PE4151

Document category: Product Specification

UltraCMOS® Low-frequency Passive Mixer with Integrated LO Amplifier

Features

- Ultra-high linearity quad MOSFET array with integrated LO amplifier
- Low conversion loss
- High LO isolation
- RoHS-compliant 10-lead MSOP package
- Ideal for highly magnetic environments

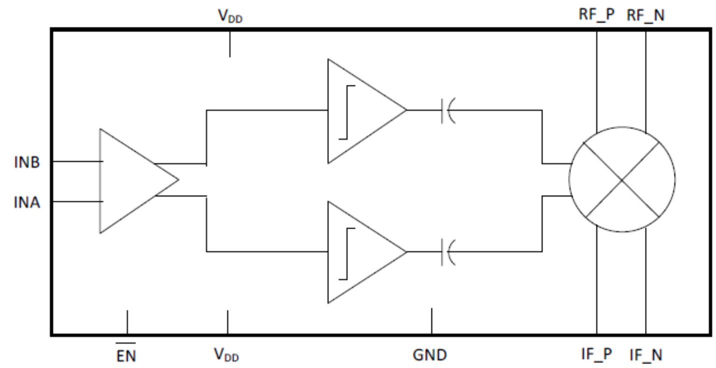

Figure 1. PE4151 functional diagram

Applications

- Up- and down-conversion
- Mobile radios
- Cellular infrastructure equipment
- STB/CATV systems

Product description

The PE4151 is an ultra-high linearity quad MOSFET mixer with an integrated LO amplifier. The LO amplifier allows for LO drive levels of less than 0 dBm to produce IIP3 values like a quad MOSFET array driven with a 15 dBm LO drive. It is designed for use in up- and down-conversion applications, such as mobile radios, cellular infrastructure equipment, and STB/CATV systems.

The PE4151 operates with differential signals at the RF and IF ports, while the LO port can be differential or single-ended.

The PE4151 is an ideal mixer core for a wide range of mixer products, including module-level solutions that incorporate baluns or other single-ended matching structures enabling three-port operation.

The PE4151 is manufactured on the pSemi 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. This process enables the PE4151 to have an elevated level of performance.

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 listed in Table 1.

Latch-up Immunity

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

Table 1. Absolute maximum ratings

Parameter or condition	Min	Max	Unit
V_{DS} maximum DC plus peak AC across drain-source	–	±3.3	V
I_{DS-DC} maximum DC current across drain-source	–	6	mA
T_{ST} storage temperature range	-65	+150	°C
T_J operating junction temperature	–	+125	°C
VESD ESD voltage: HBM, MIL_STD 883 Method 3015.7	–	1000	V

Electrical specifications

Table 2: Electrical specifications

Parameter	Min	Typ	Max	Unit
Current drain, as a function of frequency	–	5	8	mA
Off-state leakage current	–	–	20	μA
RF input frequency: - VHF band - UHF1 band - UHF2 band	 136 380 450	–	 174 470 520	 MHz MHz MHz
LO frequency: - VHF band - UHF1 band - UHF2 band	 245.65 270.35 340.35	–	 283.65 360.35 410.35	 MHz MHz MHz
IF output frequency	44.85	–	109.65	MHz
LO input power	-10	-8	-6	dBm
RF input power	–	–	2	dBm
Conversion loss: - VHF band - UHF1 band - UHF2 band	–	 6.5 7 7	 8 8.5 8.5	 dB dB dB
Third-order input intercept (IIP3):[2]	20	26	–	dBm
Second-order input intercept (IIP2):[2] - VHF band - UHF1 band - UHF2 band	 40 35 35	 55 45 45	–	 dBm dBm dBm
RF-to-IF isolation	35	50	–	dB
LO-to-IF isolation	25	40	–	dB
LO-to-RF isolation	25	43	–	dB

Parameter	Min	Typ	Max	Unit

1. Measurements taken on PE4151 evaluation board with M/A-Com ETK4-2T baluns on the RF and IF ports. For details, see Figure 44.
2. IIP2 and IIP3 are measured with two tones at 0 dBm, 100-kHz spacing.

Electrical specifications for HF-band operation

Table 3. Electrical specifications for HF-band operation

Parameter	Min	Typ	Max	Unit
RF input frequency	–	32.5	–	MHz
LO frequency	–	40	–	MHz
IF output frequency	–	7.5	–	MHz
LO input power	−10	−8	−6	dBm
RF input power	–	–	2	dBm
Conversion loss	–	5	6.5	dB
Third-order input intercept (IIP3)	20	25	–	dBm
Second-order input intercept (IIP2)	55	65	–	dBm
RF-to-IF isolation	35	50	–	dB
LO-to-IF isolation	25	40	–	dB
LO-to-RF isolation	25	40	–	dB

* Measurements taken on PE4151 evaluation board with M/A-Com ETK4-2T baluns on the RF and IF ports. For details, see Figure 44.

Typical performance data

Figure 2–Figure 41 show the typical performance data at 25 °C, V_{DD} = 5V (Z_S = Z_L = 50Ω at 25 °C), unless otherwise specified.

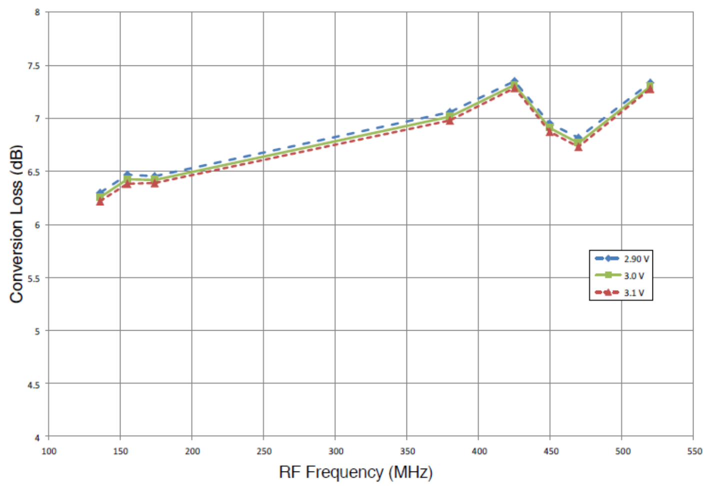

Figure 2. Conversion loss vs. voltage

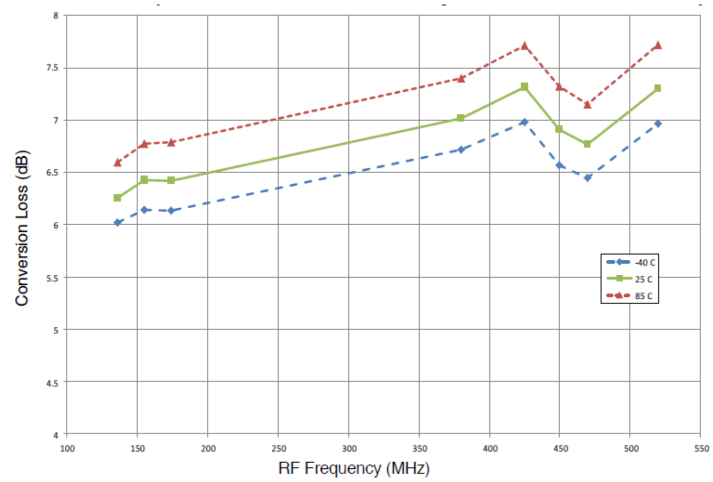

Figure 3. Conversion loss vs. temperature (3.0V, –6 dBm LO Input, 109.65 MHz IF)

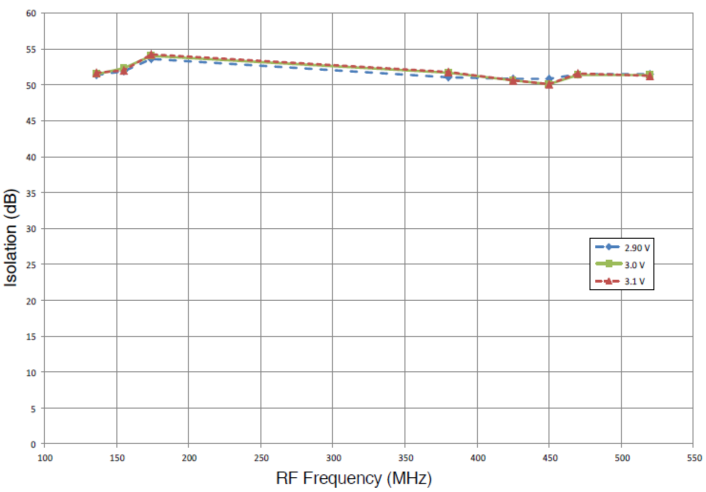

Figure 4. RF-to-IF isolation vs voltage (25 °C, –6 dBm LO input, 109.65 MHz IF)

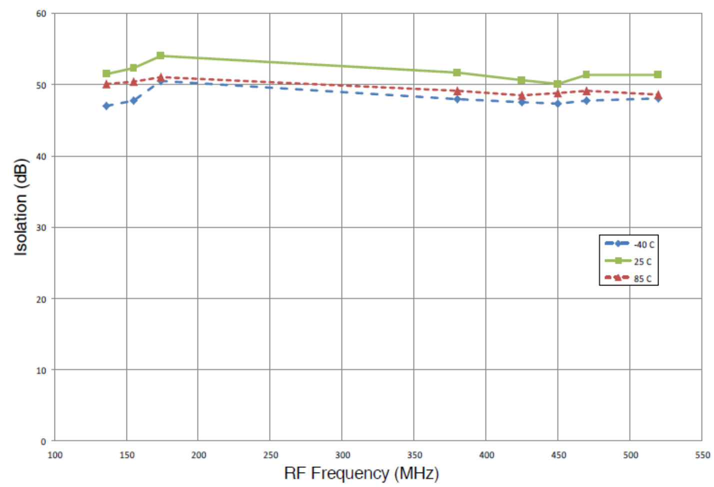

Figure 5. RF-to-IF isolation vs temperature (3.0V, –6 dBm LO input, 109.65 MHz IF)

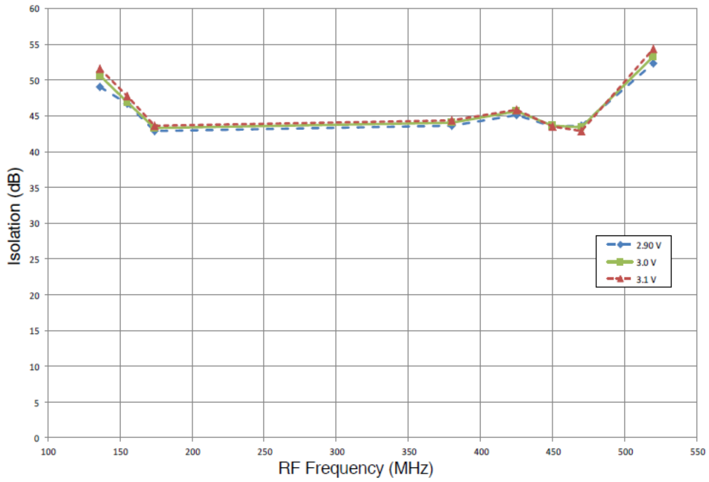

Figure 6. LO-to-IF isolation vs. voltage (25 °C, –6 dBm LO input, 109.65 MHz IF)

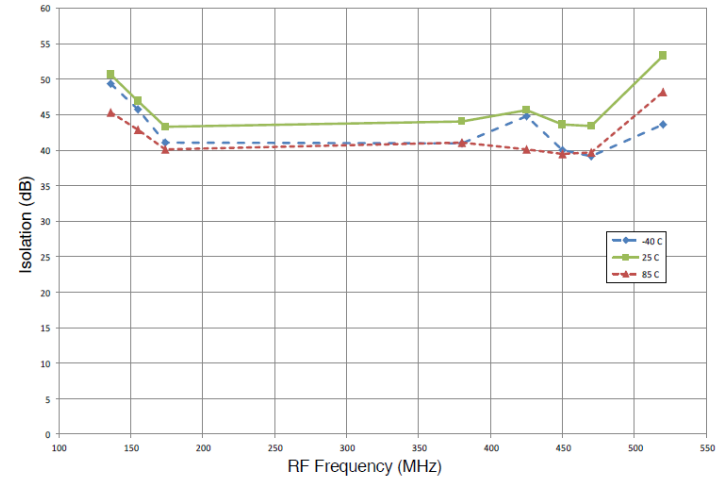

Figure 7. LO-to-IF isolation vs. temperature (3.0V, –6 dBm LO input, 109.65 MHz IF)

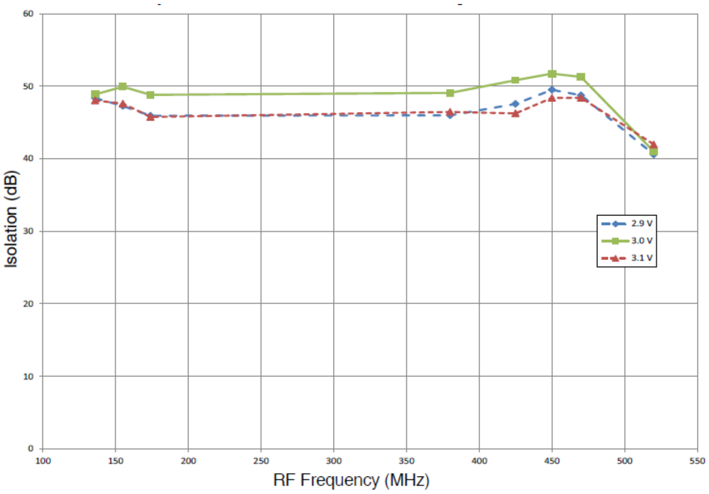

Figure 8. LO-to-RF isolation vs. voltage (25 °C, –6 dBm LO input, 109.65 MHz IF)

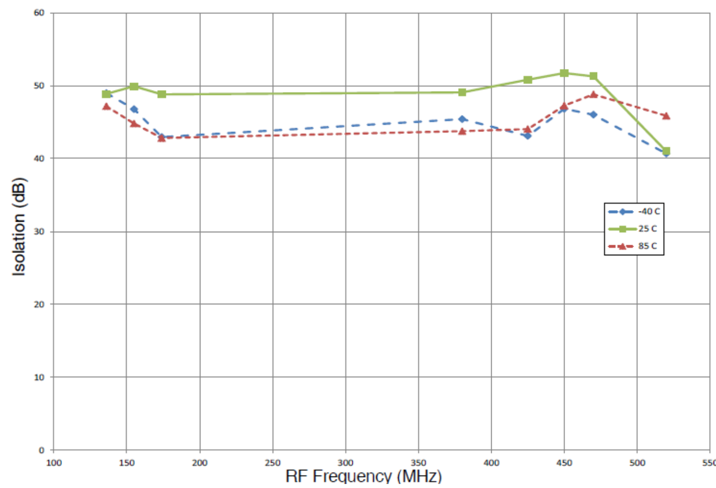

Figure 9. LO-to-RF isolation vs. temperature (3.0V, –6 dBm LO input, 109.65 MHz IF)

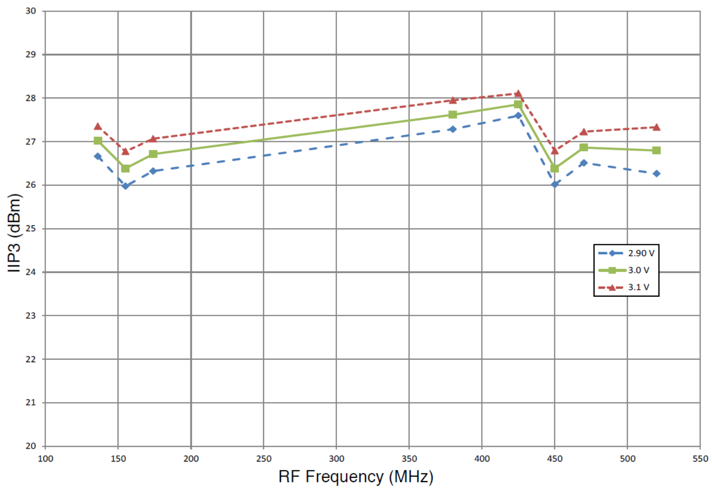

Figure 10. IIP3 vs. voltage (25 °C, –6 dBm LO input, 109.65 MHz IF)

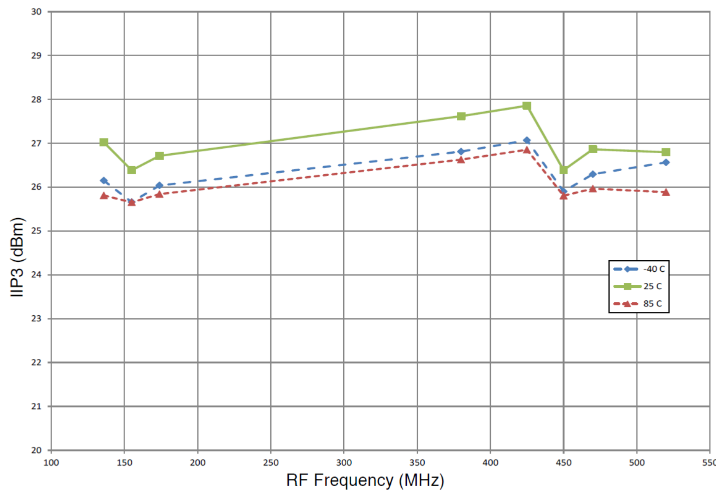

Figure 11. IIP3 vs. temperature

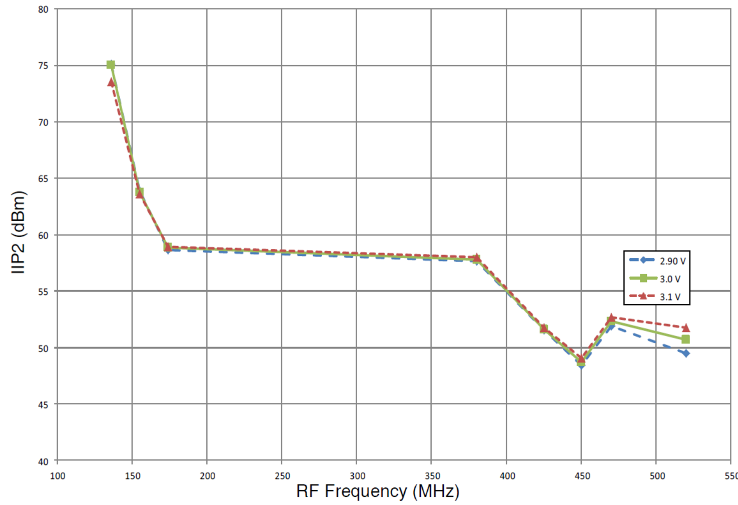

Figure 12. IIP2 vs. voltage (25 °C, –6 dBm LO input, 109.65 MHz IF)

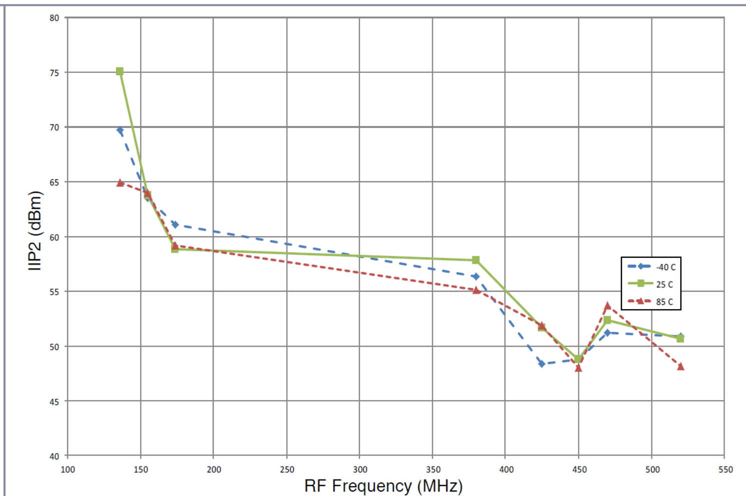

Figure 13. IIP2 vs. temperature (3.0V, –6 dBm LO input, 109.65 MHz IF)

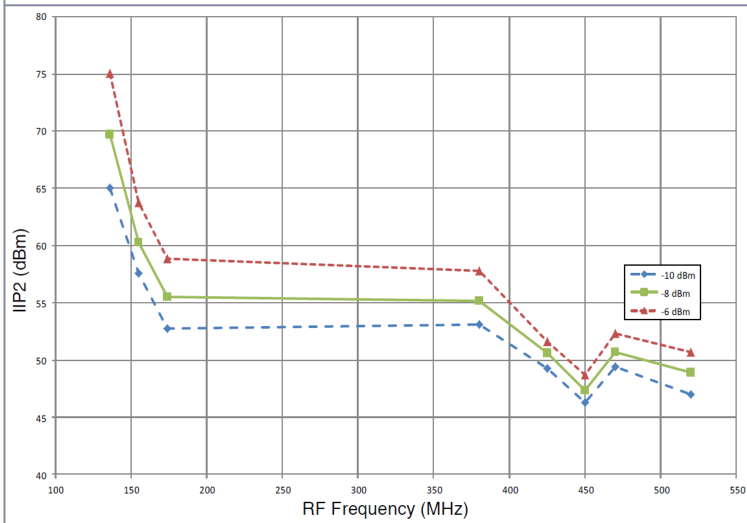

Figure 14. IIP2 vs. LO input power (3.0V, 25 °C, 109.65 MHz IF)

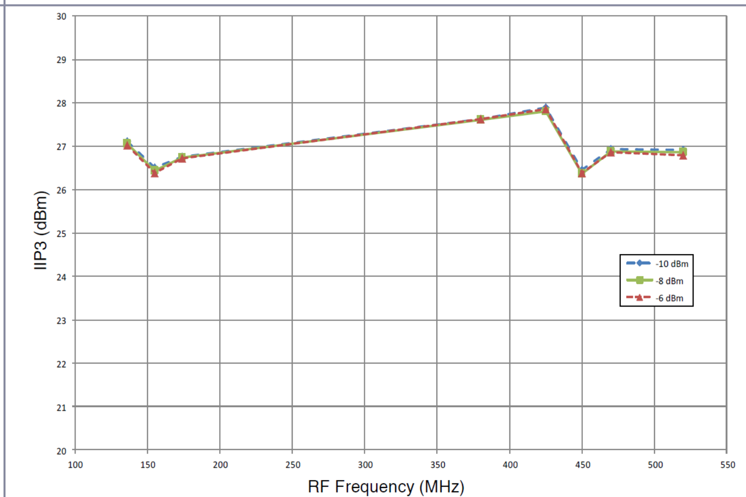

Figure 15. IIP3 vs. LO input power (3.0V, 25 °C, 109.65 MHz IF)

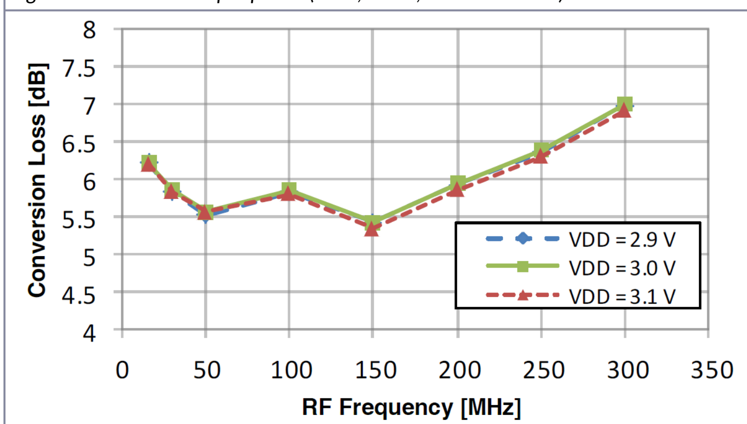

Figure 16. Conversion loss vs VDD

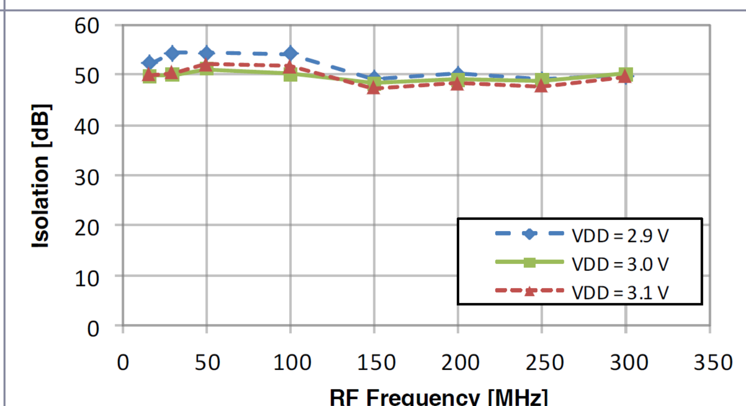

Figure 17. RF-to-IF isolation vs VDD

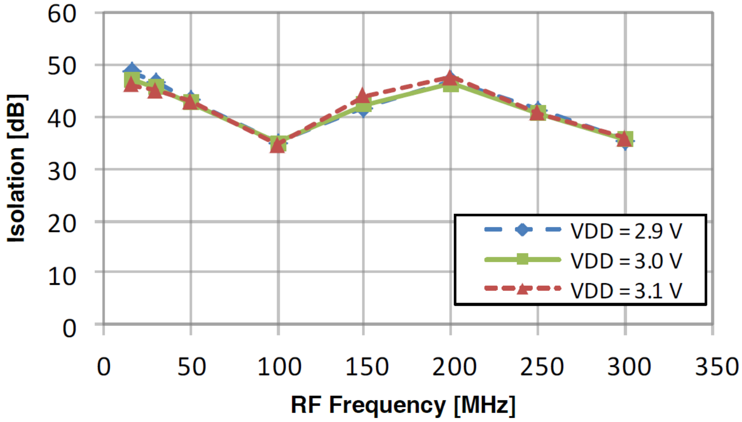

Figure 18. LO-to-IF isolation vs VDD

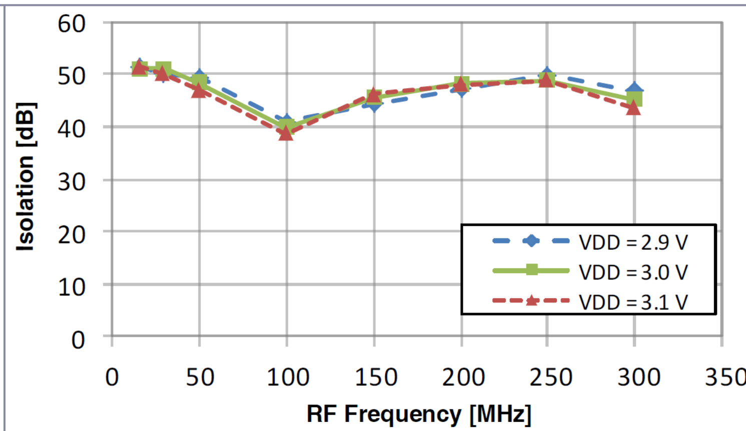

Figure 19. LO-to-RF isolation vs VDD

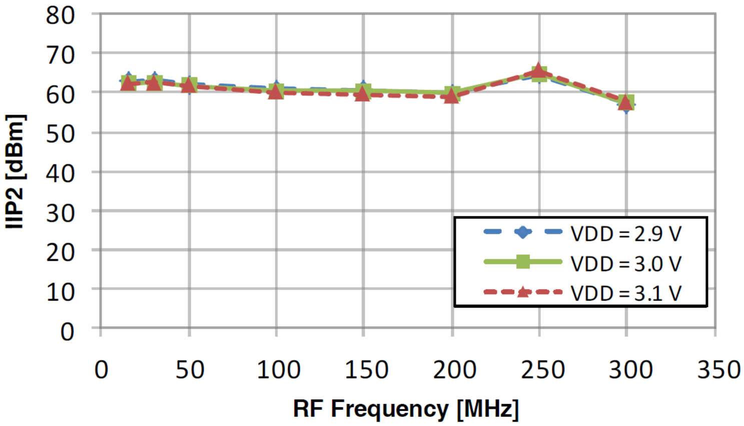

Figure 20. IIP2 vs. VDD

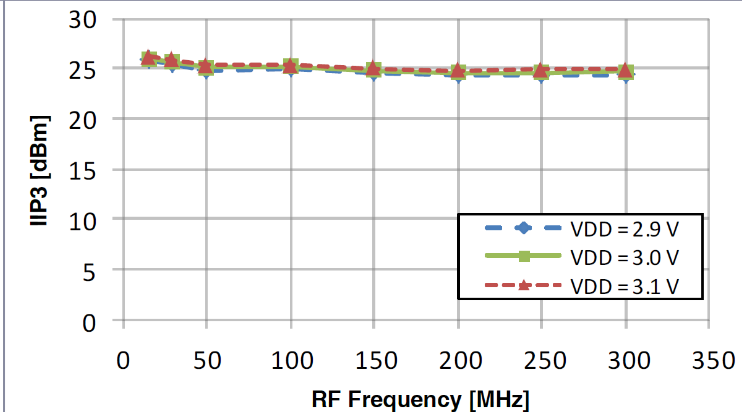

Figure 21. IIP3 vs. VDD

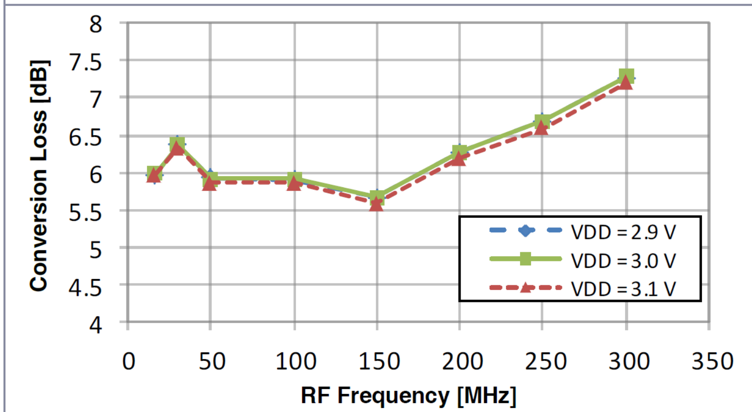

Figure 22. Conversion loss vs. VDD

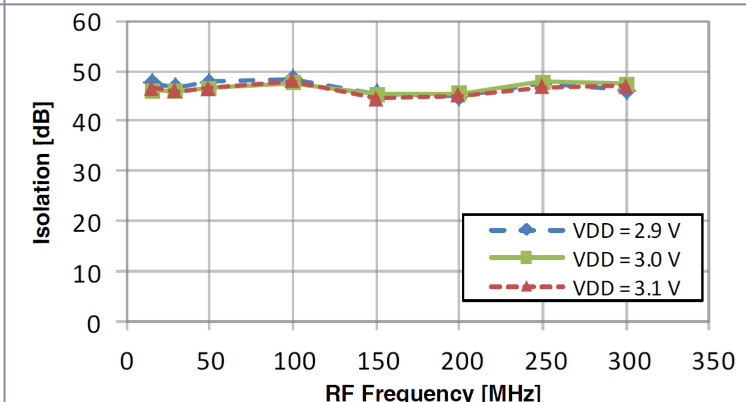

Figure 23. RF-to-IF isolation vs. VDD

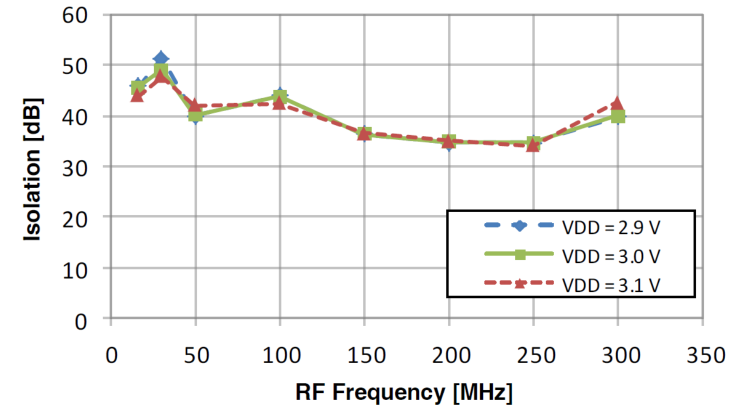

Figure 24. LO-to-IF isolation vs. VDD

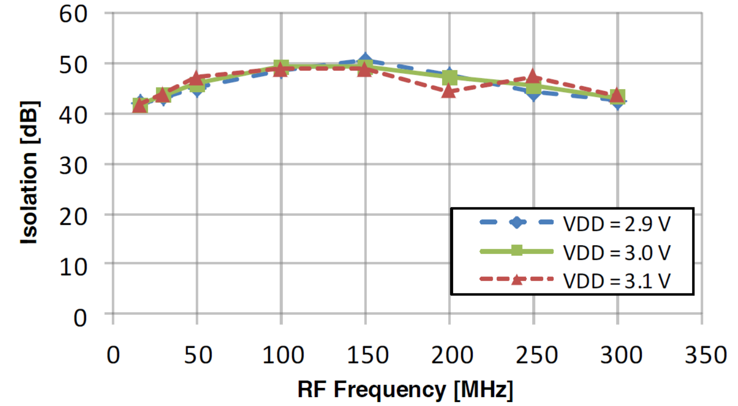

Figure 25. LO- to-RF isolation vs. VDD

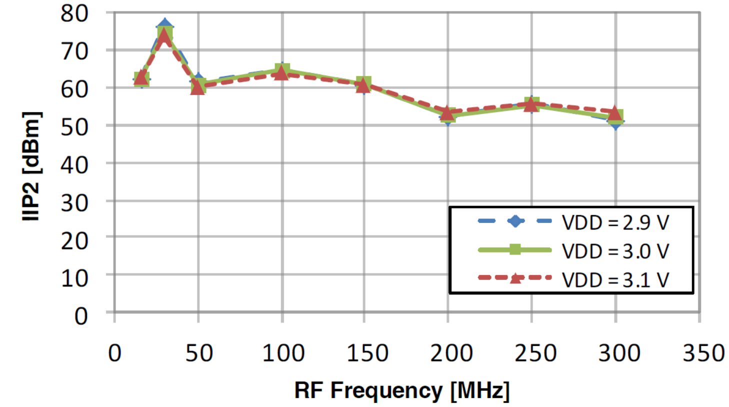

Figure 26. IIP2 vs. VDD

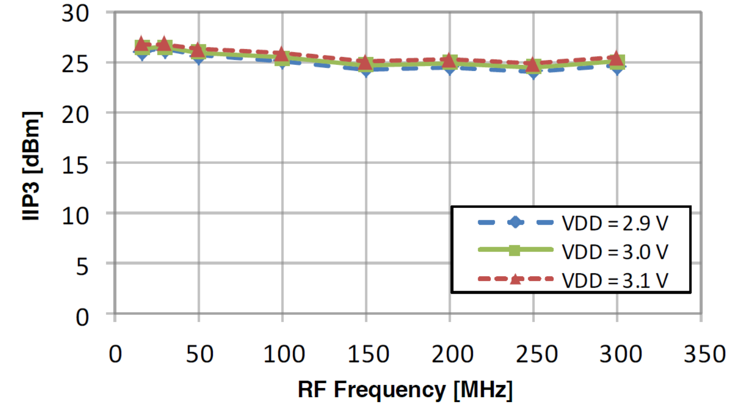

Figure 27. IIP3 vs. VDD

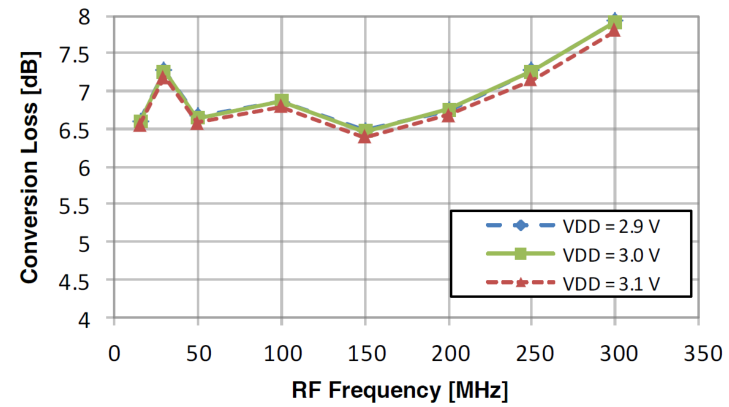

Figure 28. Conversion loss vs. VDD

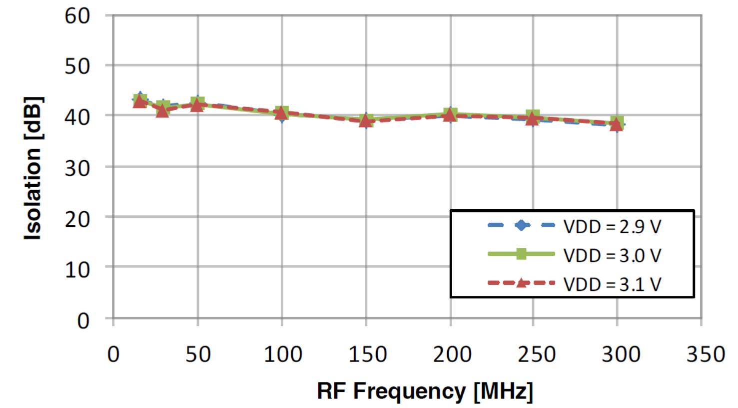

Figure 29. RF-to-IF isolation vs. VDD

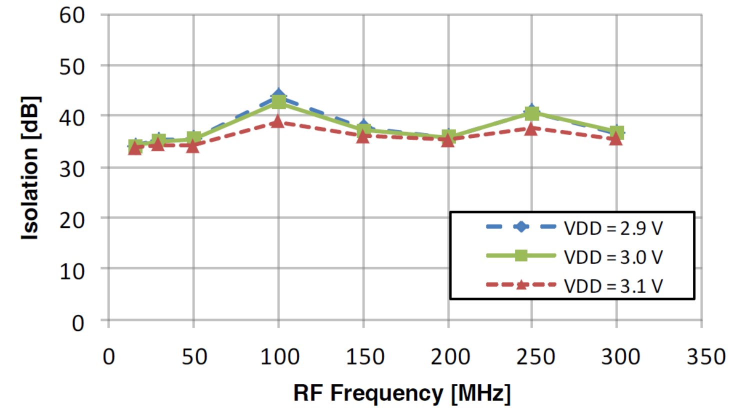

Figure 30. LO-to-IF isolation vs. VDD

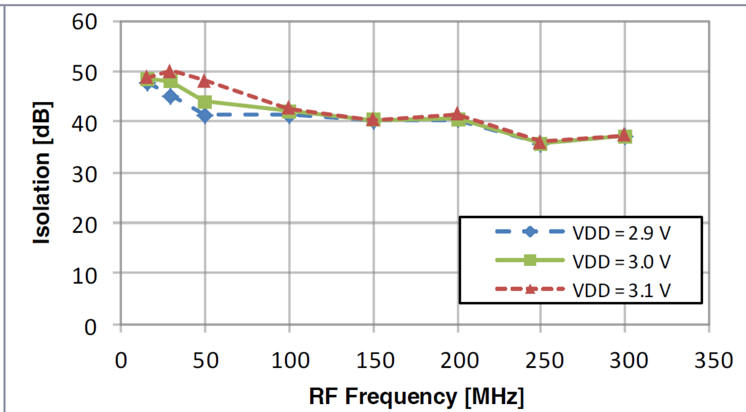

Figure 31. LO-to-RF isolation vs. VDD

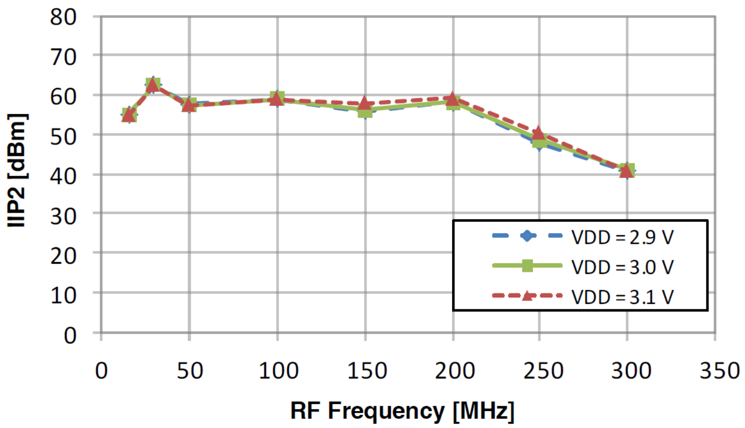

Figure 32. IIP2 vs. VDD

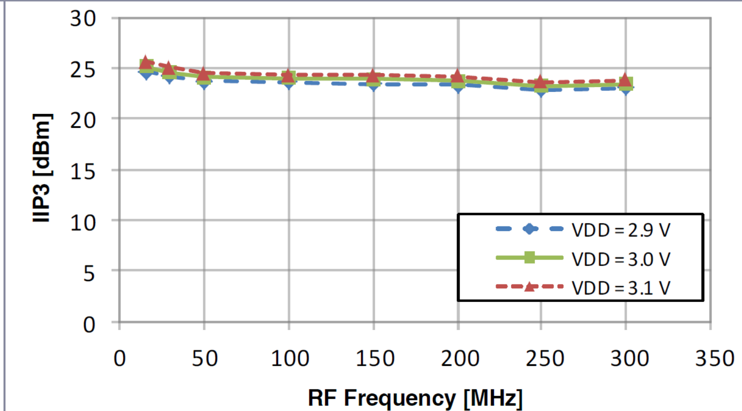

Figure 33. IIP3 vs. VDD

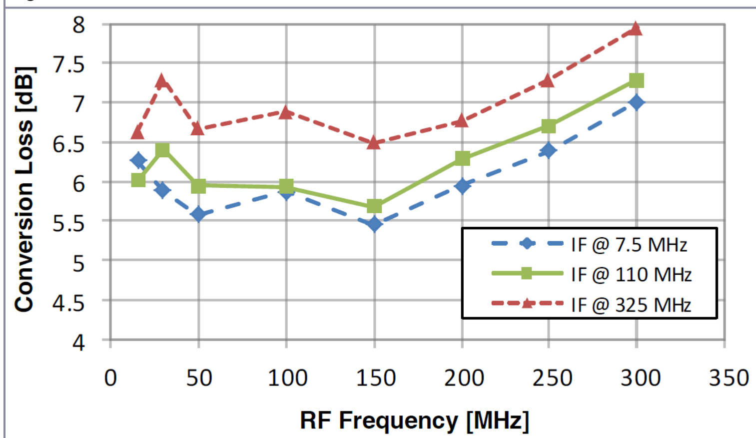

Figure 34. Conversion Loss vs. IF frequency (25 °C, –8 dBm LO input)

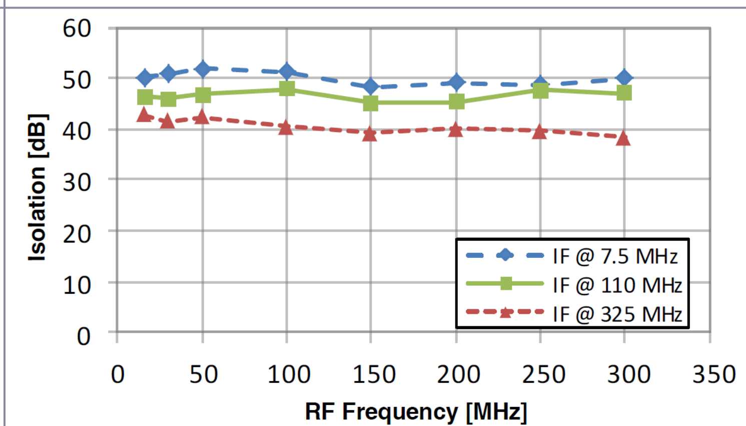

Figure 35. RF-to-IF isolation vs. IF frequency (25 °C, –8 dBm LO input)

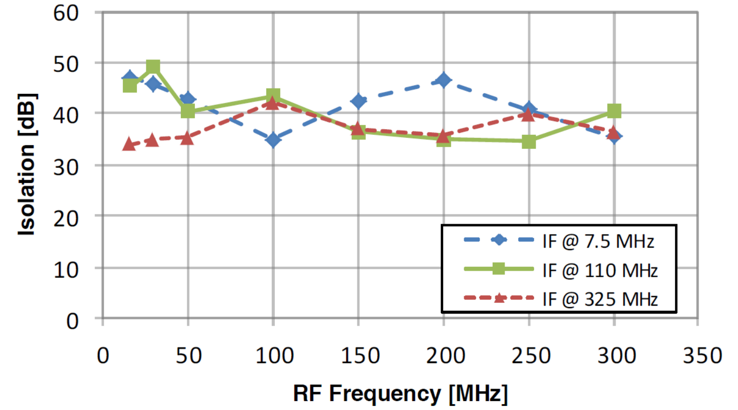

Figure 36. LO-to-IF isolation vs. IF frequency (25 °C, –8 dBm LO input)

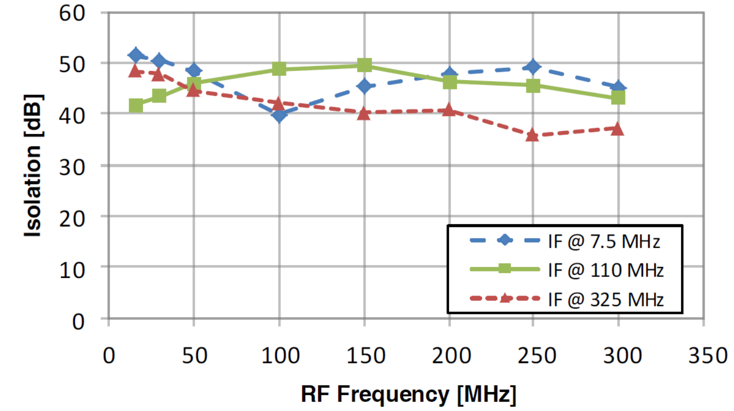

Figure 37. LO-to-RF isolation vs. IF frequency (25 °C, –8 dBm LO input)

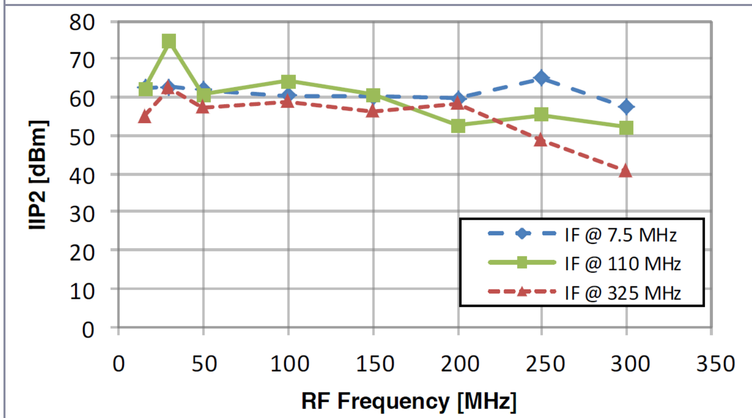

Figure 38. IIP2 vs. IF frequency (25 °C, –8 dBm LO input)

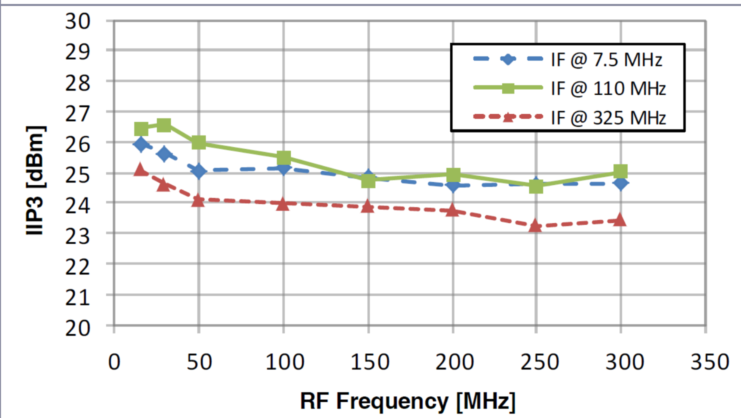

Figure 39. IIP3 vs. IF frequency (25 °C, –8 dBm LO input)

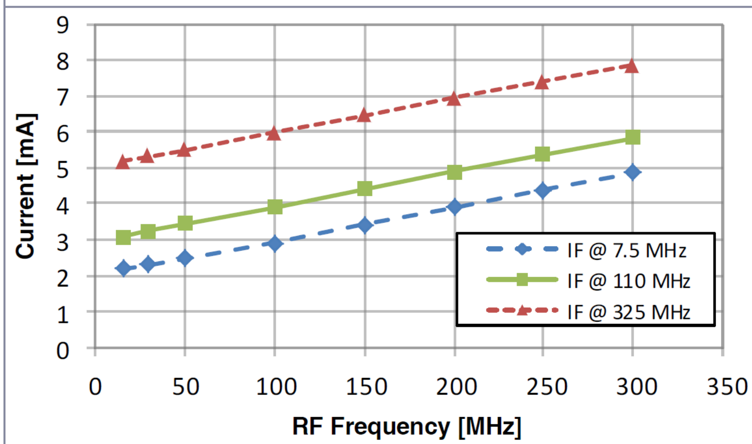

Figure 40. IDD vs. IF frequency (25 °C, –8 dBm LO input)

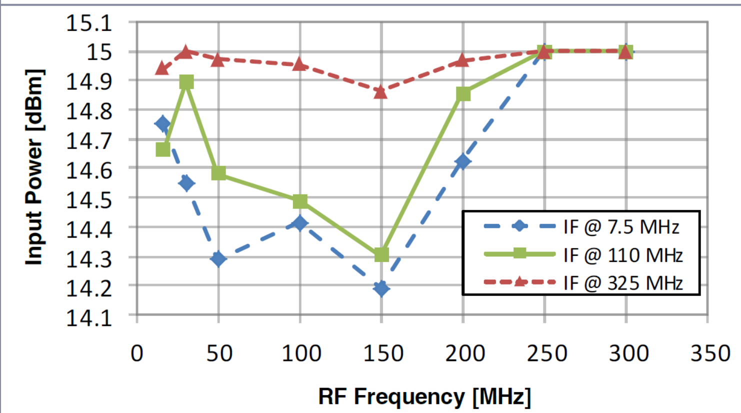

Figure 41. P1dB vs. IF frequency (25 °C, –8 dBm LO input)

Pin configuration

Figure 42 shows the PE4151 pin configuration for the 10-lead MSOP package, and Table 4 lists the description for each pin.

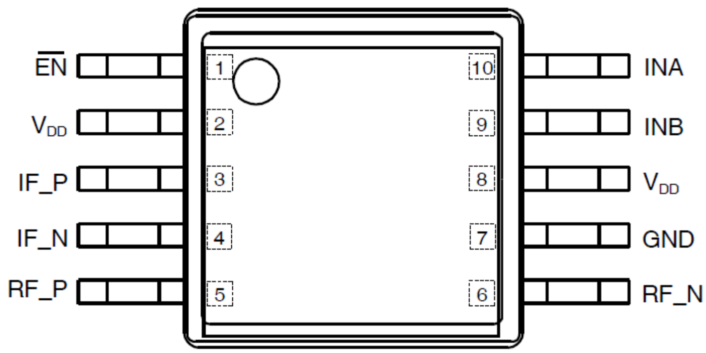

Figure 42. PE4151 pin configuration

Table 4: PE4151 pin descriptions

Pin	Symbol	Function
1	EN	Enable pin (active low)
2	V_{DD}	Supply voltage
3	IF_P	Positive IF port
4	IF_N	Negative IF port
5	RF_P	Positive RF input
6	RF_N	Negative RF input
7	GND	Ground
8	V_{DD}	Supply voltage
9	INB	Positive LO input
10	INA	Negative LO input

Evaluation kit

The mixer evaluation kit board was designed to ease customer evaluation of the PE4151 quad MOSFET mixer with integrated LO amplifier.

The RF and IF ports are connected through 50Ω transmission lines and 1:4 transmission line transformers to J5 and J7, respectively. The LO ports are connected through 50Ω transmission lines to J1 and J3, respectively, and can support either a single-ended or differential signal drive. With a single-ended input, no termination is needed on the un-used port.

The board is constructed of a two metal layer FR4 with a total thickness of 0.062". The bottom layer provides ground for the RF transmission lines. The transmission lines were designed using a coplanar waveguide with ground plane model using a trace width of 0.037", trace gaps of 0.008", dielectric thickness of 0.059", and metal thickness of 0.0015".

J6 can be used to enable or disable the part. The chip enable (EN) is active low.

Decoupling capacitors are provided on the VDD traces. Place these capacitors as close to the VDD pin as possible.

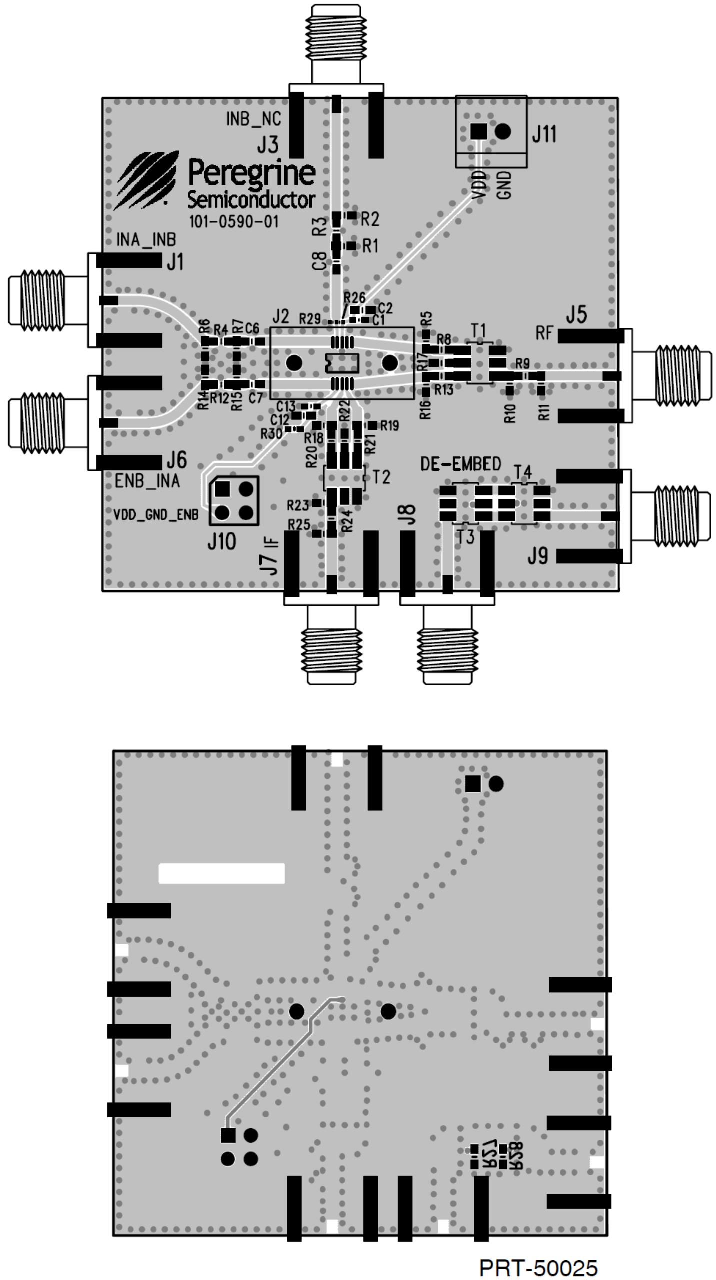

Figure 43. Evaluation board layout

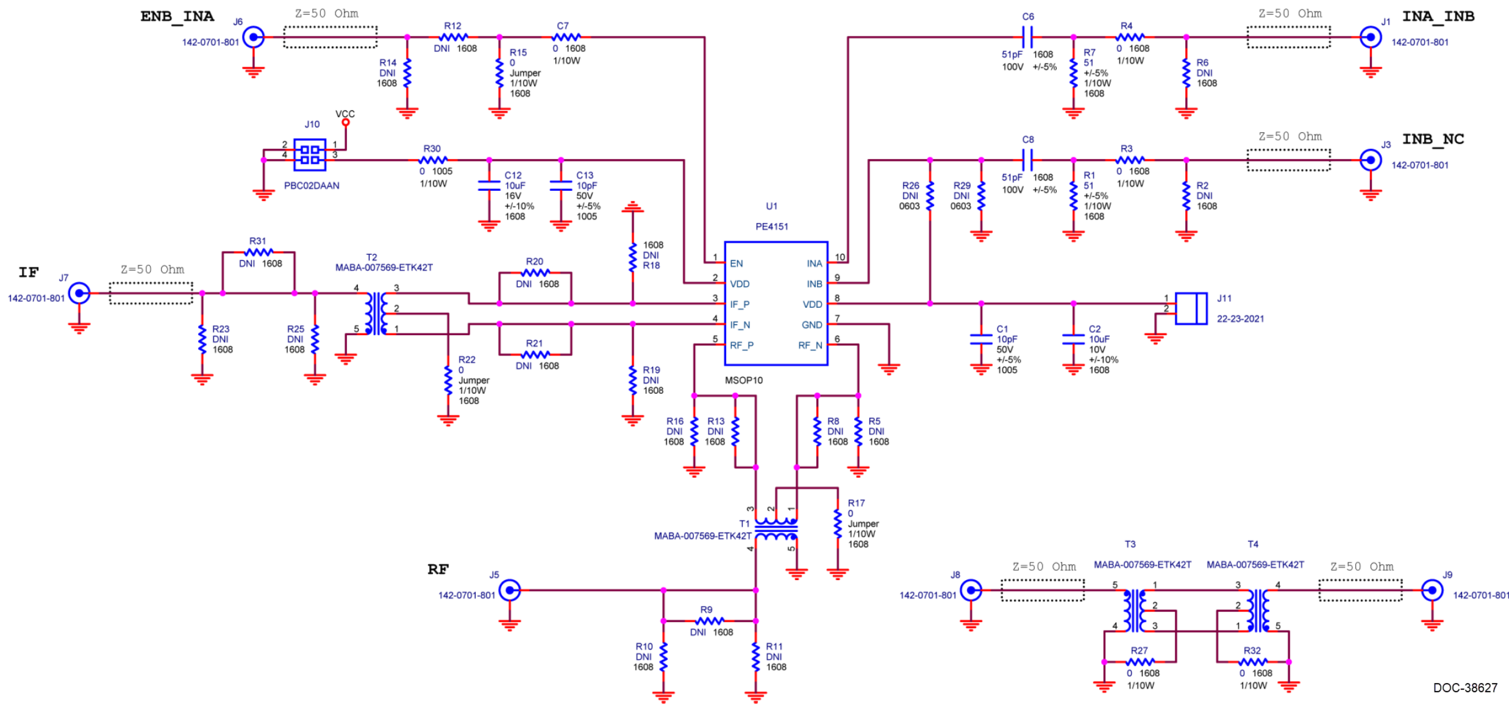

Figure 44. Evaluation board schematic

Contains parts and assemblies susceptible to damage by electrostatic discharge (ESD).

1. LO input can be differential or single ended (INA_INB/INB_NC).
2. With single-ended LO input, no termination is needed on the unused port.

Packaging information

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

Moisture sensitivity level

The PE4151 moisture sensitivity level rating for the 10-lead MSOP package is MSL1.

Package drawing

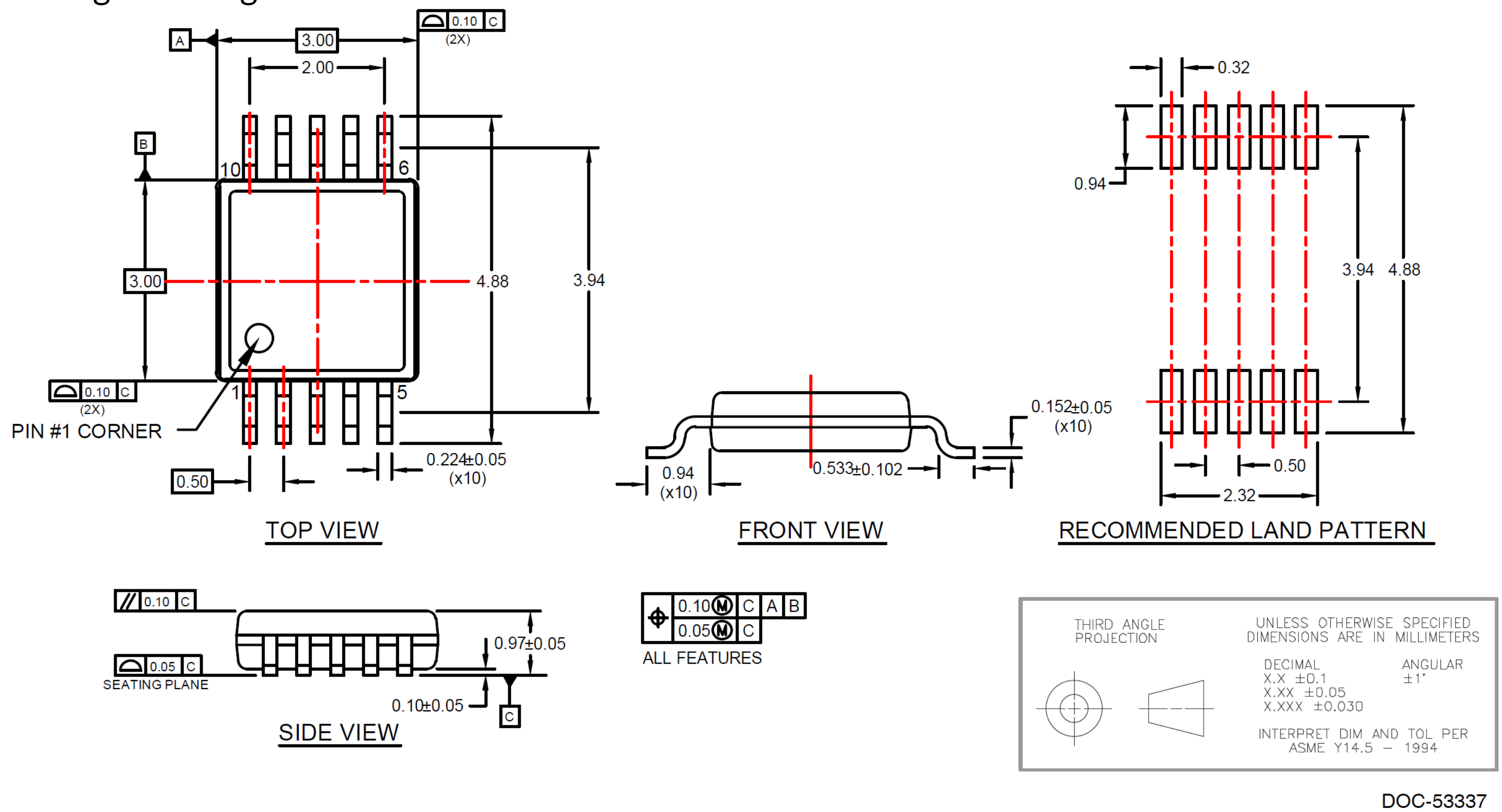

Figure 45. Package mechanical drawing for the 10-lead MSOP package

Top-marking specification

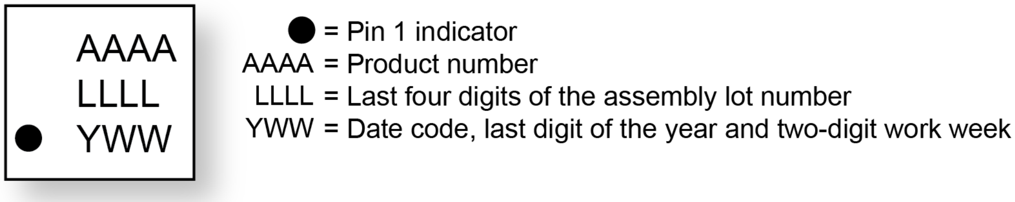

Figure 46. PE4151 package marking specification

Tape and reel specification

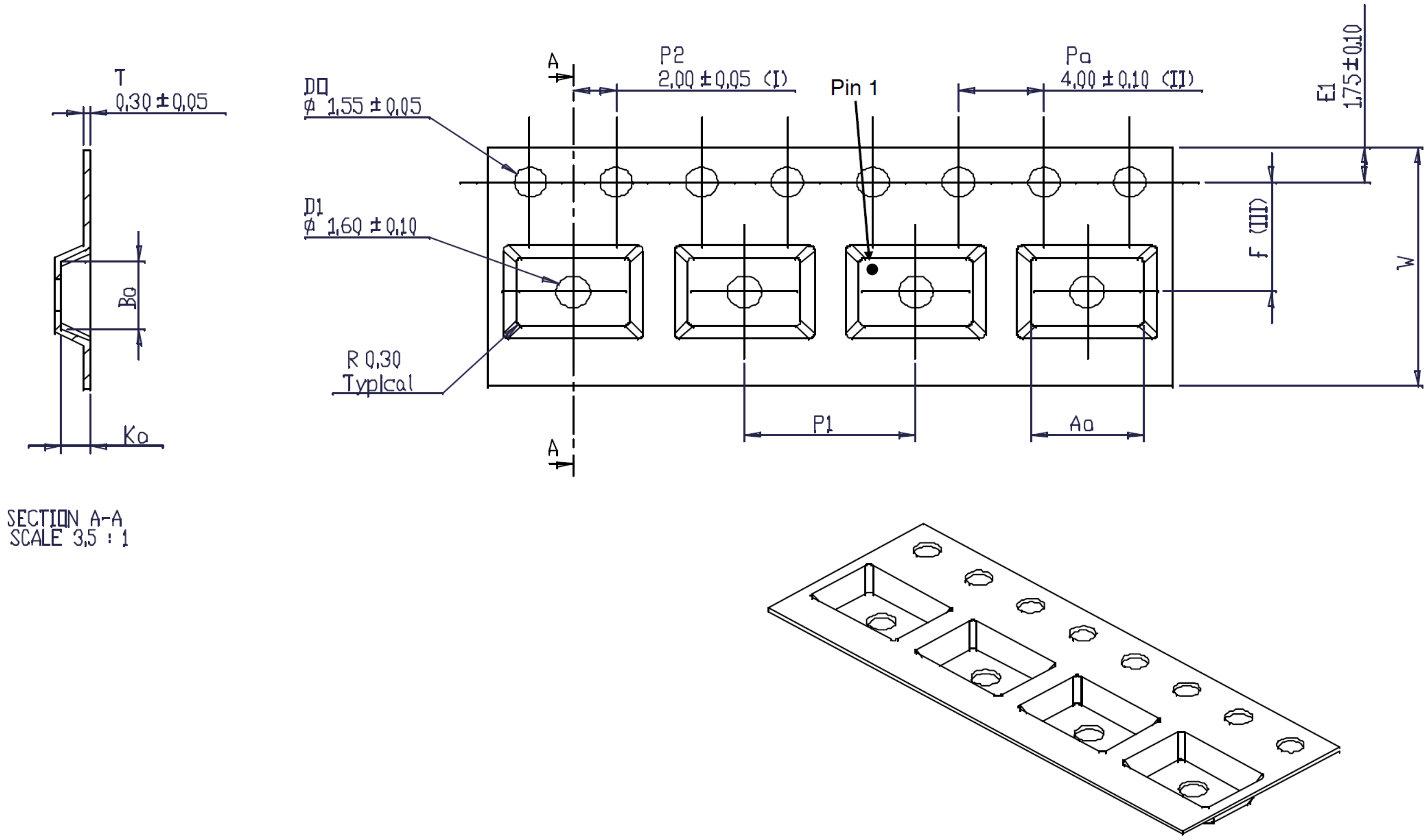

Figure 47. Tape and reel specification for the 10-lead MSOP package

- The diagram is not drawn to scale.
- The units are in millimeters (mm).
- The maximum cavity angle is five degrees.
- The bumped die is oriented active side down.

Table 5. Tape and reel dimensions

Carrier tape dimensions		
Pocket	**Nominal**	**Tolerance**
Ao	5.30	±0.10
Bo	3.40	±0.10
Ko	1.40	±0.10
F	5.50	±0.05
P1	8.00	±0.10
W	12.00	±0.30

Ordering information

Table 6. PE4151 order codes and shipping methods

Order code	Description	Packaging	Shipping method
PE4151B-Z	Low-frequency passive mixer with LO amplifier	Green 10-lead MSOP	3000 units/T&R
EK4151-02	PE4151 evaluation board	Evaluation kit	1/box

Document categories

Advance Information	The product is in a formative or design stage. The data sheet contains design target specifications for product development. Specifications and features may change in any manner without notice.
Preliminary Specification	The data sheet contains preliminary data. Additional data may be added at a later date. pSemi reserves the right to change specifications at any time without notice to supply the best possible product.
Product Specification	The data sheet contains final data. In the event that pSemi decides to change the specifications, pSemi will notify customers of the intended changes by issuing a Customer Notification Form (CNF).
Product Brief	This document contains a shortened version of the data sheet. For the full data sheet, contact sales@psemi.com.

Contact and legal information

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