

**Attachment to FCC Form 731**

**Permissive Change Request**

**FCC ID: AQZ-MX-9325**

**Exhibit 6**

**Test Report**

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## Summary of Changes

Please refer to sheet 3 of the PA schematic diagram 12007-4101 found in Exhibit 5 of the original submission for circuit details pertaining to the discussion below.

In order to allow the use of power devices from different manufacturers in the Q2 location, this transmitter had to be modified by adding C18, an 8.2 pF porcelain microwave capacitor in the final amplifier output stage. Mounting pads for this capacitor had been incorporated into the amplifier circuit board in the original design, so no physical changes are necessary other than the addition of the capacitor. No other changes in the mechanical packaging or construction were made.

In order to demonstrate continued compliance with the applicable FCC requirements as a result of this change, the following measurements were made:

- DC voltages and currents into the final amplifier stages
- RF power output
- Occupied bandwidth
- Spurious Emissions at Antenna Terminals

### 2.1033 (c)(8) DC voltages and currents into the final amplifier stages

Refer to Exhibit 4, Block Diagrams and Exhibit 5, Schematic Diagrams contained in the original submission, for the block diagrams and schematic diagrams of the Exciter and Power Amplifier PWB assemblies.

A summary of the DC power input to the transmit amplifier devices (at 5 and 25 watt output levels) is as follows:

#### 5 watt power level

<u>Device</u>	<u>Supply Volts DC</u>	<u>Current mA DC</u>	<u>Power input (W)</u>	<u>Emission mode</u>
Exciter Q10	28	200	5.6	all
PA Q1	28	900	25.2	all
PA Q2	28	1440	40.32	A2D
PA Q2	28	3580	100.2	G1D/G7D

#### 25 watt power level

<u>Device</u>	<u>Supply Volts DC</u>	<u>Current mA DC</u>	<u>Power input (W)</u>	<u>Emission mode</u>
Exciter Q10	28	200	5.6	all
PA Q1	28	900	25.2	all
PA Q2	28	3280	91.84	A2D
PA Q2	28	4240	118.7	G1D/G7D

## 2.1046 - RF power output

### Test Procedure

For the A2D emission mode, the RF power output measurement was made with the unit operating from its nominal AC input line voltage, using an internally generated test signal. This test signal consisted of the RF carrier amplitude modulated to a depth of 50% by a 2400 Hz tone. Power output was measured at a center frequency of 127.500 MHz and at the 5 watt and 25 watt power levels, with the results being recorded. Power output was also measured with the transmitter operating at AC line voltages of  $\pm 15$  percent from nominal, and the results recorded.

For the G1D and G7D emissions, power was measured using an internally generated test message approximately 25 msec in length, sent at intervals of one second. This test message consisted of the first 25 msec of a sample VDL data transmission described in Appendix F, RTCA paper no 155-00/SC172-263 (final draft Draft of RTCA specification DO-224A). The resulting emission was measured with a vector signal analyzer set to measure power over the entire burst. The analyzer display was averaged over 10 trigger events before readings were taken. As in the case of the A2D data, the power output was measured at nominal AC line voltage, and at values of AC input representing the extremes of the equipment specification, and the results recorded.

### RF Power Test Data

The RF power output test data is as follows:

#### A2D Emission, 5 watt power level:

<u>Input voltage, AC</u>	<u>Power output, watts</u>
97.75	5.27
115	5.27
132.25	5.27
195.5	5.27
230	5.27
264.5	5.27

**A2D Emission, 25 watt power level:**

<u>Input voltage, AC</u>	<u>Power output, watts</u>
97.75	27.11
115	27.09
132.25	27.11
195.5	27.10
230	27.10
264.5	27.12

**G1D/G7D Emission, 5 watt power level:**

<u>Input voltage, AC</u>	<u>Power output, dBm</u>	<u>Power output, watts</u>
97.75	36.86	4.85
115	36.86	4.85
132.25	36.86	4.85
195.5	36.86	4.85
230	36.86	4.85
264.5	36.88	4.85

**G1D/G7D Emission, 25 watt power level:**

<u>Input voltage, AC</u>	<u>Power output, dBm</u>	<u>Power output, watts</u>
97.75	43.96	23.9
115	43.95	23.8
132.25	43.95	23.8
195.5	43.95	23.8
230	43.95	23.8
264.5	43.95	23.8

## 2.1049 - Occupied bandwidth

### A2D Emission Limits

The A2D emission must meet the requirements set forth in § 87.139(a), which for an authorized bandwidth of 25 KHz are as follows:

0 to 12.5 KHz from center – no attenuation

12.5 to 25.0 KHz from center – 25 dB attenuation below carrier

25 to 62.5 KHz from center – 35 dB attenuation below carrier

beyond 62.5 KHz from center – 57 dB attenuation below carrier

### G1D/G7D Emission Limits

For the G1D and G7D emission modes, there is currently no provision for emission limits other than § 87.139(a). However, since the intended use of these modes is for VHF digital data link (VDL) service, there are proposed limits such as are described in the “Minimum Operational Performance Specification For An Airborne VDL Mode 2 Transceiver Operating in the Frequency Range 118-136.975 MHz”, March 2000 EUROCAE specification. Other organizations such as the International Civil Aviation Organization (ICAO) have similar proposed specifications for both Mode 2 and 3.

In VDL service occupied bandwidth is actually specified as adjacent channel power, or ACP. With the transmitter producing the rated average power of + 44 dBm, the EUROCAE MOPS ACP limits are as follows:

1<sup>st</sup> adjacent channel, 25 KHz from center frequency: -18 dBm \*

2<sup>nd</sup> adjacent channel, 50 KHz from center frequency: -28 dBm

4<sup>th</sup> adjacent channel, 100 KHz from center frequency: -38 dBm

8<sup>th</sup> adjacent channel, 200 KHz from center frequency: -43 dBm

16<sup>th</sup> adjacent channel, 400 KHz from center frequency: -48 dBm

32<sup>nd</sup> adjacent channel, 800 KHz from center frequency: -53 dBm

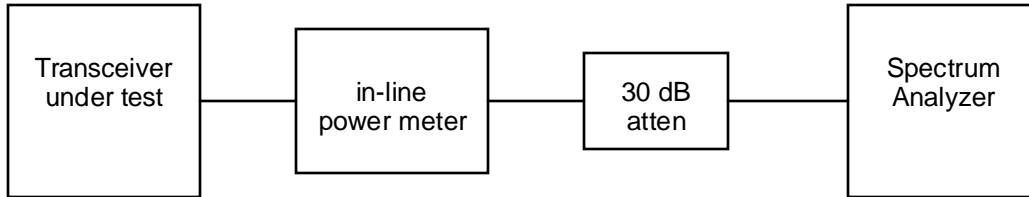
beyond 32<sup>nd</sup> adjacent channel: -53 dBm

\* **NOTE:** The 1<sup>st</sup> adjacent channel power is measured in a 16 KHz bandwidth, all others are measured in a 25 KHz bandwidth.

### Test Procedure – A2D Emission

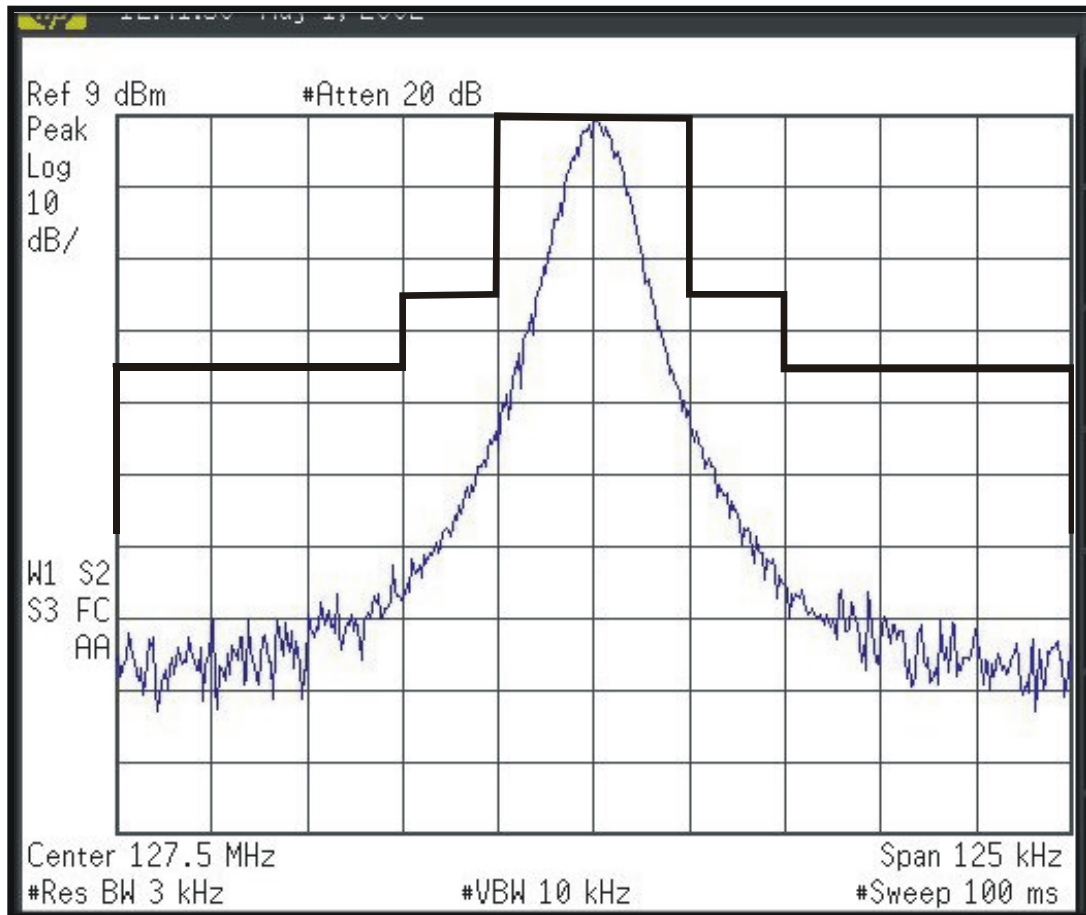
For A2D occupied bandwidth measurements two test signals were chosen – a 2400 Hz audio tone, and random AM-MSK data. Since there is no external audio input to the transceiver, both of these signals were generated internally within the transceiver and are actually part of the standard product configuration. These test signals were chosen because they represent the worst-case modulation conditions.

For each test signal the modulation level was set at maximum (90%) and data taken at power levels of 5 and 25 watts. Plots of the resulting emission were made using both video averaging and peak hold to capture the worst-case modulation products that might show up randomly.



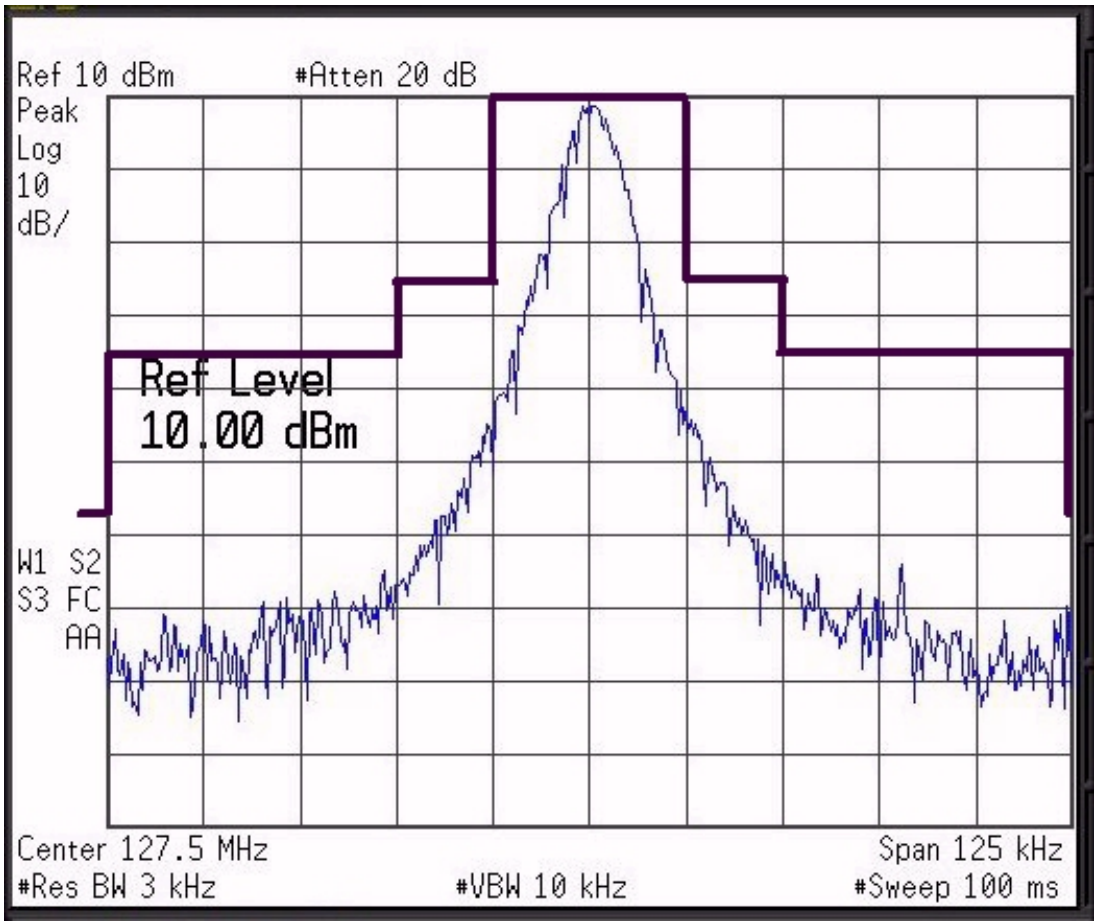
**A2D Emissions test block diagram**

**A2D Occupied Bandwidth Test Data**

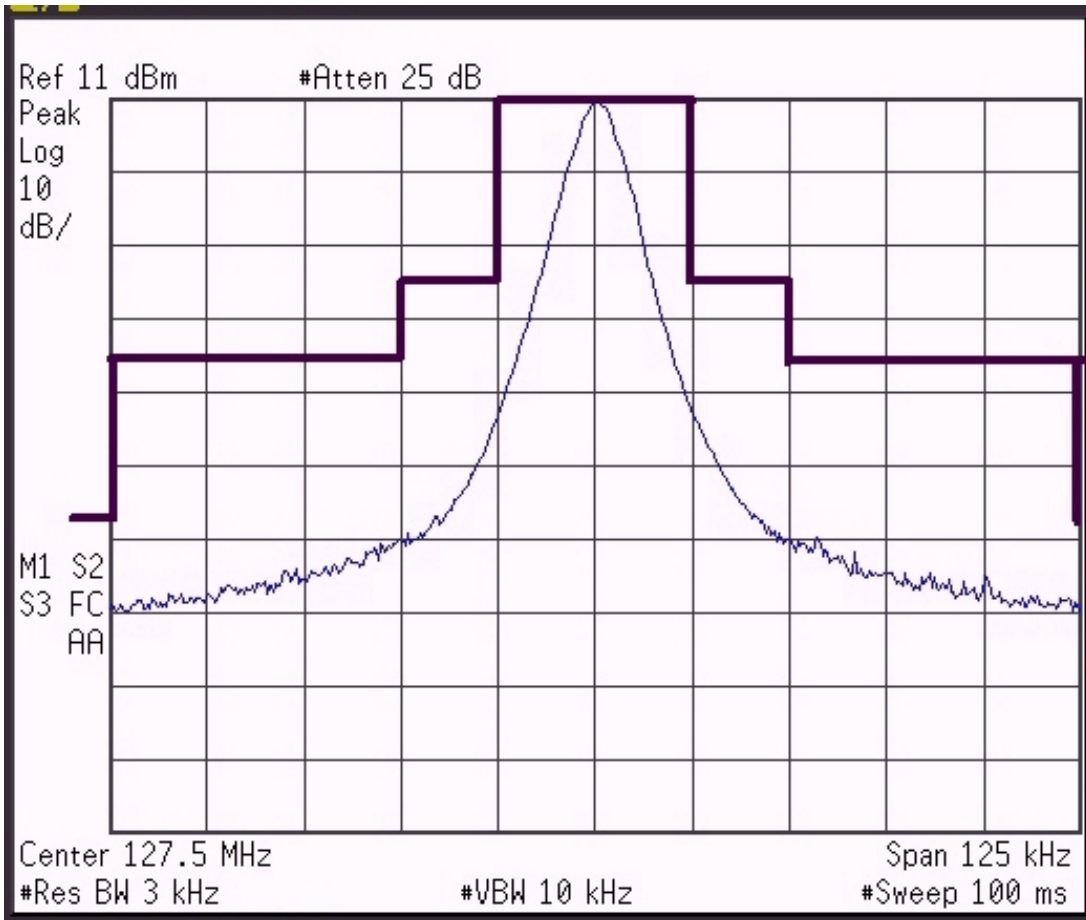


**A2D Emission, 5 Watts 2400 Hz modulation 90% AM average**

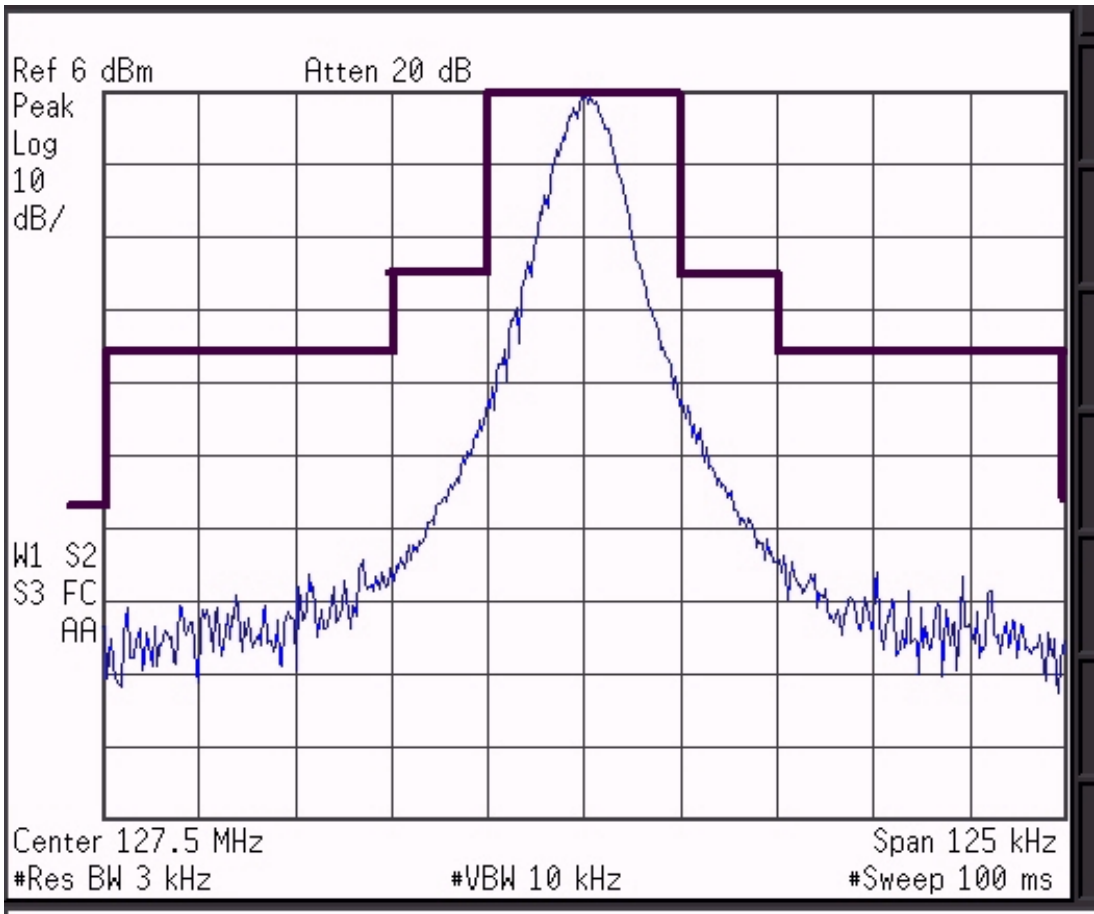




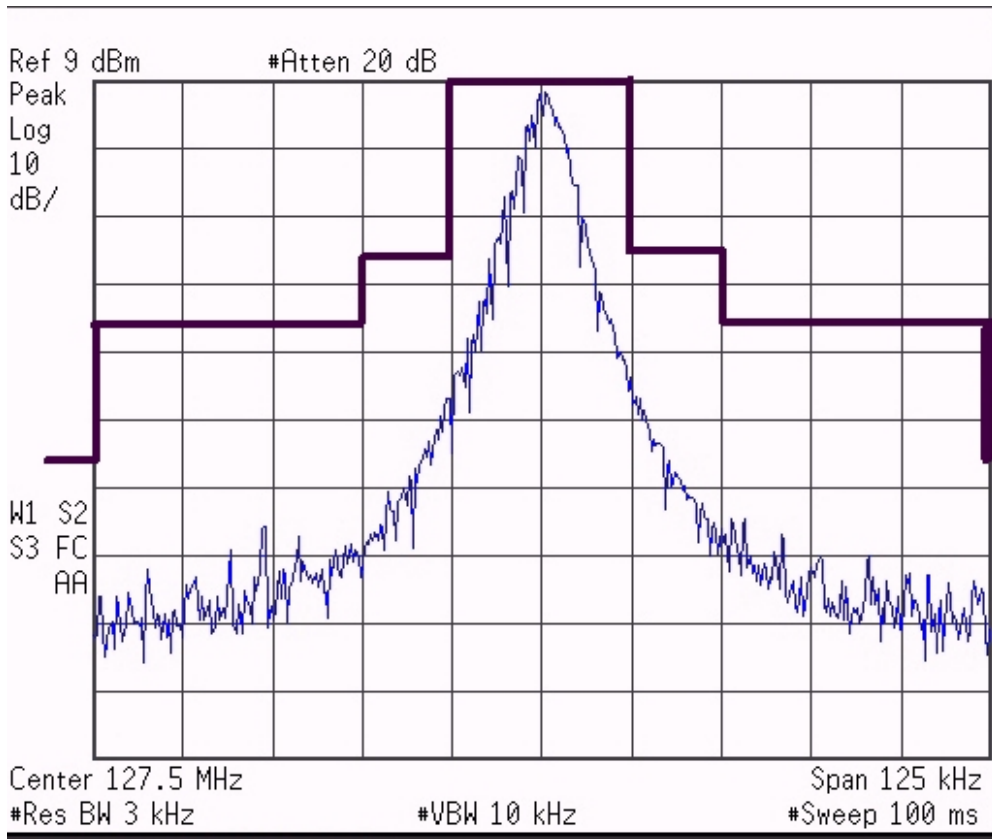
**A2D Emission, 5 Watts random data 90% AM average**



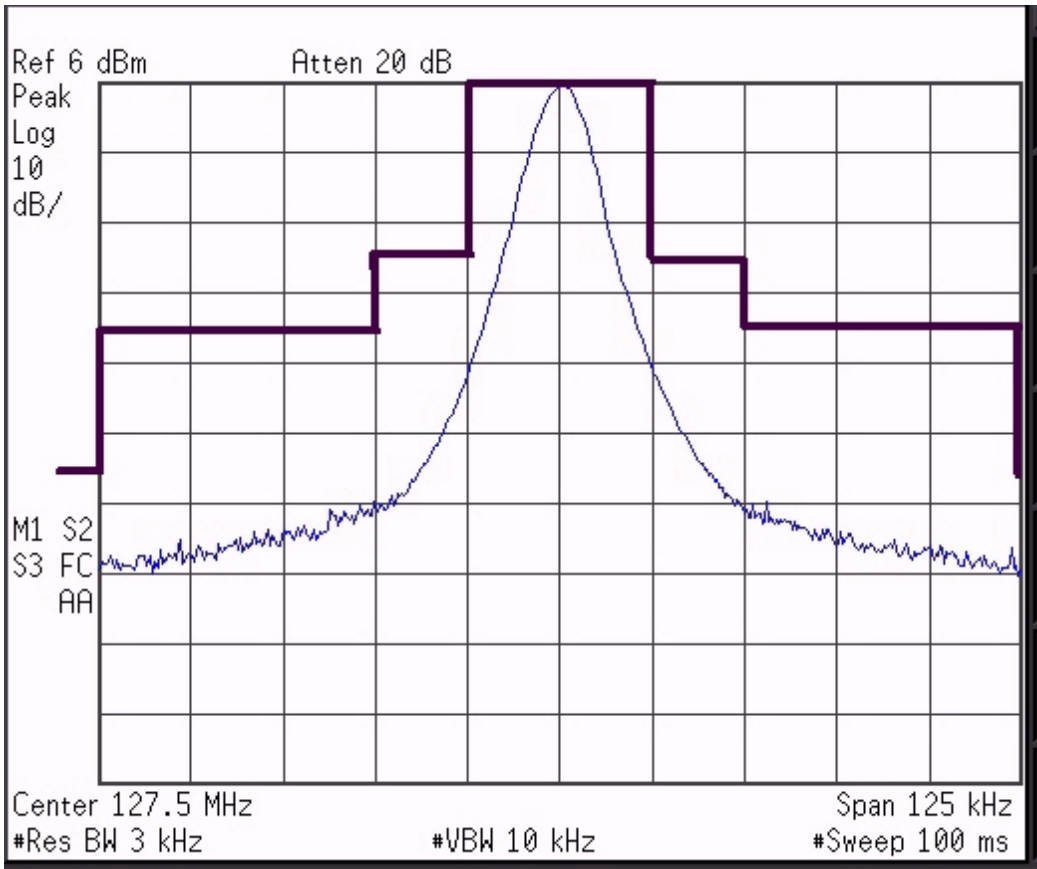
**A2D Emission, 5 Watts random data 90% AM peak hold**



**A2D Emission, 25 Watts 2400 Hz modulation 90% AM average**



**A2D Emission, 25 Watts random data 90% AM average**



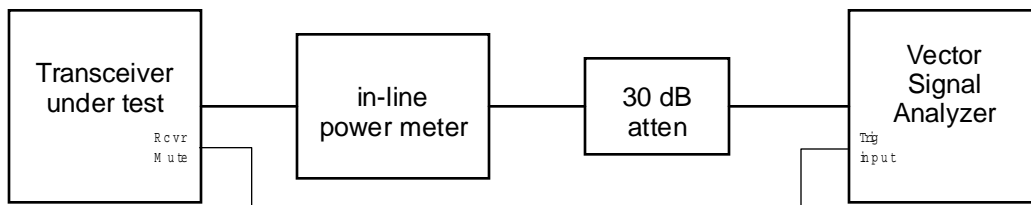
**A2D Emission, 25 Watts random data 90% AM peak hold**

## Test Procedure – G1D and G7D Emissions

For the G1D and G7D emissions, two series of tests were actually performed, one demonstrating compliance with occupied bandwidth limits per §87.139(a), and the other to prove compliance with the current EUROCAE VDL MOPS adjacent channel power limits.

For §87.139(a) compliance the test set-up shown below was used. Two different tests were performed, one using continuous random data and one using a 25 msec burst transmitted at intervals of one second. The second test message was a sample VDL data transmission as described in Appendix F, RTCA Paper No. 155-00/SC172-263 (final draft of RTCA specification DO-224A). Both test messages were generated internally within the transmitter.

The transmitter was adjusted to produce the desired power output, and the resulting emission was measured with a vector signal analyzer set to peak hold mode. The analyzer display was averaged over 60 bursts before plots were taken. This test was performed at a representative frequency of 127.5 MHz and at both 5 watt and 25 watt power levels.



### G1D/G7D Emissions Test set-up – Occupied Bandwidth and 1<sup>st</sup> Adjacent channel power

For VDL MOPS compliance testing, a more comprehensive test is required because of the burst power operating mode and the dynamic range limitations of the test equipment. When a composite D8PSK signal is passed through a linear system of finite dynamic range, adjacent channel power measurements can be degraded if special care is not taken. The tests outlined below have been used extensively during product development and have been empirically shown to be valid.

For all adjacent channel power measurements an internally generated test message was used. This message consisted of the first 25 milliseconds of a sample VDL data transmission as described in Appendix F, RTCA paper no 155-00/SC172-263 (final draft of RTCA specification DO-224A). The 25 msec message length was chosen to allow the vector signal analyzer to measure power over the entire burst.

All adjacent channel power tests were performed at a power level of 25 watts only, as this power level represents the worst-case operating condition for all adjacent channel power measurements.

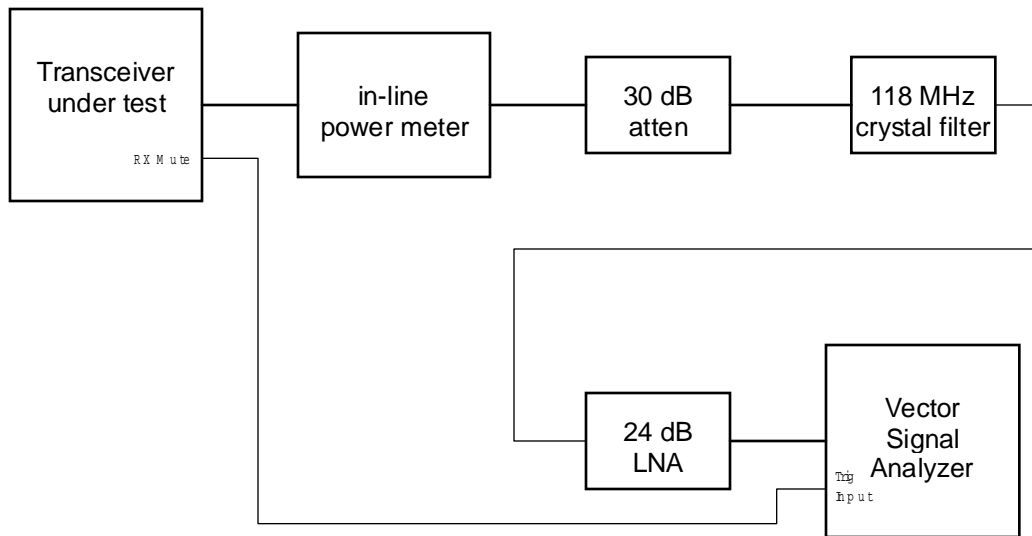
## **1<sup>st</sup> Adjacent Channel Test**

In order to characterize the first adjacent channel power, the test set-up was as shown in the above block diagram. The vector signal analyzer was set up to measure power over the entire burst by using the receiver mute signal present at the rear of the transceiver, which changes state when the transmitter starts its power ramp-up sequence. The analyzer input level was configured such that neither the instrument noise floor nor its input intercept point was a limiting factor in the measurement. The insertion loss of the attenuator was measured to be 30.3 dB across the band, and this value was used to adjust the power values appearing on the spectral plots, to obtain the actual ACP data.

## **2<sup>nd</sup> through 8<sup>th</sup> Adjacent Channel Test**

For 2<sup>nd</sup> through 8<sup>th</sup> adjacent channel power measurements, special care was taken to avoid overloading the vector signal analyzer. This test used a crystal bandpass filter with a center frequency of 118.000 MHz to remove the fundamental transmitter output. This method requires that the transmit frequency be shifted the appropriate amount away from 118 MHz for each measurement. A transmit frequency of 118 MHz was used because the transmit VCO gain is highest at 118 MHz, consequently the VCO phase noise is worst at this frequency, and ACP measurements reflect this degradation at the 4<sup>th</sup> and higher channels. Thus by using 118 MHz as a test frequency the worst case conditions could be demonstrated.

The path between the transmitter output and analyzer input was first characterized in order to obtain the net gain or loss of the measurement system. In the set-up shown below the net gain of the power meter, attenuator, crystal filter and LNA was found to be -11.3 dB. This number was then added to the actual measured power values for each frequency. Data was taken at discrete frequencies corresponding to the 2<sup>nd</sup> through 128<sup>th</sup> adjacent channel, and appear as spectral plots on following pages.



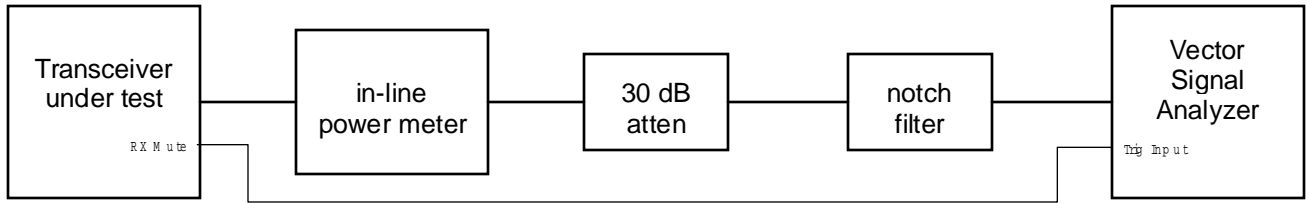
### **G1D/G7D Emissions Test Set-up – 2<sup>nd</sup> through 8<sup>th</sup> Adjacent channel power**

#### **8<sup>th</sup> Channel and Beyond Test**

For adjacent channel power measurement beyond the 8<sup>th</sup> adjacent channel, a notch filter was used to suppress the fundamental signal as shown in the block diagram below. The use of the notch filter increases the dynamic range of the vector signal analyzer. The notch filter characteristics are such that there is only 1 dB of attenuation at  $\pm 200$  KHz from the notch frequency, with a notch depth of approximately 50 dB at the fundamental. The path attenuation between the transmitter output and the analyzer input was measured and found to be  $-37.0$  dB at all frequencies 200 KHz or greater from the notch frequency of 118.000 MHz.

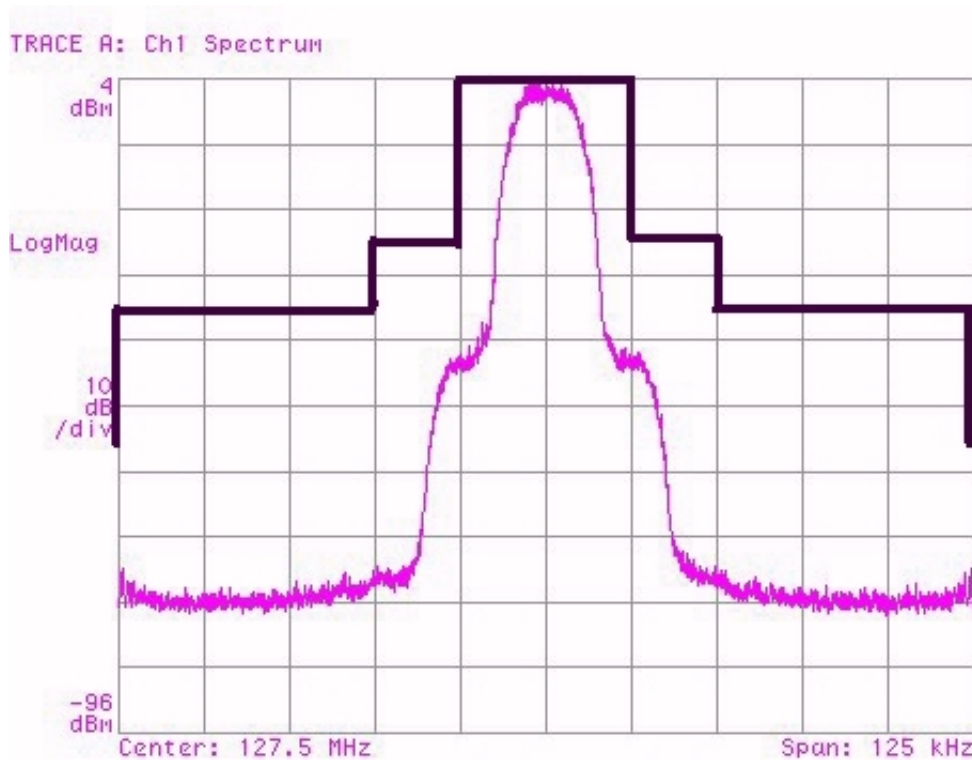
The signal analyzer was configured for a frequency span of 4 MHz. Since burst power measurement was no longer possible with this wide span, the analyzer was set to free run trigger with the display in peak hold mode. Then, while the burst message was being transmitted, the analyzer display was allowed to “paint” over a time period of 10 minutes (600 bursts), with the resulting trace captured. While this is somewhat different from the previous measurement methods used, it was felt that a wide span view was necessary to show compliance beyond the 8<sup>th</sup> channel, and that the peak hold measurement would display a worst-case condition.



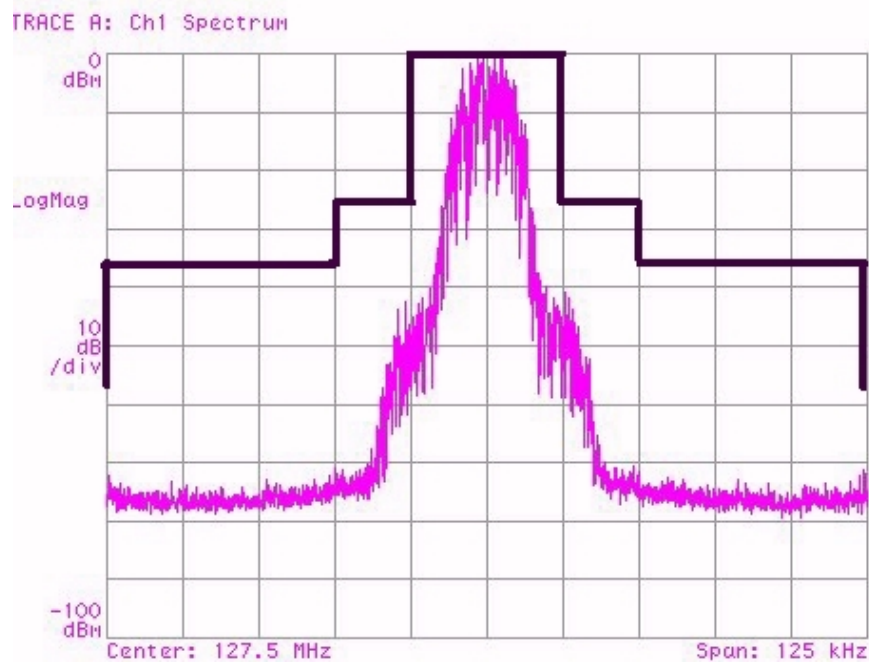


**G1D/G7D Emissions Test set-up – 8<sup>th</sup> channel and greater ACP**

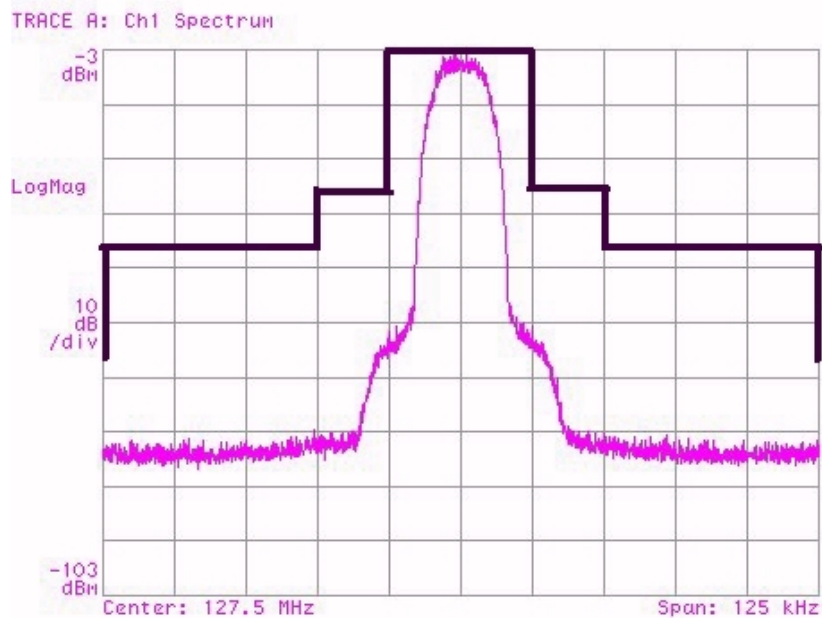
**G1D/G7D Occupied Bandwidth Test Data**



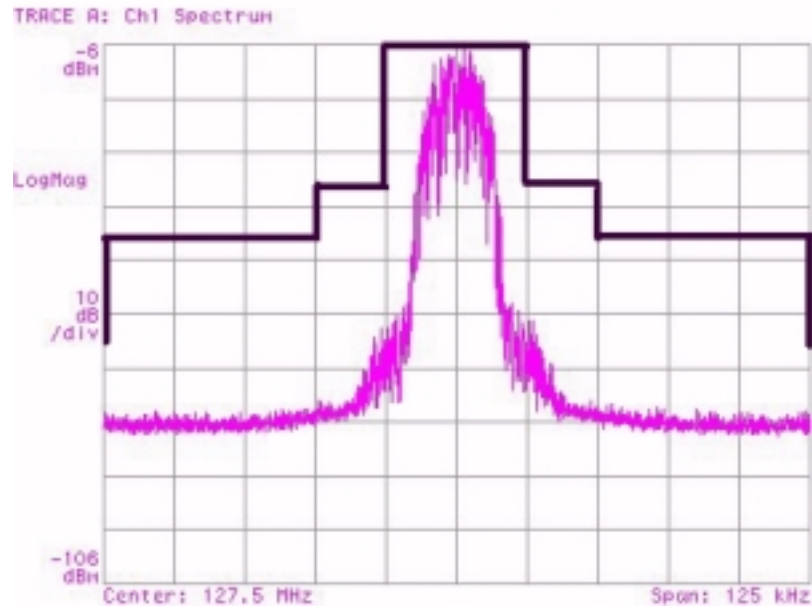
**G1D/G7D Emission, random data, 127.5 MHz, 25 W (87.139(a) limits)**



**G1D/G7D Emission, burst data, 127.5 MHz, 25 W (87.139(a) limits)**



**G1D/G7D Emission, random data, 127.5 MHz, 5 W (87.139(a) limits)**



**G1D/G7D Emission, burst data, 127.5 MHz, 5 W (87.139(a) limits)**

**G1D/G7D Adjacent Channel Power – Tabular Data**

**1<sup>st</sup> Adjacent Channel Power in 16 KHz Bandwidth, 25 Watts**

<u>Freq. MHz</u>	<u>Upper</u>	<u>Lower</u>	<u>Limit (dBm)</u>
118.000	-24.6 dBm	-23.7 dBm	-18
127.500	-23.8 dBm	-22.6 dBm	-18
136.975	-23.7 dBm	-23.4 dBm	-18

**1<sup>st</sup> Adjacent Channel Power in 25 KHz Bandwidth, 25 watts**

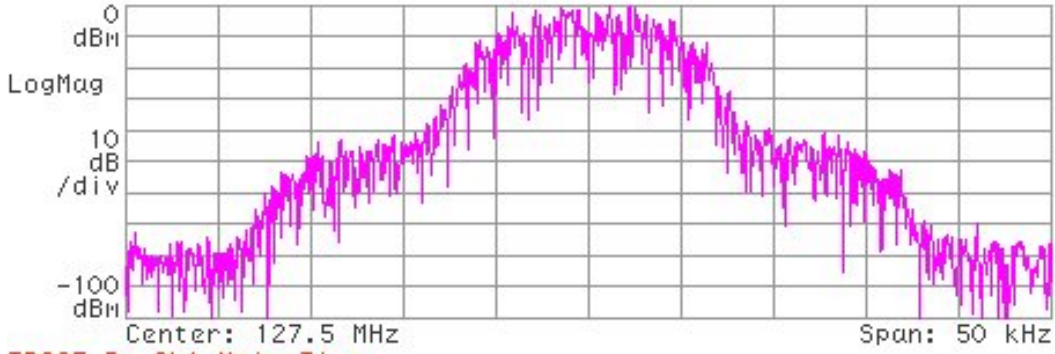
<u>Freq. MHz</u>	<u>Upper</u>	<u>Lower</u>	<u>Limit (dBm)</u>
118.000	-4.3 dBm	-6.1 dBm	0
127.500	-2.6 dBm	-4.5 dBm	0
136.975	-2.9 dBm	-4.9 dBm	0

**2<sup>nd</sup> through 128<sup>th</sup> Channel Power at 118 MHz, 25 watts**

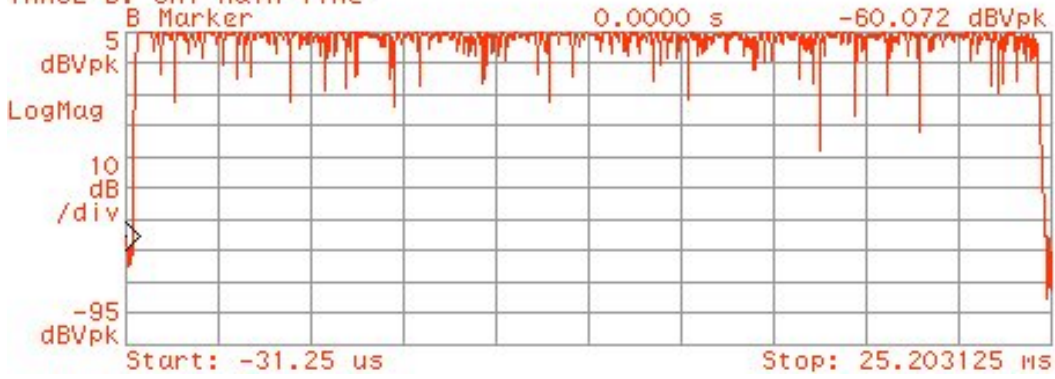
<u>Channel No.</u>	<u>Offset, KHz</u>	<u>Transmit Freq. MHz</u>	<u>ACP dBm</u>	<u>Limit dBm</u>
2 <sup>nd</sup>	50	118.050	-32.6	-28
4 <sup>th</sup>	100	118.100	-52.2	-38
8 <sup>th</sup>	200	118.200	-57.7	-43
16 <sup>th</sup>	400	118.400	-56.9	-48
32 <sup>nd</sup>	800	118.800	-66.6	-53
64 <sup>th</sup>	1600	119.600	-66.6	-53
128 <sup>th</sup>	3200	121.200	-76.4	-53

# G1D/G7D 1<sup>st</sup> Adjacent Channel Power Plots

TRACE A: Ch1 Spectrum

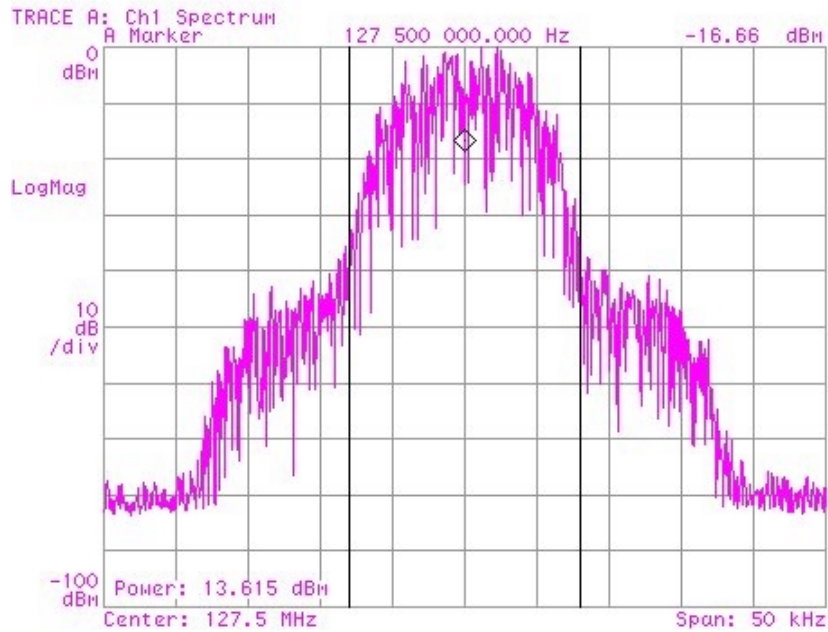


TRACE B: Ch1 Main Time

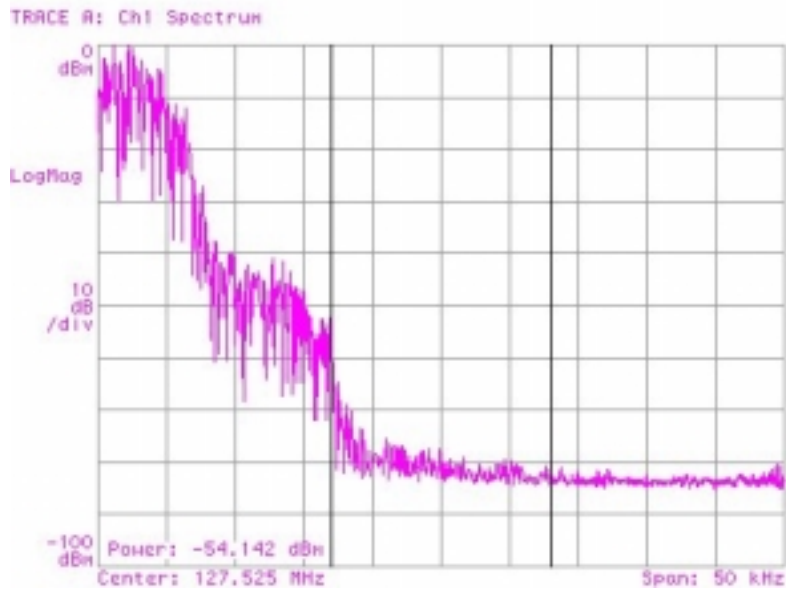


**Burst Power Measurement Display**

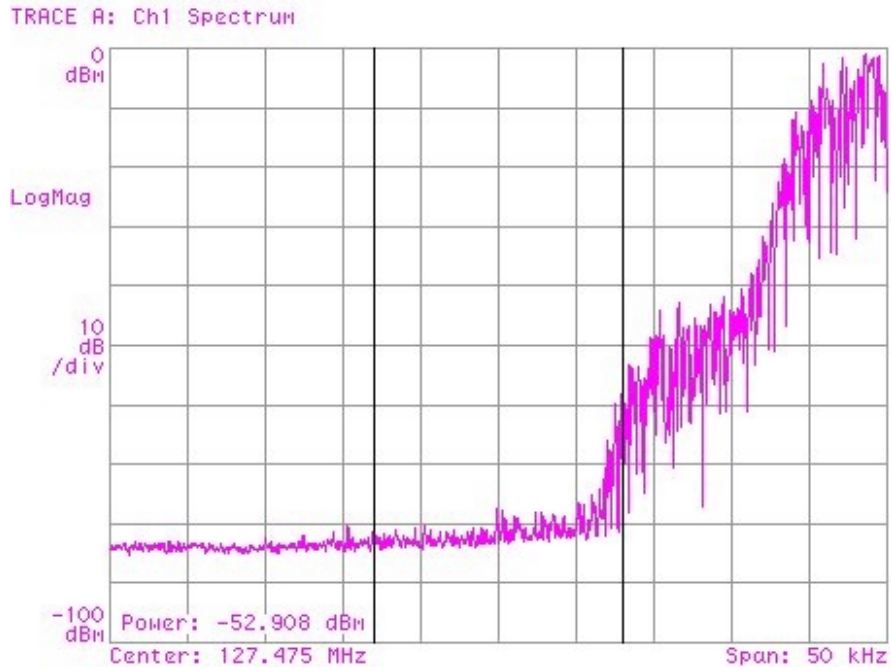
## G1D/G7D 1<sup>st</sup> Adjacent Channel Power Plots



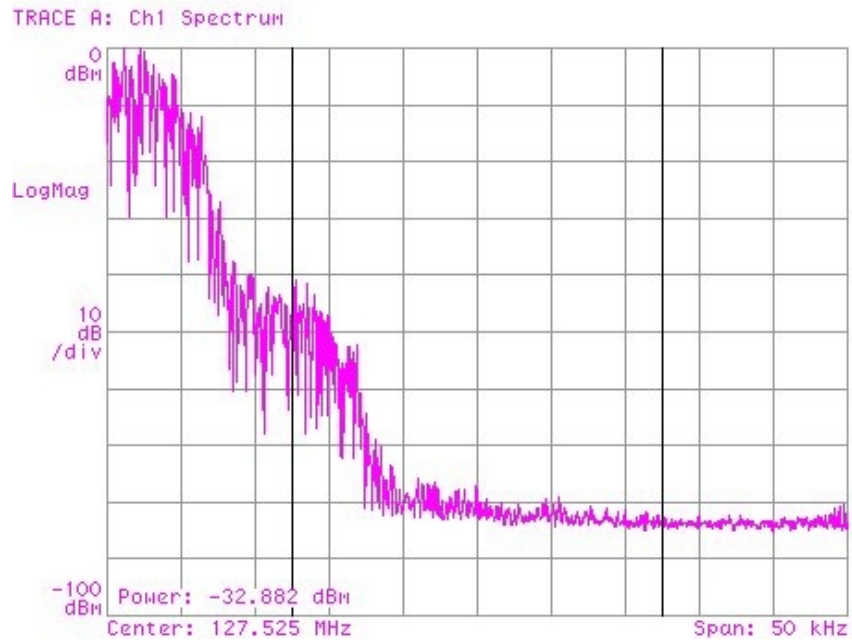
**127.5 MHz On-channel Power**



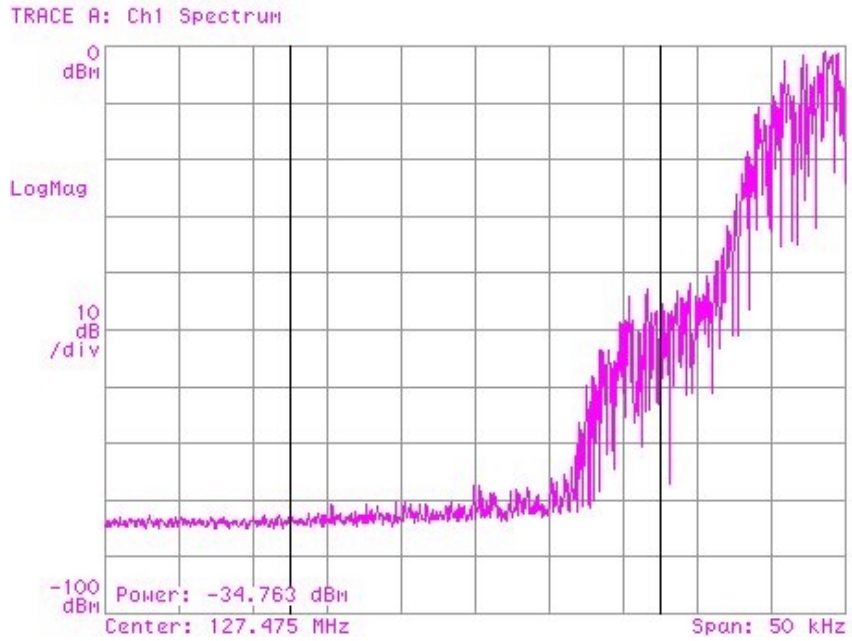
**127.5 MHz Upper 1<sup>st</sup> Adjacent Channel, 16 KHz bandwidth**



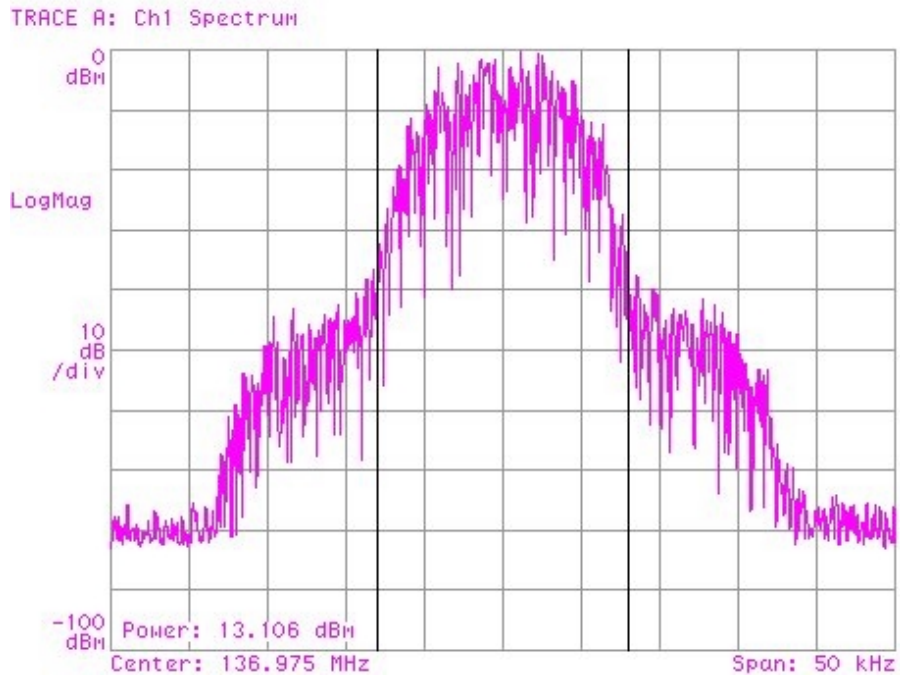
**127.5 MHz Lower 1<sup>st</sup> Adjacent Channel, 16 KHz bandwidth**



**127.5 MHz Upper 1<sup>st</sup> Adjacent Channel, 25 KHz bandwidth**

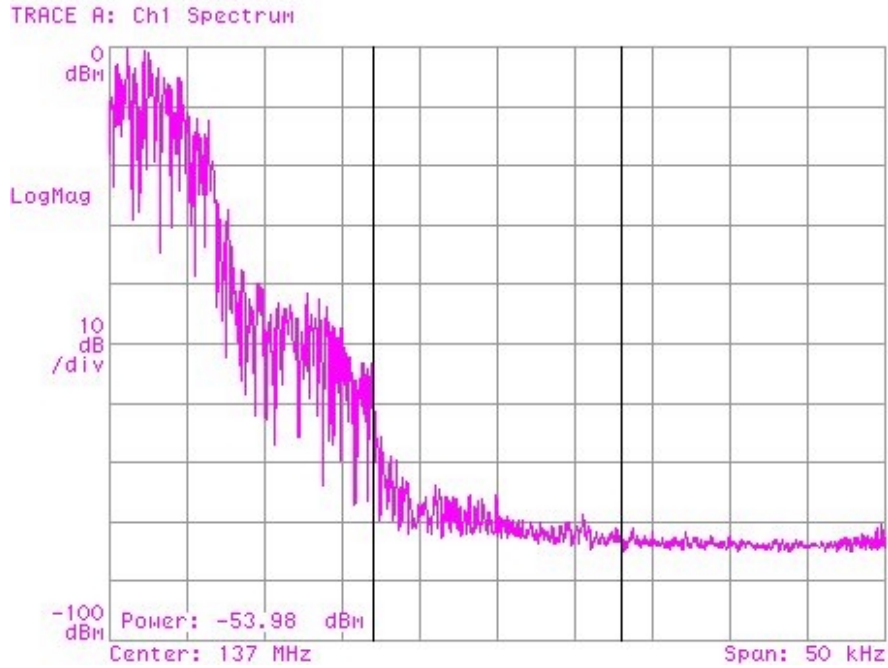


**127.5 MHz Lower 1<sup>st</sup> Adjacent Channel, 25 KHz bandwidth**

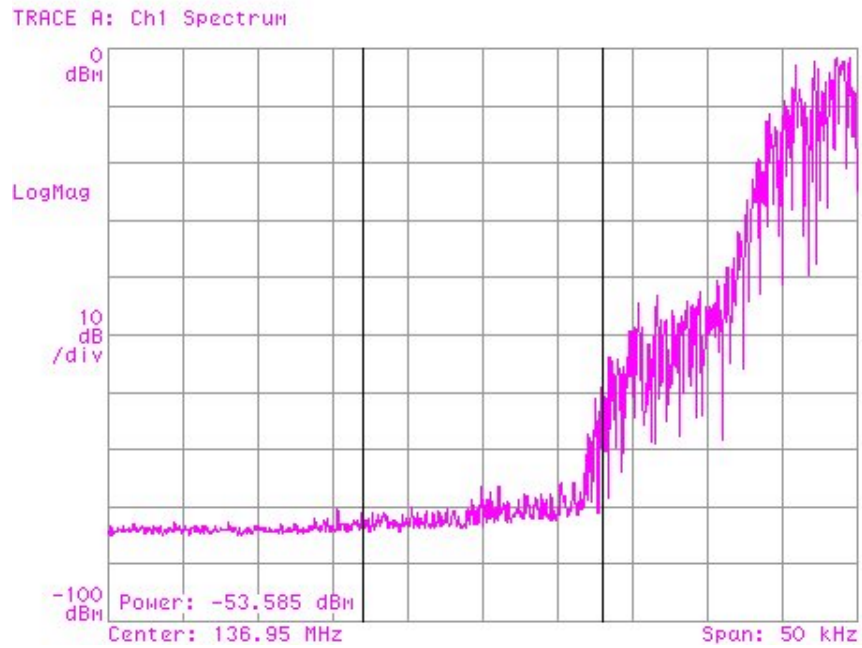


**136.975 MHz On-channel**

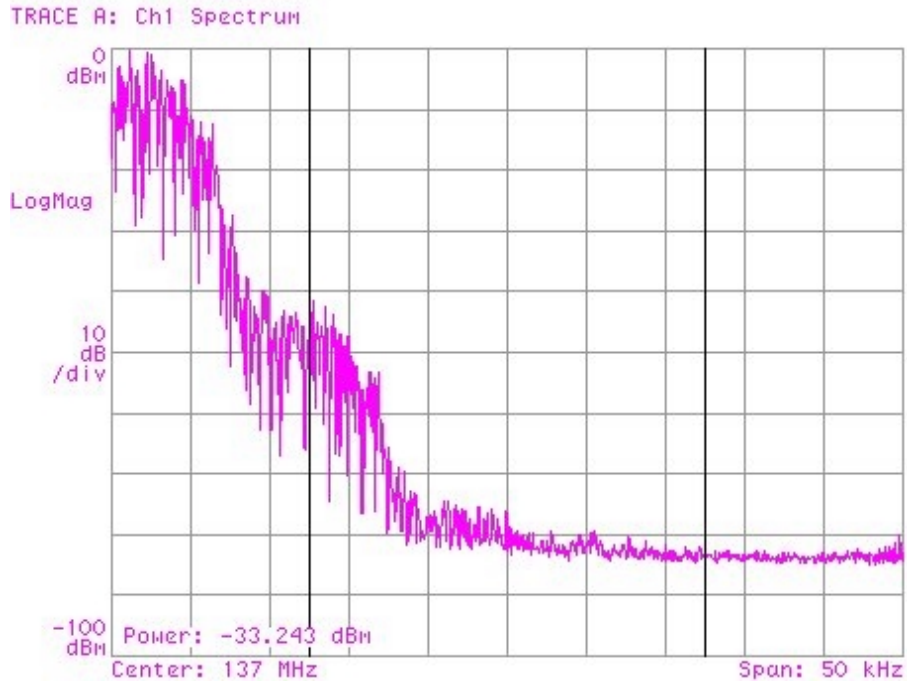




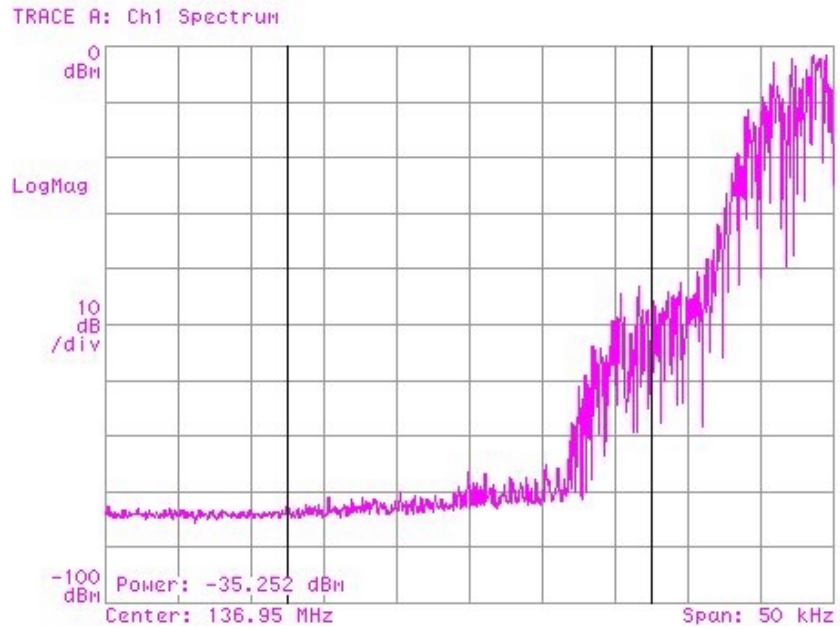
**136.975 MHz Upper 1<sup>st</sup> Adjacent Channel, 16 KHz bandwidth**



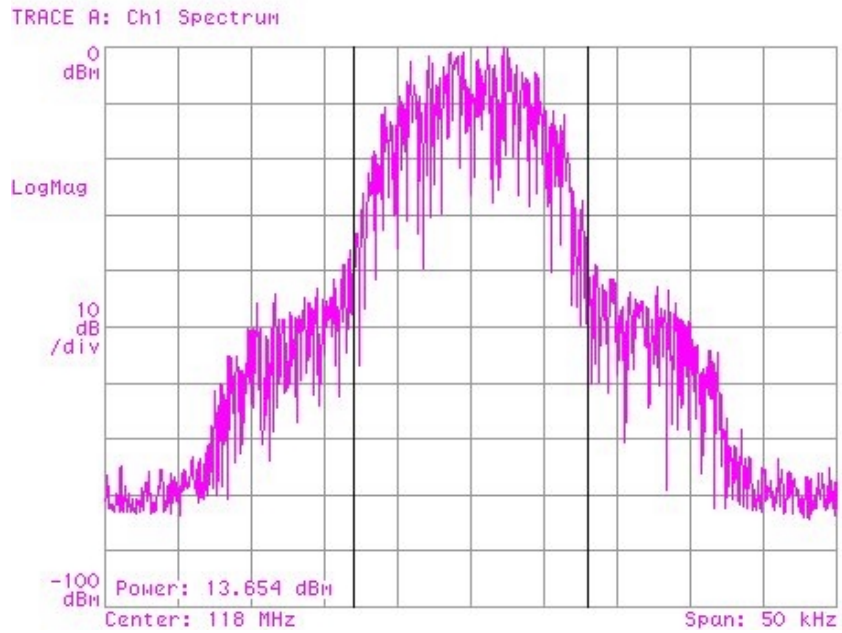
**136.975 MHz Lower 1<sup>st</sup> Adjacent Channel, 16 KHz bandwidth**



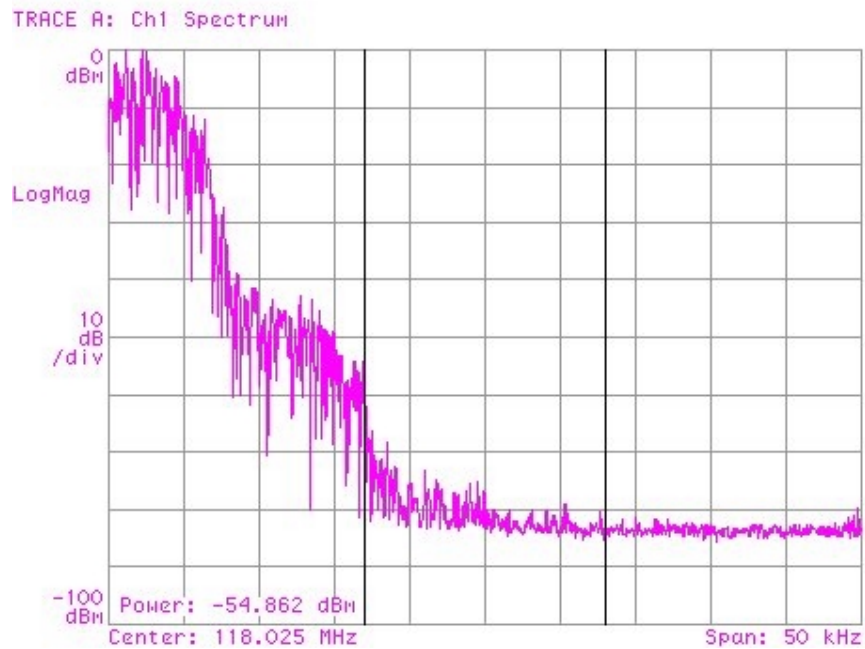
**136.975 MHz Upper 1<sup>st</sup> Adjacent Channel, 25 KHz bandwidth**



**136.975 MHz Lower 1<sup>st</sup> Adjacent Channel, 25 KHz bandwidth**

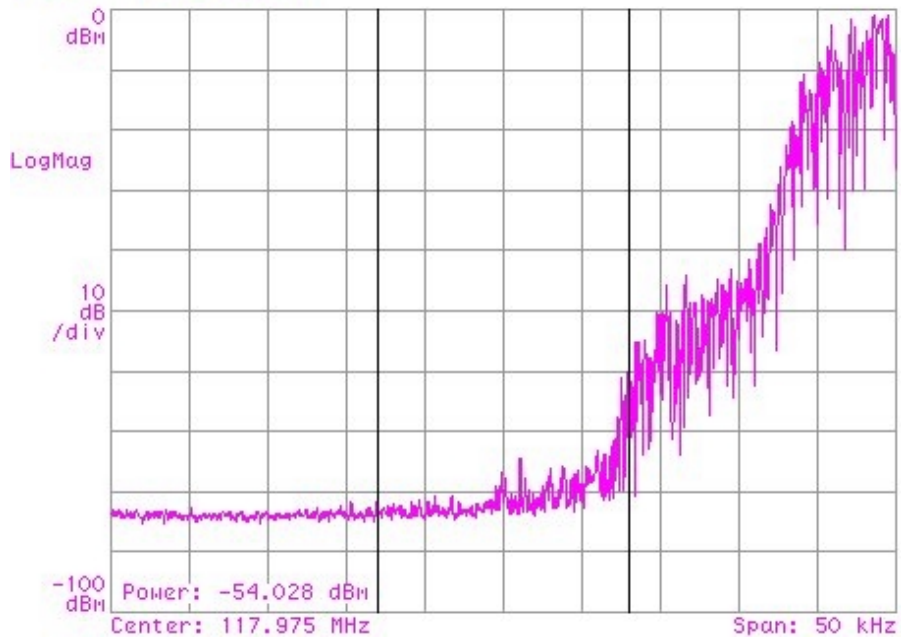


**118.00 MHz On-channel**



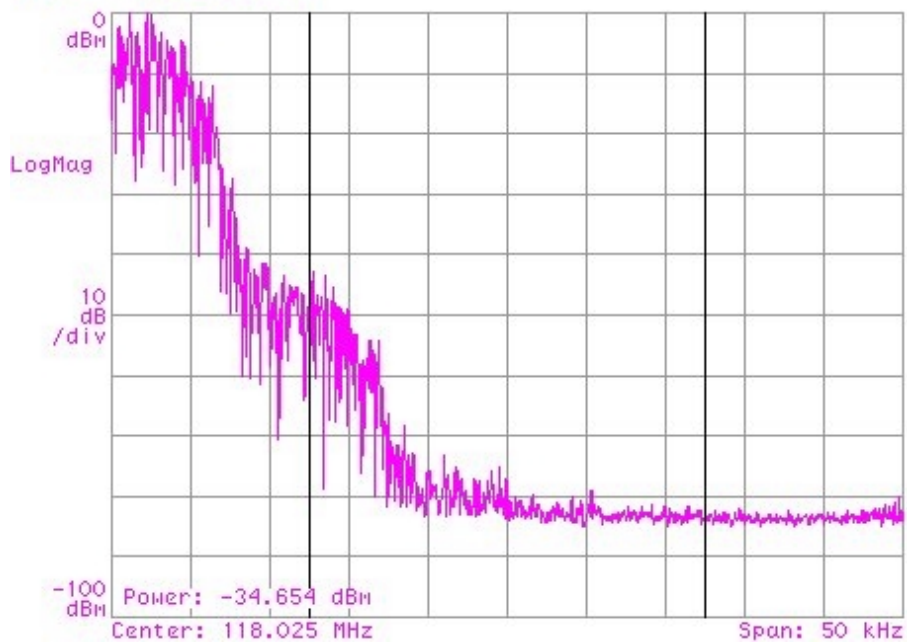
**118.00 MHz Upper 1<sup>st</sup> Adjacent Channel, 16 KHz bandwidth**

TRACE A: Ch1 Spectrum

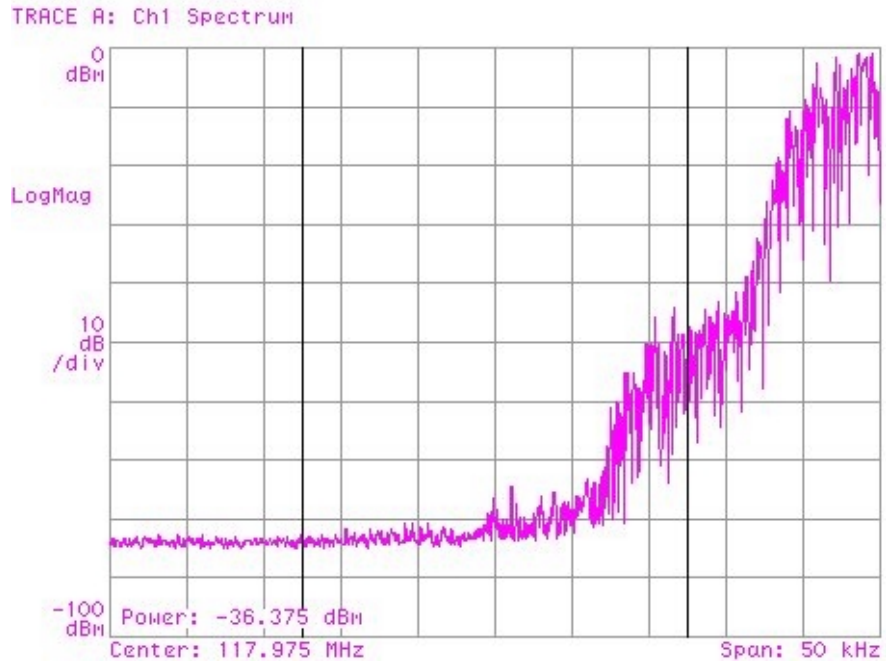


**118.00 MHz Lower 1<sup>st</sup> Adjacent Channel, 16 KHz bandwidth**

TRACE A: Ch1 Spectrum

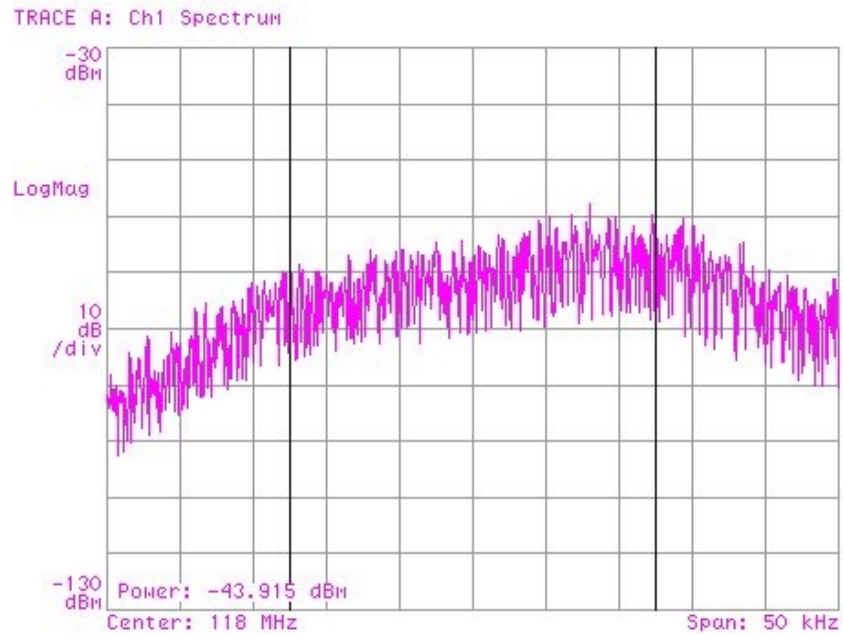


**118.00 MHz Upper 1<sup>st</sup> Adjacent Channel, 25 KHz bandwidth**

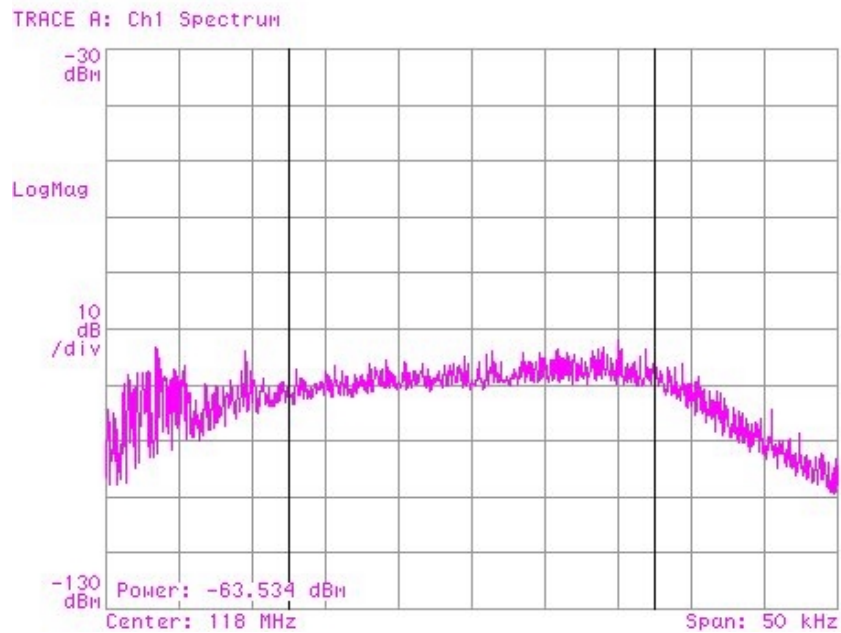


**118.00 MHz Lower 1<sup>st</sup> Adjacent Channel, 25 KHz bandwidth**

## 2<sup>nd</sup> through 128<sup>th</sup> Channel ACP Plots using Crystal Filter

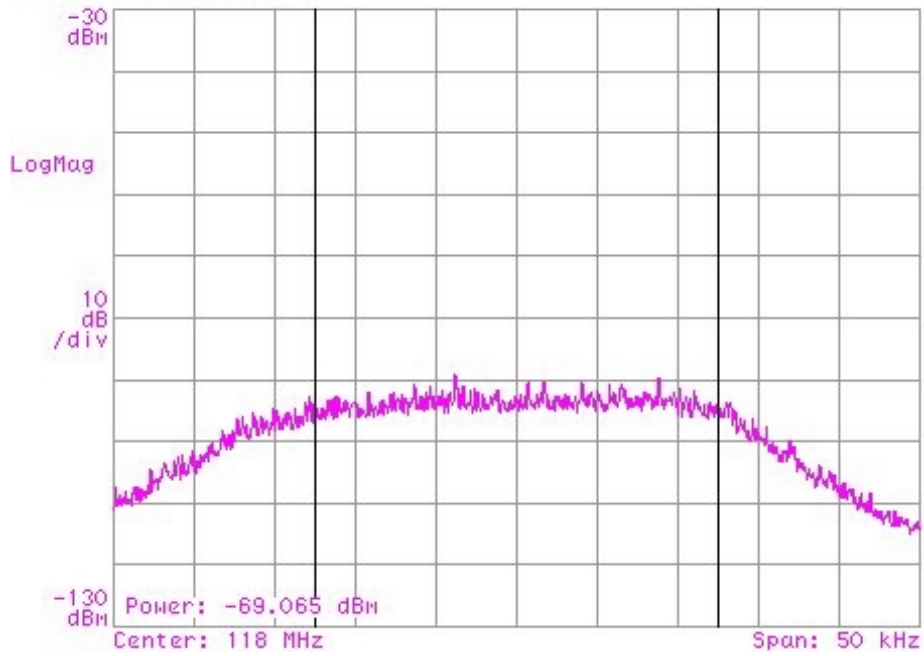


**118 MHz 2<sup>nd</sup> Adjacent Channel (Fo=118.05 MHz)**



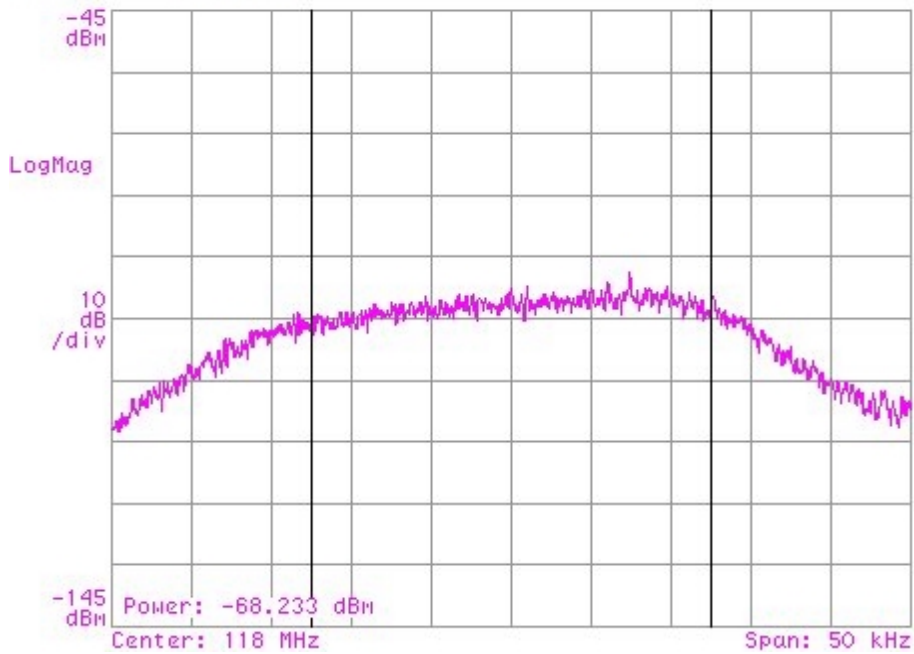
**118 MHz 4<sup>th</sup> Adjacent Channel (Fo=118.10 MHz)**

TRACE A: Ch1 Spectrum



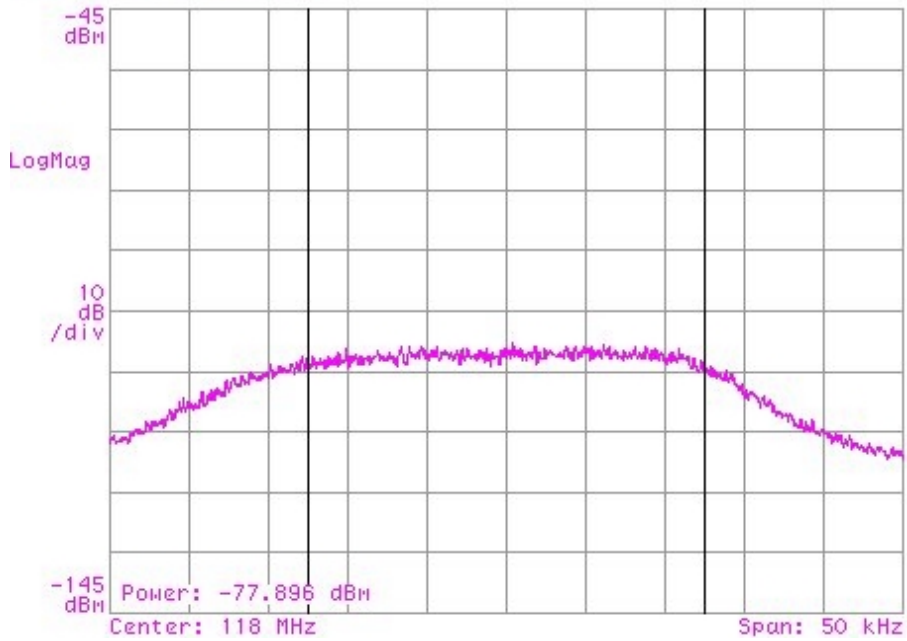
**118 MHz 8<sup>th</sup> Adjacent Channel (Fo=118.20 MHz)**

TRACE A: Ch1 Spectrum



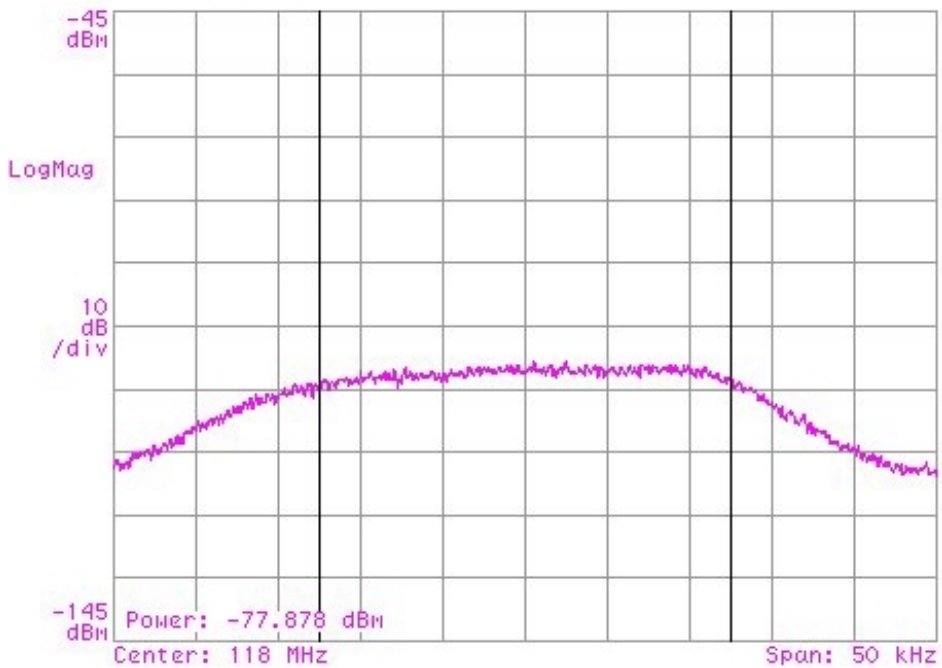
**118 MHz 16<sup>th</sup> Adjacent Channel (Fo=118.40 MHz)**

TRACE A: Ch1 Spectrum



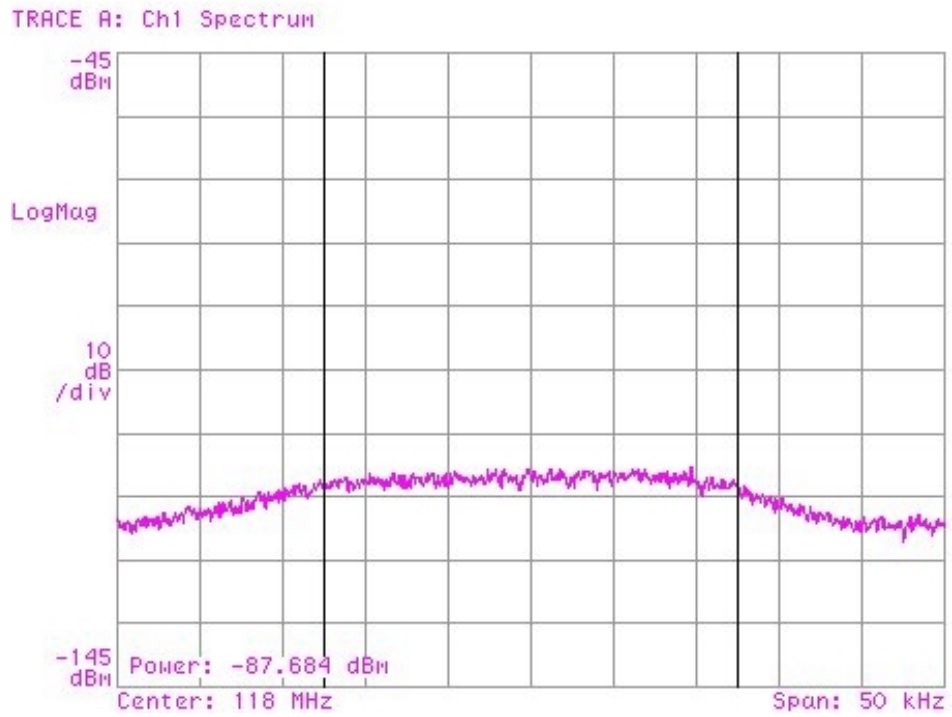
**118 MHz 32<sup>nd</sup> Adjacent Channel (Fo=118.80 MHz)**

TRACE A: Ch1 Spectrum

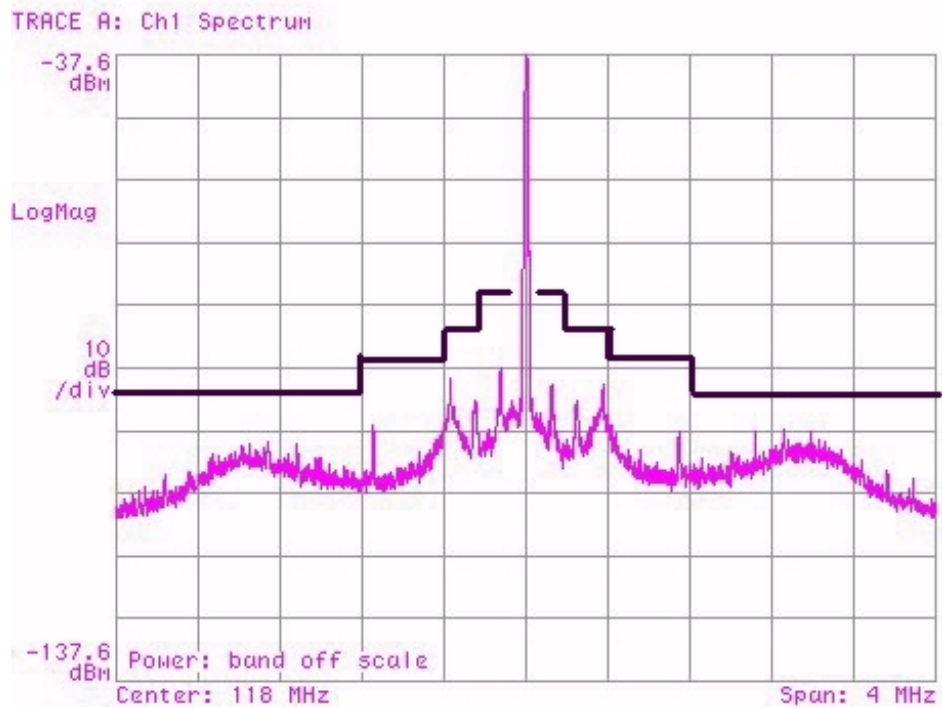


**118 MHz 64<sup>th</sup> Adjacent Channel (Fo=119.6 MHz)**





**118 MHz 128<sup>th</sup> Adjacent Channel (Fo=121.2 MHz)**

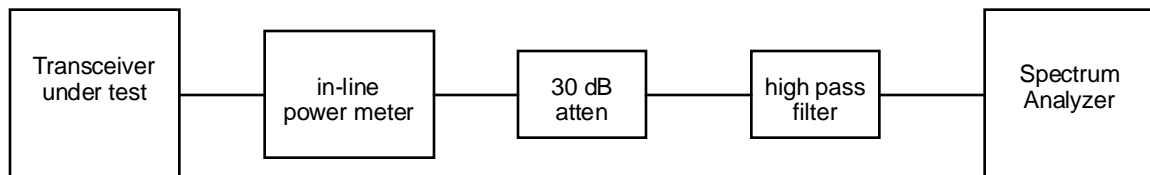


**118 MHz ACP, wideband with notch, peak hold**

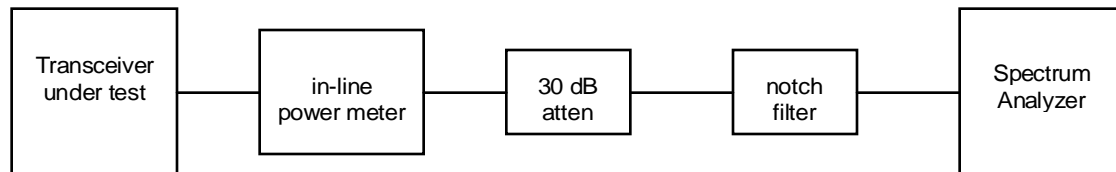
## 2.1051 - Spurious Emissions at Antenna Terminals

### Test Set-up

The block diagram below shows the test set-ups used to measure spurious emissions at the antenna terminals.



**Test Set-up for wide-band harmonic investigation**



**Test Set-up for close-in spurious investigation**

### Test Procedure

To look at wide-band harmonic output, a high-pass filter with a cut-off frequency of 205 MHz was placed in line between the 30 dB power pad and the spectrum analyzer to prevent the analyzer from being overloaded by the transmitted signal. The high pass filter response was first measured to obtain the exact amount of attenuation at each test frequency, so that the spectrum analyzer reference level could be adjusted accordingly. The transceiver under test was placed in the A2D emission mode and set to transmit a 2400 bit per second, continuous random data pattern at a power output level of 25 watts, with the modulation level set to 90 percent.

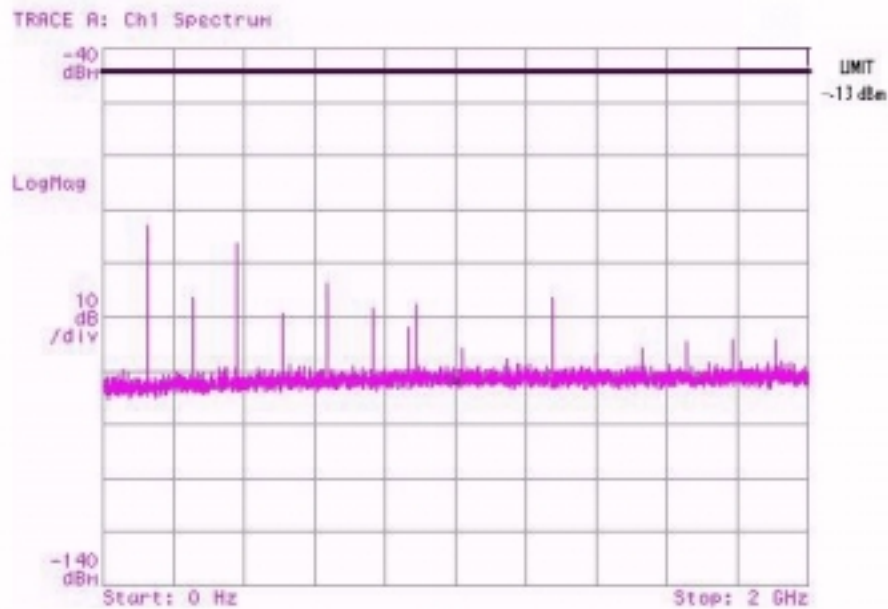
The power level of each harmonic up to 2 GHz was measured in a 16 KHz bandwidth (centered on the harmonic frequency) and the result recorded in tabular form. A plot showing harmonic and spurious output in the 10 KHz to 2 GHz range for each test frequency was also made.

To document close-in spurious emissions, the high-pass filter was replaced by a notch filter. The combined characteristics of the notch filter and attenuator were measured in order to offset the reference level of the spectrum analyzer. As in the other test, the transceiver was caused to transmit a 2400 bit per second random data pattern at a power output level of 25 watts, with the modulation level set to 90 percent.

Plots were taken with analyzer spans of 3.2, 6.4 and 50 MHz to show the location and level of spurious responses close to the center frequency. The 3.2 and 6.4 MHz span plots are included in this test report; the 50 MHz span plots revealed no additional spurious products, and were thus omitted from this report to reduce file size.

## Spurious Emissions Test Data

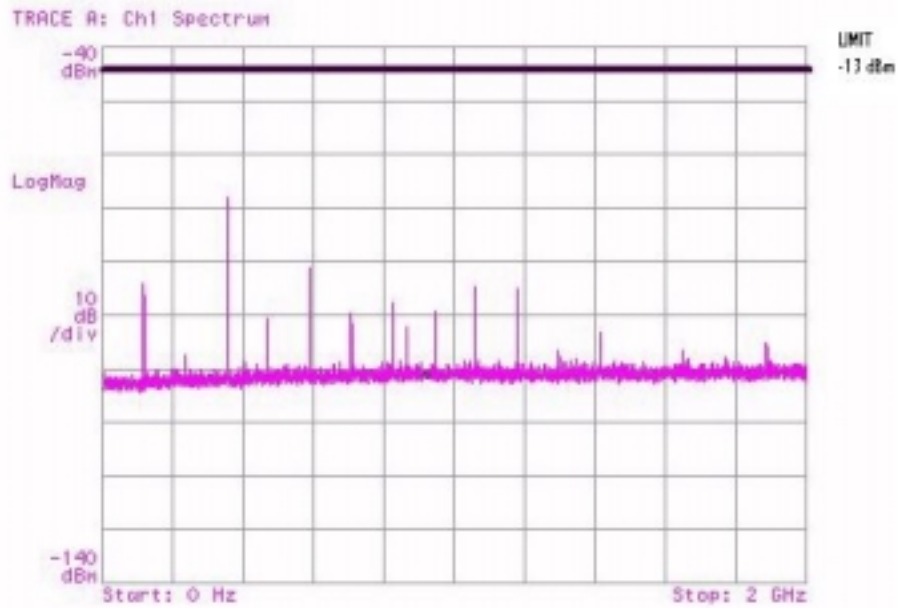
Plot of Spurious at Antenna Port, 0 to 2000 MHz, Fo = 127.5 MHz, 25 Watts



### 127.5 MHz harmonic data

Harmonic Frequency MHz	Measured level dBm	Correction factor dB	Actual spur level dBm	Limit dBm
255.0	-91.5	-31.4	-60.1	-13
382.5	-80.0	-31.2	-48.8	-13
510.0	-94.7	-31.1	-63.6	-13
637.5	-89.2	-31.3	-57.9	-13
765.0	-94.1	-31.3	-63.1	-13
892.5	-92.7	-31.0	-61.7	-13
1020.0	-102.9	-31.4	-71.5	-13
1147.5	-104.0	-31.5	-72.5	-13
1275.0	-91.41	-31.6	-59.8	-13
1402.5	-106.2	-31.8	-74.4	-13
1530.0	-104.9	-31.8	-73.1	-13
1657.5	-107.7	-32.3	-75.4	-13
1785.0	-101.5	-39.0	-62.5	-13
1912.5	-100.2	-36.8	-63.4	-13

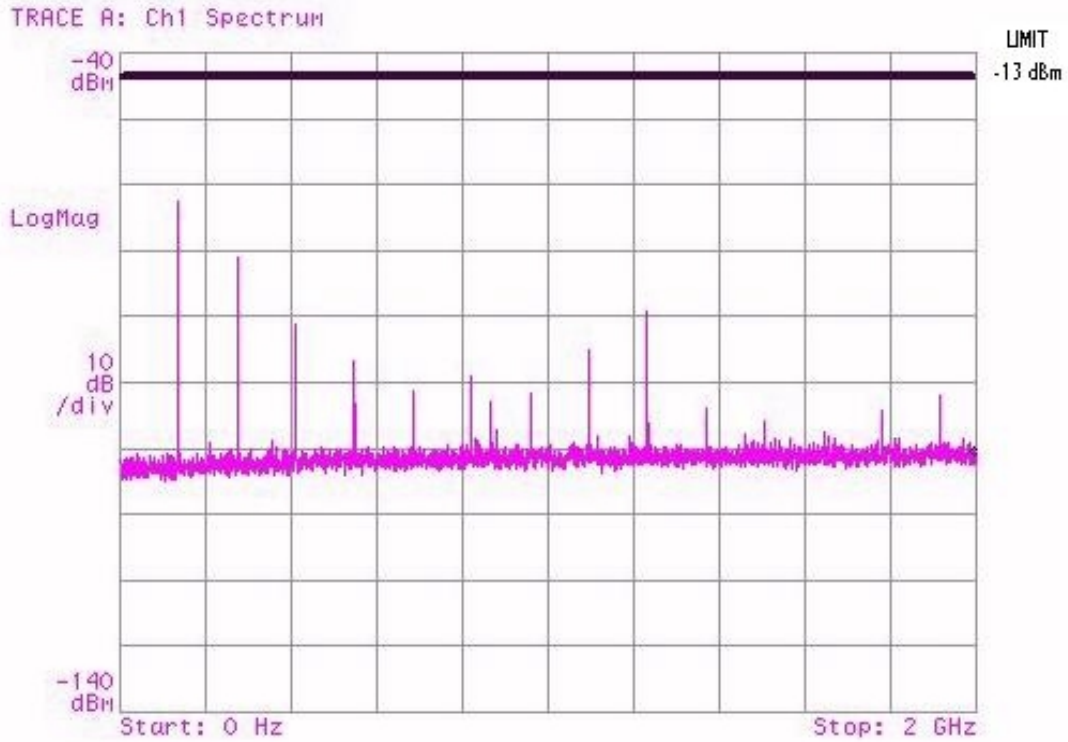
**Plot of Spurious at Antenna Port, 0 to 2000 MHz, Fo = 118 MHz, 25 watts**



**118 MHz harmonic data**

Harmonic Frequency MHz	Measured level dBm	Correction factor dB	Actual spur level dBm	Limit dBm
236	-105.4	-31.6	-73.8	-13
354	-72.8	-31.3	-41.5	-13
472	-97.8	-31.1	-66.7	-13
590	-85.9	-31.2	-54.7	-13
708	-95.9	-31.2	-64.7	-13
826	-92.9	-31.3	-61.6	-13
944	-94.8	-31.0	-63.8	-13
1062	-91.7	-31.5	-60.2	-13
1180	-91.2	-31.2	-60	-13
1298	-105.5	-31.7	-73.8	-13
1416	-101.5	-32.9	-69.6	-13
1534	-109.6	-36.0	-73.6	-13
1652	-107.3	-37.5	-69.8	-13
1770	-108.2	-39	-69.2	-13
1888	-102.1	-36	-66.1	-13

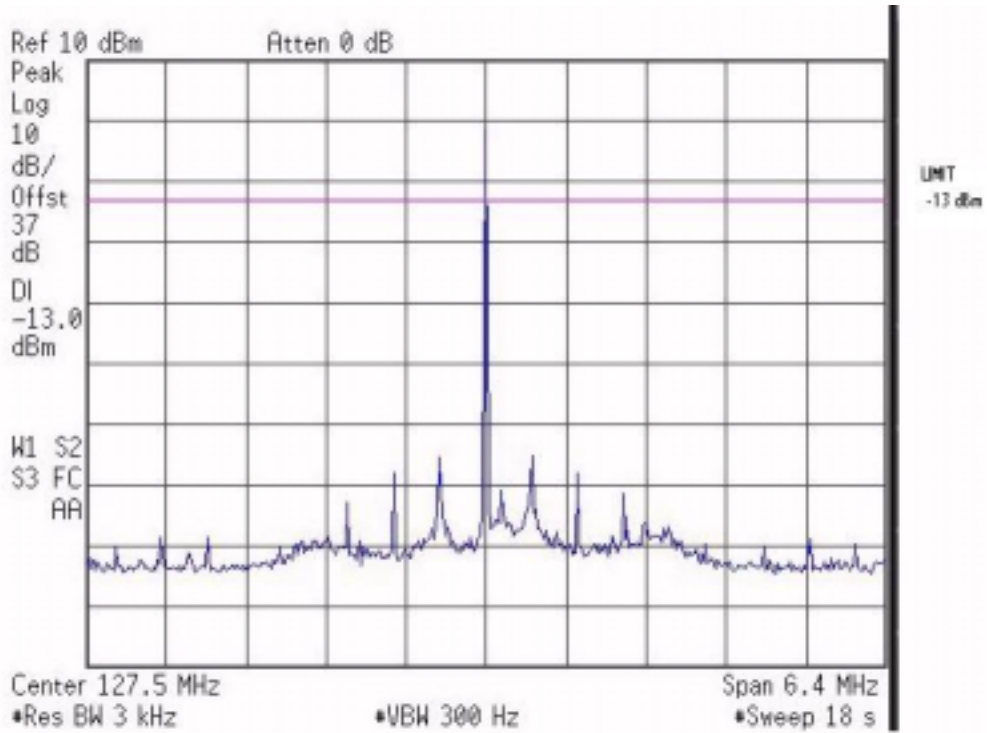
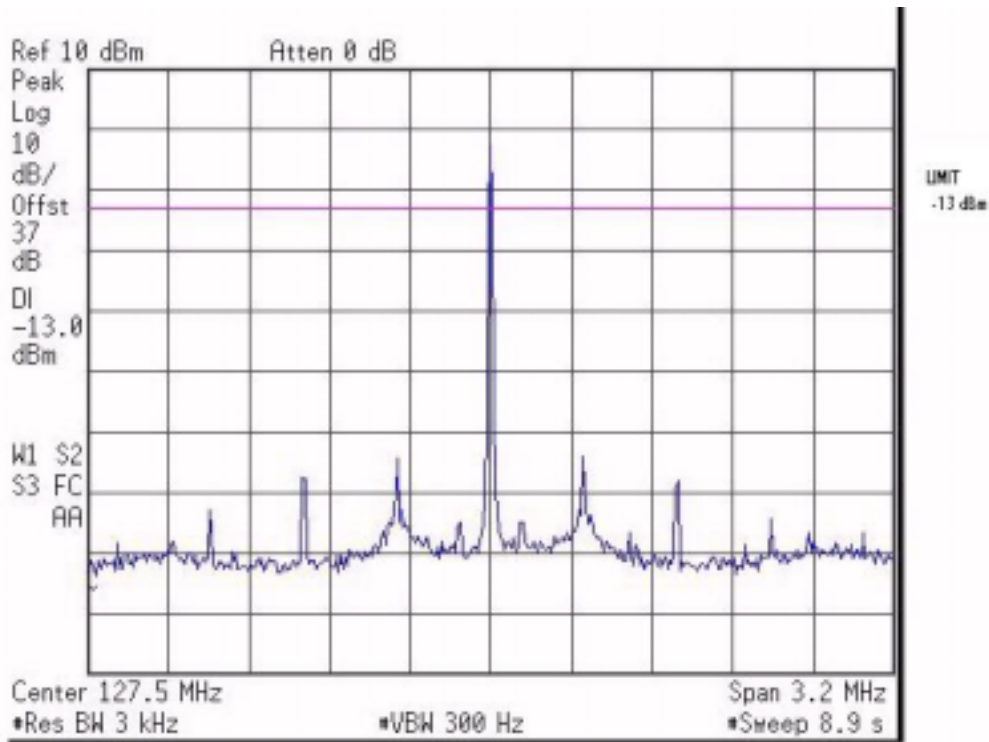
**Plot of Spurious at Antenna Port, 0 to 2000 MHz, Fo = 136.975 MHz, 25 watts**



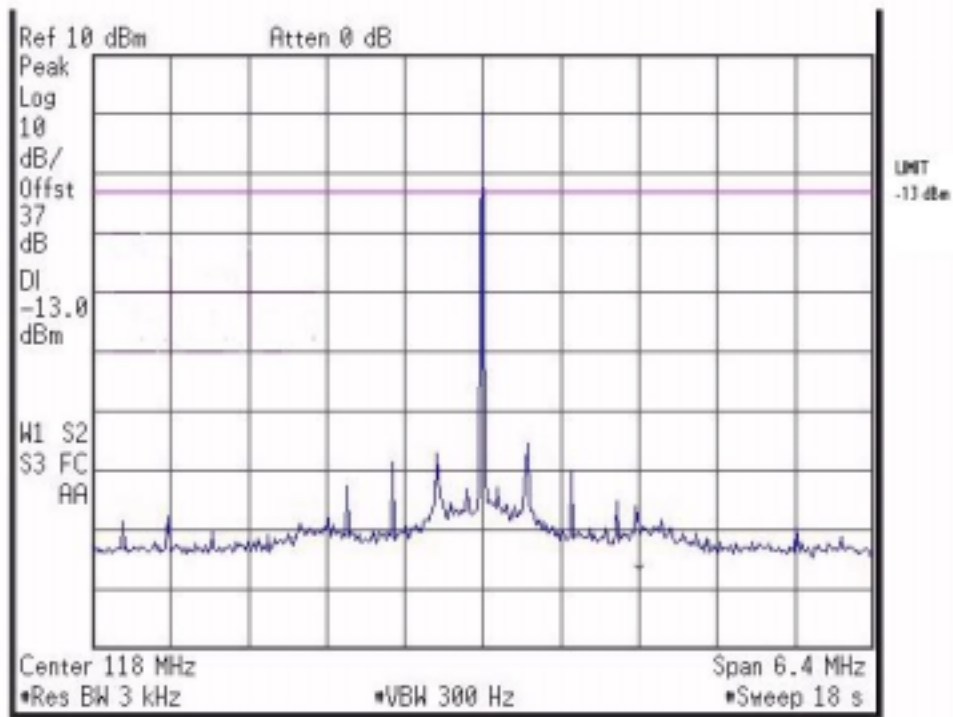
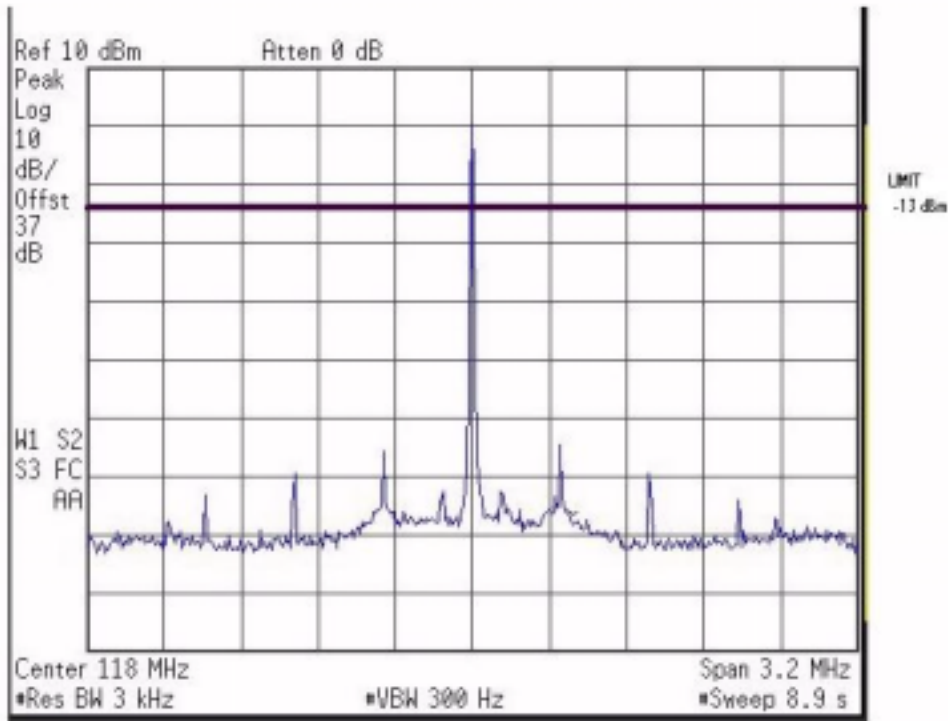
**136.975 MHz harmonic data**

Harmonic Frequency MHz	Measured level dBm	Correction factor dB	Actual spur level dBm	Limit dBm
273.950	-75.8	-31.2	-44.6	-13
410.925	-84.9	-31.1	-53.8	-13
547.900	-91.6	-31.1	-60.5	-13
684.875	-96.9	-31.3	-65.6	-13
821.850	-93.9	-31.4	-62.5	-13
958.825	-97.9	-31.1	-66.8	-13
1095.800	-88.7	-31.5	-57.2	-13
1232.775	-85.1	-31.3	-53.8	-13
1369.750	-103.2	-32.6	-70.6	-13
1506.725	-108.1	-35.2	-72.9	-13
1643.700	-108.9	-37.5	-71.4	-13
1780.675	-102.1	-39.4	-62.7	-13
1917.55	-98.2	-36.9	-61.3	-13

### Close-in Spurious Emissions, 127.5 MHz, 25 watts

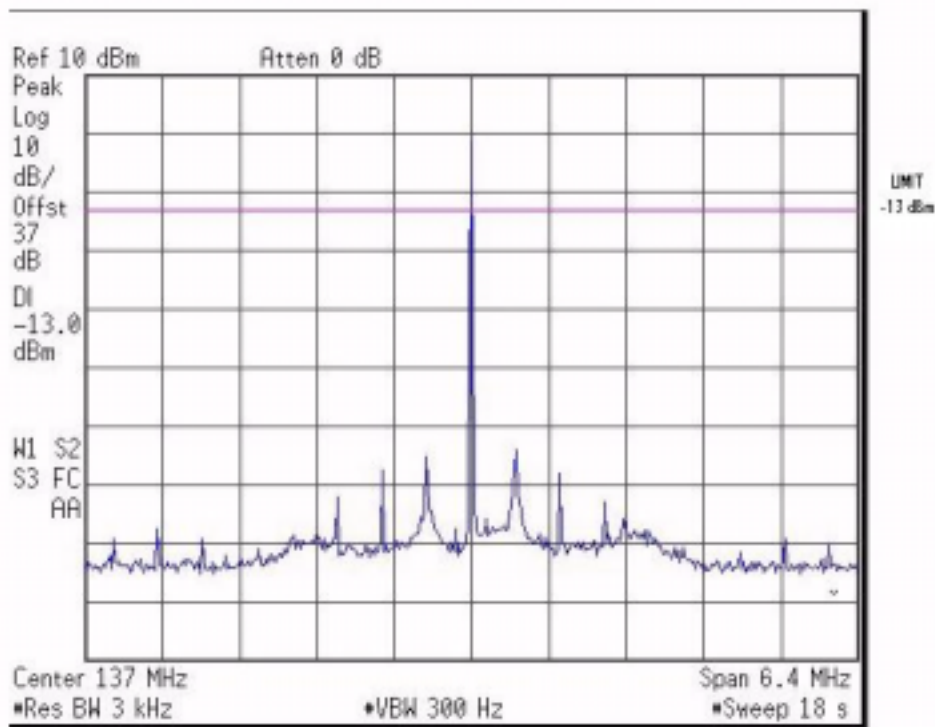
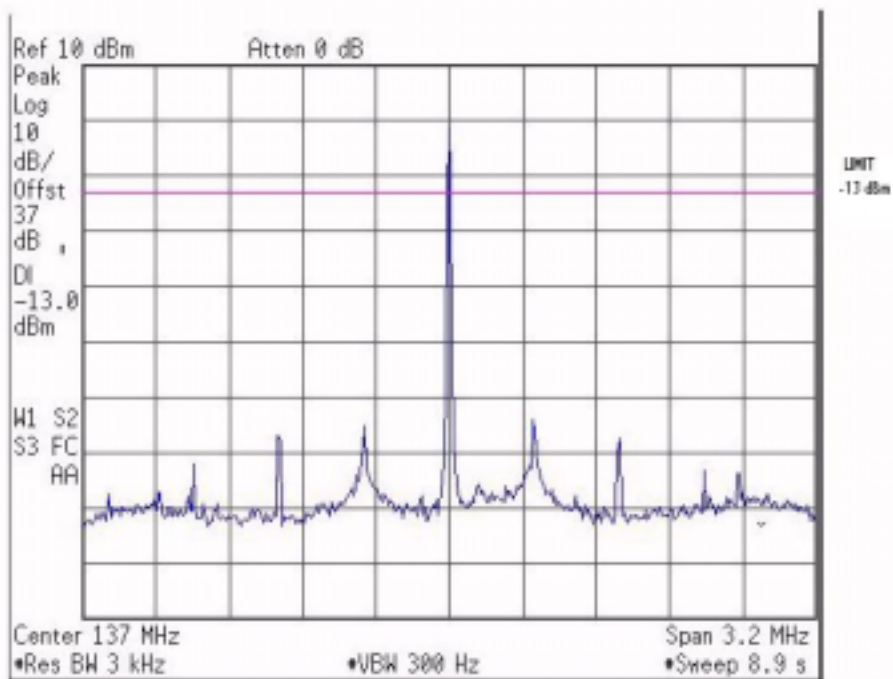


### Close-in Spurious Emissions, 118 MHz, 25 watts





**Close-in Spurious Emissions, 136.975 MHz, 25 watts**



## **2.1057 - Frequency Spectrum to be Investigated**

For all tests conducted at Harris Corporation the maximum frequency investigated was 2000 MHz. This value is greater than ten times the highest frequency used (181.975 MHz, in the receiver local oscillator circuit) in the transceiver.

## List of Test Equipment Used

For measurements conducted at Harris Corporation (occupied bandwidth, frequency stability, power output and conducted spurious at antenna terminals) the following test equipment was used.

<u>Type of equipment</u>	<u>Manufacturer</u>	<u>Model Number</u>	<u>Serial Number</u>	<u>Calibration Date</u>
Spectrum analyzer	Hewlett-Packard	E4401B	US39440385	2/19/03
Spectrum analyzer	Hewlett-Packard	8568E	2848A04834	8/9/02
Power meter	Bird	4421	3895	-
Power sensor	Bird	4022	0111	12/02/02
RF load	Res-net	RFA150NMF30	30409	9/22/03
Signal generator	Hewlett-Packard	8643	3309A00371	7/25/03
Frequency counter	Hewlett-Packard	5383A	2032A04119	11/12/02
Frequency standard	Hewlett-Packard	105B	-	3/29/02
AC power source	Pacific	345-AMX	28400	-
Variable RF atten.	Kay	432D	21685	5/17/03
Fixed RF attenuator	Mini-Circuits	CAT-x	-	-
Notch filter	TX/RX Systems	20-35-96016	36462-A	-
Vector signal analyzer	Hewlett-Packard	89441A	US39313906	1/08/03
VSA RF section	Hewlett-Packard	89441A	US39312289	1/08/03
Network Analyzer	Hewlett-Packard	8753D	3410A05658	8/09/02
High pass filter	Mini-Circuits	NHP-250	-	-
Low noise amplifier	Mini-Circuits	ZFL-500LN	-	-
Crystal filter	Piezo Technology	4133VBB	1775	-
Personal computer	Compaq	Contura 410CX	-	-
RF Power Meter	Boonton	4230	12901	6/11/02
RF Power Sensor	Boonton	51101	28729	7/12/02