EVM User's Guide: DEM-FDA-RUN-EVM

DEM-FDA-RUN-EVM Evaluation Module

Description

The DEM-FDA-RUN-EVM is an evaluation module for RUN package (WQFN 10-pin) fully-differential amplifiers (FDAs), supporting multiple high-speed FDAs. This board supports quick demonstration of functionality and capability, including the SMA connectors for ease of use and supporting multiple onboard configurable options: MFB active filter, load network to FDA, output transformer, external drive for power down and output common-mode voltage. The EVM uses banana connectors for power supply, interfacing with bench power supplies. The supply voltage range is customizable depending on FDA selection and passive component choices. By default the partially assembled EVM is configured for 2.7V to 5.5V supplies. The input & output SMAs are 50Ω-matched for interfacing with common lab equipment. One jumper is available to select between power down modes, which can be bypassed for externally driven power sequencing.

Features

- Layout optimized for high-speed signals, minimize parasitic and noise
- Flexibility to use MFB active filter with existing pads
- Configure PD, VOCM with resistors or external signals
- Easy connection to equipment and other evaluation modules with SMA connectors
- Single supply operating range configurable to circuit needs (example, 2.7V to 5.5V)
- Partial assembly to enable wide adoption and end-user configurabilty

Applications

- 16-bit to 20-bit, Differential, SAR and ΔΣ Drivers
- Differential Active Filters
- Motor Drives
- Battery Testers
- Power Analyzers

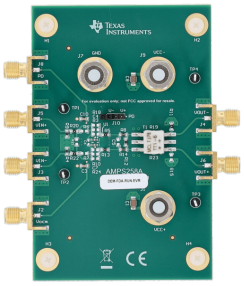

Figure 1-1. Board Image

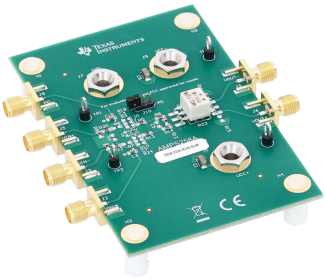

Figure 1-2. Board Image

1 Evaluation Module Overview

1.1 Introduction

The DEM-FDA-RUN-EVM evaluation module is designed to evaluate the performance of a fully-differential amplifier (FDA). The EVM interfaces with bench equipment through SMA connectors and banana jacks. The EVM supports a range of supply configurations, including the common TI supply range of 2.7V to 5.5V for FDAs. For higher voltage supplies, please confirm passive component voltage ratings and the absolute maximum supply voltage of the FDA. The PCB is designed for high-speed signals and can accommodate various lab bench measurements for observation and evaluation. The EVM SMA outputs can be connected to a subsequent data converter EVM for system-level evaluation.

1.2 Kit Contents

- DEM-FDA-RUN-EVM
- EVM Disclaimer Read Me

1.3 Specification

Table 1-1. Specification

Specification	Typical Value Range
Supply voltage range	Ex 2.7V to 5V, configurable to selected FDA (unpopulated)
Quiescent current	Ex 5.4mA for THS4535, depends on FDA choice
Output voltage swing	Ex. rail-to-rail output for THS4535
Output current drive	Ex. ±45mA for THS4535
Inputs/Outputs	Single-ended or Differential (incl. transformer)

1.4 Device Information

While the DEM-FDA-RUN-EVM is adapatble across TI FDAs in the RUN package, this user's guide will use the THS4535 as an example. The THS4535 is a 80MHz fully differential amplifier (FDA) that is specifically designed to drive fully differential analog-to-digital converters (ADCs) up to 2MSPS. The THS4535 family offers multiple options: untrimmed offset (2mV) and offset drift (2uV/°C) for THS4535, trimmed offset (50uV) and offset drift (1uV/°C) for THS4536. These parameters, along with TI's state-of-the-art packaging technology to minimize long term drift, make the THS4535 and THS4536 an excellent choice for data acquisition (DAQ) systems where DC precision is required along with the best signal-to-noise ratio (SNR) and spurious-free dynamic range (SFDR) to maximize ADC performance.

2 Hardware

2.1 Power Requirements

The DEM-FDA-RUN-EVM is presented as a partially-assembled FDA evaluation platform for the TI RUN- package. As such the power requirements are less precise, as you need to refer to the FDA device datasheet to properly consider the power requirements.

For the DEM-FDA-RUN-EVM, the supply voltage recommended operating condition is from 2.7V to 5.5V. The PCB has three banana jacks for power, including the labels VCC+ (for positive supply), VCC- (for negative supply), and GND (for ground). You can determine whether to use the device in single-supply configuration (VCC- and GND are zero volts) or split-supply configuration with VCC+ and VCC- both having non-zero voltages (positive and negative voltages are allowed).

It is recommended to set appropriate current limits on the power supply source which guard the EVM against over-current in the case of an improper or unexpected circuit. Please refer to the FDA quiescent current (Iq), output current drive (Iout), and your selected load when determining the current limit value. Please be aware of the absolute maximum ratings for the selected FDA.

2.2 Setup

Setup for the DEM-FDA-RUN-EVM includes proper connections to bench equipment, test hardware, and selection of jumpers. The base process for setup includes:

1. Connect power supplies via the banana jacks, labeled as VCC+, VCC-, and GND.
   a. Confirm appropriate quiescent current (IQ) for FDA with no input/output signal
2. Determine input and output connections
   a. Connect external input sources through SMA connectors
   b. Confirm appropriate input termination and input network resistor values
   c. Determine amplifier load network, check impedance of output network for both amplifier and transformer (or SMA) directions
      i. For example, an amplifier may prefer a 1kΩ load, while a transformer or output SMA connector may need 50Ω termination
   d. Connect outputs via SMA connectors, confirm the values of output termination resistors R11 and R15.
   e. Use or bypass the transformer T1.
3. Check and confirm load network between FDA outputs and transformer T1.
4. Confirm control signals power-down (PD) and output common-mode voltage control (VOCM)
   a. Do one of the following:
      i. Float SMA connections and let the FDA set the control pins internally
      ii. Force PD voltage using J10 jumper to VCC+ or VCC- as power-down control
      iii. Drive an external signal into PD and/or VOCM
      iv. PD default is to have FDA turned 'ON' (active-low PD)
      v. VOCM default is to have FDA VOCM biased to mid-supply
5. Begin evaluation of FDA using DEM-FDA-RUN-EVM

2.3 FDA Input Network Options

The input connections for DEM-FDA-RUN-EVM depend on several key factors:

- Single-ended or differential input signal
- Configuration and use of multiple feedback filter pads (MFB)
- Setting the desired gain or attenuation

The default configuration of the EVM is to not use the MFB filter configuration, but be in a base FDA configuration with differential inputs. The default gain is 1V/V, also referred to as a buffer or unity-gain setup.

Modifications:

1. To change from differential to single-ended inputs:

a. Set termination resistor (either R9 or R4) of the active input according to FDA datasheet recommendations
b. Set termination resistor (either R9 or R4) of the inactive, unused input according to FDA datasheet recommendations
c. An FDA web calculator is available for investigating single-ended input values.
d. R9 and R4 will be different values to account for terminating the unused input path

2. To set up MFB Filter:
   a. Calculate your MFB filter values through your preferred method
   b. Use R21, R20, R22, C6, R6, R7, as the input and gain-setting passives for the MFB filter
   c. Use R3, C4, R18 & R10, C7, R24 as the feedback path passives for the MFB filter
   d. Confirm values and proceed with evaluation
3. To change the gain-setting:
   a. Gain is set by RG and RF resistors. For example, on DEM-FDA-RUN-EVM the combination of R3 and R6, as well as the mirrored R10 and R7, set the amplifier gain.
   b. For an FDA the relationship is: Av (Gain) = RF / RG
   c. Please change RF and/or RG to accommodate the desired gain or attenuation

2.4 Active MFB Filter

The concepts of a multiple-feedback topology filter (MFB) have been discussed in greater detail and focus than will be covered in this section. However, a few resources should be presented, including:

- Active Filter Design for Differential ADCs
- Design Methodology for MFB Filters in ADC Interface Applications
- Filter Example in THS4551 Application Section (Datasheet)

The summary of components to revise, included in an MFB filter implementation on the DEM-FDA-RUN-EVM are:

- R20 & R22: zero-Ohm resistors which become gain-setting (RG) resistors
- R21 & C6: either passive can be used for resistor or capacitor for filter
- R6 & R7: RG resistors which become series filter resistors (or capacitors) for MFB
- R18, C4, R3, R24, C7, R24: feedback components for MFB setup (including feedback resistor RF and feedback capacitor CF)

Please refer to the first link for considerations for translating an op-amp MFB filter to an FDA MFB filter.

2.5 Control Signals

Power Down (PD):

The power down functionality of an amplifier is intended to provide a separate state from normal operation while still keeping the power supplies connected to the amplifier. The main components of a power down condition are:

1. The control signal: how to set and change the power down setting
   a. There is often an inverse polarity to the logic for power down, such as a low voltage (a logic '0') placing the device into power down, while a higher voltage (logic '1') maintains normal amplification.
   b. Power down control signals are specified with threshold voltages. Setting the PD pin above or below these specified voltages allows for expected control. There is an interim voltage range where the behavior is not strictly known. It is advised to not keep the control signal in the unspecified voltage range, which does not guarantee appropriate power down behavior.
   c. There is often a default condition if the PD pin is 'floated', or not connected. Refer to the amplifier datasheet for threshold voltage, control voltage, and default pin behavior information.
2. The quiescent current: the power draw of the amplifier while in power down
   a. One key benefit of using the power down feature is the reduction in operating current, known as quiescent current
   b. The quiescent current, Iq, is often reduced by 10x or 100x compared to the operating current of the amplifiers 'active' mode. For the DEM-FDA-RUN-EVM, the Iq drops from ~4.7mA to 20µA.
3. The output impedance: the resistance at the output stage of the amplifier changes when in power down
   a. It is common for an amplifiers power down behavior to include setting the output stage to be high impedance. This modifies the expected low impedance of the amplifier output stage during active mode (not in power down state. The change in output impedance affects the connected circuitry, as the output stage no longer sinks or sources current.
   b. **Note:** While the output stage may be high impedance, your feedback networks (one for each side of the fully differential amplifier) still allow current flow across your feedback resistor (RF). This is a key understanding for applications and systems where a high-impedance setting on the amplifier is preferred.
4. **Power Cycling Note**: when you remove the supply voltages entirely, such as for power cycling or other energy management, the control features from power down are not available. The amplifier does not have internal current and pull-up resistors setting the output stage to high impedance. Instead the amplifier keeps the low impedance output stage.
5. The DEM-FDA-RUN-EVM has circuitry and control jumpers to accommodate various PD configurations. There is also an impedance-matched (50 Ohm) trace to the SMA connector for external signal control.

Output Common Mode Voltage Control (VOCM):

The output common mode voltage control signal, known as VOCM, is a key internal function of the fully differential amplifier (FDA) architecture type. The internal error amplifier compares the sensed output common mode voltage to the control signal set at the VOCM pin. The resulting correction shifts the behavior of the FDA to set the appropriate output common mode voltage. This behavior is key for driving the inputs of fully differential analog-to-digital converters. The main components of VOCM functionality are:

1. VOCM has a default behavior: internal pull-up resistors set the VOCM to mid-supply (halfway point between positive and negative supplies). This default bias operates for single supply, split supply (balanced), and split supply (unbalanced) configurations of the amplifier.
2. The VOCM pin accepts a control signal which has priority (overrides) the default behavior. The VOCM pin can be set to a static (steady-state) DC voltage. This voltage is commonly the VCM (common mode voltage) output pin of the connected data converter. Additionally, the VOCM pin can be driven by a time varying signal if the output common mode must be adjusted.
3. The DEM-FDA-RUN-EVM has proper component placement and unused pads to allow for various VOCM conditions. There is also an impedance-matched (50Ω) trace to the SMA connector for external signal control.

2.6 Test Points and Jumpers

The summary of test points:

- Ground test points: 4x total, labeled TP1/TP2/TP3/TP4

The summary of jumpers:

- PD Control Jumper: 1x, labeled PD with V+ and V- connections to supply voltages

2.7 Best Practices

While key ideas and recommendations were included per section in this document, there are several overview recommendations:

- Confirm FDA connections to DEM-FDA-RUN-EVM with appropriate solder and rework analysis
- Confirm Iq (operating current) of FDA prior to testing
- Confirm the intended setup of input/output connections:
  - Input network: single-ended versus differential, proper termination (RT) resistors (traces are 50Ω impedance matched)
  - Output network: transformer use, single-ended and differential, proper termination (RT) resistors for unused output SMAs, use of any attenuator or filtering on output
- Confirm RF and RG match for both feedback paths. The FDA needs symmetrical feedback networks to function as intended.
- FDAs require both outputs to operate. Unless you are using a transformer or impedance network in your application (system) circuit, you must expect to use both FDA outputs. Proper connection of only one of the FDA outputs results in reduced performance, lower robustness, and present debugging issues to the engineer.
- Go slow: check the values in simulation or by calculation prior to setting-up the DEM-FDA-RUN-EVM.

3 Hardware Design Files

3.1 Schematics

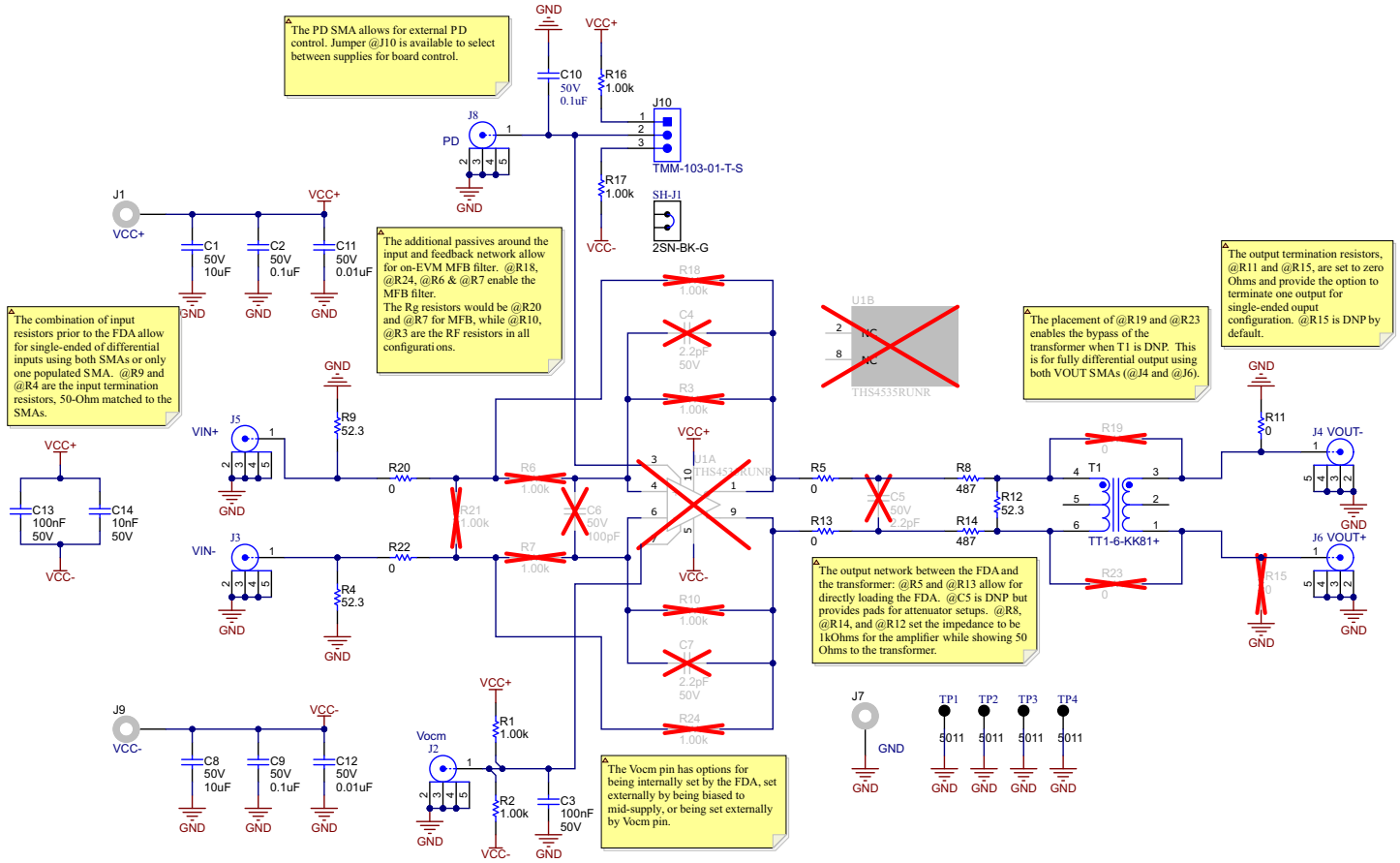

Figure 3-1. DEM-FDA-RUN-EVM Schematic

3.2 PCB Layouts

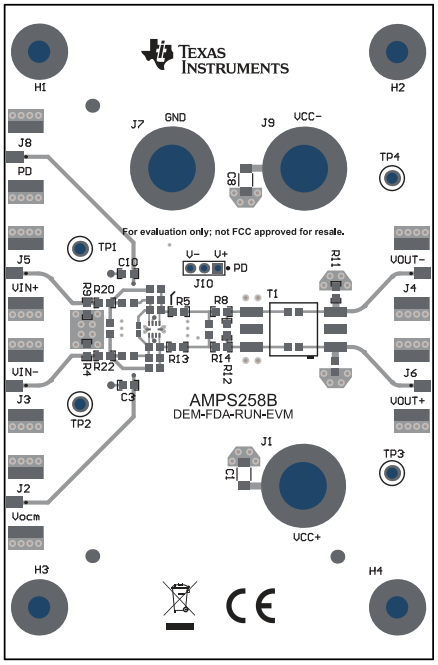

Figure 3-2. DEM-FDA-RUN-EVM Top Layer

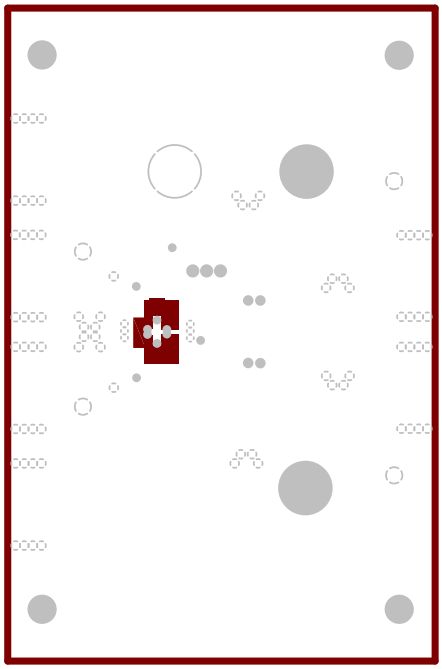

Figure 3-3. DEM-FDA-RUN-EVM GND Plane

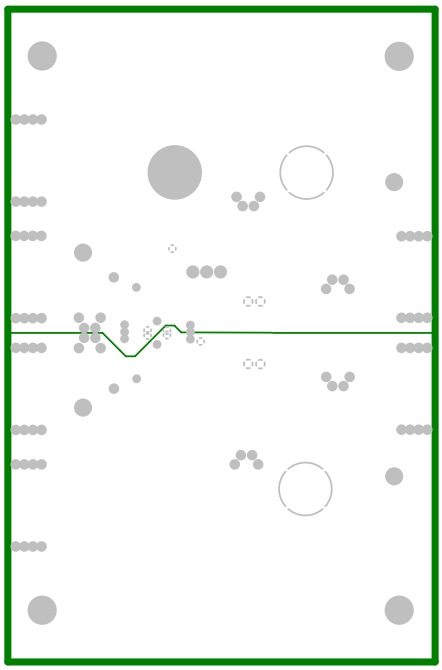

Figure 3-4. DEM-FDA-RUN-EVM Split Power Plane

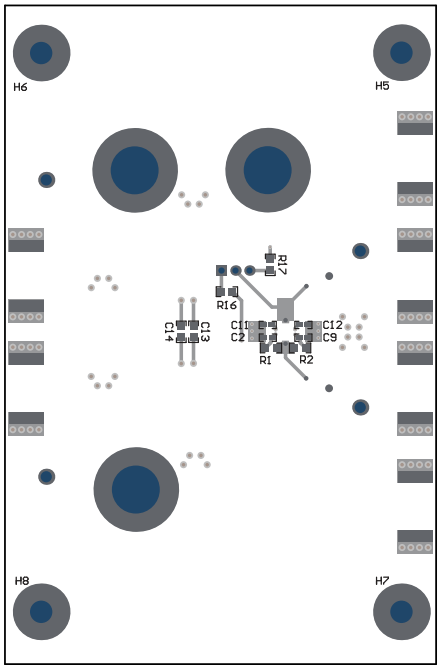

Figure 3-5. DEM-FDA-RUN-EVM Bottom Layer

3.3 Bill of Materials (BOM)

Table 3-1. Bill of Materials

Designator	Quantity	Value	Description	Package Reference	Part Number	Manufacturer
C1, C8	2	10uF	CAP, CERM, 10uF, 50V, +/- 10%, X7T, 1206_190	1206_190	GCM31CD71H106K	MuRata
C2, C9	2	0.1uF	CAP, CERM, 0.1uF, 50V, +/- 10%, X7R, 0402	0402	C1005X7R1H104K050BB	TDK
C3, C10, C13	3	0.1uF	CAP, CERM, 0.1uF, 50V, +/- 10%, X7R, 0603	0603	C1608X7R1H104K080AA	TDK
C11, C12	2	0.01uF	CAP, CERM, 0.01uF, 50V, +/- 10%, X7R, AEC-Q200 Grade 1, 0402	0402	CGA2B3X7R1H103K050BB	TDK
C14	1	0.01uF	CAP, CERM, 0.01uF, 50V, +/- 10%, X7R, 0603	0603	C1608X7R1H103K080AA	TDK
H1, H2, H3, H4	4		Machine Screw, Round, #4-40 x 1/4, Nylon, Philips panhead	Screw	NY PMS 440 0025 PH	B&F Fastener Supply
H5, H6, H7, H8	4		Standoff, Hex, 0.5"L #4-40 Nylon	Standoff	1902C	Keystone
J1, J7, J9	3		Standard Banana Jack, Uninsulated, 15A	Banana Jack	108-0740-001	Cinch Connectivity
J2, J3, J4, J5, J6, J8	6		SMA JACK 50Ω EDGE MNT, SMT	SMA JACK 50Ω EDGE MNT, SMT	901-10309	Amphenol-Tuchel Electronics
J10	1		Header, 2mm, 3 × 1, Tin, TH	Header, 2mm, 3 × 1	TMM-103-01-T-S	Samtec
R1, R2, R16, R17	4	1.00k	RES, 1.00k, 1%, 0.1W, 0603	0603	RC0603FR-071KL	Yageo
R4, R9, R12	3	52.3	RES, 52.3, 1%, 0.1W, 0603	0603	RC0603FR-0752R3L	Yageo
R5, R11, R13, R20, R22	5	0	RES, 0, 1%, 0.1W, AEC-Q200 Grade 0, 0603	0603	RMCF0603ZT0R00	Stackpole Electronics Inc
R8, R14	2	487	RES, 487, 0.5%, 0.1W, 0603	0603	RT0603DRE07487RL	Yageo America
SH-J1	1	1x2	Shunt, 2mm, Gold plated, Black	2mm Shunt, Closed Top	2SN-BK-G	Samtec
T1	1		RF Transformer, 50ohm, 0.004 to 300MHz, SMT	7.62 × 6.86mm	TT1-6-KK81+	Minicircuits
TP1, TP2, TP3, TP4	4		Test Point, Multipurpose, Black, TH	Black Multipurpose Test point	5011	Keystone Electronics
C4, C5, C7	0	2.2pF	CAP, CERM, 2.2pF, 50V, +/- 11%, C0G/NP0, 0603	0603	06035A2R2CAT2A	AVX
C6	0	100pF	CAP, CERM, 100pF, 50V, +/- 5%, C0G/NP0, AEC-Q200 Grade 1, 0402	0402	CGA2B2C0G1H101J050BA	TDK
FID1, FID2, FID3	0		Fiducial mark. There is nothing to buy or mount.	N/A	N/A	N/A
R3, R6, R7, R10, R18, R21, R24	0	1.00k	RES, 1.00k, 1%, 0.1W, 0603	0603	RC0603FR-071KL	Yageo

Table 3-1. Bill of Materials (continued)

Designator	Quantity	Value	Description	Package Reference	Part Number	Manufacturer
R15, R19, R23	0	0	RES, 0, 1%, 0.1W, AEC-Q200 Grade 0, 0603	0603	RMCF0603ZT0R00	Stackpole Electronics Inc
U1	0		High-Precision, 80MHz, Fully Differential Amplifier	WQFN10	THS4535RUNR	Texas Instruments

4 Additional Information

4.1 Trademarks

All trademarks are the property of their respective owners.

STANDARD TERMS FOR EVALUATION MODULES

1. *Delivery:* TI delivers TI evaluation boards, kits, or modules, including any accompanying demonstration software, components, and/or documentation which may be provided together or separately (collectively, an “EVM” or “EVMs”) to the User (“User”) in accordance with the terms set forth herein. User's acceptance of the EVM is expressly subject to the following terms.

   1.1 EVMs are intended solely for product or software developers for use in a research and development setting to facilitate feasibility evaluation, experimentation, or scientific analysis of TI semiconductors products. EVMs have no direct function and are not finished products. EVMs shall not be directly or indirectly assembled as a part or subassembly in any finished product. For clarification, any software or software tools provided with the EVM (“Software”) shall not be subject to the terms and conditions set forth herein but rather shall be subject to the applicable terms that accompany such Software

   1.2 EVMs are not intended for consumer or household use. EVMs may not be sold, sublicensed, leased, rented, loaned, assigned, or otherwise distributed for commercial purposes by Users, in whole or in part, or used in any finished product or production system.

2 *Limited Warranty and Related Remedies/Disclaimers*:

   2.1 These terms do not apply to Software. The warranty, if any, for Software is covered in the applicable Software License Agreement.

   2.2 TI warrants that the TI EVM will conform to TI's published specifications for ninety (90) days after the date TI delivers such EVM to User. Notwithstanding the foregoing, TI shall not be liable for a nonconforming EVM if (a) the nonconformity was caused by neglect, misuse or mistreatment by an entity other than TI, including improper installation or testing, or for any EVMs that have been altered or modified in any way by an entity other than TI, (b) the nonconformity resulted from User's design, specifications or instructions for such EVMs or improper system design, or (c) User has not paid on time. Testing and other quality control techniques are used to the extent TI deems necessary. TI does not test all parameters of each EVM. User's claims against TI under this Section 2 are void if User fails to notify TI of any apparent defects in the EVMs within ten (10) business days after delivery, or of any hidden defects with ten (10) business days after the defect has been detected.

   2.3 TI's sole liability shall be at its option to repair or replace EVMs that fail to conform to the warranty set forth above, or credit User's account for such EVM. TI's liability under this warranty shall be limited to EVMs that are returned during the warranty period to the address designated by TI and that are determined by TI not to conform to such warranty. If TI elects to repair or replace such EVM, TI shall have a reasonable time to repair such EVM or provide replacements. Repaired EVMs shall be warranted for the remainder of the original warranty period. Replaced EVMs shall be warranted for a new full ninety (90) day warranty period.

WARNING

Evaluation Kits are intended solely for use by technically qualified, professional electronics experts who are familiar with the dangers and application risks associated with handling electrical mechanical components, systems, and subsystems.

User shall operate the Evaluation Kit within TI’s recommended guidelines and any applicable legal or environmental requirements as well as reasonable and customary safeguards. Failure to set up and/or operate the Evaluation Kit within TI’s recommended guidelines may result in personal injury or death or property damage. Proper set up entails following TI’s instructions for electrical ratings of interface circuits such as input, output and electrical loads.

NOTE:

EXPOSURE TO ELECTROSTATIC DISCHARGE (ESD) MAY CAUSE DEGREDATION OR FAILURE OF THE EVALUATION KIT; TI RECOMMENDS STORAGE OF THE EVALUATION KIT IN A PROTECTIVE ESD BAG.

3 *Regulatory Notices:*

3.1 *United States*

3.1.1 *Notice applicable to EVMs not FCC-Approved:*

FCC NOTICE: This kit is designed to allow product developers to evaluate electronic components, circuitry, or software associated with the kit to determine whether to incorporate such items in a finished product and software developers to write software applications for use with the end product. This kit is not a finished product and when assembled may not be resold or otherwise marketed unless all required FCC equipment authorizations are first obtained. Operation is subject to the condition that this product not cause harmful interference to licensed radio stations and that this product accept harmful interference. Unless the assembled kit is designed to operate under part 15, part 18 or part 95 of this chapter, the operator of the kit must operate under the authority of an FCC license holder or must secure an experimental authorization under part 5 of this chapter.

3.1.2 *For EVMs annotated as FCC – FEDERAL COMMUNICATIONS COMMISSION Part 15 Compliant:*

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.

FCC Interference Statement for Class A EVM devices

NOTE: 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.

FCC Interference Statement for Class B EVM devices

NOTE: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- *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.*

3.2 *Canada*

3.2.1 *For EVMs issued with an Industry Canada Certificate of Conformance to RSS-210 or RSS-247*

Concerning EVMs Including Radio Transmitters:

This device complies with Industry Canada license-exempt RSSs. Operation is subject to the following two conditions:

(1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

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.

Concerning EVMs Including Detachable Antennas:

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.

Concernant les EVMs avec antennes détachables

Conformément à la réglementation d'Industrie Canada, le présent émetteur radio peut fonctionner avec une antenne d'un type et d'un gain maximal (ou inférieur) approuvé pour l'émetteur par Industrie Canada. Dans le but de réduire les risques de brouillage radioélectrique à l'intention des autres utilisateurs, il faut choisir le type d'antenne et son gain de sorte que la puissance isotrope rayonnée équivalente (p.i.r.e.) ne dépasse pas l'intensité nécessaire à l'établissement d'une communication satisfaisante. Le présent émetteur radio a été approuvé par Industrie Canada pour fonctionner avec les types d'antenne énumérés dans le manuel d'usage et ayant un gain admissible maximal et l'impédance requise pour chaque type d'antenne. Les types d'antenne non inclus dans cette liste, ou dont le gain est supérieur au gain maximal indiqué, sont strictement interdits pour l'exploitation de l'émetteur

3.3 *Japan*

3.3.1 *Notice for EVMs delivered in Japan:* Please see http://www.tij.co.jp/lsds/ti_ja/general/eStore/notice_01.page 日本国内に輸入される評価用キット、ボードについては、次のところをご覧ください。

https://www.ti.com/ja-jp/legal/notice-for-evaluation-kits-delivered-in-japan.html

3.3.2 *Notice for Users of EVMs Considered "Radio Frequency Products" in Japan:* EVMs entering Japan may not be certified by TI as conforming to Technical Regulations of Radio Law of Japan.

If User uses EVMs in Japan, not certified to Technical Regulations of Radio Law of Japan, User is required to follow the instructions set forth by Radio Law of Japan, which includes, but is not limited to, the instructions below with respect to EVMs (which for the avoidance of doubt are stated strictly for convenience and should be verified by User):

1. Use EVMs in a shielded room or any other test facility as defined in the notification #173 issued by Ministry of Internal Affairs and Communications on March 28, 2006, based on Sub-section 1.1 of Article 6 of the Ministry's Rule for Enforcement of Radio Law of Japan,
2. Use EVMs only after User obtains the license of Test Radio Station as provided in Radio Law of Japan with respect to EVMs, or
3. Use of EVMs only after User obtains the Technical Regulations Conformity Certification as provided in Radio Law of Japan with respect to EVMs. Also, do not transfer EVMs, unless User gives the same notice above to the transferee. Please note that if User does not follow the instructions above, User will be subject to penalties of Radio Law of Japan.

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1. 電波法施行規則第6条第1項第1号に基づく平成18年3月28日総務省告示第173号で定められた電波暗室等の試験設備でご使用いただく。
2. 実験局の免許を取得後ご使用いただく。
3. 技術基準適合証明を取得後ご使用いただく。

なお、本製品は、上記の「ご使用にあたっての注意」を譲渡先、移転先に通知しない限り、譲渡、移転できないものとします。

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東京都新宿区西新宿 6 丁目 2 4 番 1 号

西新宿三井ビル

3.3.3 *Notice for EVMs for Power Line Communication:* Please see http://www.tij.co.jp/lsds/ti_ja/general/eStore/notice_02.page

電力線搬送波通信についての開発キットをお使いになる際の注意事項については、次のところをご覧ください。https://www.ti.com/ja-jp/legal/notice-for-evaluation-kits-for-power-line-communication.html

3.4 *European Union*

3.4.1 *For EVMs subject to EU Directive 2014/30/EU (Electromagnetic Compatibility Directive)*:

This is a class A product intended for use in environments other than domestic environments that are connected to a low-voltage power-supply network that supplies buildings used for domestic purposes. In a domestic environment this product may cause radio interference in which case the user may be required to take adequate measures.

4 *EVM Use Restrictions and Warnings:*

4.1 EVMS ARE NOT FOR USE IN FUNCTIONAL SAFETY AND/OR SAFETY CRITICAL EVALUATIONS, INCLUDING BUT NOT LIMITED TO EVALUATIONS OF LIFE SUPPORT APPLICATIONS.

4.2 User must read and apply the user guide and other available documentation provided by TI regarding the EVM prior to handling or using the EVM, including without limitation any warning or restriction notices. The notices contain important safety information related to, for example, temperatures and voltages.

4.3 *Safety-Related Warnings and Restrictions:*

4.3.1 User shall operate the EVM within TI's recommended specifications and environmental considerations stated in the user guide, other available documentation provided by TI, and any other applicable requirements and employ reasonable and customary safeguards. Exceeding the specified performance ratings and specifications (including but not limited to input and output voltage, current, power, and environmental ranges) for the EVM may cause personal injury or death, or property damage. If there are questions concerning performance ratings and specifications, User should contact a TI field representative prior to connecting interface electronics including input power and intended loads. Any loads applied outside of the specified output range may also result in unintended and/or inaccurate operation and/or possible permanent damage to the EVM and/or interface electronics. Please consult the EVM user guide prior to connecting any load to the EVM output. If there is uncertainty as to the load specification, please contact a TI field representative. During normal operation, even with the inputs and outputs kept within the specified allowable ranges, some circuit components may have elevated case temperatures. These components include but are not limited to linear regulators, switching transistors, pass transistors, current sense resistors, and heat sinks, which can be identified using the information in the associated documentation. When working with the EVM, please be aware that the EVM may become very warm.

4.3.2 EVMs are intended solely for use by technically qualified, professional electronics experts who are familiar with the dangers and application risks associated with handling electrical mechanical components, systems, and subsystems. User assumes all responsibility and liability for proper and safe handling and use of the EVM by User or its employees, affiliates, contractors or designees. User assumes all responsibility and liability to ensure that any interfaces (electronic and/or mechanical) between the EVM and any human body are designed with suitable isolation and means to safely limit accessible leakage currents to minimize the risk of electrical shock hazard. User assumes all responsibility and liability for any improper or unsafe handling or use of the EVM by User or its employees, affiliates, contractors or designees.

4.4 User assumes all responsibility and liability to determine whether the EVM is subject to any applicable international, federal, state, or local laws and regulations related to User's handling and use of the EVM and, if applicable, User assumes all responsibility and liability for compliance in all respects with such laws and regulations. User assumes all responsibility and liability for proper disposal and recycling of the EVM consistent with all applicable international, federal, state, and local requirements.

5. *Accuracy of Information:* To the extent TI provides information on the availability and function of EVMs, TI attempts to be as accurate as possible. However, TI does not warrant the accuracy of EVM descriptions, EVM availability or other information on its websites as accurate, complete, reliable, current, or error-free.

6. *Disclaimers:*

6.1 EXCEPT AS SET FORTH ABOVE, EVMS AND ANY MATERIALS PROVIDED WITH THE EVM (INCLUDING, BUT NOT LIMITED TO, REFERENCE DESIGNS AND THE DESIGN OF THE EVM ITSELF) ARE PROVIDED "AS IS" AND "WITH ALL FAULTS." TI DISCLAIMS ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, REGARDING SUCH ITEMS, INCLUDING BUT NOT LIMITED TO ANY EPIDEMIC FAILURE WARRANTY OR IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE OR NON-INFRINGEMENT OF ANY THIRD PARTY PATENTS, COPYRIGHTS, TRADE SECRETS OR OTHER INTELLECTUAL PROPERTY RIGHTS.

6.2 EXCEPT FOR THE LIMITED RIGHT TO USE THE EVM SET FORTH HEREIN, NOTHING IN THESE TERMS SHALL BE CONSTRUED AS GRANTING OR CONFERRING ANY RIGHTS BY LICENSE, PATENT, OR ANY OTHER INDUSTRIAL OR INTELLECTUAL PROPERTY RIGHT OF TI, ITS SUPPLIERS/LICENSORS OR ANY OTHER THIRD PARTY, TO USE THE EVM IN ANY FINISHED END-USER OR READY-TO-USE FINAL PRODUCT, OR FOR ANY INVENTION, DISCOVERY OR IMPROVEMENT, REGARDLESS OF WHEN MADE, CONCEIVED OR ACQUIRED.

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