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 & 75 MHz Radio Control Transmitter Model T6YG
Test Report No.	**:**	FR1461
Purchase Order No.	**:**	HPF00708

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N/C	June 12, 2000		Initial release		

EMC Measurement / Technical Report
Document No. FR1461
From
Garwood Laboratories, Inc.
World Compliance Division

Test for
Futaba Corporation of America
72 & 75 MHz Radio Control Transmitter
Model T6YG

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

Test Personnel	***Test Dates***
Arnulfo Tapia- EMC Technician	5 June 2000

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

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MEASUREMENT / TECHNICAL REPORT SUMMARY

Manufacturer Company	Futaba Corporation of America
Address	101 Electronics Blvd
City, State, Zip	Huntsville, AL 35824
Country	USA
Contact Name	Steve Helms
Phone	256-461-8887
Fax	256-461-1032
Type of Authorization	Certification for 72 & 75 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 The test results complied with the 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 & 75 MHz Radio Control Transmitter
Identification of EUT	Model: T6YG FCC ID: AZPT6YG-72
Production Quantity	Multiple Units

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

1. General Information

1.1 Product Description

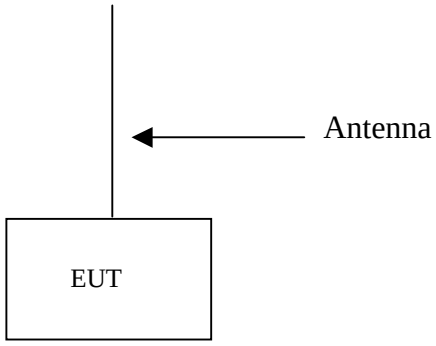
Equipment Under Test	72 & 75 MHz Radio Control (R/C) Transmitter
Model Number	T6YG
Description	The Equipment Under Test (EUT) is an FM 72 & 75MHz R/C transmitter used for aircraft and surface craft operation. The transmitter portion of the EUT operates in the frequency range of 72.010 – 72.990 MHz for aircraft operation or 75.410 – 75.990 MHz for car/boat operation. During testing, the transmitting frequencies were 72.550MHz and 75.690MHz. The transmitting power of the EUT is less than 750mW. The EUT is powered from a Futaba 9.6VDC NiCd rechargeable battery Model NT8F600B.
Clock Frequencies	6.00MHz Transmitting frequencies during test: 72.550MHz and 75.690MHz

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					
Item	*Manufacturer*	*Description*	*Model No.*	*Serial No.*	*FCC ID*
EUT	Futaba Corporation	R/C Transmitter	T6YG	N/A	AZPT6YG-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.



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 (I^2T)

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 5, 1999.

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. Ther 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 – Aircraft operation 75.41- 75.99MHz – Surface craft operation
Range of Operating Power	Fixed Output Power
Maximum Output Power	99.3mW – 75MHz 157mW – 72MHz
FCC Rating Maximum Transmitting Power	750mW
Final Stage Amplifier DC Voltage, Current	Voltage: 9.6VDC Current: 75mA

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 (2SC4272) – Final stage RF amplifier
4. Q5 (2SC2412) – Wave form shaper
5. Q6 (2SC2412) – Trainer buffer
6. Q7 (2SC2412) – Trainer buffer
7. IC1 (FP6325) – Encoder
8. IC2 (BU4051) – Encoder
9. IC3 (78L05) – Voltage Stabilizer
10. IC4 (UPC358) – Encoder
11. IC5 (UPC358) – Encoder

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.

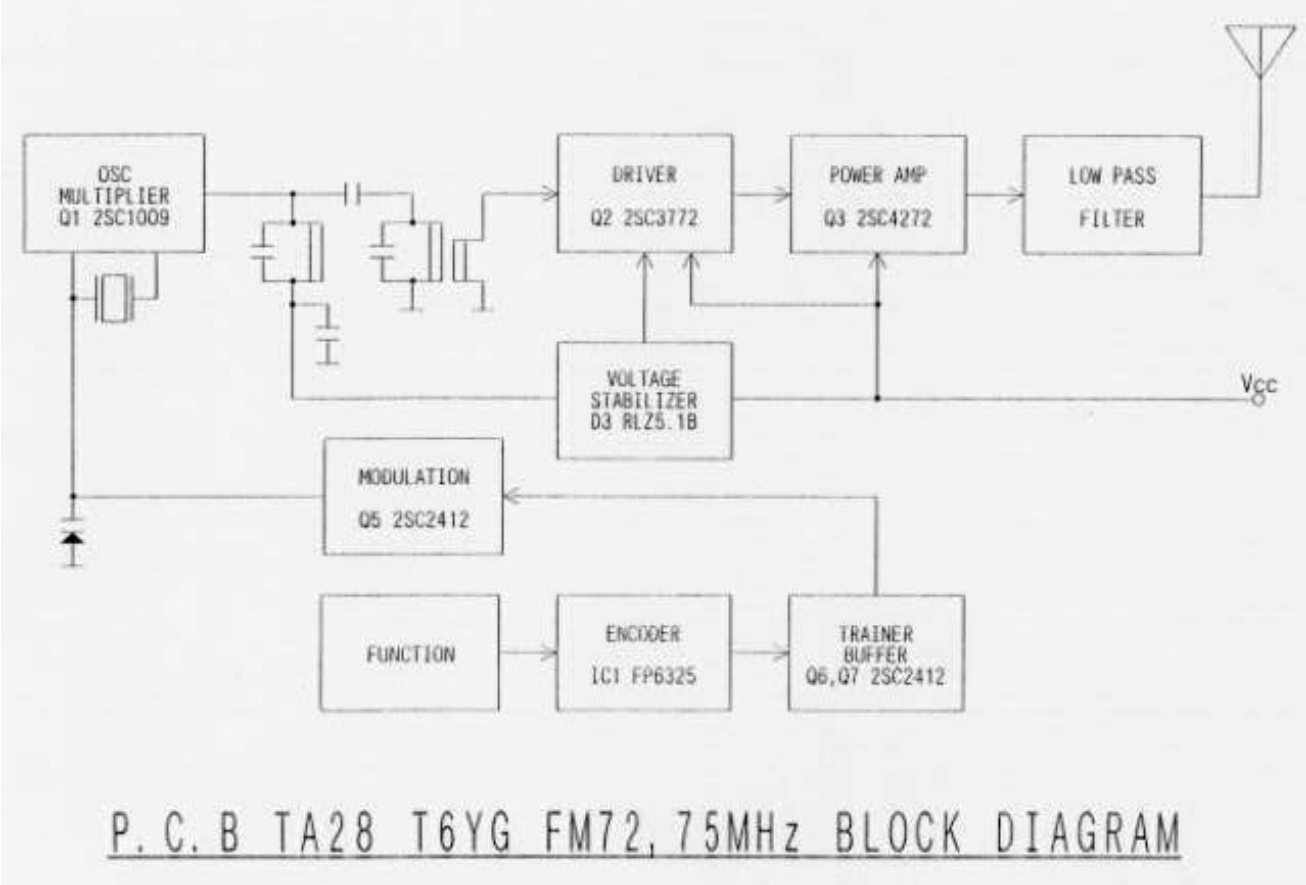
3.2 Location of Label on the EUT

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 measured field strength at 72.550 MHz was 117.2dBµV/m at a distance of 3 meters. The transmitter output power in watts was calculated to be 157mW.

The measured field strength at 75.690 MHz was 115.6dBµV/m at a distance of 3 meters. The transmitter output power in watts was calculated to be 99.3mW.

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. Test result plots are 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 10^{th} 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: 117.2 – (56 + 10log 0.157)
= 69.2 dBµV

Frequency (MHz)	Emission Level (dBµV)	Correction Factor (dB)	Corrected Reading (dBµV/m)	FCC Limit @ 3 meters (dBµV/m)	Delta to FCC Limit (dB)
72.550	109.4	7.8	117.2	-	-
145.100	43.9	14.0	57.9	69.2	-11.3
217.650	37.3	12.0	49.3	69.2	-19.9
290.200	26.8	15.7	42.5	69.2	-26.7
362.750	30.8	18.8	49.6	69.2	-19.6
435.300	27.5	19.9	47.4	69.2	-21.8
507.850	13.0	21.7	34.7	69.2	-34.5
580.400	18.6	23.0	41.6	69.2	-27.6
652.950	14.6	24.4	39.0	69.2	-30.2
725.500	16.8	25.9	42.7	69.2	-26.5

- 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.

Tuned Frequency: 75.690 MHz
Measurement Distance: 3m
FCC Limit: 115.6 – (56 + 10log 0.0993)
= 69.6dBμV

Frequency (MHz)	Emission Level (dBμV)	Correction Factor (dB)	Corrected Reading (dBμV/m)	FCC Limit @ 3 meters (dBμV/m)	Delta to FCC Limit (dB)
75.690	107.2	8.4	115.6	-	-
151.380	41.1	13.9	55.0	69.6	-14.6
227.070	38.0	12.3	50.3	69.6	-19.3
302.760	17.4	16.2	33.6	69.6	-36.0
378.450	25.4	18.9	44.3	69.6	-25.3
454.140	15.4	20.6	36.0	69.6	-33.6
529.830	16.7	22.3	39.0	69.6	-30.6
605.520	20.0	23.5	43.5	69.6	-26.1
681.210	14.9	25.1	40.0	69.6	-29.6
756.900	13.5	25.9	39.4	69.6	-30.2

- The Correction Factor consist of Antenna Factor + Cable Loss.
- Measurements were performed with 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 ±0.002% for temperature and voltage variations. Frequency measurements were made as follows:
(a) at 10 degree intervals of temperatures between -30ºC and +50ºC at the manufacturer's rated supply voltage, and
(b) at +20ºC temperature and ±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 T6YG transmitter complied with the frequency stability requirements.

Frequency Stability vs. Temperature

Frequency tuned: 75.690 MHz
Frequency Accuracy Required: 0.002%

Operating Temperature (°C)	Frequency Measured (MHz)	Frequency Deviation (Hz)	Frequency Deviation (%)
-30	75.690266	266	0.000351
-20	75.690534	534	0.000706
-10	75.690695	695	0.000918
0	75.690673	673	0.000888
+10	75.690595	595	0.000785
+20	75.690352	352	0.000465
+30	75.690138	138	0.000182
+40	75.689863	-137	-0.000182
+50	75.689700	-300	-0.000396

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	72.549942	-59	-0.000081
-20	72.550241	241	0.000332
-10	72.550487	487	0.000671
0	72.550453	453	0.000624
+10	72.550317	317	0.000437
+20	72.550164	164	0.000226
+30	72.549985	-15	-0.000021
+40	72.549841	-160	-0.000220
+50	72.549664	-336	-0.000463

Frequency Stability vs. Supply Voltage

Frequency Tuned: 75.690 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	75.689988	-12	-0.000017
8.00	75.690038	38	0.000050
8.50	75.690098	98	0.000129
9.00	75.690141	141	0.000186
9.60	75.690173	173	0.000229
10.00	75.690187	186	0.000246
10.50	75.690203	203	0.000268
11.00	75.690211	211	0.000279
11.52	75.690221	221	0.000291

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	72.549912	-88	-0.000122
8.00	72.549950	-51	-0.000070
8.50	72.550004	4	0.000005
9.00	72.550039	39	0.000054
9.60	72.550071	71	0.000098
10.00	72.550079	79	0.000109
10.50	72.550091	90	0.000125
11.00	72.550103	103	0.000141
11.52	72.550109	108	0.000150

5.5 Modulation Characteristics

Please refer to Appendix B for detailed plots 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.

6. Photographs of Test Arrangement and EUT Construction

Test Setup Pictures (Front View)
Test Setup Pictures (Rear View)

EUT Construction Front View (72 & 75MHz Units)

EUT Construction Front View
EUT Construction Back View

EUT Construction Top View

EUT with Enclosure Removed

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.

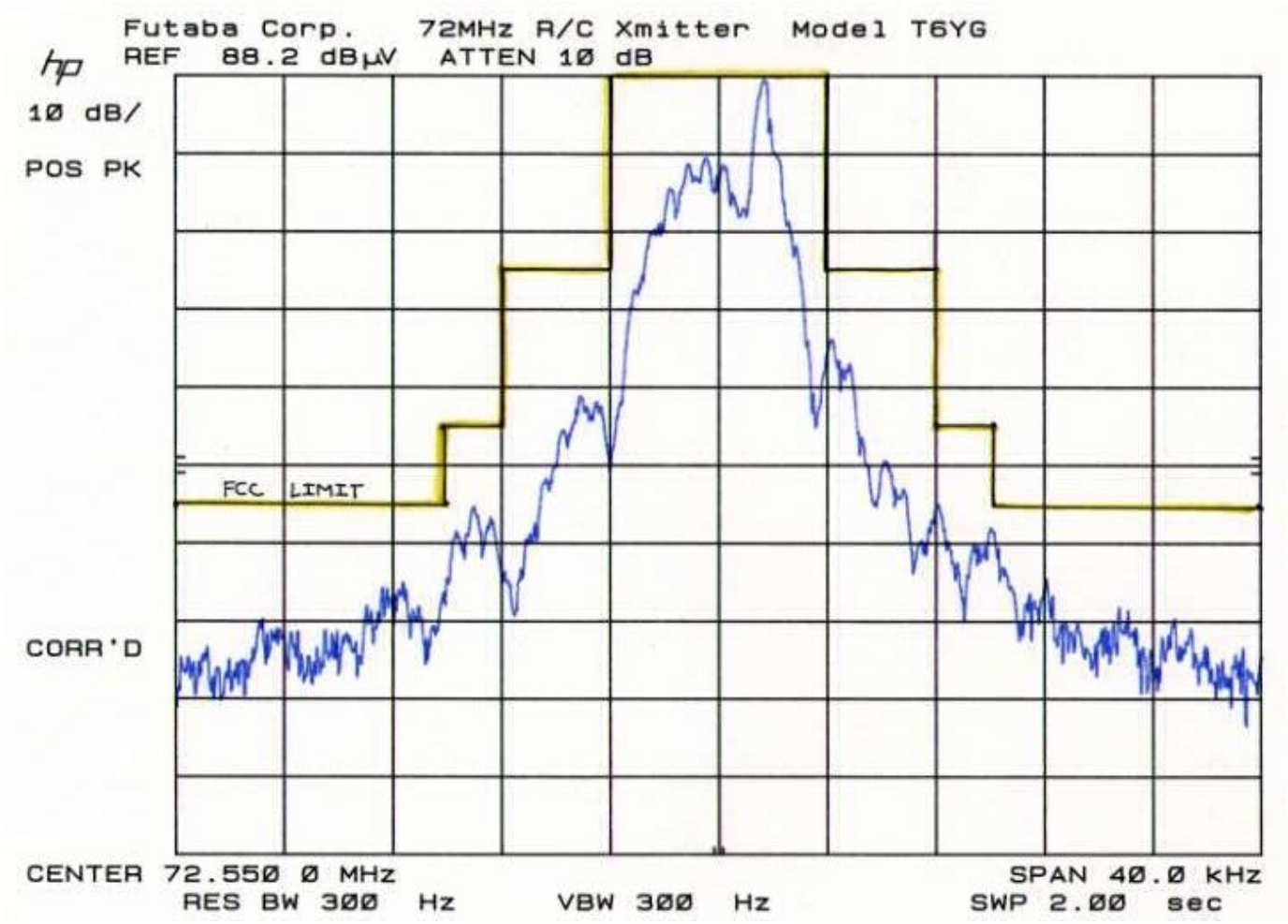
A.1 Specific Equipment Used

Test	*Instrument*	*MFG / Model No.*	*Asset No.*	*Cal. Due Date*
Conducted Emission Test				
	EMI Receiver System	Hewlett Packard	System 1	02/25/01
	RF Coax Cable	Pasternack / RG 223	20170	02/25/01
	Line Impedance Stabilization Network	ISCI/3PH-20A	20071	03/16/01
Radiated Emission Test				
	EMI Receiver System	Hewlett Packard	System 3	10/14/00
	RF Coax Cable	Times Microwave / LMR 600	20180	02/25/01
	BiLog Antenna	Chase / CBL6111A	20062	07/09/00
	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

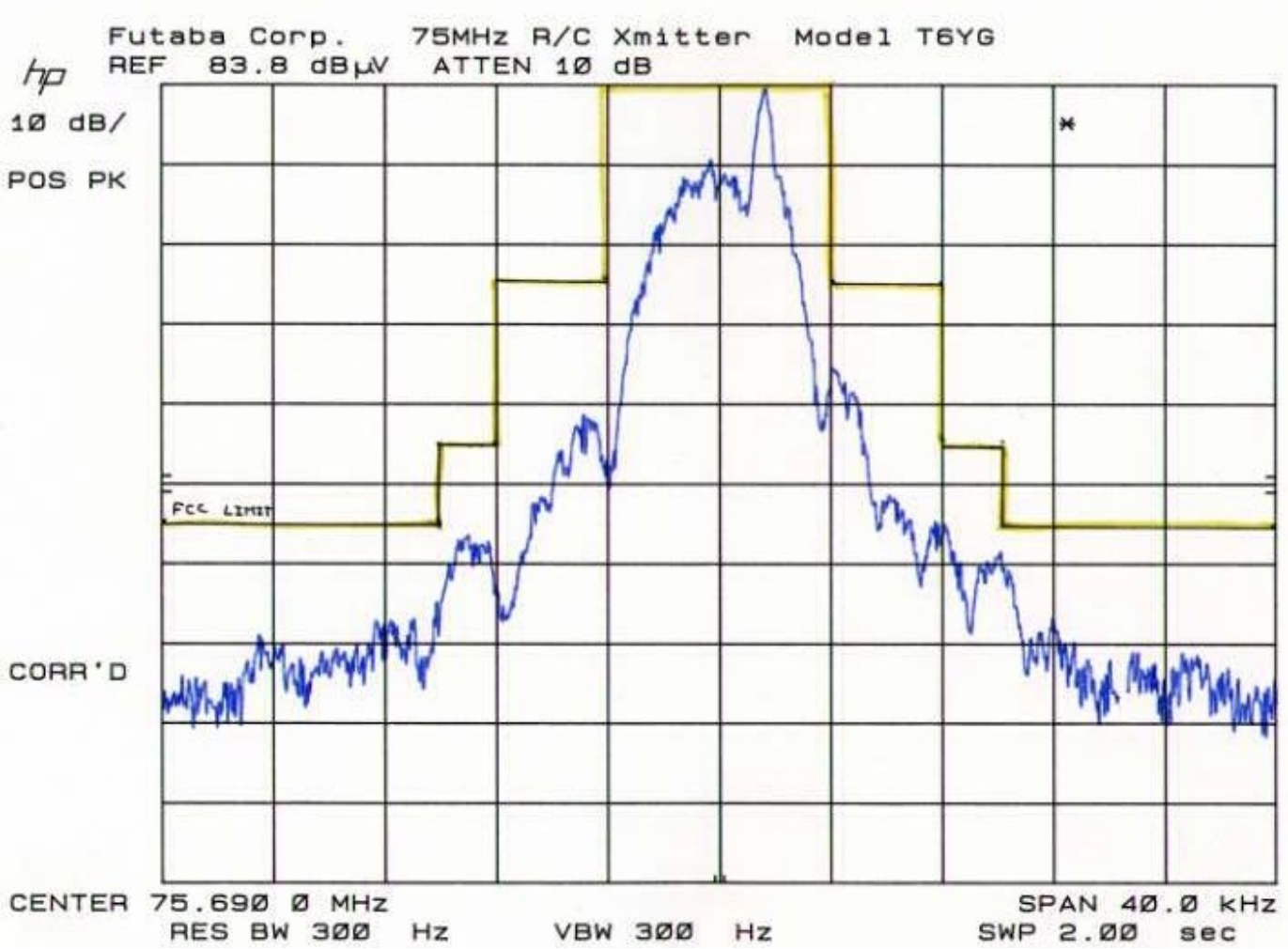
APPENDIX B – SUPPLEMENTAL TEST DATA

Basic Standard	***Test Type***	***Data Format***	***Page No.***
Part 95 Subpart C, E Part 2 Subpart J	Occupied Bandwidth 72.550 MHz	Plotted	B1
	Occupied Bandwidth 75.690 MHz	Plotted	B2
	Modulation Characteristics 72.550 MHz	Plotted	B3
	Modulation Characteristics 75.690 MHz	Plotted	B4

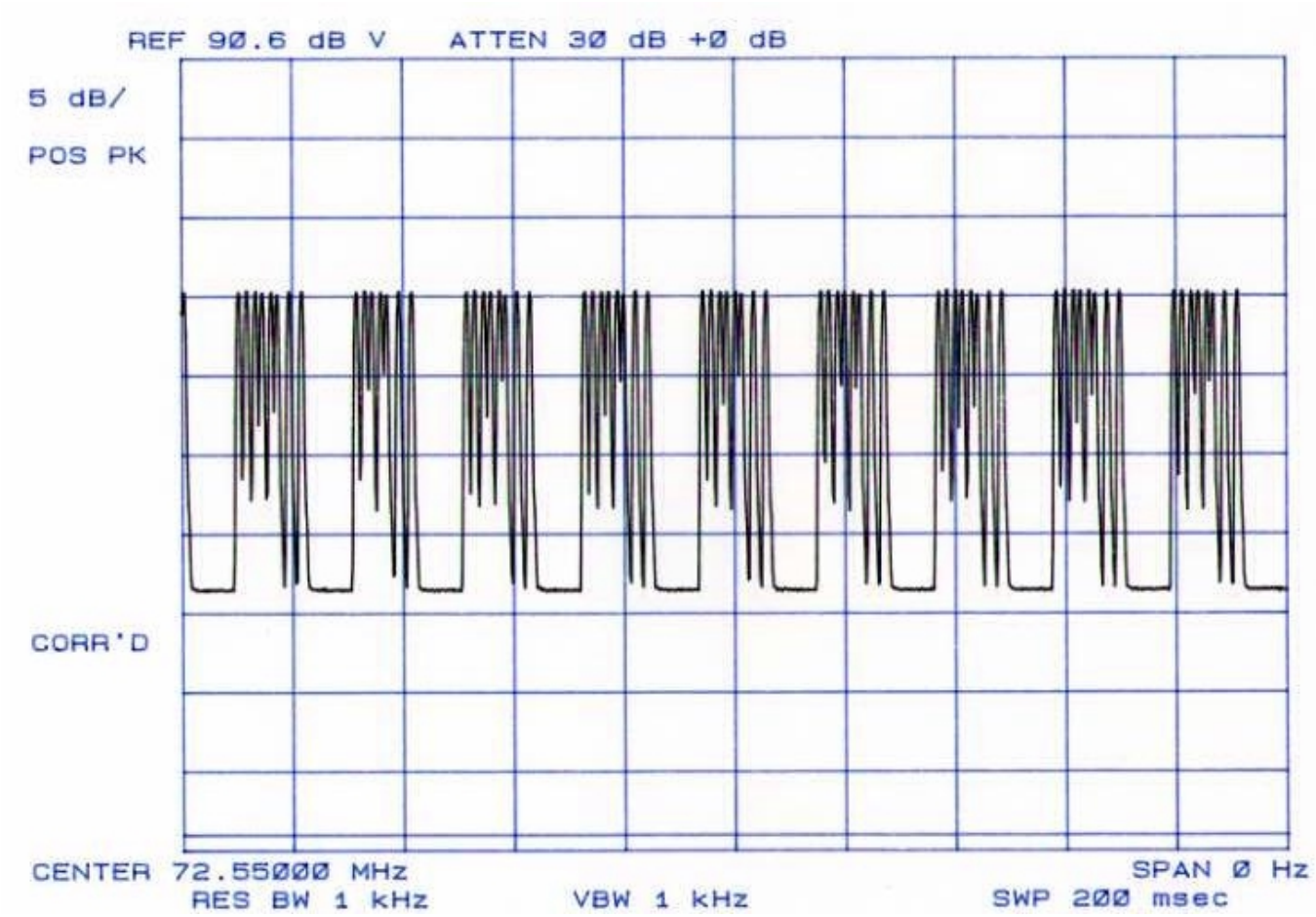
B1


Futaba Corp. 72MHz R/C Xmitter Model T6YG
REF 88.2 dBµV ATTEN 10 dB
10 dB/
POS PK
FCC LIMIT
CORR'D
CENTER 72.550 0 MHz
SPAN 40.0 kHz
RES BW 300 Hz
VBW 300 Hz
SWP 2.00 sec

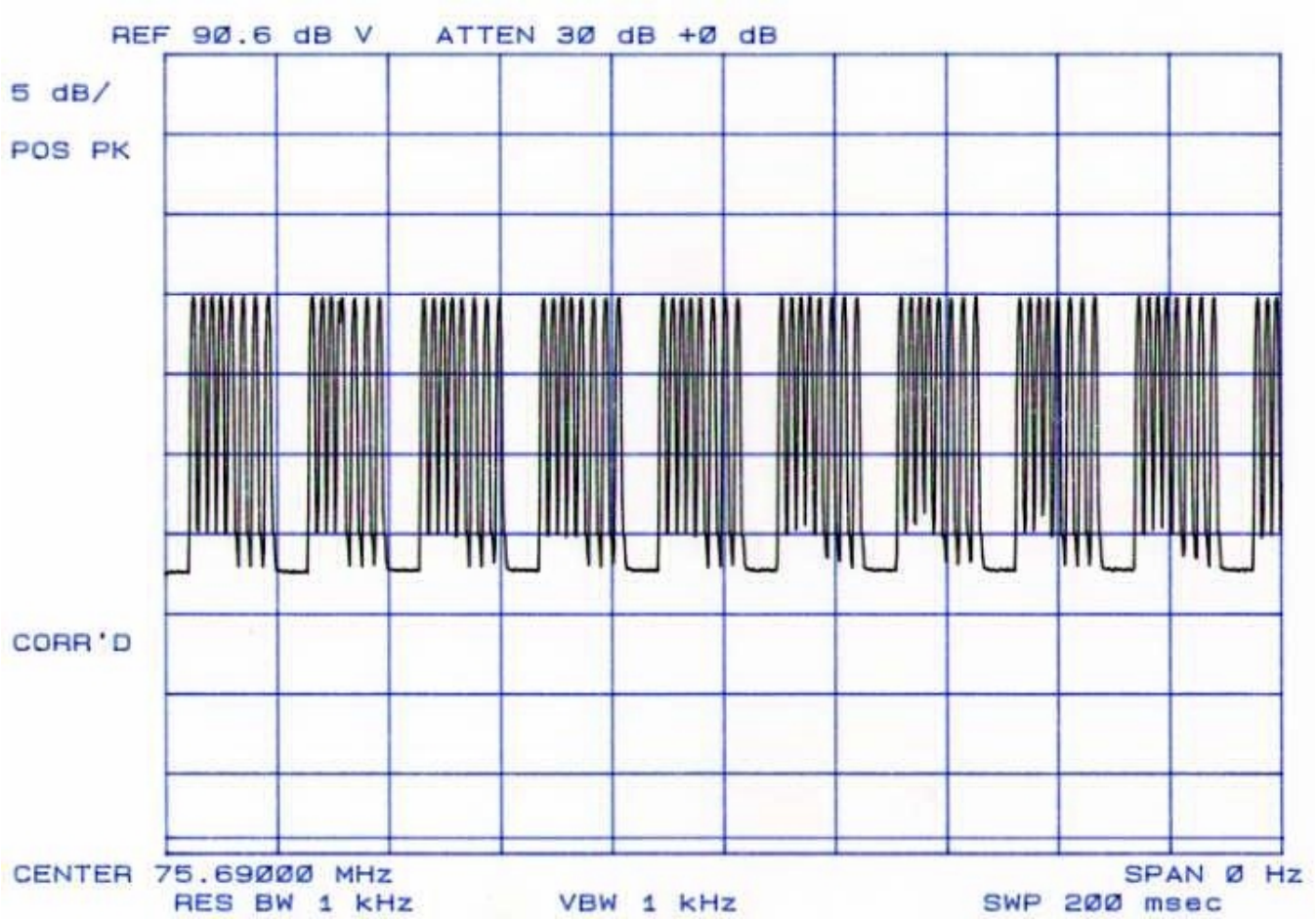
B2


Futaba Corp. 75MHz R/C Xmitter Model T6YG
REF 83.8 dBµV ATTEN 10 dB
10 dB/
POS PK
FCC LIMIT
CORR'D
CENTER 75.690 0 MHz
RES BW 300 Hz
VBW 300 Hz
SPAN 40.0 kHz
SWP 2.00 sec

B3


REF 90.6 dB V
ATTEN 30 dB +0 dB
5 dB/
POS PK
CORR'D
CENTER 72.55000 MHz
SPAN 0 Hz
RES BW 1 kHz
VBW 1 kHz
SWP 200 msec

B4


REF 90.6 dB V
ATTEN 30 dB +0 dB
5 dB/
POS PK
CORR'D
CENTER 75.69000 MHz
SPAN 0 Hz
RES BW 1 kHz
VBW 1 kHz
SWP 200 msec

ATTACHMENTS

INDEX OF ATTACHMENTS