



2.4GHz GaAs RF Front-End IC with Common Tx/Rx Port

Description

BHWM253 is a complete RF Front-End IC in advanced GaAs E/D-PHEMT process that features a simple signal-in/signal-out architecture with integrated switches and an amplifier that can be used either as LNA to improve Rx sensitivity, or PA to boost Tx Power. It is optimized for operation in the 2.4-2.5GHz band, with support to low voltage and low current operation. The device is housed in an ultra-compact 1.5x1.5mm 6L DFN (Dual Flat No-Lead) package and fully matched to 50 Ohm at both input and output, and requires only one external capacitor.

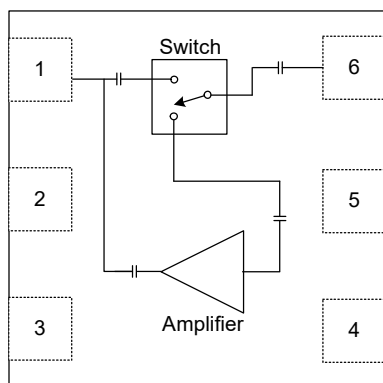
Key Features

- Advanced GaAs E/D PHEMT Process
- 2.4-2.5GHz Operation Frequency Range
- Operating Voltage: 1.2~4.2V
- Quiescent Current: 3~14mA Adjustable
- Rx Gain: 10~13dB; Noise Figure: 1.8~2dB
- Tx Insertion Loss: 1.3dB
- Amplifier OP1dB: ~12dBm at Vdd=3.3V
- Integrated ESD Protection for 600V HBM
- Ultra-Small 1.5x1.5mm DFN Package

Key Applications

- IEEE 802.11 WLAN System
- Wi-Fi Modules
- IoT Modules including ZigBee/Thread/Matter
- Wireless Audio/Video
- Remote Control
- Generic 2.4GHz TDD Radio Designs

Functional Block and Package Information

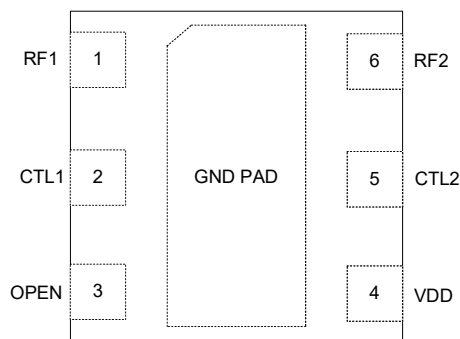


1.5x1.5x0.55mm 6L DFN



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Pin Assignment and Pin Description



(Top "See-Through" View)

| Pin Number | Pin Name | Description |
|------------|----------|----------------------------------------------------------------|
| 1 | RF1 | TRX Port for LNA Application; Antenna Port for PA Application. |
| 2 | CTL1 | Transmit/Receive Logic Control Voltage. |
| 3 | OPEN | Must be kept as open pad in PCB layout. |
| 4 | VDD | DC Supply Voltage. |
| 5 | CTL2 | Transmit/Receive Logic Control Voltage. |
| 6 | RF2 | Antenna Port for LNA Application; TRX Port for PA Application. |

Absolute Maximum Ratings

| Parameter | Rating | Unit |
|----------------------------|-------------|------|
| Maximum Supply Voltage | 4.5 | V |
| Maximum Control Voltage | 3.6 | V |
| Maximum Supply Current | 50 | mA |
| Maximum Input Power | +10 | dBm |
| Junction Temperature | +150 | °C |
| Operation Temperature | -40 to +85 | °C |
| Storage Temperature | -40 to +150 | °C |
| Moisture Sensitivity Level | MSL1 | |

Note: Do not exceed any single or combination of the above parameters. Sustained operation at or above the Absolute Maximum Ratings may result in permanent damage to the device. Maximum Input Power Rating assumes 50-Ohm load impedance.



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Electrical Specifications (For LNA Application)

Receive Mode: ANT (Pin6/RF2) to TRX (Pin1/RF1), CTL1=0, CTL2=High

| Parameter | Condition | Specification | | | Unit |
|-----------------------|----------------------------|---------------|------|------|------|
| | | Min. | Typ. | Max. | |
| Operating Frequency | | 2.4 | | 2.5 | GHz |
| Operating Voltage | VDD | 1.2 | 3.3 | 3.6 | V |
| Logic Control Voltage | For CTL2=High | 1.2 | 3.3 | 3.6 | V |
| Quiescent Current* | VDD=CTL2=3.3V, No RF Input | | 10 | | mA |
| Shutdown Current | VDD=3.3V, CTL2=0V | | 0.3 | | uA |
| Small-Signal Gain | Pin=-30dBm | | 13 | | dB |
| Noise Figure | Pin=-30dBm | | 1.8 | | dB |
| Input P1dB | VDD=3.3V | | 0 | | dBm |
| IIP3 | VDD=3.3V | | +5.5 | | dBm |
| Input Return Loss | | | 12 | | dB |
| Output Return Loss | | | 8 | | dB |
| Isolation | | | 21 | | dB |

*Quiescent current can be reduced using lower CTL2 voltage, or with an external resistor on CTL2 pin.

Transmit Mode: TRX (Pin1/RF1) to ANT (Pin6/RF2), CTL1=High, CTL2=0

| Parameter | Condition | Specification | | | Unit |
|-----------------------|---------------|---------------|------|------|------|
| | | Min. | Typ. | Max. | |
| Operating Frequency | | 2.4 | | 2.5 | GHz |
| Operating Voltage | VDD | 1.2 | 3.3 | 3.6 | V |
| Logic Control Voltage | For CTL1=High | 1.2 | 3.3 | 3.6 | V |
| Insertion Loss | | | 1.3 | | dB |
| Input Return Loss | | | 10 | | dB |
| Output Return Loss | | | 10 | | dB |

Logic Control (For LNA Application)

| CTL1 (Pin 2) | CTL2 (Pin 5) | Mode of Operation |
|--------------|--------------|--------------------|
| 0 | 0 | Off (By-Pass) |
| 1 | 0 | Transmit Switch On |
| 0 | 1 | Receive LNA On |
| 1 | 1 | Not Allowed |



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Electrical Specifications (For PA Application)

Transmit Mode: TRX (Pin6/RF2) to ANT (Pin1/RF1), CTL1=0, CTL2=High

| Parameter | Condition | Specification | | | Unit |
|-----------------------|----------------------------|---------------|------|------|---------|
| | | Min. | Typ. | Max. | |
| Operating Frequency | | 2.4 | | 2.5 | GHz |
| Operating Voltage | VDD | 3 | 3.3 | 4.2 | V |
| Logic Control Voltage | For CTL2=High | 1.2 | 3.3 | 3.6 | V |
| Quiescent Current* | VDD=CTL2=3.3V, No RF Input | | 10 | | mA |
| Shutdown Current | VDD=3.3V, CTL2=0V | | 0.3 | | uA |
| Small-Signal Gain | Pin=-30dBm | | 13 | | dB |
| Output P1dB | VDD=3.3V | | 12 | | dBm |
| Harmonics | 2f0, 3f0 at Pout=13dBm | | -30 | | dBm/MHz |
| Total Current | VDD=3.3V, Pout=13dBm | | 25 | | mA |
| Input Return Loss | | | 8 | | dB |
| Output Return Loss | | | 12 | | dB |
| Isolation | | | 21 | | dB |

*Quiescent current can be reduced using lower CTL2 voltage, or with an external resistor on CTL2 pin.

Receive Mode: ANT (Pin1/RF1) to TRX (Pin6/RF2), CTL1=High, CTL2=0

| Parameter | Condition | Specification | | | Unit |
|-----------------------|---------------|---------------|------|------|------|
| | | Min. | Typ. | Max. | |
| Operating Frequency | | 2.4 | | 2.5 | GHz |
| Operating Voltage | VDD | 1.2 | 3.3 | 4.2 | V |
| Logic Control Voltage | For CTL1=High | 1.2 | 3.3 | 3.6 | V |
| Insertion Loss | | | 1.3 | | dB |
| Input Return Loss | | | 10 | | dB |
| Output Return Loss | | | 10 | | dB |

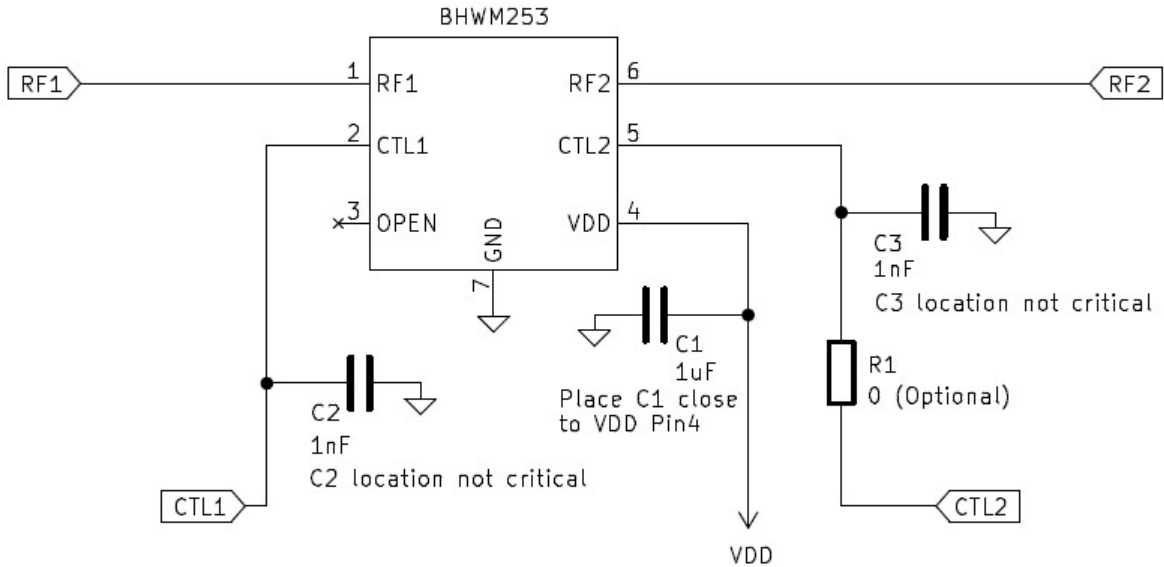
Logic Control (For PA Application)

| CTL1 (Pin 2) | CTL2 (Pin 5) | Mode of Operation |
|--------------|--------------|-------------------|
| 0 | 0 | Off (By-Pass) |
| 0 | 1 | Transmit PA On |
| 1 | 0 | Receive Switch On |
| 1 | 1 | Not Allowed |



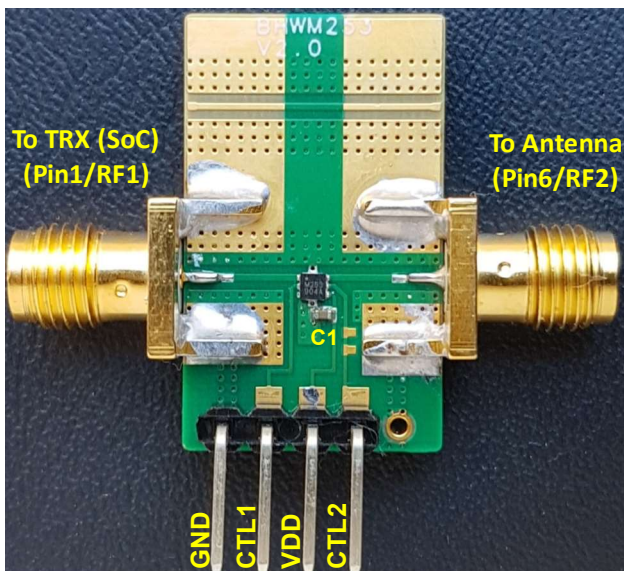
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Application Schematic

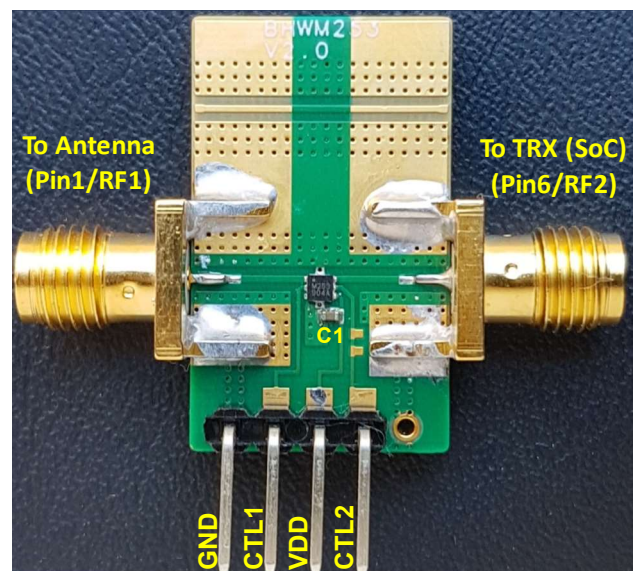


Evaluation Board

For LNA Application



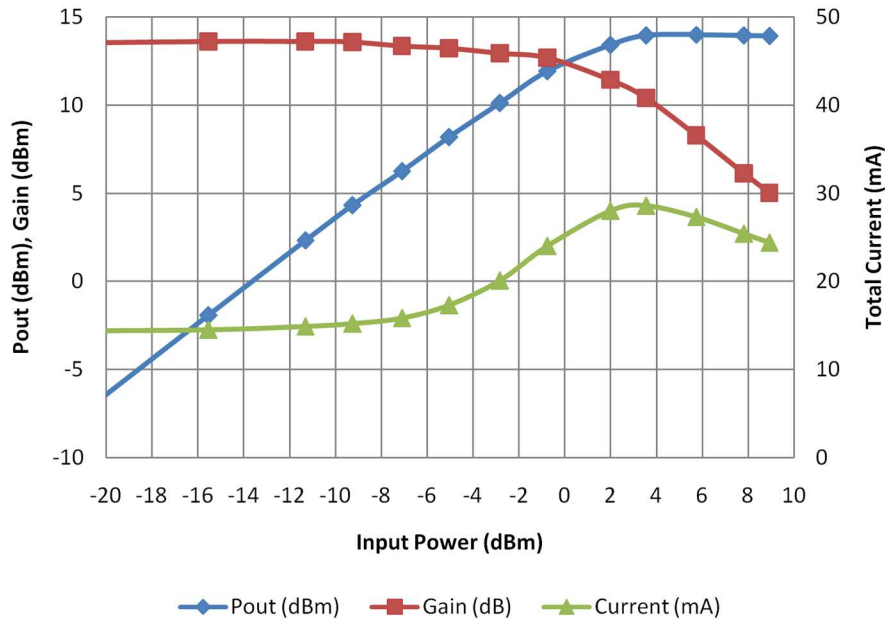
For PA Application



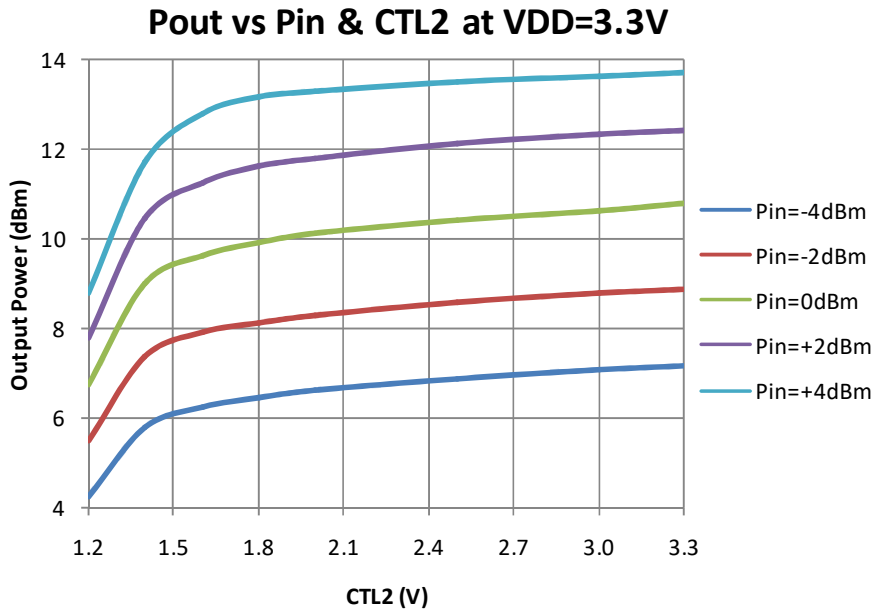


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RF Characteristics



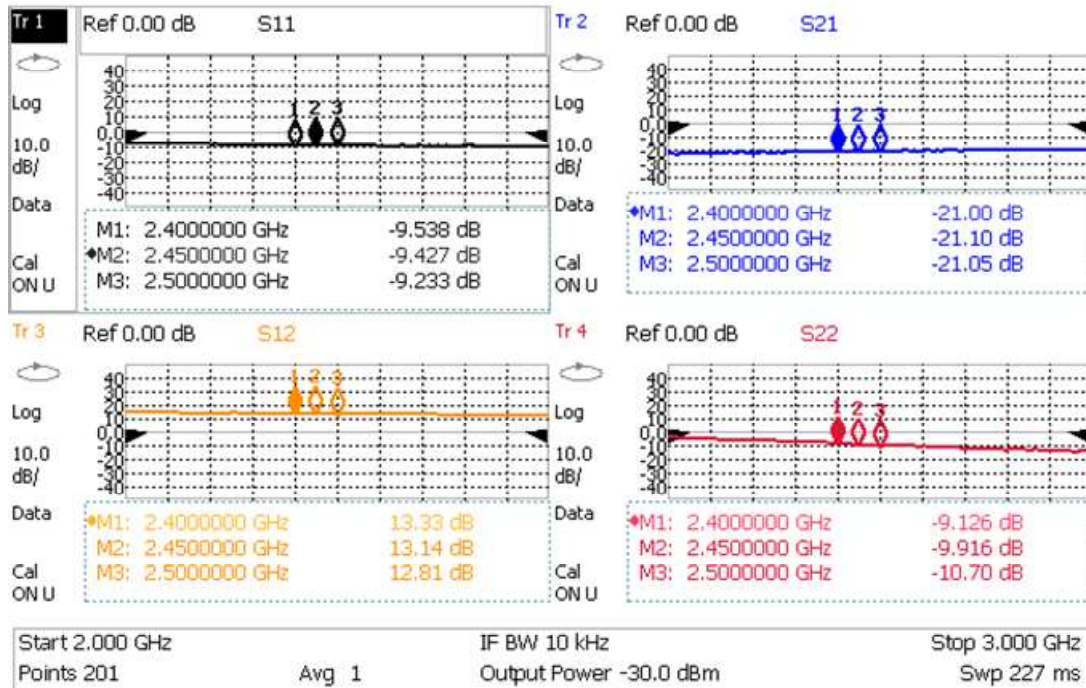
Typical CW Power Sweep Data at 2450MHz, VDD=CTL2=3.3V, CTL1=0



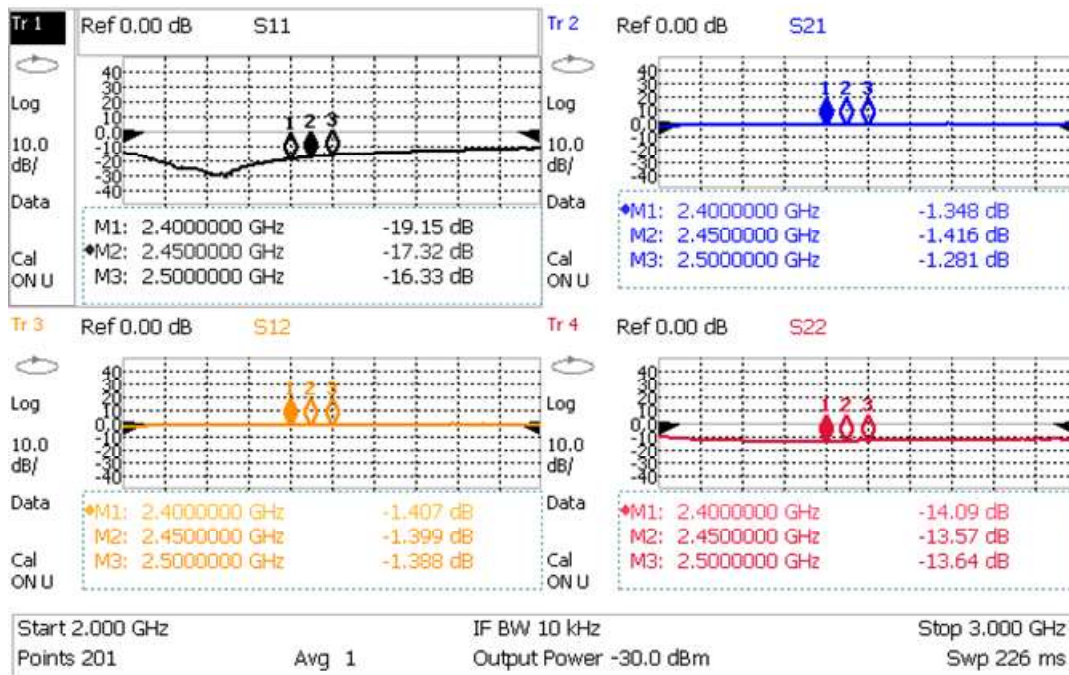
Typical Output Power vs Control Voltage CTL2, at 2450MHz, VDD=3.3V, CTL1=0



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Typical S-Parameters in Amplifier-ON Mode, VDD=CTL2=3.3V, CTL1=0

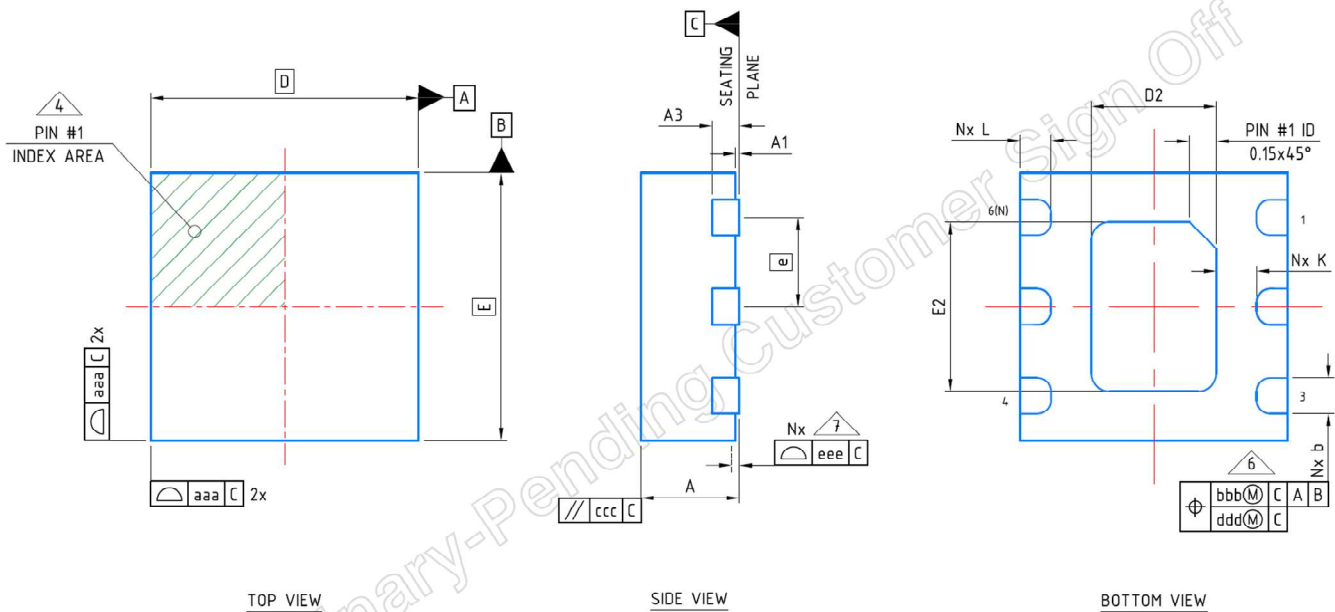


Typical S-Parameters in Switch-ON Mode, VDD=CTL1=3.3V, CTL2=0



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Package Drawing and Dimensions



| Dimension Table | | | | NOTE |
|------------------|-----------------------|----------|---------|------|
| Thickness Symbol | UT | | | |
| | MINIMUM | NOMINAL | MAXIMUM | |
| A | 0.51 | 0.55 | 0.60 | |
| A1 | 0.00 | 0.02 | 0.05 | |
| A3 | --- | 0.15 Ref | --- | |
| b | 0.15 | 0.20 | 0.25 | 6 |
| D | 1.50 BSC | | | |
| E | 1.50 BSC | | | |
| e | 0.50 BSC | | | |
| D2 | 0.55 | 0.70 | 0.80 | |
| E2 | 0.80 | 0.95 | 1.05 | |
| K | 0.15 | --- | --- | |
| L | 0.125 | 0.175 | 0.225 | |
| aaa | 0.05 | | | |
| bbb | 0.10 | | | |
| ccc | 0.10 | | | |
| ddd | 0.05 | | | |
| eee | 0.08 | | | |
| N | 6 | | | 3 |
| NE | 3 | | | 5 |
| NOTES | 1, 2 | | | |
| LF PART NO. | 443896 | | | |
| LF DWG. NO. | CARSEM-HDS-043 Rev. A | | | |

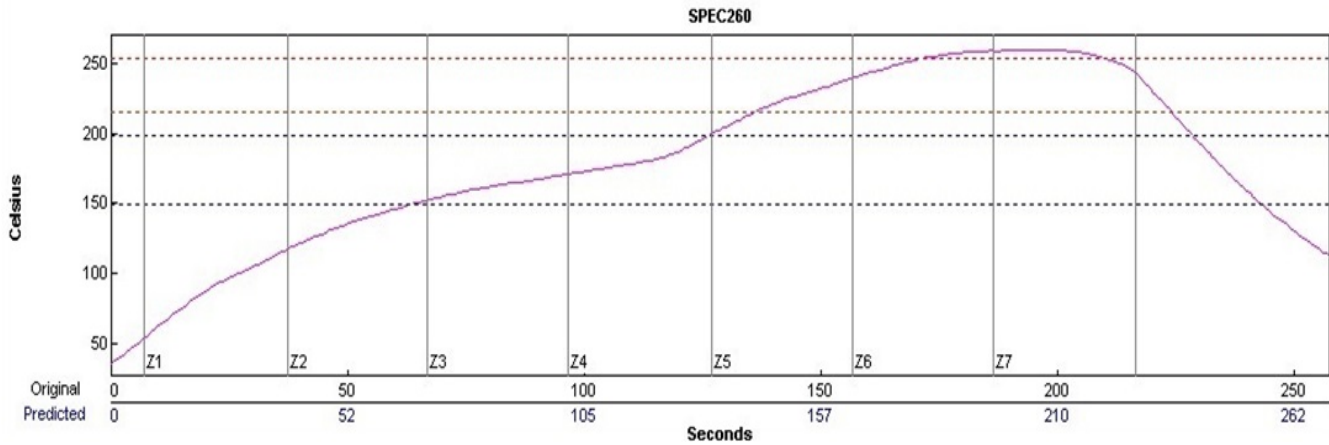
NOTE:

1. Dimensioning and tolerancing conform to ASME Y14.5-2009.
2. All dimensions are in millimeters.
3. N is the total number of terminals.
4. The location of the marked terminal #1 identifier is within the hatched area.
5. NE refers to the maximum number of terminals on E side.
6. Dimension b applies to the metalized terminal. If the terminal has a radius on the end of it, dimension b should not be measured in that radius area.
7. Coplanarity applies to the terminals and all other bottom surface metalization.



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Recommended Reflow Soldering Profile



Package Marking



- ← Line 1: Pin 1 Indicator
- ← Line 2: Part Number, M253
- ← Line 3: Datecode, YWWB

Date Code Description

Y: Year Code (e.g., 1 for 2021)

WW: Working Week (01~52)

B: Revision Code