

## Features

- Minimal External Circuitry Requirements, no RF Components on the PC Board Except Matching to the Receiver Antenna
- High Sensitivity, Especially at Low Data Rates
- SSO20 and SO20 package
- Fully Integrated VCO
- Supply Voltage 4.5V to 5.5V, Operating Temperature Range  $-40^{\circ}\text{C}$  to  $+105^{\circ}\text{C}$
- Single-ended RF Input for Easy Adaptation to I/4 Antenna or Printed Antenna on PCB
- Low-cost Solution Due to High Integration Level
- Various Types of Protocols Supported (i.e., PWM, Manchester and Bi-phase)
- Distinguishes the Signal Strength of Several Transmitters via RSSI (Received Signal Strength Indicator)
- ESD Protection According to MIL-STD. 883 (4KV HBM)
- High Image Frequency Suppression Due to 1 MHz IF in Conjunction with a SAW Front-end Filter, up to 40 dB is thereby Achievable with Newer SAWs
- Power Management (Polling) is Possible by Means of a Separate Pin via the Microcontroller
- Receiving Bandwidth BIF = 600 kHz



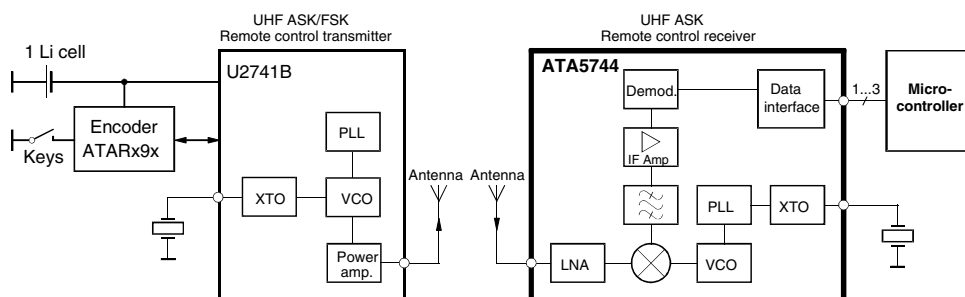
## UHF ASK Receiver

### ATA5744

## 1. Description

The ATA5744 is a PLL receiver device for the receiving range of  $f_0 = 300\text{ MHz}$  to  $450\text{ MHz}$ . It is developed for the demands of RF low-cost data communication systems with low data rates and fits for most types of modulation schemes including Manchester, Bi-phase and most PWM protocols. Its main applications are in the areas of telemetering, security technology and keyless-entry systems.

**Figure 1-1.** System Block Diagram

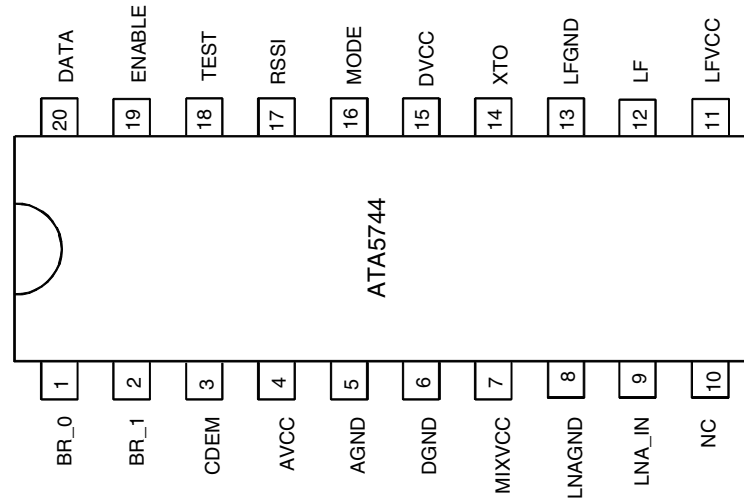


Rev. 4893A-RKE-11/05



## 2. Pin Configuration

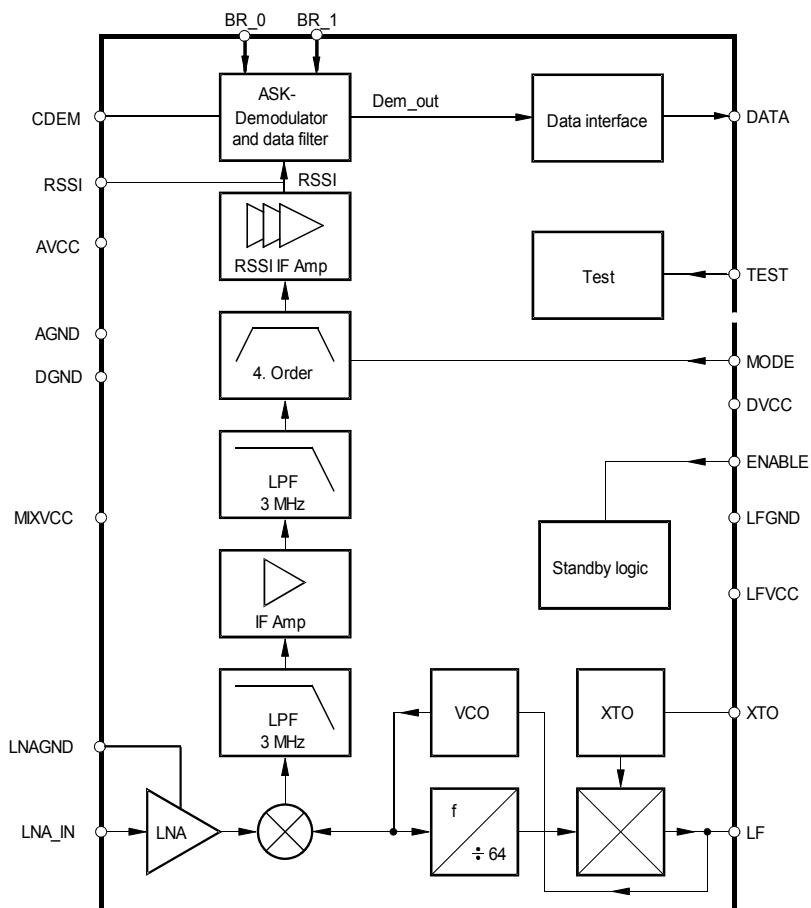
**Figure 2-1.** Pinning SO20 and SSO20



**Table 2-1.** Pin Description

| Pin | Symbol | Function                                                                         |
|-----|--------|----------------------------------------------------------------------------------|
| 1   | BR_0   | Baud rate select LSB                                                             |
| 2   | BR_1   | Baud rate select MSB                                                             |
| 3   | CDEM   | Lower cut-off frequency data filter                                              |
| 4   | AVCC   | Analog power supply                                                              |
| 5   | AGND   | Analog ground                                                                    |
| 6   | DGND   | Digital ground                                                                   |
| 7   | MIXVCC | Power supply mixer                                                               |
| 8   | LNAGND | High-frequency ground LNA and mixer                                              |
| 9   | LNA_IN | RF input                                                                         |
| 10  | NC     | Not connected                                                                    |
| 11  | LFVCC  | Power supply VCO                                                                 |
| 12  | LF     | Loop filter                                                                      |
| 13  | LFGND  | Ground VCO                                                                       |
| 14  | XTO    | Crystal oscillator                                                               |
| 15  | DVCC   | Digital power supply                                                             |
| 16  | MODE   | Selecting 433.92 MHz /315 MHz<br>Low: 315 MHz (USA)<br>High: 433.92 MHz (Europe) |
| 17  | RSSI   | Output of the RSSI amplifier                                                     |
| 18  | TEST   | Test pin, during operation at GND                                                |
| 19  | ENABLE | Selecting operation mode<br>Low: sleep mode<br>High: receiving mode              |
| 20  | DATA   | Data output                                                                      |

Figure 2-2. Block Diagram



### 3. RF Front End

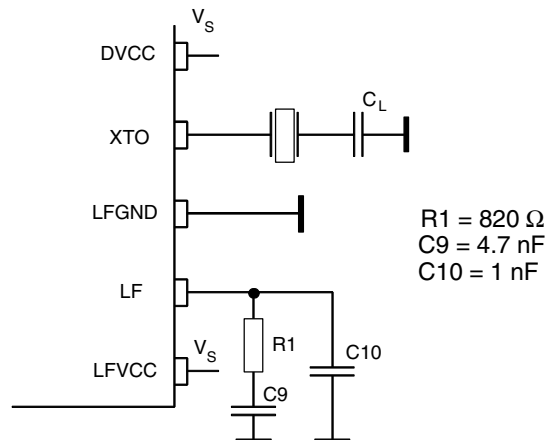
The RF front end of the receiver is a heterodyne configuration that converts the input signal into a 1-MHz IF signal. According to Figure 2-2, the front end consists of an LNA (Low-Noise Amplifier), LO (Local Oscillator), a mixer and RF amplifier.

The LO generates the carrier frequency for the mixer via a PLL synthesizer. The XTO (crystal oscillator) generates the reference frequency  $f_{XTO}$ . The VCO (Voltage-Controlled Oscillator) generates the drive voltage frequency  $f_{LO}$  for the mixer.  $f_{LO}$  is dependent on the voltage at pin LF.  $f_{LO}$  is divided by factor 64. The divided frequency is compared to  $f_{XTO}$  by the phase frequency detector. The current output of the phase frequency detector is connected to a passive loop filter and thereby generates the control voltage VLF for the VCO. By means of that configuration, VLF is controlled in a way that  $f_{LO}/64$  is equal to  $f_{XTO}$ . If  $f_{LO}$  is determined,  $f_{XTO}$  can be calculated using the following formula:

$$f_{XTO} = f_{LO}/64$$

The XTO is a one-pin oscillator that operates at the series resonance of the quartz crystal. According to Figure 3-1, the crystal should be connected to GND via a capacitor CL. The value of that capacitor is recommended by the crystal supplier. The value of CL should be optimized for the individual board layout to achieve the exact value of  $f_{XTO}$  and hereby of  $f_{LO}$ . When designing the system in terms of receiving bandwidth, the accuracy of the crystal and the XTO must be considered.

**Figure 3-1.** PLL Peripherals



The passive loop filter connected to pin LF is designed for a loop bandwidth of  $B_{\text{Loop}} = 100 \, \text{kHz}$ . This value for  $B_{\text{Loop}}$  exhibits the best possible noise performance of the LO. [Figure 3-1](#) shows the appropriate loop filter components to achieve the desired loop bandwidth

$f_{\text{LO}}$  is determined by the RF input frequency  $f_{\text{RF}}$  and the IF frequency  $f_{\text{IF}}$  using the following formula:

$$f_{\text{LO}} = f_{\text{RF}} - f_{\text{IF}}$$

To determine  $f_{\text{LO}}$ , the construction of the IF filter must be considered at this point. The nominal IF frequency is  $f_{\text{IF}} = 1 \, \text{MHz}$ . To achieve a good accuracy of the filter's corner frequencies, the filter is tuned by the crystal frequency  $f_{\text{XTO}}$ . This means that there is a fixed relation between  $f_{\text{IF}}$  and  $f_{\text{LO}}$  that depends on the logic level at pin mode. This is described by the following formulas:

$$\text{MODE} = 0 \text{ USA } f_{\text{IF}} = f_{\text{LO}}/314$$

$$\text{MODE} = 1 \text{ Europe } f_{\text{IF}} = f_{\text{LO}}/432.92$$

The relation is designed to achieve the nominal IF frequency of  $f_{\text{IF}} = 1 \, \text{MHz}$  for most applications. For applications where  $f_{\text{RF}} = 315 \, \text{MHz}$ , MODE must be set to '0'. In the case of  $f_{\text{RF}} = 433.92 \, \text{MHz}$ , MODE must be set to '1'. For other RF frequencies,  $f_{\text{IF}}$  is not equal to 1 MHz.  $f_{\text{IF}}$  is then dependent on the logical level at pin MODE and on  $f_{\text{RF}}$ . [Table 3-1 on page 5](#) summarizes the different conditions.

The RF input either from an antenna or from a generator must be transformed to the RF input pin LNA\_IN. The input impedance of that pin is provided in the electrical parameters. The parasitic board inductances and capacitances also influence the input matching. The RF receiver ATA5744 exhibits its highest sensitivity at the best signal-to-noise ratio in the LNA. Hence, noise matching is the best choice for designing the transformation network.

A good practice when designing the network, is to start with power matching. From that starting point, the values of the components can be varied to some extent to achieve the best sensitivity.

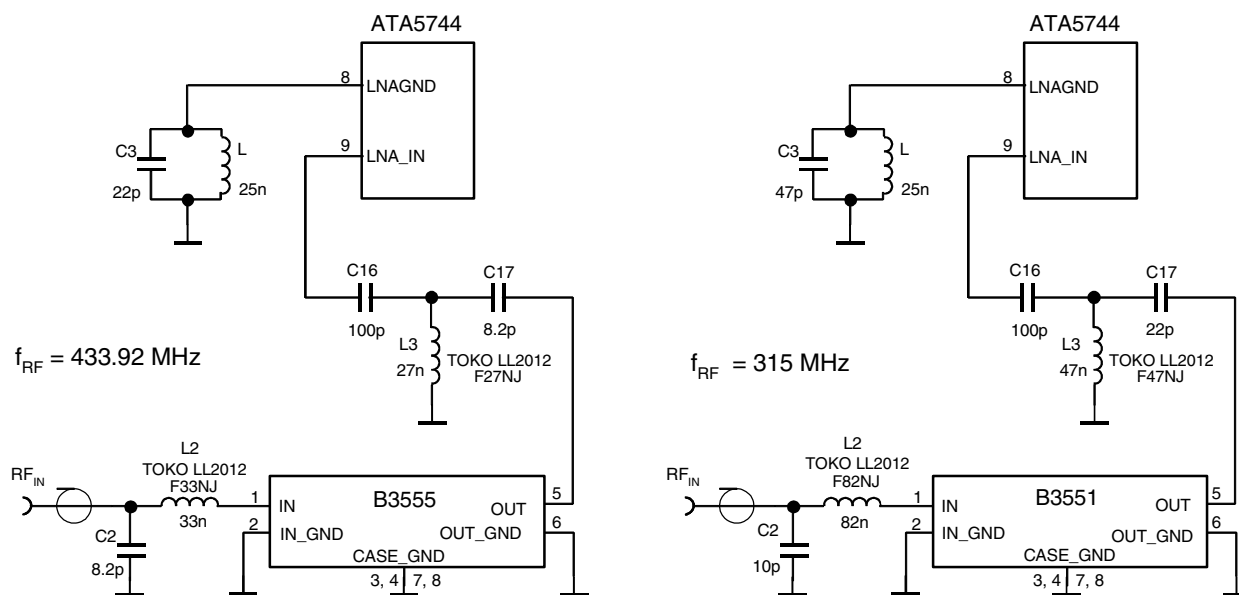
If a SAW is implemented into the input network a mirror frequency suppression of  $\Delta P_{\text{Ref}} = 40 \, \text{dB}$  can be achieved. There are SAWs available that exhibit a notch at  $\Delta f = 2 \, \text{MHz}$ . These SAWs work best for an intermediate frequency of  $\text{IF} = 1 \, \text{MHz}$ . The selectivity of the receiver is also improved by using a SAW. In typical automotive applications, a SAW is used.

Figure 3-2 shows a typical input matching network for  $f_{RF} = 315$  MHz and  $f_{RF} = 433.92$  MHz using a SAW. Figure 3-3 on page 6 illustrates the input matching to  $50\Omega$  without a SAW. The input matching networks shown in Figure 3-3 on page 6 are the reference networks for the parameters given in the electrical characteristics.

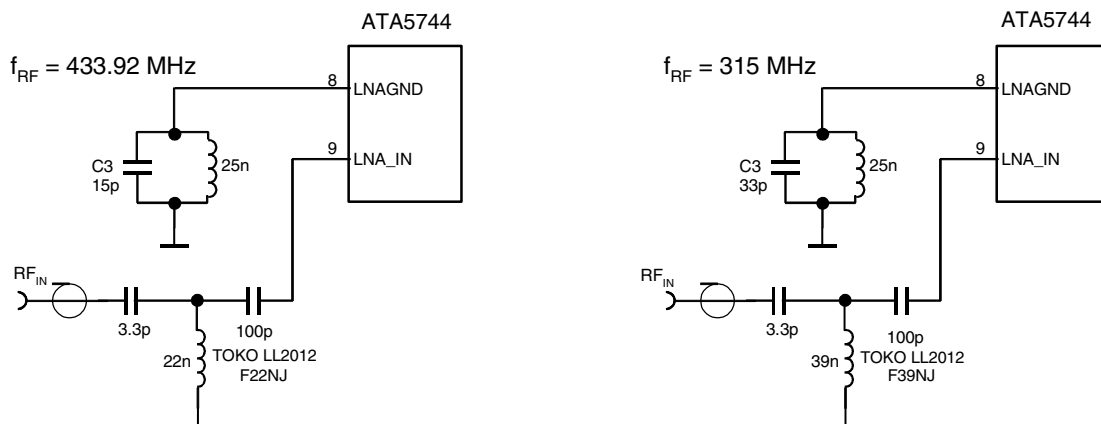
**Table 3-1.** Calculation of LO and IF Frequency

| Conditions                                              | Local Oscillator Frequency                     | Intermediate Frequency           |
|---------------------------------------------------------|------------------------------------------------|----------------------------------|
| $f_{RF} = 315$ MHz, MODE = 0                            | $f_{LO} = 314$ MHz                             | $f_{IF} = 1$ MHz                 |
| $f_{RF} = 433.92$ MHz, MODE = 1                         | $f_{LO} = 432.92$ MHz                          | $f_{IF} = 1$ MHz                 |
| $300 \text{ MHz} < f_{RF} < 365 \text{ MHz}$ , MODE = 0 | $f_{LO} = \frac{f_{RF}}{1 + \frac{1}{314}}$    | $f_{IF} = \frac{f_{LO}}{314}$    |
| $365 \text{ MHz} < f_{RF} < 450 \text{ MHz}$ , MODE = 1 | $f_{LO} = \frac{f_{RF}}{1 + \frac{1}{432.92}}$ | $f_{IF} = \frac{f_{LO}}{432.92}$ |

**Figure 3-2.** Input Matching Network with SAW Filter



**Figure 3-3.** Input Matching Network without SAW Filter



Please note that for all coupling conditions (see [Figure 3-2 on page 5](#) and [Figure 3-3](#)), the bond wire inductivity of the LNA ground is compensated. C3 forms a series resonance circuit together with the bond wire. L = 25 nH is a feed inductor to establish a DC path. Its value is not critical but must be large enough not to detune the series resonance circuit. For cost reduction, this inductor can be easily printed on the PCB. This configuration improves the sensitivity of the receiver by about 1 dB to 2 dB.

## 4. Analog Signal Processing

## 4.1 IF Amplifier

The signals coming from the RF front end are filtered by the fully integrated 4th-order IF filter. The IF center frequency is  $f_{IF} = 1$  MHz for applications where  $f_{RF} = 315$  MHz or  $f_{RF} = 433.92$  MHz is used. For other RF input frequencies, refer to [Table 3-1 on page 5](#) to determine the center frequency.

The receiver ATA5744 employs an IF bandwidth of  $B_{IF} = 600$  kHz and can be used together with the U2741B in ASK mode.

## 4.2 RSSI Amplifier

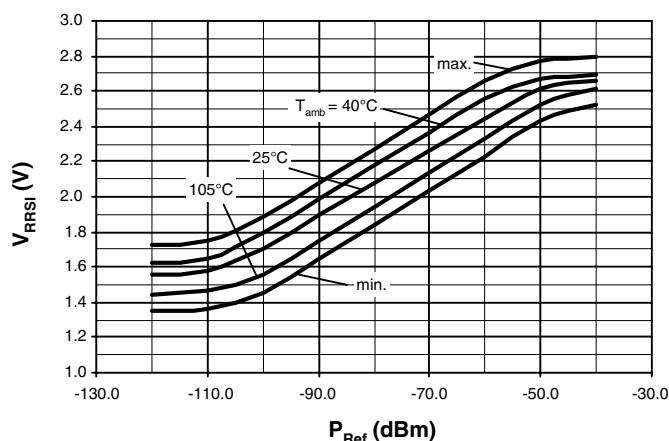
The subsequent RSSI amplifier enhances the output signal of the IF amplifier before it is fed into the demodulator. The dynamic range of this amplifier is  $DR_{RSSI} = 60$  dB. If the RSSI amplifier is operated within its linear range, the best S/N ratio is maintained. If the dynamic range is exceeded by the transmitter signal, the S/N ratio is defined by the ratio of the maximum RSSI output voltage and the RSSI output voltage due to a disturber. The dynamic range of the RSSI amplifier is exceeded if the RF input signal is about 60 dB higher compared to the RF input signal at full sensitivity.

### 4.3 Pin RSSI

The output voltage of the RSSI amplifier (VRSSI) is available at pin RSSI. Using the RSSI output signal, the signal strength of different transmitters can be distinguished. The usable input power range  $P_{Ref}$  is  $-100$  dBm to  $-55$  dBm.

Since different RF input networks may exhibit slightly different values for the LNA gain, the sensitivity values given in the electrical characteristics refer to a specific input matching. This matching is illustrated in Figure 3-3 and exhibits the best possible sensitivity.

**Figure 4-1.** RSSI Characteristics



### 4.4 ASK Demodulator and Data Filter

The signal coming from the RSSI amplifier is converted into the raw data signal by the ASK demodulator.

An automatic threshold control circuit (ATC) is employed to set the detection reference voltage to a value where a good signal-to-noise ratio is achieved. This circuit also implies the effective suppression of any kind of inband noise signals or competing transmitters. If the S/N ratio exceeds 10 dB, the data signal can be detected properly.

The output signal of the demodulator is filtered by the data filter before it is fed into the digital signal processing circuit. The data filter improves the S/N ratio as its passband can be adopted to the characteristics of the data signal. The data filter consists of a 1st-order highpass and a 1st-order lowpass filter.

The highpass filter cut-off frequency is defined by an external capacitor connected to pin CDEM. The cut-off frequency of the highpass filter is defined by the following formula:

$$f_{cu\_DF} = \frac{1}{2 \times \pi \times R_1 \times CDEM}$$

Recommended values for CDEM are given in the electrical characteristics.

The cut-off frequency of the lowpass filter is defined by the selected baudrate range (BR\_Range). BR\_Range is defined by the pins BR\_0 and BR\_1. BR\_Range must be set in accordance to the used baudrate.

**Table 4-1.** Definition of BR\_Range by the Pins BR\_0 and BR\_1

| BR_1 | BR_0 | BR_Range |
|------|------|----------|
| 0    | 0    | 0        |
| 0    | 1    | 1        |
| 1    | 0    | 2        |
| 1    | 1    | 2        |

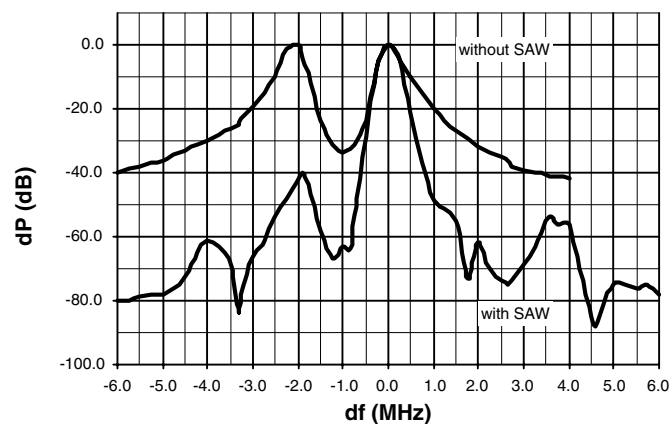
Each BR\_Range is defined by a minimum and a maximum edge-to-edge time (tee\_sig). These limits are defined in the electrical characteristics. They should not be exceeded to maintain full sensitivity of the receiver.

## 4.5 Receiving Characteristics

The RF receiver ATA5744 can be operated with and without a SAW front-end filter. In a typical automotive application, a SAW filter is used to achieve better selectivity. The selectivity with and without a SAW front-end filter is illustrated in [Figure 4-1 on page 7](#). Note that the mirror frequency is reduced by 40 dB. The plots are printed relatively to the maximum sensitivity. If a SAW filter is used, an insertion loss of about 4 dB must be considered.

When designing the system in terms of receiving bandwidth, the LO deviation must be considered as it also determines the IF center frequency. The total LO deviation is calculated to be the sum of the deviation of the crystal and the XTO deviation of the ATA5744. Low-cost crystals are specified to be within  $\pm 100$  ppm. The XTO deviation of the ATA5744 is an additional deviation due to the XTO circuit. This deviation is specified to be  $\pm 30$  ppm. If a crystal of  $\pm 100$  ppm is used, the total deviation is  $\pm 130$  ppm in that case. Note that the receiving bandwidth and the IF-filter bandwidth are equivalent.

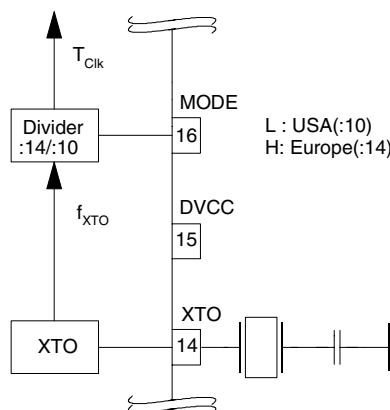
**Figure 4-2.** Receiving Frequency Response



## 4.6 Basic Clock Cycle of the Digital Circuitry

The complete timing of the digital circuitry and the analog filtering is derived from one clock. According to Figure 4-3, this clock cycle  $T_{Clk}$  is derived from the crystal oscillator (XTO) in combination with a divider. The division factor is controlled by the logical state at pin MODE. According to chapter 'RF Front End', the frequency of the crystal oscillator ( $f_{XTO}$ ) is defined by the RF input signal ( $f_{RFIn}$ ) which also defines the operating frequency of the local oscillator ( $f_{LO}$ ).

**Figure 4-3.** Generation of the Basic Clock Cycle



Pin MODE can now be set in accordance with the desired clock cycle  $T_{Clk}$ .  $T_{Clk}$  controls the following application-relevant parameters:

Timing of the analog and digital signal processing

IF filter center frequency ( $f_{IF0}$ )

Most applications are dominated by two transmission frequencies:  $f_{Send} = 315$  MHz is mainly used in USA,  $f_{Send} = 433.92$  MHz in Europe. In order to ease the usage of all  $T_{Clk}$ -dependent parameters, the electrical characteristics display three conditions for each parameter.

- Application USA  
( $f_{XTO} = 4.90625$  MHz, MODE = L,  $T_{Clk} = 2.0383$   $\mu$ s)
- Application Europe  
( $f_{XTO} = 6.76438$  MHz, MODE = H,  $T_{Clk} = 2.0697$   $\mu$ s)
- Other applications  
( $T_{Clk}$  is dependent on  $f_{XTO}$  and on the logical state of pin MODE. The electrical characteristic is given as a function of  $T_{Clk}$ ).

The clock cycle of some function blocks depends on the selected baud rate range (BR\_Range) which is defined by the pins BR\_0 and BR\_1. This clock cycle  $T_{XClk}$  is defined by the following formulas for further reference:

|                       |                               |
|-----------------------|-------------------------------|
| BR_Range = BR_Range0: | $T_{XClk} = 8 \times T_{Clk}$ |
| BR_Range1:            | $T_{XClk} = 4 \times T_{Clk}$ |
| BR_Range2:            | $T_{XClk} = 2 \times T_{Clk}$ |
| BR_Range3:            | $T_{XClk} = 1 \times T_{Clk}$ |

## 5. Pin ENABLE

Via the pin ENABLE the operating mode of the receiver can be selected (see [Figure 5-1](#) and [Figure 5-2](#)).

If the pin ENABLE is held to Low, the receiver remains in sleep mode. All circuits for signal processing are disabled and only the XTO is running in that case. The current consumption is  $I_S = I_{Soff}$  in that case. During the sleep mode the receiver is not sensitive to a transmitter signal.

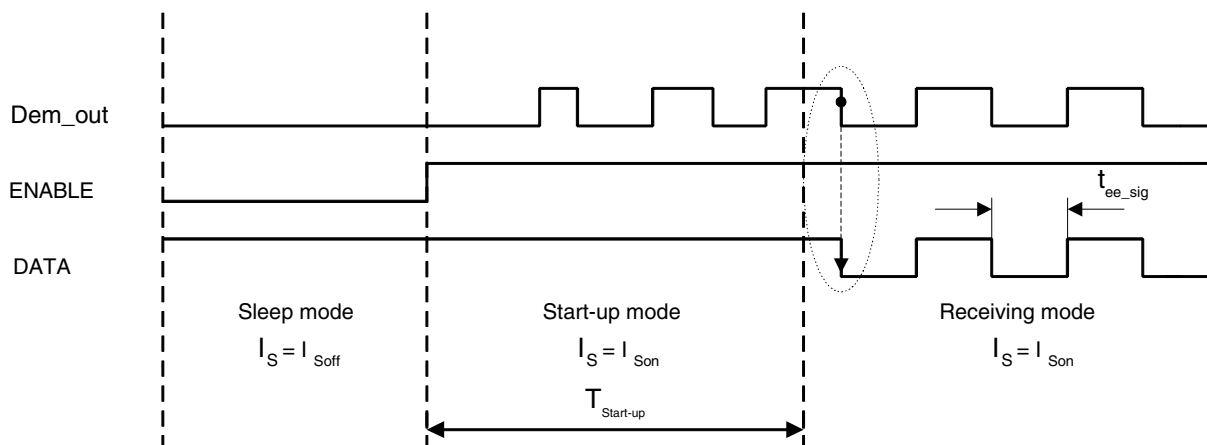
To activate the receiver, the pin ENABLE must be held to High. During the start-up period,  $T_{Startup}$ , all signal processing circuits are enabled and settled. The duration of the start-up period depends on the selected baud-rate range (BR\_Range).

After the start-up period, all circuits are in a stable condition and the receiver is in the receiving mode.

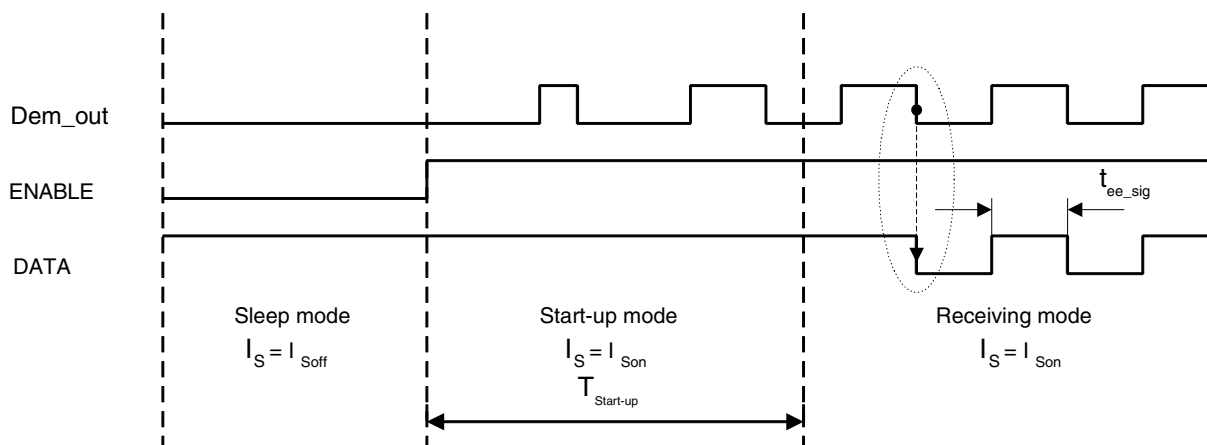
In receiving mode, the internal data signal (Dem\_out) is switched to pin DATA. To avoid incorrect timing at the begin of the data stream, the begin is synchronized to a falling edge of the incoming data signal. The receiver stays in the receiving mode until it is switched back to sleep mode via pin ENABLE.

During start-up and receiving mode, the current consumption is  $I_S = I_{Son}$ .

**Figure 5-1.** Enable Timing (1)



**Figure 5-2.** Enable Timing (2)

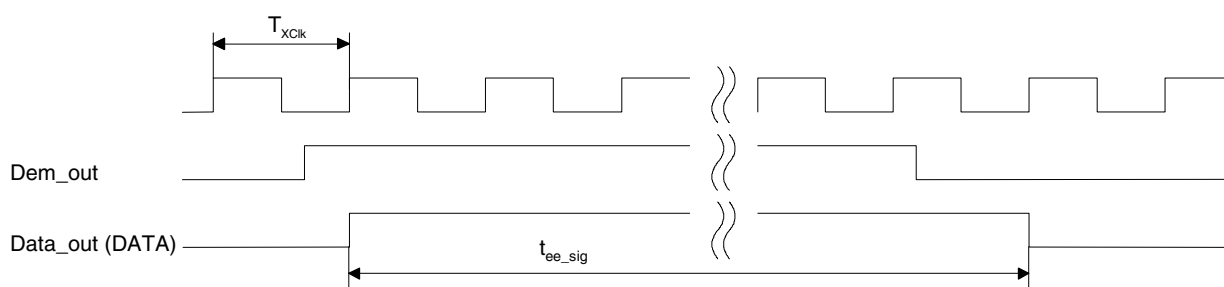


## 6. Digital Signal Processing

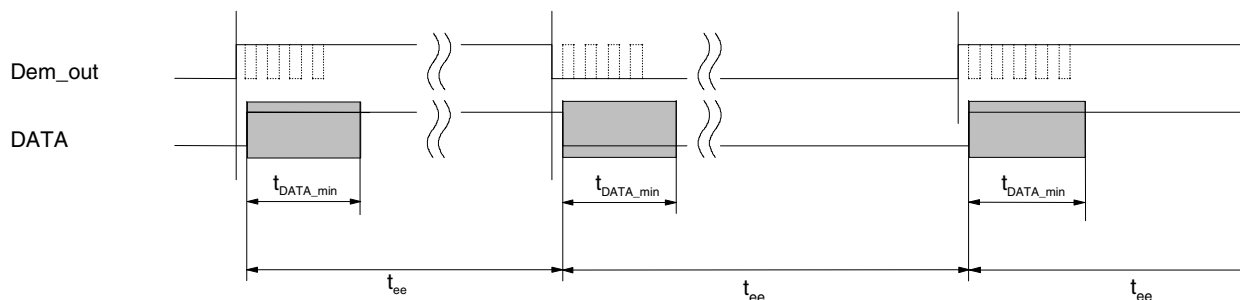
The data from the ASK demodulator (Dem\_out) is digitally processed in different ways and as a result converted into the output signal DATA. This processing depends on the selected baudrate range (BR\_Range). [Figure 6-1 on page 11](#) illustrates how Dem\_out is synchronized by the extended basic clock cycle  $T_{XClk}$ . Data can change its state only after  $T_{XClk}$  has elapsed. The edge-to-edge time period  $t_{ee\_sig}$  of the DATA signal as a result is always an integral multiple of  $T_{XClk}$ .

The minimum time period between two edges of the data signal is limited to  $t_{ee\_sig} \geq T_{DATA\_min}$ . This implies an efficient suppression of spikes at the DATA output. At the same time it limits the maximum frequency of edges at DATA. This eases the interrupt handling of a connected microcontroller.

**Figure 6-1.** Synchronization of the Demodulator Output



**Figure 6-2.** Debouncing of the Demodulator Output



## 7. Absolute Maximum Ratings

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

| Parameters                                | Symbol        | Min. | Max. | Unit |
|-------------------------------------------|---------------|------|------|------|
| Supply voltage                            | $V_S$         |      | 6    | V    |
| Power dissipation                         | $P_{tot}$     |      | 450  | mW   |
| Junction temperature                      | $T_j$         |      | 150  | °C   |
| Storage temperature                       | $T_{stg}$     | −55  | +125 | °C   |
| Ambient temperature                       | $T_{amb}$     | −40  | +105 | °C   |
| Maximum input level, input matched to 50Ω | $P_{in\_max}$ |      | 10   | dBm  |

## 8. Thermal Resistance

| Parameters                     | Symbol     | Value | Unit |
|--------------------------------|------------|-------|------|
| Junction ambient SO20 package  | $R_{thJA}$ | 100   | K/W  |
| Junction ambient SSO20 package | $R_{thJA}$ | 100   | K/W  |

## 9. Electrical Characteristics

All parameters refer to GND,  $T_{amb} = -40^{\circ}\text{C}$  to  $+105^{\circ}\text{C}$ ,  $V_S = 4.5\text{V}$  to  $5.5\text{V}$ ,  $f_0 = 433.92\text{ MHz}$  and  $f_0 = 315\text{ MHz}$ , unless otherwise specified. ( $V_S = 5\text{V}$ ,  $T_{amb} = 25^{\circ}\text{C}$ )

| Parameters                                                                                                   | Test Conditions                                       | Symbol                | 6.76438 MHz Osc.<br>(MODE:1) |      |                              | 4.90625 MHz Osc.<br>(MODE:0) |      |                              | Variable Oscillator                                       |      |                                                      | Unit                 |
|--------------------------------------------------------------------------------------------------------------|-------------------------------------------------------|-----------------------|------------------------------|------|------------------------------|------------------------------|------|------------------------------|-----------------------------------------------------------|------|------------------------------------------------------|----------------------|
|                                                                                                              |                                                       |                       | Min.                         | Typ. | Max.                         | Min.                         | Typ. | Max.                         | Min.                                                      | Typ. | Max.                                                 |                      |
| Basic Clock Cycle of the Digital Circuitry                                                                   |                                                       |                       |                              |      |                              |                              |      |                              |                                                           |      |                                                      |                      |
| Basic clock cycle                                                                                            | MODE = 0 (USA)<br>MODE = 1 (Europe)                   | T <sub>Clk</sub>      | 2.0697                       |      | 2.0697                       | 2.0383                       |      | 2.0383                       | 1/(f <sub>xto</sub> /10)<br>1/(f <sub>xto</sub> /14)      |      | 1/(f <sub>xto</sub> /10)<br>1/(f <sub>xto</sub> /14) | μs<br>μs             |
| Extended basic clock cycle                                                                                   | BR_Range0                                             | T <sub>XClk</sub>     | 16.6                         |      | 16.6                         | 16.3                         |      | 16.3                         | 8 × T <sub>Clk</sub>                                      |      | 8 × T <sub>Clk</sub>                                 | μs                   |
|                                                                                                              | BR_Range1                                             |                       | 8.3                          |      | 8.3                          | 8.2                          |      | 8.2                          | 4 × T <sub>Clk</sub>                                      |      | 4 × T <sub>Clk</sub>                                 | μs                   |
|                                                                                                              | BR_Range2                                             |                       | 4.1                          |      | 4.1                          | 4.1                          |      | 4.1                          | 2 × T <sub>Clk</sub>                                      |      | 2 × T <sub>Clk</sub>                                 | μs                   |
|                                                                                                              | BR_Range3                                             |                       | 2.1                          |      | 2.1                          | 2.0                          |      | 2.0                          | 1 × T <sub>Clk</sub>                                      |      | 1 × T <sub>Clk</sub>                                 | μs                   |
| Start-up time<br>(see <a href="#">Figure 5-1</a><br>and <a href="#">Figure 5-2</a><br>on page 10)            | BR_Range0                                             | T <sub>Startup</sub>  | 1855                         |      | 1855                         | 1827                         |      | 1827                         | 896.5                                                     |      | 896.5                                                | μs                   |
|                                                                                                              | BR_Range1                                             |                       | 1061                         |      | 1061                         | 1045                         |      | 1045                         | 512.5                                                     |      | 512.5                                                | μs                   |
|                                                                                                              | BR_Range2                                             |                       | 1061                         |      | 1061                         | 1045                         |      | 1045                         | 512.5                                                     |      | 512.5                                                | μs                   |
|                                                                                                              | BR_Range3                                             |                       | 663                          |      | 663                          | 653                          |      | 653                          | 320.5                                                     |      | 320.5                                                | μs                   |
|                                                                                                              |                                                       |                       |                              |      |                              |                              |      |                              | × T <sub>Clk</sub>                                        |      | × T <sub>Clk</sub>                                   | μs                   |
| Receiving Mode                                                                                               |                                                       |                       |                              |      |                              |                              |      |                              |                                                           |      |                                                      |                      |
| Intermediate frequency                                                                                       | MODE=0 (USA)<br>MODE=1 (Europe)                       | f <sub>IF</sub>       |                              | 1.0  |                              |                              | 1.0  |                              | f <sub>XTO</sub> × 64/314<br>f <sub>XTO</sub> × 64/432.92 |      | MHz<br>MHz                                           |                      |
| Minimum time period between edges at pin DATA                                                                | BR_Range0                                             | T <sub>DATA_min</sub> | 165                          |      | 165                          | 163                          |      | 163                          | 10 × T <sub>XClk</sub>                                    |      | 10 × T <sub>XClk</sub>                               | μs                   |
|                                                                                                              | BR_Range1                                             |                       | 83                           |      | 83                           | 81                           |      | 81                           | 10 × T <sub>XCl</sub>                                     |      | 10 × T <sub>XCl</sub>                                | μs                   |
|                                                                                                              | BR_Range2                                             |                       | 41.4                         |      | 41.4                         | 40.7                         |      | 40.7                         | 10 × T <sub>XClk</sub>                                    |      | 10 × T <sub>XClk</sub>                               | μs                   |
|                                                                                                              | BR_Range3<br>( <a href="#">Figure 6-2</a> on page 11) |                       | 20.7                         |      | 20.7                         | 20.4                         |      | 20.4                         | 10 × T <sub>XClk</sub>                                    |      | 10 × T <sub>XClk</sub>                               | μs                   |
| Edge to edge time period of the data signal for full sensitivity<br>( <a href="#">Figure 5-1</a> on page 10) | BR_Range0<br>BR_Range1<br>BR_Range2<br>BR_Range3      | t <sub>ee_sig</sub>   | 400<br>200<br>100<br>50      |      | 8479<br>8479<br>8479<br>8479 | 400<br>200<br>100<br>50      |      | 8350<br>8350<br>8350<br>8350 | BR_Range<br>×<br>2 μs/T <sub>CLK</sub>                    |      | 4097 ×<br>T <sub>CLK</sub>                           | μs<br>μs<br>μs<br>μs |

## 10. Electrical Characteristics (continued)

| Parameters                        | Test Conditions                                                                                     | Symbol         | Min. | Typ.                      | Max. | Unit                                 |
|-----------------------------------|-----------------------------------------------------------------------------------------------------|----------------|------|---------------------------|------|--------------------------------------|
| Current consumption               | Sleep mode (XTO active)                                                                             | $I_{Soff}$     |      | 190                       | 276  | $\mu\text{A}$                        |
|                                   | IC active (startup-, receiving mode) pin DATA = H                                                   | $I_{Son}$      |      | 7.1                       | 8.7  | mA                                   |
| <b>LNA Mixer</b>                  |                                                                                                     |                |      |                           |      |                                      |
| Third-order intercept point       | LNA/ mixer/ IF amplifier input matched according to <a href="#">Figure 3-3</a> on page 6            | IIP3           |      | -28                       |      | dBm                                  |
| LO spurious emission at $RF_{in}$ | Input matched according to <a href="#">Figure 3-3</a> on page 6, required according to I-ETS 300220 | $IS_{LORF}$    |      | -73                       | -57  | dBm                                  |
| Noise figure LNA and mixer (DSB)  | Input matching according to <a href="#">Figure 3-3</a> on page 6                                    | NF             |      | 7                         |      | dB                                   |
| LNA_IN input impedance            | At 433.92 MHz<br>At 315 MHz                                                                         | $Z_{iLNA\_IN}$ |      | 1.0    1.56<br>1.3    1.0 |      | k $\Omega$    pF<br>k $\Omega$    pF |

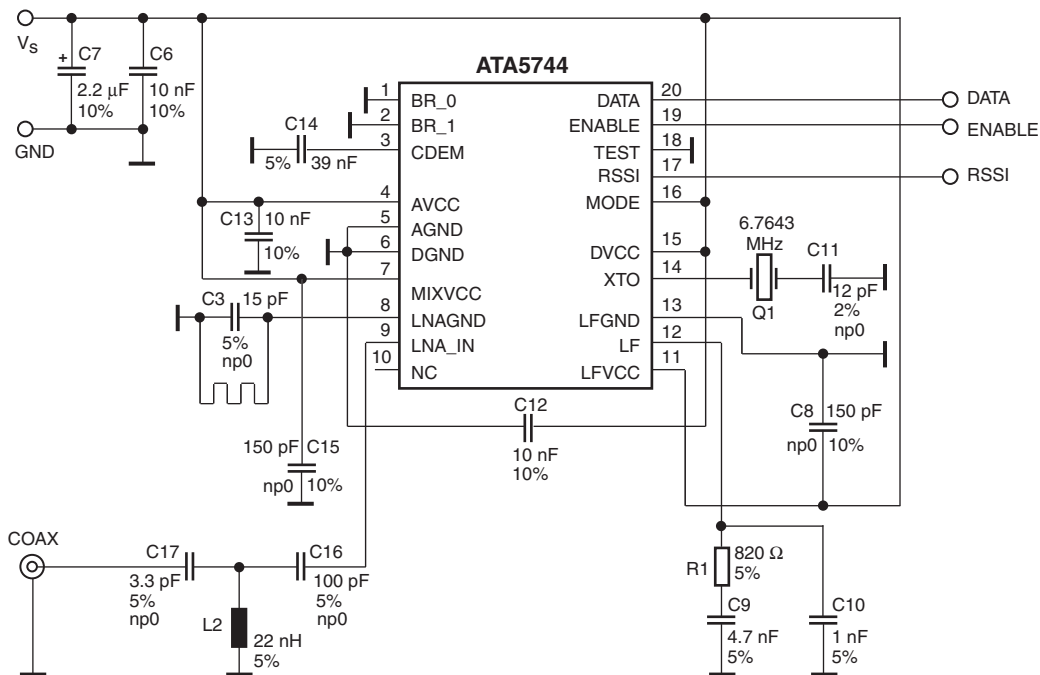
## 10. Electrical Characteristics (continued)

| Parameters                                                                                                         | Test Conditions                                                                                                                                                                                                        | Symbol           | Min.                | Typ.        | Max.                | Unit                 |
|--------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------|---------------------|-------------|---------------------|----------------------|
| 1 dB compression point (LNA, mixer, IF amplifier)                                                                  | Input matched according to <a href="#">Figure 3-3 on page 6</a> , referred to $RF_{in}$                                                                                                                                | $IP_{1db}$       |                     | -40         |                     | dBm                  |
| Maximum input level                                                                                                | Input matched according to <a href="#">Figure 3-3 on page 6</a> , $BER \leq 10^{-3}$                                                                                                                                   | $P_{in\_max}$    |                     |             | -20                 | dBm                  |
| <b>Local Oscillator</b>                                                                                            |                                                                                                                                                                                                                        |                  |                     |             |                     |                      |
| Operating frequency range VCO                                                                                      |                                                                                                                                                                                                                        | $f_{VCO}$        | 299                 |             | 449                 | MHz                  |
| Phase noise VCO/LO                                                                                                 | $f_{osc} = 432.92$ MHz<br>at 1 MHz<br>at 10 MHz                                                                                                                                                                        | L (fm)           |                     | -93<br>-113 | -90<br>-110         | dBc/Hz<br>dBc/Hz     |
| Spurious of the VCO                                                                                                | at $\pm f_{XTO}$                                                                                                                                                                                                       |                  |                     | -55         | -47                 | dBc                  |
| VCO gain                                                                                                           |                                                                                                                                                                                                                        | $K_{VCO}$        |                     | 190         |                     | MHz/V                |
| Loop bandwidth of the PLL                                                                                          | For best LO noise (design parameter)<br>$R1 = 820\Omega$<br>$C9 = 4.7$ nF<br>$C10 = 1$ nF                                                                                                                              | $B_{Loop}$       |                     | 100         |                     | kHz                  |
| Capacitive load at pin LF                                                                                          |                                                                                                                                                                                                                        | $C_{LF\_tot}$    |                     |             | 10                  | nF                   |
| XTO operating frequency                                                                                            | XTO crystal frequency, appropriate load capacitance must be connected to XTAL<br>$f_{XTAL} = 6.764375$ MHz (EU)                                                                                                        | $f_{XTO}$        | 6.764375<br>-30 ppm | 6.764375    | 6.764375<br>+30 ppm | MHz                  |
|                                                                                                                    | $f_{XTAL} = 4.90625$ MHz (US)                                                                                                                                                                                          |                  | 4.90625<br>-30 ppm  | 4.90625     | 4.90625<br>+30 ppm  | MHz                  |
| Series resonance resistor of the crystal                                                                           | $f_{XTO} = 6.764$ MHz<br>4.906 MHz                                                                                                                                                                                     | $R_S$            |                     |             | 150<br>220          | $\Omega$<br>$\Omega$ |
| Static capacitance of the crystal                                                                                  |                                                                                                                                                                                                                        | $C_o$            |                     |             | 6.5                 | pF                   |
| <b>Analog Signal Processing</b>                                                                                    |                                                                                                                                                                                                                        |                  |                     |             |                     |                      |
| Input sensitivity                                                                                                  | Input matched according to <a href="#">Figure 3-3</a><br>ASK (level of carrier)<br>$BER \leq 10^{-3}$ (Manchester),<br>$f_{in} = 433.92$ MHz/ 315 MHz<br>$T = 25^\circ\text{C}$ , $V_S = 5\text{V}$ , $f_{IF} = 1$ MHz | $P_{Ref\_ASK}$   |                     |             |                     |                      |
|                                                                                                                    | BR_Range0 (1 kBd)                                                                                                                                                                                                      |                  | -107                | -110        | -112                | dBm                  |
|                                                                                                                    | BR_Range1 (2 kBd)                                                                                                                                                                                                      |                  | -105                | -108        | -110                | dBm                  |
|                                                                                                                    | BR_Range2 (4 kBd)                                                                                                                                                                                                      |                  | -103                | -106        | -108                | dBm                  |
|                                                                                                                    | BR_Range3 (8 kBd)                                                                                                                                                                                                      |                  | -101                | -104        | -106                | dBm                  |
| Sensitivity variation for the full operating range compared to<br>$T_{amb} = 25^\circ\text{C}$ , $V_S = 5\text{V}$ | $f_{in} = 433.92$ MHz/315 MHz<br>$f_{IF} = 1$ MHz<br>$P_{ASK} = P_{Ref\_ASK} + \Delta P_{Ref}$                                                                                                                         | $\Delta P_{Ref}$ | +2.5                |             | -1.5                | dB                   |

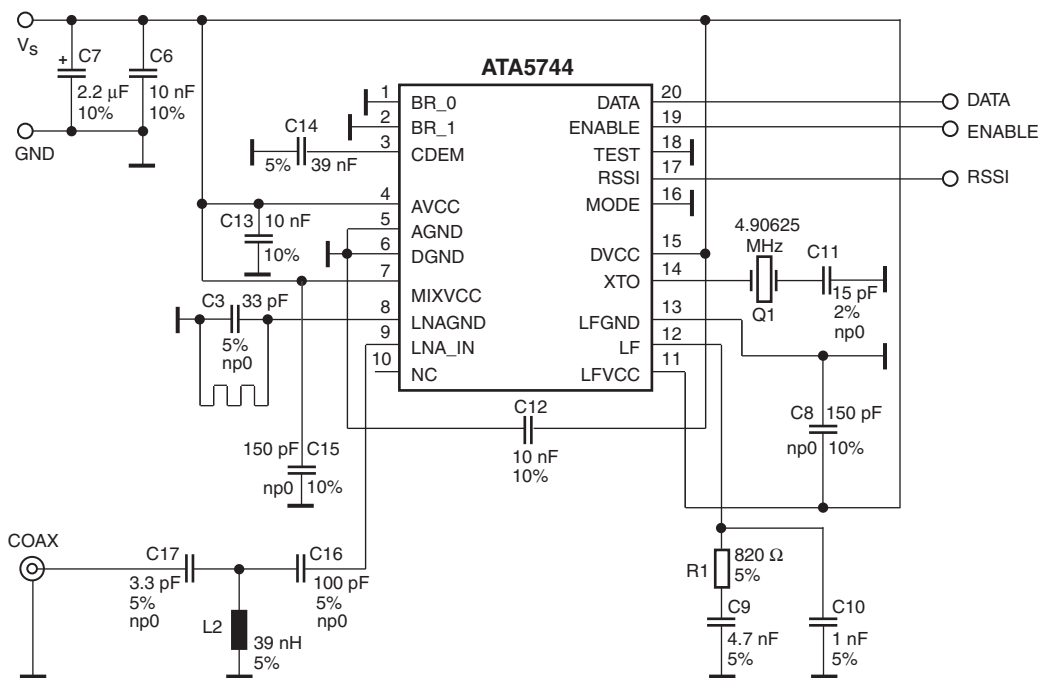
## 10. Electrical Characteristics (continued)

| Parameters                                                                                                                           | Test Conditions                                                                                                                                                                                | Symbol                | Min.                       | Typ.                      | Max.                        | Unit                     |
|--------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|----------------------------|---------------------------|-----------------------------|--------------------------|
| Sensitivity variation for full operating range including IF filter compared to<br>$T_{amb} = 25^{\circ}\text{C}$ , $V_S = 5\text{V}$ | $f_{in} = 433.92\text{ MHz} / 315\text{ MHz}$<br>$f_{IF} = 0.79\text{ MHz to } 1.21\text{ MHz}$<br>$f_{IF} = 0.73\text{ MHz to } 1.27\text{ MHz}$<br>$P_{ASK} = P_{Ref\_ASK} + \Delta P_{Ref}$ | $\Delta P_{Ref}$      | +5.5<br>+7.5               |                           | -1.5<br>-1.5                | dB<br>dB                 |
| S/N ratio to suppress inband noise signals                                                                                           |                                                                                                                                                                                                | SNR                   |                            | 10                        | 12                          | dB                       |
| Dynamic range RSSI amplifier                                                                                                         |                                                                                                                                                                                                | $\Delta R_{RSSI}$     |                            | 60                        |                             | dB                       |
| RSSI output voltage range                                                                                                            |                                                                                                                                                                                                | $V_{RSSI}$            | 1.0                        |                           | 3.0                         | V                        |
| RSSI gain                                                                                                                            |                                                                                                                                                                                                | $G_{RSSI}$            |                            | 20                        |                             | mV/dB                    |
| RI of pin CDEM for cut-off frequency calculation                                                                                     | $f_{cu\_DF} = \frac{1}{2 \times \pi \times R_1 \times CDEM}$                                                                                                                                   | $R_1$                 | 28                         | 40                        | 55                          | k $\Omega$               |
| Recommended CDEM for best performance                                                                                                | BR_Range0<br>BR_Range1<br>BR_Range2<br>BR_Range3                                                                                                                                               | CDEM                  |                            | 33<br>18<br>10<br>6.8     |                             | nF<br>nF<br>nF<br>nF     |
| Upper cut-off frequency data filter                                                                                                  | Upper cut-off frequency<br>BR_Range0<br>BR_Range1<br>BR_Range2<br>BR_Range3                                                                                                                    | $f_u$                 | 1.75<br>3.5<br>7.0<br>14.0 | 2.2<br>4.4<br>8.8<br>17.6 | 2.65<br>5.3<br>10.6<br>21.2 | kHz<br>kHz<br>kHz<br>kHz |
| <b>Digital Ports</b>                                                                                                                 |                                                                                                                                                                                                |                       |                            |                           |                             |                          |
| Data output<br>- Saturation voltage LOW<br>- Internal pull-up resistor                                                               | $I_{ol} = 1\text{ mA}$                                                                                                                                                                         | $V_{OI}$<br>$R_{Pup}$ | 39                         | 0.08<br>50                | 0.3<br>65                   | V<br>k $\Omega$          |
| ENABLE input<br>- Low-level input voltage<br>- High-level input voltage                                                              | Sleep mode<br>Receiving mode                                                                                                                                                                   | $V_{ll}$<br>$V_{lh}$  | $0.8 \times V_S$           |                           | $0.2 \times V_S$            | V<br>V                   |
| MODE input<br>- Low-level input voltage<br>- High-level input voltage                                                                | Division factor = 10<br>Division factor = 14                                                                                                                                                   | $V_{ll}$<br>$V_{lh}$  | $0.8 \times V_S$           |                           | $0.2 \times V_S$            | V<br>V                   |
| BR_0 input<br>- Low-level input voltage<br>- High-level input voltage                                                                |                                                                                                                                                                                                | $V_{ll}$<br>$V_{lh}$  | $0.8 \times V_S$           |                           | $0.2 \times V_S$            | V<br>V                   |
| BR_1 input<br>- Low-level input voltage<br>- High-level input voltage                                                                |                                                                                                                                                                                                | $V_{ll}$<br>$V_{lh}$  | $0.8 \times V_S$           |                           | $0.2 \times V_S$            | V<br>V                   |
| TEST input<br>- Low-level input voltage                                                                                              | Test input must always be set to LOW                                                                                                                                                           | $V_{ll}$              |                            |                           | $0.2 \times V_S$            | V                        |

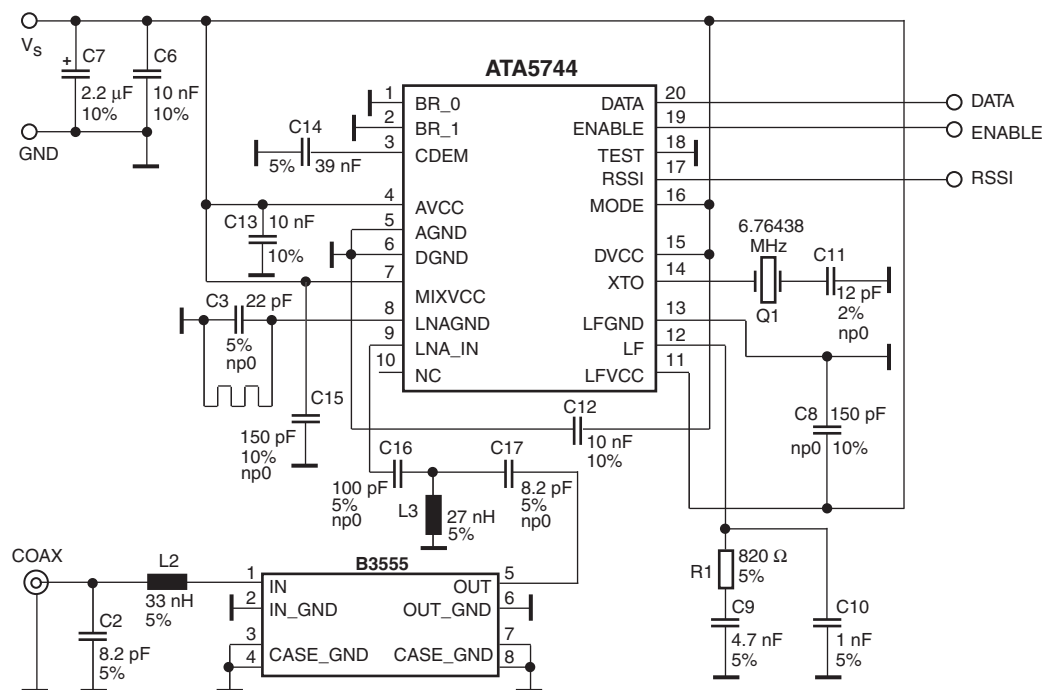
**Figure 10-1.** Application Circuit:  $f_{RF} = 433.92$  MHz, without SAW Filter



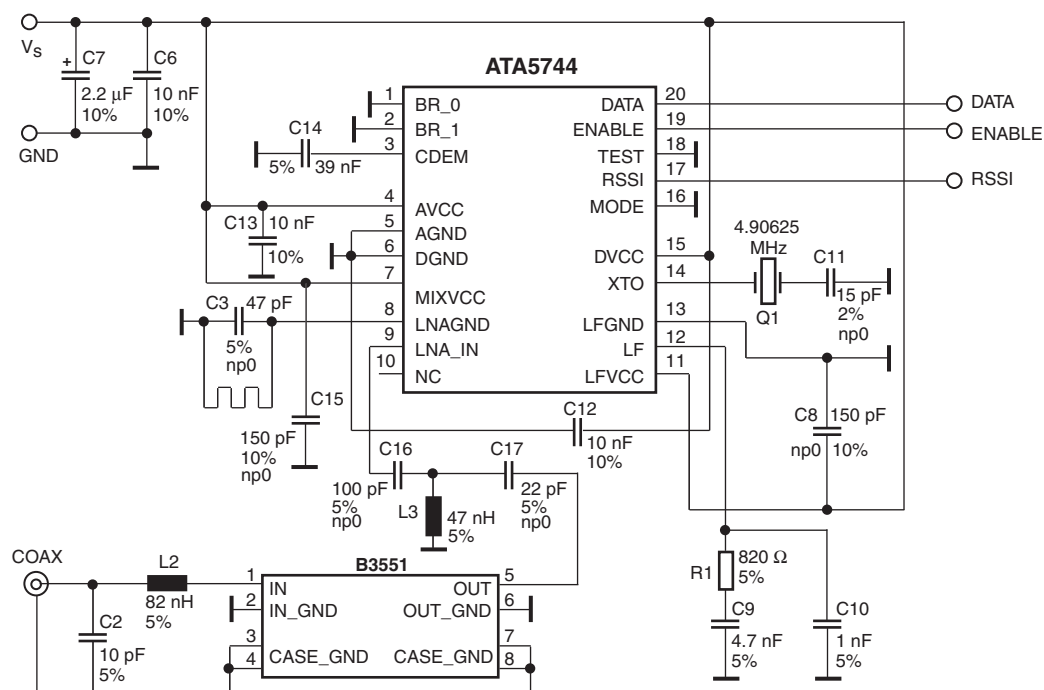
**Figure 10-2.** Application Circuit:  $f_{RF} = 315$  MHz, without SAW Filter



**Figure 10-3.** Application Circuit:  $f_{RF} = 433.92$  MHz, with SAW Filter



**Figure 10-4.** Application Circuit:  $f_{RF} = 315 \text{ MHz}$ , with SAW Filter



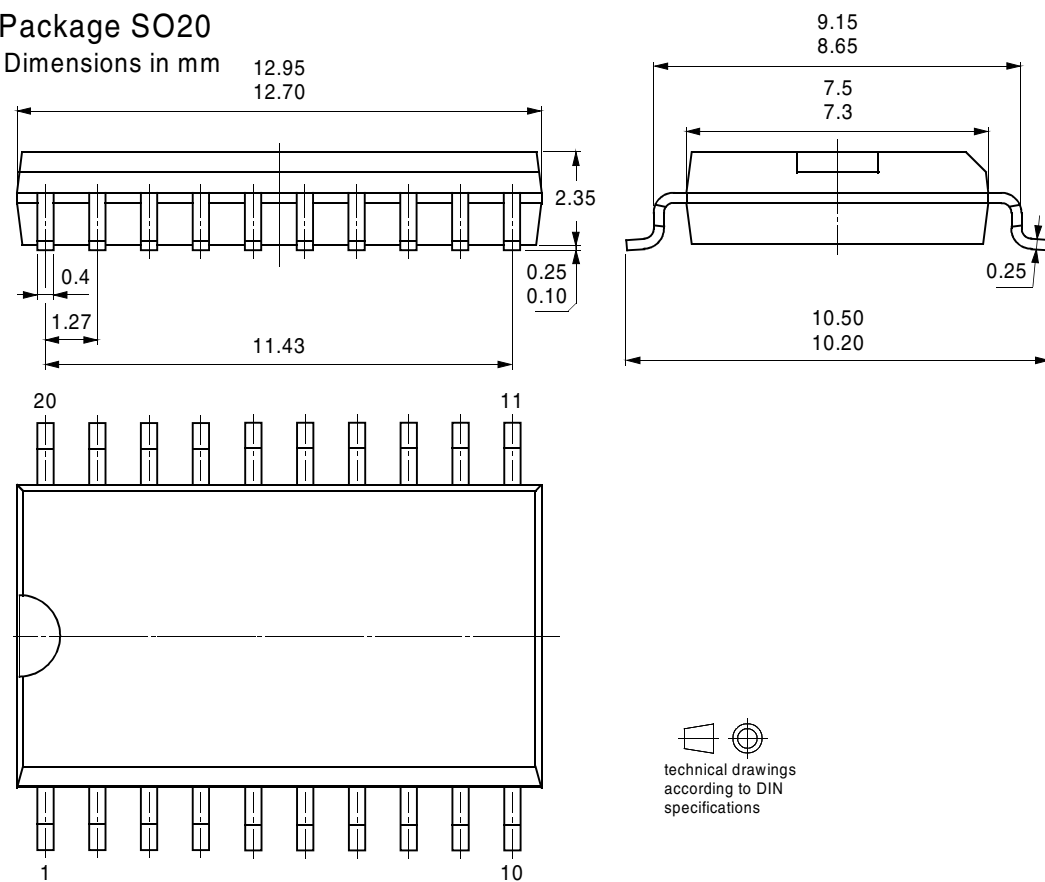
## 11. Ordering Information

| Extended Type Number | Package | Remarks                   |
|----------------------|---------|---------------------------|
| ATA5744N-TKSY        | SSO20   | Tube, Pb-free             |
| ATA5744N-TKQY        | SSO20   | Taped and reeled, Pb-free |
| ATA5744N-TGSY        | SO20    | Tube, Pb-free             |
| ATA5744N-TGQY        | SO20    | Taped and reeled, Pb-free |

## 12. Package Information

### Package SO20

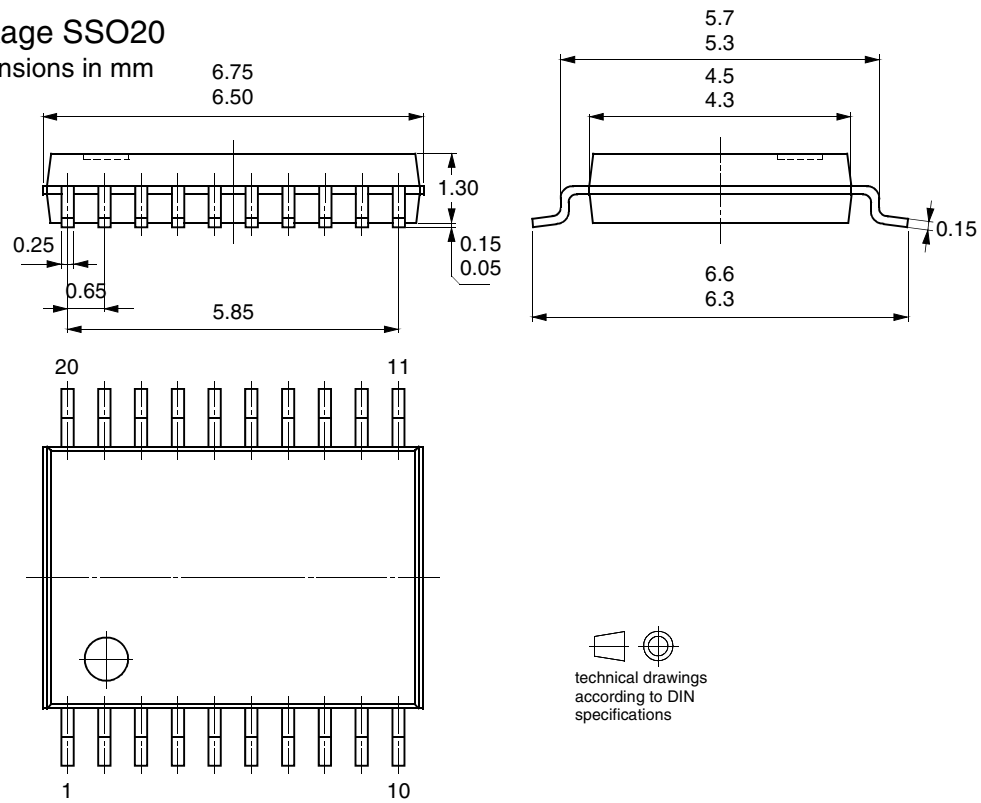
Dimensions in mm



technical drawings  
according to DIN  
specifications

## Package SSO20

Dimensions in mm





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