

## Features

- ☐ Single superhet architecture for low external component count
- ☐ FSK for digital data and FM reception for analog signal transmission
- ☐ FM/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
- ☐ Surface mount package LQFP32

## Ordering Information

| Part No. | Temperature Code   | Package Code |
|----------|--------------------|--------------|
| TH71101  | E (-40 °C to 85°C) | NE (LQFP32)  |

## Application Examples

- ☐ General digital and analog 315 MHz or 433 MHz ISM band usage
- ☐ Low-power telemetry
- ☐ Alarm and security systems
- ☐ Keyless car and central locking
- ☐ Pagers

## Technical Data Overview

- ☐ Input frequency range: 300 MHz to 450 MHz
  - ☐ Power supply range: 2.5 V to 5.5 V at 315 MHz and 2.7 V to 5.5 V at 433 MHz
  - ☐ Temperature range: -40 °C to +85 °C
  - ☐ Operating current: 6.5 mA at low gain and 8.2 mA at high gain mode
  - ☐ Standby current: < 100 nA
  - ☐ Sensitivity: -111 dBm<sup>1)</sup> with 40 kHz IF filter BW (incl. SAW front-end filter loss)
  - ☐ Sensitivity: -104 dBm<sup>2)</sup> with 150 kHz IF filter BW (incl. SAW front-end filter loss)
  - ☐ Range of IF: 455 kHz to 21.4 MHz
  - ☐ Maximum input level: -10 dBm at ASK and 0 dBm at FSK
  - ☐ Image rejection: > 55 dB (e.g. with SAW front-end filter and at 10.7 MHz IF)
  - ☐ Spurious emission: < -70 dBm
  - ☐ Input frequency acceptance: ±50 kHz (with AFC option)
  - ☐ RSSI range: 70 dB
  - ☐ Frequency deviation range: ±5 kHz to ±120 kHz
  - ☐ Maximum data rate: 80 kbit/s NRZ
  - ☐ Maximum analog modulation frequency: 15 kHz
- <sup>1)</sup> at ± 8 kHz FSK deviation, BER = 3·10<sup>-3</sup> and phase-coincidence demodulation
- <sup>2)</sup> at ± 50 kHz FSK deviation, BER = 3·10<sup>-3</sup> and phase-coincidence demodulation

## General Description

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 (DEMODO) 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

With the TH71101 receiver chip, various circuit configurations can be arranged in order to meet a number of different customer requirements. For FM/FSK reception the IF tank used in the phase coincidence demodulator can be constituted either by a ceramic resonator or an LC tank (optionally with a varactor diode to create an AFC circuit). In ASK configuration, the RSSI signal is feed to an ASK detector, which is constituted by the operational amplifier.

| Demodulation    | Type of receiver                              |
|-----------------|-----------------------------------------------|
| <b>FM / FSK</b> | narrow-band RX with ceramic demodulation tank |
| <b>FM / FSK</b> | wide-band RX with LC demodulation tank        |
| <b>ASK</b>      | RX with RSSI-based demodulation               |

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 frontend 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 frontend 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.

Block Diagram

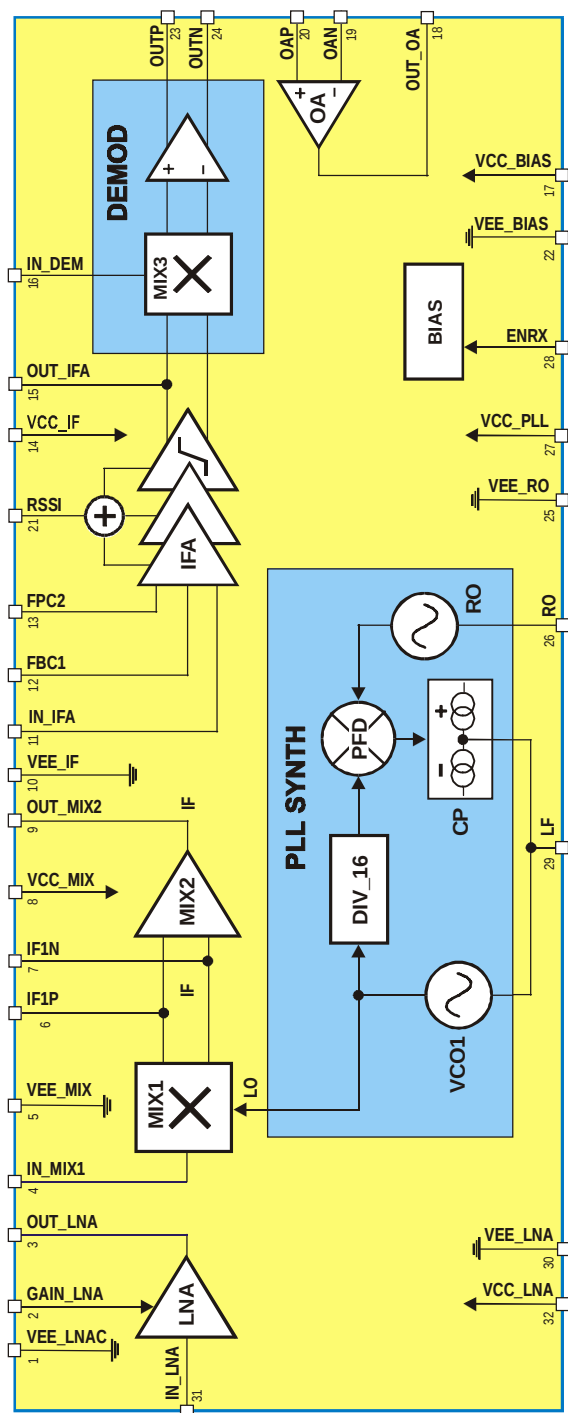


Fig. 1: TH71101 block diagram

## Frequency Planning

Frequency planning is straightforward for single-conversion applications because there is only one IF that might 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.

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), the IF and the LO frequency respectively, for a given RF.

| 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       | $RF - 2IF$       | $RF + 2IF$       |

The following table depicts crystal, LO and image signals considering the examples of 315 MHz and 433.6 MHz RF reception at IF = 10.7 MHz.

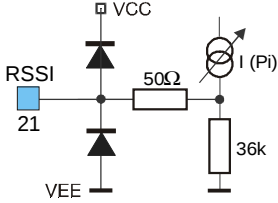
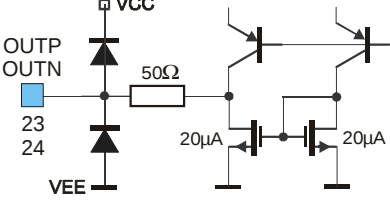
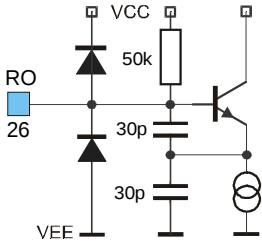
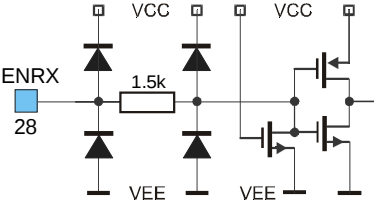
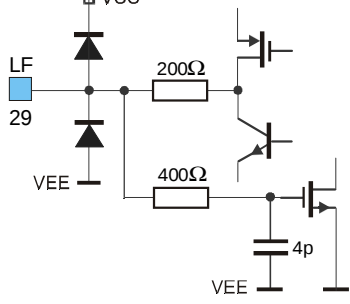
| Signal type    | RF = 315 MHz | RF = 315 MHz    | RF = 433.6 MHz  | RF = 433.6 MHz |
|----------------|--------------|-----------------|-----------------|----------------|
| Injection type | low          | high            | low             | high           |
| REF / MHz      | 19.01875     | <b>20.35625</b> | <b>26.43125</b> | 27.76875       |
| LO / MHz       | 304.3        | <b>325.7</b>    | <b>422.9</b>    | 444.3          |
| RF image / MHz | 293.6        | <b>336.4</b>    | <b>412.2</b>    | 455.0          |

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 430 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 433.6 MHz, respectively.

## Pin Definition and Description

| 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 (CMOS input with hysteresis)                                         |
| 4       | IN_MIX1  | analog input  |                      | MIX1 input, approx. 33Ω single-ended                                                  |
| 5       | VEE_MIX  | ground        |                      | LNA biasing ground                                                                    |
| 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        |                      | MIX1 and MIX2 positive supply                                                         |
| 9       | OUT_MIX2 | analog output |                      | MIX2 output, approx. 330Ω output impedance                                            |
| 10      | VEE_IF   | ground        |                      | ground for MIX2, 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 for IFA, DEMOD                                                                   |
| 15      | OUT_IFA  | analog I/O    |                      | IFA output and MIX3 input (of DEMOD)                                                             |
| 16      | IN_DEM   | analog input  |                      | DEMOM 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, input voltage limited to approx. 0.7 V <sub>pp</sub> between pins OAP and OAN |
| 20      | OAP      | analog input  |                      | negative OA input, input voltage limited to approx. 0.7 V <sub>pp</sub> between pins OAP and OAN |

| 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 for general bias system and OA                                  |
| 23      | OUTP     | analog output |    | FSK/FM positive output, output impedance of 100kΩ to 300kΩ             |
| 24      | OUTN     | analog        |                                                                                      | FSK/FM negative output, output impedance of 100kΩ to 300kΩ             |
| 25      | VEE_RO   | ground        |                                                                                      | ground of dividers, PFD and RO                                         |
| 26      | RO       | analog input  |    | RO input, Colpitts type oscillator with internal feed-back capacitors  |
| 27      | VCC_PLL  | supply        |                                                                                      | positive supply of RO, DIV, PFD and charge pump                        |
| 28      | ENRX     | digital input |  | mode control input (CMOS Input)                                        |
| 29      | LF       | analog output |   | charge pump output and VCO1 control input                              |
| 30      | VEE_LNA  | ground        |                                                                                      | LNA biasing ground                                                     |
| 32      | VCC_LNA  | supply        |                                                                                      | positive supply of LNA biasing                                         |

## Technical Data

### Mode Configurations

| ENRX | Mode | Description        |
|------|------|--------------------|
| 0    | SBY  | standby mode       |
| 1    | ON   | entire chip active |

**Note:** ENRX are pulled down internally

### LNA Gain Control

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

**Note:** hysteresis between gain modes to ensure stability

### Absolute Maximum Ratings

| Parameter               | Symbol            | Condition / Note                                                                              | Min          | Max                  | Unit   |
|-------------------------|-------------------|-----------------------------------------------------------------------------------------------|--------------|----------------------|--------|
| Supply voltage          | V <sub>CC</sub>   |                                                                                               | 0            | 7.0                  | V      |
| Input voltage           | V <sub>IN</sub>   |                                                                                               | - 0.3        | V <sub>CC</sub> +0.3 | V      |
| Input RF level          | P <sub>imax</sub> | no damage                                                                                     |              | 10                   | dBm    |
| Storage temperature     | T <sub>STG</sub>  |                                                                                               | -40          | +125                 | °C     |
| Electrostatic discharge | ESD               | human body model,<br>MIL STD 883D<br>method 3015.7, all pins<br>except OUT_IFA<br>pin OUT_IFA | -500<br>-500 | +500<br>+250         | V<br>V |

### Normal Operating Conditions

| Parameter                 | Symbol               | Condition                | Min | Max  | Unit   |
|---------------------------|----------------------|--------------------------|-----|------|--------|
| Supply voltage at 315 MHz | V <sub>CC, 315</sub> | f <sub>i</sub> ≤ 400 MHz | 2.5 | 5.5  | V      |
| Supply voltage at 433 MHz | V <sub>CC, 433</sub> | f <sub>i</sub> > 400 MHz | 2.7 | 5.5  | V      |
| Operating temperature     | T <sub>a</sub>       |                          | -40 | +85  | °C     |
| Input frequency           | f <sub>i</sub>       |                          | 300 | 450  | MHz    |
| Frequency deviation       | Δf                   | at FM or FSK             | ±5  | ±120 | kHz    |
| FSK data rate             | R <sub>FSK</sub>     | NRZ                      |     | 40   | kbit/s |
| FM bandwidth              | f <sub>m</sub>       |                          |     | 15   | kHz    |
| ASK data rate             | R <sub>ASK</sub>     | NRZ                      |     | 80   | kbit/s |

## 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 |
|-----------------------------------|------------------|---------------------------------------------|------|-----|------|------|
| Standby current                   | $I_{SBY}$        | ENRX=0                                      |      |     | 100  | nA   |
| Total supply current at low gain  | $I_{cc, low}$    | ENRX=1,<br>LNA at LOW GAIN                  | 5.0  | 6.5 | 8.0  | mA   |
| Total supply current at high gain | $I_{cc, high}$   | ENRX=1,<br>LNA at HIGH GAIN                 | 6.5  | 8.2 | 10.0 | mA   |
| Opamp input offset voltage        | $V_{offs}$       |                                             | -20  |     | 20   | mV   |
| Opamp input offset current        | $I_{offs}$       | $I_{OAP} - I_{OAN}$                         | -50  |     | 50   | nA   |
| Opamp input bias current          | $I_{bias}$       | $0.5 * (I_{OAP} + I_{OAN})$                 | -100 |     | 100  | nA   |
| RSSI voltage at low input level   | $V_{RSSI, low}$  | $P_i = -65\text{ dBm}$ ,<br>LNA at LOW GAIN | 0.5  | 1.0 | 1.5  | V    |
| RSSI voltage at high input level  | $V_{RSSI, high}$ | $P_i = -35\text{ dBm}$ ,<br>LNA at LOW GAIN | 1.25 | 1.9 | 2.45 | V    |

## AC System Characteristics

all parameters under normal operating conditions, unless otherwise stated;  
all parameters based on test circuits for FSK (Fig. 2), FM (Fig. 4) and ASK (Fig. 5), respectively;  
typical values at  $T_a = 23\text{ }^{\circ}\text{C}$  and  $V_{cc} = 3\text{ V}$ , RF at 433.6 MHz, second IF at 10.7 MHz

| Parameter                                | Symbol             | Condition                                                                                           | Min | Typ  | Max                      | Unit          |
|------------------------------------------|--------------------|-----------------------------------------------------------------------------------------------------|-----|------|--------------------------|---------------|
| start-up time – FSK/FM                   | $T_{FSK}$          | ENRX from 0 to 1,<br>valid data at output                                                           |     |      | 0.9                      | ms            |
| start-up time – ASK                      | $T_{ASK}$          | depends on ASK<br>detector time constant,<br>valid data at output                                   |     |      | $R3 \cdot C12 + T_{FSK}$ | ms            |
| input sensitivity – FSK<br>(narrow band) | $P_{min, n}$       | $B_{IF2} = 40\text{ kHz}$<br>$\Delta f = \pm 15\text{ kHz}$ (FSK/FM)<br>$BER \leq 3 \cdot 10^{-3}$  |     | -111 |                          | dBm           |
| input sensitivity – FSK<br>(wide band)   | $P_{min, w}$       | $B_{IF2} = 150\text{ kHz}$<br>$\Delta f = \pm 50\text{ kHz}$ (FSK/FM)<br>$BER \leq 3 \cdot 10^{-3}$ |     | -104 |                          | dBm           |
| input sensitivity – ASK<br>(narrow band) | $P_{minA, n}$      | $B_{IF2} = 40\text{ kHz}$<br>$BER \leq 3 \cdot 10^{-3}$                                             |     | -109 |                          | dBm           |
| input sensitivity – ASK<br>(wide band)   | $P_{minA, w}$      | $B_{IF2} = 150\text{ kHz}$<br>$BER \leq 3 \cdot 10^{-3}$                                            |     | -106 |                          | dBm           |
| maximum input signal – FSK/FM            | $P_{max, FM}$      | $BER \leq 3 \cdot 10^{-3}$<br>LNA at LOW GAIN                                                       |     | 0    |                          | dBm           |
| maximum input signal – ASK               | $P_{max, ASK}$     | $BER \leq 3 \cdot 10^{-3}$<br>LNA at LOW GAIN                                                       |     | -10  |                          | dBm           |
| spurious emission                        | $P_{spur}$         |                                                                                                     |     |      | -70                      | dBm           |
| image rejection                          | $\Delta P_{imag}$  |                                                                                                     |     | 55   |                          | dB            |
| blocking immunity                        | $\Delta P_{block}$ | $\Delta f_{block} > \pm 2\text{ MHz}$ , note 1                                                      |     | 57   |                          | dB            |
| VCO gain                                 | $K_{VCO}$          |                                                                                                     |     | 250  |                          | MHz/V         |
| Charge pump current                      | $I_{CP}$           |                                                                                                     |     | 60   |                          | $\mu\text{A}$ |

**Notes:** 1. desired signal with FSK/FM or ASK modulation, CW blocking signal

## Test Circuits

### FSK Reception

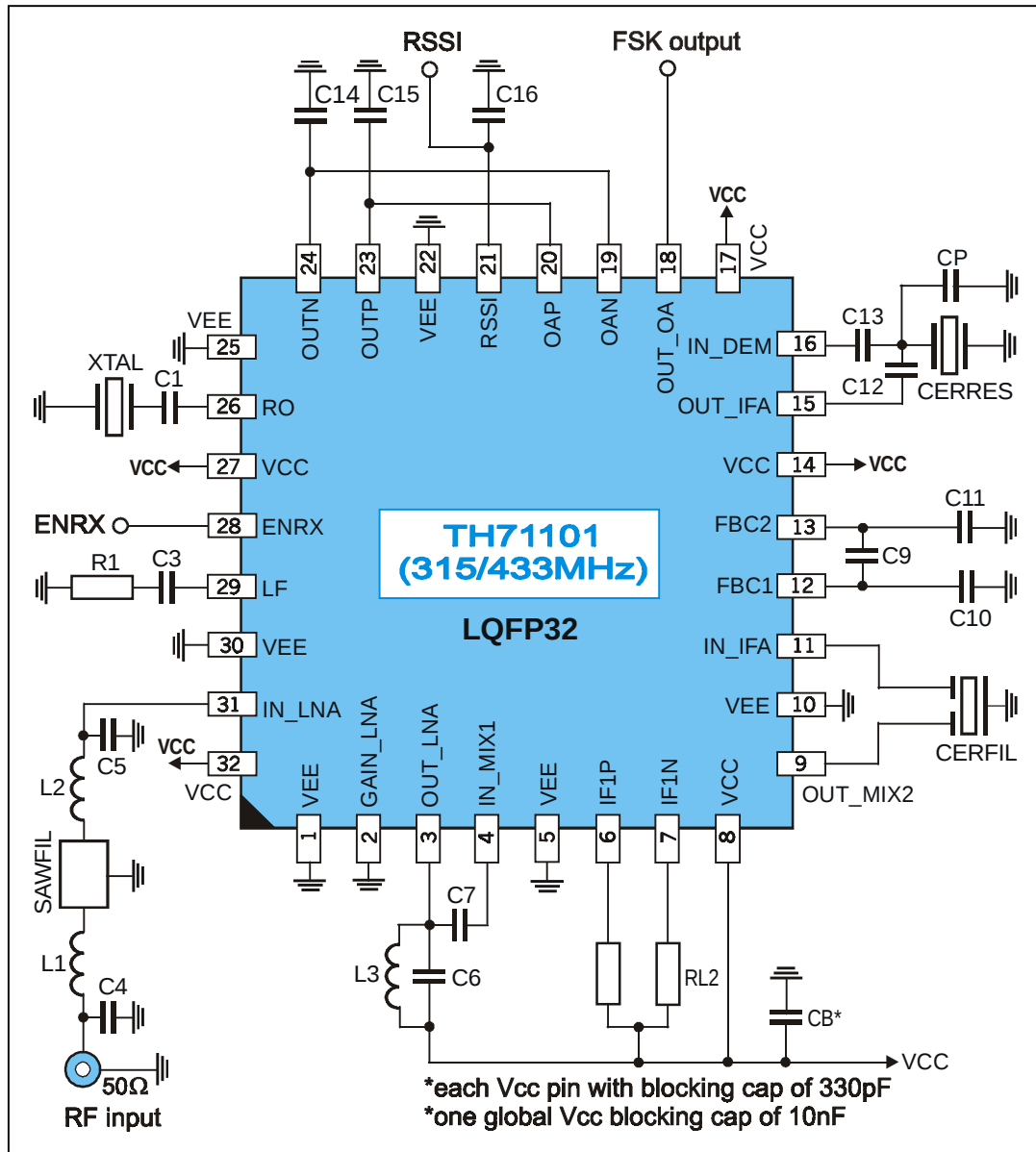


Fig. 2: Test circuit for FSK reception

FSK test circuit component list to Fig. 2

| Part   | Size        | Value / Type                                   | Tolerance                                                               | Description                                                                                                         |
|--------|-------------|------------------------------------------------|-------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------|
| C1     | 0805        | 15 pF                                          | ±10%                                                                    | crystal series capacitor                                                                                            |
| C3     | 0805        | 1 nF                                           | ±10%                                                                    | loop filter capacitor                                                                                               |
| C4     | 0603        | 3.3 pF                                         | ±5%                                                                     | capacitor to match to SAW filter input                                                                              |
| C5     | 0603        | 3.3 pF                                         | ±5%                                                                     | capacitor to match to SAW filter output                                                                             |
| C6     | 0603        | 4.7 pF                                         | ±5%                                                                     | LNA output tank capacitor                                                                                           |
| C7     | 0603        | 2.2 pF                                         | ±5%                                                                     | MIX1 input matching capacitor                                                                                       |
| C9     | 0805        | 33 nF                                          | ±10%                                                                    | IFA feedback capacitor                                                                                              |
| C10    | 0603        | 1 nF                                           | ±10%                                                                    | IFA feedback capacitor                                                                                              |
| C11    | 0603        | 1 nF                                           | ±10%                                                                    | IFA feedback capacitor                                                                                              |
| C12    | 0603        | 1.5 pF                                         | ±5%                                                                     | DEMODO phase-shift capacitor                                                                                        |
| C13    | 0603        | 680 pF                                         | ±10%                                                                    | DEMODO coupling capacitor                                                                                           |
| CP     | 0805        | 10 – 12 pF                                     | ±5%                                                                     | CERRES parallel capacitor                                                                                           |
| C14    | 0805        | 10 – 47 pF                                     | ±5%                                                                     | demodulator output low-pass capacitor, depending on data rate                                                       |
| C15    | 0805        | 10 – 47 pF                                     | ±5%                                                                     | demodulator output low-pass capacitor, depending on data rate                                                       |
| C16    | 0603        | 330 pF                                         | ±10%                                                                    | RSSI output low-pass capacitor                                                                                      |
| R1     | 0805        | 10 kΩ                                          | ±10%                                                                    | loop filter resistor                                                                                                |
| RL1    | 0805        | 470 Ω                                          | ±5%                                                                     | MIX1 bias resistor                                                                                                  |
| RL2    | 0805        | 470 Ω                                          | ±5%                                                                     | MIX1 bias resistor                                                                                                  |
| L1     | 0603        | 33 nH                                          | ±5%                                                                     | inductor to match SAW filter                                                                                        |
| L2     | 0603        | 33 nH                                          | ±5%                                                                     | inductor to match SAW filter                                                                                        |
| L3     | 0603        | 15 nH                                          | ±5%                                                                     | LNA output tank inductor                                                                                            |
| XTAL   | HC49 SMD    | <b>26.43125 MHz</b><br>@ RF = 433.6 MHz        | ±25ppm calibration<br>±30ppm temp.                                      | fundamental-mode crystal, C <sub>load</sub> = 10 pF to 15pF, C <sub>0, max</sub> = 7 pF, R <sub>m, max</sub> = 50 Ω |
| SAWFIL | QCC8C       | <b>B3555</b><br>@ RF = 433.6 MHz               | B <sub>3dB</sub> = 860 kHz<br>±100 kHz<br>(f <sub>0</sub> = 433.92 MHz) | low-loss SAW filter from EPCOS                                                                                      |
| CERFIL | Leaded type | SFE10.7MFP<br>@ B <sub>IF2</sub> = 40 kHz      | TBD                                                                     | ceramic filter from Murata                                                                                          |
|        | SMD type    | SFECV10.7MJS-A<br>@ B <sub>IF2</sub> = 150 kHz | ±40 kHz                                                                 |                                                                                                                     |
| CERRES | SMD type    | CDACV10.7MG18-A                                |                                                                         | ceramic demodulator tank from Murata                                                                                |

NIP – not in place, may be used optionally

**FSK Circuit with AFC and Ceramic Resonator Tolerance Compensation**

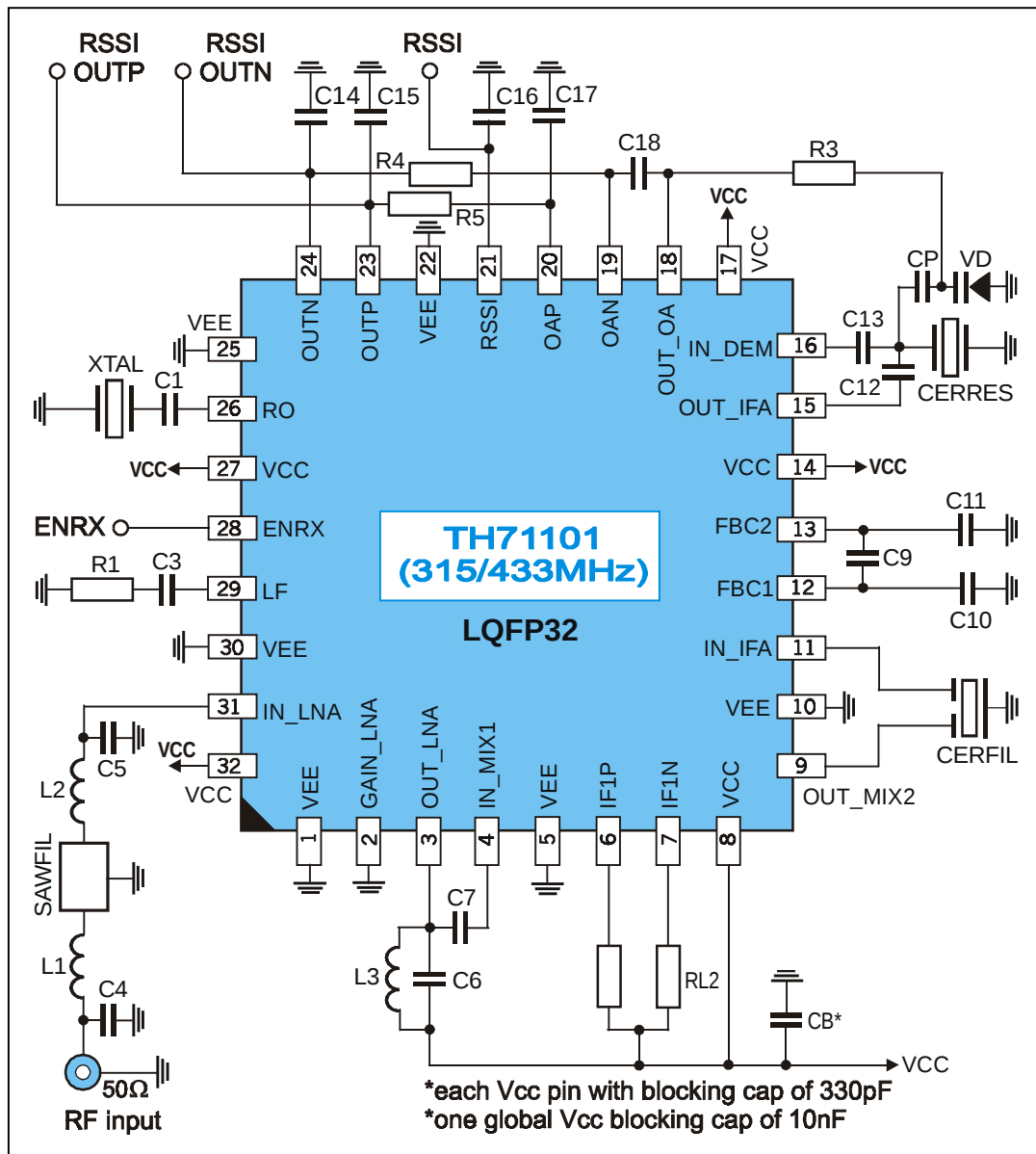


Fig. 3: Test circuit for FSK with AFC and resonator compensation

**Circuit Feature**

- ❑ Improves input frequency acceptance range up to  $RF_{nom} \pm 50$  kHz
- ❑ Eliminates calibration tolerances of ceramic resonator
- ❑ Eliminates temperature tolerances of ceramic resonator
- ❑ Non-inverted and inverted CMOS-compatible outputs

FSK test circuit with AFC component list to Fig. 3

| Part   | Size        | Value / Type                                   | Tolerance                                                               | Description                                                                                                         |
|--------|-------------|------------------------------------------------|-------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------|
| C1     | 0805        | 15 pF                                          | ±10%                                                                    | crystal series capacitor                                                                                            |
| C3     | 0805        | 1 nF                                           | ±10%                                                                    | loop filter capacitor                                                                                               |
| C4     | 0603        | 3.3 pF                                         | ±5%                                                                     | capacitor to match to SAW filter input                                                                              |
| C5     | 0603        | 3.3 pF                                         | ±5%                                                                     | capacitor to match to SAW filter output                                                                             |
| C6     | 0603        | 4.7 pF                                         | ±5%                                                                     | LNA output tank capacitor                                                                                           |
| C7     | 0603        | 2.2 pF                                         | ±5%                                                                     | MIX1 input matching capacitor                                                                                       |
| C9     | 0805        | 33 nF                                          | ±10%                                                                    | IFA feedback capacitor                                                                                              |
| C10    | 0603        | 1 nF                                           | ±10%                                                                    | IFA feedback capacitor                                                                                              |
| C11    | 0603        | 1 nF                                           | ±10%                                                                    | IFA feedback capacitor                                                                                              |
| C12    | 0603        | 1.5 pF                                         | ±5%                                                                     | DEMODO phase-shift capacitor                                                                                        |
| C13    | 0603        | 680 pF                                         | ±10%                                                                    | DEMODO coupling capacitor                                                                                           |
| CP     | 0805        | 27 pF                                          | ±5%                                                                     | ceramic resonator loading capacitor                                                                                 |
| C14    | 0805        | 10 – 47 pF                                     | ±5%                                                                     | demodulator output low-pass capacitor, depending on data rate                                                       |
| C15    | 0805        | 10 – 47 pF                                     | ±5%                                                                     | demodulator output low-pass capacitor, depending on data rate                                                       |
| C16    | 0603        | 330 pF                                         | ±10%                                                                    | RSSI output low-pass capacitor                                                                                      |
| C17    |             | 33 nF                                          | ±10%                                                                    | integrator capacitor, fixed                                                                                         |
| C18    | 0805        | 33 nF                                          | ±10%                                                                    | integrator capacitor, @ 0.5 to 2 kbit/s NRZ                                                                         |
|        |             | 10 nF                                          |                                                                         | integrator capacitor, @ 2 to 20 kbit/s NRZ                                                                          |
|        |             | 1 nF                                           |                                                                         | integrator capacitor, @ 20 to 40 kbit/s NRZ                                                                         |
| R1     | 0805        | 10 kΩ                                          | ±10%                                                                    | loop filter resistor                                                                                                |
| R3     | 0805        | 100 kΩ                                         | ±10%                                                                    | varactor diode biasing resistor                                                                                     |
| R4     | 0805        | 680 kΩ                                         | ±10%                                                                    | integrator resistor                                                                                                 |
| R5     | 0805        | 680 kΩ                                         | ±10%                                                                    | integrator resistor                                                                                                 |
| RL1    | 0805        | 470 Ω                                          | ±5%                                                                     | MIX1 bias resistor                                                                                                  |
| RL2    | 0805        | 470 Ω                                          | ±5%                                                                     | MIX1 bias resistor                                                                                                  |
| L1     | 0603        | 33 nH                                          | ±5%                                                                     | inductor to match SAW filter                                                                                        |
| L2     | 0603        | 33 nH                                          | ±5%                                                                     | inductor to match SAW filter                                                                                        |
| L3     | 0603        | 15 nH                                          | ±5%                                                                     | LNA output tank inductor                                                                                            |
| VD     | SOD-323     | BB535                                          |                                                                         | varactor diode from Infineon                                                                                        |
| XTAL   | HC49 SMD    | <b>26.43125 MHz</b><br>@ RF = 433.6 MHz        | ±25ppm calibration<br>±30ppm temp.                                      | fundamental-mode crystal, C <sub>load</sub> = 10 pF to 15pF, C <sub>0, max</sub> = 7 pF, R <sub>m, max</sub> = 50 Ω |
| SAWFIL | QCC8C       | <b>B3555</b><br>@ RF = 433.6 MHz               | B <sub>3dB</sub> = 860 kHz<br>±100 kHz<br>(f <sub>0</sub> = 433.92 MHz) | low-loss SAW filter from EPCOS                                                                                      |
| CERFIL | Leaded type | SFE10.7MFP<br>@ B <sub>IF2</sub> = 40 kHz      | TBD                                                                     | ceramic filter from Murata                                                                                          |
|        | SMD type    | SFECV10.7MJS-A<br>@ B <sub>IF2</sub> = 150 kHz | ±40 kHz                                                                 |                                                                                                                     |
| CERRES | SMD type    | CDACV10.7MG18-A                                |                                                                         | ceramic demodulator tank from Murata                                                                                |

NIP – not in place, may be used optionally

## FM Reception

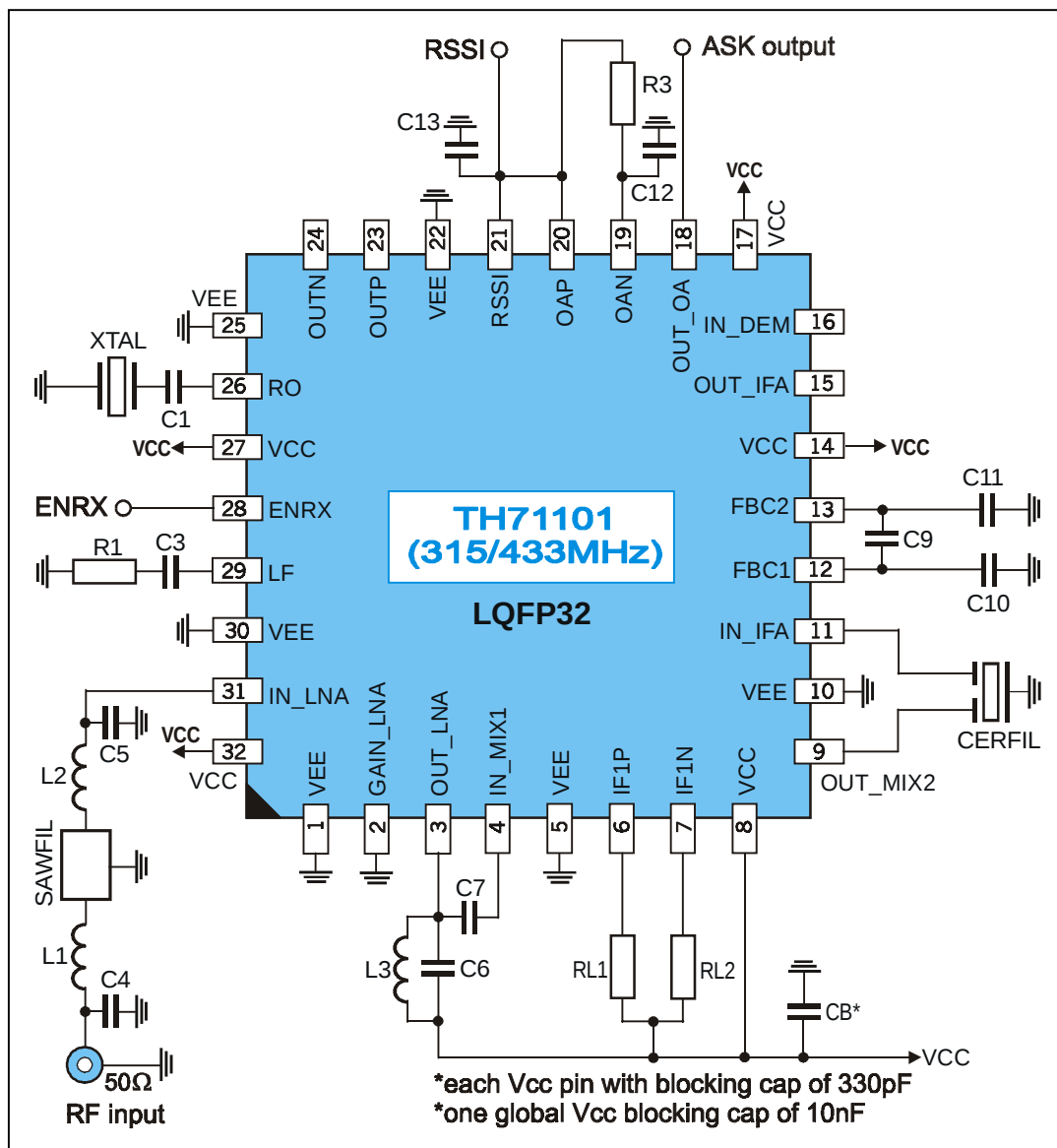


Fig. 4: Test circuit for FM reception

FM test circuit component list to Fig. 4

| Part   | Size        | Value / Type                                   | Tolerance                                                               | Description                                                                                                         |
|--------|-------------|------------------------------------------------|-------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------|
| C1     | 0805        | 15 pF                                          | ±10%                                                                    | crystal series capacitor                                                                                            |
| C3     | 0805        | 1 nF                                           | ±10%                                                                    | loop filter capacitor                                                                                               |
| C4     | 0603        | 3.3 pF                                         | ±5%                                                                     | capacitor to match to SAW filter input                                                                              |
| C5     | 0603        | 3.3 pF                                         | ±5%                                                                     | capacitor to match to SAW filter output                                                                             |
| C6     | 0603        | 4.7 pF                                         | ±5%                                                                     | LNA output tank capacitor                                                                                           |
| C7     | 0603        | 2.2 pF                                         | ±5%                                                                     | MIX1 input matching capacitor                                                                                       |
| C9     | 0805        | 33 nF                                          | ±10%                                                                    | IFA feedback capacitor                                                                                              |
| C10    | 0603        | 1 nF                                           | ±10%                                                                    | IFA feedback capacitor                                                                                              |
| C11    | 0603        | 1 nF                                           | ±10%                                                                    | IFA feedback capacitor                                                                                              |
| C12    | 0603        | 1.5 pF                                         | ±5%                                                                     | DEMODO phase-shift capacitor                                                                                        |
| C13    | 0603        | 680 pF                                         | ±10%                                                                    | DEMODO coupling capacitor                                                                                           |
| CP     | 0805        | 10 – 12 pF                                     | ±5%                                                                     | CERRES parallel capacitor                                                                                           |
| C14    | 0805        | 100 pF                                         | ±5%                                                                     | sallen-Key low-pass filter capacitor, to set cut-off frequency                                                      |
| C15    | 0805        | 100 pF                                         | ±5%                                                                     | sallen-Key low-pass filter capacitor, to set cut-off frequency                                                      |
| C16    | 0603        | 330 pF                                         | ±10%                                                                    | RSSI output low-pass capacitor                                                                                      |
| R1     | 0805        | 10 kΩ                                          | ±10%                                                                    | loop filter resistor                                                                                                |
| R3     | 0805        | 12 kΩ                                          | ±5%                                                                     | sallen-Key filter resistor, to set desired filter characteristic                                                    |
| R4     | 0805        | 6.8 kΩ                                         | ±5%                                                                     | sallen-Key filter resistor, to set desired filter characteristic                                                    |
| R5     | 0805        | 33 kΩ                                          | ±5%                                                                     | sallen-Key filter resistor, to set cut-off frequency                                                                |
| R6     | 0805        | 33 kΩ                                          | ±5%                                                                     | sallen-Key filter resistor, to set cut-off frequency                                                                |
| RL1    | 0805        | 470 Ω                                          | ±5%                                                                     | MIX1 bias resistor                                                                                                  |
| RL2    | 0805        | 470 Ω                                          | ±5%                                                                     | MIX1 bias resistor                                                                                                  |
| L1     | 0603        | 33 nH                                          | ±5%                                                                     | inductor to match SAW filter                                                                                        |
| L2     | 0603        | 33 nH                                          | ±5%                                                                     | inductor to match SAW filter                                                                                        |
| L3     | 0603        | 15 nH                                          | ±5%                                                                     | LNA output tank inductor                                                                                            |
| XTAL   | HC49 SMD    | <b>26.43125 MHz</b><br>@ RF = 433.6 MHz        | ±25ppm calibration<br>±30ppm temp.                                      | fundamental-mode crystal, C <sub>load</sub> = 10 pF to 15pF, C <sub>0, max</sub> = 7 pF, R <sub>m, max</sub> = 50 Ω |
| SAWFIL | QCC8C       | <b>B3555</b><br>@ RF = 433.6 MHz               | B <sub>3dB</sub> = 860 kHz<br>±100 kHz<br>(f <sub>0</sub> = 433.92 MHz) | low-loss SAW filter from EPCOS                                                                                      |
| CERFIL | leaded type | SFE10.7MFP @<br>B <sub>IF2</sub> = 40 kHz      | TBD                                                                     | ceramic filter from Murata                                                                                          |
|        | SMD type    | SFECV10.7MJS-A<br>@ B <sub>IF2</sub> = 150 kHz | ±40 kHz                                                                 |                                                                                                                     |
| CERRES | SMD type    | CDACV10.7MG18-A                                |                                                                         | ceramic demodulator tank from Murata                                                                                |

NIP – not in place, may be used optionally

## ASK Reception

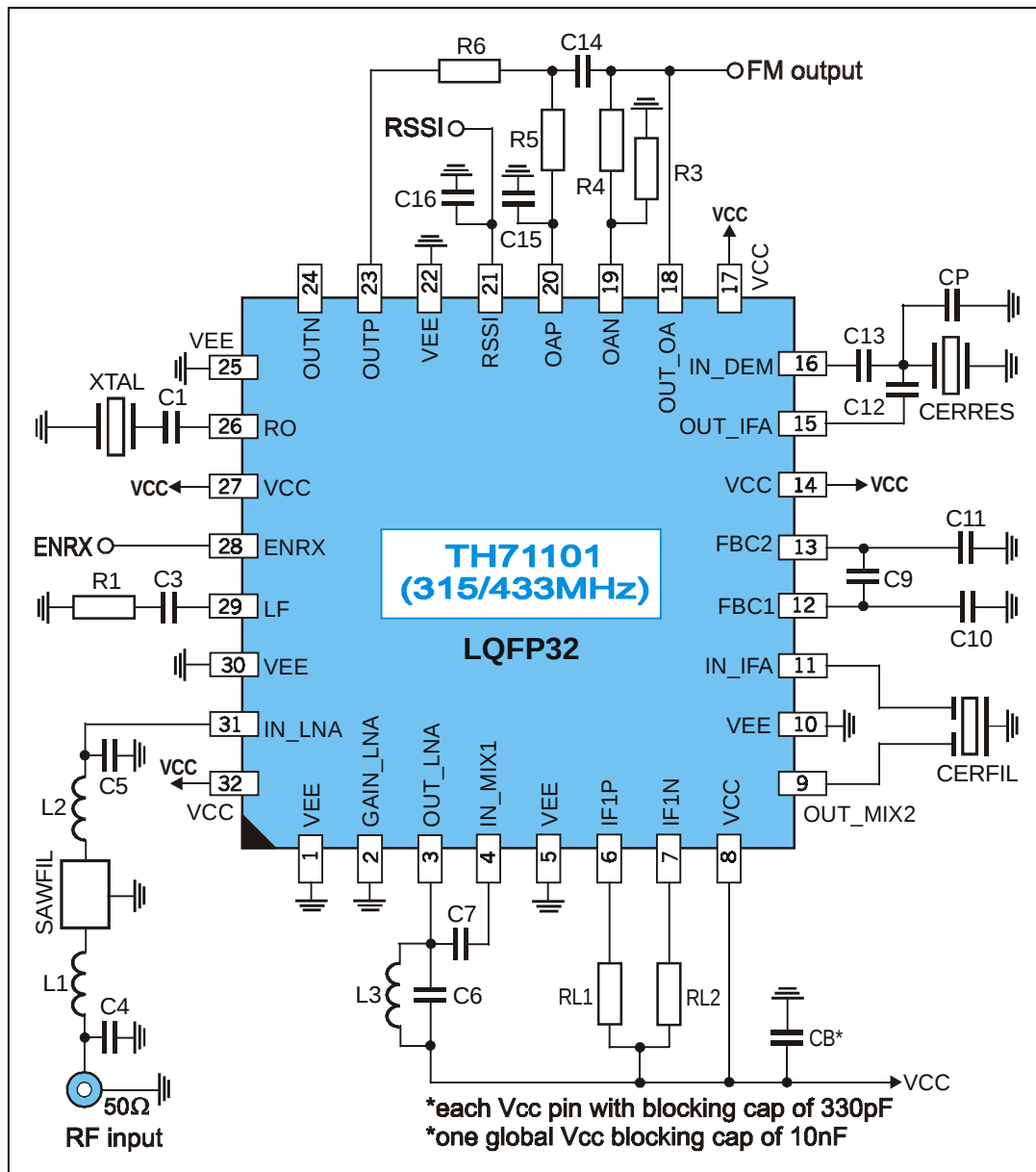


Fig. 5: Test circuit for ASK reception

ASK test circuit component list to Fig. 5

| Part   | Size        | Value / Type                                | Tolerance                                                               | Description                                                                                                         |
|--------|-------------|---------------------------------------------|-------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------|
| C1     | 0805        | 15 pF                                       | ±10%                                                                    | crystal series capacitor                                                                                            |
| C3     | 0805        | 1 nF                                        | ±10%                                                                    | loop filter capacitor                                                                                               |
| C4     | 0603        | 3.3 pF                                      | ±5%                                                                     | capacitor to match to SAW filter input                                                                              |
| C5     | 0603        | 3.3 pF                                      | ±5%                                                                     | capacitor to match to SAW filter output                                                                             |
| C6     | 0603        | 4.7 pF                                      | ±5%                                                                     | LNA output tank capacitor                                                                                           |
| C7     | 0603        | 2.2 pF                                      | ±5%                                                                     | MIX1 input matching capacitor                                                                                       |
| C9     | 0805        | 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 nF to 10 nF                               | ±10%                                                                    | ASK data slicer capacitor, depending on data rate                                                                   |
| C13    | 0603        | 330 pF                                      | ±10%                                                                    | RSSI output low-pass capacitor                                                                                      |
| R1     | 0805        | 10 kΩ                                       | ±10%                                                                    | loop filter resistor                                                                                                |
| R3     | 0603        | 100 kΩ                                      | ±5%                                                                     | ASK data slicer resistor, depending on data rate                                                                    |
| RL1    | 0805        | 470 Ω                                       | ±5%                                                                     | MIX1 bias resistor                                                                                                  |
| RL2    | 0805        | 470 Ω                                       | ±5%                                                                     | MIX1 bias resistor                                                                                                  |
| L1     | 0603        | 33 nH                                       | ±5%                                                                     | inductor to match SAW filter                                                                                        |
| L2     | 0603        | 33 nH                                       | ±5%                                                                     | inductor to match SAW filter                                                                                        |
| L3     | 0603        | 15 nH                                       | ±5%                                                                     | LNA output tank inductor                                                                                            |
| XTAL   | HC49 SMD    | <b>26.43125 MHz</b><br>@ RF = 433.6 MHz     | ±25ppm calibration<br>±30ppm temp.                                      | fundamental-mode crystal, C <sub>load</sub> = 10 pF to 15pF, C <sub>0, max</sub> = 7 pF, R <sub>m, max</sub> = 50 Ω |
| SAWFIL | QCC8C       | <b>B3555</b><br>@ RF = 433.6 MHz            | B <sub>3dB</sub> = 860 kHz<br>±100 kHz<br>(f <sub>0</sub> = 433.92 MHz) | low-loss SAW filter from EPCOS                                                                                      |
| CERFIL | leaded type | SFE10.7MFP @ B <sub>IF2</sub> = 40 kHz      | TBD                                                                     | ceramic filter from Murata                                                                                          |
|        | SMD type    | SFECV10.7MJS-A @ B <sub>IF2</sub> = 150 kHz | ±40 kHz                                                                 |                                                                                                                     |

NIP – not in place, may be used optionally

## Package Dimensions

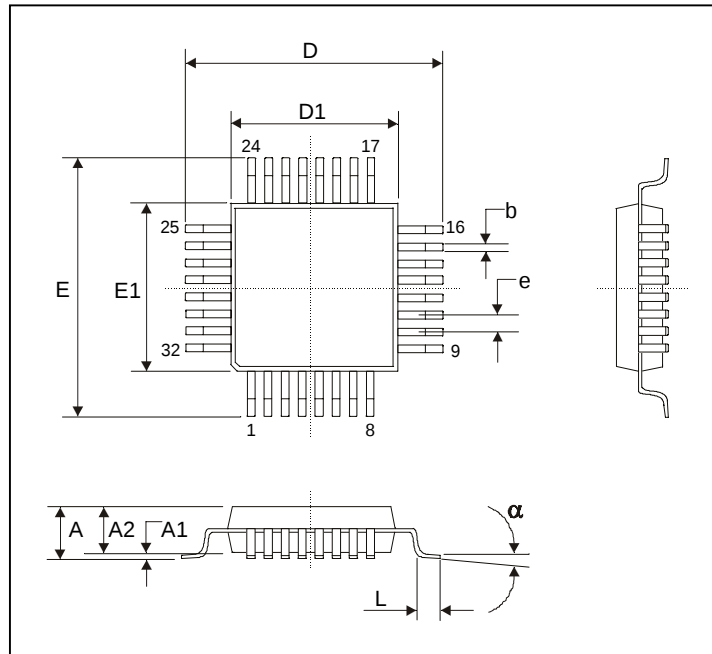


Fig. 6: LQFP32

| All Dimension in mm, coplanarity < 0.1mm    |        |       |       |       |       |       |       |       |          |
|---------------------------------------------|--------|-------|-------|-------|-------|-------|-------|-------|----------|
|                                             | E1, D1 | A     | A1    | A2    | e     | b     | L     | E, D  | $\alpha$ |
| min                                         | 7.00   |       | 0.05  | 1.35  | 0.8   | 0.30  | 0.45  | 9.00  | 0°       |
| max                                         |        | 1.60  | 0.15  | 1.45  |       | 0.45  | 0.75  |       | 7°       |
| All Dimension in inch, coplanarity < 0.004" |        |       |       |       |       |       |       |       |          |
| min                                         | 0.276  |       | 0.002 | 0.053 | 0.031 | 0.012 | 0.018 | 0.354 | 0°       |
| max                                         |        | 0.630 | 0.006 | 0.057 |       | 0.018 | 0.030 |       | 7°       |

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## *Your Notes*

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