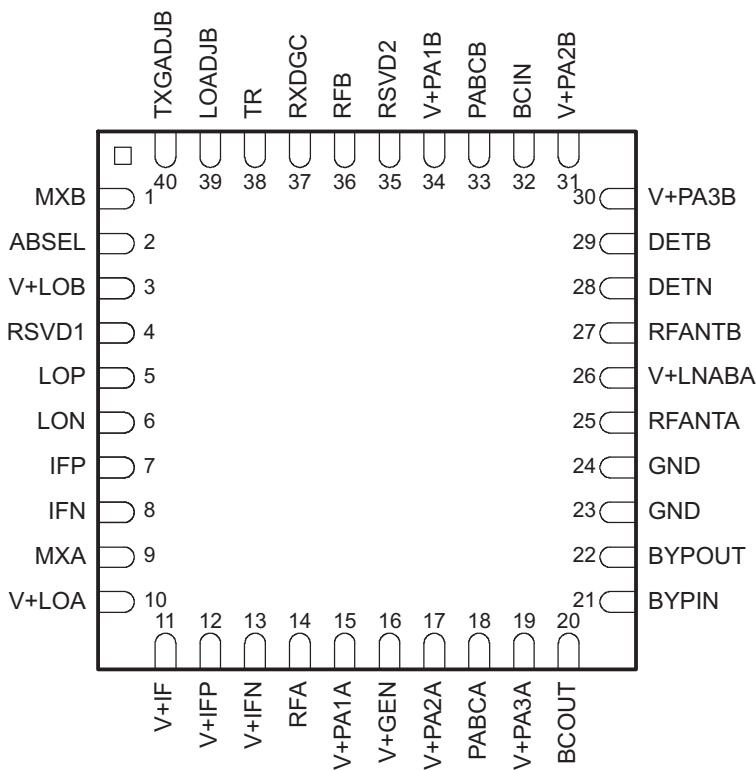


High-Power Dual-Band (2.4-GHz to 2.5-GHz and 4.9-GHz to 5.9-GHz) RF Front-End

FEATURES

- Highly Integrated 802.16 d/e Radio Frequency Front End ASIC
- Fully Integrated Up/Down Converters, LNAs, PAs and T/R Switches
- Super Heterodyne Architecture for Superior Adjacent Channel Rejection Performance
- Differential LO and IF Interface for Enhanced Spurious/EMI Performance
- Common Frequency Plan uses a Single LO and Common IF for Single IF Filter for Both Bands
- Integrated Temperature Compensated TX Power Detectors
- PA Bias Control Function
- Antenna Port $OP_{1dB} = +23$ dBm Typical
- Antenna Port $OIP3 = +33$ dBm, Typical
- Frequency Range: 2.4 to 2.5 and 4.9 to 5.9 GHz
- Noise Figure: 4 dB ISM Band, 6 dB 5 GHz Bands Typical
- Typical Gain: 38 dB TX, 20 dB RX
- IF = 374 MHz

TRF2436 PACKAGE
(TOP VIEW)



Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.



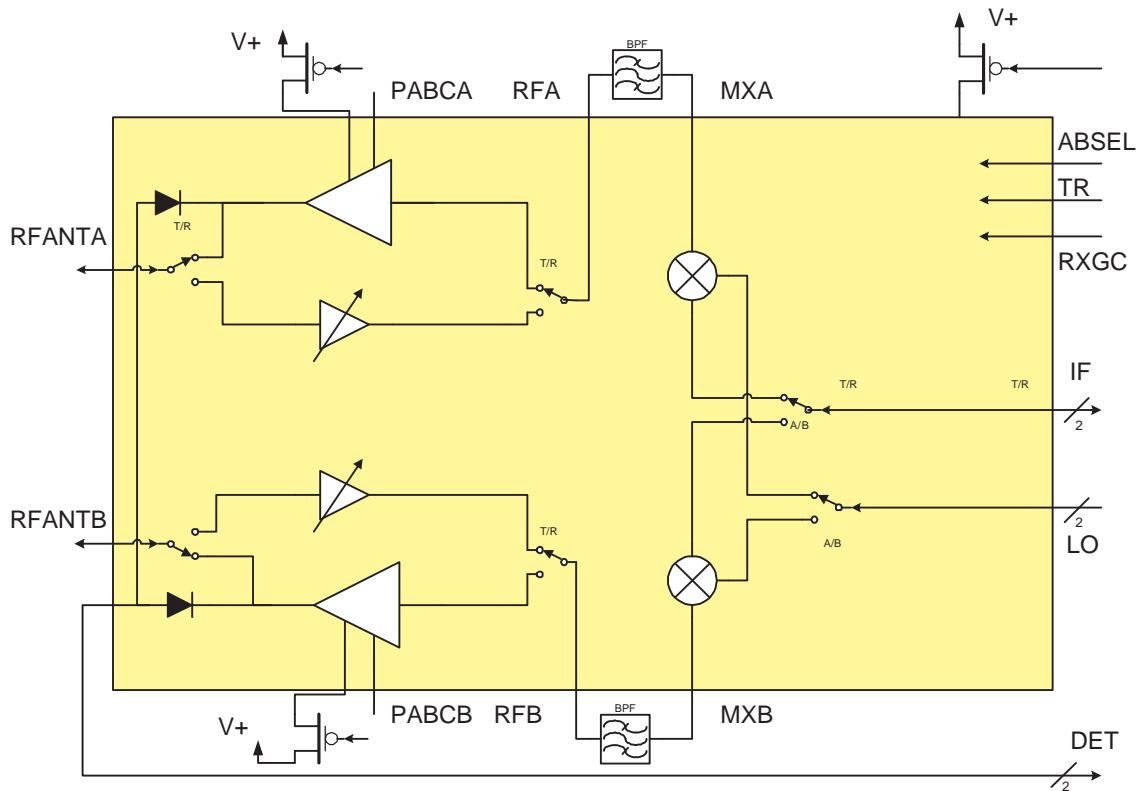
These devices have limited built-in ESD protection. The leads should be shorted together or the device placed in conductive foam during storage or handling to prevent electrostatic damage to the MOS gates.

DESCRIPTION

The TRF2436 is a fully integrated Dual Band Tri Mode Radio Frequency Front End (RFFE) designed specifically for use in 802.16 d/e applications. The TRF2436 is designed to perform RF up and down conversions in the unlicensed ISM and 4.9-5.9 GHz bands. The TRF2436 uses a common IF frequency for both bands, eliminating the need for additional IF filtering. Combined with the TI TRF2432 IF/IQ Transceiver/Synthesizer, the TRF2436 completes the TI WLAN two-chip radio.

The TRF2436 incorporates all of the RF blocks for both the “b” and “a” bands except for low cost ceramic filters. The ASIC includes LNAs, PAs, mixers, bias circuitry, RX gain control, transmit coupler detectors, and T/R switches. High integration and internal RF matching enhances performance and greatly reduce external part count. The only external components needed (other than simple passives) for operation are RF filters and external low power DC switching FETs.

Functional Block Diagram



DEVICE INFORMATION

TERMINAL FUNCTIONS

| TERMINAL | | I/O | TYPE | DESCRIPTION |
|----------|-----|-----|---------|--|
| NAME | NO. | | | |
| MXB | 1 | I/O | RF SE | B band RF Input/Output to mixer. 50-Ω single ended. Do not apply DC. |
| ABSEL | 2 | I | Digital | Band select pin. HIGH = A-band. LOW = B-band. |
| V+LOB | 3 | I | Power | B band LO amplifier bias +3.3V |
| RSVD1 | 4 | - | - | Not connected for normal operation. Leave Open. |
| LOP | 5 | I | RF Dif. | LO input (differential) Positive, AC coupled |

DEVICE INFORMATION (continued)
TERMINAL FUNCTIONS (continued)

| TERMINAL | | I/O | TYPE | DESCRIPTION |
|----------|--------|-----|---------|---|
| NAME | NO. | | | |
| LON | 6 | I | RF Dif. | LO input (differential) Negative, AC coupled |
| IFP | 7 | I/O | RF Dif. | IF input/output (differential) Positive, DC coupled, typical DC Voltage is 2.6V |
| IFN | 8 | I/O | RF Dif. | IF input/output(differential) Negative, DC coupled, typical DC Voltage is 2.6V |
| MXA | 9 | I/O | RF SE | A band RF Input/Output to mixer. 50-Ω single ended. Do not apply DC. |
| V+LOA | 10 | I | Power | A band LO amplifier bias +3.3V |
| V+IF | 11 | I | Power | IF amplifier bias +3.3V. |
| V+IFP | 12 | I | Power | IFP amplifier bias +3.3V. |
| V+IFN | 13 | I | Power | IFN amplifier bias +3.3V. |
| RFA | 14 | I/O | RF SE | A Band RF Input/Output to PA/LNA. 50-Ω single ended. AC coupled. |
| V+PA1A | 15 | I | Power | A band Power amplifier bias +3.3V. |
| V+GEN | 16 | I | Power | DC Bias Control Bias +3.3V. |
| V+PA2A | 17 | I | Power | A band Power amplifier bias +3.3V. |
| PABCA | 18 | - | - | A band PA Bias Control Input |
| V+PA3A | 19 | - | - | A band Power amplifier bias +3.3V. |
| BCOUT | 20 | O | Analog | Bias Control Output. |
| BYPIN | 21 | I | Analog | DC Bias Bypass Input |
| BYPOUT | 22 | O | Analog | DC Bias Bypass Output |
| GND | 23, 24 | - | - | Connect to ground |
| RFANTA | 25 | I/O | RF SE | A band RF in/out to antennas. AC coupled. |
| V+LNABA | 26 | I | Power | A and B Band LNA bias +3.3V. |
| RFANTB | 27 | I/O | RF SE | B band RF in/out to antennas. AC coupled. |
| DETN | 28 | O | Analog | Negative RF power detector output |
| DETP | 29 | O | Analog | Positive RF power detector output. |
| V+PA3B | 30 | I | Power | B band Power amplifier bias +3.3V. |
| V+PA2B | 31 | I | Power | B band Power amplifier bias +3.3V. |
| BCIN | 32 | I | Analog | Bias control input |
| PABCB | 33 | - | - | B band PA Bias Control Input |
| V+PA1B | 34 | I | Power | B band Power amplifier bias +3.3V. |
| RSVD2 | 35 | - | - | Not Connected for normal operation. Leave Open. |
| RFB | 36 | I/O | RF SE | B band RF Input/Output to PA/LNA. 50-Ω single ended. AC coupled. |
| RXDGC | 37 | I | Digital | Rx Gain Control. HIGH = minimum gain. LOW = maximum gain |
| TR | 38 | I | Digital | Transmit/Receive mode control. HIGH = transmit. LOW = receive. |
| LOADJB | 39 | - | - | Not connected for normal operation. Leave Open. B band LO amp bias adjust. |
| TXGADJB | 40 | - | - | Not connected for normal operation. Leave open. PAB Amplifier bias adjust. |

ABSOLUTE MAXIMUM RATINGS

over operating free-air temperature range (unless otherwise noted)

| | | | VALUE | UNIT |
|------------------|-------------------------------------|-----------------------|------------|------|
| V _{CC} | DC supply voltage | | 0 to 6.9 | V |
| I _{CC} | DC supply current | | 600 | mA |
| | RF input power | Any port and any mode | 10 | dBm |
| V _{ID} | Digital input voltage | | -0.3 to 5 | V |
| T _{JC} | Junction temperature | | 175 | °C |
| θ _{JC} | Thermal resistance junction-to-case | | 35 | °C/W |
| T _A | Operating temperature | | -20 to 85 | °C |
| T _{stg} | Storage temperature | | -40 to 105 | °C |
| | Lead temperature | 40 sec maximum | 220 | °C |

DC CHARACTERISTICSTYP ratings are at 25°C and V_{CC} = 3.3 V, MIN and MAX ratings are over operating free-air temperature and voltage ranges (unless otherwise noted)

| PARAMETER | | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|-----------------|--------------------------|---------------------------------|-----|-----|-----|------|
| V _{CC} | Supply voltage | Specification compliant | 2.7 | 3.3 | 4.2 | V |
| I _{CC} | Total supply current | B Band, RX Mode | | 65 | 105 | mA |
| | | A Band, RX Mode | | 80 | 120 | mA |
| | | B Band, TX Mode, Max PABC input | | 410 | 520 | mA |
| | | A Band, TX Mode, Max PABC input | | 450 | 550 | mA |
| V _{IH} | High-level input voltage | | 1.7 | | | V |
| V _{IL} | Low-level input voltage | | | | 0.5 | V |
| I _{IH} | High-level input current | | | 100 | 300 | μA |
| I _{IL} | Low-level input current | | | | -50 | μA |

RECEIVER CHARACTERISTICSTR = Low, 2 dB base band filter loss in RX band, MIN, TYP, and MAX rating are at 25°C and V_{CC} = 3.3 V (unless otherwise noted)

| PARAMETER | | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|------------------|--------------------|-----------------------------------|------|-----|------|------|
| f _{IRF} | RF input frequency | B band | 2400 | | 2500 | MHz |
| | | A band | 4900 | | 5900 | |
| f _{LO} | LO input frequency | B band | 2774 | | 2874 | MHz |
| | | A band | 2637 | | 3137 | |
| f _{IF} | IF input frequency | | | 374 | | MHz |
| G | Gain | B Band High Gain Mode RXGC=LOW | 17 | 19 | | dB |
| | | A Band High Gain Mode RXGC=LOW | 18 | 23 | | |
| ΔG | Gain step size | B Band Low Gain Mode RXGC=HIGH | | 25 | | dB |
| | | A Band Low Gain Mode RXGC=HIGH | | 15 | | |
| | Noise figure | B Band. Max Gain | | 4 | 5 | dB |
| | | A Band. Max Gain | | 6 | 7.5 | |

RECEIVER CHARACTERISTICS (continued)

TR = Low, 2 dB base band filter loss in RX band, MIN, TYP, and MAX rating are at 25°C and $V_{CC} = 3.3$ V (unless otherwise noted)

| PARAMETER | | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|---------------------------------|--------------------------------------|--|-----|-----|-----|------|
| Input P _{-1dB} | | B Band High Gain Mode RXGC=LOW | -16 | -13 | | dBm |
| | | B Band Low Gain Mode RXGC=HIGH | | | | |
| | | A Band High Gain Mode RXGC=LOW | -22 | -18 | | |
| | | A Band Low Gain Mode RXGC=HIGH | -16 | -13 | | |
| Input 3rd order intercept point | | B Band High Gain Mode RXGC=LOW | -6 | -2 | | dBm |
| | | B Band Low Gain Mode RXGC=HIGH | 4 | 8 | | |
| | | A Band High Gain Mode RXGC=LOW | -12 | -8 | | |
| | | A Band Low Gain Mode RXGC=HIGH | -6 | -3 | | |
| RF input return loss | Z = 50 Ω Both Bands, Both Gain modes | 8 | | | dB | |
| LNA out return loss RF | Z = 50 Ω Both Bands, Both Gain modes | 9 | | | dB | |
| Mixer input MX return loss | Z = 50 Ω Both Bands | 10 | | | dB | |
| Output return loss | Measured into 200 Ω differential | 10 | | | dB | |
| LO at MX leakage | | B band | | -30 | | dBm |
| | | A Band (5274-6274 MHz) | | -30 | | |
| LO at IF leakage | | Both bands | | -40 | | dBm |
| Gain flatness full band | | B band | | 1 | | dB |
| | | A band | | 2 | | |
| Gain flatness / 22 MHz | | Both bands | | | | dB |
| Gain settling time | | Full range to within 0.5 dB final. All bands | | 0.3 | | μs |
| RF to RFANT isolation | | In Band: B Band High Gain Mode RXGC=LOW | | 30 | | dB |
| | | In Band: B Band Low Gain Mode RXGC=HIGH | | 5 | | |
| | | In Band: A Band High Gain Mode RXGC=LOW | | 25 | | |
| | | In Band: A Band Low Gain Mode RXGC=HIGH | | 35 | | |

TRANSMITTER CHARACTERISTICS

TR = High, 2 dB base band filter loss in RX band, MIN, TYP, and MAX rating are at 25°C and $V_{CC} = 3.3$ V (unless otherwise noted)

| PARAMETER | | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|------------------|---------------------|-----------------|------|-----|------|------|
| f _{IF} | IF input frequency | | | 374 | | MHz |
| f _{ORF} | RF output frequency | B band | 2400 | | 2500 | MHz |
| | | A band | 4900 | | 5900 | MHz |
| f _{LO} | LO input frequency | B band | 2774 | | 2874 | MHz |
| | | A band | 2637 | | 3137 | MHz |
| G | Gain | B Band | 37 | 40 | | dB |
| | | A Band | 40 | 43 | | dB |

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TRANSMITTER CHARACTERISTICS (continued)

TR = High, 2 dB base band filter loss in RX band, MIN, TYP, and MAX rating are at 25°C and $V_{CC} = 3.3$ V (unless otherwise noted)

| PARAMETER | | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|-----------|------------------------------------|---|------|------|-----|---------|
| | Output 1 dB gain compression | B band. max PABC input | 22 | 23.5 | | dBm |
| | | A band. max PABC input | 20.5 | 22.5 | | dBm |
| | | 5150 – 5350 MHz Max PABC input, $V_{+PA} = 2.9$ V min, Other $V_{CC} = 2.7$ V min | 20.5 | 22.5 | | dBm |
| | Output 3rd order intercept | B band | 32 | 35 | | dBm |
| | | A band | 30 | 32.5 | | dBm |
| | Noise figure | Both bands | | 8 | | dB |
| | IF input return loss | Measured into 200 Ω differential | 8 | | | dB |
| | Mixer output return loss MX | Z = 50 Ω both bands | 10 | | | dB |
| | RF input return loss RF | Z = 50 Ω both bands | 8 | | | dB |
| | RFANT return loss | Z = 50 Ω both bands | 6 | | | dB |
| I_{kG} | LO leakage at MX | B band | | -35 | | dBm |
| | | A band (5274-6274 MHz) | | -35 | | dBm |
| | Gain flatness full band | B band | | 1 | | dB |
| | | A band | | 2 | | dB |
| | Gain flatness / 22 MHz | Both bands | | | | dB |
| | PA harmonics | Both bands CW at P1 dB | | | -20 | dBc |
| | RFANT to RF isolation | B band | | 50 | | dB |
| | | A band | | 50 | | dB |
| | PA Off Isolation RF to RFANT | In band: both bands | 50 | | | dB |
| | PA Turn On Time | To within 0.5 dB max power | | 0.2 | | μ s |
| | PA Turn Off Time | To within -20 dB max power | | 0.2 | | μ s |
| | PA droop | From max power after turn-on time, Maximum on duration is 200 ms | | | 0.5 | dB |
| | PA Bias Control Input Range (PABC) | Max Current corresponds to max PA bias state | | | | mA |

COMMON ELECTRICAL CHARACTERISTICS

MIN, TYP, and MAX ratings are at 25°C and $V_{CC} = 3.3$ V (unless otherwise noted)

| PARAMETER | | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|-----------|----------------------|---|-----|-----|-----|----------|
| | TR_SEL switch time | Gain within 0.5dB. Not Including PA ramp time | | 0.3 | 1 | μ s |
| | AB_SEL switch time | | | | 1 | μ s |
| | LO input power | Reference to 100 Ω differential | -1 | | 5 | dBm |
| | LO input return loss | Measured to 100 Ω differential at 25°C | 6 | | | |
| | IF port impedance | Differential | | 200 | | Ω |
| | LO port impedance | | | 100 | | Ω |

TYPICAL CHARACTERISTICS

A Band Detector Output

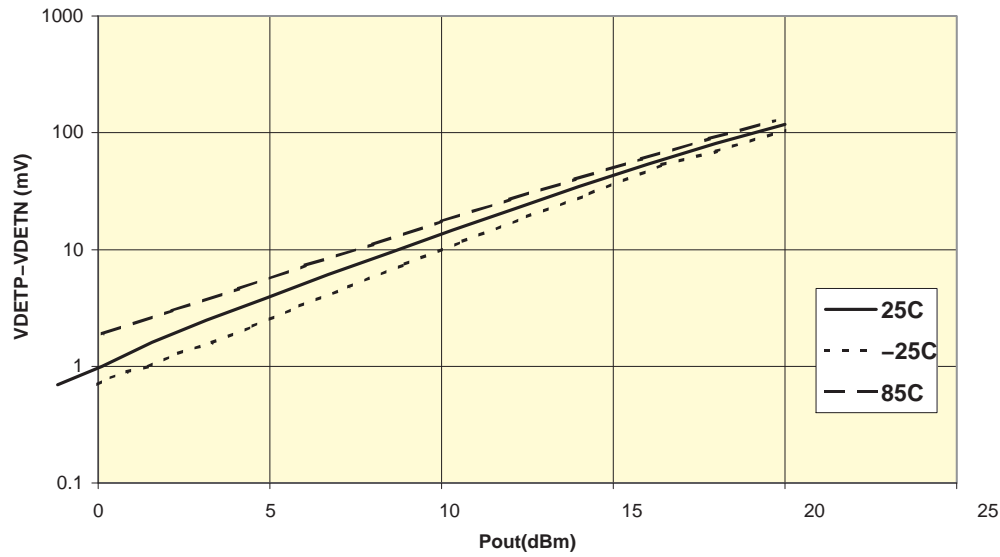


Figure 1. A Band Detector Output

B Band Detector Output



Figure 2. B Band Detector Output

PACKAGING INFORMATION

| Orderable Device | Status (1) | Package Type | Package Drawing | Pins | Package Qty | Eco Plan (2) | Lead/Ball Finish (6) | MSL Peak Temp (3) | Op Temp (°C) | Device Marking (4/5) | Samples |
|------------------|---------------|--------------|-----------------|------|-------------|-----------------|-------------------------|----------------------|--------------|-------------------------|---------|
| TRF2436IRTBR | OBSOLETE | VQFN | RTB | 40 | | TBD | Call TI | Call TI | | TRF 2436 | |
| TRF2436IRTBRG4 | OBSOLETE | VQFN | RTB | 40 | | TBD | Call TI | Call TI | | TRF 2436 | |
| TRF2436IRTBT | OBSOLETE | VQFN | RTB | 40 | | TBD | Call TI | Call TI | | TRF 2436 | |

(1) The marketing status values are defined as follows:

ACTIVE: Product device recommended for new designs.

LIFEBUY: TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

NRND: Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

PREVIEW: Device has been announced but is not in production. Samples may or may not be available.

OBSOLETE: TI has discontinued the production of the device.

(2) Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check <http://www.ti.com/productcontent> for the latest availability information and additional product content details.

TBD: The Pb-Free/Green conversion plan has not been defined.

Pb-Free (RoHS): TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.

Pb-Free (RoHS Exempt): This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.

Green (RoHS & no Sb/Br): TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

(3) MSL, Peak Temp. - The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

(5) Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

(6) Lead/Ball Finish - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead/Ball Finish values may wrap to two lines if the finish value exceeds the maximum column width.

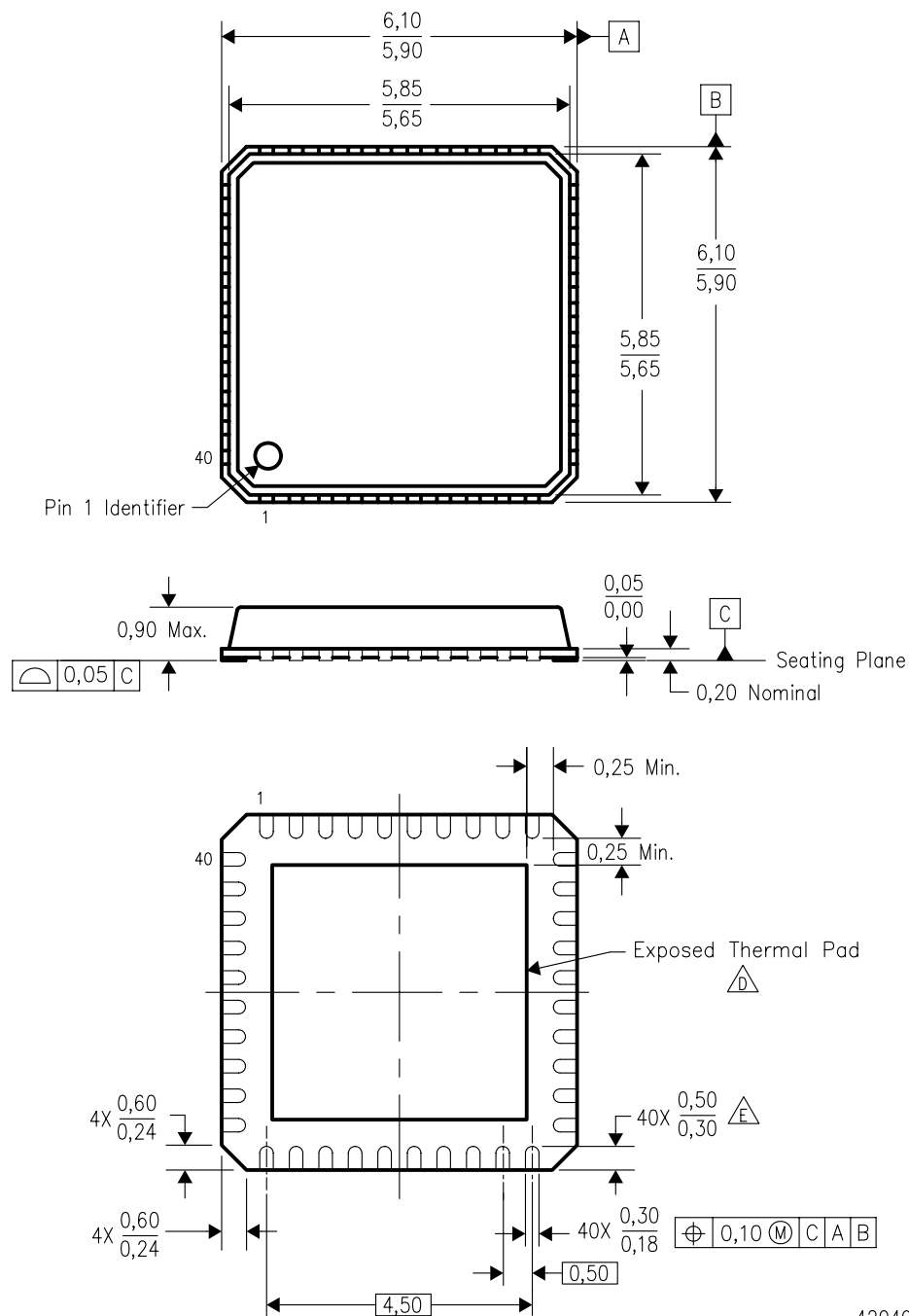
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RTB (S-PQFP-N40)

PLASTIC QUAD FLATPACK



- NOTES: A. All linear dimensions are in millimeters.
 Dimensioning and tolerancing per ASME Y14.5M-1994.
 B. This drawing is subject to change without notice.
 C. QFN (Quad Flatpack No-Lead) Package configuration.
- \triangle The package thermal pad must be soldered to the board for thermal and mechanical performance. See the Product Data Sheet for details regarding the exposed thermal pad dimensions.
 \triangle Some products have selected lands extended past 0,50 length. See Product Data Sheet for details regarding specific land length exceptions.

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