User's Guide

SLWU073–October 2011

TRF3705EVM Evaluation Module

This user's guide provides instructions for evaluating the TRF3705 modulator with a TRF3705EVM evaluation module. The TRF3705 is a quadrature modulator for up-converting the in-phase (I) and quadrature-phase (Q) signals to RF signals in the transmit chain, typically used between the digital-to-analog converter and the RF power amplifier.

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1.1 System Block Diagram

The basic radio system block diagram in Figure 1 shows where the TRF3705 fits in the transmitter.

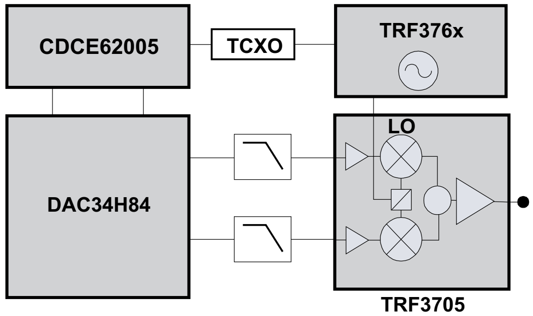

Figure 1. TRF3705 System Block Diagram

1.2 EVM Jumper Configuration

Table 1 lists the locations of the installed jumpers in the default configuration of the evaluation module (EVM).

Table 1. Default Jumper Connections

Jumper	Description	Default	Notes
JP1	Power Down	Pins 2-3	Powered On
JP2	Gain Control	Pins 2-3	Low Gain Mode

2 TRF3705 EVM Test Configuration

2.1 *Test Block Diagram*

Figure 2 shows the test setup for general testing of the TRF3705.

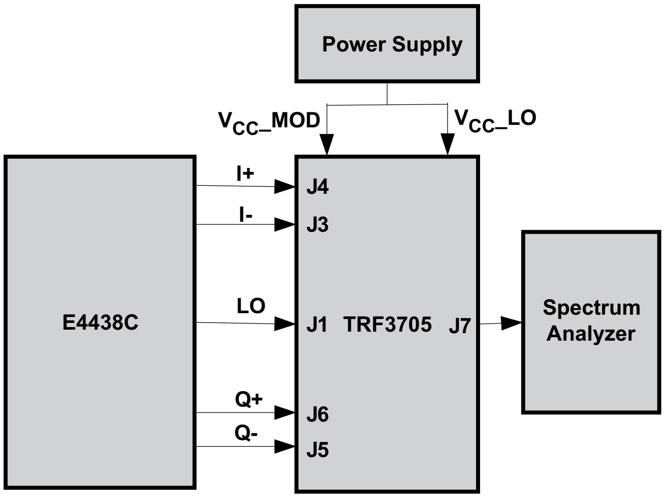

Figure 2. Test Setup Block Diagram

2.2 *Test Equipment*

The following equipment is required for completing RF Testing:

- Power supply with current readout — Agilent E3631 or equivalent
- Signal generator for LO input signal — Agilent E4438C or equivalent
- Arbitrary waveform generator — Agilent E4438C or equivalent
- Spectrum analyzer — Agilent E4440A or equivalent

2.3 *Calibration*

The RF cables must be good quality RF cables due to the high-frequency signals.

- Measure the insertion loss of the RF output cable, and use this value to compensate for the measured output power.
- Measure the insertion loss of the LO input cable, and use this value to compensate for the desired LO power.

3 EVM Test Procedure

3.1 Single-Tone Output Power Test

1. Connect power supplies:
   - Set V_{CC} supply to 3.3 V and set the current limit to 500 mA.
   - Connect the V_{CC} supply to header TP2. Connect the ground to TP1.
2. Use a suitable 50-Ω output signal generator to supply the LO signal with 0 dBm with the cable loss compensated and the desired frequency f_{LO} = 1 GHz to J1; terminate J2 with 50 Ω to ground.
3. Use a digital-to-analog converter or an arbitrary waveform generator to provide I/Q input signals. A typical setup is as follows: a 1-Vpp sinusoidal wave in differential mode for both I and Q signals with a frequency of f_1, a dc offset of 0.25 V, and an output impedance of 50 Ω. Use an Agilent E4438C vector signal generator to provide I/Q signals in the following example.
   - Press **Preset.**
   - Press **Mode** → **More (1 of 2)** → **Multitone.**
   - Press **Initialize Table** → **Number of Tones** → **12** → **Enter.**
   - Press **Freq Spacing** → **1** → **MHz.**
   - Press **Done.**
   - Highlight each row of the first 11 rows, and press **Toggle State** to turn the selected tone off; keep only the last row with the BB frequency of 5.5 MHz. Now, 5.5-MHz, single-tone, BB I/Q signals are configured for E4438C.
   - Press **Multitone Off/On** until On is highlighted to generate the multitone waveform.
   - Connect I signals to J4 (I+) and J3 (I–), and the Q signals to J5 (Q–) and J6 (Q+).
   - Adjust the differential I or Q voltage level to be 1 Vpp by pressing **Mode** → **I/Q** → **I/Q Output Control** → **I/Q Output Atten** → enter **9** → Press **dB**. The voltage can be measured by an oscilloscope. Note that the differential voltage is twice the single-ended voltage.
   - Set the common-mode voltage (CMV) of E4438A to 0.25 V by pressing **Mode** → **I/Q** → **I/Q Output Control** → **Common Mode I/Q Offset** → **250** → **mV**. Use a dc voltage meter to monitor the dc common voltage at the inputs of I and Q, and fine-tune the CMV setting until it is measured to be 250 mV.
4. Verify that jumper connection of pin 2 and pin 3 on JP2 to set device in low gain mode
5. Verify that jumper connection of pin 2 and pin 3 at JP1 to ensure that power down is not engaged.
6. Monitor Vcc at TP1 to ensure that Vcc is 3.3 V. Verify that the current draw is about 305 mA ± 15 mA.
7. Connect a spectrum analyzer to the SMA connector marked RFOUT (J7), and measure the TRF3705 output power at $f_{LO} + f_1$ = 1005.5 MHz. The RF power must be 3.5 dBm ± 1 dBm after the RF cable loss is compensated.

3.2 Two-Tone OIP3 Test

The output third-order intercept point (OIP3) is a measure of the linearity performance of a nonlinear device. It is measured by a two-tone test. The following exercise measures OIP3 following all listed steps in Section 3.1.

1. Press **Mode** → **More (1 of 2)** → **Multitone**.
2. Highlight row 11 for frequency offset = 4.5 MHz, press **Toggle State**, and then press **Apply Multitone** to turn on a 4.5-MHz tone. Now, two tones with equal amplitude and frequencies, f_1 = 4.5 and f_2 = 5.5 MHz, are configured for E4438C.
3. Measure the RF power of both RF tones, P_0, which must be between –1.8 dBm to –2.8 dBm.
4. Measure the power, P_{IM3}, of the third-order intermodulation product associated with each RF tone. It is approximately –66.5 dBm after the cable loss compensation.
5. OIP_3 can be calculated by the equation $OIP_3 = P_0 + (P_0 – P_{IM3})/2$. The worst OIP3 associated with either the low- or the high-frequency tone is selected as the OIP3 of the modulator. The OIP3 at 1 GHz is approximately –29.8 dBm ± 1 dBm. Caution must be taken for accurately measuring the small P_{IM3} when the large P_0 is present. It is helpful to reduce the span and RBW settings of the spectrum analyzer so that the IM3 component is at least 20 dB above the noise floor, as well as by increasing the RF attenuator setting until P_{IM3} is no longer varying with increased RF attenuation setting.

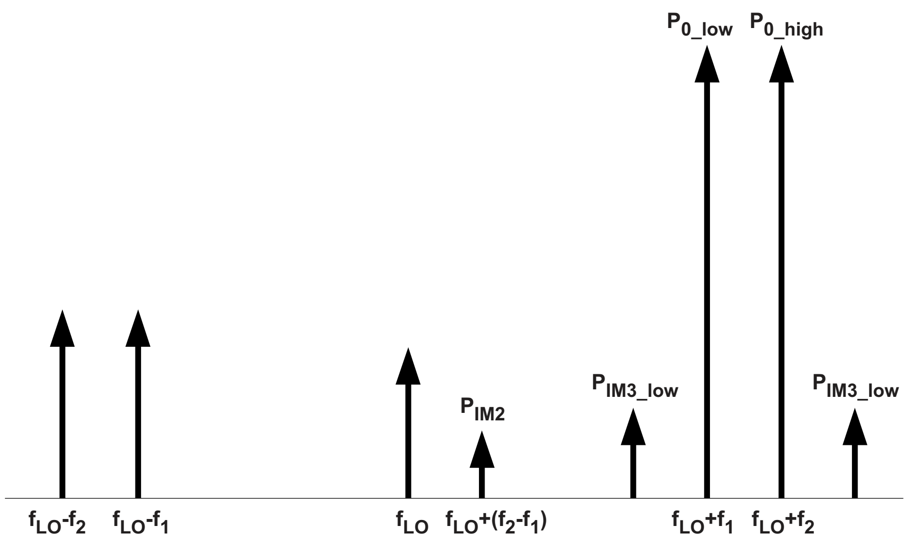

Figure 3. Two-Tone OIP3 Output Spectrum

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- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

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