# Test Report 8/2007

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|---|---|
| **Applicant** | Dataradio Inc., a Calamp Company<br>5500 Royalmount Avenue<br>Suite 200, TMR, Montreal<br>Quebec, Canada, H4P 1H7 |
| **EUT catalog number** | GPG3-6085-170-0B<br>GPG3-6085-ADB-0B |
| **Model** | Gemini 3.5 700/800 MHz |
| **EUT Identification (FCC, IC, other)** | FCC ID: EOTGPDB<br>Industry Canada: 773A-EOTGPDB |
| **In Accordance With (main references)** | FCC Part 90 Private Land Mobile Radio Services<br>RSS 119 issue 9 |
| **Tested By** | R&D of Dataradio Inc<br>5500 Royalmount Avenue<br>Suite 200, TMR, Montreal<br>Quebec, Canada, H4P 1H7 |
| **Document #/pages** | 156-90000-899 / 15 pages |
| **Authorized By** | Michel Martin |
| | Director R&D, Datardio Montreal |
| **Release Date** | January 11, 2008 |

# Report Summary

These tests were condusted on a sample of equipment for the purpose of demonstrating compliance with the restrictions of the 12.5kHz and 25.0kHz channel, as defined in the rules of either FCC Part 90 or Canada's RSS 119 issue 9 at the testing date. The tests were performed in accordance with ANSI TIA-603 C.

The assessment summary is:

EQUIPMENT UNDER TEST Pilot Gemini 3.5 700/800 MHz
SERIAL NUMBER ( S ): Production Gemini GCU III modem- MAC ID#- 0B43
6085-170 S/N 92822 pilot MDP transceiver

SPECIFICATIONS: FCC part 90.543 (a) to (f), RSS 119 issue 9 paragraph 5.8.10

COMPLAINCE STATUS: **Compliant**

EXCLUSIONS: None

NON-COMPLAINCES: None

TEST RESULTS SUMMARY

| Test name | Page No | Worst case data | Margin | Assessment |
|---|---|---|---|---|
| Emissions limitations | | | | |
| at frequency offsets <400kHz | 7 | -40.9 /-60.9dBc | 0.9 dB | Passed |
| frequency offsets 400 to 12MHz | 8 | -73.4dBc/30kHz | 8.6dB | Passed |
| from 1000MHz to receive band | 12 | -95.0dBc/30kHz | 20.0dB | Passed |
| in the receiver band (764-776MHz) | 13 | Noise Floor | 16dB | Passed |
| 99% Occupied bandwidth | 15 | 16.0k, 14.4kHz | 25kHz | Passed |
| 99% Occupied bandwidth | 16 | 7.0kHz | 12.5kHz | Passed |

The technical data included in this report has been accumulated through tests that were performed by me or under my direction. To the best of my knowledge, all of the data is true and correct

PERFORMED BY: Constantin Pintilei DATE: 12/21/07

TEST CONDITIONS:

The procedure shown in EIA/TIA 603 C – 2004 paragraph 2.2.14.2 was the standard procedure followed through the test. This measurement method is similar to the one shown in FCC part 90.543(b) or in Canada's RSS 119 issue 9 paragraph 4.3.

The reference instrument, Agilent's spectrum analyzer E4401B, has enabled both options regarding the Adjacent Channel Power Measure software and the Channel Power over BW measurement software .

The test ran in standard environmental test conditions, at $22^0$C, 30-50% RH.

TEST EQUIPMENT:

| Equipment | Manufacturer | Model | Asset # | Last cal | Next Cal |
|---|---|---|---|---|---|
| Notch filter | Sinclair | NA | R&D Notch | CBT | - |
| DC Power Supply | Astron | VS-20M | s/n 97010044 | CBT | - |
| Modulation meter | IFR | COM-120B | DR637 | 05/2007 | 05/2008 |
| Spectrum Analyzer | Agilent | E4401B | DR624 | 11/2007 | 11/2008 |
| Spectrum Analyzer | Agilent | 8563EC | DR231 | 09/2007 | 09/2008 |
| Network Analyzer | Agilent | 8714ES | s/n US40501280 | 11/2006 | 11/2007 |

CBT- Calibration before test
NB- New batteries, bateries changed before test

NAME OF TEST: Emissions limitations Dataradio G3 Modem at narrowband 700MHz

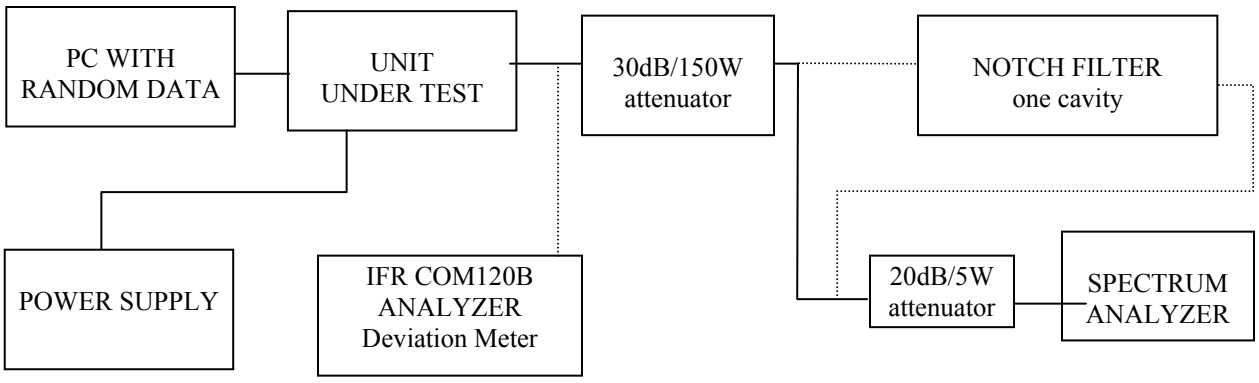
RULE PART NUMBER: FCC 90.543 , IC RSS 119 para 5.8

MINIMUM STANDARD: Narrowband 12.5kHz /25kHz mobile transmitter ACCP requirements:

| Offset from Center requency (kHz) | Measurement Bandwidth (kHz) | Maximum ACCP Relative (dBc) |
|---|---|---|
| 9.375 | 6.25 | -40 (for 12.5 khz channel only) |
| 15.625 | 6.25 | -40/-60 (-40 for 25kHz channel, -60 for 12.5 kHz channel ) |
| 21.875 | 6.25 | -60 |
| 37.50 | 25.00 | -60 |
| 62.50 | 25.00 | -65 |
| 87.50 | 25.00 | -65 |
| 150.00 | 100.00 | -65 |
| 250.00 | 100.00 | -65 |
| 350.00 | 100.00 | -65 |
| 400 to 1200..... | 30(swept) | -75 |
| 1200 to receive band | 30(swept) | -75 |
| in the receive band | 30(swept) | -100 |

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.

TEST SET-UP:




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.

**Reference power in the main channel**, (FCC 90.534(b)(1), RSS 119 4.3(1))

There are two set-ups used to qualify the unit on ACCP requirements, in the second one a notch filter is added to atenuators in order to increase the dynamic range of the instrument.

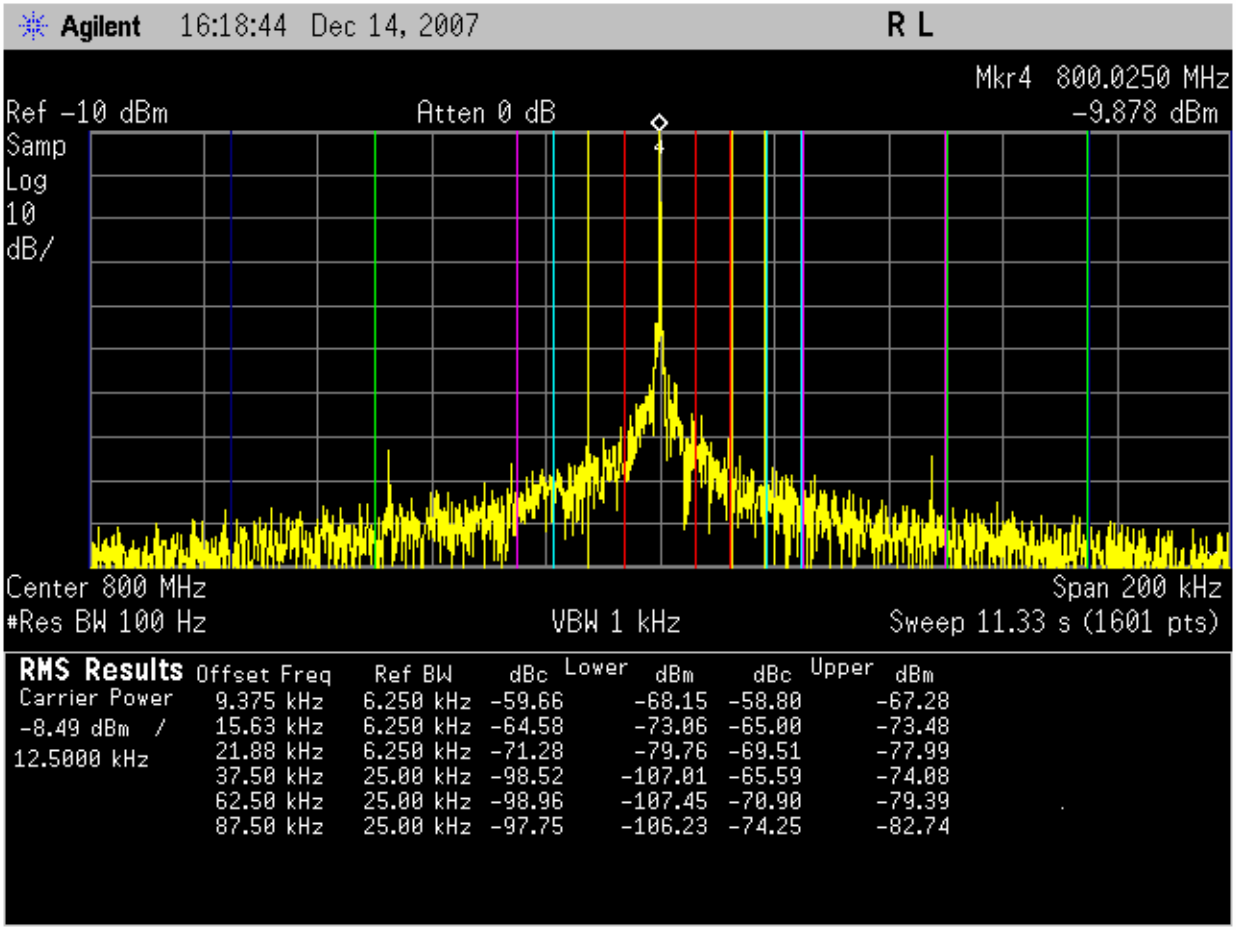
1st set-up – 50db attenuators:

Settings:12.50kHz Channel Bandwidth Display resolution for power integration =125Hz

Frequency sweep over 200kHz, channel frequency 800.025MHz , data reading at 30W :-8.5 dBm

Total RF power is 30W⇔ 45dBm. This makes the total attenuation of the setup about 51.5dB. In the set-up there are two attenuation pads of 30dB and 20dB, cables and connectors RF.
In order to convert readings of the instrument to absolute power, 51.5dB must be added to the reading of the display.

The reference power reads **–8.49dBm**



2nd set-up – 50db attenuators+notch filter:

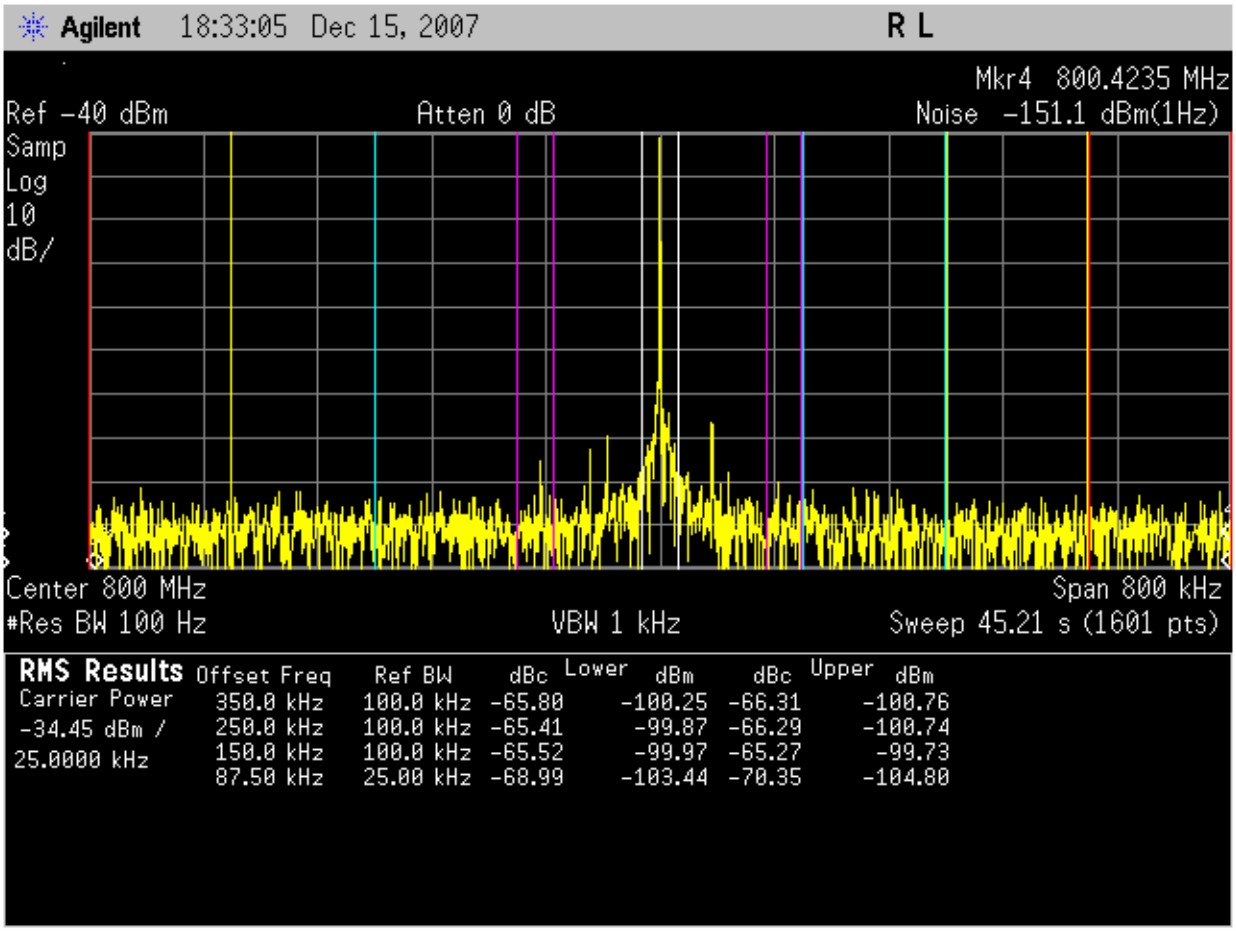
Settings:25.0kHz Channel Bandwidth Display resolution for power integration =500Hz

Frequency sweep –400kHz to +400kHz, 1 cavity notch filter 35 dB attenuation on the center frequency, carrier readings. Filter's characteristic is available on page 10.

Data reading at 30W :-34.5 dBm.

Total RF power is 30W⇔ 45dBm. This makes the total carrier attenuation of the setup to be 79.5dB. In the set-up there are two attenuation pads of 30dB and 20dB, the notch filter cables and connectors RF.
In order to convert readings of the instrument to absolute power, notch attenuation values at specified frequency offsets must be added to the instrument readings. Notch attenuation values are provided in page 10.

When the notch filter is used in the set-up the reference power reads **–34.5dBm**



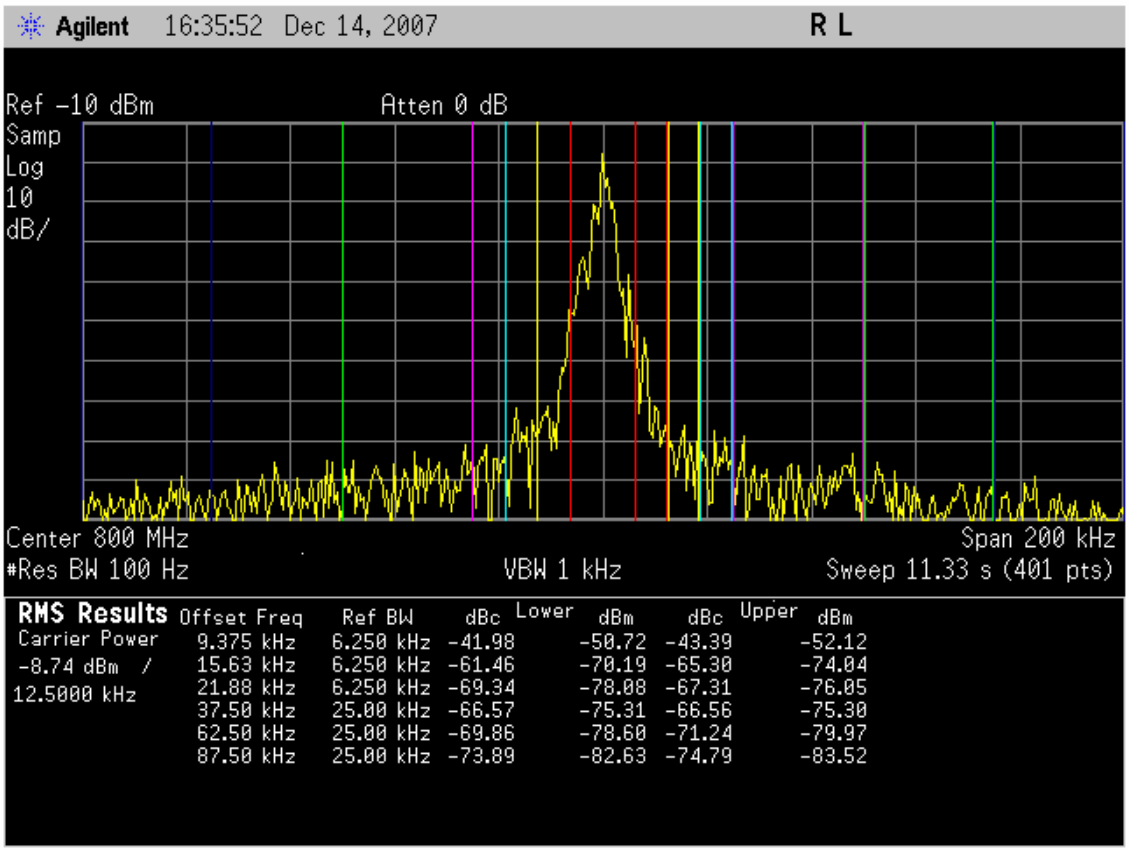
**Non-swept power measurements: Power Level at frequency offsets <400kHz** (90.534(b)(2), RSS 119 4.3.(2))
Settings:
RBW=100Hz, Video BW=1kHz, Sweep = Detector mode: sample, Display resolution = 500Hz ,
Reference level -10dBm, 25kHz channel noise=-85dBm
UUT in center channel of the 794-806MHz band: Channel frequency 800.02500 MHz.

For FSK type modulations the ACCP limitations arise in the 1st adjacent channel. In order to brief data presented in plots here below is a table showing ACCP readings for the first two adjacent channels, rounded to nearest 0.1

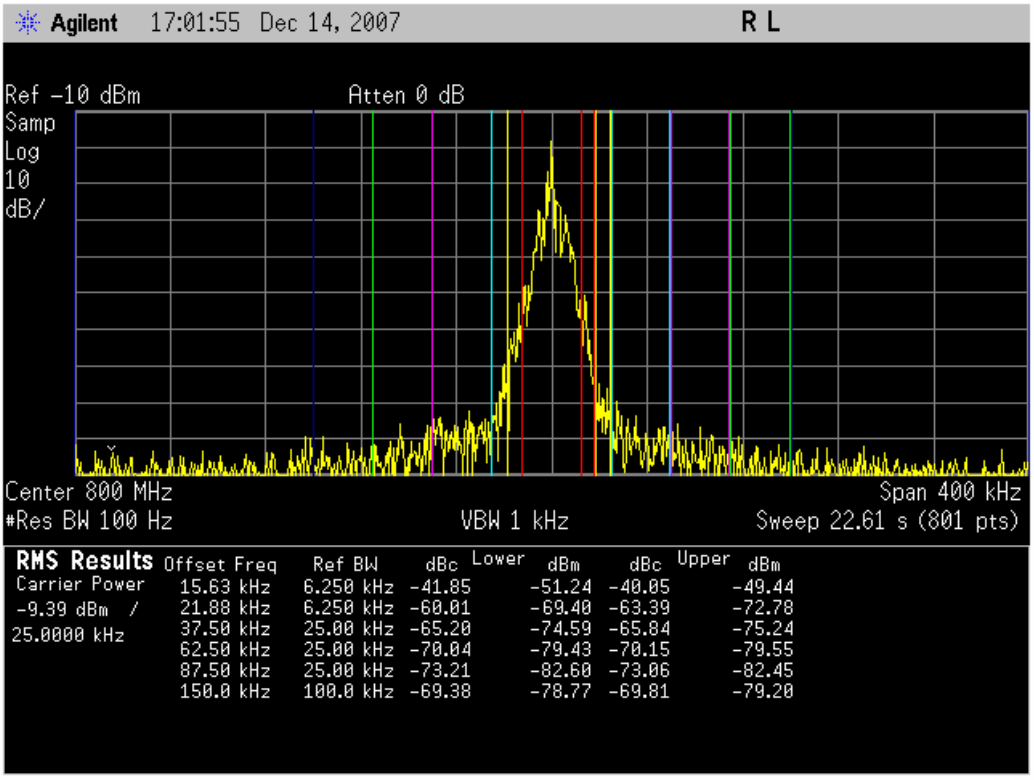
| frequency Offset (kHz) | -21.88 | -15.63 | -9.375 | channe l | 9.375 | +15.63 | +21.88 |
|---|---|---|---|---|---|---|---|
| Maximum ACP (dBc) | -60 | -60/-40 | -40/NA | | -40/NA | -60/-40 | -60 |
| Channel Power (dBm) for 32kbps 16FSK | -78.1 | -70.2 | -50.7 | -8.7 | -52.1 | -74.0 | -76.0 |
| ACCP reading (dBc) for 32kbps 16FSK | -69.4 | -62.0 | -42.0 | NA | -43.4 | -65.3 | -67.3 |
| ACCP corrected using power reference | -69.6 | -62.2 | -42.2 | **-8.5*** | -43.6 | -65.5 | -67.5 |
| Channel Power (dBm) for 43.2kbps 8FSK | -68.4 | -51.2 | NA | -9.4 | NA | -49.4 | -72.7 |
| ACCP reading (dBc) for 43.2kbps 8FSK | -60.0 | -41.8 | | NA | | -40.0 | -63.4 |
| ACCP corrected using power reference | **-60.9** | -42.7 | | **-8.5*** | | **-40.9** | -64.3 |
| Channel Power (dBm) for 64kbps 16FSK | -69.9 | -51.0 | NA | -9.0 | NA | -51.3 | -71.5 |
| ACCP reading (dBc) for 64kbps 16FSK | -60.9 | -42.0 | | NA | | -42.3 | -62.5 |
| ACCP corrected using power reference | -61.4 | -42.5 | | **-8.5*** | | -42.8 | -63.0 |

*) expressed in dBm

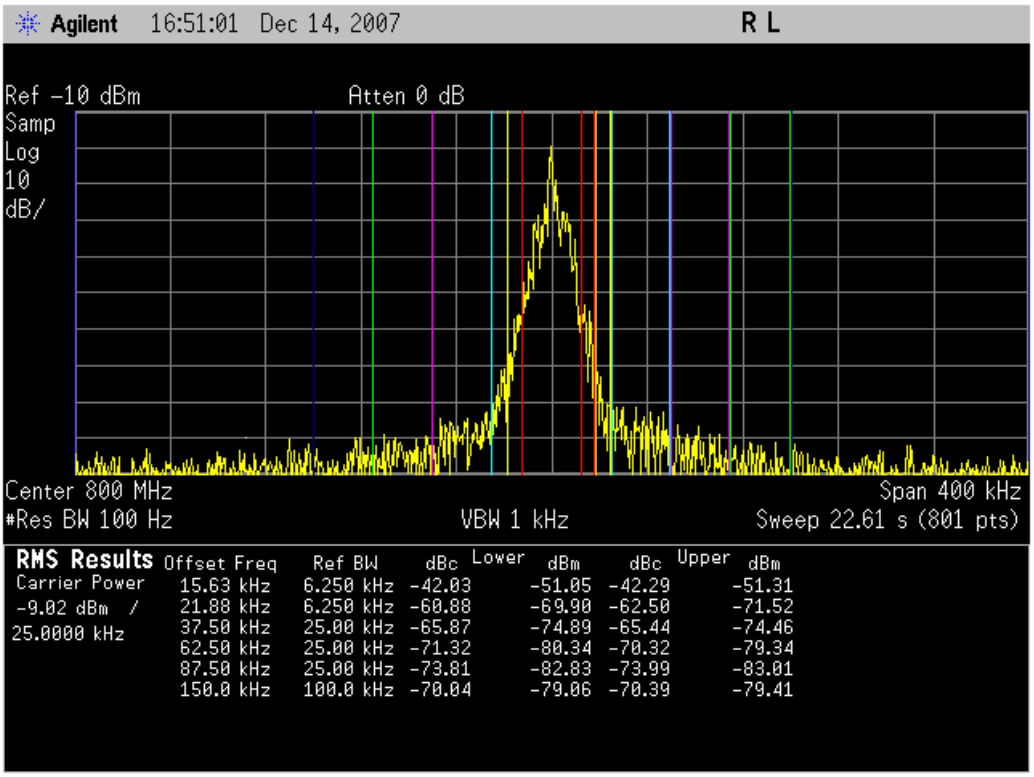
Display capture for the modulation of 32kbps SRRC16FSK at +/- 1.33 kHz reference deviation, proposed for 12.5kHz narrowband channels.



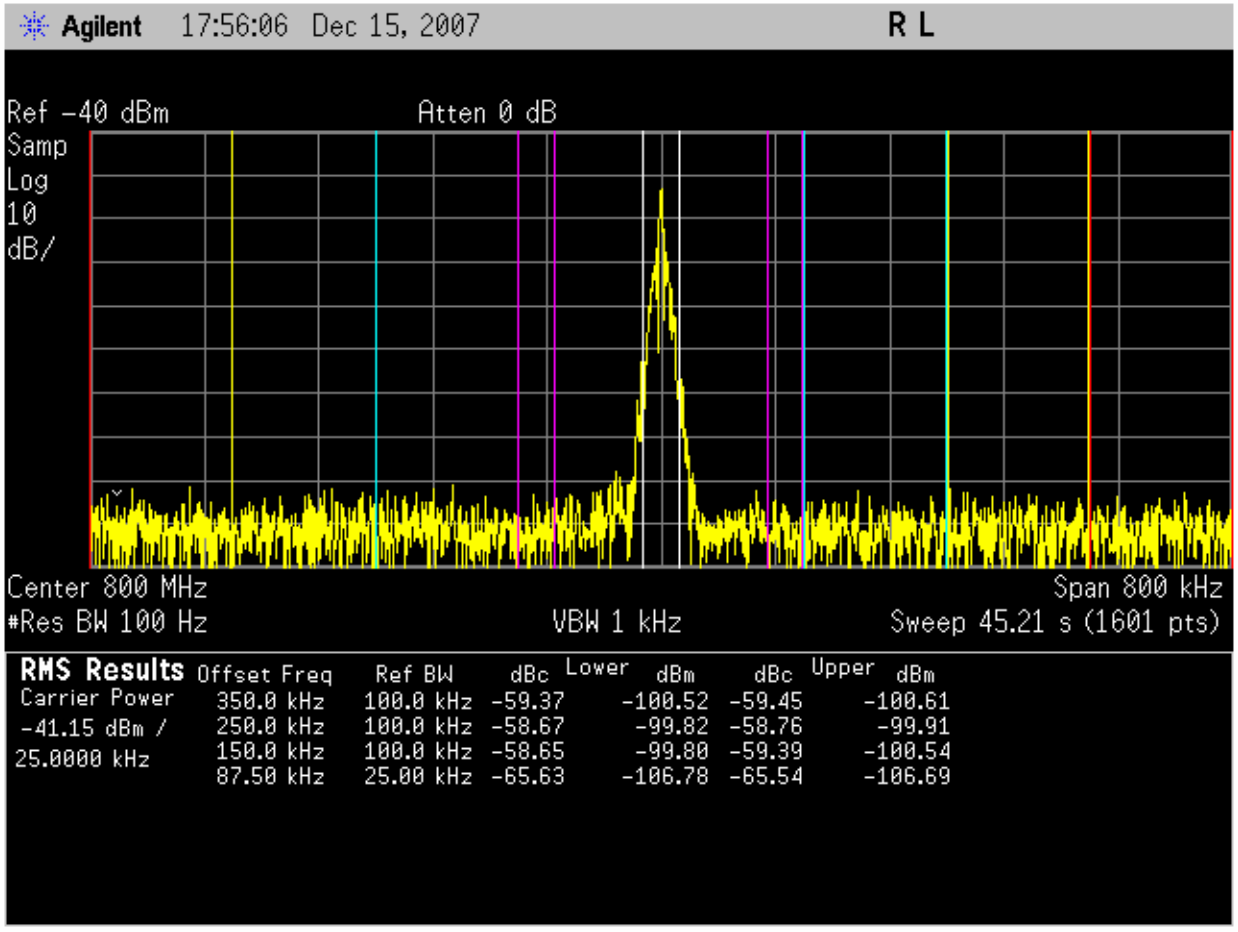
Display capture for the modulation of 43.2kbps SRRC8FSK at +/- 3.27 kHz reference deviation, proposed for 25.0kHz narrowband channels.




Display capture for the modulation of 64kbps SRRC16FSK at +/- 2.73 kHz reference deviation, proposed for 25.0kHz narrowband channels



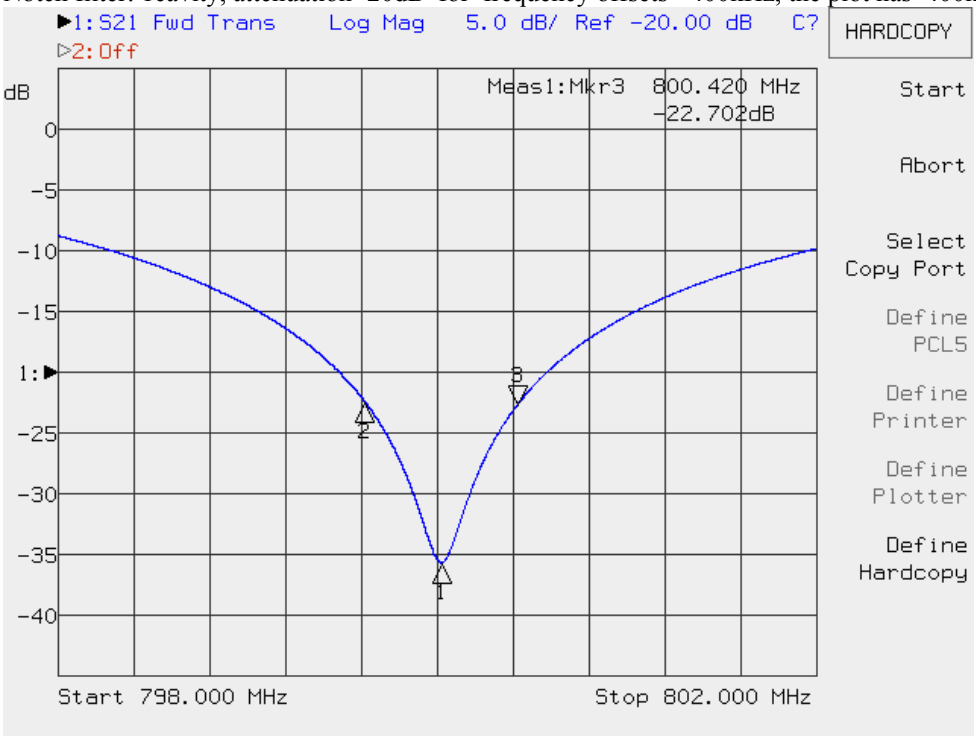
Display capture for the frequency offsets between 87.5kHz and 350kHz. In order to increase the dynamic range the notch filter was connected.




The modulation of 64kbps SRRC16FSK at +/- 2.73 kHz reference deviation, proposed for 25.0kHz narrowband channels yielded the narrowest margin to the specification, reading only 3.3 dB margin.

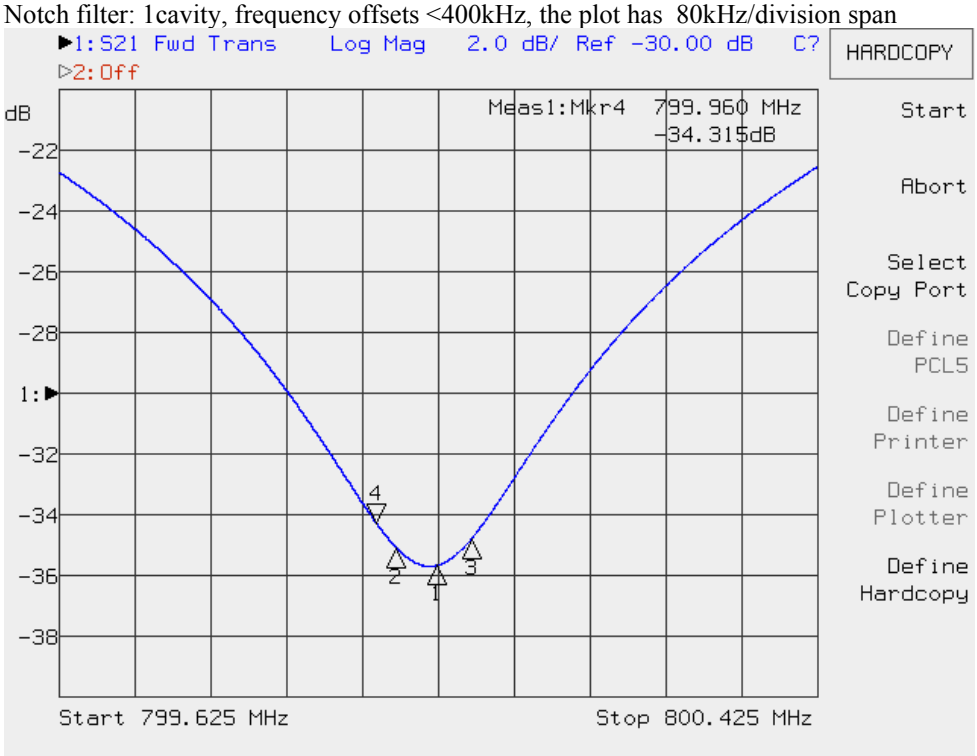
| frequency Offset (kHz) | -350 | -250 | -150 | channel | +150 | +250 | +350 |
|---|---|---|---|---|---|---|---|
| Maximum ACP (dBc) | -65 | -65 | -65 | | -65 | -65 | -65 |
| Channel Power reading (dBm) | -100.5 | -99.8 | -99.8 | -34.5* | -100.5 | -99.9 | -100.6 |
| (+)Notch correction (dB) | +23.2 | +26.8 | +30.5 | -33.5 | +30.0 | +25.9 | +23.4 |
| Corrected power reading (dBm) | -77.3 | -73.0 | -69.3 | -1.0 | -70.9 | -74.0 | -76.6 |
| ACCP corrected using power reference (dBc) | -76.3 | -72.0 | **-68.3** | **ref** | -69.9 | -73.0 | -75.6 |

Notch filter: 1cavity, attenuation<20dB for frequency offsets >400kHz, the plot has 400kHz/division span




Marker 1- 800.025MHz @ -35.7dB, Marker 2 – 799.62MHz @ -22.5dB, Marker 3 – 800.420MHz @ -22.7dB

Notch filter: 1cavity, frequency offsets <400kHz, the plot has 80kHz/division span




Other selected attenuations:

| Freq offset (kHz) | -350 | -250 | -150 | -87.5 | 0 | +87.5 | +150 | +250 | +350 |
|---|---|---|---|---|---|---|---|---|---|
| Notch atten (dB) | -23.2 | -26.8 | -30.5 | -33.5 | -35.6 | -32.3 | -29.5 | -26.1 | -23.5 |
| Delta with channel ref (dB) | 10.3 | 8.8 | 5.1 | 2.1 | ref | 3.3 | 6.1 | 9.5 | 12.1 |

**Swept power measurements Power Levels at frequency offsets >400kHz** (90.534(b)(3) RSS 119 4.3.(3))

- **frequency offsets between 400kHz and 12MHz**

Settings

Notch filter: 1cavity, 35dB attenuation on 800.025MHz, attenuation for 400kHz-12MHz offsets between 22dB and 1dB. See a plot of the filter's characteristic on page 10. For the corection to get absolute power reading in the 30kHz channel swept worst case of 22dB was added. One 30dB/150W attenuator in the set-up.

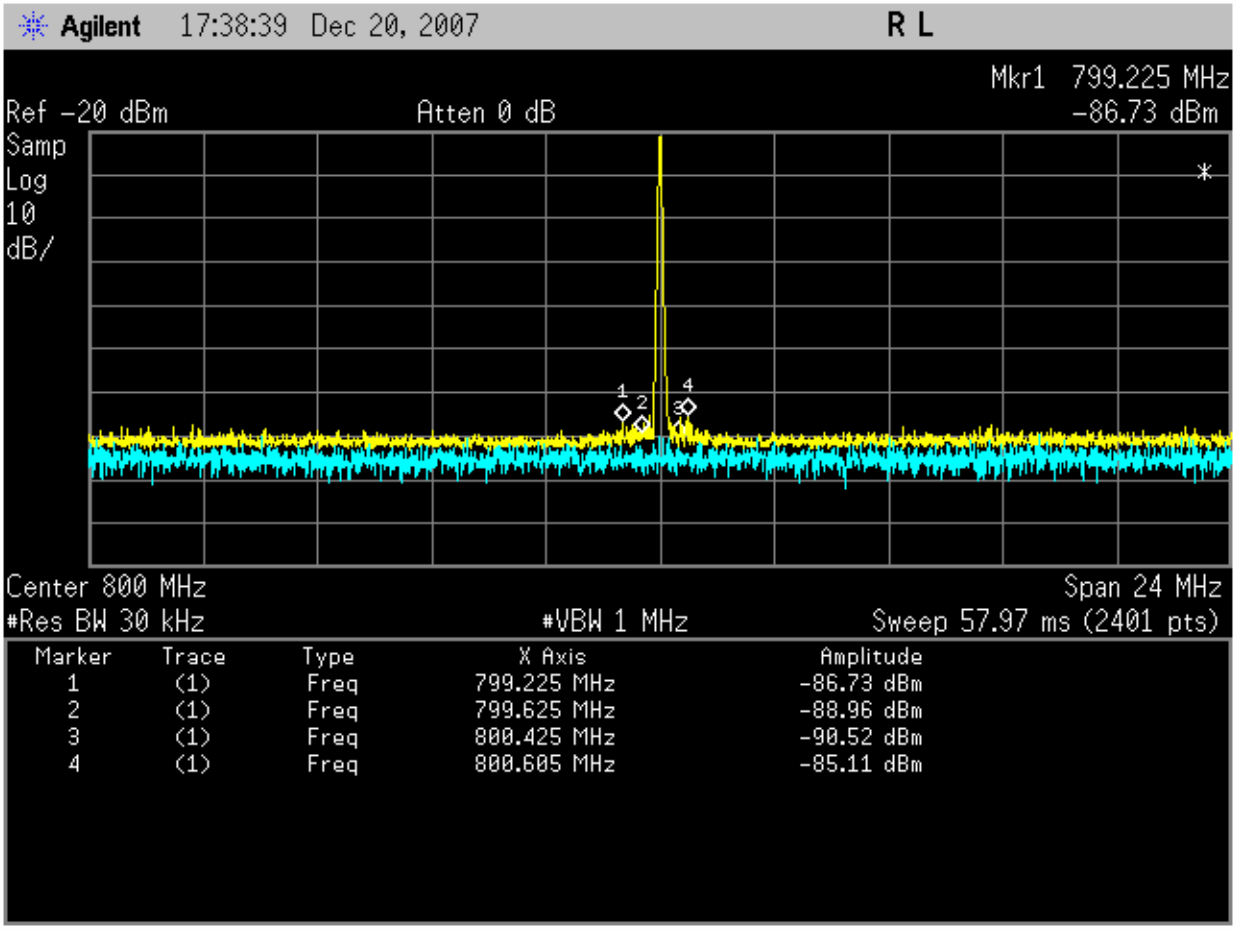
Spectrum analyzer: RBW=3kHz, Span=300kHz (instruments channel power auto-setting), Display resolution (2401 display points)= 125Hz Detector mode: sample; Instrument's noise floor for -20dBm reference level equated to 30kHz channel –105.5dBm/30kHz (density noise =150.0dBm/Hz),

Test's dynamic range includes the instrument's dynamic range plus the delta notch attenuation at 400kHz offset:
[Ref level-NF]+[Notch atten of carrier-notch atten at offset]= [-20dBm-(-105dBm)]+[35.6dB-22dB]=98.6dB OK

Test data:
Data spectrum was swept for the 30kHz channel power at frequency offsets between 400kHz and 1200KHz. The maximum relative ACCP = -65dBc >-88.11 dBc

| Worst case reading at frequency of | Max Reading 30kHz channel power | Corrected for 30kHz channel power (+30+22dB) | Relative ACCP (Carrier at +45dBm) | Margin from –65dBc |
|---|---|---|---|---|
| Lower @ 799.22MHz | -82.5 dBm/30kHz | -30.5dBm/30kHz | -75.5dBc | 10.5dB |
| Upper@ 800.61MHz | -80.4 dBm/30kHz | -28.4 dBm/30kHz | -73.4dBc | **8.6dB** |

The capture below has data trace (yellow) vs noise trace (blue) and shows an overview of the spectrum investigated.



- **frequency offsets between 12MHz and the uppermost receive frequency (776MHz)**

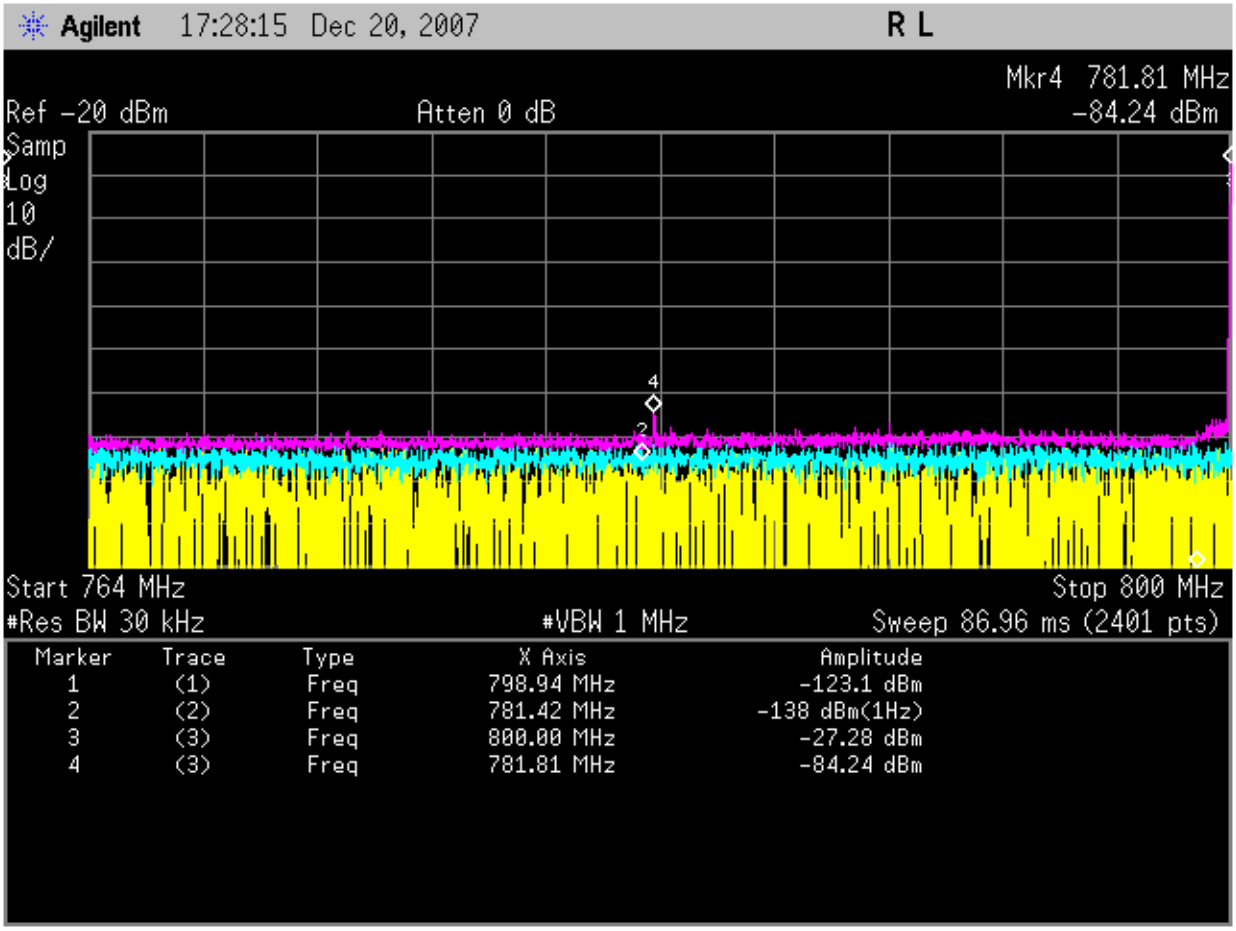
Notch filter: 1cavity, 35dB attenuation on 800.025MHz, attenuation from 788MHz (this is 12 MHz offset) to 776MHz decreases between 1dB and 0.6dB. See a plot of the filter's characteristic on page 14. One 30dB/150W attenuator in the set-up.

Spectrum analyzer: RBW=30kHz, VBW 1MHz, Display resolution (2401 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)

Test's dynamic range includes the instrument's dynamic range plus the delta notch attenuation at 12MHz offset:
[Ref level-NF]+[Notch atten of carrier-notch atten at offset]= [-20dBm-(-102dBm)]+[35dB-1dB]=116dB OK

The capture below has current data trace in Sample mode (yellow, trace 1) vs reference noise trace in Peak Hold mode (blue, trace 2) and vs data trace in Peak Hold Mode (magenta, trace 3).
Marker 1- reads marker's power on the yellow trace, on sample reading
Marker 2 – reads marker's noise PSD on noise in Peak hold (trace 2); PSD =-138dBm/Hz⇔-94dBm/30kHz
Marker 3- reads absolute power on the carrier channel, at 800.025MHz; the notch is connected to the set-up
Marker 4 – reads absolute power on the most significant spurs at 781.81MHz at –84.24dBm.

ACP Calculation 30kHz channel= Channel power –(Spur reading +Notch correction)
ACP =+45dBm –(-84dBm+34dB)=+45dbm-(-50dBm)=**-95dBc**




The value required for maximum absolute ACCP =–75dBc/30kHz bandwidth. >-95dBc. Margin= 20dB

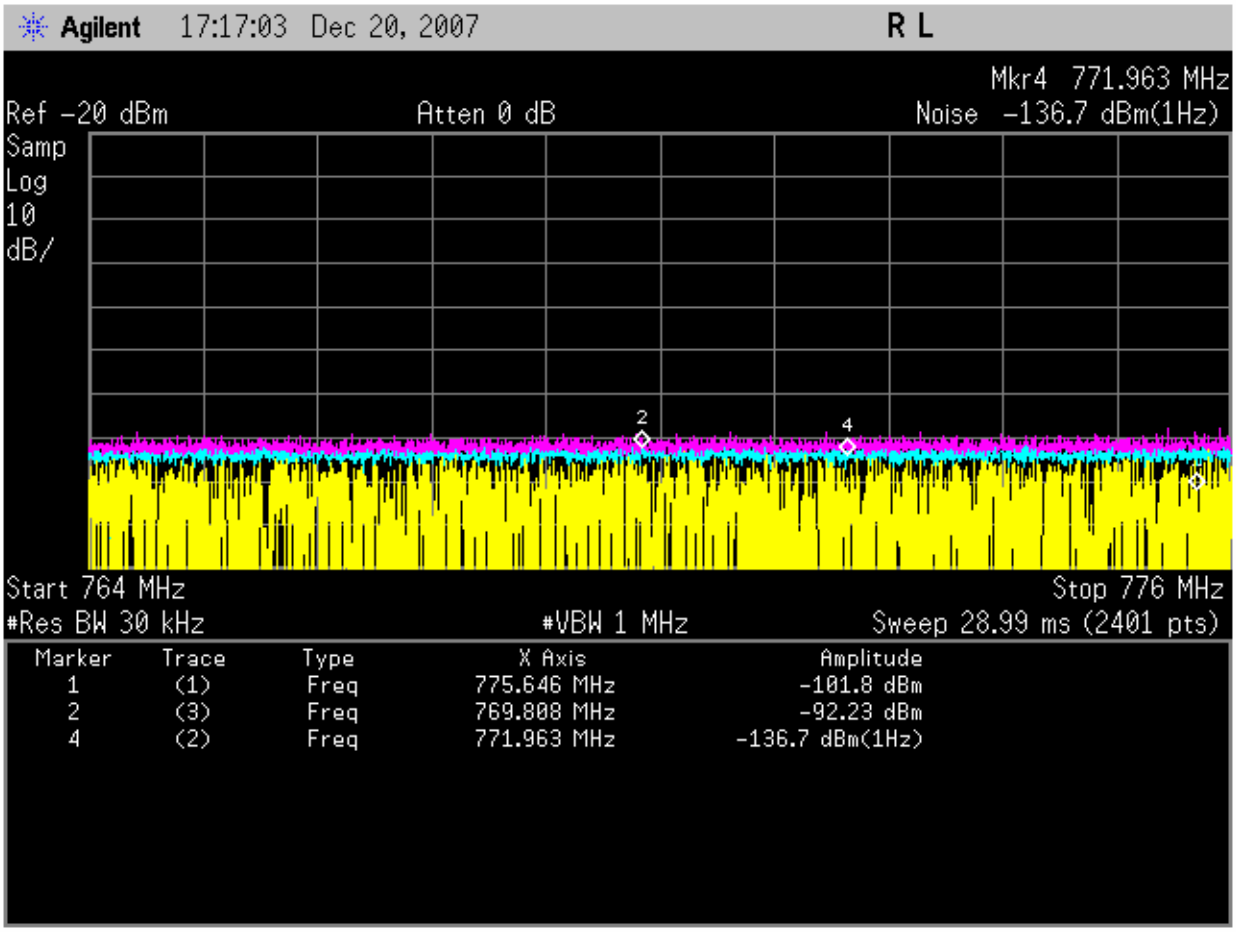
- **Coupled Power in receiver channels (764-776 MHz)**

Notch filter: 1cavity, 35dB attenuation on 800.025MHz.. The attenuation from 764MHz to 776MHz varies between 0.3dB and 0.6dB See a plot of the filter's characteristic on page 14. One 30dB/150W attenuator in the RF path

Spectrum analyzer: RBW=30kHz, VBW 1MHz, Display resolution (2401 display points)= 5kHz 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)

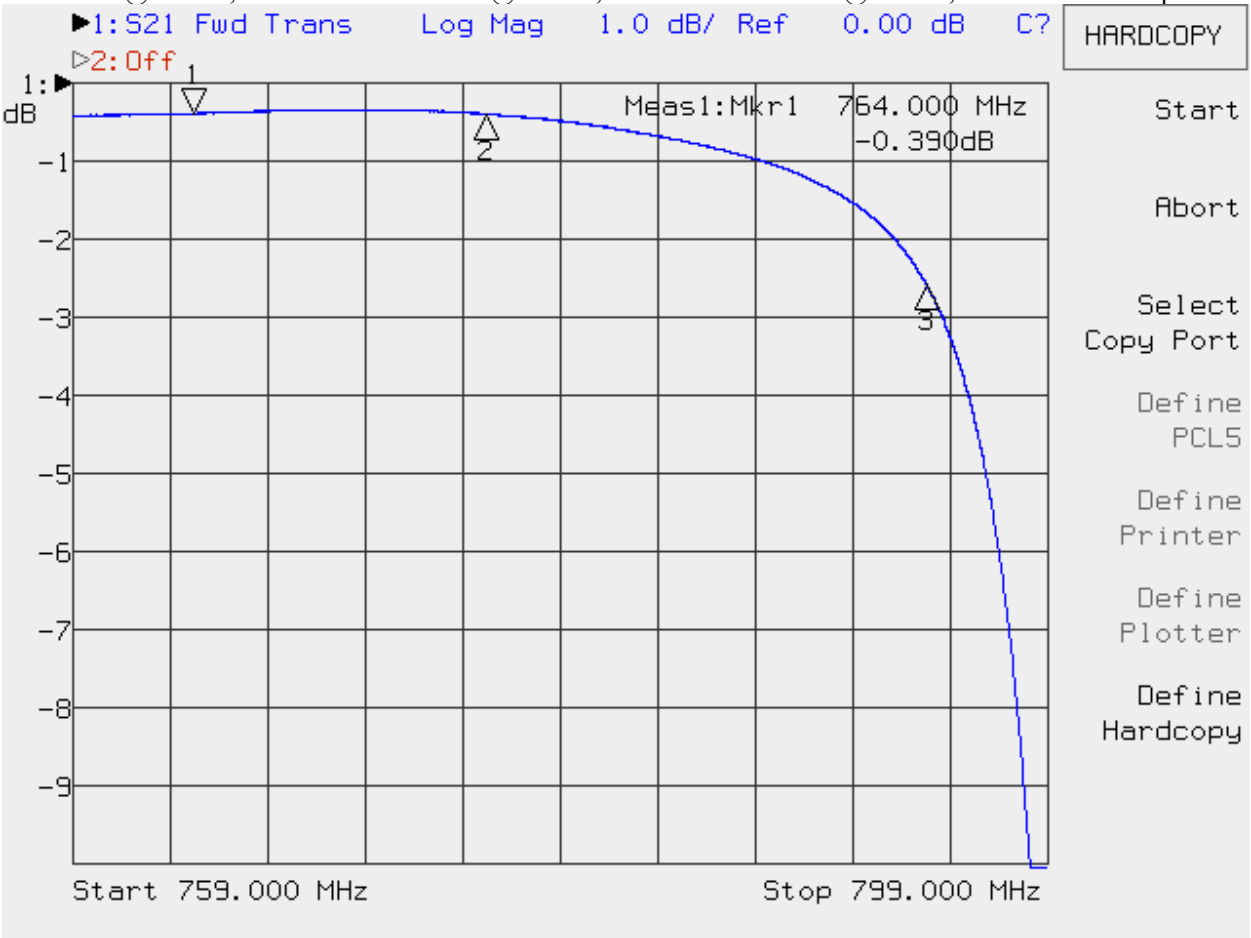
Test's dynamic range includes the instrument's dynamic range plus the delta notch attenuation in the receive band : [Ref level-NF]+[Notch atten of carrier-notch atten at offset]= [-20dBm-(-102dBm)]+[35dB-1dB]=116dB OK

There are no products exceeding instruments's noise floor, 100dBc required, Noise floor yields 116dBc, 16dB margin




The value required for maximum absolute ACCP =–100dBc/30kHz bandwidth. > Noise floor at –116dBc

Notch filter 1 cavity from . Center frequency 800.025 attenaution 35.6dB (not on the plot display). Marker 1- 794.0MHz @ -0.6dB, Marker 2 – 776.0MHz @ -0.4dB, Marker 3 – 794.MHz @ -2.6dB, 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 or 8FSK) already approved for the 800MHz band. For 32kbps there is a difference at the deviation setting, from 2.8kHz used in NPSPAC channels to 1.3 kHz for narrowband 12.5kHz channels in 700MHz band, in order to accommodate the specific requirements.

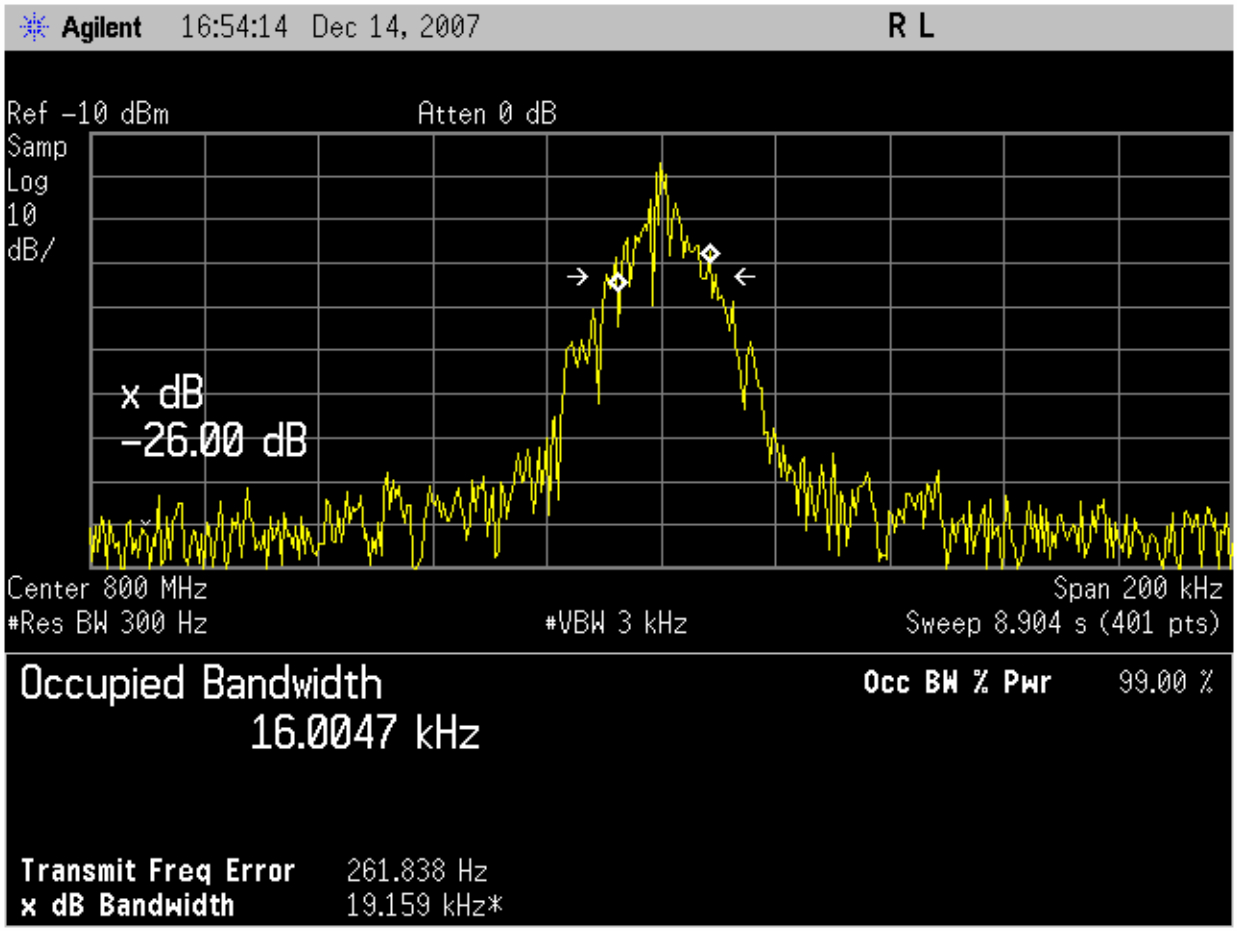
The deviation setting requires an initial deviation adjustment using a reference tone of 1kHz. On the deviation meter of the IFR COM 120B the IF is set to 30kHz.

Overall the digital modulations proposed in 700 MHz narrowband channels are:

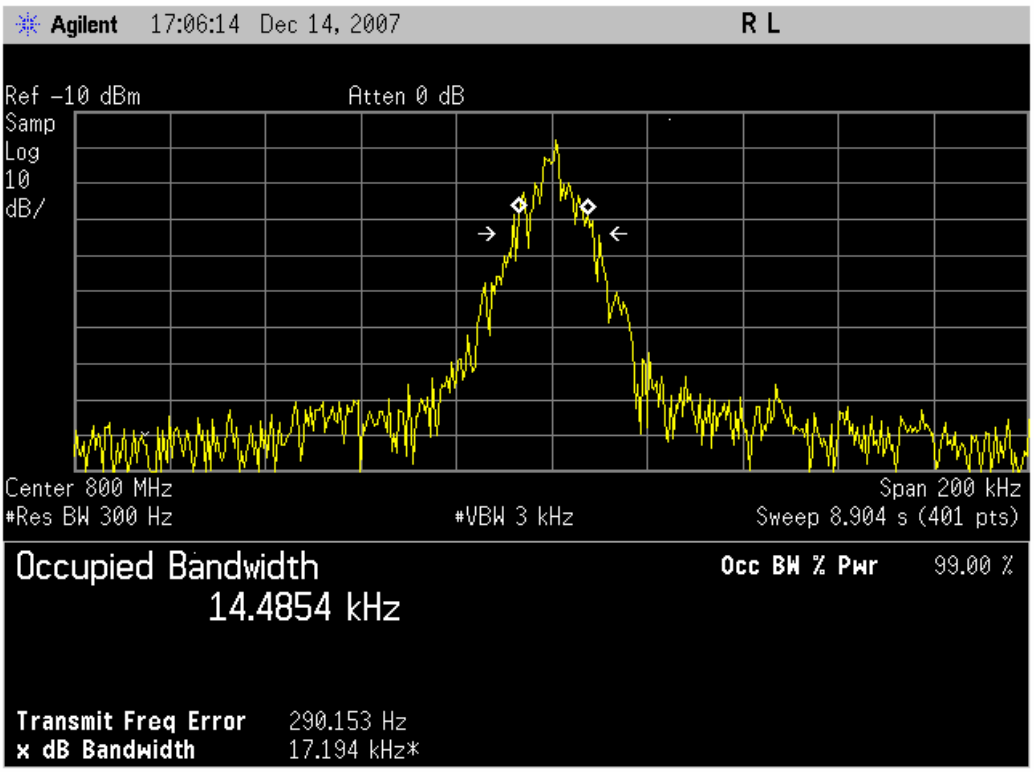
| Bit rate | levels FSK | Symbol rate | Pulse shape and modulation type | Acronyms/ factor / 3dB cutoff frequency | Ref Deviation | Occupied Bandwidth |
|---|---|---|---|---|---|---|
| 64 kb/s | 16 | 16000 baud | Squared Root Raised Cosine 16 Level Frequency Shift Keying | SRRC16FSK α=0.4 8000Hz | ± 2.7 kHz | 16004Hz |
| 43.2 kb/s | 8 | 14400 baud | Squared Root Raised Cosine 8 Level Frequency Shift Keying | SRRC8FSK α=0.4 7200Hz | ± 3.2 kHz | 14483Hz |
| 32 kb/s | 16 | 8000 baud | Squared Root Raised Cosine 16 LevelsFrequency Shift Keying | SRRC16FSK α=0.4 4000Hz | ± 1.3 kHz | 7075Hz |

**Plot capture for 99% OCBW:**

Display capture for the modulation of 64kbps SRRC16FSK at +/- 2.73 kHz reference deviation/ 25.0kHz narrowband channels



OCBW capture for the modulation of 43.2kbps SRRC8FSK at +/- 3.27 kHz reference deviation/25kHz channels




OCBW capture for the modulation of 32kbps SRRC16FSK at +/- 1.33 kHz reference deviation, / 12.5kHz channels