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Electromagnetic Emissions Test Report and Application for Grant of Equipment Authorization pursuant to FCC Part 15, Subpart C Specifications for an Intentional Radiator on the SAIC Model: RTR-4i Imaging System

FCC ID:	LPRRTR-4Ri
GRANTEE:	SAIC 16701 West Barnardo Drive San Diego, CA. 92127
TEST SITE:	Elliott Laboratories, Inc. 684 W. Maude Avenue Sunnyvale, CA 94086
REPORT DATE:	January 7, 2003
FINAL TEST DATE:	December 6, December 11 and December 23, 2002
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SCOPE

An electromagnetic emissions test has been performed on the RF module of the SAIC model RTR-4i Imaging System pursuant to Subpart C of Part 15 of FCC Rules for intentional radiators. Conducted and radiated emissions data has been collected, reduced, and analyzed within this report in accordance with measurement guidelines set forth in ANSI C63.4-1992 as outlined in Elliott Laboratories test procedures.

The transmitter above has been tested in a simulated typical installation to demonstrate compliance with the relevant FCC performance and procedural standards.

Final system data was gathered in a mode that tended to maximize emissions by varying orientation of EUT, orientation of power and I/O cabling, antenna search height, and antenna polarization.

Every practical effort was made to perform an impartial test using appropriate test equipment of known calibration. All pertinent factors have been applied to reach the determination of compliance.

The test results recorded herein are based on a single type test of the SAIC model RTR-4i Imaging System and therefore apply only to the tested sample. The sample was selected and prepared by Dave Rose of SAIC

OBJECTIVE

The primary objective of the manufacturer is compliance with Subpart C of Part 15 of FCC Rules for the radiated and conducted emissions of intentional radiators. Certification of these devices is required as a prerequisite to marketing as defined in Part 2 the FCC Rules.

Certification is a procedure where the manufacturer or a contracted laboratory makes measurements and submits the test data and technical information to the FCC. The FCC issues a grant of equipment authorization upon successful completion of their review of the submitted documents. Once the equipment authorization has been obtained, the label indicating compliance must be attached to all identical units, which are subsequently manufactured.

STATEMENT OF COMPLIANCE

The tested sample of SAIC model RTR-4i Imaging System RF module complied with the requirements of Subpart C of Part 15 of the FCC Rules for low power intentional radiators.

Maintenance of FCC compliance is the responsibility of the manufacturer. Any modification of the product that may result in increased emissions should be checked to ensure compliance has been maintained (i.e., printed circuit board layout changes, different line filter, different power supply, harnessing or I/O cable changes, etc.).

EMISSION TEST RESULTS

The following emissions tests were performed on the SAIC model RTR-4i Imaging System RF module. The actual test results are contained in an exhibit of this report.

LIMITS OF CONDUCTED INTERFERENCE VOLTAGE

The EUT tested complied with the limits detailed in FCC Rules Part 15 Section 15.207 for an intentional radiator.

The following measurement was extracted from the data recorded during the conducted emissions scan and represents the highest amplitude emission relative to the specification limit. The actual test data and any correction factors are contained in an exhibit of this report.

120V/60Hz

Frequency MHz	Level dBuV	Power Lead	15.207 Limit	15.207 Margin	Detector QP/Ave	Comments
0.1916	47.7	Neutral	53.9	-6.2	AV	

LIMITS OF RADIATED FIELD STRENGTH –INTENTIONAL RADIATOR

The EUT tested complied with the limits detailed in FCC Rules Part 15 Section 15.231(b) and 15.209 in the case of emissions falling within the frequency bands specified in Section 15.205.

The following measurement was extracted from the data recorded during the radiated electric field emissions scan and represents the highest amplitude emission relative to the specification limit. The actual test data and any correction factors are contained in an exhibit of this report.

Frequency MHz	Level dBuV/m	Pol v/h	15.231(a) Limit	15.231(a) Margin	Detector Pk/QP/Avg	Azimuth degrees	Height meters	Comments
418	78.2	v	80.3	-2.1	Avg	242	1	

BANDWIDTH

The EUT tested complied with the limits detailed in FCC Rules Part 15 Section 15.231(c). The 20dB bandwidth was 155 kilohertz.

DUTY CYCLE CALCULATION

A control message consists of 3 words, separated by approximately 60 msec, each word being approximately 43.6 msec long. Each word starts with a 12 bit (thin bits) synchronization preamble. A 1.96 msec pause and then 66 control bits follow this preamble. The bits are defined as follows:

Control Bit duration	=	570 µsec (duration = sum of "on" and "off" times)
Synchronization Bit Duration	=	400 µsec
Fat Bit "on" time	=	400 µsec
Thin Bit "on" time	=	200 µsec

"on" time schedule:

Preamble: 12 thin bits x 200 µsec	=	2.4 msec
Control Bits: 66 fat bits x 400 µsec	=	26.4 msec
		28.8 msec

The maximum duty cycle for the control signals is therefore 28.8% when measured over any 100msec period. This corresponds to a duty cycle correction factor of 10.8 dB to be applied to peak readings to calculate the average level of the signal.

PERIOD OF OPERATION

The EUT tested complied with the limits detailed in FCC Rules Part 15 Section 15.231(a) for control signals.

MEASUREMENT UNCERTAINTIES

ISO Guide 17025 requires that an estimate of the measurement uncertainties associated with the emissions test results be included in the report. The measurement uncertainties given below are based on a 95% confidence level and were calculated in accordance with NAMAS document NIS 81.

Measurement Type	Frequency Range (MHz)	Calculated Uncertainty (dB)
Conducted Emissions	0.15 to 30	± 2.4
Radiated Emissions	30 to 1000	± 3.6

EQUIPMENT UNDER TEST (EUT) DETAILS

GENERAL

The SAIC model RTR-4i Imaging System is a portable digital X-Ray imaging system, which is designed for in-field radioscopic imaging. It consists of several component parts and options. The RF module contains the transmitter and receives power and signals from the Imager. The RF module and Imager can be placed in many positions during operation.

The components of the system used for testing were treated as table-top equipment during testing to simulate the end user environment. The electrical rating of the Imager power supply is 100-240 V~, 1.2 Amps, 47-63 Hz. The X-Ray Receiver is power from a 9 V battery.

The sample was received on December 11, 2002 and tested on December 11, December 13 and December 23, 2002. The EUT consisted of the following component(s):

Manufacturer	Model	Description	Serial Number
SAIC	RTR-4i Controller	Controller	
SAIC	RTR-4i Integrated Imager	Imager	
SAIC	RTR-4i RF Module	Transmitter	
SAIC	RTR-4i X-Ray Receiver	Receiver	
Golden Engineering	XR-200 X-Ray Source	X-Ray Source	
Sceptre	PSD-1822APL05	Power Supply	

OTHER EUT DETAILS

The Imaging system may be configured in wired and in wireless modes. In the wired mode, the RF module and X-Ray receiver are not used and cables are employed between the controller and imager and between the imager and the X-ray source. In the wireless mode, the cables are replaced with wireless links, one from the controller to the imager and one from the imager to the X-ray source. The RF module may be directly connected to the imager or connected with a cable. This is the remote wireless mode. This set of tests covers the wireless link between the Imager and the X-Ray source, which consists of a control transmitter operating at 418 MHz connected to the Imager and a corresponding receiver connected to the X-Ray source.

The system may also contain a WiFi Wireless LAN device (typically operating under FCC 15.247). This device will be a transmitter that has been approved by the FCC for mobile applications.

ENCLOSURE

The RF module enclosure is primarily constructed of aluminum. It measures approximately 30 cm wide by 16 cm deep by 35 cm high.

ANTENNA CONNECTOR

The antenna connector is an RP-SMA type from LINX Technologies, Inc. The connector is an SMA jack with a pin (i.e. reverse-sex) so that a standard SMA plug cannot be connected to it. This style of connector is not readily available and so meets the requirements of FCC 15.203.

SUPPORT EQUIPMENT

The following equipment was used as local support equipment for emissions testing:

Manufacturer/Model/Description	Serial Number
SAIC RTR-4i Integrated Imager X-Ray Imager	-

No remote support equipment was used during emissions testing, although the controller was used at a remote location to initial transmissions from the RF module during testing.

EXTERNAL I/O CABLING

The I/O cabling configuration during emissions testing was as follows:

		Cable(s)		
Port	Connected To	Description	Shielded or Unshielded	Length (m)
Imager RF module	RF module	Multicore	Shielded	2.8
Imager Power input	Power adapter	Two wire	Unshielded	1.5
Power adapter	AC Mains	Three wire	Unshielded	1.5

EUT OPERATION

The Transmitter was commanded to transmit during testing on command from the controller. For some tests, the transmitter was forced to transmit continuously using a push button (SW1) on the transmitter PCB.

COMMAND STRUCTURE

There is only one command sent by the transmitter - Fire the X-Ray Source. Due to the consistent rate at which x-ray pulses are fired, the number of pulses can be controlled by controlling the amount of time the x-ray source is told to fire. The Imager calculates this x-ray source on time and, when the Imager is ready to capture an image tells the transmitter to transmit. The receiver used on the x-ray source decodes the command signals and closes a relay that is connected to the x-ray source that tells the source to fire.

When the user of the system wants an x-ray of something, the user selects how many pulses the x-ray source should fire. That information is sent to the imager, which forwards the x-ray pulse count to the Microchip. The Microchip encrypts the pulse count and forwards the encrypted information to the Linx 418MHz transmitter module. The Microchip uses a 32 bit hopping code and the decoder in the x-ray trigger receiver may not synchronize during the first transmission. To guarantee that the fire x-ray pulses command gets through to the x-ray source, the fire x-ray pulses command is sent 3 times.

During qualification testing, the x-ray imaging system was placed in a factory diagnostics/testing mode, which repeatedly ordered the x-ray source to fire. The repeat interval was on the order of 4 to 6 seconds. Under expected operating conditions, the user will take 1 to 4 x-rays of an object per week. To alleviate any concerns about the switch SW1 in section 4C of drawing 120904, the switch is mounted on the printed wiring board inside the unit and is not accessible unless the cover has been removed. Refer to the Theory of Operations for more details.

TEST SITE

GENERAL INFORMATION

Final test measurements were taken on December 6, December 11 and December 23, 2002 at the Elliott Laboratories Open Area Test Site #3&4 located at 684 West Maude Avenue, Sunnyvale, California. The test site contains separate areas for radiated and conducted emissions testing. Pursuant to section 2.948 of the Rules, construction, calibration, and equipment data has been filed with the Commission.

The FCC recommends that ambient noise at the test site be at least 6 dB below the allowable limits. Ambient levels are below this requirement with the exception of predictable local TV, radio, and mobile communications traffic. The test site contains separate areas for radiated and conducted emissions testing. Considerable engineering effort has been expended to ensure that the facilities conform to all pertinent FCC requirements.

CONDUCTED EMISSIONS CONSIDERATIONS

Conducted emissions testing is performed in conformance with ANSI C63.4-1992. Measurements are made with the EUT connected to the public power network through a nominal, standardized RF impedance, which is provided by a line impedance stabilization network, known as a LISN. A LISN is inserted in series with each current-carrying conductor in the EUT power cord.

RADIATED EMISSIONS CONSIDERATIONS

The FCC has determined that radiation measurements made in a shielded enclosure are not suitable for determining levels of radiated emissions. Radiated measurements are performed in an open field environment. The test site is maintained free of conductive objects within the CISPR defined elliptical area incorporated in ANSI C63.4 guidelines.

MEASUREMENT INSTRUMENTATION

RECEIVER SYSTEM

An EMI receiver as specified in CISPR 16-1 is used for emissions measurements. The receivers used can measure over the frequency range of 9 kHz up to 2000 MHz. These receivers allow both ease of measurement and high accuracy to be achieved. The receivers have Peak, Average, and CISPR (Quasi-peak) detectors built into their design so no external adapters are necessary. The receiver automatically sets the required bandwidth for the CISPR detector used during measurements.

For measurements above the frequency range of the receivers, a spectrum analyzer is utilized because it provides visibility of the entire spectrum along with the precision and versatility required to support engineering analysis. Average measurements above 1000MHz are performed on the spectrum analyzer using the linear-average method with a resolution bandwidth of 1 MHz and a video bandwidth of 10 Hz.

INSTRUMENT CONTROL COMPUTER

The receivers utilize either a Rohde & Schwarz EZM Spectrum Monitor/Controller or contain an internal Spectrum Monitor/Controller to view and convert the receiver measurements to the field strength at an antenna or voltage developed at the LISN measurement port, which is then compared directly with the appropriate specification limit. This provides faster, more accurate readings by performing the conversions described under Sample Calculations within the Test Procedures section of this report. Results are printed in a graphic and/or tabular format, as appropriate. A personal computer is used to record all measurements made with the receivers.

The Spectrum Monitor provides a visual display of the signal being measured. In addition, the controller or a personal computer run automated data collection programs which control the receivers. This provides added accuracy since all site correction factors, such as cable loss and antenna factors are added automatically.

LINE IMPEDANCE STABILIZATION NETWORK (LISN)

Line conducted measurements utilize a fifty microhenry Line Impedance Stabilization Network as the monitoring point. The LISN used also contains a 250 uH CISPR adapter. This network provides for calibrated radio frequency noise measurements by the design of the internal low pass and high pass filters on the EUT and measurement ports, respectively.

FILTERS/ATTENUATORS

External filters and precision attenuators are often connected between the receiving antenna or LISN and the receiver. This eliminates saturation effects and non-linear operation due to high amplitude transient events.

ANTENNAS

A biconical antenna is used to cover the range from 30 MHz to 300 MHz and a log periodic antenna is utilized from 300 MHz to 1000 MHz. Narrowband tuned dipole antennas are used over the entire 30 to 1000 MHz range for precision measurements of field strength. Above 1000 MHz, a horn antenna is used. The antenna calibration factors are included in site factors programmed into the test receivers.

ANTENNA MAST AND EQUIPMENT TURNTABLE

The antennas used to measure the radiated electric field strength are mounted on a non-conductive antenna mast equipped with a motor-drive to vary the antenna height.

ANSI C63.4 specifies that the test height above ground for table mounted devices shall be 80 centimeters. Floor mounted equipment shall be placed on the ground plane if the device is normally used on a conductive floor or separated from the ground plane by insulating material from 3 to 12 mm if the device is normally used on a non-conductive floor. During radiated measurements, the EUT is positioned on a motorized turntable in conformance with this requirement.

INSTRUMENT CALIBRATION

All test equipment is regularly checked to ensure that performance is maintained in accordance with the manufacturer's specifications. All antennas are calibrated at regular intervals with respect to tuned half-wave dipoles. An exhibit of this report contains the list of test equipment used and calibration information.

TEST PROCEDURES

EUT AND CABLE PLACEMENT

The FCC requires that interconnecting cables be connected to the available ports of the unit and that the placement of the unit and the attached cables simulate the worst case orientation that can be expected from a typical installation, so far as practicable. To this end, the position of the unit and associated cabling is varied within the guidelines of ANSI C63.4, and the worst-case orientation is used for final measurements.

CONDUCTED EMISSIONS

Conducted emissions are measured at the plug end of the power cord supplied with the EUT. Excess power cord length is wrapped in a bundle between 30 and 40 centimeters in length near the center of the cord. Preliminary measurements are made to determine the highest amplitude emission relative to the specification limit for all the modes of operation. Placement of system components and varying of cable positions are performed in each mode. A final peak mode scan is then performed in the position and mode for which the highest emission was noted on all current carrying conductors of the power cord.

RADIATED EMISSIONS

Radiated emissions measurements are performed in two phases as well. A preliminary scan of emissions is conducted in which all significant EUT frequencies are identified with the system in a nominal configuration. At least two scans are performed from 30 MHz up to the frequency required by the regulation specified on page 1. One or more of these is with the antenna polarized vertically while the one or more of these is with the antenna polarized horizontally. During the preliminary scans, the EUT is rotated through 360°, the antenna height is varied and cable positions are varied to determine the highest emission relative to the limit.

A speaker is provided in the receiver to aid in discriminating between EUT and ambient emissions. Other methods used during the preliminary scan for EUT emissions involve scanning with near field magnetic loops, monitoring I/O cables with RF current clamps, and cycling power to the EUT.

Final maximization is a phase in which the highest amplitude emissions identified in the spectral search are viewed while the EUT azimuth angle is varied from 0 to 360 degrees relative to the receiving antenna. The azimuth, which results in the highest emission is then maintained while varying the antenna height from one to four meters. The result is the identification of the highest amplitude for each of the highest peaks. Each recorded level is corrected in the receiver using appropriate factors for cables, connectors, antennas, and preamplifier gain. Emissions, which have values close to the specification limit may also be measured with a tuned dipole antenna to determine compliance.

SPECIFICATION LIMITS AND SAMPLE CALCULATIONS

The limits for conducted emissions are given in units of microvolts, and the limits for radiated emissions are given in units of microvolts per meter at a specified test distance. Data is measured in the logarithmic form of decibels relative to one microvolt, or dB microvolts (dBuV). For radiated emissions, the measured data is converted to the field strength at the antenna in dB microvolts per meter (dBuV/m). The results are then converted to the linear forms of uV and uV/m for comparison to published specifications.

For reference, converting the specification limits from linear to decibel form is accomplished by taking the base ten logarithm, then multiplying by 20. These limits in both linear and logarithmic form are as follows:

CONDUCTED EMISSIONS SPECIFICATION LIMITS, SECTION 15.207

The table below shows the limits for the emissions on the AC power line from an intentional radiator and a receiver.

Frequency Range (MHz)	Limit (uV)	Limit (dBuV)
0.450 to 30.000	250	48

FUNDAMENTAL AND HARMONIC LIMITS 15.231 (b)

The table below shows the limits for both the Fundamental and Harmonic emissions for each frequency band of operation detailed in Section 15.231 (b) for control signals.

Operating Frequency (MHz)	Field strength (microvolts/m)	Harmonics (microvolts/m)
70 - 130	1250	125
130 - 174	1250 - 3750	125 - 375
174 – 260	3750	375
260 – 470	3750 – 12,500	375 - 1250
Above 470	12,500	1250

RADIATED EMISSIONS SPECIFICATION LIMITS, SECTION 15.209

The table below shows the limits for the spurious emissions from transmitters that fall in restricted bands.

Frequency Range (MHz)	Limit (uV/m @ 3m)	Limit (dBuV/m @ 3m)
0.009-0.490	$2400/F_{KHz}$ @ 300m	$67.6-20*\log_{10}(F_{KHz})$ @ 300m
0.490-1.705	$24000/F_{KHz}$ @ 30m	$87.6-20*\log_{10}(F_{KHz})$ @ 30m
1.705 to 30	30 @ 30m	29.5 @ 30m
30 to 88	100	40
88 to 216	150	43.5
216 to 960	200	46.0
Above 960	500	54.0

SAMPLE CALCULATIONS - CONDUCTED EMISSIONS

Receiver readings are compared directly to the conducted emissions specification limit (decibel form) as follows:

$$R_r - S = M$$

where:

R_r = Receiver Reading in dBuV

S = Specification Limit in dBuV

M = Margin to Specification in +/- dB

SAMPLE CALCULATIONS - RADIATED EMISSIONS

Receiver readings are compared directly to the specification limit (decibel form). The receiver internally corrects for cable loss, preamplifier gain, and antenna factor. The calculations are in the reverse direction of the actual signal flow, thus cable loss is added and the amplifier gain is subtracted. The Antenna Factor converts the voltage at the antenna coaxial connector to the field strength at the antenna elements. A distance factor, when used for electric field measurements, is calculated by using the following formula:

$$F_d = 20*LOG_{10} (D_m/D_s)$$

where:

F_d = Distance Factor in dB

D_m = Measurement Distance in meters

D_s = Specification Distance in meters

Measurement Distance is the distance at which the measurements were taken and Specification Distance is the distance at which the specification limits are based. The antenna factor converts the voltage at the antenna coaxial connector to the field strength at the antenna elements.

The margin of a given emission peak relative to the limit is calculated as follows:

$$R_c = R_r + F_d$$

and

$$M = R_c - L_s$$

where:

R_r = Receiver Reading in dBuV/m

F_d = Distance Factor in dB

R_c = Corrected Reading in dBuV/m

L_s = Specification Limit in dBuV/m

M = Margin in dB Relative to Spec

EXHIBIT 1: Test Equipment Calibration Data

1 Page

Conducted and Radiated Emissions, 03-Dec-02
Engineer: jgonzalez

Manufacturer	Description	Model #	Assett #	Cal interval	Last Calibrated	Cal Due
Elliott Laboratories	Log Periodic Antenna 300-1000 MHz	EL300.1000	55	12	10/25/2001	11/25/2002
EMCO	Biconical Antenna, 30-300 MHz	3110B	1320	12	6/3/2002	6/3/2003
Rohde & Schwarz	Pulse Limiter	ESH3 Z2	372	12	7/18/2002	7/18/2003
Rohde & Schwarz	Test Receiver, 0.009-30 MHz	ESH3	215	12	3/14/2002	3/14/2003
Rohde & Schwarz	Test Receiver, 20-1300MHz	ESVP	273	12	2/6/2002	2/6/2003
Solar Electronics Co	LISN	8028-50-TS-24-BNC	904	12	6/19/2002	6/19/2003

Radiated Emissions, 30 - 1000 MHz, 06-Dec-02
Engineer: Chris

Manufacturer	Description	Model #	Assett #	Cal interval	Last Calibrated	Cal Due
EMCO	Log Periodic Antenna, 0.2-2 GHz	3148	1321	12	4/23/2002	4/23/2003
Rohde & Schwarz	Test Receiver, 20-1300 MHz	ESVP	1317	12	5/3/2002	5/3/2003

Radiated Emissions, 30 - 6500 MHz, 11-Dec-02
Engineer: Chris

Manufacturer	Description	Model #	Assett #	Cal interval	Last Calibrated	Cal Due
EMCO	Log Periodic Antenna, 0.2-1 GHz	3146	1294	12	4/12/2002	4/12/2003
Rohde & Schwarz	Test Receiver, 0.009-2000 MHz	ESN	1332	12	4/16/2002	4/16/2003

Conducted and Radiated Emissions, 23-Dec-02
Engineer: jcadigal

Manufacturer	Description	Model #	Assett #	Cal interval	Last Calibrated	Cal Due
Elliott Laboratories	FCC / CISPR LISN	LISN-4, OATS	362	12	4/19/2002	4/19/2003
EMCO	Biconical Antenna, 30-300 MHz	3110B	1320	12	6/3/2002	6/3/2003
EMCO	Log Periodic Antenna, 0.2-2 GHz	3148	1347	12	10/30/2002	10/30/2003
Rohde & Schwarz	Pulse Limiter	ESH3 Z2	372	12	7/18/2002	7/18/2003
Rohde & Schwarz	Test Receiver, 0.009-30 MHz	ESH3	215	12	3/14/2002	3/14/2003
Rohde & Schwarz	Test Receiver, 20-1300MHz	ESVP	273	12	2/6/2002	2/6/2003

EXHIBIT 2: Test Data Log Sheets

ELECTROMAGNETIC EMISSIONS

TEST LOG SHEETS

AND

MEASUREMENT DATA

T49566 14 Pages

Elliott

EMC Test Data

Client:	SAIC	Job Number:	J49434
Model:	RTR-4i Imager System	T-Log Number:	T49545
		Proj Eng:	David Bare
Contact:	David Rose		
Emissions Spec:	FCC 15.231	Class:	-
Immunity Spec:	-	Environment:	-

EMC Test Data

For The

SAIC

Model

RTR-4i Imager System

Client:	SAIC	Job Number:	J49434
Model:	RTR-4i Imager System	T-Log Number:	T49545
		Proj Eng:	David Bare
Contact:	David Rose		
Emissions Spec:	FCC 15.231	Class:	-
Immunity Spec:	-	Environment:	-

EUT INFORMATION

General Description

The SAIC model RTR 4 Imaging System is a portable digital X-Ray imaging system, which is designed for in-field radioscopic imaging. It consists of several component parts and options. The RF module contains the transmitter and receives power and signals from the Imager. The RF module and X-Ray receiver can be placed in many positions during operation. The components of the system used for testing were treated as table-top equipment during testing to simulate the end user environment. The electrical rating of the Imager power supply is 100-240 V~, 1.2 Amps, 47-63 Hz. The X-Ray Receiver is powered from a 9 V battery.

Equipment Under Test

Manufacturer	Model	Description	Serial Number	FCC ID
SAIC	RTR-4i Controller	Controller	-	-
SAIC	RTR-4i Integrated Imager	Imager	-	-
SAIC	RTR-4i RF Module	Transmitter	-	-
SAIC	RTR-4i X-Ray Receiver	Receiver	-	-
Golden Engineering	XR-200 X-Ray Source	X-Ray Source	-	-
Sceptre	PSD-1822APL05	Power Supply	-	-

Other EUT Details

The EUT may be configured in wired and in wireless modes. In the wired mode, the RF module and X-Ray receiver are not used and cables are employed between the controller and imager and between the imager and the X-ray source. In the wireless mode, the cables are replaced with wireless links, one from the controller to the imager and one from the imager to the X-ray source. The RF module may be directly connected to the imager or connected with a cable. This is the remote wireless mode. This set of tests covers the wireless link between the Imager and the X-Ray source, which consists of a control transmitter operating at 418 MHz on the Imager and a corresponding receiver connected to the X-Ray source.

EUT Enclosure

The X-Ray receiver enclosure is primarily constructed of plastic and aluminum.It measures approximately 30 cm wide by 16cm deep by 35 cm high.

The X-Ray source enclosure is primarily constructed of plastic and aluminum. It measures approximately 11 cm wide by 32cm deep by 18 cm high.

The Imager enclosure is primarily constructed of plastic and aluminum. It measures approximately 33 cm wide by 28 cm deep by 5cm high.

Modification History

Mod. #	Test	Date	Modification
1	RE, CE	12/23/2002	Added ferrite to remote wireless I/O port

Client:	SAIC	Job Number:	J49434
Model:	RTR-4i Imager System	T-Log Number:	T49545
		Proj Eng:	David Bare
Contact:	David Rose		
Emissions Spec:	FCC 15.231	Class:	-
Immunity Spec:	-	Environment:	-

Test Configuration #1

Local Support Equipment

Manufacturer	Model	Description	Serial Number	FCC ID
SAIC	RTR-4i Integrated Imager	X-Ray Imager	-	-

Remote Support Equipment

Manufacturer	Model	Description	Serial Number	FCC ID
None				

Interface Cabling and Ports

		Cable(s)		
Port	Connected To	Description	Shielded or Unshielded	Length(m)
Imager RF module	RF Module	Multicore	Shielded	2.8
Imager Power input	Power adapter	Two wire	Unshielded	1.5
Power adapter	AC Mains	Three wire	Unshielded	1.5

EUT Operation During Emissions

The Transmitter was commanded to transmit during testing on command from the controller. For some tests, the transmitter was forced to transmit continuously using a push button on the transmitter PCB. The X-Ray source was not powered to prevent accidental exposure.

Elliott

EMC Test Data

Client:	SAIC	Job Number:	J49434
Model:	RTR-4i Imager System	T-Log Number:	T49545
		Proj Eng:	David Bare
Contact:	David Rose		
Spec:	FCC 15.231	Class:	-

Radiated Emissions

Test Specifics

Objective: The objective of this test session is to perform engineering evaluation testing of the EUT with respect to the specification listed above.

Date of Test: 12/6/2002
Test Engineer: Chris Byleckie
Test Location: SVOATS #4

Config. Used: 2
Config Change: None
EUT Voltage: 230V/50Hz

General Test Configuration

The EUT and all local support equipment were located on the turntable for radiated emissions testing. Remote support equipment was located approximately 30 meters from the test area

On the OATS, the measurement antenna was located 3 meters from the EUT for the measurement range 30 - 10000 MHz .

Ambient Conditions:

Temperature: 16°C
Rel. Humidity: 58%

Summary of Results

Run #	Test Performed	Limit	Result	Margin
1	RE, Preliminary Scan 30 - 4180 MHz	FCC 15.231(a)	Pass	Refer to individual runs

Modifications Made During Testing:

No modifications were made to the EUT during testing

Deviations From The Standard

No deviations were made from the requirements of the standard.

Elliott

EMC Test Data

Client:	SAIC	Job Number:	J49434
Model:	RTR-4i Imager System	T-Log Number:	T49545
		Proj Eng:	David Bare
Contact:	David Rose		
Spec:	FCC 15.231	Class:	-

Run #1: Preliminary Radiated Emissions, 30-4180 MHz
Avg value calculated using a 10.8 dB duty cycle correction factor obtained from a maximum on time during any 100 msec period of 28.8 msec.

Frequency	Level	Pol	FCC 15.231(a)		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
418.000	89.0	v	-	-	Pk	242	1.0	
418.000	78.2	v	80.3	-2.1	Avg	242	1.0	
428.930	19.3	v	46.0	-26.7	QP	163	1.0	Receiver LO
428.930	16.1	h	46.0	-29.9	QP	244	2.7	Receiver LO
836.000	24.5	v	60.3	-35.8	Pk	0	1.0	
1254.000	30.0	v	60.3	-30.3	Pk	0	1.0	noise floor
1672.000	33.2	v	60.3	-27.1	Pk	0	1.0	noise floor
2090.000	36.7	v	60.3	-23.6	Pk	0	1.0	noise floor
2508.000	40.1	v	60.3	-20.2	Pk	0	1.0	noise floor

Client:	SAIC	Job Number:	J49434
Model:	RTR-4i Imager System	T-Log Number:	T49545
		Proj Eng:	David Bare
Contact:	David Rose		
Spec:	FCC 15.231	Class:	N/A

Conducted Emissions

Test Specifics

Objective: The objective of this test session is to perform final qualification testing of the EUT with respect to the specification listed above.

Date of Test: 12/11/2002
Test Engineer: Chris Byleckie
Test Location: SVOATS #4

Config. Used: 1
Config Change:
EUT Voltage: 120V/60Hz

General Test Configuration

The EUT and all local support equipment were located on a table
When measuring the conducted emissions from the EUT's antenna port, the antenna port of the EUT was connected to the spectrum analyzer or power meter via a suitable attenuator to prevent overloading the measurement system. All measurements are corrected to allow for the external attenuators used.

Ambient Conditions:

Temperature: ??°C
Rel. Humidity:

Summary of Results

Run #	Test Performed	Limit	Result	Margin
1	20dB Bandwidth	15.231	Pass	Refer to plots
2	Duty Cycle	15.231	Pass	Refer to plots
3	Out of Band	15.231	Pass	Refer to plots

Modifications Made During Testing:

No modifications were made to the EUT during testing

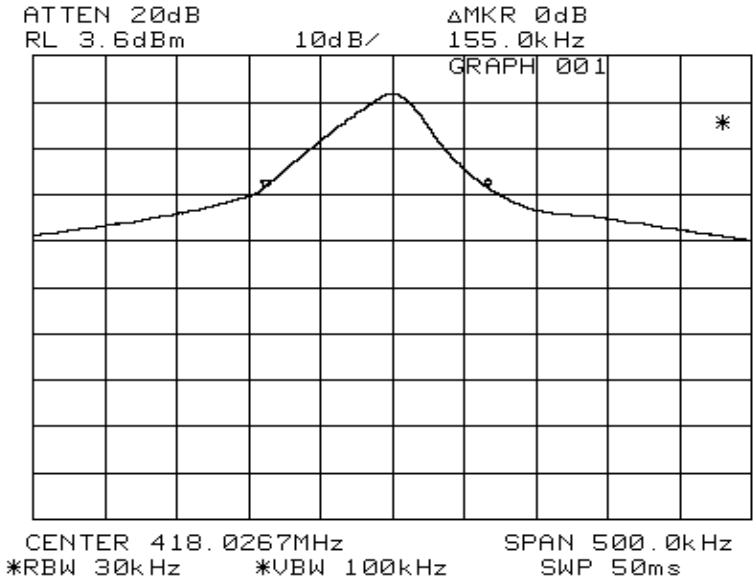
Deviations From The Standard

No deviations were made from the requirements of the standard.

Client:	SAIC	Job Number:	J49434
Model:	RTR-4i Imager System	T-Log Number:	T49545
		Proj Eng:	David Bare
Contact:	David Rose		
Spec:	FCC 15.231	Class:	N/A

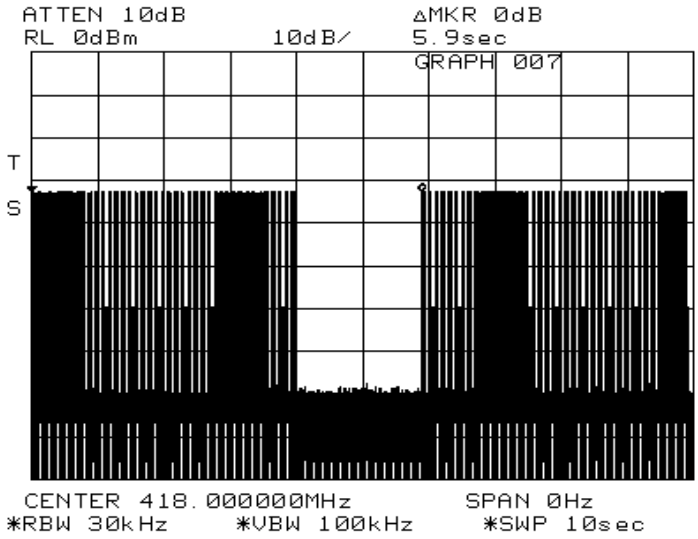
Run #1: 20dB Signal Bandwidth

Frequency (MHz)	Resolution Bandwidth	20dB Signal Bandwidth	Graph reference #
418.026	30kHz	155 kHz	1



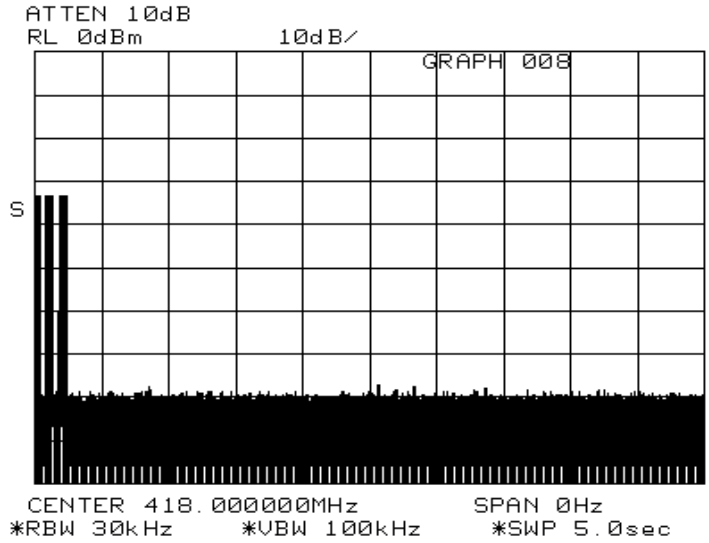
Client:	SAIC	Job Number:	J49434
Model:	RTR-4i Imager System	T-Log Number:	T49545
		Proj Eng:	David Bare
Contact:	David Rose		
Spec:	FCC 15.231	Class:	N/A

Run #2 Transmit duration and Duty Cycle
99 pulses, 0 delay 5 images, transmitted message



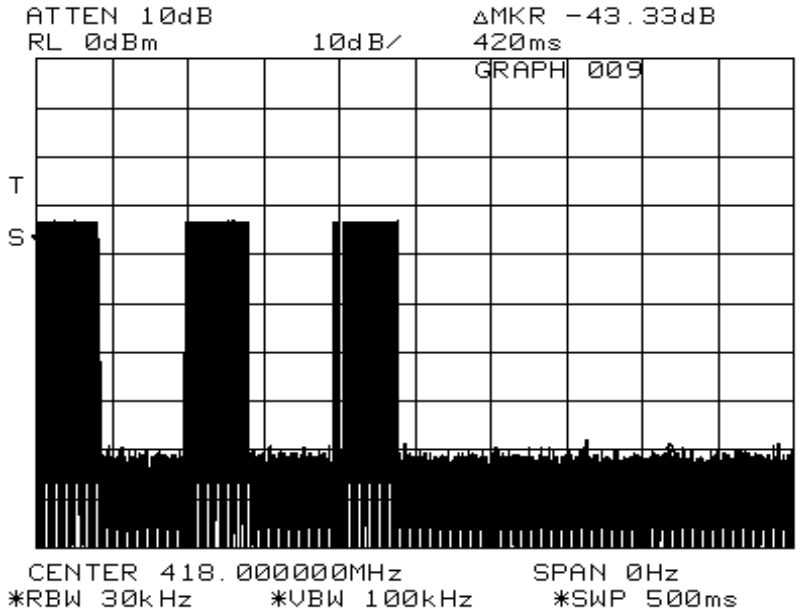
Maximun transmit duration < 5 sec

7 pulses, 0 delay, 1 image, Transmited message

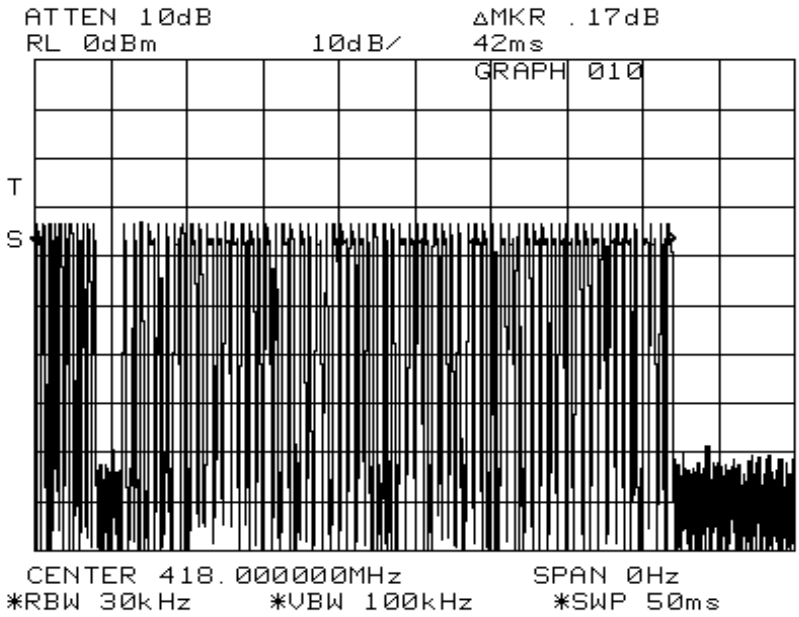


Client:	SAIC	Job Number:	J49434
Model:	RTR-4i Imager System	T-Log Number:	T49545
		Proj Eng:	David Bare
Contact:	David Rose		
Spec:	FCC 15.231	Class:	N/A

7 pulses, 0 delay, 1 image, Transmitted message

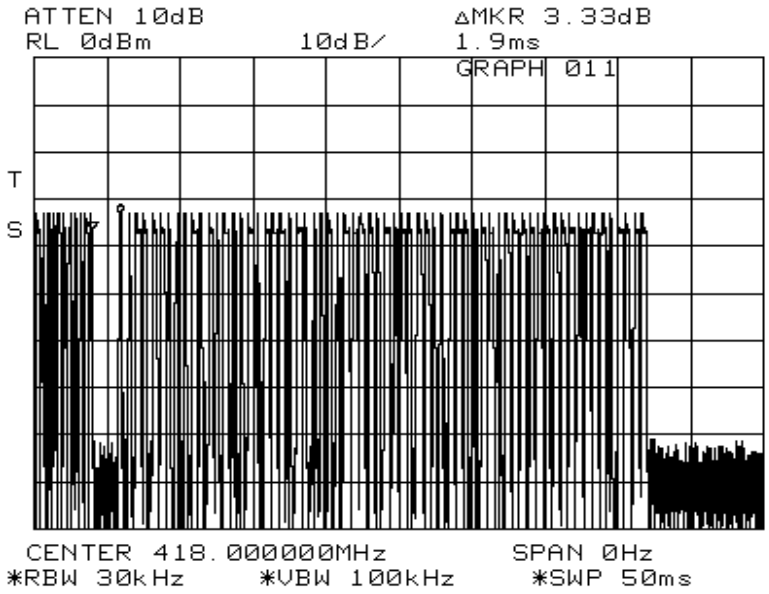


7 pulses, 0 delay, 1 image, transmitted word

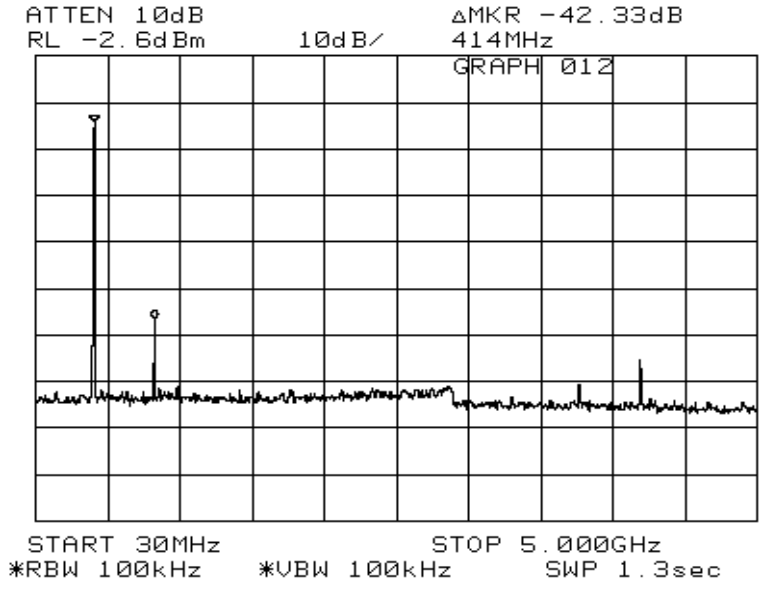


Client:	SAIC	Job Number:	J49434
Model:	RTR-4i Imager System	T-Log Number:	T49545
		Proj Eng:	David Bare
Contact:	David Rose		
Spec:	FCC 15.231	Class:	N/A

7 pulses, 0 delay, 1 image, Transmitted word



Run #3 Out of Band



Client:	SAIC	Job Number:	J49434
Model:	RTR-4i Imager System	T-Log Number:	T49545
		Proj Eng:	David Bare
Contact:	David Rose		
Spec:	FCC 15.231	Class:	-

Conducted Emissions - Power Ports

Test Specifics

Objective: The objective of this test session is to perform final qualification testing of the EUT with respect to the specification listed above.

Date of Test: 12/23/2002
Test Engineer: Joseph Cadigal
Test Location: SVOATS #3
Config. Used: 1
Config Change: none
EUT Voltage: 120V/60Hz

General Test Configuration

For tabletop equipment, the EUT was located on a wooden table, 40 cm from a vertical coupling plane and 80cm from the LISN.

Ambient Conditions:

Temperature: 11.2°C
Rel. Humidity: 47%

Summary of Results

Run #	Test Performed	Limit	Result	Margin
1	CE, AC Power 120V/60Hz	EN55022B	Pass	-8.0dB @ 0.194MHz

Modifications Made During Testing:

Modifications were made to the EUT during testing. See below.

Deviations From The Standard

No deviations were made from the requirements of the standard.

Elliott

EMC Test Data

Client:	SAIC	Job Number:	J49434
Model:	RTR-4i Imager System	T-Log Number:	T49545
		Proj Eng:	David Bare
Contact:	David Rose		
Spec:	FCC 15.231	Class:	-

Run #1: AC Power Port Conducted Emissions, 0.15 - 30MHz, 120V/60Hz
Stewart ferrite model 28A2024-0A0 added on remote wireless I/O port

Frequency	Level	AC	EN55022 B		Detector	Comments
MHz	dBµV	Line	Limit	Margin	QP/Ave	
0.194	45.9	Line 1	53.9	-8.0	Average	
0.192	45.7	Neutral	54.0	-8.3	Average	
0.192	55.3	Neutral	64.0	-8.7	QP	
0.194	55.1	Line 1	63.9	-8.8	QP	
0.447	37.3	Neutral	46.9	-9.6	Average	
0.255	39.9	Line 1	51.6	-11.7	Average	
0.447	43.8	Neutral	56.9	-13.1	QP	
0.255	47.8	Line 1	61.6	-13.8	QP	
0.314	27.2	Line 1	49.9	-22.7	Average	
0.314	36.0	Line 1	59.9	-23.9	QP	
0.177	39.7	Neutral	64.6	-24.9	QP	
0.177	17.8	Neutral	54.6	-36.8	Average	

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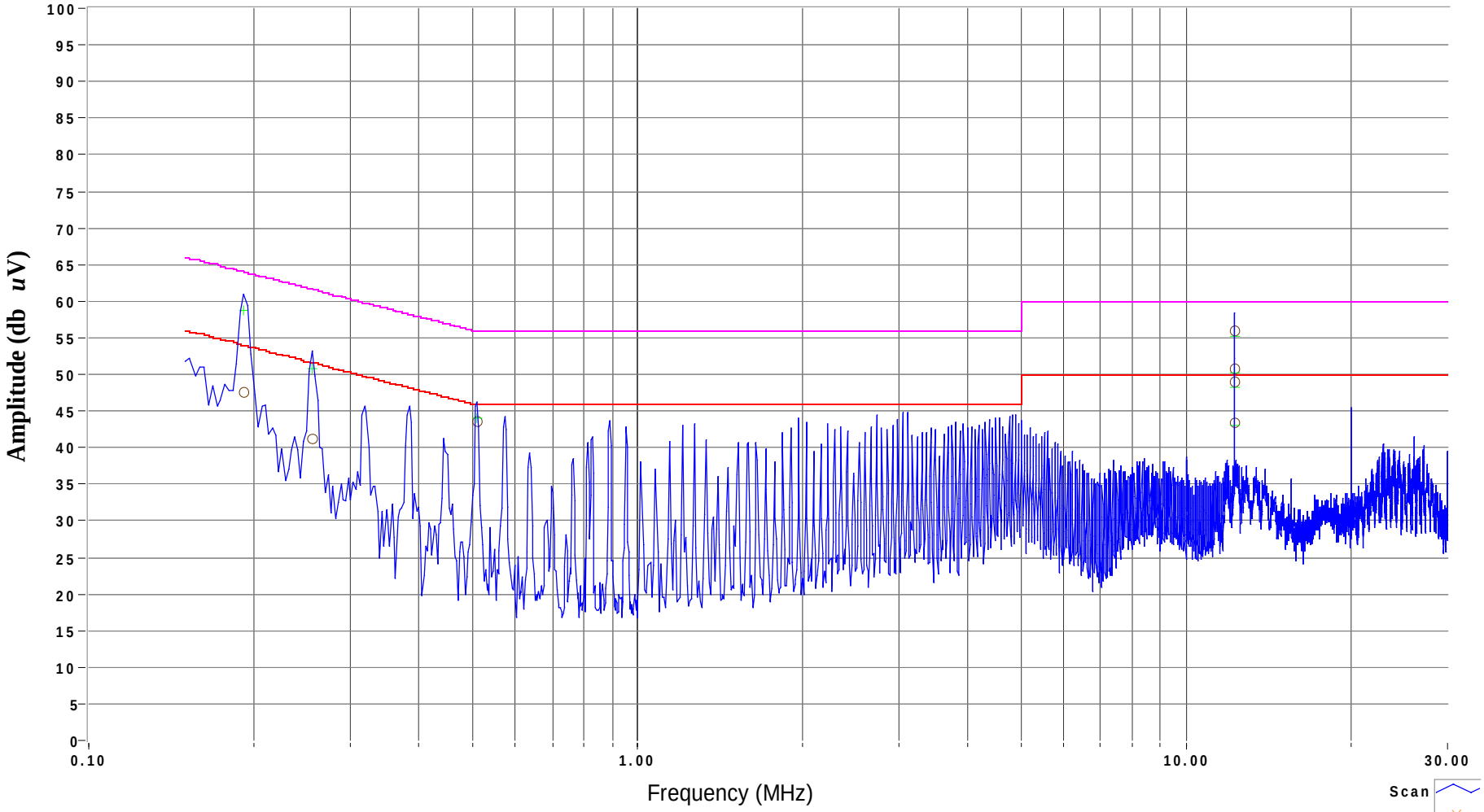
SVOATS #3: SAIC RT-4 Imager Run 1

Spec: EN55022B

Mains Lead Neutral

J48434 / T49566



120V / 60 Hz

Scan
Peak
Quasi-peak
Average
Average Limit
QuasiPeak Limit

12/13/02

Chris Byleckie

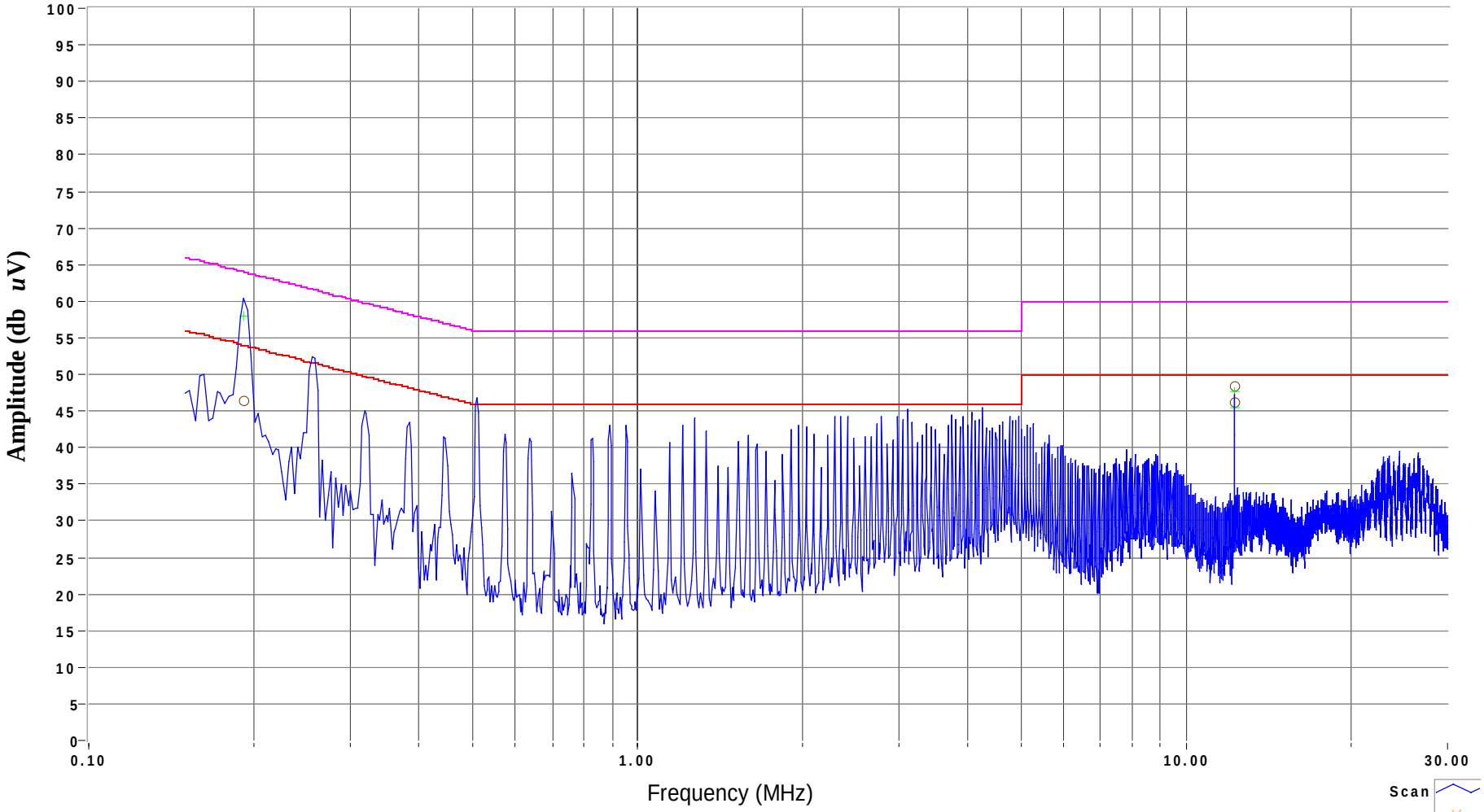
Elliott

SVOATS #3: SAIC RT-4 Imager Run 2

Spec: EN55022B

Mains Lead Neutral

T49434 / T49566



120V /60 Hz Single clip on ferrite (Fair Rite P/N 0444173951) on DC side of AC adapter right next to EUT

Scan
Peak
Quasi-peak
Average
Average Limit
QuasiPeak Limit

12/13/02

Chris Byleckie

EXHIBIT 3: Test Configuration Photographs

Uploaded as separate attachment

EXHIBIT 4: Theory of Operation SAIC Model RTR-4i Imaging System

Uploaded as separate attachment

EXHIBIT 5: Proposed FCC ID Label & Label Location

Uploaded as separate attachment

EXHIBIT 6: Detailed Photographs SAIC Model RTR-4i Imaging System

Uploaded as separate attachment

EXHIBIT 7: Installation Guide SAIC Model RTR-4i Imaging System

Uploaded as separate attachment

EXHIBIT 8: Block Diagram SAIC Model RTR-4i Imaging System

Uploaded as separate attachment

EXHIBIT 9: Schematic Diagrams SAIC Model RTR-4i Imaging System

Uploaded as separate attachment

EXHIBIT 10: RF Exposure Concerns

Uploaded as separate attachment