

## 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, FSK modem,

power-supply management.

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

### Features

- Symmetrical input of microphone amplifier
- Symmetrical output of earpiece amplifier
- Compander
- Pre- and deemphasis

- Data management by FSK coding
- Power-supply management
- Serial bus

**Application:** CT1 plus, 900 MHz ISM USA

### Block Diagram

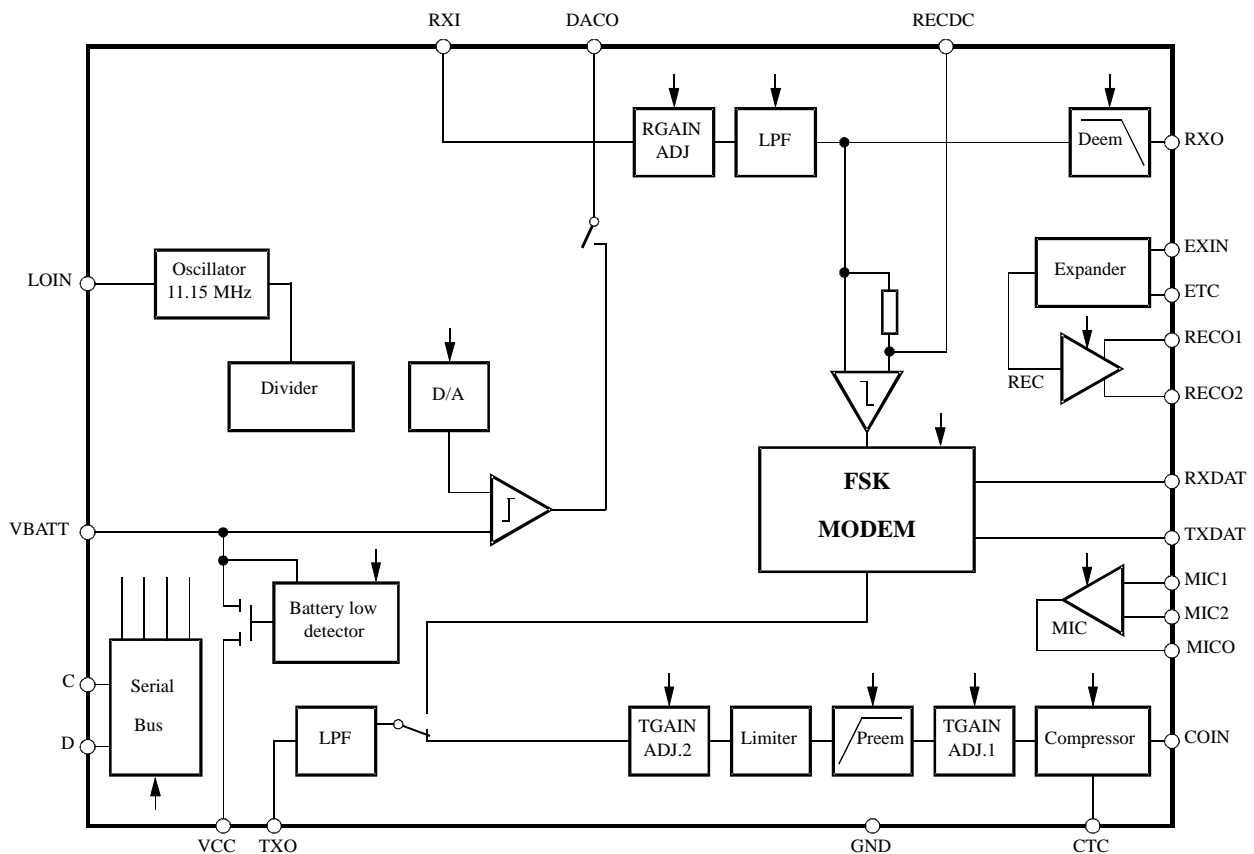


Figure 1. Block diagram

### Ordering Information

Extended Type Number	Package	Remarks
U3502BM-AFL	SO24	Tube, MOQ 360
U3502BM-AFLG3	SO24	Taped and reeled, MOQ 2000

## Pin Description

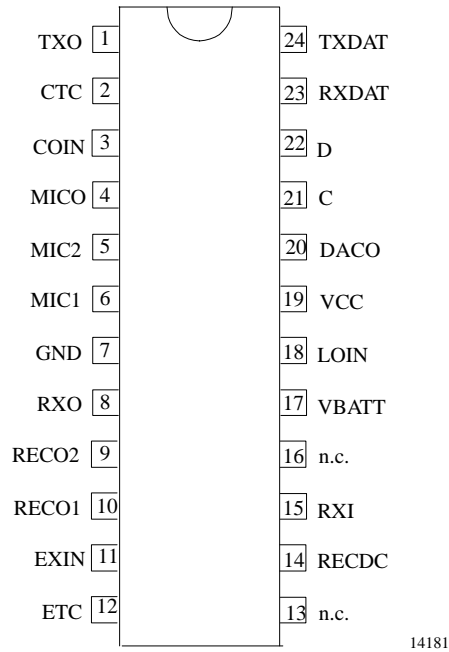
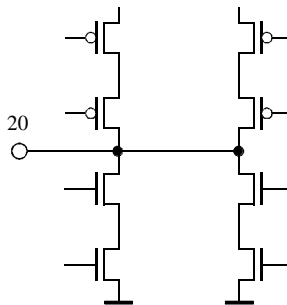
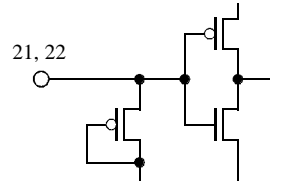
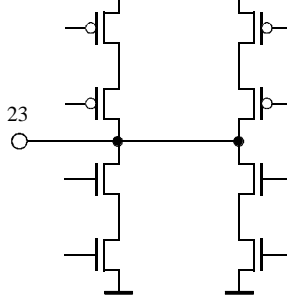
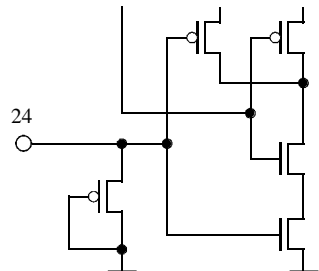


Figure 2. Pinning

Pin	Symbol	Function	Configuration
1	TXO	Transmit section analog output	14725
2	CTC	Compressor time constant control analog output	14726
3	COIN	Compressor analog input	14727
4	MICO	Microphone amplifier output	14728

Pin	Symbol	Function	Configuration
5	MIC2	Non-inverting input of microphone amplifier	
6	MIC1	Inverting input of microphone amplifier	
7	GND	LF analog/ digital ground	
8	RXO	Intermediate receive analog output	
9	RECO2	Symmetrical output of receive amplifier	
10	RECO1	Symmetrical output of receive amplifier	
11	EXIN	Expander analog input	

Pin	Symbol	Function	Configuration
12	ETC	Expander time constant control analog output	
13	n.c.	Not connected	
14	REDC	Reference-voltage generation for FSK demodulator	
15	RXI	Audio input for receive signal	
16	n.c.	Not connected	
17	VBATT	Battery supply	
18	LOIN	Local oscillator input for TCO or SC filter oscillator: 11.15 MHz	
19	VCC	Supply-voltage output for peripherals and internal supply of digital part	

Pin	Symbol	Function	Configuration
20	DACO	D/A comparator output	
21	C	Clock input of serial bus	
22	D	Data input of serial bus	
23	RXDAT	Receive data digital output	
24	TXDAT	Transmit data digital input	

## 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 SO24	$R_{thJA}$	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	Symbol	Min.	Typ.	Max.	Unit	
<b>Current consumption</b>							
ERX2 0	ERX1 0	ERXO 0	EEA 0	EDEE 0	ETX 0	EPREE 0	
Operating Voltage range			3.1	3.6	4.7	V	
Inactive mode	$V_{Batt} = 2.9\text{ V}$		30	60	80	$\mu\text{A}$	
Standby mode				0.3	0.5	mA	
RX demodulating MODEM-signal	ERX1 = 1		1.7	2.6	3.7	mA	
Operating current, RX and TX completely active	ERX2 = ERX1 = ERXO = EEA =EDEE = ETX = 1			7	11.5	mA	
<b>Receiver – Input resistance (see figure 3)</b>							
Input resistance RXI <sub>min</sub>	Minimum value by maximum RGAIN (see register)	RXI <sub>min</sub>		35		k $\Omega$	
Input resistance RXI <sub>max</sub>	Maximum value by minimum RGAIN (see register)	RXI <sub>max</sub>		123		k $\Omega$	
<b>RX audio, GRX0 = GRX1 = GRX2 = 1, GRX3 = 0 (see figure 3)</b>							
Change of RX0 signal deemphasis bypass	EDEE = 0; 1		-0.5	0	0.5	dB	
Gain adjust range				15		dB	
Gain adjust step			0.8	1	1.2	dB	
Output signal vs. frequency rela- tive to 1 kHz (0 dB) deemphasis bypassed	100 Hz 300 Hz 1800 Hz 3400 Hz 4350 Hz 4610 Hz			0.5 0.2 -0.4 0.3 -15.1 -57		dB	
Output signal versus frequency relative to 1 kHz (0 dB) deem- phasis enable EDEE = 1	100 Hz 300 Hz 1800 Hz 3400 Hz 4350 Hz 4610 Hz			7.1 5.7 -4.8 -9.4 -27.1 -68		dB	
Total harmonic distortion	$V_{RXI} = -10\text{ dBV}$ $V_{RXI} = -20\text{ dBV}$				2.5 2.5	%	
Audio mute	$\Delta\text{FM} = 2.5\text{ kHz}$ ERX0 = 0 ERX1 = 0 ERX2 = 0		65			dB	
Output impedance		Z <sub>RXO</sub>			100	$\Omega$	
RXO output voltage		V <sub>RXO</sub>			1	V <sub>pp</sub>	
<b>Expander (see figure 4)</b>							
EEA 1	GEA0 0	GEA1 0	GEA2 0	GEA3 1	GEA4 1		
Gain-reference level	$V_{EXIN} = -10\text{ dBV}_{\text{rms}}$		GOREC	11	13	15	dB
Change of gain when expander is bypassed	BCOMP = 1			-0.5		0.5	dB
Gain tracking	$V_{EXIN} = -20\text{ dBV}_{\text{rms}}$ $V_{EXIN} = -30\text{ dBV}_{\text{rms}}$ $V_{EXIN} = -35\text{ dBV}_{\text{rms}}$ $V_{EXIN} = -40\text{ dBV}_{\text{rms}}$			-21 -41 -53	-50 -60	-19 -39 -47	dB

## Electrical Characteristics (continued)

Parameters	Test Conditions	Symbol	Min.	Typ.	Max.	Unit
Input impedance			9.5		14.5	kΩ
Gain change versus supply voltage	V <sub>Batt</sub> = 3.2 V to 4.7 V		-0.5		0.5	dB
Attack time	V <sub>EXIN</sub> = step -20 dBV <sub>rms</sub> → -14 dBV <sub>rms</sub> , measure time after step when output voltage is 0.75 times the final value	t <sub>r</sub>		16		ms
Release time	V <sub>EXIN</sub> = step 14 dBV <sub>rms</sub> → -20 dBV <sub>rms</sub> , measure time after step when output voltage is 1.5 times the final value	t <sub>f</sub>		16		ms
<b>Earpiece amplifier</b> BCOMP = 1, EEA = 1, V <sub>EXIN</sub> = 100 mV <sub>rms</sub> (see figure 4)						
Maximum gain	GEA0 GEA1 GEA2 GEA3 1 1 1 1 GEA4 = 1		19	20	21	dB
Medium gain	GEA0 GEA1 GEA2 GEA3 0 0 0 0 GEA4 = 1		4	5	6	dB
Minimum gain	GEA0 GEA1 GEA2 GEA3 0 0 0 0 GEA4 = 0		-12	-11	-10	dB
Gain change vs. supply voltage	V <sub>Batt</sub> = 3.2 V to 4.7 V		-0.2		0.2	dB
Gain-adjust range				31		dB
Gain-adjust step			0.8	1	1.2	dB
Output impedance				10	30	Ω
Distortion		d <sub>t</sub>			1	%
Output offset voltage	V <sub>EXIN</sub> = 0 mV <sub>rms</sub>		-200		200	mV
Output-voltage swing (peak-to-peak)	Increase V <sub>EXIN</sub> until distortion (RECO1/ RECO2) is 5%	V <sub>pp</sub>	4.8	5.0		V
<b>Low-frequency transmitter</b>						
GMIC	EPREE	BSCR	G1TX	G2TX	BCOMP	ETX
1	1	1	1000	1000	1	1
<b>Microphone amplifier</b> V <sub>MIC</sub> = 10 mV <sub>rms</sub> , f <sub>IN</sub> = 1 kHz (see figure 5)						
Gain	High gain: GMIC = 1 Low gain: GMIC = 0		31 23	32 24	33 25	dB
Gain change vs. supply voltage	V <sub>Batt</sub> = 3.2 V to 4.7 V		-0.2	0	0.2	dB
Differential input impedance			41	75	103	kΩ
Output impedance				10	35	Ω
Distortion	V <sub>MIC</sub> = 10 mV <sub>rms</sub>	d <sub>t</sub>			1	%
Output noise (psophmetrically weighted)	V <sub>MIC</sub> = 0 V <sub>rms</sub> high gain (inputs closed across 200 Ω)				50	μV <sub>rmsp</sub>
<b>TX audio</b> V <sub>COIN</sub> = -20 dBV <sub>rms</sub> (see figure 6)						
Gain	GTX (TXO, COIN)		2.5	5.5	8.5	dB
Change of gain TXO	EPREE = 0		-0.5	0	0.5	dB
Gain between 3.2 and 4.7 V			-1	0	1	dB
TX gain-adjust range adj. 1				15		dB
TX gain-adjust step adj. 1			0.8	1	1.2	dB

## Electrical Characteristics (continued)

Parameters	Test Conditions	Symbol	Min.	Typ.	Max.	Unit					
LIM gain-adjust range adj. 2				15		dB					
LIM gain-adjust step adj. 2			0.8	1	1.2	dB					
TX gain versus frequency (pre-emphasis bypassed) relative to 1-kHz reference level 0 dB	100 Hz 300 Hz 1800 Hz 3400 Hz 4350 Hz 7300 Hz			-3.4 -0.6 0.3 0.0 -3.8 -6.5		dB					
Gain versus frequency with pre-emphasis relative to 1-kHz reference level 0 dB	100 Hz 300 Hz 1800 Hz 3400 Hz 4350 Hz 7300 Hz			-9.3 -5.9 4.4 7.7 5.9 -54.4		dB					
Total band ripple	300 to 3400 Hz preemphasis bypassed				2	dB					
<b>Limiters</b>											
Output voltage (peak-to-peak)	Increase $V_{COIN}$ until $d = 5\%$ at TX0 then measure VTX0		1.2	1.68	2.3	$V_{pp}$					
Mute	ETX = 0, $V_{COIN} = -10$ dBV attenuation at TX0 output		65			dB					
Output impedance			7	10	14	k $\Omega$					
<b>Compressor / compressor (see figure 6)</b>											
	BSCR	EPREE	G2TX0	G2TX1	G2TX2	G2TX3	ETX	G1TX0	G2TX1	G1TX2	G1TX3
	1	0	0	1	0	1	1	0	0	1	0
Input impedance	BCOMP = 1							9	14	22	k $\Omega$
Gain reference level G0TX	$V_{COIN} = -10$ dBV <sub>rms</sub>						G0TX	1	5.5	10	dB
Gain change when compressor is bypassed	$V_{COIN} = -10$ dBV <sub>rms</sub> BCOMP = 1							-0.5		0.5	dB
Gain tracking	$V_{COIN} = -30$ dBV <sub>rms</sub> $V_{COIN} = -50$ dBV <sub>rms</sub> $V_{COIN} = -60$ dBV <sub>rms</sub> $V_{COIN} = -70$ dBV <sub>rms</sub>							-11 -21 -22		-9 -19 -28	dB
Attack time	$V_{COIN} =$ step $-30$ dBV <sub>rms</sub> $\rightarrow$ $-18$ dBV <sub>rms</sub> measure time after step when output voltage is 1.5 times the final value						$t_r$		3.5		ms
Release time	$V_{COIN} =$ step $-18$ dBV <sub>rms</sub> $\rightarrow$ $-30$ dBV <sub>rms</sub> measure time after step when output voltage is 0.75 times the final value						$t_f$		14.4		ms



**Electrical Characteristics (continued)**

Parameters	Test Conditions	Symbol	Min.	Typ.	Max.	Unit
<b>FSK modem (1200 Bauds)</b>						
FSK-demodulator Input signal discriminator IFIN1-IFIN2—RXDAT  2100 Hz — = 0 1300 Hz — = 1	IFIN = 450 kHz VIFIN = 0.5 mV <sub>rms</sub> df = 2.4 kHz ERX1 = 1 GDEM = 0 (high gain) GRX3 = 1 (+1dB)		1720		1660	Hz Hz
FSK – modulator TXDAT — TXO Output signal level TXDAT — TXOUT  Signal distortion TXDAT — TXOUT	ETX = 1 EFSK = 1 TXDAT = 0 TXOUT = 2100 Hz TXDAT = 1 TXOUT = 1300 Hz TXDAT = 0 TXOUT = 2100 Hz TXDAT = 1 TXOUT = 1300 Hz		0.87		1.54 1.54	V <sub>pp</sub> V <sub>pp</sub>
Output signal frequency	TXDAT = 0 TXDAT = 1		2100 1300			Hz
Output signal – Distortion – Offset level			1.5	2		% V
<b>Logical part (see figure 9)</b>						
Inputs: C, D, TXDAT Low-voltage input High-voltage input Input leakage current (0 < V <sub>I</sub> < V <sub>CC</sub> )			2.5 –1		0.5 1	V V μA μA
Input LOIN Input leakage current pin XCK (0 < V <sub>I</sub> < V <sub>CC</sub> )			–5		5	μA
Outputs: DACO, RXDAT Output low Output high	I <sub>ol</sub> = 10 μA I <sub>oh</sub> = –10 μA		0.9 × V <sub>CC</sub>		0.1 × V <sub>CC</sub>	
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		t <sub>sud</sub> t <sub>hd</sub> t <sub>cl</sub> t <sub>ch</sub> t <sub>eon</sub>  t <sub>eh</sub> t <sub>eof</sub>	0.1 0 2 2 0.1  0.2 0.2			μs μs μs μs μs  μs μs

## Electrical Characteristics (continued)

Parameters	Test Conditions	Symbol	Min.	Typ.	Max.	Unit
<b>Battery management</b>						
Max batlow	DA0 to 6 = 1, RBAT = 1		3.8	3.95	4.1	V
Min batlow over switch	DA0 to 6 = 27 BIN, RBAT = 1		3.05	3.2	3.35	V
Max bathigh	DA0 to 6 = 1, RBAT = 0		4.85	5.05	5.25	V
Min bathigh	DA0 to 6 = 0, RBAT = 0		3.93	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
<b>Battery switch</b>						
Off threshold	DA0 to 6 = 1, RBAT = 1		2.9	3.0	3.1	V
On threshold	DA0 to 6 = 27 BIN, RBAT = 1		3.15	3.25	3.35	V
Hysteresis			220	250	280	mV
Switch R <sub>on</sub>	DA0 to 6 = 0, RBAT = 0			35	50	Ω

<b>Max batlow</b>	:	MAXBL (battery voltage when all DAC bits are high, low range)
<b>Min batlow</b>	:	MINBL (battery voltage when DAC bits are 0011011, low range)
<b>Max bathigh</b>	:	MAXBH (battery voltage when all DAC bits are high, high range)
<b>Min bathigh</b>	:	MINBH (battery voltage when all DAC bits are low, high range)
<b>Adjust step</b>	:	Adjust step
<b>Max – Min</b>	:	MAXBH – MINBH
<b>MINBL – SWOFF</b>	:	MINBL – SWOFF
<b>Off threshold</b>	:	SWOFF (off threshold of the battery switch)
<b>On threshold</b>	:	SWON (on threshold of the battery switch)
<b>Hysteresis</b>	:	SWON – SWOFF
<b>Switch R<sub>on</sub></b>	:	Switch R <sub>on</sub> (resistance of the switch transistor, when switch is “ON”)

**Test Circuits**

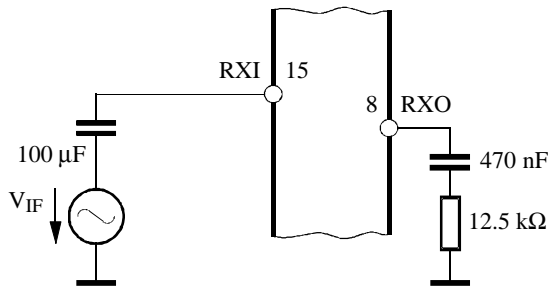


Figure 3. RX audio

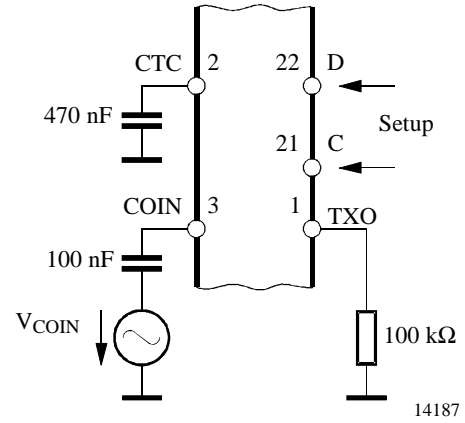


Figure 6. TX audio

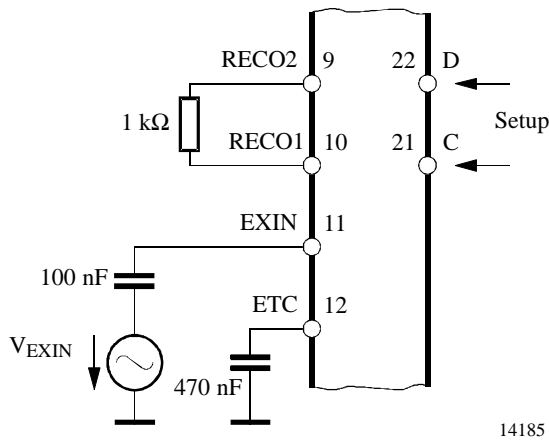


Figure 4. Expander

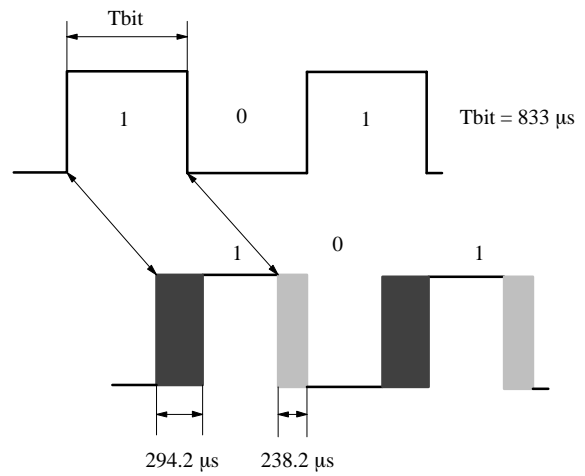


Figure 7. Jitter of rise and fall time edge of FSK modem

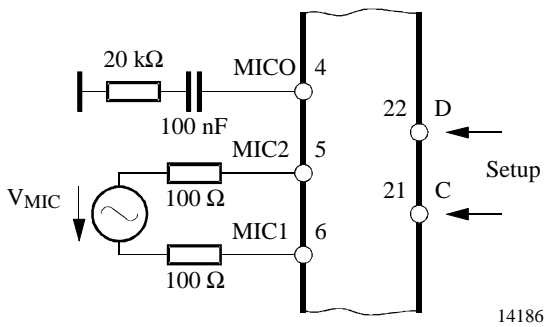


Figure 5. Microphone amplifier

## Serial Bus Interface

The circuit is remoted by an external microcontroller through the serial bus.

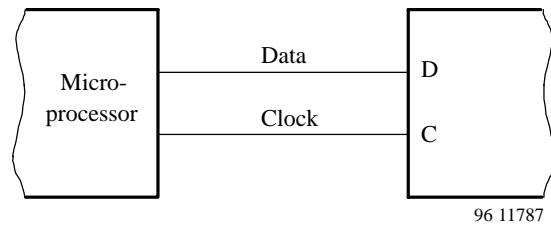
The data is a 12-bit word:

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

D7 – D0: contents of register

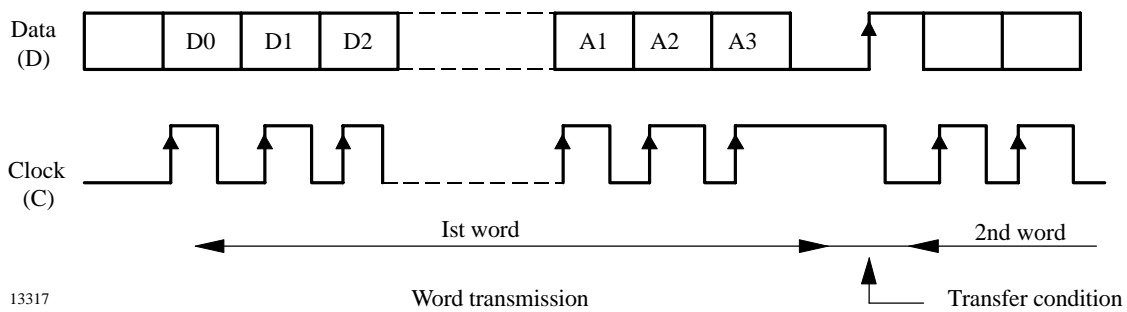
The data line must be stable when the clock is high and data must be shifted serially.

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



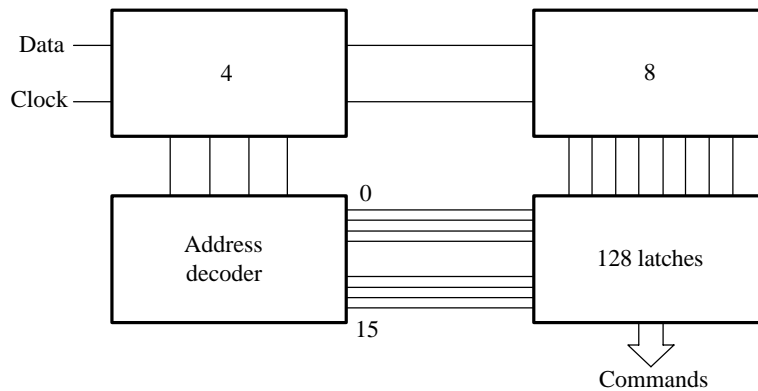
96 11787

Figure 8. Connection lines



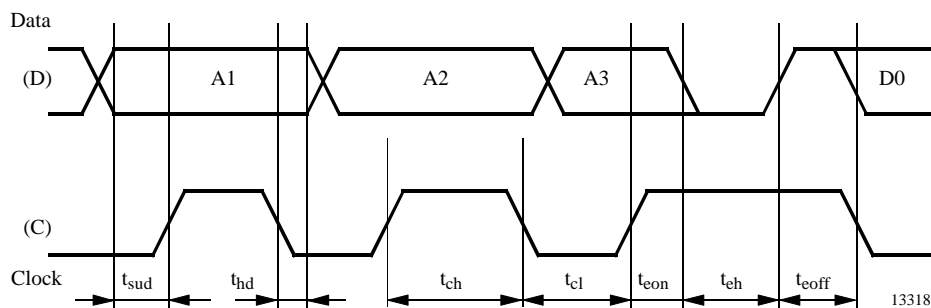
13317

Figure 9. Serial bus transmission



96 11789

Figure 10. Block diagram



13318

Figure 11. Serial bus timing

## Content of Internal Registers

The register have the following structure:

D7	D6	D5	D4	D3	D2	D1	D0
----	----	----	----	----	----	----	----

R0: Reference for D/A converter

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

MUXDA: D/A multiplexing, "1" enables battery detection

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

free	EDDE	EEA	ERXO	ERX1	free	free	ERX2
------	------	-----	------	------	------	------	------

EDDE: Enable deemphasis (disables bypass)

EEA: Enable earpiece amplifier

ERXO: Enable RXO output

ERX(1:2): Enable parts of RXLF

R4: Enable functions transmit

free	RBAT	BCOMP	BSCR	GMIC	EFSK	EPREE	ETX
------	------	-------	------	------	------	-------	-----

RBAT: Battery detection high/low range

BCOMP: Bypass compressor and expander

BSCR: It is mandatory to keep 1

GMIC: Gain of microphone preamplifier

EFSK: Enable modulator of FSK modem

EPREE: Enable pre-emphasis (disables bypass)

ETX: Enable TX low frequency part

R5:

free	MTX	free	free	free	free	GEA4	free
------	-----	------	------	------	------	------	------

GEA4: Gain earpiece amplifier MSB (see also R1)

MTX: Mute transmit section

## Application Circuit

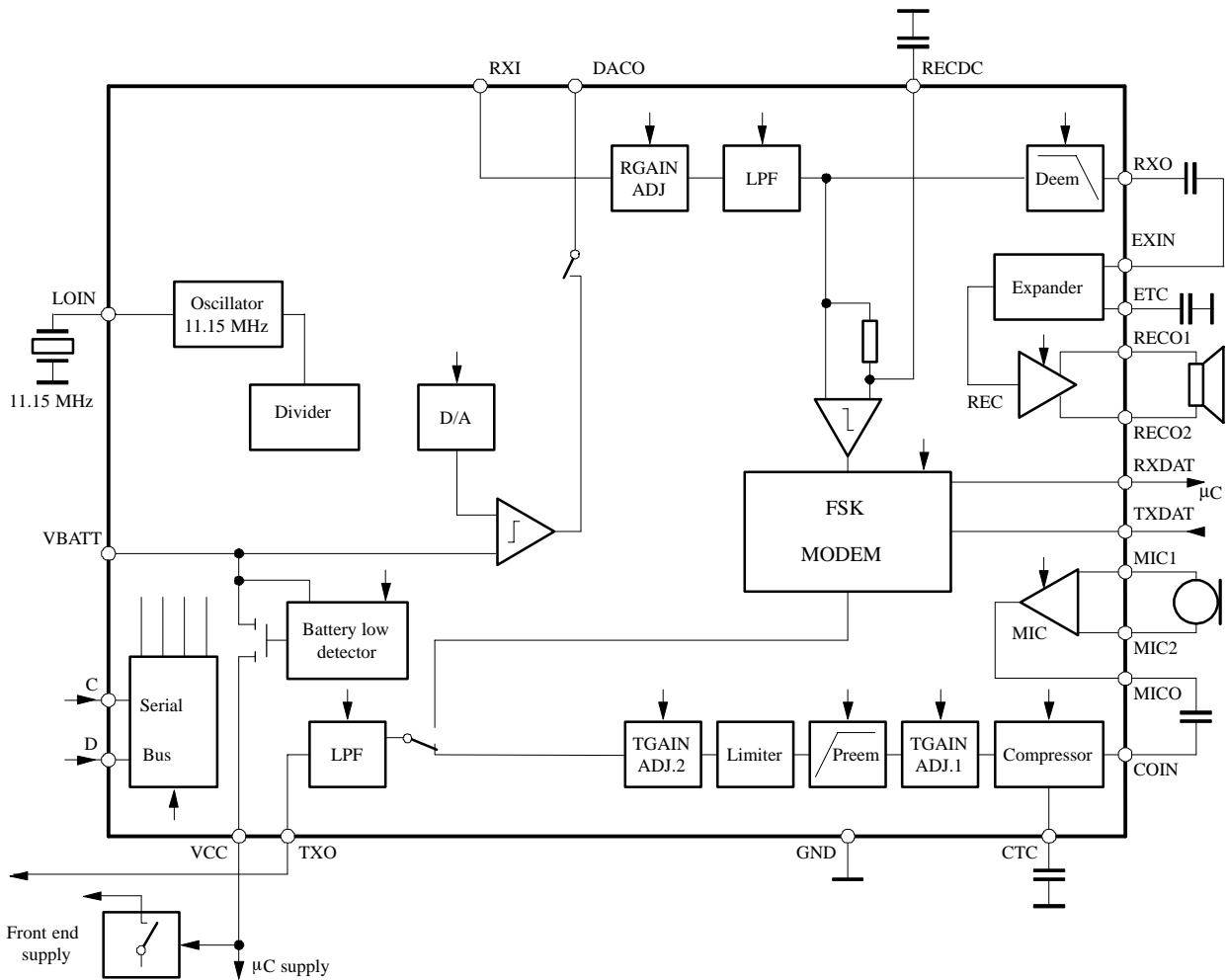
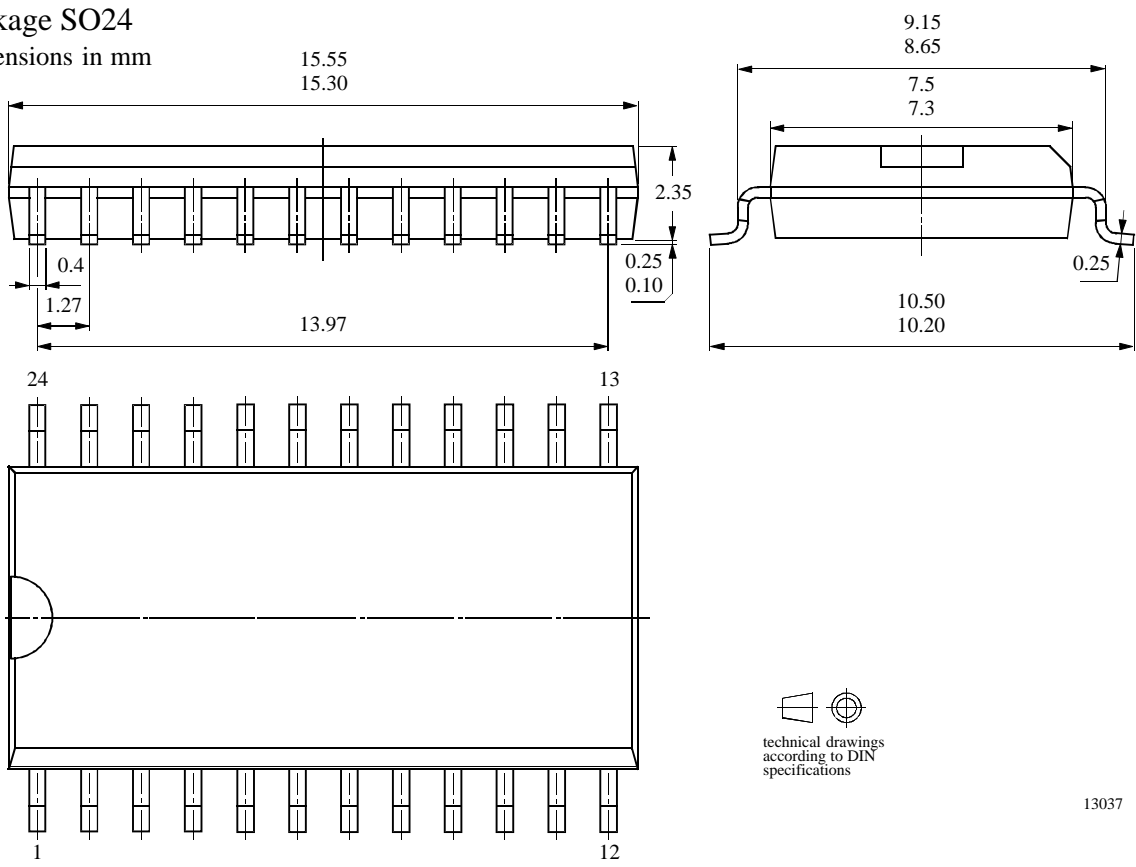



Figure 12. Application circuit

**Package Information**

Package SO24

Dimensions in mm



  
technical drawings  
according to DIN  
specifications

13037

## 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.

**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 Semiconductors products for any unintended or unauthorized application, the buyer shall indemnify TEMIC Semiconductors 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.

**Data sheets can also be retrieved from the Internet: <http://www.temic-semi.com>**

TEMIC Semiconductor GmbH, P.O.B. 3535, D-74025 Heilbronn, Germany  
Telephone: 49 (0)7131 67 2594, Fax number: 49 (0)7131 67 2423