

Evaluating the **ADRF6780** 5.9 GHz to 23.6 GHz, Wideband Upconverter

FEATURES

Full feature evaluation board for the **ADRF6780**
On-board USB for serial port interface (SPI) control
5 V operation
ACE software interface for SPI control

EVALUATION KIT CONTENTS

ADRF6780-EVALZ evaluation board

EQUIPMENT NEEDED

5 V dc power supply
RF signal generator
Spectrum analyzer

DOCUMENTS NEEDED

ADRF6780 data sheet
ADRF6780-EVALZ evaluation board user guide

SOFTWARE NEEDED

Analysis|Control|Evaluation (ACE) software
USB drivers for the **ADRF6780-042654**, Rev. A (**ADRF6780-EVALZ**) evaluation board

GENERAL DESCRIPTION

The **ADRF6780** is a silicon germanium (SiGe) design, wideband, microwave upconverter optimized for point to point microwave radio designs operating in the 5.9 GHz to 23.6 GHz frequency range.

The upconverter offers two modes of frequency translation. The device is capable of direct conversion to radio frequency (RF) from baseband IQ input signals, as well as single sideband (SSB) upconversion from a real intermediate frequency (IF) input carrier frequency. The baseband inputs are high impedance and are generally terminated off chip with 100 Ω differential back terminations. The baseband IQ input path can be disabled and a modulated real IF signal anywhere from 800 MHz to 3500 MHz can be fed into the IF input path and upconverted to 5.9 GHz to 23.6 GHz while suppressing the unwanted sideband by typically better than 25 dBc. The serial port interface (SPI) allows for

ADRF6780-042654, REV. A (**ADRF6780-EVALZ**) EVALUATION BOARD



Figure 1.

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tweaking of the quadrature phase adjustment to allow for optimum sideband suppression. In addition, the SPI interface allows for powering down the output power detector to reduce power consumption when power monitoring is not necessary.

The **ADRF6780** upconverter comes in a compact, thermally enhanced, 5 mm \times 5 mm LFCSP package. The **ADRF6780** operates over the -40°C to $+85^{\circ}\text{C}$ temperature range.

For full details on the **ADRF6780**, see the **ADRF6780** data sheet, which should be consulted in conjunction with this **ADRF6780-EVALZ** evaluation board user guide when using this evaluation board.

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REVISION HISTORY**4/16—Revision 0: Initial Version**

EVALUATION BOARD HARDWARE

The [ADRF6780-042654](#), Rev. A ([ADRF6780-EVALZ](#)) comes with a [ADRF6780](#) chip, and Figure 2 shows the location of this chip on the evaluation board and the block diagram of the [ADRF6780](#).

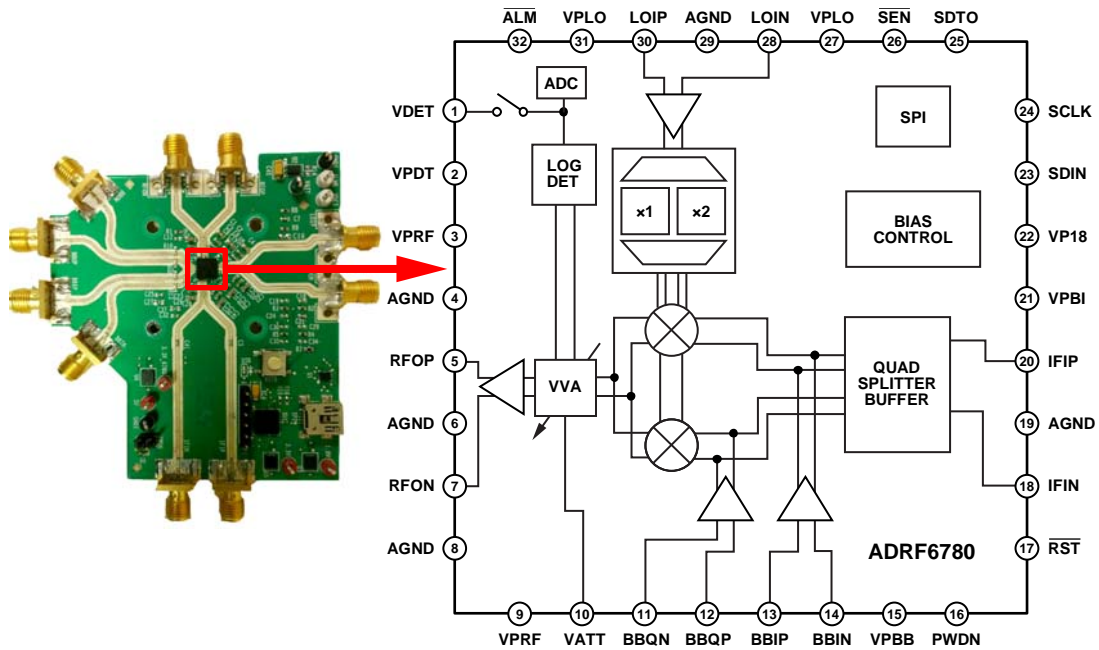


Figure 2. Evaluation Board Configuration

The [ADRF6780-EVALZ](#) evaluation board has IF/IQ inputs for the two LO modes ($\times 1/\times 2$) that the device supports. When evaluating the device in IF mode, connect the IF inputs, IFIN and IFIP, to a signal generator. Note that, when using the IF mode, the IQ inputs must be kept floating without termination resistors (R10 to R13). When evaluating the devices in IQ mode, connect the IQ inputs, BBIN, BBIP, BBQN, and BBQP, to an IQ baseband generator. Use $50\ \Omega$ termination resistors (R10, R11, R12, and R13) with the IQ inputs. The [ADRF6780-EVALZ](#) runs on 5 V dc supplies. Figure 3 shows the top side of the [ADRF6780-EVALZ](#) evaluation board and is intended for evaluation purposes only with no implied guarantee of performance or reliability.

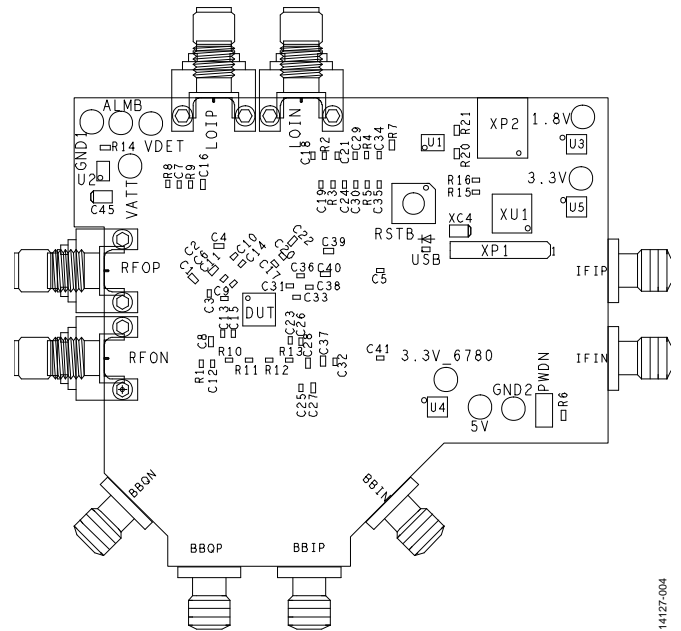


Figure 3. Top View of the [ADRF6780-EVALZ](#)

Connect the 5 V dc to the 5V test point, and ground to the GND1 test point. The 3.3V and 1.8V test points are for evaluation purposes only. Connect the spectrum analyzer differentially to the Southwest/SRI 2.92 mm connectors, RFON and RFOP. It is recommended to use a 180° hybrid from 5.9 GHz to 23.6 GHz to view the single-ended RF output. Connect LOIN and LOIP the Southwest/SRI 2.92 mm connectors, differentially to the low phase signal generator. Use a 180° hybrid from 5.9 GHz to 14 GHz for the differential inputs. In IF mode, connect IFIP and IFIN differentially to the signal generator (use a 180° hybrid from 500 MHz to 4 GHz for the differential inputs), keep the IQ inputs floating, and remove any termination from the [ADRF6780-EVALZ](#). In IQ mode, connect BBIN, BBIP, BBQN, and BBQP to the I/Q baseband generator. In addition, connect the PC to the [ADRF6780-EVALZ](#) by using the mini-USB connector (J2). See Figure 5 and Figure 6 for the [ADRF6780-EVALZ](#) lab connections. When using the [AD5601](#) nanoDAC® to generate the VATT voltage, note that the 2600 mV dc power supply is

not needed (see the Setting VATT Voltage for the ADRF6780 section for additional details). Figure 4 shows the block diagram of the [ADRF6780](#) lab bench setup, and Figure 3 shows the top view of the [ADRF6780-EVALZ](#). The [ADRF6780-EVALZ](#) also features a PWDN jumper to power down the device and a reset button to hard reset the [ADRF6780-EVALZ](#).

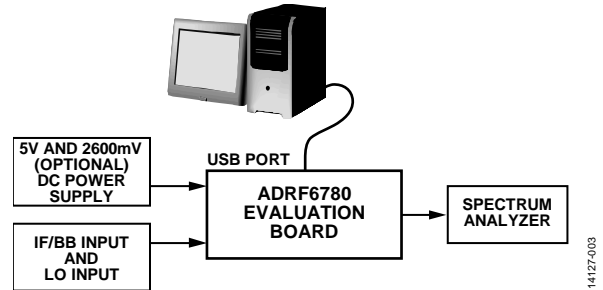


Figure 4. Block Diagram of the [ADRF6780](#)

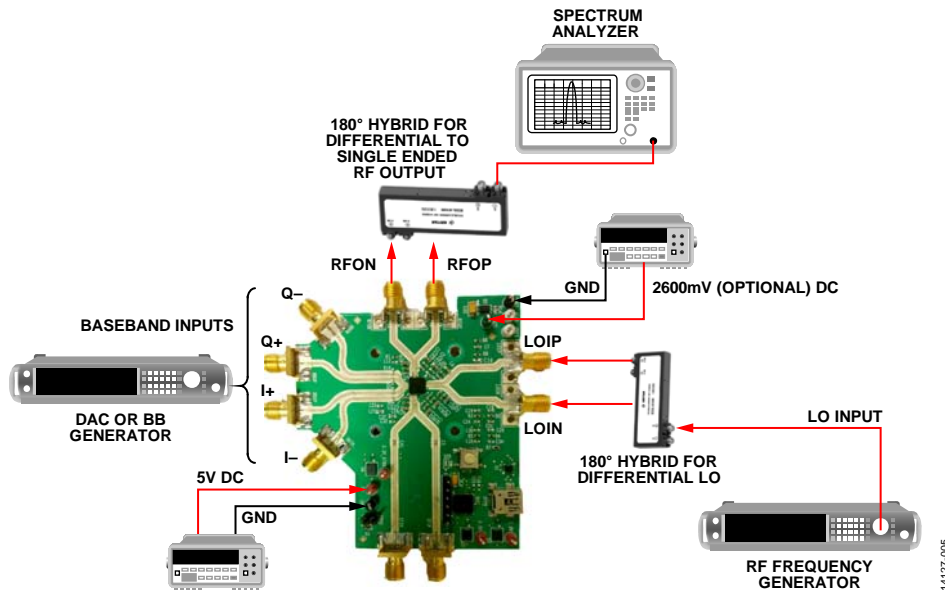


Figure 5. [ADRF6780](#) Lab Bench Setup for the IQ Inputs

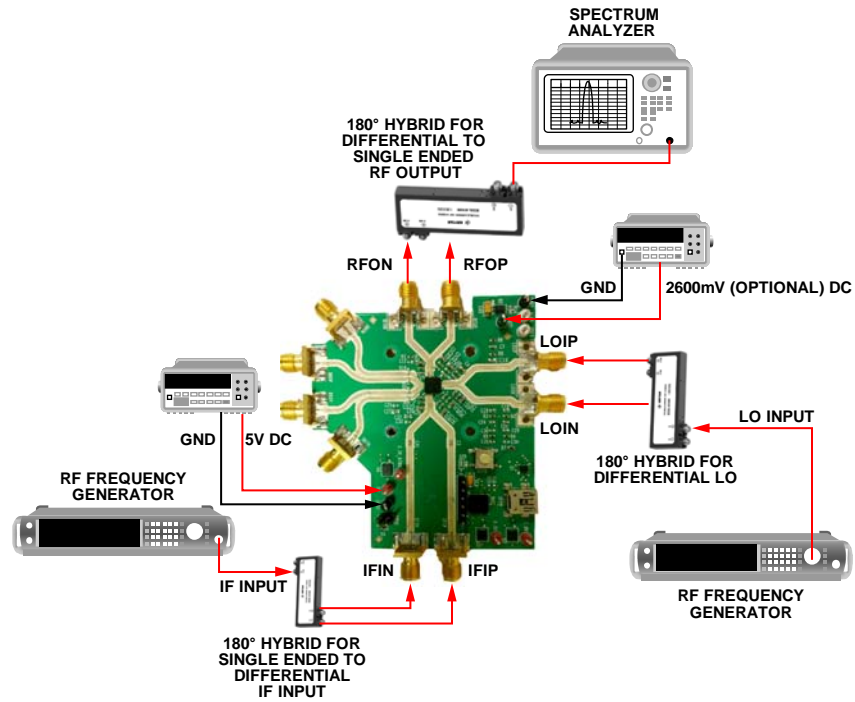


Figure 6. ADRF6780 Lab Bench Setup for the IF Inputs

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EVALUATION BOARD SOFTWARE QUICK START PROCEDURES

INSTALLING THE ACE SOFTWARE AND ADRF6780 PLUGINS AND DRIVERS

The ADRF6780-EVALZ software uses the Analog Devices, Inc., Analysis|Control|Evaluation (ACE) software. For instructions on how to install and use the ACE software, go to www.analog.com/ACE.

After the ACE software is installed, USB drivers must also be installed to use the ADRF6780-EVALZ. To install these drivers, go to the Evaluation Kits section of the ADRF6780 product page.

Once the installations are finished, the ADRF6780-EVALZ evaluation board plugin will appear when you open the ACE software (see Figure 7).

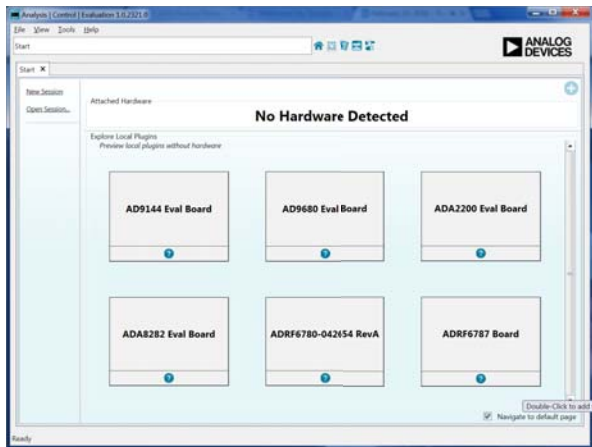


Figure 7. ADRF6780-EVALZ Evaluation Board Plugin Window after Opening the ACE Software

INITIAL SETUP

To set up the ADRF6780-EVALZ, take the following steps:

1. Connect a USB cable to the PC and then to the ADRF6780-EVALZ.
2. Power up the ADRF6780-EVALZ with a 5 V dc supply. When the USB cable is connected to the PC, the blue LED lights up. The PC should recognize the ADRF6780-EVALZ as the ADRF6780-042654, Rev. A.
3. Open the ACE software. The ADRF6780-042654, Rev. A (ADRF6780-EVALZ) appears in the **Attached Hardware** section (see Figure 8). Double-click on the evaluation board plugin. If the device is turned off and on, or if the USB cable is unplugged and plugged in, while the ACE software is open, you may lose contact with the ADRF6780-EVALZ. If this happens, click the **System** tab, then click the **USB** symbol on the ADRF6780-042654, Rev. A subsystem, and then click **Acquire** to talk to the ADRF6780-EVALZ again.

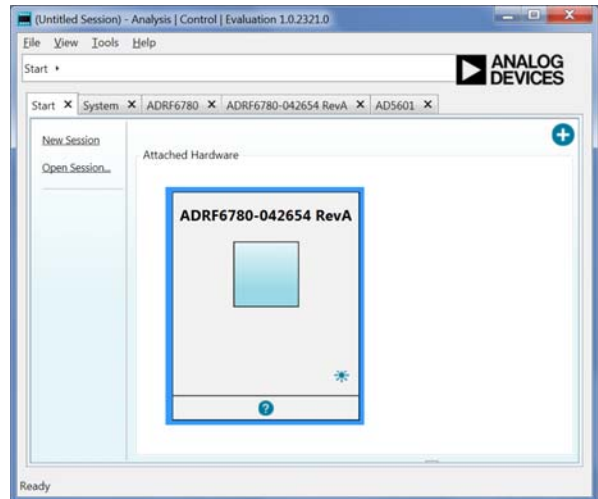


Figure 8. Attached Hardware Section when the ADRF6780-042654, Rev. A (ADRF6780-EVALZ) Is Connected

- The **ADRF6780-042654, Rev. A** tab then opens. On the left-side of the screen, click **Initial Configuration** to open this menu. Go to **Gain Setup** to enter the VATT voltage Note that 2600 mV is the highest gain for the device (see Figure 9). Click **Apply** and then double-click the **ADRF6780** button (see the middle of the screen shown in Figure 9).

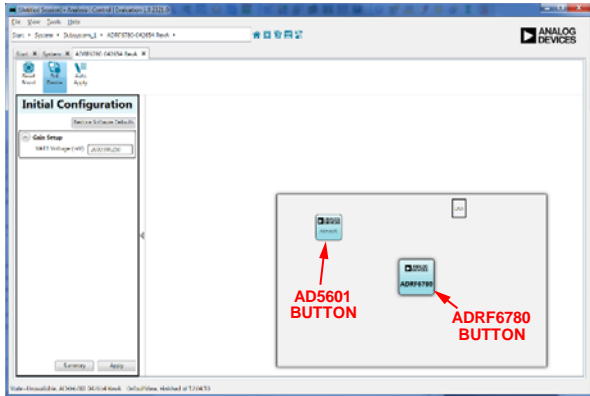


Figure 9. Initial Configuration for the Gain Setup and Board Plugin View

- The **ADRF6780** block diagram now appears (see Figure 10).

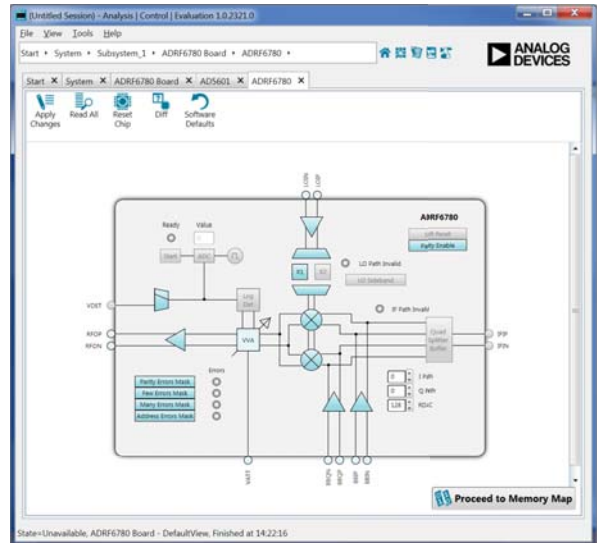


Figure 10. ADRF6780 Block Diagram in the ACE Software

ADRF6780 BLOCK DIAGRAM AND ITS FUNCTIONS

The ADRF6780 ACE plugin is conveniently organized so that it appears similar to the block diagram shown in the ADRF6780 data sheet. In this way, it is easy to correlate the functions on the ADRF6780-EVALZ with the descriptions in the ADRF6780-EVALZ data sheet. A full description of each block and register and its settings is given in the ADRF6780 data sheet. Some of the blocks and their functions are described as they pertain to

the ADRF6780-EVALZ. The full screen ADRF6780 block diagram with labels is shown in Figure 11, and Table 1 describes the functionality of each block.

Due to ongoing improvements and enhancements to the software, note that some of the screen images in this user guide may not be the latest versions found in the software.

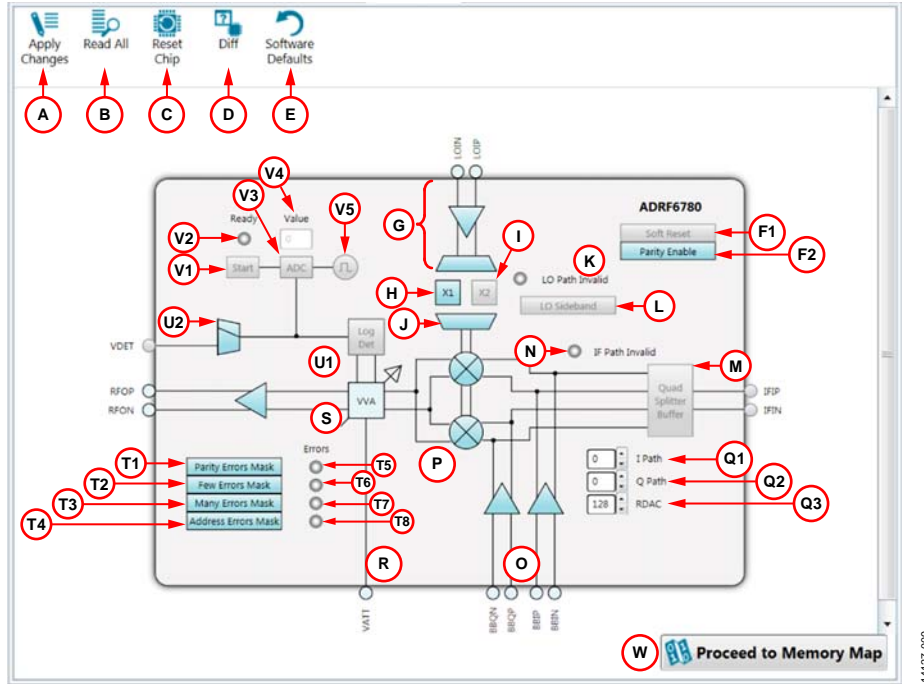


Figure 11. ADRF6780 Block Diagram with Labels

Table 1. ADRF6780 Block Diagram Label Functions (See Figure 11)

Label	Function
A	To apply all of the register values to the device, click Apply Changes (Label A). If Auto Apply is highlighted in the ADRF6780-042654, Rev. A tab, then the Apply Changes feature (Label A) and the Read All feature (Label B) continuously run every few seconds, and the Apply Changes (Label A) and Read All (Label B) buttons do not need to be clicked to apply or read back the block diagram settings.
B	To read back all of the SPI registers of the device, click Read All (Label B). If Auto Apply is highlighted in the ADRF6780-042654, Rev. A tab, then the Apply Changes feature (Label A) and the Read All feature (Label B) continuously run every few seconds, and the Apply Changes (Label A) and Read All (Label B) buttons do not need to be clicked to apply or read back the block diagram settings.
C	Click Reset Chip (Label C) to reset the 1.8 V SPI. Note that it has similar functionality as the Soft Reset button (Label F1).
D	Click Diff (Label D) to shows registers that are different on the device.
E	Click Software Defaults (Label E) to load the software defaults on to the device, and then click Apply Changes (Label A).
F1	Click Soft Reset (Label F1) and then Apply Changes (Label A) to set the SOFT_RESET bit (Bit 14, Register 0x00). When Soft Reset is highlighted, the soft reset feature is enabled. When Soft Reset is not highlighted, the soft reset feature is disabled. After resetting the device, disable the SOFT_RESET bit and enable the PARITY_EN bit (Bit 15, Register 0x00).
F2	Click Parity Enable (Label F2) and then Apply Changes (Label A) to set the PARITY_EN bit (Bit 15, Register 0x00). When Parity Enable is highlighted, the PARITY_EN bit is enabled. When Parity Enable is not highlighted, the PARITY_EN bit is disabled.
G	Click LO Buffer Enable (Label G) and Apply Changes (Label A) to set the LO_BUFFER_ENABLE bit (Bit 6, Register 0x03). When LO Buffer Enable is highlighted, the LO buffer is enabled. When LO Buffer Enable is not highlighted, the LO buffer is disabled.
H	Click LO PPF Enable (Label H) and Apply Changes (Label A) to set the LO_PPF_ENABLE bit (Bit 2, Register 0x03). When LO PPF Enable is highlighted, the LO_PPF_ENABLE bit is enabled. When LO PPF Enable is not highlighted, the LO_X2_ENABLE bit is disabled.

Label	Function
I	Click LO x2 Enable (Label I) and Apply Changes (Label A) to set the LO_x2_ENABLE bit (Bit 3, Register 0x03). When LO x2 Enable is highlighted, the LO_x2_ENABLE bit is enabled. When LO x2 Enable is not highlighted, the LO_x2_ENABLE bit is disabled.
J	Click LO Enable (Label J) and Apply Changes (Label A) to set the LO_ENABLE bit (Bit 1, Register 0x03). When LO Enable is highlighted, the LO_ENABLE bit is enabled. When LO Enable is not highlighted, the LO_ENABLE bit is disabled.
K	When the LO_PPF_ENABLE and LO_x2_ENABLE bits (Bits[3:2], Register 0x03) are enabled simultaneously, the LO Path Invalid light turns green.
L	Click LO Sideband (Label L) and Apply Changes (Label A) to set the LO_SIDE BAND bit (Bit 10, Register 0x05). When LO Sideband is highlighted, the LO_SIDE BAND bit is enabled. When LO Sideband is not highlighted, the LO_SIDE BAND bit is disabled.
M	Click Quad Splitter Buffer (Label M) and Apply Changes (Label A) to set the IF_MODE_ENABLE bit (Bit 5, Register 0x03). When Quad Splitter Buffer is highlighted, the IF_MODE_ENABLE bit is enabled. When Quad Splitter Buffer is not highlighted, the IF_MODE_ENABLE bit is disabled.
O	Click IQ Mode Enable (Label O) and Apply Changes (Label A) to set the IQ_MODE_ENABLE bit (Bit 4, Register 0x03). When IQ Mode Enable is highlighted, the IQ_MODE_ENABLE bit is enabled. When IQ Mode Enable is not highlighted, the IQ_MODE_ENABLE bit is disabled.
P	Click Upconverter Bias Enable (Label P) and Apply Changes (Label A) to set the UC_BIAS_ENABLE bit (Bit 0, Register 0x03). When Upconverter Bias Enable is highlighted, the UC_BIAS_ENABLE bit is enabled. When Upconverter Bias Enable is not highlighted, the UC_BIAS_ENABLE bit is disabled.
Q1 to Q3	Linearity blocks (I Path , Q Path , and RDAC). Use the scroll or enter a value between 0 and 15 in the I Path box (Label Q1) and click Apply Changes (Label A) to set the I_PATH_PHASE_ACCURACY bits (Bits[3:0], Register 0x05). Use the scroll or enter a value between 0 and 15 in the Q Path box (Label Q2) and click Apply Changes (Label A) to set the Q_PATH_PHASE_ACCURACY bits (Bits[7:4], Register 0x05). The I Path and Q Path are each 4-bit controllers that allow users to change the quadrature phase accuracy tuning to lower the RF output image. Use the scroll or enter a value between 0 and 255 in the RDAC box (Label Q3) and click Apply Changes (Label A) to set the RDAC_LINERIZE bits (Bits[7:0], Register 0x04). The default value is 128. RDAC is an 8-bit controller that can improve the RF harmonic performance.
R	See the Setting VATT Voltage for the ADRF6780 section for additional details.
S	Click VGA Buffer Enable (Label S) and Apply Changes (Label A) to set the VGA_BUFFER_ENABLE bit (Bit 8, Register 0x03). When VGA Buffer Enable is highlighted, the VGA_BUFFER_ENABLE bit is enabled. When VGA Buffer Enable is not highlighted, the VGA_BUFFER_ENABLE bit is disabled.
T1 to T8	Error Mask and ReadBack follow: Click Parity Errors Mask (Label T1) and Apply Changes (Label A) to set the PARITY_ERROR_MASK bit (Bit 15, Register 0x02). When Parity Errors Mask is highlighted, the PARITY_ERRORS_MASK bit is enabled. When Parity Errors Mask is not highlighted, the PARITY_ERROR_MASK bit is disabled. Click Few Errors Mask (Label T2) and Apply Changes (Label A) to set the TOO_FEW_ERRORS_MASK bit (Bit 14, Register 0x02). When the Few Errors Mask is highlighted, the TOO_FEW_ERRORS_MASK bit is enabled. When the Few Errors Mask is not highlighted, the TOO_FEW_ERRORS_MASK bit is disabled. Click Many Errors Mask (Label T3) and Apply Changes (Label A) to set the TOO_MANY_ERRORS_MASK bit (Bit 13, Register 0x02). When Many Errors Mask is highlighted, the TOO_MANY_ERRORS_MASK bit is enabled. When Many Errors Mask is not highlighted, the TOO_MANY_ERRORS_MASK bit is disabled. Click Address Errors Mask (Label T4) and Apply Changes (Label A) to set the ADDRESS_RANGE_ERROR_MASK bit (Bit 12, Register 0x02). When Address Errors Mask is highlighted, the ADDRESS_RANGE_ERROR_MASK bit is enabled. When Address Errors Mask is not highlighted, the ADDRESS_RANGE_ERROR_MASK bit is disabled. When the PARITY_ERROR_MASK bit (Bit 15, Register 0x02) is set, Parity Error will light up green (Label T5) when then the PARITY_ERROR bit (Bit 15, Register 0x01) gets toggled. When the TOO_FEW_ERRORS_MASK bit (Bit 14, Register 0x02) is set, Too Few Errors will light up green (Label T6) when the TOO_FEW_ERRORS bit (Bit 14, Register 0x01) gets toggled. When the TOO_MANY_ERRORS_MASK bit (Bit 13, Register 0x02) is set, Too Many Errors will light up green (Label T7) when the TOO_MANY_ERRORS bit (Bit 13, Register 0x01) gets toggled. When the ADDRESS_RANGE_ERROR_MASK bit (Bit 12, Register 0x02) is set, Address Range Error will light up green (Label T8) when the ADDRESS_RANGE_ERROR bit (Bit 12, Register 0x01) gets toggled.

Label	Function
U1 to U2	<p>Detectors follow.</p> <p>Click Detector Enable (Label U1) and Apply Changes (Label A) to set the DETECTOR_ENABLE bit (Bit 7, Register 0x03). Note that this turns on the detector. When Detector Enable is highlighted, the DETECTOR_ENABLE bit is enabled. When Detector Enable is highlighted, the DETECTOR_ENABLE bit is disabled.</p> <p>Click VDET Output Select (Label U2) and Apply Changes (Label A) to set the VDET_OUTPUT_SELECT bit (Bit 3, Register 0x06). When the switch is set toward the VDET pin (Bit 3 = 1), the detector output can be read from the VDET test point on the board. When the switch is not set toward the VDET test point (Bit 3 = 0), the VDET output does not appear on the test point.</p>
V1 to V5	<p>ADCs follow.</p> <p>Click ADC Start (Label V1) and then Apply Changes (Label A) to set the ADC_START bit (Bit 2, Register 0x06). When ADC Start Enable is highlighted, the ADC_START bit is enabled. When ADC Start Enable is not highlighted, the ADC_START bit is disabled.</p> <p>Ready light (Label V2) displays the ADC status. Click Read All (Label B). If Ready LED is green, the ADC is ready. If Ready LED is not green then the ADC is busy. This bit reads the ADC_STATUS bit in (Bit 8, Register 0x0C).</p> <p>Click ADC Enable (Label V3) and Apply Changes (Label A) to set the ADC_ENABLE bit (Bit 1, Register 0x06). When ADC Enable is highlighted, the ADC_ENABLE bit is enabled. When ADC Enable is not highlighted, the ADC_ENABLE bit is disabled.</p> <p>The ADC Value field (Label V4) reads back the decimal ADC value for the detector. It reads back from the ADC_VALUE bits, 8 bits (Bits[7:0], Register 0x0C).</p> <p>Click ADC Clock (Label V5) and Apply Changes (Label A) to set the ADC_CLOCK_ENABLE bit (Bit 0, Register 0x06). When ADC Clock is highlighted, the ADC_CLOCK_ENABLE is enabled. When ADC Clock is not highlighted, the ADC_CLOCK_ENABLE is disabled.</p> <p>To read the ADC value, the ADC_CLOCK_ENABLE, ADC_ENABLE, and ADC_START bits (Bits[3:0], Register 0x06) must be highlighted (press Apply Changes, Label A). Next, press Read All (Label B). If Ready LED (Label V2) is not green, keep pressing Read All (Label B) until it is green. When the Ready LED is green, click ADC Start (Label V1) to disable it (ADC Start button unhighlights), and then press Apply Changes (Label A). Lastly, click Read All (Label A) again to get the ADC value.</p>
W	Click Proceed to Memory Map (Label W) to open the ADRF6780 memory map (see Figure 12).

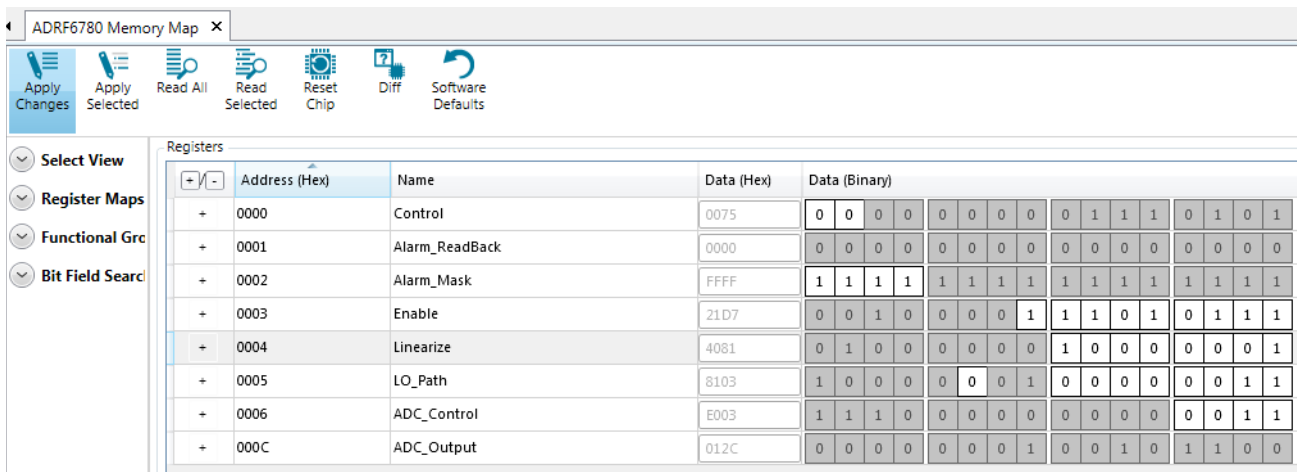


Figure 12. ADRF6780 Memory Map in the ACE Software

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SETTING VATT VOLTAGE FOR THE ADRF6780

The ADRF6780-EVALZ comes with the AD5601 nanoDAC. The AD5601 nanoDAC sets the VATT voltage for the VATT pin of the ADRF6780. When the ADRF6780 evaluation board plugin is opened, the voltage can be set in the **Initial Configuration** menu. Note that 2600 mV is the highest gain setting for the devices.

When using an external power supply for the VATT voltage, use the AD5601 nanoDAC plugin to change the voltage or power down the nanoDAC. To open the nanoDAC plugin, select the AD5601 tab at the top of the ACE software window or double click the AD5601 button within the ADRF6780-042654, Rev. A tab (see Figure 9). Figure 13 shows the AD5601 nanoDAC user interface. The user interface contains two section: the **Power Down Modes** section and the VATT voltage section.

To power up or power down the AD5601 nanoDAC, go to the **Power-Down Modes** section. To use the AD5601 nanoDAC, set the **Power-Down Modes** box to 0. When the VATT voltage is being applied externally, through the test loop, set the **Power-Down Modes** box to 1, 2, or 3. For more information on the different power-down modes of the AD5601 nanoDAC, see the power-down modes section of the AD5601 data sheet.

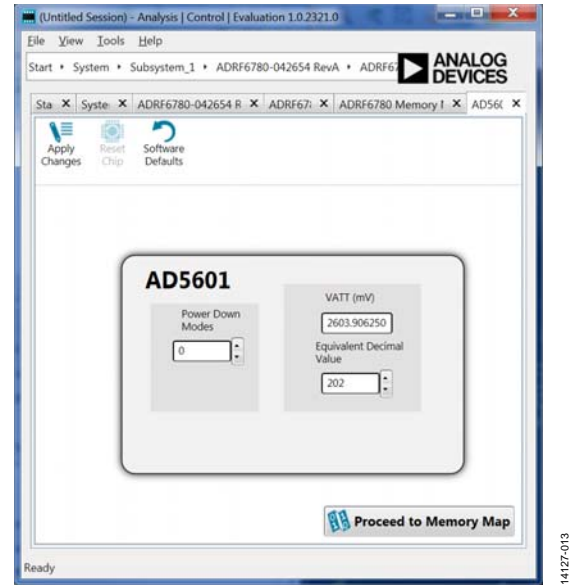


Figure 13. AD5601 nanoDAC User Interface

To set the VATT voltage, type a number in the **VATT (mV)** box or type the corresponding decimal number for an 8-bit register in the **Equivalent Decimal Value** box. The VATT (mV) range available is from 0 mV to 3300 mV. To set the lowest gain for the ADRF6780, set **VATT (mV)** to 0, and to set the highest gain for the ADRF6780, set **VATT (mV)** to 2600. Note that, there is no change in the gain of the ADRF6780 above 2600 mV.

After making any changes to the voltage or the power-down mode, click **Apply Changes** shown in the top left of the ACE software window (see Figure 13). When the **Auto Apply** button is selected in the ADRF6780-042654, Rev. A tab, these changes take place automatically; therefore, there is no need to click **Apply Changes**.

TEST RESULTS

When testing the [ADRF6780-EVALZ](#) board, the following are the expected results. VATT = 2600 mV was used for both the IF results and the IQ results.

IF RESULTS

Resistors R10 to R13 were taken out for the IF measurements that follow. The hybrids and evaluation board have not been deembedded.

Figure 14 shows the results of an IF input of 2000 MHz at -10 dBm, single tone mixed, with an 8 GHz LO at 0 dBm to an RF output of 10 GHz for a LO $\times 1$ mode and upper sideband settings.

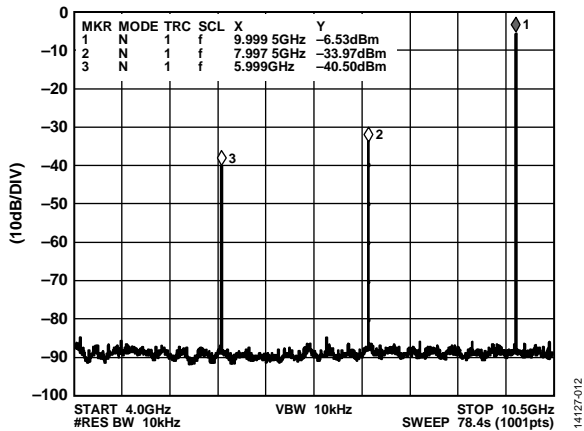


Figure 14. [ADRF6780](#) Results for a LO $\times 1$ Mode with Upper Sideband Settings and Set to IF Mode

Figure 15 shows the graphical user interface (GUI) settings for the results shown in Figure 14.

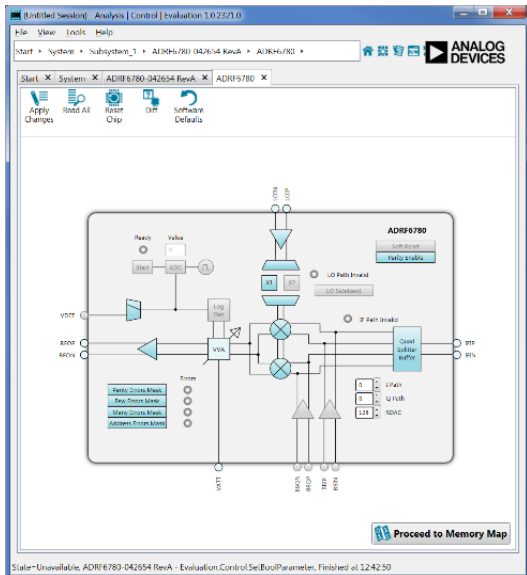


Figure 15. [ADRF6780](#) GUI Settings for a LO in $\times 1$ Mode with Upper Sideband Settings and Set to IF Mode

Figure 16 shows the results of an IF input of 2000 MHz at -10 dBm, single tone mixed, with an 8 GHz LO at 0 dBm to an RF output of 6 GHz for a LO $\times 1$ mode and lower sideband settings.

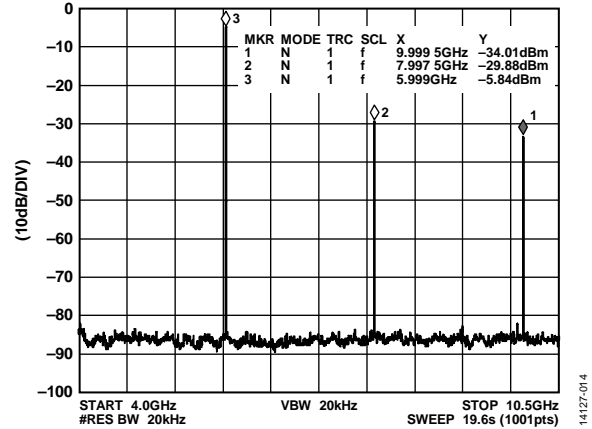


Figure 16. [ADRF6780](#) Results for a LO $\times 1$ Mode with Lower Sideband Settings and Set to IF Mode

Figure 17 shows the GUI settings for the results shown in Figure 16.

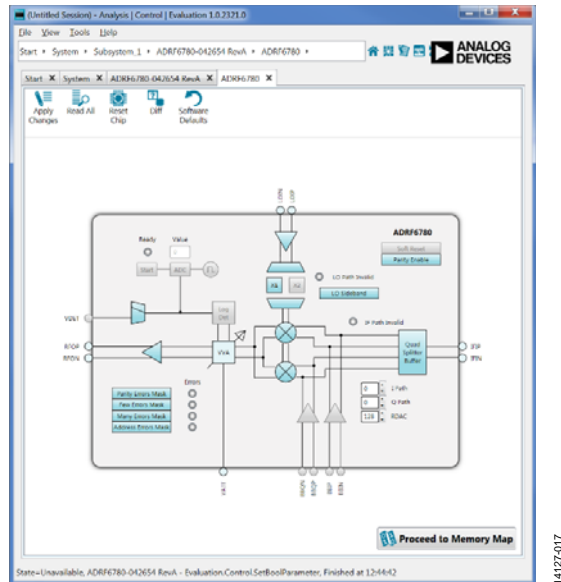


Figure 17. [ADRF6780](#) GUI Settings for a LO in $\times 1$ Mode with Lower Sideband Settings and Set to IF Mode

Figure 18 shows the results of an IF input of 2000 MHz at -10 dBm, single tone mixed, with an 8 GHz LO at 0 dBm to an RF output of 18 GHz for a LO x2 mode and lower sideband settings.

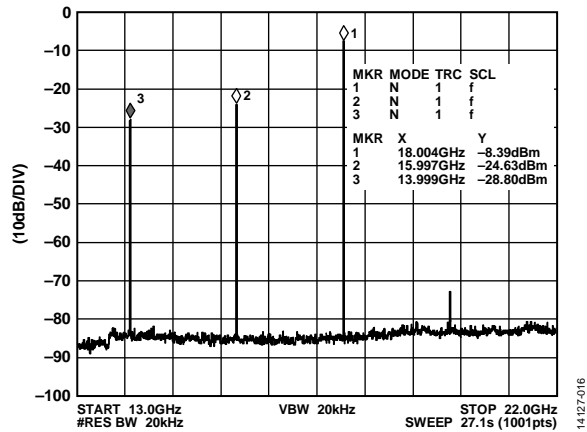


Figure 18. ADRF6780 Results for a LO x2 Mode with Upper Sideband Settings and Set to IF Mode

Figure 19 shows the GUI settings for the results shown in Figure 18.

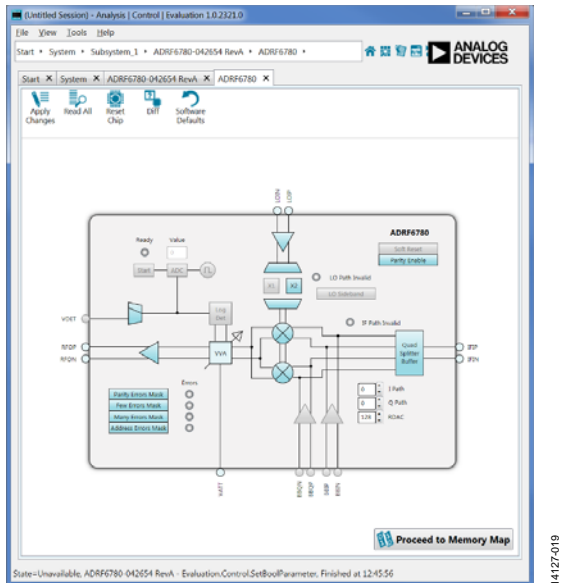


Figure 19. ADRF6780 GUI Settings for a LO x2 Mode with Upper Sideband Settings and Set to IF Mode

Figure 20 shows the results of an IF input of 2000 MHz at -10 dBm, single tone mixed, with an 8 GHz LO at 0 dBm to an RF output of 14 GHz for a LO x2 mode and lower sideband settings.

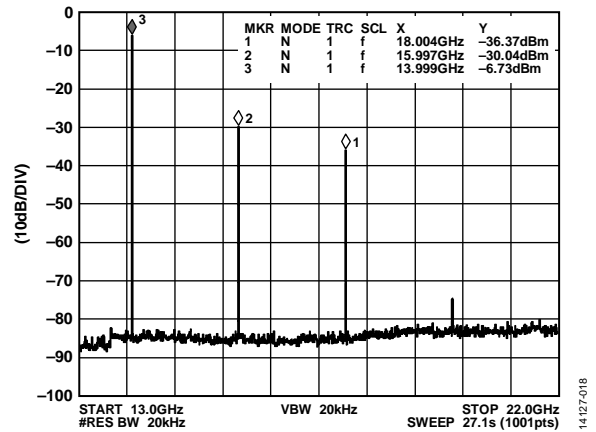


Figure 20. ADRF6780 Results for a LO x2 Mode with Lower Sideband Settings and Set to IF Mode

Figure 21 shows the GUI settings for the results shown in Figure 20.

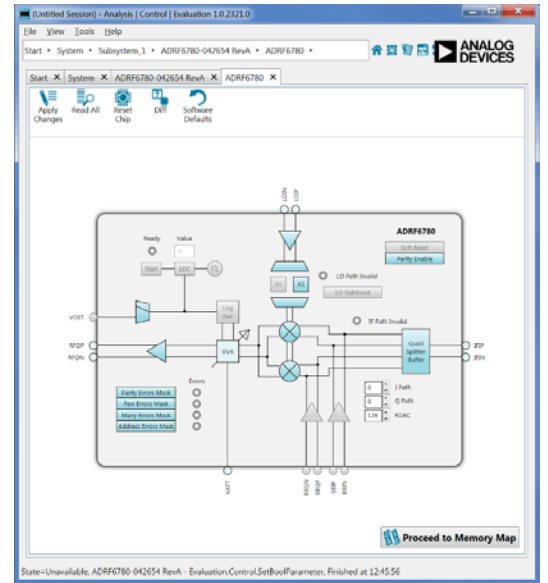


Figure 21. ADRF6780 GUI Settings for a LO x2 Mode with Lower Sideband Settings and Set to IF Mode

IQ RESULTS

Resistors R10 to R13 were added for the IQ measurements that follow. The hybrids and evaluation board have not been deembedded.

Figure 22 shows the IQ output, lower sideband for a signal of 10 MHz, 160 mV p-p, and 0.5 V common-mode, single tone mixed, with an 8 GHz LO at 0 dBm to an RF output of 7.99 GHz for a LO $\times 1$ mode and lower sideband settings.

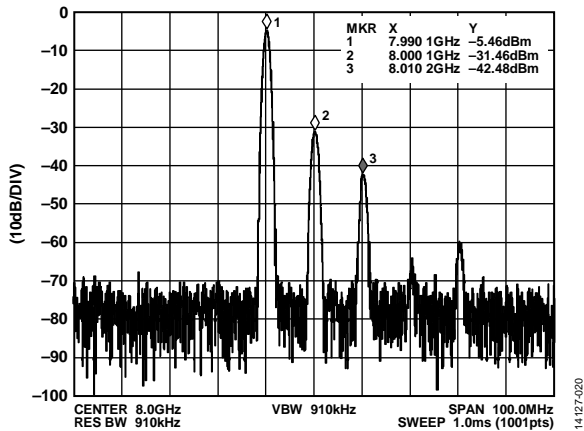


Figure 22. *ADRF6780* Results for a LO in $\times 1$ Mode with Lower Sideband Settings and Set to IQ Mode

Figure 23 shows the GUI settings for the results shown in Figure 22.

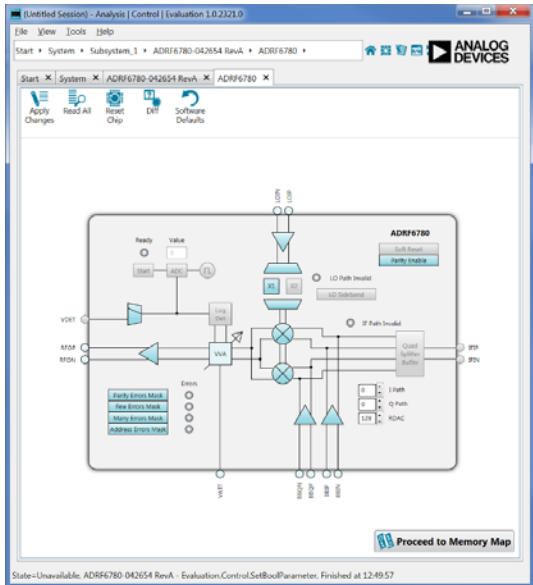


Figure 23. *ADRF6780* GUI Settings for a LO in $\times 1$ Mode with Lower Sideband Settings and Set to IQ Mode

Figure 24 shows the IQ output, lower sideband for a signal of 10 MHz, 160 mV p-p, and 0.5 V common-mode, single tone mixed, with an 8 GHz LO at 0 dBm to an RF output of 8.01 GHz for a LO $\times 1$ mode and upper sideband settings.

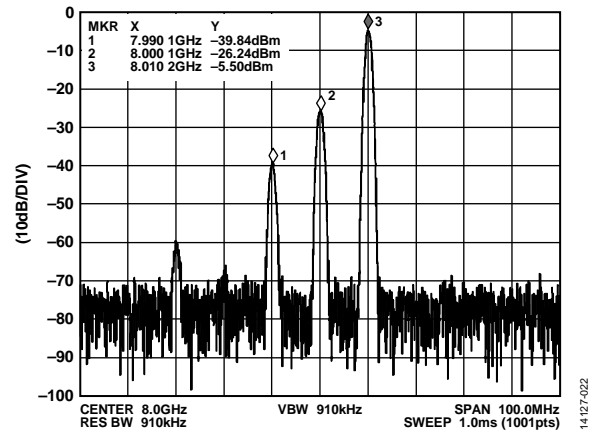


Figure 24. *ADRF6780* Results for a LO in $\times 1$ Mode with Upper Sideband Settings and Set to IQ Mode

Figure 25 shows the GUI settings for the results shown in Figure 24.

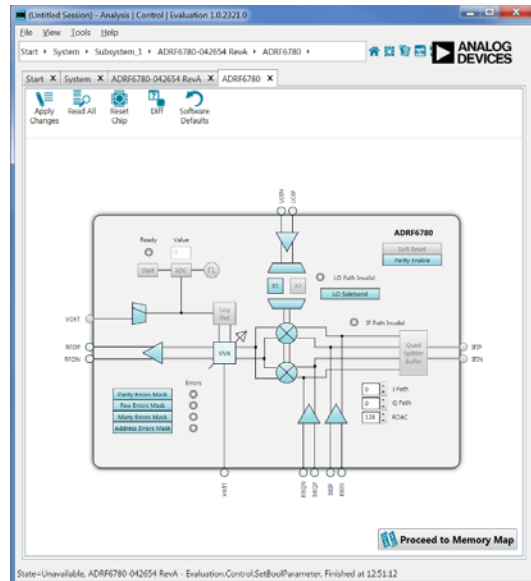


Figure 25. *ADRF6780* GUI Settings for a LO in $\times 1$ Mode with Upper Sideband Settings and Set to IQ Mode

Figure 26 shows the IQ output, lower sideband for a signal of 10 MHz, 160 mV p-p, and 0.5 V common-mode, single tone mixed, with an 8 GHz LO at 0 dBm to an RF output of 15.99 GHz for LO $\times 2$ mode and lower sideband settings.

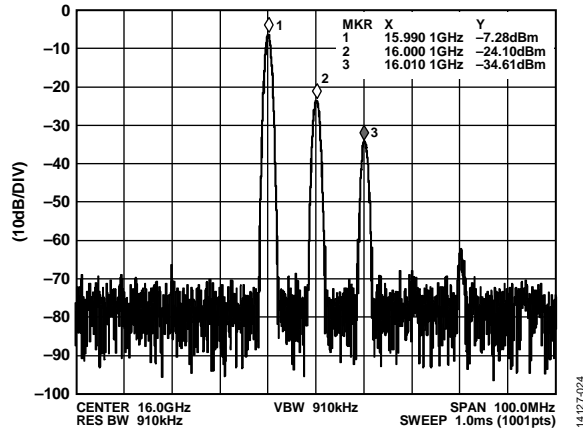


Figure 26. ADRF6780 Results for a LO in $\times 2$ Mode with Lower Sideband Settings and Set to IQ Mode

Figure 27 shows the GUI settings for the results shown in Figure 26.

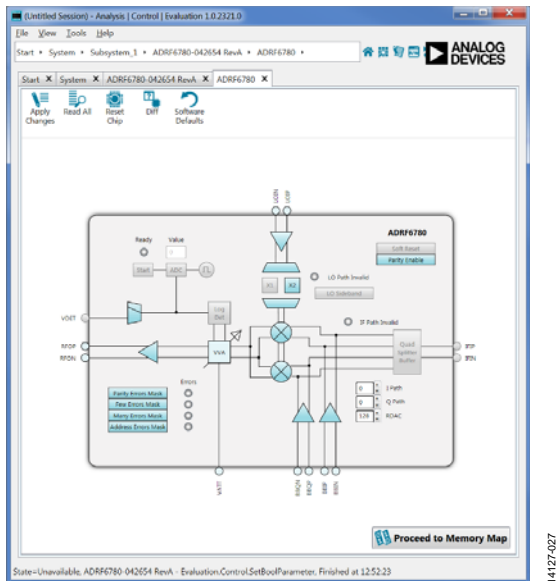


Figure 27. ADRF6780 GUI Settings for a LO in $\times 2$ Mode with Lower Sideband Settings and Set to IQ Mode

Figure 28 shows the IQ output, lower sideband for a signal of 10 MHz, 160 mV p-p, and 0.5 V common-mode, single tone mixed, with an 8 GHz LO at 0 dBm to an RF output of 16.01 GHz for LO $\times 2$ mode and upper sideband settings.

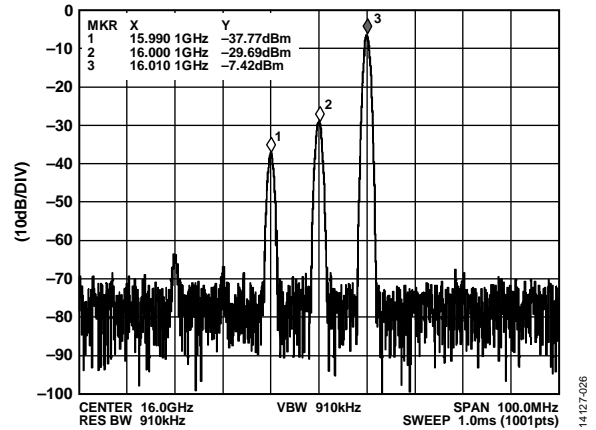


Figure 28. ADRF6780 Results for a LO in $\times 2$ Mode with Upper Sideband Settings and Set to IQ Mode

Figure 29 shows the GUI settings for the results shown in Figure 28.

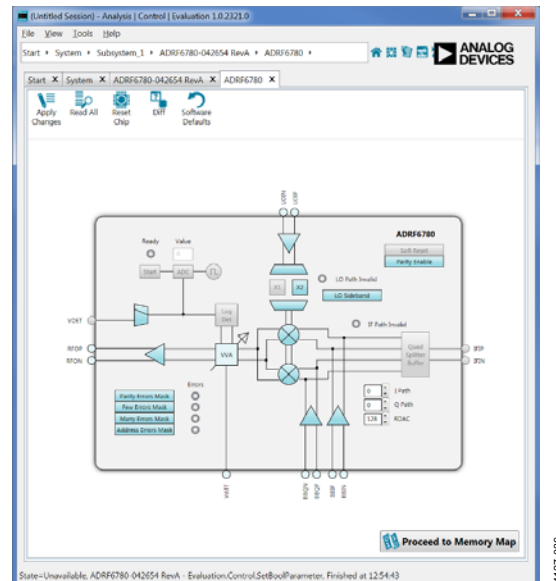


Figure 29. ADRF6780 GUI Settings for a LO in $\times 2$ Mode with Upper Sideband Settings and Set to IQ Mode

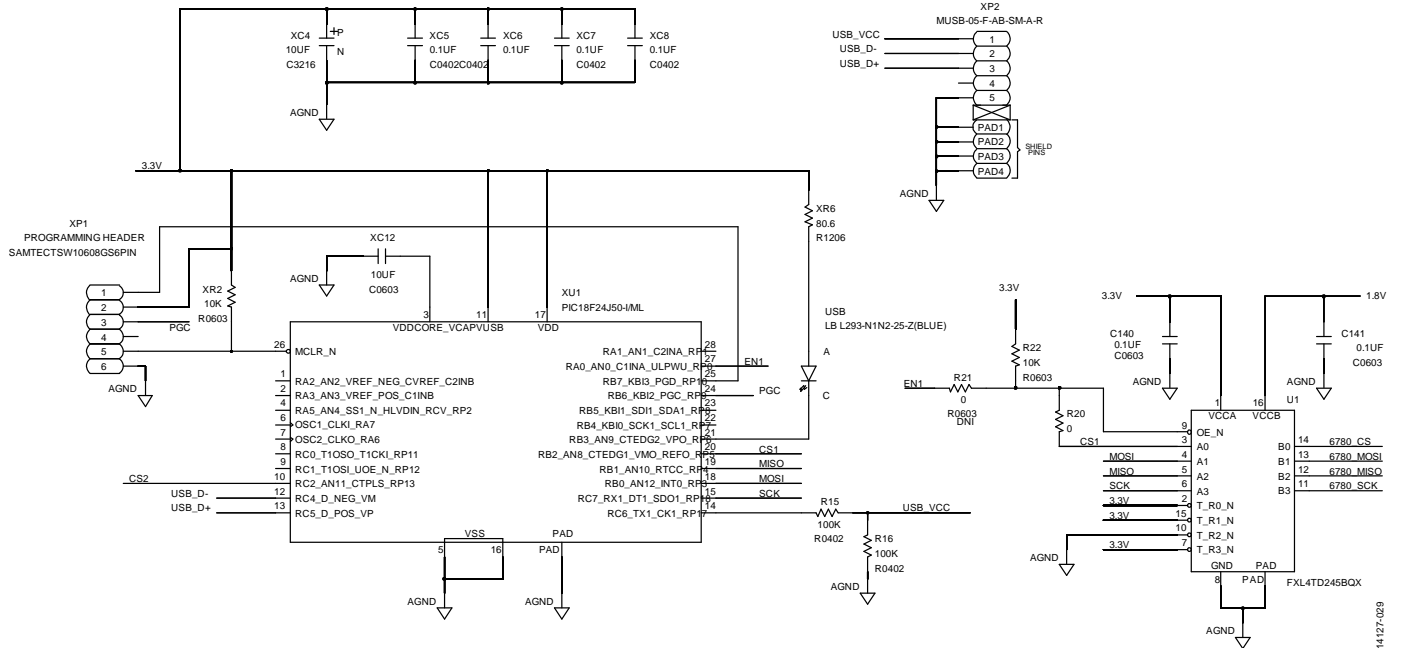
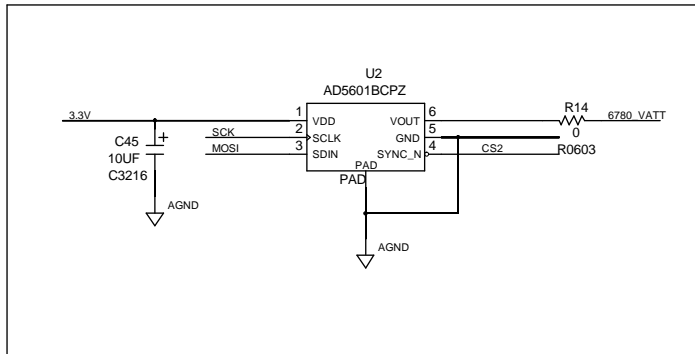
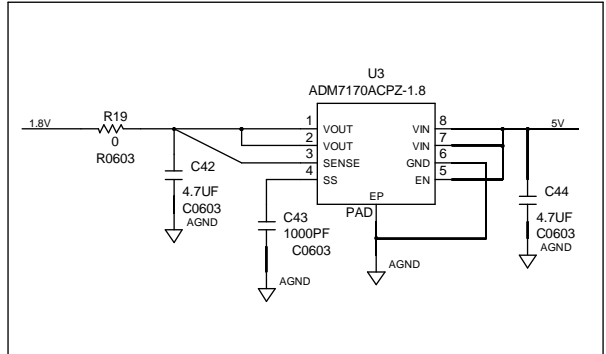


Figure 31. ADRF6780-EVALZ Evaluation Board Schematic, Page 2

NANODAC



1.8V LDO REGULATOR



3.3V LDO REGULATORS

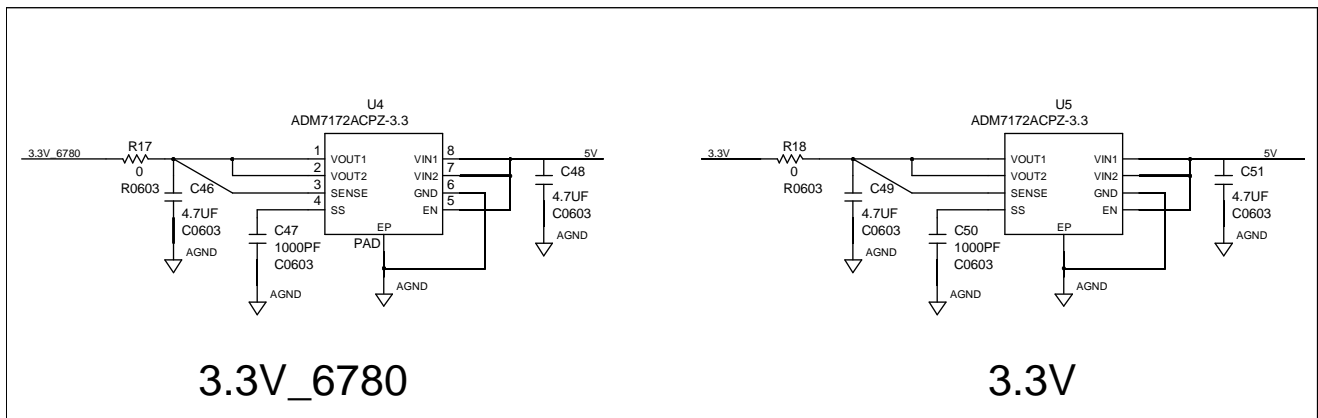
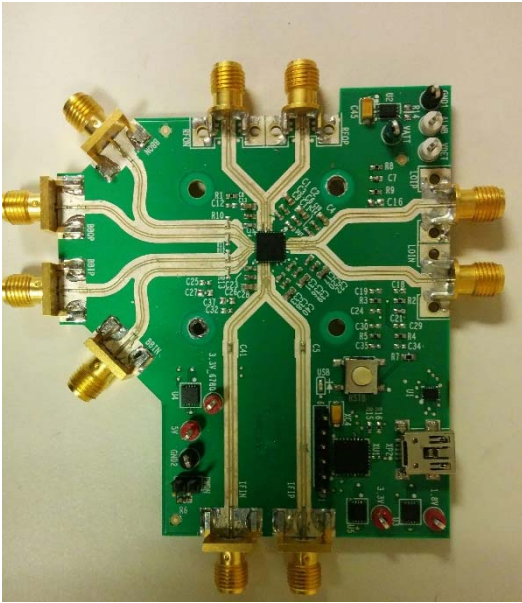


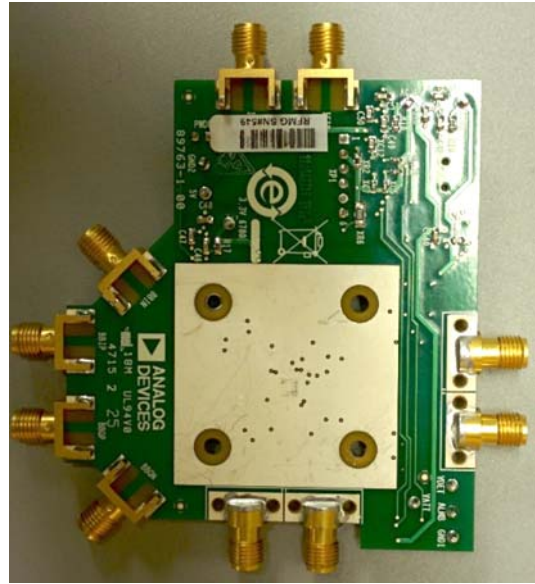
Figure 32. ADRF6780-EVALZ Evaluation Board Schematic, Page 3

ADRF6780-EVALZ EVALUATION BOARD ARTWORK



14127-031

Figure 33. ADRF6780-EVALZ Evaluation Board Top



14127-032

Figure 34. ADRF6780-EVALZ Evaluation Board Bottom

ORDERING INFORMATION

BILL OF MATERIALS

Table 2. **ADRF6780-EVALZ** Configuration Options

Component	Function	Default Condition
VPLO3.3V, VPDT5V, VPRF5V, VPBB3.3V, VPBI3.3V, 1P8V, AGND	Power supplies and ground.	Not applicable
LOIN, LOIP, VDET, RFON, RFOP, BBIN, BBIP, BBQN, BBQN, IFIN, IFIP, VATT	Data and clock.	Not applicable
SCLK, SDIN, SENB, SDTO	SPI.	Not applicable
R2 to R5	33 Ω series resistors for SPI pins.	R2, R3, R4, R5 = 33 Ω (0402)
5V, 3.3V, 3.3V_6780, 1.8V, VDET, ALMB, VATT, GND1 to GND2	Test points.	Not applicable
PWDN	Power-down function.	Apply 1.8 V on PWDN (Pin2) jumper to power down the device
R1, R9, R14, R15, R17 to R20, XR2, XR6	Shorts or power supply decoupling resistors.	R1, R9, R17, R18, R19 = 0 Ω (0402), R8 = 5.1 k Ω (0402), R15 = 100 k Ω (0402), R14, R20 = 0 Ω (0402), XR2 = 10 k Ω (0603), XR6 = 80.6 Ω (1206)
R6, R7, R16, R22	Pull-up or pull-down resistors.	R6, R7, R22 = 10 k Ω (0603), R16 = 100 k Ω (0402)
C1 to C4, C6, C7, C8 to C11, C13 to C15, C17, C20, C22, C23, C26, C28, C31, C33, C36, C38 to C40, C42 to C51, XC12, XC4 to XC8, C140, C141	These capacitors provide the required decoupling of the supply related pins.	XC4, C45 = 10 μ F (3216), XC12 = 10 μ F (0603), C42, C44, C46, C48, C49, C51 = 4.7 μ F (0603), C1, C2, C4, C8, C22, C28, C39, C40 = 0.1 μ F (0603), XC5, XC6, XC7, XC8 = 0.1 μ F (0402), C3, C6, C10, C13, C20, C26, C36, C38 = 4.7 nF (0402), C43, C47, C50 = 1000 pF (0603), C9, C11, C14, C15, C17, C23, C31, C33 = 33 pF (0402), C7 = 10 pF (0402), C140, C141 = 0.1 μ F (0603)
R10 to R13	These resistors provide a broadband 50 Ω termination for baseband input data; remove when using IF inputs (IF mode).	R10, R11, R12, R13 = 49.9 Ω (0402)
C5, C41	AC coupling capacitors.	C5, C41 = 100 pF (0402)
C21	CS decoupling resistor.	C21 = 100 pF (0402)
C12, C16, C18, C19, C24, C25, C27, C29, C30, C32, C34, C35, C37, R21	Do not install (DNI).	C16, C24, C34, C35 = (0402), C27, C37, R21 = (0603), C12, C18, C19, C25 = (0402), C29, C30, C32 = (0402)
XP1	Programming header.	Not applicable
XP2	Mini USB connector.	Connect the mini USB cable to XP2 to interface with the SPI
RSTB	Reset button.	Click RSTB to reset the device
USB	Blue LED.	Is blue when the USB is connected to XP2, and the PC and the ADRF6780 evaluation board is powered on with a 5 V supply
XU1	Microcontroller.	PIC18F24J50
U1	Level shifter.	FXL4TD245BQX

Component	Function	Default Condition
U3 to U5	3.3 V and 1.8 V regulators.	ADM7170 (U3) = 1.8 V regulator, ADM7172 (U4) = 3.3 V regulator, ADM7172 (U5) = 3.3 V regulator for ADRF6780
U2	AD5601 nanoDAC.	Not applicable
DUT	ADRF6780, device under test.	Not applicable

**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.

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