1000-MHz Quadrature Demodulator

Description

The U2791B silicon monolithic integrated circuit is a quadrature demodulator which is manufactured using TEMIC Semiconductors' advanced UHF technology. This demodulator features a frequency range from 100 Mhz to 1000 MHz, low current consumption, selectable gain, power-down mode and adjustment-free handling. The IC is suitable for direct conversion and image rejection applications in digital radio systems up to 1 GHz such as cellular radio, cordless telephone, cable TV and satellite TV systems.

Electrostatic sensitive device.
Observe precautions for handling.

Features

- Supply voltage 5 V (typ.)
- Very low power consumption 125 mW (typ.)
- Very good image rejection by means of phase control loop for precise 90° phase shifting
- Duty-cycle regeneration for single ended LO input signal
- Low LO input level –10 dBm (typ.)
- LO frequency from 100 MHz to 1 GHz
- Power-down mode
- 25 dB gain control

Block Diagram

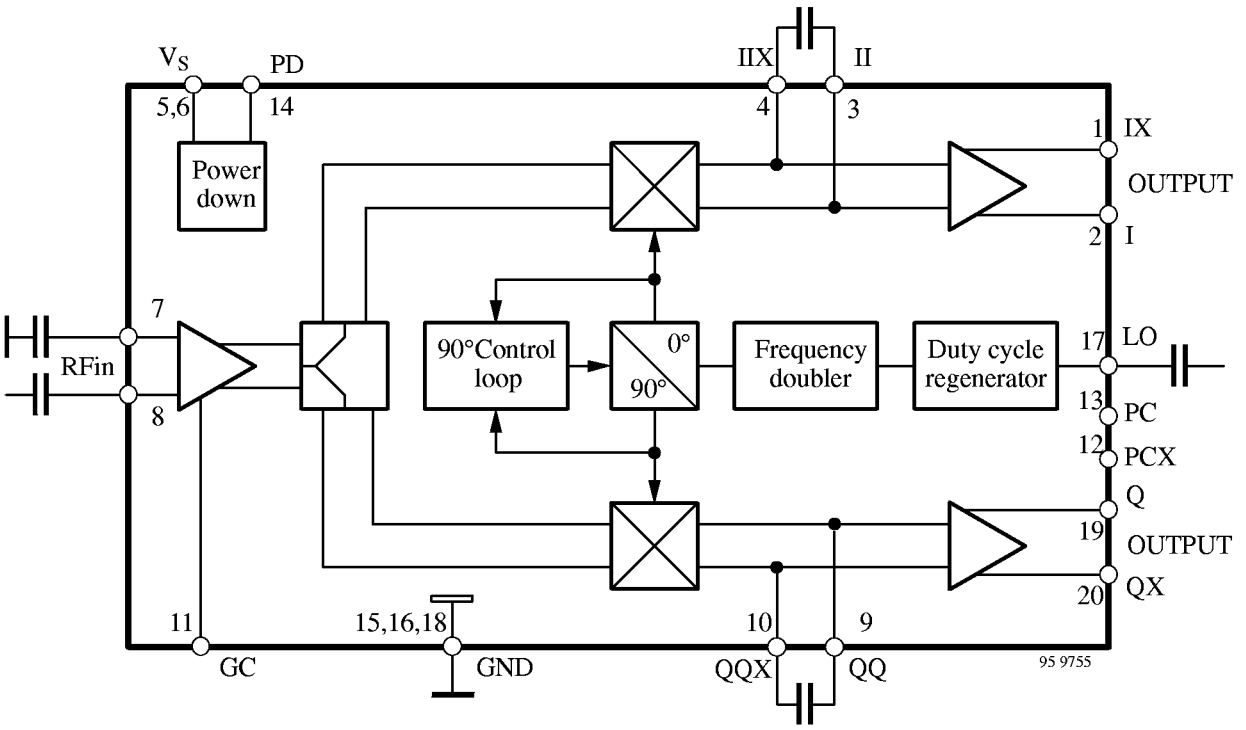


Figure 1.

Ordering Information

Extended Type Number	Package	Remarks
U2791B-FS	SSO20	

Pin Description

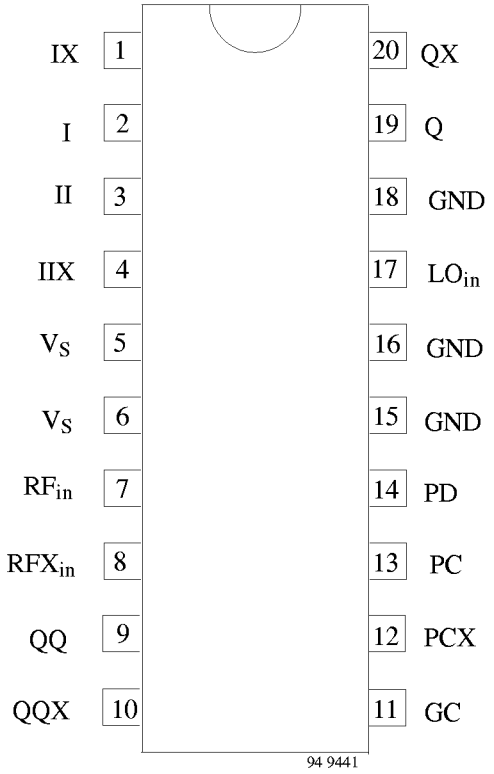


Figure 2.

Pin	Symbol	Function
1	IX	IX output
2	I	I output
3	II	II lowpass filter I
4	IIX	IIX lowpass filter I
5	V_S	Supply voltage
6	V_S	Supply voltage
7	RF_{in}	RF input
8	RFX_{in}	RFX input
9	QQ	QQ lowpass filter Q
10	QQX	QQX lowpass filter Q
11	GC	GC gain control
12	PCX	PCX phase control
13	PC	PC phase control
14	PD	PD power down
15	GND	Ground
16	GND	Ground
17	LO_{in}	LO input
18	GND	Ground
19	Q	Q output
20	QX	QX output

Absolute Maximum Ratings

Parameters		Symbol	Value	Unit
Supply voltage	Pins 5 and 6	V_S	6	V
Input voltage	Pins 7, 8 and 17	V_i	0 to V_S	V
Junction temperature		T_j	125	°C
Storage-temperature range		T_{stg}	–40 to 125	°C

Operating Range

Parameters		Symbol	Value	Unit
Supply-voltage range	Pins 5 and 6	V_S	4.75 to 5.25	V
Ambient-temperature range		T_{amb}	–40 to 85	°C

Thermal Resistance

Parameters		Symbol	Value	Unit
Junction ambient	SSO 20	R_{thJA}	140	K/W

Electrical Characteristics

Test conditions (unless otherwise specified); V_S = 5 V, T_{amb} = 25°C, referred to test circuit
System impedance Z_O = 50 Ω, fiLO = 950 MHz, PiLO = –10 dBm

Parameters	Test Conditions / Pins	Symbol	Min.	Typ.	Max.	Unit
Supply-voltage range	Pins 5 and 6	V_S	4.75		5.25	V
Supply current	Pins 5 and 6	I_S		30		mA
Power-down mode, PD						
"OFF"mode supply current	$V_{PD} \le 0.5$ V Pins 5, 6 V_{PD} = 1.0 V Pin 14 Note 1	IsPD		≤ 1 20		µA
Switch voltage	Pin 14					
"Power ON"		VPON	4			V
"Power DOWN"		VPOFF			1	V
LO input, LO_{in}	Pin 17					
Frequency range		fiLO	100		1000	MHz
Input level	Note 2	PiLO	–12	–10	–5	dBm
Input impedance	See figure 8	ZiLO		50		Ω
Voltage standing wave ratio	See figure 4	VSWRLO		1.2	2	
Duty-cycle range		LODCR	0.4		0.6	
RF input, RF_{in}						
Noise figure (DSB) symmetrical output	@ 950 MHz Note 3 @ 100 MHz Pins 7 and 8	NF		12 10		dB
Frequency range	Pins 7 and 8	fiRF			fiLO	MHz
–1 dB input compression point	Pins 7 and 8 High gain Low gain	 ICPHG ICPLG		 –8 +3.5		dBm
Second-order IIP	Note 4 Pins 7 and 8	IIP2HG		35		dBm
Third-order IIP	Pins 7 and 8 High gain Low gain	 IIP3HG IIP3LG		 +3 +13		dBm
LO leakage	Pins 7 and 8 Symmetric input Asymmetric input	LOL		 ≤ –60 ≤ –55		dBm
Input impedance	Pins 7 and 8 see figure 8	ZiRF		500‖0.8		Ω‖pF

Note 1: During power-down status a load circuitry with DC-isolation to GND is assumed, otherwise a current of $I \approx (V_S - 0.8\ V)/RI$ has to be added to the above power-down current for each output I, IX, Q, QX.
Note 2: The required LO level is a function of the LO frequency (see figure 5).
Note 3: Measured with input matching. For 950 MHz, the optional transmission line T3 at the RF input may be used for this purpose. Noise figure measurements without using the differential output signal result in a worse noise figure.
Note 4: Using Pins 7 and 8 as a symmetric RF input, the second-order IIP can be improved.

Electrical Characteristics (continued)

Test conditions (unless otherwise specified); V_S = 5 V, T_{amb} = 25°C, referred to test circuit
System impedance Z_O = 50 Ω, fiLO = 950 MHz, PiLO = –10 dBm

Parameters	Test Conditions / Pins	Symbol	Min.	Typ.	Max.	Unit
I/O outputs	Emitter follower I = 0.6 mA	I, IX / Q, QX				
3-dB bandwidth w/o external C	Note 5 Pins 1, 2, 19 and 20	BWI/Q	≥ 30			MHz
I/Q amplitude error	Pins 1, 2, 19 and 20	AII/Q		≤ ±0.2		dB
I/Q phase error	Pins 1, 2, 19 and 20	QEI/Q		≤ ±1.5		Deg
I/Q maximum output swing	Pins 1, 2, 19 and 20 Symm. output R_L > 5 kΩ	Max I/Q			2	V_{PP}
DC output voltage	Pins 1, 2, 19 and 20	VOUT		2.8		V
DC output offset voltage	Note 6 Pins 1, 2, 19 and 20	VOFSI/Q I/IX Q/QX		≤ 30		mV
Output impedance	Pins 1, 2, 19 and 20 see figure 8	Zout		50		Ω
Gain control, GC						
Control range power gain, gain high/gain low	Note 7 Pin 11	GCR PGH/GGL		25 23/–2		dB
Switch voltage						
"Gain high"	Pin 11	GCVHigh			1	V
"Gain low"	Note 8 Pin 11	GCVLow				V
Settling time, ST						
Power "OFF" – "ON"		STON		< 4		µs
Power "ON" – "OFF"		STOFF		< 4		µs

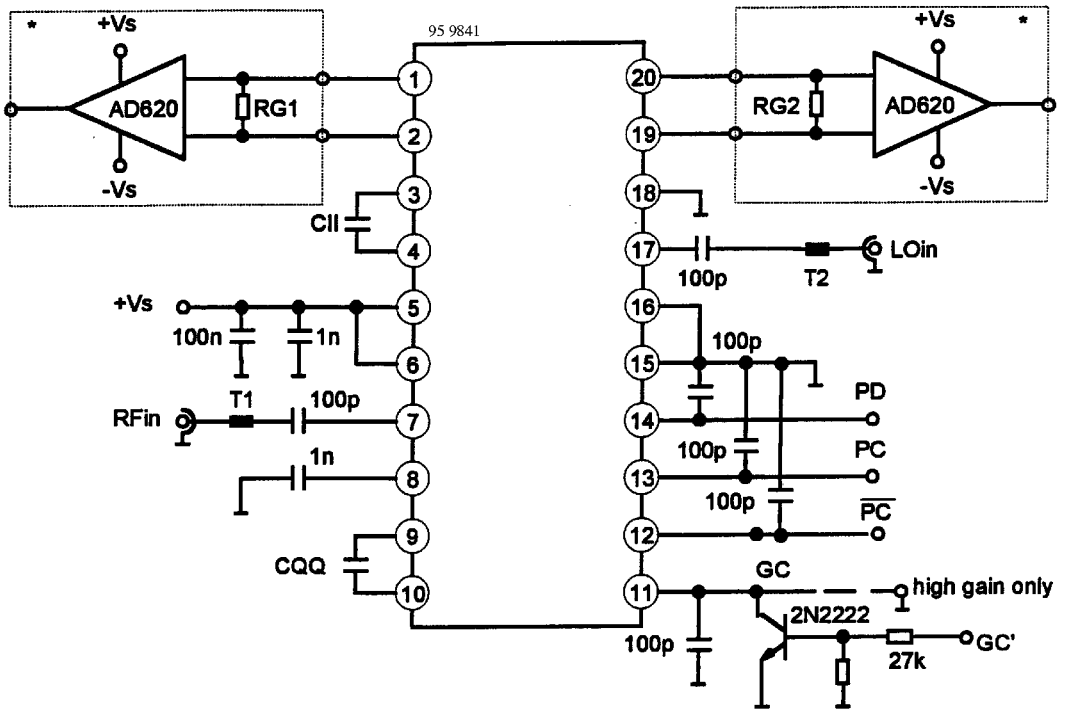
Note 5: Due to test board parasitics, this bandwidth is reduced and not equal for I, IX, Q, QX.
If symmetry and full bandwidth is required, the lowpass Pins 3, 4, 9 and 10 should be isolated from the board.
The bandwidth of the I/Q outputs can be increased further by using a resistor between Pins 3, 4, 9 and 10.
These resistors shunt the internal loads of RI ∼ 5.4 kΩ The decrease in gain here has to be considered.

Note 6: Output emitter follower internal, a current I = 0.6 mA allows only small voltage swing with a 50 Ω load.
For low signal distortion the load impedance should be RI ≥ 5 kΩ.

Note 7: Referred to the level of the output vector $\sqrt{I^2 + Q^2}$.

Note 8: The low gain status is achieved with an open or high-ohmic Pin 11. A recommended application circuit for switching between high and low-gain status is shown in figure 3.

Test Circuit



* optional for single-ended tests (notice 3 dB bandwidth of AD620)
T1, T2 = transmission line Z_O = 50 Ω.
If no GC function is required, connect Pin 11 to GND.
For high and low-gain status GC' is to be switched to GND respectively to V_S.

Figure 3.

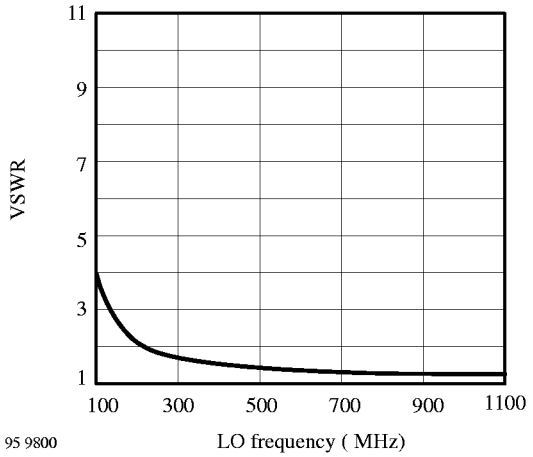


Figure 4. Typical VSWR frequency response of the LO input

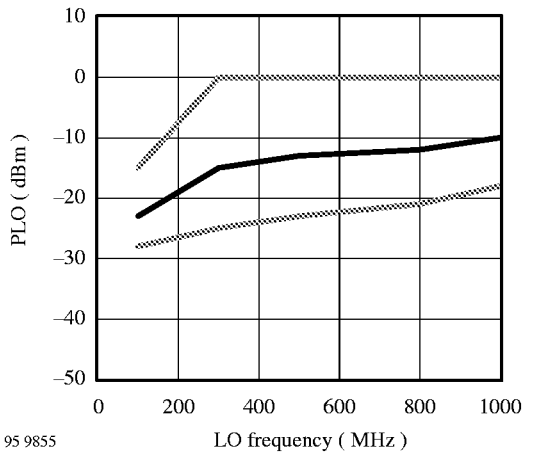


Figure 5. Typical suitable LO power range vs. frequency

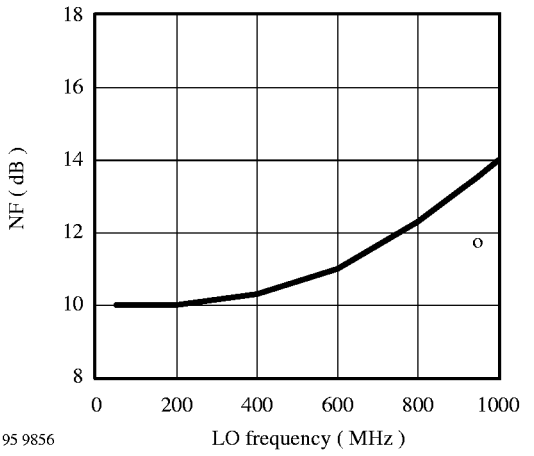


Figure 6. Noise figure vs. LO frequency;
o: value at 950 MHz with RF input matching with T3

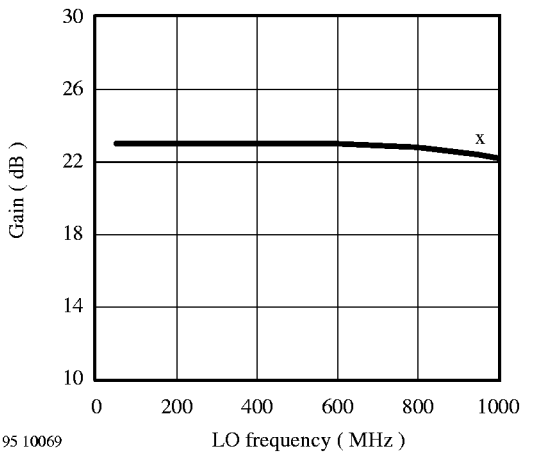


Figure 7. Gain vs. LO frequency,
x: value at 950 MHz with RF input matching with T3

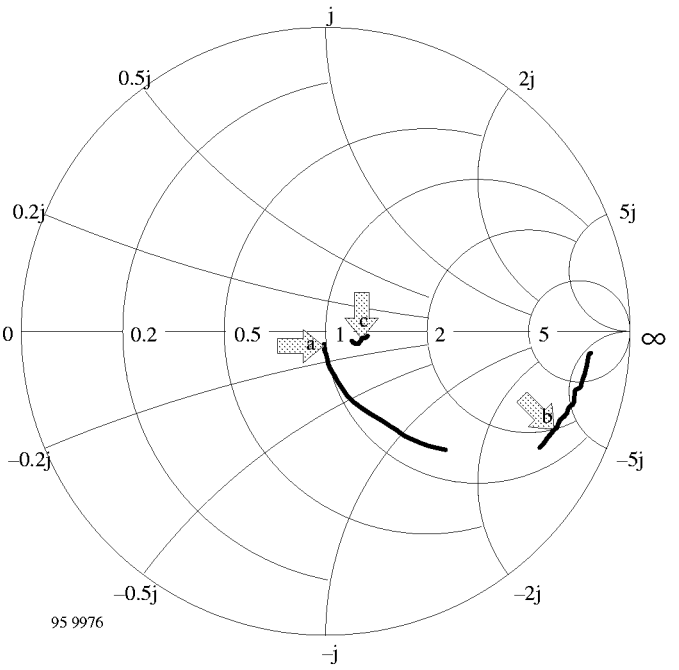


Figure 8. Typical S11 frequency response of the
a: LO input, LO frequency from 100 MHz to 1100 MHz, marker: 950 MHz
b: RF input, RF frequency from 100 MHz to 1100 MHz, marker: 950 MHz
c: I/Q outputs, baseband frequency from 5 MHz to 55 MHz, marker: 25 MHz

Evaluation Board Layout

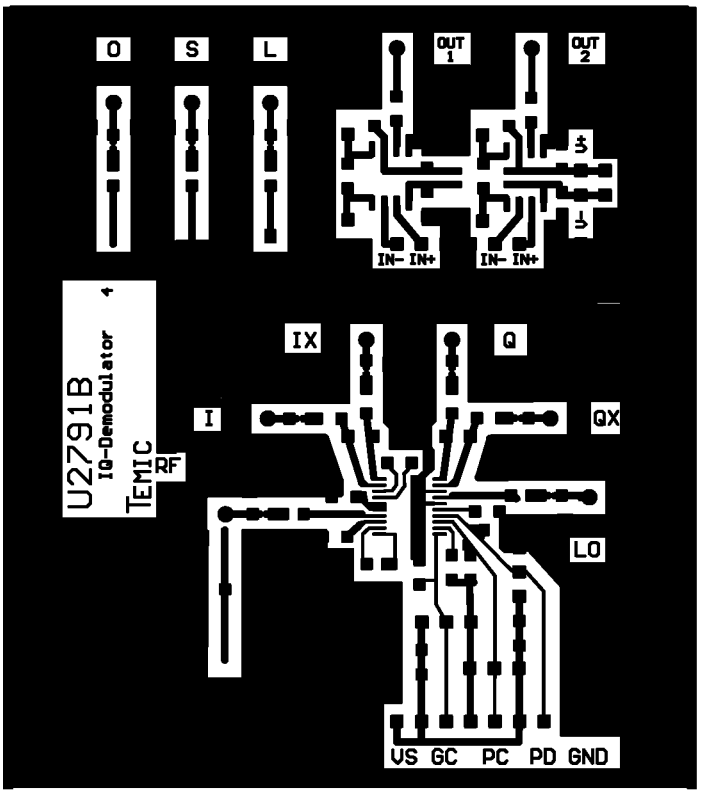


Figure 9.

Evaluation Board with Test Circuit

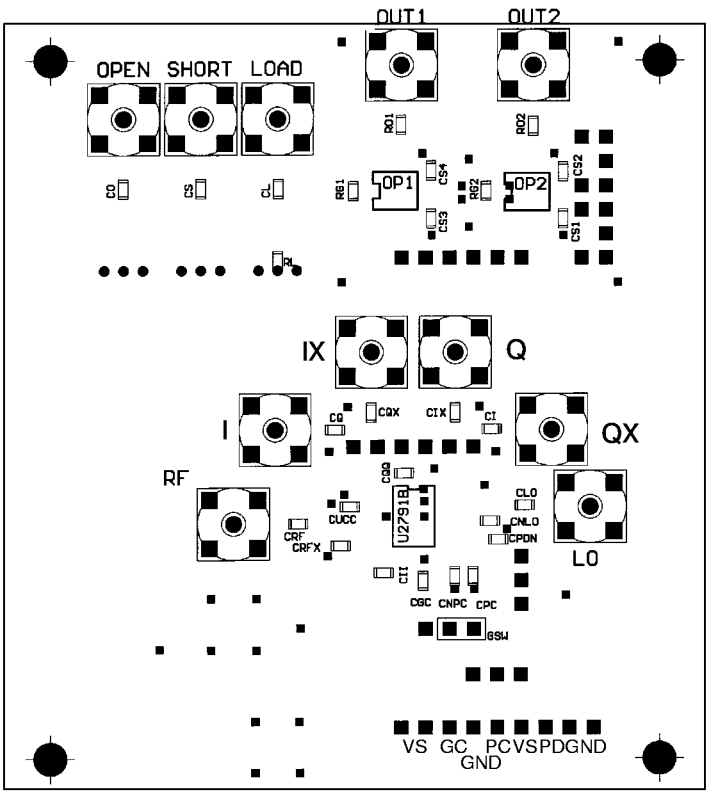


Figure 10. Evaluation board with test circuit

External Components

CUCC	100 nF
CRFX	1 nF
CLO	100 pF
CNLO	0 Ω
CRF	100 pF
CII, CQQ	optional external lowpass filters
T3	transmission line for RF-input matching to connect optionally
CI, CIX, CQ, CQX	optional for AC-coupling at baseband outputs
CPDN	100 pF
CGC	100 pF
CPC	100 pF
CNPC	100 pF
GSW	gain switch

Calibration Part

CO, CS, CL	100 pF
RL	50 Ω

Conversion to Single-Ended Output

OP1, OP2	AD620
RG1, RG2	prog. gain, see datasheet, for 5.6 kΩ a gain of 1 to 50 Ω is achieved together with RD1 and RD2
RD1, RD2	450 Ω
CS1, CS2	100 nF
CS3, CS4,	100 nF

Description of the Evaluation Board

Board material: epoxy; $\epsilon r = 4.8$, thickness = 0.5 mm
transmission lines: $Z_O = 50\ \Omega$

The board offers the following functions

- The test circuit for the U2791B:

– The supply voltage and the control inputs GC, PC and PD are connected via a plug strip. The control input voltages can be generated via external potentiometers; then the inputs should be AC-grounded (time requirements in burst-mode for power up have to be considered).

– The outputs I, IX, Q, QX are DC coupled via an plug strip or can be AC-connected via SMB plugs for high frequency tests e.g. noise figure or s-parameter measurement. The Pins II, IIX, QQ, QQX allow user-definable filtering with 2 external capacitors CII, CQQ.

– The offsets of both channels can be adjusted with two potentiometers or resistors.

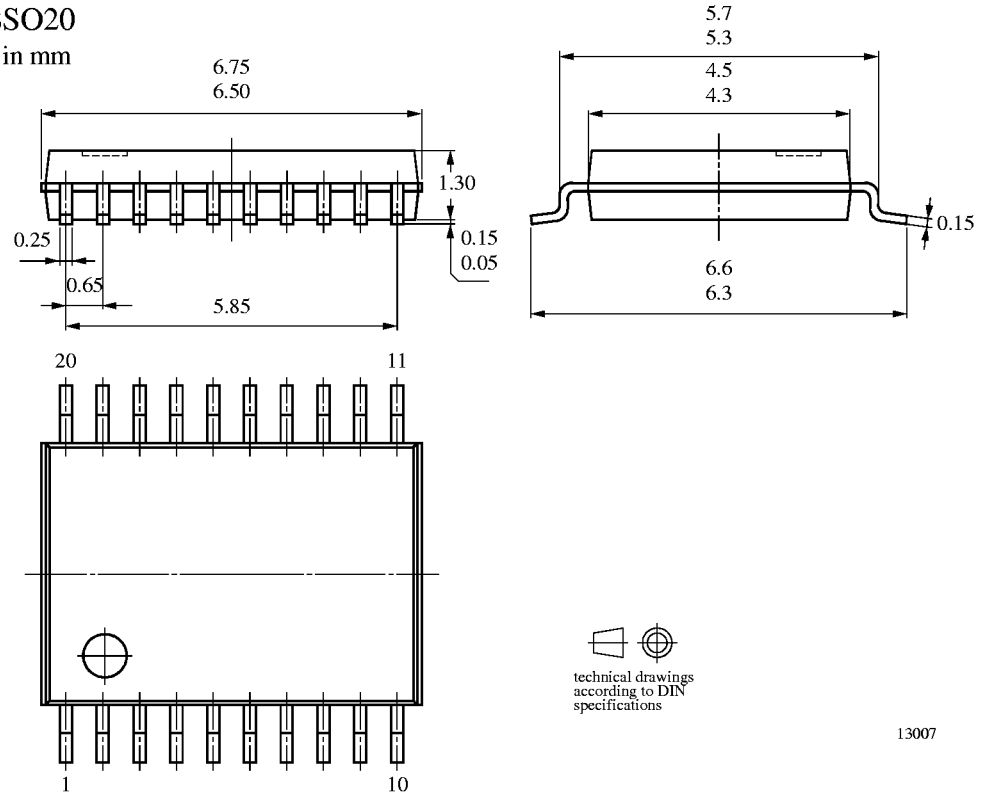
– The LO- and the RF-inputs are AC-coupled and connected via SMB plugs. If transmission line T3 is connected to the RF-input and AC-grounded at the other end, gain and noise performance can be improved (input matching to 50 Ω).

– The complementary RF-input is AC-coupled to GND (CRFX = 1 nF).

- A calibration part which allows to calibrate an s-parameter analyzer directly to the in- and output-signal ports of the U2791B.
- For single-ended measurements at the demodulator outputs, two OPs (e.g., AD620 or other) can be configured with programmable gain; together with an output-divider network RD = 450 Ω to RL = 50 Ω, direct measurements with 50-Ω load impedances are possible at frequencies < 100 kHz.

Package Information

Package SSO20
Dimensions in mm



Ozone Depleting Substances Policy Statement

It is the policy of **TEMIC Semiconductor GmbH** to

1. Meet all present and future national and international statutory requirements.

2. Regularly and continuously improve the performance of our products, processes, distribution and operating systems with respect to their impact on the health and safety of our employees and the public, as well as their impact on the environment.

It is particular concern to control or eliminate releases of those substances into the atmosphere which are known as ozone depleting substances (ODSs).

The Montreal Protocol (1987) and its London Amendments (1990) intend to severely restrict the use of ODSs and forbid their use within the next ten years. Various national and international initiatives are pressing for an earlier ban on these substances.

TEMIC Semiconductor GmbH has been able to use its policy of continuous improvements to eliminate the use of ODSs listed in the following documents.

1. Annex A, B and list of transitional substances of the Montreal Protocol and the London Amendments respectively

2. Class I and II ozone depleting substances in the Clean Air Act Amendments of 1990 by the Environmental Protection Agency (EPA) in the USA

3. Council Decision 88/540/EEC and 91/690/EEC Annex A, B and C (transitional substances) respectively.

TEMIC Semiconductor GmbH can certify that our semiconductors are not manufactured with ozone depleting substances and do not contain such substances.

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