

SMARTMESH[®] IA-510 LM2650

2.4 GHz Ultra Low-power Embedded Network Manager

About SmartMesh IA-510

Dust Networks' SmartMesh[®] IA-510 is an industry-leading wireless networking solution designed for critical monitoring and control applications. SmartMesh IA-510 serves a wide range of applications from renewable energy generation, such as solar monitoring, to factory machine health monitoring and data center energy management. The SmartMesh IA-510 system delivers dynamic network optimization and intelligent routing to achieve unsurpassed levels of wireless network scalability, system-wide reliability and low latency, coupled with industrial-class security. Additionally, ultra low-power operation permits even greater deployment flexibility for wire-free applications.

Product Description—LM2650

Optimized for small networks, the SmartMesh IA-510 LM2650 network manager integrates Dust Networks' robust Intelligent Networking Platform and industry-leading low-power radio technology to provide a self-forming, self-healing SmartMesh IA-510 network with unmatched network reliability, ultra low-power consumption, and ease of use. The LM2650 supports up to 32 SmartMesh IA-510 motes (DN2510 or M2510), creating a self-configuring, reliable wireless mesh network.

The LM2650's Intelligent Networking Platform uses sophisticated network management algorithms to enable the deployment of low-power wireless sensor networks that deliver proven performance in the face of harsh RF and environmental conditions, offering years of uninterrupted operation.

The LM2650 embedded network manager is highly flexible and can operate on battery, solar power, or line power. Additionally, the manager offers a comprehensive set of serial APIs to deliver a rich and flexible development environment. The APIs also provide full visibility and control over network configuration, security administration, network status, and performance statistics.

Key Features

Ultra-Low Power Operation

- Low power manager operation enables battery or solar, powered operation

Intelligent Networking Platform

- Dynamic network optimization maintains network health and enables greater than 99.99% network reliability even in the most challenging environments
- Intelligent routing lowers latency, reduces network power consumption, and eliminates in-network packet collisions
- Performance profiles enable users to configure network operation based on power, latency, and throughput

Fast and Low Risk Integration

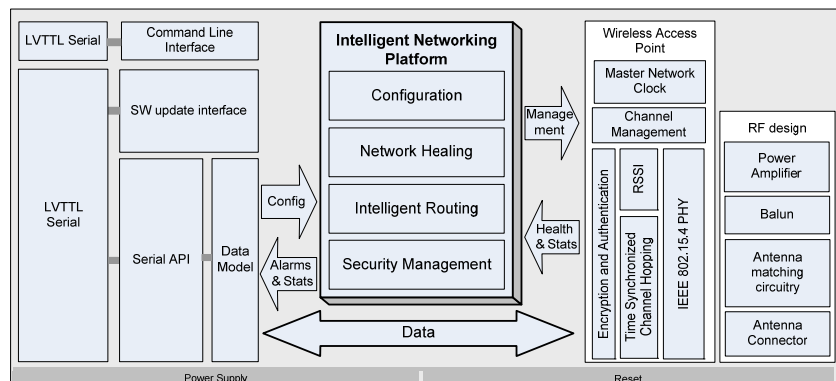
- Comprehensive set of APIs deliver rich and flexible development environment
- Fully integrated RF capabilities—simply add an antenna

Global Market Solution

- IEEE 802.15.4-certified radio operates on 2.4 GHz global license-free band providing customers with a single product for world-wide use
- Modular 2.4GHz band RF certifications for FCC, IC and CE dramatically reduce cost and complexity of wireless device certification

Robust Security Management

- Industry-proven security meets standards for critical infrastructure
- 128-bit AES encryption ensures secure data transmission
- Access control lists ensure that only authorized devices can join a network
- Dynamic encryption key distribution eliminates manual intervention



| | |
|--------------------------|----------------------------------------------------|
| Table of Contents | |
| 1.0 | Absolute Maximum Ratings3 |
| 2.0 | Normal Operating Conditions3 |
| 3.0 | Electrical Specifications3 |
| 3.1 | Device Load 4 |
| 3.2 | DC Characteristics..... 4 |
| 3.3 | Radio 5 |
| 3.3.1 | Radio Specifications 5 |
| 3.3.2 | Antenna Specifications..... 6 |
| 4.0 | Interfaces6 |
| 4.1 | Hardware Interfaces..... 6 |
| 4.1.1 | Serial 1 Interface 6 |
| 4.1.2 | Serial 2 Interface 8 |
| 4.1.3 | Reset 9 |
| 4.2 | Electrical Interface 9 |
| 4.2.1 | J1 Board-to-board Pin Out..... 9 |
| 4.2.1.1 | Recommended Mating Connectors 9 |
| 4.2.2 | J2 MuP JTAG Connector10 |
| 4.2.3 | J6 AP SPI+ Connector.....10 |
| 5.0 | Mechanical Specifications.....11 |
| 5.1 | LM2650 Mechanical Drawings11 |
| 6.0 | Regulatory and Standards Compliance12 |
| 6.1 | FCC Compliance.....12 |
| 6.1.1 | FCC Testing12 |
| 6.1.2 | FCC-approved Antennas.....13 |
| 6.1.3 | OEM Labeling Requirements13 |
| 6.2 | IC Compliance13 |
| 6.2.1 | IC Testing.....13 |
| 6.2.2 | IC-approved Antennas13 |
| 6.2.3 | OEM Labeling Requirements13 |
| 6.3 | CE Compliance14 |
| 6.3.1 | Declaration of Conformity14 |
| 6.3.2 | European Compliance14 |
| 6.3.3 | OEM Labeling Requirements14 |
| 6.3.4 | Restrictions.....14 |
| 6.4 | RoHS Compliance.....14 |
| 6.5 | Industrial Environment Operation14 |
| 7.0 | Ordering Information15 |

1.0 Absolute Maximum Ratings

The absolute maximum ratings shown below should not be violated under any circumstances. Permanent damage to the device may be caused by exceeding one or more of these parameters.

Table 1 Absolute Maximum Ratings

| Parameter | Min | Typ | Max | Units | Comments |
|---------------------------|------|-----|------|-------|----------------------------------|
| Supply voltage | -0.3 | | 3.6 | V | |
| Voltage on Input Pins | -0.3 | | 3.6 | V | |
| Input RF level | | | 10 | dBm | Input power at antenna connector |
| Storage temperature range | -40 | | +85 | °C | |
| VSWR of antenna | | | 3:1 | | |
| ESD protection | | | | | |
| Antenna connector | | | ±250 | V | HBM |
| All other connectors | | | ±2 | kV | HBM |
| | | | ±200 | V | CDM |

All voltages are referenced to V_{SS}



Caution! This is an ESD sensitive device. Use proper ESD handling procedures when working with the device to prevent permanent damage.

2.0 Normal Operating Conditions

Table 2 Normal Operating Conditions

| Parameter | Min | Typ | Max | Units | Comments |
|-------------------------------------------------------------------|-----|-----|-----|-------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Operational supply voltage range (between V_{DD} and V_{SS}) | 3.0 | 3.3 | 3.6 | V | This includes noise and load regulation. During power on, it is essential that the maximum V_{DD} rise time defined in the <i>LM2650 Hardware Integration Guide</i> be met. |
| Voltage supply noise | | | 100 | mV _{p-p} | 50 Hz–50 MHz |
| Peak current | | | 115 | mA | |
| Average current | | 1 | | mA | +3.3V, 25 °C |
| Operating temperature range | -40 | | +85 | °C | |
| Maximum allowed temperature ramp during operation | | | 8 | °C/min | -40 °C to +85 °C |
| Operating relative humidity | 10 | | 95 | % RH | Non-condensing |

The specifications listed are for the power supply connected to V_{DD} and V_{SS} and apply over the operating temperature range unless otherwise specified.

3.0 Electrical Specifications

I/O specifications are given below for each I/O level type given in the board-to-board connector tables in sections 4.1 and 4.2.1. Unless otherwise noted, supply voltage is 3.3 V and temperature range is -40 °C to +85 °C.

3.1 Device Load

Table 3 Device Load

| Parameter | Min | Typ | Max | Units | Comments |
|-------------------|-----|-----|------|-------|------------------------------------|
| Total capacitance | | | 14.5 | μF | V _{DD} to V _{SS} |
| Total inductance | | | 5.5 | μH | Excluding Ferrite Beads |

3.2 DC Characteristics

Table 4 Digital I/O Type 1

| Digital Signal | Min | Typ | Max | Units | Comments |
|--------------------------------------------|-----------------------|-----|-----------------------|-------|----------|
| V _{IL} (low-level input voltage) | -0.3 | | 0.6 | V | |
| V _{IH} (high-level input voltage) | 0.8 x V _{DD} | | V _{DD} + 0.3 | V | |
| Input leakage current | | 50 | | nA | 25 °C |

Table 5 Digital I/O Type 2

| Digital Signal | Min | Typ | Max | Units | Comments |
|---------------------------------------------|-----------------------|-----|-----|-------|--------------------------------|
| V _{IL} (low-level input voltage) | -0.3 | | 0.8 | V | |
| V _{IH} (high-level input voltage) | 2.0 | | 5.5 | V | |
| V _{OL} (low-level output voltage) | | | 0.4 | V | I _{OL} > -8 mA, 85 °C |
| V _{OH} (high-level output voltage) | V _{DD} - 0.4 | | | V | I _{OH} < 8 mA, 85 °C |
| Digital current* | | | | | |
| Output source - single pin | | | 8 | mA | 25 °C |
| Output sink - single pin | | | 8 | mA | 25 °C |
| Input leakage current | | 40 | 400 | nA | Typ 25 °C, Max 85 °C |

* This current level guarantees that the output voltage meets V_{OH} and V_{OL} specifications above.

Table 6 Digital I/O Type 3

| Digital Signal | Min | Typ | Max | Units | Comments |
|---------------------------------------------|-----------------------|-----|-----------------------|-------|----------|
| V _{IL} (low-level input voltage) | -0.3 | | 0.6 | V | |
| V _{IH} (high-level input voltage) | 2.0 | | V _{DD} + 0.3 | V | |
| V _{OL} (low-level output voltage) | | | 0.4 | V | |
| V _{OH} (high-level output voltage) | V _{DD} - 0.2 | | | V | |
| Digital current* | | | | | |
| Output source (single pin) | | 100 | | μA | 25 °C |
| Output sink (single pin) | | 1.6 | | mA | 25 °C |
| Input leakage current | | 50 | | nA | 25 °C |

* This current level guarantees that the output voltage meets V_{OH} and V_{OL} specifications above.

Table 7 Digital I/O Type 4

| Digital Signal | Min | Typ | Max | Units | Comments |
|---------------------------------------------|-----------------------|-----|-----|-------|----------------------------------|
| V _{OL} (low-level output voltage) | | | 0.6 | V | I _{OL} > -0.6 mA, 85 °C |
| V _{OH} (high-level output voltage) | V _{DD} - 0.4 | | | V | I _{OH} < 0.6 mA, 85 °C |
| Digital current* | | | | | |
| Output source - single pin | | | 16 | mA | 25 °C |
| Output sink - single pin | | | 16 | mA | 25 °C |

* This current level guarantees that the output voltage meets V_{OH} and V_{OL} specifications above.

Table 8 Digital I/O Type 5

| Digital Signal | Min | Typ | Max | Units | Comments |
|---------------------------------------------|-----------------------|-----|-----|-------|--------------------------------|
| V _{IL} (low-level input voltage) | -0.3 | | 0.8 | V | |
| V _{IH} (high-level input voltage) | 2.0 | | 5.5 | V | |
| V _{OL} (low-level output voltage) | | | 0.4 | V | I _{OL} > -2 mA, 85 °C |
| V _{OH} (high-level output voltage) | V _{DD} - 0.4 | | | V | I _{OH} < 2 mA, 85 °C |
| Digital current* | | | | | |
| Output source - single pin | | | 2 | mA | 25 °C |
| Output sink - single pin | | | 2 | mA | 25 °C |
| Input leakage current | | 20 | 200 | nA | Typ 25 °C, Max 85 °C |
| Pull-up resistance | 6 | | 21 | kOhm | |

* This current level guarantees that the output voltage meets V_{OH} and V_{OL} specifications above.

3.3 Radio

3.3.1 Radio Specifications

Table 9 Radio Specifications

| Parameter | Min | Typ | Max | Units | Comments |
|--------------------------------|--------|-------|--------|-------|----------------------------------------------------------------------------|
| Operating frequency | 2.4000 | | 2.4835 | GHz | |
| Number of channels | | 15 | | | |
| Channel separation | | 5 | | MHz | |
| Occupied channel bandwidth | | 2.7 | | MHz | At -20 dBc |
| Frequency accuracy | -40 | | +40 | ppm | |
| Modulation | | | | | IEEE 802.15.4 DSSS |
| Raw data rate | | 250 | | Kbps | |
| Receiver operating input level | | 0 | | dBm | |
| Receiver sensitivity | | -92.5 | | dBm | At 50% PER, V _{DD} = 3 V, 25 °C |
| | | -90 | | dBm | At 1% PER, V _{DD} = 3 V, 25 °C, (inferred by 50% PER measurement) |
| Output power, conducted | | | | | |
| Power amplifier enabled: | | | | | |
| At 25 °C | | +8 | | dBm | |
| Power amplifier disabled: | | | | | |
| At 25 °C | | -2 | | dBm | |
| Range* | | | | | |
| Power amplifier enabled: | | | | | |
| Indoor † | | 100 | | m | 25 °C, 50% RH, +2 dBi omnidirectional antenna |
| Outdoor † | | 300 | | m | |
| Free Space | | 1200 | | | |
| Power amplifier disabled: | | | | | |
| Indoor † | | 25 | | m | |
| Outdoor † | | 200 | | m | |
| Free Space | | 350 | | | |

* Actual RF range performance is subject to a number of installation-specific variables including, but not restricted to ambient temperature, relative humidity, presence of active interference sources, line-of-sight obstacles, near-presence of objects (for example, trees, walls, signage, and so on) that may induce multipath fading. As a result, actual performance varies for each instance.

† 1 meter above ground.

3.3.2 Antenna Specifications

A MMCX-compatible jack receptacle is provided on board for the antenna connection. For antenna location, refer to the mechanical drawing in section 5.1. The antenna must meet specifications in Table 10. For a list of antennae pre-approved for RF certification, see section 6.1.2.

Table 10 Antenna Specifications

| Parameter | Value |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------|
| Frequency range | 2.4–2.4835 GHz |
| Impedance | 50 Ω |
| Gain LM2650 | +2 dBi maximum |
| Pattern | Omni-directional |
| Maximum VSWR | 3:1 |
| Connector | MMCX* |
| * The LM2650 can accommodate the following RF mating connectors: <ul style="list-style-type: none">• MMCX straight connector such as Johnson 135-3402-001, or equivalent• MMCX right angle connector such as Tyco 1408149-1, or equivalent | |

When the LM2650 is placed inside an enclosure, the antenna should be mounted such that the radiating portion of the antenna protrudes from the enclosure, and connected using a MMCX connector on a coaxial cable. For optimum performance, allow the antenna to be positioned vertically when installed.

4.0 Interfaces

4.1 Hardware Interfaces

Table 11 Hardware Interface Summary

| Port | Description | Pins |
|----------|------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------|
| Serial 1 | UART 6-pin (plus ground) | $\overline{\text{RTS_T}}$, $\overline{\text{CTS_T}}$, TX, $\overline{\text{RTS_R}}$, $\overline{\text{CTS_R}}$, RX, V_{SS} |
| Serial 2 | CLI UART | $\overline{\text{RTS_A}}$, TX_A, $\overline{\text{CTS_A}}$, $\overline{\text{RTS_B}}$, $\overline{\text{CTS_B}}$, RX_B, V_{SS} |
| Reset | Active low reset input | $\overline{\text{RST}}$ |
| MuP JTAG | Programming & development of LM2650 code | $\overline{\text{TMS}}$, TCK TDI, TDO, V_{SS} |
| AP SPI+ | Programming of the AP | $\overline{\text{FLASH_P_EN}}$, SCK, MOSI, MISO, $\overline{\text{SPI_CS}}$, V_{DD} , V_{SS} |

4.1.1 Serial 1 Interface

The serial 1 interface is designed for embedded integration with controllers. This serial interface provides programmatic access for configuration, management, and data access to the LM2650. The port is a 6-pin flow-controlled LVTTTL (3.3 V) serial interface accessible through the board-to-board connector.

Table 12 Serial 1 Parameters

| Parameter | Value |
|--------------|--------------------|
| Bit rate | 115200 |
| Parity | N |
| Data bits | 8 |
| Stop bit | 1 |
| Flow control | Hardware handshake |

Figure 1 illustrates the process that the LM2650 uses to transmit serial data:

1. The LM2650 drives $\overline{\text{RTS_T}}$ to active and checks level on $\overline{\text{CTS_T}}$.
2. If the LM2650 times out before the $\overline{\text{CTS_T}}$ becomes active, the LM2650 restores $\overline{\text{RTS_T}}$ to inactive and aborts the transmission.
3. If $\overline{\text{CTS_T}}$ is active, the LM2650 transmits the packet.
4. $\overline{\text{RTS_T}}$ is restored to inactive by the LM2650 prior to the $t_{\text{EOP to RTS_T}}$ timeout expiring.
5. OEM Controller must restore $\overline{\text{CTS_T}}$ to inactive prior to $t_{\text{RTS_T to CTS_T}}$ timeout expiring.

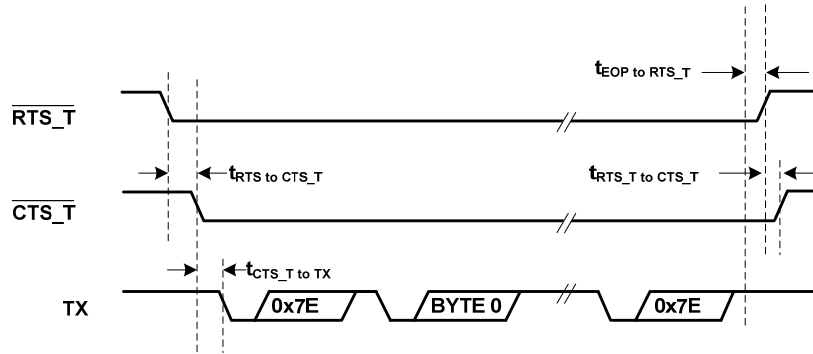


Figure 1 Packet Transmission from LM2650

Figure 2 illustrates the process that the LM2650 uses to receive serial data:

1. The OEM Controller must drive $\overline{\text{RTS_R}}$ to active and wait for a falling edge on $\overline{\text{CTS_R}}$.
2. If the OEM Controller times out before the $\overline{\text{CTS_R}}$ becomes active ($t_{\text{RTS_R to CTS_R}}$), the OEM Controller must restore $\overline{\text{RTS_R}}$ to inactive and try again.
3. If $\overline{\text{CTS_R}}$ becomes active, then the OEM Controller can transmit a packet.
4. OEM Controller must restore $\overline{\text{RTS_R}}$ to inactive prior to $t_{\text{EOP to RTS_R}}$ timeout expiring.
5. $\overline{\text{CTS_R}}$ is restored to inactive by the LM2650 prior to the $t_{\text{RTS_R to CTS_R}}$ timeout expiring.

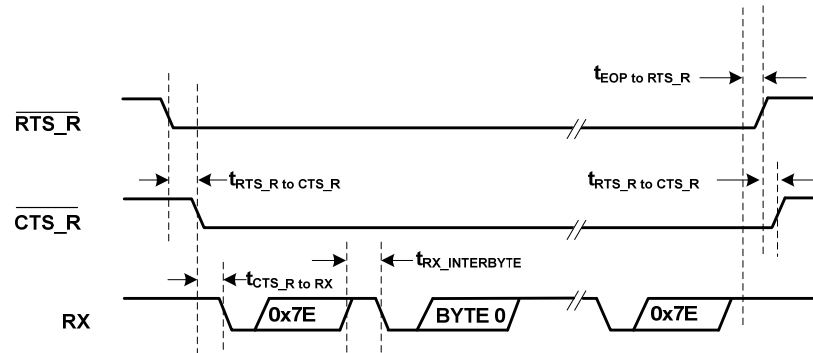


Figure 2 Packet Transmission to LM2650

Table 13 UART Timing Values

| Variable | Description | Min | Max | Units |
|-------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|-----|------------|
| $t_{\text{RX_BAUD}}$ | Deviation from baud rate | -2 | +2 | % |
| $t_{\text{RX_STOP}}$ | Number of stop bits (115.2 kbps) | 1 | | bit period |
| $t_{\text{TX_BAUD}}$ | Deviation from baud rate | -1 | +1 | % |
| $t_{\text{TX_STOP}}$ | Number of stop bits | 1 | | bit period |
| $t_{\text{RTS_R to CTS_R}}$ | Assertion of $\overline{\text{RTS_R}}$ to assertion of $\overline{\text{CTS_R}}$, or negation of $\overline{\text{RTS_R}}$ to negation of $\overline{\text{CTS_R}}$ | 0 | 22 | ms |
| $t_{\text{CTS_R to RX}}$ | Assertion of $\overline{\text{CTS_R}}$ to start of byte | 0 | 20 | ms |

| Variable | Description | Min | Max | Units |
|-------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|-----|-------|
| $t_{\text{EOP to RTS}_R}$ | End of packet (end of the last stop bit) to negation of $\overline{\text{RTS}}_R$ | 0 | 22 | ms |
| $t_{\text{RTS}_T \text{ to CTS}_T}$ | Assertion of $\overline{\text{RTS}}_T$ to assertion of $\overline{\text{CTS}}_T$, or negation of $\overline{\text{RTS}}_T$ to negation of $\overline{\text{CTS}}_T$ | 0 | 22 | ms |
| $t_{\text{CTS}_T \text{ to TX}}$ | Assertion of $\overline{\text{CTS}}_T$ to start of byte | 0 | 20 | ms |
| $t_{\text{EOP to RTS}_T}$ | End of packet (end of the last stop bit) to negation of $\overline{\text{RTS}}_T$ | 0 | 22 | ms |
| $t_{\text{RX_INTERBYTE}}$ | Interbyte delay | | 100 | ms |
| $t_{\text{EOP to ACK}}$ | End of packet to acknowledge | | 200 | ms |

4.1.2 Serial 2 Interface

The serial 2 interface supports the command line software interface used for troubleshooting. For information about the command line interface, refer to the *IA-510 Command Line Interface Guide*.

Table 14 Serial 2 Parameters

| Parameter | Value |
|--------------|--------|
| Bit rate | 115200 |
| Parity | N |
| Data bits | 8 |
| Stop bit | 1 |
| Flow control | None* |

* For serial 2 operation, the $\overline{\text{RTS}}_A$ pin must be actively driven to logic 0. When $\overline{\text{RTS}}_A$ is driven to logic 0, the LM2650 remains active, increasing average power consumption significantly.

4.1.3 Reset

The $\overline{\text{RST}}$ input pin is internally pulled up. Connecting it is optional; however, in applications operating in the presence of EMI, the $\overline{\text{RST}}$ pin should be actively driven high. If driven externally, it is recommended that an open collector output drive the $\overline{\text{RST}}$ pin signal, as the in circuit programming interfaces will actively drive $\overline{\text{RST}}$. Note that the LM2650 may also be reset using the serial API *reset* command, and this is the recommended method of resetting the LM2650 once it has completed its boot process. The $\overline{\text{RST}}$ pin should only be used to reset the LM2650 if communication with the LM2650 is lost. For information about API commands, refer to the *LA-510 LM2650 Manager Serial API Guide*. For requirements on reset timing, see the *LM2650 Hardware Integration Guide*.

4.2 Electrical Interface

4.2.1 J1 Board-to-board Pin Out

Table 15 J1 Board-to-board Connector

| Pin Number | Pin Name | I/O Direction | I/O Type | Comment |
|------------|----------------------------|---------------|----------------|----------------------|
| 1 | V _{DD} | In | 3.3 V ± 0.3V | |
| 2 | NC | - | Do not connect | Reserved |
| 3 | V _{SS} | - | | |
| 4 | $\overline{\text{RTS_R}}$ | In | 2 | |
| 5 | TX | Out | 4 | |
| 6 | $\overline{\text{CTS_T}}$ | In | 2 | |
| 7 | $\overline{\text{RTS_T}}$ | Out | 2 | |
| 8 | V _{SS} | - | | |
| 9 | $\overline{\text{CTS_R}}$ | Out | 2 | |
| 10 | RX | In | 2 | |
| 11 | V _{SS} | - | | |
| 12 | $\overline{\text{RTS_A}}$ | Out | 2 | |
| 13 | TX _A | Out | 2 | |
| 14 | $\overline{\text{CTS_A}}$ | In** | 2 | Signal is inactive |
| 15 | $\overline{\text{RTS_B}}$ | In** | 2 | Signal is inactive |
| 16 | V _{SS} | - | | |
| 17 | $\overline{\text{CTS_B}}$ | Out | 2 | Signal is inactive |
| 18 | RX _B | In | 2 | |
| 19 | V _{SS} | - | | |
| 20 | $\overline{\text{RST}}$ | In* | 5 | Active low MuP reset |

*The $\overline{\text{RST}}$ input pin is internally pulled up. When driven low, the LM2650 is hardware reset until the signal is de-asserted. Refer to section 4.1.2 for timing requirements on the $\overline{\text{RST}}$ pin.

** These pins are internally pulled up.

4.2.1.1 Recommended Mating Connectors

The LM2650's J1 connector is FCIConnect's Rib-Cage connectors for reliability in high vibration environments (87024-610TRLF). The mating connector options for this connector are shown in the table below.

Table 16 Recommended Mating Connectors

| Connector | Mated Height (mm) |
|-----------------|-------------------|
| FCI 87409-110LF | 5.74 |
| FCI 90098-110LF | 7.57 |
| FCI 73547-110LF | 9.25 |

4.2.2 J2 MuP JTAG Connector

Table 17 J2 MuP JTAG Connector

| Pin Number | Pin Name | I/O Direction | I/O Type | Comment |
|------------|-------------------------|---------------|--------------|-----------------------|
| 1 | V _{DD} | In | 3.3 V ± 0.3V | Supply |
| 2 | V _{DD} | In | 3.3 V ± 0.3V | Supply |
| 3 | Logic 1 | Out | 3.3V ± 0.3V | |
| 4 | V _{SS} | - | | |
| 5 | TDI | - | 2 | JTAG test data in |
| 6 | V _{SS} | - | | |
| 7 | $\overline{\text{TMS}}$ | - | 2 | JTAG test mode select |
| 8 | V _{SS} | - | | |
| 9 | TCK | - | 2 | JTAG test clock |
| 10 | V _{SS} | - | | |
| 11 | TCK* | - | 2 | JTAG test clock |
| 12 | V _{SS} | - | | |
| 13 | TDO | - | 2 | JTAG test data out |
| 14 | V _{SS} | - | | |
| 15 | $\overline{\text{RST}}$ | In | 5 | Active low MuP reset |
| 16 | V _{SS} | - | | |
| 17 | V _{SS} | - | | |
| 18 | V _{SS} | - | | |
| 19 | V _{SS} | - | | |
| 20 | V _{SS} | - | | |

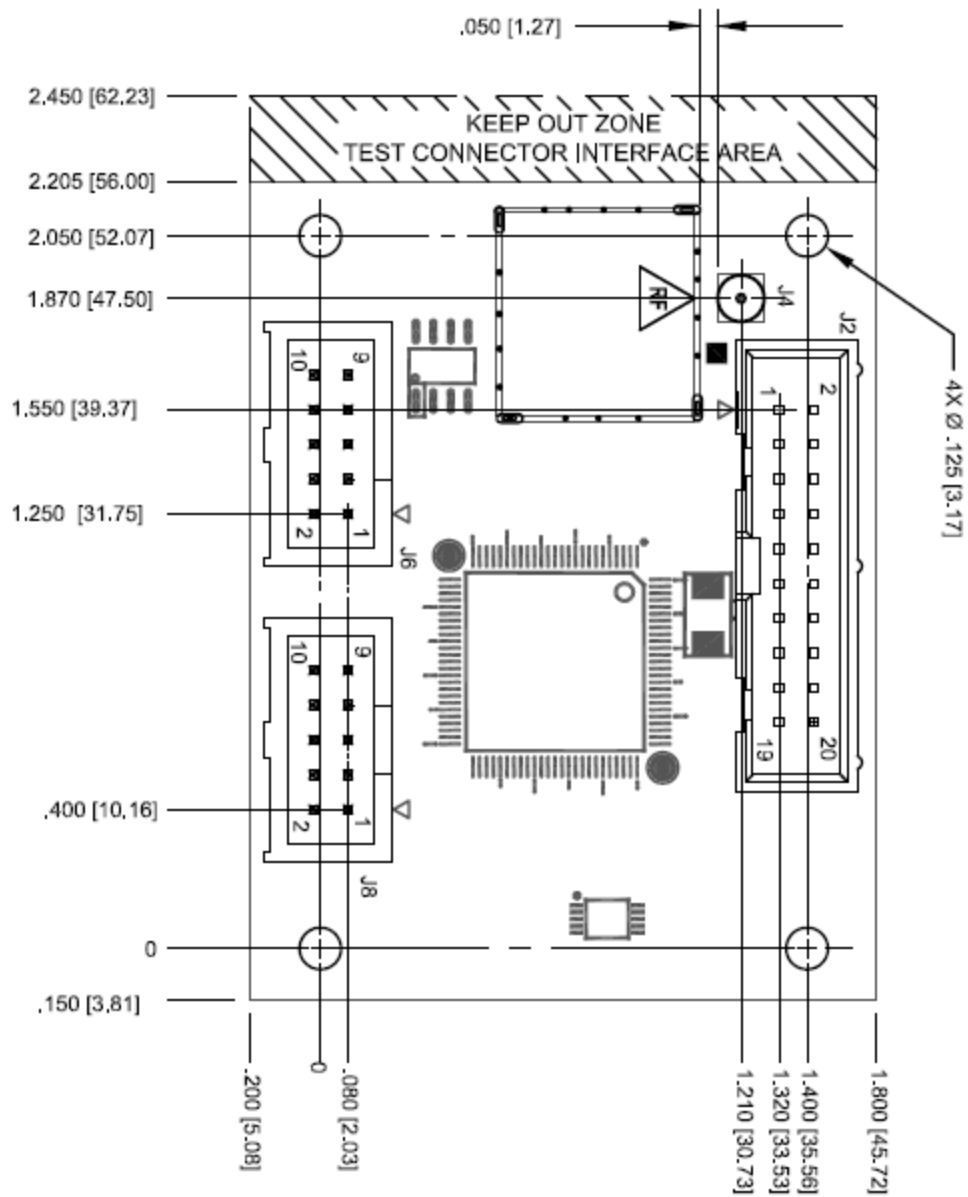
4.2.3 J6 AP SPI+ Connector

J6 AP SPI+ Connector

| Pin Number | Pin Name | I/O Direction | I/O Level | Comment |
|------------|----------------------------------|---------------|--------------|--------------------------|
| 1 | $\overline{\text{SPI_CS}}$ | In* | 3 | SPI chip select |
| 2 | $\overline{\text{FLASH_P_EN}}$ | In* | 1 | SPI flash program enable |
| 3 | SCK | In* | 3 | Serial clock |
| 4 | MOSI | In* | 3 | Serial data in |
| 5 | MISO | Out | 3 | Serial data out |
| 6 | $\overline{\text{AP_RST}}$ | In | 1 | Access point reset |
| 7 | V _{DD} | In | 3.3 V ± 0.3V | Supply |
| 8 | V _{SS} | - | | |
| 9 | NC | - | | Reserved |
| 10 | $\overline{\text{RST}}$ | In | 5 | Active low MuP reset |

5.0 Mechanical Specifications

5.1 LM2650 Mechanical Drawings



PRIMARY DIMENSIONS ARE IN INCHES
 DIMENSIONS IN [mm] ARE MILLIMETERS

UNLESS OTHERWISE SPECIFIED, ALL DIMENSIONS +/- .010 INCH.

Figure 3 LM2650 (Top)

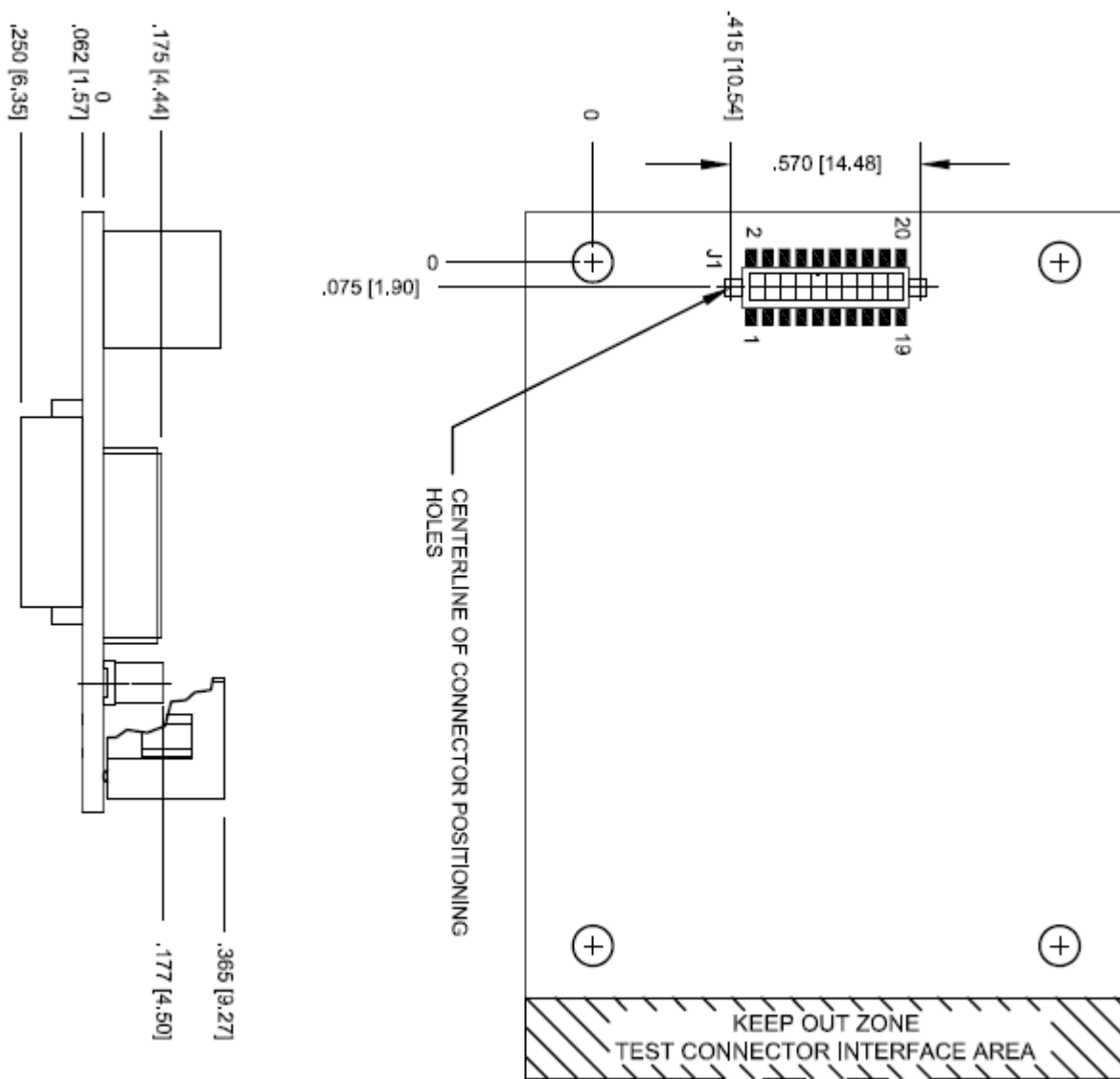


Figure 4 LM2650 (Side and Bottom)

6.0 Regulatory and Standards Compliance

6.1 FCC Compliance

6.1.1 FCC Testing

The LM2650 Embedded Manager complies with Part 15.247 modular (Intentional Radiator) of the FCC rules and regulations. In order to fulfill FCC certification requirements, products incorporating the LM2650 Embedded Manager must comply with the following:

1. An external label must be provided on the outside of the final product enclosure specifying the FCC identifier, as described in section 6.1.3 below.
2. The antenna must be electrically identical to the FCC-approved antenna specifications for the LM2650 as described in 6.1.2, with the exception that the gain may be lower than specified in Table 18.
3. The device integrating the LM2650 may not cause harmful interference, and must accept any interference received, including interference that may cause undesired operation.
4. An unintentional radiator scan must be performed on the device integrating the LM2650 Embedded Manager, per FCC rules and regulations, CFR Title 47, Part 15, Subpart B. See FCC rules for specifics on requirements for declaration of conformity.

6.1.2 FCC-approved Antennas

The following are FCC-approved antenna specifications for the LM2650.

Table 18 FCC-approved Antenna Specifications for the LM2650

| Gain | Pattern | Polarization | Frequency | Connector |
|----------------|-----------------|--------------|----------------|-----------|
| +2 dBi maximum | Omnidirectional | Vertical | 2.4–2.4835 GHz | MMCX |

6.1.3 OEM Labeling Requirements

The Original Equipment Manufacturer (OEM) must ensure that FCC labeling requirements are met. The outside of the final product enclosure must have a label with the following (or similar) text specifying the FCC identifier. The FCC ID and certification code must be in Latin letters and Arabic numbers and visible without magnification.

Contains transmitter module FCC ID: SJC-LM2610

or

Contains FCC ID: SJC-LM2610

6.2 IC Compliance

6.2.1 IC Testing

The LM2650 is certified for modular Industry Canada (IC) RSS-210 approval. The OEM is responsible for its product to comply with IC ICES-003 and FCC Part 15, Sub. B - Unintentional Radiators. The requirements of ICES-003 are equivalent to FCC Part 15 Sub. B and Industry Canada accepts FCC test reports or CISPR 22 test reports for compliance with ICES-003.

6.2.2 IC-approved Antennas

The LM2650 is designed to operate with antennas meeting the specifications shown in Table 19. Antennas not included in this list or having gains greater than shown in Table 19 are strictly prohibited for use with this device. The required antenna impedance is 50 Ohms. To reduce potential radio interference to other users, the antenna type and its gain should be such that the equivalent isotropically radiated power (EIRP) is not more than that permitted for successful communication. 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.

Table 19 IC-approved Antenna Specifications for the LM2650

| Gain | Pattern | Polarization | Frequency | Connector |
|----------------|-----------------|--------------|----------------|-----------|
| +2 dBi maximum | Omnidirectional | Vertical | 2.4–2.4835 GHz | MMCX |

6.2.3 OEM Labeling Requirements

The Original Equipment Manufacturer (OEM) must ensure that IC labeling requirements are met. The outside of the final product enclosure must have a label with the following (or similar) text specifying the IC identifier. The IC ID and certification code must be in Latin letters and Arabic numbers and visible without magnification.

Contains IC: 5853-LM2610

6.3 CE Compliance

6.3.1 Declaration of Conformity

We, Dust Networks, of 30695 Huntwood Ave, Hayward, CA 94544 USA, declare under our sole responsibility that our product, SmartMesh LM2650, and in combination with our accessories, to which this declaration relates is in conformity with the appropriate standards ETSI EN 300 328, ETSI EN 301 489-17 and EN 60950, following the provisions of Radio Equipment and Telecommunication Terminal Equipment directive 99/5/EC with requirements covering EMC directive 89/336/EEC, and low voltage directive 2006/95/EEC.

6.3.2 European Compliance

If the LM2650 manager is incorporated into a product, the manufacturer must ensure compliance of the final product to the European harmonized EMC and low-voltage/safety standards. A Declaration of Conformity must be issued for each of these standards and kept on file as described in Annex II of the R&TTE Directive. Furthermore, the manufacturer must maintain a copy of this LM2650 user documentation and ensure the final product does not exceed the specified power ratings, antenna specifications, and/or installation requirements as specified in the user manual. If any of these specifications are exceeded in the final product, a submission must be made to a notified body for compliance testing to all required standards.

6.3.3 OEM Labeling Requirements

The ‘CE’ marking must be affixed to a visible location on the OEM product. The CE mark shall consist of the initials “CE” taking the following form:

- If the CE marking is reduced or enlarged, the proportions given in the drawing below must be respected.
- The CE marking must have a height of at least 5 mm except where this is not possible because of the nature of the apparatus.
- The CE marking must be affixed visibly, legibly, and indelibly.

Furthermore, since the usage of the 2400 – 2483.5 MHz band is not harmonized throughout Europe, the Restriction sign must be placed to the right of the ‘CE’ marking as shown below. See the R&TTE Directive, Article 12 and Annex VII for more information.

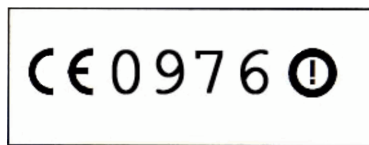


Figure 5 CE Label Requirements

6.3.4 Restrictions

Norway prohibits operation near Ny-Alesund in Svalbard. More information can be found at the Norway Posts and Telecommunications site (www.npt.no).

6.4 RoHS Compliance

Restriction of Hazardous Substances (RoHS) is a directive that places maximum concentration limits on the use of cadmium (Cd), lead (Pb), hexavalent chromium (Cr+6), mercury (Hg), Polybrominated Biphenyl (PBB) and Polybrominated Diphenyl Ethers (PBDE). Dust Networks is committed to meeting the requirements of the European Community directive 2002/95/EC.

This product has been specifically designed to utilize RoHS compliant materials and to eliminate, or reduce, the use of restricted materials to comply with 2002/95/EC.

The Dust Networks RoHS compliant design features include:

- RoHS compliant solder for solder joints
- RoHS compliant base metal alloys
- RoHS compliant precious metal plating
- RoHS compliant cable assemblies and connector choices

6.5 Industrial Environment Operation

The LM2650 is designed to meet the requirements of harsh industrial environments, which includes:

- **Shock and Vibration**—The LM2650 complies with high vibration pipeline testing, as specified in IEC 60770-1.
- **Temperature Extremes**—The LM2650 is designed for industrial storage and operational temperature range of –40 °C to +85 °C.

7.0 Ordering Information

This section explains Dust Networks' order code format. The product order code specifies the model number, software code, production status, and any special instructions for the product. Table 20 describes the order code options. *Note that not all options are valid for every product.* Please contact your Dust Networks Sales Representative for specific product order code information.

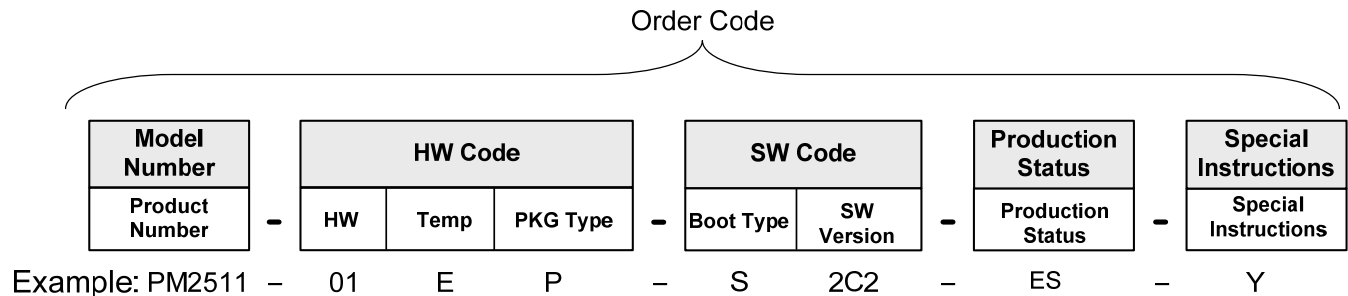


Table 20 Order Code Descriptions

| Code Type | Description |
|----------------------|-----------------------------------------------------------------------------------------------------------------------------------------|
| Product Number | Product number |
| HW | Hardware revision |
| Temp | Temperature: C = Commercial E = Extended industrial H = High temperature industrial Z = Software only order |
| PKG Type | Package type: Q = QFN L = LGA P = PCA E = Packaged products K = Development or evaluation kit Z = Software only order |
| Boot Type | Boot type: S = Standard boot L = Low-current boot Z = Hardware only order |
| SW Version | Software version |
| Production Status | ES = Engineering sample Empty = Production |
| Special Instructions | Y = Special instructions Empty = No special instructions |

Contact Information:

Dust Networks
 30695 Huntwood Ave.
 Hayward, CA 94544
Toll-Free Phone: 1 (866) 289-3878
Website: www.dustnetworks.com
Email: sales@dustnetworks.com

Trademarks

SmartMesh-XX, SmartMesh-XD, SmartMesh-XT, and SmartMesh IA-510 are trademarks of Dust Networks, Inc. The Dust Networks logo, Dust, Dust Networks, and SmartMesh are registered trademarks of Dust Networks, Inc. All third-party brand and product names are the trademarks of their respective owners and are used solely for informational purposes.

Copyright

This documentation is protected by United States and international copyright and other intellectual and industrial property laws. It is solely owned by Dust Networks, Inc. and its licensors and is distributed under a restrictive license. This product, or any portion thereof, may not be used, copied, modified, reverse assembled, reverse compiled, reverse engineered, distributed, or redistributed in any form by any means without the prior written authorization of Dust Networks, Inc.

RESTRICTED RIGHTS: Use, duplication, or disclosure by the U.S. Government is subject to restrictions of FAR 52.227-14(g) (2)(6/87) and FAR 52.227-19(6/87), or DFAR 252.227-7015 (b)(6/95) and DFAR 227.7202-3(a), and any and all similar and successor legislation and regulation.

Disclaimer

This documentation is provided “as is” without warranty of any kind, either expressed or implied, including but not limited to, the implied warranties of merchantability or fitness for a particular purpose.

This documentation might include technical inaccuracies or other errors. Corrections and improvements might be incorporated in new versions of the documentation.

Dust Networks does not assume any liability arising out of the application or use of any products or services and specifically disclaims any and all liability, including without limitation consequential or incidental damages.

Dust Networks products are not designed for use in life support appliances, devices, or other systems where malfunction can reasonably be expected to result in significant personal injury to the user, or as a critical component in any life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness. Dust Networks customers using or selling these products for use in such applications do so at their own risk and agree to fully indemnify and hold Dust Networks and its officers, employees, subsidiaries, affiliates, and distributors harmless against all claims, costs, damages, and expenses, and reasonable attorney fees arising out of, directly or indirectly, any claim of personal injury or death associated with such unintended or unauthorized use, even if such claim alleges that Dust Networks was negligent regarding the design or manufacture of its products.

Dust Networks reserves the right to make corrections, modifications, enhancements, improvements, and other changes to its products or services at any time and to discontinue any product or service without notice. Customers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All products are sold subject to Dust Network's terms and conditions of sale supplied at the time of order acknowledgment or sale.

Dust Networks does not warrant or represent that any license, either express or implied, is granted under any Dust Networks patent right, copyright, mask work right, or other Dust Networks intellectual property right relating to any combination, machine, or process in which Dust Networks products or services are used. Information published by Dust Networks regarding third-party products or services does not constitute a license from Dust Networks to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from Dust Networks under the patents or other intellectual property of Dust Networks.

© Dust Networks, Inc., 2010. All Rights Reserved.

Document number: 020-0041 rev 2 SmartMesh IA-510 (L) LM2650 Datasheet

Last Revised: August 20, 2010

| Document Status | Product Status | Definition |
|-------------------------|---------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Advanced Information | Planned or under development | This datasheet contains the design specifications for product development. Dust Networks reserves the right to change specifications in any manner without notice. |
| Preliminary | Engineering samples and pre-production prototypes | This datasheet contains preliminary data; supplementary data will be published at a later time. Dust Networks reserves the right to make changes at any time without notice in order to improve design and supply the best possible product. The product is not fully qualified at this point. |
| No Identification Noted | Full production | This datasheet contains the final specifications. Dust Networks reserves the right to make changes at any time without notice in order to improve design and supply the best possible product. |
| Obsolete | Not in production | This datasheet contains specifications for a product that has been discontinued by Dust Networks. The datasheet is printed for reference information only. |