

## AM / FM - PLL

### Description

The U4289BM is an integrated circuit in BICMOS technology for frequency synthesizers. It performs all the functions of a PLL radio tuning system and is controlled

by an I<sup>2</sup>C bus. The device is designed for all frequency synthesizer applications in radio receivers, as well as RDS ( **R**adio **D**ata **S**ystem ) applications.

### Features

- Reference oscillator up to 15 MHz
- Two programmable 16 bit dividers adjustable from 2 to 65535
- High signal/noise ratio
- Fine tuning steps:  
AM  $\geq$  1 kHz  
FM  $\geq$  2 kHz
- Few external component required due to integrated loop-push-pull stage for AM/FM

### Ordering and Package Information

Extended Type Number	Package	Remarks
U4289BM-AFP	SO16 plastic	
U4289BM-AFPG3	SO16 plastic	Taping according to IEC-286-3

### Block Diagram

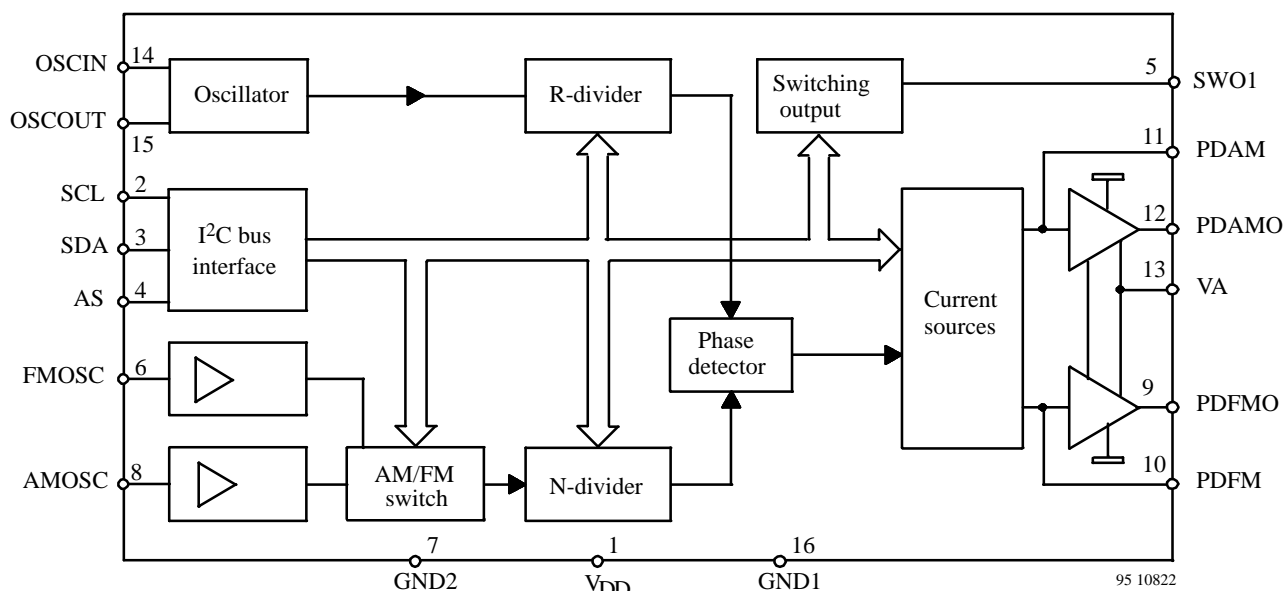
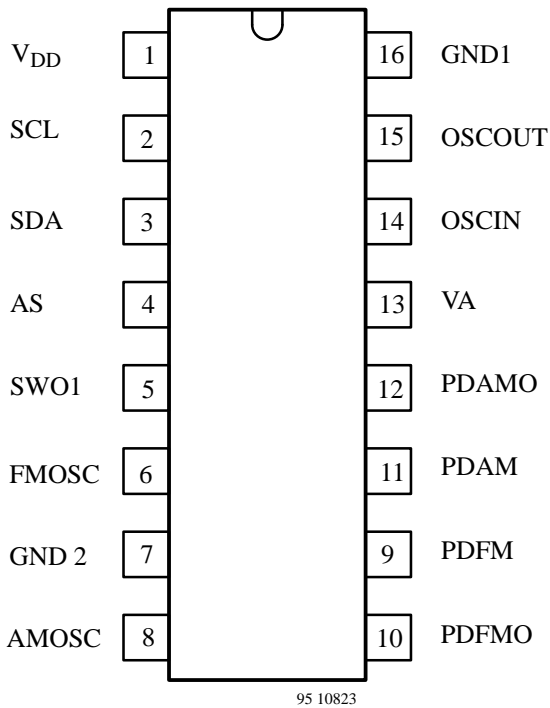


Figure 1.

## Pin Description



Pin	Symbol	Function
1	V <sub>DD</sub>	Supply voltage
2	SCL	I <sup>2</sup> C bus clock
3	SDA	I <sup>2</sup> C bus data
4	AS	Address selection
5	SWO1	Switching output
6	FMOSC	FM oscillator input
7	GND 2	Ground 2 (analogue)
8	AMOSC	AM oscillator input
9	PDFMO	FM analogue output
10	PDFM	FM current output
11	PDAM	AM current output
12	PDAMO	AM analogue output
13	VA	Analogue supply voltage
14	OSCIN	Oscillator input
15	OSCOU	Oscillator output
16	GND1	Ground 1 (digital)

## Functional Description

The U4289BM is controlled via the 2-wire I<sup>2</sup>C bus. For programming there are one module address byte, two sub-address bytes and five data bytes.

The module address contains a programmable address bit A 1 which with address select input AS (Pin 4) makes it possible to operate two U4289BM in one system. If bit A 1 is identical with the status of the address select input AS, the chip is selected .

The subaddress determines which one of the data bytes is transmitted first. If subaddress of R-divider is transmitted, the sequence of the next data bytes is DB 0 (Status), DB 1 and DB 2.

If subaddress of N-divider is transmitted, the sequence of the next data bytes is DB 3 and DB 4. The bit organisation

of the module address, subaddress and 5 data bytes are shown in figure 2.

Each transmission on the I<sup>2</sup>C bus begins with the "START"- condition and has to be ended by the "STOP"-condition (see figure 3).

The integrated circuit U4289BM has two separate inputs for AM and FM oscillator. Pre-amplified AM and FM signals are fed to the 16 bit N-divider via AM/FM switch. AM/FM switch is controlled by software. Tuning steps can be selected by 16 bit R-divider. Further there is a digital memory phase detector. There are two separate current sources for AM and FM amplifier (charge pump) as given in electrical characteristics. It allows independent adjustment of gain, whereby providing high current for high speed tuning and low current for stable tuning.

**Bit Organization**

	MSB							LSB
Module address	1	1	0	0	1	0	0/1	0
	A7	A6	A5	A4	A3	A2	A1	A0

Subaddress (R-divider)	X	X	X	0	0	1	X	X
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Subaddress (N-divider)	X	X	X	X	1	1	X	X
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	MSB							LSB
Data byte 0 (Status)	SWO1				AM/ FM	PD ANA	PD POL	PD CUR
	D7	D6	D5	D4	D3	D2	D1	D0

Data byte 1	$2^{15}$	R-divider						$2^8$
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Data byte 2	$2^7$	R-divider						$2^0$
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Data byte 3	$2^{15}$	N-divider						$2^8$
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Data byte 4	$2^7$	N-divider						$2^0$
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	<b>LOW</b>	<b>HIGH</b>
AM/FM	FM-operation	AM-operation
PD – ANA	PD analogue	TEST
PD – POL	Negative polarity	Positive polarity
PD – CUR	Output current 2	Output current 1

Figure 2.

## Transmission Protocol

	MSB	LSB									
S	Address		A	Subaddress	A	Data 0	A	Data 1	A	Data 2	P
	A7	A0		R-divider							

	MSB	LSB							
S	Address		A	Subaddress	A	Data 3	A	Data 4	P
	A7	A0		N-divider				A	

S = Start    P = Stop    A = Acknowledge

Figure 3.

## Absolute Maximum Ratings

Parameters	Symbol	Value	Unit
Supply voltage                      Pin 1	$V_{DD}$	-0.3 to +6	V
Input voltage                      Pins 2, 3, 4, 6, 8, 14 and 15	$V_I$	-0.3 to $V_{DD} + 0.3$	V
Output current                      Pins 3 and 5	$I_O$	-1 to +5	mA
Output drain voltage              Pin 5	$V_{OD}$	15	V
Analogue supply voltage              Pin 13 with 220 $\Omega$ seriell resistance 2 minutes <sup>1)</sup>	$V_A$	6 to 15	V
	$V_A$	24	V
Output current                      Pins 9 and 12	$I_{AO}$	-1 to +20	mA
Ambient temperature range	$T_{amb}$	-30 to +85	$^{\circ}C$
Storage temperature range	$T_{stg}$	-40 to +125	$^{\circ}C$
Junction temperature	$T_j$	125	$^{\circ}C$
Electrostatic handling (modified MIL STD 883 D method 3015.7: all supply pins connected together)	$\pm V_{ESD}$	1000	V

<sup>1)</sup> corresponding our application circuit (page 7)

## Thermal Resistance

Parameters	Symbol	Value	Unit
Junction ambient	$R_{thJA}$	160	K/W

## Electrical Characteristics

$V_{DD} = 5\text{ V}$ ,  $V_A = 10\text{ V}$ ,  $T_{amb} = 25^\circ\text{C}$ , unless otherwise specified

Parameters	Test conditions / Pin	Symbol	Min.	Typ.	Max.	Unit
Supply voltage	Pin 1	$V_{DD}$	4.5	5.0	5.5	V
Quiescent supply current	AM-mode FM-mode	Pin 1	$I_{DD}$	4.0	7.0	mA
<b>FM input sensitivity, <math>R_G = 50\ \Omega</math> FMOSC</b>						
$f_i = 70$ to $120\text{ MHz}$	Pin 6	$V_{SFM}$	40			$\text{mV}_{\text{rms}}$
$f_i = 160\text{ MHz}$	Pin 6	$V_{SFM}$	150			$\text{mV}_{\text{rms}}$
<b>AM input sensitivity, <math>R_G = 50\ \Omega</math> AMOSC</b>						
$f_i = 0.6$ to $35\text{ MHz}$	Pin 8	$V_{SAM}$	40			$\text{mV}_{\text{rms}}$
<b>Oscillator input sensitivity, <math>R_G = 50\ \Omega</math> OSCIN</b>						
$f_i = 0.1$ to $15\text{ MHz}$	Pin 14	$V_{SOSC}$	100			$\text{mV}_{\text{rms}}$
<b>Phase detector PDFM</b>						
Output current 1	Pin 10	$\pm I_{PDFM}$	1600	2000	2400	$\mu\text{A}$
Output current 2	Pin 10	$\pm I_{PDFM}$	400	500	600	$\mu\text{A}$
Leakage current	Pin 10	$\pm I_{PDFML}$			20	nA
<b>Phase detector PDAM</b>						
Output current 1	Pin 11	$\pm I_{PDAM}$	160	200	240	$\mu\text{A}$
Output current 2	Pin 11	$\pm I_{PDAM}$	40	50	60	$\mu\text{A}$
Leakage current	Pin 11	$\pm I_{PDAML}$			20	nA
<b>Analogue output PDFMO, PDAMO</b>						
Saturation voltage LOW HIGH	Pins 9 and 12 $I = 15\text{ mA}$	$V_{\text{satL}}$ $V_{\text{satH}}$	9.5	200 9.95	400	$\text{mV}$ V
<b>I<sup>2</sup>C bus SCL, SDA, AS</b>						
Input voltage HIGH LOW	Pins 2, 3 and 4	$V_{i\text{BUS}}$	3.0 0		$V_{DD}$ 1.5	V V
Output voltage Acknowledge LOW	Pin 3 $I_{\text{SDA}} = 3\text{ mA}$	$V_O$			0.4	V
Clock frequency	Pin 2	$f_{\text{SCL}}$			100	kHz
Rise time SDA, SCL	Pins 2 and 3	$t_r$			1	$\mu\text{s}$
Fall time SDA, SCL	Pins 2 and 3	$t_f$			300	ns
Period of SCL HIGH LOW	Pin 2 HIGH LOW	$t_H$ $t_L$	4.0 4.7			$\mu\text{s}$ $\mu\text{s}$
<b>Setup time</b>						
Start condition Data Stop condition Time space <sup>1)</sup>		$t_{\text{sSTA}}$ $t_{\text{sDAT}}$ $t_{\text{sSTOP}}$ $t_{\text{wSTA}}$	4.7 250 4.7 4.7			$\mu\text{s}$ ns $\mu\text{s}$ $\mu\text{s}$
<b>Hold time</b>						
Start condition DATA		$t_{\text{hSTA}}$ $t_{\text{hDAT}}$	4.0 0			$\mu\text{s}$ $\mu\text{s}$

<sup>1)</sup> This is a space of time where the bus must be free from data transmission and before a new transmission can be started.

## Bus Timing

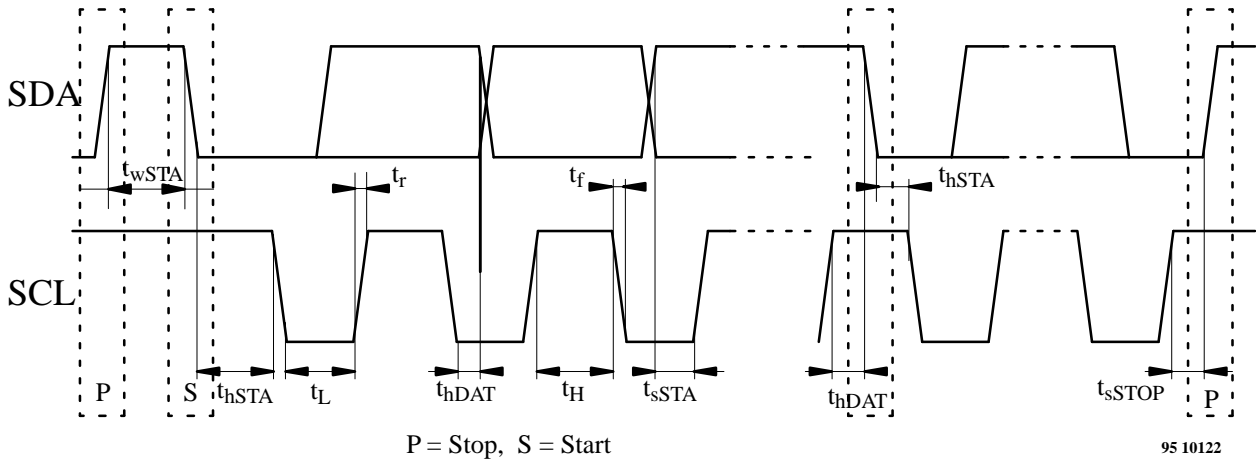


Figure 4.

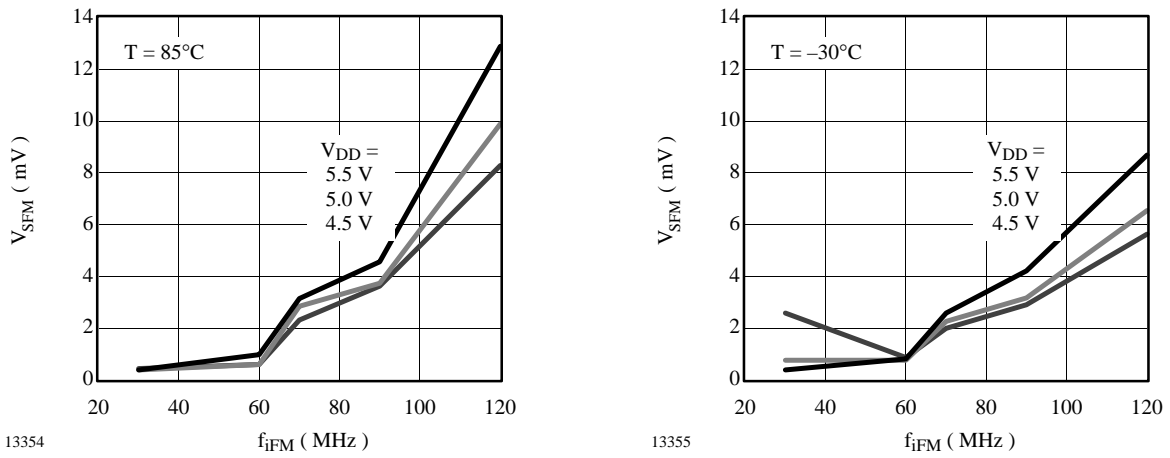


Figure 5. FM input sensitivity

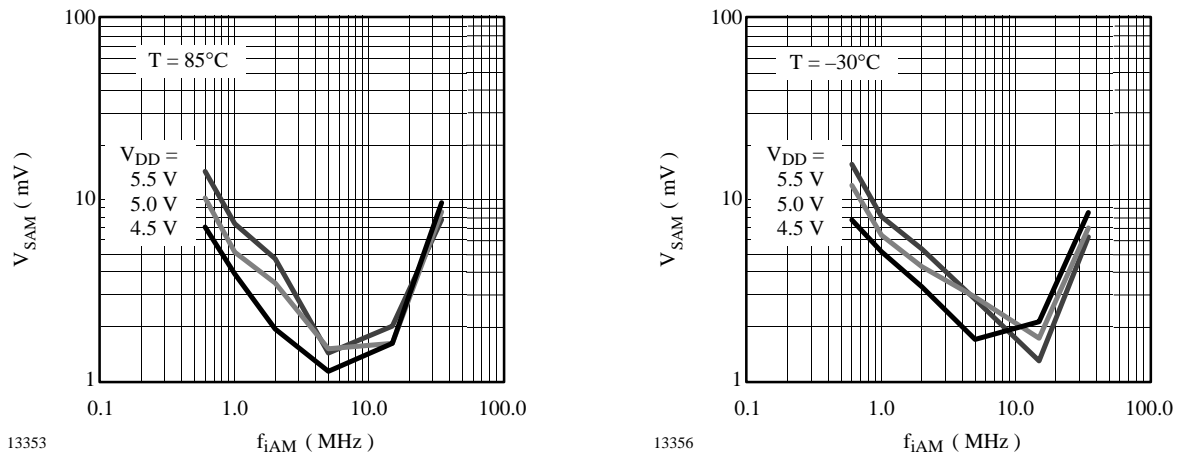


Figure 6. AM input sensitivity

**Application Circuit**

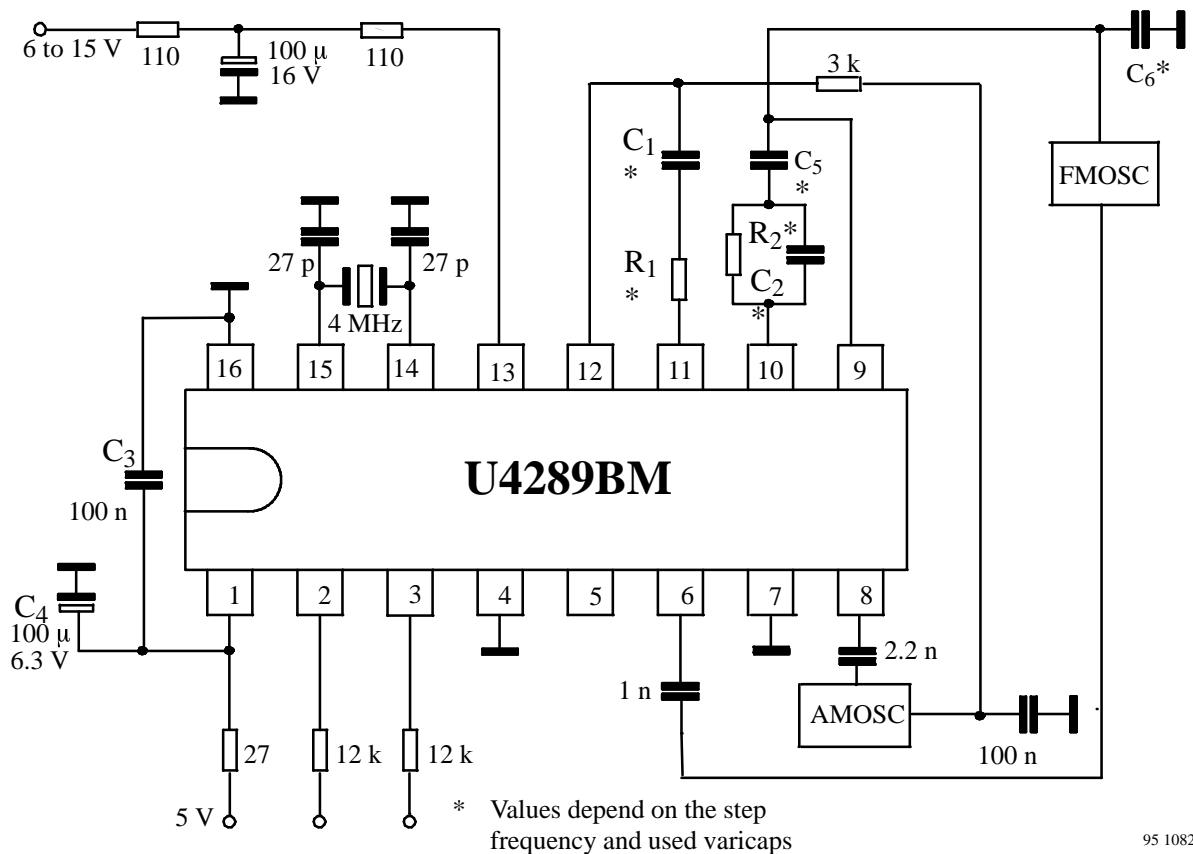


Figure 7.

## Recommendations for Applications

- $C_3 = 100 \text{ nF}$  should be very close to Pin 1 ( $V_{DD}$ ) and Pin 16 (GND 1)
- GND 2 (Pin 7 – analog ground) and GND 1 (Pin 16 – digital ground) must be connected according to figure 8
- 4 MHz crystal must be very close to Pin 14 and Pin 15
- Components of the charge pump ( $C_1/R_1$  for AM and  $C_2/R_2$  for FM) should be very close to Pin 11 with respect to Pin 10.

## PCB-Layout

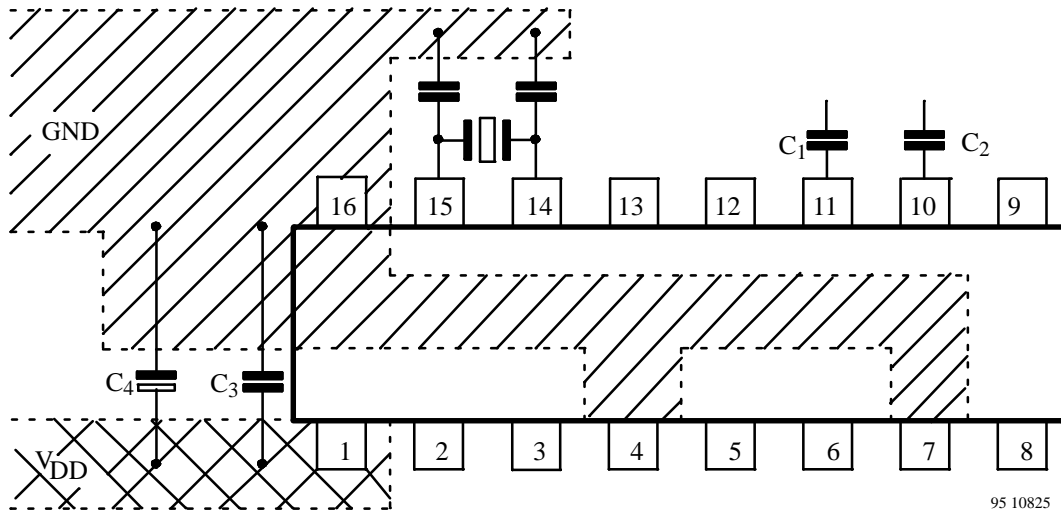


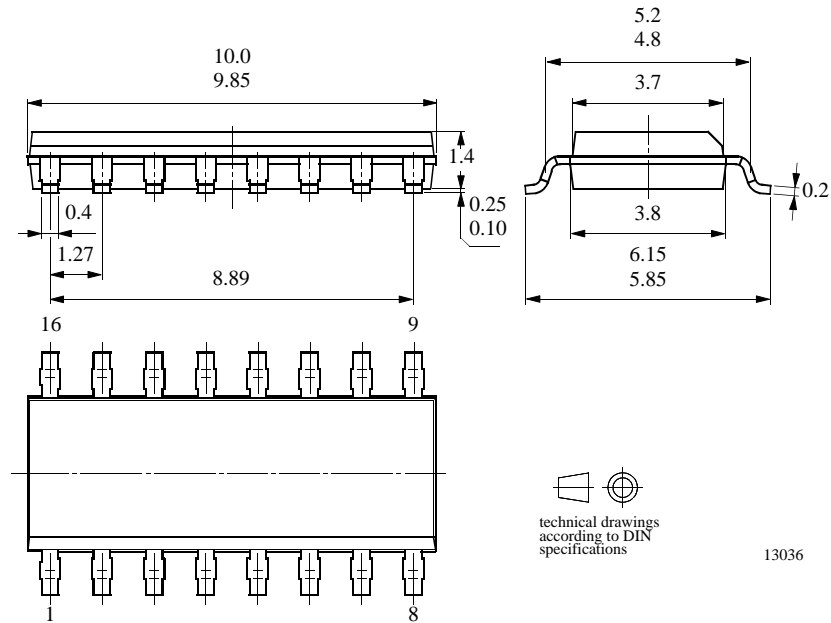
Figure 8.



**Package Information**

Package SO16

Dimensions in mm



## Ozone Depleting Substances Policy Statement

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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.

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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.

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