



# RF Daughter Boards for ADF7020 & ADF7020-1 ISM Band Transceiver

Preliminary Technical Data

**EVAL-ADF7020-XDBX**

## FEATURES

- ADF7020 & ADF7020-1 ISM Band Transceiver Radio module
- Can plug into basic mother board (EVAL-ADF70XXMB) or development platform with embedded microcontroller (EVAL-ADF70XXMB2)
- RF daughter-card designed on low-cost 2-layer PCB as reference design for cost-sensitive applications
- Combined output matching circuit optimized for best sensitivity and Tx power efficiency
- Software programmable modulation schemes; GFSK/ FSK/ ASK/OOK/G-ASK
- PC Software for Register Programming
- Loop filter setup for operation at 38.4kbps

## GENERAL DESCRIPTION

The ADF7020 and ADF7020-1 are FSK/GFSK/ASK/OOK transceivers which are designed for operation in the licensed and unlicensed VHF/UHF bands from 80MHz to 956MHz. There are different versions of the evaluation board available which are optimized for particular frequency bands. The daughter-board contains all the required components for operation of the radio, including loop filter, output matching, antenna and connector to mother board.

To control the ADF7020/ADF7020-1 register settings via the PC you will need the EVAL-ADF70XXMB mother board. This technical note describes usage with the EVAL-ADF70XXMB boards. This is the recommended board for detailed evaluation and RF testing of the parts.

The EVAL-ADF70XXMB2 controller board comes as part of the ADF702X Development Kit. This mother board allows the user to set up a network of units using the ADIismLINK protocol and thus evaluate the parts performance in a networked environment. Further details and documentation on the EVAL-ADF70XXMB2 development platform is available on the [www.analog.com](http://www.analog.com) website.

Table 1: Ordering Codes

| Board Number                 | RF Band           | Rx Data Rate   | Tx Data Rate <sup>1</sup> | Loop Bandwidth <sup>2</sup> |
|------------------------------|-------------------|----------------|---------------------------|-----------------------------|
| EVAL-ADF70XXMB <sup>3</sup>  | -                 | -              | -                         | -                           |
| EVAL-ADF70XXMB <sup>24</sup> | -                 | -              | -                         | -                           |
| EVAL-ADF7020DB1              | 902 MHz – 928 MHz | Up to 200 kbps | Up to 50 kbps             | 50 kHz                      |
| EVAL-ADF7020DB2              | 862 MHz - 870 MHz | Up to 200 kbps | Up to 50 kbps             | 50 kHz                      |
| EVAL-ADF7020DB3              | 433 MHz - 445 MHz | Up to 200 kbps | Up to 50 kbps             | 50 kHz                      |
| EVAL-ADF7020-1DB4            | 405 MHz - 435 MHz | Up to 200 kbps | Up to 50 kbps             | 50 kHz                      |
| EVAL-ADF7020-1DB6            | 470 MHz - 510 MHz | Up to 200 kbps | Up to 50 kbps             | 50 kHz                      |
| EVAL-ADF7020-1DB7            | 310 MHz – 340 MHz | Up to 200 kbps | Up to 50 kbps             | 50 kHz                      |
| EVAL-ADF7020-1DB8            | 128 MHz – 142 MHz | Up to 200 kbps | Up to 50 kbps             | 50 kHz                      |
| EVAL-ADF7020-1DB5            | Adjustable        | -              | -                         | -                           |

1. The data rate may be increased by increasing the PLL Loop Bandwidth, see Page10 or use ADIismPLL.
2. Optimized for FSK. For ASK or OOK typically need to increase the Loop BW to greater than 100kHz to avoid VCO pulling
3. Simple mother board for direct register programming and radio performance evaluation.
4. Controller mother board to run ADIismLINK protocol for range testing, PER measurements , system development etc.

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**HARDWARE DESCRIPTION**

The RF module, which is plugged into the mother board, consists of the ADF7020 or ADF7020-1 device, output matching circuit optimized for operation in a certain frequency band, harmonic filter, PLL loop filter, de-coupling and xtal. This RF module provides a low-cost, optimally matched RF reference design which you can use as a starting point for your design. A low-cost BOM is achieved by using a 2-layer PCB, a low-cost xtal, and a simple combined output matching circuit which eliminates the need for an external switch.

There are two different versions of the daughter card, one which uses a low-cost dielectric harmonic filter from Murata the other which uses a standard LC harmonic filter. Gerber files for both are available for download on the ADF7020 product page. Schematics are shown in Figures 9 and 10. The DB1 and DB2 boards use the dielectric filter while all other boards use the LC filter.

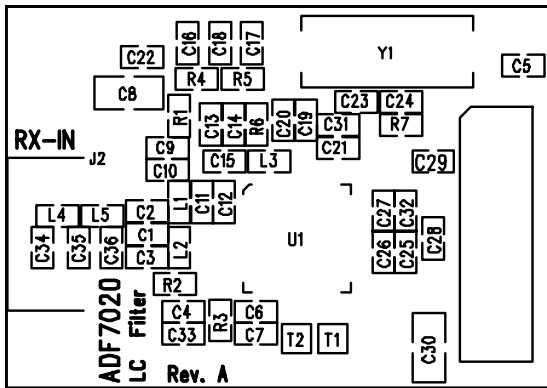


Figure 1: .LC Filter version-silkscreen

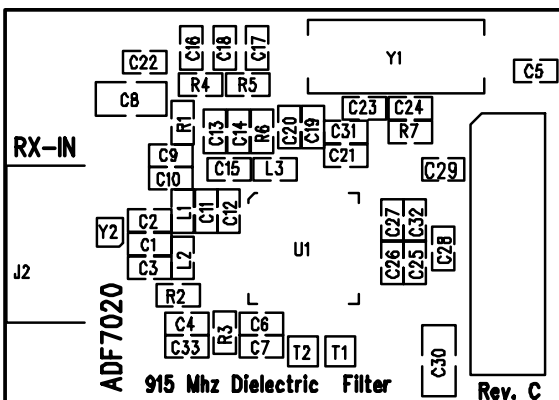


Figure 2. Dielectric Filter version – silkscreen

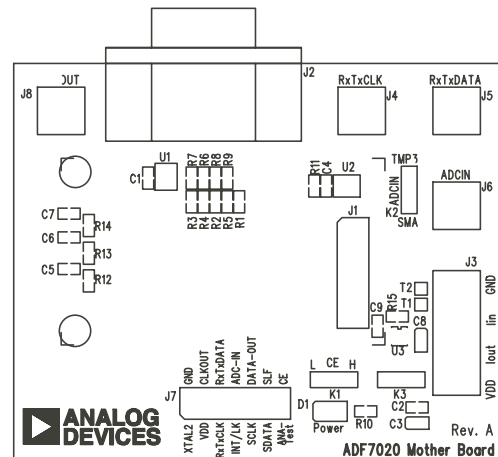


Figure 3.. Mother Board Silkscreen – component side view

The mother board (MB) comes with a cable for connecting to the printer port of a PC. The cable diagram is shown in Figure 5. The MB can be supplied directly with an external supply of 2.3V to 3.6V or a battery voltage from 3V to 9V by switching in a regulator using jumper K3. There is an on-board 11.0592MHz AT crystal. The crystal combined with 33pF shunt capacitors provide the low cost frequency reference for the local oscillator.

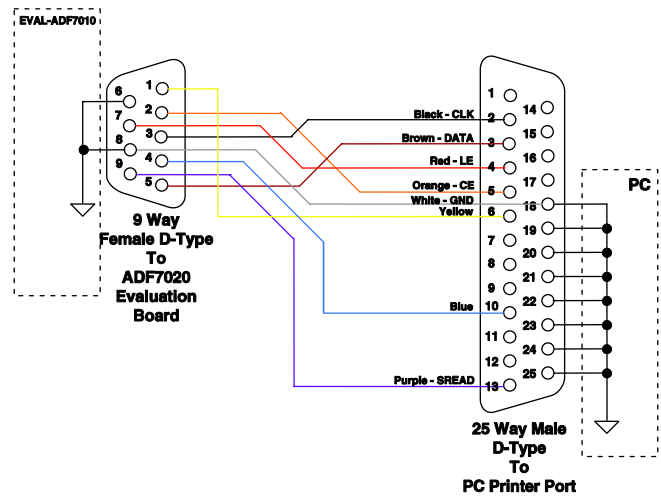


Figure 4. PC Cable Diagram

The necessary SMA connectors are included to interface the part to the measurement instrument (Normally a spectrum analyzer in Tx mode and a RF signal generator in Rx mode). Care should be taken to ensure that no DC level exists at the ANTENNA SMA.

The parallel port has 5V voltage levels, so there is a voltage divider to bring this down to levels acceptable to the ADF7020 /ADF7020-1 device.

The silk screen for the basic mother board is shown in Figure 4.

**Output Matching Circuit**

The ADF7020/ADF7020-1 exhibits optimum performance in terms of sensitivity, transmit power, and current consumption, only if its RF input and output ports are properly matched to the antenna impedance. For cost-sensitive applications, the ADF7020/ADF7020-1 is equipped with an internal Rx/Tx switch, which facilitates the use of a simple combined passive PA/LNA matching network as outlined in Figure 6. Please refer to Datasheet for more details.

For ease of design the matching and harmonic filter components are provided for the most commonly used bands (see Table5-8) Please refer to Application Note AN-764 and Application Note AN-859 for more details on PA/LNA matching for the ADF7020 and ADF7020-1 devices.

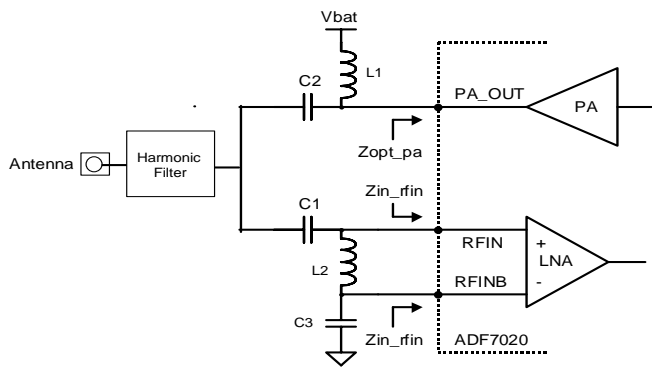


Figure 5.. LNA/PA Output Matching Circuit

**CHOICE OF VCO INDUCTOR FOR ADF7020-1**

The ADF7020-1 uses the same VCO core as the ADF7020 but with the VCO tank inductor (L3) external to allow the user to set the operating frequency. The frequency of oscillation can be

approximated using the following formula:

$$F_{VCO} = \frac{1}{2\pi\sqrt{(L_{INT} + L_{EXT}) \times (C_{VAR} + C_{FIXED})}}$$

The length of the PCB track to the external inductor pad will effect the total L<sub>EXT</sub>: The ADF7020-1 VCO Frequency range vs. external inductor value as measured on the EVAL-ADF7020-1DBX boards is shown in Figure7. If you are using a different length of PCB track to the ADI Evaluation boards you need to take this into consideration. ADIsimPLL will give you the total external inductance (chip inductor + PCB track) needed for a given frequency range so that your desired frequency band lies in the middle of the range where possible. It is also possible to shift the frequency by use of the VCO Adjust bits which has the effect of adjusting C<sub>VAR</sub>.

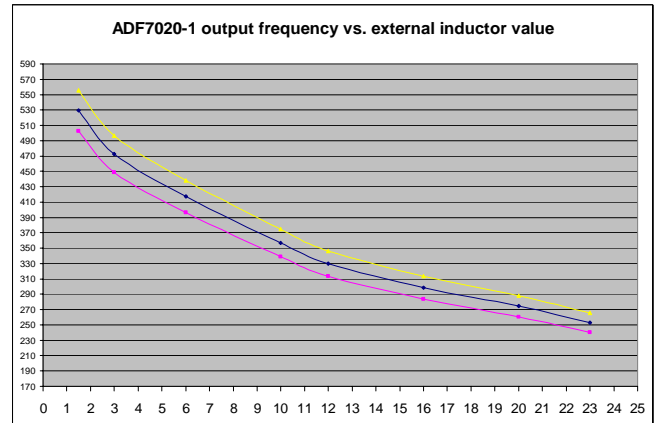


Figure 6. Direct Output Frequency vs. External Inductor Value(L3)

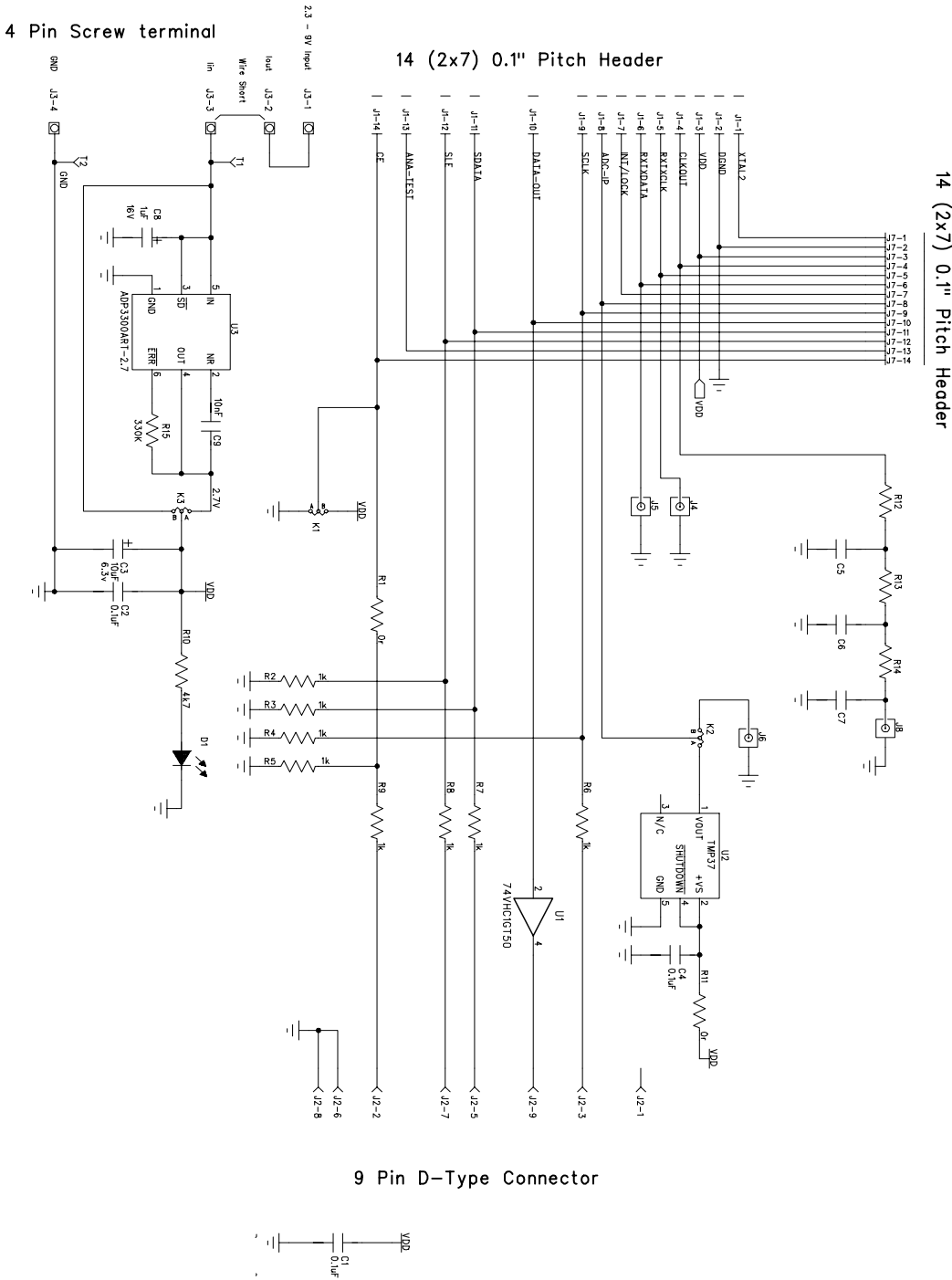


Figure 8. EVAL-ADF70XXMB Mother Board Circuit Diagram

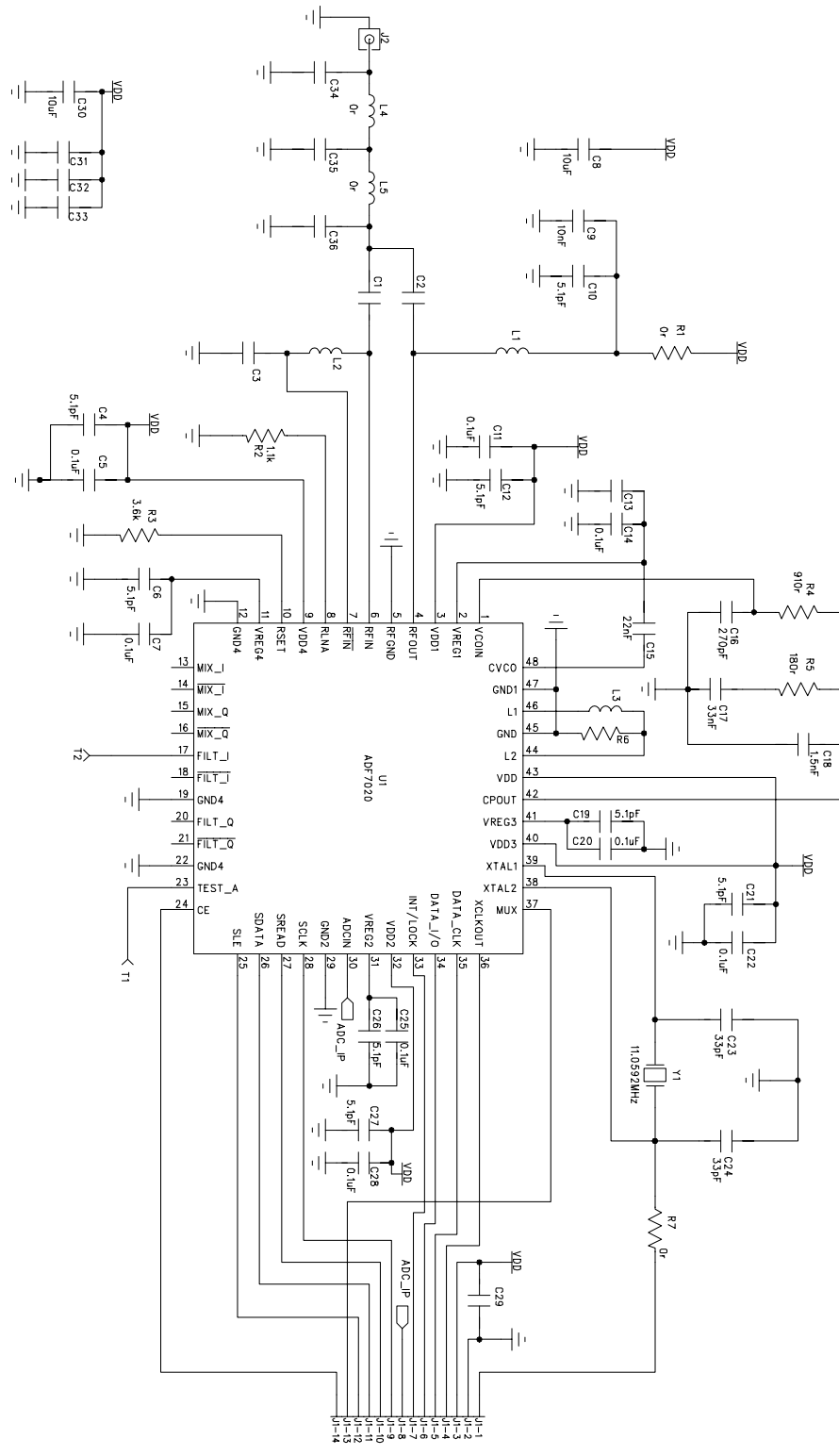


Figure 9. RF Module (LC harmonic filter) Circuit Diagram used for ADF7020DB3 and for all ADF7020-1 daughter boards (DB4, DB5, DB6, DB7 and DB8)

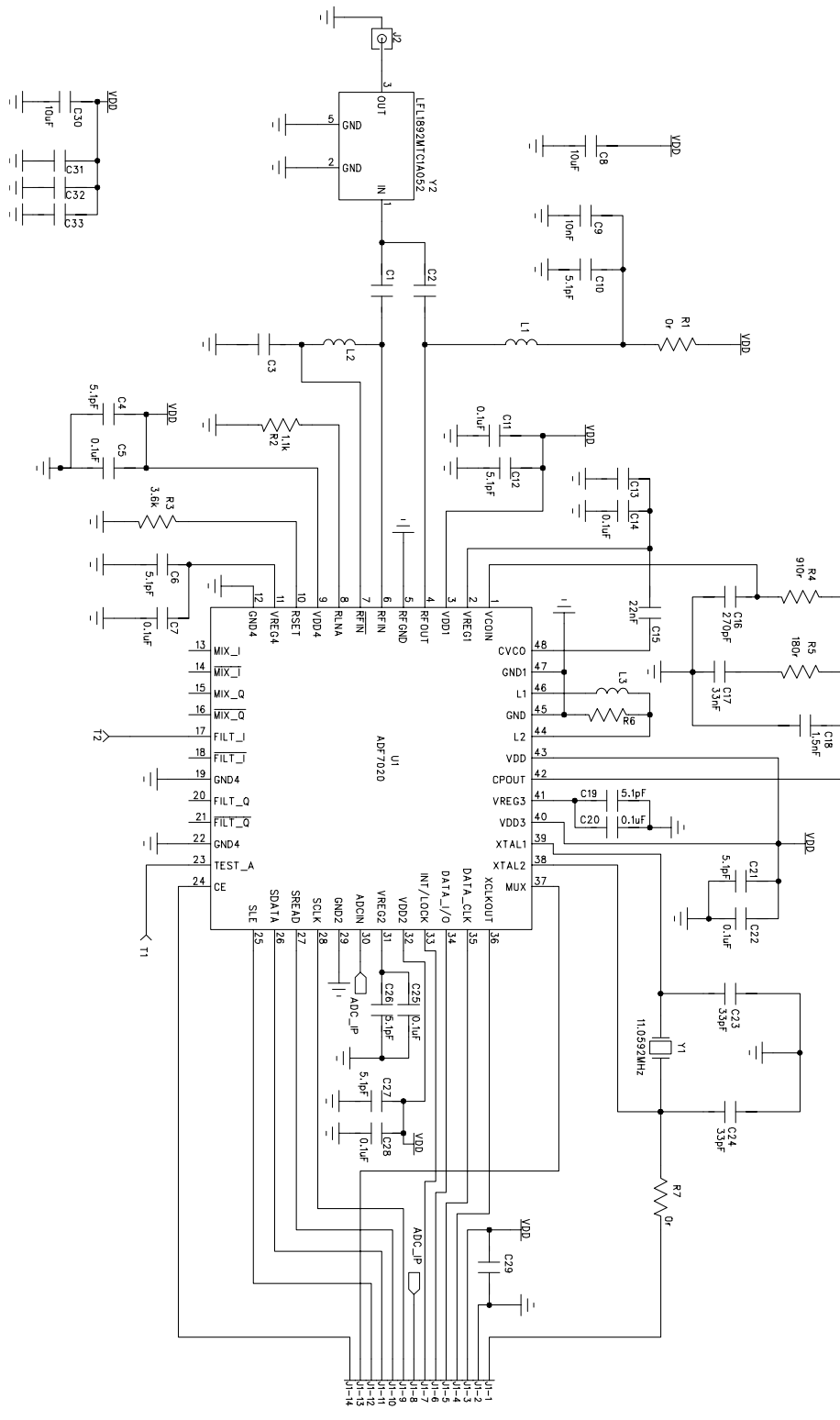


Figure 10. RF Module (Dielectric Filter version) Circuit Diagram used for ADF7020DB1 and ADF7020DB2

**SOFTWARE DESCRIPTION**

The ADF7020 and ADF7020-1 software applications can be downloaded from the Analog Devices Website at [http://www.analog.com/Analog\\_Root/static/techSupport/designTools/evaluationBoards/downloadSoftware\\_ISM.html](http://www.analog.com/Analog_Root/static/techSupport/designTools/evaluationBoards/downloadSoftware_ISM.html) . This will run the Installshield setup utility that will install all information and software relevant to the ADF70XX Devices. Note, it is recommended to turn off your anti-virus software during install as this can interfere with the install process. Choose the directory you wish to install into and proceed. Once the program is setup, run ADF7020RevX.X.exe to launch the program for the ADF7020 or ADF7020-1RevX.X.exe for the ADF7020-1. The window shown below should appear – you will need a screen resolution of 1024 x 768 to use the program.

This is the main window and is divided up into several sections some of which have their own sub-windows which are indicated by a raised button. For example in the PLL Options section, you enter the sub-window by clicking on the “Synth Settings” button. The green and red toggle buttons turn a feature on or off.

After selecting Tx or Rx mode, you can select the required

modulation scheme by clicking on the drop-down box in the Modulation Options section. In the FSK panel you should enter the deviation frequency, data-rate, demodulation type and IF Bandwidth. In Rx mode all the appropriate clock frequencies are chosen for you based on these inputs. You will need to click on the AFC/Advanced button to force the software to auto-calculate these clock frequencies which will be displayed on the AFC/Advanced sub-window. This window also contains the AFC function and ability to select the various demod locking features(See Register4 Description in Datasheet)

Another feature of the software is to display the output of the Readback pin on the ADF7020 (see Readback section in ADF7020 Datasheet for more details). This can display the battery voltage, temperature, external ADC input or frequency error on the screen.

For direct programming of the ADF7020/ADF7020-1 , click on the Registers button. This allows you to enter Hex values into individual registers. This is useful for de-bugging the register settings that you will use in your embedded microcontroller

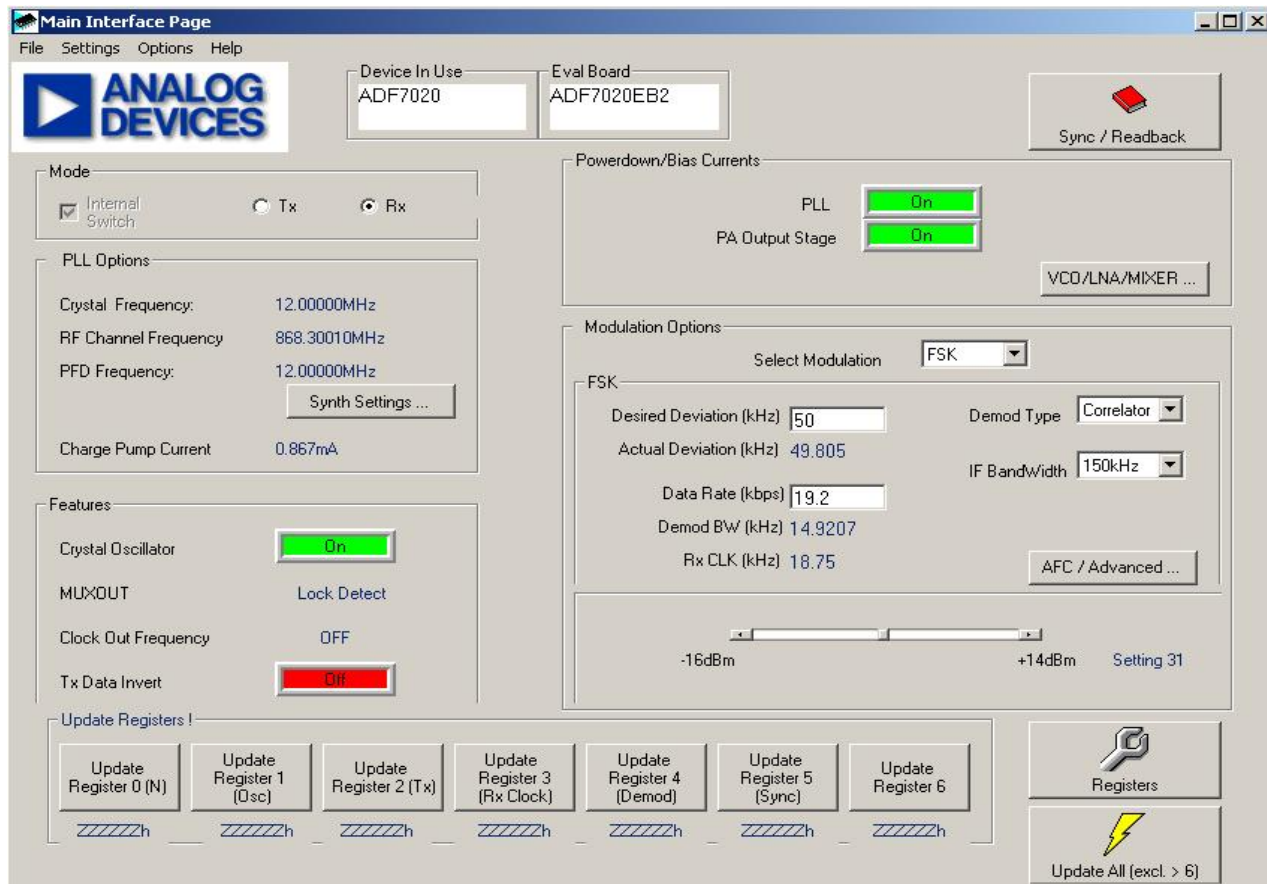


Figure 11. Software Front Panel Display

**GETTING STARTED WITH THE ADF7020 AND ADF7020-1**

The evaluation performed will be specific to each application, but this section will enable users to familiarise themselves with the features of the ADF7020/ADF7020-1.

**Initial Setup**

As described in the Hardware Description section, the evaluation board is divided into two; an RF module containing the ADF7020 and a mother-board which accepts the RF module and contains the power supply block and some I/O pins. You need to mount the RF module onto the mother-board, ensuring correct alignment by having the drill-holes in the module above the screw-holders on the mother board.

Apply 3V to the VDD pin, with the regulator jump switch K3 connected to position B. An ammeter can be placed in series with the supply by connecting to Iin and Iout, otherwise place a wire short across Iin and Iout. The ChipEnable link (K1) is initially connected to GND, so you should connect this to VDD for normal operation. Once CE is High, the part will become active and approximately 2.2mA is drawn. The default conditions on power-up are:

|                            |                 |
|----------------------------|-----------------|
| Crystal Oscillator circuit | ON              |
| CLKout                     | ON (div-by-8)   |
| PLL                        | OFF             |
| PA                         | OFF             |
| Regulators                 | ON              |
| Muxout                     | Regulator Ready |

To check the part has powered-up correctly, monitor the XCLKOUT pin (pin4 on mother-board test-header), this should be a 3Vp-p square wave with a frequency of XTAL\_frequency/8. Also the voltage on the Regulator pins should be between 2.0V and 2.2V, you can check this by probing the top of C5 (VREG4 pin) on the RF module.

**Evaluating the ADF7020 in Rx and Tx modes**

Before setting up an RF link, it is usually informative to evaluate the ADF7020/ADF7020-1 in either Tx mode or Rx mode. The typical setup for this is shown in Figures 12 and 13. To select between Tx and Rx modes in the software select the required mode in the top left of the front display panel.

**Note:** All of the ADF7020 and ADF7021 daughter boards have an 11.0592MHz xtal except for the ADF7020-1DB7 which has a 9.8304MHz xtal. In the following text for simplicity it will be assumed that the crystal is 11.0592MHz.

**Test Procedure for the ADF7020 in Tx Mode**

Use a supply of 3V and the setup as shown in Figure 12. At first you can just connect RxTxData to GND.

1. Ensure that the CE Link is connected to High. The current drawn should be typically 2.2mA. The regulators are now powered-up.

2. Check XCLKOUT (Pin4 on test-header) using a scope. Signal should be 3Vp-p square wave with frequency equal to XTAL\_FREQ/8. This is the power-up default. The crystal is oscillating and the XCLKOUT feature is working correctly.

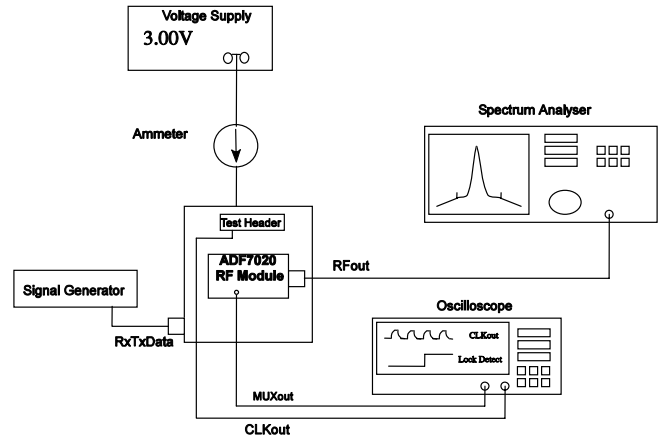


Figure 12. Evaluation board setup for Tx mode

3. Using the ADF7020 or ADF7020-1 Software, setup the following Tx parameters:
  - a. Ensure Tx Mode is selected in Mode sub-window
  - b. Click on Synth Settings and set
    - i. RF Channel Frequency (Direct Output) to your desired frequency.
    - ii. You can also toggle the VCO divide-by-2 button to get half this frequency. This divider is placed outside the PLL loop and thus does not affect the N-Divider settings. For example to obtain 433MHz from the ADF7020, you should set the Direct Output to 866MHz and enable divide-by-2.
    - iii. Fcrystal = 11.0592MHz
    - iv. FPF = 11.0592MHz
    - v. Hit Calculate and Load Now
  - c. Click Charge-pump current, set this to 1.44mA
  - d. Bias Currents – Click VCO/LNA/Mixer... button
    - i. VCO Adjust = 0 (See datasheet for recommended settings)
    - ii. Set VCO bias to 2.75mA (ADF7020)

For ADF7020-1 set VCO-bias according to datasheet table 5



- iii. Set LNA Bias = 800uA
  - iv. Set Mixer Linearity = Normal
  - v. Set PA bias to 9uA
  - vi. Hit Load Now and Return to Front Panel
- e. Features Sub-window
- i. Set crystal oscillator ON
  - ii. Tx Data Invert ON(this will give high level as RxTxData connected to GND).
- f. Modulation Options
- i. Select OOK
  - ii. Using slide-bar change the power setting to 43.
4. Hit the Update All Button on the Software
  5. Examine the output using the spectrum analyser. The output should be locked to the programmed output frequency and the output power should be approximately +10dBm. There will be some error in the output frequency due to error in the xtal, you should note this as it will be useful for debugging the Rx section. You can adjust the output power using the output power slide-bar in the software.
  6. Re-enter the Synth Settings sub-window and change the output frequency and verify it covers your required frequency range.
  7. In-band Phase Noise is measured by narrowing the span on the spectrum analyser to 10kHz and turning Marker Noise ON. A typical measurement for 0dBm output power is -90dBc/Hz at 5kHz offset. ADISimPLL will help you predict the expected phase noise numbers.
  8. You can now apply modulation to the TxDATA pin and monitor spurious, adjacent channel power and harmonic levels.

**Test Procedure for the ADF7020/ADF7020-1 in Rx mode**

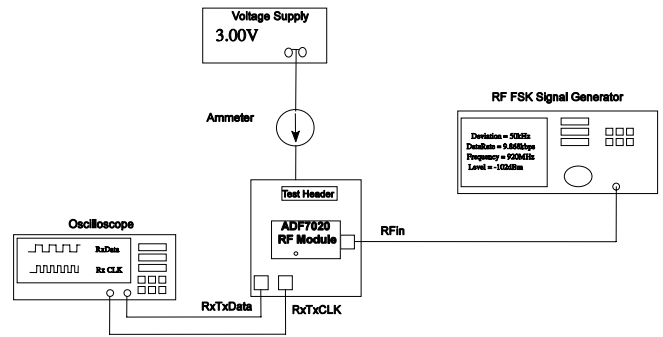


Figure 13. Evaluation board setup for Rx mode

Use a supply of 3V and the setup as shown in Figure 13. It is important to note that the ADF7020/ADF7020-1 uses a low-IF architecture where the IF is operating at 200kHz. This means the LO frequency should be set to 200kHz below the incoming RF frequency. The ADF7020 and ADF7020-1 software takes care of this automatically for you.

9. Setup your signal generator to output an FSK signal at the desired frequency, and -70dBm level. Select the data-rate (9.6kbps) and deviation frequency(20kHz).
10. Using the ADF7020/ADF7020-1 software, setup the following Rx parameters:
  - a. Ensure Rx Mode is selected in Mode sub-window
  - b. In Synth Settings select the RF Frequency to the signal generator Output frequency. The LO will automatically be programmed to RF - 200kHz.
  - c. Modulation Options
    - i. Select FSK Modulation
    - ii. Set Desired Deviation = 20kHz
    - iii. Set Data-Rate = 9.6 (kbps)
    - iv. Set Demod Type = Linear
    - v. Set IF Bandwidth = 150kHz
    - vi. Click on AFC/Advanced button and enable AFC. This will compensate for errors in the crystal if the error at RF is less than +/-50kHz. Step5 in the Tx Mode setup will tell you the error.
11. Hit the Update All Button on the Software
12. Using the scope, probe the RxTxData pin and RxTxCLK. They should be 3V p-p square-waves with frequencies of 4.8kHz and 9.6kHz respectively. Ensure that these square-waves are triggered correctly and are not flickering.

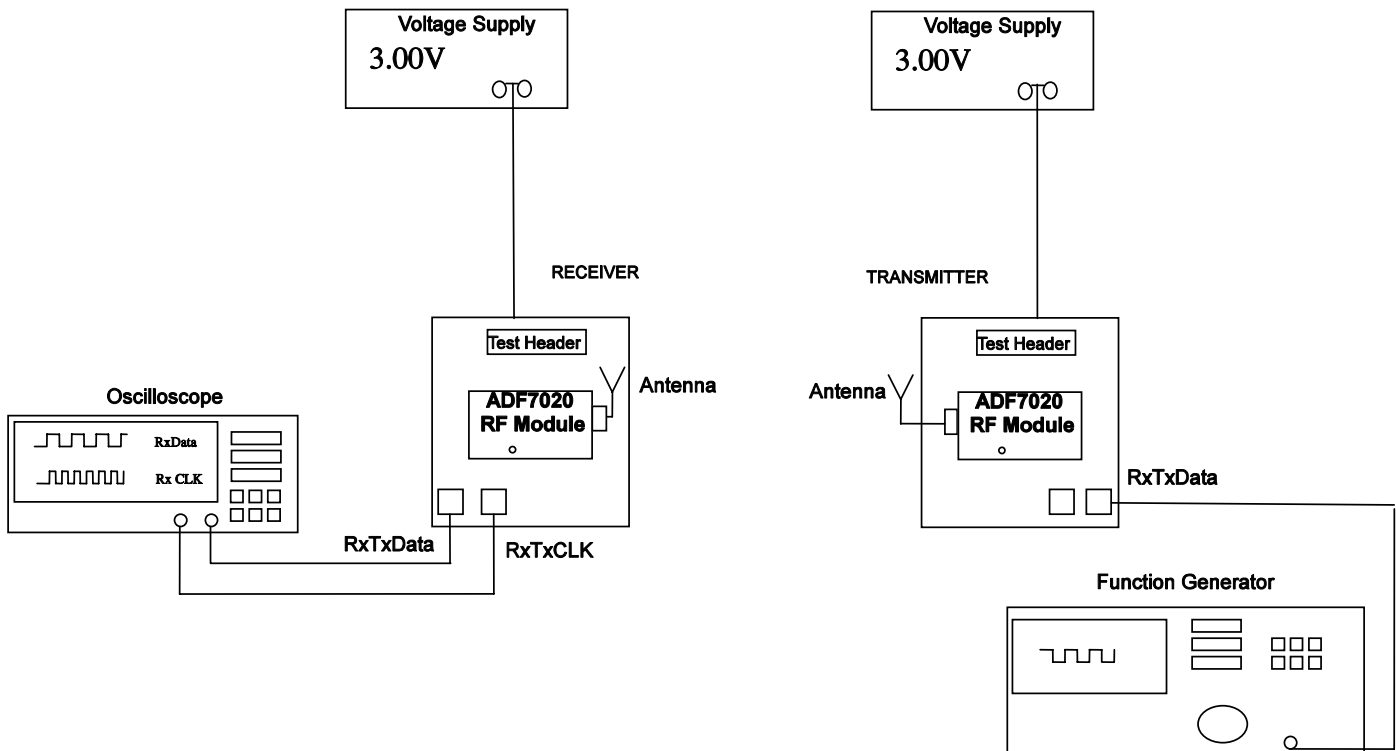
- If you don't have a built-in BER tester you can estimate the sensitivity point, by reducing the level on the frequency generator until you see the RxTxData waveform 'flickering' which corresponds to errors in the received data. Typically if you see a flicker/error once per second you can roughly estimate this to be the sensitivity point. Note the level on the Signal Generator when this happens. For this setup it should be  $-102\text{dBm} \pm 2\text{dBm}$ .
- Change the demodulator type to correlator in the software and click Update All. Measure the sensitivity again. It should now be better than  $-106\text{dBm}$ .

**Readback Function**

It's possible to enable the on-chip ADC on the ADF7020/ADF7020-1 and readback a selection of parameters, including battery voltage, temperature(from either the on-board

temperature sensor or TMP37 IC device), Frequency Error, External voltage and RSSI.

To activate this feature, click on the Sync/Readback Toggle button. In the sub-window select the type of readback required. The appropriate value should be displayed on the screen. In Tx mode the ADC is powered-off by default to save power, so in order to readback correctly you need to enable the ADC. This can be done by clicking the status button in the ADC Status section to "ON" before clicking the Readback button. Since the ADC is used in Rx mode for the AGC function, the ADC is powered-on by default in this mode. Thus in Rx mode, valid battery voltage, temperature, frequency error and external voltage readback data can only be retrieved when AGC is disabled. This can be done by manually setting bit 19 (Gain Control) in register 9 (AGC register) low. In practical cases the user would typically do a battery voltage readback in Tx mode



## SETTING UP AN RF LINK USING THE ADF7020DBX OR ADF7020-1DBX

The EVAL-ADF70XXMB2 boards which contain an embedded microcontroller running a wireless network protocol is the simplest way to setup and RF Link. If you are using the EVAL-ADF70XXMB boards it is still possible to setup a basic link using the antennas and software provided. The most straightforward way to do this is to have one board acting as a dedicated Transmitter and one board as the dedicated Receiver. This configuration is shown above. Note if you want to use one board as a remote unit, you can connect a battery to the power-block. If the battery voltage is greater than 3.6V you should use the 3V regulator on the mother-board by connecting the jump switch K3 to position A.

### Tx Setup

1. Configure function generator to output a 3Vp-p square-wave at 4.8kHz.
2. Follow steps 3a. to 3d. on Page 6.
3. Select FSK Modulation and set desired deviation to 20kHz and output power setting to 48.
4. Hit the Update All button and check the signal on a Spectrum Analyzer to ensure this is outputting at the correct frequency and level.
5. Connect the antenna provided and disconnect the PC cable from the board.

### Rx Setup

Connect the antenna to the Receiver and the PC cable to the receiver mother-board

Follow steps 9. to 12. on Page8.

1. The de-modulated signal should appear on the scope.
2. You should now be in a position to apply your own modulation and de-modulate this correctly.

**SETTING PLL LOOP BANDWIDTHS**

The Eval Boards have been built using a 50kHz PLL LBW. From measurements made on SNR and modulation quality of the FSK signal, it is recommended to use a LBW > 1.5 x Datarate.

So for the default filter on the Eval Board, this gives a max. datarate close to 38.4kbps. If you want to operate the board at higher data-rates you need to modify the loop filter according

to the values in Tables 2 & 3 for the ADF7020. For the ADF7020-1 it is recommended to use ADIismPLL to design the loop filter.

ADISimPLL V3.0 allows you to simulate these effects and design loop filters for various data-rates and different RF Output frequencies.. For output frequency/xtal/data-rate combinations not covered below you should use ADISimPLL V3.0 (or later).

**Table 2: ADF7020DB1 FILTER (902-928MHZ)**

| Xtal     | Data Rate        | PLL LBW | Min Channel Spacing | R Divider | Icp    | C18   | R5   | C17   | R4   | C16   |
|----------|------------------|---------|---------------------|-----------|--------|-------|------|-------|------|-------|
| 11.0592M | 0.3 – 38.4kbps   | 50k     | 150kHz              | 1         | 1.44mA | 1.5nF | 180r | 33nF  | 910r | 270pF |
| 11.0592M | 38.4 - 76.8 kbps | 115k    | 200kHz              | 1         | 1.44mA | 560pF | 680r | 5.6nF | 1.2k | 180pF |
| 11.0592M | 76.8 - 153.6kbps | 215k    | 500kHz              | 1         | 1.44mA | 150pF | 1.3k | 1.5nF | 2.5k | 30pF  |
| 11.0592M | 153.6 - 200 kbps | 250k    | 500kHz              | 1         | 1.44mA | 100pF | 1.5k | 1.2nF | 3k   | 27pF  |
| 14.7456M | 0.3 – 38.4kbps   | 50k     | 150kHz              | 1         | 1.44mA | 2.7nF | 220r | 39nF  | 470r | 1.2nF |
| 14.7456M | 38.4 - 76.8 kbps | 115k    | 200kHz              | 1         | 1.44mA | 560pF | 510r | 8.2nF | 1.2k | 220pF |
| 14.7456M | 76.8 - 153.6kbps | 215k    | 500kHz              | 1         | 1.44mA | 150pF | 1k   | 2.2nF | 2.2k | 56pF  |
| 14.7456M | 153.6 - 200 kbps | 250k    | 500kHz              | 1         | 1.44mA | 120pF | 1.1k | 1.8nF | 2.5k | 39pF  |

Note: Need to set VCO\_Adjust=0 to give correct Kvco

**Table 3: ADF7020DB2/3 Filter (433M/868MHz)**

| Xtal     | Data Rate        | PLL LBW | Min Channel Spacing | R Divider     | Icp    | C18   | R5   | C17   | R4   | C16   |
|----------|------------------|---------|---------------------|---------------|--------|-------|------|-------|------|-------|
| 11.0592M | 0.3 - 38.4kbps   | 50k     | 150kHz              | 1             | 1.44mA | 3.3nF | 180r | 56nF  | 470r | 1.2nF |
| 11.0592M | 38.4 - 76.8 kbps | 115k    | 200kHz              | 1             | 1.44mA | 1.8nF | 220r | 22nF  | 470r | 680pF |
| 11.0592M | 76.8 - 153.6kbps | 215k    | 500kHz              | 1             | 1.44mA | 470pF | 430r | 6.8nF | 910r | 220pF |
| 11.0592M | 153.6 - 200 kbps | 250k    | 500kHz              | 1             | 1.44mA | 270pF | 620r | 3.3nF | 1.2k | 120pF |
| 14.7456M | 0.3 - 38.4kbps   | 50k     | 150kHz              | 2 (See Note4) | 1.44mA | 1.8nF | 270r | 22nF  | 560r | 820pF |
| 14.7456M | 38.4 - 76.8 kbps | 115k    | 200kHz              | 2             | 1.44mA | 1.2nF | 360r | 15nF  | 750r | 470pF |
| 14.7456M | 76.8 - 153.6kbps | 215k    | 500kHz              | 2             | 1.44mA | 270pF | 750r | 3.3nF | 1.5k | 120pF |
| 14.7456M | 153.6 - 200 kbps | 250k    | 500kHz              | 2             | 1.44mA | 150pF | 1k   | 2.2nF | 2k   | 68pF  |

Notes:

1. Deviation typ. +/- (Baud-rate/2)
2. Xtal frequency needs to be chosen so that CDR\_CLK is within 3% of (32 x Data-rate). For example if you have 12MHz xtal and want 180kbps, allowable range is 181.87kbps to 193.125kbps, need to adjust data-rate or xtal accordingly
3. For filter designed with 12MHz xtal (11.0592MHz should have minimal effect on phase margin)
4. Nmin=31, so for 433MHz => PFDmax=13.96MHz

**BILL OF MATERIALS**

Table 4. Bill Of Materials for the EVAL-ADF7020DBX and EVAL-ADF7020-1DBX Daughter Boards (Common to all versions)

| Qty | Name                              | Value        | Tolerance | PCB Decal   | Manufacturing Part No.         |
|-----|-----------------------------------|--------------|-----------|-------------|--------------------------------|
| 8   | C5,C7,C11,C14,C20,<br>C22,C25,C28 | 0.1uF        | ±10%      | 0402        |                                |
| 2   | C8,C30                            | 10uF         | ±10%      | 0805        |                                |
| 1   | C9                                | 10nF         | ±10%      | 0402        |                                |
| 1   | C15                               | 22nF         | ±10%      | 0402        |                                |
| 8   | C4,C6,C10,C12,C19,<br>C21,C26,C27 | 5.1pF        | ±0.5pF    | 0402        |                                |
| 2   | C23,C24                           | 33pF         | ±5%       | 0402        |                                |
| 5   | C13,C29,C31,C32,C33               | Not Inserted |           | 0402        |                                |
| 1   | J1                                |              |           | HEADER14    |                                |
| 1   | J2                                |              |           | SMA_EDGE_RF |                                |
| 2   | R1, R7                            | 0r           | ±5%       | 0402        |                                |
| 1   | R2                                | 1.1k         | ±5%       | 0402        |                                |
| 1   | R3                                | 3.6k         | ±5%       | 0402        |                                |
|     | R6                                | Not Inserted |           | 0402        |                                |
|     | T1                                |              |           | TESTPOINT   |                                |
|     | T2                                |              |           | TESTPOINT   |                                |
| 1   | U1                                |              |           | LFCSP-48    | ADF7020BCPZ/ ADF7020-<br>1BCPZ |
|     |                                   |              |           |             |                                |

Table 5. Bill Of Materials for components specific to EVAL-ADF7020DB1 Daughter Board

| Qty | Name | Value        | Tolerance     | PCB Decal       | Manufacturing Part No.    |
|-----|------|--------------|---------------|-----------------|---------------------------|
| 1   | C1   | 2.7pF        |               | 0402            | GRM1555C1H2R7CZ01D        |
| 1   | C2   | 8.2pF        |               | 0402            | GRM1555C1H8R2CZ01D        |
| 1   | C3   | 3.0pF        |               | 0402            | GRM1555C1H3R0CZ01D        |
| 1   | L1   | 4.3nH        |               | 0402            | Coilcraft 0402CS-4N3X_JLW |
| 1   | L2   | 8.7nH        |               | 0402            | Coilcraft 0402CS-8N7X_JLW |
|     | L3   | Not inserted |               | 0402            |                           |
| 1   | R4   | 910r         | ±5%           | 0402            |                           |
| 1   | R5   | 180r         | ±5%           | 0402            |                           |
| 1   | C16  | 270pF        | ±10%          | 0402            |                           |
| 1   | C17  | 33nF         | ±10%          | 0402            |                           |
| 1   | C18  | 1.5nF        | ±10%          | 0402            |                           |
| 1   | Y1   | 11.0592MHz   | ±30ppm / 20pF | HC49_4H_SMX     |                           |
| 1   | Y2   |              |               | LFL18924MTC1A05 | Murata LFL18924MTC1A05    |

Table 6. Bill Of Materials for components specific to EVAL-ADF7020DB2 Daughter Board

| Qty | Name | Value        | Tolerance     | PCB Decal       | Manufacturing Part No.    |
|-----|------|--------------|---------------|-----------------|---------------------------|
| 1   | C1   | 2.7pF        |               | 0402            | GRM1555C1H2R7CZ01D        |
| 1   | C2   | 8.2pF        |               | 0402            | GRM1555C1H8R2CZ01D        |
| 1   | C3   | 3.0pF        |               | 0402            | GRM1555C1H3R0CZ01D        |
| 1   | L1   | 4.3nH        |               | 0402            | Coilcraft 0402CS-4N3X_JLW |
| 1   | L2   | 8.7nH        |               | 0402            | Coilcraft 0402CS-8N7X_JLW |
|     | L3   | Not Inserted |               | 0402            |                           |
| 1   | R4   | 470r         | ±5%           | 0402            |                           |
| 1   | R5   | 180r         | ±5%           | 0402            |                           |
| 1   | C16  | 1.2nF        | ±10%          | 0402            |                           |
| 1   | C17  | 56nF         | ±10%          | 0402            |                           |
| 1   | C18  | 3.3nF        | ±10%          | 0402            |                           |
| 1   | Y1   | 11.0592MHz   | ±30ppm / 20pF | HC49_4H_SMX     |                           |
| 1   | Y2   |              |               | LFL18924MTC1A05 | Murata LFL18924MTC1A05    |

Table 7. Bill Of Materials for components specific to EVAL-ADF7020DB3 Daughter Board

| Qty | Name    | Value        | Tolerance     | PCB Decal   | Manufacturing Part No.    |
|-----|---------|--------------|---------------|-------------|---------------------------|
| 1   | C1      | 4.7pF        |               | 0402        |                           |
| 1   | C2      | 10pF         |               | 0402        |                           |
| 1   | C3      | 6.8pF        |               | 0402        |                           |
| 1   | L1      | 13nH         |               | 0402        | Coilcraft 0402CS-13NX_JLW |
| 1   | L2      | 27nH         |               | 0402        | Coilcraft 0402CS-27NX_JLW |
|     | L3      | Not Inserted |               | 0402        |                           |
| 1   | L4      | 22nH         |               | 0402        | Coilcraft 0402CS-22NX_JLW |
| 1   | L5      | 20nH         |               | 0402        | Coilcraft 0402CS-20NX_JLW |
| 1   | R4      | 910r         | ±5%           | 0402        |                           |
| 1   | R5      | 180r         | ±5%           | 0402        |                           |
| 2   | C34,C36 | Not Inserted |               | 0402        |                           |
| 1   | C35     | 6.8pF        |               | 0402        |                           |
| 1   | Y1      | 11.0592MHz   | ±30ppm / 20pF | HC49_4H_SMX |                           |

Table 8. Bill Of Materials for components specific to EVAL-ADF7020-1DB4 Daughter Board.

| Qty                      | Name    | Value        | Tolerance     | PCB Decal   | Manufacturing Part No.    |
|--------------------------|---------|--------------|---------------|-------------|---------------------------|
| <b>Matching</b>          |         |              |               |             |                           |
| 1                        | C1      | 4.7pF        |               | 0402        |                           |
| 1                        | C2      | 8.2pF        |               | 0402        |                           |
| 1                        | C3      | 4.7pF        |               | 0402        |                           |
| 1                        | L1      | 18nH         |               | 0402        | Coilcraft 0402CS-18NX_JLW |
| 1                        | L2      | 36nH         |               | 0402        | Coilcraft 0402CS-36NX_JLW |
| <b>VCO Tank Inductor</b> |         |              |               |             |                           |
| 1                        | L3      | 6.2nH        | 2%            | 0402        | Coilcraft 0402CS-6N2X_GLU |
| <b>Harmonic Filter</b>   |         |              |               |             |                           |
| 1                        | L4      | 27nH         |               | 0402        | Coilcraft 0402CS-27NX_JLW |
| 1                        | L5      | 30nH         |               | 0402        | Coilcraft 0402CS-30NX_JLW |
| 1                        | C35     | 5.6pF        |               | 0402        |                           |
| 2                        | C34,C36 | Not Inserted |               | 0402        |                           |
| <b>Loop Filter</b>       |         |              |               |             |                           |
| 1                        | R4      | 1.2k         | ±5%           | 0402        |                           |
| 1                        | R5      | 560r         | ±5%           | 0402        |                           |
| 1                        | C16     | 390pF        | ±10%          | 0402        |                           |
| 1                        | C17     | 15nF         | ±10%          | 0402        |                           |
| 1                        | C18     | 1000pF       | ±10%          | 0402        |                           |
| 1                        | Y1      | 11.0592MHz   | ±30ppm / 20pF | HC49_4H_SMX |                           |



Table 9. Bill Of Materials for components specific to EVAL-ADF7020-1DB6 Daughter Board.

| Qty                      | Name    | Value        | Tolerance     | PCB Decal   | Manufacturing Part No.    |
|--------------------------|---------|--------------|---------------|-------------|---------------------------|
| <b>Matching</b>          |         |              |               |             |                           |
| 1                        | C1      | 3.9pF        |               | 0402        |                           |
| 1                        | C2      | 8.2pF        |               | 0402        |                           |
| 1                        | C3      | 3.9pF        |               | 0402        |                           |
| 1                        | L1      | 13nH         |               | 0402        | Coilcraft 0402CS-13NX_JLW |
| 1                        | L2      | 30nH         |               | 0402        | Coilcraft 0402CS-30NX_JLW |
| <b>VCO Tank Inductor</b> |         |              |               |             |                           |
| 1                        | L3      | 2.7nH        | 2%            | 0402        | Coilcraft 0402CS-2N7X_GLU |
| <b>Harmonic Filter</b>   |         |              |               |             |                           |
| 1                        | L4      | 18nH         |               | 0402        | Coilcraft 0402CS-18NX_JLW |
| 1                        | L5      | 20nH         |               | 0402        | Coilcraft 0402CS-20NX_JLW |
| 1                        | C35     | 5.6pF        |               | 0402        |                           |
| 2                        | C34,C36 | Not Inserted |               | 0402        |                           |
| <b>Loop Filter</b>       |         |              |               |             |                           |
| 1                        | R4      | 800r         | ±5%           | 0402        |                           |
| 1                        | R5      | 400r         | ±5%           | 0402        |                           |
| 1                        | C16     | 680pF        | ±10%          | 0402        |                           |
| 1                        | C17     | 22nF         | ±10%          | 0402        |                           |
| 1                        | C18     | 1500pF       | ±10%          | 0402        |                           |
| <b>XTAL</b>              |         |              |               |             |                           |
| 1                        | Y1      | 11.0592MHz   | ±30ppm / 20pF | HC49_4H_SMX |                           |

**Table 10. Bill Of Materials for components specific to EVAL-ADF7020-1DB7 Daughter Board.**

| Qty                      | Name    | Value        | Tolerance     | PCB Decal   | Manufacturing Part No.    |
|--------------------------|---------|--------------|---------------|-------------|---------------------------|
| <b>Matching</b>          |         |              |               |             |                           |
| 1                        | C1      | 5.6pF        |               | 0402        |                           |
| 1                        | C2      | 10pF         |               | 0402        |                           |
| 1                        | C3      | 6.8pF        |               | 0402        |                           |
| 1                        | L1      | 30nH         |               | 0402        | Coilcraft 0402CS-30NX_JLW |
| 1                        | L2      | 56nH         |               | 0402        | Coilcraft 0402CS-56NX_JLW |
| <b>VCO Tank Inductor</b> |         |              |               |             |                           |
| 1                        | L3      | 13nH         | 2%            | 0402        | Coilcraft 0402CS-13NX_GLU |
| <b>Harmonic Filter</b>   |         |              |               |             |                           |
| 1                        | L4      | 51nH         |               | 0402        | Coilcraft 0402CS-51NX_JLW |
| 1                        | L5      | 47nH         |               | 0402        | Coilcraft 0402CS-47NX_JLW |
| 1                        | C35     | 6.8pF        |               | 0402        |                           |
| 2                        | C34,C36 | Not Inserted |               | 0402        |                           |
| <b>Loop Filter</b>       |         |              |               |             |                           |
| 1                        | R4      | 1.5k         | ±5%           | 0402        |                           |
| 1                        | R5      | 680r         | ±5%           | 0402        |                           |
| 1                        | C16     | 330pF        | ±10%          | 0402        |                           |
| 1                        | C17     | 10nF         | ±10%          | 0402        |                           |
| 1                        | C18     | 820pF        | ±10%          | 0402        |                           |
| <b>XTAL</b>              |         |              |               |             |                           |
| 1                        | Y1      | 9.8304MHz    | ±30ppm / 20pF | HC49_4H_SMX |                           |

Table 11. Bill Of Materials for components specific to EVAL-ADF7020-1DB8 Daughter Board.

| Qty                      | Name    | Value        | Tolerance     | PCB Decal   | Manufacturing Part No.    |
|--------------------------|---------|--------------|---------------|-------------|---------------------------|
| <b>Matching</b>          |         |              |               |             |                           |
| 1                        | C1      | 12pF         |               | 0402        |                           |
| 1                        | C2      | 18pF         |               | 0402        |                           |
| 1                        | C3      | 10pF         |               | 0402        |                           |
| 1                        | L1      | 100nH        |               | 0603        | Coilcraft 0603CS-R10X-JLU |
| 1                        | L2      | 200nH        |               | 0603        | Coilcraft 0603CS-R20X-JLU |
| <b>VCO Tank Inductor</b> |         |              |               |             |                           |
| 1                        | L3      | 22nH         | 2%            | 0603        | Coilcraft 0402CS-22NX_GLU |
| <b>Harmonic Filter</b>   |         |              |               |             |                           |
| 1                        | L4      | 150nH        |               | 0603        | Coilcraft 0603CS-R15X-JLU |
| 1                        | L5      | 130nH        |               | 0603        | Coilcraft 0603CS-R13X-JLU |
| 1                        | C35     | 15pF         |               | 0402        |                           |
| 2                        | C34,C36 | Not Inserted |               | 0402        |                           |
| <b>Loop Filter</b>       |         |              |               |             |                           |
| 1                        | R4      | 1.0k         | ±5%           | 0402        |                           |
| 1                        | R5      | 390r         | ±5%           | 0402        |                           |
| 1                        | C16     | 470pF        | ±10%          | 0402        |                           |
| 1                        | C17     | 15nF         | ±10%          | 0402        |                           |
| 1                        | C18     | 1000pF       | ±10%          | 0402        |                           |
| <b>XTAL</b>              |         |              |               |             |                           |
| 1                        | Y1      | 11.0592MHz   | ±30ppm / 20pF | HC49_4H_SMX |                           |

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