

# Evaluation Boards for ADF7023 ISM Band Transceiver EVAL-ADF7023DBxZ

## Features

Frequency bands
862 MHz to 928 MHz
431 MHz to 464 MHz
Programmable datarates and modulation
1 kbps to 300 kbps
FSK/GFSK/OOK/MSK/GMSK modulation
Very low power consumption
12.8 mA in PHY_RX mode (maximum front-end gain)
24.1 mA in PHY_TX mode (10 dBm output, single-ended PA)
0.75 μA in PHY_SLEEP mode (32 kHz RC oscillator active)
1.28 μA in PHY_SLEEP mode (32 kHz XTAL oscillator active)
0.33 μA in PHY_SLEEP mode (Deep Sleep Mode 1)
High Sensitivity
Programmable output power
–20 dBm to +13.5 dBm (single-ended PA)
-20 dBm to +10 dBm (differential PA)
Excellent receiver selectivity and blocker resilience

# **General Description**

The ADF7023 is a very low power, high performance, highly integrated 2FSK/GFSK/OOK/MSK/GMSK transceiver designed for operation in the 862 MHz to 928 MHz and 431 MHz to 464 MHz frequency bands, which cover the worldwide licensefree ISM bands at 433 MHz, 868 MHz, and 915 MHz. It is suitable for circuit applications that operate under the European ETSI EN300-220, the North American FCC (Part 15), the Chinese short-range wireless regulatory standards, or other similar regional standards.

The ADF7023 evaluation platform consists of a 4-layer PCB daughter card which plugs into the Eval-ADF7xxxMB3Z motherboard.

#### **Board Number RF Frequency** Description EVAL-ADF7XXXMBZ3 Mother board required for evaluation of the ADF7023 daughter boards Eval-ADF7023DB1Z 868/915 MHz Two separate matching networks: One for the single ended PA and one for the LNA Eval-ADF7023DB2Z 868/915 MHz One combined matching network incorporating the single ended PA and LNA Eval-ADF7023DB3Z 433 MHz Two separate matching networks: One for the single ended PA and one for the LNA Eval-ADF7023DB4Z 433 MHz One combined matching network incorporating the single ended PA and LNA

#### Table 1 Evaluation Boards

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## **Revision History**

Date: April 18<sup>th</sup> 2013 Revision: Rev. 1.1

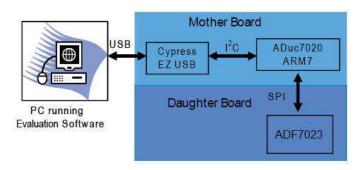
This document accompanies:

ADF7023 software release 1.5.4 Daughter boards using the layout files ADF702xDBExZ RevB and ADF702xDBFxZ RevB Mother board version EVAL-ADF7XXX\_MB3Z RevB running firmware version 2.0.2.3 or higher

# **Hardware Overview**

The Evaluation Platform consists of the Eval-ADF7XXXMB3Z mother board to which an appropriate daughter card may be connected. The available daughter cards are given in Table 1. Schematics for the daughter cards are given in the *ADF7023 Evaluation Board Schematics and BOMs* section of this document.

The mother board may be powered via the USB cable supplied. The 5V from the USB cable is regulated down to 3.3 V for the Cypress EZ USB IC, the ADuC7020 microcontroller and the ADF7023 transceiver. Alternatively a battery may be used to power the microcontroller and transceiver. A 3.6V battery is shipped with the boards.



Hardware Overview

## **Getting Started**

### Installing Software

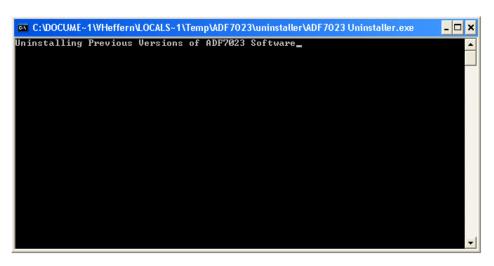
The ADF7023 evaluation software and documentation can be installed from the Analog Devices ftp site.

(ftp.analog.com/pub/RFL/ADF7023)

The software installation should be carried out before plugging in the ADF7023 Evaluation Boards.

#### Installation Procedure

- Run ADF7023 Rev1.5.4 FULL.exe to install the evaluation software for the ADF7023. The install will place the relevant files in the folder C:\Program Files\Analog Devices BV\ADF7023. It will also create shortcuts on the start menu. Any previous versions of the software will be removed before the installation commences (Figure 1).
- 2.





3. Click on "Yes" to install the software (Figure 2).





4. Click "*Next*" (Figure 3):

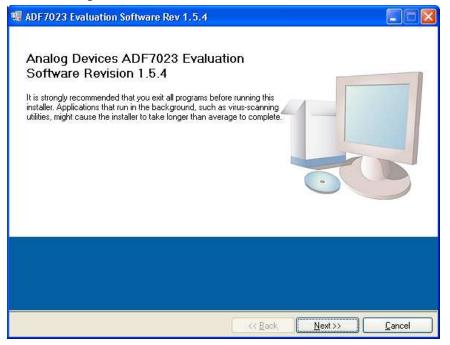


Figure 3

5. Click "*Next*" (Figure 4):

ADF7023 Evaluation Software Rev 1.5.4	
Destination Directory Select the primary installation directory.	
All software will be installed in the following location(s). To install software into a different location(s), click the Browse button and select another directory.	
Directory for ADF7023 Evaluation Software Rev 1.5.4	
C:\Program Files\Analog Devices BV\ADF7023\ Browse	
Cance	

Figure 4

6. Click "I accept this license Agreement"

Then Click " <i>Next</i> " (Figure 5):
🔹 ADF7023 Evaluation Software Rev 1.4.4
License Agreement You must accept the license(s) displayed below to proceed.
NATIONAL INSTRUMENTS SOFTWARE LICENSE AGREEMENT
INSTALLATION NOTICE: THIS IS A CONTRACT. BEFORE YOU DOWNLOAD THE SOFTWARE AND/OR COMPLETE THE INSTALLATION PROCESS, CAREFULLY READ THIS AGREEMENT. BY DOWNLOADING THE SOFTWARE AND/OR CLICKING THE APPLICABLE BUTTON TO COMPLETE THE INSTALLATION PROCESS, YOU CONSENT TO THE TERMS OF THIS AGREEMENT AND YOU AGREE TO BE BOUND BY THIS AGREEMENT. IF YOU DO NOT WISH TO BECOME A PARTY TO THIS AGREEMENT AND BE BOUND BY ALL OF ITS TERMS AND CONDITIONS, CLICK THE APPROPRIATE BUTTON TO CANCEL THE INSTALLATION PROCESS, DO NOT INSTALL OR USE THE SOFTWARE, AND RETURN THE SOFTWARE WITHIN THIRTY (30) DAYS OF RECEIPT OF THE SOFTWARE (WITH ALL ACCOMPANYING WRITTEN MATERIALS, ALONG WITH THEIR CONTAINERS) TO THE PLACE YOU OBTAINED THEM. ALL RETURNS SHALL BE SUBJECT TO NI'S THEN CURRENT RETURN POLICY.
● Laccept the License Agreement.
I do not accept the License Agreement.
Cancel

Figure 5

7. Click "*Next*" (Figure 6):

ADF7023 Evaluation Software Rev 1.5.4	
Start Installation Review the following summary before continuing.	
Adding or Changing •ADF7023 Evaluation Software Rev 1.5.4 Files	
Click the Next button to begin installation. Click the Back button to change the installation settings.	
Save File C Back Next >>	Cancel

Figure 6

#### 8. Click "*Next*" (Figure 7):

ADF7023 Evaluation Software Rev 1.5.4			
Installation Complete			
The installer has finished updating your system.			
	<< <u>B</u> ack	Next >>	Einish

Figure 7

9. Click "*Next*" (Figure 8):



Figure 8

10. Click "*Next*" (Figure 9):

😽 ADF7xMB3 Drivers Install 3.4.2.0 Setup	
Choose Install Location Choose the folder in which to install ADF7xMB3 Drivers Install 3.4.2.0.	
Setup will install ADF7xMB3 Drivers Install 3.4.2.0 in the following folder. To install in a different folder, click Browse and select another folder. Click Install to start the installati	on.
Destination Folder           C:\Program Files\Analog Devices\ADF7x_MB3 32\Drivers         Browse	
Space required: 2.5MB Space available: 42.3GB	
Nullsoft Install System v2.46	ncel
Nullsoft Install System v2,46	ncel

Figure 9

11. Click "*Next*" (Figure 10):

🗑 ADF7xMB3 Drivers Insta	ıll 3.4.2.0 Setup
	Completing the ADF7xMB3 Drivers Install 3.4.2.0 Setup Wizard ADF7xMB3 Drivers Install 3.4.2.0 has been installed on your computer. Click Finish to close this wizard.
	< Back Einish Cancel

Figure 10

**12.** At this point the ADF7xxxMB3Z Motherboard can be plugged into a free USB port.

#### **13.** The following screen will appear:

Ensure the *"Install the software automatically"* option is checked as in Figure 11. Then click *"Next"* :

Found New Hardware Wizard	
Welcome to the Found New Hardware Wizard	
	This wizard helps you install software for:
	ADF7XXXMBZ3 Board #2
	If your hardware came with an installation CD or floppy disk, insert it now.
	What do you want the wizard to do?
	<ul> <li>Install the software automatically (Recommended)</li> <li>Install from a list or specific location (Advanced)</li> </ul>
	Click Next to continue.
	< Back Next > Cancel

#### Figure 11

Figure 12):

**14.** Click *"Continue Anyway"* (

Hardwar	e Installation
	The software you are installing for this hardware: ADF7XXXMBZ3 Board #2 has not passed Windows Logo testing to verify its compatibility with Windows XP. (Tell me why this testing is important.) Continuing your installation of this software may impair or destabilize the correct operation of your system either immediately or in the future. Microsoft strongly recommends that you stop this installation now and contact the hardware vendor for software that has passed Windows Logo testing.
	Continue Anyway

Figure 12

#### 15. Click "Finish" ( Figure 13):

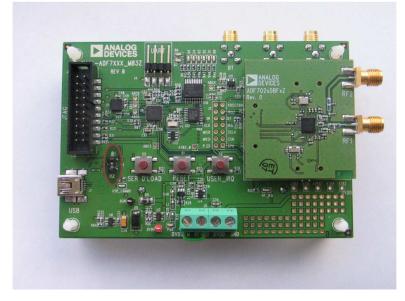
Found New Hardware Wizard	
	Completing the Found New Hardware Wizard The wizard has finished installing the software for: ADF7XXXMBZ3 Board #2
	Click Finish to close the wizard.
	K Back Finish Cancel

Figure 13

## **Connecting the Evaluation Boards**

This software can allow **TWO** evaluation boards to be connected to a single PC. The EVAL board and the software must be setup accordingly.

Ensure that Switch 4 is in the correct position before connecting to the PC as shown in Figure 14.





- To set the first board as "BOARD 1" (Figure 15) on the Software set the switch shown in Figure 14 to "B1"
- To set the second board as "BOARD 2" (Figure 15) on the Software set the switch shown in Figure 14 to "B2"

Ensure the evaluation mother board with the desired daughter card is connected to the PC via USB cable before running the software.

Run the ADF7023 software from Start-> Programs->Analog Devices->ADF7xxx->ADF7023.

Once the software is running press Connect USB (Figure 16).

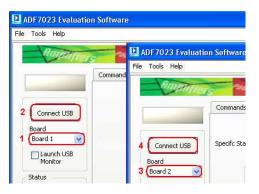


Figure 15

### **Using the Evaluation Software**

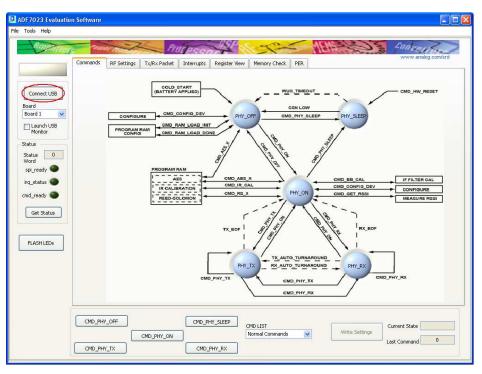


Figure 16

Wait until the BUSY signal above the Connect USB button is turned off before pressing any further buttons on the software interface.

The Firmware for the motherboard is automatically checked each time the software is loaded to ensure the revisions are kept up to date.

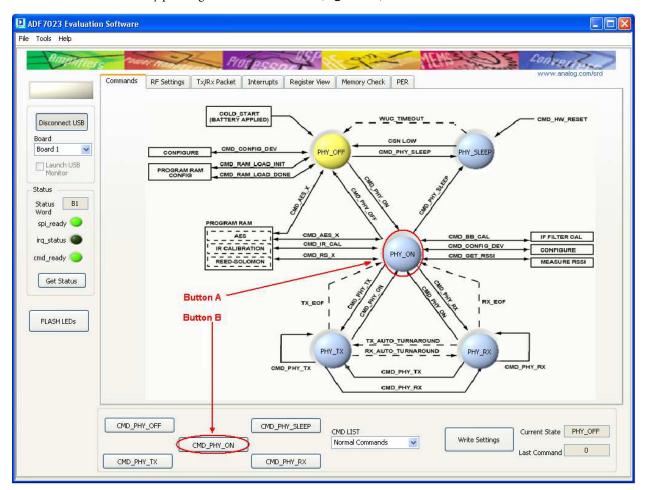
If the firmware is out of date the following message will pop up (Figure 17):

The Firmware Revision on this board is out of date. Do you want to update this Firmware?
Yes No

Figure 17

To go through the update procedure, refer to the *Mother Board Firmware Update* section.

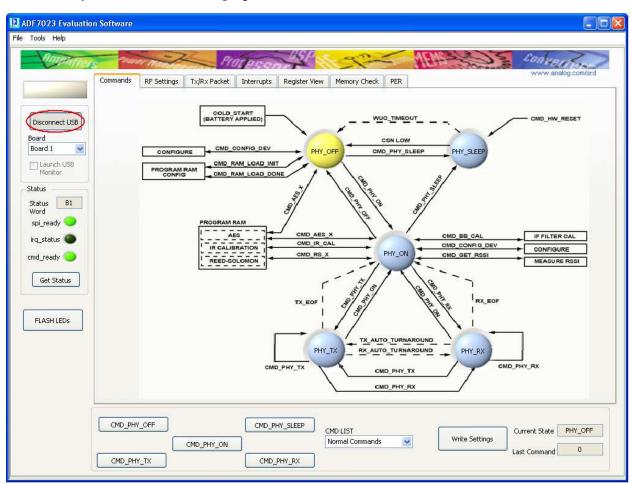
Next enter state PHY\_ON by pressing the command CMD\_PHY\_ON.



This can be done by pressing Button A or Button B (Figure 18).

Figure 18

The current status of the ADF7023 will be reflected by the color of the buttons on the "Commands" tab.



Note: If at any time it is desired to unplug the USB cable, click "*Disconnect USB*" first (Figure 19).

Figure 19

## Mother Board Firmware Version

The Motherboard firmware revision check is done automatically when "Connect USB" is clicked. If the firmware revision is not correct a popup screen will appear asking the user to update the Firmware (Figure 20).

The Firmware Revision on this board is out of date. Do you want to update this Firmware?
Yes No



To manually check the firmware after connecting the USB select <u>Help</u> -> <u>Check Firmware Revision</u> as shown in

#### Figure 21Error! Reference source not found..

If this value is less than 02.00.02.05 then the firmware version will need to be updated.

Firmware update procedure can be found in the *Mother Board Firmware Update* section.

le Tools Help	
Check Firmware SW Rev 1.5.4	Revision Processon SP
Cor	mmands RF Settings Tx/Rx Packet Interrupts Register View Memory Check PER
	Firmware Revision Readback.vi
Disconnect USB Board Board 1 Launch USB Monitor Status Status B1 Word spi_ready irq_status	Firmware Revision Code02.00.02.05Major Revision02Minor Revision00REV02Internal05
cmd_ready 🥌 Get Status	

Figure 21

## Mother Board Firmware Update

- 1. Before beginning this procedure ensure ONLY the board you wish to update the firmware on is connected to the PC.
- 2. To update the firmware select "*Tools*" -> "*Motherboard Firmware Download*" (Figure 22).



**3.** Select the desired firmware version "*EVAL\_ADF7XXXMB3Z\_Rev\_2.0.2.5.hex*" from the default directory (Figure 23).

12C_Downloader_Vi.vi	
File	
Source Directory GC:\Program Files\Analog Devices BV\ADF7xxxMB3z Firmware\ EVAL_ADF70xxMB23_Rev2.0.2.5 hex	
Download Firmware	

Figure 23

4. Click "*Download Firmware*" and follow the onscreen instructions ( Figure 24).

🖳 12C_Downloader_Vi.vi
File
Source Directory
C:\Program Files\Analog Devices BV\ADF7xxxMB3z Firmware\
Download Firmware
Download I innivare

Figure 24

5. "*SER DLOAD* and "*RESET*" buttons will be referenced and can be found as shown in Figure 25.

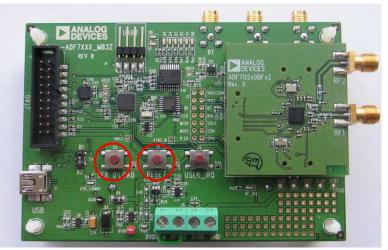


Figure 25

- 6. Disconnect and then reconnect the USB cable from the evaluation platform.
- 7. The mother board firmware is now updated.

### Basic RF testing in SPORT Mode

- 1. Select the "<u>RF Settings</u>" Tab and set the RF parameters as required. (Figure 26 point(<u>1</u>))
- 2. If not already in *PHY\_ON* enter this state by pressing *CMD\_PHY\_ON*. (*Figure 26 point* (<u>5</u>))
- 3. Select the *SPORT Mode* (*Figure 26 point* (<u>2</u>))
- Press *Update Needed*. This writes the settings to BBRAM and then does a CMD\_CONFIG\_DEV. (*Figure 26 point* (<u>3</u>))
- 5. Press CMD\_PHY\_RX. The part now enters PHY\_RX. (Figure 26 point (4))
- 6. To exit <u>PHY RX</u> press <u>CMD PHY ON</u> (Figure 26 point (<u>5</u>))

Bingenner	Plan pro USP 200 Million Conversion
Connect USB 30ard Board 1 Launch USB Monitor itatus Status Status Status Spi_ready	Commands       RF Settings       Tx/Rx Packet       Interrupts       Register View       Memory Check       PER       Www.analog.com/src         Mode       SPORT Mode       (GP0 = RxData, GP1 = DataClk, GP2 = TxData, GP4 = SWD)       2         Specific Standard       Image: Specific Standard
irq_status ● cmd_ready ● Get Status	Transmitter     AFC Kp 3     Readback       Modulation Scheme     2FSK     AFC Ki     7       PA Level     15     AGC Mode     Free Running       PA Ramp     4 codes/bit     Other     AFC I       PA Select     Single ended     TX such humanand     IF filter
FLASH LEDs	PA Select Single ended     TX_auto_turnaround [ RX_auto_turnaround ] External PA enable (ATB3) [ External LNA enable (ATB4) ]     Mixer       CMD_PHY_OFF     6     CMD_PHY_SLEEP     CMD_LIST       CMD_PHY_ON     4     Normal Commands     Update Needed

Figure 26

- While in *PHY\_RX* with SPORT mode enabled, the received data demodulated by the ADF7023 will appear at the **DR** SMA connector on the mother board as shown in *Figure 27*
- A clock synchronized with the demodulated data will appear at the CLK SMA connector as shown in *Figure 27*.

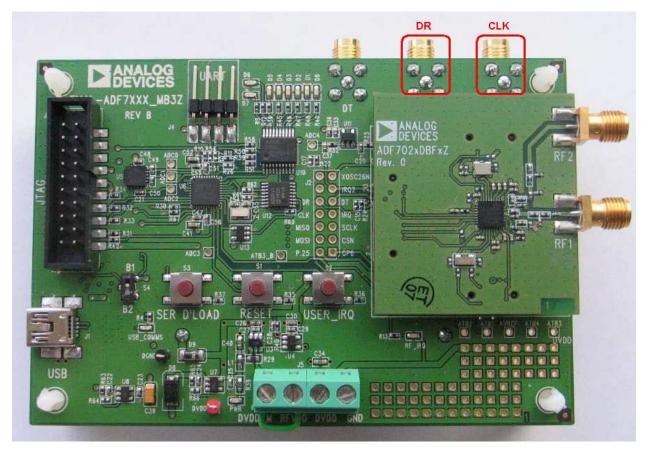


Figure 27

## Entering PHY\_TX for basic RF Carrier testing

- 1. Select the "<u>*RF Settings*</u>" Tab and set the RF parameters as required. (*Figure 28point* (<u>1</u>)
- 2. Select "*Packet Mode*" (Figure 28point (2))
- 3. Set Tx Test Mode to "*Transmit Carrier*" (Figure 28point (<u>3</u>))
- 4. Ensure part is in <u>PHY\_ON</u> (Figure 28point (<u>4</u>))
- Press Update Needed. This writes the settings to BBRAM and then does a CMD\_CONFIG\_DEV (Figure 28point (5))
- 6. Press "<u>CMD PHY TX</u>" to enter transmit mode (continuous carrier transmission) (Figure 28point (<u>6</u>))
- 7. To exit <u>PHY\_TX</u> press <u>CMD\_PHY\_ON</u>(Figure 28point (<u>4</u>))

Amenner	Platesen		LAS Converter
	Commands RF Settings Tx/Rx Packet Interrupts	Register View Memory Check PER	www.analog.com/srd
	Mode Packet Mode (Comms processor handles	Tx/Rx packets)	2
Connect USB	Specifc Standard Normal Standard	~	
Board Board 1	RF/Modualtion	Receiver	Test Modes/Debug
Launch USB	Channel Frequency 915.0000 😂	IF Bandwidth 100kHz 💌	
Monitor	Frequency Deviation (kHz) 20.0	Demod Scheme 2FSK/GFSK/MSK/GMSK	Tx Test Mode Transmit Carrier 3
tatus Status B1	Data Rate (kbps) 40.0 📚	AFC Mode Disable	Select GPIO None
Word spi_ready 🔾		Expected Max RF Freq Error (kHz) 50.0 📚	
irq_status 🔘	Transmitter	АРС Кр 🛛 3 📚	Readback
md_ready 🔵	Modulation Scheme 2FSK 💌	AFC Ki 🛛 7 📚	PHY_RX ADC
Get Status	PA Level 15	AGC Mode Free Running 💽	
	PA Ramp 4 codes/bit	Other	RSSI LNA
FLASH LEDs	PA Select Single ended	TX_auto_turnaround	AFC Mixer
		RX_auto_turnaround	
		External PA enable (ATB3) 🔲	Readback
		External LNA enable (ATB4) 📃	
			5
	CMD_PHY_OFF 4 CMD_PHY	CMD LIST Normal Commands	Update Needed Current State PHY_OFF

Figure 28

## Entering PHY\_TX for basic RF Data testing

- 1. Select the "<u>RF Settings</u>" Tab and set the RF parameters as required. (Figure 29 point (<u>1</u>))
- 2. Select the SPORT Mode . (Figure 29 point (2))
- 3. Ensure part is in <u>PHY ON</u> (Figure 29 point (<u>4</u>))
- Press *Update Needed*. This writes the settings to BBRAM and then does a CMD\_CONFIG\_DEV. (*Figure 29 point* (<u>3</u>))
- 5. Press "<u>CMD PHY TX</u>" to enter transmit mode (continuous carrier transmission) (Figure 29 point (<u>5</u>))
- 6. To exit <u>PHY\_TX</u> press <u>CMD\_PHY\_ON</u>(Figure 29 point (<u>4</u>))

Amenner	Plot esen	States 1	Converter
	Commands RF Settings Tx/Rx Packet Interrupts Mode (SPORT Mode (GP0 = RxData, GP1 = Dat	Register View Memory Check PER	www.analog.com/srd
	Specific Standard Normal Standard	×	
ard	RF/Modualtion	Receiver	Test Modes/Debug
oard 1 🛛 🛃	Channel Frequency 915.0000	IF Bandwidth 100kHz 💌	
Monitor	Frequency Deviation (kHz) 20.0	Demod Scheme 2FSK/GFSK/MSK/GMSK	Tx Test Mode None
atus B1 ord pi_ready 🔵	Data Rate (kbps) 40.0 📚	AFC Mode Disable Expected Max RF Freq Error (kHz) 50.0 📚	Select GPIO None 💌 Test Mode
q_status 🔘	Transmitter	AFC Kp 3 📚	Readback
d_ready 🥥	Modulation Scheme 2F5K 💌	AFC KI 7	PHY_RX ADC
Get Status	PA Level 15 📚	AGC Mode Free Running	RSSI
	PA Ramp 4 codes/bit		IF Filter
ELASH LEDs	PA Select Single ended	Other	AFC Mixer
		RX_auto_turnaround 🗌 External PA enable (ATB3) 📃	Readback
		External LNA enable (ATB4)	
			Current State PHY_OFF

Figure 29

- While in <u>*PHY\_Tx*</u> with SPORT mode enabled, the transmitted data must synchronized with the output clock seen on the **CLK** SMA connector on the mother board as shown in (*Figure 30*)
- The Tx data line, from the users Tx device, should be connected to the **DT** SMA connector as shown in (*Figure 30*).

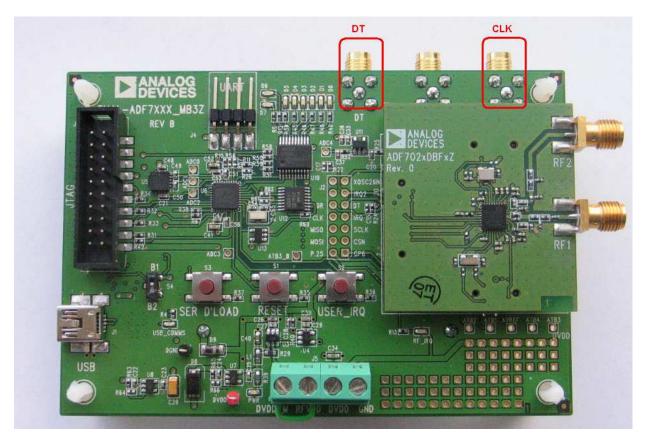


Figure 30

# Simple Rx / Tx Test in Packet Mode

This section gives a brief introduction on how to Transmit and Receive a packet using the ADF7023 Platform.

## Rx Setup in Packet Mode

The settings which follow are for use with EVAL-ADF7023DB1z daughter boards. If you are using a different Daughter board, ensure that the frequency is set within the correct range of the board you are using. Please refer to *Table 1 Evaluation Boards* if you are unsure what the frequency range of you board is designed for.

#### **Receiver Board RF Settings**

- Ensure the First ADF7023 Daughter board is correctly plugged into the First Mother board and that the "Current\_State" is "<u>PHY\_ON</u>" on the First instance of the ADF7023 Software. Refer to Connecting the Evaluation Boards for setup procedures.
- 2. Select the "*RF Settings*" Tab (Figure 31 point (<u>1</u>))
- 3. Ensure "Packet mode" is selected. (Figure 31 point (2))
- 4. Set the "*RF/Modulation*" parameters as required. (Figure 31 point (<u>3</u>))
- Set the "*Receiver*" parameters as required. (Figure 31 point (<u>4</u>)) If using AFC ensure the AFC pull in range is set to the desired value. (A value of half the IF bandwidth is recommended.)

ADF7023 Evaluatio	n Software
e Tools Help	
Amenner	Same A Plot as convertes
	Commands RF Settings Tx/Rx Packet Interrupts Register View Memory Check PER
	Mode (Packet Mode (Comms processor handles Tx/Rx packets)
Disconnect USB	Specific Standard 🛛
Board Board 1	RF/Modualtion 3 Receiver 4 Test Modes/Debug
Launch USB Monitor	Channel Frequency 915.0000 C Demod Scheme 2F5K/GFSK/MSK/GMSK V
Status Status B2 Word spi_ready	Data Rate (kbps) 40.0  AFC Mode Disable  Expected Max RF Freq Error (HE) 50.0
irq_status	Transmitter AFC Kp 3  Readback Readback
Get Status	PA Level 15 C AGC Mode Free Running RSSI LINA
FLASH LEDs	PA Select Single ended
	External PA enable (ATB3)  External LNA enable (ATB4)
	CMD_PHY_OFF     CMD_PHY_SLEEP     CMD LIST       CMD_PHY_ON     Normal Commands     Write Settings
	CMD_PHY_TX CMD_PHY_RX Last Command B1

Figure 31

#### **Receiver Board Rx Packet Settings**

Using the Tx/Rx packet tab you can set up the packet format and configure the packet handler. (Figure 32point (<u>1</u>))

- 1. The transmitted preamble length sync word and CRC can be defined by the user. (Figure 32point (2)) (Note: Ensure CRC is enabled for this test. You have the choice to use the default CRC or enable a programmable CRC whose polynomial may be set in registers 0x11E and 0x11F.)
- Ensure you are using a fixed packet length and that, "*Packet Length Max*" is set equal the payload length. (Figure 32point (<u>3</u>))
- Set up the Rx base address. (Figure 32point (<u>4</u>)) (Note : This is the start address of the received packet in Packet Ram Memory.)
- 4. Write the settings to the device using the "<u>Update Needed</u>" button. (Figure 32point (<u>5</u>))

DF7023 Evaluatio Tools Help	n Software
Tools Help	
Amenner	Converting
	Commands RF Settings TX/RX Packet Interrupts Register View Memory Check PER
]	Transmit Packet Format
Disconnect USB	
Board	Preamble         SWD         Payload Data (Enter in Hex)         CRC           AAAAAAAAAAAAAAAA         123456         0102030405060708090A0B0C0D0E0F10111213141516171819         XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Board 1 🛛 💌	
Launch USB Monitor	Tx Base Address ×10 Write Payload to RAM
Status	SWD/Preamble/CRC Data Coding Packet Length
Status B1	
Word	
spi_ready 💙	Sync Word Length (bits) 24 SExample CRCs (X(16) + X(12) + X(5) + 1 (default)
irq_status 🔘	Sync Byte (Hex) ×123456 Programmable CRC
cmd_ready 🔵	
Get Status	Receive Packet Filtering
	Preamble/Sync/CRC Filtering Address Filtering Rx Packet RAM
FLASH LEDs	20 20 0F 0F 1F 05 1F 33 22 00 02 03 04 00 00 00 00 00 00 00 00 00 00 00 00
	Preamble Match 0 bit errors allowed 💟 00 00 00 00 00 00 00 00 00 00 00 00 00
	Sync Error Tolerance 0 bit errors allowed 💌 Rx Base Address × 10 Read Rx Packet
	CMD_PHY_OFF CMD_PHY_SLEEP CMD LIST Current State PHY_ON
	CMD_PHY_ON Normal Commands V Update Needed
	CMD_PHY_TX CMD_PHY_RX Last Command B1
1	

Figure 32

#### **Receiver Board Interrupts**

Interrupts may be configured for various conditions in the "*Interrupts*" tab. (Figure 33 point (<u>1</u>))

- Set the "*crc\_correct*" interrupt. (Figure 33 point (<u>2</u>)) This will give an interrupt signal upon reception of a packet with a valid CRC.
- 2. Write the settings to the device using the "<u>Update Needed</u>" button. (Figure 33 point (<u>3</u>))
- Put the part into Receive by pressing "<u>CMD\_PHY\_RX</u>" (Figure 33 point (<u>4</u>)) (Note: Ensure that the current state of the part is in "PHY\_ON" before pressing "<u>CMD\_PHY\_RX</u>".)

"*Board* 1" is now in Receive and waits for a transmitted signal. It will remain in Rx until a valid packet with a valid CRC is received.

ADF7023 Evaluation	n Software
File Tools Help	
Amplifiers	Profit         Convertion           Commands         RF Settings         Tx/Rx Packet         Interrupts         Register View         Memory Check         PER         wwww.analog.com/srd
Disconnect USB Board Board 1	num_wakeups
Launch USB Monitor	lpm_rssi_det 💿 🗖
Status	AES_Done 🔘 🗌
Status B2 Word	battery_alarm 🕥 🔲 tx_eof 🌑 🗌
spi_ready 🔵	rc_ready
irq_status	wuc_timeout
cmd_ready 🔵	
Get Status	cmd_finished
FLASH LEDs	
	CMD LIST Current State PHY_ON Normal Commands V Update Needed
	CMD_PHY_TX CMD_PHY_RX Last Command B1
1	

Figure 33

## Tx Setup in Packet Mode

The settings which follow are for use with EVAL-ADF7023DB1z daughter boards. If you are using a different Daughter board, ensure that the frequency is set within the correct range of the board you are using. Please refer to table x if you are unsure what the frequency range of you board is designed for.

#### Transmitter Board RF Settings

- Ensure the Second ADF7023 Daughter board is correctly plugged into the Second Mother board and that the "Current\_State" is "<u>PHY\_ON</u>" on the Second instance of the ADF7023 Software. Refer to Connecting the Evaluation Boards section for setup procedures.
- 2. Select the "*RF Settings*" Tab (Figure 34 point (<u>1</u>))
- 3. Ensure "*Packet mode*" is selected. (Figure 34 point (<u>2</u>))
- Set the "*RF/Modulation*" parameters as required. (Figure 34 point (<u>3</u>))
   (Note : Ensure the Transmitter *RF/Modulation* parameters are the same as the Receiver *RF/Modulation* parameters previously setup).

5.	Set the "Transmitter"	' parameters as	required.	(Figure	34 point ( <u>4</u> ))
----	-----------------------	-----------------	-----------	---------	------------------------

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File Tools Help	
Maganer	Commands (RF Settings) Tx/Rx Packet Interrupts Register View Memory Check PER www.analog.com/srd
Disconnect USB Board 2 Launch USB Monitor Status	Mode       Packet Mode       (Comms processor handles Tx/Rx packets)       2         Spedif: Standard       V       2         RF/Moduation       3       V         Channel Frequency       915.0000 ©       Frequency Deviation (kHz)       Tx Test Modes/Debug         Tx Test Mode       None       V         Select GP10       None       V
Status B2 Word spi_ready irq_status cmd_ready Get Status	Image: Construct version     Expected Max RF       Freq Error (H4z)     So.0       Image: Construct version     AFC Kp 3       AFC Kp 3     AFC Kp 7       PA Level 15     AFC Kp 7       PA Ramp 4 codes/bit     Other
FLASHLEDs	PA Select Single ended       TX_auto_turnaround [       Mixer         RX_auto_turnaround [       RX_auto_turnaround [       Rxeadback         External PA enable (ATB3) [       External PA enable (ATB4) [       Readback         CMD_PHY_OFF       CMD_PHY_SLEEP       CMD_LIST       Current State
	CMD_PHY_ON     Normal Commands     Write Settings       CMD_PHY_TX     CMD_PHY_RX

Figure 34

#### Transmitter Board Tx Packet Settings

Using the Tx/Rx packet tab you can set up the packet format and configure the packet handler. Ensure these settings are the same as the Receiver settings previously set. (Figure 35 point ( $\underline{1}$ ))

- The transmitted preamble length sync word and CRC can be defined by the user. (Figure 35 point (2)) (Note: Ensure CRC is enabled for this test. You have the choice to use the default CRC or enable a programmable CRC whose polynomial may be set in registers 0x11E and 0x11F.)
- Ensure you are using a fixed packet length and that, "*Packet Length Max*" is set equal the payload length. (Figure 35 point (<u>3</u>))
- Set up the Tx base address. (Figure 35 point (<u>4</u>))
   (Note : This is the start address of the Transmitted packet in Packet Ram Memory.)
- Insert Hex data in the <u>Payload Data</u> field (Figure 35 point (<u>5</u>)) then click "<u>Write Payload to RAM</u>" (Figure 35 point (<u>6</u>))
- 5. Write the settings to the device using the "<u>Update Needed</u>" button. (Figure 35 point (<u>Z</u>))

1	
America	PIOLESCON POLESCON
	Commands RF Settings Tx/Rx Packet Interrupts Register View Memory Check PER
Disconnect USB Board Board 2 Launch USB Monitor Status Status Status B2 Word spi_ready	Transmit Packet Format          Preamble       SWD       Pavload Data (Enter in Hex)       6       CRC         AAAAAAAAAAAAAAAA       123456       0102030405060708090A0B0C0D0E0F10111213141516171819       XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
irq_status 🔘 cmd_ready 🌖 Get Status	Sync Byte (Hex) ×123456     Programmable CRC       Receive Packet Filtering     Receive Packet Filtering       Preamble/Sync/CRC Filtering     Address Filtering       Rx Packet RAM
FLASH LEDs	Preamble Match       0 bit errors allowed         Sync Error Tolerance       0 bit errors allowed             Rx Base Address       ×10    Read Rx Packet
	CMD_PHY_OFF     CMD_PHY_SLEEP     CMD_LIST     Current State     PHY_ON       CMD_PHY_ON     Normal Commands     V     Update Needed     Last Command       CMD_PHY_TX     CMD_PHY_RX     CMD_PHY_RX     Last Command     B1

Figure 35

#### Transmitter Board Interrupts

Interrupts may be configured for various conditions in the "*Interrupts*" tab. (Figure 36point (<u>1</u>))

- Set the "*tx\_eof*" interrupt. (Figure 36point (<u>2</u>)) This will give an interrupt signal after a packet has been fully transmitted.
- 2. Write the settings to the device using the "<u>Update Needed</u>" button. (Figure 36point (<u>3</u>))
- Transmit a packet by clicking "<u>CMD PHY TX</u>" (Figure 36point (<u>4</u>)) (Note: Ensure that the current state of the part is in "PHY\_ON" before pressing "<u>CMD PHY TX</u>".)

"Board 2" is now in Transmit and once a packet is transmitted the part returns to the PHY\_ON state.

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Board					
Board 2			num_wakeups 🌑 🗌		
Launch USB Monitor			lpm_rssi_det 🌑 🗌		
Status			AES_Done 🔘 🗌		
Status B2		battery_alarm 🔵 🗖	tx_eof 🕥 🗹 2		
spi_ready 🔵		rc_ready 🌰 🗖	address_match 🌑 🔲		
irq_status 🔘		wuc_timeout	crc_correct 🌑 🗖		
md_ready 🧿		spi_ready 🕚 🥅	sync_detect 🔘 🗌	Read Source	
			premable detect 🔘 🔲	Clear All Interrupts	
Get Status					
FLASH LEDs					
	CMD_PHY_OFF	CMD_PHY_SLEEP			
			CMD LIST	Update Needed	Current State PHY_ON
	4	4D_PHY_ON			ast Command B1
		CMD_PHY_RX			

Figure 36

## Reading Interrupt Source on Transmitter board

Once the Transmitter has transmitted a packet you should now see "Interrupt Detected!" on both instances of the software. (Figure 37 point (<u>1</u>))

On the Transmitter board the interrupt signifies that a packet has been successfully transmitted. To check the source of the interrupt, click "*Read Source*" (Figure 37 point (<u>2</u>))

To Clear the interrupt status click "<u>Clear All Interrupts</u>" (Figure 37 point (<u>3</u>))

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Commands	RF Settings Tx/	Rx Packet Interrupts	Register View	Memory Check	PER		www.analog.cor
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				AES_Done			
F2		battery_alarm		tx_eof	) 🖂		
ady 😑		rc_ready 🤇		address_match			
tus 🕒		wuc_timeout		crc_correct		2	
idy 🥥		spi_ready		sync_detect 🧲		Read Source	
Status		cmd_finished		premable detect 🧲		Clear All Interrupts	
1 LEDs							
			- 72				

Figure 37

## Reading Interrupt Source on Receiver board

Once the Transmitter has transmitted a packet you should now see "Interrupt Detected!" on the Receiver software instance. (Figure 38 point  $(\underline{1})$ )

On the Receiver board the interrupt signifies that a packet has been successfully Received with a valid CRC.

To check the source of the interrupt, click "<u>Read Source</u>" (Figure 38 point (<u>2</u>))

To Clear the interrupt status click "<u>Clear All Interrupts</u>" (Figure 38 point (<u>3</u>))

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Commands	RF Settings Tx/Rx Packet Interrupts	Register View	Memory Check	PER		www.analog.com
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onitor			lpm_rssi_det			
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atus 🔵	wuc_timeout				2	
eady 🥥	spi_ready 🧿		sync_detect		Read Source	
et Status	cmd_finished 🥥	E F	oremable detect 🌘		Clear All Interrupts	
SH LEDs						

Figure 38

## Running a Packet Error Rate Test

To run a packet error rate test the previous section, Simple Rx / Tx Test in Packet Mode, must first be followed. Once interrupts are observed, on both the Rx and Tx software instances, the Packet Error Rate (PER) test may be used.

#### Configuring the Receiver board for the PER test

- Once all of the Receiver and packet parameters are setup correctly (as in <u>Rx Setup in Packet Mode</u> section) then select the "<u>PER</u>" Tab. (Figure 39 point (<u>1</u>))
- 2. Select the "<u>*Rx Board Setup*</u>" Tab (Figure 39 point (<u>2</u>))
- 3. Set the number of packets to be received, "<u>No. of Packets to Rx</u>" (Figure 39 point (<u>3</u>))
- 4. Write these settings to the uC by clicking "*Write Rx Settings*" (Figure 39 point (<u>4</u>))
- To begin the test and put the receiver into Rx click "*Begin PER Rx*" (Figure 39 point (<u>5</u>)) (Note: The receiver will remain in Rx waiting for a packet to be transmitted from a valid transmitter.)
- If at any time you wish to terminate the test manually press "<u>Stop Test</u>". (Figure 39 point (<u>6</u>)) (Note: The test will stop automatically once it receives the final transmitted packet.)

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	Commands RF Setting	s Tx/Rx Packet	Interrupts Re	gister View	Memory Check	PER			www.analog.com/srd
	TxBoard Setup	Rx Board Setup p	acket Setup						
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Disconnect USB		33	<u> </u>						
Board 1 🛛 😽		<b>)</b> 1,000	No. of Pack	kets to Rx			0 Succes	sfuly Received	- 7
Launch USB Monitor		Missed Packets	LED					- 71 0- 07	Packets
tatus	(	111-16-	4 Rx Settings				0 Missec	Packets	
Status B2							0 Total F	ackets	
Word spi_ready 🔵	C C		5						
irq_status	PE	»							
md_ready 🥥	1							C	)%
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Get Status	Tes	st Progression							
								c	)%
FLASH LEDs									
	C C		6			1 .			- 12 I
			Stop Test			Ensu	re Rx is sta	irted Be	fore Tx
	<u>.</u>								
	CMD PHY_OFF		CMD_PHY_SI	EEP	MDUICT				ent State PHY_ON
					MD LIST		1000 2000		encource Phr_ON
		CMD_PHY_ON	ר	1	Normal Commands	~	Write Settin	ngs	Command B1

Figure 39

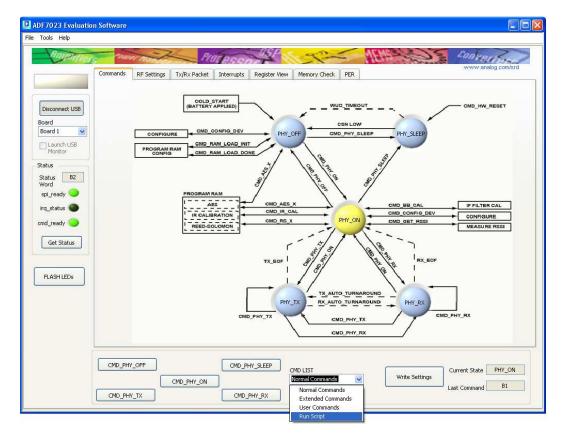
#### Configuring the Transmitter board for the PER test

- Once all of the Transmitter and packet parameters are setup correctly (as in <u>Tx Setup in Packet Mode</u> section) then select the "<u>PER</u>" Tab. (Figure 40 point (<u>1</u>))
- 2. Select the "*<u>Tx Board Setup</u>*" Tab (Figure 40 point (<u>2</u>))
- Set the number of packets to be received, "<u>No. of Packets to Tx</u>" (Figure 40 point (<u>3</u>)) (Note: Ensure the number of packets on the Receive and Transmit side are set the same.)
- Set the delay between each transmitted packet from the "<u>Delay Between Packets</u>" dropdown menu. (Figure 40 point (<u>4</u>))
- 5. Write these settings to the uC by clicking "<u>Write Tx Settings</u>" (Figure 40 point (<u>5</u>))
- To begin the test and put the receiver into Tx click "<u>Begin PER Tx</u>" (Figure 40 point (<u>5</u>)) (Note: The transmitter will continuously transmit packets until "<u>No. of Packets to Tx</u>" value is reached.)
- If at any time you wish to terminate the test manually press <u>"Stop Test</u>". (Figure 40 point <u>(6)</u>) (Note: The test will stop automatically once the transmitter has transmitted the final packet.)

ADF7023 Evaluati	on Software	
ile Tools Help		
Angentie	Commands RF Settings Tx/Rx Packet Interrupts Register View Memory Check (PER)	Converter www.analog.com/srd
	Commands RF Settings TX/KX Packet Interrupts Register view memory Lines.	
Disconnect USB	Kx buaru setupi Patiket Setupi	
Board Board 2	1,000 3 No. of Packets to Tx	
Monitor Status	Delay Between Packets	
Status B2 Word spi_ready 🔵		
irq_status 🔘	5 Write Tx Settings	
cmd_ready 🔵	6	
Get Status	Begin PER Tx	
FLASH LEDs	7 Stop Test	
	Skip resk	
	Ensure Rx is started Before Tx	
	CMD_PHY_OFF CMD_PHY_SLEEP CMD_LIST Write Settings Write Settings	Current State PHY_ON
		Last Command B1

Figure 40

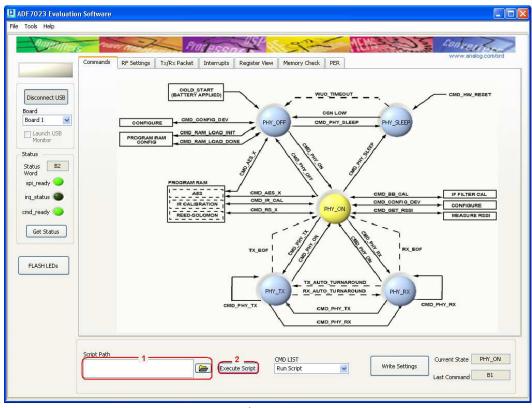
## **Running a Script**



1. Select "*<u>Run Script</u>*" from the "<u>*CMD LIST*</u>" drop down menu as shown in *Figure 41*Figure 41.

Figure 41

2. Select the path where the script file is stored. (Figure 42Figure 40 point (<u>1</u>))



3. Click "*Execute Script*" to run the selected script. (Figure 42Figure 40 point (2)

Figure 42

#### **Using Scripts**

Scripts can be written in Notepad and saved with a file extension of .txt

The following are examples can be used:

- To write to a PACKET\_RAM register enter the line "18xxyy" where "xx" represents the last eight bits of the address to be written to and "yy" represents the value to be stores at this address.
  - For Example if you need to write 0xAB to PACKET\_RAM location 0x010, then the script code would be : 1810AB
- To write to a BBRAM register enter the line "19xxyy" where "xx" represents the last eight bits of the address to be written to and "yy" represents the value to be stores at this address.
  - For Example if you need to write 0xCD to BBRAM location 0x123, then the script code would be : 1923CD
- To write to a MCR register enter the line "1Bxxyy" where "xx" represents the last eight bits of the address to be written to and "yy" represents the value to be stores at this address.
  - For Example if you need to write 0xEF to MCR location 0x345, then the script code would be : 1B45EF
- To introduce a delay before the next script command enter the line "Sxxxx". Where "xxxx" represents an integer multiple of 1ms.
  - For example to enter a delay of 120ms before the next command is to be issued then the script code would be: "S120"
- To issue a COMMAND enter the desired command.
  - For Example to enter "*PHY\_OFF*", then the script code would be : B1
  - For Example to enter "<u>PHY\_ON</u>", then the script code would be : B2
  - For Example to enter "*PHY\_TX*", then the script code would be : B5
- To introduce comments in the file use "//" before the comment.

### Scripting Example

The following script would be used for the previous examples:

//Start of script

1810AB	//Set Packet_Ram address 0x010 to AB
1923CD	//Set BBRam address 0x123 to CD
1B45EF	//Set MCR address 0x345 to EF
S120	//Delay for 120ms
B1	//Enter PHY_OFF
B2	//Enter PHY_ON
B5	//Enter PHY_Tx

//End of script

# **ADF7023 Evaluation Board Schematics and BOMs**

Qty	Name	Value	Tolerance	PCB Decal	Manufacturing Part No.
1	C1	1.5nF	±5%	0402	GRM155R71H152KA01D
9	C14, C16, C24, C28, C30, C33, C37, C62, C65	220nF	±10%	0402	GRM155R61A224KE19D
2	C15, C27	100pF	±5%	0402	GRM1555C1H101JZ01D
3	C23, C34, C35	18pF	±5%	0402	GRM1555C1H180JZ01D
1	C25	150nF	±5%	0402	GRM155R61A154KE19D
2	C26, C42	10uF	±20%	0603	6R3R14X106MV4T
2	C39, C40	5.6pF	±5%	0402	GRM1555C1H5R6DZ01D
4	R3, R4, R8, R9	DNI			Not inserted
1	R12	36k	±1%	0402	MCR01MZPF3602
1	R15	100k	±1%	0402	MCR01MZPF1003
1	R16	1.1k	±1%	0402	MCR01MZPF1101
1	Y1	26MHz			NX3225SA-26.000000MHZ-G2
1	Y2	32.768kHz			ABS07-32.768KHZ-7-T
1	U1			LFCSP-32	ADF7023

#### Table 2 Components Common to All Daughter Boards

#### Table 3 Eval-ADF7023DB1Z Components (868/915MHz Separate Matches)

Qty	Name	Value	Tolerance	PCB Decal	Manufacturing Part No.
1	C2	1pF	±0.25pF	0402	GRM1555C1H1R0CA01D
2	C3, C5	2.2pF	±0.25pF	0402	GRM1555C1H2R2CZ01D
1	C18	56pF	±5%	0402	GRM1555C1H470JZ01D
1	C19	2.7pF	±0.25pF	0402	GRM1555C1H2R7CZ01D
1	C20	1.2pF	±0.25pF	0402	GRM1555C1H1R2CZ01D
1	C66	100pF	±5%	0402	GRM1555C1H101JZ01D

1	C67	47pF	±5%	0402	GRM1555C1H470JZ01D
1	L1	1.8nH	±5%	0402	Coilcraft 0402CS-1N8XJL
1	L2	24nH	±5%	0402	Coilcraft 0402CS-24NXJL
1	L3	12nH	±5%	0402	Coilcraft 0402CS-12NXJL
1	L4	6.2nH	±5%	0402	Coilcraft 0402CS-6N2XJL
1	L6	47nH	±5%	0402	Coilcraft 0402CS-47NXJL
2	L5, L10	12nH	±5%	0402	Coilcraft 0402CS-12NXJL

#### Table 4 Eval-ADF7023DB2Z Components (868/915MHz Combined Match)

Qty	Name	Value	Tolerance	PCB Decal	Manufacturing Part No.
1	C2	DNI			Not Inserted
2	C3,C22	2.2pF	±0.25pF	0402	GRM1555C1H2R2CZ01D
1	C18	56pF	±5%	0402	GRM1555C1H470JZ01D
2	C19	2.7pF	±0.25pF	0402	GRM1555C1H2R7CZ01D
1	C20	1.8pF	±0.25pF	0402	GRM1555C1H1R8CZ01D
1	C66	100pF	±5%	0402	GRM1555C1H101JZ01D
1	C67	47pF	±5%	0402	GRM1555C1H470JZ01D
1	L1	1.8nH	±5%	0402	Coilcraft 0402CS-1N8XJL
3	L2, L4, L9	12nH	±5%	0402	Coilcraft 0402CS-11NXJL
1	L3	11nH	±5%	0402	Coilcraft 0402CS-11NXJL
1	L6	47nH	±5%	0402	Coilcraft 0402CS-47NXJL
1	L7	24nH	±5%	0402	Coilcraft 0402CS-24NXJL

#### Table 5 Eval-ADF7023DB3Z Components (433MHz Separate Matches)

Qty	Name	Value	Tolerance	PCB Decal	Manufacturing Part No.
1	C2	1.2pF	±0.25pF	0402	GRM1555C1H1R2CZ01D
2	C3, C5	3.9pF	±0.25pF	0402	GRM1555C1H3R9CZ01D
3	C19, C20	5.6pF	±0.25pF	0402	GRM1555C1H5R6DZ01D

2	C18, C67	270pF	±5%	0402	GRM1555C1H271JA01D
1	C66	100pF	±5%	0402	GRM1555C1H101JZ01D
1	L1	15nH	±5%	0402	Coilcraft 0402CS-15NXJL
1	L2	82nH	±5%	0402	Coilcraft 0402CS-82NXJL
2	L3, L4	27nH	±5%	0402	Coilcraft 0402CS-27NXJL
2	L5, L10	33nH	±5%	0402	Coilcraft 0402CS-11NXJL
1	L6	100nH	±5%	0402	Coilcraft 0402CS-R10XJL

#### Table 6 Eval-ADF7023DB4Z Components (433MHz Combined Match)

Qty	Name	Value	Tolerance	PCB Decal	Manufacturing Part No.
1	C2	DNI			Not Inserted
1	C3, C22	3.9pF	±0.25pF	0402	GRM1555C1H3R9CZ01D
2	C18, C67	270pF	±5%	0402	GRM1555C1H271JA01D
1	C19	4.7pF	±0.1pF	0402	GRM1555C1H4R7BA01D
1	C20	2.7pF	±0.1pF	0402	GRM1555C1H2R7BA01D
1	C66	100pF	±5%	0402	GRM1555C1H101JZ01D
1	L1	13nH	±5%	0402	Coilcraft 0402CS-13NXJL
1	L2, L9	33nH	±5%	0402	Coilcraft 0402CS-33NXJL
1	L3	30nH	±5%	0402	Coilcraft 0402CS-30NXJL
1	L4	41nH	±5%	0402	Coilcraft 0402CS-41NXJL
1	L6	100nH	±5%	0402	Coilcraft 0402CS-R10XJL
1	L7	82nH	±5%	0402	Coilcraft 0402CS-82NXJL

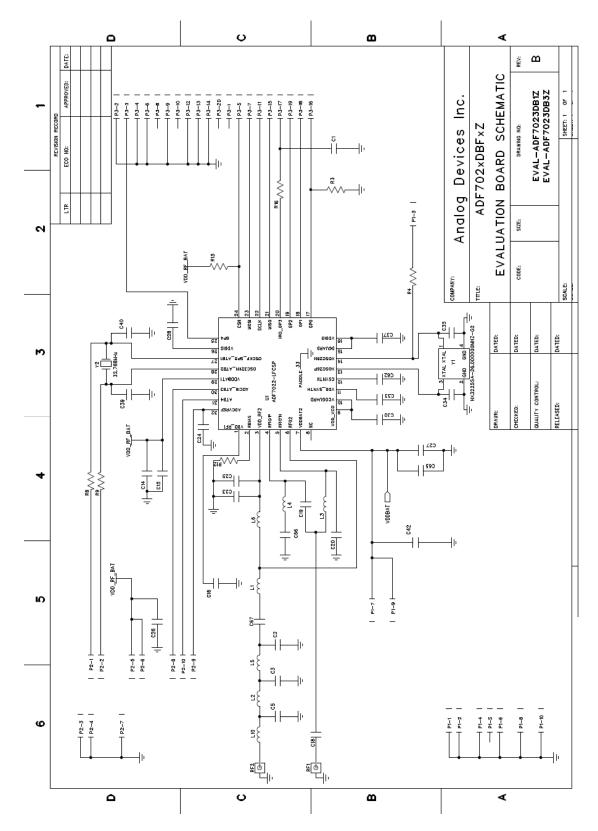


Figure 43 Separate PA and LNA Matches Board Schematic (DB1Z, DB3Z)

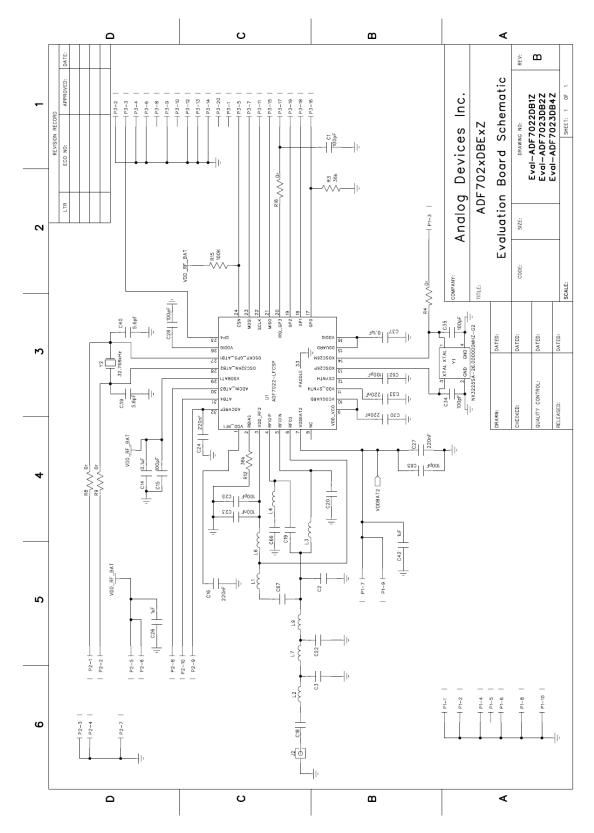


Figure 44 Combined PA and LNA Match Board Schematic (DB2Z, DB4Z)

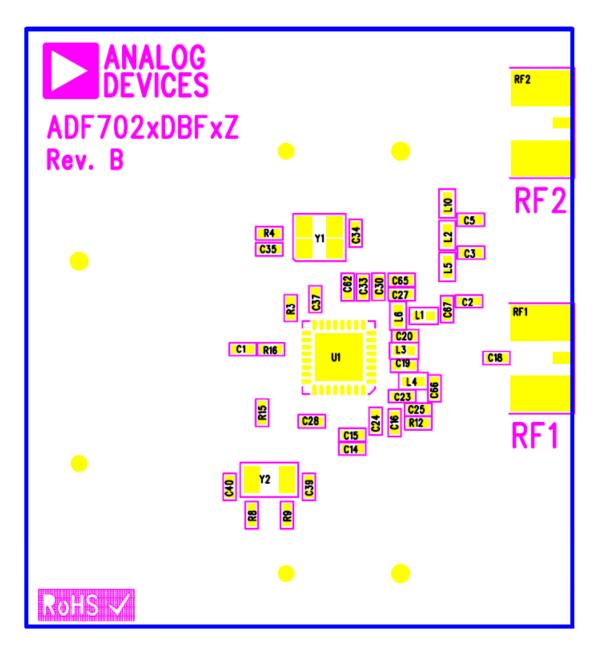


Figure 45 Separate PA and LNA Matches Board Silkscreen (DB1Z, DB3Z)

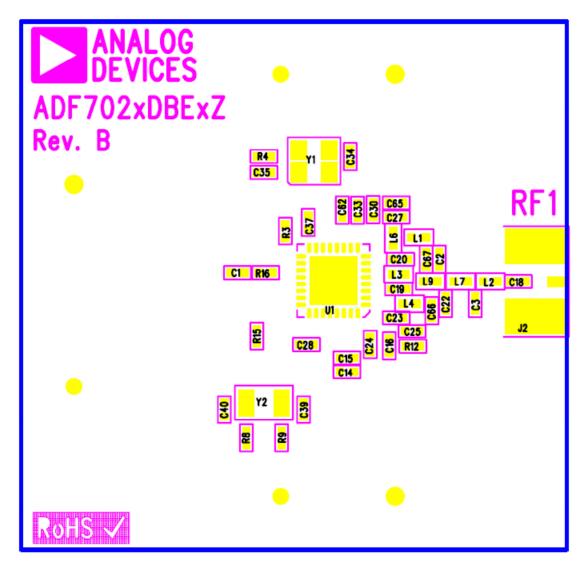


Figure 46 Combined PA and LNA Match Board Silkscreen (DB2Z, DB4Z)

## Eval-ADF7XXXMB3Z Mother Board Schematics and Silk Screen

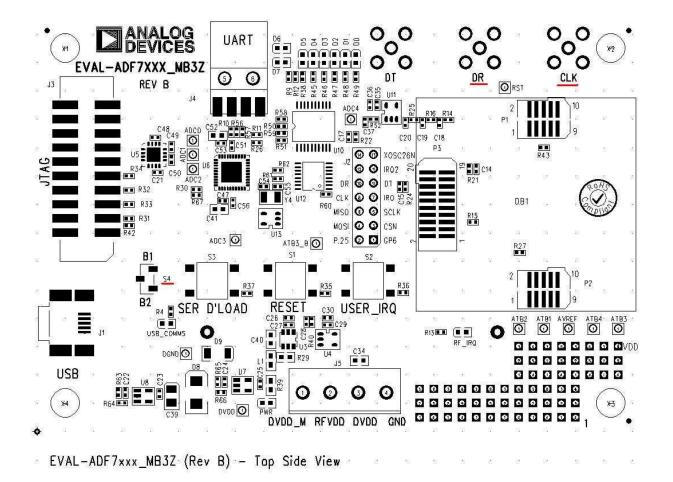
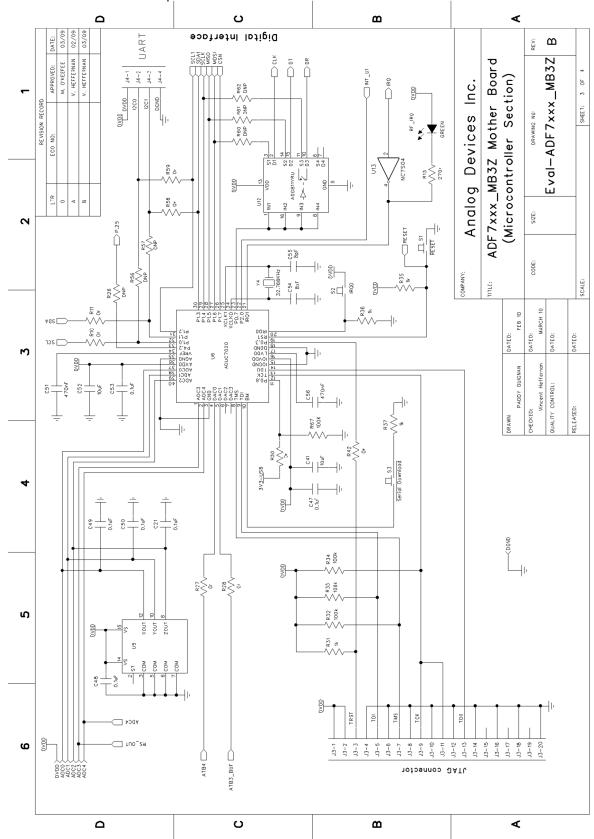
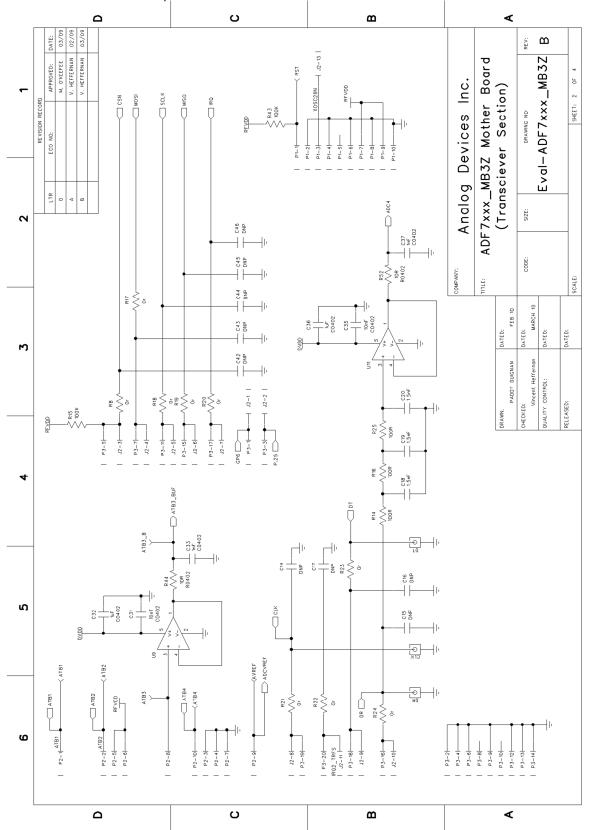


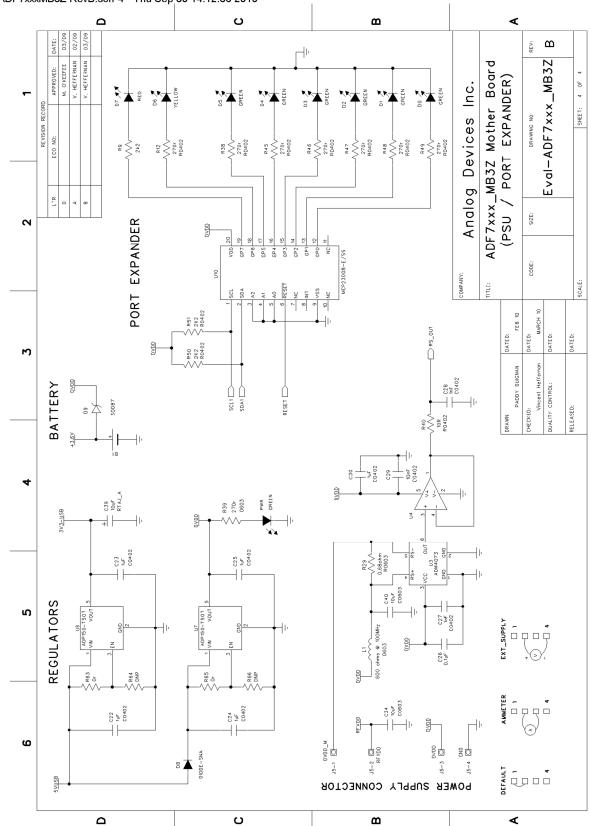
Figure 47 Mother Board Silkscreen

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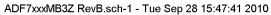


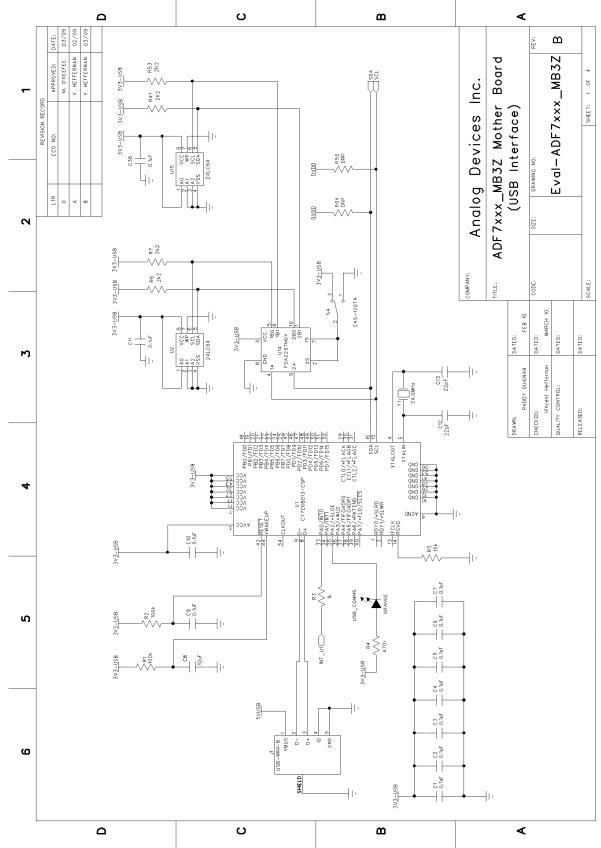
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