

Telephone Speech Circuit

Description

The U4030B is an electronic speech circuit for standard and feature telephones. It replaces the hybrid transformer, earphone and microphone interface and the supply voltage generation for external components, e.g. dialer or microcomputers. Using the U4030B in telephone circuit designs can improve transmission quality and results in

cost savings through shorter and more flexible design procedures. It reduces the amount of external components needed. The U4030B uses Atmel Wireless & Microcontrollers's reliable bipolar technology and is offered in a SO20 package.

Features

- Microphone amplifier with
 - Symmetrical input
 - Privacy function
 - Anticlipping
- Built in ear protection
- Power down input
- Mute input
- DTMF interface
- Low line impedance during pulse dialing

Benefits

- Independent adjustment of
 - Transmission gain
 - Receiving gain
 - Sidetone suppression
 - Frequency response
- Low-impedance supply voltage for all external blocks

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• Supply voltage for an electret microphone

Applications

- Standard telephone
- Fax machine
- Answering machine
- Cordless telephone

Block Diagram

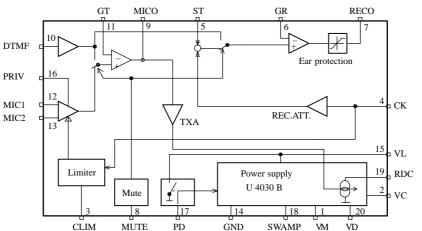


Figure 1.

Ordering Information

Extended Type Number	Package	Remarks
U4030B-AFL	SO20	Tube
U4030B-AFLG3	SO20	Taped and reeled

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U4030B



Pin Description

V_{M}	1	20	V_{D}
$V_{\rm C}$	2	19	RDC
CLIM	3	18	SWAMP
CK	4	17	PD
ST	5	16	PRIVACY
GR	6	15	$V_{\rm L}$
RECO	7	14	GND
MUTE	8	13	MIC2
MICO	9	12	MIC1
DTMF	10	11	GT

Pin	Symbol	Function
1	V_{M}	Supply voltage for an elecret microphone, virtual ground
2	V _C	The internal inductance of the circuit is proportional to the value of the capacitor at this pin. A resistor connected to ground may be used to reduce the line voltage
3	CLIM	Time constant of anticlipping in trans. path
4	CK	Input of receive amplifier
5	ST	Input of sidetone amplifier, must be DC-coupled to $V_{\rm M}$
6	G_R	Input for receive gain control
7	RECO	Output of receiving amplifier
8	MUTE	Active high input to switch circuit in DTMF-condition
9	MICO	Output of microphone amplifier

Pin	Symbol	Function
10	DTMF	Input for DTMF signals (AC-coupled). In mute condition a small portion of the signal at this pin is monitored to the receive output
11	GT	Input for transmit gain control
12	MIC1	Inverting input of microphone amplifier
13	MIC2	Non-inverting input of microphone amplifier
14	GND	Ground (reference point for DC and AC signals)
15	$V_{\rm L}$	Line voltage
16	PRIVACY	Active high input to disable microphone amplifier
17	PD	Power down input. Active high input for reducing the current consumption of the circuit. Simultaneously V _L is shorted by an internal switch
18	SWAMP	A resistor connected from this point to ground converts the excess line current into heat in order to prevent the IC from thermal destruction at high line currents
19	RDC	Input of power supply
20	V_{D}	Unregulated supply voltage for peripheral circuits. Output current capability and output voltage increase with line current



Circuit Description

Reference for all descriptions is figure 9, unless otherwise specified.

Power Supply

DC characteristic

The power supply stage determines the voltage/ current characteristic of the circuit. The DC-slope is adjusted to $100~\Omega$. A resistor connected from Pin 2 to Pin 14 may be used to reduce the line voltage (figure 2).

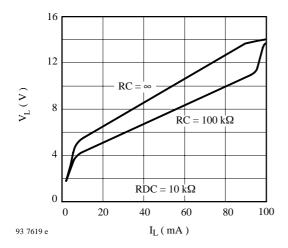


Figure 2. DC characteristics

 $\begin{array}{l} V_L \!\!=\!\! (0.0033 \times I_{DC} \!\!+\! I_{OFFSET}) \times (R30||RC) \!\!+\! VRS \!\!+\! IRDC \\ \times RDC \end{array}$

with:

 $\begin{array}{ll} I_{OFFSET} & = 150 \; \mu A \\ VRS & = 150 \; mV \\ R30 & = 30 \; k\Omega \end{array}$

IDC = $I_L - (750 \mu A + 0.023 \times I_L)$

$\mathbf{V}_{\mathbf{D}}$

An unregulated voltage, V_D , is generated to supply the internal and external circuits. The maximum voltage at this pin is limited by an internal Z-diode to a value of 6.2 V. The available output current is shown in figure 3.

V_{M}

The supply voltage for an electret microphone is derived from V_D (see figure 4). The output resistance is set to

300 Ω and the maximum output current is 300 μ A. The V_M -pin is virtual ground for the receiving amplifier.

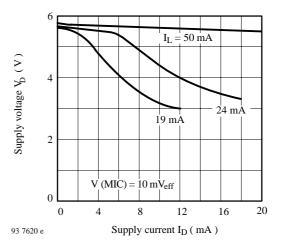


Figure 3. Supply voltage, V_D

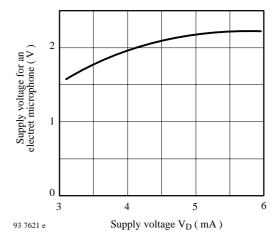


Figure 4. Electret microphone supply, $V_{\mbox{\scriptsize M}}$

Swamp

Line current which is not used for internal and external circuits is converted into heat via resistance Rswamp in order to prevent the IC from thermal destruction at high line currents.

The speech circuit will be high ohmic when the voltage at SWAMP reaches 6 V. Typical characteristics for various resistors are shown in figure 5.

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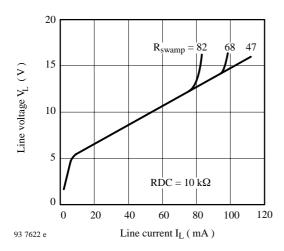


Figure 5. Typical DC characteristics for various SWAMP resistors

Charge Up Circuit

By OFF HOOK the handset, an integrated charge up circuit provides V_D with the whole line current. When V_D reaches 2.2 V, the charge up circuit is automatically switched off.

The specifications for the German "Deutsche Telekom" (speech readiness, start time) will be fulfilled even with $1000 \, \mu F$ at Pin 20.

Figure 6 illustrates the transient behavior of the circuit at $I_L = 20 \text{ mA}$.

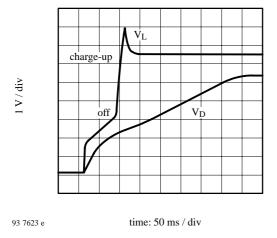


Figure 6. Charge up characteristics at $I_L = 20 \text{ mA}$

Electronic Inductance

The AC resistance (Rimp 1 k Ω) of the telephone should be much higher than the DC resistance (325 Ω), the latter being decoupled via an electronic inductance.

The value of L is given by:

$$L = CVC \times RDC \times 30 \,k\Omega \parallel R$$

where

 $\begin{array}{ll} RDC &= 10~\Omega \\ CVC &= 10~\mu F \\ R30 &= 30~k\Omega \\ RC &= infinite \\ L &= 3~H \end{array}$

Transmit

Microphone amplifier

The microphone amplifier of U4030B has symmetrical inputs (MIC1 and MIC2) with an input resistance of 60 k Ω (typical). It has a gain of 29 dB which is adjustable with resistances RS1 and RS2 as follows:

$$\begin{split} G_T &= V_{MICO} / V_{(MIC1, MIC2)} \\ &= 20 \ log[(RS1 / RS2) + 1] \ dB \end{split}$$

A low pass function can be realised with CSLP. The corner frequency is given by:

fC =
$$1/(2\pi \text{ RS1 CSLP})$$

When the AC level on V_L is very high, the amplification of the microphone is reduced by the limiter function. The threshold of the limiter is fixed at 5.5 dBm (typical).

DTMF

The amplification of the DTMF signal is determined by the ratio of RS1 and RS2 as follows:

$$\begin{split} G_D &= V_{MICO} \, / \, V_{DTMF} \\ &= 20 \, log \{ 0.19 \, \times \, [(RS1 \, / \, RS2) \, + \, 1] \} \end{split}$$

An external voltage divider is used to adjust the proper DTMF level at line.

For monitoring the dialing procedure, an attenuated DTMF signal is sent to the earpiece. The Deutsche Telekom specification is fulfilled with the nominal value of the transmit and receive gain.



Transmit Output Amplifier

The output signal of the microphone and DTMF preamplifier is internally coupled to a second amplifier (TXA) which is used to modulate a controlled current source. Assuming a termination of 600 Ω at a line, the gain from MICO to V_L is typically 15.6 dB.

Receive Amplifier

The receive signal is taken from line via capacitor C_{CK} . A resistive attenuator (–32 dB) sets the appropriate input level for the following output amplifier. The input impedance at Pin 4 is typically 80 k Ω .

Voltage gain is:

$$G_R$$
 = 20 log (V_{ear} / V_L) dB
= -32 dB + 20 log[(RR1 / RR2) + 1] dB
= +1.8 dB

The adjustment range for receive gain G_R is typically $-4~\mathrm{dB}$ to $+8~\mathrm{dB}$.

The built-in ear protection limits the output swing at Pin 7 to 2.4 V_{pp} ($V_D > 4$ V). For high receive gain, the maximum undistorted output level might not be sufficient due to clipping by ear protection.

Sidetone

The amplified microphone signal is available at the input of the sidetone loop, MICO. The loop consists of a transmit amplifier (transconductance STX), the impedance at line, receive attenuator (gain) and the sidetone network (figure 7).

The sidetone cancellation is achieved by comparing a part of the line signal with the output of the sidetone network $(VST \rightarrow VR)$. Assuming a real impedance of the telephone (R_{Tel}) the optimum sidetone network can be calculated:

$$\begin{array}{l} a = \left(S_{TX} \times R_{APP} \times G\right) / \left(1 - S_{TX} \times R_{APP} \times G\right) \\ Z_{NW} = S_{TX} \times R \times G \times Z_{Line} \end{array}$$

Adjustment to the sensitivities of the handset can be done independently from the sidetone network because receive and transmit gain are set outside of the sidetone loop.

Power Down (PD)

The speech circuit is switched low ohmic by selecting a high level at PD during the pulse dialling. The voltage drop across the IC will be typically 1.5 V. During this time the capacitor CVD will not be discharged, because an internal power down switches off all internal amplifiers. In order to avoid cracks, it is recommended to activate power down while sending the dial pulses (figure 8).

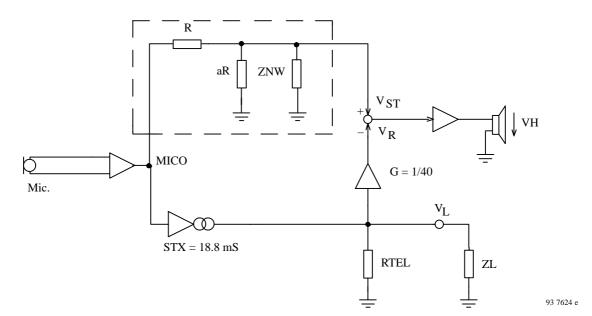


Figure 7. Schematic of the sidetone

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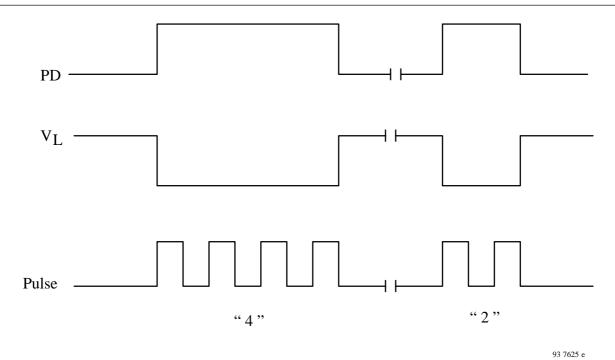


Figure 8. Recommended timing diagram for power down diagram

Absolute Maximum Ratings

Parameters	Symbol	Value	Unit
Line current (according to figure11)	$I_{\rm L}$	200	mA
DC line voltage	$V_{ m L}$	16	V
Storage temperature range	T_{stg}	−55 to +150	°C
Junction temperature	Ti	150	°C
Ambient temperature range	T_{amb}	-25 to +65	°C
Power dissipation $T_{amb} = 60^{\circ}C$ DIP20	P _{tot}	820	mW
SO20	P _{tot}	640	mW

Thermal Resistance

Parameters		Symbol	Value	Unit
Junction ambient	DIP20	R _{thJA}	110	K/W
	SO20	R _{thJA}	140	K/W



Electrical Characteristics

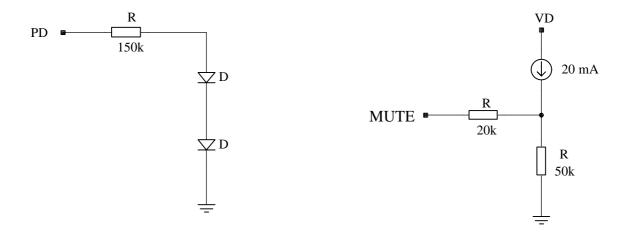
f = 1000 Hz, $T_{amb} = 25$ °C, reference point Pin 14, unless otherwise specified

D	T . C . 1::: / D:	0 1 1	3.7:		3.6	
Parameters	Test Conditions / Pins	Symbol	Min.	Тур.	Max.	Unit
DC characteristics (figure	T .					T
DC voltage in speech mode	$I_L = 19 \text{ mA}$	$V_{\rm L}$	6.2	6.5	6.8	V
	$ I_{L} = 26 \text{ mA} $ $I_{L} = 60 \text{ mA} $		10.0	7.2	11.0	V V
Tuonguit amulifian and aid			10.0	10.3	11.0	V
Transmit amplifier and sid	etone reduction (figure 12)	D	45.0	60.0	00.0	10
Input resistance	X 24 A	R _I	45.0	60.0	80.0	kΩ
Transmit gain	$I_L = 24 \text{ mA}$	G _T	44.2	44.7	45.2	dB
Gain variation	$19 \text{ mA} \leq I_L \leq 60 \text{ mA}$	ΔG_{T}	-0.5		+0.5	dB
Noise at line,	$R_L = 600 \Omega$	nO				
psophometrically weighted	$Z_{RECO} = 68 \text{ nF}$				-75.0	dDmm
	$Z_{MIC} = 68 \text{ nF}$ $I_L = 19 \text{ to } 60 \text{ mA}$				-/5.0	dBmp
Sidetone gain (figure 12)	1 <u>L</u> = 19 to 00 mA	G		33.5		dB
	$R_{ m L} ightarrow \infty$	G_{ST}			6.3	dBm
Max. output voltage	$d \leq 5\%$	V _{Omax}		5.5	0.3	UDIII
	$V_{\text{MIC}} = 5.4 \text{ mV}$					
Common mode rejection	V MIC = 3.4 III V	CMRR		80.0		dB
ratio		CIVIKK		00.0		ub
Mute: reduction of	$Z_{RECO} = 68 \text{ nF}$		60.0			dB
voltage amplification	RECO					
Privacy: reduction of			60.0			dB
voltage amplification						
Receiving amplifier (figure	13)					
Gain	$Z_{RECO} = 68 \text{ nF}$	G_{R}	-3.9	-3.4	-2.9	dB
	$I_L = 24 \text{ mA}$					
Gain variation	$19 \text{ mA} \leq I_{\text{L}} \leq 60 \text{ mA}$	ΔG_{R}	-0.5		0.5	dB
Noise at earphone	$I_L = 19$ to 60 mA	n_{I}			-78	dBmp
psophometrically weighted	Load T, $R = 600 \Omega$					
	$Z_{RECO} = 68 \text{ nF}$					
26	$Z_{\text{MIC}} = 68 \text{ nF}$	* 7	600	650		* 7
Max. output voltage	$I_L = 19 \text{ to } 60 \text{ mA}$	V _{Omax}	600	650		mVrms
	$Z_{RECO} = 68 \text{ nF}$ $d \le 2\%$					
Switching threshold of ear	$I_L = 19 \text{ to } 60 \text{ mA}$		0.7		1.3	Vrms
protection	$Z_{RECO} = 68 \text{ nF}$		0.7		1.3	VIIIIS
protection	VGEN = 3 Vrms					
Voltage amp. from	Zear = 68 nF		-7	_4	-1	dB
DTMF to RECO	2001 - 00 111		,		1	
Output impedance					10	Ω
Power down (figure 14)	1	1		1	1	1
PD-off input voltage		VI			0.3	V
PD-on input voltage		V _I	2			V
Input current	V _I = 6 V	I _I			130	μA
Line voltage	PD on, $I_L = 24 \text{ mA}$	$V_{\rm L}$		1.5	130	V
Input current consumption	PD on	I _D		1.5	100	μΑ
at V _D	I D OII	1D			100	μΑ
ut 1 D					1	

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Parameters	Test Conditions / Pins	Symbol	Min.	Тур.	Max.	Unit
Mute input, (figure 14)						
MUTE input current	$V_{MUTE} = 6 V$ $V_{MUTE} = 0.3 V$	I _{MUTE}			120 -25	μA μA
MUTE-off input voltage		V _{MUTE}			0.3	V
MUTE-on input voltage		V _{MUTE}	1.5			V
Supply voltages (figure 12)						
Output voltage	$\begin{split} I_L &= 19 \text{ mA} \\ I_D &= 4.5 \text{ mA} \\ V_{MIC} &= 10 \text{ mV} \end{split}$	V_{D}	4.0	4.5		V
	$I_{L} = 50 \text{ mA}$ $I_{D} = 15 \text{ mA}$ $V_{MIC} = 10 \text{ mV}$		5.5		6.2	V
Output voltage	$\begin{split} I_L &= 19 \text{ mA} \\ I_D &= 3 \text{ mA} \\ I_M &= 300 \mu\text{A} \end{split}$	V_{M}		2.2		V
Output current		$I_{\mathbf{M}}$			300	μΑ
Output resistance		RO		300		Ω
DTMF-amplifier (figure 14	4)					
Input resistance		R_{D}	22	31	37	kΩ
DTMF-gain	$\begin{aligned} Load &= Z_R \\ 0 &< R_v < 1530 \ \Omega \end{aligned}$	G_{D}	24.7	26	27	dB
Max. output voltage	$I_L = 19 \text{ to } 60 \text{ mA}$ $Load = Z_R$ $d \le 2\%$		1.8			V _{rms}
Privacy (figure 14)						
PRIV-on input voltage		V _{PRIV}	2			V
PRIV-off input voltage		V _{PRIV}			0.8	V
Input current	$V_{PRIV} = 6 V$	I _{PRIV}			60	μΑ

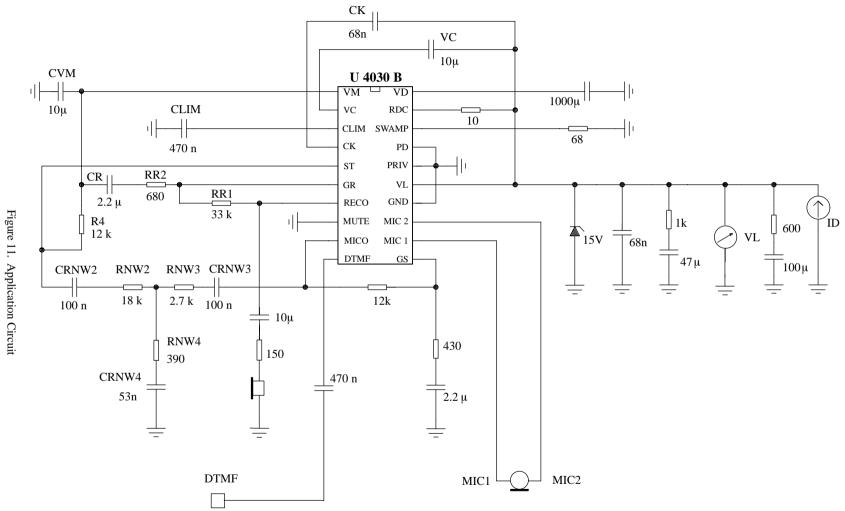


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Figure 9. PD input

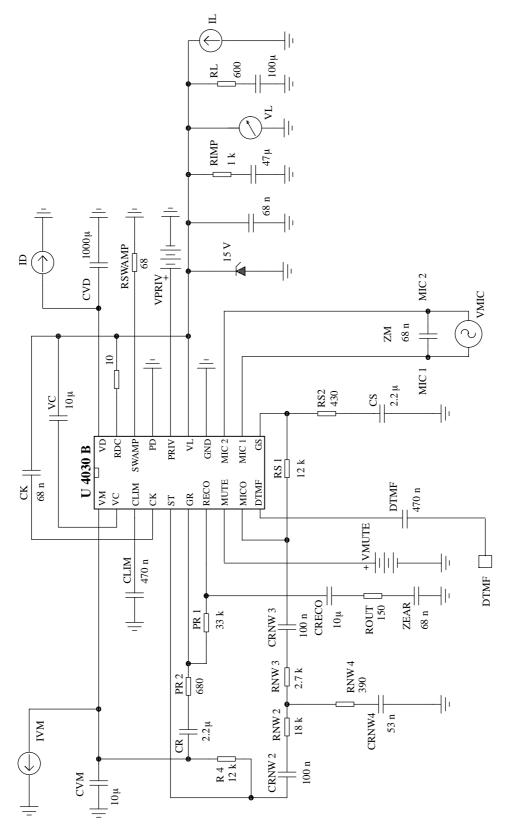
Figure 10. Mute input





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Figure 12. Transmit gain

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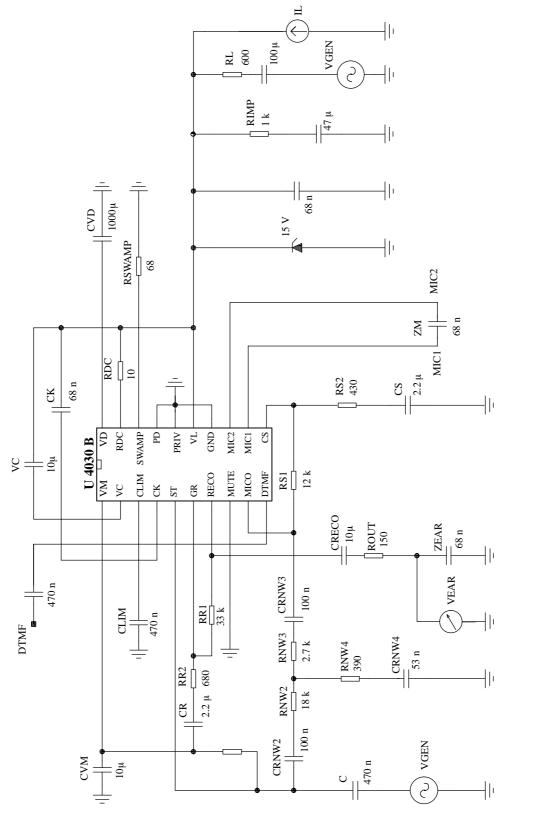


Figure 13. Receiving gain and sidetone amplification

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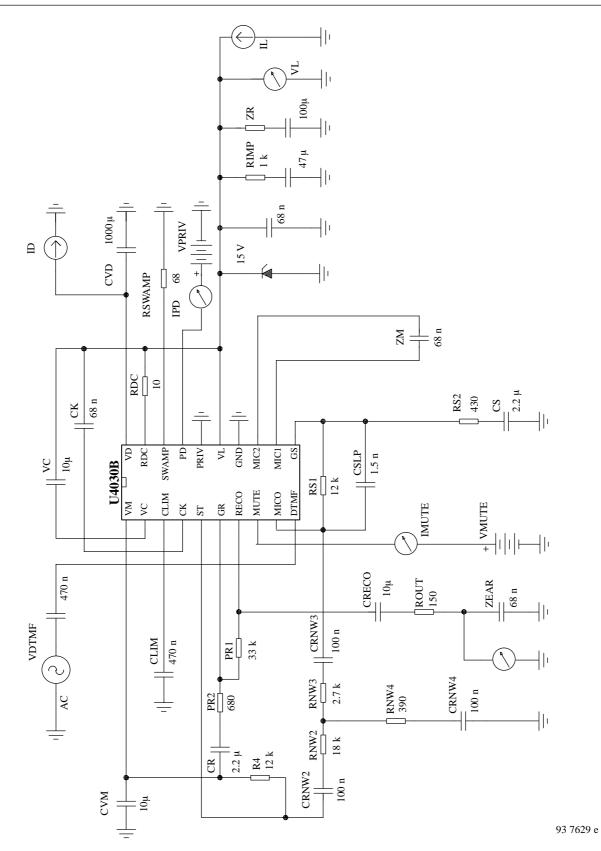
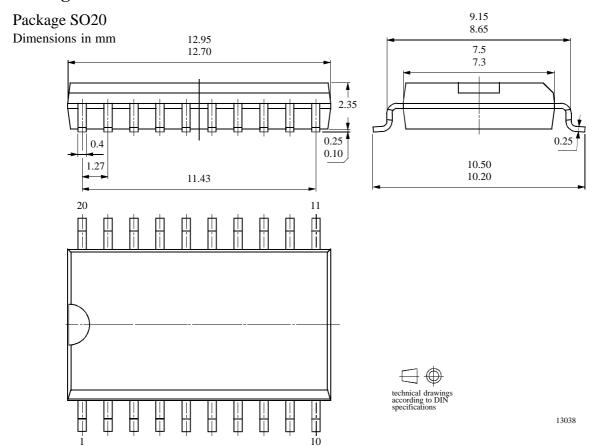


Figure 14. DTMF gain



Package Information



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Ozone Depleting Substances Policy Statement

It is the policy of Atmel Germany GmbH to

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

Atmel Germany 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.

Atmel Germany 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 Atmel Wireless & Microcontrollers products for any unintended or unauthorized application, the buyer shall indemnify Atmel Wireless & Microcontrollers 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.atmel-wm.com

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