I. INFORMATION REQUIRED UNDER PART 2

Para.

2.10033(a) This Application for Certification is filed on form 731 with all questions answered.

2.10033(b) N/A

2.10033(c)(1) The full name and address of the applicant and manufacturer for certification is:

Spectronic-Denmark A/S
Skindbjergvej 44
DK 8500 Grenaa
Denmark

(2) The FCC Identifier of the device is QKE-INCA-TXHA

(3) A copy of the operating instructions is included in the EXHIBITS.

(4) Emission: NBFM Voice – Designator: 11K2F3E
Emissions calculation is included in the EXHIBITS.

(5) Frequency Range: 150 –174 MHz

(6) Power: Two power levels: 300 mW at 135 mA; 6 VDC
and 1.0 W at 360 mA; 6 VDC

(7) Maximum Power Rating of 1.1 Watt

(8) All stages are powered by 2.75 VDC regulated supplies with the exception of the driver and the final amplifier devices, which are connected to a step-down regulator. The output voltage is 4.65 VDC in high-power mode, and 2.45 VDC in low -power mode

(9) A tune-up procedure is included in the EXHIBITS.

(10) A schematic diagram is included in the EXHIBITS.

(11) A drawing and photo of the equipment identification label is included in the EXHIBITS.

(12) Photographs showing the external and internal construction of the equipment are included in the EXHIBITS.

(13) N/A

(14) Test Data as required by (46)§§(47) 2.1046 through 2.1057, inclusive, is measured in accordance with the procedure setout in (48)§ 2.1041.

(15) N/A

(16) N/A

I.I RF EXPOSURE STATEMENT

Data required by § 1.1310 Radiofrequency radiation exposure limits.

CALCULATION METHOD OF RF SAFETY DISTANCE:
$S = PG/4\pi r^2 = EIRP/4\pi r^2 \Rightarrow r = \sqrt{(PG/4\pi S)} = \sqrt{(EIRP/4\pi S)}$
Where: P: power input to the antenna in mW
EIRP: Equivalent (effective) isotropic radiated power.
S: power density mW/cm2
G: numeric gain of antenna relative to isotropic radiator
r: distance to centre of radiation in cm
P = 1100 mW (max. power measured at 157.450 MHz)
$G < 2.15$ dBi (monopole) = $10^{(2.15/10)}$ numeric
$S_{30} = 0.2$ mW/cm^2 (refer to § 1.1310 table 1 (B) Limits for General Population/Uncontrolled Exposures – 30 min.)
$S_6 = 1$ mW/cm^2 (refer to § 1.1310 table 1 (A) Limits for Occupational/Controlled Exposures – 6 min)

RESULT
$r_{30} = \sqrt{(PG/ 4\pi S)} = \sqrt{((1100 * 10^{(2.15/10)}) / (4\pi(0.2))} = 29.6$ cm for General Population/Uncontrolled Exposures – 30 min

$r_6 = \sqrt{(PG/ 4\pi S)} = \sqrt{((1100 * 10^{(2.15/10)}) / (4\pi(1))} = 9.4$ cm for Occupational/Controlled Exposures – 6 min

So, the minimum safety distance for 2.15dBi monopole antenna is approximately 30 cm or 0.3 meters for General Population/Uncontrolled Exposures – 30 min

and

approximately 10 cm or 0.1 meters for General Population/Uncontrolled Exposures – 6 min

II. TEST DATA

Data required by (46)§§(47) 2.1046 through 2.1057, inclusive, is measured in accordance with the procedures setout in (48)§ 2.1041.

RF POWER OUTPUT 2.1046(a), 2.1033(c)(8)

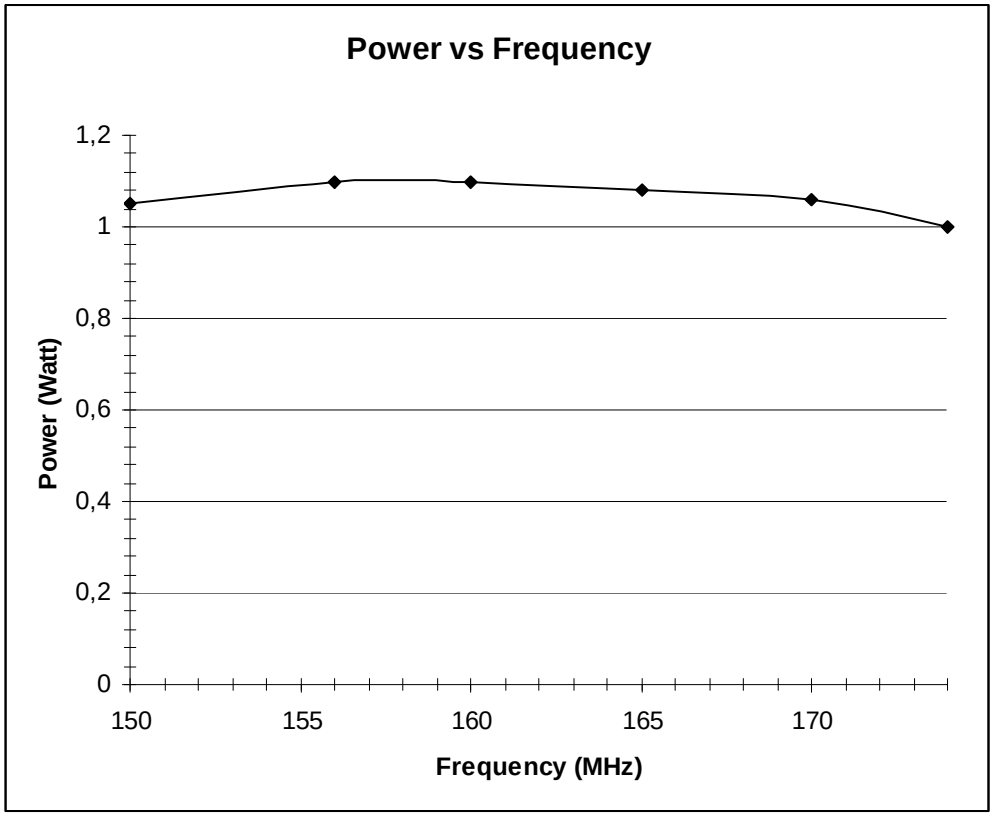
Power output measurements were made at the RF output connector.
This test was done with an unmodulated carrier in accordance with §90.205(d).

The power output was measured with a Rhode & Schwarz ESPI Test receiver.

The electrical characteristics of the RF load was 50 + j0 Ohms (50 ohms pure resistive).

The RF power measured mid-band was 1.10W at 6.0V DC.

Test results:
PASS. Thus the sample complies with §90.205(d).



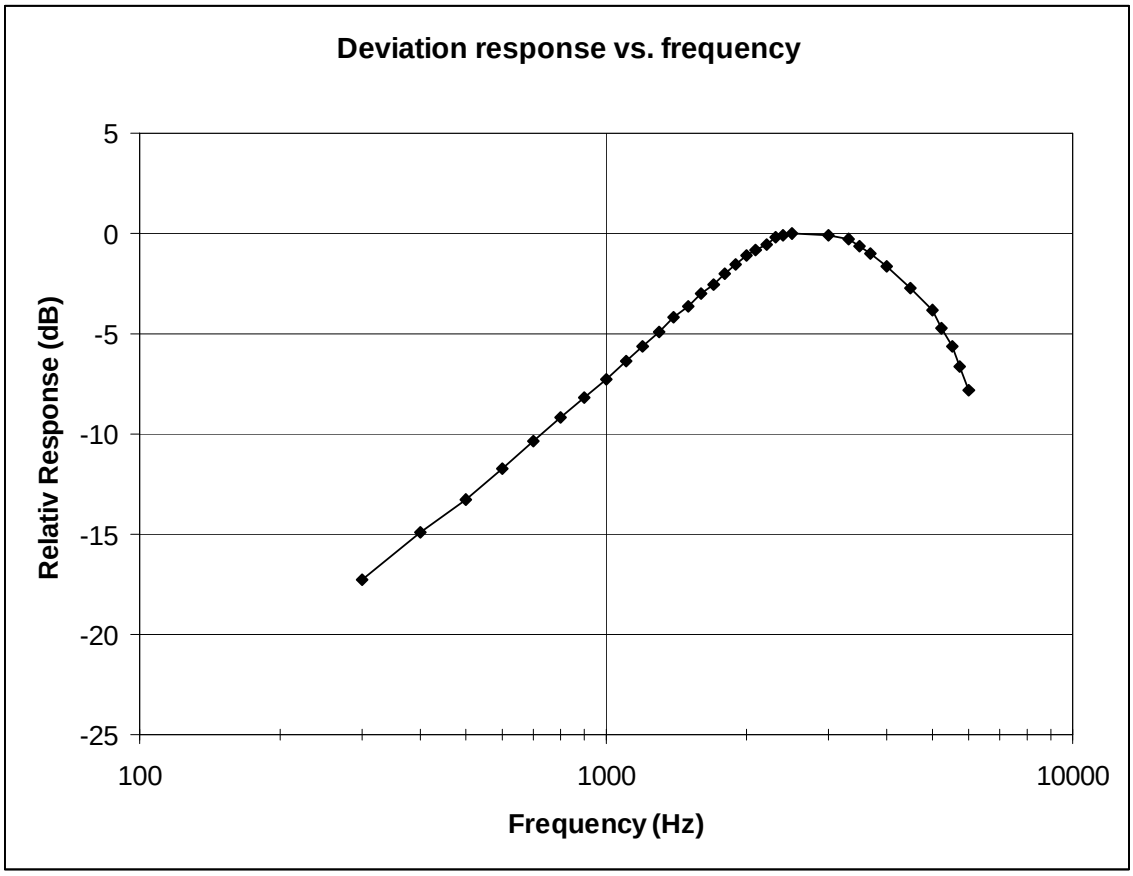
MODULATION CHARACTERISTICS 2.1047(a), 90.211(a)

Spectrum analyzer data is included which shows that the equipment will meet the modulation requirements under §90.211(a). This transmitter is equipped with an audio low pass filter circuit.

Test results:
PASS.

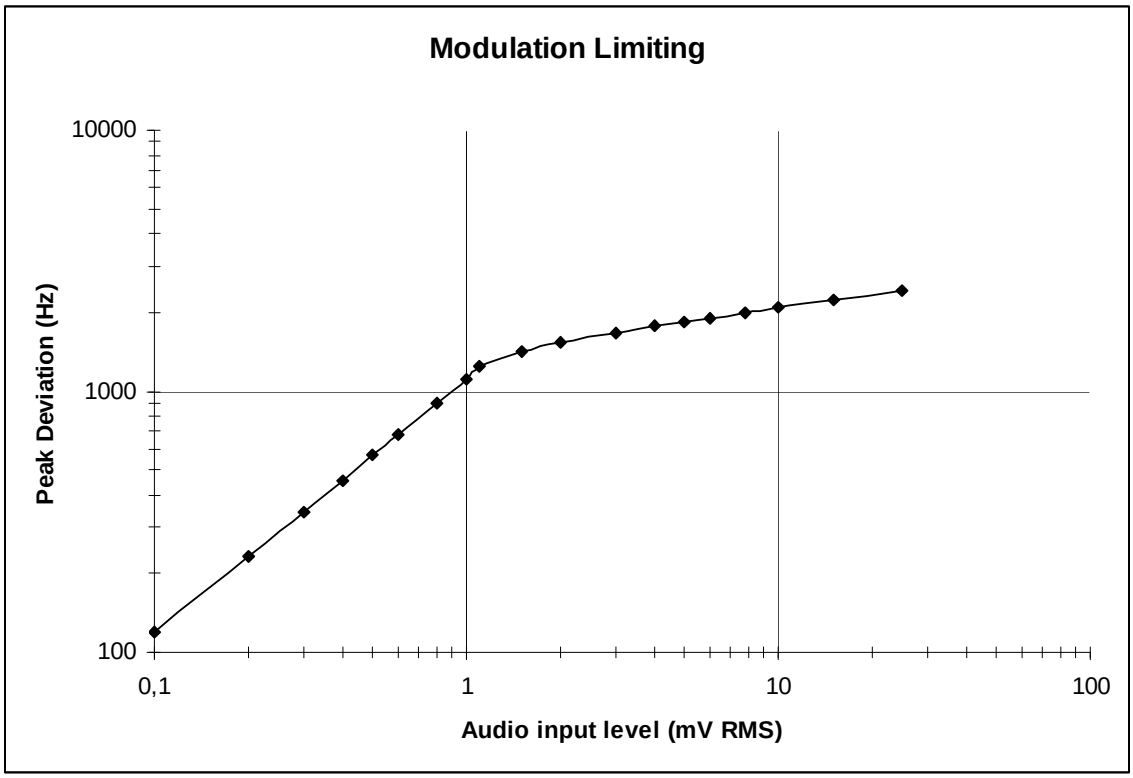
Frequency Response

Measurement data showing the frequency response of the transmitter is tabulated and graphed below. A reference level of 1.25 kHz deviation (as measured with the Rhode & Schwarz ESPI Test receiver) at the frequency of maximum response (2500 Hz) was used. At each test frequency, the input audio level was adjusted to maintain the reference deviation.



Modulation Limiting

Curves showing frequency deviation versus the microphone input levels are shown below, tested at the frequency of maximum deviation (2.5 kHz). The information submitted shows the modulation limiting capability throughout the range of input signals employed. A H.P. 33120A Function Generator was used to generate the modulation, and the Rhode & Schwarz ESPI Test receiver was used to measure modulation. A 3.3 k ohms resistor in series with the audio generator was used to simulate the output impedance of the microphone. Audio levels were verified with a HP34401A Multimeter.



OCCUPIED BANDWIDTH 2.1049, 90.211(a)

The next series of plots are taken from the Rhode & Schwarz ESPI Test receiver. The transmitter was modulated by the H.P 33120A Function Generator with a sine wave at 2500 Hz at a level 16 dB above that required to produce 50% modulation (1.25 kHz deviation). A 3.3 k ohms resistor in series with the audio generator was used to simulate the output impedance of the microphone. Audio levels were verified with a HP34401A multimeter. The transmitter output connector was connected to the input of the test receiver via a 1 meter test cable made of RG-316 coaxial cable, terminated with a BNC and a MMCX connector and a BIRD model 8303-100-N10DB, 50-ohm, 10dB attenuator.

Power was supplied to the test sample via an Amrel LPS-305 Power Supply and test leads.

Paragraph 90.210(d) states that for transmitters that are designed to operate with a 12.5 kHz channel bandwidth, any emission must be attenuated below the power (P) of the highest emission contained within the authorized bandwidth as follows:

1) 0n any frequency removed from the center of the authorized bandwidth f0 to 5.625 kHz removed from f0: Zero dB.

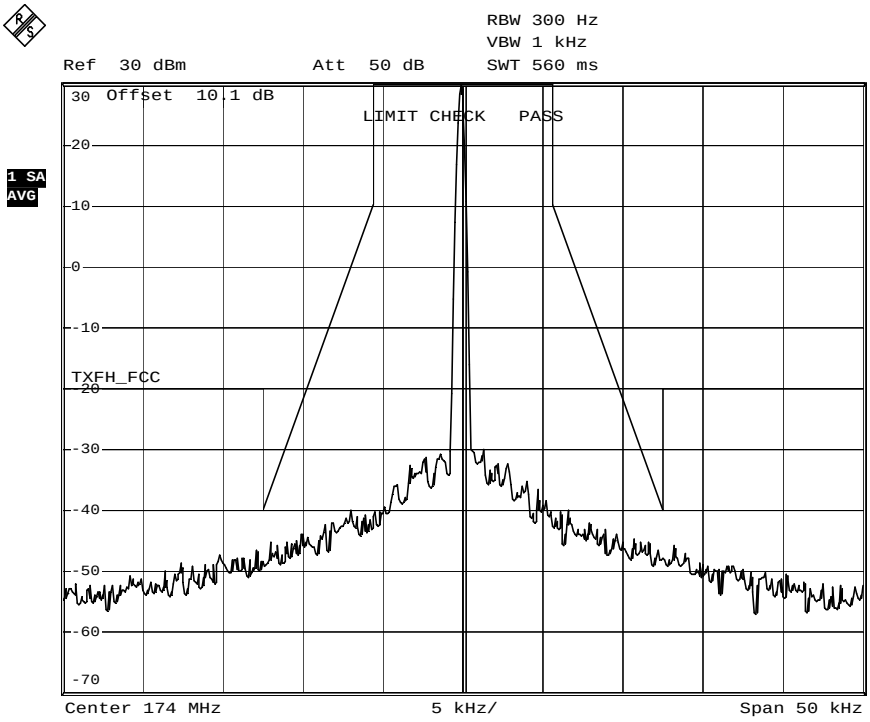
2) 0n any frequency removed from the center of the authorized bandwidth by a displacement frequency (fd in kHz) of more than 5.625 kHz but no more than 12.5 kHz: At least 7.25 (fd – 2.88 kHz) dB.

3) 0n any frequency removed from the center of the authorized bandwidth by a displacement frequency (fd in kHz) of more than 12.5 kHz: At least 50+ log(P) or 70 dB, whichever is the lesser attenuation.

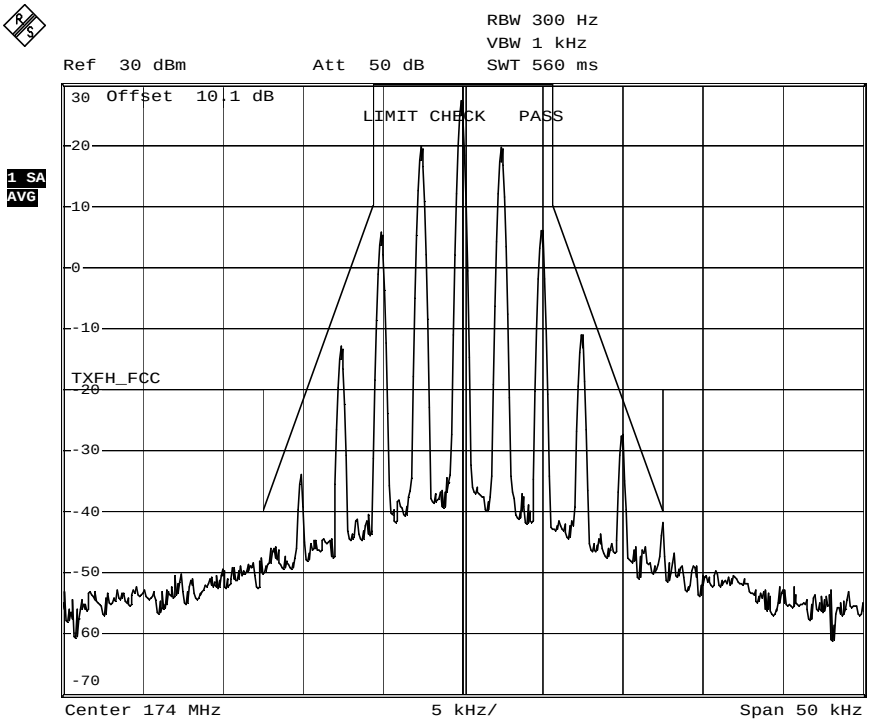
The authorized bandwidth is 12.5 kHz; the frequency of the sample was set for 161.025 MHz. The first plot shows the unmodulated carrier. The second plot shows the modulated carrier. The mask is superimposed on both spectral plots.

All emissions are below the required limits.

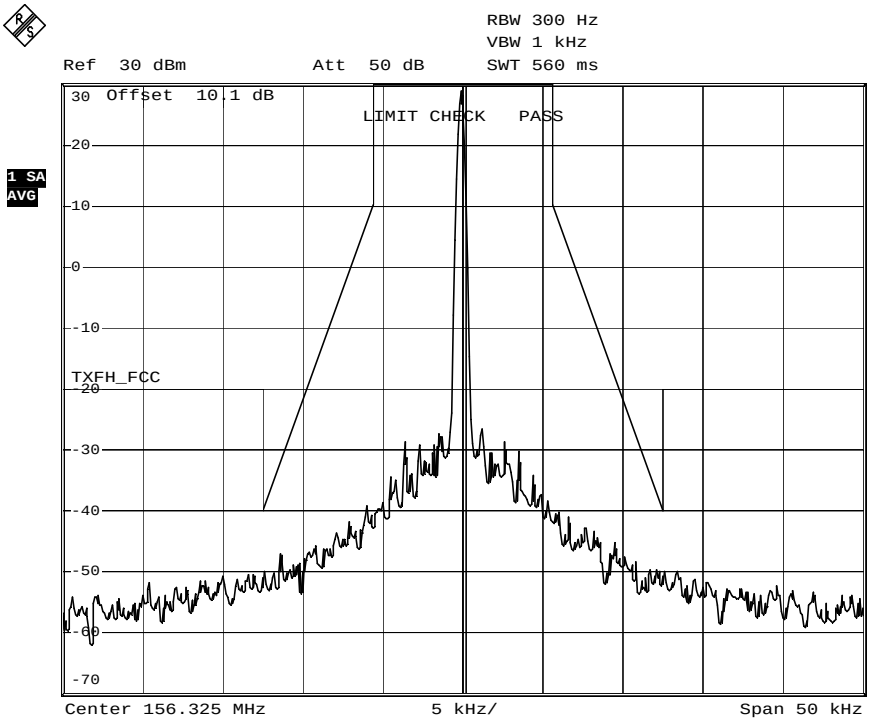
Test results:
PASS. Thus, the sample complies with 90.211(a).



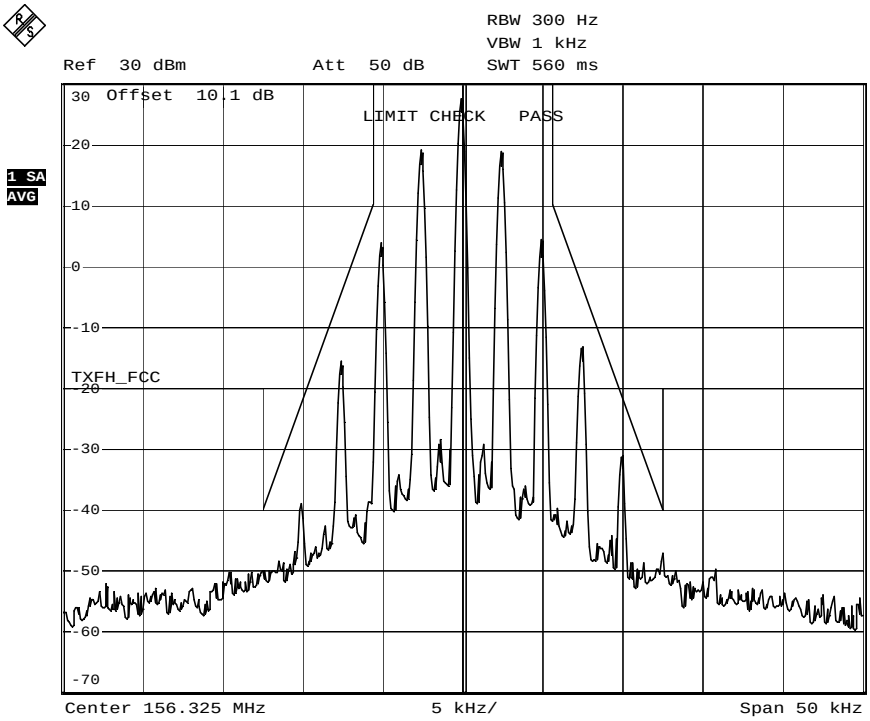
Date: 18.JUN.2005 11:26:23



Date: 18.JUN.2005 11:31:08



Date: 18.JUN.2005 12:34:12



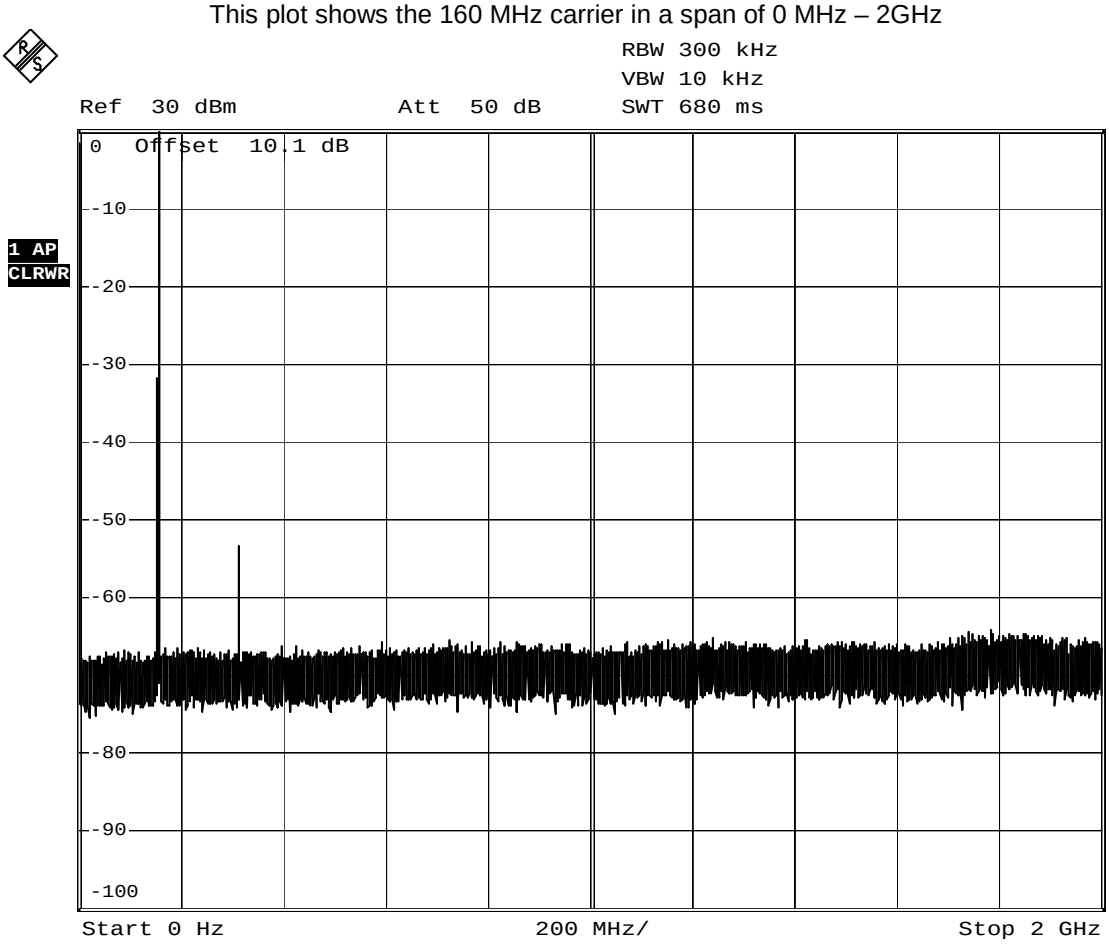
Date: 18.JUN.2005 12:33:22

SPURIOUS EMISSIONS AT ANTENNA TERMINALS 2.1053, 90.209

As required by §§2.1053 and 90.209, Emission Mask D, spurious emissions measurements at the antenna terminals were made using the Rhode & Schwarz ESPI Test receiver. The transmitter was modulated by the H.P 33120A Function Generator with a sine wave at 2500 Hz at a level 16dB above that required to produce 50% modulation (1.25 kHz deviation). A 3.3 k ohms resistor in series with the audio generator was used to simulate the output impedance of the microphone. Audio levels were verified with a HP 34401A Multimeter. The transmitter output connector was connected to a BIRD model 8303-100-N10DB, 50-ohm, 10dB attenuator at the input of the spectrum analyzer, via a 1 meter test cable made of RG-316coax.
The spectrum was investigated over the range 9 kHz – 1.75 GHz per §2.1057(a)(1).
All emissions more than 250%, removed from the center of the authorized bandwidth must be attenuated by at least 50 + 10 log (P) dB below the intentional carrier. Since the maximum measured unmodulated carrier power was 1100 mW, this yields a minimum required attenuation of 50.41 dBc.
All spurious emissions are attenuated below this level. The only significant spur is the second harmonic at –53 dBc.

Test results:
PASS. Thus the sample complies with 2.1053 and 90.209 Emission Mask D.

This plot shows the 160 MHz carrier in a span of 0 MHz – 2GHz



Date: 18.JUN.2005 12:50:17

FIELD STRENGTH OF SPURIOUS RADIATION 2.1053 and 90.209

Test Conditions:	Standard temperature and Humidity External Power: 6 VDC from a battery pack with four Lithium AA 1.5V cells A short Pigtail made of RG-316 coax with MMCX connector in the TX end and a 50 Ohm SMA termination in the other end.
Minimum Standard	§2.1053 The power of any emission shall be attenuated below the carrier power (P) by at least 50 + 10 log (P in Watt) dB or 70 dB, whichever is the lesser attenuation.
Test Method / Setup	TIA-603-C, 2.2.12 Unwanted Emissions: Radiated Spurious

Test results:
PASS. The strongest spurious emission is at the 6th harmonic of the 150.775 MHz test frequency with a level of -31.53 dBm. This is 11.53 dB below the limit.

Calculation of Radiated Power Limit

The maximum radiated power is 1.1 Watt.

Attenuation Requirement: §2.1053 require that the spurious radiated emissions are attenuated at least 50 + 10 log (1.1) = 50.41 dB below the unmodulated carrier field strength.

Limit (dBm) = 30.41dBm – 50.41 dB = -20dBm

Net (dBm) = Generator Level (dBm) – TX cable Loss (dB) + TX Antenna Gain (dB)

Where:

Net (dBm) is the dipole equivalent power and

Generator Level (dBm) is the generator output power into the substitution antenna.

Field Strength Test Set Up

The OATS calibration includes the table, tent (see photos) and the following equipment.

RF-Field Emission. 1 - 3 GHz

Test set up	ID no.	Description	Manufacturer	Type no.	Set up uncert.
S	ID0140	Spectrum analyzer	Hewlett Packard	8562A	
	29557	Antenna Log. per.	Scientific-Atlanta, Inc.	27-1.01/6	
	ID0462	Amplifier	Mini Curtis	ZKL-2R7	
	K132	Cable	Suhner	217-U	
	K090	Cable. Permanent			
	K131	Cable	Suhner	217-U	
	D012	Fuse	Anritsu		

RF-Field Emission. 30 - 1000 MHz

Test set up	ID no.	Description	Manufacturer	Type no.	Set up uncert.
G +	0161	Measuring receiver	Rohde & Schwarz	ESVS 10	± 2,2 dB
OATS		Antenna mast	HD Diesel	MA240	
		Turn table	HD Diesel	DT 430	
	0241	Amplifier	Mini circuit	ZFL-1000H	
	J0246	Bilog Antenna	Chase	CBL 6111	
	0237	Bilog Antenna	Chase	CBL 6111 A	
	0254	Bilog Antenna	Chase	CBL 6111 A	
	K121, K122	Cable	Suhner	RG214 HIFLEX	
	K001	Cable, Rum5 - Coax-switch	Suhner	RG214U	
	K012	Cable, Coax-switch - OATS	Suhner	RG213	
	K113	Cable, Coax -switch - receiver	Suhner	RG213	
	K090	Cable OATS	Suhner	RG213	
	D061	Coax-switch	Daiwa	CS-201	

Extra equipment used during the substitute method measurement:

Description	Manufacturer	ID / Type no.
Signal Generator:	Marconi	2024
TX Antenna:	Telemeter Electronic	HL-3000 SER # 10097
TX cable:	Delta	K130

Field Strength Test Set Up Photos

TXFH-RC field strength set up for max radiation

TXFH-RC field strength measurement below 1GHz and at 10m distance

TXFH-RC field strength measurement above 1GHz and at 3m distance

Field Strength Test Result

Emission Measurement: **Field Emission on Open Area Test Site (OATS).**			Them
Basic test standard:		FCC Spurious Emission.	
		Part 90.210, 2.1053.	

Result:		Comment to result.					
	Passed X	Limits specified in used standard were not exceeded during measurements.					
	Failed						
Client							
EUT		TXHF-RC					
Used Emission standard			Status of test			Test	
	Mask D			Non accredited		Responsible	
				DANAK Accredited X		Performed by	JHE/CRL
				Reg. no.:	19k	Project no.	
				Temp.	18.4 °C	Date	2005-12-12
				Humidity	79 %RH	Time	
Used Test Equipment				Setup G	R&S. ESVS 10		
				Setup GG	R&S. ESVS 10		
				Setup S			
Test mode / setup		TIA-603-C, 2.2.12 Unwanted Emissions: Radiated Spurious					

Test Frequency	Frequency	EUT Reading	Generator Reading	TX Antenna Gain	TX Cable Loss	Net	Limit	Margin	Antenna Height	Ant. Pol.	Distance
MHz	MHz	dBµV/m	dBm	dB	dB	dBm	dBm	dB	m	H/V	m
150,77500	-	-	-	-	-				-	-	-
-	301,55000	54,6	-37,2	4,79	4,1	-36,51	-20	16,51	3,0	H	10
-	452,32500	34,6	-60,6	5,92	5,1	-59,78	-20	39,78	2,0	H	10
-	603,10000	55,3	-38,9	6,35	6,2	-38,75	-20	18,75	1,5	H	10
-	753,87500	49,1	-48,4	6,48	7,1	-49,02	-20	29,02	1,6	H	10
-	904,65000	63,8	-30,3	6,67	7,9	-31,53	-20	11,53	1,0	H	10
-	1055,42500	58,0	-38,6	6,64	8,7	-40,66	-20	20,66	1,7	H	3
-	1206,20000	50,5	-46,3	6,69	9,5	-49,11	-20	29,11	1,5	H	3
-	1356,97500	57,0	-39	6,81	10,1	-42,29	-20	22,29	1,3	H	3
-	1507,75000	44,5	-51,5	6,94	11,1	-55,66	-20	35,66	1,1	H	3

Emission Measurement:
Field Emission on Open Area Test Site (OATS).

Them

Basic test standard:		FCC Spurious Emission.
		Part 90.210, 2.1053.

Result:	Comment to result.
Passed X	Limits specified in used standard were not exceeded during measurements.
Failed	
Client	
EUT	TXHF-RC

Used Emission standard		Status of test		Test	
Mask D		Non accredited		Responsible	
		DANAK Accredited X		Performed by	JHE/CRL
		Reg. no.:	19k	Project no.	
		Temp.	18.4 °C	Date	2005-12-12
		Humidity	79 %RH	Time	

Used Test Equipment		
	Setup G	R&S. ESVS 10
	Setup GG	R&S. ESVS 10
	Setup S	

Test mode / setup	TIA-603-C, 2.2.12 Unwanted Emissions: Radiated Spurious

Test Frequency	Frequency	EUT Reading	Generator Reading	TX Antenna Gain	TX Cable Loss	Net	Limit	Margin	Antenna Height	Ant. Pol.	Distance
MHz	MHz	dBµV/m	dBm	dB	dB	dBm	dBm	dB	m	H/V	m
157,45000	-	-			-				-	-	-
-	314,90000	56,0	-38,9	4,76	4,2	-38,34	-20	18,34	3,5	H	10
-	472,35000	29,2	-67,2	6,10	5,2	-66,30	-20	46,30	2,0	H	10
-	629,80000	44,3	-51,9	6,37	6,3	-51,83	-20	31,83	1,4	H	10
-	787,25000	58,2	-36,7	6,43	7,2	-37,47	-20	17,47	1,2	H	10
-	944,70000	62,5	-32,6	6,67	8,2	-34,13	-20	14,13	1,0	H	10
-	1102,15000	60,0	-35,8	6,70	9,0	-38,10	-20	18,10	1,6	H	3
-	1259,60000	51,5	-45,5	6,68	9,8	-48,62	-20	28,62	1,4	H	3
-	1417,05000	56,0	-40	6,85	10,5	-43,65	-20	23,65	1,3	H	3
-	1574,50000	51,0	-45	6,90	11,4	-49,50	-20	29,50	1,1	H	3

Emission Measurement:
Field Emission on Open Area Test Site (OATS).

Them

Basic test standard:		FCC Spurious Emission.
		Part 90.210, 2.1053.

Result:	Comment to result.
Passed X	Limits specified in used standard were not exceeded during measurements.
Failed	
Client	
EUT	TXHF-RC

Used Emission standard		Status of test		Test	
Mask D		Non accredited		Responsible	
		DANAK Accredited X		Performed by	JHE/CRL
		Reg. no.:	19k	Project no.	
		Temp.	18.4 °C	Date	2005-12-12
		Humidity	79 %RH	Time	

Used Test Equipment		
	Setup G	R&S. ESVS 10
	Setup GG	R&S. ESVS 10
	Setup S	

Test mode / setup	TIA-603-C, 2.2.12 Unwanted Emissions: Radiated Spurious

Test Frequency	Frequency	EUT Reading	Generator Reading	TX Antenna Gain	TX Cable Loss	Net	Limit	Margin	Antenna Height	Ant. Pol.	Distance
MHz	MHz	dBµV/m	dBm	dB	dB	dBm	dBm	dB	m	H/V	m
173,39625	-	-			-				-	-	-
-	346,79250	61,4	-32,4	5,10	4,3	-31,60	-20	11,60	3,0	H	10
-	520,18875	28,0	-69,7	6,21	5,5	-68,99	-20	48,99	2,4	H	10
-	693,58500	50,5	-44,7	6,52	6,8	-44,98	-20	24,98	1,5	H	10
-	866,98125	57,6	-36,5	6,58	7,8	-37,72	-20	17,72	1,0	H	10
-	1040,37750	65,0	-31,3	6,62	8,7	-33,38	-20	13,38	1,0	H	10
-	1213,77375	66,0	-31	6,69	9,5	-33,81	-20	13,81	1,5	H	3
-	1387,17000	66,0	-29,5	6,83	10,4	-33,07	-20	13,07	1,3	H	3
-	1560,56625	55,0	-39	6,93	11,3	-43,37	-20	23,37	1,1	H	3
-	1733,96250	53,5	-39,5	6,95	12,2	-44,75	-20	24,75	1,1	H	3

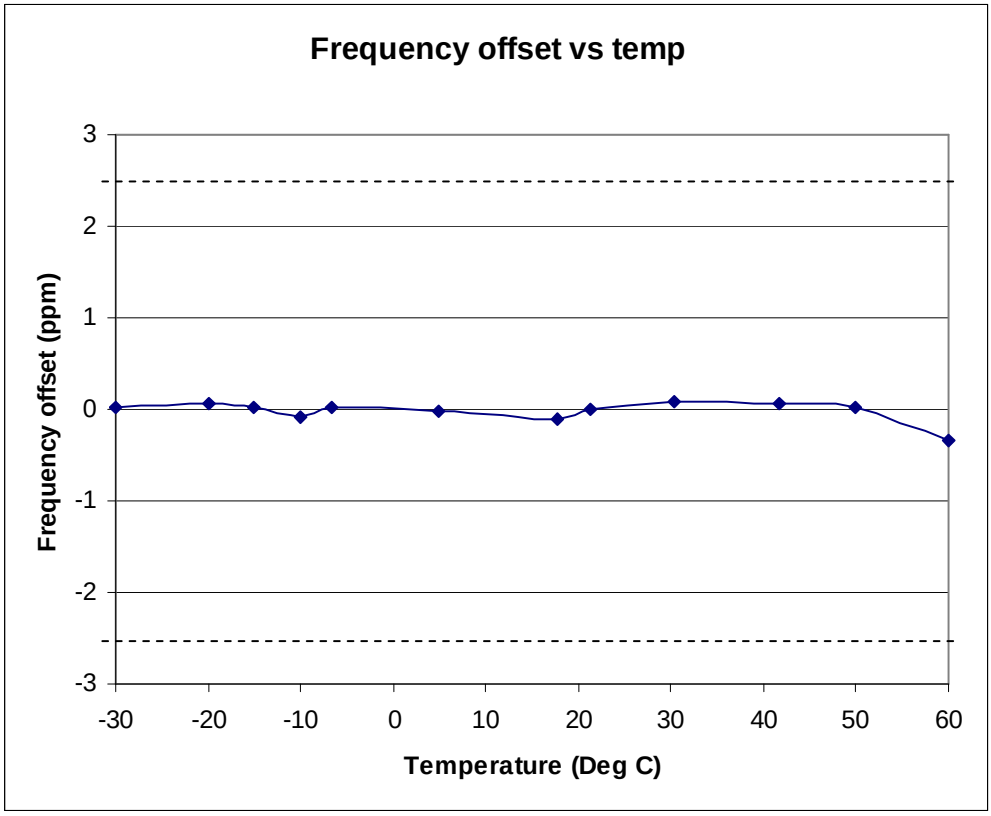
FREQUENCY STABILITY 2.1055, 90.213, 90.214

Frequency stability measurements were made over the temperature range of –30°C to +60°C. Variations of the primary DC voltage were varied from 5 to 15 VDC. Frequency measurements were made using a direct (10 dB attenuated) connection to the Rhode & Schwarz ESPI Test receiver with a frequency accuracy of better than 0.1 ppm.

Power variations were accomplished with a variable regulated DC supply, an Amrel LPS-305 Power Supply. Environmental conditions were accomplished with a GSED environmental chamber. The temperature was first lowered to -30°C and then in creased in 10°C increments. At each temperature, short- term transient effects were monitored and no adverse effects were noted. The frequency was recorded fifteen seconds after the turn on of the transmitter.

Test results:
PASS. Thus the maximum drift observed was only 60 Hz. The combination of the maximum bandwidth and the frequency drift would not cause the emission waveform to drift beyond the limit from the assigned frequency.

The table below shows the frequency vs. temperature data.



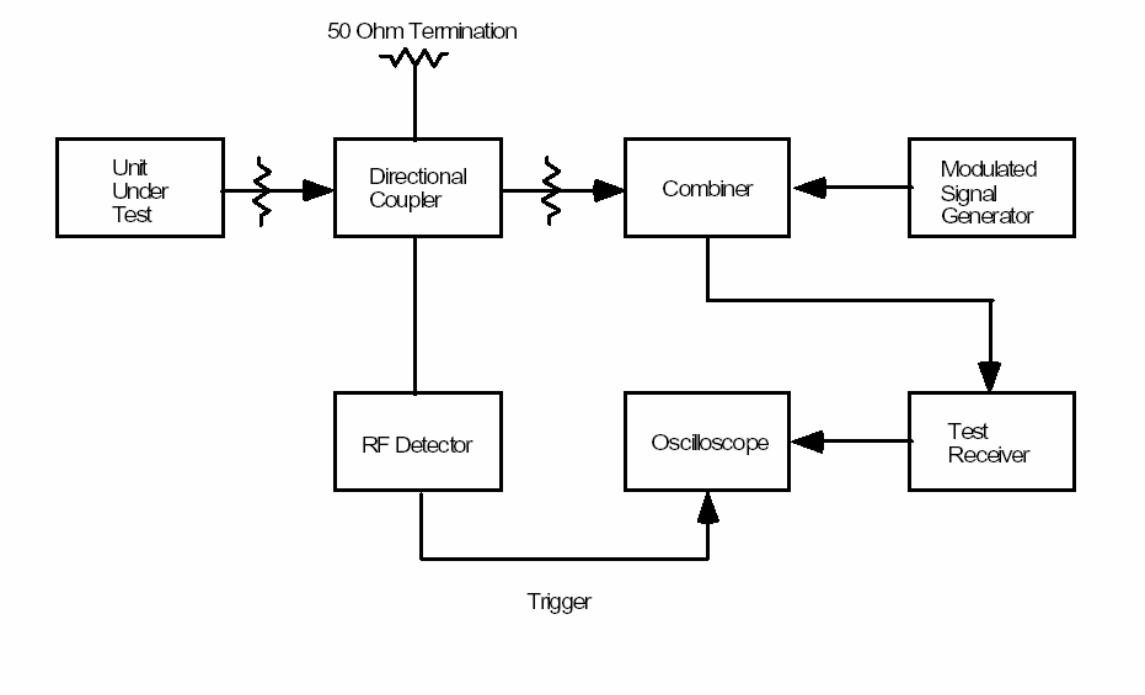
TRANSIENT FREQUENCY BEHAVIOR 90.214

The transient frequency behavior test was carried out in accordance with TIA/EIA 603 §2.2.19 method of measurement §3.2.19 standard. This test measures the amount of time required for the unmodulated higher amplitude test sample to “capture” or “release” a weaker 25 kHz FM modulated test signal during key-up and key-down. This is an indirect method of measuring the time that it takes for a transmitter to come on-channel and allows transition effects to be recorded.
The device was powered up and down manually with a test lead and the power supply positive terminal. A fast responding diode detector acts as a trigger signal for the oscilloscope.

As shown in the oscilloscope plots, three time periods are observed. The t_1, t_2, t_3 mask limits are superimposed on the data runs. These plots indicate the t_{on} and t_{off} points and the related frequency displacement. The frequency difference remained within the limits of 90.213 between t_2 and t_3.

Test results:
PASS. The test sample comes on frequency smoothly and remains within the limits of the mask.

BLOCK DIAGRAM
Transient Frequency Behavior 90.214

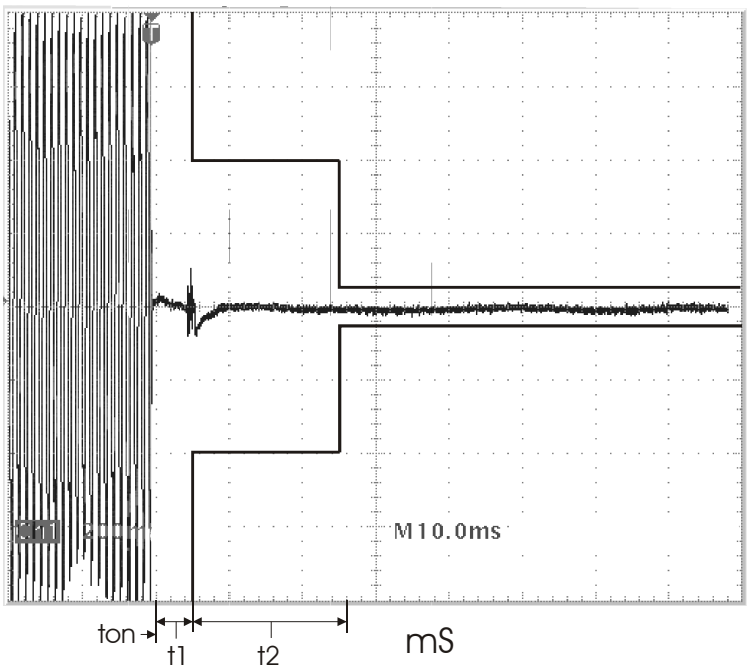


Equipment list

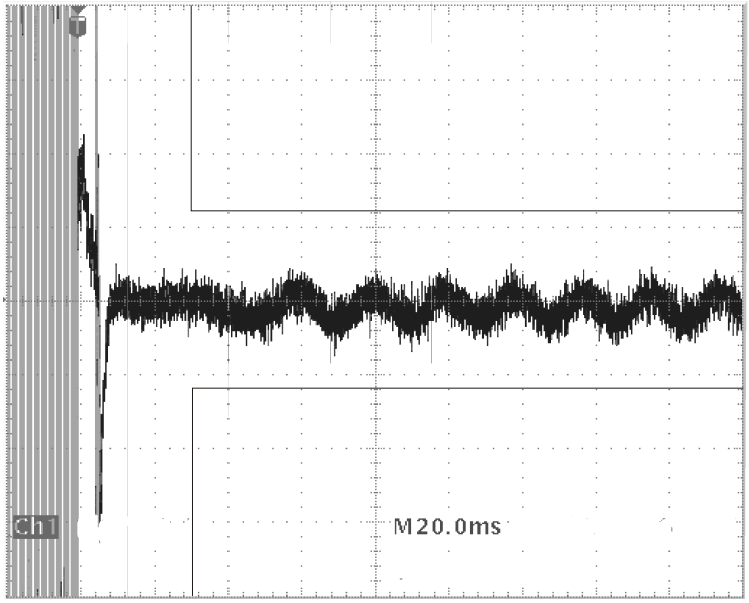
Directional Coupler:	Werlatone	C1795.
Combiner:	Mini Circuits	ZFSC-2-2
Signal Generator:	Marconi	2024
Test Receiver:	Rhode & Schwarz	ESPI

Oscilloscope:	Tektronix	TDS 3032
RF Detector:	Danlab	DT1

Transient Frequency Behavior of Transmitter



Transient Frequency Behavior of Transmitter



Transient Frequency Behavior of Transmitter