True Time Delay
4 - 12 GHz

MADU-FR1008
Rev. V1

Features

- Insertion Loss: 7 dB
- P1dB: 12 dBm
- Power Consumption: 410 mW
- Total Current: 82 mA
- Voltage: +/-5 V
- Lead-Free 6 mm, 48-Lead PQFN

Applications

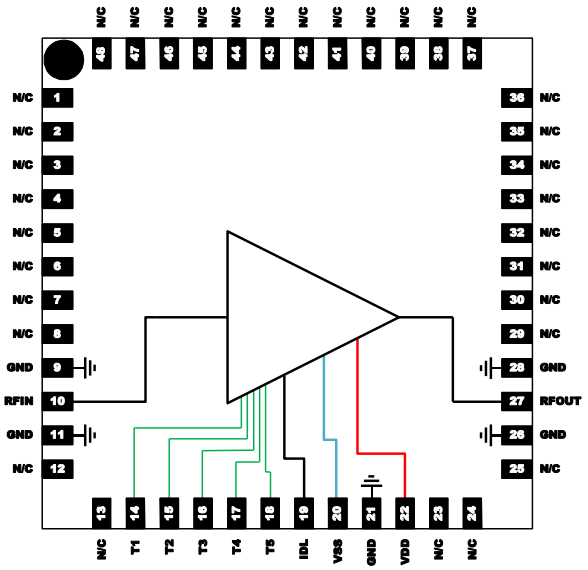
- RADAR

Description

The MADU-FR1008 is a GaAs MMIC 5-bit True Time Delay operating from 4 GHz up to 12 GHz packaged in a 6 mm plastic QFN.

The application of True Time Delay instead of phase shifter offers an enhanced broadband bandwidth with less beam squinting effects. This device has a range of 310 ps with 10 to 160 ps steps. It uses an optimum switched line to obtain very low delay error and insertion loss variation.

Functional Schematic



Pin Configuration[3]

Pin #	Function
1 - 8, 12, 13, 23 - 25, 29 - 48	No Connection
9, 11, 21, 26, 28	Ground
10	RFIN
14	T1 : 10 ps Time Delay Control Input
15	T2 : 20 ps Time Delay Control Input
16	T3 : 40 ps Time Delay Control Input
17	T4 : 80 ps Time Delay Control Input
18	T5 : 160 ps Time Delay Control Input
19	IDL
20	VSS
22	VDD
27	RFOUT
Paddle[4]	GND pad

3. MACOM recommends connecting unused package pins to ground.
4. The exposed pad centered on the package bottom must be connected to RF and DC ground.

Ordering Information[1,2]

Part Number	Package
MADU-FR1008-TR0500	500 part reel
MADU-FR1008-001SMB	Evaluation Board

1. Reference Application Note M513 for reel size information.
2. MADU-FR1008 also exists in die form: CGY2393SUH/C1.

* Restrictions on Hazardous Substances, compliant to current RoHS EU directive.

Electrical Specifications: Freq. = 4 - 12 GHz, T_A = +25°C, V_{SS} = -5 V, V_{DD} = +5 V, Z_0 = 50 Ω

Parameter	Test Conditions	Units	Min.	Typ.	Max.
Insertion Loss	Reference State	dB	—	7	10.5
Input Return Loss	—	dB	—	-10	—
Output Return Loss	—	dB	—	-8	—
True Time Delay Range	—	ps	290	310	330
Total Current (I_{DD} + I_{SS})	—	mA	—	82	—
Input P1dB	—	dB	—	14	—

Absolute Maximum Ratings[5,6]

Parameter	Absolute Maximum
Input RF ports	+23 dBm
Operating Voltage	+6 V
Junction Temperature[7,8]	+150°C
Operating Temperature	-40°C to +85°C
Storage Temperature	-40°C to +150°C

5. Exceeding any one or combination of these limits may cause permanent damage to this device.
6. MACOM does not recommend sustained operation near these survivability limits.
7. Operating at nominal conditions with $T_J \leq$ +200°C will ensure MTTF > 1 x 10^9 hours.
8. Junction Temperature (T_J) = T_C + Θjc * (V * I)
   Typical thermal resistance (Θjc) = 42.9 °C/W.
   a) For T_C = +25°C,
   T_J = 42.6 °C @ 5 V, 82 mA
   b) For T_C = +85°C,
   T_J = 105 °C @ 5 V, 87 mA

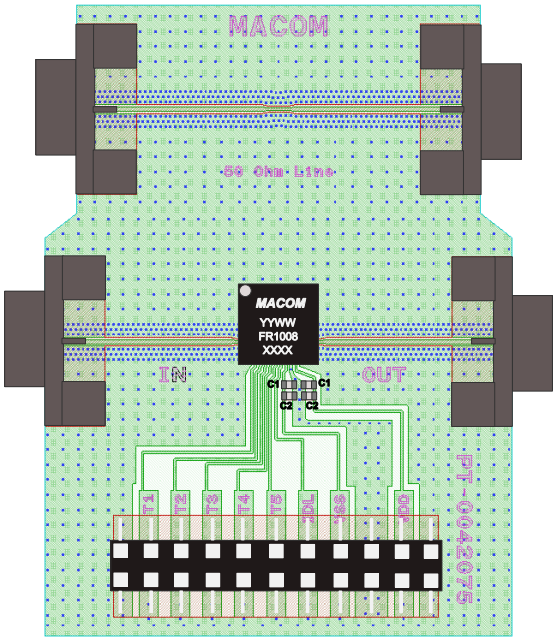
Handling Procedures

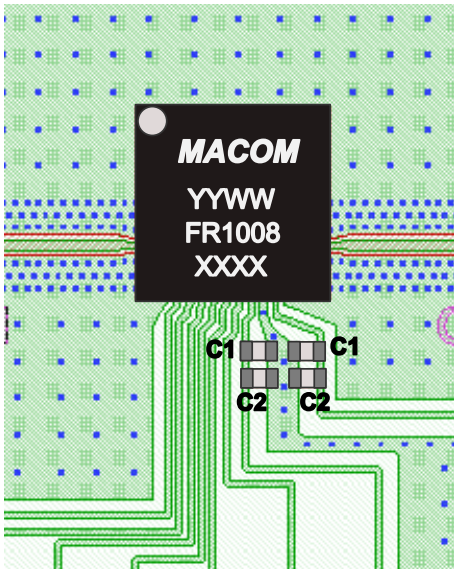
Please observe the following precautions to avoid damage:

Static Sensitivity

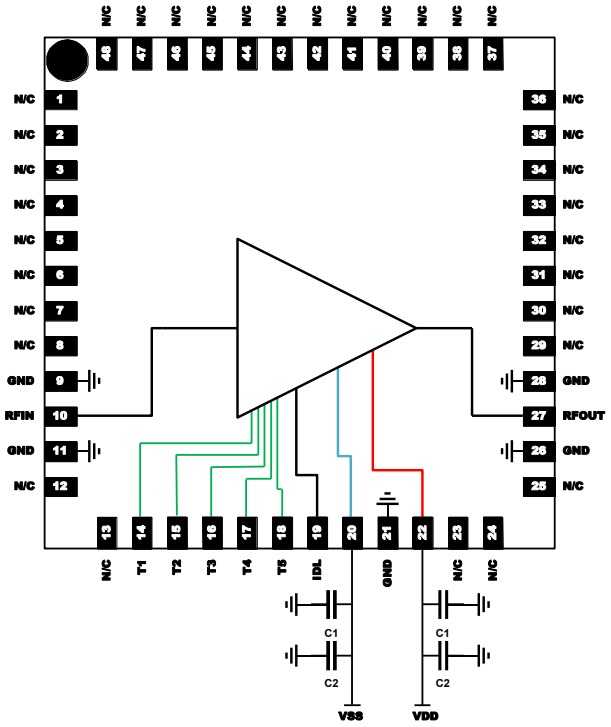
These electronic devices are sensitive to electrostatic discharge (ESD) and can be damaged by static electricity. Proper ESD control techniques should be used when handling these devices.

PCB Layout





Application Schematic



Biasing Procedure

Biasing UP
Set I_D limit to 150 mA.
Ensure voltages are at 0 before turning on DC supply.
Set V_{SS} to -5 V and V_{DD} to +5 V.
Ensure $I_D \approx 82$ mA.

Biasing Down
Set V_{DD} and then V_{SS} to 0 V.
Turn off DC supply.

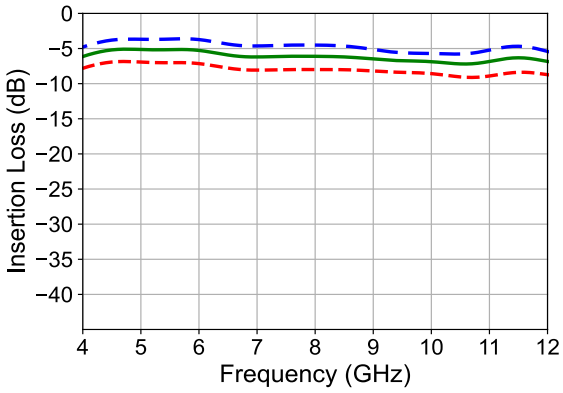
Parts List

Part	Value	Case Style	Manufacturer	Manufacturer's Part number
C1	47 pF	0402	MURATA	GRT1555C1H470JA02D
C2	0.1uF	0402	KYOCERA AVX	0402YD104KAT2A

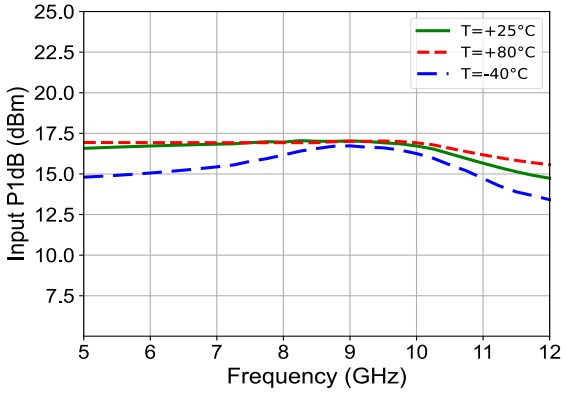
Typical Performance Curves: @ PCB level with De-Embedding

V_{DD} = +5 V, V_{SS} = -5 V, I_{DD} = 73 mA, I_{SS} = 9 mA

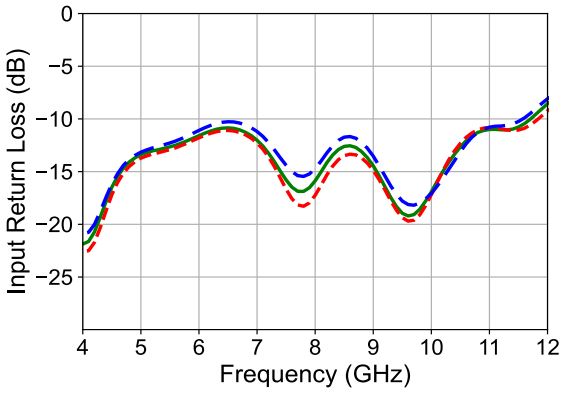
Insertion loss vs. Frequency over Temperature



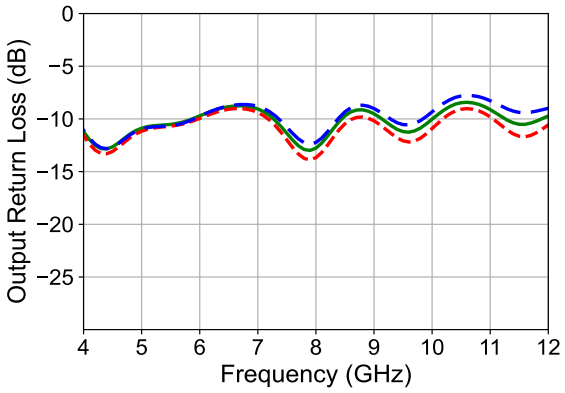
Input P1dB vs. Frequency over Temperature



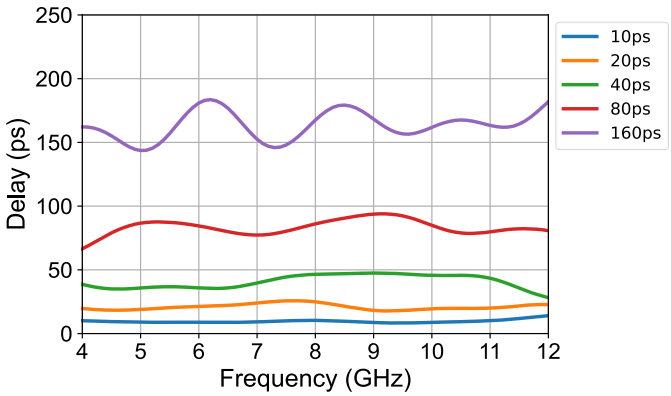
Input Return Loss vs. Frequency over Temperature



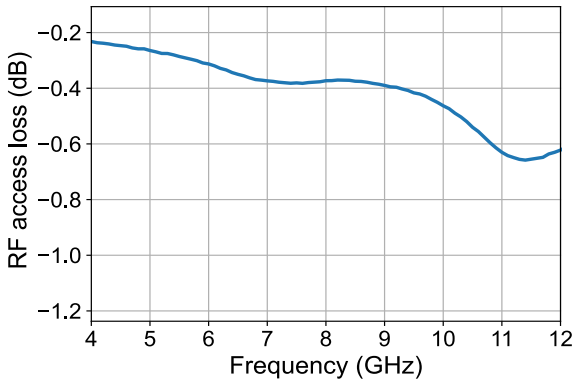
Output Return Loss vs. Frequency over Temperature



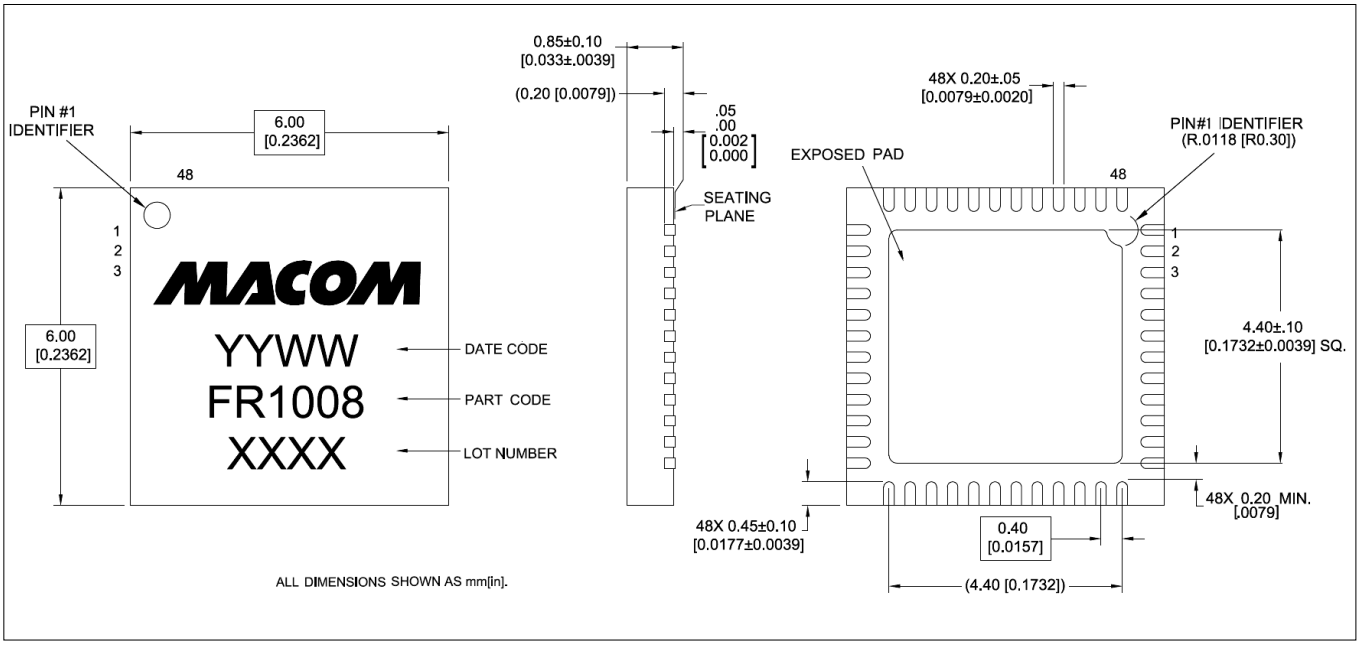
Time delay vs. Frequency over Temperature



PCB RF Access Loss vs. Frequency



Lead-Free 6 mm 48-Lead PQFN†



† Reference Application Note S2083 for lead-free solder reflow recommendations.
Meets JEDEC moisture sensitivity level 3 requirements.
Plating is 100% matte tin over copper.

Revision History

Rev	Date	Change description
V1	09/24/25	Production Release