

# TH71101

315/433MHz

FSK/ASK Receiver

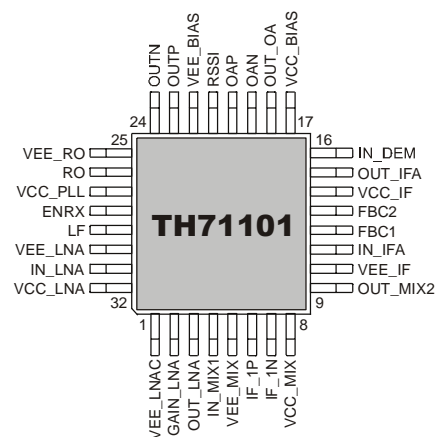
## Features

- Single-conversion superhet architecture for low external component count
- FSK demodulation with phase-coincidence demodulator
- Low current consumption in active mode and very low standby current
- Switchable LNA gain for improved dynamic range
- RSSI allows signal strength indication and ASK detection
- 32-pin Low profile Quad Flat Package (LQFP)

## Application Examples

- General digital data transmission
- Tire Pressure Monitoring Systems (TPMS)
- Remote Keyless Entry (RKE)
- Wireless access control
- Alarm and security systems
- Garage door openers
- Remote Controls
- Home and building automation
- Low-power telemetry systems

## Pin Description



## Ordering information

| Product Code | Temperature Code | Package Code | Option Code | Packing Form Code |
|--------------|------------------|--------------|-------------|-------------------|
| TH71101      | E                | NE           | CAA-000     | RE                |
| TH71101      | E                | NE           | CAA-000     | TR                |

### Legend:

Temperature Code: E for Temperature Range -40°C to 85°C  
Package Code: NE for LQFP  
Packing Form: RE for Reel, TR for Tray  
Ordering example: TH71101ENE-CAA-000-RE

## General Description

The TH71101 FSK/ASK single-conversion superheterodyne receiver IC is designed for applications in the European 433MHz industrial-scientific-medical (ISM) band, according to the EN 300 220 telecommunications standard. It can also be used for any other system with carrier frequencies ranging from 300MHz to 450MHz (e.g. for applications according to FCC part 15 and ARIB STD-T67).

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## 1. Theory of Operation

### 1.1. General

With the TH71101 receiver chip, various circuit configurations can be arranged in order to meet a number of different customer requirements. For FSK reception the IF tank used in the phase coincidence demodulator can be constituted by an external ceramic discriminator. In ASK configuration, the RSSI signal is fed to an ASK detector, which is constituted by the operational amplifier.

A double-conversion variant, called TH71102, is also available. This receiver IC allows a higher degree of image rejection, achieved in conjunction with an RF front-end filter. Both RXICs have the same die. At the TH71102, the second mixer (MIX2) is used to down-convert the first IF (IF1) to the second IF (IF2). At the TH71101, MIX2 operates as an amplifier.

Efficient RF front-end filtering is realized by using a SAW, ceramic or helix filter in front of the LNA and by adding an LC filter at the LNA output.

The TH71101 receiver IC consists of the following building blocks:

- PLL synthesizer (PLL SYNTH) for generation of the local oscillator signal LO, parts of the PLL SYNTH are: the high-frequency VCO1, the feedback divider DIV\_16, a phase-frequency detector (PFD) with charge pump (CP) and a crystal-based reference oscillator (RO)
- Low-noise amplifier (LNA) for high-sensitivity RF signal reception
- First mixer (MIX1) for down-conversion of the RF signal to the IF
- IF pre amplifier which is a mixer cell (MIX2) that operates as an amplifier
- IF amplifier (IFA) to amplify and limit the IF signal and for RSSI generation
- Phase coincidence demodulator (DEMOD) with third mixer (MIX3) to demodulate the IF signal
- Operational amplifier (OA) for data slicing, filtering and ASK detection
- Bias circuitry for bandgap biasing and circuit shutdown

### 1.2. Technical Data Overview

- |  |   |
|--|---|
| ▪ Input frequency range: 300 to 450 MHz  | ▪ Range of IF: 400 kHz to 22 MHz  |
| ▪ Power supply range: 2.3 to 5.5 V @ ASK | ▪ Maximum input level: -10 dBm @ ASK  |
| ▪ Temperature range: -40 to +85 °C       | ▪ 0 dBm @ FSK   |
| ▪ Standby current: 50 nA                 | ▪ Image rejection: > 45 dB (e.g. with 433.92 MHz SAW front-end filter and at 10.7 MHz IF) |
| ▪ Operating current: 6.5 mA @ low gain   | ▪ Spurious emission: < -70 dBm  |
| ▪ 8.2 mA @ high gain                     | ▪ Input frequency acceptance range: up to ±100 kHz  |
| ▪ Sensitivity: -113 dBm @ ASK 1)         | ▪ RSSI range: 70 dB   |
| ▪ -107 dBm @ FSK 2)                      | ▪ FSK deviation range: ±2.5 kHz to ±80 kHz  |
| ▪ Maximum data rate: 260 kbps NRZ @ ASK  |   |
| ▪ 180 kbps NRZ @ FSK                     |   |

1) at 4 kbps NRZ, BER =  $3 \cdot 10^{-3}$ , 180 kHz IF filter BW, without SAW front-end-filter loss

2) at 4 kbps NRZ, BER =  $3 \cdot 10^{-3}$ , ± 20 kHz FSK deviation, 180 kHz IF filter BW, without SAW front-end-filter loss

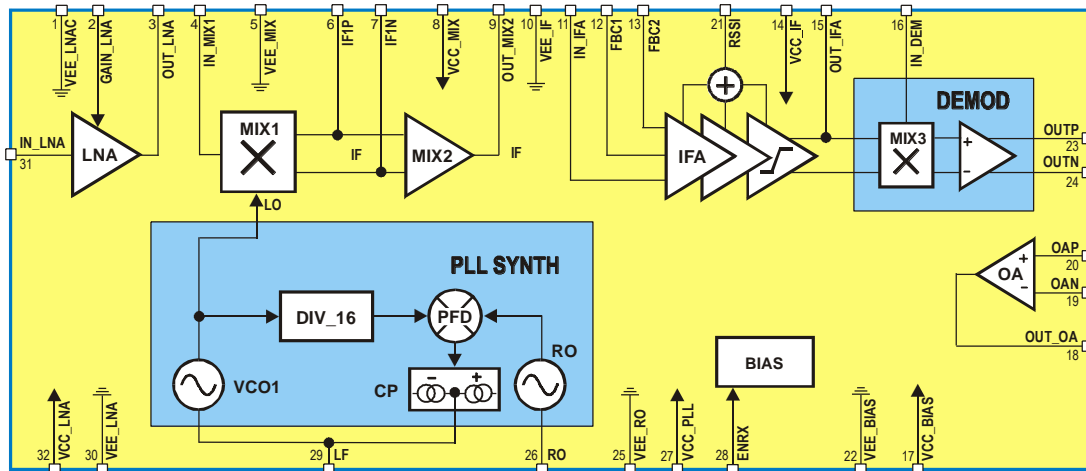


Fig. 1: TH71101 block diagram

### 1.4. Mode Configurations

| ENRX | Mode       | Description |
|------|------------|-------------|
| 0    | RX standby | RX disabled |
| 1    | RX active  | RX enable   |

*Note: ENRX are pulled down internally*

### 1.5. LNA GAIN Control

| V <sub>GAIN_LNA</sub> | Mode      | Description          |
|-----------------------|-----------|----------------------|
| < 0.8 V               | HIGH GAIN | LNA set to high gain |
| > 1.4 V               | LOW GAIN  | LNA set to low gain  |

*Note: hysteresis between gain modes to ensure stability*

### 1.6. Frequency Planning

Frequency planning is straightforward for single-conversion applications because there is only one IF that can be chosen, and then the only possible choice is low-side or high-side injection of the LO signal (which is now the one and only LO signal in the receiver).

The receiver's single-conversion architecture requires careful frequency planning. Besides the desired RF input signal, there are a number of spurious signals that may cause an undesired response at the output. Among them is the image of the RF signal that must be suppressed by the RF front-end filter.

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By using the internal PLL synthesizer of the TH71101 with the fixed feedback divider ratio of  $N = 16$  (DIV\_16), two types of down-conversion are possible: low-side injection of LO and high-side injection of LO. The following table summarizes some equations that are useful to calculate the crystal reference frequency (REF) and the LO frequency, for a given RF and IF.

| Injection type | low              | high             |
|----------------|------------------|------------------|
| REF            | $(RF - IF)/16$   | $(RF + IF)/16$   |
| LO             | $16 \bullet REF$ | $16 \bullet REF$ |
| IF             | $RF - LO$        | $LO - RF$        |
| RF image       | $RF - 2IF$       | $RF + 2IF$       |

### 1.6.1. Selected Frequency Plans

The following table depicts crystal, LO and image signals considering the examples of 315 MHz and 433.92 MHz RF reception at IF = 10.7 MHz.

| Signal type    | RF = 315 MHz | RF = 315 MHz    | RF = 433.92 MHz | RF = 433.92 MHz |
|----------------|--------------|-----------------|-----------------|-----------------|
| Injection type | low          | <b>high</b>     | <b>low</b>      | high            |
| REF / MHz      | 19.01875     | <b>20.35625</b> | <b>26.45125</b> | 27.78875        |
| LO / MHz       | 304.3        | <b>325.7</b>    | <b>423.22</b>   | 444.62          |
| RF image / MHz | 293.6        | <b>336.4</b>    | <b>412.52</b>   | 455.32          |

The selection of the reference crystal frequency is based on some assumptions. As for example: the image frequency should not be in a radio band where strong interfering signals might occur (because they could represent parasitic receiving signals), the LO signal should be in the range of 300 MHz to 450 MHz (because this is the optimum frequency range of the VCO1). Furthermore the IF should be as high as possible to achieve highest RF image rejection. The columns in bold depict the selected frequency plans to receive at 315 MHz and 433.92 MHz, respectively.

### 1.6.2. Maximum Frequency Coverage

| Parameter      | $f_{\min}$ | $f_{\max}$ |
|----------------|------------|------------|
| Injection type | high       | low        |
| RF / MHz       | 289.3      | 460.7      |
| REF / MHz      | 18.75      | 28.125     |
| LO / MHz       | 300        | 450        |
| IF / MHz       | 10.7       | 10.7       |

## 2. Pin Definitions and Descriptions

| Pin No. | Name     | I/O Type      | Functional Schematic | Description  |
|---------|----------|---------------|----------------------|--|
| 3       | OUT_LNA  | analog output |                      | LNA open-collector output, to be connected to external LC tank that resonates at RF          |
| 31      | IN_LNA   | analog input  |                      | LNA input, approx. 26Ω single-ended  |
| 1       | VEE_LNAC | ground        |                      | ground of LNA core (cascode)   |
| 2       | GAIN_LNA | analog input  |                      | LNA gain control (input with hysteresis)<br><br>RX standby: no pull-up<br>RX active: pull-up |
| 4       | IN_MIX1  | analog input  |                      | MIX1 input, approx. 33Ω single-ended   |
| 5       | VEE_MIX  | ground        |                      | ground of MIX1 and MIX2  |
| 6       | IF1P     | analog I/O    |                      | open-collector output, to be connected to external LC tank that resonates at first IF        |
| 7       | IF1N     | analog I/O    |                      | open-collector output, to be connected to external LC tank that resonates at first IF        |
| 8       | VCC_MIX  | supply        |                      | positive supply of MIX1 and MIX2   |
| 9       | OUT_MIX2 | analog output |                      | MIX2 output, approx. 330Ω output impedance   |
| 10      | VEE_IF   | ground        |                      | ground of IFA and DEMOD  |

| Pin No. | Name     | I/O Type      | Functional Schematic | Description  |
|---------|----------|---------------|----------------------|--|
| 11      | IN_IFA   | analog input  |                      | IFA input, approx. 2.2kΩ input impedance           |
| 12      | FBC1     | analog I/O    |                      | to be connected to external IFA feedback capacitor |
| 13      | FBC2     | analog I/O    |                      | to be connected to external IFA feedback capacitor |
| 14      | VCC_IF   | supply        |                      | positive supply of IFA and DEMOD                   |
| 15      | OUT_IFA  | analog I/O    |                      | IFA output and MIX3 input (of DEMOD)               |
| 16      | IN_DEM   | analog input  |                      | DEMOD input, to MIX3 core                          |
| 17      | VCC_BIAS | supply        |                      | positive supply of general bias system and OA      |
| 18      | OUT_OA   | analog output |                      | OA output, 40uA current drive capability           |
| 19      | OAN      | analog input  |                      | negative OA input                                  |
| 20      | OAP      | analog input  |                      | positive OA input                                  |

| Pin No. | Name     | I/O Type      | Functional Schematic | Description  |
|---------|----------|---------------|----------------------|--|
| 21      | RSSI     | analog output |                      | RSSI output, for RSSI and ASK detection, approx. 36kΩ output impedance |
| 22      | VEE_BIAS | ground        |                      | ground of general bias system and OA                                   |
| 23      | OUTP     | analog output |                      | FSK positive output, output impedance of 100kΩ to 300kΩ                |
| 24      | OUTN     | analog output |                      | FSK negative output, output impedance of 100kΩ to 300kΩ                |
| 25      | VEE_RO   | ground        |                      | ground of DIV, PFD, RO and charge pump                                 |
| 26      | RO       | analog input  |                      | RO input, Colpitts type oscillator with internal feedback capacitors   |
| 27      | VCC_PLL  | supply        |                      | positive supply of DIV, PFD, RO and charge pump                        |
| 28      | ENRX     | digital input |                      | mode control input, CMOS-compatible with internal pull-down circuit    |
| 29      | LF       | analog I/O    |                      | charge pump output and VCO1 control input                              |
| 30      | VEE_LNA  | ground        |                      | ground of LNA biasing  |
| 32      | VCC_LNA  | supply        |                      | positive supply of LNA biasing   |



### 3. Technical Data

#### 3.1. Absolute Maximum Ratings

| Parameter               | Symbol     | Condition / Note     | Min   | Max          | Unit |
|-------------------------|------------|----------------------|-------|--------------|------|
| Supply voltage          | $V_{CC}$   |                      | 0     | 7.0          | V    |
| Input voltage           | $V_{IN}$   |                      | -0.3  | $V_{CC}+0.3$ | V    |
| Input RF level          | $P_{iRF}$  | @ LNA input          |       | 10           | dBm  |
| Storage temperature     | $T_{STG}$  |                      | -40   | +125         | °C   |
| Junction temperature    | $T_J$      |                      |       | +150         | °C   |
| Thermal Resistance      | $R_{thJA}$ |                      |       | 60           | K/W  |
| Power dissipation       | $P_{diss}$ |                      |       | 0.1          | W    |
| Electrostatic discharge | $V_{ESD1}$ | human body model, 3) | -1.0  | +1.0         | kV   |
|                         | $V_{ESD2}$ | human body model, 4) | -0.75 | +0.75        |      |

3) all pins except OUT\_LNA, IF1P and IF1N

4) pin OUT\_LNA, IF1P and IF1N

#### 3.2. Normal Operating Conditions

| Parameter                 | Symbol       | Condition                   | Min                | Max                | Unit |
|---------------------------|--------------|-----------------------------|--------------------|--------------------|------|
| Supply voltage            | $V_{CC,FSK}$ | 0 °C to 85 °C               | 2.5                | 5.5                | V    |
|                           |              | -20 °C to 85 °C             | 2.6                | 5.5                |      |
|                           |              | -40 °C to 85 °C             | 2.7                | 5.5                |      |
|                           | $V_{CC,ASK}$ | -40 °C to 85 °C             | 2.3                | 5.5                |      |
| Operating temperature     | $T_A$        |                             | -40                | +85                | °C   |
| Input low voltage (CMOS)  | $V_{IL}$     | ENRX pin                    |                    | $0.3 \cdot V_{CC}$ | V    |
| Input high voltage (CMOS) | $V_{IH}$     | ENRX pin                    | $0.7 \cdot V_{CC}$ |                    | V    |
| Input frequency range     | $f_i$        |                             | 289.3              | 460.7              | MHz  |
| IF range                  | $f_{IF}$     |                             | 0.4                | 22                 | MHz  |
| XOSC frequency            | $f_{ref}$    | set by the crystal          | 18.75              | 28.125             | MHz  |
| VCO frequency             | $f_{LO}$     | $f_{LO} = 16 \cdot f_{ref}$ | 300                | 450                | MHz  |
| Frequency deviation       | $\Delta f$   |                             | $\pm 2.5$          | $\pm 80$           | kHz  |
| FSK data rate             | $R_{FSK}$    | NRZ, C15 = NIP, 5)          |                    | 180                | kbps |
| ASK data rate             | $R_{ASK}$    | NRZ, C16 = NIP, 5)          |                    | 260                | kbps |

5)  $B_{IF} = 400$  kHz,  $P_{IN} = -90$  dBm

#### 3.3. Crystal Parameters

| Parameter          | Symbol | Condition            | Min   | Max    | Unit     |
|--------------------|--------|----------------------|-------|--------|----------|
| Crystal frequency  | $f_0$  | fundamental mode, AT | 18.75 | 28.125 | MHz      |
| Load capacitance   | $C_L$  |                      | 10    | 15     | pF       |
| Static capacitance | $C_0$  |                      |       | 7      | pF       |
| Series resistance  | $R_1$  |                      |       | 50     | $\Omega$ |

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**3.4. DC Characteristics**

all parameters under normal operating conditions, unless otherwise stated;  
 typical values at  $T_A = 23\text{ }^\circ\text{C}$  and  $V_{CC} = 3\text{ V}$

| Parameter                                | Symbol           | Condition                              | Min                | Typ  | Max                | Unit          |
|--|------------------|--|--------------------|------|--------------------|---------------|
| <b>Operating Currents</b>                |                  |  |                    |      |                    |               |
| Standby current                          | $I_{SBY}$        | ENRX=0                                 |                    | 50   | 100                | nA            |
| Supply current at low gain               | $I_{CC, low}$    | ENRX=1<br>GAIN_LNA=1                   | 4.0                | 6.5  | 12.0               | mA            |
| Supply current at high gain              | $I_{CC, high}$   | ENRX=1<br>GAIN_LNA=0                   | 4.5                | 8.2  | 14.0               | mA            |
| <b>Digital Pin Characteristics</b>       |                  |  |                    |      |                    |               |
| Input low voltage CMOS                   | $V_{IL}$         | ENRX pin                               | -0.3               |      | $0.3 \cdot V_{CC}$ | V             |
| Input high voltage CMOS                  | $V_{IH}$         | ENRX pin                               | $0.7 \cdot V_{CC}$ |      | $V_{CC} + 0.3$     | V             |
| Pull down current<br>ENRX pin            | $I_{PDEN}$       | ENRX=1                                 | 0.1                | 2    | 10                 | $\mu\text{A}$ |
| Low level input current<br>ENRX pin      | $I_{INLEN}$      | ENRX=0                                 |                    |      | 0.05               | $\mu\text{A}$ |
| <b>Analog Pin Characteristics</b>        |                  |  |                    |      |                    |               |
| High level input current<br>GAIN_LNA pin | $I_{INHAIN}$     | GAIN_LNA=1                             |                    |      | 0.05               | $\mu\text{A}$ |
| Pull up current<br>GAIN_LNA pin active   | $I_{PUGAINa}$    | GAIN_LNA=0<br>ENRX=1                   | 0.08               | 0.15 | 0.3                | $\mu\text{A}$ |
| Pull up current<br>GAIN_LNA pin standby  | $I_{PUGAINs}$    | GAIN_LNA=0<br>ENRX=0                   |                    |      | 0.05               | $\mu\text{A}$ |
| High gain input voltage                  | $V_{IHAIN}$      | ENRX=1                                 |                    |      | 0.7                | V             |
| Low gain input voltage                   | $V_{ILGAIN}$     | ENRX=1                                 | 1.5                |      |                    | V             |
| <b>Opamp Characteristics</b>             |                  |  |                    |      |                    |               |
| Opamp input offset voltage               | $V_{offs}$       |  | -35                |      | 35                 | mV            |
| Opamp input offset current               | $I_{offs}$       | $I_{OAP} - I_{OAN}$                    | -50                |      | 50                 | nA            |
| Opamp input bias current                 | $I_{bias}$       | $0.5 \cdot (I_{OAP} + I_{OAN})$        | -150               |      | 150                | nA            |
| <b>RSSI Characteristics</b>              |                  |  |                    |      |                    |               |
| RSSI voltage at low input level          | $V_{RSSI, low}$  | $P_i = -65\text{ dBm}$ ,<br>GAIN_LNA=1 | 0.5                | 1.0  | 1.5                | V             |
| RSSI voltage at high input level         | $V_{RSSI, high}$ | $P_i = -35\text{ dBm}$ ,<br>GAIN_LNA=1 | 1.2                | 1.9  | 2.5                | V             |

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**3.5. AC System Characteristics**

all parameters under normal operating conditions, unless otherwise stated;

typical values at  $T_A = 23\text{ °C}$  and  $V_{CC} = 3\text{ V}$ ,

RF at 433.92 MHz; SAW frond-end filter loss and IF at 10.7 MHz;

all parameters based on test circuits as shown in Fig. 2, Fig.3 and Fig. 5

| Parameter                             | Symbol            | Condition   | Min | Typ  | Max                              | Unit          |
|---------------------------------------|-------------------|---|-----|------|----------------------------------|---------------|
| <b>Receive Characteristics</b>        |                   |   |     |      |                                  |               |
| Input sensitivity – FSK (standard)    | $P_{min, ST}$     | $B_F = 180\text{kHz}$ ,<br>$\Delta f = \pm 20\text{kHz}$ ,<br>4kbps NRZ,<br>$BER \leq 3 \cdot 10^{-3}$ , 6) |     | -104 |                                  | dBm           |
| Input sensitivity – FSK (narrow band) | $P_{min, NB}$     | $B_F = 30\text{kHz}$ ,<br>$\Delta f = \pm 5\text{kHz}$ ,<br>4kbps NRZ,<br>$BER \leq 3 \cdot 10^{-3}$ , 6)   |     | -108 |                                  | dBm           |
| Input sensitivity – ASK               | $P_{min, ASK}$    | $B_F = 180\text{kHz}$ ,<br>4kbps NRZ,<br>$BER \leq 3 \cdot 10^{-3}$ , 6)                                    |     | -110 |                                  | dBm           |
| Maximum input signal – FSK            | $P_{max, FSK}$    | $BER \leq 3 \cdot 10^{-3}$<br>GAIN_LNA = 1  |     | 0    |                                  | dBm           |
| Maximum input signal – ASK            | $P_{max, ASK}$    | $BER \leq 3 \cdot 10^{-3}$<br>GAIN_LNA = 1  |     | -10  |                                  | dBm           |
| Spurious emission                     | $P_{spur}$        |   |     |      | -70                              | dBm           |
| Image rejection                       | $\Delta P_{imag}$ |   |     | 45   |                                  | dB            |
| <b>Start-up Parameters</b>            |                   |   |     |      |                                  |               |
| Crystal start-up time                 | $T_{XTL}$         | ENRX from 0 to 1  |     |      | 0.9                              | ms            |
| Receiver start-up time                | $T_{RX}$          | ENRX from 0 to 1,<br>depends on data slicer<br>time constant,<br>valid data at output                       |     |      | $T_{XTL}$<br>+<br>$R4 \cdot C17$ |               |
| <b>PLL Parameters</b>                 |                   |   |     |      |                                  |               |
| VCO gain                              | $K_{VCO}$         |   |     | 250  |                                  | MHz/V         |
| Charge pump current                   | $I_{CP}$          |   |     | 60   |                                  | $\mu\text{A}$ |

6) incl. 3 dB loss of front-end SAW filter

## 4. Test Circuits

### 4.1. Standard FSK Reception

#### 4.1.1. Standard FSK Application Circuit

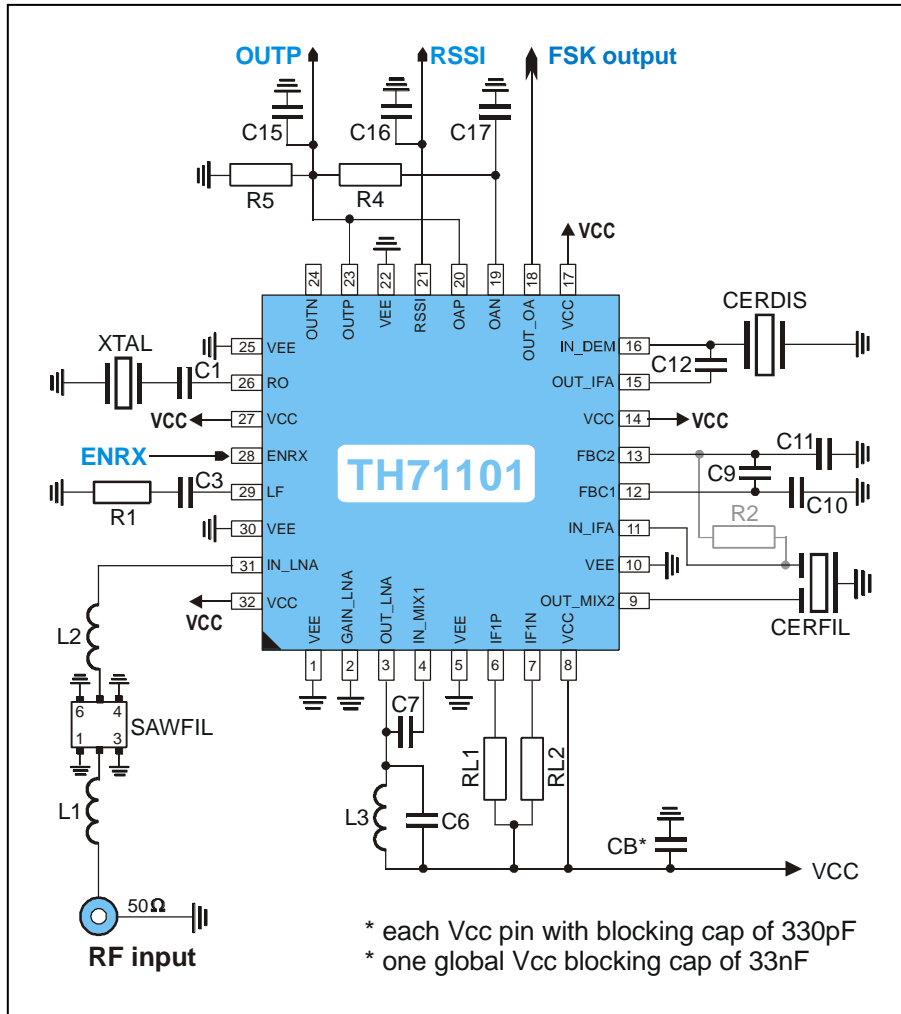


Fig. 2: Test circuit for FSK reception

#### Circuit Features

- Tolerates input frequency variations
- Well-suited for NRZ, Manchester and similar codes

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**4.1.2. Standard FSK Component List**

| Part   | Size            | Value<br>@ 433.92 MHz                            | Tolerance                   | Description  |
|--------|-----------------|--|-----------------------------|--|
| C1     | 0805            | 27 pF  | ±5%                         | crystal series capacitor   |
| C3     | 0603            | 1 nF   | ±10%                        | loop filter capacitor  |
| C6     | 0603            | 4.7 pF   | ±5%                         | LNA output tank capacitor  |
| C7     | 0603            | 2.2 pF   | ±5%                         | MIX1 input matching capacitor  |
| C9     | 0603            | 33 nF  | ±10%                        | IFA feedback capacitor   |
| C10    | 0603            | 1 nF   | ±10%                        | IFA feedback capacitor   |
| C11    | 0603            | 1 nF   | ±10%                        | IFA feedback capacitor   |
| C12    | 0805            | 10 pF  | ±5%                         | DEMODO phase-shift capacitor   |
| C15    | 0805            | 100 pF   | ±5%                         | demodulator output low-pass capacitor,<br>this value for data rates < 20 kbps NRZ        |
| C16    | 0805            | 1.5 nF   | ±10%                        | RSSI output low-pass capacitor   |
| C17    | 0805            | 10 nF  | ±10%                        | data slicer capacitor, this value for data rates > 0.8 kbps NRZ                          |
| R1     | 0603            | 10 kΩ  | ±5%                         | loop filter resistor   |
| R2     | 0603            | 330 Ω  | ±5%                         | optional CERFIL output matching resistor   |
| R4     | 0805            | 330 kΩ   | ±5%                         | data slicer resistor   |
| R5     | 0805            | 220 kΩ   | ±5%                         | loading resistor   |
| RL1    | 0805            | 470 Ω  | ±5%                         | MIX1 bias resistor   |
| RL2    | 0805            | 470 Ω  | ±5%                         | MIX1 bias resistor   |
| L1     | 0603            | 68 nH  | ±5%                         | SAW filter matching inductor from Würth-Elektronik<br>(WE-KI series), or equivalent part |
| L2     | 0603            | 82 nH  | ±5%                         |  |
| L3     | 0603            | 15 nH  | ±5%                         | LNA output tank inductor from Würth-Elektronik (WE-KI series),<br>or equivalent part     |
| XTAL   | SMD<br>6x3.5    | 26.45125 MHz<br>@ RF = 433.92 MHz                | ±25ppm cal.<br>±30ppm temp. | fundamental-mode crystal from<br>Telcona/Horizon or equivalent part                      |
| SAWFIL | SMD<br>3x3      | SAFCC433MBLOX00<br>(f <sub>0</sub> = 433.92 MHz) | B <sub>3dB</sub> = 840 kHz  | low-loss SAW filter from Murata, or equivalent part                                      |
| CERFIL | SMD<br>3.45x3.1 | SFECF10M7HA00                                    | B <sub>3dB</sub> = 180 kHz  | ceramic filter from Murata, or equivalent part   |
| CERDIS | SMD<br>4.5x2    | CDSCB10M7GA135                                   |                             | ceramic discriminator from Murata, or equivalent part                                    |

- For component values for other frequencies, please refer to the EVB descriptions

## 4.2. Narrow Band FSK Reception

### 4.2.1. Narrow Band FSK Application Circuit

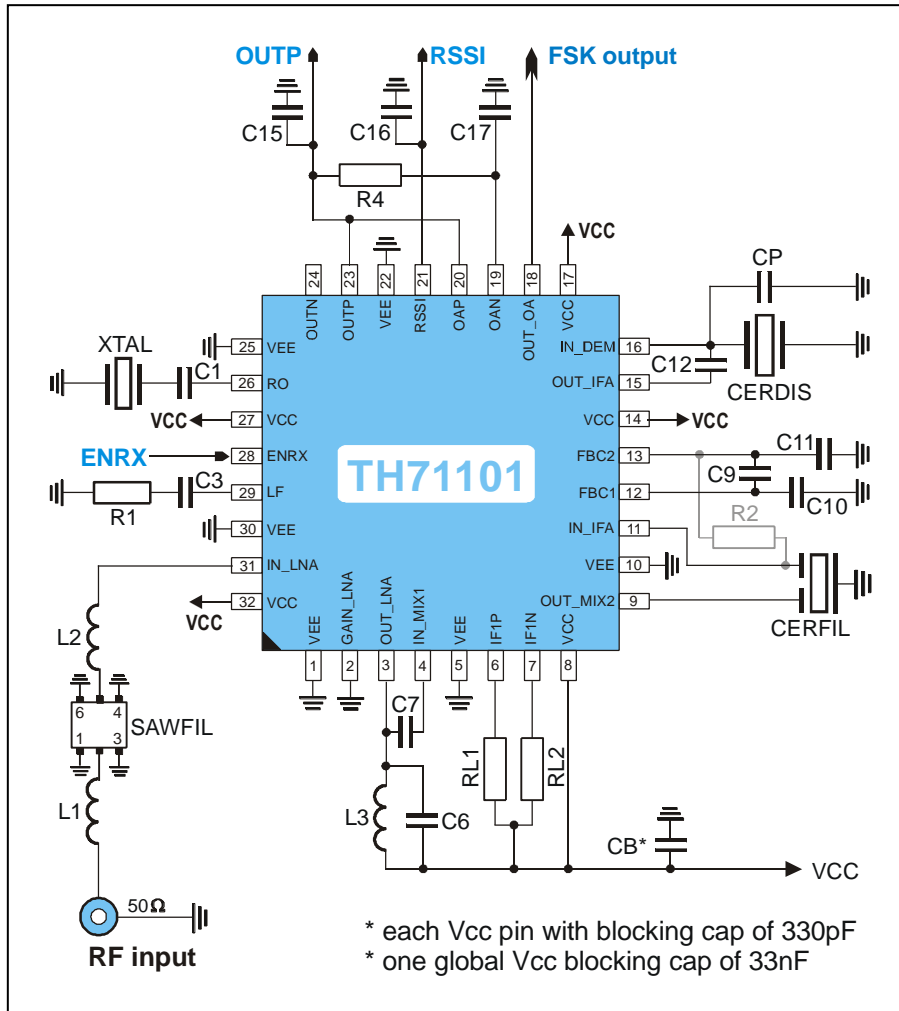


Fig. 3: Test circuit for FSK reception (narrow band)

### Circuit Features

- Applicable for narrow band FSK

**TH71101**

315/433MHz

FSK/ASK Receiver

**4.2.2. Narrow Band FSK Component List**

| Part   | Size           | Value<br>@ 433.92 MHz                            | Tolerance                   | Description  |
|--------|----------------|--|-----------------------------|--|
| C1     | 0805           | 27 pF  | ±5%                         | crystal series capacitor   |
| C3     | 0603           | 1 nF   | ±10%                        | loop filter capacitor  |
| C6     | 0603           | 4.7 pF   | ±5%                         | LNA output tank capacitor  |
| C7     | 0603           | 2.2 pF   | ±5%                         | MIX1 input matching capacitor  |
| C9     | 0603           | 33 nF  | ±10%                        | IFA feedback capacitor   |
| C10    | 0603           | 1 nF   | ±10%                        | IFA feedback capacitor   |
| C11    | 0603           | 1 nF   | ±10%                        | IFA feedback capacitor   |
| C12    | 0805           | 1.5 pF   | ±5%                         | DEMODO phase-shift capacitor   |
| C15    | 0805           | 220 pF   | ±5%                         | demodulator output low-pass capacitor,<br>this value for data rates < 10 kbps NRZ        |
| C16    | 0805           | 1.5 nF   | ±10%                        | RSSI output low-pass capacitor   |
| C17    | 0805           | 10 nF  | ±10%                        | data slicer capacitor, this value for data rates > 0.8 kbps NRZ                          |
| CP     | 0603           | 6.8 - 8.2 pF                                     | ±5%                         | ceramic resonator loading capacitor  |
| R1     | 0603           | 10 kΩ  | ±5%                         | loop filter resistor   |
| R2     | 0603           | 330 Ω  | ±5%                         | optional CERFIL output matching resistor   |
| R4     | 0805           | 330 kΩ   | ±5%                         | data slicer resistor   |
| RL1    | 0805           | 470 Ω  | ±5%                         | MIX1 bias resistor   |
| RL2    | 0805           | 470 Ω  | ±5%                         | MIX1 bias resistor   |
| L1     | 0603           | 68 nH  | ±5%                         | SAW filter matching inductor from Würth-Elektronik<br>(WE-KI series), or equivalent part |
| L2     | 0603           | 82 nH  | ±5%                         |  |
| L3     | 0603           | 15 nH  | ±5%                         | LNA output tank inductor from Würth-Elektronik (WE-KI series),<br>or equivalent part     |
| XTAL   | SMD<br>6x3.5   | 26.45125 MHz<br>@ RF = 433.92 MHz                | ±25ppm cal.<br>±30ppm temp. | fundamental-mode crystal from<br>Telcona/Horizon or equivalent part                      |
| SAWFIL | SMD<br>3x3     | SAFCC433MBLOX00<br>(f <sub>0</sub> = 433.92 MHz) | B <sub>3dB</sub> = 840 kHz  | low-loss SAW filter from Murata, or equivalent part                                      |
| CERFIL | Leaded<br>type | SFKLA10M7NL00                                    | B <sub>3dB</sub> = 30 kHz   | ceramic filter from Murata, or equivalent part   |
|        |                | SFVLA10M7LF00                                    | B <sub>3dB</sub> = 80 kHz   | optional, ceramic filter from Murata, or equivalent part                                 |
| CERDIS | SMD<br>4.5x2   | CDSCB10M7GA135                                   |                             | ceramic discriminator from Murata, or equivalent part                                    |

- For component values for other frequencies, please refer to the EVB descriptions

### 4.3. ASK Reception

#### 4.3.1. ASK Application Circuit

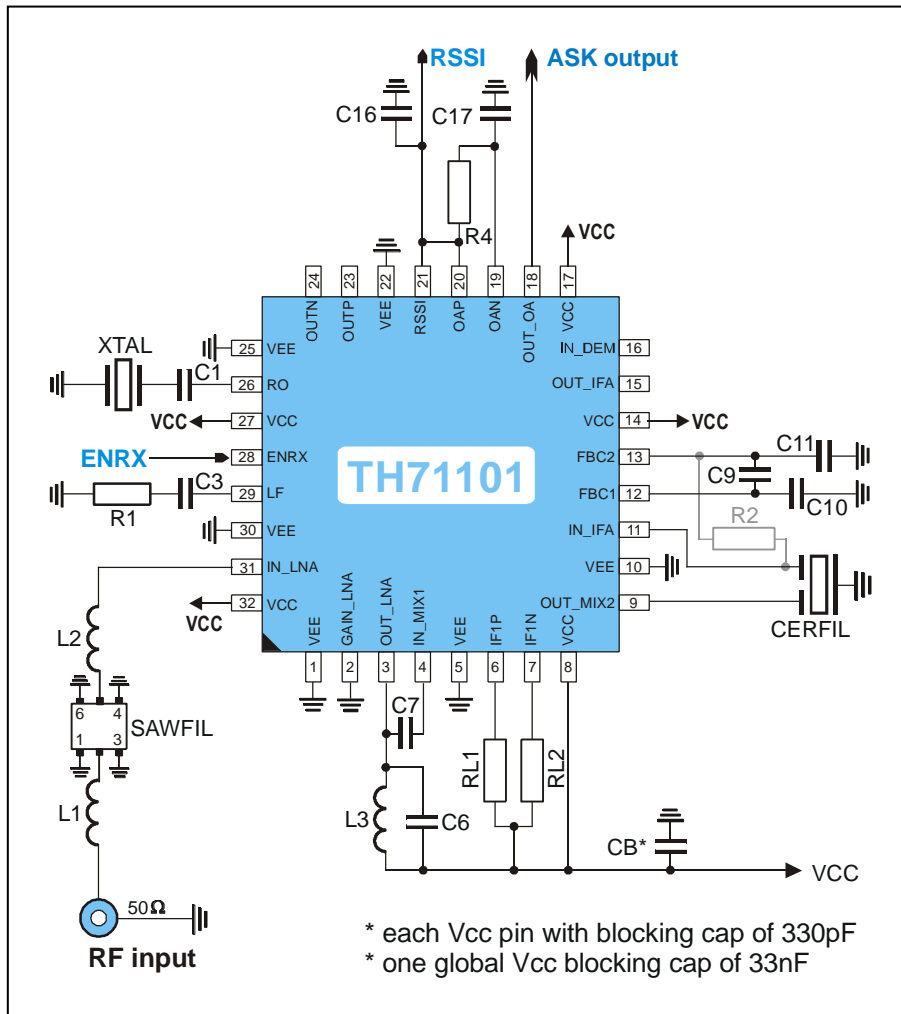


Fig. 5: Test circuit for ASK reception



**TH71101**

315/433MHz


FSK/ASK Receiver

**4.3.2. ASK Component List**

| Part   | Size            | Value<br>@ 433.92 MHz                            | Tolerance                   | Description  |
|--------|-----------------|--|-----------------------------|--|
| C1     | 0805            | 27 pF  | ±5%                         | crystal series capacitor   |
| C3     | 0603            | 1 nF   | ±10%                        | loop filter capacitor  |
| C6     | 0603            | 4.7 pF   | ±5%                         | LNA output tank capacitor  |
| C7     | 0603            | 2.2 pF   | ±5%                         | MIX1 input matching capacitor  |
| C9     | 0603            | 33 nF  | ±10%                        | IFA feedback capacitor   |
| C10    | 0603            | 1 nF   | ±10%                        | IFA feedback capacitor   |
| C11    | 0603            | 1 nF   | ±10%                        | IFA feedback capacitor   |
| C16    | 0805            | 1.5 nF   | ±10%                        | RSSI output low-pass capacitor,<br>this value for data rates < 10 kbps NRZ               |
| C17    | 0805            | 10 nF  | ±10%                        | data slicer capacitor, this value for data rates > 0.8 kbps NRZ                          |
| R1     | 0603            | 10 kΩ  | ±5%                         | loop filter resistor   |
| R2     | 0603            | 330 Ω  | ±5%                         | optional CERFIL output matching resistor   |
| R4     | 0805            | 330 kΩ   | ±5%                         | data slicer resistor   |
| RL1    | 0805            | 470 Ω  | ±5%                         | MIX1 bias resistor   |
| RL2    | 0805            | 470 Ω  | ±5%                         | MIX1 bias resistor   |
| L1     | 0603            | 68 nH  | ±5%                         | SAW filter matching inductor from Würth-Elektronik<br>(WE-KI series), or equivalent part |
| L2     | 0603            | 82 nH  | ±5%                         |  |
| L3     | 0603            | 15 nH  | ±5%                         | LNA output tank inductor from Würth-Elektronik (WE-KI series),<br>or equivalent part     |
| XTAL   | SMD<br>6x3.5    | 26.45125 MHz<br>@ RF = 433.92 MHz                | ±25ppm cal.<br>±30ppm temp. | fundamental-mode crystal from<br>Telcona/Horizon or equivalent part                      |
| SAWFIL | SMD<br>3x3      | SAFCC433MBLOX00<br>(f <sub>0</sub> = 433.92 MHz) | B <sub>3dB</sub> = 840 kHz  | low-loss SAW filter from Murata, or equivalent part                                      |
| CERFIL | SMD<br>3.45x3.1 | SFECF10M7HA00                                    | B <sub>3dB</sub> = 180 kHz  | ceramic filter from Murata, or equivalent part   |
|        | Leaded<br>type  | SFVLA10M7LF00                                    | B <sub>3dB</sub> = 80 kHz   | optional, ceramic filter from Murata, or equivalent part                                 |

- For component values for other frequencies, please refer to the EVB descriptions

## 5. Package Description

 The device TH71101 is RoHS compliant.

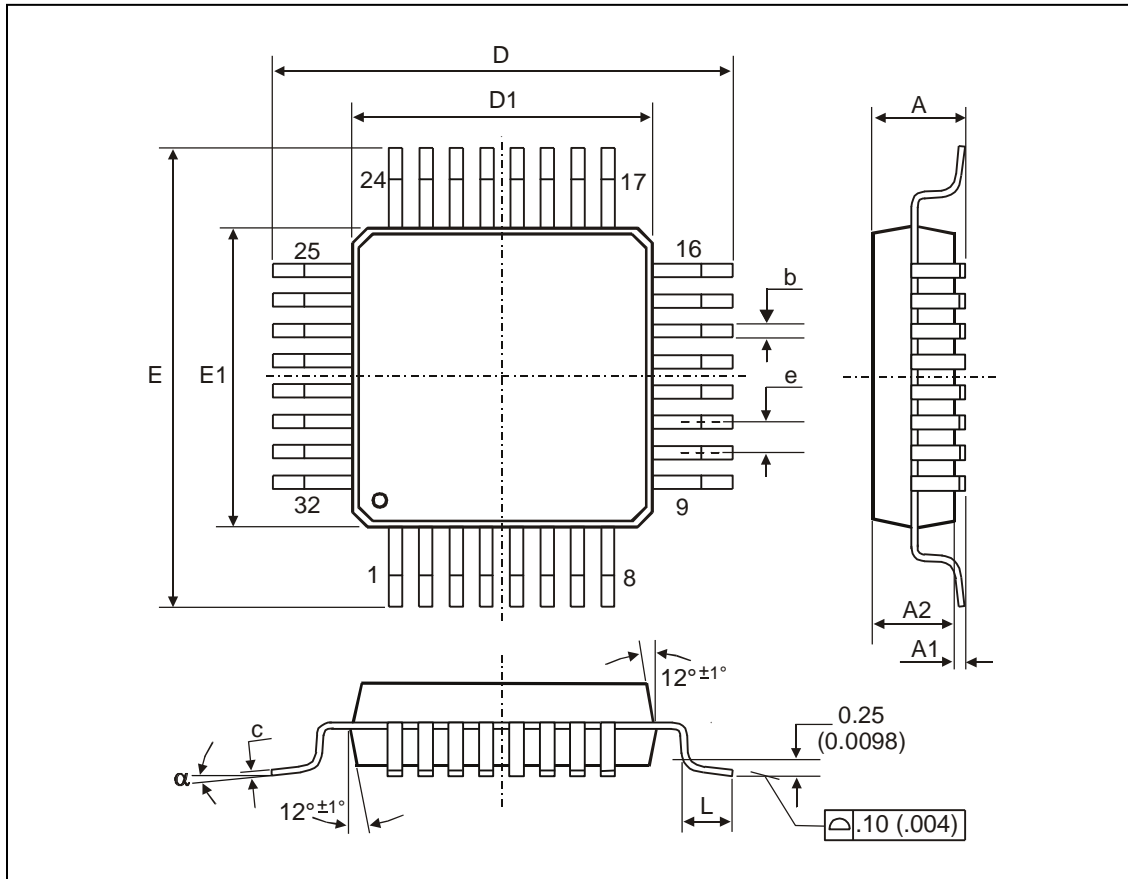


Fig. 6: LQFP32 (Low profile Quad Flat Package)

| All Dimension in mm, coplanarity < 0.1mm    |        |       |       |       |       |       |       |        |       |          |
|---|--------|-------|-------|-------|-------|-------|-------|--------|-------|----------|
|   | E1, D1 | E, D  | A     | A1    | A2    | e     | b     | c      | L     | $\alpha$ |
| min   | 7.00   | 9.00  | 1.40  | 0.05  | 1.35  | 0.8   | 0.30  | 0.09   | 0.45  | 0°       |
| max   |        |       | 1.60  | 0.15  | 1.45  |       | 0.45  | 0.20   |       | 0.75     |
| All Dimension in inch, coplanarity < 0.004" |        |       |       |       |       |       |       |        |       |          |
|   | E1, D1 | E, D  | A     | A1    | A2    | e     | b     | c      | L     | $\alpha$ |
| min   | 0.276  | 0.354 | 0.055 | 0.002 | 0.053 | 0.031 | 0.012 | 0.0035 | 0.018 | 0°       |
| max   |        |       | 0.063 | 0.006 | 0.057 |       | 0.018 | 0.0079 |       | 0.030    |

### 5.1. Soldering Information

- The device TH71101 is qualified for MSL3 with soldering peak temperature 260 deg C according to JEDEC J-STD-20.

## 6. Standard information regarding manufacturability of Melexis products with different soldering processes

Our products are classified and qualified regarding soldering technology, solderability and moisture sensitivity level according to following test methods:

### Reflow Soldering SMD's (Surface Mount Devices)

- IPC/JEDEC J-STD-020  
Moisture/Reflow Sensitivity Classification for Nonhermetic Solid State Surface Mount Devices (classification reflow profiles according to table 5-2)
- EIA/JEDEC JESD22-A113  
Preconditioning of Nonhermetic Surface Mount Devices Prior to Reliability Testing (reflow profiles according to table 2)

### Wave Soldering SMD's (Surface Mount Devices) and THD's (Through Hole Devices)

- EN60749-20  
Resistance of plastic- encapsulated SMD's to combined effect of moisture and soldering heat
- EIA/JEDEC JESD22-B106 and EN60749-15  
Resistance to soldering temperature for through-hole mounted devices

### Iron Soldering THD's (Through Hole Devices)

- EN60749-15  
Resistance to soldering temperature for through-hole mounted devices

### Solderability SMD's (Surface Mount Devices) and THD's (Through Hole Devices)

- EIA/JEDEC JESD22-B102 and EN60749-21  
Solderability

For all soldering technologies deviating from above mentioned standard conditions (regarding peak temperature, temperature gradient, temperature profile etc) additional classification and qualification tests have to be agreed upon with Melexis.

The application of Wave Soldering for SMD's is allowed only after consulting Melexis regarding assurance of adhesive strength between device and board.

Melexis is contributing to global environmental conservation by promoting **lead free** solutions. For more information on qualifications of **RoHS** compliant products (RoHS = European directive on the Restriction Of the use of certain Hazardous Substances) please visit the quality page on our website: <http://www.melexis.com/quality.aspx>

## 7. ESD Precautions

Electronic semiconductor products are sensitive to Electro Static Discharge (ESD). Always observe Electro Static Discharge control procedures whenever handling semiconductor products.

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