gTSC0023 B
E-band TX MMIC
71-86 GHz

Features

- Full E-band coverage
- 21 dB conversion gain
- 25 dB gain control range
- 16/26 dBm P1dB/OIP3
- Direct conversion or IF up conversion

Typical Applications

- E-band point-to-point radio
- Active imaging
- Automotive radar
- Fiber over radio

Description

gTSC0023 is a complete highly integrated transmitter for E-band radio applications. The transmitter offers more than 25 dB gain control (from the VGA and MPA) to compensate for temperature dependent gain variations. The transmitter has a ×6 frequency multiplier, IQ mixer, VGA, power amplifier and envelope/power detector integrated on the chip. The differential IQ mixer is highly linear with low conversion loss. The frequency multiplier has low spuriouses and flat output power throughout the entire E-band. The medium power amplifier (MPA) at the output delivers more than 16 dBm (P1dB) output power. The output envelope/power detector can be used for both power and envelope tracking thanks to its wide output bandwidth. The TSC0023B is suitable for wideband high modulation Gbit/s communications.

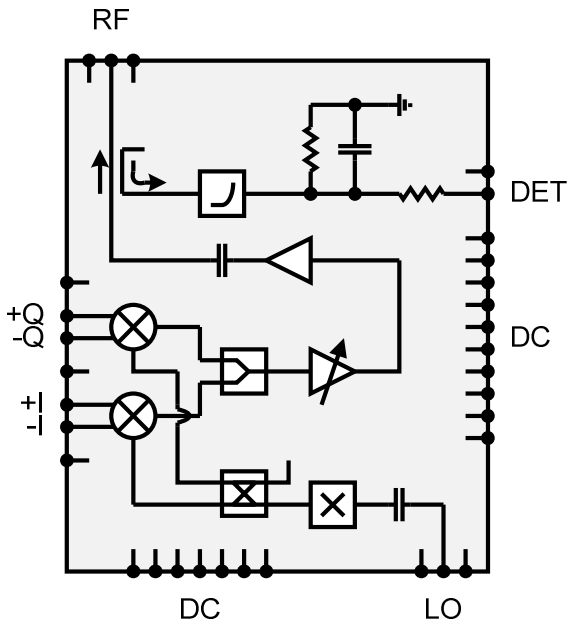

Figure 1. Block diagram of the transmitter.

Gotmic AB, Arvid Hedvalls Backe 4, S-411 33 Göteborg, Sweden. Tel: +46 (0) 31 184 030
http://www.gotmic.se/

ELECTRICAL PERFORMANCE

Table 1. Electrical performance T_A=25°C

Parameter	Min	Typ	Max	Unit
RF frequency	71		86	GHz
IF frequency	DC		12	GHz
LO input frequency	11.8		14.3	GHz
LO input power	8	10	12	dBm
LO multiplication factor		6		
Max conversion gain[1]	18	21	23	dB
Gain control range	25			dB
LO to RF suppression[2]	40	45		dBc
Image rejection ratio (IRR)	20			dB
P1dB[3]	14	16	18	dBm
PSAT[3]	17	19	21	dBm
OIP3[3]	24	26		dBm
OIP2[2,3]	40	50		dBm
Out of band spuriouses			-40	dBm
RF return loss	8	10		dB
LO return loss	10	14		dB
Power consumption	1100	1200	1500	mW

MEASURED PERFORMANCE

The chip has been measured on-wafer using CW and 2-tone input test signals. The transmitter uses typical bias settings if not specified differently.

Table 2. Test conditions

Parameter	Setting
IF input power	-13 dBm/tone
IF input frequency	1 GHz
Frequency separation	10 MHz
Temperature	25°C

[1] Gain temperature coefficient is -0.05 dB/°C.

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

[3] At maximum gain. VGA drain current (ID1_VGA+ID2_VGA) = 100 mA.

Gotmic AB, Arvid Hedvalls Backe 4, S-411 33 Göteborg, Sweden. Tel: +46 (0) 31 184 030
http://www.gotmic.se/

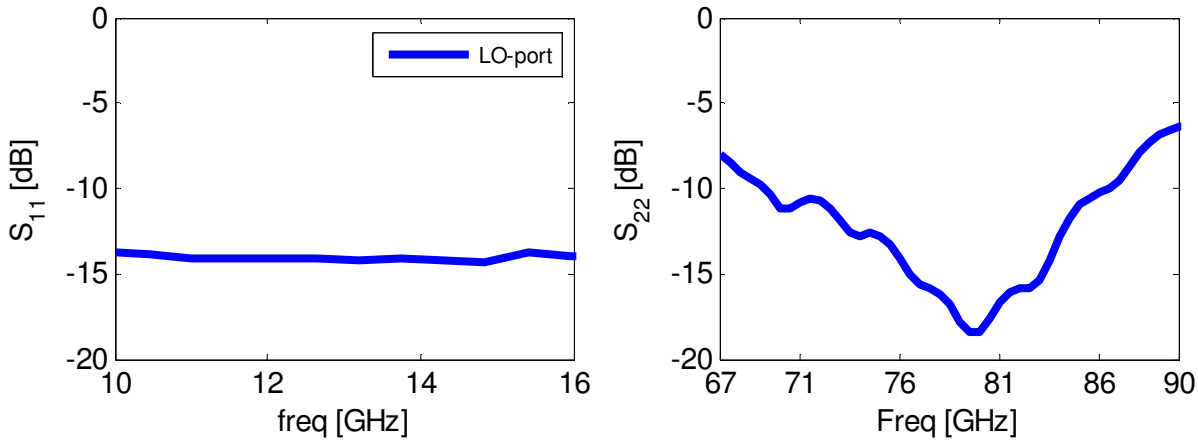

Figure 2. (Left): Input matching of the LO-port. (Right): Output matching of the PA.

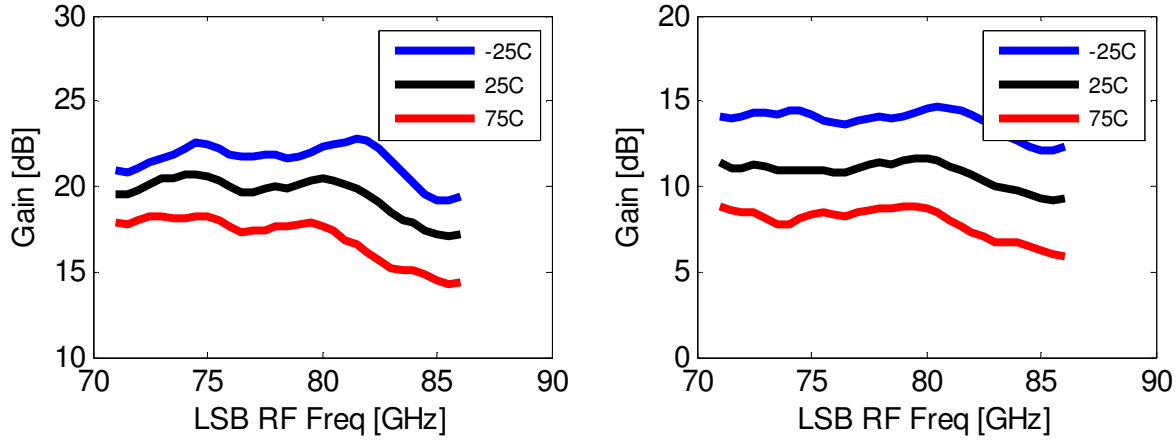

Figure 3. (Left): Maximum conversion gain vs frequency (ID1_VGA + ID2_VGA is 100 mA). (Right): Intermediate conversion gain vs frequency (ID1_VGA + ID2_VGA is 15 mA).

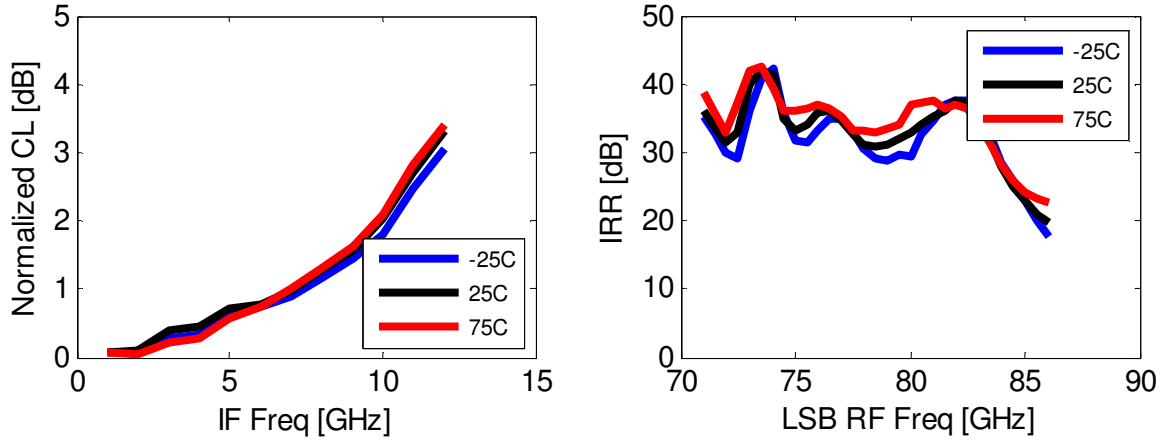

Figure 4. (Left): IF BW measured at a fixed RF frequency of 71 GHz (Right): IRR vs frequency. (ID1_VGA + ID2_VGA is 100 mA).

Gotmic AB, Arvid Hedvalls Backe 4, S-411 33 Göteborg, Sweden. Tel: +46 (0) 31 184 030
http://www.gotmic.se/

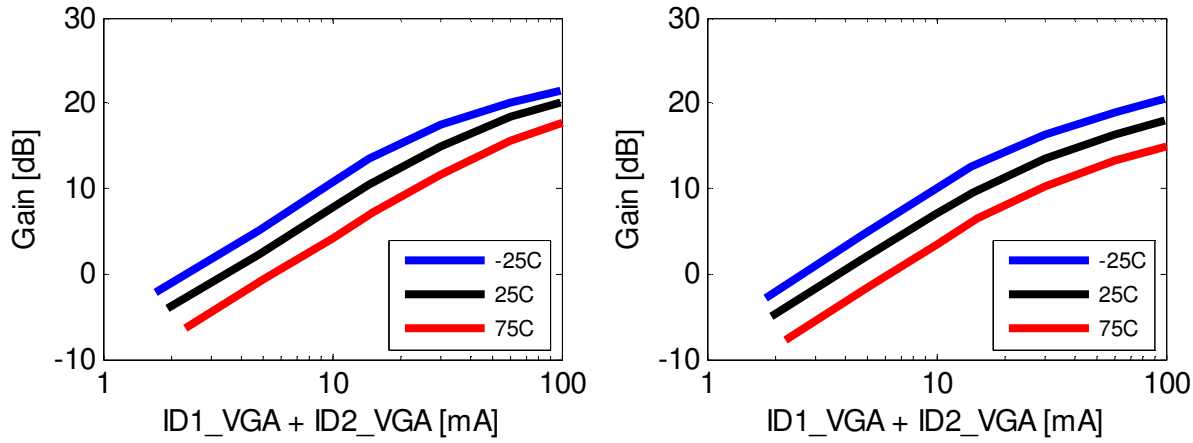

Figure 5. (Left): Gain vs VGA drain current, measured at 73.5 GHz. (Right): 83.5 GHz.

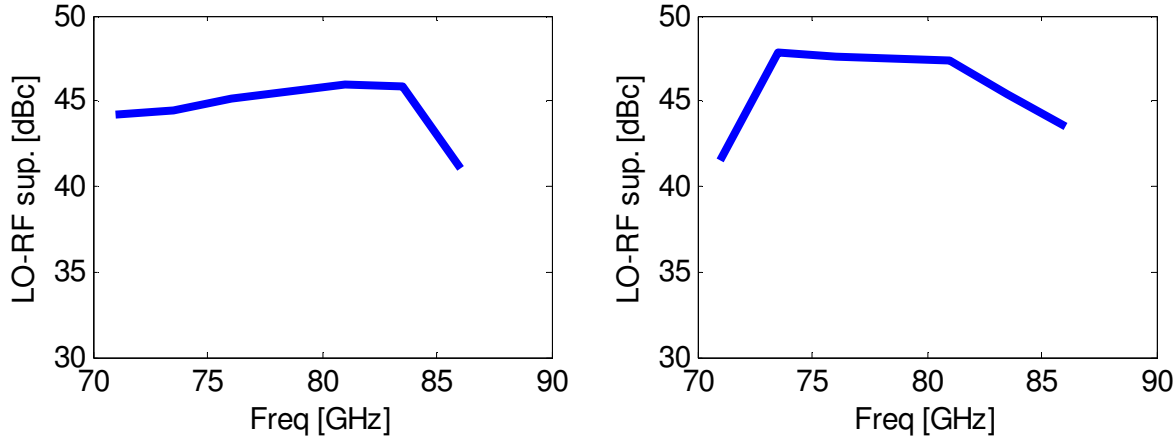

Figure 6. (Left): LO to RF suppression at maximum gain (ID1_VGA + ID2_VGA = 100 mA). (Right): LO to RF supr. at intermediate gain (ID1_VGA + ID2_VGA = 15 mA). IQ DC offset is applied to cancel the LO.

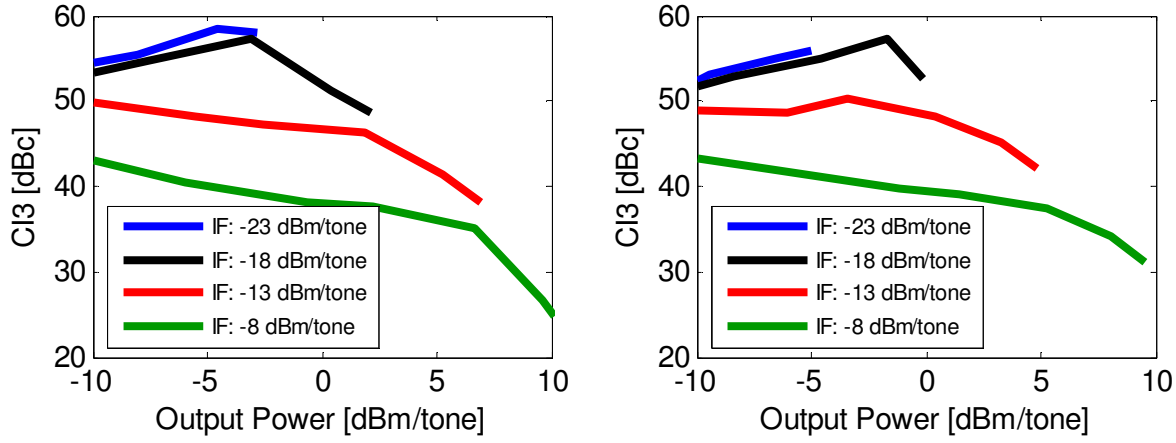

Figure 7. (Left): Third order intermodulation measured at 73.5 GHz, while varying the gain of the VGA to adjust the output power level. (Right): Measured at carrier frequency 83.5 GHz.

Gotmic AB, Arvid Hedvalls Backe 4, S-411 33 Göteborg, Sweden. Tel: +46 (0) 31 184 030
http://www.gotmic.se/

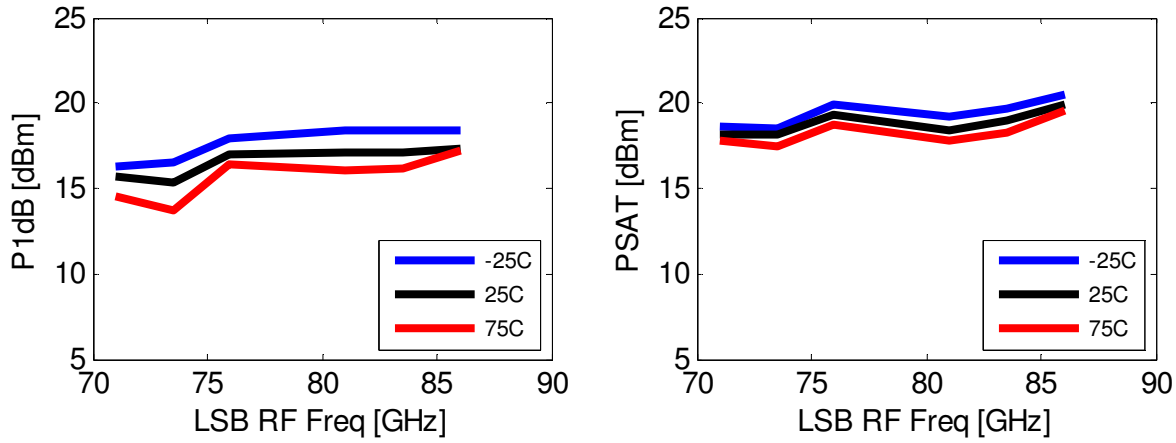

Figure 8. (Left): P1dB at max gain vs freq. (Right): PSAT at max gain vs freq. (ID1_VGA + ID2_VGA is 100 mA)

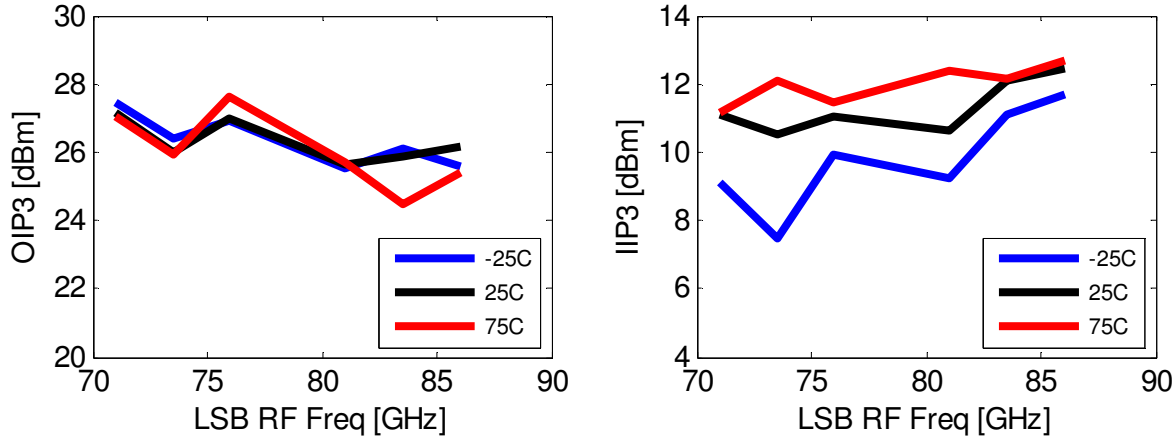

Figure 9. (Left): OIP3 vs frequency at maximum gain (ID1_VGA + ID2_VGA = 100 mA). (Right): IIP3 vs frequency measured at intermediate gain (ID1_VGA + ID2_VGA = 15 mA).

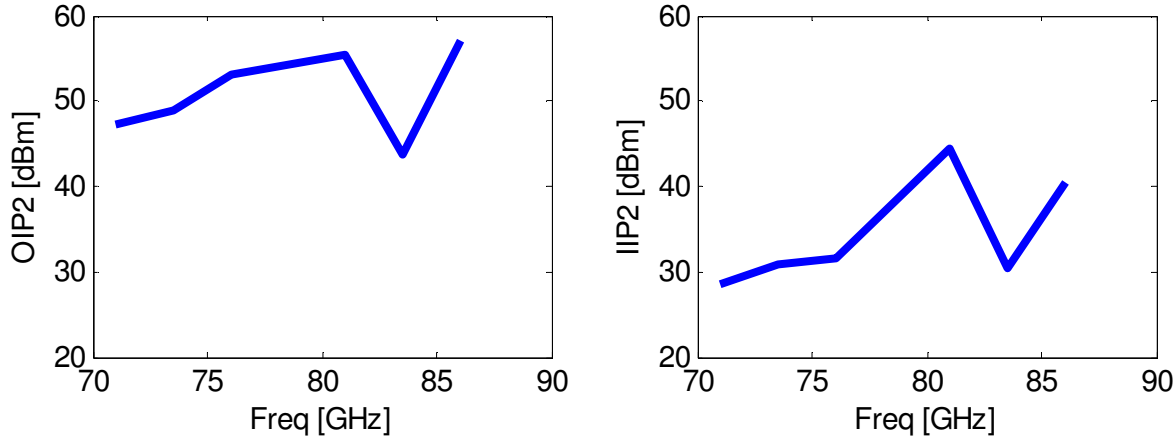

Figure 10. (Left): 2nd order intercept point (OIP2) at maximum gain (ID1_VGA + ID2_VGA is 100 mA). (Right): 2nd order intercept point (IIP2) at intermediate gain (ID1_VGA + ID2_VGA is 15 mA).

Gotmic AB, Arvid Hedvalls Backe 4, S-411 33 Göteborg, Sweden. Tel: +46 (0) 31 184 030
http://www.gotmic.se/

RECOMMENDED OPERATING CONDITIONS

Bias should first be applied to the gates (VG…) followed by the drains (VD…). The gate voltages must be adjusted within the min/max range indicated in Table 3-Table 7 to obtain the specified drain currents. The drain currents are stated with all input signals off.

Table 3. Electrical settings on connector P1

Connector P1	Pad No.	Interface	I/O
GND	1		Ground
RF	2	Z_0 = 50 Ohm, AC coupled	Output
GND	3		Ground

Table 4. Electrical settings on connector P2

Connector P2	Pad No.	Bias settings (V/mA)			I/O
		Min	Typ[4]	Max	
VG1_VGA[5]	1	-1.2	-0.9	-0.4	Input
VD1_VGA[5]	2	3.2	3.3 / 7.5	3.4	Input
VG2_VGA[5]	3	-1.2	-0.9	-0.4	Input
VD2_VGA[5]	4	3.2	3.3 / 7.5	3.4	Input
VOUT_DET	5	0		VREF_DET	Output
VREF_DET	6		2.4		Output
GND	7				Ground
VG_DET	8	-1.1	-0.9	-0.7	Input
VD_DET	9	3.2	3.3 / <1	3.4	Input
VD1_PA	10	2.4	2.5 / 130	2.6	Input
VG1_PA	11	-0.5	-0.3	-0.1	Input
VG2_PA	12	-0.6	-0.4	-0.2	Input
VD2_PA	13	3.2	3.3 / 120	3.4	Input

[4] The gain is typically 12 dB when biasing the VGA at 15 mA (intermediate gain setting).

[5] Connect VG1_VGA together with VG2_VGA after a series 500 Ohm resistor on each gate. Connect VD1_VGA together with VD2_VGA.

Gotmic AB, Arvid Hedvalls Backe 4, S-411 33 Göteborg, Sweden. Tel: +46 (0) 31 184 030
http://www.gotmic.se/

Table 5. Electrical settings on connector P3

Connector P3	Pad No.	Interface	I/O
GND	1		Ground
LO	2	Z_0 = 50 Ohm, AC coupled	Input
GND	3		Ground

Table 6. Electrical settings on connector P4

Connector P4	Pad No.	Bias settings (V/mA)			I/O
		Min	Typ[4]	Max	
VG_MIX	1	-1.0	-0.8	-0.6	Input
VD_AMP	2	3.2	3.3 / 45	3.4	Input
VG_AMP	3	-0.6	-0.4	-0.2	Input
GND	4				Ground
VD_X2	5	3.2	3.3 / 10	3.4	Input
VD_X3	6	3.2	3.3 / 26	3.4	Input
VG_X2	7	-0.9	-0.8	-0.7	Input
VG_X3	8	-0.55	-0.45	-0.35	Input
NC	9				NC

Table 7. Electrical settings on connector P5

Connector P5	Pad No.	Interface	I/O
GND	1		Ground
Q+	2	Z_0 = 100 Ohm differential impedance, DC coupled	Input
Q-	3		Input
GND	4		Ground
I+	5	Z_0 = 100 Ohm differential impedance, DC coupled	Input
I-	6		Input
GND	7		Ground

ABSOLUTE MAXIMUM RATINGS

Table 8. Absolute Maximum Ratings

Parameter	
Gate-source voltage	-2 to +0.7 V
Drain-source voltage	4.5 V
Gate-drain breakdown voltage	8 V
ID1_VGA, ID1_VGA	50 mA
ID1_PA, ID2_PA	200 mA
ID_AMP, ID_X2	80 mA
ID_X3	60 mA
IF in (I+, I-, Q+, Q-)	+7 dBm/ch.
IF in (I+, I-, Q+, Q-)	3 Vpp/ch.
LO input power	+15 dBm
Operating temperature	-40 to + 85°C
Storage temperature	-65 to +150°C

Gotmic AB, Arvid Hedvalls Backe 4, S-411 33 Göteborg, Sweden. Tel: +46 (0) 31 184 030
http://www.gotmic.se/

OUTLINE DRAWING

Mechanical drawing with pad locations is also available in dxf-file format on the web. The substrate thickness is 50 µm (GaAs).

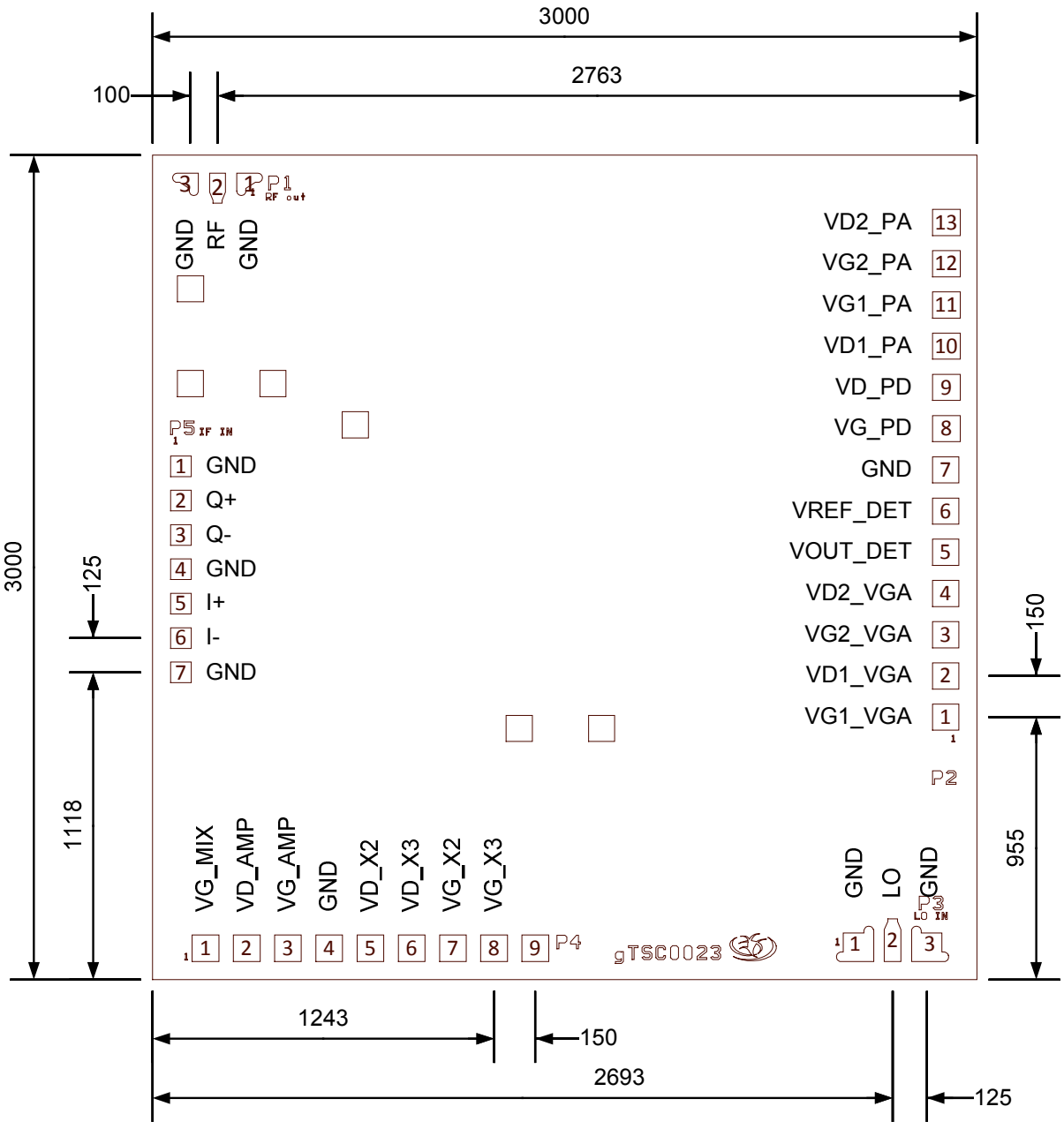

Figure 11. Outline drawing of the gTSC0023 MMIC. Dimensions are in um.