Performance Certification to EMC Directive

Normative Standard: **EN61000-6-2, EN 61000-6-3: 2006**

Test Unit Description and Serial Number:

TFT RC MONITOR FAMILY

S/N: TFT-Y46660

Test Report # 2732, 2771, 9/15/10 Addendum
Dates of Test: 06/06/07 through 07/07/07, 09/10/07 through 09/20/07, 09/15/10
Test Laboratory:

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

EN 61000-6-3 EMISSIONS

TEST METHOD	LIMITS
IEC 61000-6-3 Am 1:2002-11 (Cispr 11) Radiated Emissions	B
IEC 61000-6-3 Am 1:2002-11 (Cispr 11) Conducted Emissions (DC Power Supply)	A

EN 61000-6-2 IMMUNITY

TEST METHOD		LEVEL
EN 61000-4-2 Cons Ed 1.2:2001-04 Electrostatic Discharge Test	2, 4, 6 and 8 kV Air Discharge 2 and 4 kV Contact Discharge	A
EN 61000-4-3 Ed. 3.0: 2006-02 Radiated Immunity Test	10 V/M (10 V/M minimum) 1000 Hz, 80% AM modulation, 900 Mhz, 100% AM, 200 Hz, Square Wave, 30-1000, 1.4-2.0 GHz, 2.0-2.7 GHz (reduced level)	A
EN 61000-4-4 Ed. 2.0: 2004-07 Electrical Fast Transients	.5, 1 and 2 kV Line to Line	B
EN 61000-4-5 Ed. 2.0: 2005-11 Electrical Surge Test	.5 kV Line to Line	A
EN 61000-4-6 Ed. 2.2: 2006-05 Conducted Immunity	3 V RMS Common Mode	A

Performance Level:

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

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

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. 2732, 2771

Test Specifications

EN 61000-6-3 Level A 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

Test Device: **TFT RC MONITOR FAMILY**

Serial Number: **TFT-Y46660**

Conducted For:

Mr. Tim Miller
Task Force Tips, Inc.
2800 East Evans Ave.
Valparaiso, Indiana 46383-6940
Ph: 1-219-462-6161
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Dates of Test: 06-06-07 through 07-07-07, 09/10/07 through 09/20/07

Technical Data Taken by and
Report Written by:

George A. Bowman

George Bowman
Midwest EMI Associates

NARTE Certified Engineer, EMC-000738NE

Approved By:

Mr. Tim Miller
Project Engineer
Task Force Tips, Inc.

1.0 PURPOSE:

The purpose of this test sequence is to qualify the compliance of the TFT RC MONITOR FAMILY to the IEC 61000-6-2 and 61000-6-3 commercial 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 and IEC 61000-4-6 conducted immunity test. The sponsor group has made many more improvements for this third round of tests.

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 TFT RC Monitor family consists of the Tornado (500 gpm), Hurricane (1250 gpm), Typhoon (1500 gpm), and Monsoon (2000 gpm) monitors. Each of these monitors allows the user to remotely control the direction and shape of the water stream. The monitors can be installed on top of truck, bumpers, aerials, or fixed installations.

Every monitor in the TFT RC Monitor family uses identical electronics, membrane switches, cables, connectors, enclosures, and gear motors. Each monitor is equipped with a control box which houses the motor control boards and a communication board that allows the RC monitor to be connected to remote operator stations via RS485. The electronics are capable of 12 volt or 24 volt nominal system voltage and automatically adjust the speed of the motors to compensate for voltage differences. The following circuit boards are housed in this control box: Y5100 motor boards, Y5110-B communication board, Y5105 base board, Y5710 radio board.

Remote operator stations are available to allow the user to control the water stream from a safe distance. Communication interface boxes are available that allow a user to convert discrete signals from switches or a multiplex system into RS485 and then control the water stream. The Y5112-B connection board is contained in the Y4E-RP panel mount operator station. The Y5113-B interface board is contained in the Y4E-COMM communication interface box and the Y5378-B dual interface board is contained in the Y5860/Y5855 electronics enclosure.

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

EN 61000-6-2 Ed. 2.0 (2005-01), "Electromagnetic compatibility (EMC) - Part 6-2: Generic standards - Immunity for industrial environments"

EN 61000-6-3 Ed. 2.0 (2006-07), "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, 2004-06, "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.*

6.3 SPECTRUM ANALYZER CHARACTERISTICS:

This facility uses a type TEK 2756P/TEK 2712 automated spectrum analyzer and a USAFlex 486 Advanta 50 MHz measuring system. The 6 dB impulse bandwidth settings and wideband correction xaaaaaaaaaafactors are listed below:

TEK 2756P Analyzer

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

TEK 2712 Analyzer (Dual Analyzers in Use)

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

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

6.4 Certificates of Calibration

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

a)	Tek2756P Spectrum Analyzer	BO20224	26 Mar 08
b)	Wavetek 2520A RF Generator	0222011	30 Mar 08
c)	Carver TFM-35 250 W/Ch. Audio Amp	3097104	N/A
d)	ENI RF Power Amplifier (525LA)	367	N/A
e)	ENI RF Power Amplifier (2100L)	129	N/A
f)	Eaton 15100B Power Amplifier	1529-07090	24 Mar 08
g)	Tektronix TDS 420 Oscilloscope	B021212	24 Mar 08
h)	EMCO 3109 Power Biconical (1/3/10 Meters)	9011-2504	17 Mar 08
i)	EMCO 3101 Power Conical	9007-3450	N/A (1/3m)
j)	EMCO 6502 Active Loop	1038	18 Mar 08
k)	EMCO 3301B Active E Field	9009-3044	19 Mar 08
l)	EMCO 3147 Wide Range Log Periodic	9102-1019	23 Mar 08
m)	EMCO 3107B Power E Field	9310-2435	N/A
m)	Amplifier Research FM1000	12456	N/A

n)	Amplifier Research FP1000		60701	21 Mar 08
o)	Amplifier Research FP1000		60488	3 Mar 08
p)	IFI EFS-4 E Field Susceptibility (Holladay 3004EX with HSE405 Probe)		39883	14 Mar 08
q)	IFI LMT-B Light Modulator		1117-B	N/A
r)	IFI EFS-1 E Field Susceptibility		245738	N/A
s)	Solar 6741-1 RF Current Probe		911308	N/A
t)	Fluke 45 True RMS Voltmeter	**EJ574714013**	24 Mar 08	
u)	Schaffner NSG 433 ESD Gun and Contact Discharge Adapter		107 402-664/0	30 Mar 08
v)	Solar Loop Sensor 7334-1		----------	N/A
w)	Solar Loop Sensor 9311-1		931101	N/A
x)	Solar RF Coupler 7415-3 906016		N/A	
y)	Solar Line Impedance Stabilization Network		8028-50-TS-24-BNC	N/A
z)	Solar VDE Filter Network		8907-250-TS-24-BP	N/A
aa)	Ohmic Instrument BET-300-ADL		522	25 Mar 08
ab)	Werlatone C1795 Dir. Coupler		3442	30 Mar 08
ac)	Solar Current Injection Probe Type 9108-1N		935012	N/A
ad)	Tektronix TR 503B Tracking Generator		B011216	25 Mar 08
ae)	Acme 2KVA Isolation Transformer		T-3-53042-S	N/A
af)	Xentek Extreme Isolation Transformer Model 5410 (2 in use)			
ag)	Tektronix P6202 RF Probe		------	N/A
ah)	Staco Power Variac Type 3PN2210 (0-140VAC) 3.1KVA		N/A	
ai)	Helmholtz Coil Stepdown Xfrmr-Chicago Xfrmer Type P-6492			N/A
aj)	Goldstar Signal Generator Mod FG-2002c	201621	25 Mar 08	
ak)	Holladay Magnetic Field Probe Model HI-3624	83957	15 Mar 08	
al)	Tektronix 2712 Spectrum Analyzer (Quasipeak)		B022520	24 Mar 08
am)	Voltec PM100 Power Analyzer		AA04/8495	25 Mar 08
an)	EMCO 3142 Biconilog Antenna		1052	1 Mar 08
ao)	Haefely P90.1 EN 61000-4-4 Fast Transient Tester		083 593-14	19 Mar 08
ap)	Hewlett Packard 3400A AC Voltmeter		1218A14443	24 Mar 08
aq)	Amplifier Research FP2031 Isotropic Probe		18309	5 Mar 08
ar)	Haefely 250 600/00 (61000-4-5 Surge Tester)		583 334-05	19 Mar 08
as)	Fischer CISPR 14 Absorbing Clamp type F-201		235	7 Mar 08
at)	Fischer IEC 801-6 Transducer		165	23 Mar 08
au)	Solar 9123-1N Current Clamp		956015	23 Mar 08
av	Fischer IC 801-6 CDN FCC-801-M3-25		95	7 Mar 08
aw)	Tektronix 2712 Spectrum Analyzer (Quasipeak)	B022981	24 Mar 08	
ax)	C. C. Moore Automated Mast Assembly Model DAPM4/6			N/A
ay)	C. C. Moore Automated Turntable Model DTT-4		N/A	
z	Antenna Research LPB2520		1152	20 Mar 08
ba)	Behlman Power Pass 50 Hz AC Source (50, 60, 400 Hz)	0005	N/A	
bb)	California Instruments WP1251 AC Source (50, 60 Hz)		N/A	
bc)	Plitron Extreme Toroidal Isolation Transformers (2)			
bd)	Edmund Scientific Thermometer/Hygrometer		None	31 Mar 08
be)	Coaxial Bird Pads (x2) 8306-030-N3DB	None	30 Mar 08	
bf)	High Current Source, Associated Research 3030D	A140006	25 Mar 08	
bg)	California Instruments 5001ix High Power Source	HK52945	25 Mar 08	
bh)	Line Leakage tester, Associated Research 510L	130007	25 Mar 08	

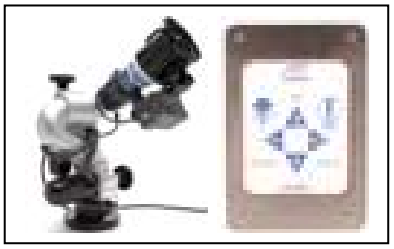
bi) Hipot Tester, Associated Research 3570D		090595	25 Mar 08
bh) GAASfet Preamplifier		None	25 Mar 08
bi) Ametek Tachometer Model 1726		R035292	24 Mar 08
bj) Bird Attenuator (x2), 75 Watt, 75-A-MFN-10	R035290	N/A	
bk) HP 8482A Power Sensor		S/N: 2652A18474	24 Mar 08
bl) HP 435B Power Meter		S/N: 2702A17563	24 Mar 08
bm) Simpson Model 383 Thermometer	B001531	24 Mar 08	
bn) Wavetek 27XT Voltmeter		96120787	24 Mar 08
bo) HP 8657A Programmable Synthesizer	365	17 Mar 08	
bp) Fluke 75			24 Mar 08
bq) ENI 525LA			19 Mar 08
br) Tek 495P Opt 5/7		B020147	30 Mar 08
bs) Amplifier Research FP2036 (.5-5Ghz)			04 Sep 08

7.0 CONCLUSION OF RADIO FREQUENCY INTERFERENCE EMISSIONS AND SUSCEPTIBILITY TESTS:

The TFT RC MONITOR FAMILY was evaluated for all tests in the configuration requested by the sponsor group for compliance with the diagnostic instruments standards, IEC 61326 Cor. 1:2002 and IEC 61000-6-3:2006. The configuration requested was that of the packaged unit system in an orientation that exercised its fire fighting control nozzle via a remote control connection.

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

EP0336 Circuit Board Improvements
Board Change Summary



Y5100 rev1 motor boards, 07172007 hardware

- Changed from a 2-layer to 4-layer board
- Changed to micro with internal oscillator
- Redesigned motor driver circuit
- Changed from linear regulator to switching regulator
- Added diodes, transient voltage suppressors on encoder lines
- Added pull-up resistors on encoder lines
- Enabled digital filtering in the micro for each encoder channel
- Slowed PWM frequency from 31 kHz to about 2 kHz
- Five FETs changed to IRFR2405PBFCT, 55V, 56A
- TDK Ferrite Beads MMZ2012R601A installed in series w/QEA & QEB

- Ferrites (Steward 25B0562-200) installed around H & V encoder and motor wires
- Added code for brown-out detect at power-up
- Added 200pF capacitors to motor brushes

Y5110-B communication board, 8/15/06 hardware

- Changed from a 2-layer to 4-layer board
- Changed to micro with internal oscillator
- Changed from linear regulator to switching regulator
- Added Littlefuse V5.5MLA TSV device installed across Vcc to gnd
- Added Littlefuse V33MLA TSV device installed across Vbat to gnd
- Communication code includes debounce routine for membrane switch inputs.

Y5710 Maxstream radio board 900 MHz

- No changes

Y5105 rev2 base board, 06212007 hardware

- Added Vishay 1.5KE39CA/23 Transorb device between + & -
- Ferrites (Steward 28B0625-100) installed around power/comm. wires

Y5112-B connection board, 05252007 hardware

- See schematic for input chip modifications
- Changed to micro with internal oscillator
- Changed from linear regulator to switching regulator
- Added 100 uF electrolytic capacitor between Vpro & gnd
- Added TDK ILHB1206RK601V ferrite beads in series with Vbat & gnd
- Added Vishay 1.5KE39CA/23 Transorb device between + & -
- Added Littlefuse V33MLA TSV device installed across Vbat to gnd

Y5113-B rev 1 interface board, 06192007 hardware

- See schematic for input chip modifications
- Changed to micro with internal oscillator
- Changed from linear regulator to switching regulator
- Added 22 uF electrolytic capacitor between Vpro & gnd
- Added Vishay 1.5KE39CA/23 Transorb device between + & -
- Added Littlefuse V33MLA TSV device installed across Vbat to gnd

Y5378-B rev 1 dual interface board, 06192007 hardware

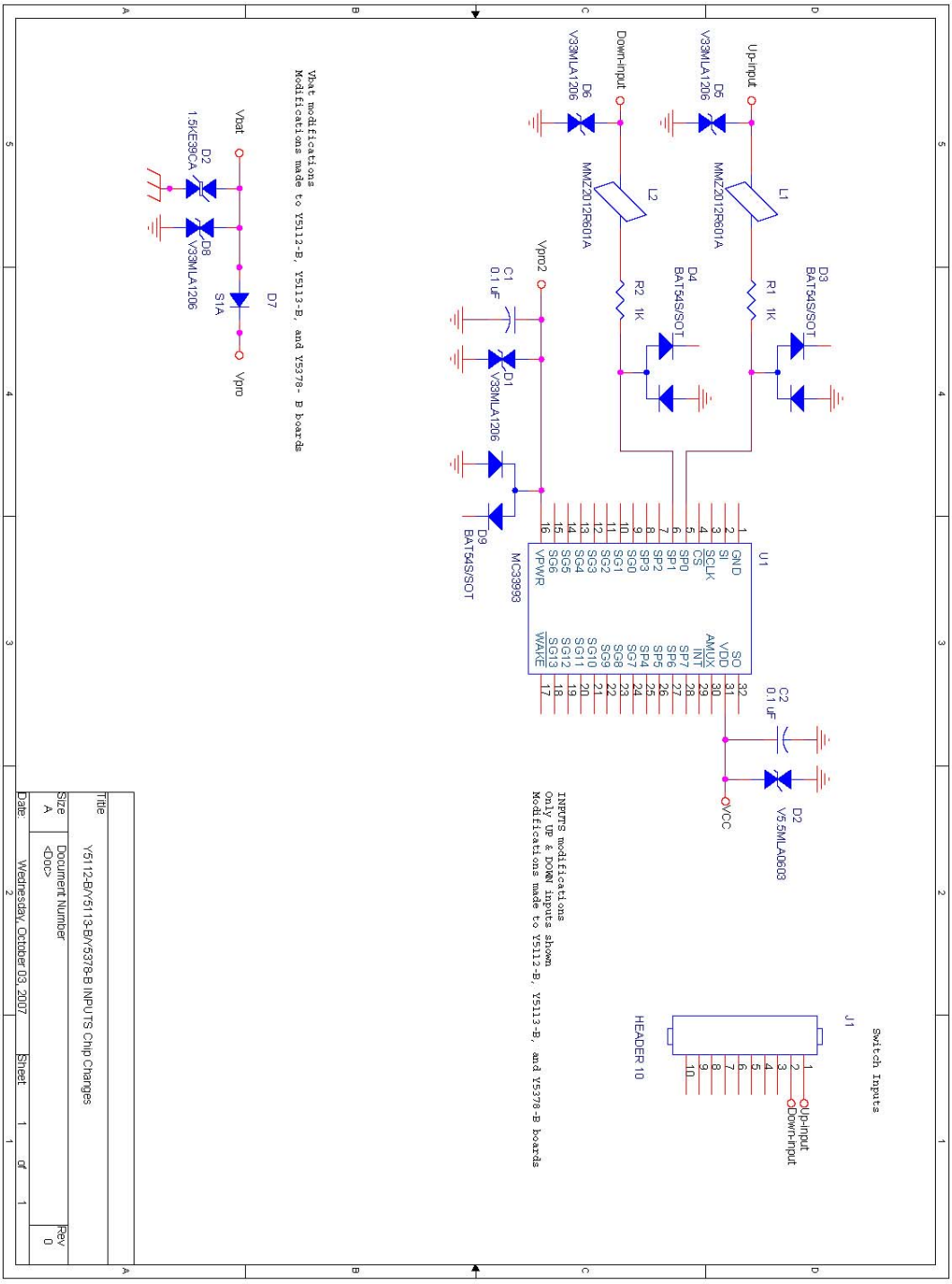
- See schematic for input chip modifications
- Changed to micro with internal oscillator
- Changed from linear regulator to switching regulator

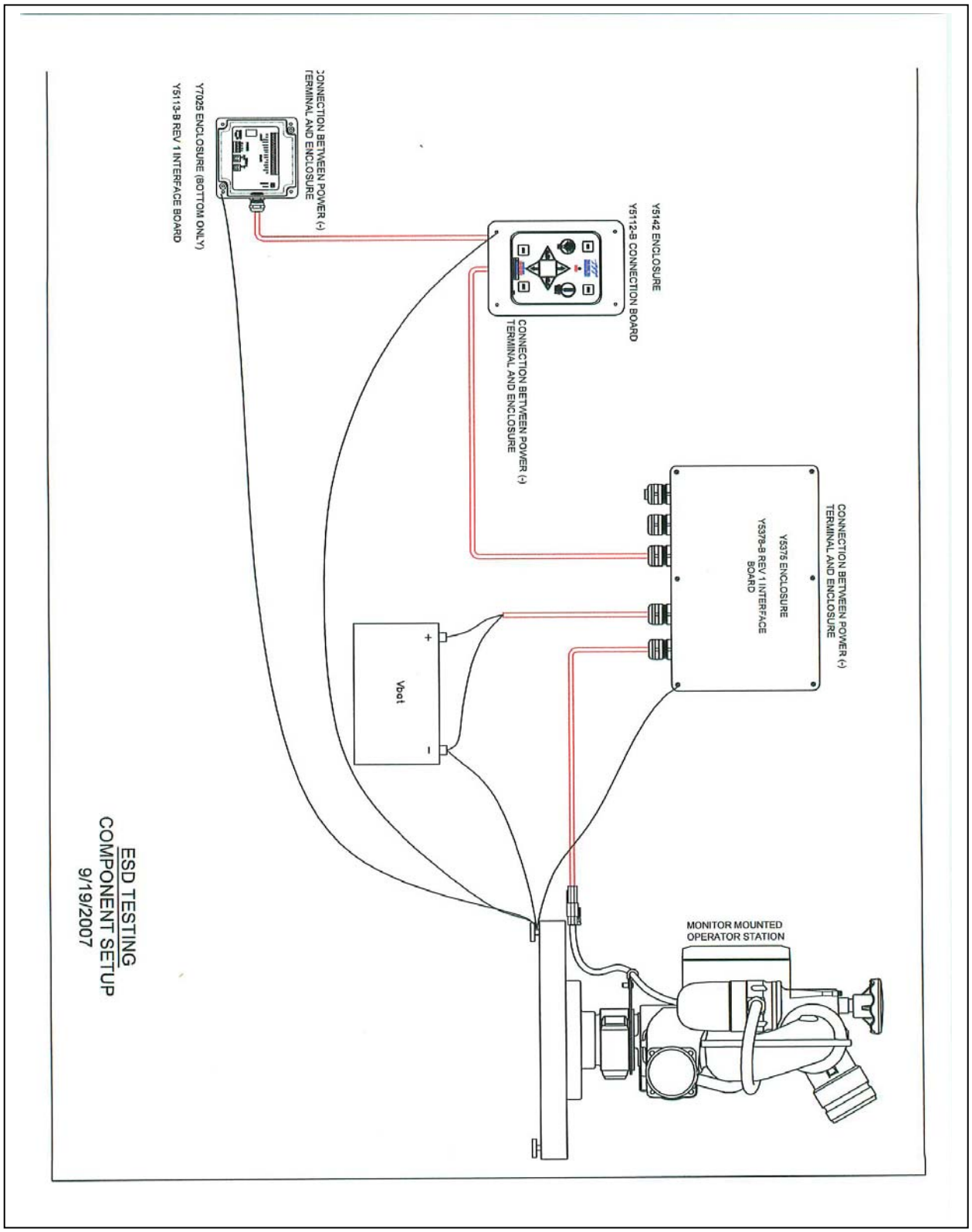
- Added 22 uF electrolytic capacitor between Vpro & gnd
- Added Vishay 1.5KE39CA/23 Transorb device between + & -
- Added Littlefuse V33MLA TSV device installed across Vbat to gnd
- See attached sheet for wiring of system.

Addendum (9/15/2010)

EP0448 Y4E-RP Redesign

Changed from standard purchased/machined die-cast aluminum enclosure (Y5142) to an in-house machined bar stock aluminum enclosure, part numbers Y5155 and Y5156. The new enclosure is hardcoat anodized (HB2A). There are no electrical/circuit/component changes to Y5112-B circuit board from initial testing. The only board change is to shorten the length, removing unpopulated board material, to fit into enclosure. A Y5595 wire jumper is installed between the back half of enclosure (Y5155) and board BLACK (-) terminal block.


Switch Inputs
J1
HEADER 10
Up-Input
Down-Input
D2
V5.5MLA0603
VCC
C2
0.1 uF
U1
MC33993
GND
SI
SCLK
CS
SPO
SP1
SP2
SP3
SG0
SG1
SG2
SG3
SG4
SG5
SG6
VPWR
SO
VDD
AMUX
INT
SP7
SP6
SP5
SP4
SG7
SG8
SG9
SG10
SG11
SG12
SG13
WAKE
INPUTS modifications
Only UP & DOWN inputs shown
Modifications made to Y5112-B, Y5113-B, and Y5378-B boards
D9
BAT54S/SOT
D1
V33MLA1206
C1
0.1 uF
Vpro2
D4
BAT54S/SOT
R2 1K
L2
MMZ2012R601A
D6
V33MLA1206
Down-Input
D3
BAT54S/SOT
R1 1K
L1
MMZ2012R601A
D5
V33MLA1206
Up-Input
Vbat modifications
Modifications made to Y5112-B, Y5113-B, and Y5378- B boards
D7
S1A
D8
V33MLA1206
D2
1.5KE39CA
Vbat
Vpro
Title
Y5112-BX/Y5113-BX/Y5378-B INPUTS Chip Changes
Size
A
Document Number
<Doc>
Rev
0
Date:
Wednesday, October 03, 2007
Sheet
1
of
1


ESD TESTING
COMPONENT SETUP
9/19/2007
Y7025 ENCLOSURE (BOTTOM ONLY)
Y5113-B REV 1 INTERFACE BOARD
CONNECTION BETWEEN POWER (-) TERMINAL AND ENCLOSURE
Y5142 ENCLOSURE
Y5112-B CONNECTION BOARD
CONNECTION BETWEEN POWER (-) TERMINAL AND ENCLOSURE
Y5376 ENCLOSURE
Y5378-B REV 1 INTERFACE BOARD
CONNECTION BETWEEN POWER (-) TERMINAL AND ENCLOSURE
Vbat
+
-
MONITOR MOUNTED OPERATOR STATION

Nemko

Nemko Laboratory Authorisation

Aut. No.: 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 page.**

Nemko has assessed 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 Nemko Document NLA -10. During the visit by the Nemko representative it was found that the Laboratory is capable of performing tests within the Scope of the Authorisation.

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.

In order to maintain the Authorisation, 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 Authorisation. The Authorisation may be withdrawn at any time if the conditions are no longer considered to be fulfilled.

The Authorisation is valid through 31 December 2008.

Dallas, Texas 01 March 2006

For Nemko AS:

TB Ketterling

TB Ketterling, Nemko EMC Coordinator

NLA 3 ELA ED4-2003

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 RC MONITOR FAMILY** 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.

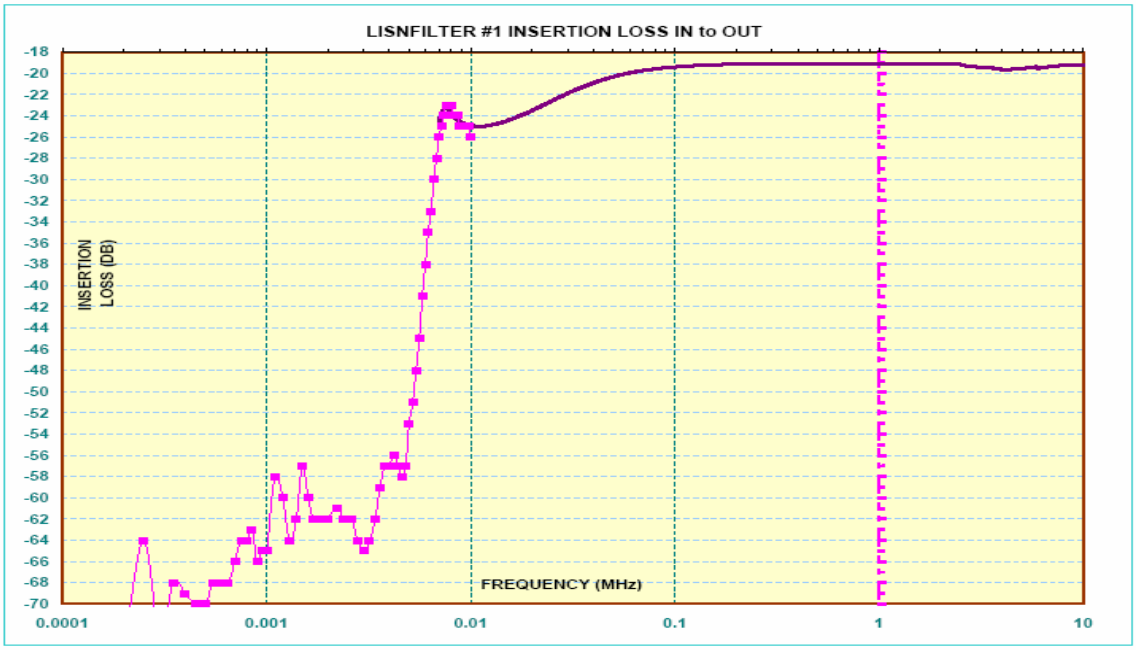
VDE LIMITS

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.


LISNFILTER #1 INSERTION LOSS IN to OUT
INSERTION LOSS (DB)
-18
-20
-22
-24
-26
-28
-30
-32
-34
-36
-38
-40
-42
-44
-46
-48
-50
-52
-54
-56
-58
-60
-62
-64
-66
-68
-70
FREQUENCY (MHz)
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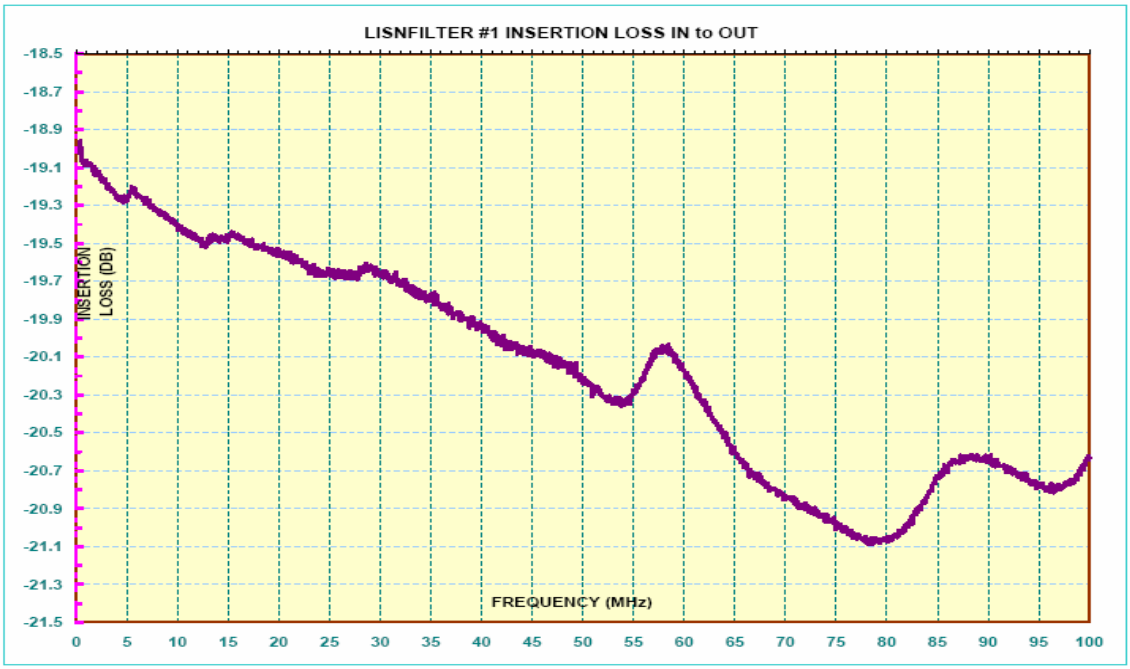
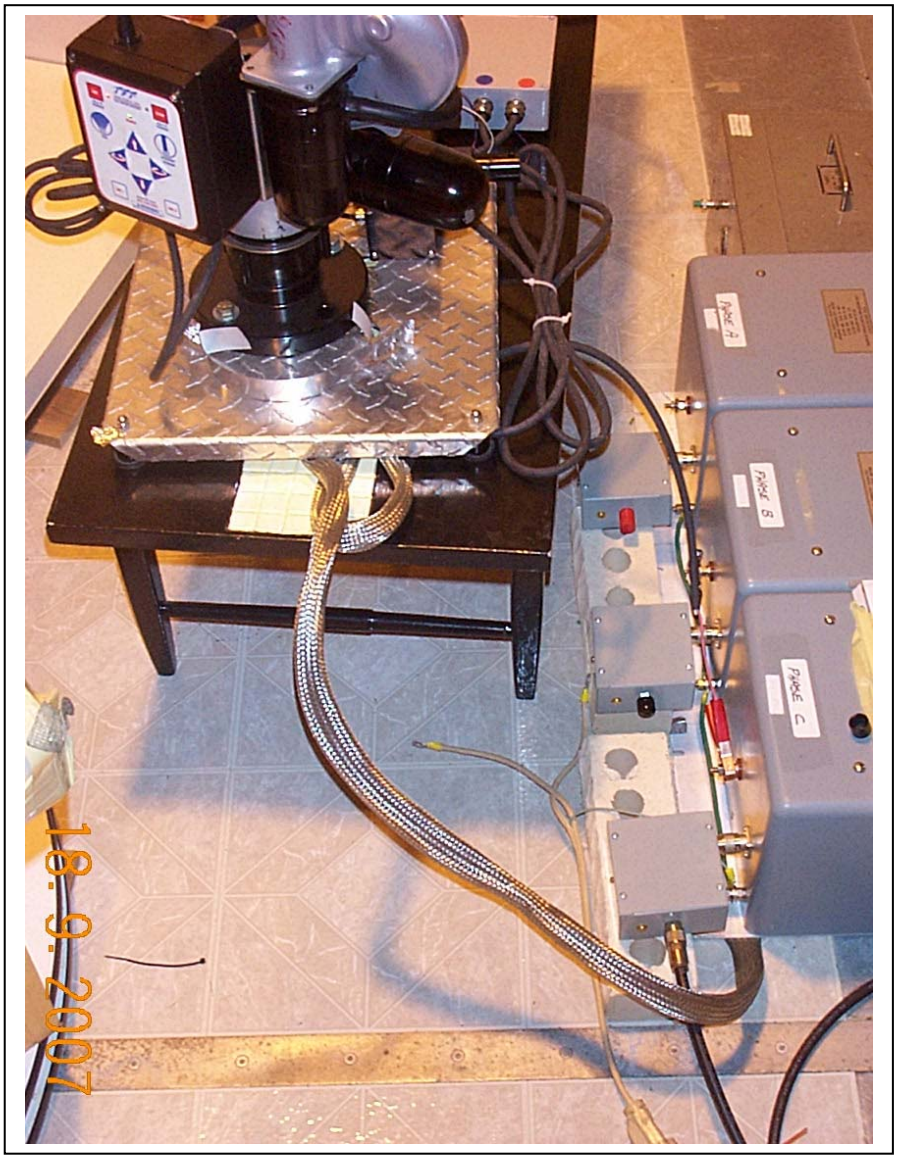
0.001
0.01
0.1
1
10


LISNFILTER #1 INSERTION LOSS IN to OUT
INSERTION LOSS (DB)
-18.5
-18.7
-18.9
-19.1
-19.3
-19.5
-19.7
-19.9
-20.1
-20.3
-20.5
-20.7
-20.9
-21.1
-21.3
-21.5
FREQUENCY (MHz)
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
95
100

4.0 CONCLUSION OF RADIO FREQUENCY INTERFERENCE EMISSIONS TESTS:

The TFT Monitor Family was measured for its conducted emissions per EN61000-6-3 for DC operated devices. The standard calls out for a Cispr A performance level. After measuring and improving the system the objective was achieved after adding the changes shown in the summary at the beginning of this report.

Problem emission was found to be about 480 KHz from one of the switcher supplies and changes were made specifically to reduce those emissions to acceptable levels.



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 RC MONITOR FAMILY was operated in its normal mode using a 12 VDC lead acid battery for power.

3.2 GROUNDING:

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

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

3.3 RADIATED CONFIGURATION:

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

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

3.4 TEST SAMPLE OPERATION:

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

3.5 TEST PROCEDURES/LIMITS OF ACCEPTANCE:

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

VDE LIMITS (ELECTRIC FIELDS - CISPR 11)

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

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

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

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

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

4.0 CONCLUSION OF RADIO FREQENCY INTERFERENCE EMISSIONS TESTS:

Preliminary Test

The device was oriented with the front of the EUT facing the antenna initially. The unit was varied in position and antenna height with a 2 or 3 meter antenna height found typically to be worst case. The orientation of the unit was typically with the Monitor keypad on the control box facing front at 0 degrees wrt the antenna.

Final Testing – 06-07-07

The data for this testing is shown on pages B1-B14. Graph B1 shows the ambient; Graph B2 shows the peak mode in comparison in the range of 20-75 MHz and Page B3 shows the quasipeak. Several emissions in the 70-73 Mhz range were over the limit due to motor action (see tabular data on B4). Ferrites were added in Graph B4A with tabular data on B4B. An ambient signal at 64 MHz was detected along with motor noise from the EUT in that range after several ferrites were added. Other emissions were from TV channel 2 and a common carrier. The area was once again tested on B5 with tabular data on B5A. This time the emissions appeared to be compliant since the signal at 64 MHz dwarfed the motor emissions seen nearby that carrier. Several frequencies were individually searched and found not to be from the EUT. Other emissions above the line were due to TV channel 2 and the beginning of the FM band.

In the 75-170 MHz range, Graph B6 shows the ambient, B6A shows the peak and B7 shows the quasipeak emissions. Tabular data is shown on B8. Ambient emissions consist of TV channel 5, FM band the intentional radiators at 152-158 and 162 MHz. Emissions in the mid band area were discovered to be airplane emissions and none exceeded the limit. A noise bump from the EUT around 110 Mhz was not found to exceed the Class B limit.

In the 160-300 MHz range, the ambient is shown on Graph B9, and peak level on B10. No areas of emission from the EUT appeared to exceed the limit. Other emissions seen were from TV Channels 7, 9, and 11, and a common carrier at about 220 MHz.

In the 300-640 MHz, the ambient is shown on B11 and the peak level emissions are shown on B12. Other high emissions are numerous UHF TV stations. 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.

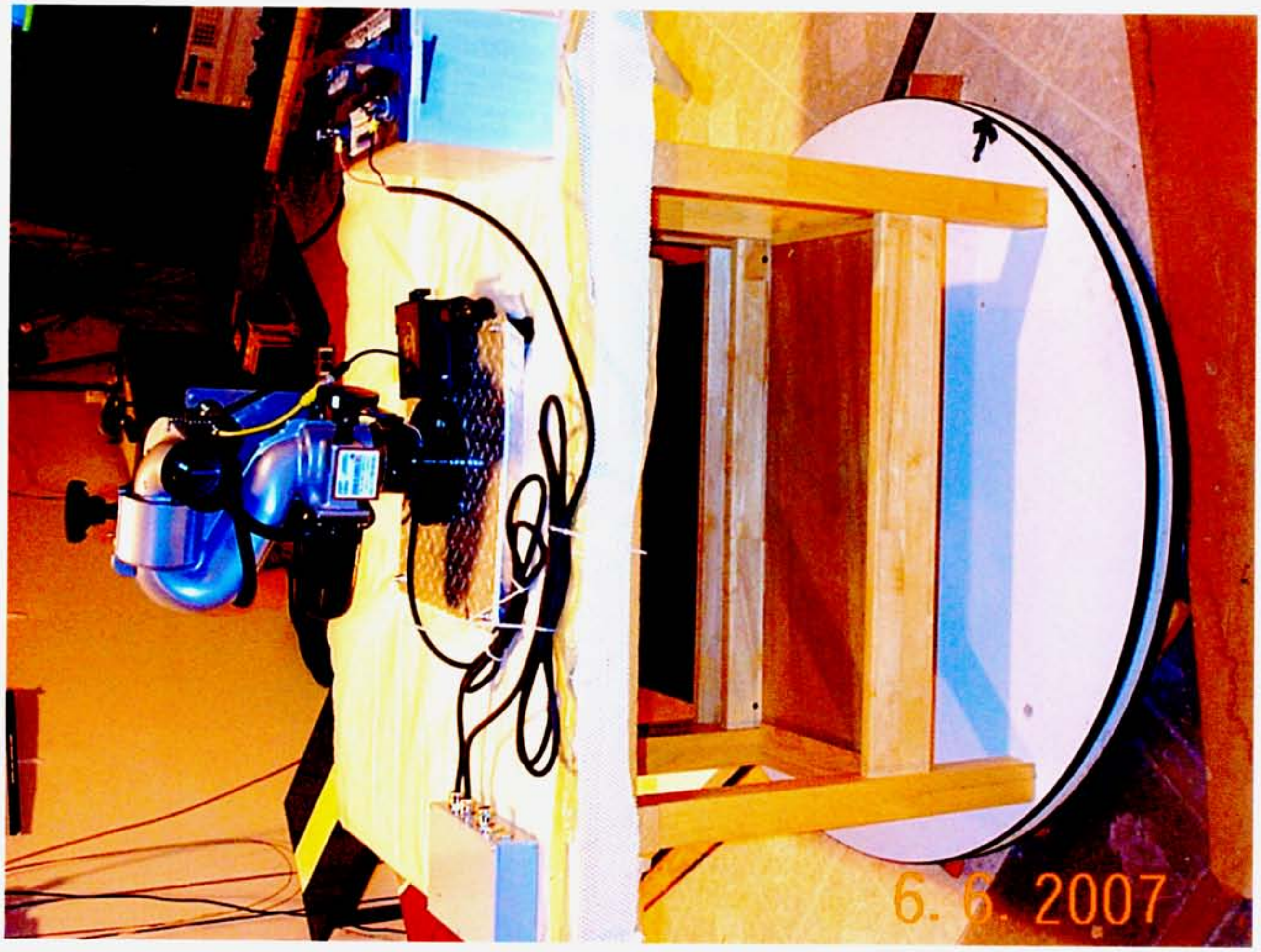
In the 620-1000 MHz, the ambient is shown on B13 and peak level on B14. Other high emissions are numerous UHF TV stations and the cell telephone band around 900 MHz. When the graphs were overlaid, no excess level introduced by the EUT was seen.

The TFT RC MONITOR was fully compliant with the Cispr 11 B level specification without alteration. 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.

REPEAT TESTING ON 9-20-2007

Repeat testing was performed on 9-20-2007 with all improvements added. The results of the testing revealed no degradation had been suffered with the new configuration as listed in the summary. All data is supplied with this report. One Emission requiring special attention included 66.62 MHz that turned out to have a low QP value under the limit, all others were inspected and found to have acceptable margin to the standard.

Repeat Testing on 9-17-2010 -- The EUT was retested with a new anodized case in bands 1 and 2 to assure there was no change in the emissions profile. The unit passed the requirement. Additional data supplied at the end of this Appendix.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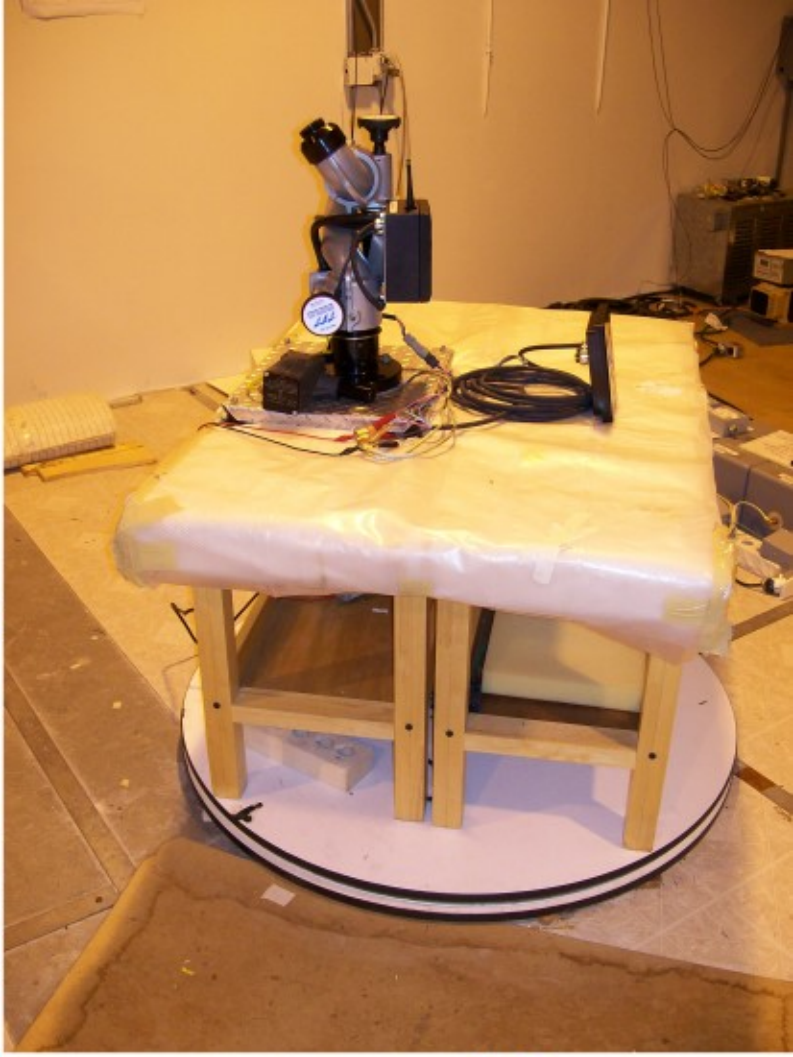

APPENDIX C

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	REPETITION	BURST	BURST PERIOD

	OUTPUT TEST VOLTAGE	RATE	DURATION	
1	.5 KV	5.0 KHZ	15 MSEC	300 MSEC
2	1 KV	5.0 KHZ	15 MSEC	300 MSEC
3	2 KV	5.0 KHZ	15 MSEC	300 MSEC
4	4 KV	2.5 KHZ	15 MSEC	300 MSEC

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

3.3 EFT GENERATOR CHARACTERISTICS:

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

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

3.4 COUPLING DECOUPLING NETWORK CHARACTERISTICS:

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

3.5 COUPLING CLAMP CHARACTERISTICS:

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

3.6 GROUND REFERENCE PLANE:

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

3.7 REFERENCE DOCUMENT:

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

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

3.8 ACCEPTABILITY CRITERION:

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

An unacceptable operating response to the stimulus was:

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

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

4.0 TEST RESULTS

The TFT Monitor was tested at .5, 1 KV and 2 KV using the Haefely Clamp on the battery and RS485 lines feeding the main control box. There were no adverse results detected at .5 KV however at 1 KV the Monitor was noted to stop followed by the red light going out on the wireless remote controlling it. One other effect noticed was a hesitation in operation.

After review the sponsor group made substantial changes to the operation of the unit as shown in the set of details shown in the summary of this report. When those changes were made the only effect noted up to and including 2 KV was a brief hesitation in the movement of the water cannon that immediately corrected when the influence ended. Since this hesitation issue is not related to safety concerns and it corrected after the test concluded it has achieved a "B" level of compliance.


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14. 4. 2007

APPENDIX D

RADIATED RADIO FREQUENCY INTERFERENCE SUSCEPTIBILITY TEST

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

1.0 PURPOSE:

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

2.0 DESCRIPTION OF TEST APPARATUS:

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

3.0 TEST PROCEDURES:

3.1 POWER LEADS & CABLE PLACEMENT:

The TFT RC MONITOR FAMILY was powered by a 12 VDC lead acid battery.

3.2 TEST SETUP:

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

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

3.3 MODULATION:

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

3.4 ANTENNAS AND AMPLIFIERS:

The radiating antennas/amplifiers used during the test were:

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

4.0 LIMITS AND RESULTS OF TEST:

4.1 RADIATED LIMITS:

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

4.2 RESULTS OF TEST:

The TFT RC MONITOR was exposed to a 10 V/M immunity wave from 30 to 1000 MHz with 1000 Hz, 80% modulation. It was also exposed to the same field in the 900 to 925 MHz cellular phone test using 200 Hz, 100% square wave modulation. It was also tested from 1000-2700 MHz at user selected bands without noticeable problems.

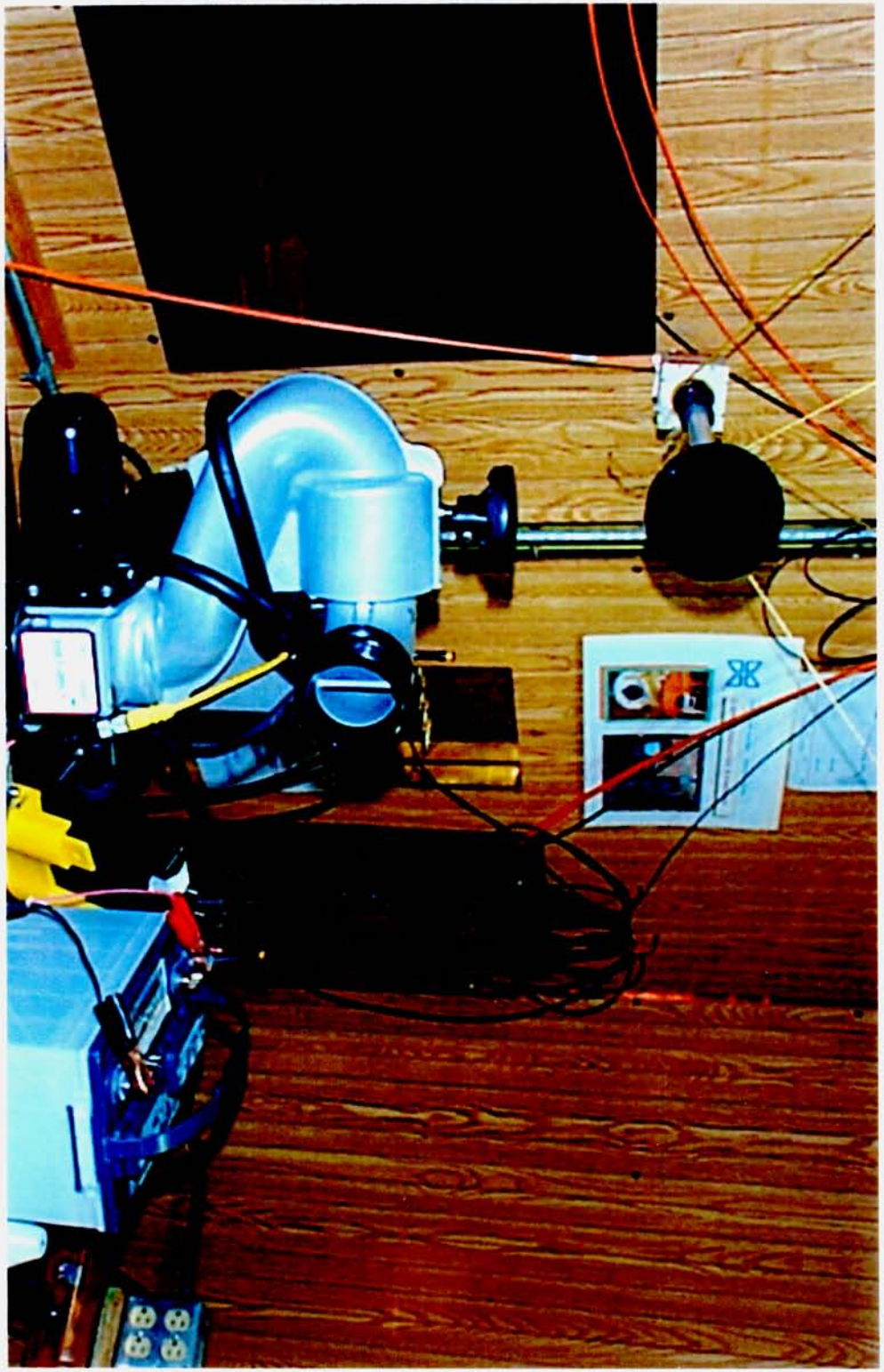
During testing the system was continuously monitored for correct functioning so that a) the nozzle went back in forth in a predictable pattern that did not change over time and 2) did not stop or change operational mode during testing. During the test the following adverse reactions were checked for:

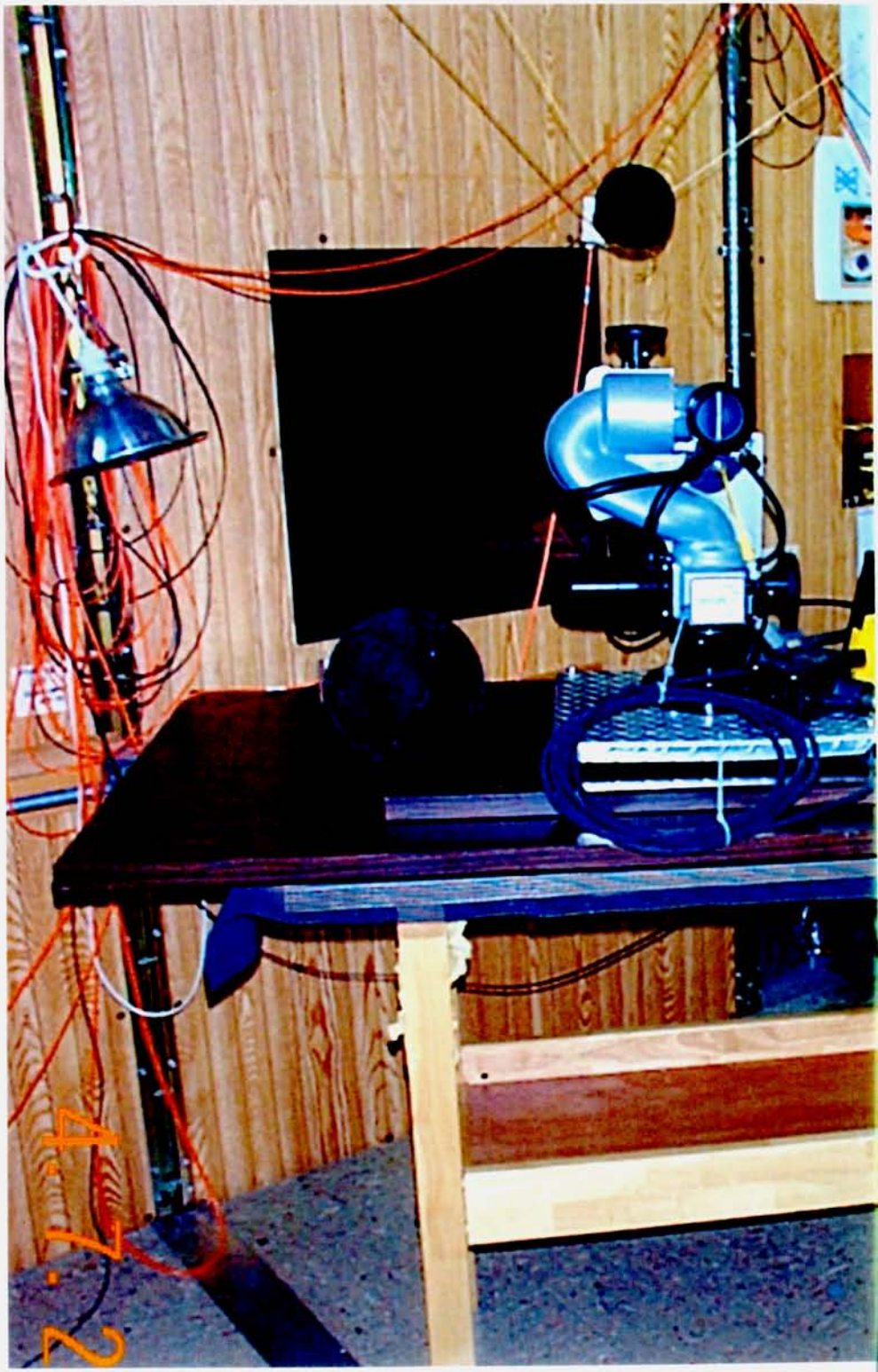
1) **The encoder did not "slip" during the test sending the water cannon pointing in the wrong direction**
2) **The motor of the cannon did not stop without command from the host**

3) **The motor of the cannon did not start unless commanded from the host**
4) **The motor continued in the state it was commanded to stay in either stopped or moving**

The sponsor group made several ferrite modifications and modifications to the debounce circuitry culminating in the final configuration depicted in the beginning of this report. In the final test (8/30/07), focused on the 100-250 MHz range, there were no adverse findings under the criterion shown above. Other ranges were cleared of problems in testing done on August 21 and 22, 2007 as shown.

The EUT passed with an A acceptance level. Various results taken over the period of a month are attached.

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6. 6. 2007

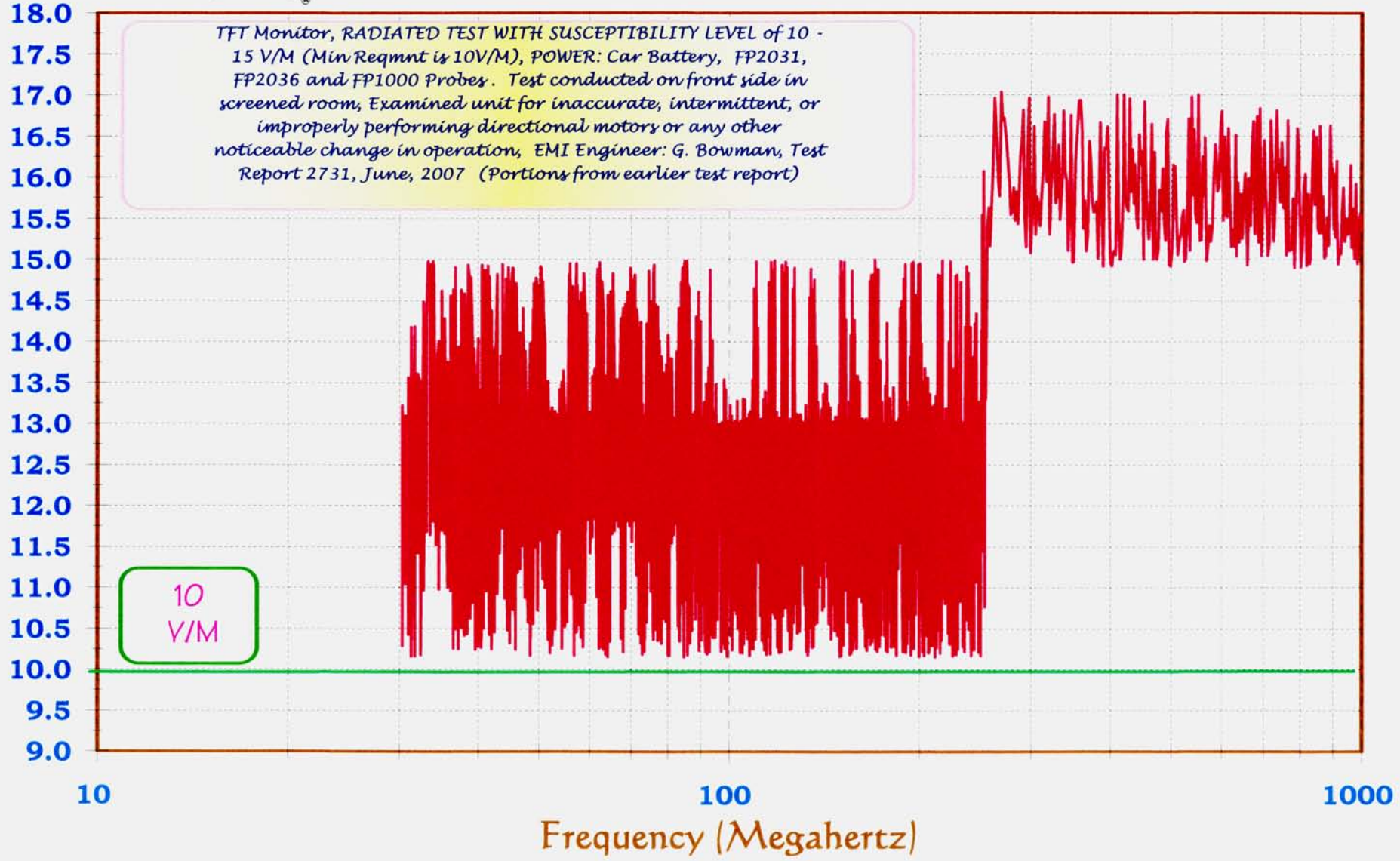

Weitz-Gant
6. 6. 2007


MEGA-TRON
DEEP CYCLE
6. 6. 2007


6. 6. 2007

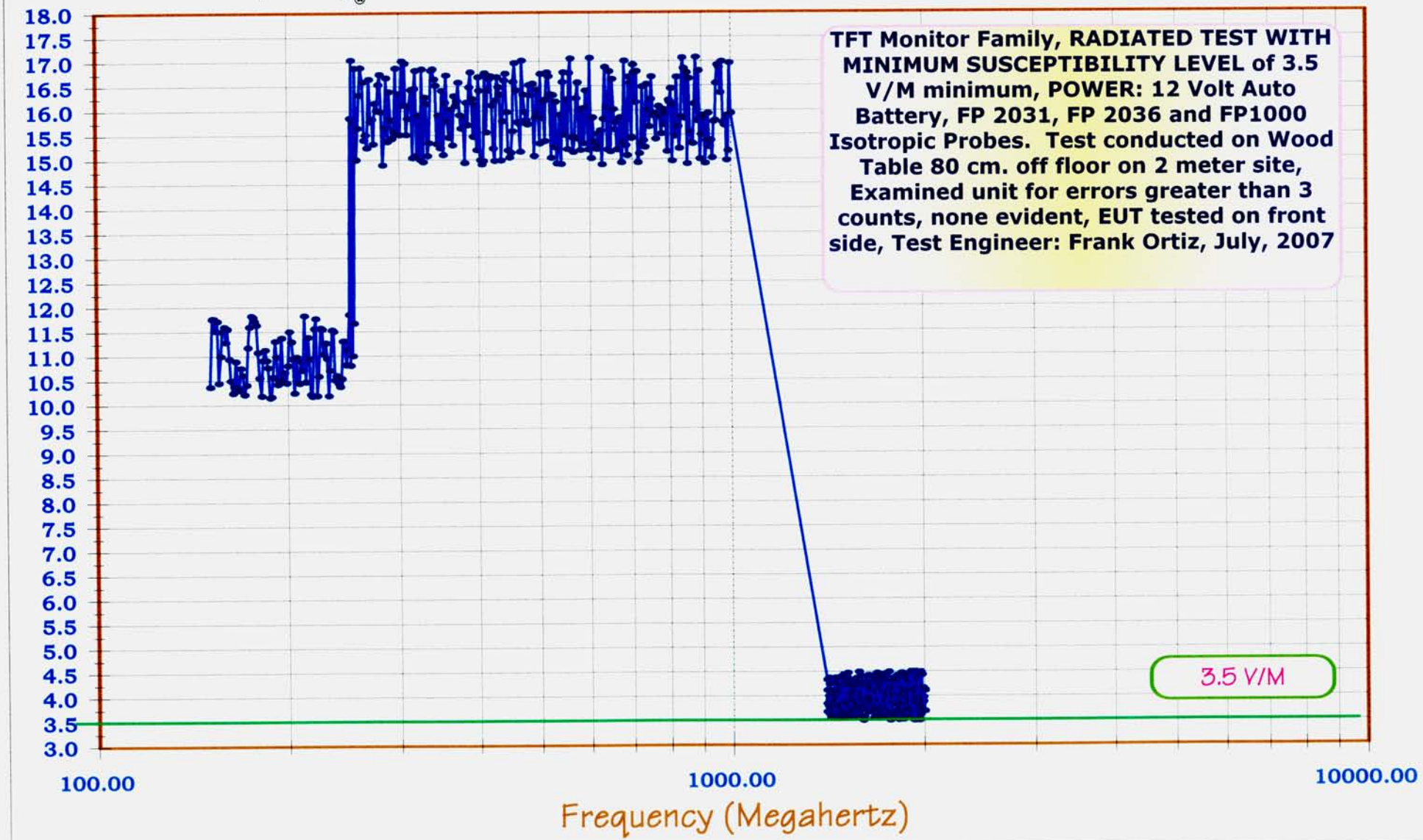
EN 61000-4-3 Radiated Susceptibility

FP2031, FP2036 & FP1000 Probes



EN61000-4-3 Radiated Susceptibility

FP2031, FP2036 & FP1000 (Averaged)



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	REPETITION RATE	Pulse Synchronism	Mode Supplied

	VOLTAGE	of Pulse	(Degrees)	
1	.5 KV	30 Sec	0,90,180,270	1,2,3
2	1 KV	30 Sec	0,90,180,270	1,2,3
3	2 KV	45 Sec	0,90,180,270	1,2

3.3 EFT 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 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.

APPENDIX F

CONDUCTED SUSCEPTIBILITY TEST

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

1.0 PURPOSE:

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

2.0 DESCRIPTION OF TEST APPARATUS:

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

The test also requires analysis of data using a high speed computer and graphical presentation of data. The computer used was a USA Flex Advanta 50 MHz 486 controller with Quattro Pro for Windows and Word for Windows for tabular presentation. The test requires characterization of all components and a dedicated computer program to cycle the test equipment in a precise manner that induces required common mode currents in the EUT cables.

3.0 TEST PROCEDURES:

3.1 POWER LEADS:

The device tested was plugged into a source of 120VAC, 60Hz through two Line Impedance Stabilization Networks, Solar type 8028-50-TS-24-BNC. The AC cord was made physically as short as possible to permit maximum energy into the E.U.T.

3.2 TEST SETUP:

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

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

3.3 MODULATION:

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

3.4 AMPLIFIERS USED:

The amplifiers used during the test were:

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

3.5 TEST PROCEDURES:

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

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

4.0 LIMITS AND RESULTS OF TEST:

4.1 CONDUCTED LIMITS:

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

4.2 RESULTS OF TEST

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

In a second test a Solar clamp was used on the cable of wires going from the Monitor Mounted Operator Station to the Y5375 Enclosure (See sponsor group block diagram) and the test was rerun in the .15 to 300 MHz range. Again no adverse events were noted, the device continued to exercise a normal routine throughout the test.

The device passed the EN 61000-4-6 requirement at 3 V RMS in either case without noticeable failures.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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 RC MONITOR FAMILY** 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 (06-10-07) and (09-20-2007)

The ESD test was conducted on 13 surfaces in areas showing cracks in the package, switches, connectors or screws. The EUT was only subjected to ESD intensity levels of 2 and 4 KV in contact discharge because all areas are metal other than the display and they do not need air discharge testing. The display itself was not found to allow an arc into sensitive control lines, and the periphery of the display arced into metal.

The following symptoms were noted during the test:
None
The device performed flawlessly during testing. It was also retested completely on 9-20-2007 and was found to work flawlessly after further improvements were made. The device was given an "A" acceptance rating.

ADDENDUM (9-17-2010) -- EUT was exposed to repeat testing on all points using the new anodized case. The results of the test showed the EUT passed the test on all points using the new case.

ESD TEST LOCATIONS

TFT RC MONITOR FAMILY

TEST POINT	Description
1	HCP
2	VCP
3	Front Panel Display Window
4	Select Buttons
5	Read/Ent Button
6	Hose Head
7	Motor Bodies
8	Base Metal
9	Gray Box
10	Screwheads of Gray Box
11	Gray Attachment to Motor Box
12	Rubber Cables
13	Antenna
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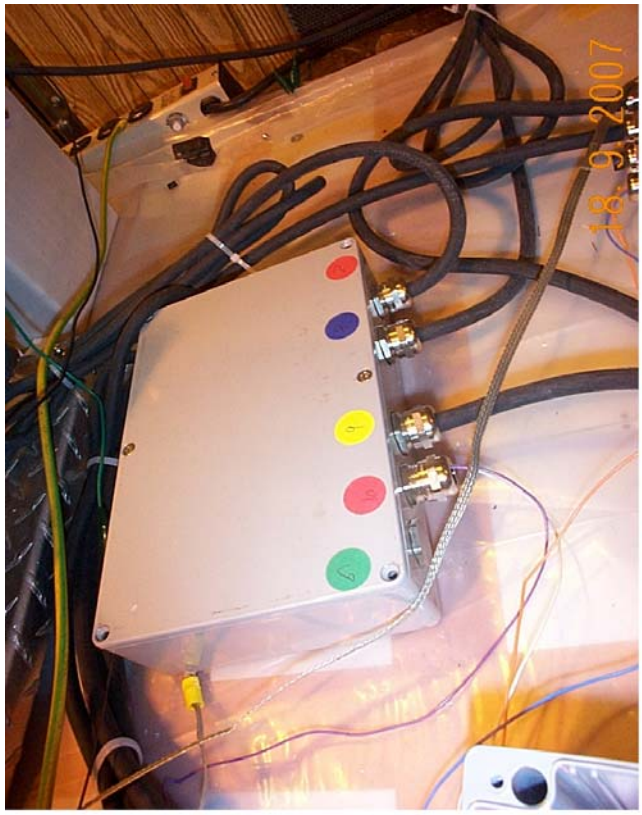
Note: Photograph of locations are attached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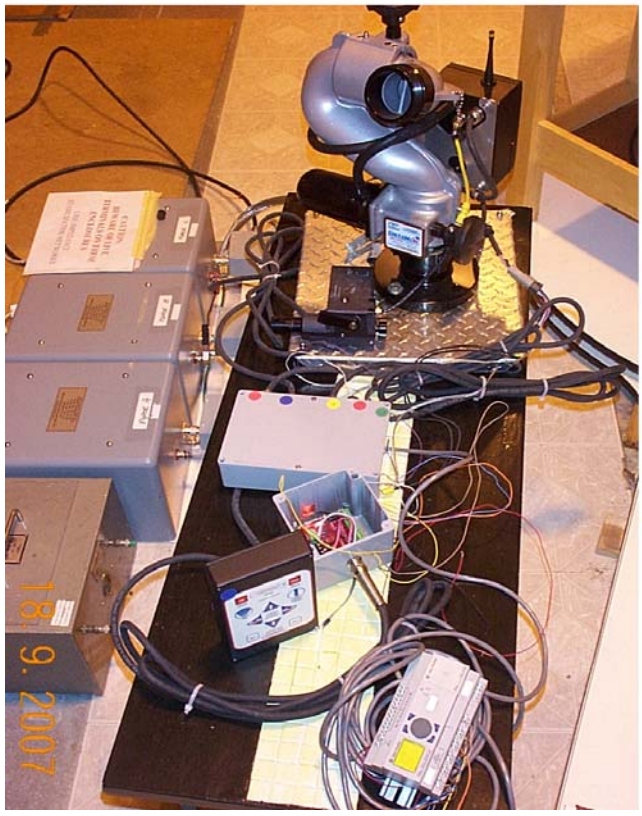
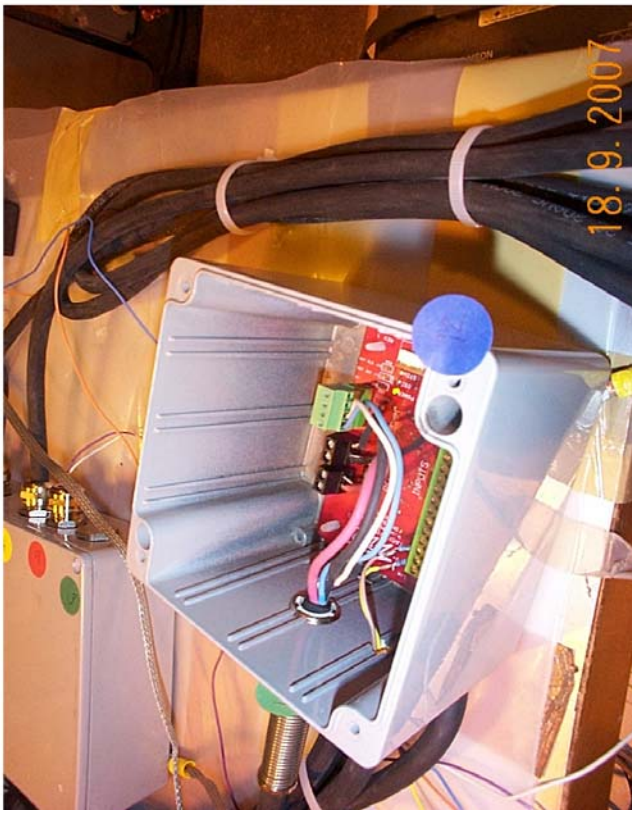

18. 9. 2007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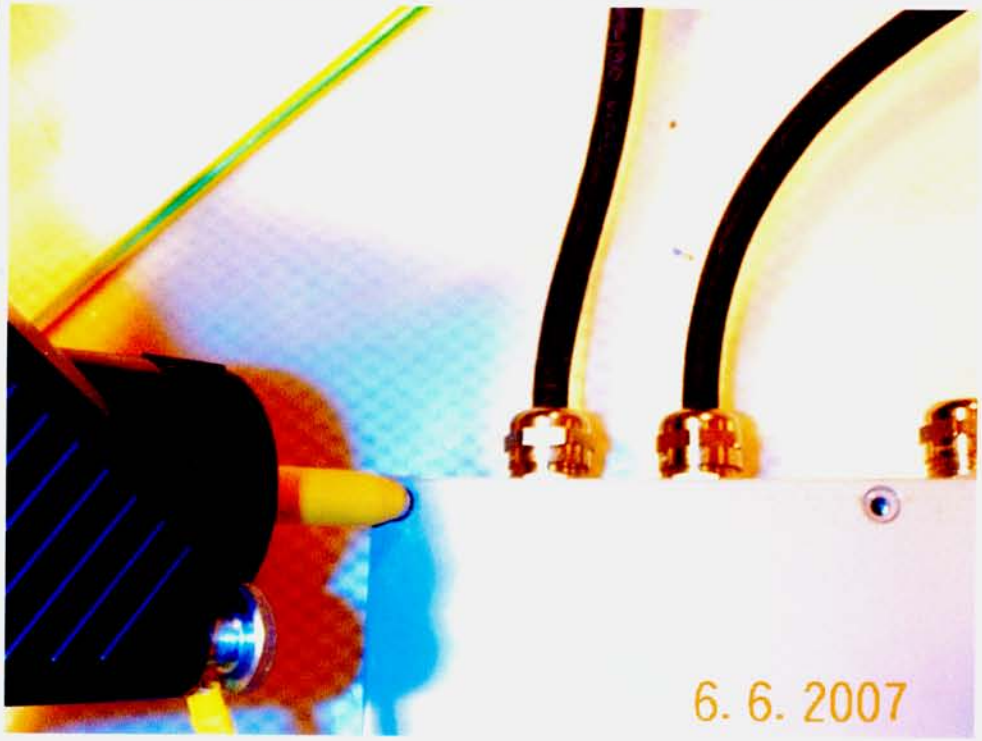
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