



EMC Measurement / Technical Report

FCC Test Specification : FCC Part 95, Subpart C
Radio Control (R/C) Radio Service

Equipment Authorization : Certification

Manufacturer : Futaba Corporation of America

Equipment Under Test : 72 MHz Radio Control Transmitter
Model T6DA

Test Report No. : FR1575

Purchase Order No. : JPH-70061

<i>Document History</i>					
<i>Revision</i>	<i>Issue Date</i>	<i>Affected Pages</i>	<i>Description of Modifications</i>	<i>Revised By</i>	<i>Approved By</i>
N/C	November 7, 2000		Initial release		



EMC Measurement / Technical Report

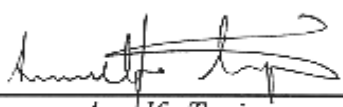
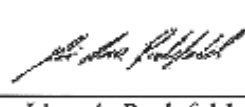
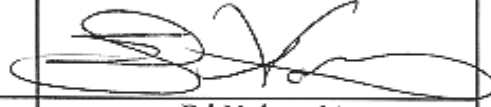
Document No. FR1575

From

**Garwood Laboratories, Inc.
World Compliance Division**

Test for

**Futaba Corporation of America
72 MHz Radio Control Transmitter
Model T6DA**

WRITTEN BY	REVIEWED BY	REVIEWED BY
		
Arnulfo Tapia EMC Sr. Technician	Lisa A. Rodefeld Quality Manager	Ed Nakauchi NARTE Certified

Test Personnel	Test Dates
Arnulfo Tapia- EMC Sr. Technician	2 November 2000

Test Facility Address City, State, Zip Code Phone Fax	Garwood Laboratories, Inc.-OC 565 Porter Way Placentia, CA 92870 (714) 572-2027 (714) 572-2025
--	--

This report may be reproduced in full, partial reproduction may only be made with the written consent of the laboratory. The results in this report pertain only to the specified equipment tested. This report may not be used to claim product endorsement by NVLAP or any agency of the U.S. government.



TABLE OF CONTENTS

MEASUREMENT/TECHNICAL REPORT SUMMARY.....	4
1. GENERAL INFORMATION.....	5
1.1 Product Description	5
1.2 Configuration of Tested System	5
1.3 Test Facility.....	6
2. TECHNICAL INFORMATION	7
2.1 Circuit Diagram	7
2.2 Function of Each Active Device.....	7
2.3 Tune - Up Alignment Procedure.....	7
2.4 Frequency Stabilizing Circuitry.....	7
2.5 Additional Circuit Information.....	8
3. PRODUCT LABELING	9
3.1 FCC ID Label.....	9
3.2 Location of Label on the EUT	9
3.3 Information to the User.....	9
4. BLOCK DIAGRAMS OF EUT	10
5. TEST RESULTS.....	11
5.1 Transmitter Power	11
5.2 Emission Bandwidth	12
5.3 Field Strength of Spurious Radiation	13
5.4 Frequency Stability	14
5.5 Modulation Characteristics	16
5.6 Crystal Access Restrictions.....	17
6. PHOTOGRAPHS OF TEST ARRANGEMENTS & EUT CONSTRUCTION.....	18
APPENDIX A - TEST EQUIPMENT USED.....	24
APPENDIX B - SUPPLEMENTAL TEST DATA	25
ATTACHMENTS.....	28



Garwood Laboratories, Inc. - World Compliance Division
Electromagnetic Compatibility

MEASUREMENT / TECHNICAL REPORT SUMMARY

Manufacturer Company Address City, State, Zip Country Contact Name Phone Fax	Futaba Corporation of America 2865 Wall Triana Hwy Huntsville, AL 35824 USA Steve Helms 256-461-7348 256-461-7349
Type of Authorization	Certification for 72 MHz R/C Transmitter
Applicable FCC Rules	This technical report is to certify that Equipment Under Test (EUT) complied with the requirements of: FCC Pt.95 Subpart C – Radio Control Radio Service Technical Regulations found in FCC Pt. 95 Subpart E All the tests necessary to show compliance to the requirements were performed and are listed below. RF Power Output Field Strength of Spurious Radiation Emission Bandwidth Modulation Characteristics Frequency Stability The test data presented in this report has been acquired using the guidelines set forth in: FCC Pt.15 § 2.1046, §2.1047, §2.1049, §2.1053
Test Results	The EUT complied with the applicable FCC requirements. The test results presented in this document are valid only for the equipment identified herein under the test conditions described. Repeatability of these test results will only be achieved with identical measurement conditions. The EUT is a battery-operated device; therefore, the conducted emissions test is not applicable.
Equipment Under Test	72 MHz Radio Control Transmitter
Identification of EUT	Model: T6DA FCC ID: AZPT6DA-72
Production Quantity	Multiple Units

EMC Test Laboratory Facility Address City, State, Zip Code Country Contact Name Title Phone Fax	Garwood Laboratories, Inc. -OC World Compliance Division 565 Porter Way Placentia, CA 92870 USA Tony Masone General Manager (714) 572-2027 (714) 572-2025
--	---



1. General Information

1.1 Product Description

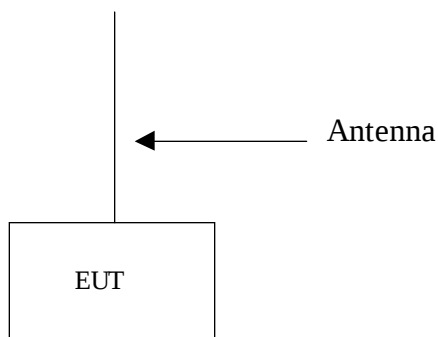
Equipment Under Test	72MHz Radio Control (R/C) Transmitter
Model Number	T6DA
Description	The Equipment Under Test (EUT) is an FM 72 MHz 6-Channel Radio Control Transmitter Model T6DA that is used for aircraft operation. The transmitter portion of the EUT can be tuned to any one frequency in the model aircraft frequency band of 72.010 – 72.990 MHz. During testing the transmitting frequency was set to 72.550MHz. The transmitting power of the EUT is less than 750mW. The EUT derives its operating voltage from a Futaba 9.6VDC NiCd rechargeable battery Model NT8F600B.
Clock Frequencies	4.00 MHz Transmitter frequency 72.55MHz

1.2 Configuration of Tested System

The following table lists all of the components of the tested system. FCC ID numbers are included if available for a tested system component.

Tested System Details					
<i>Item</i>	<i>Manufacturer</i>	<i>Description</i>	<i>Model No.</i>	<i>Serial No.</i>	<i>FCC ID</i>
EUT	Futaba Corporation	R/C Transmitter	T6DA	Not Available	AZPT6DA-72

The Equipment Under Test (EUT) was tested as a stand-alone unit. The EUT contains an integral antenna, which was extended to its maximum length during the test. The EUT derives its operating voltage from a 9.6VDC rechargeable battery. During the field strength measurements the 9.6VDC battery was fully charged.





Garwood Laboratories, Inc. - World Compliance Division *Electromagnetic Compatibility*

1.3 Test Facility

The Open Area Test Site (OATS) and measurement facilities used to collect the test data are located at Garwood Laboratories, Inc. World Compliance Division test facility in Placentia, CA. This facility has been fully described in a report submitted to the FCC and accepted in a letter dated 28 January 2000 (31040/SIT 1300F2) registration #90681.

The test facility is also recognized and accredited from following accreditation organizations:

NVLAP

Garwood Laboratories, Inc. is recognized under the National Voluntary Laboratory Accreditation Program (NVLAP/NIST) for satisfactory compliance with criteria established in Title 15, Part 285 Code of Federal Regulations. These criteria encompass the requirements of ISO/IEC Guide 25 and the relevant requirements of ISO 9002 (ANSI/ASQC Q92-1987) as suppliers of calibration or test results. NVLAP Code: 200119-0, Effective through December 31, 2000.

FCC

This site has been registered and fully described in a report filed with the (FCC) Federal Communications Commission. The acceptance letter from the FCC is maintained in our files. Reference : 31040/SIT 1300F2, Registration #90681, January 28, 2000. With the above and NVLAP, Garwood Laboratories is an authorized test laboratory for the DoC process.

Technology International (I²T)

Garwood Laboratories, Inc. has been assessed in accordance with ISO Guide 25 and with ITI's assessment criteria. Based upon this assessment, Technology International (Europe), Ltd. Has granted approval for specifications implementing the EU Directive on EMC (89/336/EEC). The scope of the approval was provided on a Schedule of Assessment supplied with a certificate and is available upon request. Certificate #99-051, Dated: May 9, 2000.

ACA

Garwood Laboratories, Inc. can also perform testing for the Australian C-Tick mark as a result of our NVLAP accreditation and the MRA (Mutual Recognition Agreement) between the US and Australia.

VCCI

Garwood Laboratories, Inc. has been accepted as a member to the VCCI. Our conducted and radiated measurement facilities have been registered in accordance with Regulations for Voluntary Control Measures. Registration C574, C575, C576, R561.

Industry Canada

Garwood Laboratories, Inc. is registered by Industry Canada for performance of measurements and complies with RSP 100. Reference IC 3298, Dated: March 11, 1999.

BSMI (Formerly known as BCIQ)

Garwood Laboratories, Inc. can perform testing for Taiwan to the CNS requirements. This is as a result of our NVLAP accreditation and the MRA (Mutual Recognition Agreement) between the US and Taiwan.

Nmi (Nederlands Meetinstituut)

Garwood Laboratories, Inc. has entered into a cooperative agreement with Nmi Certin B.V. of the Netherlands. There are a Notified Body for the RATTE Directive and Maritime Directive as well as a Competent Body for the EMC Directive.



2. Technical Information

Type of Emission	8K00F1D
Operating Frequency Range	72.01 – 72.99MHz – model aircraft band
Range of Operating Power	Fixed Output Power
Maximum Output Power	111mW
FCC Rating Maximum Transmitting Power	750mW

2.1 Circuit Diagram

Please refer to the Circuit Schematics in the Attachment section of this report.

2.2 Function of Each Active Device

1. Q1 (2SC1009) – Oscillator & Multiplier
2. Q2 (2SC3772) – Driver
3. Q3 (2SC4910) – Final stage RF amplifier
4. Q4 (2SC2412) – Wave form shaper
5. Q5 (2SC2412) – Buffer
6. IC1 (78L05) – Voltage Stabilizer
7. IC2 (78L05) – Voltage Stabilizer
8. IC3 (4051) – Encoder
9. IC4 (4051) – Encoder
10. IC5 (358) – Encoder
11. IC6 (FP6339) - Encoder

2.3 Tune-Up Alignment Procedure

1. L1, L2, L3, L4, L5, L6 --- Tune to generate the maximum power.
2. Repeat step 1 again.
3. Turn the core of L5 clockwise $\frac{1}{4}$ of a turn.
4. Turn the core of L4 counter-clockwise $\frac{1}{8}$ of a turn

2.4 Frequency Stabilizing Circuitry

1. IC1 (78L05) – Regulated IC. Supply voltage of oscillator.
2. Crystal – Stabilizes oscillating frequency
3. C1 (CH68p) – Temperature compensated capacitor.
4. C2 (CH100p) – Temperature compensated capacitor.
5. C3 (CH39p) – Temperature compensated capacitor.



2.4 Additional Circuit Information

1. The type of oscillator utilized by the transmitter is a Crystal controlled modified Colpitts oscillator.
2. The following components are used for suppression of spurious radiation from the antenna:
 - Low Pass π Filter
 - L4, L5 (7GD0005)
 - C22 (CH 68pF)
 - C24 (CH 12pF)
 - C25 (CH 82pF)
 - C26 (CH 3pF)
 - C28 (CH 2pF)
3. Audio Low Pass Filter
 - C29 (470 μ F)
 - C30 (2.2nF)
 - Q4 (2S2412)
 - R20 (10k)
 - R21 (10k)
 - R22 (43k)
4. No Digital Modulation technique was employed. No Phase Locked Loop circuitry was used.



3. Product Labeling

3.1 FCC ID Label

All devices authorized under the certification procedures are required to display an identification label showing the FCC Identifier (FCC ID) under which they are authorized.

Example:

FCC ID: XXX123

XXX = Indicates manufacturer's Grantee Code

123 = Indicates manufacturer's Equipment Product Code

In addition, the manufacturer (or importer) is responsible for having the compliance label produced, and for having it affixed to each unit that is marketed or imported.

FCC Compliance Label:

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

3.2 Location of Label on the EUT

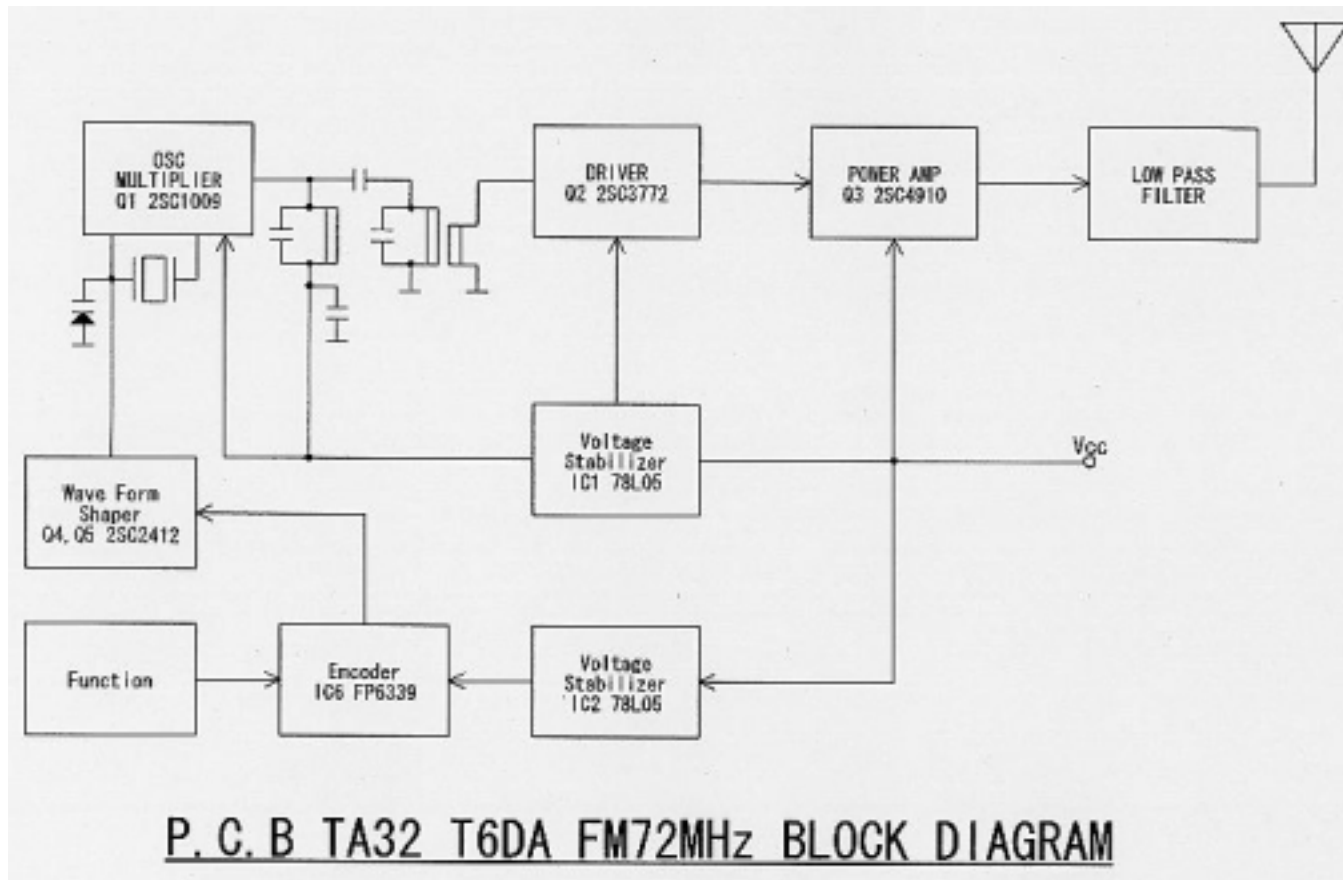
As stated in §15.19, the label shall be located in a conspicuous location on the device. When the device is so small or for such use that it is not practicable to place the compliance label on it, the information required should be placed in a prominent location in the instruction manual or pamphlet supplied to the user. Alternatively, the compliance label can be placed on the container in which the device is marketed. However, the FCC identifier must be displayed on the device.

3.3 Information to the user

The users manual or instruction manual for an intentional or unintentional radiator shall caution the user that changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.



4. Block Diagram of the EUT





5. Test Results

5.1 Transmitter Power

The transmitter's output power was found by measuring the field strength of the transmitter in the open area test site and converting the field strength in volts/meter to power in watts. The field strength was measured at a distance of 3 meters. The following formula was used to convert the field strength (FS) in volts/meter to transmitter output power (TP) in watts:

$$TP = (FS \times D)^2 / (30 \times G),$$

Where, D is the distance in meters between the two antennas and G is the antenna numerical gain referenced to isotropic gain. The integral antenna of the EUT is assumed to have a gain of one, G=1. The output power should not exceed 750mW, for an R/C transmitter operating in the frequency band of 72 – 76MHz.

Results:

The field strength measured at 72.550 MHz was 115.7dBμV/m at a distance of 3 meters. The transmitter output power in watts was calculated to be 111mW.



5.2 Emission Bandwidth

An R/C transmitter is allowed to transmit any appropriate non-voice emission, which meets the emission limitations for an R/C transmitter. The authorized bandwidth for any emission type transmitted by an R/C transmitter is 8kHz.

Test Results:

The occupied bandwidth of the EUT complied with the emission bandwidth requirement. During testing, all control switches and buttons were investigated for the worst-case modulated signal. The occupied bandwidth plot submitted was the worst-case condition. The test result plot is enclosed in Appendix B.



5.3 Field Strength of Spurious Radiation

Measurements were made to detect spurious radiation. The EUT was placed 80 centimeters above the ground plane on a non-conductive tabletop 1.0-meter width by 1.5-meter length. The configuration of the EUT and its cables were varied to maximize the amplitude level of the emissions if applicable. Rotating the turntable 360 degrees and varying the antenna height from 1 to 4 meters maximized the emissions. Measurements were made with a Bi-Log antenna up to the 10th harmonic of the fundamental in both vertical and horizontal polarization. The distance between the EUT and the measuring antenna was 3 meters. The unwanted emissions should be less than the transmitter field strength by at least $56 + 10 \log (TP)$ dB on any frequency removed from the center of the authorized bandwidth by more than 250%. The following table contains the results:

Tuned Frequency: 72.550 MHz
Measurement Distance: 3m
FCC Limit: $115.7 - (56 + 10 \log 0.111)$
= 69.2 dB μ V

Frequency (MHz)	Emission Level (dB μ V)	Correction Factor (dB)	Corrected Reading (dB μ V/m)	FCC Limit @ 3 meters (dB μ V/m)	Delta to FCC Limit (dB)
72.550	107.9	7.8	115.7	-	-
145.100	34.9	14.0	48.9	69.2	-20.3
217.650	40.5	12.0	52.5	69.2	-16.7
290.200	39.8	15.7	55.5	69.2	-13.7
362.750	32.3	18.8	51.1	69.2	-18.1
435.300	31.3	19.9	51.2	69.2	-18.0
507.850	23.9	21.7	45.6	69.2	-23.6
580.400	21.4	23.0	44.4	69.2	-24.8
652.950	21.2	24.4	45.6	69.2	-23.6
725.500	21.6	25.9	47.5	69.2	-21.7

- The Correction Factor consist of Antenna Factor + Cable Loss.
- Measurements were performed in both vertical and horizontal antenna polarization. Vertical antenna polarization measurements were worst case.
- All readings are peak with specified CISPR bandwidth unless stated otherwise.



5.4 Frequency Stability

Frequency stability is a measure of the frequency drift due to temperature and supply voltage variations, with reference to the frequency measured at 20°C and the rated supply voltage.

Test Requirement:

For transmitters operating in the frequency bands of 72.01-72.99MHz or 75.41-75.99MHz, the carrier frequency stability should be maintained at $\pm 0.002\%$ for temperature and voltage variations. Frequency measurements were made as follows:

- (a) at 10 degree intervals of temperatures between -30°C and +50°C at the manufacturer's rated supply voltage, and
- (b) at +20°C temperature and $\pm 15\%$ supply voltage variations.

Note, for handheld equipment that is only capable of operating from internal batteries, reduce the primary supply voltage to the battery operating end point. The manufacturer should specify the battery operating endpoint voltage of the equipment.

Test Results:

The data below shows that the T6DA transmitter complied with the frequency stability requirements.

Frequency Stability vs. Temperature

Frequency tuned: 72.550 MHz
Frequency Accuracy Required: 0.002%

Operating Temperature (°C)	Frequency Measured (MHz)	Frequency Deviation (Hz)	Frequency Deviation (%)
-30	72.549625	-375	-0.000517
-20	72.549895	-106	-0.000145
-10	72.550411	411	0.000567
0	72.550380	380	0.000524
+10	72.550375	375	0.000517
+20	72.550245	245	0.000338
+30	72.549960	-40	-0.000055
+40	72.549687	-313	-0.000432
+50	72.549458	-542	-0.000747



Garwood Laboratories, Inc. - World Compliance Division
Electromagnetic Compatibility

Frequency Stability vs. Supply Voltage

Frequency Tuned: 72.550 MHz Frequency Accuracy Required: 0.002%
Normal Input Voltage: 9.6VDC Temperature: 20°C

Input Voltage (V)	Frequency Measured (MHz)	Frequency Deviation (Hz)	Frequency Deviation (%)
7.68	72.550016	16	0.000021
8.00	72.550014	14	0.000019
8.50	72.550013	13	0.000018
9.00	72.550015	15	0.000021
9.60	72.550012	12	0.000016
10.00	72.550014	14	0.000019
10.50	72.550009	9	0.000012
11.00	72.550009	9	0.000012
11.52	72.550005	5	0.000007



5.5 Modulation Characteristics

Please refer to Appendix B for a plot of the modulation characteristics.



5.6 Crystal Access Restrictions

The EUT has no control knobs, switches, or other type of adjustments either on the operating front panel or on the exterior of the transmitter enclosure which when manipulated can result in violation of the rules. The plug in crystal of the transmitter is glued and therefore not accessible to the user.



5. Photographs of Test Arrangement and EUT Construction

Test Setup Picture (Front View)

Test Setup Picture (Rear View)



EUT Construction Front View



EUT Construction Back View



EUT Construction Top View



EUT PCB Components Side



EUT Solder Side



APPENDIX A - TEST EQUIPMENT USED

The absolute performance calibration of equipment requiring calibration is performed on an as needed basis in accordance with MIL-STD 45662A. However, calibration periods do not exceed one (1) year. The test equipment is capable of making measurements within tolerances of at least +/- 2dB amplitude and +/- 2% frequency deviation. Equipment certifications showing traceability to NIST (National Institute of Standards and Technology) are maintained on file at Garwood Laboratories, Inc. Placentia, CA. All equipment is checked and verified for proper operation before and after each series of tests.

A.1 Specific Equipment Used

<i>Test</i>	<i>Instrument</i>	<i>MFG / Model No.</i>	<i>Asset No.</i>	<i>Cal. Due Date</i>
<i>Conducted Emission Test</i>				
	EMI Receiver System	Hewlett Packard	System 1	07/25/01
	RF Coax Cable	Pasternack / RG 223	20170	02/25/01
	Line Impedance Stabilization Network	ISCI/3PH-20A	20071	04/27/01
<i>Radiated Emission Test</i>				
	EMI Receiver System	Hewlett Packard	System 3	10/17/01
	RF Coax Cable	Times Microwave / LMR 600	20180	02/25/01
	BiLog Antenna	Chase / CBL6111A	20062	03/03/01
	Pre-Amplifier	ISCI / RFPA/Z FL-2000	20007	02/25/01
	High Pass Filter	Mini-Circuits / NHP-100	20359	Verified Before Use
	High Pass Filter	Mini-Circuits / NHP-250	20361	Verified Before Use

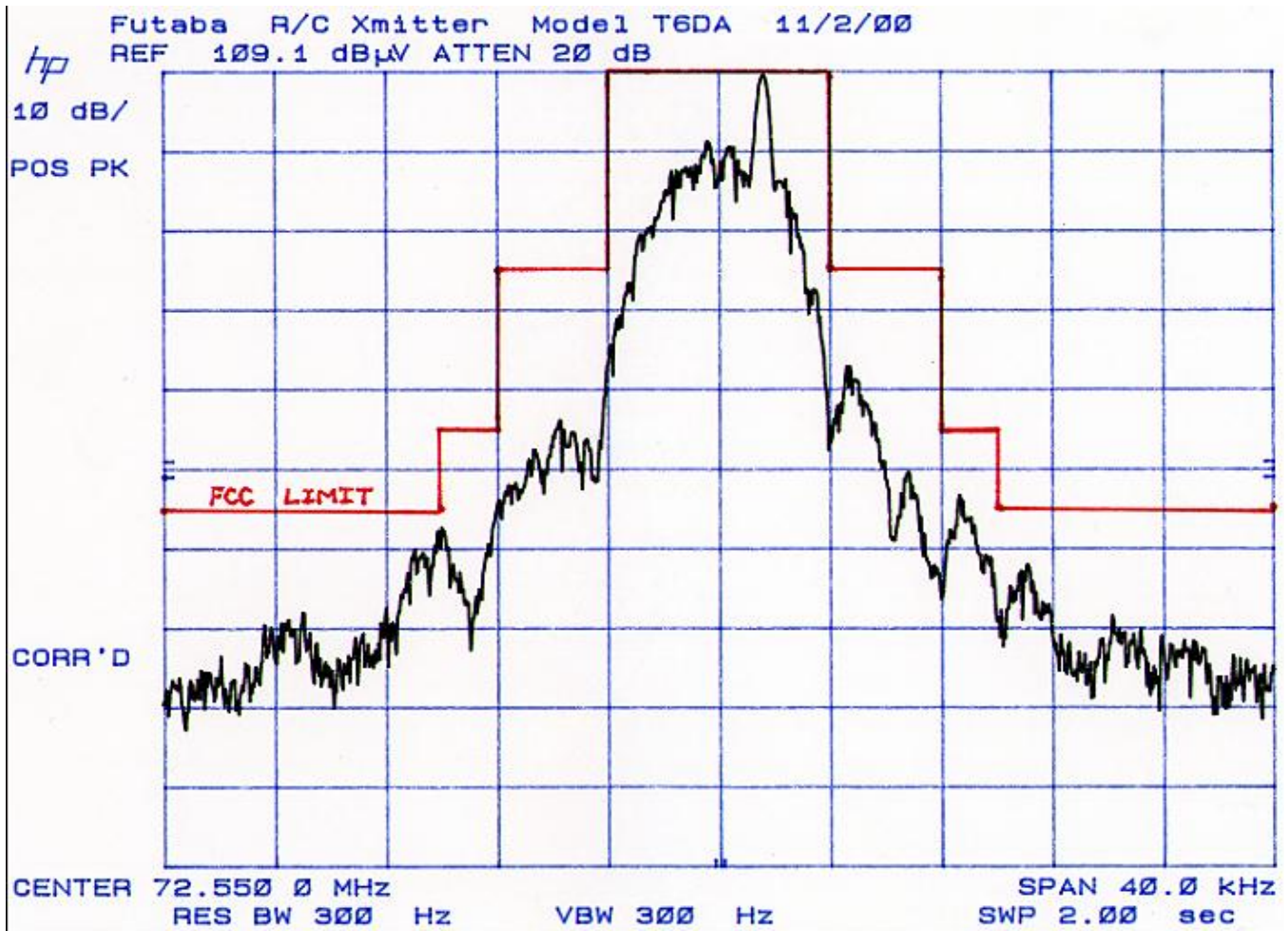


APPENDIX B – SUPPLEMENTAL TEST DATA

<i>Basic Standard</i>	<i>Test Type</i>	<i>Data Format</i>	<i>Page No.</i>
FCC Pt. 95 Subpart C	Occupied Bandwidth 72.550 MHz	Plotted	B1
	Modulation Characteristics 72.550 MHz	Plotted	B3

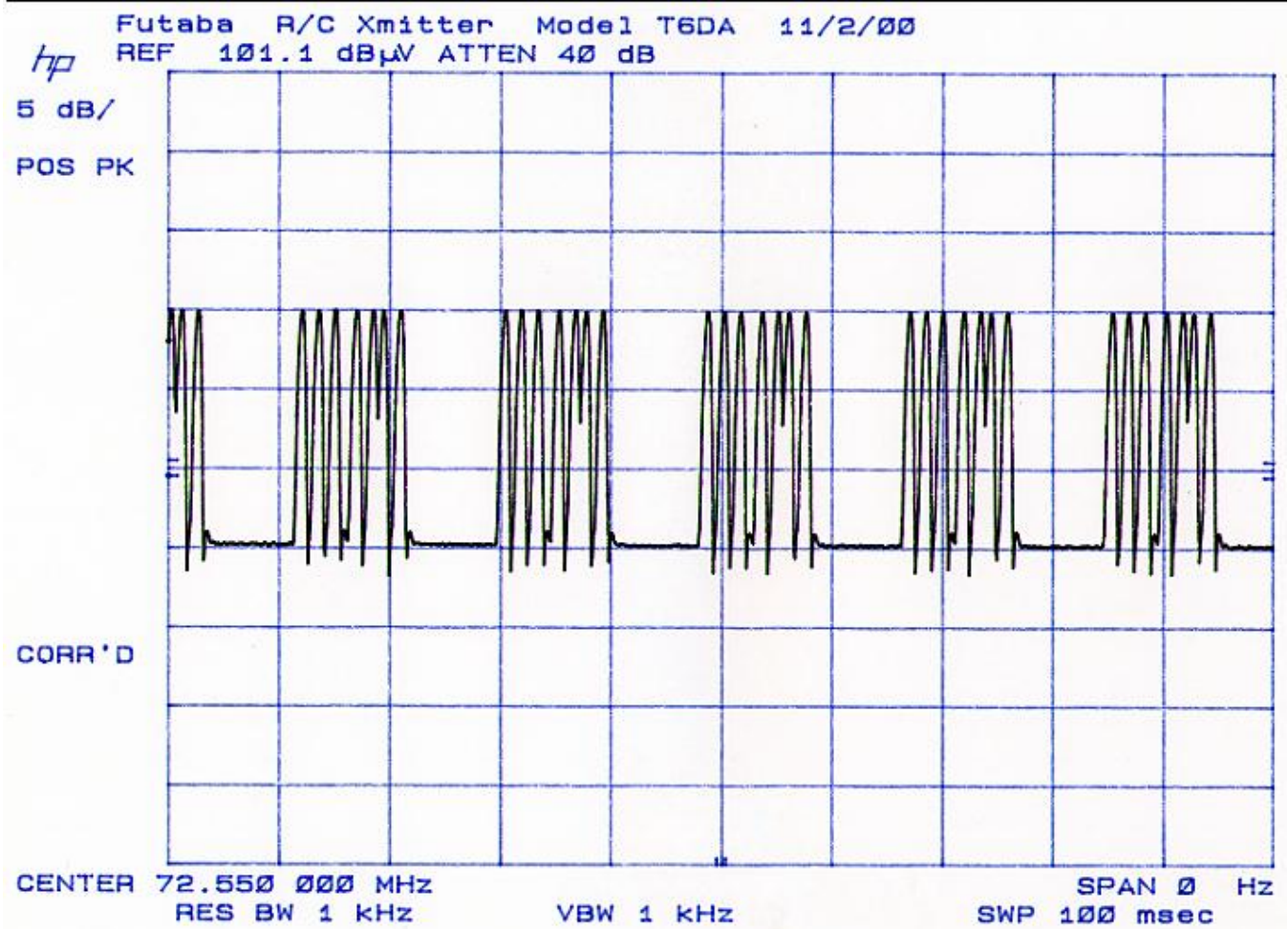


B1





B2





ATTACHMENTS

INDEX OF ATTACHMENTS

<i>Description of Contents</i>	<i>Page No.</i>
Circuit Schematics	Exhibit A
PCB Layout and Parts List Component Side	Exhibit B
PCB Layout Solder Side	Exhibit C
Parts List Solder Side	Exhibit D
Preliminary Instruction Manual	Exhibit E