



Mini-Circuits

MMIC DIE

# X3 Frequency Multiplier

CY3-723-D+

50Ω Output 40 to 72 GHz

## THE BIG DEAL

- Wideband Output Frequency: 40 to 72 GHz
- Excellent Fundamental and Harmonic Suppression:
  - F1: 41 dBc Typ.
  - F2: 33 dBc Typ.
  - F4: 33 dBc Typ.
- Input Drive Level: +12 to +19 dBm
- Conversion Loss: 21.1 dB Typ.

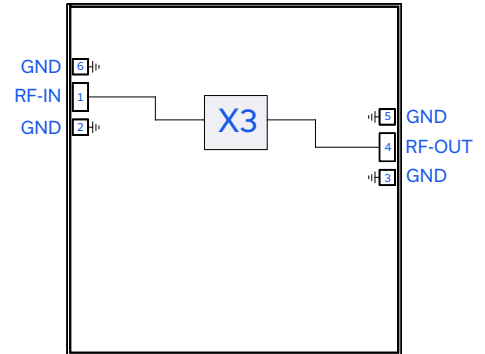
## APPLICATIONS

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

## PRODUCT OVERVIEW

Mini-Circuits' CY3-723-D+ is a wideband MMIC Frequency Tripler, converting input frequencies from 13.3 to 24 GHz into output frequencies from 40 to 72 GHz. Its wide output range makes this model suitable for broadband systems as well as a wide variety of narrow-band applications. The CY3-723-D+ die utilizes GaAs HBT technology and is suitable for chip and wire assemblies.

## FUNCTIONAL DIAGRAM



SEE ORDERING INFORMATION ON THE LAST PAGE

## KEY FEATURES

Features	Advantages
Broadband, 40 to 72 GHz output	With an output frequency range spanning 40 to 72 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: <ul style="list-style-type: none"><li>• F1, 41 dBc Typ.</li><li>• F2, 33 dBc Typ.</li><li>• F4, 33 dBc Typ.</li></ul>	Harmonic and fundamental filtering requirements are dramatically simplified due to the high suppression resulting from internal cancellation within the diode configuration.
Wide input power range, +12 to +19 dBm	Wide input power signal range accommodates different input signal levels while still maintain low conversion loss.
Unpackaged Die	Enables integration into hybrid chip and wire assemblies.



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ELECTRICAL SPECIFICATIONS<sup>1,3</sup> AT +25°C AND Z<sub>0</sub> = 50Ω, UNLESS NOTED OTHERWISE

Parameter		Input Frequency (GHz)	Min	Typ.	Max.	Unit
Multiplication Factor			3			
Frequency Range, Input (F1)			13.33	-	22.33	GHz
Frequency Range, Output (F3)			40	-	72	GHz
Input Power			+12	+18	+19	dBm
Conversion Loss (F3)		13.3 - 15		20.5		dB
		15 - 16.6		19.5		
		16.6 - 18.3		20.1		
		18.3 - 20		21.7		
		20 - 22.3		23.6		
		22.3 - 24		25.0		
Harmonic Output <sup>2</sup>	F1	13.3 - 15		50		dBc
		15 - 16.6		50		
		16.6 - 18.3		42		
		18.3 - 20		36		
		20 - 22.3		30		
		22.3 - 24		28		
	F2	13.3 - 15		49		dBc
		15 - 16.6		41		
		16.6 - 18.3		31		
		18.3 - 20		25		
		20 - 22.3		22		
		22.3 - 24		19		
	F4	13.3 - 15		31		dBc
		15 - 16.6		42		
		16.6 - 18.3		31		
		18.3 - 20		36		
		20 - 22.3		28		
		22.3 - 24		28		

1. Measured on Mini-Circuits Die Evaluation board. See Figure 3 for test conditions.

2. Harmonics of input frequency below the power of desired output F3.

3. All specifications are measured with RF input power = +18 dBm.





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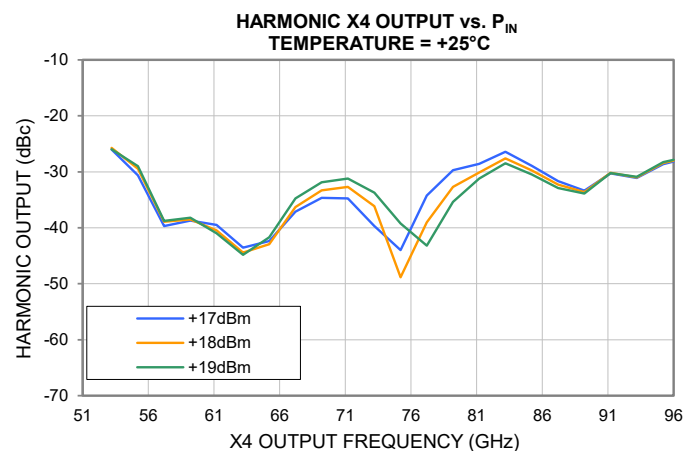
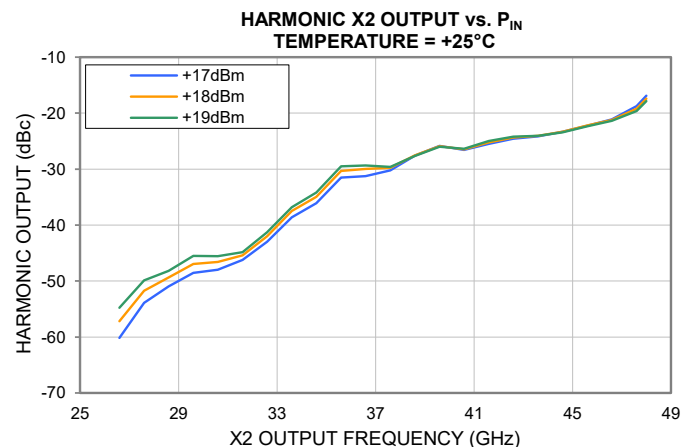
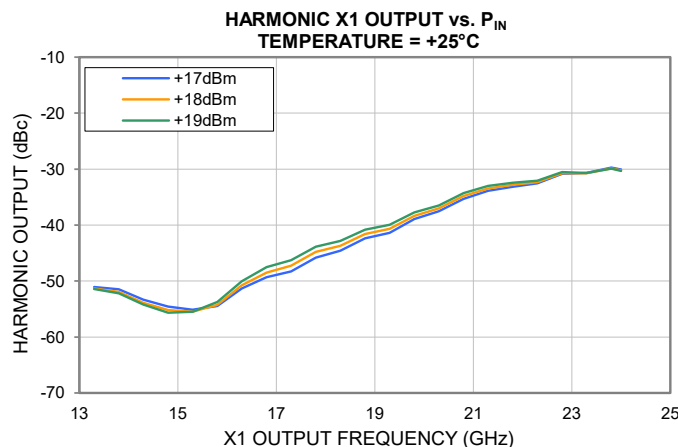
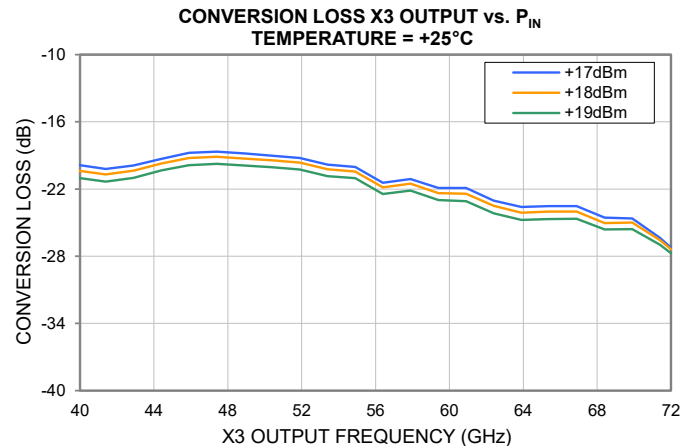
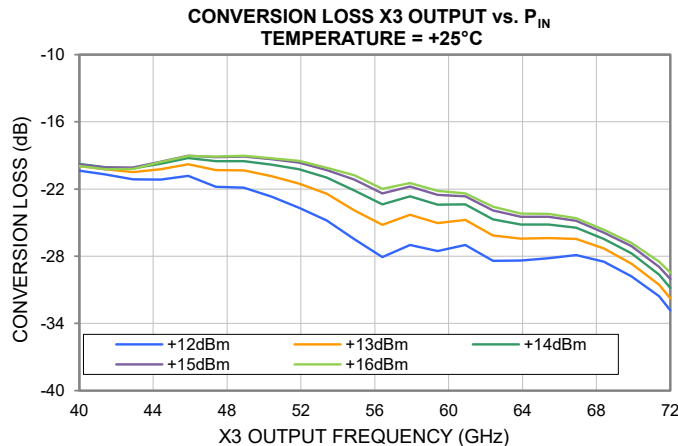
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## TYPICAL PERFORMANCE GRAPHS



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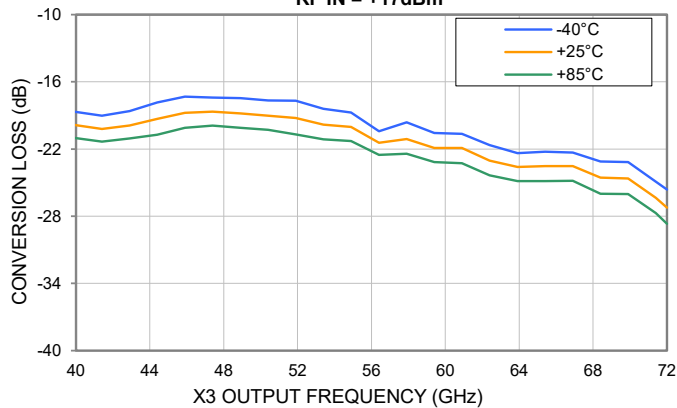
CY3-723-D+

Mini-Circuits

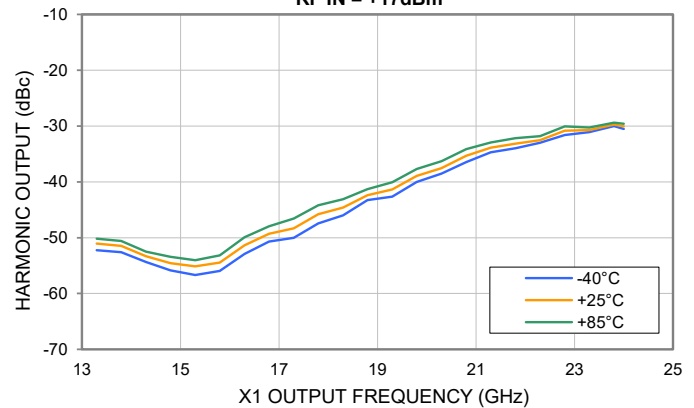
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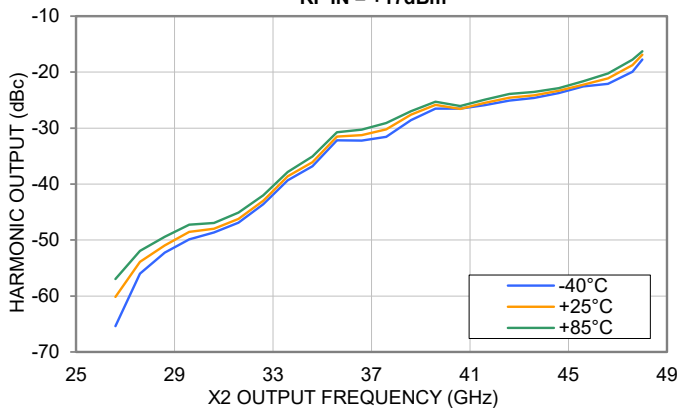
CONVERSION LOSS X3 OUTPUT vs. TEMPERATURE  
RF IN = +17dBm



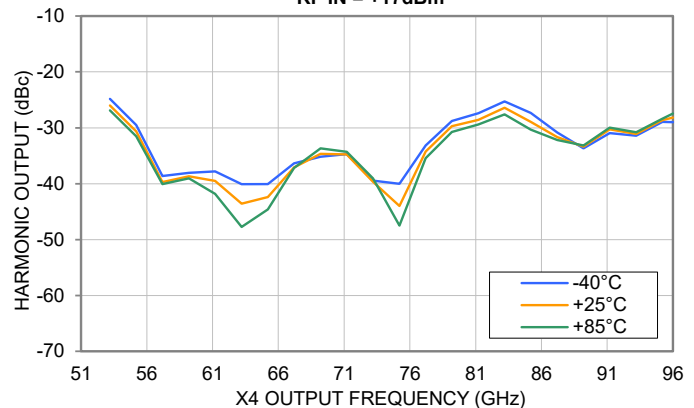
HARMONIC X1 OUTPUT vs. TEMPERATURE  
RF IN = +17dBm



HARMONIC X2 OUTPUT vs. TEMPERATURE  
RF IN = +17dBm



HARMONIC X4 OUTPUT vs. TEMPERATURE  
RF IN = +17dBm





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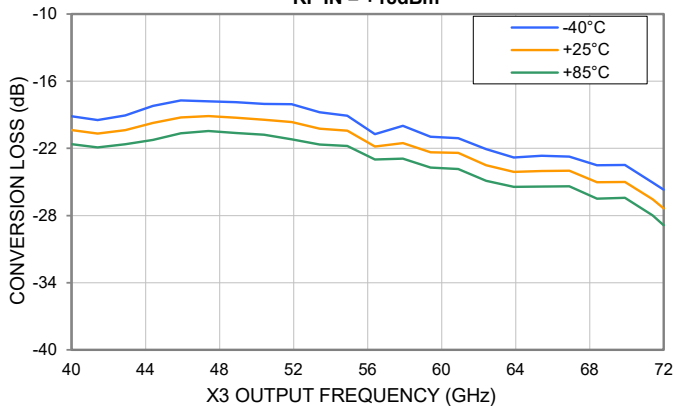
CY3-723-D+

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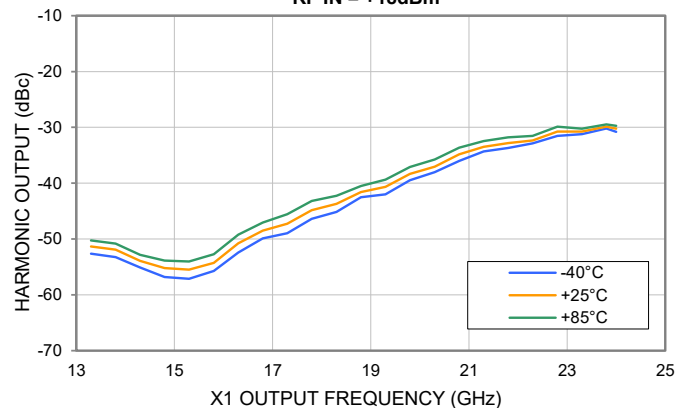
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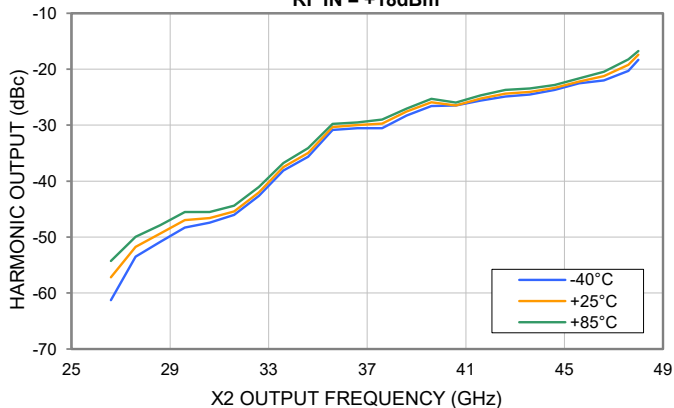
CONVERSION LOSS X3 OUTPUT vs. TEMPERATURE  
RF IN = +18dBm



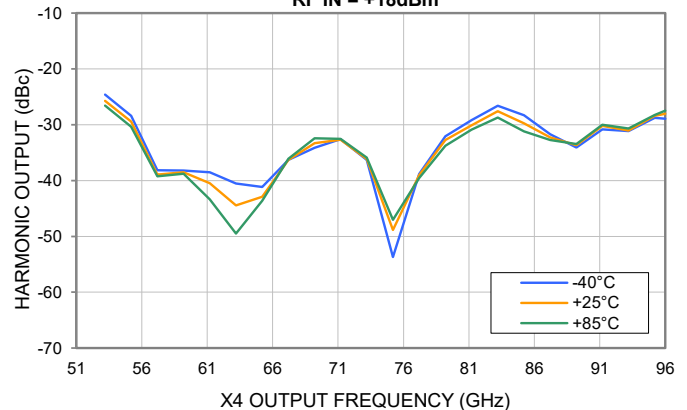
HARMONIC X1 OUTPUT vs. TEMPERATURE  
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HARMONIC X2 OUTPUT vs. TEMPERATURE  
RF IN = +18dBm



HARMONIC X4 OUTPUT vs. TEMPERATURE  
RF IN = +18dBm





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# X3 Frequency Multiplier

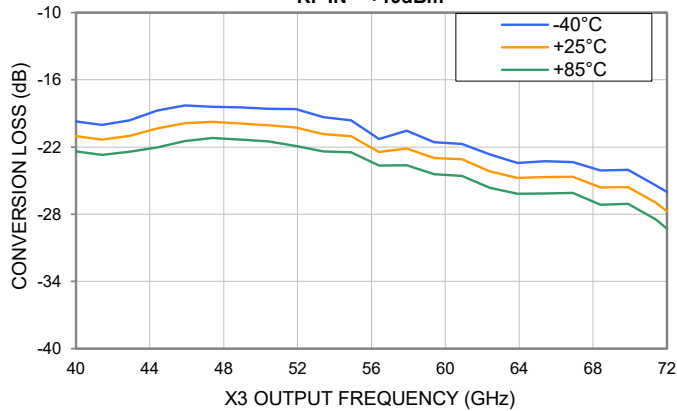
CY3-723-D+

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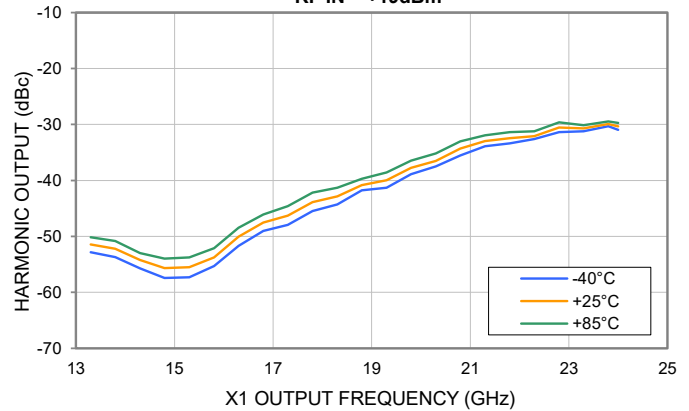
50Ω Output 40 to 72 GHz

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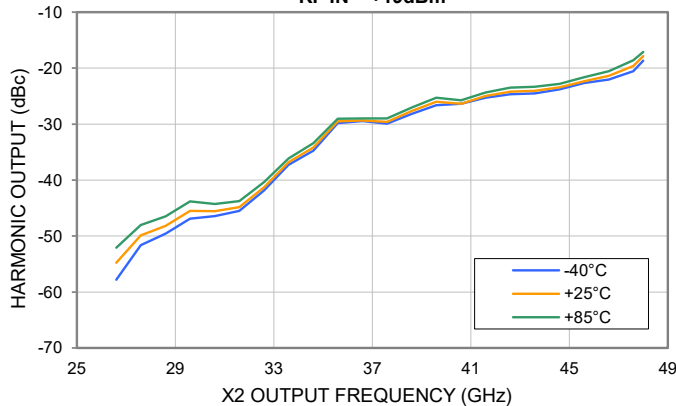
CONVERSION LOSS X3 OUTPUT vs. TEMPERATURE  
RF IN = +19dBm



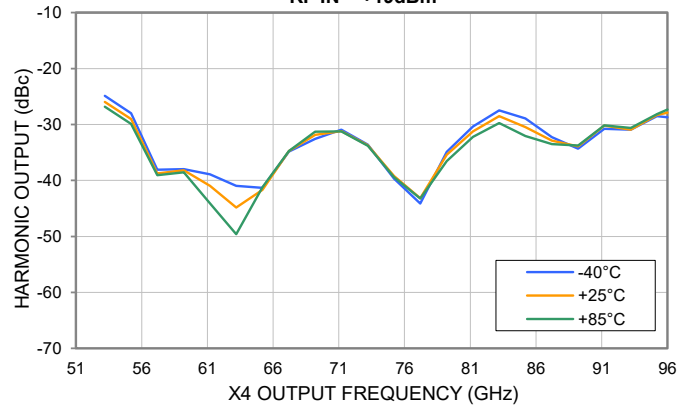
HARMONIC X1 OUTPUT vs. TEMPERATURE  
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RF IN = +19dBm



HARMONIC X4 OUTPUT vs. TEMPERATURE  
RF IN = +19dBm





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## ABSOLUTE MAXIMUM RATINGS<sup>4</sup>

Parameter	Ratings
Operating Temperature <sup>5</sup>	-40°C to +85°C
Storage Temperature (for Die) <sup>6</sup>	-65°C to +150°C
RF Input Power	+22 dBm
Junction Temperature <sup>7</sup>	+150°C

4. Permanent damage may occur if any of these limits are exceeded. Electrical maximum ratings are not intended for continuous normal operation.

5. Bottom of Die.

6. For die shipped in Gel-Pak see ENV-80 (limited by packaging).

7. Hot spot temperature on die.



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## FUNCTIONAL DIAGRAM

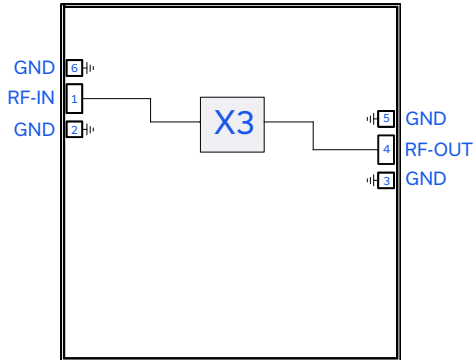


Figure 1. CY3-723-D+ Functional Diagram

## PAD DESCRIPTION

Function	Pad #	Description (Refer to Figure 1)
RF-IN	1	Connect to RF Input.
RF-OUT	4	Connect to RF Output.
GND	2, 3, 5 & 6	Connected to die backside through vias. Bond wires to ground are optional.

## DIE OUTLINE: inches [mm], Typical

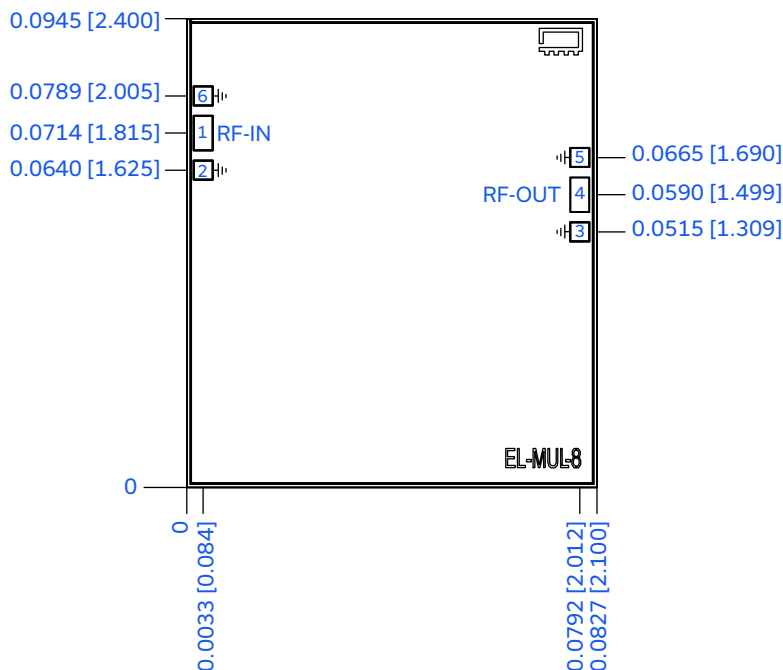


Figure 2. CY3-723-D+ Die Outline

## DIMENSIONS: inches [mm], Typical

Die Size	0.0827 x 0.0945 [2.100 x 2.400]
Die Thickness	0.0040 [0.100]
Bond Pad Sizes:	
Pads 1 & 4	0.0036 x 0.0068 [0.092 x 0.172]
Pad 2, 3, 5 & 6	0.0036 x 0.0036 [0.092 x 0.092]
Plating (Pads & Bottom of Die)	Gold







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Keysight PNA-X N5247B  
Network Analyzer with 110 GHz Frequency Extender

PORT 3 R3 RCVR C PORT 1 PORT 2

6dB ZVA-0.5W303G+ VDD=12V IDD=460mA 3dB 2x (ZCDC20-E18653+) RF-IN X3 RF-OUT Die Test Board Freq. Ext.

## TEST PARAMETERS AND CONDITIONS

DUT attached on a Mini-Circuits Die Characterization Test Board. Conversion Loss and Harmonic Output are measured using PNA-X Network Analyzer.

Test Conditions:

For Conversion Loss and Harmonic Rejection: RF input power: +12 to +19 dBm.





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## ASSEMBLY DIAGRAM

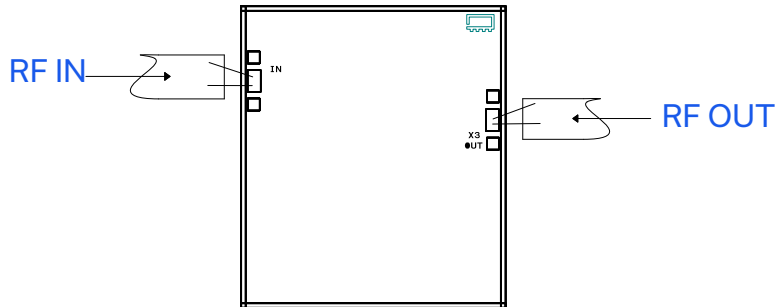



Figure 4. CY3-723-D+ Assembly Diagram

- Bond wire diameter: 1 mil
- Bond wire lengths from Die Pad to PCB at RF-IN & RF-OUT ports:  $11 \pm 1$  mils
- Typical Gap from Die edge to PCB edge: 3 mils
- PCB thickness and material: 3.5 mils (Thickness: 0.5 oz copper on each side).

## ASSEMBLY AND HANDLING PROCEDURE

1. **Storage**  
Die should be stored in a dry nitrogen purged desiccator or equivalent.
2.  **ESD Precautions**  
MMIC Multiplier Die are susceptible to electrostatic and mechanical damage. Die are supplied in anti-static protected material, which should be opened only in clean room conditions at an appropriately grounded anti-static workstation.
3. **Die Handling and Attachment**  
Devices require careful handling using tools appropriate for manipulating semiconductor chips. It is recommended to handle the chips along the edges with a custom designed collet. The surface of the chips have exposed air bridges and should not be touched with a vacuum collet, tweezers or fingers. The die mounting surface must be clean and flat. Using conductive silver-filled epoxy, apply sufficient adhesive to meet the required bond line thickness, fillet height and coverage around the total periphery of the device. The recommended epoxy is Ablestik 84-1 LMISR4 or equivalent. Parts should be cured in a nitrogen-filled atmosphere per manufacturer's recommended cure profile.
4. **Wire Bonding**  
Openings in the surface passivation above the gold bond pads are provided to allow wire bonding to the die. Thermosonic bonding is recommended with minimized ultrasonic content. Bond force, time, ultrasonic power and temperature are all critical parameters. The suggested interconnect is pure gold, 1 mil diameter wire. Bonds are recommended to be made from the bond pads on the die to the package or substrate. All bond wire length and bond wire height should be kept as short as possible, unless specified by design, to minimize performance degradation due to undesirable series inductance.





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ADDITIONAL DETAILED INFORMATION IS AVAILABLE ON OUR DASHBOARD

[CLICK HERE](#)

Performance Data	Table Graphs										
Case Style	Die										
RoHs Status	Compliant										
Die Ordering and Packaging Information	<table><tr><td>Quantity, Package</td><td>Model No.</td></tr><tr><td>Gel - Pak: 5, 10, 50, KGD*</td><td>CY3-723-DG+</td></tr><tr><td>Medium†, Partial wafer: &lt;460</td><td>CY3-723-DP+</td></tr><tr><td>Full wafer†</td><td>CY3-723-DF+</td></tr><tr><td colspan="2">†Available upon request contact sales representative. Refer to <a href="#">AN-60-067</a></td></tr></table>	Quantity, Package	Model No.	Gel - Pak: 5, 10, 50, KGD*	CY3-723-DG+	Medium†, Partial wafer: <460	CY3-723-DP+	Full wafer†	CY3-723-DF+	†Available upon request contact sales representative. Refer to <a href="#">AN-60-067</a>	
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Full wafer†	CY3-723-DF+										
†Available upon request contact sales representative. Refer to <a href="#">AN-60-067</a>											
Die Marking	EL-MUL-8										
Environmental Ratings	ENV-80										

\*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 are capable of meeting typical RF electrical parameters 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.
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