

## Dual-Channel FM Sound Demodulator for TV Systems

### Description

The U2860B-B is a dual-channel FM sound demodulator realized with Atmel Wireless & Microcontrollers' advanced bipolar process. All TV FM standards, from 4.5 up to 6.5 MHz (standard M, B/G, I, D/K) can be processed

with high performance. The circuit is alignment-free and has a minimum number of external components. With 5 V supply voltage, the U2860B-B is suitable for TV, VCR and multimedia applications.

### Features

- Two alignment-free PLL FM demodulators, automatic lock in on the received sound carrier frequency
- Mono and dual channel application
- Sound IF inputs provided for ceramic filters
- Automatic mute for 2nd sound channel (squelch)
- Mute function for both sound channels
- 5 V supply voltage, low power consumption
- Few external components

### Block Diagram

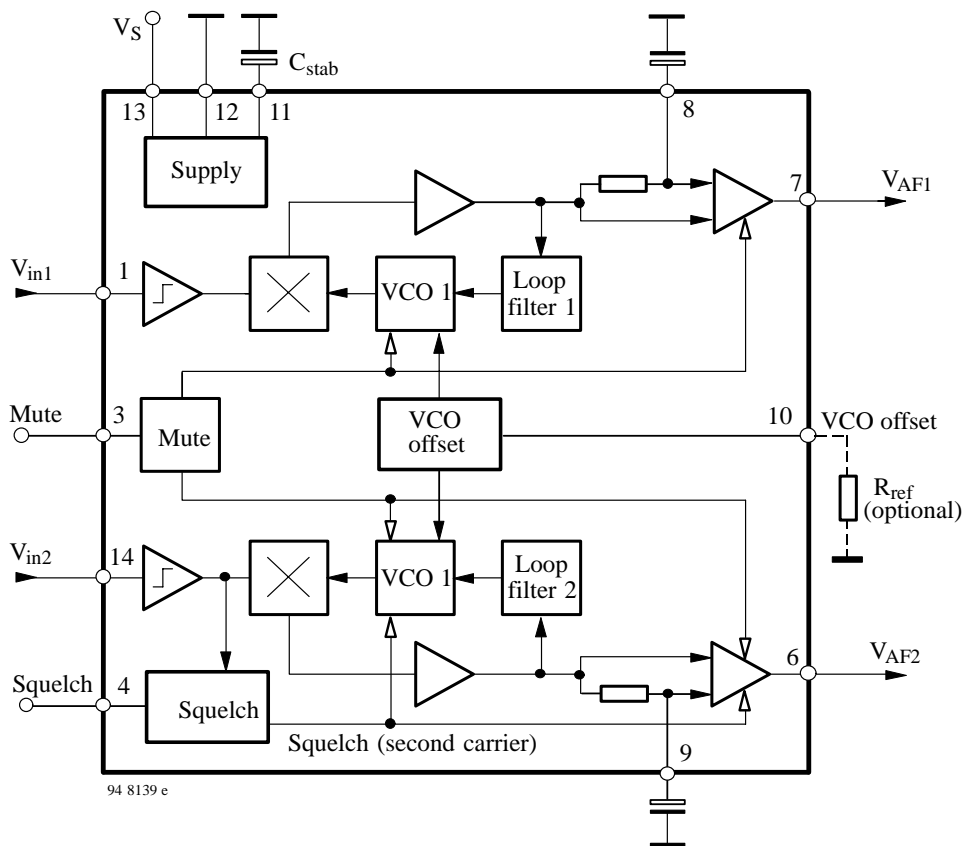


Figure 1. Block diagram

## Ordering Information

Extended Type Number	Package	Remarks
U2860B-B	DIP14	
U2860B-BFP	SO14	taped

### Circuit Description

The U2860B-B includes two identical sound IF channels. Each consists of a limiter amplifier, PLL FM demodulator and AF amplifier. Additionally, this circuit contains a squelch function, mute switch and internal voltage regulation.

#### Limiter Amplifiers

The intercarrier signals are fed through external ceramic bandpass filters to a 7-stage limiter amplifier. This guarantees high input sensitivity and excellent AM suppression.

#### PLL FM Demodulators

The alignment-free "Phase Locked Loop" (PLL) demodulator covers a wide frequency range of 4.5 MHz up to 6.5 MHz with low noise performance. The linear voltage to frequency characteristic results in low harmonic distortion. The free-running frequency of the internal VCO circuit is about 5.5 MHz. For this frequency, the input sensitivity and VCO locking is optimal. An additional external resistor at Pin 10 allows a frequency shift of  $\pm 1$  MHz via an internal offset current. With this option, it is possible to shift the optimum conditions to the upper frequency (6.5 MHz) or to the lower frequency (4.5 MHz). The offset current acts simultaneously on both VCO circuits. If no resistor is connected, the offset current is disabled.

### Audio Amplifiers

The demodulated signals are amplified to 500 mVrms with low output impedance at the audio outputs (Pin 6 and Pin 7). AC decoupling at Pin 8 and Pin 9 of the audio amplifiers leads to high common mode rejection.

#### Squelch Function

For channel 2 the audio output amplifier and VCO2 is muted automatically (squelch) when the second sound carrier is not present. This avoids a wrong identification for stereo and dual sound in the stereo decoder. Therefore, with mono sound, there is no output signal at Pin 6. The automatic squelch function can be disabled by switching Pin 4 to ground.

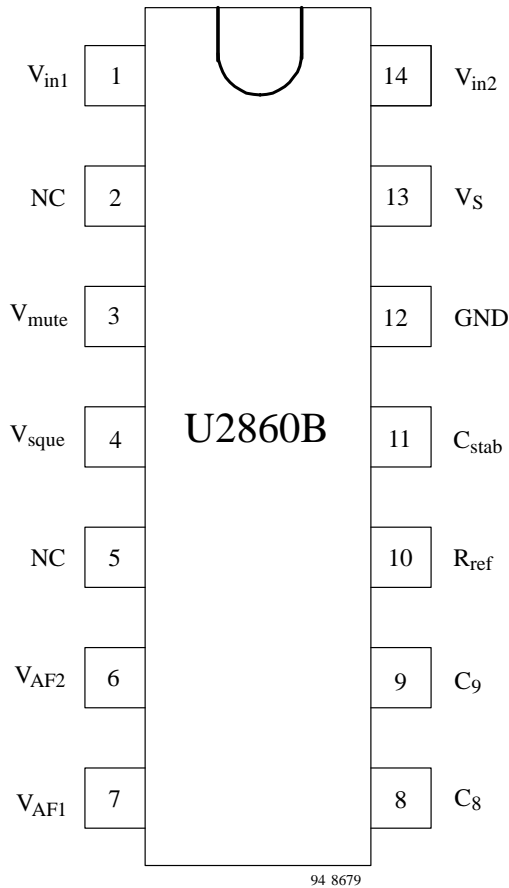
#### Mute Switch

Simultaneously muting of both circuits is possible by switching Pin 3 to ground.

#### Internal Voltage Stabilizer

The internal bandgap reference ensures constant performance independent of supply voltage and temperature.

## Pin Description



Pin	Symbol	Function
1	$V_{in1}$	Inter-carrier input of sound channel 1 (5.5 MHz)
2	NC	Not connected
3	$V_{mute}$	Mute for sound channel 1+2 "on/off"
4	$V_{sque}$	Automatic mute for 2nd sound channel (squellch) "on/off"
5	NC	Not connected
6	$V_{AF2}$	Audio output AF2 of sound channel 2
7	$V_{AF1}$	Audio output AF1 of sound channel 1
8	$C_8$	Decoupling capacitor for sound channel 1
9	$C_9$	Decoupling capacitor for sound channel 2
10	$R_{ref}$	VCO offset of the free-running frequency
11	$C_{stab}$	Internal supply voltage stabilization
12	GND	Ground
13	$V_S$	Supply voltage
14	$V_{in2}$	Inter-carrier input of sound channel 2 (5.74 MHz)

Figure 2. Connection diagram

## Maximum Ratings

Reference point Pin 12, unless otherwise specified

Parameters	Symbol	Value	Unit
Supply voltage	$V_S$	9.0	V
Supply current	$I_S$	33	mA
Power dissipation $V_S = +9\text{ V}$	$P$	300	mW
Output currents	$I_{out}$	$\pm 1.5$	mA
External voltages	$V_{ext}$	2.0	V
	$V_{ext}$	$V_S$	V
	$V_{ext}$	4.5 V	V
Junction temperature	$T_j$	+125	°C
Storage temperature	$T_{stg}$	-25 to +125	°C
Electrostatic handling *) all pins	$V_{ESD}$	$\pm 200$	V

\*) Machine model in accordance with ESD S5.2 standard

## Operating Range

Parameters	Symbol	Value	Unit
Supply voltage range Pin 13	$V_S$	4.5 to 9.0	V
Ambient temperature	$T_{amb}$	0 to +85	°C

## Thermal Resistance

Parameters	Symbol	Value	Unit
Junction ambient when soldered to PCB	$R_{thJA}$	90	K/W

## Electrical Characteristics

$V_S = 5\text{ V}$ ,  $T_{amb} = 25^\circ\text{C}$ , reference point Pin 12, unless otherwise specified

Parameters	Test Conditions / Pins	Symbol	Min.	Typ.	Max.	Unit
<b>DC-supply</b> Pin 13						
Supply voltage range		$V_S$	4.5	5.0	9.0	V
Supply current		$I_S$		27	33	mA
<b>Intercarrier input 1</b> Pin 1						
DC input voltage		$V_{DC}$		1.75		V
Input resistance	See note 1	$R_{in}$		680	750	$\Omega$
Input limiting voltage	Input signal $v_{in}$ : $f = 5.5\text{ MHz}$ output signal AF1: $v_{AF1} \Rightarrow -3\text{ dB}$	$v_{lim}$			150	$\mu\text{V}$
<b>Intercarrier input 2</b> Pin 14						
DC input voltage		$V_{DC}$		1.75		V
Input resistance	See note 1	$R_{in}$		680	750	$\Omega$
Input limiting voltage	Input signal $v_{in}$ : $f = 5.74\text{ MHz}$ output signal AF2: $v_{AF2} \Rightarrow -3\text{ dB}$	$v_{lim}$			150	$\mu\text{V}$
Input signal for automatic second sound carrier "mute off" (squelch)	Audio output AF2 active	$v_{in}$	> 0.7	1.0	< 1.5	mV
<b>FM demodulators, internal VCO's</b> Pin 10						
Free-running frequency		$f_{VCO}$		5.5		MHz
Oscillator drift (free-running) as function of temperature	$\Delta T = 55^\circ\text{C}$	$\Delta f_{VCO}$		500		kHz
Oscillator shift (free-running) as function of supply voltage	$4.5\text{ V} < V_S < 5.5\text{ V}$	$\Delta f_{VCO}$		200		kHz
Adjustment range of free-running frequencies	By external resistor $R_{ref}$ at Pin 10	$\Delta f_{adj}$	$\pm 1$			MHz
Adjustment resistance for free-running frequencies		$R_{ref}$	15	22	30	k $\Omega$

## Electrical Characteristics (continued)

$V_S = 5\text{ V}$ ,  $T_{\text{amb}} = 25^\circ\text{C}$ , reference point Pin 12, unless otherwise specified

Parameters	Test Conditions / Pins	Symbol	Min.	Typ.	Max.	Unit
<b>FM demodulators, internal VCO's</b> Pin 10						
Steepness of free-running frequency adjustment	Resistor $R_{\text{ref}}$ at Pin 10	S		200		kHz/k $\Omega$
Capture range of PLL's		$\Delta f_{\text{cap}}$	$\pm 1.4$	$\pm 1.9$		MHz
Holding range of PLL's		$\Delta f_{\text{hold}}$	$\pm 2.0$	$\pm 3.0$		MHz
<b>Audio outputs, AF1 (Pin 7) and AF2 (Pin 6)</b>						
DC output voltage		$V_{\text{DC}}$		2.2		V
DC output current		$I_{\text{DC}}$		1.0	-1.3	mA
Output resistance	See note 1	$R_{\text{out}}$		150		$\Omega$
AC output peak current		$i_{\text{AC}}$			$\pm 1.0$	mA
AF output voltage, RMS value	$v_{\text{in}} = 10\text{ mV}$ , $f = 5.5\text{ MHz}$ , FM-dev. = 27 kHz, $f_{\text{mod}} = 1\text{ kHz}$	$v_{\text{AF}}$		500		mV
Difference between the output signals		$\Delta v_{\text{AF}}$			$\pm 1$	dB
Total harmonic distortion	$v_{\text{in}} = 10\text{ mV}$ , $f = 5.5\text{ MHz}$ , FM-dev. = 27 kHz, $f_{\text{mod}} = 1\text{ kHz}$	THD		0.1	0.5	%
AM suppression	$v_{\text{in}} = 10\text{ mV}$ , $f = 5.5\text{ MHz}$ , $f_{\text{mod}} = 1\text{ kHz}$ , reference signal: FM-dev. = 50 kHz test signal: $m = 30\%$	$\alpha_{\text{AM}}$	46	66		dB
Crosstalk attenuation between the AF outputs	$f = 50\text{ Hz}$ to 12.5 kHz	$\alpha_{\text{att}}$		70		dB
Supply voltage ripple rejection	$V_{\text{RR}} < 200\text{ mV}$ , $f = 70\text{ Hz}$	RR		24		dB
<b>Mute switch</b> Pin 3						
Control voltage - muteoff - mute on	AF outputs active AF outputs not active	$V_{\text{mute}}$	2.0 0		$V_S$ 0.8	V V
Control current		$I_{\text{mute}}$		150		$\mu\text{A}$
<b>Squelch function</b> Pin 4						
Control voltage for automatic mute-2nd carrier "off"		$V_{\text{sque}}$	0		0.8	V
Control voltage for automatic mute-2nd carrier "on"			2.0		$V_S$	V
Control current		$I_{\text{sque}}$		150		$\mu\text{A}$

**Notes** 1.) This parameter is given as an application information and not measured during final testing.

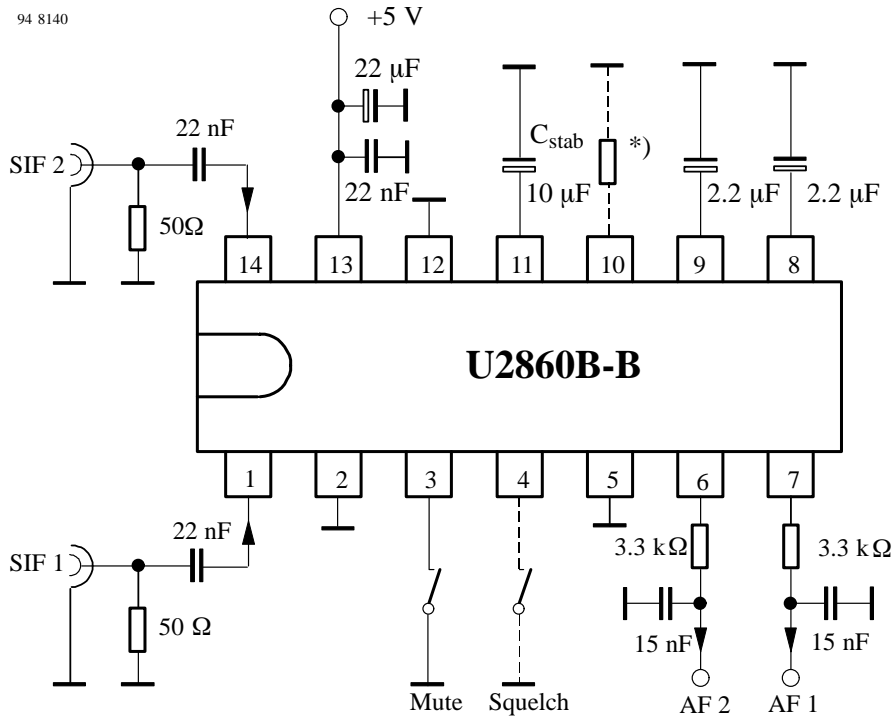


Figure 3. Test circuit

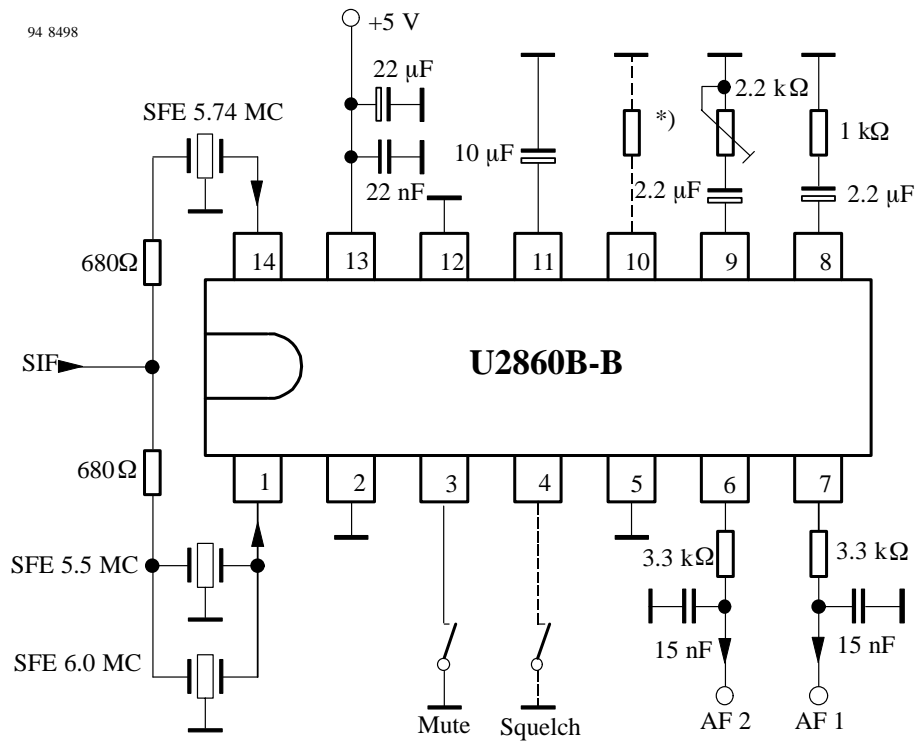
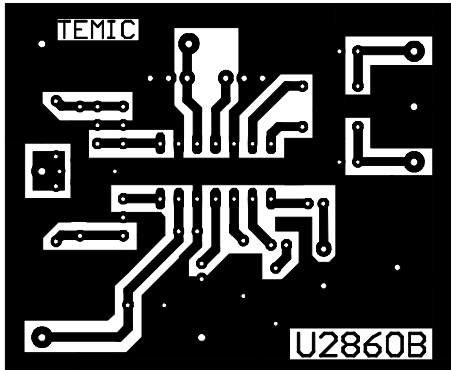
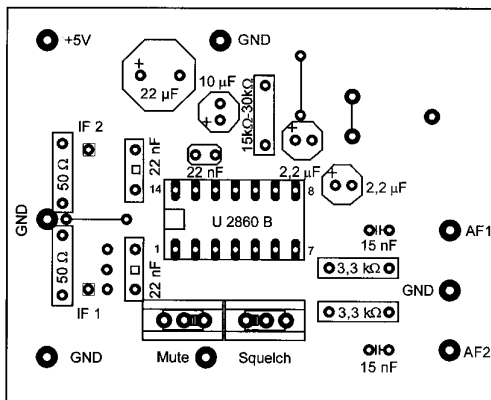


Figure 4. Application circuit



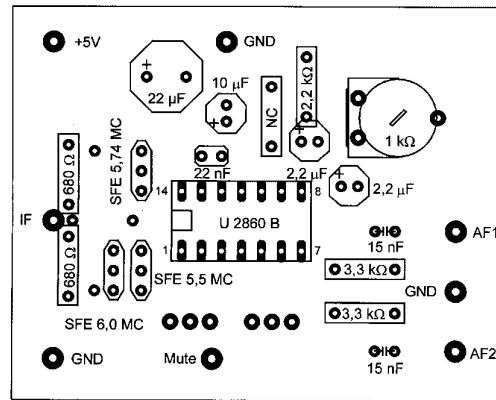
95 10708

Figure 5. PCB layout (test/application circuit)



95 10709

Figure 6. Component layout (test circuit)



95 10710

Figure 7. Component layout (application circuit)

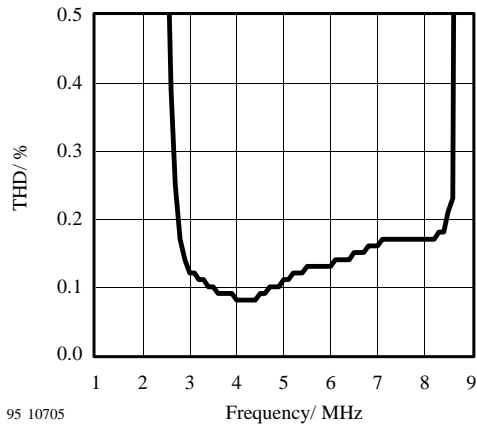


Figure 8. Total harmonic distortion

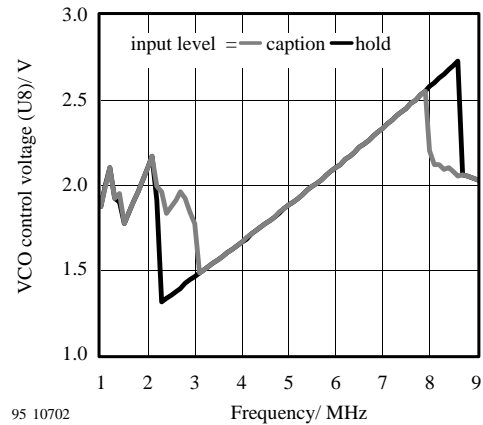


Figure 11. Capture and hold range

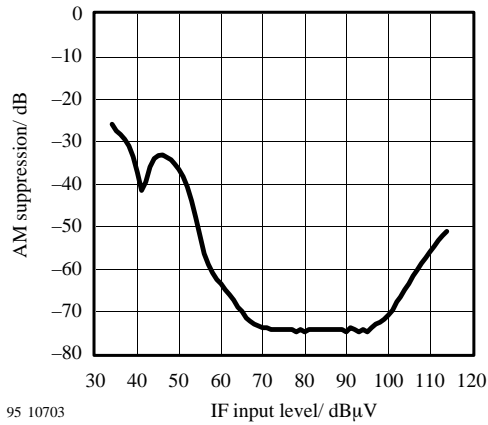


Figure 9. AM suppression

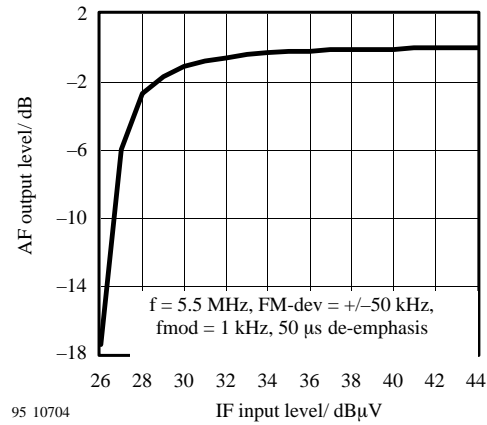


Figure 12. Limiter characteristics

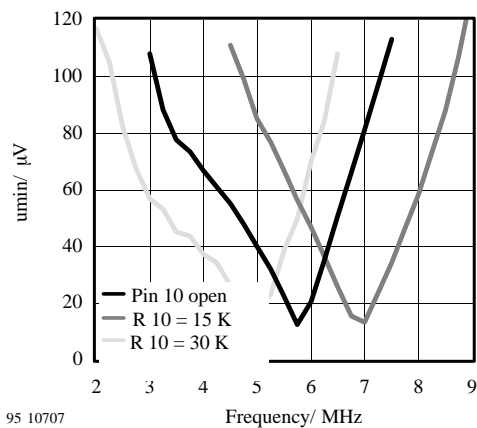


Figure 10. VCO free-running frequency

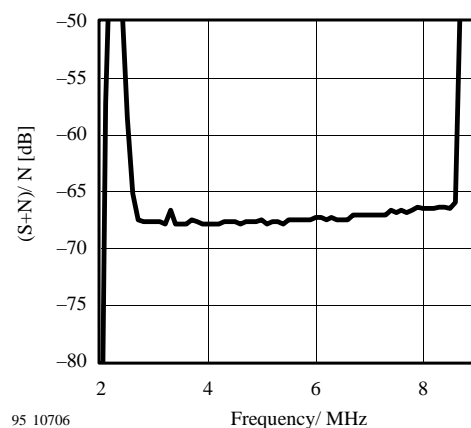


Figure 13. Signal to noise ratio



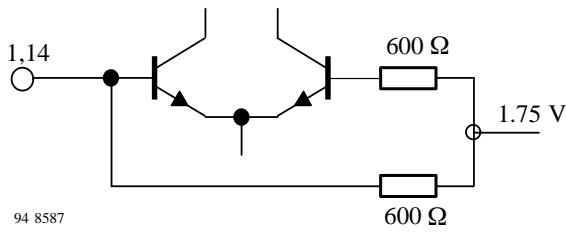


Figure 14. SIF inputs

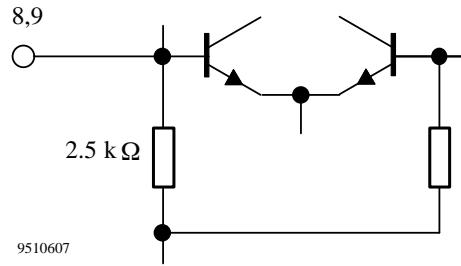


Figure 17. Decoupling capacitor

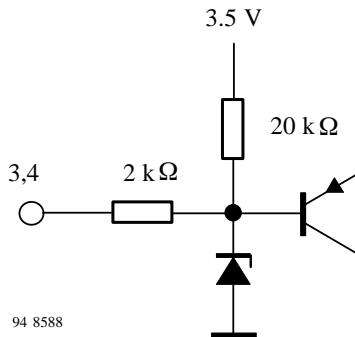


Figure 15. Mute switch/squelch switch

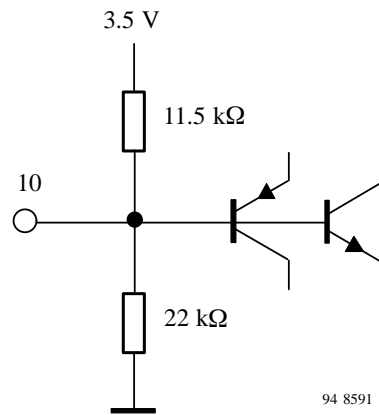


Figure 18. VCO offset (reference resistor)

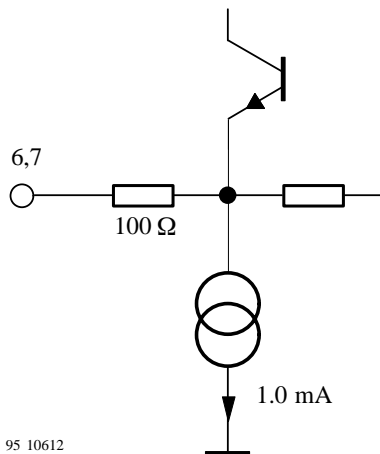


Figure 16. Audio outputs

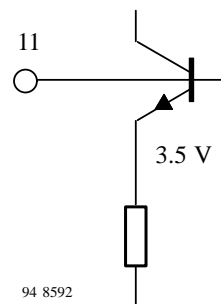
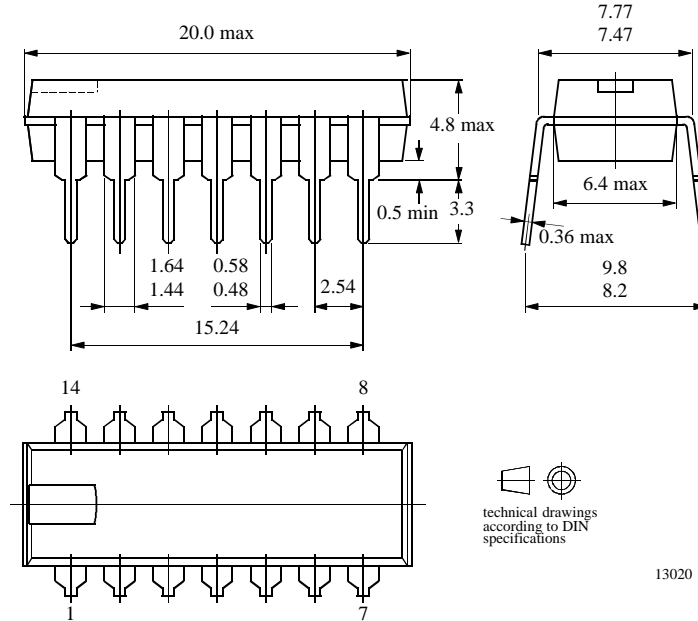


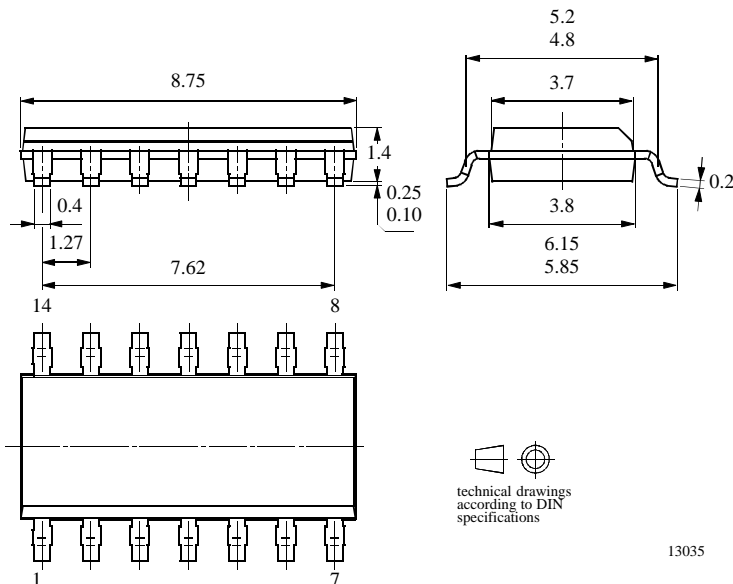
Figure 19. Internal supply voltage stabilization

## Package Information

Package DIP14  
Dimensions in mm



Package SO14  
Dimensions in mm



## 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.
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.

**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>**

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