Evaluation Board Documentation

TRF7610 RF Power Amplifier S-Parameter EVM

APPLICATION BRIEF: SWRA026

Wireless Communication Business Unit

Digital Signal Processing Solutions
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TEXAS INSTRUMENTS

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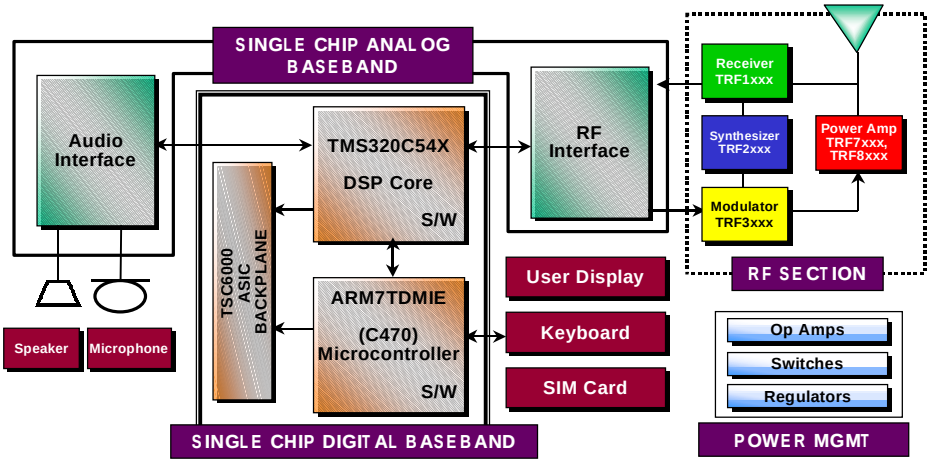
Abstract

This document describes the Texas Instruments (TI™) TRF7610 RF power amplifier S-parameter evaluation module (EVM) and is primarily aimed at device assessment. The TRF7610 RF power amplifier is a silicon MOSFET power amplifier IC for 900-MHz applications, tailored specifically for global systems for mobile communications (GSM).

This document contains S-parameter board assembly instructions, calibration structure information, and calibration kit definition procedures.

Product Support

The TI Advantage Extends Beyond RF to Every Other Major Wireless System Block



Digital Baseband

TI's single-chip Digital Baseband Platform, combines two high-performance core processors – a digital signal processor tailored for digital wireless applications and a microcontroller designed specifically for low-power embedded systems. The customizable platform helps wireless digital telephone manufacturers lower component counts, save board space, reduce power consumption, introduce new features, save development costs and achieve faster time to market, at the same time giving them flexibility and performance to support any standard worldwide.

Analog Baseband

TI analog baseband components provide a Mixed-signal bridge between the real world of analog signals and digital signal processors, the key enabling technology of the digital wireless industry. Using a seamless architecture for wireless communications technology, TI matches its baseband interfaces, radio frequency ICs and power management ICs to digital signal processing engines to create complete DSP Solutions for digital wireless systems.

Power Management

TI provides power management solutions with integration levels designed to meet the needs of a range of wireless applications. From discrete LDOs and voltage supervisors to complete power supplies for the baseband section, TI power management solutions play an important role in increasing wireless battery life, time-to-market and system functionality.

For more information visit the Wireless Communications web site at www.ti.com/sc/docs/wireless/home.htm.

Related Documentation

The following list specifies product names, part numbers, and literature numbers of corresponding TI documentation.

- *TRF7610 Silicon MOSFET Power Amplifier IC for GSM*, December 1997, Literature number SLWS059A
- *TRF7610 RF Power Amplifier 4.8 Volt GSM Application*, Literature number SWRA016
- *Thermal Considerations for RF Power Amplifier Devices Application Report,* Literature Number SLWA009

World Wide Web

Our World Wide Web site at **www.ti.com** contains the most up to date product information, revisions, and additions. Users registering with TI&ME can build custom information pages and receive new product updates automatically via email.

Email

For technical issues or clarification on switching products, please send a detailed email to **sc-infomaster@ti.com**. Questions receive prompt attention and are usually answered within one business day.

S-Parameter EVM Assembly

Figure 1 illustrates the Texas Instruments TRF7610 S-parameter EVM. As illustrated, the assembly consists of

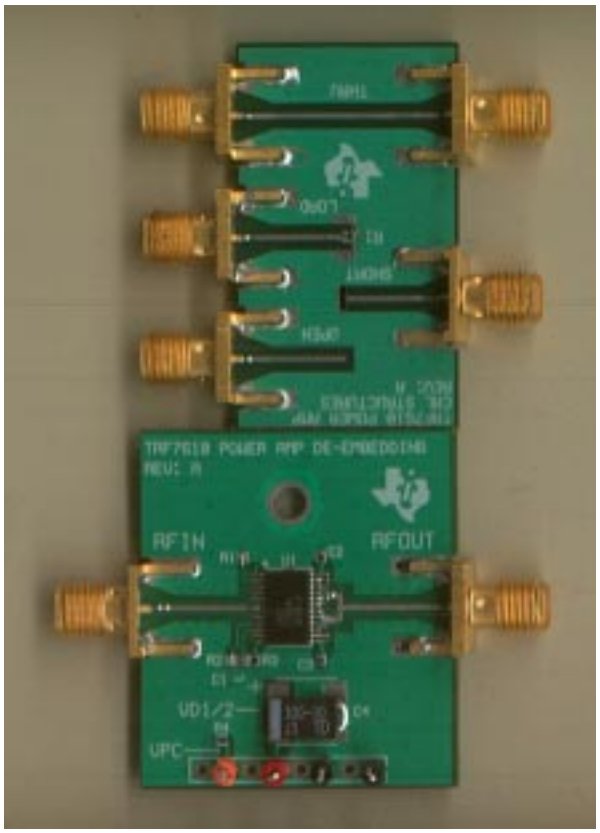
- Printed circuit board (PCB)
- Seven 3.5mm SMA/PCB connectors
- External components

  C1 through C4, R1, R2, R1 (load)
- TRF7610 RF IC in a TSSOP-24 package

The PCB includes all of the necessary structures for a standard TRL calibration:

- Through line
- Short circuit
- Open circuit
- 50 ohm load

Figure 1. TRF7610 S-Parameter Test Board



All of the structures are properly labeled for ease of identification.

- C1 – 100 pF
- C2, C3 – 0.033 µF
- C4 – 100 µF
- R1 – 2200 ohms
- R2, R3 – 5100 ohms
- R1 (load) – 51 ohms

The first step in assembly is to mount the TRF7610 to the PCB. To maintain good electrical and thermal performance, the device must be soldered on the backside of the package. TI suggests tinning the device prior to mounting. A poor backside connection will cause device failure due to thermal heating and/or poor RF performance due to poor source grounding.

All external components should then be installed on the de-embedding board. Following the device installation, the power connectors should be installed by soldering the connectors to the backside vias.

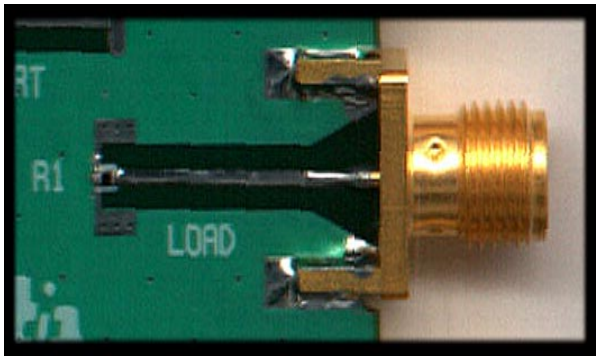
CAUTION:

The TRF7610 is an ESD (electrostatic discharge) sensitive device. Please follow proper ESD procedures.

The 51 ohm resistor (R1 load) should be installed following the TRF7610 device. Figure 2 illustrates the placement of the resistor at the end of the transmission line. The resistor should span from the end of the transmission line to the topside ground at the end of the transmission line.

The single 51 ohm resistor can be replaced by two parallel 100 ohm resistors attached at the same location. TI has found that a single resistor yields acceptable results (-30 dB return loss at 900 MHz.)

Figure 2. R1 (Load) Placement



SMA connectors should be attached to the PCB at designated locations. Figure 3 and Figure 4 illustrate the top and bottom solder connections needed to successfully mount the connectors. The gap between the connector and the PCB should be minimized to reduce stray capacitance. The center pin of the connector should be short, as shown in Figure 3. TI has found that long center pins prevent a good connection between the ground plane of the PCB and the connector, thus causing excess capacitance to be included in the measurement.

Figure 3. Top Solder Connections for SMA Connectors

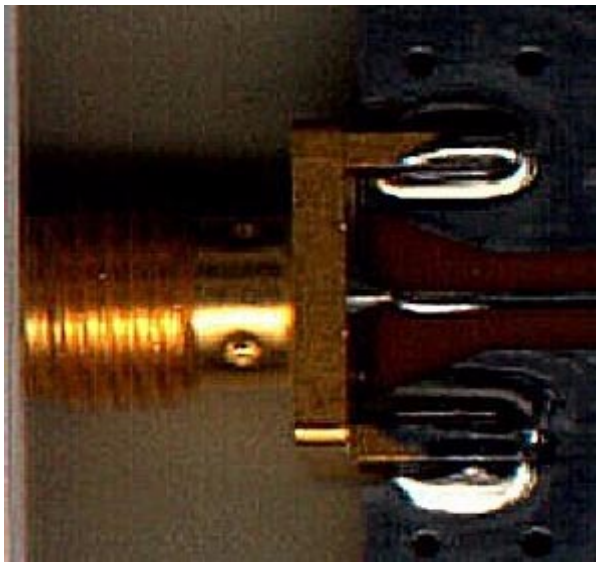
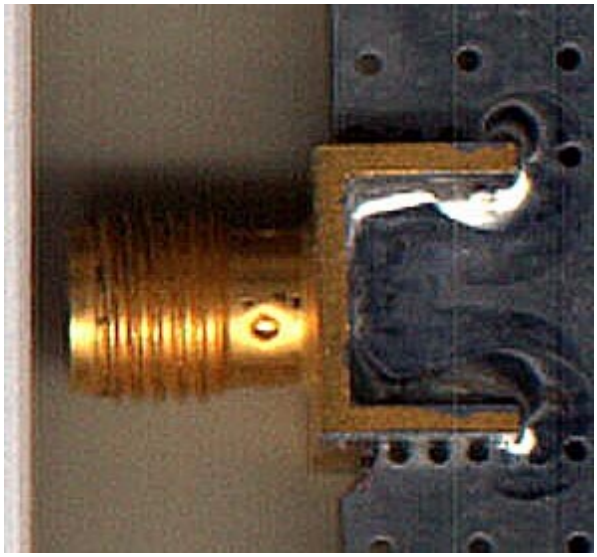


Figure 4. Bottom Solder Connections for SMA Connectors



Calibration Structures

The calibration structures are typical of any TRL calibration kit. The test board includes a 50 ohm thru line, short circuit, open circuit, and 50 ohm load. It is recommended that a full TRL 2-port calibration be performed to test the TRF7610. This calibration takes into account all of the provided calibration structures and yields accurate calibration and measurements.

The thru line is a low loss 50 ohm transmission line. This structure is used to calibrate for line losses occurring from the 3.5mm connector to the measurement reference plane. This transmission line is exactly twice the length of the open circuit and short-circuit calibration structures.

The short circuit transmission line provides a calibration structure that measures a unity reflection and 180-degree phase shift. To minimize stray capacitance, the structure is grounded to the top and bottom ground planes through a single large via. This provides an accurate reflection standard.

The length of the short circuit line determines the measurement reference plane. The length of the short circuit line is exactly half of the length of the thru line and exactly the length of the input and output transmission lines to which the TRF7610 is attached. This provides accurate measurement reference planes at the input and output of the device under test.

The load standard consists of a 50 ohm transmission line equal in length to the open and short circuit standards that are terminated in 50 ohms. This provides a zero reflection calibration standard used to normalize the system impedance.

The open circuit transmission line standard provides a calibration structure of unity reflection and zero degree phase shift. The length of the transmission line, along with the accompanying short circuit calibration standard, also determines the measurement reference plane. Thus, it is equal in length to the load and short circuit standards and half the length of the thru standard. Nevertheless, the open circuit transmission line must be measured to account for any fringing capacitance. The value of fringing capacitance must be programmed into the network analyzer.

The fringing capacitance of the open circuit transmission line is measured as follows.

1) Perform a one-port calibration using 3.5mm SMA calibration standards.

2) Measure the 50 ohm load standard and store that value in memory.

3) Program the display function to display DATA-MEMORY.

4) Measure the short circuit standard and adjust the port extension to yield a 180 degree phase response over the frequency band of interest. (TI calibrated from 10 MHz to 6 GHz.)

5) Measure the open circuit standard and display the results on an admittance smith chart. Fit the capacitance curve to the polynomial $C_0+C_1f+C_2f^2+C_3f^3$ (TI used only the first term, C_0, to calibrate up to 1 GHz.) The coefficient is provided in a following section.

NOTE:
The open-circuit capacitance measured by the user can vary greatly due to PC board manufacturing tolerances.

Calibration Kit Definition

To accurately characterize the TRF7610, a calibration kit must be defined in the network analyzer. TI employs an HP8753 network analyzer to characterize cellular-frequency parts; however, the following procedure applies to other network analyzers, such as the HP8510.

1) Enter the menu on the spectrum analyzer that accesses the calibration kit. (For the HP8753, use the *CAL KIT* key.)

2) From the calibration menu, select the calibration kit to be modified. An underline appears beneath the calibration kit name.

3) For the HP8753, select MORE, MODIFY [cal kit], and DEFINE STANDARD.

4) The standard types appear in a list on the softkey menu display. Use a sequence of keystrokes from the following list to select the calibration standard to define. After pressing the desired sequence of keystrokes, select the underlined calibration standard.

   Short 1 and x1

   Open 2 and x1

   Load 3 and x1

   Thru 4 and x1

   Note: The x1 button is located on the right side of the number keypad.

1) Select the short circuit standard by pressing the 1 and x1 keys. An underline appears beneath the SHORT standard.

2) Press the softkey corresponding to SHORT.

3) Select SPECIFY OFFSET. Ensure that the OFFSET DELAY is 0 Sec. and the COAX selection is highlighted. If the COAX selection is not highlighted, press the softkey corresponding to COAX.

4) Select STD OFFSET DONE.

5) Select STD DONE (DEFINED) to exit back to the calibration standard selection menu.

6) Select DEFINE STANDARD, then press the 2 and x1 keys. An underline appears beneath the OPEN standard.

7) Press the softkey corresponding to OPEN.

8) Select C0 and enter the value of the C0 coefficient in fF. (For example, the value for the TRF7610 S-parameter board, measured by TI, is listed below.)

C0 (fF)
70

1) Select C1 and enter the value for the TRF7610 board listed below. Ensure that the C2 and C3 values are both set to zero.

2) Select SPECIFY OFFSET. Ensure that the OFFSET DELAY is 0 Sec. and the COAX selection is highlighted. If the COAX selection is not highlighted, press the softkey corresponding to COAX.

3) Select STD OFFSET DONE.

4) Select STD DONE (DEFINED) to exit back to the calibration standard selection menu.

5) Select DEFINE STANDARD, then press the 3 and x1 keys. An underline appears beneath the LOAD standard.

6) Select LOAD. Ensure that FIXED is underlined.

7) Select SPECIFY OFFSET. Ensure that the OFFSET DELAY is 0 Sec. and the COAX selection is highlighted. If the COAX selection is not highlighted, press the softkey corresponding to COAX.

8) Select STD OFFSET DONE.

9) Select STD DONE (DEFINED) to exit back to the calibration standard selection menu.

10) Select DEFINE STANDARD, then press the 4 and x1 keys. An underline appears beneath the DELAY/THRU standard.

11) Select DELAY/THRU, then select SPECIFY OFFSET. Ensure that the OFFSET DELAY is 0 Sec. and the COAX selection is highlighted. If the COAX selection is not highlighted, press the softkey corresponding to COAX.

12) Select STD OFFSET DONE.

13) Select STD DONE (DEFINED) to exit back to the calibration standard selection menu.

14) Select LABEL KIT, then select ERASE TITLE. Enter a new title using the select wheel and SELECT LETTER softkey.

15) Select DONE when finished labeling the cal kit.

16) Select KIT DONE, then select SAVE USER KIT.

The calibration kit may be saved to disk by selecting the kit at the same time that a measurement is saved to disk. The network analyzer can be calibrated for S-parameter measurements on the TRF7610 by using the user-defined calibration kit and the standards on the TRF7610 S-parameter board.

Evaluation Board Disclaimer

Please note that the enclosed evaluation boards are experimental Printed Circuit Boards and are therefore only intended for device evaluation.

We would like to draw your attention to the fact that these boards have been processed through one or more of Texas Instruments' external subcontractors which have not been production qualified.

Device parameters measured, using these boards, are not representative of any final data sheet or of a final production version. Texas Instruments does not represent or guarantee that a final version will be made available after device evaluation.

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References

Hewlett Packard Company, *HP 8753D Network Analyzer User's Guide*, 1994, 1995, Hewlett Packard Company, pp. 5-24 through 5-26

Hewlett Packard Company, *RF Design and Measurement Seminar*, pp. 149-158