Features:

- Low cost single conversion superheterodyne receiver architecture
- Compatible with rfPIC™ and rfHCS series of RF transmitters
- Easy interface to PICmicro® microcontroller (MCU) and KEELoo® decoders
- VCO phase locked to quartz crystal reference:
  - Narrow receiver bandwidth
  - Maximizes range and interference immunity
- Selectable LNA gain control for improved dynamic range
- Selectable IF bandwidth via external ceramic IF filter
- Received Signal Strength Indicator (RSSI) for signal strength indication (FSK, FM) and ASK demodulation
- FSK/FM quadrature (phase coincidence) detector demodulator
- 32-Lead LQFP package

UHF ASK/FSK Receiver:

- Single frequency receiver set by crystal frequency
- Receive frequency range:

<table>
<thead>
<tr>
<th>Device</th>
<th>Frequency Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>rfRXD0420</td>
<td>300 MHz to 450 MHz</td>
</tr>
<tr>
<td>rfRXD0920</td>
<td>800 MHz to 930 MHz</td>
</tr>
</tbody>
</table>

- Maximum data rate:
  - ASK: 80 Kbps NRZ
  - FSK: 40 Kbps NRZ
- IF frequency range: 455 kHz to 21.4 MHz
- RSSI range: 70 dB
- Frequency deviation range: ±5 kHz to ±120 kHz
- Maximum FM modulation frequency: 15 kHz

Applications:

- Wireless remote command and control
- Wireless security systems
- Remote Keyless Entry (RKE)
- Low power telemetry
- Low power FM receiver
- Home automation
- Remote sensing

Bi-CMOS Technology:

- Wide operating voltage range
- Low current consumption in Active and Standby modes
  - rfRXD0420
    - 8.2 mA (typical, LNA High Gain mode)
    - <100 nA standby
  - rfRXD0920
    - 9.2 mA (typical, LNA High Gain mode)
    - <100 nA standby
- Wide temperature range:
  - Industrial: -40°C to +85°C
1.0 DEVICE OVERVIEW

The rfRXD0420/0920 are low cost, compact single frequency short-range radio receivers requiring only a minimum number of external components for a complete receiver system. The rfRXD0420 covers the receive frequency range of 300 MHz to 450 MHz and the rfRXD0920 covers 800 MHz to 930 MHz. The rfRXD0420 and rfRXD0920 share a common architecture. They can be configured for Amplitude Shift Keying (ASK), Frequency Shift Keying (FSK), or FM modulation. The rfRXD0420/0920 are compatible with rfPIC™ and rfHCS series of RF transmitters.

- High frequency stability over temperature and power supply variations
- Low spurious signal emission
- High large-signal handling capability with selectable LNA gain control for improved dynamic range
- Selectable IF bandwidth via external low cost ceramic IF filter. The IF Frequency range is selectable between 455 kHz to 21.4 MHz. This facilitates the use of readily available low cost 10.7 MHz ceramic IF filters in a variety of bandwidths.
- ASK or FSK for digital data reception
- FM modulation for analog signal reception
- FSK/FM demodulation using quadrature detector (phase coincidence detector)
- Received Signal Strength Indication (RSSI) for signal strength indication and ASK detection
- Wide supply voltage range
- Low active current consumption
- Very low standby current

The rfRXD0420/0920 is a single conversion superheterodyne architecture. A block diagram is illustrated in Figure 1-1. The rfRXD0420/0920 consists of:

- Low-noise amplifier (LNA) - Gain selectable
- Mixer for down-conversion of the RF signal to the Intermediate Frequency (IF) followed by an IF preamplifier
- Fully integrated Phase-Locked Loop (PLL) frequency synthesizer for generation of the Local Oscillator (LO) signal. The frequency synthesizer consists of:
  - Crystal oscillator
  - Phase-frequency detector and charge pump
  - High-frequency Voltage Controlled Oscillator (VCO)
  - Fixed feedback divider
    - rfRXD0420 = divide by 16
    - rfRXD0920 = divide by 32
- IF limiting amplifier to amplify and limit the IF signal and for Received Signal Strength Indication (RSSI) generation
- Demodulator (DEMOD) section consists of a phase detector (MIXER2) and amplifier creating a quadrature detector (also known as a phase coincidence detector) to demodulate the IF signal in FSK and FM modulation applications
- Operational amplifier (OPA) that can be configured as a comparator for ASK or FSK data decision or as a filter for FM modulation.
- Bias circuitry for bandgap biasing and circuit shutdown
FIGURE 1-1: rfRXD0420/0920 BLOCK DIAGRAM
## TABLE 1-1: rfRXD0420/0920 PINOUT I/O DESCRIPTION

<table>
<thead>
<tr>
<th>Pin Name</th>
<th>Pin Number</th>
<th>Pin Type</th>
<th>Buffer Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>LNA GAIN</td>
<td>2</td>
<td>I</td>
<td>CMOS</td>
<td>LNA gain control (with hysteresis)</td>
</tr>
<tr>
<td>LNA OUT</td>
<td>3</td>
<td>O</td>
<td>Analog</td>
<td>LNA output (open collector)</td>
</tr>
<tr>
<td>1IF IN</td>
<td>4</td>
<td>I</td>
<td>Analog</td>
<td>1st IF stage input</td>
</tr>
<tr>
<td>1IF +</td>
<td>6</td>
<td>--</td>
<td>Analog</td>
<td>MIXER1 bias (open collector)</td>
</tr>
<tr>
<td>1IF -</td>
<td>7</td>
<td>--</td>
<td>Analog</td>
<td>MIXER1 bias (open collector)</td>
</tr>
<tr>
<td>1F OUT</td>
<td>9</td>
<td>O</td>
<td>Analog</td>
<td>1st IF stage output</td>
</tr>
<tr>
<td>2IF IN</td>
<td>11</td>
<td>I</td>
<td>Analog</td>
<td>2nd IF stage input</td>
</tr>
<tr>
<td>FBC1</td>
<td>12</td>
<td>--</td>
<td>Analog</td>
<td>Limiter IF Amplifier external feedback capacitor</td>
</tr>
<tr>
<td>FBC2</td>
<td>13</td>
<td>--</td>
<td>Analog</td>
<td>Limiter IF Amplifier external feedback capacitor</td>
</tr>
<tr>
<td>2F OUT</td>
<td>15</td>
<td>O</td>
<td>Analog</td>
<td>2nd IF stage output</td>
</tr>
<tr>
<td>DEM IN</td>
<td>16</td>
<td>I</td>
<td>Analog</td>
<td>Demodulator input</td>
</tr>
<tr>
<td>OPA</td>
<td>18</td>
<td>O</td>
<td>Analog</td>
<td>Operational amplifier output</td>
</tr>
<tr>
<td>OPA -</td>
<td>19</td>
<td>I</td>
<td>Analog</td>
<td>Operational amplifier input (negative)</td>
</tr>
<tr>
<td>OPA +</td>
<td>20</td>
<td>I</td>
<td>Analog</td>
<td>Operational amplifier input (positive)</td>
</tr>
<tr>
<td>RSSI</td>
<td>21</td>
<td>O</td>
<td>Analog</td>
<td>Received signal strength indicator output</td>
</tr>
<tr>
<td>DEM OUT +</td>
<td>23</td>
<td>O</td>
<td>Analog</td>
<td>Demodulator output (positive)</td>
</tr>
<tr>
<td>DEM OUT -</td>
<td>24</td>
<td>O</td>
<td>Analog</td>
<td>Demodulator output (negative)</td>
</tr>
<tr>
<td>XTAL</td>
<td>26</td>
<td>I</td>
<td>Analog</td>
<td>Crystal oscillator input</td>
</tr>
<tr>
<td>ENRX</td>
<td>28</td>
<td>I</td>
<td>CMOS</td>
<td>Receiver enable input</td>
</tr>
<tr>
<td>LF</td>
<td>29</td>
<td>I</td>
<td>Analog</td>
<td>External loop filter connection. Common node of charge pump output and VCO tuning input.</td>
</tr>
<tr>
<td>LNA IN</td>
<td>31</td>
<td>I</td>
<td>Analog</td>
<td>LNA input</td>
</tr>
<tr>
<td>VDD</td>
<td>8, 14, 17, 27, 32</td>
<td>P</td>
<td>Positive supply</td>
<td></td>
</tr>
<tr>
<td>VSS</td>
<td>1, 5, 10, 25, 30</td>
<td>P</td>
<td>Ground reference</td>
<td></td>
</tr>
</tbody>
</table>

Legend:  I = Input, O = Output, I/O = Input/Output, P = Power, CMOS = CMOS compatible input or output
2.0 CIRCUIT DESCRIPTION

This section gives a circuit description of the internal circuitry of the rfRXD0420/0920 receiver. External connections and components are given in the APPLICATION CIRCUITS section.

2.1 Bias Circuitry

Bias circuitry provides bandgap biasing and circuit shutdown capabilities. The ENRX (Pin 28) modes are summarized in Table 2-1. The ENRX pin is a CMOS compatible input and is internally pulled down to Vss.

TABLE 2-1: BIAS CIRCUITRY CONTROL

<table>
<thead>
<tr>
<th>ENRX(1)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Standby mode</td>
</tr>
<tr>
<td>1</td>
<td>Receiver enabled</td>
</tr>
</tbody>
</table>

Note 1: ENRX has internal pull-down to Vss

2.2 Frequency Synthesizer

The Phase-locked Loop (PLL) frequency synthesizer generates the Local Oscillator (LO) signal. It consists of:

- Crystal oscillator
- Phase-frequency detector and charge pump
- Voltage Controlled Oscillator (VCO)
- Fixed feedback divider:
  - rfRXD0420 = divide by 16
  - rfRXD0920 = divide by 32

2.2.1 CRYSTAL OSCILLATOR

The internal crystal oscillator is a Colpitts type oscillator. It provides the reference frequency to the PLL. A crystal is normally connected to the XTAL (Pin 26) and ground. The internal capacitance of the crystal oscillator is 15 pF. Alternatively, a signal can be injected into the XTAL pin from a signal source. The signal should be AC coupled via a series capacitor at a level of approximately 600 mVpp.

2.3 Low Noise Amplifier

The PLL consists of a phase-frequency detector, charge pump, voltage-controlled oscillator (VCO), and fixed divide-by-16 (rfRXD0420) or divide-by-32 (rfRXD0920) divider. The rfRXD0420/0920 employs a charge pump PLL that offers many advantages over the classical voltage phase detector PLL: infinite pull-in range and zero steady state phase error. The charge pump PLL allows the use of passive loop filters that are lower cost and minimize noise. Charge pump PLLs have reduced flicker noise thus limiting phase noise.

An external loop filter is connected to pin LF (Pin 29). The loop filter controls the dynamic behavior of the PLL, primarily lock time and spur levels. The application determines the loop filter requirements.

The VCO gain for the rfRXD0420/0920 receivers are listed in Table 2-2.

TABLE 2-2: PLL PARAMETERS

<table>
<thead>
<tr>
<th>Device</th>
<th>Kvco(1)</th>
<th>Icp(1)</th>
<th>Divider</th>
</tr>
</thead>
<tbody>
<tr>
<td>rfRXD0420</td>
<td>250 MHz/V at 433 MHz</td>
<td>60 µA</td>
<td>16</td>
</tr>
<tr>
<td>rfRXD0920</td>
<td>300 MHz/V at 868 MHz</td>
<td>60 µA</td>
<td>32</td>
</tr>
</tbody>
</table>

Note 1: Typical value

The LF pin is illustrated in Figure 2-2.

FIGURE 2-2: BLOCK DIAGRAM OF LOOP FILTER PIN

The LNA is a high-gain amplifier whose primary purpose is to lower the overall noise figure of the entire receiver thus enhancing the receiver sensitivity. The LNA is an open-collector cascode design. The benefits of a cascode design are:

- high gain with low noise
- high-frequency
- wide bandwidth
- low effective input capacitance with stable input impedance
- high output resistance
- high reverse isolation that provides improved stability and reduces LO leakage
Approximate LNA noise figures are listed in Table 2-3.

**TABLE 2-3: LNA NOISE FIGURES**

<table>
<thead>
<tr>
<th>Device</th>
<th>Noise Figure(1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>rfRXD0420</td>
<td>TBD</td>
</tr>
<tr>
<td>rfRXD0920</td>
<td>TBD</td>
</tr>
</tbody>
</table>

Note 1: Approximate value

LNA\textsubscript{IN} (Pin 31) has an input impedance of approximately 26 \(\Omega\) || 2 pF single-ended.

LNA\textsubscript{OUT} (Pin 3) has an open-collector output and is pulled up to V\textsubscript{DD} via a tuned circuit.

**Important:** To ensure LNA stability the V\textsubscript{SS} pin (Pin 1) must be connected to a low impedance ground.

The LNA pins are illustrated in Figure 2-3.

**FIGURE 2-3: BLOCK DIAGRAM OF LNA PINS**

The gain of the LNA can be selected between High and Low Gain modes by the LNA\textsubscript{GAIN} pin (Pin 2). LNA\textsubscript{GAIN} is a CMOS input with hysteresis. Table 2-4 summarizes the voltage levels and modes for LNA gain.

In the High Gain mode the LNA operates normally. In Low Gain mode the gain of the LNA is reduced approximately 25 dB, reduces total supply current, and increases maximum input signal levels (see Electrical Characteristics section for values).

**TABLE 2-4: LNA GAIN CONTROL**

<table>
<thead>
<tr>
<th>LNA\textsubscript{GAIN}</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 0.8 V</td>
<td>High Gain mode</td>
</tr>
<tr>
<td>&gt; 1.4 V</td>
<td>Low Gain mode</td>
</tr>
</tbody>
</table>

**2.4 MIXER1 and IF Preamp**

MIXER1 performs down-conversion of the RF signal to the Intermediate Frequency (IF) and is followed by an IF preamplifier.

1IF\textsubscript{IN} (Pin 4) has an approximately 33 \(\Omega\) single-ended input impedance. The 1IF\textsubscript{IN} pin is illustrated in Figure 2-4.

The 1IF\textsubscript{+} (Pin 6) and 1IF\textsubscript{-} (Pin 7) are bias connections to the MIXER1 balanced collectors. Both pins are open-collector outputs and are individually pulled up to V\textsubscript{DD} by a load resistor. The MIXER1 bias pins are illustrated in Figure 2-5.

1IF\textsubscript{OUT} (Pin 9) has an approximately 330 \(\Omega\) single-ended output impedance. The 330 \(\Omega\) impedance provides a direct match to low cost ceramic IF filters. The 1IF\textsubscript{OUT} pins is illustrated in Figure 2-6.

**FIGURE 2-4: BLOCK DIAGRAM OF MIXER1 PIN**

**FIGURE 2-5: BLOCK DIAGRAM OF MIXER1 BIAS PINS**

**FIGURE 2-6: BLOCK DIAGRAM OF IF PREAMP PIN**

**2.5 IF Limiting Amplifier with RSSI**

The IF Limiting Amplifier amplifies and limits the IF signal at the 2IF\textsubscript{IN} pin (Pin 11). It also generates the Received Signal Strength Indicator (RSSI) signal (Pin 21).

**2.5.1 IF LIMITING AMPLIFIER**

Magnitude control circuitry is used in the last stage of the receiver to keep the signal constant for demodulation. It can consist of a limiting or Automatic Gain Control (AGC) amplifier. A limiting amplifier is
employed in this design because it can handle a larger
dynamic range while consuming less power with simple
circuitry than AGC circuitry.

The internal resistance of the 2IF\textsubscript{IN} pin is approximately
2.2 kΩ. In order to terminate ceramic IF filters whose
output impedance is 330 Ω, a 390 Ω resistor can be
paralleled to the 2IF\textsubscript{IN} and FBC2 pins.

FBC1 (Pin 12) and FBC2 (Pin 13) are connected to
external feedback capacitors.

The IF Limiting Amplifier pins are illustrated in
Figures 2-7 and 2-8.

2.5.2 RECEIVED SIGNAL STRENGTH
INDICATOR (RSSI)

The RSSI signal is proportional to the log of the signal
at 2IF\textsubscript{IN}. The 2IF\textsubscript{IN} input RSSI range is approximately
40 µV to 160 mV. The slope of the RSSI output is
approximately 26 mV/dB of RF signal.

The RSSI output has an internal 36 kΩ resister to Vss
fed by a current source. This resister converts the
RSSI current to voltage.

For Amplitude Shift Keying (ASK) demodulation, RSSI
is compared to a reference voltage (static or dynamic).
Post detector filtering is easily implemented by
connecting a capacitor to ground from the RSSI pin
effectively creating an RC filter with the internal 36 kΩ
resister.

For FSK and FM demodulation, the RSSI represents
the received signal strength of the incoming RF signal.

2.6 Demodulator

The demodulator (DEMOD) section consists of a phase
detector (MIXER2) and amplifier creating a quadrature
detector (also known as a phase coincidence detector)
to demodulate the IF signal in FSK and FM modulation
applications. The quadrature detector provides all the
IF functions required for FSK and FM demodulation
with only a few external parts.

The in-phase signal comes directly from the output of
the IF limiting amplifier to MIXER2. The quadrature
signal is created by an external tuned circuit from the
output of the IF limiting amplifier (2IF\textsubscript{OUT}, Pin 15) AC-
coupled to the MIXER2 DEM\textsubscript{IN} (Pin 16) input. The input
impedance of the DEM\textsubscript{IN} pin is approximately 47 kΩ.

The external tuned circuit can be constructed from sim-
ple inductor-capacitor (LC) components but will require
one of the elements to be tunable. A no-tune solution
can be constructed with a ceramic discriminator.

The output voltage of the DEMOD amplifier (DEMout+ and
DEMout-, Pins 23 and 24) depends on the peak
deveation of the FSK or FM signal and the Q of the
external tuned circuit. DEMout+ and DEMout- are high
impedance outputs with only a 20 µA current capability.

The Demodulator pins are illustrated in Figures 2-10 and
2-11.
2.7 Operational Amplifier

The internal operational amplifier (OPA) can be configured as a comparator for ASK or FSK or as a filter for FM modulation applications.

The Op Amp pins are illustrated in Figures 2-12 and 2-13.

FIGURE 2-11: BLOCK DIAGRAM OF DEMODULATOR OUTPUT PINS

FIGURE 2-12: BLOCK DIAGRAM OF OP AMP INPUT PINS

FIGURE 2-13: BLOCK DIAGRAM OF OP AMP OUTPUT PIN
3.0 APPLICATION CIRCUITS

This section provides general information on application circuits for the rfRXD0420/0920 receiver. The following connections and external components provide starting points for designs and list the minimum circuitry recommended for general purpose applications.

Performance of the radio system (transmitter and receiver) is affected by component selection and the environment in which it operates. Each system design has its own unique requirements. Specifications for a particular design requires careful analysis of the application and compromises for a practical implementation.

3.1 General

This subsection lists connections and components that are common between applications. The following subsections give specific circuit connections and components for ASK, FSK and FM applications.

3.1.1 BYPASS CAPACITORS

Bypass capacitors should be placed as physically close as possible to VDD pins 8, 14, 17, 27 and 32 respectively. Additional bypassing and board level low-pass filtering of the power supply may be required depending on the application.

3.1.2 FREQUENCY PLANNING

The rfRXD0420/0920 receivers are single-conversion superheterodyne architecture with a single IF frequency. The receive frequency is set by the crystal frequency (fXTAL) and intermediate frequency (fIF). For a majority of applications an external crystal is connected to XTAL (Pin 26). Figure 3-1 illustrates an example circuit with an optional trim capacitor.

![FIGURE 3-1: XTAL EXAMPLE CIRCUIT WITH OPTIONAL TRIM CAPACITOR](image)

The crystal load capacitance should be specified to include the internal load capacitance of the XTAL pin of 15 pF plus PCB stray capacitance (approximately 2 to 3 pF). A trim capacitor can be used to trim the crystal on frequency within the limitations of the crystal’s trim sensitivity and pullability. Figure 3-2 illustrates the effect the trim capacitor has on the receive frequency for the rfRXD0420 at 433.92 MHz. Keep in mind that this graph represents one example circuit and the actual results depends on the crystal and PCB layout.

![FIGURE 3-2: RECEIVE FREQUENCY VS. TRIM CAPACITANCE](image)

Note that a 0 Ω resistor, in the lower left of the graph, represents an infinite capacitance. This will be the lowest frequency obtainable for the crystal and PCB combination.

Calculation of the crystal frequency requires knowledge of the receive frequency (fRF) and intermediate frequency (fIF). Figure 3-3 is a worksheet to assist the designer in calculating the crystal frequency. Table 3-1 lists crystal frequencies for popular receive frequencies. Table 3-2 lists crystal parameters required for ordering crystals. For background information on crystal selection see Application Note AN826, Crystal Oscillator Basics and Crystal Selection for rfPICTM and PICmicro® Devices.

<table>
<thead>
<tr>
<th>TABLE 3-1: CRYSTAL FREQUENCIES FOR POPULAR RECEIVE FREQUENCIES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Receive Frequency</td>
</tr>
<tr>
<td>-------------------</td>
</tr>
<tr>
<td>rfRXD0420</td>
</tr>
<tr>
<td>315 MHz</td>
</tr>
<tr>
<td>433.92 MHz</td>
</tr>
<tr>
<td>rfRXD0920</td>
</tr>
<tr>
<td>868.3 MHz</td>
</tr>
<tr>
<td>915 MHz</td>
</tr>
<tr>
<td>(1) Low-side injection (2) High-side injection</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>TABLE 3-2: CRYSTAL PARAMETERS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parameter</td>
</tr>
<tr>
<td>Frequency:</td>
</tr>
<tr>
<td>Mode:</td>
</tr>
<tr>
<td>Load Capacitance:</td>
</tr>
<tr>
<td>ESR:</td>
</tr>
</tbody>
</table>

These values are for design guidance only.
FIGURE 3-3: FREQUENCY PLANNING WORKSHEET

Step 1: Identify receive ($f_{rf}$) and IF frequency ($f_{if}$).

$$f_{rf} = \underline{\text{____________________}}$$

$$f_{if} = \underline{\text{____________________}}$$

Step 2: Calculate crystal frequencies for high- and low-side injection:

**High-side Injection**

$$f_{XTAL\text{-}HIGH} = \frac{f_{rf} + f_{if}}{\text{PLL divide ratio}} = \frac{16}{32} \text{ if rfRXD0420}$$

**Low-side Injection**

$$f_{XTAL\text{-}LOW} = \frac{f_{rf} - f_{if}}{\text{PLL divide ratio}} = \frac{16}{32} \text{ if rfRXD0920}$$

Step 3: Calculate Local Oscillator (LO) frequencies ($f_{lo}$) using $f_{XTAL\text{-}HIGH}$ and $f_{XTAL\text{-}LOW}$:

**High-side Injection**

$$f_{lo\text{-}HIGH} = f_{XTAL\text{-}HIGH} \times \text{PLL Divide Ratio} = \underline{\text{____________________}} \times \frac{16}{32} \text{ if rfRXD0420}$$

**Low-side Injection**

$$f_{lo\text{-}LOW} = f_{XTAL\text{-}LOW} \times \text{PLL Divide Ratio} = \underline{\text{____________________}} \times \frac{16}{32} \text{ if rfRXD0920}$$

Step 4: Select high-side injection ($f_{lo\text{-}HIGH}$) or low-side injection ($f_{lo\text{-}LOW}$) that corresponds to the LO frequency that is between the ranges of:

<table>
<thead>
<tr>
<th>Device</th>
<th>LO Frequency Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>rfRXD0420</td>
<td>300 to 430 MHz</td>
</tr>
<tr>
<td>rfRXD0920</td>
<td>800 to 915 MHz</td>
</tr>
</tbody>
</table>

Step 5: From the chosen injection mode in Step 4, write the selected crystal frequency ($f_{XTAL}$) and circle injection mode.

$$f_{XTAL} = \underline{\text{____________________}} \quad \text{(circle one)}$$

High-side Injection  Low-side Injection

Step 6: Calculate image frequency ($f_{rf\text{-image}}$) for the Injection mode chosen:

**if High-side Injection**

$$f_{rf\text{-image}} = f_{rf} + (2 \times f_{if}) = \underline{\text{____________________}} + (2 \times \underline{\text{____________________}}) = \underline{\text{____________________}}$$

**if Low-side Injection**

$$f_{rf\text{-image}} = f_{rf} - (2 \times f_{if}) = \underline{\text{____________________}} - (2 \times \underline{\text{____________________}}) = \underline{\text{____________________}}$$

Note: Image frequency should be sufficiently filtered by the preselector for the application.
3.1.3 PLL LOOP FILTER

An external PLL loop filter is connected to pin LF (Pin 29). The loop filter controls the dynamic behavior of the PLL, primarily lock time and spur levels. Generally, the PLL lock time is a small fraction of the overall receiver start-up time (see Electrical Characteristics Section). The crystal oscillator is the largest contributor to start-up time. Thus, for the majority of applications, design loop filter values for a wide loop bandwidth to suppress noise. Figure 3-4 illustrates an example filter circuit for a wide frequency range suitable for a majority of applications.

**FIGURE 3-4: PLL LOOP FILTER EXAMPLE CIRCUIT**

![PLL Loop Filter Example Circuit](image)

3.1.4 PRESELECTOR

Receiver performance is heavily influenced by the preselector (also known as the front-end filter). The purpose of the preselector is to filter unwanted signals and noise from entering the receiver.

The most important unwanted signal is the image frequency ($f_{\text{rf-image}}$). Pay particular attention to the image frequency calculated in Figure 3-3 as this will be the frequency that needs to be filtered out by the preselector.

The preselector can be designed using a simple LC filter or a Surface Acoustic Wave (SAW) filter. A simple LC filter provides a low cost solution but will have the least effect filtering the image frequency. A SAW filter can effectively filter the image frequency with a minimum of 40 dB attenuation.

The SAW filter has the added advantage of filtering wide-band noise and improving the signal-to-noise ratio (SNR) of the receiver.

SAW filters require impedance matching. Refer to the manufacturers' data sheet and application notes for SAW filter pinouts, specified impedances and recommended matching circuits. Figure 3-5 shows a SAW filter example circuit.

A secondary purpose of the preselector is to provide impedance matching between the antenna and LNAIN (Pin 31).

3.1.5 ANTENNA

Receiver performance and device packaging influence antenna selection. There are many third-party antennas to choose from. Third-party antennas typically have an impedance of 50 Ω. The preselector components should be chosen to match the impedance of the antenna to the LNAIN (Pin 31) impedance of $26 \ \Omega \parallel 2 \ \text{pF}$. The designer can chose to use a simple wire antenna. The length of the wire should be one-quarter the wavelength ($\lambda$) of the receive frequency. For example, the wavelength of 433.92 MHz is:

\[
\lambda = \frac{c}{f_{\text{rf}}} \\
= \frac{3 \times 10^8 \text{ m/s}}{433.92 \times 10^6 \text{ Hz}} \\
= 0.69 \text{ m}
\]

Therefore

\[
0.25\lambda = 17.3 \text{ cm or 6.8 inches}
\]

Finally, the wire antenna should be impedance matched to the preselector. The typical impedance of a one-quarter wavelength wire antenna is 36 Ω.

3.1.6 LNA GAIN

For a majority of applications, LNAGAIN can be tied to Vss (ground) enabling High Gain mode. If the application requires short range communications, LNAGAIN can be tied to Vdd (pulled up) enabling Low Gain mode.

More Information on LNAGAIN operation can be found in the Circuit Description section.

**FIGURE 3-5: SAW FILTER EXAMPLE CIRCUIT**

![SAW Filter Example Circuit](image)

Note: Refer to SAW filter manufacturer's data sheet for pin outs and values for impedance matching components.
3.1.7 LNA TUNED CIRCUIT

The LNAOUT (Pin 3) has an open-collector output. It is pulled up to VDD via a tuned circuit. It is also connected to 1IFIN (Pin 4) via a series decoupling capacitor. The 1IFIN input impedance is approximately 33 Ω || 1.5 pF.

**Important:** To ensure LNA stability the Vss pin (Pin 1) must be connected to a low impedance ground.

As shown in Figure 3-6, components C1 and L1 make up the tuned circuit and provide collector current via pull-up. Together with decoupling capacitor C2, they provided impedance matching between the LNA and MIXER1. To a lesser extent, C1, L1, and C2 provide band-pass filtering at the receive frequency (f_{rf}).

Component values depend on the selected receive frequency. The challenge is to design the circuit with the fewest components setting Q as high as possible as limited by component tolerances. For a majority of applications it is best to design a wide bandwidth tuned circuit to account for manufacturing and component tolerances. The best approach is to design the tuned circuit using a filter simulation program. Table 3-3 lists example component values for popular receive frequencies.

![Figure 3-6: LNA Output to MIXER1 Example Circuit](image)

<table>
<thead>
<tr>
<th>f_{rf}</th>
<th>C1</th>
<th>L1</th>
<th>C2</th>
</tr>
</thead>
<tbody>
<tr>
<td>315 MHz</td>
<td>7.0 pF</td>
<td>22 nH</td>
<td>6.0 pF</td>
</tr>
<tr>
<td>433.92 MHz</td>
<td>3.0 pF</td>
<td>15 nH</td>
<td>6.0 pF</td>
</tr>
<tr>
<td>868.3 MHz</td>
<td>2.0 pF</td>
<td>7.6 nH</td>
<td>3.0 pF</td>
</tr>
<tr>
<td>915 MHz</td>
<td>2.0 pF</td>
<td>6.8 nH</td>
<td>3.0 pF</td>
</tr>
</tbody>
</table>

These values are for design guidance only.

3.1.8 MIXER1 BIAS

The 1IF+ (Pin 6) and 1IF- (Pin 7) are bias connections to the MIXER1 balanced collectors. Both pins are open-collector outputs and are individually pulled up to VDD by a load resistor. Figure 3-7 shows a MIXER1 bias example circuit.

![Figure 3-7: MIXER1 Bias Example Circuit](image)

3.1.9 INTERMEDIATE FREQUENCY (IF) FILTER

The IF filter defines the overall adjacent signal selectivity of the receiver. For a majority of applications, low-cost 10.7 MHz ceramic IF filters are used. These are available in a variety of bandwidths and packages.

IF filter bandwidth selection is a function of:

- modulation (ASK, FSK or FM)
- signal bandwidth
- frequency and temperature tolerances of the transmitter and receiver components

The typical input and output impedance of ceramic filters is 330 Ω. 1IFOUT (Pin 9) has an approximately 330 Ω single-ended output impedance and provides a direct match to the ceramic IF filter. The internal resistance of the 2IFIN (Pin 11) is approximately 2.2 kΩ. In order to terminate ceramic IF filters a 390 Ω resistor can be paralleled to the 2IFIN and FBC2 (Pin 13). Figure 3-8 shows an example circuit schematic using a 10.7 MHz ceramic IF filter.

3.1.10 IF LIMITING AMPLIFIER EXTERNAL FEEDBACK CAPACITORS

FBC1 (Pin 12) and FBC2 (Pin 13) are connected to external feedback capacitors. Figure 3-8 shows component values and connections for these capacitors.
FIGURE 3-8: IF FILTER, LIMITING AMPLIFIER AND DEMODULATOR BLOCK DIAGRAM
FIGURE 3-9:  ASK APPLICATION CIRCUIT
3.2 Amplitude Shift Keying (ASK)

Figure 3-9 illustrates an example ASK applications circuit.

The IF Limiting Amplifier with RSSI is used as an ASK detector. The RSSI signal is post detector filtered and then compared to a reference voltage to determine if the incoming RF signal is a logical one or zero. The reference voltage can be configured as a dynamic voltage level determined by the incoming RF signal strength or by a predetermined fixed level.

3.2.1 RSSI POST DETECTOR FILTERING

The RSSI signal is low-passed filtered to remove high frequency and pulse noise to aid the decision making process of the comparator and increase the sensitivity of the receiver. The RSSI signal low-pass filter is a RC filter created by the RSSI output impedance of 36 kΩ and capacitor C1. Setting the time constant (RC = \( \tau \)) of the RC filter depends on the signal period and when the signal decision will be made.

3.2.1.1 Signal Period

Optimum sensitivity of the receiver with reasonable pulse distortion occurs when the RC filter time constant is between 1 and 2 times the signal period. If the time constant of the RC filter is set too short, there is little noise filtering benefit. However, if the time constant of the RC filter is set too long, the data pulses will become elongated causing inter-symbol interference.

3.2.1.2 Signal Decision

If the bit decision occurs in the center of the signal period (such as KEELOQ decoders), then one or two times the RC filter time constant should be set at less than or equal to half the signal period. Figure 3-10 illustrates this method. The top trace represents the received on-off keying (OOK) signal. The bottom trace shows the RSSI signal after the RC low-pass filter.

3.2.2 COMPARATOR

The internal operational amplifier is configured as a comparator. The RSSI signal is applied to OPA+ (Pin 20) and compared with a reference voltage on OPA- (Pin 19) to determine the logic level of the received signal. The reference voltage can be dynamic or static.

The choice of dynamic versus static reference voltage depends in part on the ratio of logical ones versus zeros of the data (this can also be thought of as the AC content of the data). Provided the ratio has an even number of logical ones versus zeros, a dynamic reference voltage can be generated with a simple low-pass filter. The advantage of the dynamic reference voltage is the increased receiver sensitivity compared to a fixed reference voltage. However, the comparator will output random data. The decoder (for example, a programmed PICmicro MCU or KEELOQ decoder) must distinguish between random noise and valid data.

The choice of a static reference voltage depends in part on the DC content of the data. That is, the data has an uneven number of logical ones versus zeros. The disadvantage of the static reference voltage is decreased receiver sensitivity compared to a dynamic reference voltage. In this case, the comparator will output data without random noise.
3.2.2.1 DYNAMIC REFERENCE VOLTAGE

A dynamic reference voltage can be derived by averaging the received signal with a low-pass filter. The example ASK application circuit shown in Figure 3-9, the low-pass filter is formed by R1 and C2. The output of the low-pass filter is then fed to OPA-.

The setting of the R1-C2 time constant depends on the ratio of logical ones versus zeros and a trade off in stability versus receiver reaction time. If the received signal has an even number of logical ones versus zeros, the time constant can be set relatively short. Thus the reference voltage can react quickly to changes in the received signal amplitude and differences in transmitters. However, it may not be as stable and can fluctuate with the ratio of logical ones and zeros. If the time constant is set long, the reference voltage will be more stable. However, the receiver cannot react as quickly upon the reception of a received signal.

Selection of component values for R1 and C2 is an iterative process. First start with a time constant between 10 to 100 times the signal rate. Second, view the reference voltage against the RSSI signal to determine if the values are suitable. Figure 3-12 is an oscilloscope screen capture of an incoming RF square wave modulated signal (ASK on-off keying). The top trace is the data output of OPA (Pin 18). The two bottom traces are the RSSI signal (Pin 21, bottom square wave) and generated reference voltage (Pin 19, bottom trace centered in the RSSI square wave). The goal is to select values for R1 and C2 such that the reference voltage is in the middle of the RSSI signal. This reference voltage level provides the optimum data comparison of the incoming data signal.

3.2.2.2 STATIC REFERENCE VOLTAGE

A static reference voltage can be derived by a voltage divider network.

FIGURE 3-12: RSSI AND REFERENCE VOLTAGE COMPARISON
FIGURE 3-13: FSK APPLICATION CIRCUIT
3.3 Frequency Shift Keying (FSK)

Figure 3-13 illustrates an example FSK application circuit.

3.3.1 IF FILTER CONSIDERATIONS

As mentioned in the Section 3.1 above, IF filter bandwidth selection is a function of:
- modulation (ASK, FSK or FM)
- signal bandwidth
- frequency and temperature tolerances of the transmitter and receiver components

The occupied bandwidth of binary FSK signals is 2 times the peak frequency deviation plus 2 times the signal bandwidth. For example, if the data rate is 2400 bits per second Manchester encoded, the signal bandwidth is 4800 baud or 1200 Hz, and if the peak frequency deviation is 24 kHz, the minimum bandwidth of the IF filter is:

$$IF\ BW_{min} = (2 \times 2400) + (2 \times 24000)$$

$$IF\ BW_{min} = 52800\ Hz$$

Add to this value the frequency and temperature tolerances of the transmitter and receiver components.

FSK signals are more sensitive to group delay variations of the IF filter. Therefore, a filter with a low group delay variation should be used. As an alternative, a filter with wider than required bandwidth can be used because the group delay variation in the center of the bandpass will be relatively constant.

3.3.2 FSK DETECTOR

The demodulator (DEMOD) section consists of a phase detector (MIXER2) and amplifier creating a quadrature detector (also known as a phase coincidence detector) to demodulate the IF signal in FSK and FM modulation applications. The in-phase signal comes directly from the output of the IF limiting amplifier to MIXER2. The quadrature signal is created by an external tuned circuit from the output of the IF limiting amplifier (2IFOUT, Pin 15) AC-coupled to the MIXER2 DEMIN (Pin 16) input.

3.3.2.1 LC Discriminator

The external tuned circuit can be constructed from simple inductor-capacitor (LC) components. This type circuit produces and excellent output. However, one of the elements (L or C) must be tunable. Figure 3-14 illustrates an example LC discriminator circuit using a tunable capacitor. A similar circuit with a tunable inductor is also possible. Resistor R1 = 4.7 kΩ reduces the Q of the circuit so that frequency deviations of up to 75 kHz can be demodulated.

3.3.2.2 Ceramic Discriminator

A no-tune solution can be constructed with a ceramic discriminator. Figure 3-15 illustrates an example ceramic discriminator circuit.

The ceramic discriminator acts as a parallel tuned circuit at the IF frequency (for example, 10.7 MHz). The parallel capacitor C3 tunes the ceramic resonator. The high Q of this circuit enables higher output of the detector for small frequency deviations. However, smaller frequency deviations require better frequency tolerances at the transmitter and receiver.

In order to detect wider deviation or off-frequency signals, the detector bandwidth has to be increased. This can be accomplished by reducing the Q of the tuned circuit. One method is to parallel a resistor across the ceramic discriminator. A second is to increase the value of the coupling capacitor C1 increasing the load on the detector. The result of reducing the Q of the discriminator will be that the detector output will be smaller.
3.3.3 POST DETECTOR FILTERING

Care should be taken in selecting the values of capacitors C1 and C2 (Figure 3-13) so that the output of the detector is not distorted and receiver sensitivity improved. These values are chosen depending on the data signal rate.

Generally, if the data signal rate is fast then the filter time constant can be set short. Conversely, if the signal rate is slow, the filter time constant can be set long. The designer should observe the output of the detector with an oscilloscope and perform operational and/or bit error rate testing to confirm receiver performance.

3.3.4 COMPARATOR

The output of the DEMOD amplifier (DEMOUT+ and DEMOUT-, Pins 23 and 24) depends on the peak deviation of the FSK or FM signal and the Q of the external tuned circuit. DEMout+ and DEMout- are high impedance outputs with only a 20 μA current capability. The capacitance on these pins limit the maximum data signal rate. The nominal output voltage of these pins is 1.23V.
FIGURE 3-16: FM APPLICATION CIRCUIT
3.4 Frequency Modulation (FM)

Figure 3-16 illustrates an example FM application circuit.

3.4.1 FSK DETECTOR

FM demodulation is performed in the same manner as described in the FSK section above.

3.4.2 OPERATIONAL AMPLIFIER

The internal operational amplifier is configured as an active low-pass filter.

FM audio is typically de-emphasized. It is recommended that de-emphasis circuitry be connected at the output of the operational amplifier rather than the output of the detector.
4.0 ELECTRICAL CHARACTERISTICS

Absolute Maximum Ratings

Supply voltage: 0 to +7.0V
Input voltage: -0.3 to Vcc+0.3V
Input RF level: 10dBm
Storage temperature: -40 to +125°C

† NOTICE: Stresses above 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 those or any other conditions above those indicated in the operation listings of this specification is not implied. Exposure to maximum rating conditions for extended periods may affect device reliability.
4.1 DC Characteristics: rfRXD0420 (Industrial)

<table>
<thead>
<tr>
<th>Param No.</th>
<th>Sym</th>
<th>Characteristic</th>
<th>Min</th>
<th>Typ†</th>
<th>Max</th>
<th>Units</th>
<th>Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>VCC</td>
<td>Supply Voltage</td>
<td>2.5</td>
<td>—</td>
<td>5.5</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2.7</td>
<td>—</td>
<td>5.5</td>
<td>V</td>
<td>f_{rf} &lt; 400 MHz</td>
</tr>
<tr>
<td>ISTBY</td>
<td>Standby Current</td>
<td>5.0</td>
<td>6.5</td>
<td>8.0</td>
<td>mA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ICC</td>
<td>Supply Current</td>
<td>6.5</td>
<td>8.2</td>
<td>10.0</td>
<td>mA</td>
<td>ENRX = 0</td>
<td></td>
</tr>
<tr>
<td>VOPA</td>
<td>Op Amp input voltage offset</td>
<td>-20</td>
<td>—</td>
<td>20</td>
<td>mV</td>
<td>LNAAGAIN = 1</td>
<td></td>
</tr>
<tr>
<td>IOPA</td>
<td>Op Amp input current offset</td>
<td>-50</td>
<td>—</td>
<td>50</td>
<td>nA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IBIAS</td>
<td>Op Amp input bias current</td>
<td>-100</td>
<td></td>
<td>100</td>
<td>nA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>VRSSI</td>
<td>RSSI voltage</td>
<td>0.5</td>
<td>1.0</td>
<td>1.5</td>
<td>V</td>
<td>LNAAGAIN = 1</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.25</td>
<td>1.9</td>
<td>2.45</td>
<td>V</td>
<td>LNAAGAIN = 0</td>
<td></td>
</tr>
</tbody>
</table>

* These parameters are characterized but not tested.
† Data in “Typ” column is at 3V, 23°C unless otherwise stated. These parameters are for design guidance only and are not tested.

4.2 AC Characteristics: rfRXD0420 (Industrial)

<table>
<thead>
<tr>
<th>Param No.</th>
<th>Sym</th>
<th>Characteristic</th>
<th>Min</th>
<th>Typ†</th>
<th>Max</th>
<th>Units</th>
<th>Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>TFSK</td>
<td>Start-up time - FSK/FM</td>
<td>0.9</td>
<td>ms</td>
<td></td>
<td>ENRX = 0 to 1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TASK</td>
<td>Start-up time - ASK</td>
<td>R1xC1</td>
<td>ms</td>
<td>Note 1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sensitivity - Narrowband FSK</td>
<td>-111</td>
<td>dBm</td>
<td>Note 2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sensitivity - Wideband FSK</td>
<td>-104</td>
<td>dBm</td>
<td>Note 3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sensitivity - Narrowband ASK</td>
<td>-109</td>
<td>dBm</td>
<td>Note 4</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sensitivity - Wideband ASK</td>
<td>-106</td>
<td>dBm</td>
<td>Note 5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Input RF level maximum FSK/ FM</td>
<td>0</td>
<td>dBm</td>
<td>LNAAGAIN = 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Input RF level maximum ASK</td>
<td>-10</td>
<td>dBm</td>
<td>LNAAGAIN = 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* These parameters are characterized but not tested.
† Data in “Typ” column is at 3V, 23°C, f_{rf} = 433.6 MHz, IF = 10.7 MHz unless otherwise stated. These parameters are for design guidance only and are not tested.

Note 1: Dependant on ASK detector time constant.

2: IF bandwidth = 40 kHz, Δf = +/- 15 kHz, BER <= 3 x 10^{-3}
3: IF bandwidth = 150 kHz, Δf = +/- 50 kHz, BER <= 3 x 10^{-3}
4: IF bandwidth = 40 kHz, BER <= 3 x 10^{-3}
5: IF bandwidth = 150 kHz, BER <= 3 x 10^{-3}
4.3 **DC Characteristics: rfRXD0920 (Industrial)**

**DC CHARACTERISTICS**

<table>
<thead>
<tr>
<th>Param No.</th>
<th>Sym</th>
<th>Characteristic</th>
<th>Min</th>
<th>Typ†</th>
<th>Max</th>
<th>Units</th>
<th>Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>VCC</td>
<td>Supply Voltage</td>
<td>2.5</td>
<td>—</td>
<td>5.5</td>
<td>V</td>
<td>f&lt;sub&gt;rf&lt;/sub&gt; &lt; 900 MHz</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>3.3</td>
<td>—</td>
<td>5.5</td>
<td>V</td>
<td>f&lt;sub&gt;rf&lt;/sub&gt; &gt; 900 MHz</td>
</tr>
<tr>
<td></td>
<td>ISTBY</td>
<td>Standby Current</td>
<td>6.0</td>
<td>7.5</td>
<td>9.0</td>
<td>mA</td>
<td>LNA GAIN = 1</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>7.5</td>
<td>9.2</td>
<td>11.0</td>
<td>mA</td>
<td>LNA GAIN = 0</td>
</tr>
<tr>
<td></td>
<td>VOPA</td>
<td>Op Amp input voltage offset</td>
<td>-20</td>
<td>—</td>
<td>20</td>
<td>mV</td>
<td></td>
</tr>
<tr>
<td></td>
<td>IOPA</td>
<td>Op Amp input current offset</td>
<td>-50</td>
<td>—</td>
<td>50</td>
<td>nA</td>
<td></td>
</tr>
<tr>
<td></td>
<td>IBIAS</td>
<td>Op Amp input bias current</td>
<td>-100</td>
<td></td>
<td>100</td>
<td>nA</td>
<td></td>
</tr>
<tr>
<td></td>
<td>VRSSI</td>
<td>RSSI voltage</td>
<td>0.5</td>
<td>1.0</td>
<td>1.5</td>
<td>V</td>
<td>LNA GAIN = 1</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1.25</td>
<td>1.9</td>
<td>2.45</td>
<td>V</td>
<td>LNA GAIN = 0</td>
</tr>
</tbody>
</table>

* These parameters are characterized but not tested.
† Data in “Typ” column is at 3V, 23°C unless otherwise stated. These parameters are for design guidance only and are not tested.

4.4 **AC Characteristics: rfRXD0920 (Industrial)**

**AC CHARACTERISTICS**

<table>
<thead>
<tr>
<th>Param No.</th>
<th>Sym</th>
<th>Characteristic</th>
<th>Min</th>
<th>Typ†</th>
<th>Max</th>
<th>Units</th>
<th>Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>TFSK</td>
<td>Start-up time - FSK/FM</td>
<td>0.9</td>
<td>ms</td>
<td></td>
<td></td>
<td>ENRX = 0 to 1</td>
</tr>
<tr>
<td></td>
<td>TASK</td>
<td>Start-up time - ASK</td>
<td></td>
<td>R1xC1</td>
<td>ms</td>
<td></td>
<td>Note 1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sensitivity - Narrowband FSK</td>
<td>-109</td>
<td>dBm</td>
<td></td>
<td></td>
<td>Note 2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sensitivity - Wideband FSK</td>
<td>-102</td>
<td>dBm</td>
<td></td>
<td></td>
<td>Note 3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sensitivity - Narrowband ASK</td>
<td>-108</td>
<td>dBm</td>
<td></td>
<td></td>
<td>Note 4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sensitivity - Wideband ASK</td>
<td>-104</td>
<td>dBm</td>
<td></td>
<td></td>
<td>Note 5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Input RF level maximum FSK/FM</td>
<td>0</td>
<td>dBm</td>
<td></td>
<td></td>
<td>LNA GAIN = 1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Input RF level maximum ASK</td>
<td>-10</td>
<td>dBm</td>
<td></td>
<td></td>
<td>LNA GAIN = 1</td>
</tr>
</tbody>
</table>

* These parameters are characterized but not tested.
† Data in “Typ” column is at 3V, 23°C, f<sub>rf</sub> = 433.6 MHz, IF = 10.7 MHz unless otherwise stated. These parameters are for design guidance only and are not tested.

**Note 1:** Dependant on ASK detector time constant.

**Note 2:** IF bandwidth = 40 kHz, Δf = +/- 15 kHz, BER <= 3 x 10<sup>-3</sup>

**Note 3:** IF bandwidth = 150 kHz, Δf = +/- 50 kHz, BER <= 3 x 10<sup>-3</sup>

**Note 4:** IF bandwidth = 40 kHz, BER <= 3 x 10<sup>-3</sup>

**Note 5:** IF bandwidth = 150 kHz, BER <= 3 x 10<sup>-3</sup>
5.0 PACKAGING INFORMATION

5.1 Package Marking Information

Legend: 

- **XX...X**: Customer specific information*
- **Y**: Year code (last digit of calendar year)
- **YY**: Year code (last 2 digits of calendar year)
- **WW**: Week code (week of January 1 is week ‘01’)
- **NNN**: Alphanumeric traceability code

Note: In the event the full Microchip part number cannot be marked on one line, it will be carried over to the next line thus limiting the number of available characters for customer specific information.

* Standard PICmicro device marking consists of Microchip part number, year code, week code, and traceability code. For PICmicro device marking beyond this, certain price adders apply. Please check with your Microchip Sales Office. For QTP devices, any special marking adders are included in QTP price.
5.2 Package Details

The following section gives the technical details of the package.

32-Lead Plastic Low Profile Quad Flat Package (LQ) 7 x 7 x 1.4 mm Body

Not available at this time.
ON-LINE SUPPORT

Microchip provides on-line support on the Microchip World Wide Web site.
The web site is used by Microchip as a means to make files and information easily available to customers. To view the site, the user must have access to the Internet and a web browser, such as Netscape® or Microsoft® Internet Explorer. Files are also available for FTP download from our FTP site.

Connecting to the Microchip Internet Web Site

The Microchip web site is available at the following URL:

www.microchip.com

The file transfer site is available by using an FTP service to connect to:

ftp://ftp.microchip.com

The web site and file transfer site provide a variety of services. Users may download files for the latest Development Tools, Data Sheets, Application Notes, User's Guides, Articles and Sample Programs. A variety of Microchip specific business information is also available, including listings of Microchip sales offices, distributors and factory representatives. Other data available for consideration is:

- Latest Microchip Press Releases
- Technical Support Section with Frequently Asked Questions
- Design Tips
- Device Errata
- Job Postings
- Microchip Consultant Program Member Listing
- Links to other useful web sites related to Microchip Products
- Conferences for products, Development Systems, technical information and more
- Listing of seminars and events

SYSTEMS INFORMATION AND UPGRADE HOT LINE

The Systems Information and Upgrade Line provides system users a listing of the latest versions of all of Microchip's development systems software products. Plus, this line provides information on how customers can receive the most current upgrade kits. The Hot Line Numbers are:

1-800-755-2345 for U.S. and most of Canada, and
1-480-792-7302 for the rest of the world.

092002
READER RESPONSE

It is our intention to provide you with the best documentation possible to ensure successful use of your Microchip product. If you wish to provide your comments on organization, clarity, subject matter, and ways in which our documentation can better serve you, please FAX your comments to the Technical Publications Manager at (480) 792-4150.

Please list the following information, and use this outline to provide us with your comments about this document.

To: Technical Publications Manager
RE: Reader Response

From: Name ____________________________
Company ____________________________
Address _____________________________
City / State / ZIP / Country _____________

Telephone: (_____ ) _______ - ________
FAX: (_____ ) _______ - ________

Application (optional):

Would you like a reply? _____ Y _____ N

Device: rfRXD0420/0920

Literature Number: DS70090A

Questions:

1. What are the best features of this document?

2. How does this document meet your hardware and software development needs?

3. Do you find the organization of this document easy to follow? If not, why?

4. What additions to the document do you think would enhance the structure and subject?

5. What deletions from the document could be made without affecting the overall usefulness?

6. Is there any incorrect or misleading information (what and where)?

7. How would you improve this document?
## PRODUCT IDENTIFICATION SYSTEM

To order or obtain information, e.g., on pricing or delivery, refer to the factory or the listed sales office.

<table>
<thead>
<tr>
<th>PART NO.</th>
<th>X</th>
<th>XX</th>
<th>XXX</th>
</tr>
</thead>
<tbody>
<tr>
<td>Device</td>
<td>rfRXD0420-I/LQ UHF ASK/FSK/FM Receiver</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>rfRXD0920-I/LQ UHF ASK/FSK/FM Receiver</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>rfRXD0420T-I/LQ UHF ASK/FSK/FM Receiver</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(Tape &amp; Reel) rfRXD0920T-I/LQ UHF ASK/FSK/FM Receiver</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(Tape &amp; Reel)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Temperature Range</td>
<td>I = -40°C to +85°C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Package</td>
<td>LQ = LQFP32</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pattern</td>
<td>Special Requirements</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Examples:

a) rfRXD0420-I/LQ = Industrial temp, LQFP package
b) rfRXD0920-I/LQ = Industrial temp, LQFP package

---

### Sales and Support

**Data Sheets**

Products supported by a preliminary Data Sheet may have an errata sheet describing minor operational differences and recommended workarounds. To determine if an errata sheet exists for a particular device, please contact one of the following:

1. Your local Microchip sales office
2. The Microchip Corporate Literature Center U.S. FAX: (480) 792-7277
3. The Microchip Worldwide Site (www.microchip.com)

Please specify which device, revision of silicon and Data Sheet (include Literature #) you are using.

**New Customer Notification System**

Register on our web site (www.microchip.com/cn) to receive the most current information on our products.
Note the following details of the code protection feature on Microchip devices:

- Microchip products meet the specification contained in their particular Microchip Data Sheet.
- Microchip believes that its family of products is one of the most secure families of its kind on the market today, when used in the intended manner and under normal conditions.
- There are dishonest and possibly illegal methods used to breach the code protection feature. All of these methods, to our knowledge, require using the Microchip products in a manner outside the operating specifications contained in Microchip’s Data Sheets. Most likely, the person doing so is engaged in theft of intellectual property.
- Microchip is willing to work with the customer who is concerned about the integrity of their code.
- Neither Microchip nor any other semiconductor manufacturer can guarantee the security of their code. Code protection does not mean that we are guaranteeing the product as “unbreakable.”

Code protection is constantly evolving. We at Microchip are committed to continuously improving the code protection features of our products. Attempts to break microchip’s code protection feature may be a violation of the Digital Millennium Copyright Act. If such acts allow unauthorized access to your software or other copyrighted work, you may have a right to sue for relief under that Act.

Information contained in this publication regarding device applications and the like is intended through suggestion only and may be superseded by updates. It is your responsibility to ensure that your application meets with your specifications. No representation or warranty is given and no liability is assumed by Microchip Technology Incorporated with respect to the accuracy or use of such information, or infringement of patents or other intellectual property rights arising from such use or otherwise. Use of Microchip’s products as critical components in life support systems is not authorized except with express written approval by Microchip. No licenses are conveyed, implicitly or otherwise, under any intellectual property rights.

Trademarks

The Microchip name and logo, the Microchip logo, KEELoo, MPLAB, PIC, PICmicro, PICSTART, PRO MATE and PowerSmart are registered trademarks of Microchip Technology Incorporated in the U.S.A. and other countries.

FilterLab, microID, MXDEV, MXLAB, PICMASTER, SEEVAL and The Embedded Control Solutions Company are registered trademarks of Microchip Technology Incorporated in the U.S.A.

Accuron, dsPIC, dsPICDEM.net, ECONOMONITOR, FanSense, FlexROM, fuzzyLAB, In-Circuit Serial Programming, ICSP, ICEPIC, microPort, Migratable Memory, MPASM, MPLIB, MPLINK, MPSIM, PICC, PICKit, PICDEM, PICDEM.net, PowerCal, PowerInfo, PowerTool, rfPIC, Select Mode, SmartSensor, SmartShunt, SmartTel and Total Endurance are trademarks of Microchip Technology Incorporated in the U.S.A. and other countries.

Serialized Quick Turn Programming (SQTP) is a service mark of Microchip Technology Incorporated in the U.S.A.

All other trademarks mentioned herein are property of their respective companies.

© 2003, Microchip Technology Incorporated, Printed in the U.S.A., All Rights Reserved.

Printed on recycled paper.

Microchip received QS-9000 quality system certification for its worldwide headquarters, design and wafer fabrication facilities in Chandler and Tempe, Arizona in July 1999 and Mountain View, California in March 2002. The Company’s quality system processes and procedures are QS-9000 compliant for its PICmicro® 8-bit MCUs, KEELOO® code hopping devices, Serial EEPROMs, microperipherals, non-volatile memory and analog products. In addition, Microchip’s quality system for the design and manufacture of development systems is ISO 9001 certified.
AMERICAS
Corporate Office
2355 West Chandler Blvd.
Chandler, AZ 85224-6199
Tel: 480-792-7200 Fax: 480-792-7277
Technical Support: 480-792-7627
Web Address: http://www.microchip.com

Rocky Mountain
2355 West Chandler Blvd.
Chandler, AZ 85224-6199
Tel: 480-792-7966 Fax: 480-792-4338

Atlanta
3780 Mansell Road, Suite 130
Alpharetta, GA 30022
Tel: 770-640-0034 Fax: 770-640-0307

Boston
2 Lan Drive, Suite 120
Westford, MA 01886
Tel: 978-692-3848 Fax: 978-692-3821

Chicago
333 Pierce Road, Suite 180
Itasca, IL 60143
Tel: 630-285-0071 Fax: 630-285-0075

Dallas
4570 Westgrove Drive, Suite 160
Addison, TX 75001
Tel: 972-818-7423 Fax: 972-818-2924

Detroit
Tri-Atria Office Building
32255 Northwestern Highway, Suite 190
Farmington Hills, MI 48334
Tel: 248-538-2250 Fax: 248-538-2260

Kokomo
2767 S. Albright Road
Kokomo, Indiana 46902
Tel: 765-864-8360 Fax: 765-864-8387

Los Angeles
18201 Von Karman, Suite 1090
Irvine, CA 92612
Tel: 949-263-1888 Fax: 949-263-1338

San Jose
Microchip Technology Inc.
2107 North First Street, Suite 590
San Jose, CA 95131
Tel: 408-436-7950 Fax: 408-436-7955

Toronto
6285 Northam Drive, Suite 108
Mississauga, Ontario L4V 1X5, Canada
Tel: 905-673-0699 Fax: 905-673-6509

ASIA/PACIFIC
Australia
Microchip Technology Australia Pty Ltd
Suite 22, 41 Rawson Street
Epping 2121, NSW
Australia
Tel: 61-2-9868-6733 Fax: 61-2-9868-6755

China - Beijing
Microchip Technology Consulting (Shanghai) Co., Ltd., Beijing Liaison Office
Unit 915
Beijing, 100027, No. China
Tel: 86-10-85282100 Fax: 86-10-85282104

China - Chengdu
Microchip Technology Consulting (Shanghai) Co., Ltd., Chengdu Liaison Office
Rm. 2401-2402, 24th Floor,
Ming Xing Financial Tower
No. 88 TIDU Street
Chengdu 610016, China
Tel: 86-28-86766200 Fax: 86-28-86766599

China - Fuzhou
Microchip Technology Consulting (Shanghai) Co., Ltd., Fuzhou Liaison Office
Unit 28F, World Trade Plaza
No. 71 Wuli Road
Fuzhou 350001, China
Tel: 86-591-7503506 Fax: 86-591-7503521

China - Hong Kong SAR
Microchip Technology Hong Kong Ltd.
Unit 901-6, Tower 2, Metroplaza
223 Hing Fong Road
Kwai Fong, N.T., Hong Kong
Tel: 852-2401-1200 Fax: 852-2401-3431

China - Shanghai
Microchip Technology Consulting (Shanghai) Co., Ltd.
Room 701, Bldg. B
Far East International Plaza
No. 317 Xian Xia Road
Shanghai, 200051
Tel: 86-21-6275-5700 Fax: 86-21-6275-5060

China - Shenzhen
Microchip Technology Consulting (Shanghai) Co., Ltd., Shenzhen Liaison Office
Rm. 1812, 18/F, Building A, United Plaza
Shenzhen 518033, China
Tel: 86-755-82901380 Fax: 86-755-82966626

China - Qingdao
Rm. B503, Fullhope Plaza
No. 12 Hong Kong Central Rd.
Qingdao 266071, China
Tel: 86-532-5027355 Fax: 86-532-5027205

India
Microchip Technology Inc.
India Liaison Office
Divyasree Chambers
1 Floor, Wing A (A3/A4)
No. 11, O’Shaugnessy Road
Bangalore, 560 025, India
Tel: 91-80-2290061 Fax: 91-80-2290062

Japan
Microchip Technology Japan K.K.
Benex S-1 EF
3-18-20, Shin-yokohama
Kohoku-Ku, Yokohama-shi
Kanagawa, 222-0033, Japan
Tel: 81-45-471-6168 Fax: 81-45-471-6122

Korea
Microchip Technology Korea
168-1, Youngbo Bldg. 3 Floor
Samung-Dong, Kangnam-Ku
Seoul, Korea 135-882
Tel: 82-2-554-7200 Fax: 82-2-558-5934

Singapore
Microchip Technology Singapore Pte Ltd.
200 Middle Road
#07-02 Prime Centre
Singapore, 188980
Tel: 65-6334-8870 Fax: 65-6334-8850

Taiwan
Microchip Technology (Barbados) Inc.,
Taiwan Branch
11F-3, No. 207
Tung Hua North Road
Taipei, 106, Taiwan
Tel: 886-2-2717-7175 Fax: 886-2-2545-0139

EUROPE
Austria
Microchip Technology Austria GmbH
Dursisstrasse 2
A-4600 Wels
Austria
Tel: 43-7242-2244-399 Fax: 43-7242-2244-393

Denmark
Microchip Technology Nordic ApS
Regus Business Centre
Lautrup Hoj 1-3
Ballerpark DK-2750 Denmark
Tel: 45 4420 9895 Fax: 45 4420 9910

France
Microchip Technology SARL
Parc d’Activite du Moulin de Massy
43 Rue du Saule Trapu
Batiment A - 1er Etage
91300 Massy, France
Tel: 33-1-69-53-63-20 Fax: 33-1-69-30-90-79

Germany
Microchip Technology GmbH
Steinheilstrasse 10
D-85737 Ismaning, Germany
Tel: 49-89-627-144 0 Fax: 49-89-627-144-44

Italy
Microchip Technology SRL
Centro Direzionale Colleoni
Palazzo Taurus 1 Via Colleoni 1
20014 Agrate Brianza
Milan, Italy
Tel: 39-039-65791-1 Fax: 39-039-6899883

United Kingdom
Microchip Ltd.
505 Eskdale Road
Winnersh Triangle
Wokingham
Berkshire, England RG41 5TU
Tel: 44 118 921 5869 Fax: 44-118 921-5820

© 2003 Microchip Technology Inc.