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FCC Part 22 Certification Application

FCC Form 731

For The

**VIPER SC 100
VHF RADIO MODEM**

FCC ID: NP4-5018-500

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1.0 Transmitter Rated Power Output

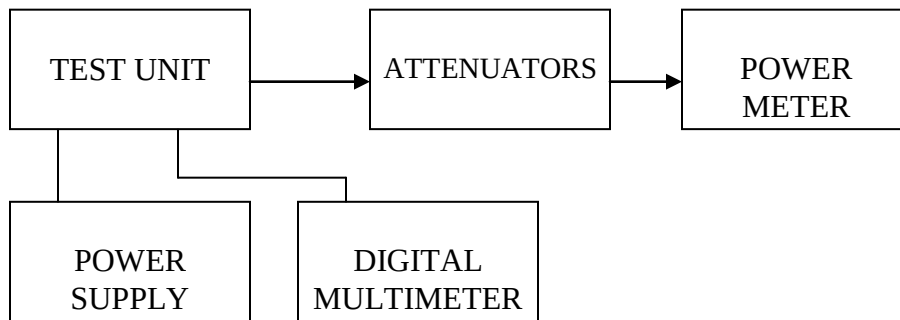
RULE PART NUMBER: 2.1046 (a) (c), 22.535

TEST RESULTS: See results below

TEST CONDITIONS: Standard Test Conditions

TEST EQUIPMENT: 50-Ohm Atten, Bird Electronics Model 50-A-MFN-20 (20dB, 50W)
 50-Ohm Atten, Bird Electronics Model 10-A-MFN-10 (10dB, 10W)
 Power Supply, Hewlett Packard Model 6653A
 Digital Multimeter, HP 3478A
 Power Meter, Model HP437B

TEST SET-UP:



§22.535 Effective radiated power limits.

The effective radiated power (ERP) of transmitters operating on the channels listed in §22.531 must not exceed the limits in this section.

(a) *Maximum ERP.* The ERP must not exceed the applicable limits in this paragraph under any circumstances.

Frequency range (MHz)	Maximum ERP (Watts)
35-36	600
43-44	500
152-159	1400
931-932	3500

Note: The maximum power output of the Viper VHF Transceiver/Modem is 12 Watts. This device will be professionally installed. It is the responsibility of the licensee and installer to properly install the device and be in compliance with the ERP limits of Part 22.535.

TEST RESULTS:

Frequency (MHz)	DC Voltage at Final (Vdc)	DC Current into Final (Adc)	DC Power into Final (W)	RF Power Output (W)
157.451250	12.0	2.56	30.72	12.0

2.0 Frequency Stability

RULE PART NUMBER: 2.1055 (d)(1), 22.355;

MINIMUM STANDARD: Shall not exceed ± 5.00 ppm.

Except as otherwise provided in this part the carrier frequency of each transmitter in the Public Mobile Services must be maintained within the tolerances given in Table C-1 of this section.

TABLE C-1—FREQUENCY TOLERANCE FOR TRANSMITTERS IN THE PUBLIC MOBILE SERVICES

Frequency range (MHz)	Base, fixed (ppm)	Mobile >3 watts (ppm)	Mobile ≤ 3 watts (ppm)
50 to 450	5.0	5.0	50.0

Per test data supplied in the original certification NP4-5018-500:

The frequency tolerance of the Viper VHF Transceiver/Modem is 1.0 parts per million as granted in NP4-5018-500.

3.0 Transmitter Occupied Bandwidth Necessary Bandwidth

RULE PART NUMBER: FCC: 2.201, 2.202, 2.1033 (c)(14), 2.1049 (h), 2.1041, 22.359;

Necessary Bandwidth Measurement

This radio modem uses digital modulation signals, passing through a Squared Root Raised Cosine $\alpha=0.2$ or $\alpha=0.5$ DSP implemented low-pass filter to an FM transceiver. The digital modulation is based on SRRC4FSK allows a SRRC2FSK subset to be used for lower bit rate with a better sensitivity reception. The necessary bandwidth calculation for this type of modulation is not covered by paragraphs (1), (2) or (3) from 2.202(c). Therefore, the approach outlined in (2.202(c)(4)) is applicable in this case.

The measurement explanations are provided below.

Necessary Bandwidth Measurement:

Channel Spacing	Emission Type	Data Rate	Baud Rate	Measured Peak Deviation	Measured 99% Occupied BW
6.25 kHz	3K30 F1D	4 kbps	4000	1.03 kHz	3.30 kHz
6.25 kHz	3K55 F1D	8 kbps	4000	1.04 kHz	3.55 kHz
6.25 kHz	3K20 F1D	12 kbps	4000	1.15 kHz	3.20 kHz
6.25 kHz	3K45 F1D	16 kbps	4000	1.056 kHz	3.45 kHz
12.5 kHz	8K20 F1D	8 kbps	8000	3.00 kHz	8.20 kHz
12.5 kHz	8K30 F1D	16 kbps	8000	3.50 kHz	8.30 kHz
12.5 kHz	8K50 F1D	24 kbps	8000	3.725 kHz	8.50 kHz
12.5 kHz	8K08 F1D	32 kbps	8000	3.728 kHz	8.08 kHz
25 kHz	16K5 F1D	16 kbps	16000	6.26 kHz	16.5 kHz
25 kHz	16K8 F1D	32 kbps	16000	7.21 kHz	16.8 kHz
25 kHz	17K8 F1D	48 kbps	16000	7.59 kHz	17.8 kHz
25 kHz	17K0 F1D	64 kbps	16000	7.52 kHz	17.0 kHz

THEORY OF MEASUREMENT

The way to define the Occupied Bandwidth is “the frequency bandwidth such that, below its lower and above its upper frequency limits, the mean powers radiated are each equal to 0.5 percent of the total mean power radiated by a given emission” (FCC 2.202), the mathematics are as follows:

$$0.005*TP=P_{(f1)}=\int_0^{f1} PSD(f)df$$

$$0.995*TP=P_{(f2)}=\int_0^{f2} PSD(f)df$$

$$OBW=f2-f1$$

where TP (total mean power) is

$$TP=\int_0^{+\infty} PSD(f)df=(1/t)\int_{-\infty}^{+\infty}|z(t)|^2dt$$

and PSD (power spectral distribution) is

$$\text{PSD}(f) = |Z(f)|^2 + |Z(-f)|^2 \quad 0 \leq f < \infty$$

and expresses the positive frequency representation of the transmitter output power for $z(t)$ signal.

By applying these mathematics to the measurements, it is possible to measure the Occupied Bandwidth using a digital spectrum analyzer.

The Occupied Bandwidth measurement is in two parts relatively independent of each other. The first gives the RF spectrum profile, and the second calculates the frequency limits and they result in the Occupied bandwidth. While the first involves RF measurement instrumentation, the second is strictly a computational part related to measured trace.

TEST EQUIPMENT:

50-Ohm Attenuator, Bird Electronics Model 50-A-FFN-20 (20dB, 50W)
 50-Ohm Attenuator, Bird Electronics Model 10-A-MFN-10 (10dB, 10W)
 DC Power Supply, Hewlett Packard Model 6653A
 Spectrum Analyzer, Hewlett Packard Model HP8563E
 Modulation Analyzer, Hewlett Packard Model HP8901A

TEST SET-UP:

For the above requirements, the occupied bandwidth of a transmitter was measured using an HP8563E using the following settings:

Occupied BW % Power: 99%

Trace: Max Hold A

RBW: 100 Hz (6.25 and 12.5 kHz channels)

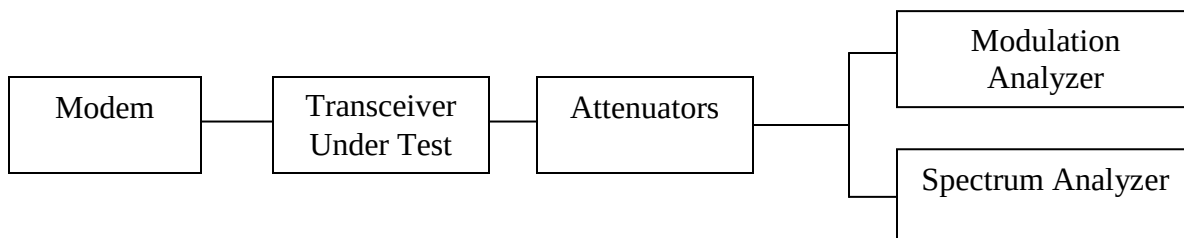
RBW: 300 Hz (25 kHz and 50 kHz channels)

VBW: 3 kHz

SPAN: 100 kHz (6.25 and 12.5 kHz channels)

SPAN: 150 kHz (25 kHz channels)

SPAN: 200 kHz (50 kHz channels)



MODULATION SOURCE DESCRIPTION:

The 4-level signaling transmits two information bits per symbol (baud), which yields a bit rate of twice the on-air baud rate. Hence the 64 kbps references in the Installation Guide correspond to a transmitter baud rate of 32000 baud. The 8-level signaling transmits three information bits per symbol (baud), which yields a bit rate of three times the on-air baud rate. Hence the 12, 24, 48, or 96 kbps references in the Installation Guide correspond to a transmitter baud rate of 4000, 8000, 16000 or 32000 baud. The 16-level signaling transmits four information bits per symbol (baud), which yields a bit rate of four times the on-air baud rate. Hence the 16, 32, 64, or 128 kbps references in the Installation Guide correspond to a transmitter baud rate of 4000, 8000, 16000 or 32000 baud. That digital signal is digitally filtered (Square Root Raised Cosine pulse shaping with $\alpha=0.2$ or 0.5) by the DSP and converted to I&Q components, then fed to the digital to analog converter. This SRRC4FSK, SRRC8FSK, or SRRC16FSK wave shape applied to the FM modulator will then produce a compact RF spectrum, when using proper frequency deviation, to fit inside the restrictive masks inherent to the intended channel bandwidth.

TX Data Test Pattern:

The transmit “test data” pattern command produces a 107,3741,823 bit pseudo- random pattern. This pattern is generated by the DSP. The 107,3741,823 bit sequence is repeated thereafter as long is necessary to complete the test duration, this sequence lasts 67,109 seconds at 16 kbps. Commonly this is longer than the test duration. This pattern is applied to the DSP modulator for mapping to 4-FSK, 8-FSK and 16-FSK and pulse shaping with SRRC $\alpha=0.2$ or $\alpha=0.5$ depending on the channel selection. This data follows same modulation process as described in MODULATION SOURCE DESCRIPTION and the resulting base band signal feeds the modulator's input of the transceiver.

4.0 Part 22.359 Occupied Bandwidth Requirements

NAME OF TEST: Transmitter Occupied Bandwidth for Emission Designators
3K30F1D, 3K55F1D, 3K20F1D, 3K45F1D, 8K20F1D, 8K30F1D, 8K50F1D, 8K08F1D, 16K5F1D, 16K8F1D, 17K8F1D and 17K0F1D

RULE PART NUMBER: FCC: 2.106, 2.202, 2.1049 (c) (1), 22.359 (a) (b)

MINIMUM STANDARDS: The intended Frequencies Bands of Operation per FCC Part 2.106 for Part 22 are:
 150.800-152.855 MHz
 157.450-161.775 MHz
 The Test Frequencies chosen for each bandwidth setting are one standard channel spacing (+/-) away from the Band Edge per the table below to show compliance at the band edges.

Band Edge Frequency	Test Frequencies per Bandwidth		
	6.25 kHz Channel	12.5 kHz Channel	25.0 kHz Channel
150.800000	150.806250 MHz	150.812500 MHz	150.825000 MHz
157.450000	157.456250 MHz	157.462500 MHz	157.475000 MHz
161.775000	161.768750 MHz	161.762500 MHz	161.750000 MHz

The Part 22 Emission Mask as defined below exceeds the requirement.

Sidebands and Spurious [Rule 22.359 (a), Rule 22.359 (b) P = 12 Watts]
 All Sidebands and spurious outside the Frequency Bands of Operation to be attenuated:

$$43 + 10\log_{10}(P). \text{ At 12W that is 53.8 dB.}$$

The plots supplied in this section clearly show the Viper VHF Transceiver/Modem show the sidebands and spurious outside the Frequency Bands of Operation to meet the requirement.

For Transmitter Spurious and Harmonics measurements outside the Occupied Bandwidth refer to the NP4-5018-500. Transmitter Spurious and Harmonics were shown to be $55+10\log(P)$ which exceeds the $43+10\log(P)$ of Part 22.359 requirement.

§22.359 Emission limitations.

The rules in this section govern the spectral characteristics of emissions in the Public Mobile Services, except for the Air-Ground Radiotelephone Service (see §22.861, instead) and the Cellular Radiotelephone Service (see §22.917, instead).

(a) *Out of band emissions.* The power of any emission outside of the authorized operating frequency ranges must be attenuated below the transmitting power (P) by a factor of at least $43 + 10 \log (P)$ dB.

(b) *Measurement procedure.* Compliance with these rules is based on the use of measurement instrumentation employing a resolution bandwidth of 30 kHz or more. In the 60 kHz bands immediately outside and adjacent to the

authorized frequency range or channel, a resolution bandwidth of at least one percent of the emission bandwidth of the fundamental emission of the transmitter may be employed. A narrower resolution bandwidth is permitted in all cases to improve measurement accuracy provided the measured power is integrated over the full required measurement bandwidth (i.e., 30 kHz or 1 percent of emission bandwidth, as specified). The emission bandwidth is defined as the width of the signal between two points, one below the carrier center frequency and one above the carrier center frequency, outside of which all emissions are attenuated at least 26 dB below the transmitter power.

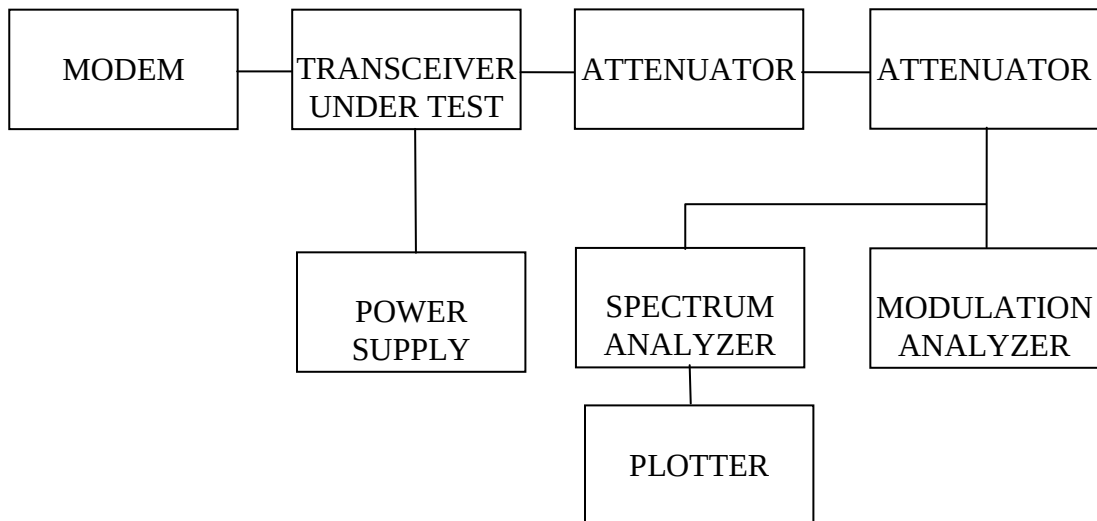
TEST RESULTS: Meets minimum standards (see data on following page)

TEST CONDITIONS: Standard Test Conditions, 25 C
RF Power Level = 12 Watts
Voltage = 20VDC

TEST PROCEDURE: TIA/EIA – 603-C

TEST EQUIPMENT: 50-Ohm Attenuator, Bird Electronics Model 50-A-FFN-20 (20dB, 50W)
50-Ohm Attenuator, Bird Electronics Model 10-A-MFN-10 (10dB, 10W)
50-Ohm Attenuator, Pasternack Model PE7002-10 (10dB)
DC Power Supply, Hewlett Packard Model 6653A
Spectrum Analyzer, Hewlett Packard Model HP8563E
Modulation Analyzer, Hewlett Packard Model HP8901A

TEST SET-UP:



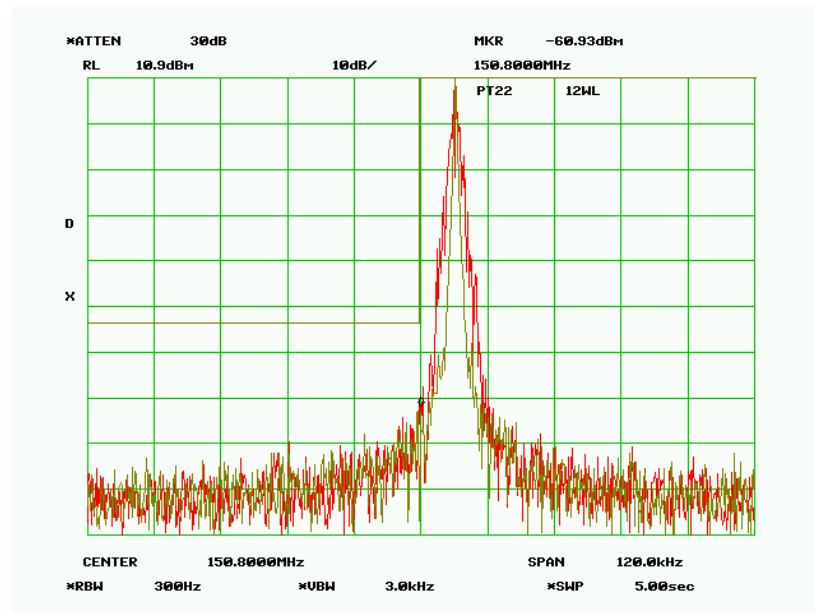
Band Edge – 150.800000, Test Frequency - 150.806250 MHz

Power Output - 12.0 Watts

SPECTRUM FOR EMISSION - 3K30F1D

Data Rate = 4 kbps

PEAK DEVIATION = 1.03 kHz



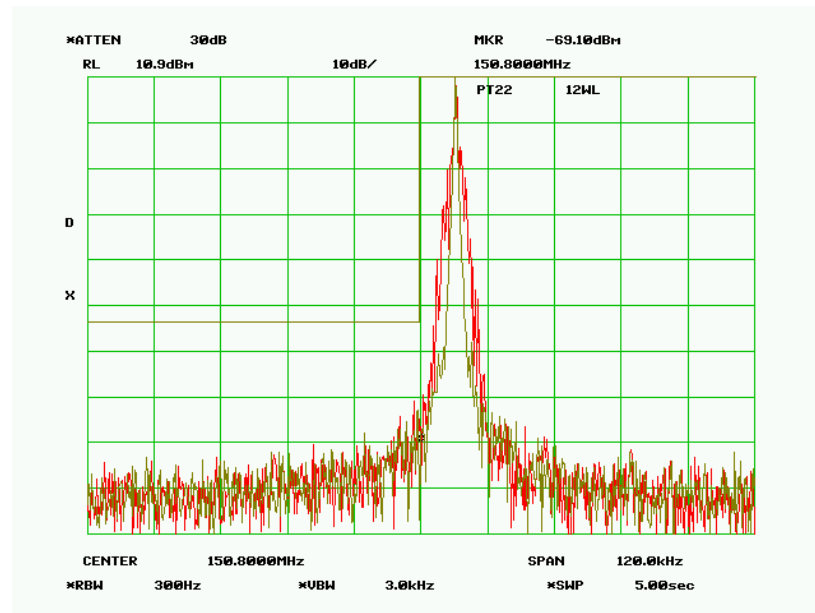
Band Edge – 150.800000, Test Frequency - 150.806250 MHz

Power Output - 12.0 Watts

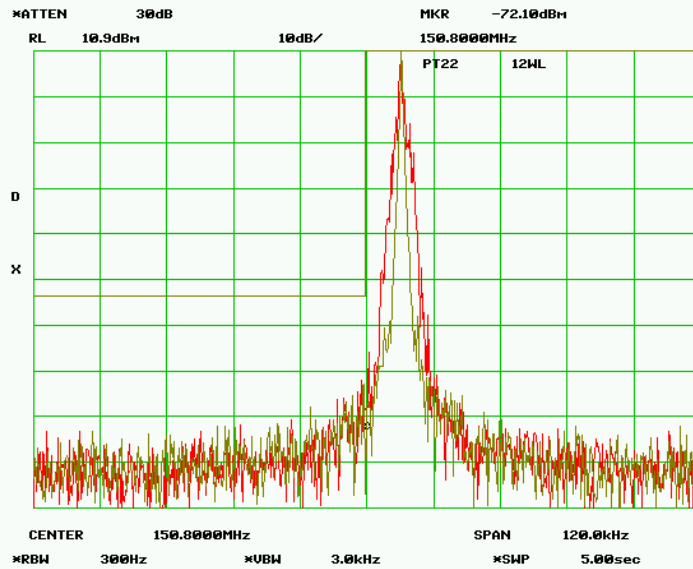
SPECTRUM FOR EMISSION - 3K55F1D

Data Rate = 8 kbps

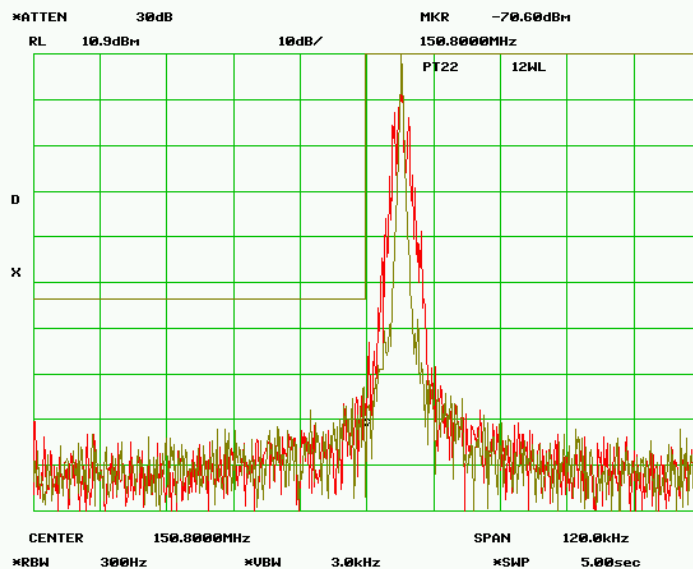
PEAK DEVIATION = 1.04 kHz



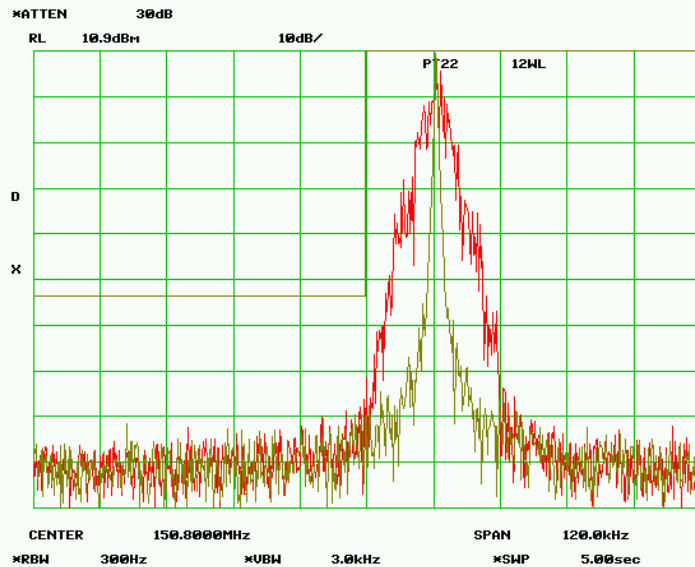
Band Edge – 150.800000, Test Frequency - 150.806250 MHz
 Power Output - 12.0 Watts
 SPECTRUM FOR EMISSION - 3K20F1D
 Data Rate = 12 kbps
 PEAK DEVIATION = 1.15 kHz



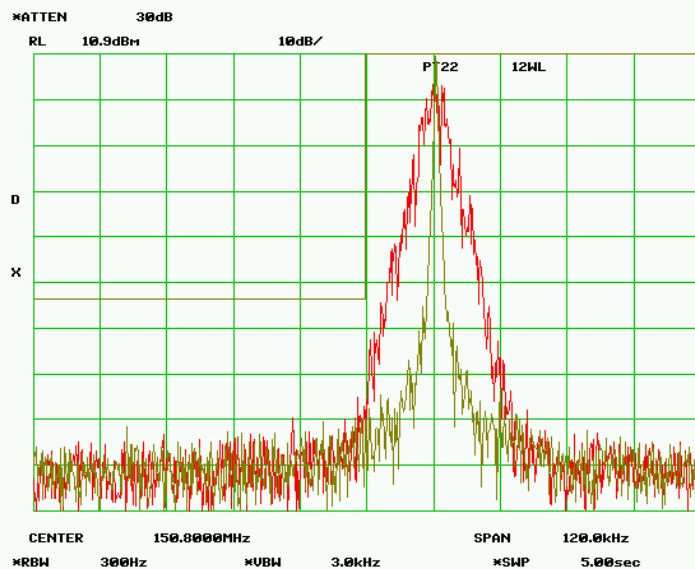
Band Edge – 150.800000 Test Frequency - 150.806250 MHz
 Power Output - 12.0 Watts
 SPECTRUM FOR EMISSION - 3K45F1D
 Data Rate = 16 kbps
 PEAK DEVIATION = 1.056 kHz



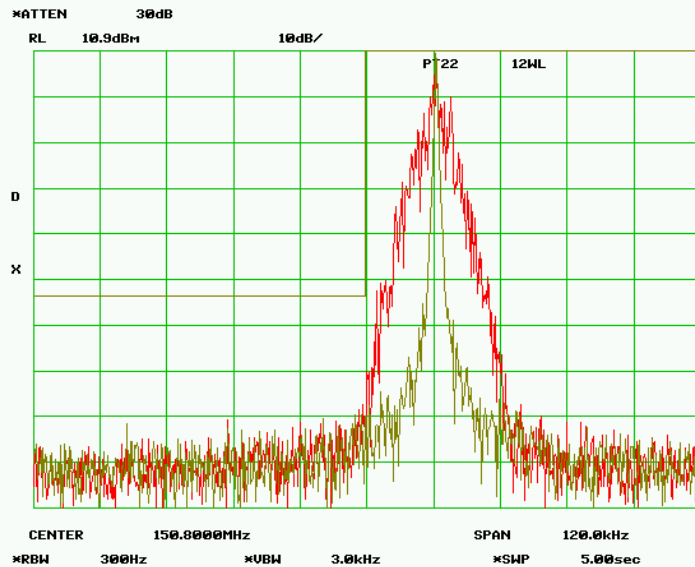
Band Edge – 150.800000, Test Frequency - 150.812500 MHz
 Power Output - 12.0 Watts
 SPECTRUM FOR EMISSION - 8K20F1D
 Data Rate = 8 kbps
 PEAK DEVIATION = 3.00 kHz



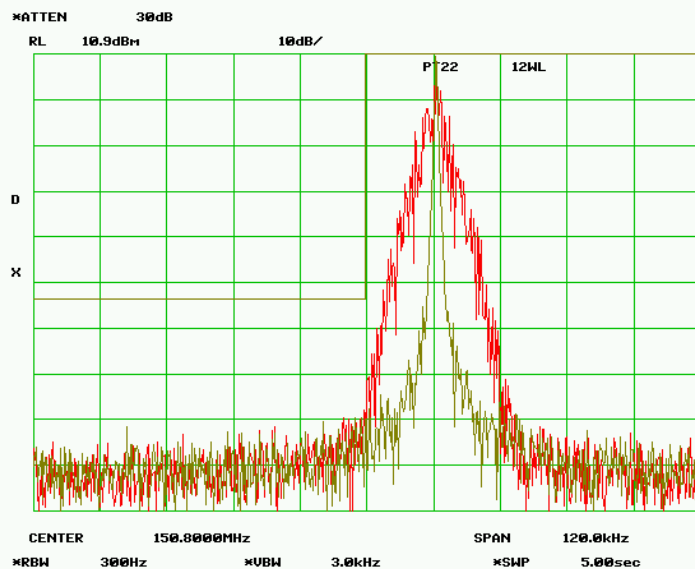
Band Edge – 150.800000, Test Frequency - 150.812500 MHz
 Power Output - 12.0 Watts
 SPECTRUM FOR EMISSION - 8K30F1D
 Data Rate = 16 kbps
 PEAK DEVIATION = 3.50 kHz



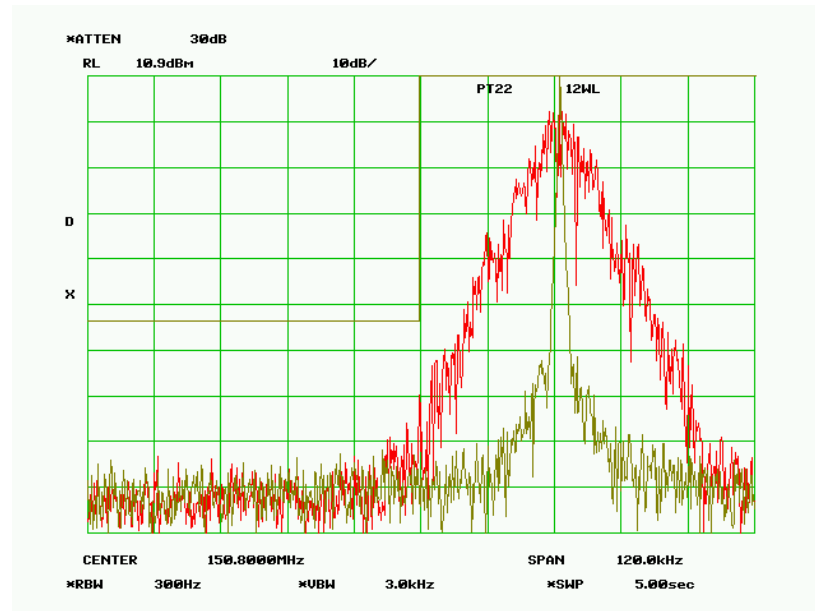
Band Edge – 150.800000, Test Frequency - 150.812500 MHz
 Power Output - 12.0 Watts
 SPECTRUM FOR EMISSION - 8K50F1D
 Data Rate = 24 kbps
 PEAK DEVIATION = 3.725 kHz



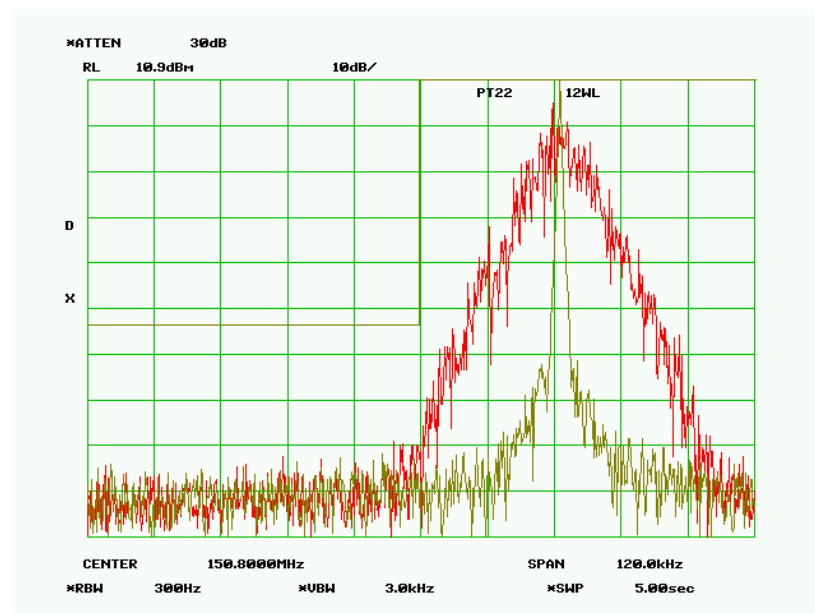
Band Edge – 150.800000, Test Frequency - 150.812500 MHz
 Power Output - 12.0 Watts
 SPECTRUM FOR EMISSION - 8K08F1D
 Data Rate = 32 kbps
 PEAK DEVIATION = 3.728 kHz



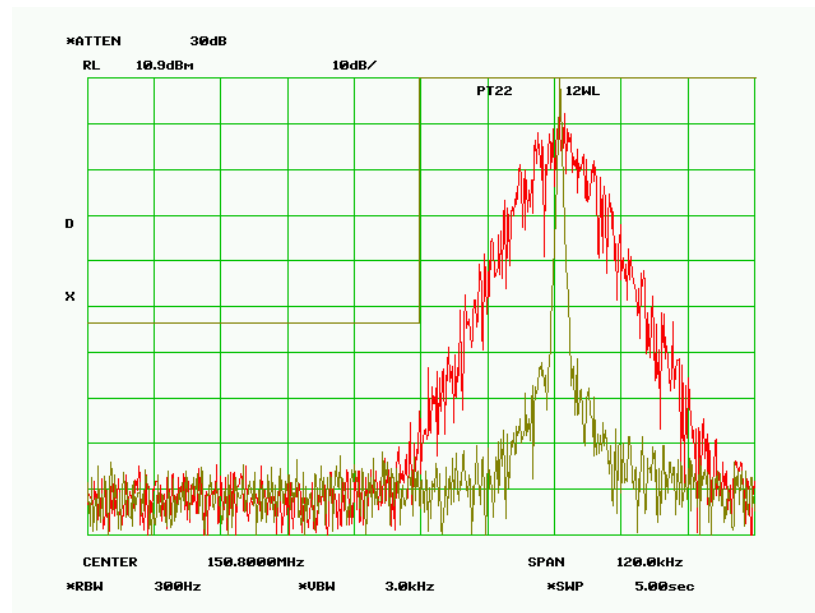
Band Edge – 150.800000, Test Frequency - 150.825000 MHz
Power Output - 12.0 Watts
SPECTRUM FOR EMISSION - 16K5F1D
Data Rate = 16 kbps
PEAK DEVIATION = 6.26 kHz



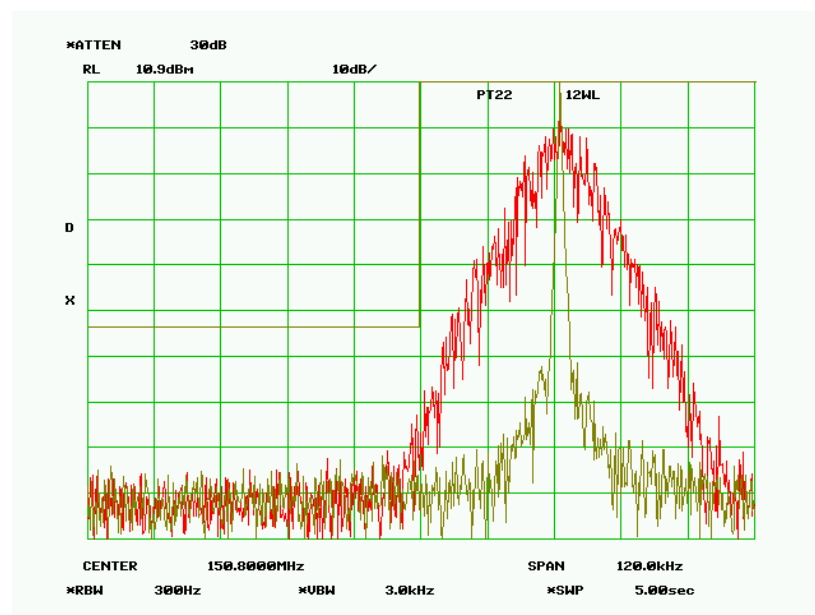
Band Edge – 150.800000, Test Frequency - 150.825000 MHz
Power Output - 12.0 Watts
SPECTRUM FOR EMISSION - 16K8F1D
Data Rate = 32 kbps
PEAK DEVIATION = 7.21 kHz



Band Edge – 150.800000, Test Frequency - 150.825000 MHz
Power Output - 12.0 Watts
SPECTRUM FOR EMISSION - 17K8F1D
Data Rate = 48 kbps
PEAK DEVIATION = 7.59 kHz



Band Edge – 150.800000, Test Frequency - 150.825000 MHz
Power Output - 12.0 Watts
SPECTRUM FOR EMISSION - 17K0F1D
Data Rate = 64 kbps
PEAK DEVIATION = 7.52 kHz



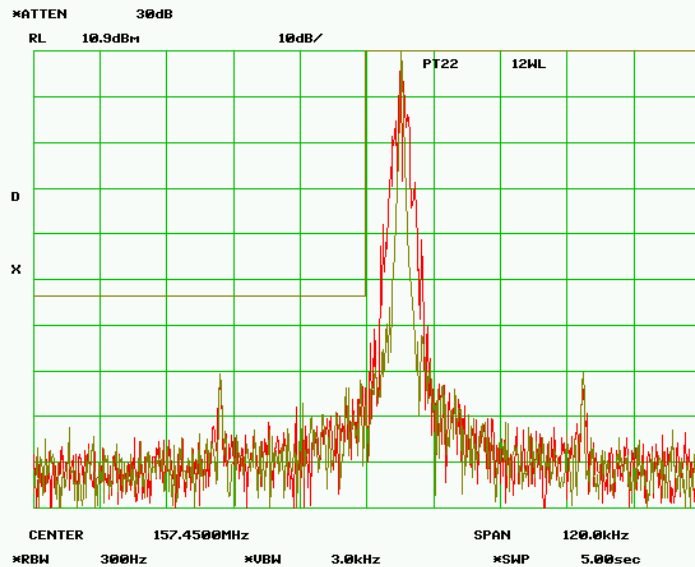
Band Edge – 157.450000, Test Frequency - 157.456250 MHz

Power Output - 12.0 Watts

SPECTRUM FOR EMISSION - 3K30F1D

Data Rate = 4 kbps

PEAK DEVIATION = 1.03 kHz



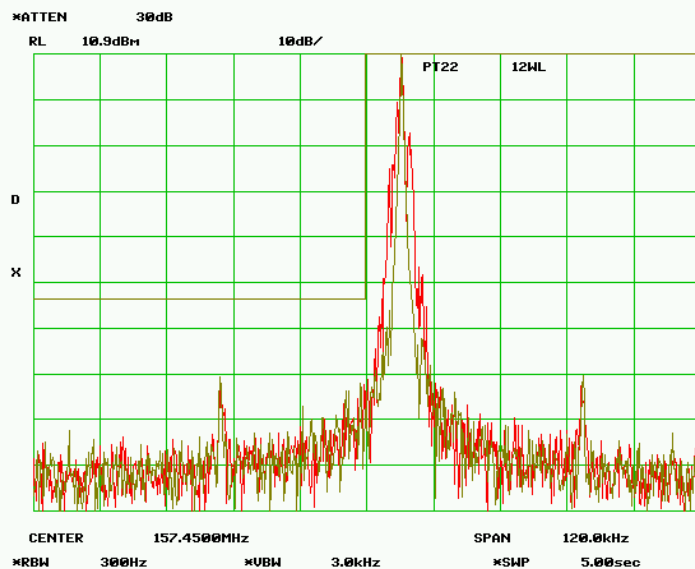
Band Edge – 157.450000, Test Frequency - 157.456250 MHz

Power Output - 12.0 Watts

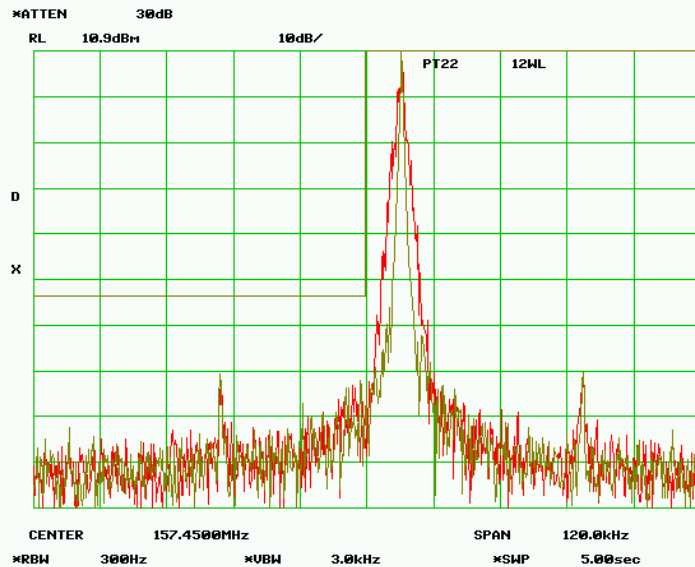
SPECTRUM FOR EMISSION - 3K55F1D

Data Rate = 8 kbps

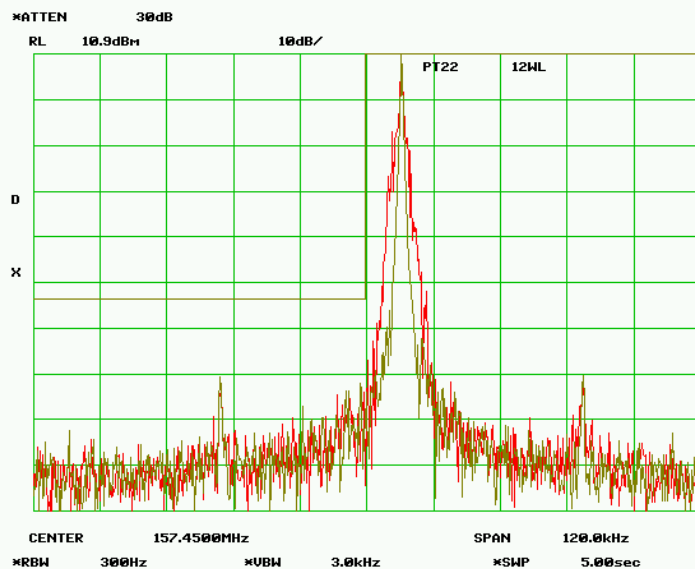
PEAK DEVIATION = 1.04 kHz



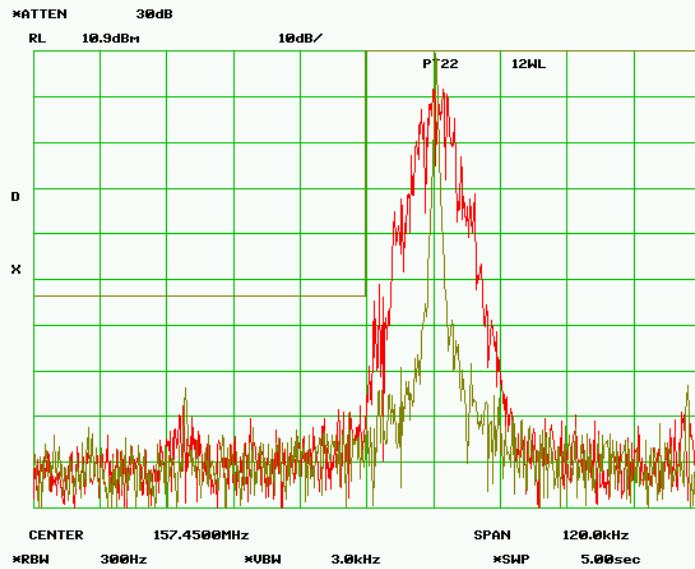
Band Edge – 157.450000, Test Frequency - 157.456250 MHz
 Power Output - 12.0 Watts
 SPECTRUM FOR EMISSION - 3K20F1D
 Data Rate = 12 kbps
 PEAK DEVIATION = 1.15 kHz



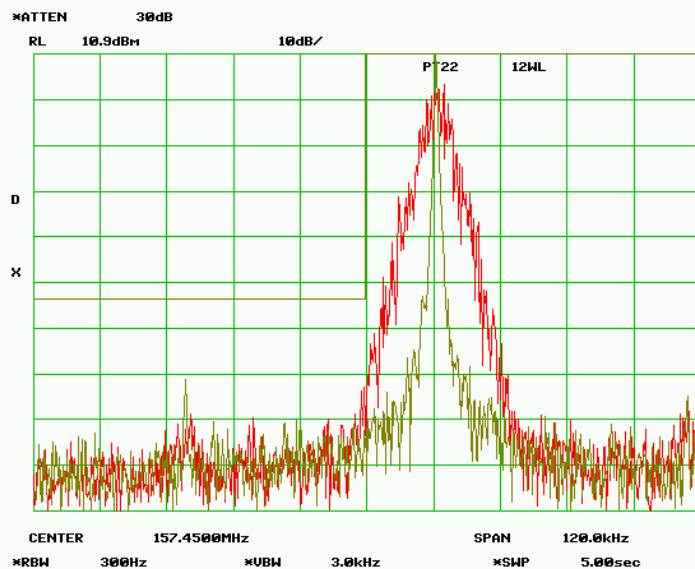
Band Edge – 157.450000, Test Frequency - 157.456250 MHz
 Power Output - 12.0 Watts
 SPECTRUM FOR EMISSION - 3K45F1D
 Data Rate = 16 kbps
 PEAK DEVIATION = 1.056 kHz



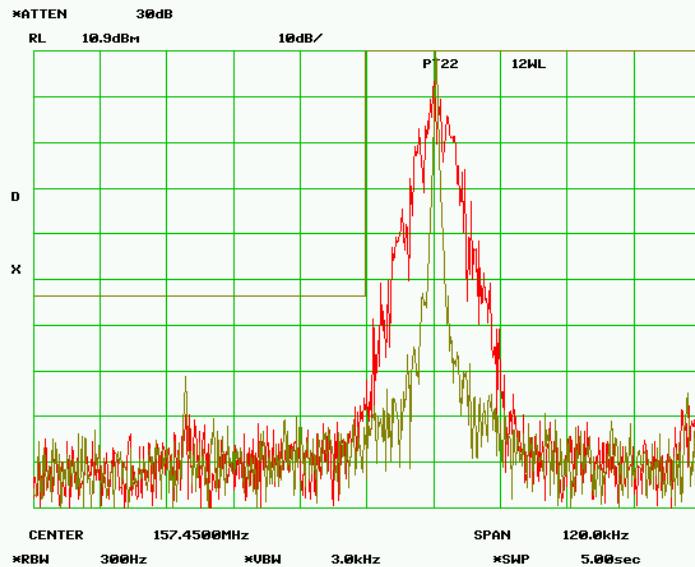
Band Edge – 157.450000, Test Frequency - 157.462500 MHz
 Power Output - 12.0 Watts
 SPECTRUM FOR EMISSION - 8K20F1D
 Data Rate = 8 kbps
 PEAK DEVIATION = 3.00 kHz



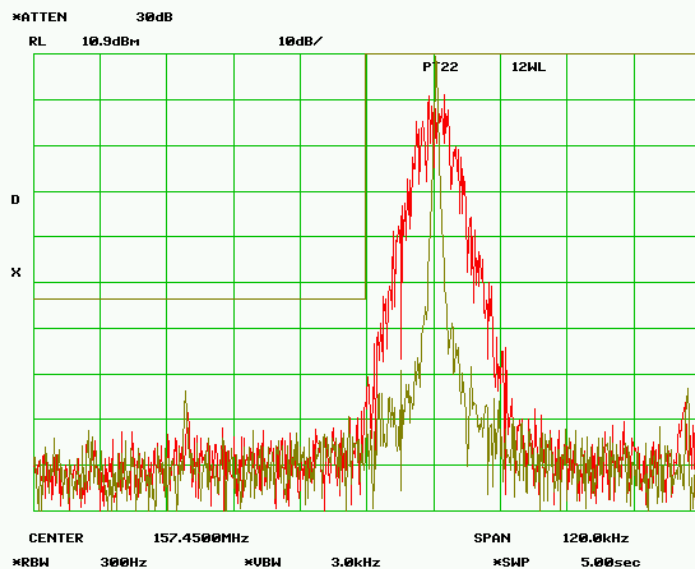
Band Edge – 157.450000, Test Frequency - 157.462500 MHz
 Power Output - 12.0 Watts
 SPECTRUM FOR EMISSION - 8K30F1D
 Data Rate = 16 kbps
 PEAK DEVIATION = 3.50 kHz



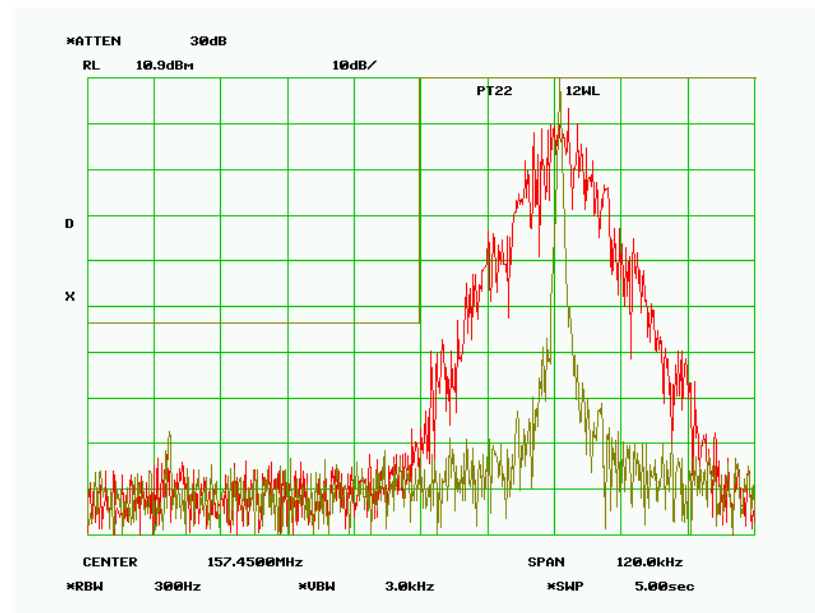
Band Edge – 157.450000, Test Frequency - 157.462500 MHz
 Power Output - 12.0 Watts
 SPECTRUM FOR EMISSION - 8K50F1D
 Data Rate = 24 kbps
 PEAK DEVIATION = 3.725 kHz



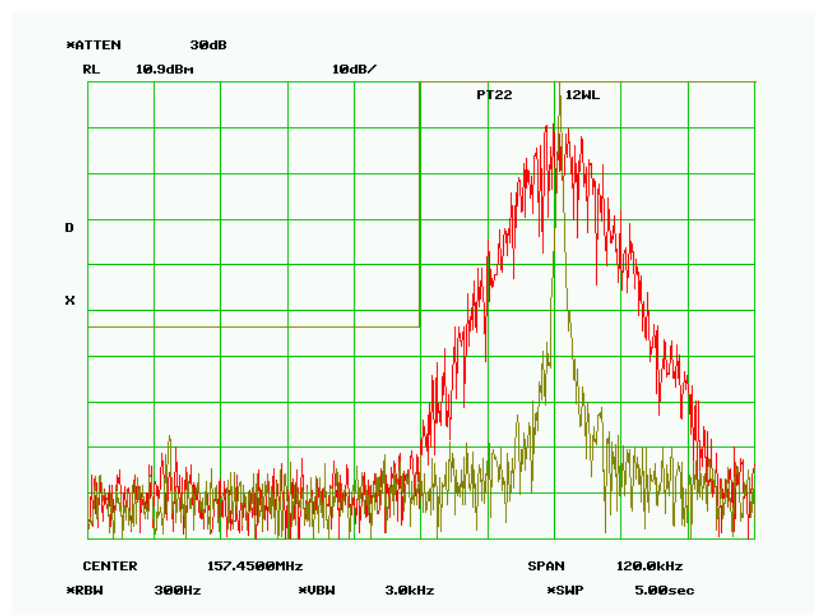
Band Edge – 157.450000, Test Frequency - 157.462500 MHz
 Power Output - 12.0 Watts
 SPECTRUM FOR EMISSION - 8K08F1D
 Data Rate = 32 kbps
 PEAK DEVIATION = 3.728 kHz



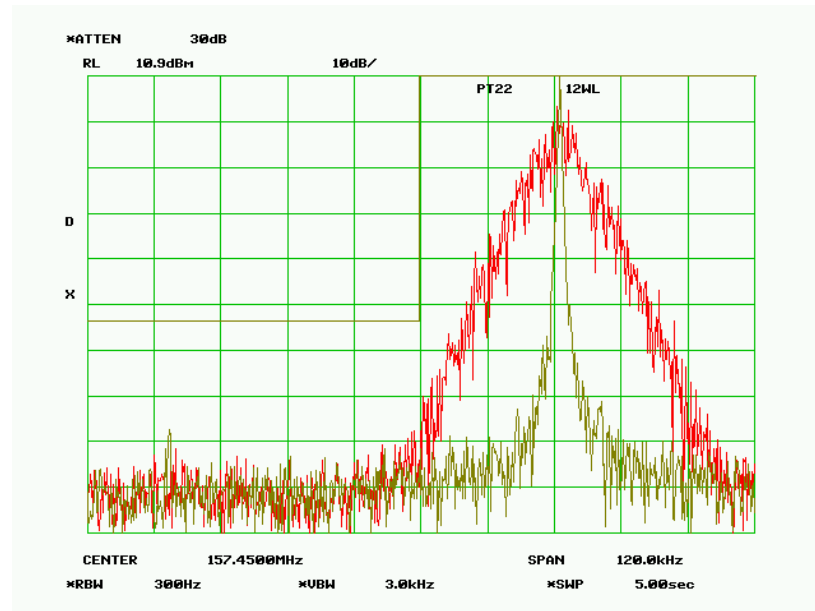
Band Edge – 157.450000, Test Frequency - 157.475000 MHz
Power Output - 12.0 Watts
SPECTRUM FOR EMISSION - 16K5F1D
Data Rate = 16 kbps
PEAK DEVIATION = 6.26 kHz



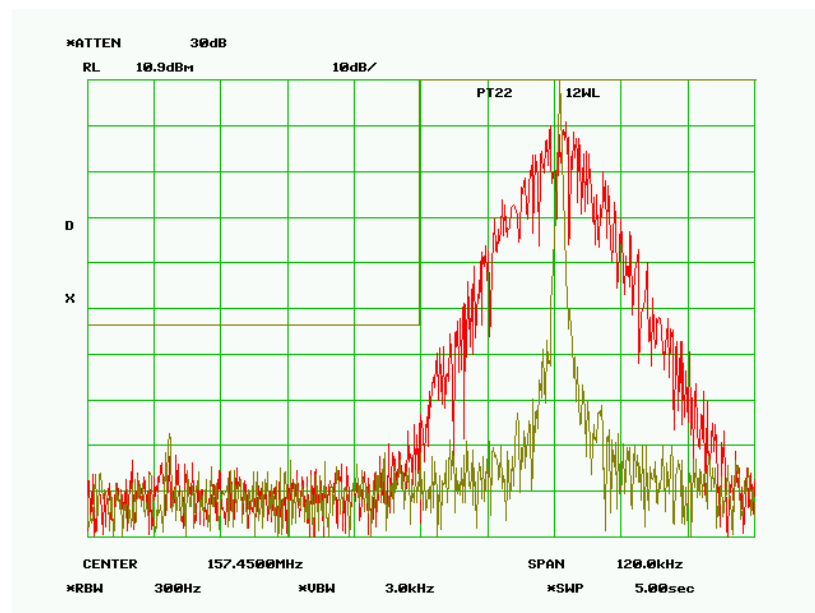
Band Edge – 157.450000, Test Frequency - 157.475000 MHz
Power Output - 12.0 Watts
SPECTRUM FOR EMISSION - 16K8F1D
Data Rate = 32 kbps
PEAK DEVIATION = 7.21 kHz



Band Edge – 157.450000, Test Frequency - 157.475000 MHz
 Power Output - 12.0 Watts
 SPECTRUM FOR EMISSION - 17K8F1D
 Data Rate = 48 kbps
 PEAK DEVIATION = 7.59 kHz



Band Edge – 157.450000, Test Frequency - 157.475000 MHz
 Power Output - 12.0 Watts
 SPECTRUM FOR EMISSION - 17K0F1D
 Data Rate = 64 kbps
 PEAK DEVIATION = 7.52 kHz



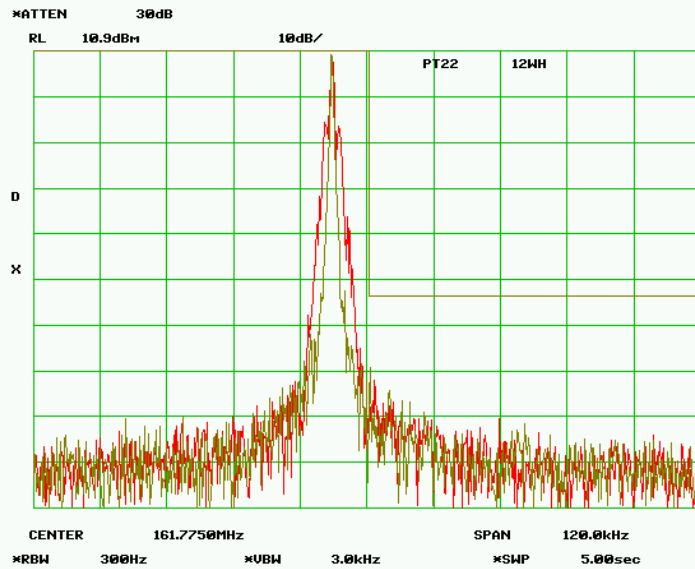
Band Edge – 161.775000, Test Frequency – 161.768750 MHz

Power Output - 12.0 Watts

SPECTRUM FOR EMISSION - 3K30F1D

Data Rate = 4 kbps

PEAK DEVIATION = 1.03 kHz



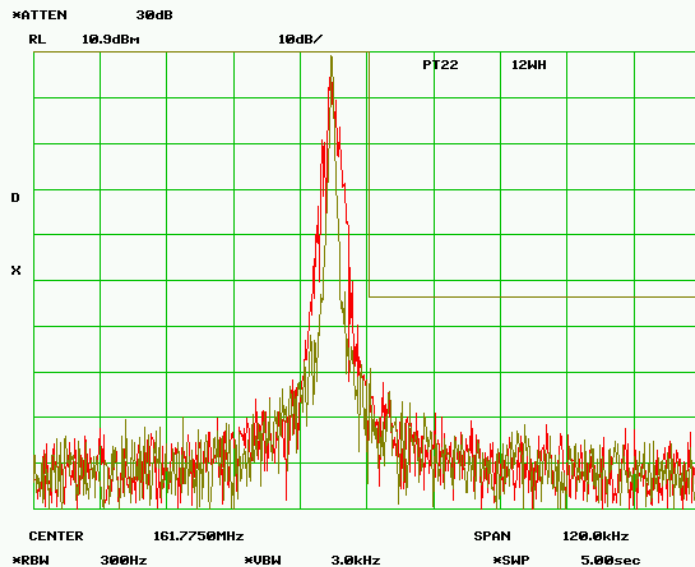
Band Edge – 161.775000, Test Frequency – 161.768750 MHz

Power Output - 12.0 Watts

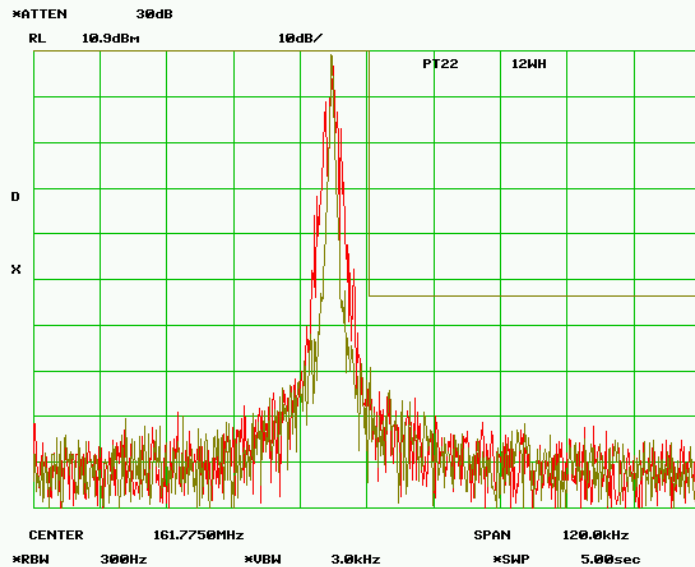
SPECTRUM FOR EMISSION - 3K55F1D

Data Rate = 8 kbps

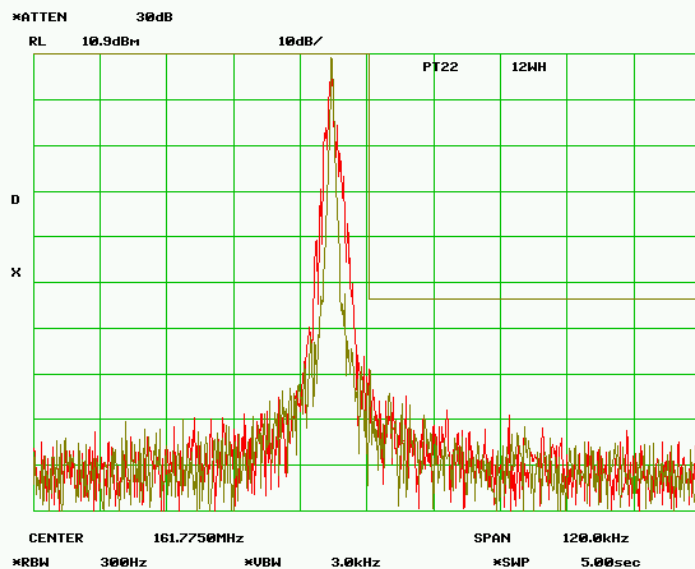
PEAK DEVIATION = 1.04 kHz



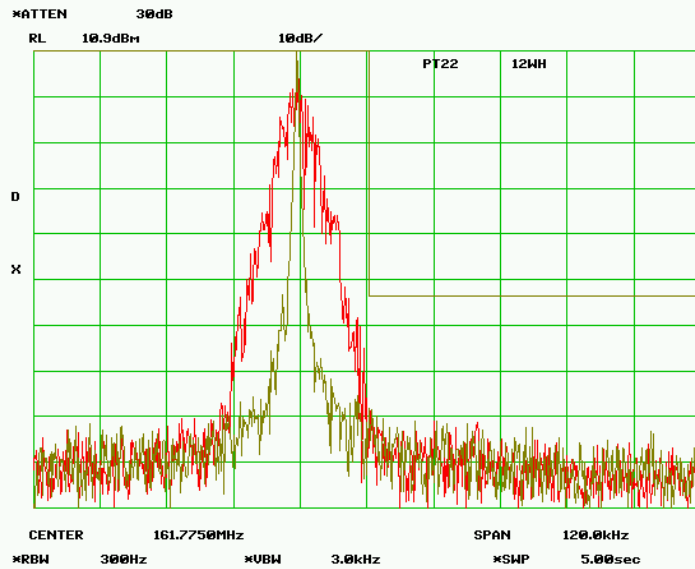
Band Edge – 161.775000, Test Frequency – 161.768750 MHz
 Power Output - 12.0 Watts
 SPECTRUM FOR EMISSION - 3K20F1D
 Data Rate = 12 kbps
 PEAK DEVIATION = 1.15 kHz



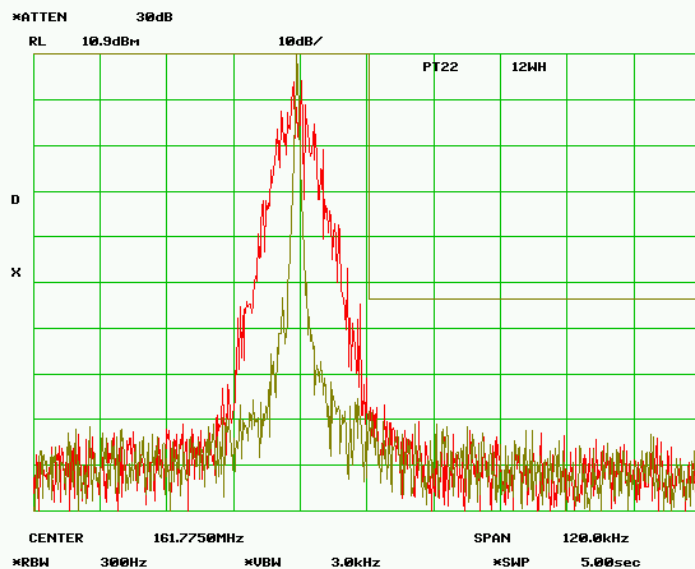
Band Edge – 161.775000, Test Frequency – 161.768750 MHz
 Power Output - 12.0 Watts
 SPECTRUM FOR EMISSION - 3K45F1D
 Data Rate = 16 kbps
 PEAK DEVIATION = 1.056 kHz



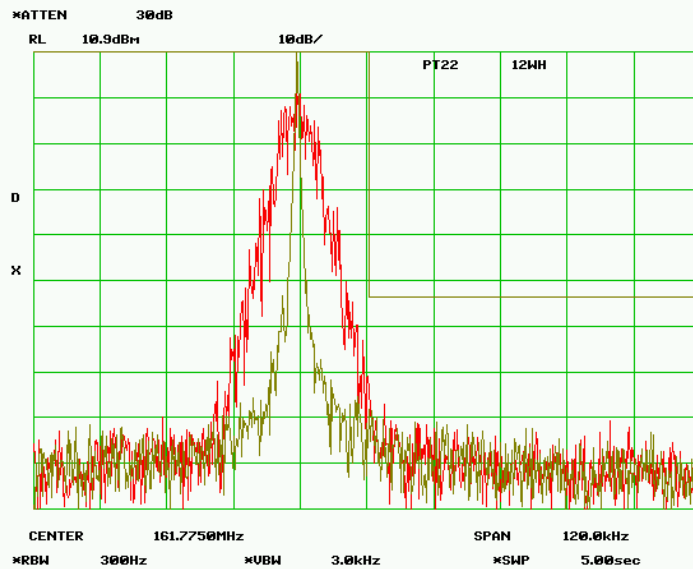
Band Edge – 161.775000, Test Frequency – 161.762500 MHz
 Power Output - 12.0 Watts
 SPECTRUM FOR EMISSION - 8K20F1D
 Data Rate = 8 kbps
 PEAK DEVIATION = 3.00 kHz



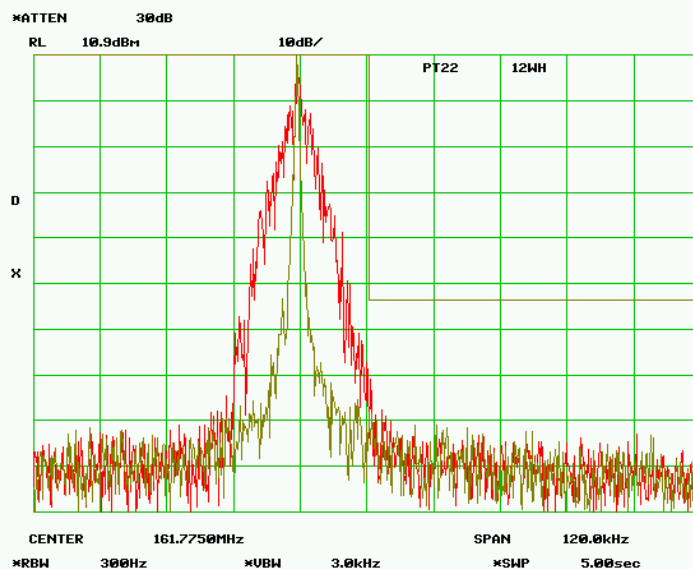
Band Edge – 161.775000, Test Frequency – 161.762500 MHz
 Power Output - 12.0 Watts
 SPECTRUM FOR EMISSION - 8K30F1D
 Data Rate = 16 kbps
 PEAK DEVIATION = 3.50 kHz



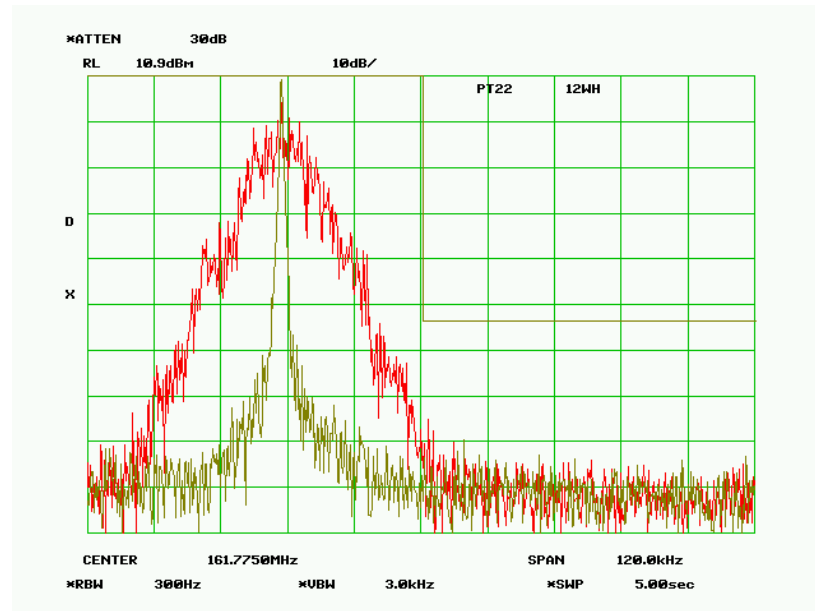
Band Edge – 161.775000, Test Frequency – 161.762500 MHz
 Power Output - 12.0 Watts
 SPECTRUM FOR EMISSION - 8K50F1D
 Data Rate = 24 kbps
 PEAK DEVIATION = 3.725 kHz



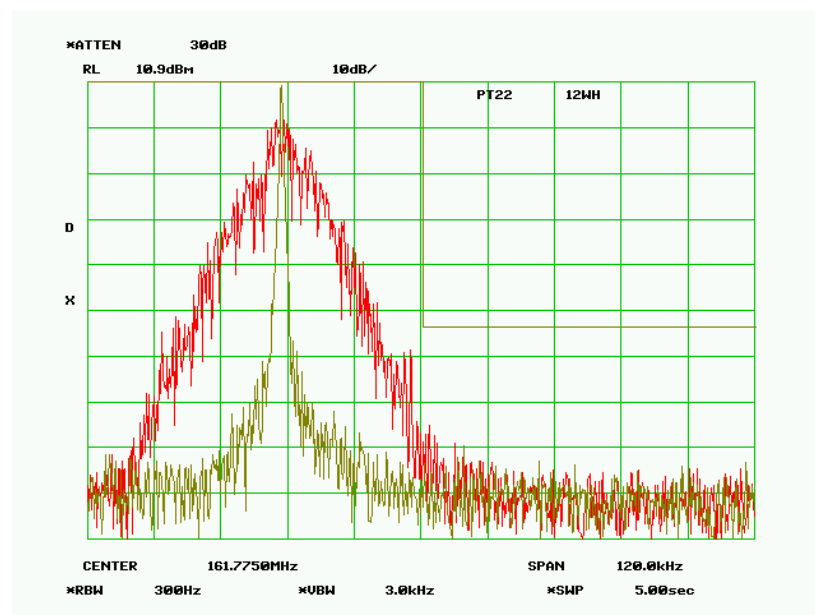
Band Edge – 161.775000, Test Frequency – 161.762500 MHz
 Power Output - 12.0 Watts
 SPECTRUM FOR EMISSION - 8K08F1D
 Data Rate = 32 kbps
 PEAK DEVIATION = 3.728 kHz



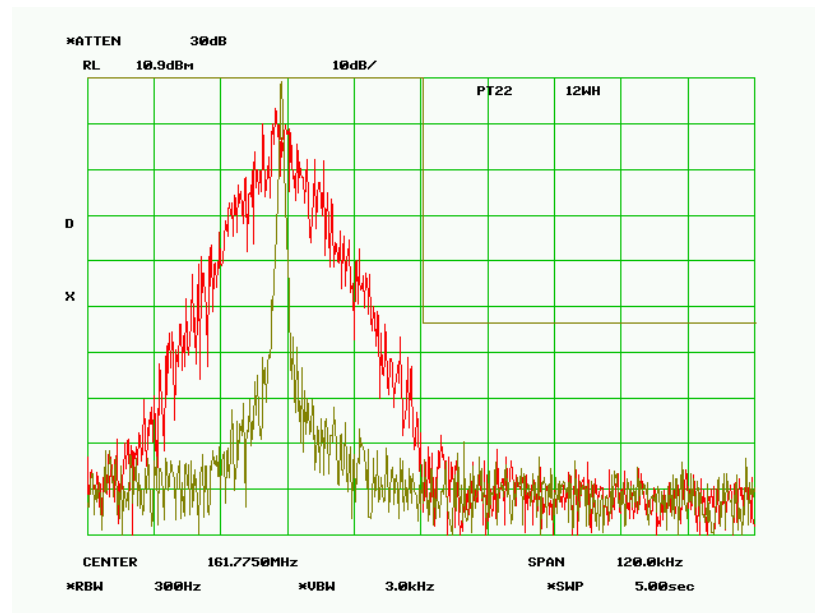
Band Edge – 161.775000, Test Frequency – 161.750000 MHz
Power Output - 12.0 Watts
SPECTRUM FOR EMISSION - 16K5F1D
Data Rate = 16 kbps
PEAK DEVIATION = 6.26 kHz



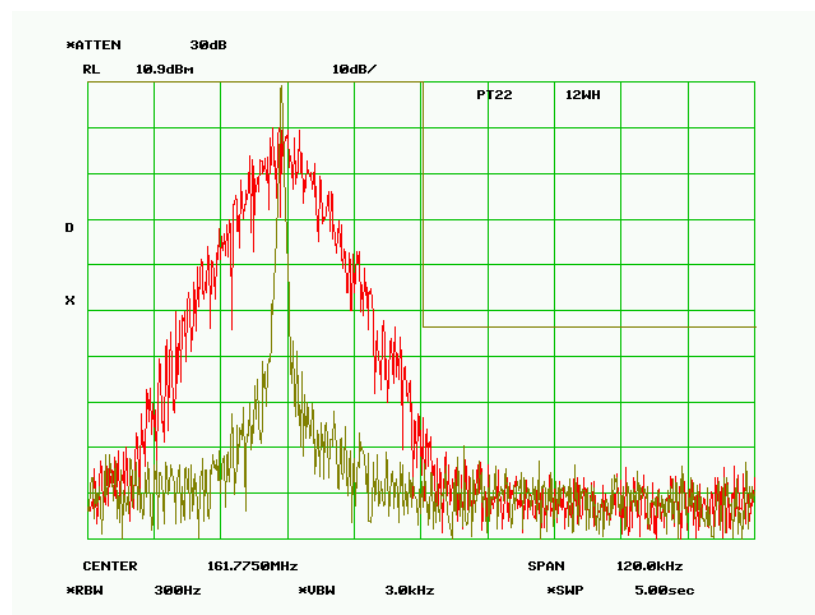
Band Edge – 161.775000, Test Frequency – 161.750000 MHz
Power Output - 12.0 Watts
SPECTRUM FOR EMISSION - 16K8F1D
Data Rate = 32 kbps
PEAK DEVIATION = 7.21 kHz



Band Edge – 161.775000, Test Frequency – 161.750000 MHz
Power Output - 12.0 Watts
SPECTRUM FOR EMISSION - 17K8F1D
Data Rate = 48 kbps
PEAK DEVIATION = 7.59 kHz



Band Edge – 161.775000, Test Frequency – 161.750000 MHz
Power Output - 12.0 Watts
SPECTRUM FOR EMISSION - 17K0F1D
Data Rate = 64 kbps
PEAK DEVIATION = 7.52 kHz



5.0 Calibration Information

Equipment	Serial Number	Cal Date	Cal Due
HP 8563E Spectrum Analyzer	3350A01938	6/19/2013	6/19/2014
Agilent E8257D Signal Generator	MY44320507	6/19/2013	6/19/2014
HP 8901A Modulation Analyzer	2924A02774	6/19/2013	6/19/2014
HP 437B Power Meter	3125U22336	6/19/2013	6/19/2014

Instruments have been calibrated using standards with accuracies traceable to NIST standards.