

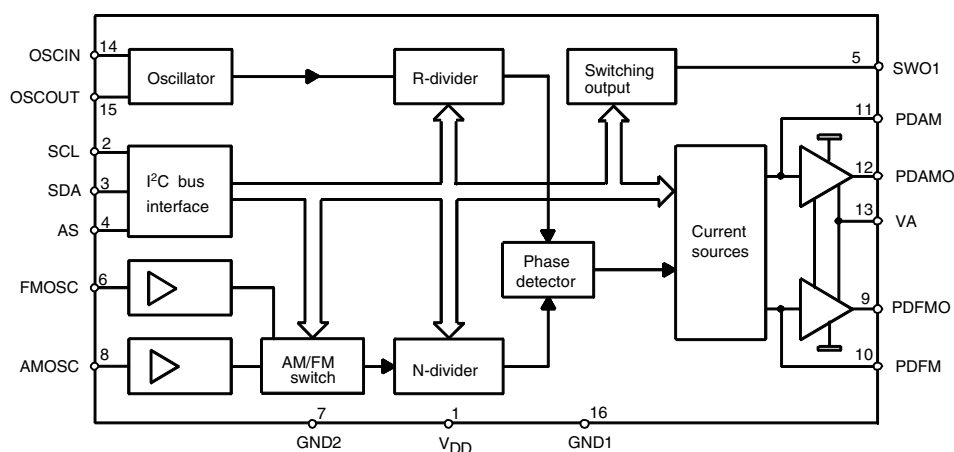
## Features

- Reference Oscillator up to 15 MHz
- Two Programmable 16-bit Dividers Adjustable from 2 to 65535
- Fine Tuning Steps
  - AM  $\geq 1$  kHz
  - FM  $\geq 2$  kHz
- Loop-push-pull Stage for AM/FM
- High Signal/Noise Ratio

## 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 a 2-wire bus. The device is designed for all frequency synthesizer applications in radio receivers, as well as for RDS (Radio Data System) applications.

Figure 1. Block Diagram



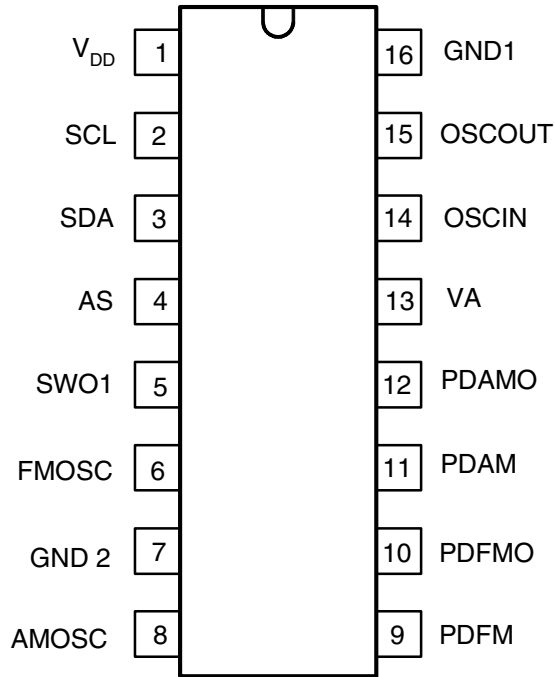
## AM/FM PLL with 1 Switch

## U4289BM



## Pin Configuration

**Figure 2.** Pinning SO16



## Pin Description

| Pin | Symbol          | Function              |
|-----|-----------------|-----------------------|
| 1   | V <sub>DD</sub> | Supply voltage        |
| 2   | SCL             | Bus clock             |
| 3   | SDA             | Bus data              |
| 4   | AS              | Address selection     |
| 5   | SWO1            | Switching output      |
| 6   | FMOSC           | FM oscillator input   |
| 7   | GND2            | Ground 2 (analog)     |
| 8   | AMOSC           | AM oscillator input   |
| 9   | PDFM            | FM current output     |
| 10  | PDFMO           | FM analog output      |
| 11  | PDAM            | AM current output     |
| 12  | PDAMO           | AM analog output      |
| 13  | VA              | Analog supply voltage |
| 14  | OSCIN           | Oscillator input      |
| 15  | OSCOUT          | Oscillator output     |
| 16  | GND1            | Ground 1 (digital)    |

## Functional Description

The U4289BM is controlled via the 2-wire bus. One module address byte, two subaddress bytes and five data bytes enable programming.

The module address contains a programmable address bit A 1, which (along with address select input AS, pin 4), enables the operation of two U4289BM devices 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 of the data bytes is transmitted first. If the subaddress of the R-divider is transmitted, the sequence of the next data bytes is DB 0 (Status), DB 1 and DB 2. If the subaddress of the N-divider is transmitted, the sequence of the next data bytes is DB 3 and DB 4. The bit organization of the module address, subaddress and 5 data bytes is shown in table "Bit Organization" on page 7.

Each transmission on the bus begins with the "START" condition and has to be ended by the "STOP" condition (see table "Transmission Protocol" on page 7).

The integrated circuit U4289BM has two separate inputs for the AM and FM oscillators. Pre-amplified AM and FM signals are fed to the 16-bit R-divider via the AM/FM switch. The AM/FM switch is software controlled. Tuning steps can be selected by the 16-bit R-divider.

Furthermore, the device provides a digital memory phase detector and two separate current sources for AM and FM amplifier (charge pump) as given in the Table "Electrical Characteristics" on page 4. It allows independent gain adjustment, providing high current for high-speed tuning and low current for stable tuning.

## Absolute Maximum Ratings

Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

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

Note: 1. Corresponding to the application circuit (Figure 8 on page 8)

## 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                     | Pins    | Symbol          | Min. | Typ. | Max.     | Unit              |
|-------------------------------------------------------------|-------------------------------------|---------|-----------------|------|------|----------|-------------------|
| Supply voltage                                              |                                     | 1       | $V_{DD}$        | 4.5  | 5.0  | 5.5      | V                 |
| Quiescent supply current                                    | AM mode/FM mode                     | 1       | $I_{DD}$        |      | 4.0  | 7.0      | mA                |
| FM input sensitivity,<br>$R_G = 50\ \Omega$ , FMOSC         | $f_i = 70\text{ to }120\text{ MHz}$ | 6       | $V_{SFM}$       | 40   |      |          | mV <sub>rms</sub> |
|                                                             | $f_i = 160\text{ MHz}$              | 6       | $V_{SFM}$       | 150  |      |          | mV <sub>rms</sub> |
| AM input sensitivity,<br>$R_G = 50\ \Omega$ , AMOSC         | $f_i = 0.6\text{ to }35\text{ MHz}$ | 8       | $V_{SAM}$       | 40   |      |          | mV <sub>rms</sub> |
| Oscillator input sensitivity,<br>$R_G = 50\ \Omega$ , OSCIN | $f_i = 0.1\text{ to }15\text{ MHz}$ | 14      | $V_{SOSC}$      | 100  |      |          | mV <sub>rms</sub> |
| <b>Phase Detector PDFM</b>                                  |                                     |         |                 |      |      |          |                   |
| Output current 1                                            |                                     | 10      | $\pm I_{PDFM}$  | 1600 | 2000 | 2400     | $\mu\text{A}$     |
| Output current 2                                            |                                     | 10      | $\pm I_{PDFM}$  | 400  | 500  | 600      | $\mu\text{A}$     |
| Leakage current                                             |                                     | 10      | $\pm I_{PDFML}$ |      |      | 20       | nA                |
| <b>Phase Detector PDAM</b>                                  |                                     |         |                 |      |      |          |                   |
| Output current 1                                            |                                     | 11      | $\pm I_{PDAM}$  | 160  | 200  | 240      | $\mu\text{A}$     |
| Output current 2                                            |                                     | 11      | $\pm I_{PDAM}$  | 40   | 50   | 60       | $\mu\text{A}$     |
| Leakage current                                             |                                     | 11      | $\pm I_{PDAML}$ |      |      | 20       | $\mu\text{A}$     |
| <b>Analog Output PDFMO, PDAMO</b>                           |                                     |         |                 |      |      |          |                   |
| Saturation voltage LOW                                      | $I = 15\text{ mA}$                  | 9, 12   | $V_{satL}$      |      | 200  | 400      | mW                |
| Saturation voltage HIGH                                     | $I = 15\text{ mA}$                  | 9, 12   | $V_{satH}$      | 9.5  | 9.95 |          | V                 |
| <b>Bus SCL, SDA, AS</b>                                     |                                     |         |                 |      |      |          |                   |
| Input voltage HIGH                                          |                                     | 2, 3, 4 | $V_{iBUS}$      | 3.0  |      | $V_{DD}$ | V                 |
| Input voltage LOW                                           |                                     | 2, 3, 4 | $V_{iBUS}$      | 0    |      | 1.5      | V                 |
| Output voltage acknowledge LOW                              | $I_{SDA} = 3\text{ mA}$             | 3       | $V_O$           |      |      | 0.4      | V                 |
| Clock frequency                                             |                                     | 2       | $f_{SCL}$       |      |      | 100      | kHz               |
| Rise time SDA, SCL                                          |                                     | 2, 3    | $t_r$           |      |      | 1        | $\mu\text{s}$     |
| Fall time SDA, SCL                                          |                                     | 2, 3    | $t_f$           |      |      | 300      | ns                |
| Period of SCL HIGH                                          |                                     | 2       | $t_H$           | 4.0  |      |          | $\mu\text{s}$     |
| Period of SCL LOW                                           |                                     | 2       | $t_L$           | 4.7  |      |          | $\mu\text{s}$     |

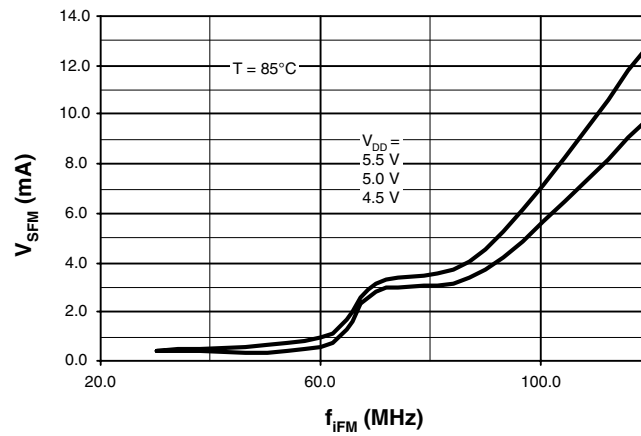
## Electrical Characteristics (Continued)

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

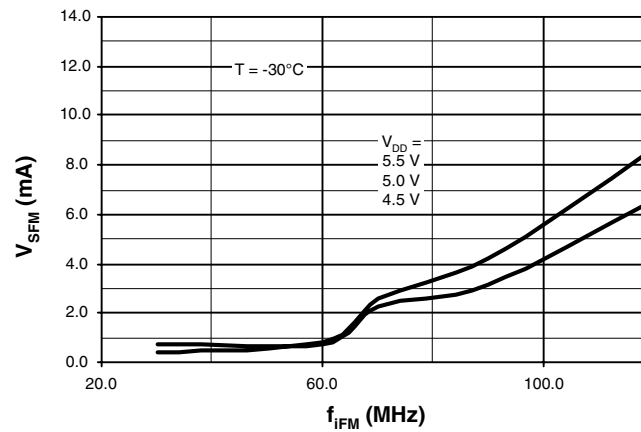
| Parameters                | Test Conditions | Pins | Symbol      | Min. | Typ. | Max. | Unit          |
|---------------------------|-----------------|------|-------------|------|------|------|---------------|
| <b>Set-up Time</b>        |                 |      |             |      |      |      |               |
| Start condition           |                 |      | $t_{sSTA}$  | 4.7  |      |      | $\mu\text{s}$ |
| Data                      |                 |      | $t_{sDAT}$  | 250  |      |      | $\mu\text{s}$ |
| Stop condition            |                 |      | $t_{sSTOP}$ | 4.7  |      |      | $\mu\text{s}$ |
| Time space <sup>(1)</sup> |                 |      | $t_{wSTA}$  | 4.7  |      |      | $\mu\text{s}$ |
| <b>Hold Time</b>          |                 |      |             |      |      |      |               |
| Start condition           |                 |      | $t_{hSTA}$  | 4.0  |      |      | $\mu\text{s}$ |
| DATA                      |                 |      | $t_{hDAT}$  | 0    |      |      | $\mu\text{s}$ |

Note: 1. This is a period of time where the bus must be free from data transmission before a new transmission can be started.

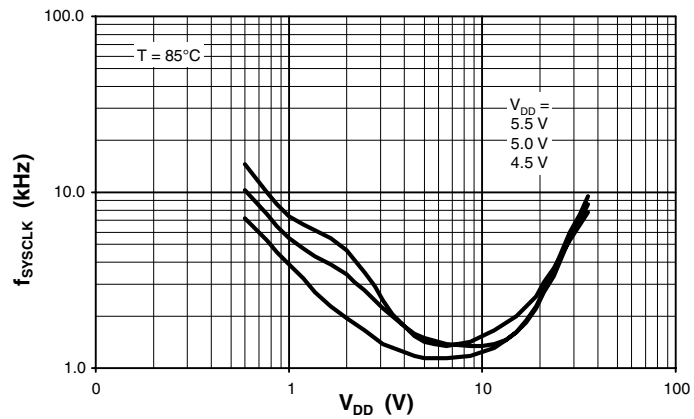
**Figure 3.** FM Input Sensitivity,  $T_{amb} = +85^\circ\text{C}$



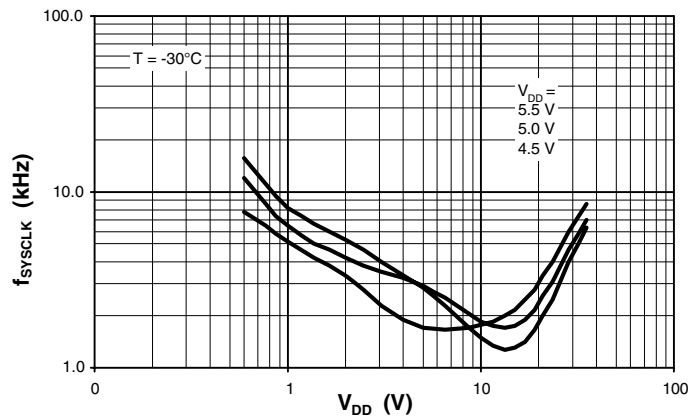
**Figure 4.** FM Input Sensitivity,  $T_{amb} = -30^\circ\text{C}$



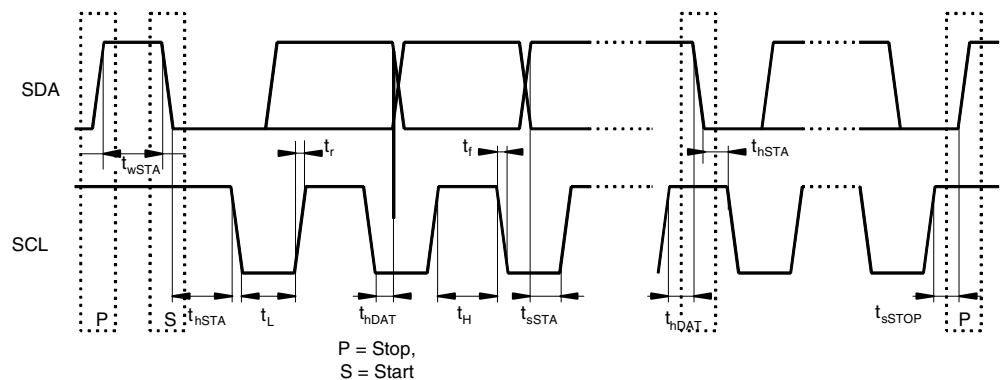
**Figure 5.** AM Input Sensitivity,  $T_{amb} = +85^{\circ}\text{C}$



**Figure 6.** AM Input Sensitivity,  $T_{amb} = -30^{\circ}\text{C}$



**Figure 7.** Bus Timing



## 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              |
| Subaddress (N-divider) | X               | X         | X  | X  | 1     | 1        | X        | X              |
| 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 <sup>15</sup> | R-divider |    |    |       |          |          | 2 <sup>8</sup> |
| Data byte 2            | 2 <sup>7</sup>  | R-divider |    |    |       |          |          | 2 <sup>0</sup> |
| Data byte 3            | 2 <sup>15</sup> | N-divider |    |    |       |          |          | 2 <sup>8</sup> |
| Data byte 4            | 2 <sup>7</sup>  | N-divider |    |    |       |          |          | 2 <sup>0</sup> |

**Table 1.** Function Mode

| Bit Description | Mode     | LOW               | HIGH              |
|-----------------|----------|-------------------|-------------------|
| D3              | AM/FM    | FM operation      | AM operation      |
| D2              | PD - ANA | PD analog         | TEST              |
| D1              | PD - POL | Negative polarity | Positive polarity |
| D0              | PD - CUR | Output current 2  | Output current 1  |

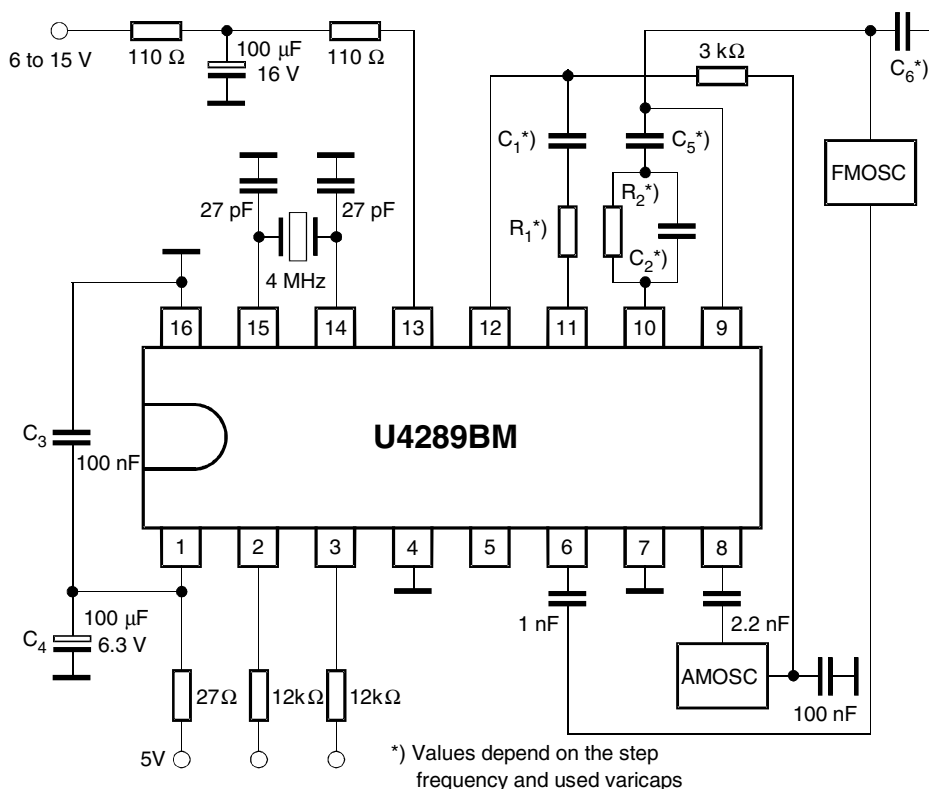
## Transmission Protocol

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

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

Note: S = Start, P = Stop, A = Acknowledge

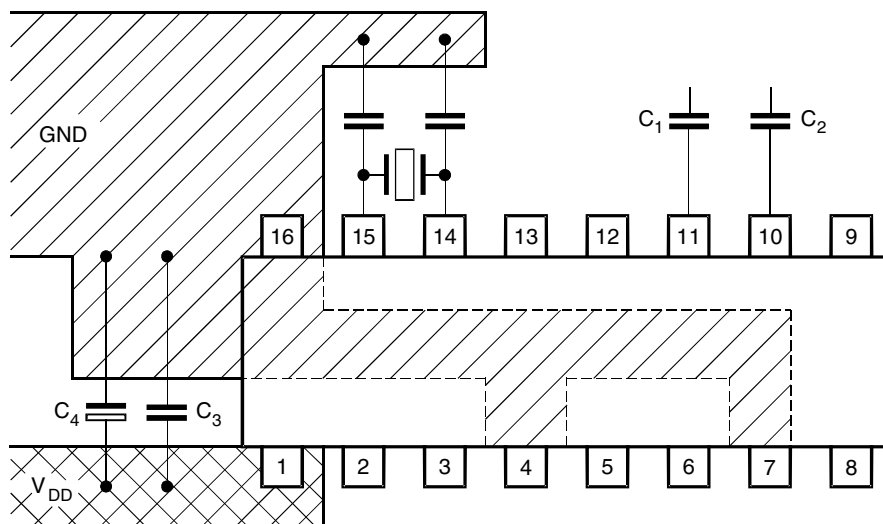
**Figure 8.** Application Circuit



## Recommendations for Applications

- $C_3 = 100 \text{ nF}$  should be very close to pin 1 ( $V_{DD}$ ) and pin 16 (GND 1)
- GND2 (pin 7, analog ground) and GND1 (pin 16, digital around) 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.

**Figure 9.** PCB Layout



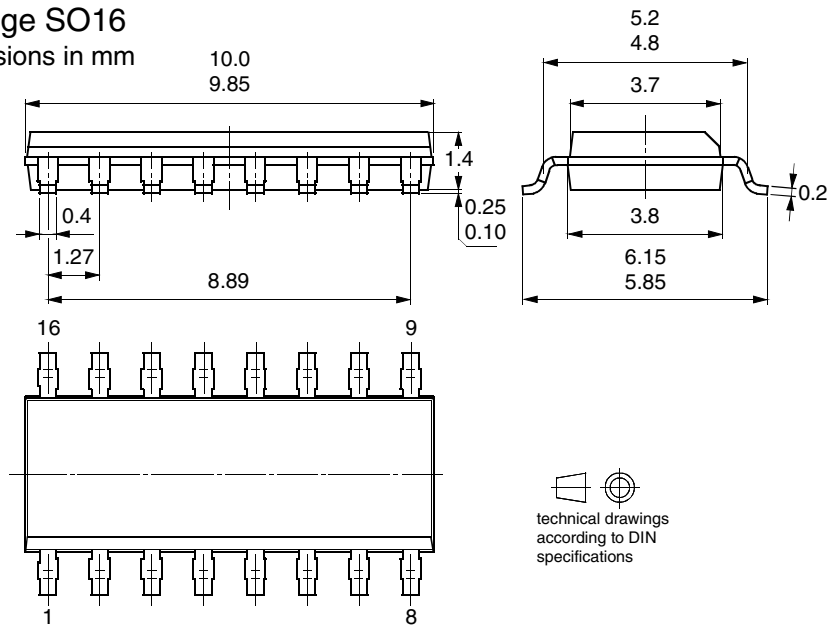


## Ordering Information

| Extended Type Number | Package      | Remarks                       |
|----------------------|--------------|-------------------------------|
| U4289BM-MFP          | SO16 plastic | –                             |
| U4289BM-MFPG3        | SO16 plastic | Taping according to IEC-286-3 |

## Package Information

Package SO16  
Dimensions in mm





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