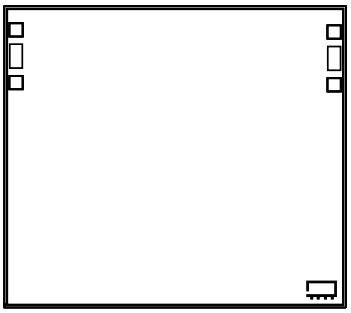
MMIC DIE

X3 Frequency Multiplier CY3-223-D+

50Ω Output 10 to 22 GHz

THE BIG DEAL

- Ultra-wideband, output from 10 to 22 GHz
- Wide input power range, +12 to +18 dBm
- Low Conversion Loss, 17 dB Typ.
- Good Fundamental and Harmonic Suppression: F1 > +34 dBc; F2 > +45 dBc; F4 > +50 dBc.



+RoHS Compliant
The +Suffix identifies RoHS Compliance.
See our website for methodologies and qualifications

SEE ORDERING INFORMATION ON THE LAST PAGE

APPLICATIONS

- 5G MIMO and Back Haul Radio Systems
- Satellite Communications
- Test and Measurement Equipment
- Radar, EW, and ECM Defense Systems

PRODUCT OVERVIEW

Mini-Circuits' CY3-223-D+ is an ultra-wideband MMIC Frequency Tripler, converting input frequencies from 3.33 to 7.33 GHz into output frequencies from 10 to 22 GHz. Its wide output range makes this model suitable for broadband systems as well as a wide variety of narrow-band applications. The CY3-223-D+ die utilizes GaAs HBT technology and is suitable for chip and wire assemblies.

KEY FEATURES

Feature	Advantages
Broadband, 10 to 22 GHz output	With an output frequency range spanning 10 to 22 GHz, this multiplier supports broadband applications such as defense and instrumentation as well as a wide range of narrowband system requirements including 5G.
Excellent fundamental and harmonic suppression: • F1, +30 dBc • F2, +45 dBc • F4, +50 dBc	Reduces spurious signals and the need for additional filtering.
Unpackaged Die	Enable user to integrate it directly into hybrids.
Wide input power range, +12 to +18 dBm	Wide input power signal range accommodates different input signal levels while still maintaining a low Conversion Loss.

REV. A
ECO-018288
CY3-223-D+
MCL NY
230711

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ELECTRICAL SPECIFICATIONS[1] AT 25°C AND Zo = 50Ω, UNLESS NOTED OTHERWISE

Parameter		Condition (GHz)	RF Input = +12 dBm Min.	Typ.	Max.	Unit
Multiplication Factor				3		
Frequency Range, Input (F1)			3.33		7.33	GHz
Frequency Range, Output (F2)			10	-	22	GHz
Input Power			+12		+18	dBm
Conversion Loss		3.33		22.0		dB
		4		18.0		
		5		16.4		
		6		18.2		
		7.33		22.1		
Harmonic Output[2]	F1	3.33		45.8		dBc
		4		49.8		
		5		46.6		
		6		44.9		
		7.33		22.1		
	F2	3.3		86.1		dBc
		4		71.9		
		5		55.1		
		6		45.0		
		7.33		39.9		
	F3	3.33		47.9		dBc
		4		48.9		
		5		56.2		
		6		51.7		
		7.33		40.9		

1. Die soldered in a 4x4 mm 24L MCLP and measured on Mini-Circuits Characterization Test Board TB-CY3-223C+.
2. Harmonics of input frequency below the power level of F3.

MAXIMUM RATINGS[3]

Parameter	Ratings
Operating Temperature	-40°C to +85°C
Storage Temperature	-65°C to +150°C
RF Input Power	+22 dBm (5 minute max) +19 dBm (Continuous)

3. Permanent damage may occur if any of these limits are exceeded.

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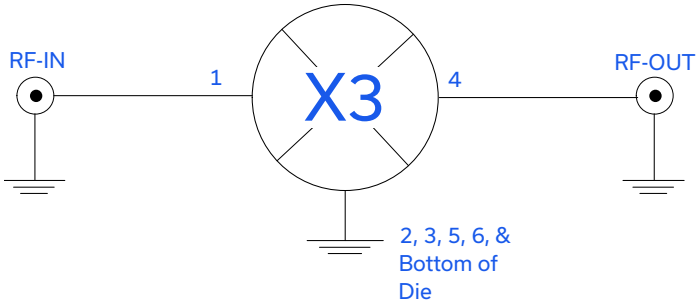
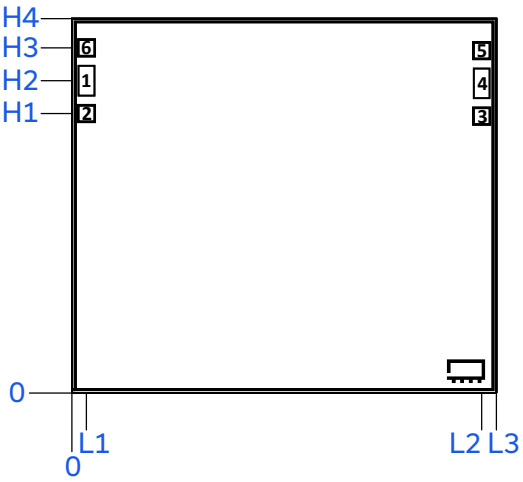
SIMPLIFIED SCHEMATIC AND PAD DESCRIPTION



Function	Pad Number	Description
RF-IN	1	RF-Input Pad.
RF-OUT	4	RF-Output Pad.
Ground	2, 3, 5, 6 & Bottom of Die	The bond pads are connected to back-side through vias and do not require wire-bond connections to ground.

BONDING PAD POSITION

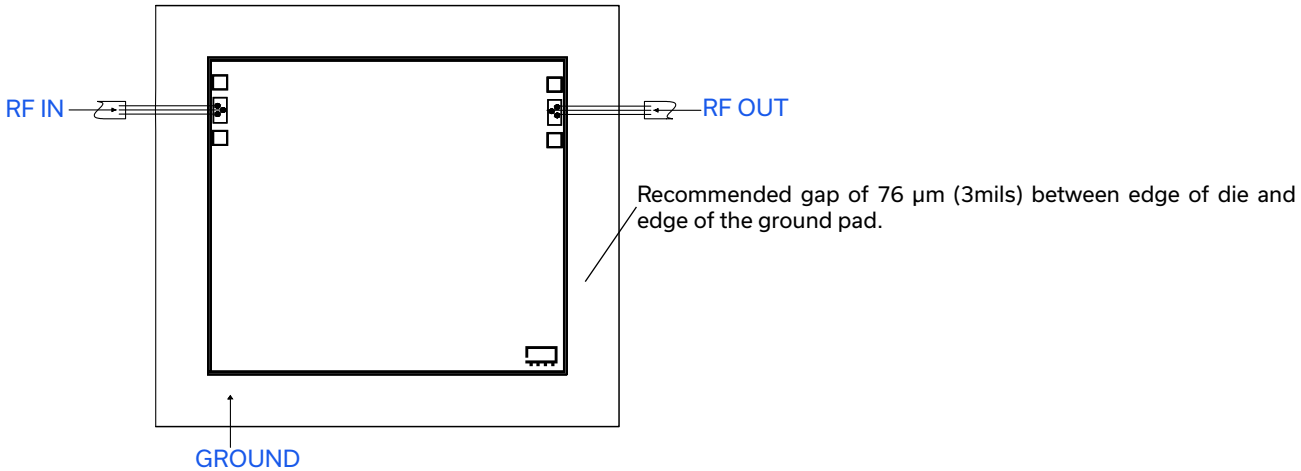


DIMENSIONS IN µM, TYPICAL

L1	L2	L3	H1	H2	H3	H4
85	2375	2460	1620	1810	2000	2170

Thickness	Die Size	Pad Size 1 & 4	Pad Size 2, 3, 5, & 6
100	2460 x 2170	92 x 172	92 x 92

ASSEMBLY DIAGRAM



1. Recommended bond length for RF-IN & RF-Out: 305 µm (12mils)
2. Recommended amount of bonding wires per port: 3

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APPLICATION AND CHARACTERIZATION CIRCUIT

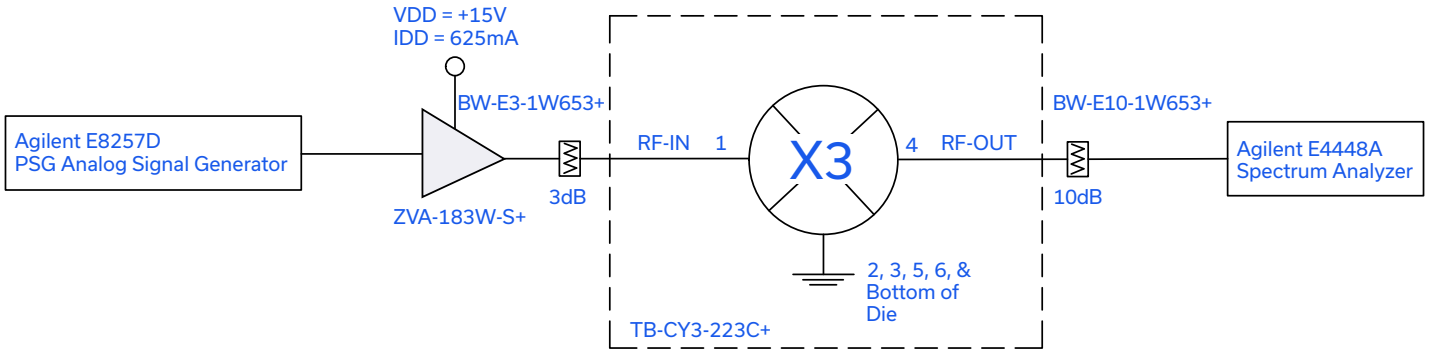

Fig 1. Application and Characterization Circuit
Note: This block diagram is used for characterization.
(DUT is soldered onto a 4x4 24L MCLP and measured on Mini-Circuits Characterization test board TB-CY3-223C+) Conversion Loss and Harmonic Output are measured using Agilent E4448A PSA Spectrum Analyzer

ASSEMBLY PROCEDURE

1. Storage
   Die should be stored in a dry nitrogen purged desiccators or equivalent.
2. ESD
   MMIC HBT Multiplier die are susceptible to electrostatic and mechanical damage. Die are supplied in antistatic protected material, which should be open in clean room conditions at an appropriately grounded anti-static workstation.
3. Die Handling and Attachment
   Devices need careful handling using correctly designed collets, it is recommended to handle the chip along the edges with a custom design collet. The die mounting surface must be clean and flat. Using conductive silver filled epoxy, recommended epoxies are Ablestik 84-1 LMISR4 or equivalents. Apply sufficient epoxy to meet required epoxy bond line thickness, epoxy fillet height and epoxy coverage around total periphery. Parts shall be cured in a nitrogen filled atmosphere per manufacturer's cure condition.
4. Wire Bonding
   Bond pad openings in the surface passivation above the bond pads are provided to allow wire bonding to the die gold bond pads. Thermo-sonic bonding is used with minimized ultrasonic content. Bond force, time, ultrasonic power and temperature are all critical parameters. Suggested wire is pure gold, 1mil diameter. Bonds must be made from the bond pads on the die to the packaged or substrate. All bond wire length and bond wire height should be kept as short as possible unless specified by the Assembly Drawing to minimize performance degradation due to undesirable series inductance

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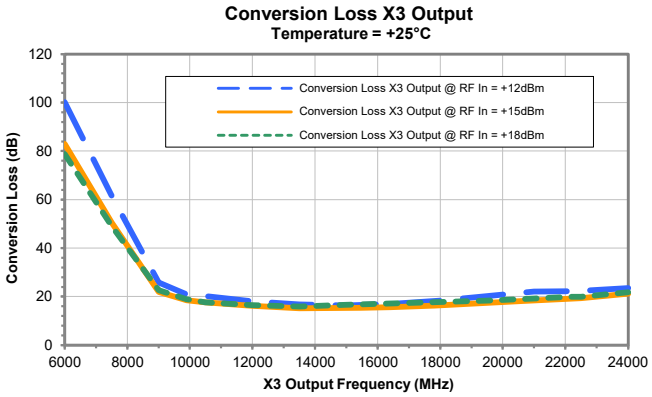
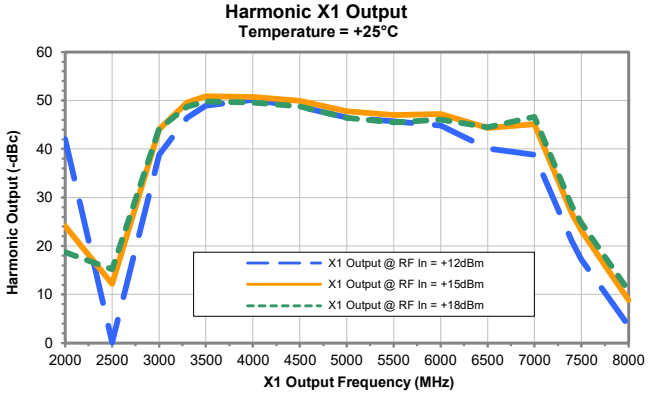
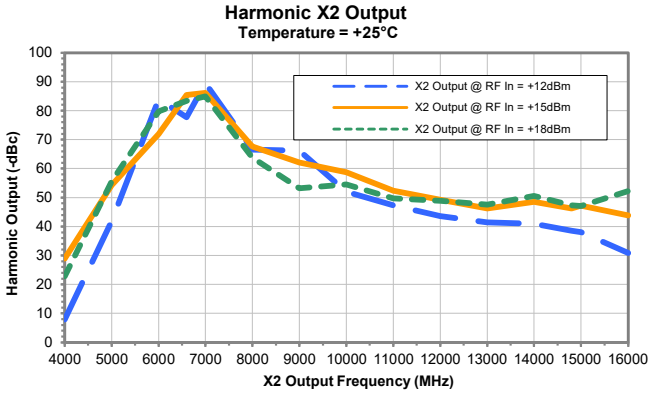
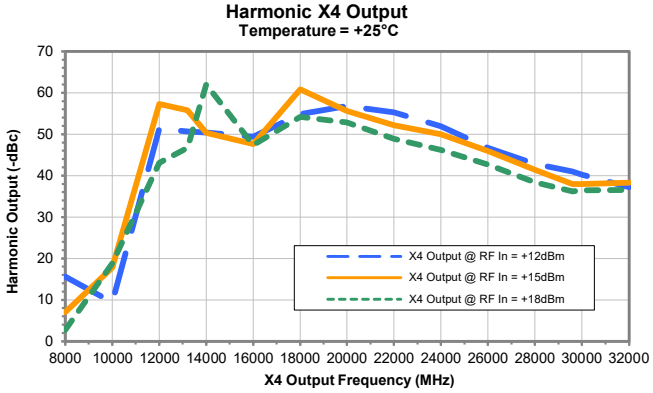
TYPICAL PERFORMANCE CURVES









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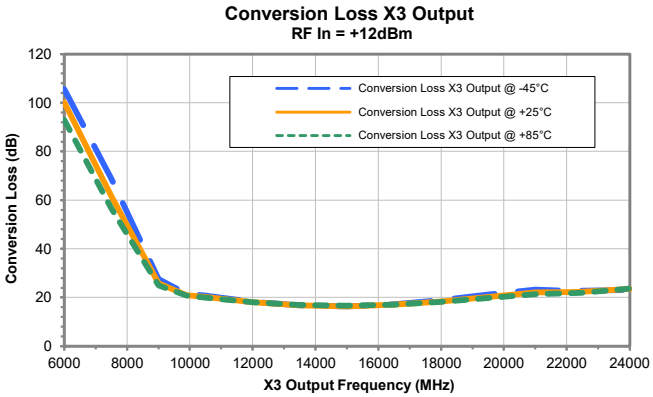

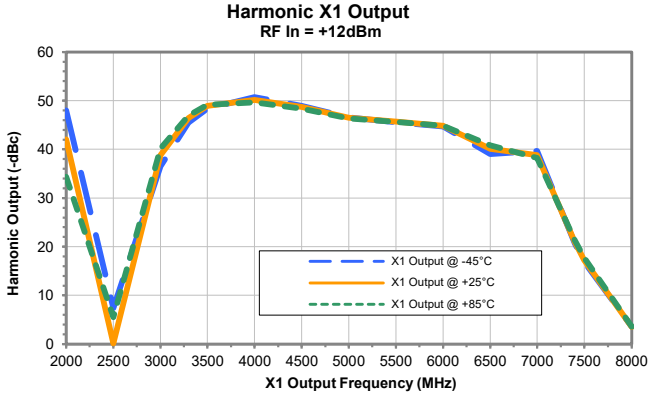

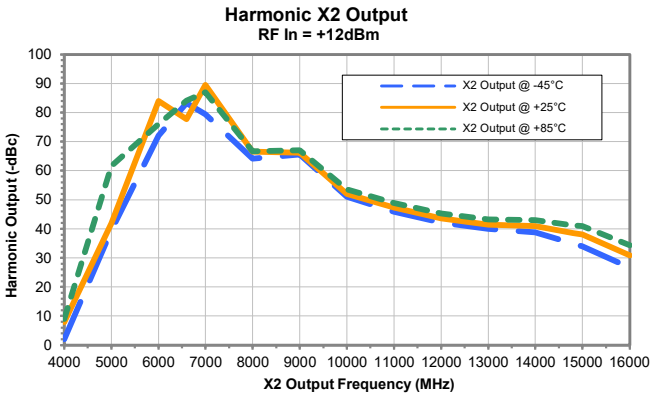

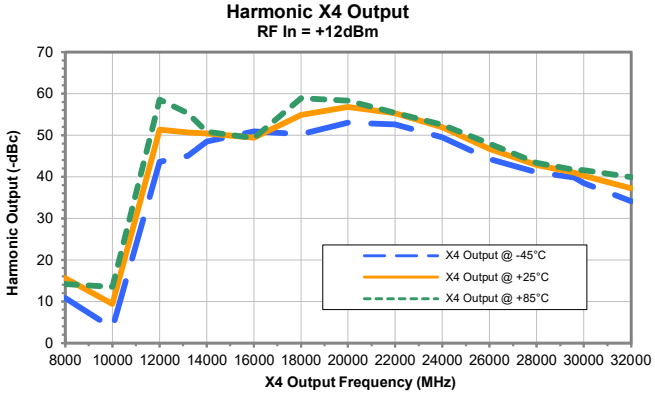

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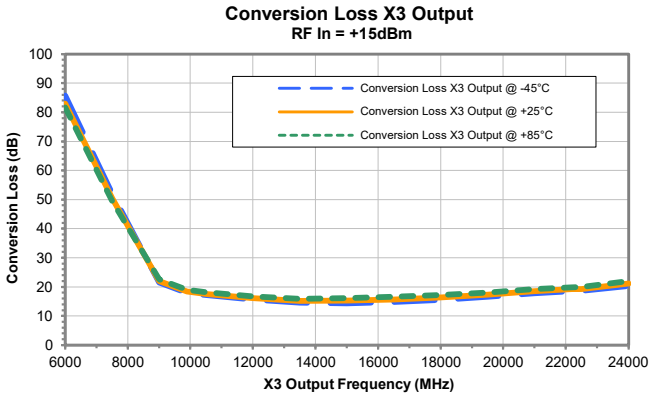

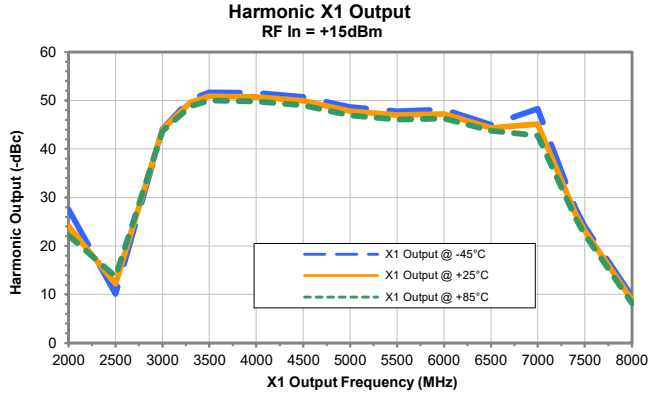

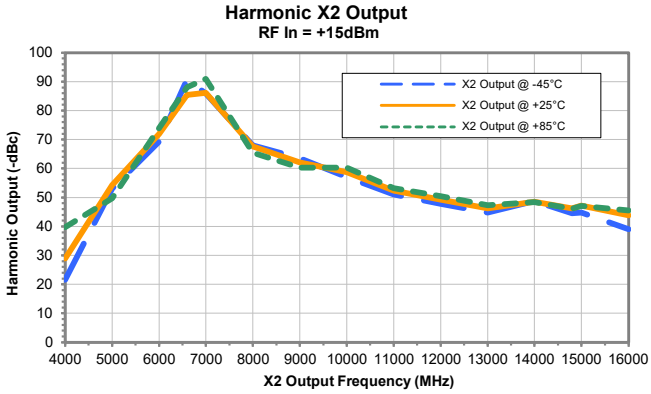

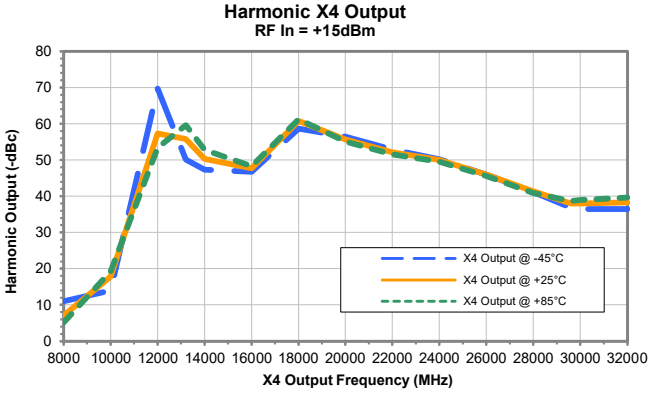

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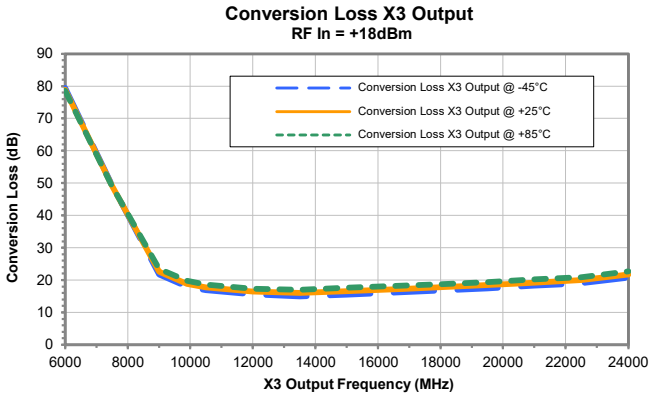

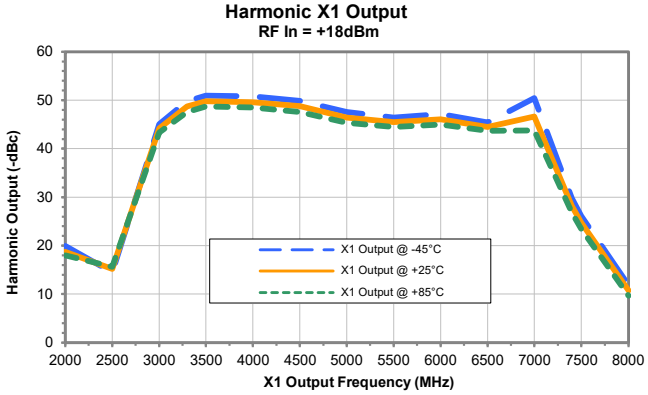

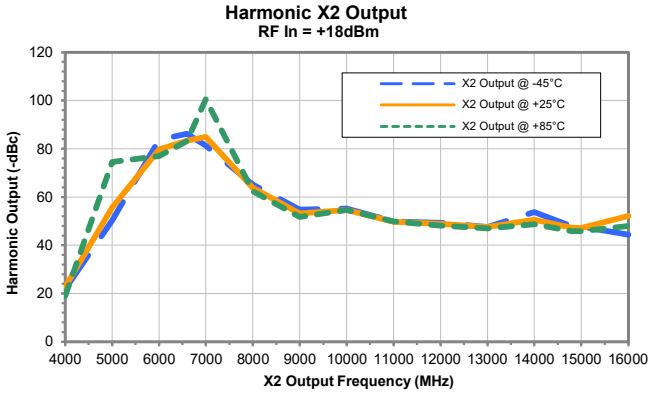

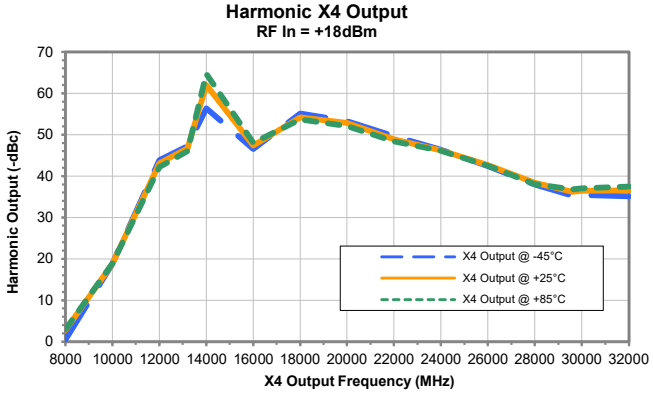

X3 Frequency Multiplier CY3-223-D+

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ADDITIONAL DETAILED TECHNICAL INFORMATION IS AVAILABLE ON OUR DASH BOARD.

Performance Data	Data Table Swept Graphs	
Case Style	Die	
Die Ordering and packaging information	Quantity, Package Gel – Pak: 5, 10, 50 Medium†, Partial wafer: KGD*<440 Full Wafer	Model No. CY3-223-DG+ CY3-223-DP+ CY3-223-DF+
Die Marking	EL-MUL-2	
Environmental Ratings	ENV80	

*Known Good Die ('KGD') means that the die in question have been subjected to Mini-Circuits DC test performance criteria and measurement instructions and that the parametric data of such die fall within a predefined range. While DC testing is not definitive, it does provide a higher degree of confidence that die is capable of meeting typical RF electrical performance specified by Mini-Circuits.

NOTES

A. Performance and quality attributes and conditions not expressly stated in this specification document are intended to be excluded and do not form a part of this specification document.

B. Electrical specifications and performance data contained in this specification document are based on Mini-Circuit's applicable established test performance criteria and measurement instructions.

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Frequency Multiplier CY3-223-D+

Typical Performance Data

TEST CONDITION: RF In = +12dBm

Frequency (MHz)				Temperature = -45°C			
				Conversion Loss (dB)	Harmonic Output* (-dBc)		
X1 Output	X2 Output	X3 Output	X4 Output	X3 Output	X1 Output	X2 Output	X4 Output
2000	4000	6000	8000	105.68	47.98	2.04	10.80
2500	5000	7500	10000	68.79	7.41	39.47	3.64
3000	6000	9000	12000	27.48	36.51	72.08	43.55
3300	6600	9900	13200	21.57	45.47	83.28	45.05
3500	7000	10500	14000	20.72	48.32	79.44	48.50
4000	8000	12000	16000	18.18	50.78	64.14	50.86
4500	9000	13500	18000	16.75	48.96	65.55	50.21
5000	10000	15000	20000	16.45	46.56	51.06	53.06
5500	11000	16500	22000	17.15	45.57	45.84	52.58
6000	12000	18000	24000	18.92	44.67	42.14	49.44
6500	13000	19500	26000	21.20	39.02	39.95	44.29
7000	14000	21000	28000	23.18	39.69	38.77	41.03
7400	14800	22200	29600	22.60	20.65	34.95	39.80
7500	15000	22500	30000	22.75	16.84	33.95	38.50
8000	16000	24000	32000	23.04	3.61	26.62	34.09

* Harmonic Output below power level of X3 Output

Frequency (MHz)				Temperature = +25°C			
				Conversion Loss (dB)	Harmonic Output* (-dBc)		
X1 Output	X2 Output	X3 Output	X4 Output	X3 Output	X1 Output	X2 Output	X4 Output
2000	4000	6000	8000	100.27	42.05	7.99	15.63
2500	5000	7500	10000	61.52	0.18	41.88	9.42
3000	6000	9000	12000	25.79	38.77	84.02	51.33
3300	6600	9900	13200	21.00	46.41	77.74	50.62
3500	7000	10500	14000	20.19	48.92	89.56	50.36
4000	8000	12000	16000	18.03	50.19	66.52	49.41
4500	9000	13500	18000	16.75	48.72	66.21	54.90
5000	10000	15000	20000	16.47	46.51	52.02	56.87
5500	11000	16500	22000	17.02	45.68	47.29	55.27
6000	12000	18000	24000	18.41	44.86	43.54	51.93
6500	13000	19500	26000	20.23	40.10	41.39	46.73
7000	14000	21000	28000	22.12	38.80	40.96	42.84
7400	14800	22200	29600	22.28	20.92	38.58	40.97
7500	15000	22500	30000	22.42	17.22	38.01	40.19
8000	16000	24000	32000	23.47	3.50	30.83	37.19

* Harmonic Output below power level of X3 Output

Frequency (MHz)				Temperature = +85°C			
				Conversion Loss (dB)	Harmonic Output* (-dBc)		
X1 Output	X2 Output	X3 Output	X4 Output	X3 Output	X1 Output	X2 Output	X4 Output
2000	4000	6000	8000	93.07	34.33	9.05	14.15
2500	5000	7500	10000	56.54	5.49	61.68	13.55
3000	6000	9000	12000	24.90	40.14	76.07	58.53
3300	6600	9900	13200	20.75	46.94	84.05	55.27
3500	7000	10500	14000	19.93	49.11	87.03	50.86
4000	8000	12000	16000	18.03	49.66	66.73	49.35
4500	9000	13500	18000	16.88	48.36	66.97	58.89
5000	10000	15000	20000	16.65	46.35	53.54	58.34
5500	11000	16500	22000	17.13	45.59	48.86	55.33
6000	12000	18000	24000	18.21	44.84	45.33	52.52
6500	13000	19500	26000	19.72	40.84	43.18	47.92
7000	14000	21000	28000	21.41	38.24	42.97	43.33
7400	14800	22200	29600	21.84	21.32	41.21	41.67
7500	15000	22500	30000	22.00	17.71	40.99	41.57
8000	16000	24000	32000	23.69	3.59	34.34	39.91

* Harmonic Output below power level of X3 Output

Typical Performance Data

TEST CONDITION: RF In = +15dBm

Frequency (MHz)				Temperature = -45°C			
				Conversion Loss (dB)	Harmonic Output* (-dBc)		
X1 Output	X2 Output	X3 Output	X4 Output	X3 Output	X1 Output	X2 Output	X4 Output
2000	4000	6000	8000	85.75	27.55	21.61	11.05
2500	5000	7500	10000	52.04	10.14	53.08	13.95
3000	6000	9000	12000	21.53	44.08	69.33	69.72
3300	6600	9900	13200	17.89	50.19	90.75	50.15
3500	7000	10500	14000	17.15	51.72	85.86	47.32
4000	8000	12000	16000	15.66	51.60	67.96	46.78
4500	9000	13500	18000	14.63	50.75	63.56	58.65
5000	10000	15000	20000	14.44	48.66	57.00	56.46
5500	11000	16500	22000	14.82	47.80	51.03	52.86
6000	12000	18000	24000	15.57	48.11	47.82	50.23
6500	13000	19500	26000	16.60	44.96	44.81	45.93
7000	14000	21000	28000	17.82	48.25	48.71	41.21
7400	14800	22200	29600	18.47	27.81	44.55	36.84
7500	15000	22500	30000	18.60	24.06	44.77	36.47
8000	16000	24000	32000	20.35	9.64	39.08	36.47

* Harmonic Output below power level of X3 Output

Frequency (MHz)				Temperature = +25°C			
				Conversion Loss (dB)	Harmonic Output* (-dBc)		
X1 Output	X2 Output	X3 Output	X4 Output	X3 Output	X1 Output	X2 Output	X4 Output
2000	4000	6000	8000	82.99	24.10	28.94	7.09
2500	5000	7500	10000	50.46	12.20	54.28	17.80
3000	6000	9000	12000	21.98	44.02	72.01	57.31
3300	6600	9900	13200	18.44	49.57	85.40	55.80
3500	7000	10500	14000	17.61	50.91	86.22	50.32
4000	8000	12000	16000	16.15	50.70	67.59	47.66
4500	9000	13500	18000	15.26	49.90	62.09	60.84
5000	10000	15000	20000	15.28	47.79	58.71	55.63
5500	11000	16500	22000	15.70	46.98	52.32	52.13
6000	12000	18000	24000	16.36	47.19	49.29	49.97
6500	13000	19500	26000	17.33	44.30	46.24	45.95
7000	14000	21000	28000	18.54	45.09	48.52	41.39
7400	14800	22200	29600	19.26	26.72	46.21	38.00
7500	15000	22500	30000	19.28	23.17	47.25	37.99
8000	16000	24000	32000	21.20	8.86	43.86	38.30

* Harmonic Output below power level of X3 Output

Frequency (MHz)				Temperature = +85°C			
				Conversion Loss (dB)	Harmonic Output* (-dBc)		
X1 Output	X2 Output	X3 Output	X4 Output	X3 Output	X1 Output	X2 Output	X4 Output
2000	4000	6000	8000	81.68	22.17	39.82	5.17
2500	5000	7500	10000	49.45	13.68	49.68	19.25
3000	6000	9000	12000	22.55	43.70	74.02	53.37
3300	6600	9900	13200	19.04	48.78	88.11	59.62
3500	7000	10500	14000	18.12	50.01	90.96	52.80
4000	8000	12000	16000	16.72	49.82	65.48	48.26
4500	9000	13500	18000	15.98	48.99	60.26	61.34
5000	10000	15000	20000	16.15	46.88	60.25	55.10
5500	11000	16500	22000	16.57	46.09	53.24	51.58
6000	12000	18000	24000	17.16	46.24	50.47	49.50
6500	13000	19500	26000	18.10	43.74	47.30	45.63
7000	14000	21000	28000	19.24	42.74	48.37	40.88
7400	14800	22200	29600	19.88	25.79	46.06	38.70
7500	15000	22500	30000	19.91	22.36	47.05	39.00
8000	16000	24000	32000	21.95	8.17	45.53	39.64

* Harmonic Output below power level of X3 Output

Typical Performance Data

TEST CONDITION: RF In = +18dBm

Frequency (MHz)				Temperature = -45°C			
				Conversion Loss (dB)	Harmonic Output* (-dBc)		
X1 Output	X2 Output	X3 Output	X4 Output	X3 Output	X1 Output	X2 Output	X4 Output
2000	4000	6000	8000	79.49	19.93	21.90	0.51
2500	5000	7500	10000	49.27	14.51	50.23	18.76
3000	6000	9000	12000	21.73	45.07	83.75	43.88
3300	6600	9900	13200	17.93	49.82	86.25	47.24
3500	7000	10500	14000	16.84	50.99	81.28	56.42
4000	8000	12000	16000	15.54	50.83	65.22	46.51
4500	9000	13500	18000	15.04	49.84	54.81	55.15
5000	10000	15000	20000	15.53	47.54	55.16	53.27
5500	11000	16500	22000	16.12	46.40	49.83	49.68
6000	12000	18000	24000	16.79	47.10	49.35	46.34
6500	13000	19500	26000	17.44	45.40	47.56	42.42
7000	14000	21000	28000	18.26	50.42	53.80	37.97
7400	14800	22200	29600	18.86	29.76	47.91	35.29
7500	15000	22500	30000	18.99	26.08	47.74	35.41
8000	16000	24000	32000	20.72	11.89	44.34	35.14

* Harmonic Output below power level of X3 Output

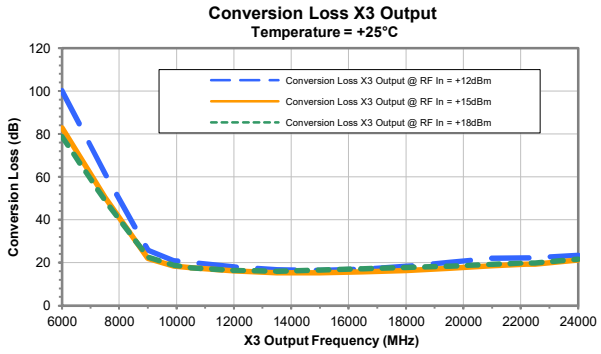
Frequency (MHz)				Temperature = +25°C			
				Conversion Loss (dB)	Harmonic Output* (-dBc)		
X1 Output	X2 Output	X3 Output	X4 Output	X3 Output	X1 Output	X2 Output	X4 Output
2000	4000	6000	8000	78.88	18.70	22.83	2.75
2500	5000	7500	10000	49.02	15.17	55.61	18.79
3000	6000	9000	12000	22.59	44.17	79.78	43.06
3300	6600	9900	13200	18.87	48.68	83.36	46.70
3500	7000	10500	14000	17.70	49.86	85.00	62.08
4000	8000	12000	16000	16.43	49.56	63.79	47.39
4500	9000	13500	18000	16.05	48.82	53.15	54.21
5000	10000	15000	20000	16.59	46.43	54.56	52.84
5500	11000	16500	22000	17.15	45.46	49.78	48.86
6000	12000	18000	24000	17.77	46.06	48.83	46.19
6500	13000	19500	26000	18.40	44.44	47.60	42.63
7000	14000	21000	28000	19.26	46.60	50.57	38.41
7400	14800	22200	29600	19.93	28.22	47.33	36.18
7500	15000	22500	30000	19.96	24.71	47.08	36.44
8000	16000	24000	32000	21.75	10.77	52.20	36.53

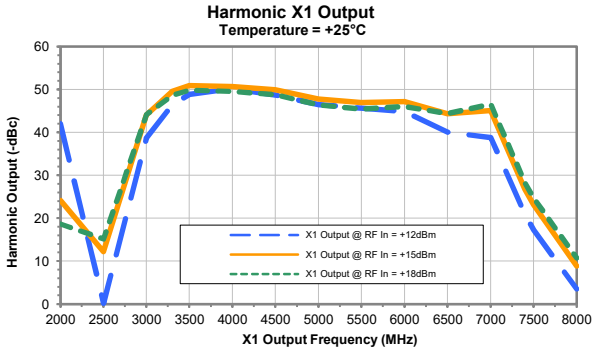
* Harmonic Output below power level of X3 Output

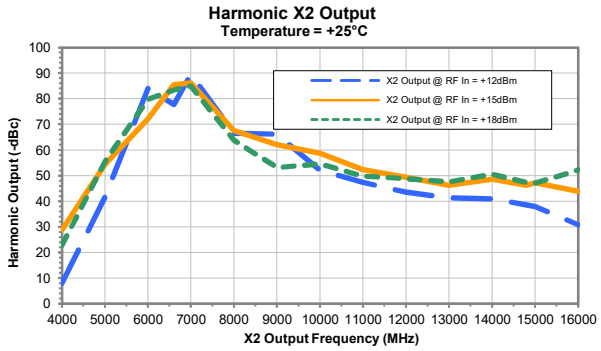
Frequency (MHz)				Temperature = +85°C			
				Conversion Loss (dB)	Harmonic Output* (-dBc)		
X1 Output	X2 Output	X3 Output	X4 Output	X3 Output	X1 Output	X2 Output	X4 Output
2000	4000	6000	8000	78.66	18.00	19.10	2.97
2500	5000	7500	10000	48.91	15.63	74.58	18.86
3000	6000	9000	12000	23.49	43.36	76.95	42.14
3300	6600	9900	13200	19.80	47.56	83.16	46.03
3500	7000	10500	14000	18.58	48.73	100.57	64.70
4000	8000	12000	16000	17.36	48.50	62.40	48.08
4500	9000	13500	18000	17.07	47.60	51.68	53.69
5000	10000	15000	20000	17.64	45.34	54.58	52.10
5500	11000	16500	22000	18.16	44.50	49.80	48.37
6000	12000	18000	24000	18.74	44.99	48.13	46.13
6500	13000	19500	26000	19.36	43.68	47.02	42.48
7000	14000	21000	28000	20.20	43.78	48.73	38.06
7400	14800	22200	29600	20.81	26.85	45.77	36.75
7500	15000	22500	30000	20.84	23.49	45.79	37.05
8000	16000	24000	32000	22.69	9.72	47.94	37.44

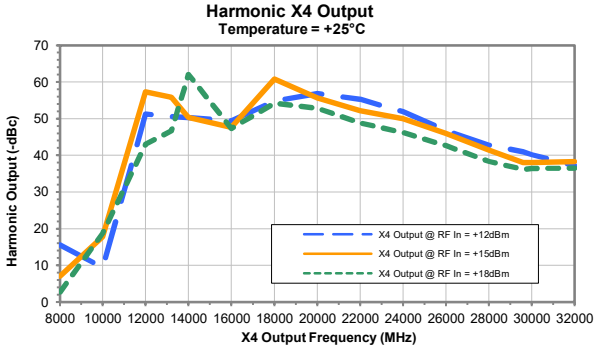
* Harmonic Output below power level of X3 Output

Typical Performance Curves

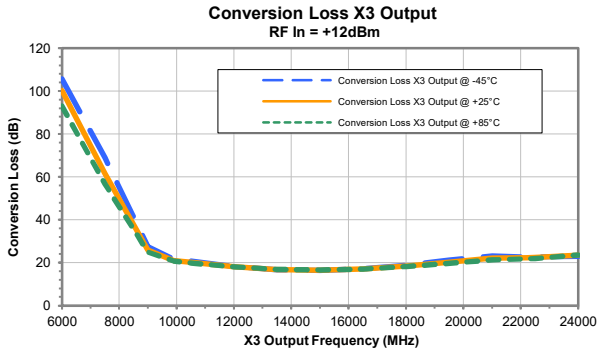


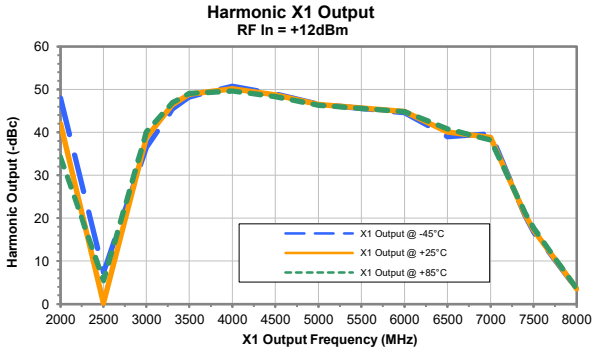


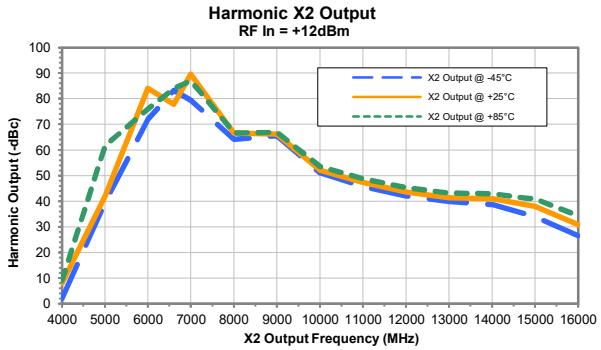


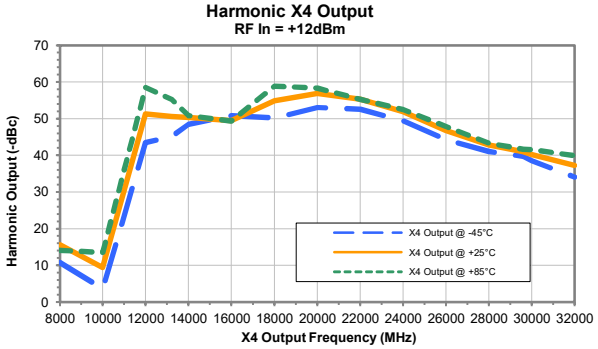


Typical Performance Curves

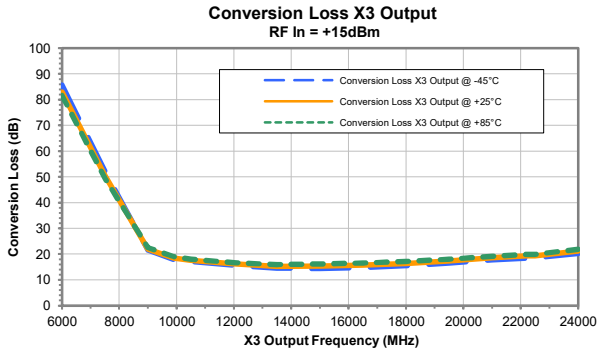


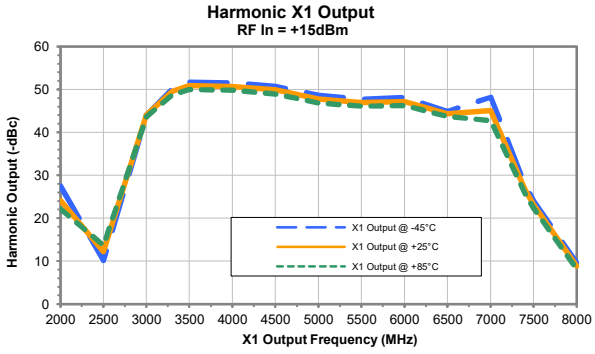


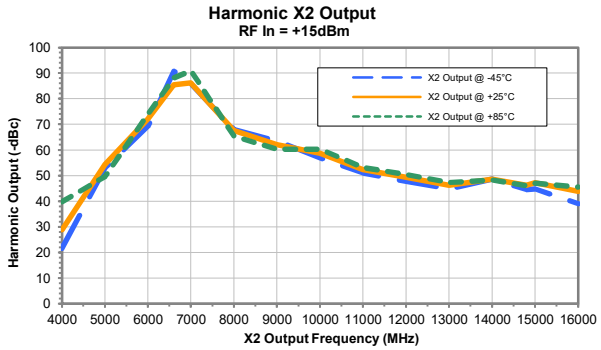


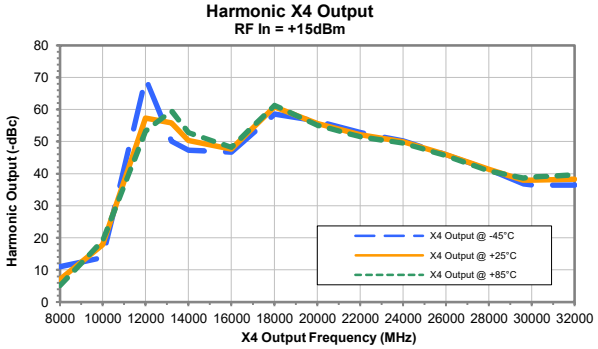


Typical Performance Curves

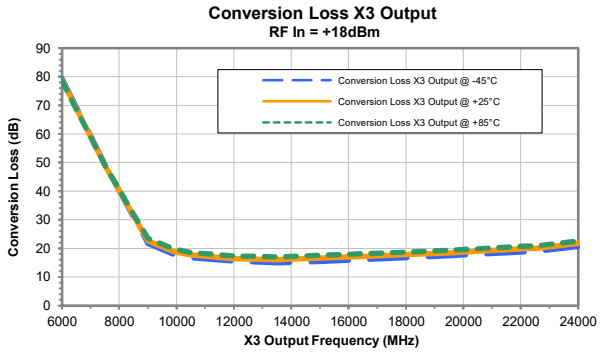


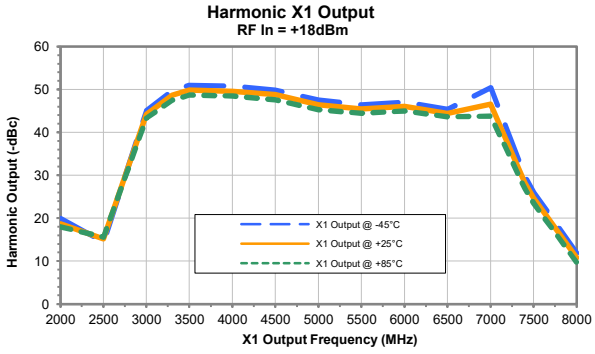


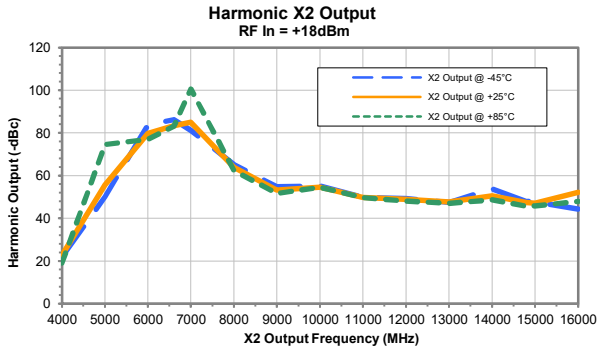


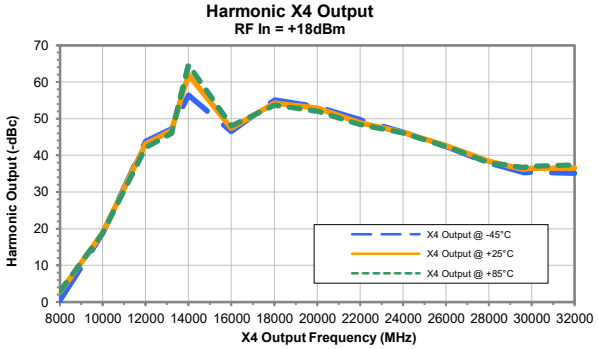


Typical Performance Curves









Mini-Circuits

Environmental Specifications ENV80

All Mini-Circuits products are manufactured under exacting quality assurance and control standards, and are capable of meeting published specifications after being subjected to any or all of the following physical and environmental test.

Specification	Test/Inspection Condition	Reference/Spec
Operating Temperature	-40° to 85° C or -40° to 105° C or -55° to 105° C or -45° to 105° C Ambient Environment	Refer to Individual Model Data Sheet
Storage Environment (Die)	-65° to 150°C	Individual Model Data Sheet
Storage Environment(Packaging)	-40° to 70°C and 40 to 60% humidity (In Factory Shipped Package)	