TEMIC

TELEFUNKEN Semiconductors

U2791B

100-MHz Quadrature Demodulator

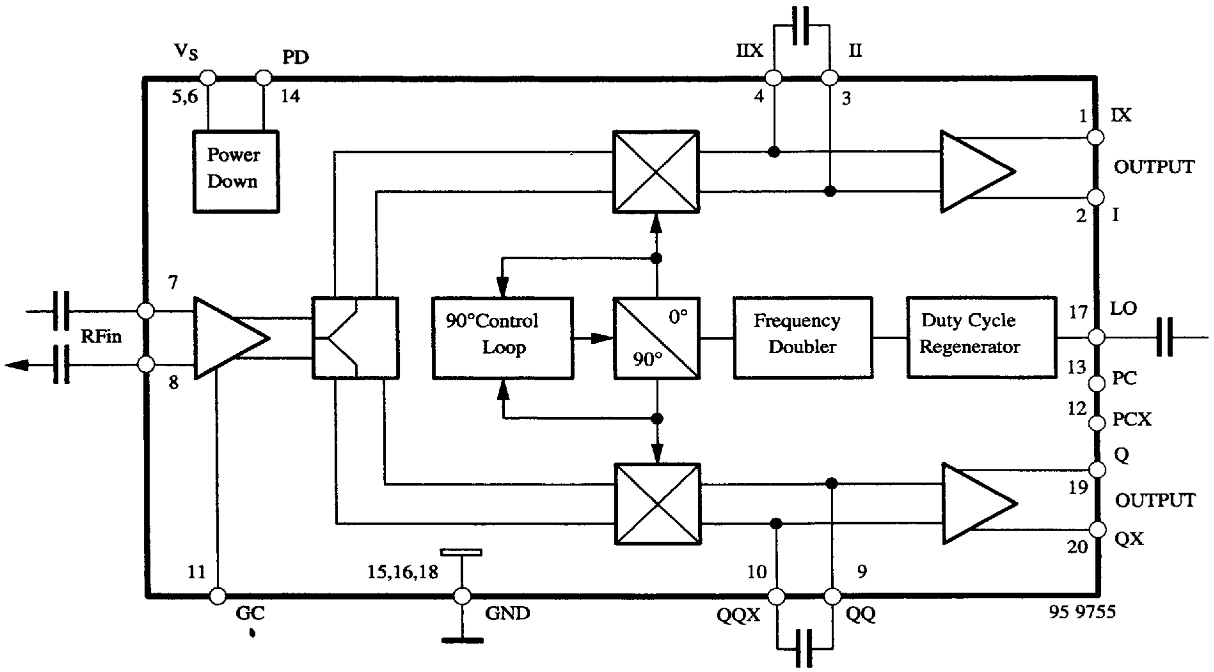
Description

U2791B silicon monolithic integrated circuit is a quadrature demodulator that is manufactured using TELEFUNKEN's advanced UHF technology. This demodulator features a frequency range from 100 – 1000 MHz, low current consumption, selectable gain, power down mode and is adjustment free. 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.

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



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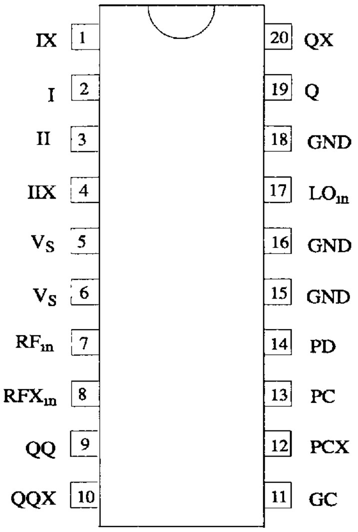
Pin Description



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Pin	Symbol	Function
1	IX	IX output
2	I	I output
3	II	II low pass filter I
4	IIX	IIX low pass 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 low pass filter Q
10	QQX	QQX low pass 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

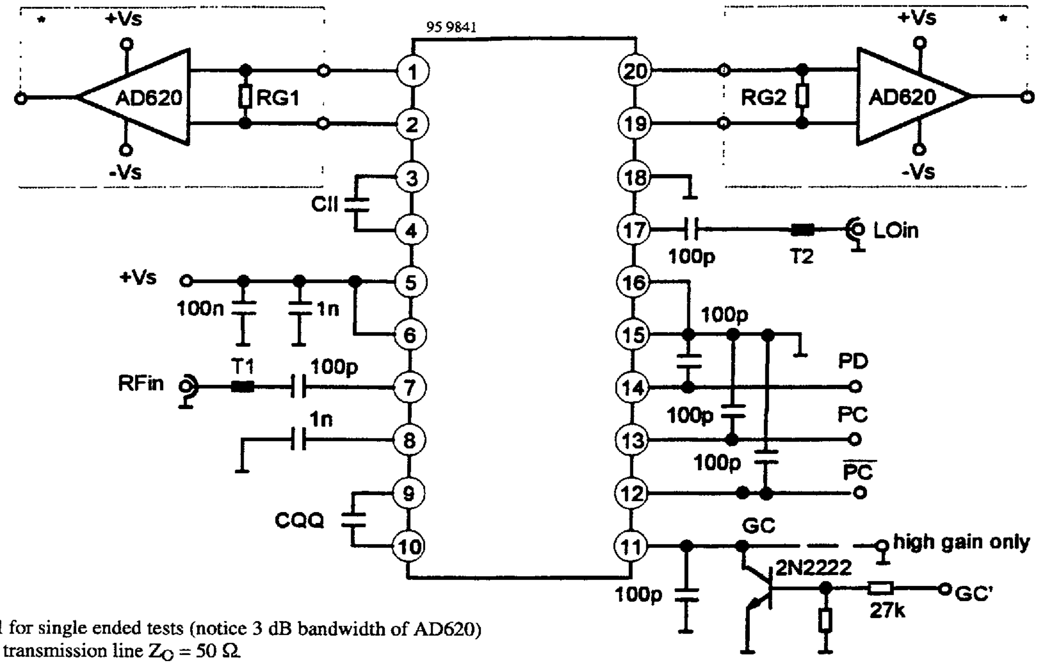
Parameters	Test Conditions / Pins	Symbol	Min.	Typ.	Max.	Unit
Supply voltage range	Pins 5 and 6	V_S	4.75		5.25	V
Supply current	Pins 5 and 6	I_S		32		mA
Power Down Mode, PD						
"OFF"mode supply current	V_{PD} ≤ 0.5 V Pins 5, 6 V_{PD} = 1.0 V Pin 14 Note 1	IsPD		≤ 1 20		μA
Switch Voltage (Pin 14)						
"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 5	ZiLO		50		Ω
Voltage standing wave ratio	See figure 2	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	100		1000	MHz
–1 dB input compression point	Pins 7 and 8 High gain Low gain	ICPHG ICPLG		–8 +3.5		dBm
2nd order IIP	Pins 7 and 8	IIP2HG		35		dBm
Input 3rd 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	See figure 6 Pins 7 and 8	ZiRF		500Ω‖ 0.8pF		
I/O Outputs	Emitter follower I = 0.6 mA	I, IX / Q, QX				
3 dB-bandwidth w/o external C	Note 4 Pins 1, 2, 19, 20	BWI/Q	≥ 30			MHz
I/Q amplitude imbalance	Pins 1, 2, 19, 20	AII/Q		≤ ±0.2		dB
I/Q quadrature error	Pins 1, 2, 19, 20	QEI/Q		≤ ±1.5		Deg
I/Q maximum output swing	Pin 1, 2, 19, 20 Symm. output R_L > 5 kΩ	Max I/Q			2	V_{PP}
DC output voltage	Pins 1, 2, 19, 20	VOUT		2.8		V
DC output offset voltage	Note 5 Pins 1, 2, 19 and 20	VOFSI/Q I/IX Q/QX		≤ 30		mV
Output impedance	Pins 1, 2, 19 and 20	Zout		50		Ω

Electrical Characteristics (Cont'd)

Parameters	Test Conditions / Pins	Symbol	Min.	Typ.	Max.	Unit
Gain Control, GC						
Control range power gain gain high/gain low	Pin 11	GCR PGH/GGL		25 23/–2		dB
Switch voltage						
"Gain high"	Pin 11	GCVHigh			1	V
"Gain low"	Note 6 Pin 11	GCVLow				V
Settling Time, ST						
Power "OFF" – "ON"		STON		< 4		µs
Power "ON" – "OFF"		STOFF		< 4		µs

Notes
1. During power down status a load circuitry with dc-isolation to GND is assumed otherwise a current of I ≈ (V_S –0.8 V) /RI has to be added to the above power down current for each output I, IX, Q, QX.
2. The required LO-Level is a function of the LO-frequency (see figure 4).
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.
4. 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 low-pass 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 the pins 3, 4, 9 and 10. This resistors shunt the internal loads of RI ~ 5.4 kΩ The decrease in gain here has to be considered.
5. Output emitter follower internal acurrent 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.
6. The low gain status is achieved with an open or high ohmic pin 11. A recommended application circuit is shown in figure 1.

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 1.

Figure 2. Typical VSWR Requency Response of the LO Input

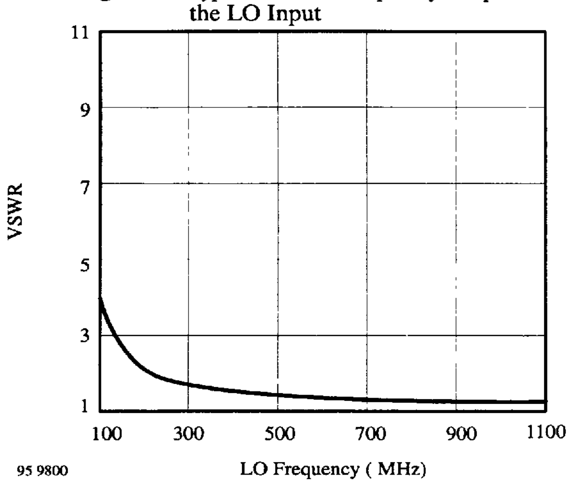


Figure 3. Noise Figure vs. LO Frequence

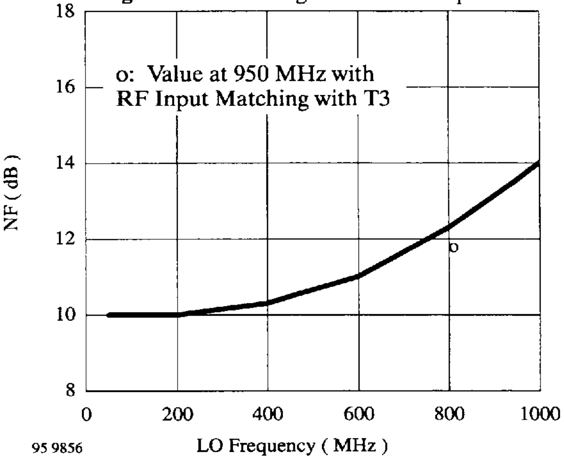


Figure 4. Typical Suitable LO Power Range vs. Frequency

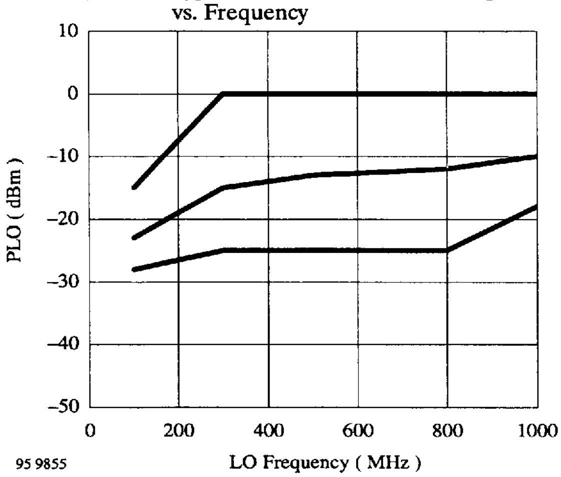
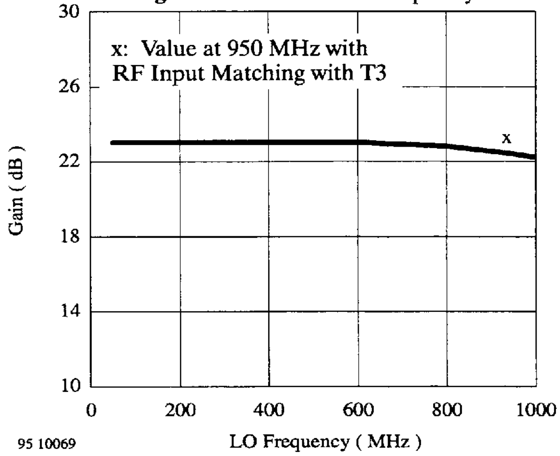


Figure 5. Gain vs. LO Frequency



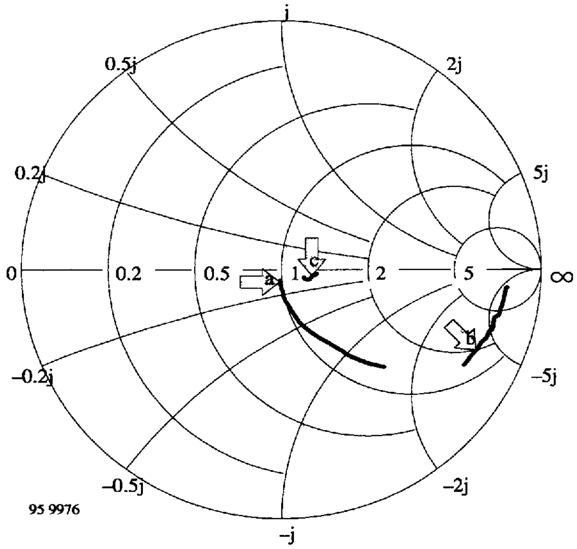
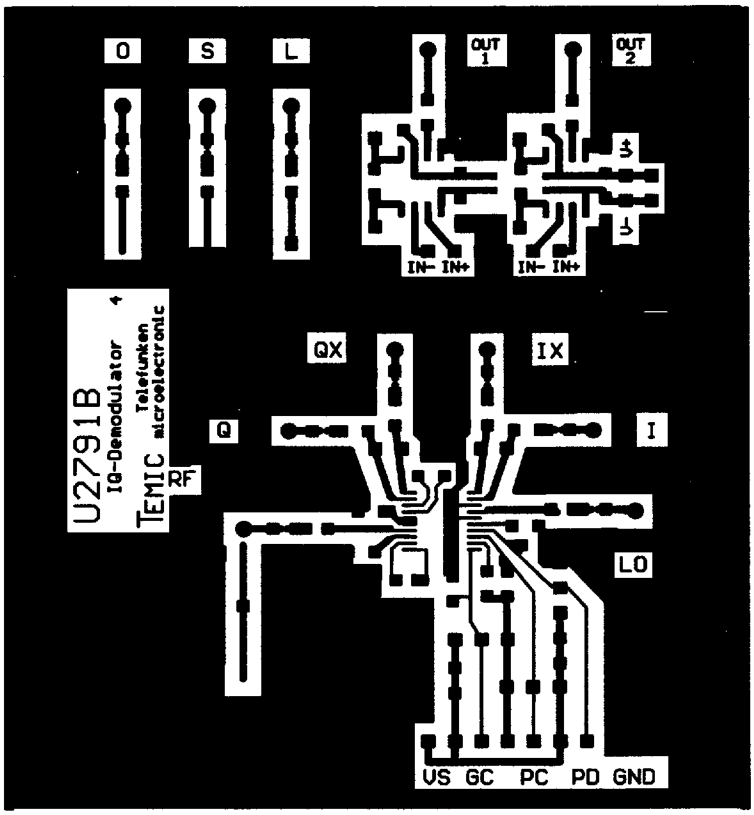


Figure 6. Typical S11 frequency response of the
a: LO input, LO frequency from 100 MHz to 1100 MHz, marker: 950 MHz
b: RF input, RF frequency from 100 MHz to 1100 MHz, marker: 950 MHz
c: I/Q outputs, baseband frequency from 5 MHz to 55 MHz, marker: 25 MHz.

Board Layout



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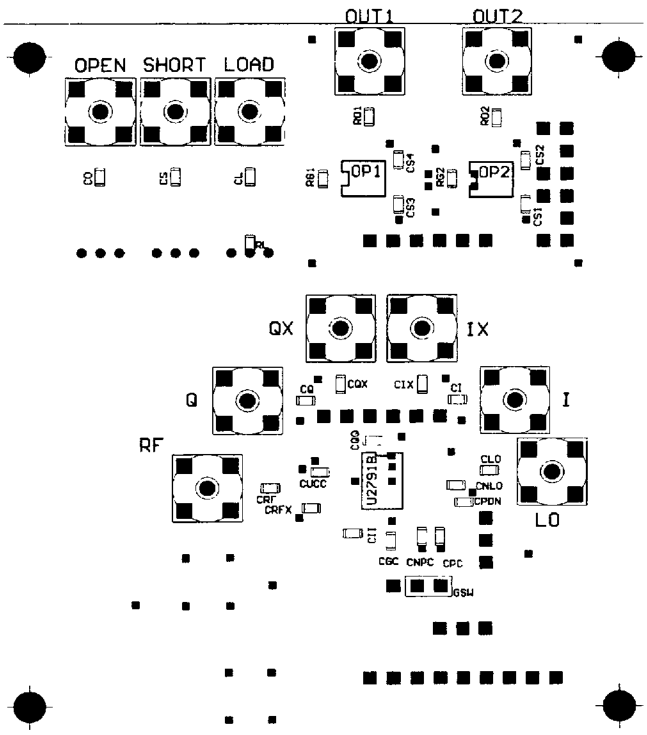
Board Layout



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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 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.
  - Also the offsets of both channels can be adjusted with two potis 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 direct to the in- and output-signals ports of the U2791B.
- For single ended measurements at the demodulator outputs, two OP's (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.

Dimensions in mm

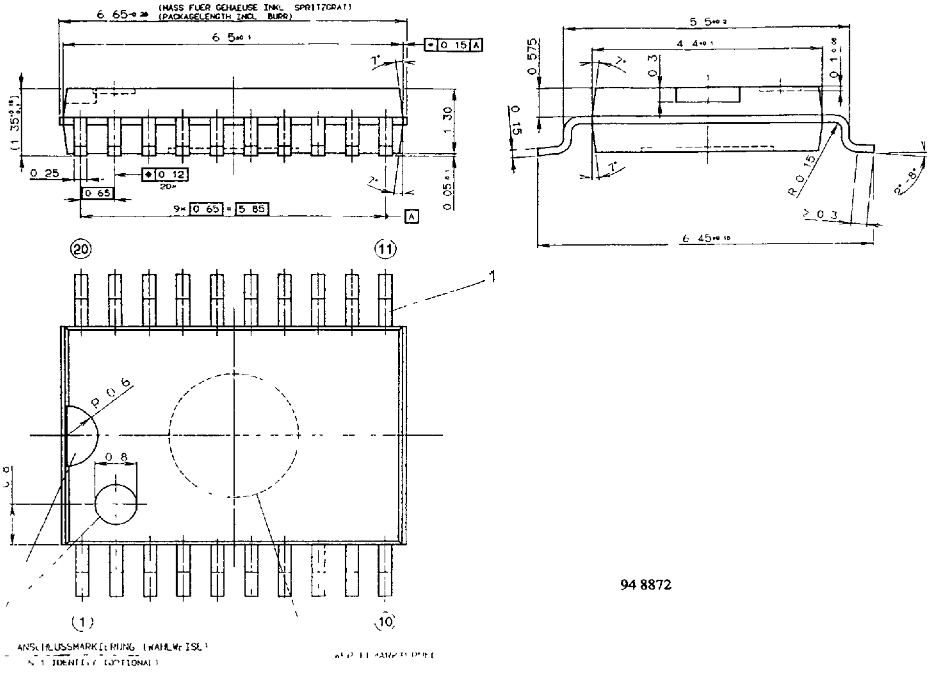

Figure 7. SSO-20 Package

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