Performance Certification to EMC Directive

Normative Standard: **EN61000-6-2:2016, EN 61000-6-3: 2007 & A1:2011**

Test Unit Description and Serial Number:

TFT RCMONITOR CANBUS INTERFACE (EP0839)

S/N: EMI Prototype

Test Report # 3808

Dates of Test: 02-27-2018 through 03-01-2018

Test Laboratory:

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

Industry Canada Industrie Canada

EN 61000-6-3 :2007 & A1:2011 EMISSIONS

TEST METHOD	LIMITS
IEC 61000-6-3 Am 1:2007 & A1:2011 (Cispr 11) Radiated Emissions	B
IEC 61000-6-3 Am 1:2007 & A1:2011 (Cispr 11) Conducted Emissions (DC Power Supply)	B

EN 61000-6-2 :2016 IMMUNITY

TEST METHOD		LEVEL
IEC 61000-4-2 :2008-12 Electrostatic Discharge Test	2, 4, 6 and 8 kV Air Discharge 2, 4 & 6 kV Contact Discharge	A
IEC 61000-4-3 :2006+A1:2007+A2:2010 Radiated Immunity Test	13 V/M (10 V/M minimum) 1000 Hz, 80% AM modulation, 900 Mhz, 100% AM, 200 Hz, Square Wave, 25 MHz to 2.7 GHz	A
IEC 61000-4-4 :2012-04 Electrical Fast Transients	.5, 1 and 2 kV Line to Line	A
IEC 61000-4-5 : 2005 Electrical Surge Test	.5 kV Line to Line	A
IEC 61000-4-6 :2013-10 Conducted Immunity	3 & 10 V RMS Common Mode	A
IEC 61000-4-8 :2009 Magnetic Immunity	30 A/M Min (800 A/M Applied) Three Axes, 40Hz to 500 Hz	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.

George A. Bowman

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

BBB MEMBER CHICAGO & NORTHERN ILLINOIS

Nemko Accredited ELA

ACIL

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

Midwest EMI Associates Test Service
Report No. 3808

Industry Canada Industrie Canada

Test Specifications

EN 61000-6-3 Level B Conducted Emissions
EN 61000-6-3 Level B Radiated Emissions
EN 61000-4-2 Electrostatic Discharge
EN 61000-4-3 Radiated Immunity
EN 61000-4-4 Electrical Fast Transients
EN 61000-4-5 Surge Test
EN61000-4-6 Conducted Immunity Test
EN 61000-4-8 Magnetic Immunity

Test Device: **TFT RCMONITOR CANBUS INTERFACE (EP0839)**

Serial Number: **EMI Prototype**

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

Dates of Test: 02-27-2018 through 03-01-2018

Technical Data Taken by and
Report Written by:

George Bowman
Midwest EMI Associates

Approved By:

Mr. Tim Miller
Senior Design Engineer
Task Force Tips, Inc.

1.0 PURPOSE:

The purpose of this test sequence is to qualify the compliance of the TFT RCMONITOR CANBUS INTERFACE (EP0839) to the IEC 61000-6-2 industrial and 61000-6-3 residential, commercial and light industrial standards. This report covers testing to the IEC 61000-6-3 (Cispr 11) B level radiated and conducted emissions, IEC 61000-4-2 electrostatic discharge test, IEC 61000-4-3 radiated immunity standards, IEC 61000-4-4 electrical fast transients, IEC 61000-4-5 Surge Test, IEC 61000-4-6 conducted immunity test and IEC 61000-4-8 magnetic immunity test. This version provides CANBUS conversion for the TFT Monitor system.

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2.0 TEST FACILITY:

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

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

3.0 DESCRIPTION OF TEST SAMPLE:

The YE-CAN2 MULTIPLEX INTERFACE - FOR RC MONITORS AND VUMS The Multiplex Interface Control converts CANbus signals into serial communications for controlling a TFT RC monitor or valve. This module is designed to work on a J1939 CANbus system and allows control of all TFT RC Monitors and RC Valve Under Monitor. Module typically installed in-line with power/comm cable at base of monitor or valve.

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3.2 POWER REQUIREMENT:

The primary power supplied to the test sample was a 12 Volt Lead Acid Battery however the normal power is a fire engine 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:

EN 61000-6-1 Ed. 2.0 (2016), "Electromagnetic compatibility (EMC) - Part 6: Generic standards - Section 1: Immunity for residential, commercial and light-industrial environments"

EN 61000-6-2 Ed. 2.0 (2016), "Electromagnetic compatibility (EMC) - Part 6-2: Generic standards - Immunity for industrial environments"

EN 61000-6-3 Ed. 2.0 (2007) & A1:2011, "Electromagnetic compatibility (EMC) - Part 6: Generic standards - Section 3: Emission standard for residential, commercial and light-industrial environments"

EN 61000-6-4 Ed. 2.0 (2006-07), "Electromagnetic compatibility (EMC) - Part 6: Generic standards - Section 4: Emission standard for industrial environments"

EN 61326 Ed. 1 (2006-06), "Electrical equipment for measurement, control and laboratory use - EMC requirements"

IEC 60601-1-2 (2005), "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

Cispr 22 (EN55022), Consol. Ed. 5.2, 2006-03, "Information technology equipment - Radio disturbance characteristics - Limits and methods of measurement"

Cispr 11 (EN55011) Cons. Ed. 4.1, 2009, "Industrial, scientific and medical (ISM) radio-frequency equipment - Electromagnetic disturbance characteristics - Limits and methods of measurement"

CISPR Publication Number 16-1-1, (2006-11) Cons. Edition 1.1, "Specification for radio disturbance and immunity measuring apparatus and methods - Part 1-1: Radio disturbance and immunity measuring apparatus - 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 a 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	0.7716	dB	0	dB
0.1	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
0.1	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	932.0	kHz	0.6117	dB	0	dB
300	kHz	310	kHz	10.173	dB	10.5	dB
120	kHz	119	kHz	18.5	dB	18.5	dB
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

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:

	Instrument	**Serial No**	**Calibration Due**
a)	Tek2756P Spectrum Analyzer	BO20224	26-Aug-18
b)	Wavetek 2520A RF Generator	222011	30-Aug-18
c)	Carver TFM-35 250 W/Ch. Audio Amp	3097104	1-Jun-01
d)	ENI RF Power Amplifier (525LA)	367	30-Aug-18
e)	ENI RF Power Amplifier (2100L)	129	30-Aug-18
f)	Eaton 15100B Power Amplifier	1529-07090	24-Aug-18
g)	Tektronix TDS 420 Oscilloscope	B021212	24-Aug-18
h)	EMCO 3109 Power Biconical (1/3/10 Meters)	9011-2504	17-Aug-18

i)	EMCO 3101 Power Conical	9007-3450	7-Nov-93 (1/3m)
j)	EMCO 6502 Active Loop	1038	18-Aug-18
k)	EMCO 3301B Active E Field	9009-3044	19-Aug-18
l)	EMCO 3147 Wide Range Log Periodic	9102-1019	23-Aug-18
m)	EMCO 3107B Power E Field	9310-2435	N/A
m)	Amplifier Research FM1000	12456	N/A
n)	Amplifier Research FP1000	60701	21-Aug-18
o)	Amplifier Research FP1000	60488	3-Aug-18
p)	IFI EFS-4 E Field Susceptibility (Holladay 3004EX with HSE405 Probe)	39883	14-Aug-18
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-Aug-18
u)	Schaffner NSG 435 ESD Gun	107	15-Aug-18
v)	Solar Loop Sensor 7334-1	n/a	n/a
w)	Solar Loop Sensor 9311-1	931101	n/a
x)	Solar RF Coupler 7415-3906016	n/a	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-Aug-18
ab)	Werlatone C1795 Dir. Coupler	3442	30-Aug-18
ac)	Solar Current Injection Probe Type 9108-1N	935012	n/a
ad)	Tektronix TR 503B Tracking Generator	B011216	25-Aug-18
ae)	Acme 2KVA Isolation Transformer	T-3-53042-S	n/a
af)	Xentek Extreme Isolation Transformer Model 5410 (2 in use)	n/a	n/a
ag)	Tektronix P6202 RF Probe	n/a	n/a
ah)	Staco Power Variac Type 3PN2210 (0-140VAC) 3.1KVA	n/a	n/a
ai)	Helmholtz Coil Stepdown Xfrmr-Chicago Xfrmer Type P-6492	n/a	n/a
aj)	Goldstar Signal Generator Mod FG-2002c	201621	25-Aug-18
ak)	Holladay Magnetic Field Probe Model HI-3624	83957	15-Aug-18
al)	Tektronix 2712 Spectrum Analyzer (Quasipeak)	B022520	24-Aug-18
am)	Voltec PM100 Power Analyzer	AA04/8495	25-Aug-18
an)	EMCO 3142 Biconilog Antenna	1052	1-Aug-18
ao)	Haefely P90.1 IEC 61000-4-4 Fast Transient Tester	083 593-14	19-Aug-18
ap)	Hewlett Packard 3400A AC Voltmeter	1218A14443	24-Aug-18
aq)	Amplifier Research FP2031 Isotropic Probe	18309	5-Aug-18
ar)	Haefely 250 600/00 (61000-4-5 Surge Tester)	583 334-05	19-Aug-18
as)	Fischer CISPR 14 Absorbing Clamp type F-201	235	7-Aug-18
at)	Fischer IEC 801-6 Transducer	165	23-Aug-18
au)	Solar 9123-1N Current Clamp	956015	23-Aug-18
av	Fischer IC 801-6 CDN FCC-801-M3-25	95	7-Aug-18
aw)	Tektronix 2712 Spectrum Analyzer (Quasipeak) B022981	n/a	24-Aug-18
ax)	C. C. Moore Automated Mast Assembly Model DAPM4/6	n/a	n/a
ay)	C. C. Moore Automated Turntable Model DTT-4	n/a	n/a

az)	Antenna Research LPB2520	1152	20-Aug-18
ba)	Behlman Power Pass 50 Hz AC Source (50, 60, 400 Hz)	n/a	n/a
bb)	California Instruments WP1251 AC Source (50, 60 Hz)	n/a	n/a
bc)	Plitron Extreme Toroidal Isolation Transformers (2)	n/a	n/a
bd)	Edmund Scientific Thermometer/Hygrometer	n/a	31-Aug-18
be)	Coaxial Bird Pads (x2) 8306-030-N3DB	n/a	30-Aug-18
bf)	High Current Source, Associated Research 3030D	A140006	25-Aug-18
bg)	California Instruments 5001ix High Power Source	HK52945	25-Aug-18
bh)	Line Leakage tester, Associated Research 510L	130007	25-Aug-18
bi)	Hipot Tester, Associated Research 3570D	90595	25-Aug-18
bh)	GAASfet Preamplifier	n/a	30-Aug-18
bi)	Ametek Tachometer Model 1726	R035292	24-Aug-18
bj)	Bird Attenuator (x2), 75 Watt, 75-A-MFN-10	R035290	30-May-04
bk)	HP 8482A Power Sensor	2652A18474	24-Aug-18
bl)	HP 435B Power Meter	2702A17563	24-Aug-18
bm	Simpson Model 383 Thermometer	B001531	24-Aug-18
bn)	Wavetek 27XT Voltmeter	96120787	24-Aug-18
bo)	HP 8657A Programmable Synthesizer	365	27-Aug-18
bp)	Fluke 75	n/a	24-Aug-18
bq)	Fluke 21 Series III	n/a	24-Aug-18
br)	ENI 525LA	n/a	19-Aug-18
bs)	Tek 495P Opt 5/7	B020147	30-Aug-18
bt)	Amplifier Research FP2036 (.5-5Ghz)	n/a	4-Sep-18

Note: Items that do not show a current calibration are obsolete, were not used in test or do not need calibration because they have no calibratable parts. In particular the following items are present at this facility but do not carry current calibration:
c) Carver TFM-35 250 W/Ch. Audio Amp 1-Jun-01
i) EMCO 3101 Power Conical 7-Nov-93 (1/3m)
r) IFI EFS-1 E Field Susceptibility 1-Feb-99
bj) Bird Attenuator (x2), 75 Watt, 75-A-MFN-10 30-May-04

7.0 CONCLUSION OF RADIO FREQUENCY INTERFERENCE EMISSIONS AND SUSCEPTIBILITY TESTS:

The TFT RCMONITOR CANBUS INTERFACE (EP0839) was evaluated for all tests in the configuration requested by the sponsor group for compliance with the generic instruments standards, IEC 61000-6-2 :2007 & A1:2011 and IEC 61000-6-3 :2005. The configuration requested was that of the packaged unit system in an orientation that exercised the CANbus function. For test purposes the sponsor group supplied a Y4E-RP-D Operator Station configured for CANbus that could be observed during all test sequences to verify communication link.

The prototype required a few changes as summarized below. After the change were added, the device was fully functional and communicated properly.

Changes

1) **Added AISM 1003-103J in place of R11 on the CANBUS board**
2) **Added .01uF ceramic capacitor in parallel with C7, prior to voltage regulator**
3) **Moved and rotated 10 uF capacitor (C7) closer to the voltage regulator output schottky diode**

8.0 CANADIAN TESTING REQUIREMENTS (ICES-001)

A transition period ending December 1, 2006 is provided, within which compliance with either ICES-001 Issue 3 or ICES-001 Issue 4 will be accepted. **After the above date, only compliance with ICES-001 Issue 4 will be accepted.**

In this Standard,

"ISM radio frequency generator" means any interference-causing equipment that generates and/or uses locally radio frequency energy for industrial, scientific, medical, domestic or similar purposes, excluding applications in the field of telecommunications, information technology and other applications covered by other Industry Canada standards.

Labeling Requirements

A record of the measurement method and results shall be retained by the manufacturer or importer for a period of **at least five years and made available for examination on the request of the Minister.**

The manufacturer, importer or supplier shall meet the labeling requirements set out in this section and in Notice 2014 – DRS1003 for electronic labeling for every unit:

prior to marketing in Canada, for ISM RF Generators manufactured in Canada and
prior to importation into Canada, for imported ISM RF Generators.

Each unit of an ISM RF Generator model shall bear a label which represents the manufacturer's or importer's Self-Declaration of Compliance (SDoC) to Industry Canada ICES-001. This label shall be permanently affixed to the ISM RF Generator or displayed electronically and its text must be clearly legible. If the dimensions of the device are too small or if it is not practical to place the label on the ISM RF Generator and electronic labeling has not been implemented, the label shall be, upon agreement with Industry Canada, placed in a prominent location in the user manual supplied with the ISM RF Generator. The user manual may be in an electronic format and must be readily available.

Industry Canada ICES-001 Compliance Label: *CAN ICES-1/NMB-1*

9.0 FCC COMPLIANCE STATEMENT

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions:
1. This device may not cause harmful interference, and
2. This device must accept any interference received, including
interference that may cause undesired operation.

FCC WARNING

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation.
This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a
particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

• Reorient or relocate the receiving antenna. • Increase the separation between the equipment and the receiver.
• Connect the equipment into an outlet different from that to which
the receiver is connected.
• Consult the dealer or an experienced radio/TV technician for help.

Nemko Laboratory Authorization
Authorization Number: ELA 175

EMC Laboratory:	**Midwest EMI Associates** **21234 W. Commercial Drive, Unit F** **Mundelein, IL 60060 USA**
Scope of Authorization:	**All standards for EMC and radio transmission that are listed on the accompanying "Scope of Authorization" pages.**

Nemko has assesses the quality assurance system, the testing facilities, qualifications and testing practices of the relevant parts of the organization. The quality assurance system of the laboratory has been validated against ISO/IEC 17025 or equivalent. The laboratory also fulfils the conditions described in the Nemko Document NLA-10. During the audit by the Nemko representative it was found that the laboratory is capable of performing tests within the "Scope of Authorization".

Accordingly, Nemko will normally accept test results from the laboratory on a partial or complete basis, with rights of review as stated in NLA-10, for certification of the products tested.

In order to maintain the Authorization, the information given in the pertinent NLA-10 must be carefully followed. Nemko is to be promptly notified about any changes in the situation at the laboratory which may affect the basis for this Authorization. The Authorization may be withdrawn by Nemko at any time if the conditions are no longer considered fulfilled.

This Authorization is valid through 23 December 2018

Nemko USA, San Diego, 23 December 2016

For Nemko AS

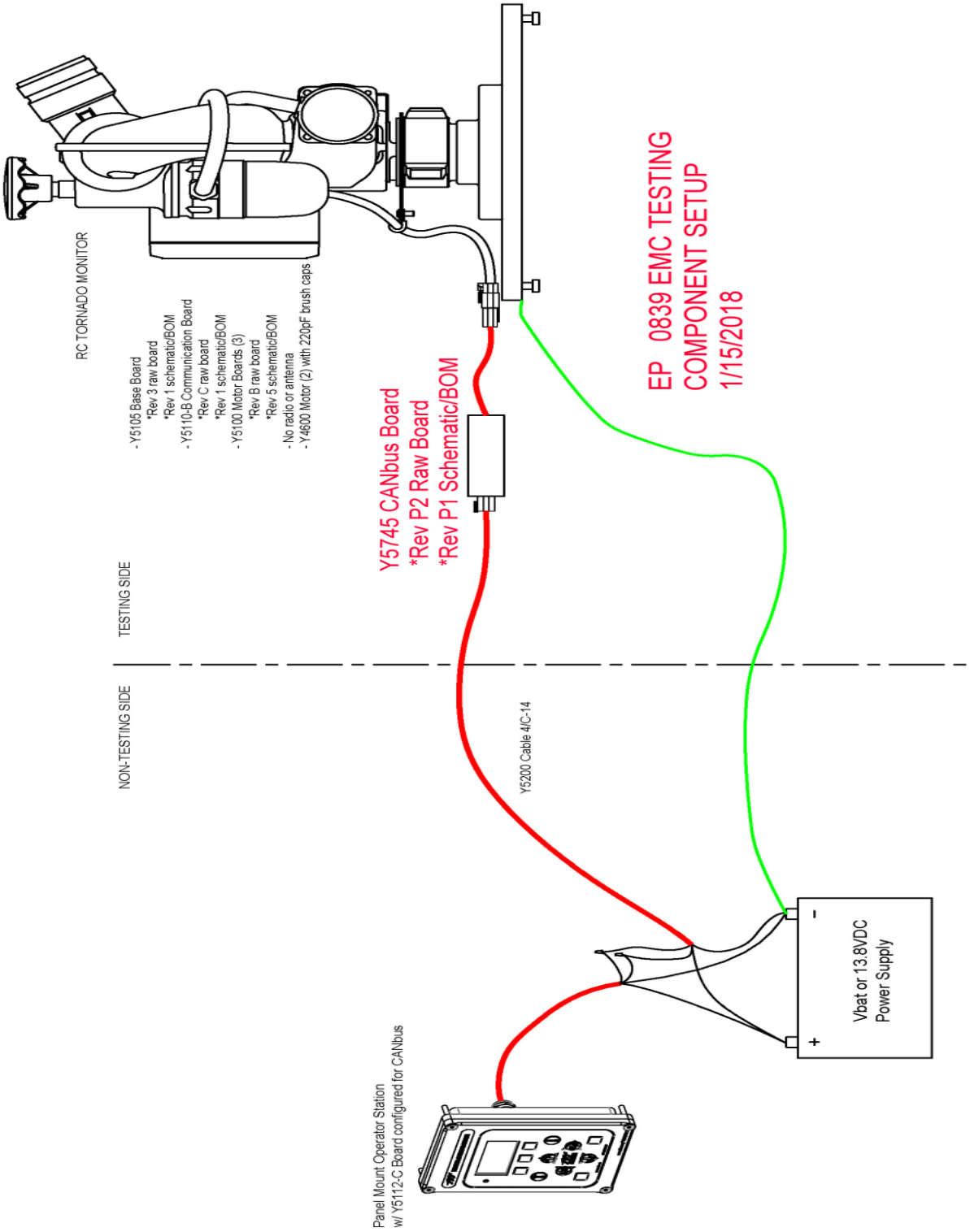
James E Morris

James E. Morris, Nemko USA

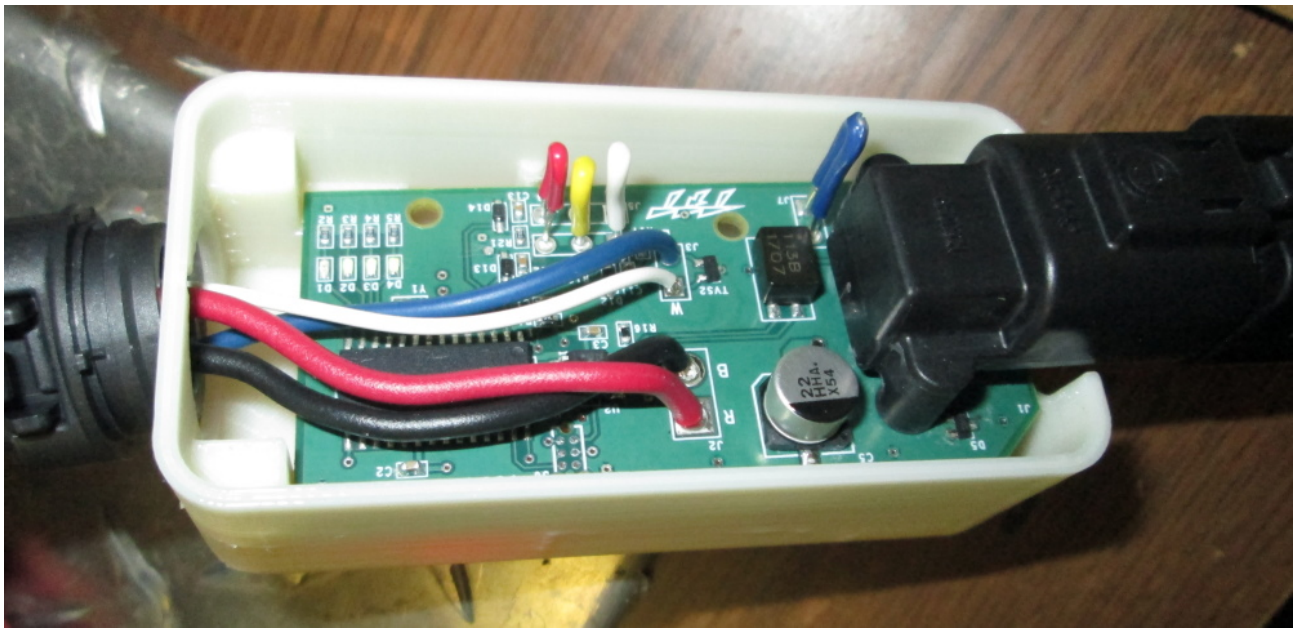
EMC and Wireless Divisions Manger

Nemko AS - Head Office, Gaustadalléen 30, P.O. Box 73 Blindern, 0314 Oslo, Norway
Phone: +47 22 96 03 30 - Fax: +47 22 96 05 50

Y5745 CANBUS BLOCK DIAGRAM



Y5745 CANBUS ADAPTER / EP0839 Project



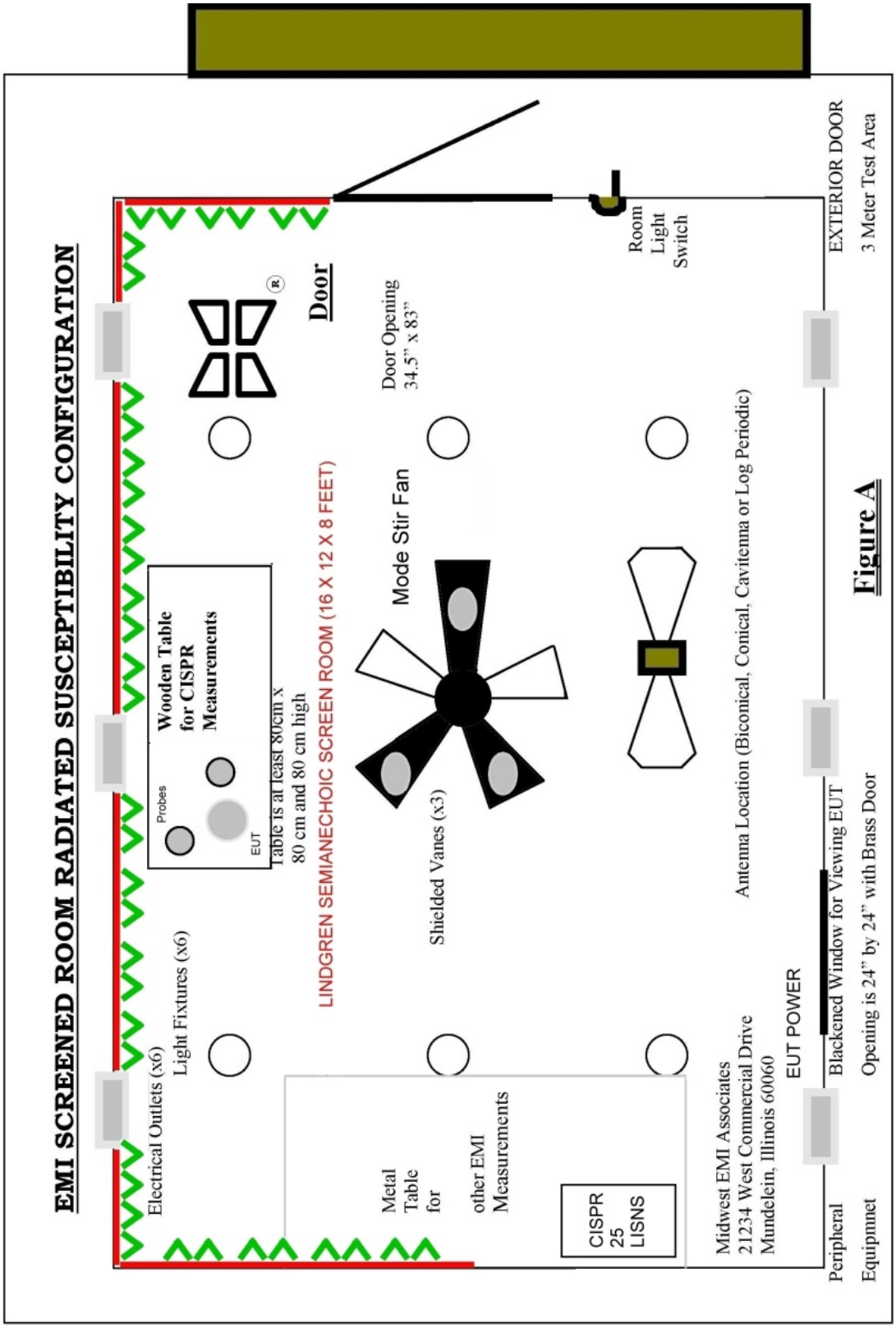

EMI SCREENED ROOM RADIATED SUSCEPTIBILITY CONFIGURATION
Electrical Outlets (x6)
Light Fixtures (x6)
Probes
EUT
Wooden Table for CISPR Measurements
Table is at least 80cm x 80 cm and 80 cm high
LINDGREN SEMIANECHOIC SCREEN ROOM (16 X 12 X 8 FEET)
Door
Door Opening 34.5" x 83"
Mode Stir Fan
Shielded Vanes (x3)
Room Light Switch
Metal Table for other EMI Measurements
CISPR 25 LISNS
Midwest EMI Associates
21234 West Commercial Drive
Mundelein, Illinois 60060
Antenna Location (Biconical, Conical, Cavitenna or Log Periodic)
EUT POWER
Peripheral Equipmnet
Blackened Window for Viewing EUT
Opening is 24" by 24" with Brass Door
EXTERIOR DOOR
3 Meter Test Area
Figure A

Table of Contents

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 RCMONITOR CANBUS INTERFACE (EP0839)** 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.

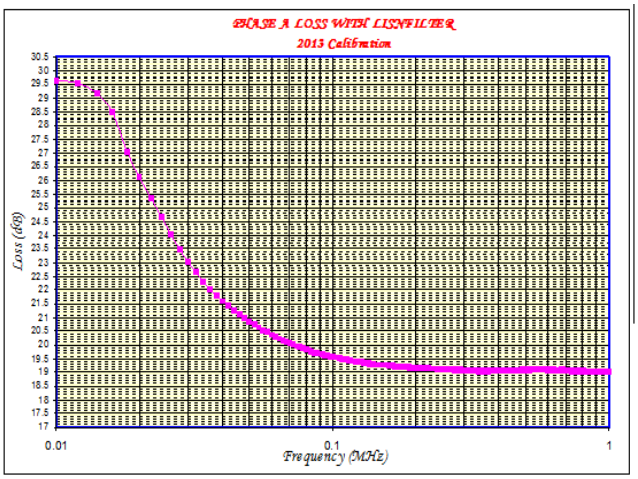
VDE LIMITS

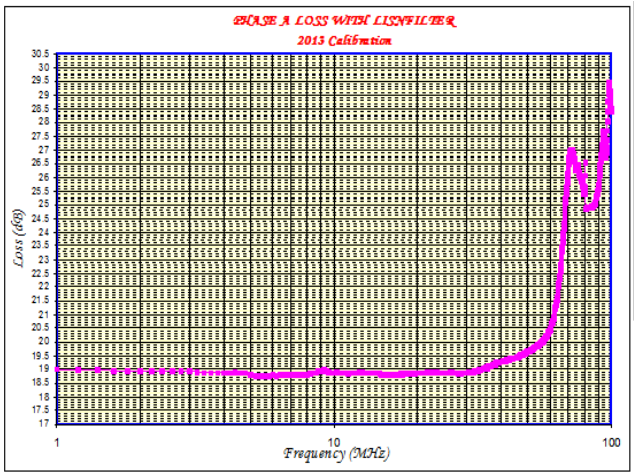
For CISPR 11 (EN55011), 22 (EN55022) or 14 (EN55014) B level conducted compliance starting at 150 kHz the allowed level is 66 dBuV and decreases at a linear rate with the log of frequency to 56 dBuV at 500 kHz. From 500 kHz to 5 MHz the allowed level is 56 dBuV, and 60 dBuV from 5 MHz to 30 MHz at the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

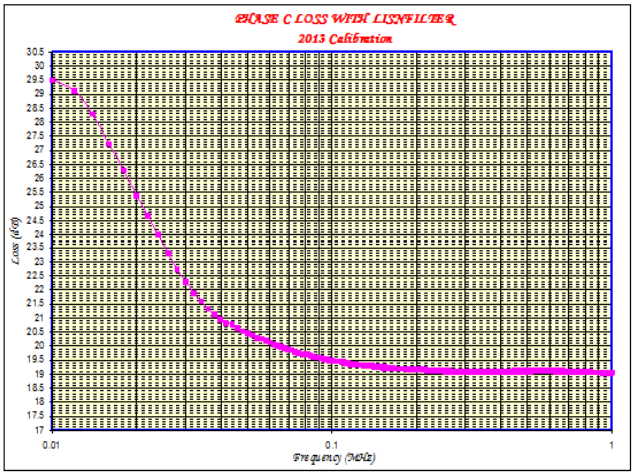
3.6 CALIBRATION DATA:

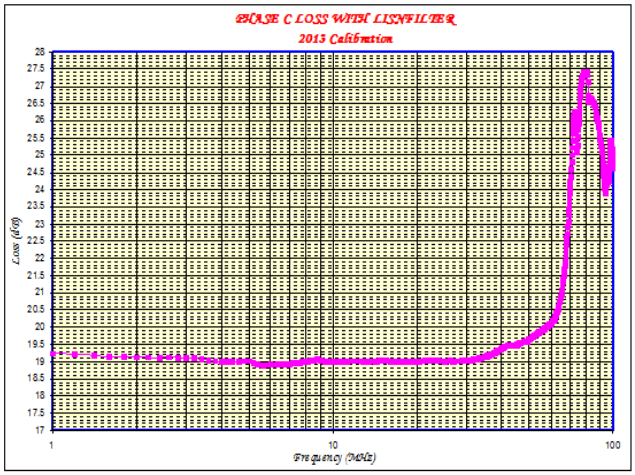
The results of the latest recalibration of the LISN's are contained on the next page over the range of 1 kHz to 1 MHz. The LISN is isolated from the spectrum analyzer by two 10-dB pads on either side of a five-pole rolloff filter. The insertion loss of each LISN has been compared and calibrated to that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

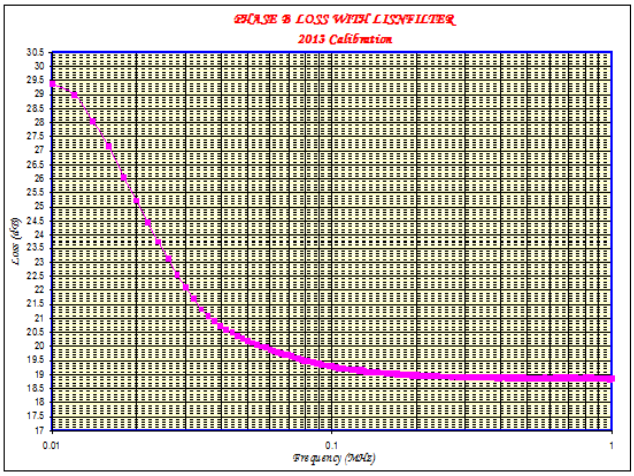
In the range higher than 1 MHz up to 100 MHz the characteristic of each LISN is flat with an insertion loss of no greater than 1.5 dB. In all cases the deviation from the perfect LISN response has been compensated for in a computer correction table file (approximately 150 points). The actual lower end of LISN response used for substantiation of customer data is 10 kHz.

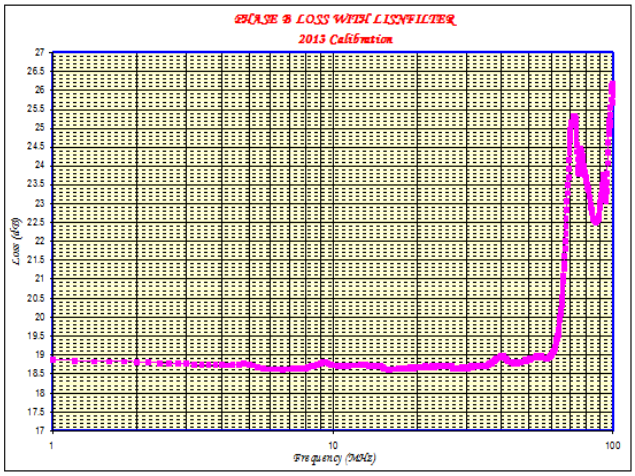

PHASE A LOSS WITH LISNFILTER
2013 Calibration
Loss (dB)
Frequency (MHz)
0.01
0.1
1


PHASE A LOSS WITH LISNFILTER
2013 Calibration
Loss (dB)
Frequency (MHz)
1
10
100


PHASE C LOSS WITH LISNFILTER
2013 Calibration
Loss (dB)
Frequency (MHz)
0.01
0.1
1

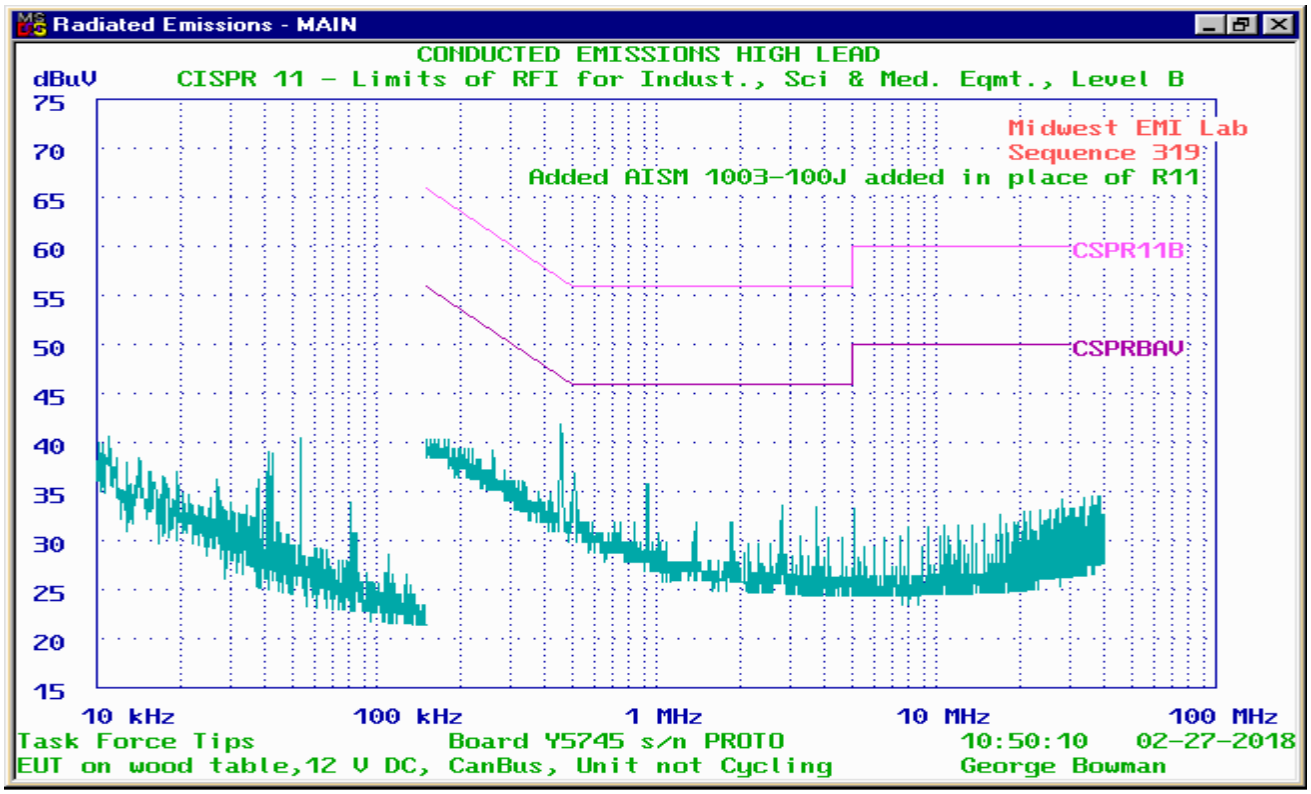

PHASE C LOSS WITH LISNFILTER
2013 Calibration
Loss (dB)
Frequency (MHz)
1
10
100

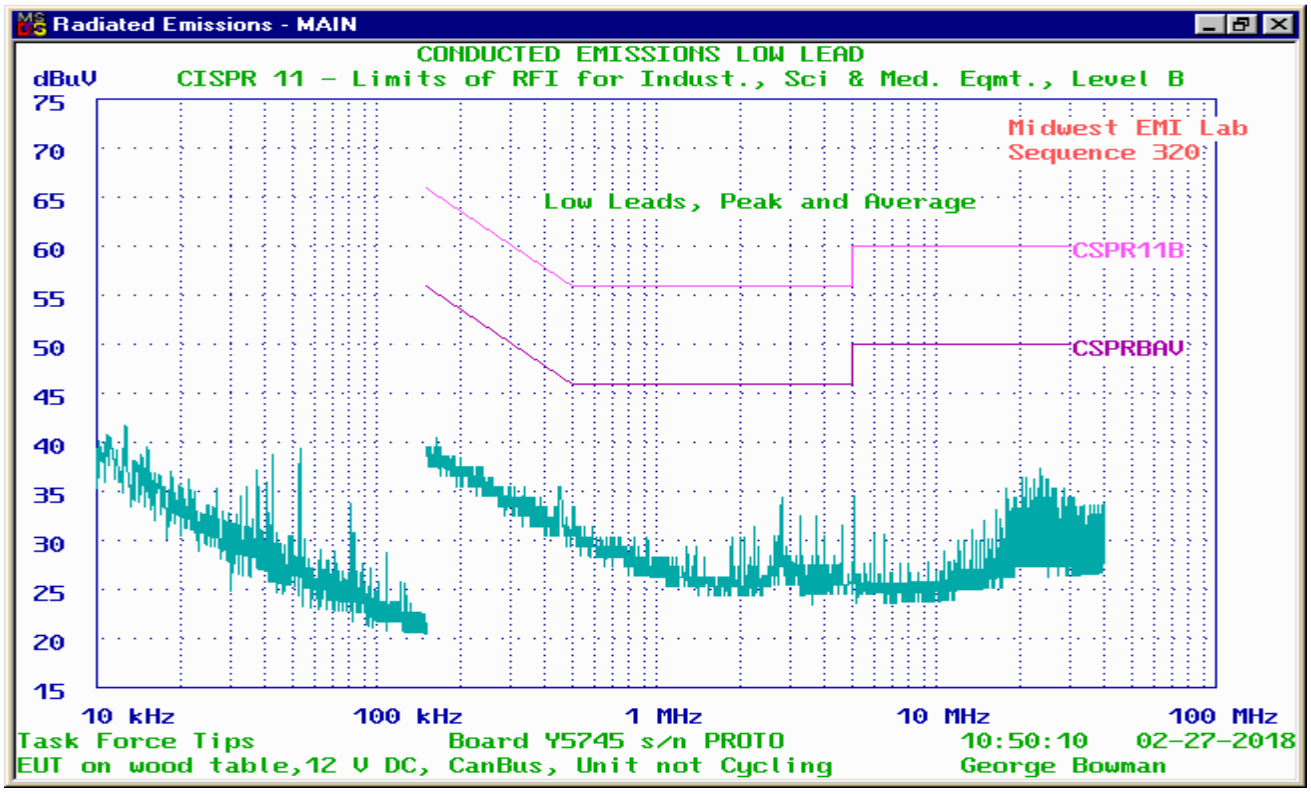

PHASE B LOSS WITH LISNFILTER
2013 Calibration
Loss (dB)
Frequency (MHz)
0.01
0.1
1


PHASE B LOSS WITH LISNFILTER
2013 Calibration
Loss (dB)
Frequency (MHz)
1
10
100

4.0 CONCLUSION OF RADIO FREQUENCY INTERFERENCE EMISSIONS TESTS:

The TFT EP0426/EP0359 Relay Interface was measured for its conducted emissions per EN61000-6-3 for DC operated devices. After measuring and improving the system the Cispr B objective was achieved after adding the change shown in the summary at the beginning of this report.


Radiated Emissions - MAIN
CONDUCTED EMISSIONS HIGH LEAD
dBuV
CISPR 11 - Limits of RFI for Indust., Sci & Med. Eqmt., Level B
75
70
65
60
55
50
45
40
35
30
25
20
15
Midwest EMI Lab
Sequence 319
Added AISM 1003-100J added in place of R11
CSPR11B
CSPRBAV
10 kHz
100 kHz
1 MHz
10 MHz
100 MHz
Task Force Tips
Board Y5745 s/n PROTO
10:50:10
02-27-2018
EUT on wood table,12 V DC, CanBus, Unit not Cycling
George Bowman


Radiated Emissions - MAIN
CONDUCTED EMISSIONS LOW LEAD
dBuV
CISPR 11 - Limits of RFI for Indust., Sci & Med. Eqmt., Level B
75
70
65
60
55
50
45
40
35
30
25
20
15
Midwest EMI Lab
Sequence 320
Low Leads, Peak and Average
CSPR11B
CSPRBAV
10 kHz
100 kHz
1 MHz
10 MHz
100 MHz
Task Force Tips
Board Y5745 s/n PROTO
10:50:10
02-27-2018
EUT on wood table,12 V DC, CanBus, Unit not Cycling
George Bowman

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 RCMONITOR CANBUS INTERFACE (EP0839) 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 CanBus interface facing to the front at 0 degrees wrt the antenna.

Final Testing – 02-07-2018

Seq. 913 shows the ambient; Seq. 919 shows the quasipeak mode in comparison in the range of 20-75 MHz. All emissions were checked with one at 35 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.

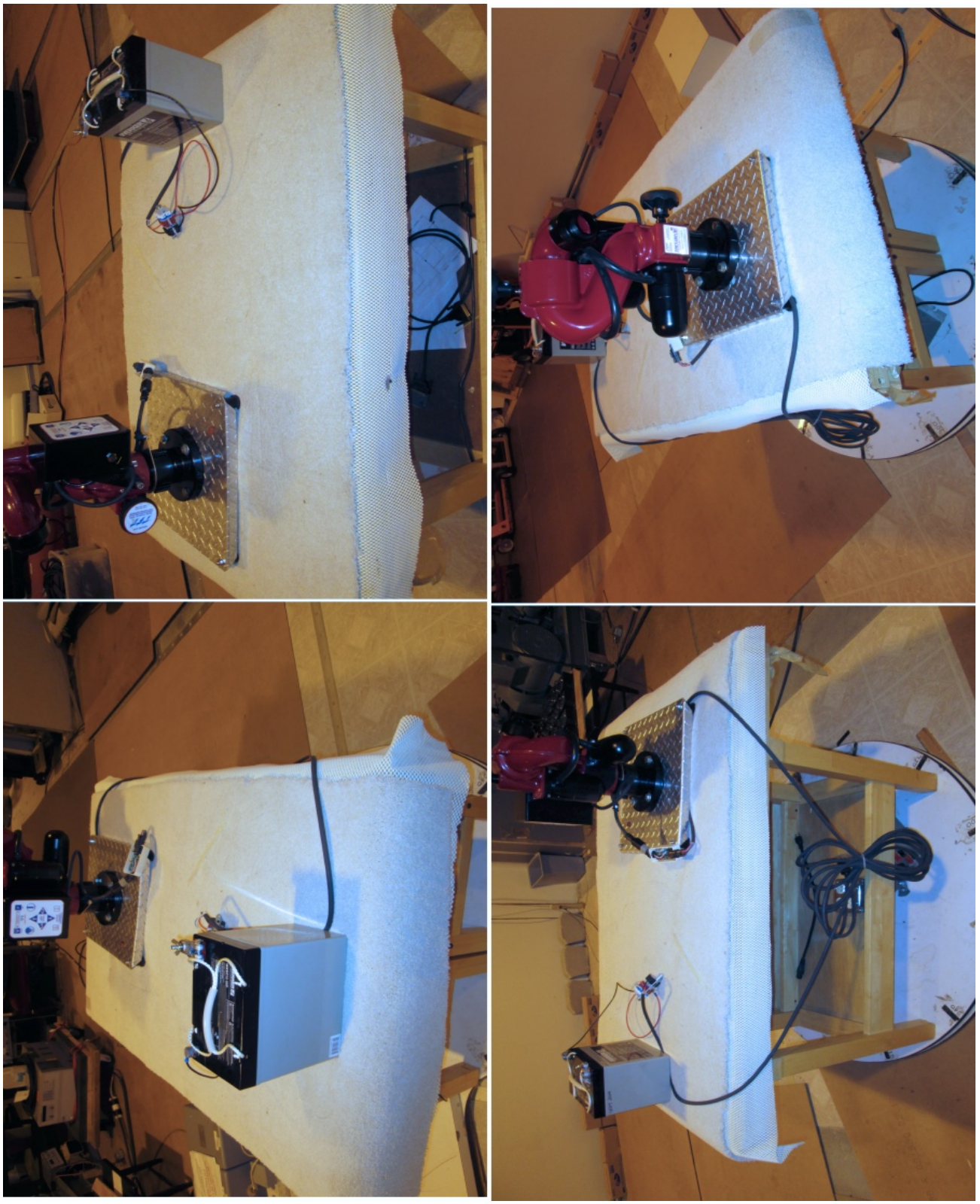
In the 75-170 MHz range, Seq. 914 shows the ambient and Seq. 920 shows the quasipeak emissions. Ambient emissions consist of the FM band and an intentional radiators at 147 MHz. Emissions above the line in the mid band area were discovered to be sporadic airplane emissions. No other emissions from the EUT appeared to be above the line.

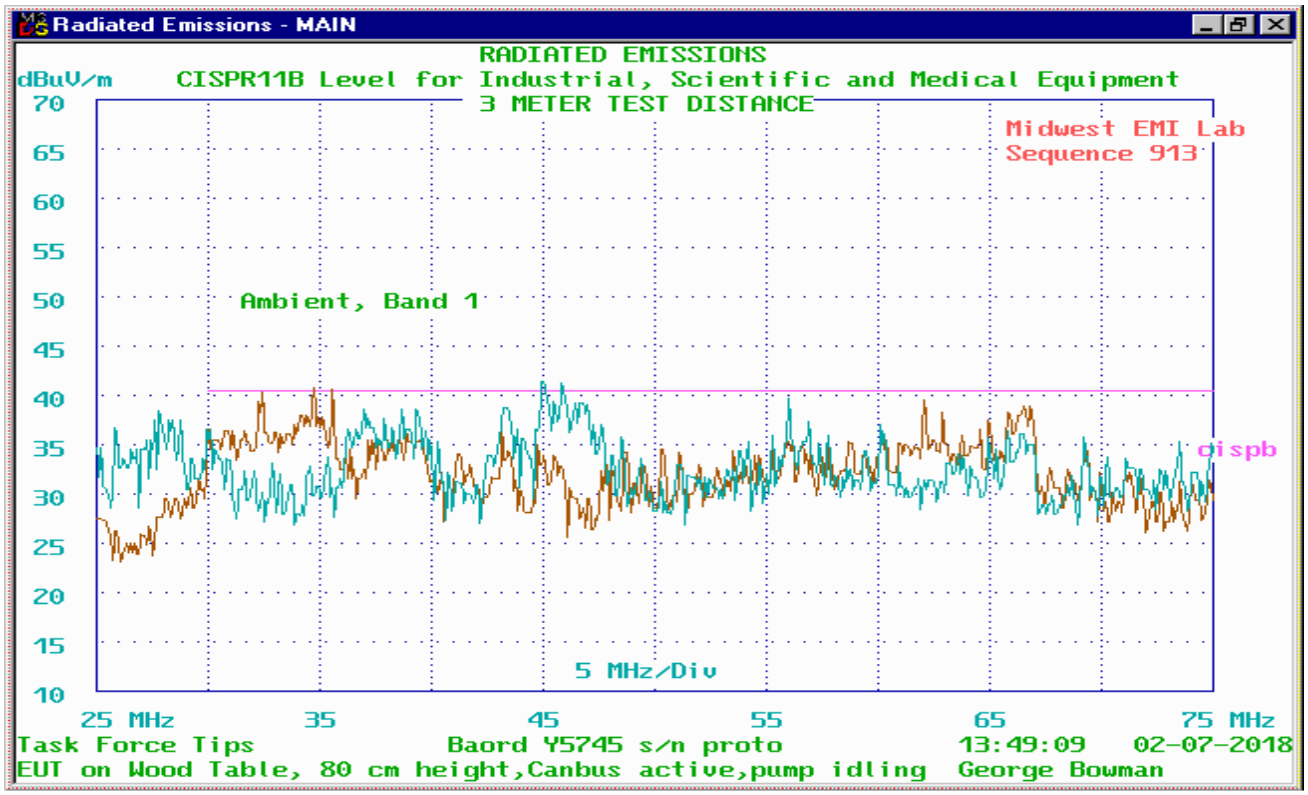
In the 160-300 MHz range, the ambient is shown on Seq. 915, and peak level on Seq. 921. No areas of emission from the EUT appeared to exceed the limit. Other emissions seen were from TV Channels 7 and 11, and a common carrier at about 220 MHz.

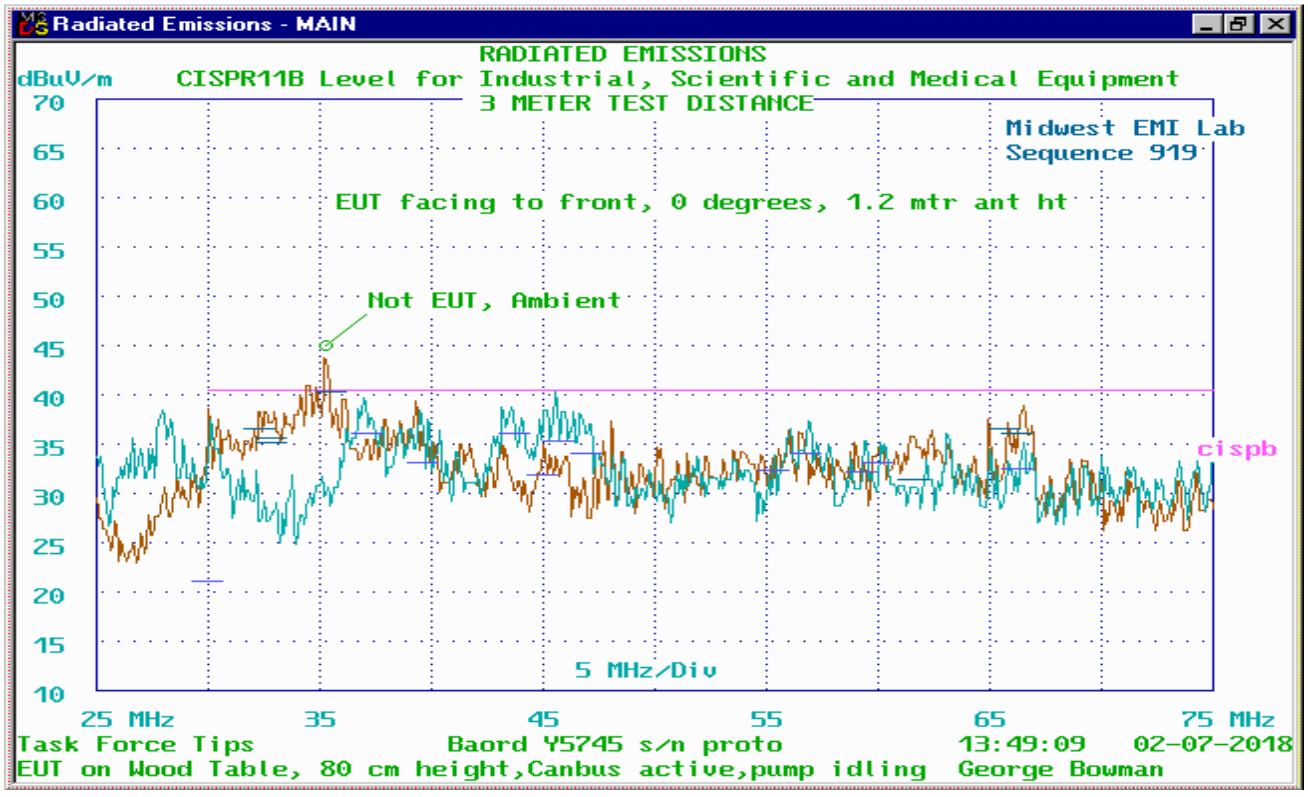
In the 300-640 MHz, the ambient is shown on Seq. 917 and the quasipeak level emissions are shown on Seq 922. Other high emissions are numerous UHF TV stations and they are identified. Two emissions found in this range different from the ambient were individually inspected and not found to be due to the EUT but were from limo taxi services.

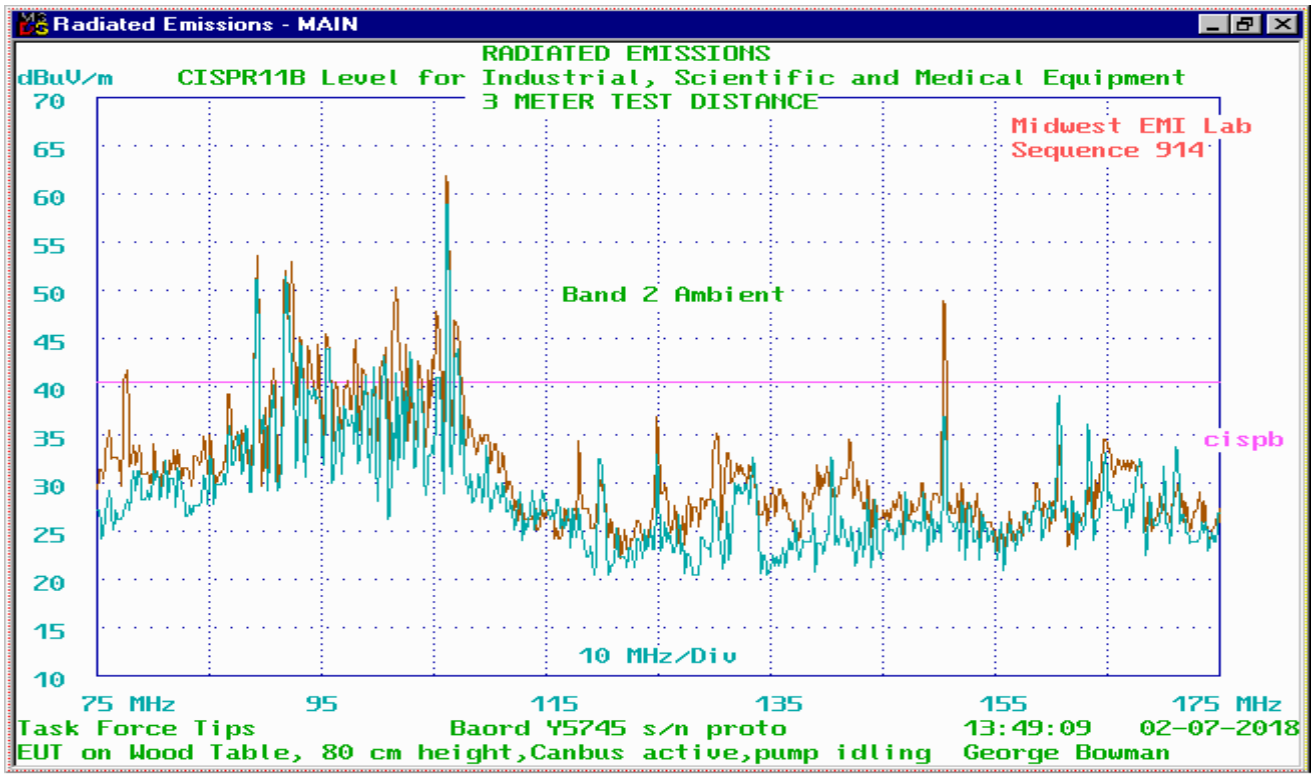
In the 620-1000 MHz, the ambient is shown on Seq. 916 and quasipeak level on Seq. 920. Other high emissions are numerous UHF TV stations and the cell telephone band around 900 MHz that is identified. When the graphs were overlaid, no excess level introduced by the EUT was seen.

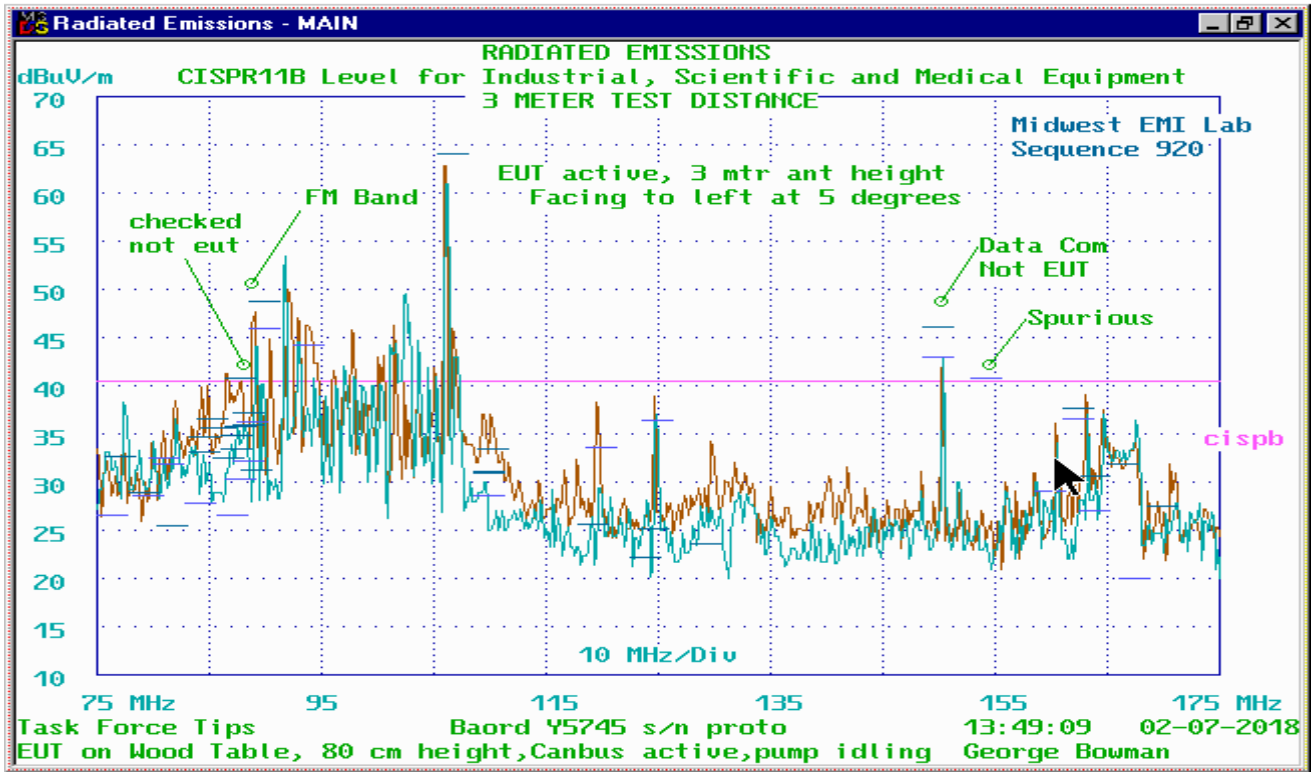
The CanBus Interface Controller was fully compliant with the Cispr 11 B level specification. The actual battery used for this test was a large 12 volt lead acid battery that was attached to the battery terminals by clip leads.

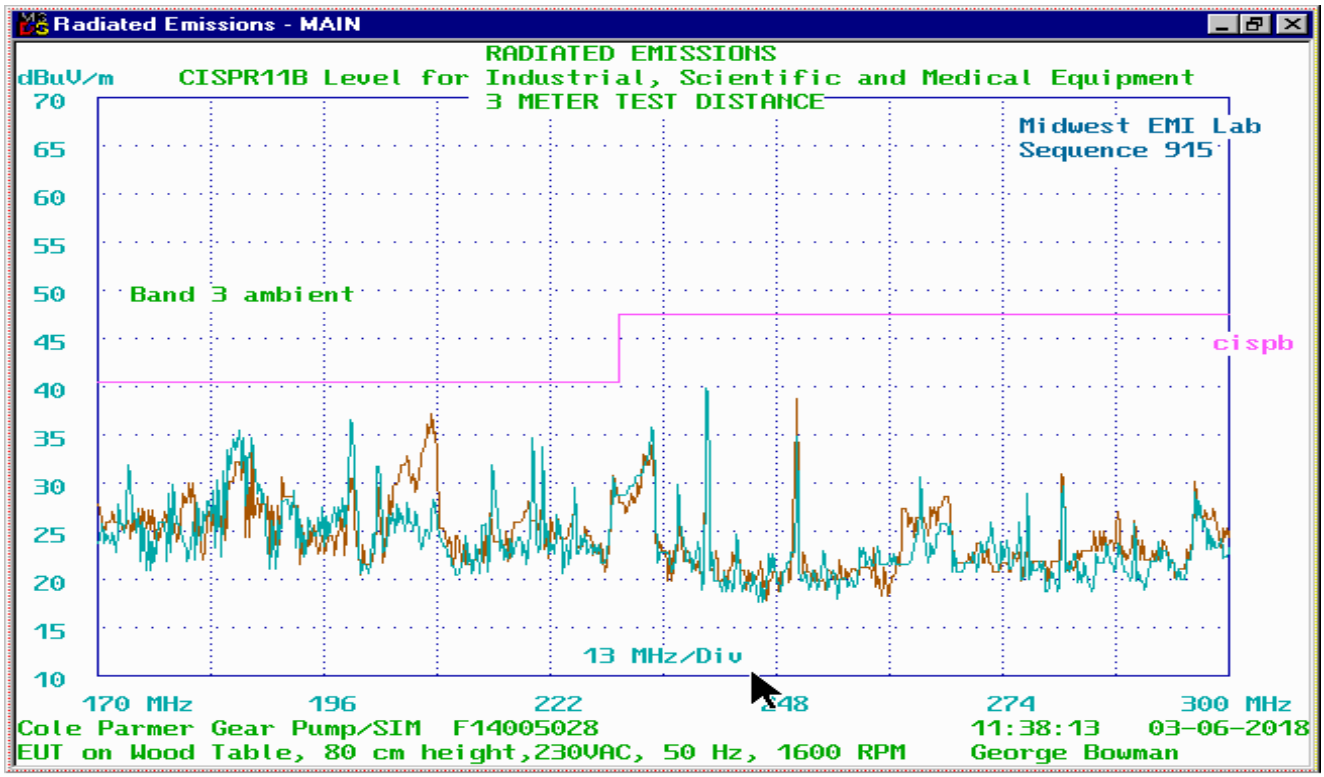


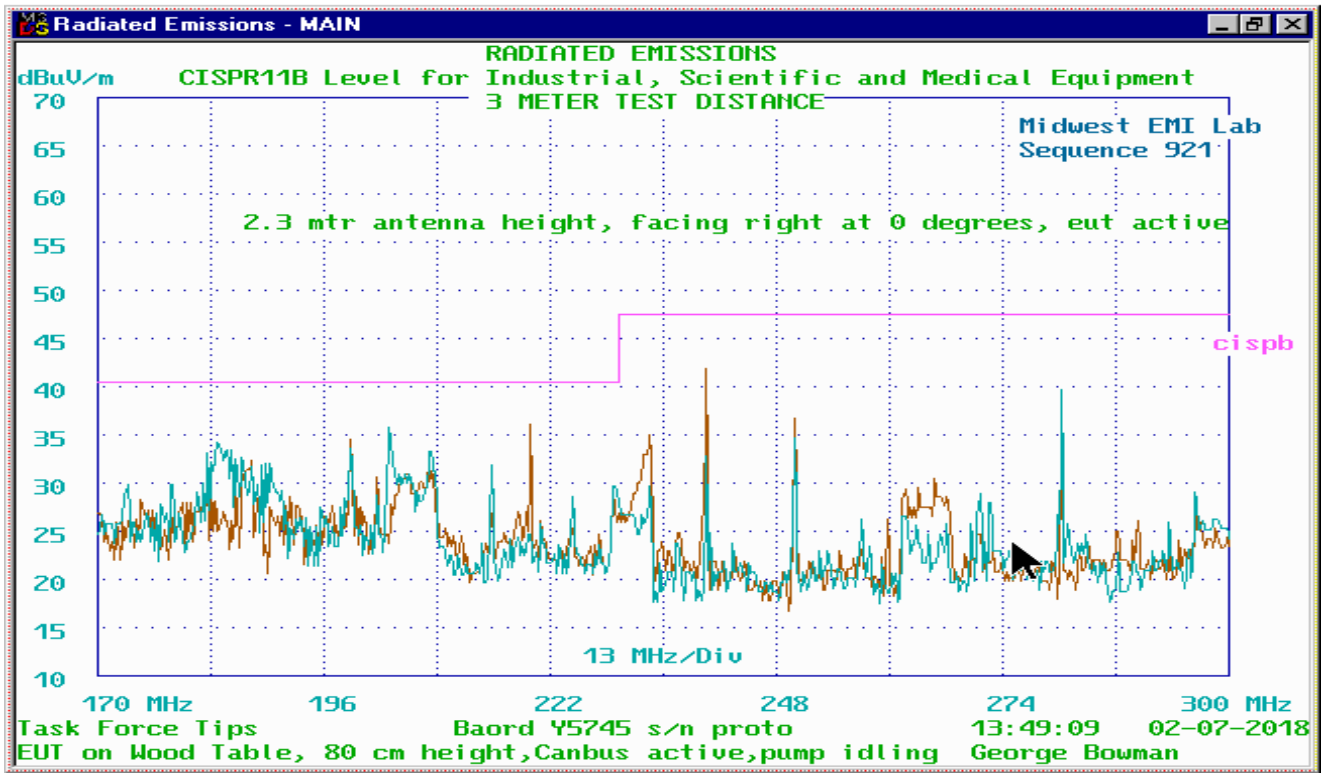

Radiated Emissions - MAIN
RADIATED EMISSIONS
dBuV/m
CISPR11B Level for Industrial, Scientific and Medical Equipment
3 METER TEST DISTANCE
Midwest EMI Lab
Sequence 913
Ambient, Band 1
cispb
5 MHz/Div
25 MHz
35
45
55
65
75 MHz
Task Force Tips
Baord Y5745 s/n proto
13:49:09
02-07-2018
EUT on Wood Table, 80 cm height,Canbus active,pump idling
George Bowman

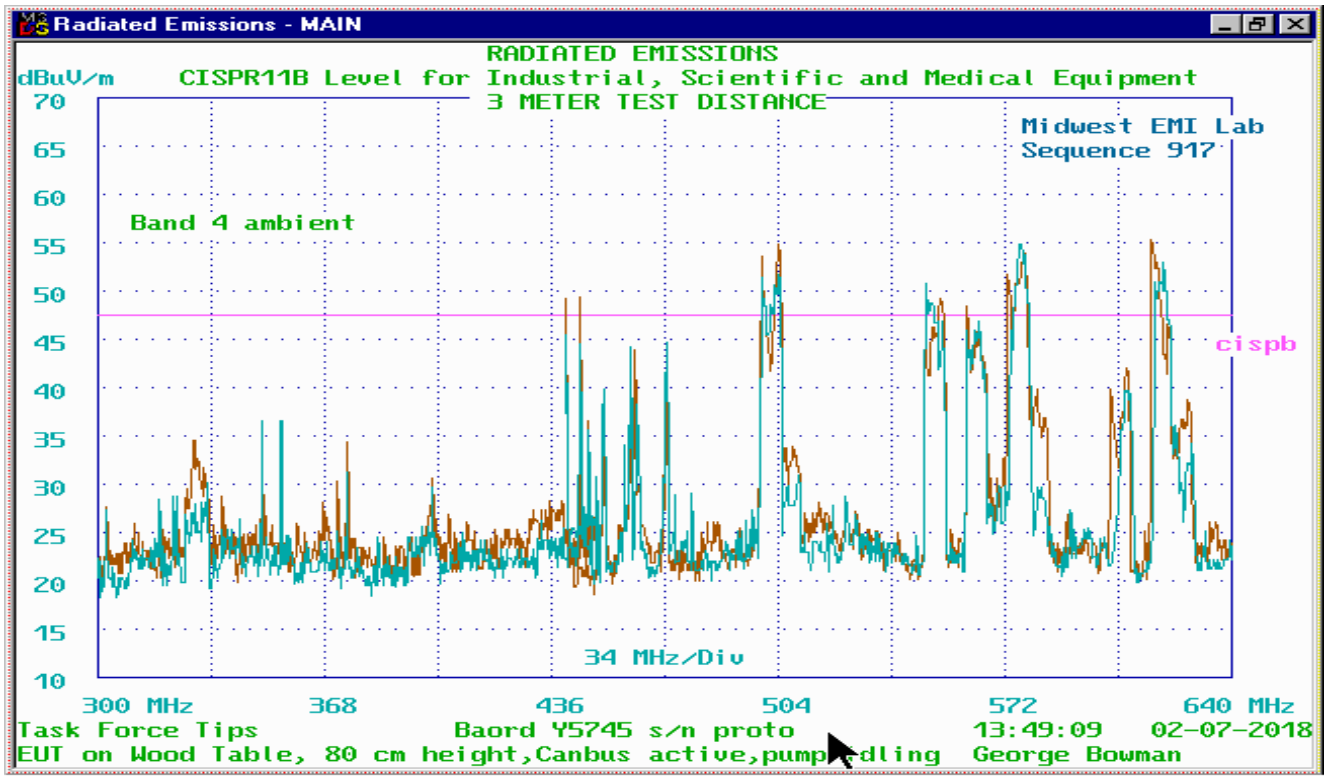

Radiated Emissions - MAIN
RADIATED EMISSIONS
dBuV/m
CISPR11B Level for Industrial, Scientific and Medical Equipment
3 METER TEST DISTANCE
Midwest EMI Lab
Sequence 919
EUT facing to front, 0 degrees, 1.2 mtr ant ht
Not EUT, Ambient
cispb
5 MHz/Div
25 MHz
35
45
55
65
75 MHz
Task Force Tips
Baord Y5745 s/n proto
13:49:09
02-07-2018
EUT on Wood Table, 80 cm height,Canbus active,pump idling
George Bowman

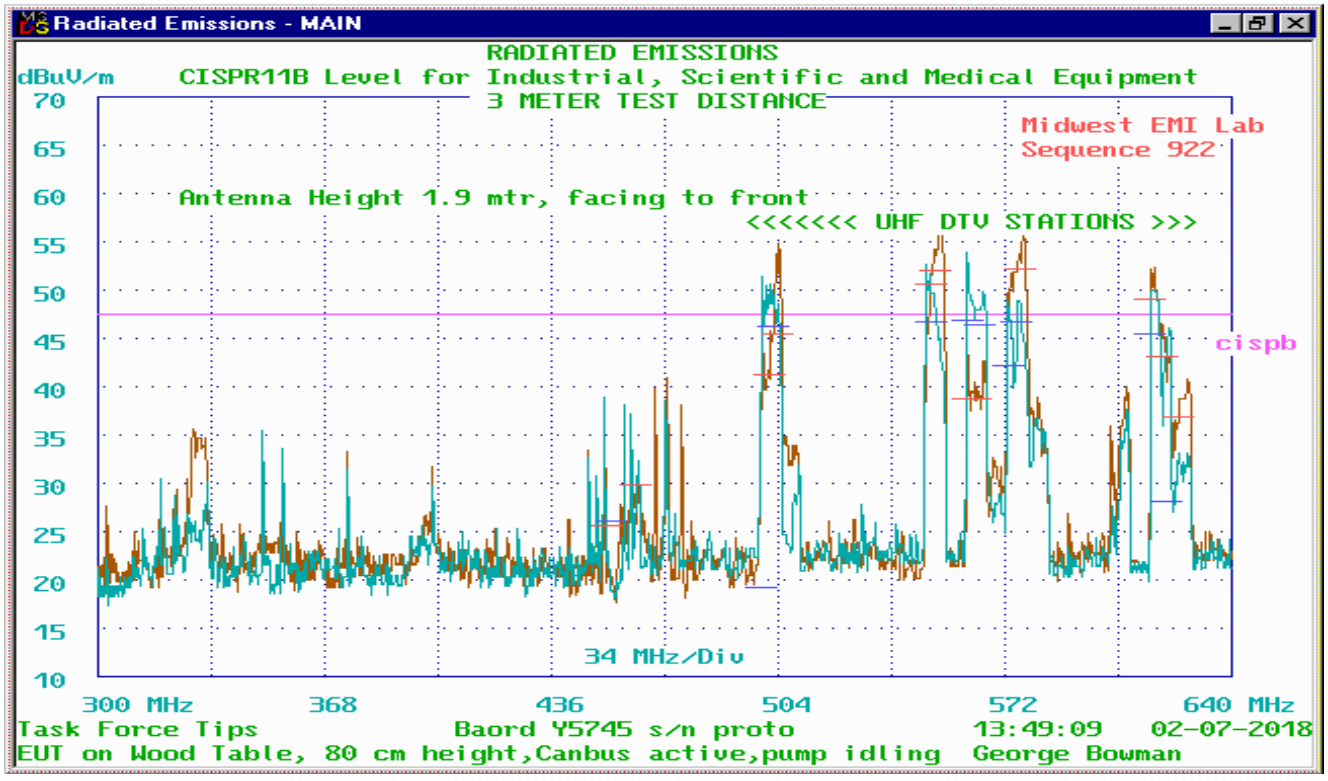

Radiated Emissions - MAIN
RADIATED EMISSIONS
dBuV/m
CISPR11B Level for Industrial, Scientific and Medical Equipment
3 METER TEST DISTANCE
Midwest EMI Lab
Sequence 914
Band 2 Ambient
cispb
10 MHz/Div
75 MHz
95
115
135
155
175 MHz
Task Force Tips
Baord Y5745 s/n proto
13:49:09
02-07-2018
EUT on Wood Table, 80 cm height,Canbus active,pump idling
George Bowman

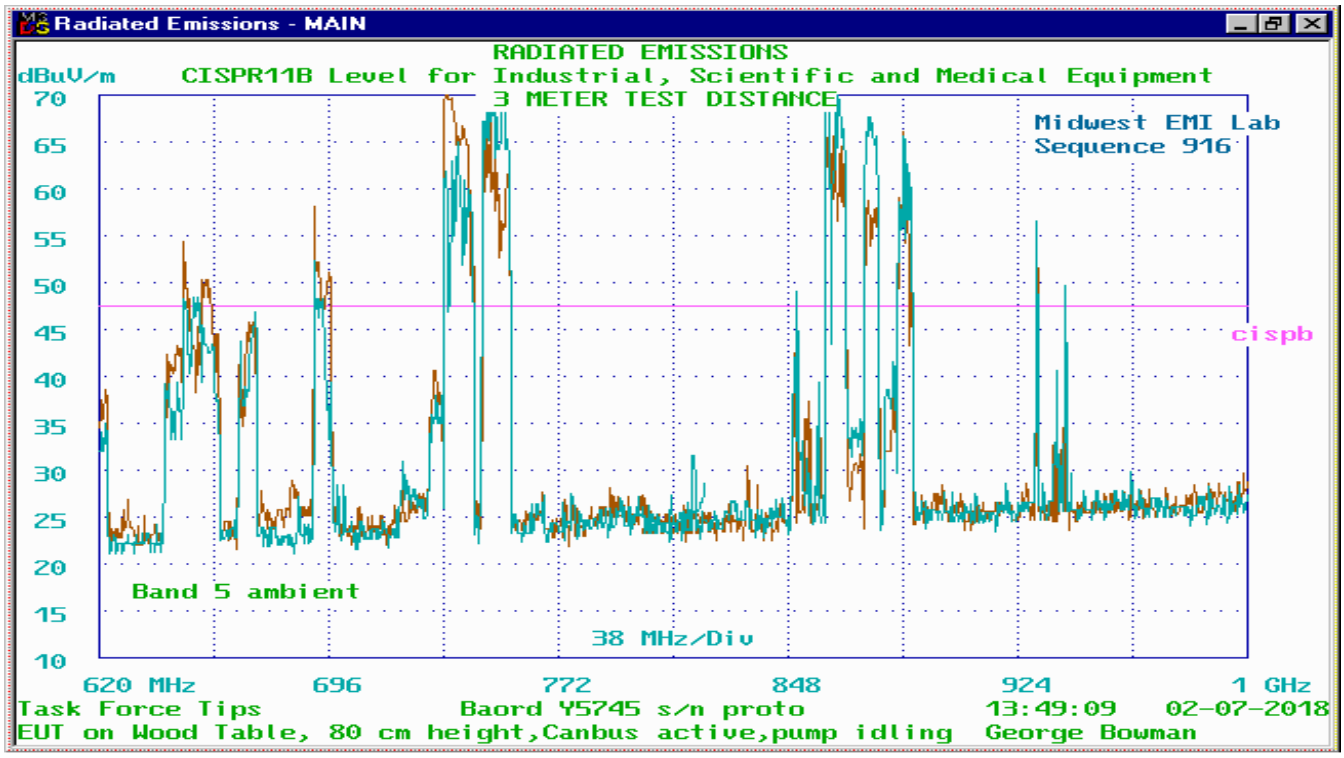

Radiated Emissions - MAIN
RADIATED EMISSIONS
dBuV/m
CISPR11B Level for Industrial, Scientific and Medical Equipment
3 METER TEST DISTANCE
Midwest EMI Lab
Sequence 920
EUT active, 3 mtr ant height
Facing to left at 5 degrees
FM Band
checked
not eut
Data Com
Not EUT
Spurious
cispb
10 MHz/Div
75 MHz
95
115
135
155
175 MHz
Task Force Tips
Baord Y5745 s/n proto
13:49:09
02-07-2018
EUT on Wood Table, 80 cm height,Canbus active,pump idling
George Bowman

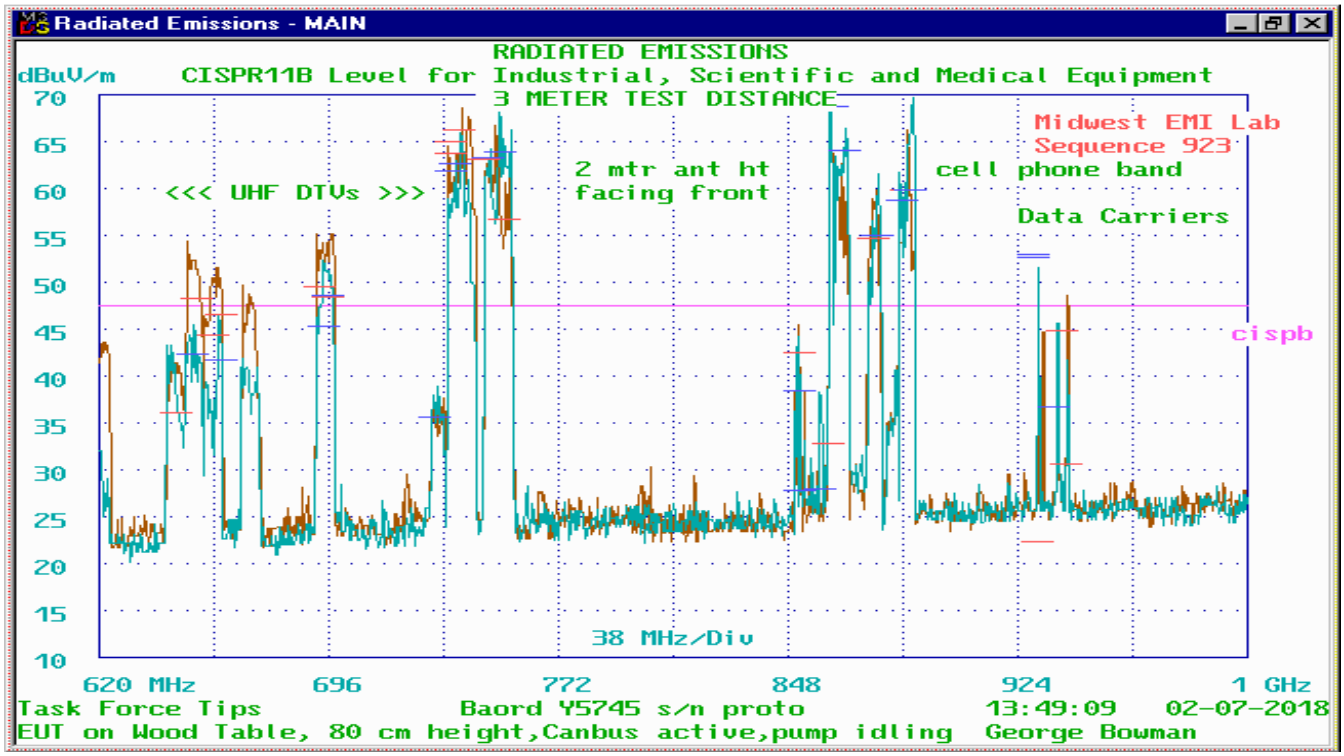

Radiated Emissions - MAIN
RADIATED EMISSIONS
dBuV/m
CISPR11B Level for Industrial, Scientific and Medical Equipment
3 METER TEST DISTANCE
Midwest EMI Lab
Sequence 915
Band 3 ambient
cispb
70
65
60
55
50
45
40
35
30
25
20
15
10
13 MHz/Div
170 MHz
196
222
248
274
300 MHz
Cole Parmer Gear Pump/SIM F14005028
11:38:13 03-06-2018
EUT on Wood Table, 80 cm height,230VAC, 50 Hz, 1600 RPM
George Bowman


Radiated Emissions - MAIN
RADIATED EMISSIONS
dBuV/m
CISPR11B Level for Industrial, Scientific and Medical Equipment
3 METER TEST DISTANCE
Midwest EMI Lab
Sequence 921
2.3 mtr antenna height, facing right at 0 degrees, eut active
cispb
70
65
60
55
50
45
40
35
30
25
20
15
10
13 MHz/Div
170 MHz
196
222
248
274
300 MHz
Task Force Tips
Baord Y5745 s/n proto
13:49:09 02-07-2018
EUT on Wood Table, 80 cm height,Canbus active,pump idling
George Bowman


Radiated Emissions - MAIN
RADIATED EMISSIONS
dBuV/m
CISPR11B Level for Industrial, Scientific and Medical Equipment
3 METER TEST DISTANCE
Midwest EMI Lab
Sequence 917
Band 4 ambient
cispb
34 MHz/Div
70
65
60
55
50
45
40
35
30
25
20
15
10
300 MHz
368
436
504
572
640 MHz
Task Force Tips
Baord Y5745 s/n proto
13:49:09
02-07-2018
EUT on Wood Table, 80 cm height,Canbus active,pump idling
George Bowman


Radiated Emissions - MAIN
RADIATED EMISSIONS
dBuV/m
CISPR11B Level for Industrial, Scientific and Medical Equipment
3 METER TEST DISTANCE
Midwest EMI Lab
Sequence 922
Antenna Height 1.9 mtr, facing to front
<<<<<<< UHF DTV STATIONS >>>
cispb
34 MHz/Div
70
65
60
55
50
45
40
35
30
25
20
15
10
300 MHz
368
436
504
572
640 MHz
Task Force Tips
Baord Y5745 s/n proto
13:49:09
02-07-2018
EUT on Wood Table, 80 cm height,Canbus active,pump idling
George Bowman


Radiated Emissions - MAIN
RADIATED EMISSIONS
dBuV/m
CISPR11B Level for Industrial, Scientific and Medical Equipment
3 METER TEST DISTANCE
Midwest EMI Lab
Sequence 916
cispb
Band 5 ambient
38 MHz/Div
620 MHz
696
772
848
924
1 GHz
Task Force Tips
Baord Y5745 s/n proto
13:49:09
02-07-2018
EUT on Wood Table, 80 cm height,Canbus active,pump idling
George Bowman


Radiated Emissions - MAIN
RADIATED EMISSIONS
dBuV/m
CISPR11B Level for Industrial, Scientific and Medical Equipment
3 METER TEST DISTANCE
Midwest EMI Lab
Sequence 923
<<< UHF DTVs >>>
2 mtr ant ht
facing front
cell phone band
Data Carriers
cispb
38 MHz/Div
620 MHz
696
772
848
924
1 GHz
Task Force Tips
Baord Y5745 s/n proto
13:49:09
02-07-2018
EUT on Wood Table, 80 cm height,Canbus active,pump idling
George Bowman

SHEET 1 **cispb RADIATED QUASI-PEAK REPORT**
CISPR11B Level for Industrial, Scientific and Medical Equipment
3 METER TEST DISTANCE
TIME: 13:49:09 **Midwest EMI**
DATE: 02-07-2018 **Associates**
TEST ITEM: Task Force Tips
SERIAL NUMBER: Baord Y5745 s/n proto **Sequence Number: 919**
COMMENTS: EUT on Wood Table, 80 cm height,Canbus active,pump idling
TEST PERFORMED BY: George Bowman

Peak Frequency (MHz)	Peak Interference (dBuV/m)	Quasi-peak Freq. (MHz)	Quasi-peak Interfer (dBuV/m)	Spec. Level (dBuV/m)	Antenna Polar (H/V)
32.44337	38.701	32.317	36.598	40.500	Horizontal
32.78821	37.636	32.8682	35.227	40.500	Horizontal
32.79266	36.646	32.8615	35.628	40.500	Horizontal
35.55728	38.933	35.5189	40.450	40.500	Horizontal
61.69051	37.024	61.5401	31.504	40.500	Horizontal
65.51815	38.775	65.6566	36.656	40.500	Horizontal
66.11203	38.540	66.2432	36.159	40.500	Horizontal
29.89729	39.760	29.9237	21.156	40.500	Vertical
37.29736	40.432	37.171	36.149	40.500	Vertical
39.6971	41.199	39.6635	33.167	40.500	Vertical
43.73107	42.084	43.8183	36.224	40.500	Vertical
44.94058	40.640	45.0798	32.028	40.500	Vertical
45.64507	40.565	45.7627	35.325	40.500	Vertical
46.99377	40.590	47.0362	34.182	40.500	Vertical
55.34095	36.995	55.3186	32.351	40.500	Vertical
56.90916	41.133	56.7772	34.104	40.500	Vertical
56.66226	38.585	56.7855	34.101	40.500	Vertical
59.22049	38.364	59.3085	32.261	40.500	Vertical
59.96209	37.820	60.0341	33.209	40.500	Vertical
66.41763	37.359	66.23439	32.509	40.500	Vertical

SHEET 1 cispb RADIATED QUASI-PEAK REPORT
CISPR11B Level for Industrial, Scientific and Medical Equipment
3 METER TEST DISTANCE
TIME: 13:49:09 Midwest EMI
DATE: 02-07-2018 Associates
TEST ITEM: Task Force Tips
SERIAL NUMBER: Baord Y5745 s/n proto Sequence Number: 920
COMMENTS: EUT on Wood Table, 80 cm height,Canbus active,pump idling
TEST PERFORMED BY: George Bowman

Peak Frequency (MHz)	Peak Interference (dBuV/m)	Quasi-peak Freq. (MHz)	Quasi-peak Interfer (dBuV/m)	Spec. Level (dBuV/m)		Antenna Polar (H/V)
77.33797	38.303	77.22839	32.807	40.500		Horizontal
79.32955	38.072	79.2328	28.993	40.500		Horizontal
81.78903	42.623	81.705	25.506	40.500		Horizontal
84.44898	43.343	84.64660	33.220	40.500		Horizontal
84.76779	42.146	84.6614	34.822	40.500		Horizontal
86.59999	45.628	86.6888	32.542	40.500		Horizontal
88.56326	49.562	88.5065	36.018	40.500		Horizontal
87.58896	42.820	87.74420	40.802	40.500	*	Horizontal
85.7353	40.336	85.54730	35.665	40.500		Horizontal
85.40000	38.742	85.4952	36.657	40.500		Horizontal
87.31276	45.628	87.47280	33.561	40.500		Horizontal
87.40000	44.550	87.4888	34.964	40.500		Horizontal
88.5583	38.632	88.5167	37.219	40.500		Horizontal
86.29259	44.997	86.0934	35.650	40.500		Horizontal
88.06923	49.562	87.8708	35.922	40.500		Horizontal
89.59999	41.481	89.40000	31.251	40.500		Horizontal
90.10003	47.292	90.0904	48.752	40.500	*	Horizontal
106.6997	48.785	106.7245	64.191	40.500	*	Horizontal
109.804	41.413	110.0008	31.240	40.500		Horizontal
109.8	39.031	109.9968	31.040	40.500		Horizontal
110.1953	40.804	110.1913	33.548	40.500		Horizontal
119.4	42.955	119.2368	25.651	40.500		Horizontal
123.8379	40.225	123.9963	22.225	40.500		Horizontal
124.6143	45.174	124.7959	25.257	40.500		Horizontal
129.6	39.177	129.4072	23.704	40.500		Horizontal
149.9998	47.330	150.0134	46.230	40.500	*	Horizontal
162.5667	41.740	162.5611	37.662	40.500		Horizontal
163.6468	40.399	163.8452	30.683	40.500		Horizontal
170.074	36.541	170.03	27.503	40.500		Horizontal
166.5569	38.847	166.5985	31.882	40.500		Horizontal
76.79295	41.409	76.6018	26.589	40.500		Vertical
79.78046	37.970	79.7805	28.665	40.500		Vertical
81.07196	38.660	81.22880	32.608	40.500		Vertical
81.45541	40.294	81.2602	31.912	40.500		Vertical
84.2	38.134	84.34399	27.950	40.500		Vertical
88.67739	48.753	88.511	32.225	40.500		Vertical
88.01863	41.496	87.86579	30.388	40.500		Vertical
87.2	37.450	87.21680	26.651	40.500		Vertical
90.09976	43.587	90.0574	46.019	40.500	*	Vertical
89.000	48.753	89.0904	36.258	40.500		Vertical
94.07071	43.676	93.89230	44.329	40.500	*	Vertical

SHEET 2 **cispb RADIATED QUASI-PEAK REPORT**
CISPR11B Level for Industrial, Scientific and Medical Equipment
3 METER TEST DISTANCE
TIME: 13:49:09 **Midwest EMI**
DATE: 02-07-2018 **Associates**
TEST ITEM: Task Force Tips
SERIAL NUMBER: Baord Y5745 s/n proto **Sequence Number: 920**
COMMENTS: EUT on Wood Table, 80 cm height,Canbus active,pump idling
TEST PERFORMED BY: George Bowman

Peak Frequency (MHz)	Peak Interference (dBuV/m)	Quasi-peak Freq. (MHz)	Quasi-peak Interfer (dBuV/m)	Spec. Level (dBuV/m)		Antenna Polar (H/V)
109.8159	39.174	110.0111	28.681	40.500		Vertical
119.8875	41.432	119.9899	33.750	40.500		Vertical
124.8503	41.363	125.0183	36.427	40.500		Vertical
150.0006	44.842	150.0166	43.040	40.500	*	Vertical
154.6	50.477	154.4368	40.876	40.500	*	Vertical
159.7846	37.772	159.9838	29.170	40.500		Vertical
162.5141	40.588	162.5613	36.585	40.500		Vertical
163.6412	39.296	163.8412	27.093	40.500		Vertical
167.5254	39.295	167.3382	20.088	40.500		Vertical

SHEET 1 **cispb RADIATED QUASI-PEAK REPORT**
CISPR11B Level for Industrial, Scientific and Medical Equipment
3 METER TEST DISTANCE
TIME: 13:49:09 **Midwest EMI**
DATE: 02-07-2018 **Associates**
TEST ITEM: Task Force Tips
SERIAL NUMBER: Baord Y5745 s/n proto **Sequence Number: 922**
COMMENTS: EUT on Wood Table, 80 cm height,Canbus active,pump idling
TEST PERFORMED BY: George Bowman

Peak Frequency (MHz)	Peak Interference (dBuV/m)	Quasi-peak Freq. (MHz)	Quasi-peak Interfer (dBuV/m)	Spec. Level (dBuV/m)		Antenna Polar (H/V)
452.9887	44.952	453.1863	25.775	47.500		Horizontal
462	46.142	462.052	29.942	47.500		Horizontal
500.9571	51.234	501.1579	41.300	47.500		Horizontal
504	57.074	504.1728	45.479	47.500		Horizontal
550.2345	52.056	550.4136	50.711	47.500	*	Horizontal
551.5192	57.573	551.708	52.045	47.500	*	Horizontal
560.8215	46.160	560.6487	38.878	47.500		Horizontal
563.6057	45.539	563.7857	38.866	47.500		Horizontal
576.4718	56.632	576.5342	52.325	47.500	*	Horizontal
615.2673	55.923	615.2681	49.205	47.500	*	Horizontal
619.0595	49.038	619.0027	43.206	47.500		Horizontal
624.4745	44.928	624.4512	36.892	47.500		Horizontal
453.966	44.961	454.1476	26.243	47.500		Vertical
498.8	54.145	498.6368	19.338	47.500		Vertical
502.3601	52.732	502.2161	46.389	47.500		Vertical
549.7596	54.120	549.5667	46.836	47.500		Vertical
550.0714	52.940	550.1386	46.845	47.500		Vertical
561.6058	54.882	561.4154	46.889	47.500		Vertical
564.5511	52.006	564.5623	46.507	47.500		Vertical
573.5519	53.676	573.3703	42.270	47.500		Vertical
575.8877	51.336	575.8869	46.739	47.500		Vertical
615.8053	54.604	615.6357	45.605	47.500		Vertical
620.5653	47.432	620.3653	28.220	47.500		Vertical

SHEET 1 **cispb RADIATED QUASI-PEAK REPORT**
CISPR11B Level for Industrial, Scientific and Medical Equipment
3 METER TEST DISTANCE
TIME: 13:49:09 **Midwest EMI**
DATE: 02-07-2018 **Associates**
TEST ITEM: Task Force Tips
SERIAL NUMBER: Baord Y5745 s/n proto **Sequence Number: 923**
COMMENTS: EUT on Wood Table, 80 cm height,Canbus active,pump idling
TEST PERFORMED BY: George Bowman

Peak Frequency (MHz)	Peak Interference (dBuV/m)	Quasi-peak Freq. (MHz)	Quasi-peak Interfer (dBuV/m)	Spec. Level (dBuV/m)		Antenna Polar (H/V)
645.8252	46.710	645.9796	36.232	47.500		Horizontal
652.3049	56.347	652.4442	48.355	47.500	*	Horizontal
658	54.660	657.872	44.456	47.500		Horizontal
660.693	53.151	660.8946	46.638	47.500		Horizontal
693.0752	57.886	693.2071	49.606	47.500	*	Horizontal
695.6	58.194	695.6528	48.591	47.500	*	Horizontal
735.9942	69.290	736.063	65.005	47.500	*	Horizontal
736.5845	70.498	736.3981	63.810	47.500	*	Horizontal
739.3647	72.638	739.4327	66.252	47.500	*	Horizontal
748.1002	70.918	747.9657	63.211	47.500	*	Horizontal
754.294	64.834	754.1396	56.829	47.500	*	Horizontal
851.6	48.920	851.48	42.520	47.500		Horizontal
862	72.330	862.1992	32.834	47.500		Horizontal
876.9073	61.156	877.1088	54.785	47.500	*	Horizontal
886.8	68.188	886.76	59.886	47.500	*	Horizontal
930.4	54.038	930.224	22.439	47.500		Horizontal
938.7978	50.106	938.9962	44.902	47.500		Horizontal
940	52.100	939.8264	30.700	47.500		Horizontal
651.5898	48.482	651.4602	42.405	47.500		Vertical
660.9134	50.050	660.9974	41.796	47.500		Vertical
694.0684	51.777	694.174	45.372	47.500		Vertical
695.7229	55.078	695.5709	48.694	47.500	*	Vertical
731.2332	46.130	731.3772	35.627	47.500		Vertical
736.4	68.628	736.2096	61.927	47.500	*	Vertical
738.8604	70.745	738.7003	62.742	47.500	*	Vertical
748.277	69.758	748.3321	63.377	47.500	*	Vertical
753.4173	71.673	753.3293	63.960	47.500	*	Vertical
852.1846	50.400	852.1702	38.557	47.500		Vertical
852.3866	48.942	852.193	27.857	47.500		Vertical
858.8	47.929	858.756	28.028	47.500		Vertical
863.2325	74.574	863.1821	68.798	47.500	*	Vertical
867.0269	70.546	867.1245	64.146	47.500	*	Vertical
877.6	64.630	877.6752	55.029	47.500	*	Vertical
885.6457	64.058	885.5561	58.866	47.500	*	Vertical
888.7787	66.898	888.7563	59.898	47.500	*	Vertical
929.7098	55.104	929.6443	52.997	47.500	*	Vertical
929.6698	51.820	929.6306	52.797	47.500	*	Vertical
935.7926	51.561	935.9918	36.756	47.500		Vertical

APPENDIX C

ELECTRICAL FAST TRANSIENT/BURST TEST

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

1.0 PURPOSE:

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

2.0 DESCRIPTION OF TEST APPARATUS:

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

3.0 TEST PROCEDURES:

3.1 POWER LEADS:

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

3.2 POLARITY and TEST LEVELS:

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

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

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

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

- 4 KV is available on the instrument but not presently required by standards.

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 CANBUS adapter Y5745 was tested at 1 KV using the Haefely Clamp on the battery and RS485 lines feeding the main control box. There were no adverse results detected. The enclosure port DC lines were tested directly at .5 and 1 KV and again no adverse effects were noted. The EUT passed the test with an "A" acceptance level.


HAEFELY TRENCH
PSURGE 4010
HAEFELY TRENCH

Midwest EMI Associates
21234 West Commercial Drive
Mundelein, Illinois 60060

IEC PUBLICATION NUMBER 1000-4-4, PART 4, FIRST EDITION, 1995
BRITISH STANDARD 61000-4-4, PART 4, FIRST EDITION, 2000
SECTION 4. ELECTRICAL FAST TRANSIENT/BURST IMMUNITY TEST

MANUFACTURER: TASK FORCE TIPS TEST ENGINEER INITIALS: SB

EQUIPMENT UNDER TEST: P5745 CAMERAS DATE OF TEST: 2-23-18

MODEL #: P5745 SERIAL #: PROTO

TEMPERATURE: 65.1 HUMIDITY LEVEL: 45.9%

HAEFELY CLAMP TEST

THIS TEST UITILIZES AN APPLICATION CLAMP THAT IS NOT PHYSICALLY TIED TO THE POWER LINE. IN THIS TEST THE CABLE BUNDLE IS PLACED INSIDE THE HAEFELY CLAMP AND EFT IMPULSES ARE APPLIED TO THE CABLE VIA THE ACTION OF THE CAPACITIVE CLAMP. THIS TEST IS USED ON CABLE BUNDLES LONGER THAN 3 METERS OR IN SITUATIONS WHERE USE OF THE TRADITIONAL APPARATUS IS NOT FEASIBLE.

APPLIED BURST LEVEL: AS LISTED BELOW
REPETITION FREQUENCY: 5 KILOHERTZ AC ADAPTER TYPE: (TWO) (THREE) TERMINAL
BURST DURATION: 15 MSEC BURST PERIOD: 300 MSEC
TEST DURATION: (120 SECONDS) OR : _____ MINUTES
POWER INPUT: (120 VAC / 60 Hz) (230VAC / 50 Hz) (480VAC/50Hz/3 PHASE) OR : 12 V

INSTRUMENT SETUP/NOMINAL CONDITIONS: _____

VOLTAGE OF APPLICATION	OBSERVATIONS MINUS	OBSERVATIONS PLUS
.5 KILOVOLT		
1 KILOVOLT	✓	✓
2 KILOVOLT		
4 KILOVOLT		
_____ KILOVOLT		
_____ KILOVOLT		
_____ KILOVOLT		

- FAILURE MODE WAS: NONE

RESULTS OF .5 kV TEST: _____
RESULTS OF 1 kV TEST: NONE
RESULTS OF 2 kV TEST: _____
RESULTS OF 4 kV TEST: _____

COMMENTS: NO EFFECTS

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 :2012

Electromagnetic compatibility (EMC) – Part 4-4: Testing and measurement techniques – Electrical Fast Transient/Burst Immunity Test

Manufacturer: TASK FORCE TIPS Test Engineer Initials: JB

Equipment Under Test: CAN BUS ADAPTER Date of Test: 2-28-18

Model #: Y5795 Serial #: PROTO

Temperature: 65.1 F Humidity Level: 44.3%

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

INSTRUMENT SETUP/NOMINAL CONDITIONS: RUNNING PROGRAM

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

* Failure Mode was: NONE
Checkmark Indicates no failure was observed, * Indicates Device Malfunctioned

APPLIED BURST LEVEL: **1 Kilovolt (Test Severity Level 2)**
REPETITION FREQUENCY: ~~5~~ 25 Kilohertz **AC ADAPTER TYPE: (TWO) (THREE) TERMINAL**
BURST DURATION: 15 Msec BURST PERIOD: 300 Msec
TEST DURATION: 120 Seconds
POWER INPUT: (120 VAC / 60 Hz) (230VAC / 50 Hz) (208VAC/3PH, 50 Hz) OR BAT VOLT: 12 V

INSTRUMENT SETUP/NOMINAL CONDITIONS: RUNNING PROGRAM

mode of appearance PLUS	PLUS OBSERVATIONS	MINUS
Neutral with respect to the GRP	✓	✓
Line with respect to the GRP	✓	✓
Neutral and Line with respect to the GRP	✓	✓
PE with respect to the GRP	✓	✓
Line and PE with respect to the GRP	✓	✓
Neutral and PE with respect to the GRP	✓	✓
Neutral, Line and PE with respect to the GRP	✓	✓

* Failure Mode was: NONE
Checkmark 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 2.7 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 three bands covers 27 MHz to 6000 MHz however the actual test range covered was 25 MHz to 6 GHz.

3.0 TEST PROCEDURES:

3.1 POWER LEADS & CABLE PLACEMENT:

The TFT RCMONITOR CANBUS INTERFACE (EP0839) 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/amplifier possibly used during the test were:
a) The EMCO Model 3107B Power E field antenna from 10 KHz to 25 MHz, horizontal polarization only,
b) The Antenna Research LPB 2520 Biconilog antenna from 25-2700 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 - 2700 MHz a 100 watt Ophir linear amplifier module was used. Above this range a TWT amplifier may be used up to 6 GHz.
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 1% per step every 8 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:

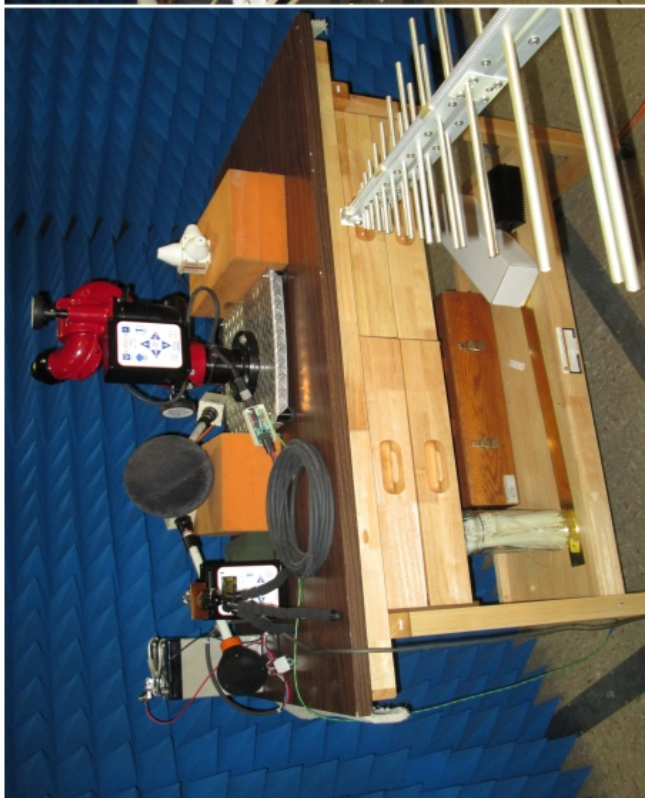
4.1 RADIATED LIMITS:

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 6000 MHz. A graph is shown of the actual averaged field strength presented to the prototype during the test.

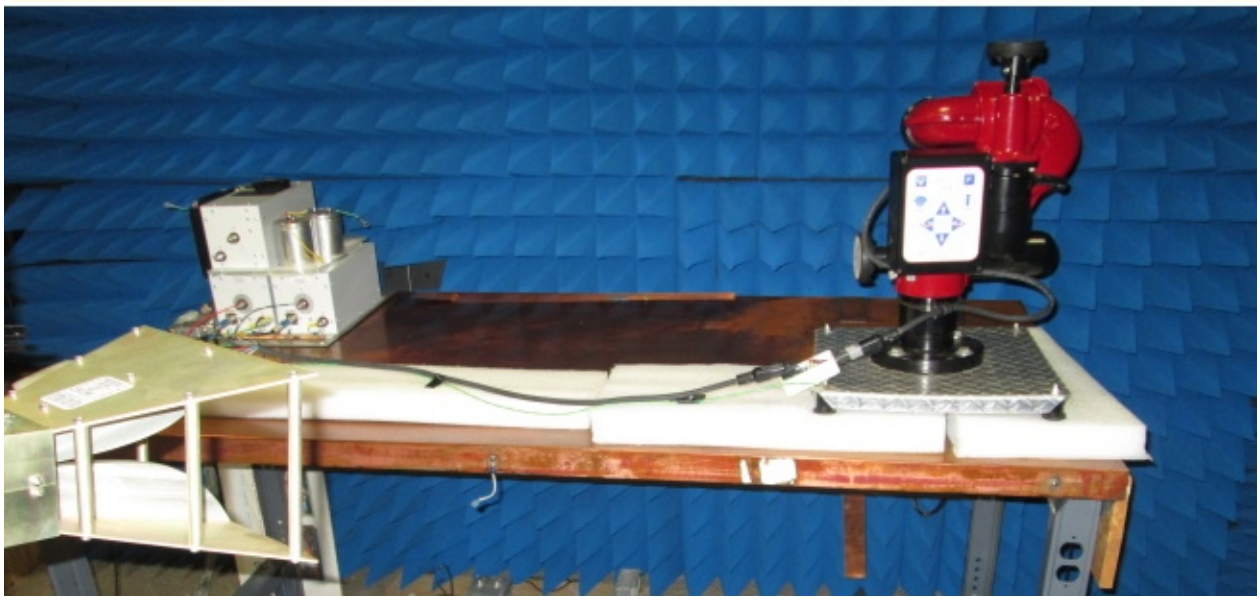
4.2 RESULTS OF TEST:

The TFT RC MONITOR CANBUS INTERFACE (EP0839) was exposed to a 13 V/M immunity wave from 25 to 3300 MHz with 1000 Hz, 80% modulation and also with GSM pulse modulation, 217 Hz rate. There was no interruption to communications noticed and as a system perform normally throughout the test.

The system was also tested manually from 3.3 GHz to 6 GHz with pulse modulation at a level exceeding 7 V/M with no change to operation noted.




varian
CAUTION
VZC6961 4 to 8GHz 20 Watts SN-6562



Date: 02-27-18 Page 1 of 2	IMMUNITY Worksheet	Midwest EMI Associates Mundelein, Illinois	Form: EN 61000-4-3

Device: TFT CANBUS Sponsor: TM Date: 2/27/18 S/W Ver: 1.00 S/N: PROTO

Tests Performed: (Radiated) (Conducted) (Magnetic) (CS114) (SAEJ1113-21) (BCI)

Probes: (CS114) (Fischer CDN) (A/R ~~FP2031~~ ~~(A/R FP2035)~~ ~~(A/R FP1000)~~) (Solar Injection Clamps)

Technician: JB
Project No: EP0889

Mod Freq: 2 10 100 (1000) Hz
Modulation Depth: 50% (80%) 100% Other:
POWER: 230 208 120 VAC or L2 VDC
Power Frequency: (50) (60) (400) Hz

Room of Test (Screen) (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) (mA)	Dwell Time: (Sec)	Antenna Type	Results: Include any Failure Modes Observed in the EUT during the test. Video Camera System Used? (Yes) No
80M	10%	13	8	BL H	Spring up, Can Bus Normal
864M	"	"	"	"	" " "
1123	"	"	"	"	" " "
1539	"	"	"	"	" " "
2200	"	"	"	"	" " "
2200	"	"	"	"	ADD BRAKE, NORMAL
2700	"	13→4.5	8	BL H	Spring up, OK
3300	"	4.5	"	"	" "
80M	1%	13	8	BL V	Spring up, Can Bus OK
872M	"	"	"	"	" " "
1145M	"	"	"	"	" " "
1500	"	"	"	"	" " "
1923	"	"	"	"	" " "
2200	"	"	"	"	" " "
2700	"	13→4.5	"	"	" " "
3300	"	4.5	"	"	" " "
80M	1%	13	8	BL V	Spring up, OK, Normal
151	"	"	"	"	" " "
215M	"	"	"	"	" " "
266M	"	"	"	"	" " "
335	"	"	"	"	" " "
470	"	"	"	"	" " "
500	"	"	"	"	" " "

Notes: MONITOR, CANBUS + READOUT

Date: 02-28-17 Page 2 of 2	IMMUNITY Worksheet	Midwest EMI Associates Mundelein, Illinois	Form: EN 61000-4-3

Device: JET CAMERAS Sponsor: TTM Date: 2-28-17 S/W Ver: 1.00 S/N: PROTO

Tests Performed: (Radiated) (Conducted) (Magnetic) (CS114) (SAEJ1113-21) (BCI)

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

Technician: BB

Project No: EP0887

Mod Freq: 2 10 100 (1000) Hz

Modulation Depth: 50% 80% 100% Other:

POWER: 230 208 120 VAC or 12 VDC
Power Frequency: (50) (60) (400) 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) (mA)	Dwell Time: (Sec)	Antenna Type	Results: Include any Failure Modes Observed in the EUT during the test Video Camera System Used? (Yes) (No)
25M	1%	3	8	BL H	Facing up, Sensor, Thermal
57M	"	"	"	"	" " "
85M	"	"	"	"	" " "
105M	"	"	"	"	" " "
157M	"	"	"	"	" " "
2HM	"	"	"	"	" " "
326M	"	"	"	"	" " "
389M	"	"	"	"	" " "
426M	"	"	"	"	" " "
500M	"	"	"	"	" " "
			NO FAULTS		

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	10 Sec	0,90,180,270	1,2,3
2	1 KV	10 Sec	0,90,180,270	1,2,3
3	2 KV	20 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 RC MONITOR CANBUS INTERFACE (EP0839) was tested on its DC leads in line to line mode at a 500 volt application in positive and negative polarities. The EUT experienced no anomalies with this application and passed the test. The EUT was also tested at a 1000 volt application in both polarities from line and neutral to earth potential with no malfunctions or change to operation noted.

Haefely Trench AG EMC Test Systems Basel/Switzerland

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

System: PSURGE 4010
Test: 2KVN1PNE
Start-Date: 28.02.2018 Start-Time: 10:11

******* 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	-----	+0.49kV	+3A	
L1-PE	2	+0.50kV	-----	+0.49kV	+3A	
L1-PE	3	+0.50kV	-----	+0.49kV	+3A	
L1-PE	4	+0.50kV	-----	+0.49kV	+3A	
L1-PE	5	+0.50kV	-----	+0.49kV	+3A	
L1-PE	6	+0.50kV	-----	+0.49kV	+3A	
L1-PE	7	+0.50kV	-----	+0.49kV	+3A	
L1-PE	8	+0.50kV	-----	+0.49kV	+3A	
L1-PE	9	+0.50kV	-----	+0.49kV	+3A	
L1-PE	10	+0.50kV	-----	+0.49kV	+3A	
L1-PE	11	+0.50kV	-----	+0.49kV	+3A	
L1-PE	12	+0.50kV	-----	+0.49kV	+3A	
L1-PE	13	+0.50kV	-----	+0.49kV	+3A	
L1-PE	14	+0.50kV	-----	+0.49kV	+3A	
L1-PE	15	+0.50kV	-----	+0.49kV	+3A	
L1-PE	16	+0.50kV	-----	+0.49kV	+3A	
L1-PE	17	+0.50kV	-----	+0.49kV	+3A	
L1-PE	18	+0.50kV	-----	+0.49kV	+3A	
L1-PE	19	+0.50kV	-----	+0.49kV	+3A	
L1-PE	20	+0.50kV	-----	+0.49kV	+3A	
L1-PE	21	+0.50kV	-----	+0.49kV	+3A	
L1-PE	22	+0.50kV	-----	+0.49kV	+3A	
L1-PE	23	+0.50kV	-----	+0.49kV	+3A	
L1-PE	24	+0.50kV	-----	+0.49kV	+3A	
L1-PE	25	+0.50kV	-----	+0.49kV	+3A	
L1-PE	26	+0.50kV	-----	+0.49kV	+3A	
L1-PE	27	+0.50kV	-----	+0.49kV	+3A	
L1-PE	28	+0.50kV	-----	+0.49kV	+3A	
L1-PE	29	+0.50kV	-----	+0.49kV	+3A	
L1-PE	30	+0.50kV	-----	+0.49kV	+3A	
L1-PE	31	+0.50kV	-----	+0.49kV	+3A	
L1-PE	32	+0.50kV	-----	+0.49kV	+3A	
L1-PE	33	+0.50kV	-----	+0.49kV	+2A	
L1-PE	34	+0.50kV	-----	+0.49kV	+3A	
L1-PE	35	+0.50kV	-----	+0.49kV	+3A	
L1-PE	36	+0.50kV	-----	+0.49kV	+3A	
L1-PE	37	+0.50kV	-----	+0.49kV	+3A	
L1-PE	38	+0.50kV	-----	+0.49kV	+3A	
L1-PE	39	+0.50kV	-----	+0.49kV	+3A	
L1-PE	40	+0.50kV	-----	+0.49kV	+3A	

>>> Test passed. <<<

Test: 2KVN1PNE
Stop-Date: 28.02.2018 Stop-Time: 10:24

Haefely Trench AG EMC Test Systems Basel/Switzerland

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

System: PSURGE 4010
Test: 2KVN1PNE
Start-Date: 28.02.2018 Start-Time: 10:25

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

Coup. Path	Imp. No.	U nominal	Syncro Angle	U-peak	I-peak	Info.
L1-PE	1	+1.00kV	-----	+0.92kV	+0.01kA	
L1-PE	2	+1.00kV	-----	+0.93kV	+0.01kA	
L1-PE	3	+1.00kV	-----	+0.93kV	+0.01kA	
L1-PE	4	+1.00kV	-----	+0.93kV	+0.01kA	
L1-PE	5	+1.00kV	-----	+0.93kV	+0.01kA	
L1-PE	6	+1.00kV	-----	+0.93kV	+0.01kA	
L1-PE	7	+1.00kV	-----	+0.93kV	+0.01kA	
L1-PE	8	+1.00kV	-----	+0.93kV	+0.01kA	
L1-PE	9	+1.00kV	-----	+0.93kV	+0.01kA	
L1-PE	10	+1.00kV	-----	+0.93kV	+0.01kA	
L1-PE	11	+1.00kV	-----	+0.93kV	+0.01kA	
L1-PE	12	+1.00kV	-----	+0.93kV	+0.01kA	
L1-PE	13	+1.00kV	-----	+0.93kV	+0.01kA	
L1-PE	14	+1.00kV	-----	+0.93kV	+0.01kA	
L1-PE	15	+1.00kV	-----	+0.93kV	+0.01kA	
L1-PE	16	+1.00kV	-----	+0.93kV	+0.01kA	
L1-PE	17	+1.00kV	-----	+0.93kV	+0.01kA	
L1-PE	18	+1.00kV	-----	+0.93kV	+0.01kA	
L1-PE	19	+1.00kV	-----	+0.93kV	+0.01kA	
L1-PE	20	+1.00kV	-----	+0.93kV	+0.01kA	
L1-PE	21	+1.00kV	-----	+0.93kV	+0.01kA	
L1-PE	22	+1.00kV	-----	+0.93kV	+0.01kA	
L1-PE	23	+1.00kV	-----	+0.93kV	+0.01kA	
L1-PE	24	+1.00kV	-----	+0.93kV	+0.01kA	
L1-PE	25	+1.00kV	-----	+0.93kV	+0.01kA	
L1-PE	26	+1.00kV	-----	+0.93kV	+0.01kA	
L1-PE	27	+1.00kV	-----	+0.93kV	+0.01kA	
L1-PE	28	+1.00kV	-----	+0.93kV	+0.01kA	
L1-PE	29	+1.00kV	-----	+0.93kV	+0.01kA	
L1-PE	30	+1.00kV	-----	+0.93kV	+0.01kA	
L1-PE	31	+1.00kV	-----	+0.93kV	+0.01kA	
L1-PE	32	+1.00kV	-----	+0.93kV	+0.01kA	
L1-PE	33	+1.00kV	-----	+0.93kV	+0.01kA	
L1-PE	34	+1.00kV	-----	+0.93kV	+0.01kA	
L1-PE	35	+1.00kV	-----	+0.93kV	+0.01kA	
L1-PE	36	+1.00kV	-----	+0.93kV	+0.01kA	
L1-PE	37	+1.00kV	-----	+0.93kV	+0.01kA	
L1-PE	38	+1.00kV	-----	+0.93kV	+0.01kA	
L1-PE	39	+1.00kV	-----	+0.93kV	+0.01kA	
L1-PE	40	+1.00kV	-----	+0.94kV	+0.01kA	

>>> Test passed. <<<

Test: 2KVN1PNE
Stop-Date: 28.02.2018 Stop-Time: 10:29

Haefely Trench AG EMC Test Systems Basel/Switzerland

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

System: PSURGE 4010
Test: 2KVN1PNE
Start-Date: 28.02.2018 Start-Time: 10:29

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

Coup. Path	Imp. No.	U nominal	Syncro Angle	U-peak	I-peak	Info.
L1-PE	1	-1.00kV	-----	-0.92kV	-0.01kA	
L1-PE	2	-1.00kV	-----	-0.92kV	-0.01kA	
L1-PE	3	-1.00kV	-----	-0.92kV	-0.01kA	
L1-PE	4	-1.00kV	-----	-0.93kV	-0.01kA	
L1-PE	5	-1.00kV	-----	-0.93kV	-0.01kA	
L1-PE	6	-1.00kV	-----	-0.93kV	-0.01kA	
L1-PE	7	-1.00kV	-----	-0.93kV	-0.01kA	
L1-PE	8	-1.00kV	-----	-0.93kV	-0.01kA	
L1-PE	9	-1.00kV	-----	-0.93kV	-0.01kA	
L1-PE	10	-1.00kV	-----	-0.93kV	-0.01kA	
L1-PE	11	-1.00kV	-----	-0.93kV	-0.01kA	
L1-PE	12	-1.00kV	-----	-0.93kV	-0.01kA	
L1-PE	13	-1.00kV	-----	-0.93kV	-0.01kA	
L1-PE	14	-1.00kV	-----	-0.93kV	-0.01kA	
L1-PE	15	-1.00kV	-----	-0.93kV	-0.01kA	
L1-PE	16	-1.00kV	-----	-0.93kV	-0.01kA	
L1-PE	17	-1.00kV	-----	-0.93kV	-0.01kA	
L1-PE	18	-1.00kV	-----	-0.93kV	-0.01kA	
L1-PE	19	-1.00kV	-----	-0.93kV	-0.01kA	
L1-PE	20	-1.00kV	-----	-0.93kV	-0.01kA	
L1-PE	21	-1.00kV	-----	-0.93kV	-0.01kA	
L1-PE	22	-1.00kV	-----	-0.93kV	-0.01kA	
L1-PE	23	-1.00kV	-----	-0.93kV	-0.01kA	
L1-PE	24	-1.00kV	-----	-0.93kV	-0.01kA	
L1-PE	25	-1.00kV	-----	-0.93kV	-0.01kA	
L1-PE	26	-1.00kV	-----	-0.93kV	-0.01kA	
L1-PE	27	-1.00kV	-----	-0.93kV	-0.01kA	
L1-PE	28	-1.00kV	-----	-0.93kV	-0.01kA	
L1-PE	29	-1.00kV	-----	-0.93kV	-0.01kA	
L1-PE	30	-1.00kV	-----	-0.93kV	-0.01kA	
L1-PE	31	-1.00kV	-----	-0.93kV	-0.01kA	
L1-PE	32	-1.00kV	-----	-0.93kV	-0.01kA	
L1-PE	33	-1.00kV	-----	-0.93kV	-0.01kA	
L1-PE	34	-1.00kV	-----	-0.93kV	-0.01kA	
L1-PE	35	-1.00kV	-----	-0.93kV	-0.01kA	
L1-PE	36	-1.00kV	-----	-0.93kV	-0.01kA	
L1-PE	37	-1.00kV	-----	-0.93kV	-0.01kA	
L1-PE	38	-1.00kV	-----	-0.93kV	-0.01kA	
L1-PE	39	-1.00kV	-----	-0.93kV	-0.01kA	
L1-PE	40	-1.00kV	-----	-0.93kV	-0.01kA	

>>> Test passed. <<<

Test: 2KVN1PNE
Stop-Date: 28.02.2018 Stop-Time: 10:32

Haefely Trench AG EMC Test Systems Basel/Switzerland

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

System: PSURGE 4010
Test: 2KVN1PNE
Start-Date: 28.02.2018 Start-Time: 10:32

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

Coup. Path	Imp. No.	U nominal	Syncro Angle	U-peak	I-peak	Info.
N-PE	1	-1.00kV	-----	-0.93kV	-0.01kA	
N-PE	2	-1.00kV	-----	-0.94kV	-0.01kA	
N-PE	3	-1.00kV	-----	-0.94kV	-0.01kA	
N-PE	4	-1.00kV	-----	-0.94kV	-0.01kA	
N-PE	5	-1.00kV	-----	-0.94kV	-0.01kA	
N-PE	6	-1.00kV	-----	-0.94kV	-0.01kA	
N-PE	7	-1.00kV	-----	-0.94kV	-0.01kA	
N-PE	8	-1.00kV	-----	-0.94kV	-0.01kA	
N-PE	9	-1.00kV	-----	-0.94kV	-0.01kA	
N-PE	10	-1.00kV	-----	-0.94kV	-0.01kA	
N-PE	11	-1.00kV	-----	-0.94kV	-0.01kA	
N-PE	12	-1.00kV	-----	-0.94kV	-0.01kA	
N-PE	13	-1.00kV	-----	-0.94kV	-0.01kA	
N-PE	14	-1.00kV	-----	-0.94kV	-0.01kA	
N-PE	15	-1.00kV	-----	-0.94kV	-0.01kA	
N-PE	16	-1.00kV	-----	-0.94kV	-0.01kA	
N-PE	17	-1.00kV	-----	-0.94kV	-0.01kA	
N-PE	18	-1.00kV	-----	-0.94kV	-0.01kA	
N-PE	19	-1.00kV	-----	-0.94kV	-0.01kA	
N-PE	20	-1.00kV	-----	-0.94kV	-0.01kA	
N-PE	21	-1.00kV	-----	-0.94kV	-0.01kA	
N-PE	22	-1.00kV	-----	-0.94kV	-0.01kA	
N-PE	23	-1.00kV	-----	-0.94kV	-0.01kA	
N-PE	24	-1.00kV	-----	-0.94kV	-0.01kA	
N-PE	25	-1.00kV	-----	-0.94kV	-0.01kA	
N-PE	26	-1.00kV	-----	-0.94kV	-0.01kA	
N-PE	27	-1.00kV	-----	-0.94kV	-0.01kA	
N-PE	28	-1.00kV	-----	-0.94kV	-0.01kA	
N-PE	29	-1.00kV	-----	-0.94kV	-0.01kA	
N-PE	30	-1.00kV	-----	-0.94kV	-0.01kA	
N-PE	31	-1.00kV	-----	-0.94kV	-0.01kA	
N-PE	32	-1.00kV	-----	-0.94kV	-0.01kA	
N-PE	33	-1.00kV	-----	-0.94kV	-0.01kA	
N-PE	34	-1.00kV	-----	-0.94kV	-0.01kA	
N-PE	35	-1.00kV	-----	-0.94kV	-0.01kA	
N-PE	36	-1.00kV	-----	-0.94kV	-0.01kA	
N-PE	37	-1.00kV	-----	-0.94kV	-0.01kA	
N-PE	38	-1.00kV	-----	-0.94kV	-0.01kA	
N-PE	39	-1.00kV	-----	-0.94kV	-0.01kA	
N-PE	40	-1.00kV	-----	-0.94kV	-0.01kA	

>>> Test passed. <<<

Test: 2KVN1PNE
Stop-Date: 28.02.2018 Stop-Time: 10:36

Haefely Trench AG EMC Test Systems Basel/Switzerland

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

System: PSURGE 4010
Test: 2KVN1PNE
Start-Date: 28.02.2018 Start-Time: 10:36

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

Coup. Path	Imp. No.	U nominal	Syncro Angle	U-peak	I-peak	Info.
N-PE	1	+1.00kV	-----	+0.92kV	+0.01kA	
N-PE	2	+1.00kV	-----	+0.92kV	+0.01kA	
N-PE	3	+1.00kV	-----	+0.93kV	+0.01kA	
N-PE	4	+1.00kV	-----	+0.93kV	+0.01kA	
N-PE	5	+1.00kV	-----	+0.93kV	+0.01kA	
N-PE	6	+1.00kV	-----	+0.93kV	+0.01kA	
N-PE	7	+1.00kV	-----	+0.93kV	+0.01kA	
N-PE	8	+1.00kV	-----	+0.93kV	+0.01kA	
N-PE	9	+1.00kV	-----	+0.93kV	+0.01kA	
N-PE	10	+1.00kV	-----	+0.93kV	+0.01kA	
N-PE	11	+1.00kV	-----	+0.93kV	+0.01kA	
N-PE	12	+1.00kV	-----	+0.93kV	+0.01kA	
N-PE	13	+1.00kV	-----	+0.93kV	+0.01kA	
N-PE	14	+1.00kV	-----	+0.93kV	+0.01kA	
N-PE	15	+1.00kV	-----	+0.93kV	+0.01kA	
N-PE	16	+1.00kV	-----	+0.93kV	+0.01kA	
N-PE	17	+1.00kV	-----	+0.93kV	+0.01kA	
N-PE	18	+1.00kV	-----	+0.93kV	+0.01kA	
N-PE	19	+1.00kV	-----	+0.93kV	+0.01kA	
N-PE	20	+1.00kV	-----	+0.93kV	+0.01kA	
N-PE	21	+1.00kV	-----	+0.93kV	+0.01kA	
N-PE	22	+1.00kV	-----	+0.93kV	+0.01kA	
N-PE	23	+1.00kV	-----	+0.93kV	+0.01kA	
N-PE	24	+1.00kV	-----	+0.93kV	+0.01kA	
N-PE	25	+1.00kV	-----	+0.93kV	+0.01kA	
N-PE	26	+1.00kV	-----	+0.93kV	+0.01kA	
N-PE	27	+1.00kV	-----	+0.93kV	+0.01kA	
N-PE	28	+1.00kV	-----	+0.93kV	+0.01kA	
N-PE	29	+1.00kV	-----	+0.93kV	+0.01kA	
N-PE	30	+1.00kV	-----	+0.93kV	+0.01kA	
N-PE	31	+1.00kV	-----	+0.93kV	+0.01kA	
N-PE	32	+1.00kV	-----	+0.93kV	+0.01kA	
N-PE	33	+1.00kV	-----	+0.93kV	+0.01kA	
N-PE	34	+1.00kV	-----	+0.93kV	+0.01kA	
N-PE	35	+1.00kV	-----	+0.93kV	+0.01kA	
N-PE	36	+1.00kV	-----	+0.93kV	+0.01kA	
N-PE	37	+1.00kV	-----	+0.93kV	+0.01kA	
N-PE	38	+1.00kV	-----	+0.93kV	+0.01kA	
N-PE	39	+1.00kV	-----	+0.93kV	+0.01kA	
N-PE	40	+1.00kV	-----	+0.93kV	+0.01kA	

>>> Test passed. <<<

Test: 2KVN1PNE
Stop-Date: 28.02.2018 Stop-Time: 10:40

Haefely Trench AG EMC Test Systems Basel/Switzerland

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

System: PSURGE 4010
Test: 2KVN1PNE
Start-Date: 28.02.2018 Start-Time: 10:41

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

Coup. Path	Imp. No.	U nominal	Syncro Angle	U-peak	I-peak	Info.
L1-N	1	-0.50kV	-----	-0.09kV	-217A	
L1-N	2	-0.50kV	-----	-0.09kV	-218A	
L1-N	3	-0.50kV	-----	-0.09kV	-218A	
L1-N	4	-0.50kV	-----	-0.09kV	-218A	
L1-N	5	-0.50kV	-----	-0.09kV	-218A	
L1-N	6	-0.50kV	-----	-0.09kV	-218A	
L1-N	7	-0.50kV	-----	-0.09kV	-218A	
L1-N	8	-0.50kV	-----	-0.09kV	-218A	
L1-N	9	-0.50kV	-----	-0.09kV	-218A	
L1-N	10	-0.50kV	-----	-0.09kV	-218A	
L1-N	11	-0.50kV	-----	-0.09kV	-218A	
L1-N	12	-0.50kV	-----	-0.09kV	-218A	
L1-N	13	-0.50kV	-----	-0.09kV	-218A	
L1-N	14	-0.50kV	-----	-0.09kV	-218A	
L1-N	15	-0.50kV	-----	-0.09kV	-218A	
L1-N	16	-0.50kV	-----	-0.09kV	-218A	
L1-N	17	-0.50kV	-----	-0.09kV	-218A	
L1-N	18	-0.50kV	-----	-0.09kV	-218A	
L1-N	19	-0.50kV	-----	-0.09kV	-218A	
L1-N	20	-0.50kV	-----	-0.09kV	-218A	
L1-N	21	-0.50kV	-----	-0.09kV	-218A	
L1-N	22	-0.50kV	-----	-0.09kV	-218A	
L1-N	23	-0.50kV	-----	-0.09kV	-218A	
L1-N	24	-0.50kV	-----	-0.09kV	-218A	
L1-N	25	-0.50kV	-----	-0.09kV	-218A	
L1-N	26	-0.50kV	-----	-0.09kV	-218A	
L1-N	27	-0.50kV	-----	-0.09kV	-218A	
L1-N	28	-0.50kV	-----	-0.09kV	-218A	
L1-N	29	-0.50kV	-----	-0.09kV	-218A	
L1-N	30	-0.50kV	-----	-0.09kV	-218A	
L1-N	31	-0.50kV	-----	-0.09kV	-218A	
L1-N	32	-0.50kV	-----	-0.09kV	-218A	
L1-N	33	-0.50kV	-----	-0.09kV	-218A	
L1-N	34	-0.50kV	-----	-0.09kV	-218A	
L1-N	35	-0.50kV	-----	-0.09kV	-218A	
L1-N	36	-0.50kV	-----	-0.09kV	-218A	
L1-N	37	-0.50kV	-----	-0.09kV	-218A	
L1-N	38	-0.50kV	-----	-0.09kV	-218A	
L1-N	39	-0.50kV	-----	-0.09kV	-218A	
L1-N	40	-0.50kV	-----	-0.09kV	-218A	

>>> Test passed. <<<

Test: 2KVN1PNE
Stop-Date: 28.02.2018 Stop-Time: 10:45

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-400 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 50 uH 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 400 MHz. Since this is the required level and just the .15-80 Mhz range needs to be passed the device passed the test. The wire bundle included the communications wires so no additional cable wires needed testing.

In a second test the level was increased to 10 Vrms and the test was rerun over the entire range of frequencies. No communications disruptions occurred during this test.

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


MONITOR OPERATOR STATION
TFT

Date: 2-28-18 Page 1 of 1	IMMUNITY Worksheet	Midwest EMI Associates Mundelein, Illinois	Form: EN 61000-4-3

Device: TFT CANBUS Sponsor: Tim Date: 2-28-18 S/W Ver: 1.00 S/N: PROTO

Tests Performed: (Radiated) (Conducted) (Magnetic) (CS114) (SAEJ1113-21) (BCI)

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

Technician: ZB

Project No: EP0889

Mod Freq: 2 10 100 (1000) Hz

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

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

Room of Test (Scarfm) (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) (mA)	Dwell Time: (Sec)	Antenna Type	Results: Include any Failure Modes Observed in the EUT during the test Video Camera System Used? (Yes) (No)		
100K	PER PGM	3	PER PGM	OPWR CLAMP	Timing up, Communication		
990K	"	"	"	"	"	"	"
2.1M	"	"	"	"	"	"	"
33M	"	"	"	"	"	"	"
47M	"	"	"	"	"	"	"
59M	"	"	"	"	"	"	"
73M	"	"	"	"	"	"	"
80M	"	"	"	"	"	"	"
125M	"	"	"	"	"	"	"
251M	"	"	"	"	"	"	"
309M	"	"	"	"	"	"	"
400M	"	"	"	"	"	"	"
100K	PER PGM	10	PER PGM	OPWR CLAMP	Timing up, Normal		
1.7M	"	"	"	"	"	"	
25M	"	"	"	"	"	"	
53M	"	"	"	"	"	"	
74M	"	"	"	"	"	"	
121M	"	"	"	"	"	"	
152M	"	"	"	"	"	"	
191M	"	"	"	"	"	"	
246M	"	"	"	"	"	"	
320M	"	"	"	"	"	"	
400M	"	"	"	"	"	"	

Notes: No Failures

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 RCMONITOR CANBUS INTERFACE (EP0839)** 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 (02-09-18)

The ESD test was conducted on 8 surfaces in areas showing cracks in the package, switches, connectors or screws. All referenced portions of the case received ESD pulses of 2, 4, 6 and 8 KV air discharge as well as contact discharge of 2, 4 and 6 KV. In addition a programming wire was directly struck with the same levels.

All plastic portions of the case when tested resulted in no discharges. The programming wire, HCP and VCP planes all readily accepted charge. The following symptoms were noted during the test:

None

The device was given an "A" acceptance rating.

ESD TEST LOCATIONS

TFT RC MONITOR CANBUS INTERFACE (EP0839)

TEST POINT	Description
1	HCP
2	VCP
3	CanBus Bottom
4	CanBus Left Side
5	CanBus Right Side
6	Programming wire
7	Input Connector
8	Output Connector
9	
10	
11	
12	

Note: Photograph of locations are attached

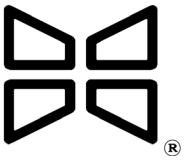
Data Sheet 1 of 1	**ESD DATA SHEET** Schaffner NSG 435 Gun	**Midwest EMI Associates Mundelein, Illinois**	Form: Issued 11/22/09 **MEMI-1A**

Sponsor Group: Task Force Tips Model: Y5745_CANBUS ADAPTER S/N: Proto
Manager: Tim Miller Temp: 66.2 Hum: 44.1% Technician: GB S/W ver.:
Date of Test 3/01/18 Time: 01:30 pm EUT: Prototype Unit
Placement of EUT: ESD Table, Front Room Wood Table ✓ FLOOR
Grounding: Pole Terminal Outlet ✓ FLOOR 1 Meg from HCP to Ground Plane
Configuration of EUT: Running , watching front panel display for change in state, or adapter change
Note: All Points are Tested with 10 Shots in Single Shot Mode Unless Otherwise Stated

Reference:	**TEST POINT**: HCP				**TEST POINT**: VCP			
EN 61000-4-2	**PLUS POLARITY**		**MINUS POLARITY**		**PLUS POLARITY**		**MINUS POLARITY**	
Voltage (KV)	Air D/charge	CONTACT Mode	Air D/charge	CONTACT Mode	Air D/charge	CONTACT Mode	Air D/charge	CONTACT Mode
2	✓	✓	✓	✓	✓	✓	✓	✓
4	✓	✓	✓	✓	✓	✓	✓	✓
6		✓		✓		✓		✓
8	✓	MIT	✓	MIT	✓	MIT	✓	MIT
15	MIT		MIT		MIT		MIT	
Reference:	**TEST POINT**: CONFIG ENDED JUMPER 2				**TEST POINT**: CONFIG OPENED JUMPER 2			
EN 61000-4-2	**PLUS POLARITY**		**MINUS POLARITY**		**PLUS POLARITY**		**MINUS POLARITY**	
Voltage (KV)	Air D/charge	CONTACT Mode	Air D/charge	CONTACT Mode	Air D/charge	CONTACT Mode	Air D/charge	CONTACT Mode
2	✓	✓	✓	✓	✓	✓	✓	✓
4	✓	✓	✓	✓	✓	✓	✓	✓
6		✓		✓		✓		✓
8	✓		✓		✓		✓	
15								
Reference:	**TEST POINT**: RIGHT SIDE BOX				**TEST POINT**: LEFT SIDE BOX			
EN 61000-4-2	**PLUS POLARITY**		**MINUS POLARITY**		**PLUS POLARITY**		**MINUS POLARITY**	
Voltage (KV)	Air D/charge	CONTACT Mode	Air D/charge	CONTACT Mode	Air D/charge	CONTACT Mode	Air D/charge	CONTACT Mode
2	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**
4	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**
6		**N/A**		**N/A**		**N/A**		**N/A**
8	**N/A**		**N/A**		**N/A**		**N/A**	
15								
Reference:	**TEST POINT**: INPUT POWER CONN.				**TEST POINT**: OUTPUT POWER CONNECTOR			
EN 61000-4-2	**PLUS POLARITY**		**MINUS POLARITY**		**PLUS POLARITY**		**MINUS POLARITY**	
Voltage (KV)	Air D/charge	CONTACT Mode	Air D/charge	CONTACT Mode	Air D/charge	CONTACT Mode	Air D/charge	CONTACT Mode
2	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**
4	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**
6		**N/A**		**N/A**		**N/A**		**N/A**
8	**N/A**		**N/A**		**N/A**		**N/A**	
15								

Notes: Checkmark " ✓ "device passed with visible discharge. " N/A "device passed with no visible discharge.
A strike out " / " means the point was not tested. An "F" means a failure occurred.
Notes:_____

APPENDIX H



FDA/EC MAGNETIC SUSCEPTIBILITY TEST

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

1.0 PURPOSE:

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

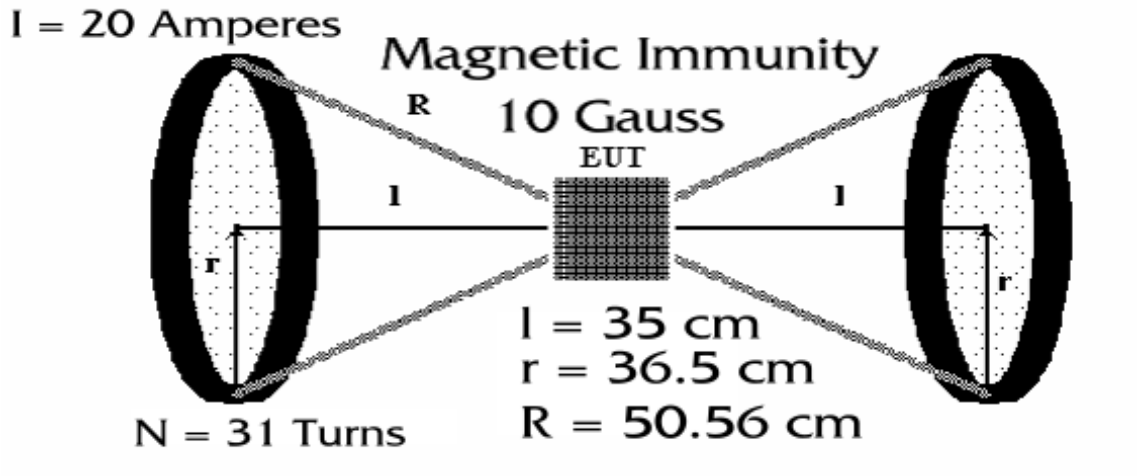
2.3 Calculations

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

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

$$B \text{ (Tesla)} = .5\,\mu_o * I * \frac{r^2}{R^3} * N, \qquad \mu_o = 4\,\pi \text{ x } 10^{-7} \text{ T x m/A}$$

I = 20 Amps RMS, 60 Hz

$$B \text{ (V/m)} = 188.5 * I * \frac{r^2}{R^3} * N$$

N = 25 Turns
r = .5 m, R = .6403m

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

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

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 RC MONITOR CANBUS INTERFACE (EP0839) 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 to 6 gauss field being applied in this range. There was no apparent effect on the device due to the 40 Hz to 500 Hz magnetic field. The EUT passed the IEC 61000-4-8 recommendation.


LOW BATTERY
200 μT
20 μT
2 mT
2 μT
OFF
200 nT
HOLADAY
HI-3624
ELF MAGNETIC
FIELD METER
SERIAL NO.