Performance Certification to EMC Directive

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

Test Unit Description and Serial Number:

TFT EP0468 BIV/VUM DISPLAY

M/N: A5821 BIV/VUM DISPLAY

Test Report # 3045

Dates of Test: 09-30-2010 through 10-15-2010

Test Laboratory:

Midwest EMI Associates, Inc.
Electromagnetic Interference Laboratory
21234 W. Commercial Drive
Mundelein, Illinois 60060
Tel: (847)-918-9886

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 and 4 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	A
EN 61000-4-5 Ed. 2.0: 2006 Electrical Surge Test	.5 kV Line to Line	A
EN 61000-4-6 Ed. 2.2: 2009 Conducted Immunity	3 & 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

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

Midwest EMI Associates Test Service
Report No. 3045

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 EP0468 BIV/VUM DISPLAY**

M/N: **A5821 BIV/VUM DISPLAY**

Conducted For: **Mr. Steve J. Ferry**
Task Force Tips
3701 Innovation Way
Valparaiso, IN 46383
Ph: 1-219-462-6161
Fax: 1-219-464-7155

Dates of Test: 09-30-2010 through 10-15-2010

Technical Data Taken by and
Report Written by:

George Bowman
Midwest EMI Associates

NARTE Certified Engineer, EMC-000738NE

Approved By:

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

1.0 PURPOSE:

The purpose of this test sequence is to qualify the compliance of the TFT EP0468 BIV/VUM DISPLAY 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.

.

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 under test may be placed are identified on Figure A.

3.0 DESCRIPTION OF TEST SAMPLE:

The BIV/VUM Valve display designed under project EP0468 replaces the current A5821 valve display board which is a modified A5822 that has the motor control functionality disabled. This re-design is an extension of EP0406 which included the redesign of the motor controller portion of the A5822 into a different board (A5825) to be enclosed inside the motor enclosure as well as the A5830 which is an optional interface board with feedback relays, both of which were previously tested to the above standards. The A5821 board consists of a microcontroller, 5 volt switching regulator, a load dump TVS, one 4-digit 7-segment display, and a membrane switch on the enclosure with open/stop/close inputs in addition to LEDs indicating current valve position.

Communication between the display board and the motor board is RS-485 serial protocol. Boards are typically powered by nominal 12 or 24 volt vehicle power system. The A5821 display board will be mounted in an anodized aluminum enclosure.

The BIV/VUM display will be used in conjunction with the TFT BIV/VUM valve control system to control and display for either a TFT RC Ball Intake Valve or a TFT RC Valve Under Monitor.

EMI SCREENED ROOM RADIATED SUSCEPTIBILITY CONFIGURATION

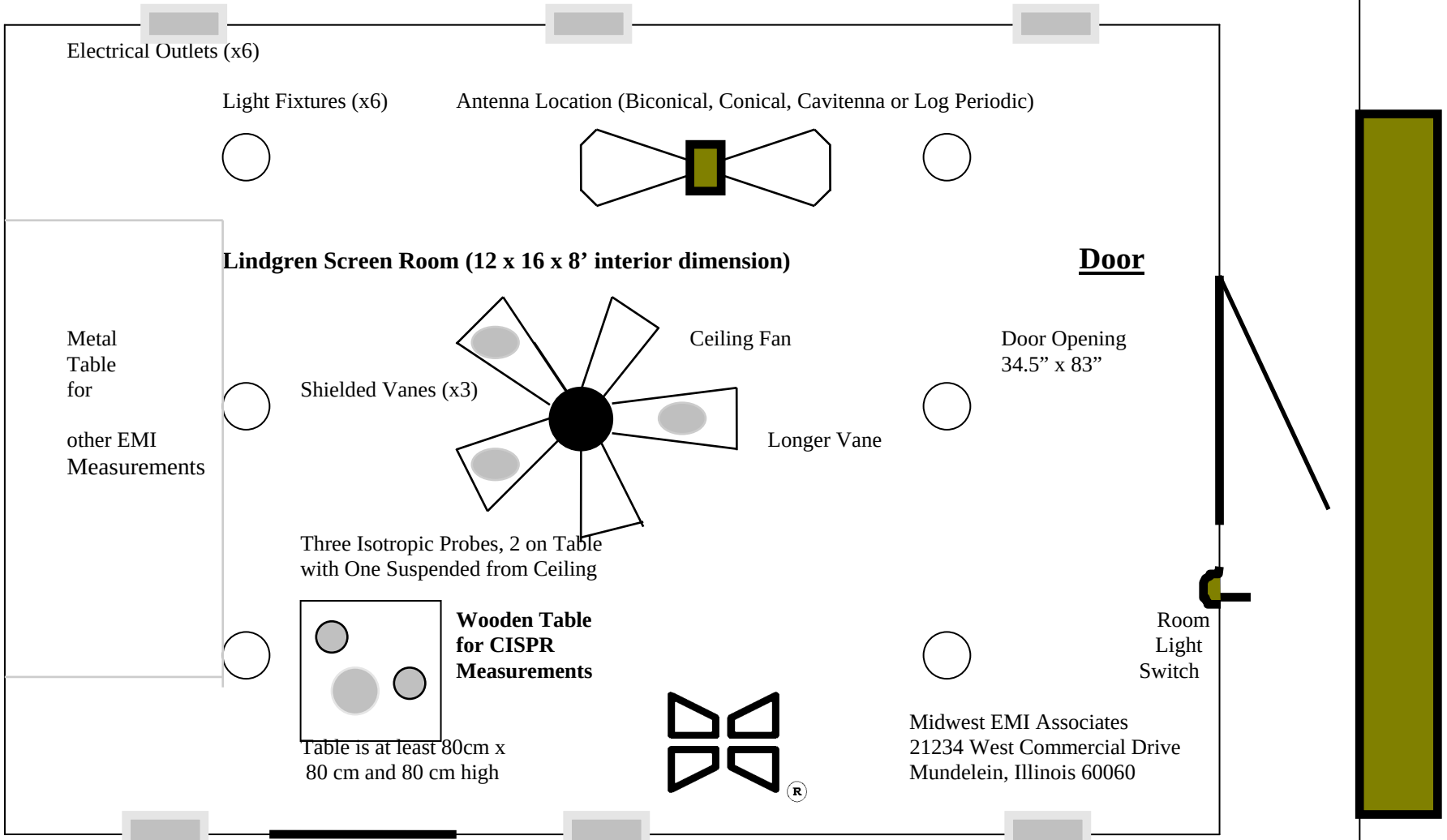


Figure A

3.2 POWER REQUIREMENT:

The primary power supplied to the test sample was a 12 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 Jun 11
b)	Wavetek 2520A RF Generator	0222011	30 Jun 11
c)	Carver TFM-35 250 W/Ch. Audio Amp	3097104	1 Jun 01
d)	ENI RF Power Amplifier (525LA)	367	30 Jun 11
e)	ENI RF Power Amplifier (2100L)	129	30 Jun 11
f)	Eaton 15100B Power Amplifier	1529-07090	24 Jun 11
g)	Tektronix TDS 420 Oscilloscope	B021212	24 Jun 11
h)	EMCO 3109 Power Biconical (1/3/10 Meters)	9011-2504	17 Jun 11
i)	EMCO 3101 Power Conical	9007-3450	7 Nov 93 (1/3m)

j)	EMCO 6502 Active Loop	1038	18 Jun 11
k)	EMCO 3301B Active E Field	9009-3044	19 Jun 11
l)	EMCO 3147 Wide Range Log Periodic	9102-1019	23 Jun 11
m)	EMCO 3107B Power E Field	9310-2435	N/A
m)	Amplifier Research FM1000	12456	N/A
n)	Amplifier Research FP1000	60701	21 Jun 11
o)	Amplifier Research FP1000	60488	3 Jun 11
p)	IFI EFS-4 E Field Susceptibility (Holladay 3004EX with HSE405 Probe)	39883	14 Jun 11
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 Jun 11
u)	Schaffner NSG 433 ESD Gun and Contact Discharge Adapter	107 402-664/0	30 Jun 11
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 Jun 11
ab)	Werlatone C1795 Dir. Coupler	3442	30 Jun 11
ac)	Solar Current Injection Probe Type 9108-1N	935012	N/A
ad)	Tektronix TR 503B Tracking Generator	B011216	25 Jun 11
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 Jun 11
ak)	Holladay Magnetic Field Probe Model HI-3624	83957	15 Jun 11
al)	Tektronix 2712 Spectrum Analyzer (Quasipeak)	B022520	24 Jun 11
am)	Voltec PM100 Power Analyzer	AA04/8495	25 Jun 11
an)	EMCO 3142 Biconilog Antenna	1052	1 Jun 11
ao)	Haefely P90.1 EN 61000-4-4 Fast Transient Tester	083 593-14	19 Jun 11
ap)	Hewlett Packard 3400A AC Voltmeter	1218A14443	24 Jun 11
aq)	Amplifier Research FP2031 Isotropic Probe	18309	5 Jun 11
ar)	Haefely 250 600/00 (61000-4-5 Surge Tester)	583 334-05	19 Jun 11
as)	Fischer CISPR 14 Absorbing Clamp type F-201	235	7 Jun 11
at)	Fischer IEC 801-6 Transducer	165	23 Jun 11
au)	Solar 9123-1N Current Clamp	956015	23 Jun 11
av	Fischer IC 801-6 CDN FCC-801-M3-25	95	7 Jun 11
aw)	Tektronix 2712 Spectrum Analyzer (Quasipeak)	B022981	24 Jun 11
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 Jun 11
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	31 Jun 11
be)	Coaxial Bird Pads (x2) 8306-030-N3DB	None	30 Jun 11
bf)	High Current Source, Associated Research 3030D	A140006	25 Jun 11
bg)	California Instruments 5001ix High Power Source	HK52945	25 Jun 11
bh)	Line Leakage tester, Associated Research 510L	130007	25 Jun 11
bi)	Hipot Tester, Associated Research 3570D	090595	25 Jun 11
bh)	GAASfet Preamplifier	None	30 Jun 11
bi)	Ametek Tachometer Model 1726	R035292	24 Jun 11
bj)	Bird Attenuator (x2), 75 Watt, 75-A-MFN-10	R035290	30 May 04
bk)	HP 8482A Power Sensor	S/N: 2652A18474	24 Jun 11
bl)	HP 435B Power Meter	S/N: 2702A17563	24 Jun 11
bm)	Simpson Model 383 Thermometer	B001531	24 Jun 11
bn)	Wavetek 27XT Voltmeter	96120787	24 Jun 11
bo)	HP 8657A Programmable Synthesizer	365	27 Jun 11
bp)	Fluke 75		24 Jun 11
bq)	Fluke 21 Series III		24 Jun 11
br)	ENI 525LA		19 Jun 11
bs)	Tek 2755P Opt 5/7	B020147	30 Jun 11
bt)	Amplifier Research FP2036 (.5-5Ghz)		04 Sep 11

7.0 CONCLUSION OF RADIO FREQUENCY INTERFERENCE EMISSIONS AND SUSCEPTIBILITY TESTS:

The TFT EP0468 BIV/VUM DISPLAY 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/hydrant activation function and the corresponding EP0468 display from that activation.

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

Changes

A one ohm series resistor was augmented with an additional impeder inductor to reduce ingress of EMI into the housing. The designation was TDK MMZ2012R601A.

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 EP0468 BIV/VUM DISPLAY** 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.

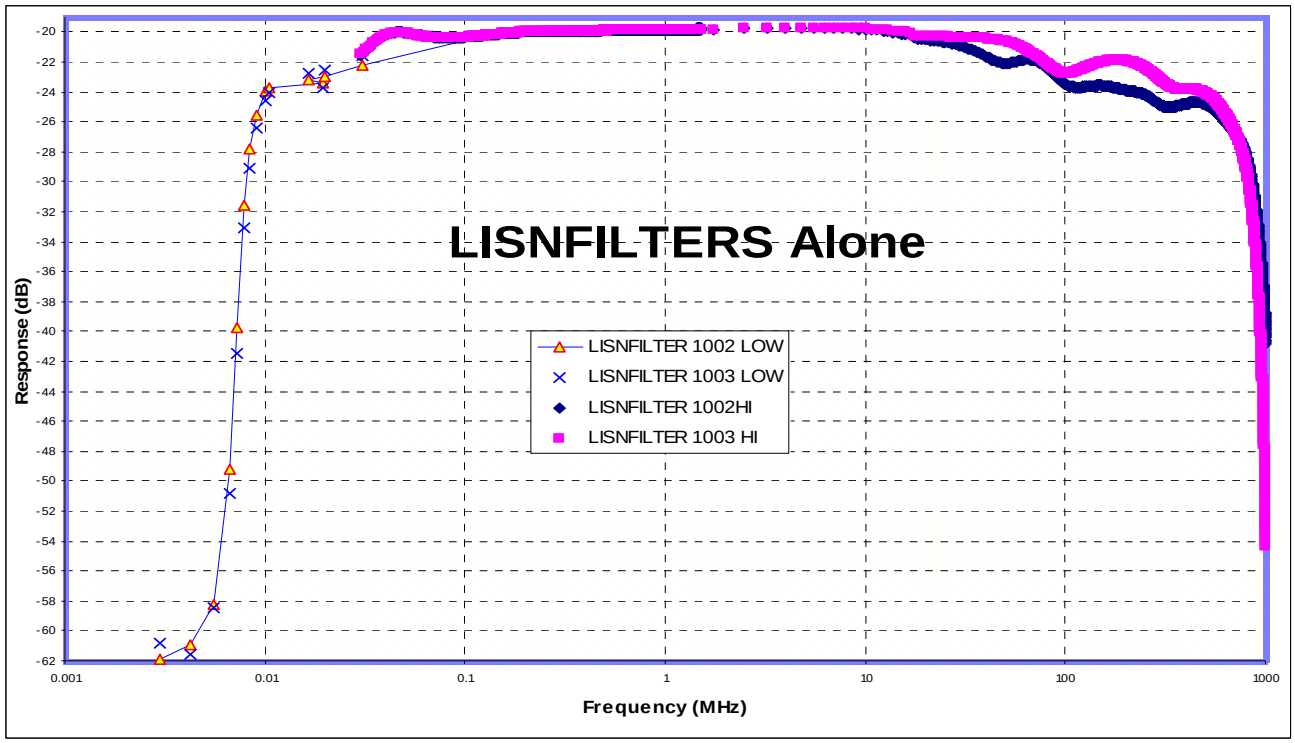
VDE LIMITS

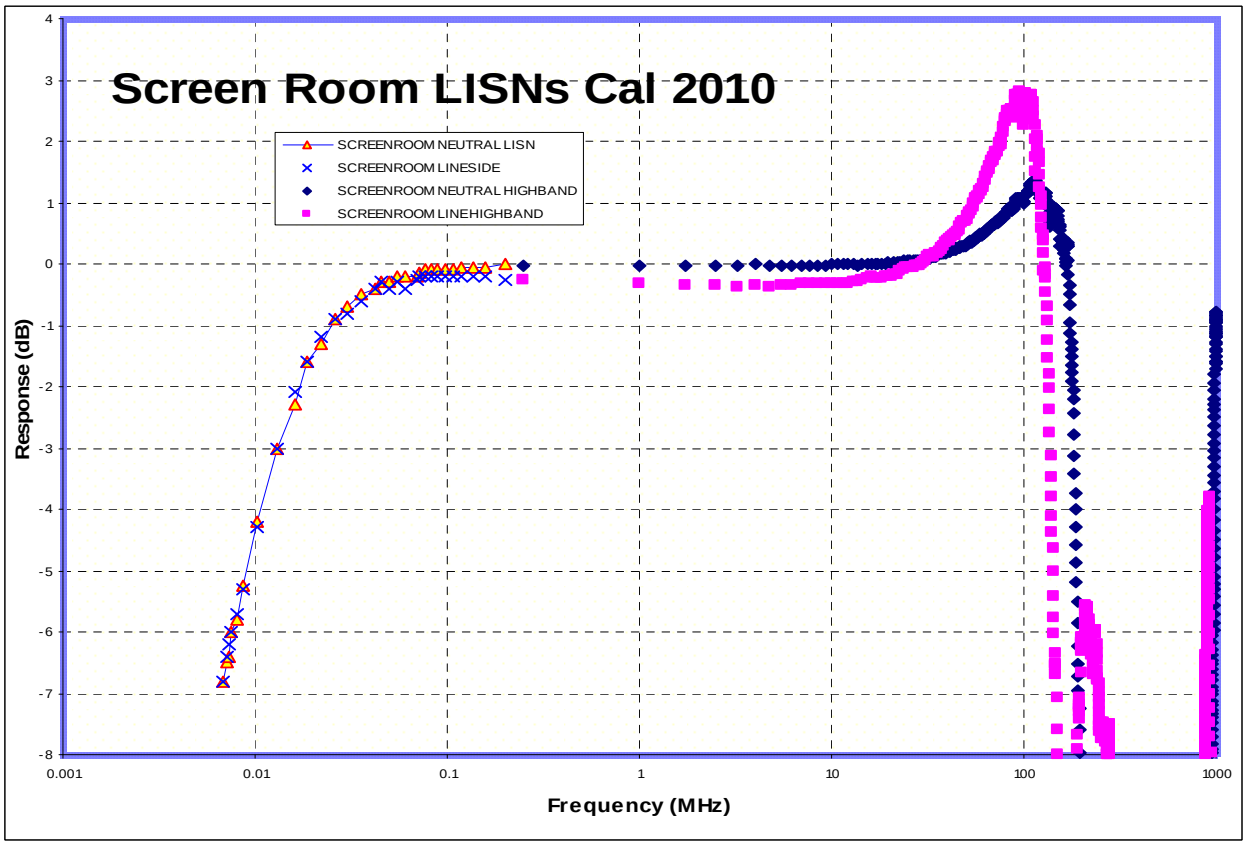
For CISPR 11 (EN55011), 22 (EN55022) or 14 (EN55014) B level conducted compliance starting at 150 kHz the allowed level is 66 dBuV and decreases at a linear rate with the log of frequency to 56 dBuV at 500 kHz. From 500 kHz to 5 MHz the allowed level is 56 dBuV, and 60 dBuV from 5 MHz to 30 MHz at the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

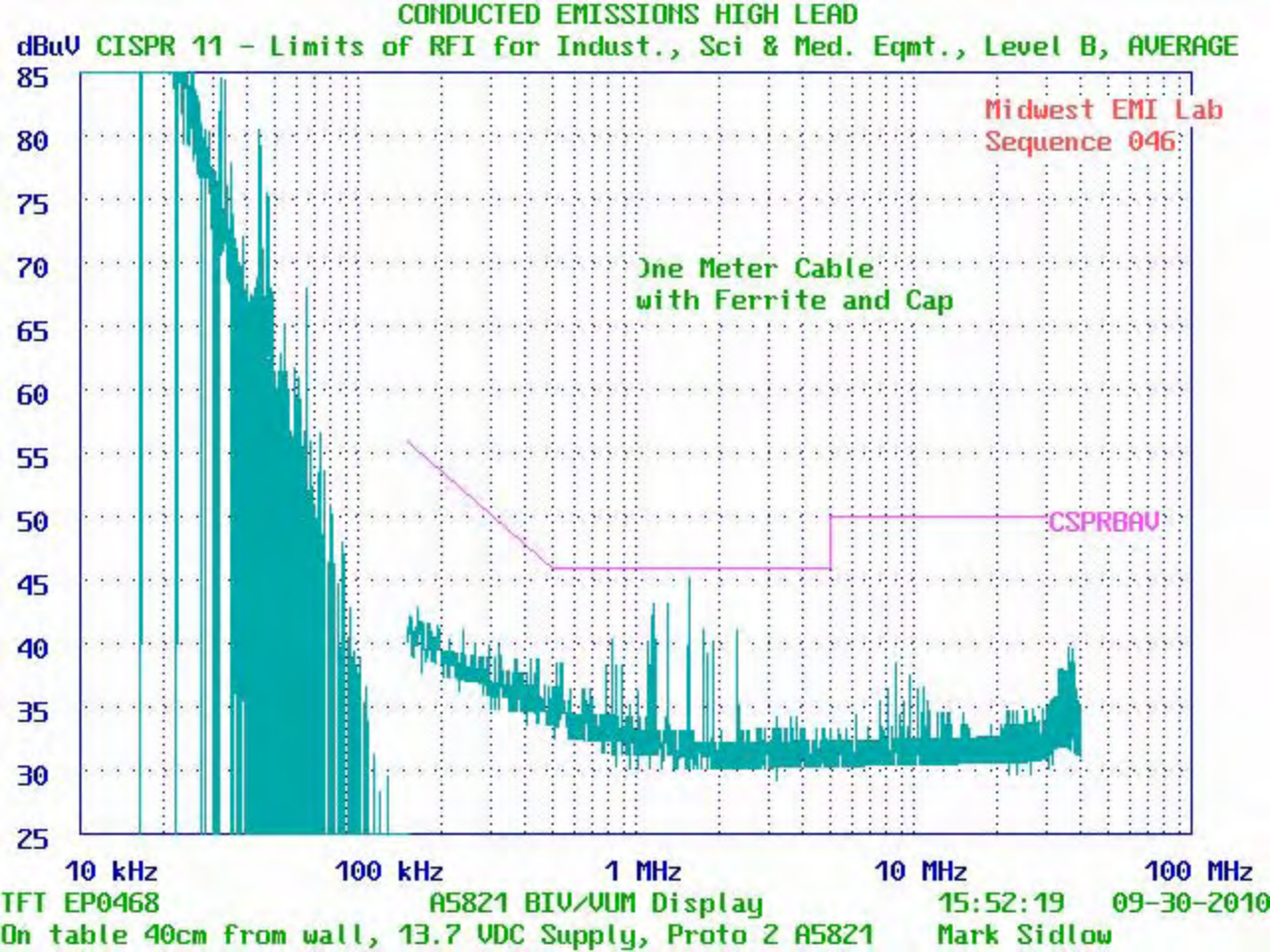
In the range higher than 1 MHz up to 100 MHz the characteristic of each LISN is flat with an insertion loss of no greater than 3 dB. In all cases the deviation from the perfect LISN response has been compensated for in a computer correction table file (approximately 150 points). The actual lower end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

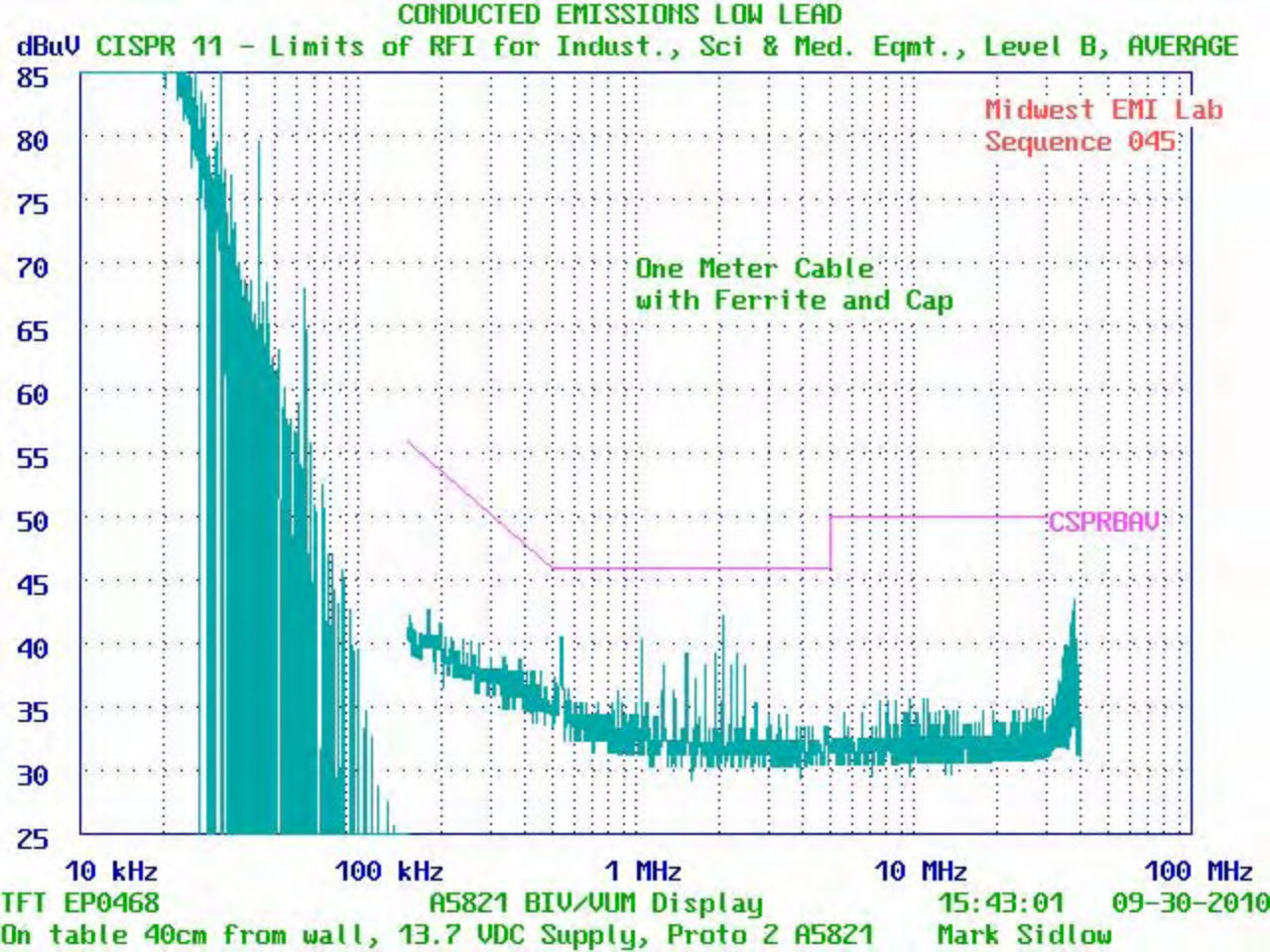

LISNFILTERS Alone
LISNFILTER 1002 LOW
LISNFILTER 1003 LOW
LISNFILTER 1002HI
LISNFILTER 1003 HI
Response (dB)
Frequency (MHz)

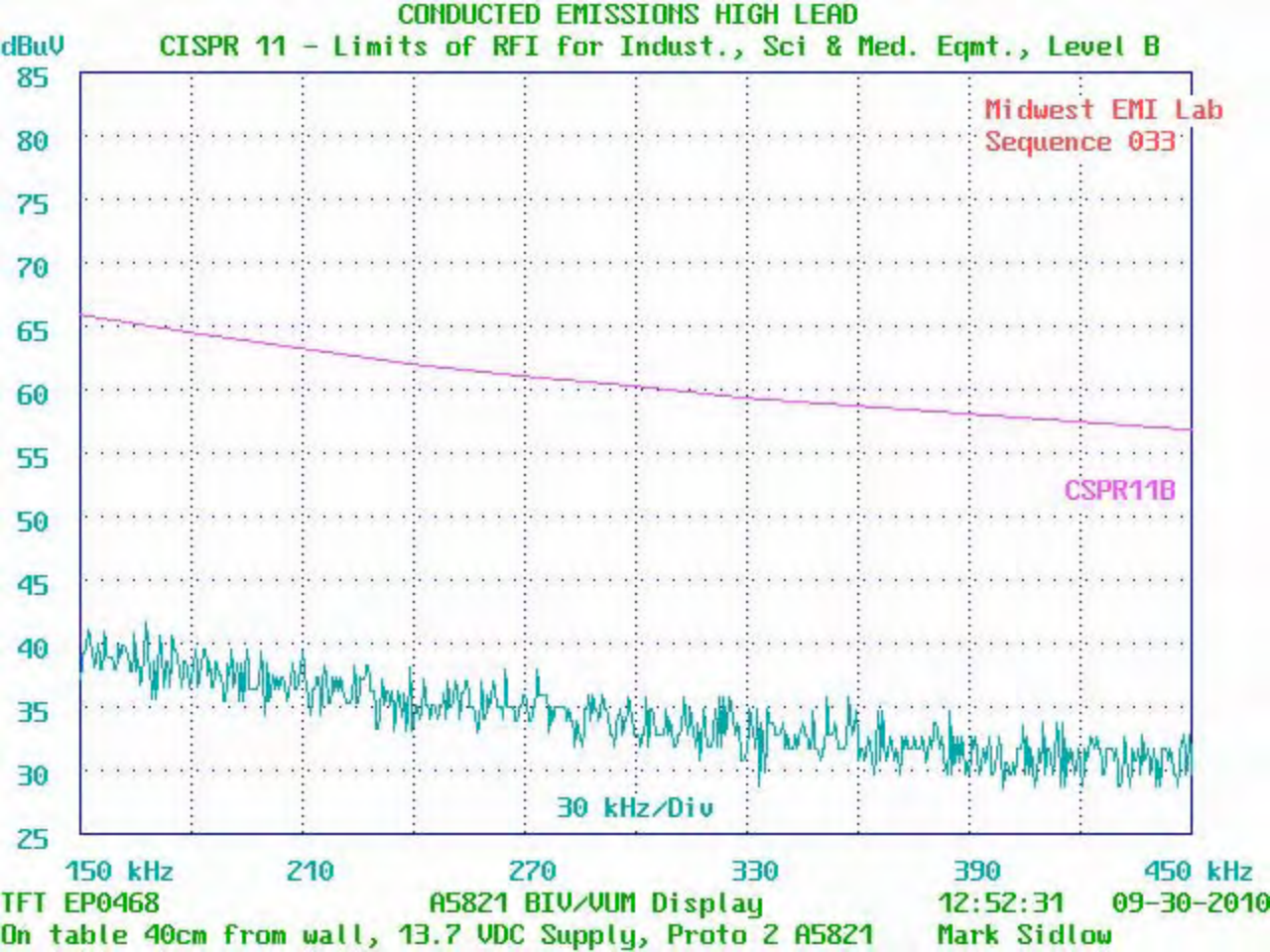

Screen Room LISNs Cal 2010
SCREENROOM NEUTRAL LISN
SCREENROOM LINESIDE
SCREENROOM NEUTRAL HIGHBAND
SCREENROOM LINEHIGHBAND
Response (dB)
Frequency (MHz)

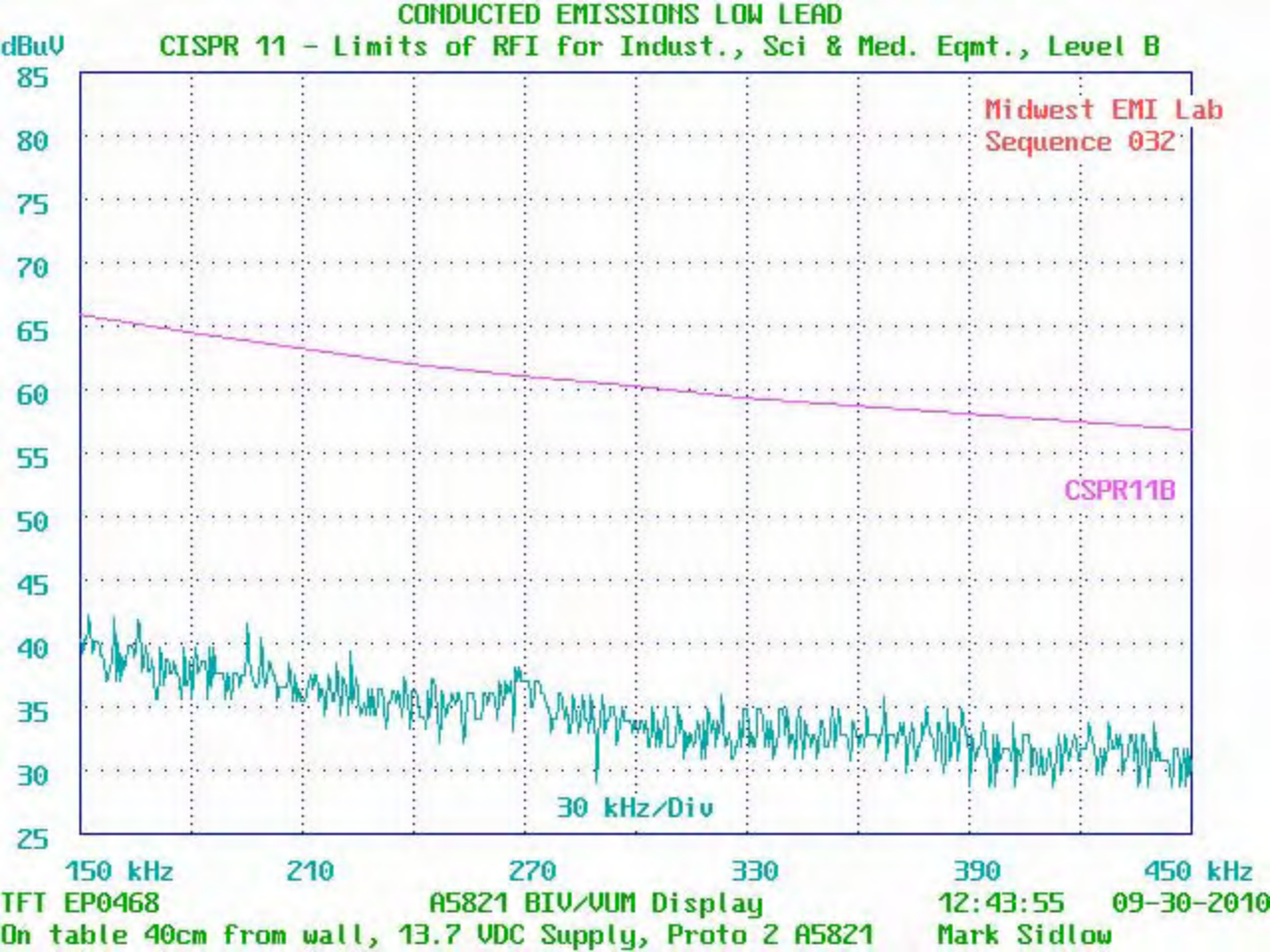
4.0 CONCLUSION OF RADIO FREQUENCY INTERFERENCE EMISSIONS TESTS:

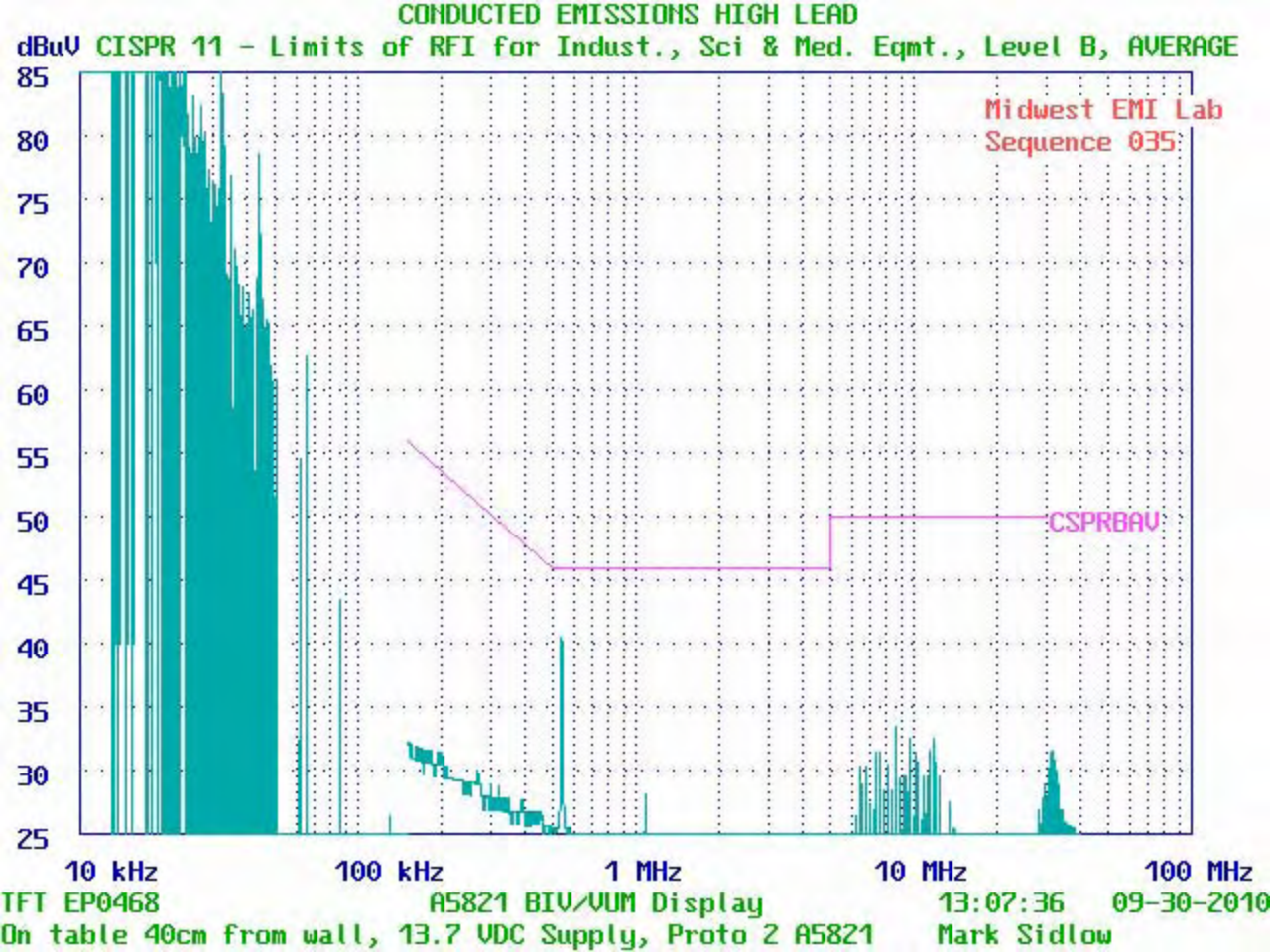
The TFT EP0468 BIV/VUM DISPLAY was measured for its conducted emissions per EN61000-6-3 for DC operated devices. After measuring and improving the system the EUT achieved the Cispr B level after reducing the excessive length of the cable to the standard one meter length.

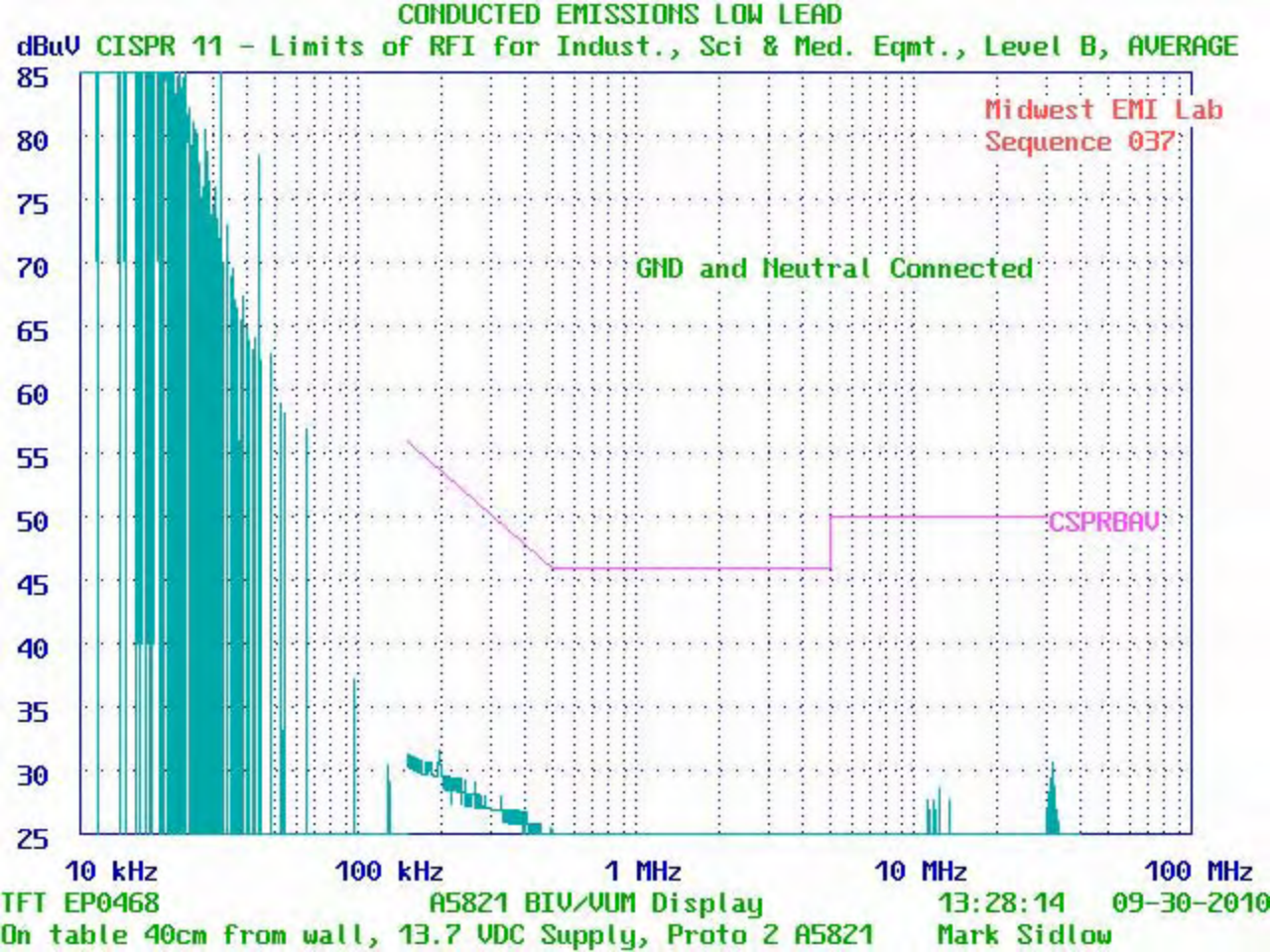

CONDUCTED EMISSIONS HIGH LEAD
dBuV CISPR 11 - Limits of RFI for Indust., Sci & Med. Eqmt., Level B, AVERAGE
85
80
75
70
65
60
55
50
45
40
35
30
25
Midwest EMI Lab
Sequence 046
)ne Meter Cable
with Ferrite and Cap
CSPRBAV
10 kHz
100 kHz
1 MHz
10 MHz
100 MHz
TFT EP0468
A5821 BIV/VUM Display
15:52:19
09-30-2010
On table 40cm from wall, 13.7 VDC Supply, Proto 2 A5821
Mark Sidlow


CONDUCTED EMISSIONS LOW LEAD
dBuV CISPR 11 - Limits of RFI for Indust., Sci & Med. Eqmt., Level B, AVERAGE
Midwest EMI Lab
Sequence 045
One Meter Cable
with Ferrite and Cap
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 EP0468
A5821 BIV/VUM Display
15:43:01
09-30-2010
On table 40cm from wall, 13.7 VDC Supply, Proto 2 A5821
Mark Sidlow


CONDUCTED EMISSIONS HIGH LEAD
dBuV
CISPR 11 - Limits of RFI for Indust., Sci & Med. Eqmt., Level B
85
80
75
70
65
60
55
50
45
40
35
30
25
Midwest EMI Lab
Sequence 033
CSPR11B
30 kHz/Div
150 kHz
210
270
330
390
450 kHz
TFT EP0468
A5821 BIV/VUM Display
12:52:31
09-30-2010
On table 40cm from wall, 13.7 VDC Supply, Proto 2 A5821
Mark Sidlow


CONDUCTED EMISSIONS LOW LEAD
dBuV
CISPR 11 - Limits of RFI for Indust., Sci & Med. Eqmt., Level B
85
80
75
70
65
60
55
50
45
40
35
30
25
Midwest EMI Lab
Sequence 032
CSPR11B
30 kHz/Div
150 kHz
210
270
330
390
450 kHz
TFT EP0468
A5821 BIV/VUM Display
12:43:55
09-30-2010
On table 40cm from wall, 13.7 VDC Supply, Proto 2 A5821
Mark Sidlow


CONDUCTED EMISSIONS HIGH LEAD
dBuV CISPR 11 - Limits of RFI for Indust., Sci & Med. Eqmt., Level B, AVERAGE
Midwest EMI Lab
Sequence 035
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 EP0468
A5821 BIV/VUM Display
13:07:36
09-30-2010
On table 40cm from wall, 13.7 VDC Supply, Proto 2 A5821
Mark Sidlow


CONDUCTED EMISSIONS LOW LEAD
dBuV CISPR 11 - Limits of RFI for Indust., Sci & Med. Eqmt., Level B, AVERAGE
85
80
75
70
65
60
55
50
45
40
35
30
25
Midwest EMI Lab
Sequence 037
GND and Neutral Connected
CSPRBAV
10 kHz
100 kHz
1 MHz
10 MHz
100 MHz
TFT EP0468
A5821 BIV/VUM Display
13:28:14
09-30-2010
On table 40cm from wall, 13.7 VDC Supply, Proto 2 A5821
Mark Sidlow

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 EP0468 BIV/VUM DISPLAY 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 1 meter antenna height found typically to be worst case. The orientation of the unit was typically with the control box and valve facing front at 0 degrees wrt the antenna.

Final Testing – 09/30/2010

Seq. 614 shows the ambient; Seq. 613 shows the quasipeak mode in comparison in the range of 20-75 MHz. All emissions were checked with two at 52 and 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.

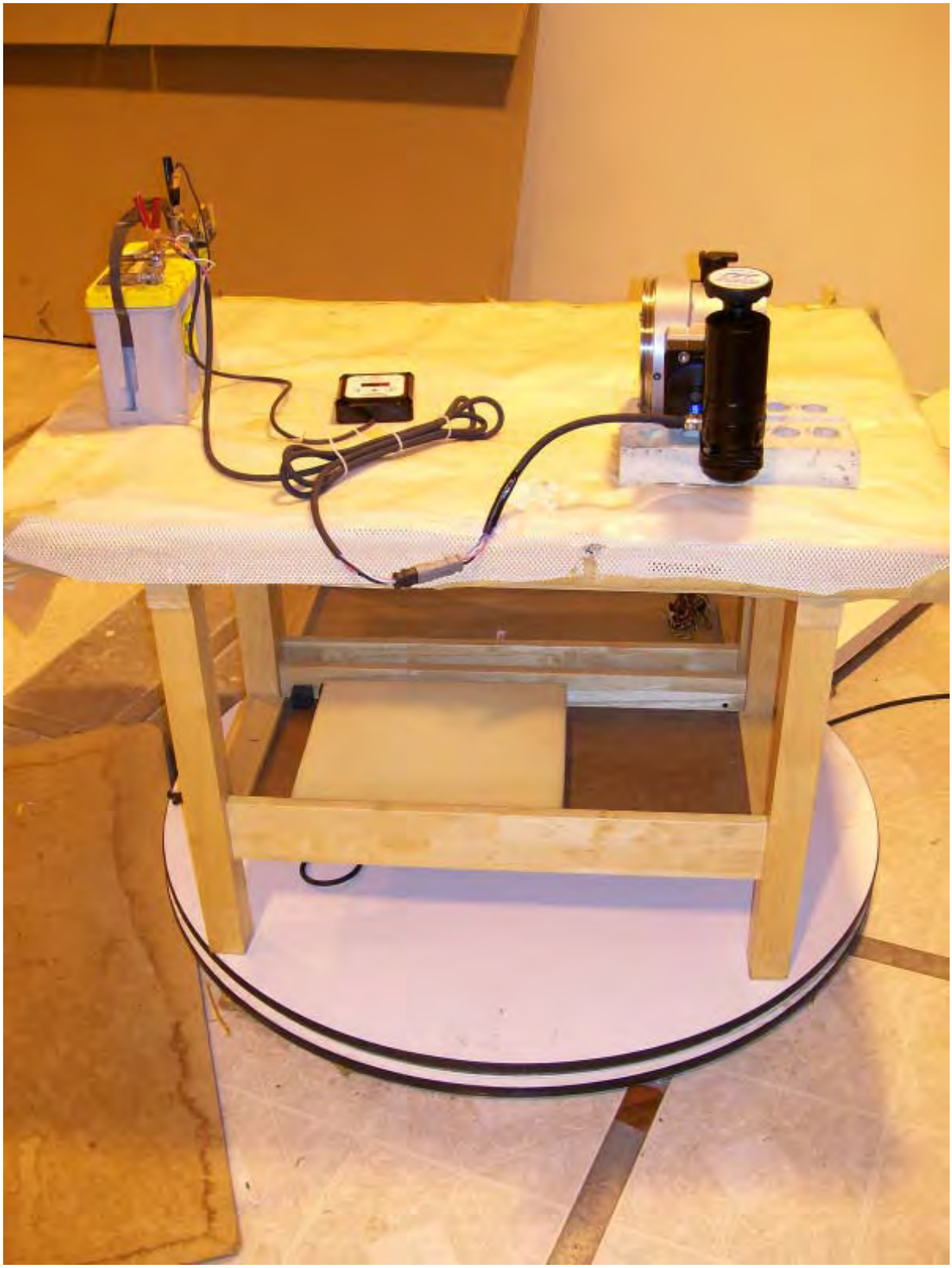
In the 75-170 MHz range, Seq. 603 shows the ambient and Seq. 604 shows the quasipeak emissions. Ambient emissions consist of the FM band and the intentional radiators at 152-158 and 162 MHz. Emissions above the line in the mid band area were discovered to be sporadic airplane emissions. No other emissions from the EUT appeared to be above the line.

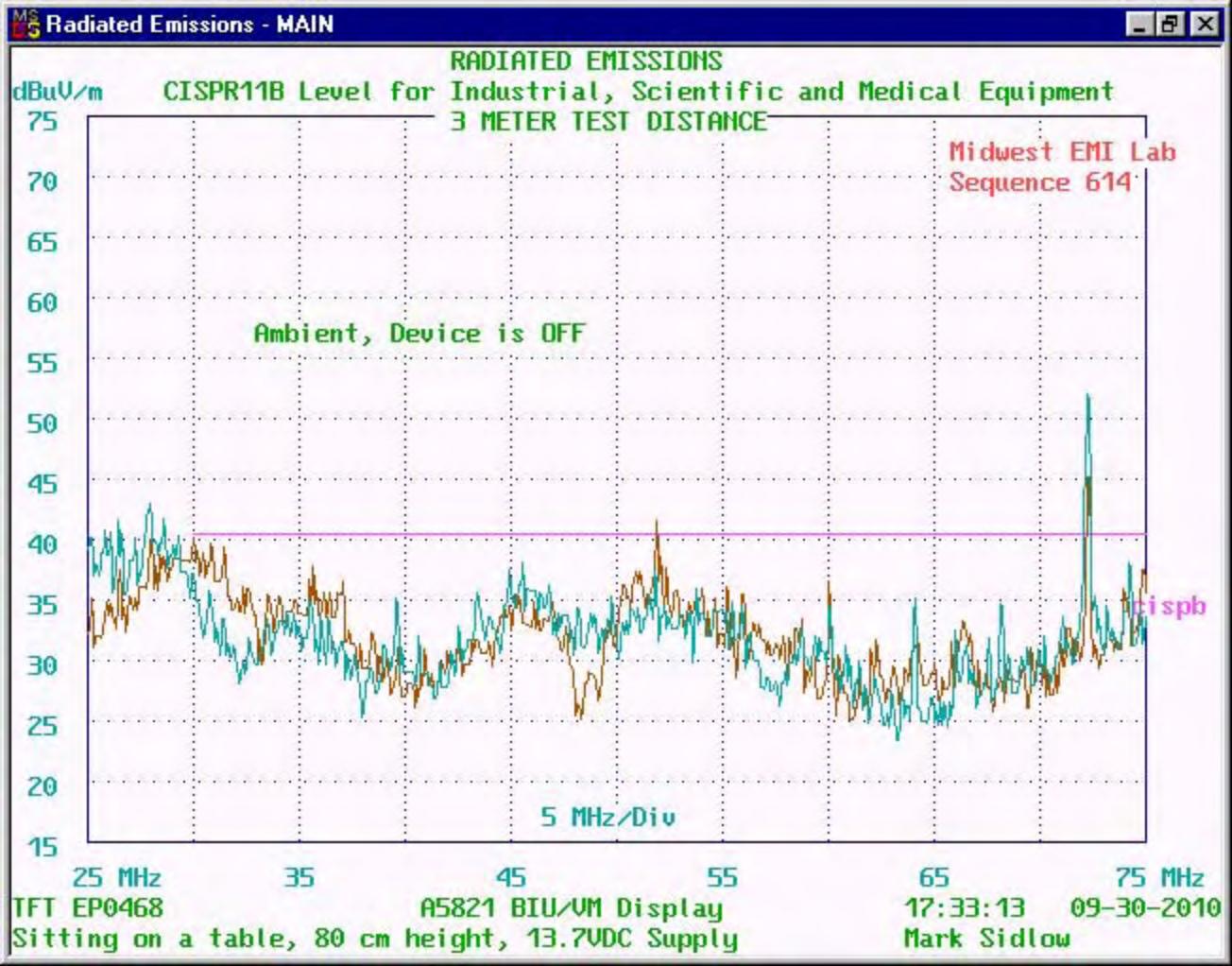
In the 160-300 MHz range, the ambient is shown on Seq. 605, and peak level on Seq. 606. No areas of emission from the EUT appeared to exceed the limit. Other emissions seen were from TV Channels 7 and 11.

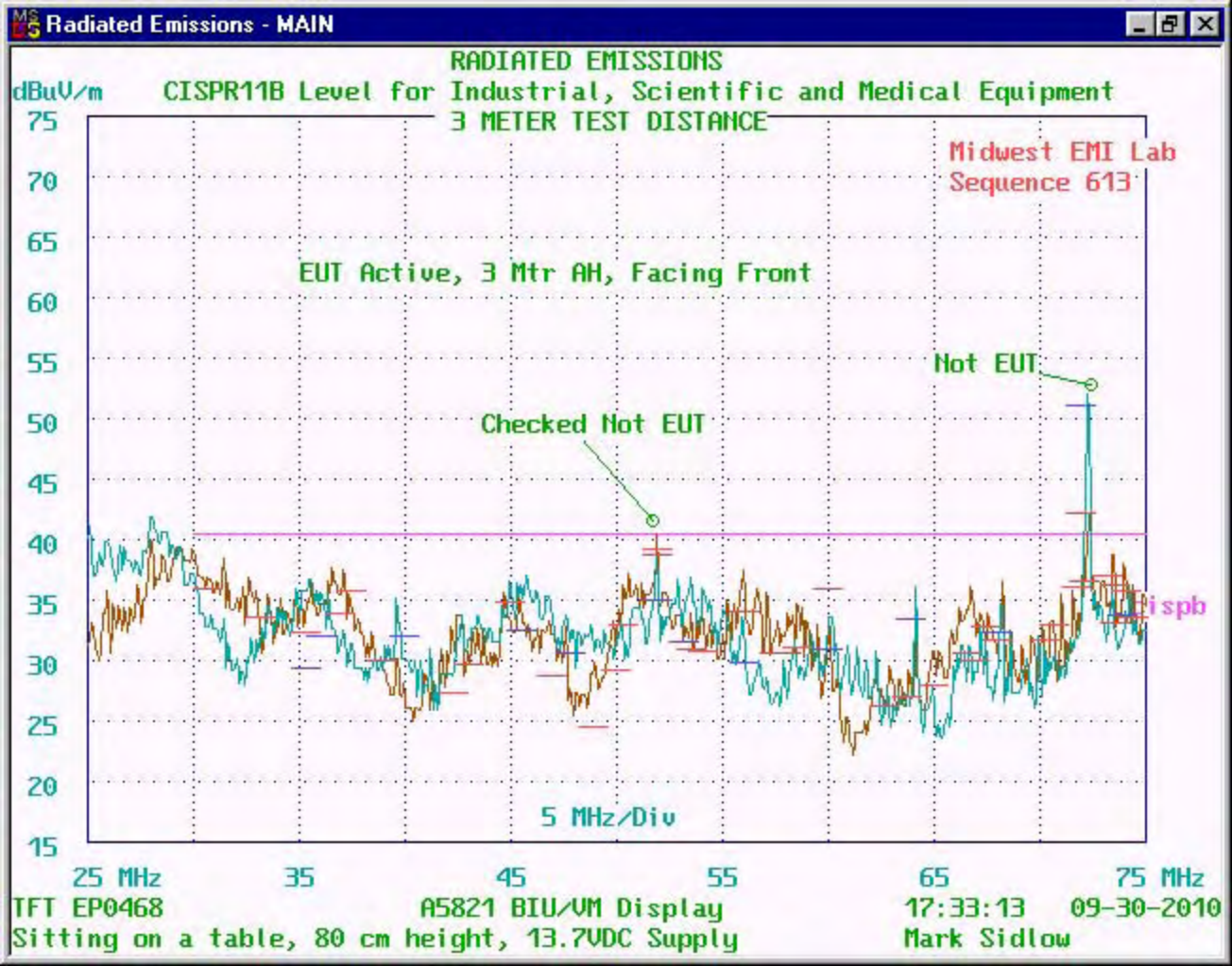
In the 300-640 MHz, the ambient is shown on Seq. 607 and the peak level emissions are shown on Seq 608. Other high emissions are numerous UHF TV stations and they are identified. Two emissions found in this range different from the ambient were individually inspected and not found to be due to the EUT but were from limo taxi services.

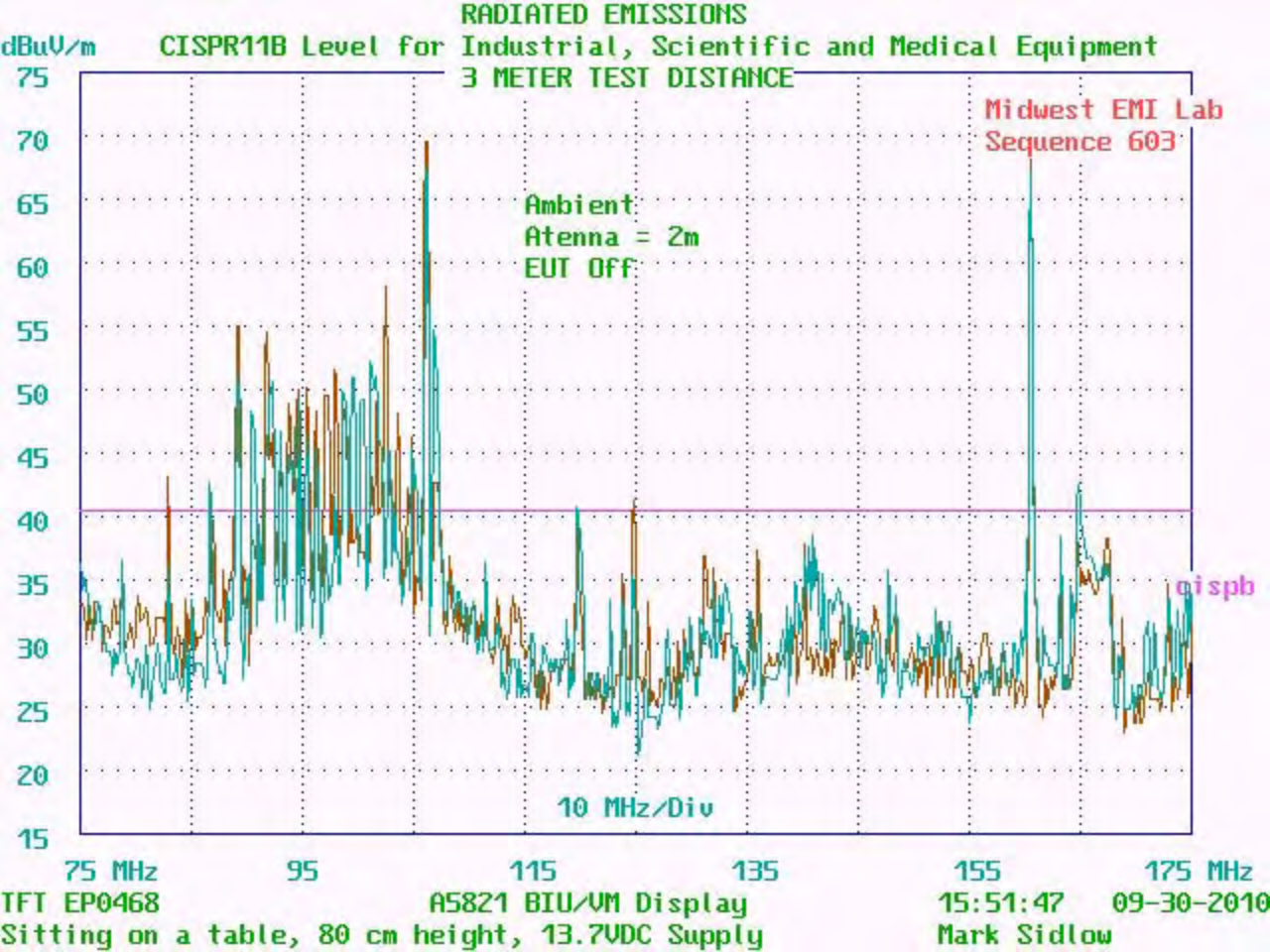
In the 620-1000 MHz, the ambient is shown on Seq. 609 and peak level on Seq. 611. Other high emissions are numerous UHF TV stations and the cell telephone band around 900 MHz that is identified. When the graphs were overlaid, no excess level introduced by the EUT was seen.

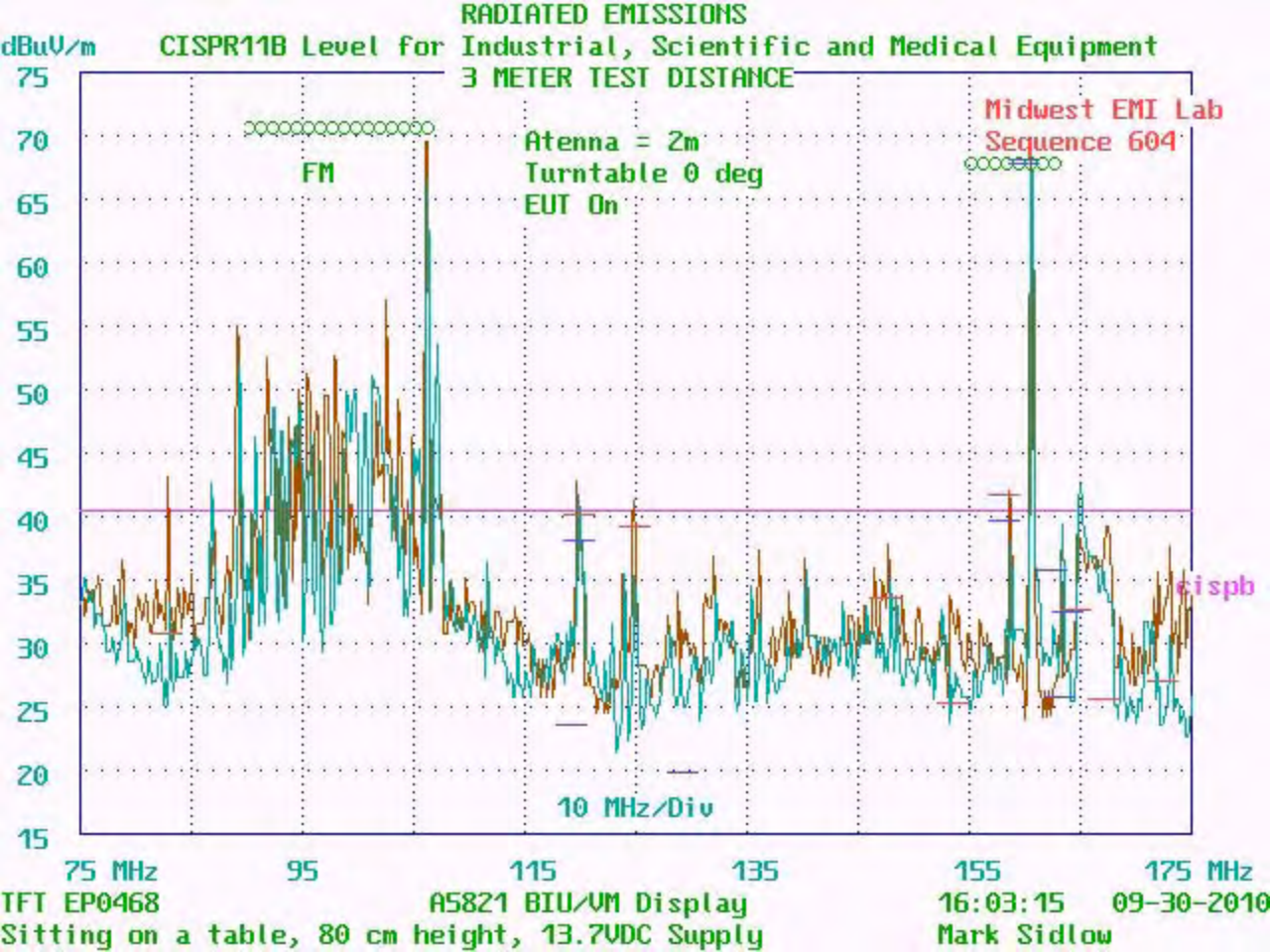
The TFT BIV_VUM Valve Controller was fully compliant with the Cispr 11 B level specification. The actual battery used for this test was a large 12 volt lead acid battery that was attached to the battery terminals by clip leads.

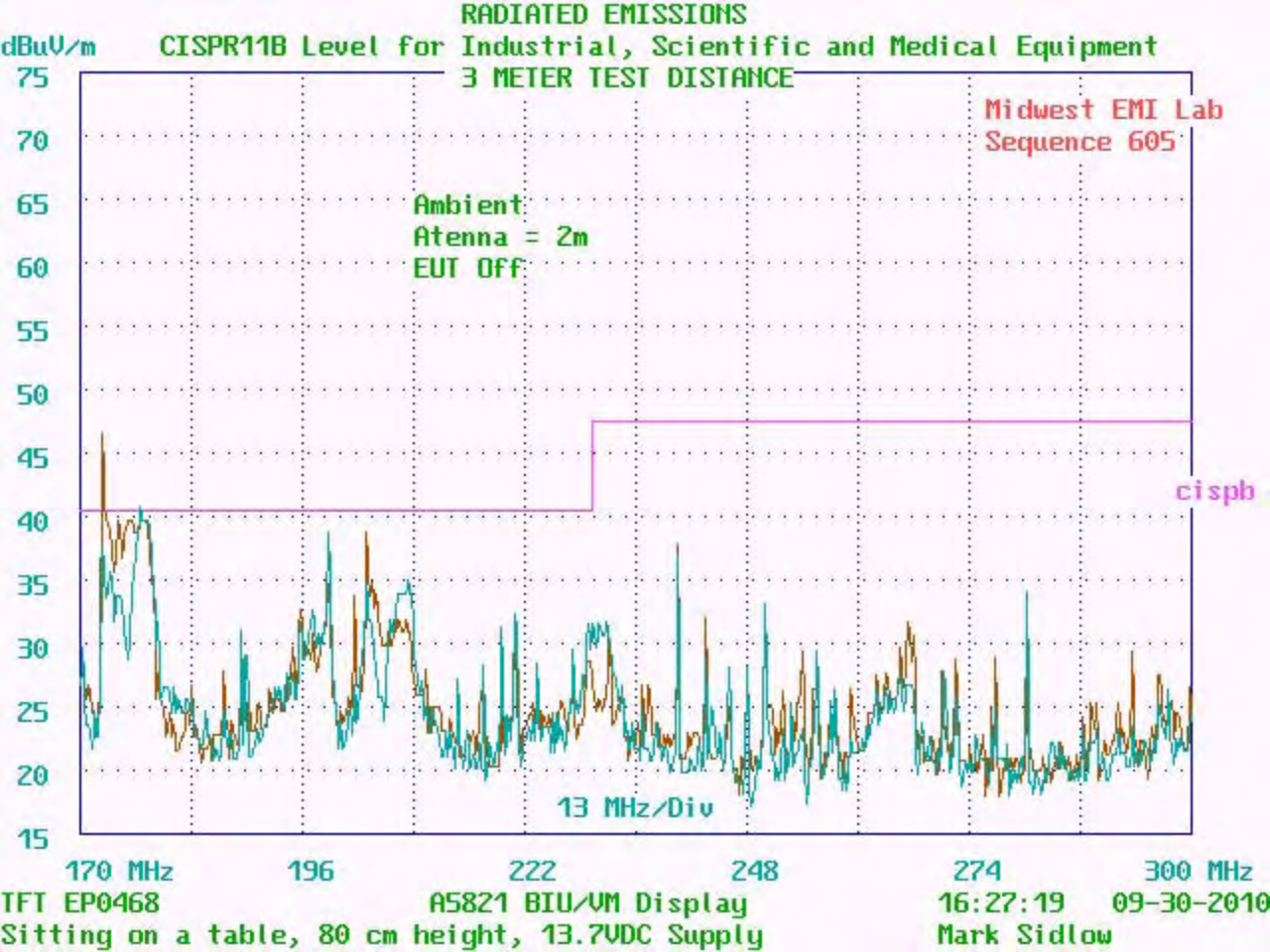


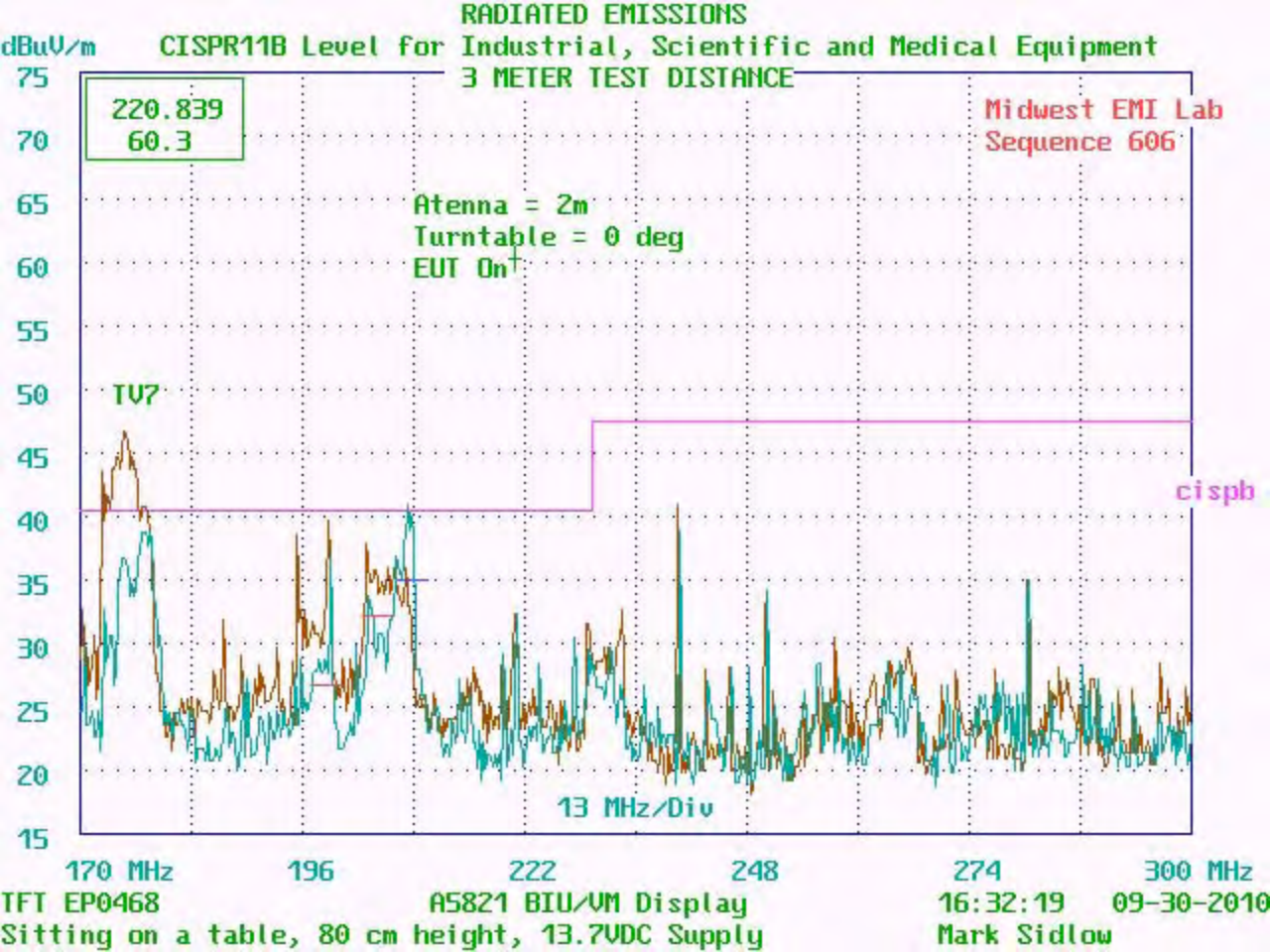

Radiated Emissions - MAIN
RADIATED EMISSIONS
dBuV/m
CISPR11B Level for Industrial, Scientific and Medical Equipment
3 METER TEST DISTANCE
Midwest EMI Lab
Sequence 614
Ambient, Device is OFF
cispb
5 MHz/Div
75
70
65
60
55
50
45
40
35
30
25
20
15
25 MHz
35
45
55
65
75 MHz
TFT EP0468
A5821 BIU/VM Display
17:33:13
09-30-2010
Sitting on a table, 80 cm height, 13.7VDC Supply
Mark Sidlow

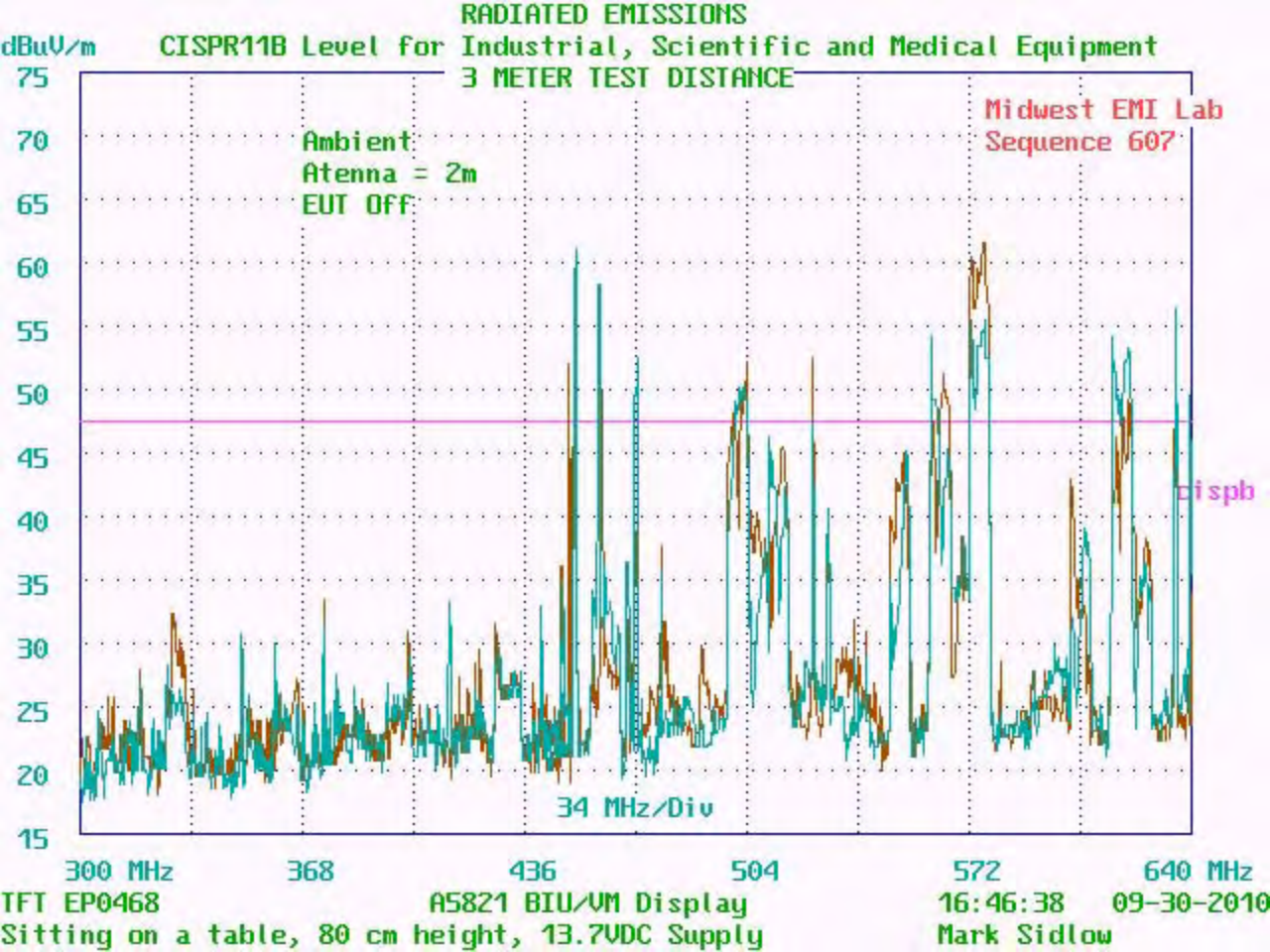

Radiated Emissions - MAIN
RADIATED EMISSIONS
dBuV/m
CISPR11B Level for Industrial, Scientific and Medical Equipment
3 METER TEST DISTANCE
Midwest EMI Lab
Sequence 613
EUT Active, 3 Mtr AH, Facing Front
Not EUT
Checked Not EUT
ispb
5 MHz/Div
75
70
65
60
55
50
45
40
35
30
25
20
15
25 MHz
35
45
55
65
75 MHz
TFT EP0468
A5821 BIU/VM Display
17:33:13
09-30-2010
Sitting on a table, 80 cm height, 13.7VDC Supply
Mark Sidlow

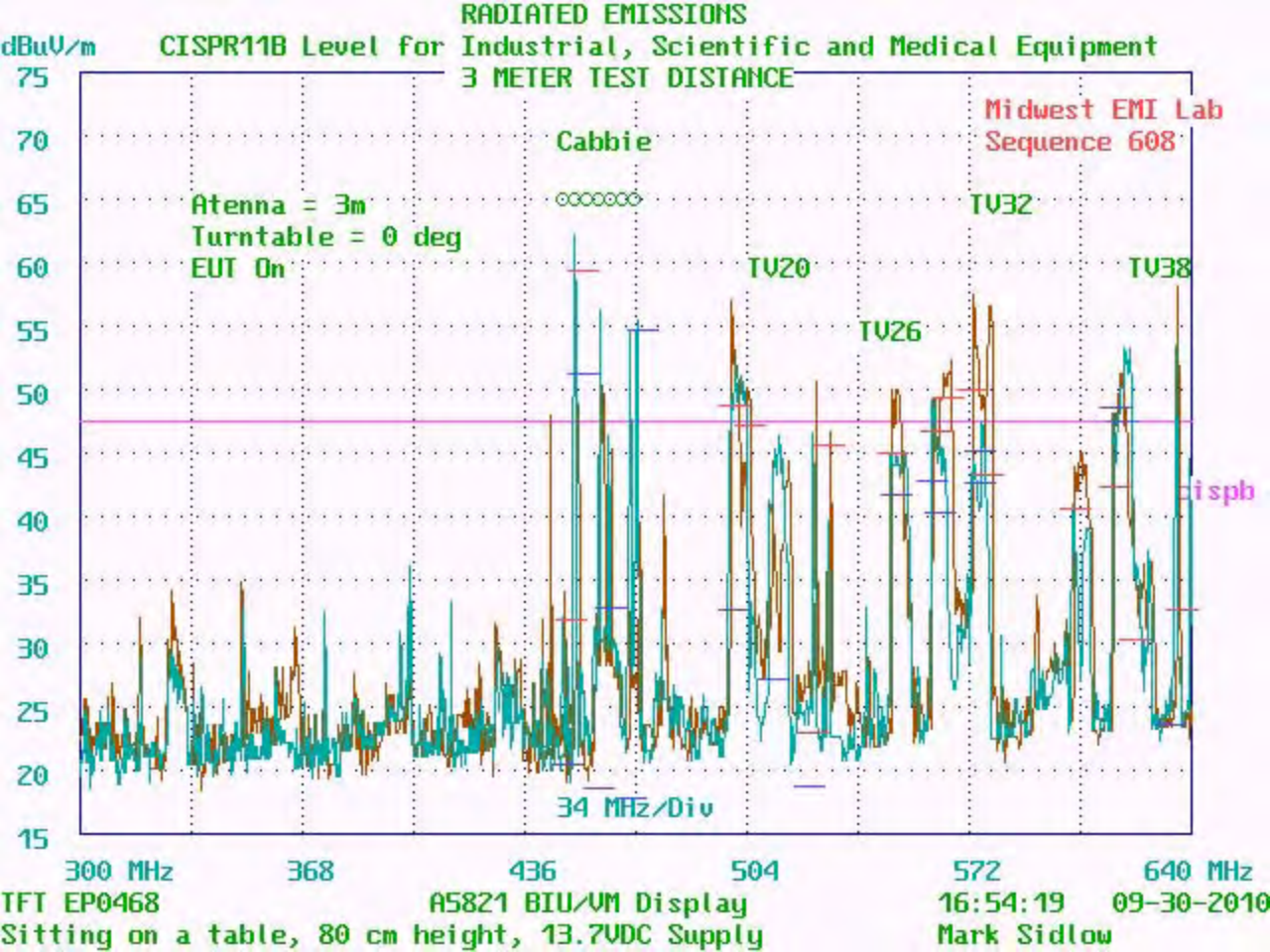

RADIATED EMISSIONS
dBuV/m
CISPR11B Level for Industrial, Scientific and Medical Equipment
3 METER TEST DISTANCE
Midwest EMI Lab
Sequence 603
Ambient
Atenna = 2m
EUT Off
cispb
10 MHz/Div
75
70
65
60
55
50
45
40
35
30
25
20
15
75 MHz
95
115
135
155
175 MHz
TFT EP0468
A5821 BIU/VM Display
15:51:47
09-30-2010
Sitting on a table, 80 cm height, 13.7VDC Supply
Mark Sidlow

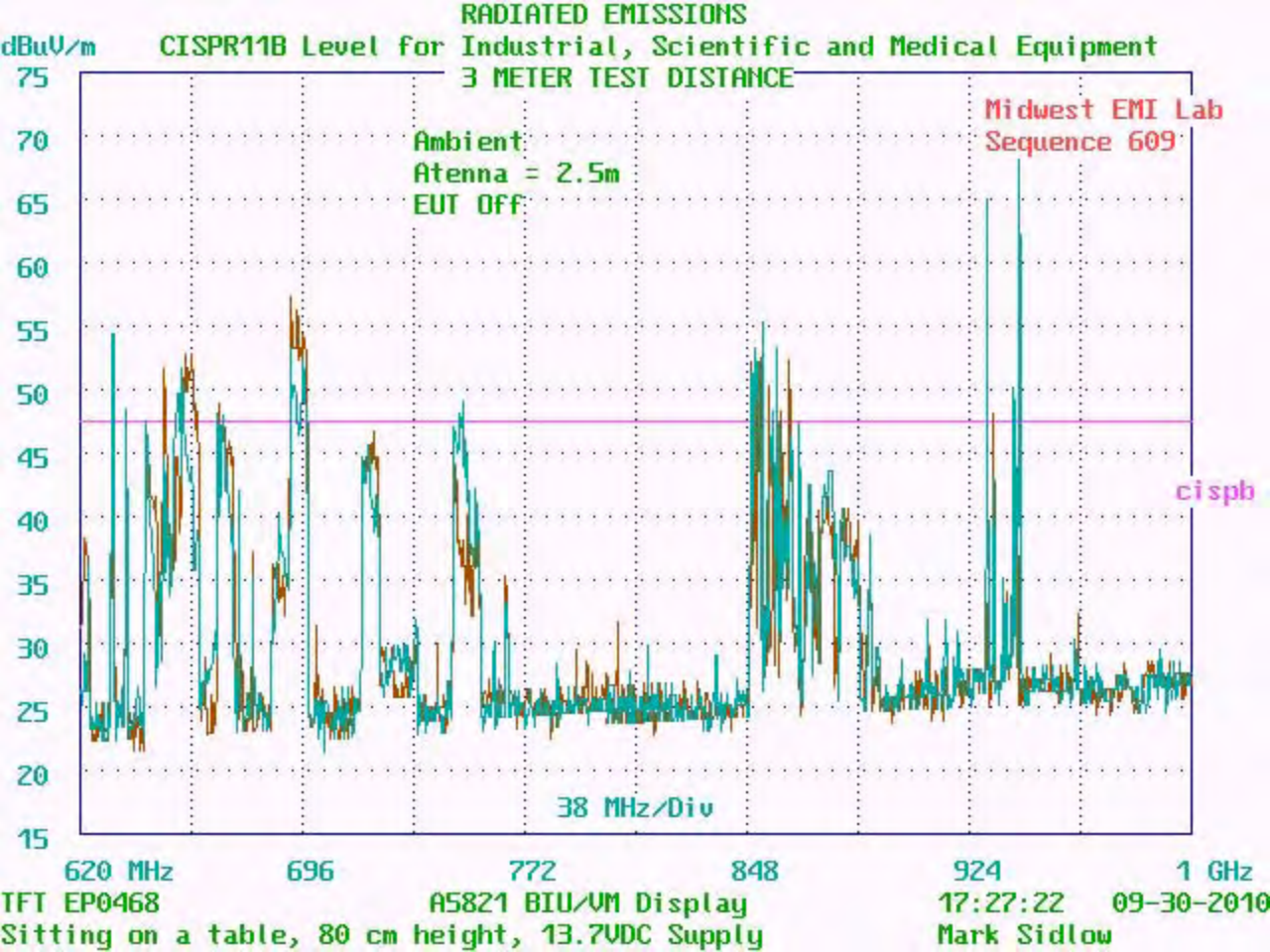

RADIATED EMISSIONS
dBuV/m
CISPR11B Level for Industrial, Scientific and Medical Equipment
3 METER TEST DISTANCE
75
70
65
60
55
50
45
40
35
30
25
20
15
FM
Atenna = 2m
Turntable 0 deg
EUT On
Midwest EMI Lab
Sequence 604
cispb
10 MHz/Div
75 MHz
95
115
135
155
175 MHz
TFT EP0468
A5821 BIU/VM Display
16:03:15
09-30-2010
Sitting on a table, 80 cm height, 13.7VDC Supply
Mark Sidlow

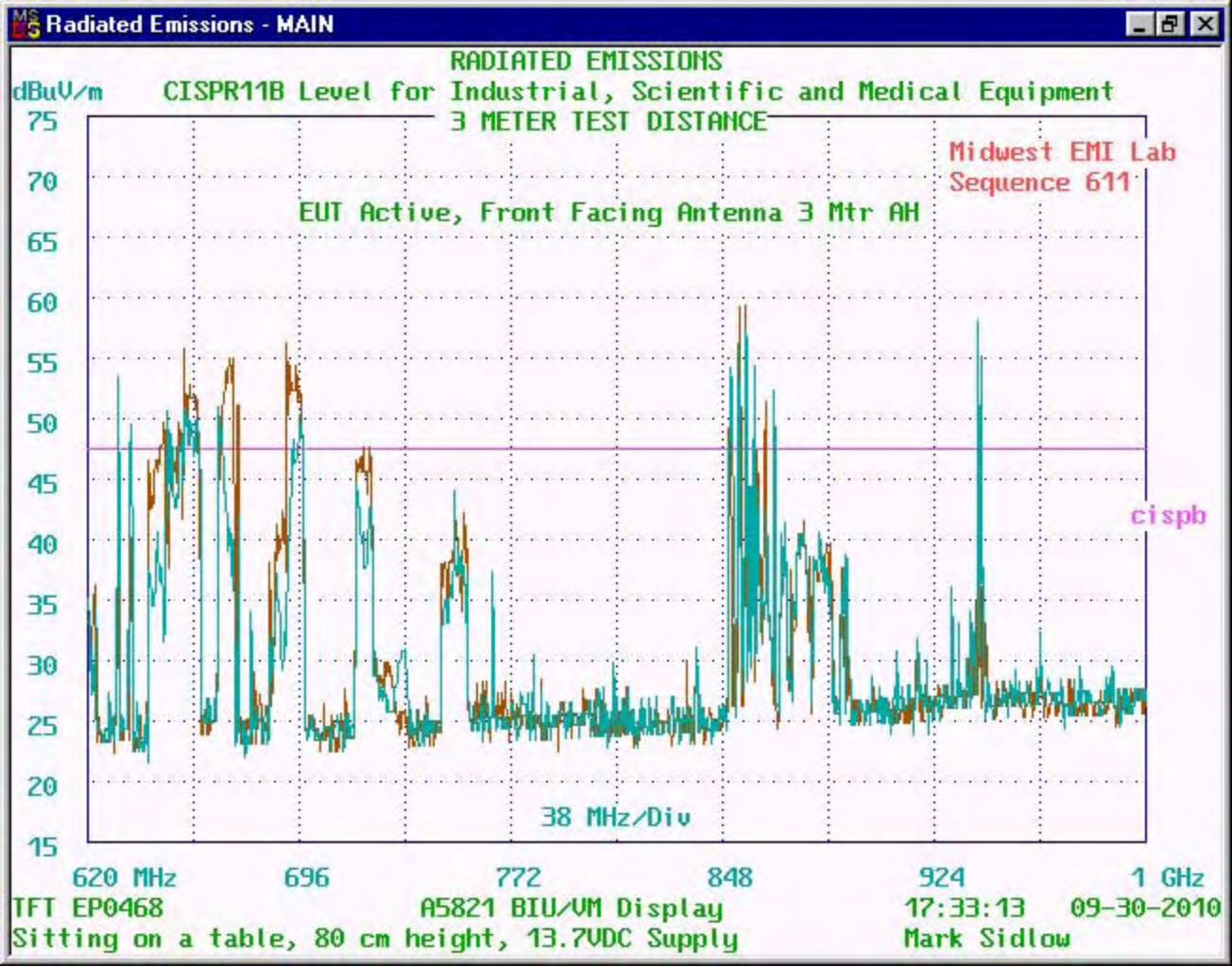

RADIATED EMISSIONS
dBuV/m
CISPR11B Level for Industrial, Scientific and Medical Equipment
3 METER TEST DISTANCE
Midwest EMI Lab
Sequence 605
Ambient
Atenna = 2m
EUT Off
cispb
13 MHz/Div
75
70
65
60
55
50
45
40
35
30
25
20
15
170 MHz
196
222
248
274
300 MHz
TFT EP0468
A5821 BIU/VM Display
16:27:19
09-30-2010
Sitting on a table, 80 cm height, 13.7VDC Supply
Mark Sidlow


RADIATED EMISSIONS
dBuV/m
CISPR11B Level for Industrial, Scientific and Medical Equipment
3 METER TEST DISTANCE
220.839
60.3
Midwest EMI Lab
Sequence 606
Atenna = 2m
Turntable = 0 deg
EUT On
TV7
cispb
13 MHz/Div
75
70
65
60
55
50
45
40
35
30
25
20
15
170 MHz
196
222
248
274
300 MHz
TFT EP0468
A5821 BIU/VM Display
16:32:19
09-30-2010
Sitting on a table, 80 cm height, 13.7VDC Supply
Mark Sidlow


RADIATED EMISSIONS
dBuV/m
CISPR11B Level for Industrial, Scientific and Medical Equipment
3 METER TEST DISTANCE
Midwest EMI Lab
Sequence 607
Ambient
Atenna = 2m
EUT 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 EP0468
A5821 BIU/VM Display
16:46:38
09-30-2010
Sitting on a table, 80 cm height, 13.7VDC Supply
Mark Sidlow


RADIATED EMISSIONS
dBuV/m
CISPR11B Level for Industrial, Scientific and Medical Equipment
3 METER TEST DISTANCE
Midwest EMI Lab
Sequence 608
Cabbie
Atenna = 3m
Turntable = 0 deg
EUT On
TV20
TV26
TV32
TV38
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 EP0468
A5821 BIU/VM Display
16:54:19
09-30-2010
Sitting on a table, 80 cm height, 13.7VDC Supply
Mark Sidlow


RADIATED EMISSIONS
dBuV/m
CISPR11B Level for Industrial, Scientific and Medical Equipment
3 METER TEST DISTANCE
Midwest EMI Lab
Sequence 609
Ambient
Atenna = 2.5m
EUT Off
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 EP0468
A5821 BIU/VM Display
17:27:22
09-30-2010
Sitting on a table, 80 cm height, 13.7VDC Supply
Mark Sidlow


Radiated Emissions - MAIN
RADIATED EMISSIONS
dBuV/m
CISPR11B Level for Industrial, Scientific and Medical Equipment
3 METER TEST DISTANCE
Midwest EMI Lab
Sequence 611
EUT Active, Front Facing Antenna 3 Mtr AH
75
70
65
60
55
50
45
40
35
30
25
20
15
cispb
38 MHz/Div
620 MHz
696
772
848
924
1 GHz
TFT EP0468
A5821 BIU/VM Display
17:33:13
09-30-2010
Sitting on a table, 80 cm height, 13.7VDC Supply
Mark Sidlow

SHEET 1 cispb RADIATED QUASI-PEAK REPORT
CISPR11B Level for Industrial, Scientific and Medical Equipment
3 METER TEST DISTANCE
TIME: 17:33:13 Midwest EMI
DATE: 09-30-2010 Associates
TEST ITEM: TFT EP0468
SERIAL NUMBER: A5821 BIU/VM Display Sequence Number: 613
COMMENTS: Sitting on a table, 80 cm height, 13.7VDC Supply
TEST PERFORMED BY: Mark Sidlow

Peak Frequency (MHz)	Peak Interfer. (dBuV/m)	Quasi-peak Freq. (MHz)	Quasi-peak Interfer. (dBuV/m)	Spec. Level (dBuV/m)		Antenna Polarization (H/V)
30.5	37.28	30.66	36.00	40.50		Horizontal
33.25791	35.51	33.1787	33.74	40.50		Horizontal
35.19882	33.63	35.3428	32.39	40.50		Horizontal
36.8465	35.98	36.8825	34.05	40.50		Horizontal
37.40668	39.83	37.5195	35.85	40.50		Horizontal
38.86221	30.71	38.943	30.13	40.50		Horizontal
42.35669	31.02	42.3511	27.40	40.50		Horizontal
42.8321	35.19	42.9689	29.83	40.50		Horizontal
45.05771	34.65	45.0329	34.99	40.50		Horizontal
46.82823	33.49	47.0154	28.90	40.50		Horizontal
48.75131	30.54	48.9049	24.54	40.50		Horizontal
49.82199	31.22	50.0196	29.23	40.50		Horizontal
50.3102	33.85	50.439	33.02	40.50		Horizontal
51.91924	41.61	52.012	38.76	40.50		Horizontal
52.01725	35.85	52.0117	39.26	40.50		Horizontal
53.79477	33.30	53.6012	31.08	40.50		Horizontal
54.3458	32.72	54.1746	30.80	40.50		Horizontal
55.92522	34.49	56.006	34.21	40.50		Horizontal
57.3849	29.96	57.5785	30.77	40.50		Horizontal
58.01228	33.97	58.0611	30.63	40.50		Horizontal
58.40674	33.46	58.5123	31.11	40.50		Horizontal
60.03686	34.88	60.0209	35.97	40.50		Horizontal
62.89293	29.67	62.7665	26.38	40.50		Horizontal
63.6516	29.10	63.682	27.06	40.50		Horizontal
64.93198	29.17	65.06	27.99	40.50		Horizontal
66.79680	35.26	66.60080	30.69	40.50		Horizontal
67.02209	38.40	67.0093	30.14	40.50		Horizontal
67.37050	37.22	67.5201	32.95	40.50		Horizontal
68.02618	35.03	68.0014	31.76	40.50		Horizontal
70.52428	31.39	70.3259	31.81	40.50		Horizontal
70.63209	31.25	70.7769	33.05	40.50		Horizontal
71.69973	34.33	71.7045	36.24	40.50		Horizontal
71.93895	36.10	72.02379	42.21	40.50	*	Horizontal
72.28073	37.96	72.1559	36.68	40.50		Horizontal
72.9868	37.52	73.1404	37.10	40.50		Horizontal
73.37445	39.08	73.5729	33.22	40.50		Horizontal
73.56644	36.59	73.6152	36.24	40.50		Horizontal

[redacted]

SHEET 2 cispb RADIATED QUASI-PEAK REPORT
CISPR11B Level for Industrial, Scientific and Medical Equipment
3 METER TEST DISTANCE
TIME: 17:33:13 Midwest EMI
DATE: 09-30-2010 Associates
TEST ITEM: TFT EP0468
SERIAL NUMBER: A5821 BIU/VM Display Sequence Number: 613
COMMENTS: Sitting on a table, 80 cm height, 13.7VDC Supply
TEST PERFORMED BY: Mark Sidlow

Peak Frequency (MHz)	Peak Interfer. (dBuV/m)	Quasi-peak Freq. (MHz)	Quasi-peak Interfer. (dBuV/m)	Spec. Level (dBuV/m)		Antenna Polarization (H/V)
39.93786	37.75	40.0075	32.08	40.50		Vertical
45.53212	38.33	45.5713	32.61	40.50		Vertical
47.60329	38.58	47.7953	30.68	40.50		Vertical
51.84014	38.61	52.0089	35.06	40.50		Vertical
55.89653	35.59	56.0149	29.91	40.50		Vertical
53.30722	36.54	53.2728	31.72	40.50		Vertical
59.96534	36.98	60.0237	30.97	40.50		Vertical
63.93192	36.85	64.0047	33.55	40.50		Vertical
67.91331	36.03	68.0061	32.46	40.50		Vertical
71.99844	52.45	72.000	51.20	40.50	*	Vertical
71.99839	52.51	72.0048	51.20	40.50	*	Vertical
74.12231	39.54	74.0031	33.84	40.50		Vertical

[redacted]

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:

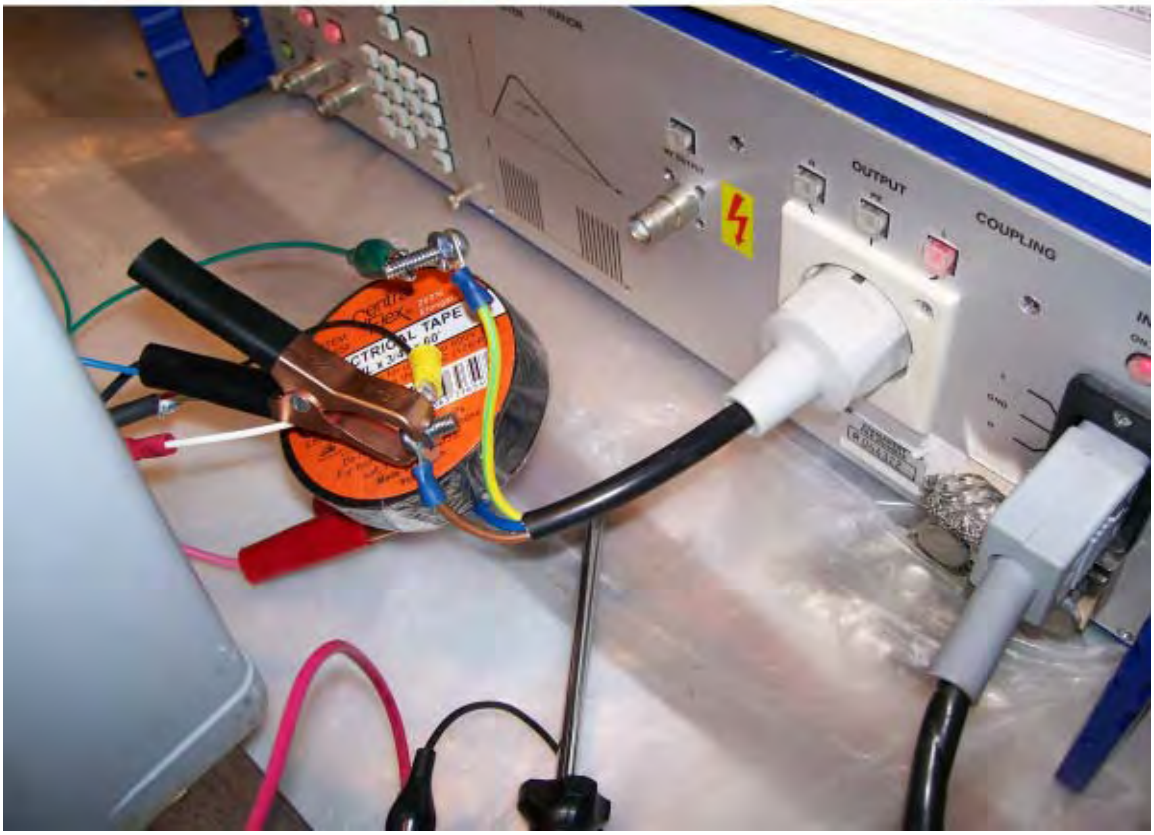
An unacceptable operating response to the stimulus was:

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 EP0468 BIV/VUM DISPLAY 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 the only effect noted was an LED display that flickered slightly. After application the EUT performed perfectly normally. Since the display flicker is not objectionable the EUT met all requirements with an "A" acceptance level.


OUTPUT
COUPLING

Midwest EMI Associates
21234 West Commercial Drive
Mundelein, Illinois 60060

IEC Publication Number 61000-4-4, Part 4, 2nd Edition, 2004
British Standard 61000-4-4, Part 4, 2nd Edition, 2004
Section 4. Electrical Fast Transient/Burst Immunity Test

Manufacturer: TFT Test Engineer Initials: JB

Equipment Under Test: EP0468 Date of Test: 10/11/2010

Model #: A5821 BIU/VM Display Serial #: _____

Temperature: 77 Humidity Level: 40

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)~~ OR BATTERY VOLTAGE: 12 V

INSTRUMENT SETUP/NOMINAL CONDITIONS: Running Hydrant Valve

MODE OF APPEARANCE	PLUS OBSERVATIONS	MINUS
Line with respect to the GRP	✓	✓
Neutral with respect to the GRP	✓	✓
PE with respect to the GRP	✓	✓
Line and Neutral 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, Read < 3m backup to EP0468
Number "1" 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) OR BATTERY VOLTAGE: 12 V

INSTRUMENT SETUP/NOMINAL CONDITIONS: RUNNING HYDRANT VALVE

MODE OF APPEARANCE	PLUS OBSERVATIONS	MINUS
Line with respect to the GRP	✓	✓
Neutral with respect to the GRP	✓	✓
PE with respect to the GRP	✓	✓
Line and Neutral 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: _____
Number "1" indicates no failure was observed, * indicates device malfunctioned

Midwest EMI Associates
21234 West Commercial Drive
Mundelein, Illinois 60060

IEC Publication Number 61000-4-4, Part 4, 2nd Edition, 2004-07
Section 4. Electrical Fast Transient/Burst Immunity Test

Manufacturer: TFT Test Engineer Initials: M.S

Equipment Under Test: EP0468 Date of Test: 10/11/10

Model #: A5821 BTU/VM DISPLAY Serial #: _____

Temperature: 74° Humidity Level: 40%

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) or Battery Voltage: 12 V

Instrument Setup/Nominal Conditions: RUNNING HYDRANT VALVE

Mode of Appearance	Plus Observations	Minus
Line with respect to the GRP	✓	LED FLICKER
Neutral with respect to the GRP	✓	LED FLICKER
PE with respect to the GRP	LED FLICKER	LED FLICKER
Neutral and Line with respect to the GRP	LED FLICKER	LED FLICKER
Line and PE with respect to the GRP	LED FLICKER	✓
Neutral and PE with respect to the GRP	✓	LED FLICKER
Neutral, Line and PE with respect to the GRP	✓	✓

* Failure Mode was: LED FLICKER (OTHERWISE OK)
Number "1" 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) or Battery Voltage: _____ V

Instrument Setup/Nominal Conditions: _____

Mode of Appearance	Plus Observations	Minus
Liine with respect to the GRP		
Neutral with respect to the GRP		
PE with respect to the GRP		
Neutral and Line 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: _____
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 EP0468 BIV/VUM DISPLAY 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 EP0468 BIV/VUM DISPLAY 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 hydrant 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. During the test the following reactions were checked for and succeeded:

1) **The display indicated the proper direction of valve opening and closing**
2) **The display of the valve condition indicated correctly a valve open state**
3) **The display of the valve condition indicated correctly a valve closed state**
4) **The incremental position on the display matched the condition of the valve**

The data set refers to use of a ferrite absorber placed inside the EUT enclosure. This was used as an attempt to correct a motor stoppage issue. The sponsor group found the motor was faulty. 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.

Page 1 of ___	EN 61000-4-3 Worksheet	Midwest EMI Associates Mundelein, Illinois	Form: EN 61000-4-3/6

Device: TFT RP0468 Sponsor: TFT Date: 10/1/2010 S/W Ver: _____ S/N: _____

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

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

Technician: M.S

Project No: STEVE

Mod Freq: Hertz (2) (10) (100) (1000)

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

POWER: (230) (208) (120) VAC or 13.7VDC
Power Frequency: (50) (60) (400) 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	7	B, L	START HORIZONTAL SWEEP 30-500
107					VALVE STOPPED TURNING - ADDED FERRITES
100	1%	10	7	B, L	START HORIZONTAL SWEEP 100-500
390					SKIPPING NUMBERS ON DISPLAY
					RESET BUT
370	1%	10	7	B, L	START HORIZONTAL SWEEP 370-500
500					STOP HORIZONTAL SWEEP
30	1%	10	7	B, L	START VERTICAL SWEEP 30-500
33					VALVE PAUSED. RESET BUT
30	1%	10	7	B, L	START VERTICAL SWEEP 30-500
500M	"	"	"	"	Finish Vertical
					Added 28BO434 ferrite
					to 4 wires inside Enclosure
350M	10%	10	7	BL V	going up VER
500	1%	10	7	BL V	" " ADK, normal
	Recheck Problem Areas				HORIZONTAL
100M	1%	10	7	BL H	going up, ADK
125M	"	"	"	"	" " "
350M	"	"	"	"	" " "
450	"	"	"	"	" " "

Notes: _____

Page 2 of ___	EN 61000-4-3 Worksheet	Midwest EMI Associates Mundelein, Illinois	Form: EN 61000-4-3/6

Device: TFT BP0468 Sponsor: TPT Date: 10/11/10 S/W Ver: _____ S/N: _____

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

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

Technician: M.S

Project No: _____

Mod Freq: Hertz (2) (10) (100) (1000)

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

POWER: (230) (208) (120) VAC or 13.7 VDC
Power Frequency: (50) (60) (400) 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)
500	1%	10	7	B,L	START HORIZONTAL SWEEP 500-1000
1000					END HORIZONTAL SWEEP
500	1%	10	7	B,L	START VERTICAL SWEEP 500-1000
1000					END VERTICAL SWEEP
1000	1%	10	7	B,L	START VERTICAL SWEEP 1000-2200
2200					END VERTICAL SWEEP
1000	1%	10	7	B,L	START HORIZONTAL SWEEP 1000-2200
2200					END HORIZONTAL
2200	1%	10	7	B,L	START HORIZONTAL SWEEP 2200-2500
2500					END HORIZONTAL
2200	1%	10	7	B,L	START VERTICAL SWEEP 2200-2500
2500					END VERTICAL

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 EP0468 BIV/VUM DISPLAY was tested on its DC leads in line to line mode at a 500 volt application in positive and negative polarities. The ground of the surge generator was attached to the case of the EUT. Then testing was also performed at .5 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: 11.10.2010 Start-Time: 14:21

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

Coup. Path	Imp. No.	U nominal	Syncro Angle	U-peak	I-peak	Info.
L1-PE	1	+0.50kV	-----	+0.47kV	+7A	
L1-PE	2	+0.50kV	-----	+0.47kV	+7A	
L1-PE	3	+0.50kV	-----	+0.47kV	+7A	
L1-PE	4	+0.50kV	-----	+0.47kV	+7A	
L1-PE	5	+0.50kV	-----	+0.47kV	+7A	
L1-PE	6	+0.50kV	-----	+0.47kV	+7A	
L1-PE	7	+0.50kV	-----	+0.47kV	+7A	
L1-PE	8	+0.50kV	-----	+0.47kV	+7A	
L1-PE	9	+0.50kV	-----	+0.47kV	+7A	
L1-PE	10	+0.50kV	-----	+0.47kV	+7A	

>>> Test passed. <<<

Test: 22222222
Stop-Date: 11.10.2010 Stop-Time: 14:23

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: 11.10.2010 Start-Time: 14:24

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

Coup. Path	Imp. No.	U nominal	Syncro Angle	U-peak	I-peak	Info.
L1-PE	1	-0.50kV	-----	-0.47kV	-7A	
L1-PE	2	-0.50kV	-----	-0.47kV	-7A	
L1-PE	3	-0.50kV	-----	-0.47kV	-7A	
L1-PE	4	-0.50kV	-----	-0.47kV	-7A	
L1-PE	5	-0.50kV	-----	-0.47kV	-7A	
L1-PE	6	-0.50kV	-----	-0.47kV	-7A	
L1-PE	7	-0.50kV	-----	-0.47kV	-7A	
L1-PE	8	-0.50kV	-----	-0.47kV	-7A	
L1-PE	9	-0.50kV	-----	-0.47kV	-7A	
L1-PE	10	-0.50kV	-----	-0.47kV	-7A	

>>> Test passed. <<<

Test: 22222222
Stop-Date: 11.10.2010 Stop-Time: 14:25

```
*  Stop-Date:   11.10.2010                    Stop-Time:    14:16  *
*                                                                  *
********************************************************************


********************************************************************
*                                                                  *
*  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:   11.10.2010                 Start-Time:    14:16  *
*                                                                  *
*******   Combination Wave 1,2/50us;8/20us   ********************
*                                                                  *
*  Coup.   Imp.    U nom-    Syncro                                *
*  Path    No.       inal    Angle    U-peak    I-peak    Info.    *
*  ------------------------------------------------------------    *
*  N-PE      1     +0.50kV   -----    +0.47kV   +7A                 *
*  N-PE      2     +0.50kV   -----    +0.47kV   +7A                 *
*  N-PE      3     +0.50kV   -----    +0.47kV   +7A                 *
*  N-PE      4     +0.50kV   -----    +0.47kV   +7A                 *
*  N-PE      5     +0.50kV   -----    +0.47kV   +7A                 *
*  N-PE      6     +0.50kV   -----    +0.47kV   +7A                 *
*  N-PE      7     +0.50kV   -----    +0.47kV   +7A                 *
*  N-PE      8     +0.50kV   -----    +0.47kV   +7A                 *
*  N-PE      9     +0.50kV   -----    +0.47kV   +7A                 *
*  N-PE     10     +0.50kV   -----    +0.47kV   +7A                 *
*     >>> Test passed. <<<                                         *
*                                                                  *
*  Test:         22222222                                          *
*  Stop-Date:    11.10.2010                 Stop-Time:    14:18  *
*                                                                  *
********************************************************************


********************************************************************
*                                                                  *
*  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:   11.10.2010                 Start-Time:    14:18  *
*                                                                  *
*******   Combination Wave 1,2/50us;8/20us   ********************
*                                                                  *
*  Coup.   Imp.    U nom-    Syncro                                *
*  Path    No.       inal    Angle    U-peak    I-peak    Info.    *
*  ------------------------------------------------------------    *
*  N-PE      1     -0.50kV   -----    -0.47kV   -7A                 *
*  N-PE      2     -0.50kV   -----    -0.47kV   -7A                 *
*  N-PE      3     -0.50kV   -----    -0.47kV   -7A                 *
*  N-PE      4     -0.50kV   -----    -0.47kV   -7A                 *
*  N-PE      5     -0.50kV   -----    -0.47kV   -7A                 *
*  N-PE      6     -0.50kV   -----    -0.47kV   -7A                 *
*  N-PE      7     -0.50kV   -----    -0.47kV   -7A                 *
*  N-PE      8     -0.50kV   -----    -0.47kV   -7A                 *
*  N-PE      9     -0.50kV   -----    -0.47kV   -7A                 *
*  N-PE     10     -0.50kV   -----    -0.47kV   -7A                 *
*     >>> Test passed. <<<                                         *
```

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: 11.10.2010 Start-Time: 14:07

******* 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	-----	+0.12kV	+180A	
L1-N	2	+0.50kV	-----	+0.12kV	+181A	
L1-N	3	+0.50kV	-----	+0.12kV	+181A	
L1-N	4	+0.50kV	-----	+0.12kV	+181A	
L1-N	5	+0.50kV	-----	+0.12kV	+181A	
L1-N	6	+0.50kV	-----	+0.12kV	+181A	
L1-N	7	+0.50kV	-----	+0.12kV	+181A	
L1-N	8	+0.50kV	-----	+0.12kV	+181A	
L1-N	9	+0.50kV	-----	+0.12kV	+181A	
L1-N	10	+0.50kV	-----	+0.12kV	+181A	

>>> Test passed. <<<

Test: 22222222
Stop-Date: 11.10.2010 Stop-Time: 14:09

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: 11.10.2010 Start-Time: 14:09

******* 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	-----	-0.08kV	-224A	
L1-N	2	-0.50kV	-----	-0.08kV	-224A	
L1-N	3	-0.50kV	-----	-0.07kV	-225A	
L1-N	4	-0.50kV	-----	-0.08kV	-225A	
L1-N	5	-0.50kV	-----	-0.07kV	-225A	
L1-N	6	-0.50kV	-----	-0.08kV	-225A	
L1-N	7	-0.50kV	-----	-0.07kV	-225A	
L1-N	8	-0.50kV	-----	-0.07kV	-225A	
L1-N	9	-0.50kV	-----	-0.08kV	-225A	
L1-N	10	-0.50kV	-----	-0.07kV	-225A	

>>> Test passed. <<<

Test: 22222222
Stop-Date: 11.10.2010 Stop-Time: 14:11

```
**********************************************************************

**********************************************************************
*                                                                    *
*  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:   11.10.2010                 Start-Time:    14:12    *
*                                                                    *
*******   Combination Wave 1,2/50us;8/20us   ********************    *
*                                                                    *
*  Coup.   Imp.    U nom-    Syncro                                  *
*  Path    No.       inal    Angle    U-peak    I-peak    Info.      *
*  ------------------------------------------------------------      *
*  L1-PE     1     -0.50kV   -----    -0.47kV   -7A                  *
*  L1-PE     2     -0.50kV   -----    -0.47kV   -7A                  *
*  L1-PE     3     -0.50kV   -----    -0.47kV   -7A                  *
*  L1-PE     4     -0.50kV   -----    -0.47kV   -7A                  *
*  L1-PE     5     -0.50kV   -----    -0.47kV   -7A                  *
*  L1-PE     6     -0.50kV   -----    -0.47kV   -7A                  *
*  L1-PE     7     -0.50kV   -----    -0.47kV   -7A                  *
*  L1-PE     8     -0.50kV   -----    -0.47kV   -7A                  *
*  L1-PE     9     -0.50kV   -----    -0.47kV   -7A                  *
*  L1-PE    10     -0.50kV   -----    -0.47kV   -7A                  *
*    >>> Test passed. <<<                                            *
*                                                                    *
*  Test:         22222222                                            *
*  Stop-Date:    11.10.2010                 Stop-Time:     14:13    *
*                                                                    *
**********************************************************************

**********************************************************************
*                                                                    *
*  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:   11.10.2010                 Start-Time:    14:14    *
*                                                                    *
*******   Combination Wave 1,2/50us;8/20us   ********************    *
*                                                                    *
*  Coup.   Imp.    U nom-    Syncro                                  *
*  Path    No.       inal    Angle    U-peak    I-peak    Info.      *
*  ------------------------------------------------------------      *
*  L1-PE     1     +0.50kV   -----    +0.47kV   +7A                  *
*  L1-PE     2     +0.50kV   -----    +0.47kV   +7A                  *
*  L1-PE     3     +0.50kV   -----    +0.47kV   +7A                  *
*  L1-PE     4     +0.50kV   -----    +0.47kV   +7A                  *
*  L1-PE     5     +0.50kV   -----    +0.47kV   +7A                  *
*  L1-PE     6     +0.50kV   -----    +0.47kV   +7A                  *
*  L1-PE     7     +0.50kV   -----    +0.47kV   +7A                  *
*  L1-PE     8     +0.50kV   -----    +0.47kV   +7A                  *
*  L1-PE     9     +0.50kV   -----    +0.47kV   +7A                  *
*  L1-PE    10     +0.50kV   -----    +0.47kV   +7A                  *
*    >>> Test passed. <<<                                            *
*                                                                    *
*  Test:         22222222                                            *
```

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 USA Flex Advanta 50 MHz 486 controller 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.

Page 1 of ___	EN 61000-4-3 Worksheet	Midwest EMI Associates Mundelein, Illinois	Form: EN 61000-4-3/6

Device: TFT BP0468 Sponsor: TFT Date: 10/11/10 S/W Ver: _____ S/N: _____

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

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

Technician: M.S

Project No: _____

Mod Freq: Hertz (2) (10) (100) (1000)

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

POWER: (230) (208) (120) VAC or 13.7 VDC
Power Frequency: (50) (60) (400) 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)
100K		3			START SWEEP 100K-2.5M
2.5M					END SWEEP
2.5M		3			START SWEEP 2.5M-300M
300M					END SWEEP
100K		10			START SWEEP 100K-2.5M
2.5M					END SWEEP
2.5M		10			START SWEEP 2.5M-300M
300M					END SWEEP

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 EP0468 BIV/VUM DISPLAY** 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. One provisional point was also chosen which was the negative lead of the vehicle battery. The EUT was subjected to ESD intensity levels of 2, 4 and 6 KV in contact discharge because all areas are metal other than the display and they do not need air discharge testing. The display itself was not found to allow an arc into sensitive control lines, and the periphery of the display arced into metal.

The following symptoms were noted during the test:

None

The provisional point was the negative lead of the battery. When this point was struck the display of the EUT went out at 8 KV air or 4 KV contact. Cycling power restored the system to normal. It was determined that this terminal would not be exposed during use and therefore the sponsor group is considering whether it should be included in the analysis. When the VCP return line was attached to the negative terminal the same effect also occurs to the display. When the VCP return line was attached to the grounding point of the ESD gun there was no effect on the display.

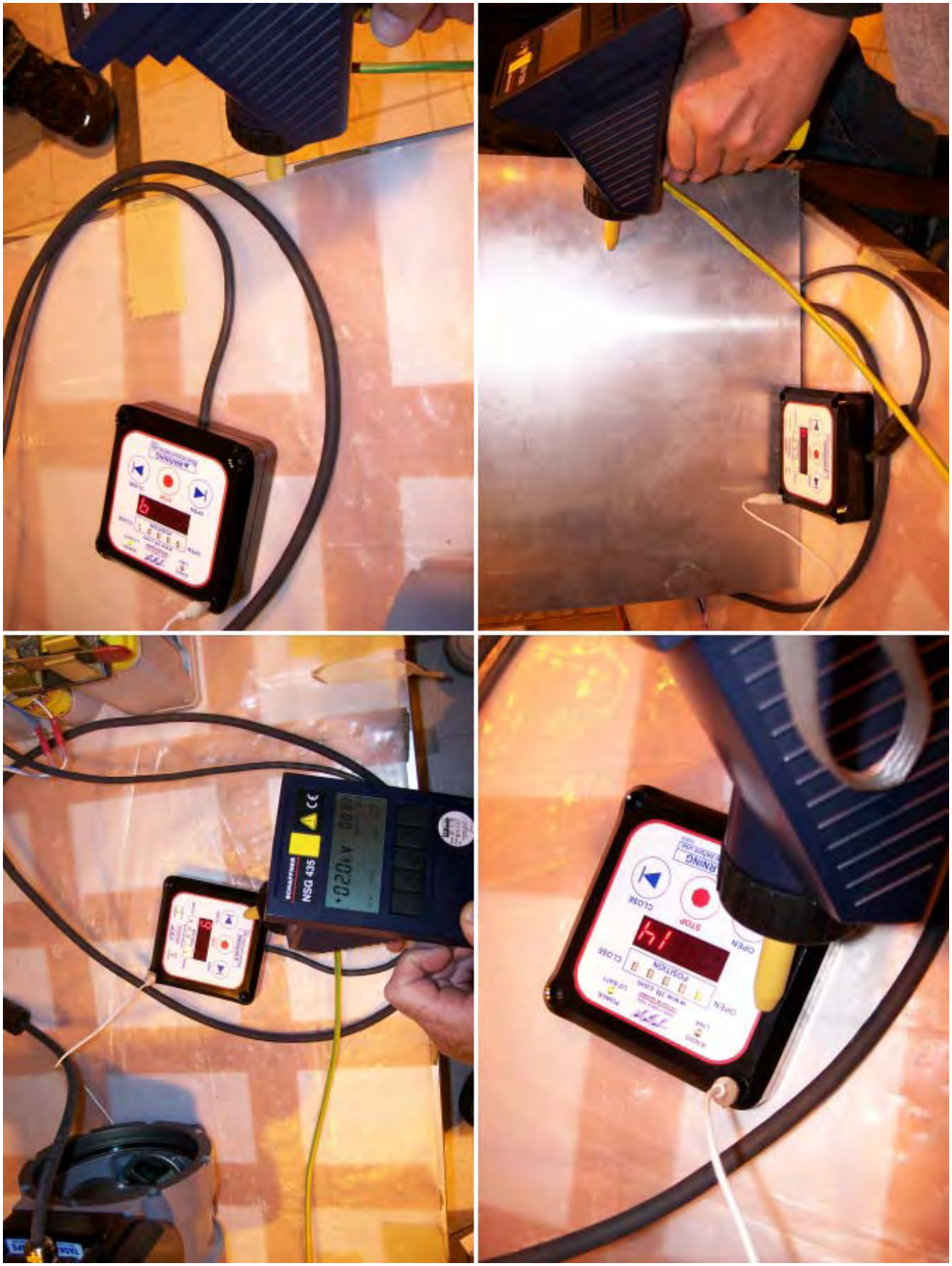
A discussion with the sponsor group revealed that the actual configuration used consists **the valve mounted to the fire engine and the display mounted in the cab to the chassis which would prevent a very low impedance between the two and the negative terminal of the battery would not be exposed in normal use. Therefor the point was eliminated and the EUT passed with an A acceptance level.**

ESD TEST LOCATIONS

TFT EP0468 BIV/VUM DISPLAY

TEST POINT	Description
1	HCP
2	VCP
3	Display Upper Left
4	Display Upper Right
5	Anywhere on Top of Display
6	Anywhere on Sides of Display
7	Anywhere on Bottom of Display
8	Interior areas where keys are in display
9	
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
20	
21	
22	
23	
24	
25	
26	

Note: Photograph of locations are attached


NSG 435
STOP
CLOSE
OPEN
POSITION

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

Sponsor Group: TFT EP0436 Serial Number: EMI Proto
Manager: Steve Ferry Temp: 78.2°F Hum: 48.1% Technician: MS S/W ver.: Test Code

Date of Test: 10/11/2010 Time: 9:00 AM 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 12 VDC Bat
Note: All Points are Tested with 10 Shots in Single Shot Mode each phase unless otherwise stated

Reference: EN 61000-4-2		**TEST POINT: HCP**				**TEST POINT: VCP**			
		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	OK				OK			

Reference: EN 61000-4-2		**TEST POINT: Display Upper Left**				**TEST POINT: Display Upper Right**			
		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	OK				OK			

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: (✓) No Errors This Page → Found Discharge to (−) lead (BATTERY) caused display to blank out until restart power

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

Sponsor Group: TFT EP0436 Serial Number: EMI Proto
Manager: Steve Ferry Temp: 78.2°F Hum: 48.1% Technician: MS S/W ver.: Test Code
Date of Test: 10/11/2010 Time: 9:00 AM 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 12 VDC Bat
Note: All Points are Tested with 10 Shots in Single Shot Mode each phase unless otherwise stated

Reference: EN 61000-4-2		**TEST POINT:** Display TOP Antenna **PLUS POLARITY**		**MINUS POLARITY**		**TEST POINT:** Display Side Antenna **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	OK		OK		OK		OK	

Reference: EN 61000-4-2		**TEST POINT:** Display Bottom **PLUS POLARITY**		**MINUS POLARITY**		**TEST POINT:** Display Antenna **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	(✓)	(✓)	(✓)	(✓)	(✓) n/a	(✓) n/a	(✓) n/a	(✓) n/a
3	3								
4	4	(✓)	(✓)	(✓)	(✓)	(✓) n/a	(✓) n/a	(✓) n/a	(✓) n/a
5	5								
6	6	(✓)	(✓)	(✓)	(✓)	(✓) n/a	(✓) n/a	(✓) n/a	(✓) n/a
7	7								
8	8	(✓)		(✓)		(✓) n/a		(✓) n/a	
9	9								
10	10	OK		OK		NO ARCS		→	

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: ____(✓)_No Errors This Page No faults this page

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 power frequencies.

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

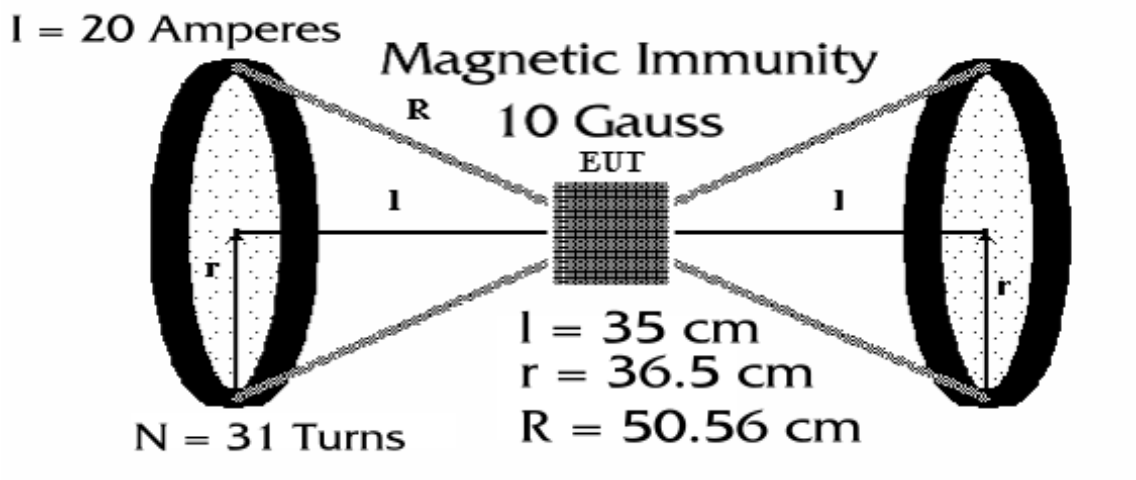
The fabricated antennas for the 50/60 Hz test consist of two bundled coils of average diameter of 73 cm. with 31 turns of #12 AWG insulated, CSA approved standard copper wire. The bundled coil dimension is a 1.5" diameter. The coils are arranged on an axis so that they are parallel to each other and 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 EP0468 BIV/VUM DISPLAY was exposed in three axes to a swept field as measured by Holladay Magnetic Field Probe Model HI-3624. The current was maintained fairly constant at 22 amperes in the range of 40 to 500 Hz resulting in a 10 gauss field being applied in this range. There was no apparent effect on the device and it passed the IEC 61000-4-8 recommendation.