

Cordless Telephone Signal Processor

Description

The programmable cordless phone signal processor includes all necessary low frequency parts such as microphone- and earphone amplifier, compander, pre-emphasis, deemphasis, scrambler, data management, power-supply management, as well as RF receiving parts

such as IF converter, FM demodulator. RSSI and low noise amplifier.

Several gains and mutes in transmit and receive direction are controlled by serial bus while compander, pre- and deemphasis and scrambler can be bypassed.

Features

RF Receiver Part

- Low-noise amplifier
- IF converter
- FM demodulator
- RSSI

Low Frequency Part

- Symmetrical input of microphone amplifier
- Symmetrical output of earpiece amplifier

- Compander
- Pre- and deemphasis
- Scrambler
- Data management
- Power-supply management
- Serial bus

Application: CT0

Block Diagram

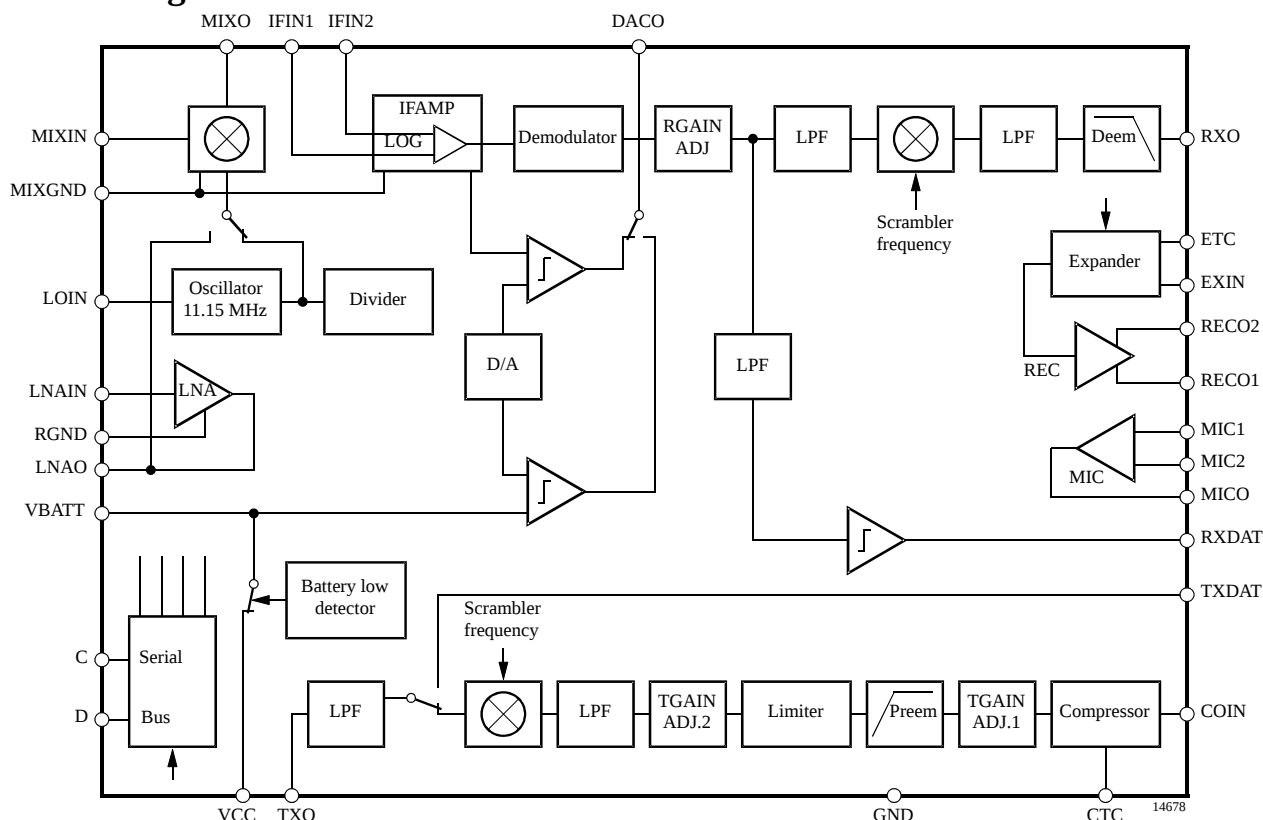


Figure 1. Block diagram

Pin Description

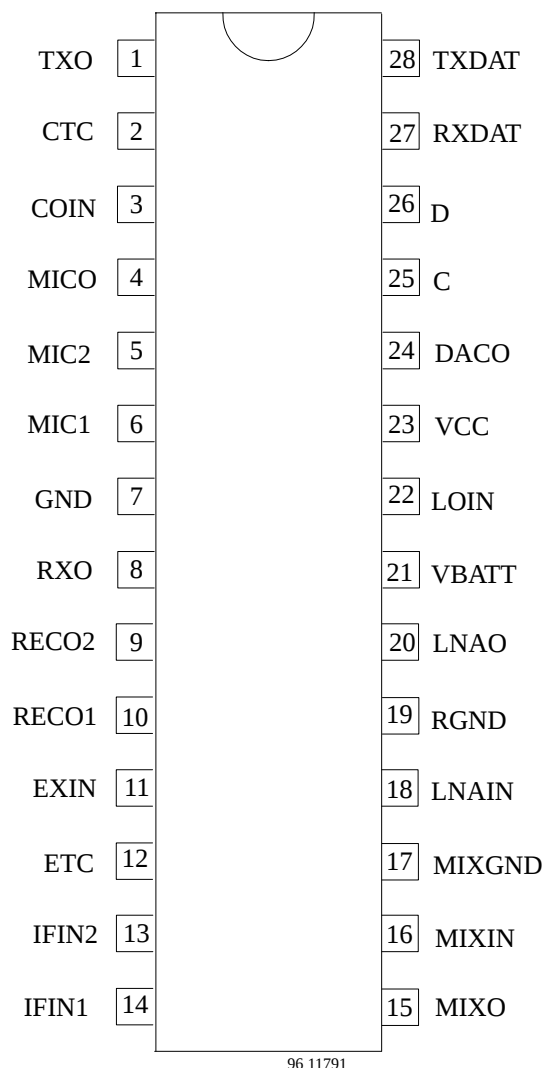


Figure 2. Pinning

Pin	Symbol	Function
1	TXO	Transmit section analog output
2	CTC	Compressor time constant control analog output
3	COIN	Compressor analog input
4	MICO	Microphone amplifier output
5	MIC2	Non-inverting input of microphone amplifier
6	MIC1	Inverting input of microphone amplifier
7	GND	LF analog/ digital ground
8	R XO	Intermediate receive analog output
9	RECO2	Symmetrical output of receive amplifier
10	RECO1	Symmetrical output of receive amplifier
11	EMN	Expander analog input
12	ETC	Expander time constant control analog output
13	IFIN2	Symmetrical IF amplifier input
14	IFIN1	Symmetrical IF amplifier input
15	MIXO	Mixer output
16	MIXIN	Mixer input
17	MIXGND	IF amplifier and mixer ground
18	LNAIN	Low-noise amplifier input
19	RGND	Low-noise amplifier ground
20	LNAO	Low-noise amplifier output/ External LO input
21	VBATT	Battery supply
22	LOIN	Local oscillator input (11.15 MHz)
23	VCC	Supply-voltage output for peripherals and internal supply of digital part
24	DACO	D/A comparator output
25	C	Clock input of serial bus
26	D	Data input of serial bus
27	R XDAT	Receive data digital output
28	T XDAT	Transmit data input

Order Information

Extended Type Number	Package	Remarks
U3500BM-BFL	SO28	
U3500BM-BFLG3	SO28	Taped and reeled

Absolute Maximum Ratings

Parameters	Symbol	Value	Unit
Supply voltage	V_{Batt}, V_{CC}	5.5	V
Junction temperature	T_j	+125	°C
Ambient temperature	T_{amb}	–25 to +75	°C
Storage temperature	T_{stg}	–50 to +125	°C
Power dissipation $T_{amb} = 60^{\circ}\text{C}$	P_{tot}	1	W

Thermal Resistance

Parameters	Symbol	Value	Unit
Junction ambient SO28	R_{thJA}	120	K/W

Electrical Characteristics

Test conditions (unless otherwise specified): $V_{Batt} = V_{CC} = 3.6\text{ V}$, $T_{amb} = +25^{\circ}\text{C}$

Parameters			Test Conditions / Pins		Symbol	Min.	Typ.	Max.	Unit	Fig.
Current consumption										
ERX2	ELNA	ERXHF	ERX1	ERXO	EEA	EDEE	ETX	EPREE		
0	0	0	0	0	0	0	0	0		
Operating voltage range						3.1	3.6	5.2	V	
Inactive mode			V _{Batt} = 2.9 V			30	60	80	μA	
Standby mode							100	120	μA	
RX waiting for RSSI			ELNA = ERXHF = 1			1.7	2.5	3.4	mA	
RX waiting for data			ELNA = ERXHF = ERX1 = 1			1.45	1.9	2.45	mA	
Operating current, RX and TX completely active			ERX2 = ELNA = ERXHF = ERX1 = ERXO = EEA = EDEE = GDEM = ETX = 1			4.5	6.5	9.5	mA	
Low noise amplifier (LNA) f = 41.4 MHz, input level = −50 dBm										
Supply current						0.8	1	1.2	mA	3
Input impedance						160	200	240	Ω	3
Output impedance						40	80	120	Ω	3
Gain			f = 50 MHz			20	23	26	dB	3
Noise figure			Bandwidth = 1 MHz				4	5	dB	3
1-dB input compression point						−27	−24		dBm	3
Third-order input intercept point			f = 41.4 MHz f = 41.4125 MHz Input level = −60 dBm			−15	−12		dBm	3
Frequency range FRF						20		50	MHz	3

Parameters	Test Conditions / Pins	Symbol	Min.	Typ.	Max.	Unit	Fig.
Receiver							
IF mixer, $f = 10.7$ MHz							
Input resistance			2000	3000	4000	Ω	4
Input capacitance			2.5	3	3.5	pF	4
Output impedance			1200	1500	1800	Ω	4
Gain GVMIX	Input level 7 mV _{rms}	G _{MIX}	13	15	17	dB	4
Input compression point			-17			dBm	4
Third-order input intercept point			-9			dBm	4
Carrier breakthrough from internal LO (11.15 MHz) to IF output					300	μ V _{rms}	4
Carrier breakthrough from internal LO (11.15 MHz) to RF input					10	μ V _{rms}	4
IF amplifier: RSSI							
Input resistance			1.6	2	2.5	k Ω	5
RSSI-sensitivity	VIF = 0 μ V _{rms} starting from 0 increase RSSI-level until mean of sampled signal at DACO is ≤ 0.2 RSSI-level = CON0 VIF = 25.4 μ V _{rms} , $f = 450$ kHz increase RSSI level again until mean of sampled signal at DACO is ≤ 0.2 . RSSI-level = CON1 RSSI-sensitivity = CON1-CON0		1				5
RSSI-input voltage dynamic range			60	65		dB	5
RSSI-level number of programmable steps *)				127			5
RSSI-level step size in the logarithmic region			0.35	0.46	0.6	dB	5

*) RSSI Level Programming (Typical Values)

Input Voltage VIF (μ V _{rms})	RSSI Level (Decimal)
0	5
25.4	8
42.4	14
424	54
4240	97
42400	111

Parameters	Test Conditions / Pins	Symbol	Min.	Typ.	Max.	Unit	Fig.
RF demodulator $f_{IF} = 450 \text{ kHz}$, $f_{MOD} = 1 \text{ kHz}$, $V_{IF} = 500 \mu V_{rms}$ BSCR EDEE GRX0 GRX1 GRX2 GRX3 ERX1 ERX0 ERX2 1 0 1 1 1 0 1 1 1							
Recovered audio	GDEM = 0, $\Delta f_{FM} = 2.5 \text{ kHz}$ GDEM = 1, $\Delta f_{FM} = 5.0 \text{ kHz}$		0.4 0.4	0.8 0.8	1.6 1.6	V_{pp} V_{pp}	6
Recovered audio output voltage drop	$V_{Batt} = 3.1 \text{ to } 5.2 \text{ V}$		-1		+1	dB	6
AM rejection ratio	30% AM		30	35		dB	6
RX audio							
Change of RX0 signal deemphasis bypass	EDEE = 0		-0.5	0	0.5	dB	6
Gain adjust range			12	15	17	dB	6
Gain adjust step			0.8	1	1.2	dB	6
Output signal vs. frequency relative to 1 kHz (0 dB) deemphasis bypassed	100 Hz 300 Hz 1800 Hz 3200 Hz 4100 Hz		-7.5 -2.0 -1.3 -0.8	-6.5 -1.0 -0.3 0.2	-5.5 0 0.7 1.2 -60	dB	6
Output signal vs. frequency relative to 1 kHz (0 dB) deemphasis enable EDEE = 1	100 Hz 300 Hz 1800 Hz 3200 Hz 4100 Hz		-0.7 3.7 -5.7 -10	0.3 4.7 -4.7 -9.0	1.3 5.7 -3.7 -8.0 -66	dB	6
Total harmonic distortion	$\Delta f_{FM} = 250 \text{ Hz}$ $\Delta f_{FM} = 2.50 \text{ kHz}$				3.5 3.5	% %	6
Audio mute	$\Delta f_{FM} = 2.5 \text{ kHz}$, ERX0 = 0 ERX1 = 0, ERX2 = 0		65			dB	6
Output impedance					100	Ω	
Expander EEA GEA0 GEA1 GEA2 GEA3 GEA4 1 0 0 0 1 1							
Gain reference level	VEXIN = -10 dBV _{rms}	GOREC	11	13	15	dB	7
Change of gain when expander is bypassed	BCOMP = 1		-0.5		0.5	dB	7
Gain tracking	VEXIN = -20 dBV _{rms} VEXIN = -30 dBV _{rms} VEXIN = -35 dBV _{rms} VEXIN = -40 dBV _{rms}		-21 -41 -53	 -50 -60	-19 -39 -47	dB	7
Input impedance			9.5		14.5	k Ω	7
Gain change vs. supply voltage	$V_{Batt} = 3.1 \text{ to } 5.2 \text{ V}$		-0.5		0.5	dB	7
Attack time	VEXIN = step -20 dBV _{rms} → -14 dBV _{rms} , measure time after step, when output voltage has 0.75 times the final value	t_f		16		ms	7
Release time	VEXIN = step 14 dBV _{rms} → -20 dBV _{rms} , measure time after step, when output voltage has 1.5 times of the final value	t_f		16		ms	7

Parameters	Test Conditions / Pins	Symbol	Min.	Typ.	Max.	Unit	Fig.
Earpiece amplifier BCOMP = 1, EEA = 1, VEXIN = 100 mV _{rms}							
Medium gain	GEA0 GEA1 GEA2 GEA3 0 0 0 0 GEA4 = 1		4	5	6	dB	7
Minimum gain	GEA0 GEA1 GEA2 GEA3 0 0 0 0 GEA4 = 0		-12	-11	-10	dB	7
Gain change versus V _S	V _{Batt} = 3.1 to 5.2 V		-0.2		0.2	dB	7
Gain adjust range				31		dB	7
Gain adjust step			0.8	1	1.2	dB	7
Output impedance				10	30	Ω	7
Distortion		d _t			2	%	7
Output offset voltage	VEXIN = 0 mV _{rms}		-200		200	mV	7
Output voltage swing	Increase VEXIN until distortion (RECO1/ RECO2) is 5%		4.8	5.0		V _{pp}	7
Maximum gain	GEA0 GEA1 GEA2 GEA3 1 1 1 1 GEA4 = 1		19	20	21	dB	7
Low Frequency Transmitter							
GMIC	EPREE	BSCR	GLTX	G2TX	BCOMP	ETX	
1	1	1	1000	1000	1	1	
Microphone Amplifier VMIC = 10 mV _{rms} , f _{IN} = 1 kHz							
Gain	High gain: GMIC = 1 Low gain: GMIC = 0		31 23	32 24	33 25	dB dB	8
Gain change versus V _S	V _{Batt} = 3.1 to 5.2 V		-0.2	0	0.2	dB	8
Differential input impedance			41	75	103	kΩ	8
Output impedance				10	35	Ω	8
Distortion	VMIC = 10 mV _{rms}	d _t			1	%	8
Output noise (psophmetrically weighted)	VMIC = 0 V _{rms} high gain (inputs closed across 200 Ω)				50	μV _{rmsp}	8
TX Audio VCOIN = -20 dBV _{rms}							
Gain	GTX (COIN, TXO)		2.5	5.5	8.5	dB	9
Change of gain TXO	EPREE = 0		-0.5	0	0.5	dB	9
Gain between 3.2 and 5.2 V			-1	0	+1	dB	9
TX gain adjust range adj. 1			12	15	18	dB	9
TX gain adjust step adj. 1			0.8	1	1.2	dB	9
LIM gain adjust range adj. 2				15		dB	9
LIM gain adjust range adj. 2			0.8	1	1.2	dB	9
TX gain vs. frequency (preemphasis bypassed) relative to 1 kHz reference level 0 dB	100 Hz 300 Hz 1800 Hz 3200 Hz 4100 Hz		-1.3 -1.3 -0.8 -1.9 -25.9	-0.3 -0.3 0.2 0.9 -23.9	0.7 0.7 1.2 0.1 -21.9	dB	9
Gain vs. frequency with preemphasis relative to 1 kHz reference level 0 dB	100 Hz 300 Hz 1800 Hz 3200 Hz 4100 Hz		-0.8 -6.8 3.3 6.0 16.6	-7.0 -5.8 4.3 7.0 -14.6	-6.0 -4.8 5.3 8.0 -12.6	dB	9
Total band ripple	V _{Batt} = 3.1 to 5.2 V VCOIN = -20 dBV				2	dB	9

Parameters	Test Conditions / Pins	Symbol	Min.	Typ.	Max.	Unit	Fig.			
Limiter										
Output voltage	Increase VCOIN until d = 5% at TX0 then measure VTX0		1.05		2.0	Vpp	9			
Mute	ETX = 0, VCOIN = −10 dBV attenuation at TX0 output		56			dB	9			
Output impedance TX0			7	10	14	kΩ	9			
Compressor										
BSCR	EPREE	G2TX0	G2TX1	G2TX2	G2TX3	EIX	GITX0	G1TX1	G1TX2	G1TX3
1	0	0	1	0	1	1	0	0	1	0
Input impedance	BCOMP = 1		9	14	22	kΩ	9			
Gain reference level G0TX	VCOIN = −10 dBV _{rms}	G0TX	1	5.5	10	dB	9			
Gain change when compressor is bypassed	VCOIN = −10 dBV _{rms} BCOMP = 1		0.5		0.5	dB	9			
Gain tracking	VCOIN = −30 dBV _{rms} VCOIN = −50 dBV _{rms} VCOIN = −60 dBV _{rms} VCOIN = −70 dBV _{rms}		−11 −21 −22		−9 −19 −28	dB	9			
Attack time	VCOIN= step −30 dBV _{rms} → −18 dBV _{rms} measure time after step when output voltage has 1.5 times the final value	t _f		3.5		ms	9			
Release time	VCOIN= step −18 dBV _{rms} → −30 dBV _{rms} measure time after step when output voltage has 0.75 times the final value	t _f		14.4		ms	9			
Scrambler										
EPREE	BSCR	BCOMP								
0	0	1								
Conversion gain versus frequency FIN (1 kHz) reference level 0 dB	FIN=1kHz, FOUT=3.1kHz FIN=0.1kHz, FOUT=4.0kHz FIN=0.3kHz, FOUT=3.8kHz FIN=0.7kHz, FOUT=3.4kHz FIN=1.8kHz, FOUT=2.3kHz FIN=2.6kHz, FOUT=1.5kHz FIN=3.2kHz, FOUT=0.9kHz FIN=3.4kHz, FOUT=0.7kHz		−1.0 −4.4 −2.1 −0.8 −1.1 −1.1 −2.5 −5	0 −3.4 −1.1 0.2 −0.1 −0.1 −0.5 −4	1.0 −2.4 −0.1 1.2 0.9 0.9 −0.5 −3	dB	11			
Carrier break through				10	20	mV _{rms}				
Descrambler										
EDEE	BSCR	BCOMP								
0	0	1								
Conversion gain vs. frequency	FIN=4kHz, FOUT=0.1kHz FIN=3.8kHz, FOUT=0.3kHz FIN=3.4kHz, FOUT=0.7kHz FIN=2.3kHz, FOUT=1.8kHz FIN=1.5kHz, FOUT=2.6kHz FIN=0.9kHz, FOUT=3.2kHz FIN=0.7kHz, FOUT=3.4kHz		−3.6 −1.3 −0.4 −1.5 −0.4 −1.7 −1.9	−2.6 −0.3 0.6 0.5 0.6 −0.3 −0.9	−1.6 0.7 1.6 0.5 1.6 0.7 0.1	dB	11			
Carrier break through	Measure FOUT = 4.099 kHz			0.1	0.5	mV _{rms}				

Parameters	Test Conditions / Pins	Symbol	Min.	Typ.	Max.	Unit	Fig.
Data management							
Receive data management	GDEM 1	ERX1 1	ERXHF 1				
Duty cycle RXDAT	$V_{IF} = 100 \mu V_{rms}$ $f_{IF} = 450 \text{ kHz}$ $f_{MIF} = 1 \text{ kHz}$ $\Delta f_{IF} = 5 \text{ kHz}$		0.4	0.5	0.6		10
Transmit data management	ETX1 1						
Input impedance TXDAT				200		k Ω	10
Final value of step response	ETDM = 1, BSCR = 1 $V_{TXDAT} = \text{step}$ 1.5 V $\rightarrow$ 1.75 V Measure step at TXO			311		mV	10
Logical Part							
Inputs: C, D Low voltage input High voltage input Input leakage current ($0 < V_I < V_{CC}$)			$0.8 \times V_{CC}$ -1		$0.2 \times V_{CC}$ +5	μA	
Input LOIN Input leakage current ($0 < V_I < V_{CC}$)			-5		5	μA	
Outputs: DACO, RXDAT Output low Output high	lol = 10 μA loh = -10 μA		$0.9 \times V_{CC}$		$0.1 \times V_{CC}$		
Serial bus Data set-up time Data hold time Clock low time Clock high time Hold time before transfer condition Data low pulse on transfer condition Data high pulse on transfer condition	tsud thd tcl tch teon teh teof		0.1 0 2 2 0.1 0.2 0.2			μs μs μs μs μs μs μs	14

Parameters	Test Conditions / Pins	Symbol	Min.	Typ.	Max.	Unit	Fig.
Battery Management							
Max bat low	DA0 to 6 = 1, RBAT = 1		3.7	3.95	4.1	V	
Min bat low over switch	DA0 to 6 = 27 BIN, RBAT = 1		3.05	3.2	3.35	V	
Max bat high	DA0 to 6 = 1, RBAT = 0		4.75	5.05	5.25	V	
Min bat high	DA0 to 6 = 0, RBAT = 0		3.83	4.1	4.27	V	
Adjust step			3.5	7.5	11.5	mV	
Max – Min			852.5	952.5	1052.5	mV	
MINBL – SWOFF			100	200	300	mV	
Battery Switch							
Off threshold	DA0 to 6 = 1, RBAT = 1		2.9	3.0	3.1	V	
On threshold	DA0 to 6 = 27 BIN, RBAT = 1		3.1	3.2	3.35	V	
Hysteresis			220	250	280	mV	
Switch ron	DA0 to 6 = 0, RBAT = 0			35	50	Ω	

Max bat low	:	MAXL (battery voltage when all DAC bits are high, low range)
Min bat low	:	MINBL (battery voltage when DAC bits are 001 1011, low range)
Max bat high	:	MAXBH (battery voltage when all DAC bits are high, high range)
Min bat high	:	MINBH (battery voltage when all DAC bits are low, high range)
Adjust step	:	Adjust step
Max – Min	:	MAXBH – MINBH
MINBL – SWOFF	:	MINBL – SWOFF
Off threshold	:	SWOFF (off threshold of the battery switch)
On threshold	:	SWON (on threshold of the battery switch)
Hysteresis	:	SWON– SWOFF
Switch ron	:	Switch Ron (resistance of the switch transistor, when switch is “ON”)

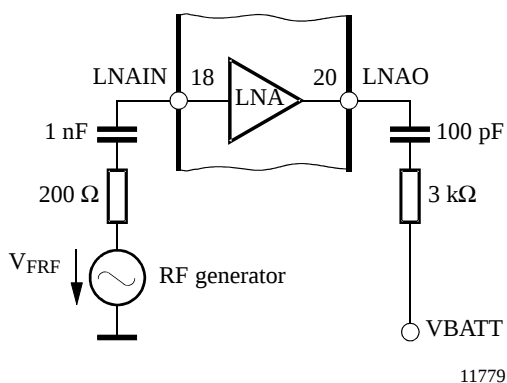


Figure 3.

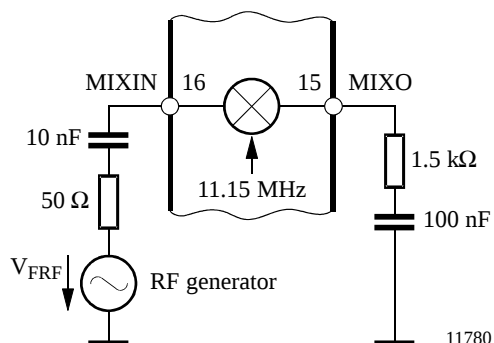
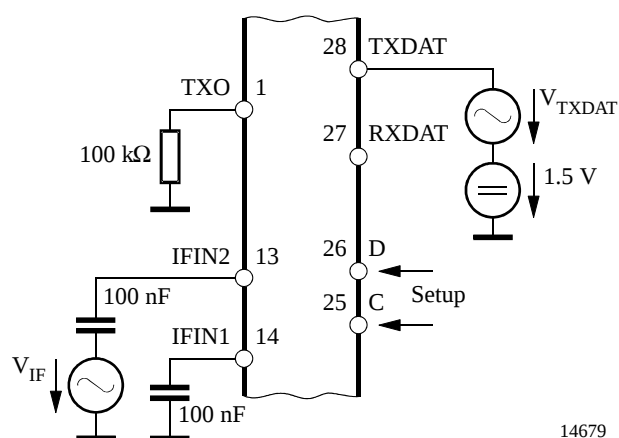
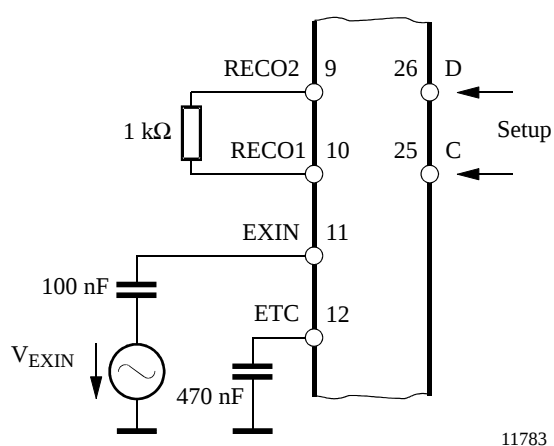
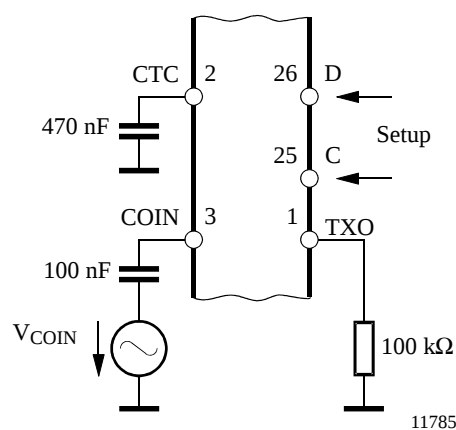
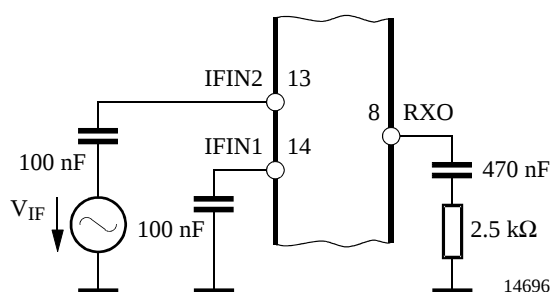
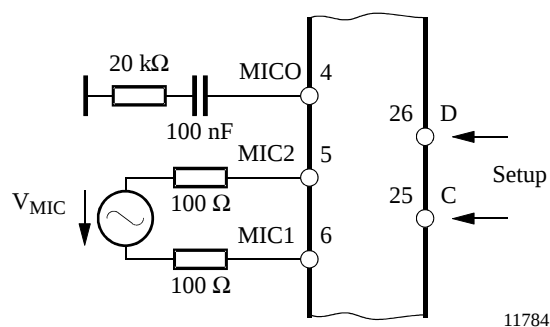
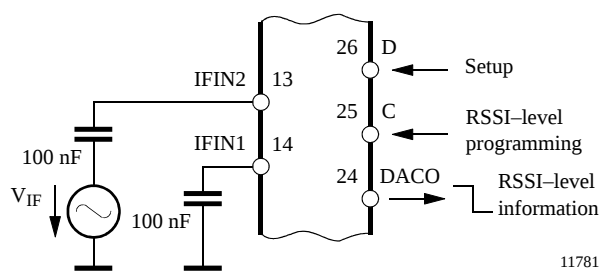
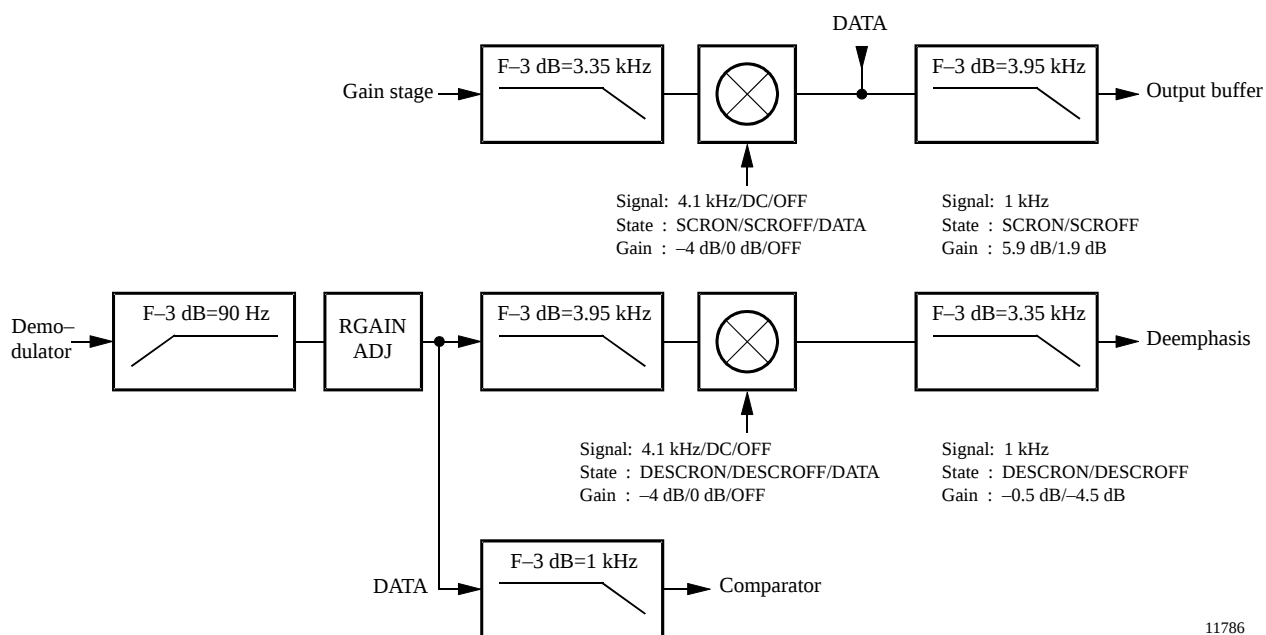


Figure 4.





Serial Bus Interface

The circuit is remoted by an external microcontroller through the serial bus (programming can be started 10 μ s after power supply settled).

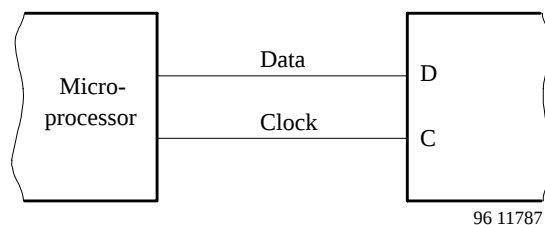
The data is an 12-bit word:

A3 – A0: address of the destination register (0 to 15)

D7 – D0: contents of register

The data line must be stable when the clock is high and data must be serially shifted.

After 12 clock periods, the transfer to the destination register is (internally) generated by a low-to-high transition of the data line when the clock is high.



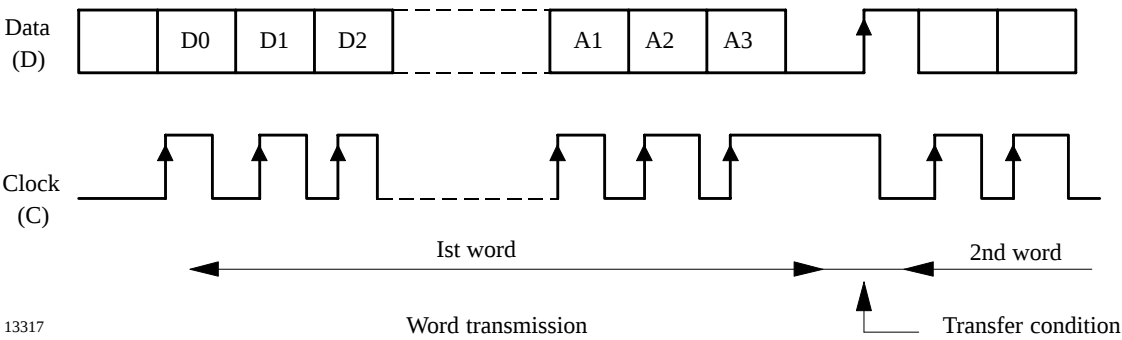


Figure 13.

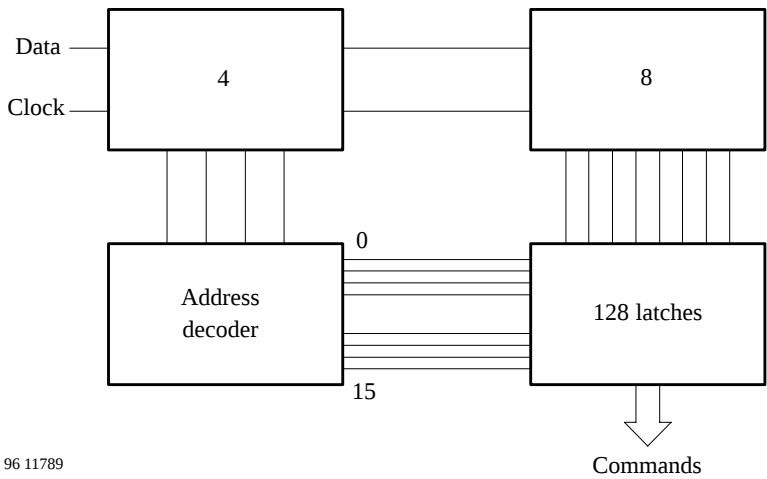


Figure 14.

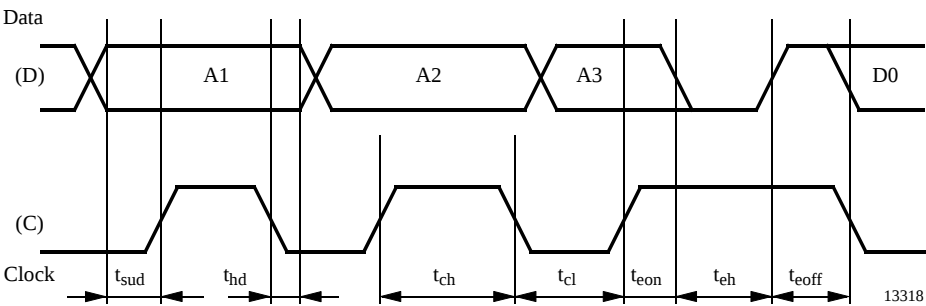


Figure 15.

Content of Internal Registers

The registers have the following structure:

D7	D6	D5	D4	D3	D2	D1	D0
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R0: Reference for D/A converter

MUXDA	DA6	DA5	DA4	DA3	DA2	DA1	DA0
-------	-----	-----	-----	-----	-----	-----	-----

MUXDA: D/A multiplexing

DA(6:0): Reference voltage D/A

R1: Gain adjustment RECLF

GEA3	GEA2	GEA1	GEA0	GRX3	GRX2	GRX1	GRX0
------	------	------	------	------	------	------	------

GEA(3:0): Gain earpiece amplifier (see also R5)

GRX(3:0): Gain adjustment RX

R2: Gain adjustment TRANLF

G2TX3	G2TX2	G2TX1	G2TX0	G1TX3	G1TX2	G1TX1	G1TX0
-------	-------	-------	-------	-------	-------	-------	-------

G2TX(3:0): Gain adjustment TX after limiter

G1TX(3:0): Gain adjustment TX

R3: Enable functions receive

GDEM	EDDE	EEA	ERXO	ERX1	ERXHF	ELNA	ERX2
------	------	-----	------	------	-------	------	------

GDEM: Gain demodulator

EDDE: Enable deemphasis (disables bypass)

EEA: Enable earpiece amplifier

ERXO: Enable RXO output

ERXHF: Enable mixer and IF amplifier

ELNA: Enable low-noise amplifier

ERX(1:0): Enable parts of RXLF

R4: Enable functions transmit

SSCCK	RBAT	BCOMP	BSCR	GMIC	ETDM	EPREE	ETX
-------	------	-------	------	------	------	-------	-----

SSCCK: Shift SC-clock (shifts SC-clock by 17/16)

RBAT: Battery detection high/low range

BCOMP: Bypass compressor and expander

BSCR: Bypass scrambler and descrambler

GMIC: Gain of microphone preamplifier

ETDM: Enable transmit data management

EPREE: Enable preemphasis (disables bypass)

ETX: Enable TX low frequency part

R5:

free	free	free	free	free	free	GEA4	EXTLO
------	------	------	------	------	------	------	-------

GEA4: Gain earpiece amplifier MSB (see also R1)

EXTLO: Select input mixer

R6 – R15: reserved for U3550BM

Example of Mode Setting Using Enable Bits

(U3500B + U3550B)

	Active Mode (Transmission)	Active Mode (PLL Convergence Waiting)	Receive Mode (Only Data)	Receive Mode (RX Waiting)	Standby Mode (ex. Battery Low)	Inactive Mode (Switch Off)
*PA (VTX PIN), EEA	X					
*EVCO1 ETX, ERX2, ERXO	X	X				
ERX1	X	X	X			
ERXHF, ELNA *EVCO3 RSSI / Battery Management (MUXDA)	X	X	X	X		
LOGIC PART (Enables when $V_{Batt} > 3.2\text{ V}$)	X	X	X	X	X	
Switch Comparator (Always Enabled)	X	X	X	X	X	X

* refer to U3550BM

Application Circuit

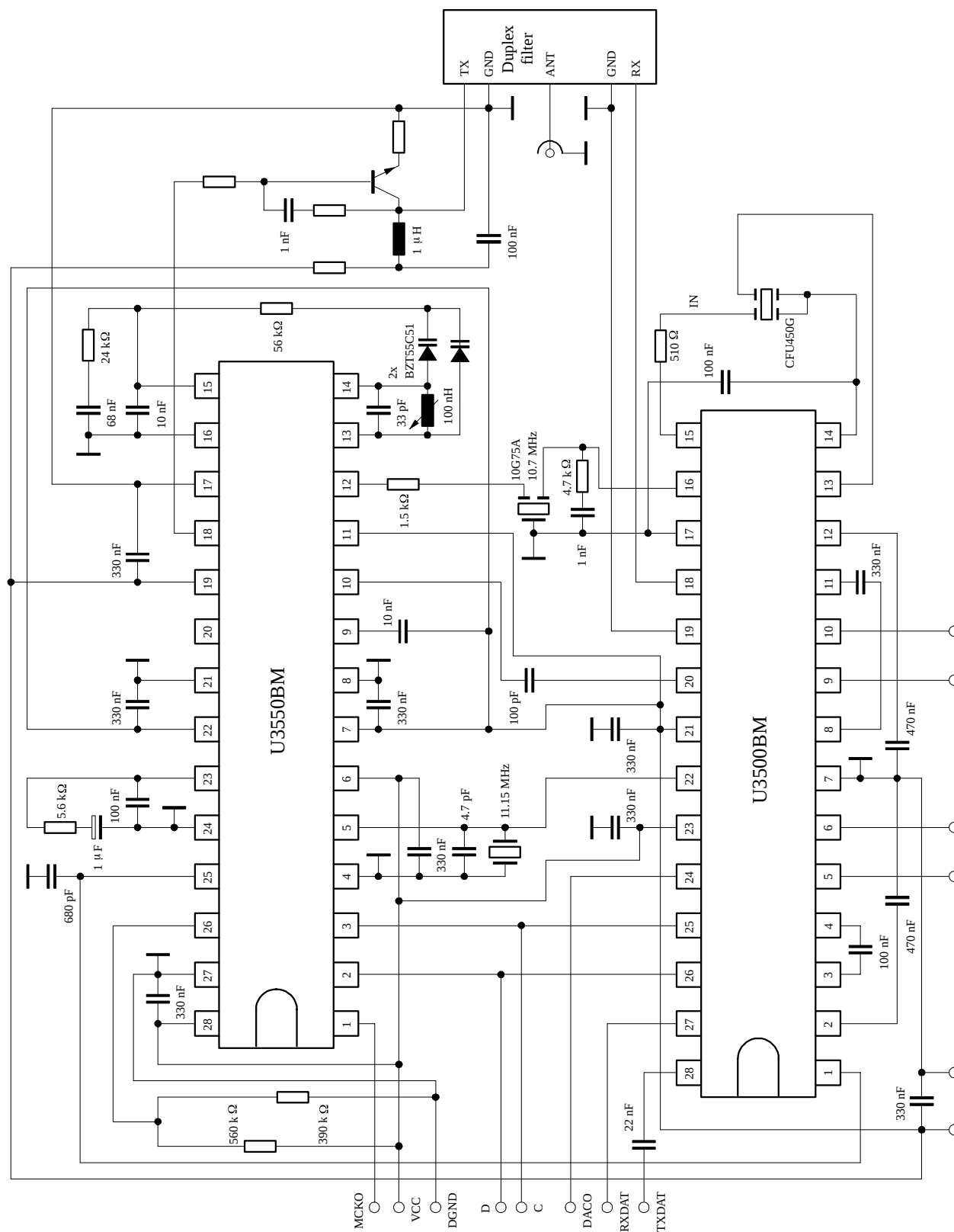
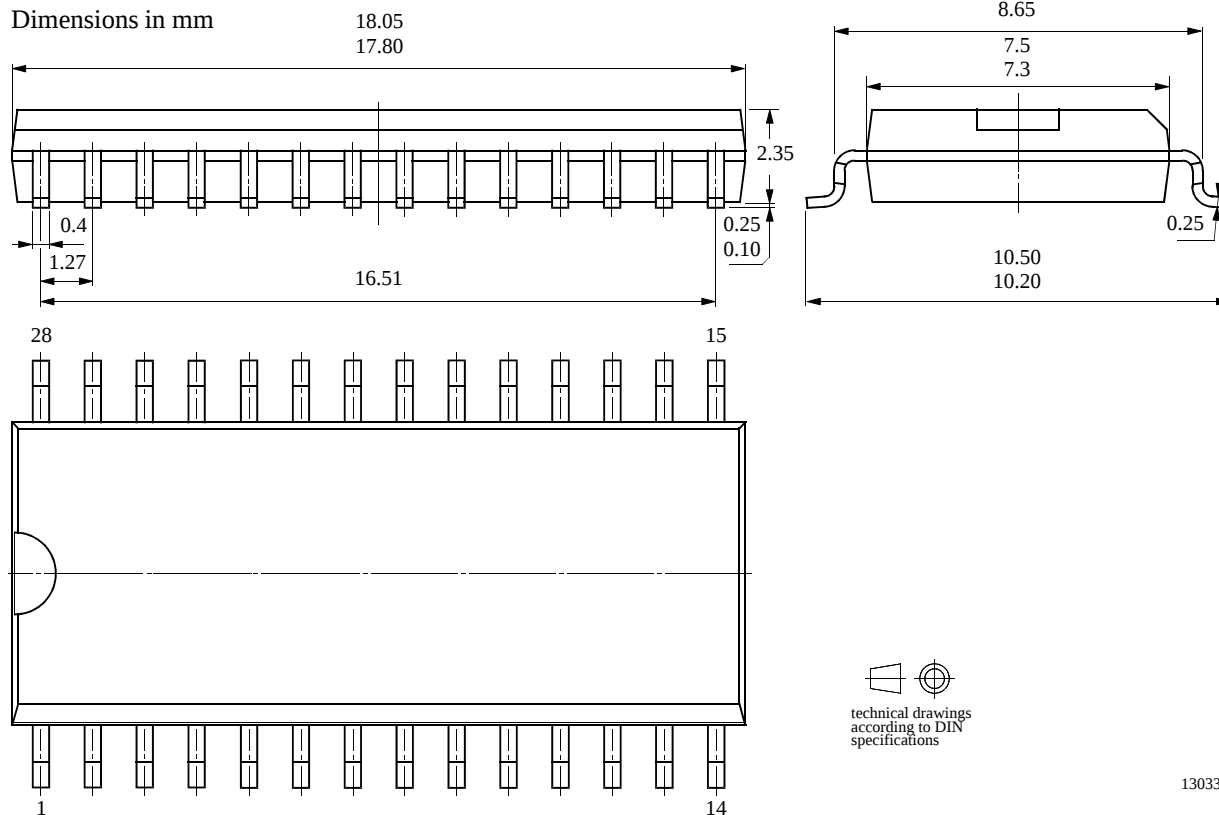


Figure 16.

Package Information

Package SO28

Dimensions in mm



13033

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 (ODS).

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 semiconductor division 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.

We reserve the right to make changes to improve technical design and may do so without further notice.

Parameters can vary in different applications. All operating parameters must be validated for each customer application by the customer. Should the buyer use TEMIC products for any unintended or unauthorized application, the buyer shall indemnify TEMIC against all claims, costs, damages, and expenses, arising out of, directly or indirectly, any claim of personal damage, injury or death associated with such unintended or unauthorized use.

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