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TRX_024_06

24 GHz Highly Integrated IQ Transceiver (Silicon Germanium Technology)

Preliminary Data Sheet

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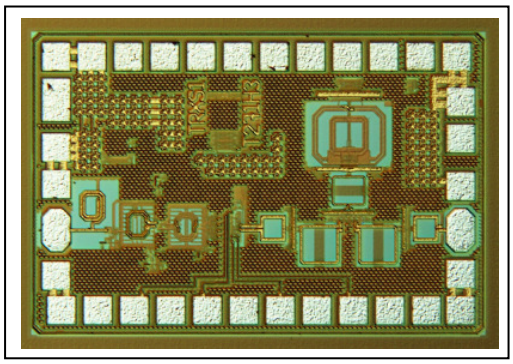
0.2	TRX_024_06_02	Data Sheet TRX_024_06	1 of 16

Table of Contents

List of Tables

List of Figures

1 Features



- Radar transceiver for 24 GHz ISM band
- Single supply voltage of 3.3V
- Fully ESD protected device
- Low power consumption 300mW
- Integrated low phase noise Push-Push VCO
- Transmitter with power control in four steps
- Receiver with homodyne quadrature mixer
- Low-noise-amplifier (LNA) with gain control
- Single ended TX output
- Single ended RX input
- QFN-20 leadless plastic package 3x3mm2
- Pb-free (RoHS compliant) package
- IC is available as bare die as well

1.1 Overview

The IC is an integrated transceiver circuit for the 24 GHz ISM-band in the frequency range 24.0GHz – 24.25GHz. It includes a low-noise-amplifier (LNA) with gain control, quadrature mixers, poly-phase filter, Voltage Controlled Oscillator with digital band switching and divide by 32 circuit. The receiver can be powered down if PWR_RX pin is supplied with 0V. The gain of the receiver can be digitally controlled by Vct pin, Vct = 3.3 V sets the receiver in high gain modus, Vct = 0 V sets the receiver in low gain modus. The output power of the transmitter can be controlled by pwr0 and pwr1 inputs. The IC is fabricated in SiGe BiCMOS technology by using the bipolar part and the CMOS part.

1.2 Applications

The main use of the TRX transceiver IC in wireless communication systems and in radar systems for the ISM-band from 24.0 GHz to 24.25 GHz and for UWB-applications between 23GHz and 29GHz.

2 Block Diagram

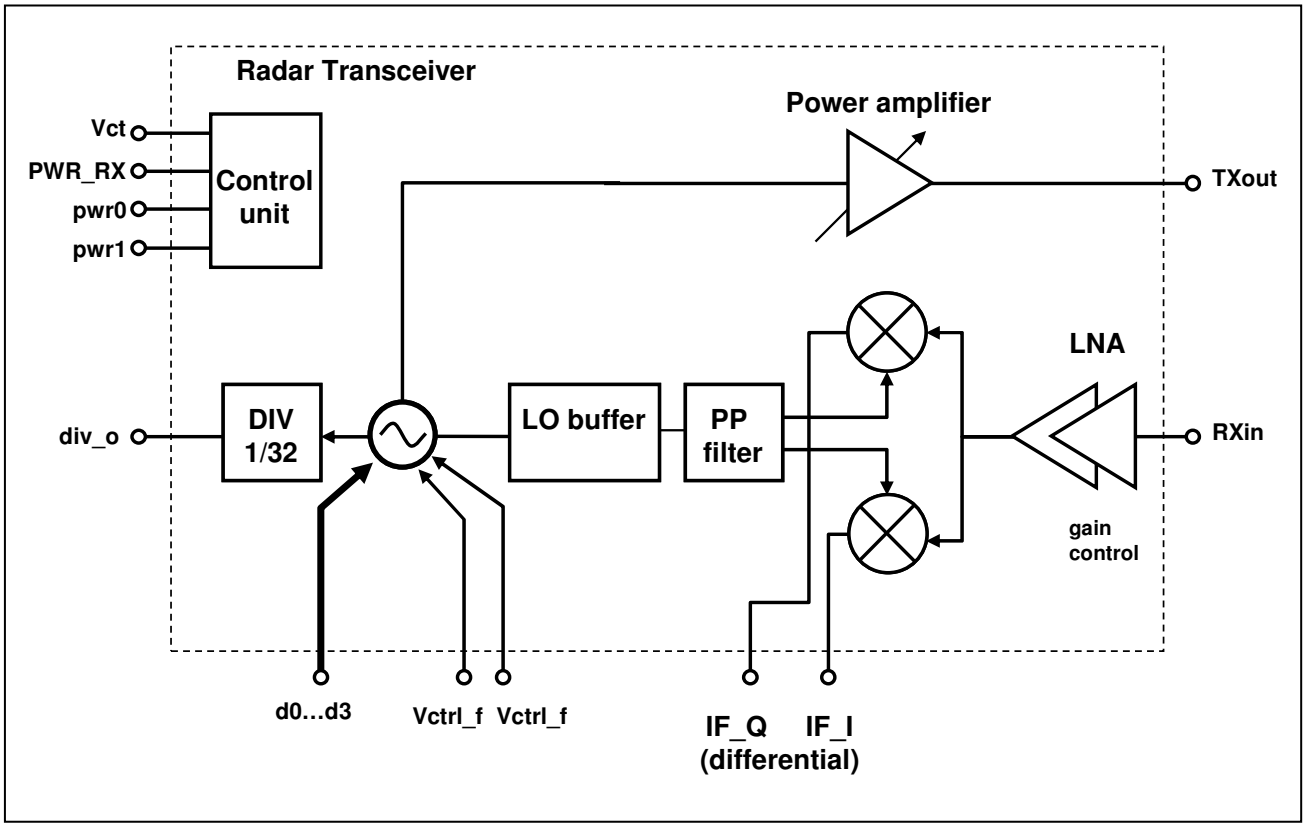


Figure 1 TRX_024_06 Block Diagram

3 Electrical Characteristics

3.1 Absolute Maximum Ratings

T_A= 25°C unless otherwise noted

Table 1 Absolute Maximum Ratings

Parameter	Symbol	Min.	Typ.	Max.	Unit	Remarks / Condition
Supply Voltage	V_{cc}	+3.0	+3.3	+3.6	V	to GND
DC voltage at RF Pins	V_{DCRF}	0	-	0.002	V	IC provides low ohmic circuit to GND for TXout and RXin
Operating temperature range	T_{use}	-40	-	+85	°C	Industrial
Storage temperature range	T_{store}	-65	-	+150	°C	
Junction temperature	T_{junc}			+150	°C	
Input power into pin RFin	P_{IN}	-	-	0	dBm	
DC voltage at control inputs	V_{ctl}	0	-	3.3	V	d0, d1, d2, d3, Vctrl
Supply current consumption	I_{CC}	-	80	94	mA	@ 3.3V Vcc

Attempted operation outside the absolute maximum ratings of the part may cause permanent damage to the part. Actual performance of the IC is only guaranteed within the operational specifications, not at absolute maximum ratings.

3.2 Thermal Resistance

Table 2 Thermal Resistance

Parameter	Symbol	Min.	Typ.	Max.	Unit	Remarks / Condition
Thermal resistance from junction to soldering point	R_{thJS}	-	-	50	K/W	see application notes

3.3 ESD Integrity

Table 3 ESD Integrity

Parameter	Symbol	Min.	Typ.	Max.	Unit	Remarks / Condition
ESD robustness of TXout, RFin	V_{ESD}	1,3	-	2	kV	All RF-Pins [1)]
ESD robustness of all low frequency and DC pins	V_{ESD}	1,3		2	kV	

1) According to ESDA/JEDEC Joint Standard for Electrostatic Discharge Sensitivity Testing, Human Body Model (HBM) Component Level, ANSI/ESDA/JEDEC JS-001-2011

4 RF Characteristics

4.1 Transmitter Section TX

T_A= -40℃ + 85℃ unless otherwise noted

Table 4 Typical Characteristics Transmitter Section

Parameter	Symbol	Min.	Typ.	Max.	Unit	Remarks / Condition
Transmitter frequency range	f_{TX}	22.60		25.97	GHz	
Tuning voltage VCO	V_{ctrl}	0.0	-	3.0	V	
Tuning slope VCO	$\Delta f_{TX}/\Delta V_{ctrl}$					
Number adjustable frequency bands		-	16	-	-	d0 – d3: VCO band switching, each input with internal pull-down resistor (120 kOhm)
Pushing VCO	$\Delta f_{TX}/\Delta V_{CC}$				MHz/V	@ f = 24,15 GHz
Phase Noise	P_N	-	-102	-105	dBc/Hz	@ 1MHz offset
Output impedance	Z_{TXout}		50		Ω	
Transmitter output power	P_{TX}	2.5	4	6	dBm	
Adjustable range output power	P_{TX_ADJ}	-10		6	dBm	Power Amplifier Gain control bits 11 – P_{out_max} 10 – P_{out_max} – 2 dBm 01 – P_{out_max} – 10 dBm 00 – OFF
Divider division ratio	D_{div_o}	-	32	-	-	-
Divider output power	P_{div_o}	-7	-5	-4	dBm	Divider output loaded with 50Ω, DC coupled, external decoupling capacitor required (min 100pF)
Divider output frequency range	f_{div_o}	706		811	MHz	
Divider output voltage					V	
Divider output source current					mA	
Divider output sink current					mA	

4.2 Receiver Section RX

T_A= -40°C + 85°C unless otherwise noted

Table 5 Typical Characteristics Receiver Section

Parameter	Symbol	Min.	Typ.	Max.	Unit	Remarks / Condition
Receiver frequency range	f_{RX}	22.60	-	25.97	GHz	
Receiver input impedance	Z_{RXIN}		50		Ω	
Number adjustable gain modes			2			Adjustable LNA gain control (internal pull-up resistor)
Gain high gain mode				18	dB	V_{ct}=3.3 V
Gain low gain mode				11	dB	V_{ct}=0 V
IF frequency range	f_{IF}	0	-	200	MHz	
IF output impedance			47Ω		Ω	differential
IF 1/f corner frequency						tbd
IQ amplitude balance			0.5		dB	
IQ phase balance			10		deg	
Noise figure (DSB) high gain mode			4		dB	Simulated (Double side band @ f_{IF}=1MHz)
Noise figure (DSB) low gain mode			6	-	dB	Simulated
Input Compression Point		-20	-	-13	dBm	
Input 3rd order intercept point						tbd

5 Application Circuit

5.1 Chip Outline

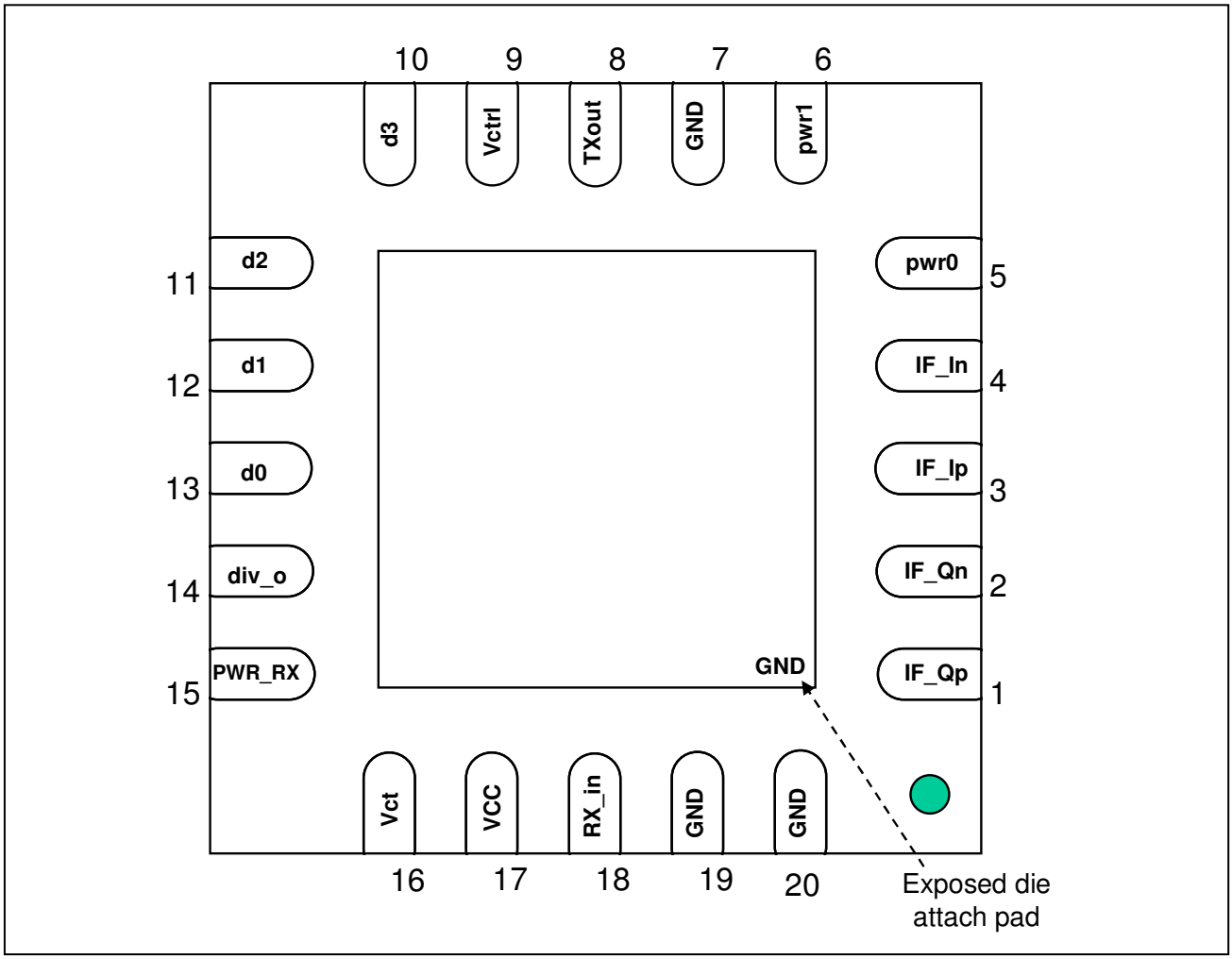


Figure 2 TRX_024_06 Chip outline (top view)

5.2 Pin Description

Table 6 Pin Description

Pin No.	Name	Description
1	IF_Qp	IF Outputs, DC coupled, external AC coupling capacitors required
2	IF_Qn	
3	IF_Ip	
4	IF_In	
5	pwr0	Power Amplifier Gain control bits (internal pull-up resistors) 11 – P_{out_max} 10 – P_{out_max} – 2 dBm 01 – P_{out_max} – 10 dBm 00 – OFF
6	pwr1	
7	GND	Ground
8	TXout	Transmitter output, 50Ω
9	Vctrl	VCO tuning
10	d3	VCO band switching, each input with internal pull-down resistor (12 kOhm)

11	d2	
12	d1	
13	d0	
14	div_o	Divider output, 50Ω, DC coupled, external decoupling capacitor required (min 100pF)
15	PWR_RX	Receiver Enable (internal pull-up resistor)
16	Vct	LNA gain control (internal pull-up resistor)
17	vcc	Supply voltage
18	RXin	RF input, 50Ω
19	GND	Ground
20	GND	Ground
21	GND	Die attach pad to ground

5.3 Application Circuit Schematic

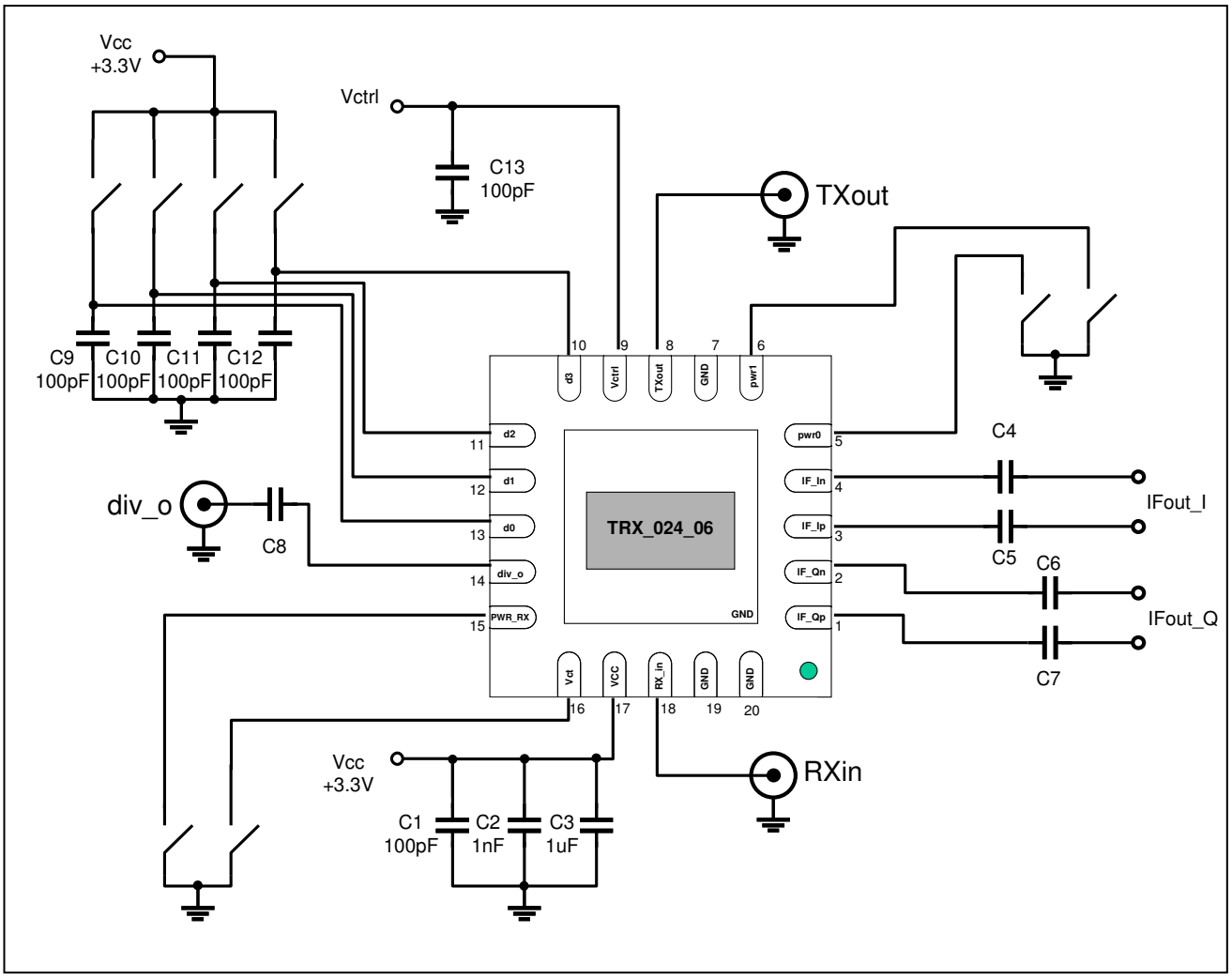


Figure 3 TRX_024_06 Application Circuit (Top view)

5.4 Evaluation Board

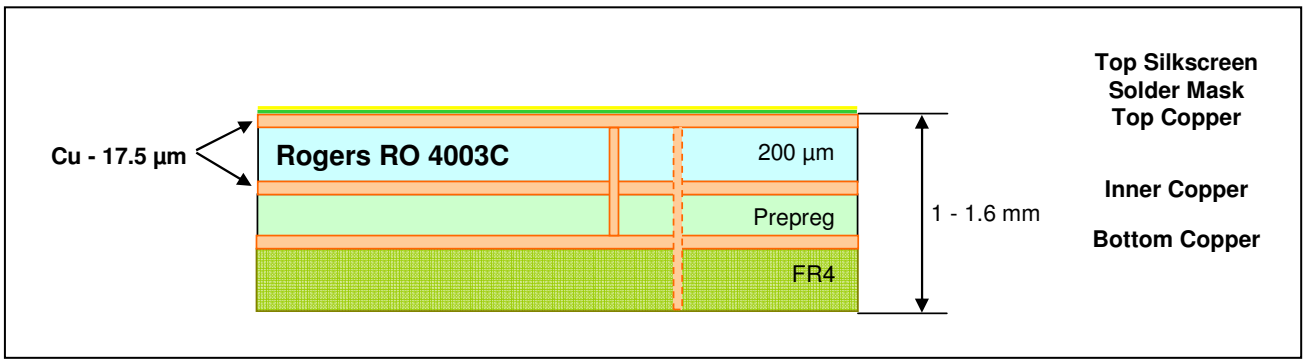


Figure 4 TRX_024_06 Evaluation board stack-up

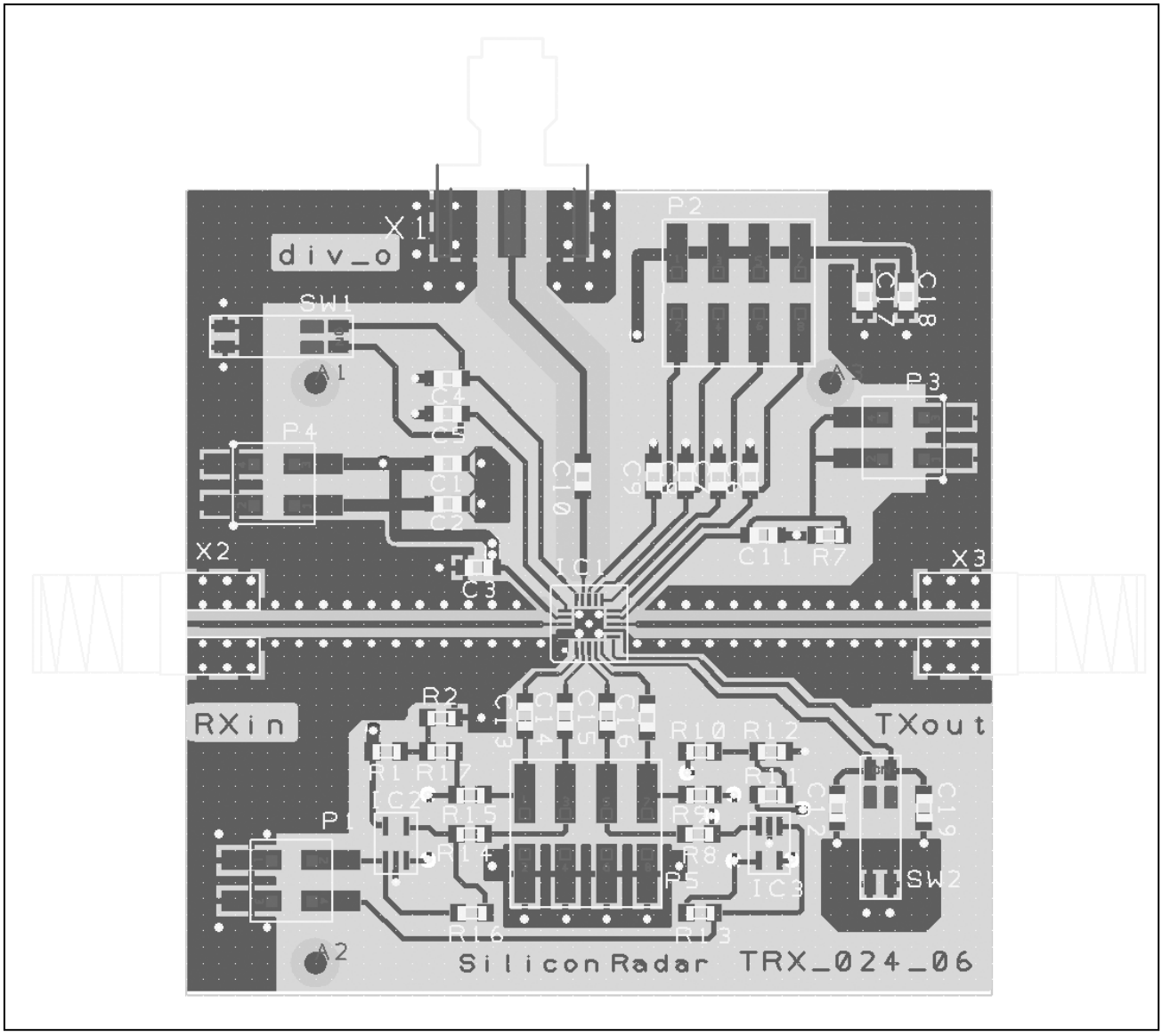
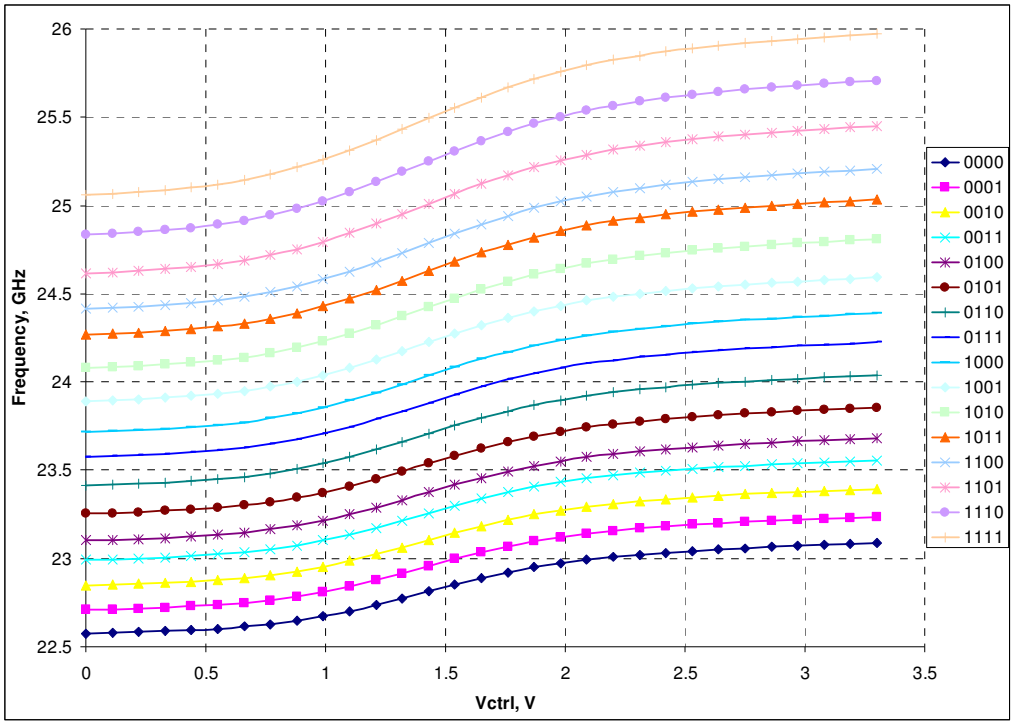


Figure 5 TRX_024_06 Evaluation Board Layout (Top view) including via holes

6 Measurement Results



Frequency bands of integrated oscillator

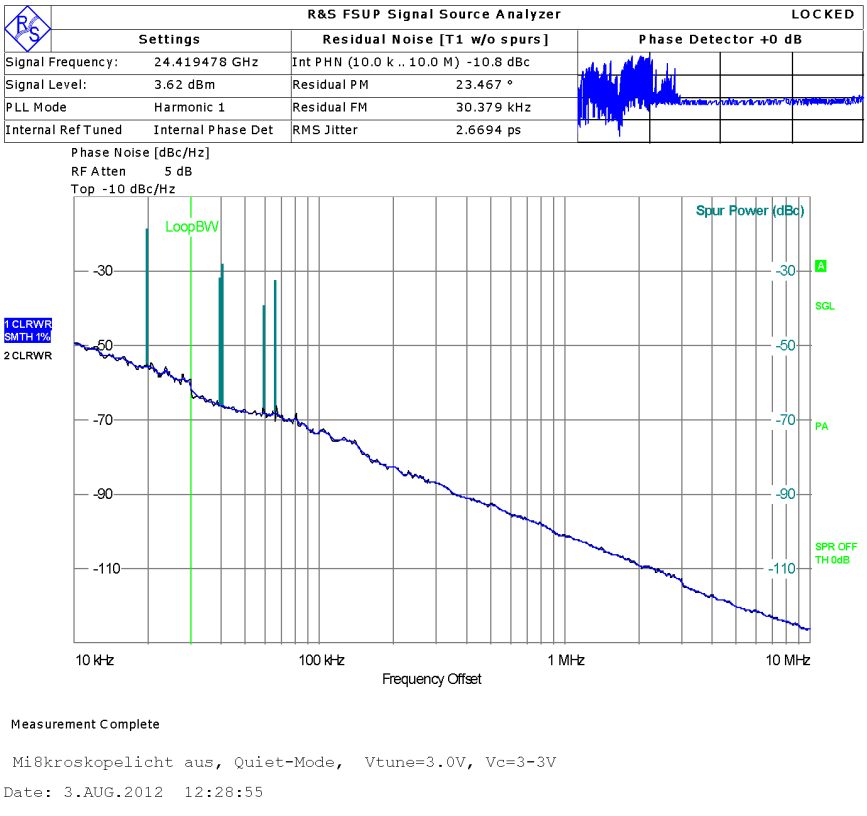
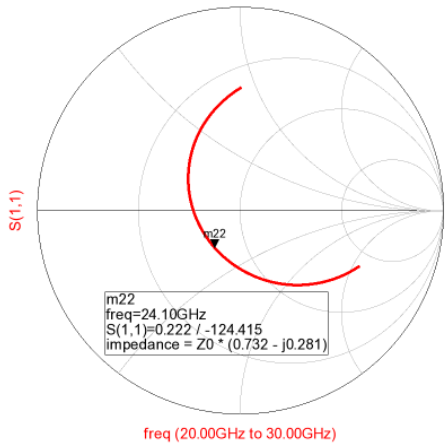
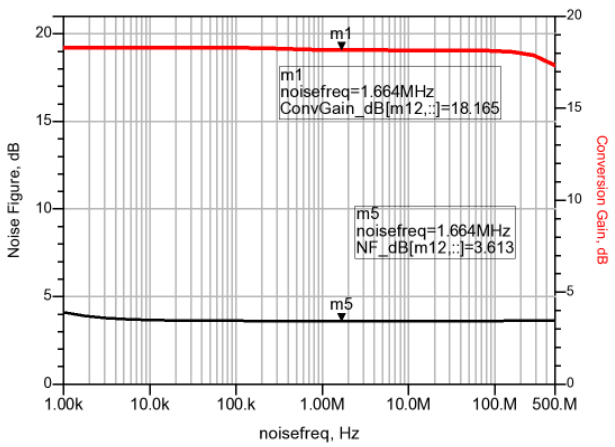


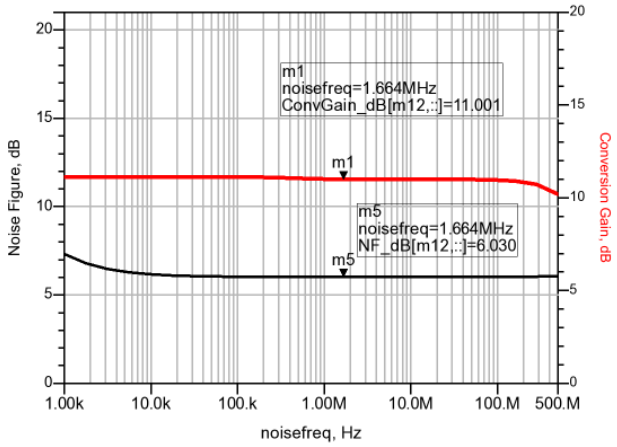
Figure 6 TRX_024_06 Measurement results

7 Simulation Results

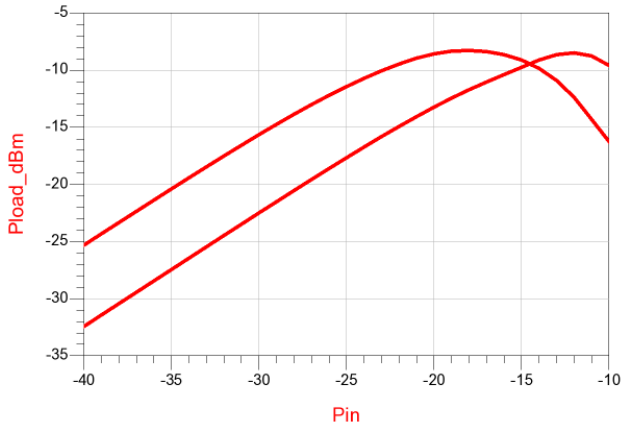




Simulated conversion gain and noise figure (DSB) of the receiver in High-Gain modus



Simulated conversion gain and noise figure (DSB) of the receiver in Low-Gain modus

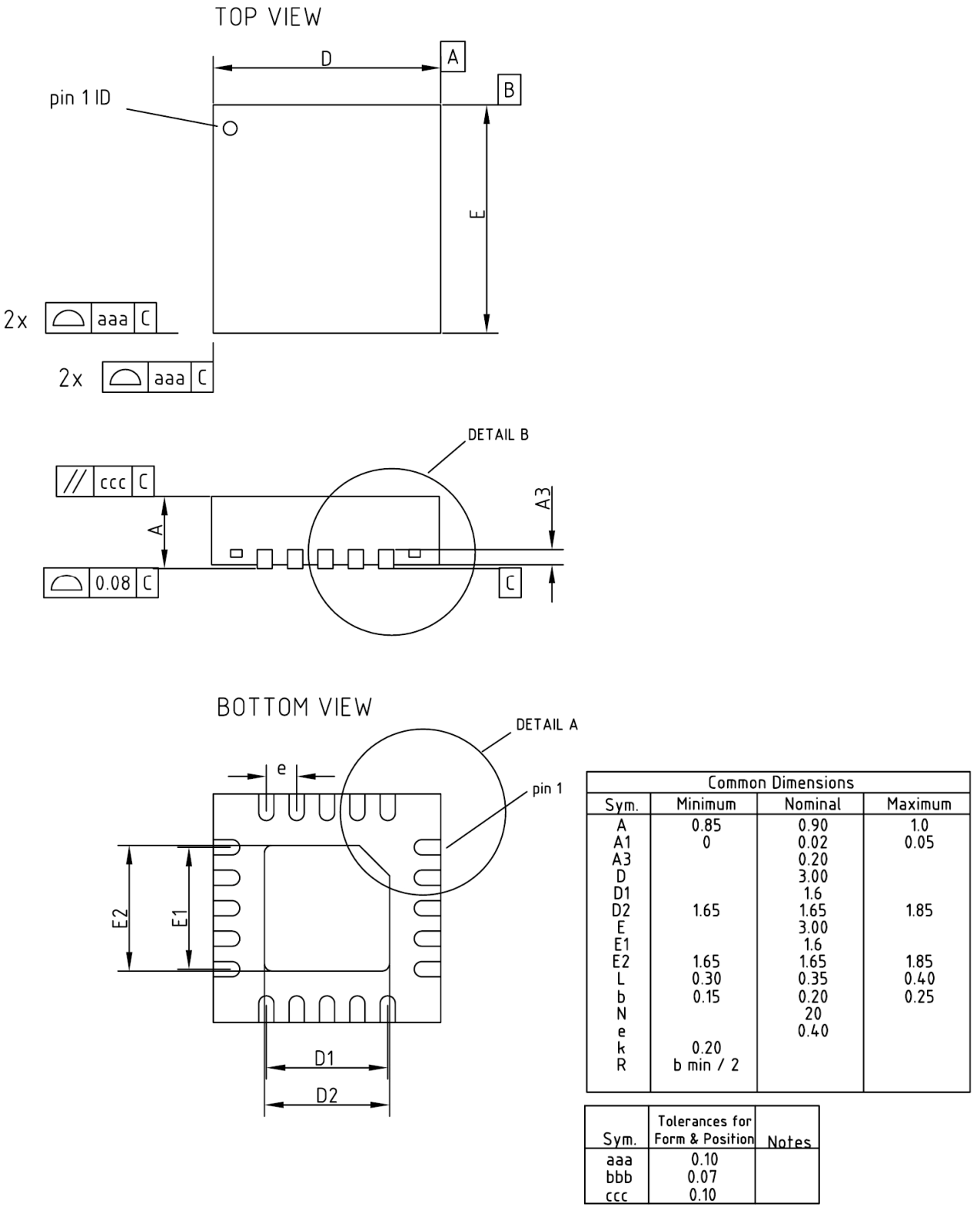


Simulated linearity of the receiver in High- and Low-Gain modus

Figure 7 TRX_024_06 Measurement results

8 Physical Characteristics

8.1 Mechanical Data QFN

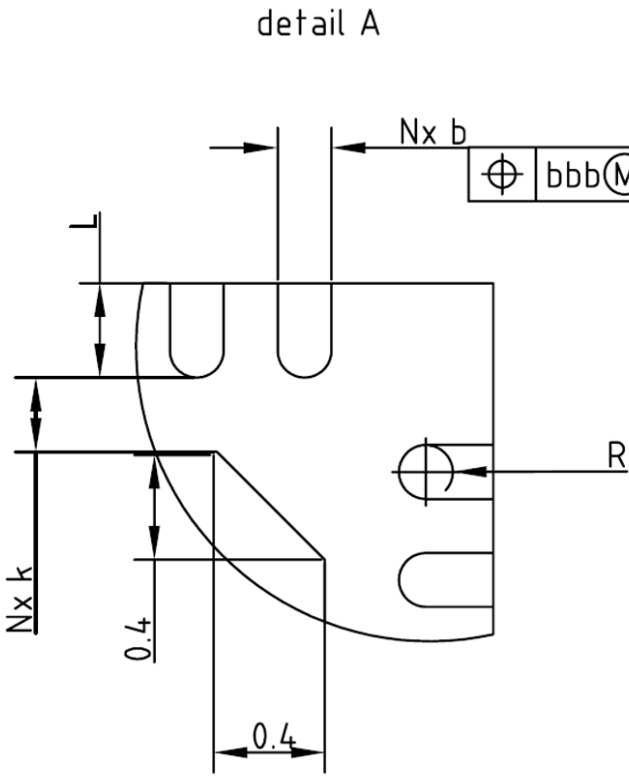


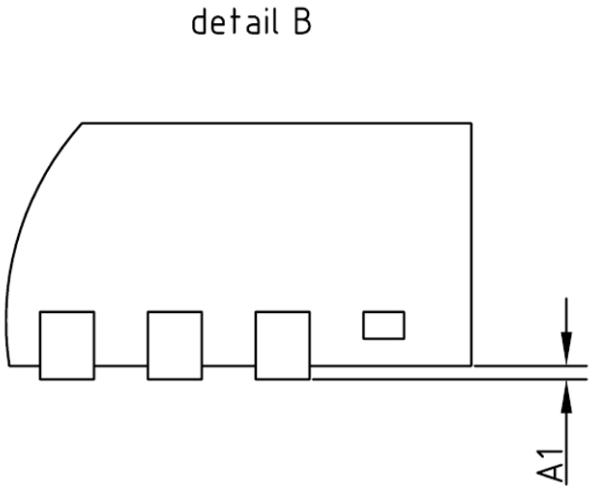
Common Dimensions			
Sym.	Minimum	Nominal	Maximum
A	0.85	0.90	1.0
A1	0	0.02	0.05
A3		0.20	
D		3.00	
D1		1.6	
D2	1.65	1.65	1.85
E		3.00	
E1		1.6	
E2	1.65	1.65	1.85
L	0.30	0.35	0.40
b	0.15	0.20	0.25
N		20	
e		0.40	
k	0.20		
R	b min / 2		

Sym.	Tolerances for Form & Position	Notes
aaa	0.10	
bbb	0.07	
ccc	0.10	

Figure 8 Mechanical data QFN 20Lead 3x3mm 0.4 pitch

8.2 Mechanical Data QFN





Common Dimensions			
Sym.	Minimum	Nominal	Maximum
A	0.85	0.90	1.0
A1	0	0.02	0.05
A3		0.20	
D		3.00	
D1		1.6	
D2	1.65	1.65	1.85
E		3.00	
E1		1.6	
E2	1.65	1.65	1.85
L	0.30	0.35	0.40
b	0.15	0.20	0.25
N		20	
e		0.40	
k	0.20		
R	b min / 2		

Sym.	Tolerances for Form & Position	Notes
aaa	0.10	
bbb	0.07	
ccc	0.10	

Figure 9 Mechanical data details QFN 20Lead 3x3mm 0.4 pitch

8.3 Package Footprint

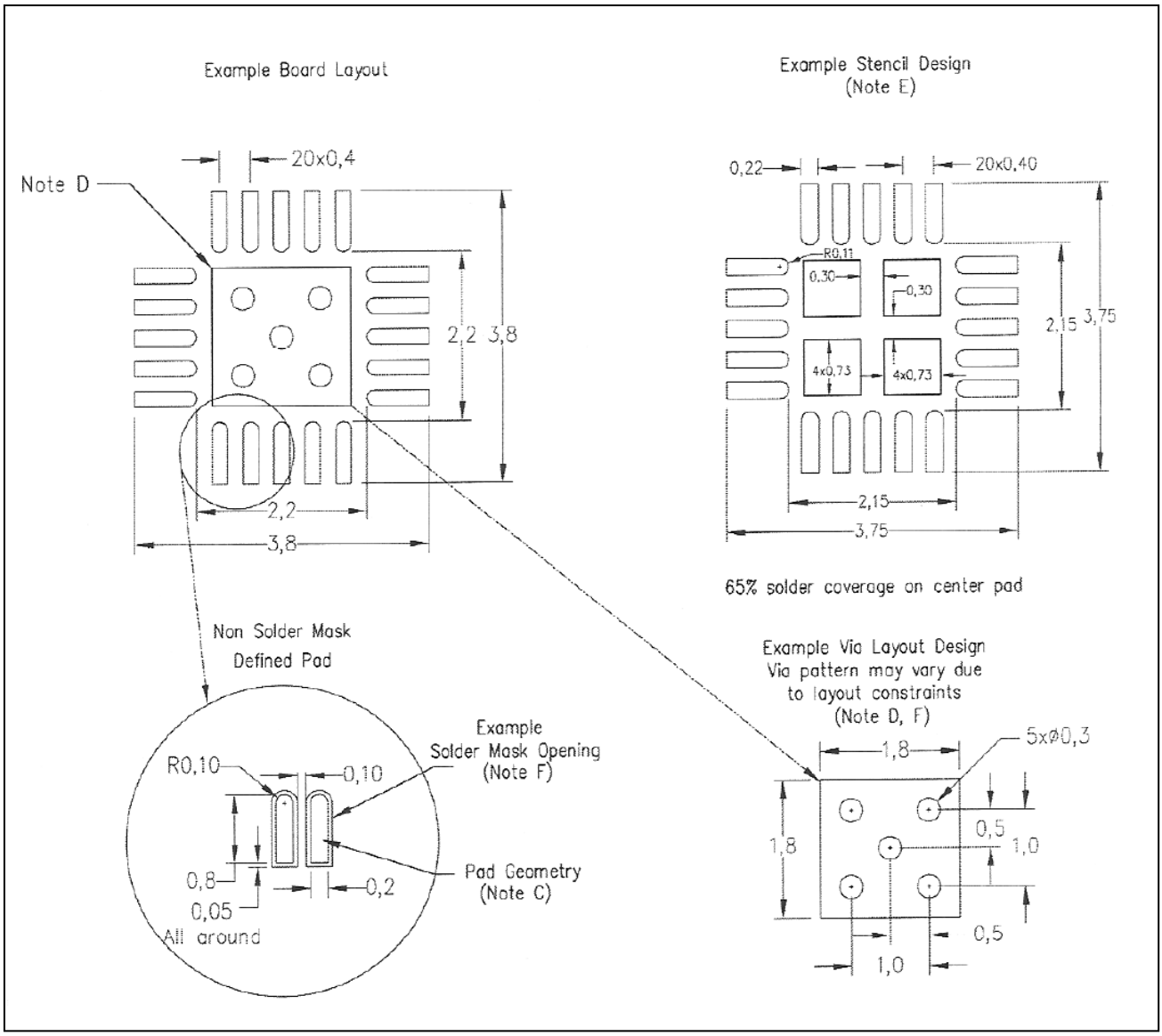


Figure 10 TRX_024_06 Package Footprint and Example Stencil Design

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