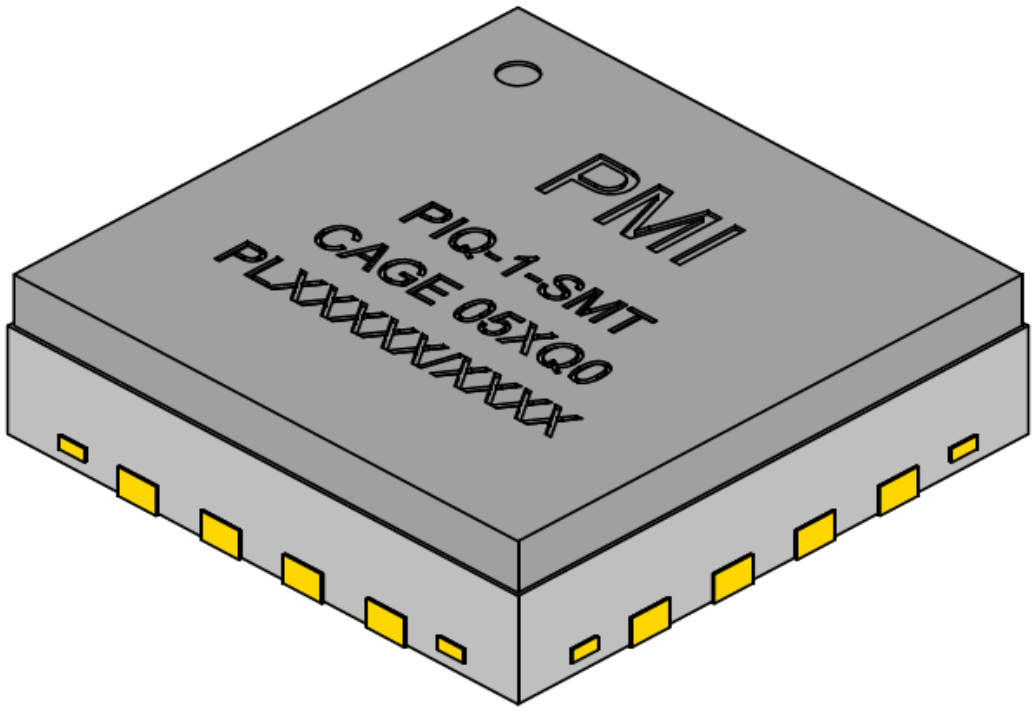
TYPICAL CHARACTERISTICS ON PIQ-1-SMT

THE PIQ-1-SMT IS AN INTEGRATED BROADBAND IQ VECTOR MODULATOR WITH FULLY DIFFERENTIAL INPUTS AND OUTPUTS (LO AND RF) PORTS AND SINGLE ENDED ON THE BASEBAND (I AND Q) INPUTS. AN ON-CHIP BROADBAND QUADRATURE GENERATOR NETWORK ALLOWS THE PIQ-1-SMT TO ACHIEVE MULTI-OCTAVE FREQUENCY COVERAGE. THE PIQ-1-SMT OPERATES WITH A SINGLE POSITIVE VCC = 4V @ 250 mA SUPPLY AND IS SUPPLIED IN A QFN PACKAGE.



REPORTED BY: ANTON L.
TESTED BY: ANTON L.
DATE: 3/23/2026

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PMI
PLANAR MONOLITHICS

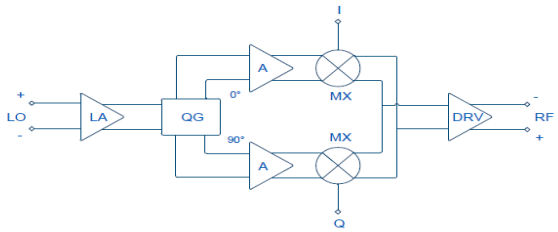
DESCRIPTION:
THE PIQ-1-SMT IS AN INTEGRATED BROADBAND IQ VECTOR MODULATOR WITH FULLY DIFFERENTIAL INPUTS AND OUTPUTS (LO AND RF) PORTS AND SINGLE ENDED ON THE BASEBAND (I AND Q) INPUTS. AN ON-CHIP BROADBAND QUADRATURE GENERATOR NETWORK ALLOWS THE PIQ-1-SMT TO ACHIEVE MULTI-OCTAVE FREQUENCY COVERAGE. THE PIQ-1-SMT OPERATES WITH A SINGLE POSITIVE VCC = 4V @ 250 mA SUPPLY AND IS SUPPLIED IN A QFN PACKAGE.

CONF.	REV.	DESCRIPTION	DATE	APPROVED
	A1	ORIGINAL RELEASE	7/21/25	
	A2	ECN #26-0022	2/6/26	
	A3	ECN #26-0070	3/24/26	

SPECIFICATIONS (PAGE 1):

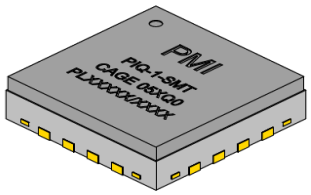
- INPUTS: LO+ (POSITIVE PHASE TERMINAL OF THE LO)
  LO- (NEGATIVE PHASE TERMINAL OF THE LO)
  LO PORTS ARE 100Ω DIFFERENTIAL
  LO COMMON MODE DC LEVEL IS NOMINALLY 2.16V ± 100 mV
  LO INPUTS MUST BE DC BLOCKED
  I (IN-PHASE COMPONENT)
  Q (QUADRATURE-PHASE COMPONENT)
  I AND Q PORTS ARE 50Ω SINGLE-ENDED
- OUTPUTS: RF+ (POSITIVE PHASE TERMINAL OF THE RF)
  RF- (NEGATIVE PHASE TERMINAL OF THE RF)
  RF PORTS ARE 100Ω DIFFERENTIAL
  COMMON MODE DC LEVEL IS NOMINALLY 3.4V ± 100 mV
  RF OUTPUTS MUST BE DC BLOCKED
- LO FREQUENCY RANGE: 100 MHz TO 20 GHz
- LO INPUT POWER: -10 TO 10 dBm
- RF FREQUENCY RANGE: 100 MHz TO 20 GHz
- LO OUTPUT POWER: -12 dBm TYP.
- BASEBAND I/Q BANDWIDTH: 10 GHz (DC TO 10 GHz)
  I AND Q INPUT CAN BE USED DC COUPLED OR AC COUPLED
  DC: 0 TO 2.16V. COMMON MODE LEVEL IS 1.08V ± 50 mV
  AC: UP TO 10 GHz. LINEAR TO 0 dBm IN TOTAL (EQUIVALENT TO -3 dBm AT BOTH I AND Q)
- I/Q COMMON-MODE BIAS: 1.08V ± 50 mV
- CARRIER (LO) LEAKAGE: -42 dBc TYP.
- VOLTAGE CONVERSION GAIN: -20 dB TYP.
- I/Q GAIN IMBALANCE: 0.5 dB TYP.
- QUADRATURE PHASE ERROR: 1° MAX.
- SIDEBAND SUPPRESSION: 30 dB TYP. (W/ ARB AT 1 MHz, SIN & COS ON I AND Q)
- VSWR: 2.5:1 TYP. (LO+, LO-, RF+, RF-)
  2.0:1 TYP. (I, Q)
- RF-LO ISOLATION: -50 dBc TYP.
- LO-BASEBAND ISOLATION: -45 dBc TYP.
- RF-BASEBAND ISOLATION: -40 dBc TYP.
- I-Q CROSSTALK: -40 dBc TYP.
- P1dB: -5 dBm TYP.
- IP3: 5 dBm TYP.
- IP2: 45 dBm TYP.
- HARMONIC DISTORTION: 2nd HARMONIC: -35 dBc TYP.
  3rd HARMONIC: -20 dBc TYP.
  4th HARMONIC: -50 dBc TYP.
  5th HARMONIC: -35 dBc TYP.
- SPURIOUS EMISSIONS: -30 dBm TYP.
- SFDR: 20 dB TYP.

NOTE: SPECIFICATIONS WILL VARY OVER TEMPERATURE
NOTE: THE ABOVE SPECIFICATIONS ARE SUBJECT TO CHANGE OR REVISION



LO = Local oscillator input
LA = Limiting amplifier
QG = Quadrature generator
MX = Mixer
DRV = Driver
A = Amplifier
RF = RF output
I/Q = Vector modulation inputs

PIN FUNCTIONS	
EP	GND
PIN 1	GND
PIN 2	LO+
PIN 3	LO-
PIN 4	GND
PIN 5	VCC
PIN 6	GND
PIN 7	Q
PIN 8	GND
PIN 9	GND
PIN 10	RF+
PIN 11	RF-
PIN 12	GND
PIN 13	GND
PIN 14	I
PIN 15	GND
PIN 16	VCC



PMI CONFIDENTIAL AND PROPRIETARY

APPROVALS	DATE
DRAWN AL	7/28/2025
HELD/DWN	
ISSUED	

PMI PLANAR MONOLITHICS
TITLE: FINAL ASSEMBLY
PIQ-1-SMT
SIZE B | FSCM NO. 05XQ0 | DWG NO. 27052640 | REV. A3
SCALE 16:1 | SHEET 1 OF 2

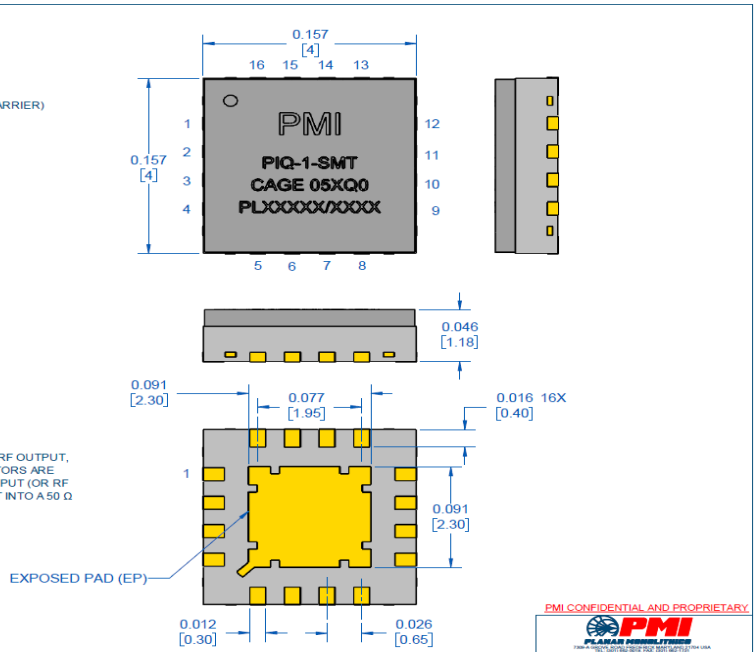
SPECIFICATIONS (PAGE 2):

- AM/AM CONVERSION: LINEAR UP TO Vp = 1080 mV
- AM/PM CONVERSION: ± 3° TYP.
- OUTPUT NOISE SPECTRAL DENSITY: -150 dBm/Hz TYP.
- NOISE FIGURE: 50 dB TYP.
- RESIDUAL PHASE NOISE: -100 dBm/Hz TYP. @ 1 KHz
  -110 dBm/Hz TYP. @ 1 MHz
- RESIDUAL AM NOISE: -80 dBm/Hz MAX. (REFERENCED TO LO LEAKAGE CARRIER)
- SNR: 55 dB TYP. (FOR BW = 1 MHz)
- EVM (RMS): 3.5% TYP. (NOT IMPAIRED)
  1% TYP. (IMPAIRED)
- MER (RMS): 30 dB (NOT IMPAIRED)
  40 dB TYP. (IMPAIRED)
- BER: 10^-4 TYP. (NOT IMPAIRED)
  10^-9 TYP. (IMPAIRED)
- ACPR: -40 dBc. TYP.
- IBW: 400 MHz MIN.
- OBW: 5.5 MHz TYP. (FOR QAM-64 BW = 6.25 MHz)
- BASEBAND MAGNITUDE FLATNESS: ± 0.5 dB (OVER 375 MHz BASEBAND BW)
- BASEBAND LINEARITY: ±1 dB MAX. UP TO 1.08 Vp
- GROUP DELAY: TBD
- GROUP DELAY RIPPLE: TBD
- I/Q SKEW: TBD
- CMRR: TBD
- TRANSIENT RESPONSE: TBD
- VCC: 4V ± 5%
  BYPASS CAPACITORS RECOMMENDED
- CURRENT: 250 mA TYP.
- DC POWER DISSIPATION (W): 1.2 W MAX.
- PACKAGE SIZE: 0.157" x 0.157" x 0.047"
  [4.0 mm x 4.0 mm x 1.2 mm]
- EXPOSED PAD (EP) SIZE: 0.091 x 0.091"
  [2.3 mm x 2.3 mm]
- JEDEC OUTLINE: MO-220 (VGGC-2)
- ADDITIONAL NOTES: FOR SINGLE ENDED LO DRIVE OR SINGLE ENDED RF OUTPUT, USE BROADBAND BALUNS (DC BLOCKING CAPACITORS ARE STILL REQUIRED). ALTERNATIVELY, USE ONE LO INPUT (OR RF OUTPUT) WHILE TERMINATING THE UNUSED INPUT INTO A 50 Ω LOAD (DC BLOCKING IS STILL REQUIRED)
  HEAT SINKING REQUIRED
  MAX REFLOW TEMPERATURE: 245°C

ENVIRONMENTAL RATINGS:

- TEMPERATURE: -55°C TO +85°C (OPERATING)
  -64°C TO +125°C (STORAGE)
- HUMIDITY: MIL-STD-202, METHOD 103B COND. B
- SHOCK: MIL-STD-202, METHOD 213B COND. B
- VIBRATION: MIL-STD-202, METHOD 204D COND. B
- ALTITUDE: MIL-STD-202, METHOD 105C COND. B
- TEMPERATURE CYCLE: MIL-STD-202, METHOD 107D COND. A

NOTE: SPECIFICATIONS WILL VARY OVER TEMPERATURE
NOTE: THE ABOVE SPECIFICATIONS ARE SUBJECT TO CHANGE OR REVISION



PMI CONFIDENTIAL AND PROPRIETARY

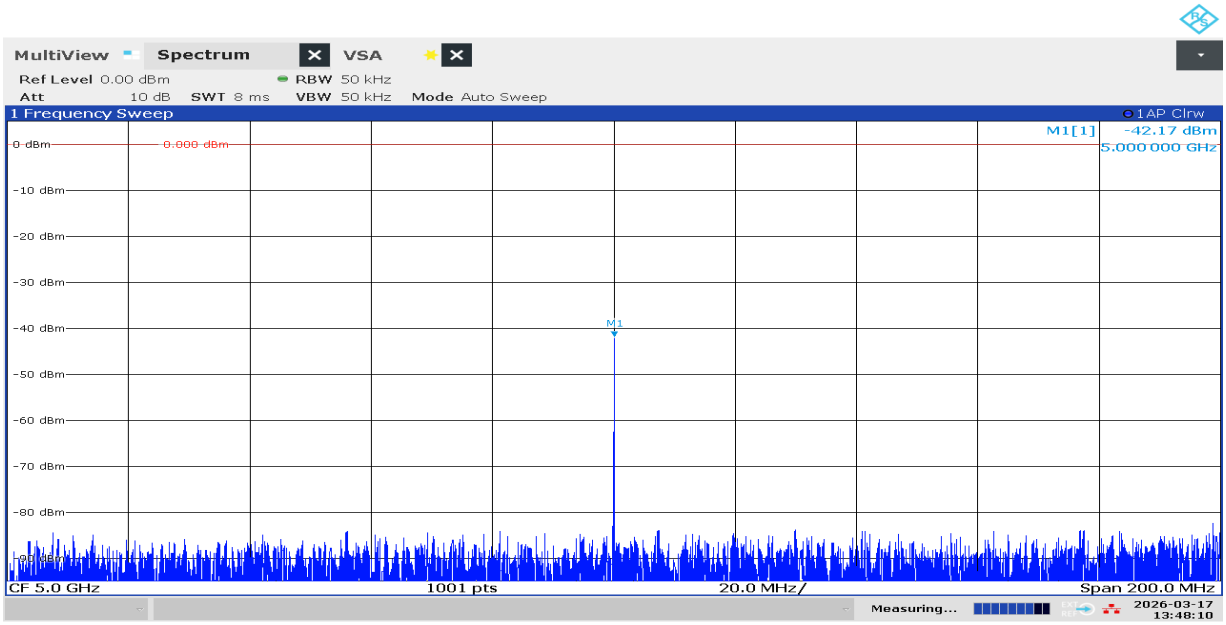
PMI PLANAR MONOLITHICS
TITLE: OUTLINE
PIQ-1-SMT
SIZE B | FSCM NO. 05XQ0 | DWG NO. 27052640 | REV. A3
SCALE 16:1 | SHEET 2 OF 2

Test Item No.	Parameters	Specified Value	Measured Value @+25°C
1	LO Frequency Range:	100 MHz TO 20 GHz	**100 MHz TO 20 GHz**
2	LO Input Power:	-10 TO 10 dBm	**0 dBm TYP.**
3	RF Frequency Range:	100 MHz TO 20 GHz	**100 MHz TO 20 GHz**
4	RF Output Power:	-12 dBm TYP.	**-12.6 dBm**
5	Baseband I/Q Bandwidth:	10 GHz (DC TO 10 GHz)	**10 GHz**
6	I/Q Common-mode Bias:	1.08 V ± 50mV	**1.08 V**
7	Carrier (LO) Leakage	-40 dBc TYP.	**-42.1 dBc**
8	Voltage Conversion Gain	-20 dB TYP.	**-22.7 dB**
9	I/Q Gain Imbalance	0.5 dB TYP.	**0.61 dB**
10	Quadrature Phase Error:	1.0° MAX.	**0.1°**
11	Sideband Suppression (SBS):	30 dB TYP.	**-22.7 dB**
12	LO+, LO- VSWR:	2.5:1 TYP.	**1.65:1 AVG.**
13	RF-, RF+ VSWR:	2.5:1 TYP.	**1.89:1 AVG.**
14	I, Q VSWR:	2:1 TYP.	**1.58:1 AVG.**
15	RF-LO Isolation:	-50 dBc TYP.	**-49.2 dBc**

Test Item No.	Parameters	Specified Value	Measured Value @+25°C
16	LO-Baseband Isolation:	-45 dBc TYP.	**-47.2 dBc**
17	RF-Baseband Isolation:	-40 dBc TYP.	**-41.6 dBc**
18	I-Q Crosstalk:	-40 dBc TYP.	**-40.6 dBc**
19	P1dB:	-5 dBm TYP.	**-6.6 dBm**
20	IP3:	5 dBm TYP.	**3.3 dBm**
21	IP2:	45 dBm TYP.	**43.8 dBm**
22	Harmonic Distortion:	2nd harmonic: -35 dBc TYP. 3rd harmonic: -20 dBc TYP. 4th harmonic: -50 dBc TYP. 5th harmonic:-35 dBc TYP.	**2nd harmonic: -35.4 dBc TYP.** **3rd harmonic: -21.6 dBc TYP.** **4th harmonic: -51.9 dBc TYP.** **5th harmonic:-33.5 dBc TYP.**
23	Spurious Emissions:	-30 dBm TYP.	**-28 dBm**
24	SFDR (Spurious-Free Dynamic Range):	20 dB TYP.	**21.6 dB**
25	AM/AM Conversion:	LINEAR UP TO Vp = 1080 mV	**LINEAR UP TO Vp = 1080 mV**
26	AM/PM Conversion:	± 3° TYP.	**2.3°**
27	Output Noise Spectral Density:	-150 dBm/Hz	**-148 dBm/Hz**
28	Noise Figure:	50 dB TYP.	**48.7 dB**
29	Residual Phase Noise:	-100 dBm/Hz (@ 1 kHz) TYP. -110 dBm/Hz (@ 1 MHz) TYP.	**-97 dBm/Hz (1 KHz)** **-110 dBm/Hz (1 MHz)**
30	Residual AM Noise:	-80 dBm/Hz MAX.	**-82 dBm/Hz MAX.**
31	SNR:	55 dB TYP.	**53.5 dB**

Test Item No.	Parameters	Specified Value	Measured Value @+25°C
32	EVM (Error Vector Magnitude):	3.5% TYP. (not impaired) 1% TYP. (impaired)	**3.69 % (not impaired)** **1.05 % (impaired)**
33	MER (Modulation Error Ratio):	30 dB TYP. (not impaired) 40 dB TYP. (impaired)	**28.65 dB (not impaired)** **39.55 dB (impaired)**
34	BER (Bit Error Rate):	10^-4 TYP. (not impaired) 10^-9 TYP. (impaired)	**~10^-4 (not impared)** **~10^-9 (impaired)**
35	ACPR (Adjacent Channel Power Ratio):	-40 dBc TYP.	**-42.8 dBc**
36	IBW (Instantaneous bandwidth):	400 MHz. MIN.	**400 MHz. MIN.**
37	OBW (Occupied Bandwidth):	5.5 MHz (for QAM64 @ 5 MHz Symbol Rate)	**5.59 MHz**
38	Baseband magnitude flatness:	±0.5 dB TYP. (Over 375 MHz Baseband)	**±0.5 dB**
39	Baseband Linearity:	1 dB MAX. (Up to 1.08 BB Vp) 4 dB MAX. (At 2.00 BB Vp - max drive)	**1 dB UP TO 1.08 Vp** **3.6 dB @ MAX DRIVE**
40	Group Delay:	TBD	**TBD**
41	Group Delay Ripple:	TBD	**TBD**
42	I/Q Skew:	TBD	**TBD**
43	CMRR:	TBD	**TBD**
44	Transient Response:	TBD	**TBD**
45	I/Q DC Range:	0 TO 3.3 V	**0 TO 3.3 V**
46	VCC:	4V ± 5%	**4.01V**
47	Current:	250 mA TYP.	**230 mA**

LO Leakage = -42.17 dBc (Carrier = 5 GHz)



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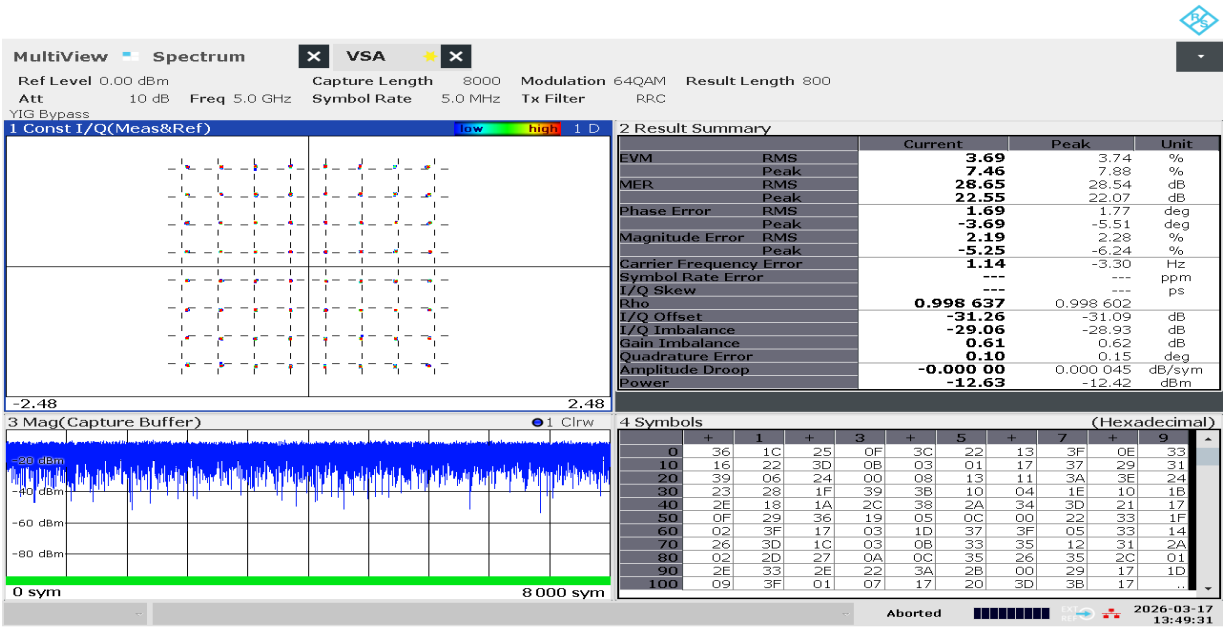
Constellation Diagram (QAM-64 @ 5 MSyb, Carrier = 5 GHz, not impaired)



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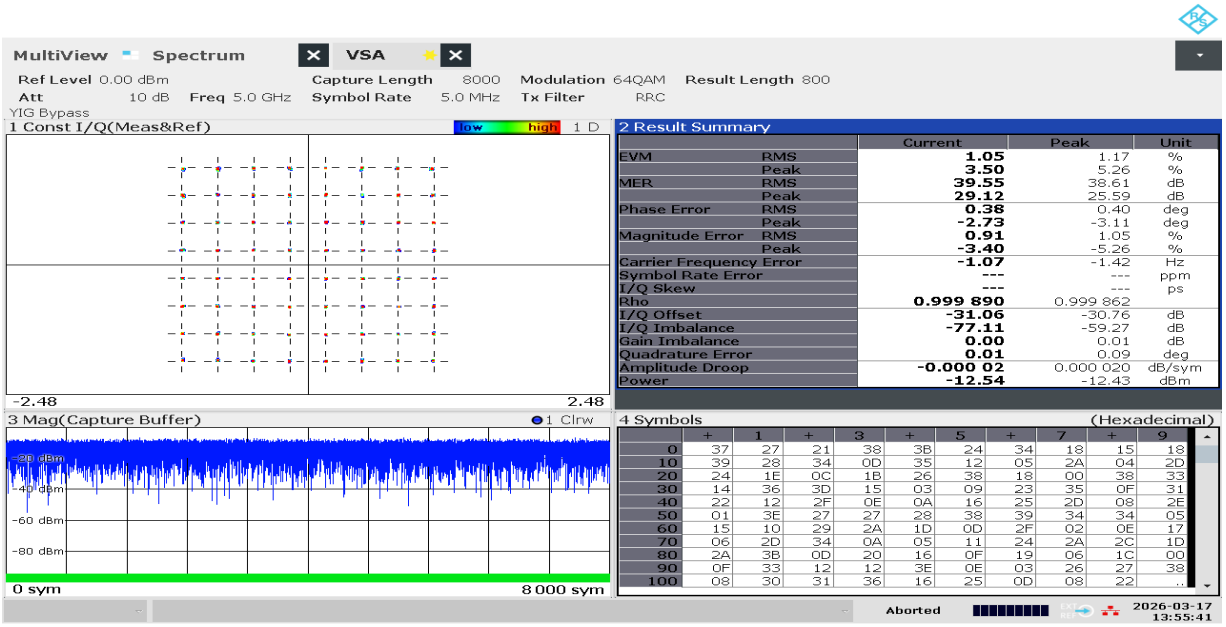
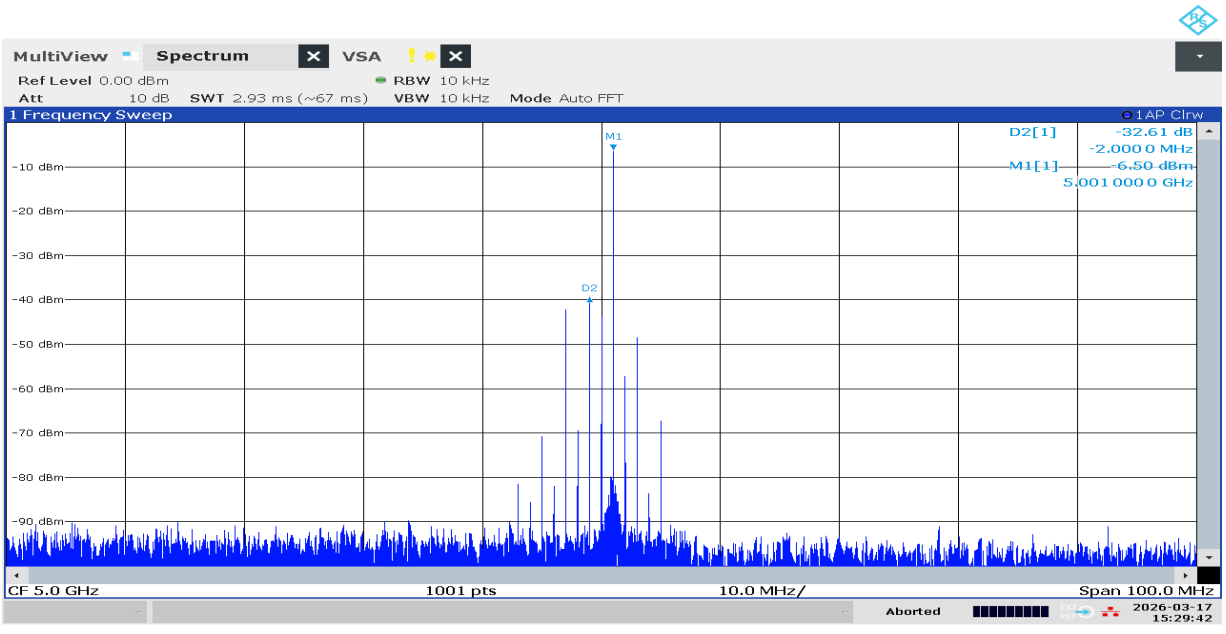
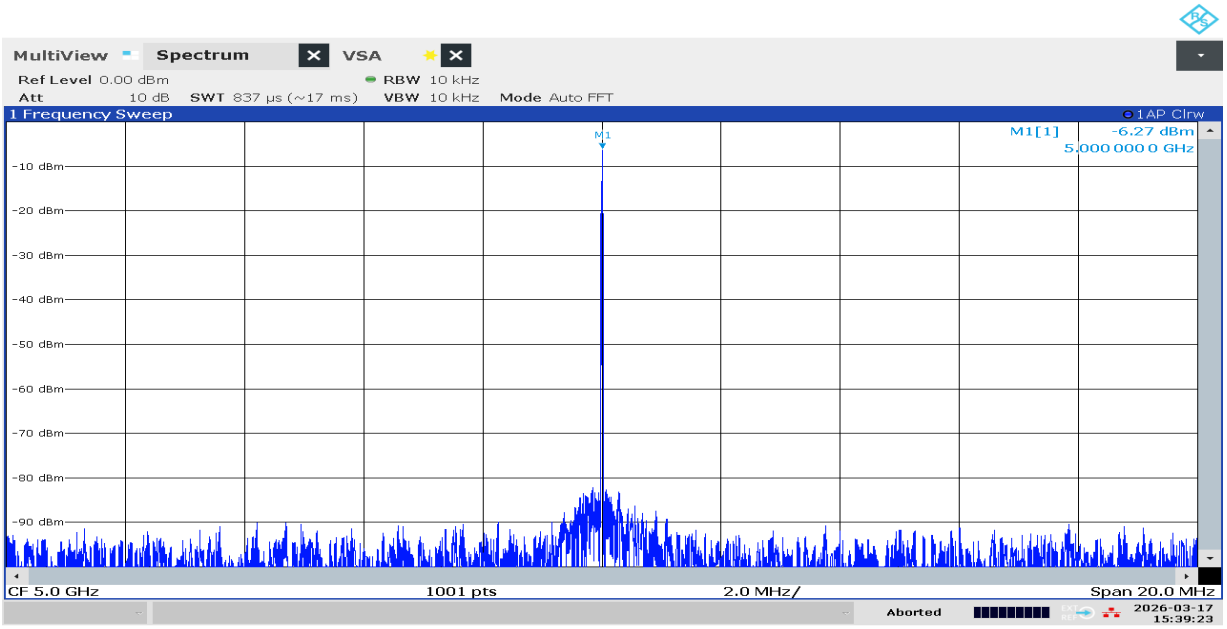
Constellation Diagram (QAM-64 @ 5 MSyb, Carrier = 5 GHz, impaired)



Sideband Suppression (SBS) = -22.7 dB



DC-coupled I/Q @ 5 GHz Carrier



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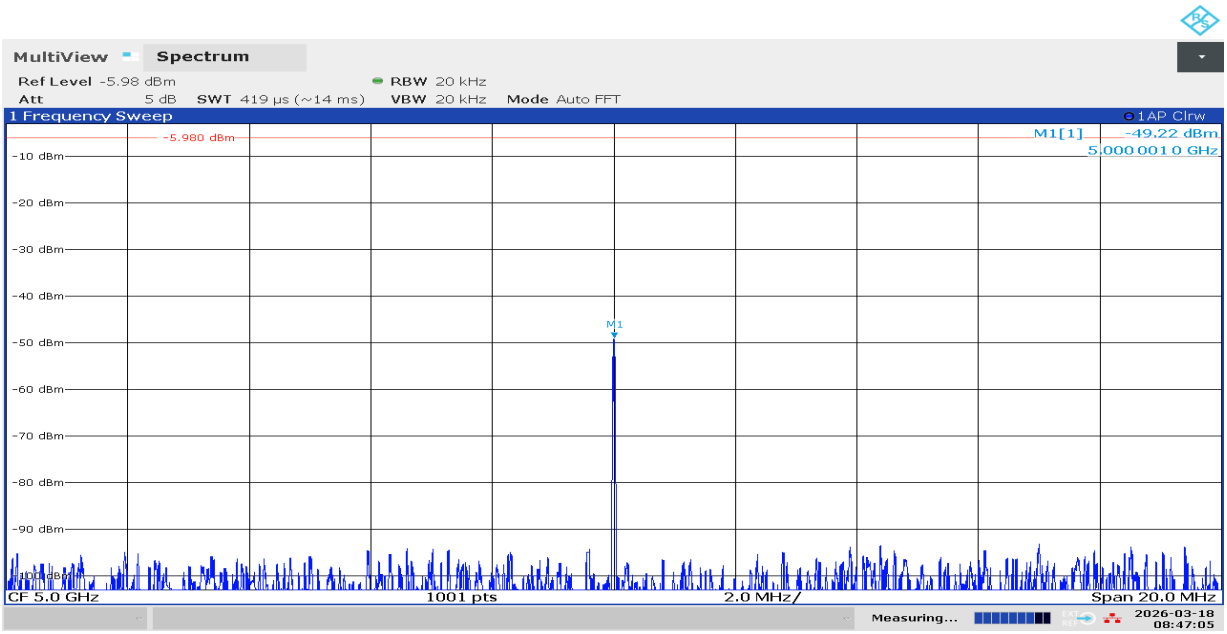
RF-LO Isolation = -49.22 dBc



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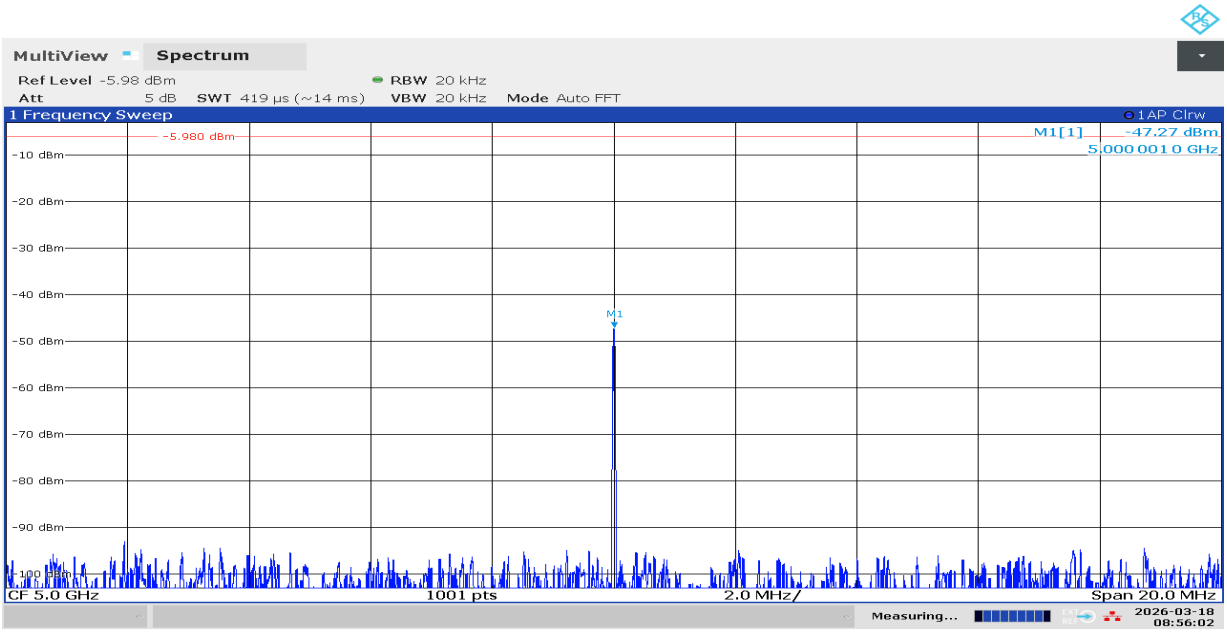
LO-Baseband Isolation = -47.27 dBc



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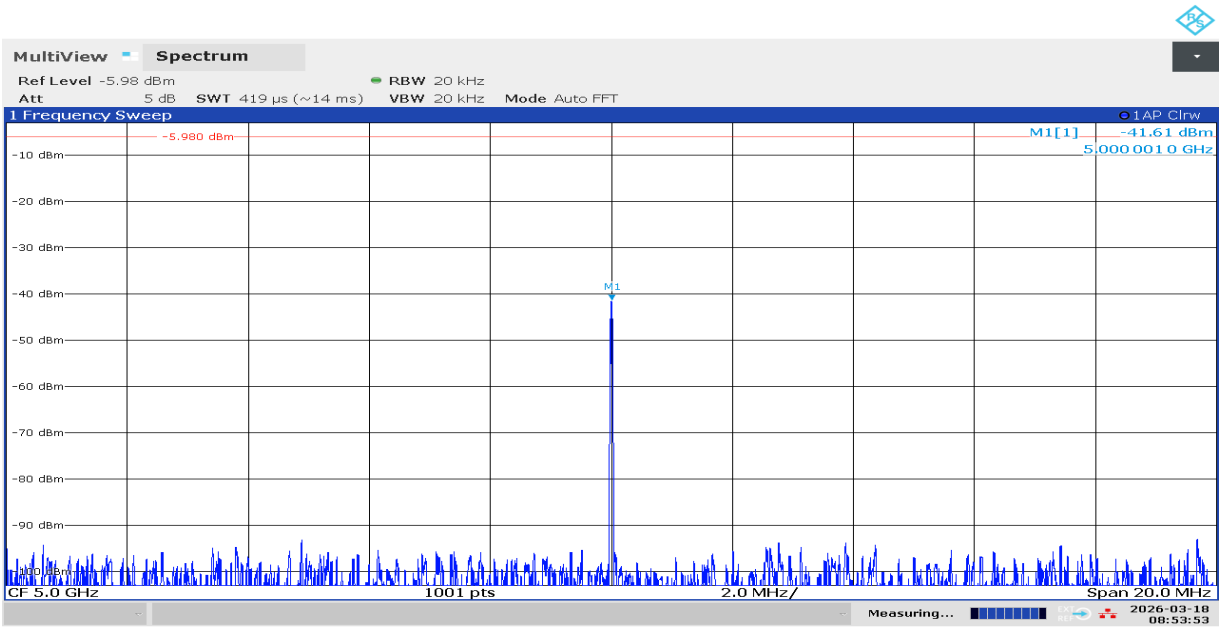
RF-Baseband Isolation = -41.61 dBc



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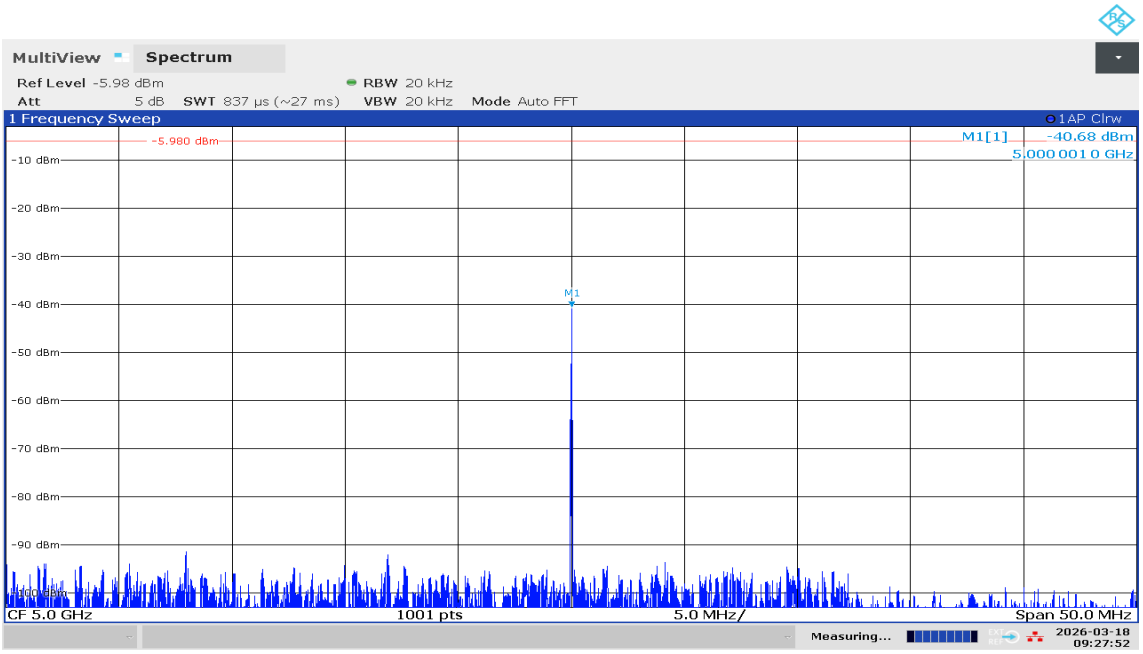
I-Q Crosstalk = -40.68 dBc



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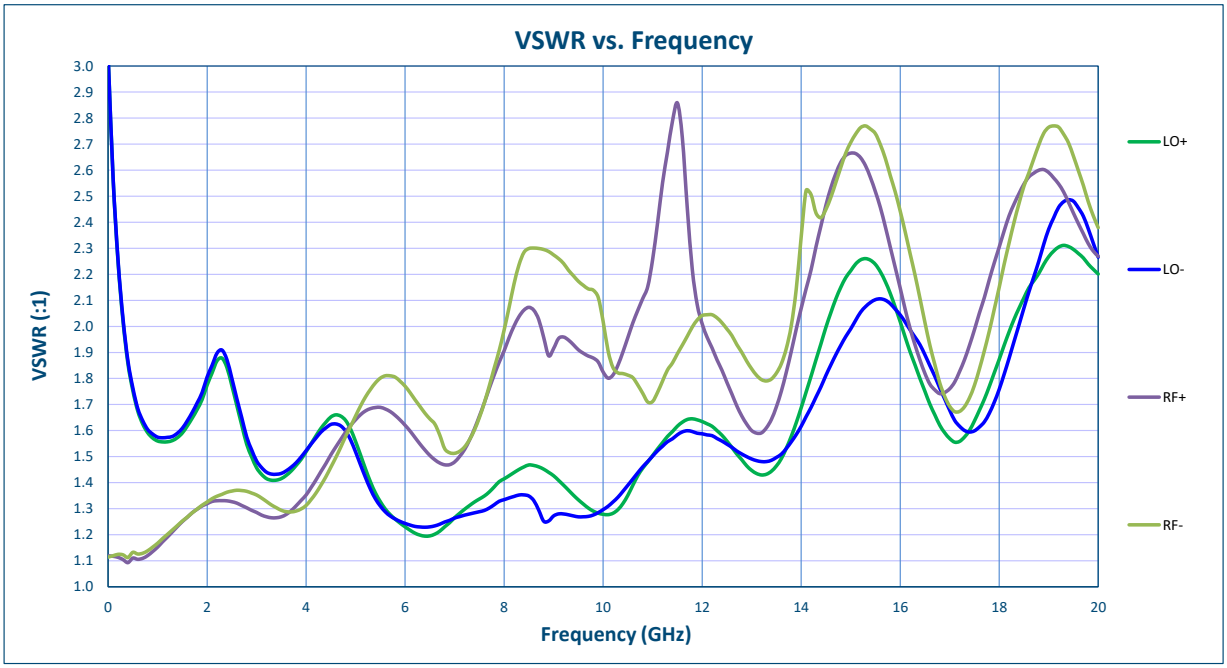
LO, RF VSWR



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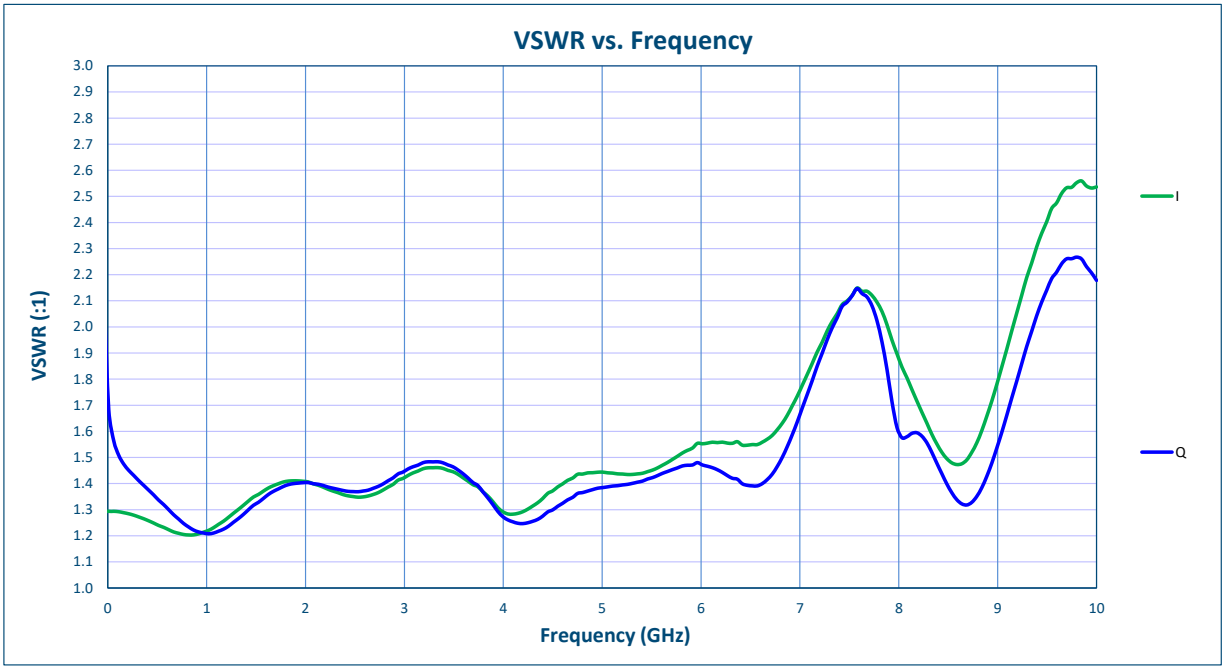
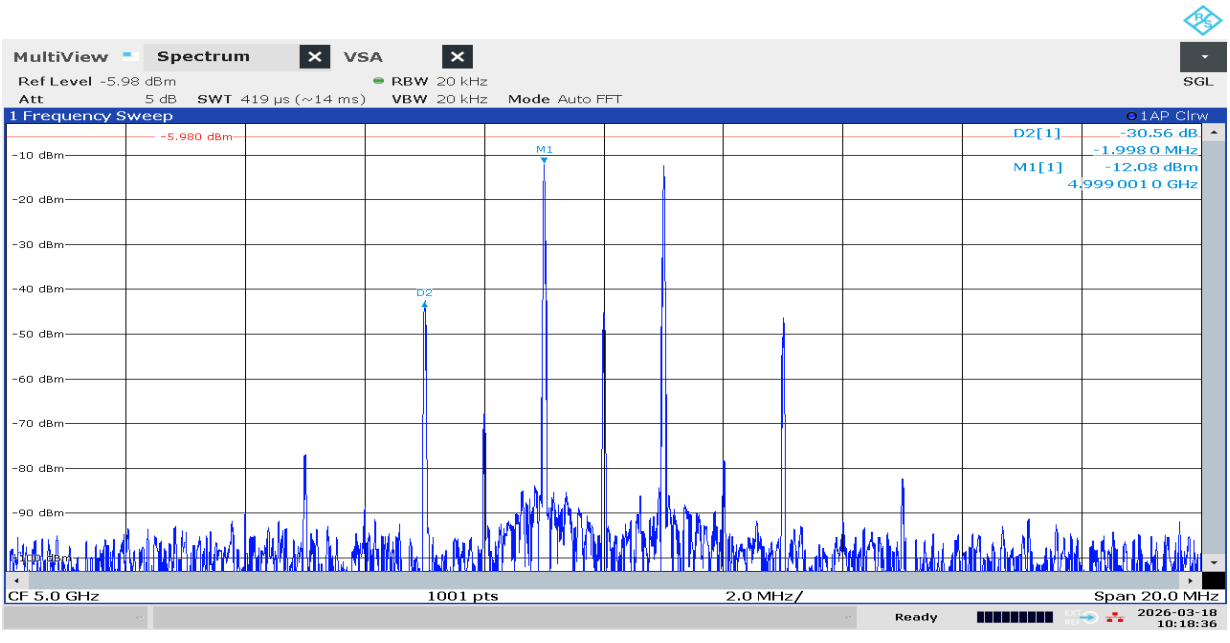
I,Q VSWR



IP3 @ +3.3 dBm



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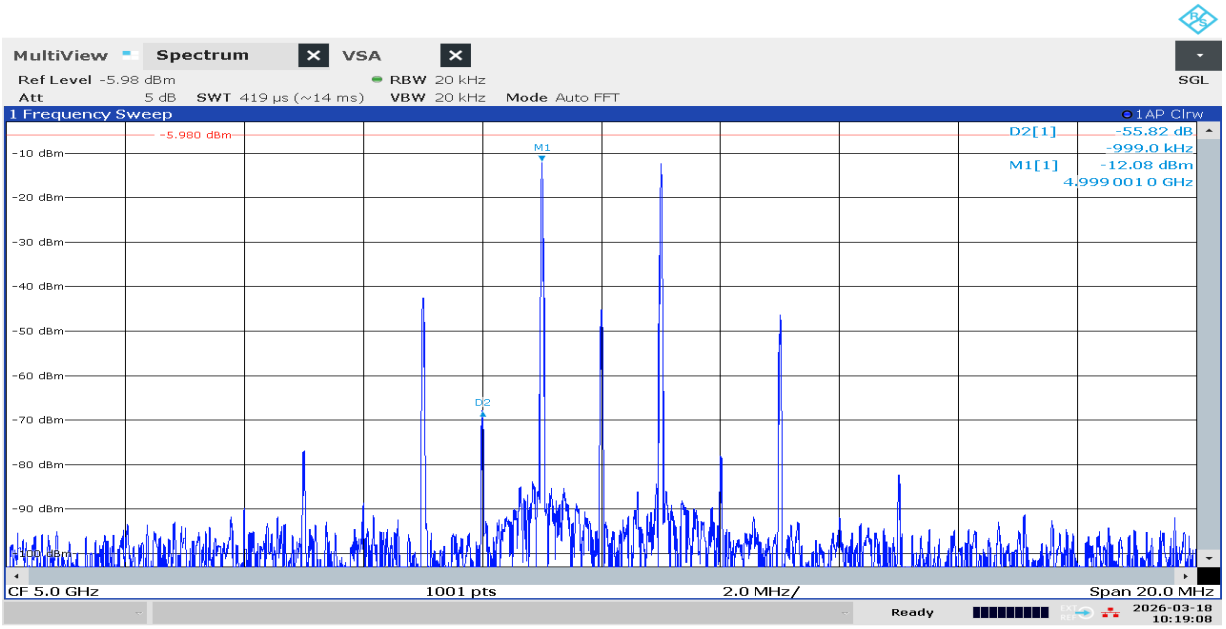
IP2 @ +43.8 dBm



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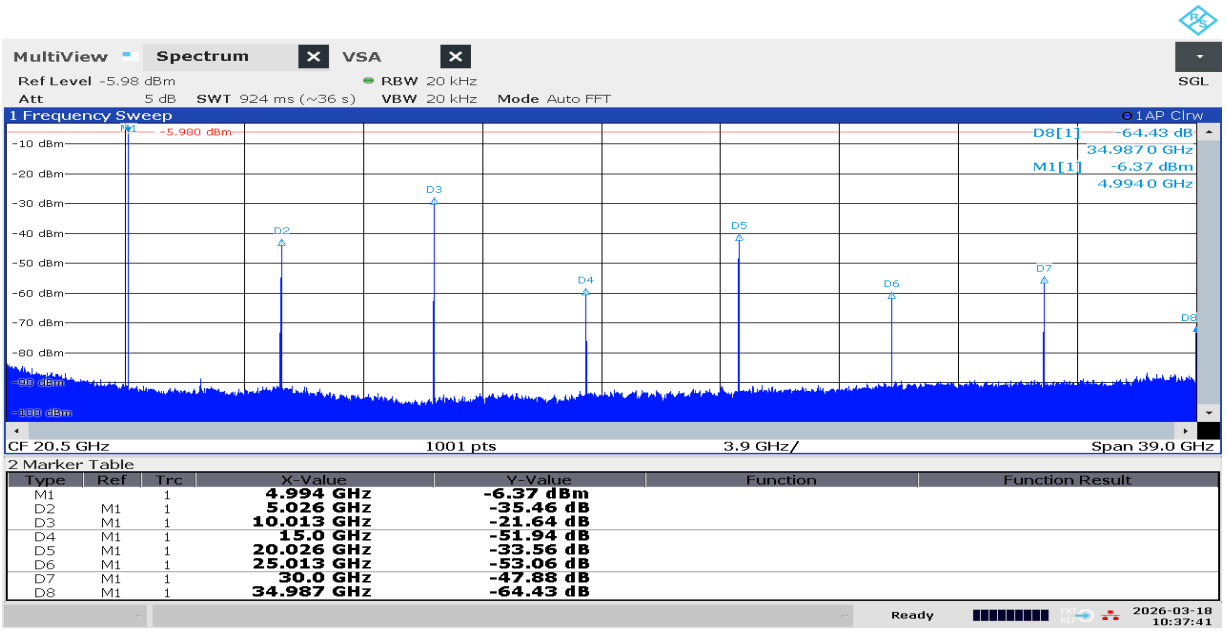
Harmonic Distortion



2 Marker Table

Type	Ref	Trc	X-Value	Y-Value	Function	Function Result
M1		1	4.994 GHz	-6.37 dBm		
D2	M1	1	5.026 GHz	-35.46 dB		
D3	M1	1	10.013 GHz	-21.64 dB		
D4	M1	1	15.0 GHz	-51.94 dB		
D5	M1	1	20.026 GHz	-33.56 dB		
D6	M1	1	25.013 GHz	-53.06 dB		
D7	M1	1	30.0 GHz	-47.88 dB		
D8	M1	1	34.987 GHz	-64.43 dB		

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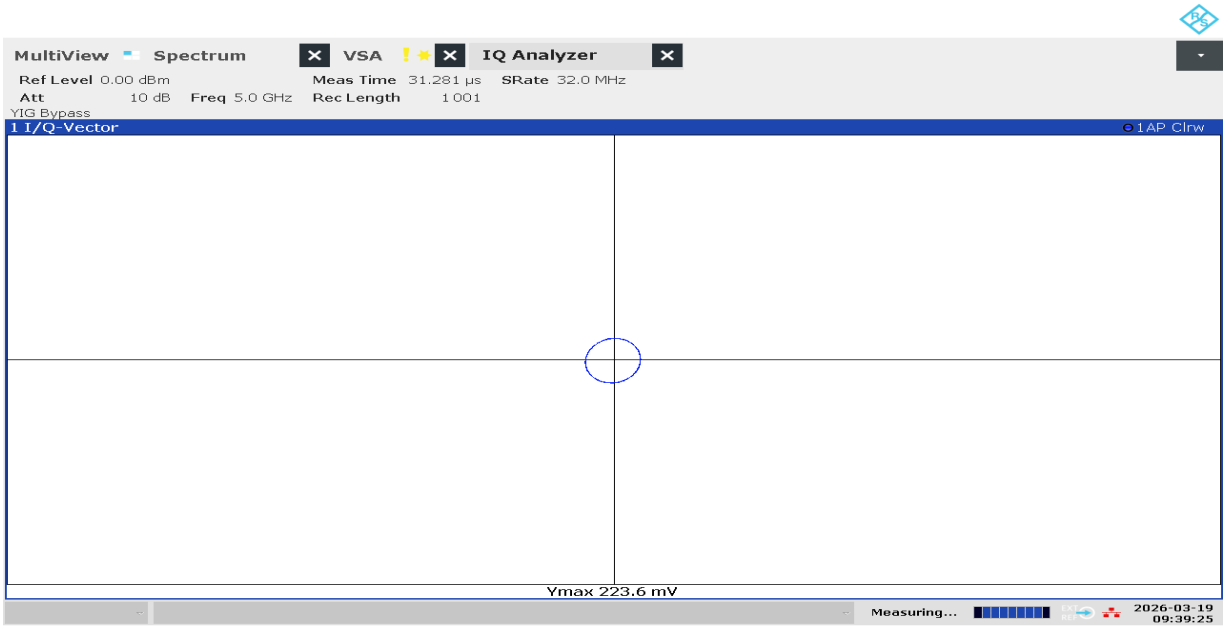
IQ Circle with Vp = 200 mV Baseband centered at 1.08 V



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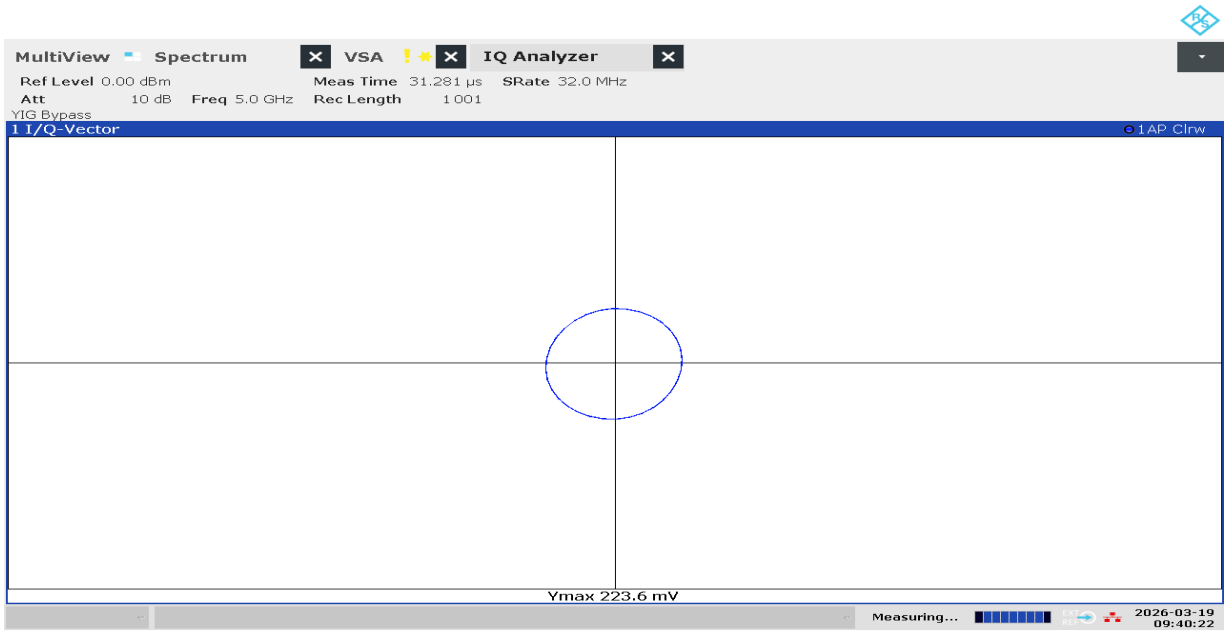
IQ Circle with Vp = 500 mV Baseband centered at 1.08 V



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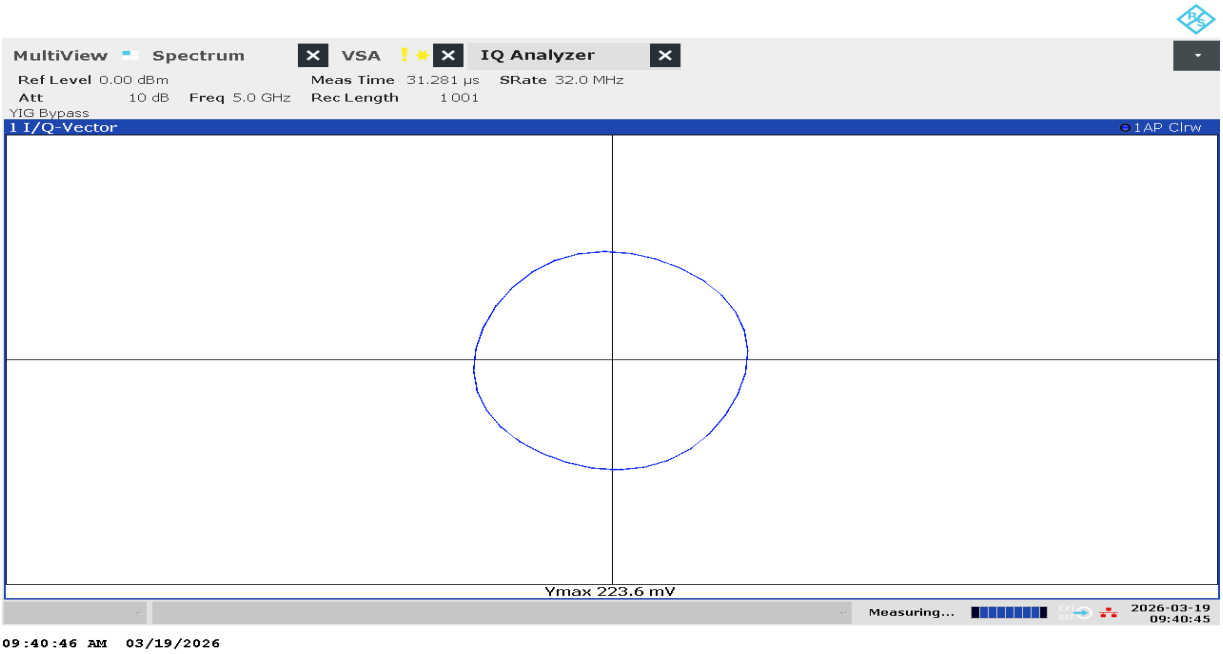
IQ Circle with Vp = 1080 mV Baseband centered at 1.08 V



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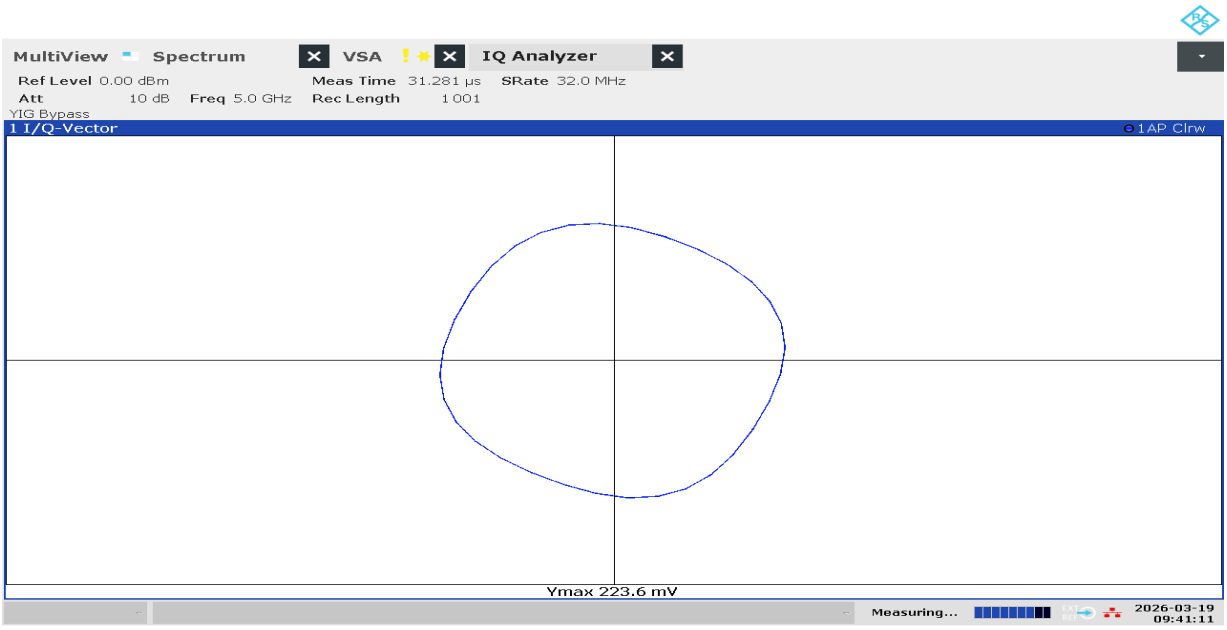
IQ Circle with Vp = 1500 mV Baseband centered at 1.08 V



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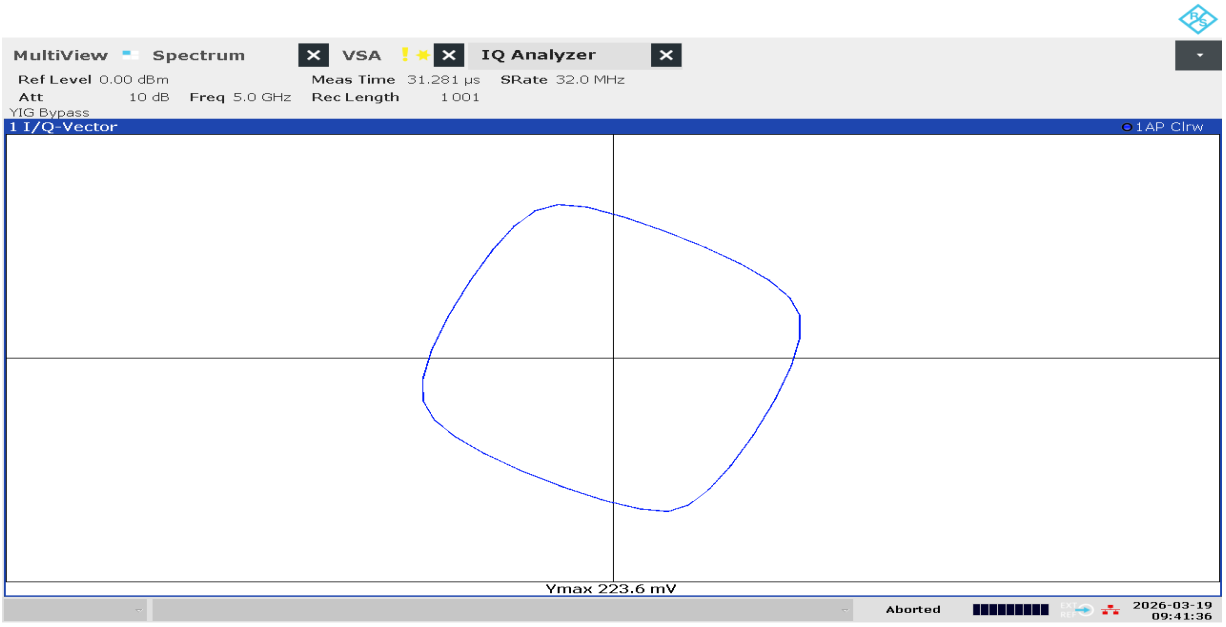
IQ Circle with Vp = 2000 mV Baseband centered at 1.08 V



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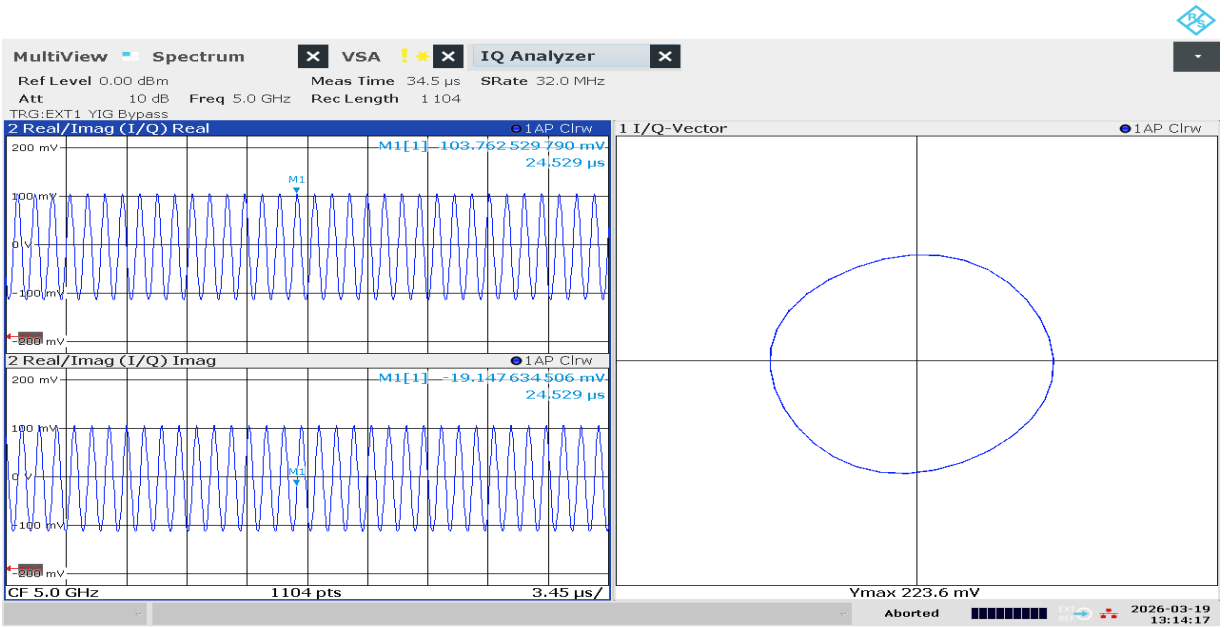
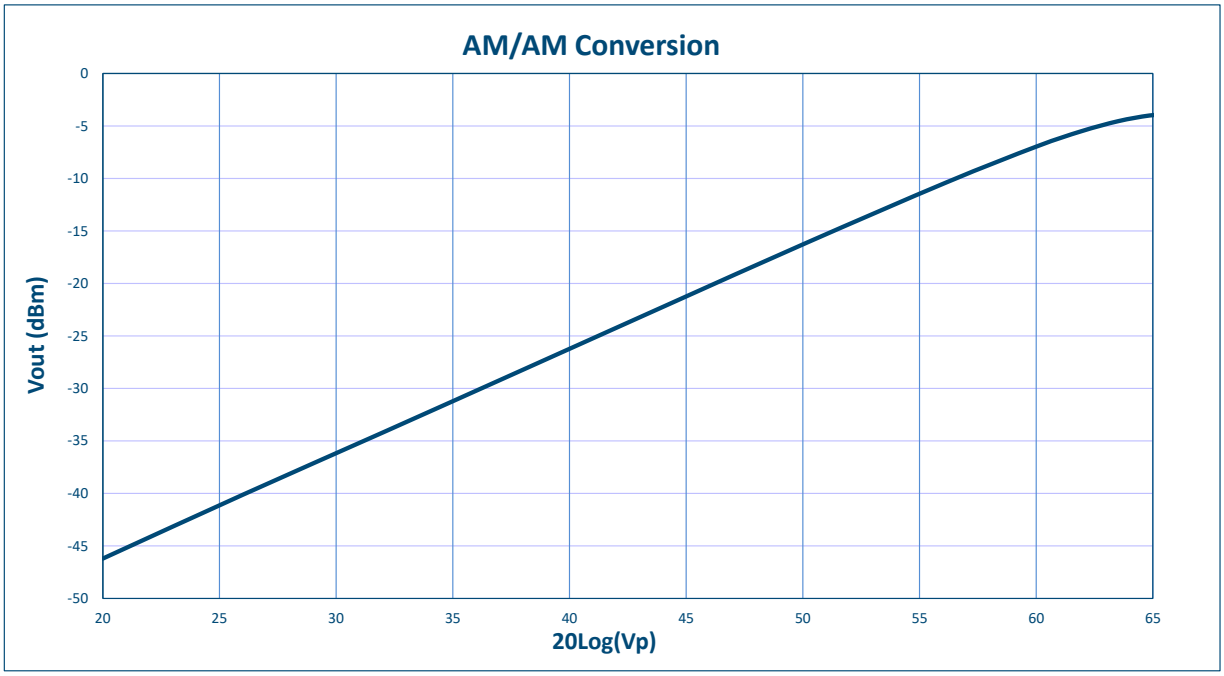
IQ Real/Imag with Vp = 1080 mV Baseband centered at 1.08 V

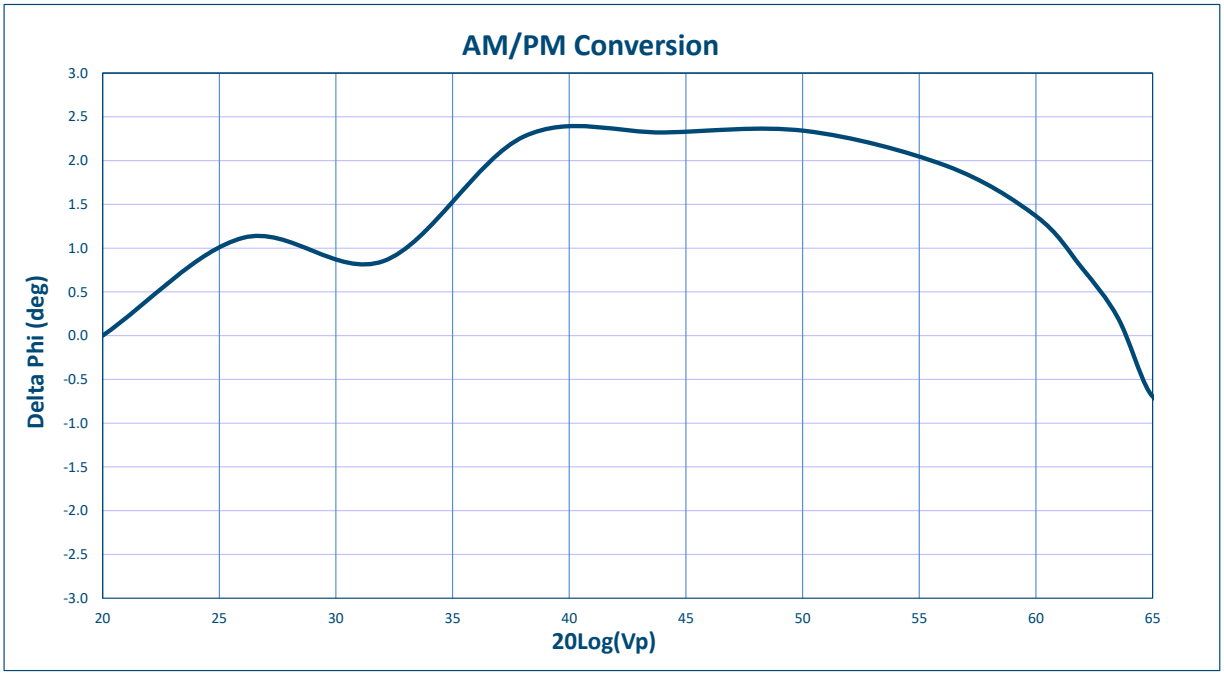


01:14:18 PM 03/19/2026

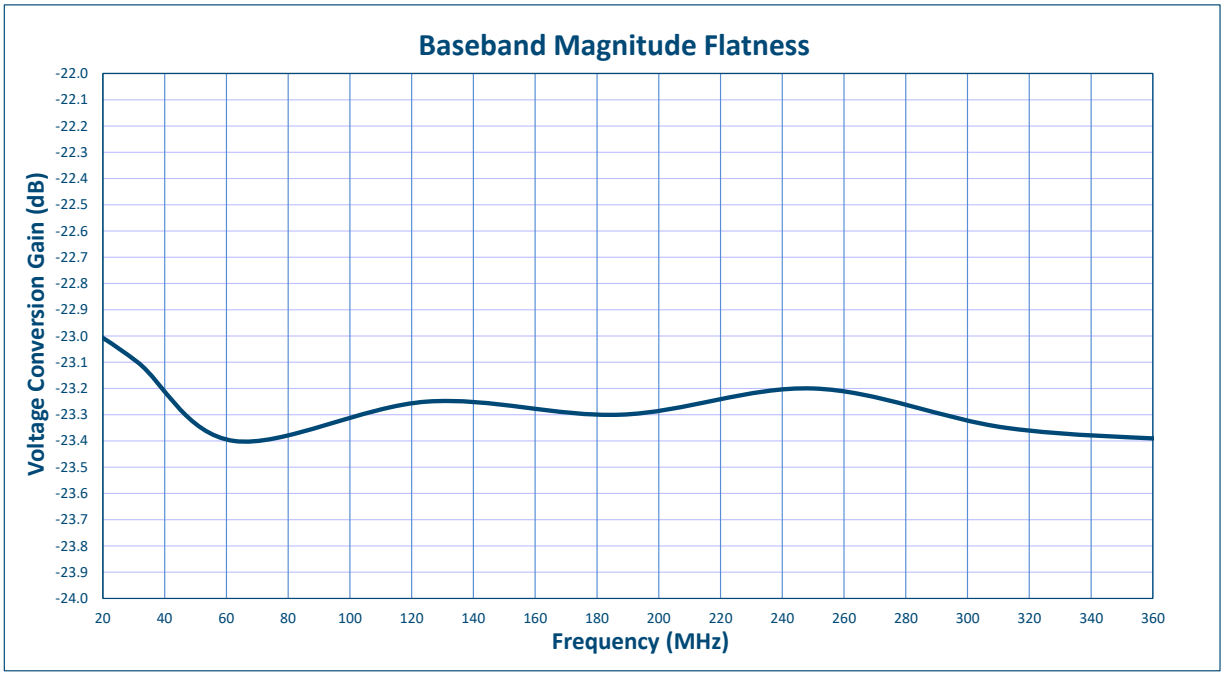
AM/AM Conversion



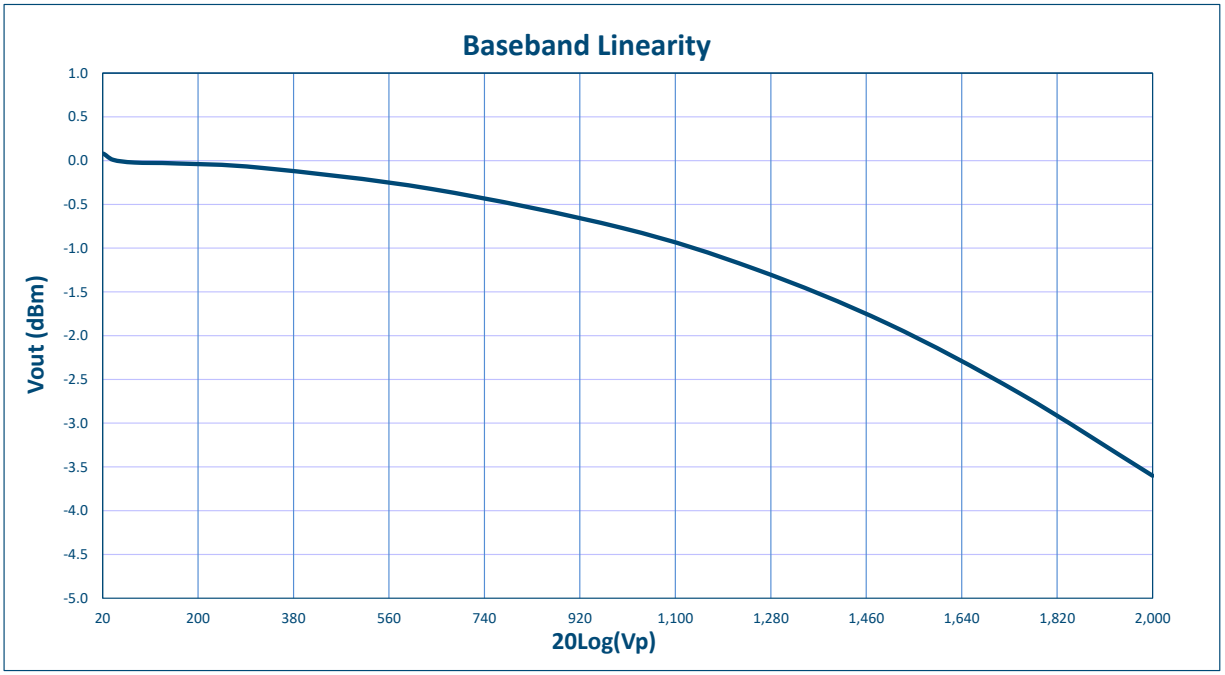
AM/PM Conversion - 2.3° (peak)



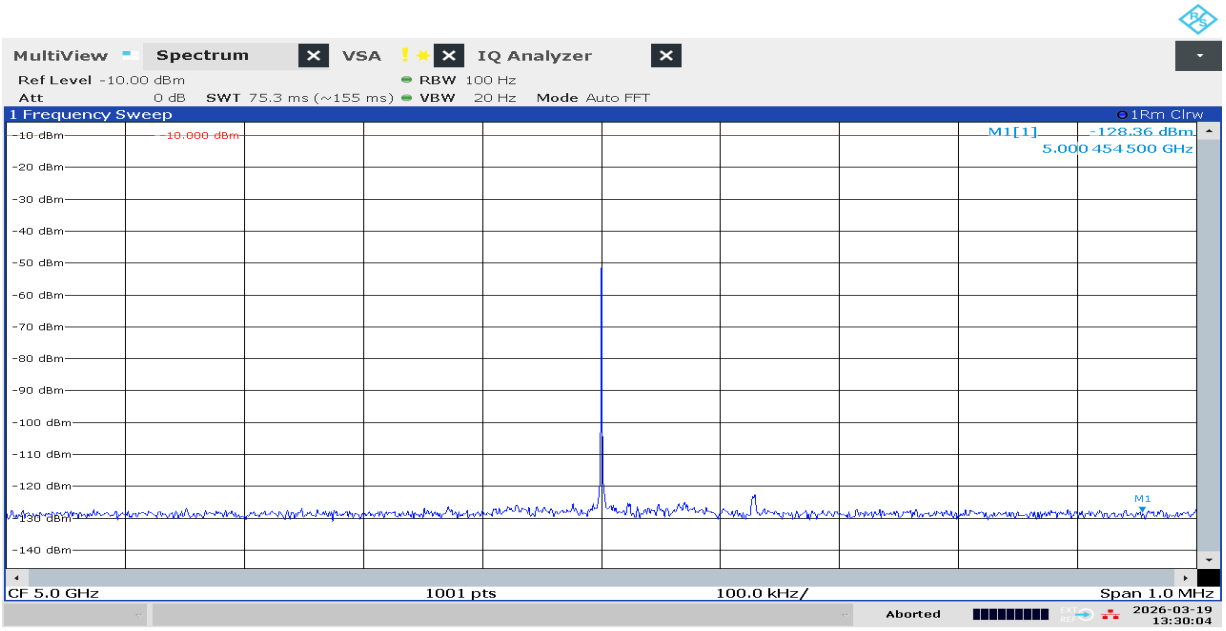
Baseband Magnitude Flatness ±0.5dB



Baseband Linearity: 1 dB MAX. up to 1.08 Vp; 3.6 dB MAX. at highest drive

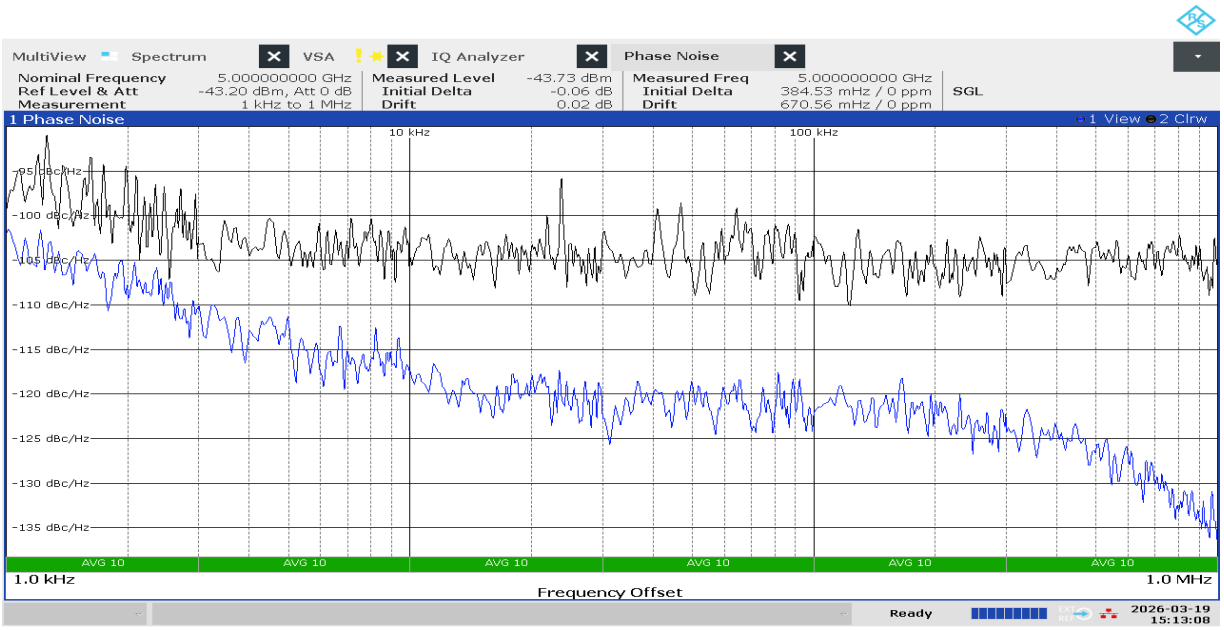


Output Noise Spectral Density = -148.36 dBm/Hz



01:30:05 PM 03/19/2026

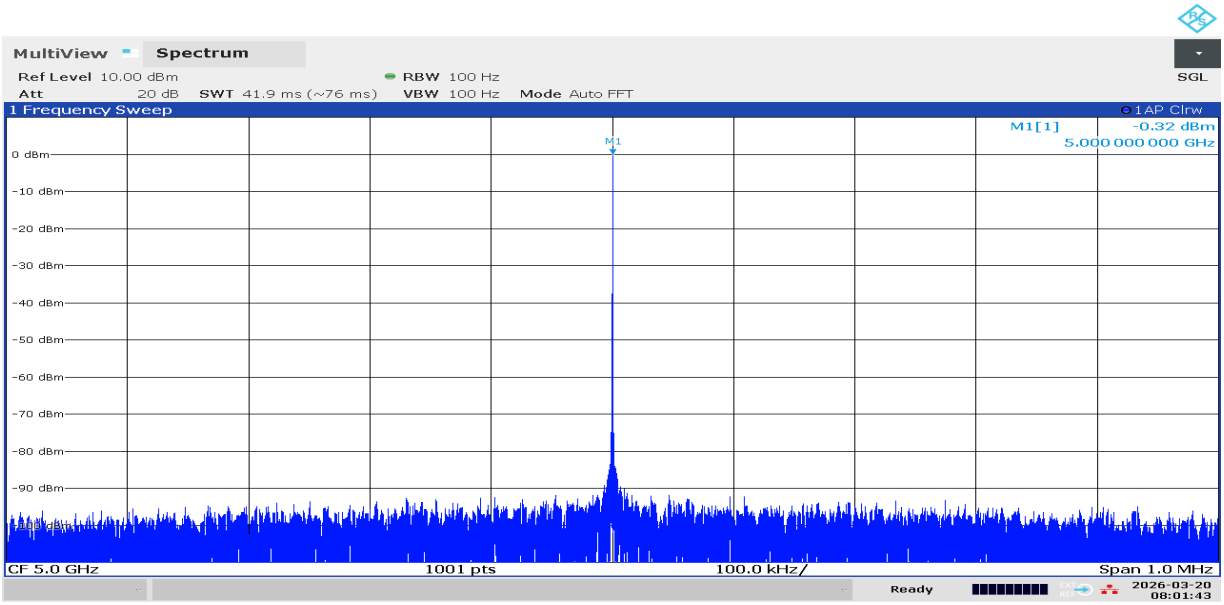
Residual Phase Noise @ -97 dBc/Hz (1 KHz), -110 dBc/Hz (1 MHz)



03:13:09 PM 03/19/2026

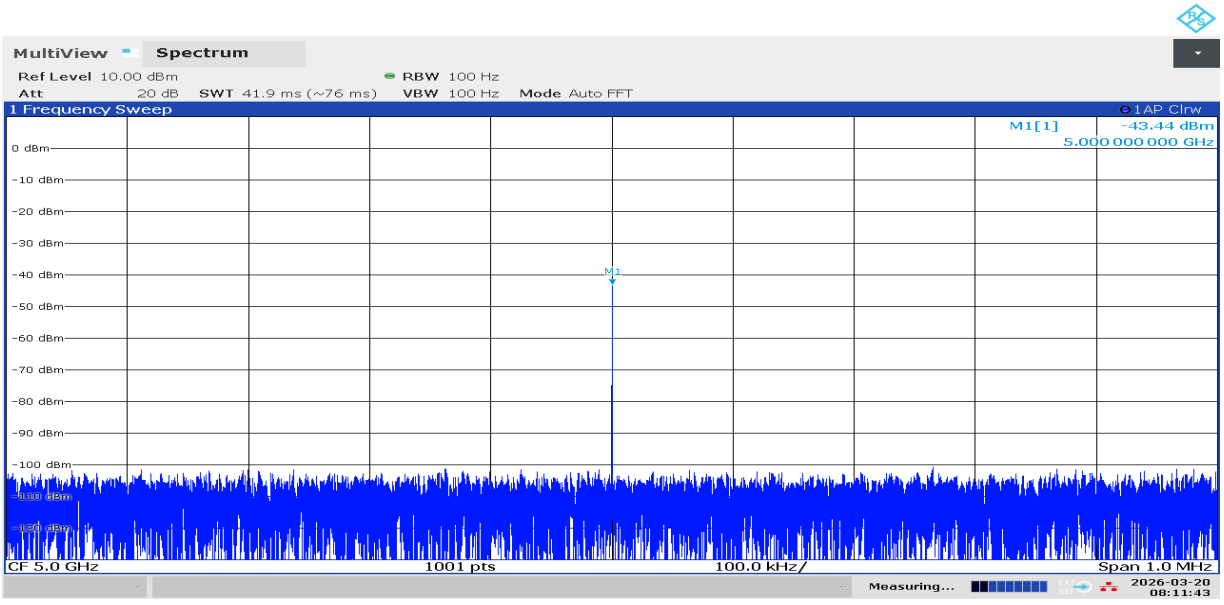
Residual AM Noise @ -82 dBc/Hz NAX. (Referenced to the residual LO leakage carrier at output)

LO:



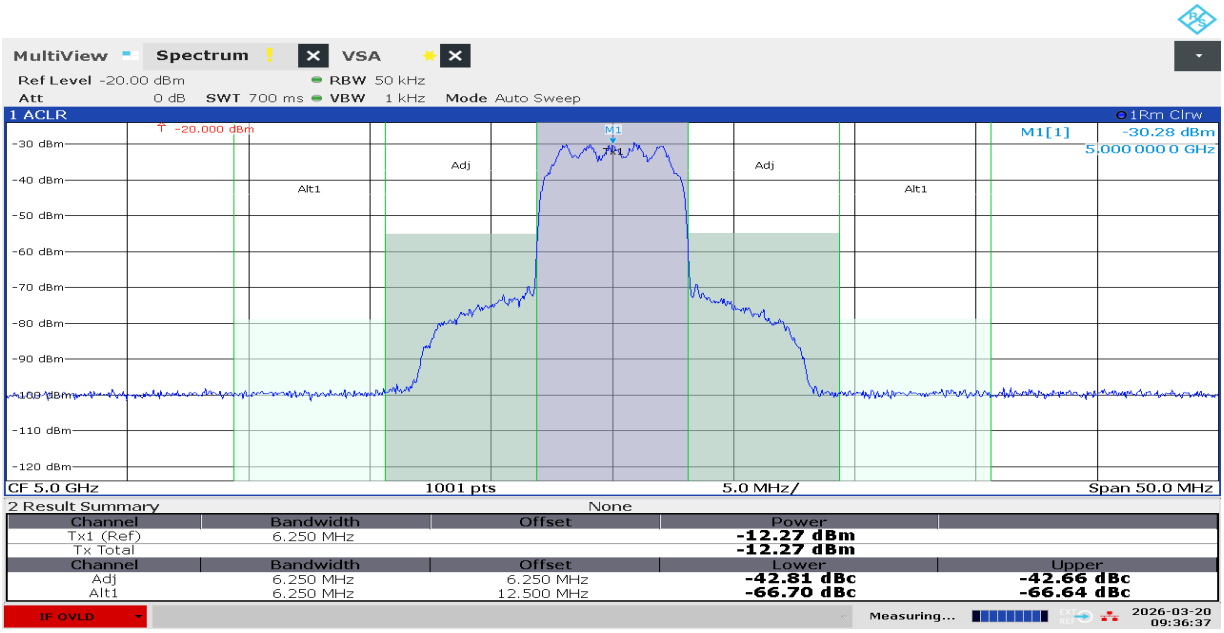
08:01:44 AM 03/20/2026

Output:



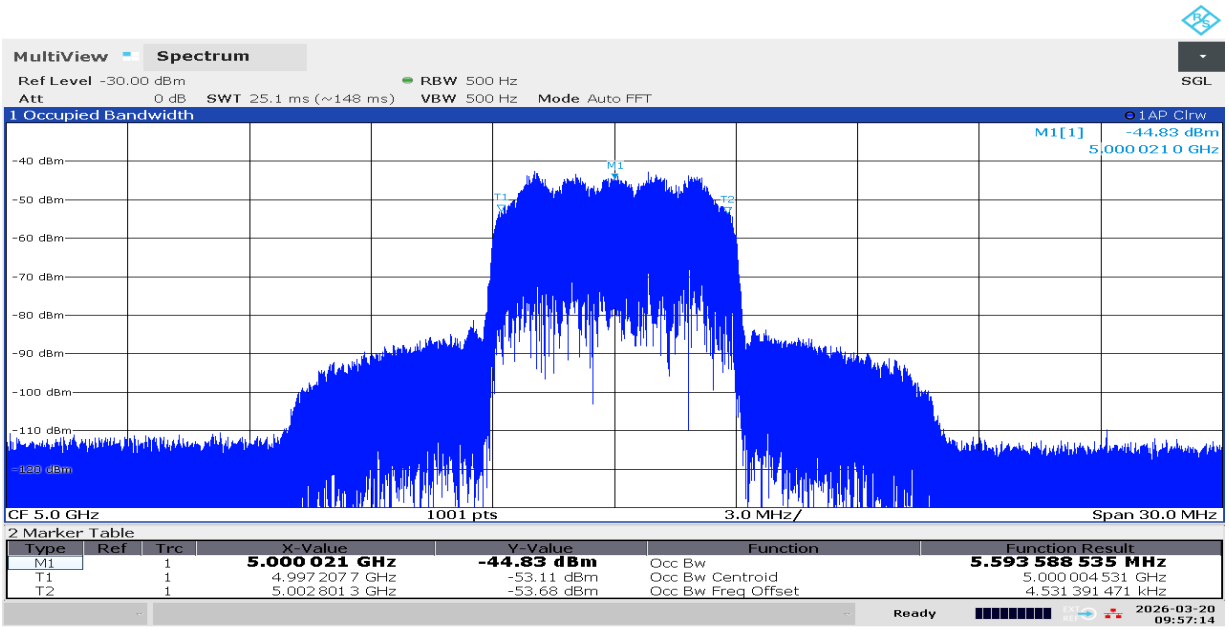
08:11:43 AM 03/20/2026

Adjacent Channel Power Ratio (ACPR) @ -42.8 dBc (for roll-off factor 0.25, BW = 6.25 MHz)



09:36:37 AM 03/20/2026

Occupied Bandwidth (OBW) = 5.59 MHz



09:57:15 AM 03/20/2026