**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.

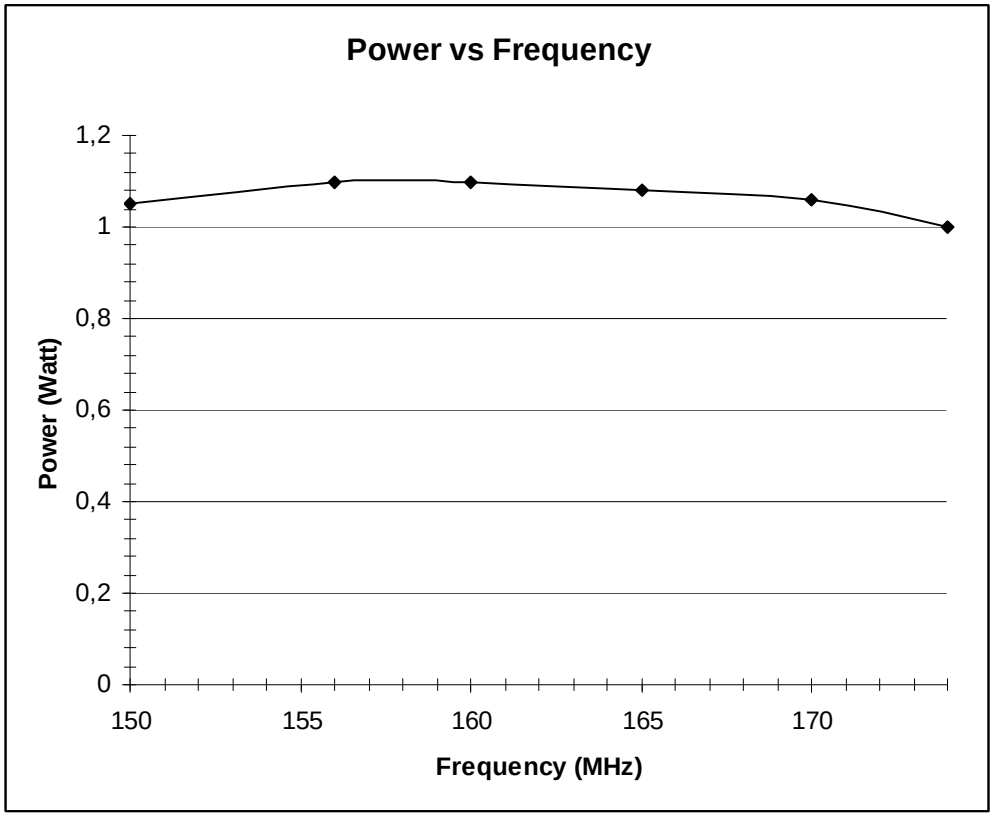
**RF POWER OUTPUT 2.1046(a), 2.1033(c)(8)**

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.
Thus the sample complies with §90.205(d).

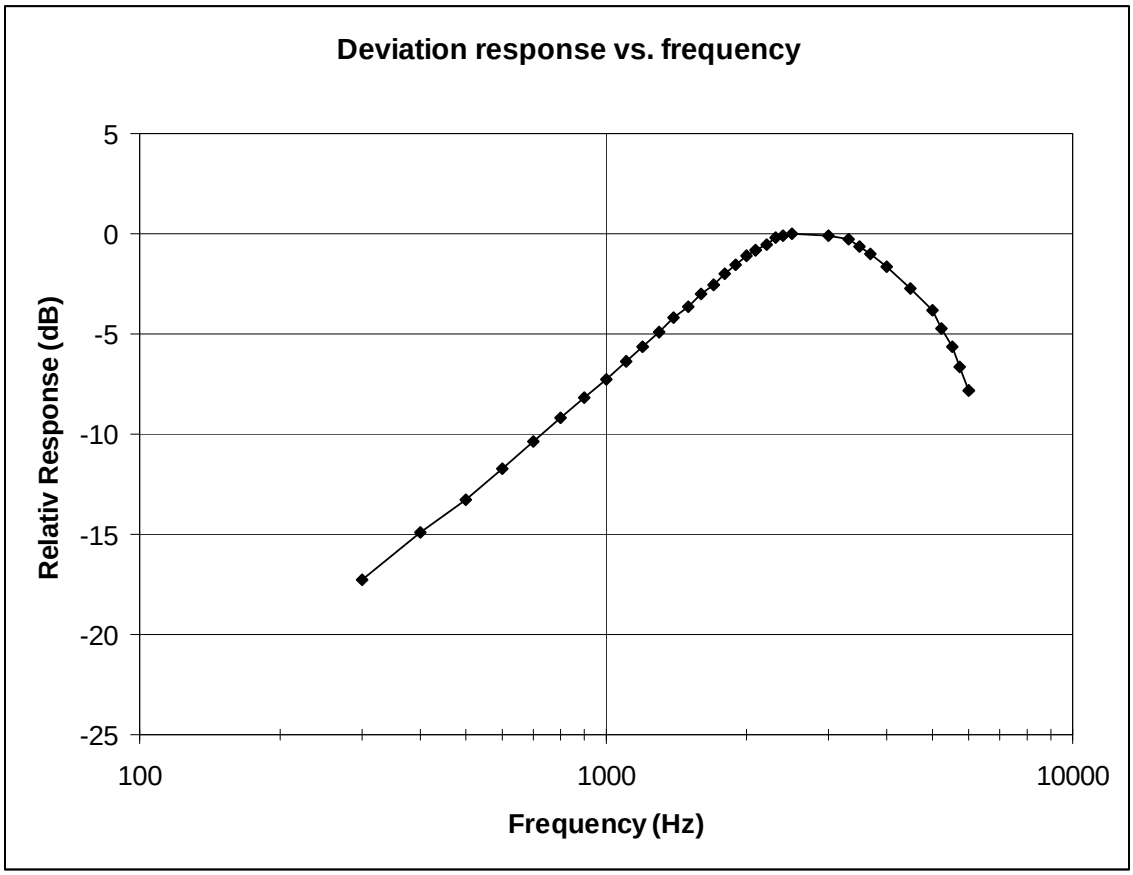


**MODULATION CHARACTERISTICS 2.1047(a), 90.211(a)**

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.

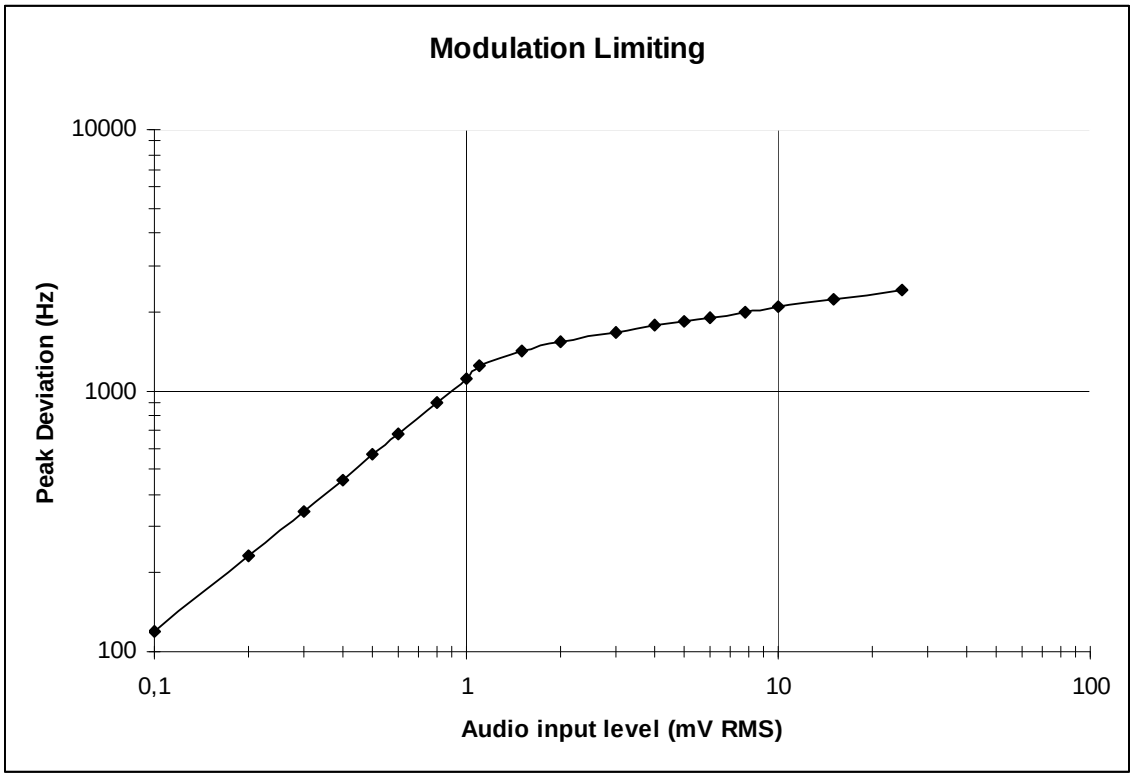
*Frequency Response*

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:

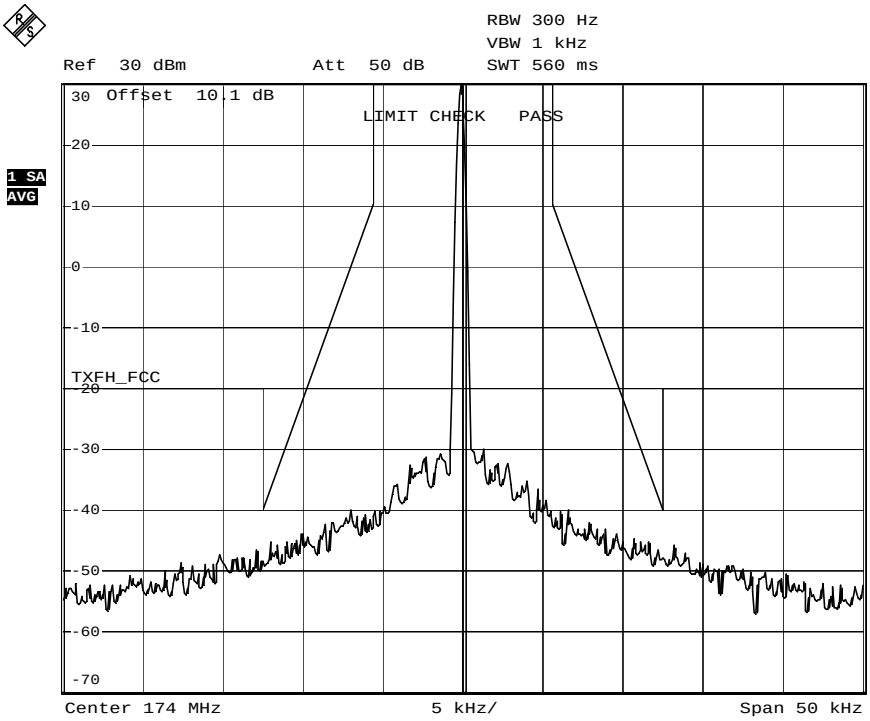
1) 0n any frequency removed from the center of the authorized bandwidth f0 to 5.625 kHz removed from f0: Zero dB.

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.

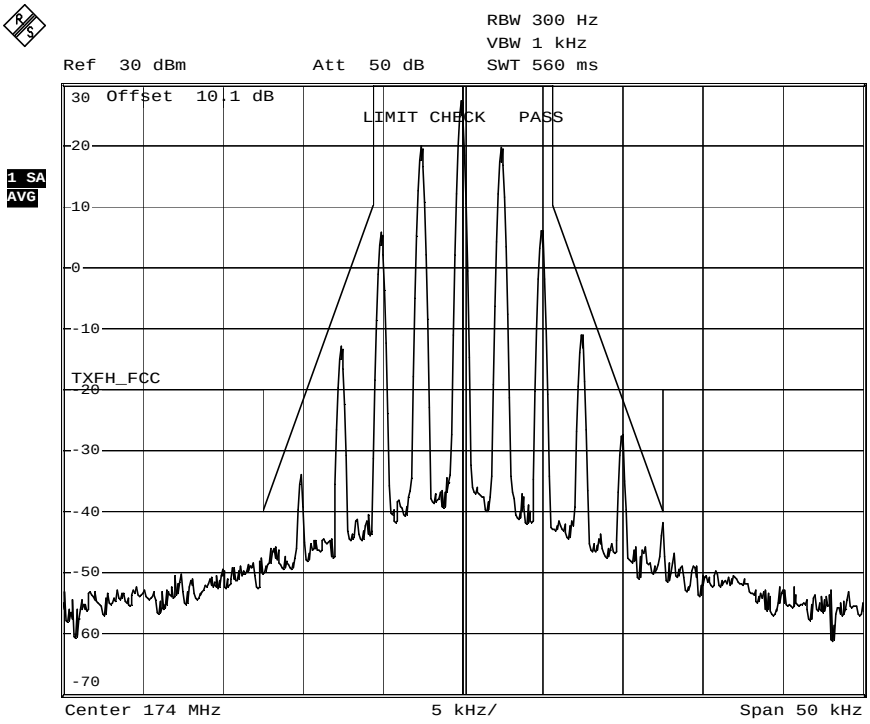
3) 0n any frequency removed from the center of the authorized bandwidth by a displacement frequency (fd in kHz) of more than 12.5 kHz: At least 50+ log(P) or 70 dB, whichever is the lesser attenuation.

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.

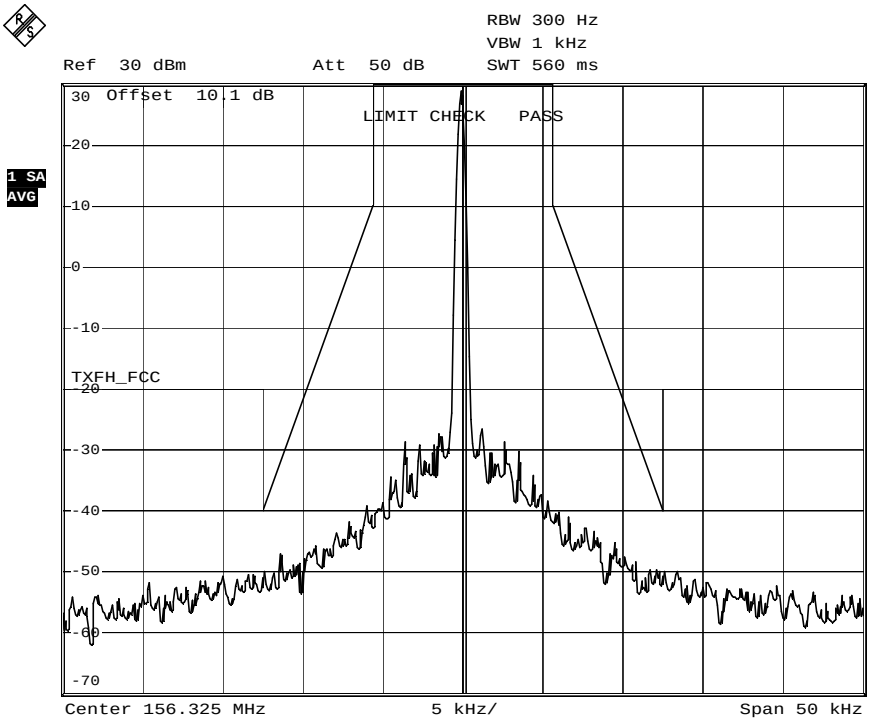
All emissions are below the required limits. Thus, the sample complies with 90.211(a).



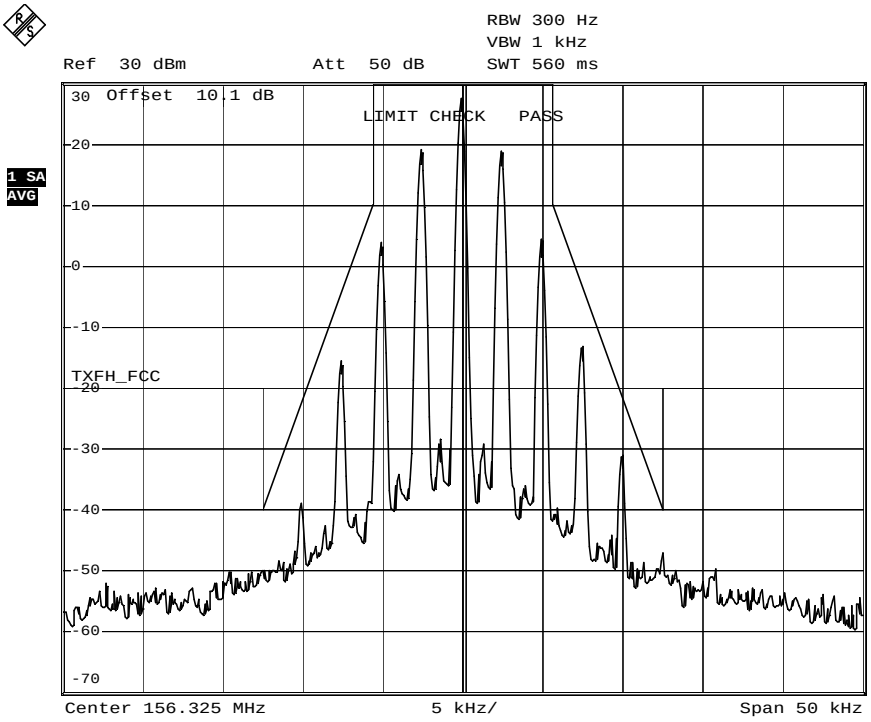

Date: 18.JUN.2005 11:26:23




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



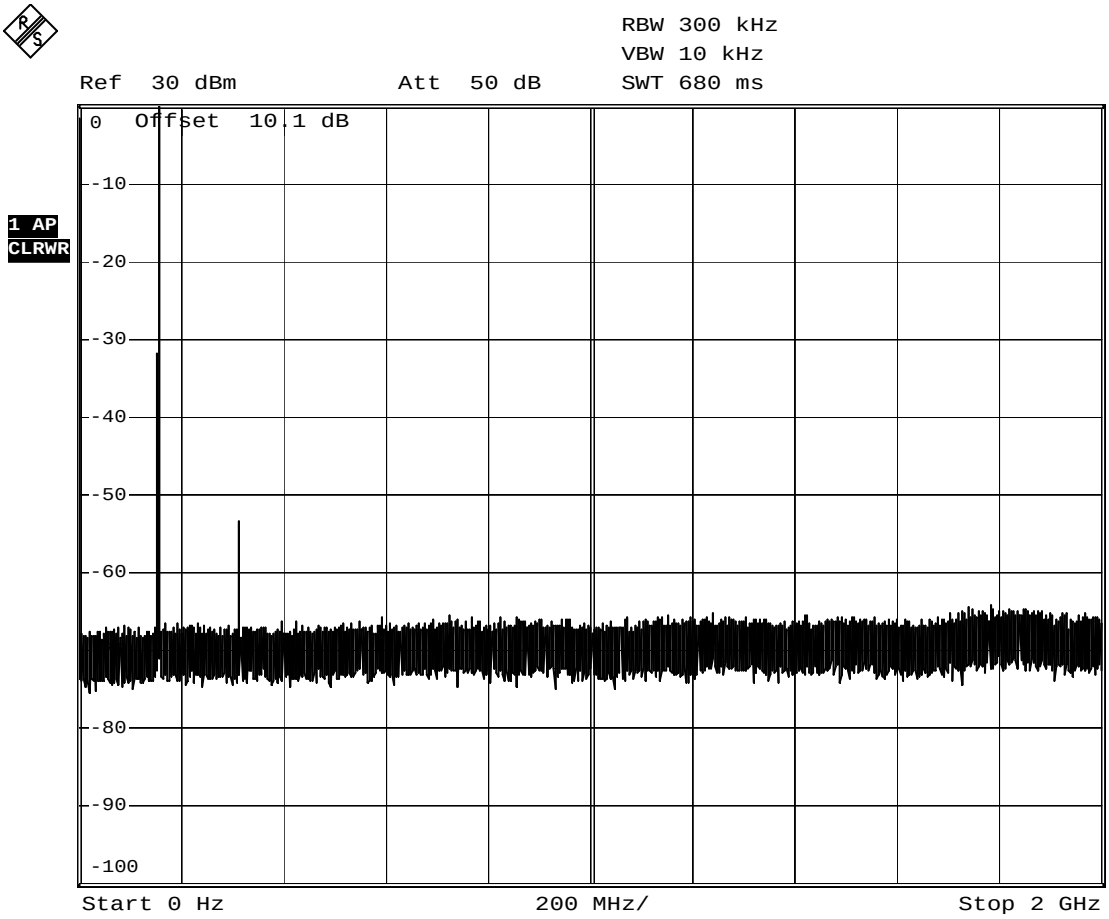

Date: 18.JUN.2005 12:34:12




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.
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 42cm 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 + 10log P) dB or 70 dB, whichever is the lesser attenuation.

*Theoretical Calculation of Radiated Power Limit below 1000 MHz*

The emissions limit is expressed in terms of equivalent power that would have to be fed into a dipole antenna in order to produce the same electric field strength.

Based on the maximum rated output power of 1.1W and the formula $E$ = SQRT(30$G$Pt)/R

Where: E = Electric Field Intensity in V/m
G = Antenna Gain = 1.64
Pt = Power in Watts
R = Distance from test sample to antenna in Meters = 10
E = SQRT (49.2 X 1.1)/10 = 0.736V/m = 117.33dBuV/m

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

Limit @ 10m = 117.3 – 50.4 dB = 66.9 dBµV/m

*Theoretical Calculation of radiated Power Limit above 1000 MHz*

For all emissions above 1000 MHz, the source of the emission is assumed to be isotropic. Therefore the antenna gain G = 1 and the limit is:

Limit @ 3m = 125.6– 50.4 dB = 75.2 dBµV/m

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. |
|---|---|---|---|---|---|
| | | | | | ± 2,2 dB |
| G + OATS | 0161 | Measuring receiver | Rohde & Schwarz | ESVS 10 | |
| | | 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 | Cable | Suhner | RG214 HIFLEX | |
| | K122 | | | | |
| | 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 | |

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:**<br>**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 | 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 | 2005-08-23 |
| | | | | Humidity | 79 %RH | Time | |

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

| Test mode / setup | |
|---|---|

| Test Frequency | Harmonic Frequency | Measurement | Limit | Margin | Antenna height | Antenna polarity | Comments |
|---|---|---|---|---|---|---|---|
| MHz | MHz | dBµV/m | dBµV/m | dBµV/m | m | H/V | |
| 150.775 | - | - | - | - | - | - | - |
| - | 301.550 | 54.6 | 66.9 | 12.3 | 3.0 | H | 10m distance |
| - | 452.325 | 34.6 | 66.9 | 32.3 | 2.5 | H | - |
| - | 603.100 | 55.3 | 66.9 | 11.6 | 1.5 | H | - |
| - | 753.875 | 49.1 | 66.9 | 17.8 | 1.6 | H | - |
| - | 904.650 | 60.8 | 66.9 | 6.1 | 1.0 | H | - |
| - | 1055.425 | 58.0 | 74.8 | 16.8 | 1.7 | H | 3m distance |
| - | 1206.200 | 50.5 | 74.8 | 24.3 | 1.6 | H | - |
| - | 1356.975 | 57.0 | 74.8 | 17.8 | 1.2 | H | - |
| - | 1507.750 | 44.5 | 74.8 | 30.3 | 1.0 | H | - |
| | | | | | | | |

**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 | Limits specified in used standard were not exceeded during measurements. |
| Failed | |
| Client | |
| EUT | TXFH-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 | 2005-08-23 |
| | | | Humidity | 79 %RH | Time | |

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

| Test mode / setup | |
|---|---|

| Test Frequency | Harmonic Frequency | Measurement | Limit | Margin | Antenna height | Antenna polarity | Comments |
|---|---|---|---|---|---|---|---|
| MHz | MHz | dBµV/m | dBµV/m | dBµV/m | m | H/V | |
| 157.450 | - | - | - | - | - | - | - |
| - | 314.900 | 56.0 | 66.9 | 10.9 | 3.5 | H | 10m distance |
| - | 472.350 | 29.2 | 66.9 | 37.7 | 2.0 | H | - |
| - | 629.800 | 44.3 | 66.9 | 22.6 | 1.4 | H | - |
| - | 787.250 | 58.2 | 66.9 | 8.7 | 1.2 | H | - |
| - | 944.700 | 60.5 | 66.9 | 6.4 | 1.0 | H | - |
| - | 1102.150 | 60.0 | 75.2 | 15.2 | 1.6 | H | 3m distance |
| - | 1259.600 | 51.5 | 75.2 | 23.7 | 1.4 | H | - |
| - | 1417.050 | 56.0 | 75.2 | 19.2 | 1.3 | H | - |
| - | 1574.500 | 51.0 | 75.2 | 24.2 | 1.1 | H | - |
| | | | | | | | |

**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 | Limits specified in used standard were not exceeded during measurements. |
| Failed | |
| Client | |
| EUT | TXFH-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 | 2005-08-23 |
| | | Humidity | 79 %RH | Time | |

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

| Test mode / setup | |
|---|---|

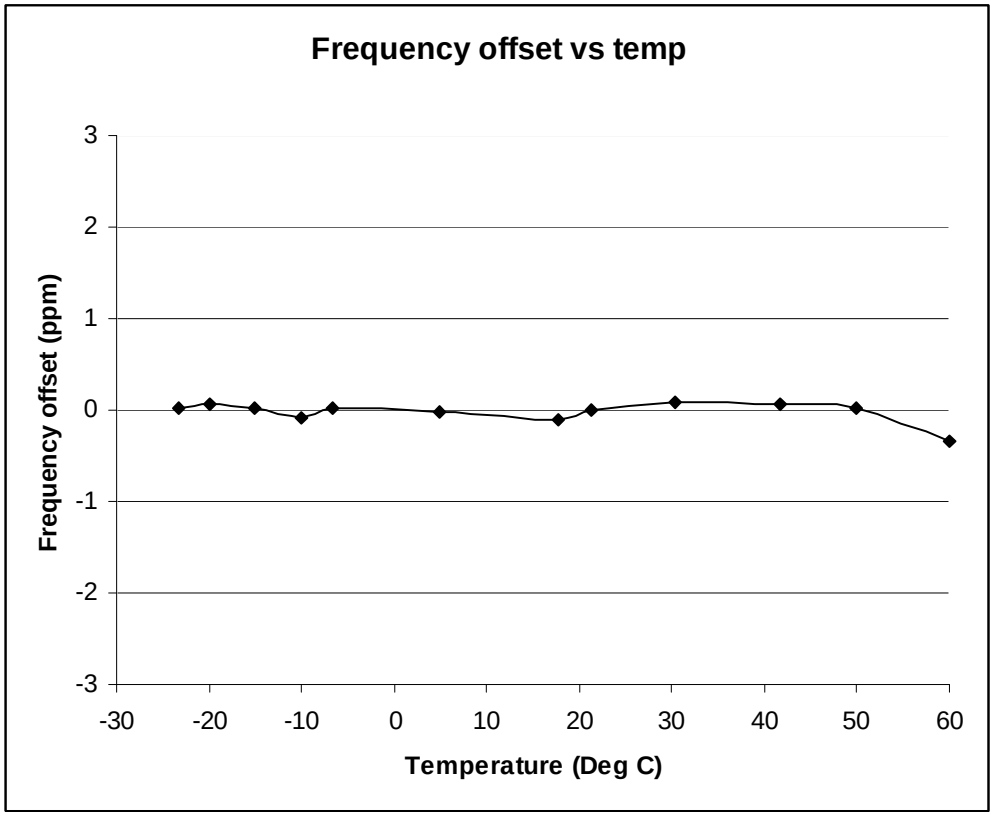
| Test Frequency | Harmonic Frequency | Measurement | Limit | Margin | Antenna height | Antenna polarity | Comments |
|---|---|---|---|---|---|---|---|
| MHz | MHz | dBµV/m | dBµV/m | dBµV/m | m | H/V | |
| 173,39625 | - | - | - | - | - | - | - |
| - | 346.79250 | 60.4 | 66.9 | 6.5 | 3.0 | H | 10m distance |
| - | 520.18875 | 28.0 | 66.9 | 38.9 | 2.4 | H | - |
| - | 693.58500 | 50.5 | 66.9 | 16.4 | 1.5 | H | - |
| - | 866.98125 | 57.6 | 66.9 | 9.3 | 1.0 | H | - |
| - | 1040.37750 | 65.0 | 75.2 | 10.2 | 1.0 | H | 3m distance |
| - | 1213.77375 | 66.0 | 75.2 | 9.2 | 1.3 | H | - |
| - | 1387.17000 | 66.0 | 75.2 | 9.2 | 1.3 | H | - |
| - | 1560.56625 | 55.0 | 75.2 | 20.2 | 1.7 | H | - |
| - | 1733.96250 | 53.5 | 75.2 | 21.7 | 1.1 | H | - |
| | | | | | | | |

**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.

The table below shows the frequency vs. temperature data.

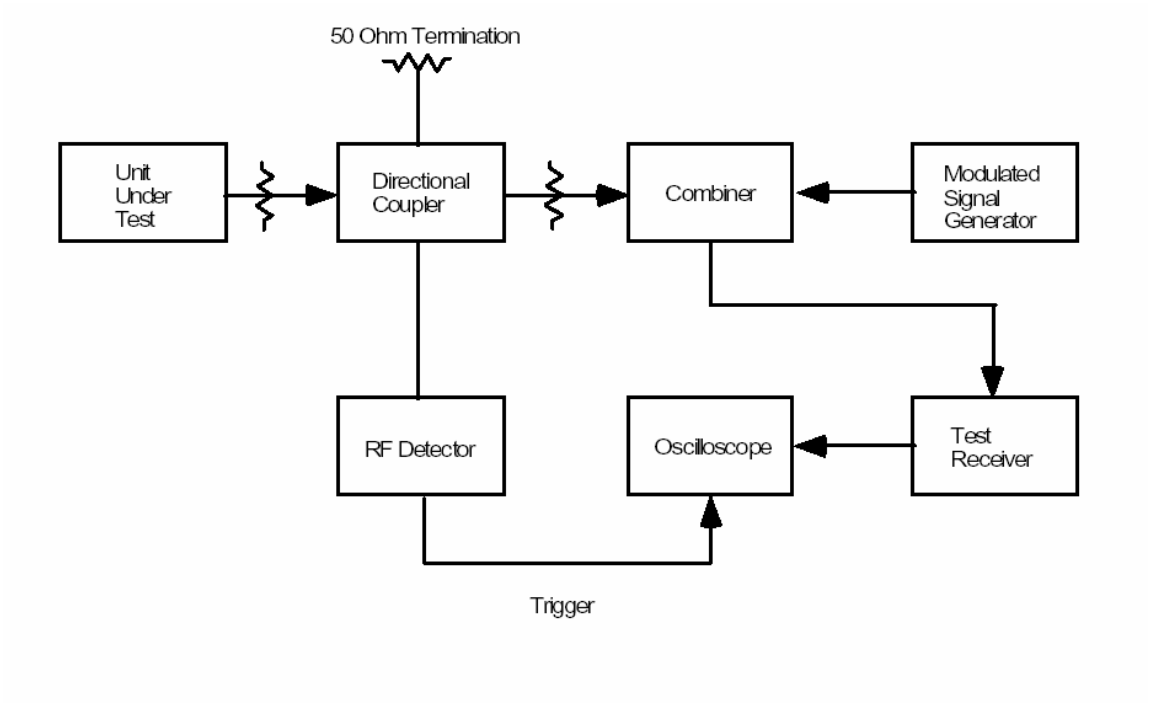


**TRANSIENT FREQUENCY BEHAVIOR 90.214**

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 $t_3$. The test sample comes on-frequency smoothly and remains within the limits of the mask.

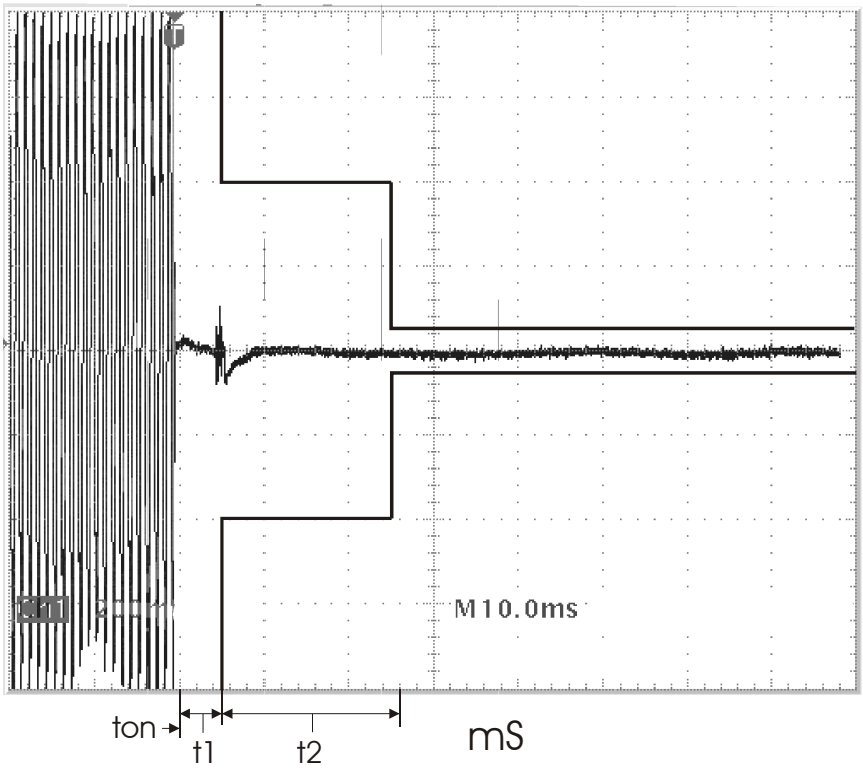
BLOCK DIAGRAM
Transient Frequency Behavior 90.214



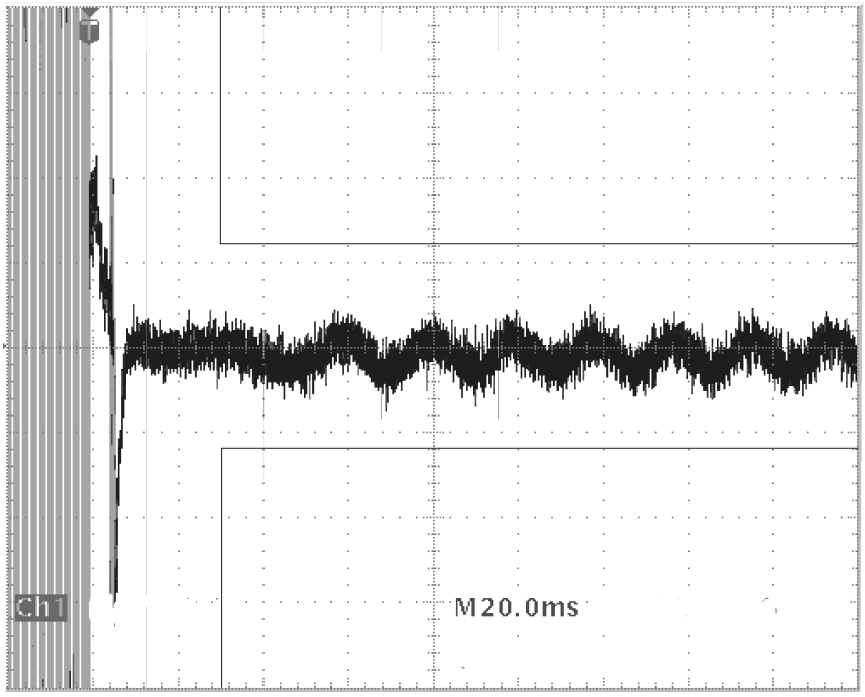

Equipment list

| | | |
|---|---|---|
| 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