TRF37T05EVM Evaluation Module

This user's guide provides instructions for evaluating the TRF37T05 modulator with a TRF37T05EVM evaluation module. The TRF37T05 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.

Contents

1 Introduction 2
1.1 System Block Diagram 2
1.2 EVM Jumper Configuration 2
2 TRF37T05 EVM Test Configuration 3
2.1 Test Block Diagram 3
2.2 Test Equipment 3
2.3 Calibration 3
3 EVM Test Procedure 4
3.1 Single-Tone Output Power Test 4
3.2 Two-Tone OIP3 Test 5

List of Figures

1 TRF37T05 System Block Diagram 2
2 Test Setup Block Diagram 3
3 Two-Tone OIP3 Output Spectrum 5

List of Tables

1 Default Jumper Connections 2

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1 Introduction

1.1 System Block Diagram

The basic radio system block diagram in Figure 1 shows where the TRF37T05 fits in the transmitter.

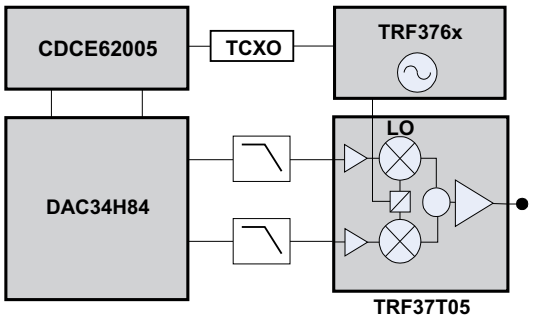


Figure 1. TRF37T05 System Block Diagram

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

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2 TRF37T05 EVM Test Configuration

2.1 Test Block Diagram

Figure 2 shows the test setup for general testing of the TRF37T05.

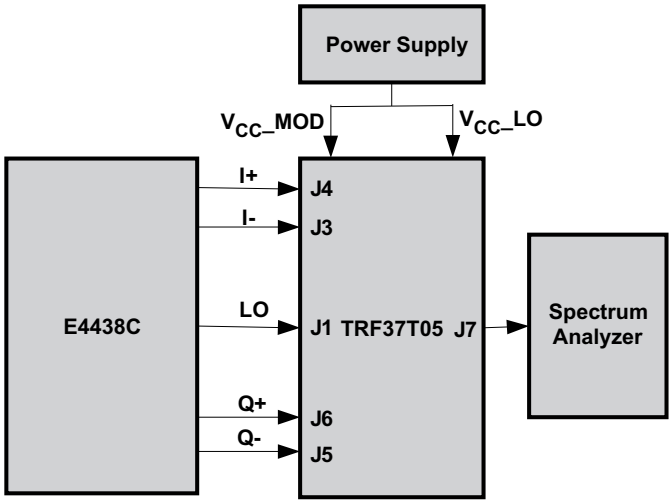


Figure 2. Test Setup Block Diagram

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.

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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 TRF37T05 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.

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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.

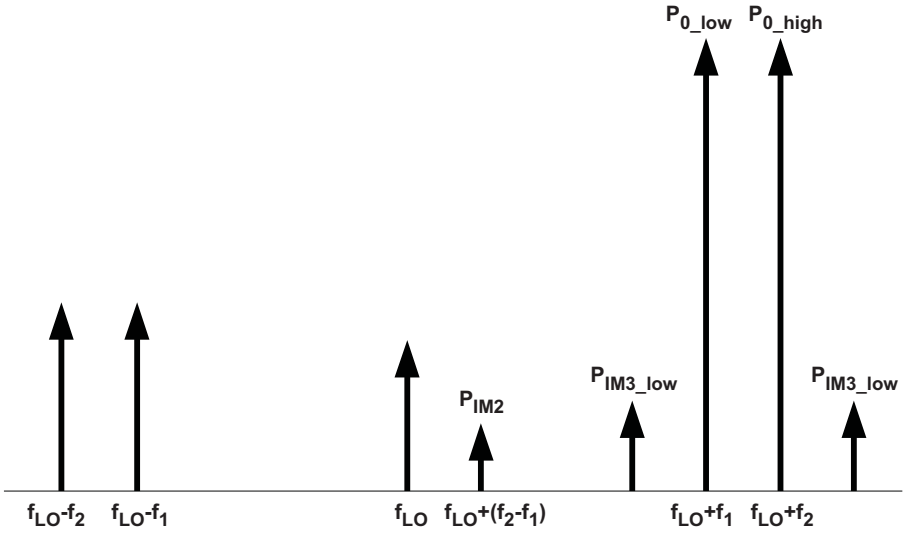


Figure 3. Two-Tone OIP3 Output Spectrum

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Caution

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

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This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

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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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Under Industry Canada regulations, this radio transmitter may only operate using an antenna of a type and maximum (or lesser) gain approved for the transmitter by Industry Canada. To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (e.i.r.p.) is not more than that necessary for successful communication.

This radio transmitter has been approved by Industry Canada to operate with the antenna types listed in the user guide with the maximum permissible gain and required antenna impedance for each antenna type indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device.

Cet appareil numérique de la classe A ou B est conforme à la norme NMB-003 du Canada.

Les changements ou les modifications pas expressément approuvés par la partie responsable de la conformité ont pu vider l'autorité de l'utilisateur pour actionner l'équipement.

Concernant les EVMs avec appareils radio

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes : (1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

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2. Use this product only after you obtained the license of Test Radio Station as provided in Radio Law of Japan with respect to this product, or
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