Annex A: Document # 156-90000-891

NAME OF TEST:	Emissions limitations and 99% Occupied bandwidth for Dataradio G3 Modem at 128000 bps 16FSK
RULE PART NUMBER:	90.543
UNIT UNDER TEST	Prototype Gemini 3.5 700/800 MHz
SERIAL NUMBER (S):	Production Gemini GCU III modem- MAC ID#- 0A99 6085-170 S/N 00007 pilot MDP transceiver – Modulation and ACP compliance
TEST CONDITIONS:	90.543(b) was the standard procedure followed through the test. The instrument E4401B has Adjacent Channel Power Measure software embedded Channel Power over BW measurement built-in software. Standard Test Conditions, 25 C.

NAME OF TEST: Emissions limitations Dataradio G3 Modem at 128000 bps 16FSK

RULE PART NUMBER: 90.543

MINIMUM STANDARD: Wideband 150kHz mobile transmitter ACCP requirements:

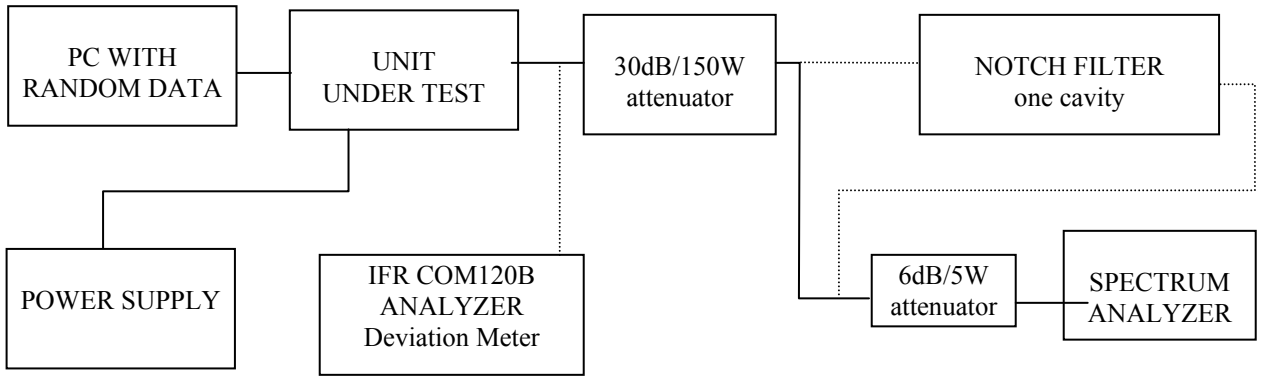
Offset from Center requency (kHz)	Measurement Bandwidth (kHz)	Maximum ACCP Relative (dBc)
100....	50	-40
200...	50	-50
300...	50	-50
400...	50	-50
600 to 1000.....	30(swept)	-60
1000 to receive band	30(swept)	-70
in the receive band	30(swept)	-100

TEST RESULTS: Meets minimum standard (see test data on the following pages)

TEST EQUIPMENT: Notch filter tuned before test, characteristic provided
DC Power Supply , Astron Model VS-20M
Attenuators Bird 30dB/150W model 150-SA-MFN-30 and 6dB/5W model 5-A-MFN-06
IFR COM-120B – modulation meter setting IF 30kHz, atten 30dB reading at 30W
Spectrum Analyzer, Model Agilent E4401B
with Adjacent Channel Power Measure software embedded
Agilent PSA/ESA -software for plot captures in Word documents provided by Agilent.

PERFORMED BY: Constantin Pintilei DATE: 05/09/07

TEST SET-UP:



NAME OF TEST: Adjacent Channel Coupled Power (Continued)
Dataradio G3 Modem at 128000 bps 16FSK

TX Data Test Pattern:

The transmit "test data" pattern command produces a 2047 bit pseudo-random pattern. This pattern is generated by the internal software using the polynomial $X^{11}+X^{9}+1$ form and a 12-bit shift register. Initial value of the register is 111111111110 (FFE hex). The 2047 bit sequence is repeated thereafter as long is necessary to complete the test duration . This pattern is applied to the DSP processor data input for encoding and pulse shaping as described above.

Explanations for the 50kHz wideband mobile transmitter

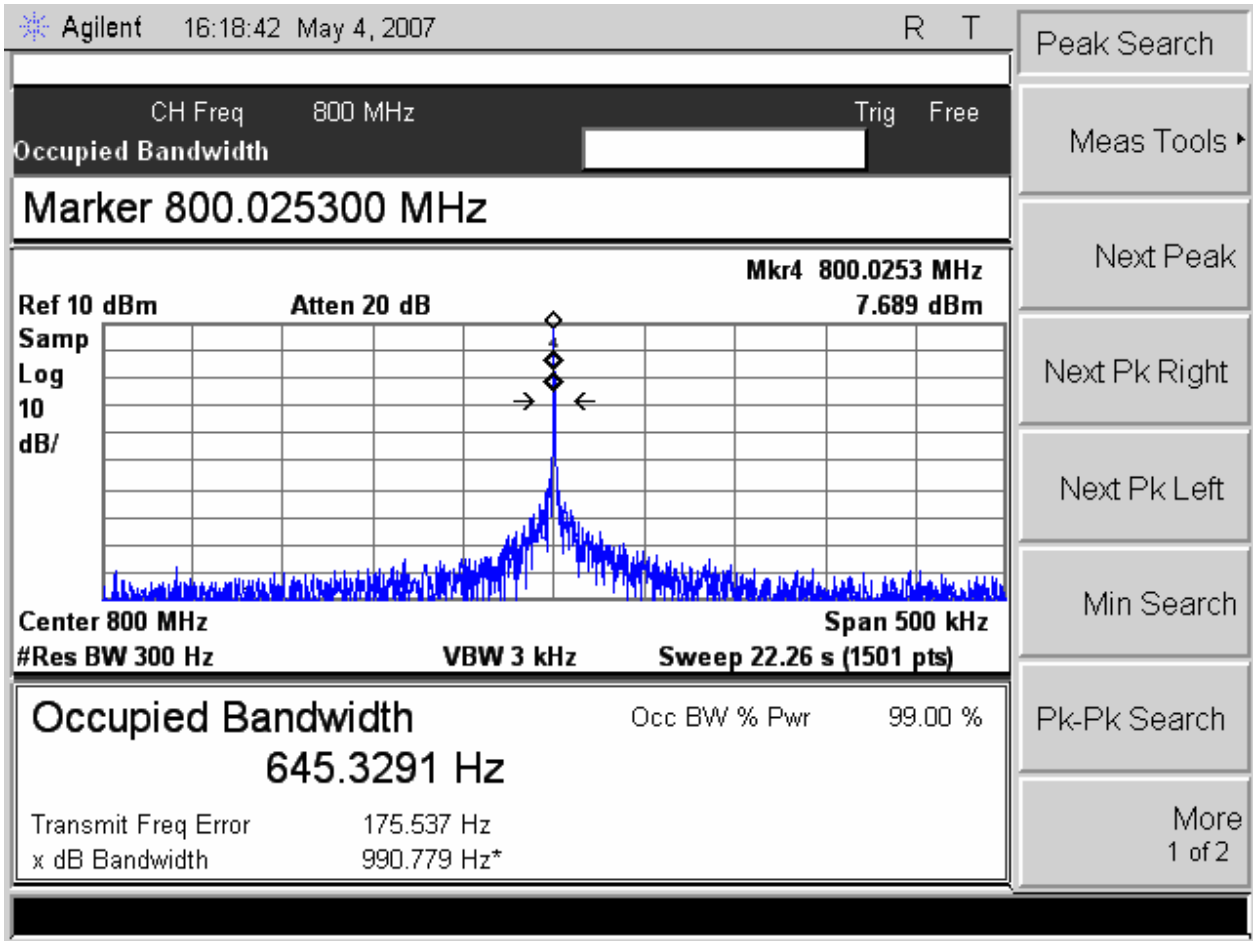
As per 90.531(c), there are two band segments that are designated for use with wideband emissions. Each of these wideband segments is divided into 120 channels with a channel size of 50 kHz. Next, the part 90.531(d)(2) reads that two or three contiguous wideband (50 kHz) channels may be used in combination as 100 kHz or 150 kHz channels, respectively. Meantime, the specification for ACCP in 90.543 addresses only the 150kHz mobile transmitter requirements, with no explicit reference to 50kHz or 100kHz mobile transmitter requirements.

For the test purposes the specifications available in 90.543 are considered such that in the 150 kHz band of a three-channel block each channel can be considered to have its own 50kHz transmitter. In this reading the rule is applied for the 50kHz transmitter when transmitting on any of the three-combined channels, namely the low, center or high side channel. Therefore Adjacent Channel Coupled Power has to be measured also for frequency offsets of 50kHz from the center frequency of the 50kHz channel in use and the restriction of a maximum ACCP less than –40dBc must be applied for conformity.

Reference power in the main channel, (90.534(b)(1))
Settings:150kHz Channel Bandwidth

channel 180, 800.025MHz , data reading at 30W : 7.7 dBm

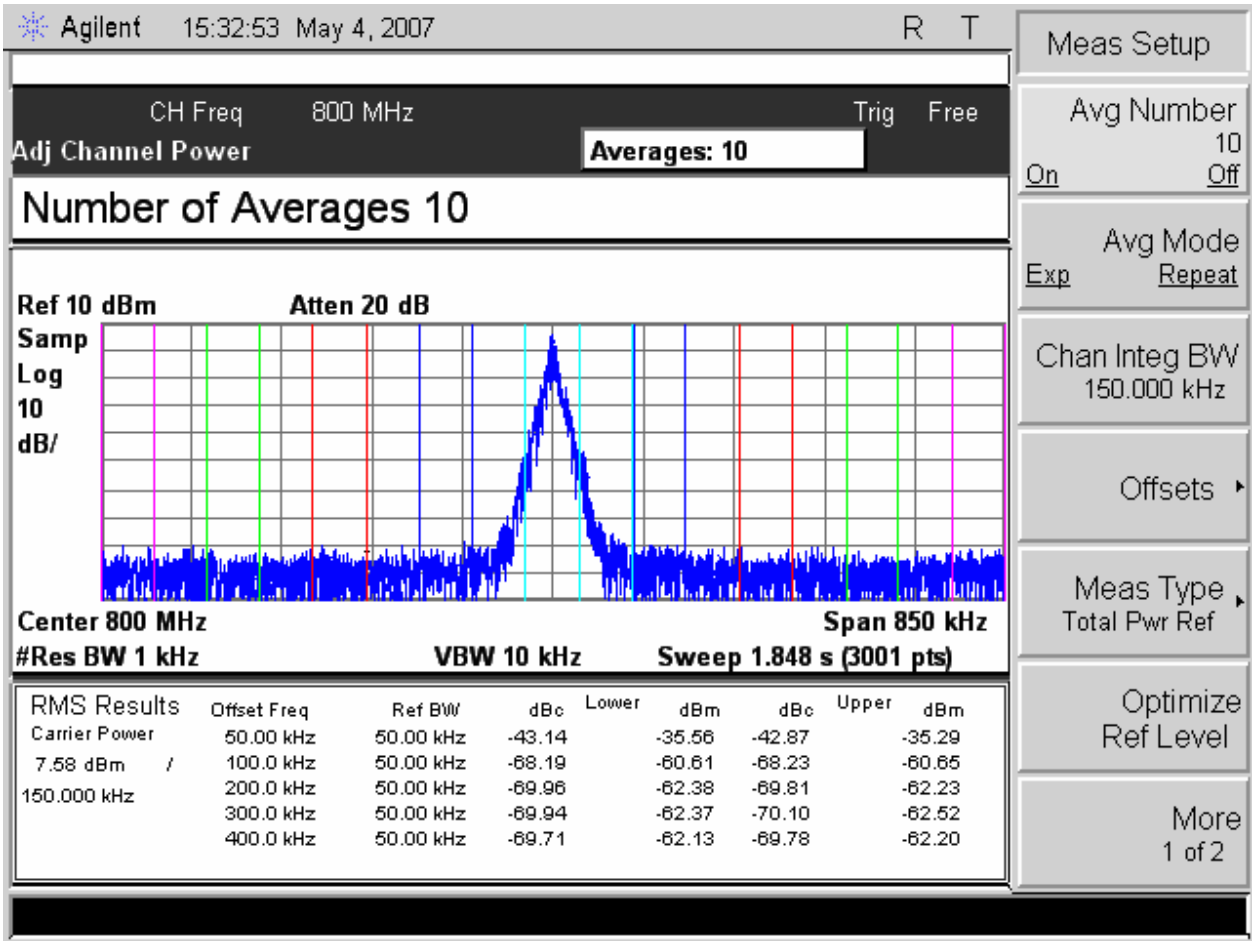
Total RF power is 30W⇔ 45dBm. This makes the total attenuation of the setup about 37.3dB. In the set-up there are two attenuation pads of 30dB and 6dB, cables and connectors RF.
To convert readings of the instrument to absolute power 37.3dB must be added to the reading of the display .



Power Level at frequency offsets <600kHz (90.534(b)(2))
Settings: 150kHz reference Channel bandwidth, 50kHz offset channel bandwidth
RBW=1kHz, Video BW=10kHz, Span=0.85MHz , Sweep = Detector mode: sample
Display resolution (3001 display points)= 283.6Hz ,
Reference level +10dBm, 50kHz channel noise=-69.5dBm

UUT in center channel of the 794-806MHz band: Channel 180, frequency 800.02500 MHz.

frequency Offset (kHz)	-400	-300	-200	-100	-50	0	50	100	200	300	400
Channel Power read dBm	-62.1	-62.3	-62.3	-60.6	-35.5	***7.58***	-35.2	-60.6	-62.2	-62.5	-62.2
Absolute (dBm) channel power correction 37.3dB	-24.8	-25.0	-25.0	-23.3	2.7	***44.9***	3.1	-28.1	-24.9	-25.2	-24.9
ACCP (difference) dBc	-69.7	-69.9	-69.9	-68.1	-43.1	NA	-42.8	-68.2	-69.8	-70.1	-69.7



Power Levels at frequency offsets >600kHz (90.534(b)(3)

- **frequency offsets between 600kHz and 1000 kHz**

Settings

Notch filter: 1cavity, 35dB attenuation on 800.025MHz, attenuation for 600kHz-1MHz offsets between 14dB and 18dB. See a plot of the filter's characteristic on page 8. Marker 1- 800.025MHz @ -34.8dB, Marker 2 – 800.625MHz @ -18.5dB, Marker 3 – 799.425MHz @ -19.5dB, 1.8MHz/division span

Spectrum analyzer: RBW=30kHz, Span=500kHz (instruments channel power auto-setting), Display resolution (2001 display points)= 25Hz Detector mode: sample; Instrument's noise floor for -20dBm reference level equated to 30kHz channel –100.01dBm/50kHz = -102.0 dBm/30kHz (density noise =147.0dBm/Hz),

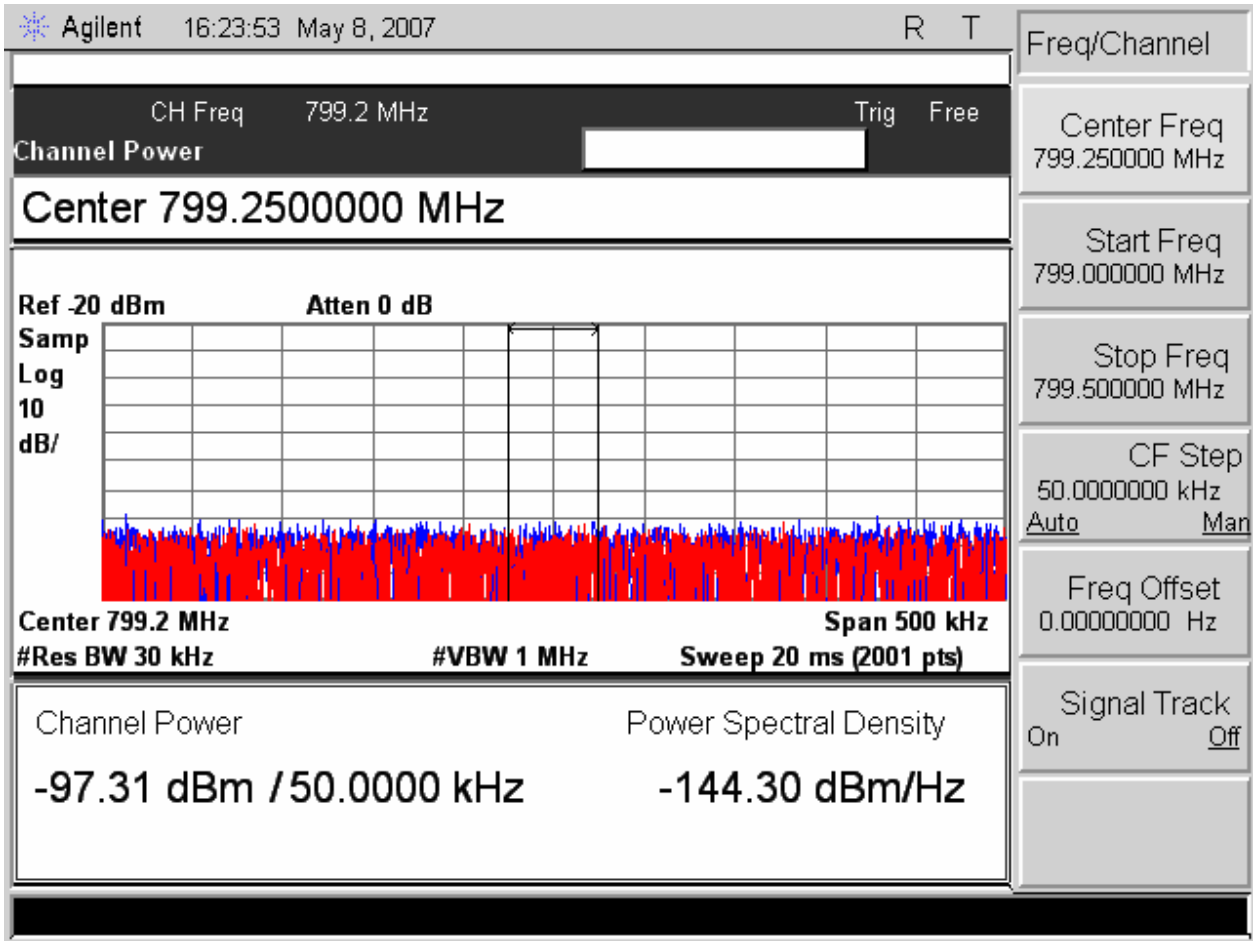
Instrument's dynamic range including the notch attenuation: -20dBm-(-102dBm/30kHz)+34.8dB=116.8dB

Test data:

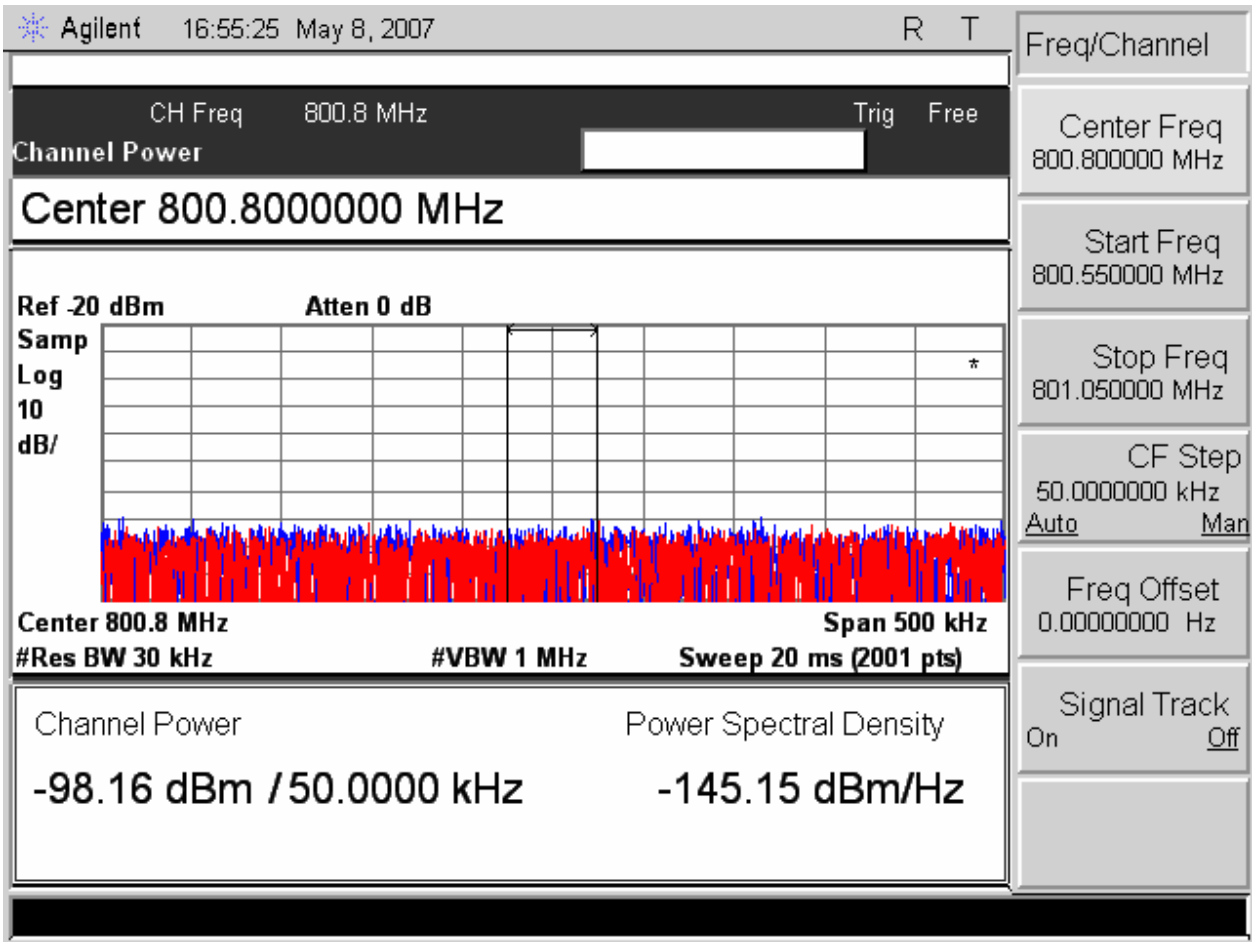
The capture below has data trace (blue) vs noise trace (red). Data spectrum was swept for the 30kHz channel power at frequency offsets between 550kHz and 1050KHz. The maximum relative ACCP = -60dBc >-88.5 dBc

	Reading PSD dBm/Hz	Reading 50khz channel power	Corrected for 30kHz channel power	Relative ACCP Carrier at 45dBm
Lower	-144.30	-97.31 dBm/50KHz	-43.5dBm/30kHz	-88.5dbc
Upper	-145.15	-98.16 dBm/50khz	-44.4 db,/30khz	-89.4dBc

Calculation 30kHz channel=PSD+45 (correction for 30kHz channel)+18.5 (Notch filter worst case) +37.3 (Set-up attenuation)

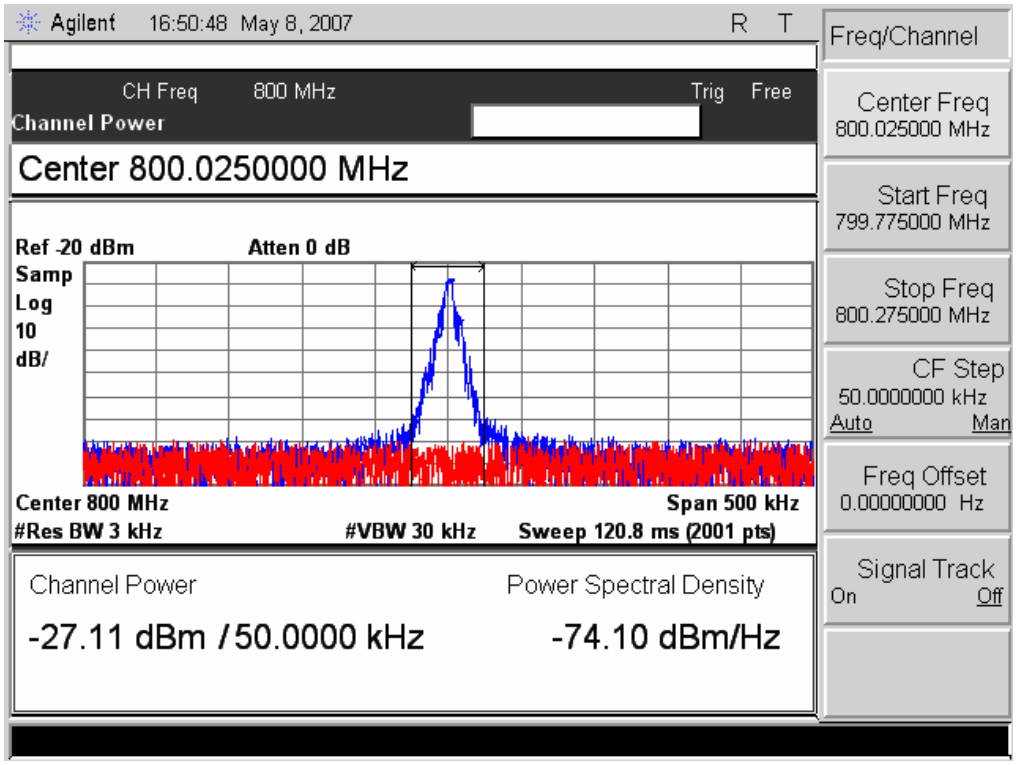


Frequency sweep –1050kHz to –550kHz

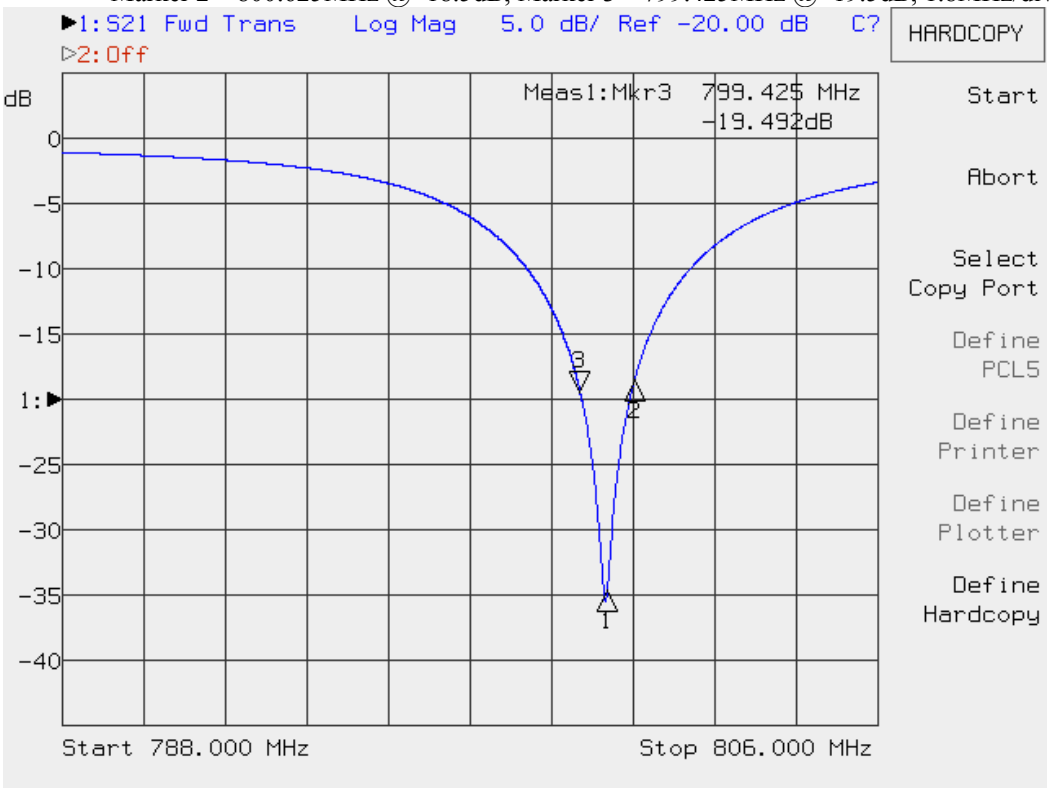


Frequency sweep +500kHz to +1000kHz

Frequency sweep –250kHz to +250kHz, 1 cavity notch filter 35dB attenuation on the center frequency.



Notch filter: 1cavity, attenuation>18dB for frequency offsets >600kHz Marker 1- 800.025MHz @ -34.8dB, Marker 2 – 800.625MHz @ -18.5dB, Marker 3 – 799.425MHz @ -19.5dB, 1.8MHz/division span



- **frequency offsets between 1000kHz and the uppermost receive frequency (776MHz)**

Notch filter: 1cavity, 35dB attenuation on 800.025MHz, attenuation for 1MHz offset to 794MHz decreases between 14dB and 2.6dB. The attenuation from 794MHz to 776MHz decreases between 2.6dB and 0.4db See a plot of the filter's characteristic on page 11. Marker 1-764.0MHz @ -0.4dB, Marker 2 – 776.0MHz @ -0.4dB, Marker 3 – 794MHz @ -2.6dB, 4.0MHz/division span

Spectrum analyzer: RBW=30kHz, VBW 1MHz, Display resolution (2001 display points)= 21kHz Detector mode: sample; Instrument's noise floor for -20dBm reference level equated to 30kHz channel – 100.01dBm/50kHz = -102.0 dBm/30kHz (density noise =-147.0dBm/Hz)

Instrument's dynamic range including the notch attenuation: -20dBm-(-102dBm/30Hz)+35dB=117dB

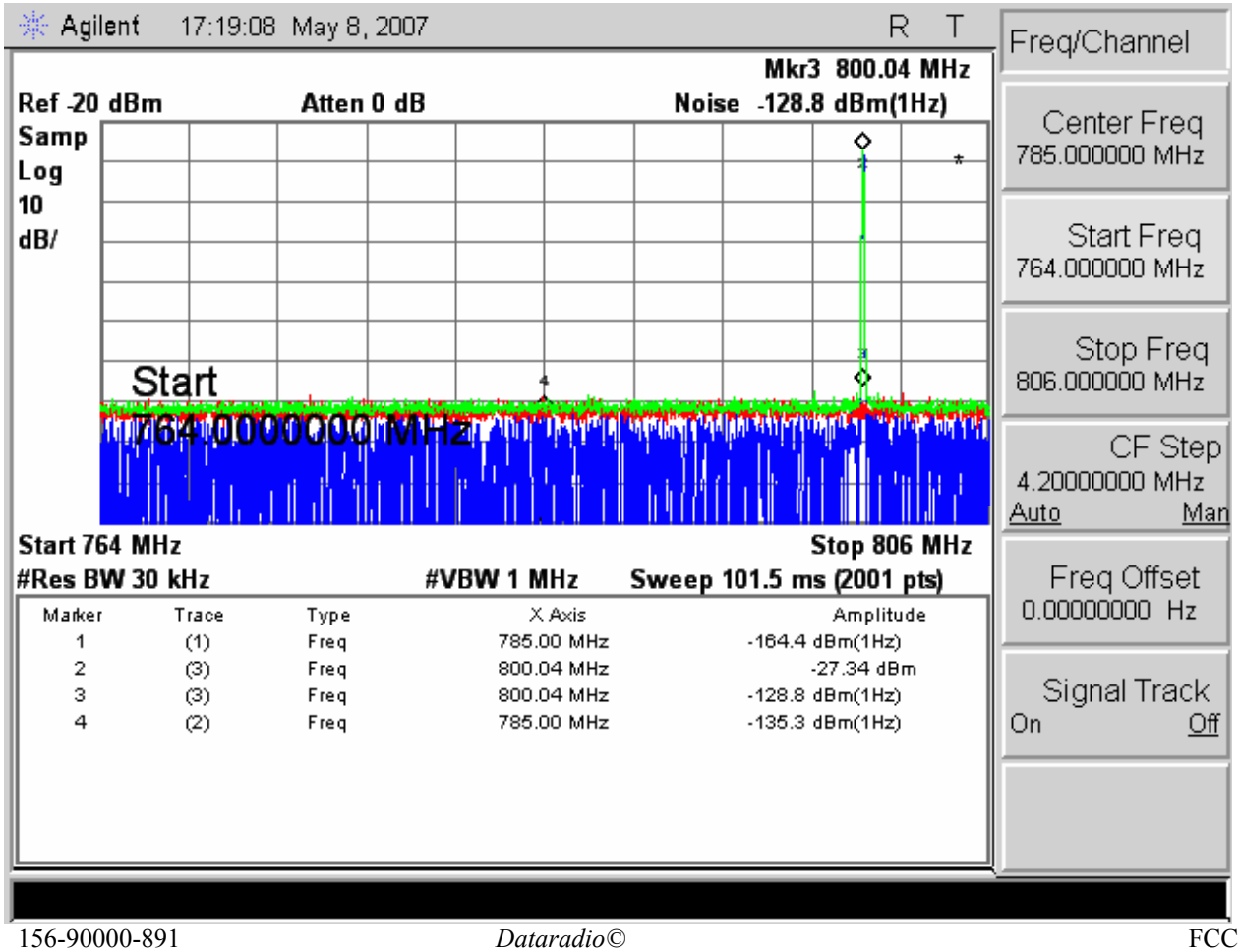
The capture below has current data trace in Sample mode (blue) vs reference noise trace in Peak Hold mode (red) and vs data trace in Peak Hold Mode (green).
Marker 1- reads marker's noise PSD on blue trace,
Marker 2- reads absolute power on data trace in Peak hold; the notch is connected to the set-up
Marker 3 – reads marker's noise PSD on data trace in Peak hold; the notch is connected to the set-up
Marker 4 – reads marker's noise on instrument's default noise, no input.

There are no products exceeding instruments's noise floor.

Calculation 30kHz channel=-147.0+45 (correction for 30kHz channel)+14 (Notch filter worst case at 799mhz) +37.3 (Set-up attenuation) = -50.7dBm

ACCP=-50.7dBm - 45dBm (30W output power reference) = -95.7dBc

The value required for maximum absolute ACCP =–70dBc/30kHz bandwidth. >--95.7dBc



- **Coupled Power in receiver channels (764-776 MHz)**

Notch filter: 1cavity, 35dB attenuation on 800.025MHz.. The attenuation from 764MHz to 776MHz varies decreases between 0.3dB and 0.4db See a plot of the filter's characteristic on page 11. Marker 1-764.0MHz @ -0.4dB, Marker 2 – 776.0MHz @ -0.4dB, Marker 3 – 794MHz @ -2.6dB, 4.0MHz/division span

Spectrum analyzer: RBW=30kHz, VBW 1MHz, Display resolution (2001 display points)= 21kHz Detector mode: sample; Instrument's noise floor for -20dBm reference level equated to 30kHz channel – 100.01dBm/50kHz = -102.0 dBm/30kHz (density noise =147.0dBm/Hz)

Instrument's dynamic range including the notch attenuation: -20dBm-(-102dBm/30Hz)+35dB=117dB

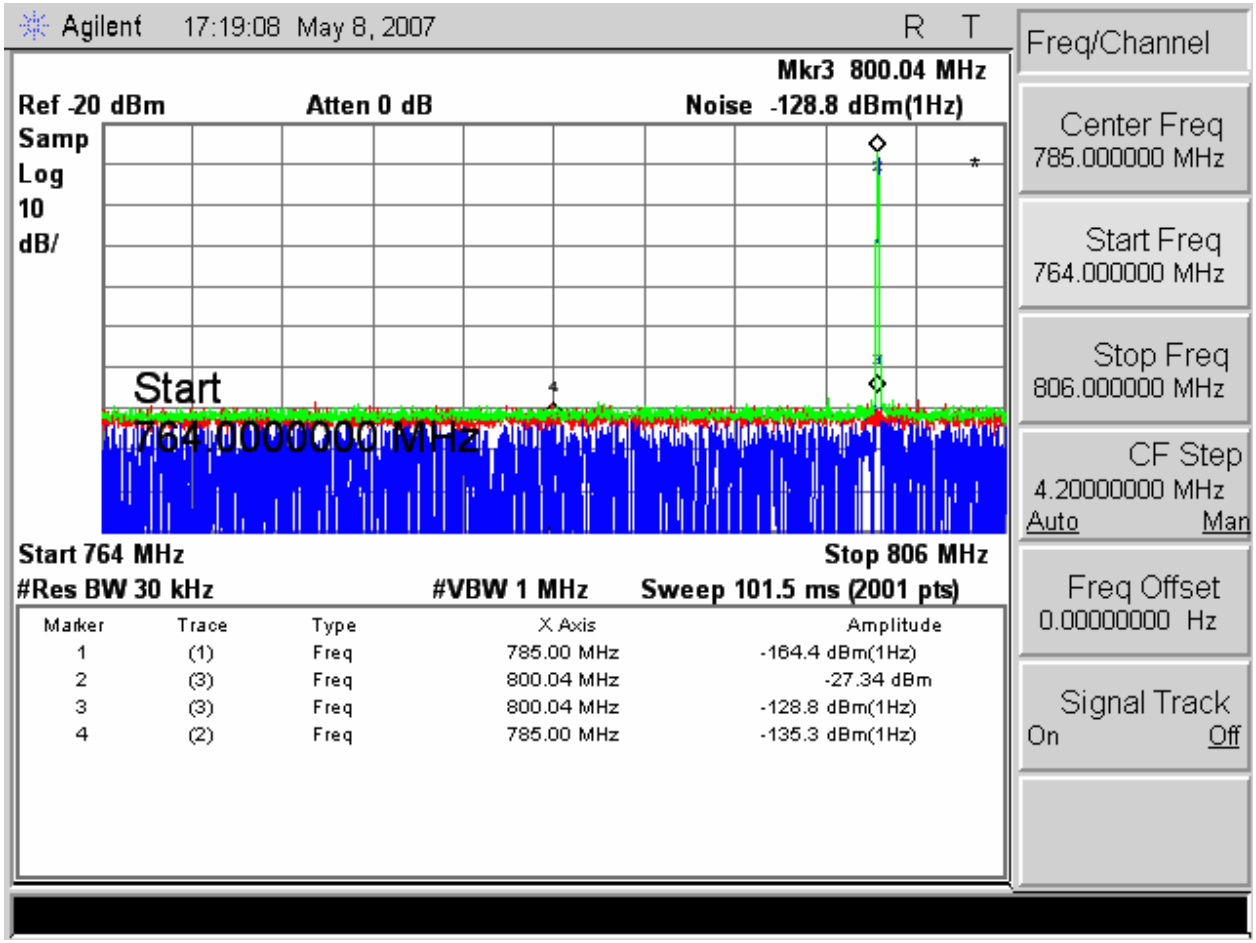
The capture below has current data trace in Sample mode (blue) vs reference noise trace in Peak Hold mode (red) and vs data trace in Peak Hold Mode (green).

There are no products exceeding instruments's noise floor.

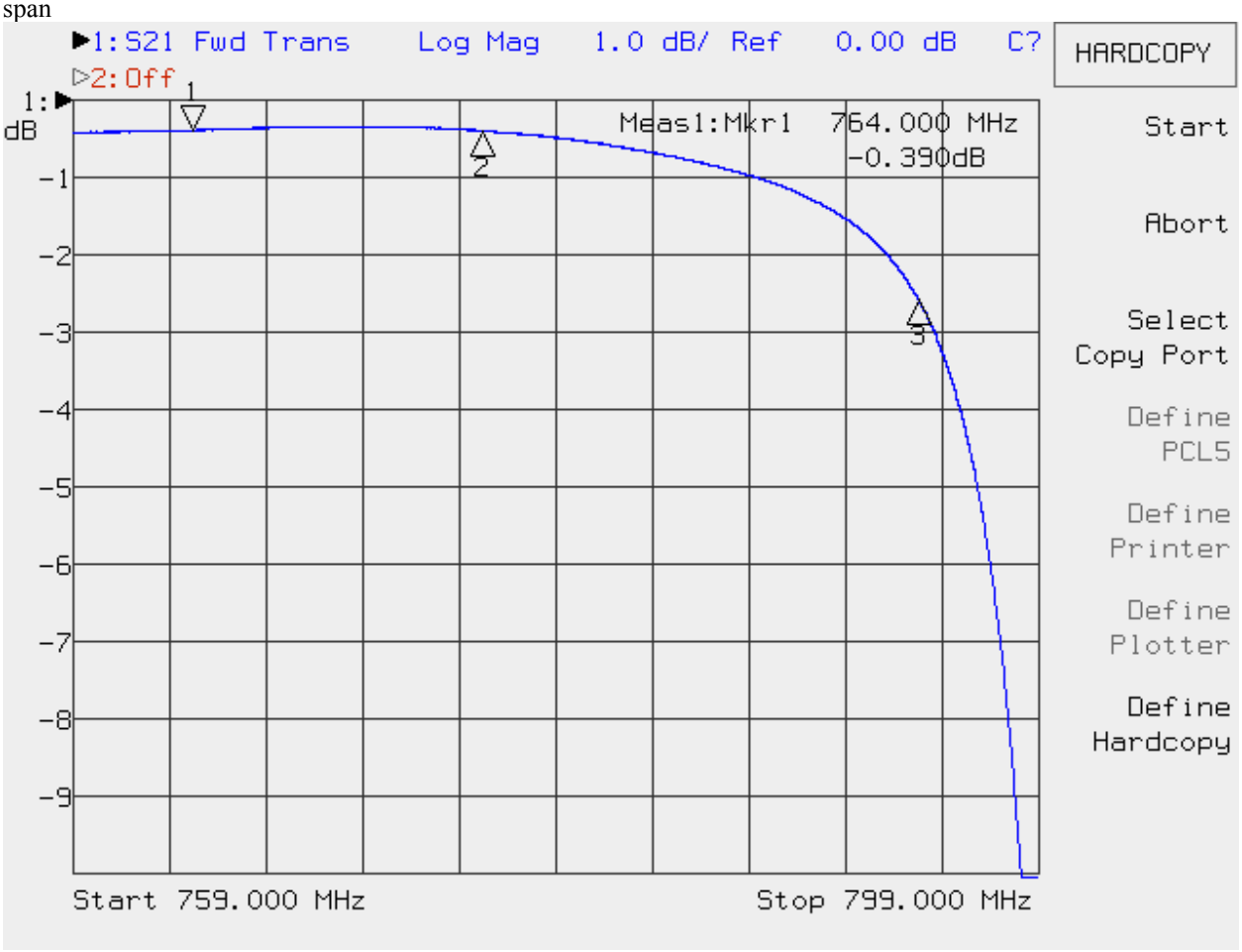
Calculation 30kHz channel=-147.0+45 (correction for 30kHz channel)+ 0.3 (Notch filter worst case) +37.3 (Set-up attenuation) = -64.4dBm

ACCP=-64.4dBm - 45dBm (30W output power reference) = -109.4dBc

The value required for maximum absolute ACCP =–100dBc/30kHz bandwidth. >-109.4dBc



Notch filter 1 cavity from . Center frequency 800.025 attenaution 34.8dB (not on the plot display). Marker 1- 794.0MHz @ -2.6dB, Marker 2 – 776.0MHz @ -0.4dB, Marker 3 – 799.425MHz @ -19.5dB, 4.0MHz/division span



Authorised bandwidth – 99% occuped bandwidth data (90.543(d))

The proposed change does not change modulation techninques in terms of pulse shape (Squared Root Raised Cosine) or modulation techniques (16FSK, 8FSK or 4FSK). The difference comes from the symbol rate that was increased to 32000bps to accommodate the spectral efficiency required for channels of 50kHz

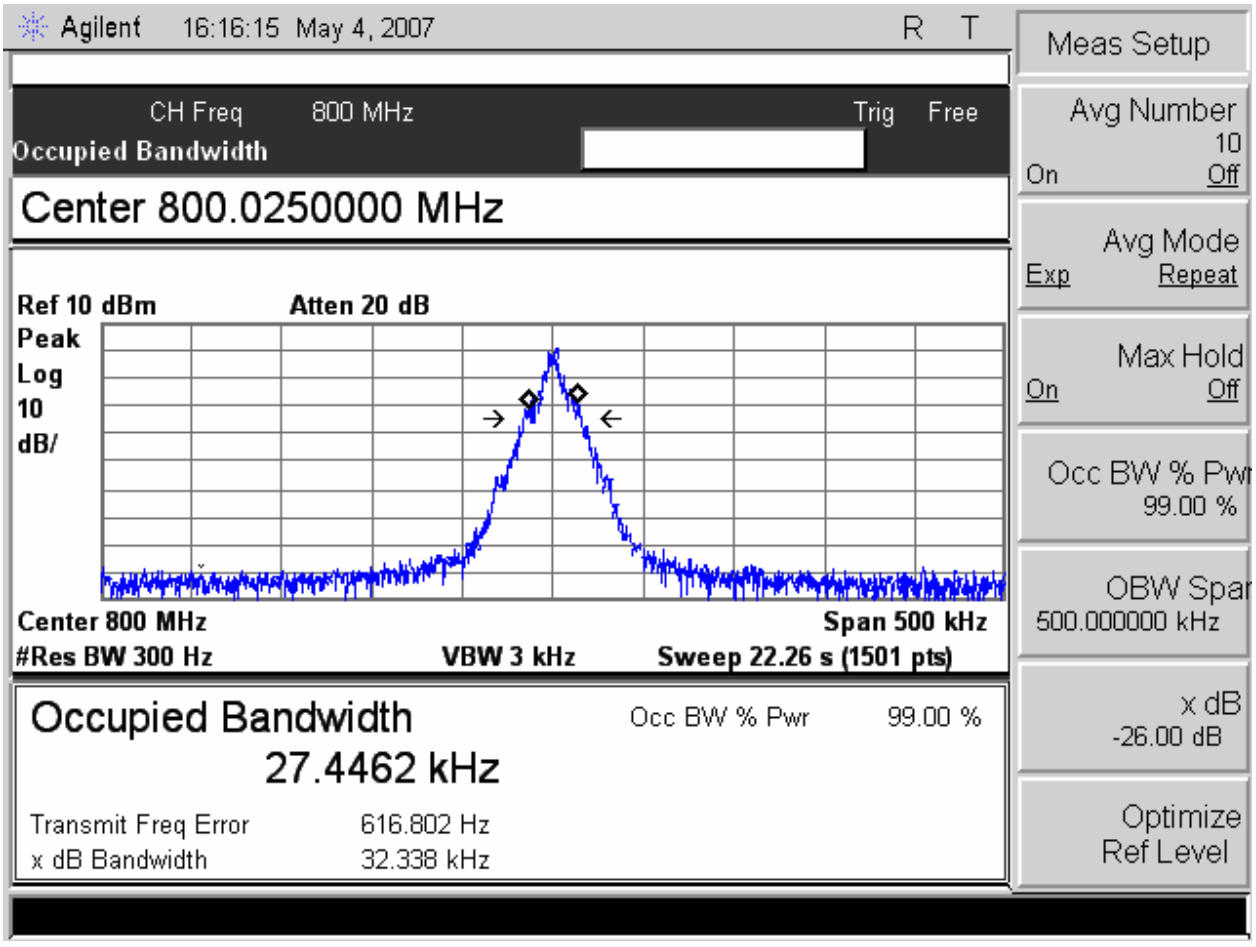
The deviation setting requires an initial deviation adjustment using a reference tone of 1kHz. Keeping this reference for data deviation, random data deviation reading is recorded for the test purposes. On the deviation meter of the IFR COM 120B the IF is set to 30kHz.

Overall the digital modulations proposed in 700 MHz band are:

Bit rate	levels FSK	Symbol rate	Pulse shape and modulation type	Acronyms/ factor / 3dB cutoff frequency	Deviation data/tone	Occupied Bandwidth
128 Kb/s	16	32000 bauds	Squared Root Raised Cosine 16 Levels Frequency Shift Keying	SRRC16FSK α=0.4 16000Hz	± 7.6 KHz ± 5.4 KHz	27446Hz
96* Kb/s	8*	32000 bauds	Squared Root Raised Cosine 16 Levels Frequency Shift Keying	SRRC16FSK α=0.4 16000Hz	± 7.5 KHz ± 5.4 KHz	27671Hz*
64* Kb/s	4*	32000 bauds	Squared Root Raised Cosine 16 Levels Frequency Shift Keying	SRRC16FSK α=0.4 16000Hz	± 7.8 KHz ± 4.7 KHz	27671Hz*

*) subset of 16FSK modulation scheme

Plot capture for 99% OCBW of 128kbps 16FSK



A OCBW plot for all three subsets of modulation (16FSK, 8FSK and 4FSK) is provided below. For this capture the RBW was set to 1kHz to allow faster sweeps and the peak hold mode capture was ran over more traces