RRUL 11 B2 – Remote Radio Unit PCS Radio Compliance
FCC CFR 47 Part 24 Test Report

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Approvals and Key Reviewers

Name	Function	Role	Status
David Bolzon	Regulatory/PI Object Leader	Author / Approver	Approved
David Webster	Regulatory Prime	Reviewer	29 Oct 2010

Revision History

Issue	Description of change	Changed by	Date
0.1	Draft	David Bolzon	21 October 2010
1.0	Approved	David Bolzon	29 October 2010

Reference Documents

1. FCC 47 CFR Part 24 “Personal Communications Services”
2. FCC 47 CFR Part 15 “Unintentional Radiators”
3. FCC 47 CFR Part 2 “Frequency Allocations and Radio Treaty maters; general rules and regulations”
4. ICES-003 “Digital Apparatus” EMC
5. EN 50385:2002—Product Standard to Demonstrate the Compliance of Radio Base Stations and Fixed Terminal Stations for Wireless Telecommunication Systems with the Basic Restrictions or the Reference Levels Related to Human Exposure to Radio-Frequency Electromagnetic Fields (110 MHz–40 GHz)—General Public
6. EN 55022, Limits and methods of measurement of radio disturbance characteristics of information technology equipment (CISPR22: 1997), 1998, European Committee for Electro-technical Standardization
7. SM.328: "Spectra and bandwidth of emissions".
8. CISPR 22: "Limits and methods of measurement of radio disturbance characteristics of information technology equipment".
9. CISPR 16-1-1: "Specification for radio disturbance and immunity measuring apparatus and methods - Measuring apparatus".
10. ETSI TS 136 141 V8.2.0 (2009-04) LTE; Evolved Universal Radio Access (E-UTRA); Base Station (BS) conformance testing (3GPP TS 36.141 version 8.2.0 Release 8)
11. ETSI TS 136 104 V8.5.0 (2009-04) LTE; Evolved Universal Terrestrial Radio Access (E-UTRA);Base Station (BS) radio transmission and reception (3GPP TS 36.104 version 8.5.0 Release 8)
12. ETSI TS 136 113 V8.1.0 (2009-01) LTE; Evolved Universal Terrestrial Radio Access (E-UTRA);Base Station (BS) and repeater Electro Magnetic Compatibility (EMC) (3GPP TS 36.113 version 8.1.0 Release 8)
13. 3GPP TS 36.141 V9.0.0 (2009-05): 3rd Generation Partnership Project; Technical Specification Group Radio Access Network; Evolved Universal Terrestrial Radio Access (E-UTRA) ; Base Station (BS) conformance testing (Release 9).
14. 3GPP TS 36.104 V9.0.0 (2009-05) 3rd Generation Partnership Project; Technical Specification Group Radio Access Network; Evolved Universal Terrestrial Radio Access (E-UTRA); Base Station (BS) radio transmission and reception (Release 9)
15. 3GPP TS 36.113 V9.0.0(2009-05) 3rd Generation Partnership Project; Technical Specification Group Radio Access Network; Evolved Universal Terrestrial Radio Access (E-UTRA); Base Station (BS) and repeater Electro Magnetic Compatibility (EMC) (Release 9)
16. 3GPP TS 36.211 V8.7.0 (2009-05) 3rd Generation Partnership Project; Technical Specification Group Radio Access Network; Evolved Universal Terrestrial Radio Access (E-UTRA); Physical Channels and Modulation (Release 8)
17. 3GPP TS 36.212 V8.7.0 (2009-05) 3rd Generation Partnership Project; Technical Specification Group Radio Access Network; Evolved Universal Terrestrial Radio Access (E-UTRA); Multiplexing and channel coding (Release 8)
18. 3GPP TS 36.213 V8.7.0 (2009-05) 3rd Generation Partnership Project; Technical Specification Group Radio Access Network; Evolved Universal Terrestrial Radio Access (E-UTRA); Physical layer procedures (Release 8)
19. PCS LTE Remote Radio Unit, System Design Specification (RRUL 11 B2)

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Acronyms

RRU	Remote Radio Unit
RRUL	Remote Radio Unit LTE
DDM	Dual Duplexer Module
BTS	Base Station Transceiver
EUT	Equipment Under Test
LTE	Long Term Evolution
ACP	Adjacent Channel Power
CPRI	Common Public Radio Interface
NIST	National Institute of Standards and Technology
NRTL	National Recognized Testing Laboratory
NVLAP	National Voluntary Laboratory Accreditation Program
LAP	Laboratory Accreditation Programs
IC	Industry Canada
FCC	Federal Communication Commission
CFR	Code of Federal Regulations (US)
CAB	Conformity assessment body
EMC	Electromagnetic Compatibility
EMI	Electromagnetic interference
RTTE	Radio and Telecommunications Terminal Equipment
TTE	Telecommunications equipment
TCB	Telecom Certification Body
CCB	Canadian Certification Body
IECEE	International Electro-technical Committee for Conformity Testing to Standards for Electrical Equipment
NCB	National Certification Bodies
CBTL	CB Test Laboratory
ITL	Independent Test Laboratory
ITE	Information Technology Equipment

1 Summary

Applicant:	Ericsson Canada 3500 Carling Ave. Ottawa, On Canada K2H 8E9
Apparatus:	KRC 131 144/1 (RRUL11 B2 Broadband PCS)
Application:	Fixed Wireless Base Station Transceiver
FCC ID:	VZTAKRC131144-1
In Accordance With:	FCC CFR 47 Part 24 Broadband Personal Communications Services

This test report has been prepared for the purpose of demonstrating compliance with FCC CFR Title 47 Part 24. Conducted measurements have been performed in accordance with ANSI TIA-603-B-2002. Radiated tests have been conducted is accordance with ANSI C63.4-2003. Radiated emissions are assessed and measured at an accredited ITL in a 3 meter or 10 meter Semi-Anechoic chamber. Conducted Emissions have been assessed at Ericsson Carling facilities using calibrated equipment in accordance with FCC CFR 47 Part 24 and Part 2 Requirements.

The assessment summary is as follows:

Apparatus Assessed:	KRC 131 144/1 (RRUL 11 B2 Remote Radio Unit - PCS)
Specification:	FCC CFR 47 Part 24 Personal Communications Services Broadband PCS
Compliance Status:	Compliant
Exclusions:	None
Non-compliances:	None
Report Release History:	Original Release

2 Introduction

This document supports the FCC test process and filing requirements for North American approvals. Measurements are conducted to satisfy and demonstrate compliance to the Essential parameters for Radio Compliance and Conformance to the following standards:

- FCC CFR 47 Part 24, Subpart E, Broadband Personal Communications Services.
- FCC CFR 47, Subpart 2, Subpart J, Equipment Authorization Procedures – Equipment Authorization.

The initial RRU deployment will support a 5MHz and 10MHz BW for Fixed Wireless Base Station (BTS) applications with a rated output power of 30W (44.8dBm) in a 2 x 2 MIMO configuration. Frequency band for authorization will address the US PCS Block.

Hardware Description

The BTS equipment is comprised of the following:

1) KRC 131 144/1 RRUL 11 B2: LTE Remote Radio Unit [RRUL] **EUT**
2) CPRI Modem Emulator (RU-Master LPC 102 400/5 R1B S/N T01E495866)

RRU Details

Frequency: FCC PCS Band

Transmit / Downlink: 1930MHz – 1990MHz – PCS Block

- Modulation: OFDMA, QPSK, 16QAM, 64QAM
- BW: 5/10 MHz
- MIMO, 2 x 2 (Spatial Multiplexing)
- Diversity, 2 Way Transmit
- Throughput: Up to 60 Mbps
- Power: 44.8dBm (30W)
- PAPR: 7dB

Duplex: FDD (30MHz)

Frequency Stability: +/-0.05ppm

Channel Raster: 100 kHz

Receive / Uplink: 1850 - 1910MHz – PCS: Block

- Modulation: SC-FDMA, QPSK, 16QAM
- BW: 5/10 MHz
- MIMO, 2 x 2, Multi-User with 2 additional ports for co-site application
- Throughput: Up to 20Mbps
- Diversity, 2 and 2 Co-Site Receive

RRU Physical Details:

PWR: -48V (typical) DC 350W (max), Size: 17” x 11.3” x 8.7” (H x W x D), Weight: 53lbs

3 Equipment Under Test

3.1 Product Identification

The Equipment Under Test (UUT) is identified for Fixed Base Station operation as follows:
Ericsson Remote Radio Unit RRUL 11 B2 (PCS 1930MHz – 1990MHz) KRC 131 144/1

3.2 Technical Specifications of the EUT

Manufacturer:	Ericsson Canada
Operating Frequency:	Downlink …TX: 1930 – 1990MHz (5/10MHz) Uplink …….RX: 1850 – 1910MHz (5/10MHz)
Emission Designator:	5MHz: 5M00 W7D 10MHz: 10M0 W7D
Modulation:	LTE OFDMA, QPSK, 16QAM, 64QAM (Two transmitters, 2 receivers per sector)
Antenna Data: (for reference only)	Andrew HBX-6513DS-T6M 12.9dBd, 15.0dBi (max) Beam-width – Horizontal 65°

3.3 Technical Description

The Ericsson LTE RRU (RRUL) is a single sector Transceiver (2 transmitter, 2 receivers per radio / sector with co-site receive ports (2) provided) operating in FDD mode which will be introduced as part of Ericsson's next generation BTS product line. The initial RRU product offering addresses the LTE air interface, while the RRU radio architecture will be 4G agnostic to support OFDM based air interfaces including the long term evolution of GSM/UMTS (LTE), 802.16e OFDMA standards with Multiple Inputs Multiple Outputs (MIMO) operation. Transmitter outputs (TX1, TX2) are isolated and non-correlated for external interface to customer furnished antenna.

The Radio design will address outdoor installations for pole and building/wall mount deployment. RRU electronics are housed in a weather protected environmental enclosure intended for co-location in proximity to the customer furnished antenna. The RRU has an integrated active duplexer for enhanced up link performance and antenna interface. Compliance and performance testing will include a band / spectrum dependent DDM (duplexer) integrated with the RRU product offering.

The RRU operates over the North American PCS band employing a band specific duplexer designed to limit operations to specific customer requirements. The initial RRU product offering will operate over a Down Link (DL) transmit frequency band from 1930MHz to 1990MHz, for channel bandwidths of 5 and 10MHz. LTE modulation formats OFDMA QPSK, 16QAM and 64QAM will be assessed at a rated output of 30W per transmitter.

The recommended customer furnished antenna detail is as follows:
MFG: Andrew Antenna
Model: HBX-6513DS-T6M
Gain: 12.9dBd (15.0dBi)
Beam width: Horizontal 65°

The Ericsson RRU design consists of logical sections comprised of Digital, RF, Power Amplifiers, and a Power Supply and distribution housed in a single outdoor enclosure. Heat fins on the enclosure external surface provide convection cooling for thermal and environmental control. For protection against solar impact, a sun shield mounted on the unit provides additional thermal protection to limit direct solar exposure. The unit operates over an ambient temperature of -40°C to +55°C including sun loading.

The digital section provides processing resources to the RRU CPRI based optical link to the Modem and Soft Radio Core. This single sector Radio is targeted to support up to 20MHz base band data bandwidth. (Initial deployment will be limited to 10MHz) The digital section of the transceiver card provides the processing solution for the 4G Radio.

The PSU provides primary power conversion from a nominal input of -48VDC (350W) for the internal PCB circuit requirements. The PA board produces the RF output power for BTS transmission at a rated power up to 30W per transmitter port. The RRU consists of a Radio transceiver and integrated active Duplexer combination for applicable FCC compliance. All compliance measurements and ratings are referenced at the antenna ports / duplexer interface.

Radio Standard is LTE, OFDMA TX, (SC-FDMA RX) configured for a 2x2 MIMO operating mode with an output rated power of 30W (44.8dBm) at the antenna port. Transmit outputs 1 and 2 are isolated, non-correlated outputs connected to two isolated customer furnished antenna and are measured/verified independently. The DPM amplified receive signal RX1/RX2 are sampled for additional (co-site) receive ports RX3/RX4.

The TX Modulation schemes of QPSK, 16QAM, and 64QAM will be supported along with an operational bandwidth of 5MHz and 10MHz for initial product release in the PCS Block spectrum. QPSK, 16QAM, and 64 QAM will employ 3/4 CTC data rate coding. The RRU employs a CPRI (Common Public Radio Interface) for interoperability and standardization of the radio protocol interface. To demonstrate compliance, appropriate LTE waveforms will be utilized to generate the RF output, rated power and bandwidth requirements with respect to the modulation variables. Bandwidths of 5MHz and 10MHz will be assessed for operation within the PCS block.

The KRC 131 144/1 has an added feature to permit Co-Site Receive functionality. Two isolated receiver outputs are provided on the connector Interface enabling this feature.

Table 3-1: Applicable FCC PCS Blocks

Band	***Bandwidth***	***Frequency***
2	**60MHz**	**1930 - 1990MHz** and 1850 - 1910MHz

Test Units

Part 24: UUT KRC 131 144/1 RRUL 11 B2 PCS, SN: CH50000503
CPRI Modem interface with LTE Test Vectors and traffic (RUMA LPC 102 400/5)

Part 15/24: UUT KRC 131 144/1 RRUL 11 B2 PCS, SN: CH50000503
CPRI Modem interface with LTE Test Vectors and traffic (RUMA LPC 102 400/5)

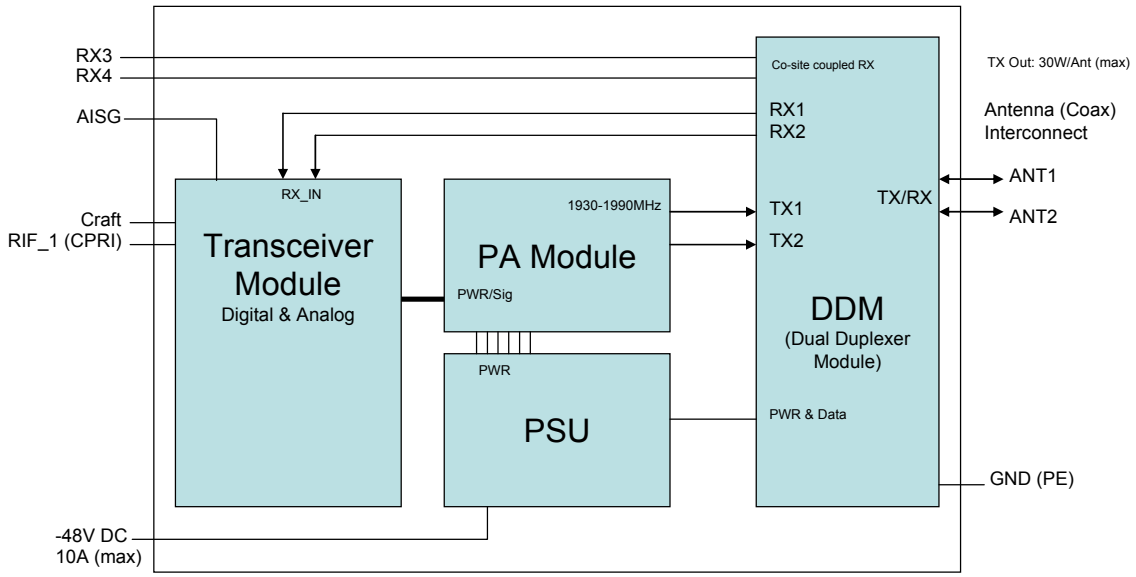

Figure 3-1: UUT – Block Diagram RRUL 11 B2 PCS

4 Test Conditions

4.1 Specifications

The apparatus has been assessed against the following specifications:
FCC CFR 47 Part 24 Broadband Personal Communications Services (PCS)

4.2 Test Environment

All tests are performed under the following environmental conditions:

Temperature range	:	15 – 30 ^{O}C
Humidity range	:	20 - 75 %
Pressure range	:	86 - 106 kPa
Power supply range	:	+/- 5% of rated voltages

4.3 Test Equipment

Table 4-1: Conducted Emissions - List of Test Equipment

Equipment	Manufacturer	Model No.	Asset/Serial No.	Cal Due
Signal Analyzer (20Hz-26.5GHz)	Agilent	MXA N9020A	1081485/MY47380593	02 Nov 2011
Signal Analyzer (20Hz-26.5GHz)	Agilent	MXA N9020A	1099578/MY49100286	08 May 2011
Signal Analyzer (20Hz-8.45GHz)	Agilent	MXA N9020A	1099580/MY49100143	11 Sept 2011
Power Meter	HP	438A	L0544032	24 Nov 2010
Power Sensor	HP	8481A	US37290233	24 Nov 2010
Attenuator 30dB (Qty=2)	Narda	769-30	NA	NA
Attenuator 20dB (Qty=2)	Meca	650-20-1F4	NA	NA
Network Analyzer (Path Loss Calibration)	Agilent	N5230	MY45000798	NA
Climatic Chamber	Burnsco	RTC-37P-3-3	07-07	27 Oct 2010
Power Supply	Sorenson	DLM 60-10	R2310	NCR
Digital Volt Meter	Fluke			

Table 4-2 Radiated Emissions - List of Test Equipment

Equipment	Manufacturer	Model No.	Asset/Serial No.	Next Cal.
10 m EMI Test Chamber				
RF Amplifier	Hewlett Packard	8447D	SSG013045	09/24/2010
Spec. A, RF Pre-selector	Hewlett Packard	85685A	SSG012010	03/02/2011
Receiver/Spectrum Analyzer	Hewlett Packard	8566B	SSG012521	03/02/2011
Spectrum Analyzer Display	Hewlett Packard	85662A	SSG012433	03/02/2011
Quasi Peak Adaptor	Hewlett Packard	85650A	SSG012620	03/02/2011
50 Coax cable	HUBER + SUHNER	106A	SSG012453	01/28/2011
50 Coax cable	HUBER + SUHNER	106A	SSG012455	01/28/2011
50 Coax cable	HUBER + SUHNER	104PEA	SSG012041	10/07/2011
50 Coax cable	HUBER + SUHNER	104PEA	SSG012131	10/29/2010
Horn Antenna, Double ridged	EMCO	3115	SSG012298	02/19/2011
Pre-Amplifier	BNR	LNA	SSG012360	02/15/2011
Bilog Antenna	ARA	LPB 2520	SSG012772	12/21/2010
Power Supply	Hewlett Packard	6216A	SSG013063	NR
Spectrum Analyzer	Hewlett Packard	8564E	SSG012069	04/15/2011
50 Coax cable	Micro-Coax	UFA 210B	SSG012376	01/08/2011
50 Coax cable	HUBER + SUHNER	102A	SSG013084	01/07/2011
Horn Antenna, 18-26GHz	EMCO	3160-09	SSG012292	12/22/2010
DC Power Supply	BNR	Nortel 12V	SSG013628	NR
Active Loop Antenna (H Field)	EMCO	6502	SSG012080	12/01/2010
Active Monopole Antenna	EMCO	3301B	SSG012083	04/16/2011
Signal Generator	Anritsu	69369A	SSG012138	09/28/2010
Horn Antenna, Double ridged	EMCO	3115	SSG012267	03/12/2011
50 Coax cable	HUBER + SUHNER	104PEA	SSG012409	01/27/2011
Attenuator	Aeroflex/Weinschel	6070-10	SSG012140	10/29/2010
Radio Frequency Filter	FSY Microwave	DC 9371	SSG013702	02/10/2011

Note: N/A = Not Applicable, NCR = No Cal Required, COU = CAL On Use

5 Applicable Tests

This section contains the following:

FCC CFR 47 Part 24: Test Requirements

The column headed 'Required' indicates whether the associated clauses were invoked for the apparatus under test. The following abbreviations are used:

N No: Not Applicable / Not Relevant.

Y Yes: Mandatory i.e. the apparatus shall conform to these tests.

N/T Not Tested

The results compiled in this document are in accordance and representative of the operation of the apparatus as originally submitted.

5.1 FCC Part 24: Test Parameters

Table 5-1: Applicable Test Parameters / Results Summary

Clause	Test Method	Test description	Required	Result
24.232	2.1046	RF Output Power	Y	
------	2.1047	Modulation Characteristics	Y	
------	2.1049	Occupied Bandwidth	Y	
24.238	2.1051	Band Edge Compliance	Y	
24.238	2.1051, 2.1057	Spurious Emissions at the Antenna Terminal	Y	
24.236	2.1053, 2.1057	Field Strength of Spurious Emissions	Y	
24.235	2.1055	Frequency Stability	Y	

6 Test Results

6.1 Effective Radiated Power / Channel Power

Clause 24.232 Limits: FCC CFR Broadband PCS Fixed Base Station

> (a) Base stations are limited to 1640 watts peak equivalent isotropically radiated power (EIRP) with an antenna height up to 300 meters HAAT, except as described in paragraph (b) below. *See* 24.53 for HAAT calculation method. Base station antenna heights may exceed 300 meters with a corresponding reduction in power; *see* Table 1 of this section. The service area boundary limit and microwave protection criteria specified in 24.236 and 24.237 apply.

Test Conditions:

All modulation (QPSK, 16QAM, and 64QAM) modes and different data rates are evaluated using representative waveforms of all modulation schemes. The test results shall include 5MHz and 10MHz bandwidths configurations for Lower, Middle and Upper band frequency offsets as applicable.

Physical Channels

A downlink physical channel corresponds to a set of resource elements carrying information originating from higher layers and is the interface defined between 36.212 and 36.211 [16]. The following downlink physical channels are defined:

- Physical Downlink Shared Channel, PDSCH – QPSK, 16QAM, 64QAM
- Physical Broadcast Channel, PBCH - QPSK
- Physical Downlink Control Channel, PDCCH - QPSK
- Physical Control Format Indicator Channel, PCFICH - QPSK
- Physical Hybrid ARQ Indicator Channel, PHICH - BPSK

LTE standard defines BPSK as an ARQ Indicator Channel, thus being embedded into the LTE signal and does not contain traffic data. As BPSK is embedded in each modulation scheme, waveforms tested represent the worst case conditions.

Test Setup

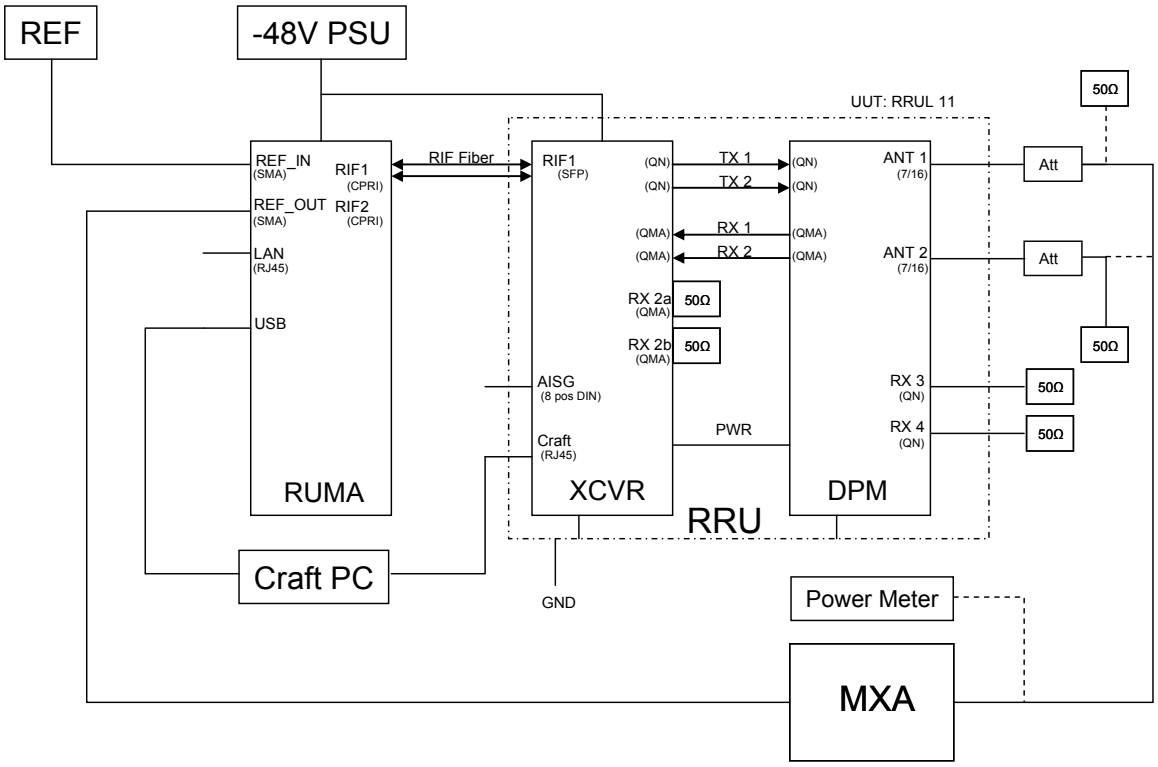

Figure 6-1 RRU Radio Compliance Set Up / Configuration

Procedure:

Channel Power measurements for each output shall be conducted for the applicable bandwidths and modulation schemes for the Lower, Middle and Upper frequency offsets as warranted. The following tables are used to summarize recorded results in addition to applicable captured plots.

Table 6-1: Setting / Measurement Results – 5MHz Channel Power

Setting		5MHz Channel Power Output (dBm)					
		QPSK		16 QAM		64 QAM	
		TX1	TX2	TX1	TX2	TX1	TX2
Frequency (Lower CH_ 625)	1932.5MHz	44.86	44.73	44.98	44.99	44.76	44.76
Frequency (Middle CH_ 900)	1960.0MHz	44.95	44.86	44.79	44.96	44.82	44.65
Frequency (Upper CH_1175)	1987.5MHz	44.87	44.85	44.82	44.82	44.91	44.75
RBW	180kHz						
VBW	1.8MHz						
CH BW	5MHz						
Span	20MHz						
Sweep	1ms						
Reference Level Offset	53.2dB						
Detector	RMS	Aggregate Power =10^(10*LOG(10^(TX1/10)+10^(TX2/10))/10)/1000					
Attenuation	10dB	61.88W		63.03W		60.83W	

Table 6-2: Setting / Measurement Results – 10MHz Channel Power

Setting		10MHz Channel Power Output (dBm)					
		QPSK		16 QAM		64 QAM	
		TX1	TX2	TX1	TX2	TX1	TX2
Frequency (Lower CH_ 650)	1935.0MHz	45.00	44.77	45.11	45.02	45.03	44.89
Frequency (Middle CH_ 900)	1960.0MHz	44.82	44.85	44.87	44.78	44.88	44.85
Frequency (Upper CH_1150)	1985.0MHz	44.97	44.97	44.95	44.80	44.92	44.75
RBW	180kHz						
VBW	1.8MHz						
CH BW	10MHz						
Span	20MHz						
Sweep	1ms						
Reference Level Offset	53.2dB						
Detector	RMS	Aggregate Power =10^(10*LOG(10^(TX1/10)+10^(TX2/10))/10)/1000					
Attenuation	10dB	62.81W		64.20W		62.67W	

5MHz Aggregate Power = TX1 + TX2
=10*log(10^(44.98/10) + 10^(44.99/10)) = 48.006dBm/5MHz = 10^(48.00/10)/1000 = **63.03W/5MHz**

10MHz Aggregate Power = TX1 + TX2
=10*log(10^(45.11/10) + 10^(45.02/10)) = 48.08dBm/10MHz = 10^(48.08/10)/1000 = **64.20W/10MHz**

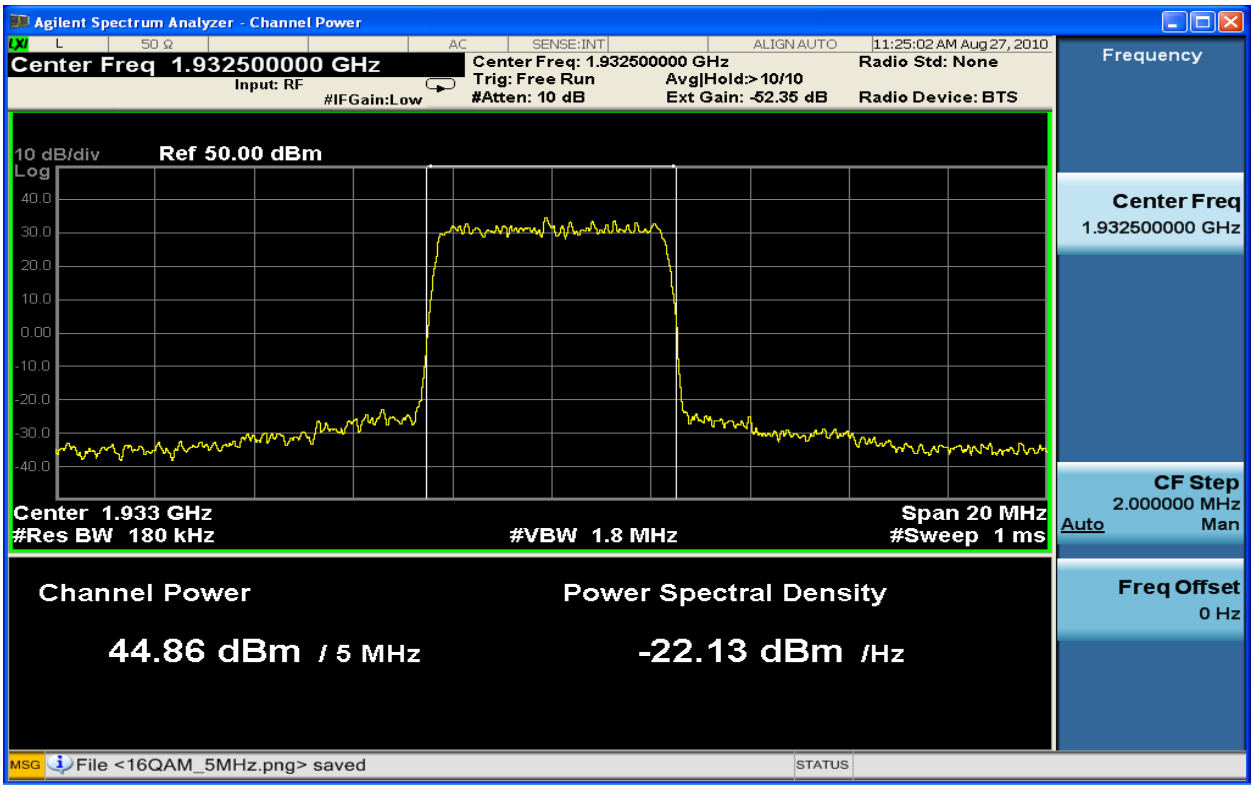

Figure 6-2: 5MHz BW Channel Power TX1_QPSK at 1932.5 MHz

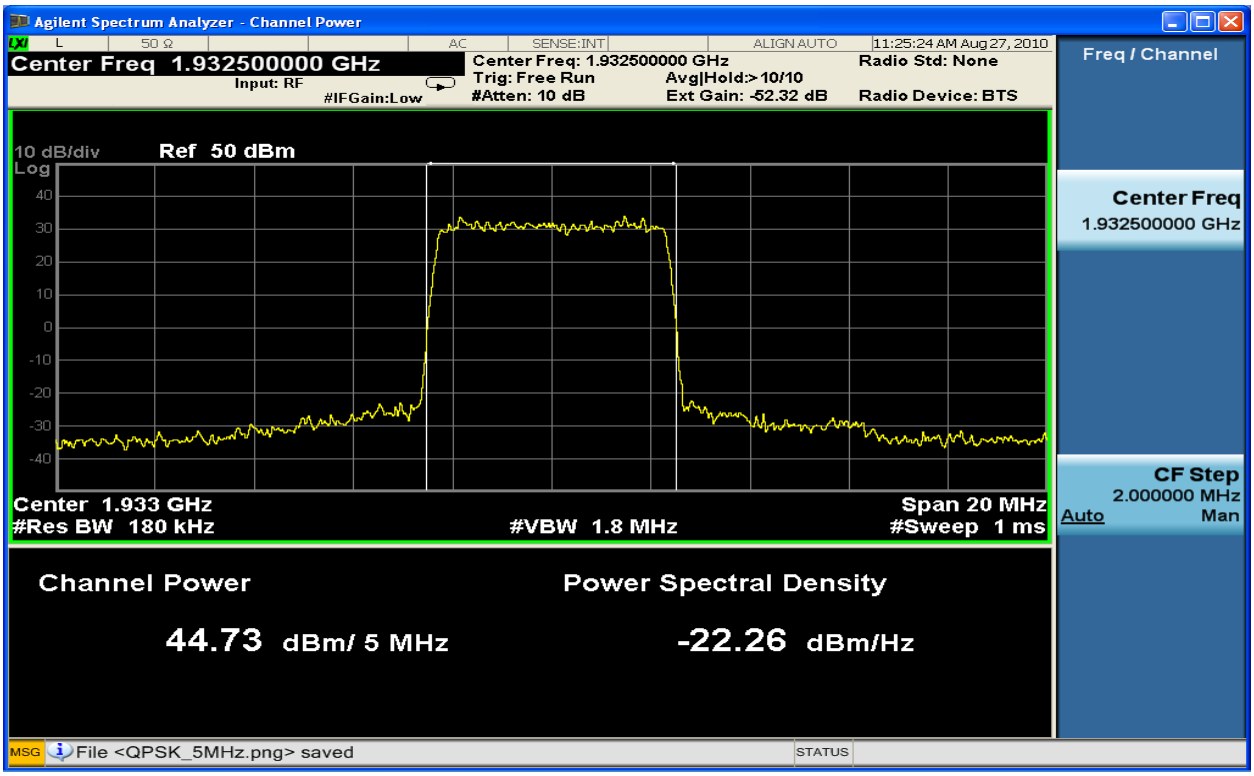

Figure 6-3: 5MHz BW Channel Power TX2_QPSK at 1932.5 MHz

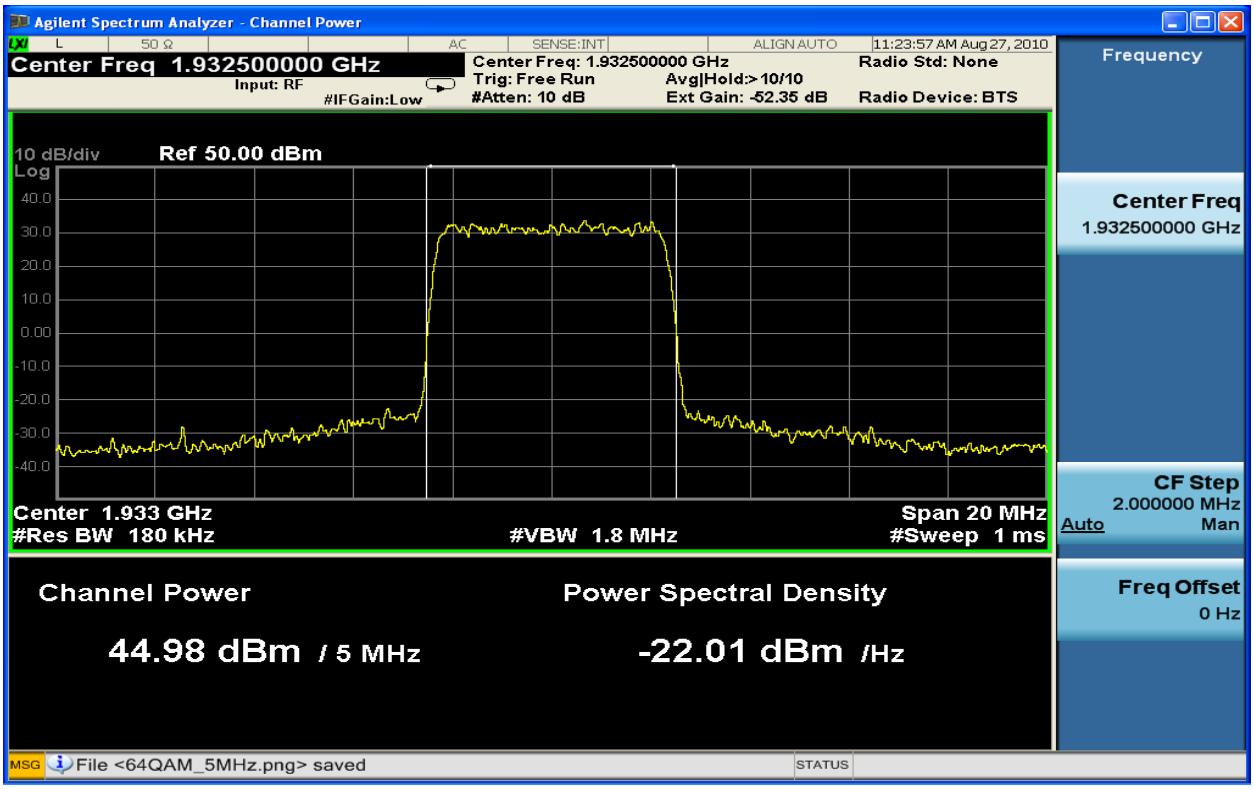

Figure 6-4: 5MHz BW Channel Power TX1_16QAM at 1932.5 MHz

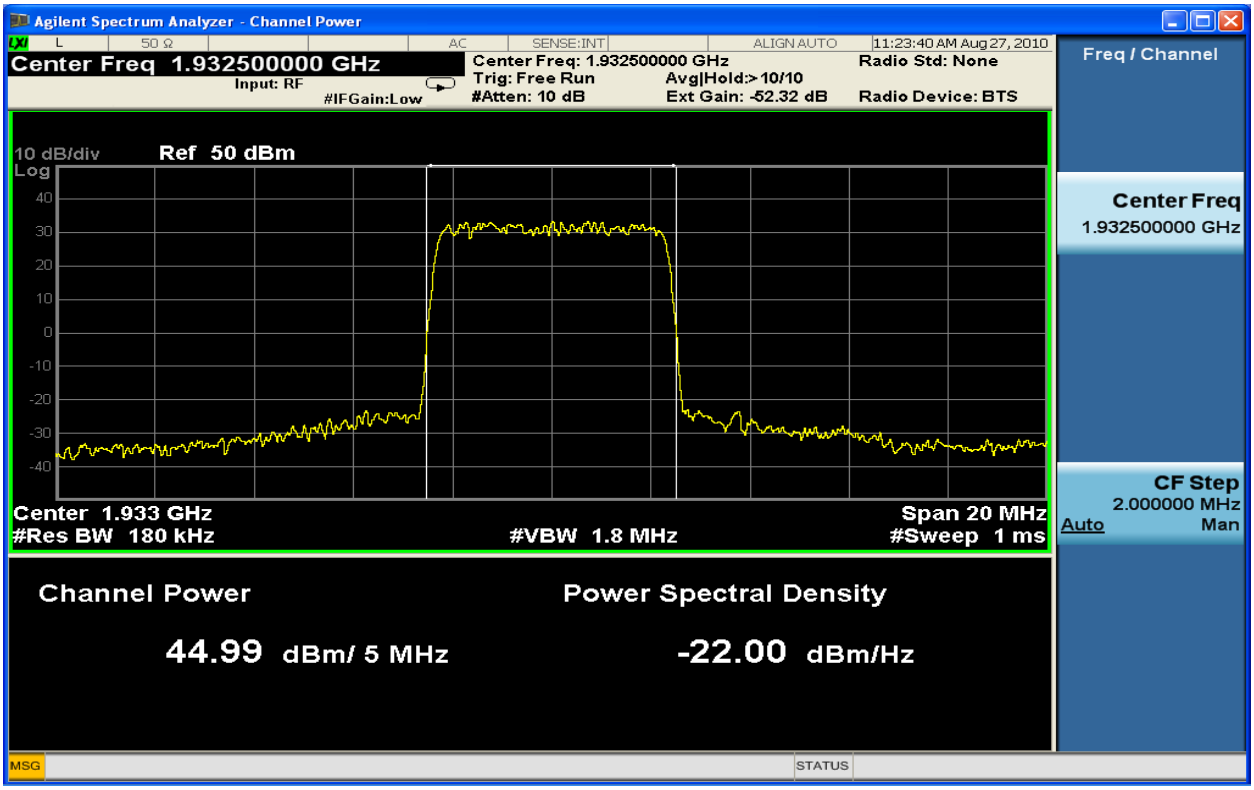

Figure 6-5: 5MHz BW Channel Power TX2_16QAM at 1932.5 MHz

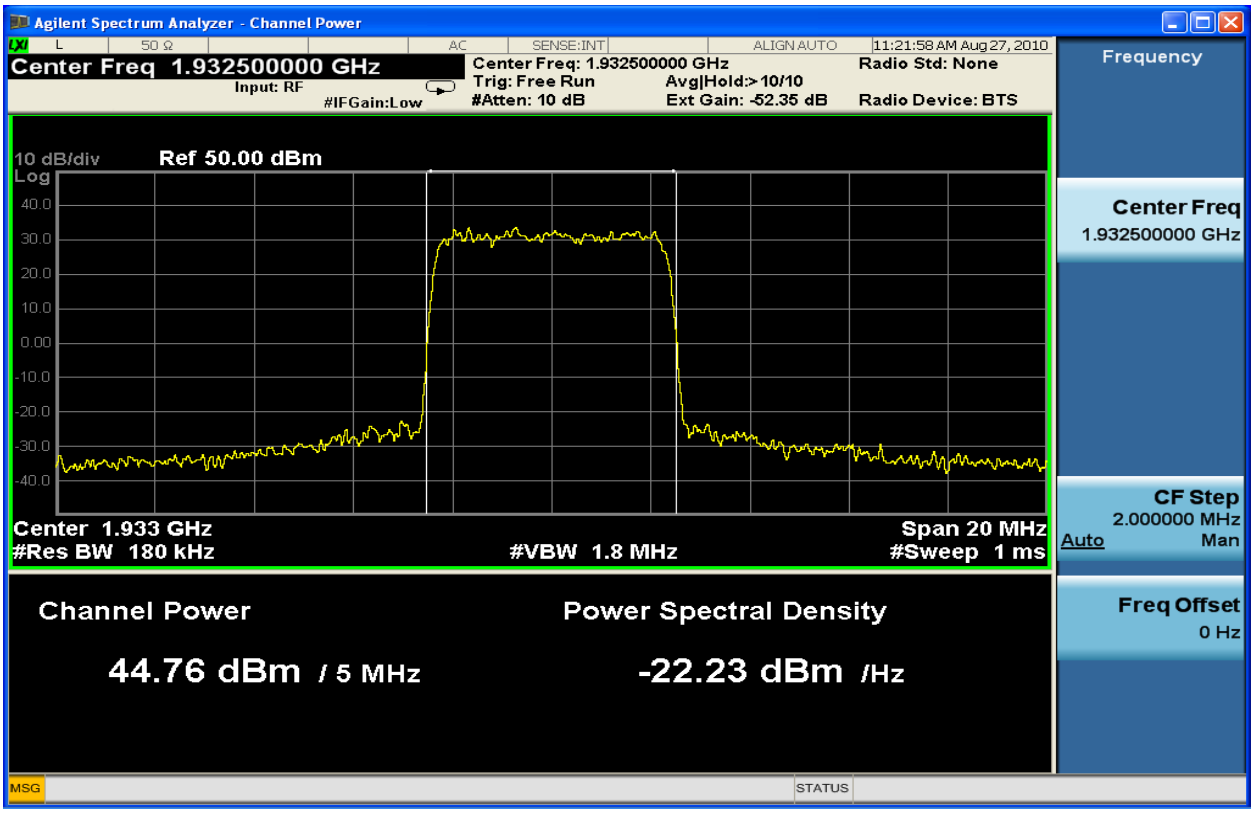

Figure 6-6: 5MHz BW Channel Power TX1_64QAM at 1932.5 MHz

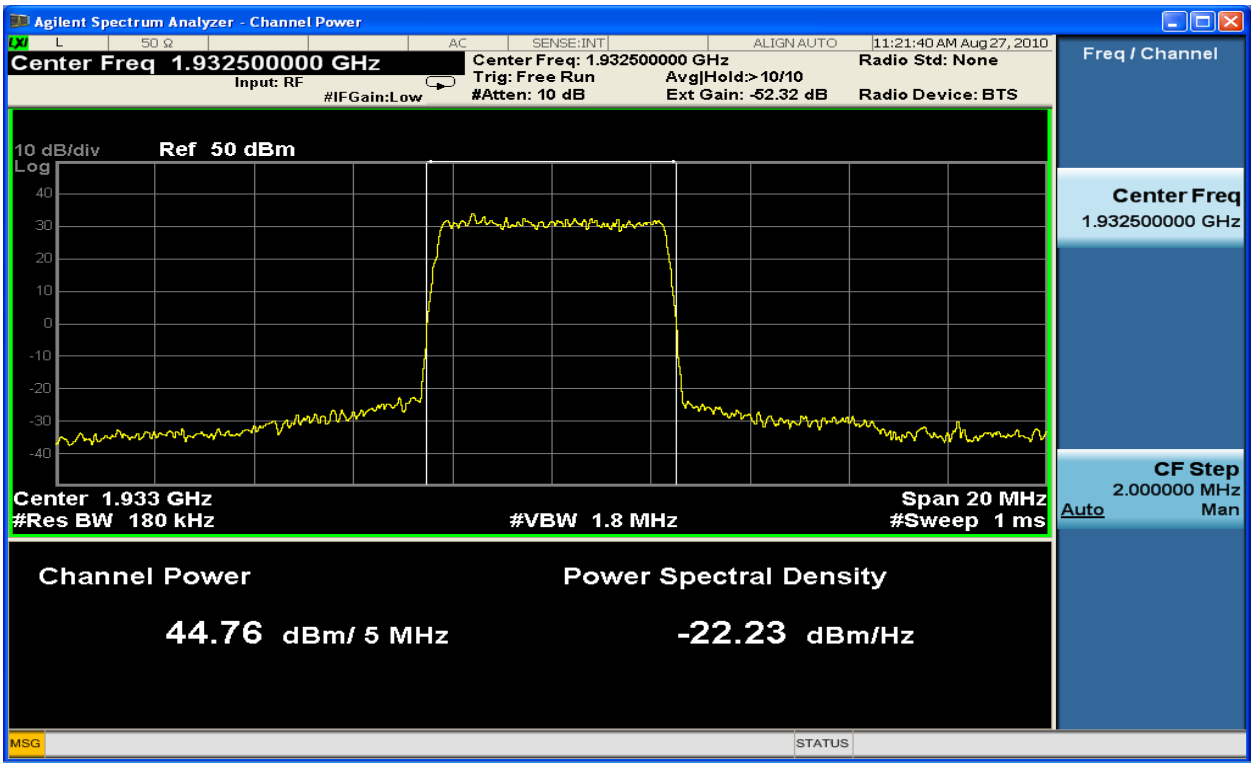

Figure 6-7: 5MHz BW Channel Power TX2_64QAM at 1932.5 MHz

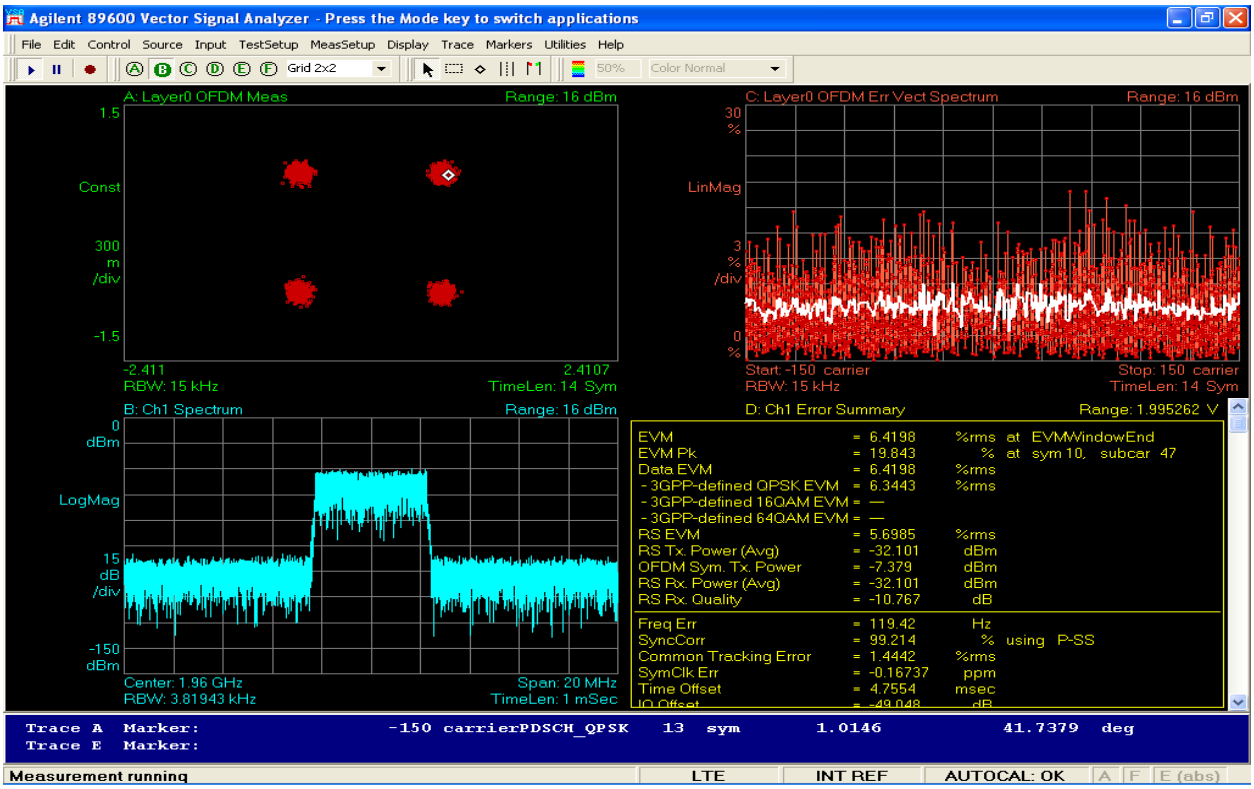

Figure 6-8 : 5MHz BW Modulation TX1_QPSK at 1960.0 MHz

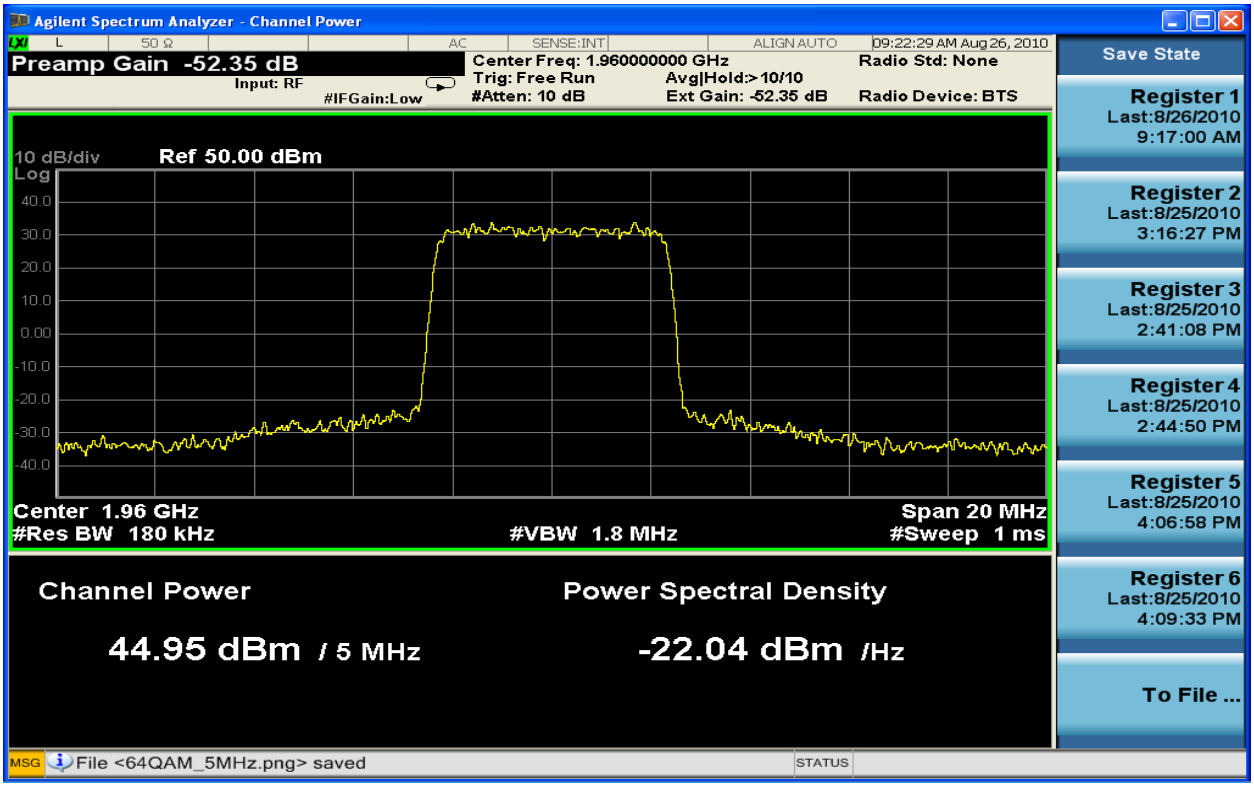

Figure 6-9 : 5MHz BW Channel Power TX1_QPSK at 1960.0 MHz

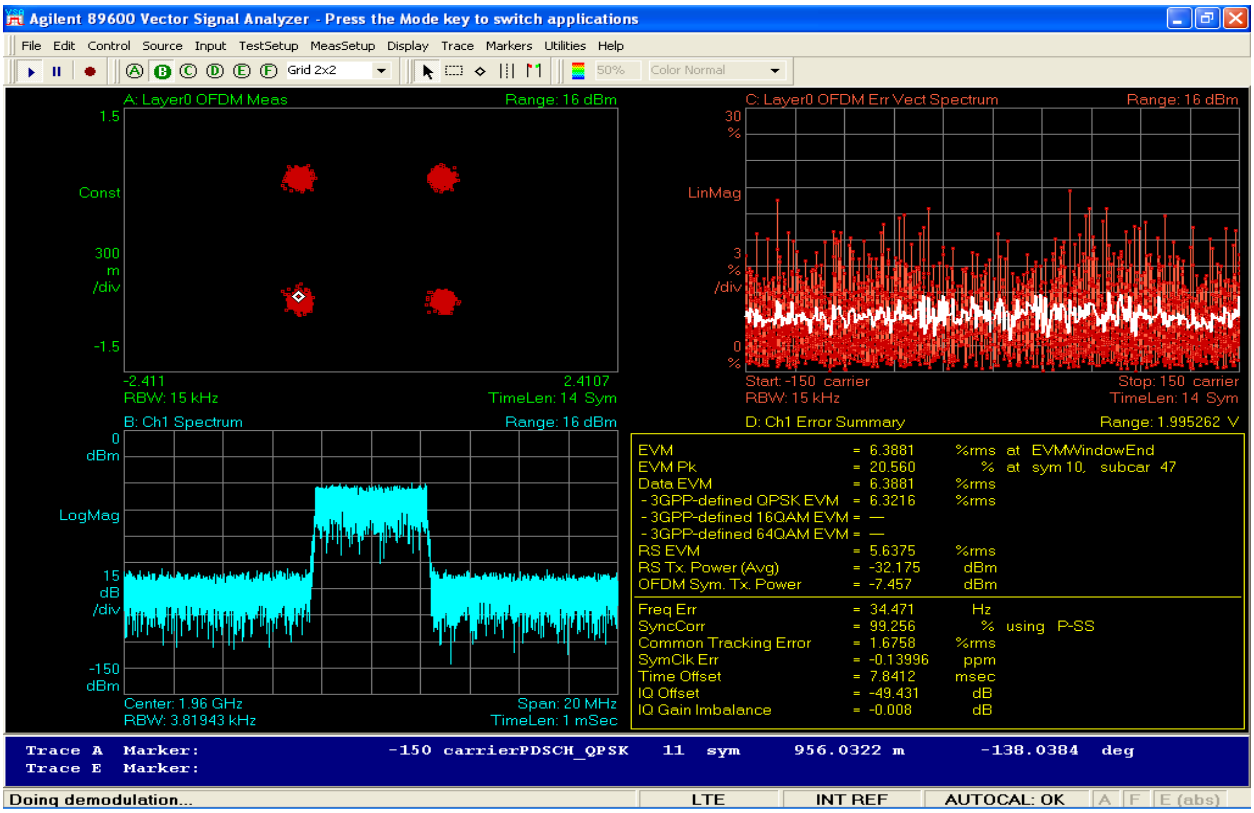

Figure 6-10 : 5MHz BW Modulation TX2_QPSK at 1960.0 MHz

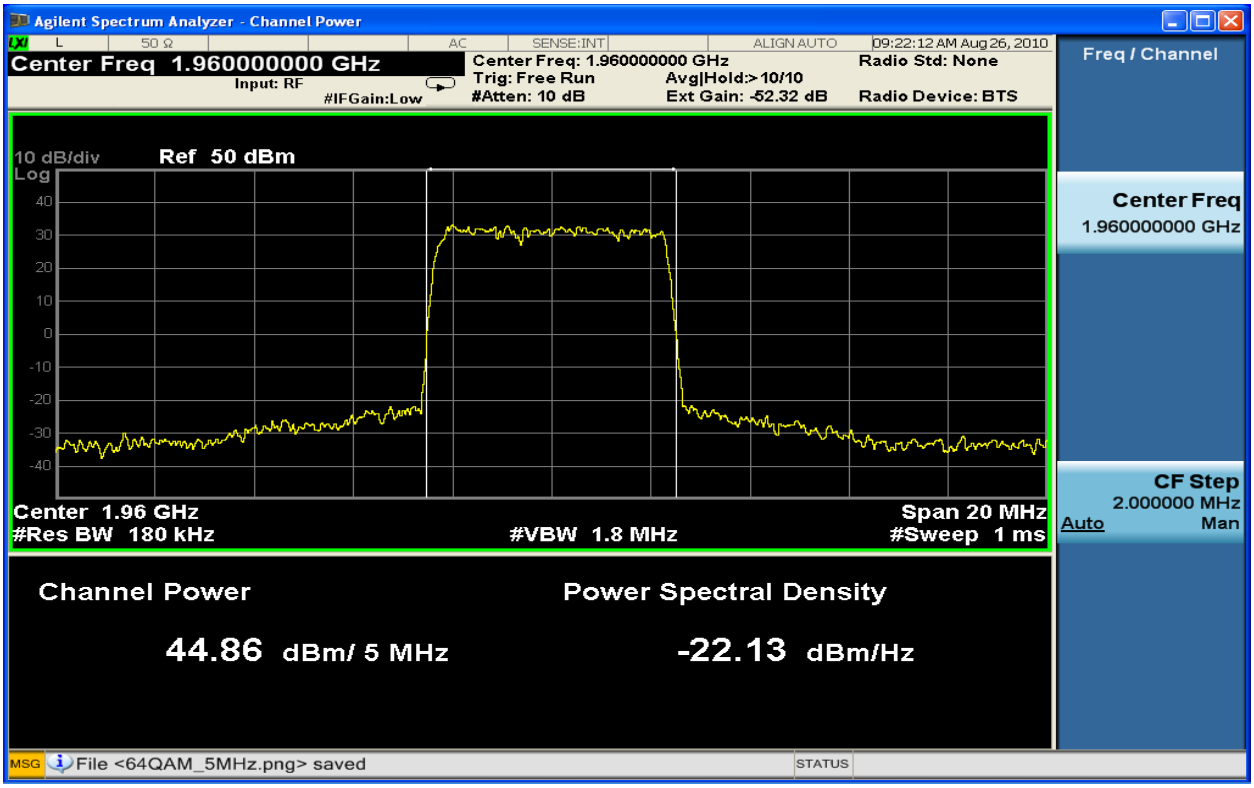

Figure 6-11 : 5MHz BW Channel Power TX2_QPSK at 1960.0 MHz

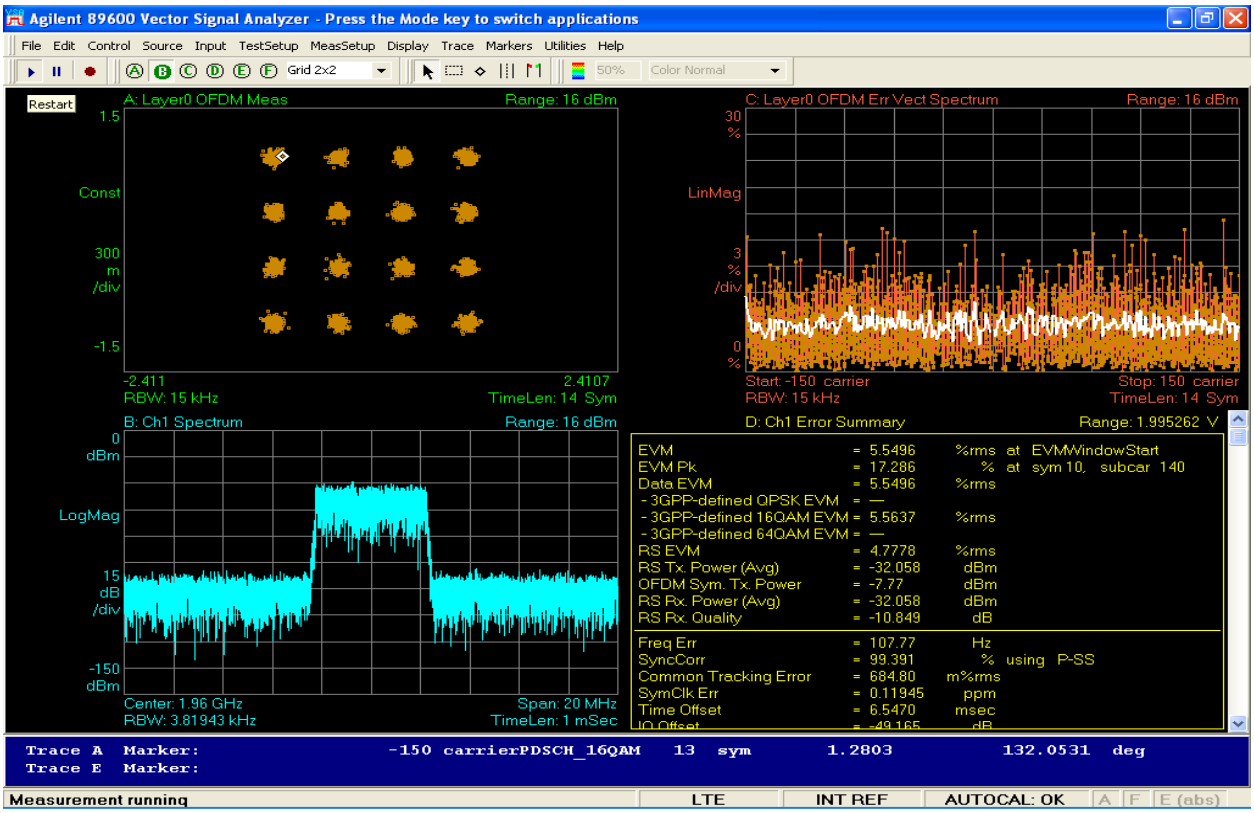

Figure 6-12 : 5MHz BW Modulation TX1_16QAM at 1960.0 MHz

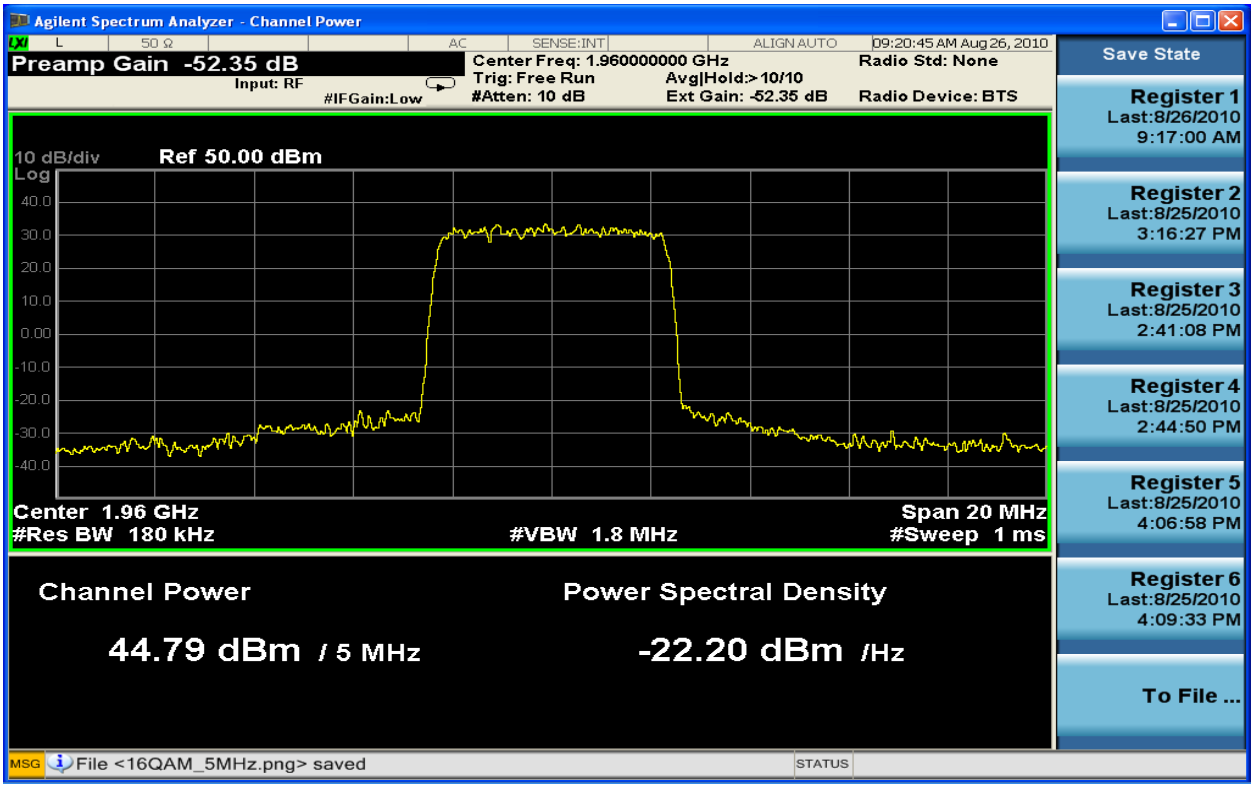

Figure 6-13 : 5MHz BW Channel Power TX1_16QAM at 1960.0 MHz

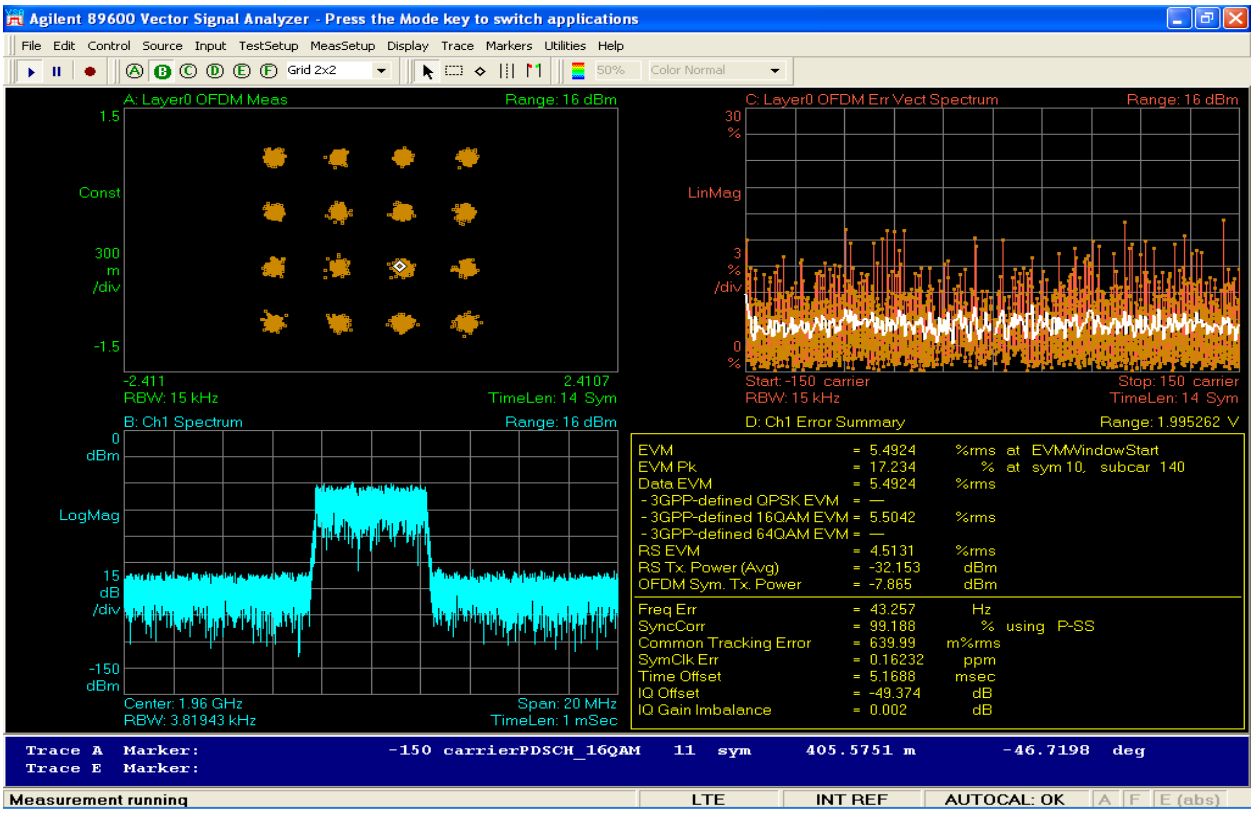

Figure 6-14 : 5MHz BW Modulation TX2_16QAM at 1960.0 MHz

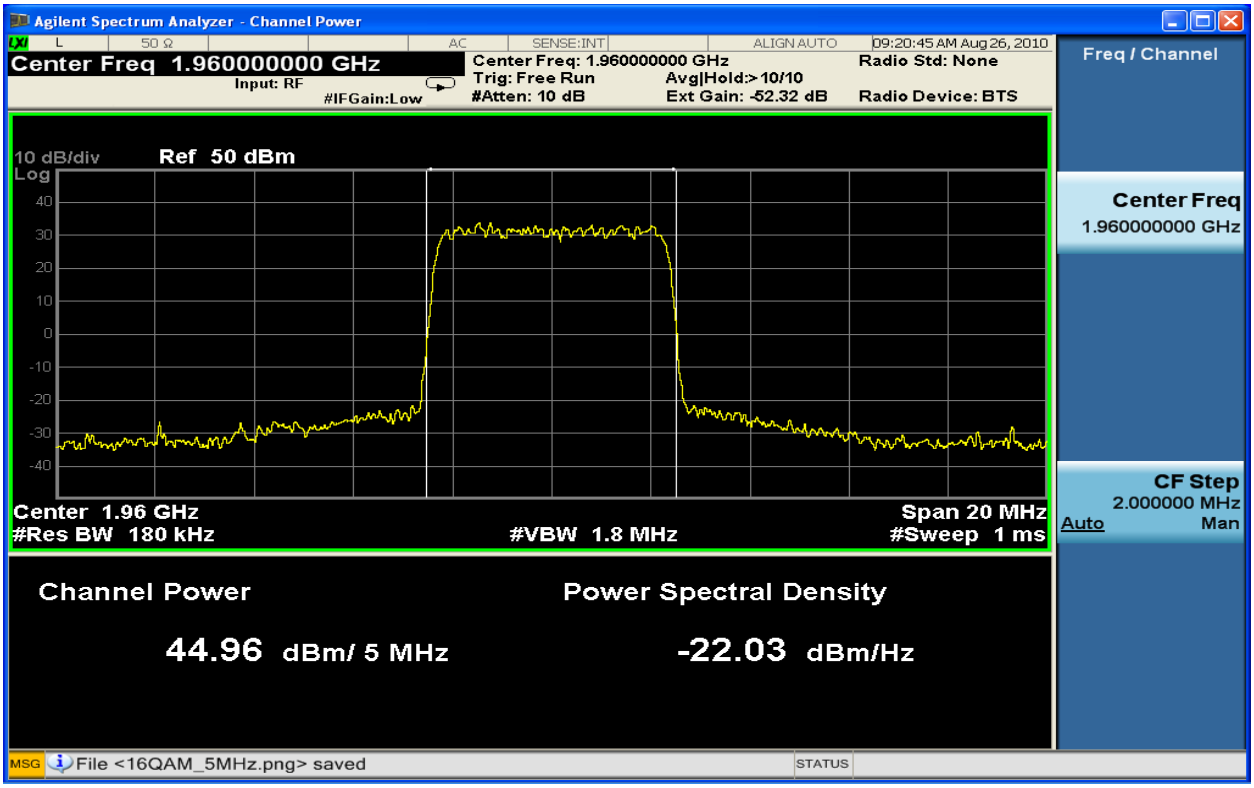

Figure 6-15 : 5MHz BW Channel Power TX2_16QAM at 1960.0 MHz

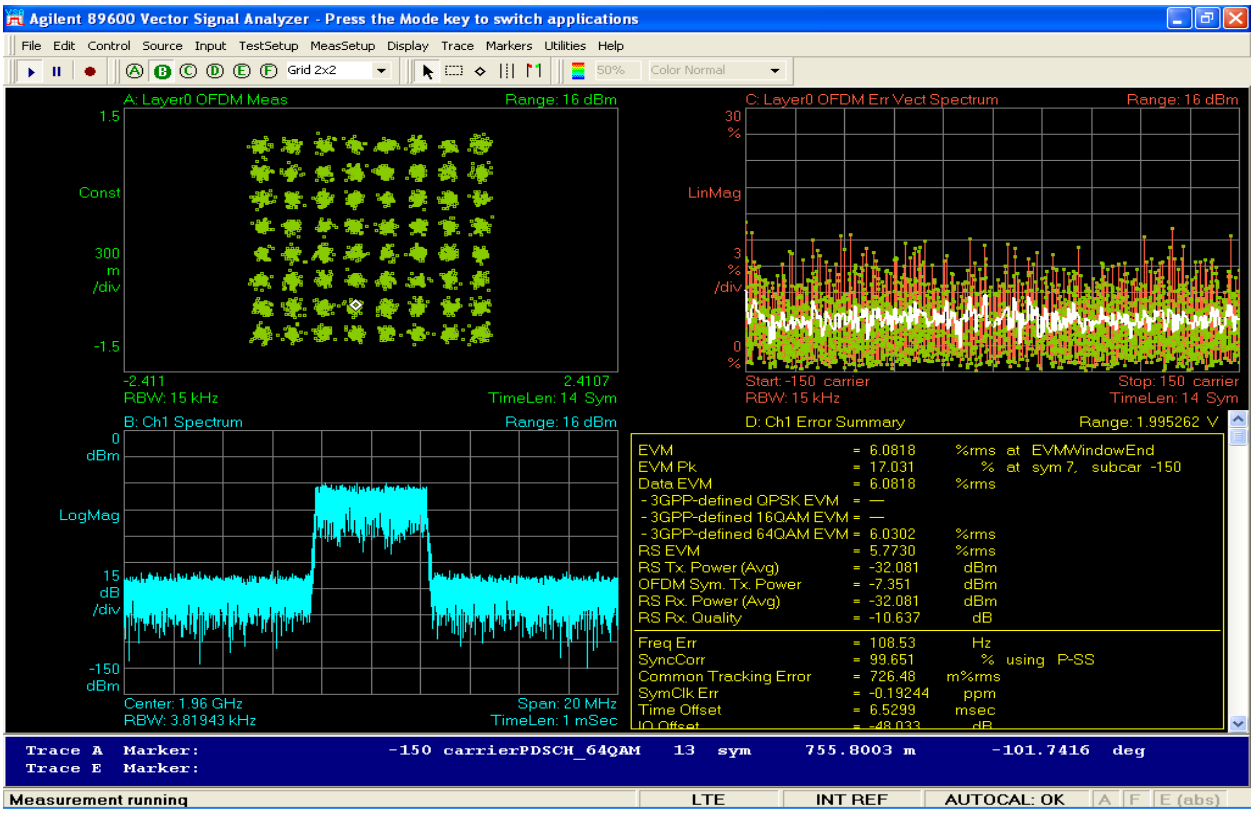

Figure 6-16 : 5MHz BW Modulation TX1_64QAM at 1960.0 MHz

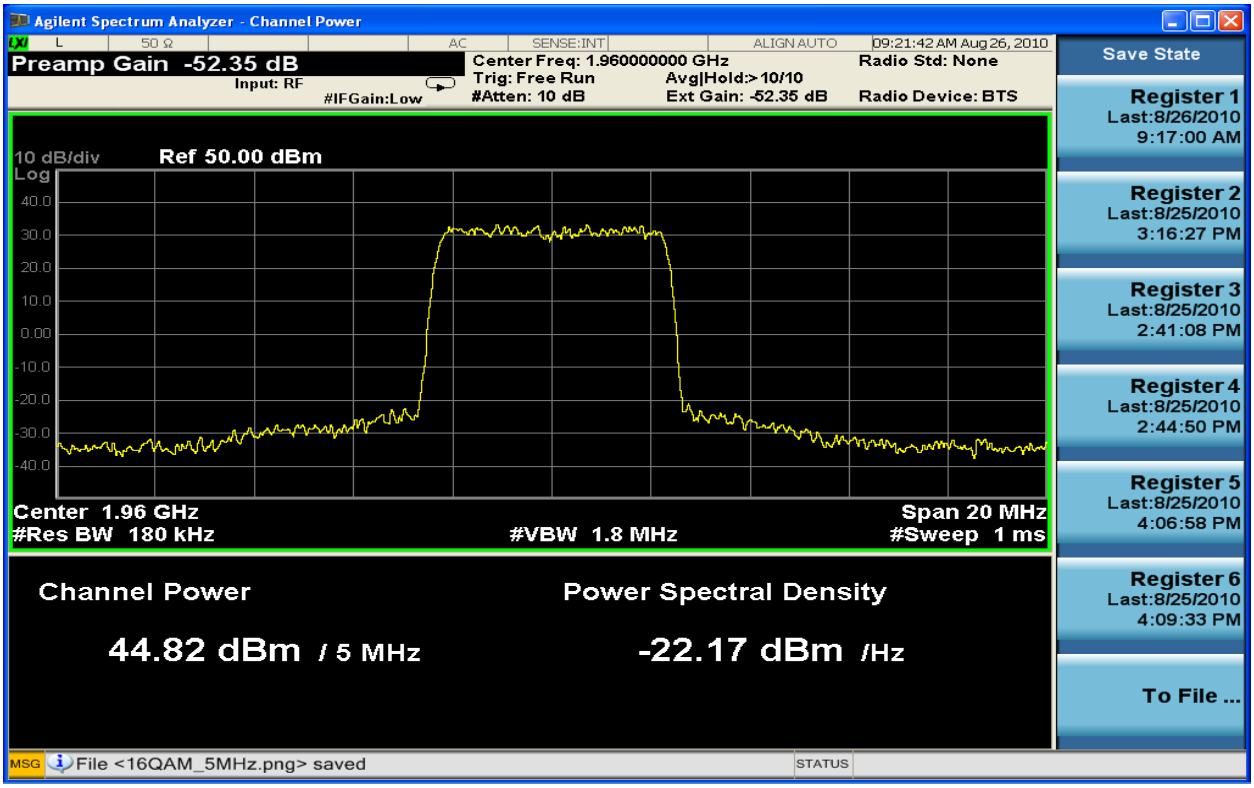

Figure 6-17 : 5MHz BW Channel Power TX1_64QAM at 1960.0 MHz

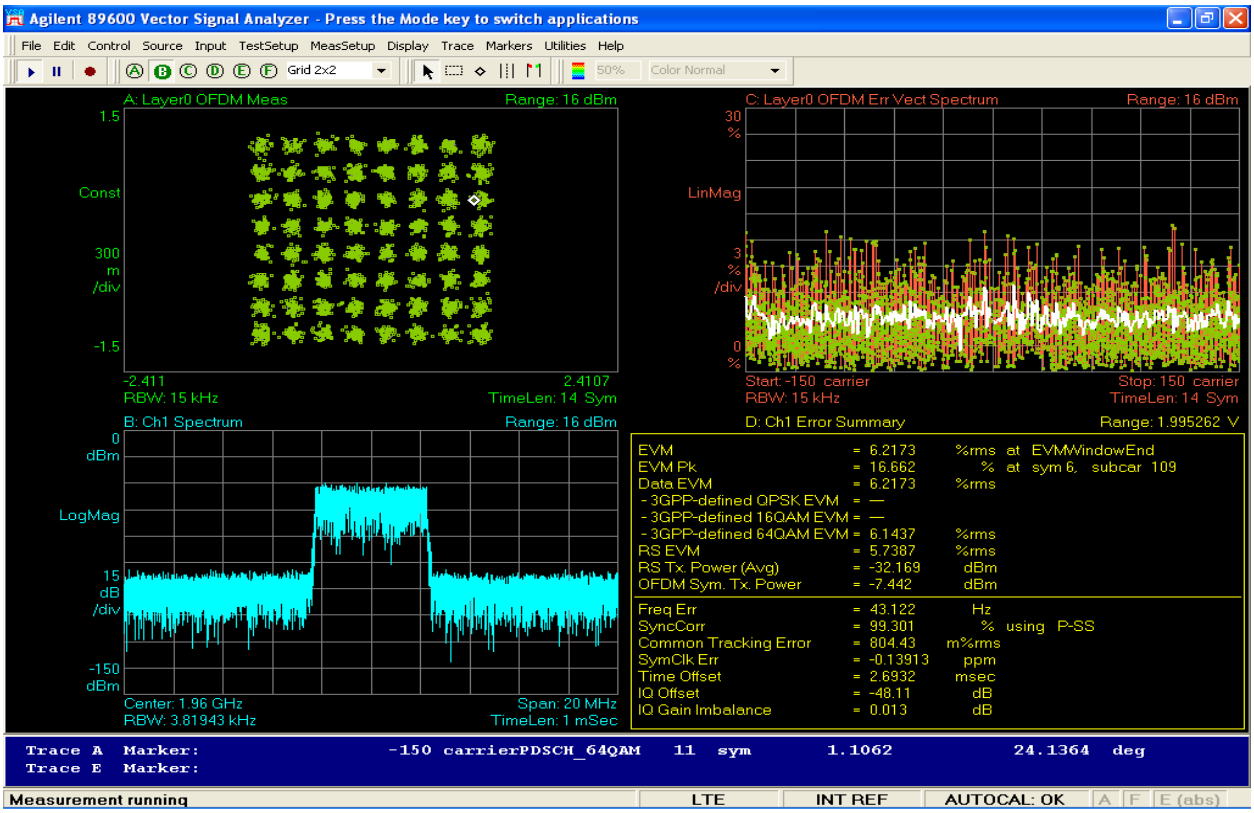

Figure 6-18 : 5MHz BW Modulation TX2_64QAM at 1960.0 MHz

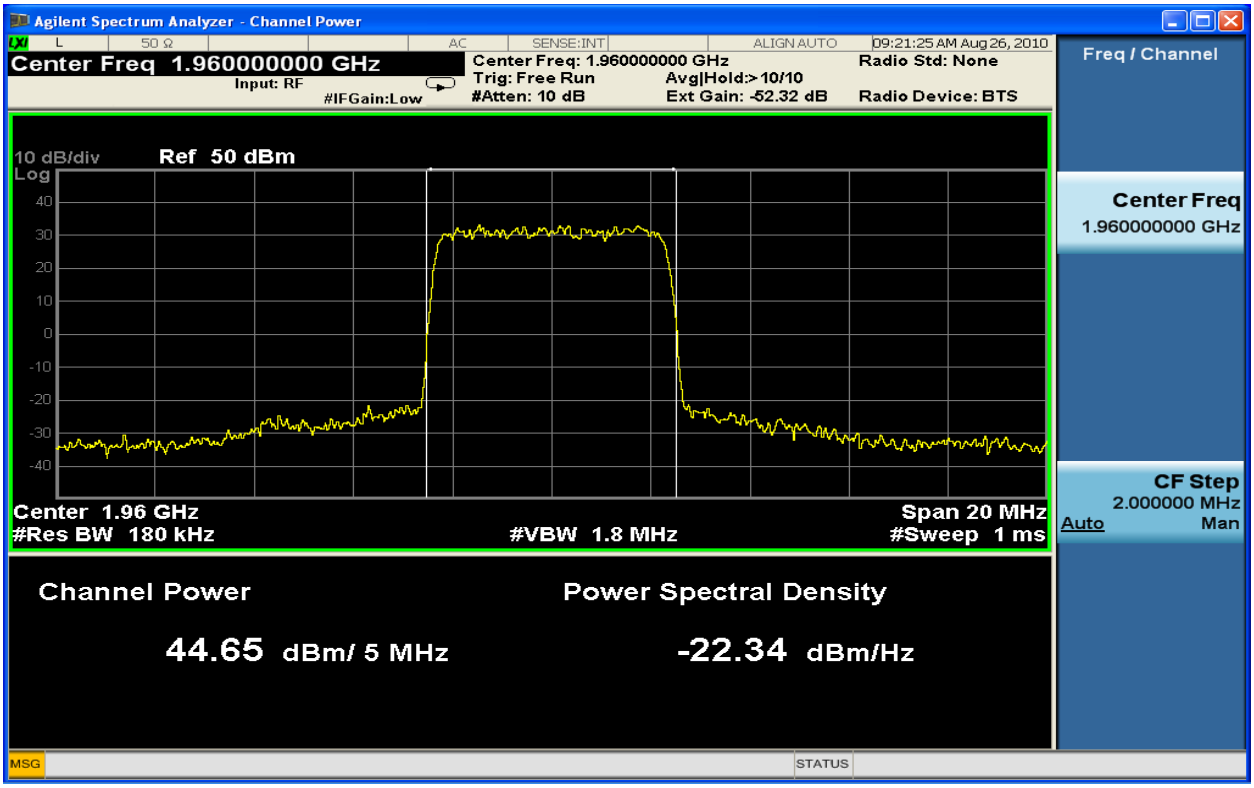

Figure 6-19 : 5MHz BW Channel Power TX2_64QAM at 1960.0 MHz

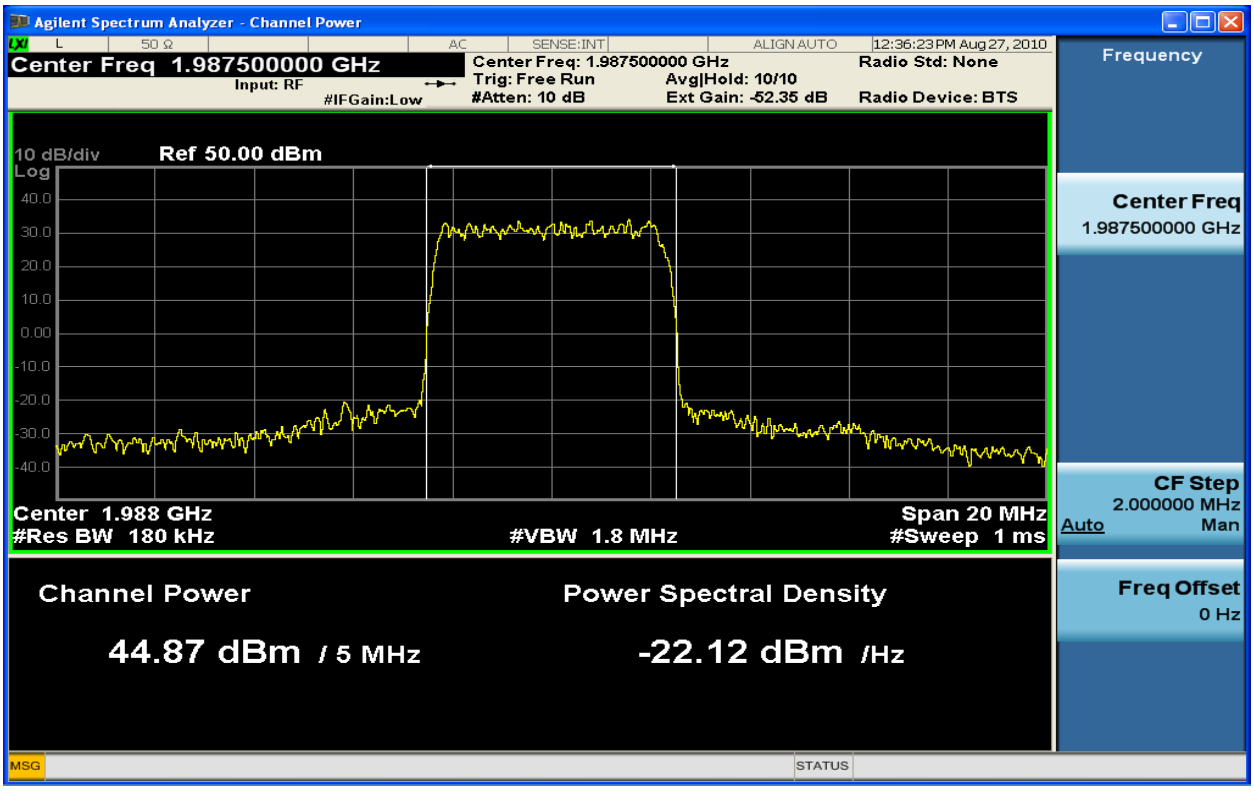

Figure 6-20 : 5MHz BW Channel Power TX1_QPSK at 1987.5 MHz

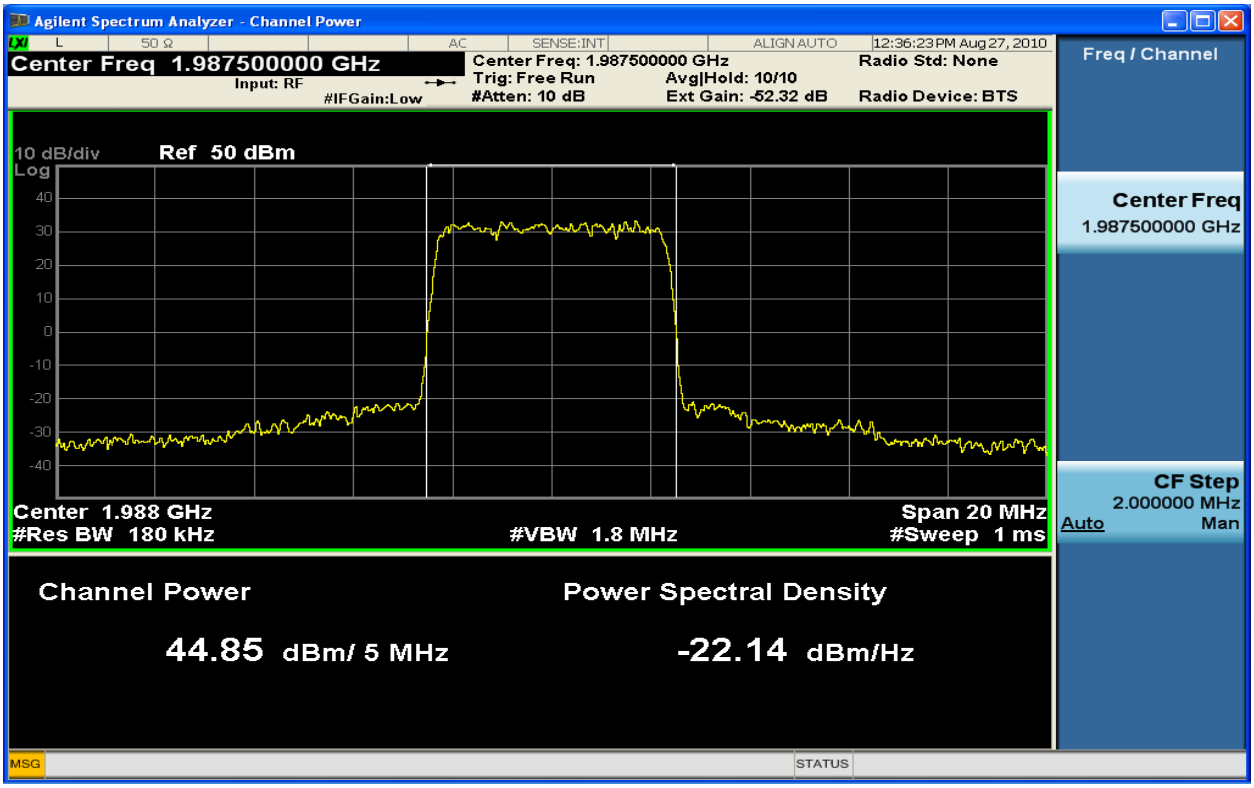

Figure 6-21 : 5MHz BW Channel Power TX2_QPSK at 1987.5 MHz

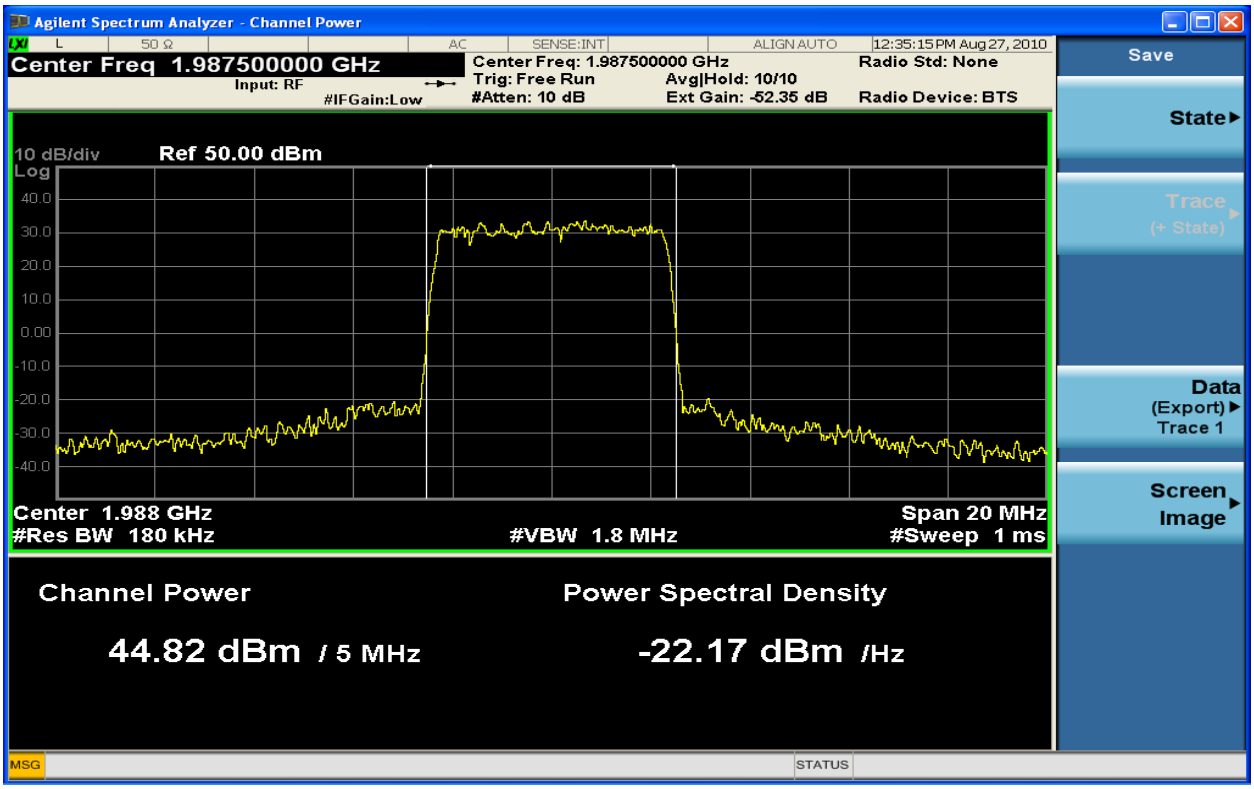

Figure 6-22 : 5MHz BW Channel Power TX1_16QAM at 1987.5 MHz

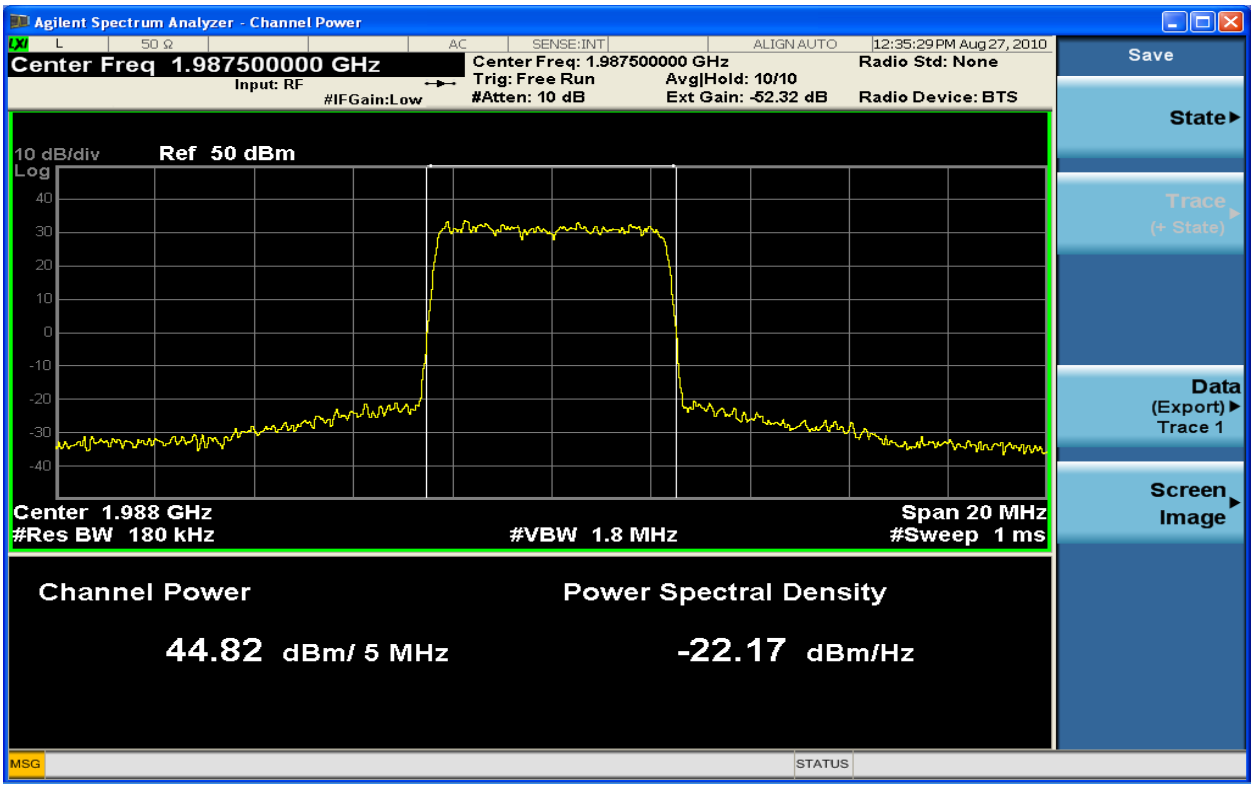

Figure 6-23 : 5MHz BW Channel Power TX2_16QAM at 1987.5 MHz

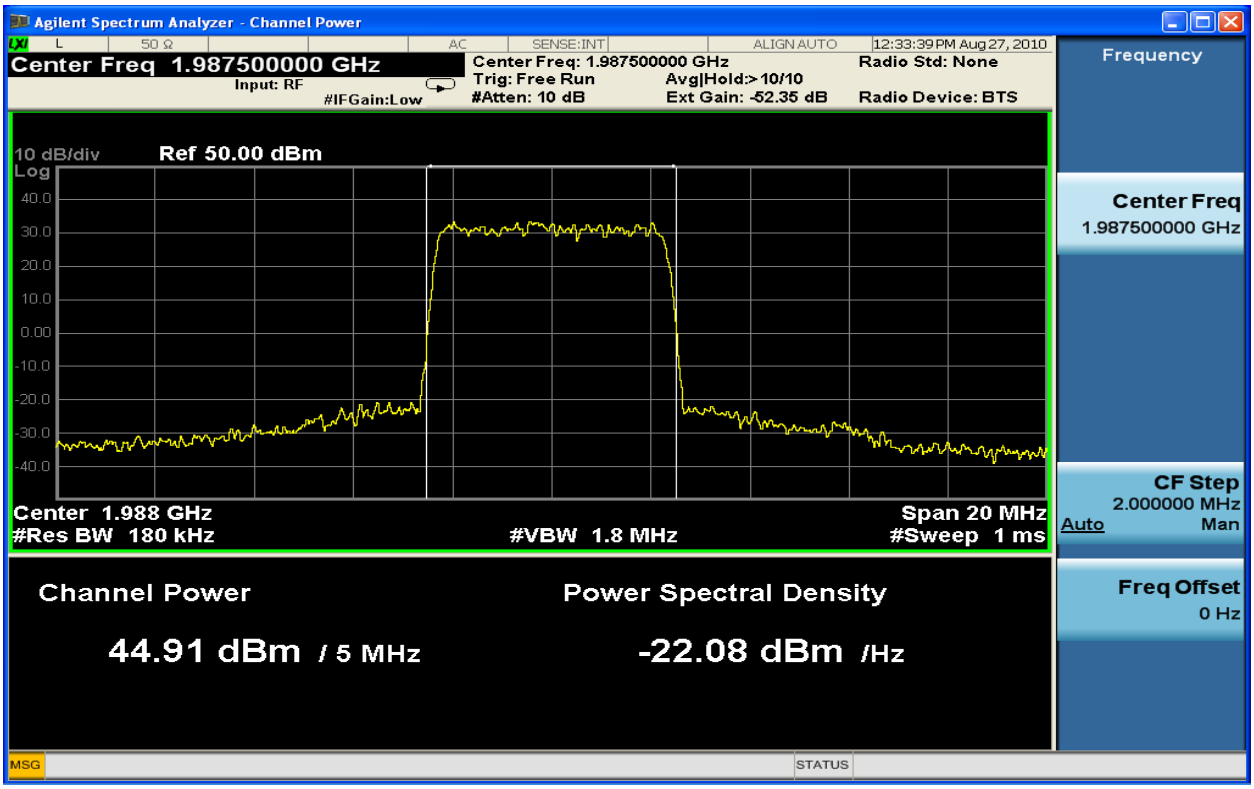

Figure 6-24 : 5MHz BW Channel Power TX1_64QAM at 1987.5 MHz

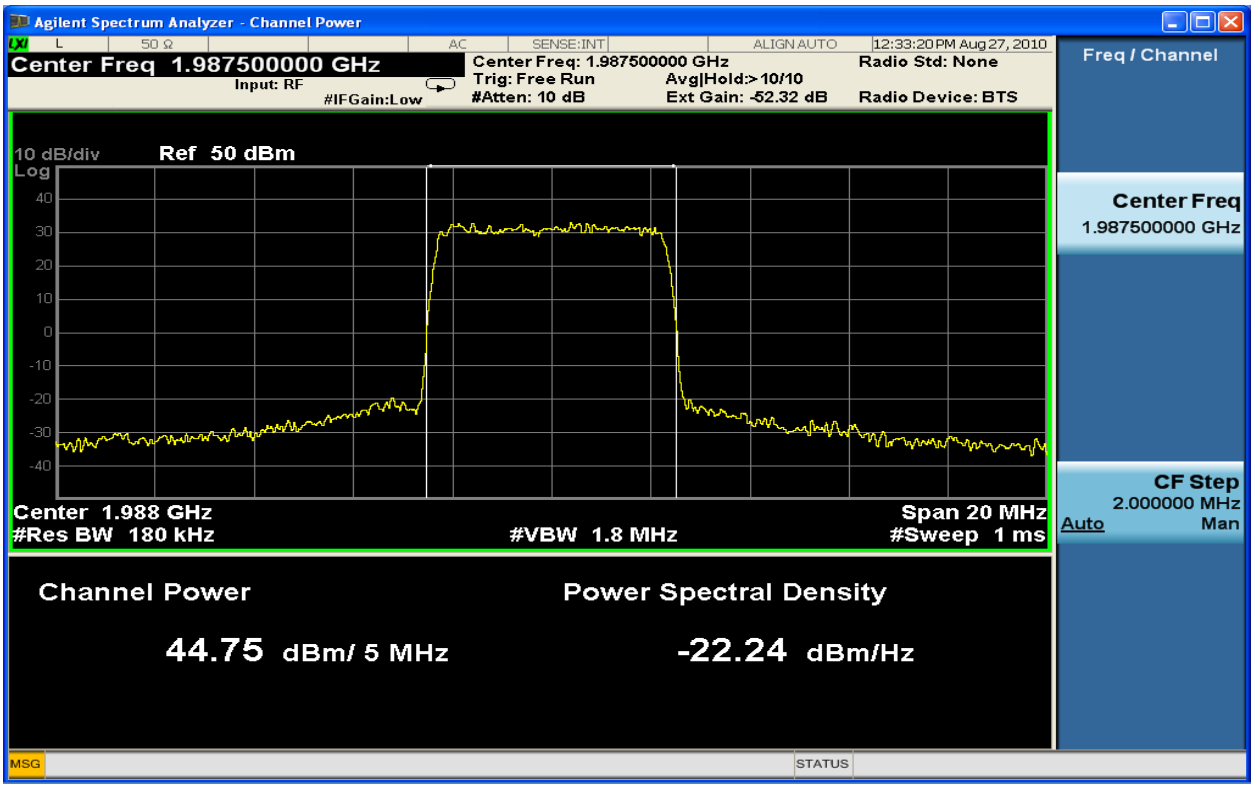

Figure 6-25 : 5MHz BW Channel Power TX2_64QAM at 1987.5 MHz

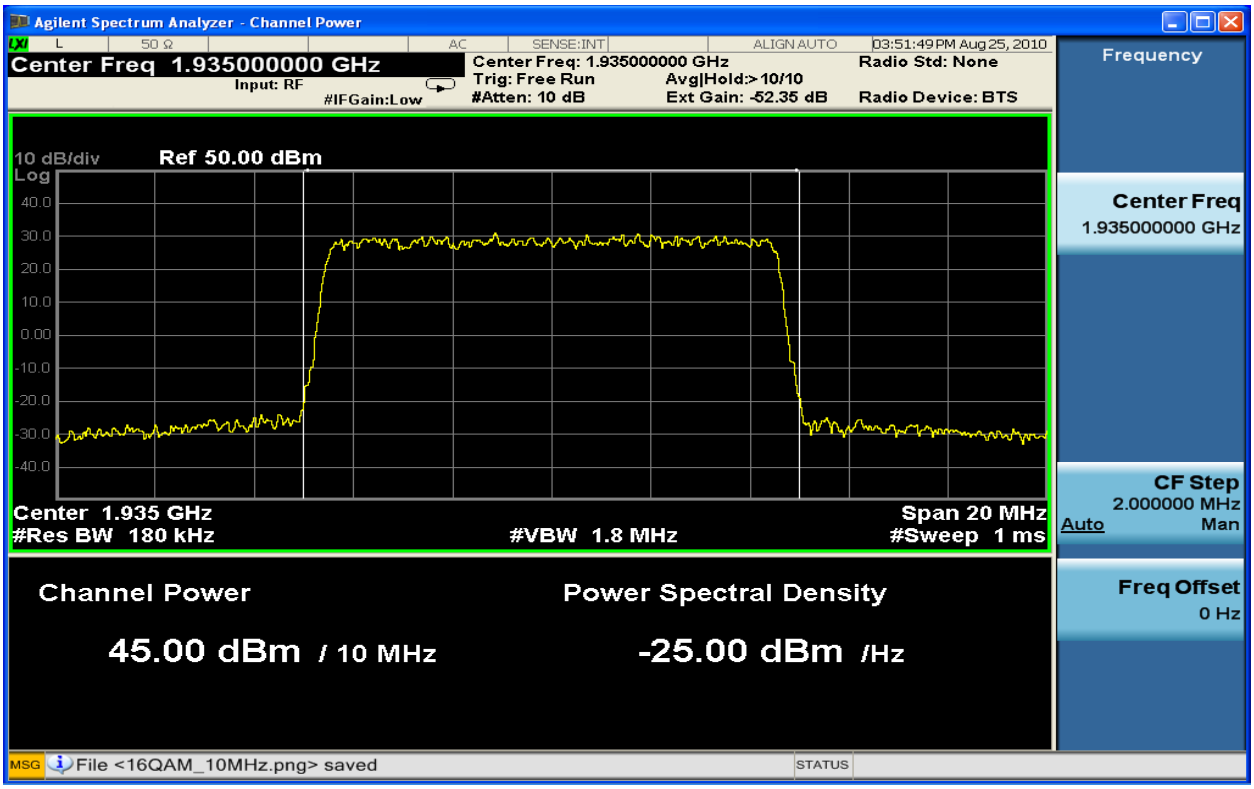

Figure 6-26 : 10MHz BW Channel Power TX1_QPSK at 1935.0 MHz

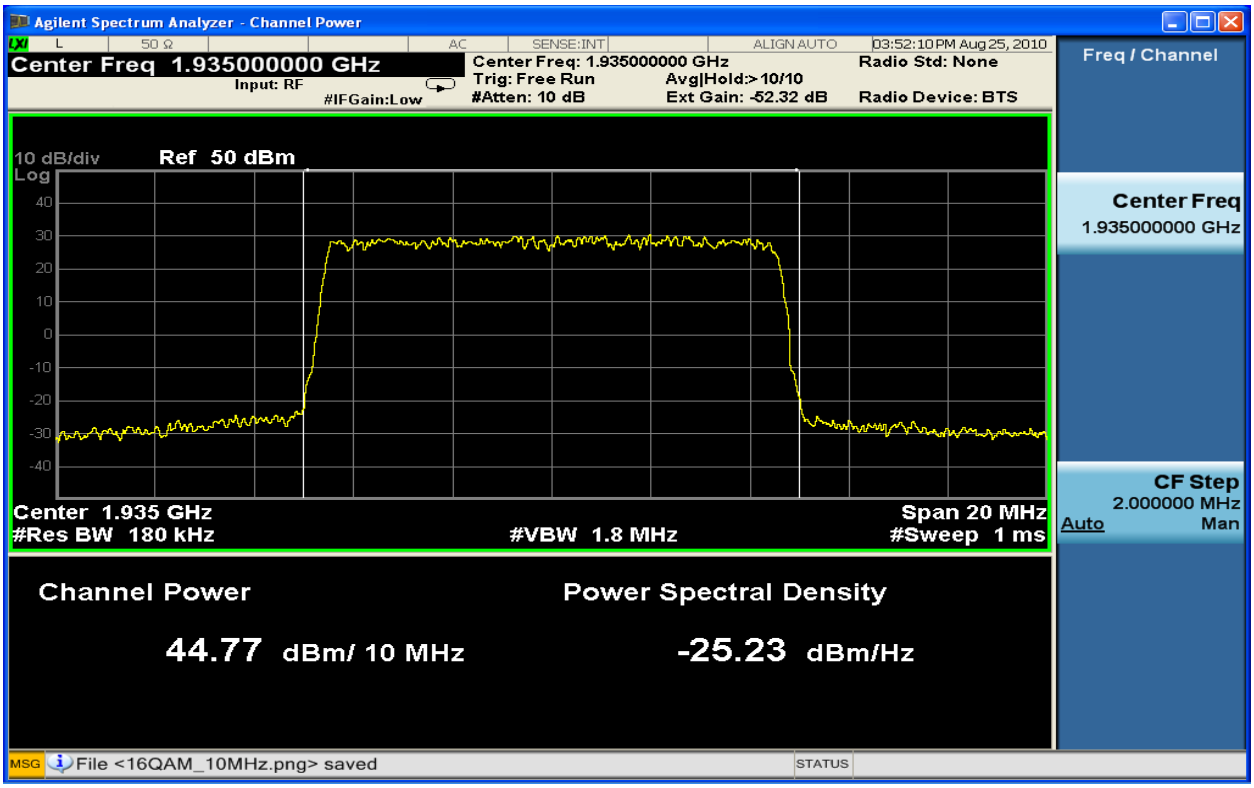

Figure 6-27 : 10MHz BW Channel Power TX2_QPSK at 1935.0 MHz

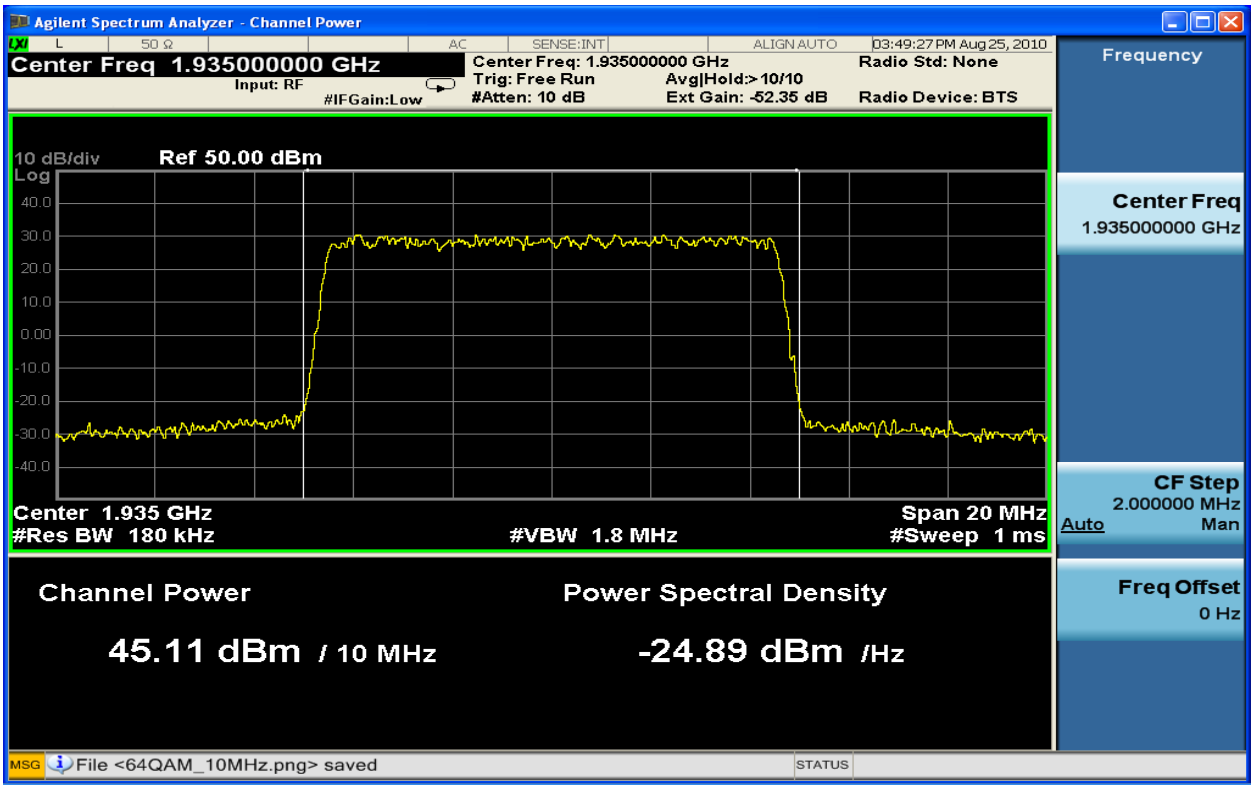

Figure 6-28 : 10MHz BW Channel Power TX1_16QAM at 1935.0 MHz

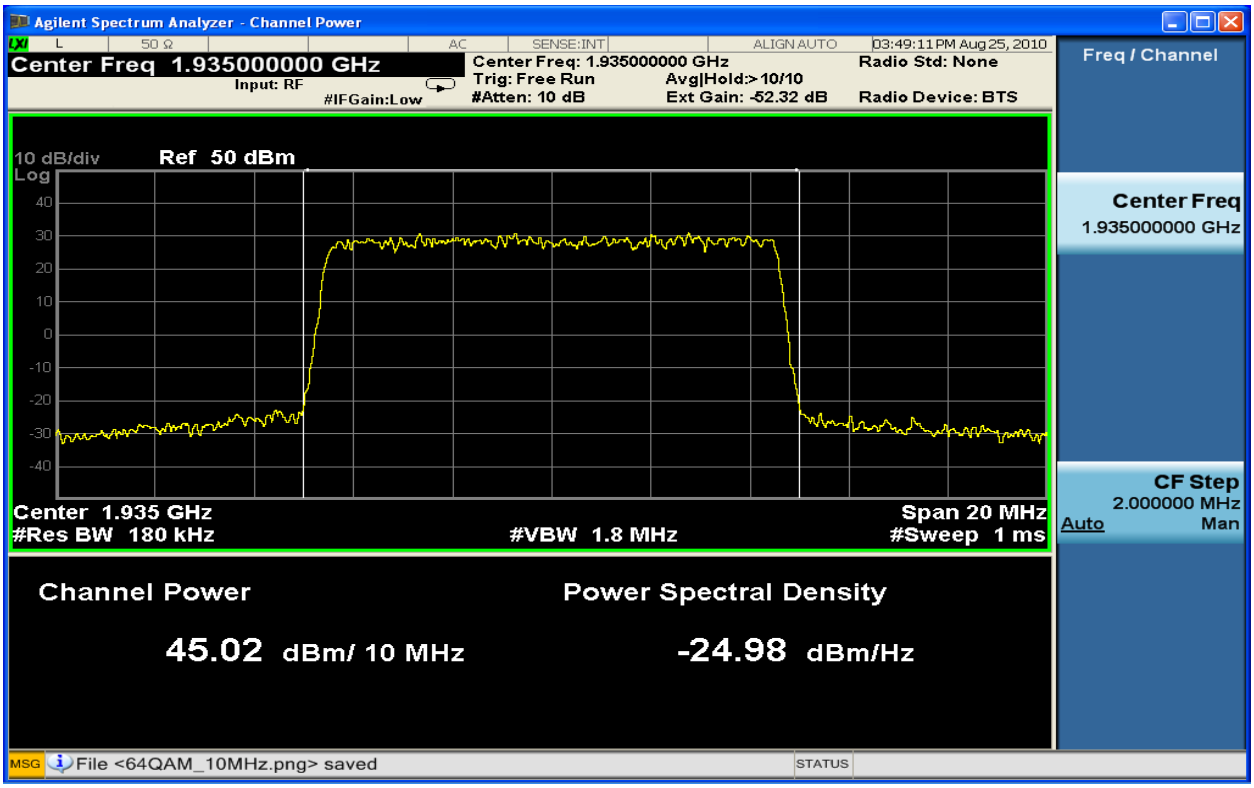

Figure 6-29 : 10MHz BW Channel Power TX2_16QAM at 1935.0 MHz

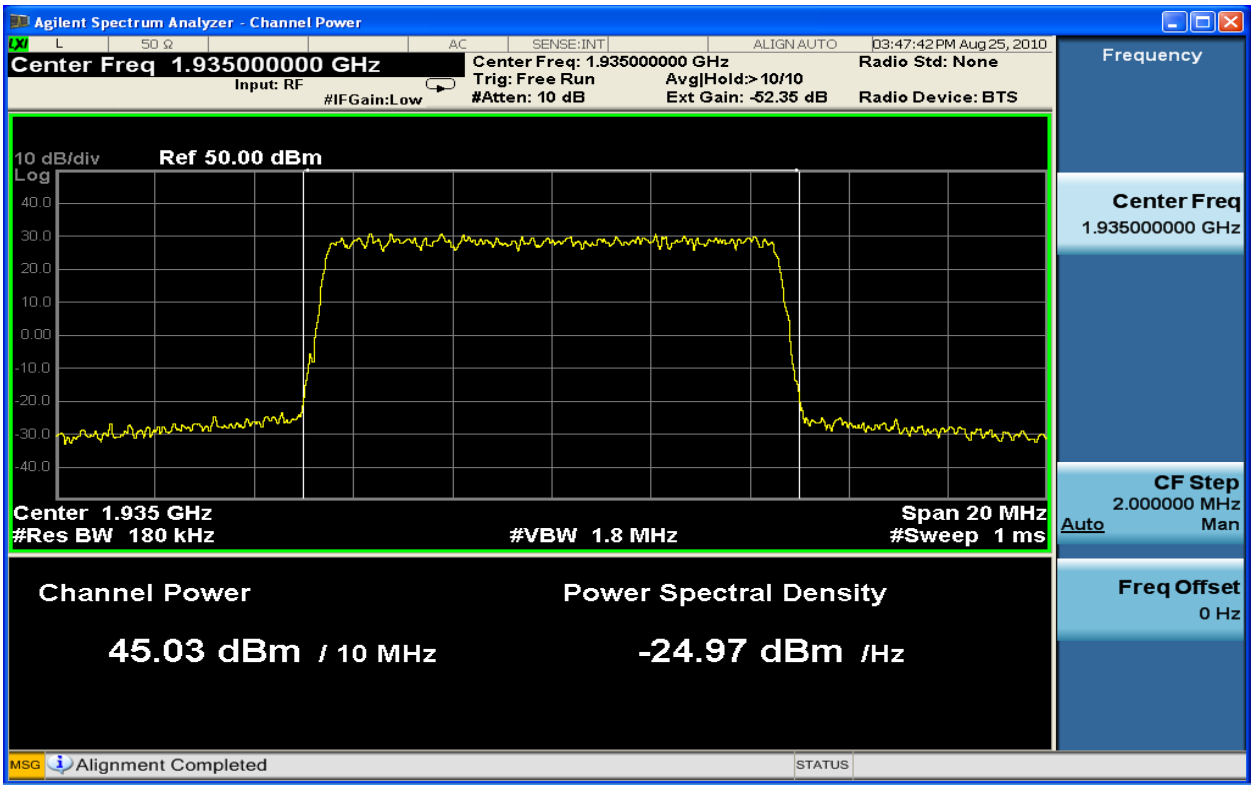

Figure 6-30 : 10MHz BW Channel Power TX1_64QAM at 1935.0 MHz

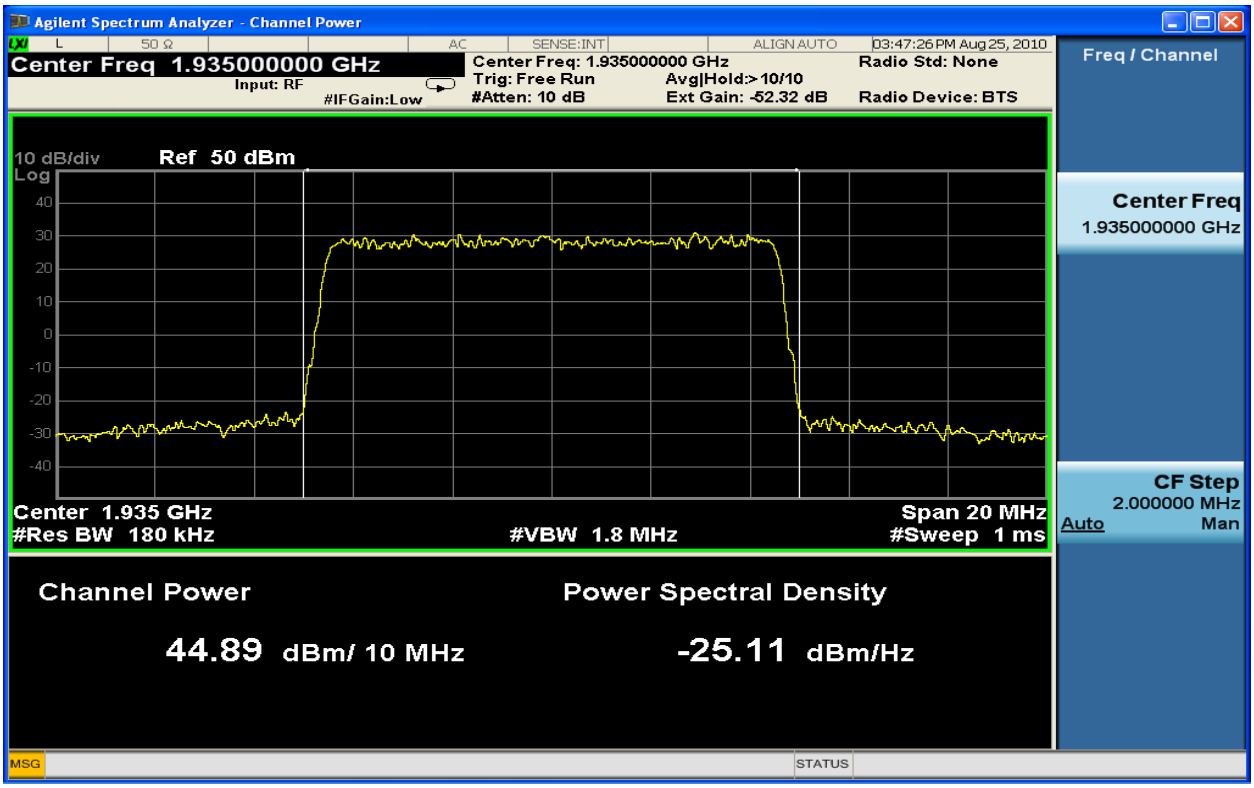

Figure 6-31 : 10MHz BW Channel Power TX2_64QAM at 1935.0 MHz

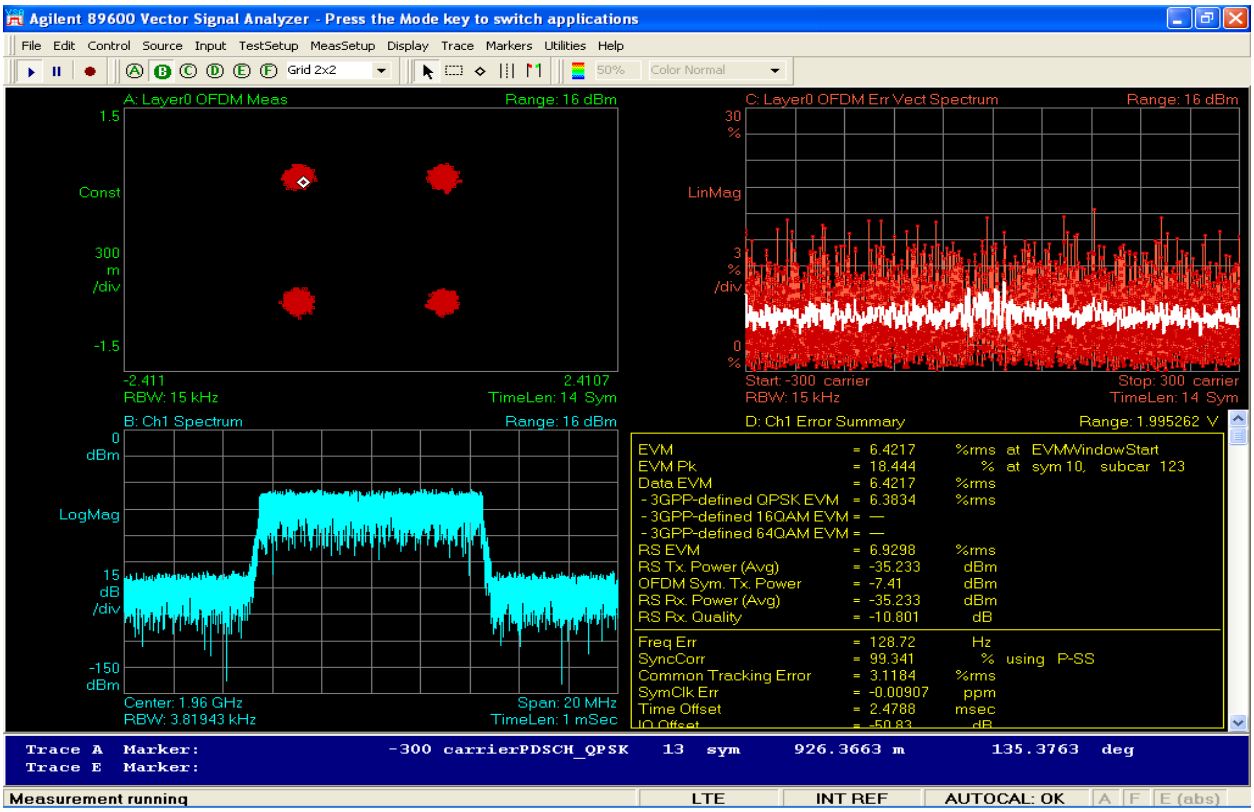

Figure 6-32 : 10MHz BW Modulation TX1_QPSK at 1960.0 MHz

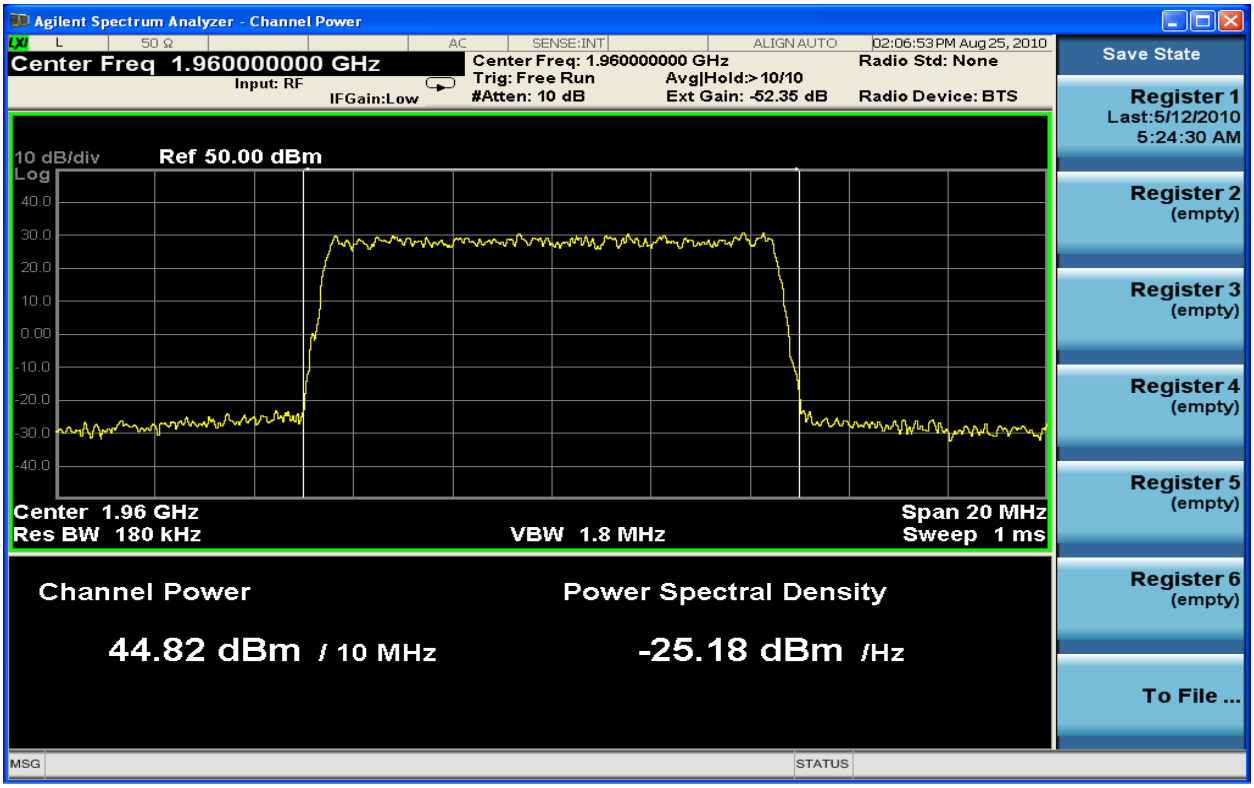

Figure 6-33 : 10MHz BW Channel Power TX1_QPSK at 1960.0 MHz

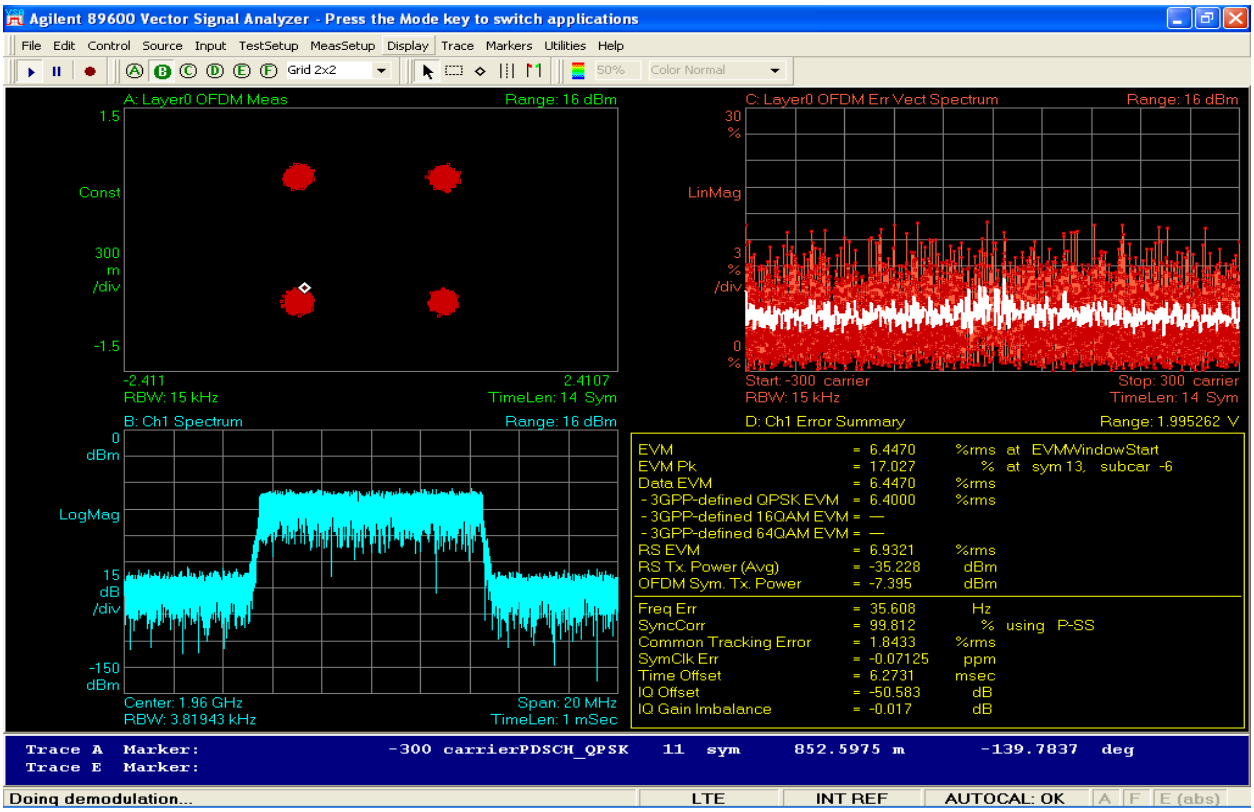

Figure 6-34 : 10MHz BW Modulation TX2_QPSK at 1960.0MHz

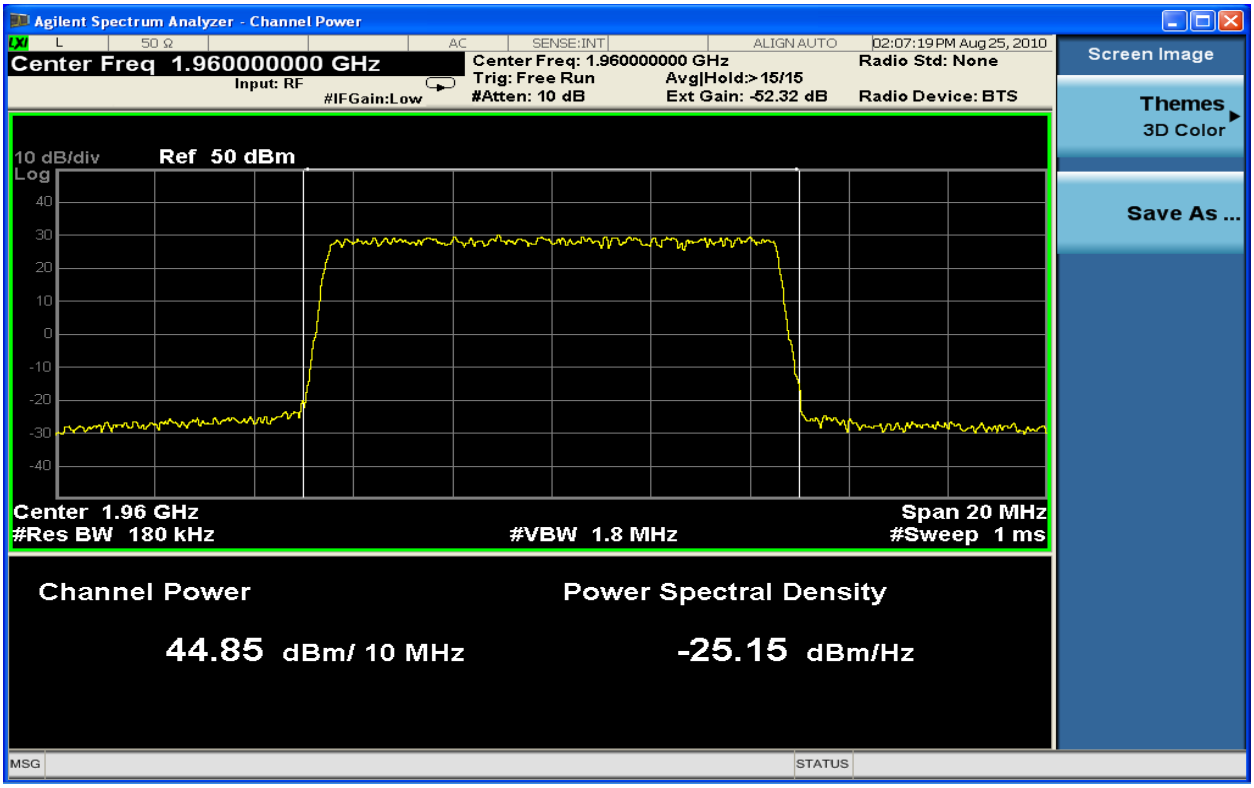

Figure 6-35 : 10MHz BW Channel Power TX2_QPSK at 1960.0 MHz

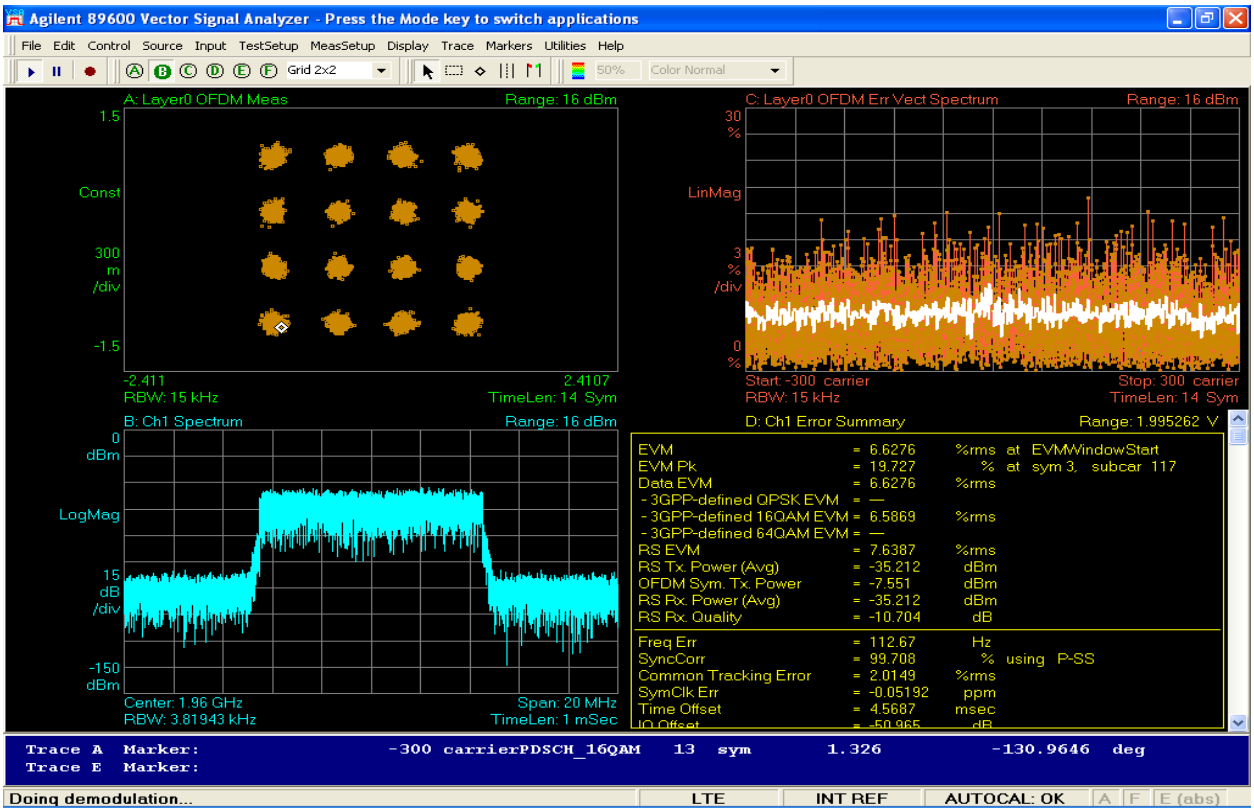

Figure 6-36 : 10MHz BW Modulation TX1_16QAM at 1960.0 MHz

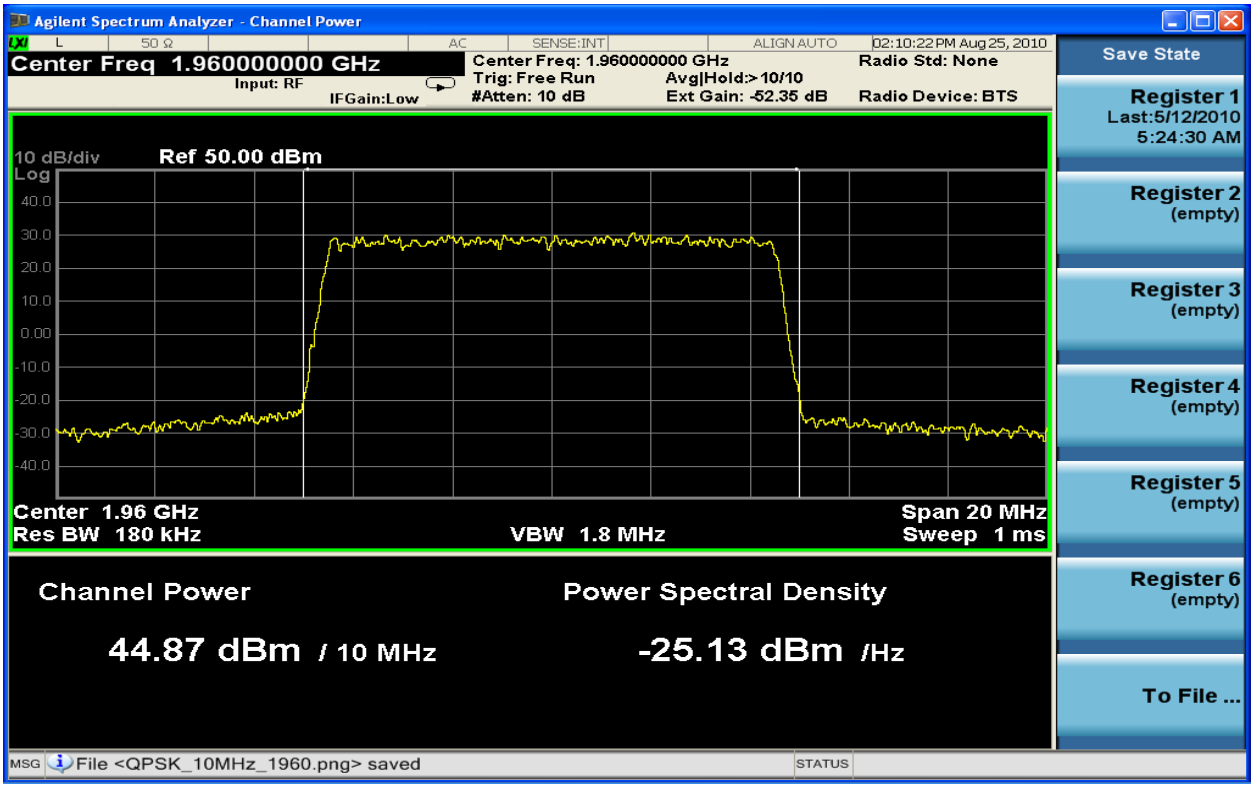

Figure 6-37 : 10MHz BW Channel Power TX1_16QAM at 1960.0 MHz

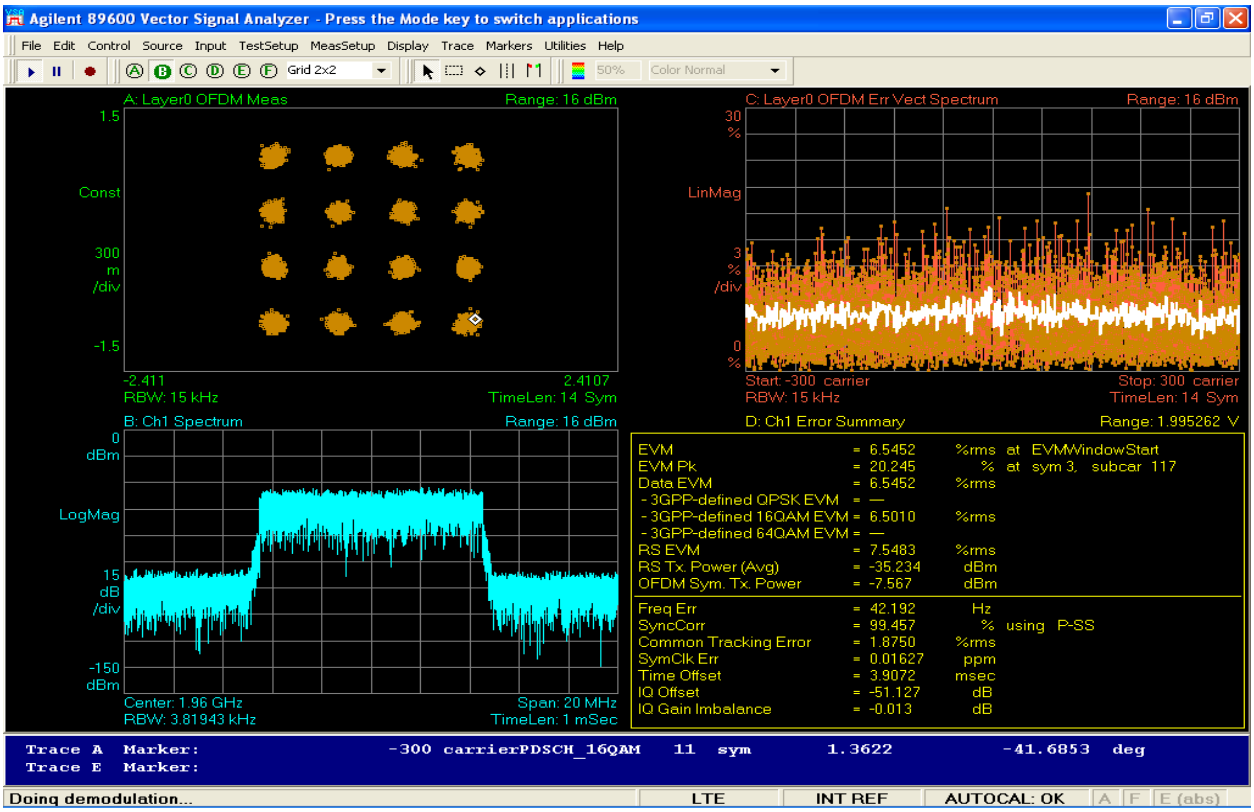

Figure 6-38 : 10MHz BW Modulation TX2_16QAM at 1960.0MHz

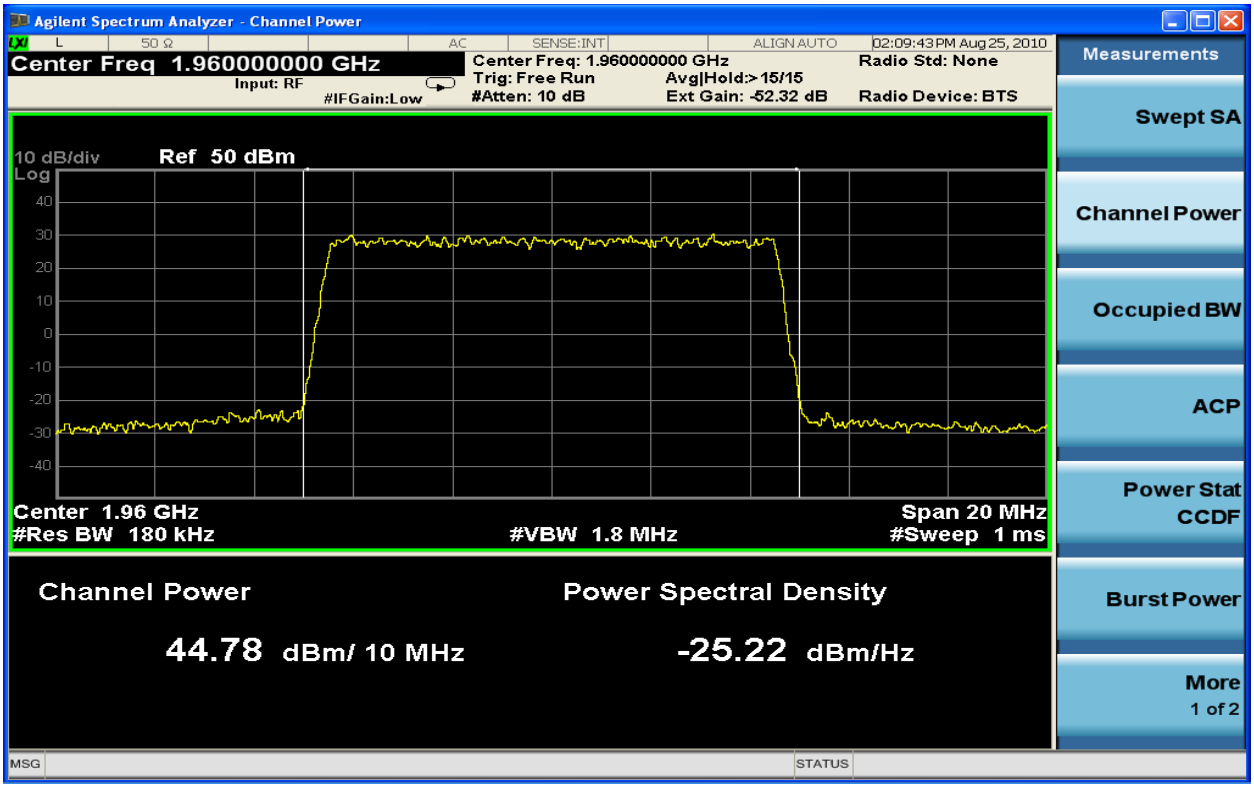

Figure 6-39 : 10MHz BW Channel Power TX2_16QAM at 1960.0 MHz

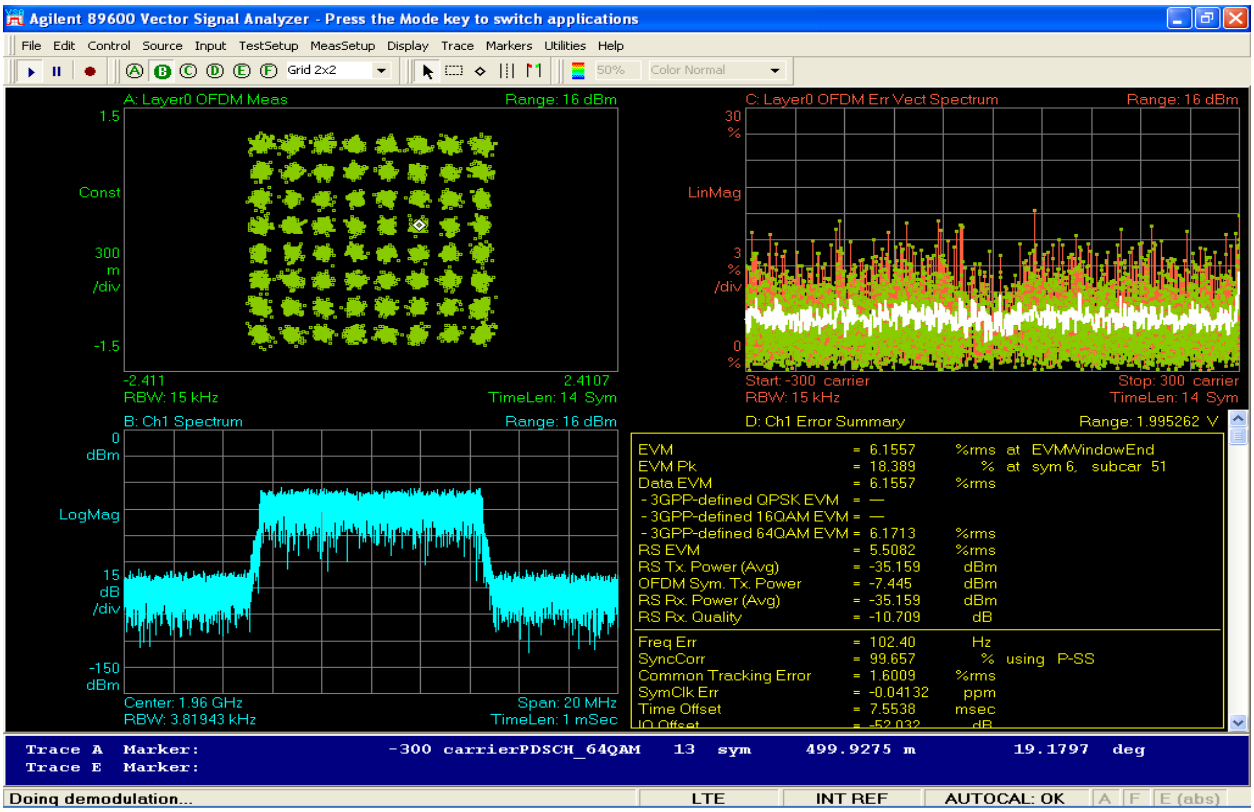

Figure 6-40 : 10MHz BW Modulation TX1_64QAM at 1960.0 MHz

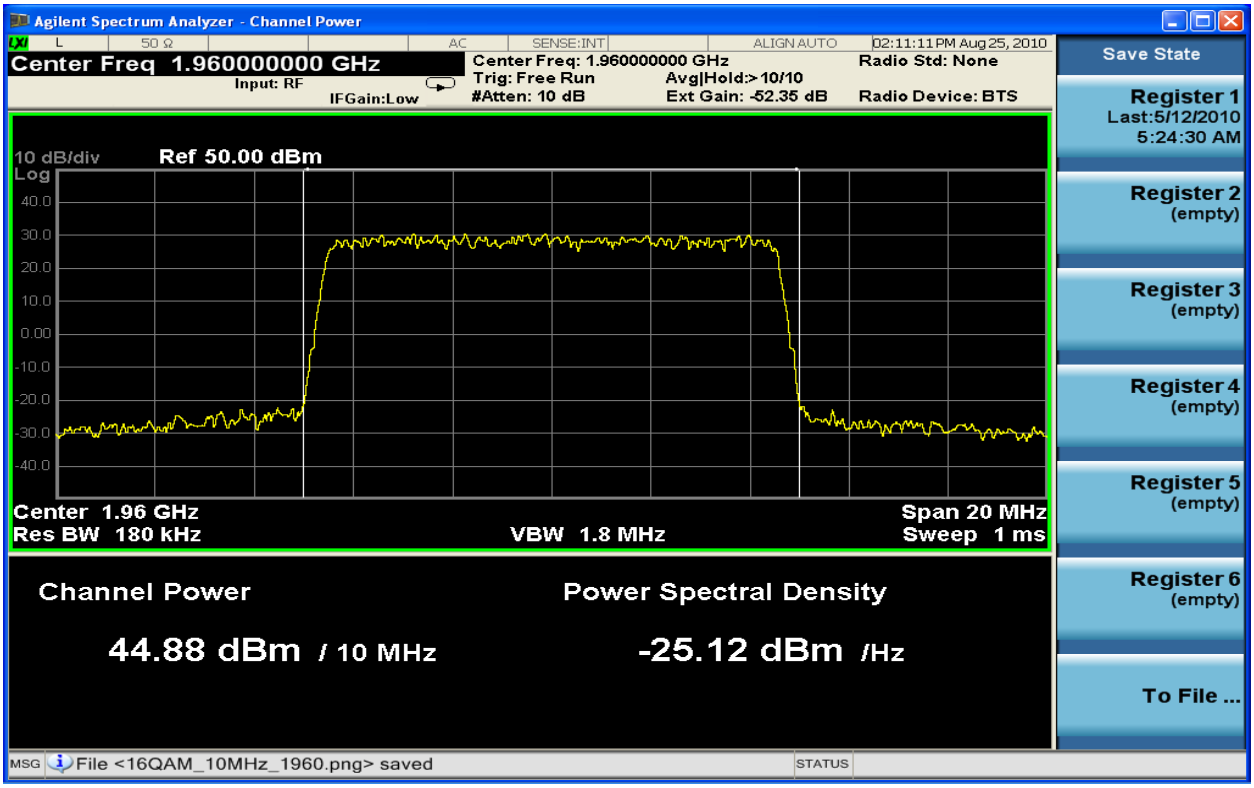

Figure 6-41 : 10MHz BW Channel Power TX1_64QAM at 1960.0MHz

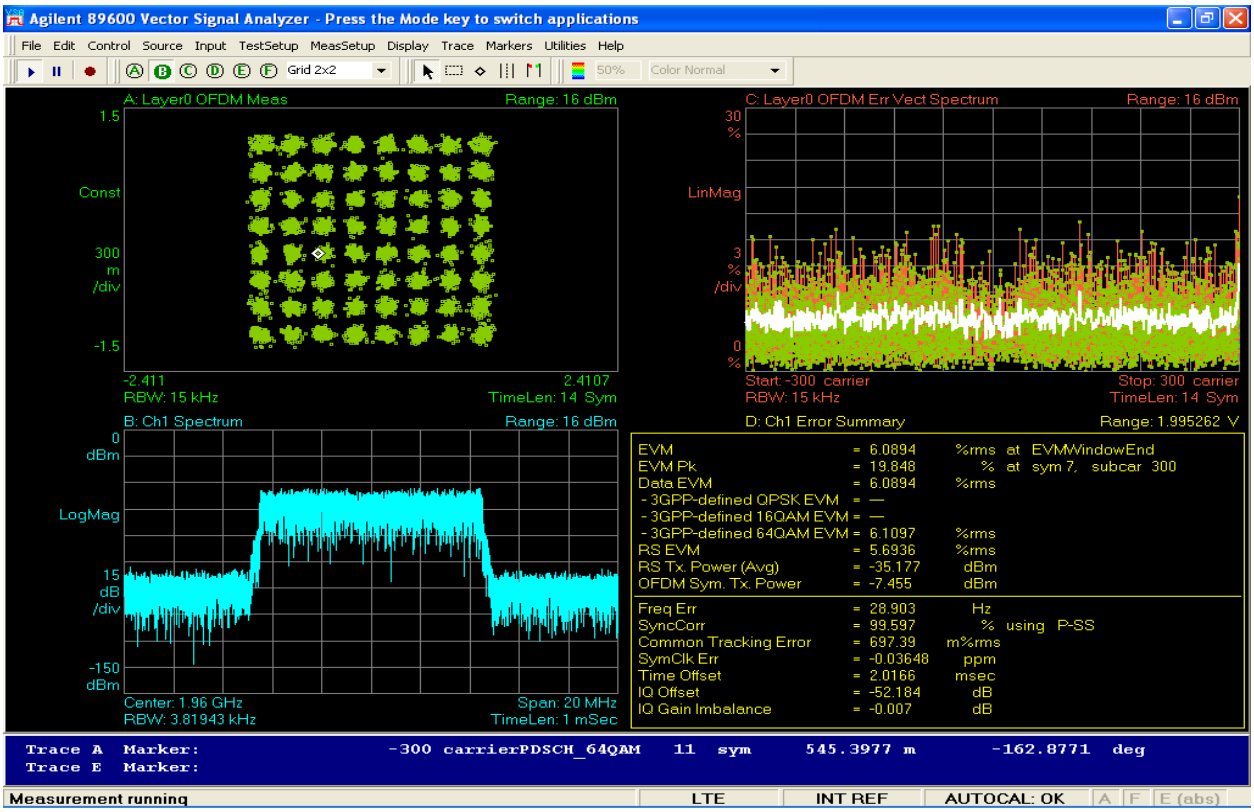

Figure 6-42 : 10MHz BW Modulation TX2_64QAM at 1960.0MHz

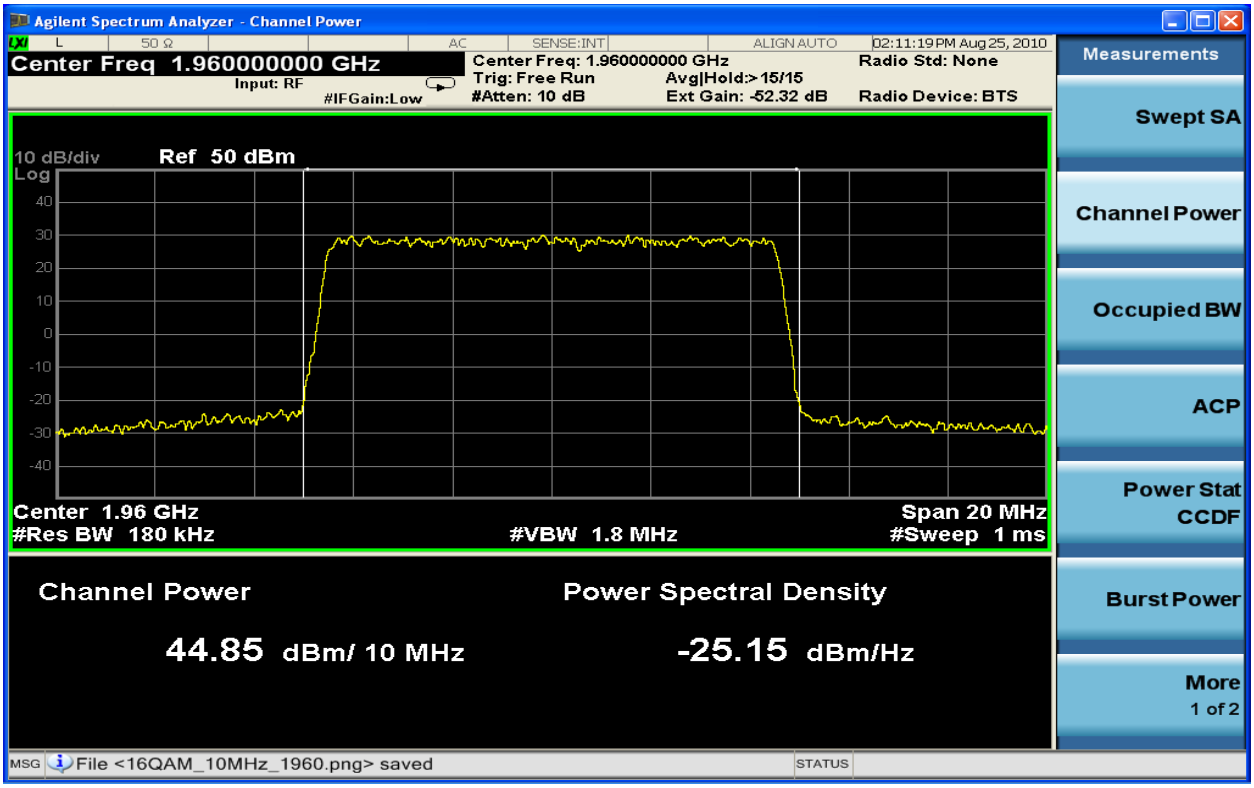

Figure 6-43 : 10MHz BW Channel Power TX2_64QAM at 1960.0MHz

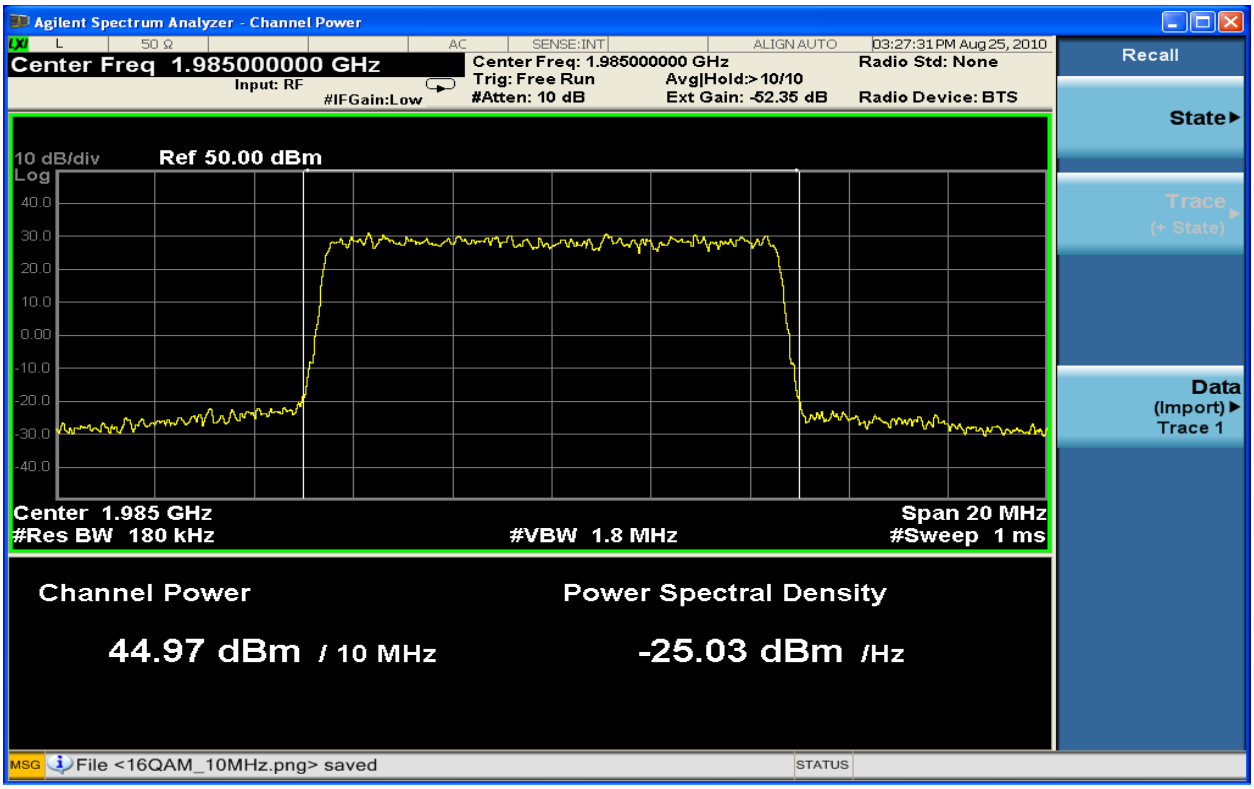

Figure 6-44 : 10MHz BW Channel Power TX1_QPSK at 1985.0 MHz

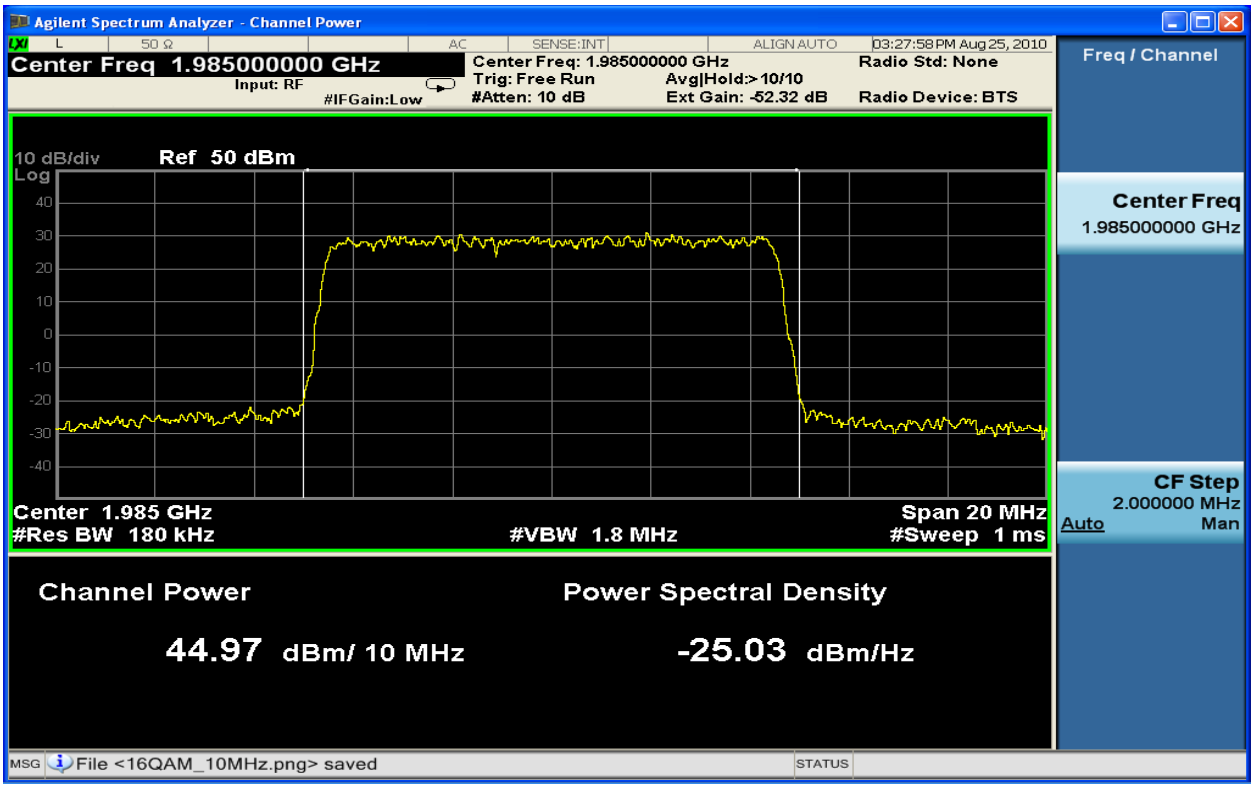

Figure 6-45 : 10MHz BW Channel Power TX2_QPSK at 1985.0 MHz

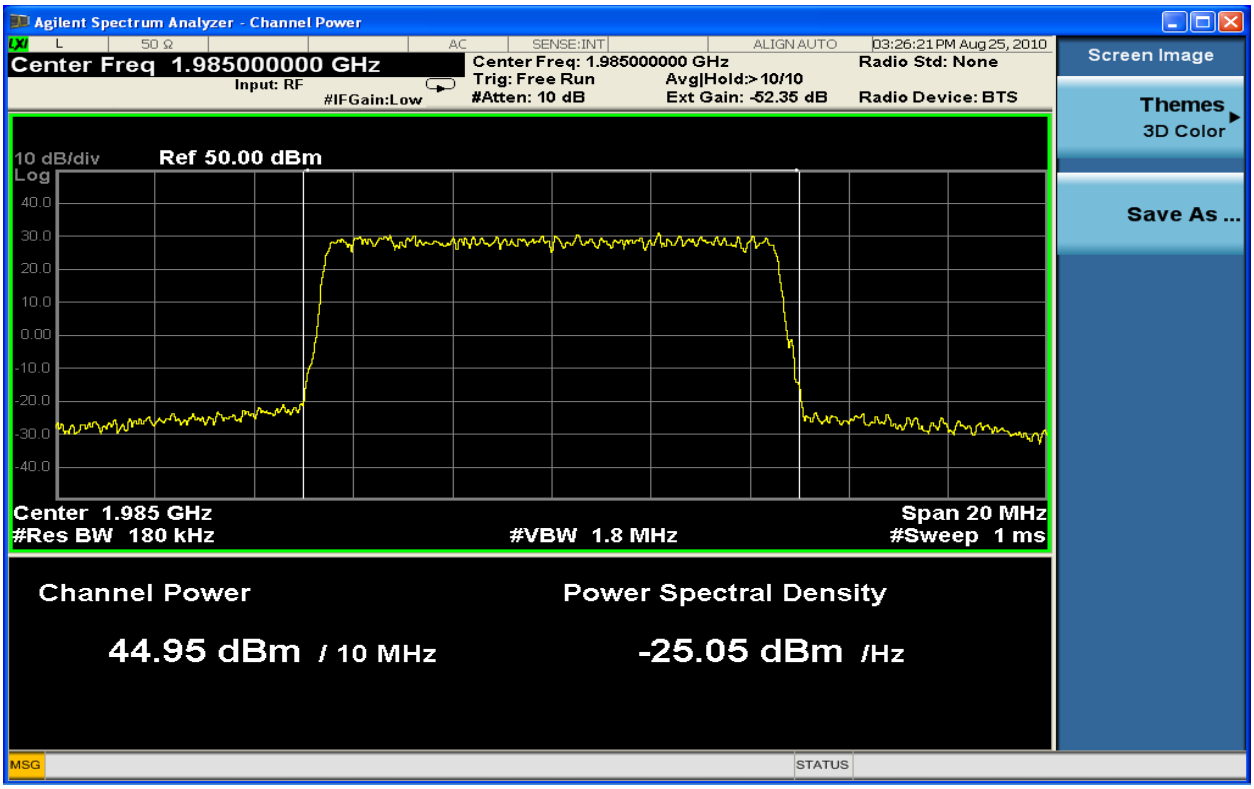

Figure 6-46 : 10MHz BW Channel Power TX1_16QAM at 1985.0 MHz

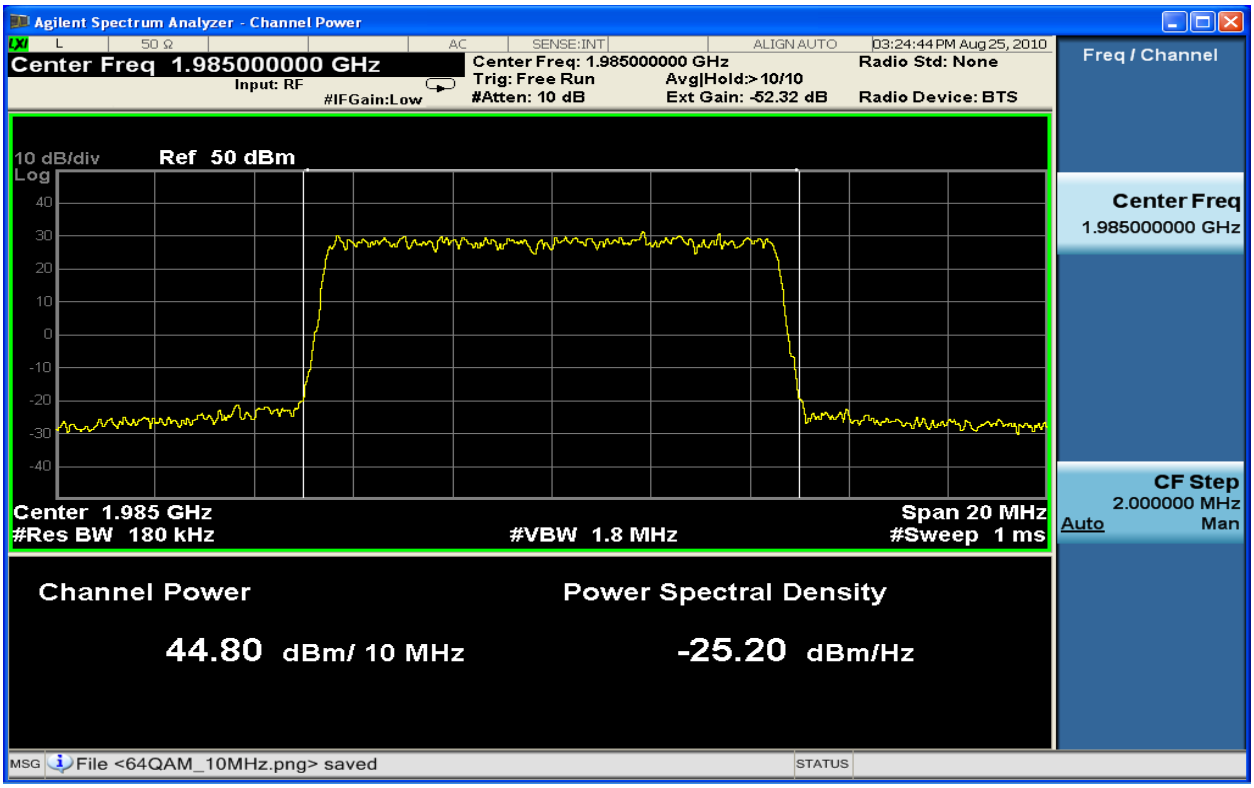

Figure 6-47 : 10MHz BW Channel Power TX2_16QAM at 1985.0 MHz

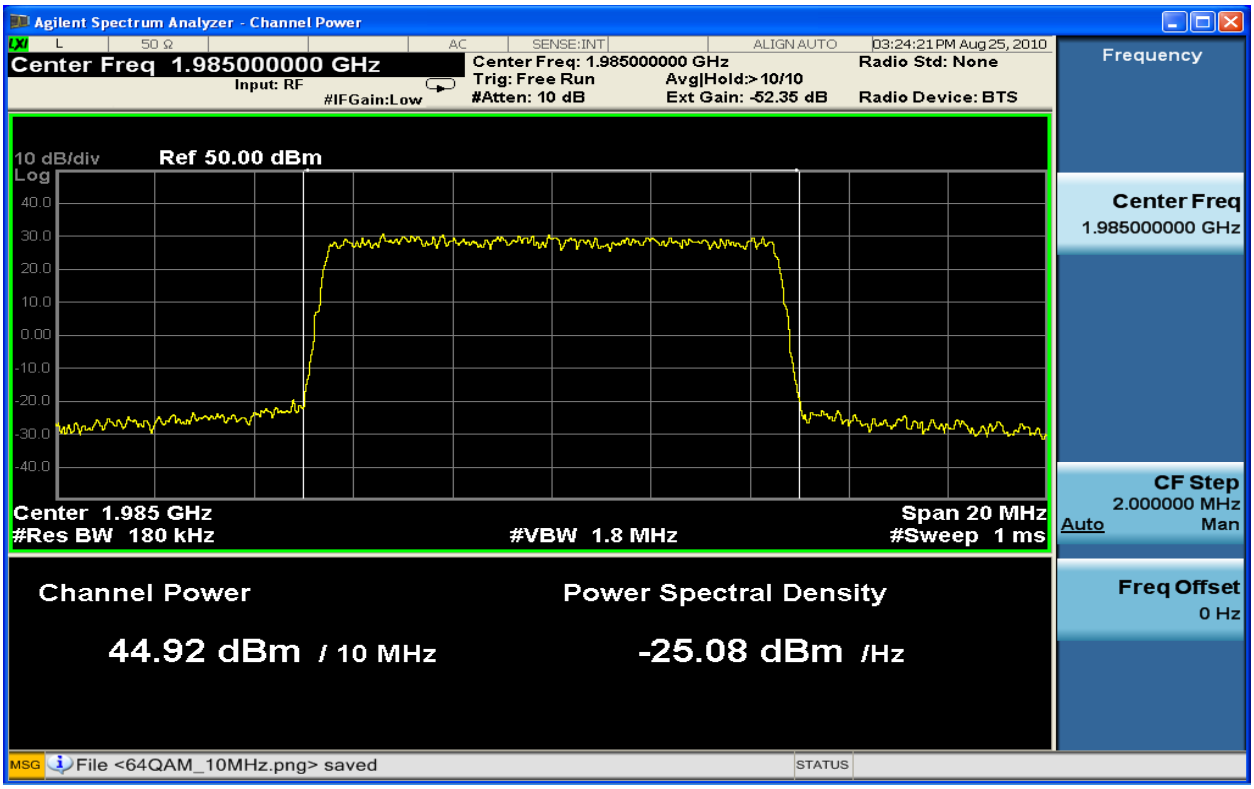

Figure 6-48 : 10MHz BW Channel Power TX1_64QAM at 1985.0 MHz

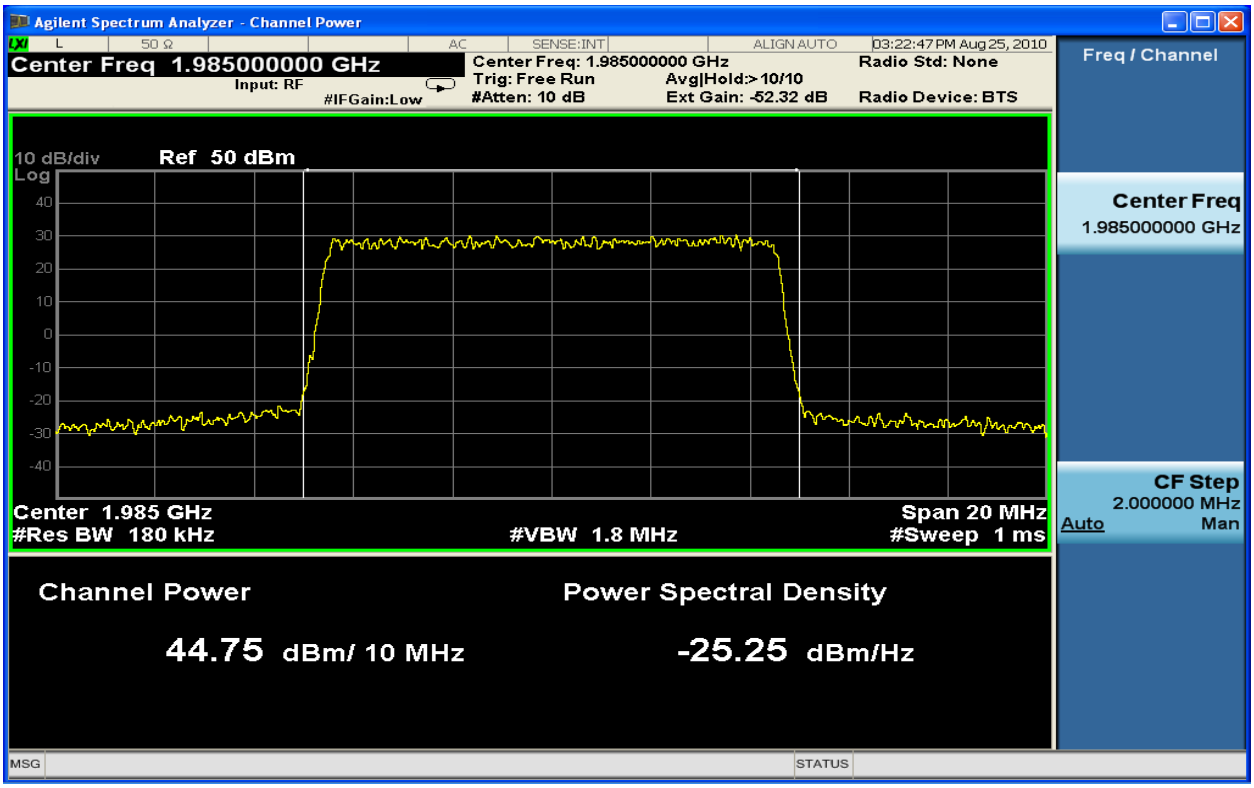

Figure 6-49 : 10MHz BW Channel Power TX2_64QAM at 1985.0 MHz

6.2 RF Safety

Licensees and manufacturers are subject to the radio frequency radiation exposure requirements specified in sections 1.1307(b), 2.1091, and 2.1093 of this chapter, as appropriate.

Technical information showing the basis for this statement must be submitted to the Commission upon request.

The following spread sheet shows an example of the required calculation for MPE (Maximum Permissible Exposure) for RF safety submissions. This calculation is required as a separate exhibit under the FCC submission.

RF Safety: Based on the rated output power and 15.0dB antenna gain, a minimum distance of 3.0 meters to the operating antenna must be maintained.

ERICSSON

Prediction of MPE limit at a given distance

Reference_1: Equation from page 51 of EN 50385: Basic standard for the calculation and measurement of electromagnetic field strength and SAR related to human exposure from radio base stations and fixed terminal stations for wireless telecommunication systems (110 MHz - 40 GHz)
Reference 2: Equation from page 18 of OET Bulletin 65, Edition 97-01: Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields.

RRUL 11 B2: 1930 - 1990MHz

$$S = \frac{PG}{4\pi R^2}$$

where: S = power density
P = power input to the antenna
G = power gain of the antenna in the direction of interest relative to an isotropic radiator
R = distance to the center of radiation of the antenna

Maximum peak output power at antenna input terminal:	44.80	(dBm)
Maximum peak output power at antenna input terminal:	30199.5172	(mW)
Antenna gain(typical):	15	(dBi)
Maximum antenna gain:	31.6227766	(numeric)
Prediction distance:	300	(cm)
Prediction frequency:	2155	(MHz)
MPE limit for uncontrolled exposure at prediction frequency:	1	(mW/cm^2)
Power density at prediction frequency:	0.844399	(mW/cm^2)
Maximum allowable antenna gain:	15.73452373	(dBi)
Margin of Compliance:	0.734523735	

6.3 Occupied Bandwidth

Clause 24.232 2.1049

(a) *Occupied bandwidth.* 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. Occupied BW is the portion of the spectrum which contains 99% of the emitted energy (.5% of the remaining is above and .5% is below the occupied BW). The occupied bandwidth may not exceed the authorized bandwidth in the radio service rules. The occupied bandwidth test should be performed for each type of emission listed on the grant.

Procedure:

The following procedure and conditions shall apply for Occupied Bandwidth measurements. As applicable, Lower, Middle and Upper frequency offsets, modulation, and bandwidths shall be assessed and recorded along with the relevant captured plots.

Test Setup

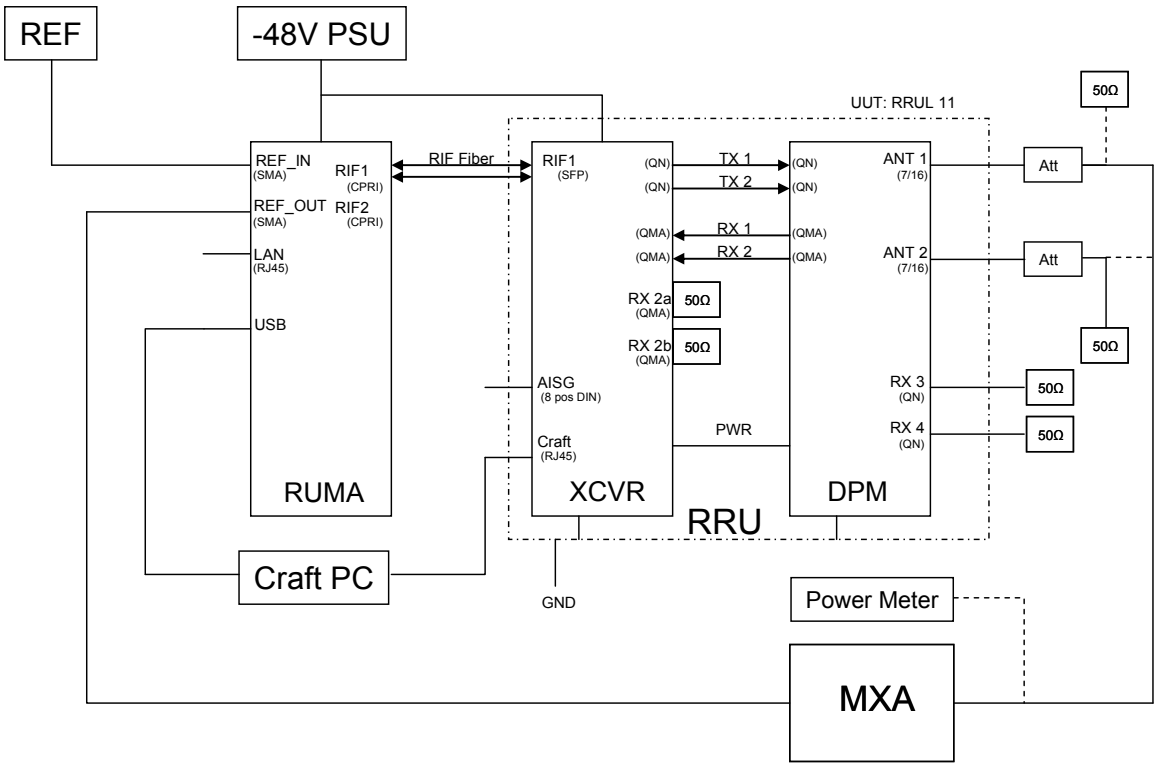

Figure 6-50 RRU Radio Compliance Set Up / Configuration

The following tables are used to summarize recorded results in addition to applicable captured plots.

Table 6-3: Setting / Measurement Results – Occupied Bandwidth 5MHz

Setting		Occupied Bandwidth (MHz)					
		QPSK		16 QAM		64 QAM	
		TX1	TX2	TX1	TX2	TX1	TX2
Frequency (Lower CH_ 625)	1932.5MHz	4.579	4.566	4.533	4.549	4.509	4.554
Frequency (Middle CH_ 900)	1960.0MHz	4.557	4.565	4.525	4.561	4.538	4.563
Frequency (Upper CH_1175)	1987.5MHz	4.555	4.549	4.534	4.552	4.541	4.554
RBW	180kHz						
VBW	1.8MHz						
CH BW	5MHz						
Span	20MHz						
Sweep	1ms						
Reference Level Offset	53.2dB						
Detector	Peak						
Attenuation	10dB						

Table 6-4: Setting / Measurement Results – Occupied Bandwidth 10MHz

Setting		Occupied Bandwidth (MHz)					
		QPSK		16 QAM		64 QAM	
		TX1	TX2	TX1	TX2	TX1	TX2
Frequency (Lower CH_ 650)	1935.0MHz	8.965	8.960	8.975	8.957	8.978	8.932
Frequency (Middle CH_ 900)	1960.0MHz	8.996	8.984	8.955	8.948	8.936	8.957
Frequency (Upper CH_1150)	1985.0MHz	8.967	8.936	8.962	8.998	8.959	8.959
RBW	180kHz						
VBW	1.8MHz						
CH BW	10MHz						
Span	20MHz						
Sweep	1ms						
Reference Level Offset	53.2dB						
Detector	Peak						
Attenuation	10dB						

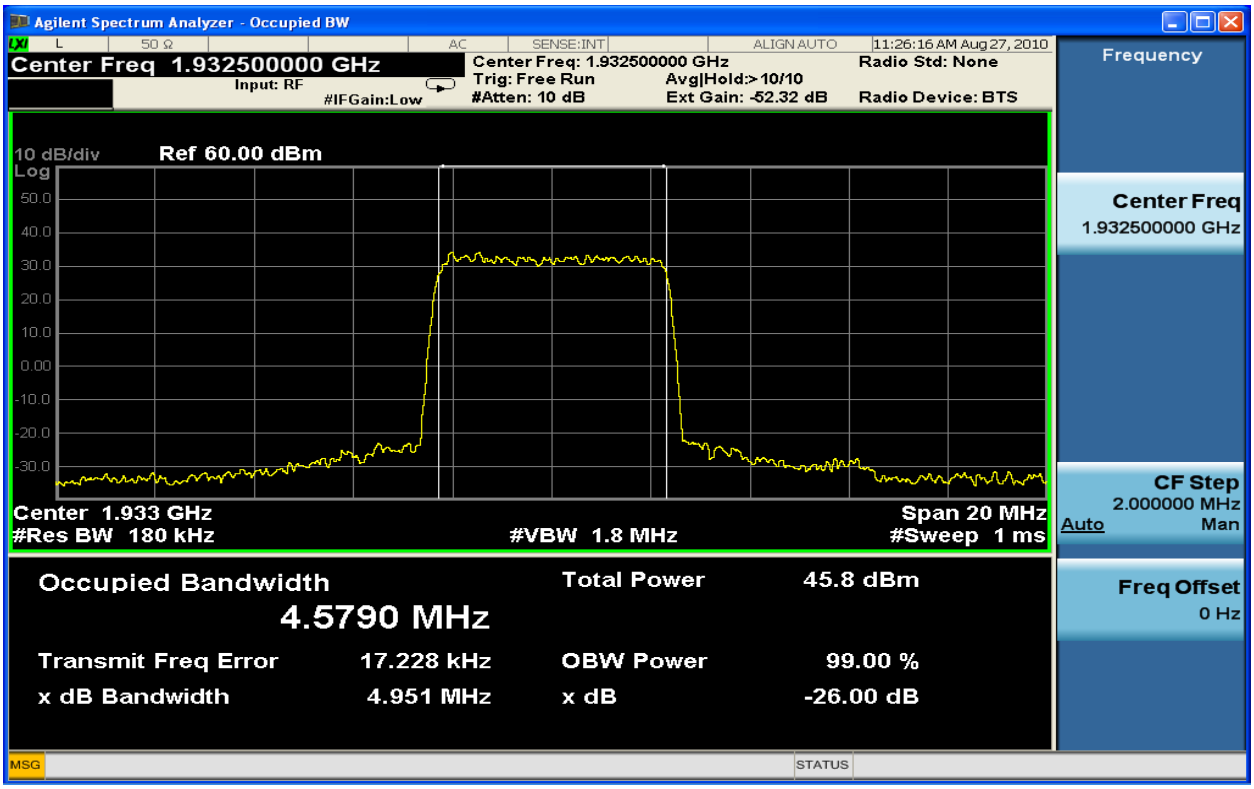

Figure 6-51: 5MHz Occupied Bandwidth TX1_QPSK at 1932.5 MHz

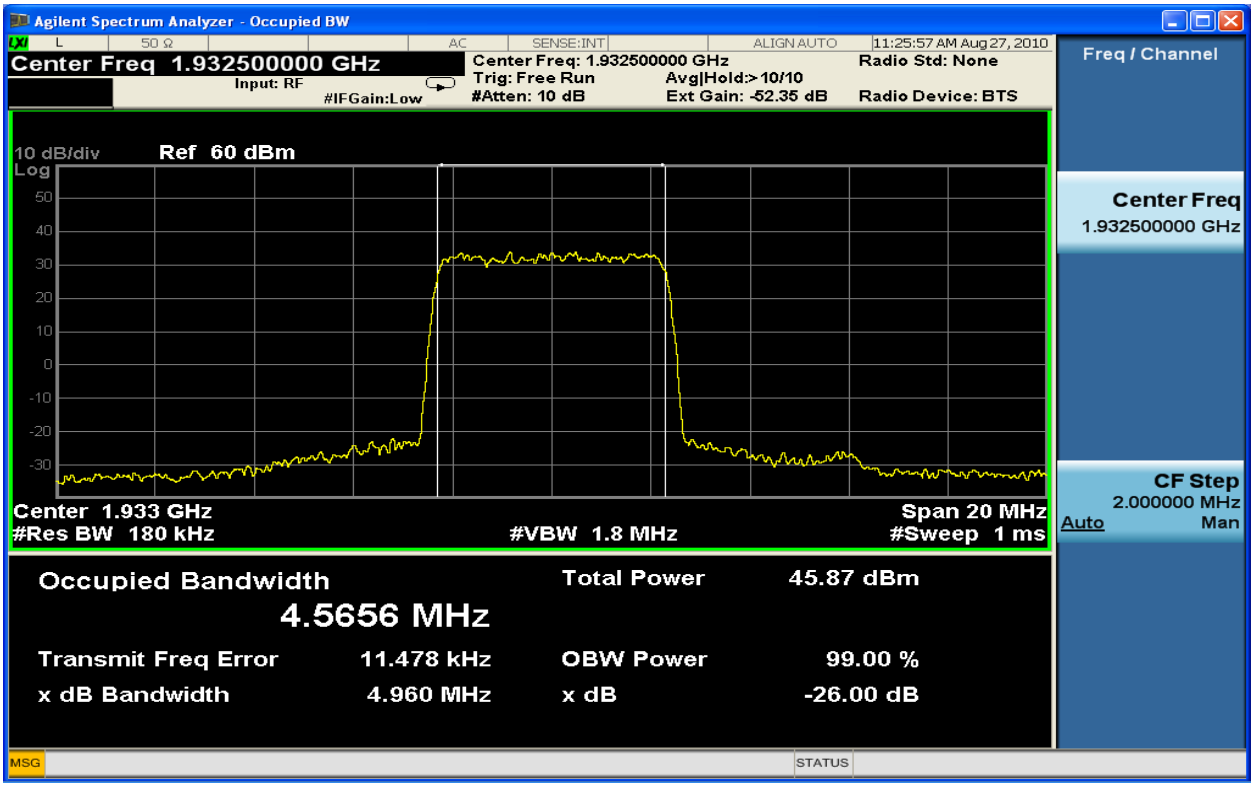

Figure 6-52: 5MHz Occupied Bandwidth TX2_QPSK at 1932.5 MHz

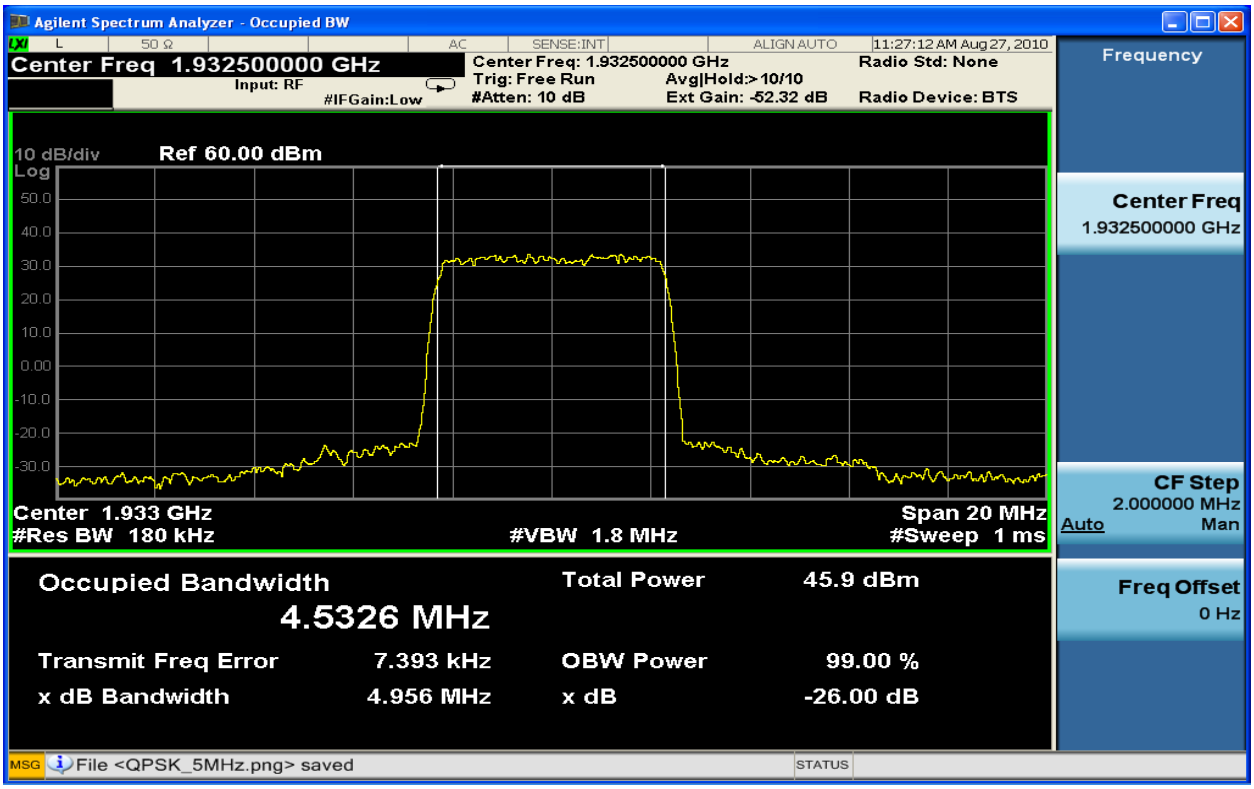

Figure 6-53: 5MHz Occupied Bandwidth TX1_16QAM at 1932.5 MHz

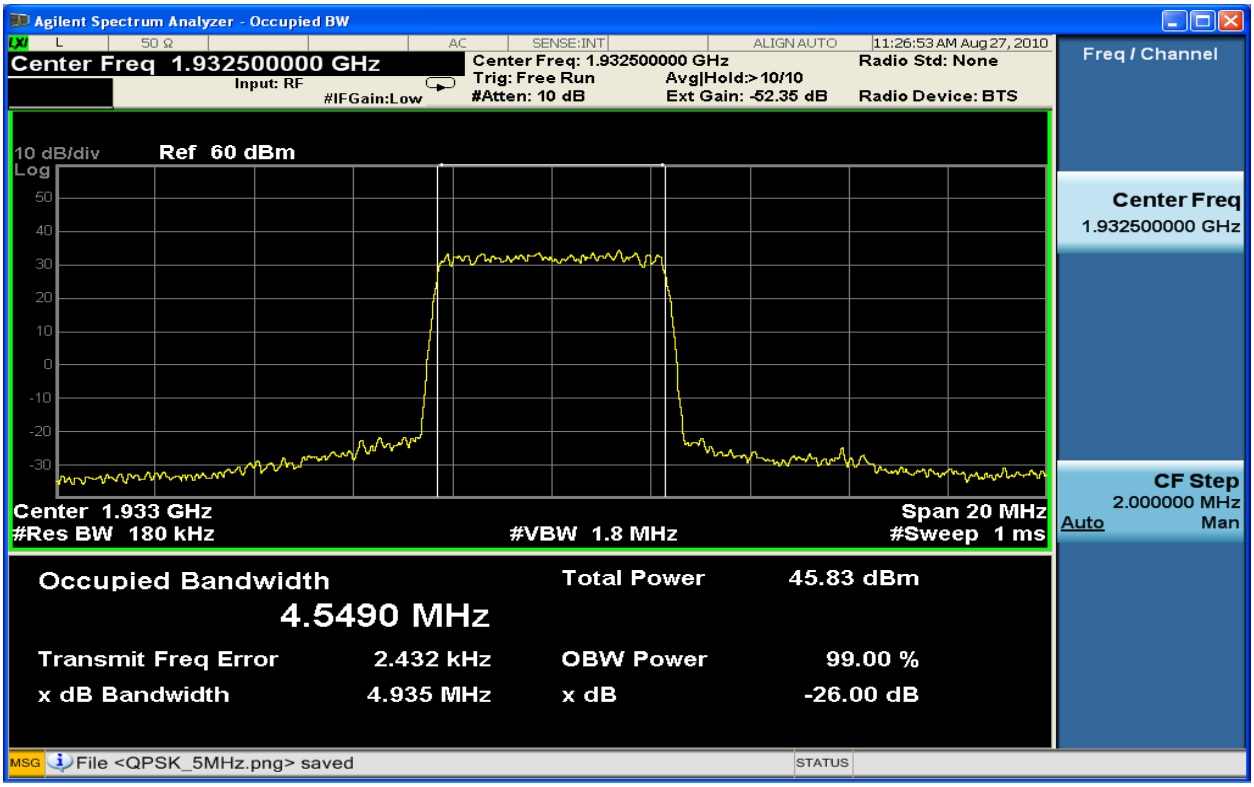

Figure 6-54: 5MHz Occupied Bandwidth TX2_16QAM at 1932.5 MHz

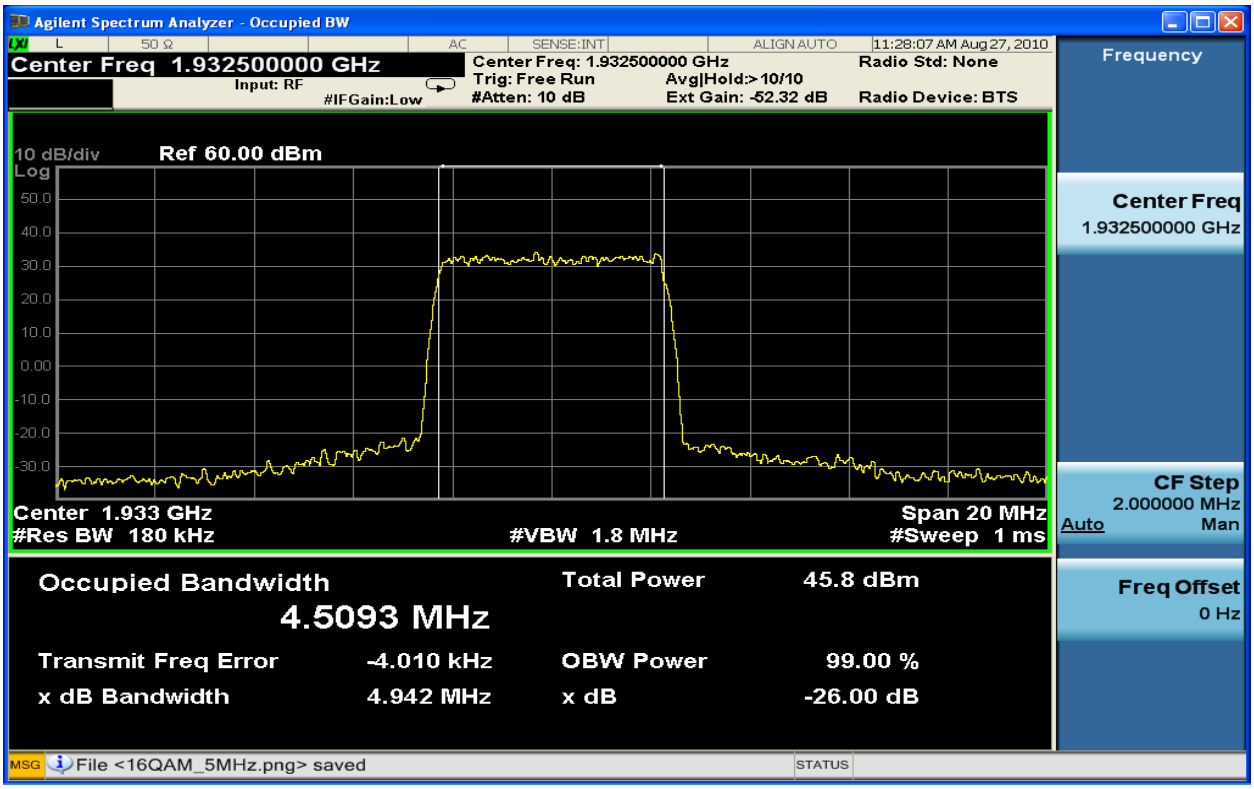

Figure 6-55: 5MHz Occupied Bandwidth TX1_64QAM at 1932.5 MHz

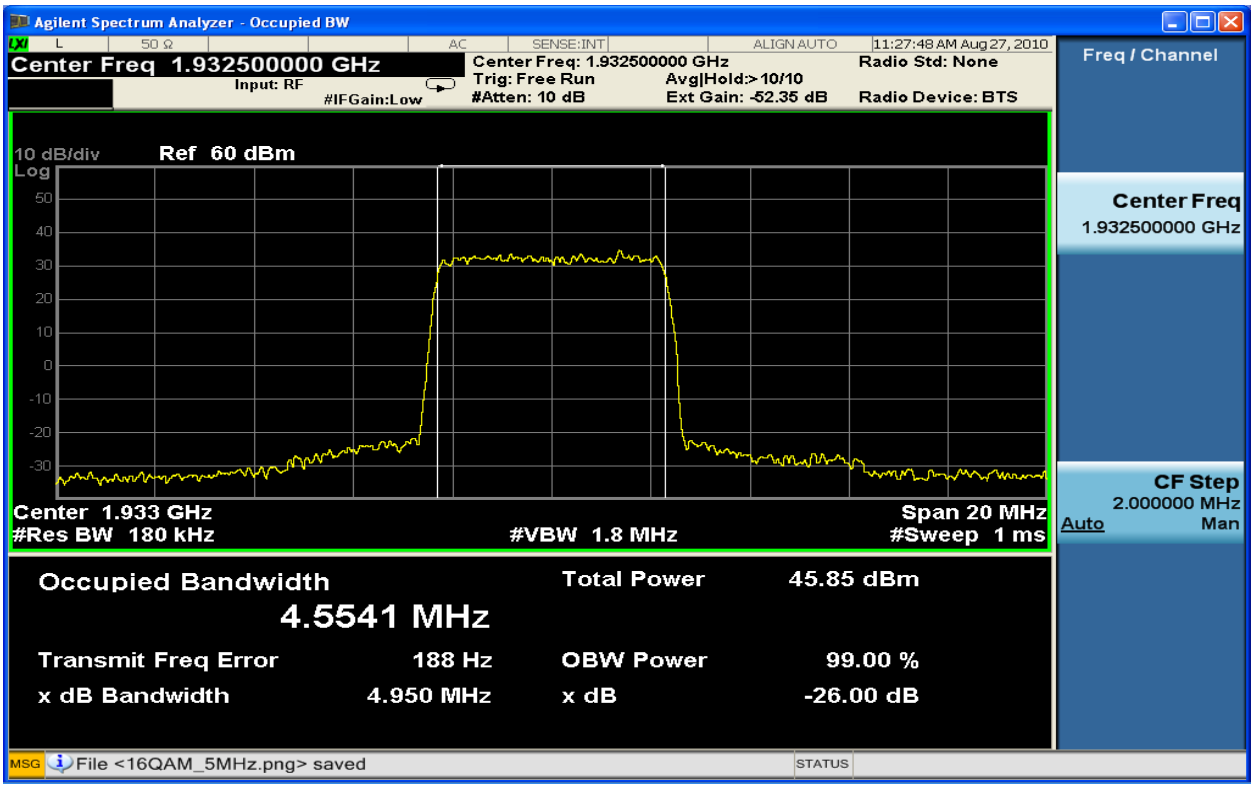

Figure 6-56: 5MHz Occupied Bandwidth TX2_64QAM at 1932.5 MHz

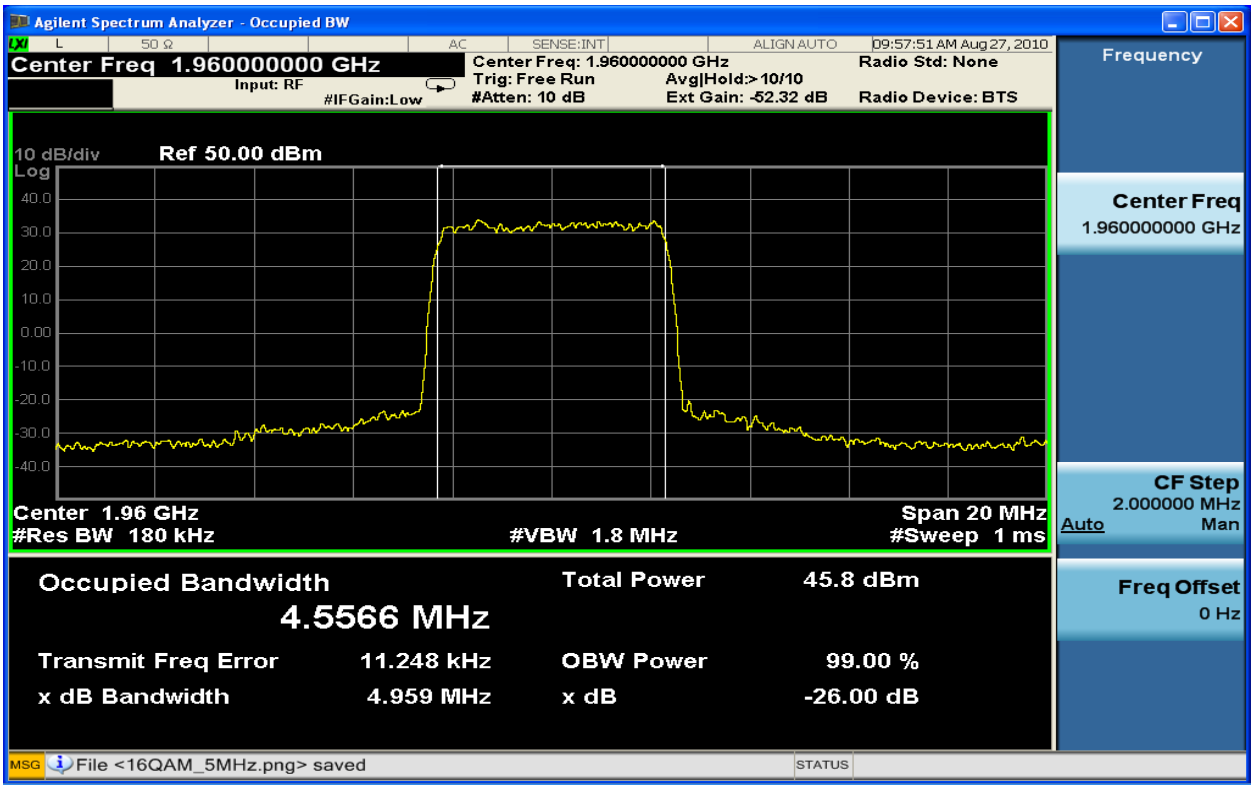

Figure 6-57: 5MHz Occupied Bandwidth TX1_QPSK at 1960.0 MHz

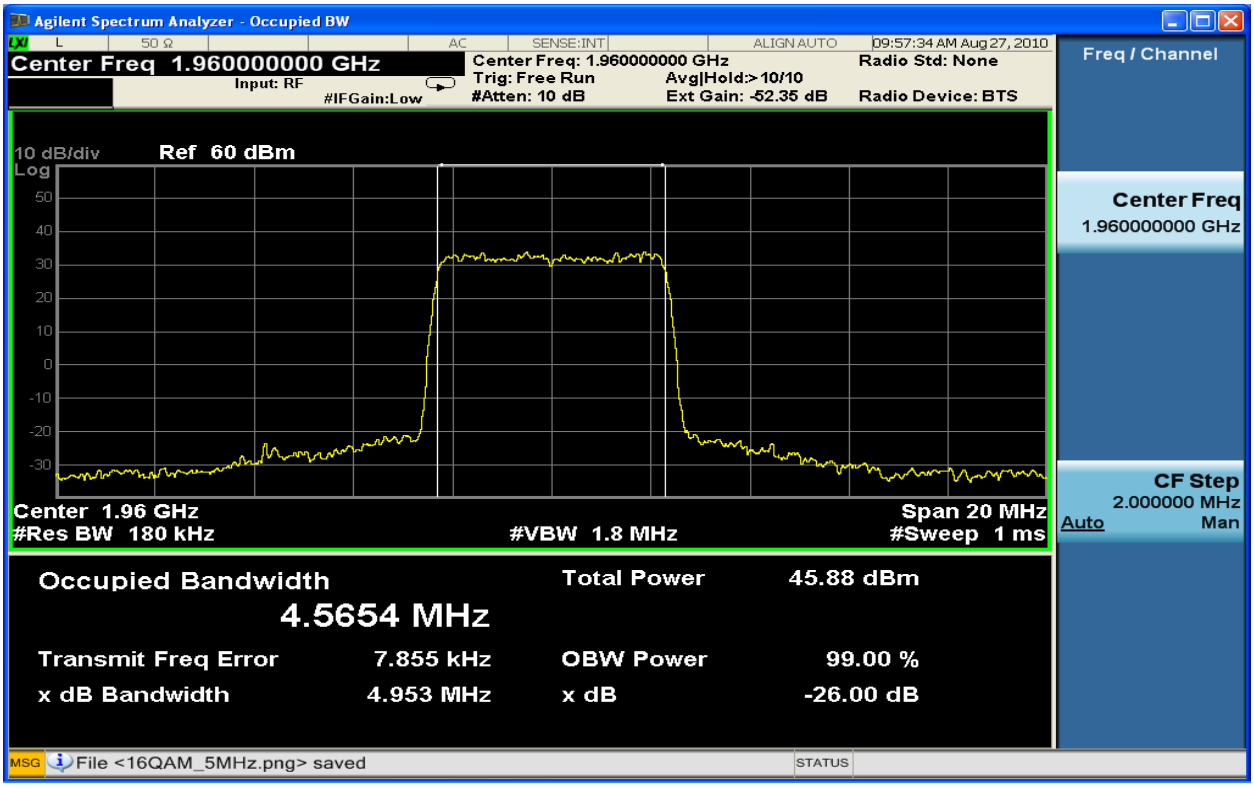

Figure 6-58: 5MHz Occupied Bandwidth TX2_QPSK at 1960.0 MHz

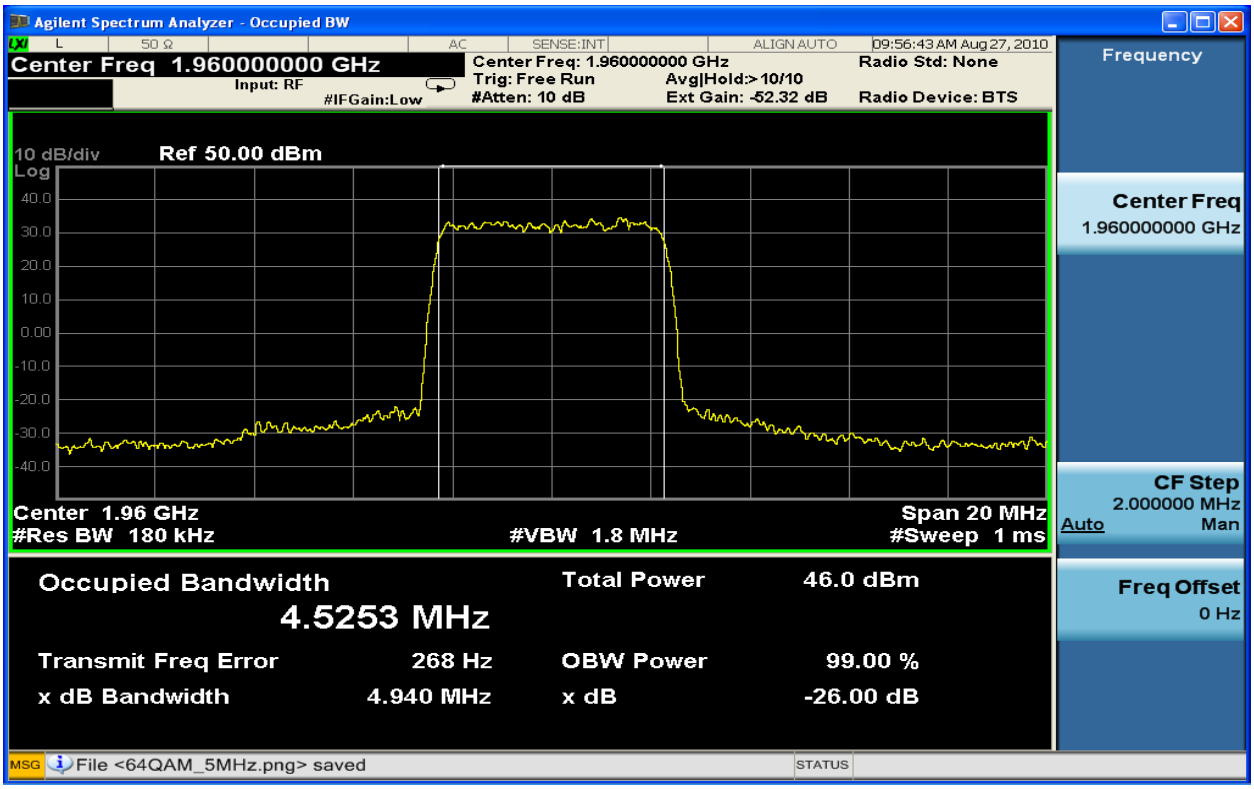

Figure 6-59: 5MHz Occupied Bandwidth TX1_16QAM at 1960.0 MHz

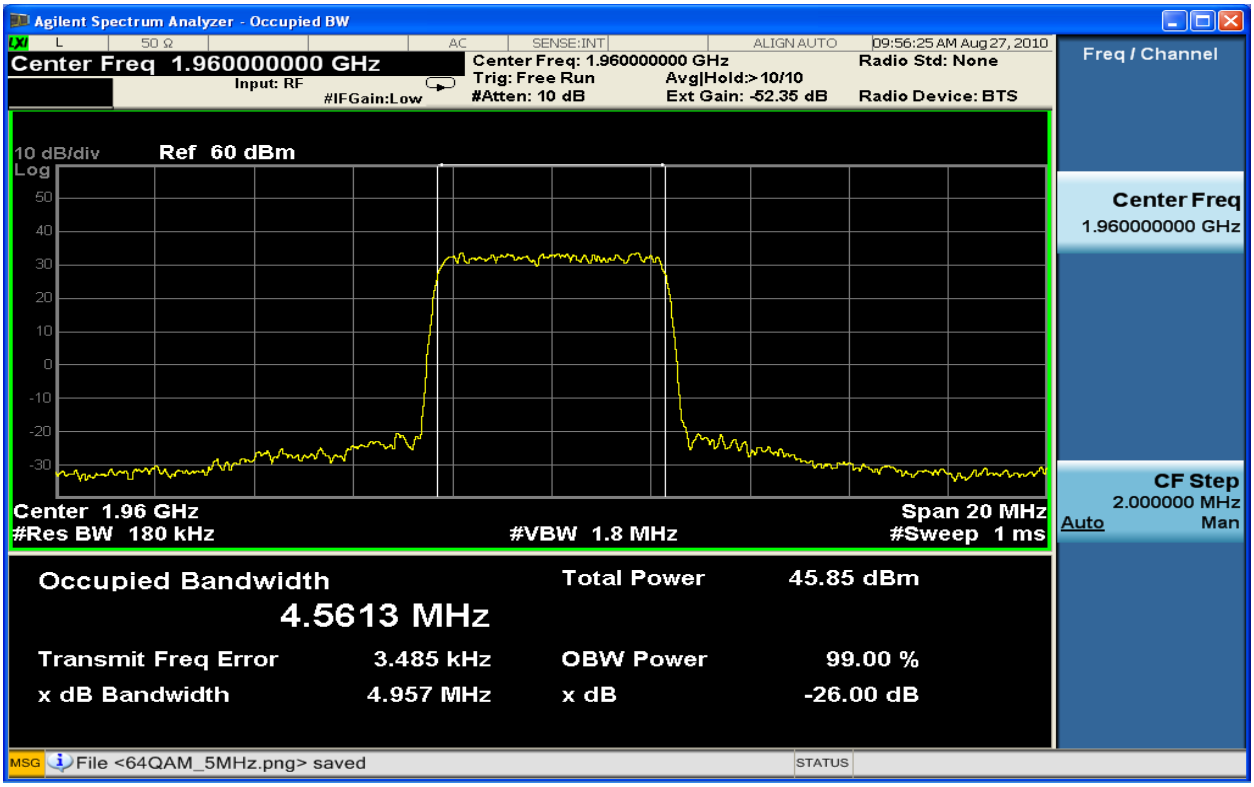

Figure 6-60: 5MHz Occupied Bandwidth TX2_16QAM at 1960.0 MHz

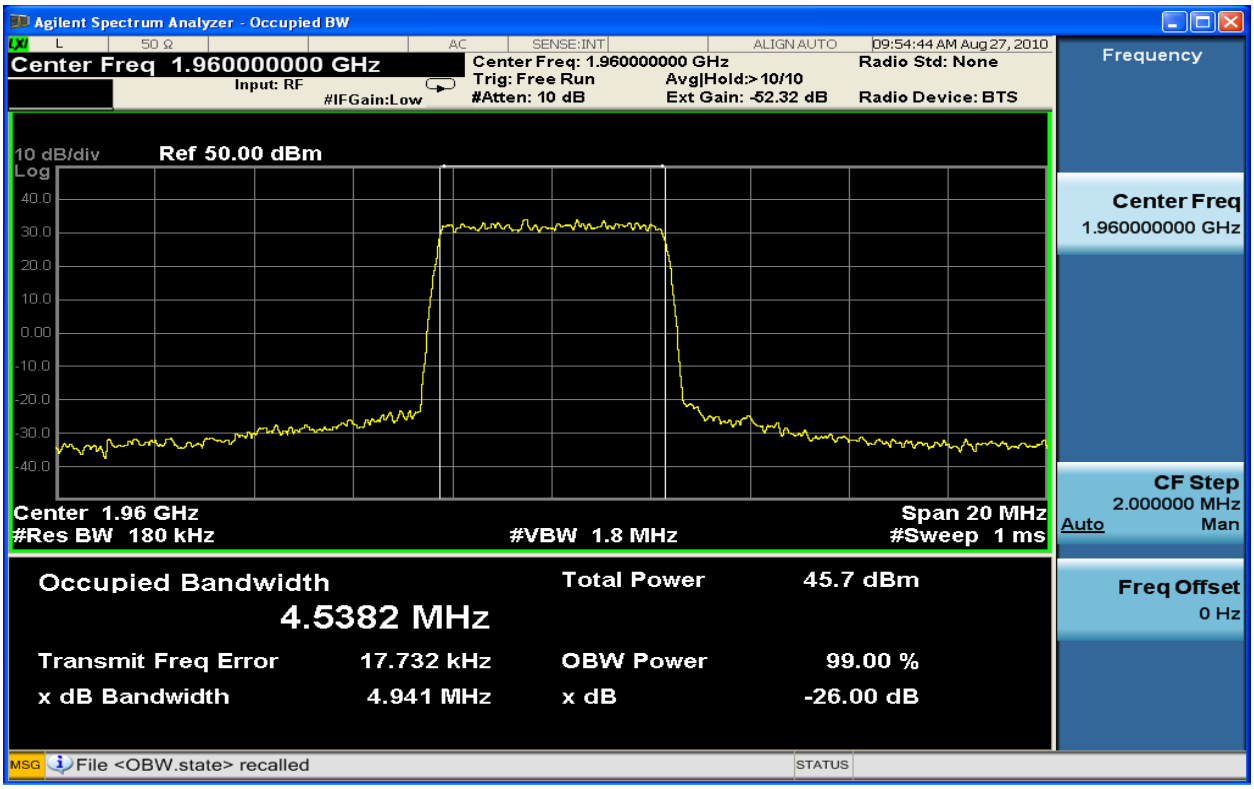

Figure 6-61: 5MHz Occupied Bandwidth TX1_64QAM at 1960.0 MHz

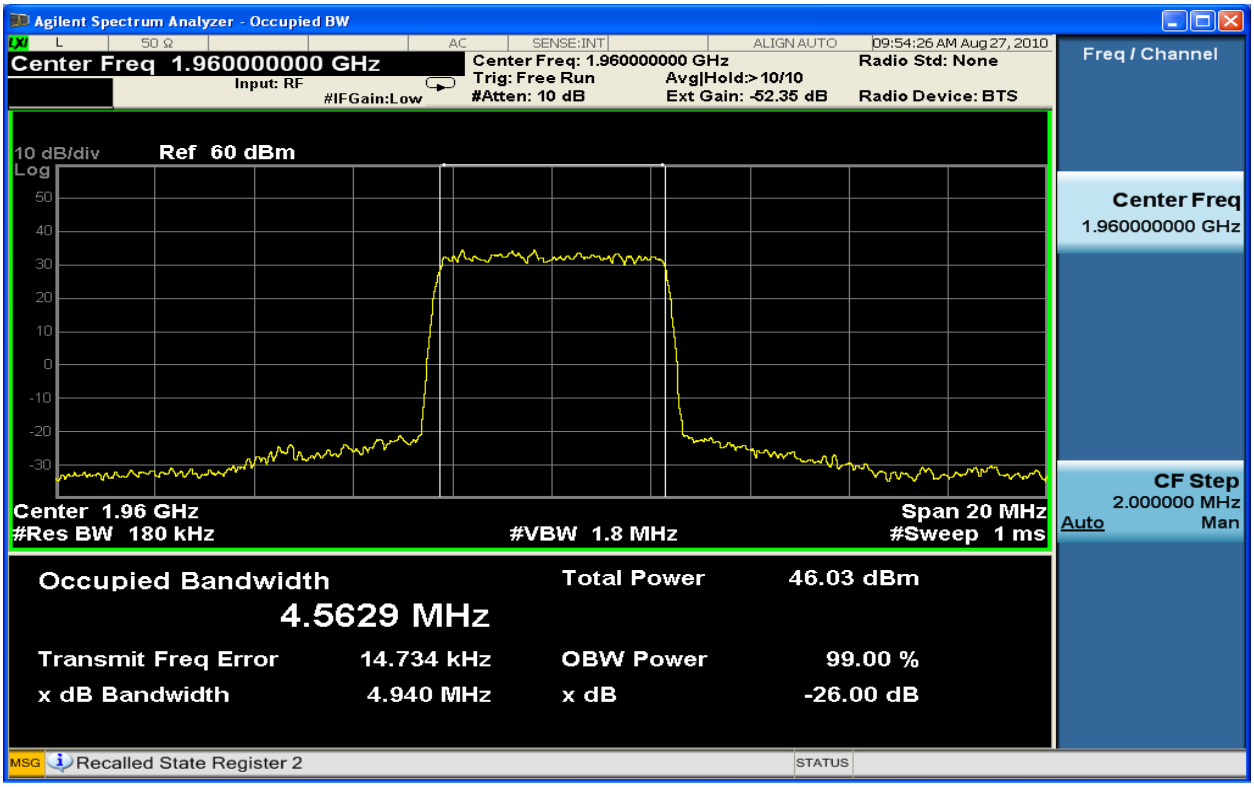

Figure 6-62: 5MHz Occupied Bandwidth TX2_64QAM at 1960.0 MHz

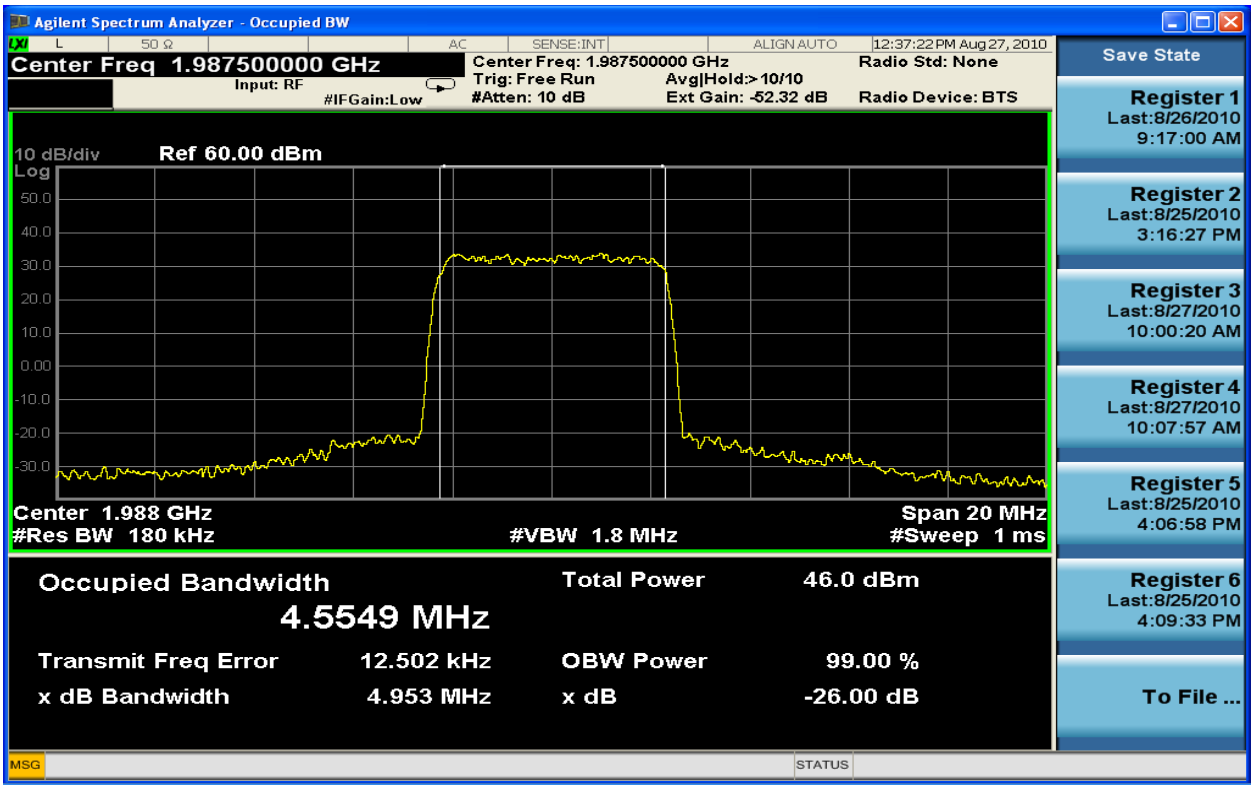

Figure 6-63: 5MHz Occupied Bandwidth TX1_QPSK at 1987.5 MHz

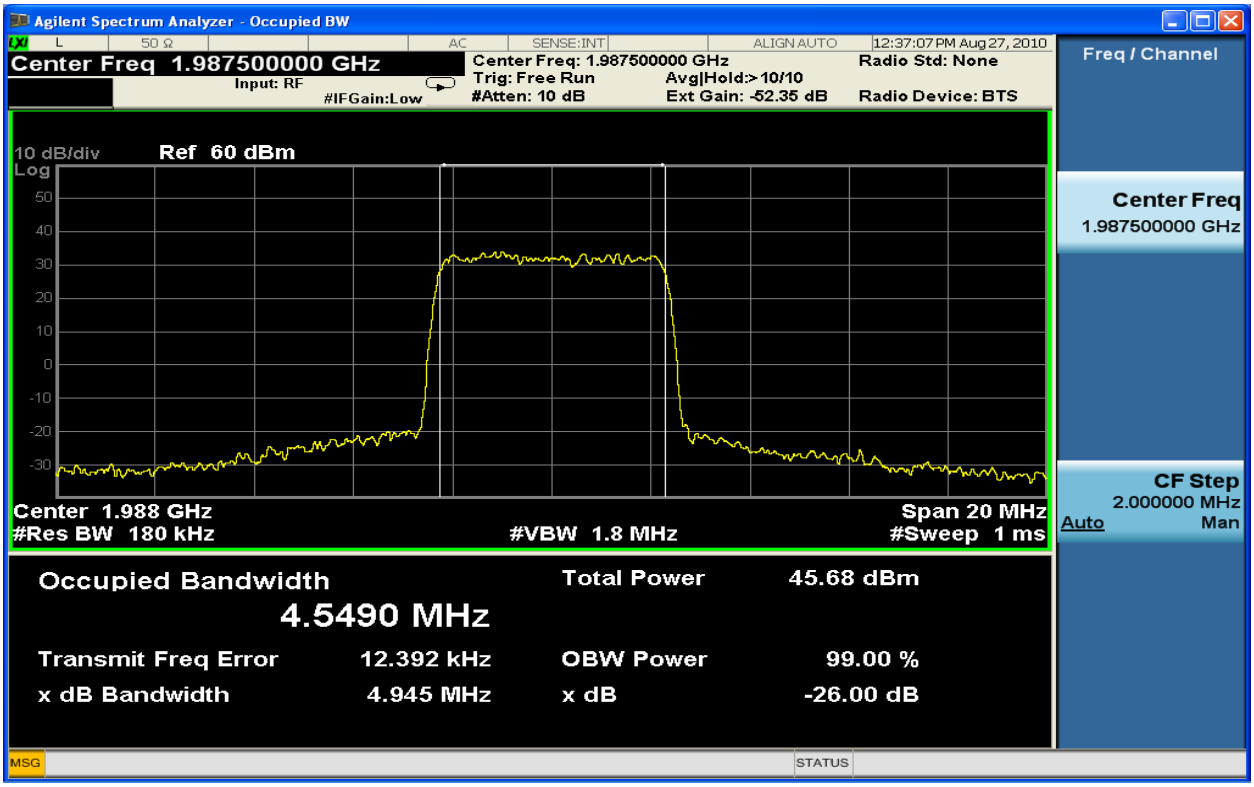

Figure 6-64: 5MHz Occupied Bandwidth TX2_QPSK at 1987.5 MHz

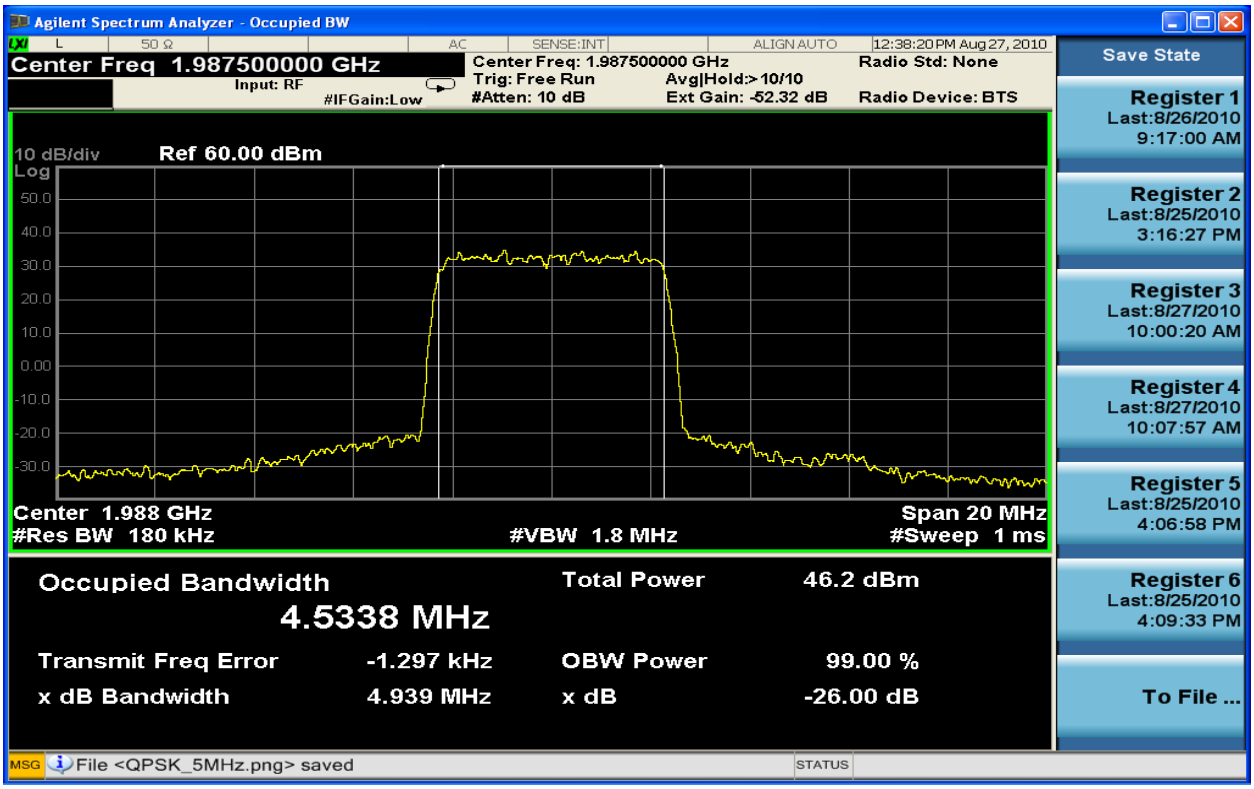

Figure 6-65: 5MHz Occupied Bandwidth TX1_16QAM at 1987.5 MHz

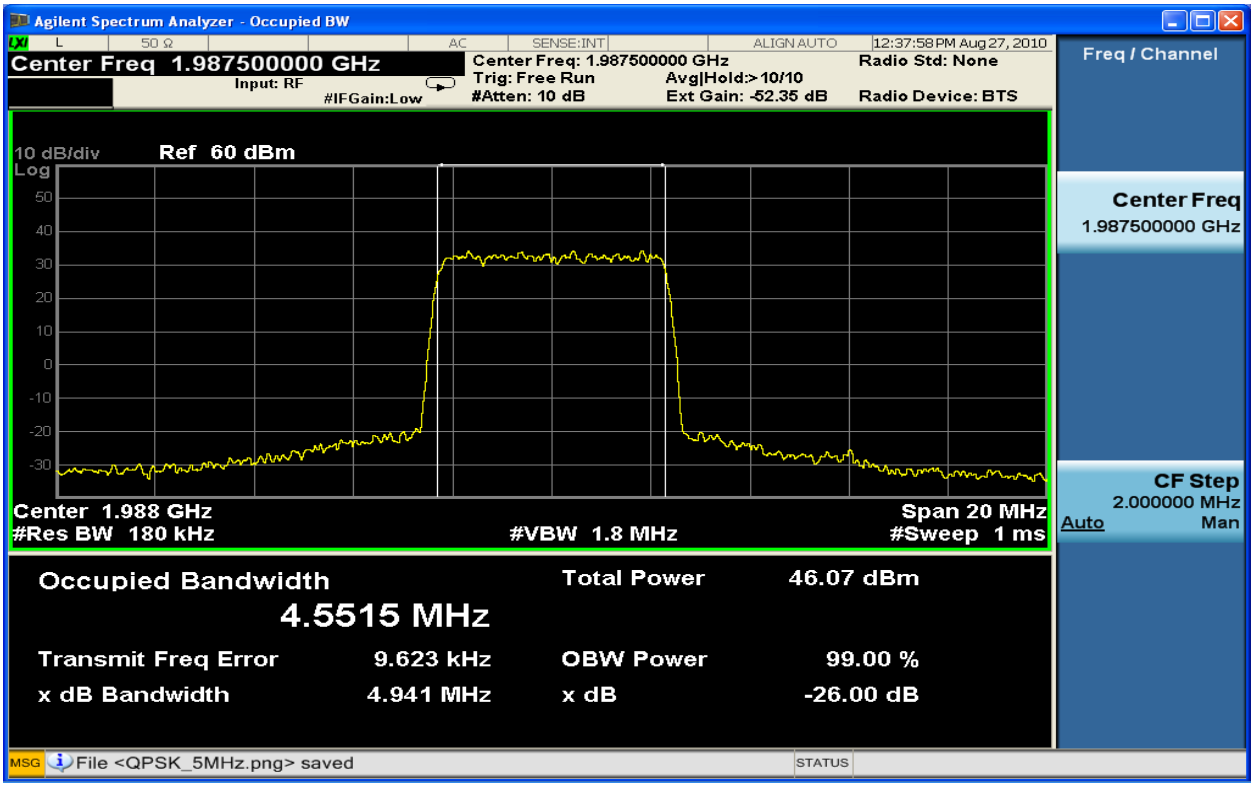

Figure 6-66: 5MHz Occupied Bandwidth TX2_16QAM at 1987.5 MHz

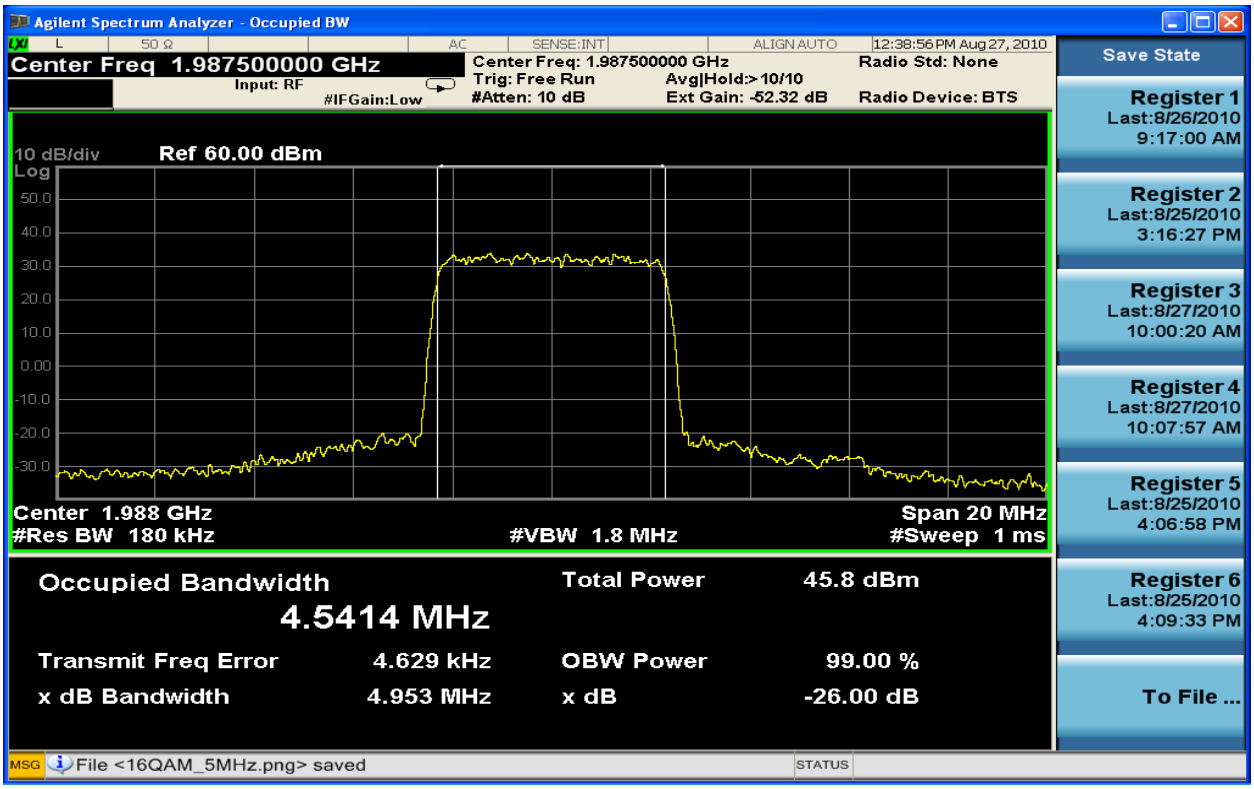

Figure 6-67: 5MHz Occupied Bandwidth TX1_64QAM at 1987.5 MHz

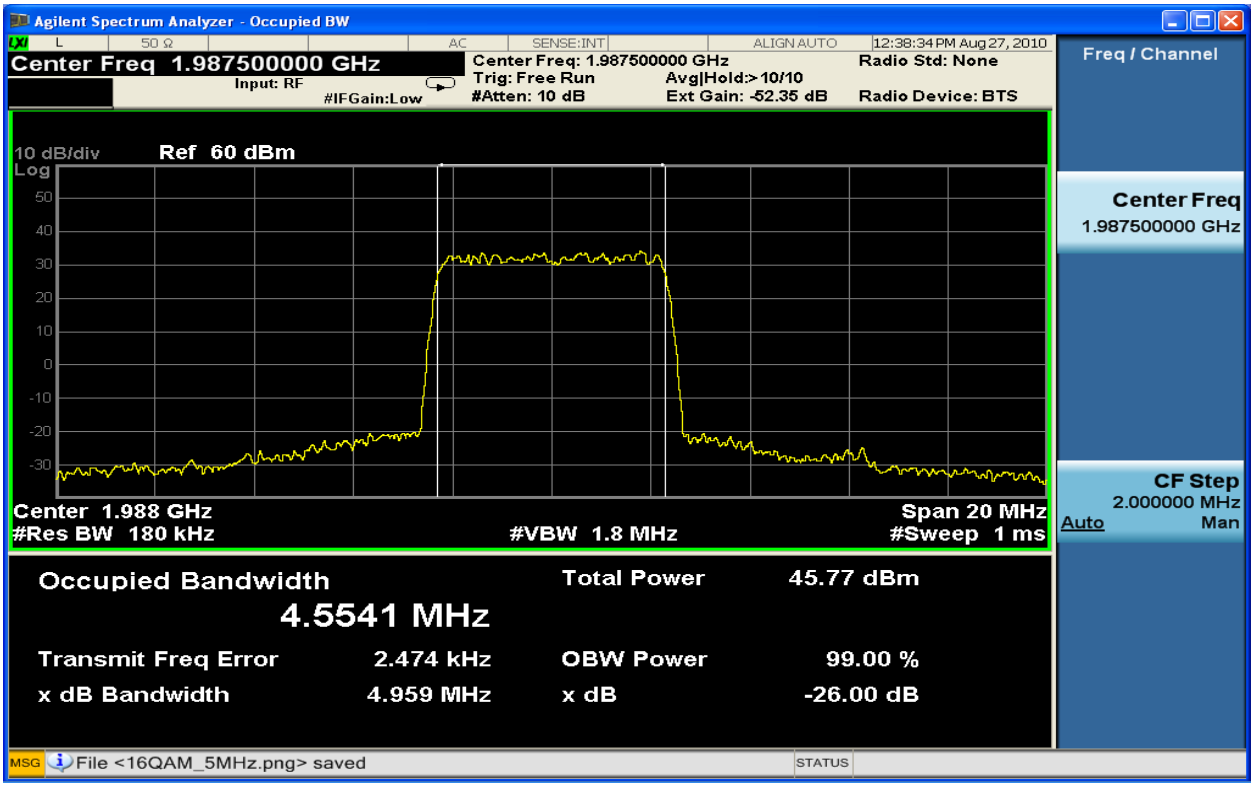

Figure 6-68: 5MHz Occupied Bandwidth TX2_64QAM at 1987.5 MHz

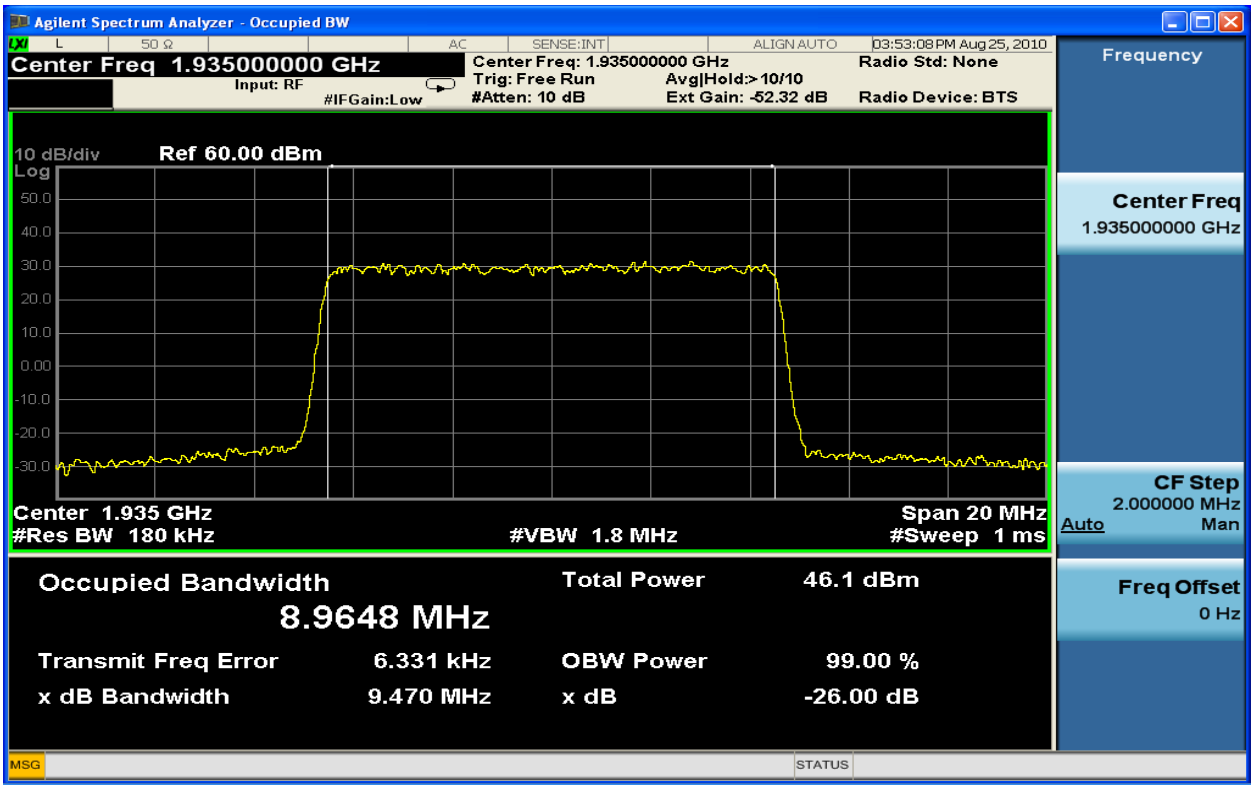

Figure 6-69: 10MHz Occupied Bandwidth TX1_QPSK at 1935.0 MHz

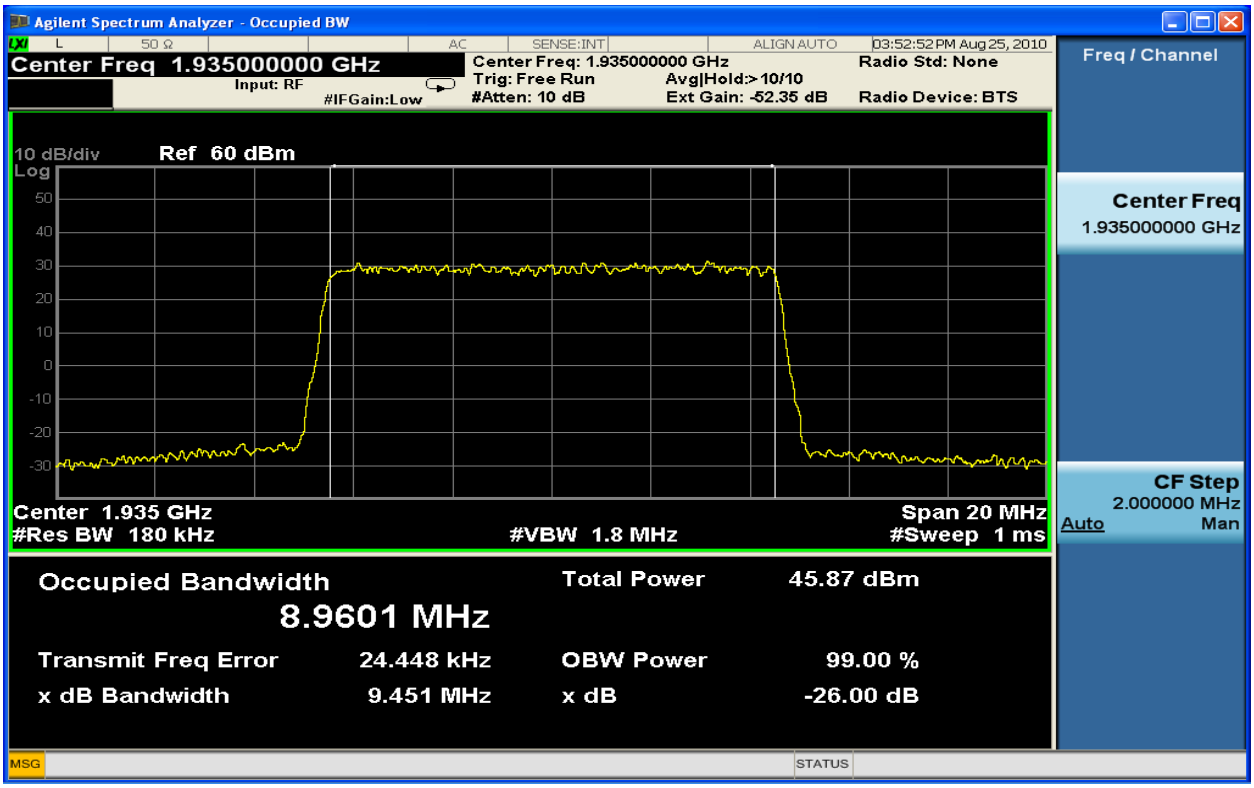

Figure 6-70: 10MHz Occupied Bandwidth TX2_QPSK at 1935.0 MHz

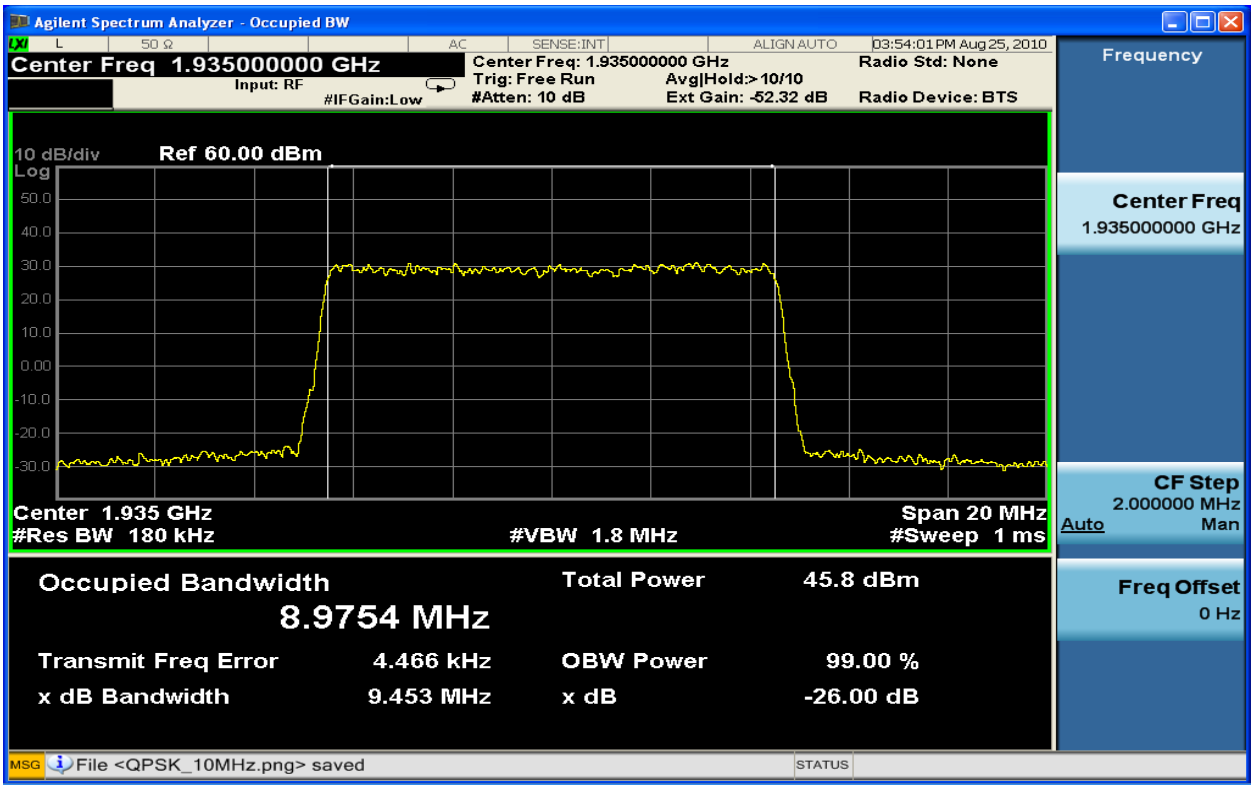

Figure 6-71: 10MHz Occupied Bandwidth TX1_16QAM at 1935.0 MHz

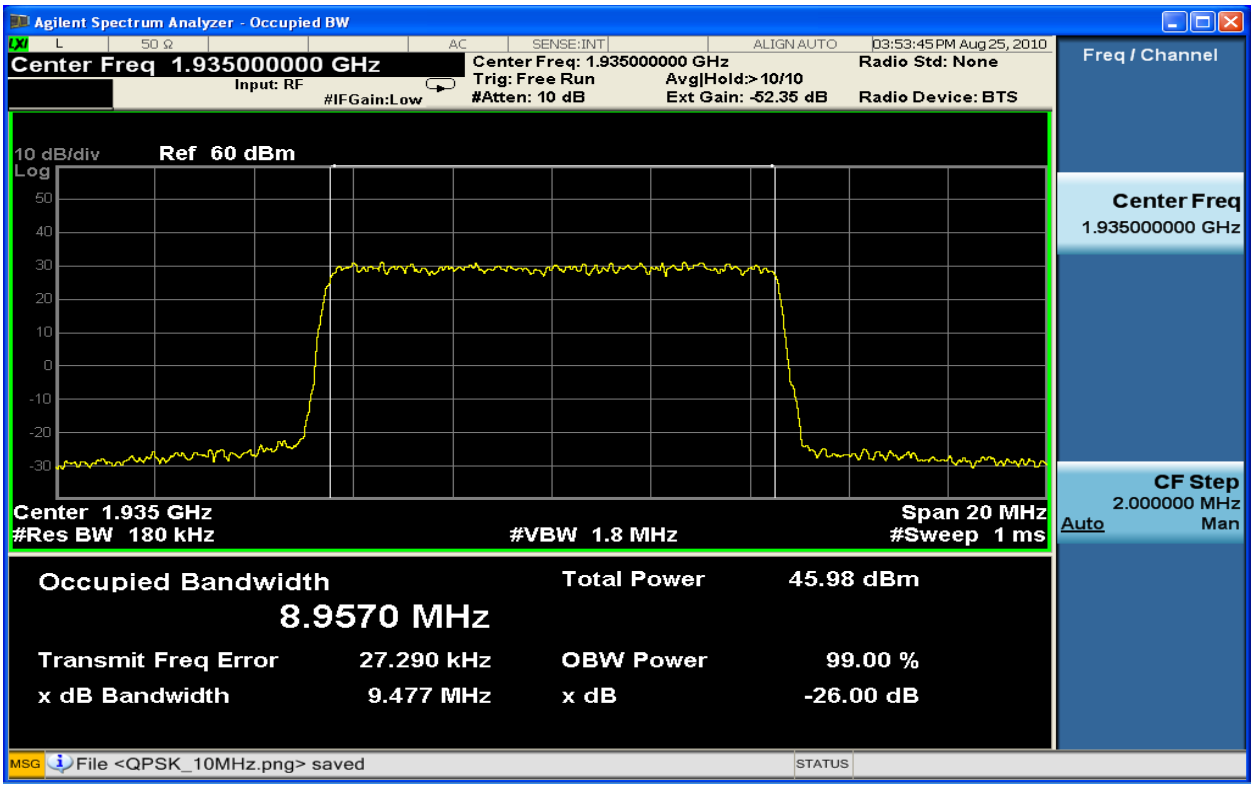

Figure 6-72: 10MHz Occupied Bandwidth TX2_16QAM at 1935.0 MHz

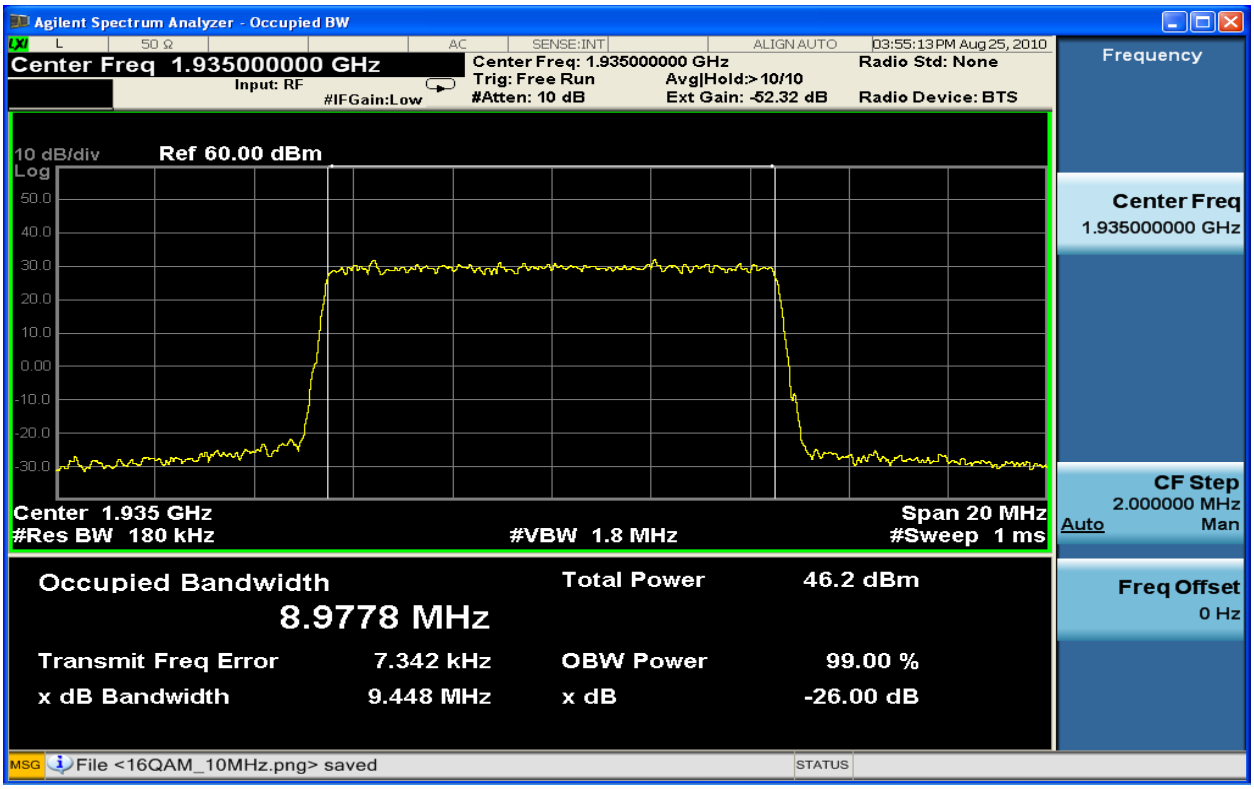

Figure 6-73: 10MHz Occupied Bandwidth TX1_64QAM at 1935.0 MHz

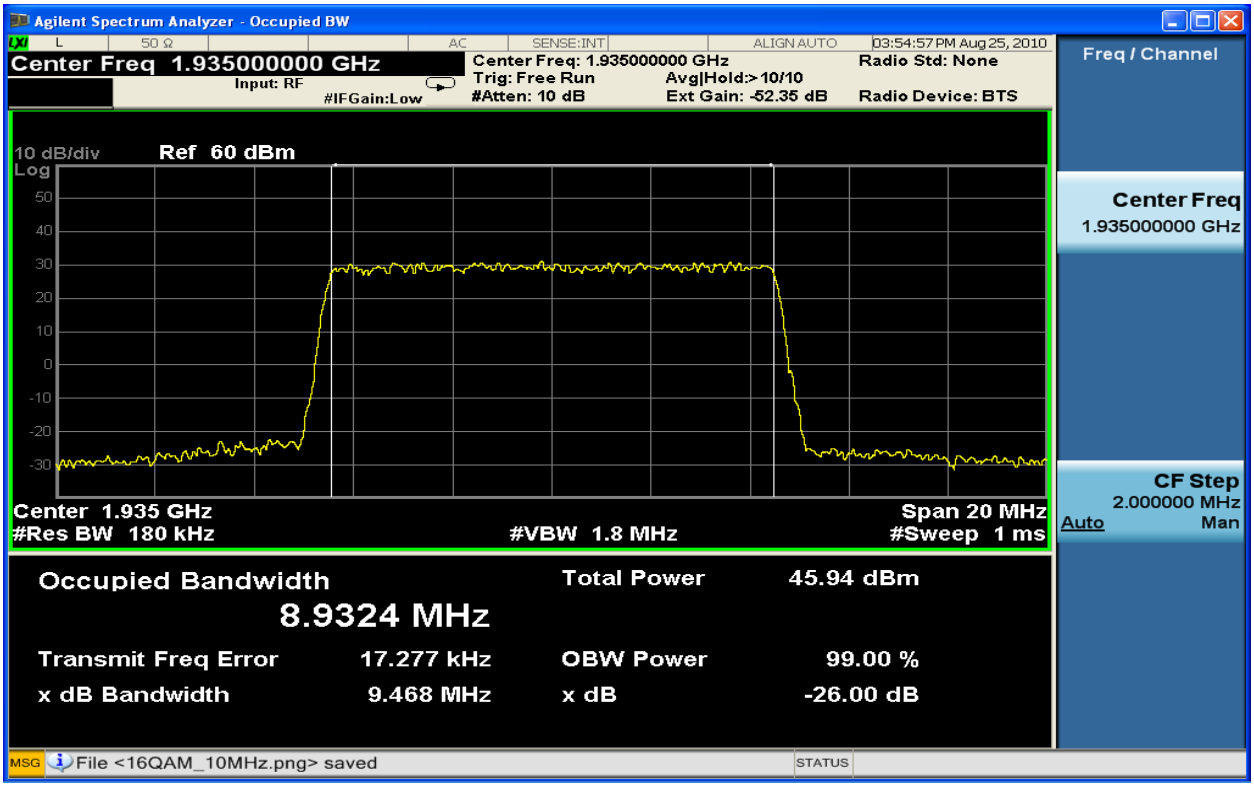

Figure 6-74: 10MHz Occupied Bandwidth TX2_64QAM at 1935.0 MHz

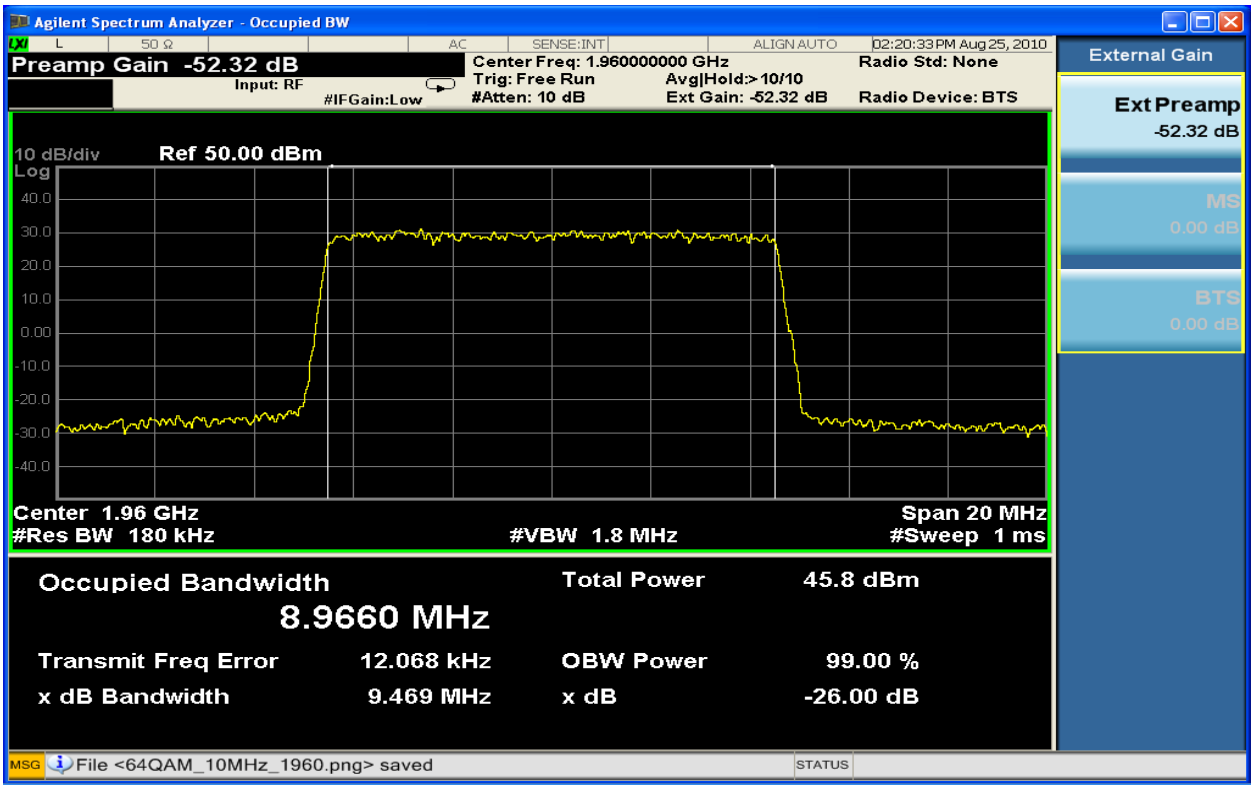

Figure 6-75: 10MHz Occupied Bandwidth TX1_QPSK at 1960.0 MHz

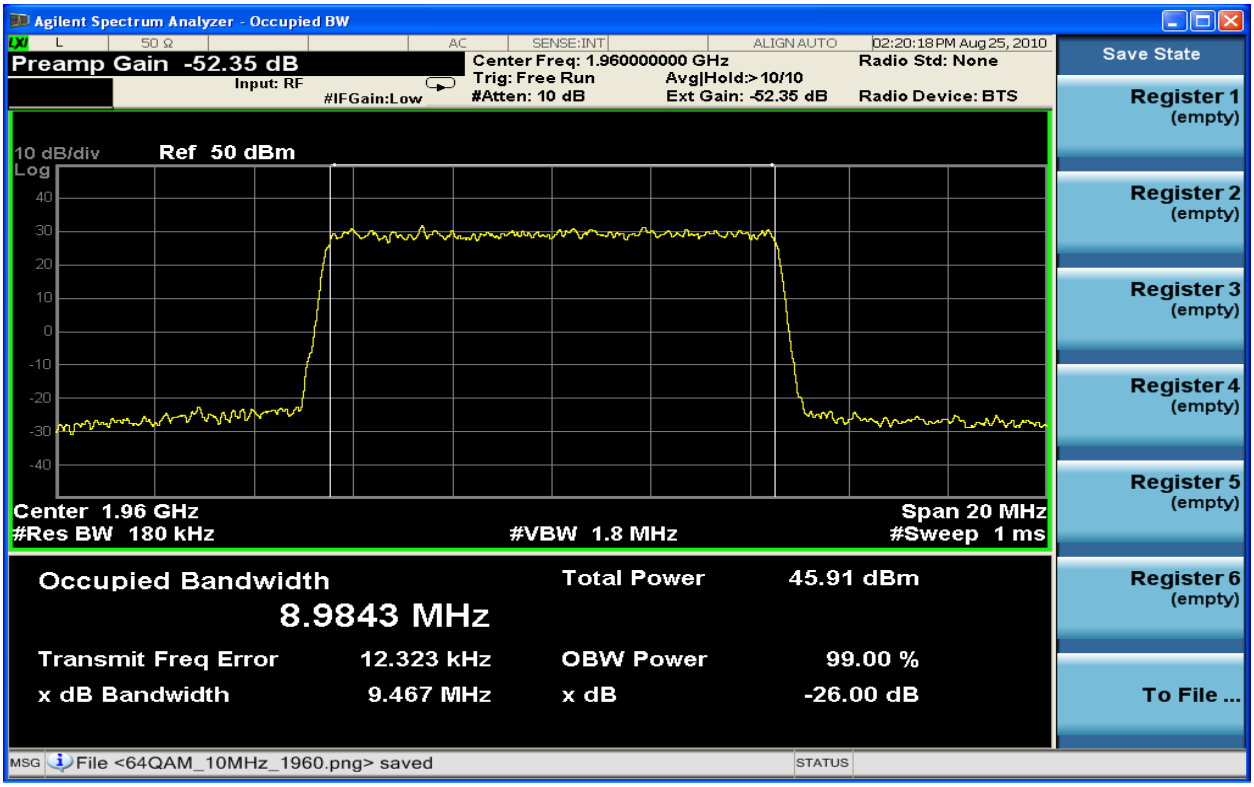

Figure 6-76: 10MHz Occupied Bandwidth TX2_QPSK at 1960.0 MHz

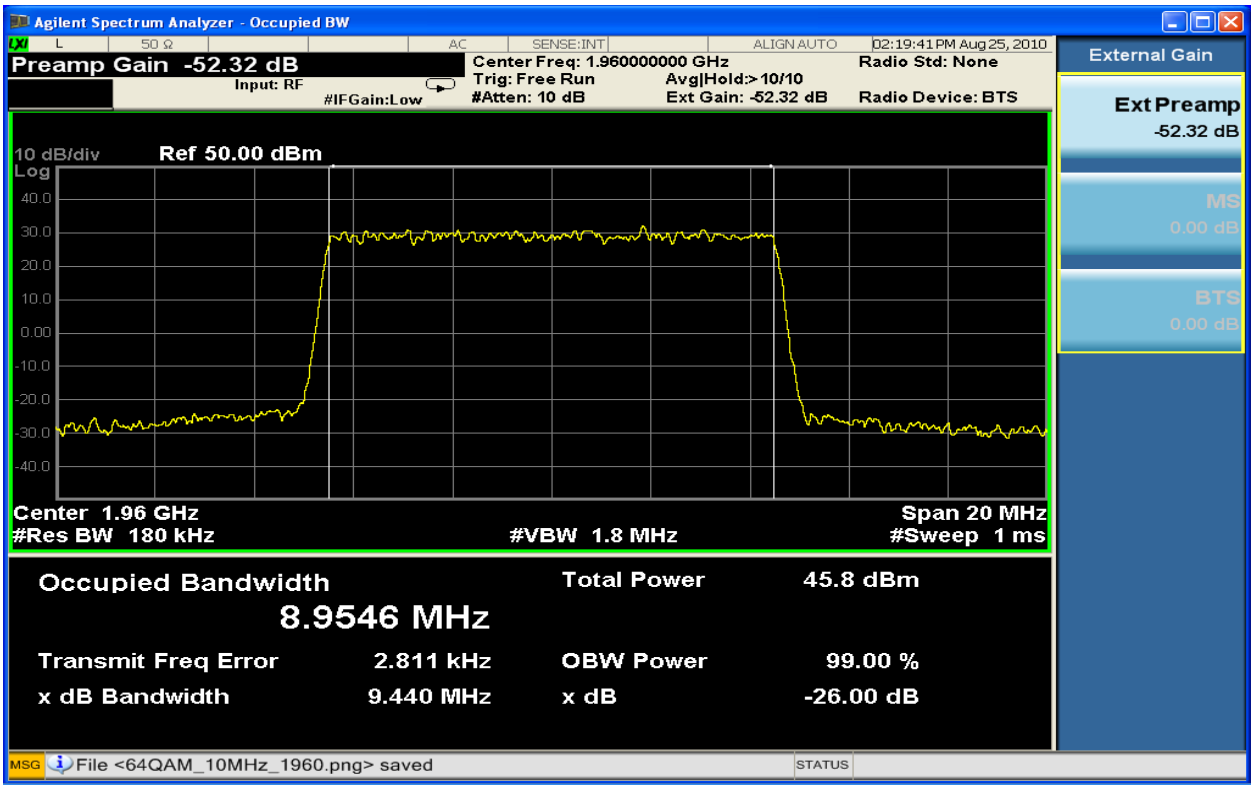

Figure 6-77: 10MHz Occupied Bandwidth TX1_16QAM at 1960.0 MHz

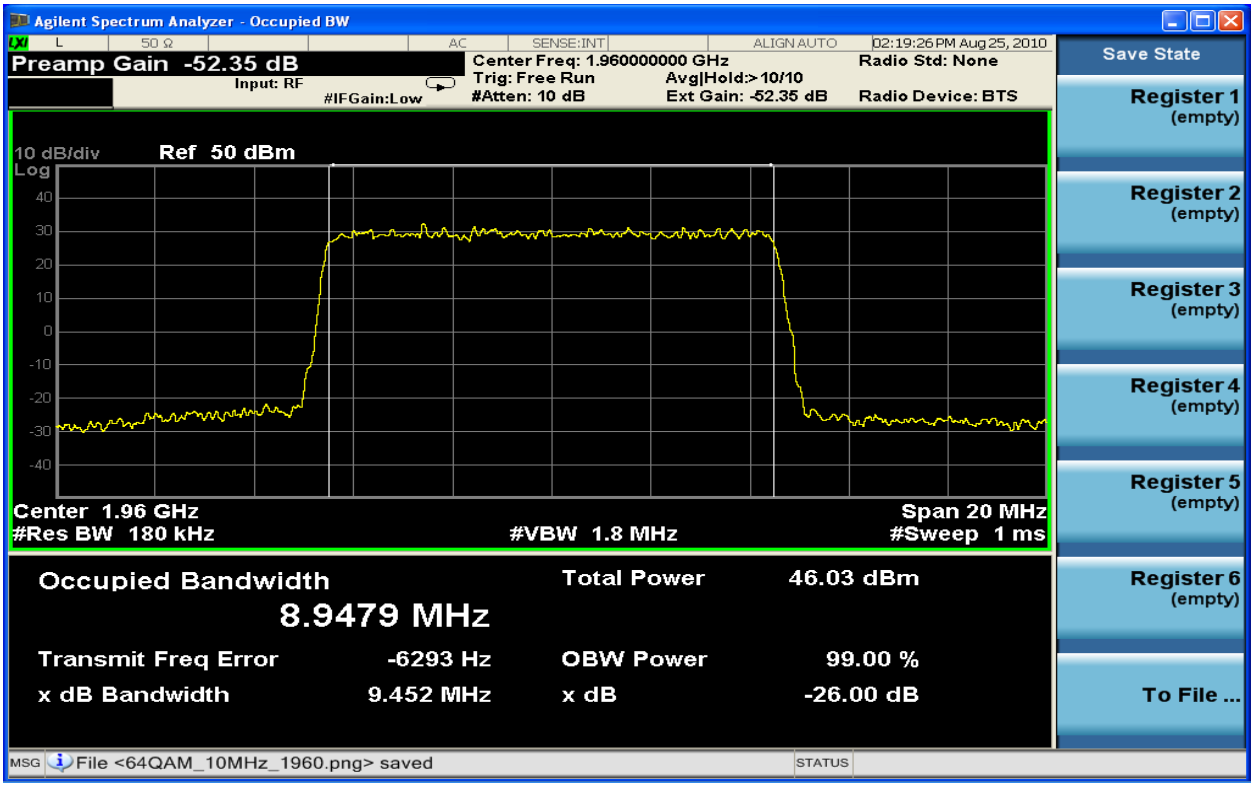

Figure 6-78: 10MHz Occupied Bandwidth TX2_16QAM at 1960.0 MHz

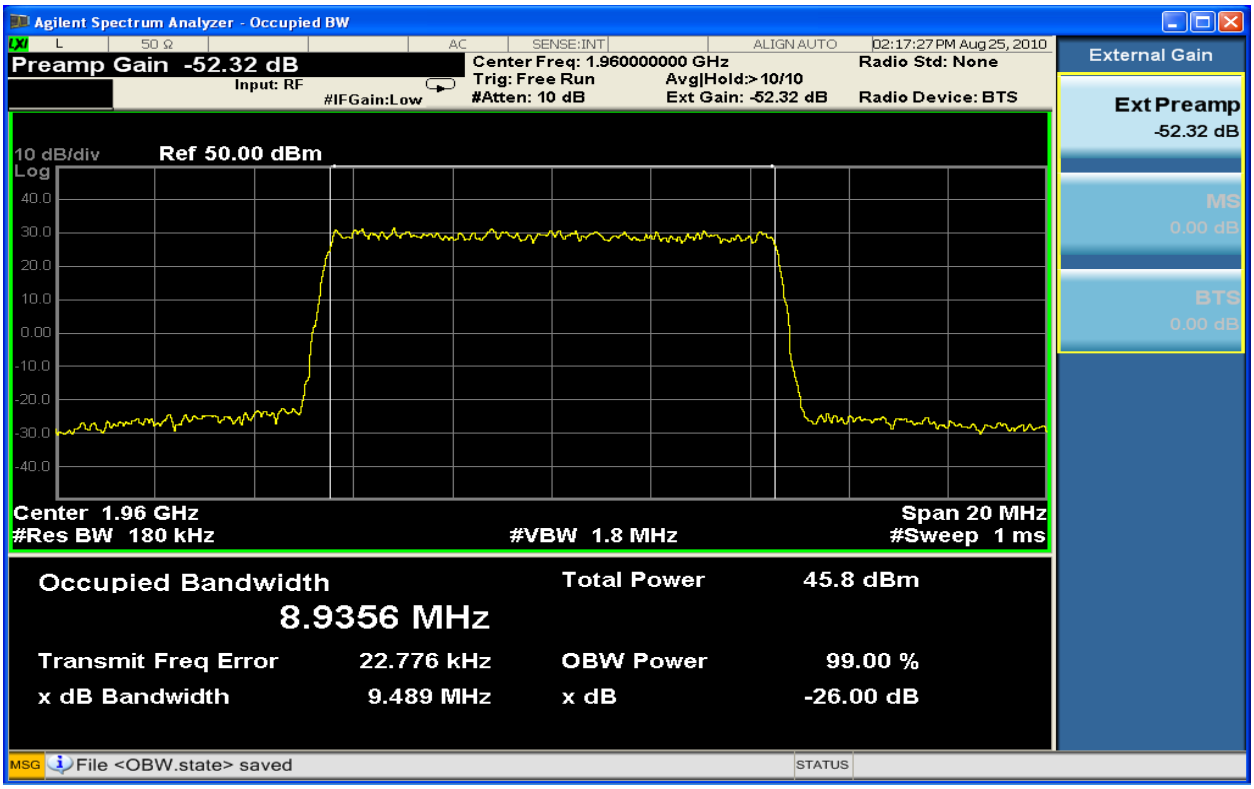

Figure 6-79: 10MHz Occupied Bandwidth TX1_64QAM at 1960.0 MHz

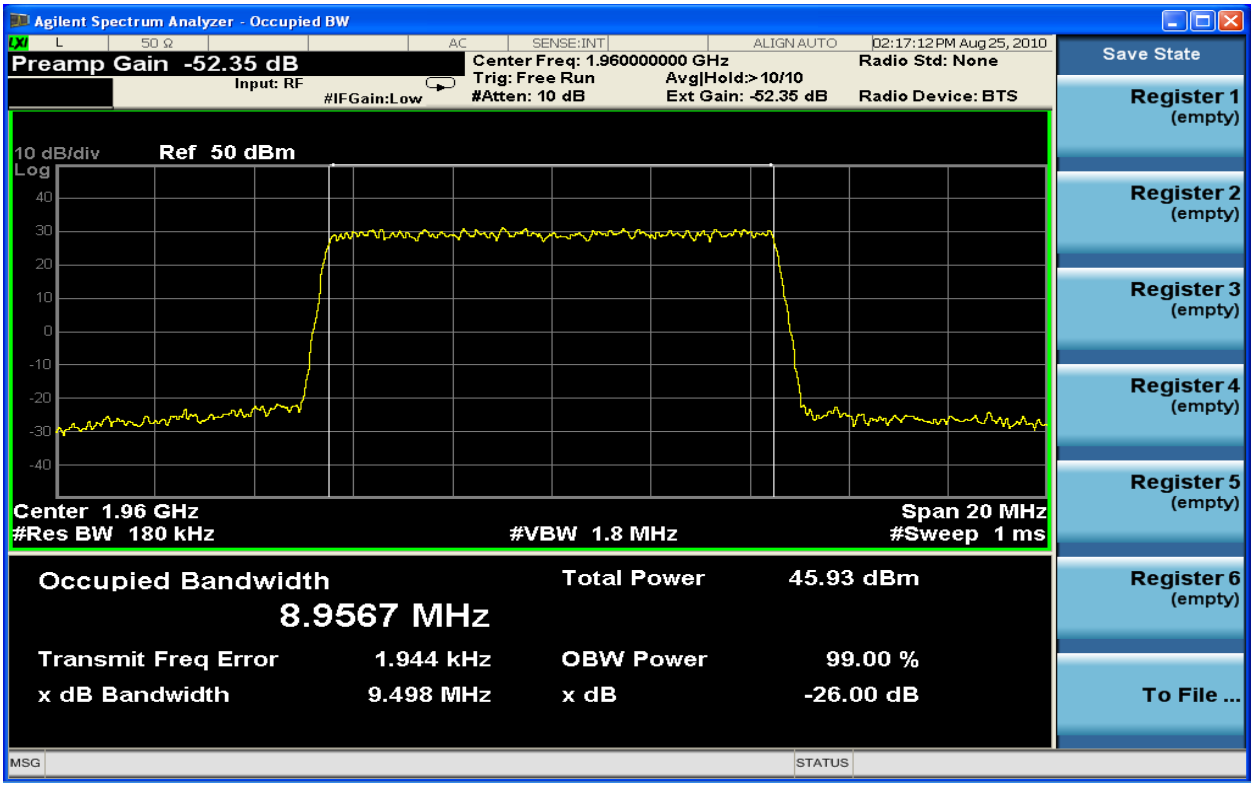

Figure 6-80: 10MHz Occupied Bandwidth TX2_64QAM at 1960.0 MHz

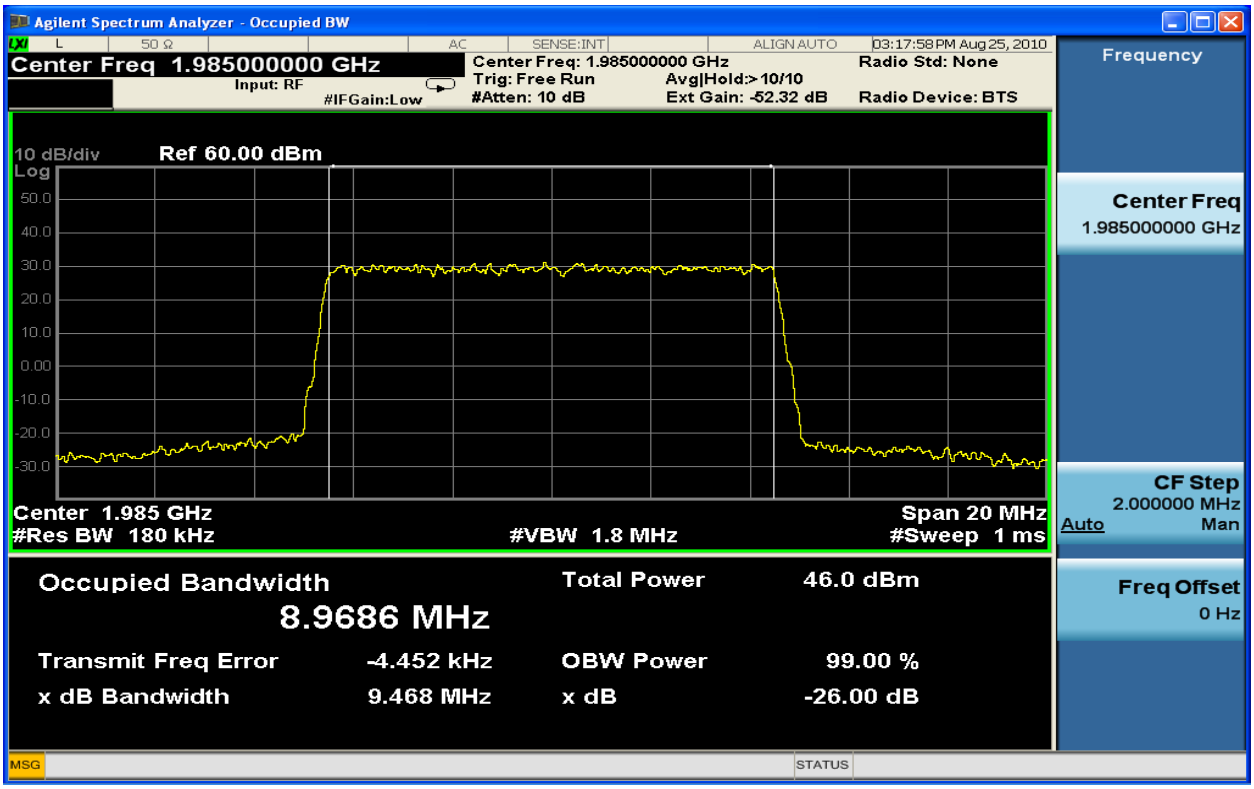

Figure 6-81: 10MHz Occupied Bandwidth TX1_QPSK at 1985.0 MHz

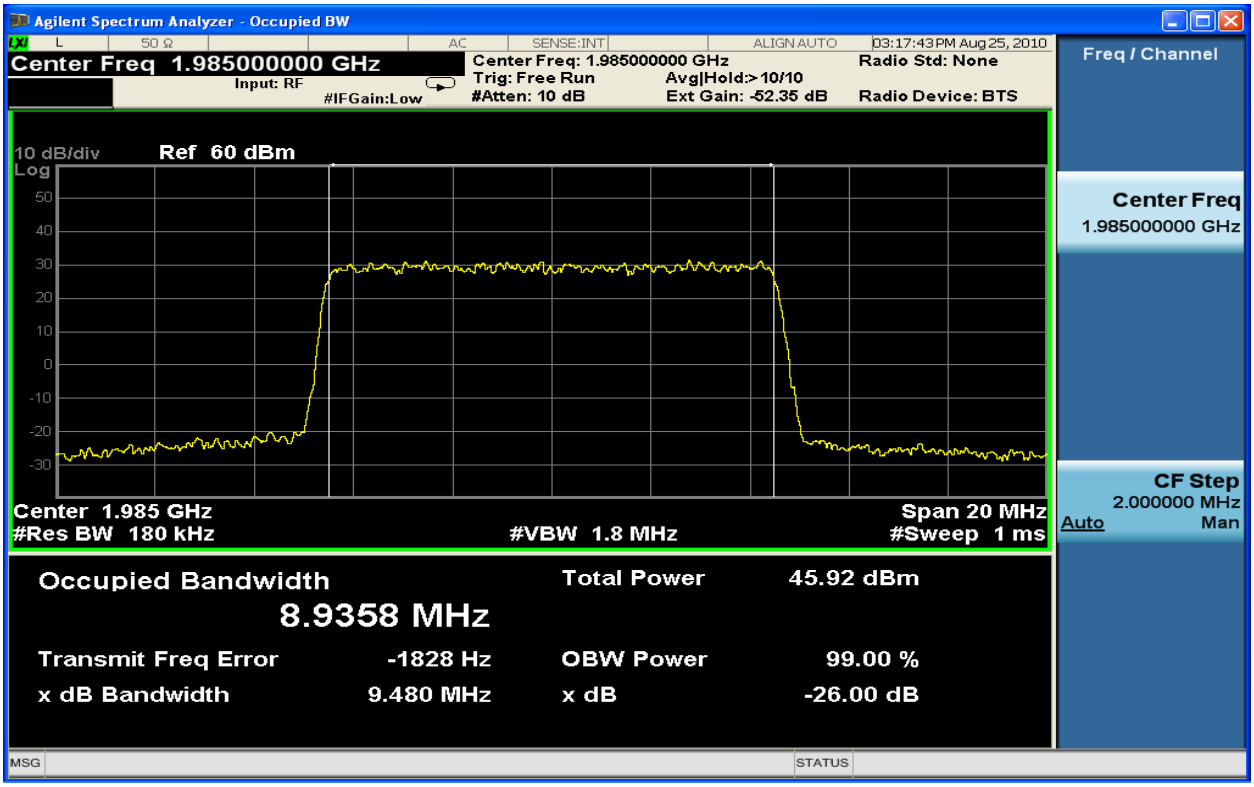

Figure 6-82: 10MHz Occupied Bandwidth TX2_QPSK at 1985.0 MHz

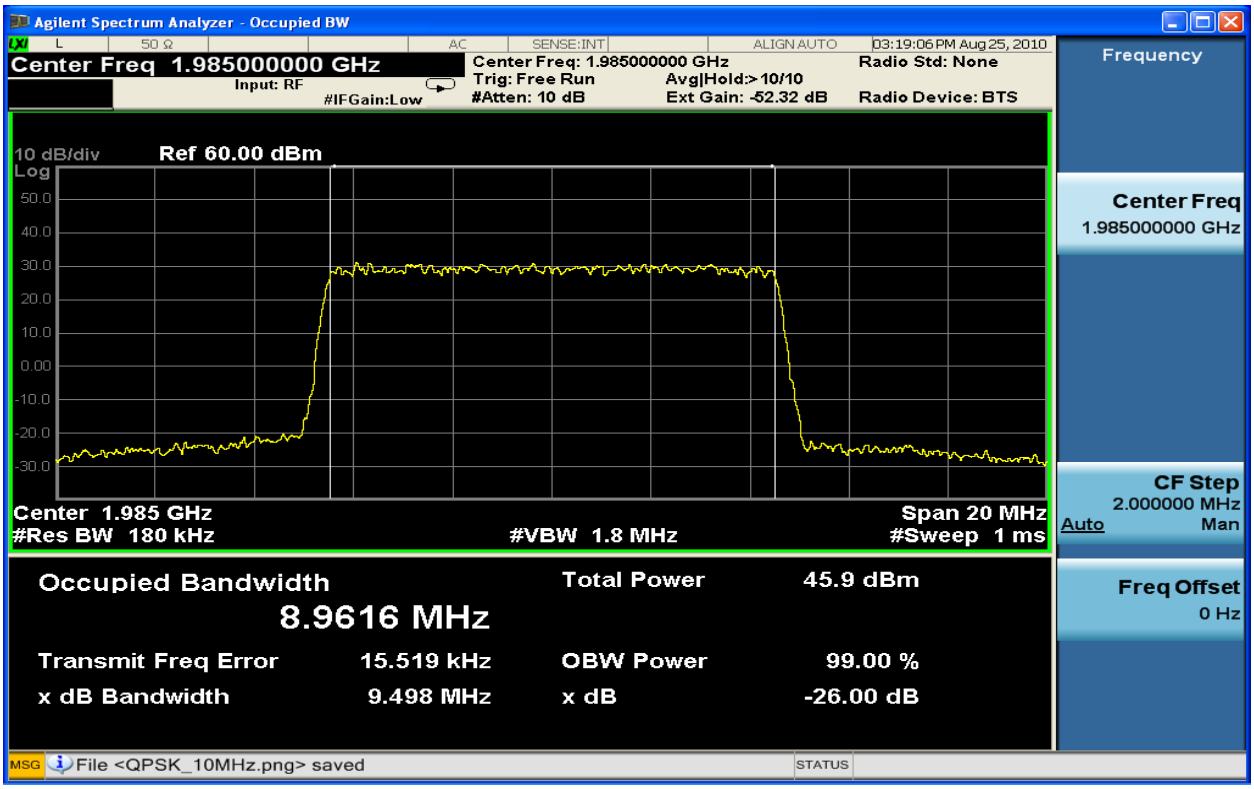

Figure 6-83: 10MHz Occupied Bandwidth TX1_16QAM at 1985.0 MHz

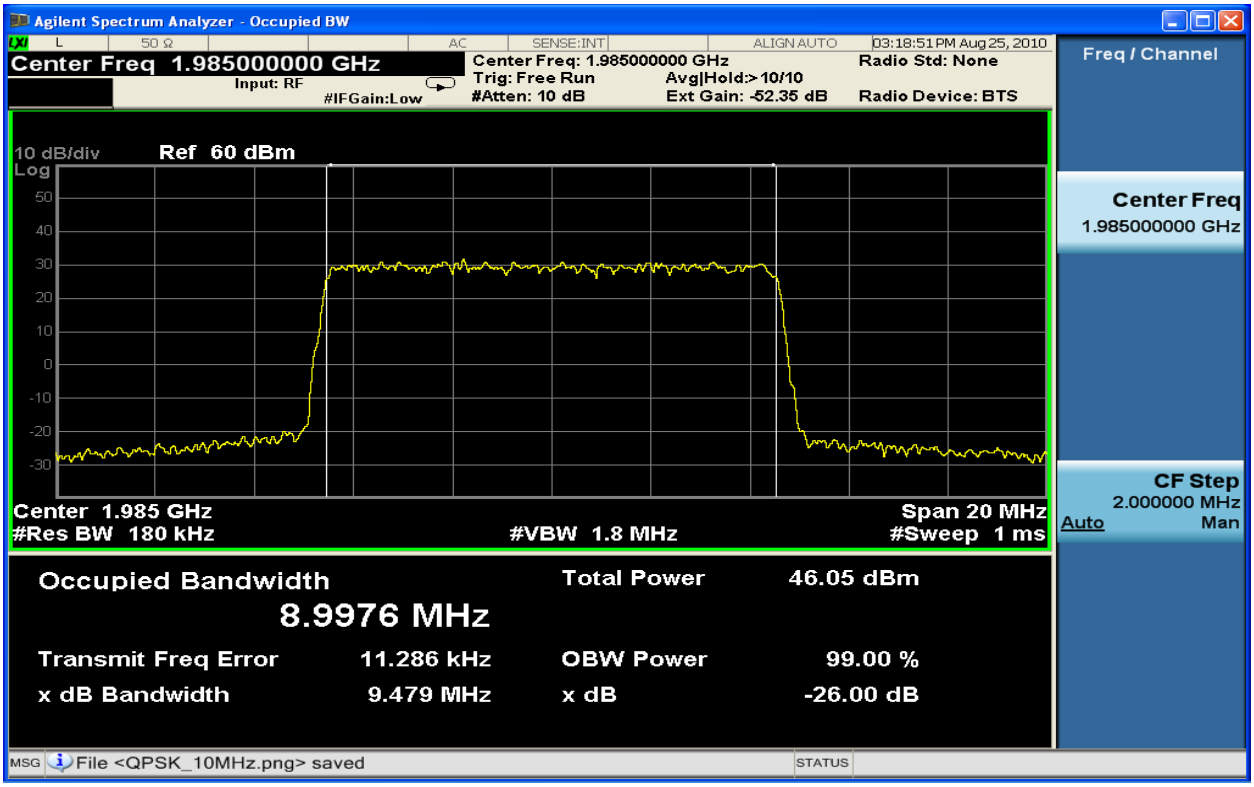

Figure 6-84: 10MHz Occupied Bandwidth TX2_16QAM at 1985.0 MHz

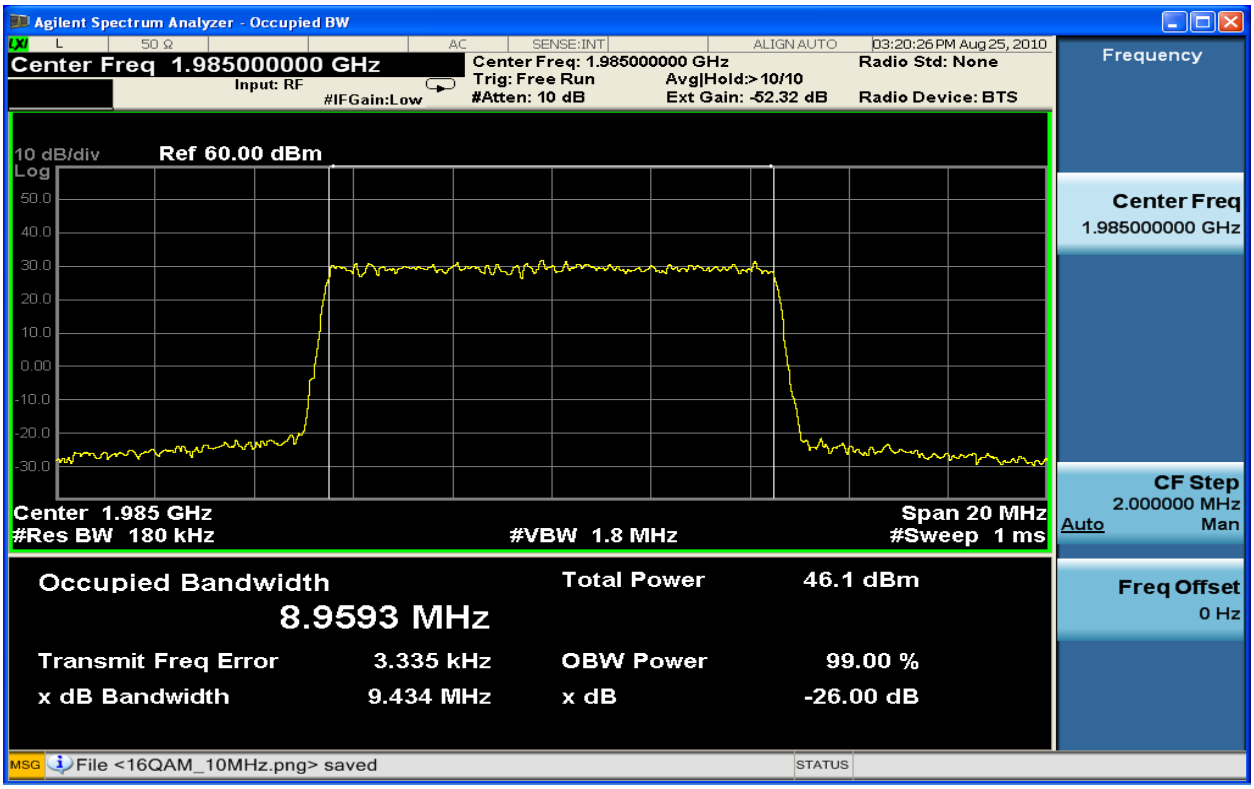

Figure 6-85: 10MHz Occupied Bandwidth TX1_64QAM at 1985.0 MHz

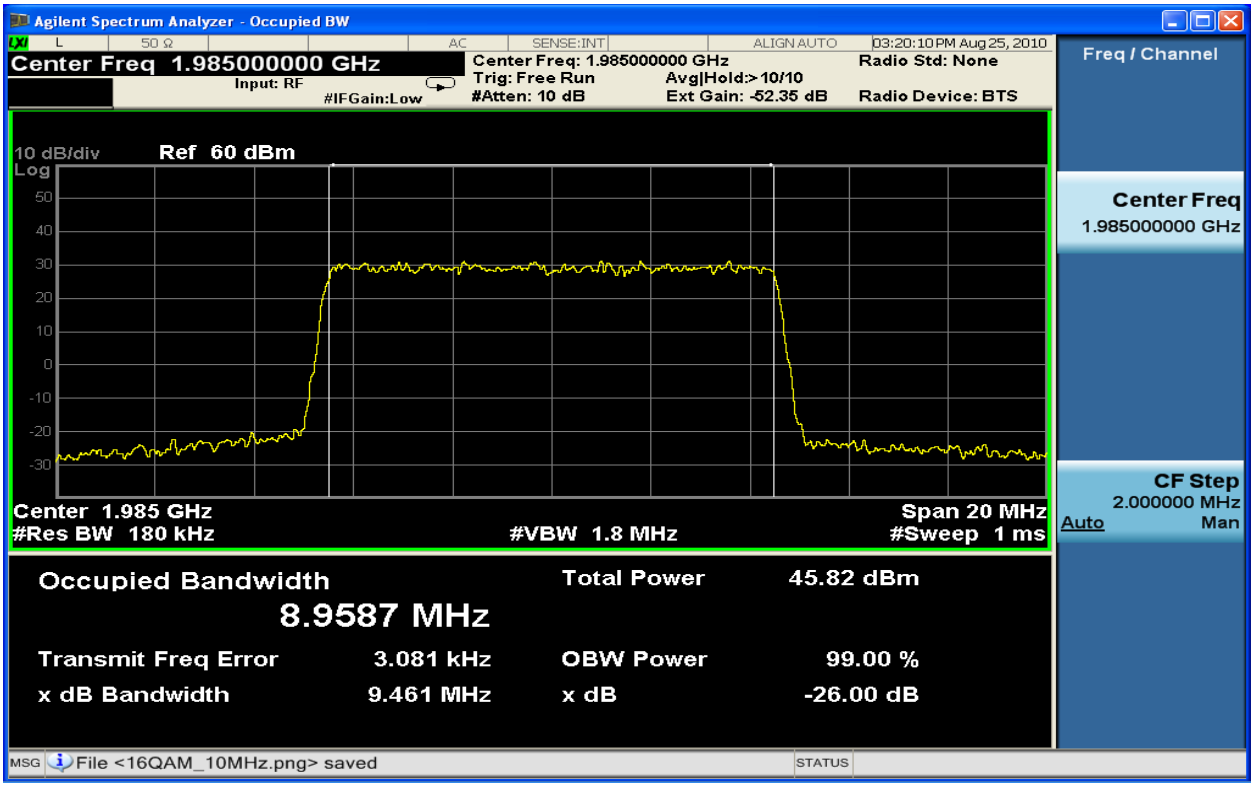

Figure 6-86: 10MHz Occupied Bandwidth TX2_64QAM at 1985.0 MHz

6.4 Spurious Emissions at the Antenna Terminal

Clause 24.238 2.1051

The rules in this section govern the spectral characteristics of emissions in the Broadband Personal Communications Service.

(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 1 MHz or greater. However, in the 1 MHz bands immediately outside and adjacent to the frequency block 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.* 1 MHz 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.

(c) *Alternative out of band emission limit.*

Licensees in this service may establish an alternative out of band emission limit to be used at specified band edge(s) in specified geographical areas, in lieu of that set forth in this section, pursuant to a private contractual arrangement of all affected licensees and applicants. In this event, each party to such contract shall maintain a copy of the contract in their station files and disclose it to prospective assignees or transferees and, upon request, to the FCC.

(d) *Interference caused by out of band emissions.*

If any emission from a transmitter operating in this service results in interference to users of another radio service, the FCC may require a greater attenuation of that emission than specified in this section.

Test Setup:

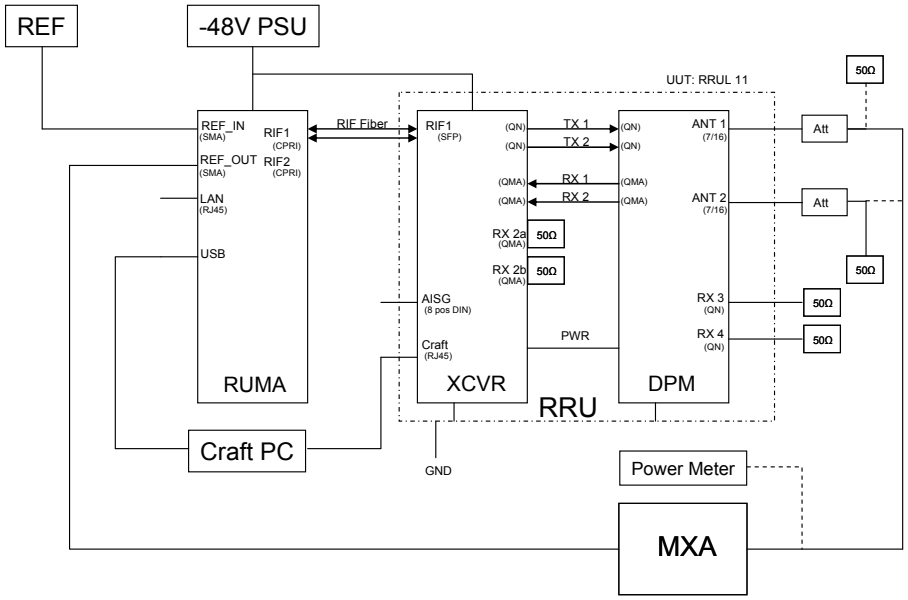

Figure 6-87 RRU Radio Compliance Set Up / Configuration

Procedure:

The following procedure and conditions shall apply for Spurious Emission measurements. As applicable, lower and high side offsets from the channel shall be assessed with respect to all modulation, and bandwidths as well as all emissions up to 26.5GHz. Results shall be compiled and recorded along with the relevant captured plots.

FCC Limit = PWR $_{(dBm)}$ – [43 + 10log(PWR $_{(W)}$)] = 44.8 – 43 + 10log(30) = -13dBm

Table 6-5: Setting / Measurement Results – Spurious Emissions Band Edge BW = 5MHz

Setting Measurement ACP < 2MHz		Spurious Emissions (dBm) FCC Limit -13dBm					
		QPSK		16 QAM		64 QAM	
		TX1	TX2	TX1	TX2	TX1	TX2
		Lower Edge Emission					
Frequency (Lower CH_ 625)	1932.5MHz	-27.15	-27.01	-27.48	-26.42	-27.49	-26.58
Frequency (Middle CH_ 900)	1960.0MHz	-27.08	-26.02	-27.16	-25.78	-27.64	-25.80
Frequency (Upper CH_1175)	1987.5MHz	-24.64	-24.71	-24.60	-24.80	-24.95	-24.70
		Upper Edge Emission					
Frequency (Lower CH_ 625)	1932.5MHz	-27.15	-27.13	-26.93	-26.53	-27.25	-26.91
Frequency (Middle CH_ 900)	1960.0MHz	-26.26	-25.28	-25.77	-24.94	-26.07	-25.66
Frequency (Upper CH_1175)	1987.5MHz	-24.49	-24.92	-23.90	-24.66	-24.81	-24.25
RBW (MBW=50/100kHz)	30kHz						
VBW	30kHz						
CH BW	5MHz	Lower Margin to FCC Limit (dB)					
Reference Level Offset	53.2dB	11.64	11.71	11.60	11.80	11.95	11.70
Detector	RMS	Upper Margin to FCC Limit (dB)					
Attenuation	6dB	11.49	14.13	10.90	11.66	11.81	11.25

Table 6-6: Setting / Measurement Results – Spurious Emissions Band Edge BW = 10MHz

Setting Measurement ACP < 2MHz		Spurious Emissions (dBm) FCC Limit -13dBm					
		QPSK		16 QAM		64 QAM	
		TX1	TX2	TX1	TX2	TX1	TX2
		Lower Edge Emission					
Frequency (Lower CH_ 650)	1935.0MHz	-28.24	-28.11	-27.89	-28.08	-28.91	-28.03
Frequency (Middle CH_ 900)	1960.0MHz	-27.28	-26.87	-27.06	-26.57	-26.91	-26.70
Frequency (Upper CH_1150)	1985.0MHz	-25.05	-25.44	-25.27	-24.88	-25.39	-25.34
		Upper Edge Emission					
Frequency (Lower CH_ 650)	1935.0MHz	-28.97	--29.07	-28.95	-28.97	-29.62	-28.96
Frequency (Middle CH_ 900)	1960.0MHz	-28.66	-28.22	-29.14	-28.53	-28.95	-28.21
Frequency (Upper CH_1150)	1985.0MHz	-27.48	-26.94	-27.20	-26.69	-27.30	-27.08
RBW (MBW=100kHz)	30kHz						
VBW	30kHz						
CH BW	10MHz	Lower Margin to FCC Limit (dB)					
Reference Level Offset	53.2dB	12.05	12.44	12.27	11.88	12.39	12.34
Detector	RMS	Upper Margin to FCC Limit (dB)					
Attenuation	6dB	14.48	13.94	14.20	13.69	14.30	14.08

Table 6-7: Setting / Results – BW = 5MHz, Spurious Emissions 30MHz - 26.5GHz

Setting **Measurement 30MHz – 26.5GHz**		**Spurious Emissions (dBm) FCC Limit -13dBm** **64 QAM** **TX1** **TX2**					
Frequency (Lower CH_ 625)	1932.5MHz	All Emission were below MXA noise floor					
Frequency (Upper CH_1175)	1987.5MHz	All Emission were below MXA noise floor					
RBW	3.0MHz						
VBW							
CH BW	5MHz						
Reference Level Offset	53.2 dB						
Detector	RMS	**Margin to FCC Limit (dB)**					
Attenuation	6dB	>7dB					

Table 6-8: Setting / Results – BW = 10MHz, Spurious Emissions 30MHz – 26.5GHz

Setting **Measurement 30MHz – 26.5GHz**		**Spurious Emissions (dBm) FCC Limit -13dBm** **64 QAM** **TX1** **TX1**					
Frequency (Lower CH_ 650)	1935.0MHz	All Emission were below MXA noise floor					
Frequency (Upper CH_1150)	1985.0MHz	All Emission were below MXA noise floor					
RBW	3.0MHz						
VBW							
CH BW	10MHz						
Reference Level Offset	53.2dB						
Detector	RMS	**Margin to FCC Limit (dB)**					
Attenuation	6dB	>7dB					

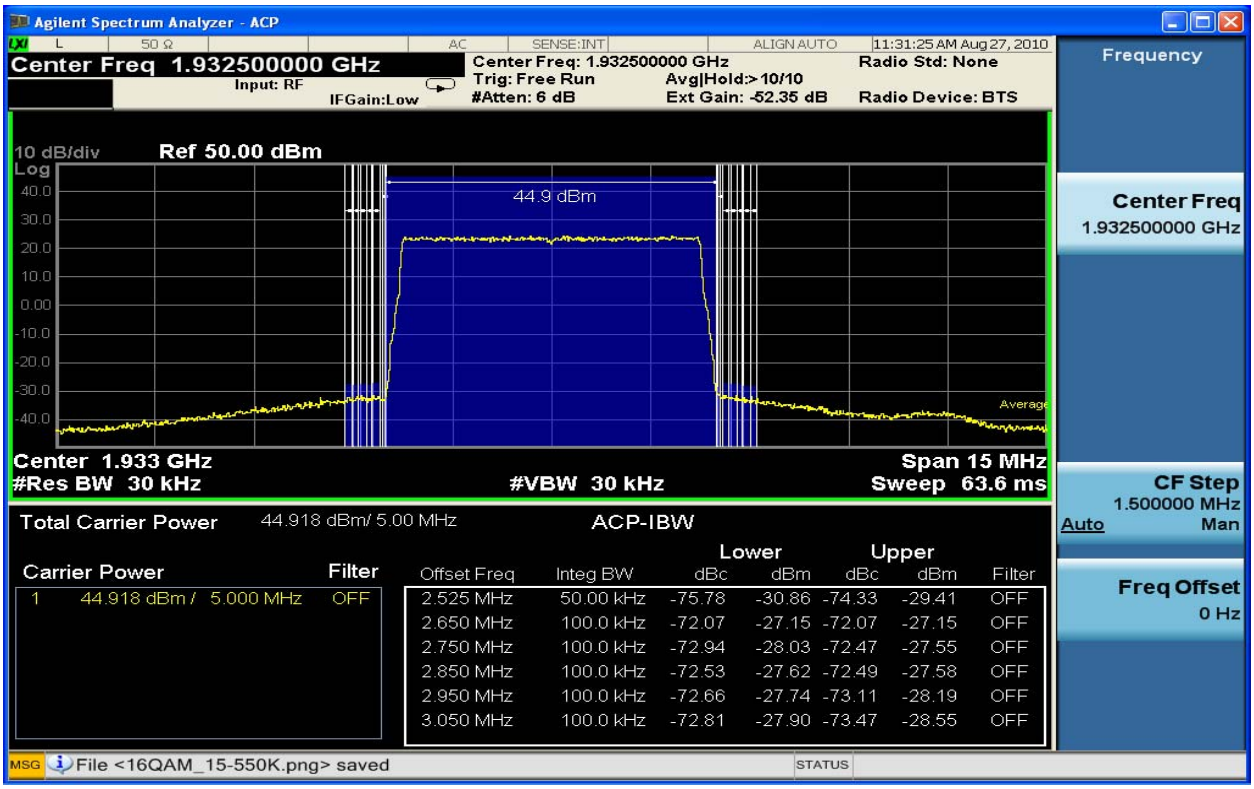

Figure 6-88 Spurious Emissions 1932.5MHz TX1_QPSK 5MHz Band Edge (ACP 15kHz – 550kHz)

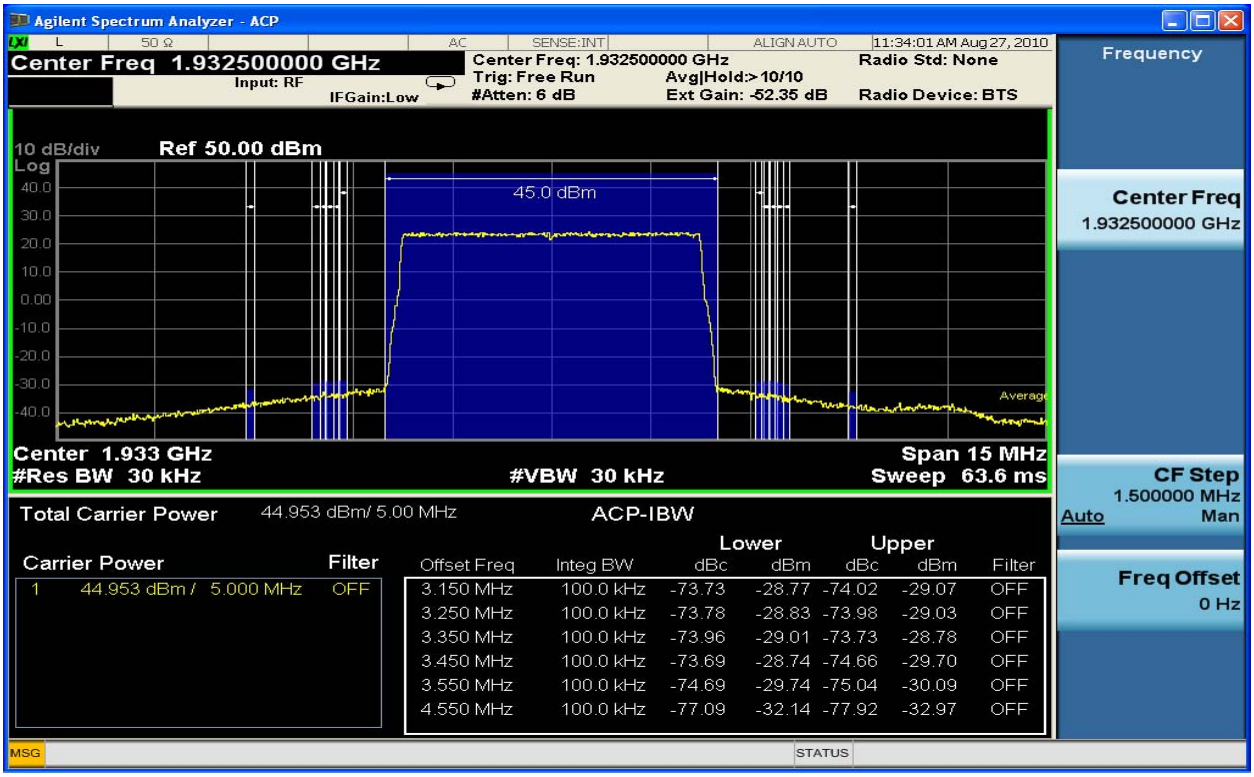

Figure 6-89 Spurious Emissions 1932.5MHz TX1_QPSK 5MHz Band Edge (ACP 650kHz – 2MHz)

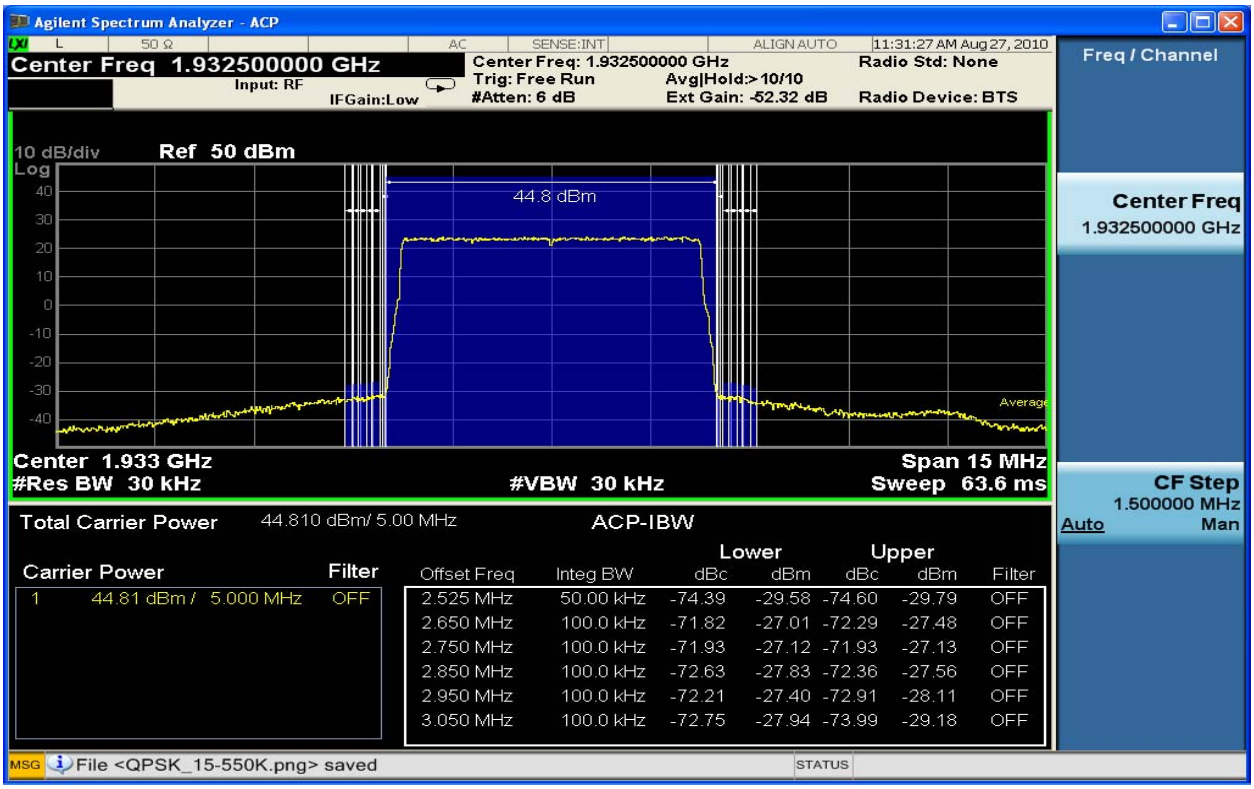

Figure 6-90 Spurious Emissions 1932.5MHz TX2_QPSK 5MHz Band Edge (ACP 15kHz – 550kHz)

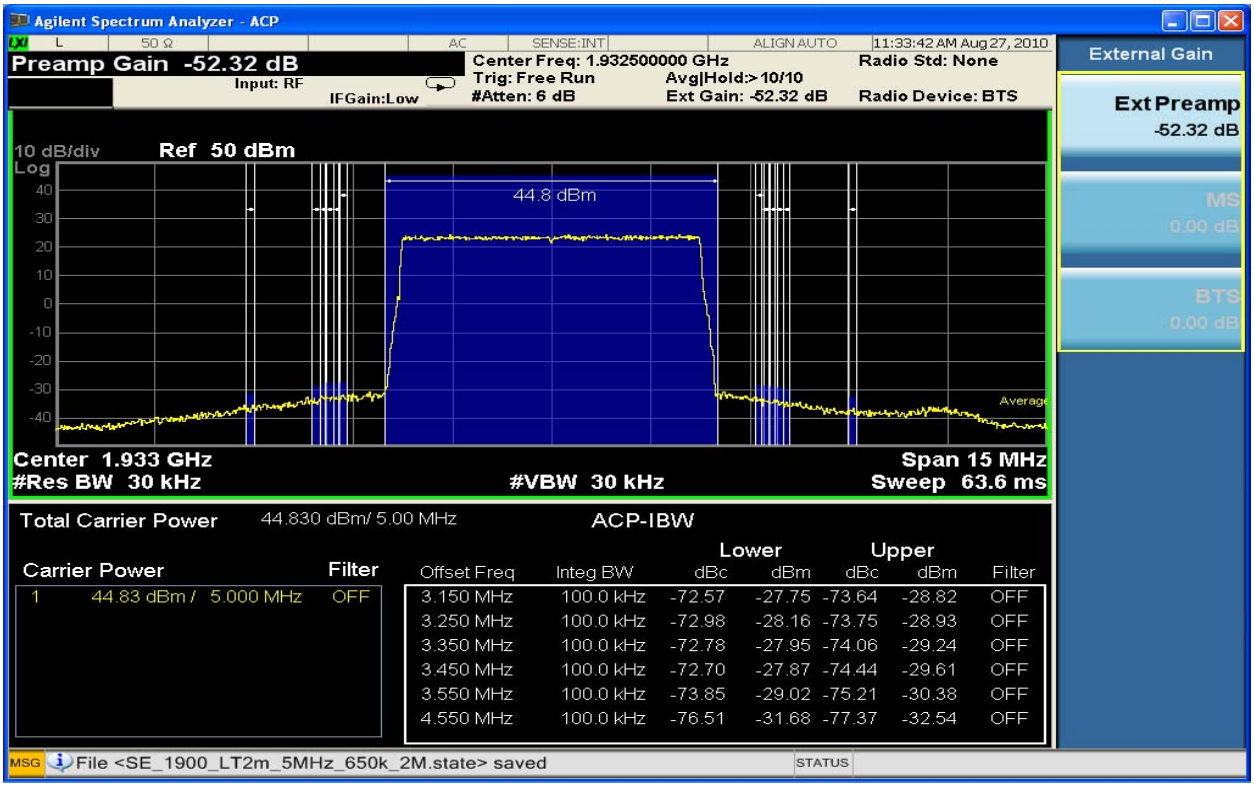

Figure 6-91 Spurious Emissions 1932.5MHz TX2_QPSK 5MHz Band Edge (ACP 650kHz – 2MHz)

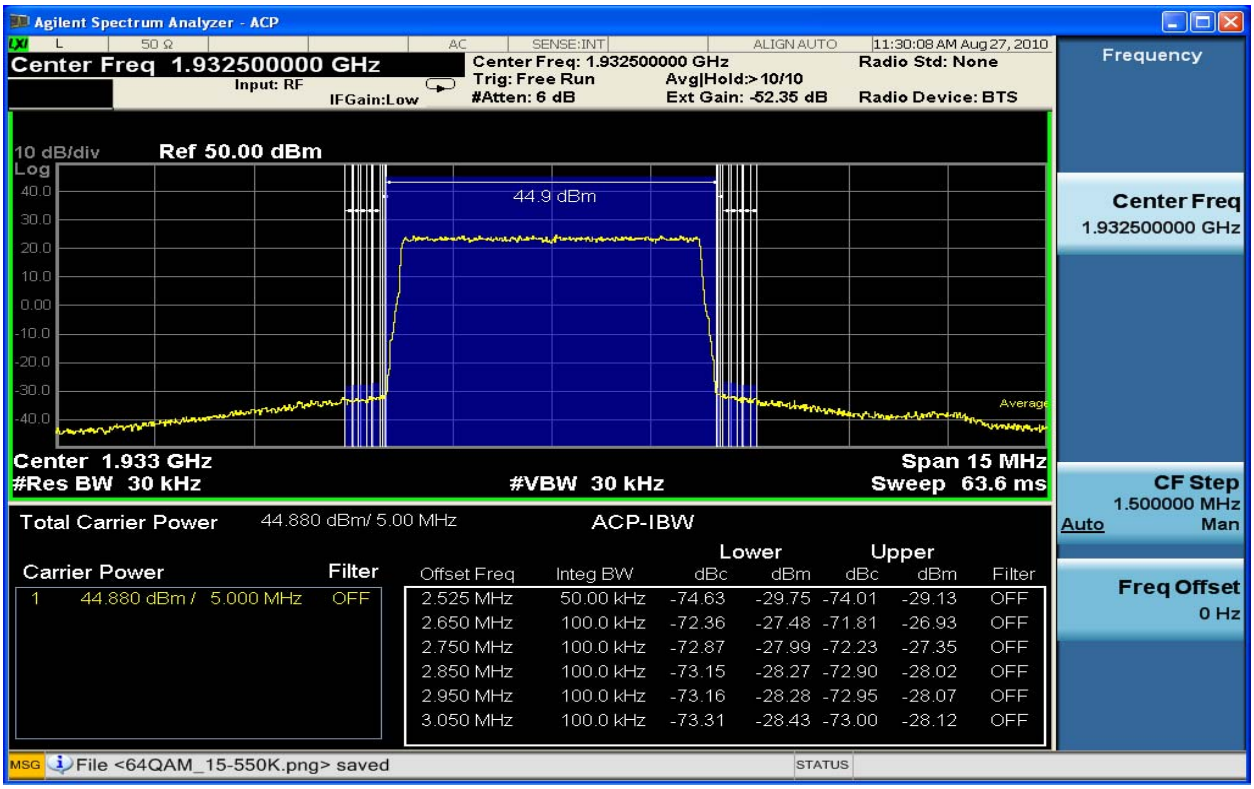

Figure 6-92 Spurious Emissions 1932.5MHz TX1_16QAM 5MHz Band Edge (ACP 15kHz – 550kHz)

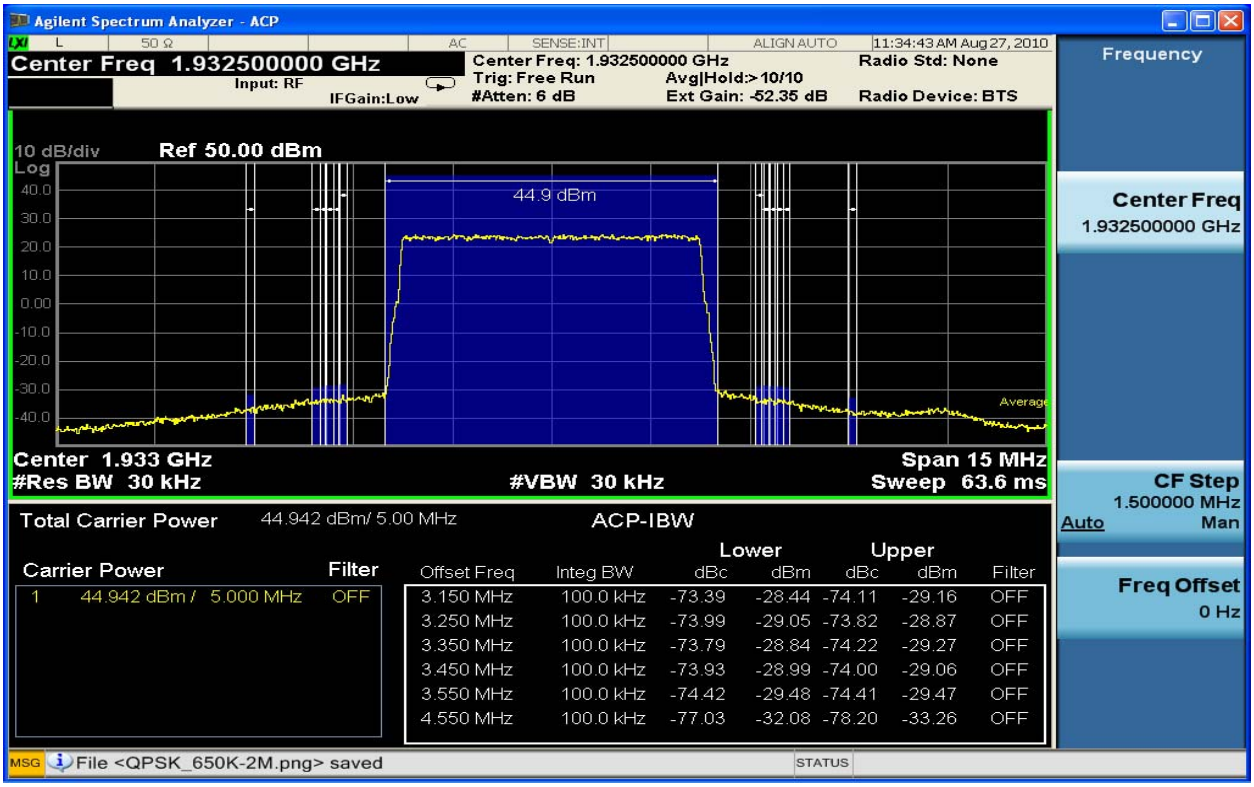

Figure 6-93 Spurious Emissions 1932.5MHz TX1_16QAM 5MHz Band Edge (ACP 650kHz – 2MHz)

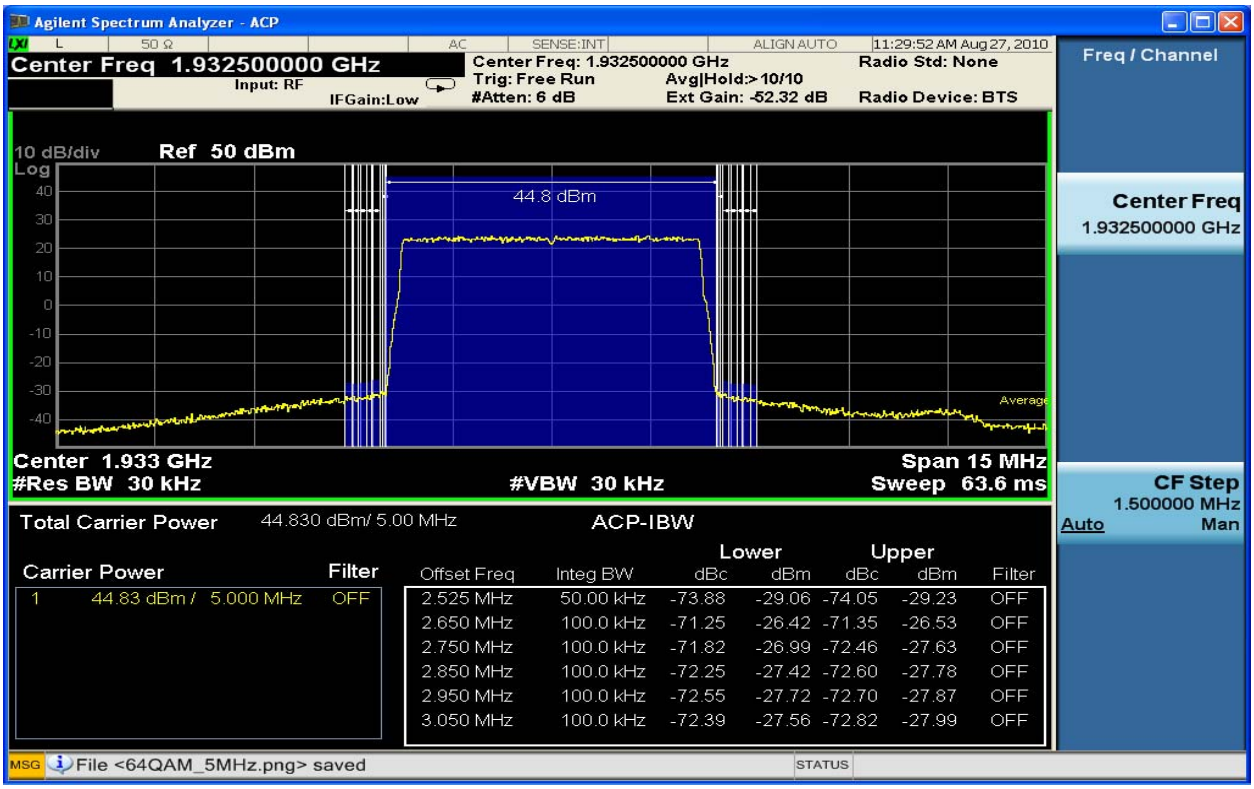

Figure 6-94 Spurious Emissions 1932.5MHz TX2_16QAM 5MHz Band Edge (ACP 15kHz – 550kHz)

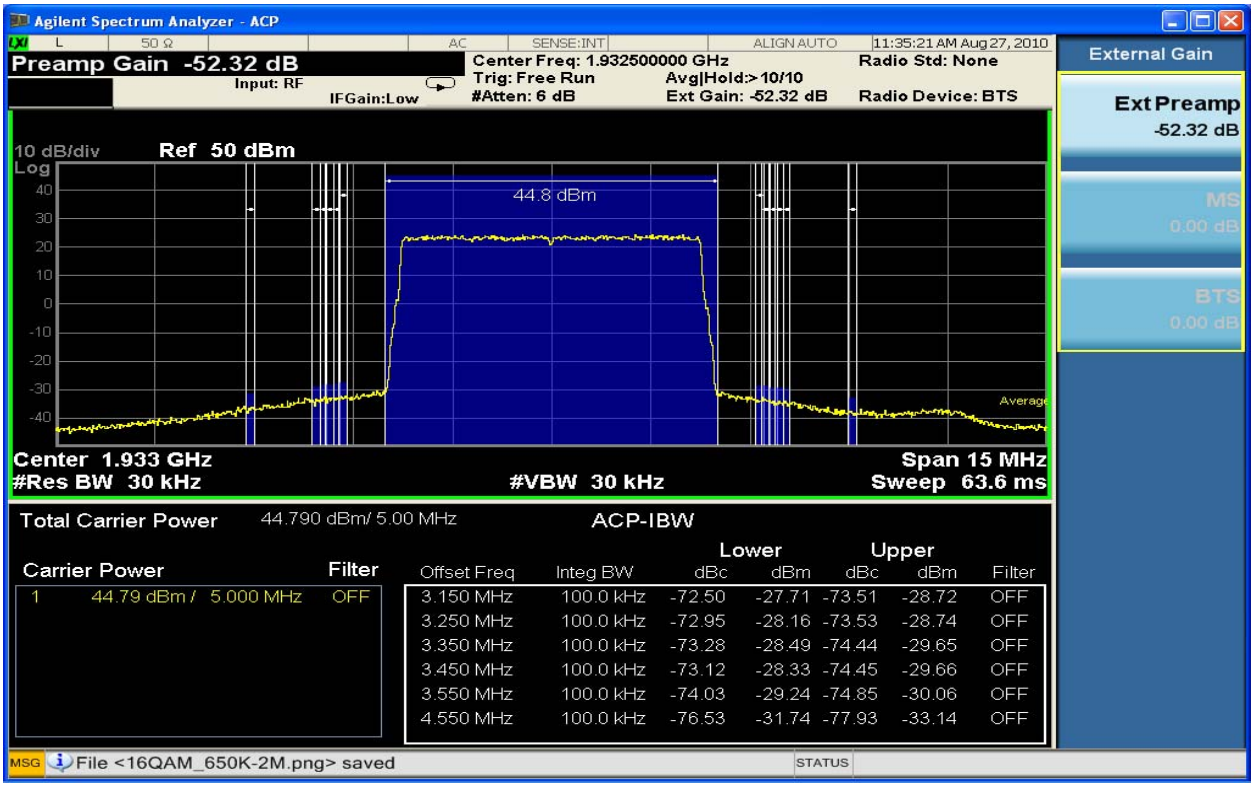

Figure 6-95 Spurious Emissions 1932.5MHz TX2_16QAM 5MHz Band Edge (ACP 650kHz – 2MHz)

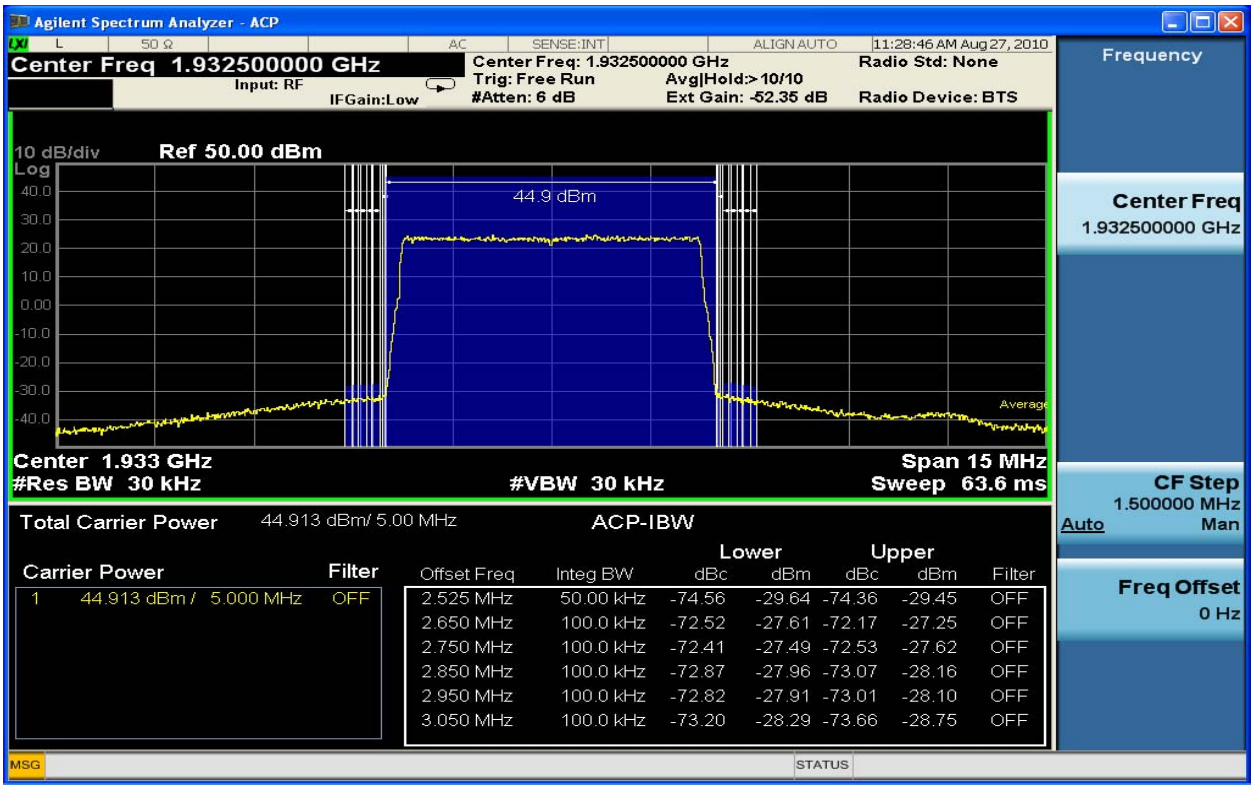

Figure 6-96 Spurious Emissions 1932.5MHz TX1_64QAM 5MHz Band Edge (ACP 15kHz – 550kHz)

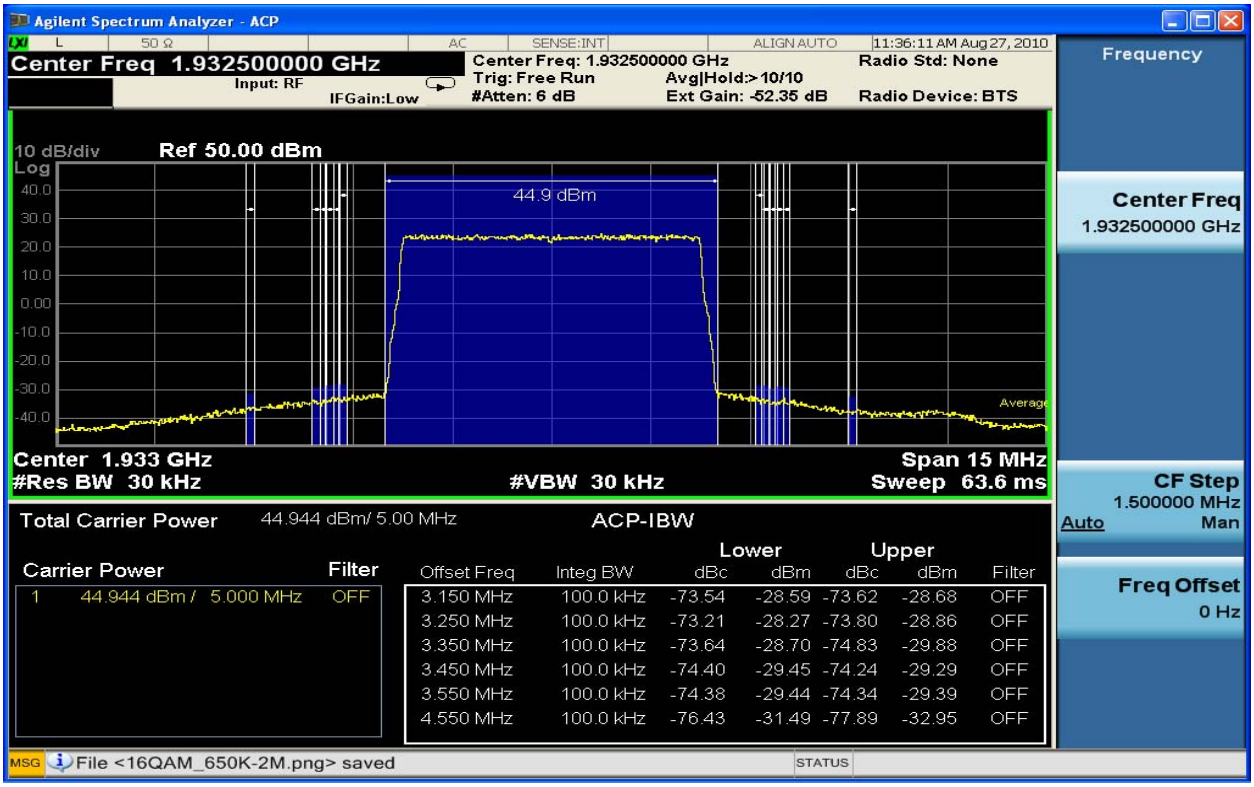

Figure 6-97 Spurious Emissions 1932.5MHz TX1_64QAM 5MHz Band Edge (ACP 650kHz – 2MHz)