

DATA SHEET
SE2436L: High Power 2.4 GHz 802.15.4 Front End Module

Applications

- Smart Meters
- In-home appliances
- Smart thermostats

Features

- Integrated PA with 27 dBm output power
- Integrated LNA with programmable bypass
- Integrated antenna switching with Tx and Rx diversity function
- Low FEM noise figure of 2.5 dB typical
- Differential 100 Ω common Tx/Rx RF interface
- Fast switch ON/OFF time <1 μsec
- 2.0 V – 4.8 V supply operation
- Sleep mode current <1 μA
- 4 x 4 x 0.9 mm 24 pin QFN
- Pb-free, RoHS compliant and Halogen free

Product Description

The SE2436L is a high performance, fully integrated RF Front End Module designed for ZigBee/Smart Energy and 802.15.4 applications requiring high transmit power.

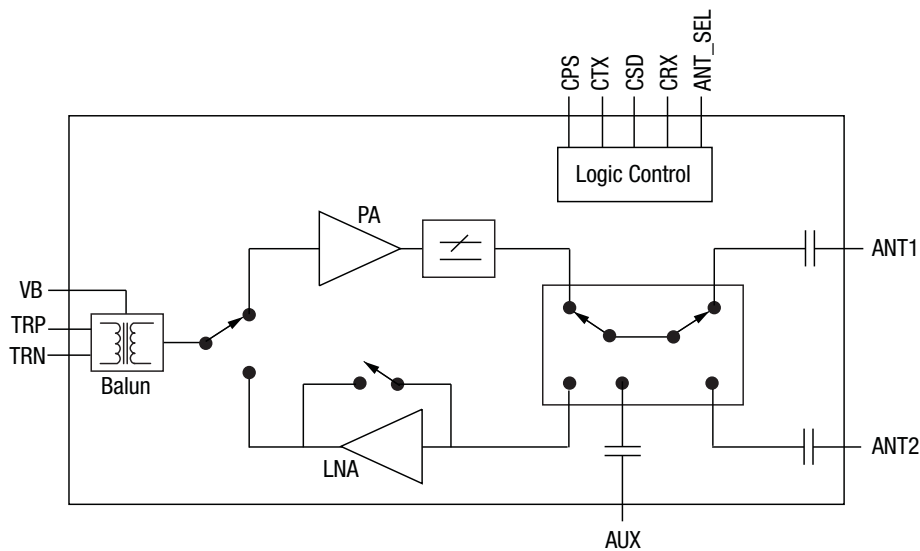
The SE2436L is designed for ease of use and maximum flexibility, with fully matched 50 Ω output, and 100 Ω differential input, integrated inter-stage matching and harmonic filter, and digital controls compatible with 1.6 – 3.6 V CMOS levels.

The RF blocks operate over a wide supply voltage range from 2.0 to 4.8V allowing the SE2436L to be used in battery powered applications over a wide spectrum of the battery discharge curve.

Ordering Information

| Part No. | Package | Remark |
|-------------|------------|----------------|
| SE2436L-S | 24 pin QFN | Samples |
| SE2436L-R | 24 pin QFN | Tape & Reel |
| SE2436L-EK1 | N/A | Evaluation kit |

Functional Block Diagram



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Figure 1: Functional Block Diagram

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Pin Out Diagram

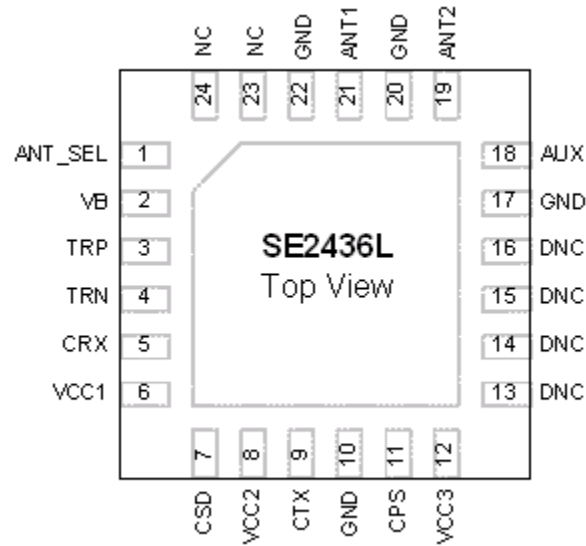


Figure 2: SE2436L Pinout

Pin Out Description

| Pin No. | Name | Description |
|---------|---------|---|
| 1 | ANT_SEL | Connect to GPIO signal to control antenna switch (see “Logic controls” table) |
| 2 | VB | I/O balun DC connection (optional, please refer to SoC or RFIC requirements) |
| 3 | TRP | Transmit/Receive port from/to transceiver, 100 Ω differential |
| 4 | TRN | Transmit/Receive port from/to transceiver, 100 Ω differential |
| 5 | CRX | Connect to GPIO signal to control SE2436L modes (see “Logic controls” table) |
| 6 | VCC1 | Connect to positive supply |
| 7 | CSD | Connect to GPIO signal to control SE2436L modes (see “Logic controls” table) |
| 8 | VCC2 | Connect to positive supply |
| 9 | CTX | Connect to GPIO signal to control SE2436L modes (see “Logic controls” table) |
| 10 | GND | Connect to PCB ground |
| 11 | CPS | Connect to GPIO signal to control SE2436L modes (see “Logic controls” table) |
| 12 | VCC3 | Connect to positive supply |
| 13 | DNC | Leave unconnected |
| 14 | DNC | Leave unconnected |
| 15 | DNC | Leave unconnected |
| 16 | DNC | Leave unconnected |

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| Pin No. | Name | Description |
|---------|------|--|
| 17 | GND | Connect to PCB ground |
| 18 | AUX | Auxiliary I/O port |
| 19 | ANT2 | Connect to 50 Ω antenna |
| 20 | GND | Connect to PCB ground |
| 21 | ANT1 | Connect to 50 Ω antenna |
| 22 | GND | Connect to PCB ground |
| 23 | NC | Not internally connected |
| 24 | NC | Not internally connected |
| Paddle | GND | Exposed die paddle; electrical and thermal ground; Connect to PCB ground |

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Absolute Maximum Ratings

These are stress ratings only. Exposure to stresses beyond these maximum ratings may cause permanent damage to, or affect the reliability of the device. Avoid operating the device outside the recommended operating conditions defined below. This device is ESD sensitive. Handling and assembly of this device should be at ESD protected workstations.

| Symbol | Definition | Min. | Max. | Unit |
|----------------------|--------------------------------------|------|------|------|
| VCC | Supply Voltage | -0.3 | 4.8 | V |
| T _{OP} | Operating temperature | -40 | 85 | °C |
| T _{STORAGE} | Storage temperature | -40 | 125 | °C |
| | ESD all pins (HBM) | - | 1000 | V |
| Pin_Tx_max | Tx input power at TR port | - | +6 | dBm |
| Pin_Rx_max | Rx input power at ANT1 or ANT2 ports | - | +10 | dBm |
| VSWR | Voltage Standing Wave Ratio | | 10:1 | |

Recommended Operating Conditions

| Symbol | Parameter | Min. | Typ. | Max. | Unit |
|----------------|--|------|------|------|------|
| T _A | Ambient temperature | -40 | 25 | 85 | °C |
| | Current drive capability from VB_IN to TRN and TRP ports | | | 30 | mA |
| VCC | Supply voltage on VCC | 2.0 | 4.0 | 4.8 | V |
| | Logic input voltages | 0 | - | 3.6 | V |

DC Electrical Characteristics

Conditions: VCC = 4.0 V, T_A = 25 °C, as measured on Skyworks Solutions's SE2436L-EK1 evaluation board (de-embedded to device), unless otherwise noted

| Symbol | Parameter | Conditions | Min. | Typ. | Max. | Unit |
|--------------------------|----------------------|--|------|------|------|------|
| I _{CC-Tx27} | Total Supply Current | Tx mode P _{OUT} = 27 dBm CPS = CSD = CTX = Logic '1' | - | 400 | - | mA |
| I _{CC-Tx} | Quiescent Current | No RF CPS = CSD = CTX = Logic '1' | - | 80 | - | mA |
| I _{CC-Rx} | Total Supply Current | Rx mode CRX = CPS = CSD = Logic '1', CTX = 0 V | - | 5 | 7 | mA |
| I _{CC-RxBypass} | Total Supply Current | Rx bypass mode CRX = CSD = Logic '1', CPS = CTX = 0 V | - | - | 300 | uA |

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| Symbol | Parameter | Conditions | Min. | Typ. | Max. | Unit |
|---------------------|----------------------|--|------|------|------|------|
| I _{CC_OFF} | Sleep Supply Current | No RF, CSD = 0 V or CRX = CTX = 0 V, all digital controls at 0 V | - | - | 1 | μA |

Logic Characteristics

Conditions: VCC = 4.0 V, T_A = 25 °C, as measured on Skyworks Solutions' SE2436L-EK1 evaluation board (de-embedded to device), unless otherwise noted.

| Symbol | Parameter | Note | Min. | Typ. | Max. | Unit |
|-----------------|------------------|------|------|------|------|------|
| V _{IH} | Logic input high | | 1.6 | - | 3.6 | V |
| V _{IL} | Logic input low | | 0 | - | 0.3 | V |
| I _{IH} | Logic input high | | - | - | 2 | μA |
| I _{IL} | Logic input low | | - | - | 1 | μA |

Logic Controls

Conditions: VCC = 4.0 V, T_A = 25 °C

| Mode | Mode description | Note | CPS | CSD | CRX | CTX |
|------|----------------------|---------|-----|-----|-----|-----|
| 0 | All off (sleep mode) | 1, 3 | 0 | 0 | 0 | 0 |
| 0 | All off (sleep mode) | 1, 2, 3 | 0 | 1 | 0 | 0 |
| 1 | Rx bypass mode | 1, 2 | 0 | 1 | 1 | 0 |
| 2 | Rx mode | 1, 2 | 1 | 1 | 1 | 0 |
| 3 | TX bypass mode | 1,2 | 0 | 1 | 0 | 1 |
| 4 | Tx mode | 1, 2 | 1 | 1 | 0 | 1 |
| 5 | Auxiliary mode | 1,2 | 1 | 0 | 1 | X |

- Note:**
- (1) Logic '0' level compliant to V_{IL} as specified in the "Logic Characteristics" table
 - (2) Logic '1' level compliant to V_{IH} as specified in the "Logic Characteristics" table
 - (3) All logic signals must be in a defined state in order to meet the sleep current specification at 1 uA max

Conditions: VCC = 4.0 V, T_A = 25 °C

| Mode description | Note | CPS | CSD | CTX | CRX | ANT_SEL |
|-------------------|------|-----|-----|-----|-----|---------|
| ANT1 port enabled | 1 | X | X | X | X | 0 |
| ANT2 port enabled | 2 | X | X | X | X | 1 |

- Note:**
- (1) Logic '0' level compliant to V_{IL} as specified in the "Logic Characteristics" table
 - (2) Logic '1' level compliant to V_{IH} as specified in the "Logic Characteristics" table

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AC Electrical Characteristics, Transmit

Conditions: VCC = 4.0 V, TA = 25 °C, as measured on Skyworks Solutions' SE2436L-EK1 evaluation board (de-embedded to device), all unused ports terminated with 50 Ω, unless otherwise noted.

| Symbol | Parameter | Condition | Note | Min. | Typ. | Max. | Unit |
|--------------------|------------------------------------|--|------|--|----------------|------|---------|
| F _{IN} | Frequency Range | | | 2400 | - | 2483 | MHz |
| P _{out} | Output power at ANT1 or ANT2 ports | VCC = 4.0 V VCC = 3.3 V VCC = 3.0 V | 1 | - | 27 25 22 | - | dBm |
| S ₂₁ | Small Signal Gain | | 1 | 27 | 30 | 33 | dB |
| ΔS ₂₁ | Small Signal Gain Variation | | 1 | - | - | 2 | dBp-p |
| S _{21byp} | Small Signal Gain bypass | | 1 | - | -2.5 | - | dB |
| Tx_G | Large Signal Gain Variation | Pin at 0 dBm | 1 | - | - | 1 | dBp-p |
| HD2-HD10 | Harmonics | P _{OUT} = 27 dBm | 1, 2 | - | - | -42 | dBm/MHz |
| ACP | Spectral Mask | | 1, 3 | - | - | -30 | dBm |
| Trise | Turn on time | | 4 | - | - | 800 | ns |
| Tfall | Turn off time | | 5 | - | - | 800 | ns |
| STAB | Stability | CW, P _{IN} = 0 dBm 0.1 GHz – 20 GHz Load VSWR = 6:1 | | All non-harmonically related outputs less than -42 dBm/MHz | | | |
| RU | Ruggedness | CW, P _{IN} = +6 dBm, Load VSWR = 10:1 | | No permanent damage | | | |

- Note:**
- (1) 2400 – 2483 MHz
 - (2) IEEE 802.15.4 source
 - (3) Integrated power from band edges to Fc ± 3.5 MHz
 - (4) From 50% of CTX edge to 90% of final RF output power
 - (5) From 50% of CTX edge to 10% of final RF output power

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AC Electrical Characteristics, Receive

Conditions: VCC = 4.0 V, TA = 25 °C, as measured on Skyworks Solutions' SE2436L-EK1 evaluation board (de-embedded to device), all unused ports terminated with 50 Ω, unless otherwise noted.

| Symbol | Parameter | Condition | Note | Min. | Typ. | Max. | Unit |
|--------------------|---|---|------|------|------|------|------|
| F _{IN} | Frequency Range | | | 2400 | - | 2483 | MHz |
| Rx_gain | Receive gain | CPS = CSD = logic '1', CTX = logic '0' | 1 | 9.0 | 11.5 | 14 | dB |
| NF | Receive noise figure | CPS = CSD = logic '1', CTX = logic '0' | 1 | - | 2.5 | 3.5 | dB |
| IIP3 | Input 3 rd order intercept | CPS = CSD = logic '1', CTX = logic '0' | 1 | -3 | 2 | - | dBm |
| IP1dB | Input 1-dB compression point | CPS = CSD = logic '1', CTX = logic '0' | 1 | -13 | -8 | - | dBm |
| S _{11ANT} | Antenna port return loss | | 1 | - | -14 | -10 | dB |
| Trise | Turn on time | | 2 | - | - | 800 | ns |
| Tfall | Turn off time | | 3 | - | - | 800 | ns |
| G_bp | Gain in bypass mode | CPS = CTX = logic '0', CSD = logic '1' | | - | -3 | - | dB |
| IP1dB | Input 1-dB compression point in bypass mode | CPS = CTX = logic '0', CSD = logic '1' | | 19 | - | - | dBm |

- Note:**
- (1) 2400 – 2483 MHz
 - (2) From 50% of CTX edge to 90% of final RF output power
 - (3) From 50% of CTX edge to 10% of final RF output power

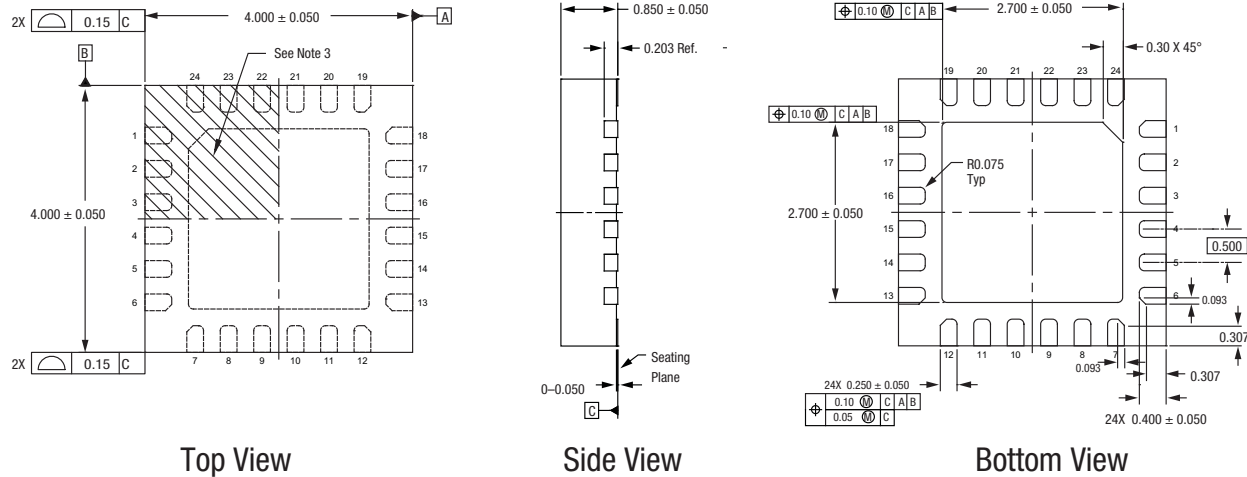
AC Electrical Characteristics, Diversity Antenna Function

Conditions: VCC = 4.0 V, TA = 25 °C, as measured on Skyworks Solutions' SE2436L-EK1 evaluation board (de-embedded to device), all unused ports terminated with 50 Ω, unless otherwise noted.

| Symbol | Parameter | Min. | Typ. | Max. | Unit |
|------------------------|---|------|------|------|------|
| ISOL _{ANTSW} | Isolation Between ANT1 and ANT2 Ports | - | -20 | - | dB |
| S _{11ANT1,2} | Input return loss into 50 Ω, ANT1 and ANT2 ports | - | -14 | -6 | dB |
| S _{22ANT1,2} | Output return loss into 50 Ω, ANT1 and ANT2 ports | - | -14 | -6 | dB |
| T _{ANT1-ANT2} | Antenna 1 to Antenna 2 switching time | - | 800 | - | nsec |

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Package Drawing



- Notes:
- All measurements are in millimeters.
 - Dimensions and tolerances according to ASME Y14.5M-1994.
 Unless otherwise specified, the following values apply:
 Decimal Tolerance: Angular Tolerance:
 X.X (1 place) ± 0.1 mm ±1°
 X.XX (2 places) ± 0.05 mm
 X.XXX (3 places) ± 0.025 mm
 - Terminal #1 identification mark located within marked area.
 - Unless specified, dimensions are symmetrical about center lines.

Y0676

Figure 3: Package Drawing

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Tape and Reel Information

| Parameter | Value |
|------------------|----------------|
| Devices Per Reel | 3000 |
| Reel Diameter | 13 inches |
| Tape Width | 12 millimeters |

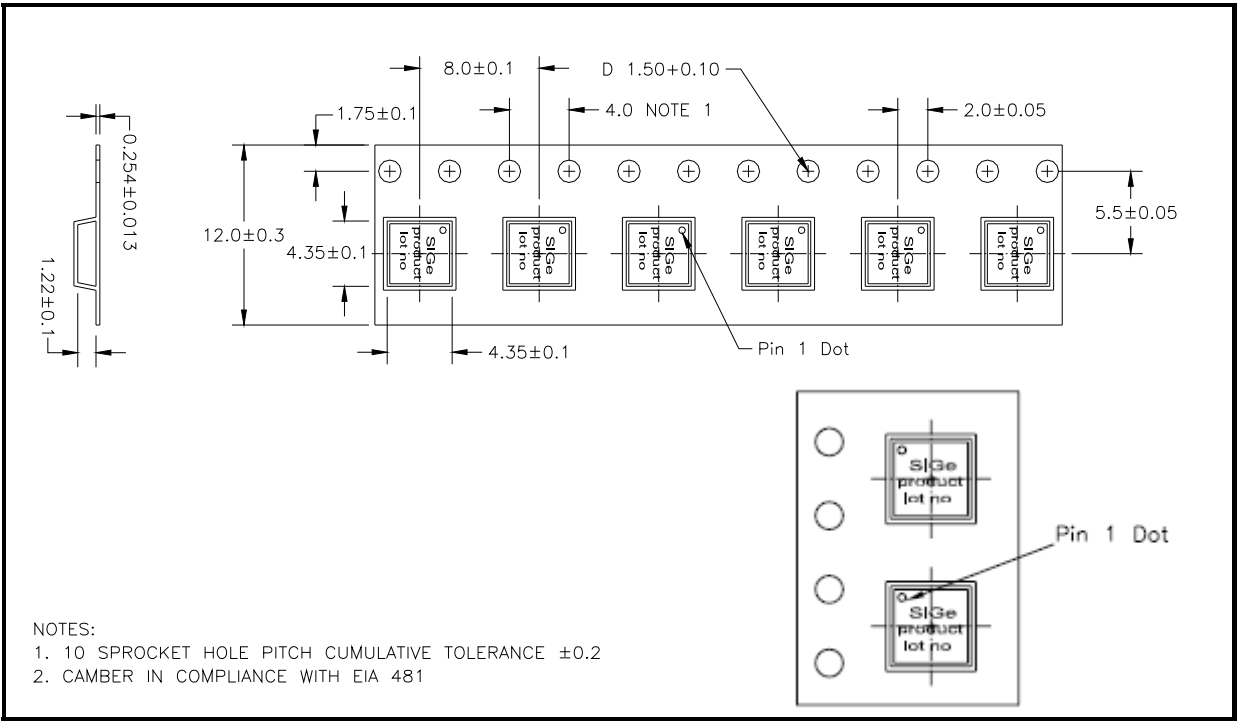


Figure 4: Detailed Tape and Reel Information (All diminsions in Millimeters)

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Recommended Reflow Temperature Profile

| Profile Feature | SnPb Eutectic Assembly | Lead (Pb) Free Assembly |
|--|------------------------|-------------------------|
| Average Ramp-up Rate (T_L to T_P) | 3°C/s (max) | 3°C/s (max) |
| Preheat | | |
| Temperature Min. (T_{smin}) | 100°C | 150°C |
| Temperature Max. (T_{smax}) | 150°C | 200°C |
| Time (Min. to Max) (t_s) | 60 - 120s | 60 - 80s |
| Ramp Up | | |
| T_{smax} to t_L | - | 3°C/s (max) |
| Time 25°C to Peak Temperature | 6 mins. (max) | 8 mins. (max) |
| Reflow | | |
| Temperature (t_L) | 183°C | 217°C |
| Time maintained above t_L | 60 - 150s | 60 - 150s |
| Peak Temperature (t_p) | 240 ±5°C | 260 +0/-5°C |
| Time Within 5°C of Actual Peak Temperature (t_p) | 10 - 30s | 20 - 40s |
| Ramp-Down | | |
| Ramp-Down Rate | 6°C/s (max) | 6°C/s (max) |



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Reflow Profile (Reference JEDEC J-STD-020)

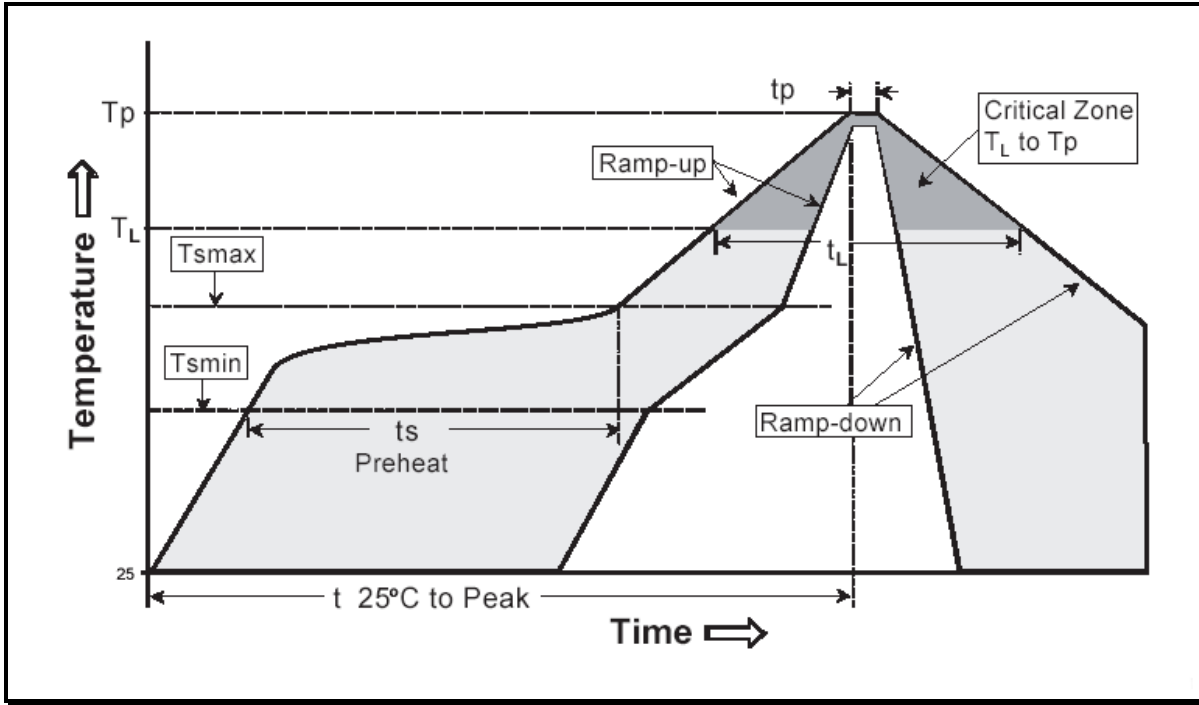


Figure 5: Reflow temperature profile

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Branding Information

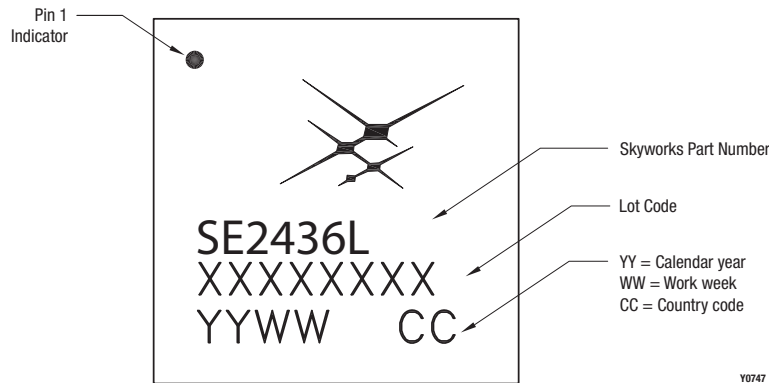


Figure 6: SE2436L Typical Part Marking

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