ADMX7103-EBZ: 6G FR3 Radio Front-End

FEATURES

- FR3 TX and RX RF front end board
- RF carriers 6GHz to 18GHz
- Power management and biasing
- 4GHz iBW (with tunable filter enabled)
- EVM < −50 dB
- High dynamic range
- Programmable using an SPI interface
- TX P1dB: 27dBm
- TX LO nulling capability
- RX noise figure: 3.5dB at 12GHz
- Tunable filters for spur rejection
- Calibration using temperature sensors

PACKAGE CONTENT

- ADMX7103-EBZ board
- AC-DC power supply for ADMX7103-EBZ
- Raspberry Pi board with SD card
- Raspberry Pi power supply
- Mini-Circuits 90° splitter (ZX10Q-2-13-S+)
- Two short SMA cables
- 50Ω SMA connector load
- USB fan

ADDITIONAL EQUIPMENT NEEDED

- Two signal generators to cover the frequency range of 1GHz to 18 GHz
- One spectrum analyzer to cover the frequency range of 1GHz to 18 GHz
- Windows PC or laptop

GENERAL DESCRIPTION

The ADMX7103-EBZ is a 6G, Frequency Range 3 (FR3), radio front end (RFFE) reference design that supports frequencies from 6GHz to18GHz and instantaneous bandwidths up to 4GHz. The FR3 RFFE includes transmit (TX) and receive (RX) modes for signal generation and spectrum analysis applications, respectively. Each TX and RX path has dedicated local oscillator (LO) inputs to support time division duplex (TDD) and frequency-divison duplex (FDD) operation. The design supports both 5G and 6G signal generation and a spectrum analyzer/demodulator. In-phase/quadrature (I/Q) intermediate frequency (IF) ports are provided for TX inputs and RX outputs.

EVALUATION BOARD PHOTOGRAPH

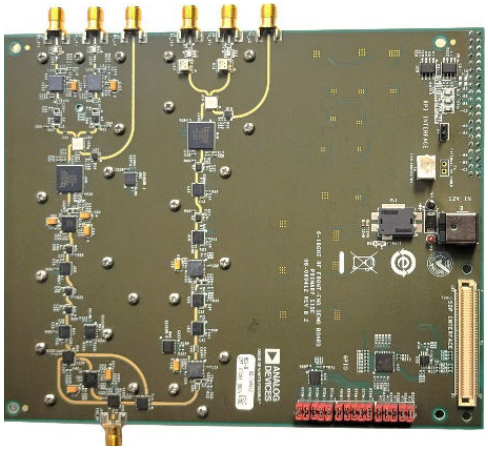


Figure 1. ADMX7103-EBZ Board

TABLE OF CONTENTS

REVISION HISTORY

12/2025—Revision 0: Initial Version

BLOCK DIAGRAM

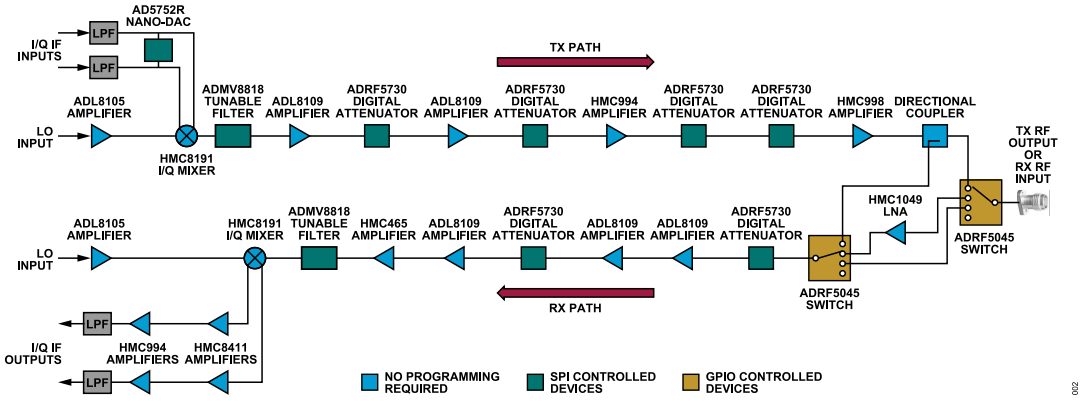


Figure 2. ADMX7103 Block Diagram

ADMX7103-EBZ USER GUIDE

This document guides the user to setup and evaluate the ADMX7103-EBZ board in conjunction with the Raspberry Pi (RPi) board.

TX HARDWARE SETUP

The ADMX7103-EBZ board operates with the RPi board, which serves as the controller for configuring the ADMX7103-EBZ board.

The hardware setup includes the following:

- ADMX7103-EBZ board (power adapter included in the ADMX7103-EBZ package)
- RPi board (power adapter included in the ADMX7103-EBZ package)
- Mini-Circuits 90°power splitter
- SMA cables
- Two signal generators
- Spectrum analyzer
- PC running windows
- USB powered fan

Transmit Test

The following diagram (Figure 3) shows the test configuration of the ADMX7103-EBZ board for a transmit test. It shows connections of power supplies, signal generators, and a spectrum analyzer. The RPi board is connected to test the computer with an Ethernet cable. A small benchtop USB fan is required for heat dissipation of the ADMX7103-EBZ board.

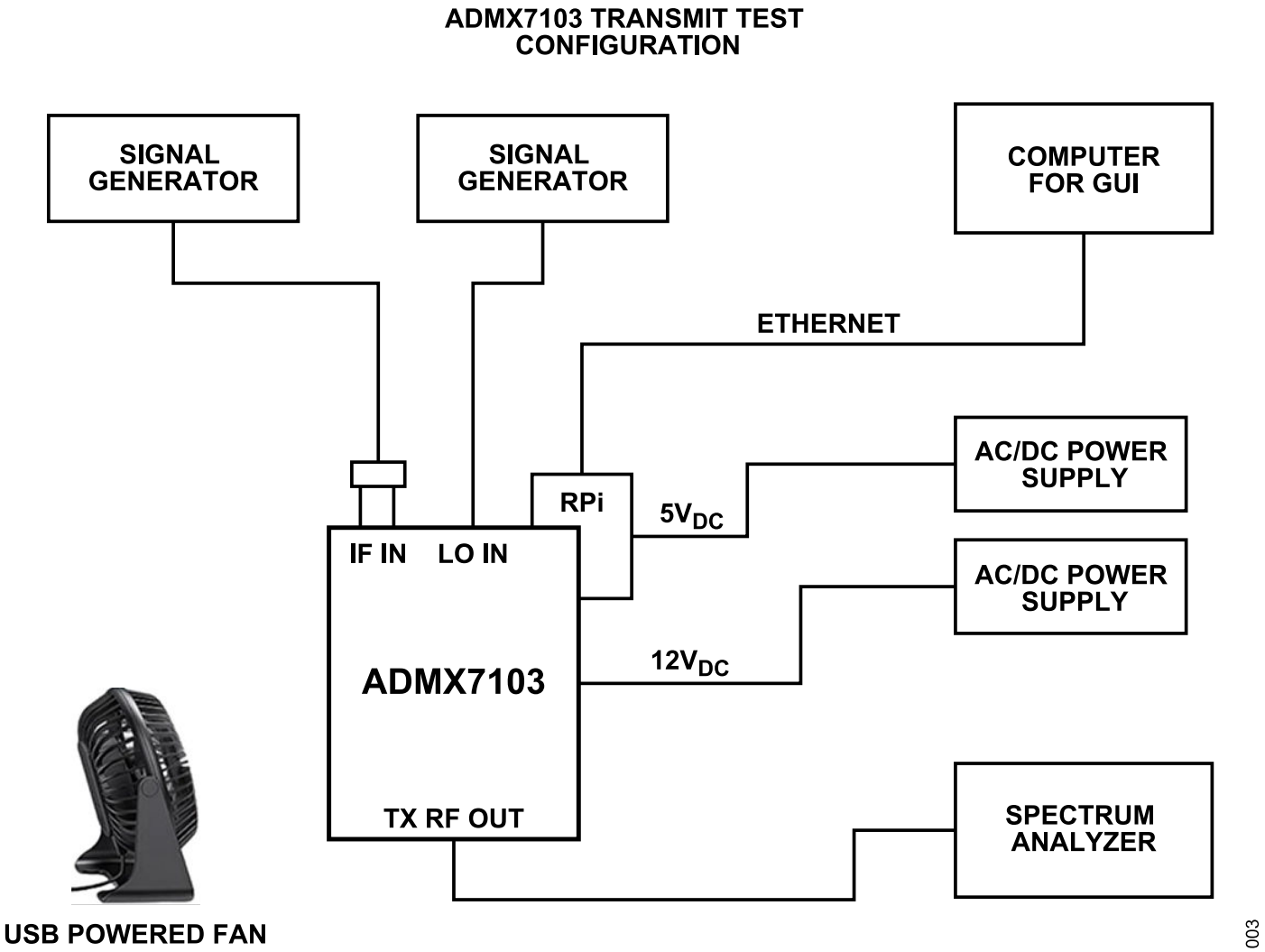


Figure 3. Hardware Configuration for ADMX7103 Transmit Test

ADMX7103-EBZ USER GUIDE

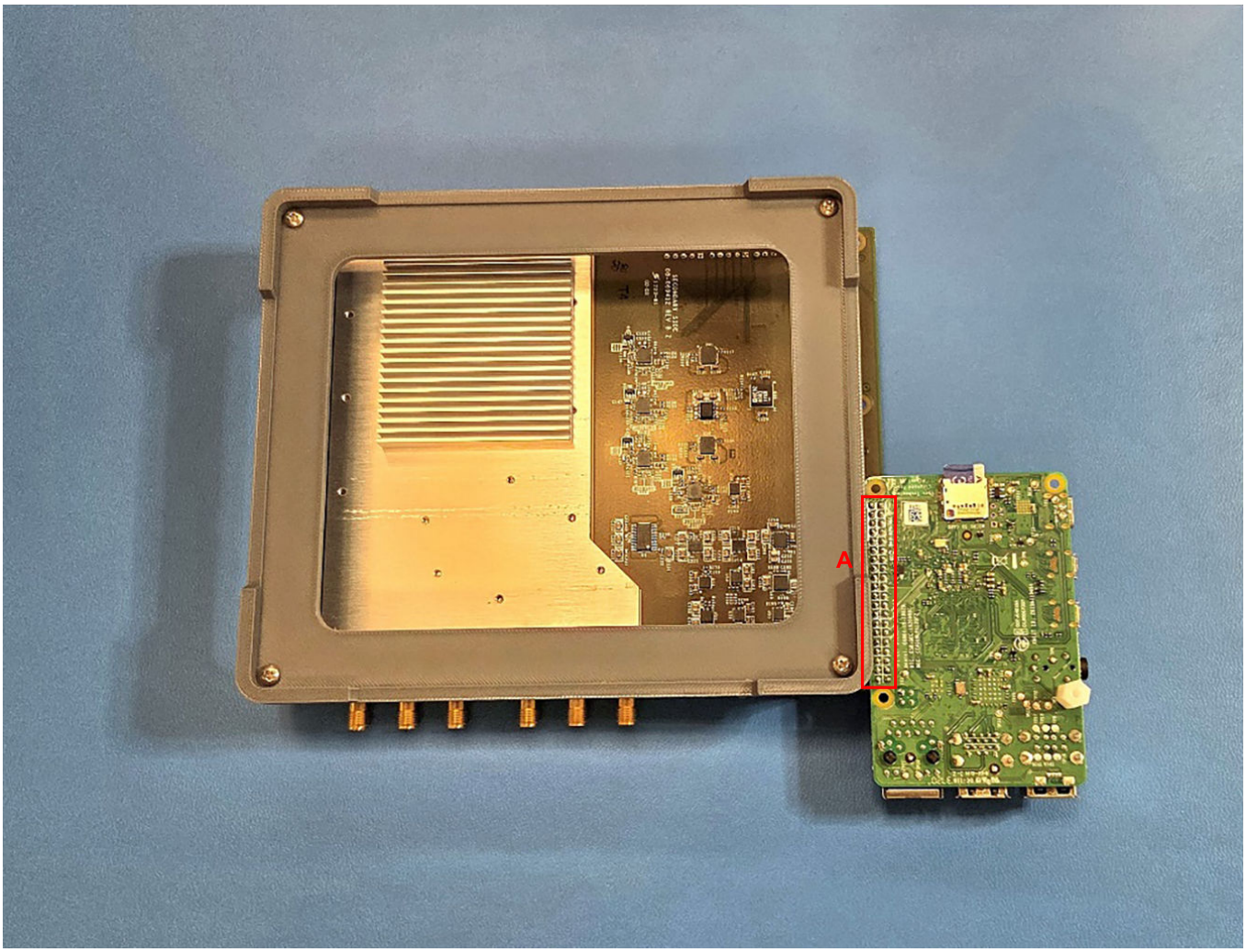
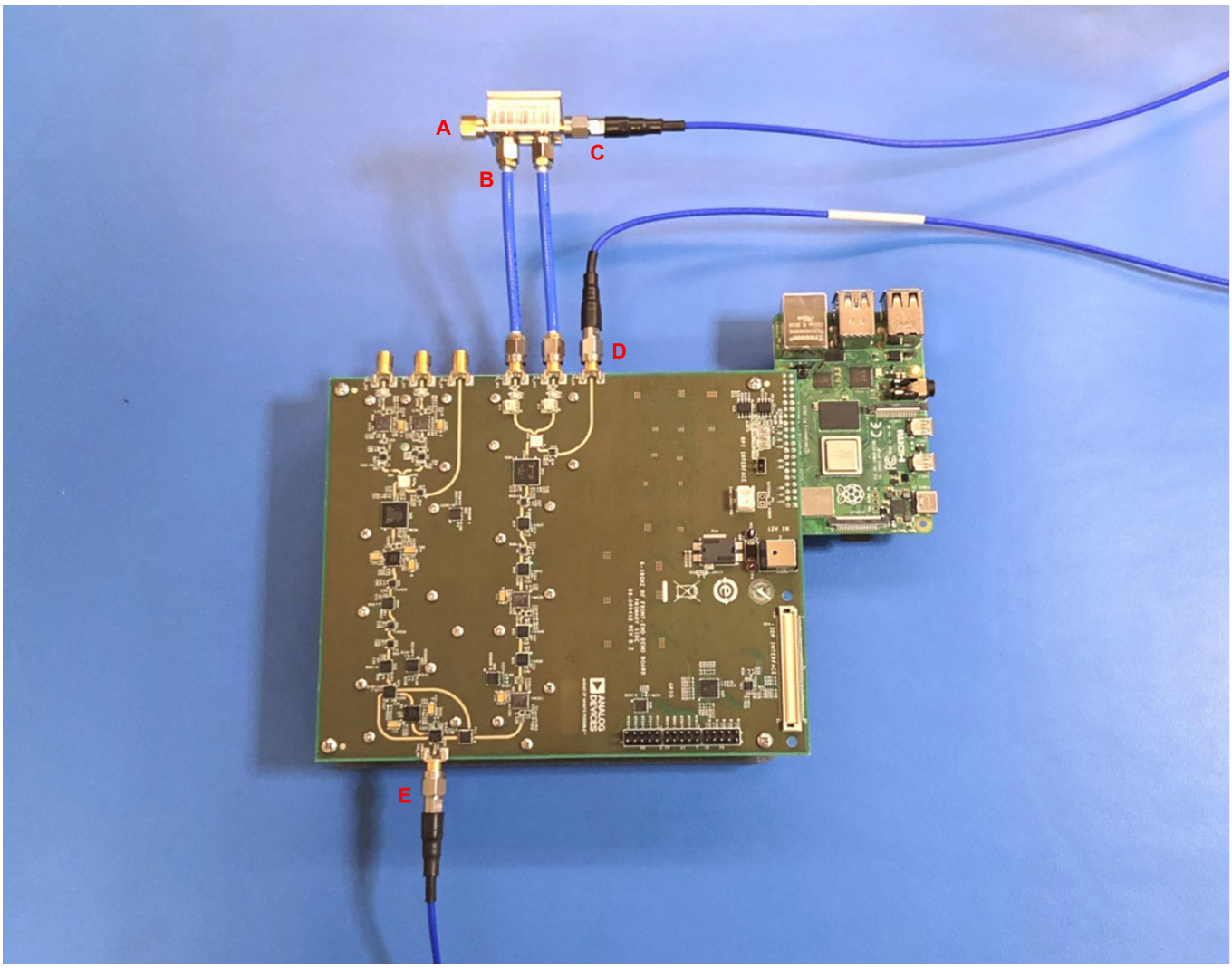


Figure 4. Connect the RPi Board to the 40-Pin Connecter on the Bottom of the ADMX7103 Board

ADMX7103-EBZ USER GUIDE

Connect TX IF I/Q inputs, LO input, and TX RF output as follows (see Figure 5):

1. Install a 50Ω load on the Mini-Circuits splitter connecter labeled 50 Ohm
2. Connect Port 1 and Port 2 on Mini-Circuits splitter to TX I/Q IF ports as shown using the two short SMA cables. This configuration is for upper sideband operation. The I/Q connectors can be swapped for Lower side-band operation.
3. Connect one of the signal generators to the IN connector on the Mini-Circuits splitter using an SMA cable. Set the signal generator to 1GHz and the power at the splitter input connector to −5dBm.
4. Connect the second signal generator to the LO input port. Set the signal generator to 6GHz and the power at the connector to −10dBm.
5. Connect the spectrum analyzer to the TX RF output port.



005

Figure 5. Connect TX IF I/Q Inputs, LO Input, and TX RF Output

ADMX7103-EBZ USER GUIDE

Connect Ethernet, ADMX7103, and RPi power as follows (see Figure 6):

1. On the test PC, set the Ethernet to a static IP with the address of 192.168.0.1.
2. Connect the Ethernet cable on the RPi to test the PC.
3. Then, plug in the AC/DC 12V DC wall adapter to the ADMX7103 board and confirm the green light-emitting diode (LED) lights up.
4. Next, plug in the RPi USB AC/DC converter. The green and red lights should start flashing as the RPi board turns on.

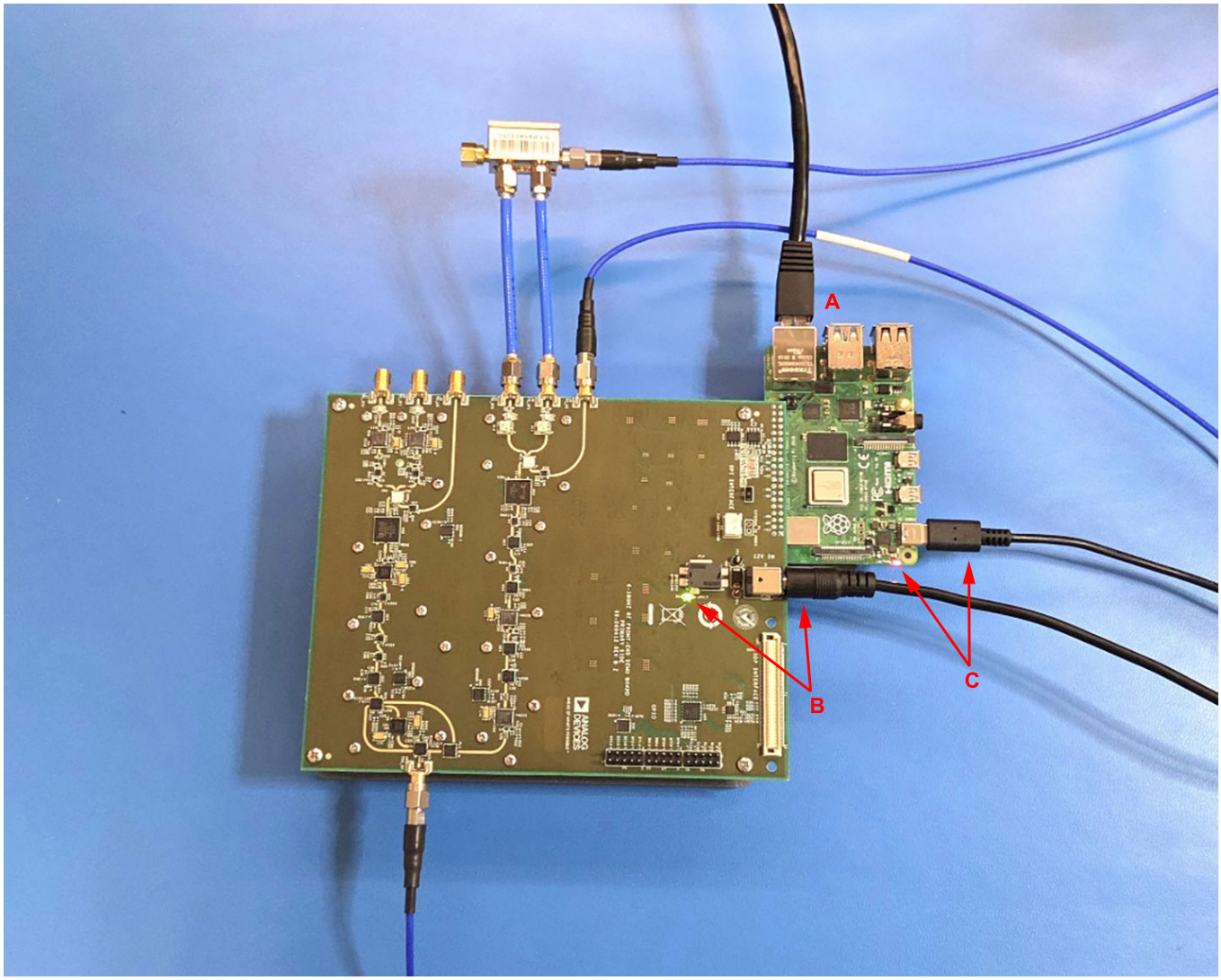
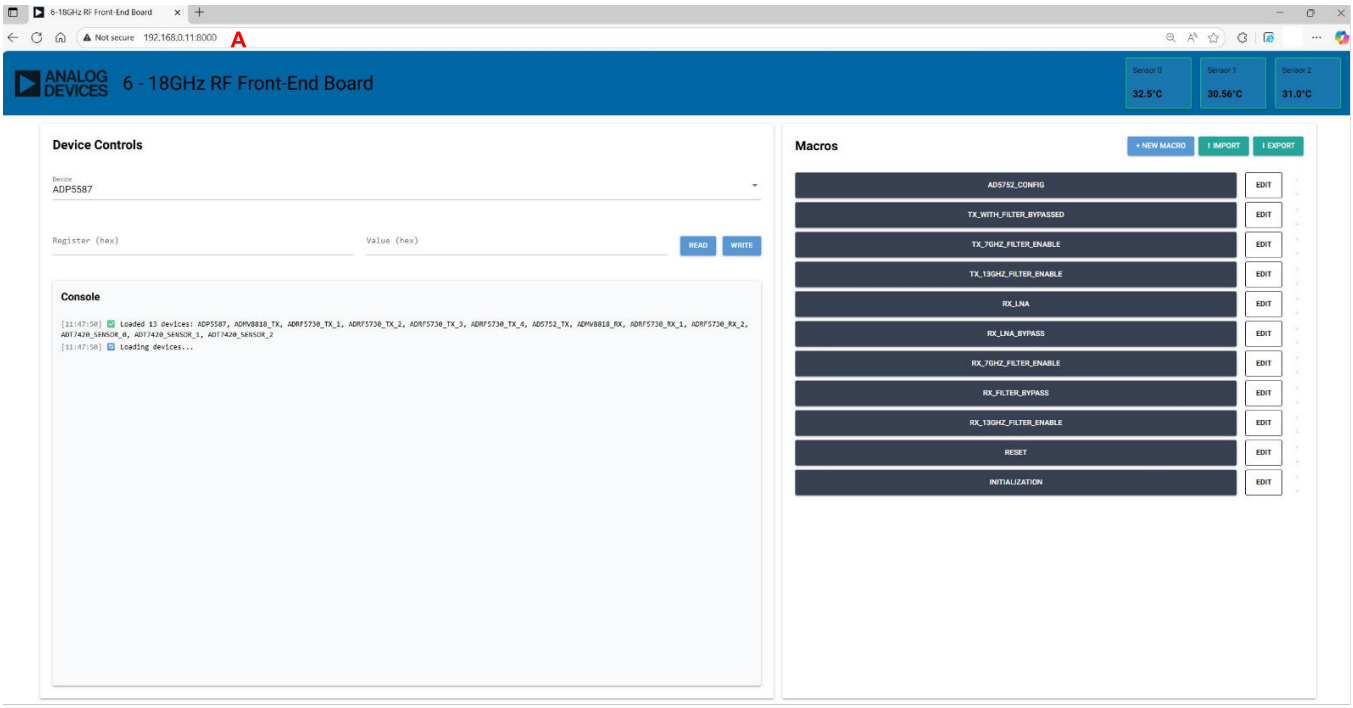


Figure 6. Connect Ethernet, ADMX7103 and RPi power

ADMX7103-EBZ USER GUIDE

SOFTWARE SETUP

Open your web browser and navigate to **192.168.0.11:8000**. This connects to the front-end interface of the RPi and loads the web user interface (UI).



007

Figure 7. 6GHz to 18GHz Front-End Board

ADMX7103-EBZ USER GUIDE

PROGRAM THE ADMX7103

1. Click on the **AD5752_CONFIG** macro button to configure the nano-DAC for the LO nulling routine. (**Label A** in Figure 8).
2. Click on the **TX_WITH_FILTER_DISABLED** macro button. (**Label B** in Figure 8).

   This enables the TX and sets the ADMV8818 tunable filter to bypass mode.

   Green boxes flash at the bottom of the screen to indicate that the macros are successfully executed. (**Label C** in Figure 8).
3. You should see the 7GHz carrier on the spectrum analyzer (refer to the marker in Figure 9). LO leakage (6GHz), unwanted sideband, and harmonics will also be present. To suppress those, complete the following two steps.
4. Go to the pull-down and select the **AD5752_TX**.
5. Change step size on DAC A and DAC B from 1 to 100.

   DAC A and DAC B apply a DC voltage to the I/Q ports of the mixer for LO nulling. Look at LO feedthrough on the spectrum analyzer and click up/down on DAC A until the LO is at its lowest level, then move to DAC B and repeat. You may have to go back and forth between DAC A and DAC B a couple times to maximize LO nulling. The step size can be reduced to 1 for fine tuning once course nulling is complete. The binary value and DAC voltage is displayed at each step. The next page contains a spectral plot that shows typical LO leakage after nulling.
6. This Spectral plot shows LO leakage after LO nulling. The LO is > 50 dB lower than the previous plot , prior to LO nulling.
7. Next press the **TX_7GHz_FILTER_ENABLE** macro button. This enables the ADMV8818 and programs the pass band for 7GHz. The spectral plot on the next page shows typical RF output with LO nulling and 7GHz filter applied.

   An additional macro sets the filter to 13GHz.

   Two registers program the TX ADMV8818 frequency and bandwidth, registers 0x20 and 0x21. Refer to ADMV8818 data sheet for additional frequency settings.

   Using the pull-down to select the ADMV8818_RX allows the user to write the individual registers.

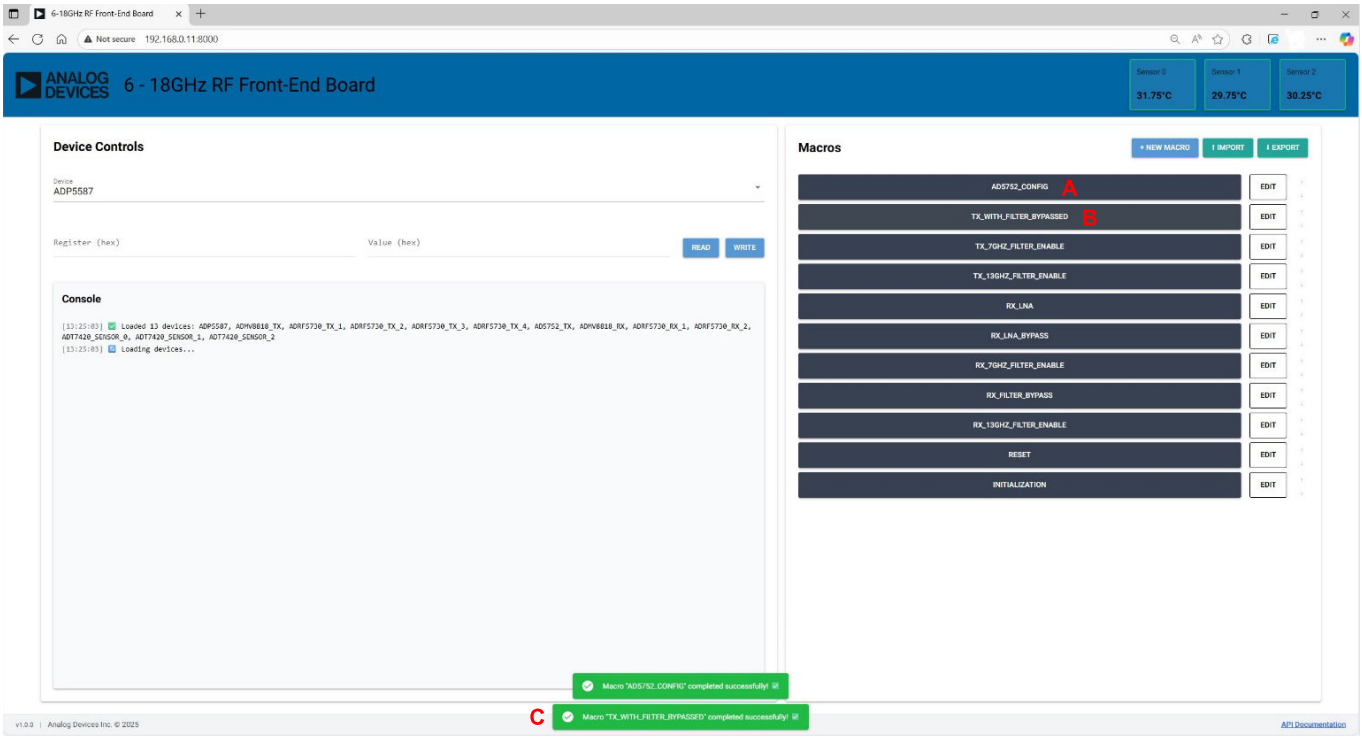
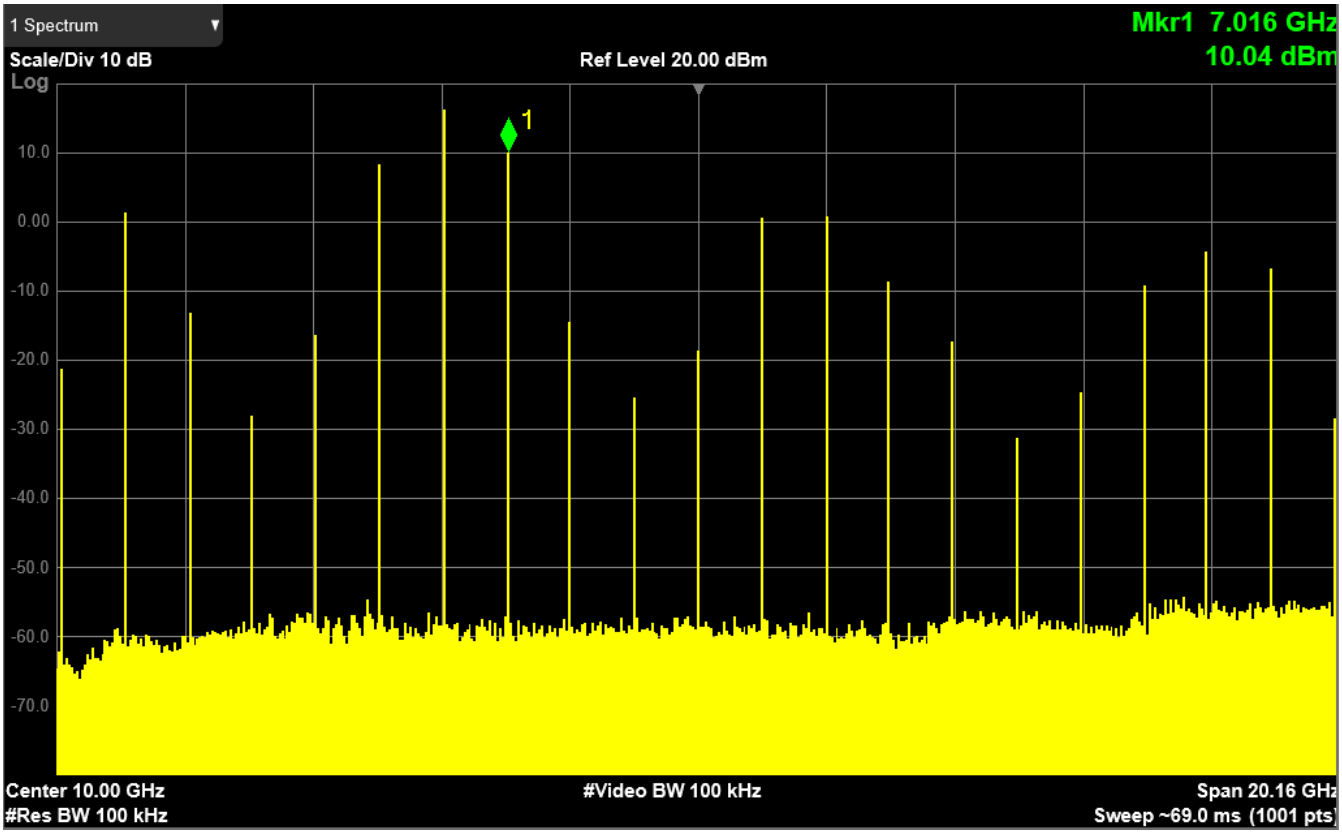


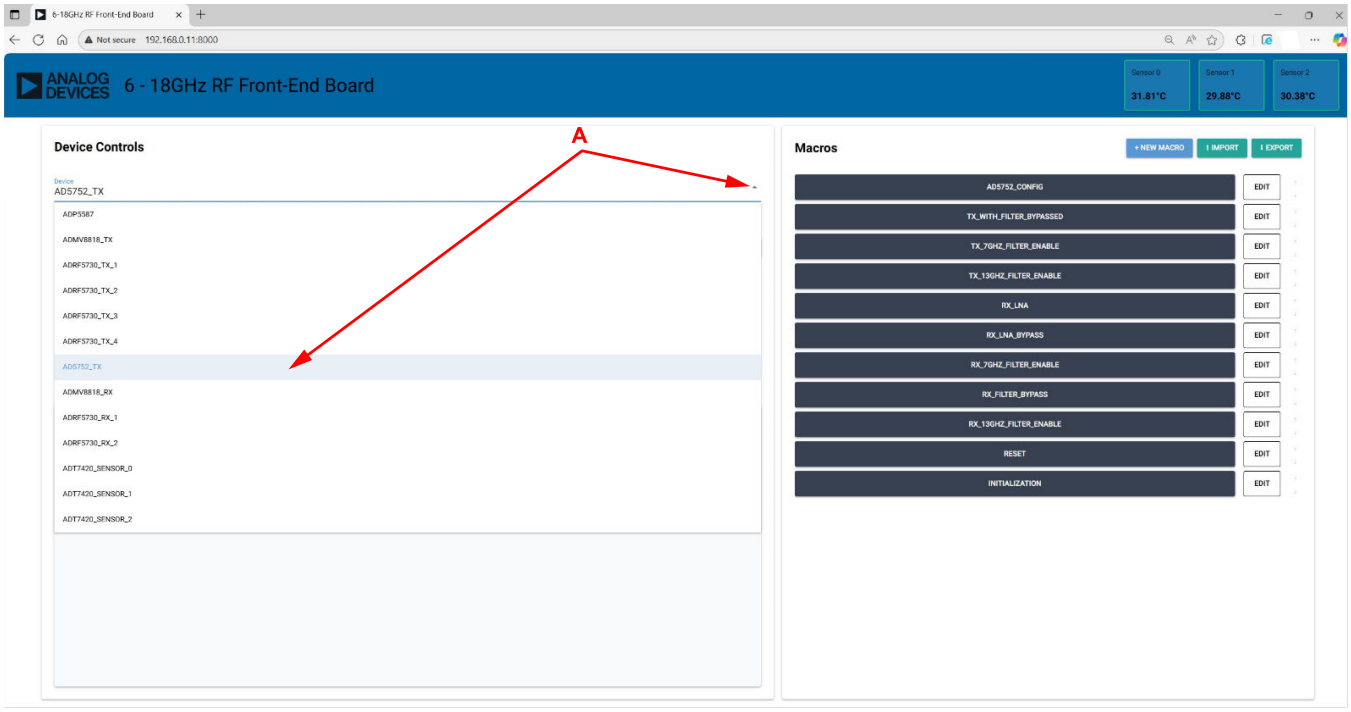
Figure 8. Device Controls

ADMX7103-EBZ USER GUIDE



609

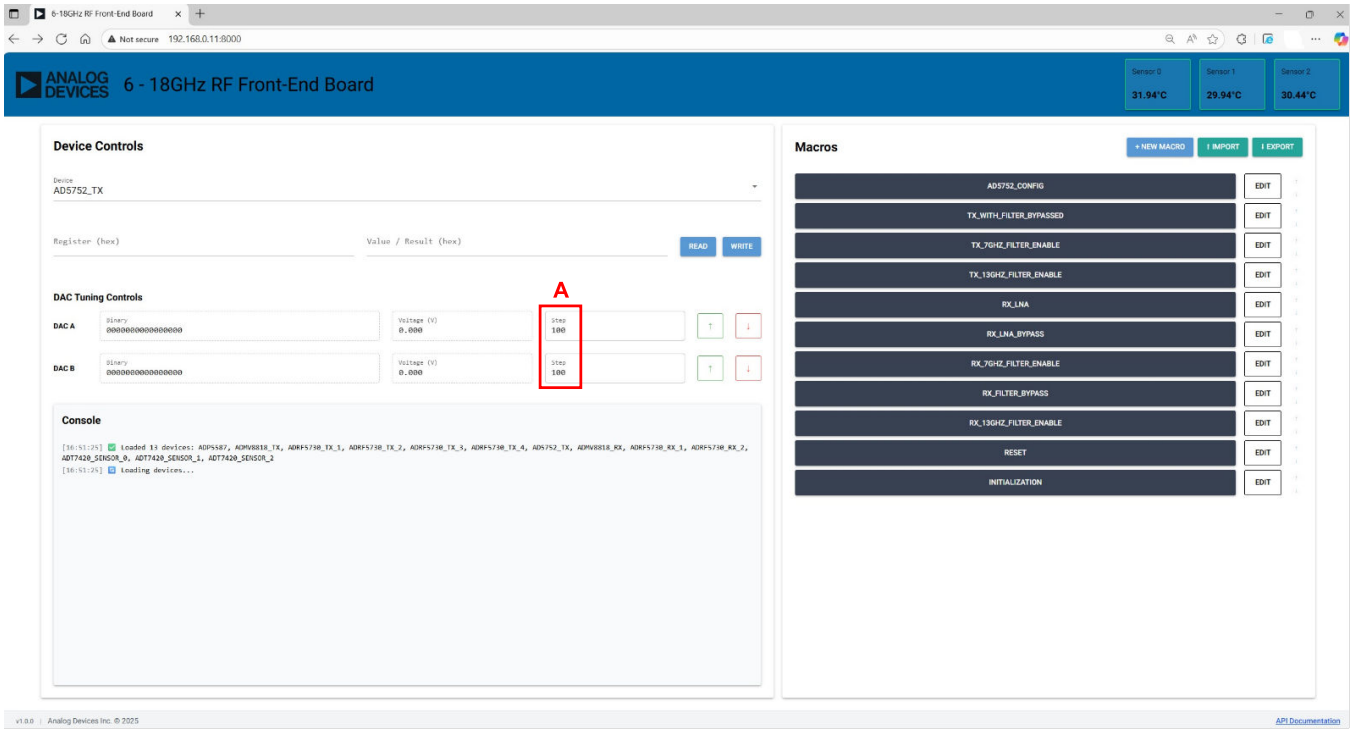
Figure 9. Reference Level 20.00dBm



010

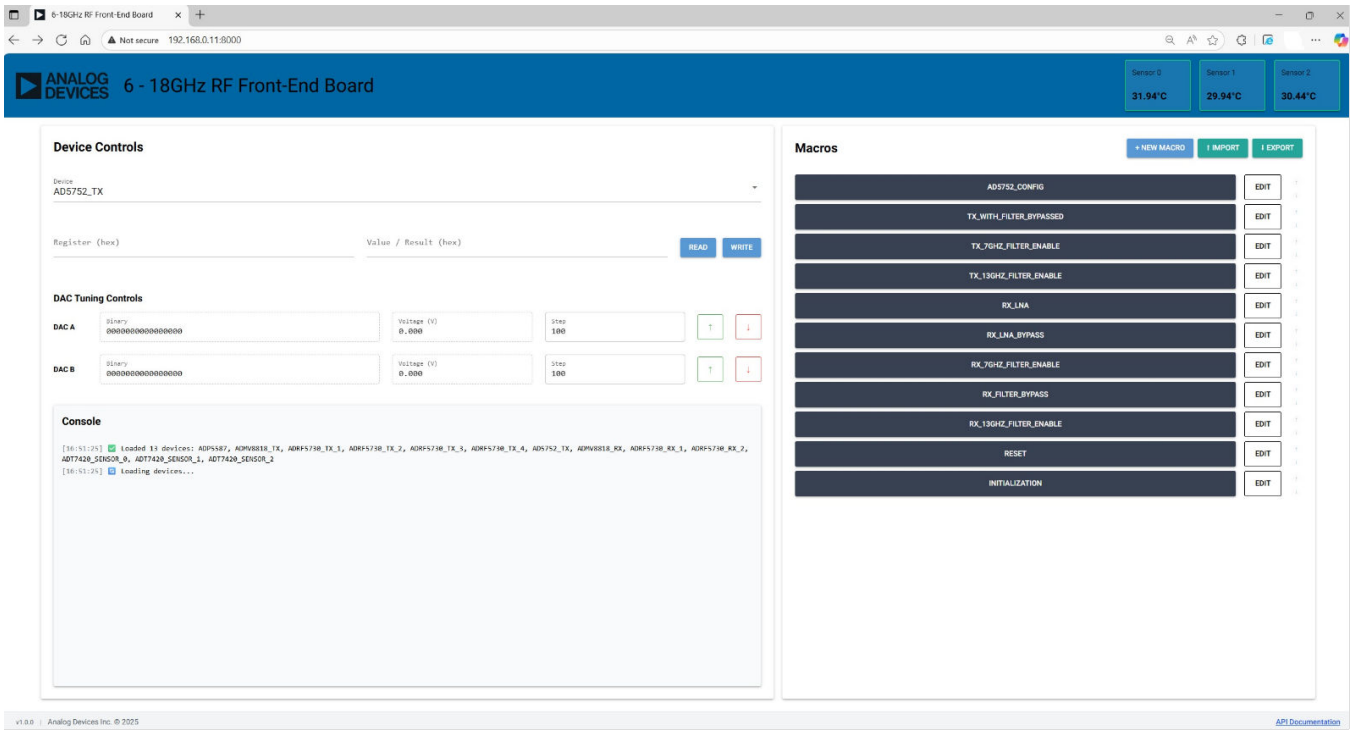
Figure 10. AD5752_TX Settings

ADMX7103-EBZ USER GUIDE



011

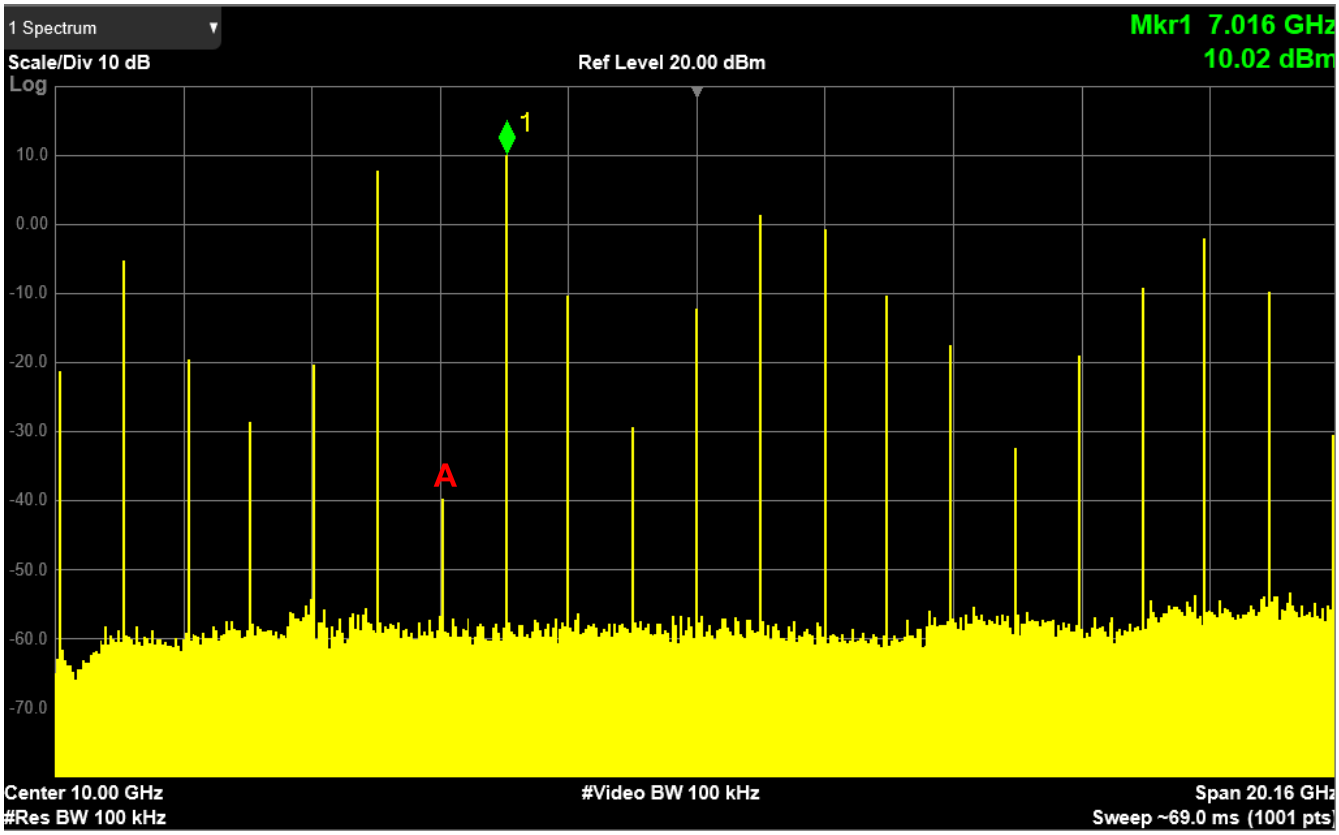
Figure 11. DAC Tuning Controls



012

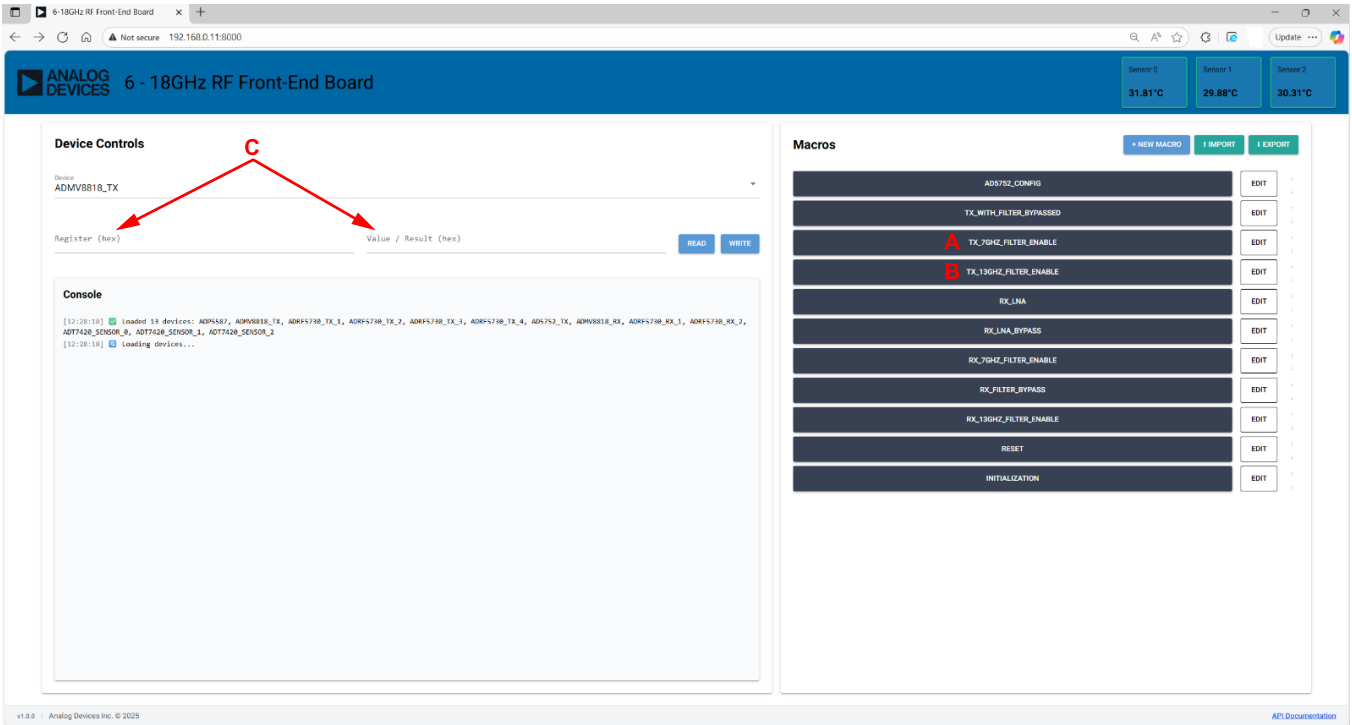
Figure 12. Apply Voltage to DAC A and DAC B

ADMX7103-EBZ USER GUIDE



013

Figure 13. Spectral Plot LO Leakage After LO Nulling



014

Figure 14. Typical RF Output with LO Nulling and 7GHz Filter Applied

ADMX7103-EBZ USER GUIDE

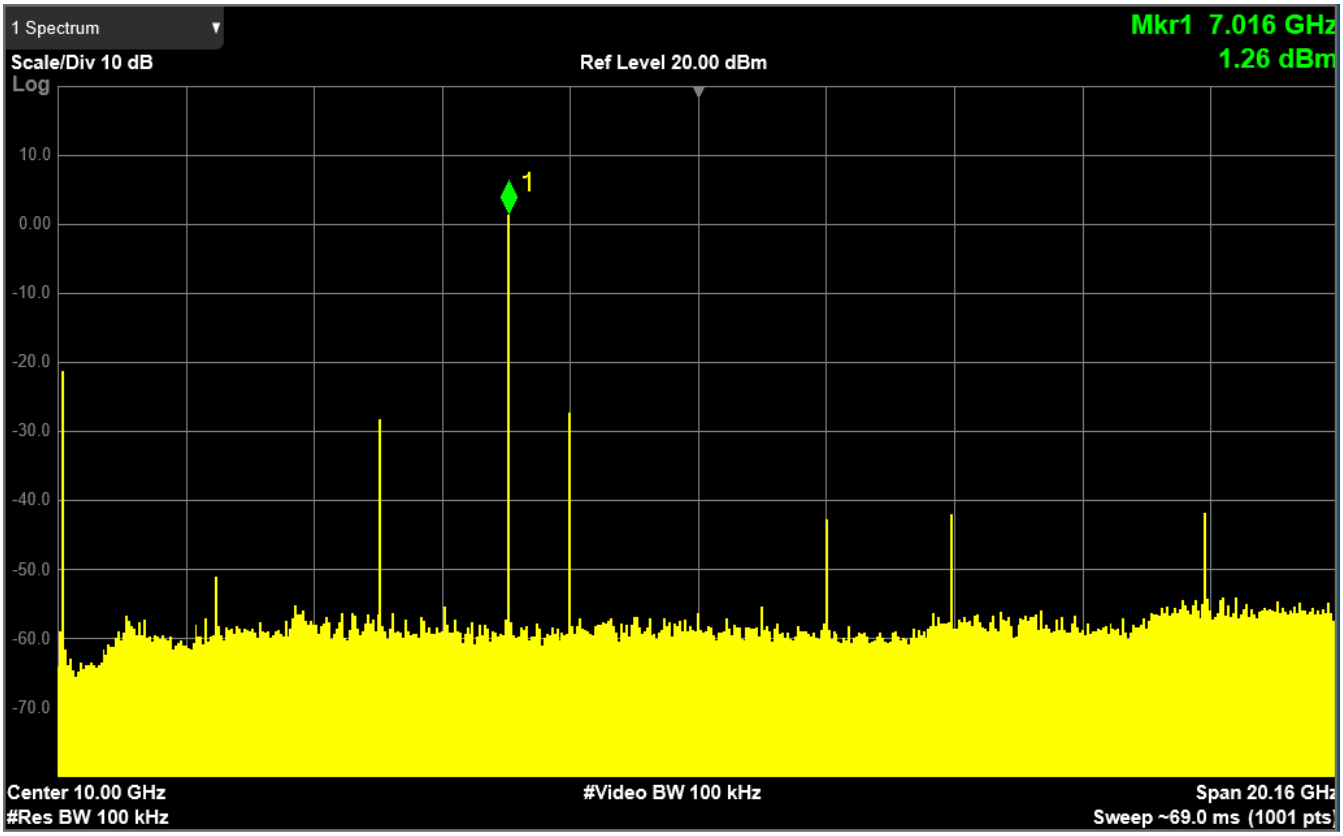


Figure 15. ADRF5730_TX_1 to ADMV5730_TX_4

ADMX7103-EBZ USER GUIDE

There are four digital attenuators in the TX chain that provide 126dB of dynamic range (ADRF5730_TX_1 to ADMV5730_TX_4). Refer to Figure 2, this shows the location of the attenuators in the TX chain. ADRF5730_TX_1 is the first attenuator in the TX chain, ADRF_TX_2 is the second attenuator in the TX chain, etc. The pull-down provides access to the four attenuators. Each attenuator has 31.5dB of range adjustable in 0.5dB steps. Register hex settings are 00 to 3F, 00 is 0 dB and 3F is 31.5dB. Click on the individual attenuator to access the register read/write and program the desired value. Default setting for all four attenuators is 0dB.

There are three temperature sensors located on the ADMX7103 board. Using the USB fan for cooling should keep the board temps below 40°C

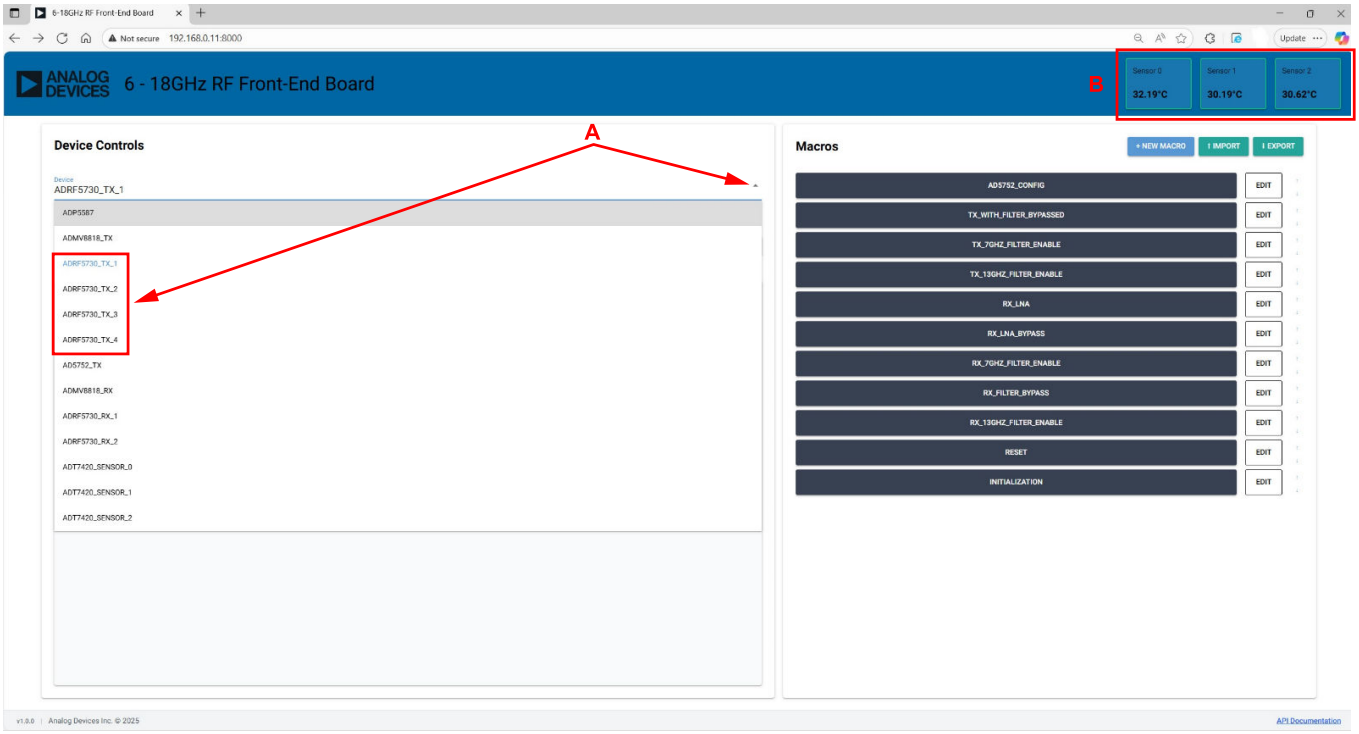


Figure 16. Temperature control of the ADMX7103 board

ADMX7103-EBZ USER GUIDE

RX HARDWARE SETUP

The ADMX7103-EBZ board works with Raspberry Pi (RPi) board. The RPi serves as the controller for configuring the ADMX7103-EBZ board.

The hardware setup includes the following components:

- ADMX7103-EBZ board (power adapter included in the ADMX7103-EBZ package)
- Raspberry pi board (power adapter included in the ADMX7103-EBZ package)
- Mini-Circuits 90° power splitter
- SMA cables
- Two signal generators
- Spectrum analyzer
- PC running Windows
- USB powered fan

Figure 17 shows the test configuration of the ADMX7103-EBZ board for a receiver test. This shows connections of power supplies, signal generators, and the spectrum analyzer. The Raspberry Pi board is connected to test computer with an Ethernet cable. A small benchtop USB fan is required for heat dissipation of the ADMX7103-EBZ board.

Connect the RX I/Q IF inputs as follows (see Figure 18):

1. Install 50 Ω load on Mini-Circuits splitter connecter labeled **50 Ohm** (**Label A**).
2. Connect the spectrum analyzer to the **IN** connector on the Mini-Circuits splitter using SMA cable (**Label B**).
3. Connect Port 1 and Port 2 on the Mini-Circuits splitter to RX I/Q IF ports (as shown in Figure 18 **Label C**) using the two short SMA cables. This configuration is for upper sideband operation.
4. Connect one of signal generators to the LO input port (**Label D**). Set the signal generator to 6GHz and the power at the connector to −10dBm.
5. Connect the second signal generator to the RX RF input port (**Label E**). Set the second signal generator to 7GHz and the power at the connector to −60dBm.
6. On the test PC, set the Ethernet to the static IP with address of **192.168.0.1**.
7. Connect the Ethernet cable on RPi to the test PC (as shown in Figure 19 **Label A**).
8. Next, plug in the AC/DC 12V DC wall adapter to the ADMX7103 board and confirm the green LED lights up (**Label B**).
9. Then, plug in the Raspberry Pi USB AC/DC converter (**Label C**). The green and red lights should start flashing as the Raspberry Pi board starts up.

ADMX7103-EBZ USER GUIDE

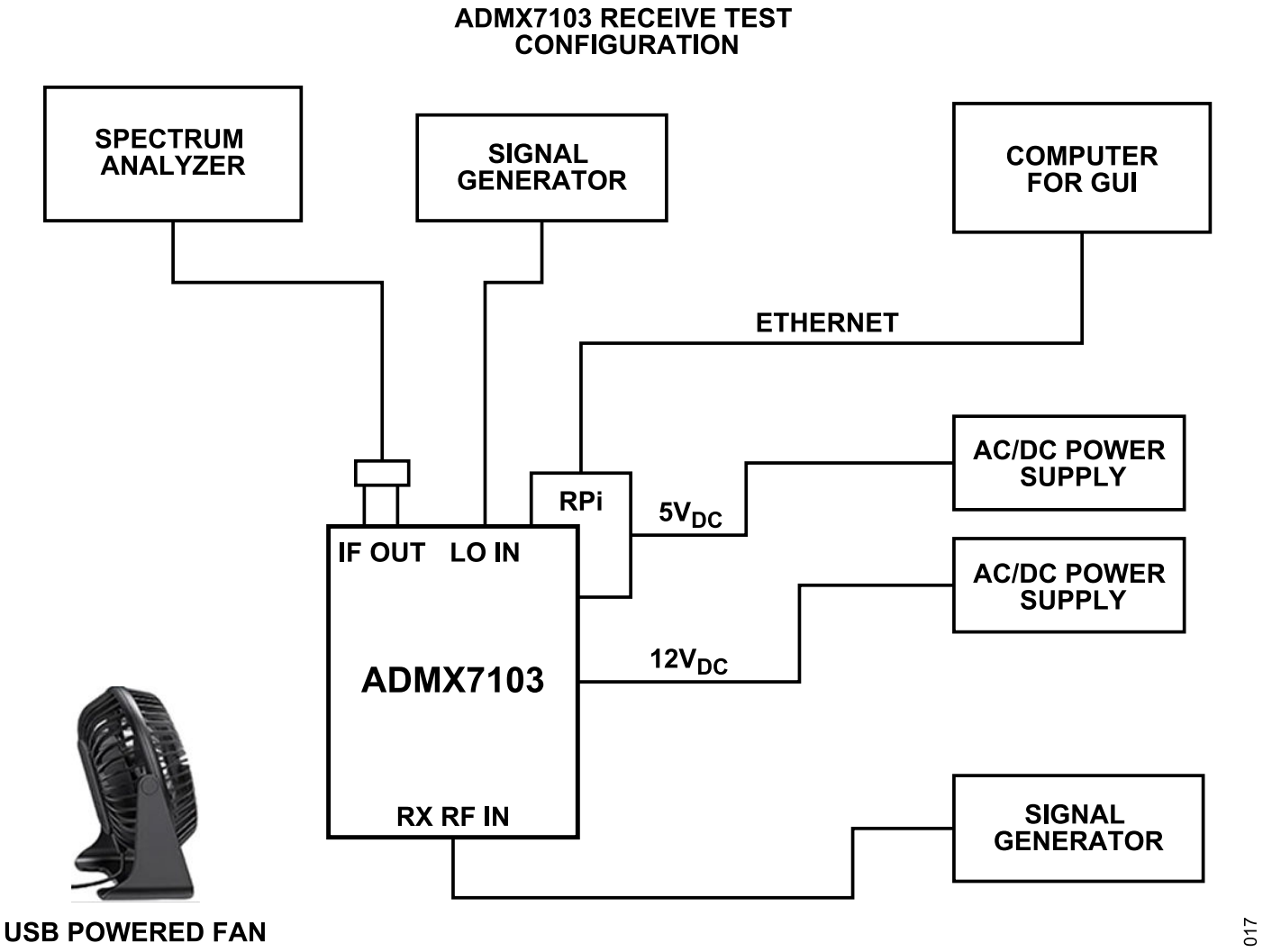


Figure 17. ADMX7103-EBZ Receive Test Configuration

ADMX7103-EBZ USER GUIDE

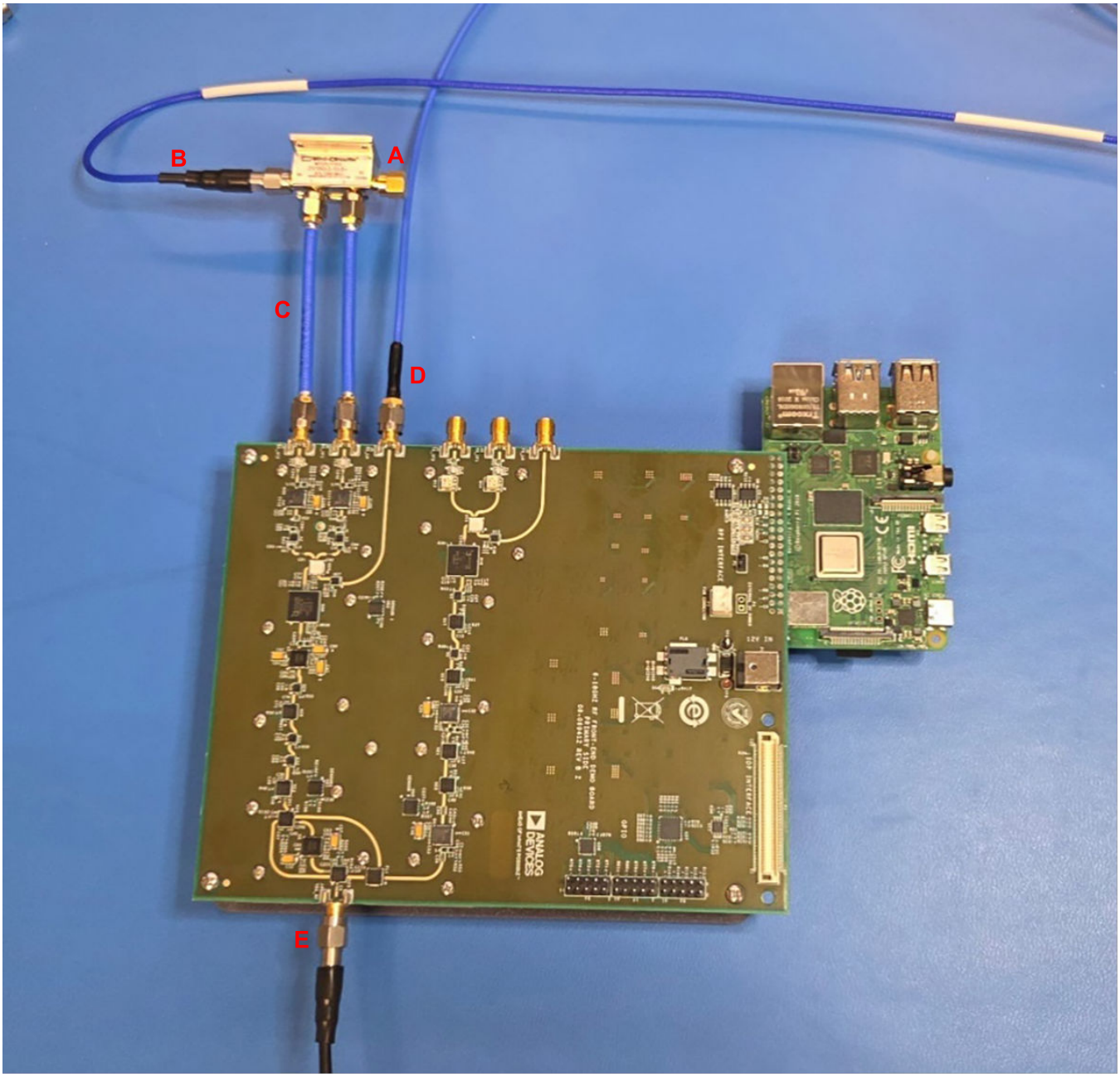
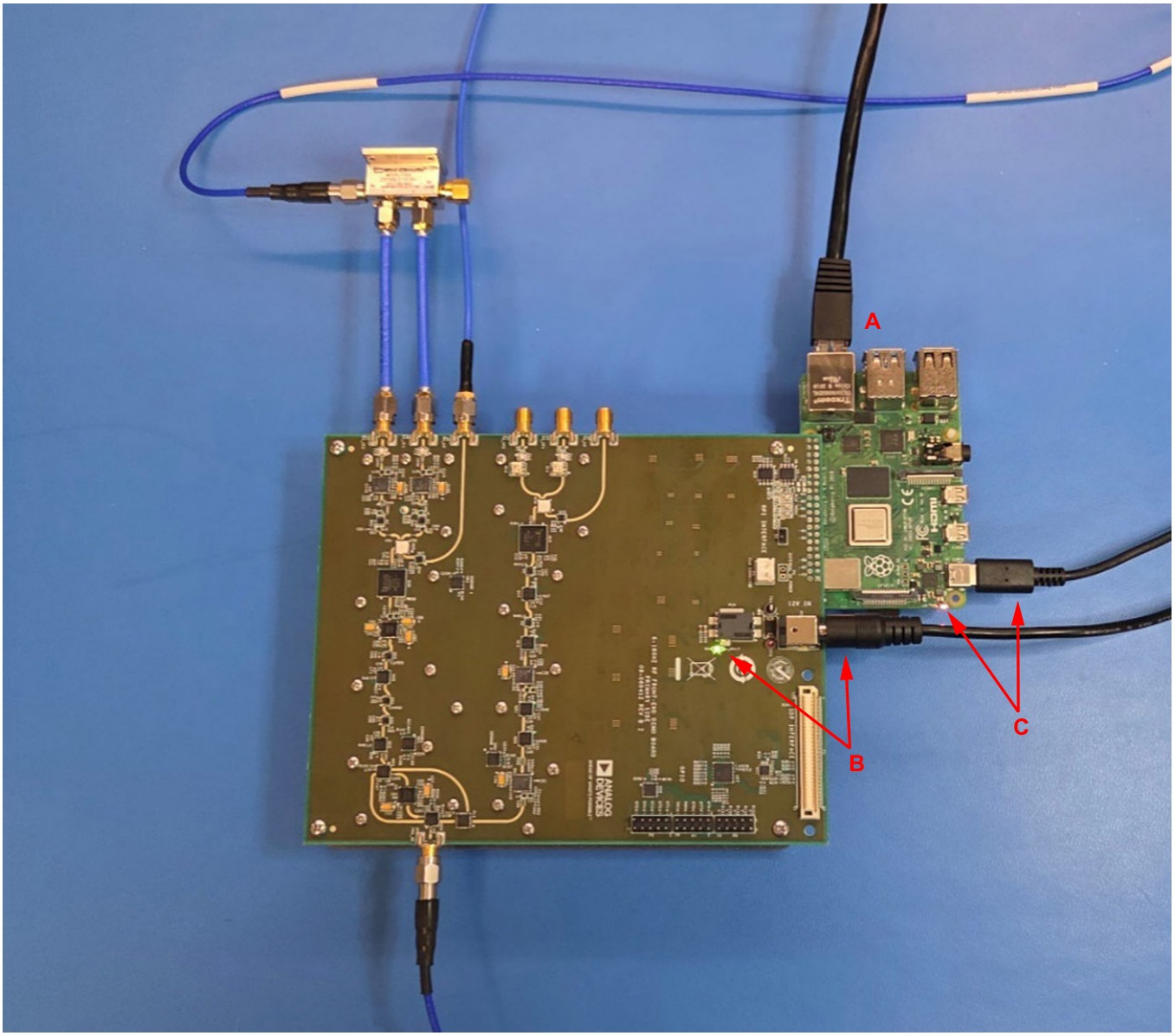


Figure 18. Connecting the Second Signal Generator to RX RF Input Port

ADMX7103-EBZ USER GUIDE



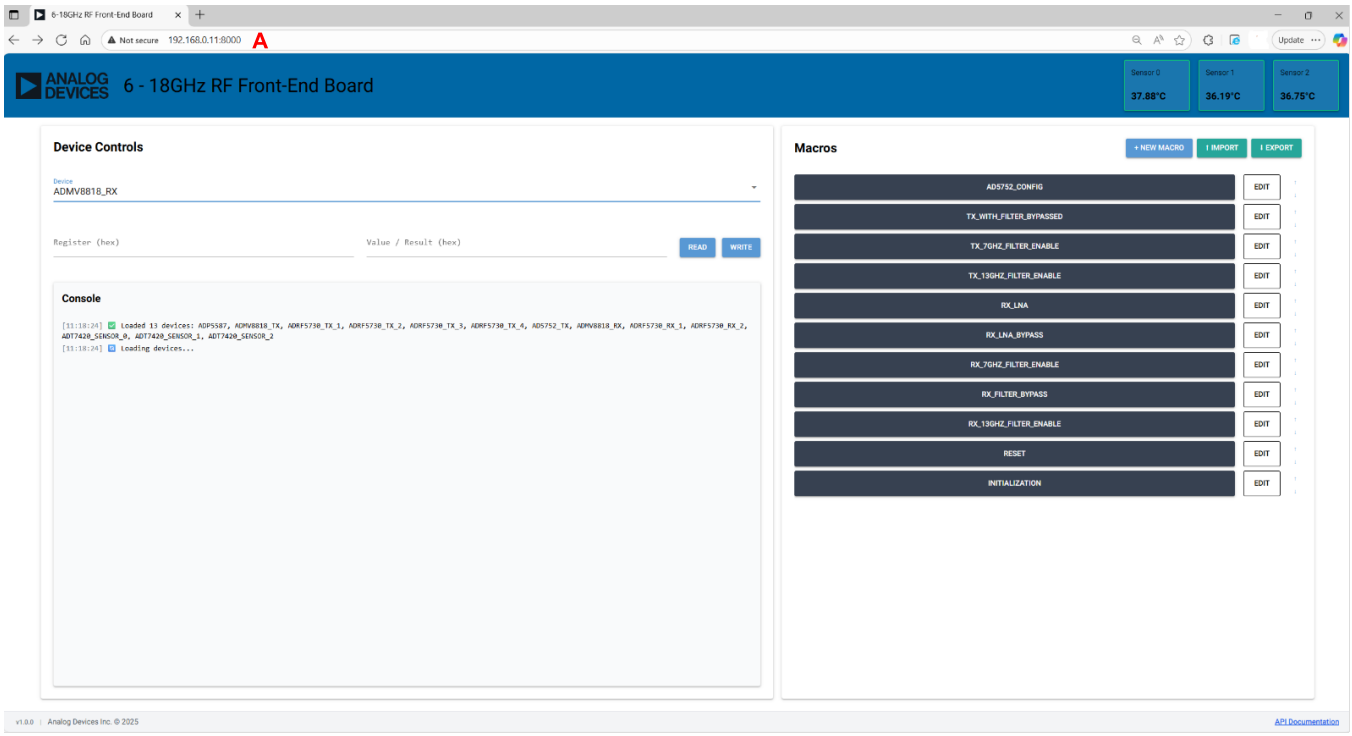
019

Figure 19. Plug In Raspberry Pi USB AC/DC Converter

ADMX7103-EBZ USER GUIDE

SOFTWARE SETUP

Open your web browser and navigate to **192.168.0.11:8000** (**Label A**). This connects to the front-end interface of Raspberry Pi and loads the web user interface (UI).

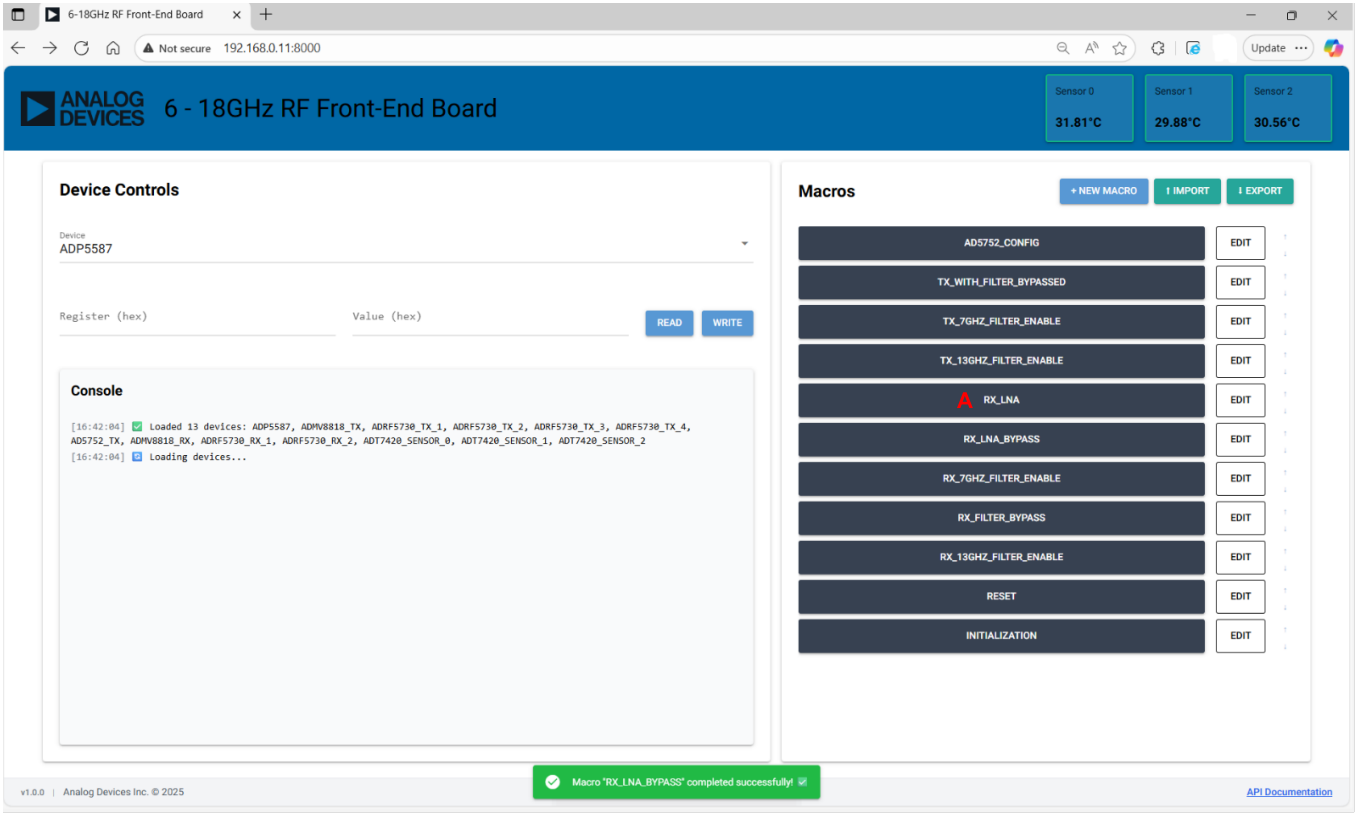


020

Figure 20. Raspberry Pi Front-End Interface

ADMX7103-EBZ USER GUIDE

Click on the **RX_LNA** macro button. This will enable the RX with the ADMV8818 tunable filter in bypass mode. There will be a 1GHz IF tone at the output of the receiver. Refer to the two spectral plots on the following page.



021

Figure 21. Console Settings

ADMX7103-EBZ USER GUIDE

These two plots show the typical IF output spectrum when receiving a 7GHz RF frequency. An upper side-band 7GHz RX signal with 6GHz LO provides a down-converted 1GHz IF output signal. The first plot is zoomed in on the 1GHz IF signal. The second plot shows a wide-band frequency spectrum.

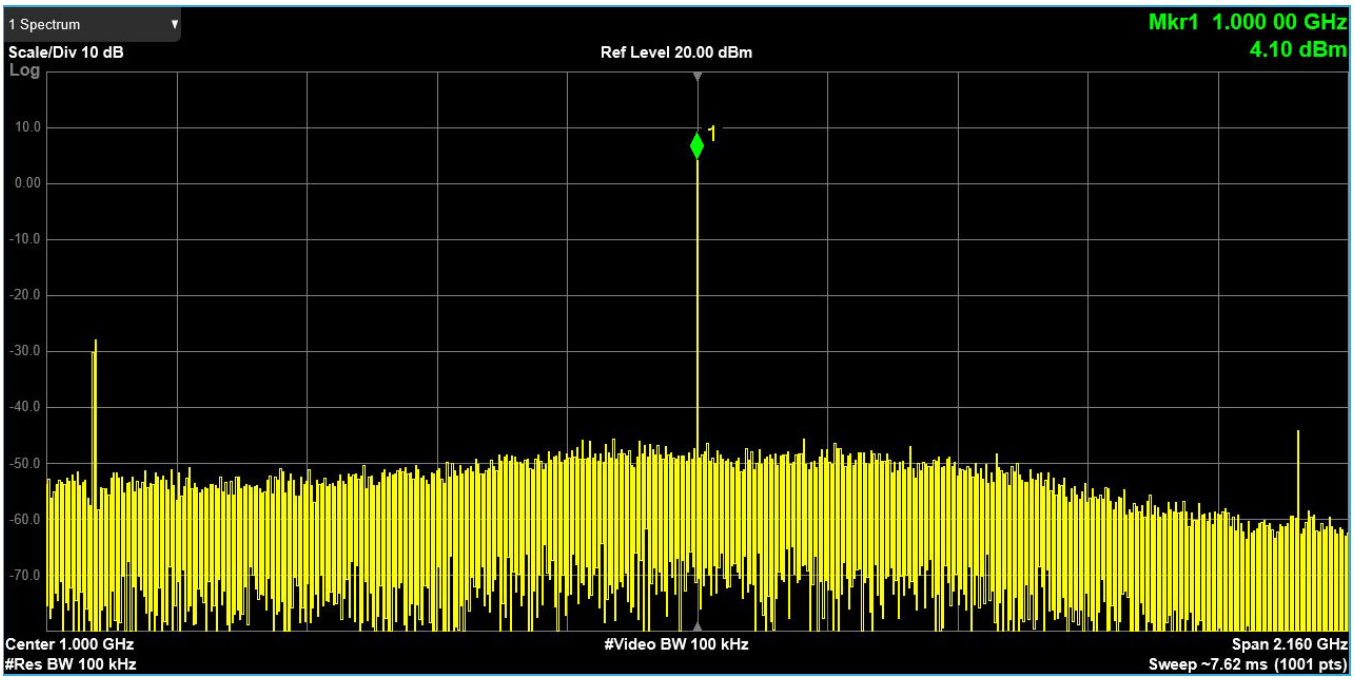


Figure 22. 1GHz IF Signal

ADMX7103-EBZ USER GUIDE

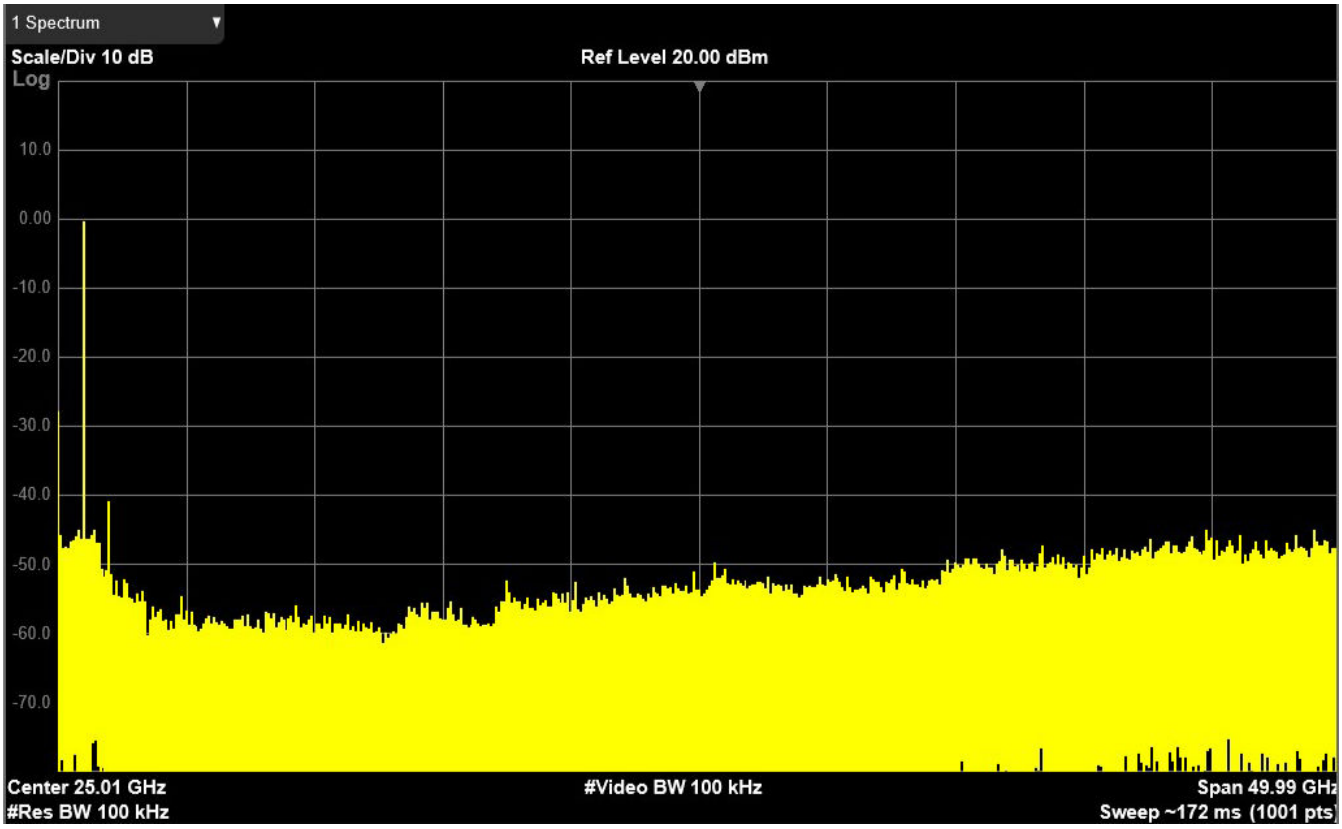
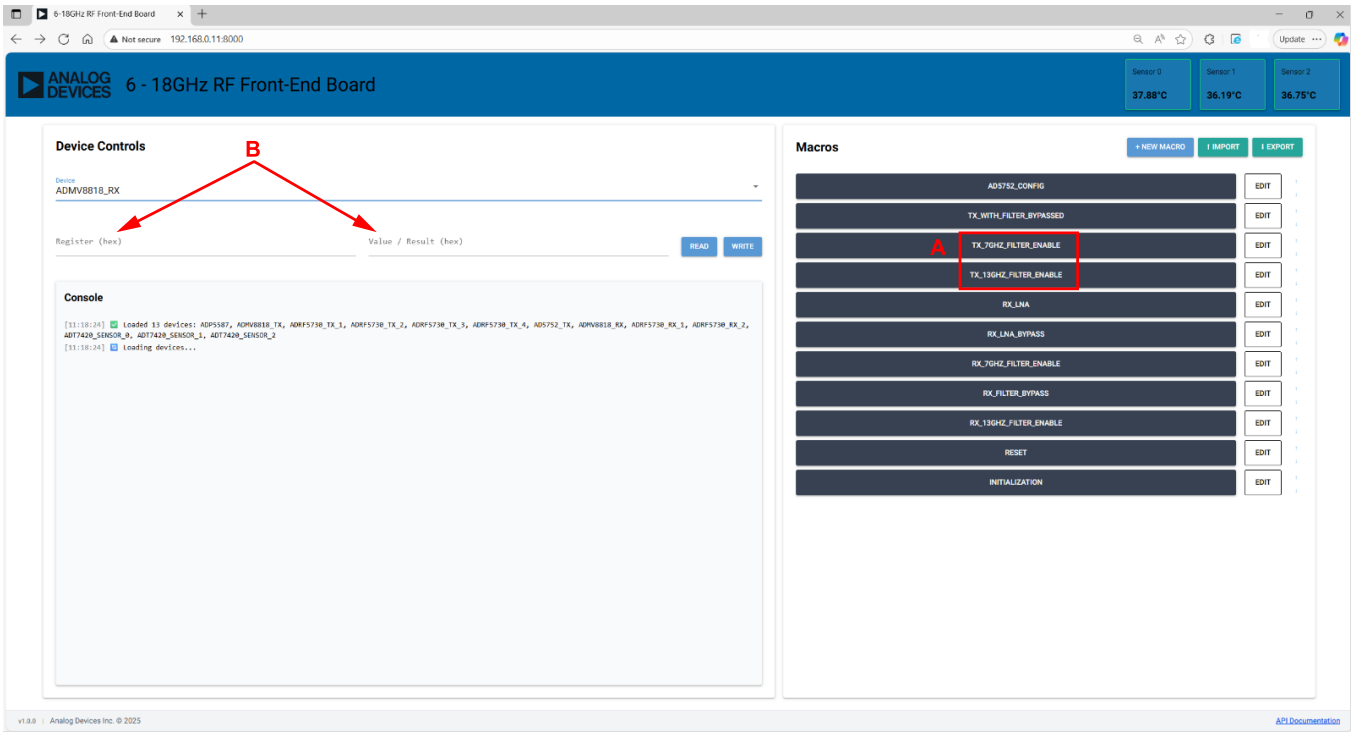


Figure 23. Wideband Frequency Spectrum

ADMX7103-EBZ USER GUIDE

If receiving a high-power signal of > −30dBm, select the **RX_LNA_BYPASS** macro. This macro bypasses the LNA and will prevent the receiver from being compressed by the strong RX signal. Refer to the block diagram Figure 2, this details the LNA bypass path. Also, if other received signals are present at the RX IF output, the **RX_7GHZ_FILTER_ENABLE** can be enabled to filter the unwanted signals and the IF output. There is also an additional macro that sets the filter to 13GHz.

Two registers program the RX ADMV8818 frequency and bandwidth, Register 0x20 and Register 0x21. Refer to ADMV8818 data sheet for additional frequency settings. Using the pull-down to select the ADMV8818_RX allows the user to write the individual registers.



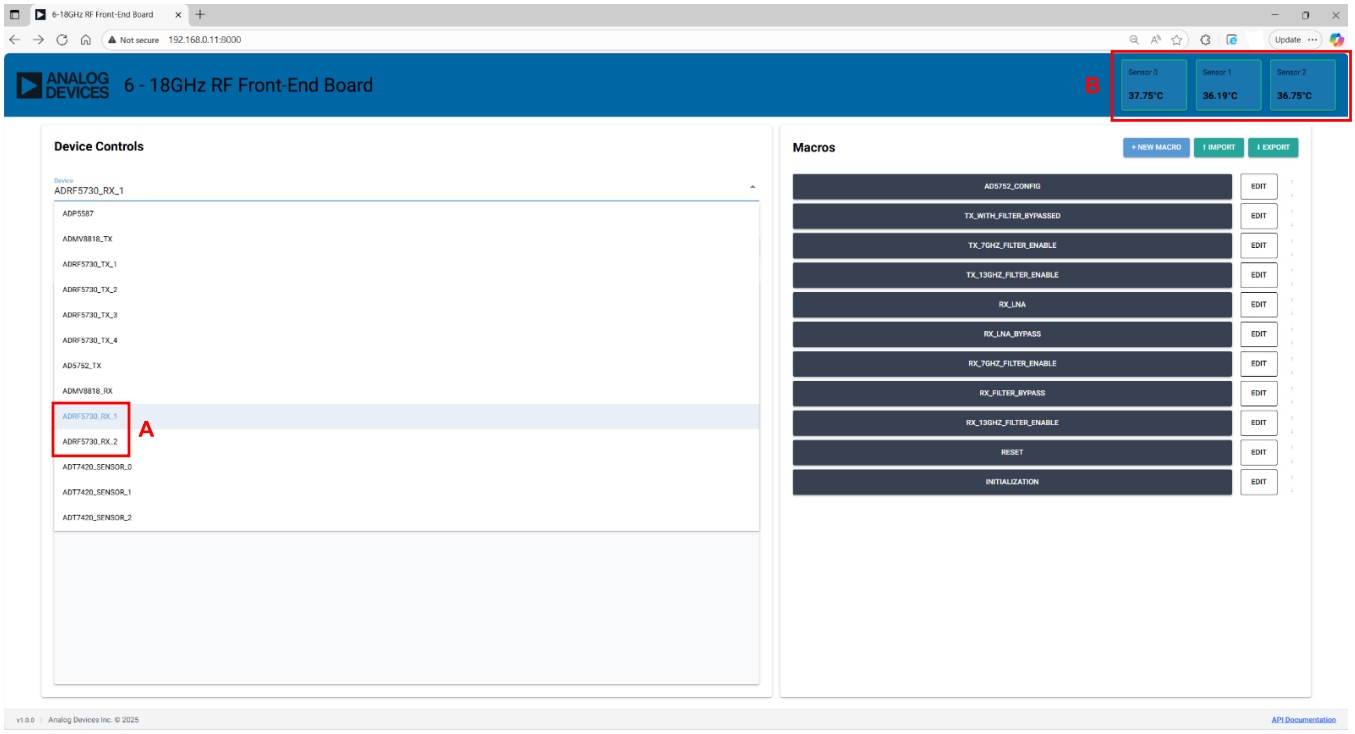
024

Figure 24. ADMV8818_RX

ADMX7103-EBZ USER GUIDE

There are two digital attenuators in the RX chain that provide 63dB of dynamic range (ADRF5730_RX_1 and ADRF5730_RX_2). Refer to Figure 2, this shows the location of the attenuators in the RX chain. ADRF5730_RX_1 is the first attenuator in the RX chain, ADRF_RX_2 is the second attenuator in the RX chain. The pull-down provides access to the two attenuators. Each attenuator has 31.5dB of range adjustable in 0.5dB steps. Register hex settings are 00 to 3F, 00 is 0dB and 3F is 31.5dB. Click on the individual attenuator to access the register read/write and program the desired value. Default setting for both attenuators is 0dB.

There are three temperature sensors located on the ADMX7103 board. Using the USB fan for cooling should keep the board temps below 40°C.



025

Figure 25. Attenuator Access

NOTES

ESD Caution
ESD (electrostatic discharge) sensitive device. Charged devices and circuit boards can discharge without detection. Although this product features patented or proprietary protection circuitry, damage may occur on devices subjected to high energy ESD. Therefore, proper ESD precautions should be taken to avoid performance degradation or loss of functionality.