PE4152

Document Category: Product Specification

UltraCMOS® Quad MOSFET Mixer

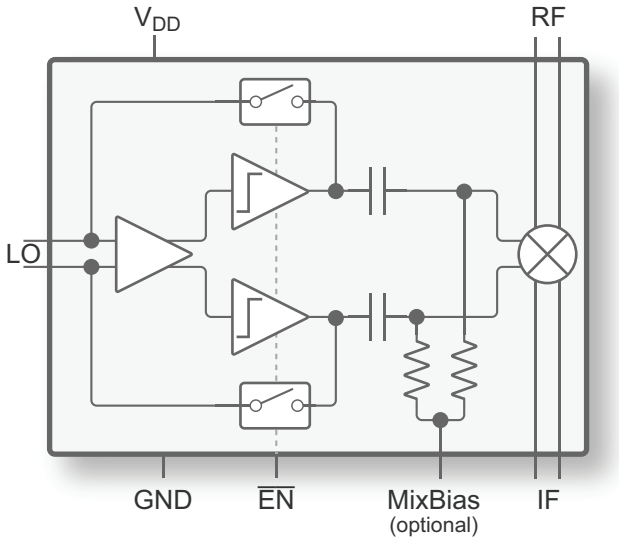
Features

- Quad MOSFET array with integrated LO enable and bypass mode
- Ultra-high linearity in both LO modes:
  - LO enable: 25 dBm IIP3, 52 dBm IIP2
  - LO bypass: 24 dBm IIP3, 46 dBm IIP2
- High isolation in both LO modes:
  - LO enable: 30/30 dB LO–RF/IF
  - LO bypass: 60/58 dB LO–RF/IF
- Low conversion loss in both LO modes
- Packaging: 20-lead 4 × 4 × 0.85 mm QFN

Applications

- Land-mobile-radio (LMR):
  - Portable radio
  - Mobile radio
- Cellular infrastructure
- Set-top box (STB)/CATV systems

Figure 1 • PE4152 functional diagram



Product description

The PE4152 is a high linearity quad metal-oxide-semiconductor field-effect transistor (MOSFET) mixer with an integrated local oscillator (LO) amplifier. The LO amplifier allows for LO input drive levels of less than 0 dBm to produce third-order intercept point (IIP3) values similar to a quad MOSFET array driven with a 15 dBm LO drive. The PE4152 operates with differential signals at the radio frequency (RF) and intermediate frequency (IF) ports and the integrated LO buffer amplifier drives the mixer core. It can be used as an upconverter or a downconverter.

The PE4152 also offers an integrated LO amplifier bypass option, providing additional flexibility for low power or increased linearity operation. The bypassed LO amplifier allows superior LO-to-RF and LO-to-IF isolation levels relative to the enabled mode.

The PE4152 is manufactured on pSemi's UltraCMOS® process, a patented variation of silicon-on-insulator (SOI) technology on a sapphire substrate, offering the performance of GaAs with the economy and integration of conventional CMOS.

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Absolute maximum ratings

Exceeding the absolute maximum ratings listed in **Table 1** could cause permanent damage. Restrict operation to the limits in **Table 2**. Operation between the operating range maximum and the absolute maximum for extended periods could reduce reliability.

ESD precautions

When handling this UltraCMOS device, observe the same precautions as with any other ESD-sensitive devices. Although this device contains circuitry to protect it from damage due to ESD, do not exceed the rating specified in **Table 1**.

Latch-up immunity

Unlike conventional CMOS devices, UltraCMOS devices are immune to latch-up.

Table 1 • PE4152 absolute maximum ratings

Parameter or condition	Min	Max	Unit
Supply voltage, V_{DD}	–	4.0	V
Maximum DC plus peak AC across drain-source	–	±3.3	V
Maximum DC current across drain-source	–	6	mA
Maximum AC current across drain-source	–	36	mA_{P-P}
Storage temperature range	–65	+150	°C
Operating junction temperature	–	+125	°C
ESD voltage HBM, all pins(*)	–	1000	V
Note: * Human body model (MIL-STD 883 Method 3015).			

Recommended operating conditions

Table 2 lists the PE4152 recommended operating conditions. Do not operate devices outside the recommended operating conditions listed below.

Table 2 • PE4152 recommended operating conditions

Parameter	Min	Typ	Max	Unit
Supply voltage, V_{DD}	2.9	–	3.1	V
Operating temperature range	–40	–	+85	°C
LO input power (LO enable)	–10	–	–6	dBm
LO input power (LO bypass)	–	–	23	dBm
RF input power (LO enable)	–	–	2	dBm
RF input power (LO bypass)	–	–	2	dBm

Electrical specifications

Table 3 and **Table 4** list the PE4152 key electrical specifications at +25 °C and V_{DD} = 3.0V, unless otherwise specified.

Table 3 • PE4152 electrical specifications for LO enable mode

Parameter	Condition	Min	Typ	Max	Unit
Current drain	A function of frequency	–	9.5	16	mA
Off state leakage current	–	–	–	20	µA
RF input frequency	VHF band UHF1 band UHF2 band 700 MHz 800 MHz 900 MHz	136 380 450 764 851 935	–	174 470 520 776 870 941	MHz
LO frequency	VHF band UHF1 band UHF2 band 700 MHz 800 MHz 900 MHz	245.65 270.35 340.35 873.65 741.35 825.35	–	283.65 360.35 410.35 885.65 760.35 831.35	MHz
IF output frequency	–	–	109.65	–	MHz
LO input power	–	–10	–	–6	dBm
RF input power	–	–	–	2	dBm
Conversion loss(1)	VHF, UHF1, UHF2 700, 800, and 900 MHz	–	6.5 7.3	7.0 8.25	dB
Input IP3(2)	–	20.5	25	–	dBm
Input IP2(3)	VHF, UHF1, UHF2 700, 800, and 900 MHz	45 40	52 50	–	dBm
RF-to-IF isolation(4)	VHF, UHF1, UHF2 700, 800, and 900 MHz	35 35	45 45	–	dB
LO-to-IF isolation	–	18.5	22	–	dB
LO-to-RF isolation	–	26	30	–	dB

Notes:
1) Measured with a 1:1 balun on the RF and IF ports.
2) Measured with two tones at 2 dBm, 100 kHz spacing.
3) Measured with half-IF method.
4) Measured with an input frequency equal to IF.

Table 4 • PE4152 electrical specifications for LO bypass mode

Parameter	Condition	Min	Typ	Max	Unit
Off state leakage current	–	–	20	–	µA
RF input frequency	VHF band UHF1 band UHF2 band 700 MHz 800 MHz 900 MHz	136 380 450 764 851 935	–	174 470 520 776 870 941	MHz
LO frequency	VHF band UHF1 band UHF2 band 700 MHz 800 MHz 900 MHz	245.65 270.35 340.35 873.65 741.35 825.35	–	283.65 360.35 410.35 885.65 760.35 831.35	MHz
IF output frequency	–	–	109.65	–	MHz
LO input power	–	–	–	23	dBm
RF input power	–	–	–	2	dBm
Conversion loss(1)	VHF, UHF1, UHF2 700, 800, and 900 MHz	–	6.5 7.5	8.0 8.7	dB
Input IP3(2)	VHF, UHF1, UHF2 700, 800, and 900 MHz	24 19	26 24	–	dBm
Input IP2(3)	VHF, UHF1, UHF2 700, 800, and 900 MHz	–	46 46	–	dBm
RF-to-IF isolation(4)	VHF, UHF1, UHF2 700, 800, and 900 MHz	–	38 38	–	dB
LO-to-IF isolation	–	30	58	–	dB
LO-to-RF isolation	–	35	60	–	dB

Notes:
1) Measured with a 1:1 balun on the RF and IF ports.
2) Measured with two tones at 2 dBm, 100 kHz spacing.
3) Measured with half-IF method.
4) Measured with an input frequency equal to IF.

Typical performance data

Figure 2–Figure 23 show the typical performance data at +25 °C and V_{DD} = 3.0V, unless otherwise specified.

Figure 2 • Conversion loss vs. LO power (LO enable)

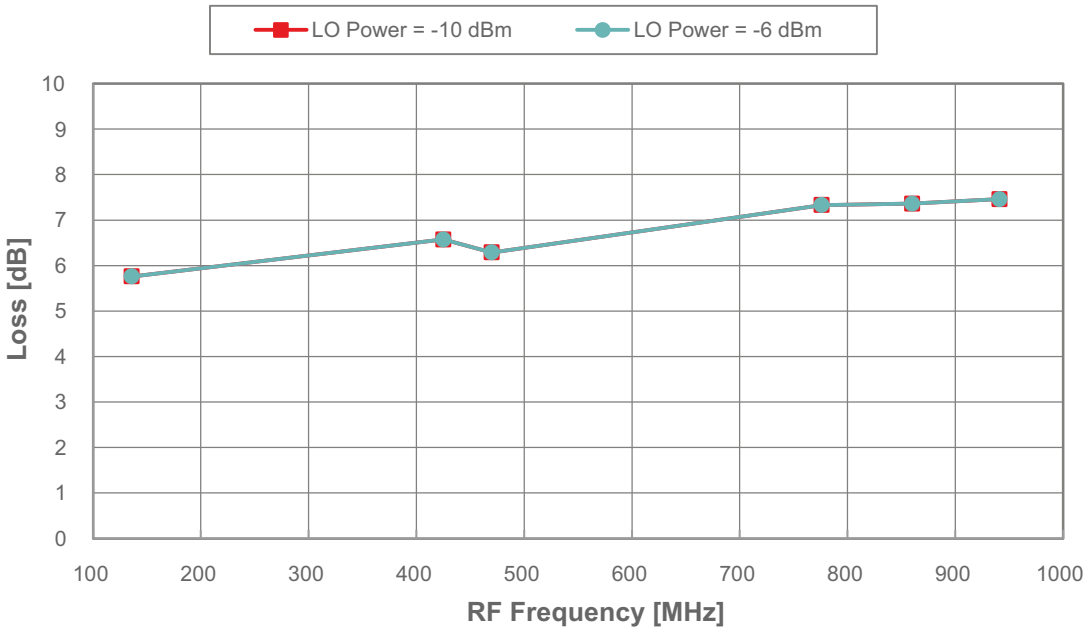


Figure 3 • Conversion loss vs. V_{DD} (LO enable)

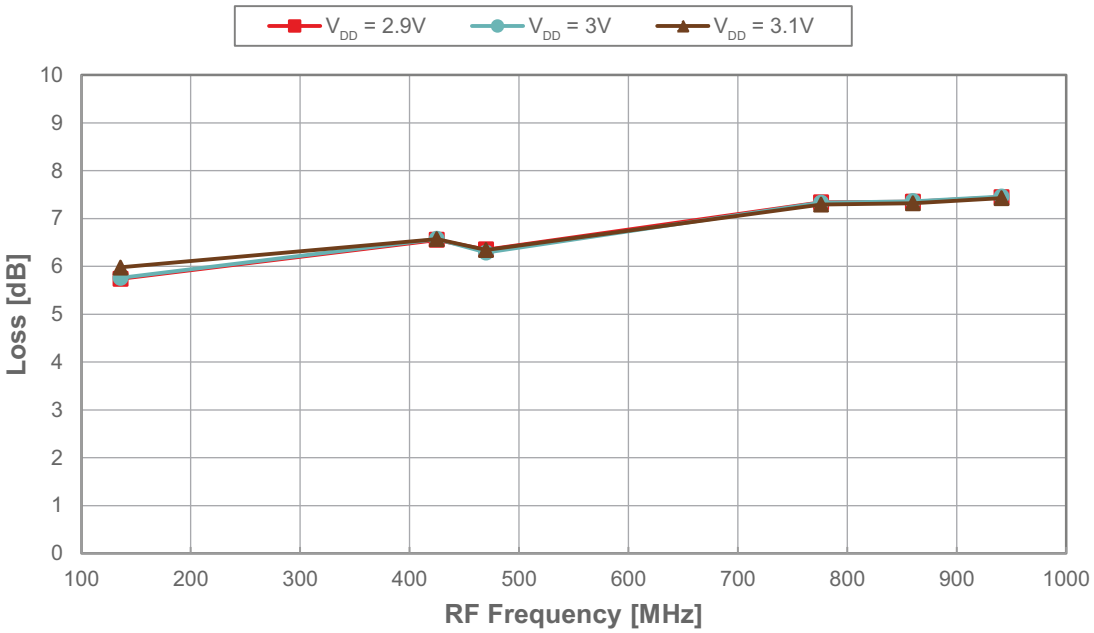


Figure 4 • Conversion loss vs. temperature (LO enable)

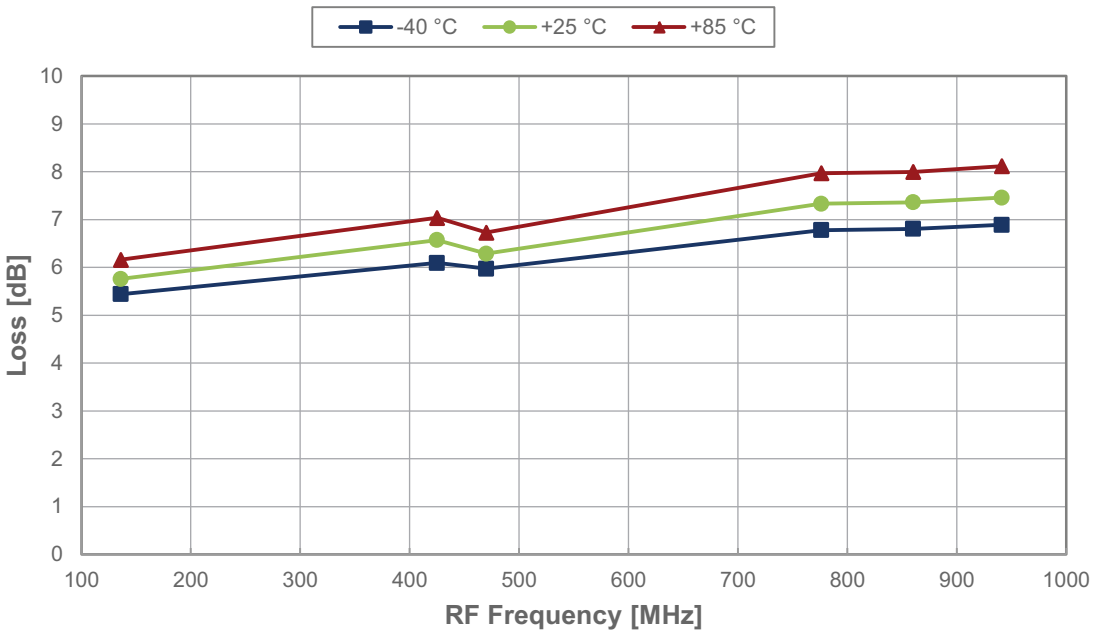


Figure 5 • Conversion loss vs. LO power (LO bypass enable)

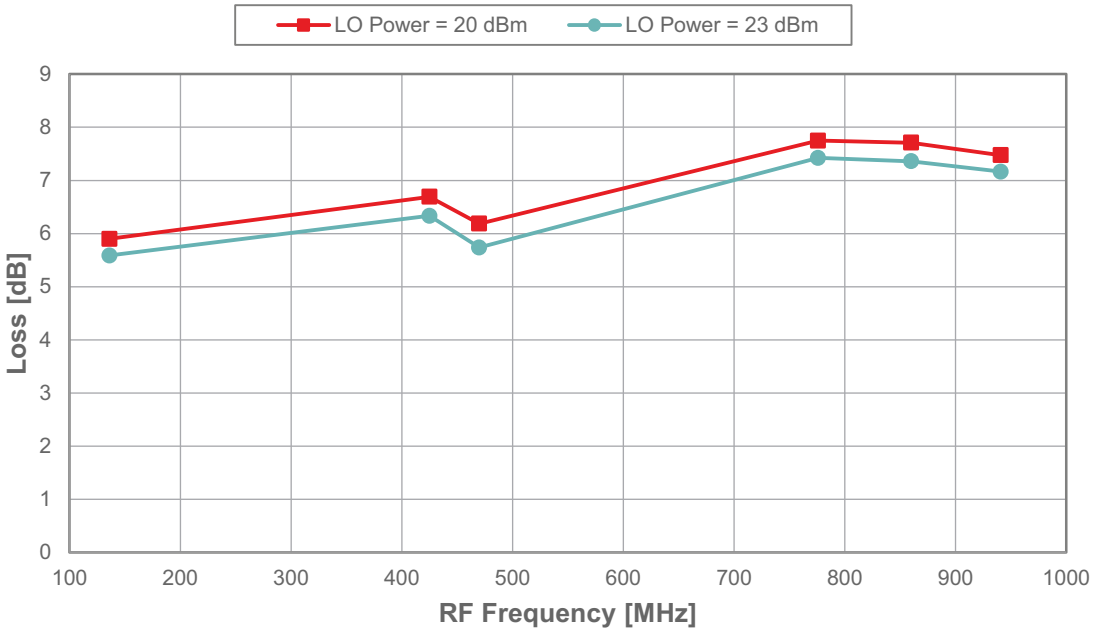


Figure 6 • Conversion loss vs. V_{DD} (LO bypass enable)

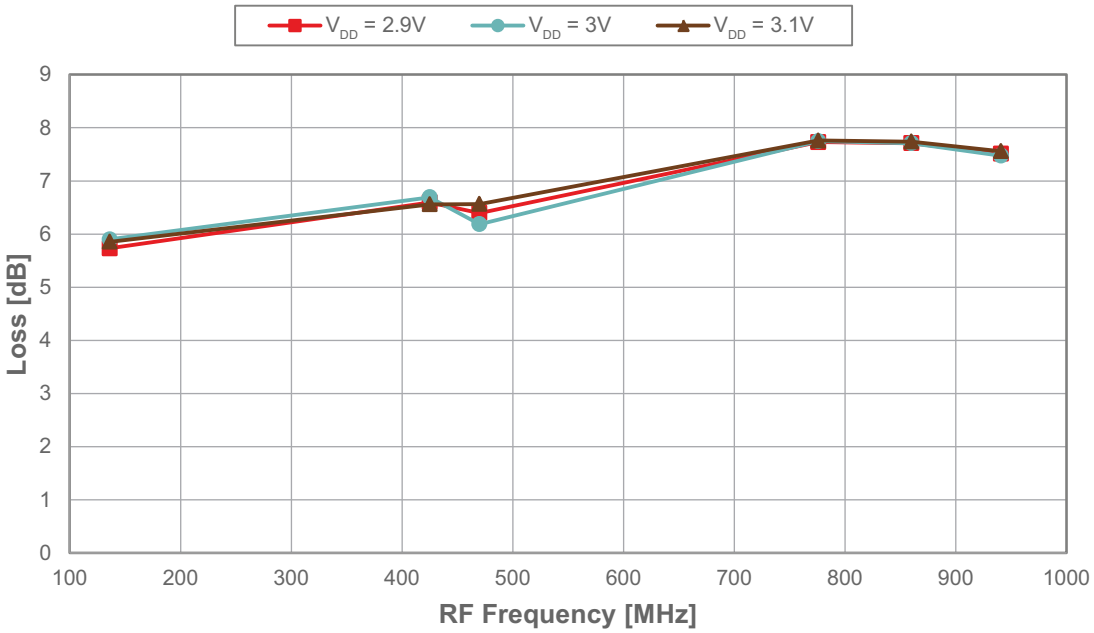


Figure 7 • Conversion loss vs. temperature (LO bypass enable)

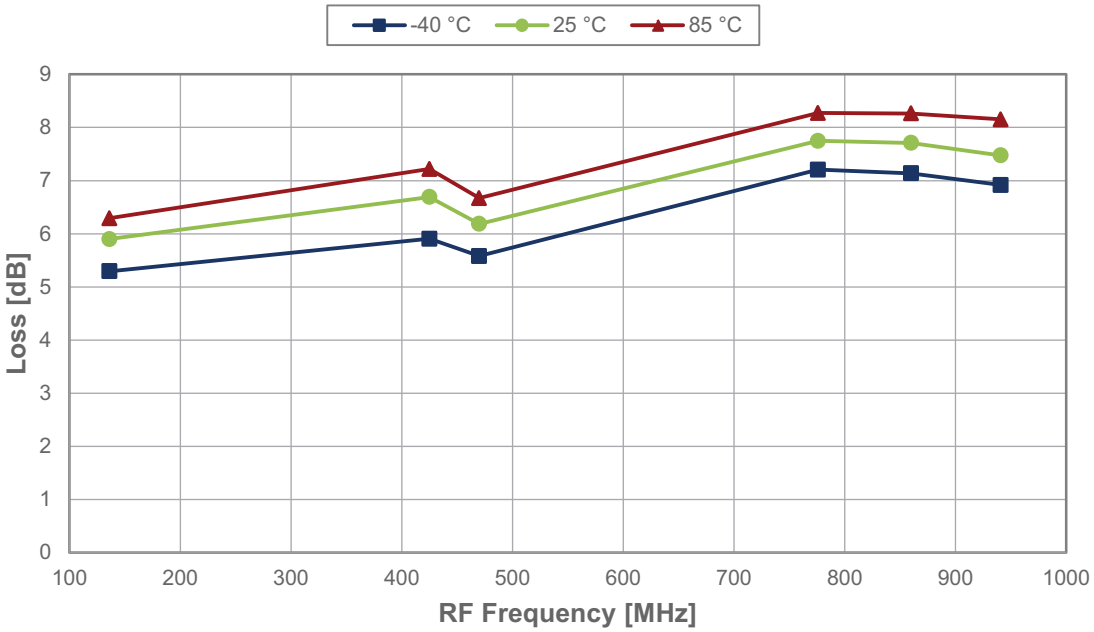


Figure 8 • IIP2/IIP3 vs. LO power (LO bypass)

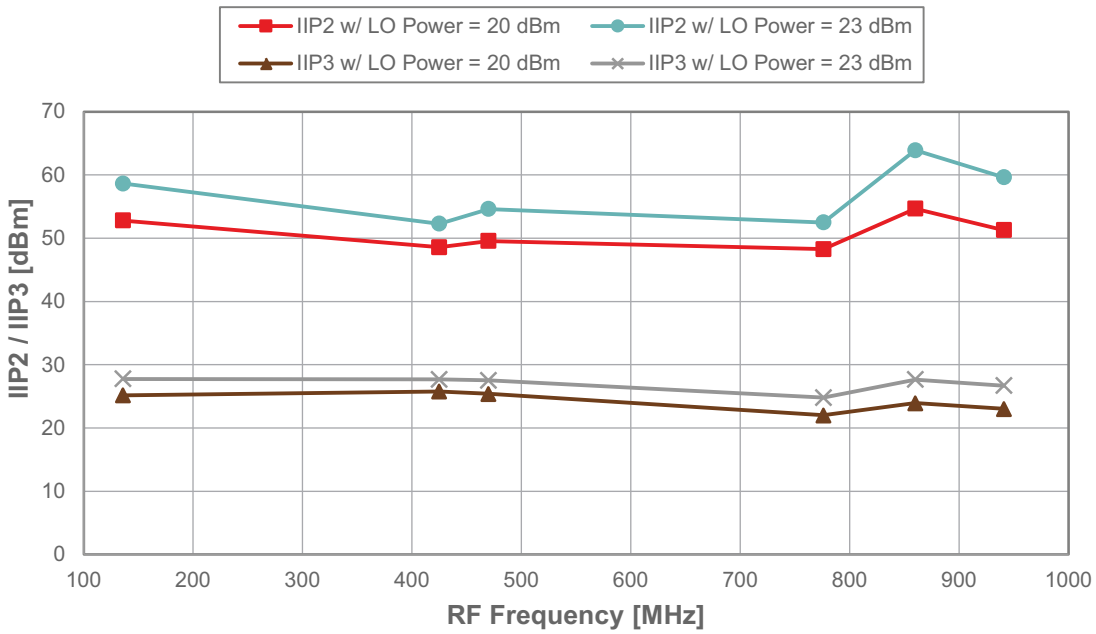


Figure 9 • IIP2/IIP3 vs. temperature (LO bypass)

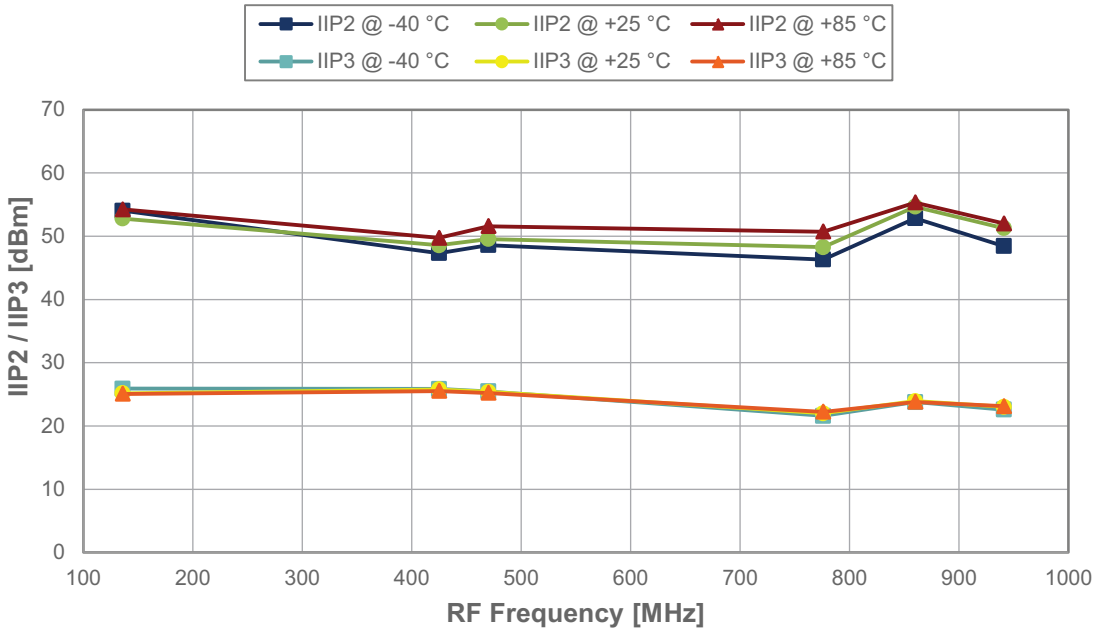


Figure 10 • IIP2/IIP3 vs. LO power (LO enable)

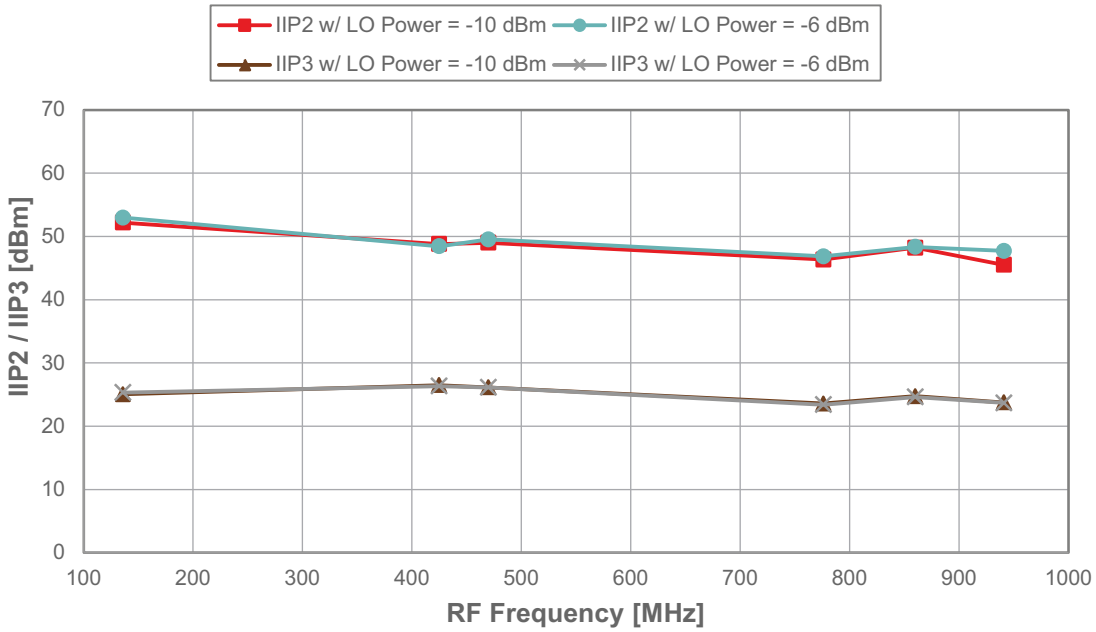


Figure 11 • IIP2/IIP3 vs. temperature (LO enable)

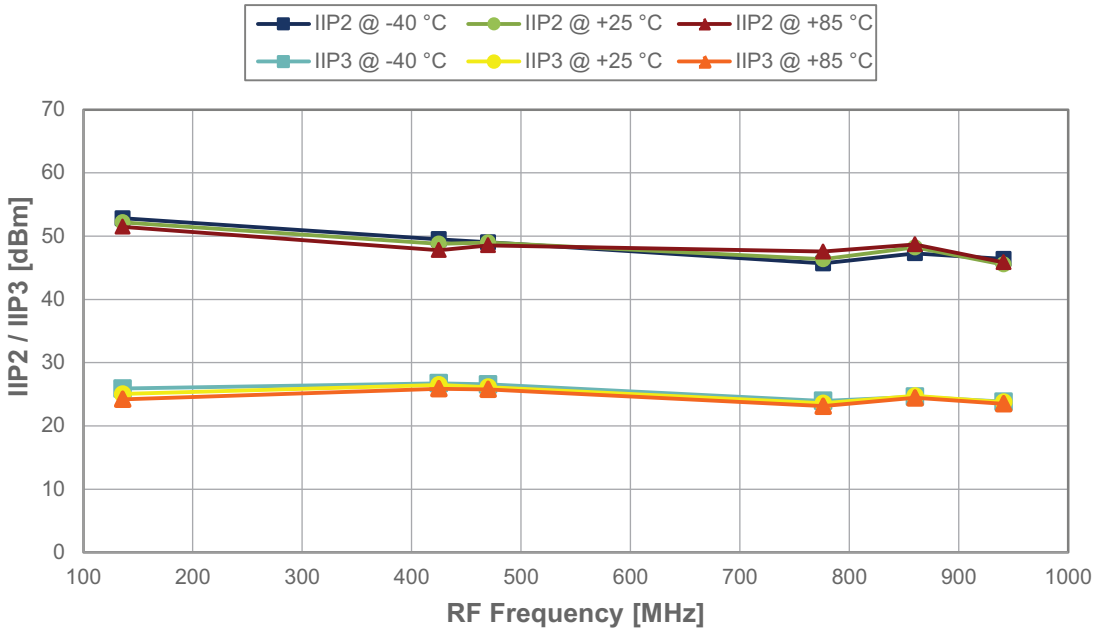


Figure 12 • LO–IF isolation vs. LO power (LO bypass)

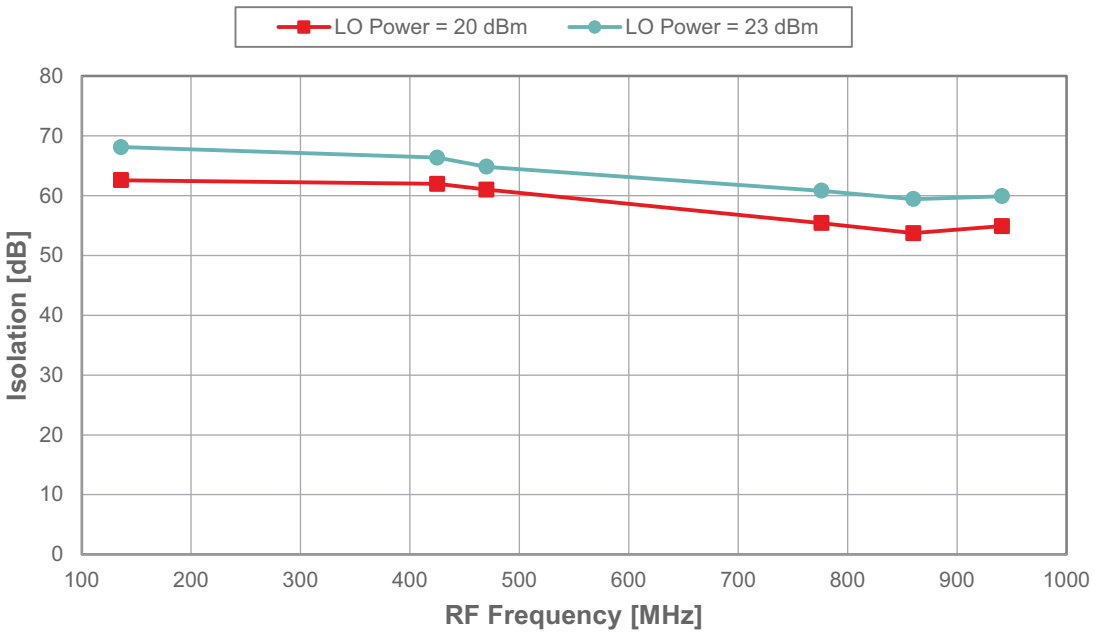


Figure 13 • LO–IF isolation vs. temperature (LO bypass)

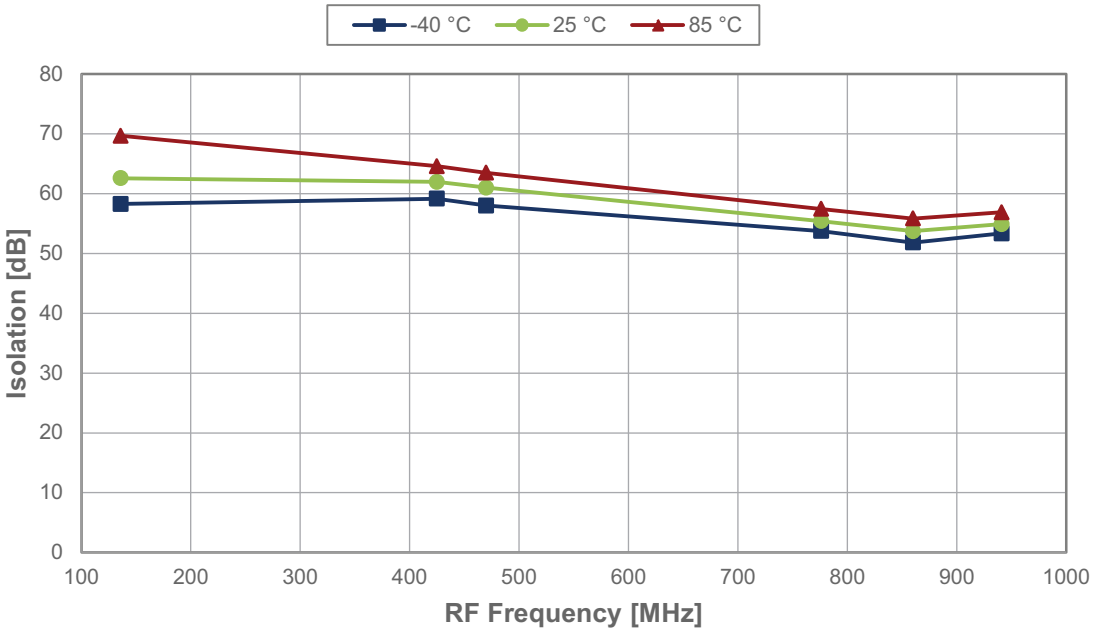


Figure 14 • LO–IF isolation vs. LO power (LO enable)

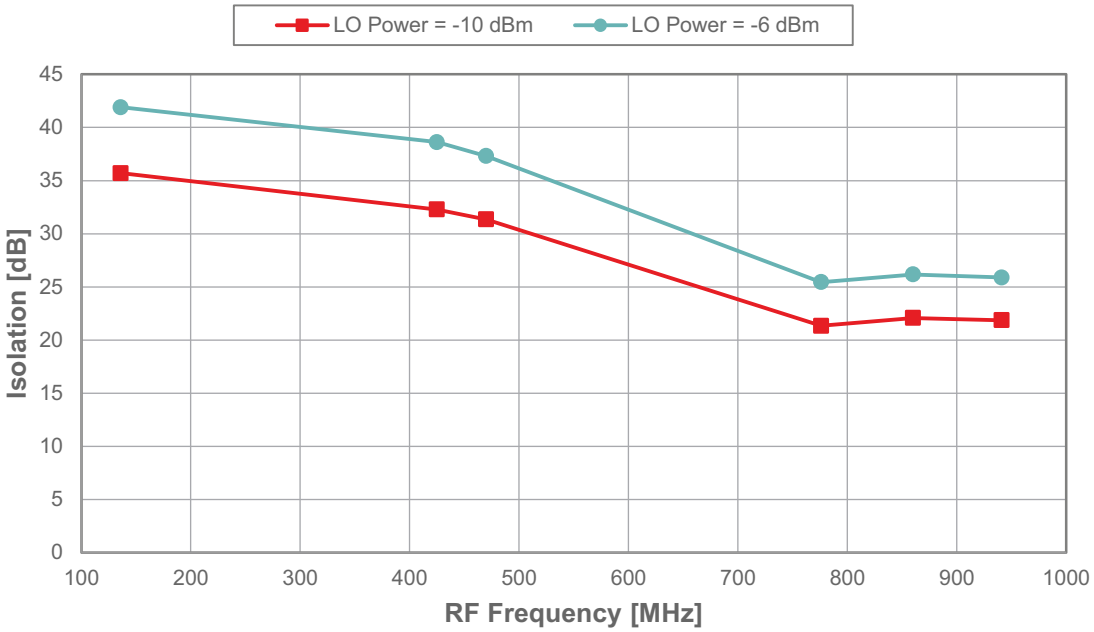


Figure 15 • LO–IF isolation vs. temperature (LO enable)

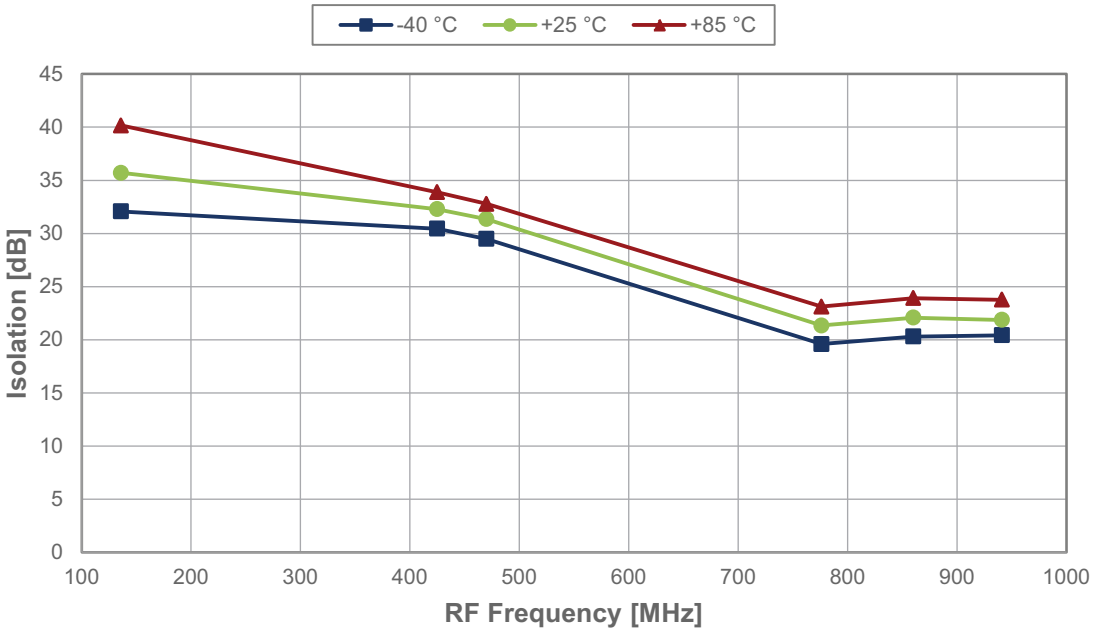


Figure 16 • LO–RF isolation vs. LO power (LO bypass)

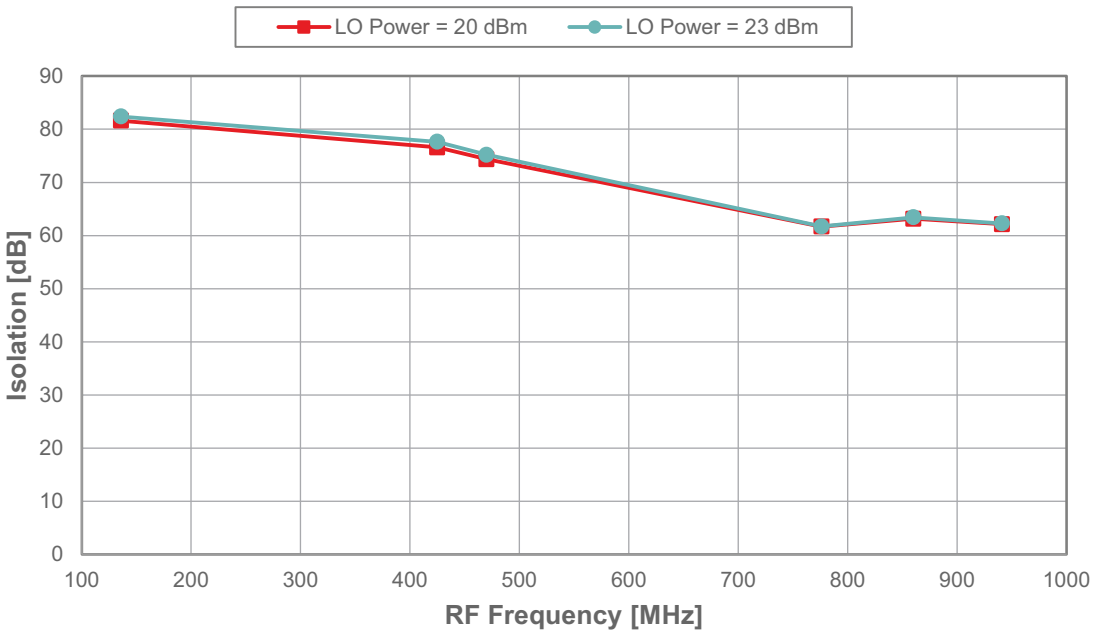


Figure 17 • LO–RF isolation vs. temperature (LO bypass)

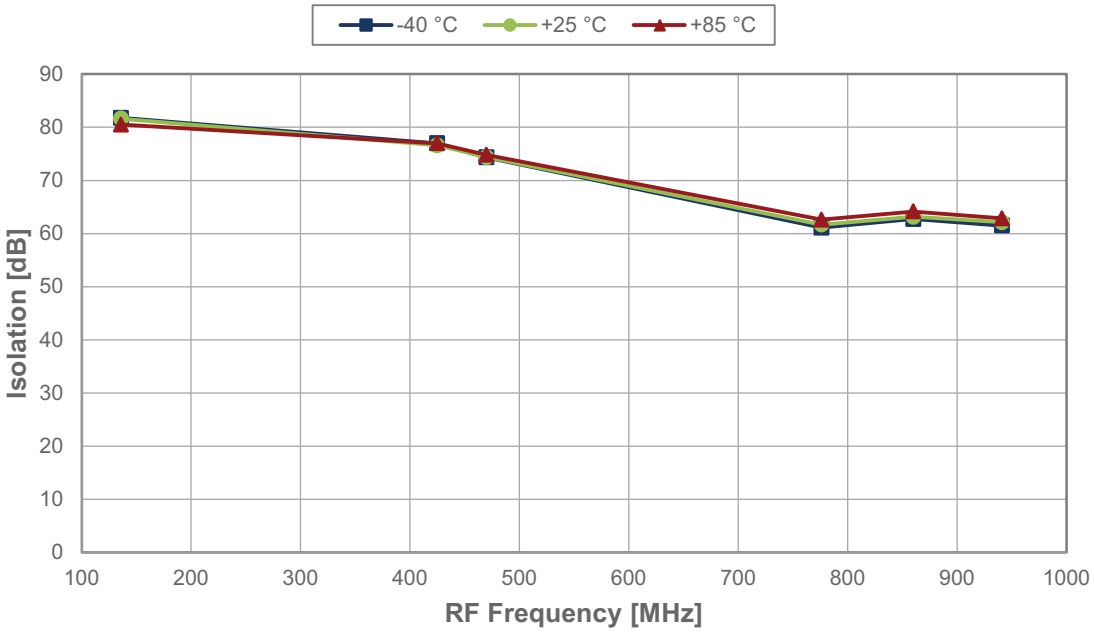


Figure 18 • LO–RF isolation vs. LO power (LO enable)

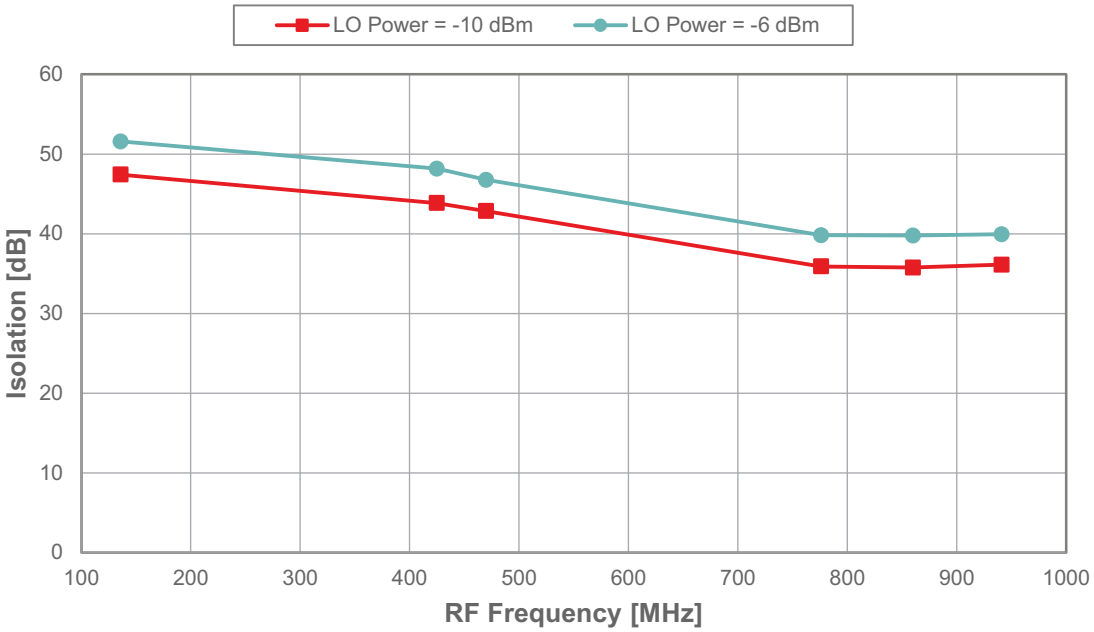


Figure 19 • LO–RF isolation vs. temperature (LO enable)

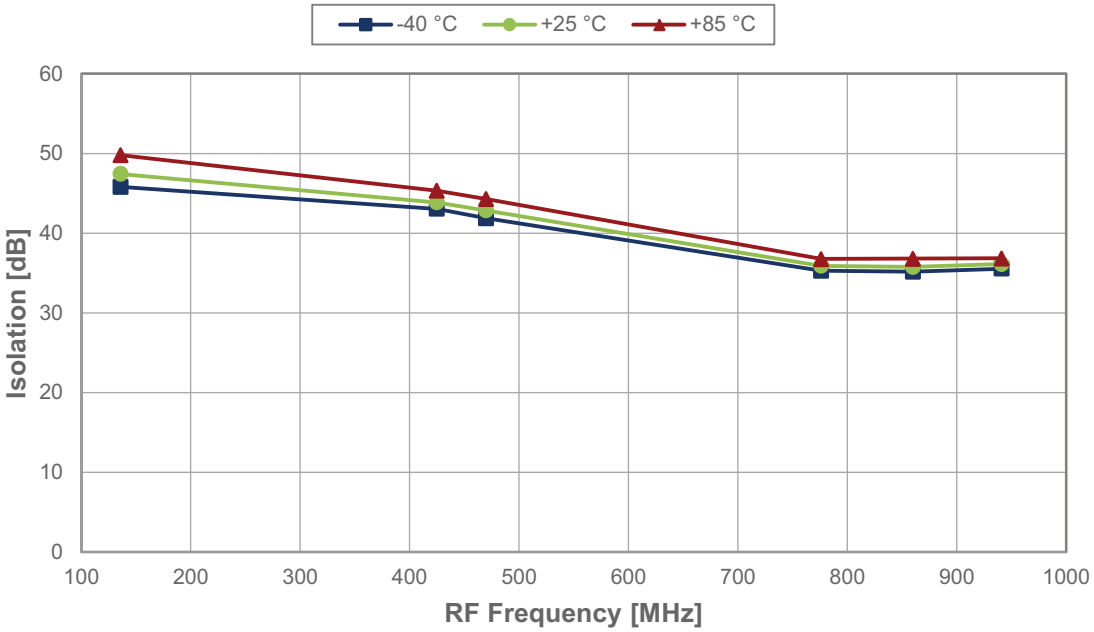


Figure 20 • RF–IF isolation vs. LO power (LO bypass)

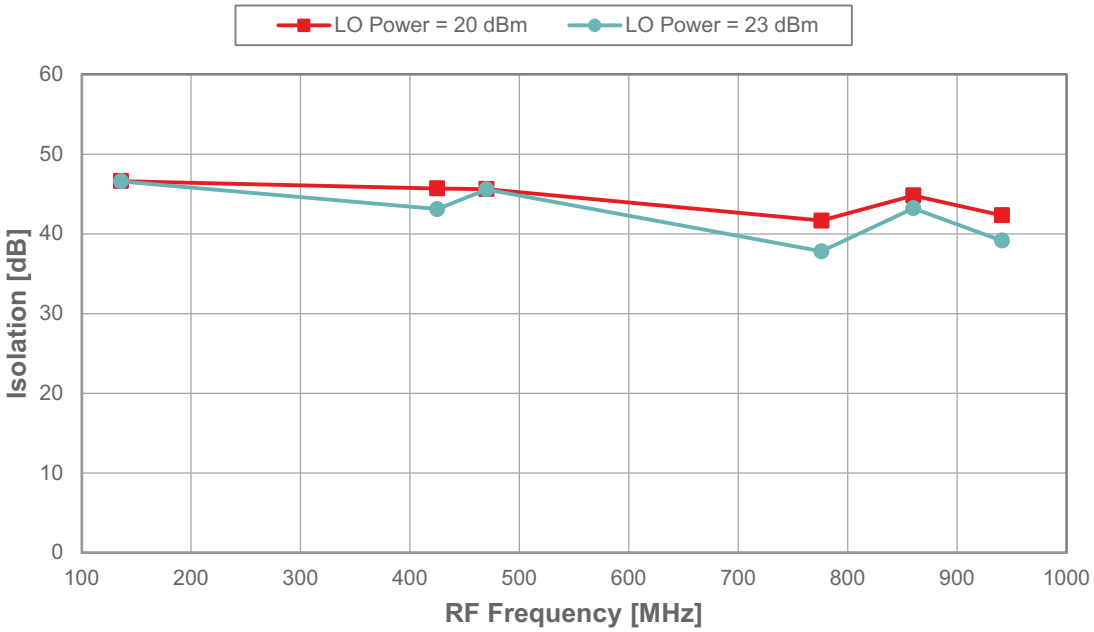


Figure 21 • RF–IF isolation vs. temperature (LO bypass)

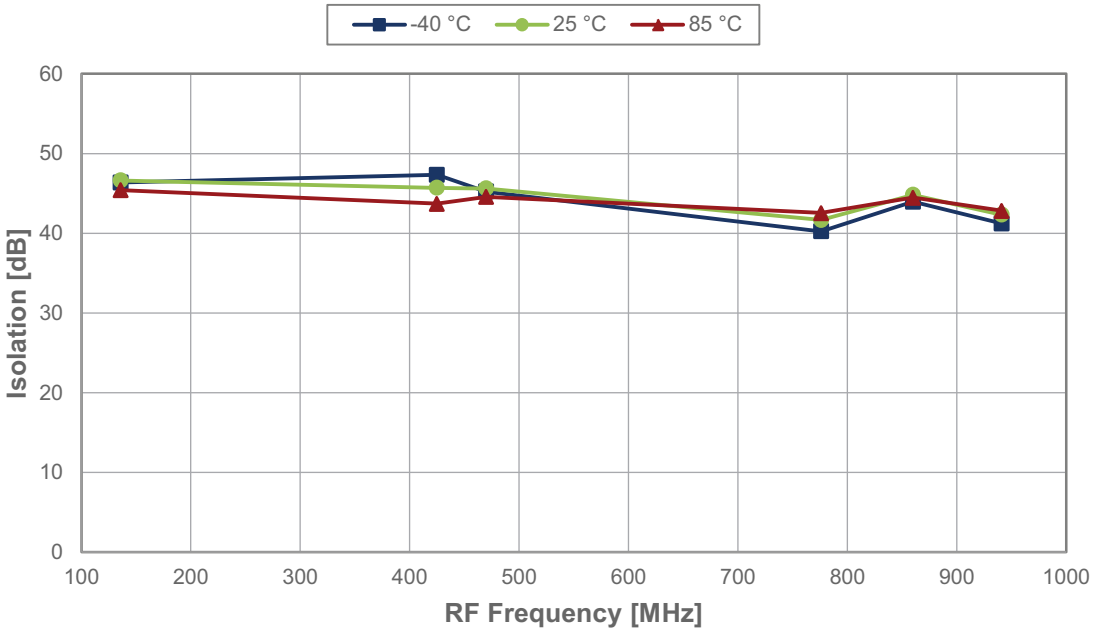


Figure 22 • RF–IF isolation vs. LO power (LO enable)

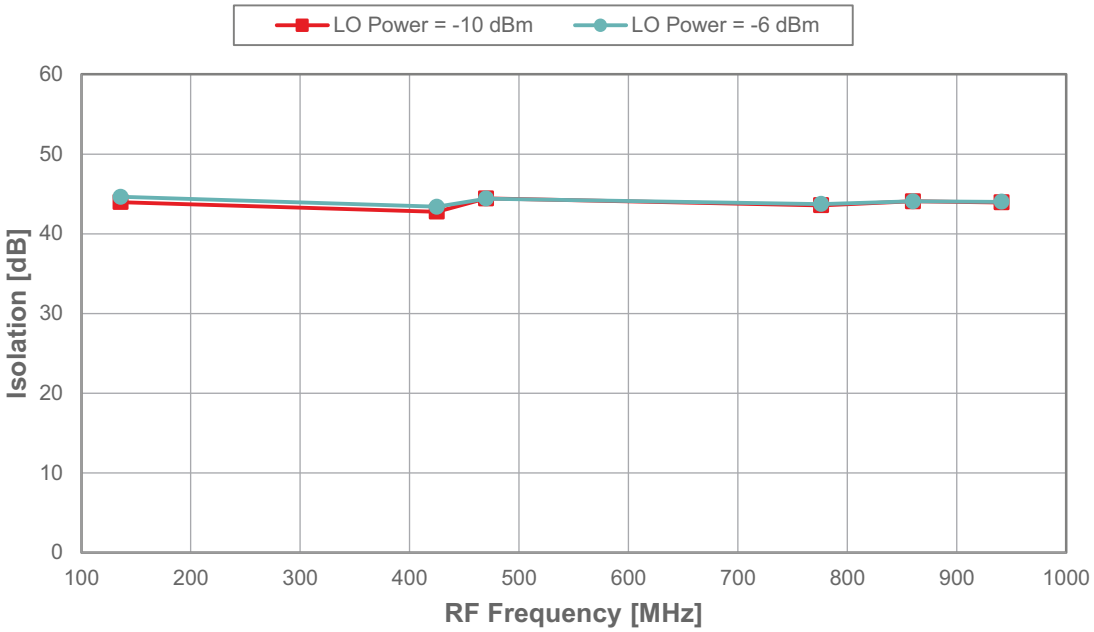
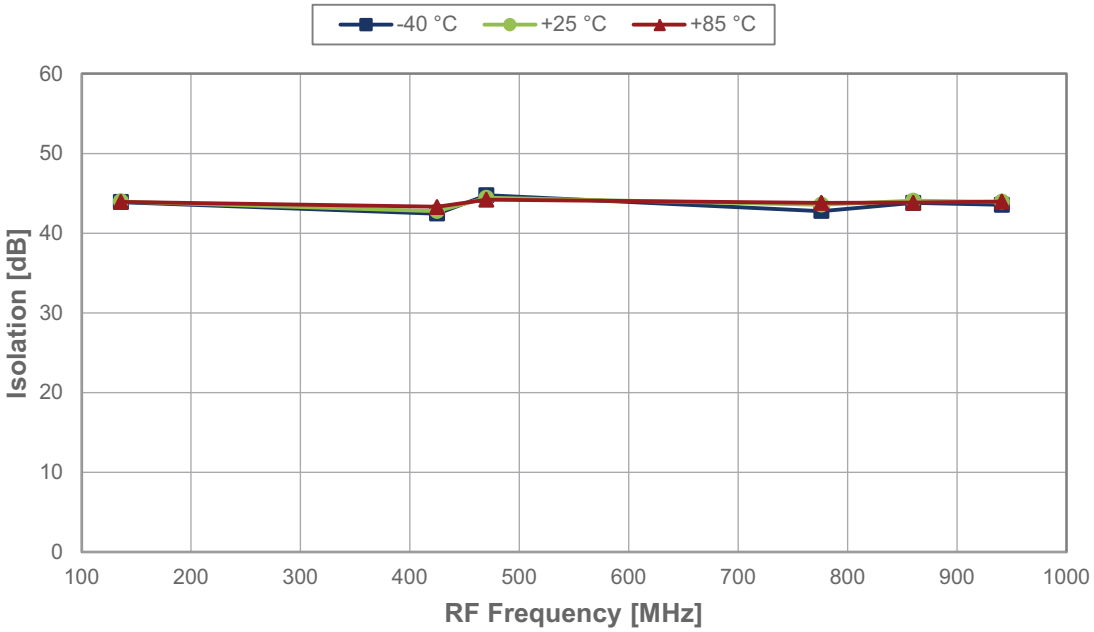


Figure 23 • RF–IF isolation vs. temperature (LO enable)



Evaluation kit

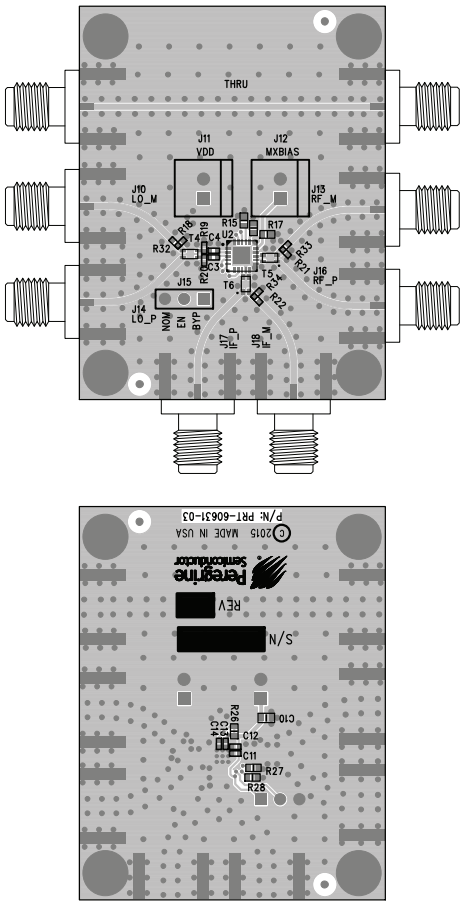
pSemi designed the PE4152 evaluation board (EVB) to ease your evaluation of the PE4152 mixer. The EVB is assembled with a PE4152 field-effect transistor (FET) mixer, baluns, headers, and sub-miniature version A (SMA) connectors.

V_{DD} is applied to the device at J11. To select the LO bypass mode, apply an active high signal to pin 6 via jumper J15 as show in **Figure 24**. pSemi selected the baluns to provide uniform amplitude and phase balance across the 100–1000 MHz frequency range.

For the best performance, the PCB design must use proper RF layout techniques:

- The signal lines must have 50Ω impedance.
- The package ground (exposed pad) must be connected directly to the ground plane.

Figure 24 • PE4152 evaluation board layout



Pin configuration

Figure 25 shows the PE4152 pin map for the 20-lead 4 × 4 × 0.85 mm QFN package, and **Table 5** lists the description for each pin.

Figure 25 • Pin configuration, top view

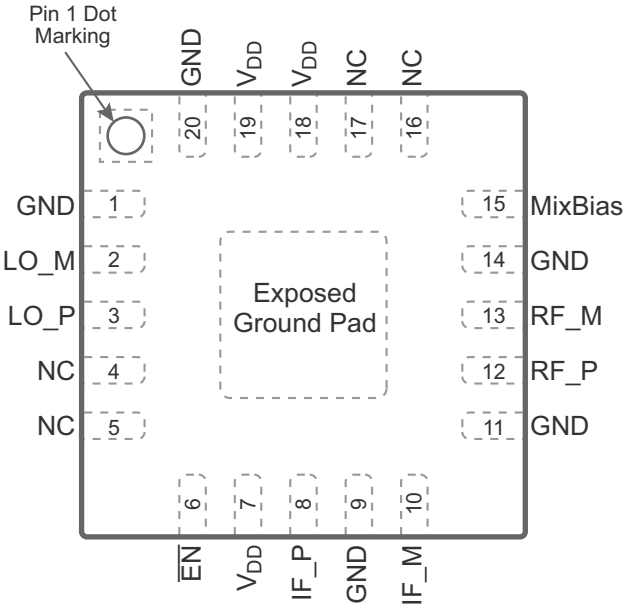


Table 5 • PE4152 pin descriptions

Pin no.	Pin name	Description
1, 9, 11, 14, 20	GND	Ground
2	LO_M	Minus LO output
3	LO_P	Positive LO output
4, 5, 16, 17	NC	No connect
6	$\overline{EN}$	LO enable (active low)
7, 18, 19	V_{DD}	Supply voltage
8	IF_P	Positive IF port
10	IF_M	Minus IF port
12	RF_P	Positive RF input
13	RF_M	Minus RF port
15	MixBias(*)	External mixer bias
Pad	GND	Exposed pad. Ground for proper operation

Note: * For applications where the DC level of the RF and IF ports are not at 0V, the MixBias pin can be set to the equivalent DC bias level. For example, if the RF and IF signals are biased at 1 VDC, a 1V level can be applied to the MixBias pin. This maintains the RF performance similar to the 0V case. The MixBias pin can be used in both LO states.

Packaging information

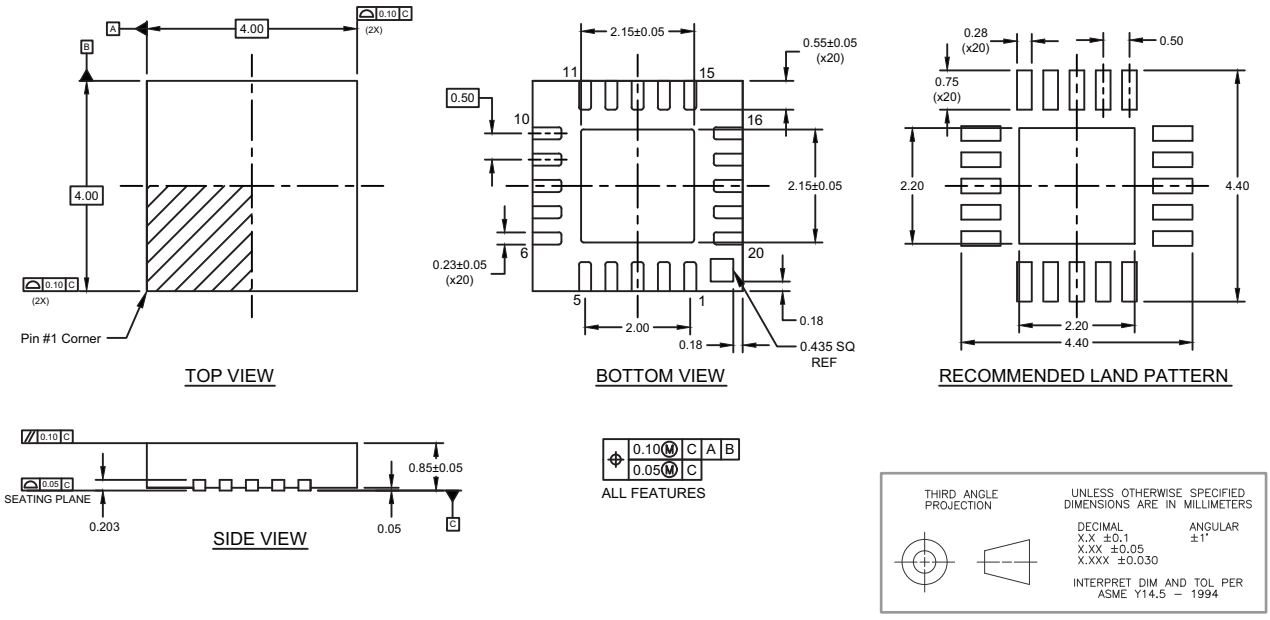
This section provides the PE4152 packaging data, including the moisture sensitivity level, package drawing, package marking information, and tape-and-reel information.

Moisture sensitivity level

The PE4152 moisture sensitivity level rating for the 20-lead 4 × 4 × 0.85 mm QFN package is MSL1.

Package drawing

Figure 26 • Package mechanical drawing for the 20-lead 4 × 4 × 0.85 mm QFN package



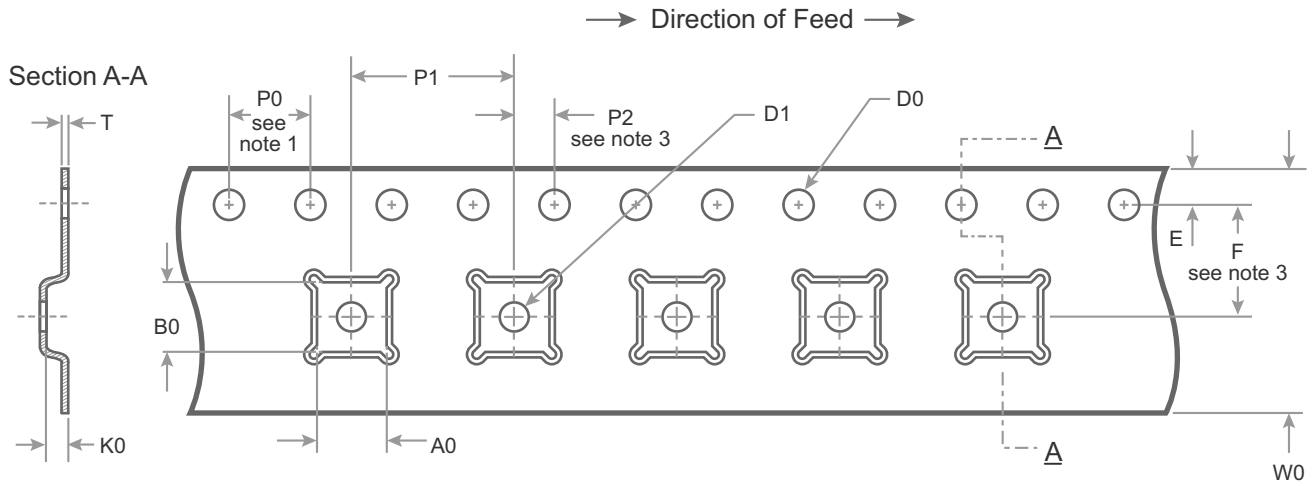
Top-marking specification

Figure 27 • PE4152 package marking specification

● = Pin 1 indicator
YY = Last two digits of assembly year
WW = Assembly work week
ZZZZZZ = Assembly lot code (maximum six characters)

Tape and reel specification

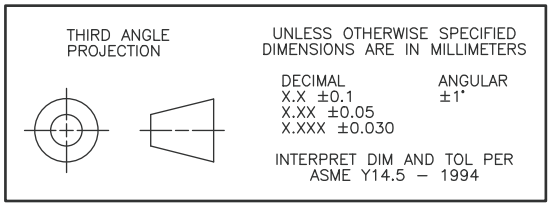
Figure 28 • Tape and reel specification for the 20-lead 4 × 4 × 0.85 mm QFN package

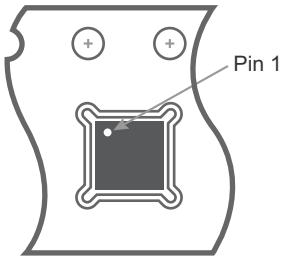


A0	3.30
B0	3.30
K0	1.10
D0	1.50 + 0.1/ -0.0
D1	1.5 min
E	1.75 ± 0.10
F	5.50 ± 0.05
P0	4.00
P1	8.00
P2	2.00 ± 0.05
T	0.30 ± 0.05
W0	12.00 ± 0.3

Notes:

1. 10 Sprocket hole pitch cumulative tolerance ±0.2
2. Camber in compliance with EIA 481
3. Pocket position relative to sprocket hole measured as true position of pocket, not pocket hole





Device Orientation in Tape

Ordering information

Table 6 lists the PE4152 order codes and shipping methods.

Table 6 • PE4152 order codes and shipping methods

Order code	Description	Packaging	Shipping method
PE4152A-Z	PE4152 mixer with integrated LO	Green 20-lead 4 × 4 mm QFN	3000 units/T&R
EK4152-02	PE4152 evaluation kit	Evaluation kit	1/box

Document categories

Advance Information

The product is in a formative or design stage. The datasheet contains design target specifications for product development. Specifications and features may change in any manner without notice.

Preliminary Specification

The datasheet contains preliminary data. Additional data may be added at a later date. pSemi reserves the right to change specifications at any time without notice in order to supply the best possible product.

Product Specification

The datasheet contains final data. In the event pSemi decides to change the specifications, pSemi will notify customers of the intended changes by issuing a CNF (Customer Notification Form).

Product Brief

This document contains a shortened version of the datasheet. For the full datasheet, contact sales@psemi.com.

Sales contact

For additional information, contact Sales at sales@psemi.com.

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