

MEASUREMENT/TECHNICAL REPORT

**Company - Model: Zebra Technologies
2400 Wireless 2.4Ghz transmitter
Class II permissive change for
FCC ID: I28MD-TRCV-24GHZ
January 10, 2001**

Description: This is a report to support a request for class II permissive change.

Equipment Type: Low Power Communications Device Transmitter (DXX)

Report prepared for: Zebra Technologies
30 Plan Way
Warwick, RI 02886-1012
Phone: (401) 739-5800
Fax: (401) 732-0145

Report prepared by: Chad A. Bell
Curtis-Straus LLC
527 Great Road
Littleton, MA 01460
Phone: 978-486-8880
FAX: 978-486-8828

Table of Contents

[INTRODUCTION](#) 3

[1.0 STATEMENT OF CONFORMITY](#)..... 5

[2.0 GENERAL DESCRIPTION](#)..... 6

[2.1 Product Description](#) 6

[2.2 Related Submittal\(s\) Grants](#) 6

[2.3 Test Methodology](#) 6

[2.4 Test Facility](#)..... 6

[2.5 Test Equipment Used](#)..... 7

[3.0 MEASUREMENT RESULTS](#) 8

[3.1 Operating Frequency](#) 8

[3.2 Electric Field Strength Radiation Measurements](#)..... 8

[3.3 Emissions Plots](#)..... 10

Introduction

This report is an application for a class 2 permissive change of a transmitter module operating pursuant to Part 15.249 of the FCC Rules, Code of Federal Regulations 47 and Public Notice DA 00-1407 for modular transmitters. The original grant was issued under FCC ID: I28MD-TRCV-24GHZ. The model number covered by this report is the Zebra Technologies 2400 Wireless. This report is designed to demonstrate the compliance of this device with the requirements outlined in Part 15 of CFR 47 using the methods outlined in Part 2 of CFR 47. The current revision date, October 1, 1998, of each Part has been used for technical requirements.

Note: Only those exhibits that are new or changed appear in this application.

The original grant was for five separate antennas, each with the same transmitter module (for use in 5 different printers). The same transmitter circuit that was used for the original application was used for this testing. This report is to add 4 new antennas for use with the original module. For the original application, the highest gain antenna was tested from 30MHz to 25GHz. The remaining antennas were checked at all frequencies found within 10dB of the limit with the highest gain antenna. Since the antennas in this application have gain characteristics less than the high gain antenna from the original application, the same test method was followed and only the emissions within 10dB of the limit during the original scan were rechecked. A fresh battery was used for each configuration.

This Short-Range Radio Frequency (SRRF) transceiver module is used in conjunction with Manchester Encoding of the digital data that it transmits. Manchester Encoding is required for optimum operation of the RF Monolithics TR-1000 transceiver IC that is used in this design. Manchester encoding ensures a 50% ones density in the data stream by converting each bit into two bits, one of which is a 1 and the other a 0.

This radio uses ON-OFF keying modulation. The transmitter (carrier) is on when the radio is transmitting a 1 and off when the radio is transmitting a 0. Combining the modulation scheme with the Manchester Encoding, the transmitter will only be on 50% of the time during any transmission.

According to 47 CFR Part 15.35, we are allowed to average our transmission over a pulse train up to 100 milliseconds in length. The averaging factor is based on the 50% on time of the transmitter: $20 \log (.5) = -6.02 \text{ dB}$.

The units were tested with the transmitter constant on and all readings indicated in the accompanying data are peak readings. Therefore, all emissions from the transmitter operating with this duty cycle will be averaged with this factor.

Emissions were maximized by rotating the unit in all three orthogonal axes. There was no maximization of the module's antenna because it is affixed to the module in such a way that it cannot be manipulated. AC line conducted emissions was not performed. This device is intended for use in battery power devices only. A statement in the users guide indicated that the approval is only valid in devices that are battery powered with no AC connection.

The confidential information and descriptions included in this application are detailed descriptions of the products, block diagrams, component specifications, and schematic diagrams. We hereby respectfully request under the provision of section 0.457d of the code that the documents listed below be held confidential.

Exhibit 6.1: Technical Descriptions and Block Diagrams

Exhibit 6.2: Schematics

Exhibit 6.3: Bill of Materials

Zebra Technologies is requesting that the Technical Descriptions, Block Diagrams, Schematics and Bill of Materials be kept confidential in the FCC application because of the proprietary design developed by Zebra Technologies that is unique to the industry.

FCC ID: I28MD-TRCV-24GHZ is a modular low power radio transceiver designed to operate according to FCC Rules Part 15.249. The following steps have been taken to insure that I28MD-TRCV-24GHZ (referred to below as "the module") meets the FCC requirements for a modular approval: The module is completely shielded. Only the connectors are exposed. The TXDATA input is buffered on the module itself. Input voltage variations on TXDATA will not effect the modulation or the transmitter output power. The module has it's own on-board 3-volt regulator. All RF circuitry operates from the 3 volts. Fluctuations in the 5-volt supply to the module will not effect the modulation or the transmitter output power. The antenna connector used on the module has only one manufacturer and is not readily available. We have used the same connector on previous modular approvals and the FCC has considered it a non-standard connector. In addition, the module will only be used in devices with internal antennas of the type specified in the application. These internal antennas require complete disassembly of the unit to access and are not user serviceable or user replaceable. Therefore the antenna system meets the requirements of Section 15.203. The module was tested in a stand-alone configuration but using a family of antennas that included all of the antenna configurations that the module will see in production. Each module will be labeled with the FCC ID# and warning message as shown on the AA15642-1 drawing which is included with this application.

Following is a list of the new antennas that were used with each of the corresponding printers:

Printer Name	Part Number of Antenna
Symbol	Symbol 960SL
Cameo 2	CQ15731
Cameo 3 PEP	CQ15729-1
Encore 4	BL13283

1.0 Statement of Conformity

The Zebra Technologies 2400 Wireless has been found to conform with the following parts of the 47 CFR as detailed below:

Part 2	Part 15	Comments
	15.15(b)	The product contains no user accessible controls that increase transmission power above allowable levels.
2.925	15.19	The label is shown in the label exhibit.
	15.21	Information to the user is shown in the instruction manual exhibit.
	15.27	No special accessories are required for compliance.
	15.203	The antenna connector used on the module has only one manufacturer and is not readily available.
	15.205 15.209	The fundamental is not in a Restricted band and the spurious and harmonic emissions in the Restricted bands comply with the general emission limits of 15.209.
	15.207	The unit is battery powered without the capability of being recharged or operated from the AC mains.
	15.249(a)	The unit complies with the field strength limits of the 15.249(a) table including the 20dB peak restriction of 15.35(b) and 15.249(d).
	15.249(c)	The unit complies with the field strength limits of the 15.209(a) table.

2.0 General Description

2.1 Product Description

The Zebra Technologies 2400 Wireless serves as a wireless connection for Zebra's wireless printers and their Dome Antenna accessory.

2.2 Related Submittal(s) Grants

There are no other approvals required for this device.

2.3 Test Methodology

Radiated emission testing was performed according to the procedures in ANSI C63.4 (1992). Radiated testing was performed at an antenna to EUT distance of 3 meters below 1 GHz, and at distances of 3 meter(s) and 1 meter above 1 GHz. The actual test distance used is noted in the test data sheets. The device's performance was investigated to 25GHz.

All other performance tests were made in accordance with the procedures outlined in Part 15 of CFR 47. The applicable sections provided under Part 15 are provided in the measurement section of this report, Exhibit 3.

2.4 Test Facility

Curtis-Straus LLC

All testing was performed at Curtis-Straus (A2LA certificate number 1627-01). The open area test site used to collect the radiated data is located at 527 Great Road, Littleton, MA 01460. Site "F" was used.

2.5 Test Equipment Used

SPECTRUM ANALYZERS					
X	Analyzer	Model No.	Company	Serial No.	Calibration Due
X	GREEN 9kHz-26.5GHz	8593E	HP	3829A03618	05-OCT-2001

OPEN AREA TEST SITES (OATS)					
X	Site	FCC Code	IC Code	VCCI Code	Calibration Due
X	"F" Florida	93448	IC 2762-F	R-468/ C-480	28-JUN-2001

ANTENNAS					
X	Antenna	Model No.	Company	Serial No.	Calibration Due
X	ORANGE Horn: 1-18GHz	3115	EMCO	0004-6123	17-APR-2001

PREAMPLIFIERS					
X	Preamplifier	Model No.	Company	Serial No.	Calibration Due
X	YELLOW-BLACK 1-20GHz	SMC-12A	MITEQ	535055	09-OCT-2001

METEOROLOGICAL METERS					
X	Meter	Model No.	Company	Serial No.	Calibration Due
X	TEMPERATURE /HUMIDITY GAUGE	TH300	Dickson	9044101	27-MAR-2001
X	ATMOSPHERIC PRESSURE GAUGE	BA928	Oregon Scientific	C3166-1	21-AUG-2001

TRACEABLE CLOCKS					
X	Clock	Model No.	Company	Serial No.	Calibration Due
X	5003	5003	Control Company	99026940	11-DEC-2001

Unless otherwise noted the calibration interval is one year. All equipment is calibrated using standards traceable to NIST or other nationally recognized calibration standard.

3.0 Measurement Results

3.1 Operating Frequency

This device operates at 2482.0 MHz.

3.2 Electric Field Strength Radiation Measurements

Radiated Emissions Table											Curtis-Straus LLC		
Date: 29-Dec-00			Company: Zebra Technologies							Table 1			
Engineer: Chad A. Bell			EUT Desc: 2.4Ghz transmitter with new antenna							Work Order: EA1478			
Frequency Range: 1-18Ghz								Measurement Distance: 3 m					
Notes: Symbol 960SL antenna								EUT Max Freq: 2482Mhz					
Antenna Polarization (H / V)	Frequency (MHz)	Reading (dBμV)	Preamp Factor (dB)	Antenna Factor (dB/m)	Cable Factor (dB)	Duty Cycle Factor (dB)	Adjusted Reading (dBμV/m)	---			FCC Class B		
								Limit (dBμV/m)	Margin (dB)	Result (Pass/Fail)	Limit (dBμV/m)	Margin (dB)	Result (Pass/Fail)
H	2470.6	39.0	20.7	30.2	2.3	6.0	44.8	---	---	---	54.0	-9.2	Pass
H	2478.0	38.9	20.7	30.2	2.3	6.0	44.7	---	---	---	54.0	-9.3	Pass
H	2482.0	76.8	20.7	30.2	2.3	6.0	82.6	---	---	---	94.0	-11.4	Pass
H	2486.0	40.8	20.7	30.3	2.3	6.0	46.7	---	---	---	54.0	-7.3	Pass
H	2493.25	37.5	20.7	30.3	2.3	6.0	43.4	---	---	---	54.0	-10.6	Pass
H	3072.0	33.9	21.1	32.4	2.8	0.0	48.0	---	---	---	54.0	-6.0	Pass
H	4096.0	35.3	20.9	33.4	3.6	0.0	51.4	---	---	---	54.0	-2.6	Pass
H	4530.0	37.0	20.7	33.5	3.7	6.0	47.5	---	---	---	54.0	-6.5	Pass
H	4964.2	33.2	20.6	34.7	3.7	6.0	45.0	---	---	---	54.0	-9.0	Pass
H	6578.1	32.0	19.7	36.4	3.9	6.0	46.6	---	---	---	54.0	-7.4	Pass
Table Result: Pass by -2.6 dB Worst Freq: 4096.0 MHz													
Test Site: "F"		Pre-Amp: Yel-Blk		Cable: 3m Microflex		Analyzer: Green		Antenna: Orange Horn					

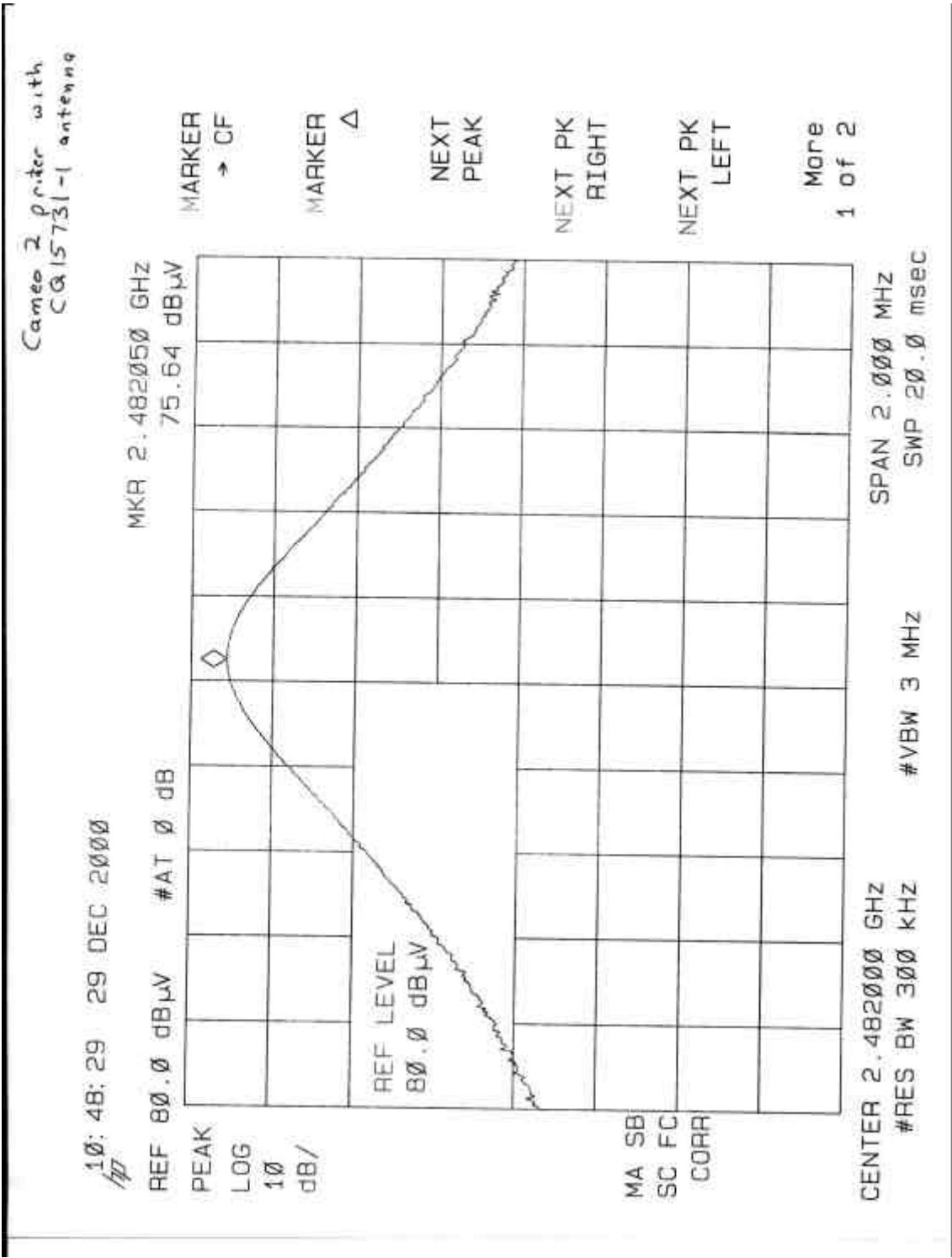
Radiated Emissions Table											Curtis-Straus LLC		
Date: 29-Dec-00			Company: Zebra Technologies							Table 2			
Engineer: Chad A. Bell			EUT Desc: 2.4Ghz transmitter with new antenna							Work Order: EA1478			
Frequency Range: 1-18Ghz								Measurement Distance: 3 m					
Notes: Cameo 2 printer with CQ15731-1 antenna								EUT Max Freq: 2482Mhz					
Antenna Polarization (H / V)	Frequency (MHz)	Reading (dBμV)	Preamp Factor (dB)	Antenna Factor (dB/m)	Cable Factor (dB)	Duty Cycle Factor (dB)	Adjusted Reading (dBμV/m)	---			FCC Class B		
								Limit (dBμV/m)	Margin (dB)	Result (Pass/Fail)	Limit (dBμV/m)	Margin (dB)	Result (Pass/Fail)
H	2470.6	39.2	20.7	30.2	2.3	6.0	45.0	---	---	---	54.0	-9.0	Pass
H	2478.0	38.5	20.7	30.2	2.3	6.0	44.3	---	---	---	54.0	-9.7	Pass
H	2482.0	75.6	20.7	30.2	2.3	6.0	81.4	---	---	---	94.0	-12.6	Pass
H	2486.0	40.8	20.7	30.3	2.3	6.0	46.7	---	---	---	54.0	-7.3	Pass
H	2493.25	38.3	20.7	30.3	2.3	6.0	44.2	---	---	---	54.0	-9.8	Pass
H	3072.0	34.0	21.1	32.4	2.8	0.0	48.1	---	---	---	54.0	-5.9	Pass
H	4096.0	35.3	20.9	33.4	3.6	0.0	51.4	---	---	---	54.0	-2.6	Pass
H	4530.0	37.0	20.7	33.5	3.7	6.0	47.5	---	---	---	54.0	-6.5	Pass
H	4964.2	33.4	20.6	34.7	3.7	6.0	45.2	---	---	---	54.0	-8.8	Pass
H	6578.1	32.0	19.7	36.4	3.9	6.0	46.6	---	---	---	54.0	-7.4	Pass
Table Result:		Pass	by	-2.6 dB				Worst Freq:		4096.0 MHz			
Test Site: "F"		Pre-Amp: Yel-Blk		Cable: 3m Microflex		Analyzer: Green		Antenna: Orange Horn					

Radiated Emissions Table										Curtis-Straus LLC			
Date: 29-Dec-00			Company: Zebra Technologies							Table 3			
Engineer: Chad A. Bell			EUT Desc: 2.4Ghz transmitter with new antenna							Work Order: EA1478			
Frequency Range: 1-18Ghz								Measurement Distance: 3 m					
Notes: Cameo 3 PEP printer with CQ15729-1 antenna								EUT Max Freq: 2482Mhz					
Antenna Polarization (H / V)	Frequency (MHz)	Reading (dBµV)	Preamp Factor (dB)	Antenna Factor (dB/m)	Cable Factor (dB)	Duty Cycle Factor (dB)	Adjusted Reading (dBµV/m)	---			FCC Class B		
								Limit (dBµV/m)	Margin (dB)	Result (Pass/Fail)	Limit (dBµV/m)	Margin (dB)	Result (Pass/Fail)
H	2470.6	39.0	20.7	30.2	2.3	6.0	44.8	---	---	---	54.0	-9.2	Pass
H	2478.0	39.1	20.7	30.2	2.3	6.0	44.9	---	---	---	54.0	-9.1	Pass
H	2482.0	77.9	20.7	30.2	2.3	6.0	83.7	---	---	---	94.0	-10.3	Pass
H	2486.0	40.9	20.7	30.3	2.3	6.0	46.8	---	---	---	54.0	-7.2	Pass
H	2493.25	38.4	20.7	30.3	2.3	6.0	44.3	---	---	---	54.0	-9.7	Pass
H	3072.0	34.0	21.1	32.4	2.8	0.0	48.1	---	---	---	54.0	-5.9	Pass
H	4096.0	35.3	20.9	33.4	3.6	0.0	51.4	---	---	---	54.0	-2.6	Pass
H	4530.0	37.0	20.7	33.5	3.7	6.0	47.5	---	---	---	54.0	-6.5	Pass
H	4964.2	33.4	20.6	34.7	3.7	6.0	45.2	---	---	---	54.0	-8.8	Pass
H	6578.1	32.0	19.7	36.4	3.9	6.0	46.6	---	---	---	54.0	-7.4	Pass
Table Result: Pass by -2.6 dB										Worst Freq: 4096.0 MHz			
Test Site: "F"		Pre-Amp: Yel-Blk		Cable: 3m Microflex		Analyzer: Green		Antenna: Orange Horn					

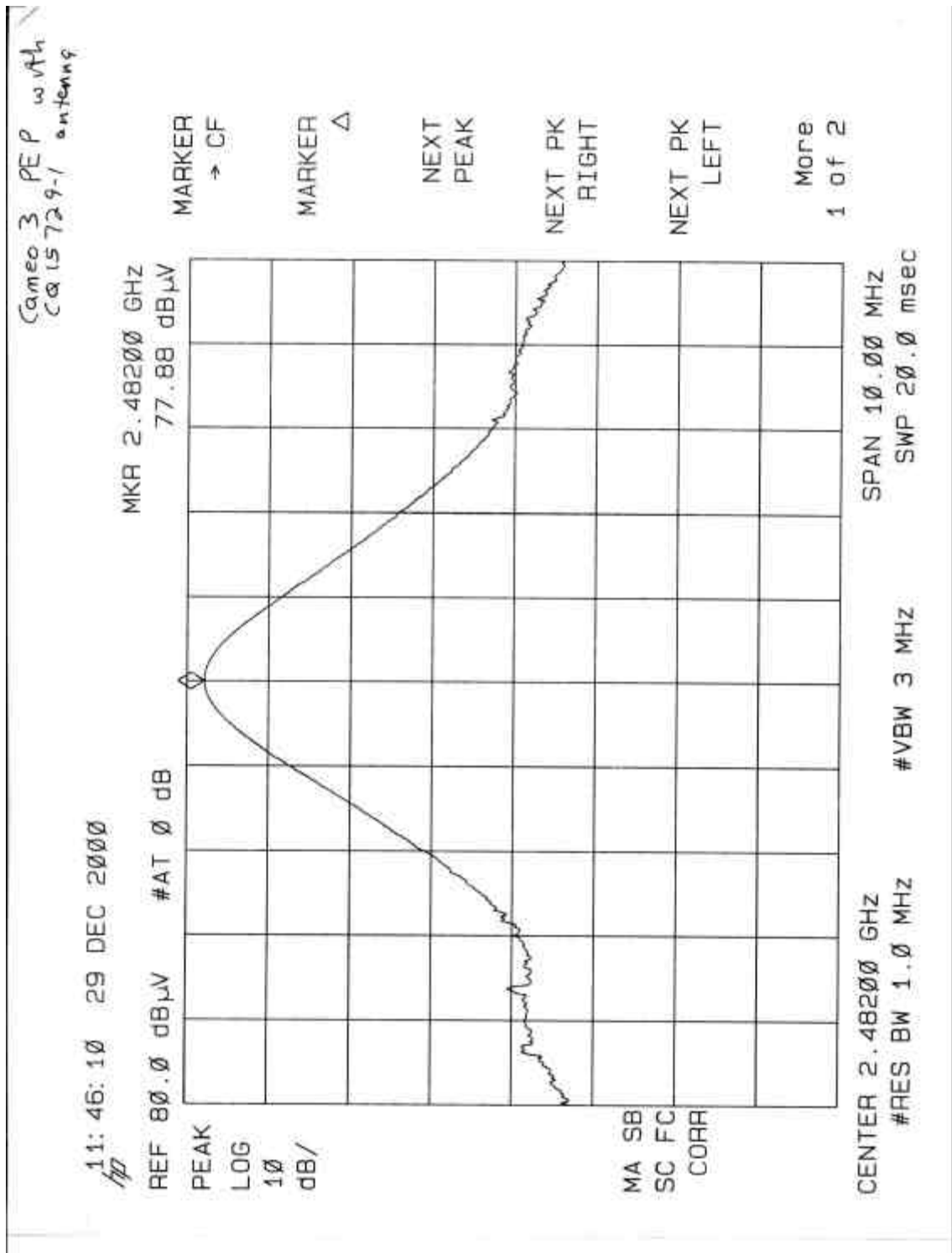
Radiated Emissions Table											Curtis-Straus LLC		
Date: 29-Dec-00			Company: Zebra Technologies							Table 4			
Engineer: Chad A. Bell			EUT Desc: 2.4Ghz transmitter with new antenna							Work Order: EA1478			
Frequency Range: 1-18Ghz							Measurement Distance: 3 m						
Notes: Encore 4 printer with BL13283 antenna							EUT Max Freq: 2482Mhz						
Antenna Polarization (H / V)	Frequency (MHz)	Reading (dBµV)	Preamp Factor (dB)	Antenna Factor (dB/m)	Cable Factor (dB)	Duty Cycle Factor (dB)	Adjusted Reading (dBµV/m)	---			FCC Class B		
								Limit (dBµV/m)	Margin (dB)	Result (Pass/Fail)	Limit (dBµV/m)	Margin (dB)	Result (Pass/Fail)
H	2470.6	39.4	20.7	30.2	2.3	6.0	45.2	---	---	---	54.0	-8.8	Pass
H	2478.0	39.5	20.7	30.2	2.3	6.0	45.3	---	---	---	54.0	-8.7	Pass
H	2482.0	77.9	20.7	30.2	2.3	6.0	83.7	---	---	---	94.0	-10.3	Pass
H	2486.0	40.8	20.7	30.3	2.3	6.0	46.7	---	---	---	54.0	-7.3	Pass
H	2493.25	38.0	20.7	30.3	2.3	6.0	43.9	---	---	---	54.0	-10.1	Pass
H	3072.0	33.0	21.1	32.4	2.8	0.0	47.1	---	---	---	54.0	-6.9	Pass
H	4096.0	35.4	20.9	33.4	3.6	0.0	51.5	---	---	---	54.0	-2.5	Pass
H	4530.0	37.8	20.7	33.5	3.7	6.0	48.3	---	---	---	54.0	-5.7	Pass
H	4964.2	33.8	20.6	34.7	3.7	6.0	45.6	---	---	---	54.0	-8.4	Pass
H	6578.1	31.9	19.7	36.4	3.9	6.0	46.5	---	---	---	54.0	-7.5	Pass
Table Result: Pass by -2.5 dB											Worst Freq: 4096.0 MHz		
Test Site: "F"		Pre-Amp: Yel-Blk		Cable: 3m Microflex		Analyzer: Green			Antenna: Orange Horn				

Fundamental

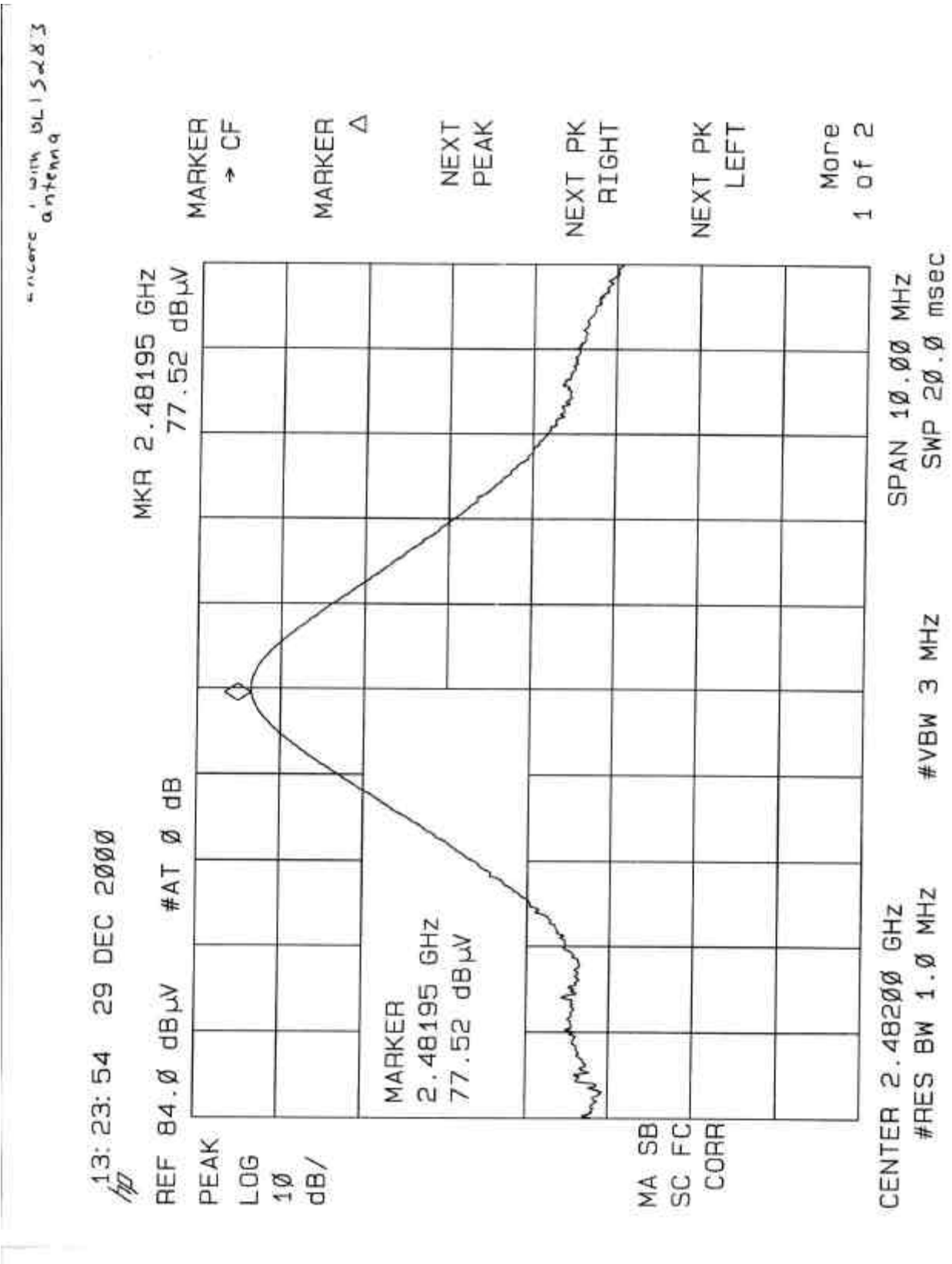




Cameo 2 printer with CQ15731 antenna



Cameo 3 PEP printer with CQ15729-1 antenna



Encore 4 printer with BL13283 antenna