*	*36.761*	*59.294*	*76.531*
219.6	*61.391*	*211.01*	*57.295*	*62.834*
280.8	*71.568*	*278.01*	*54.769*	*60.792*
285	*64.467*	*289.42*	*51.766*	*60.669*
286.8	*59.766*	*293.39*	*52.964*	*60.617*
329.4	*52.753*	*327.78*	*52.254*	*59.466*
353.4	*70.247*	*344.98*	*49.149*	*58.882*
358.2	*60.346*	*356.72*	*51.846*	*58.770*
387.6	*58.438*	*381.67*	*47.040*	*58.115*
427.8	*57.029*	*424.28*	*47.230*	*57.295*
444	*50.726*	*437.72*	*46.927*	*56.987*

SHEET 1 BSF CSPRB CONDUCTED QUASI-PEAK REPORT

Low ~~High~~ Lead

CISPR 22 - Limits of RFI for ITE, Switch & Ctrl, Level B

TIME: 20:05:41 Midwest EMI

DATE: 09-08-2011 Associates

TEST ITEM: TFT Gatable Valve

SERIAL NUMBER: EMI Prototype Unit Sequence Number: 212

COMMENTS: On table 40cm from wall, 12Vdc, EUT OPERATING

TEST PERFORMED BY: George Bowman

Peak Freq. (kHz)	Peak Interfer. (dBuV)	Quasi-peak Freq. (kHz)	Quasi-peak Interfer. (dBuV)	Spec. Level (dBuV)
27.11093	*71.326*	*27.111*	*62.563*	*80.209*
198	*68.301*	*198.06*	*59.201*	*63.694*
224.4	*74.589*	*210.72*	*56.695*	*62.654*
254.4	*63.778*	*251.28*	*56.979*	*61.612*
300	*66.462*	*308.1*	*55.060*	*60.243*
303	*62.061*	*288.9*	*55.966*	*60.160*
347.4	*56.749*	*346.02*	*54.249*	*59.024*
372.6	*63.742*	*361.2*	*52.345*	*58.443*
442.8	*61.326*	*430.74*	*51.928*	*57.009*
445.8	*58.125*	*438.78*	*54.627*	*56.953*

APPENDIX B1

FCC/VDE RADIATED EMISSIONS TEST

(EN55011, EN55022, EN55014)

1.0 PURPOSE:

The purpose of this test sequence is to perform compliance testing to FCC Part 15, VDE 0871, CISPR 11 and 22 and other tests that can be run on a 3 meter indoor test site or in a screen room.

2.0 INDOOR TEST FACILITY DESCRIPTION:

The indoor test site is situated inside a 3000 sq. ft. building located at Midwest EMI Associates, 21234 W. Commercial Drive, Mundelein Illinois. This site has flat plane above which is situated multiple 1/2" thick 4 x 8 foot wood panels with double-sided galvanized steel plates comprising an overall dimension of approximately 24 by 32 feet. The plates are interconnected by "top hat" grounding connections that is further grounded by connection to the main power ground into the earth satisfying ANSI requirements. These tests require that the antenna be raised and lowered over a 1 to 4 meter distance on an antenna mast such that the radials clear obstructions by at least 1 meter. The size of the site will accommodate three-meter Cispr measurements. All objects are clear of the ellipse defined in ANSI for a three-meter site. The antenna mast is the C.C. Moore Company automated mast assembly Model DAPM4/6 and the antenna turntable is the C.C. Moore Company automated turntable Model DTT-4.

3.0 CONFIGURATION AND OPERATION OF TEST SAMPLE:

3.1 POWER REQUIREMENT:

The TFT EP0306: JOYSTICK OPERATOR STATION WITH VALVE POSITION CONTROL was operated in its normal mode using a 12 VDC lead acid battery for power.

3.2 GROUNDING:

Any possible alternate ground provided for the test sample was interrupted by the wooden table upon which the sample was placed and which situates the test sample 80 cm. above the floor of the lab area.

The EMC receiver, a Tektronix 2712, is located outside the screen room and is grounded with a two inch copper strap at the rear of the instrument and a 2 AWG welding cable at the front of the instrument.

3.3 RADIATED CONFIGURATION:

In radiated tests, the test sample was oriented so that the area exhibiting the greatest amount of radiation was facing the antenna.

All measurements were performed using the peak and quasi peak reading capability of the Tek 2712.

3.4 TEST SAMPLE OPERATION:

All test measurements were made with the unit in its normal measuring mode after a 3-minute power up period. The EUT was pumping at its maximum rate during this test.

3.5 TEST PROCEDURES/LIMITS OF ACCEPTANCE:

The general procedures are dictated in the individual protocols listed such as ANSI 63.4, FCC Part 15, CISPR 11, and CISPR 22. The limits for FCC rules presently are given in Part 15.109 of 47 CFR 1 (10-9-1990) Edition of the Federal Code of Regulations. **The antenna used is the Antenna Research LPB 2520 Biconilog antenna in both its horizontal and vertical modes for 5-meter compliance tests.**

VDE LIMITS (ELECTRIC FIELDS - CISPR 11)

Above 30 MHz the limit is written at 30 meters. From 30 MHz to 230 MHz the "A" level allowed is 30 uV/m, and 37 dBuV/m) from 230 MHz to 1000 MHz. Since the specification is written at 30 meters the extrapolated allowed values to 3 meters are 50 dBuV/m and 57 dBuV/m respectively. If this requirement is passed and the Cispr 11 B level limit is not passed then the following warning is recommended to be included in the instructions for use:

> **This (Equipment and/or System) is suitable for use in all establishments other than domestic and those directly connected to the low voltage power supply network that supplies buildings used for domestic purposes.**

Sale of devices is not restricted when this warning is included in the instructions.

For CISPR 11 B level, the allowed radiated emissions are measured at a 10 meters distance. The allowed levels are 30 dBuV/m from 30 to 230 MHz, and from 230 to 1000 MHz the level is 37 dBuV/m. The levels have been linearly extrapolated on the graphs to 5 meters, which reflects a 6 dB increase.

Hereinafter, the equipment under test will be referred to as the E.U.T. All radiated tests above 30 MHz are made with horizontal and vertical polarizations where applicable.

4.0 CONCLUSION OF RADIO FREQENCY INTERFERENCE EMISSIONS TESTS:

Preliminary Test

The device was oriented with the front of the EUT facing the antenna initially. The unit was varied in position and antenna height with a 2 meter antenna height found typically to be worst case. The orientation of the unit was typically with the control box and joystick facing front at 0 degrees wrt the antenna. Device was cycling for all tests.

Final Testing – 09/22/2010

Seq. 313 shows the ambient; Seq. 322 shows the quasipeak mode in comparison in the range of 20-75 MHz. All emissions were checked with one at 72 MHz found to be from the ambient, all others found to be in compliance as confirmed by the quasipeak measurement. Tabular data is shown at the end of the graphical data.

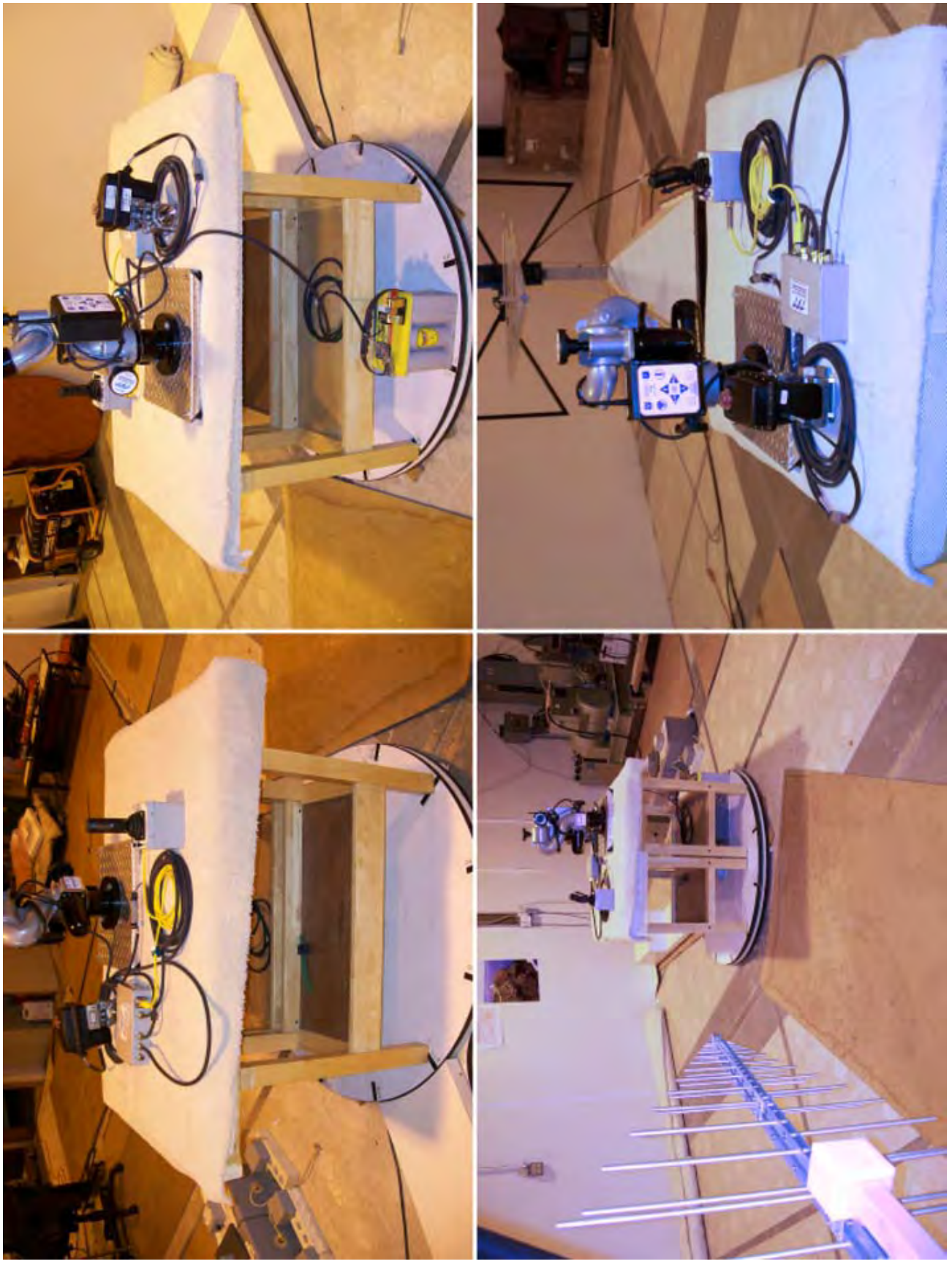
In the 75-170 MHz range, Seq. 315 shows the ambient and Seq. 327 shows the quasipeak emissions. Ambient emissions consist of the FM band and the intentional radiators at 152-158 and 162 MHz. Emissions above the line in the mid band area were discovered to be sporadic airplane emissions. No other emissions from the EUT appeared to be above the line. Emissions low in the frequency range appeared to be FM related carriers.

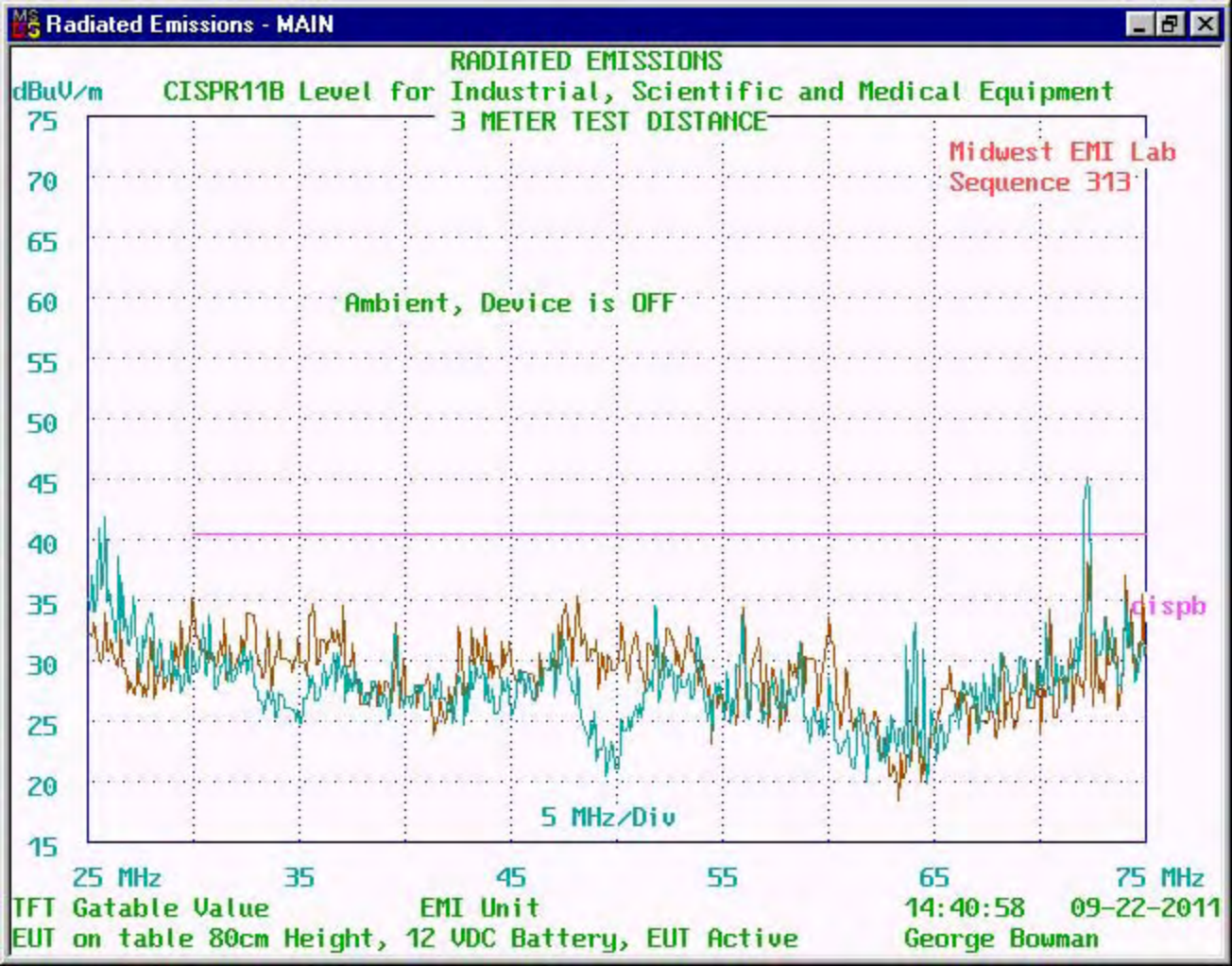
In the 170-300 MHz range, the ambient is shown on Seq. 316, and peak level on Seq. 326. No areas of emission from the EUT appeared to exceed the limit. Other emissions seen were from TV Channels 7 and 11 and an ambient radio station at 224 MHz.

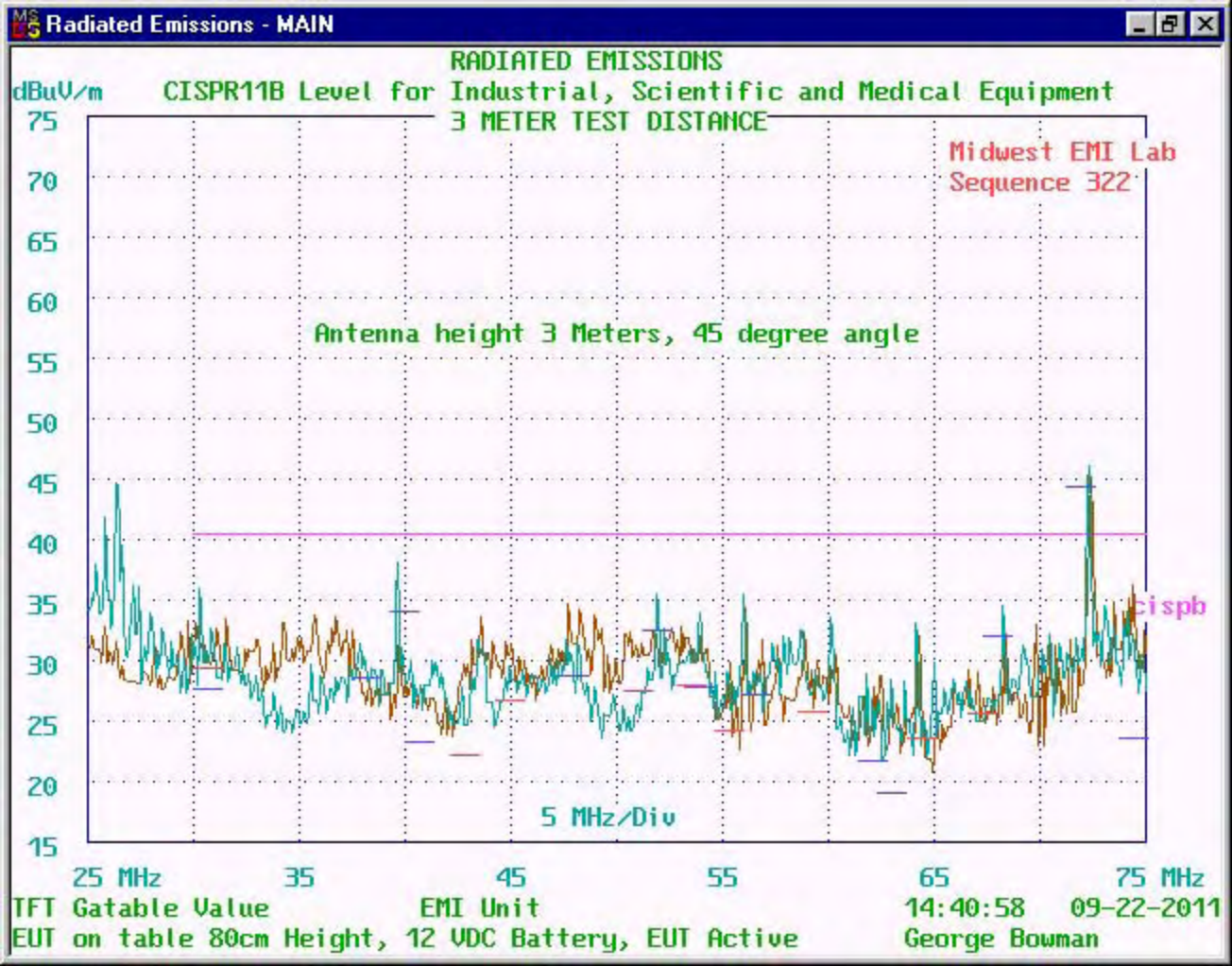
In the 300-640 MHz, the ambient is shown on Seq. 318 and the peak level emissions are shown on Seq. 323. Other high emissions are numerous UHF TV stations and they are identified in the summary at the beginning of this document. Two emissions found in this range 440-450 MHz different from the ambient were individually inspected and not found to be due to the EUT but were from limo taxi services.

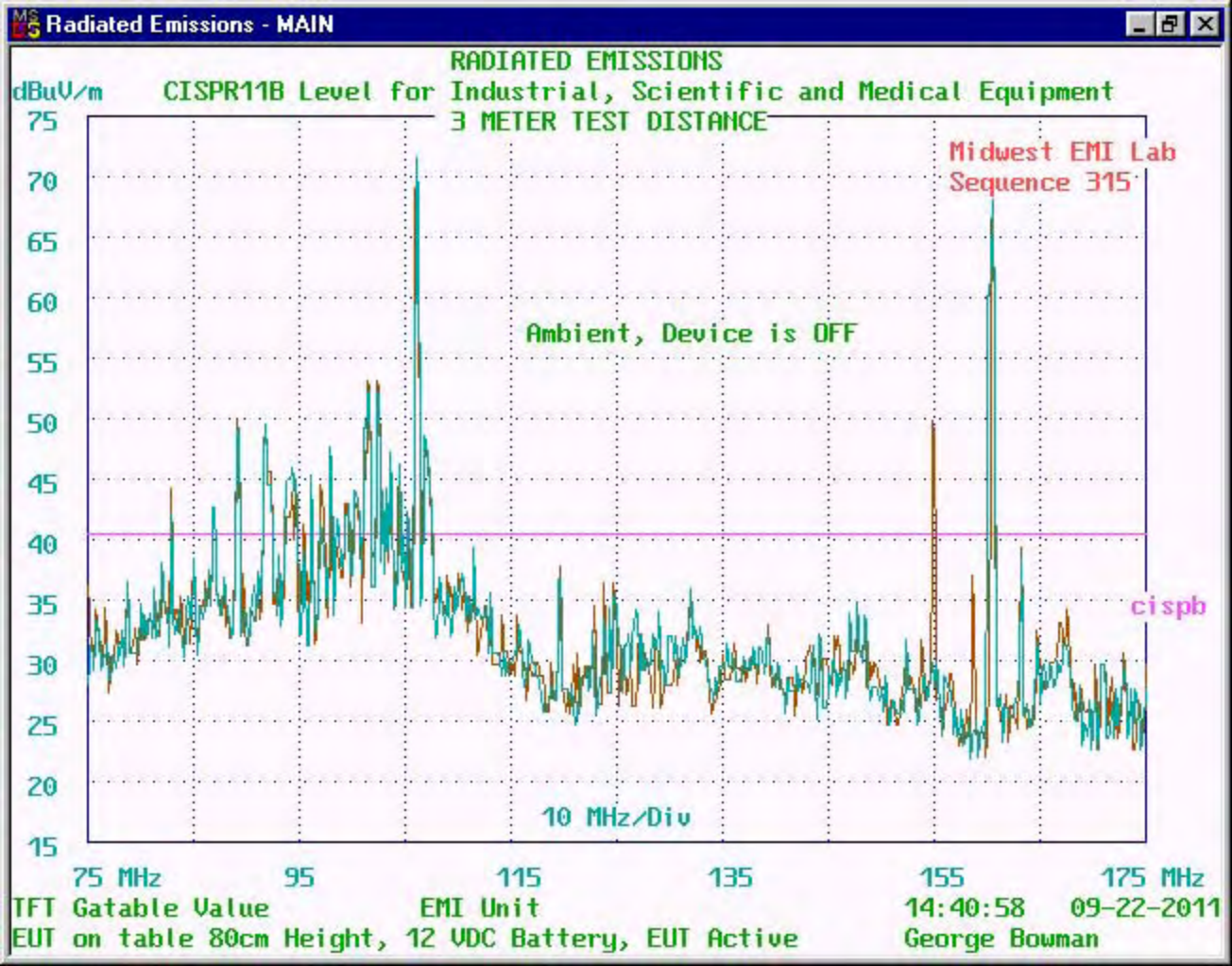
In the 620-1000 MHz, the ambient is shown on Seq. 321 and peak level on Seq. 322. Other high emissions are numerous UHF TV stations (see summary at the beginning of this document) and the cell telephone band around 900 MHz that is identified. When the graphs were overlaid, no excess level introduced by the EUT was seen.

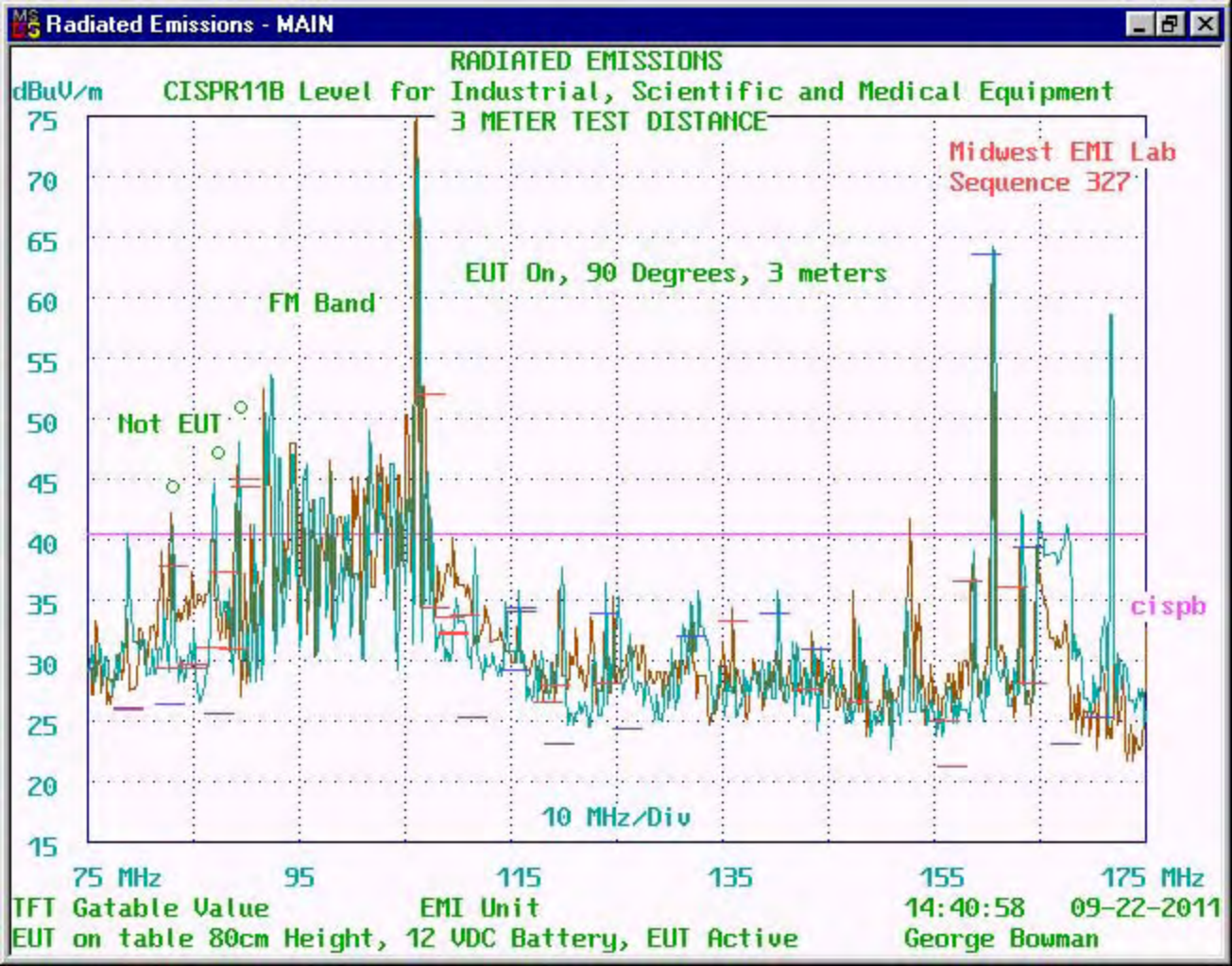
The TFT EP0306 was fully compliant with the Cispr 11 B level specification. The actual battery used for this test was a large 12 volt lead acid battery that was attached to the battery terminals by clip leads.

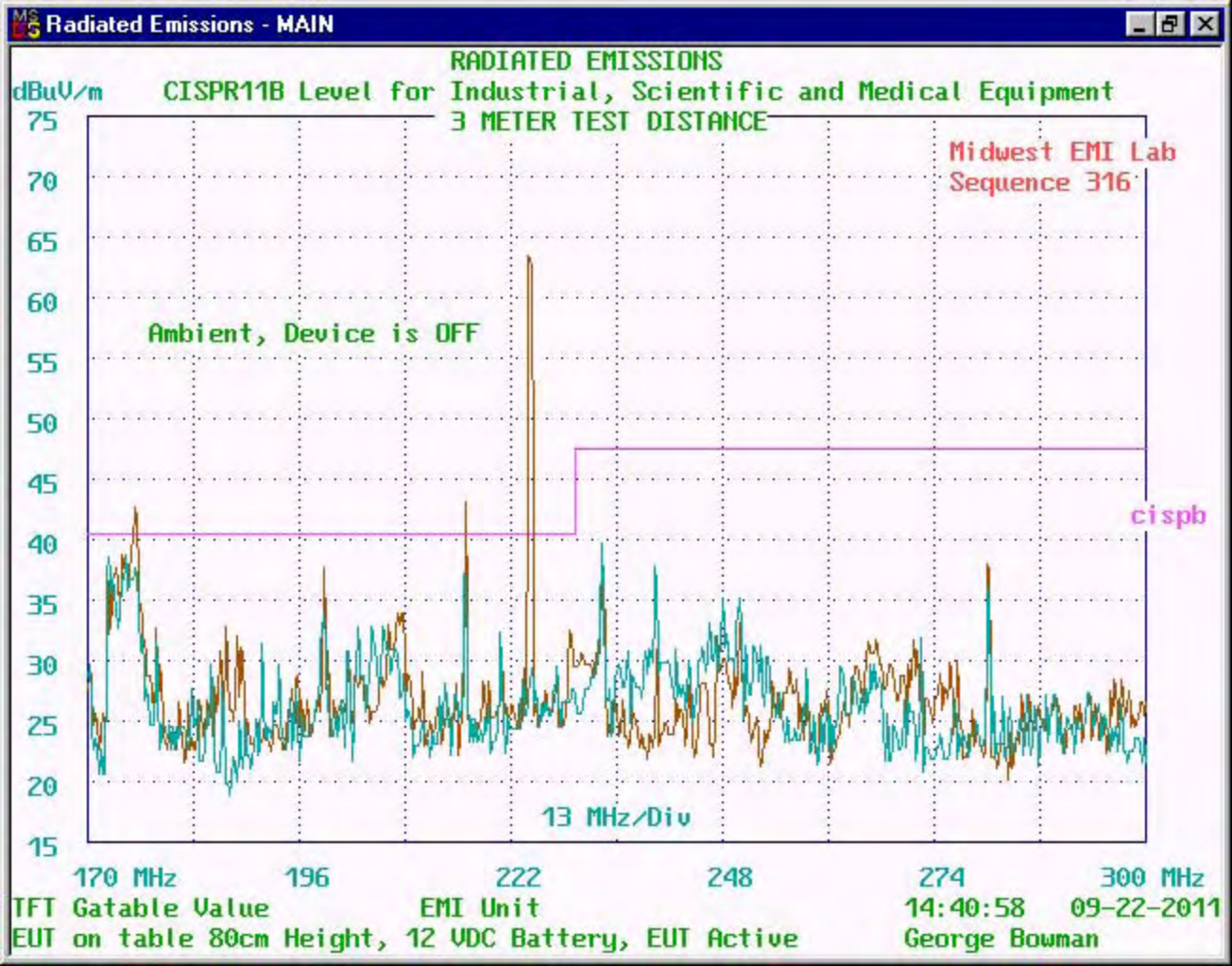


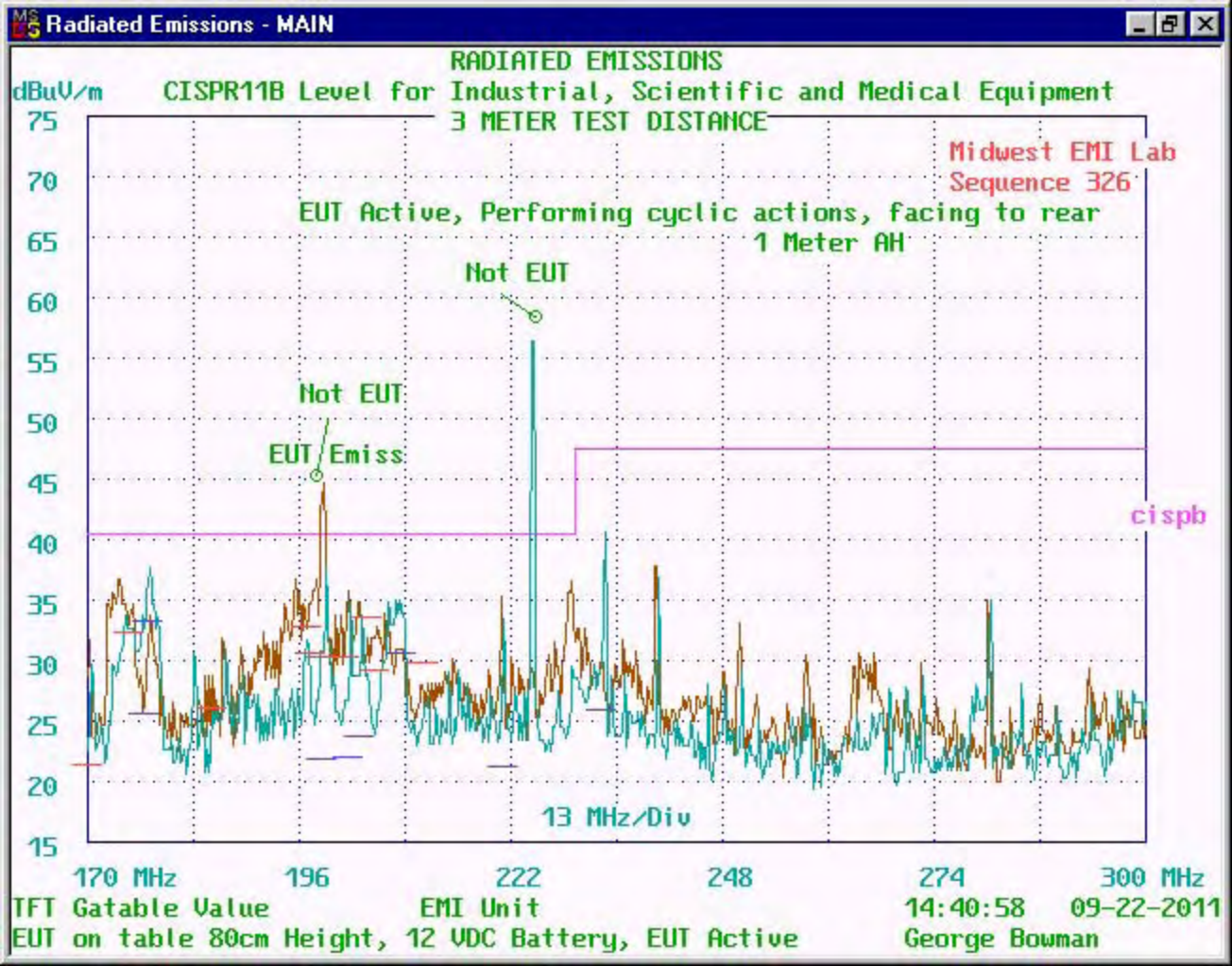

Radiated Emissions - MAIN
RADIATED EMISSIONS
dBuV/m
CISPR11B Level for Industrial, Scientific and Medical Equipment
3 METER TEST DISTANCE
Midwest EMI Lab
Sequence 313
Ambient, Device is OFF
dispb
5 MHz/Div
75
70
65
60
55
50
45
40
35
30
25
20
15
25 MHz
35
45
55
65
75 MHz
TFT Gatable Value
EMI Unit
14:40:58
09-22-2011
EUT on table 80cm Height, 12 VDC Battery, EUT Active
George Bowman

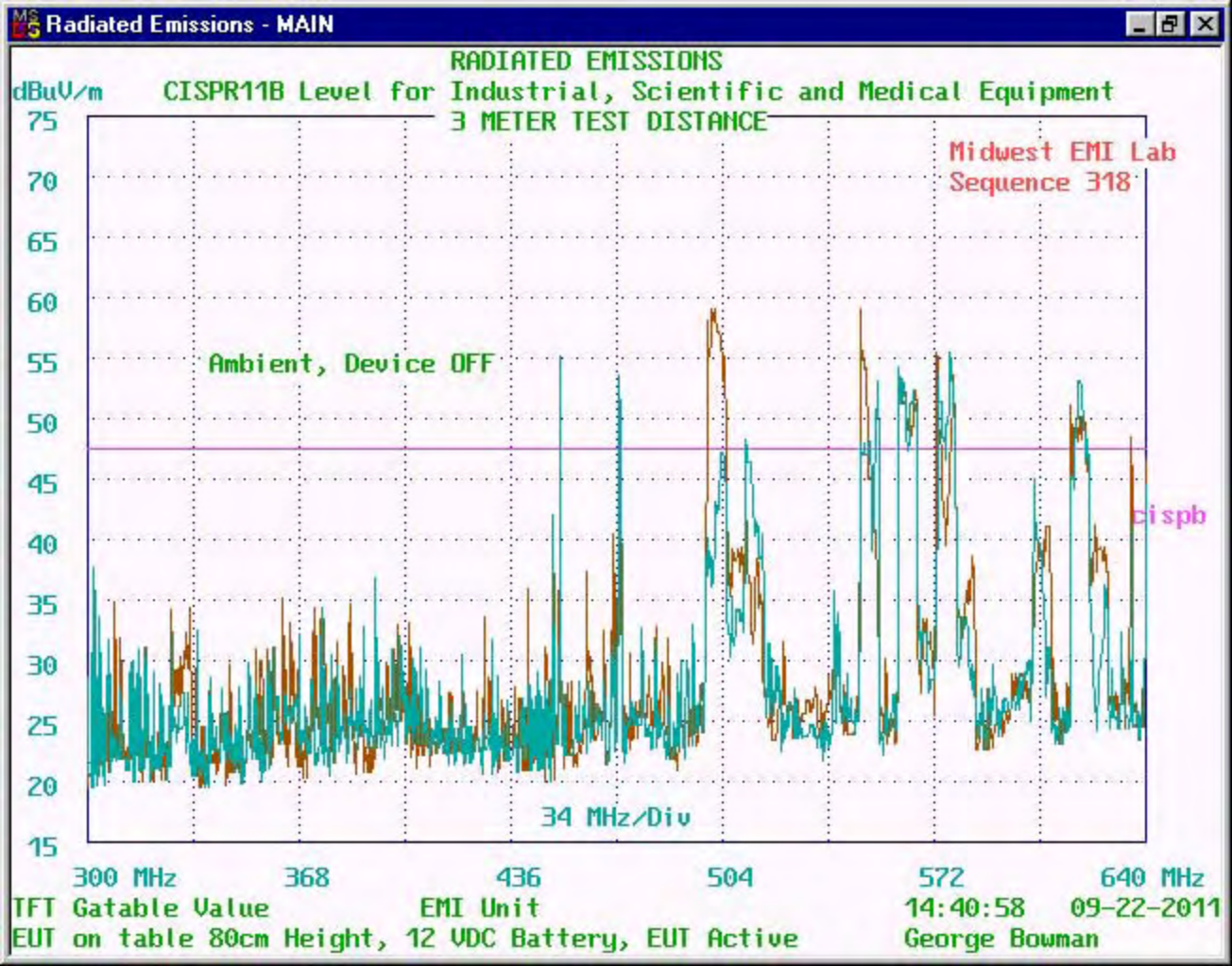

Radiated Emissions - MAIN
RADIATED EMISSIONS
dBuV/m
CISPR11B Level for Industrial, Scientific and Medical Equipment
3 METER TEST DISTANCE
Midwest EMI Lab
Sequence 322
Antenna height 3 Meters, 45 degree angle
cispb
5 MHz/Div
75
70
65
60
55
50
45
40
35
30
25
20
15
25 MHz
35
45
55
65
75 MHz
TFT Gatable Value
EMI Unit
14:40:58
09-22-2011
EUT on table 80cm Height, 12 VDC Battery, EUT Active
George Bowman

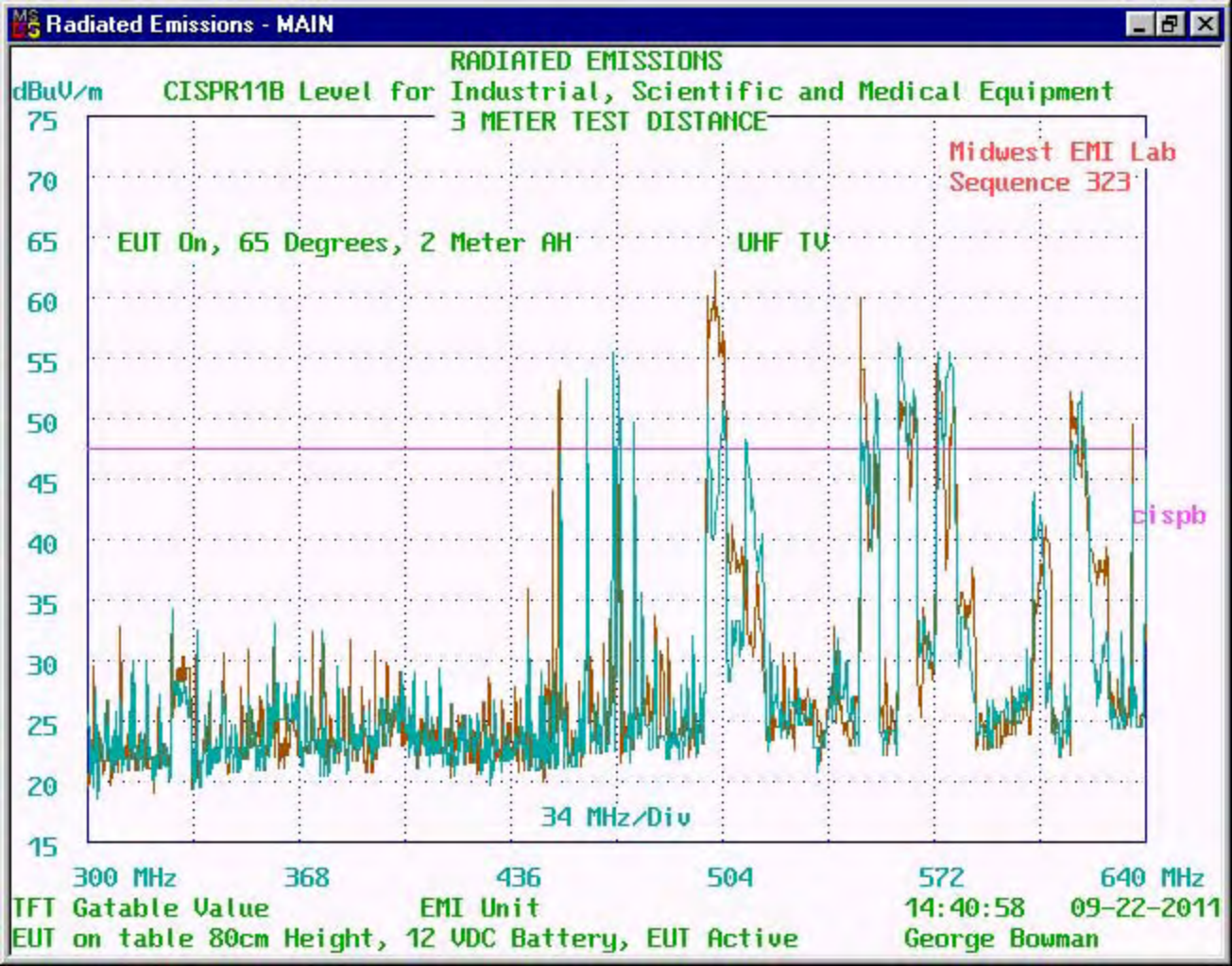

Radiated Emissions - MAIN
RADIATED EMISSIONS
dBuV/m
CISPR11B Level for Industrial, Scientific and Medical Equipment
3 METER TEST DISTANCE
Midwest EMI Lab
Sequence 315
Ambient, Device is OFF
cispb
10 MHz/Div
75
70
65
60
55
50
45
40
35
30
25
20
15
75 MHz
95
115
135
155
175 MHz
TFT Gatable Value
EMI Unit
14:40:58
09-22-2011
EUT on table 80cm Height, 12 VDC Battery, EUT Active
George Bowman

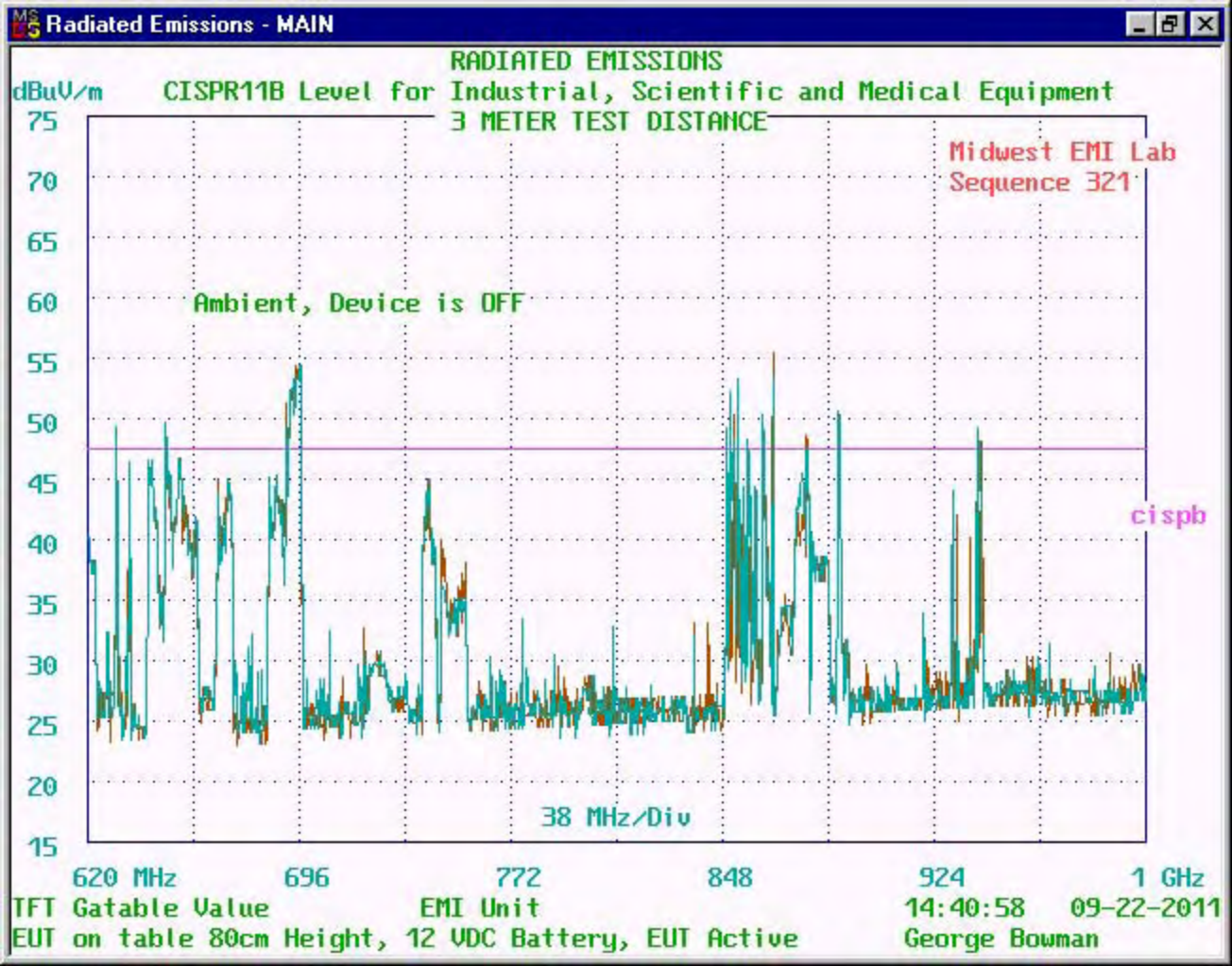

Radiated Emissions - MAIN
RADIATED EMISSIONS
dBuV/m
CISPR11B Level for Industrial, Scientific and Medical Equipment
3 METER TEST DISTANCE
Midwest EMI Lab
Sequence 327
EUT On, 90 Degrees, 3 meters
FM Band
Not EUT
cispb
10 MHz/Div
75
70
65
60
55
50
45
40
35
30
25
20
15
75 MHz
95
115
135
155
175 MHz
TFT Gatable Value
EMI Unit
14:40:58
09-22-2011
EUT on table 80cm Height, 12 VDC Battery, EUT Active
George Bowman

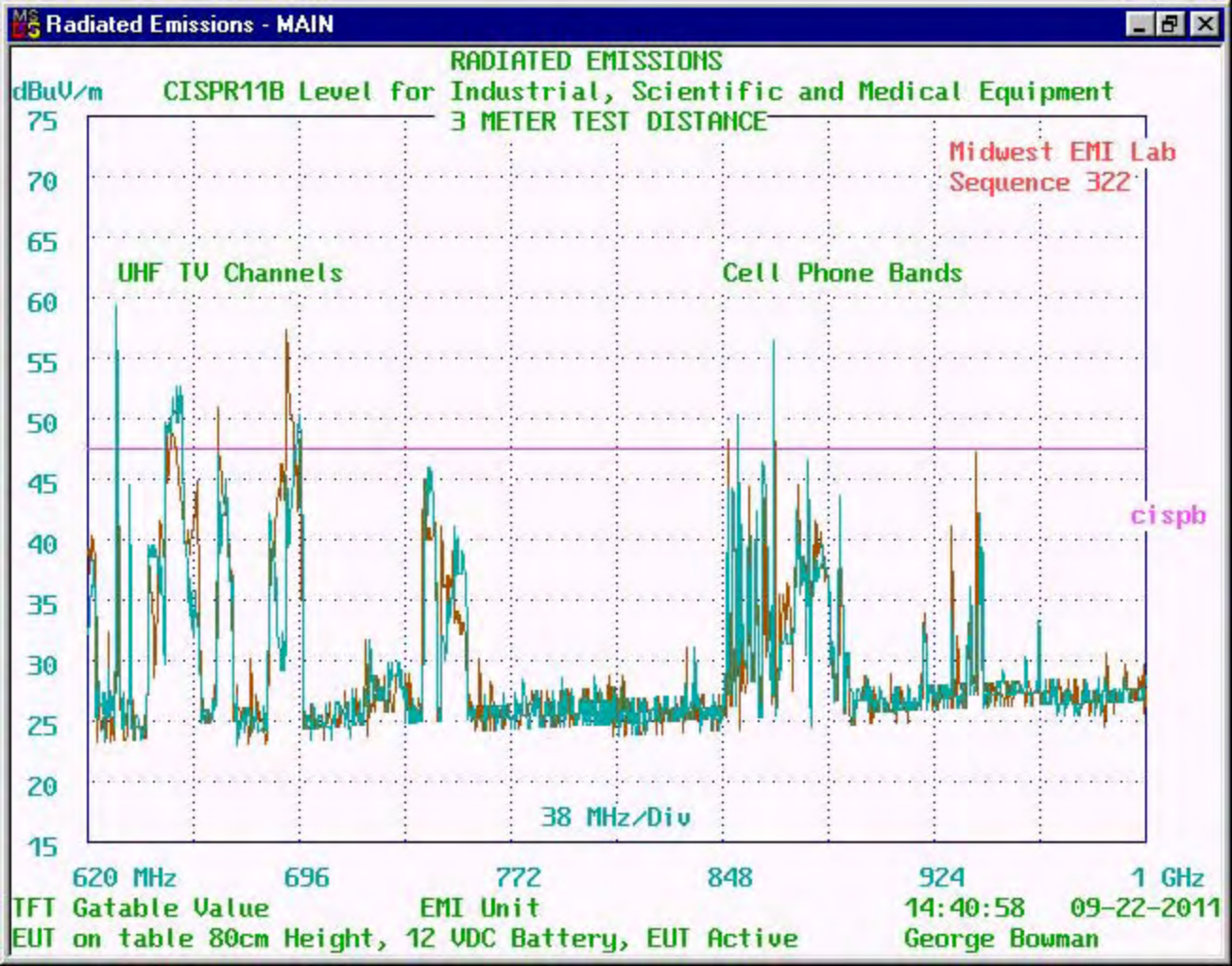

Radiated Emissions - MAIN
RADIATED EMISSIONS
dBuV/m
CISPR11B Level for Industrial, Scientific and Medical Equipment
3 METER TEST DISTANCE
Midwest EMI Lab
Sequence 316
Ambient, Device is OFF
cispb
75
70
65
60
55
50
45
40
35
30
25
20
15
13 MHz/Div
170 MHz
196
222
248
274
300 MHz
TFT Gatable Value
EMI Unit
14:40:58
09-22-2011
EUT on table 80cm Height, 12 VDC Battery, EUT Active
George Bowman


Radiated Emissions - MAIN
RADIATED EMISSIONS
dBuV/m
CISPR11B Level for Industrial, Scientific and Medical Equipment
3 METER TEST DISTANCE
Midwest EMI Lab
Sequence 326
EUT Active, Performing cyclic actions, facing to rear
1 Meter AH
Not EUT
Not EUT
EUT Emiss
cispb
75
70
65
60
55
50
45
40
35
30
25
20
15
13 MHz/Div
170 MHz
196
222
248
274
300 MHz
TFT Gatable Value
EMI Unit
14:40:58
09-22-2011
EUT on table 80cm Height, 12 VDC Battery, EUT Active
George Bowman


Radiated Emissions - MAIN
RADIATED EMISSIONS
dBuV/m
CISPR11B Level for Industrial, Scientific and Medical Equipment
3 METER TEST DISTANCE
Midwest EMI Lab
Sequence 318
Ambient, Device OFF
cispb
75
70
65
60
55
50
45
40
35
30
25
20
15
34 MHz/Div
300 MHz
368
436
504
572
640 MHz
TFT Gatable Value
EMI Unit
14:40:58
09-22-2011
EUT on table 80cm Height, 12 VDC Battery, EUT Active
George Bowman


Radiated Emissions - MAIN
RADIATED EMISSIONS
dBuV/m
CISPR11B Level for Industrial, Scientific and Medical Equipment
3 METER TEST DISTANCE
Midwest EMI Lab
Sequence 323
EUT On, 65 Degrees, 2 Meter AH
UHF TV
cispb
34 MHz/Div
75
70
65
60
55
50
45
40
35
30
25
20
15
300 MHz
368
436
504
572
640 MHz
TFT Gatable Value
EMI Unit
14:40:58
09-22-2011
EUT on table 80cm Height, 12 VDC Battery, EUT Active
George Bowman


Radiated Emissions - MAIN
RADIATED EMISSIONS
dBuV/m
CISPR11B Level for Industrial, Scientific and Medical Equipment
3 METER TEST DISTANCE
Midwest EMI Lab
Sequence 321
Ambient, Device is OFF
cispb
38 MHz/Div
75
70
65
60
55
50
45
40
35
30
25
20
15
620 MHz
696
772
848
924
1 GHz
TFT Gatable Value
EMI Unit
14:40:58
09-22-2011
EUT on table 80cm Height, 12 VDC Battery, EUT Active
George Bowman


Radiated Emissions - MAIN
RADIATED EMISSIONS
dBuV/m
CISPR11B Level for Industrial, Scientific and Medical Equipment
3 METER TEST DISTANCE
Midwest EMI Lab
Sequence 322
UHF TV Channels
Cell Phone Bands
cispb
75
70
65
60
55
50
45
40
35
30
25
20
15
38 MHz/Div
620 MHz
696
772
848
924
1 GHz
TFT Gatable Value
EMI Unit
14:40:58
09-22-2011
EUT on table 80cm Height, 12 VDC Battery, EUT Active
George Bowman

SHEET 1 cispb RADIATED QUASI-PEAK REPORT
CISPR11B Level for Industrial, Scientific and Medical Equipment
3 METER TEST DISTANCE
TIME: 14:40:58 Midwest EMI
DATE: 09-22-2011 Associates
TEST ITEM: TFT Gatable Value
SERIAL NUMBER: EMI Unit Sequence Number: 326
COMMENTS: EUT on table 80cm Height, 12 VDC Battery, EUT Active
TEST PERFORMED BY: George Bowman

Peak Frequency (MHz)	Peak Interference (dBuV/m)	Quasi-peak Freq. (MHz)	Quasi-peak Interfer (dBuV/m)	Spec. Level (dBuV/m)	Antenna Polar (H/V)
170	*40.795*	*170.1544*	*21.489*	*40.500*	*Horizontal*
175.2799	*37.386*	*175.2863*	*32.430*	*40.500*	*Horizontal*
185.5667	*35.105*	*185.5291*	*26.164*	*40.500*	*Horizontal*
196.7242	*36.061*	*196.7154*	*32.814*	*40.500*	*Horizontal*
198.9	*44.418*	*198.892*	*30.418*	*40.500*	*Horizontal*
201.7	*35.050*	*201.6064*	*30.447*	*40.500*	*Horizontal*
204.3588	*36.199*	*204.3324*	*33.631*	*40.500*	*Horizontal*
205.3883	*35.854*	*205.4283*	*29.264*	*40.500*	*Horizontal*
211.6463	*29.736*	*211.4463*	*29.846*	*40.500*	*Horizontal*
197.3	*34.039*	*197.2656*	*30.737*	*40.500*	*Horizontal*
177.2759	*35.427*	*177.1479*	*25.723*	*40.500*	*Vertical*
177.3	*36.717*	*177.4208*	*33.413*	*40.500*	*Vertical*
199.1	*35.713*	*198.9512*	*22.016*	*40.500*	*Vertical*
202.2	*35.165*	*202.1792*	*22.165*	*40.500*	*Vertical*
203.5	*33.805*	*203.5024*	*23.805*	*40.500*	*Vertical*
208.6413	*36.648*	*208.6909*	*30.663*	*40.500*	*Vertical*
221	*35.332*	*221.1976*	*21.338*	*40.500*	*Vertical*
233.2	*40.692*	*233.248*	*26.093*	*47.500*	*Vertical*

SHEET 1 cispb RADIATED QUASI-PEAK REPORT
CISPR11B Level for Industrial, Scientific and Medical Equipment
3 METER TEST DISTANCE
TIME: 14:40:58 Midwest EMI
DATE: 09-22-2011 Associates
TEST ITEM: TFT Gatable Value
SERIAL NUMBER: EMI Unit Sequence Number: 322
COMMENTS: EUT on table 80cm Height, 12 VDC Battery, EUT Active
TEST PERFORMED BY: George Bowman

Peak Frequency (MHz)	Peak Interference (dBuV/m)	Quasi-peak Freq. (MHz)	Quasi-peak Interfer (dBuV/m)	Spec. Level (dBuV/m)		Antenna Polar (H/V)
30.56435	36.480	30.662	29.499	40.500		Horizontal
42.71773	38.075	42.9153	22.340	40.500		Horizontal
45.09345	35.968	44.9783	26.812	40.500		Horizontal
50.97716	33.623	51.0388	27.652	40.500		Horizontal
53.608	34.602	53.5816	27.978	40.500		Horizontal
55.11621	34.840	55.2858	24.347	40.500		Horizontal
59.1824	33.902	59.2568	25.793	40.500		Horizontal
64.54172	36.844	64.44329	23.700	40.500		Horizontal
67.46088	45.066	67.3601	25.705	40.500		Horizontal
30.46327	34.728	30.6649	27.697	40.500		Vertical
38.06749	34.391	38.2355	28.740	40.500		Vertical
39.91303	37.738	40.0098	34.079	40.500		Vertical
40.78629	33.284	40.6343	23.304	40.500		Vertical
47.82467	33.041	48.0103	28.833	40.500		Vertical
51.86776	35.512	52.0022	32.654	40.500		Vertical
53.75049	34.922	53.9505	27.952	40.500		Vertical
56.53899	36.908	56.5214	27.337	40.500		Vertical
62.08867	38.855	62.2055	21.782	40.500		Vertical
62.9935	35.731	62.9727	19.111	40.500		Vertical
68.1084	34.591	67.994	32.068	40.500		Vertical
72.10115	39.767	71.9996	44.400	40.500	*	Vertical
74.34833	39.843	74.5403	23.717	40.500		Vertical

SHEET 1 cispb RADIATED QUASI-PEAK REPORT
CISPR11B Level for Industrial, Scientific and Medical Equipment
3 METER TEST DISTANCE
TIME: 12:58:00 Midwest EMI
DATE: 09-09-2011 Associates
TEST ITEM: TFT Gatable Value
SERIAL NUMBER: EMI Unit Sequence Number: 309
COMMENTS: EUT on table 80cm Height, 12 VDC Battery, EUT Active
TEST PERFORMED BY: George Bowman

Peak Frequency (MHz)	Peak Interference (dBuV/m)	Quasi-peak Freq. (MHz)	Quasi-peak Interfer (dBuV/m)	Spec. Level (dBuV/m)		Antenna Polar (H/V)
116.6	*45.987*	*116.6832*	*43.087*	*40.500*	*	*Horizontal*
122.6	*46.409*	*122.4672*	*28.119*	*40.500*		*Horizontal*
129.5238	*46.331*	*129.423*	*27.461*	*40.500*		*Horizontal*
152.6	*66.506*	*152.4536*	*68.805*	*40.500*	*	*Horizontal*
106.2	*69.015*	*106.0024*	*37.479*	*40.500*		*Vertical*
116.7434	*45.286*	*116.7466*	*43.088*	*40.500*	*	*Vertical*

SHEET 1 cispb RADIATED QUASI-PEAK REPORT
CISPR11B Level for Industrial, Scientific and Medical Equipment
3 METER TEST DISTANCE
TIME: 14:40:58 Midwest EMI
DATE: 09-22-2011 Associates
TEST ITEM: TFT Gatable Value
SERIAL NUMBER: EMI Unit Sequence Number: 327
COMMENTS: EUT on table 80cm Height, 12 VDC Battery, EUT Active
TEST PERFORMED BY: George Bowman

Peak Frequency (MHz)	Peak Interference (dBuV/m)	Quasi-peak Freq. (MHz)	Quasi-peak Interfer (dBuV/m)	Spec. Level (dBuV/m)		Antenna Polar (H/V)
78.59999	36.223	78.76560	25.938	40.500		Horizontal
82.8	42.158	82.96720	29.481	40.500		Horizontal
84.76246	38.408	84.8969	29.718	40.500		Horizontal
86.8	41.917	86.66079	31.192	40.500		Horizontal
89.000	44.715	88.88719	30.994	40.500		Horizontal
89.99768	36.860	90.1185	45.018	40.500	*	Horizontal
90.10142	41.568	90.1174	44.517	40.500	*	Horizontal
84.8	38.408	84.8856	29.417	40.500		Horizontal
83.33504	34.949	83.2486	37.819	40.500		Horizontal
87.59999	35.363	87.7424	37.389	40.500		Horizontal
107.562	38.438	107.462	52.041	40.500	*	Horizontal
108.0139	37.146	107.9107	34.422	40.500		Horizontal
109.2	37.254	109.3976	33.689	40.500		Horizontal
109.8	38.056	109.608	32.427	40.500		Horizontal
109.7982	37.439	109.6014	32.326	40.500		Horizontal
110.9283	36.821	110.7595	33.888	40.500		Horizontal
118.4	39.399	118.4592	26.699	40.500		Horizontal
119.471	39.365	119.3254	28.071	40.500		Horizontal
124.6243	36.849	124.4331	28.162	40.500		Horizontal
135.7792	37.620	135.9792	33.298	40.500		Horizontal
143.4806	40.004	143.3542	27.685	40.500		Horizontal
148	32.223	147.9992	26.623	40.500		Horizontal
156	40.528	155.9944	25.128	40.500		Horizontal
157.8922	32.606	158.0922	36.630	40.500		Horizontal
156.7954	40.548	156.6394	21.259	40.500		Horizontal
162.3349	38.757	162.5333	36.133	40.500		Horizontal
164.4	39.505	164.3432	28.200	40.500		Horizontal
78.82178	40.242	78.7578	26.238	40.500		Vertical
83.000	41.885	82.9512	26.478	40.500		Vertical
87.29133	43.954	87.44969	25.736	40.500		Vertical
111.6	40.402	111.5456	25.395	40.500		Vertical
115.4405	37.980	115.5157	29.280	40.500		Vertical
115.8776	37.980	116.0192	34.383	40.500		Vertical
116.2	40.084	116.0112	34.083	40.500		Vertical
119.6	37.249	119.8008	23.233	40.500		Vertical
123.9485	37.613	124.0077	33.996	40.500		Vertical
126	36.742	125.9904	24.443	40.500		Vertical
132	36.355	132.0176	32.053	40.500		Vertical
140	36.290	140.0064	33.989	40.500		Vertical
144.2	34.280	144.0112	31.004	40.500		Vertical
159.868	63.170	159.9856	63.698	40.500	*	Vertical

SHEET 2 cispb RADIATED QUASI-PEAK REPORT
CISPR11B Level for Industrial, Scientific and Medical Equipment
3 METER TEST DISTANCE
TIME: 14:40:58 Midwest EMI
DATE: 09-22-2011 Associates
TEST ITEM: TFT Gatable Value
SERIAL NUMBER: EMI Unit Sequence Number: 327
COMMENTS: EUT on table 80cm Height, 12 VDC Battery, EUT Active
TEST PERFORMED BY: George Bowman

Peak Frequency (MHz)	Peak Interference (dBuV/m)	Quasi-peak Freq. (MHz)	Quasi-peak Interfer (dBuV/m)	Spec. Level (dBuV/m)	Antenna Polar (H/V)
163.9703	*41.976*	*164.0975*	*39.477*	*40.500*	*Vertical*
170.7382	*33.064*	*170.7622*	*25.366*	*40.500*	*Vertical*
167.5251	*39.958*	*167.6579*	*23.249*	*40.500*	*Vertical*

APPENDIX C

ELECTRICAL FAST TRANSIENT/BURST TEST

(EN 61000-4-4, First Edition, 1995 and successors)

1.0 PURPOSE:

The purpose of this test is to insure that commercial or medical devices will not be susceptible to electrical spikes or transients applied to their input AC or DC leads. This investigation evaluated the immunity of the EUT to controlled fast, low energy transients on the power or peripheral cable input lines. The burst duration is typically 15 ms and the repetition rate of the salvo of pulses is about 300 ms for commercial equipment. The applicable standard is the European IEC 61000-4-4 regimen.

2.0 DESCRIPTION OF TEST APPARATUS:

The test apparatus for this test consists of the Haefely P90.1 (Article 093 204.1), S/N 083 485-32 with attendant cables and Cable Adapter 093 506.1 S/N 083 593-14. The general configuration of the test unit is described in the following test report.

3.0 TEST PROCEDURES:

3.1 POWER LEADS:

Application of the EFT generator to the EUT was performed with the power input cable routed vertically, from the EFT/B generator to the EUT. Power of 120 VAC/ 60- Hz was applied through the line and neutral leads of the EFT generator that included an internal coupler/decoupler mechanism. The power leads were less than one meter per standard. If longer ones are supplied by the manufacturer the excess is gathered into a flat coil with a .4 meter diameter and situated at a distance of .1 meter above the ground reference plane.

3.2 POLARITY and TEST LEVELS:

The electrical fast transient/burst was applied for the following modes of operation:

1) Line with respect to the GRP (Ground Reference Plane)
2) Neutral with respect to the GRP
3) Line and Neutral with respect to the GRP
4) Protective Earth with respect to the GRP
5) Line and Protective Earth with respect to the GRP
6) Neutral and Protective Earth with respect to the GRP
7) Neutral, Line and Protective Earth with respect to the GRP

Tests were performed for the following EFT/B voltage levels, repetition rates, period and duration, for asynchronous triggering with respect to the AC line input:

LEVEL	OPEN CIRCUIT OUTPUT TEST VOLTAGE	REPETITION RATE	BURST DURATION	BURST PERIOD
1	.5 KV	5.0 KHZ	15 MSEC	300 MSEC
2	1 KV	5.0 KHZ	15 MSEC	300 MSEC
3	2 KV	5.0 KHZ	15 MSEC	300 MSEC
4	4 KV	2.5 KHZ	15 MSEC	300 MSEC

The test duration of each test, at each voltage level, for each mode of operation, for positive and negative polarities was 2 minutes.

3.3 EFT GENERATOR CHARACTERISTICS:

Per standard and generator specifications the following are the EFT characteristics:

Maximum energy: 4 mJ/pulse at 2KV into 50 ohm load
Polarity: Positive/Negative
Output type: Coaxial (Cable Clamp Operation)
Dynamic source impedance: 50 ohms +/- 20% /1-100 MHz
DC blocking capacitor: 10 NF
Repetition frequency: variable
Rise time of one pulse: 5 ns +/- 30 %
Impulse Duration: 50 ns +/- 30%
Power source synchronism condition: Asynchronous
Burst Duration: 15 ms +/- 20%
Burst Period: 300 ms +/- 20%

3.4 COUPLING DECOUPLING NETWORK CHARACTERISTICS:

Frequency Range: 1 to 100 MHz
Coupling Capacitors: 33 NF
Decoupling attenuation in the non-symmetrical condition: >20dB
Cross talk attenuation in network between lines: >30 dB
Insulation withstand of coupling capacitors: 5 kV (1.2/50uS)

3.5 COUPLING CLAMP CHARACTERISTICS:

Typical coupling capacitance: 50-200 puff
Usable diameter range of round cables: 4-40 mm
Insulation withstand voltage: 5 KV

3.6 GROUND REFERENCE PLANE:

The ground reference plane is greater than 1x1 meter and allows at least 10 cm of excess dimension beyond the longest dimension of the EUT. The EUT is put on a wooden support approximately 80 cm. above the ground reference plane. A very short strap of negligible inductance (#2 AWG braided cable) and resistance couples the EFT to the GRP. All other structures that were conductive were at least .5 meter from the EUT per standard.

3.7 REFERENCE DOCUMENT:

The reference document that defines the scope of the investigation, specific details, acceptability of test methods and results, techniques and construction details, as required, may be found in:

EN 61000-4-4, Second Edition, 2004 entitled "Electromagnetic compatibility (EMC) - Part 4-4: Testing and measurement techniques - Electrical fast transient/burst immunity test- Section 4: Electrical fast transient/burst immunity test, Basic EMC Publication" and successors

3.8 ACCEPTABILITY CRITERION:

The following criterion was established to determine the compliance of the EUT to the test regimen:

An unacceptable operating response to the stimulus was:

1) Any variation in a displayed character on a front panel display
2) Any permanent cessation of communication or adverse effect noticeable as a result of the application of EFT pulses
3) Any response of any kind that required an operator intervention to reset or recontrol the device to resume normal operation
4) Damage to the EUT such that it would be rendered inoperable or operate outside the manufacturer's specifications

A small variation in light intensity of a display or a small variation in a displayed operating parameter in response to the applied stimulus is considered acceptable if it is within the normal operating tolerances of the instrument.

4.0 TEST RESULTS

The TFT EP0306: JOYSTICK OPERATOR STATION WITH VALVE POSITION CONTROL was tested at .5, 1 KV and 2 KV using the standard power supply connections. There were no adverse results detected at any application of .5 and 1 KV and at 2 KV. After application the EUT performed perfectly normally. The EUT met all requirements with an "A" acceptance level.


TFT
TASK FORCE TIPS

Midwest EMI Associates
21234 West Commercial Drive
Mundelein, Illinois 60060

IEC Publication Number EN 61000-4-4, Part 4
2nd Edition, 2004-07, Amendment 1 (2010-11) Ed. 2
Electrical Fast Transients/Burst Immunity Test

Manufacturer: TFT Test Engineer Initials: JB

Equipment Under Test: GATABLE VALVE Date of Test: 9/9/2011

Model #: Y4E-JS-SLD Serial #: 9/9/2011 EMI UNIT

Temperature: 72.5 Humidity Level: 61-4

APPLIED BURST LEVEL: **.5 Kilovolt (Test Severity Level 1)**
REPETITION FREQUENCY: 5 Kilohertz **AC ADAPTER TYPE: (TWO) (THREE) TERMINAL**
BURST DURATION: 15 Msec BURST PERIOD: 300 Msec
TEST DURATION: 120 Seconds
POWER INPUT: (120 VAC / 60 Hz) (230VAC / 50 Hz) (208VAC 3PH, 50 Hz) OR BAT VOLT: 12 V

INSTRUMENT SETUP/NOMINAL CONDITIONS: OSCILLATING NORMALLY

Mode of Appearance	MINUS OBSERVATIONS	PLUS
Neutral with respect to the GRP	✓	✓
Line with respect to the GRP	✓	✓
Neutral and Line with respect to the GRP	✓	✓
PE with respect to the GRP	✓	✓
Line and PE with respect to the GRP	✓	✓
Neutral and PE with respect to the GRP	✓	✓
Neutral, Line and PE with respect to the GRP	✓	✓

* Failure Mode was: (NONE) NONE

Letter " ✓ " Indicates no failure was observed, * Indicates Device Malfunctioned

APPLIED BURST LEVEL: **1 Kilovolt (Test Severity Level 2)**
REPETITION FREQUENCY: 5 Kilohertz **AC ADAPTER TYPE: (TWO) (THREE) TERMINAL**
BURST DURATION: 15 Msec BURST PERIOD: 300 Msec
TEST DURATION: 120 Seconds
POWER INPUT: (120 VAC / 60 Hz) (230VAC / 50 Hz) (208VAC 3PH, 50 Hz) OR BAT VOLT: 12 V

INSTRUMENT SETUP/NOMINAL CONDITIONS: OSCILLATING NORMALLY

Mode of Appearance	MINUS OBSERVATIONS	PLUS
Neutral with respect to the GRP	✓	✓
Line with respect to the GRP	✓	✓
Neutral and Line with respect to the GRP	✓	✓
PE with respect to the GRP	✓	✓
Line and PE with respect to the GRP	✓	✓
Neutral and PE with respect to the GRP	✓	✓
Neutral, Line and PE with respect to the GRP	✓	✓

* Failure Mode was: (NONE) NONE

Number " ✓ " Indicates no failure was observed, * Indicates Device Malfunctioned

Midwest EMI Associates
21234 West Commercial Drive
Mundelein, Illinois 60060

IEC Publication Number EN 61000-4-4, Part 4
2nd Edition, 2004-07, Amendment 1 (2010-11) Ed. 2
Electrical Fast Transients/Burst Immunity Test

Manufacturer: TFT Test Engineer Initials: JB

Equipment Under Test: CATABLE VALVE Date of Test: 9/9/2011

Model #: _____ Serial #: 9/9/2011 EMI UNIT

Temperature: 72-5 Humidity Level: 61-4

APPLIED BURST LEVEL: **2 Kilovolt (Test Severity Level 3)**
REPETITION FREQUENCY: 5 Kilohertz **AC ADAPTER TYPE: (TWO) (THREE) TERMINAL**
BURST DURATION: 15 Msec BURST PERIOD: 300 Msec
TEST DURATION: 120 Seconds
POWER INPUT: (120 VAC / 60 Hz) (230VAC / 50 Hz) (208VAC 3PH, 50 Hz) OR BAT VOLT: 12 V

INSTRUMENT SETUP/NOMINAL CONDITIONS: OSCILLATING NORMALLY

Mode of Appearance	MINUS OBSERVATIONS	PLUS
Neutral with respect to the GRP	✓	✓
Line with respect to the GRP	✓	✓
Neutral and Line with respect to the GRP	✓	✓
PE with respect to the GRP	✓	✓
Line and PE with respect to the GRP	✓	✓
Neutral and PE with respect to the GRP	✓	✓
Neutral, Line and PE with respect to the GRP	✓	✓

* Failure Mode was: (NONE) OCCASIONAL GATE SEARCH (VALVE CHANGE POSITION)
Letter " ✓ " Indicates no failure was observed, * Indicates Device Malfunctioned

APPLIED BURST LEVEL: **4 Kilovolt (Test Severity Level 4)**
REPETITION FREQUENCY: 2.5 Kilohertz **AC ADAPTER TYPE: (TWO) (THREE) TERMINAL**
BURST DURATION: 15 Msec BURST PERIOD: 300 Msec
TEST DURATION: 120 Seconds
POWER INPUT: (120 VAC / 60 Hz) (230VAC / 50 Hz) (208VAC 3PH, 50 Hz) OR BAT VOLT: _____ V

INSTRUMENT SETUP/NOMINAL CONDITIONS: _____

Mode of Appearance	MINUS OBSERVATIONS	PLUS
Neutral with respect to the GRP		
Line with respect to the GRP		
Neutral and Line with respect to the GRP		
PE with respect to the GRP		
Line and PE with respect to the GRP		
Neutral and PE with respect to the GRP		
Neutral, Line and PE with respect to the GRP		

* Failure Mode was: _(NONE) _____
Number " ✓ " Indicates no failure was observed, * Indicates Device Malfunctioned

Midwest EMI Associates
21234 West Commercial Drive
Mundelein, Illinois 60060

IEC Publication Number 1000-4-4, Part 4, First Edition, 1995
British Standard 61000-4-4, Part 4, First Edition, 2000
Section 4. Electrical Fast Transient/Burst Immunity Test

Manufacturer: TFT Test Engineer Initials: RB

Equipment Under Test: GATABLE VALVE Date of Test: 9/9/2011

Model #: Y4E-JS-SLD Serial #: 9/9/2011 EMI UNIT

Temperature: 72.5 Humidity Level: 61.4

Haefely Clamp Test

This test uitilizes an application clamp that is not physically tied to the power line. In this test the cable bundle is placed inside the Haefely clamp and EFT impulses are applied to the cable via the action of the capacitive clamp. This test is used on cable bundles longer than 3 meters or in situations where use of the traditional apparatus is not feasible.

Applied Burst Level: As Listed Below
Repetition Frequency: 5 Kilohertz AC Adapter Type: (TWO) (THREE) terminal
Burst Duration: 15 Msec Burst Period: 300 Msec
Test Duration: 120 Seconds or : _____ Minutes
Power Input: (120 VAC / 60 Hz) (230VAC / 50 Hz) (480VAC/50Hz/3 Phase) or : _____ V

Instrument Setup/Nominal Conditions: JOYSTICK + VALVE CABLE

Voltage of Application	Minus Observations Plus	
.5 Kilovolt	✓	✓
1 Kilovolt	✓	✓
2 Kilovolt		
4 Kilovolt		
_____ Kilovolt		
_____ Kilovolt		
• _____ Kilovolt		

- Failure Mode was: NONE

Results of .5 kV Test: OK

Results of 1 kV Test: OK

Results of 2 kV Test: _____

Results of 4 kV Test: _____

Comments: _____

Number "1" Indicates no failure was observed, * Indicates Device Malfunctioned

APPENDIX D

RADIATED RADIO FREQUENCY INTERFERENCE SUSCEPTIBILITY TEST

(EN 61000-4-3, EN 1000-4-3, RS03 and successors)

1.0 PURPOSE:

The purpose of this test is to insure that commercial devices will not be susceptible to radiated electric fields. The frequency range tested is 10 KHz to 1 GHz nominally or higher for specific tests. The applicable standards are EN 61000-4-3, EN 1000-4-3 and Military Standard 461C Part 4, RS03 test.

2.0 DESCRIPTION OF TEST APPARATUS:

For this test, the TEK2756P Spectrum Analyzer may be used as a monitoring device with a biconical or conical antenna, and the Amplifier Research FM1000/FP1000 receiving system (optically isolated interface) is used for sensing purposes The two FP1000 and one FP2031 RF field probes are linked by an optical fiber cable outside the screen room for the purpose of closed loop control. The field is created using one of three different antennas with an amplifier such as the Model 2100L (lowband), ENI Model 525LA (midband), or Eaton Model 15100B (highband). The IEC test in two bands covers 27 MHz to 1000 MHz however the actual test range covered was 30 MHz to 1 GHz.

3.0 TEST PROCEDURES:

3.1 POWER LEADS & CABLE PLACEMENT:

The TFT EP0306: JOYSTICK OPERATOR STATION WITH VALVE POSITION CONTROL was powered by a 12 VDC lead acid battery.

3.2 TEST SETUP:

The E.U.T. was placed on top of a nonconducting table at a .8 meter height. A closed circuit camera was positioned in front of the pressure monitor to check for variations in speed or pressure in the tube. Three isotropic probes (See picture at end of appendices) were placed in close proximity to the sides of the unit. The EUT was exposed to an elevated RF input level on one face which was the rear face of the unit. To accommodate EN 61000-4-3 as much as possible the antennas were adjusted to a 2 meter distance from the sample.

The computer program automatically cycles the isotropic probe through X, Y and Z polarizations, takes readings from three isotropic probes, averages the probe field strengths and applies correction to maintain the field strength at the sponsor group's requested value. This is done by turning off the modulation while the probe is being measured and then turning the modulation on for a variable amount of time. This permits accurate field strength measurement even though the modulation rate is low. In this case the modulation was turned on for 6 seconds per point.

3.3 MODULATION:

The modulation applied externally to the Wavetek 2520A was a 1000 Hz sinusoid which was used to generate an 80% AM signal which is consistent with EN 61000-4-3.

3.4 ANTENNAS AND AMPLIFIERS:

The radiating antennas/amplifiers used during the test were:

a) The EMCO Model 3107B Power E field antenna from 10 KHz to 50 MHz, horizontal polarization only,
b) The Antenna Research LPB 2520 Biconilog antenna from 50 MHz-1000 MHz, horizontal and vertical polarization,
c) Power amplifiers were used to drive all antennas. In the low band test (where applicable), the 100 Watt ENI Model 2100L was used from 10 KHz- 12 MHz. In the mid-band test that can range from 1-520 MHz or 12-520 MHz, a 25 Watt linear ENI model 525LA was used. From 500 - 1000 MHz a 15 watt linear amplifier Eaton Model 15100B was used.
d) Sweep rate of amplifiers was adjusted so that the rate did not exceed 1.5 x 10^{-3} decades/second and the step size never exceeded the 1% change limit of EN 61000-4-3. The rate was adjusted to approximately 100-1000 KHz per step every 3 seconds and the sweep was continuous between steps. Polarization was horizontal and vertical when the Biconilog was used.

4.0 LIMITS AND RESULTS OF TEST:

4.1 RADIATED LIMITS:

The radiated susceptibility immunity should not be lower than 3 or 10 V/M as prescribed by EN 61000-4-3. The IEC range is 80 MHz to 1000 MHz. A graph is shown of the actual averaged field strength presented to the prototype during the test.

4.2 RESULTS OF TEST:

The TFT EP0306: JOYSTICK OPERATOR STATION WITH VALVE POSITION CONTROL was exposed to a 10 V/M immunity wave from 30 to 1000 MHz with 1000 Hz, 80% modulation. It was also exposed to the same field in the 900 to 925 MHz cellular phone test using 200 Hz, 100% square wave modulation. It was also tested from 1000-2700 MHz at 10 V/M without noticeable problems.

During testing the system was continuously monitored for correct functioning so that a) the valve opened and closed in a predictable pattern that did not change over time and 2) did not stop or change operational mode during testing. When the area was subsequently retested as a spot measurement the absorber was not needed and it was taken out. The EUT passed with an A acceptance level.

Date: 9/8/11 Page 2 of __	EN 61000-4-3 Worksheet	Midwest EMI Associates Mundelein, Illinois	Form: EN 61000-4-3

Device: Y4E-JS Sponsor: TFT S/W Ver: _____ S/N: N/A

Tests Performed: (Radiated) (Conducted) (Magnetic) (CS114)

Probes: (CS114) (Fischer CDN) (A/R FP2031) (A/R FP2036) (A/R FP1000) (Solar Injection Clamps)

Technician: BSF

Project No: _____

Mod Freq: 2 10 100 (1000 Hz)

Modulation Depth: 50% (80%) 100% Other: _____

POWER: 230 208 120 VAC or (12) VDC
Power Frequency: (50) (60) (400) (3 Ph) Hz

Room of Test (Scrnrm) (2 Mtr) (5 Mtr) (Outside)
Pos: (A) (B) (C)

Antennae: B=Biconical, C=Conical, L=Log-Periodic, BL=Biconilog, H=Horn, (V=Vertical), H=Horizontal Polarization

Orientation: (Pole Stand) (Wooden Table) (Copper Table) (Floor) (Back Room)

Frequency (M=MHz) (K=KHz)	Inc Freq (KHz) or (1%) if blank	Immunity Level (V) (V/M)	Dwell Time: (Sec)	Antenna Type	Results: Include any Failure Modes Observed in the EUT during the test. Video Camera System Used? (Yes) (No)
30	1%	13	6	BLV	OK, EUT 25LA
57	"	"	"		"
75	"	"	"		"
98	"	"	"		"
114	"	"	"		"
140	"	"	"		"
188	"	"	"		"
220	"	"	"		"
275 - 288	"	"	"		issue, stopped oscillating *
340	"	"	"		OK
395	"	"	"		"
458	"	"	"		"
501	"	"	"		" Switch to Eaton 15605
577	"	"	"		"
716	"	"	"		"
891	"	"	"		"
971	"	"	"		"
1000	"	"	"		"
1206	"	12	"		"
1300	"	"	"		"
1630	"	"	"		"
1980	"	"	"		"
2200	"	"	"		" Switch to Rightward Horn
2700	"	"	"		"
250-300	"	"	5		moved Antennas

* Recheck 283MHz

Notes: moved Antenna still had, then applied
Applied 7427632 by Wurth

Date: 9/8/11 Page 1 of ___	EN 61000-4-3 Worksheet	Midwest EMI Associates Mundelein, Illinois	Form: EN 61000-4-3
Device: Y4E-JS	Sponsor: TET	S/W Ver: ___	S/N: N/A

Tests Performed: (Radiated) (Conducted) (Magnetic) (CS114)

Probes: (CS114) (Fischer CDN) (A/R FP2031) (A/R FP2036) (A/R FP1000) (Solar Injection Clamps)

Technician: BRIAN FILAR

Project No: ___

Mod Freq: 2 10 100 (1000 Hz)

Modulation Depth: 50% (80%) 100% Other: ___

POWER: 230 208 120 VAC or 12 VDC

Power Frequency: (50) (60) (400) (3 Ph) Hz

Room of Test (Scrnrm) (2 Mtr) (5 Mtr) (Outside) Pos: (A) (B) (C)

Antennae: B=Biconical, C=Conical L=Log Periodic, BL=Biconilog, H=Horn V=Vertical, (H=Horizontal) Polarization

Orientation: (Pole Stand) (Wooden Table) (Copper Table) (Floor) (Back Room)

Frequency (M=MHz) (K=KHz)	Inc Freq (KHz) or (1%) if blank	Immunity Level (V) (V/M)	Dwell Time: (Sec)	Antenna Type	Results: Include any Failure Modes Observed in the EUT during the test. Video Camera System Used? (Yes) (No)
30	1%	13	6	BLH	OK, ENI 525 LA
46	"	"	"		"
80	"	"	"		"
95	"	"	"		"
120	"	"	"		"
150	"	"	"		"
200	"	"	"		"
250	"	"	"		"
286	"	"	"		"
328	"	"	"		"
440	"	"	"		"
500	"	"	"		" Switch to Eaton 5100B
590	"	"	"		"
675	"	"	"		"
811	"	"	"		"
1000	"	"	"		"
1200	"	"	"		"
1251	"	"	"		"
1320	"	12	"		"
1518	"	"	"		"
2000	"	"	"		"
2200	"	"	"		" Switch to Highland Horn
2700	"	"	"		"
900-925	"	"	"	BLH	Cell Phone Test
900-925	"	"	"	BLV	" " "

AOK

Notes: ___

APPENDIX E

ELECTRICAL SURGE IMMUNITY TEST

(IEC 61000-4-5, First Edition, 1995 and successors)

1.0 PURPOSE:

The purpose of this test is to insure that commercial or medical devices will not be susceptible to electrical surges applied to their input AC or DC leads. This investigation evaluated the immunity of the EUT to controlled high-energy transients on the power or peripheral cable input lines. The open circuit voltage ranges from .2 to 4.2 kV with a 1.2 / 50 us waveshape and the short circuit current ranges up to 2.1 kA with an 8 / 20 uS waveshape. The surge simulates lightning pulses in the proximity of the mains supplying power to the EUT. The applicable standard is the European EN 61000-4-5 regimen.

2.0 DESCRIPTION OF TEST APPARATUS:

The test apparatus for this test consists of the Haefely Psurge 4010 with attendant cables and adapters. The general configuration of the test unit is described in the following test report.

3.0 TEST PROCEDURES:

3.1 POWER LEADS:

Application of the surge generator to the EUT was performed with the power input cable routed horizontally, from the surge generator to the EUT. Power was applied through the line and neutral leads of the surge generator that included an internal coupler/decoupler mechanism. The power leads were less than two meters as required. If longer ones are supplied by the manufacturer and are not detachable the excess is gathered into a flat coil with a .4 meter diameter and situated at a distance of .1 meter above the ground reference plane. Where an IEC connector is used a < 2 meter cable is supplied.

3.2 POLARITY and TEST LEVELS:

The surge wave was applied in the following modes of operation:

1) Line with respect to the Protective Earth
2) Neutral with respect to the Protective Earth
3) Between Line and Neutral with respect to the GRP

Tests were performed for the following surge voltage levels, repetition rates, period and duration, for synchronous triggering with respect to the AC line input:

LEVEL	OPEN CIRCUIT OUTPUT TEST VOLTAGE	REPETITION RATE of Pulse	Pulse Synchronism (Degrees)	Mode Supplied
1	.5 KV	30 Sec	0,90,180,270	1,2,3
2	1 KV	30 Sec	0,90,180,270	1,2,3
3	2 KV	45 Sec	0,90,180,270	1,2

3.3 SURGE GENERATOR CHARACTERISTICS:

Per standard and generator specifications the following are the surge characteristics:

Open Circuit Voltage: Programmable .2 to 4.2 KV, 1.2 / 50 uS
Short Circuit Current: up to 2.1 Kilo Amperes
Polarity: Positive/Negative
Repetition Rate: up to 6 impulses/Minute at Umax or 12 at 2.2 KV/Min.
Max EUT current: 16 amps
Repetition frequency: variable
Electronic Overcurrent: 0-16 Amps
Impulse Measurement Accuracy: Voltage and Current +/- 3%

3.4 COUPLING DECOUPLING NETWORK CHARACTERISTICS:

Coupling Capacitors: 18 uF

3.5 QUALITY:

Meets the design and manufacturing requirements of ISO 9001

3.6 GROUND REFERENCE PLANE:

The ground reference plane is greater than 1x1 meter and allows at least 10 cm of excess dimension beyond the longest dimension of the EUT. The EUT is put on a wooden support approximately 10 cm. above the ground reference plane. In alternate configurations the EUT may be placed on a table adjacent to the 1x1 meter plane and above a 3 meter plane of the radiated emission test site.

3.7 REFERENCE DOCUMENT:

The reference document that defines the scope of the investigation, specific details, acceptability of test methods and results, techniques and construction details, as required, may be found in:

> IEC 61000-4-5, First Edition, 1995 entitled "Electromagnetic Compatibility, Part 4: Testing and Measurement Techniques - Section 4: Electrical fast transient/burst immunity test, Basic EMC Publication" and succeeding revisions.

3.8 ACCEPTABILITY CRITERION:

The following criterion was established to determine the compliance of the EUT to the test regimen:

An unacceptable operating response to the stimulus was:

1) Any permanent variation in a displayed image
2) Any permanent variation in the normal operation of the device or permanent changes to the EUT.
3) Any response of any kind that required an operator intervention to reset or recontrol the device to resume normal operation.
4) Damage to the EUT such that it would be rendered inoperable or operate outside the manufacturer's specifications.

A small variation in light intensity of a display or a small variation in a displayed operating parameter in response to the applied stimulus is considered acceptable if it is within the normal operating tolerances of the instrument.

4.0 SURGE IMMUNITY TEST RESULTS:

The TFT EP0306: JOYSTICK OPERATOR STATION WITH VALVE POSITION CONTROL was tested on its DC leads in line to line mode at a 500 or 1000 volt application in positive and negative polarities. Then testing was also performed at 1 KV from line to PE and neutral to PE mode. The EUT experienced no anomalies with this application and passed the test with an "A" acceptance level.

Haefely Trench AG EMC Test Systems Basel/Switzerland

T E S T P R O T O C O L

System: PSURGE 4010
Test: 22222222
Start-Date: 09.09.2011 Start-Time: 09:23

******* Combination Wave 1,2/50us;8/20us ********************

Coup. Path	Imp. No.	U nominal	Syncro Angle	U-peak	I-peak	Info.
L1-N	1	-0.50kV	-----	-0.09kV	-221A	
L1-N	2	-0.50kV	-----	-0.08kV	-221A	
L1-N	3	-0.50kV	-----	-0.08kV	-221A	
L1-N	4	-0.50kV	-----	-0.08kV	-222A	
L1-N	5	-0.50kV	-----	-0.08kV	-221A	
L1-N	6	-0.50kV	-----	-0.08kV	-221A	
L1-N	7	-0.50kV	-----	-0.08kV	-222A	
L1-N	8	-0.50kV	-----	-0.08kV	-222A	
L1-N	9	-0.50kV	-----	-0.08kV	-222A	
L1-N	10	-0.50kV	-----	-0.09kV	-221A	
L1-N	11	-0.50kV	-----	-0.09kV	-222A	
L1-N	12	-0.50kV	-----	-0.09kV	-222A	
L1-N	13	-0.50kV	-----	-0.09kV	-222A	
L1-N	14	-0.50kV	-----	-0.09kV	-222A	
L1-N	15	-0.50kV	-----	-0.09kV	-221A	
L1-N	16	-0.50kV	-----	-0.09kV	-222A	
L1-N	17	-0.50kV	-----	-0.09kV	-221A	
L1-N	18	-0.50kV	-----	-0.09kV	-222A	
L1-N	19	-0.50kV	-----	-0.09kV	-222A	
L1-N	20	-0.50kV	-----	-0.09kV	-222A	

>>> Test passed. <<<

Test: 22222222
Stop-Date: 09.09.2011 Stop-Time: 09:26

Haefely Trench AG EMC Test Systems Basel/Switzerland

T E S T P R O T O C O L

System: PSURGE 4010
Test: 22222222
Start-Date: 09.09.2011 Start-Time: 09:27

******* Combination Wave 1,2/50us;8/20us ********************

Coup. Path	Imp. No.	U nominal	Syncro Angle	U-peak	I-peak	Info.
L1-N	1	+0.50kV	-----	+0.11kV	+194A	
L1-N	2	+0.50kV	-----	+0.11kV	+194A	
L1-N	3	+0.50kV	-----	+0.11kV	+194A	
L1-N	4	+0.50kV	-----	+0.11kV	+194A	
L1-N	5	+0.50kV	-----	+0.11kV	+194A	

L1-N	6	+0.50kV	-----	+0.11kV	+194A	
L1-N	7	+0.50kV	-----	+0.11kV	+194A	
L1-N	8	+0.50kV	-----	+0.11kV	+194A	
L1-N	9	+0.50kV	-----	+0.11kV	+194A	
L1-N	10	+0.50kV	-----	+0.11kV	+194A	
L1-N	11	+0.50kV	-----	+0.11kV	+194A	
L1-N	12	+0.50kV	-----	+0.11kV	+194A	
L1-N	13	+0.50kV	-----	+0.11kV	+194A	
L1-N	14	+0.50kV	-----	+0.11kV	+194A	
L1-N	15	+0.50kV	-----	+0.11kV	+194A	
L1-N	16	+0.50kV	-----	+0.11kV	+194A	
L1-N	17	+0.50kV	-----	+0.11kV	+194A	
L1-N	18	+0.50kV	-----	+0.11kV	+194A	
L1-N	19	+0.50kV	-----	+0.11kV	+194A	
L1-N	20	+0.50kV	-----	+0.11kV	+194A	

>>> Test passed. <<<

Test: 22222222

Stop-Date: 09.09.2011 Stop-Time: 09:30

Haefely Trench AG EMC Test Systems Basel/Switzerland

T E S T P R O T O C O L

System: PSURGE 4010

Test: 22222222

Start-Date: 09.09.2011 Start-Time: 09:31

******* Combination Wave 1,2/50us;8/20us **********

Coup. Path	Imp. No.	U nominal	Syncro Angle	U-peak	I-peak	Info.
L1-N	1	+1.00kV	-----	+0.17kV	+0.43kA	
L1-N	2	+1.00kV	-----	+0.13kV	+0.44kA	
L1-N	3	+1.00kV	-----	+0.13kV	+0.44kA	
L1-N	4	+1.00kV	-----	+0.13kV	+0.44kA	
L1-N	5	+1.00kV	-----	+0.13kV	+0.44kA	
L1-N	6	+1.00kV	-----	+0.13kV	+0.44kA	
L1-N	7	+1.00kV	-----	+0.13kV	+0.44kA	
L1-N	8	+1.00kV	-----	+0.13kV	+0.44kA	
L1-N	9	+1.00kV	-----	+0.13kV	+0.44kA	
L1-N	10	+1.00kV	-----	+0.13kV	+0.44kA	
L1-N	11	+1.00kV	-----	+0.13kV	+0.44kA	
L1-N	12	+1.00kV	-----	+0.13kV	+0.44kA	
L1-N	13	+1.00kV	-----	+0.13kV	+0.44kA	

>>> Line Output 1 Phase turned OFF. <<<

>>> Test stopped by user! <<<

Test: 22222222

Stop-Date: 09.09.2011 Stop-Time: 09:33

Haefely Trench AG EMC Test Systems Basel/Switzerland

T E S T P R O T O C O L

System: PSURGE 4010
Test: 22222222
Start-Date: 09.09.2011 Start-Time: 09:47

******* Combination Wave 1,2/50us;8/20us ********************

Coup. Path	Imp. No.	U nominal	Syncro Angle	U-peak	I-peak	Info.
L1-N	1	-1.00kV	-----	-0.16kV	-0.44kA	
L1-N	2	-1.00kV	-----	-0.16kV	-0.45kA	
L1-N	3	-1.00kV	-----	-0.16kV	-0.45kA	
L1-N	4	-1.00kV	-----	-0.16kV	-0.45kA	
L1-N	5	-1.00kV	-----	-0.16kV	-0.45kA	
L1-N	6	-1.00kV	-----	-0.16kV	-0.45kA	
L1-N	7	-1.00kV	-----	-0.16kV	-0.45kA	
L1-N	8	-1.00kV	-----	-0.16kV	-0.45kA	
L1-N	9	-1.00kV	-----	-0.16kV	-0.45kA	
L1-N	10	-1.00kV	-----	-0.16kV	-0.45kA	
L1-N	11	-1.00kV	-----	-0.16kV	-0.45kA	
L1-N	12	-1.00kV	-----	-0.16kV	-0.45kA	
L1-N	13	-1.00kV	-----	-0.16kV	-0.45kA	
L1-N	14	-1.00kV	-----	-0.16kV	-0.45kA	
L1-N	15	-1.00kV	-----	-0.16kV	-0.45kA	
L1-N	16	-1.00kV	-----	-0.16kV	-0.45kA	
L1-N	17	-1.00kV	-----	-0.16kV	-0.45kA	
L1-N	18	-1.00kV	-----	-0.16kV	-0.45kA	
L1-N	19	-1.00kV	-----	-0.16kV	-0.45kA	
L1-N	20	-1.00kV	-----	-0.16kV	-0.45kA	

>>> Test passed. <<<

Test: 22222222
Stop-Date: 09.09.2011 Stop-Time: 09:57

Haefely Trench AG EMC Test Systems Basel/Switzerland

T E S T P R O T O C O L

System: PSURGE 4010
Test: 22222222
Start-Date: 09.09.2011 Start-Time: 09:58

******* Combination Wave 1,2/50us;8/20us ********************

Coup. Path	Imp. No.	U nominal	Syncro Angle	U-peak	I-peak	Info.

```
*  L1-N     1    +1.00kV  -----   +0.17kV  +0.43kA              *
*    >>> Test stopped by user! <<<                               *
*                                                               *
*  Test:         22222222                                       *
*  Stop-Date:    09.09.2011                Stop-Time:    09:59  *
*                                                               *
*****************************************************************
```

APPENDIX F

CONDUCTED SUSCEPTIBILITY TEST

Common Mode Voltage Interference (Ref: EN 61000-4-6)

1.0 PURPOSE:

The purpose of this test is to insure that commercial or medical devices will not be susceptible to conducted RF energy when induced on peripheral cabling. The frequency range possible to be tested is 150 KHz-300 MHz. The required range is 150 KHz to 80 MHz. The applicable standard and test method is described in Euronorm standard EN 61000-4-6:2001.

2.0 DESCRIPTION OF TEST APPARATUS:

The test apparatus required is described in the reference includes a signal generator, amplifier, wideband directional coupler, several attenuators, a calibration fixture, a wideband coupling probe, a coaxial load, and two spectrum analyzers. The test also can be run with one spectrum analyzer provided the test is run twice exactly the same way. The test equipment actually used was (in the order above) a Wavetek 2520 generator, one amplifier which is the ENI 525LA (mid band), a Werlatone C1795 directional coupler, Bird Model 8306-200-Nxx 20 Watt power attenuators (3, 10, and 20 dB), a Fischer IEC 801-6 CDN FCC-801-M3-25, and a Tektronix 2756P spectrum analyzer.

The test also requires analysis of data using a high speed computer and graphical presentation of data. The computer used was a HP Omnibook 900 with Quattro Pro for Windows and Word for Windows for tabular presentation. The test requires characterization of all components and a dedicated computer program to cycle the test equipment in a precise manner that induces required common mode currents in the EUT cables.

3.0 TEST PROCEDURES:

3.1 POWER LEADS:

The device tested was plugged into a source of 12 VDC through two Line Impedance Stabilization Networks, Solar type 8028-50-TS-24-BNC. The AC cord was made physically as short as possible to permit maximum energy into the E.U.T.

3.2 TEST SETUP:

The test setup complies with the relevant portions of the reference standard. The Wavetek signal generator runs a specific pattern of signal frequencies and amplitudes to cover the range of interest in such a way that the required levels are maintained very closely. The calibration step is performed prior to the EUT portion of the test using a reference load which consists of a 150 ohm to 50 ohm pad and other apparatus to calibrate the levels to 1, 3 and 10 V RMS. The monitor probe used in the test on the EUT was a Solar type 6741-1.

The test was performed inside of the screened room with the EUT on a metal table very close to the CDN which rested on a copper tabletop to provide optimum grounding and the flattest RF level possible to the EUT. The copper table is 80 cm. off the floor of the room.

3.3 MODULATION:

The required 1000 Hz, 80% AM modulation signal was used.

3.4 AMPLIFIERS USED:

The amplifiers used during the test were:

a) The ENI 2100L from .15 to .3 MHz, 100 Watts
b) The ENI 525LA from .3 MHz - 400MHz, 25 Watts.

3.5 TEST PROCEDURES:

A calibration step is first required to set the levels to be used in the test on the EUT. The Fischer CDN is first arranged with two coupling devices that effectively short the three outputs of the CDN together and also convert the desired 150-ohm impedance to 50 ohms. These special adapters are placed on the AE port and EUT port for terminations. The EUT port was additionally fitted with a 20-dB power pad leading to the spectrum analyzer that acted as a receiver. The power for the RF input of the CDN was generated by the Wavetek signal source through the ENI 525LA power amp along with 15 feet of RG214 cable and terminated in the RF port.

The signal levels were then iteratively adjusted so that the output level would always maintain at least the 3 or 10 V RMS requirement. It is important to note that the standard requires a 3 or 10 V RMS open circuit output into the EUT. For the 10 V RMS case, if a 50 ohm termination is used the true matched level is 5 V RMS. The resistive 150 to 50 ohm matching pad further reduces the level by a factor of 3 for an overall gain reduction of 6 times. This means the output leading to the spectrum analyzer is 1.67 volts (10/6). The addition of the 20 dB pad (to avoid any reflections) further reduces the amplitude to .167 volts which is the flat level that is needed to be maintained over the frequency range.

4.0 LIMITS AND RESULTS OF TEST:

4.1 CONDUCTED LIMITS:

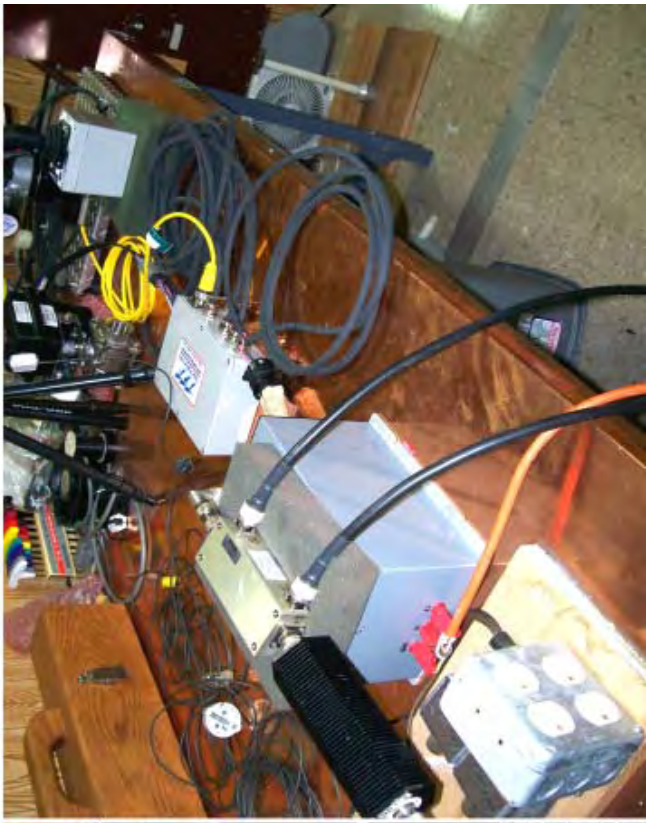
The conducted immunity of the EUT must not be less than the level defined in the reference standard. The possible levels are 1, 3 or 10 V RMS. The dwell time to exercise the functions of the EUT was 3 seconds per point. The total number of points taken was 750 over the 150 KHz to 300 MHz range. The range required to pass for this test is only 150 KHz to 80 MHz. In the higher range of 80-300 MHz the dwell time was also 3 seconds.

4.2 RESULTS OF TEST

Testing was performed on the power leads going from the battery to the circuitry using the CDN. When the device was initially tested at the minimum 3 V RMS level it performed normally throughout the entire range of frequencies of .15 to 300 MHz. Since this is the required level and just the .15-80 Mhz range needs to be passed the device passed the test.

In a second test the level was raised to 10 V RMS and testing was rerun. When exposed to this level the same normal effects were noted and the device was seen to continue its normal sequence throughout the test.

The device passed the EN 61000-4-6 requirement at 3 V and 10 V RMS in either case without noticeable failures.

Date: 9/22/14 Page 1 of 1	EN 61000-4-3 Worksheet	Midwest EMI Associates Mundelein, Illinois	Form: EN 61000-4-3

Device: TFT GATE Sponsor: S/W Ver: S/N: N/A

Tests Performed: (Radiated) (Conducted) (Magnetic) (CS114)

Probes: (CS114) (Fischer CDN) (A/R FP2031) (A/R FP2036) (A/R FP1000) (Solar Injection Clamps)

Technician: BSF

Project No:

Mod Freq: 2 10 100 (1000 Hz)

Modulation Depth: 50% (80%) 100% Other:

POWER: 230 208 120 VAC or (12) VDC

Power Frequency: (50) (60) (400) (3 Ph) Hz

Room of Test (Scrnrm) (2 Mtr) (5 Mtr) (Outside)

Pos: (A) (B) (C)

Antennae: B=Biconical, C=Conical L=Log Periodic, BL=Biconilog, H=Horn V=Vertical, H=Horizontal Polarization

Orientation: (Pole Stand) (Wooden Table) (Copper Table) (Floor) (Back Room)

Frequency (M=MHz) (K=KHz)	Inc Freq (KHz) or (1%) if blank	Immunity Level (V) (V/M)	Dwell Time: (Sec)	Antenna Type	Results: Include any Failure Modes Observed in the EUT during the test Video Camera System Used? (Yes) (No)
150 K	per Pgm	10	per Pgm	CDN	No Effect
2.5 M	"	"	"	"	"
80 M	"	"	"	"	"
120 M	"	"	"	"	"
240 M	"	"	"	"	"
300 M	"	"	"	"	"

Notes:

APPENDIX G

ELECTROSTATIC DISCHARGE TEST

(EN 61000-4-2, Protocol MEMI-1)

1.0 PURPOSE:

The purpose of this test is to insure that commercial or medical devices will not be susceptible to electrostatic discharge transients applied to the case and circuitry. The device should show no degradation within 5 seconds of application. This also applies to application of charges to the horizontal and vertical coupling planes. The European directive mandates passing of the 8 kV air discharge in single shot mode and 4 kV contact discharge. The actual test was conducted at up to +/- 8KV air and 4 kV contact discharge.

2.0 DESCRIPTION OF TEST APPARATUS:

The Schaffner NSG 435 electrostatic gun is used. The device under test may be mounted on a table or pole clamp for testing. The gun meets EN 61000-4-2 test standard requirements.

All tests are done with the tip which best simulates a human finger. The modes that are selectable are 1) continuous mode, or 2) single shot mode. The gun also has positive or negative polarity settings.

3.0 TEST PROCEDURES:

3.1 POWER LEADS:

The **TFT EP0306: JOYSTICK OPERATOR STATION WITH VALVE POSITION CONTROL** was powered by 12V DC battery.

3.2 TEST SETUP:

The EN 61000-4-2 directive specifies a horizontal and vertical coupling plane for testing packaged devices. The device was tested on the three-meter site and this formed the horizontal-coupling plane. It was placed on an 80-centimeter table above the ground plane.

The ESD gun was handheld and only one location on the ground screen was chosen for discharge that is located below the table. The ESD gun return lead was grounded to a terminal strip and the table that formed the reference earth potential.

3.3 TEST METHOD: Qualification Test (Single Shot Only)

If single shot mode is utilized for qualification tests the operating conditions are the same as shown in paragraph 3.2. At each voltage which may also include the horizontal or vertical coupling plate, the position is struck 20 times at a 1 second succession in minus and plus polarity settings. After each increment of 20 shots, the next preselected point is tested. A recording of the degradations noted is made on the data sheets and supplementary notes are made as to the response of the test sample. Special attention is given to any failure modes that appear to be unsafe.

4.0 RESULTS OF TEST (10-11-2010)

The ESD test was conducted on 8 surfaces in areas showing cracks in the package, switches, connectors or screws. The EUT was subjected to ESD intensity levels of 2, 4 and 6 KV in contact discharge and 2, 4, 6 and 8 kV in air discharge testing.

The following symptoms were noted during the test:

None

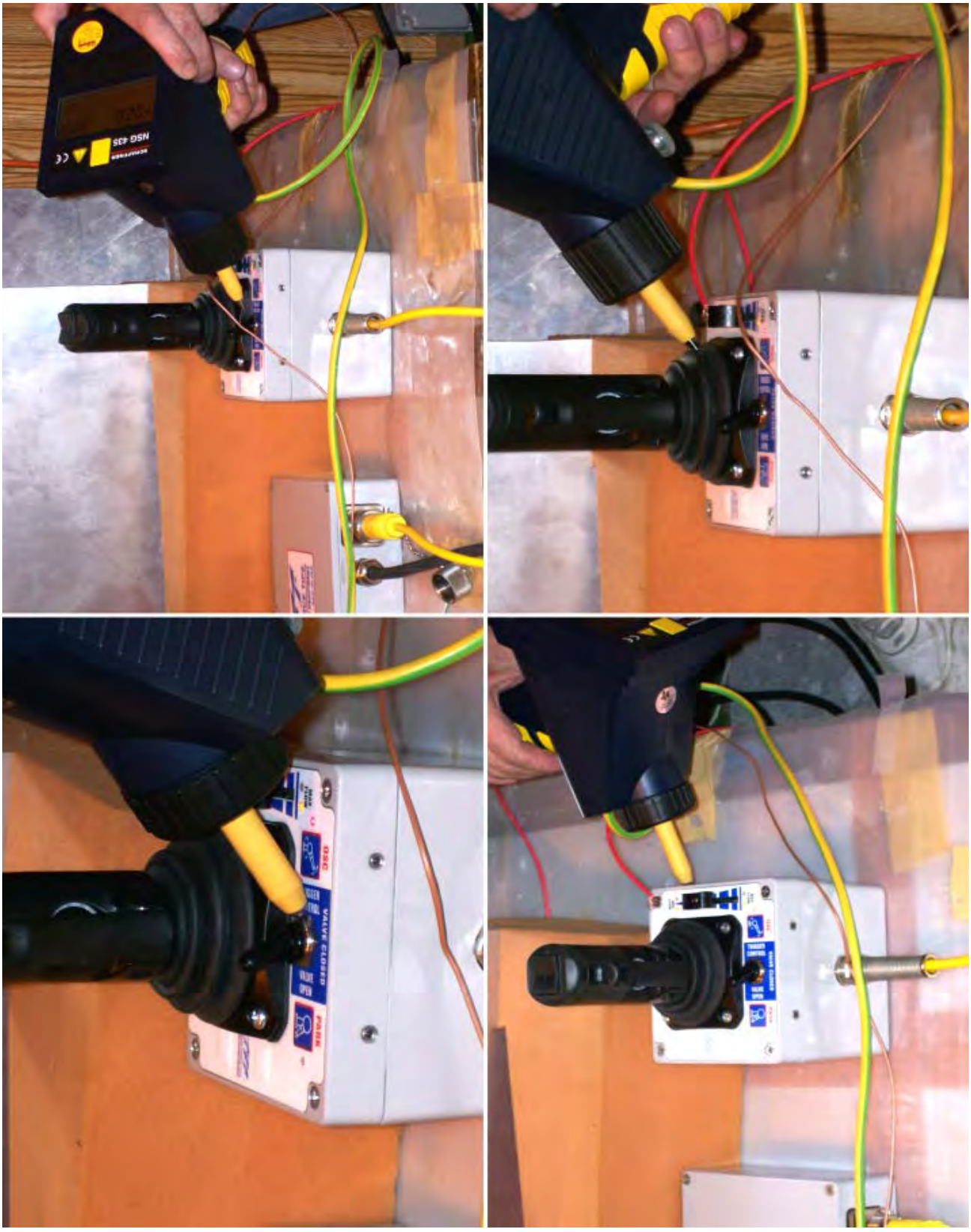
The device was given an "A" acceptance rating.

ESD TEST LOCATIONS

TFT EP0306: JOYSTICK OPERATOR STATION WITH VALVE POSITION CONTROL

TEST POINT	Description
1	HCP
2	VCP
3	Valve Inter Box Lid
4	Valve Cable
5	Power Cable
6	Joystick Cable
7	Monitor Cable
8	Joystick Lid
9	Joystick Box Cable
10	Joystick Park Switch
11	Joystick Oscillator Switch
12	Slider Switch
13	Joystick Mounting Screws
14	Joystick SS
15	Joystick Switch Foy
16	Joystick Trigger
17	Joystick Switch Toggle
18	
19	
20	
21	
22	
23	
24	
25	
26	

Note: Photograph of locations are attached


NSG 435
VALVE CLOSED
VALVE OPEN
PARK

Data Sheet 1 of 4 5	**ESD DATA SHEET** Schaffner NSG 435 Gun	**Midwest EMI Associates Mundelein, Illinois**	Form: Issued 11/22/09 **MEMI-1A**

Sponsor Group: _TFT Gatable Valve **Serial Number:** __EMI Proto_____
Manager:_Steve_ **Temp:** 72.4°F **Hum:** 68.8% **Technician:** BF **S/W ver.:** 1.0

Date of Test: 9/9/11 **Time:** 5:00 pM **EUT:** Prototype / Production Unit
Placement of EUT: ESD Table ___✓_____ **Pole Mount** _____ **Wood Table** ___ **FLOOR** ___
Grounding: Pole___ **Terminal Strip** __✓___ **FLOOR**____ **1 Meg to Metal Frame of EUT.** __
Configuration of EUT: EUT power DC 12V
Note: All Points are Tested with 10 Shots in Single Shot Mode each phase unless otherwise stated

Reference: EN 61000-4-2		**TEST POINT:** Horizontal Plane				**TEST POINT:** Vertical Plane			
		PLUS POLARITY		**MINUS POLARITY**		**PLUS POLARITY**		**MINUS POLARITY**	
REF. LINE	**KILO VOLTS**	Air D/charge	CONTACT Mode	Air D/charge	CONTACT Mode	Air D/charge	CONTACT Mode	Air D/charge	CONTACT Mode
1	1								
2	2	(✓)	(✓)	(✓)	(✓)	(✓)	(✓)	(✓)	(✓)
3	3								
4	4	(✓)	(✓)	(✓)	(✓)	(✓)	(✓)	(✓)	(✓)
5	5								
6	6	(✓)	(✓)	(✓)	(✓)	(✓)	(✓)	(✓)	(✓)
7	7								
8	8	(✓)		(✓)		(✓)		(✓)	
9	9								
10	10								

Reference: EN 61000-4-2		**TEST POINT:** Valve Jnt. box Lid				**TEST POINT:** Valve Cable			
		PLUS POLARITY		**MINUS POLARITY**		**PLUS POLARITY**		**MINUS POLARITY**	
REF. LINE	**KILO VOLTS**	Air D/charge	CONTACT Mode	Air D/charge	CONTACT Mode	Air D/charge	CONTACT Mode	Air D/charge	CONTACT Mode
1	1								
2	2	(✓)	(✓)	(✓)	(✓)	( ) NA	( ) NA	( ) NA	( ) NA
3	3								
4	4	(✓)	(✓)	(✓)	(✓)	( ) NA	( ) NA	( ) NA	( ) NA
5	5								
6	6	(✓)	(✓)	(✓)	(✓)	( ) NA	( ) NA	( ) NA	( ) NA
7	7								
8	8	(✓)		(✓)		( ) NA		( ) NA	
9	9								
10	10								

Notes: A Checkmark ( ) means the device passed the 10 shots successfully with a discharge being seen. A blank ( ) means the point was not tested. A Star sign (*) means a failure occurred that is described below
Notes:_____
_____

Data Sheet 2 of 5	**ESD DATA SHEET** Schaffner NSG 435 Gun	**Midwest EMI Associates Mundelein, Illinois**	Form: Issued 11/22/09 **MEMI-1A**

Sponsor Group: TFT Gatable Valve **Serial Number:** EMI Proto
Manager: Steve **Temp:** 72.4°F **Hum:** 68.8% **Technician:** BF **S/W ver.:** 1.0

Date of Test: 9/9/11 **Time:** 5:00 pM **EUT:** Prototype / **Production** Unit
Placement of EUT: ESD Table ✓ **Pole Mount** ____ **Wood Table** ____ **FLOOR** ____
Grounding: Pole ____ **Terminal Strip** ✓ **FLOOR** ____ **1 Meg to Metal Frame of EUT.** ____
Configuration of EUT: EUT power DC 12V
Note: All Points are Tested with 10 Shots in Single Shot Mode each phase unless otherwise stated

Reference: EN 61000-4-2		**TEST POINT:** Power Cable				**TEST POINT:** Joy stick Cable			
		PLUS POLARITY		**MINUS POLARITY**		**PLUS POLARITY**		**MINUS POLARITY**	
REF. LINE	**KILO VOLTS**	Air D/charge	CONTACT Mode	Air D/charge	CONTACT Mode	Air D/charge	CONTACT Mode	Air D/charge	CONTACT Mode
1	1								
2	2	( ) ND	( ) ND	( ) ND	( ) ND	( ) ND	( ) ND	( ) ND	( ) ND
3	3								
4	4	( ) ND	( ) ND	( ) ND	( ) ND	( ) ND	( ) ND	( ) ND	( ) ND
5	5								
6	6	( ) ND	( ) ND	( ) ND	( ) ND	( ) ND	( ) ND	( ) ND	( ) ND
7	7								
8	8	( ) ND		( ) ND		( ) ND		( ) ND	
9	9								
10	10								

Reference: EN 61000-4-2		**TEST POINT:** Monitor Cable				**TEST POINT:** Joy stick Lcd			
		PLUS POLARITY		**MINUS POLARITY**		**PLUS POLARITY**		**MINUS POLARITY**	
REF. LINE	**KILO VOLTS**	Air D/charge	CONTACT Mode	Air D/charge	CONTACT Mode	Air D/charge	CONTACT Mode	Air D/charge	CONTACT Mode
1	1								
2	2	( ) ND	( ) ND	( ) ND	( ) ND	(✓)	(✓)	(✓)	(✓)
3	3								
4	4	( ) ND	( ) ND	( ) ND	( ) ND	(✓)	(✓)	(✓)	(✓)
5	5								
6	6	( ) ND	( ) ND	( ) ND	( ) ND	(✓)	(✓)	(✓)	(✓)
7	7								
8	8	( ) ND		( ) ND		(✓)		(✓)	
9	9								
10	10								

Notes: A Checkmark ( ) means the device passed the 10 shots successfully with a discharge being seen. A blank ( ) means the point was not tested. A Star sign (*) means a failure occurred that is described below
Notes:_____
_____

Data Sheet 5 of 5	**ESD DATA SHEET** Schaffner NSG 435 Gun	**Midwest EMI Associates Mundelein, Illinois**	Form: Issued 11/22/09 **MEMI-1A**

Sponsor Group: _TFT Gatable Valve **Serial Number:** __EMI Proto_____
Manager:_Steve_ **Temp:** 72.4°F **Hum:** 68.8% **Technician:** BF **S/W ver.:** 1.0

Date of Test: 9/9/11 **Time:** 5:00 pM **EUT:** Prototype / Production Unit
Placement of EUT: ESD Table ___✓_____ **Pole Mount** _____ **Wood Table** ___ **FLOOR** ___
Grounding: Pole___ **Terminal Strip** __✓___ **FLOOR**____ **1 Meg to Metal Frame of EUT.** __
Configuration of EUT: EUT power DC 12V
Note: All Points are Tested with 10 Shots in Single Shot Mode each phase unless otherwise stated

Reference: EN 61000-4-2		**TEST POINT:** Joy stick box cable				**TEST POINT:** Joy stick Push switch			
		PLUS POLARITY		**MINUS POLARITY**		**PLUS POLARITY**		**MINUS POLARITY**	
REF. LINE	**KILO VOLTS**	Air D/charge	CONTACT Mode	Air D/charge	CONTACT Mode	Air D/charge	CONTACT Mode	Air D/charge	CONTACT Mode
1	1								
2	2	(✓)	(✓)	(✓)	(✓)	( ) ND	( ) ND	( ) ND	( ) ND
3	3								
4	4	(✓)	(✓)	(✓)	(✓)	( ) ND	( ) ND	( ) ND	( ) ND
5	5								
6	6	(✓)	(✓)	(✓)	(✓)	( ) ND	( ) ND	( ) ND	( ) ND
7	7								
8	8	(✓)		(✓)		( ) ND		( ) ND	
9	9								
10	10								

Reference: EN 61000-4-2		**TEST POINT:** Joy stick Osc switch				**TEST POINT:** Slider switch			
		PLUS POLARITY		**MINUS POLARITY**		**PLUS POLARITY**		**MINUS POLARITY**	
REF. LINE	**KILO VOLTS**	Air D/charge	CONTACT Mode	Air D/charge	CONTACT Mode	Air D/charge	CONTACT Mode	Air D/charge	CONTACT Mode
1	1								
2	2	( ) ND	( ) ND	( ) ND	( ) ND	(✓)	(✓)	(✓)	(✓)
3	3								
4	4	( ) ND	( ) ND	( ) ND	( ) ND	(✓)	(✓)	(✓)	(✓)
5	5								
6	6	( ) ND	( ) ND	( ) ND	( ) ND	(✓)	(✓)	(✓)	(✓)
7	7								
8	8	( ) ND		( ) ND		(✓)		(✓)	
9	9								
10	10								

Notes: A Checkmark ( ) means the device passed the 10 shots successfully with a discharge being seen. A blank ( ) means the point was not tested. A Star sign (*) means a failure occurred that is described below
Notes:_____
_____

Data Sheet 4 of 4 5	**ESD DATA SHEET** Schaffner NSG 435 Gun	**Midwest EMI Associates Mundelein, Illinois**	Form: Issued 11/22/09 **MEMI-1A**

Sponsor Group: _TFT Gatable Valve **Serial Number:** __EMI Proto_____
Manager:_Steve_ **Temp:** 72.4°F **Hum:** 68.8% **Technician:** BF **S/W ver.:** 1.0

Date of Test: 9/9/11 **Time:** 5:00 pM **EUT:** Prototype / Production Unit
Placement of EUT: ESD Table ___✓_____ **Pole Mount** _____ **Wood Table** ___ **FLOOR** ___
Grounding: Pole___ **Terminal Strip** __✓___ **FLOOR**___ **1 Meg to Metal Frame of EUT.** __
Configuration of EUT: EUT power DC 12V
Note: All Points are Tested with 10 Shots in Single Shot Mode each phase unless otherwise stated

Reference: EN 61000-4-2		**TEST POINT:** Joy stick mounting screws				**TEST POINT:** _____			
		PLUS POLARITY		**MINUS POLARITY**		**PLUS POLARITY**		**MINUS POLARITY**	
REF. LINE	**KILO VOLTS**	Air D/charge	CONTACT Mode	Air D/charge	CONTACT Mode	Air D/charge	CONTACT Mode	Air D/charge	CONTACT Mode
1	1								
2	2	(✓)	(✓)	(✓)	(✓)	( )	( )	( )	( )
3	3								
4	4	(✓)	(✓)	(✓)	(✓)	( )	( )	( )	( )
5	5								
6	6	(✓)	(✓)	(✓)	(✓)	( )	( )	( )	( )
7	7								
8	8	(✓)		(✓)		( )		( )	
9	9								
10	10								

Reference: EN 61000-4-2		**TEST POINT:** _____				**TEST POINT:** _____			
		PLUS POLARITY		**MINUS POLARITY**		**PLUS POLARITY**		**MINUS POLARITY**	
REF. LINE	**KILO VOLTS**	Air D/charge	CONTACT Mode	Air D/charge	CONTACT Mode	Air D/charge	CONTACT Mode	Air D/charge	CONTACT Mode
1	1								
2	2	( )	( )	( )	( )	( )	( )	( )	( )
3	3								
4	4	( )	( )	( )	( )	( )	( )	( )	( )
5	5								
6	6	( )	( )	( )	( )	( )	( )	( )	( )
7	7								
8	8	( )		( )		( )		( )	
9	9								
10	10								

Notes: A Checkmark ( ) means the device passed the 10 shots successfully with a discharge being seen. A blank ( ) means the point was not tested. A Star sign (*) means a failure occurred that is described below
Notes:_____
_____

Data Sheet 3 of 5	**ESD DATA SHEET** Schaffner NSG 435 Gun	**Midwest EMI Associates Mundelein, Illinois**	Form: Issued 11/22/09 **MEMI-1A**

Sponsor Group: _TFT Gatable Valve **Serial Number:** __EMI Proto_____
Manager:_Steve_ **Temp:** 72.4°F **Hum:** 68.8% **Technician:** BF **S/W ver.:** 1.0

Date of Test: 9/9/11 **Time:** 5:00 pM **EUT:** Prototype / Production Unit
Placement of EUT: ESD Table ___✓_____ **Pole Mount** _____ **Wood Table** ___ **FLOOR** ___
Grounding: Pole___ **Terminal Strip** __✓__ **FLOOR**___ **1 Meg to Metal Frame of EUT.** __
Configuration of EUT: EUT power DC 12V
Note: All Points are Tested with 10 Shots in Single Shot Mode each phase unless otherwise stated

Reference: EN 61000-4-2		**TEST POINT:** Joy stick SS				**TEST POINT:** Joy switch Fog			
		PLUS POLARITY		**MINUS POLARITY**		**PLUS POLARITY**		**MINUS POLARITY**	
REF. LINE	**KILO VOLTS**	Air D/charge	CONTACT Mode	Air D/charge	CONTACT Mode	Air D/charge	CONTACT Mode	Air D/charge	CONTACT Mode
1	1								
2	2	( ) ND	( ) ND	( ) ND	( ) ND	( ) ND	( ) ND	( ) ND	( ) ND
3	3								
4	4	( ) ND	( ) ND	( ) ND	( ) ND	( ) ND	( ) ND	( ) ND	( ) ND
5	5								
6	6	( ) ND	( ) ND	( ) ND	( ) ND	( ) ND	( ) ND	( ) ND	( ) ND
7	7								
8	8	( ) ND		( ) ND		( ) ND		( ) ND	
9	9								
10	10								

Reference: EN 61000-4-2		**TEST POINT:** Joy stck trigger				**TEST POINT:** Joy stick Switch Toggle			
		PLUS POLARITY		**MINUS POLARITY**		**PLUS POLARITY**		**MINUS POLARITY**	
REF. LINE	**KILO VOLTS**	Air D/charge	CONTACT Mode	Air D/charge	CONTACT Mode	Air D/charge	CONTACT Mode	Air D/charge	CONTACT Mode
1	1								
2	2	( ) ND	( ) ND	( ) ND	( ) ND	(✓)	(✓)	(✓)	(✓)
3	3								
4	4	( ) ND	( ) ND	( ) ND	( ) ND	(✓)	(✓)	(✓)	(✓)
5	5								
6	6	( ) ND	( ) ND	( ) ND	( ) ND	(✓)	(✓)	(✓)	(✓)
7	7								
8	8	( ) ND		( ) ND		(✓)		(✓)	
9	9								
10	10								

Notes: A Checkmark ( ) means the device passed the 10 shots successfully with a discharge being seen. A blank ( ) means the point was not tested. A Star sign (*) means a failure occurred that is described below
Notes:_____
_____

APPENDIX H

FDA/EC MAGNETIC SUSCEPTIBILITY TEST

(EN 61000-4-8 Power Line Immunity Test, AAMI DF-39 METHOD)

1.0 PURPOSE:

The purpose of this test is to insure that medical devices will not be susceptible to low frequency magnetic energy. This test is normally conducted only at 50 or 60 Hertz and with very high electromagnetic fields that could be experienced with heavy machinery or MRI machines. These tests are outlined in IEC EN 61000-4-8, FDA document MDS-201-0004 and Military Standard RS101. In the AAMI DF-39 method the frequency range is extended to 500 Hz encompassing all known international power frequencies. The EN 61326-1: 2006 requirement is 30 A/M.

2.0 DESCRIPTION OF TEST APPARATUS:

2.1 Test Method and Exceptions

The test method for magnetic field susceptibility of MDS-201-0004 is listed in paragraph 4.3.4 subparagraph a) and specifies the Helmholtz coil must be larger than the maximum dimension of the test sample. In some cases, medical equipment is very large and the coils and power supply needed would be unmanageable from a floor volume and cost standpoint. Instead, as an exception, we use coils that create strong localized fields that are well in excess of the standard. The dimensions of the coils and all calculations are shown in the next section.

In performing the MDS specification at 50/ 60 Hz for large devices, the coils are held 80 cm apart and they are moved in a parallel plane up and down the device under test. The coils are properly phased with field aiding so that locally over all surfaces the field requirements are met. This is also done in all axes as specified in MDS-201-0004, paragraph 4.3.4.d.

2.2 Loop Antenna Pair

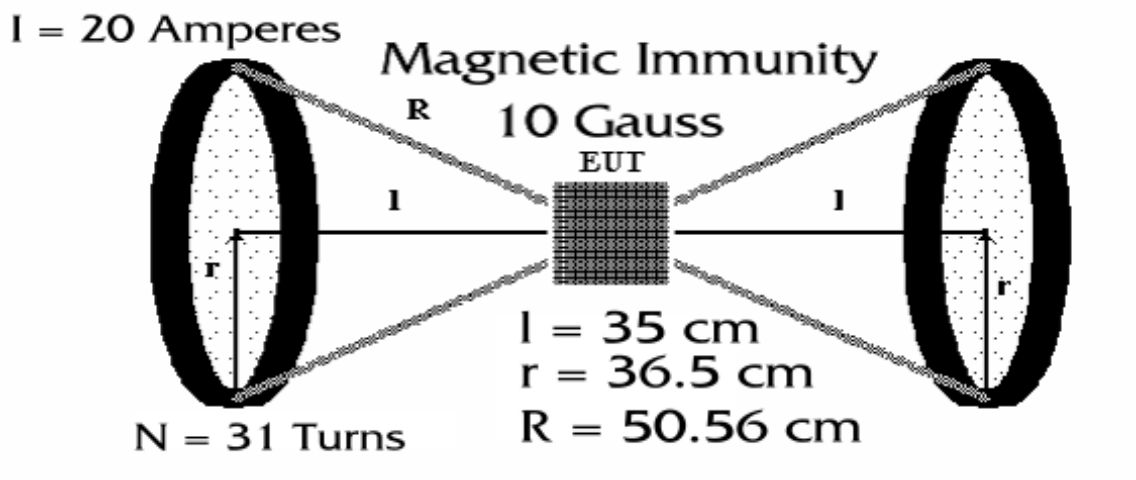
The fabricated antennas for the 50/60 Hz test consist of two bundled coils of average diameter of 73 cm. with 31 turns of #12 AWG insulated, CSA approved standard copper wire. The bundled coil dimension is a 1.5" diameter. The coils are arranged on an axis so that they are parallel to each other and are 70 cm apart.

Using the "right hand" rule, the coils are phased so that the flux generated is aiding. The field generated by the coils is measured by the calibrated Holladay probe. The analysis below correlates the calculated field strength of the coils to the empirically measured field strength. The actual field is approximately twice as great by adding the flux generated by the two coils.

2.3 Calculations

Given: Coil Diameter:	73 cm.
Current:	20 amperes
Coil Distance:	70 centimeters
Number of turns:	31 turns

Units: 1 Tesla = 10^4 Gauss=3 x 10^8 V/m=240 dBpT= 8 x10^5 A/M
μ_o = .4π x 10^{-7} T m/A, 10 Gauss = 800 A/M



Calculate: Field Strength (V/m) at point halfway between the coils.

Let: l = distance from each coil to midpoint, cm
R = distance from midpoint to radius of coil, cm
r = radius of coil, cm

$R = \sqrt{l^2 + r^2} = \sqrt{35^2 + 36.5^2} = 50.56$ cm

B (Tesla) = .5 μ_o * I * $\frac{r^2}{R^3}$ * N , μ_o = 4 π x 10^{-7} T x m/A
I = 20 Amps RMS, 60 Hz

B (V/m) = 188.5 * I * $\frac{r^2}{R^3}$ * N N = 25 Turns
r = .5 m, R = .6403m

B(V/m) = 188.5 * 20 * $(.35)^2$ /$(.5056)^3$ * 31 = 110769 V/m

Since two coils are acting the field strength is about two times as great, or 221537 V/m, or equivalently, 227 dBuV/m.

Empirical Finding:

Using a 9311-1 loop antenna between the two coils at the 70 cm. distance and with 20 amperes applied the actual recorded strength was about 10 Gauss or 300000 V/M, 229.5 dBuV/m.

As seen the recorded strength is a few dB higher than calculated and is attributed to mutual inductive coupling between the coils that magnifies the apparent field.

The agreement is quite good and the equivalent empirical magnetic field in tesla at 20 Amps is 1 milli Tesla (10 Gauss, 800 A/M).

2.4 Test Set Up

2.4.1 The device was placed on a wood table at an 80 cm. height and the loop antenna pair was placed in all axes to assure complete exposure of the EUT. The current was adjusted to the maximum obtainable that was 20 amperes, 40-500 Hz.

3.0 MODULATION -- No modulation is specified for this test.

4.0 LIMITS AND TEST RESULTS

4.1 Magnetic Field Limit - MDS-201-0004 & IEC Recommendation

The magnetic field susceptibility of the device should not be less than the level defined in the AAMI DF-39 medical specification (1 Gauss). The IEC recommendation ranges up to 400 amperes/meter. The EN 61326 requirement is 30 A/M.

4.2 RESULTS

The TFT EP0306: JOYSTICK OPERATOR STATION WITH VALVE POSITION CONTROL was exposed in three axes to a swept field as measured by Holladay Magnetic Field Probe Model HI-3624. The current was initially set at 22 amperes in the range of 40 to 500 Hz resulting in a 10 gauss (800 A/M) to 6 Gauss (480 A/M) field being applied in this range. There was no apparent effect on the device and it passed the IEC 61000-4-8 recommendation.