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Measured Radio Frequency Emissions
From

Lear Corporation Transmitter
FCC ID: KOBGTE12A
IC: 3521A-GTE12A

Test Report No. 417124-628
April 16, 2012

For:
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Summary

Tests for compliance with FCC Regulations, CFR 47, Part 15 and with Industry Canada RSS-210/Gen, were performed on a Lear, FCC ID: KOBGTE12A, IC: 3521A-GTE12A. This device under test (DUT) is subject to the rules and regulations as a Transmitter.

In testing completed on March 28, 2012, the DUT tested met the allowed specifications for radiated emissions by 0.9 dB. Conducted emissions are not subject to regulation as the DUT is powered by a 12 VDC automotive power system.

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1. Introduction

This Lear Transmitter was tested for compliance with FCC Regulations, Part 15, adopted under Docket 87-389, April 18, 1989 as subsequently amended, and with Industry Canada RSS-210/Gen, Issue 8, December 2010. Tests were performed at the University of Michigan Radiation Laboratory Willow Run Test Range following the procedures described in ANSI C63.4-2003 "Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz". The Site description and attenuation characteristics of the Open Site facility are on file with FCC Laboratory, Columbia, Maryland (FCC Reg. No: 91050) and with Industry Canada, Ottawa, ON (File Ref. No: IC 2057A-1).

2. Equipment Used

The test equipment commonly used in our facility is listed in Table 2.1. Except where indicated as a pre-test, monitoring, or support device; all equipment listed below is a part of the University of Michigan Radiation Laboratory (UMRL) quality system. This quality system has been established to ensure all equipment has a clearly identifiable classification, calibration expiry date, and that all calibrations are traceable to national standards.

Table 2.1 Test Equipment.

Test Instrument	Used	Manufacturer/Model	Q Number
Spectrum Analyzer (9kHz-26GHz)	☒	Hewlett-Packard 8593E, SN: 3412A01131	HP8593E1
Spectrum Analyzer (9kHz-6.5GHz)	☒	Hewlett-Packard 8595E, SN: 3543A01546	JDB8595E
Power Meter	☐	Hewlett-Packard, 432A	HP432A1
Harmonic Mixer (26-40 GHz)	☐	Hewlett-Packard 11970A, SN: 3003A08327	HP11970A1
Harmonic Mixer (40-60 GHz)	☐	Hewlett-Packard 11970U, SN: 2332A00500	HP11970U1
Harmonic Mixer (75-110 GHz)	☐	Hewlett-Packard 11970W, SN: 2521A00179	HP11970W1
Harmonic Mixer (140-220 GHz)	☐	Pacific Millimeter Prod., GMA, SN: 26	PMPGMA1
S-Band Std. Gain Horn	☐	S/A, Model SGH-2.6	SBAND1
C-Band Std. Gain Horn	☐	University of Michigan, NRL design	CBAND1
XN-Band Std. Gain Horn	☐	University of Michigan, NRL design	XNBAND1
X-Band Std. Gain Horn	☐	S/A, Model 12-8.2	XBAND1
X-band horn (8.2- 12.4 GHz)	☐	Narda 640	XBAND2
X-band horn (8.2- 12.4 GHz)	☐	Scientific Atlanta , 12-8.2, SN: 730	XBAND3
K-band horn (18-26.5 GHz)	☐	FXR, Inc., K638KF	KBAND1
Ka-band horn (26.5-40 GHz)	☐	FXR, Inc., U638A	KABAND1
U-band horn (40-60 GHz)	☐	Custom Microwave, HO19	UBAND1
W-band horn(75-110 GHz)	☐	Custom Microwave, HO10	WBAND1
G-band horn (140-220 GHz)	☐	Custom Microwave, HO5R	GBAND1
Bicone Antenna (30-250 MHz)	☒	University of Michigan, RLBC-1	LBBIC1
Bicone Antenna (200-1000 MHz)	☒	University of Michigan, RLBC-2	HBBIC1
Dipole Antenna Set (30-1000 MHz)	☒	University of Michigan, RLDP-1,-2,-3	UMDIP1
Dipole Antenna Set (30-1000 MHz)	☐	EMCO 3121C, SN: 992 (Ref. Antennas)	EMDIP1
Active Rod Antenna (30 Hz-50 MHz)	☐	EMCO 3301B, SN: 3223	EMROD1
Active Loop Antenna (30 Hz-50 MHz)	☐	EMCO 6502, SN:2855	EMLOOP1
Ridge-horn Antenna (300-5000 MHz)	☒	University of Michigan	UMRH1
Amplifier (5-1000 MHz)	☒	Avantek, A11-1, A25-1S	AVAMP1
Amplifier (5-4500 MHz)	☒	Avantek	AVAMP2
Amplifier (4.5-13 GHz)	☐	Avantek, AFT-12665	AVAMP3
Amplifier (6-16 GHz)	☐	Trek	TRAMP1
Amplifier (16-26 GHz)	☐	Avantek	AVAMP4
LISN Box	☐	University of Michigan	UMLISN1
Signal Generator	☐	Hewlett-Packard 8657B	HPSG1

3. Device Under Test

3.1 Description & Block Diagram

The DUT is a multifrequency transmitter (12 frequencies in total: 288, 295, 300, 303.85, 310, 315, 318, 340, 360, 372, 380, and 390 MHz), 8 x 7 x 2 cm in size, designed to emulate existing garage door openers. This transmitter has pre-programmed protocols selected by the user based upon garage door receiver information. There are three buttons on the device so that the user may program a separate protocol to each button. The antenna is integral to the device; mounted on the PCB.

Device	[Make], Model	[S/N],P/N	EMC Consideration
DUT	[Lear], UHR3	Test Module #1	15.231/RSS-210
DUT	[Lear], UHR3	Test Module #2	15.231/RSS-210

Cable	[Make], Model	Length	EMC Consideration
DC power	[Generic]	1 meter	two wire

3.2 Test Methodology

Since the DUT is capable of transmitting a large number of different protocols over 12 different frequencies, the following test procedure has been followed. The lowest frequency (288 MHz), the most capable middle frequency (318 MHz), and the highest frequency (390 MHz) have been tested for the worst case duty cycle (least on time in 100 ms window). The manufacturer states that this covers the worst case conditions for all protocols in both programming and normal operating modes. (This approach follows the recommendations of the FCC and IC in previous applications for like products by this manufacturer. See description of operation exhibit for more details.) The encodings used represent the limits of duty that the manufacturer states it will implement at a given frequency. In addition, this report includes data for all three frequencies with the DUT programmed at the manufacturer's minimum duty cycle protocols to demonstrate correct output power adjustment by the DUT.

3.3 Variants and Samples

There is only a single variant of the DUT, as tested. Two samples of the DUT were provided for testing. **Test Module #1 (TM#1)** was setup for RF transmission at 288 MHz with 10.5% duty cycle, 318 MHz with 10.5% duty cycle, and 390 MHz with 62.5% duty cycle. **Test Module #2 (TM#2)** was setup for RF transmission at 315 MHz + 390 MHz with 30.2% duty cycle, 288 MHz with 62.5% duty cycle, and 318 MHz with 63.7% duty. After emissions testing, the normal operating mode of the device was tested by clearing the memory of the test modules employed and following the user programming instructions included with this filing.

3.4 Modes of Operation

This device is capable of two principle modes of operation: NORMAL OPERTING MODE and PROGRAMMING MODE. A detailed description of these modes in included in the confidential description of operation exhibit.

In **NORMAL OPERATING MODE** there exist 2 protocols wherein both 315 MHz and 390 MHz are used sequentially during a single button press; all other protocols in this mode transmit on only a single frequency.

In **PROGRAMMING MODE** the device may transmit on up to 4 frequencies in a sequential manner during a single button press.

The peak output power of the DUT is internally adjusted according to the RF frequency and data transmitted. Duty factors are calculated in software for all fixed code transmissions. For rolling code transmissions, the duty factor is computed for the worst case maximum on time.

3.5 Exemptions

The DUT is permanently installed in a transportation vehicle. As such, digital emissions are exempt (per FCC 15.103(a) and IC correspondence on ICES-003) from regulation.

3.6 EMC Relevant Modifications

No EMI Relevant Modifications were performed by this test laboratory.

4. Emissions Limits

4.1 Radiated Emissions Limits

The DUT tested falls under the category of an Intentional Radiator. The applicable testing frequencies and corresponding emission limits set by both the FCC and IC are given in Tables 4.1 and 4.2 below.

Table 4.1. TX Emission Limits (FCC: 15.231(b), .205(a); IC: RSS-210 2.7 T4).

Frequency (MHz)	Fundamental Ave. E_{lim} (3m) (μV/m)	Fundamental Ave. E_{lim} (3m) dB (μV/m)	Spurious** Ave. E_{lim} (3m) (μV/m)	Spurious** Ave. E_{lim} (3m) dB (μV/m)
260.0-470.0	3750-12500*		375-1250	
315	6042	75.6	604.2	55.6
433.9	10966	80.8	1096.6	60.8
322-335.4 399.9-410 608-614	Restricted Bands		200	46.0
960-1240/1427(IC) 1300-1427 1435-1626.5 1645.5-1646.5 (IC) 1660-1710 1718.9-1722.2 2200-2300	Restricted Bands		500	54.0

* Linear interpolation, formula: E = -7083 + 41.67*f (MHz)
** Measure up to tenth harmonic; 120 kHz BW up to 1 GHz, 1 MHz BW above 1 GHz

Table 4.2. Spurious Emission Limits (FCC: 15.33, .35, .109/209; IC: RSS-210 2.7, T2)

Freq. (MHz)	E_{lim} (3m) μV/m	E_{lim} dB(μV/m)
30-88	100	40.0
88-216	150	43.5
216-960	200	46.0
960-2000	500	54.0

Note: Average readings apply above 1000 MHz (1 MHz BW), Quasi-Peak readings apply to 1000 MHz (120 kHz RBW), PRF of intentional emissions > 20 Hz for QPK to apply.

4.2 Power Line Conducted Emissions Limits

Table 4.3 Emission Limits (FCC:15.107 (CISPR); IC: RSS-Gen, 7.2.2 T2).

Frequency (MHz)	Class A (dBμV) Quasi-peak	Class A (dBμV) Average	Class B (dBμV) Quasi-peak	Class B (dBμV) Average
.150 - 0.50	79	66	66 - 56*	56 - 46*
0.50 - 5	73	60	56	46
5 - 30	73	60	60	50

Notes:
1. The lower limit shall apply at the transition frequency
2. The limit decreases linearly with the logarithm of the frequency in the range 0.15-0.50 MHz:
   *Class B Quasi-peak: dBμV = 50.25 - 19.12*log(f)
   *Class B Average: dBμV = 40.25 - 19.12*log(f)
3. 9 kHz RBW

5. Measurement Procedures

5.1 Semi-Anechoic Chamber Radiated Emissions

To become familiar with the radiated emission behavior of the DUT, the device is first studied and measured in our shielded semi-anechoic chamber. In the chamber there is a set-up similar to that of an outdoor 3-meter site, with a turntable, an antenna mast, and a ground plane. Instrumentation includes spectrum analyzers and other equipment as needed.

The DUT is laid on the test table as shown in the included block diagram and/or photographs. A shielded loop antenna is employed when studying emissions from 9 kHz to 30 MHz. Above 30 MHz and below 250 MHz a biconical antenna is employed. Above 250 MHz a ridge or and standard gain horn antennas are used. The spectrum analyzer resolution and video bandwidths are set so as to measure the DUT emission without decreasing the emission bandwidth (EBW) of the device. Emissions are studied for all orientations (3-axes) of the DUT and all test antenna polarizations. In the chamber, spectrum and modulation characteristics of intentional carriers are recorded. Receiver spurious emissions are measured with an appropriate carrier signal applied. Associated test data is presented in subsequent sections.

5.2 Outdoor Radiated Emissions

After measurements are performed indoors, emissions on our outdoor 3-meter Open Area Test Site (OATS) are made, when applicable. If the DUT connects to auxiliary equipment and is table or floor standing, the configurations prescribed in ANSI C63.4 are employed. Alternatively, an on-table layout more representative of actual use may be employed if the resulting emissions appear to be worst-case in such a configuration. Any intentionally radiating elements are placed on the test table flat, on their side, and on their end (3-axes) and worst case emissions are recorded. For each configuration the DUT is rotated 360 degrees about its azimuth and the receive antenna is raised and lowered between 1 and 4 meters to maximize radiated emissions from the device. Receiver spurious emissions are measured with an appropriate carrier signal applied. For devices with intentional emissions below 30 MHz, our shielded loop antenna at a 1 meter receive height is used. Low frequency field extrapolation to the regulatory limit distance is employed as needed. Emissions between 30 MHz and 1 GHz are measured using tuned dipoles and/or biconical antennas. Care is taken to ensure that the RBW and VBW used meet the regulatory requirements, and that the EBW of the DUT is not reduced. The Photographs included in this report show the Test Setup.

5.3 Radiated Field Computations

To convert the dBm values measured on the spectrum analyzer to dB(μV/m), we use expression

$$E3(dB\mu V/m) = 107 + PR + KA - KG + KE - CF$$

where
- PR = power recorded on spectrum analyzer, dBm, measured at 3 m
- KA = antenna factor, dB/m
- KG = pre-amplifier gain, including cable loss, dB
- KE = duty correction factor, dB
- CF = distance conversion (employed only if limits are specified at alternate distance), dB

When presenting the data at each frequency, the highest measured emission under all of the possible DUT orientations (3-axes) is given.

5.4 Indoor Power Line Conducted Emissions

When applicable, power line conducted emissions are measured in our semi-anechoic chamber. If the DUT connects to auxiliary equipment and is table or floor standing, the configurations prescribed in ANSI C63.4 are employed. Alternatively, an on-table layout more representative of actual use may be employed if the resulting emissions appear to be worst-case in such a configuration.

The conducted emissions measured with the spectrum analyzer and recorded (in dBµV) from 0-2 MHz and 2-30 MHz for both the ungrounded (Hi) and grounded (Lo) conductors. The spectrum analyzer is set to peak-hold mode in order to record the highest peak throughout the course of functional operation. Only when the emission exceeds or is near the limit are quasi-peak and average detection used.

5.5 Supply Voltage Variation

Measurements of the variation in the fundamental radiated emission were performed with the supply voltage varied by no less than 85% and 115% of the nominal rated value. For battery operated equipment, tests were performed using a new battery, and worst case emissions are re-checked employing a new battery.

6. Test Results

6.1 Radiated Emissions

6.1.1 Correction for Pulse Operation

When the transmitter is activated it can, in the worst case, transmit as detailed in the following table. See Figure 6.1. Computing the duty factor results in:

Freq.	On-Time	Duty Cycle Calculation	K_E (dB)
288	Min	(18 x 0.585 ms)/100 ms = 0.105	-19.6
	Max	(16 x 3.825 ms + 2 x 0.625 ms)/100 ms = 0.6245	-4.1
318	Min	(18 x 0.585 ms)/100 ms = 0.105	-19.6
	Max	(16 x 3.90 ms + 2 x 0.625 ms)/100 ms = 0.6365	-3.9
390	Min	(4.95 ms x (0.215/0.400) + 39.75 ms x (0.415/0.600))/100 ms = 0.302	-10.4
	Max	30 µs / 48.0 µs = 0.625	-4.1
315	Min	(4.95 ms x (0.215/0.400) + 39.75 ms x (0.415/0.600))/100 ms = 0.302	-10.4

6.1.2 Emission Spectrum

The relative DUT emission spectrum is recorded and is shown in Figure 6.2.

6.1.3 Emission Bandwidth

The emission bandwidth of all frequencies employed are shown in Figure 6.3.

Freq. (MHz)	20 dB BW (kHz)	Freq. (MHz)	20 dB BW (kHz)
288*	57.5	340*	62.5
295	67.5	360*	62.5
300	65.0	372	87.5
303.8	55.0	380*	70.0
310*	70.0	390*	197.5
315*	70.0		
318*	65.0		

In the worst case mode (programming mode), the eight (8) frequencies starred above may be sequentially activated during a single button use. Per FCC KDB 926416, if the highest frequency used is less than 900 MHz, the cumulative bandwidth for any mode employing multiple frequencies is restricted to 0.0025 (.25%) of the center frequency. For this product, the frequency half way between the lowest and highest frequency employed is 339 MHz. Thus, the maximum permissible cumulative bandwidth is 339 MHz x 0.25% = 847.5 kHz for the eight frequencies in question. Their cumulative bandwidth is 655 kHz.

6.1.4 Supply Voltage and Supply Voltage Variation

The DUT has been designed to be powered by a 12 VDC automotive power system. For this test, relative radiated power was measured at the fundamental as the voltage was varied from 8.0 to 18.0 volts. The emission variation is shown in Figure 6.4.

Voltage	V	=	12 VDC
Current	I	=	7.5 mA (pulsed)

6.2 Conducted Emissions

These tests do not apply, since the DUT is powered from a 12 VDC automotive system.

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Table 6.1(a) Highest Emissions Measured

	Radiated Emission - RF										Lear, GMT900; FCC/IC
#	Freq. MHz	Ant. Used	Ant. Pol.	Pr dBm	Det. Used	Ka dB/m	Kg dB	E3* dBμV/m	E3lim dBμV/m	Pass dB	Comments
1	**TM#1: Duty Cycle: 18 PWM Pulses (10.5% duty)**										
2	288.0	SBic	H	- 8.8	Pk	17.6	23.3	72.9	73.8	**0.9**	end
3	288.0	SBic	V	-21.7	Pk	17.6	23.3	60.0	73.8	13.8	side
4	576.0	SBic	H	-58.6	Pk	23.7	20.4	32.1	53.8	21.8	end
5	576.0	SBic	V	-60.5	Pk	23.7	20.4	30.2	53.8	23.7	end
6	864.0	SBic	H	-69.3	Pk	27.8	18.3	27.6	53.8	26.3	side HDTV Noise
7	864.0	SBic	V	-64.3	Pk	27.8	18.3	32.6	53.8	21.3	side HDTV Noise
8	1152.0	Horn	H	-52.1	Pk	20.2	28.0	27.5	54.0	26.5	end
9	1440.0	Horn	H	-47.1	Pk	21.1	28.0	33.4	54.0	20.6	end
10	1728.0	Horn	H	-68.6	Pk	21.8	28.0	12.6	53.8	41.2	end
11	2016.0	Horn	H	-58.2	Pk	22.5	28.1	23.6	53.8	30.2	end
12	2304.0	Horn	H	-53.6	Pk	23.3	28.3	28.8	53.8	25.1	end
13	2592.0	Horn	H	-47.6	Pk	24.1	28.2	35.7	53.8	18.2	side
14	2880.0	Horn	H	-55.2	Pk	25.0	27.9	29.3	54.0	24.7	end
15											
16			* Includes measured			19.6	dB duty factor				
17											
18	**TM#2: Duty Cycle: PWM Pulses, 16 Wide, 2 Narrow (62.5% duty)**										
19	288.0	SBic	H	-24.9	Pk	17.6	23.3	72.3	73.8	**1.5**	side
20	288.0	SBic	V	-34.9	Pk	17.6	23.3	62.3	73.8	11.5	side
21	576.0	SBic	H	-71.2	Pk	23.7	20.4	35.0	53.8	18.9	max all, HDTV Signal
22	576.0	SBic	V	-73.9	Pk	23.7	20.4	32.3	53.8	21.6	max all, HDTV Signal
23	864.0	SBic	H	-75.0	Pk	27.8	18.3	37.4	53.8	16.5	max all, HDTV Signal
24	864.0	SBic	V	-75.9	Pk	27.8	18.3	36.5	53.8	17.4	max all, HDTV Signal
25	1152.0	Horn	H	-59.1	Pk	20.2	28.0	36.0	54.0	18.0	side
26	1440.0	Horn	H	-70.1	Pk	21.1	28.0	25.9	54.0	28.1	side
27	1728.0	Horn	H	-68.1	Pk	21.8	28.0	28.6	53.8	25.2	end
28	2016.0	Horn	H	-67.6	Pk	22.5	28.1	29.7	53.8	24.1	end
29	2304.0	Horn	H	-62.5	Pk	23.3	28.3	35.4	53.8	18.5	side
30	2592.0	Horn	H	-62.3	Pk	24.1	28.2	36.5	53.8	17.4	side
31	2880.0	Horn	H	-63.7	Pk	25.0	27.9	36.3	54.0	17.7	side
32											
33			* Includes measured			4.1	dB duty factor				
34											
35											
36											
37											
38											
39											

Meas. 03/28-29/12; U of Mich.

Table 6.1(b) Highest Emissions Measured

Radiated Emission - RF											Lear, GMT900; FCC/IC
#	Freq. MHz	Ant. Used	Ant. Pol.	Pr dBm	Det. Used	Ka dB/m	Kg dB	E3* dBµV/m	E3lim dBµV/m	Pass dB	Comments
1	**TM#1: Duty Cycle: 18 PWM Pulses (10.5% duty)**										
2	318.0	SBic	H	-13.5	Pk	18.7	23.0	69.6	75.8	**6.2**	side
3	318.0	SBic	V	-15.9	Pk	18.7	23.0	67.2	75.8	8.6	side
4	636.0	SBic	H	-56.2	Pk	24.5	19.9	35.8	55.8	20.0	max all, HDTV signal
5	636.0	SBic	V	-61.4	Pk	24.5	19.9	30.6	55.8	25.2	max all, HDTV signal
6	954.0	SBic	H	-66.4	Pk	28.9	17.9	32.0	55.8	23.8	flat
7	954.0	SBic	V	-66.8	Pk	28.9	17.9	31.6	55.8	24.2	flat
8	1272.0	Horn	H	-49.4	Pk	20.7	28.0	30.7	54.0	23.3	side
9	1590.0	Horn	H	-45.3	Pk	21.5	28.0	35.6	54.0	18.4	end
10	1908.0	Horn	H	-51.8	Pk	22.3	28.0	29.9	55.8	25.9	end
11	2226.0	Horn	H	-65.8	Pk	23.1	28.1	16.6	54.0	37.4	end
12	2544.0	Horn	H	-46.8	Pk	23.9	28.3	36.2	55.8	19.6	side
13	2862.0	Horn	H	-43.4	Pk	24.9	28.2	40.7	54.0	13.3	end
14	3180.0	Horn	H	-56.1	Pk	25.9	27.9	29.3	55.8	26.5	side
15											
16			* Includes measured			19.6	dB duty factor				
17											
18	**TM#2: Duty Cycle: PWM Pulses, 16 Wide, 2 Narrow (63.7% duty)**										
19	318.0	SBic	H	-27.0	Pk	18.7	23.0	71.7	75.8	**4.1**	end
20	318.0	SBic	V	-33.5	Pk	18.7	23.0	65.2	75.8	10.6	side
21	636.0	SBic	H	-62.7	Pk	24.5	19.9	44.9	55.8	10.9	max all, HDTV signal
22	636.0	SBic	V	-59.8	Pk	24.5	19.9	47.8	55.8	8.0	max all, HDTV signal
23	954.0	SBic	H	-69.1	Pk	28.9	17.9	44.9	55.8	10.9	side
24	954.0	SBic	V	-68.0	Pk	28.9	17.9	46.0	55.8	9.8	side
25	1272.0	Horn	H	-60.7	Pk	20.7	28.0	35.0	54.0	19.0	end
26	1590.0	Horn	H	-60.3	Pk	21.5	28.0	36.2	54.0	17.8	end
27	1908.0	Horn	H	-70.2	Pk	22.3	28.0	27.1	55.8	28.7	side
28	2226.0	Horn	H	-69.9	Pk	23.1	28.1	28.1	54.0	25.9	side
29	2544.0	Horn	H	-60.0	Pk	23.9	28.3	38.6	55.8	17.2	side
30	2862.0	Horn	H	-62.2	Pk	24.9	28.2	37.5	54.0	16.5	side
31	3180.0	Horn	H	-71.3	Pk	25.9	27.9	29.7	55.8	26.1	side
32											
33			* Includes measured			4.0	dB duty factor				
34											
35											
36											
37											
38											
39											

Meas. 03/28-29/2012; U of Mich.

Table 6.1(c) Highest Emissions Measured

	Radiated Emission - RF										Lear, GMT900, FCC/IC
#	Freq. MHz	Ant. Used	Ant. Pol.	Pr dBm	Det. Used	Ka dB/m	Kg dB	E3* dBµV/m	E3lim dBµV/m	Pass dB	Comments
1	**TM#2: Duty Cycle: 12 Wake, PWM data pulses (30.2% duty)**										
2	390.0	Dip	H	-22.3	Pk	20.6	22.4	72.6	79.2	**6.7**	flat
3	390.0	Dip	V	-24.7	Pk	20.6	22.4	70.2	79.2	9.1	end
4	780.0	SBic	H	-68.7	Pk	26.5	19.0	35.4	59.2	23.8	side
5	780.0	SBic	V	-67.1	Pk	26.5	19.0	37.0	59.2	22.2	flat
6	1170.0	Horn	H	-49.8	Pk	20.3	28.0	39.1	54.0	14.9	end
7	1560.0	Horn	H	-46.2	Pk	21.4	28.0	43.8	54.0	10.2	side
8	1950.0	Horn	H	-57.7	Pk	22.4	28.0	33.3	59.2	26.0	end
9	2340.0	Horn	H	-66.7	Pk	23.4	28.0	25.3	54.0	28.7	side
10	2730.0	Horn	H	-51.3	Pk	24.5	28.1	41.7	54.0	12.3	end
11	3120.0	Horn	H	-49.9	Pk	25.7	28.3	44.1	59.2	15.1	side
12	3510.0	Horn	H	-68.1	Pk	27.0	28.2	27.3	59.2	32.0	flat
13	3900.0	Horn	H	-63.9	Pk	28.1	27.9	32.9	54.0	21.1	side
14											
15		* Includes measured			10.4	dB duty factor					
16											
17	**TM#2: Duty Cycle: 12 Wake, PWM data pulses (30.2% duty)**										
18	315.0	SBic	H	-20.7	Pk	18.6	23.0	71.5	75.6	**4.1**	
19	315.0	SBic	V	-27.5	Pk	18.6	23.0	64.7	75.6	10.9	
20											
21			* Includes measured			10.4	dB duty factor				
22											
23	**TM#1: Duty Cycle: Manchester > 100ms (62.5% duty)**										
24	390.0	Dip	H	-24.2	Pk	20.6	22.4	77.0	79.2	**2.3**	flat
25	390.0	Dip	V	-27.1	Pk	20.6	22.4	74.1	79.2	5.2	end
26	780.0	SBic	H	-67.2	Pk	26.5	19.0	43.2	59.2	16.0	end
27	780.0	SBic	V	-67.6	Pk	26.5	19.0	42.8	59.2	16.4	flat
28	1170.0	Horn	H	-55.6	Pk	20.3	28.0	39.6	54.0	14.4	end
29	1560.0	Horn	H	-51.6	Pk	21.4	28.0	44.7	54.0	9.3	side
30	1950.0	Horn	H	-58.7	Pk	22.4	28.0	38.6	59.2	20.7	end
31	2340.0	Horn	H	-64.3	Pk	23.4	28.0	34.0	54.0	20.0	side
32	2730.0	Horn	H	-54.9	Pk	24.5	28.1	44.4	54.0	9.6	end
33	3120.0	Horn	H	-53.3	Pk	25.7	28.3	47.0	59.2	12.2	side
34	3510.0	Horn	H	-68.5	Pk	27.0	28.2	33.2	59.2	26.1	side
35	3900.0	Horn	H	-67.9	Pk	28.1	27.9	35.2	54.0	18.8	side
36											
37			* Includes measured			4.1	dB duty factor				
38											

Meas. 03/28-29/2012; U of Mich.

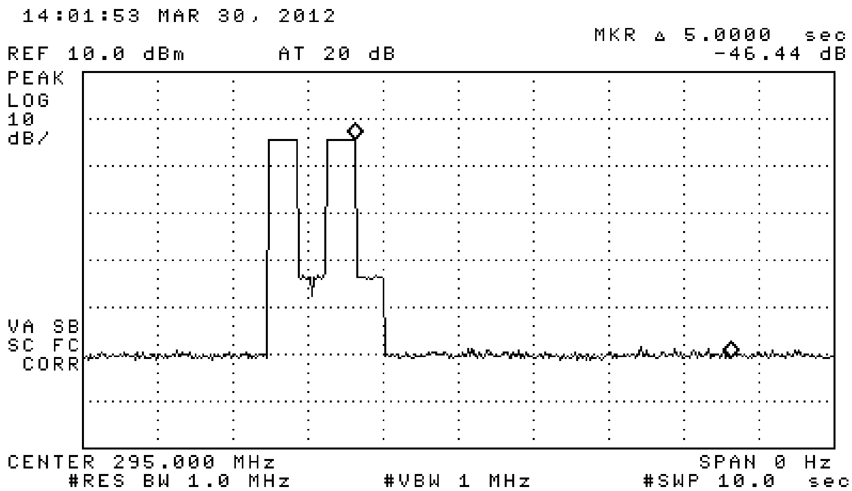


Figure 6.1(a). 5 second transmission limit verification (gate programming / normal mode).

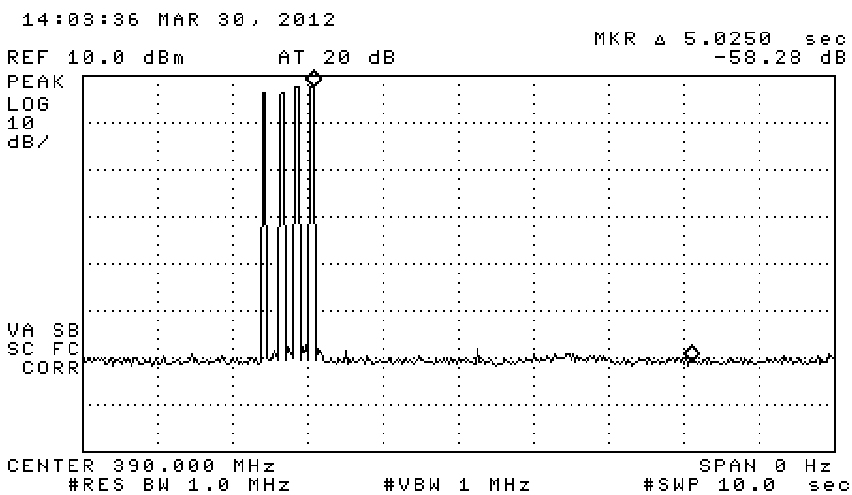


Figure 6.1(b). 5 second transmission limit verification (rolling code programming mode).

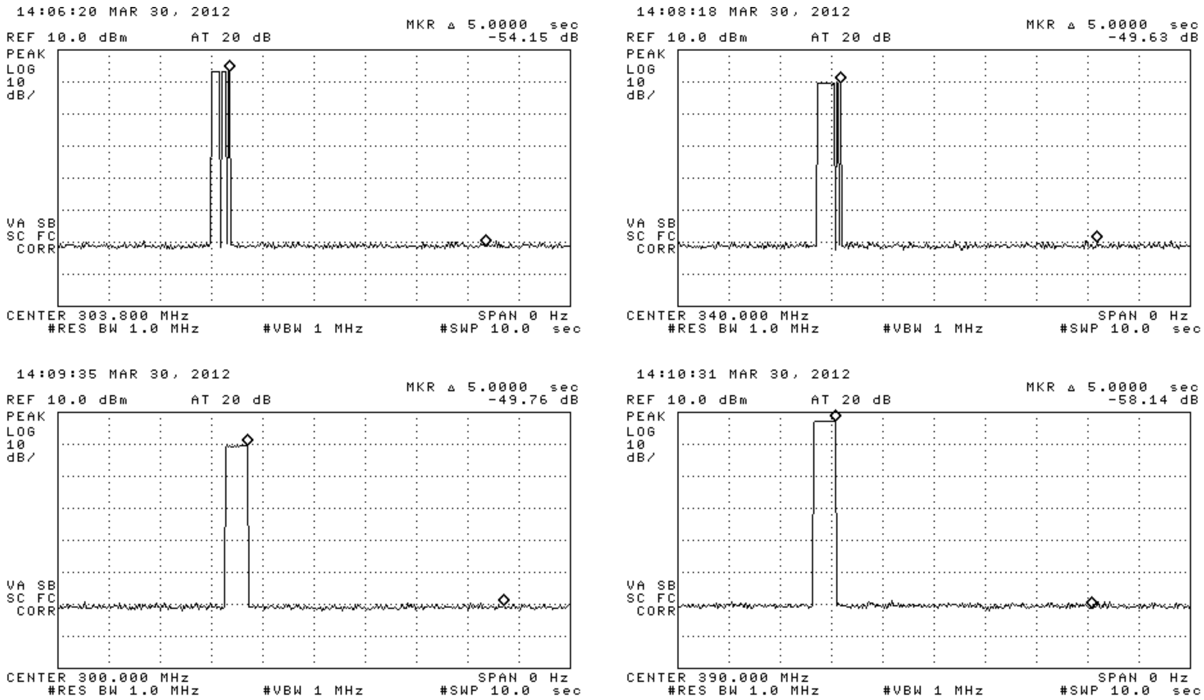


Figure 6.1(c). 5 second transmission limit verification (dip-switch programming mode).
(top, left) 8 dip-switch, (top, right) 9 dip-switch, (bottom, left) 10 dip-switch, (bottom, right) 12 dip-switch.

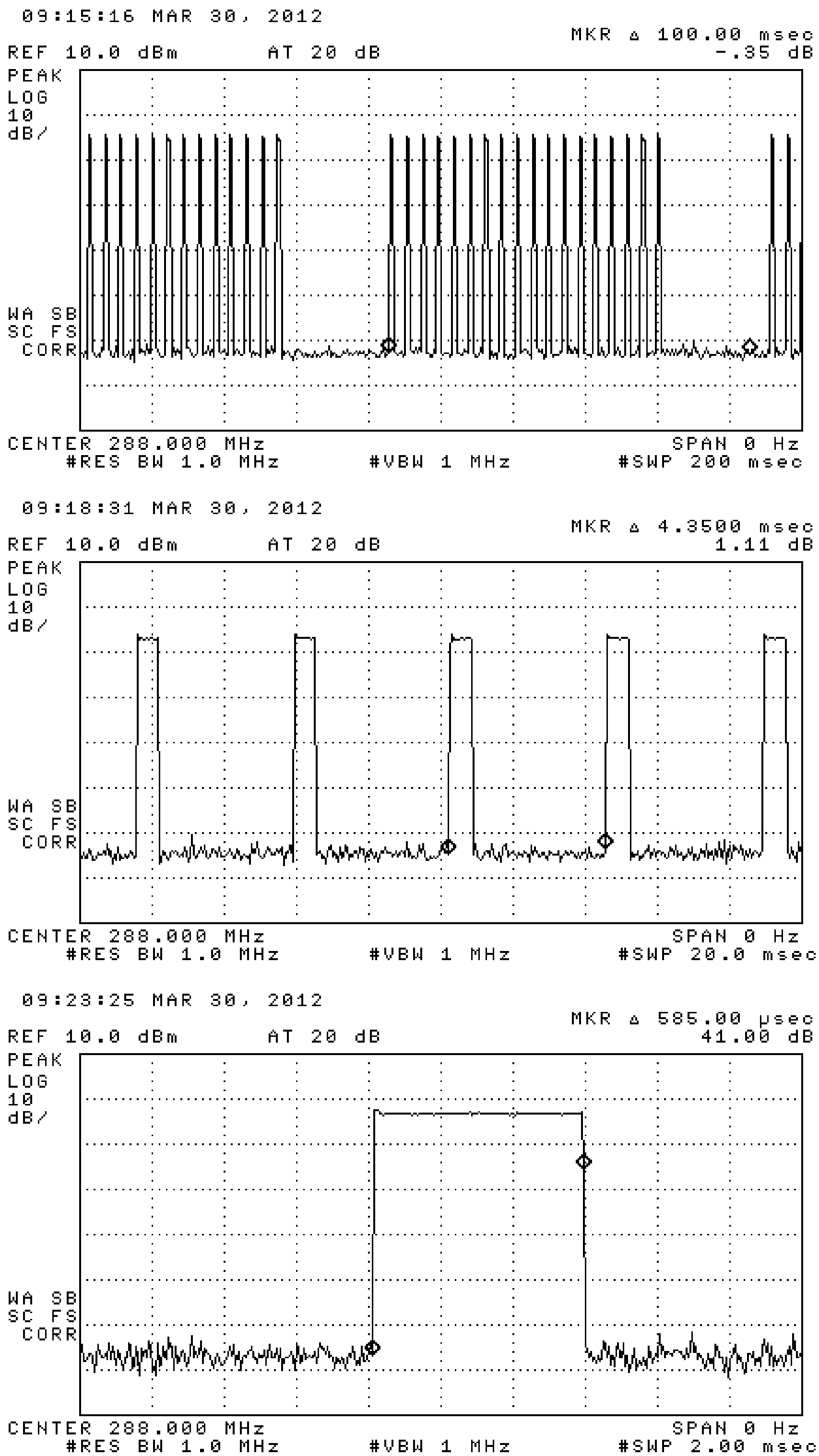


Figure 6.1(a). Transmission modulation characteristics 288 MHz.
(top) minimum on time transmission,
(center) expanded bit, (bottom) expanded period.

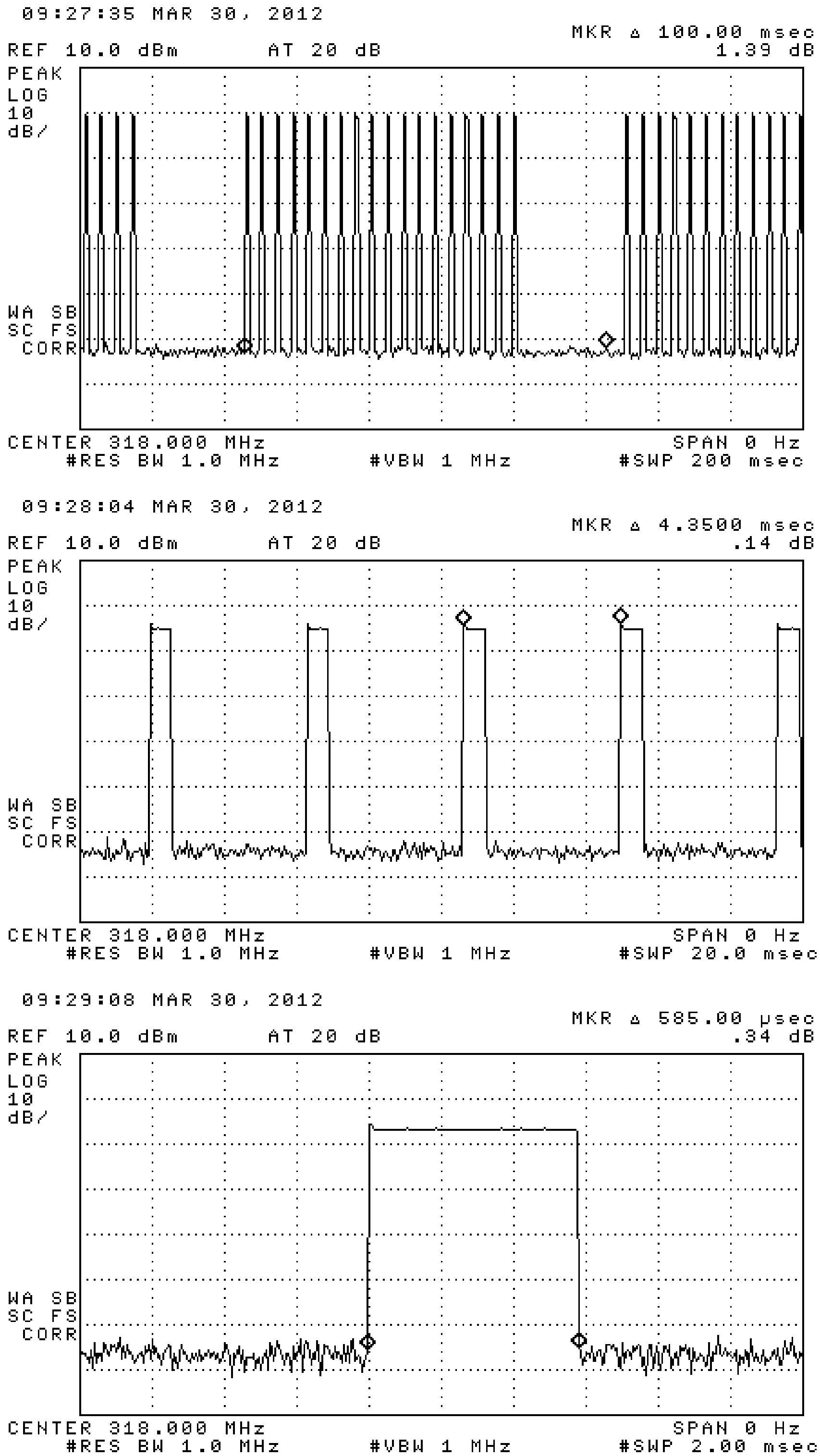
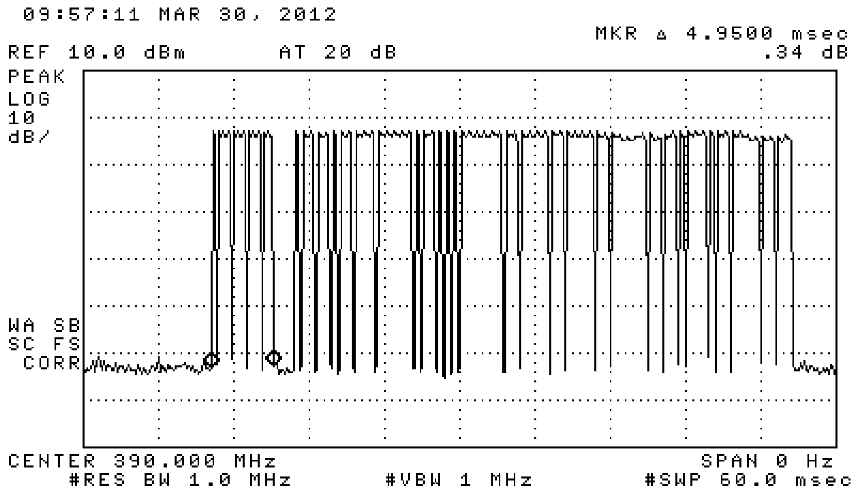
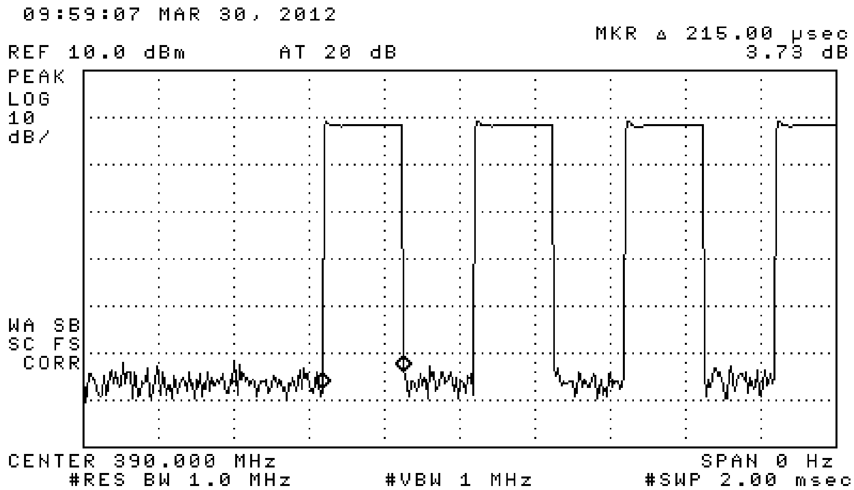


Figure 6.1(b). Transmission modulation characteristics 318 MHz.
(top) minimum on time transmission,
(center) expanded bit, (bottom) expanded period.





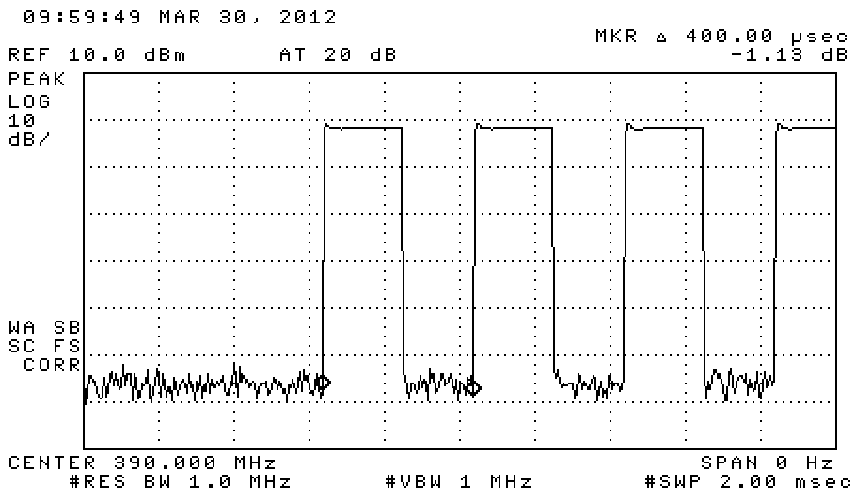


Figure 6.1(c). Transmission modulation characteristics 390 MHz (wake).
(top) minimum on time transmission (wake portion),
(center) expanded pulse width, (bottom) expanded pulse period.

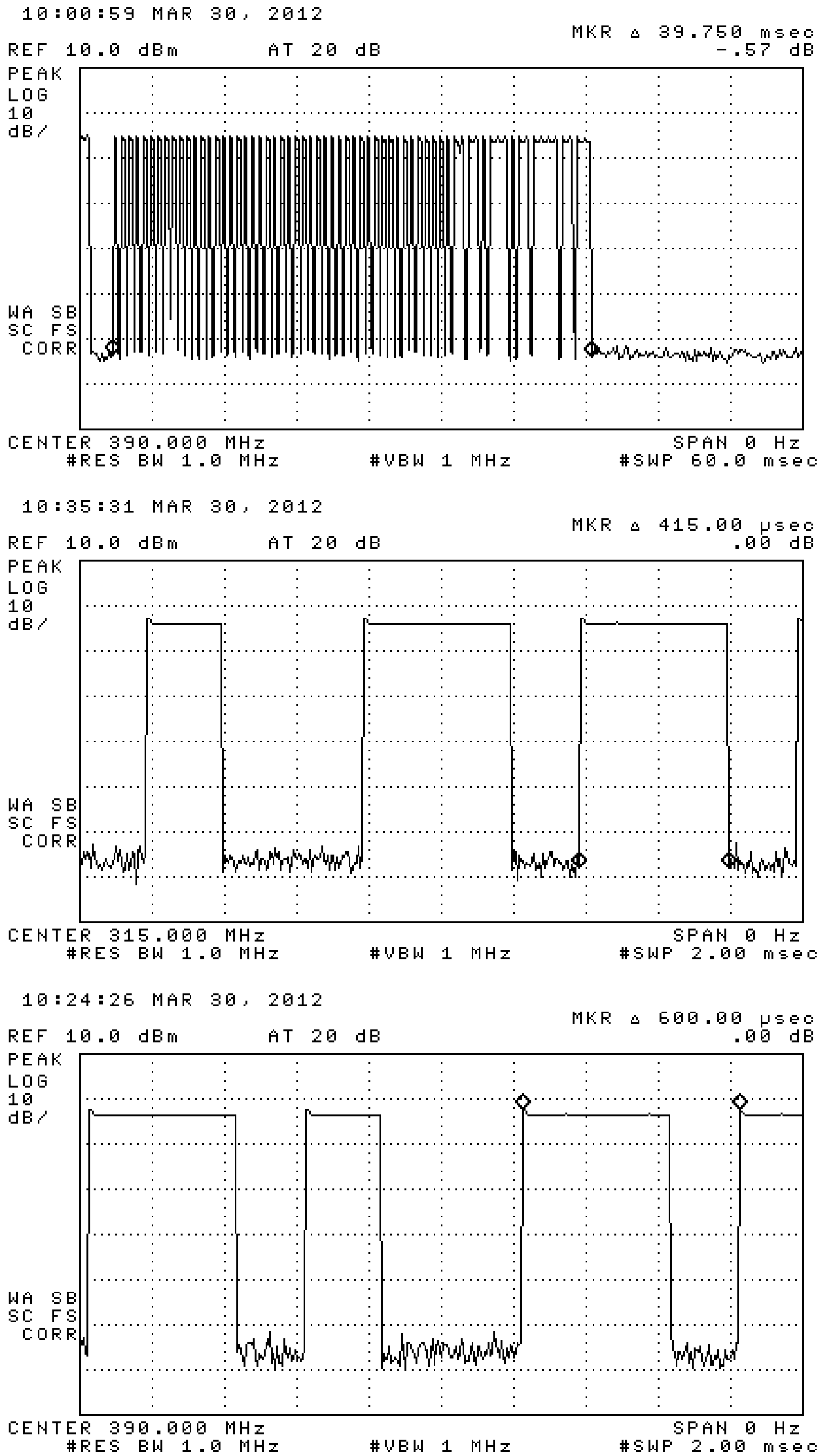


Figure 6.1(d). Transmission modulation characteristics 390 MHz (data).
(top) minimum on time transmission (data portion),
(center) expanded pulse width, (bottom) expanded pulse period.

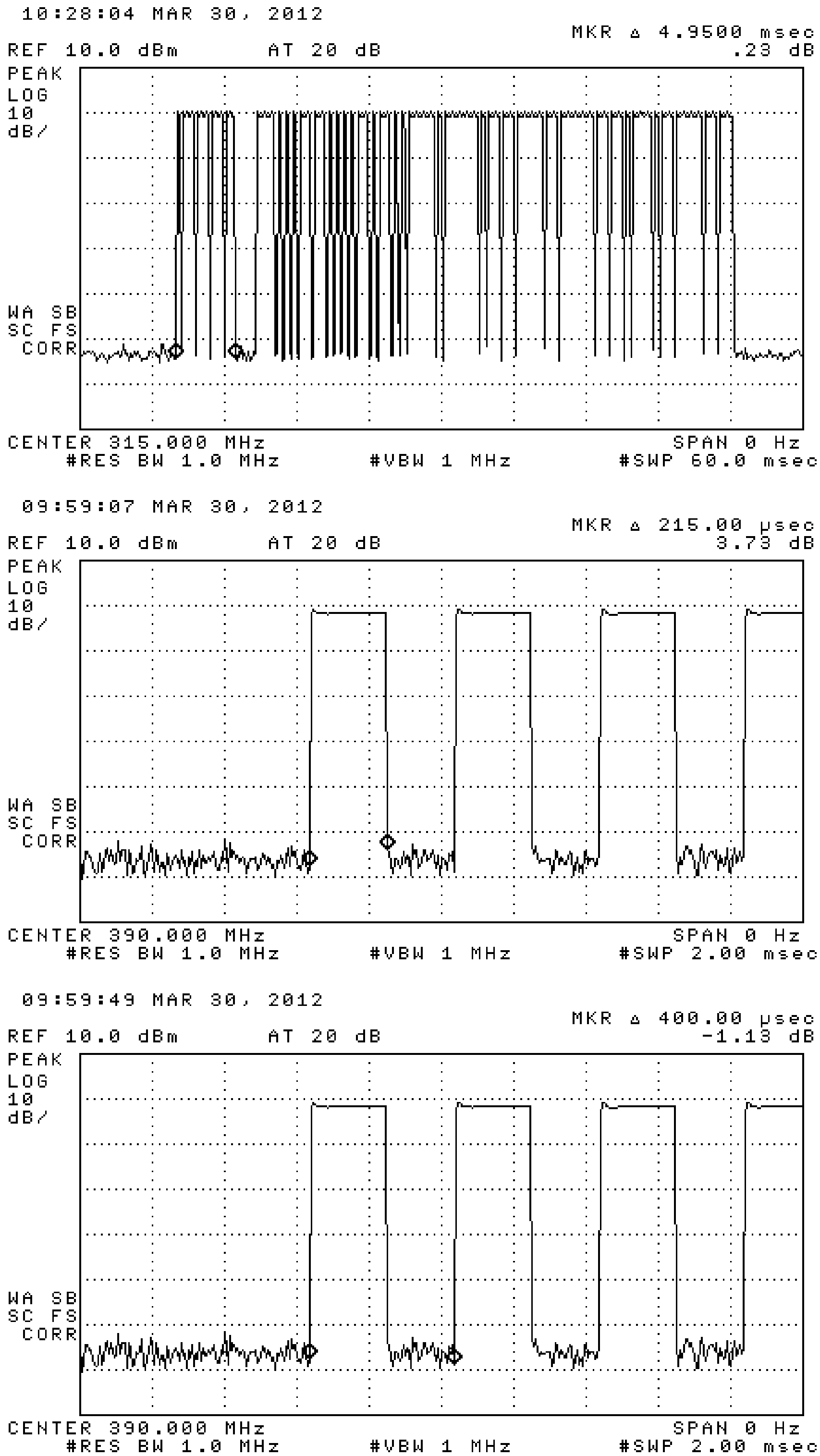


Figure 6.1(e). Transmission modulation characteristics 315 MHz (wake).
(top) minimum on time transmission (wake portion),
(center) expanded pulse width, (bottom) expanded pulse period.

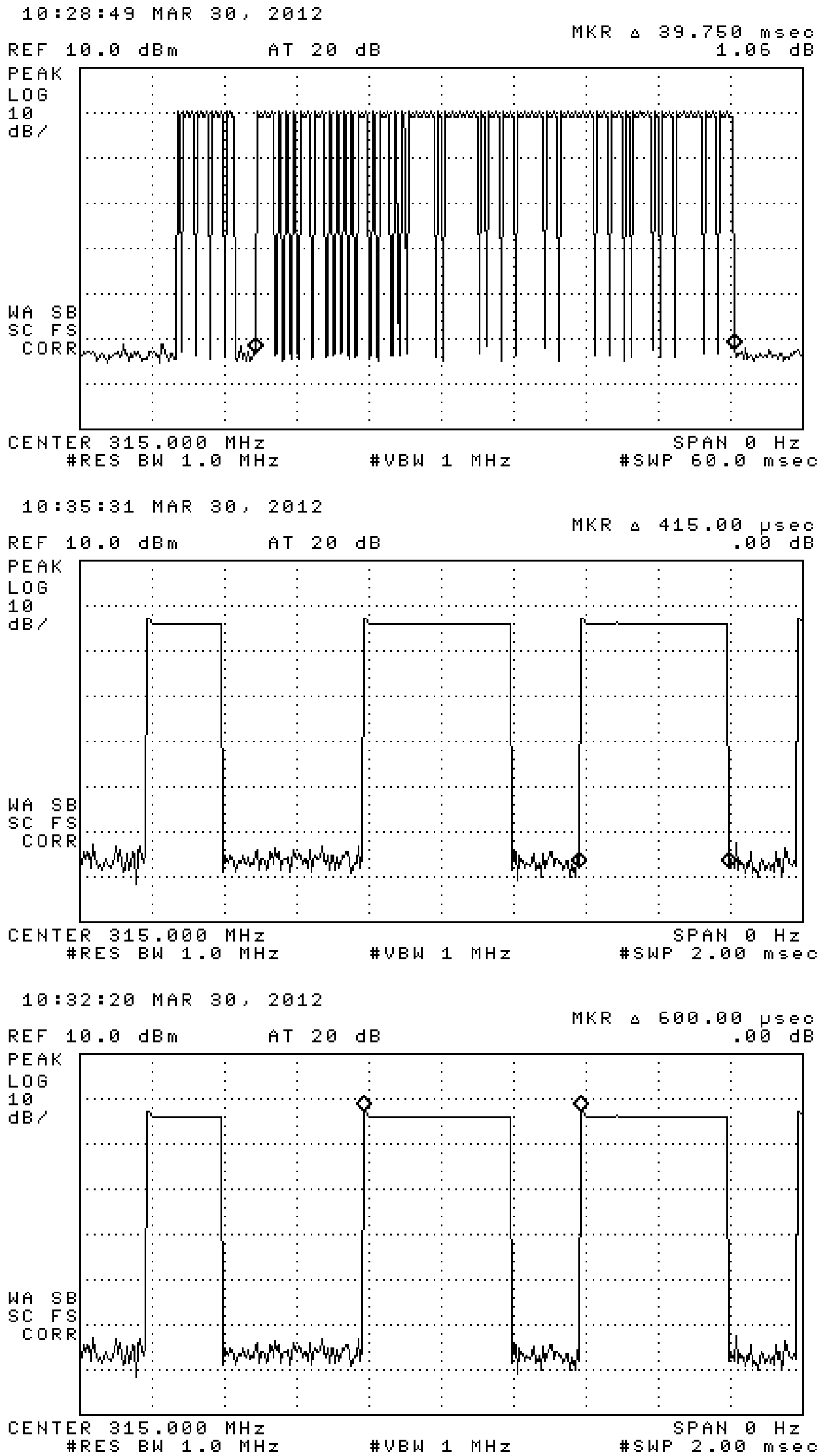
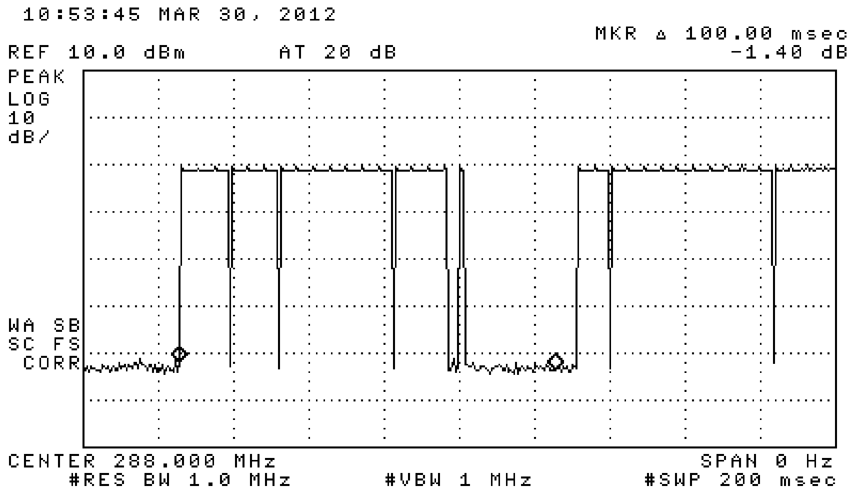
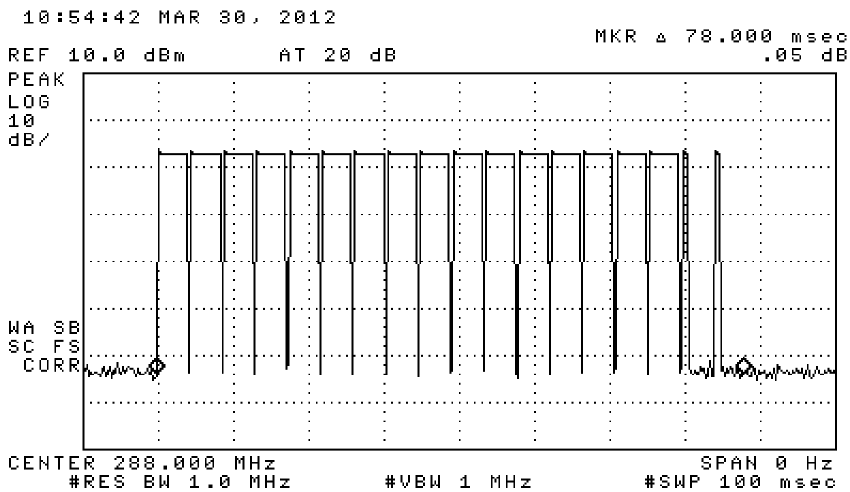


Figure 6.1(f). Transmission modulation characteristics 315 MHz (data).
(top) minimum on time transmission (data portion),
(center) expanded pulse width, (bottom) expanded pulse period.





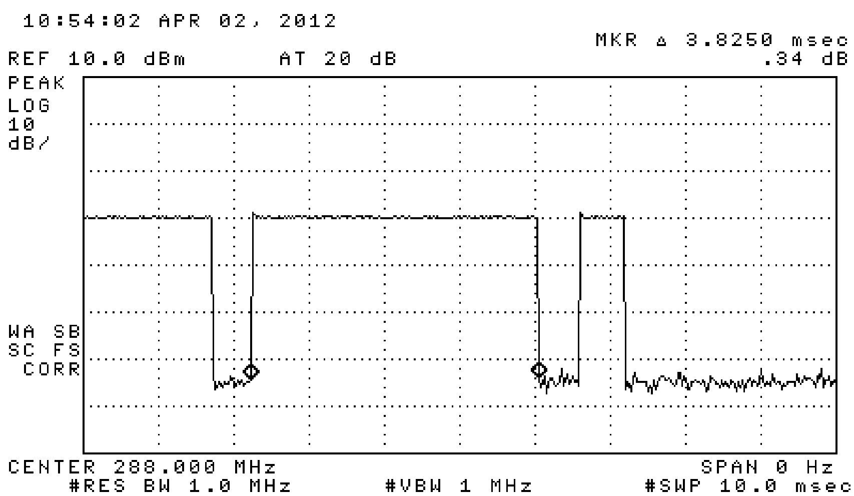


Figure 6.1(g). Transmission modulation characteristics 288 MHz.
(top) maximum on time transmission,
(center) expanded word, (bottom) PWM bit width.

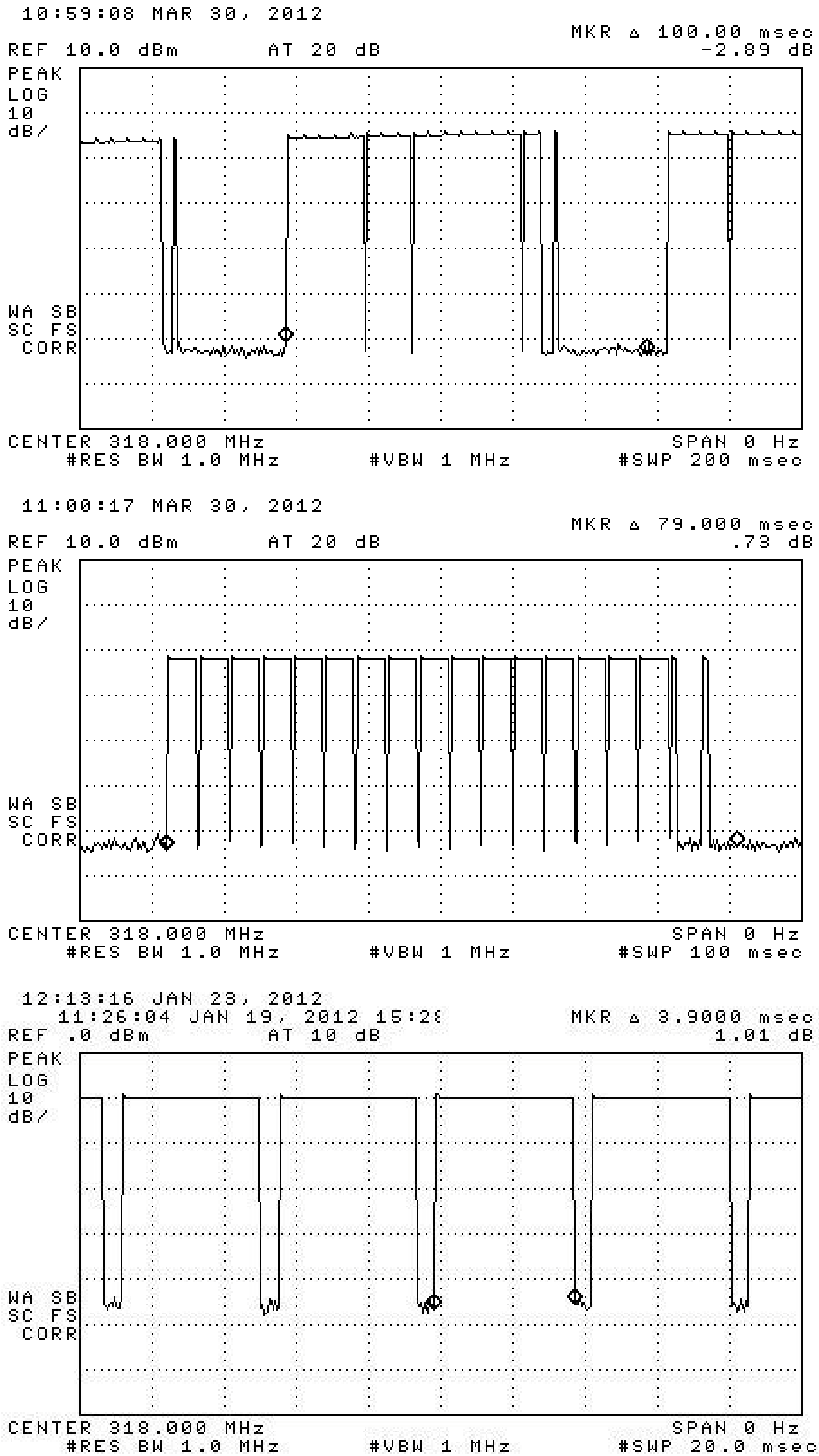


Figure 6.1(h). Transmission modulation characteristics 318 MHz.
(top) maximum on time transmission,
(center) expanded word, (bottom) PWM bit width.

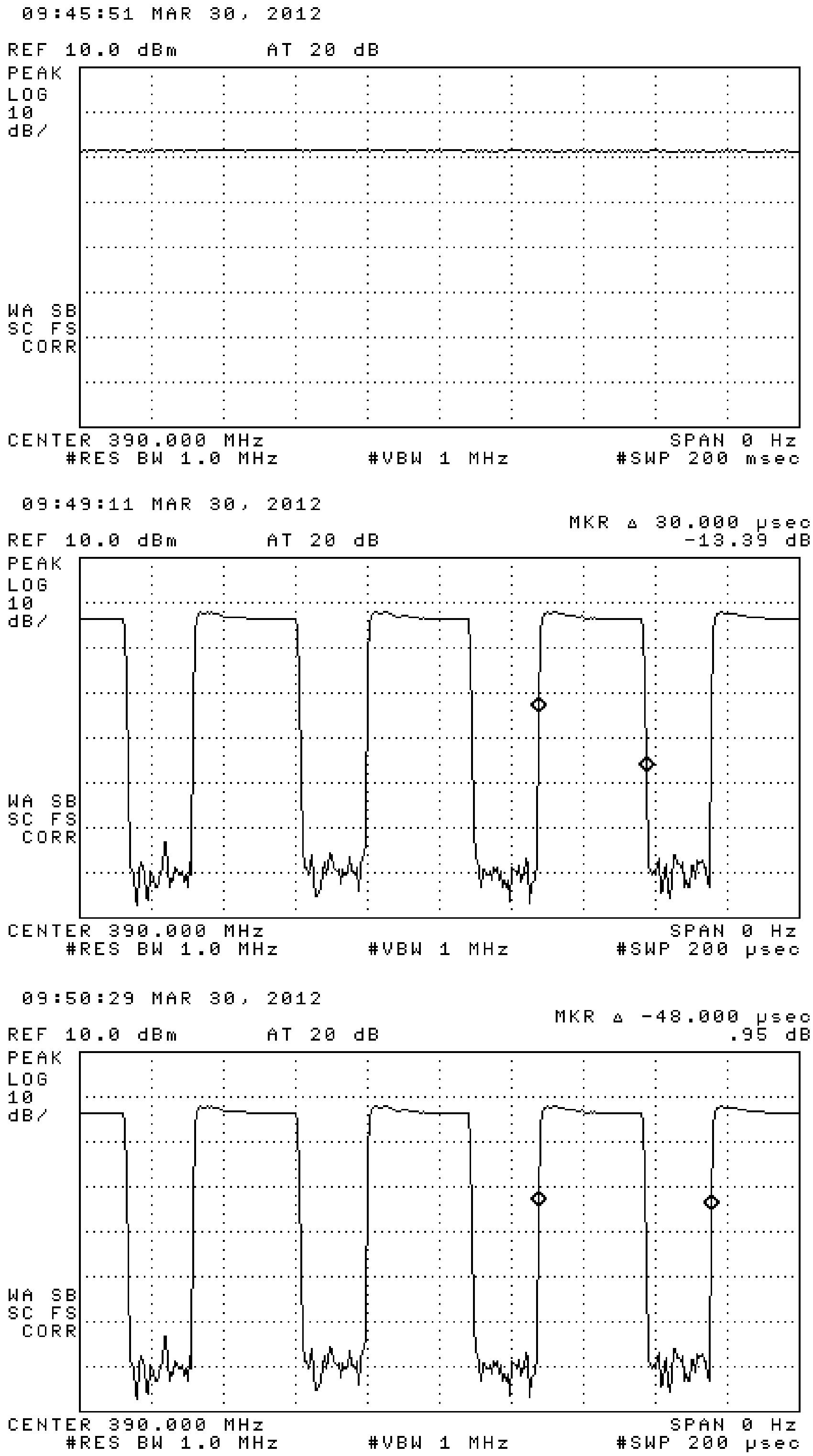


Figure 6.1(i). Transmission modulation characteristics 390 MHz.
(top) maximum on time transmission,
(center) Manchester bit width, (bottom) Manchester bit period.

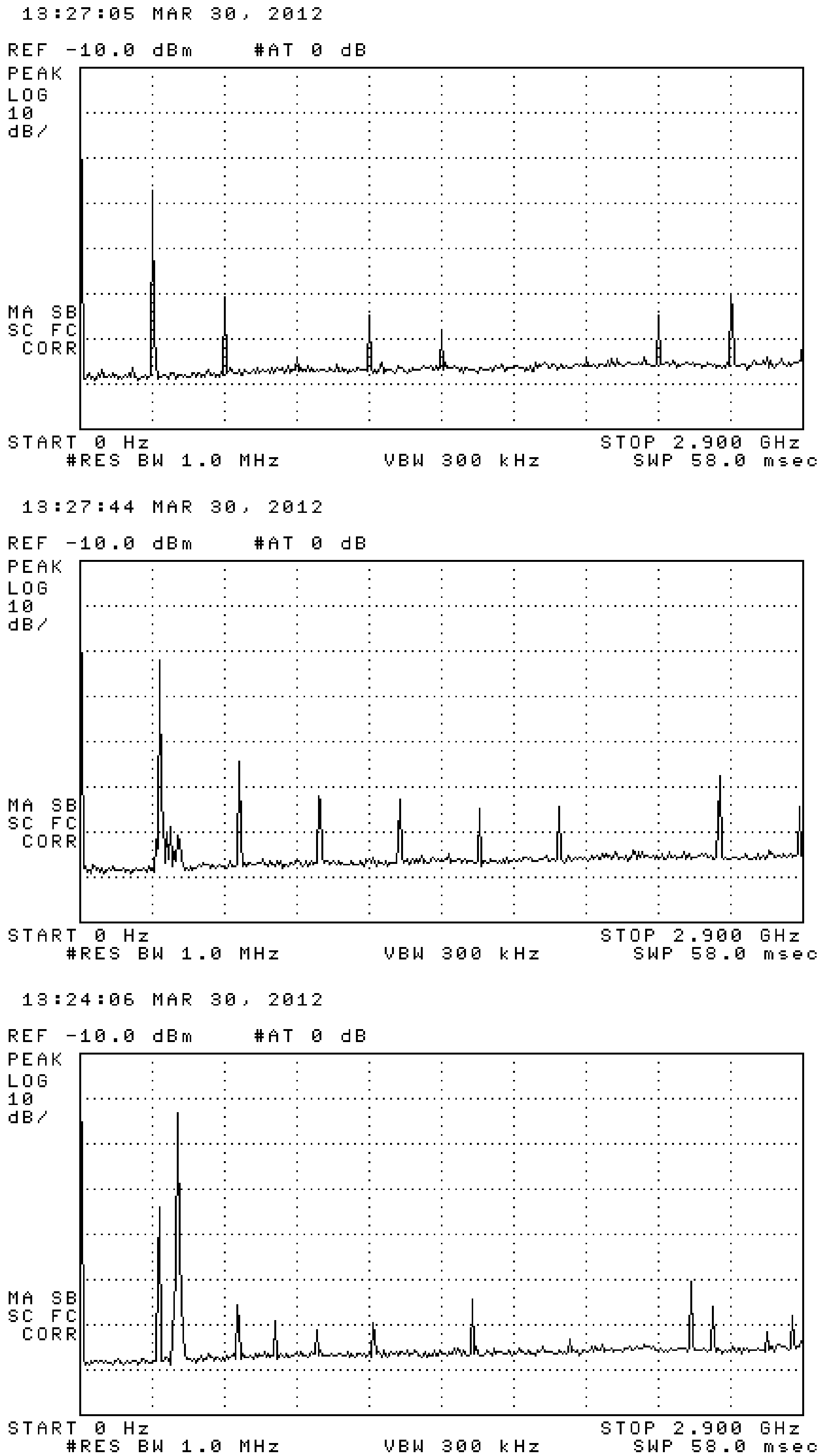


Figure 6.2. Relative emission spectrum of the DUT (pulsed emissions).
(top) 288 MHz, (middle) 318 MHz, (bottom) 315/390 MHz.
The amplitudes are only indicative (not calibrated).

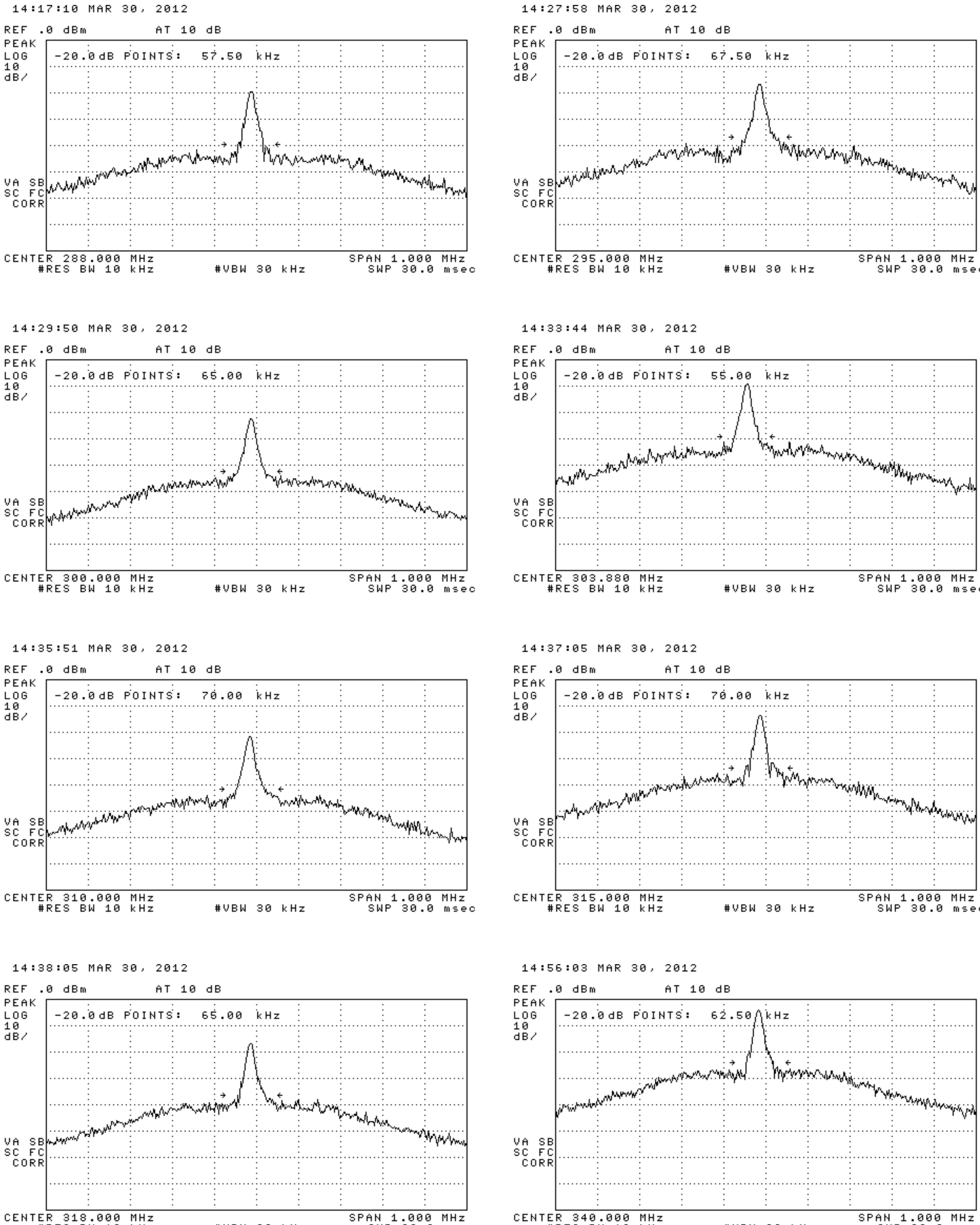


Figure 6.3(a). Worst case emission bandwidth of the DUT (pulsed).

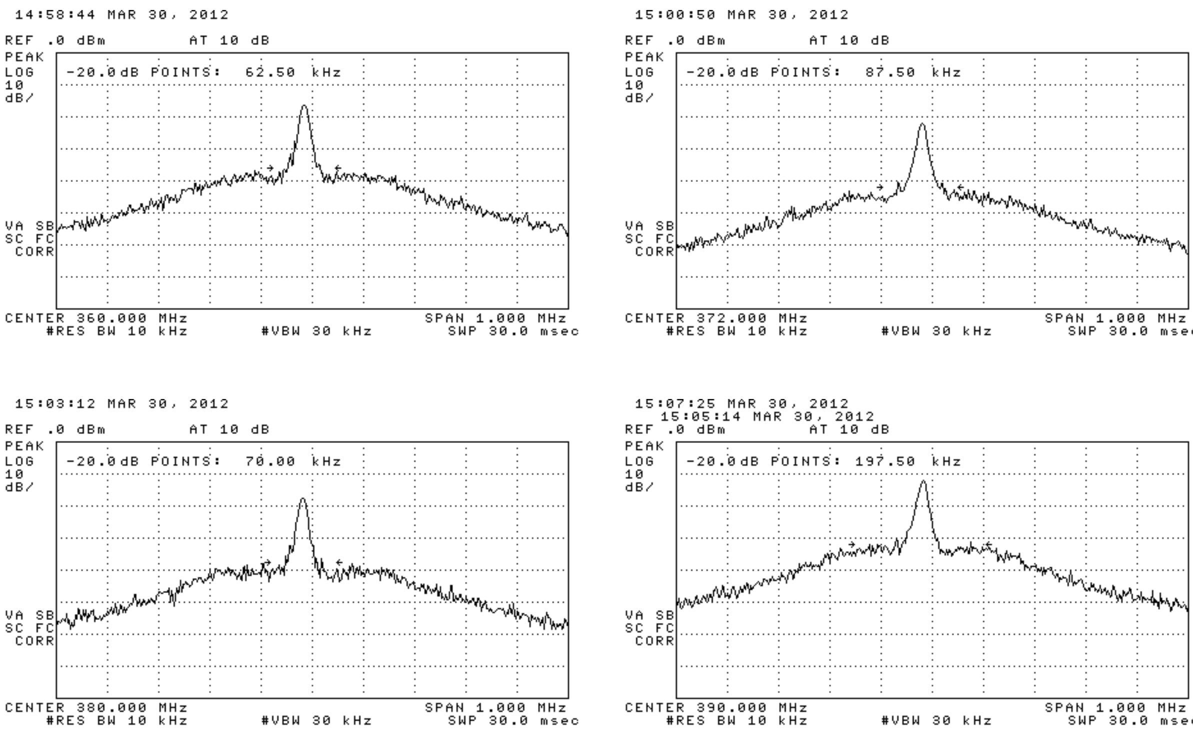


Figure 6.3(b). Measured emission bandwidth of the DUT (pulsed).

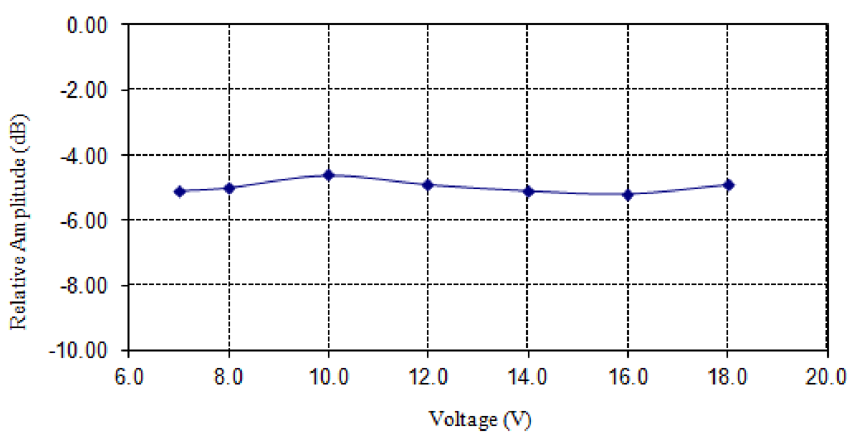
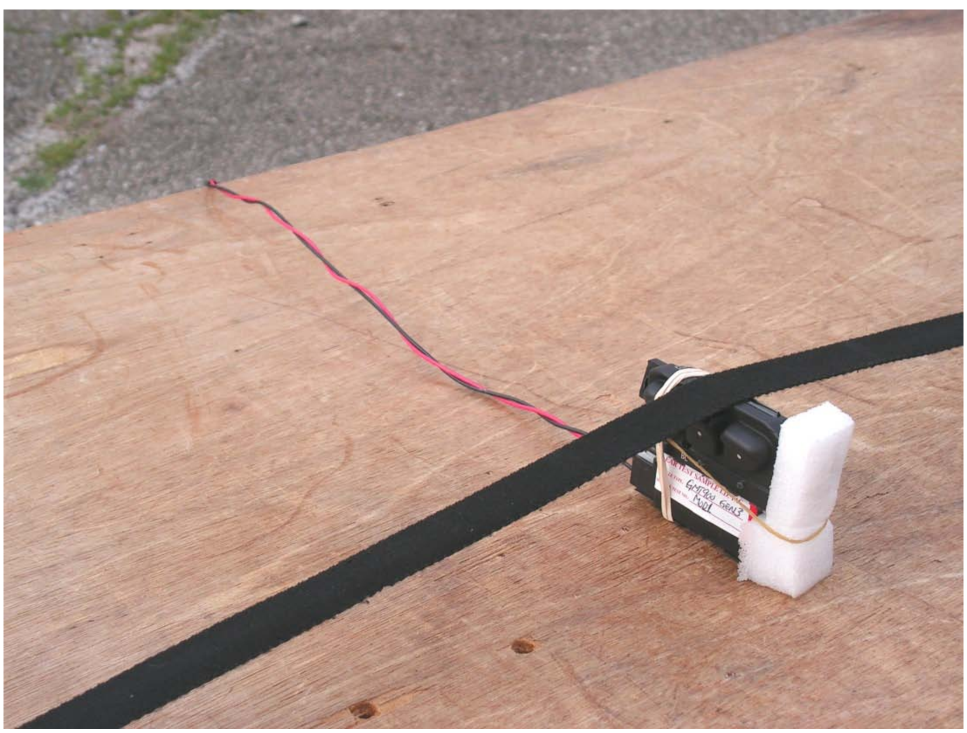


Figure 6.4. Relative emission at fundamental vs. supply voltage (pulsed).

Photograph 6.5. DUT on OATS (one of three axes tested)



Photograph 6.6. Close-up of DUT on OATS (one of three axes tested)