Elliott Laboratories Inc. 684 West Maude Avenue 408-245-7800 Phone
www.elliottlabs.com Sunnyvale, CA 94086-3518 408-245-3499 Fax

Electromagnetic Emissions Test Report and Application for Grant of Equipment Authorization pursuant to FCC Part 15, Subpart C (15.247) DTS Specifications and Industry Canada RSS 210 Issue 5 for an Intentional Radiator on the Thales Navigation, Inc. Model: Z-Max GPS Receiver

FCC ID:	NZI800963
GRANTEE:	Thales Navigation, Inc. 471 El Camino Real Santa Clara, CA 95050
TEST SITE:	Elliott Laboratories, Inc. 684 W. Maude Avenue Sunnyvale, CA 94086
REPORT DATE:	September 4, 2003
FINAL TEST DATE:	August 26, 2003

AUTHORIZED SIGNATORY: Mark Briggs

Mark Briggs
Director of Engineering

ACCREDITED

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

SCOPE

An electromagnetic emissions test has been performed on the Thales Navigation, Inc. model Z-Max GPS Receiver pursuant to Subpart C of Part 15 of FCC Rules for intentional radiators and RSS-210 Issue 5 for licence-exempt low power devices. 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 intentional radiator 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 Thales Navigation, Inc. model Z-Max GPS Receiver and therefore apply only to the tested sample. The sample was selected and prepared by Christian Legras of Thales Navigation, Inc.

The system was also tested against the relevant requirements of RSS 210 for a GPS receiver, the requirements of FCC Part 15 and RSS 119 for a UHF receiver, the requirements of FCC Part 24 and RSS 135 for a GSM radio and the requirements of FCC Part 15 and ICES 003 for digital devices. Test results for these requirements are contained in separate reports and, where applicable, in separate applications to industry Canada and the FCC.

OBJECTIVE

The primary objective of the manufacturer is compliance with Subpart C of Part 15 of FCC Rules and RSS-210 Issue 5 for license-exempt low power devices 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 that are subsequently manufactured.

SUMMARY OF RESULTS

FCC Part 15 Section	RSS 210 Section	Description	Measured Value	Comments	Result
	6.2.2(o)(a)	20dB Bandwidth	790 kHz	The channel spacing shall be greater than the 20dB bandwidth	Complies
	6.2.2(o)(a)	Channel Separation	990 kHz		Complies
	6.2.2(o)(a)	Number of Channels	79	2400- 2483.5 MHz: For systems with 75 or more hopping frequencies: average time of occupancy <0.4 second within a 30 second period.	Complies
	6.2.2(o)(a)	Channel Dwell Time	0.38 Seconds per 30 seconds		Complies
	6.2.2(o)(a)	Channel Utilization	All channels are used equally	Device uses the BlueTooth algorithm that meets all of the channel utilization requirements of 15.247 and RSS 210	Complies
15.247 (b) (3)	6.2.2(o)(a)	Output Power, 2400 - 2483.5 MHz	4.0 dBm (0.0025 Watts) EIRP = 0.0025 W	Multi-point applications: Maximum permitted is 1Watt, with EIRP limited to 4 Watts	Complies
15.247(c)	6.2.2(o)(e1)	Transmitter Spurious Emissions – 30MHz – 25GHz	No external antenna port – radiated measurements were made.	All spurious emissions < -20dBc.	Complies
15.247(c) / 15.209		Transmitter Radiated Spurious Emissions 30MHz – 25GHz	-7.3dB @ 2385.3MHz	Emissions in restricted bands must meet the radiated emissions limits detailed in 15.207. All others must be < -20dBc	Complies
	Table 3	Receiver Radiated Spurious Emissions 30MHz – 8GHz	No signals observed within 20dB of the limit	Emissions must meet the radiated emissions limits detailed in Table 3	Complies
15.207		AC Conducted Emissions	-9.2dB @ 4.904MHz		Complies
	6.6	AC Conducted Emissions	-8.6dB @ 4.904MHz		Complies
15.247 (b) (5)		RF Exposure Requirements	Output power is below 25mW and below the low threshold for SAR evaluation. Output power is below 5mW so not subject to co-location restrictions.		Complies
15.203		RF Connector	Integral antenna	Integral antenna or specialized connector required	Complies

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 Thales Navigation, Inc. model Z-Max GPS Receiver is a mobile surveying instrument. It contains a control module and various options of communications modules. In addition it has a battery module for power when in the portable mode, two external serial ports, one RS232 and one configurable in RS232 or RS422 and a dc input port. The main enclosure has a screw mount in the top that can accommodate the GPS, UHF, VOID (GPS pass through) receive antennas, or an adapter that provides coaxial ports for the GPS receive antenna and UHF receive antenna. If being used as a mobile device the Void or UHF receiver is used and the GPS antenna connects into the top of either, otherwise it connects directly into the screw mount.

The control module contains a BlueTooth FHSS transceiver and is intended to be used for short-distance communications with a control computer. It has an USB Port and a SD Interface.

The communications module may contain a GSM Transceiver and / or an UHF Receiver. The UHF receiver incorporated into this module is either one from a Pacific Crest series that cover the frequency range 410 - 470 MHz or a Thales receiver that covers the same frequency range. The GSM transceiver is a Motorola cellular transceiver module for data communications.

The device is designed to be used in two modes - portable mode and office mode. Portable mode is the mode used for field survey measurements. In this mode the device would be powered from its battery pack and the only peripheral connected would be either an external UHF transceiver or a field computer. Office mode is the mode used to download data from the device. In this mode the USB connection would be employed to transfer data from the instrument into a PC. As this is a professional product the Class A limits are appropriate for office mode.

The sample was received on August 21, 2003 and tested on August 26, 2003. The EUT consisted of the following component(s):

Manufacturer	Model	Description	Serial Number
Thales Navigation	800963	Main Unit	
Thales Navigation	800964-08	Com Module (Pacific Crest UHF Rx and GSM TRx)	
Thales Navigation	800964-09	Com Module (Pacific Crest UHF Rx and GSM TRx)	
Thales Navigation	800964-10	Com Module (Pacific Crest UHF Rx and GSM TRx)	
Thales Navigation	800964-07	Com Module (Thales UHF Rx and GSM TRx)	
Thales Navigation		Control Module	
Thales Navigation		Battery Module	

OTHER EUT DETAILS

The following UHF radios are the optional UHF receivers that may be incorporated into the communications module. Tests were performed on each receiver module.

Pacific Crest 800964-08 410-430MHz
Pacific Crest 800964-09 430-450MHz
Pacific Crest800964-10 450-470MHz
Thales Navigation 800964-07 410-470 MHz

The following Bluetooth transceiver chip is used:

Samsung BTMZ5012

The following PCS module is used:

Motorola FCC ID: IHDT6ZC1

ENCLOSURE

The main enclosure, which houses the BlueTooth transceiver and the GPS receiver) is primarily constructed from a magnesium alloy. It measures approximately 30cm tall with a triangular base section measuring 10cm x 10cm x 10cm. The optional UHF antenna that connects into the top of the main unit is approximately 60cm long.

The com module, which houses the optional UHF receiver and optional GSM modem, is primarily constructed from a magnesium alloy. It measures approximately 18cm tall and 4cm deep and 8cm wide.

MODIFICATIONS

The EUT did not require modifications during testing in order to comply with the emission specifications.

SUPPORT EQUIPMENT

Manufacturer / Model / Description	Serial Number	FCC ID
IBM / Thinkpad 2647-46U / Laptop	78-KBKA9	DoC

EUT INTERFACE PORTS

Port	Connected To	Cable(s)		
		Description	Shielded or Unshielded	Length(m)
RS232 Port B	Laptop serial	multiwire	shielded	
USB	Laptop USB	multiwire	shielded	
Pwr in	AC adapter	2 wire	unshielded	
RS433 / RS 232 Port A				

Note: Port A was not connected as the manufacturer stated that either Port A or Port B would be used and they would not both be used at the same time.

For the transmitter-related and receiver-related radiated emissions tests the USB port was not connected. Preliminary testing demonstrated that the connection of these ports only affected the digital device-related emissions and had no affect on the emissions due to the receivers or the transmitters.

EUT OPERATION DURING TESTING

The BlueTooth transmitter was set to operate in either a continuous transmit mode (maximum packet length, minimum inter-packer delay of 1us) on the specified channel (top, center or bottom) or in hopping mode for transmitter-related tests. For receiver related tests the transceiver was configured to operate in receive-only mode on the specified channel.

ANTENNA REQUIREMENTS

The antenna is integral to the device (mounted directly to the circuit board) and therefore meets the requirements of FCC 15.203.

TEST SITE

GENERAL INFORMATION

Final test measurements were taken on August 26, 2003at the Elliott Laboratories Open Area Test Site #1&2 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 Federal Communications Commission. In accordance with Industry Canada rules detailed in RSS 210 Issue 5 and RSS-212, construction, calibration, and equipment data for the test sites have been filed with the Federal Communications 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 and 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.

POWER METER

A power meter and peak power sensor are used for all direct output power measurements from transmitters as they provide a broadband indication of the power output.

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.

CONDUCTED EMISSIONS FROM ANTENNA PORT

Direct measurements are performed with the antenna port of the EUT connected to either the power meter or spectrum analyzer via a suitable attenuator and/or filter. These are used to ensure that the front end of the measurement instrument is not overloaded by the fundamental transmission.

Measurement bandwidths (video and resolution) are set in accordance with FCC procedures for the type of radio being tested.

SPECIFICATION LIMITS AND SAMPLE CALCULATIONS

The limits for conducted emissions from the AC power port are given in units of microvolts, the limits for radiated electric field emissions are given in units of microvolts per meter at a specified test distance and the output power limits are given in temrs of Watts, milliwatts or dBm. 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.

Where the radiated electric field strength is expressed in terms of the equivalent isotropic radiated power (eirp) the following formula is used to determine the field strength limit in terms of microvolts per meter at a distance of 3m from the equipment under test:

$$E = \frac{1000000 \text{ v } 30 \text{ P}}{3} \quad \text{microvolts per meter}$$

where P is the eirp (Watts)

For reference, converting the voltage and electric field strength specification limits from linear to decibel form is accomplished by taking the base ten logarithm, then multiplying by 20. Conversion of power specification limits from linear units (in milliwatts) to decibel form (in dBm) is accomplished by taking the base ten logarithm, then multiplying by 10.

FCC 15.407 (a)and RSS 210 (o) OUTPUT POWER LIMITS

The table below shows the limits for output power and output power density. Where the signal bandwidth is less than 20 MHz the maximum output power is reduced to the power spectral density limit plus 10 times the log of the bandwidth (in MHz).

Operating Frequency (MHz)	Number Of Channels	Output Power
902 – 928	>=50	1 W (30 dBm)
902 – 928	< 50	0.25 W (24 dBm)
2400 – 2483.5	>= 75	1 W (30 dBm)
2400 – 2483.5	>= 75	0.125 W (21 dBm)
5725 – 5850	>=75	1 W (30 dBm)

The maximum permitted output power is reduced by 1dB for every dB the antenna gain exceeds 6dBi. Fixed point-to-point applications using the 5725 – 5850 MHz band are not subject to this restriction.

RSS 210 (o) AND FCC 15.247 SPURIOUS RADIATED EMISSIONS LIMITS

T limits for unwanted (spurious) emissions from the transmitter falling in the restricted bands detailed in Part 15.205 and for all spurious emissions from the receiver are:

Frequency Range (MHz)	Limit (uV/m @ 3m)	Limit (dBuV/m @ 3m)
30 to 88	100	40
88 to 216	150	43.5
216 to 960	200	46.0
Above 960	500	54.0

All other unwanted (spurious) emissions shall be at least 20dB below the level of the highest in-band signal level.

FCC AC POWER PORT CONDUCTED EMISSIONS LIMITS

The table below shows the limits for emissions on the AC power line as detailed in FCC Part 15.207.

Frequency (MHz)	Average Limit (dBuV)	Quasi Peak Limit (dBuV)
0.150 to 0.500	Linear decrease on logarithmic frequency axis between 56.0 and 46.0	Linear decrease on logarithmic frequency axis between 66.0 and 56.0
0.500 to 5.000	46.0	56.0
5.000 to 30.000	50.0	60.0

RSS-210 SECTION 6.6 AC POWER PORT CONDUCTED EMISSIONS LIMITS

The table below shows the limits for emissions on the AC power line as detailed in Industry Canada RSS-210 section 6.6.

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

SAMPLE CALCULATIONS - CONDUCTED EMISSIONS

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

$$R_r - B = C$$

and

$$C - S = M$$

where:

R_r = Receiver Reading in dBuV

B = Broadband Correction Factor*

C = Corrected Reading in dBuV

S = Specification Limit in dBuV

M = Margin to Specification in +/- dB

* Broadband Level - Per ANSI C63.4, 13 dB may be subtracted from the quasi-peak level if it is determined that the emission is broadband in nature. If the signal level in the average mode is six dB or more below the signal level in the peak mode, the emission is classified as broadband.

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

Radiated Emissions, 30 - 6500 MHz, 21-Aug-03
Engineer: Mark

Manufacturer	Description		Model #	Assett #	Cal interval	Last Calibrated	Cal Due
Elliott Laboratories	Biconical Antenna, 30-300 MHz		EL30.300	773	12	3/18/2003	3/18/2004
EMCO	Horn Antenna, D. Ridge 1-18GHz		3115	487	12	4/24/2003	4/24/2004
EMCO	Log Periodic Antenna, 0.2-2 GHz		3148	1321	12	3/31/2003	3/31/2004
Filtek	High Pass Filter, 1GHz		HP12/1000-5BA	955	12	4/3/2003	4/3/2004
Hewlett Packard	EMC Spectrum Analyzer, Opt. 026	9 KHz -26.5GHz	8593EM	1141	12	3/19/2003	3/19/2004
Hewlett Packard	Microwave Preamplifier, 1-26.5GHz		8449B	785	12	1/24/2003	1/24/2004
Rohde & Schwarz	Test Receiver, 0.009-2000 MHz		ESN	1332	12	7/24/2003	7/24/2004

Conducted and Radiated Emissions, 26-Aug-03
Engineer: Chris

Manufacturer	Description		Model #	Assett #	Cal interval	Last Calibrated	Cal Due
Elliott Laboratories	FCC / CISPR LISN		LISN-3, OATS	304	12	7/1/2003	7/1/2004
EMCO	Biconical Antenna, 30-300 MHz		3110B	801	12	5/13/2003	5/13/2004
EMCO	Horn Antenna, D. Ridge 1-18GHz		3115	1242	12	10/9/2002	10/9/2003
EMCO	Log Periodic Antenna, 0.3-1 GHz		3146A	364	12	9/12/2002	9/12/2003
Filtek	High Pass Filter, 1GHz		HP12/1000-5BA	956	12	3/11/2003	3/11/2004
Hewlett Packard	Microwave Preamplifier, 1-26.5GHz		8449B	870	12	1/10/2003	1/10/2004
Rohde& Schwarz	Pulse Limiter		ESH3 Z2	812	12	1/10/2003	1/10/2004
Rohde & Schwarz	Test Receiver, 9kHz-2750MHz		ESCS 30	1337	12	12/27/2002	12/27/2003
Solar Electronics Co	LISN		8028-50-TS-24-BNC support	904	12	8/7/2003	8/7/2004
Hewlett Packard	EMC Spectrum Analyzer, Opt. 026	9 KHz -26.5GHz	8593EM	1141	12	3/19/2003	3/19/2004

EXHIBIT 2: Test Data Log Sheets

ELECTROMAGNETIC EMISSIONS

TEST LOG SHEETS

AND

MEASUREMENT DATA

T52370 20 Pages

Elliott

EMC Test Data

Client:	Thales Navigation	Job Number:	J52303
Model:	Z_Max GPS Receiver	T-Log Number:	T52370
		Account Manager:	Mike Conrad
Contact:	Christian Legras		
Emissions Spec:	FCC 15 B,C; RSS210; RSS119	Class:	A/B
Immunity Spec:		Environment:	

EMC Test Data

For The

Thales Navigation

Model

Z_Max GPS Receiver

Date of Last Test: 8/26/2003

Client:	Thales Navigation	Job Number:	J52303
Model:	Z_Max GPS Receiver	T-Log Number:	T52370
		Account Manager:	Mike Conrad
Contact:	Christian Legras		
Emissions Spec:	FCC 15 B,C; RSS210; RSS119	Class:	A/B
Immunity Spec:	Enter immunity spec on cover	Environment:	

EUT INFORMATION

General Description

The EUT is a mobile surveying instrument. It contains a control module and various options of communications modules. In addition it has a battery module for power when in the portable mode, two external serial ports, one RS232 and one configurable in RS232 or RS422 and a dc input port. The main enclosure has a screw mount in the top that can accommodate the GPS, UHF, VOID (GPS pass through) receive antennas, or an adapter that provides coaxial ports for the GPS receive antenna and UHF receive antenna. If being used as a mobile device the Void or UHF receiver is used and the GPS antenna connects into the top of either, otherwise it connects directly into the screw mount.

The control module contains a BlueTooth FHSS transceiver and is intended to be used for short-distance communications with a control computer. It has an USB Port and a SD Interface.

The communications module may contain a GSM Transceiver and / or an UHF Receiver. The UHF receiver incorporated into this module is either one from a Pacific Crest series that cover the frequency range 410 - 470 MHz or a Thales receiver that covers the same frequency range. The communication module can also contain a Motorola cellular transceiver module for data communications.

The device is designed to be used in two modes - portable mode and office mode. Portable mode is the mode used for field survey measurements. In this mode the device would be powered from its battery pack and the only peripheral connected would be either an external UHF transceiver or a field computer. Office mode is the mode used to download data from the device. In this mode the USB connection would be employed to transfer data from the instrument into a PC. As this is a professional product the Class A limits are appropriate.

Equipment Under Test

Manufacturer	Model	Description	Serial Number	FCC ID
Thales Navigation	800963	Main Unit		
Thales Navigation	800964-08	Com Module (Pacific Crest UHF Rx and PCS TRx)		
Thales Navigation	800964-09	Com Module (Pacific Crest UHF Rx and PCS TRx)		
Thales Navigation	800964-10	Com Module (Pacific Crest UHF Rx and PCS TRx)		
Thales Navigation	800964-07	Com Module (Thales UHF Rx and PCS TRx)		
Thales Navigation		Control Module		
Thales Navigation		Battery Module		

Client:	Thales Navigation	Job Number:	J52303
Model:	Z_Max GPS Receiver	T-Log Number:	T52370
		Account Manager:	Mike Conrad
Contact:	Christian Legras		
Emissions Spec:	FCC 15 B,C; RSS210; RSS119	Class:	A/B
Immunity Spec:	Enter immunity spec on cover	Environment:	

Other EUT Details

The following UHF radios are the optional UHF receivers that may be incorporated into the communications module. Tests were performed on each receiver module.

Pacific Crest 800964-08 410-430MHz
Pacific Crest 800964-09 430-450MHz
Pacific Crest 800964-10 450-470MHz
Thales Navigation 800964-07 410-470 MHz

The following BlueTooth chipset was tested with Z-Max:
Samsung BTMZ5012x0

The following PCS module was tested with Z-Max:
Motorola IHDT6AC1

EUT Enclosure

The main enclosure, which houses the BlueTooth transceiver and the GPS receiver) is primarily constructed from a magnesium alloy. It measures approximately 30cm tall with a triangular base section measuring 10cm x 10cm x 10cm. The optional UHF antenna that connects into the top of the main unit is approximately 60cm long.

The com module, which houses the optional UHF receiver and optional GSM modem, is primarily constructed from a magnesium alloy. It measures approximately 18cm tall and 4cm deep and 8cm wide.

Modification History

Mod. #	Test	Date	Modification
1	-	-	None

Modifications applied are assumed to be used on subsequent tests unless otherwise stated as a further modification.

Client:	Thales Navigation	Job Number:	J52303
Model:	Z_Max GPS Receiver	T-Log Number:	T52370
		Account Manager:	Mike Conrad
Contact:	Christian Legras		
Emissions Spec:	FCC 15 B,C; RSS210; RSS119	Class:	A/B
Immunity Spec:	Enter immunity spec on cover	Environment:	

Test Configuration #1 - "Office Mode"

Local Support Equipment

Manufacturer	Model	Description	Serial Number	FCC ID
IBM	Thinkpad	Laptop	78-KBKA9	DoC

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)
RS232 Port B	Laptop serial	multiwire	shielded	
USB	Laptop USB	multiwire	shielded	
Pwr in	AC adapter	2 wire	unshielded	
RS433/RS 232 Port A				

Note: The RS433 port was not connected as the manufacturer stated that either the RS232 or the RS433 would be used. They would not both be used a the same time

EUT Operation During Emissions

The receiver was set to operate at the top, bottom or center of its operating range during testing.
The BlueTooth transmitter was set to operate in either a continuous transmit mode on the specified channel (top, center or bottom) or in hopping mode for transmitter-related tests. For receiver related tests the transceiver was configured to operate in receive-only mode on the specified channel.
The host laptop was displaying a scrolling 'H' pattern on its screen and both serial ports (USB and RS232) were active.

Client:	Thales Navigation	Job Number:	J52303
Model:	Z_Max GPS Receiver	T-Log Number:	T52370
		Account Manager:	Mike Conrad
Contact:	Christian Legras		
Emissions Spec:	FCC 15 B,C; RSS210; RSS119	Class:	A/B
Immunity Spec:	Enter immunity spec on cover	Environment:	

Test Configuration #2 - "Portable Mode"

Local Support Equipment

Manufacturer	Model	Description	Serial Number	FCC ID
IBM	Thinkpad	Laptop	78-KBKA9	DoC

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)
RS232 Port A	Laptop serial	multiwire	shielded	
USB	Not connected			
Pwr in	Not connected			
RS433 Port B	Not connected			

Note: In portable mode the only connection that would be used would either one of the serial ports. The port would connect to an external UHF transceiver or to a field computer. The laptop was used to simulate the field computer. As Port A and Port B serial ports are electrically identical, Port B was used during testing.

For the transmitter-related and receiver-related radiated emissions tests the USB port was not connected. Preliminary testing demonstrated that the connection of these ports only affected the digital device-related emissions and had no affect on the emissions due to the receivers or the transmitters.

EUT Operation During Emissions

The receiver was set to operate at the top,bottom or center of its operating range during testing.
The BlueTooth transmitter was set to operate in either a continuous transmit mode (maximum packet length, minimum inter-packer delay of 1us) on the specified channel (top, center or bottom) or in hopping mode for transmitter-related tests. For receiver related tests the transceiver was configured to operate in receive-only mode on the specified channel

Client:	Thales Navigation	Job Number:	J52303
Model:	Z_Max GPS Receiver	T-Log Number:	T52370
		Account Manager:	Mike Conrad
Contact:	Christian Legras		
Spec:	FCC 15 B,C; RSS210; RSS119	Class:	A/B

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: 8/26/2003
Test Engineer: Chris Byleckie
Test Location: SVOATS #1
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. A second LISN was used for all local support equipment.

Ambient Conditions:

Temperature: 21 °C
Rel. Humidity: 70 %

Summary of Results

Run #	Test Performed	Limit	Result	Margin
1	CE, AC Power, 120V/60Hz	FCC 15.207, 15.107	Pass	-9.2dB @ 4.904MHz
1	CE, AC Power, 120V/60Hz	RSS 210	Pass	-8.6dB @ 4.904MHz
2	CE, AC Power,120V/60Hz	FCC 15.207, 15.107	Pass	-9.9dB @ 4.982MHz
2	CE, AC Power, 120V/60Hz	RSS 210	Pass	-10.0dB @ 14.181MHz

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:	Thales Navigation	Job Number:	J52303
Model:	Z_Max GPS Receiver	T-Log Number:	T52370
		Account Manager:	Mike Conrad
Contact:	Christian Legras		
Spec:	FCC 15 B,C; RSS210; RSS119	Class:	A/B

Run #1: AC Power Port Conducted Emissions, 0.15 - 30MHz, 120V/60Hz
Pacific Crest 800964-10 450-470MHz UHF receiver
UHF receiver set 460MHz, BlueTooth transmitting at 2440MHZ

Frequency	Level	AC	FCC 15.207		Detector	Comments
MHz	dBµV	Line	Limit	Margin	QP/Ave	
4.904	36.8	Line	46.0	-9.2	Average	
0.384	36.5	Line	48.2	-11.7	Average	
0.306	37.9	Neutral	50.1	-12.2	Average	
14.025	35.1	Neutral	50.0	-14.9	Average	
14.557	34.2	Line	50.0	-15.8	Average	
4.904	39.4	Line	56.0	-16.6	QP	
3.513	27.7	Neutral	46.0	-18.3	Average	
0.384	39.5	Line	58.2	-18.7	QP	
14.557	40.0	Line	60.0	-20.0	QP	
0.306	39.9	Neutral	60.1	-20.2	QP	
3.513	34.5	Neutral	56.0	-21.5	QP	
14.025	37.7	Neutral	60.0	-22.3	QP	

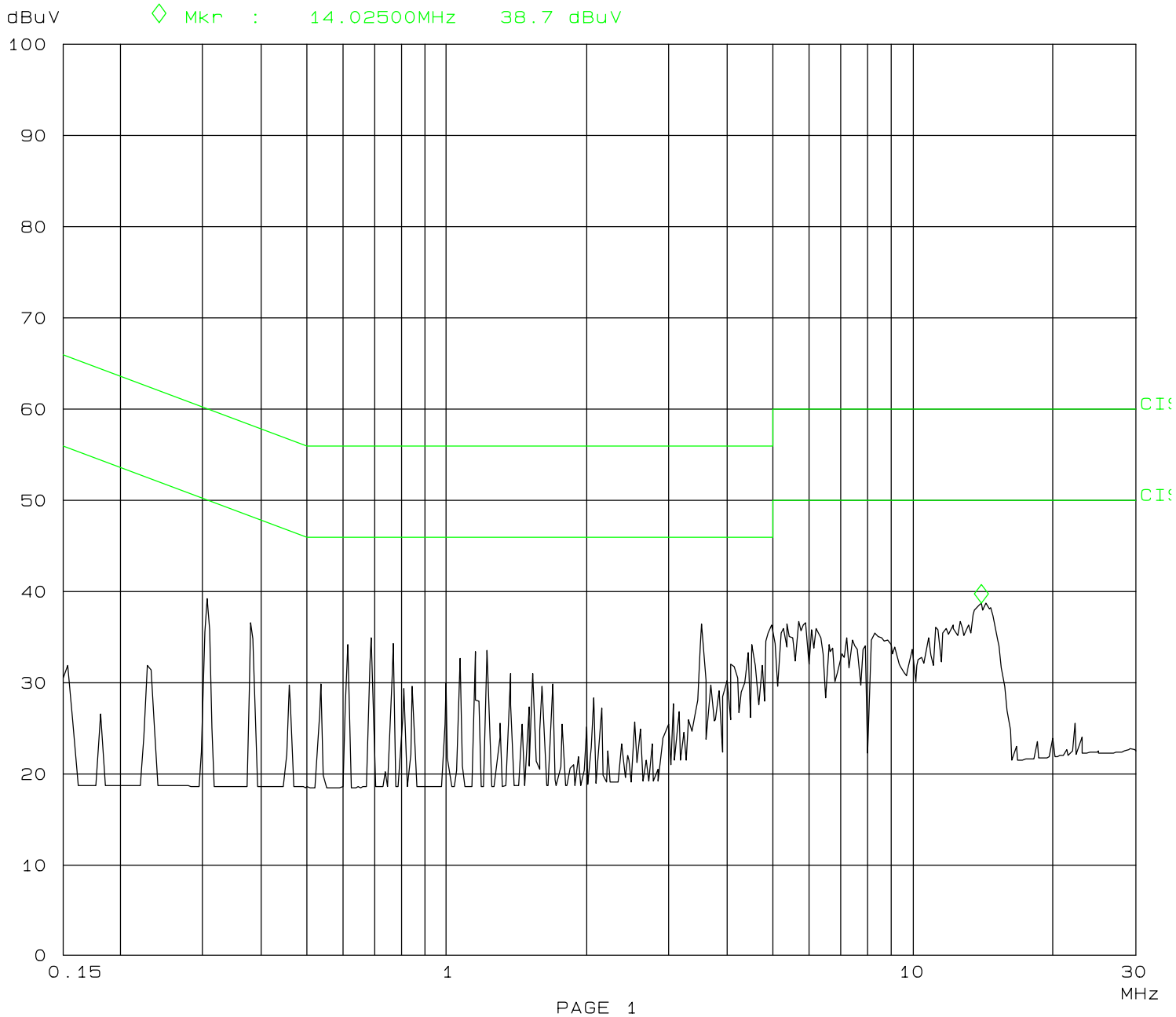
Frequency	Level	AC	RSS 210		Detector	Comments
MHz	dBµV	Line	Limit	Margin	QP/Ave	
4.904	39.4	Line	48.0	-8.6	QP	
14.557	40.0	Line	48.0	-8.0	QP	
3.513	34.5	Neutral	48.0	-13.5	QP	
14.025	37.7	Neutral	48.0	-10.3	QP	

Elliott Laboratories

26. Aug 03 12:11

AC Conducted Emissions

EUT:	Z_Max GPS Receiver w/ Pac Crest UHF rcvr
Manuf:	Thales Navigation
Op Cond:	120V/60 Hz
Operator:	Chris Byleckie
Test Spec:	EN55022 B
Comment:	J52303/T52370
	RUN1 (Neutral)

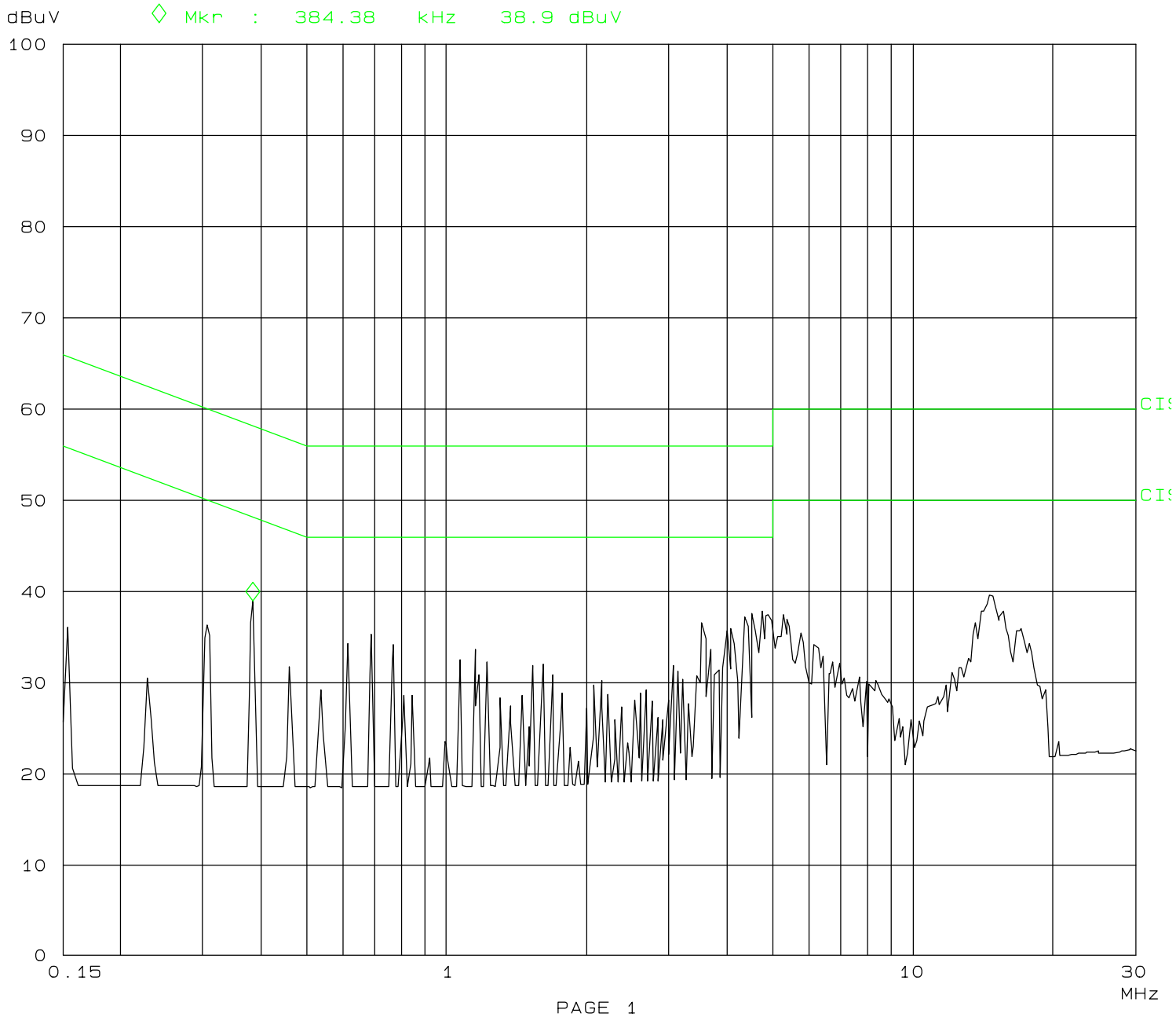


Elliott Laboratories

AC Conducted Emissions

26. Aug 03 12:05

EUT:	Z_Max GPS Receiver w/ Pac Crest UHF rcvr
Manuf:	Thales Navigation
Op Cond:	120V/60 Hz
Operator:	Chris Byleckie
Test Spec:	EN55022 B
Comment:	J52303/T52370
	RUN1 (Line1)



Elliott

EMC Test Data

Client:	Thales Navigation	Job Number:	J52303
Model:	Z_Max GPS Receiver	T-Log Number:	T52370
		Account Manager:	Mike Conrad
Contact:	Christian Legras		
Spec:	FCC 15 B,C; RSS210; RSS119	Class:	A/B

Run #2: AC Power Port Conducted Emissions, 0.15 - 30MHz, 120V/60Hz
Thales Navigation 800964-07 UHF receiver
UHF receiver set on at 450MHz, BlueTooth transmitting at 2440MHZ

Frequency	Level	AC	FCC 15.207		Detector	Comments
MHz	dBµV	Line	Limit	Margin	QP/Ave	
4.982	36.1	Line	46.0	-9.9	Average	
0.306	38.0	Neutral	50.1	-12.1	Average	
0.306	36.9	Line	50.1	-13.2	Average	
14.485	34.5	Line	50.0	-15.5	Average	
5.365	34.0	Neutral	50.0	-16.0	Average	
14.181	33.2	Neutral	50.0	-16.8	Average	
4.982	37.0	Line	56.0	-19.0	QP	
0.306	39.2	Neutral	60.1	-20.9	QP	
0.306	38.5	Line	60.1	-21.6	QP	
14.181	38.0	Neutral	60.0	-22.0	QP	
14.485	37.9	Line	60.0	-22.1	QP	
5.365	35.3	Neutral	60.0	-24.7	QP	

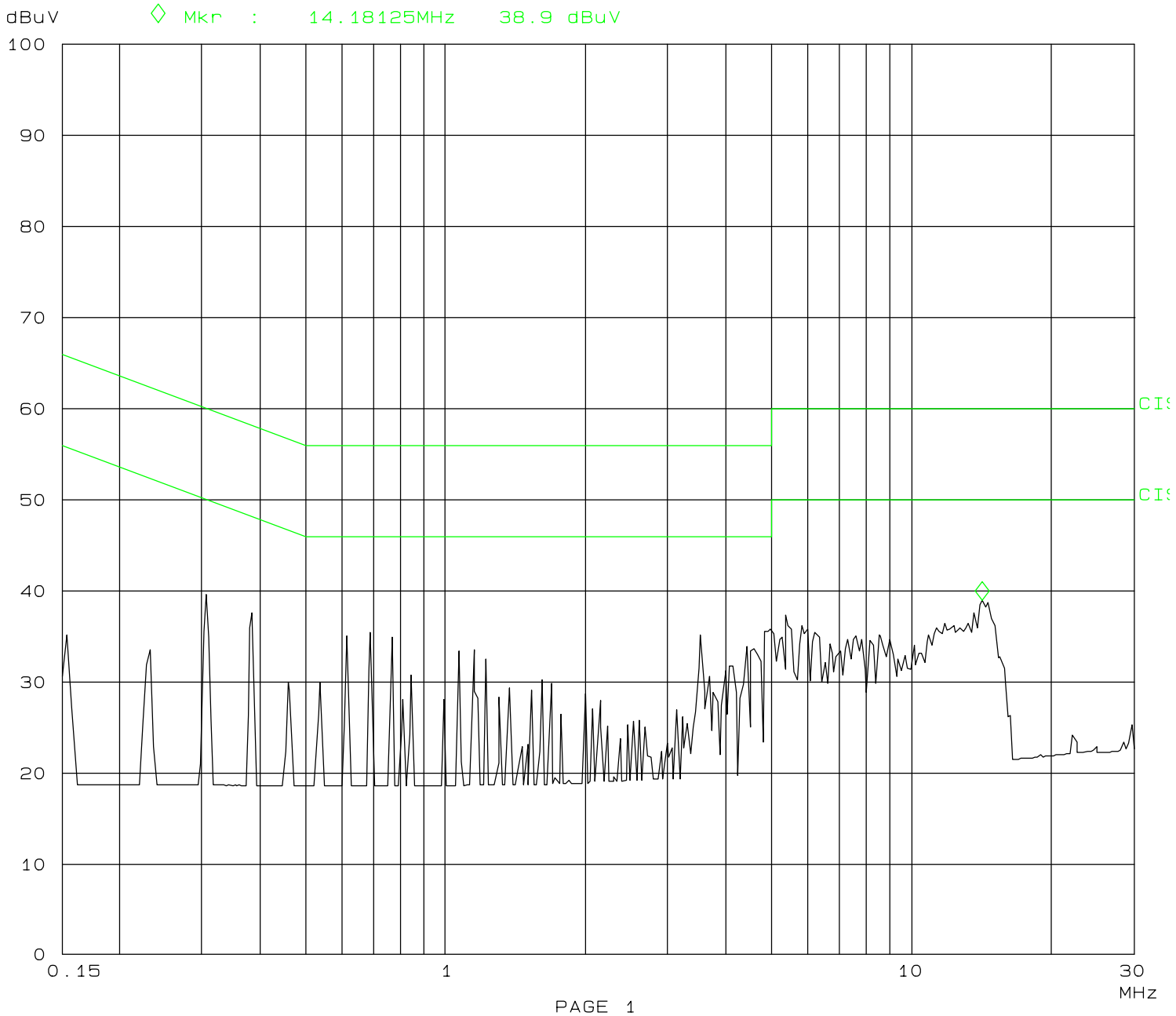
Frequency	Level	AC	RSS 210		Detector	Comments
MHz	dBµV	Line	Limit	Margin	QP/Ave	
14.181	38.0	Neutral	48.0	-10.0	QP	
14.485	37.9	Line	48.0	-10.1	QP	
4.982	37.0	Line	48.0	-11.0	QP	
5.365	35.3	Neutral	48.0	-12.7	QP	

Elliott Laboratories

26. Aug 03 12:20

AC Conducted Emissions

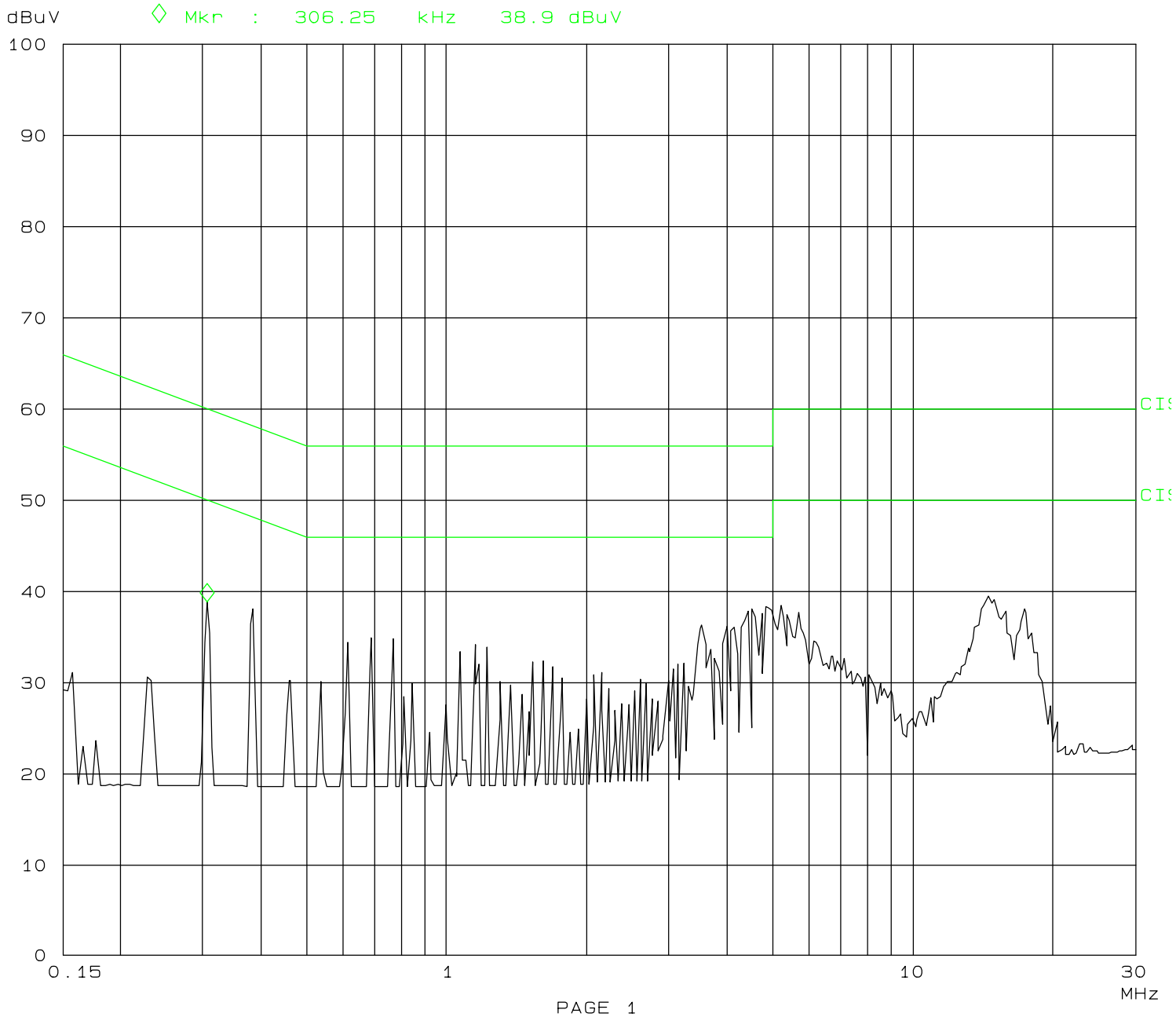
EUT:	Z_Max GPS Receiver w/ Thales UHF rcvr
Manuf:	Thales Navigation
Op Cond:	120V/60 Hz
Operator:	Chris Byleckie
Test Spec:	EN55022 B
Comment:	J52303/T52370
	RUN2 (Neutral)



Elliott Laboratories
AC Conducted Emissions

26. Aug 03 12:24

EUT:	Z_Max GPS Receiver w/ Thales UHF rcvr
Manuf:	Thales Navigation
Op Cond:	120V/60 Hz
Operator:	Chris Byleckie
Test Spec:	EN55022 B
Comment:	J52303/T52370
	RUN2 (Line)



Client:	Thales Navigation	Job Number:	J52303
Model:	Z_Max GPS Receiver	T-Log Number:	T52370
		Account Manager:	Mike Conrad
Contact:	Christian Legras		
Spec:	FCC 15 B,C; RSS210; RSS119	Class:	N/A

Radiated 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: 8/25/2003
Test Engineer: Marissa Faustino
Test Location: SVOATS #1

Config. Used: 2
Config Change: none
EUT Voltage: 120V/60Hz

General Test Configuration

The EUT and all local support equipment were located on the turntable for radiated spurious emissions testing. All remote support equipment was located approximately 30 meters from the EUT with all I/O connections running on top of the groundplane or routed in overhead in the GR-1089 test configuration.

For radiated emissions testing the measurement antenna was located 3 meters from the EUT.

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.

Unless stated otherwise the EUT was operating such that it constantly hopped on either the low, center or high channels.

Ambient Conditions:

Temperature: 22 °C
Rel. Humidity: 68 %

Summary of Results

Run #	Test Performed	Limit	Result	Margin
1	RE, 30MHz - 25GHz MHz - Spurious Emissions	FCC Part 15.209 / 15.247(c)	Pass	-7.3dB @ 2385.3MHz
2	20dB Bandwidth	15.247(a)	Pass	790 kHz
3	Output Power	15.247(b)	Pass	4.0dBm (0.0025W)
4	Channel Spacing	15.247(a)	Pass	990 kHz
4	Channel Occupancy	15.247(a)	Pass	380ms per 30 seconds
4	Number of Channels	15.247(a)	Pass	79
5	RE, 30MHz - 8GHz MHz - Spurious Emissions	RSS 210 (Receiver Mode)	Pass	> 20dB

Client:	Thales Navigation	Job Number:	J52303
Model:	Z_Max GPS Receiver	T-Log Number:	T52370
		Account Manager:	Mike Conrad
Contact:	Christian Legras		
Spec:	FCC 15 B,C; RSS210; RSS119	Class:	N/A

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.

Run #1a: Radiated Spurious Emissions, 30 - 26.5 MHz. Low Channel @ 2402 MHz

	H	V
Fundamental emission level @ 3m in 3MHz RBW:	82.7	83.1
Fundamental emission level @ 3m in 100kHz RBW:		83.0
Limit for emissions outside of restricted bands:	63 dBµV/m	

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
2385.280	46.7	V	54.0	-7.3	Avg	290	1.2	Restricted Band below 2390MHz
4804.000	44.9	V	54.0	-9.1	Avg	0	1.2	Noise Floor
2385.280	59.4	V	74.0	-14.6	Pk	290	1.2	Restricted Band below 2390MHz
4804.000	58.0	V	74.0	-16.0	Pk	0	1.2	Noise Floor

Note 1:	For emissions in restricted bands, the limit of 15.209 was used. For all other emissions, the limit was set 20dB below the level of the fundamental.
Note 2:	No other significant emissions from the system above 5GHz were observed.

Run #1b: Radiated Spurious Emissions, 30 - 26.5 MHz. Center Channel @ 2440 MHz

	H	V
Fundamental emission level @ 3m in 3MHz RBW:	81.7	80.8
Fundamental emission level @ 3m in 100kHz RBW:	81.1	80.2
Limit for emissions outside of restricted bands:	61.1 dBµV/m	

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
4880.000	57.2	H	74.0	-16.8	Pk	0	1.0	noise floor
4880.000	45.2	H	54.0	-8.8	Avg	0	1.0	noise floor

Note 1:	For emissions in restricted bands, the limit of 15.209 was used. For all other emissions, the limit was set 20dB below the level of the fundamental.
Note 2:	No other significant emissions from the system above 5GHz were observed.

Client:	Thales Navigation	Job Number:	J52303
Model:	Z_Max GPS Receiver	T-Log Number:	T52370
		Account Manager:	Mike Conrad
Contact:	Christian Legras		
Spec:	FCC 15 B,C; RSS210; RSS119	Class:	N/A

Run #1c: Radiated Spurious Emissions, 30 - 26.5 MHz. High Channel @ 2480 MHz

	H	V
Fundamental emission level @ 3m in 3MHz RBW:	81.2	81.1
Fundamental emission level @ 3m in 100kHz RBW:	79.4	
Limit for emissions outside of restricted bands:	59.4 dBµV/m	

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
2483.500	48.7	H	74.0	-25.3	Pk	0	1.1	Restricted Band above 2483.5 MHz
2483.500	36.1	H	54.0	-17.9	Avg	0	1.1	Restricted Band above 2483.5 MHz
4960.000	58.1	H	74.0	-15.9	Pk	0	1.0	Noise Floor
4960.000	45.5	H	54.0	-8.5	Avg	0	1.0	Noise Floor

Note 1:	For emissions in restricted bands, the limit of 15.209 was used. For all other emissions, the limit was set 20dB below the level of the fundamental.
Note 2:	No other significant emissions from the system above 5GHz were observed.

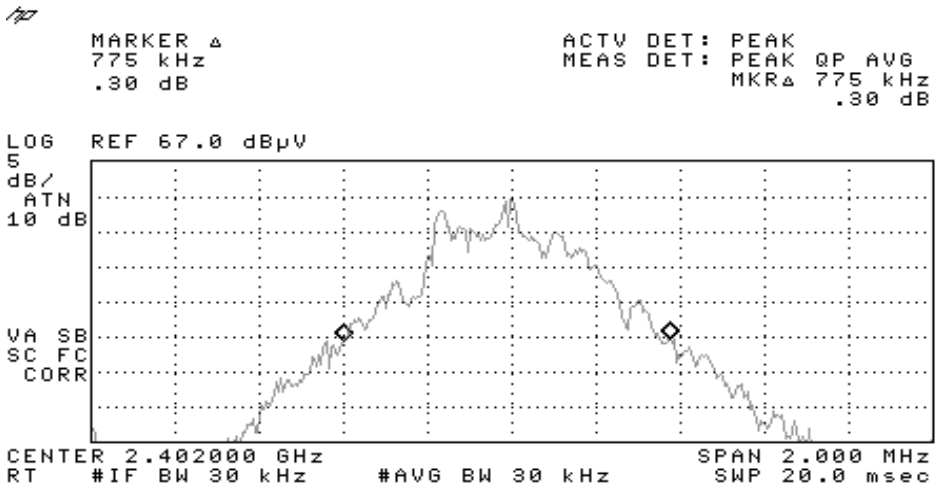
Run #2: Signal Bandwidth

Channel	Frequency (MHz)	Resolution Bandwidth	20dB Signal Bandwidth (MHz)	Graph reference #
Low	2402	30kHz	0.775	201
Mid	2440	30kHz	0.790	202
High	2480	30kHz	0.730	203

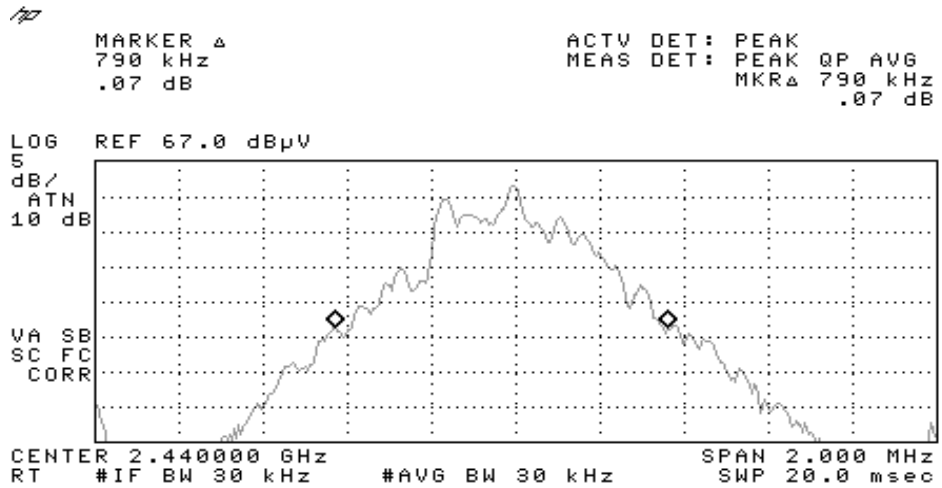
Client:	Thales Navigation	Job Number:	J52303
Model:	Z_Max GPS Receiver	T-Log Number:	T52370
		Account Manager:	Mike Conrad
Contact:	Christian Legras		
Spec:	FCC 15 B,C; RSS210; RSS119	Class:	N/A

Run #2: Signal Bandwidth

201



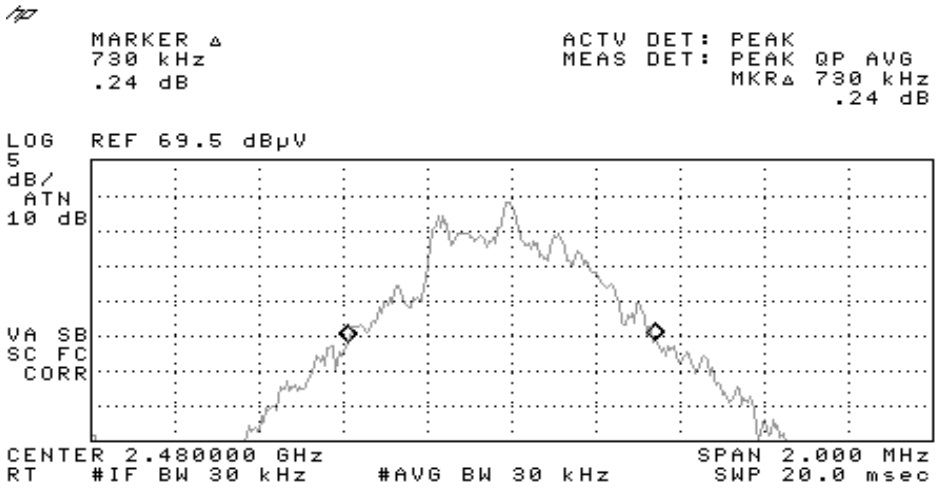
202



Client:	Thales Navigation	Job Number:	J52303
Model:	Z_Max GPS Receiver	T-Log Number:	T52370
		Account Manager:	Mike Conrad
Contact:	Christian Legras		
Spec:	FCC 15 B,C; RSS210; RSS119	Class:	N/A

Run #2: Signal Bandwidth

203



Run #3: Output Power

Frequency (MHz)	Field Strength at 3m	Antenna Pol. (H/V)	Output Power (dBm)	Output Power (W)
2402	83.1	V	3.7	0.0023
2440	81.7	H	3.2	0.0021
2480	81.2	H	4.0	0.0025

Note 1:	Radiated field strength measurements made during run #1 using RBW=VBW=3MHz
Note 2:	Output Power determined using antenna substitution method. See table below.

Antenna Substitution Measurements

Measurements made by injecting a signal level of ~0dBm into a reference antenna (EMCO 3115 Horn antenna) and adjusting the signal level until the received field strength at 3m equaled the field strength from the EUT. The EIRP was then calculated by summing the input power to the reference antenna (dBm) and the gain of the reference antenna (dBi). This method was used as the gain of the EUT's antenna was not known.

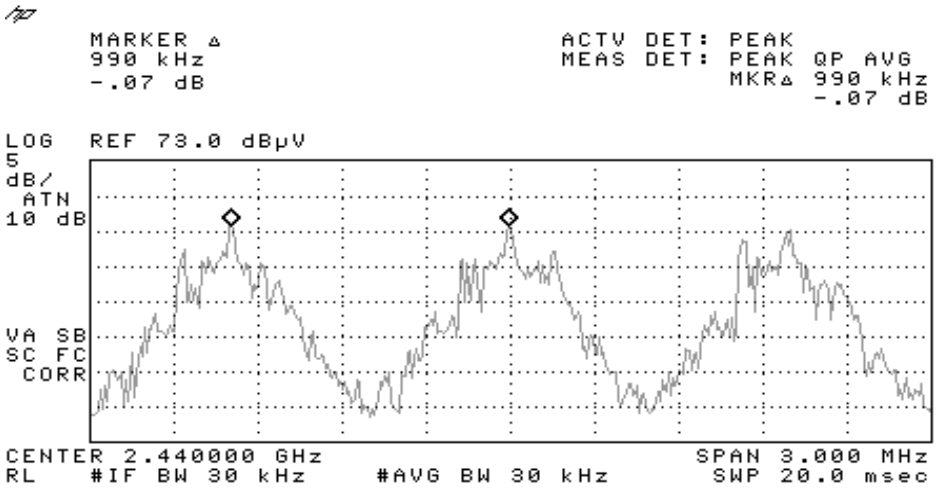
Frequency (MHz)	Field Strength at 3m	Antenna Pol. (H/V)	Antenna Gain	Input Power	EIRP (dBm)
2402	83.1	V	8.8	-5.1	3.7
2440	81.7	H	8.9	-5.7	3.2
2480	81.2	H	8.9	-4.9	4.0

Client:	Thales Navigation	Job Number:	J52303
Model:	Z_Max GPS Receiver	T-Log Number:	T52370
		Account Manager:	Mike Conrad
Contact:	Christian Legras		
Spec:	FCC 15 B,C; RSS210; RSS119	Class:	N/A

Run #4: Channel Occupancy And Spacing

The channel occupancy was measured with the radio transmitting normally (i.e. In hopping mode)

The channel spacing was: 0.990 MHz



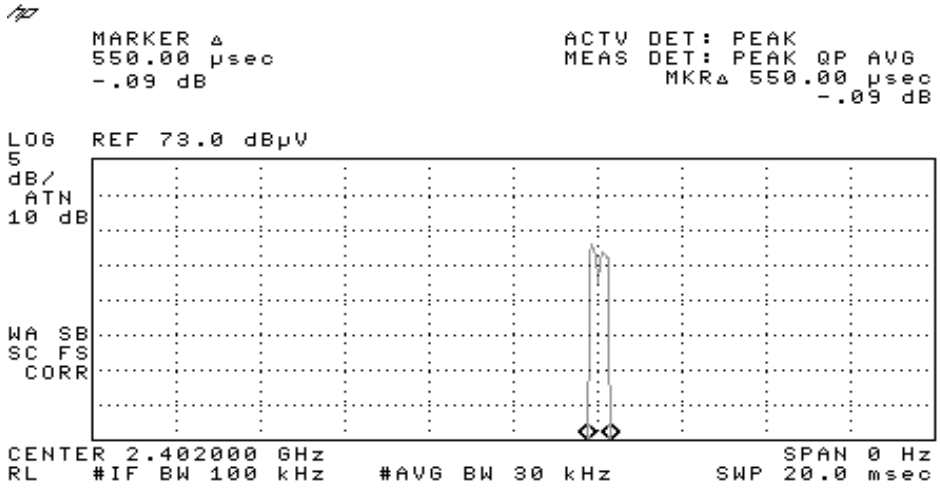
Run #5: Channel Occupancy And Spacing

The channel occupancy was measured with the radio transmitting normally (i.e. In hopping mode)

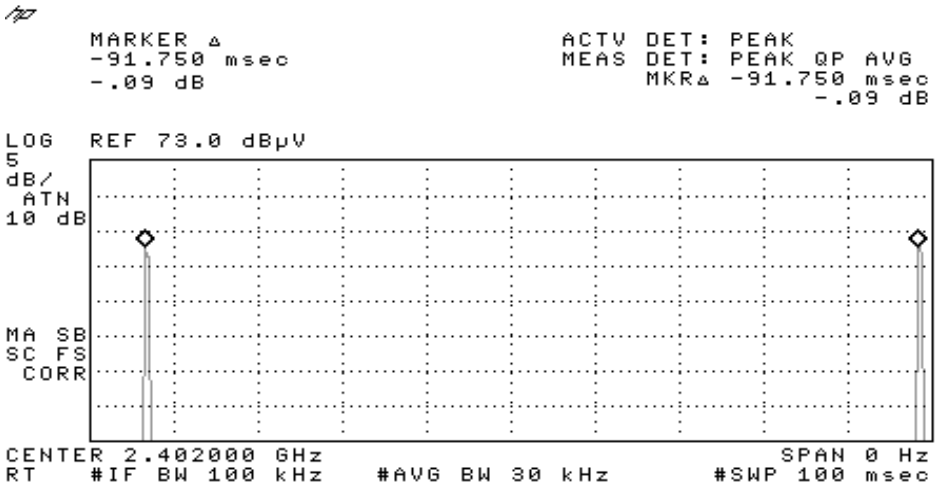
The transmit time on the channel was:	0.55	ms
The interval between hops on the same channel was:	0.09175	seconds
The number of channels was:	79	
Occupancy time per channel (interval / number of channels):	0.001161	ms
Number of times per 30 seconds a channel is used:	327	
The transmit time per channel per 30 second:	179.8	ms
The occupancy time (Tx+Rx) per channel per 30 seconds:	0.38	ms

Client:	Thales Navigation	Job Number:	J52303
Model:	Z_Max GPS Receiver	T-Log Number:	T52370
		Account Manager:	Mike Conrad
Contact:	Christian Legras		
Spec:	FCC 15 B,C; RSS210; RSS119	Class:	N/A

Plot showing transmit time on a channel (.55ms)



Plot showing time spacing between successive transmissions on the same channel (91.75ms)

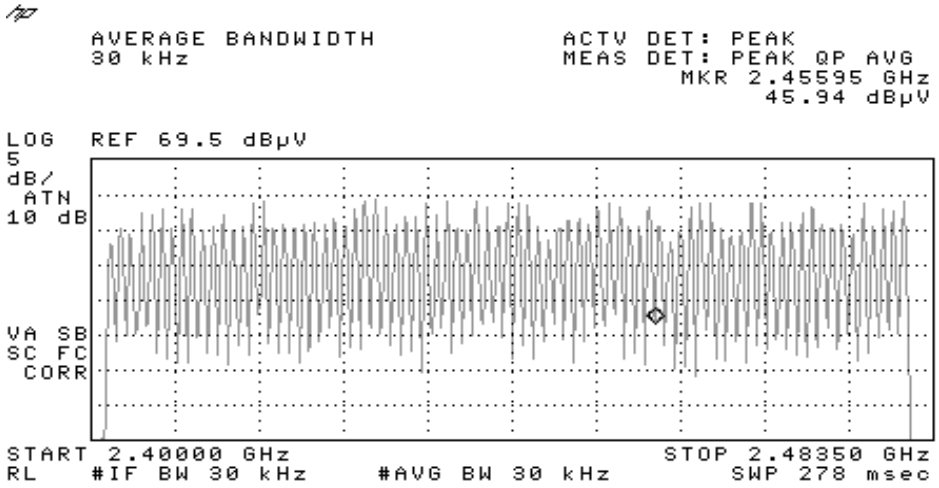


Client:	Thales Navigation	Job Number:	J52303
Model:	Z_Max GPS Receiver	T-Log Number:	T52370
		Account Manager:	Mike Conrad
Contact:	Christian Legras		
Spec:	FCC 15 B,C; RSS210; RSS119	Class:	N/A

Run #4: Number of Channels

The number of channels was verified with the radio transmitting normally (i.e. In hopping mode)

The number of channels was: 79



Run #5a, b and c: Radiated Emissions, 1000-8000 MHz: BlueTooth Receiver - Low Channel (2402 MHz), Center Channel (2440MHz) and High Channel (2480MHz)

Note 1:	No signals related to the receiver within 20dB of the limit were observed. Preliminary radiated emissions scans in an anechoic chamber below 1GHz identified all significant signals to be from the digital circuitry. No receiver or transmitter -related signals were observed.