
MITEQ
IMAGE REJECTION MIXER PRODUCTS
• IMAGE REJECTION MIXERS
• I/Q DEMODULATORS
• LOW-NOISE IMAGE REJECTION DOWNCONVERTER ASSEMBLIES

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IMAGE REJECTION PRODUCTS

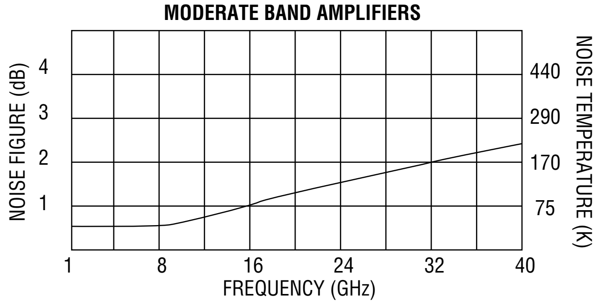
This detailed image rejection mixer section summarizes the important input, output and transfer characteristics of these devices. This catalog is also published on our web site: http://www.miteq.com. We look forward to helping you choose the best mixer from our increasing core of state-of-the-art products, so that your system will be more competitive in today's demanding marketplace. Most importantly, we are committed to satisfying not only the written technical specifications of any new product, but to ensure that the product satisfies its intended application requirements.

IMAGE REJECTION MIXER APPLICATION GUIDELINES

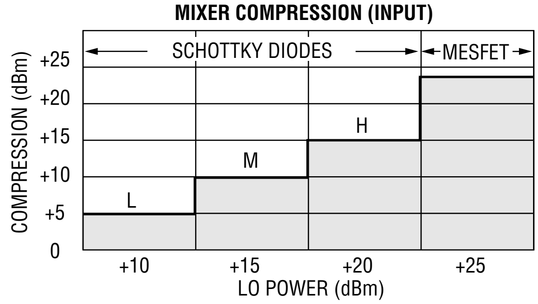
CRITICAL SPECIFICATIONS	BEST MODELS	CIRCUIT DESCRIPTION
Low cost/size	IR, IRM octave bands	Double balanced
Limited LO power	IRB, ARB series	Biasable bridge quad
Widest RF bandwidth	IRA0226 series	2 to 26 GHz, double balanced
Narrowest RF bandwidth	IR0325HA1	10% double-tuned baluns
Low I/Q DC offset	IR0502, IR0104, IR0208	Double balanced/tuned baluns
Lowest conversion loss	IR0325HA1	3.5 dB, tuned balun
Lowest noise figure	AR series	MITEQ LNA front ends
High image rejection	IRE, ARE series	Quadrature enhanced, 30 dB typ.
High IP^3, P1 dB	IRF series	Double balanced MESFET, +33 dBm typical
IF amplification	IRA, IRBA series	25 dB RF-to-IF gain
Integrated LO	LNB series	Block converter, triple balanced
Millimeter, 1/2 LO	ARE series	Back-to-back ring quads

TYPICAL PERFORMANCE RANGES

NOISE FIGURE VS. FREQUENCY
MODERATE BAND AMPLIFIERS



MIXER COMPRESSION (INPUT)



NOISE FIGURE VS. FREQUENCY
MULTIOCTAVE BAND AMPLIFIERS

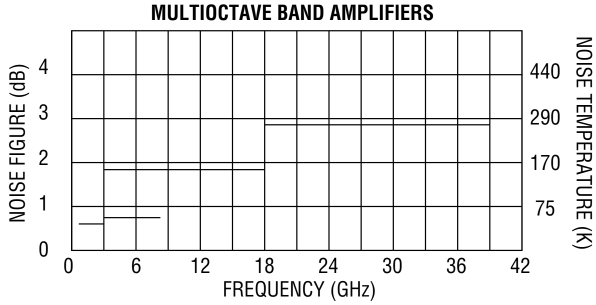


IMAGE REJECTION LIMITS

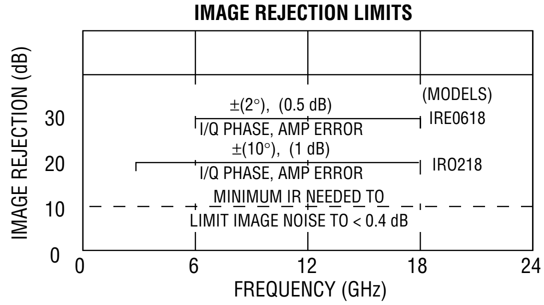
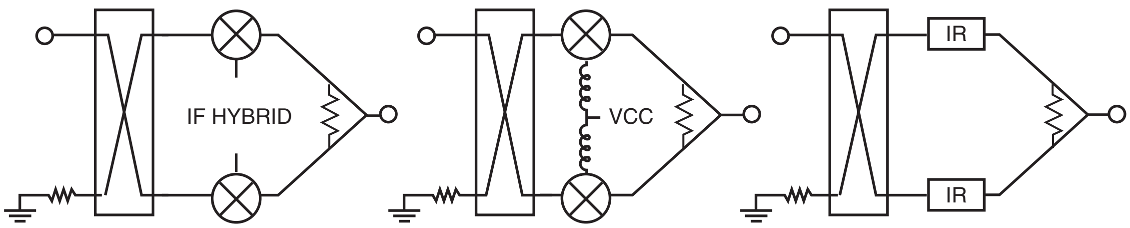


IMAGE REJECTION MIXERS AND I/Q DEMODULATORS



IR/IRM
Image Rejection

IRB
Biasable Image Rejection

IRE
Enhanced Image Rejection

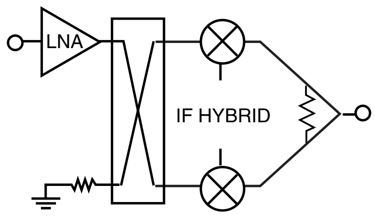
MODEL NUMBER	FREQUENCY RANGE RF AND LO (GHz)	IF (GHz) (Note 1)	NOMINAL LO POWER (dBm) (Note 2)	CONVERSION LOSS (dB) (Max.)	IMAGE REJECTION (dB) (Typ./Min.)	LO-RF ISOLATION (dB) (Typ./Min.)	INPUT IP^3 (dBm, Typ.) (Note 2)	NOTES	PAGE
IMAGE REJECTION MIXERS AND I/Q DEMODULATORS									
IR0502LC1	0.5 – 2	DC – 0.5	10 – 13	9.5	18 / 15	20 / 18	16		169
IR0102LC1	1 – 2	DC – 0.5	10 – 13	8	23 / 18	40 / 30	16		171
IR0104LC1	1 – 4	DC – 0.5	10 – 13	9.5	20 / 18	20 / 18	16		173
IRM0204LC2	2 – 4	DC – 0.5	10 – 13	7.5	25 / 18	30 / 20	16		175
IRM0208LC2	2 – 8	DC – 0.5	10 – 13	9	20 / 18	20 / 18	16		177
IRM0408LC2	4 – 8	DC – 0.5	10 – 13	8	23 / 18	30 / 20	16		179
IR0708LI3Q	7.2 – 8.4	DC – 0.25	10 – 13	10.5	30 / 25	30 / 25	15		181
IRM0812LC2	8 – 12	DC – 0.5	10 – 13	8	23 / 18	30 / 20	16		183
IRM0118LC1	1 – 18	DC – 0.5	10 – 13	11	20 / 15	20 / 18	16		185
IRM0618LC2	6 – 18	DC – 0.5	10 – 13	10	20 / 18	20 / 18	16		187
IRM0218LC1	2 – 18	DC – 0.5	10 – 13	11	20 / 18	20 / 18	18		189
IRM1218LC2	12 – 18	DC – 0.5	10 – 13	10	20 / 18	23 / 20	16		191
IRM0226LC1	2 – 26	DC – 0.5	10 – 13	14.5	18 / 15	18 / 15	18		193
IR1826NI7	18 – 26	DC – 0.5	16 – 18	10.5	17 / 15	25 / 20	17		195
IR2640NI7	26 – 40	DC – 0.5	16 – 18	10.5	17 / 15	20 / 15	17		197
IRJ085095U	8.5 – 9.5	0.02 – 0.2	7 – 9	8	25 / 18	35 / 30	14		199
IRJ085095L	8.5 – 9.5	80 – 160	7 – 9	8	25 / 18	35 / 30	14		201
ENHANCED IMAGE REJECTION MIXERS									
IRE0208LI1	2 – 8	0.02 – 0.2	13 – 15	9.5	30 / 25	30 / 24	18		203
IRE0618LI1	6 – 18	0.02 – 0.2	13 – 15	10.5	35 / 25	30 / 24	18		205
BIASABLE IMAGE REJECTION MIXERS									
IRB0218LC1	2 – 18	0.02 – 0.2	-10 – +13	12.5	20 / 18	18 / 15	0		207
I/Q PHASE DETECTOR WITH OPTIONAL VIDEO AMPS AND/OR DIGITAL OUTPUT									
IQM16020	.150 – .170	Video	10 – 13	10	N/A	N/A	N/A		209
IQD/IQDD16020	.150 – .170	Video	10 – 13	3.5K	N/A	N/A	N/A		209

GENERAL

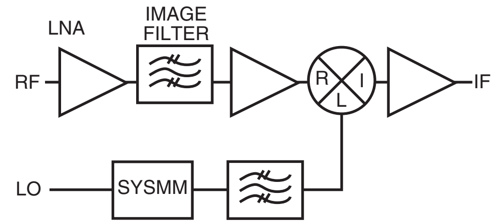
The output power capability of mixers (with and without LNAs) is chiefly determined by the LO power used. The specifications shown are mostly mixers using low-level Schottky diodes, but in all cases higher level H diodes are available requiring 10 dB more LO power and yielding a proportional increase in IF output capability. For extremely high dynamic range, with limited LO power, MESFET mixers with DC bias can be used. Conversely, for applications requiring smallest LO power (-10 dBm), where high IF output power is not required, DC biased Schottky diode designs (IRB) are cost effective.

I/Q demodulators (Q option) operate with output frequencies near DC and, therefore, do not use an IF hybrid. These units are otherwise similar to image rejection circuits with special emphasis on high LO-to-RF isolation which insures low DC output offset voltages. Each I and Q output will have 3 dB more conversion loss than that of the combined image rejection unit.

LOW-NOISE IMAGE REJECTION DOWNCONVERTER ASSEMBLIES AND I/Q DEMODULATORS



AR/ARM
Low-Noise Image Rejection
Mixer Assembly



SYSMM
Low-Noise Multiplied
LO Mixer Assembly

MODEL NUMBER	FREQUENCY RANGE RF AND LO (GHz)	FREQUENCY RANGE IF (GHz) (Note 1)	NOMINAL LO POWER (dBm) (Note 2)	RF-IF GAIN (dB) (Typ./Min.)	NOISE FIGURE (dB) (Max.)	IMAGE REJECTION (dB) (Min.)	OUTPUT IP^3 (dBm, Typ.) (Note 2)	NOTES	PAGE
IMAGE REJECTION MIXERS WITH INTEGRATED IF AMPLIFIERS									
IRBA0226LC1	2 – 26	0.02 – 0.2	-10 – +13	20 / 15	16 (Typ.)	15	15		211
IRA0226LC1	2 – 26	0.02 – 0.2	10 – 13	23 / 20	15 (Typ.)	15	20		213
IRA5459LR1	5.4 – 5.9	0.02 – 0.2	7 – 10	23 / 20	6	20	13		215
IRA8596LR1	8.5 – 9.6	0.02 – 0.2	7 – 10	23 / 20	6.5	20	13		217
LOW-NOISE IMAGE REJECTION DOWNCONVERTER ASSEMBLIES									
ARM0204LC2	2 – 4	0.02 – 0.2	10 – 13	30 / 27	1.8	18	16		219
ARM0208LC2	2 – 8	0.02 – 0.2	10 – 13	30 / 27	2.2	18	16		221
ARM0408LC2	4 – 8	0.02 – 0.2	10 – 13	30 / 27	2	18	16		223
ARL5359LC2	5.3 – 5.9	0.02 – 0.2	10 – 13	33 / 30	3.5	18	16	Limiter	225
ARM0812LC2	8 – 12	0.02 – 0.2	10 – 13	30 / 27	2.5	18	16		227
ARM0618LC2	6 – 18	0.02 – 0.2	10 – 13	24 / 22	4	18	15		229
ARM1218LC2	12 – 18	0.02 – 0.2	10 – 13	30 / 27	3.5	18	16		231
AR1826LI8	18 – 26	0.02 – 0.2	16 – 18	38 / 31	3.3	18	10		233
AR2640LI8	26 – 40	0.02 – 0.2	16 – 18	32 / 25	4	18	15		234
ARZ0227	8.5 – 9.6	0.054 – 0.066	-3 – +3	33 / 32	1.2	25	17		235
ARZ9910N01R	9.9 – 10.4	0.001 – 0.02	14 – 16	21 / 16	3	15	13		237
SBWA3435N01R	34.5 – 35.5	0.02 – 0.2	2 – 4	16 / 13	6	15	13		239
AR1314N01R	12-5 – 14.5 / 10.5	2 – 4	12 – 18	33 / 28	2.9	15	18		241
SYSMM1X3032	30 – 32 / 28	2 – 4	10 – 14	30 / 25	2.8	15	17		243
SYSMM2X3032	30 – 32 / 14	2 – 4	10 – 14	30 / 25	2.8	15	17		243
SYSMM3X3032	30 – 32 / 9.33	2 – 4	10 – 14	30 / 25	2.8	15	17		243
SYSMM1X3436	34 – 36 / 32	2 – 4	10 – 14	37 / 31	3.3	15	17		245
SYSMM2X3436	34 – 36 / 16	2 – 4	10 – 14	37 / 31	3.3	15	17		245
SYSMM3X3436	34 – 36 / 10.67	2 – 4	10 – 14	37 / 31	3.3	15	17		245
SYSMM1X3638	36 – 38 / 34	2 – 4	10 – 14	37 / 31	3.3	15	17		247
SYSMM2X3638	36 – 38 / 17	2 – 4	10 – 14	37 / 31	3.3	15	17		247
SYSMM3X3638	36 – 38 / 11.33	2 – 4	10 – 14	37 / 31	3.3	15	17		247
SYSMM1X4345	43 – 45 / 41	2 – 4	11 – 14	29 / 24	4.5	15	17		249
SYSMM2X4345	43 – 45 / 20.5	2 – 4	11 – 14	29 / 24	4.5	15	17		249
SYSMM3X4345	43 – 45 / 13.67	2 – 4	11 – 14	29 / 24	4.5	15	17		249

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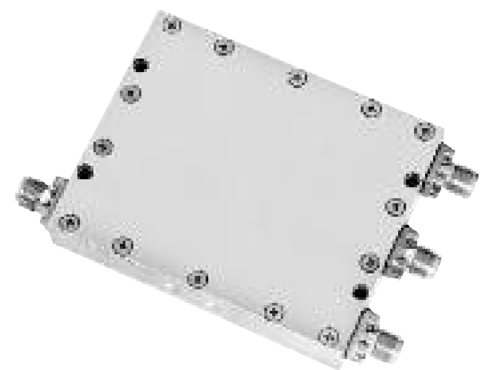
0.5 TO 2 GHz IMAGE REJECTION OR I/Q MIXERS

MODELS: IR0502LC1A, IR0502LC1B, IR0502LC1C AND IR0502LC1Q

FEATURES

- **RF/LO coverage .... 0.5 to 2 GHz**
- **IF operation .... DC to 0.5 GHz**
- **Conversion loss................ 8.5 dB typical**
- **Image rejection .... 18 dB typical**



ELECTRICAL SPECIFICATIONS

INPUT PARAMETERS	CONDITION	UNITS	MIN.	TYP.	MAX.
RF frequency range		GHz	0.5		2
RF VSWR (RF = -10 dBm)		Ratio		2:1	
LO frequency range		GHz	0.5		2
LO power range	IR0502LC1	dBm	+10	+12	+13
	IR0502MC1	dBm	+13	+15	+16
	IR0502HC1	dBm	+17	+18	+20
LO VSWR		Ratio		2.5:1	
TRANSFER CHARACTERISTICS	**CONDITION**	**UNITS**	**MIN.**	**TYP.**	**MAX.**
Conversion loss (Note 1)	RF > LO	dBm		8.5	9.5
	IR0502LC1Q	dB		11.5	12.5
Single-sideband noise figure		dB		10	
Image rejection (Note 1)	RF < LO	dB	15	18	
LO-to-RF isolation		dB	18	20	
LO-to-IF isolation		dB		20	
Input power at 1 dB compression	IR0502LC1	dBm		+6	
	IR0502MC1	dBm		+10	
	IR0502HC1	dBm		+15	
Input two-tone third-order intercept point	IR0502LC1	dBm		+16	
	IR0502MC1	dBm		+20	
	IR0502HC1	dBm		+25	
Amplitude balance	IR0502LC1Q	dB			±1.5
Phase balance	IR0502LC1Q	Degrees			±10
Truth table	IR0502LC1Q		**Port**	**RF < LO**	**RF > LO**
			I	0	-90
			Q	-90	0
OUTPUT PARAMETERS	**CONDITION**	**UNITS**	**MIN.**	**TYP.**	**MAX.**
IF frequency (image rejection mode)	IR0502LC1A	MHz	20		40
	IR0502LC1B	MHz	40		80
	IR0502LC1C	MHz	100		200
IF frequency (QIFM, I/Q demodulator mode)	IR0502LC1Q	MHz	DC		500
IF VSWR (IF = -10 dBm)		Ratio		1.5:1	

Revised: 06/18/12

IR0502LC1 TYPICAL TEST DATA

VSWR
(LO = +13 dBm)

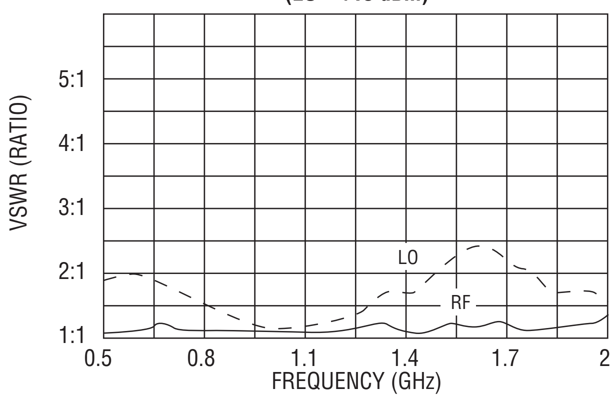
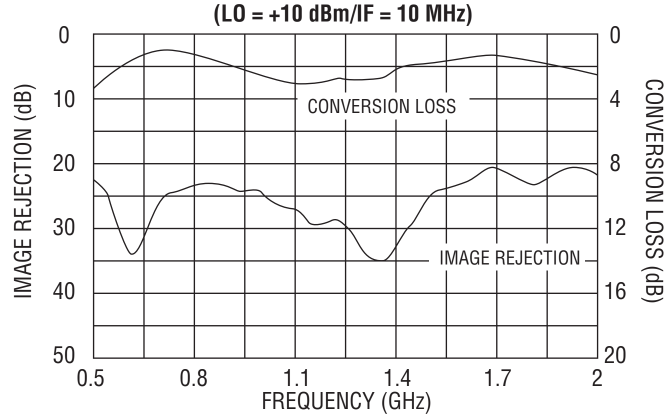
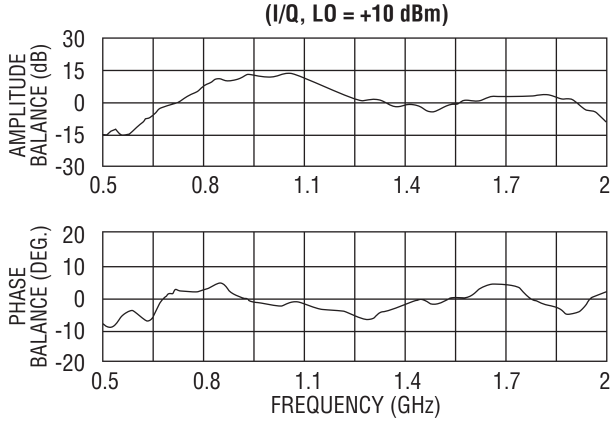


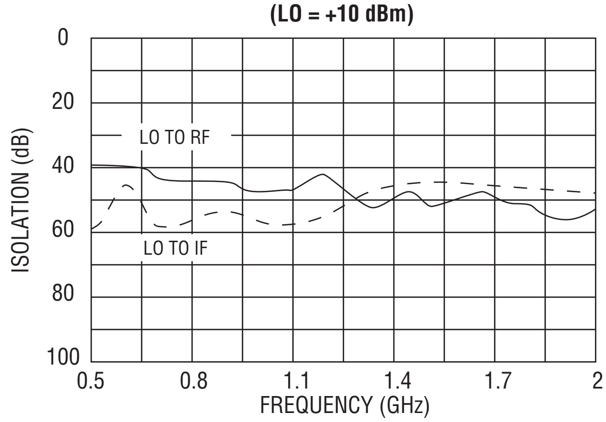
IMAGE REJECTION/CONVERSION LOSS
(LO = +10 dBm/IF = 10 MHz)



AMPLITUDE AND PHASE BALANCE
(I/Q, LO = +10 dBm)



ISOLATION
(LO = +10 dBm)



MAXIMUM RATINGS

Specification temperature.................... +25°C
Operating temperature .... -54 to +85°C
Storage temperature .... -65 to +125°C

GENERAL NOTE

1. Standard catalog unit aligned and tested for guaranteed RF > LO performance. RF < LO guaranteed performance is available, please contact MITEQ.

NOTE: Test data supplied at 25°C; conversion loss, LO-to-RF isolation, image rejection (IF Options A, B and C), phase and amplitude balance (IF Option Q).

OUTLINE DRAWINGS

IR0502LC1A, B and C

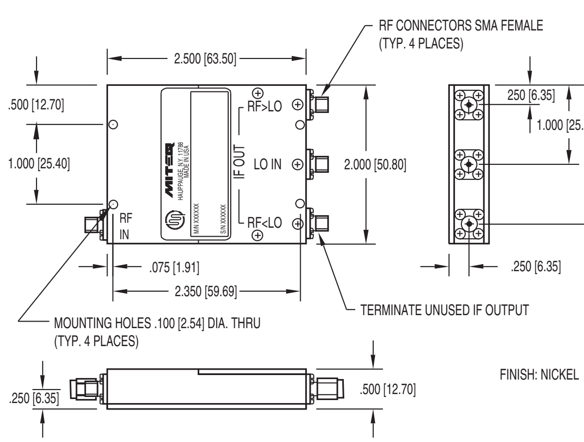
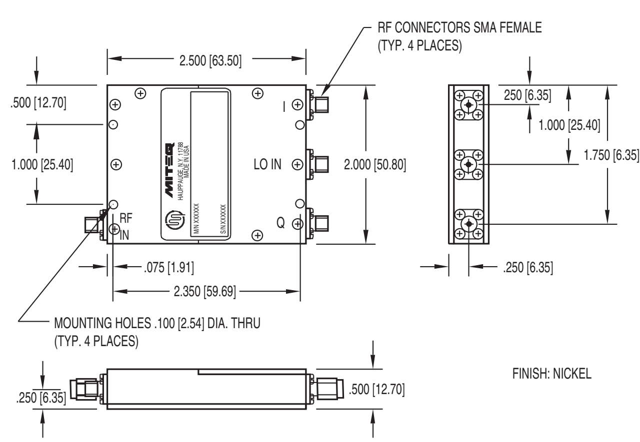


IMAGE REJECTION

IR0502LC1Q



QIFM, I/Q DEMODULATOR

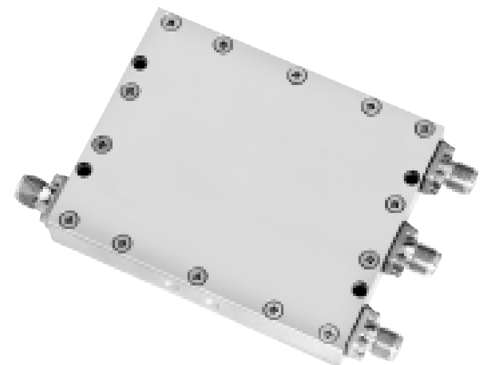
NOTE: All dimensions shown in brackets [ ] are in millimeters.

1 TO 2 GHz IMAGE REJECTION OR I/Q MIXERS

MODELS: IR0102LC1A, IR0102LC1B, IR0102LC1C AND IR0102LC1Q

FEATURES

- **RF/LO coverage .... 1 to 2 GHz**
- **IF operation .... DC to 0.5 GHz**
- **Conversion loss .... 6.5 dB typical**
- **Image rejection .... 23 dB typical**



ELECTRICAL SPECIFICATIONS

INPUT PARAMETERS	CONDITION	UNITS	MIN.	TYP.	MAX.
RF frequency range		GHz	1		2
RF VSWR (RF = -10 dBm)		Ratio		2:1	
LO frequency range		GHz	1		2
LO power range	IR0102LC1	dBm	+10	+12	+13
	IR0102MC1	dBm	+13	+15	+16
	IR0102HC1	dBm	+17	+18	+20
LO VSWR		Ratio		2.5:1	
TRANSFER CHARACTERISTICS	**CONDITION**	**UNITS**	**MIN.**	**TYP.**	**MAX.**
Conversion loss (Note 1)	RF > LO	dBm		6.5	8
	IR0102LC1Q	dB		9.5	11
Single-sideband noise figure		dB		8.5	
Image rejection (Note 1)	RF < LO	dB	18	23	
LO-to-RF isolation		dB	30	40	
LO-to-IF isolation		dB		20	
Input power at 1 dB compression	IR0102LC1	dBm		+6	
	IR0102MC1	dBm		+10	
	IR0102HC1	dBm		+15	
Input two-tone third-order intercept point	IR0102LC1	dBm		+16	
	IR0102MC1	dBm		+20	
	IR0102HC1	dBm		+25	
Amplitude balance	IR0102LC1Q	dB			±1.5
Phase balance	IR0102LC1Q	Degrees			±12.5
Truth table	IR0102LC1Q		**PORT**	**RF < LO**	**RF > LO**
			I	0	-90
			Q	-90	0
OUTPUT PARAMETERS	**CONDITION**	**UNITS**	**MIN.**	**TYP.**	**MAX.**
IF frequency (image rejection mode)	IR0102LC1A	MHz	20		40
	IR0102LC1B	MHz	40		80
	IR0102LC1C	MHz	100		200
IF frequency (QIFM, I/Q demodulator mode)	IR0102LC1Q	MHz	DC		500
IF VSWR (IF = -10 dBm)		Ratio		1.5:1	

IR0102LC1B TYPICAL TEST DATA

VSWR
(LO = +10 dBm)

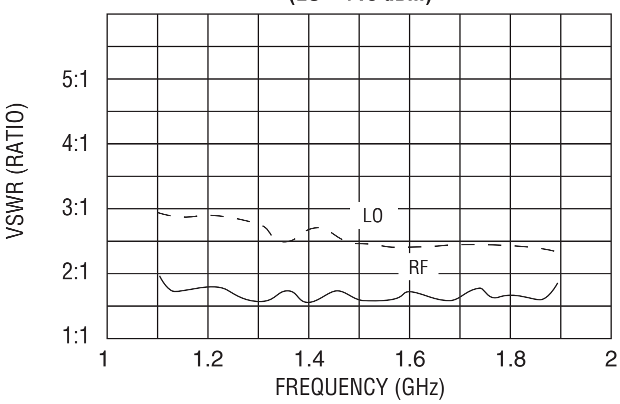
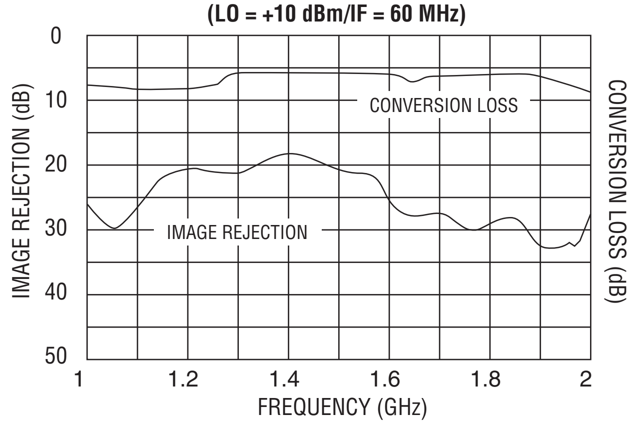
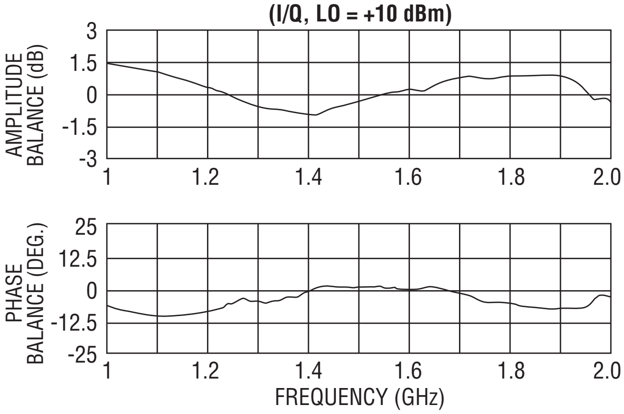


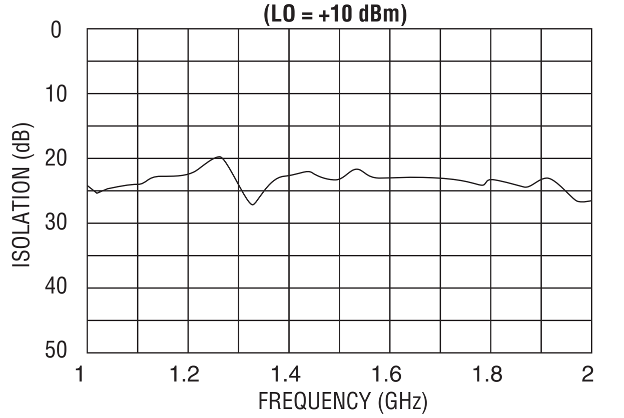
IMAGE REJECTION/CONVERSION LOSS
(LO = +10 dBm/IF = 60 MHz)



AMPLITUDE AND PHASE BALANCE
(I/Q, LO = +10 dBm)



LO-TO-RF ISOLATION
(LO = +10 dBm)



MAXIMUM RATINGS

Specification temperature.................... +25°C
Operating temperature .... -54 to +85°C
Storage temperature .... -65 to +125°C

GENERAL NOTE

1. Standard catalog unit aligned and tested for guaranteed RF > LO performance. RF < LO guaranteed performance is available, please contact MITEQ.

NOTE: Test data supplied at 25°C; conversion loss, LO-to-RF isolation, image rejection (IF Options A, B and C), phase and amplitude balance (IF Option Q).

OUTLINE DRAWINGS

IR0102LC1A, B and C

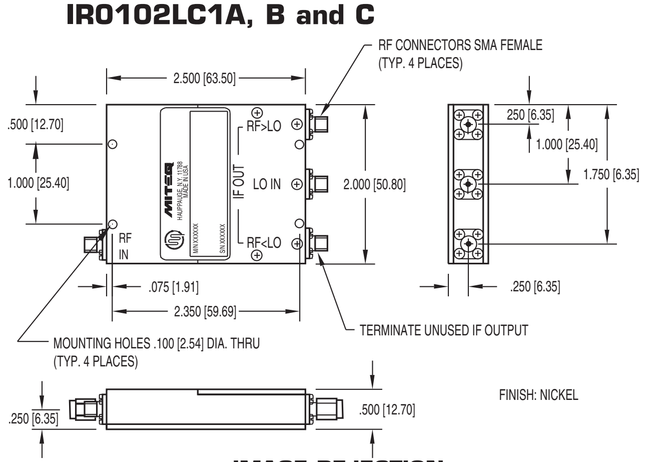
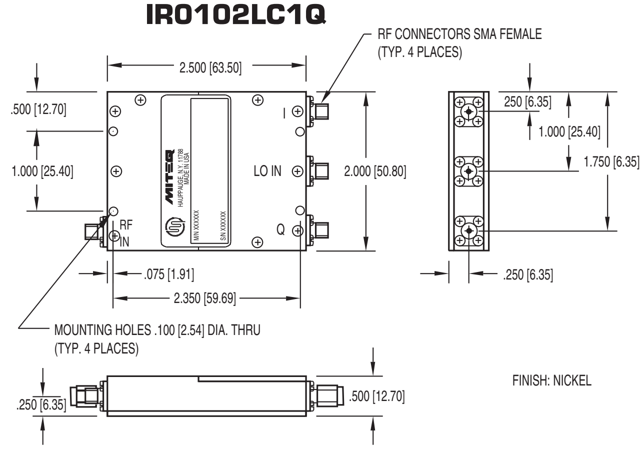


IMAGE REJECTION

IR0102LC1Q



QIFM, I/Q DEMODULATOR

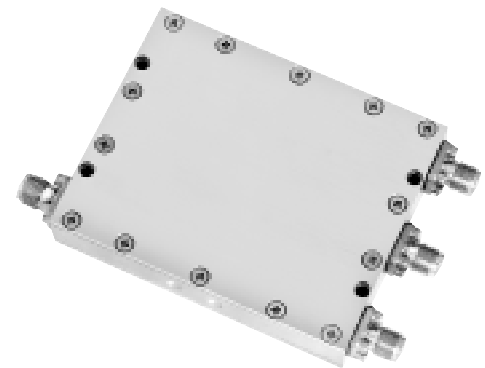
NOTE: All dimensions shown in brackets [ ] are in millimeters.

1 TO 4 GHz IMAGE REJECTION OR I/Q MIXERS

MODELS: IR0104LC1A, IR0104LC1B, IR0104LC1C AND IR0104LC1Q

FEATURES

- **RF/LO coverage................ 1 to 4 GHz**
- **IF operation....................... DC to 0.5 GHz**
- **Conversion loss................ 8 dB typical**
- **Image rejection .... 20 dB typical**



ELECTRICAL SPECIFICATIONS

INPUT PARAMETERS	CONDITION	UNITS	MIN.	TYP.	MAX.
RF frequency range		GHz	1		4
RF VSWR (RF = -10 dBm)		Ratio		2:1	
LO frequency range		GHz	1		4
LO power range	IR0104LC1	dBm	+10	+12	+13
	IR0104MC1	dBm	+13	+15	+16
	IR0104HC1	dBm	+17	+18	+20
LO VSWR		Ratio		2.5:1	
TRANSFER CHARACTERISTICS	**CONDITION**	**UNITS**	**MIN.**	**TYP.**	**MAX.**
Conversion loss (Note 1)	RF > LO	dBm		8	9.5
	IR0104LC1Q	dB		11	12.5
Single-sideband noise figure		dB		10	
Image rejection (Note 1)	RF < LO	dB	18	20	
LO-to-RF isolation		dB	18	20	
LO-to-IF isolation		dB		20	
Input power at 1 dB compression	IR0104LC1	dBm		+6	
	IR0104MC1	dBm		+10	
	IR0104HC1	dBm		+15	
Input two-tone third-order intercept point	IR0104LC1	dBm		+16	
	IR0104MC1	dBm		+20	
	IR0104HC1	dBm		+25	
Amplitude balance	IR0104LC1Q	dB			±1.5
Phase balance	IR0104LC1Q	Degrees			±12.5
Truth table	IR0104LC1Q		**PORT**	**RF < LO**	**RF > LO**
			I	0	-90
			Q	-90	0
OUTPUT PARAMETERS	**CONDITION**	**UNITS**	**MIN.**	**TYP.**	**MAX.**
IF frequency (image rejection mode)	IR0104LC1A	MHz	20		40
	IR0104LC1B	MHz	40		80
	IR0104LC1C	MHz	100		200
IF frequency (QIFM, I/Q demodulator mode)	IR0104LC1Q	MHz	DC		500
IF VSWR (IF = -10 dBm)		Ratio		1.5:1	

IR0104LC1C TYPICAL TEST DATA

VSWR
(LO = +13 dBm)

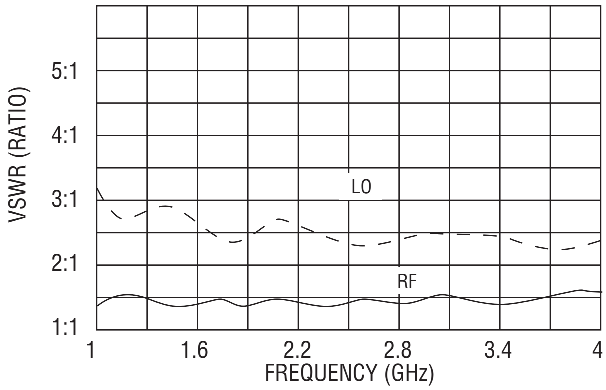
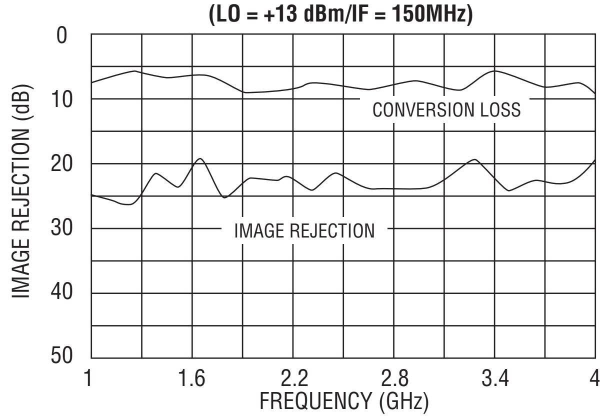
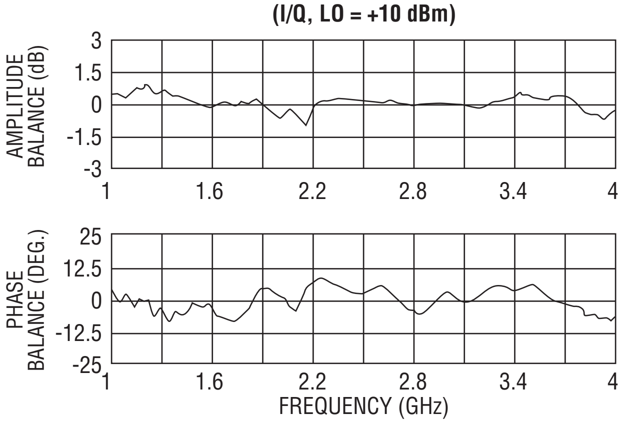


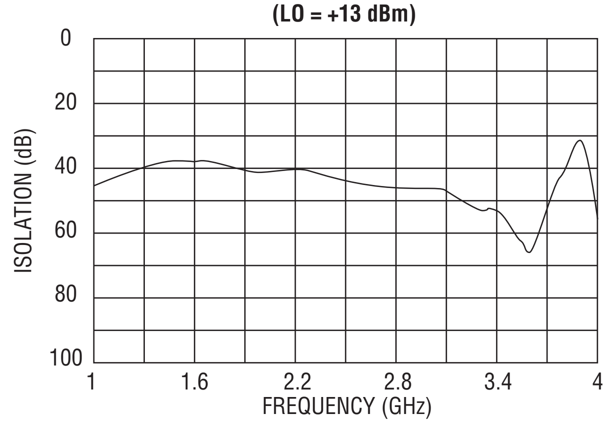
IMAGE REJECTION/CONVERSION LOSS
(LO = +13 dBm/IF = 150MHz)



AMPLITUDE AND PHASE BALANCE
(I/Q, LO = +10 dBm)



LO-TO-RF ISOLATION
(LO = +13 dBm)



MAXIMUM RATINGS

Specification temperature.................... +25°C
Operating temperature .... -54 to +85°C
Storage temperature .... -65 to +125°C

GENERAL NOTE

1. Standard catalog unit aligned and tested for guaranteed RF > LO performance. RF < LO guaranteed performance is available, please contact MITEQ.

NOTE: Test data supplied at 25°C; conversion loss, LO-to-RF isolation, image rejection (IF Options A, B and C), phase and amplitude balance (IF Option Q).

OUTLINE DRAWINGS

IR0104LC1A, B and C

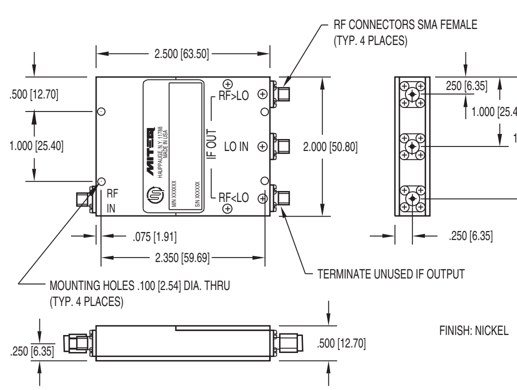
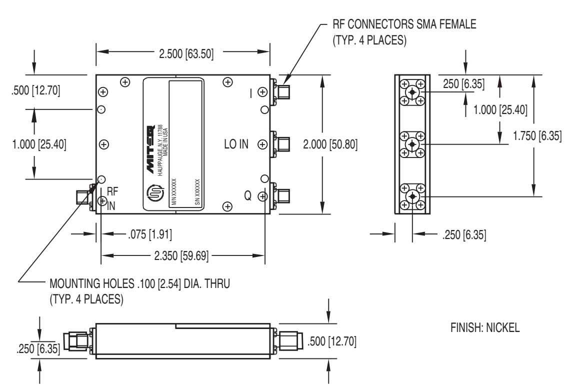


IMAGE REJECTION

IR0104LC1Q



QIFM, I/Q DEMODULATOR

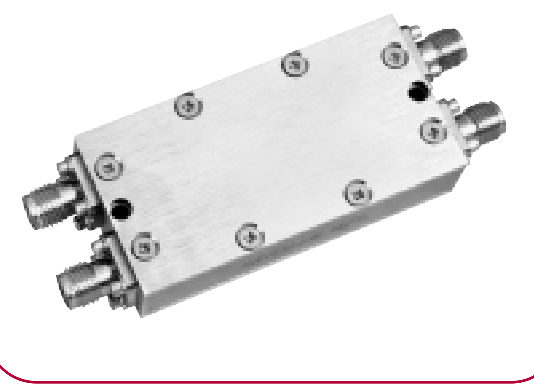
NOTE: All dimensions shown in brackets [ ] are in millimeters.

2 TO 4 GHz IMAGE REJECTION OR I/Q MIXERS

MODELS: IRM0204LC2A, IRM0204LC2B, IRM0204LC2C AND IRM0204LC2Q

FEATURES

- **RF/LO coverage................ 2 to 4 GHz**
- **IF operation....................... DC to 0.5 GHz**
- **Conversion loss................ 6 dB typical**
- **Image rejection .... 25 dB typical**



ELECTRICAL SPECIFICATIONS

INPUT PARAMETERS	CONDITION	UNITS	MIN.	TYP.	MAX.
RF frequency range		GHz	2		4
RF VSWR (RF = -10 dBm)		Ratio		2:1	
LO frequency range		GHz	2		4
LO power range	IRM0204LC2	dBm	+10	+12	+13
	IRM0204MC2	dBm	+13	+15	+16
	IRM0204HC2	dBm	+17	+18	+20
LO VSWR		Ratio		2.5:1	
TRANSFER CHARACTERISTICS	**CONDITION**	**UNITS**	**MIN.**	**TYP.**	**MAX.**
Conversion loss (Note 1)	RF > LO	dBm		6	7.5
	IRM0204LC2Q	dB		9	10.5
Single-sideband noise figure		dB		8	
Image rejection (Note 1)	RF < LO	dB	18	25	
LO-to-RF isolation		dB	20	30	
LO-to-IF isolation		dB		25	
Input power at 1 dB compression	IRM0204LC2	dBm		+6	
	IRM0204MC2	dBm		+10	
	IRM0204HC2	dBm		+15	
Input two-tone third-order intercept point	IRM0204LC2	dBm		+16	
	IRM0204MC2	dBm		+20	
	IRM0204HC2	dBm		+25	
Amplitude balance	IRM0204LC2Q	dB			±1.5
Phase balance	IRM0204LC2Q	Degrees			±10
Truth table	IRM0204LC2Q		**PORT**	**RF < LO**	**RF > LO**
			I	0	-90
			Q	-90	0
OUTPUT PARAMETERS	**CONDITION**	**UNITS**	**MIN.**	**TYP.**	**MAX.**
IF frequency (image rejection mode)	IRM0204LC2A	MHz	20		40
	IRM0204LC2B	MHz	40		80
	IRM0204LC2C	MHz	100		200
IF frequency (QIFM, I/Q demodulator mode)	IRM0204LC2Q	MHz	DC		500
IF VSWR (IF = -10 dBm)		Ratio		1.5:1	

IRM0204LC2A TYPICAL TEST DATA

VSWR
(LO = +10 dBm)

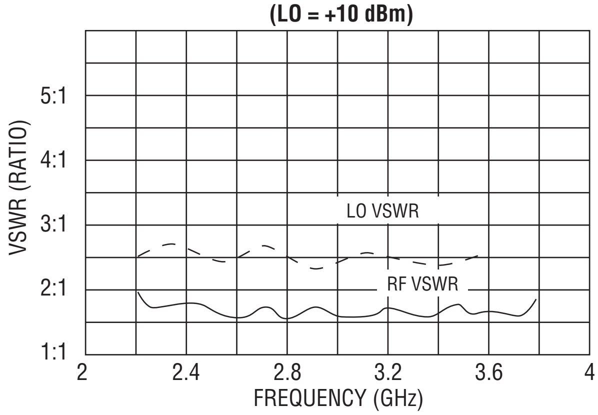
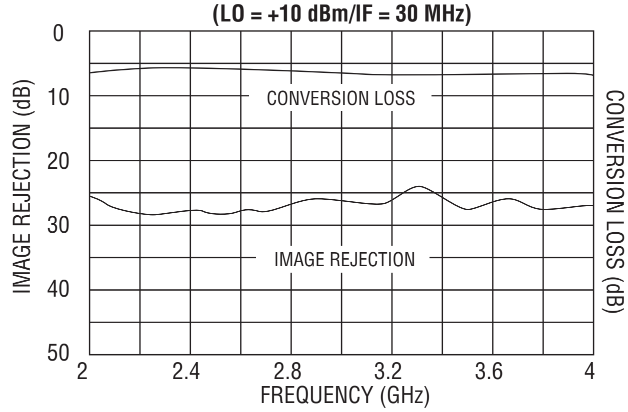
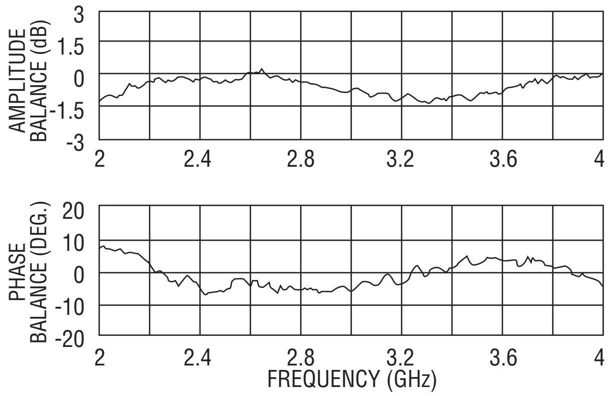


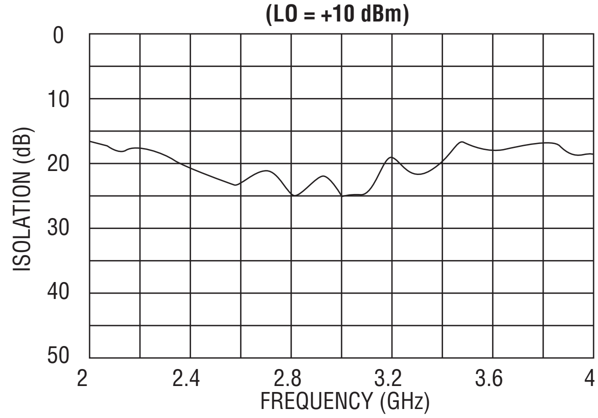
IMAGE REJECTION/CONVERSION LOSS
(LO = +10 dBm/IF = 30 MHz)



AMPLITUDE AND PHASE BALANCE
(I/Q, LO = +10 dBm)



LO-TO-RF ISOLATION
(LO = +10 dBm)



MAXIMUM RATINGS

Specification temperature .... +25°C
Operating temperature .... -54 to +85°C
Storage temperature .... -65 to +125°C

GENERAL NOTES

1. Standard catalog unit aligned and tested for guaranteed RF > LO performance. RF < LO guaranteed performance is available, please contact MITEQ.
2. For upconverter applications, please order Model Number SSM0204 Series. See Modulator section of catalog.

NOTE: Test data supplied at 25°C; conversion loss, LO-to-RF isolation, image rejection (IF Options A, B and C), phase and amplitude balance (IF Option Q).

OUTLINE DRAWINGS

IRM0204LC2A, B and C

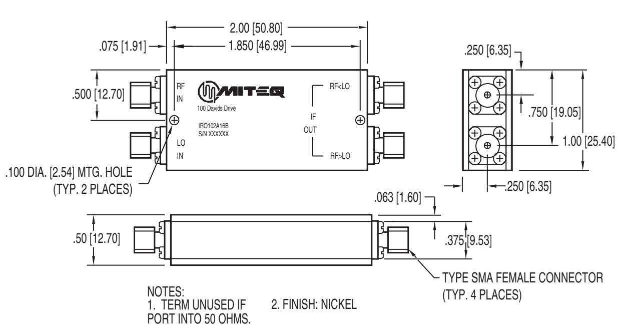
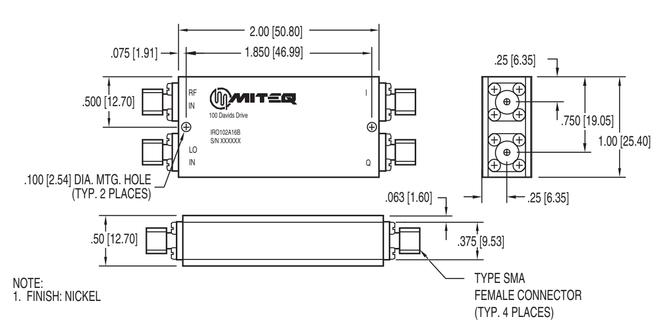


IMAGE REJECTION

IRM0204LC2Q



QIFM, I/Q DEMODULATOR

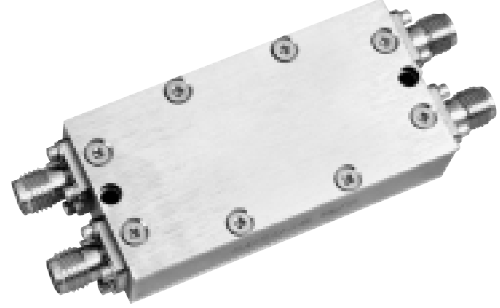
NOTE: All dimensions shown in brackets [ ] are in millimeters.

2 TO 8 GHz IMAGE REJECTION OR I/Q MIXERS

MODELS: IRM0208LC2A, IRM0208LC2B, IRM0208LC2C AND IRM0208LC2Q

FEATURES

- RF/LO coverage .... 2 to 8 GHz
- IF operation .... DC to 0.5 GHz
- Conversion loss................ 8.5 dB typical
- Image rejection .... 20 dB typical



ELECTRICAL SPECIFICATIONS

INPUT PARAMETERS	CONDITION	UNITS	MIN.	TYP.	MAX.
RF frequency range		GHz	2		8
RF VSWR (RF = -10 dBm)		Ratio		2:1	
LO frequency range		GHz	2		8
LO power range	IRM0208LC2 IRM0208MC2 IRM0208HC2	dBm dBm dBm	+10 +13 +17	+12 +15 +18	+13 +16 +20
LO VSWR		Ratio		2.5:1	
TRANSFER CHARACTERISTICS	**CONDITION**	**UNITS**	**MIN.**	**TYP.**	**MAX.**
Conversion loss (Note 1)	RF > LO IRM0208LC2Q	dBm dB		8.5 11.5	9 12
Single-sideband noise figure		dB		9.5	
Image rejection (Note 1)	RF < LO	dB	18	20	
LO-to-RF isolation		dB	18	20	
LO-to-IF isolation		dB		20	
Input power at 1 dB compression	IRM0208LC2 IRM0208MC2 IRM0208HC2	dBm dBm dBm		+6 +10 +15	
Input two-tone third-order intercept point	IRM0208LC2 IRM0208MC2 IRM0208HC2	dBm dBm dBm		+16 +20 +25	
Amplitude balance	IRM0208LC2Q	dB			±1.5
Phase balance	IRM0208LC2Q	Degrees			±10
Truth table	IRM0208LC2Q		**PORT**	**RF < LO**	**RF > LO**
			I	0	-90
			Q	-90	0
OUTPUT PARAMETERS	**CONDITION**	**UNITS**	**MIN.**	**TYP.**	**MAX.**
IF frequency (image rejection mode)	IRM0208LC2A IRM0208LC2B IRM0208LC2C	MHz MHz MHz	20 40 100		40 80 200
IF frequency (QIFM, I/Q demodulator mode)	IRM0208LC2Q	MHz	DC		500
IF VSWR (IF = -10 dBm)		Ratio		1.5:1	

IRM0208LC2A TYPICAL TEST DATA

VSWR
(LO = +10 dBm)

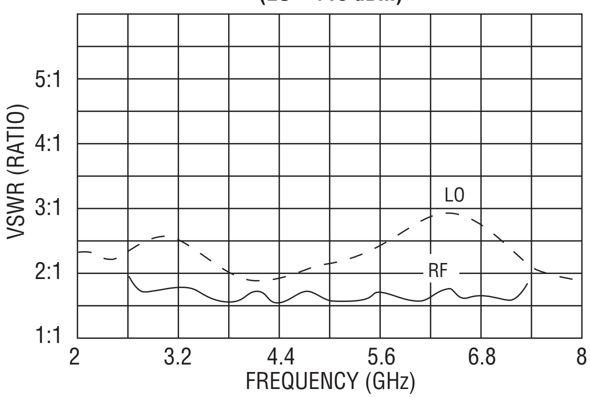
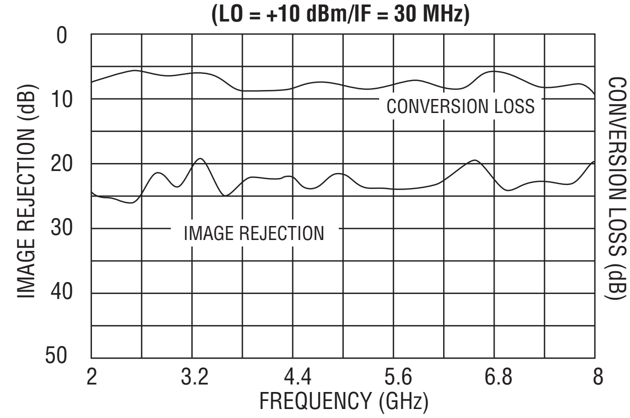
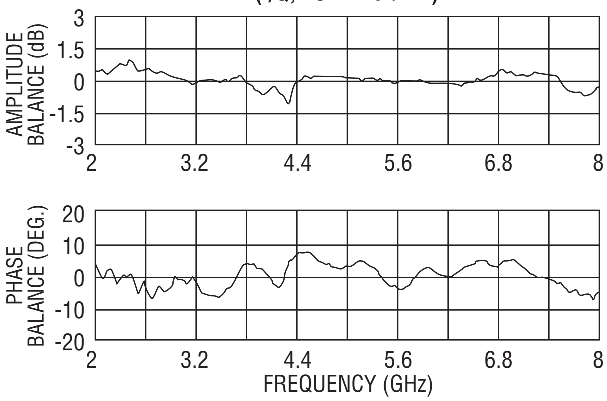


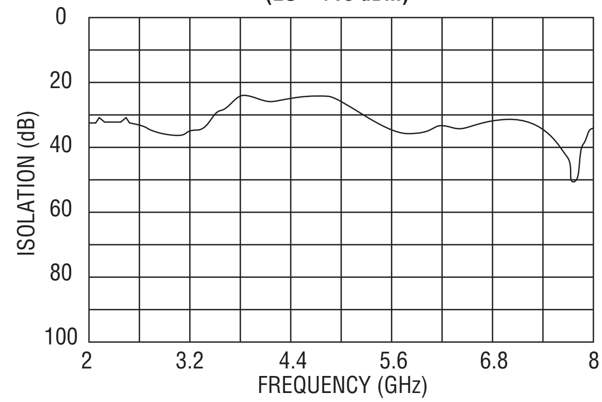
IMAGE REJECTION/CONVERSION LOSS
(LO = +10 dBm/IF = 30 MHz)



AMPLITUDE AND PHASE BALANCE
(I/Q, LO = +10 dBm)



LO-TO-RF ISOLATION
(LO = +10 dBm)



MAXIMUM RATINGS

Specification temperature .... +25°C
Operating temperature........................ -54 to +85°C
Storage temperature .... -65 to +125°C

GENERAL NOTES

1. Standard catalog unit aligned and tested for guaranteed RF > LO performance. RF < LO guaranteed performance is available, please contact MITEQ.
2. For upconverter applications, please order Model Number SSM0208 Series. See Modulator section of catalog.

NOTE: Test data supplied at 25°C; conversion loss, LO-to-RF isolation, image rejection (IF Options A, B and C), phase and amplitude balance (IF Option Q).

OUTLINE DRAWINGS

IRM0208LC2A, B and C

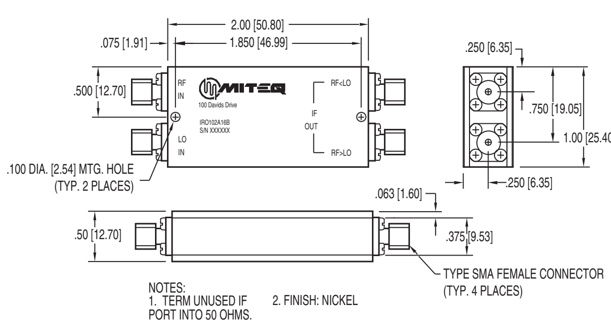
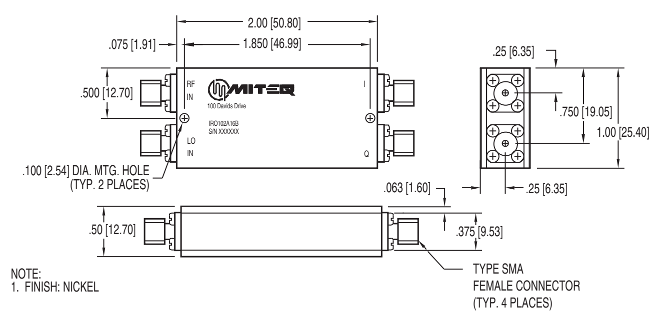


IMAGE REJECTION

IRM0208LC2Q



QIFM, I/Q DEMODULATOR

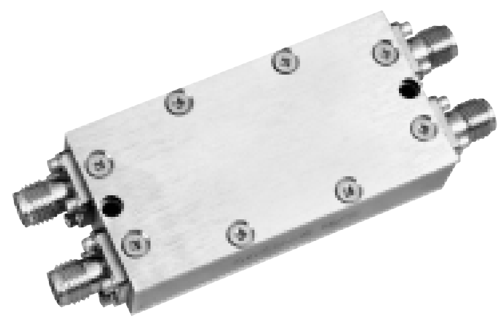
NOTE: All dimensions shown in brackets [ ] are in millimeters.

4 TO 8 GHz IMAGE REJECTION OR I/Q MIXERS

MODELS: IRM0408LC2A, IRM0408LC2B, IRM0408LC2C AND IRM0408LC2Q

FEATURES

- **RF/LO coverage................ 4 to 8 GHz**
- **IF operation....................... DC to 0.5 GHz**
- **Conversion loss................ 7.5 dB typical**
- **Image rejection .... 23 dB typical**



ELECTRICAL SPECIFICATIONS

INPUT PARAMETERS	CONDITION	UNITS	MIN.	TYP.	MAX.
RF frequency range		GHz	4		8
RF VSWR (RF = -10 dBm)		Ratio		2:1	
LO frequency range		GHz	4		8
LO power range	IRM0408LC2	dBm	+10	+12	+13
	IRM0408MC2	dBm	+13	+15	+16
	IRM0408HC2	dBm	+17	+18	+20
LO VSWR		Ratio		2.5:1	
TRANSFER CHARACTERISTICS	**CONDITION**	**UNITS**	**MIN.**	**TYP.**	**MAX.**
Conversion loss (Note 1)	RF > LO	dBm		7.5	8
	IRM0408LC2Q	dB		10.5	11
Single-sideband noise figure		dB		8.5	
Image rejection (Note 1)	RF < LO	dB	18	23	
LO-to-RF isolation		dB	20	30	
LO-to-IF isolation		dB		25	
Input power at 1 dB compression	IRM0408LC2	dBm		+6	
	IRM0408MC2	dBm		+10	
	IRM0408HC2	dBm		+15	
Input two-tone third-order intercept point	IRM0408LC2	dBm		+16	
	IRM0408MC2	dBm		+20	
	IRM0408HC2	dBm		+25	
Amplitude balance	IRM0408LC2Q	dB			±1.5
Phase balance	IRM0408LC2Q	Degrees			±10
Truth table	IRM0408LC2Q		**PORT**	**RF < LO**	**RF > LO**
			I	0	-90
			Q	-90	0
OUTPUT PARAMETERS	**CONDITION**	**UNITS**	**MIN.**	**TYP.**	**MAX.**
IF frequency (image rejection mode)	IRM0408LC2A	MHz	20		40
	IRM0408LC2B	MHz	40		80
	IRM0408LC2C	MHz	100		200
IF frequency (QIFM, I/Q demodulator mode)	IRM0408LC2Q	MHz	DC		500
IF VSWR (IF = -10 dBm)		Ratio		1.5:1	

IRM0408LC2B TYPICAL TEST DATA

VSWR
(LO = +10 dBm)

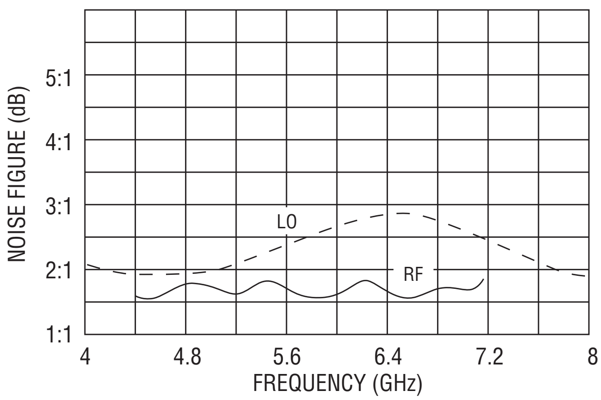
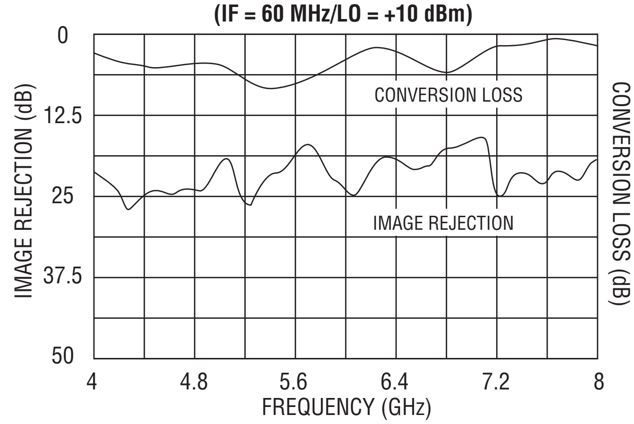
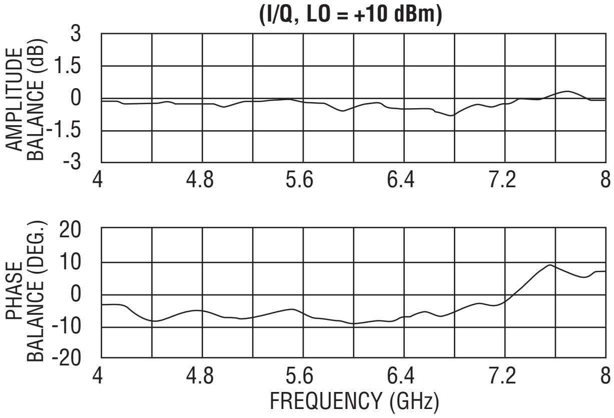


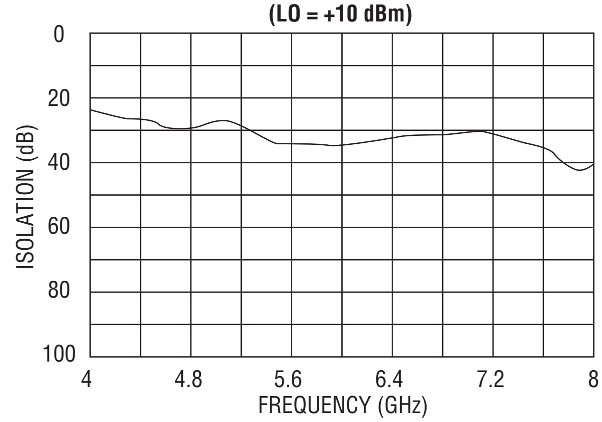
IMAGE REJECTION/CONVERSION LOSS
(IF = 60 MHz/LO = +10 dBm)



AMPLITUDE AND PHASE BALANCE
(I/Q, LO = +10 dBm)



LO-TO-RF ISOLATION
(LO = +10 dBm)



MAXIMUM RATINGS

Specification temperature .... +25°C
Operating temperature........................ -54 to +85°C
Storage temperature .... -65 to +125°C

GENERAL NOTES

1. Standard catalog unit aligned and tested for guaranteed RF > LO performance. RF < LO guaranteed performance is available, please contact MITEQ.
2. For upconverter applications, please order Model Number SSM0408 Series. See Modulator section of catalog.

NOTE: Test data supplied at 25°C; conversion loss, LO-to-RF isolation, image rejection (IF Options A, B and C), phase and amplitude balance (IF Option Q).

OUTLINE DRAWINGS

IRM0408LC2A, B and C

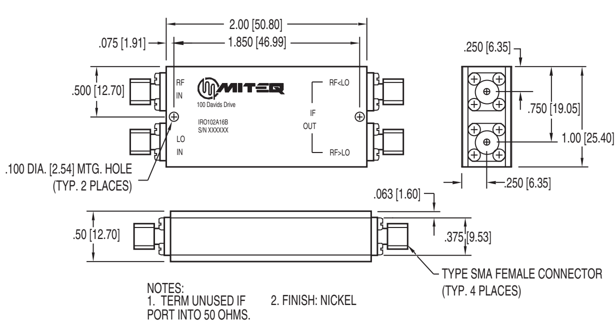
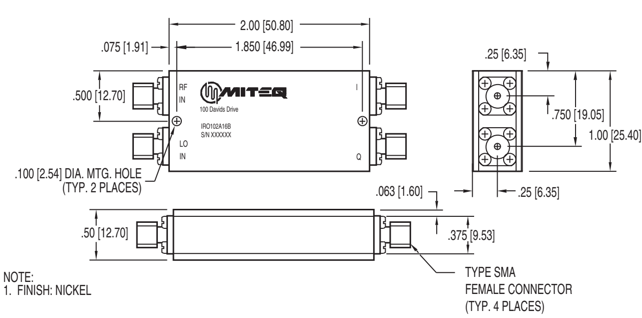


IMAGE REJECTION

IRM0408LC2Q



QIFM, I/Q DEMODULATOR

NOTE: All dimensions shown in brackets [ ] are in millimeters.

7.2 TO 8.4 GHz DIRECT SATELLITE I/Q DEMODULATOR

MODEL: IR0708LI3Q (TRI-BAND, X)

FEATURES

- **Downlink............................ 7.2 to 7.7 GHz**
  Uplink................................ 7.9 to 8.4 GHz
- **Direct I/Q demodulation .... DC to 250 MHz (50 ohms)**
- **Quadrature output accuracy .... 35 dB**
- **Linear dynamic range ...... 35 dB (2.5 mV DC-offset voltage, 150 mV linear output voltage)**

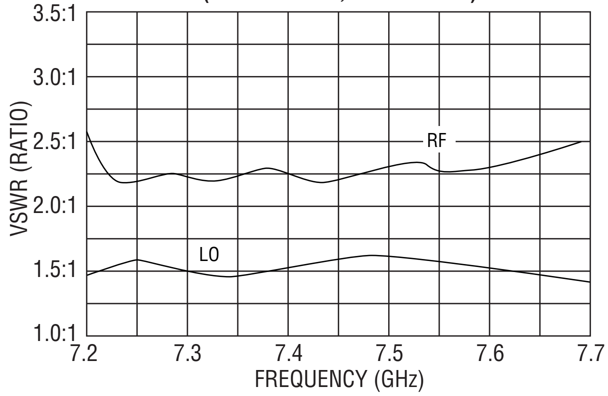
High data rate I/Q modulated microwave signals are often demodulated by one direct conversion to baseband using a phase-locked oscillator. However, in order to preserve low BER the quadrature accuracy and signal-to-noise ratio (including residual DC offset voltage) must be high. Recently at MITEQ, the electrical and physical symmetry of our microwave mixer baluns and quadrature couplers have been improved to yield LO-to-RF isolation exceeding 45 dB with very flat I/Q amplitude and phase response. These mixer qualities insure the low BER and also provide a low output VSWR interface for system baseband low-pass filters. This demodulator is an ideal complement to a similar construction I/Q linear modulator available from MITEQ.

ELECTRICAL SPECIFICATIONS

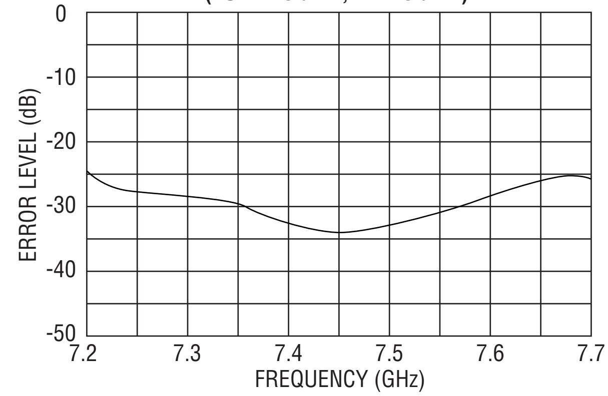
INPUT PARAMETERS	CONDITION	UNITS	MIN.	TYP.	MAX.
RF frequency range		GHz	7.2		8.4
RF VSWR	RF = +16 dBm	Ratio		2:1	2.5:1
RF power at 1 dB compression		dBm		+5	
LO frequency range		GHz	7.2		8.4
LO power range		dBm	+10		+13
LO VSWR		Ratio		1.5:1	1.8:1
TRANSFER CHARACTERISTICS	**CONDITION**	**UNITS**	**MIN.**	**TYP.**	**MAX.**
Conversion loss (I or Q output)	RF = 0 dBm	dB		9.5	10.5
Maximum linear output voltage	LO = +10 dBm, RF = +3 dBm	mV		150	
Maximum saturated output voltage	LO = +10 dBm, RF = +10 dBm	mV		400	
Maximum DC offset voltage	LO = +10 dBm, RF off	mV		2.5	5
Quadrature phase accuracy		Degrees		3	5
Quadrature amplitude accuracy		dB		0.5	0.75
LO-to-RF isolation		dB	25	30	
OUTPUT PARAMETERS	**CONDITION**	**UNITS**	**MIN.**	**TYP.**	**MAX.**
I/Q frequency range	0.5 dB bandwidth		DC		250
I/Q VSWR (Ref. = 50 ohms)	I/Q = 125 MHz	Ratio		1.4:1	

IR0708LI3Q TYPICAL TEST DATA

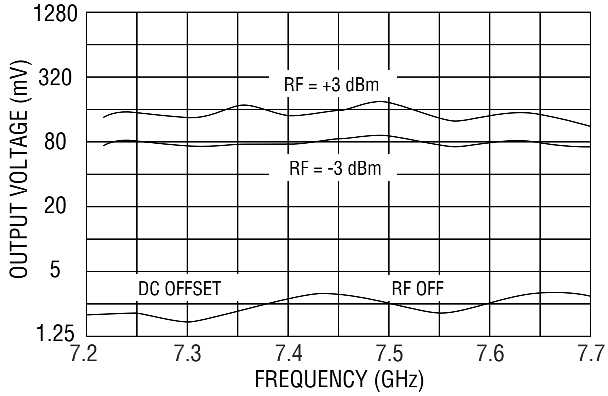
VSWR
(LO = +10 dBm, RF = +0 dBm)



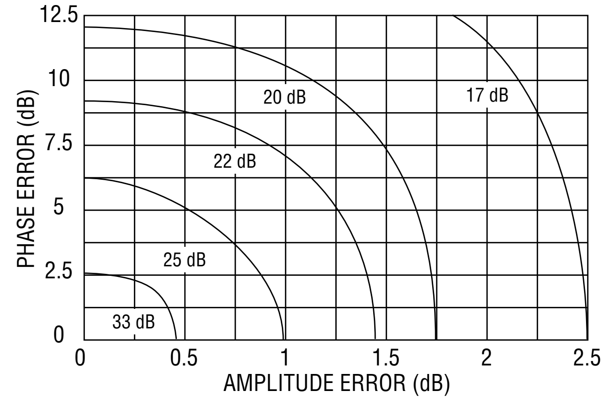
QUADRATURE ACCURACY
(LO = +10 dBm, RF = 0 dBm)



LINEAR DYNAMIC RANGE (RL = 50 Ω)



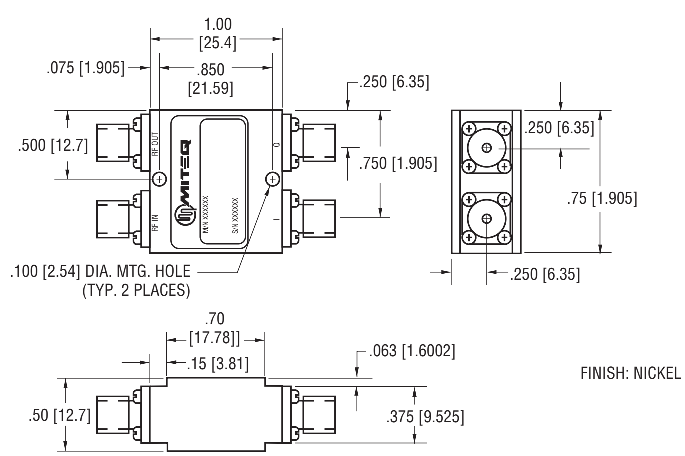
THEORETICAL QUADRATURE ACCURACY
WITH VARIOUS PHASE-AMPLITUDE ERRORS



MAXIMUM RATINGS
Specification temperature .... +25°C
Operating temperature .... -54 to +85°C
Storage temperature .... -65 to +125°C

NOTE: Test data supplied at 25°C; conversion loss, phase and amplitude balance.

OUTLINE DRAWING



FINISH: NICKEL

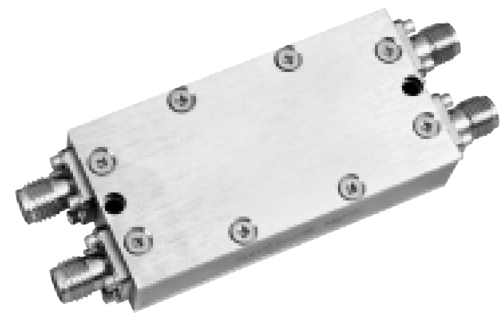
NOTE: All dimensions shown in brackets [ ] are in millimeters.

8 TO 12 GHz IMAGE REJECTION OR I/Q MIXER

MODELS: IRM0812LC2A, IRM0812LC2B, IRM0812LC2C AND IRM0812LC2Q

FEATURES

- RF/LO coverage .... 8 to 12 GHz
- IF operation .... DC to 0.5 GHz
- Conversion loss................ 6.5 dB typical
- Image rejection .... 23 dB typical



ELECTRICAL SPECIFICATIONS

INPUT PARAMETERS	CONDITION	UNITS	MIN.	TYP.	MAX.
RF frequency range		GHz	8		12
RF VSWR (RF = -10 dBm)		Ratio		2:1	
LO frequency range		GHz	8		12
LO power range	IRM0812LC2 IRM0812MC2 IRM0812HC2	dBm dBm dBm	+10 +13 +17	+12 +15 +18	+13 +16 +20
LO VSWR		Ratio		2.5:1	

TRANSFER CHARACTERISTICS	CONDITION	UNITS	MIN.	TYP.	MAX.
Conversion loss (Note 1)	RF > LO IRM0812LC2Q	dBm dB		6.5 9.5	8 11
Single-sideband noise figure		dB		8.5	
Image rejection (Note 1)	RF < LO	dB	18	23	
LO-to-RF isolation		dB	20	30	
LO-to-IF isolation		dB		20	
Input power at 1 dB compression	IRM0812LC2 IRM0812MC2 IRM0812HC2	dBm dBm dBm		+6 +10 +15	
Input two-tone third-order intercept point	IRM0812LC2 IRM0812MC2 IRM0812HC2	dBm dBm dBm		+16 +20 +25	
Amplitude balance	IRM0812LC2Q	dB			±1
Phase balance	IRM0812LC2Q	Degrees			±7.5
Truth table	IRM0812LC2Q		PORT	RF < LO	RF > LO
			I	0	-90
			Q	-90	0

OUTPUT PARAMETERS	CONDITION	UNITS	MIN.	TYP.	MAX.
IF frequency (image rejection mode)	IRM0812LC2A IRM0812LC2B IRM0812LC2C	MHz MHz MHz	20 40 100		40 80 200
IF frequency (QIFM, I/Q demodulator mode)	IRM0812LC2Q	MHz	DC		500
IF VSWR (IF = -10 dBm)		Ratio		1.5:1	

IRM0812LC2B TYPICAL TEST DATA

VSWR
(LO = +10 dBm)

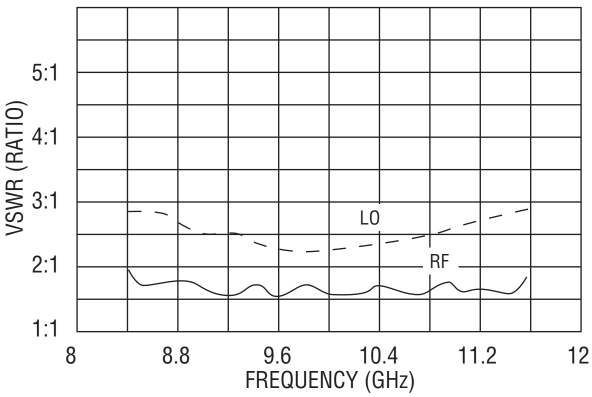
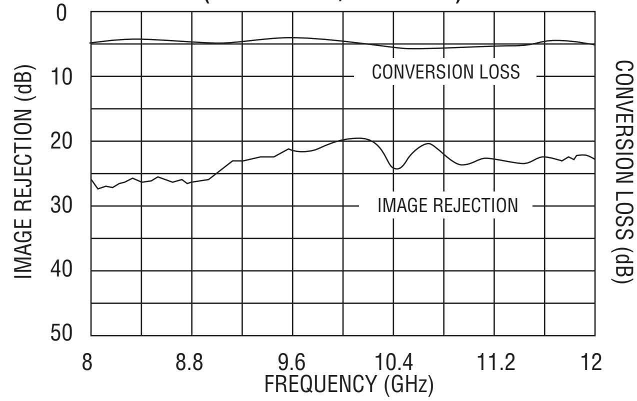
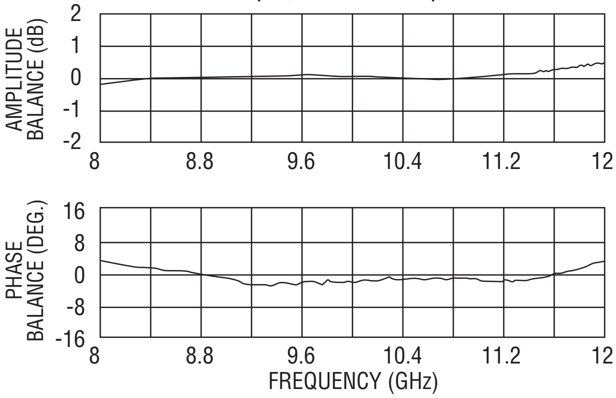


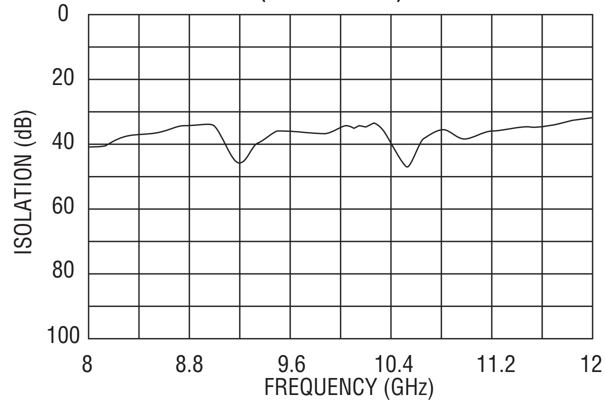
IMAGE REJECTION/CONVERSION LOSS
(LO = +10 dBm/IF = 60 MHz)



AMPLITUDE AND PHASE BALANCE
(I/Q, LO = +10 dBm)



LO-TO-RF ISOLATION
(LO = +10 dBm)



MAXIMUM RATINGS

Specification temperature.................... +25°C
Operating temperature .... -54 to +85°C
Storage temperature .... -65 to +125°C

GENERAL NOTES

1. Standard catalog unit aligned and tested for guaranteed RF > LO performance. RF < LO guaranteed performance is available, please contact MITEQ.
2. For upconverter applications, please order Model Number SSM0812 Series. See Modulator section of catalog.

NOTE: Test data supplied at 25°C; conversion loss, LO-to-RF isolation, image rejection (IF Options A, B and C), phase and amplitude balance (IF Option Q).

OUTLINE DRAWINGS

IRM0812LC2A, B and C

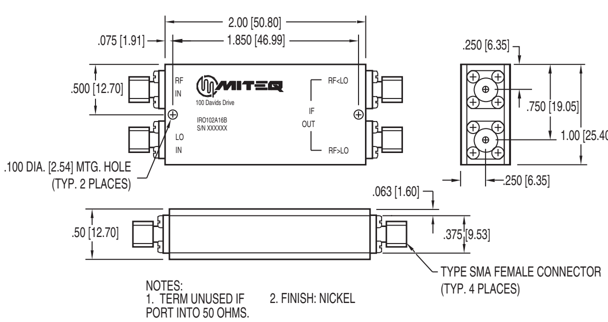
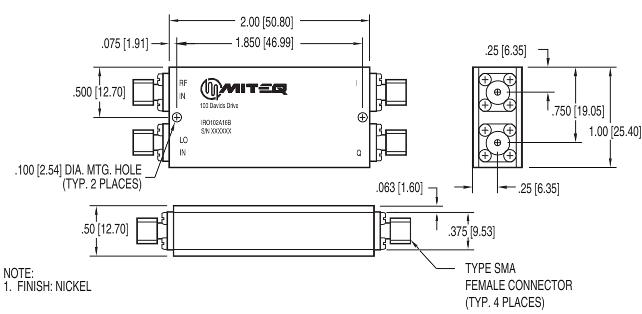


IMAGE REJECTION

IRM0812LC2Q



QIFM, I/Q DEMODULATOR

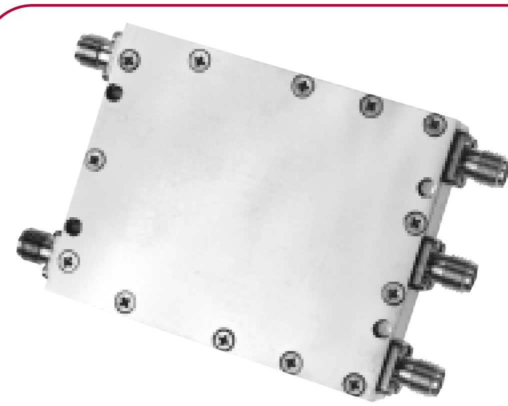
NOTE: All dimensions shown in brackets [ ] are in millimeters.

1 TO 18 GHz IMAGE REJECTION OR I/Q MIXERS

MODELS: IRM0118LC1A, IRM0118LC1B, IRM0118LC1C AND IRM0118LC1Q

FEATURES

- **RF/LO coverage................ 1 to 18 GHz**
- **IF operation....................... DC to 0.5 GHz**
- **Conversion loss................ 10 dB typical**
- **Image rejection .... 20 dB typical**



ELECTRICAL SPECIFICATIONS

INPUT PARAMETERS	CONDITION	UNITS	MIN.	TYP.	MAX.
RF frequency range		GHz	1		18
RF VSWR (RF = -10 dBm)		Ratio		3:1	
LO frequency range		GHz	1		18
LO power range	IRM0118LC1	dBm	+10	+12	+13
	IRM0118MC1	dBm	+13	+15	+16
	IRM0118HC1	dBm	+17	+18	+20
LO VSWR		Ratio		2.5:1	
TRANSFER CHARACTERISTICS	**CONDITION**	**UNITS**	**MIN.**	**TYP.**	**MAX.**
Conversion loss (Note 1)	RF > LO	dBm		10	11
	IRM0118LC1Q	dB		13	14
Single-sideband noise figure		dB		11.5	
Image rejection (Note 1)	RF < LO	dB	15	20	
LO-to-RF isolation		dB	18	20	
LO-to-IF isolation		dB		20	
Input power at 1 dB compression	IRM0118LC1	dBm		+6	
	IRM0118MC1	dBm		+10	
	IRM0118HC1	dBm		+15	
Input two-tone third-order intercept point	IRM0118LC1	dBm		+16	
	IRM0118MC1	dBm		+20	
	IRM0118HC1	dBm		+25	
Amplitude balance	IRM0118LC1Q	dB			±1.5
Phase balance	IRM0118LC1Q	Degrees			±15
Truth table	IRM0118LC1Q		**PORT**	**RF < LO**	**RF > LO**
			I	0	-90
			Q	-90	0
OUTPUT PARAMETERS	**CONDITION**	**UNITS**	**MIN.**	**TYP.**	**MAX.**
IF frequency (image rejection mode)	IRM0118LC1A	MHz	20		40
	IRM0118LC1B	MHz	40		80
	IRM0118LC1C	MHz	100		200
IF frequency (QIFM, I/Q demodulator mode)	IRM0118LC1Q	MHz	DC		500
IF VSWR (IF = -10 dBm)		Ratio		1.5:1	

IRM0118LC1B TYPICAL TEST DATA

VSWR
(LO = +10 dBm)

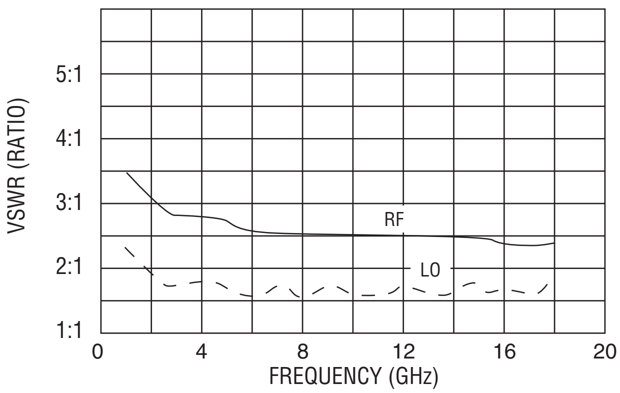
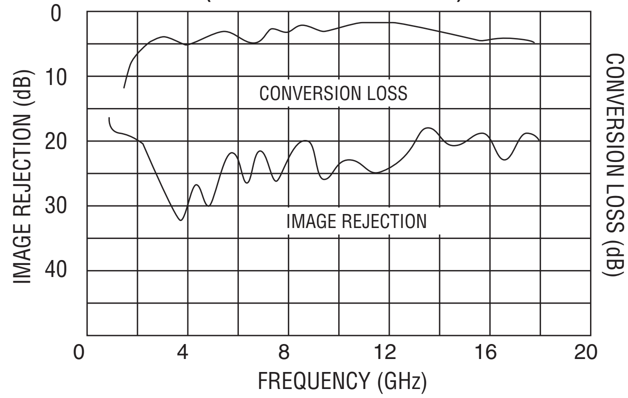
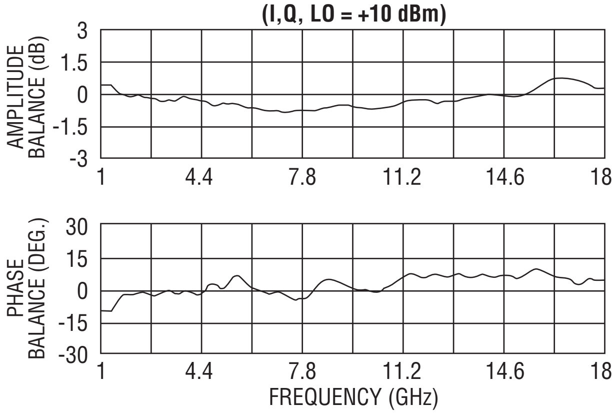


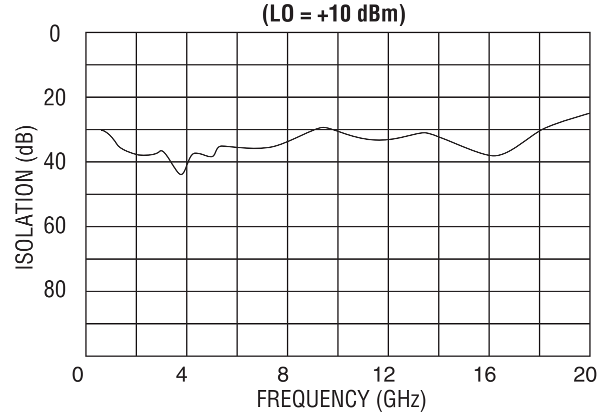
IMAGE REJECTION/CONVERSION LOSS
(LO = +10 dBm/IF = 60 MHz)



AMPLITUDE AND PHASE BALANCE
(I,Q, LO = +10 dBm)



LO-TO-RF ISOLATION
(LO = +10 dBm)



MAXIMUM RATINGS

Specification temperature.................... +25°C
Operating temperature .... -54 to +85°C
Storage temperature .... -65 to +125°C

GENERAL NOTE

1. Standard catalog unit aligned and tested for guaranteed RF > LO performance. RF < LO guaranteed performance is available, please contact MITEQ.

NOTE: Test data supplied at 25°C; conversion loss, LO-to-RF isolation, image rejection (IF Options A, B and C), phase and amplitude balance (IF Option Q).

OUTLINE DRAWINGS

IRM0118LC1A, B and C

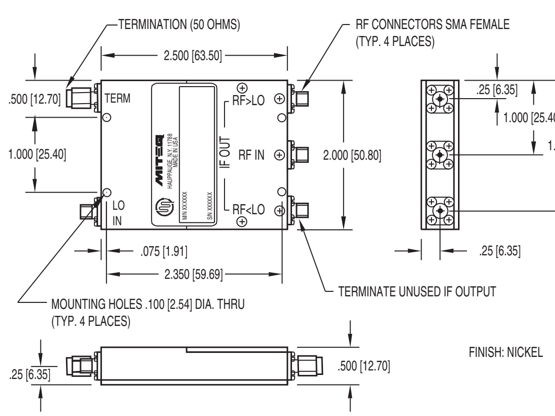
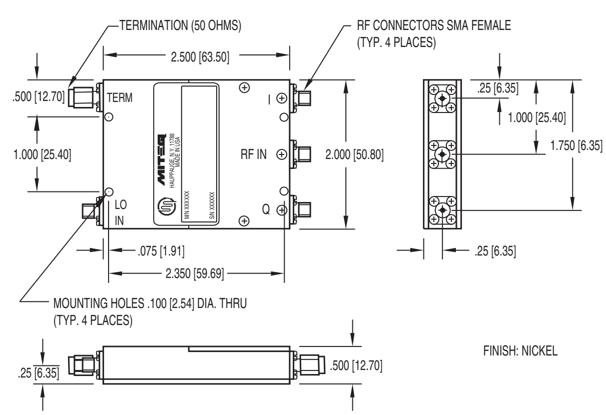


IMAGE REJECTION

IRM0118LC1Q



QIFM, I/Q DEMODULATOR

NOTE: All dimensions shown in brackets [ ] are in millimeters.

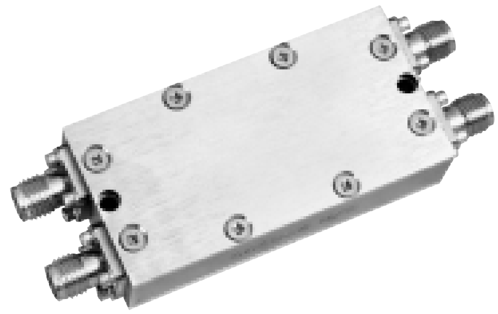
IMAGE REJECTION MIXER PRODUCTS

6 TO 18 GHz IMAGE REJECTION OR I/Q MIXERS

MODELS: IRM0618LC2A, IRM0618LC2B, IRM0618LC2C AND IRM0618LC2Q

FEATURES

- **RF/LO coverage .... 6 to 18 GHz**
- **IF operation .... DC to 0.5 GHz**
- **Conversion loss .... 9 dB typical**
- **Image rejection......................... 20 dB typical**



ELECTRICAL SPECIFICATIONS

INPUT PARAMETERS	CONDITION	UNITS	MIN.	TYP.	MAX.
RF frequency range		GHz	6		18
RF VSWR (RF = -10 dBm)		Ratio		2:1	
LO frequency range		GHz	6		18
LO power range	IRM0618LC2 IRM0618MC2 IRM0618HC2	dBm dBm dBm	+10 +13 +17	+12 +15 +18	+13 +16 +20
LO VSWR		Ratio		2.5:1	
TRANSFER CHARACTERISTICS	**CONDITION**	**UNITS**	**MIN.**	**TYP.**	**MAX.**
Conversion loss (Note 1)	RF > LO IRM0618LC2Q	dBm dB		9 12	10 13
Single-sideband noise figure		dB		10.5	
Image rejection (Note 1)	RF < LO	dB	18	20	
LO-to-RF isolation		dB	18	20	
LO-to-IF isolation		dB		20	
Input power at 1 dB compression	IRM0618LC2 IRM0618MC2 IRM0618HC2	dBm dBm dBm		+6 +10 +15	
Input two-tone third-order intercept point	IRM0618LC2 IRM0618MC2 IRM0618HC2	dBm dBm dBm		+16 +20 +25	
Amplitude balance	IRM0618LC2Q	dB			±1.5
Phase balance	IRM0618LC2Q	Degrees			±15
Truth table	IRM0618LC2Q		**PORT**	**RF < LO**	**RF > LO**
			I	0	-90
			Q	-90	0
OUTPUT PARAMETERS	**CONDITION**	**UNITS**	**MIN.**	**TYP.**	**MAX.**
IF frequency (image rejection mode)	IRM0618LC2A IRM0618LC2B IRM0618LC2C	MHz MHz MHz	20 40 100		40 80 200
IF frequency (QIFM, I/Q demodulator mode)	IRM0618LC2Q	MHz	DC		500
IF VSWR (IF = -10 dBm)		Ratio		1.5:1	

IRM0618LC2C TYPICAL TEST DATA

VSWR
(LO = +10 dBm)

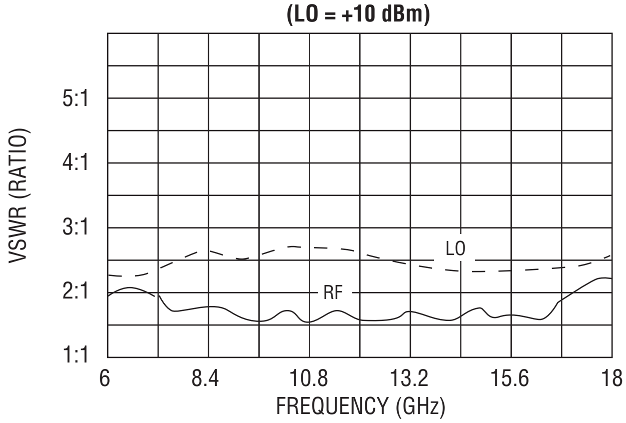
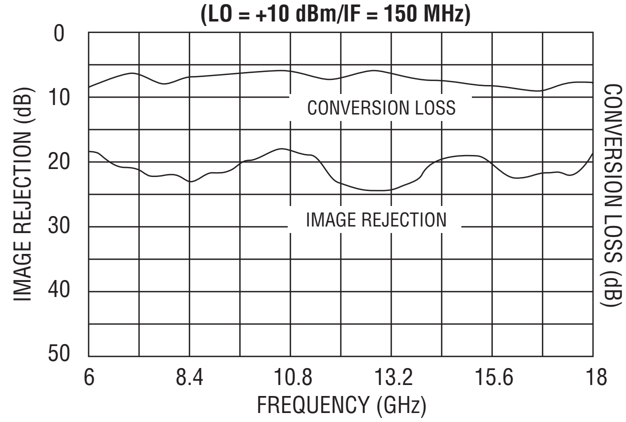
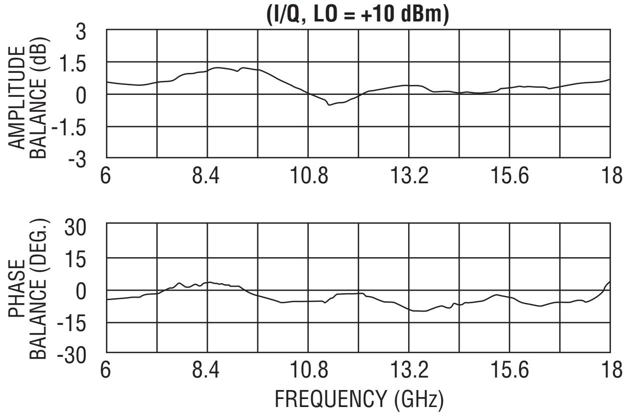


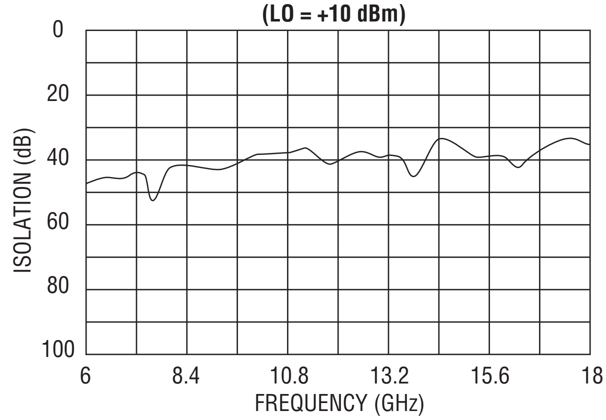
IMAGE REJECTION/CONVERSION LOSS
(LO = +10 dBm/IF = 150 MHz)



AMPLITUDE AND PHASE BALANCE
(I/Q, LO = +10 dBm)



LO-TO-RF ISOLATION
(LO = +10 dBm)



MAXIMUM RATINGS

Specification temperature.................... +25°C
Operating temperature .... -54 to +85°C
Storage temperature .... -65 to +125°C

GENERAL NOTES

1. Standard catalog unit aligned and tested for guaranteed RF > LO performance. RF < LO guaranteed performance is available, please contact MITEQ.
2. For upconverter applications, please order Model Number SSM0618 Series. See Modulator section of catalog.

NOTE: Test data supplied at 25°C; conversion loss, LO-to-RF isolation, image rejection (IF Options A, B and C), phase and amplitude balance (IF Option Q).

OUTLINE DRAWINGS

IRM0618LC2A, B and C

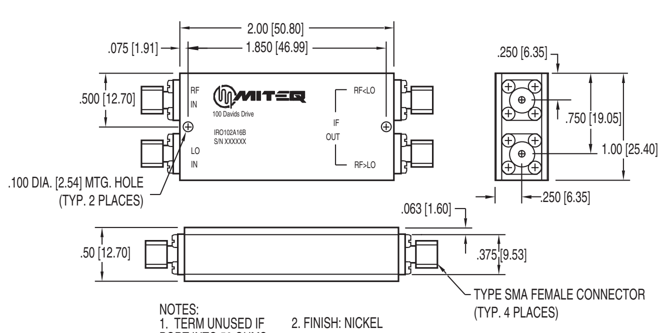
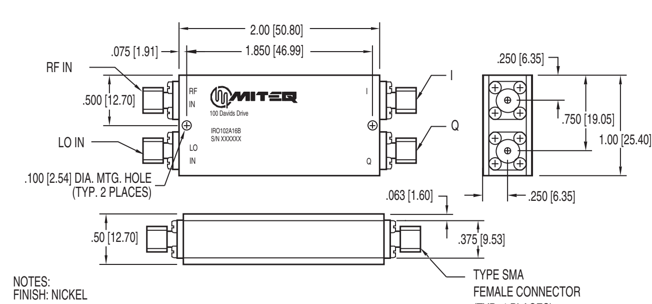


IMAGE REJECTION

IRM0618LC2Q



QIFM, I/Q DEMODULATOR

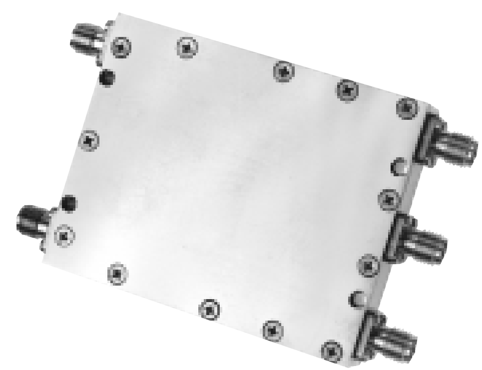
NOTE: All dimensions shown in brackets [ ] are in millimeters.

2 TO 18 GHz IMAGE REJECTION OR I/Q MIXERS

MODELS: IRM0218LC1A, IRM0218LC1B, IRM0218LC1C AND IRM0218LC1Q

FEATURES

- RF/LO coverage .... 2 to 18 GHz
- IF operation .... DC to 0.5 GHz
- Conversion loss .... 8 dB typical
- Image rejection .... 20 dB typical



ELECTRICAL SPECIFICATIONS

INPUT PARAMETERS	CONDITION	UNITS	MIN.	TYP.	MAX.
RF frequency range		GHz	2		18
RF VSWR (RF = -10 dBm)		Ratio		3:1	
LO frequency range		GHz	2		18
LO power range	IRM0218LC1	dBm	+10	+12	+13
	IRM0218MC1	dBm	+13	+15	+16
	IRM0218HC1	dBm	+17	+18	+20
LO VSWR		Ratio		2.5:1	

TRANSFER CHARACTERISTICS	CONDITION	UNITS	MIN.	TYP.	MAX.
Conversion loss (Note 1)	RF > LO	dBm		8	11
	IRM0218LC1Q	dB		11	14
Single-sideband noise figure		dB		8.5	
Image rejection (Note 1)	RF < LO	dB	18	20	
LO-to-RF isolation		dB	18	20	
LO-to-IF isolation		dB		20	
Input power at 1 dB compression	IRM0218LC1	dBm		+6	
	IRM0218MC1	dBm		+10	
	IRM0218HC1	dBm		+15	
Input two-tone third-order intercept point	IRM0218LC1	dBm		+16	
	IRM0218MC1	dBm		+20	
	IRM0218HC1	dBm		+25	
Amplitude balance	IRM0218LC1Q	dB			±1.5
Phase balance	IRM0218LC1Q	Degrees			±15
Truth table	IRM0218LC1Q		PORT	RF < LO	RF > LO
			I	0	-90
			Q	-90	0

OUTPUT PARAMETERS	CONDITION	UNITS	MIN.	TYP.	MAX.
IF frequency (image rejection mode)	IRM0218LC1A	MHz	20		40
	IRM0218LC1B	MHz	40		80
	IRM0218LC1C	MHz	100		200
IF frequency (QIFM, I/Q demodulator mode)	IRM0218LC1Q	MHz	DC		500
IF VSWR (IF = -10 dBm)		Ratio		1.5:1	

IRM0218LC1B TYPICAL TEST DATA

VSWR
(LO = +10 dBm)

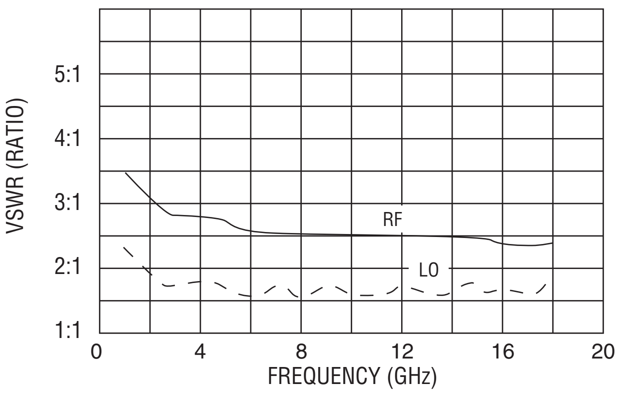
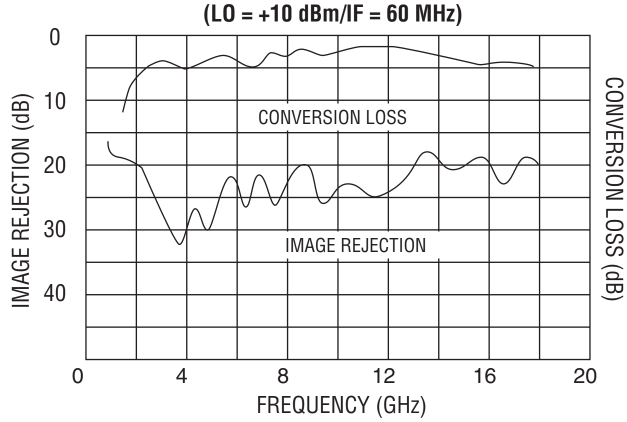
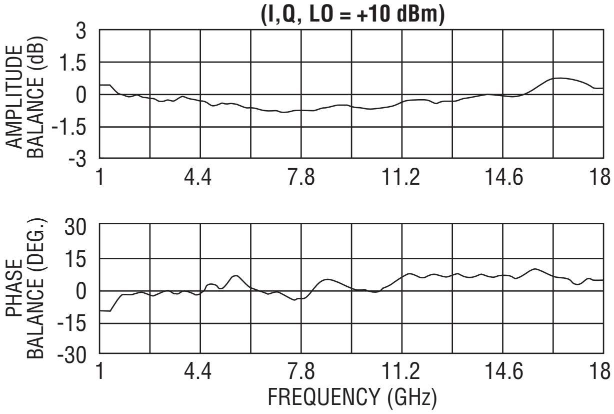


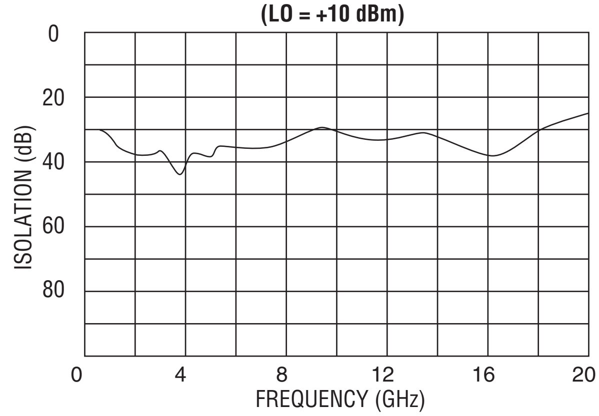
IMAGE REJECTION/CONVERSION LOSS
(LO = +10 dBm/IF = 60 MHz)



AMPLITUDE AND PHASE BALANCE
(I,Q, LO = +10 dBm)



LO-TO-RF ISOLATION
(LO = +10 dBm)



MAXIMUM RATINGS

Specification temperature.................... +25°C
Operating temperature .... -54 to +85°C
Storage temperature .... -65 to +125°C

GENERAL NOTES

1. Standard catalog unit aligned and tested for guaranteed RF > LO performance. RF < LO guaranteed performance is available, please contact MITEQ.
2. For upconverter applications, please order Model Number SSM0218 Series. See Modulator section of catalog.

NOTE: Test data supplied at 25°C; conversion loss, LO-to-RF isolation, image rejection (IF Options A, B and C), phase and amplitude balance (IF Option Q).

OUTLINE DRAWINGS

IRM0218LC1A, B and C

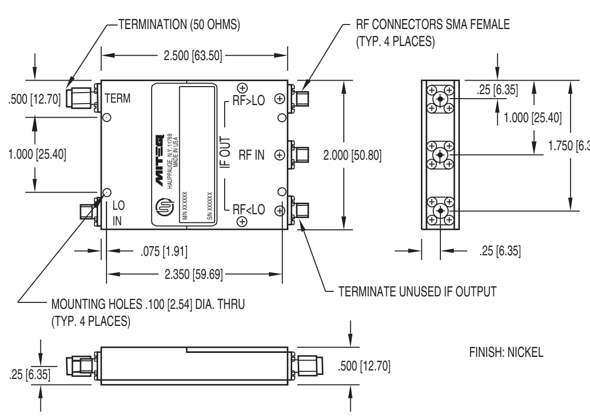
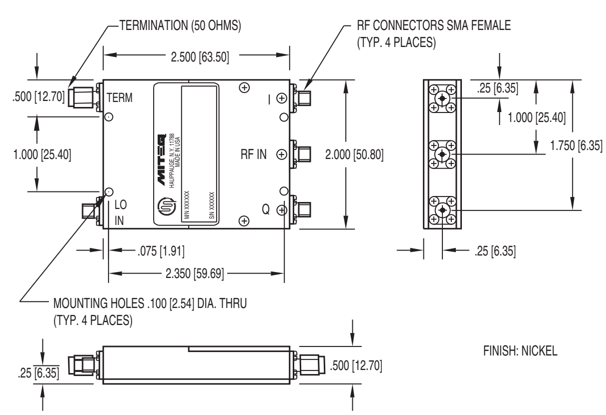


IMAGE REJECTION

IRM0218LC1Q



QIFM, I/Q DEMODULATOR

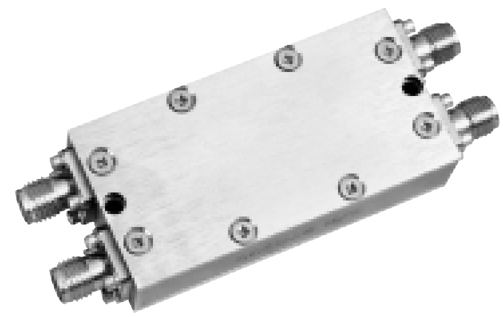
NOTE: All dimensions shown in brackets [ ] are in millimeters.

12 TO 18 GHz IMAGE REJECTION OR I/Q MIXERS

MODELS: IRM1218LC2A, IRM1218LC2B, IRM1218LC2C AND IRM1218LC2Q

FEATURES

- RF/LO coverage .... 12 to 18 GHz
- IF operation .... DC to 0.5 GHz
- Conversion loss .... 8 dB typical
- Image rejection......................... 20 dB typical



ELECTRICAL SPECIFICATIONS

INPUT PARAMETERS	CONDITION	UNITS	MIN.	TYP.	MAX.
RF frequency range		GHz	12		18
RF VSWR (RF = -10 dBm)		Ratio		2:1	
LO frequency range		GHz	12		18
LO power range	IRM1218LC2 IRM1218MC2 IRM1218HC2	dBm dBm dBm	+10 +13 +17	+12 +15 +18	+13 +16 +20
LO VSWR		Ratio		2.5:1	
TRANSFER CHARACTERISTICS	**CONDITION**	**UNITS**	**MIN.**	**TYP.**	**MAX.**
Conversion loss (Note 1)	RF > LO IRM1218LC2Q	dBm dB		8 11	10 13
Single-sideband noise figure		dB		10	
Image rejection (Note 1)	RF < LO	dB	18	20	
LO-to-RF isolation		dB	20	23	
LO-to-IF isolation		dB		20	
Input power at 1 dB compression	IRM1218LC2 IRM1218MC2 IRM1218HC2	dBm dBm dBm		+6 +10 +15	
Input two-tone third-order intercept point	IRM1218LC2 IRM1218MC2 IRM1218HC2	dBm dBm dBm		+16 +20 +25	
Amplitude balance	IRM1218LC2Q	dB			±1.5
Phase balance	IRM1218LC2Q	Degrees			±15
Truth table	IRM1218LC2Q		PORT	RF < LO	RF > LO
			I	0	-90
			Q	-90	0
OUTPUT PARAMETERS	**CONDITION**	**UNITS**	**MIN.**	**TYP.**	**MAX.**
IF frequency (image rejection mode)	IRM1218LC2A IRM1218LC2B IRM1218LC2C	MHz MHz MHz	20 40 100		40 80 200
IF frequency (QIFM, I/Q demodulator)	IRM1218LC2Q	MHz	DC		500
IF VSWR (IF = -10 dBm)		Ratio		1.5:1	

IRM1218LC2A TYPICAL TEST DATA

VSWR
(LO = +10 dBm)

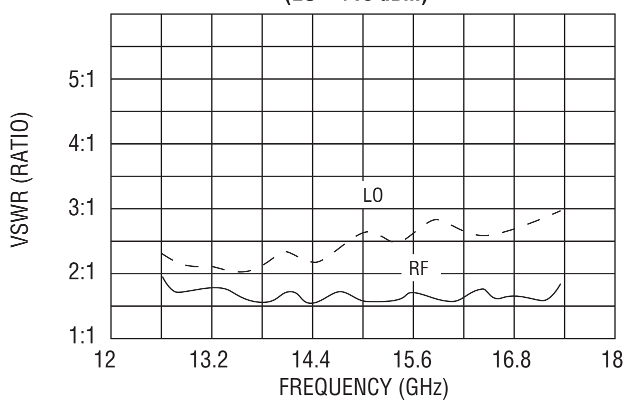
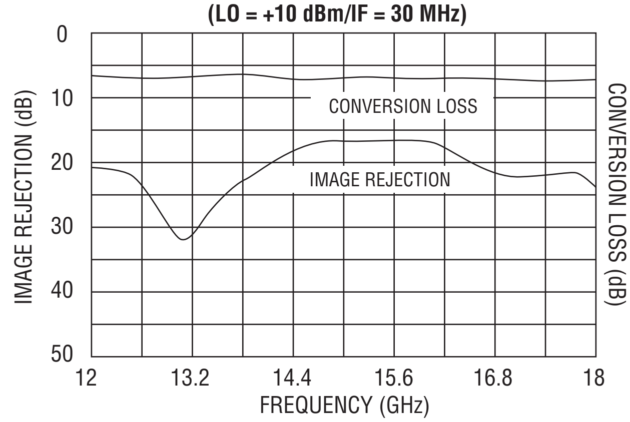
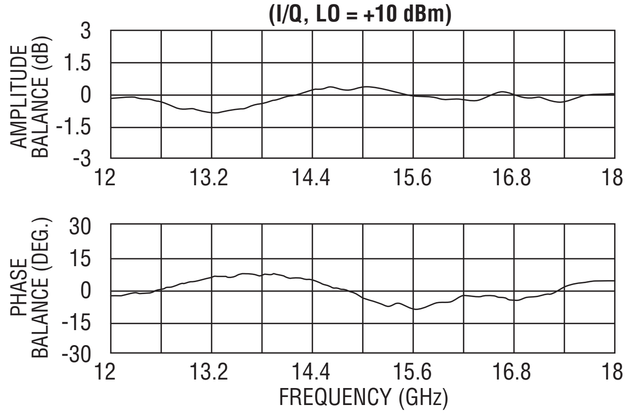


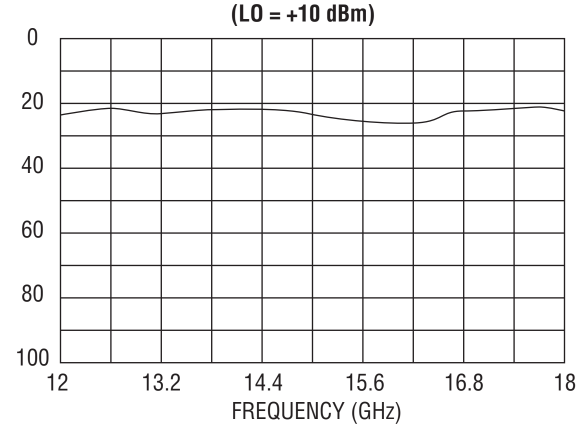
IMAGE REJECTION/CONVERSION LOSS
(LO = +10 dBm/IF = 30 MHz)



AMPLITUDE AND PHASE BALANCE
(I/Q, LO = +10 dBm)



LO-TO-RF ISOLATION
(LO = +10 dBm)



MAXIMUM RATINGS

Specification temperature.................... +25°C
Operating temperature .... -54 to +85°C
Storage temperature .... -65 to +125°C

GENERAL NOTES

1. Standard catalog unit aligned and tested for guaranteed RF > LO performance. RF < LO guaranteed performance is available, please contact MITEQ.
2. For upconverter applications, please order Model Number SSM1218 Series. See Modulator section of catalog.

NOTE: Test data supplied at 25°C; conversion loss, LO-to-RF isolation, image rejection (IF Options A, B and C), phase and amplitude balance (IF Option Q).

OUTLINE DRAWINGS

IRM1218LC2A, B and C

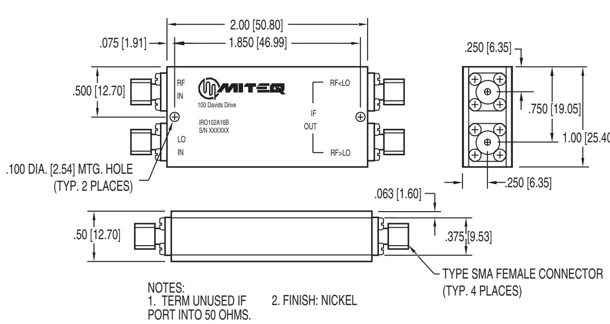
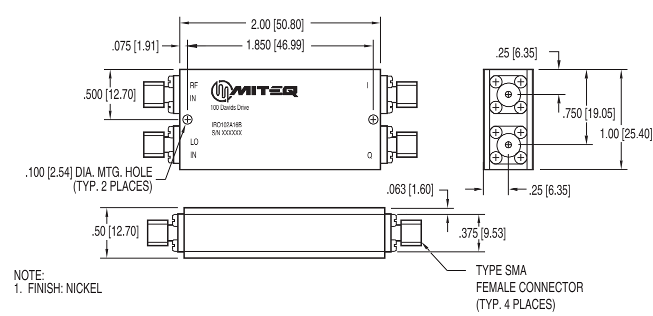


IMAGE REJECTION

IRM1218LC2Q



QIFM, I/Q DEMODULATOR

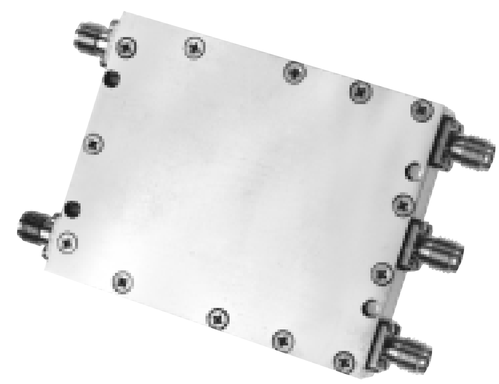
NOTE: All dimensions shown in brackets [ ] are in millimeters.

2 TO 26 GHz IMAGE REJECTION OR I/Q MIXERS

MODELS: IRM0226LC1A, IRM0226LC1B, IRM0226LC1C AND IRM0226LC1Q

FEATURES

- RF/LO coverage .... 2 to 26 GHz
- IF operation .... DC to 0.5 GHz
- Conversion loss .... 10 dB typical
- Image rejection........................... 18 dB typical



ELECTRICAL SPECIFICATIONS

INPUT PARAMETERS	**CONDITION**	**UNITS**	**MIN.**	**TYP.**	**MAX.**
RF frequency range		GHz	2		26
RF VSWR (RF = -10 dBm)		Ratio		3.5:1	
LO frequency range		GHz	2		26
LO power range	IRM0226LC1	dBm	+10	+12	+13
	IRM0226MC1	dBm	+13	+15	+16
	IRM0226HC1	dBm	+17	+18	+20
LO VSWR		Ratio		2.5:1	
TRANSFER CHARACTERISTICS	**CONDITION**	**UNITS**	**MIN.**	**TYP.**	**MAX.**
Conversion loss (Note 1)	RF > LO	dBm		10	14.5
	IRM0226LC1Q	dB		13	17.5
Single-sideband noise figure		dB		15	
Image rejection (Note 1)	RF < LO	dB	15	18	
LO-to-RF isolation		dB	15	18	
LO-to-IF isolation		dB		20	
Input power at 1 dB compression	IRM0226LC1	dBm		+6	
	IRM0226MC1	dBm		+10	
	IRM0226HC1	dBm		+15	
Input two-tone third-order intercept point	IRM0226LC1	dBm		+16	
	IRM0226MC1	dBm		+20	
	IRM0226HC1	dBm		+25	
Amplitude balance	IRM0226LC1Q	dB			±1.5
Phase balance	IRM0226LC1Q	Degrees			±15
Truth table	IRM0226LC1Q		**Port**	**RF < LO**	**RF > LO**
			I	0	-90
			Q	-90	0
OUTPUT PARAMETERS	**CONDITION**	**UNITS**	**MIN.**	**TYP.**	**MAX.**
IF frequency (image rejection mode)	IRM0226LC1A	MHz	20		40
	IRM0226LC1B	MHz	40		80
	IRM0226LC1C	MHz	100		200
IF frequency (QIFM, I/Q demodulator mode)	IRM0226LC1Q	MHz	DC		500
IF VSWR (IF = -10 dBm)		Ratio		1.5:1	

IRM0226LC1C TYPICAL TEST DATA

VSWR
(LO = +10 dBm)

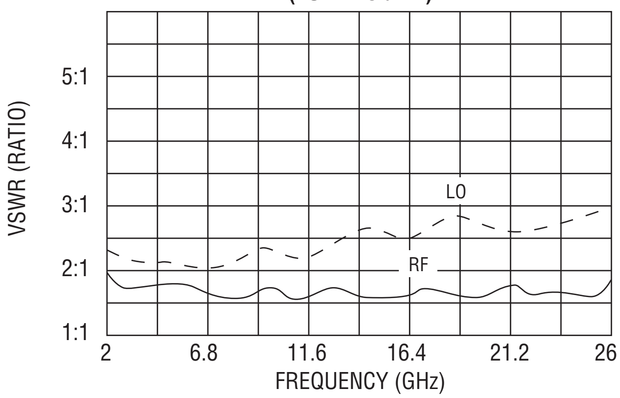
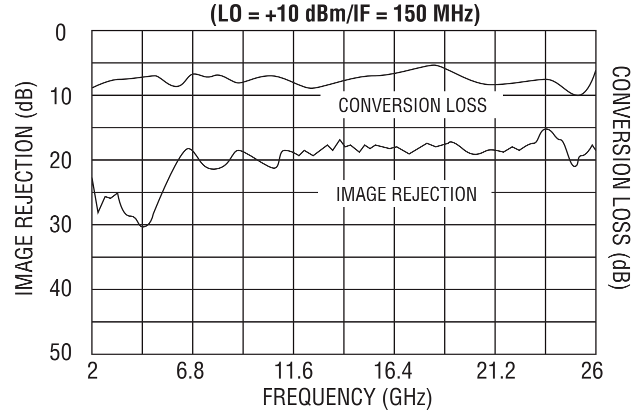
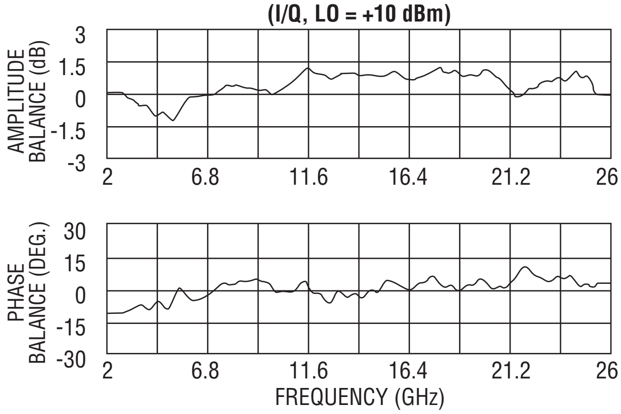


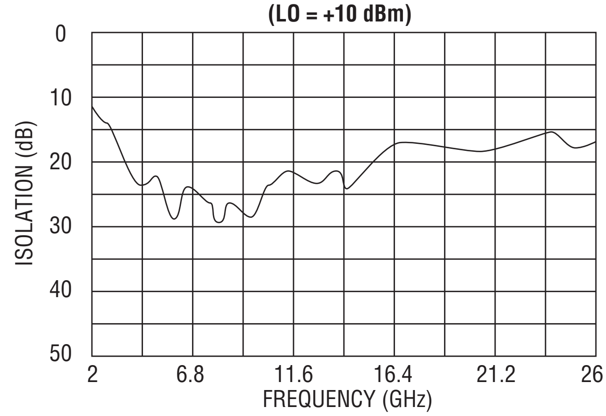
IMAGE REJECTION/CONVERSION LOSS
(LO = +10 dBm/IF = 150 MHz)



AMPLITUDE AND PHASE BALANCE
(I/Q, LO = +10 dBm)



LO-TO-RF ISOLATION
(LO = +10 dBm)



MAXIMUM RATINGS

Specification temperature.................... +25°C
Operating temperature .... -54 to +85°C
Storage temperature .... -65 to +125°C

GENERAL NOTES

1. Standard catalog unit aligned and tested for guaranteed RF > LO performance. RF < LO guaranteed performance is available, please contact MITEQ.
2. For upconverter applications, please order Model Number SSM0226 Series. See Modulator section of catalog.

NOTE: Test data supplied at 25°C; conversion loss, LO-to-RF isolation, image rejection (IF Options A, B and C), phase and amplitude balance (IF Option Q).

OUTLINE DRAWINGS

IRM0226LC1A, B and C

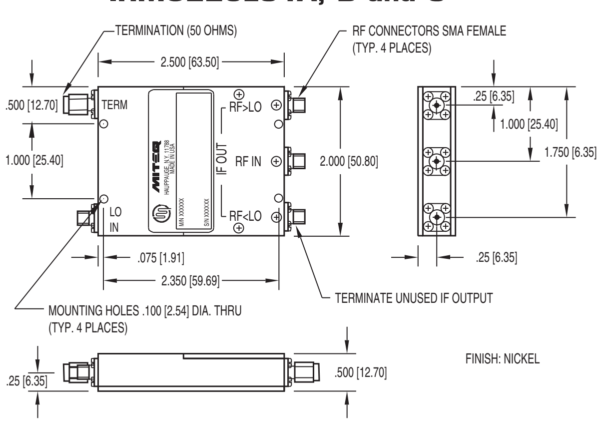
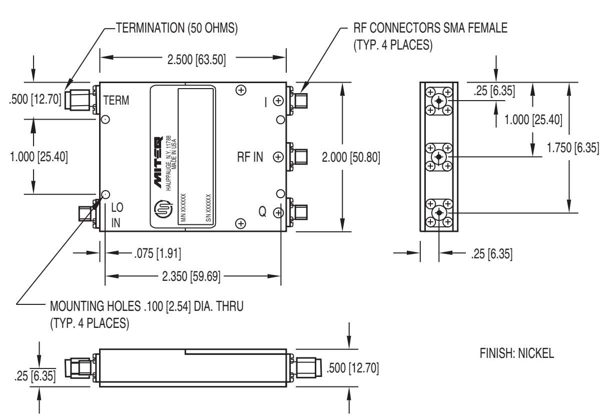


IMAGE REJECTION

IRM0226LC1Q



QIFM, I/Q DEMODULATOR

NOTE: All dimensions shown in brackets [ ] are in millimeters.

18 TO 26 GHz IMAGE REJECTION OR I/Q MIXERS

MODELS: IR1826NI7A, IR1826NI7B, IR1826NI7C AND IR1826NI7Q

FEATURES

- RF/LO coverage .... 18 to 26 GHz
- IF operation .... DC to 0.5 GHz
- LO power range .... +17 to +19 dBm
- Conversion loss................ 9 dB typical
- Image rejection .... 25 dB typical


IR1826NI7Q

MITEQ's IR Series of image rejection mixers is useful for wideband test equipment or in ultra-broadband receivers requiring rejection of an unwanted sideband of signal or noise following a low-noise front-end amplifier. These mixers are also useful as linear single-sideband upconverters by operating in the reverse mode.

ELECTRICAL SPECIFICATIONS

INPUT PARAMETERS	CONDITION	UNITS	MIN.	TYP.	MAX.
RF frequency range		GHz	18		26
RF VSWR (RF = -10 dBm, LO = +17 dBm)		Ratio		2:1	
LO frequency range		GHz	18		26
LO power range		dBm	+17		+19
LO VSWR (LO = +17 dBm)		Ratio		2.5:1	
TRANSFER CHARACTERISTICS	**CONDITION**	**UNITS**	**MIN.**	**TYP.**	**MAX.**
Conversion loss (Note 1)	RF > LO IR1826NI7Q	dB dB		9 12	10.5 13.5
Single-sideband noise figure		dB		9.5	
Image rejection (Note 1)	RF < LO	dB	18	25	
LO-to-RF isolation		dB	20	25	
LO-to-IF isolation		dB		15	
Input power at 1 dB compression	LO = +17 dBm	dBm		+7	
Input two-tone third-order intercept point	LO = +17 dBm	dBm		+17	
Amplitude balance	IR1826NI7Q	dB		±1	±1.5
Phase balance	IR1826NI7Q	Degrees		±10	±15
OUTPUT PARAMETERS	**CONDITION**	**UNITS**	**MIN.**	**TYP.**	**MAX.**
IF frequency (image rejection mode)	IR1826NI7A IR1826NI7B IR1826NI7C	MHz MHz MHz	20 40 100		40 80 200
IF frequency (QIFM, I/Q demodulator mode)	IR1826NI7Q	MHz	DC		500
IF VSWR (IF = -10 dBm, LO = +17 dBm)		Ratio		1.5:1	

IR1826NI7C TYPICAL TEST DATA

VSWR
(LO = +17 dBm)

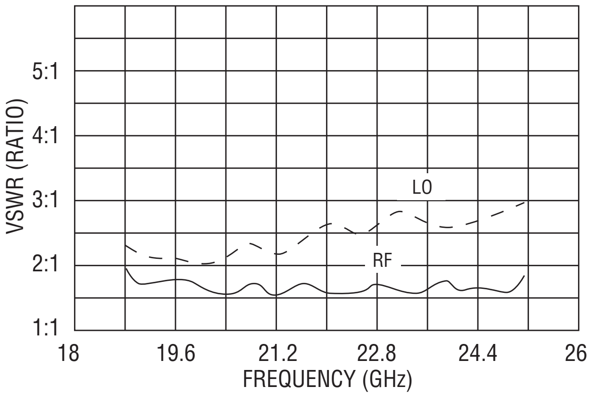
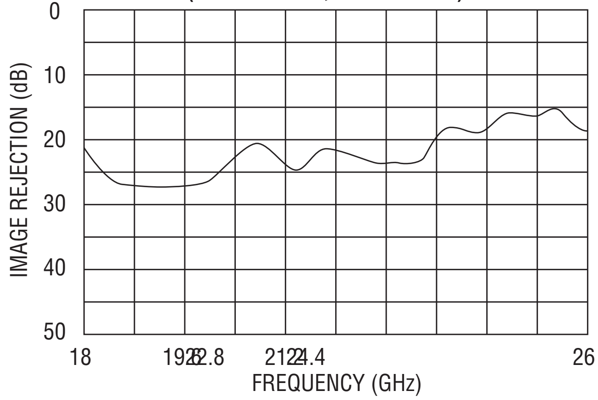
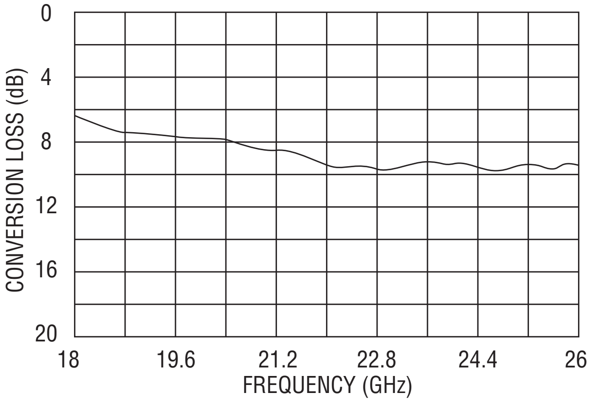


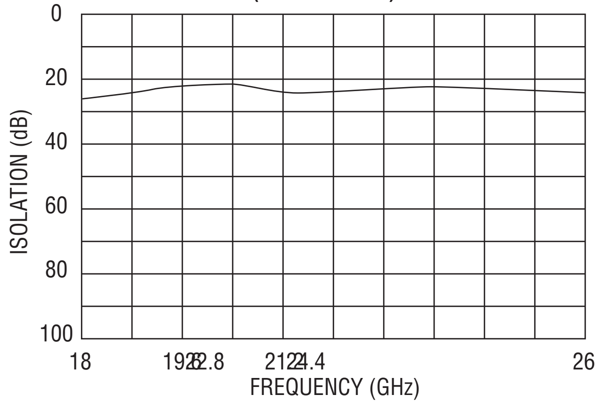
IMAGE REJECTION
(LO = +17 dBm, IF = 150 MHz)



CONVERSION LOSS
(IF = 150 MHz, LO = +17 dBm)



LO-TO-RF ISOLATION
(LO = +17 dBm)



MAXIMUM RATINGS

Specification temperature .... +25°C
Operating temperature .... -54 to +85°C
Storage temperature .... -65 to +125°C

GENERAL NOTE

1. Standard catalog unit aligned and tested for guaranteed RF > LO performance. RF < LO guaranteed performance is available, please contact MITEQ.

NOTE: Test data supplied at 25°C; conversion loss, LO-to-RF isolation, image rejection (IF Options A, B and C), phase and amplitude balance (IF Option Q).

OUTLINE DRAWINGS

IR1826NI7A, B and C

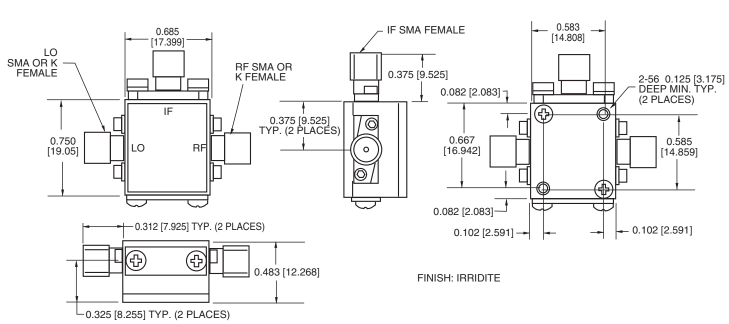
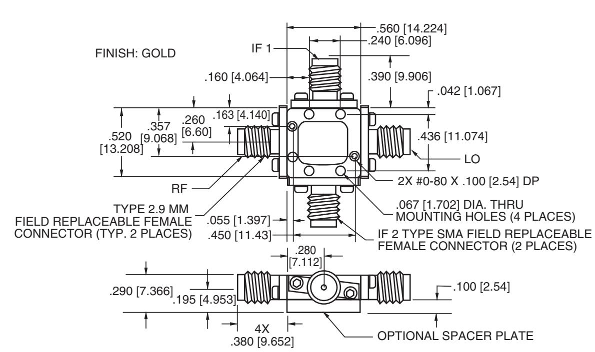


IMAGE REJECTION

IR1826NI7Q



QIFM, I/Q DEMODULATOR

NOTE: All dimensions shown in brackets [ ] are in millimeters.

26 TO 40 GHz IMAGE REJECTION OR I/Q MIXERS

MODELS: IR2640NI7A, IR2640NI7B, IR2640NI7C AND IR2640NI7Q

FEATURES

- **RF/LO coverage .... 26 to 40 GHz**
- **IF operation .... DC to 0.5 GHz**
- **LO power range .... +17 to +18 dBm**
- **Conversion loss................ 9 dB typical**
- **Image rejection .... 25 dB typical**

IR2640NI7Q

MITEQ's IR Series of image rejection mixers is useful for wideband test equipment or in ultra-broadband receivers requiring rejection of an unwanted sideband of signal or noise following a low-noise front-end amplifier. These mixers are also useful as linear single-sideband upconverters by operating in the reverse mode.

ELECTRICAL SPECIFICATIONS

INPUT PARAMETERS	CONDITION	UNITS	MIN.	TYP.	MAX.
RF frequency range		GHz	26		40
RF VSWR (RF = -10 dBm, LO = +16 dBm)		Ratio		2:1	
LO frequency range		GHz	26		40
LO power range		dBm	+17		+18
LO VSWR (LO = +16 dBm)		Ratio		2.5:1	
TRANSFER CHARACTERISTICS	**CONDITION**	**UNITS**	**MIN.**	**TYP.**	**MAX.**
Conversion loss (Note 1)	RF > LO IR2640NI7Q	dB dB		9 12	12 15
Single-sideband noise figure		dB		9.5	
Image rejection (Note 1)	RF < LO	dB	18	25	
LO-to-RF isolation		dB	20	25	
LO-to-IF isolation		dB		25	
Input power at 1 dB compression	LO = +16 dBm	dBm		+7	
Input two-tone third-order intercept point	LO = +16 dBm	dBm		+17	
Amplitude balance	IR2640NI7Q	dB		±1	±1.5
Phase balance	IR2640NI7Q	Degrees		±10	±15
OUTPUT PARAMETERS	**CONDITION**	**UNITS**	**MIN.**	**TYP.**	**MAX.**
IF frequency (image rejection mode)	IR2640NI7A IR2640NI7B IR2640NI7C	MHz MHz MHz	20 40 100		40 80 200
IF frequency (QIFM, I/Q demodulator mode)	IR2640NI7Q	MHz	DC		500
IF VSWR (IF = -10 dBm, LO = +16 dBm)		Ratio		1.5:1	

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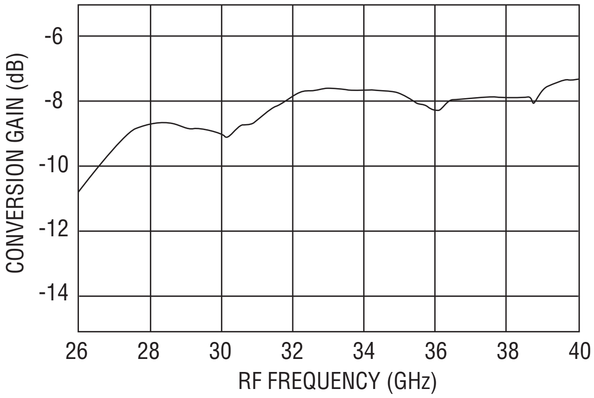
IR2640NI7C TYPICAL TEST DATA

CONVERSION GAIN, RF > LO
(LSB REJECTED LO = +16 dBm, RF = -10 dBm, IF = 150 MHz)



LO-TO-RF AND LO-TO-IF ISOLATION
(LO = +16 dBm)

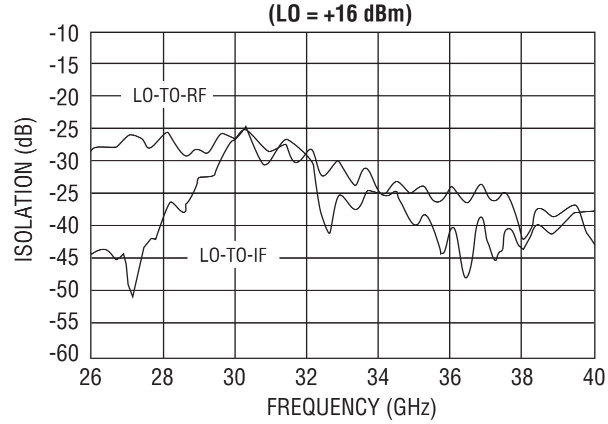
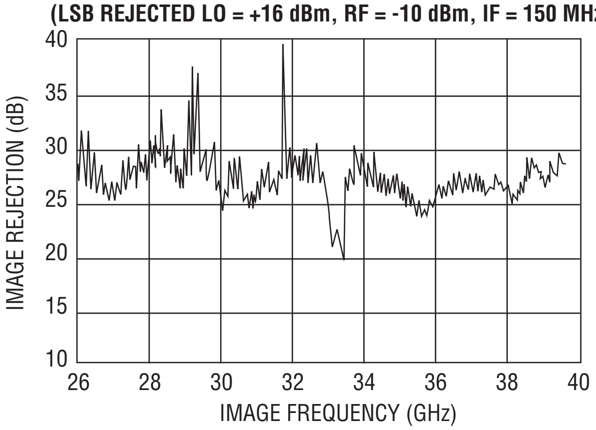
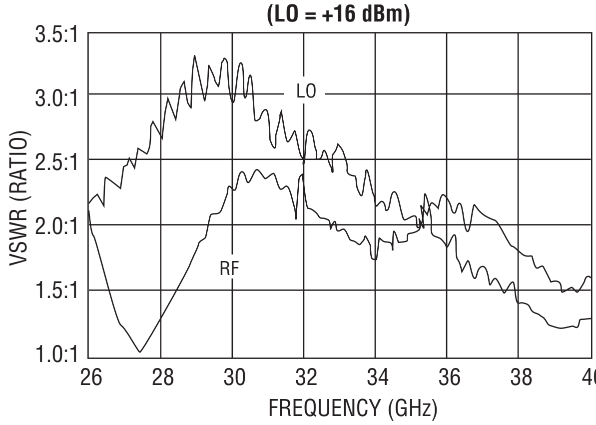


IMAGE REJECTION, IMAGE < LO
(LSB REJECTED LO = +16 dBm, RF = -10 dBm, IF = 150 MHz)



RF AND LO PORT VSWR
(LO = +16 dBm)



MAXIMUM RATINGS

Specification temperature.................... +25°C
Operating temperature .... -54 to +85°C
Storage temperature .... -65 to +125°C

GENERAL NOTE

1. Standard catalog unit aligned and tested for guaranteed RF > LO performance. RF < LO guaranteed performance is available, please contact MITEQ.

NOTE: Test data supplied at 25°C; conversion loss, LO-to-RF isolation, image rejection (IF Options A, B and C), phase and amplitude balance (IF Option Q).

OUTLINE DRAWINGS

IR2640NI7A, B and C

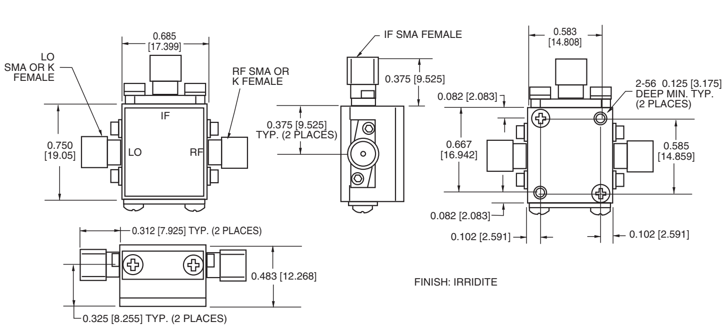
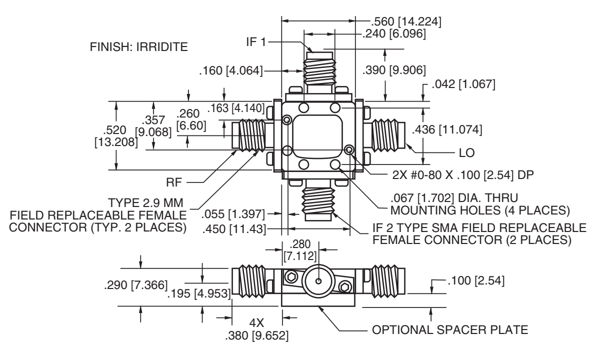


IMAGE REJECTION

IR2640NI7Q



QIFM, I/Q DEMODULATOR

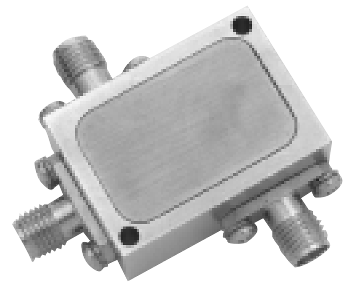
NOTE: All dimensions shown in brackets [ ] are in millimeters.

8.5 TO 9.5 GHz IMAGE REJECTION DOWNCONVERTER

MODELS: IRJ085095U30A, IRJ085095U60A, IRJ085095U120A AND IRJ085095U150A

FEATURES

- RF coverage .... 8.5 to 9.5 GHz
- LO coverage........................ 8.38 to 9.38 GHz
- IF operation .... 20 to 200 MHz
- Conversion loss................... 7 dB typical
- Image rejection .... 25 dB typical



ELECTRICAL SPECIFICATIONS

INPUT PARAMETERS	CONDITION	UNITS	MIN.	TYP.	MAX.
RF frequency range		GHz	8.5		9.5
RF VSWR		Ratio		2:1	
LO frequency range		GHz	8.38		9.38
LO power range		dBm	7		9
LO VSWR		Ratio		2:1	
TRANSFER CHARACTERISTICS	**CONDITION**	**UNITS**	**MIN.**	**TYP.**	**MAX.**
Conversion loss	@ Mid-band IF	dB		7	8
Image rejection	@ Mid-band IF	dB	18	25	
LO-to-RF isolation		dB	30	35	
LO-to-IF isolation		dB	25		
Output power at 1 dB compression		dBm		-6	
OUTPUT PARAMETERS	**CONDITION**	**UNITS**	**MIN.**	**TYP.**	**MAX.**
IF frequency range	IRJ085095U30A	MHz	20		40
	IRJ085095U60A	MHz	40		60
	IRJ085095U120A	MHz	80		160
	IRJ085095U150A	MHz	100		200
IF VSWR (IF = -10 dBm)		Ratio		1.5:1	

IRJ085095U120A TYPICAL TEST DATA

CONVERSION GAIN - UPPER SIDEBAND
(LSB REJECTED LO= +7 dBm RF= -5 dBm IF= 120 MHz)

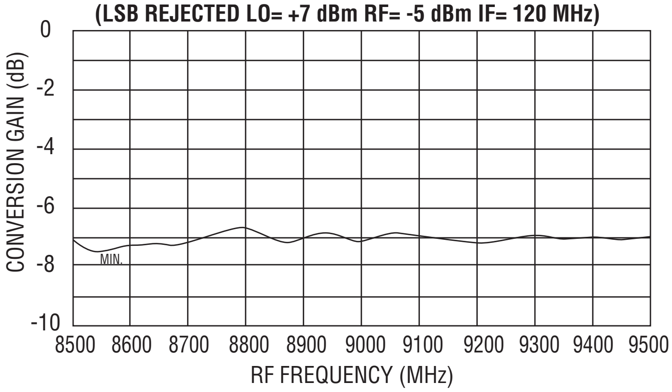
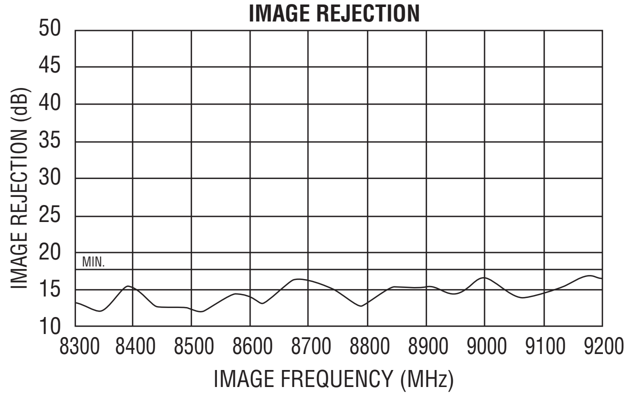
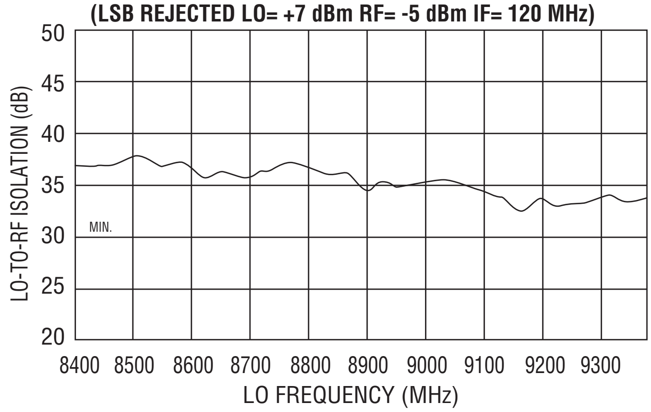


IMAGE REJECTION



LO-TO-RF ISOLATION
(LSB REJECTED LO= +7 dBm RF= -5 dBm IF= 120 MHz)

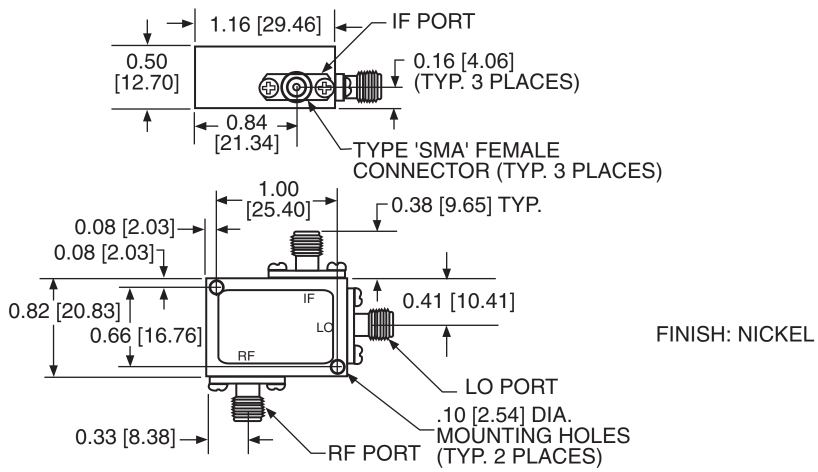


MAXIMUM RATINGS

Specification temperature .... +25°C
Operating temperature .... -55 to +85°C
Storage temperature .... -65 to +95°C

NOTE: Test data supplied at 25°C; conversion loss, LO-to-RF isolation and image rejection.

OUTLINE DRAWING



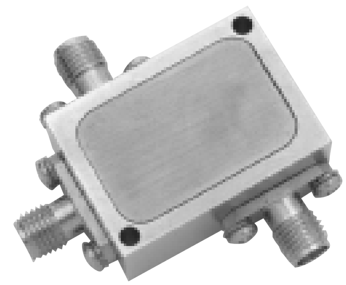
NOTE: All dimensions shown in brackets [ ] are in millimeters.

8.5 TO 9.5 GHz IMAGE REJECTION UPCONVERTER

MODEL: IRJ085095L120A

FEATURES

- RF coverage......................... 8.5 to 9.5 GHz
- LO coverage......................... 8.38 to 9.38 GHz
- IF operation.......................... 80 to 160 MHz



ELECTRICAL SPECIFICATIONS

INPUT PARAMETERS	CONDITION	UNITS	MIN.	TYP.	MAX.
IF frequency range		MHz	80	120	160
IF inpedance		Ohms		50	
LO frequency range		GHz	8.38		9.38
LO power range		dBm	7		9
LO impedance		Ohms		50	
TRANSFER CHARACTERISTICS	**CONDITION**	**UNITS**	**MIN.**	**TYP.**	**MAX.**
Conversion loss	@ 120 MHz IF	dB		7	8
Image rejection	@ 120 MHz IF	dB	18	25	
LO-to-RF isolation		dB	30	35	
LO-to-IF isolation		dB	25		
Output power at 1 dB compression		dBm		-6	
OUTPUT PARAMETERS	**CONDITION**	**UNITS**	**MIN.**	**TYP.**	**MAX.**
RF frequency range		MHz	8.5		9.5
RF impedance		Ohms		50	

IRJ085095L120A TYPICAL TEST DATA

LO FREQUENCY (MHz)	LO (dB)	LO + 1 IF (dB)	LO – 1 IF (dBc)
8380.0	-37.9	-6.4	-27.3
8580.0	-36.8	-6.8	-28.3
8780.0	-37.5	-6.7	-25.5
8980.0	-35.7	-6.7	-23.0
9180.0	-34.3	-7.5	-23.3
9380.0	-34.3	-7.1	-22.8

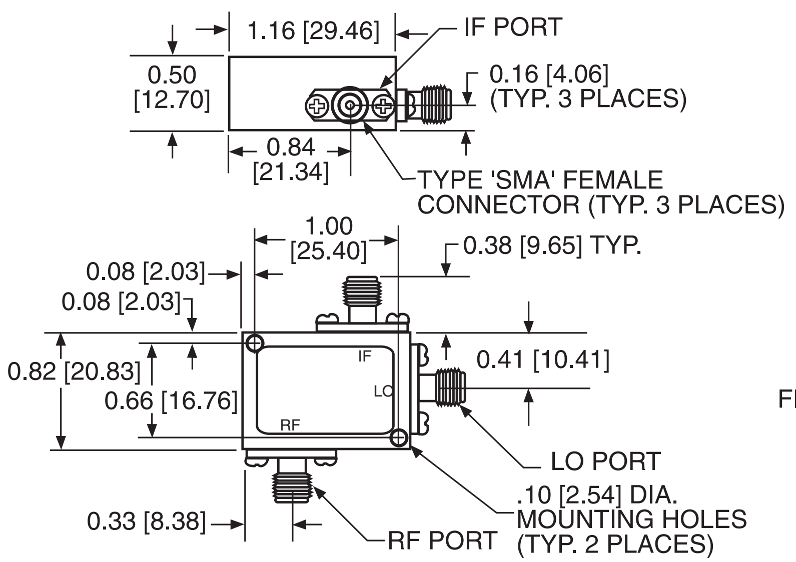
NOTE: Units measured at an IF frequency of 120 MHz and at 25°C.

MAXIMUM RATINGS

Specification temperature .... +25°C
Operating temperature .... -55 to +85°C
Storage temperature .... -65 to +95°C

NOTE: Test data supplied at 25°C; conversion loss, LO-to-RF isolation and image rejection.

OUTLINE DRAWING



FINISH: NICKEL

NOTE: All dimensions shown in brackets [ ] are in millimeters.

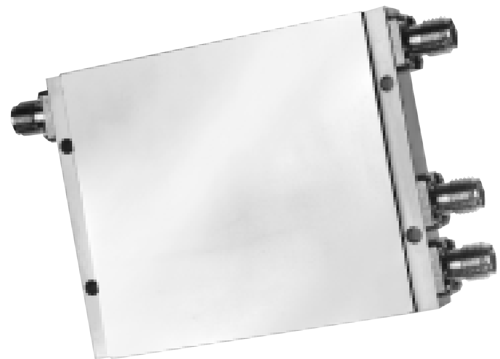
IMAGE REJECTION MIXER PRODUCTS

2 TO 8 GHz ENHANCED IMAGE REJECTION MIXERS

MODELS: IRE0208LI1A, IRE0208LI1B AND IRE0208LI1C

FEATURES

- **RF/LO coverage................ 2 to 8 GHz**
- **Conversion loss................ 9 dB typical**
- **Image rejection .... 30 dB typical**
- **Packaging.......................... Hermetically sealed**



MITEQ's Model IRE0208LI1 enhanced image rejection mixer utilizes a unique architecture developed to provide greater than 30 dB of image rejection across multioctave bands. This design inherently suppresses image frequencies by an additional 15 dB over conventional image rejection mixers without the need for phase and amplitude alignment during production test, allowing for consistent reliable performance throughout production.

ELECTRICAL SPECIFICATIONS

INPUT PARAMETERS	CONDITION	UNITS	MIN.	TYP.	MAX.
RF frequency range		GHz	2		8
RF VSWR (RF = -10 dBm)		Ratio		2:1	
LO frequency range		GHz	2		8
LO power range	IRE0208LI1	dBm	+13	+15	+16
	IRE0208HI1	dBm	+20	+22	+23
LO VSWR		Ratio		2.5:1	
TRANSFER CHARACTERISTICS	**CONDITION**	**UNITS**	**MIN.**	**TYP.**	**MAX.**
Conversion loss (Note 1)		dB		9	9.5
Single-sideband noise figure		dB		10	
Image rejection (Note 1)		dB	25	30	
LO-to-RF isolation		dB	24	30	
Input power at 1 dB compression	IRE0208LI1	dBm		+8	
	IRE0208HI1	dBm		+15	
Input two-tone third-order intercept point	IRE0208LI1	dBm		+18	
	IRE0208HI1	dBm		+25	
OUTPUT PARAMETERS	**CONDITION**	**UNITS**	**MIN.**	**TYP.**	**MAX.**
IF frequency range	IRE0208LI1A	MHz	20		40
	IRE0208LI1B	MHz	40		80
	IRE0208LI1C	MHz	100		200
IF VSWR (IF = -10 dBm)		Ratio		1.5:1	

IRE0208LI1C TYPICAL TEST DATA

VSWR
(LO = +14 dBm)

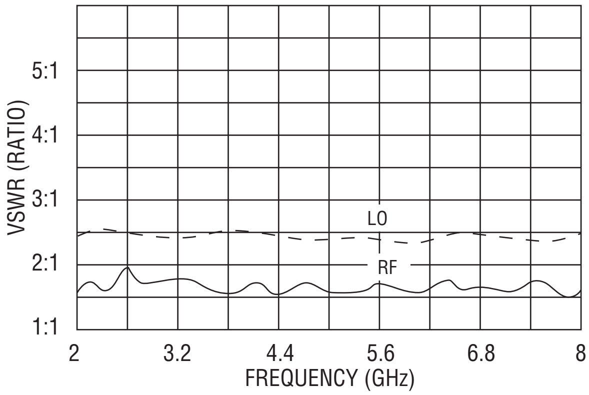
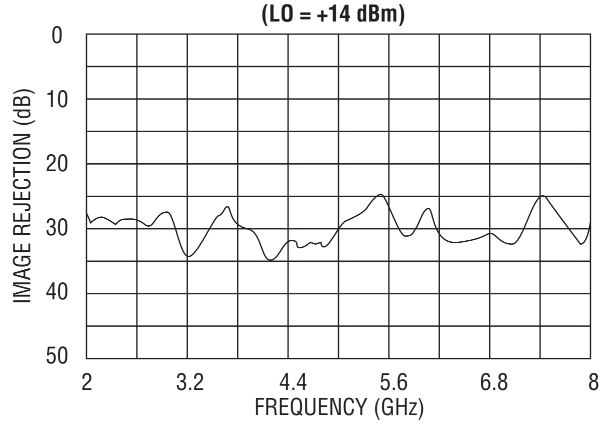
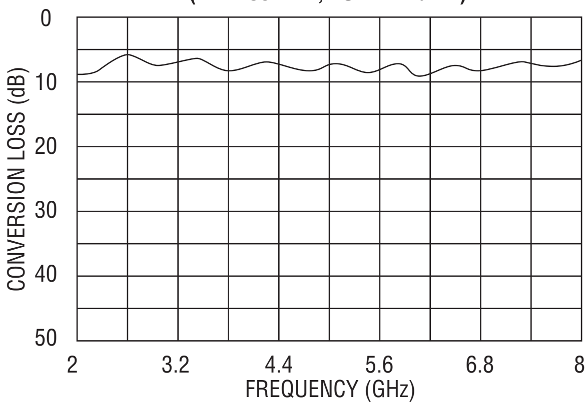


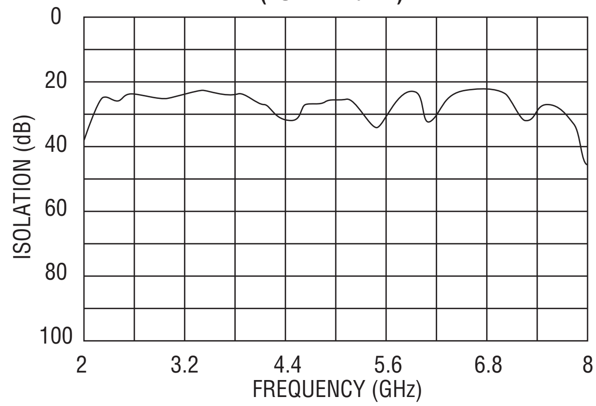
IMAGE REJECTION
(LO = +14 dBm)



CONVERSION LOSS
(IF = 150 MHz, LO = +14 dBm)



LO-TO-RF ISOLATION
(LO = +14 dBm)



MAXIMUM RATINGS

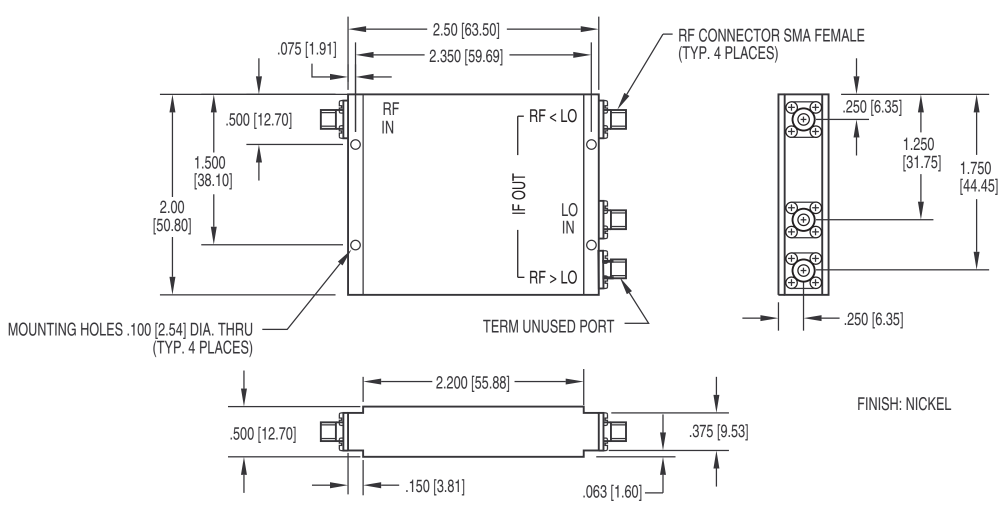
Specification temperature .... +25°C
Operating temperature .... -54 to +85°C
Storage temperature .... -65 to +125°C

GENERAL NOTE

1. Unit normally aligned for operation with LO > RF. If LO < RF is desired, please specify at time of order. Operation at both modes is a special option with some degradation in performance.

NOTE: Test data supplied at 25°C; conversion loss, LO-to-RF isolation and image rejection.

OUTLINE DRAWING



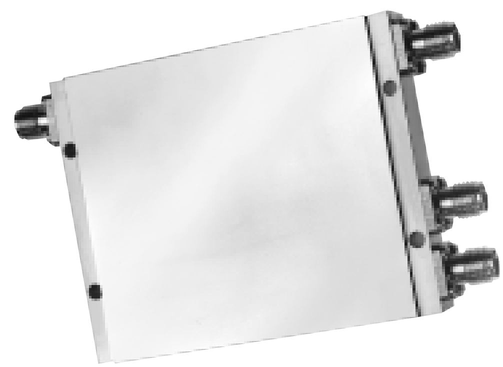
NOTE: All dimensions shown in brackets [ ] are in millimeters.

6 TO 18 GHz ENHANCED IMAGE REJECTION MIXERS

MODELS: IRE0618LI1A, IRE0618LI1B AND IRE0618LI1C

FEATURES

- **RF/LO coverage................ 6 to 18 GHz**
- **LO power range................ +13 to +15 dBm**
- **Conversion loss................ 8 dB typical**
- **Image rejection .... 35 dB typical**
- **Packaging.......................... Hermetically sealed**



MITEQ's Model IRE0618LI1 enhanced image rejection mixer utilizes a unique architecture developed to provide greater than 30 dB of image rejection across multioctave bands. This design inherently suppresses image frequencies by an additional 15 dB over conventional image rejection mixers without the need for phase and amplitude alignment during production test, thereby allowing for consistent reliable performance throughout production.

ELECTRICAL SPECIFICATIONS

INPUT PARAMETERS	CONDITION	UNITS	MIN.	TYP.	MAX.
RF frequency range		GHz	6		18
RF VSWR (RF = -10 dBm)		Ratio		1.5:1	
LO frequency range		GHz	6		18
LO power range	IRE0618LI1	dBm	+13	+15	+16
	IRE0618HI1	dBm	+20	+22	+23
LO VSWR		Ratio		2.5:1	
TRANSFER CHARACTERISTICS	**CONDITION**	**UNITS**	**MIN.**	**TYP.**	**MAX.**
Conversion loss (Note 1)		dB		8	10.5
Single-sideband noise figure		dB		8.5	
Image rejection (Note 1)		dB	25	35	
LO-to-RF isolation		dB	24	30	
Input power at 1 dB compression	IRE0618LI1	dBm		+8	
	IRE0618HI1	dBm		+15	
Input two-tone third-order intercept point	IRE0618LI1	dBm		+18	
	IRE0618HI1	dBm		+25	
OUTPUT PARAMETERS	**CONDITION**	**UNITS**	**MIN.**	**TYP.**	**MAX.**
IF frequency range (image rejection mode)	IRE0618LI1A	MHz	20		40
	IRE0618LI1B	MHz	40		80
	IRE0618LI1C	MHz	100		200
IF VSWR (IF = -10 dBm)		Ratio		1.5:1	

IRE0618LI1B TYPICAL TEST DATA

VSWR
(LO = +14 dBm)

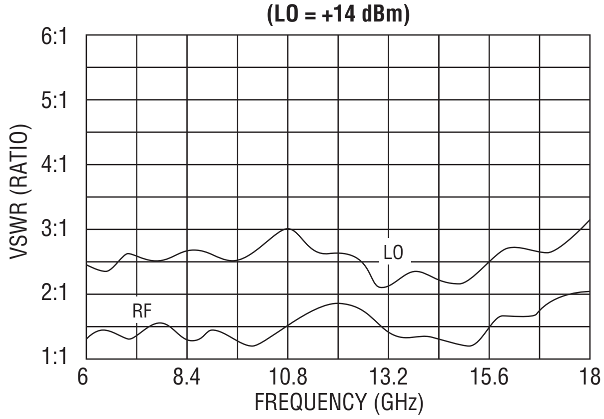
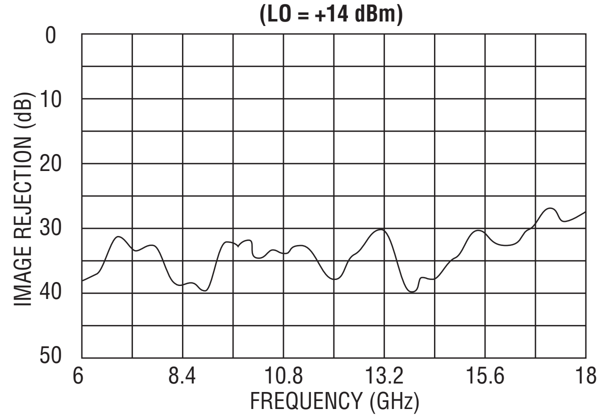
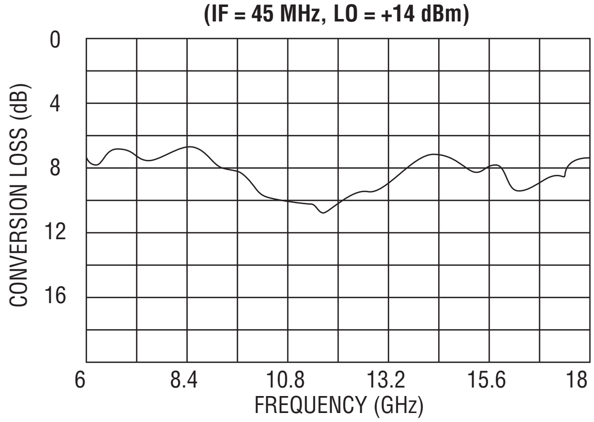


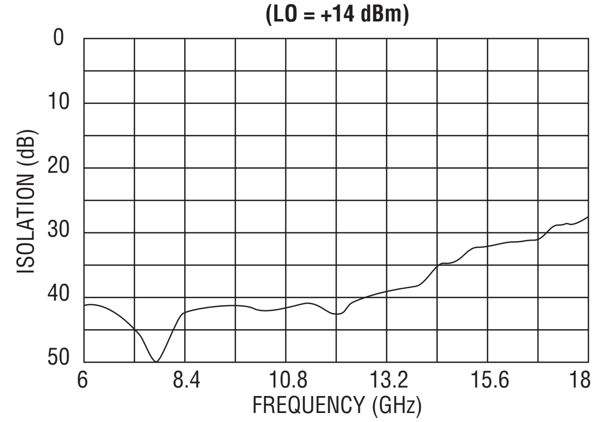
IMAGE REJECTION
(LO = +14 dBm)



CONVERSION LOSS
(IF = 45 MHz, LO = +14 dBm)



LO-TO-RF ISOLATION
(LO = +14 dBm)



MAXIMUM RATINGS

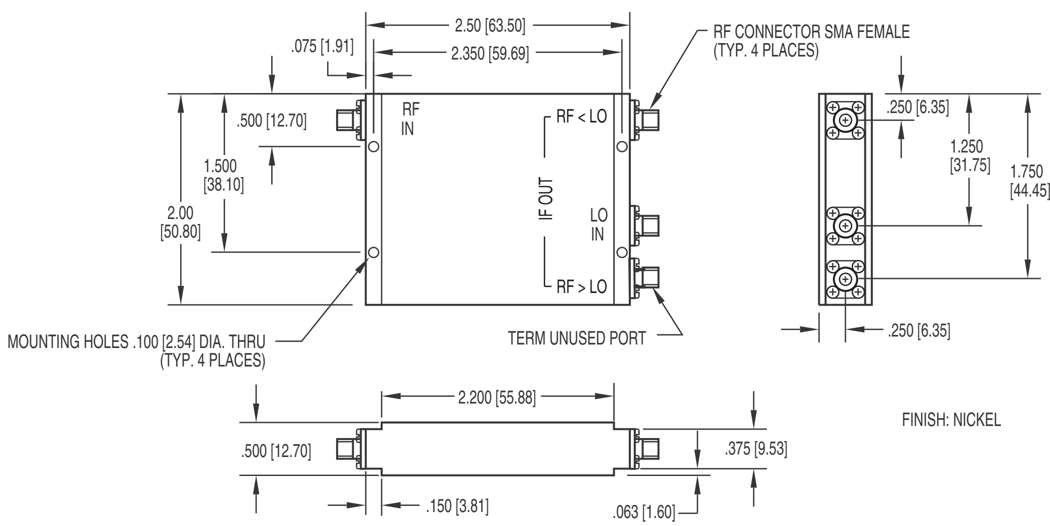
Specification temperature .... +25°C
Operating temperature .... -54 to +85°C
Storage temperature .... -65 to +125°C

GENERAL NOTE

1. Unit normally aligned for operation with LO > RF. If LO < RF is desired, please specify at time of order. Operation at both modes is a special option with some degradation in performance.

NOTE: Test data supplied at 25°C; conversion loss, LO-to-RF isolation and image rejection.

OUTLINE DRAWING



NOTE: All dimensions shown in brackets [ ] are in millimeters.

2 TO 18 GHz BIASABLE IMAGE REJECTION MIXERS

MODELS: IRB0218LC1A, IRB0218LC1B AND IRB0218LC1C

FEATURES

- **RF/LO coverage................ 2 to 18 GHz**
- **IF operation....................... 20 to 200 MHz**
- **LO power range................ -10 to +13 GHz**
- **Conversion loss................ 10 dB typical**
- **Image rejection .... 20 dB typical**

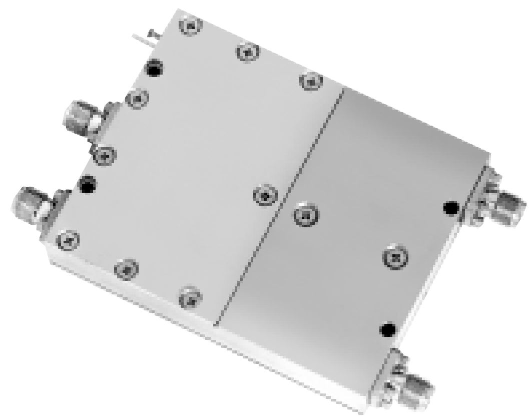


Image rejection mixers are useful for wideband test equipment or in ultra-broadband receivers requiring rejection of an unwanted sideband of signal or noise following a low-noise front-end amplifier. These mixers are also useful as linear single-sideband upconverters by operating in the reverse mode. The MITEQ IRB Series design utilizes two mixers with biasable bridge diode quads, thus allowing operation at very low LO powers. The bias circuit also automatically compensates for any power variations in the swept LO source.

ELECTRICAL SPECIFICATIONS

INPUT PARAMETERS	CONDITION	UNITS	MIN.	TYP.	MAX.
RF frequency range		GHz	2		18
RF VSWR (RF = -10 dBm, LO = 0 dBm)		Ratio		2:1	
LO frequency range		GHz	2		18
LO power range		dBm	-10	0	+13
LO VSWR (LO = 0 dBm)		Ratio		2.5:1	
DC power	+15 VDC	mA		25	
TRANSFER CHARACTERISTICS	**CONDITION**	**UNITS**	**MIN.**	**TYP.**	**MAX.**
Conversion loss (Note 1) (RF = -10 dBm, LO = 0 dBm)	RF > LO	dB		10	12.5
Single-sideband noise figure		dB		10	
Image rejection (Note 1)	RF < LO	dB	18	20	
LO-to-RF isolation		dB	15	18	
LO-to-IF isolation		dB		20	
Input power at 1 dB compression	LO = 0 dBm	dBm		-10	
Input two-tone third-order intercept point	LO = 0 dBm	dBm		0	
OUTPUT PARAMETERS	**CONDITION**	**UNITS**	**MIN.**	**TYP.**	**MAX.**
IF frequency range	IRB0218LC1A IRB0218LC1B IRB0218LC1C	MHz MHz MHz	20 40 100		40 80 200
IF VSWR (IF = -10 dBm, LO = 0 dBm)		Ratio		1.5:1	

IRB0218LC1A TYPICAL TEST DATA

VSWR
(LO = +3 dBm)

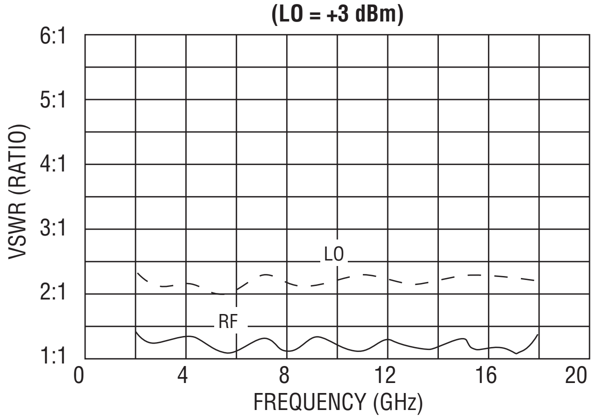
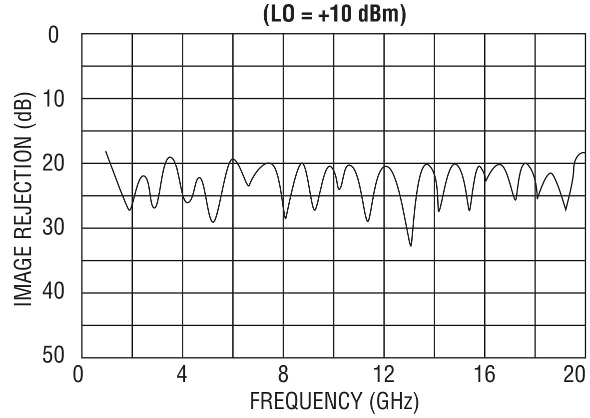
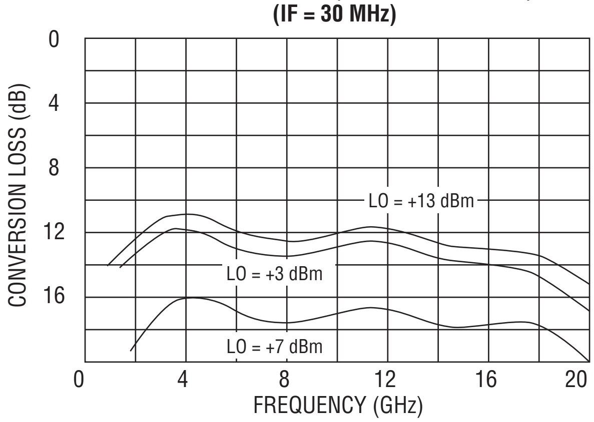


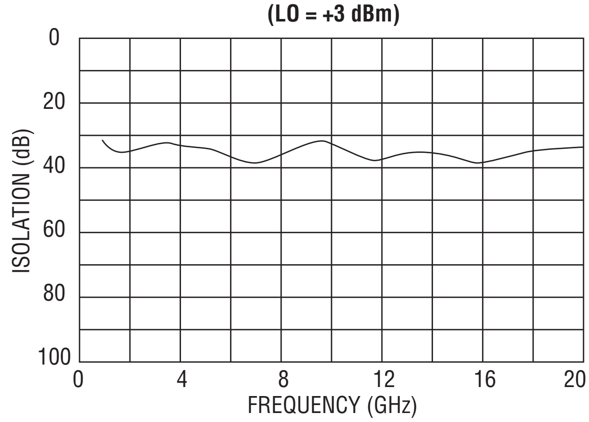
IMAGE REJECTION
(LO = +10 dBm)



CONVERSION LOSS (LO = -7 TO +13 dBm)
(IF = 30 MHz)



LO-TO-RF ISOLATION
(LO = +3 dBm)



MAXIMUM RATINGS

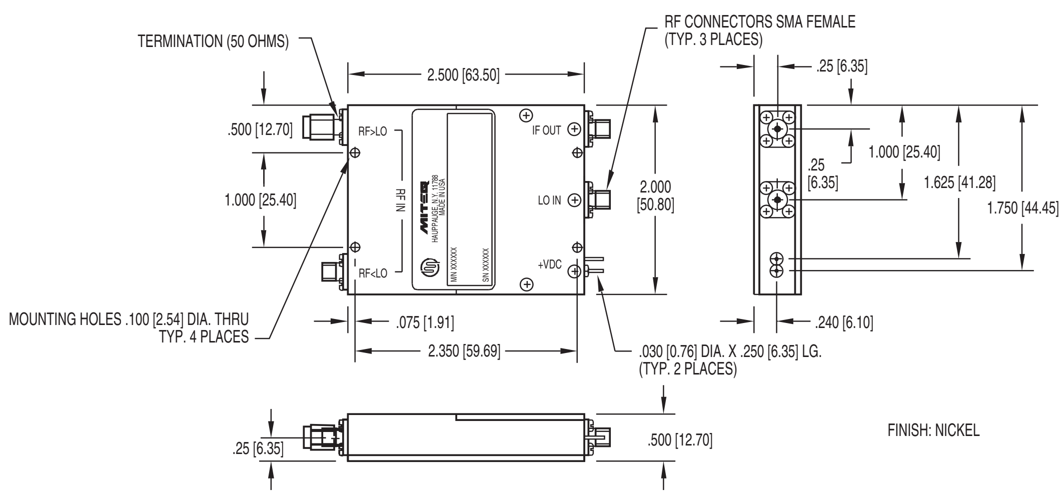
Specification temperature .... +25°C
Operating temperature................................... -54 to +85°C
Storage temperature .... -65 to +125°C

GENERAL NOTE

1. Standard catalog unit aligned and tested for guaranteed RF > LO performance. RF < LO guaranteed performance is available, please contact MITEQ.

NOTE: Test data supplied at 25°C; conversion loss, LO-to-RF isolation and image rejection.

OUTLINE DRAWING



NOTE: All dimensions shown in brackets [ ] are in millimeters.

I/Q PHASE DETECTOR WITH OPTIONAL VIDEO AMPS AND/OR DIGITAL OUTPUTS

MODELS: IQM, IQD AND IQDD16020

FEATURES

- **RF/LO coverage................ 150 to 170 MHz**
- **Center frequency.............. 160 MHz**
- **Phase accuracy .... ±5° typical**
- **I/Q output voltage............. ±2.5 volts (IQD Model)**
- **Variable offset and gain adjust**
- **Internal ±5 volt regulators**
- **Optional 8 BIT TTL output (IQDD Model)**

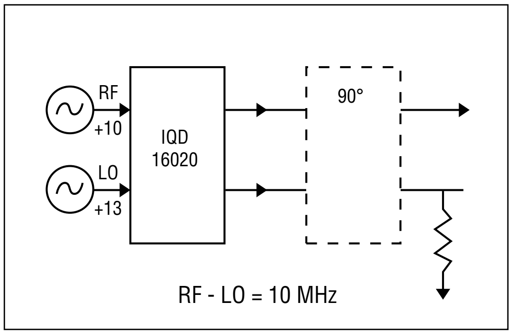
The IQM, IQD, and IQDD model I/Q phase detectors all utilize high isolation mixers and hybrids to minimize residual AC and DC circuit errors that limit phase accuracy. 10 MHz bandwidth video amplifiers are available (IQD model) to buffer outputs leading to the user's post circuitry or optional MITEQ A/D converters (IQDD model). IQM and IQD models require +13 dBm reference LO power and -20 to +10 dBm RF power for DC outputs. For AC video outputs, the lowest RF input power is limited by noise. The angular accuracy of the IQM and IQD models is measured at the maximum RF reference power.

ELECTRICAL SPECIFICATIONS

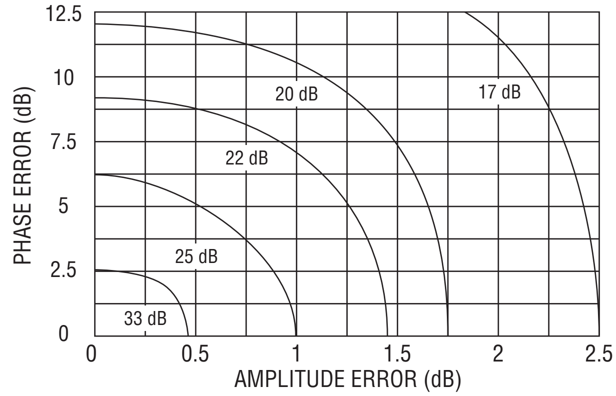
INPUT PARAMETERS	CONDITION	UNITS	MIN.	TYP.	MAX.
RF/LO frequency range (information B/W)		MHz	150		170
RF phase accuracy bandwidth		MHz	4	10	
RF VSWR (RF = +10 dBm, LO = +13 dBm)		Ratio		1.5:1	
LO power range		dBm	10		13
LO VSWR (LO = +13 dBm)	Ratio		1.7:1		
Current IQD	-15/+15	mA		-100/+100	
IQDD	-15/+15	mA		-100/+500	
TRANSFER CHARACTERISTICS	**CONDITION**	**UNITS**	**MIN.**	**TYP.**	**MAX.**
Conversion loss (IQM model)		dB		8	10
Conversion gain, K (IQD model)	Volt=KV_{RMS}COS Ø	K ratio		3.5	
Equivalent image rejection (see reverse side)	IF = 10 MHz	dB	22	25	
Linear phase accuracy $\tan^{-1} V_Q/V_I$	LO = 13, RF = +3	Degrees		5	7
OUTPUT PARAMETERS	**CONDITION**	**UNITS**	**MIN.**	**TYP.**	**MAX.**
IQM • Output voltage (RF = +10 dBm)		mV		400	
• DC offset (LO = +13 dBm, RF off)	50 ohm reference	mV		2	5
• VSWR (LO = +13 dBm)		Ratio		1.5:1	
IQD • Output voltage (RF = +10 dBm)		Volts		2.5	
• DC offset (LO = +13 dBm, RF off)		mV		30	
• VSWR (LO = +13 dBm)	-90 ohm reference	Ratio		1.5:1	
IQDD TTL 8-BIT clock rate required		MHz		20	

IQ SERIES REFERENCE DATA

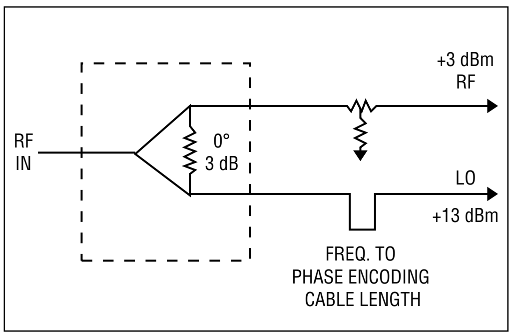
TEST SETUP FOR EQUIVALENT IMAGE REJECTION (FOR NON-DC VIDEO)



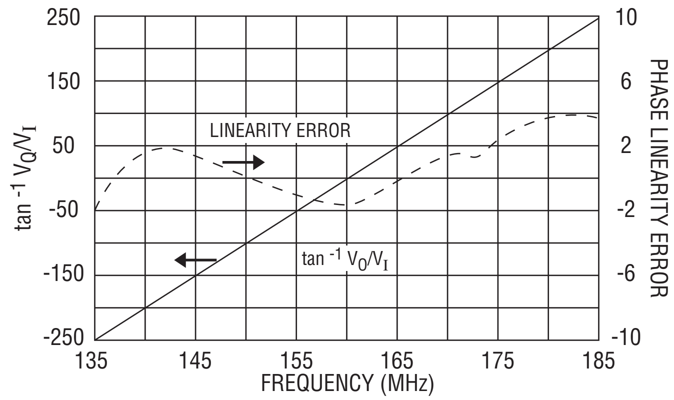
EQUIVALENT IMAGE REJECTION WITH VARIOUS PHASE-AMPLITUDE ERRORS



TEST SIGNALS FOR MEASURING I/Q PHASE LINEARITY (FOR DC VIDEO)



TAN $\frac{-1\ VQ}{VI}$ VERSUS FREQUENCY AND TYPICAL PHASE LINEARITY ERROR OF IQD16020C4



MAXIMUM RATINGS

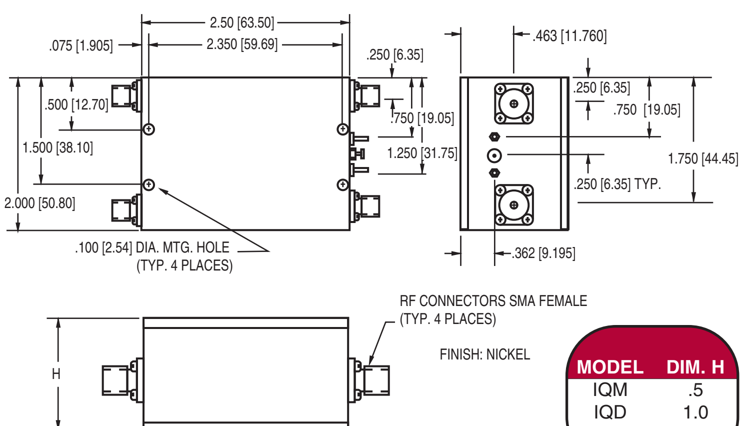
Specification temperature.................... +25°C
Operating temperature .... -30 to +70°C
Storage temperature .... -55 to +125°C

GENERAL NOTES

1. Application and test, question and answer sheet are available from MITEQ.
2. RF limiter models available with -60 to 0 dBm input dynamic range.

OUTLINE DRAWING

C4 HOUSING (Nonhermetic)

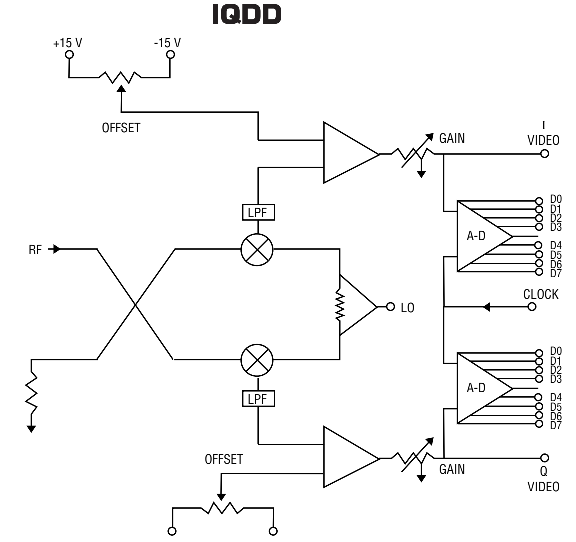


MODEL	DIM. H
IQM	.5
IQD	1.0
IQDD	1.5

NOTE: All dimensions shown in brackets [ ] are in millimeters.

BLOCK DIAGRAM

IQDD



2 TO 26 GHz IMAGE REJECTION MIXERS

MODELS: IRBA0226LC1A, IRBA0226LC1B AND IRBA0226LC1C

FEATURES

- **RF/LO coverage .... 2 to 26 GHz**
- **IF operation .... 20 to 200 MHz**
- **LO power range .... -10 to +13 dBm**
- **Conversion gain .... 20 dB typical**
- **Image rejection .... 20 dB typical**
- **Biasable**

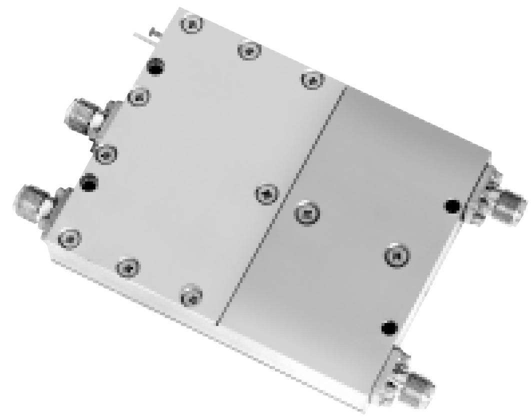


Image rejection mixers are useful for wideband test equipment or ultra-broadband receivers requiring rejection of an unwanted sideband of signal or noise following a low-noise front-end amplifier. These mixers are also useful as linear single-sideband upconverters by operating in the reverse mode. The MITEQ IRBA Series design utilizes two mixers with biasable bridge diode quads, thus allowing operation at very low LO powers. An integrated IF amplifier also makes the unit's sensitivity less dependent on load noise and mismatch.

ELECTRICAL SPECIFICATIONS

INPUT PARAMETERS	CONDITION	UNITS	MIN.	TYP.	MAX.
RF frequency range		GHz	2		26
RF VSWR (RF = -30 dBm, LO = 0 dBm)		Ratio		2:1	
LO frequency range		GHz	2		26
LO power range		dBm	-10	0	+13
LO VSWR (LO = 0 dBm)		Ratio		2.5:1	
DC power	+15 VDC	mA		75	
TRANSFER CHARACTERISTICS	**CONDITION**	**UNITS**	**MIN.**	**TYP.**	**MAX.**
Conversion gain (Note 1) (RF = -30 dBm, LO = 0 dBm)	RF > LO	dB	15	20	
Single-sideband noise figure		dB		16	
Image rejection (Note 1) (RF = -30 dBm, LO = 0 dBm)	RF < LO	dB	15	20	
LO-to-RF isolation		dB	20	25	
LO-to-IF isolation		dB		20	
Output power at 1 dB compression	LO = 0 dBm	dBm		+5	
Output two-tone third-order intercept point	LO = 0 dBm	dBm		+15	
OUTPUT PARAMETERS	**CONDITION**	**UNITS**	**MIN.**	**TYP.**	**MAX.**
IF frequency range	IRBA0226LC1A	MHz	20		40
	IRBA0226LC1B	MHz	40		80
	IRBA0226LC1C	MHz	100		200
IF VSWR (IF = -30 dBm, LO = 0 dBm)		Ratio		1.5:1	

IRBA0226LC1A TYPICAL TEST DATA

VSWR
(LO = 0 dBm)

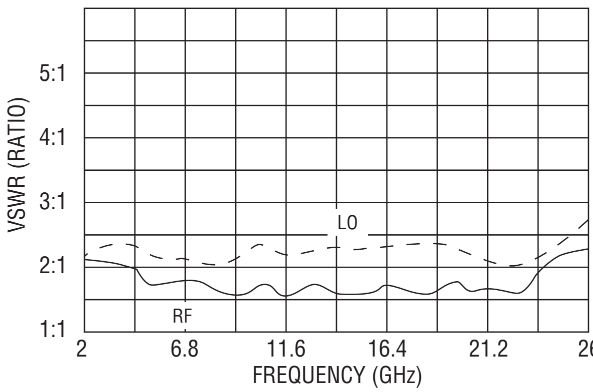
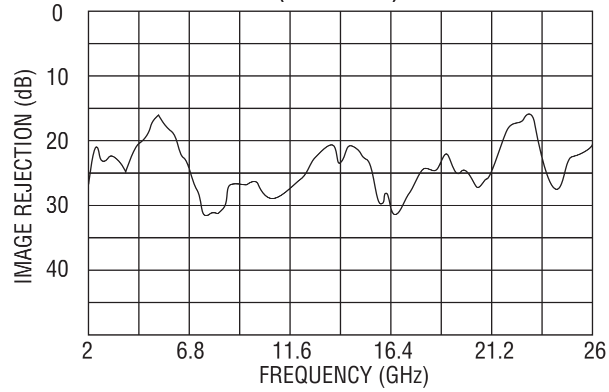
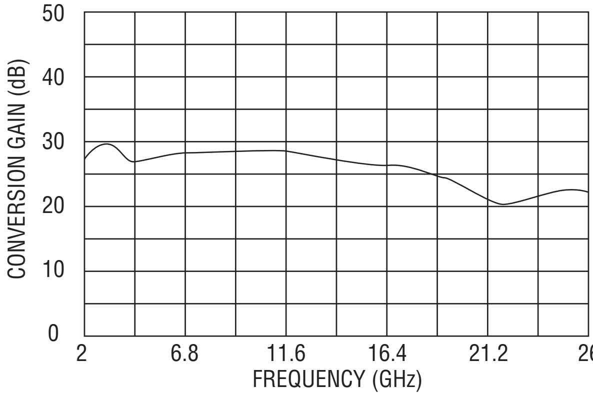


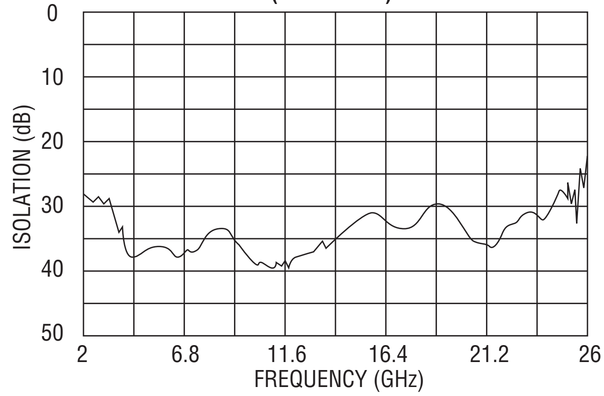
IMAGE REJECTION
(LO = 0 dBm)



CONVERSION GAIN
(IF = 30 MHz, LO = 0 dBm)



LO-TO-RF ISOLATION
(LO = 0 dBm)



MAXIMUM RATINGS

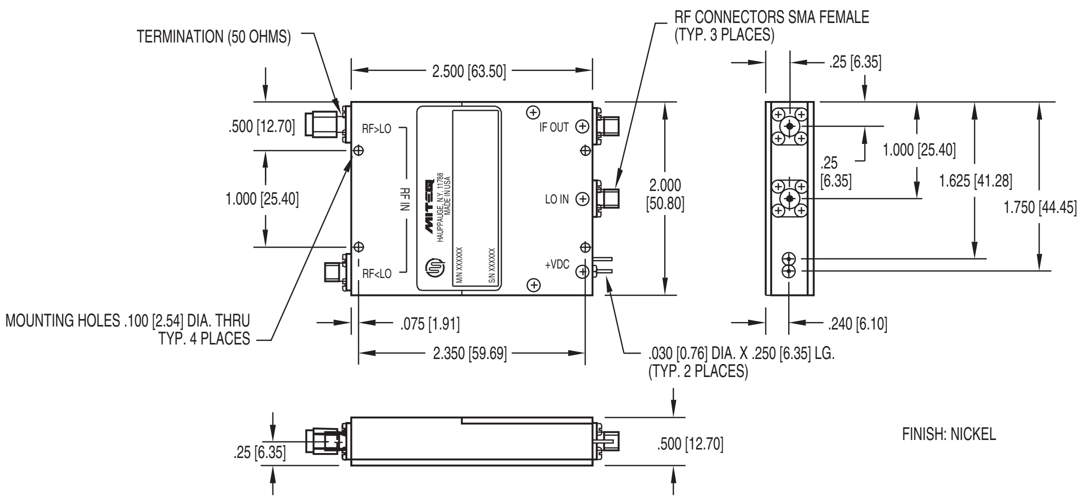
Specification temperature.................... +25°C
Operating temperature .... -54 to +85°C
Storage temperature .... -65 to +125°C

GENERAL NOTE

1. Standard catalog unit aligned and tested for guaranteed RF > LO performance. RF < LO guaranteed performance is available, please contact MITEQ.

NOTE: Test data supplied at 25°C; conversion gain, LO-to-RF isolation and image rejection.

OUTLINE DRAWING



NOTE: All dimensions shown in brackets [ ] are in millimeters.

2 TO 26 GHz IMAGE REJECTION MIXERS/IF AMP INPUT

MODELS: IRA0226LC1A, IRA0226LC1B AND IRA0226LC1C

FEATURES

- **RF/LO coverage .... 2 to 26 GHz**
- **IF operation .... 20 to 200 MHz**
- **LO power range .... +10 to +13 dBm**
- **Conversion gain .... 23 dB typical**
- **Image rejection .... 20 dB typical**

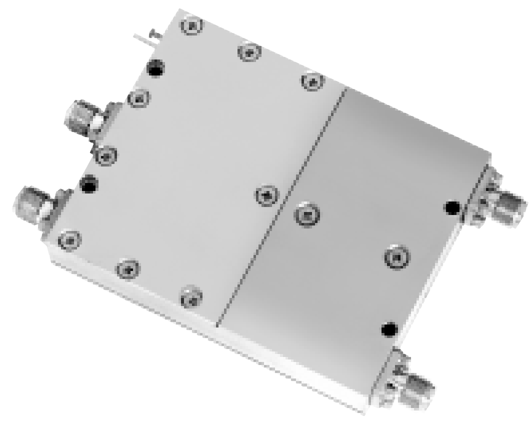


Image rejection mixers are useful for wideband test equipment or ultra-broadband receivers requiring rejection of an unwanted sideband of signal or noise following a low-noise front-end amplifier. The IRA Series of image rejection mixers has an integrated IF amplifier, thus making the overall sensitivity less dependent on the load noise. The mixer/IF interface is also optimized for best 2RF-2LO spur performance.

ELECTRICAL SPECIFICATIONS

INPUT PARAMETERS	CONDITION	UNITS	MIN.	TYP.	MAX.
RF frequency range		GHz	2		26
RF VSWR (RF = -30 dBm, LO = +12 dBm)		Ratio		2:1	
LO frequency range		GHz	2		26
LO power range		dBm	+10	+12	+13
LO VSWR (LO = +12 dBm)		Ratio		2.5:1	
DC power	+15 VDC	mA		75	
TRANSFER CHARACTERISTICS	**CONDITION**	**UNITS**	**MIN.**	**TYP.**	**MAX.**
Conversion gain (Note 1)	RF > LO	dB	20	23	
Single-sideband noise figure		dB		15	
Image rejection (Note 1)	RF < LO	dB	15	20	
LO-to-RF isolation		dB	20	35	
LO-to-IF isolation		dB		20	
Output power at 1 dB compression	LO = +13 dBm	dBm		+10	
Output two-tone third-order intercept point	LO = +13 dBm	dBm		+20	
OUTPUT PARAMETERS	**CONDITION**	**UNITS**	**MIN.**	**TYP.**	**MAX.**
IF frequency range	IRA0226LC1A IRA0226LC1B IRA0226LC1C	MHz MHz MHz	20 40 100		40 80 200
IF VSWR (IF = -30 dBm, LO = +12 dBm)		Ratio		1.5:1	

IRA0226LC1A TYPICAL TEST DATA

VSWR
(LO = +10 dBm)

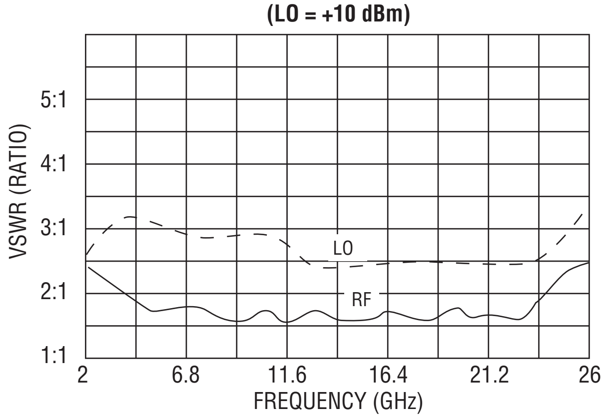
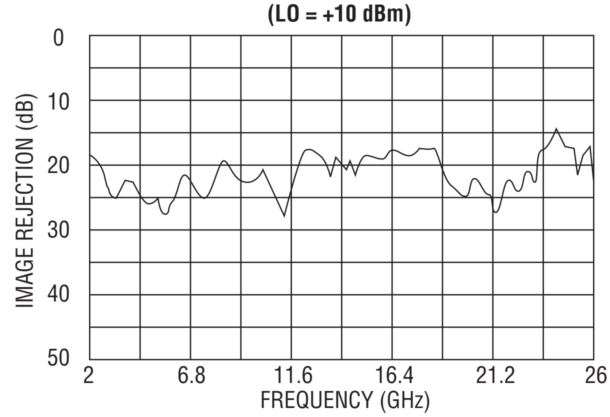
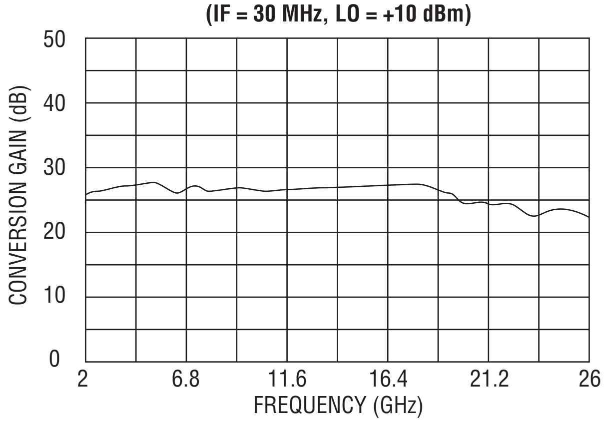


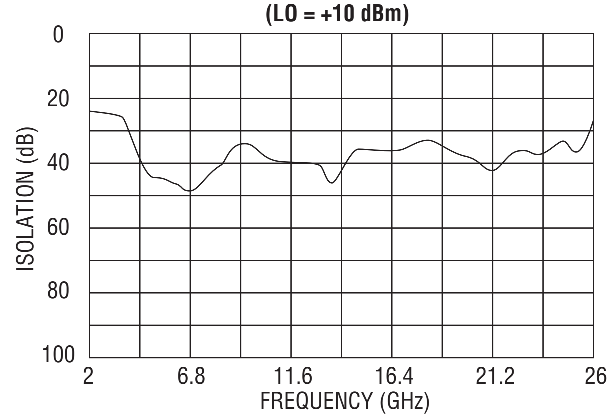
IMAGE REJECTION
(LO = +10 dBm)



CONVERSION GAIN
(IF = 30 MHz, LO = +10 dBm)



LO-TO-RF ISOLATION
(LO = +10 dBm)



MAXIMUM RATINGS

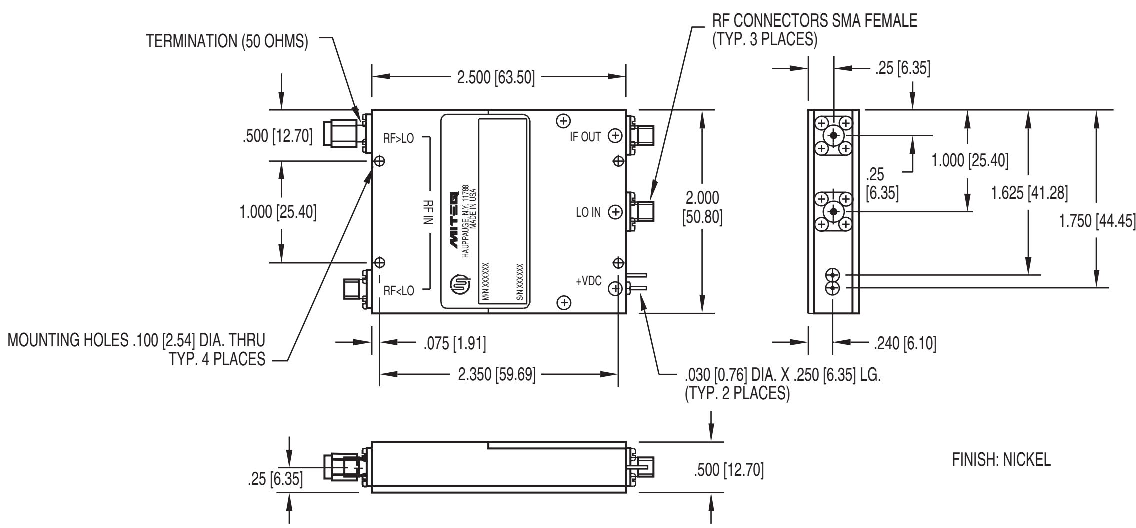
Specification temperature .... +25°C
Operating temperature .... -54 to +85°C
Storage temperature .... -65 to +125°C

GENERAL NOTE

1. Standard catalog unit aligned and tested for guaranteed RF > LO performance. RF < LO guaranteed performance is available, please contact MITEQ.

NOTE: Test data supplied at 25°C; conversion gain and LO-to-RF isolation.

OUTLINE DRAWING



NOTE: All dimensions shown in brackets [ ] are in millimeters.

5.4 TO 5.9 GHz IMAGE REJECTION MIXER/IF AMP

MODELS: IRA5459LR1A, IRA5459LR1B AND IRA5459LR1C

FEATURES

- **RF/LO coverage .... 5.4 to 5.9 GHz**
- **IF operation .... 20 to 200 MHz**
- **LO power range .... +7 to +10 dBm**
- **Conversion gain .... 27 dB typical**
- **Image rejection .... 22 dB typical**

Image rejection mixers are useful for wideband test equipment or ultra-broadband receivers requiring rejection of an unwanted sideband of signal or noise following a low-noise front-end amplifier. The IRA Series of image rejection mixers has an integrated IF amplifier, thus making the overall sensitivity less dependent on the load noise. Now available with sideband selection switch, contact factory.

ELECTRICAL SPECIFICATIONS

INPUT PARAMETERS	CONDITION	UNITS	MIN.	TYP.	MAX.
RF frequency range		GHz	5.4		5.9
RF VSWR (RF = -10 dBm)		Ratio		2:1	
LO frequency range		GHz	5.4		5.9
LO power range		dBm	+7		+10
LO VSWR		Ratio		2:1	
Bias	+15 Volts	mA		150	
TRANSFER CHARACTERISTICS	**CONDITION**	**UNITS**	**MIN.**	**TYP.**	**MAX.**
Conversion gain		dB	25	27	
Single-sideband noise figure at 25°C		dB		6	7
Image rejection (Note 1)		dB	20	22	
LO-to-RF isolation		dB	20	25	
LO-to-IF isolation		dB	20	22	
Output power at 1 dB compression point		dBm	0	+3	
OUTPUT PARAMETERS	**CONDITION**	**UNITS**	**MIN.**	**TYP.**	**MAX.**
IF frequency range	IRA5459LR1A	MHz	20		40
	IRA5459LR1B	MHz	40		80
	IRA5459LR1C	MHz	100		200
IF VSWR (IF = -10 dBm)		Ratio		1.5:1	

IMAGE REJECTION MIXER PRODUCTS

Revised: 06/18/12

MITEQ 100 Davids Drive, Hauppauge, NY 11788 • TEL: (631) 439-9220 • FAX: (631) 436-7430 • www.miteq.com

IRA5459LR1A TYPICAL TEST DATA

LO-TO-RF ISOLATION
(LO = +7 dBm)

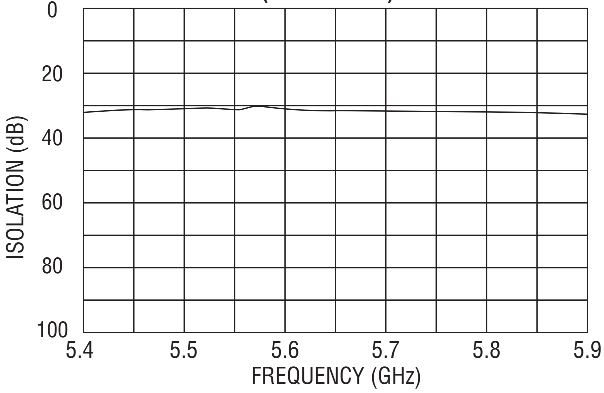
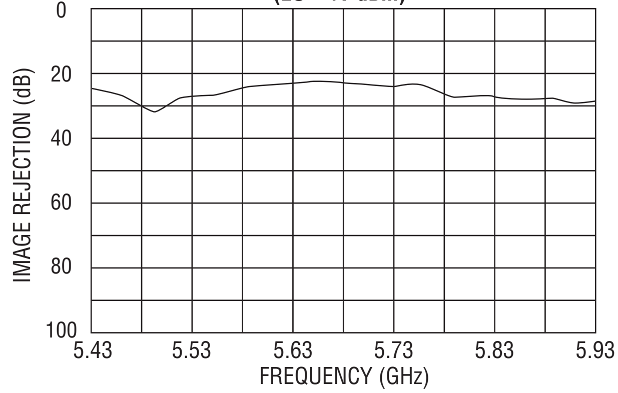
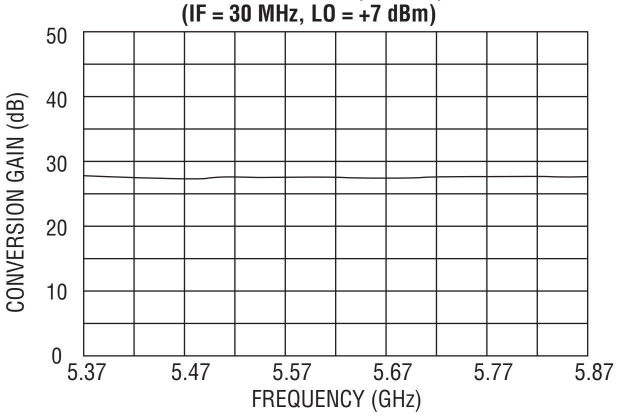


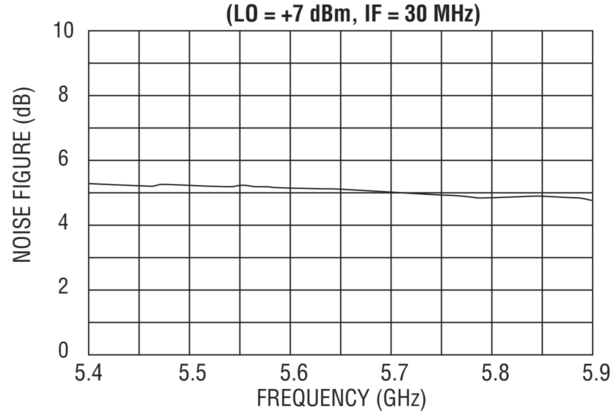
IMAGE REJECTION
(LO = +7 dBm)



CONVERSION GAIN (RF < LO)
(IF = 30 MHz, LO = +7 dBm)



NOISE FIGURE VS. LO FREQUENCY
(LO = +7 dBm, IF = 30 MHz)

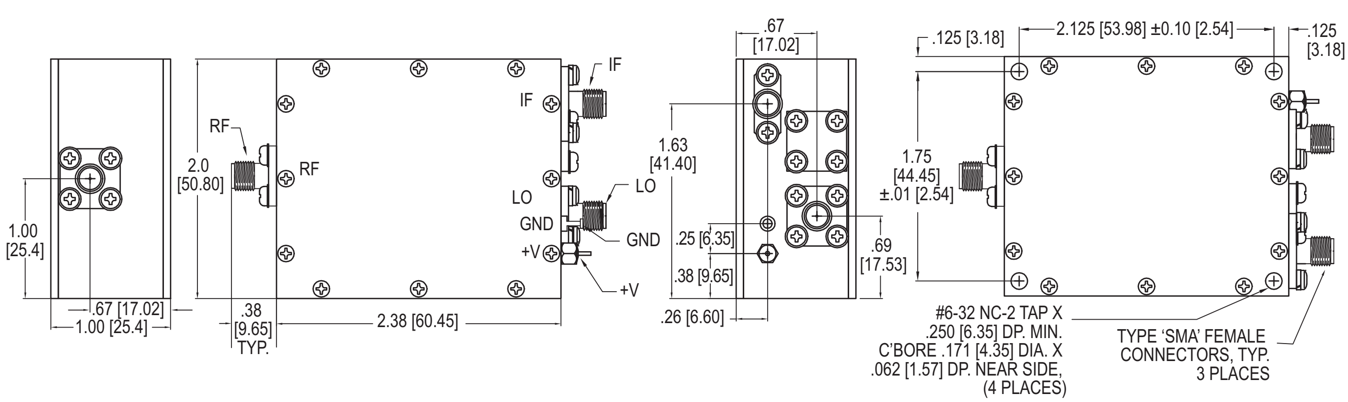


MAXIMUM RATINGS

Specification temperature .... +25°C
Operating temperature .... -54 to +85°C
Storage temperature .... -65 to +125°C

NOTE: Test data supplied at 25°C; conversion gain, noise figure, image rejection and LO-to-RF isolation.

OUTLINE DRAWING



NOTE: All dimensions shown in brackets [ ] are in millimeters.

IMAGE REJECTION MIXER PRODUCTS

Revised: 07/10/13

8.5 TO 9.6 GHz IMAGE REJECTION MIXER/IF AMP

MODELS: IRA8596LR1A, IRA8596LR1B AND IRA8596LR1C

FEATURES

- **RF/LO coverage .... 8.5 to 9.6 GHz**
- **IF operation .... 20 to 200 MHz**
- **LO power range .... +7 to +10 dBm**
- **Conversion gain .... 23 dB typical**
- **Image rejection .... 22 dB typical**

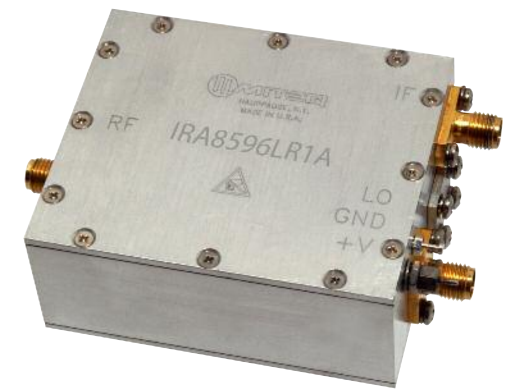


Image rejection mixers are useful for wideband test equipment or ultra-broadband receivers requiring rejection of an unwanted sideband of signal or noise following a low-noise front-end amplifier. The IRA Series of image rejection mixers has an integrated IF amplifier, thus making the overall sensitivity less dependent on the load noise.

ELECTRICAL SPECIFICATIONS

INPUT PARAMETERS	CONDITION	UNITS	MIN.	TYP.	MAX.
RF frequency range		GHz	8.5		9.6
RF VSWR (RF = -10 dBm)		Ratio		2:1	
LO frequency range		GHz	8.5		9.6
LO power range		dBm	+7		+10
LO VSWR		Ratio		2:1	
Bias	+15 volts	mA		150	
TRANSFER CHARACTERISTICS	**CONDITION**	**UNITS**	**MIN.**	**TYP.**	**MAX.**
Conversion gain		dB	20	23	
Single-sideband noise figure at 25°C		dB		6.5	7.5
Image rejection (Note 1)		dB	20	22	
LO-to-RF isolation		dB	20	25	
LO-to-IF isolation		dB	20	22	
Output power at 1 dB compression point		dBm	0	+3	
OUTPUT PARAMETERS	**CONDITION**	**UNITS**	**MIN.**	**TYP.**	**MAX.**
IF frequency	IRA8596LR1A	MHz	20		40
	IRA8596LR1B	MHz	40		80
	IRA8596LR1C	MHz	100		200
IF VSWR (IF = -10 dBm)		Ratio		1.5:1	

Revised: 07/09/13

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IRA8596LR1B TYPICAL TEST DATA

RF AND LO VSWR
(LO = +6 dBm)

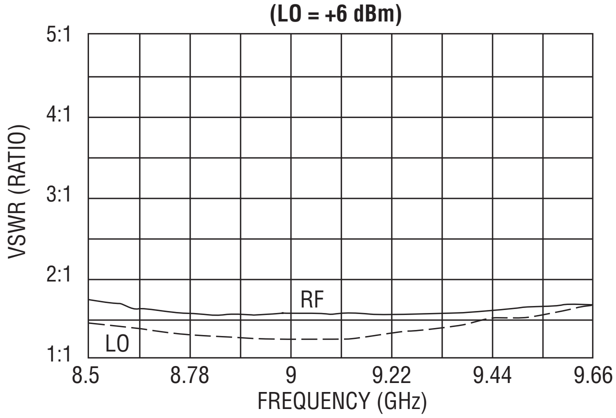
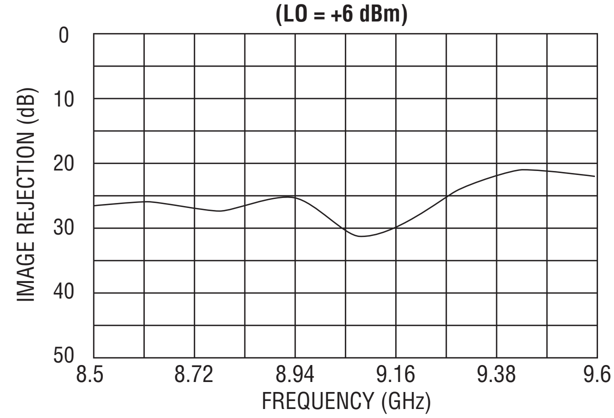
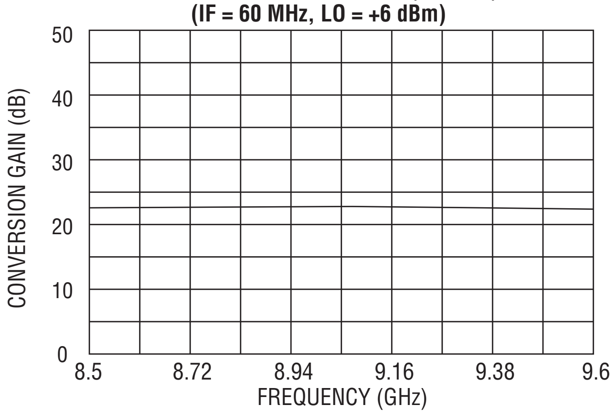


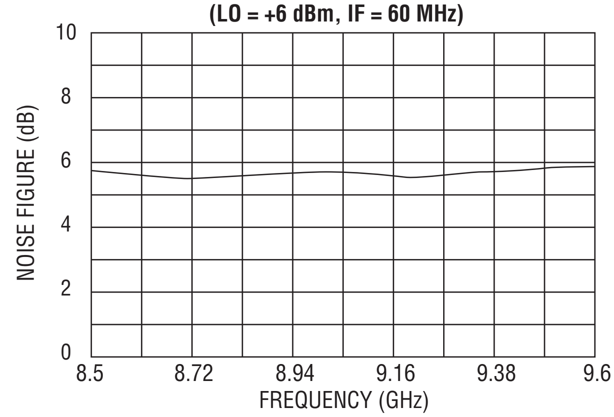
IMAGE REJECTION
(LO = +6 dBm)



RF-TO-IF CONVERSION GAIN (RF < LO)
(IF = 60 MHz, LO = +6 dBm)



NOISE FIGURE VS. LO FREQUENCY
(LO = +6 dBm, IF = 60 MHz)



MAXIMUM RATINGS

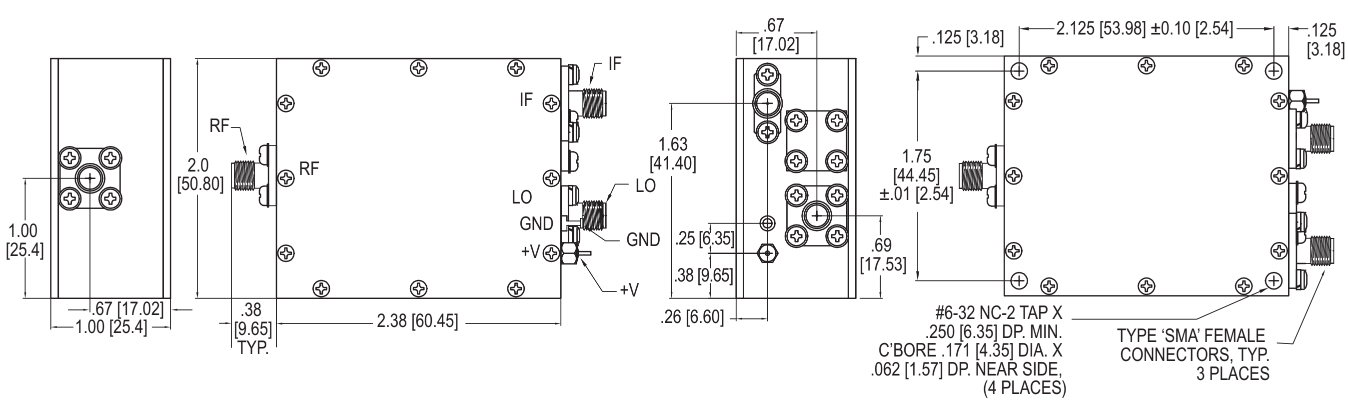
Specification temperature .... +25°C
Operating temperature .... -54 to +85°C
Storage temperature .... -65 to +125°C

GENERAL NOTE

1. Standard catalog unit aligned and tested for guaranteed RF > LO performance. RF < LO guaranteed performance is available, please contact MITEQ.

NOTE: Test data supplied at 25°C; conversion gain, noise figure and image rejection.

OUTLINE DRAWING



NOTE: All dimensions shown in brackets [ ] are in millimeters.

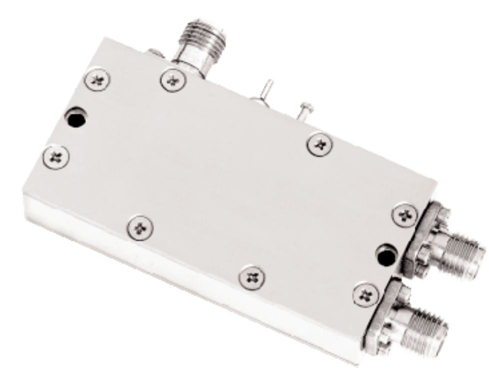
Revised: 07/10/13

2 TO 4 GHz LOW-NOISE RECEIVER FRONT ENDS

MODELS: ARM0204LC2A, ARM0204LC2B AND ARM0204LC2C

FEATURES

- **RF/LO coverage .... 2 to 4 GHz**
- **Conversion gain.................. 30 dB typical**
- **Noise figure .... 1.8 dB maximum**



MITEQ's Model AR Series offers state-of-the-art low-noise amplifiers integrated with our ultra-small image rejection mixers to provide a complete receiver front-end assembly. This device comes in a nonhermetic housing, however a hermetically-sealed housing is available for extreme environmental conditions.

ELECTRICAL SPECIFICATIONS

INPUT PARAMETERS	CONDITION	UNITS	MIN.	TYP.	MAX.
RF frequency range		GHz	2		4
RF VSWR (RF = -10 dBm, LO = +10 dBm)		Ratio		2.5:1	
LO frequency range		GHz	2		4
LO power range		dBm	+10		+13
LO VSWR (LO = +10 dBm)		Ratio		2.5:1	
DC power	+15 VDC	mA		150	
TRANSFER CHARACTERISTICS	**CONDITION**	**UNITS**	**MIN.**	**TYP.**	**MAX.**
Conversion gain (Note 1)		dB	27	30	
Single-sideband noise figure at 25°C		dB		1	1.8
Image rejection (Note 1)		dB	18	20	
LO-to-RF isolation		dB	40		
LO-to-IF isolation		dB		25	
RF-to-IF isolation		dB		25	
Output power at 1 dB compression		dBm		6	
Output two-tone third-order intercept point		dBm		16	
OUTPUT PARAMETERS	**CONDITION**	**UNITS**	**MIN.**	**TYP.**	**MAX.**
IF frequency range	ARM0204LC2A	MHz	20		40
	ARM0204LC2B	MHz	40		80
	ARM0204LC2C	MHz	100		200
IF VSWR (IF = -10 dBm, LO = +10 dBm)		Ratio		2:1	

Revised: 07/13/11

ARM0204LC2C TYPICAL TEST DATA

NOISE FIGURE
(IF = 150 MHz, LO = +10 dBm)

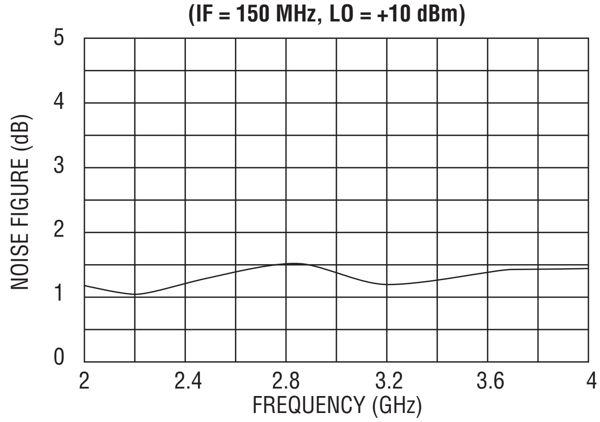
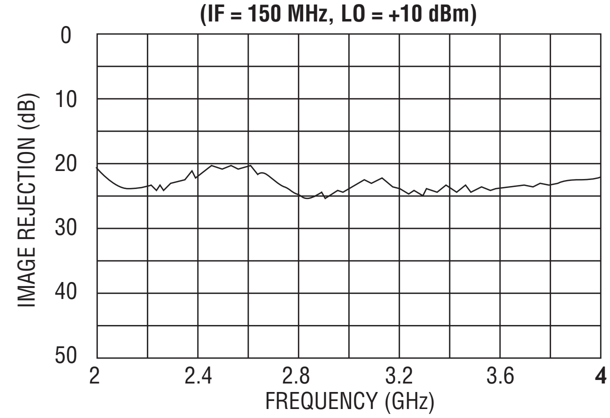
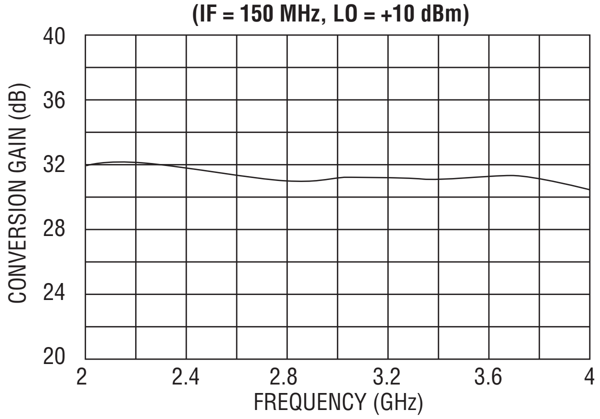


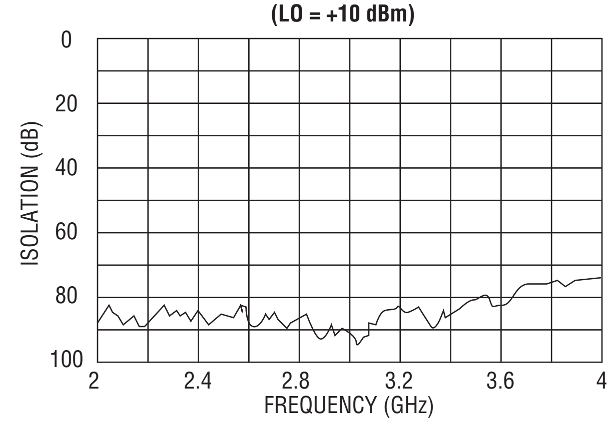
IMAGE REJECTION
(IF = 150 MHz, LO = +10 dBm)



CONVERSION GAIN
(IF = 150 MHz, LO = +10 dBm)



LO-TO-RF ISOLATION
(LO = +10 dBm)



MAXIMUM RATINGS

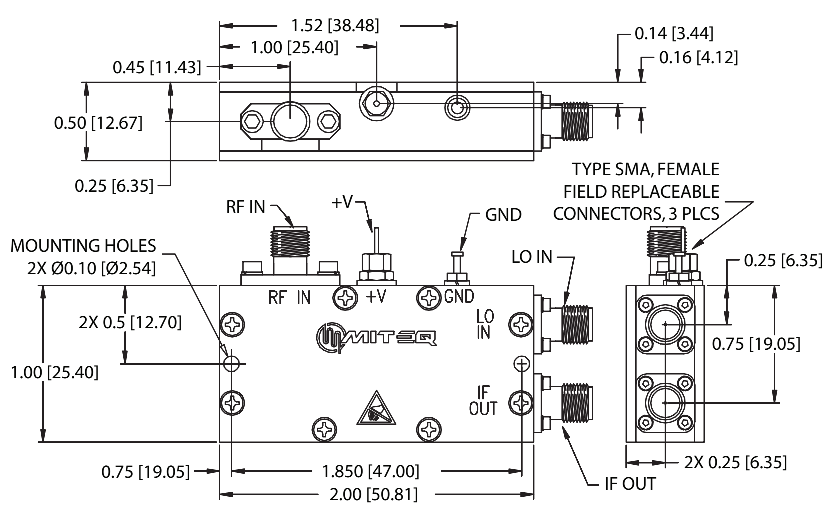
Specifications taken at .... +25°C
Operating temperature .... -54 to +85°C
Storage temperature .... -65 to +125°C

GENERAL NOTE

1. Unit aligned for RF > LO conversion.

NOTE: Test data supplied at 25°C. Conversion gain, LO-RF isolation, image rejection, noise figure.

OUTLINE DRAWING



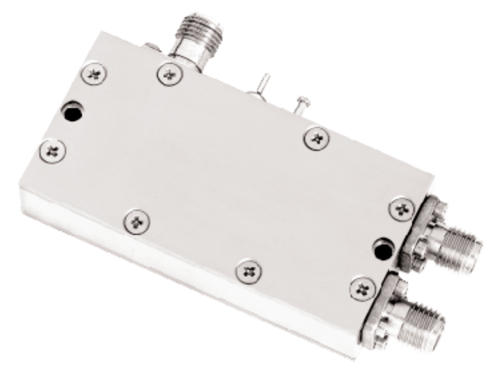
NOTE: All dimensions shown in brackets [ ] are in millimeters.

2 TO 8 GHz LOW-NOISE RECEIVER FRONT END

MODELS: ARM0208LC2A, ARM0208LC2B AND ARM0208LC2C

FEATURES

- **RF/LO frequency............... 2 to 8 GHz**
- **Conversion gain .... 30 dB typical**
- **Noise figure....................... 2 dB typical**



MITEQ's Model AR Series offers state-of-the-art low-noise amplifiers integrated with our ultra-small image rejection mixers to provide a complete receiver front-end assembly. This device comes in a nonhermetic housing, however a hermetically-sealed housing is available for extreme environmental conditions.

ELECTRICAL SPECIFICATIONS

INPUT PARAMETERS	CONDITION	UNITS	MIN.	TYP.	MAX.
RF frequency range		GHz	2		8
RF VSWR (RF = -10 dBm, LO = +10 dBm)		Ratio		2.5:1	
LO frequency range		GHz	2		8
LO power range		dBm	+10		+13
LO VSWR (LO = +10 dBm)		Ratio		2.5:1	
DC power	+15 VDC	mA		150	
TRANSFER CHARACTERISTICS	**CONDITION**	**UNITS**	**MIN.**	**TYP.**	**MAX.**
Conversion gain (Note 1)		dB	27	30	
Single-sideband noise figure at 25°C	dB		2	2.2	
Image rejection (Note 1)		dB	18	20	
LO-to-RF isolation		dB	40		
LO-to-IF isolation		dB		25	
RF-to-IF isolation		dB		25	
Output power at 1 dB compression		dBm		+6	
Output two-tone third-order intercept point		dBm		+16	
OUTPUT PARAMETERS	**CONDITION**	**UNITS**	**MIN.**	**TYP.**	**MAX.**
IF frequency range	ARM0208LC2A ARM0208LC2B ARM0208LC2C	MHz MHz MHz	20 40 100		40 80 200
IF VSWR (IF = -10 dBm, LO = +10 dBm)		Ratio		2:1	

Revised: 07/13/11

ARM0208LC2C TYPICAL TEST DATA

NOISE FIGURE
(IF = 100 MHz, LO = +10 dBm)

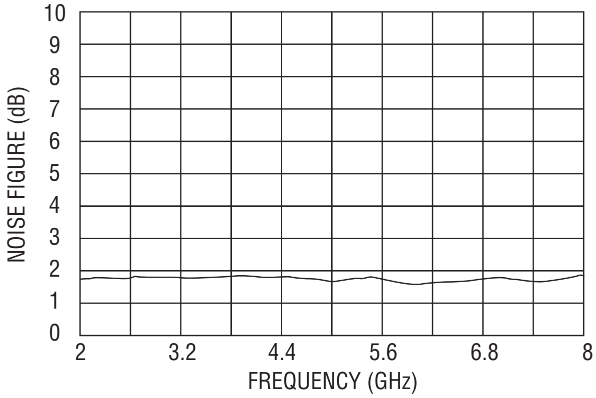
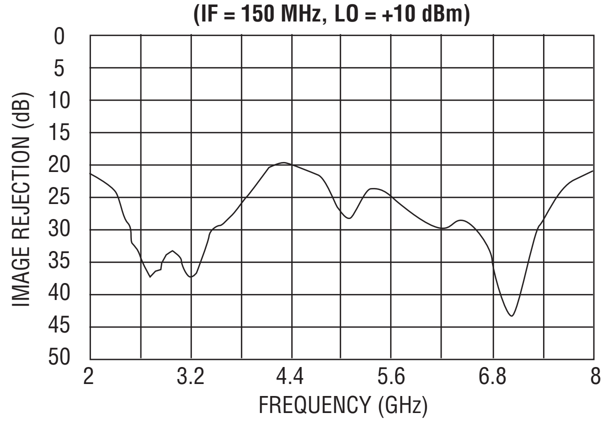
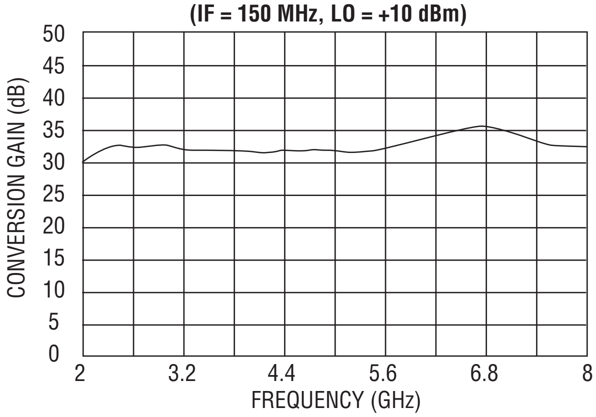


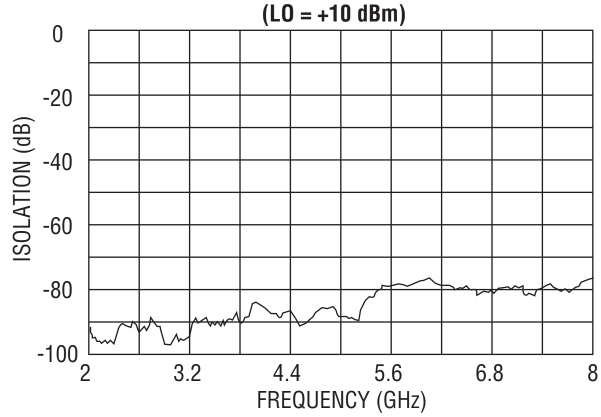
IMAGE REJECTION
(IF = 150 MHz, LO = +10 dBm)



CONVERSION GAIN
(IF = 150 MHz, LO = +10 dBm)



LO-TO-RF ISOLATION
(LO = +10 dBm)



MAXIMUM RATINGS

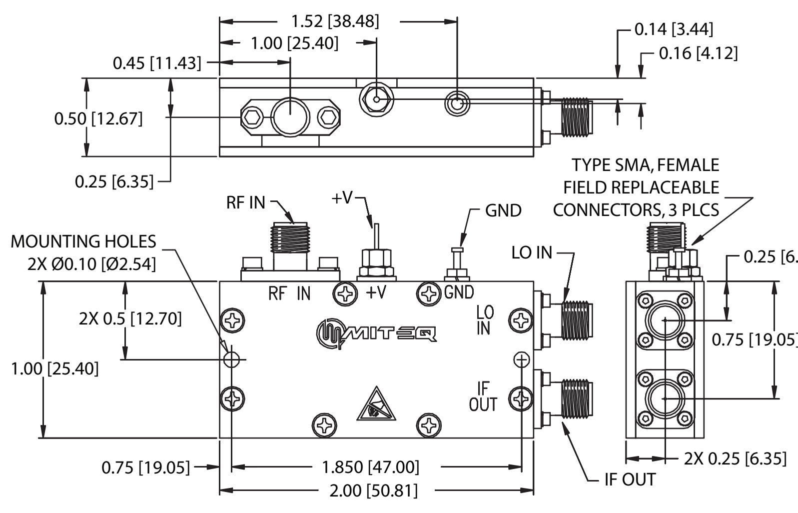
Specifications taken at .... +25°C
Operating temperature .... -54 to +85°C
Storage temperature .... -65 to +125°C

GENERAL NOTE

1. Unit aligned for RF > LO conversion.

NOTE: Test data supplied at 25°C. Conversion gain, LO-RF isolation, image rejection, noise figure.

OUTLINE DRAWING



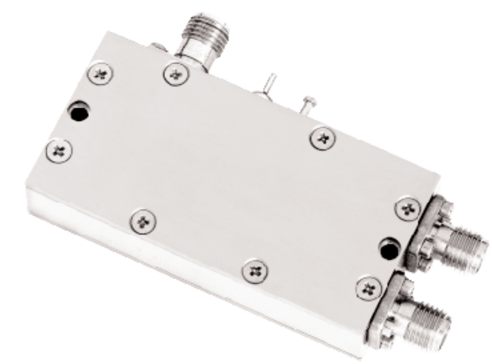
NOTE: All dimensions shown in brackets [ ] are in millimeters.

4 TO 8 GHz LOW-NOISE RECEIVER FRONT ENDS

MODELS: ARM0408LC2A, ARM0408LC2B AND ARM0408LC2C

FEATURES

- **RF/LO frequency............... 4 to 8 GHz**
- **Conversion gain .... 30 dB typical**
- **Noise figure....................... 1.5 dB typical**



MITEQ's Model AR Series offers state-of-the-art low-noise amplifiers integrated with our ultra-small image rejection mixers to provide a complete receiver front-end assembly. This device comes in a nonhermetic housing, however a hermetically-sealed housing is available for extreme environmental conditions.

ELECTRICAL SPECIFICATIONS

INPUT PARAMETERS	CONDITION	UNITS	MIN.	TYP.	MAX.
RF frequency range		GHz	4		8
RF VSWR (RF = -10 dBm, LO = +10 dBm)		Ratio		2.5:1	
LO frequency range		GHz	4		8
LO power range		dBm	+10		+13
LO VSWR (LO = +10 dBm)		Ratio		2.5:1	
DC power	+15 VDC	mA		150	
TRANSFER CHARACTERISTICS	**CONDITION**	**UNITS**	**MIN.**	**TYP.**	**MAX.**
Conversion gain (Note 1)		dB	27	30	
Single-sideband noise figure at 25°C		dB		1.5	2
Image rejection (Note 1)		dB	18	20	
LO-to-RF isolation		dB	40		
LO-to-IF isolation		dB		25	
RF-to-IF isolation		dB		25	
Output power at 1 dB compression		dBm		6	
Output two-tone third-order intercept point		dBm		16	
OUTPUT PARAMETERS	**CONDITION**	**UNITS**	**MIN.**	**TYP.**	**MAX.**
IF frequency range	ARM0408LC2A ARM0408LC2B ARM0408LC2C	MHz MHz MHz	20 40 100		40 80 200
IF VSWR (IF = -10 dBm, LO = +10 dBm)		Ratio		2:1	

Revised: 07/13/11

ARM0408LC2B TYPICAL TEST DATA

NOISE FIGURE
(IF = 60 MHz, LO = +10 dBm)

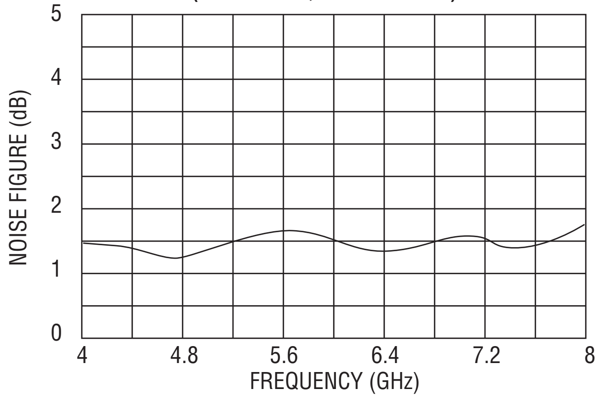
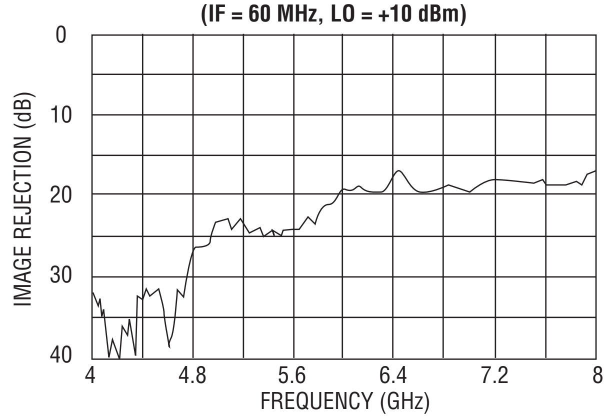
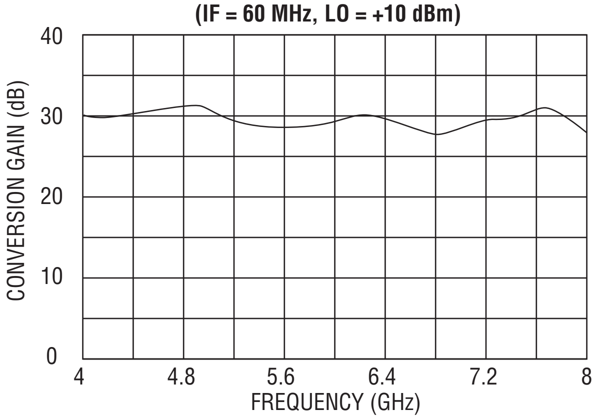


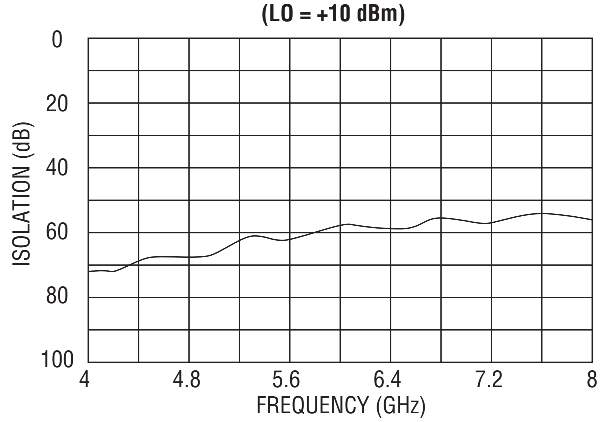
IMAGE REJECTION
(IF = 60 MHz, LO = +10 dBm)



CONVERSION GAIN
(IF = 60 MHz, LO = +10 dBm)



LO-TO-RF ISOLATION
(LO = +10 dBm)



MAXIMUM RATINGS

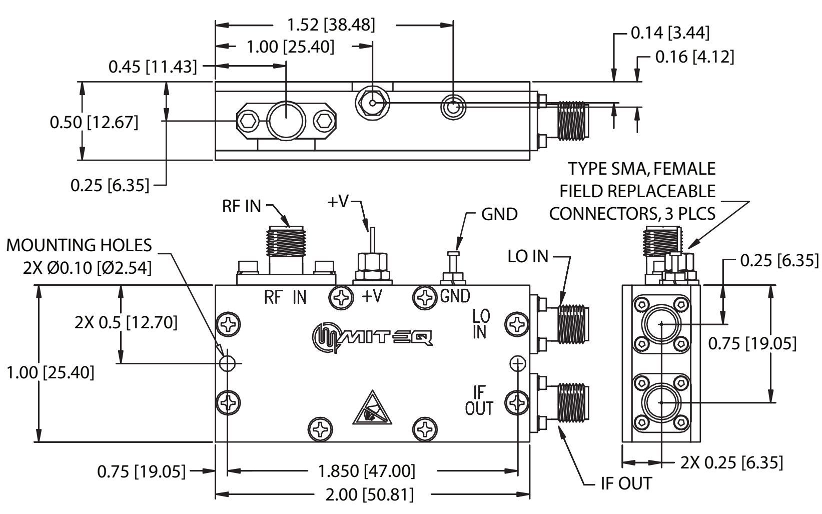
Specifications taken at .... +25°C
Operating temperature .... -54 to +85°C
Storage temperature .... -65 to +125°C

GENERAL NOTE

1. Unit aligned for RF > LO conversion.

NOTE: Test data supplied at 25°C. Conversion gain, LO-RF isolation, image rejection, noise figure.

OUTLINE DRAWING



NOTE: All dimensions shown in brackets [ ] are in millimeters.

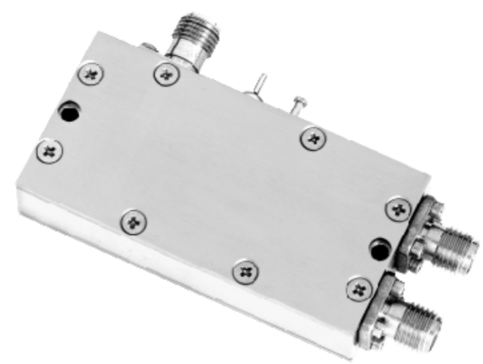
Revised: 07/13/11

5.3 TO 5.9 GHz LOW-NOISE RECEIVER FRONT ENDS

MODELS: ARL5359LC2A, ARL5359LC2B AND ARL5359LC2C

FEATURES

- **RF/LO frequency............... 5.3 to 5.9 GHz**
- **Conversion gain .... 32 dB typical**
- **Noise figure....................... 3 dB typical**
- **Limiter protection .... 1 watt CW,**
  50 watts peak



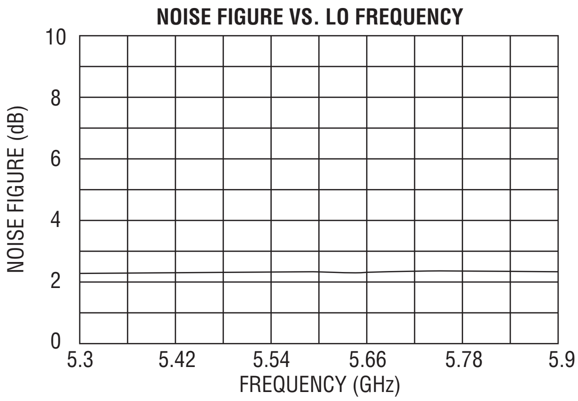
MITEQ's Model AR Series offers state-of-the-art low-noise amplifiers integrated with our ultra-small image rejection mixers to provide a complete receiver front-end assembly. This device comes in a nonhermetic housing, however a hermetically-sealed housing is available for extreme environmental conditions.

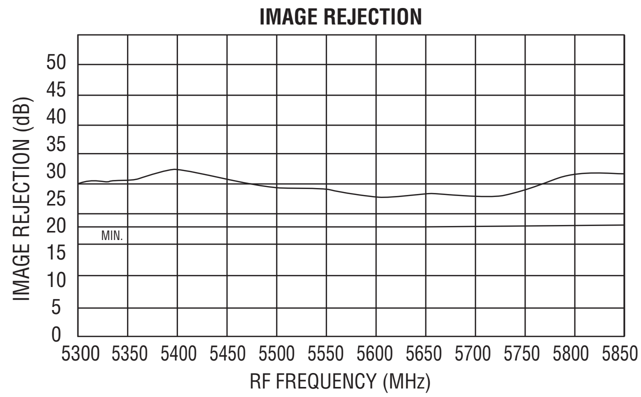
ELECTRICAL SPECIFICATIONS

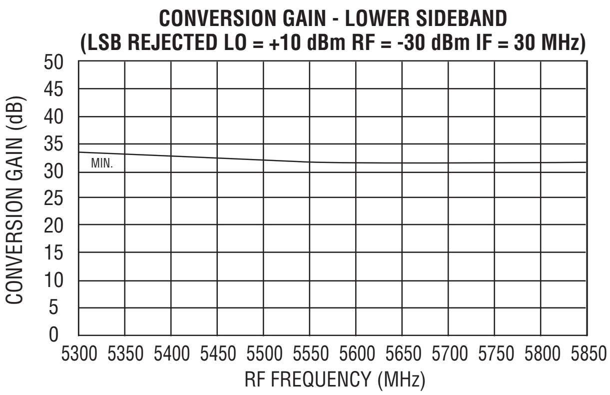
INPUT PARAMETERS	CONDITION	UNITS	MIN.	TYP.	MAX.
RF frequency range		GHz	5.3		5.9
RF VSWR (RF = -30 dBm)		Ratio		2.5:1	
Maximum input power	CW	Watts			1
	Peak	Watts			50
LO frequency range		GHz	5.3		5.9
LO power range	IRMLC1	dBm	+10		+13
LO VSWR		Ratio		2.5:1	
Bias	+15 volts	mA			150
TRANSFER CHARACTERISTICS	**CONDITION**	**UNITS**	**MIN.**	**TYP.**	**MAX.**
Conversion gain (Note 1)	RF > LO	dBm	30	33	
	IRM..LC1Q	dB			
Single-sideband noise figure at 25°C	RF < LO	dB			3.5
Image rejection (Note 1)	RF > LO	dB	18		
LO-to-RF isolation		dB	40		
LO-to-IF isolation		dB		25	
Output power at 1 dB compression	IRM.LC1	dBm		+6	
Output two-tone third-order intercept point	IRM.LC1	dBm		+16	
OUTPUT PARAMETERS	**CONDITION**	**UNITS**	**MIN.**	**TYP.**	**MAX.**
IF frequency (image rejection mode)	IRMLC1A	MHz	20		40
	IRMLC1B	MHz	40		80
	IRMLC1C	MHz	100		200
IF VSWR (IF = -10 dBm)		Ratio		2:1	

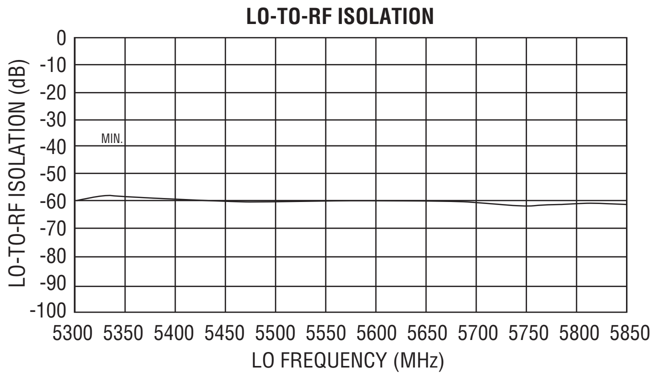
Revised: 3/19/12

ARL5359LC2A TYPICAL TEST DATA









MAXIMUM RATINGS

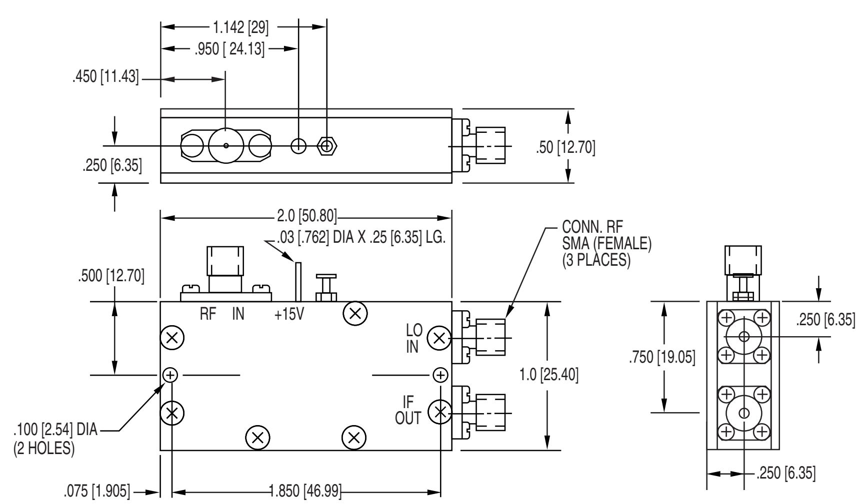
Specification temperature .... +25°C
Operating temperature .... -54 to +85°C
Storage temperature .... -65 to +125°C

GENERAL NOTE

1. Unit aligned for RF > LO conversion.

NOTE: Test data supplied at 25°C; conversion gain, LO-to-RF isolation, image rejection and noise figure.

OUTLINE DRAWING



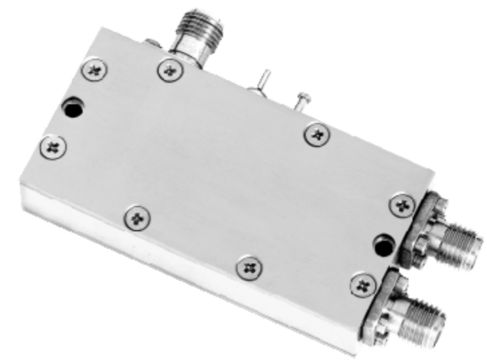
NOTE: All dimensions shown in brackets [ ] are in millimeters.

8 TO 12 GHz LOW-NOISE RECEIVER FRONT ENDS

MODELS: ARM0812LC2A, ARM0812LC2B AND ARM0812LC2C

FEATURES

- **RF/LO coverage................ 8 to 12 GHz**
- **Conversion gain .... 30 dB typical**
- **Noise figure....................... 2 dB typical**



MITEQ's Model AR Series offers state-of-the-art low-noise amplifiers integrated with our ultra-small image rejection mixers to provide a complete receiver front-end assembly. This device comes in a nonhermetic housing, however a hermetically-sealed housing is available for extreme environmental conditions.

ELECTRICAL SPECIFICATIONS

INPUT PARAMETERS	CONDITION	UNITS	MIN.	TYP.	MAX.
RF frequency range		GHz	8		12
RF VSWR (RF = -10 dBm, LO = +13 dBm)		Ratio		2.5:1	
LO frequency range		GHz	8		12
LO power range		dBm	+10		+13
LO VSWR (LO = +13 dBm)		Ratio		2.5:1	
DC power	+15 VDC	mA		150	
TRANSFER CHARACTERISTICS	**CONDITION**	**UNITS**	**MIN.**	**TYP.**	**MAX.**
Conversion gain (Note 1)		dB	27	30	
Single-sideband noise figure at 25°C		dB		2	2.5
Image rejection (Note 1)		dB	18	20	
LO-to-RF isolation		dB	40		
LO-to-IF isolation		dB		25	
RF-to-IF isolation		dB		25	
Output power at 1 dB compression		dBm		6	
Output two-tone third-order intercept point		dBm		16	
OUTPUT PARAMETERS	**CONDITION**	**UNITS**	**MIN.**	**TYP.**	**MAX.**
IF frequency range	ARM0812LC2A ARM0812LC2B ARM0812LC2C	MHz MHz MHz	20 40 100		40 80 200
IF VSWR (IF = -10 dBm, LO = +13 dBm)		Ratio		2:1	

Revised: 08/12/11

ARM0812LC2B TYPICAL TEST DATA

NOISE FIGURE
(IF = 60 MHz, LO = +13 dBm)

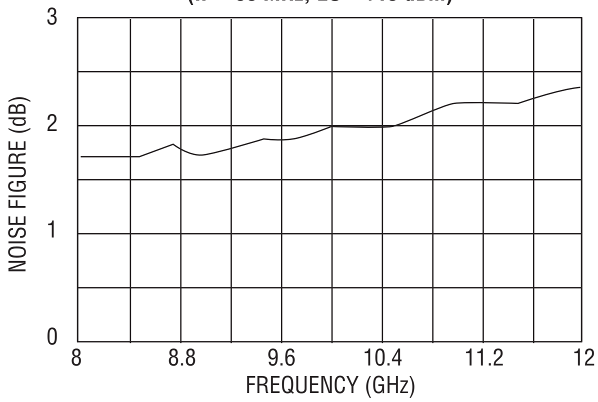
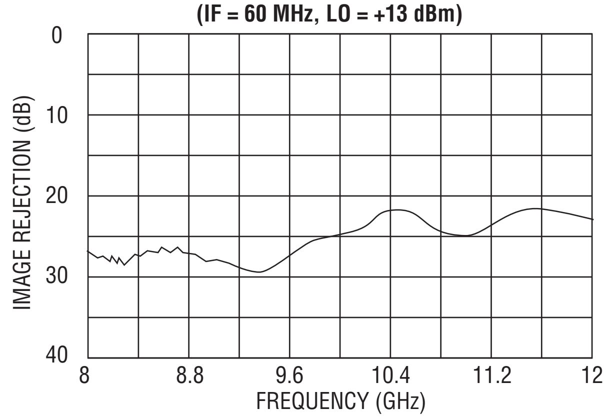
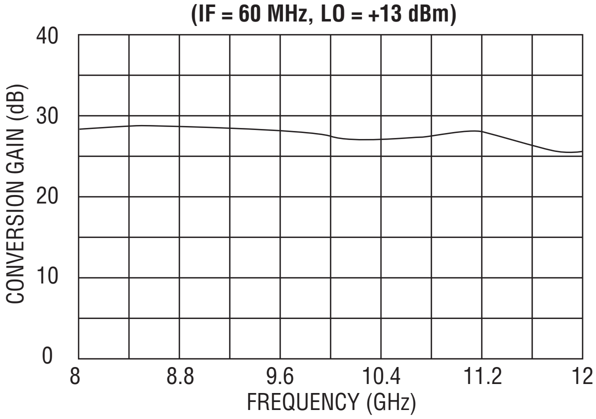


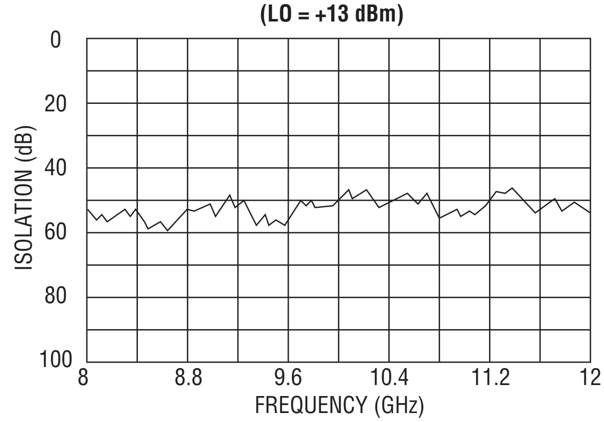
IMAGE REJECTION
(IF = 60 MHz, LO = +13 dBm)



CONVERSION GAIN
(IF = 60 MHz, LO = +13 dBm)



LO-TO-RF ISOLATION
(LO = +13 dBm)



MAXIMUM RATINGS

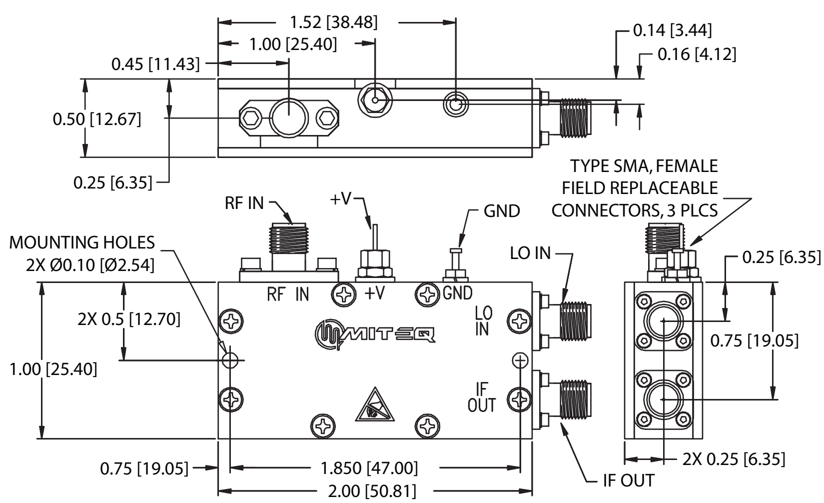
Specifications taken at .... +25°C
Operating temperature .... -54 to +85°C
Storage temperature .... -65 to +125°C

GENERAL NOTE

1. Unit aligned for RF > LO conversion.

NOTE: Test data supplied at 25°C. Conversion gain, LO-RF isolation, image rejection, noise figure.

OUTLINE DRAWING



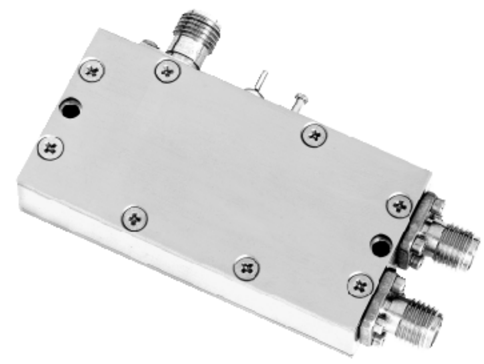
NOTE: All dimensions shown in brackets [ ] are in millimeters.

6 TO 18 GHz LOW-NOISE RECEIVER FRONT ENDS

MODELS: ARM0618LC2A, ARM0618LC2B AND ARM0618LC2C

FEATURES

- **RF/LO coverage .... 6 to 18 GHz**
- **Conversion gain .... 24 dB typical**
- **Noise figure .... 3.5 dB typical**



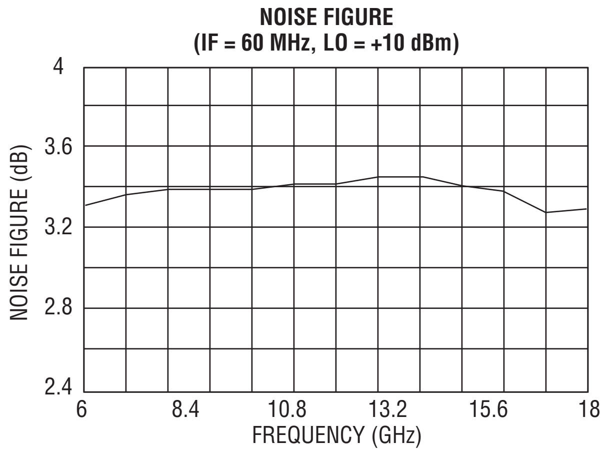
MITEQ's Model AR Series offers state-of-the-art low-noise amplifiers integrated with our ultra-small image rejection mixers to provide a complete receiver front-end assembly. This device comes in a nonhermetic housing, however a hermetically-sealed housing is available for extreme environmental conditions.

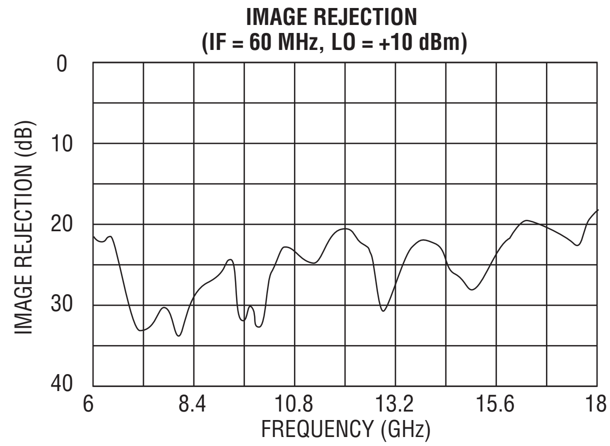
ELECTRICAL SPECIFICATIONS

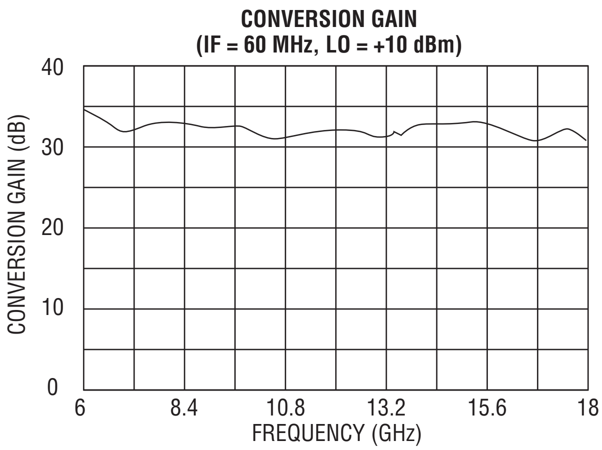
INPUT PARAMETERS	CONDITION	UNITS	MIN.	TYP.	MAX.
RF frequency range		GHz	6		18
RF VSWR (RF = -10 dBm, LO = +10 dBm)		Ratio		2.5:1	
LO frequency range		GHz	6		18
LO power range		dBm	+10		+13
LO VSWR (LO = +10 dBm)		Ratio		2.5:1	
DC power	+15 VDC	mA		150	
TRANSFER CHARACTERISTICS	**CONDITION**	**UNITS**	**MIN.**	**TYP.**	**MAX.**
Conversion gain (Note 1)		dB	22	24	
Single-sideband noise figure at 25°C		dB		3.5	4
Image rejection (Note 1)		dB	18	22	
LO-to-RF isolation		dB	40	50	
LO-to-IF isolation		dB		20	
RF-to-IF isolation		dB		20	
Output power at 1 dB compression		dBm		5	
Output two-tone third-order intercept point		dBm		15	
OUTPUT PARAMETERS	**CONDITION**	**UNITS**	**MIN.**	**TYP.**	**MAX.**
IF frequency range	ARM0618LC2A	MHz	20		40
	ARM0618LC2B	MHz	40		80
	ARM0618LC2C	MHz	100		200
IF VSWR (IF = -10 dBm, LO = +10 dBm)		Ratio		2:1	

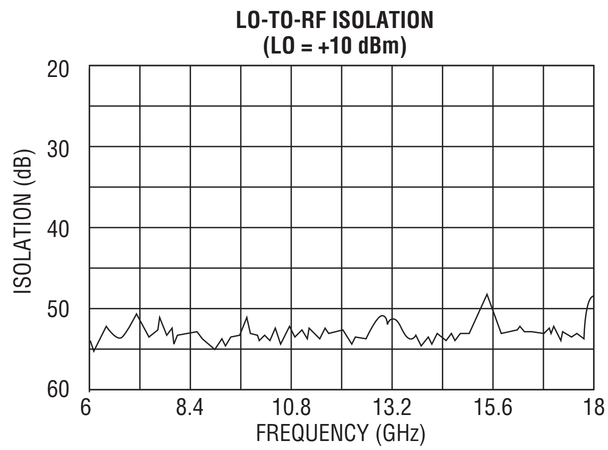
Revised: 08/12/11

ARM0618LC2B TYPICAL TEST DATA









MAXIMUM RATINGS

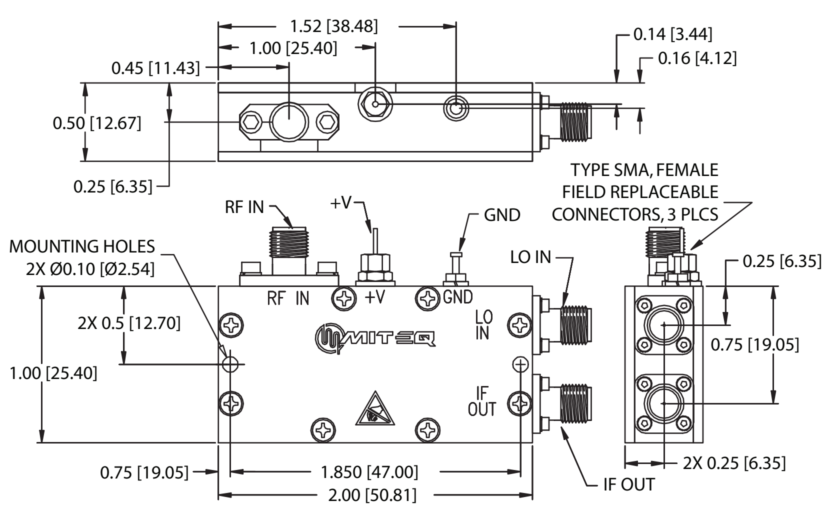
Specifications taken at .... +25°C
Operating temperature .... -54 to +85°C
Storage temperature .... -65 to +125°C

GENERAL NOTE

1. Unit aligned for RF > LO conversion.

NOTE: Test data supplied at 25°C. Conversion gain, LO-RF isolation, image rejection, noise figure.

OUTLINE DRAWING



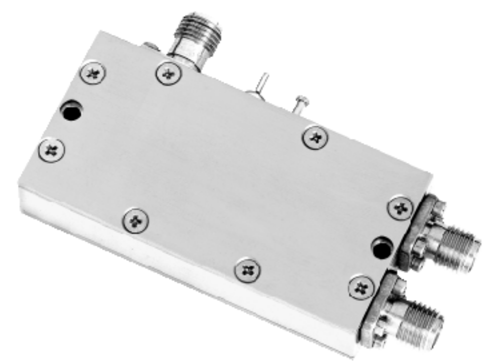
NOTE: All dimensions shown in brackets [ ] are in millimeters.

12 TO 18 GHz LOW-NOISE RECEIVER FRONT ENDS

MODELS: ARM1218LC2A, ARM1218LC2B AND ARM1218LC2C

FEATURES

- **RF/LO coverage .... 12 to 18 GHz**
- **Conversion gain .... 30 dB typical**
- **Noise figure....................... 3 dB typical**



MITEQ's Model AR Series offers state-of-the-art low-noise amplifiers integrated with our ultra-small image rejection mixers to provide a complete receiver front-end assembly. This device comes in a nonhermetic housing, however a hermetically-sealed housing is available for extreme environmental conditions.

ELECTRICAL SPECIFICATIONS

INPUT PARAMETERS	CONDITION	UNITS	MIN.	TYP.	MAX.
RF frequency range		GHz	12		18
RF VSWR (RF = -10 dBm, LO = +13 dBm)		Ratio		2.5:1	
LO frequency range		GHz	12		18
LO power range		dBm	+10		+13
LO VSWR (LO = +13 dBm)		Ratio		2.5:1	
DC power	+15 VDC	mA		150	
TRANSFER CHARACTERISTICS	**CONDITION**	**UNITS**	**MIN.**	**TYP.**	**MAX.**
Conversion gain (Note 1)		dB	27	30	
Single-sideband noise figure at 25°C		dB		3	3.5
Image rejection (Note 1)		dB	18	20	
LO-to-RF isolation		dB	40		
LO-to-IF isolation		dB		25	
RF-to-IF isolation		dB		25	
Output power at 1 dB compression		dBm		+6	
Output two-tone third-order intercept point		dBm		+16	
OUTPUT PARAMETERS	**CONDITION**	**UNITS**	**MIN.**	**TYP.**	**MAX.**
IF frequency range	ARM1218LC2A	MHz	20		40
	ARM1218LC2B	MHz	40		80
	ARM1218LC2C	MHz	100		200
IF VSWR (IF = -10 dBm, LO = +13 dBm)		Ratio		2:1	

Revised: 08/12/11

ARM1218LC2B TYPICAL TEST DATA

NOISE FIGURE
(IF = 60 MHz, LO = +13 dBm)

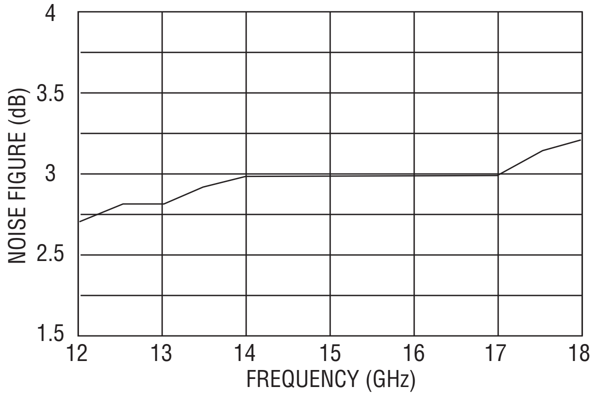
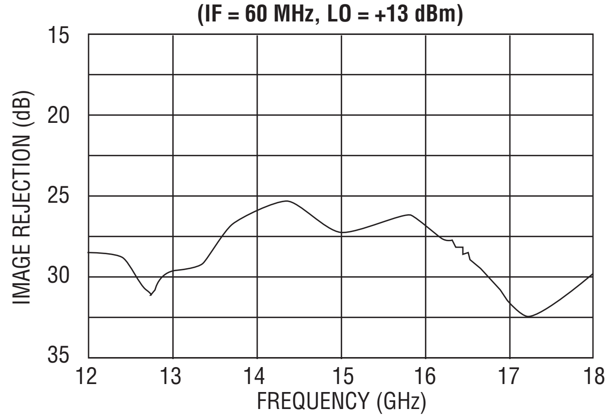
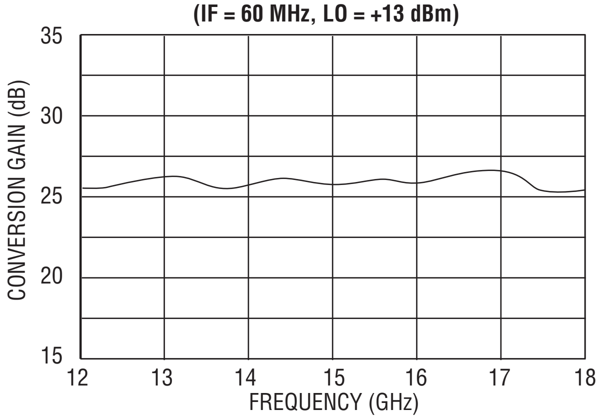


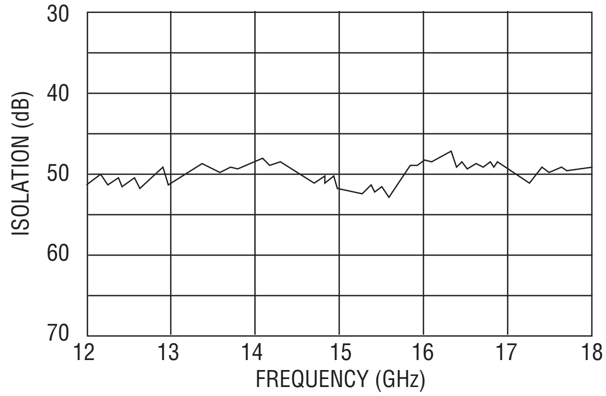
IMAGE REJECTION
(IF = 60 MHz, LO = +13 dBm)



CONVERSION GAIN
(IF = 60 MHz, LO = +13 dBm)



LO-TO-RF ISOLATION
(LO = +13 dBm)



MAXIMUM RATINGS

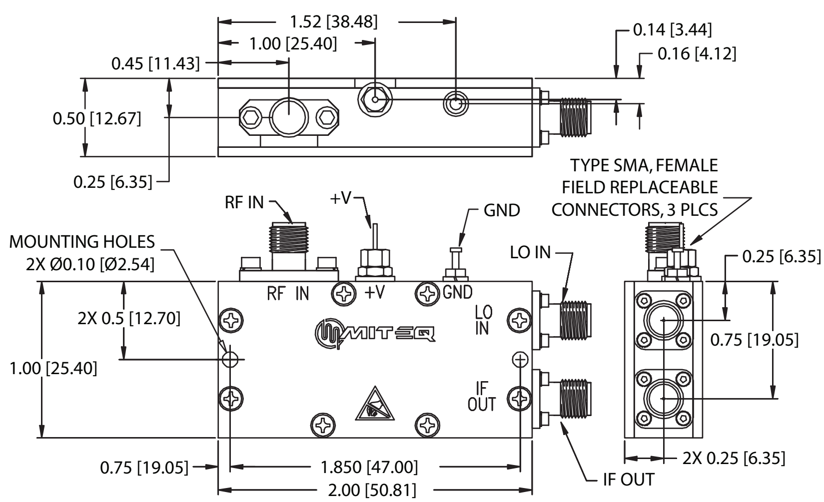
Specifications taken at .... +25°C
Operating temperature .... -54 to +85°C
Storage temperature .... -65 to +125°C

GENERAL NOTE

1. Unit aligned for RF > LO conversion.

NOTE: Test data supplied at 25°C. Conversion gain, LO-RF isolation, image rejection, noise figure.

OUTLINE DRAWING



NOTE: All dimensions shown in brackets [ ] are in millimeters.

Revised: 08/12/11

18 TO 26 GHz LOW-NOISE RECEIVER FRONT END

MODELS: AR1826LI8A, AR1826LI8B AND AR1826LI8C

FEATURES

- RF/LO coverage .... 18 to 26 GHz
- IF operation .... 20 to 200 MHz
- Conversion gain .... 35 dB typical
- Image rejection .... 23 dB typical
- Noise figure .... 2.9 dB typical

OPTIONS

- Integrated LO amplifier
- Waveguide input
- Single positive bias supply
- Custom IF frequencies
- Custom bandwidths

ELECTRICAL SPECIFICATIONS

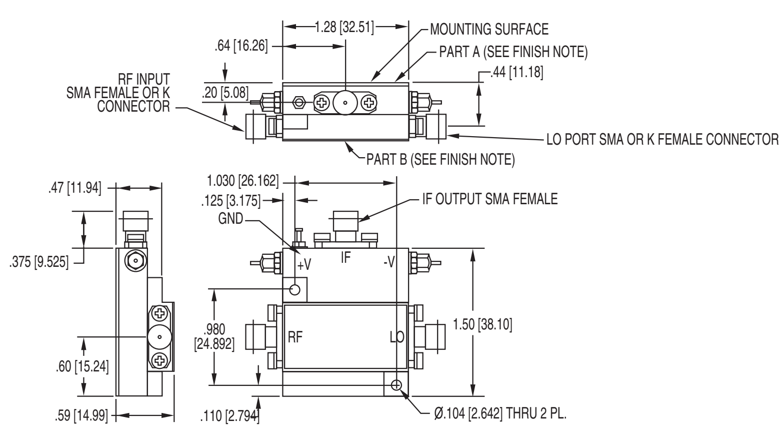
INPUT PARAMETERS	CONDITION	UNITS	MIN.	TYP.	MAX.
RF/LO frequency range		GHz	18		26
RF/LO VSWR (RF = -10 dBm)		Ratio		2.5:1	
LO power range		dBm	+16		+18
LO VSWR		Ratio		2.5:1	
Bias	@ +9 to +16 V @ -9 to -16 V	mA mA		250 30	
TRANSFER CHARACTERISTICS	**CONDITION**	**UNITS**	**MIN.**	**TYP.**	**MAX.**
Conversion gain	RF > LO	dB	31	38	
Single-sideband noise figure at 25°C		dB		2.9	3.3
Image rejection	RF < LO	dB	18	23	
LO-to-RF isolation		dB	40		
LO-to-IF isolation		dB		20	
Output power at 1 dB compression		dB	+5	+10	
OUTPUT PARAMETERS	**CONDITION**	**UNITS**	**MIN.**	**TYP.**	**MAX.**
IF frequency range	AR1826LI8A AR1826LI8B AR1826LI8C	MHz MHz MHz	20 40 100		40 80 200
IF VSWR (IF = -10 dBm)		Ratio		1.5:1	

NOTE: Test data supplied at 25°C; conversion loss, LO-to-RF isolation and image rejection.

MAXIMUM RATINGS

Specification temperature .... +25°C
Operating temperature .... -55 to +85°C
Storage temperature .... -65 to +95°C

OUTLINE DRAWING



NOTES:

Part A - Material: Aluminum
Finish: Chemical film CL3
Part B - Material: Kovar
Finish: Gold plate
All dimensions shown in brackets [ ] are in millimeters.

IMAGE REJECTION MIXER PRODUCTS

26 TO 40 GHz LOW-NOISE RECEIVER FRONT END

MODELS: AR2640LI8A, AR2640LI8B AND AR2640LI8C

FEATURES

- RF/LO coverage .... 26 to 40 GHz
- IF operation .... 20 to 200 MHz
- Conversion gain .... 32 dB typical
- Image rejection .... 23 dB typical
- Noise figure .... 3.2 dB typical

OPTIONS

- Integrated LO amplifier
- Waveguide input
- Single positive bias supply
- Custom IF frequencies
- Custom bandwidths

ELECTRICAL SPECIFICATIONS

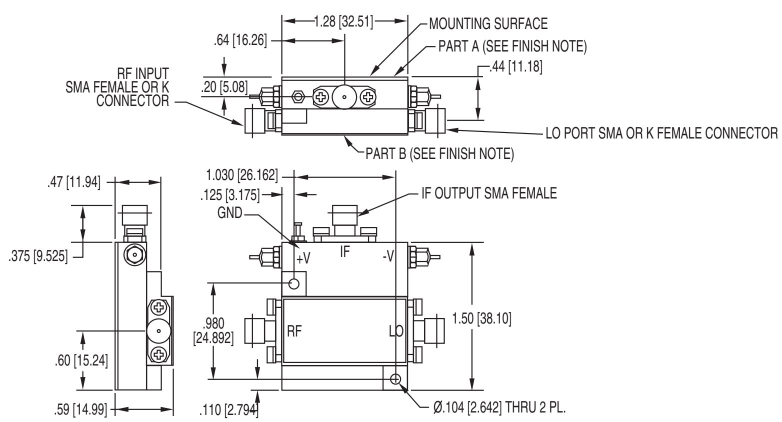
INPUT PARAMETERS	CONDITION	UNITS	MIN.	TYP.	MAX.
RF/LO frequency range		GHz	26		40
RF/LO VSWR (RF = -10 dBm)		Ratio		2.5:1	
LO power range		dBm	+16		+18
LO VSWR		Ratio		2.5:1	
Bias	@ +9 to +16 V @ -9 to -16 V	mA mA		175 30	
TRANSFER CHARACTERISTICS	**CONDITION**	**UNITS**	**MIN.**	**TYP.**	**MAX.**
Conversion gain	RF > LO	dB	25	32	
Single-sideband noise figure at 25°C		dB		3.2	4
Image rejection	RF < LO	dB	18	23	
LO-to-RF isolation		dB	40		
LO-to-IF isolation		dB		20	
Output power at 1 dB compression		dB	0	+5	
OUTPUT PARAMETERS	**CONDITION**	**UNITS**	**MIN.**	**TYP.**	**MAX.**
IF frequency range	AR2640LI8A AR2640LI8B AR2640LI8C	MHz MHz MHz	20 40 100		40 80 200
IF VSWR (IF = -10 dBm)		Ratio		1.5:1	

NOTE: Test data supplied at 25°C; conversion loss, LO-to-RF isolation and image rejection.

MAXIMUM RATINGS

Specification temperature .... +25°C
Operating temperature .... -55 to +85°C
Storage temperature .... -65 to +95°C

OUTLINE DRAWING



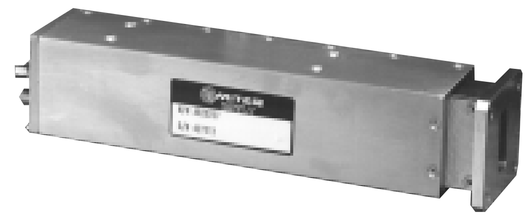
NOTES:
Part A - Material: Aluminum
Finish: Chemical film CL3
Part B - Material: Kovar
Finish: Gold Plate
All dimensions shown in brackets [ ] are in millimeters.

X-BAND LOW-NOISE RECEIVER FRONT END

MODEL: ARZ0227

FEATURES

- RF frequency range.......... 8.5 to 9.6 GHz
- Integrated LO amplifier
- Noise figure....................... 0.9 dB
- LO detector
- WR90 waveguide input



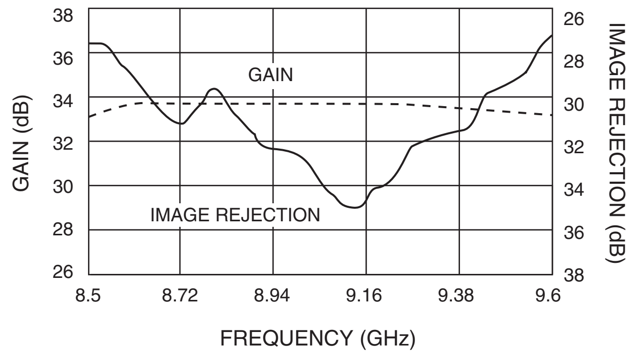
MITEQ's ARZ0227 low-noise receiver front end converts signals in X-band to 60 MHz and is ideal for radar installations with waveguide interface. The integrated PHEMT LNA offers exceptional single-sideband noise figure and is housed in a weatherproof chassis for shipborne applications.

ELECTRICAL SPECIFICATIONS

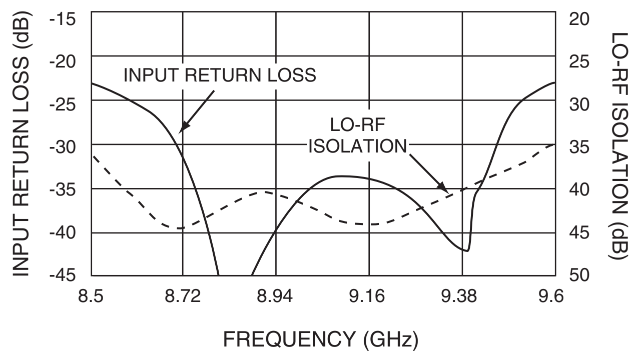
INPUT PARAMETERS	UNITS	MIN.	TYP.	MAX.
RF frequency range	GHz	8.5		9.6
RF VSWR	Ratio			1.3:1
LO frequency range	GHz	8.5		9.6
LO power range	dBm	-3		+3
LO VSWR (LO = +10 dBm)	Ratio			1.5:1
TRANSFER CHARACTERISTICS	**UNITS**	**MIN.**	**TYP.**	**MAX.**
Conversion gain (IF = 60 MHz)	dB	32	33	
Single-sideband noise figure at 25°C	dB		.9	1.2
LO-to-RF isolation	dB	40		
LO-to-IF isolation	dB	45		
RF-to-IF isolation	dB		30	
Input power at 1 dB compression	dBm	-25		
Image rejection		25	30	
OUTPUT PARAMETERS	**UNITS**	**MIN.**	**TYP.**	**MAX.**
LO detector voltage	mV		150	
IF frequency range (3 dB bandwidth)	MHz	54		66
IF VSWR (IF = -10 dBm, LO = +10 dBm)	Ratio		1.5:1	

ARZ0227 TYPICAL TEST DATA

GAIN AND IMAGE REJECTION



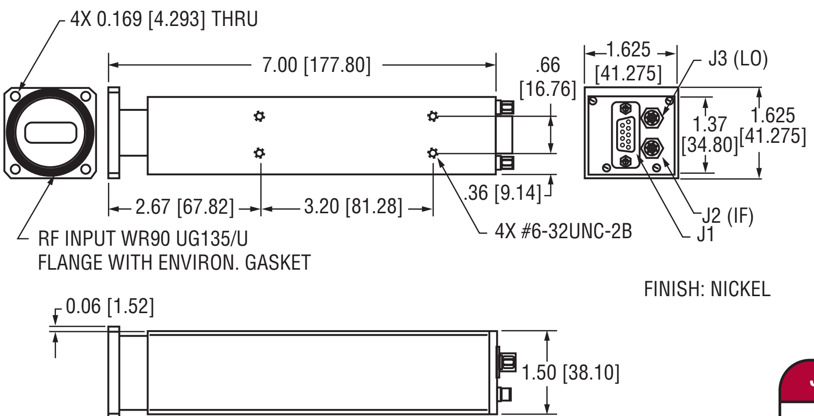
RETURN LOSS AND ISOLATION



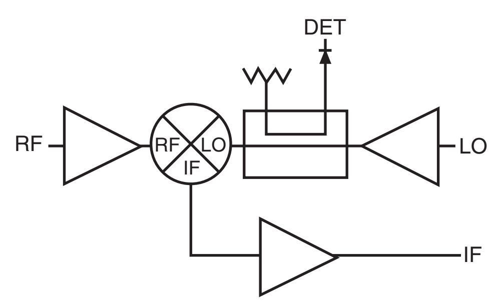
MAXIMUM RATINGS

Specification temperature .... +25°C
Operating temperature .... -55 to +85°C
Storage temperature .... -65 to +95°C

OUTLINE DRAWING



BLOCK DIAGRAM



J1	PIN NUMBER
1	+15V
2	DET
3	GND
4-9	NOT USED

NOTE: All dimensions shown in brackets [ ] are in millimeters.

9.9 TO 10.4 GHz LOW-NOISE RECEIVER FRONT END

MODEL: ARZ9910N01R

FEATURES

- **RF/LO coverage .... 9.9 to 10.4 GHz**
- **IF operation .... 0.1 to 2.0 MHz**
- **Conversion gain .... 20 dB typical**
- **Image rejection .... 15 dB minimum**
- **Limiter protection .... 350 watts CW**

ELECTRICAL SPECIFICATIONS

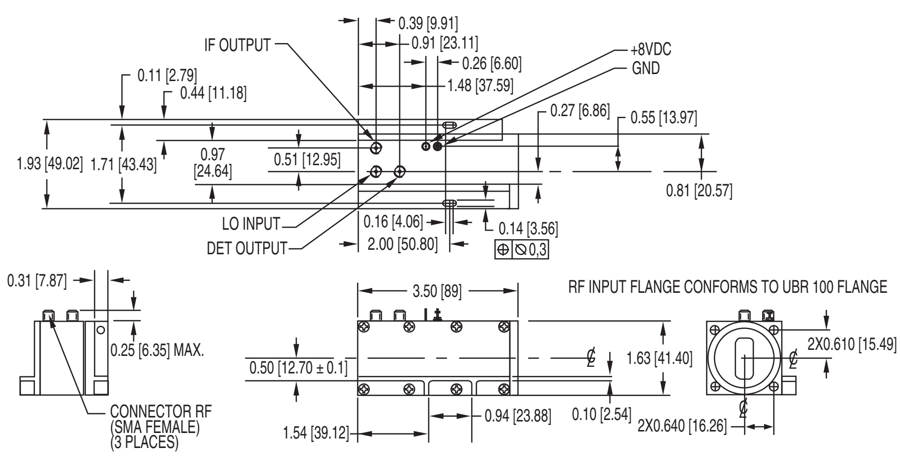
INPUT PARAMETERS	CONDITION	UNITS	MIN.	TYP.	MAX.
RF frequency range		GHz	9.9		10.4
RF VSWR (IF = -30 dBm)		Ratio		1.5:1	
Input peak power pulse		Watts			350
Input power CW		Watts			2
Input power duty cycle			10%		
Input power pulse duration		µS			25
Input power pulse rise time		µS			20
LO frequency range		GHz	9.9		10.4
LO power range		dBm	+14	+15	+16
LO VSWR		Ratio		2:1	
Supply voltage	±5%	Volts		8	
Supply voltage ripple		mV			10
TRANSFER CHARACTERISTICS	**CONDITION**	**UNITS**	**MIN.**	**TYP.**	**MAX.**
Conversion gain		dBm	16	21	
Single-sideband noise figure at 25°C		dB			3
Image rejection		dB	15		
LO-to-RF isolation		dB	25		
LO-to-IF isolation		dB	20		
Input power at 1 dB compression		dBm	-18		
Input two-tone third-order intercept point		dBm	-8		
OUTPUT PARAMETERS	**CONDITION**	**UNITS**	**MIN.**	**TYP.**	**MAX.**
IF frequency		MHz	0.1		2
Detector voltage into 50 ohms	-18 dBm	mV	15		

NOTE: Test data supplied at 25°C; conversion loss, LO-to-RF isolation and image rejection.

MAXIMUM RATINGS

Specification temperature .... +25°C
Operating temperature .... -55 to +85°C
Storage temperature .... -65 to +95°C

OUTLINE DRAWING



NOTE: All dimensions shown in brackets [ ] are in millimeters.

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34.5 TO 35.5 GHz LOW-NOISE RECEIVER FRONT END

MODEL: SBWA3435N01R

FEATURES

- **RF/LO coverage .... 34.5 to 35.5 GHz**
- **IF operation .... 20 to 200 MHz**
- **Conversion gain .... 18 dB maximum**
- **Image rejection .... 15 dB minimum**

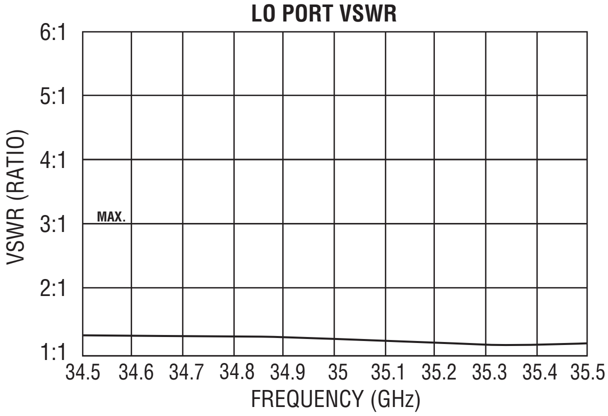
The SBWA3435N01R is an integrated low-noise converter utilizing an image rejection mixer. The internal LO amplifier allows the use of low levels of LO power. The small compact size includes waveguide interfaces on the LO and RF ports.

ELECTRICAL SPECIFICATIONS

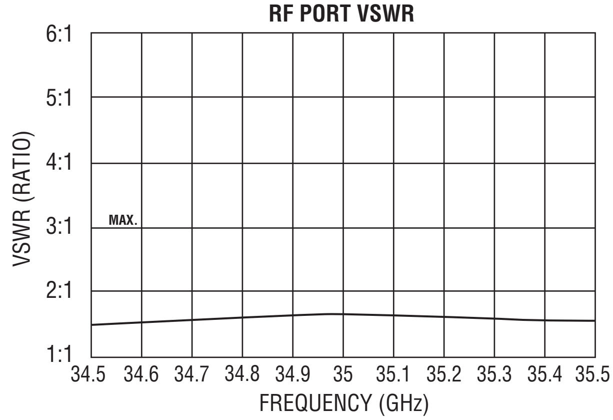
INPUT PARAMETERS	CONDITION	UNITS	MIN.	TYP.	MAX.
RF frequency range		GHz	34.5		35.5
RF VSWR (RF = -10 dBm)		Ratio		2:1	
Maximum input power	CW	mW			200
	10 ns pulse at PRF of 16 kHz	Watts			2
LO frequency range		GHz	34.5		35.5
LO power range		dBm	+2		+4
LO VSWR		Ratio		2:1	
Bias	+15 volts	mA			350
TRANSFER CHARACTERISTICS	**CONDITION**	**UNITS**	**MIN.**	**TYP.**	**MAX.**
Conversion gain		dB	13	16	18
Single-sideband noise figure at 25°C		dB		5.2	6
Image rejection		dB	15	20	
LO-to-RF isolation		dB	20		
LO-to-IF isolation		dB		20	
Input power at 1 dB compression point		dBm	-20	-15	
OUTPUT PARAMETERS	**CONDITION**	**UNITS**	**MIN.**	**TYP.**	**MAX.**
IF frequency range	SBWA3435N01RA	MHz	20		40
	SBWA3435N01RB	MHz	40		80
	SBWA3435N01RC	MHz	100		200
IF VSWR (IF = -10 dBm)		Ratio		1.5:1	

SBWA3435N01R TYPICAL TEST DATA

LO PORT VSWR



RF PORT VSWR



CONVERSION GAIN
(LO = +2 dBm, RF = -20 dBm, IF = 60 MHz)

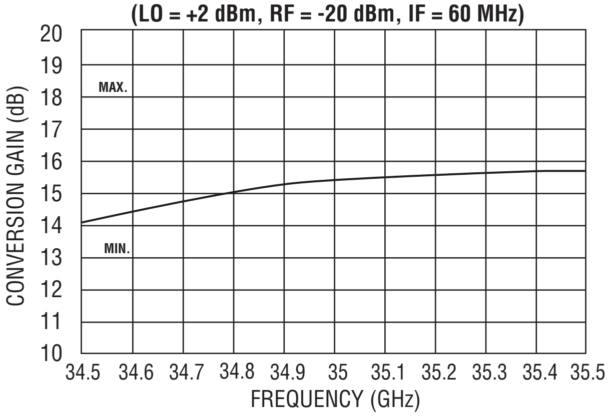
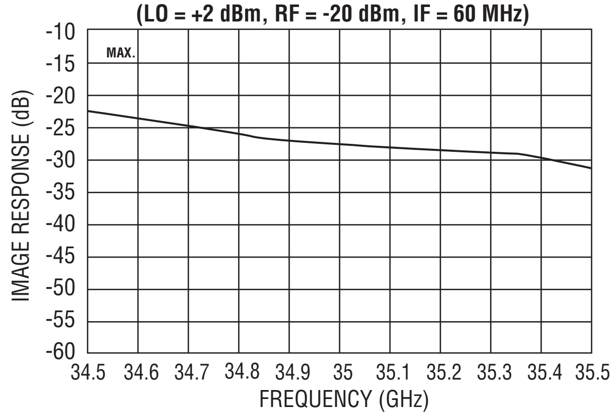


IMAGE RESPONSE
(LO = +2 dBm, RF = -20 dBm, IF = 60 MHz)

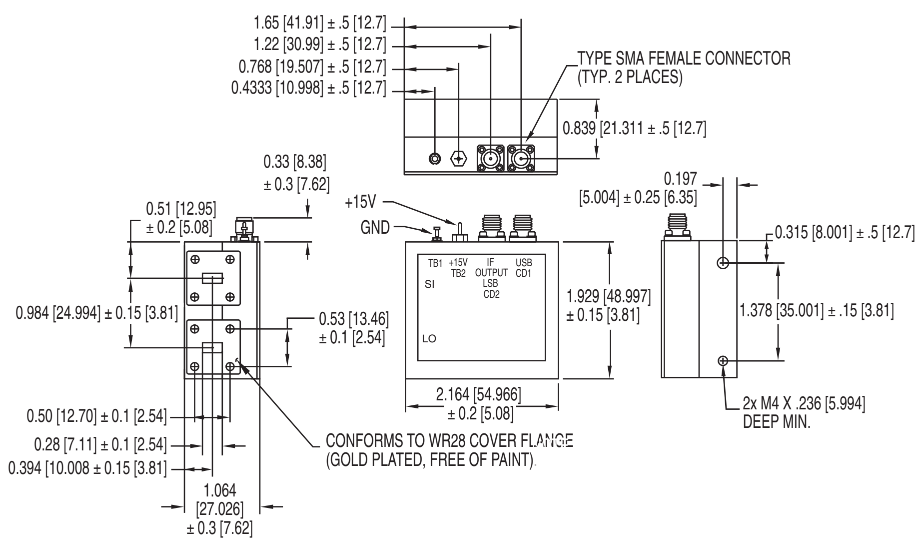


NOTE: Test data supplied at 25°C; conversion gain, LO-to-RF isolation, image rejection.

MAXIMUM RATINGS

Specification temperature .... +25°C
Operating temperature .... -55 to +85°C
Storage temperature .... -65 to +95°C

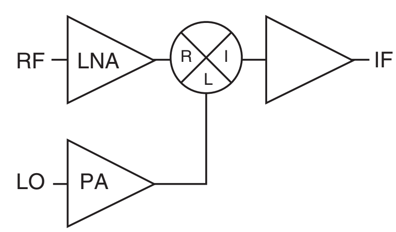
OUTLINE DRAWING



NOTE: All dimensions shown in brackets [ ] are in millimeters.

BLOCK DIAGRAM

IMAGE REJECTION MIXER



13 TO 14 GHz LOW-NOISE RECEIVER FRONT END

MODEL: AR1314N01R

FEATURES

- **Low noise figure............... 2.3 dB typical**
- **High gain .... 33 dB typical**
- **Output 1 dB comp. .... +10 dBm typical**
- **Integrated packaging ....Hermetically sealed**

The AR1314N01R is an integrated low-noise converter with internal image filtering. All devices are screened to MIL-STD-883 method 1010 and 1008 prior to hermetic sealing for high reliability. The single piece housing is a robust mechanical design for ease of use in any system. Waveguide inputs, alternate frequency bands, and quadrature or image rejection style units are available. Please contact MITEQ for more information.

ELECTRICAL SPECIFICATIONS

INPUT PARAMETERS	**CONDITION**	**UNITS**	**MIN.**	**TYP.**	**MAX.**
RF frequency range		GHz	12.5		14.5
RF VSWR	50 ohm reference	Ratio		2.5:1	
V+ bias current	@ +9 to +16 V			130	
V- bias current	@ -9 to -16 V			20	
LO frequency range		GHz		10.5	
LO power range		dBm	+12	+15	+18
LO VSWR		2.5:1			
TRANSFER CHARACTERISTICS	**CONDITION**	**UNITS**	**MIN.**	**TYP.**	**MAX.**
Conversion gain		dB	28	33	
Image rejection		dB	15	25	
Single-sideband noise figure		dB		2.3	2.9
Output power at 1 dB compression		dBm	+8	+10	
OUTPUT PARAMETERS	**CONDITION**	**UNITS**	**MIN.**	**TYP.**	**MAX.**
IF frequency range		GHz	2		4
IF VSWR		Ratio		2:1	

NOTE: Test data supplied at 25°C; conversion gain, image rejection, noise figure and output 1 dB compression point.

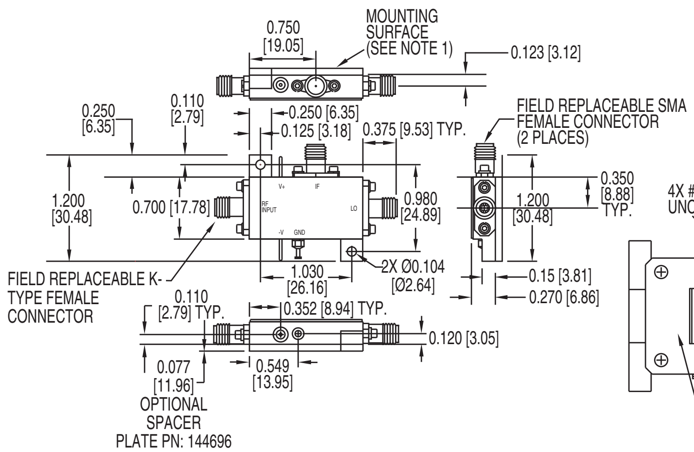
MAXIMUM RATINGS

Specification temperature .... +25°C
Operating temperature .... -40 to +65°C
Storage temperature .... -65 to +95°C

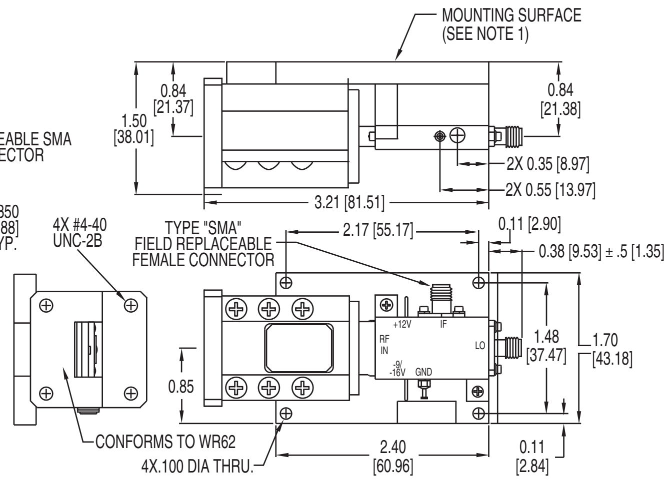
AR1314N01R

OUTLINE DRAWINGS

STANDARD UNIT

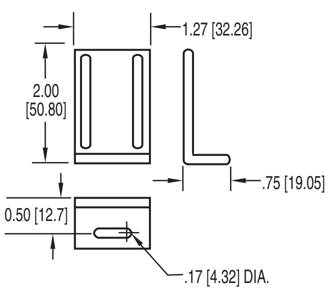


WG WAVEGUIDE OPTION



NOTES:

1. Units mounting surface shall be attached to a heatsink capable of dissipating the devices power consumption without exceeding the devices temperature limits.
2. All dimensions shown in brackets [ ] are in millimeters.



147307 L-SHAPE MOUNTING BRACKET

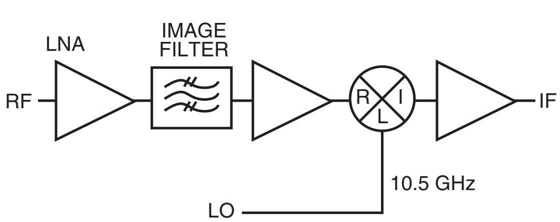
ORDERING INFORMATION

AR1314N01R ....Standard low-noise front end
AR1314N01RWG ....Front end with RF waveguide port

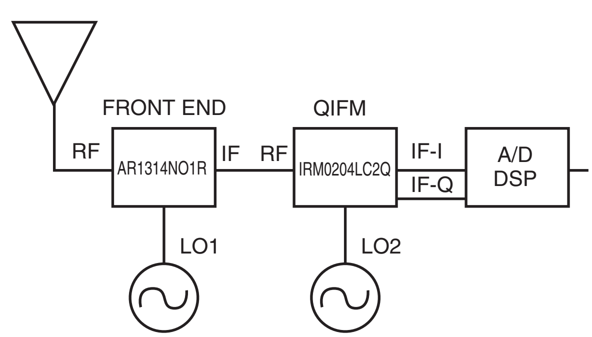
AVAILABLE OPTIONS

PART NO.	DESCRIPTION
OPT143047	External DC-DC converter to generate -V for single supply requirements
OPT163370	Heatsink for non-waveguide unit
OPT144696	Spacer plate for non-waveguide unit (used when mounting unit to a flat surface, plate allows clearance for connectors)
OPT147307	L-shape mounting bracket

BLOCK DIAGRAM



TYPICAL APPLICATION



30 TO 32 GHz LOW-NOISE FRONT END WITH LO MULTIPLIER OPTION

MODELS: SYSMM1X3032, SYSMM2X3032 AND SYSMM3X3032

FEATURES

- **Low noise figure............... 2.3 dB typical**
- **High gain .... 30 dB typical**
- **Output 1 dB comp. .... +10 dBm typical**
- **Integrated packaging .... Hermetically sealed**
- **Integrated LO multiplier**

The SYSMM3X3032 is an integrated low-noise converter with internal image filtering, and LO multiplier. The integrated LO multiplier provides higher front-end compression point than would be possible with a passive sub-harmonic mixer. Internal LO filtering reduces spurious and fundamental LO leakage. All devices are screened to MIL-STD-883 method 1010 and 1008 prior to hermetic sealing for high reliability. The single piece housing is a robust mechanical design for ease of use in any system. Waveguide inputs, alternate frequency bands, and quadrature or image rejection style units are available. Please contact MITEQ.

ELECTRICAL SPECIFICATIONS

INPUT PARAMETERS	CONDITION	UNITS	MIN.	TYP.	MAX.
RF frequency range		GHz	30		32
RF VSWR	50 ohm reference	Ratio		2.5:1	
V+ bias current	@ +9 to +16 V			290	
V- bias current	@ -9 to -16 V			30	
LO frequency range	SYSMM1X3032	GHz		28	
	SYSMM2X3032	GHz		14	
	SYSMM3X3032	GHz		9.33	
LO power range		dBm	+10	+12	+14
LO VSWR		Ratio		2.5:1	
TRANSFER CHARACTERISTICS	**CONDITION**	**UNITS**	**MIN.**	**TYP.**	**MAX.**
Conversion gain		dB	25	30	
Image rejection		dB	15	25	
Single-sideband noise figure		dB		2.3	2.8
Output power at 1 dB compression point		dBm	+7	+10	
OUTPUT PARAMETERS	**CONDITION**	**UNITS**	**MIN.**	**TYP.**	**MAX.**
IF frequency range		GHz	2		4
IF VSWR		Ratio		2:1	

NOTE: Test data supplied at 25°C; conversion gain, image rejection, noise figure and output 1 dB compression point.

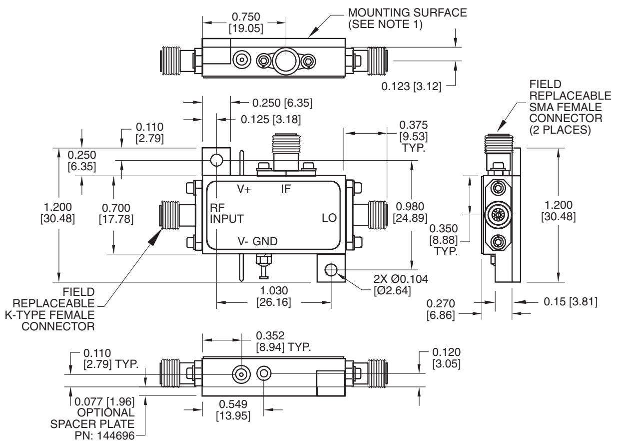
MAXIMUM RATINGS

Specification temperature .... +25°C
Operating temperature .... -40 to +65°C
Storage temperature .... -65 to +95°C

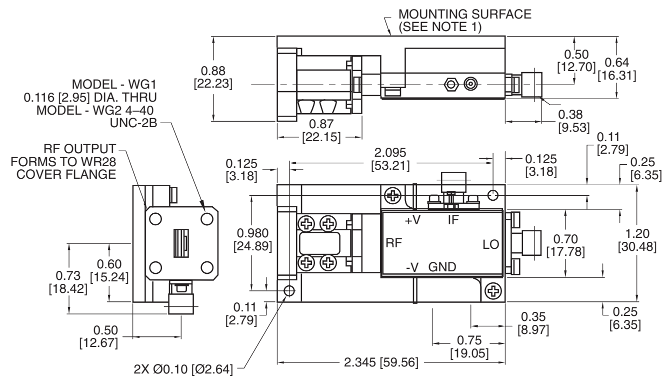
SYSMM1X3032, SYSMM2X3032 AND SYSMM3X3032

OUTLINE DRAWINGS

STANDARD UNIT

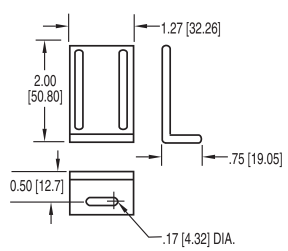


WG1, 2 WAVEGUIDE OPTIONS



NOTES:

1. Units mounting surface shall be attached to a heatsink capable of dissipating the devices power consumption without exceeding the devices temperature limits.
2. All dimensions shown in brackets [ ] are in millimeters.



147307 L-SHAPE MOUNTING BRACKET

ORDERING INFORMATION

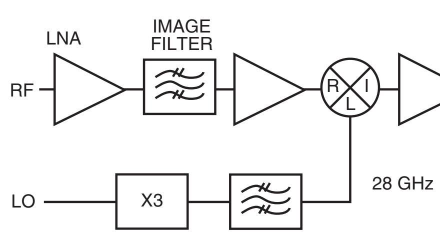
SYSMM3X3032............Front end with 3X LO multiplier
SYSMM2X3032............Front end with 2X LO multiplier
SYSMM1X3032............Front end with fundamental LO
SYSMM3X3032WG1....Front end with 3X LO multiplier and RF waveguide port
SYSMM2X3032WG1....Front end with 2X LO multiplier and RF waveguide port
SYSMM1X3032WG1....Front end with fundamental LO and RF waveguide port

Standard waveguide interface has 0.116 diameter clearance holes.
For waveguide port with #4-40 tapped holes, substitute...WG2 for...WG1.

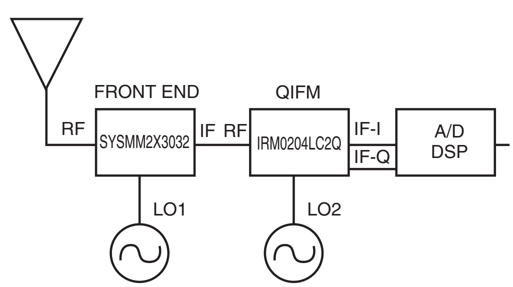
AVAILABLE OPTIONS

PART NO.	DESCRIPTION
OPT143047	External DC-DC converter to generate -V for single supply requirements
OPT163370	Heatsink for non-waveguide unit
OPT144696	Spacer plate for non-waveguide unit (used when mounting unit to a flat surface, plate allows clearance for connectors)
OPT147307	L-shape mounting bracket

BLOCK DIAGRAM



TYPICAL APPLICATION



34 TO 36 GHz LOW-NOISE FRONT END WITH LO MULTIPLIER OPTION

MODELS: SYSMM1X3436, SYSMM2X3436 AND SYSMM3X3436

FEATURES

- **Low noise figure............... 2.9 dB typical**
- **High gain .... 37 dB typical**
- **Output 1 dB comp. .... +10 dBm typical**
- **Integrated packaging .... Hermetically sealed**
- **Integrated LO multiplier**

The SYSMM3X3436 is an integrated low-noise converter with internal image filtering, and LO multiplier. The integrated LO multiplier provides higher front-end compression point than would be possible with a passive sub-harmonic mixer. Internal LO filtering reduces spurious and fundamental LO leakage. All devices are screened to MIL-STD-883 method 1010 and 1008 prior to hermetic sealing for high reliability. The single piece housing is a robust mechanical design for ease of use in any system. Waveguide inputs, alternate frequency bands, and quadrature or image rejection style units are available. Please contact MITEQ.

ELECTRICAL SPECIFICATIONS

INPUT PARAMETERS	CONDITION	UNITS	MIN.	TYP.	MAX.
RF frequency range		GHz	34		36
RF VSWR	50 ohm ref.	Ratio		2.5:1	
V+ bias current	@ +9 to +16 V			330	
V- bias current	@ -9 to -16 V			30	
LO frequency range	SYSMM1X3436 SYSMM2X3436 SYSMM3X3436	GHz GHz GHz		32 16 10.67	
LO power range		dBm	+10	+12	+14
LO VSWR		Ratio		2.5:1	
TRANSFER CHARACTERISTICS	**CONDITION**	**UNITS**	**MIN.**	**TYP.**	**MAX.**
Conversion gain		dB	31	37	
Image rejection		dB	15	25	
Single-sideband noise figure		dB		2.9	3.3
Output power at 1 dB compression point		dBm	+7	+10	
OUTPUT PARAMETERS	**CONDITION**	**UNITS**	**MIN.**	**TYP.**	**MAX.**
IF frequency range		GHz	2		4
IF VSWR		Ratio		2:1	

NOTE: Test data supplied at 25°C; conversion gain, image rejection, noise figure and output 1 dB compression point.

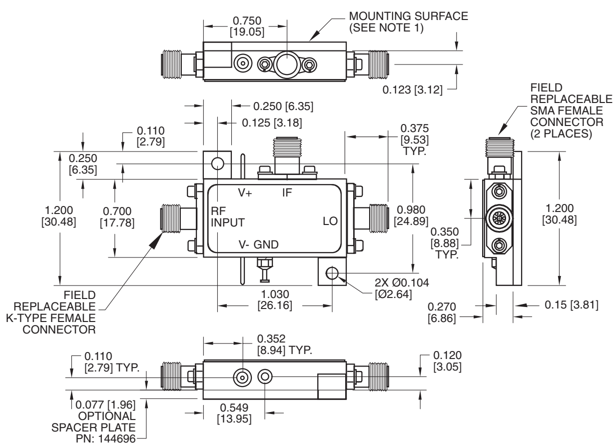
MAXIMUM RATINGS

Specification temperature .... +25°C
Operating temperature .... -40 to +65°C
Storage temperature .... -65 to +95°C

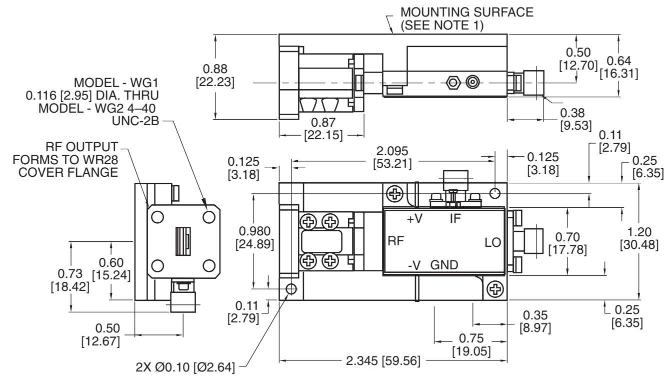
SYSMM1X3436, SYSMM2X3436 AND SYSMM3X3436

OUTLINE DRAWINGS

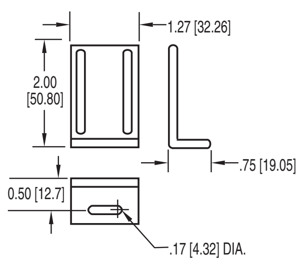
STANDARD UNIT



WG1, 2 WAVEGUIDE OPTIONS



NOTES:
1. Units mounting surface shall be attached to a heatsink capable of dissipating the devices power consumption without exceeding the devices temperature limits.
2. All dimensions shown in brackets [ ] are in millimeters.



147307 L-SHAPE MOUNTING BRACKET

ORDERING INFORMATION

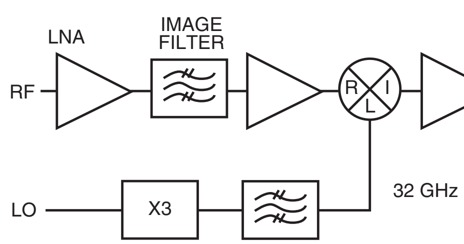
SYSMM3X3436............Front end with 3X LO multiplier
SYSMM2X3436............Front end with 2X LO multiplier
SYSMM1X3436............Front end with fundamental LO
SYSMM3X3436WG1....Front end with 3X LO multiplier and RF waveguide port
SYSMM2X3436WG1....Front end with 2X LO multiplier and RF waveguide port
SYSMM1X3436WG1....Front end with fundamental LO and RF waveguide port

Standard waveguide interface has 0.116 diameter clearance holes.
For waveguide port with #4-40 tapped holes, substitute...WG2 for...WG1.

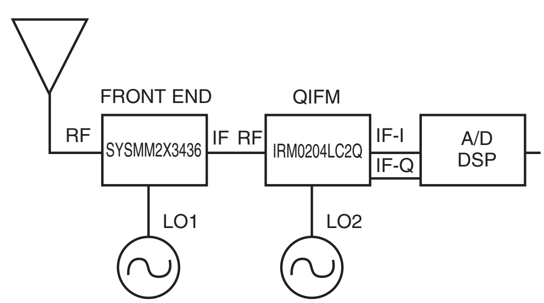
AVAILABLE OPTIONS

PART NO.	DESCRIPTION
OPT143047	External DC-DC converter to generate -V for single supply requirements
OPT163370	Heatsink for non-waveguide unit
OPT144696	Spacer plate for non-waveguide unit (used when mounting unit to a flat surface, plate allows clearance for connectors)
OPT147307	L-shape mounting bracket

BLOCK DIAGRAM



TYPICAL APPLICATION



36 TO 38 GHz LOW-NOISE FRONT END WITH LO MULTIPLIER OPTION

MODELS: SYSMM1X3638, SYSMM2X3638 AND SYSMM3X3638

FEATURES

- **Low noise figure............... 2.9 dB typical**
- **High gain .... 37 dB typical**
- **Output 1 dB comp. .... +10 dBm typical**
- **Integrated packaging .... Hermetically sealed**
- **Integrated LO multiplier**

The SYSMM3X3638 is an integrated low-noise converter with internal image filtering and LO multiplier. The integrated LO multiplier provides higher front end compression point than would be possible with a passive sub-harmonic mixer. Internal LO filtering reduces spurious and fundamental LO leakage. All devices are screened to MIL-STD-883 method 1010 and 1008 prior to hermetic sealing for high reliability. The single piece housing is a robust mechanical design for ease of use in any system. Waveguide inputs, alternate frequency bands, and quadrature or image rejection style units are available. Please contact MITEQ.

ELECTRICAL SPECIFICATIONS

INPUT PARAMETERS	CONDITION	UNITS	MIN.	TYP.	MAX.
RF frequency range		GHz	36		38
RF VSWR	50 ohm reference	Ratio		2.5:1	
V+ bias current	@ +9 to +16 V			330	
V- bias current	@ -9 to -16 V			30	
LO frequency range	SYSMM1X3638	GHz		34	
	SYSMM2X3638	GHz		17	
	SYSMM3X3638	GHz		11.33	
LO power range		dBm	+10	+12	+14
LO VSWR		Ratio		2.5:1	
TRANSFER CHARACTERISTICS	**CONDITION**	**UNITS**	**MIN.**	**TYP.**	**MAX.**
Conversion gain		dB	31	37	
Image rejection		dB	15	25	
Single-sideband noise figure		dB		2.9	3.3
Output power at 1 dB compression point		dBm	+7	+10	
OUTPUT PARAMETERS	**CONDITION**	**UNITS**	**MIN.**	**TYP.**	**MAX.**
IF frequency range		GHz	2		4
IF VSWR		Ratio		2:1	

NOTE: Test data supplied at 25°C; conversion gain, image rejection, noise figure and output 1 dB compression point.

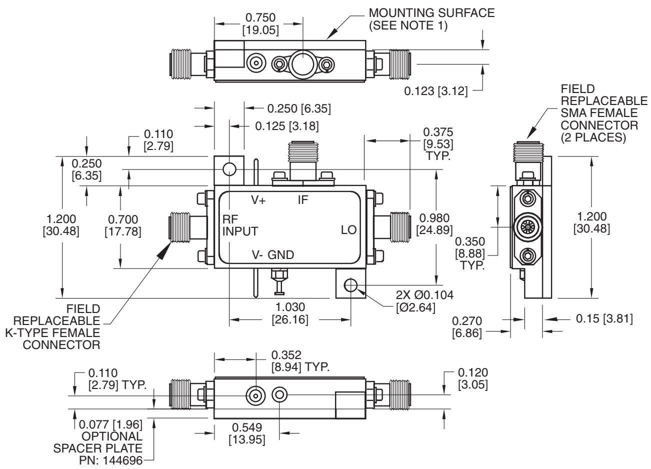
MAXIMUM RATINGS

Specification temperature .... +25°C
Operating temperature .... -40 to +65°C
Storage temperature .... -65 to +95°C

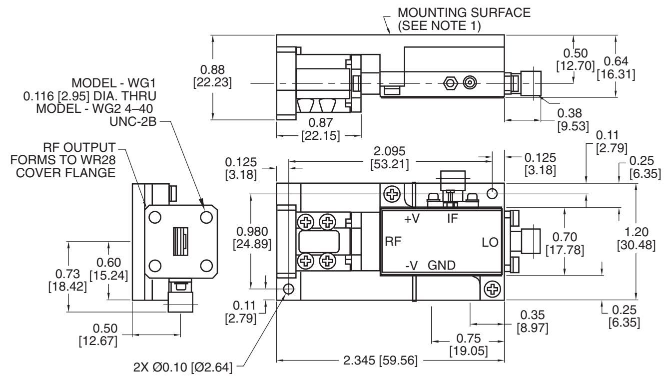
SYSMM1X3638, SYSMM2X3638 AND SYSMM3X3638

OUTLINE DRAWINGS

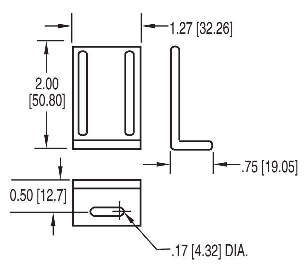
STANDARD UNIT



WG1, 2 WAVEGUIDE OPTIONS



NOTES:
1. Units mounting surface shall be attached to a heatsink capable of dissipating the devices power consumption without exceeding the devices temperature limits.
2. All dimensions shown in brackets [ ] are in millimeters.



147307 L-SHAPE MOUNTING BRACKET

ORDERING INFORMATION

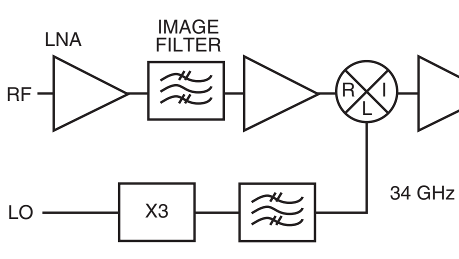
SYSMM3X3638............Front end with 3X LO multiplier
SYSMM2X3638............Front end with 2X LO multiplier
SYSMM1X3638............Front end with fundamental LO
SYSMM3X3638WG1....Front end with 3X LO multiplier and RF waveguide port
SYSMM2X3638WG1....Front end with 2X LO multiplier and RF waveguide port
SYSMM1X3638WG1....Front end with fundamental LO and RF waveguide port

Standard waveguide interface has 0.116 diameter clearance holes.
For waveguide port with #4-40 tapped holes, substitute...WG2 for...WG1.

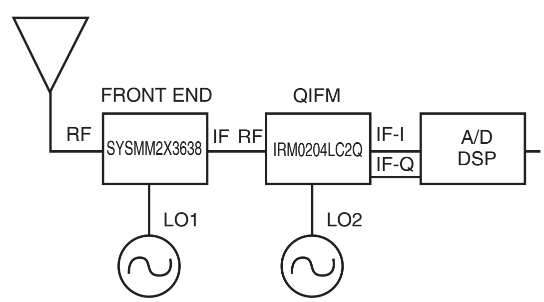
AVAILABLE OPTIONS

PART NO.	DESCRIPTION
OPT143047	External DC-DC converter to generate -V for single supply requirements
OPT163370	Heat sink for non-waveguide unit
OPT144696	Spacer plate for non-waveguide unit (used when mounting unit to a flat surface, plate allows clearance for connectors)
OPT147307	L-shape mounting bracket

BLOCK DIAGRAM



TYPICAL APPLICATION



43 TO 45 GHz LOW-NOISE FRONT END WITH LO MULTIPLIER OPTION

MODELS: SYSMM1X4345, SYSMM2X4345 AND SYSMM3X4345

FEATURES

- **Low noise figure............... 3.6 dB typical**
- **High gain .... 29 dB typical**
- **Output 1 dB comp. .... +7 dBm typical**
- **Integrated packaging .... Hermetically sealed**
- **Integrated LO multiplier**

The SYSMM3X4345 is an integrated low-noise converter with internal image filtering and LO multiplier. The integrated LO multiplier provides higher front end compression point than would be possible with a passive sub-harmonic mixer. Internal LO filtering reduces spurious and fundamental LO leakage. All devices are screened to MIL-STD-883 method 1010 and 1008 prior to hermetic sealing for high reliability. The single piece housing is a robust mechanical design for ease of use in any system. Waveguide inputs, alternate frequency bands, and quadrature or image rejection style units are available. Please contact MITEQ.

ELECTRICAL SPECIFICATIONS

INPUT PARAMETERS	CONDITION	UNITS	MIN.	TYP.	MAX.
RF frequency range		GHz	43		45
RF VSWR	50 ohm reference	Ratio		3:1	
V+ bias current	@ +9 to +16 V			380	
V- bias current	@ -9 to -16 V			30	
LO frequency range	SYSMM1X4345	GHz		41	
	SYSMM2X4345	GHz		20.5	
	SYSMM3X4345	GHz		13.67	
LO power range		dBm	+11	+12	+14
LO VSWR		Ratio		2.5:1	
TRANSFER CHARACTERISTICS	**CONDITION**	**UNITS**	**MIN.**	**TYP.**	**MAX.**
Conversion gain		dB	24	29	
Image rejection		dB	15	25	
Single-sideband noise figure		dB		3.6	4.5
Output power at 1 dB compression point		dBm		+7	
OUTPUT PARAMETERS	**CONDITION**	**UNITS**	**MIN.**	**TYP.**	**MAX.**
IF frequency range		GHz	2		4
IF VSWR		Ratio		2.5:1	

NOTE: Test data supplied at 25°C; conversion gain, image rejection, noise figure and output 1 dB compression point.

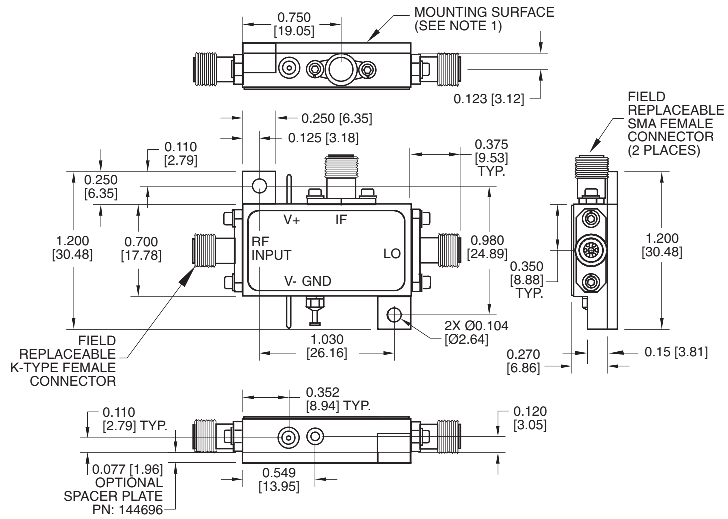
MAXIMUM RATINGS

Specification temperature .... +25°C
Operating temperature .... -40 to +65°C
Storage temperature .... -65 to +95°C

SYSMM1X4345, SYSMM2X4345 AND SYSMM3X4345

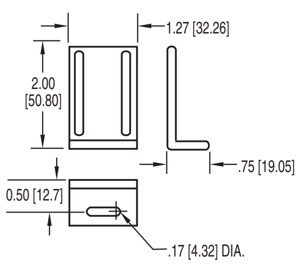
OUTLINE DRAWING

STANDARD UNIT



NOTES:

1. Units mounting surface shall be attached to a heatsink capable of dissipating the devices power consumption without exceeding the devices temperature limits.
2. All dimensions shown in brackets [ ] are in millimeters.



147307 L-SHAPE MOUNTING BRACKET

ORDERING INFORMATION

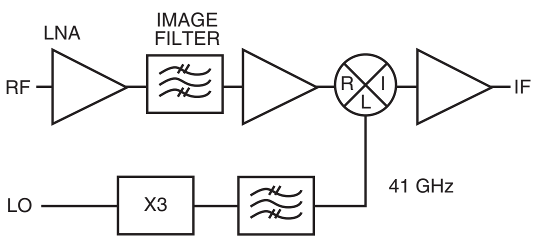
SYSMM3X4345............Front end with 3X LO multiplier
SYSMM2X4345............Front end with 2X LO multiplier
SYSMM1X4345............Front end with fundamental LO
SYSMM3X4345WG1....Front end with 3X LO multiplier and RF waveguide port
SYSMM2X4345WG1....Front end with 2X LO multiplier and RF waveguide port
SYSMM1X4345WG1....Front end with fundamental LO and RF waveguide port

Standard waveguide interface has 0.116 diameter clearance holes.
For waveguide port with #4-40 tapped holes, substitute...WG2 for...WG1.

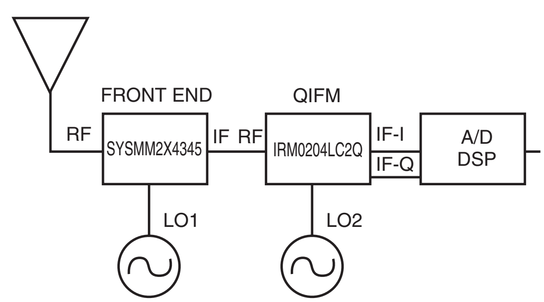
AVAILABLE OPTIONS

PART NO.	DESCRIPTION
OPT143047	External DC-DC converter to generate -V for single supply requirements
OPT163370	Heat sink for non-waveguide unit
OPT144696	Spacer plate for non-waveguide unit (used when mounting unit to a flat surface, plate allows clearance for connectors)
OPT147307	L-shape mounting bracket

BLOCK DIAGRAM



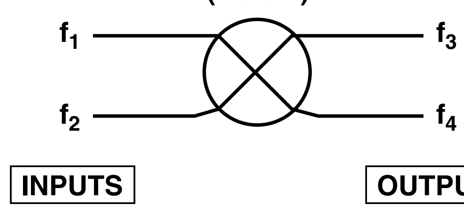
TYPICAL APPLICATION



MIXER TERMINOLOGY

The subject of mixers is often confused by the variety of different technical terms that often describe the same piece of hardware. For example, the common double-balanced mixer is useful as a downconverter, demodulator, upconverter or modulator. Other adjectives are also used to further subdivide each category such as linear, saturated, double sideband, etc. Ultimately, it is the relationship between the two input and desired output frequency bands and powers that uniquely specify each device classification. During our discussion, we will refer to the two input signal bands of any mixer as f_1 and f_2 (in increasing frequency) with respective powers P_1 and P_2. In this manner, any confusion defining the IF, RF, LO for up- and downconversion is avoided. The two output bands are $f_3 = (f_1 - f_2)$ or difference frequency and $f_4 = (f_1 + f_2)$ or sum frequency. In general, downconverters and demodulators are separated in classification from upconverters and modulators by the obvious fact that the output frequency (f_3, f_4) of the latter group is always greater than f_1, whereas f_3 is less than f_2 and f_1 for downconverters/demodulators. These two groups are further subdivided into either single- or double-sideband responses. An example of a single-sideband downconverter would be the image rejection mixer. A single-sideband upconverter rejects either output upper or lower sideband (i.e., $f_2 + 1$ or $f_2 - f_1$). The figure and table below show how all of our mixer products are defined in this catalog.

$f_2 > f_1$
$|P_1$ or $P_2| > 5$ dB
$|P_1$ or $P_2| > +10$ dBm min.



$f_3 = f_2 - f_1$
$f_4 = f_2 + f_1$

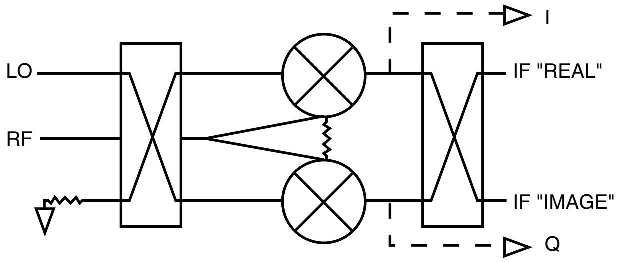
MIXER MODEL SELECTION GUIDELINE

1. Double-Sideband Mixers	❑ No image or sideband rejection
Upconverter	❑ $f_2/f_1 > 2$ using f_3, or f_4 = output
Downconverter	❑ f_3 min. > 0 and $f_2/f_1 < 2$
Demodulator	❑ f_3 min. = DC (i.e., $f_2 = f_1$)
2. Single-Sideband Downconverters	❑ Image rejection required
Image Rejection	❑ f_3 min. > 0 and $f_2/f_1 < 2$
I/Q Demodulator	❑ f_3 min. = DC (i.e., $f_2 = f_1$)
3. Single-Sideband Upconverters	❑ $f_2/f_1 > 2$
I/Q Modulator	❑ f_3 and f_4 required and $f_1 = 0$
Modulation Driven	❑ $P_2 < P_1$
Carrier Driven	❑ $P_2 > P_1$
SSB Upconverter	❑ f_2 or f_4 required and f_1 min. is not = 0
4. Low-Noise / Millimeter Subsystems	❑ f_1 or f_2 or f_2 or f_4 > 30 GHz
Low Noise	❑ SSB noise figure < 5 dB

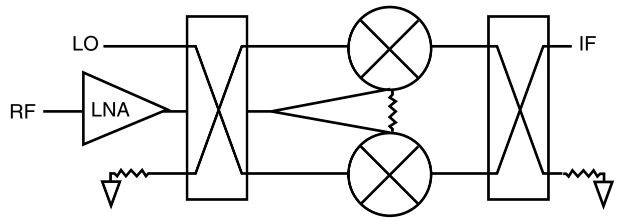
Note 1. When f_2 or f_1 is each a range or frequencies, use their midband values in the table formulas above.

IMAGE REJECTION MIXER, I/Q, QIFM CIRCUITS

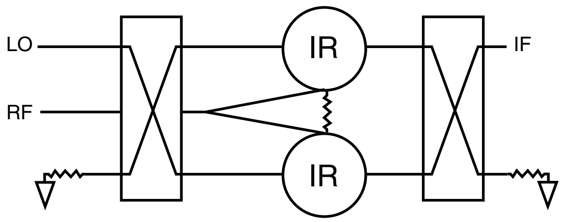
IR/IRM SERIES (Widest Bandwidth)
Image Rejection with IF Hybrid or
I/Q Demodulator without IF Hybrid



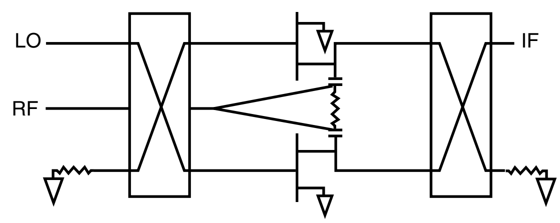
AR/ARM SERIES (Lowest Noise)
LNA-Image Rejection or QIFM (No Hybrid)



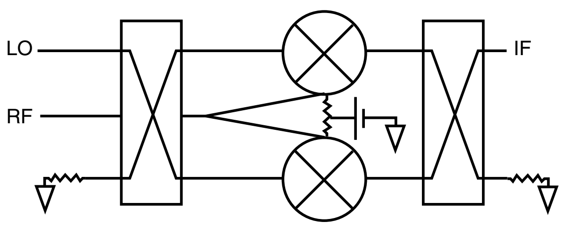
IRE SERIES (Low Quadrature Error)
Enhanced, Image Rejection



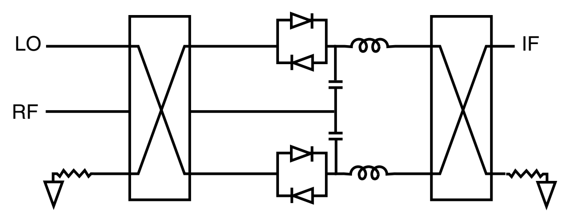
IRF SERIES (Highest IP^3/P$_1$ dB)
MESFET, Image Rejection



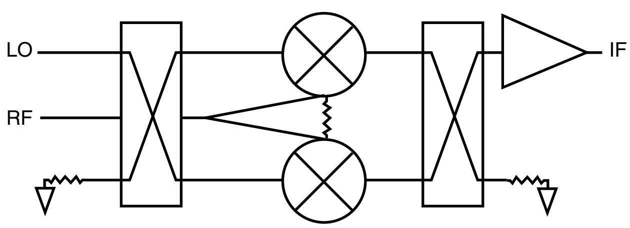
IRB SERIES (Lowest LO Power)
DC Biasable, Image Rejection



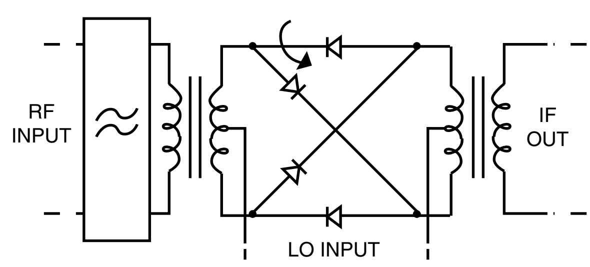
IRL SERIES (Lowest Reradiation/LO Cost)
1/2 LO, Image Rejection



IRA SERIES (Low 2RF - 2LO Spur)
IR-Mixer/IF Amplifier



IR SERIES (Lowest Conversion Loss)
Double-Tuned Filter/Baluns



APPLICATION-DRIVEN MIXER CIRCUITS

BASIC MIXER CIRCUITS

The preceding pages detail several of the basic mixer circuits discussed within this catalog. While there appear to be many similarities, there are subtle circuit differences that can greatly improve performance or reduce cost for a given receiving system application.

We will first clarify the definitions of the basic circuits.

• **Image Rejection Mixers** are principally used to suppress noise and signals from preceding low-noise amplifiers which occur at the unused or image side of the LO. Conventional "non-image" or double-sideband mixers will equally downconvert RF signals and/or noise, at frequencies above and below the LO, thus adding an effective 3 dB to the noise figure of any low-noise RF amplifier.

• **I/Q Demodulators** are further identified by the fact that the RF and LO frequencies are equal (i.e., IF= 0) and are usually coherent or phase locked. The two outputs of the I/Q demodulator are baseband spectrums of video information (including DC) that are derived from a modulated input carrier and phase-locked LO (the residual DC offset voltage of the I/Q mixers is, therefore, of considerable interest for accurate phase detection). The I/Q demodulator does not utilize an output IF hybrid since each output is usually a digital BIT stream. Because there is no quadrature combiner at the output, the conversion loss is 3 dB more than that of an image rejection mixer.

• **QIFM (Quadrature IF Mixer).** The circuitry of this device is identical to the I/Q demodulator, however the two outputs are at an IF frequency (RF ± LO) where further system processing is performed. The DC offset of the mixers used in a QIFM is not important. As with the I/Q demodulators, because there is no quadrature combiner at the output, the conversion loss is 3 dB more than that of an image rejection mixer.

• **Enhanced Image Rejection Mixer.** Conventional image rejection mixers, used for noise suppression, rarely require more than 15 dB image rejection. Enhanced designs can achieve 30 and 40 dB equivalent image rejection over multioctave and narrow bands, respectively, and when used in receivers can reduce the complexity of the tracking RF filter.

INPUT LOW-NOISE AMPLIFIERS

In general, the sensitivity of a system utilizing any of the described mixing circuits can be improved by preceding it with a low-noise amplifier (LNA) . However, this increased sensitivity is not realized without a penalty, namely dynamic range. Since the mixer's input 1 dB compression and multitone intercept point often limit the dynamic range performance of a system, it is important that the gain of the LNA and the dynamic range of the mixer are considered in a trade-off of overall receiver performance.

The following is a summary of some of the basic system-orientated concerns an engineer may wish to consider when selecting the front-end architecture. These points are based around a general design goal of any receiver system to have all of the components stressed to the same degree, in terms of their cost and performance contribution to the overall task.

• **LNA Selection.** High antenna ground noise can spoil the advantages of an expensive low-noise amplifier and make a low conversion-loss Schottky mixer more practical. When specifying the LNA, define the noise figure required by the application. Consider the system costs on dynamic range of maintaining the lowest possible noise figure, i.e., keeping the gain high throughout the entire receiver chain to minimize second-stage noise figure contributions.

• **Mixer Effect on Dynamic Range.** In almost all receiving systems, the mixer is the limiting factor in dynamic range. Select an appropriate level mixer to closely match the maximum output level of the LNA. Furthermore, the extra cost of a higher power LO needed to raise the IP^3 of a Schottky diode mixer may be wasted relative to the choice of more power efficient MESFET mixers. In all cases, set the gain for the minimum needed to maintain system sensitivity and then select the desired level mixer.

• **System Dynamic Range Limitations.** For many crowded communication receivers, the lower limit of dynamic range is not the thermal noise of the LNA, but rather the single or multitone spur products of the mixer stages. Calculate the single or multitone spur levels and back into the maximum allowable signal which causes these spurs to cross the receiver's minimum allowable threshold level. Then adjust the receiver gain and mixer level to approach the system goals.

Thus, for many receiver designs, the choice of mixer semiconductors (Schottky or MESFET) is highly dependent on the cost and power levels of the surrounding components. In addition, possible system integration problems, such as LO noise rejection, are described in greater detail in the Question and Answer (Q & A) section.

Questions and Answers about...

IMAGE REJECTION MIXERS

Q1: What is the image frequency of a mixer?

A1: The output or IF frequency of a downconverting mixer is equal to the difference between the LO (local oscillator) and the input RF frequency. Consequently, two different input RF frequencies above and below the LO (like mirror images) will yield the same output or IF frequency. The receiver designer commonly chooses the LO to be above or below the desired RF input based upon spur products, interference, spectrum inversion, etc., but in any case, the other unwanted RF response is defined as the image. Mathematically, image frequency equals 2LO–RF.

Q2: When are image rejection mixers used?

A2: Traditionally, whenever a low-noise RF preamplifier is used that has sufficient bandwidth to amplify both desired and image response noise. Image rejection mixers are particularly useful when the real and image are very close (low IF frequencies) so that a narrow-band preselector is impractical. Additionally, an image rejection mixer is used in broadband receivers without RF preamplification whenever one must discern which sideband is being converted.

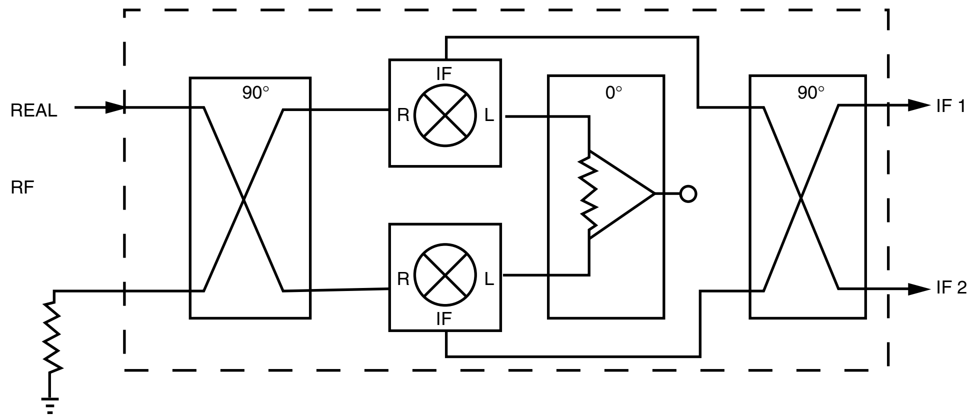
Q3: Why is it necessary to reject the image response of a receiver?

A3: Ideally, the low-noise RF amplifier preceding the mixer should only amplify weak RF signals and any noise in that same signal bandwidth. However, the amplifier will also amplify other input noise surrounding the signal bandwidth, including the image frequency. If the mixer following the RF amplifier is broadband (i.e., has two responses, real and image), then the additional undesired amplifier image noise will add to the desired real response at the mixer output. Thus, with twice as much output noise for the same desired signal level, our system noise figure is degraded by 3 dB. Even if the RF preamplifier had high enough gain to mask the noise contribution of other components in the receiver chain, the useful noise figure is still 3 dB higher than the measured noise of the preamplifier alone.

Q4: How does the image rejection mixer work?

A4: In any mixer two different input RF frequencies (above and below the LO by the same offset or IF frequency) will yield an identical output frequency. The most significant difference is that if one changes the phase of the incoming RF that is above the LO frequency by +90°, the IF output from that signal will also change by +90°. The same +90° change in the image (RF below LO) will yield a -90° IF change (in the parlance of mixer technology they are conjugates of each other). Image rejection mixers exploit this fundamental fact by first dividing the incoming RF signals into two equal paths with 90° phase differences. The hybrids used for this purpose are wide bandwidth, thus affecting real and image frequency. Furthermore, if the two RF hybrid outputs are used to feed two identical mixers driven from the same in-phase LO, their IF outputs will also differ by 90°. However, as we might suspect, the mixer IF outputs lead and lag each other by 90° for the image and RF inputs, respectively. Separating the IF outputs for image and real RF is then an easy task with an IF 90° hybrid.

MITEQ IR SERIES



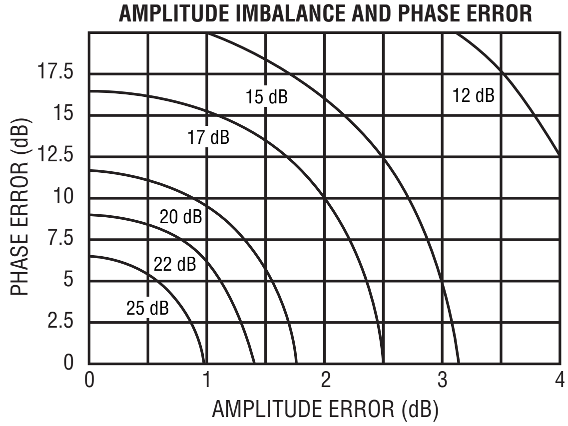
Q5: What is a QIFM or I/Q mixer?

A5: The quadrature IF mixer is an image rejection mixer without the IF hybrid. Thus each IF output is 90° apart or the I output is proportional to the SIN (W_{LO} ±W_{RF})+, whereas the Q output is proportional to COS (W_{LO} ±W_{RF})+. If one used these signals to power the horizontal and vertical inputs of an oscilloscope, a circle would be displayed for an AC IF frequency and a fixed radial vector for a DC IF or I/Q phase detector. Generally, the QIFM configuration is used for wideband digital or analog processing of video IF signals.

Q6: How is the quadrature phase and amplitude accuracy of a QIFM related to image rejection?

A6: Since the QIFM has no IF 90° hybrid, we will assume for simplicity that all phase and amplitude errors of the image rejection mixer are due to the RF/LO hybrids and mixer tracking errors. The figure below shows how various combinations of phase and amplitude errors can yield the same image rejection:

IMAGE REJECTION AS A PARAMETER OF AMPLITUDE IMBALANCE AND PHASE ERROR



REF. A. Kiiss, Image Rejection Mixers, Applied Microwave, Winter 1991/1992

Q7: What is the difference between an ordinary and the MITEQ enhanced image rejection mixer?

A7: Ordinary image rejection mixers suppress the image response by 18 to 25 dB, dependent on operating RF bandwidth. The enhanced image rejection mixer (IRE) will provide 28 to 35 dB rejection over multioctave and octave bandwidths, respectively. In addition, the MITEQ IRE Series design will also suppress the third-harmonic LO responses (3LO–RF and RF–3 LO), which typically are only 10 dB below the main or real response. Therefore, for RF operating bandwidths exceeding 3 to 1, one will observe more accurate single-sideband noise figures (typical error with ordinary image rejection mixers is approximately 0.5 to 0.9 dB).

Q8: When is it not necessary to reject the image response?

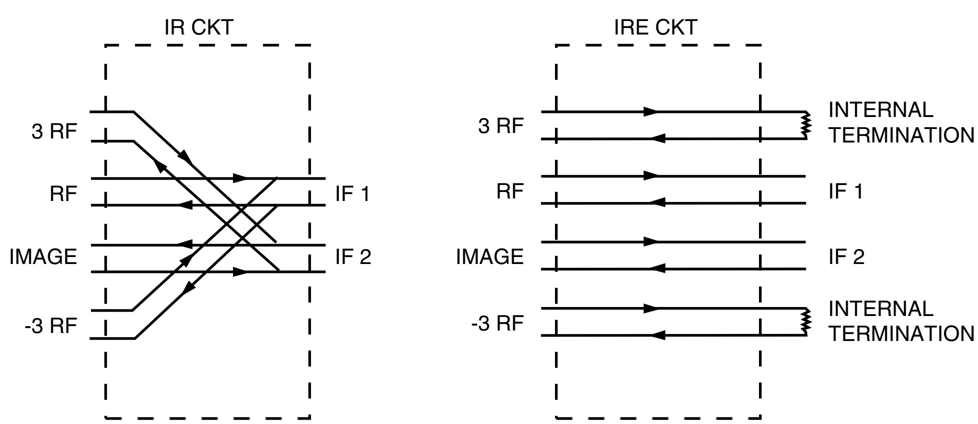
A8: In receiver applications, where signal information is contained in both the real and image response of the mixer, such as for radio astronomy applications where the signal itself is broadband noise. Of course, for some receivers, the added 3 dB of image noise may still yield a tolerable sensitivity. In addition, if the RF amplifier is narrow enough in bandwidth to exclude the image noise, an IR mixer will not be necessary. Many receivers and synthesizers also use high IF frequencies and double conversion schemes to eliminate the image response. In addition, newer MITEQ mixers with tuned RF baluns are available with enough "skirt selectivity" to effectively eliminate the image response.

Q9: Is an image rejection mixer necessary if the low-noise RF preamplifier is preceded by a narrow-band image filter near the antenna?

A9: Yes, because the sources of system noise are generally assumed to be the input amplifier source termination and any output amplifier noise. The reactive filter termination will stop input source noise of the input amplifier source termination, but in general will not influence the larger output amplifier noise source due to the gain of the amplifier.

Q10: Can the conventional and MITEQ-enhanced image rejection mixers be used in the reverse or upconverting mode?

A10: Yes, because the mixer is basically a reciprocal device, therefore the mixer can function in the linear or small IF signal mode to generate output RF energy above or below the LO frequency (dependent on which IF port is used as the input). The figure below shows a simplified signal flow graph for the conventional and MITEQ IRE Series image rejection mixers:



In this mode of operation, the device is sometimes referred to as a linear single-sideband modulator because each IF input can modulate the LO or carrier independently or in quadrature and thus transmit twice as much information in the same bandwidth. Sometimes a QIFM is used in the upconverting mode without an IF hybrid by supplying separate I/Q baseband signals. The testing methods and relative LO and IF powers for single-sideband modulators are influenced by different mixer performance criteria and, therefore, are described in a different section.

Q11: Sometimes an image recovery mixer is also referred to as an image enhanced circuit. Are these units the same as the MITEQ IRE design?

A11: No, because the MITEQ IRE unit internally terminates the unused image energy rather than recovering it and reducing the conversion loss by 0.5 to 0.9 dB. The image termination method used in the MITEQ IRE circuit is also different from the IR or conventional image rejection mixers. It is not influenced by external RF source and load mismatches.

Q12: What other "filterless" receiver design techniques will eliminate the image response?

A12: One can also employ "dual conversion" whereby a first DSB mixer IF output is chosen high enough in frequency to produce an image band that falls outside the RF input range. For example, with a 2 to 18 GHz RF input and tracking, 24 to 40 GHz LO, the IF is fixed at 22 GHz and the image (2LO–RF) is 46 to 62 GHz. A second mixer and LO would be required to downconvert the 22 GHz first IF to perhaps 1 GHz. Caution is necessary, of course, to reject the image response of the second mixer at 20 or 24 GHz, but this is easier with a fixed frequency relative to the problem of a multioctave input. The first mixer, in this example, is a TB0440LW1.

Questions and Answers about...

LNA, IMAGE REJECTION MIXERS

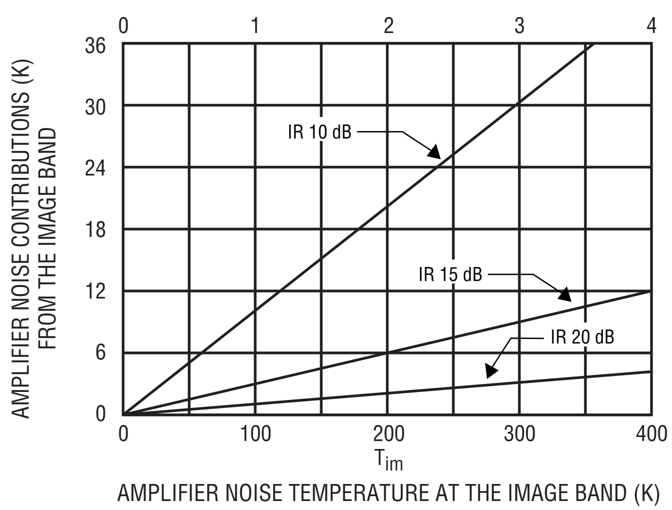
Q1: Why is it necessary to reject the image noise of the LNA?

A1: Ideally, the low-noise RF amplifier preceding the mixer should only amplify weak RF signals and any noise in that same signal bandwidth. However, the amplifier will also amplify other input noise surrounding the signal bandwidth, including the image frequency. If the mixer following the RF amplifier is broadband (i.e., has two responses, real and image), then the additional undesired amplifier image noise will add to the desired real response at the mixer output. Thus, with twice as much output noise for the same desired signal level, our system noise figure is degraded by 3 dB. Even if the RF preamplifier had high enough gain to mask the noise contribution of other components in the receiver chain, the useful noise figure is still 3 dB higher than the measured noise of the preamplifier alone.

Q2: What parameters make a low-noise RF preamplifier and an image rejection mixer compatible with each other besides the same RF frequency range?

A2: Generally, one tries to maintain the dynamic power range of the combination. For example, the maximum input RF signal that overloads the amplifier output should also just begin to overload the mixer input. For ordinary Schottky diode mixers, the 1 dB input RF compression point is about 5 dB less than the LO power. Thus, if the maximum preamplifier output power is +10 dBm, one should choose a mixer requiring an LO power of +15 to +17 dBm. Greater amplifier gains and output powers of +20 dBm are best handled with MESFET image rejection mixers which require +21 dBm LO power. Of course, many receiver applications only require operation near the noise power levels, so these compression precautions are academic.

The amount of image rejection necessary to suppress the image noise contribution is seldom more than 20 dB. For example, if the RF amplifier has a 3 dB noise figure (Te = 290 K), then the additional noise contribution from the image for 10, 15 and 20 dB of image rejection are 0.4 dB, 0.13 dB and 0.05 dB, respectively. The figure below shows noise contributions expressed in degrees Kelvin.

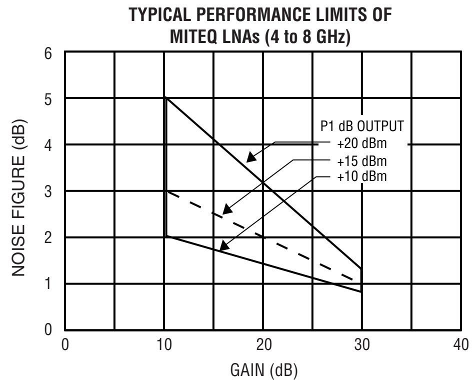


Q3: Are there other sources of noise for the LNA-IR mixer combination?

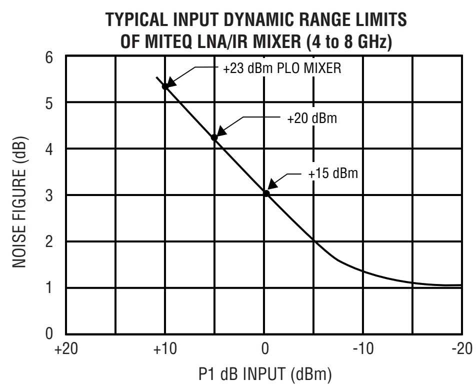
A3: For multioctave bandwidths (greater than 3 to 1), the image rejection mixer will usually have another response at 3LO–RF or RF–3LO, which is typically only -10 dB below the main RF response, thus contributing 30 K of excess noise for a Te = 300 K amplifier. The MITEQ IRE and ARE image rejection mixers will suppress the 3LO–RF and RF–3LO noise by at least 20 dB.

Q4: What are the approximate limits of single-sideband noise figure and dynamic range of MITEQ (Dept. 75) LNA/IR mixer pairs?

A4: In general, there is a trade-off between lowest overall noise figure and maximum input RF power before compression. This is due to the physical design constraints of noise figure, gain and output 1 dB compression of the LNA, as well as the 1 dB compression of the mixer, LO power and conversion loss. Both amplifier and mixer design constraints are also frequency dependent. The graph below shows the approximate limits of MITEQ octave bandwidth LNAs in the 4 to 8 GHz frequency range.



The following graph shows the corresponding noise figure and input RF power limits when the LNAs above are mated with a second-stage image rejection mixer having 8 dB conversion loss and an input 1 dB compression power that always exceeds that of the LNA output (required LO power shown on graph).



We notice that the lowest overall noise figure has, as expected, the lowest input 1 dB compression because the amplifier gain is high and completely masks the poor mixer noise figure. Let us assume that dynamic range is proportional to the difference in input power and noise figure for the cascaded pair. Thus, if we choose a different LNA with a lower gain, we observe that the input RF power increases faster (dB for dB) than the noise figure, so an improvement in dynamic range is possible. We also observe that at low amplifier gains with high input RF power limits the overall input noise figure and required mixer compression both increase rapidly. In this limit, highest input compression is achieved without an LNA (+20 dBm for MESFET mixer), but the noise figure is approximately 8 dB.

LNA, IMAGE REJECTION MIXERS (CONT.)

Q5: What undesired interactions can occur between the RF-LNA and IR-mixer?

A5: In general, one will observe characteristic amplitude and phase ripples as the amplifier output and mixer input VSWRs interact through whatever line length is used to connect the two components together. For example, a mixer and amplifier VSWR of 1.7:1 in random phase will produce amplitude and phase deviations of ±0.6 dB and ±4.0°. The ripple periodicity or frequency spacing can be altered by minimizing the distance between components, as is done in an integrated assembly. An isolator will, of course, also eliminate this problem.

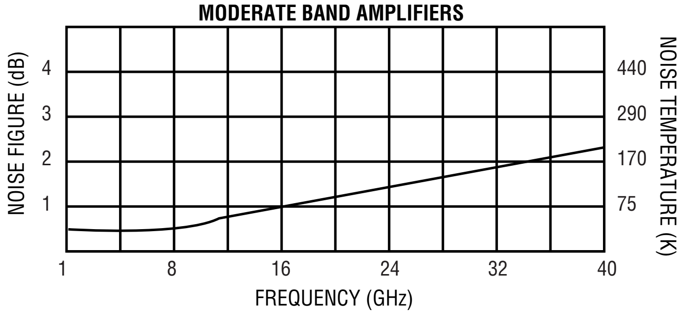
Q6: What other advantages, besides lower noise figure, does the LNA-IR-mixer combination have over the IR-mixer alone?

A6: (1) The reverse isolation of the LNA will greatly increase LO-to-RF isolation, resulting in minimal LO reradiation, typically 60 dB. (2) The amplifier isolation will also make the mixer intermodulation performance more independent of source impedance mismatch.

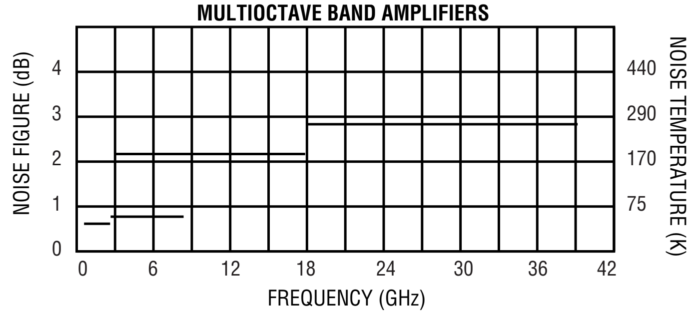
Q7: What are the performance limits of readily available MITEQ low-noise amplifiers?

A7: The figure below shows typical limits.

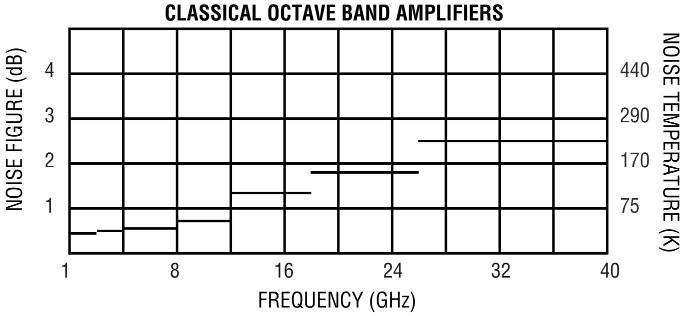
NOISE FIGURE VS. FREQUENCY
MODERATE BAND AMPLIFIERS



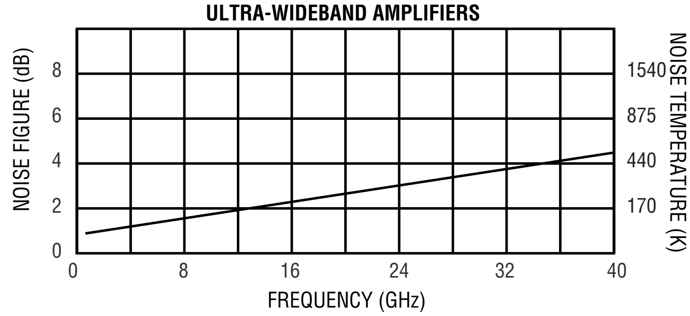
NOISE FIGURE VS. FREQUENCY
MULTIOCTAVE BAND AMPLIFIERS



NOISE FIGURE VS. FREQUENCY
CLASSICAL OCTAVE BAND AMPLIFIERS



NOISE FIGURE *
ULTRA-WIDEBAND AMPLIFIERS

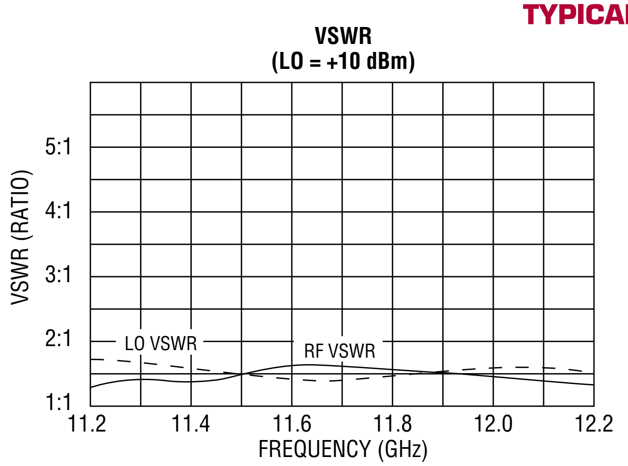


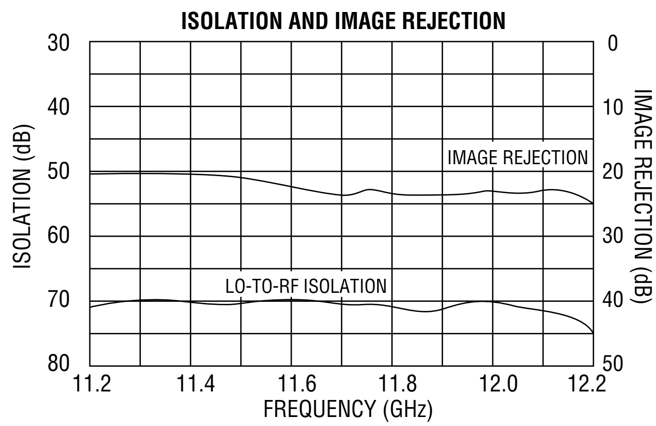
* As a function of upper cutoff frequency (lower cutoff at 100 MHz).

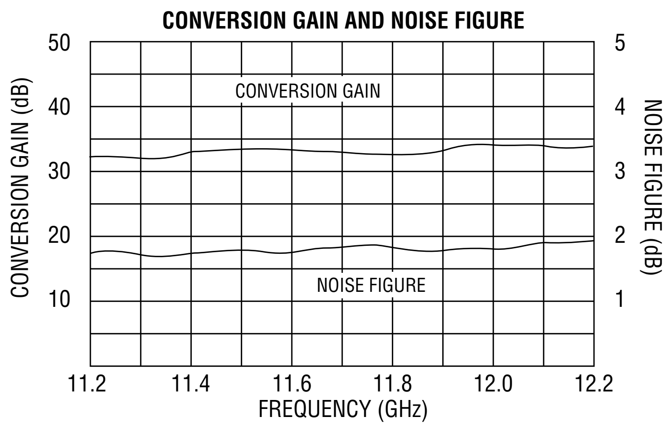
Q8: What is the typical swept performance of an X/Ku-band low-noise LNA-IR mixer?

A8: The curves below were measured at 25°C with +10 dB LO power. Standard catalog units are aligned for desired RF>LO. The connectors are field replaceable.

MITEQ MODEL: AR1112D22B
TYPICAL TEST DATA





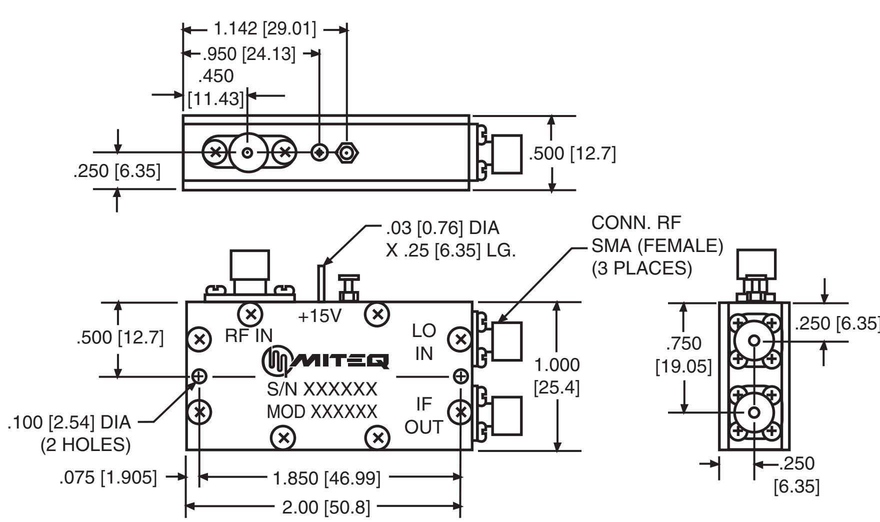


SINGLE-TONE (m) RF ±(n) LO SPUR LEVEL
RELATIVE (dBc) TO REF (RF = -20 dBm, LO = +10 dBm)

RF HARMONIC					
5	-	-	-	-	63
4	-	-	-	56	-
3	-	-	39	-	-
2	-	41	-	-	-
1	REF	-	-	-	-
	1	2	3	4	5

LO HARMONIC

OUTLINE DRAWING



Questions and Answers about...

PHASE DETECTORS

Q1: What qualities of an ordinary mixer make it suitable for phase detection?

A1: Generally, a large maximum output voltage and a low residual DC diode offset voltage. The double-balanced mixer circuit is usually chosen because the average rectified DC voltage of each diode in the quad due to the RF or LO alone is canceled, as well as other even harmonic mixing products producing a DC output (i.e., 2LO ±2RF, 4LO ±4RF). It has become customary to describe phase detector dynamic range by the ratio of maximum output to minimum DC offset voltage, since this ratio is proportional to the input phase angle and its error. The output load impedance for the diodes is typically 50 ohms, but some users specify 500 ohms, leading to 2:1 voltage differences between manufacturers. The DC offset voltage is highly dependent upon the quality of the RF and LO balun, therefore ratios of 400 mV/1 mV with medium level Schottky diodes at +7 dBm are common at lower RF frequencies. Whereas, at microwave frequencies, a ratio of 100 is more common because of generally poorer balun quality (special new microwave baluns are now available in DM series). The maximum output voltage of a double-balanced phase detector without self bias is limited by the diode forward voltage, therefore higher barrier and LO power diodes are required for greater 1 dB RF compression and output voltage.

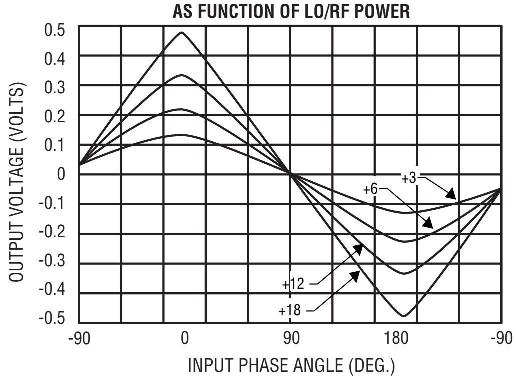
Finally, since most phase detectors are used to measure audio voltage offsets in phase-locked loop amplifications, one usually desires a mixer with diodes having low video or 1/f noise. Corner frequencies (where 1/f and noise floor intersect) of approximately 50 kHz or less are achievable with Schottky or MESFET mixers in the passive mode.

Q2: Why do most catalog double-balanced mixers have a maximum or minimum output voltage when the input signal phase is different from 0 or 90°, respectively?

A2: Generally, most mixers are not of symmetric construction. For example, the LO and RF baluns may be of different internal physical lengths and designed for different impedance levels. Such mixers will, of course, still function as a phase detector with an additional compensating external line length to make each input signal arrive at the diode quad in phase. Alternately, one can specify a double-balanced mixer with equal internal phase lengths. In either case, the output IF voltage will then be proportional to the cosine of the input RF phase angle.

Q3: How can the mixer be made less sensitive to AM signal variations?

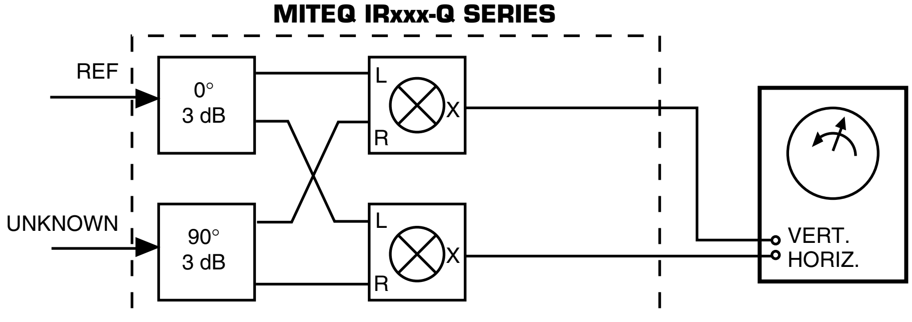
A3: The figure below shows the output voltage across 50 ohms of a typical double-balanced mixer when used as a phase detector with equal power at the RF and LO terminals.



BPSK AND QPSK PHASE DETECTORS (CONT.)

The slope of the curves at 90° can be inverted, if desired, by reversing the leads of the Schottky diode inside the mixer.

In practice, one can approximately double the output voltage and DC offset by using a 1 K output load instead of the 50 Ω value used for the graph. In either case, the best operating point for greatest output voltage to input RF phase change is, of course, at the 90° or zero crossing points. Also, note that as the input powers are raised in increments of 6 dB, the output voltage versus input RF phase becomes less sensitive to RF input power (saturated operation). In addition, the shape of the transfer curve changes from sinusoidal to triangular. Alternately, one could limit the RF signals with a saturated amplifier prior to using the phase detector to remove amplitude variations. Notice that the phase detector has two different input phase states that yield the same output voltages, thus creating ambiguous operation for measuring absolute phase. One technique for removing this phase ambiguity, and at the same time allowing the measurement of input signals with variable amplitude (without limiters), is to use an I/Q or QIFM circuit shown below.



When the reference LO and the unknown RF are applied to this circuit, two equal amplitude signals are generated at the output that are always in-phase quadrature. When these signals are applied to an oscilloscope (I/Q on horizontal/vertical plates), one will observe the traditional circle pattern. When the LO and RF are at the same frequency, the circle pattern becomes a stationary dot at an angle equal to the $\tan^{-1}$ (Q/I). If the amplitude of either LO or RF input changes, the ratio of Q/I should remain unchanged until the signals are very low and close to the DC offset voltage. This test setup is also useful for observing the relative phase noise of two oscillators that are both locked to a common reference (i.e., stationary vector) with jitter.

Q4: What specifications of a mixer limit the maximum output voltage as a phase detector?

A4: The IF output voltage of a typically double-balanced mixer appears across the parallel connection of the 4 Schottky diodes. The RF and LO are series parallel, consequently the diodes act as an internal limiter equal to the forward voltage or barrier potential of the diodes, typically ±200 mV for +7 dBm LO power quads and 1 volt for high barrier diodes.

Q5: How is the output noise of a phase detector characterized?

A5: Generally, the phase detector will have output noise equivalent to an ordinary mixer which can be characterized as a pad equal in value to the mixer conversion loss and limited to KTB, except at very low frequencies, where the so-called 1/f or flicker noise begins at the corner frequency. Schottky diodes are available with corner frequencies of 25 to 50 kHz. Back diodes or tunnel diodes with poor negative resistance often have 5 to 10 kHz corner frequency, but offer very small maximum output voltages. Schottky diode phase detectors often have excess uniform phase and amplitude noise when driven into saturation, since the higher average diode current will have a shot noise component similar to a noise diode.

Very high level MESFET mixers are capable of low 1/f noise in the passive mode (i.e., no DC voltage on drain with LO on gate). The combination of high input signal level (+20 dBm) and low 1/f noise of the passive MESFET make it one of the lowest phase noise mixers available (-170 dBc / Hz noise floor).

Q6: What phase errors can occur when the LO and RF input powers to a phase detector are kept equal, but become too low to turn on the diodes?

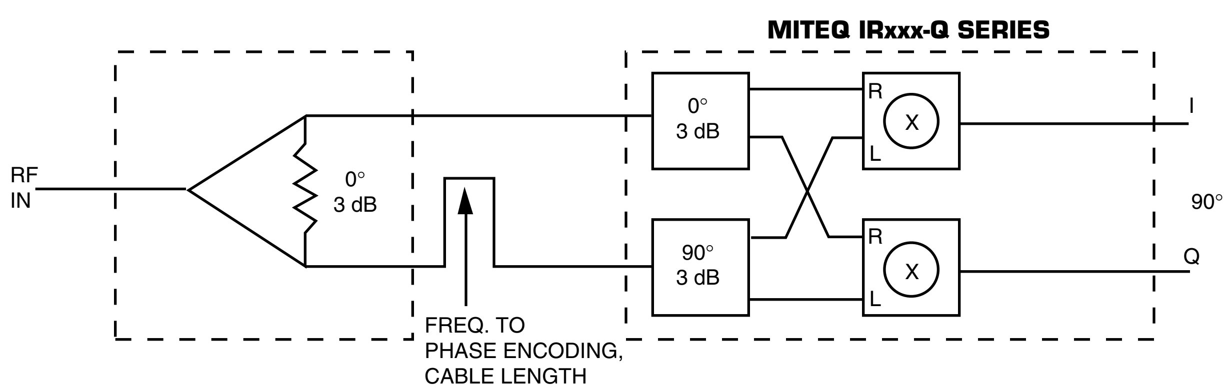
A6: The RF and LO input amplitude and phase are equal to the sum of the incident and reflected voltages at each port and thus are functions of the reflection coefficient of the mixer. Therefore, since the average impedance and reflection coefficient of a Schottky diode quad are power dependent, “round trip” reflections with a source mismatch will cause the indicated phase between the two signals to vary with power. MITEQ has recently applied for a patent on a phase detector circuit that has a low RF/LO VSWR that is independent of both input power and IF mismatch.

Q7: What precautions are necessary when using limiters prior to phase detection in order to increase dynamic range?

A7: The most important quality of the limiter is that the input-to-output transfer phase shift remain constant over the full input dynamic signal power range. Adequate filtering should also be used to eliminate harmonic energy from the limiter’s output (i.e., change square wave to sine wave).

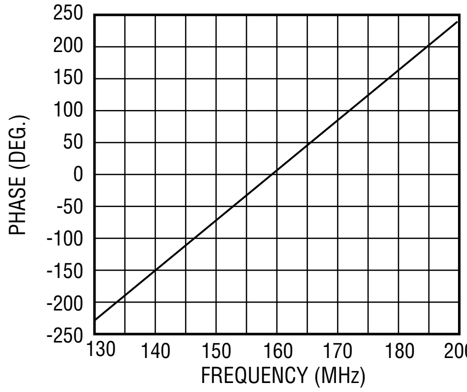
Q8: How is the accuracy of single-ended and I/Q phase detectors usually defined?

A8: Angular accuracy for a single I or Q phase detector (MITEQ PDL series) is defined as the maximum difference in degrees between the actual input phase and the phase calculated from the output voltages using the nominal phase detector function, i.e., V (out) = KCOS Ø (RF). The accuracy of each output is guaranteed for angles within 45° of zero crossover. When the phase detector has no input limiter, the measurement is made at the maximum input power. When the phase detector includes an input limiter, the accuracy is guaranteed if both input signal levels are within the dynamic range and if the difference between the two input signal levels is less than or equal to the differential dynamic range. In the case of paired I/Q phase detectors (MITEQ IQD and DPD series), the conventional accuracy definition requires accurately known input reference signals over the operating bandwidth or accuracy bandwidth. In addition, both I and Q outputs must be characterized ±45° on either side of each null point. An alternate and more practical accuracy test used at MITEQ is to calculate the phase angle via the inverse tangent of the ratio of Q/I output voltages and compare this to known input angle values from 0–360° over the operating (accuracy) bandwidth. A convenient method of generating accurately known input phase differences over the operating bandwidth is to divide the output of one generator into two paths having unequal cable lengths and, therefore, phase lengths, as shown below. One then adjusts the phase detector I/Q gains for equal outputs and the inverse tangent is plotted as shown.

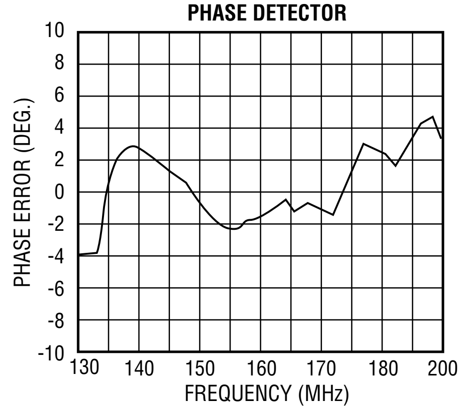


If the power division is done accurately with adequate attenuation, the unequal cable lengths will produce linearly varying phase cycles (0 to 360°) over the operating bandwidth. Greater cable length differences will produce more phase cycles over the accuracy bandwidth (this is also the principle of instantaneous frequency monitors). In any case, a plot of calculated output phase as a function of frequency should always yield a straight line if the I/Q detector is ideal. In actual practice, if the data is fitted to a best straight line, the variations would represent the unit phase errors (see data below for MITEQ IQD160).

TYPICAL I/Q OUTPUT PHASE OF MODEL IQD160A20C WHEN DRIVEN FROM POWER DIVIDER WITH UNEQUAL CABLE LENGTHS TO RF/LO PORTS



ENLARGED PHASE ERROR OF IQD160A20C PHASE DETECTOR



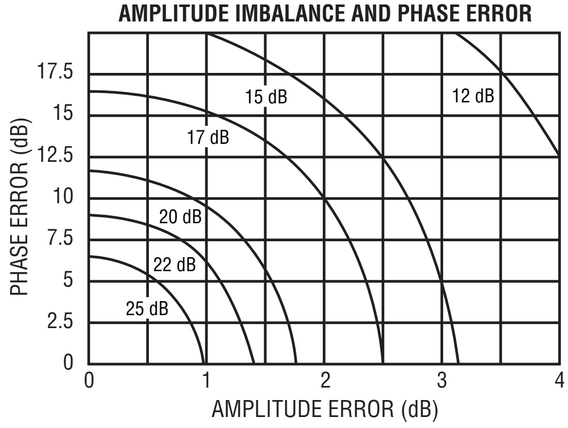
Q9: What is meant by accuracy bandwidth?

A9: The accuracy bandwidth is the range of center frequencies over which rated accuracy is maintained.

Q10: What is a simple accuracy measurement technique for I/Q phase detectors used to detect quadraphase modulation in communication receivers or whenever no DC component is required?

A10: In this application, the most important quality of the modulator and demodulator is maintaining isolation between the two orthogonal or quadrature channels of information so inter-symbol interference does not occur (the determination of actual phase angle is of lesser importance). The channel isolation is directly related to an image rejection measurement if one were to use a baseband 90° coupler at 0.5 MHz. This data is then easily swept and image rejection can be corrected equivalent to phase or amplitude error as desired. Reference the table below:

IMAGE REJECTION AS A PARAMETER OF AMPLITUDE IMBALANCE AND PHASE ERROR



REF. A. Kiiss, Image Rejection Mixers, Applied Microwave, Winter 1991/1992

Reprinted from APPLIED MICROWAVE & WIRELESS, WINTER '96. Author Donald Neuf, MITEQ, Inc., Hauppauge, NY.

Low-noise amplifiers (LNAs) are often used to increase receiver sensitivity, but their additional gain may drive the mixer into saturation earlier, reducing dynamic range. The author shows how MESFET image rejection mixers improve this situation.

GENERAL

Low-noise RF amplifiers (LNAs) are commonly used to improve the minimum detectable signal level of any receiver front end, not limited by antenna noise. However, their increased RF gain often causes most existing second-stage mixers to overload at high input signal levels, thus reducing dynamic range. As an alternate, MESFET image rejection mixers operate at the same local oscillator power as Schottky diode mixers, but provide typically 6 dB higher input RF 1 dB compression powers. Furthermore, these passive mixers have low phase-noise third-harmonic intermodulation products, which are ideal qualities for receivers that must detect signals near noise, while in the presence of multiple high level signals.

LNA-MIXER FRONT ENDS

One of the most common design challenges in radar, communication and spectral analysis receivers is to design the receiver to search for low-level RF signals in the presence of other, much higher-power level signals. The radar receiver must withstand large reflections from nearby objects, yet be sensitive to the reception of desired signals from distant targets 80 to 100 dB lower. The intermodulation between two local closely-spaced wireless communication signals must not interfere with the distant, much lower power user. The molecular resonant spectral lines of a radiated organic or material specimen must not be masked by the large excitation signal.

Most of these applications employ narrow bandwidths and, therefore, the principal undesired mixing product of the LNA or mixer is the multitone third order (i.e., $2RF_1–RF_2$ or $RF_1–2RF_2$). It is not possible to eliminate this interference by filtering because the causal and resulting spur frequencies converge upon each other in narrow bandwidth receivers.

A common receiver front end is illustrated in Figure 1. Definitions of frequently used terms are given in Appendix A. Our block diagram is more simplified than that of most actual systems so that certain basic design principles can be reviewed. We first notice that the input signal-to-noise ratio has been degraded by the appearance of IP^3 spurs from the amplifier and mixer. The concept SFDR (spur-free dynamic range) is commonly understood to mean the power difference (in dB) between the largest input signal and largest corresponding spur product above the noise.

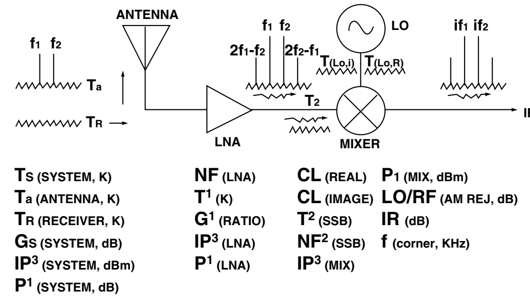


FIGURE 1

Receiver Front End Components

Noise levels in receiver components, including the antenna, are generally expressed as the equivalent temperature that an input resistive termination must be elevated (in K) to produce the same output noise as the component of interest.[1] Thus, an antenna facing the horizon (or ground) usually has a 290 K (25°C) noise temperature, whereas the space-directed antenna may experience less than 10 K, particularly at C- and X-band. This is an important consideration when choosing an LNA to upgrade the sensitivity of a receiver, because the overall system noise temperature is the sum of the antenna and receiver contributions.

The system improvement between a 35 K (0.5 dB noise figure) LNA versus a 75 K (1 dB noise figure) LNA would be marginal if 300 K antenna noise dominated the system. Conversely, for a very low antenna noise space receiving system, the distance improvement would be proportional to the square root of the old and new system noise temperatures (75/35) or 40 percent more range. LO source noise, occurring at the RF and image frequencies, is also included in the front-end model of Figure 1. Three other important basic aspects of LNA usage are:

- When the amplifier has gain at the image frequency response of the following mixer (2LO - RF), then additional noise will be converted to the output IF frequency. Thus, a 0.5 dB noise figure LNA would result in a 3.5 dB overall system noise figure. This problem is commonly avoided by using an image rejection mixer or image rejection filter at the output of the amplifier.

- High LNA gain will ensure best system noise figure, but dynamic range will be reduced, because at high input signal levels the output of the amplifier and/or mixer input will saturate. Likewise, two-tone IP^3 spur products will increase. The advantages of the high-level MESFET mixers will be discussed relative to this problem.

- Another alternative design strategy for higher dynamic range is to use a lower noise figure mixer, rather than an LNA. For this application, the high level Schottky diode image rejection and recovery mixers described may offer the best solution, particularly when the antenna noise is high.

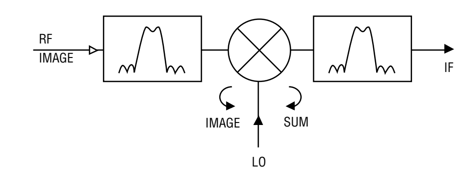
NEW IMAGE-RECOVERY MIXER CIRCUITS

The dynamic range of any mixer is determined by the difference between its conversion loss (or noise figure) at low signal levels and its input intercept power IP^3 (or 1 dB compression) at high signal levels. For wide RF/IF bandwidth applications, the maximum signal level, may also be limited by other single-tone (M x N) intermodulation products. For our discussion, however, only narrow bandwidth usage is considered, for which the two or multitone IP^3 is the dominate contributor. The maximum input RF signal is also limited by the available LO power.

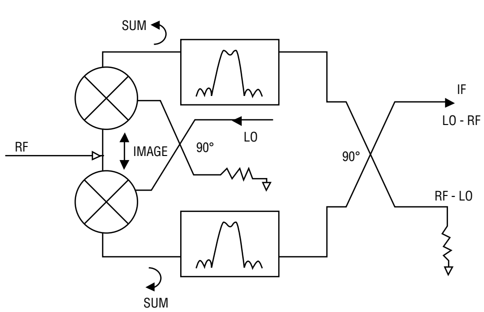
Thus, the mixer designer seeks to achieve lowest conversion loss and highest IP^3 with the least LO power. In general, the lowest conversion loss mixers currently use Schottky diodes to switch or multiply the LO and RF, while the highest IP^3 mixers use MESFET semiconductors. We will now briefly review recent test results achieved with each type of mixer.

3.5 DB CONVERSION LOSS SCHOTTKY DIODE MIXER

Image recovery mixers can be made using filter structures or hybrid circuits dependent upon the IF frequency, Figure 2. In each case, the internal mixer image energy is reflected or directed back into the mixer and converted to the IF frequency. External image signals, however, are reflected or absorbed in resistive terminations.



a. Reflective Filters (High IF Frequency)



b. Hybrid/Filter (Low IF Frequency)

FIGURE 2

Image Recovery (and Rejection) Mixer Circuits

The performance of a 4.5 dB conversion loss hybrid, 5.4 GHz image recovery circuit with a 30 MHz IF is shown in Figure 3.[2] The RF 1 dB compression point of this mixer is 0 dBm. More recently we have made a filter type image recovery mixer circuit for a narrow band receiver at 3.25 GHz with a 500 MHz IF. The unusual feature of this design is that the RF balun also acts as a low-loss, two-pole reflective image filter. Figure 4 shows the conversion loss of this mixer and the RF input response. High level diodes were used in this design which required +16 dBm LO power in order to maintain a +13 dBm RF 1 dB compression power. Two further advantages of this design are unusually high LO-to-RF isolation for AM noise rejection and the use of low 1/f noise diodes for low phase noise.

IF	**20 to 40 MHz**
RF/LO	**5.4 to 5.9 GHz**
Conversion loss	**4.5 dB**
Input IP^3	**+8 dBm**
LO VSWR	**1.5:1**
LO power	**+7 dBm**

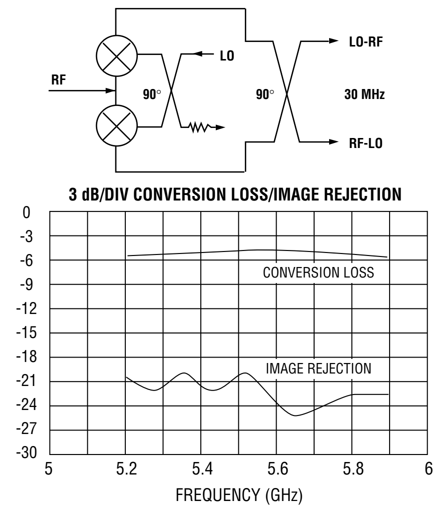


FIGURE 3

Hybrid Image Recovery Schottky Diode Mixer

Conversion loss	**3.5 dB**
RF (10% BW)	**3 to 3.3 GHz**
IF	**500 ±100 MHz**
Input IP^3	**+23 dBm**
LO power	**+17 dBm**
LO-to-RF isolation	**40 dB**
Phase noise at 10 kHz	**-165 dBc/Hz**

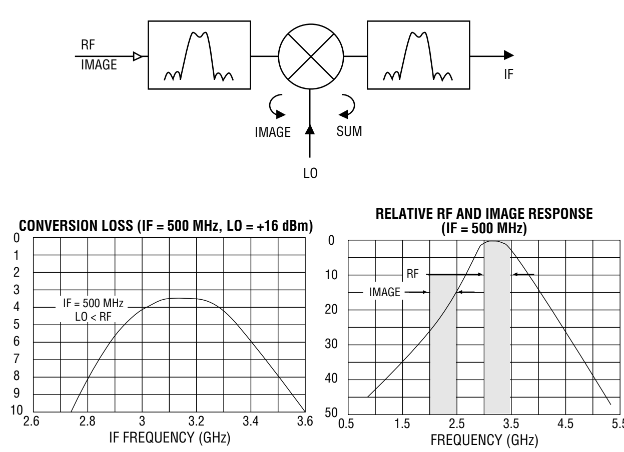


FIGURE 4

Filter/Balun Type Image Recovery Schottky Mixer

IMAGE REJECTION MIXER PRODUCTS

HIGH COMPRESSION (1/2 WATT) MESFET MIXERS

MESFET mixers evolved from the higher power characteristics of these semiconductors when used in switch applications. A very small amount of gate power controls a much larger power transfer between source and drain. Mass recognized that the odd symmetry of the drain/source E/I characteristics yields low third-order distortion.[3] Other workers utilized these characteristics to realize wide band +30 dBm (IP^3) mixers up to 8 GHz using +20 dBm LO power.[4] In general, greater LO (or gate) powers are needed for MESFETs in the mixer mode relative to the switch mode, because of the faster rates of charging and discharging the gate to source capacitance.

Recently we have extended the RF input 1 dB compression of X-band MESFET mixers to +26 dBm, respectively, using +25 dBm LO power. Double-balanced MESFET image rejection mixers were also built in the 1.8 GHz PCN band with +40 dBm (1 watt) IP^3 and an input RF compression level of +30 dBm (that is, ±10 volts peak across 50 ohms!). Most important is the fact that MESFET mixers are not necessarily restricted to high LO powers, but rather exhibit (with bias) high ratios of IP^3 to LO power in the same LO power range as Schottky mixers, thus making dynamic range retrofits feasible without changing LO power.

The performance of a 5.5 GHz image rejection mixer at various LO powers is illustrated in Figure 5. Note that a similar LO power Schottky mixer would compress at +7 dBm RF, whereas this unit handles +13 dBm RF, making it an ideal substitute when an LNA is used in front of the mixer. The following design problems and solution options illustrate both the former system design theory and the newly-designed mixer circuits in practical applications.

RF/LO	5.4 to 5.9 GHz
IF	20 to 40 MHz
Conversion loss	7.5 dB
Input IP^3	+23 dBm
LO power	+10 dBm
RF 1 dB comp.	+13 dBm

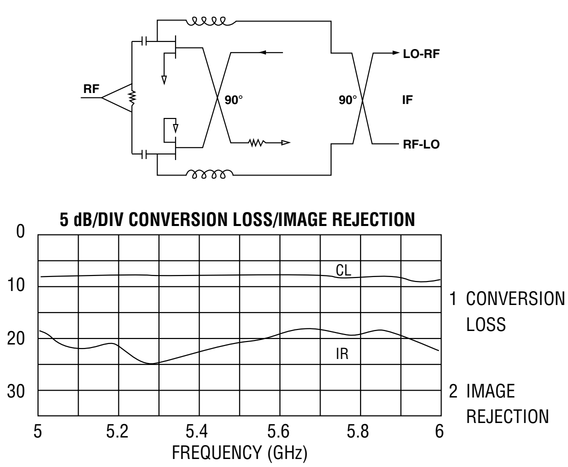


FIGURE 5

C-Band, High Power, MESFET Image Rejection Mixer

LOW-COST UPGRADE OF A COMMUNICATION RECEIVER

An existing ground communication receiver with an 8 dB single-sideband (SSB) noise figure is to be modified for a new application requiring 1.4:1 greater distance coverage. What modification options are possible, assuming that the same transmitter power, antennas and local oscillator are used? The receiving antenna has approximately 300 K of background noise (Figure 6).

Option 1: Replace the existing mixer with a 3.5 dB conversion loss Schottky diode image recovery version of the filter or hybrid type, as discussed previously. This approach maintains the same maximum input signal level, but improves minimum detectable signal without the expense of an LNA.

Option 2: A 2 dB noise figure low-noise amplifier also will achieve the required additional system sensitivity, but the full noise benefit of this amplifier is not realized because the existing receiving mixer has no image rejection. The increased system gain will, of course, restrict the maximum signal input by the same amount.

ORIGINAL SYSTEM

$T_S = T_A = T_R$
$= 300 + 1539$
$= 1839$ K
P1(s) = P1 (MIX) = +5 dBm

OPTION 1: REPLACE MIXER WITH LOW-LOSS IMAGE RECOVERY

$T_S = 300 + 627 = 927$ K
P2(s) = +5 dBm
Range Improvement $= \sqrt{\frac{1839}{927}} = 40\%$

OPTION 2: ADD 20 dB GAIN, 2 dB NOISE FIGURE LNA BEFORE EXISTING NON-IMAGE-REJECTION MIXER

$T_S = 600 + 353 = 953$ K (SSB)
P2(s) = +5 dBm -20 = -15 dBm
Range Improvement $= \sqrt{\frac{1839}{953}} = 40\%$

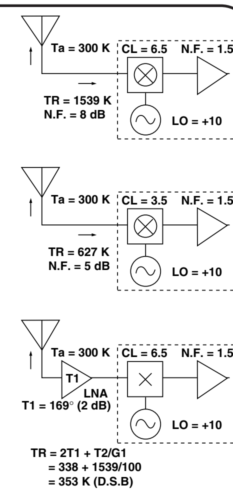


FIGURE 6

Front-End Upgrade

RADAR RANGE UPGRADE WITH EXISTING LO

Upgrade the dynamic range and sensitivity of a C-band radar receiver by utilizing an LNA and new higher power image rejection mixer with the existing LO source. It is desirable to handle a 0 dBm maximum RF input signal level.

Solution: The performance limits of a 4 to 8 GHz LNA, and the resulting front-end noise figure/1 dB compression limits when this LNA is combined with a MESFET or Schottky second-stage image rejection mixer having 6 dB conversion loss, are shown in Figure 7.[5] We first notice that the LNA noise figure, gain and output compression power are constrained to fall within a performance region defined by the circuit design and semiconductors used. Furthermore, if the image rejection mixer input power is set equal to the output power of the LNA, the overall system dynamic range can be approximated by the difference in 1 dB compression power and noise figure shown.

Most important, in order to maintain the assumed mixer input and amplifier output compression relation, we must supply adequate LO power. As already noted, herein lies the advantage of MESFET mixers. The required MESFET LO power is shown at several points on the curve of dynamic range (Figure 7), with the greater required Schottky diode mixer power also shown (in parenthesis). It can be seen from the curve that in order to maintain the desired 0 dBm input compression level, a +15 dBm LO would be required.

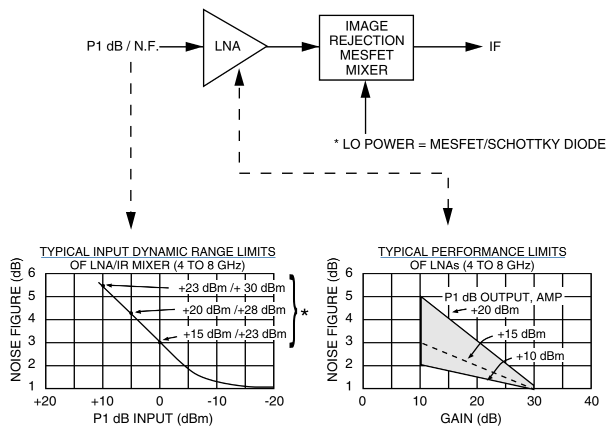


FIGURE 7

LO Power Required to Achieve Various Front Input Noise Figures and Compression Levels, MESFET or Schottky Diode Image Rejection Mixers

The best compression (-2 dBm) obtainable with the existing LO and choice of LNA is shown in Figure 8.

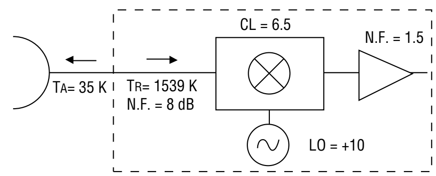
MIXER PERFORMANCE WITH A NOISY LO SOURCE

What local oscillator characteristics are desirable to avoid degrading the noise figure of a wide dynamic range MESFET mixer, particularly when low video IF information is processed?

In general, one must first be mindful of the type of modulation used for the received information (i.e., AM or PM). Amplitude and phase-time variations of the local oscillator are commonly represented in the frequency domain as a pure tone with pairs of sidebands spaced by the rate of unwanted LO modulation, including noise.

AM noise sidebands that are spaced by the system IF frequency above and below the local oscillator are particularly troublesome, because they cause additive input noise that will enter the mixer via the LO port and self-mix with the LO in the mixer and appear at the IF frequency. Fortunately, most balanced mixers reject additive AM noise applied at the LO port. The rejection of this noise is dependent upon the decoupling or LO-to-RF isolation of the mixer used and can vary from -20 to -45 dB. Ideally, one would want to choose a local oscillator source with mixer-rejected spectral noise-density sidebands at the RF and image frequencies that are lower than that of the mixer's own thermal AM noise. Double-balanced mixers having high LO-to-RF isolation are particularly desirable for highest AM noise rejection. Additive LO AM noise sidebands at the RF and image frequencies also can be reduced with a bandpass filter, provided that the IF frequency is 10 percent or more of the LO frequency.

EXISTING FRONT END



Ts = TA = TR

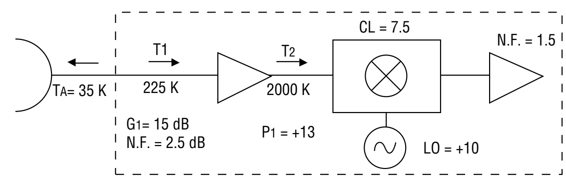
$\boxed{T_S = 35 + 1539}$

$= 1574$ K

$P_1(s) = P_1$ (MIX) $= +5$ dBm

$\boxed{IP^3(s) = +15 \text{ dBm}}$

NEW FRONT END



Ts = TA = TR

$\boxed{T_S = 35 + 289 = 325^\circ}$

$T_R = 225 + 2000/31 = 289^\circ$

$P_1(s) = P_1(MIX)/G_1 = -2$dBm

$\boxed{IP^3(s) = +8 \text{ dBm}}$

(Note: $IP^3(s)$ for Schottky Mixer = 0 dBm)

Range Improvement = $1/4\sqrt{\frac{T_S \text{ (old)}}{T_S \text{ (new)}}} = 1/4\sqrt{\frac{1539}{325}} = 1.5$ (50 % more Distance)

FIGURE 8

Radar Upgrade Using LNA/MESFET Mixer and Existing LO

The higher level (1/f) closely spaced AM noise sidebands of the local oscillator usually represent low frequency amplitude (product) modulation of the LO, which will also modulate the IF output frequency of the mixer, but the level is proportionally very low. The 1/f noise is far more deleterious when the mixer IF frequency is also low, such as for Doppler applications.

In this case, the sidebands are equal to the RF and image and will act as additive signals, as described previously. Most direct LO oscillator sources without an amplifier have considerably less AM noise than PM, because the active feedback device usually operates in a compressed or amplitude limited state. However, the mixer isolation should continue to reject AM 1/f noise when the intermediate frequency is also low.

PM noise of the local oscillator, however, will be translated directly by the mixer to the IF frequency. LO power amplifiers can add low-frequency (product) modulation or signal level-independent phase noise, as well as (additive) level dependent higher frequency RF and image phase noise when the noise figure and gain are high. The intersection of the rapidly decreasing lower frequency product noise and the flatter spectrum additive noise is known as the corner frequency. Additive PM (and AM) noise from the flat thermal spectrum of the amplifier can be minimized by filtering or using a larger input signal power with a lower gain and noise figure amplifier. This conclusion arises from Parker's PM and AM noise model for amplifiers.[6]

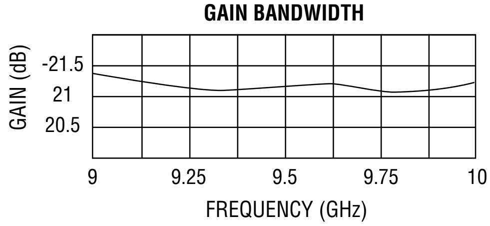
$$S_0(f) = S_A(f) = \propto_E 1/f + 2KTFG(f)/P_0$$

The 1/f product noise is, however, unaffected by the signal level. Figure 9 shows the PM noise of a high-power (+27 dBm) amplifier that we built, which is usable with very high-level MESFET mixers in phase-noise sensitive applications.

SUMMARY

In general, a good system design principle is to have all components stressed to the same degree both in terms of their cost and performance contribution to the overall task. This usually results in greatest economies (the Henry Ford design rule).[7] In the case of receiver design, we have reviewed how high antenna noise can spoil the advantages of an expensive low-noise amplifier and make a low conversion-loss Schottky mixer more practical. In addition, an improperly chosen mixer following a high gain LNA can limit the overall system dynamic range. Furthermore, the extra cost of a higher power LO needed to raise the IP^3 of a Schottky diode mixer may be wasted relative to the choice of newer, more power efficient, MESFET mixers. Finally, for many crowded communication receivers, the lower limit of dynamic range is not thermal LNA amplifier noise, but rather the single- or multitone-spur products of the second-stage mixer. Thus, for many receiver designs, the choice of mixer semiconductors (Schottky or MESFET) is highly dependent on the cost and power levels of the surrounding components.

RF .... **9 to 10 GHz**
Gain .... **20 dB**
Noise figure .... **5 dB**
P1 dB output .... **+27 dBm**
Phase noise (Δ = 1 kHz) .... **-150 dBc**



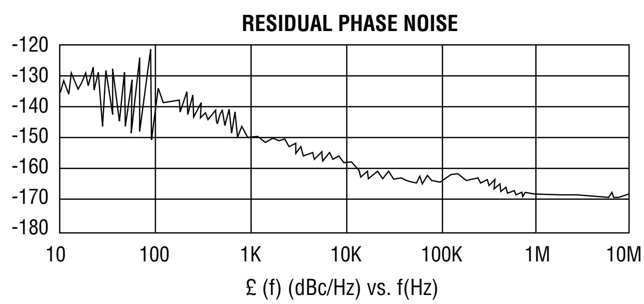


FIGURE 9

High Output Power, Ultra-low Phase Noise LO Amplifier

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Donald Neuf attended the RCA Institutes and received the BSEE degree from the Hofstra University and the MSEE degree from the Polytechnic Institute of New York. He was a consultant to the Jet Propulsion Laboratory in Pasadena, California, before joining RHG/M/A-COM as Director of Microwave Engineering. Later he joined MITEQ Inc. as the Department Head for Special Mixer Products. Mr. Neuf has published 30 technical articles and has been granted 6 patents. He is a member of the IEEE Microwave Theory and Techniques Society and has performed as a member of the Technical Program Committee for the 1991 Symposium and a Steering Committee member for the 1988 Symposium.

APPENDIX A – DEFINITION OF MIXER TERMS

TS = System equivalent noise temperature (K) = (TA + TR).

TA = Equivalent antenna ground or sky noise (K) include image when not rejected.

TR = Overall SSB receiver equivalent noise (K) = (T1 + T2/G1) with image rejection, = (2T1 + T2/G1) without image rejection DSB.

T1 = Equivalent LNA input noise temperature (K) = (N.F. – 1) To where N.F. is power ratio.

T2 = Equivalent mixer SSB input noise temperature (K) (CL-1) To + LO/RF (Rej.) {T(LO, I) + T (LO, R)}.

T (LO, I) = Equivalent noise temperature (K) of additive local oscillator noise spectral density (dBm/Hz) at image frequency. For example, when an LO amplifier is used after an ideal noiseless oscillator, then T (LO, I) = {To + T (Amp)}G.

T (LO, R) = Equivalent noise temperature (K) of additive local oscillator noise at RF frequency. In theory, the AM portion of this noise and T(LO, I) will both be suppressed by the mixer small signal or common mode LO-to-RF isolation LO/RF (Rej).

G1 = LNA gain (ratio = 10 exp (gain dB/10)).

CL = Mixer loss (power ratio) between desired RF and IF signals (i.e., 6 dB = 4).

P1(S) = Input system 1 dB gain compression power (dBm) (i.e., use the minimum quantity P1 (LNA)/G1 or P1 (MIX)/G1.

P1 (MIX) = Mixer input RF power that causes 1 dB decrease in IF output. This is highly dependent on LO power used and whether Schottky diode or MESFET semiconductors are used.

IP^3 (LNA) = Amplifier output power (each f1 or f2 tone) that will cause interfering product ($2f_1$-f_2) or (f_1-$2F_2$) to be equal in power to f_1 or f_2 tone (i.e., intercept output power of linear gain and nonlinear third-order product lines). In general, the third-order output products decrease by 3 dB for every 1 dB reduction of input signal power. Therefore, the relative difference (in dB) or dynamic range between the signal and spur powers is 2 (IP^3 - P(IN)G).

IP^3 (MIX) = IP^3 (MIX input) + CL = mixer IP^3 is traditionally specified at the input since this is the larger power due to conversion loss but, most system IP^3 calculations are based upon the output contribution of each component.

IP^3 (S) = System output third order 1/{1/IP3(LNA) + G (LNA)/IP^3(MIX)}. Assuming worst case phase coherency between each tone (Ref. P. 395, Microwave Receivers, Etc., NTIS PB84-108711).

IMAGE REJECTION MIXER ORDERING INFORMATION

MODEL NUMBER	LO POWER DESIGNATION (*)	IF FREQUENCY OPTION (**)	AVAILABLE OPTIONS
IR0502(*)C1(**)	L, M, H	A, B, C, Q	
IR0102(*)C1(**)	L, M, H	A, B, C, Q	
IR0104(*)C1(**)	L, M, H	A, B, C, Q	
IRM0204(*)C2(**)	L, M, H	A, B, C, Q	
IRM0208(*)C2(**)	L, M, H	A, B, C, Q	
IRM0408(*)C2(**)	L, M, H	A, B, C, Q	
IR0708LI3Q	-	-	
IRM0812(*)C2(**)	L, M, H	A, B, C, Q	
IRM0118(*)C1(**)	L, M, H	A, B, C, Q	
IRM0618(*)C2(**)	L, M, H	A, B, C, Q	
IRM0218(*)C1(**)	L, M, H	A, B, C, Q	
IRM1218(*)C2(**)	L, M, H	A, B, C, Q	
IRM0226(*)C1(**)	L, M, H	A, B, C, Q	
IR1826NI7(**)	-	A, B, C, Q	
IR2640NI7(**)	-	A, B, C, Q	
IRJ085095U(**)	-	30A, 60A,120A, 150A	
IRJ085095L120A	-	-	
IRE0208(*)I1(**)	L, H	A, B, C	
IRE0618(*)I1(**)	L, H	A, B, C	
IRB0218LC1(**)	-	A, B, C	
IQM16020	-	-	
IQD16020	-	-	
IQDD16020	-	-	
IRBA0226LC1(**)	-	A, B, C	
IRA0226LC1(**)	-	A, B, C	
IRA5459LR1(**)	-	A, B, C	
IRA8596LR1(**)	-	A, B, C	
ARM0204LC2(**)	-	A, B, C	
ARM0208LC2(**)	-	A, B, C	
ARM0408LC2(**)	-	A, B, C	
ARL5359LC2(**)	-	A, B, C	
ARM0812LC2(**)	-	A, B, C	
ARM0618LC2(**)	-	A, B, C	
ARM1218LC2(**)	-	A, B, C	
AR1826LI8(**)	-	A, B, C	
ARZ0227	-	-	
ARZ9910N01R	-	-	
SBWA3435N01R(**)	-	A, B, C	
AR1314N01R	-	-	
SYSMM(***)X3022	-	-	Contact Factory
SYSMM(***)X3436	-	-	Contact Factory
SYSMM(***)X3638	-	-	Contact Factory
SYSMM(***)X4345	-	-	Contact Factory