Cordless Telephone Signal Processor

Description

Cordless telephone signal processor reduces the need for many external components.

Features

RF Receiver Part

IF converter, FM demodulator, RSSI-digital information

LF Part

Microphone amplifier, earpiece amplifier, compander, preemphasis, deemphasis, scrambler, descrambler, digital power management, data management by FSK coding, transmit and receive part adjustable and mutable by serial bus, compander, pre-/ de-emphasis, scrambler with bypass function

Application: CT1, CT1P, 900 MHz USA standard

Package: SO28

Block Diagram

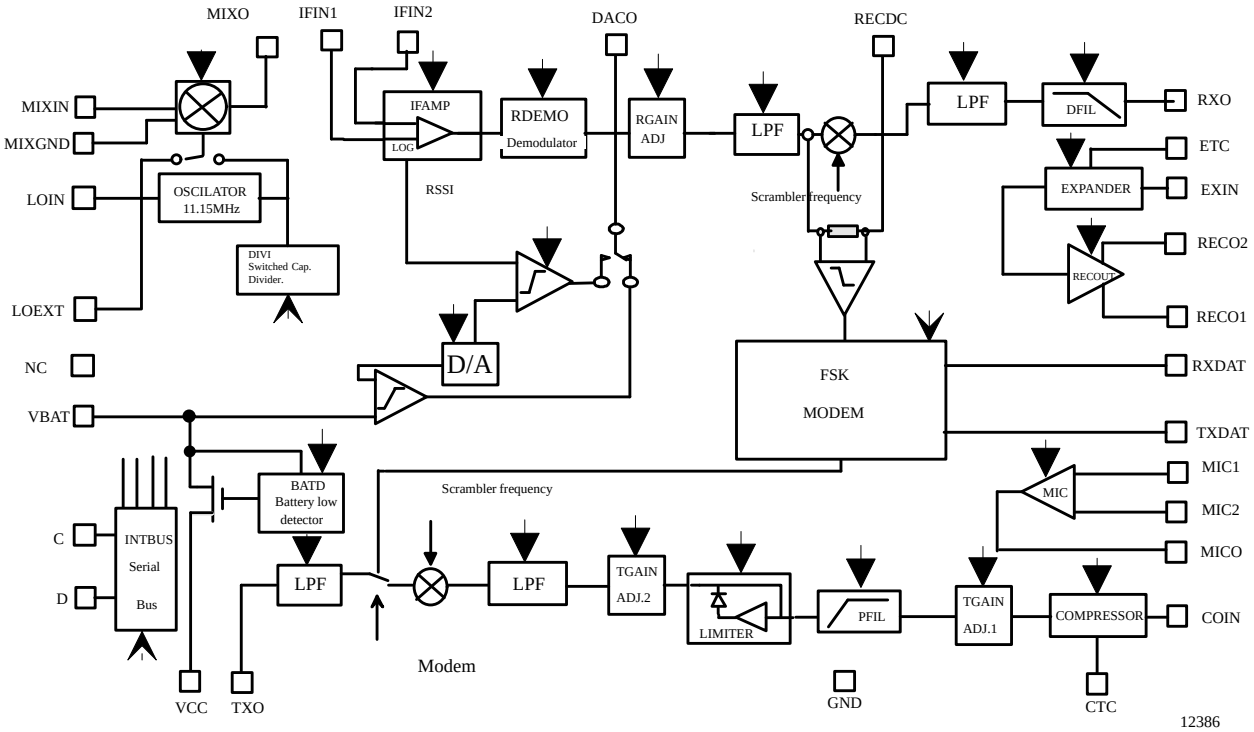


Figure 1.

Pin Description

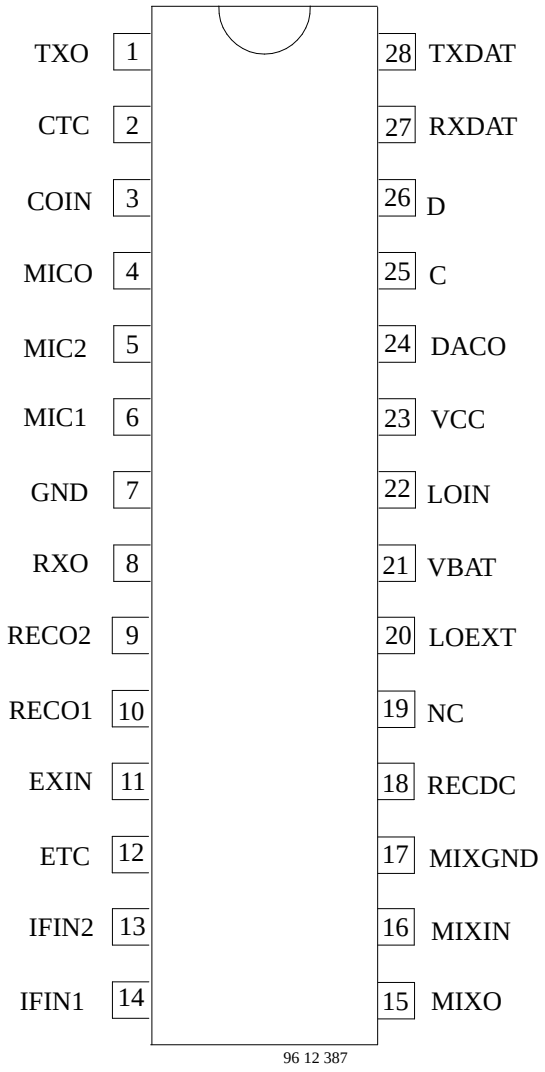


Figure 2. Pinning

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	RXO	Intermediate receive analog output
9	RECO2	Symmetrical output of receive amplifier
10	RECO1	Symmetrical output of receive amplifier
11	EXIN	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	RECDC	Reference voltage generation for FSK demodulator
19	NC	Not connected
20	LOEXT	External LO input
21	VBAT	Battery supply
22	LOIN	Local oscillator input for TCO or SC filter oscillator: 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	RXDAT	Receive data digital output
28	TXDAT	Transmit data digital input

Absolute Maximum Ratings

Parameters	Symbol	Min.	Typ.	Max.	Unit
Supply voltage	V_{BAT}, V_{CC}			5.5	V
Junction temperature	Tj			+125	°C
Ambient temperature	T_{amb}	–25		+75	°C
Storage temperature	T_{stg}	–50		+125	°C
Power dissipation	PD			1	W

Current Consumption

Test conditions (unless otherwise specified): VBAT = VCC = 3.6 V, T_{amb} = +25°C

ERX2	ELNA	ERXHF	ERX1	ERXO	EEA	EDEE	ETX	EPREE
0	0	0	0	0	0	0	0	0

Parameters	Test Conditions	Min.	Typ.	Max.	Unit
Operating voltage range		3.1	3.6	4.7	V
Inactive mode	VBAT = 2.9 V (or smaller)		60	80	µA
Standby mode			0.3	0.5	mA
RX waiting for RSSI	ERXHF = 1	1	1.6	2.4	mA
RX demodulating MODEM-signal	ERXHF = ERX1 = 1	1.7	2.6	3.7	mA
Operating current, RX and TX completely active	ERX2 = ELNA = ERXHF = ERX1 = ERXO = EEA = EDEE = GDEM = ETX = 1		7.0	11.5	mA

Receiver

IF Mixer

Electrical Characteristics

Test conditions (unless otherwise specified) VBAT = 3.6 V, ERXHF = 1, T_{amb} = 25°C, FMIXIN = 10.7 MHz, FMIXO = 450 kHz

Parameters	Test Conditions	Min.	Typ.	Max.	Unit	Fig.
Input resistance	Pin MIXIN	2000	3000	4000	Ω	3
Input capacitance	Pin MIXIN		3		pF	
Output impedance	Pin MIXO	1200	1500	1800	Ω	
Voltage gain G_{VMIX}	Input level 7 mV_{RMS}	13	15	17	dB	
Input compression point		–17			dBm	
Third order input intercept point		–9			dBm	
Carrier breakthrough from internal LO (11.15 MHz) to IF output				300	µVrms	
Carrier breakthrough from internal LO (11.15 MHz) to RF input				10	µV	
Input frequency range		10		60	MHz	
Output frequency			450		kHz	

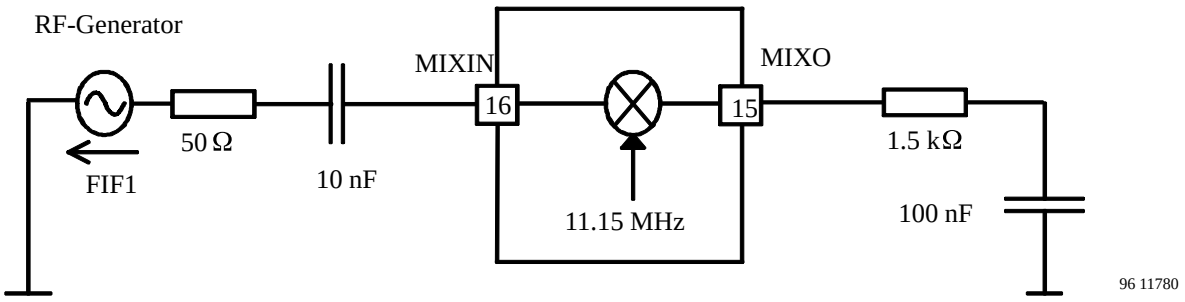


Figure 3. Test circuit

IF Amplifier: RSSI

Parameters	Test Conditions	Min.	Typ.	Max.	Unit	Fig.
Input resistance		1.6	2	2.5	kΩ	
RSSI-sensitivity	VIF = 0 µVrms starting from 0 increase RSSI-level until mean of sampled signal at DACO is ≤ 0.2 RSSI-level = CON0 VIF = 6 µVrms, F = 450 kHz increase RSSI-level again until mean of sampled signal at DACO is ≤ 0.2. RSSI-level = CON1 RSSI-sensitivity = CON1-CON0	4				4
RSSI input voltage dynamic range			65		dB	
RSSI-level number of step			127			
RSSI level step-size in the logarithmic region			0.46		dB	

RSSI Level Programming (Typical Values)

Input Voltage VIF (µVrms)	RSSI-Level (Decimal)
0	8
6	15
10	23
100	67
1000	114
10000	

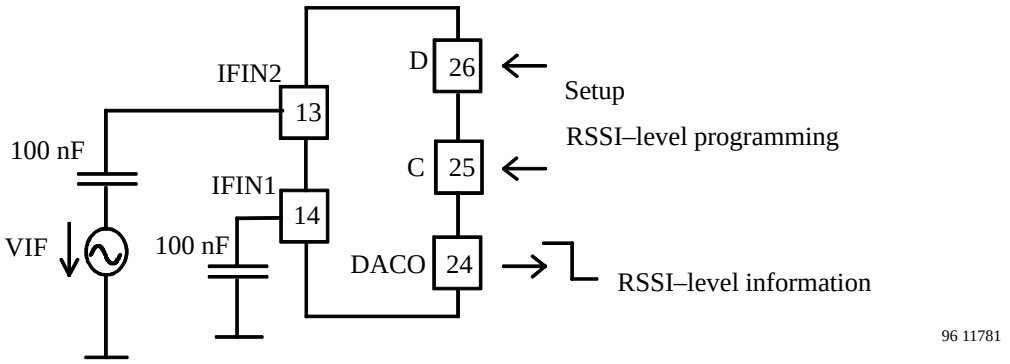


Figure 4.

RF Demodulator

IF = 450 kHz, FMOD = 1 kHz, input level = 500 µVrms

BSCR	EDEE	GRX0	GRX1	GRX2	GRX3	ERX1	ERXO
1	0	1	1	1	0	1	1

Parameters	Test Conditions	Min.	Typ.	Max.	Unit	Fig.
Recovered audio	GDEM = 0, dFM = 2.5 kHz GDEM = 1, dFM = 5 kHz	0.4	0.8	1.6	Vpp	5
Recovered audio output voltage drop	VBAT = 4.7 to 3.1 V	–3	0		dB	
AM rejection ratio	30% AM		35		dB	

RX Audio

dFM = 1 kHz, GDEM = 0

Parameters	Test Conditions	Min.	Typ.	Max.	Unit	Fig.
Change of RX0 signal deemphasis bypass	EDEE = 0; 1 FM0D = 1 kHz	–0.5	0	0.5	dB	5
RX gain adjust range			15		dB	
RX gain adjust step		0.8	1	1.2	dB	
Output signal versus frequency relative to 1 kHz (0 dB) de-emphasis bypassed	DRXGF (100 Hz) DRXGF (300 Hz) DRXGF (1800 Hz) DRXGF (3400 Hz) DRXGF (4350 Hz)	–8 –2.2 –1.4 –0.8 –80	–7 –1.2 –0.4 0.2 –60	–6 –0.2 0.6 1.2 –55	dB	
Output signal versus frequency relative to 1 kHz (0 dB) de-emphasis enable EDEE = 1	DFIL (100 Hz) DFIL (300 Hz) DFIL (1800 Hz) DFIL (3400 Hz) DFIL (4350 Hz)	–1.6 3.2 –5.7 –10.5 –80	–0.6 4.2 –4.7 –9.5 –60	0.4 5.2 –3.7 –8.5 –55	dB	
RX total harmonic distortion	dFM = 250 Hz dFM = 2.50 kHz			2.5 2.5	%	
RX audio mute	dFM = 2.5 kHz ERX0 = 0 ERX1 = 0 ERX2 = 0	65			dB	
RX output impedance				100	Ω	

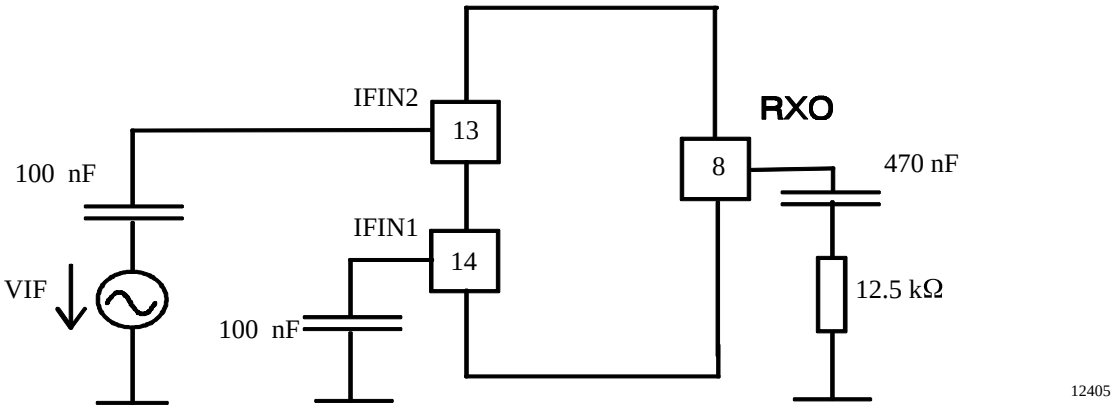


Figure 5.

Expander

EEA	GEA0	GEA1	GEA2	GEA3	GEA4
1	0	0	0	1	1

Parameters	Test Conditions	Min.	Typ.	Max.	Unit	Fig.
Gain reference level G0REC	VEXIN = –10 dBVrms	11	13	15	dB	6
Change of gain when expander is bypassed (relative to G0REC)	BCOMP = 1	–0.5		0.5	dB	
Gain tracking (relative to G0REC)	VEXIN = –20 dBV VEXIN = –30 dBV VEXIN = –35 dBV VEXIN = –40 dBV	–21 –41 –53	 –50 –60	–19 –39 –47	dB	
Input impedance		9.5		14.5	kΩ	
Change of gain due to change of supply voltage	Supply voltage between 3.2 and 5.2 V	–0.5		0.5	dB	
Attack time	VEXIN = step –20 dBVrms→ –14 dBVrms, measure time after step, when output voltage has 0.75 times the final value		16		ms	
Release time	VEXIN = step 14 dBVrms → –20 dBVrms, measure time after step, when output voltage has 1.5 times of final value		16		ms	

Earpiece Amplifier

BCOMP = 1, EEA = 1, VEXIN = 100 mVrms

Parameters	Test Conditions	Min.	Typ.	Max.	Unit	Fig.
Maximum gain	GEA0 GEA1 GEA2 GEA3 1 1 1 1 GEA4 = 1	19	20	21	dB	6
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	
Change of gain due to change of supply voltage	Supply voltage varies between 3.2 and 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	
Total harmonic distortion				1	%	
Output offset	VEXIN = 0 mV_{RMS}	–200		200	mV	
Output voltage swing	Increase VEXIN until THD at output (RECO1/ RECO2) is 5%	4.8	5.0		Vpp	

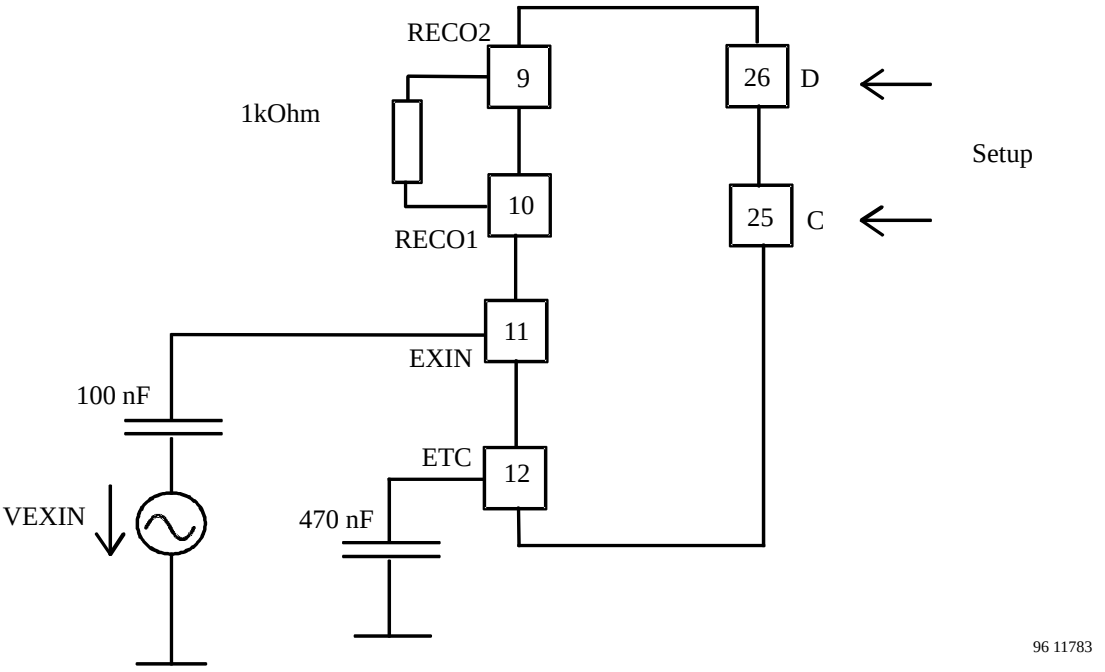


Figure 6.

LF Transmitter

GMIC	EPREE	BXCR	G1TX	G2TX	BCOMP	ETX
1	1	1	1000	1000	1	1

Microphone Amplifier

VMIC = 10 mVrms**,** FIN = 1 kHz

Parameters	Test Conditions	Min.	Typ.	Max.	Unit	Fig.
Gain	High gain: GMIC = 1 Low gain: GMIC = 0	31 23	32 24	33 25	dB	8
Change of gain due to change of supply voltage	Supply voltage varies between 3.2 and 4.7 V	–0.2	0	0.2	dB	
Differential input impedance		41	75	103	kΩ	
Output impedance			10	35	Ω	
Total harmonic distortion	VMIC = 10 mV_{RMS}			1	%	
Output noise	VMIC = 0 V_{RMS} high gain (inputs closed across 200 Ω) output voltage psophmetrically weighted			50	µVrmsp	

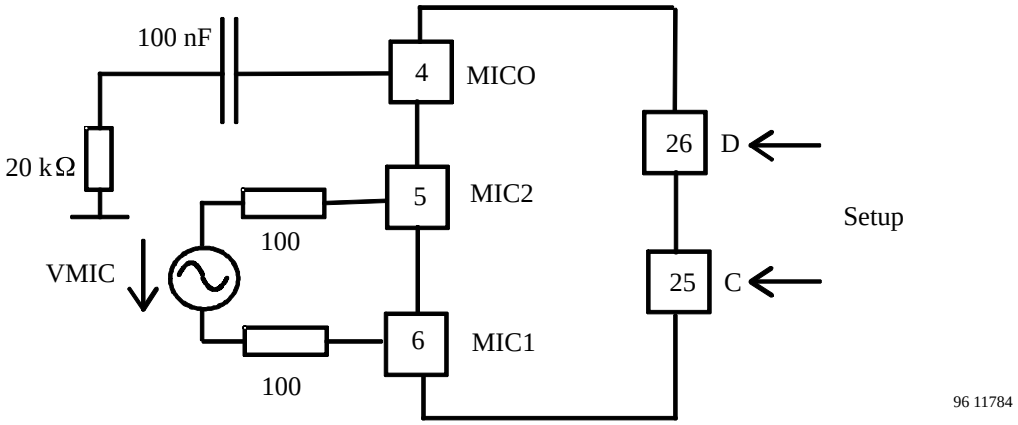


Figure 7.

TX Audio

VCOIN = –20 dBVrms

Parameters	Test Conditions	Min.	Typ.	Max.	Unit	Fig.
Change of gain TXO	EPREE = 0	–0.5	0	0.5	dB	6
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	
LIM gain adjust range adj. 2			15		dB	
LIM gain adjust range adj.2		0.8	1	1.2	dB	
TX gain versus frequency (pre-emphasis bypassed) relative to 1 kHz reference level 0 dB	DTXGT (100 Hz) DTXGT (300 Hz) DTXGT (1800 Hz) DTXGT (3400 Hz) DTXGT (4350 Hz)	–1.3 –1.2 –0.8 –1.1 –20	–0.3 –0.2 0.2 –0.1 –24	0.7 0.8 1.2 0.7 –28	dB	
Gain versus frequency with preemphasis relative to 1 kHz reference level 0 dB	PFIL (100 Hz) PFIL (300 Hz) PFIL (1800 Hz) PFIL (3400 Hz) PFIL (4350 Hz)	–7.5 –6.5 3.3 6.9 –15	–6.5 –5.5 4.3 7.9 –14	–5.5 –4.5 5.3 8.9 –13	dB	
Total band ripple	VBAT = 3.6 V and 5.2 V VCOIN = –20 dBV			2	%	
TX gain	GTX (TXO, COIN)		5.5		dB	

Limiter

Parameters	Test conditions	Min.	Typ.	Max.	Unit
TX limiter level	Increase VCOIN until THD at TX0 = 5% then measure VTX0	1.2	1.68	2.3	Vpp
TX audio mute	ETX = 0, VCOIN = –10 dBV attenuation at TX0 output	65			dB
TX output impedance		7	10	14	kΩ

Compander / Compressor

BSCR	EPREE	G2TX0	G2TX1	G2TX2	G2TX3	ETX	G1TX0	G1TX1	G1TX2	G1TX3
1	0	0	1	0	1	1	0	0	1	0

Parameters	Test conditions	Min.	Typ.	Max.	Unit	Fig.
TX input impedance COIN	BCOMP = 1	9	14	22	kΩ	8
Gain reference level G0TX	VCOIN = –10 dBVrms	1	5.5	10	dB	
Change of gain when compresser is bypassed (relative to G0TX)	VCOIN = –10 dBVrms BCOMP = 1	0,5		0.5	dB	
Gain tracking (relative to G0TX)	VCOIN = –30 dBVrms VCOIN = –50 dBVrms VCOIN = –60 dBVrms VCOIN = –70 dBVrms	–11 –21 –22	–30	–9 –19 –28		
Attack time	VCOIN = step –30 dBVrms→ –18 dBVrms measure time after step when output voltage has 1.5 times the final value		3.5		ms	
Release time	VCOIN = step –18 dBVrms→ –30 dBVrms measure time after step when output voltage has 0.75 times the final value		14.4		ms	

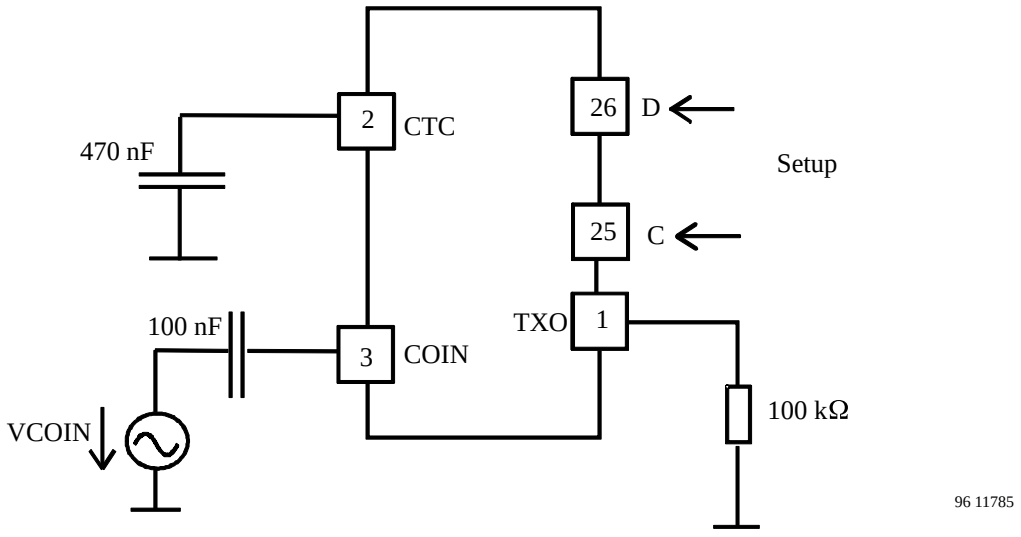


Figure 8.

Scrambler

EPREE	BSCR	BCOMP
0	0	1

Parameters	Test Conditions / Pins	Min.	Typ.	Max.	Unit
Conversion gain versus frequency FIN (1 kHz) reference level 0 dB	FIN = 100 Hz, FOUT = 4255 Hz	–4.5	–3.5	–2.5	dB
	FIN = 300 Hz, FOUT = 4055 Hz	–2.3	–1.3	–0.3	
	FIN = 700 Hz, FOUT = 3655 Hz	–0.9	0.1	1.1	
	FIN = 1800 Hz, FOUT = 2555 Hz	–1.1	–0.1	0.9	
	FIN = 2600 Hz, FOUT = 1755 Hz	–1.1	–0.1	0.9	
	FIN = 3400 Hz, FOUT = 955 Hz	–2.5	–1.5	–0.5	
	FIN = 3600 Hz, FOUT = 755 Hz	–4.9	–3.9	–2.8	
	FIN = 1000 Hz, FOUT = 3355 Hz	–1	0	1	
Carrier break through	Measure FOUT = 4355 Hz			10	mV_{RMS}

Descrambler

EDEE	BSCR	BCOMP
0	0	1

Parameters	Test Conditions / Pins	Min.	Typ.	Max.	Unit
Conversion gain Versus frequency	FIN = 4255 Hz, FOUT = 100 Hz	–3.8	–2.6	–1.8	dB
	FIN = 4055 Hz, FOUT = 300 Hz	–1.6	–0.6	0.1	
	FIN = 3655 Hz, FOUT = 700 Hz	–0.5	0.5	1.5	
	FIN = 2555 Hz, FOUT = 1800 Hz	–1.7	–0.7	0.3	
	FIN = 1755 Hz, FOUT = 2600 Hz	–0.7	6.3	1.3	
	FIN = 955 Hz, FOUT = 3400 Hz	–1.4	–0.4	0.6	
	FIN = 755 Hz, FOUT = 3600 Hz	–1.7	–0.7	0.3	
	FIN = 3355 Hz, FOUT = 1000 Hz	–1	0	1	
Carrier break through	Measure FOUT = 4355 kHz			0.3	mV_{RMS}

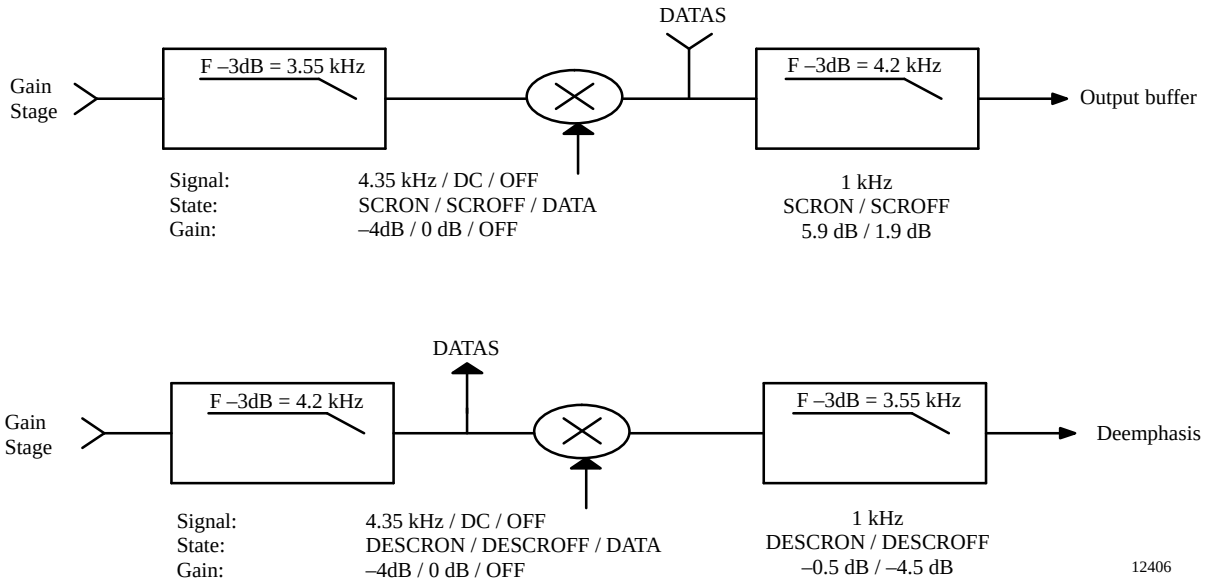


Figure 9.

FSK Modem (1200 Bauds)

Parameters	Test Conditions	Min.	Typ.	Max.	Unit
FSK-demodulator Input signal discriminator IFIN1-IFIN2——RXDAT 2100 Hz —— = 0 1300 Hz —— = 1	IFIN = 450 kHz VIFIN = 0.5 $_{mVRMS}$ 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 2 2	 Vpp Vpp % %
Output signal frequency	TXDAT = 0 TXDAT = 1	2100 1300			Hz
Output signal – Distortion – Offset level		 1.5	 2 	 	 % V
Signal level	BSCR = 1 BSCR = 0	0.93 1.4	1.12 1.61	1.35 2.1	Vpp Vpp

Electrical Characteristic of Logical Part

Parameters	Test Conditions	Min.	Typ.	Max.	Unit
Inputs: C, D, TXDAT Low voltage input High voltage input Input leakage current (0 < VI < VCC)		 2.5 –1 	 	 0.5 1	 V V µA
Input LOIN Input leakage current pin XCK (0 < VI < VCC)		 –5 	 	 5 	 µA
Outputs: DACO, RXDAT Output low Output high	 lol = 4 µA loh = –4 µA	 0.9*VCC	 	 0.1*VCC 	
Serial bus (figure?) 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	 	 	 µsec µsec µsec µsec µsec µsec µsec

Serial Bus Interface

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

The data is an 12 – bit word:

B11 – B8: address of the destination register (0 to 15)

B7 – B0: 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.

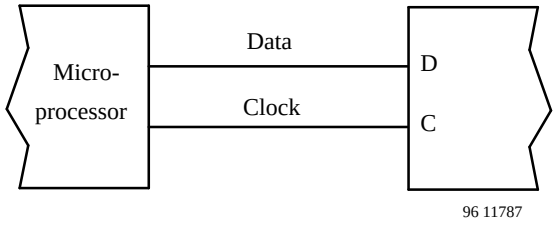


Figure 10.

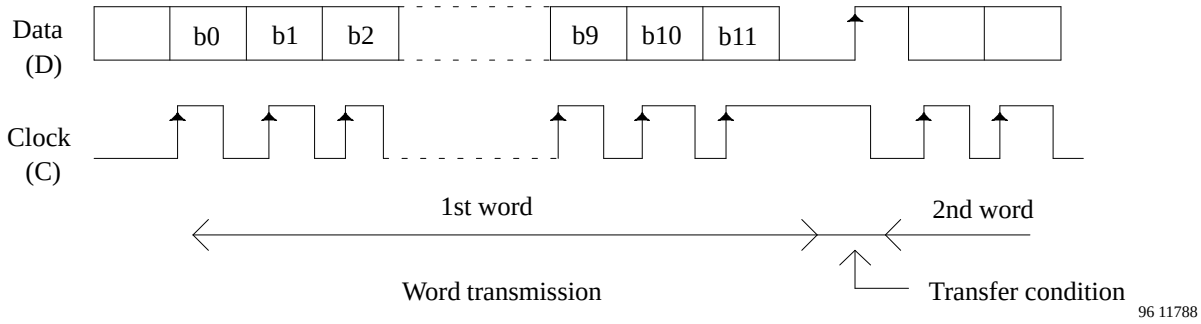


Figure 11. Serial bus transmission

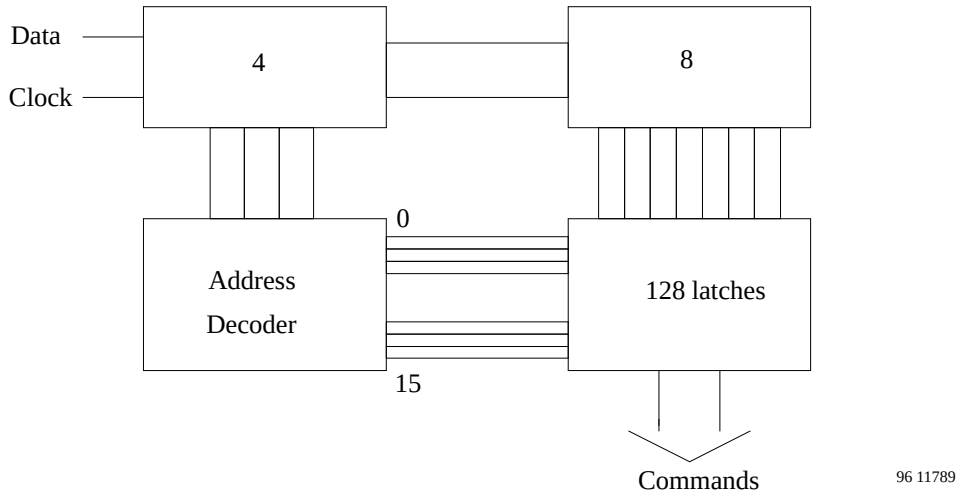


Figure 12.

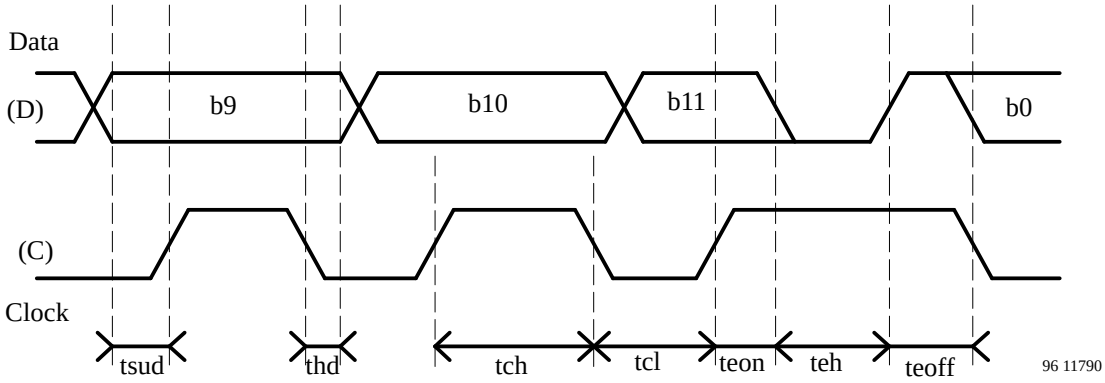


Figure 13.

Content of Internal Registers

0: Reference for D/A Converter

DA0	DA1	DA2	DA3	DA4	DA5	DA6	MUXDA

DA [0:6]: Refernce voltage D/A
MUXDA: D/A multiplexing

1: Gain adjustment RECLF

GRX0	GRX1	GRX2	GRX3	GEA0	GEA1	GEA2	GEA3

GRX [0:3]: Gain adjustment RX
GEA [0:3]: Gain earpiece amplifier (see register 5)

2: Gain adjustment TRANLF

G1TX0	G1TX1	G1TX2	G1TX3	G2TX0	G2TX1	G2TX2	G2TX3

G1TX [0:3]: Gain adjustment TX
G2TX [0:3]: Gain adjustment TX after limiter

3: Enable functions receive

ERX2	Free	ERXHF	ERX1	ERXO	EEA	EDEE	GDEM

ERX [1:2]: Enable parts of RXLF
ERXHF: Enable RX mixer and IF-amplifier
ERXO: Enable RXO output
EEA: Enable earpiece amplifier
EDEE: Enable demphasis (disable simultaneus bypass)
GDEM: Gain demodulator

4: Enable functions transmit

ETX	EPREE	EFSK	GMIC	BSCR	BCOMP	RBAT	SRSSI

ETX: Enable TX low frequency part
EPREE: Enable preemphasis (disable simultaneus bypass)
EFSK: Enable modulator of FSK-modem
GMIC: Gain of microphone preamplifier
BSCR: Bypass scrambler/ descrambler
BCOMP: Bypass compressor expander
RBAT: Battery detection high/ low range
SRSSI: RSSI sample hold

5:

EXTLO	GEA4	free	free	free	free	MTX	free

EXTLO: Select input MIXER2
GEA4: Gain earpiece amplifier MSB (see register 1)
MTX: Mute transmit path

Example of Mode Setting Using Enable Bits and Battery Switch

(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)
EEA	X					
ETX, ERX2, ERXO	X	X				
ERX1	X	X	X			
ERXHF, RSSI/Battery Management (MUXDA)	X	X	X	X		
LOGIC PART (Enabled when VBAT > 3.2V)	X	X	X	X	X	
Switch Comparator (Always Enabled)	X	X	X	X	X	X

Battery Management

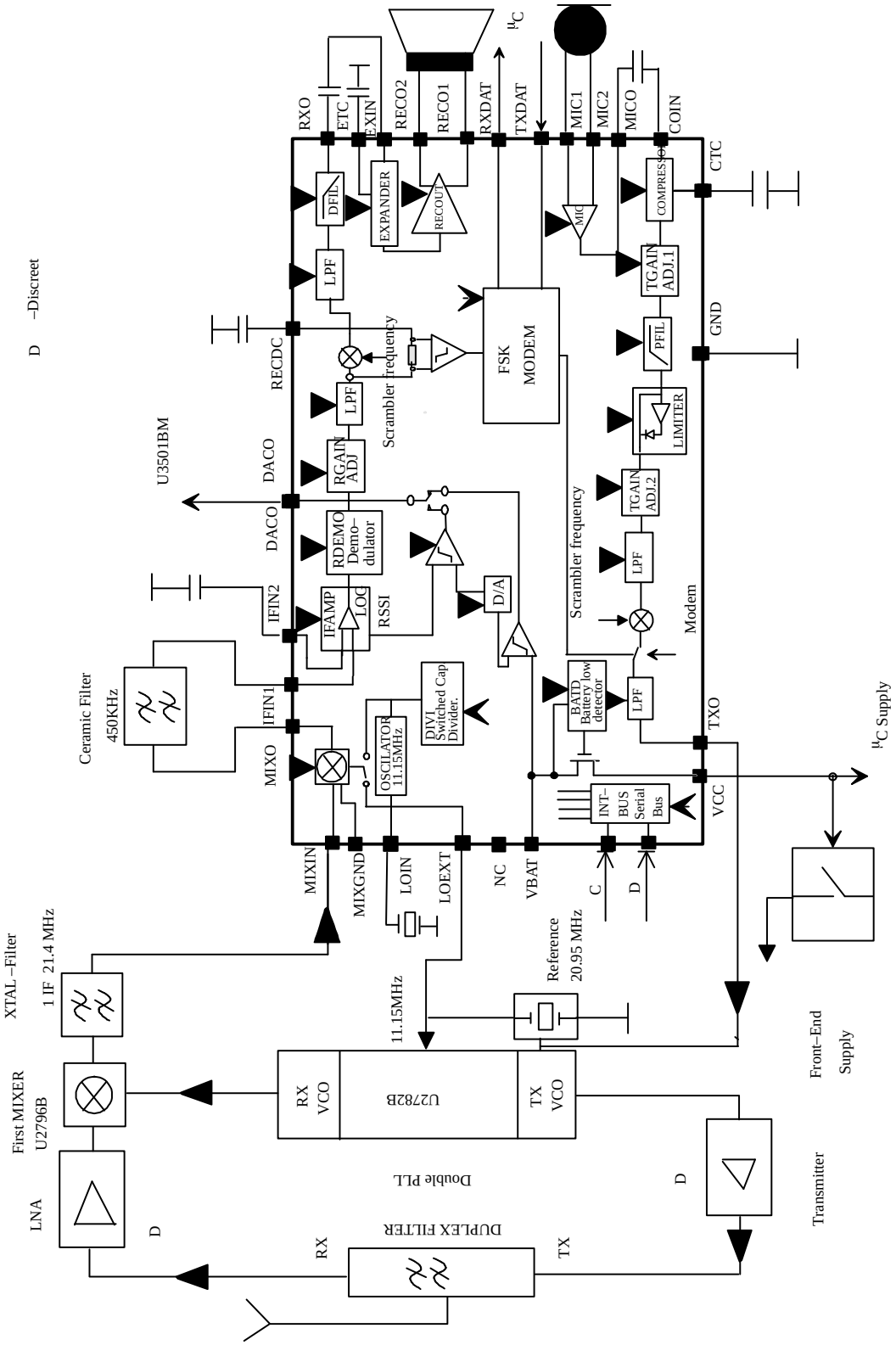
Max batlow	DA0 to 6 = 1, RBAT = 1	3.8	3.95	4.1	V
Min batlow over switch	DA0 to 6 = 27 BIN, RBAT = 1	3.05	3.2	3.35	V
Max bathigh	DA0 to 6 = 1, RBAT = 0	4.85	5.05	5.25	V
Min bathigh	DA0 to 6 = 0, RBAT = 0	3.93	4.1	4.27	V
Adjust step		3.5	7.5	11.5	mV
(Max - Min)		852.5	952.5	1052.5	mV
(MINBL - SWOFF)		100	200	300	mV

Battery Switch

Characteristic	Test Conditions	Min.	Typ.	Max.	Unit
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 ron	DA0 to 6 = 0, RBAT = 0		35	50	Ω

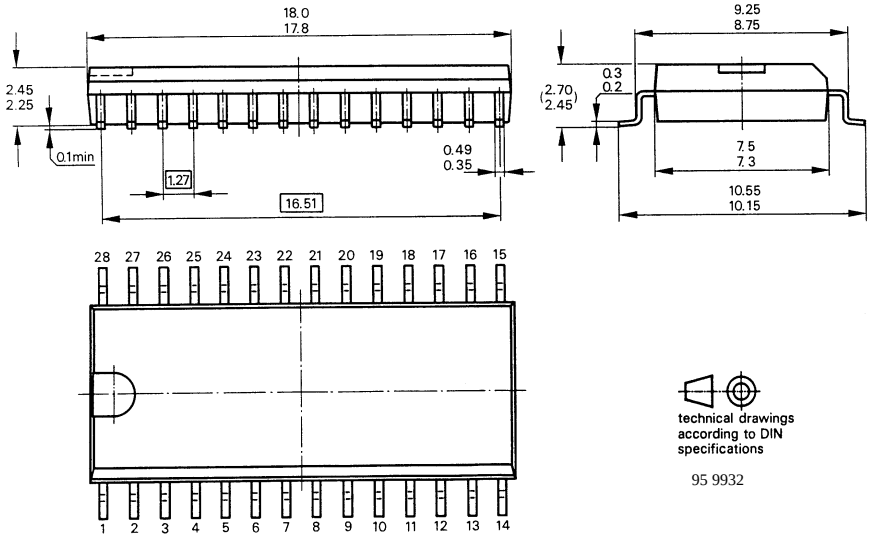
Max batlow : MAXBL (battery voltage when all DAC bits are high, low range)
Min batlow : MINBL (battery voltage when DAC bits are 0011011, low range)
Max bathigh : MAXBH (battery voltage when all DAC bits are high, high range)
Min bathigh : MINBH (battery voltage when all DAC bits are low, high range)
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 : Switch Ron (resistance of the switch transistor, when switch is “ON”)

Application Circuit of CT1



Dimensions in mm

Package SO28



Ozone Depleting Substances Policy Statement

It is the policy of **TEMIC TELEFUNKEN microelectronic 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 TELEFUNKEN microelectronic 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 can certify that our semiconductors are not manufactured with ozone depleting substances and do not contain such substances.

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