Keysight Technologies

802.11ad Integrated RF Test Solution

E7760A Wideband Transceiver

M1650A mmWave Transceiver

Data Sheet

KEYSIGHT TECHNOLOGIES

Introduction

Design your 802.11ad device with confidence

Evaluating devices at 68 GHz with 2 GHz of IF bandwidth is difficult. You need tools that step up to the challenge and prove out your design. The E7760A wideband transceiver with its built in 802.11ad application software gives you insight into both the IF and the RF of your device. Connect the E7760A to a M1650A mmWave transceiver and your measurement plane is now right next to your device. Attach six RF heads to a single E7760A to drive greater throughput in multi-device testing, or speed up beam steering calibration. Validating an 802.11ad design is tough, but with the E7760A and M1650A you'll get it done faster and with confidence.

M1650A mmWave transceiver

E7760A wideband transceiver

Figure 1. Confidently prove out your 802.11ad designs with built-in application software and a measurement plane right next to your device

Product Specifications Definitions and Conditions

The test set is expected to meet its specifications when:

- The test set is within its calibration cycle
- The test set has been stored at an ambient temperature within the allowed operating range for at least two hours before being turned on; if it had previously been stored at a temperature range inside the allowed storage range, but outside the allowed operating range
- All alignments have been run after the warm up period (E7760A, 45 minutes; M1650A, 2 hours) :
  - Within the previous 8 hours
  - If the temperature has changed more than 5 °C from the previous “ALL” alignment

Typical

The expected performance that 95% of the products exhibit with 95% confidence level at room temperature (approximately 25 °C), after alignment within the stated alignment time and temperature limits.

Nominal

The expected performance or information useful in the application of the product, but are not covered by the product warranty.

Vector signal analyzer performance

Performance	
Capture depth	1 GSa memory
Quantization	12 bit
Frequency and time specifications[1]	
CW frequency range	
E7760A (IFIO ports, quantity 2)	2.0 to 18.0 GHz
M1650A (via WR-15 flange)	55 to 68 GHz
CW measurement frequency accuracy	
Accuracy	(Analyzer frequency x frequency reference accuracy) ±50 Hz, nominal
Resolution	100 Hz
Analysis bandwidth, maximum	
E7760A	2 GHz
M1650A	2 GHz
Triggering	
IQ analyzer	Free run, external 1 (input), external 2 (output), RF burst, video, internal

Amplitude accuracy and range specifications[1]	
CW absolute amplitude accuracy	
E7760A (IFIO ports)	± 1.0 dB (–60 to +10 dBm), nominal, from 6.1 to 18 GHz
E7760A (IFIO ports)	± 1.5 dB (–80 to –60 dBm), nominal, from 6.1 to 18 GHz
E7760A (IFIO ports)	± 2.2 dB (–90 to –80 dBm), nominal, from 6.1 to 18 GHz
M1650A (WR-15 flange)	± 1.25 dB (–80 to + 5 dBm), nominal[2]
Linearity	
E7760A (IFIO ports)	± 0.4 dB (–80 to +10 dBm), nominal, 6.1 to 17.75 GHz
M1650A (WR-15 flange)	± 1.0 dB (–80 to + 5 dBm), nominal, 55 to 68 GHz
System amplitude stability, over 12 hrs, 25 °C (via mmWave ports)	
0.6 dB, after 45 minute warm up, nominal	
0.2 dB, after 2 hour warm up, nominal	

Vector signal generator performance

Performance	
ARB depth	1 GSa memory
Quantization	14 bit
Frequency and time specifications[1]	
CW frequency range	
E7760A (2 IFIO ports)	2.0 to 18.0 GHz
M1650A (WR-15 flange)	55 to 68 GHz
CW measurement frequency accuracy	
Accuracy	(Transmitter frequency x frequency reference accuracy) ±50 Hz, nominal
Resolution	100 Hz
Amplitude accuracy and range specifications[1]	
Signal generation bandwidth, maximum	
E7760A	2 GHz
M1650A	2 GHz
CW absolute amplitude accuracy[3]	
E7760A (IFIO ports)	± 1.0 dB (–45 to +5 dBm), nominal, from 6.1 to 18 GHz
E7760A (IFIO ports)	± 1.5 dB (+5 to +7 dBm), nominal, from 6.1 to 18 GHz
M1650A (WR-15 flange)	± 2.0 dB (–40 to +7 dBm), nominal, from 55 to < 65 GHz
Linearity	
M1650A (WR-15 flange)[3]	± 0.5 dB (–40 to + 7 dBm), nominal, from 55 to < 65 GHz
M1650A (WR-15 flange)	± 1.0 dB (–60 to +7 dBm), nominal, from 55 to < 65 GHz
Carrier leakage	
E7760A (IFIO ports)	< 40 dBc, nominal, from 6.1 to 18 GHz
M1650A (WR-15 flange)	< 40 dBc, nominal
System amplitude stability, over 12 hrs, 25 °C (via mmWave ports)	
0.6 dB, after 45 minute warm up, nominal	
0.2 dB, after 2 hour warm up, nominal	

1. After E7760A instrument warm up of 45 min and M1650A warmup time of 2 hours
2. At center frequency of 802.11ad channels 1, 2, 3, 4
3. Signal generator temperature compensation applied after each RF parameter update

Timebase specifications

Internal timebase	**10 MHz OCXO**
Frequency accuracy	See table below
Recommended calibration cycle	1 year
External reference input	
Frequency	10, 20, 30, 40, 50 MHz
Lock range	± 1 ppm
Amplitude	0 to 10 dBm
Connector	1 BNC
Impedance	50 Ω
Accuracy	± [(time since last adjustment x aging rate) + temperature stability + calibration accuracy], typical
Frequency stability – aging rate	
Daily	< ±0.5 ppb/day typical, after 72 hour warm up
Yearly	< ±0.10 ppm/year typical, after 72 hour warm up
Total 10 years	< ±0.6 ppm/10 years typical, after 72 hour warm up
Achievable initial calibration accuracy	$\pm 5 \times 10^{-8}$ typical
Frequency stability – temperature effects	
20 to 30 °C	< ±10 ppb, typical
Full temperature range	< ±50 ppb, typical
Frequency stability – warm up	
5 minutes over +20 to +30 °C, 1 hour	< ±0.1 ppm, typical
15 minutes over +20 to +30 °C, 1 hour	< ±0.01 ppm, typical

General performance attributes

Power requirements	
E7760A voltage & frequency	100/120 V, 50/60 Hz, and 220/240 V, 50/60 Hz
E7760A power consumption	300 W with 100-120 VAC input
E7760A, M1650A power consumption	350 W (with one M1650A) with 100-120 VAC input
E7760A, M1650A power consumption	600 W (with six M1650A) with 100-120 VAC input
Size and weight	
Dimensions	
E7760A (W x H x D mm)	425 x 89 x 559 mm
M1650A (W x H x D mm)	96 x 119 x 209 mm
E7760A rack space	2U x 1 rack width
Weight	
E7760A	15 kg (33 lbs)
M1650A	3 kg (6.6 lbs)
Environmental characteristics	
Ambient temperature	25 °C
Operating temperature	+10 to +40 °C
M1650A external housing temperature	< 20 °C above ambient
Calibration cycle	
	The recommended calibration cycle is one year; calibration services available through Keysight service centers
Maximum applied reverse power	
E7760A (IFIO ports)	+20 dBm CW, nominal
M1650A (via WR-15 flange)	+15 dBm CW, nominal
Remote programming	
Interface	LAN RJ45

E7760A rear panel

LAN TCP/IP interface	
Standard (1 port)	1000 Base-T
Connector type	RJ45 Ethertwist
Monitor output	
Connector	Mini DisplayPort (mDP) compatible with DisplayPort to VGA adapter
USB 2.0 ports	
Master (2 ports)	
Standard	Compatible with USB 2.0
Connector	USB Type-A female
Output current	0.5 A
10 MHz out	
Connector	Type-BNC female, 50 Ω
Output amplitude	9.5 dBm, nominal
Ref In	
Connector	Type-BNC female, 50 Ω
Characteristics	(see Timebase Specifications)
Trigger In 1, trigger out 2, connections	
Connector	Type-BNC female
Impedance	> 10 k Ω
Trigger level range	–5 V to +5 V

E7760A front panel

USB 2.0 ports	
Master (6 ports)	
Standard	Compatible with USB 2.0
Connector	USB Type-A female
Output current	0.5 A
RF connections	
E7760A (qty 2 IF, bidirectional)	3.5 SMA, 50 Ω
E7760A (qty 6 RF, bidirectional)	Type-N female, 50 Ω, 36 V DC output, for M1650A

M1650A

RF connections	
M1650A (connection to E7760A)	Type-N female, 50 Ω, RF cable
M1650A (RF mmWave)	WR-15 flange

Y7707A, 802.11ad application software

Analyzer performance

Error vector magnitude (EVM)	
E7760A (IFIO ports), -10 dBm, 802.11ad MCS12 signal	
8 - 11 GHz	< –32 dB, nominal
14 - 17 GHz	< –32 dB, nominal

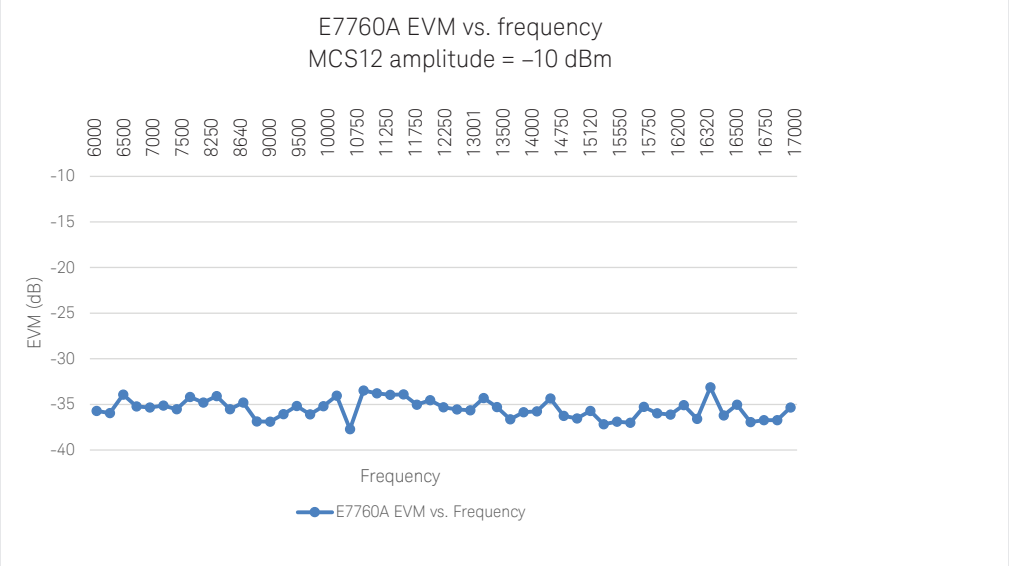

Figure 2. E7760A nominal plot of EVM vs. frequency

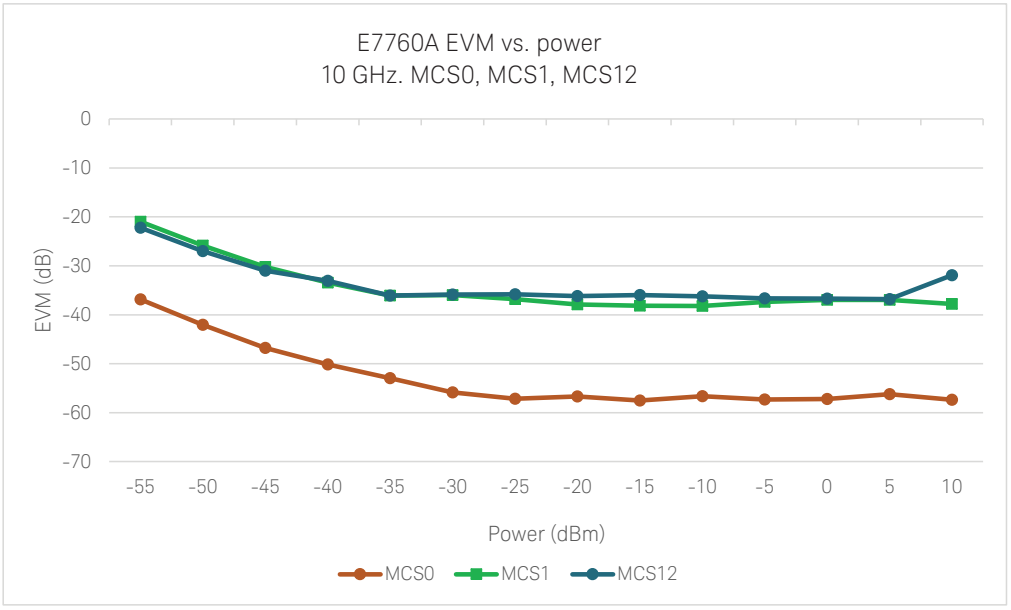

Figure 3. E7760A nominal plot of EVM at 10 GHz for MCS0, MCS1, MCS12

M1650A (WR-15 flange), –10 dBm, 802.11ad MCS12 signal, 2m cable	
802.11ad, Ch 1	< –29 dB, nominal
802.11ad, Ch 2	< –29 dB, nominal
802.11ad, Ch 3	< –29 dB, nominal
802.11ad, Ch 4	< –28 dB, nominal

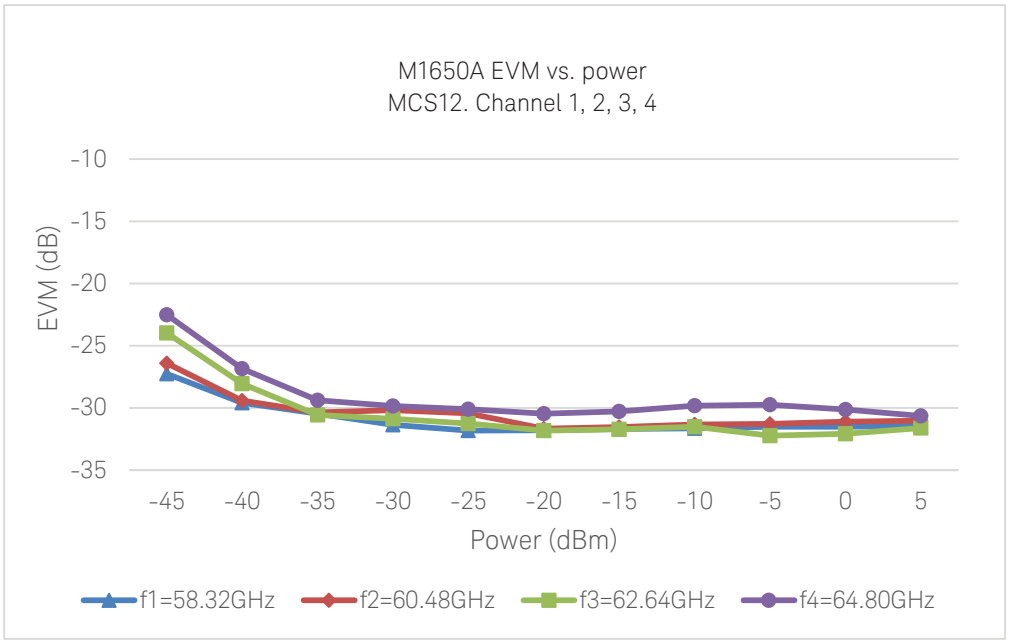

Figure 4. M1650A nominal plot of EVM for channel 1, 2, 3, 4

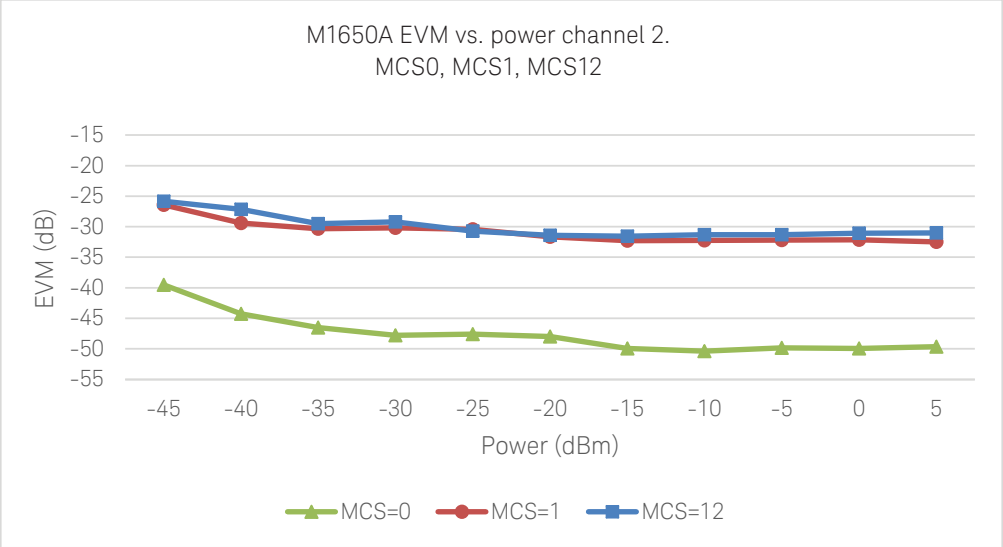

Figure 5. M1650A nominal plot of EVM vs. power, channel 2. MCS0, MCS1, MCS12

Transmit mask

E7760A transmit mask	
Operating range	Carrier power: –35 dBm to max power
Residual relative power as measured with 1 MHz resolution bandwidth	
Input signal	9.5 GHz ≤ center frequencies ≤ 15.12 GHz, at –20 dBm, –10 dBm, 0 dBm, with MCS12
± 1.2 GHz, bandwidth	–19 dBr, typical
± 2.7 GHz, bandwidth	–32 dBr, typical
± 3.06 GHz, bandwidth	–36 dBr, typical

M1650A transmit mask	
Operating range	Carrier power: –35 dBm to max power
Residual relative power as measured with 1 MHz resolution bandwidth	
Input signal	Channel 1, 2, 3, 4, at 0 dBm input power, with MCS12 signal, 2m cable
± 1.2 GHz, bandwidth	–21 dBr, nominal
± 2.7 GHz, bandwidth	–26 dBr, nominal
± 3.06 GHz, bandwidth	–33 dBr, nominal

Speed measurements (SEM transmit mask and EVM)		
Item	**Single measurement**	**Result from 10 averages**
EVM	30 ms, nominal	125 ms, nominal
SEM transmit mask	110 ms, nominal	200 ms, nominal
EVM+SEM transmit mask	140 ms, nominal	250 ms, nominal

Using channel 2, MCS12, acquisition (main time) length of 5 µs, input signal –20 dBm. Excluding setup time. Controlling computer on dedicated network, HiSLIP communication protocol.

Generator performance

Error vector magnitude (EVM)	
E7760A (IFIO ports), –10 dBm, 802.11ad MCS12 signal	
8 - 11 GHz	<–30 dB, nominal
14 - 17 GHz	<–30 dB, nominal

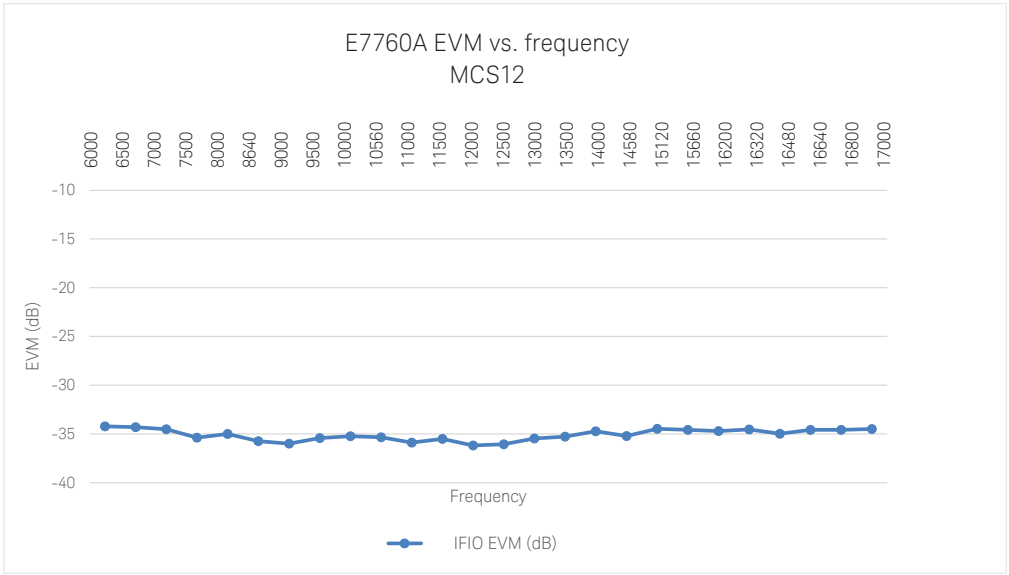

Figure 6. E7760A nominal plot of EVM vs. frequency.

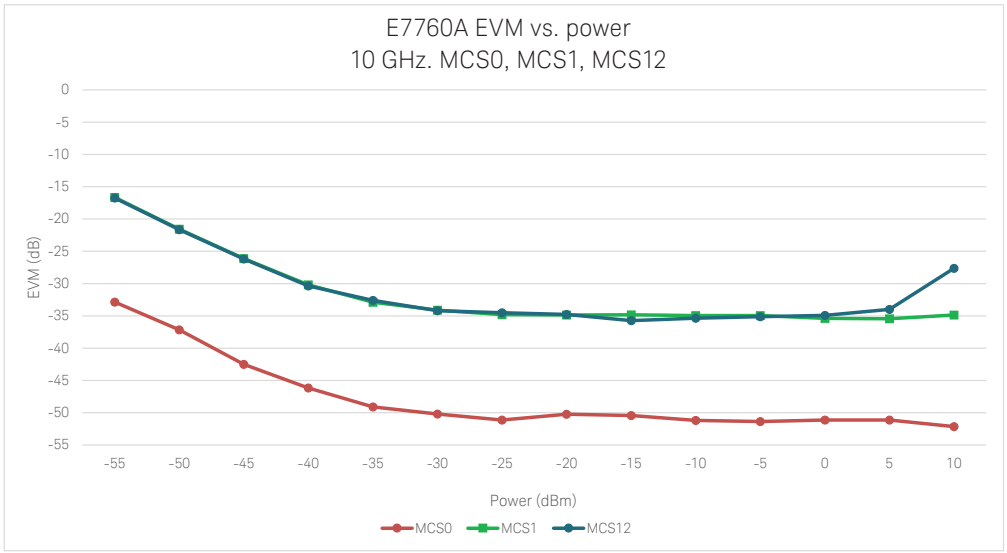

Figure 7. E7760A nominal plot of EVM vs. power at 10 GHz with MCS0, MCS1, MCS12

M1650A (WR-15 flange), –10 dBm, 802.11ad MCS12 signal, 2m cable	
802.11ad, Ch 1	< –29 dB, nominal
802.11ad, Ch 2	< –29 dB, nominal
802.11ad, Ch 3	< –29 dB, nominal
802.11ad, Ch 4	< –28 dB, nominal

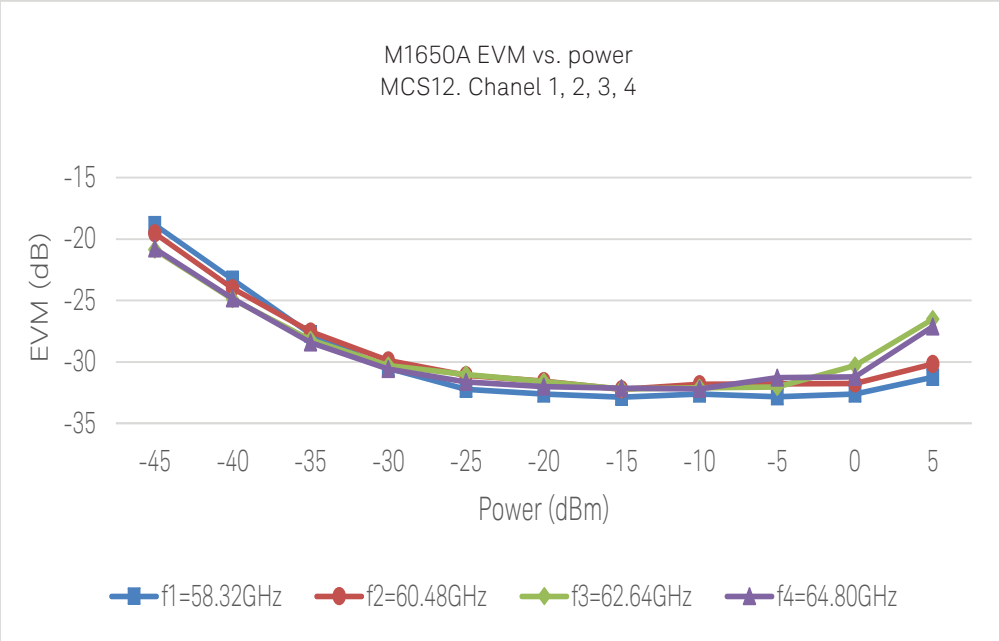

Figure 8. M1650A nominal plot of EVM for channel 1, 2, 3, 4

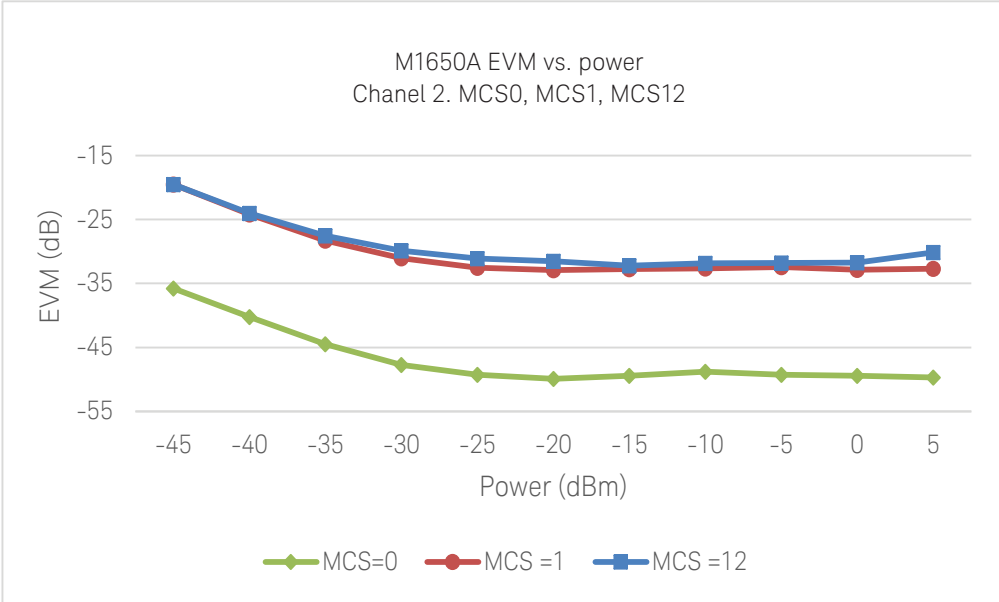

Figure 9. M1650A nominal plot of EVM vs. power, channel 2. MCS0, MCS1, MCS12

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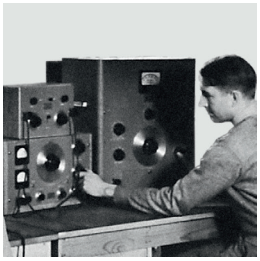

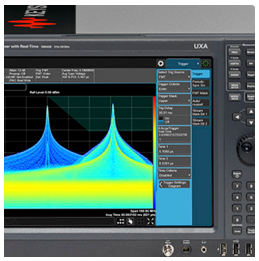

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