

Operating a 9.8-GHz RF High-Performance Synthesizer From a Buck Converter Reference Design



Description

The TIDA-00885 design uses the LMX2592, a low-noise, wideband RF PLL with integrated voltage controlled oscillator (VCO) that can produce an output frequency range from 20 MHz to 9.8 GHz. The LMX2592 has excellent performance and an integrated phase noise of 49 fs for 6 GHz output, which makes it an ideal low-noise source. There are two options to power the LMX2592 frequency synthesizer: TPS62150 and LM43601 buck converters. Only one DC-DC regulator should be enabled at a time. These are two commonly used footprints. The LM43601 is pin-to-pin-compatible with the LM46000, LM46001, LM46002, LM43600, LM43602, and LM43603. The TPS62150 DC-DC regulator is pin-to-pin compatible with TPS6213x and TPS6214x devices. Pin-to-pin and footprint compatibility adds flexibility to change the regulator depending on the specifications. The results in this report demonstrate that the LMX2592, which has internal low dropout regulators (LDOs), does not have a significant noise-performance impact from using DC-DC regulators.

Resources

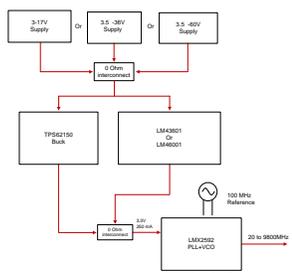
TIDA-00885	Design Folder
LMX2592	Product Folder
TPS62150	Product Folder
LM43601	Product Folder

Features

- Output Frequency Range from 20 to 9800 MHz
- Input Clock Frequency from 5 to 1400 MHz
- Industry Leading Phase Noise Performance
 - VCO Phase Noise: -134.5 dBc/Hz at 1-MHz Offset for 6-GHz Output
 - Normalized Phased Locked Loop (PLL) Noise Floor: -231 dBc/Hz
 - Normalized PLL Flicker Noise: -126 dBc/Hz
- Up to 95% Efficiency to Step-Down Voltage From 5 to 3.3 V Using On-Board DC-DC Regulators
- On-Board DC-DC Regulators are Pin-to-Pin and Footprint Compatible With Several Other Regulators.
- Flexibility to Change Regulators Depending on Specifications Needed

Applications

- Test and Measurement Equipment
- Defense and RADAR
- Microwave Backhaul
- High-Performance Clock Source for High-Speed Data Converters
- Satellite Communications



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1 System Overview

1.1 System Description

The TIDA-00885 is a low-noise, wideband RF PLL with integrated VCO that supports a frequency range from 20 MHz to 9.8 GHz. The LMX2592 has excellent performance with an integrated-phase noise of 49 fs for 6-GHz output makes it an ideal low noise source. A DC-DC buck converter powers the LMX2592 synthesizer. The two options to power the LMX2592 frequency synthesizer are the TPS62150 and LM43601 families of buck converters. Only one DC-DC regulator must be enabled at a time. There are two footprints; one for each device. The LM43601 is pin-to pin-compatible with the LM46000, LM46001, LM46002, LM43600, LM43602, and LM43603 devices.

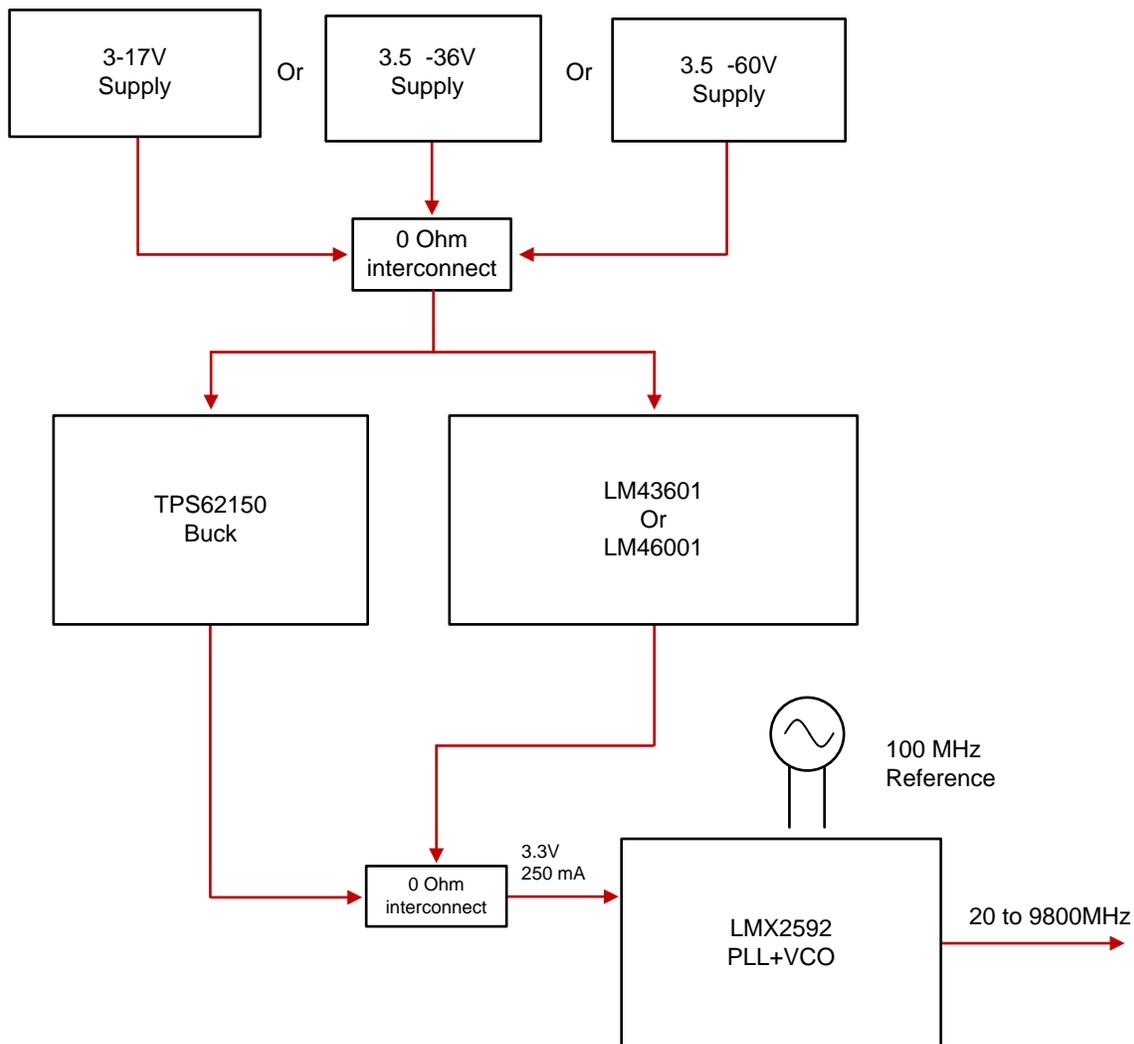
The TPS62150 DC-DC regulator is pin-to-pin compatible with the TPS6213x and TPS6214x devices. This compatibility adds flexibility to change the regulator depending on the required specifications. The DC-DC regulators must not have a significant negative impact for the test as shown in this report.

1.2 Key System Specifications

Table 1. Key System Specifications

PARAMETER	SPECIFICATIONS	
Output frequency range	20 to 9800 MHz	
Input frequency range	5 to 1400 MHz	
Input voltage range	3 to 17 V	TPS62150
	3.5 to 36 V	LM43601
	3.5 to 60 V	LM46001
DC-DC switching frequency	1.25 MHz	TPS62150
	500 kHz	LM43601
DC-DC Iout maximum	1 A	TPS62150
	1 A	LM43601
Onboard XO (not used)	100 MHz	

1.3 Block Diagram



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Figure 1. Block Diagram

1.4 Highlighted Products

1.4.1 LMX2592

The LMX2592 is a low-noise, wideband RF PLL with integrated VCO that supports a frequency range from 20 MHz to 9.8 GHz. The device supports both fractional-N and integer-N modes with a 32-bit fractional divider to allow fine-frequency selection. Integrated noise of 49 fs for 6-GHz output makes it an ideal low-noise source. Combining best-in-class PLL and integrated VCO noise with integrated LDOs, this device removes the need for multiple discrete devices in high-performance systems. The device accepts input frequencies up to 1.4 GHz, which, combined with frequency dividers and a programmable low-noise multiplier, allows flexible frequency planning. The additional programmable low-noise multiplier lets users mitigate the impact of integer-boundary spurs. In fractional-N mode, the device can adjust the output phase by a 32-bit resolution. For applications that need fast frequency changes, the device supports a fast-calibration option, which takes less than 25 μ s. This performance is achieved by using single 3.3-V supply. The LMX2592 supports two flexible differential outputs that can be configured as single-ended outputs. Users can choose to program one output from the VCO (or doubler) and the second from the channel divider. When not being used, each output can be muted separately.

1.4.2 TPS62150

The TPS6215x family is an easy-to-use synchronous step-down DC-DC converter optimized for applications with high-power density. A high-switching frequency of typically 2.5 MHz allows the use of small inductors and provides fast transient response as well as high output-voltage accuracy by the use of DCS-Control™ topology.

With a wide-operating input-voltage range of 3 to 17 V, the devices are ideally suited for systems powered from Li-Ion or other batteries as well as from 12-V intermediate-power rails. The devices support up to 1-A continuous-output current at output voltages between 0.9 and 6 V (in 100% duty-cycle mode).

The soft-start pin controls the output-voltage start-up ramp, which allows operation as either a stand-alone power supply or in tracking configurations. Power sequencing is also possible by configuring the enable (EN) and open-drain power-good (PG) pins.

In power save mode, the devices draw quiescent current of about 17 μ A from VIN. Power save mode, entered automatically and seamlessly if the load is small, maintains high efficiency over the entire load range. In shutdown mode, the device turns off and current consumption is less than 2 μ A.

The device, available in adjustable- and fixed-output voltage versions, comes in a 16-pin VQFN package measuring 3 × 3 mm (RGT).

1.4.3 LM43601

The LM43601 SIMPLE SWITCHER® regulator is an easy-to-use synchronous step-down DC-DC converter capable of driving up to 1A of load current from an input voltage ranging from 3.5 to 36 V (42-V transient). The LM43601 provides exceptional efficiency, output accuracy, and drop-out voltage in a small solution size. An extended family is available in 0.5-A, 2-A, and 3-A load current options in pin-to-pin compatible packages. Peak current-mode control is employed to achieve simple control-loop compensation and cycle-by-cycle current limiting. Optional features such as programmable switching frequency, synchronization, power-good flag, precision enable, internal soft-start, extendable soft-start, and tracking provide a flexible and easy to use platform for a wide range of applications. Discontinuous conduction and automatic frequency modulation at light loads improve light-load efficiency. The family requires few external components and pin arrangement allows a simple, optimum PCB layout. Protection features include thermal shutdown, VCC undervoltage lockout, cycle-by-cycle current limit, and output short-circuit protection. The LM43601 device is available in the HTSSOP and PWP 16-leaded package (5.1 mm × 6.6 mm × 1.2 mm) with 0.65 mm lead pitch. The device is pin-to-pin compatible with the LM46000, LM46001, LM46002, LM43600, LM43602, and LM43603.

2 System Design Theory

The TIDA-00885 consists of the LMX2592 device, which is a low-noise, high performance wideband RF PLL with integrated VCO that supports a frequency range from 20 MHz to 9.8 GHz. The reference clock input frequency is in from 5 to 1400 MHz. There is an onboard 100-MHz oscillator, but this reference design does not use the oscillator because the DC-DC converter is not a clean enough power supply for the onboard reference oscillator.

The LMX2592 input voltage is 3.3 V at 250 mA. The TPS62150 and the LM43601 can output a maximum of 1 A.

There are two different options to power the LMX2592. There is a footprint for the TPS62150 and a footprint for the LM43601. The regulators must be enabled one at a time by moving the location of 0-Ω resistors.

2.1 Frequency Synthesizer

The LMX2592 needs a reference frequency provided from an oscillator. The input frequency must be in the range of 5 to 1400 MHz. An external reference must be used or the XO must be powered from another power supply. This reference design did not use the onboard XO because the DC-DC regulators used for this reference design are not an ideal power supply for the onboard XO.

2.2 Power Supply (DC-DC Converters)

There are two buck converters (two different footprints) on the board: the TPS62150 and the LM43601. The TPS62150 can take an input voltage of up to 17 V and a maximum output current of 1 A. The TPS62150 is pin-to-pin compatible with TPS6213x and TPS62134x devices.

Table 2. List of Pin-to-Pin Compatible Devices With TPS62150

	TPS62150	TPS62130	TPS62130A	TPS62140	TPS62140A	TPS62150A
Vin (minimum) (V)	3	3	3	3	3	3
Vin (maximum) (V)	17	17	17	17	17	17
Vout (minimum) (V)	0.9	0.9	0.9	0.9	0.9	0.9
Vout (maximum) (V)	6.3	6	6	6.3	6.3	6.3
Iout (maximum) (A)	1	3	3	2	2	1
Regulated outputs (numerical)	1	1	1	1	1	1
Switching frequency (minimum) (kHz)	1250	1250	1250	1250	1250	1250
Switching frequency (maximum) (kHz)	2500	2500	2500	2500	2500	2500

The LM43601 can take an input voltage up to 36 V and a maximum output current of 1 A. The LM43601 is compatible with the LM43600, LM43602, and LM43603 devices, which have an input voltage of 36 V and a maximum output current of 0.5 A, 2 A, and 3 A, respectively.

The LM43601 is also pin-to-pin compatible with the LM46000, LM46001, and LM46002, with an input voltage of 60 V and a maximum output current of 0.5 A, 1 A, and 2 A, respectively.

Pin-to-pin compatibility gives the user flexibility to select from several regulators depending on specifications needed, which are pin-to-pin and footprint compatible.

A ferrite bead could be used at the output of the DC-DC regulator to possibly reduce the spurious performance of the synthesizer.

2.3 Programming Interface

A serial peripheral interface (SPI) is used to program the LMX2592. See the LMX2592EVM User's Guide ([SNAU195](#)) to use code loader GUI to program the LMX2592 using the USB2ANY.

3 Getting Started Hardware and Software

3.1 Hardware

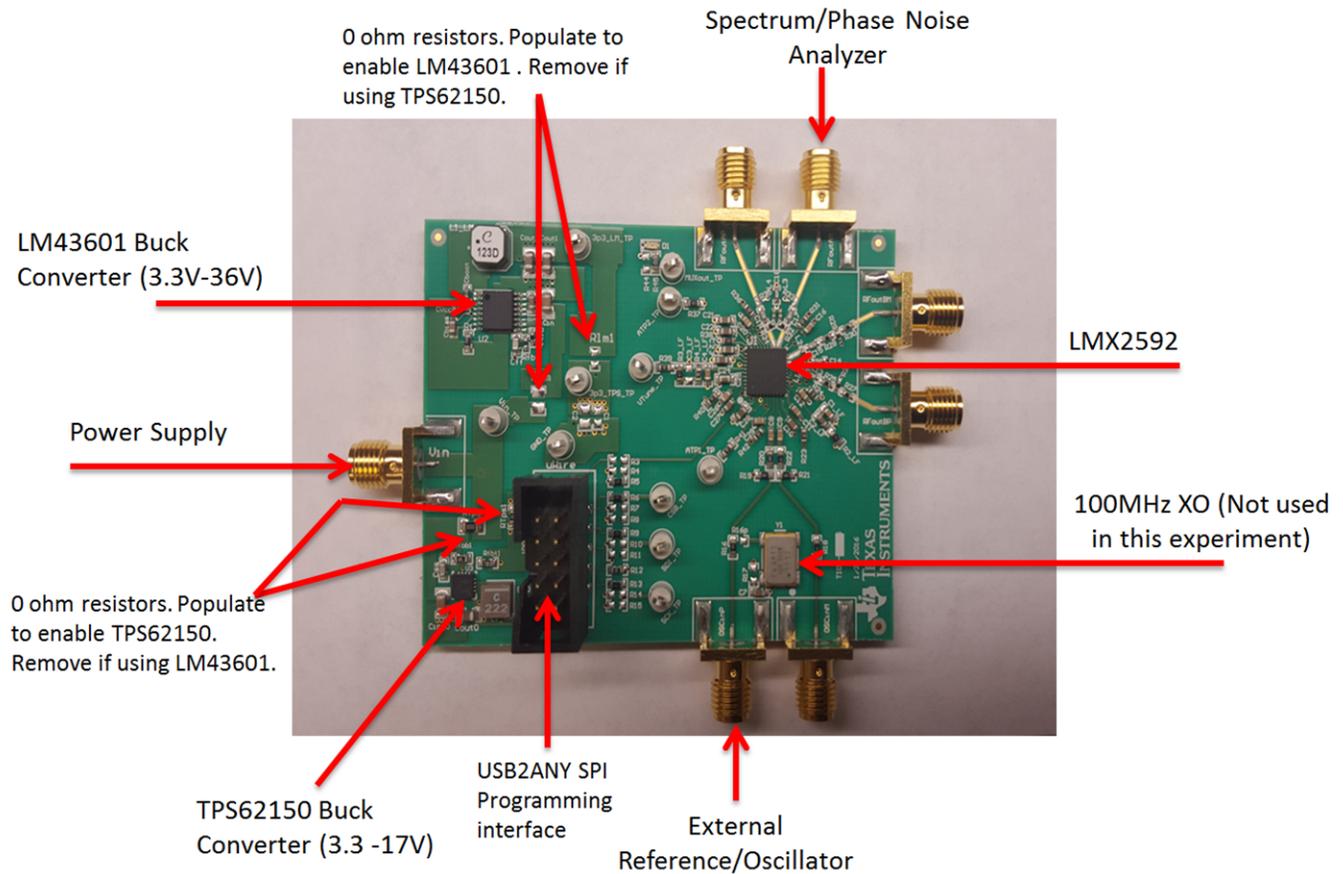


Figure 2. TIDA-00885 Top View of PCB

3.1.1 Power

Set power supply to 4 to 8 V. Connect to V_{in} .

- If operating using the default TPS62150 buck converter:
 - R_{lm} and R_{lm1}, 0-Ω resistors must not be populated.
 - **Warning:** Do not exceed 17 V_{in} for the TPS62150.
- If operating using the LM43601 buck converter:
 - Remove R_{tps} and L_{tps1} resistors.
 - Populate R_{lm} and R_{lm1} resistors.
 - **Warning:** Do not exceed 36 V_{in} for the LM43601.

A voltage of 3.3-V V_{in} may be applied with either buck converter.

3.1.2 Input Signal

1. Option 2 (R₁₆ populated, which routes the input signal from the OSC_{inP} SMA connector instead of on-board Oscillator). Set a low-phase noise signal generator (see note1) to 100 MHz with 6-dBm power level. Connect to OSC_{inP} or OSC_{inM} if a single-ended signal is found. Connect to both if there is a differential signal.
2. Remove R₁₇ to remove power from the on-board oscillator.

NOTE: If using a noisy signal source, such as a signal generator, be aware that this can dominate close-in phase noise.

3.1.3 Output Signal

1. Connect RFoutAM or RFoutAP to a phase-noise analyzer. Connect a 50-Ω termination on the unused output if using only single-end. Use a balun if using differential-ended.

3.1.4 Programming Interface

Connect the laptop to the board using the USB2ANY interface. For more details, see the LMX2592 User's Guide (SNAU195).

3.2 Software

3.2.1 Download Texas Instruments Clock and Synthesizers (TICS) Pro Software

1. Download the TICS Pro Software from TI.com: <http://www.ti.com/tool/TICSPRO-SW>.
2. To start the software, open the TICS PRO.exe from the installed directory.

3.2.2 Getting Started with TICS Pro Software

After completing the installation, start the software. The software must be opened as shown in Figure 3.

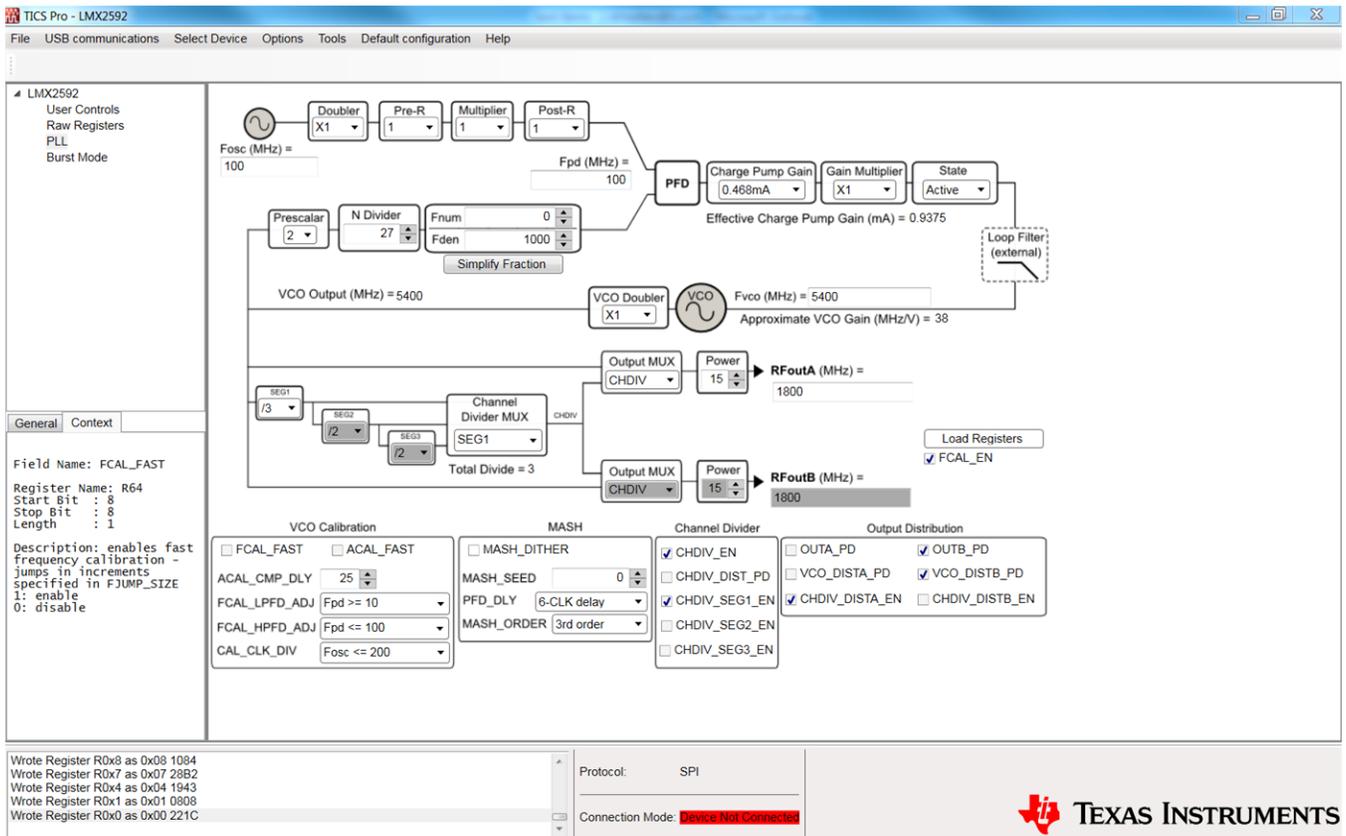


Figure 3. Getting Started with TICS Pro

- Top Menu
 - File: Load or save a setting and export or import the registers in HEX values (optional).

- *USB communications*: Check the connection with the USB2ANY module (if there is new software, follow the on-screen instructions to upgrade). Load the device (the keyboard shortcut is CTRL+L), which programs all the registers into the device.
- *Default configuration*: Load a preset setting file given to start from a known state.
- To select the LMX2592: Click *Select Device* on top menu. Then click *PLL + VCO* and select *LMX2592*.
- **Left Panel**
 - *User Controls*: Configure registers, organized by function. Hover the mouse over the register, and its information will appear in the *Context* tab on the left panel.
 - *Raw Registers*: See the entire register map. Enter a HEX value in the *Data* cell then click *Write Register* to program that value. To read registers, the MUXout pin (pin 20) must be connected to the USB2ANY (by default it is connected to the LED; switch from R40 to R39 for readback). Set MUXOUT_SEL=0 for readback. Registers are also organized by name in the *Register/Field Name* section.
- **PLL**
 - *Fosc*: Enter the input-signal frequency between 5 and 1400 MHz.
 - *Doubler*: Can double input-signal frequency (input must be 50% duty cycle to use this)
 - *Pre-R*: Divides frequencies up to 1400 MHz
 - *Multiplier*: Multiplies frequencies between 40 to 70 MHz and outputs between 180 to 250 MHz
 - *R divider*: Used for dividing frequencies below 5 MHz for very low PFD
 - *Charge Pump Gain*: This tab auto-updates UP and DN to be equal. Go to user controls section to force different values.
 - *Gain Multiplier*: Multiplies *Charge Pump Gain* by a factor
 - *State*: Changes the charge pump output state
 - *FCAL_EN*: Each time the output frequency is changed, toggle this off and on to calibrate the device to the frequency.
 - *Fvco*: Sets the VCO frequency between 3550 to 7100 MHz
 - *1X or 2X*: Enables the *VCO Doubler* from 3550 to 4900 MHz for frequencies up to 9800 MHz
 - *Divider MUX*: This determines which of the three segments are included for a total division between 2 and 192.
 - *Output MUX*: Selects the signal from the VCO output or the divider
 - *Power settings*: Changes the output power (increase from 0 to 31, then additional boost with 49 to 63)
- **Burst Mode**
 - Enter a register in *Load Register* or delay in seconds.
 - Ability to run and stop the commands in a single burst or continuous loop.

A text file with register values will be provided. These values can easily import into TICS Pro.

To download the software files for this reference design, please see the link at [TIDA-00885](#).

4 Testing and Results

4.1 Test Setup

Figure 4 and Figure 5 show the test setup used in the lab to test the reference design and to calculate the measurements in Section 4.2.

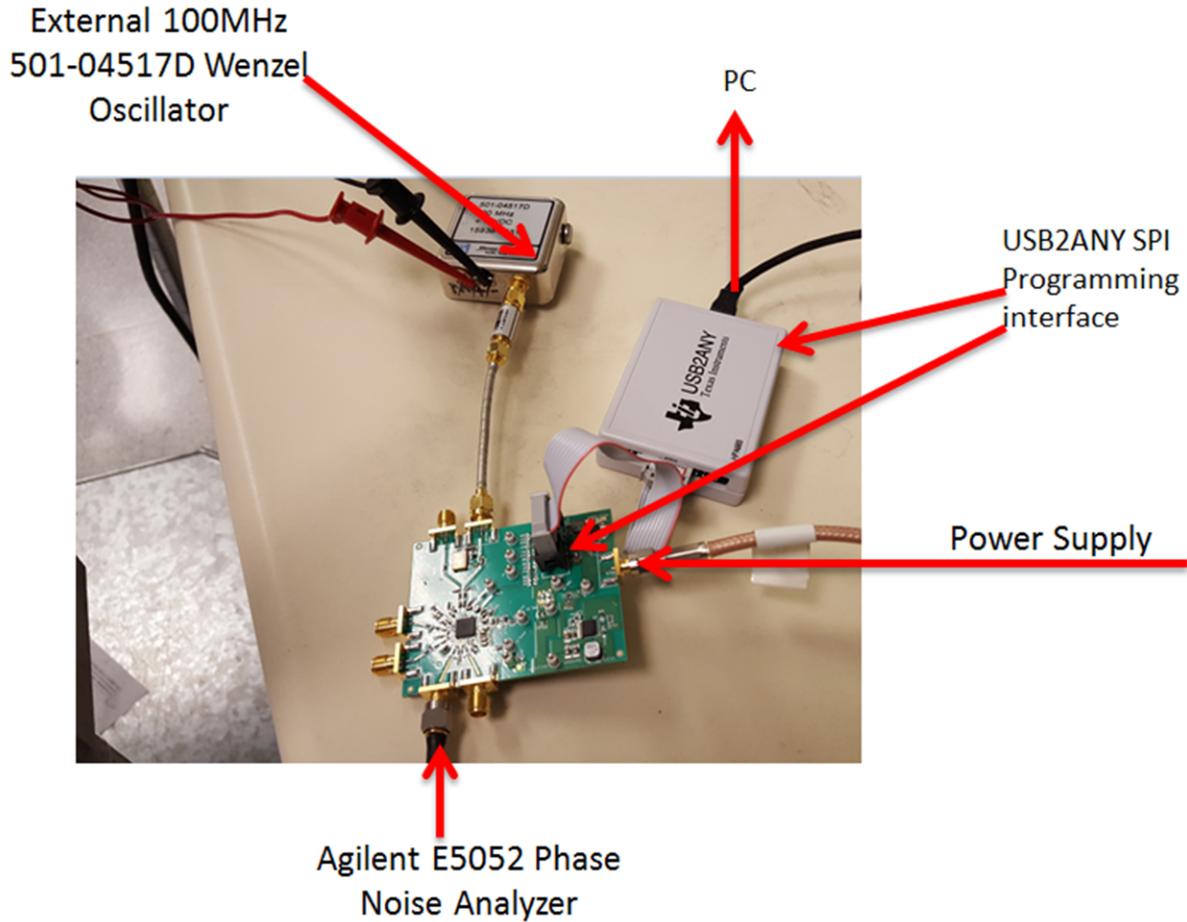


Figure 4. Test Setup

E5052 Phase Noise Analyzer

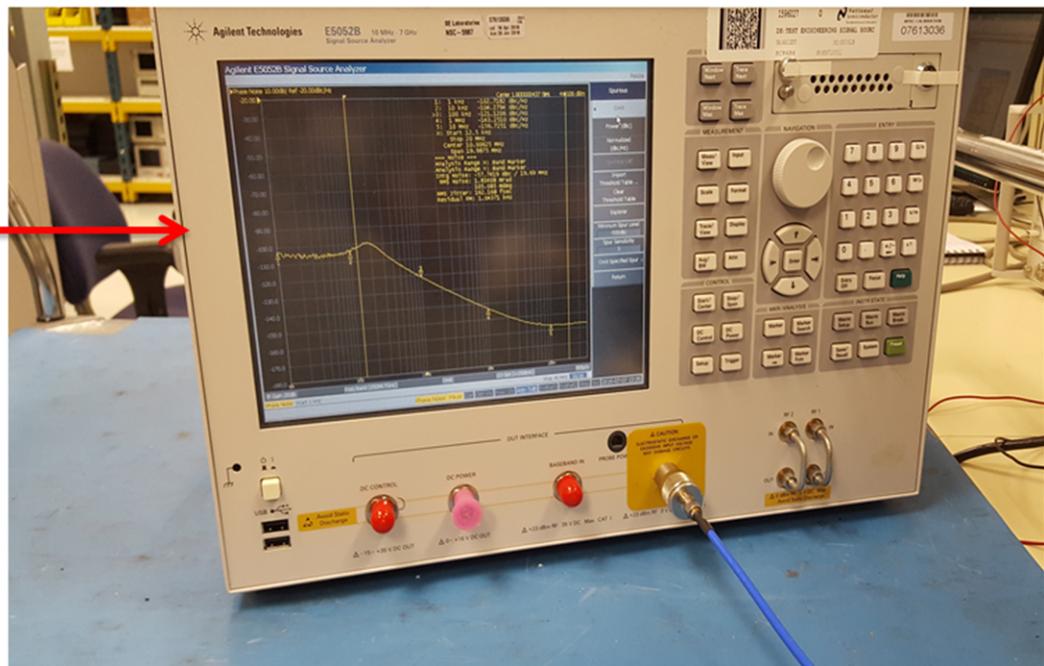


Figure 5. Test Setup with E5052

4.2 Test Data

Test results were taken using the E5052 phase-noise analyzer. Phase-noise measurements were obtained at different frequencies to determine any degradation in performance.

The reference design has two different DC-DC regulators for the user to choose depending on their specifications. Results in this document will show the performance of the LMX2592 with both regulators, connected one at a time.

4.2.1 Results at 1.8 GHz

Table 3. EVM Versus Reference Design Results at 1.8 GHz

OFFSET FREQUENCY	PHASE NOISE dBC/Hz		
	LMX2592 EVM	BOARD WITH TPS62150	BOARD WITH LM43601
1 kHz	-102.1834	-103.8562	-104.5381
10 kHz	-104.2512	-104.4959	-102.946
100 kHz	-121.8687	-121.1506	-121.1627
1 MHz	-143.9703	-143.0965	-142.0113
10 MHz	-157.7520	-157.0343	-157.1261
40 MHz	-158.4779	-157.9513	-158.0714

The performance of the LMX2592 EVM was captured. The TIDA-00885 board performance was compared with the TPS62150 enabled and was compared to the EVM performance, and then the TIDA-00885 board performance was compared with the LM43601 enabled and was compared to the EVM performance.

When enabled one at a time, both regulators decreased the voltage from 5 to 3.3 V to power the LMX2592.

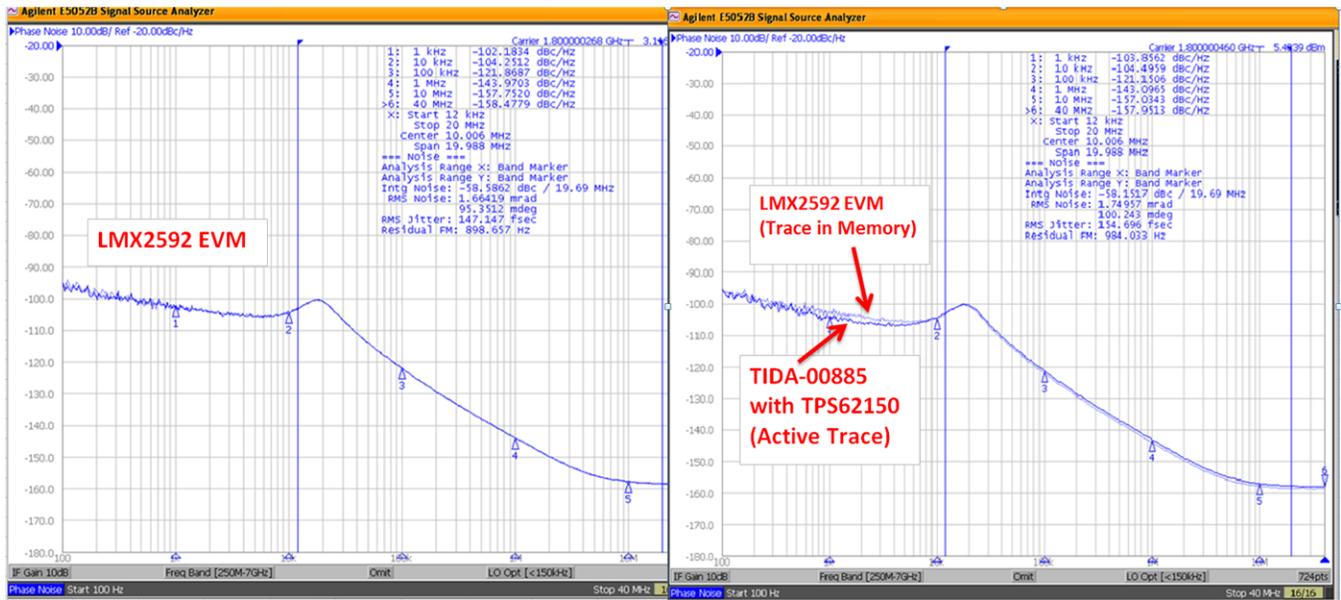


Figure 6. EVM Versus TIDA-00885 With TPS62150 at 1.8 GHz

Active trace: Reference design board
 Trace in memory: LMX2592EVM and power supply
 Frequency: 1.8 GHz
 Reference oscillator: 100-MHz Wenzel (external)

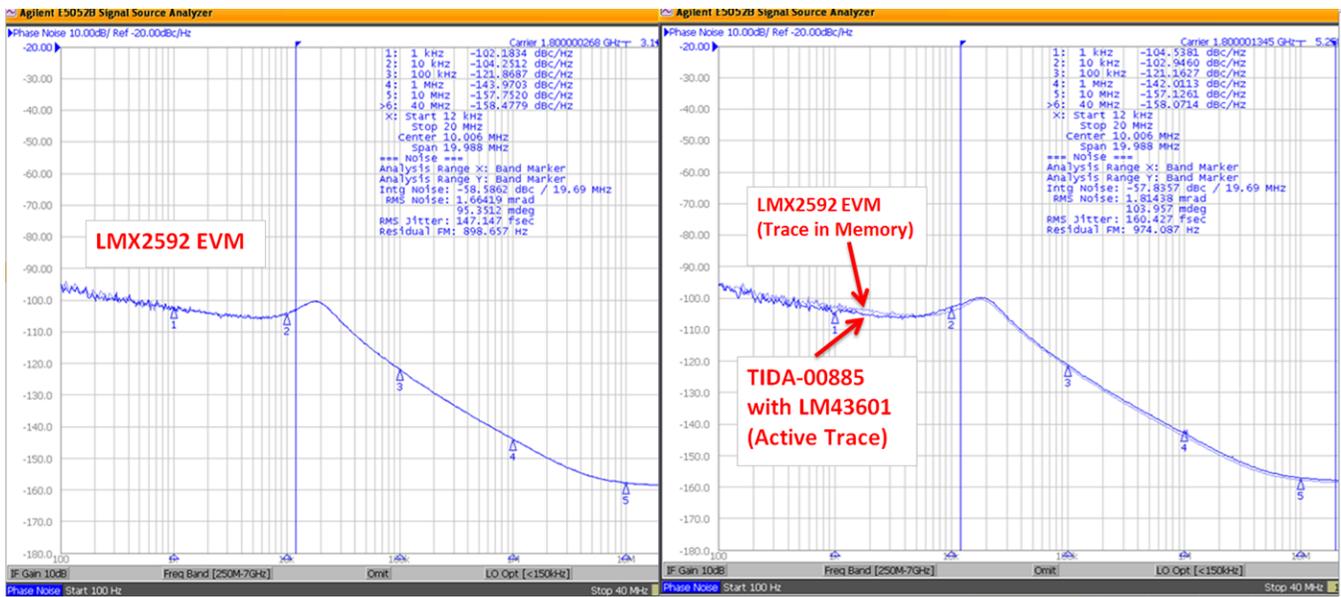


Figure 7. EVM Versus TIDA-00885 With LM43601 at 1.8 GHz

4.2.2 Results at 2.5 GHz

Table 4. EVM Versus Reference Design Results at 2.5 GHz

OFFSET FREQUENCY	PHASE NOISE dBc/Hz		
	LMX2592 EVM	BOARD WITH TPS62150	BOARD WITH LM43601
1 kHz	-101.4933	-101.8608	-100.5191
10 kHz	-99.5358	-100.5750	-99.2610
100 kHz	-118.9644	-119.2819	-119.2124
1 MHz	-140.5402	-140.8056	-139.3126
10 MHz	-154.5167	-155.2803	-155.1217
40 MHz	-155.5192	-156.7189	-156.4236

The performance of the LMX2592 EVM was captured. The TIDA-00885 board performance was compared with the TPS62150 enabled and was compared to the EVM performance, and the TIDA-00885 board performance was compared with the LM43601 enabled and was compared to the EVM performance.

When enabled one at a time, both regulators stepped down the voltage from 5 to 3.3 V to power the LMX2592.

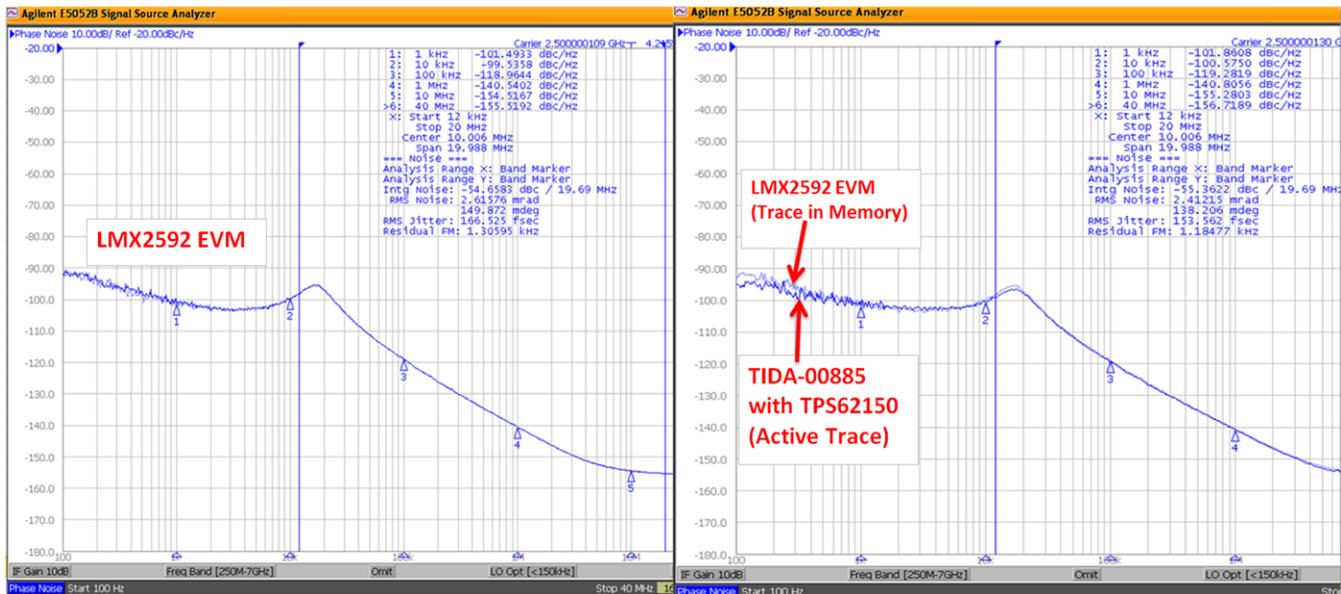


Figure 8. EVM Versus TIDA-00885 With TPS62150 at 2.5 GHz

- Active trace: Reference design board
- Trace in memory: LMX2592 EVM and power supply
- Frequency: 2.5 GHz
- Reference oscillator: 100-MHz Wenzel (external)

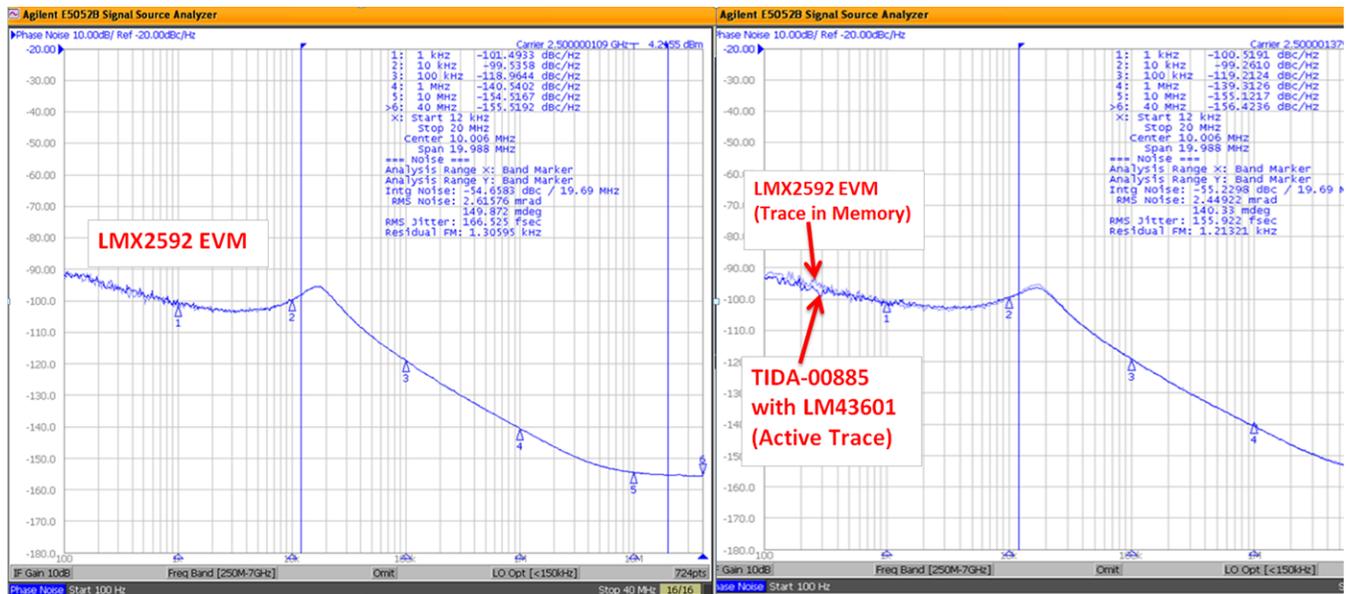


Figure 9. EVM Versus TIDA-00885 With LM43601 at 2.5 GHz

4.2.3 Results at 7 GHz

Table 5. EVM Versus Reference Design Results at 7 GHz

OFFSET FREQUENCY	PHASE NOISE dBc/Hz		
	LMX2592 EVM	BOARD WITH TPS62150	BOARD WITH LM43601
1 kHz	-90.2875	-91.9015	-91.9015
10 kHz	-91.5060	-91.3529	-91.3529
100 kHz	-108.3266	-107.8399	-107.8399
1 MHz	-130.8292	-130.3848	-130.3848
10 MHz	-150.4876	-150.3279	-150.3279
40 MHz	-150.4876	-156.1322	-156.1322

The performance of the LMX2592 EVM was captured. The TIDA-00885 board performance was compared with the TPS62150 enabled and was compared to the EVM performance, and the TIDA-00885 board performance was compared with the LM43601 enabled and was compared to the EVM performance.

When enabled one at a time, both regulators stepped down the voltage from 5 to 3.3 V to power the LMX2592.

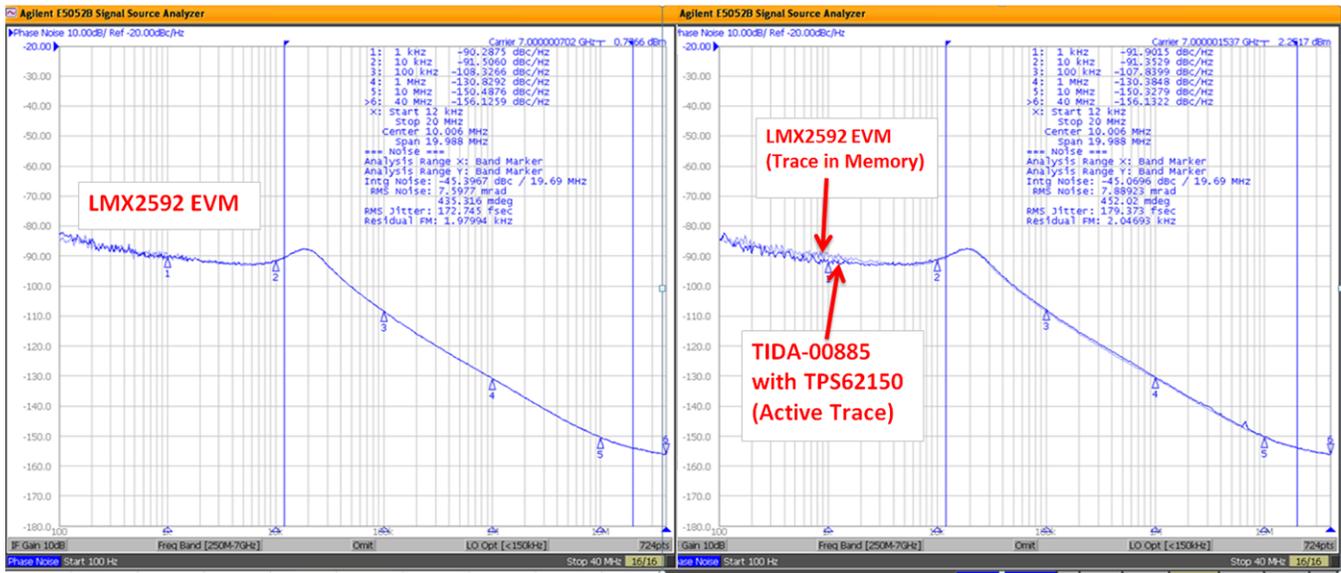


Figure 10. EVM Versus TIDA-00885 With TPS62150 at 7 GHz

Active trace: Reference design board

Trace in memory: LMX2592 EVM and power supply

Frequency: 7 GHz

Reference oscillator: 100-MHz Wenzel (external)

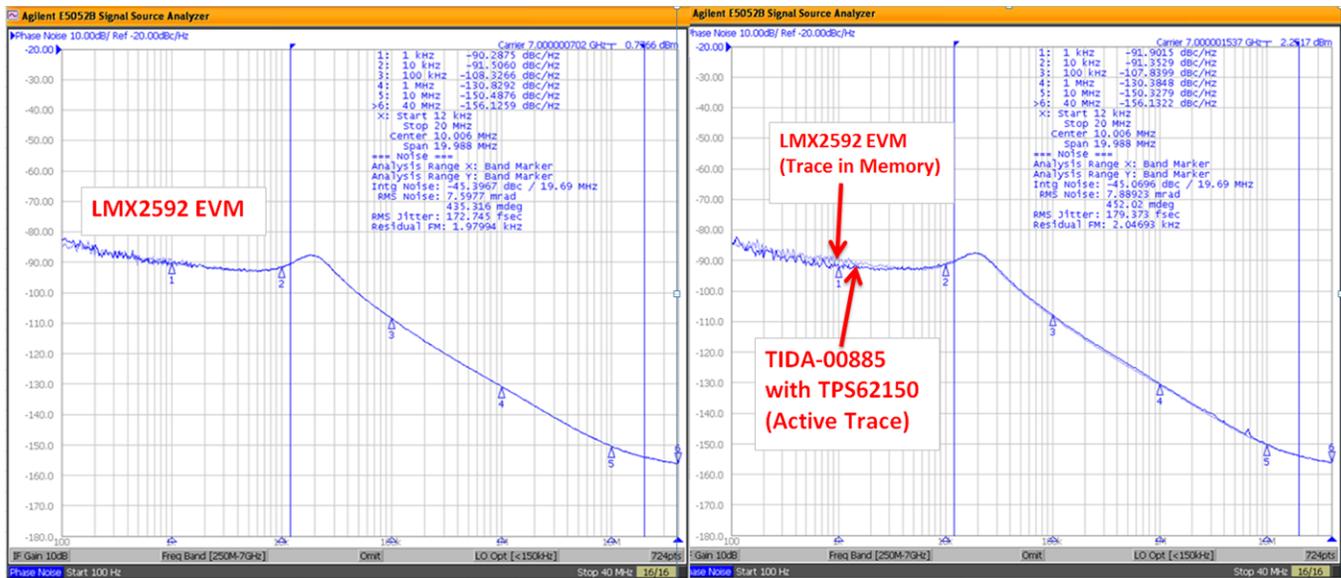


Figure 11. EVM Versus TIDA-00885 With LM43601 at 7 GHz

4.2.4 Spurious Performance

When using a DC-DC Regulator, the LMX2592 may have a spur at a frequency offset equal to the switching frequency.

The contribution is minimal which affects jitter in the range of 2 to 4 fs. Using a ferrite bead at the output of the DC-DC converter might help mitigate some of the spur or decrease the magnitude.

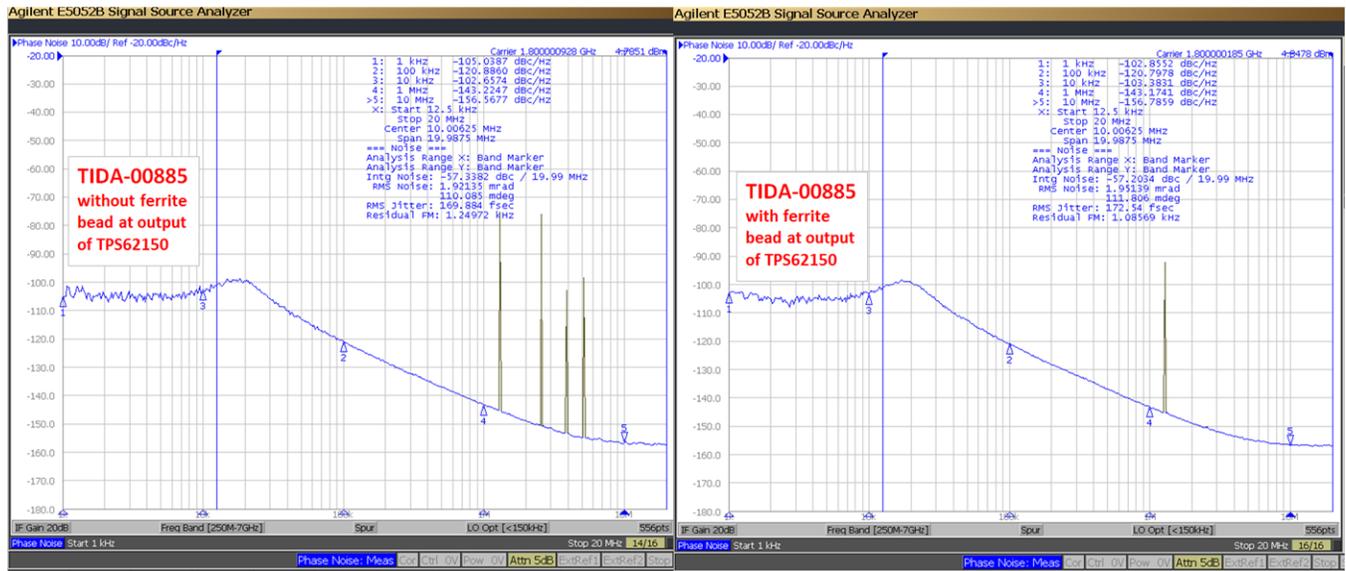


Figure 12. Spur Mitigation

5 Design Files

5.1 Schematics

To download the schematics, see the design files at [TIDA-00885](#).

5.2 Bill of Materials

To download the bill of materials (BOM), see the design files at [TIDA-00885](#).

5.3 PCB Layout Recommendations

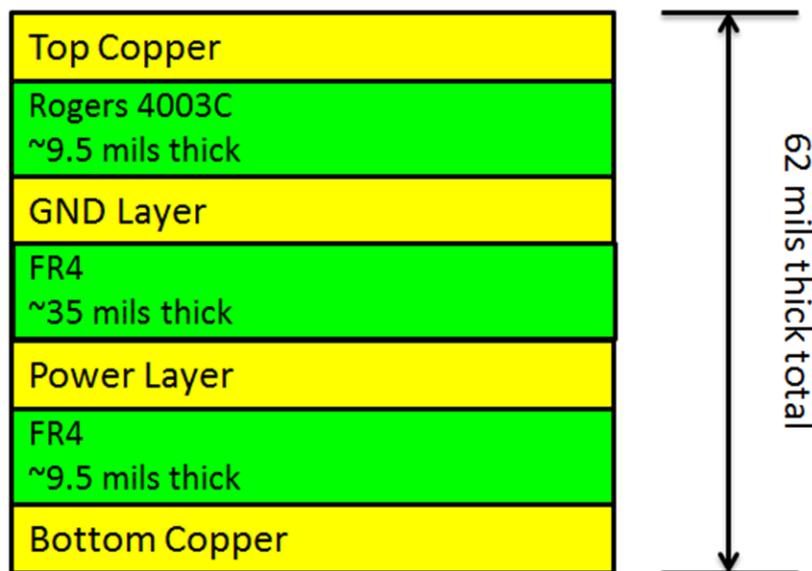


Figure 13. TIDA-00885 Layer Stack Up Information

FR4 Material was chosen because of convenience, availability, and cost.

5.3.1 Layout Prints

To download the layer plots, see the design files at [TIDA-00885](#).

5.3.2 TPS62150 Layout Guidelines

Using the proper layout is critical for the operation of a switched-mode power supply, even more at high-switching frequencies. Therefore, the PCB layout of the TPS6215x device demands careful attention to ensure operation and to get the performance specified. A poor layout can lead to issues like poor regulation (both line and load), stability and accuracy weaknesses, increased EMI radiation, and noise sensitivity.

[Figure 14](#) shows the recommended layout of the TPS6215x device, which is designed for common external ground connections. Both AGND (pin 6) and PGND (pins 15 and 16) are directly connected to the exposed thermal pad. On the PCB, the direct common-ground connection of AGND and PGND to the exposed thermal pad and the system ground (ground plane) is mandatory. Also, connect VOS (pin 14) in the shortest way to VOUT at the output capacitor. To avoid noise coupling into the VOS line, this connection should be separated from the VOUT power line and plane as shown in the layout example

(Figure 14). Provide low-inductance and -resistance paths for loops with high di and dt. Paths conducting the switched-load current should be as short and wide as possible. Provide low-capacitance paths (with respect to all other nodes) for wires with high dv and dt. The input and output capacitance should be placed as close as possible to the IC pins. Parallel wiring over long distances and narrow traces should be avoided. Loops, which conduct an alternating current, should outline an area as small as possible because this area is proportional to the energy radiated. Sensitive nodes like FB (pin 5) and VOS (pin 14) must be connected with short wires and not near high dv and dt signals (for example, SW [pins 1, 2, and 3]). Because the FB and VOS pins carry information about the output voltage, these pins should be connected as close as possible to the actual output voltage (at the output capacitor). The capacitor on SS/TR (pin 9) and on AVIN (pin 19), as well as the FB resistors, R1 and R2, should be kept close to the IC and connect directly to those pins and the system ground plane. The exposed thermal pad must be soldered to the circuit board for mechanical reliability and to achieve adequate power dissipation. The recommended layout is implemented on the EVM and shown in its User's Guide (SLVU437A).

For more information see the TPS62150 Datasheet (SLVSAL5C) and the TPS62150 User's Guide (SLVU437A).

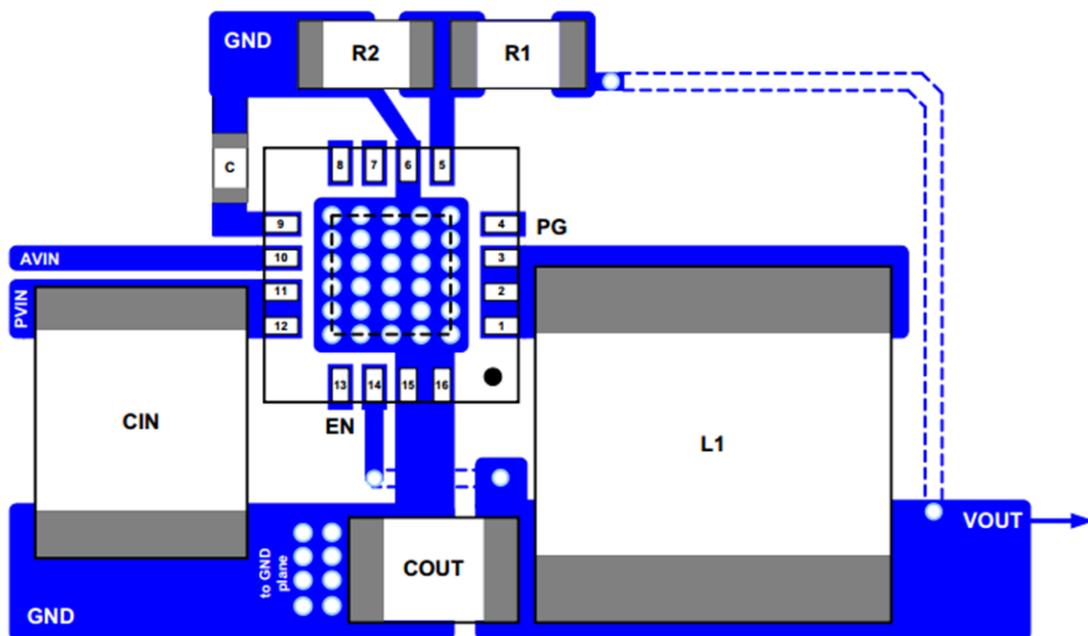


Figure 14. TPS62150 Layout Guidelines

5.3.3 LM43601 Layout Guidelines

The performance of any switching converter depends as much upon the layout of the PCB as the component selection. The following guidelines will help users design a PCB with the best power conversion performance, thermal performance, and minimized generation of unwanted EMI.

- Place ceramic, high-frequency bypass CIN as close as possible to the LM43601 VIN and PGND pins. Grounding for both the input and output capacitors should consist of localized top side planes that connect to the PGND pins and PAD.
- Place bypass capacitors for VCC and BIAS close to the pins and ground the bypass capacitors to device ground.
- Minimize trace length to the FB pin. Both feedback resistors, RFBT and RFBB should be located close to the FB pin. Place CFF directly in parallel with RFBT. If VOUT accuracy at the load is important, VOUT sense must be made at the load. Route VOUT sense path away from noisy nodes and preferably through a layer on the other side of a shielding layer.
- Minimize trace length to the FB pin. Both feedback resistors, RFBT and RFBB should be located close to the FB pin. Place CFF directly in parallel with RFBT. If VOUT accuracy at the load is important,

VOUT sense must be made at the load. Route VOUT sense path away from noisy nodes and preferably through a layer on the other side of a shielding layer.

- Have a single-point ground connection to the plane. The ground connections for the feedback, soft-start, and enable components should be routed to the ground plane. This prevents any switched or load currents from flowing in the analog ground traces. If not properly handled, poor grounding can result in degraded load regulation or erratic output voltage ripple behavior.
- Make VIN, VOUT, and ground bus connections as wide as possible. This reduces any voltage drops on the input or output paths of the converter and maximizes efficiency.
- Provide adequate device heat-sinking. Use an array of heat-sinking vias to connect the exposed pad to the ground plane on the bottom PCB layer. If the PCB has multiple copper layers, these thermal vias can also be connected to inner layer heat-spreading ground planes. Ensure enough copper area is used for heat-sinking to keep the junction temperature below 125°C.

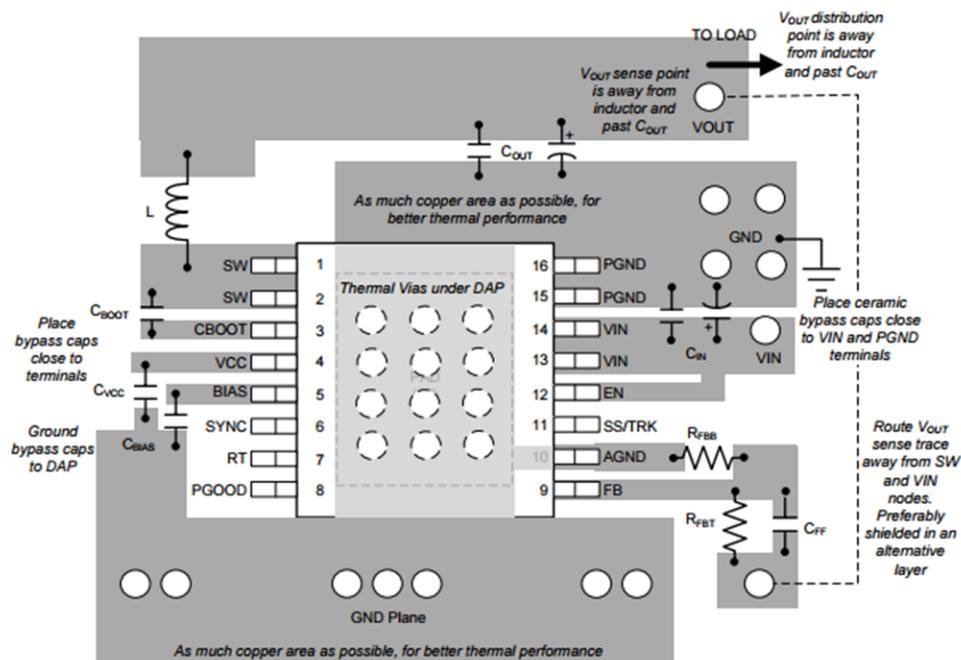


Figure 15. LM43601 Layout Guidelines

For more information see the LM43601 Datasheet ([SNVSA44A](#)) and the LM43601 User's Guide ([SNVU425](#)).

5.3.4 Frequency Synthesizer Guidelines

See EVM instructions for details. Overall, the layout guidelines are similar to most other PLL devices. The following are outstanding guidelines:

- Place output pull up components close to the pin.
- Place capacitors close to the pins.
- Ensure input signal trace is well-matched.
- Do not route any traces that carrying switching signal close to the charge pump traces and external VCO.

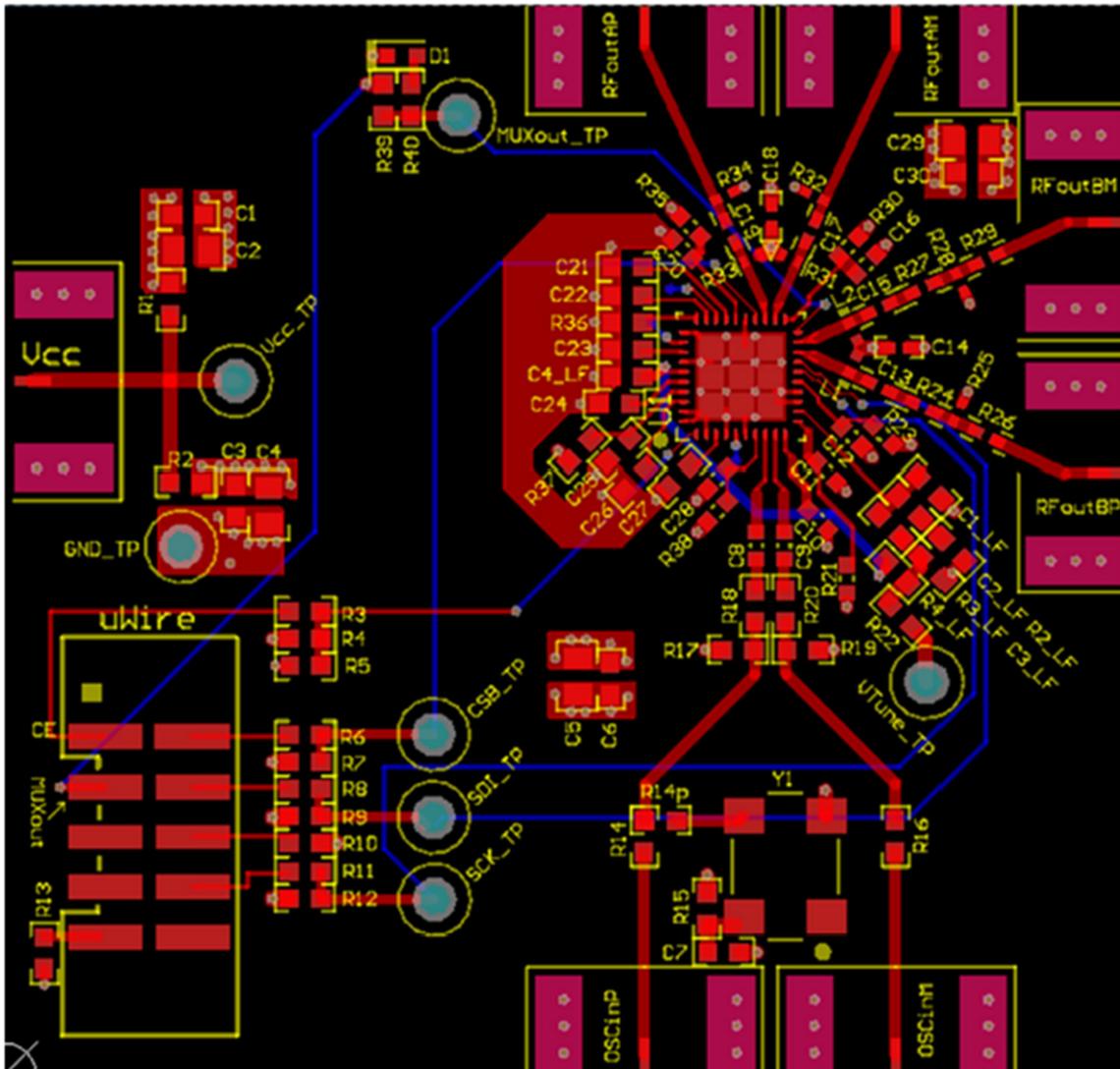


Figure 16. LMX2592 Layout Example

For more information see the LMX2592 Datasheet ([SNAS646B](#)) and the LMX2592 User's Guide ([SNAU195](#)).

5.4 Altium Project

To download the Altium project files, see the design files at [TIDA-00885](#).

5.5 Gerber Files

To download the Gerber files, see the design files at [TIDA-00885](#).

5.6 Assembly Drawings

To download the assembly drawings, see the design files at [TIDA-00885](#).

6 Software Files

To download the software files, see the design files at [TIDA-00885](#).

7 References

1. Texas Instruments, LMX2592 High Performance, Wideband PLLatinum™ RF Synthesizer with Integrated VCO, Datasheet ([LMX2592](#))
2. Texas Instruments, LMX2592EVM High Performance, Wideband PLLatinum™ RF Synthesizer Evaluation Board Operating Instructions, User's Guide ([SNAU195](#))
3. Texas Instruments, TPS6215x 3-V to 17-V, 1-A Step-Down Converter in 3-mm × 3-mm QFN Package, Datasheet ([TPS62150](#))
4. Texas Instruments, TPS62130EVM-505, TPS62140EVM-505, and TPS62150EVM-505 Evaluation Modules, User's Guide ([SLVU437A](#))
5. Texas Instruments, LM43601 SIMPLE SWITCHER® 3.5 V to 36 V 1 A Synchronous Step-Down Voltage Converter, Datasheet ([LM43601](#))
6. Texas Instruments, LM43601PWPEVM User Guide, User's Guide ([SNVU425](#))
7. Texas Instruments WEBENCH® Design Center (<http://www.ti.com/webench>)

8 About the Author (Optional)

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