gMDR0040A
W-band Quadrature mod/demod
92-114 (86-120) GHz

FEATURES

- Direct up/down conversion with differential quadrature input
- Wide IF bandwidth 0 – 12 GHz
- IIP3 typical 22 dBm
- 30 dB LO to RF isolation
- 10 dB conversion loss

TYPICAL APPLICATIONS

- WiGig
- W-band point to point communication
- Instrumentation
- Radio over fiber

DESCRIPTION

The gMDR0040A is a highly linear and balanced direct quadrature modulator and demodulator that covers the full cummunication W-band. The quadrature baseband ports feature wideband frequency coverage from DC to 12 GHz. Both LO and image suppression are excellent. LO-RF isolation features >30 dB and image suppression >25 dB.

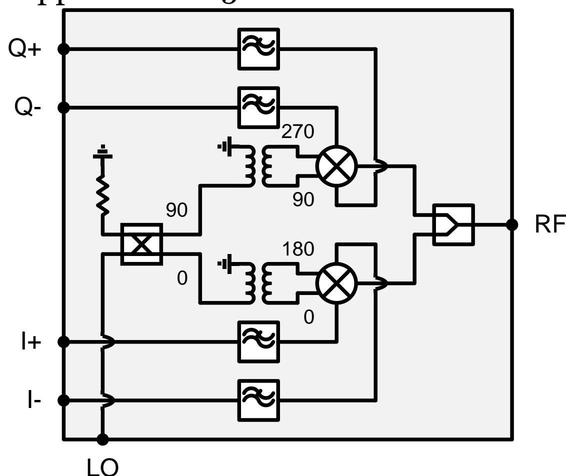

Figure 1. Block diagram of gMDR0040A

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Electrical Performance

Table 1. Electrical performance T_A=25C

Parameter	Min	Typ	Max	Unit
RF Frequency	92 (85)		114 (117)	GHz
LO Frequency	92 (85)		114 (117)	GHz
IF Frequency	DC		12	GHz
Conversion loss	9	10	12	dB
LO power	12	16	20	dBm
Power consumption		0		mW
OIP3		15		dBm
IIP3	21	23	25	dBm
OIP2		45		dBm
IIP2		TBD		dBm
Output referred P1dB	2			dBm
LO to RF isolation[1]		40		dB
Image Rejection		25		dB
RF return loss		8		dB
IF return loss		20		dB
LO return loss		20		dB

Measured Performance

The chip has been measured on-wafer using CW and 2-tone input test signals with ac-coupled I/Q-ports. If not mentioned otherwise, the transmitter uses typical settings specified in Table 2.

Table 2. Test conditions

Parameter	Setting
IF input power	-5 dBm/tone
IF input frequency	0.1 GHz
Frequency separation	10 MHz
Temperature	25°C
Gate bias (VG)	-0.8 V
LO frequency	100 GHz
LO power	16 dBm

Table 3. Absolute Maximum Ratings

[1] Apply I+, I-, Q+ and Q- DC offset voltage for LO cancellation.

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Gate bias voltage	-2 to + 0.7 V
IF in (I/I_/Q/Q_)	+13 dBm/ch.
IF in (I/I_/Q/Q_)	5 Vpp/ch.
I and Q common-mode voltage	-0.5 to +0.5 V
LO drive	+23 dBm
Operating temperature	-40 to +85°C
Storage temperature	-65 to +150°C

PORT IMPEDANCES

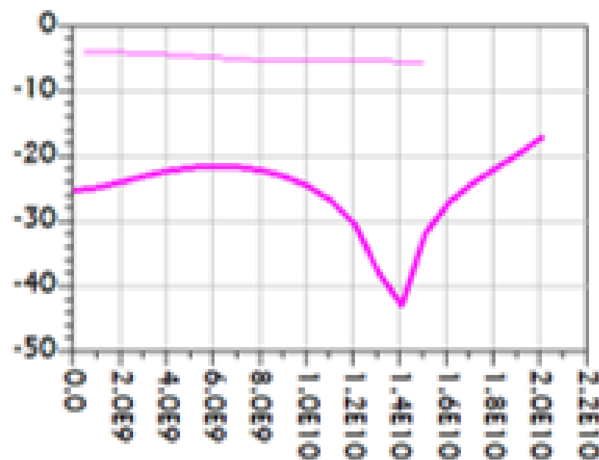

Figure 1. I/Q differential (pink) return loss vs frequency.

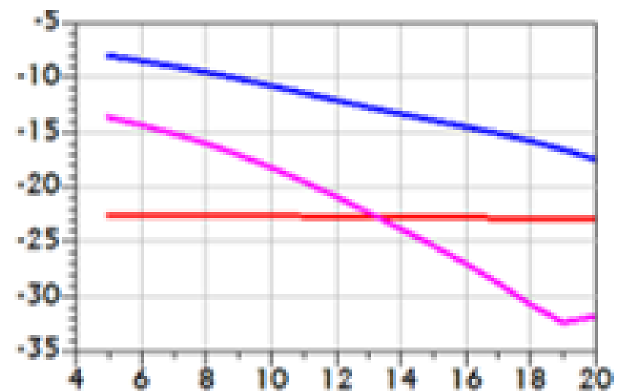

Figure 2. LO (red), RF (blue) and I/Q differential (pink) return loss vs LO power.

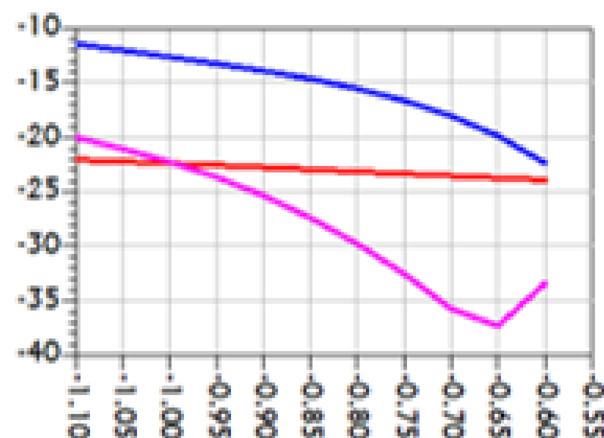

Figure 3. LO (red), RF (blue) and I/Q differential (pink) return loss vs VG.

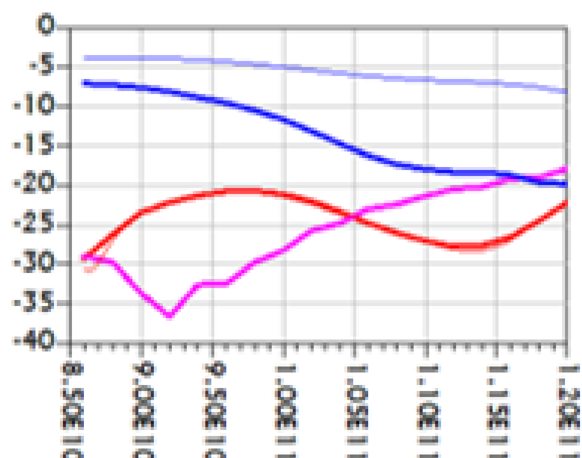

Figure 4. LO (red), RF (blue) and I/Q differential (pink) return loss vs frequency. I/Q differential return loss is fixed at 100 MHz.

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UP-CONVERSION

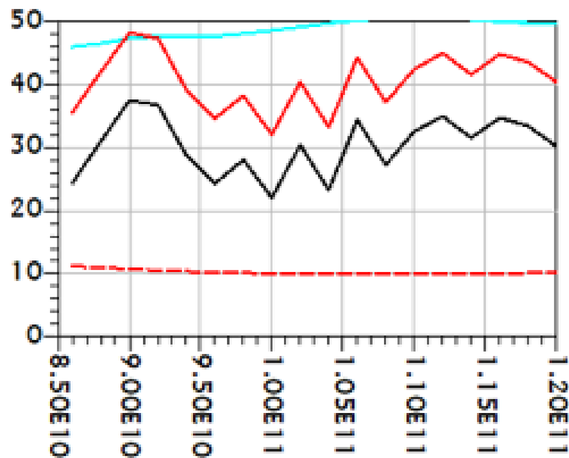

Figure 5. CL (dashed red), IRR (black) and LO-isolation (cyan) vs RF frequency.

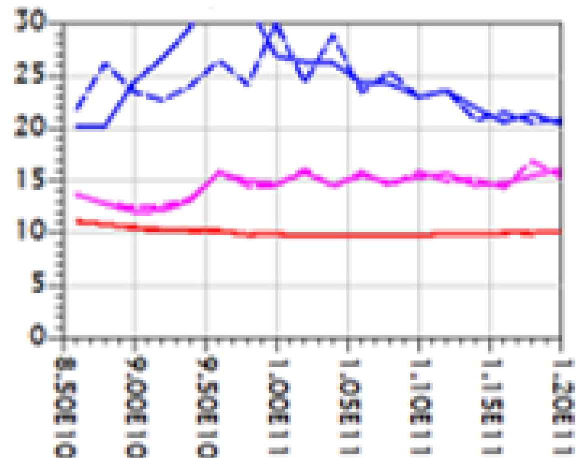

Figure 6. CL (red), IIP3 (blue) and IIP5 (pink) vs RF frequency.

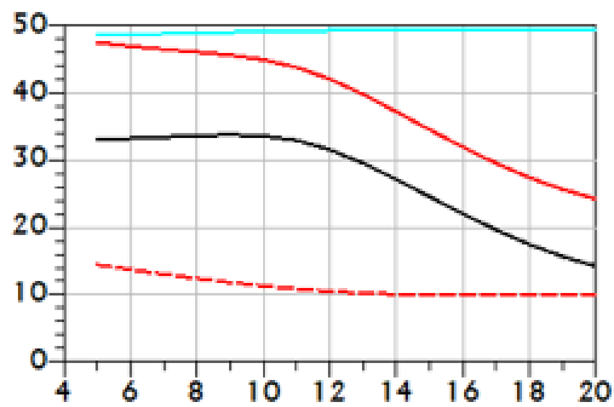

Figure 7. CL (dashed red), IRR (black) and LO-isolation (cyan) vs LO power in dBm.

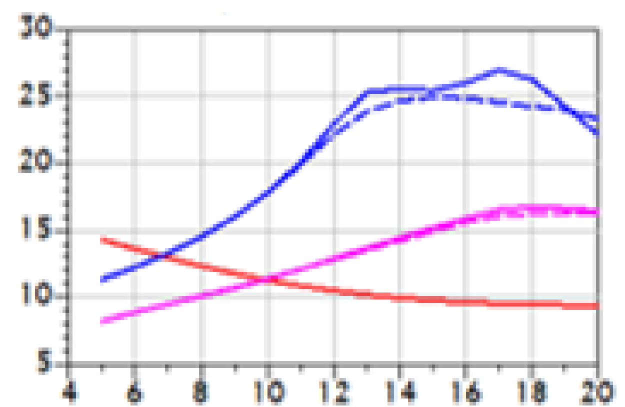

Figure 8. CL (red), IIP3 (blue) and IIP5 (pink) vs LO power in dBm.

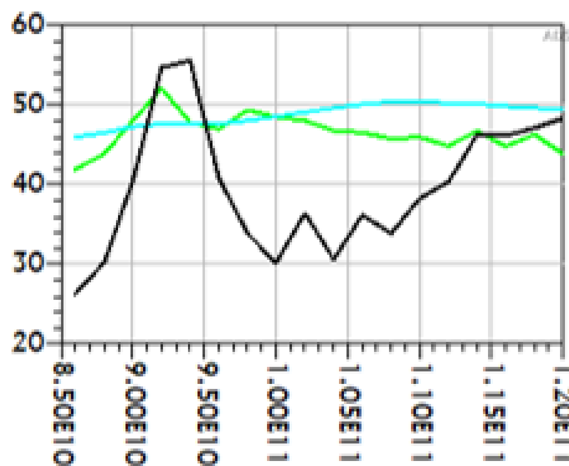

Figure 9. OIP2 (green), IRR (black) and LO-isolation (cyan) vs RF frequency.

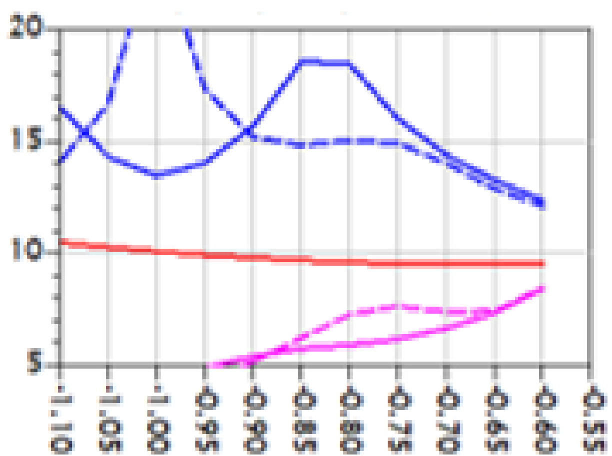

Figure 10. CL (red), OIP3 (blue) and OIP5 (pink) vs VG.

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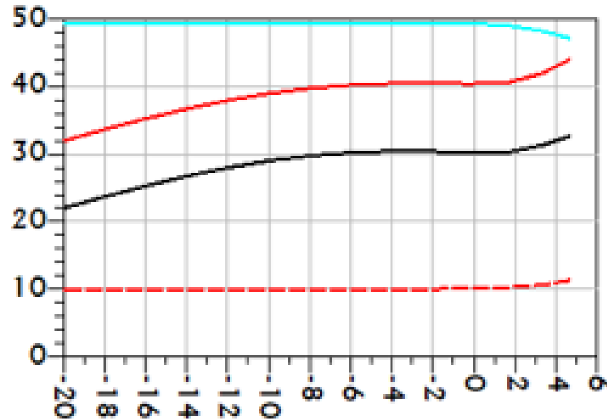

Figure 11. CL (dashed red), IRR (black) and LO isolation (cyan) vs RF output power in dBm.

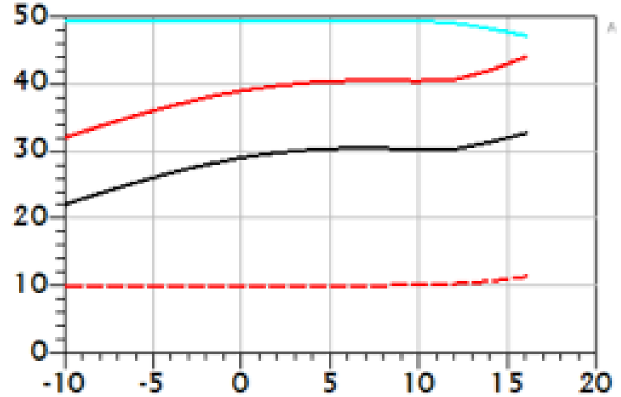

Figure 12. CL (dashed red), IRR (black) and LO isolation (cyan) vs IF input power in dBm.

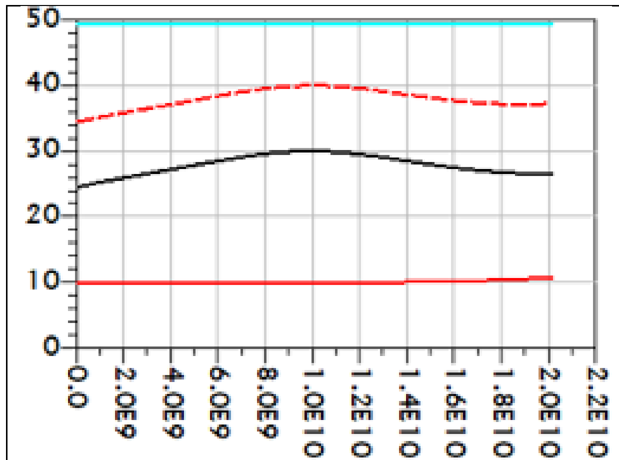

Figure 13. CL (solid red), IRR (black) and LO isolation (cyan) vs IF frequency.

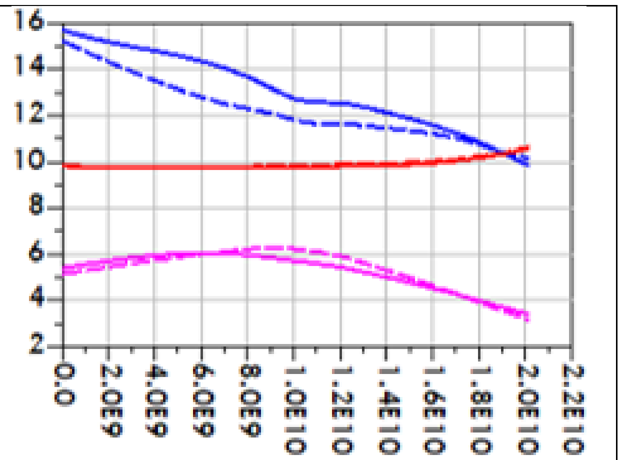

Figure 14. CL (red), OIP3 (blue) and OIP5 (pink) vs IF frequency.

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RECOMMENDED OPERATING CONDITIONS

Table 4. Electrical settings on connector P1

Connector P1	Pad No.	Bias settings (V/mA)			I/O
		Min	Typ	Max	
NC	1				
GND	2				
VG_MIX	3	-1.2	-0.8	-0.6	Input

Table 5. Electrical settings on connector P2

Connector P2	Pad No.	Interface	I/O
GND	4		Ground
RF	5	Z_0 = 50 Ohm, AC coupled	Input/ Output
GND	6		Ground

Table 6. Electrical settings on connector P3

Connector P3	Pad No.	Interface	I/O
GND	7		Ground
LO	8	Z_0 = 50 Ohm, AC coupled	Input
GND	9		Ground

Table 7. Electrical settings on connector P4

Connector P4	Pad No.	Interface	I/O
GND	10		Ground
I-	11	Z_0 = 100 Ohm differential impedance, DC coupled	Input/ Output
I+	12		Input/ Output
GND	13		Ground
Q-	14	Z_0 = 100 Ohm differential impedance, DC coupled	Input/ Output
Q+	15		Input/ Output
GND	16		Ground

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Assembly Diagram

Assemble the chip with external components according to Figure 15.

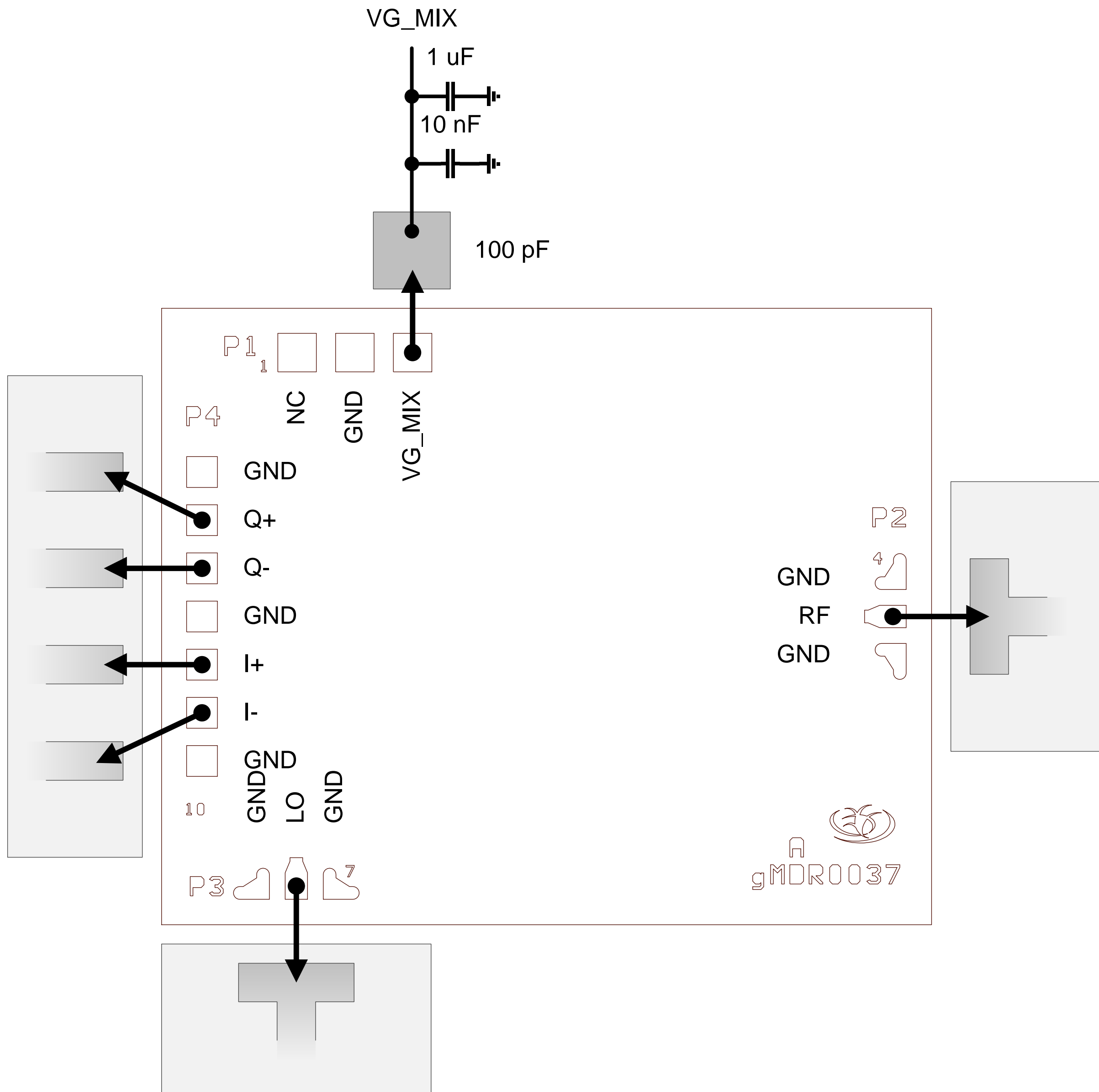

Figure 15. Assembly diagram of the chip.

Assembly Guidelines

Mount the die to an electrically grounded plane with excellent thermal properties. Make sure the surface is clean and flat before attaching the die. Both solder and epoxy can be used, we recommend eg. CM 124-08 silver epoxy.

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BONDING

The LO and RF ports are pre-matched to 50 Ohm at the pad. The I+, I-, Q+ and Q- ports are pre-matched to 100 Ohm differential characteristic impedance. For optimum performance keep bondwires as short as possible and apply an external bondwire inductance matching network. Bonding outside the area of a pad may damage the passivation layer.

DC BYPASS

For stable operation locate external DC bypass capacitors near the die to reduce the bondwire length and corresponding inductance. See assembly diagram for a recommended bypass network. Use high quality SLCs, eg. CSM-200-10X10X5-G-101-Y and low ESR ceramic or tantalum SMD capacitors.

AC OR DC COUPLING

The I+, I-, Q+ and Q- ports can be configured both dc or ac-coupled. When configured for ac operation, select external components with good RF performance to support wide bandwidth baseband signals. For dc-coupled operation, common-mode voltage should be set to 0 V.

DIFFERENTIAL OR SINGLE-ENDED PORTS

For maximum performance it's preferred to acquire and process the signals differentially. For single-ended configurations, primerly convert the differential signal to single ended by using baluns such as XX. Using only one of the I+ and Q+ ports and terminating the I- and Q- ports with 50 Ohm reduces the performance of CL, IP3 and NF by a factor of 3 dB. Return loss of the I and Q ports and IP2 are affected negatively.

SINGLE SIDEBAND CONFIGURATION

For operating the MDR0040A modulator / demodulator as an image reject mixer, suppressing the lower sideband and thereby operating USB, configure the MDR0040A with external baluns and a 90 degree hybrid as shown in Figure 16. For LSB operation, interchange the 0 and 90 degree ports of the 90-degree hybrid.

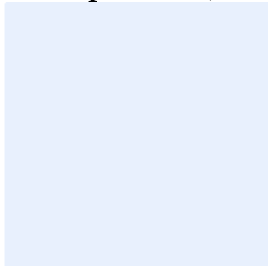

Figure 16. Configuration for operating as USB SSB mixer.

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OUTLINE DRAWING

Outline drawing shown in Figure 17. Drawing is also available in dxf-file format on request. The substrate thickness is 50 µm (GaAs).

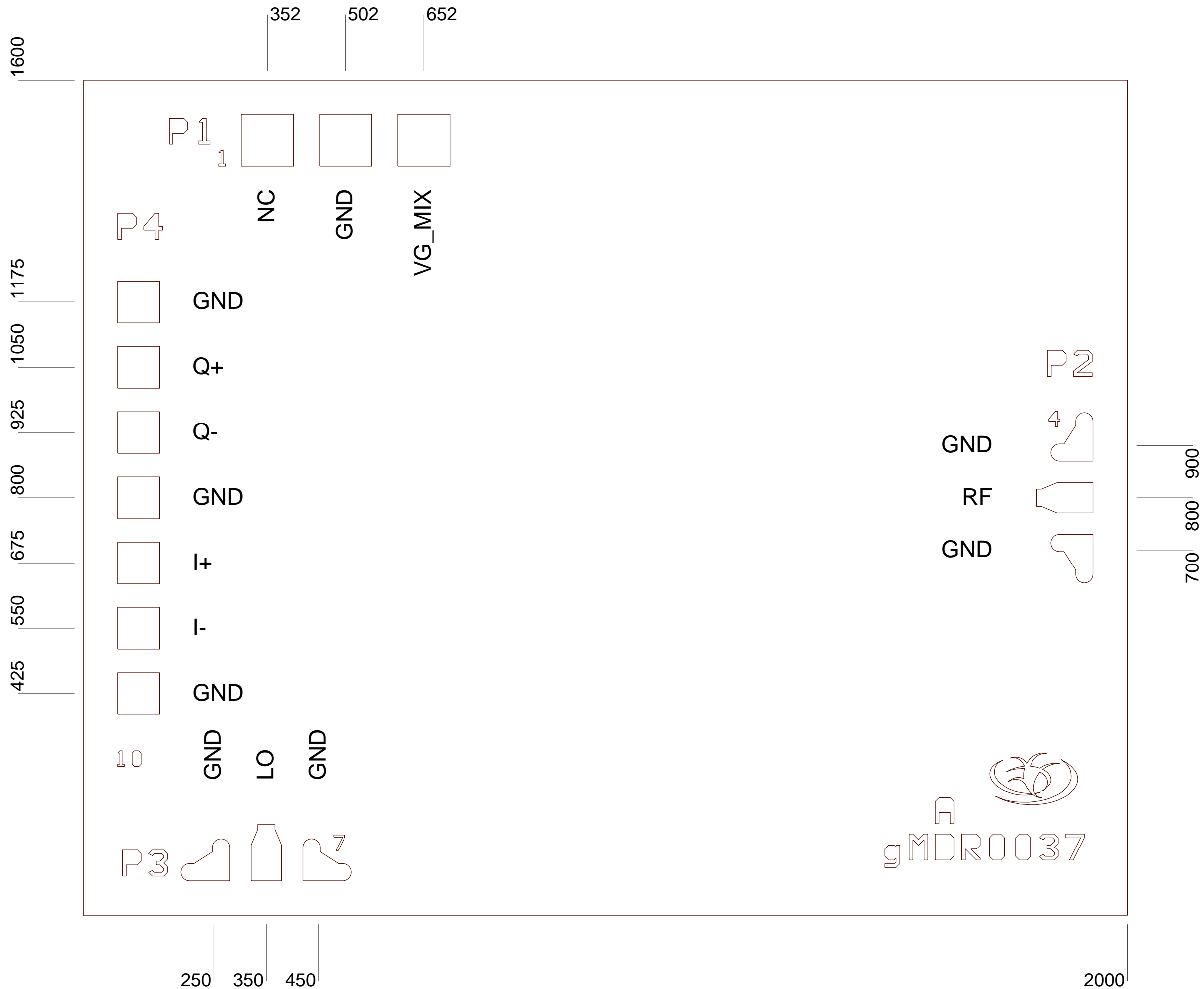

Figure 17. Outline drawing of the chip. Dimensions are in um.

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