CEL

MATRIX TRANSCEIVER MODULES

ZMXM-400 Series

Integrated Transceiver Module for ZigBee / IEEE 802.15.4

Evaluation Kits available

DESCRIPTION

The Matrix module is a 2.4 GHz IEEE 802.15.4 RF transceiver providing a cost-effective solution for data links and wireless networks. The module design is based on the IEEE 802.15.4 standard and supports peer-to-peer, star, and mesh networking. The Matrix module is offered with two transmitter output power options, either 10mW or 100mW, providing for enhanced range performance over standard IEEE 802.15.4/ZigBee implementations with the integrated power amplifier. Additionally, each module offers a Dynamic Power Configuration capability giving the ability to bypass the power amplifier for a 1mW power output when low power operation is imperative.

The Matrix module consists of the Texas Instruments CC2430, 10mW or 100mW Power Amplifier, and integrated PCB trace antenna. The module has the option to be populated with a MMCX connector for use with an external cabled antenna. The module is FCC, IC, and CE certified for fast and simple integration into end applications. The Matrix modules provide the lowest cost, best in class performance, in a compact form factor.

FEATURES

- **Supports LS Research or Z-Stack™ protocols**
- **Miniature Footprint:**
  10mW (23.4 x 28.7 mm)
  100mW (23.4 x 31.2 mm)
- **Integrated certified PCB trace antenna**
- **Optional MMCX connector for external antenna**
- **16 RF channels**
  (Channel 16 operates at reduced power levels)
- **Long Range:**
  10mW - up to 2000 feet
  100mW - up to 4000 feet
- **Output power software controlled:**
  1mW - 10mW or
  1mW - 100mW
- **17 General Purpose I/O ports**
- **Windows® Based Test Tools**
- **Serial UART interface**
- **Lowest Power Consumption**
- **Compliance Certification:**
  10mW - FCC (USA), IC (Canada), and CE (Europe) certification
  100mW - FCC (USA) and IC (Canada) certification
- **RoHS compliant**

The information in this document is subject to change without notice, please confirm data is current
Document No: 0004-00-07-00-000 (Issue C)
Date Published: December 4, 2009

LS RESEARCH
Wireless Product Development

MATRIX MODULES ORDERING INFORMATION

Part Number	Order Number	Supplying Form
ZMXM-400 Series	ZMXM-400-1	Matrix Module (10mW) with PCB Trace Antenna
	ZMXM-400-1C	Matrix Module (10mW) with optional MMCX Connector installed @ J2
	ZMXM-400-KIT-2	Matrix Module (10mW) Evaluation Kit
ZMXM-401 Series	ZMXM-401-1	Matrix Module (100mW) with PCB Trace Antenna
	ZMXM-401-1C	Matrix Module (100mW) with optional MMCX Connector installed @ J2
	ZMXM-401-KIT-1	Matrix Module (100mW) Evaluation Kit

ABSOLUTE MAXIMUM RATINGS

Rating	Value	Unit
Power Supply Voltage	3.6	Vdc
Voltage on Any Digital Pin	V_{DD} + 0.3, Max 3.6	Vdc
RF Input Power	+10	dBm
Storage Temperature Range	-45 to 125	ºC

Note: Exceeding the maximum ratings may cause permanent damage to the module or devices.
Caution: Matrix modules are sensitive to electrostatic discharge, observe precautions when handling.

OPERATING CONDITIONS

Characteristic		Min	Typ	Max	Unit
Power Supply Voltage (Vdd)					
	10mW	2.1	3.3	3.6	Vdc
	100mW	2.4	3.3	3.6	Vdc
Input Frequency		2405		2480	MHz
Ambient Temperature Range		-40	25	85	ºC
Logic Input Low Voltage		0		30% Vdd	V
Logic Input High Voltage		70% Vdd		Vdd	V

ELECTRICAL SPECIFICATIONS (@ 25 ºC, Vdd = 3.3V, unless otherwise noted)

Parameter		Min	Typ	Max	Unit
General Charcteristics					
RF Frequency Range		2400		2483.5	MHz
RF Data Rate			250		kbps
Host Data Rate					
	10 mW			115.2	kbps
	100 mW			115.2	kbps
Flash Memory			128		kB
RAM			8		kB
Power Consumption					
Transmit Mode					
	10mW		50		mA
	100mW		130		mA
Receive Mode					
	10mW		33		mA
	100mW		33		mA
Standby Mode					
	10mW			5	µA
	100mW			5	µA
Transmitter					
Nominal Output Power					
	10mW		10		dBm
	100mW		20		dBm
Nominal Output Power (DPS)			-1		dBm
Programmable Output Power range			24		dB
Error Vector Magnitude			12	35	%
Receiver					
Module Sensitivity (1% PER)			-89		dBm
Receiver Sensitivity (1% PER)			-92		dBm
Saturation (Maximum Input Level) (1% PER)		0	10		dBm
Control AC Characteristics					
RESET_N low pulse width		2.5			ns
Interrupt request pulse width		31.25			ns
Control DC Characteristics					
Logic Input Low		0	0.7	0.9	V
Logic Input High		VDD-0.25	VDD	VDD	V
Logic Output Low		0	0	0.25	V
Logic Output High		VDD-0.25	VDD	VDD	V
I/O pin pull-up and pull-down resistor		17	20	23	kΩ

Note: Please refer to the Texas Instruments CC2430 datasheet for further information and details regarding the configuration of the I/O ports.

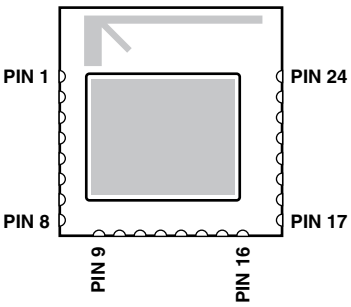


Figure 1

PIN SIGNALS I/O PORT CONFIGURATION

Matrix modules have 24 edge I/O interfaces for connection to the host board. Figure 1 shows the layout of the 24 edge castellations.

I/O PIN ASSIGNMENTS

Pin #	Name	Type	Description
1	GROUND	GND	Ground
2	P0_2	DI/DO/AI	General Purpose Digital I/0 Port 0_2 or ADC input 2
3	P0_3	DI/DO/AI	General Purpose Digital I/0 Port 0_3 or ADC input 3
4	P0_4	DI/DO/AI	General Purpose Digital I/0 Port 0_4 or ADC input 4
5	P0_5	DI/DO/AI	General Purpose Digital I/0 Port 0_5 or ADC input 5
6	P0_6	DI/DO/AI	General Purpose Digital I/0 Port 0_6 or ADC input 6
7	P0_7	DI/DO/AI	General Purpose Digital I/0 Port 0_7 or ADC input 7
8	GROUND	GND	Ground
9	MODE0	DI/DO	General Purpose Digital I/O Port 2_2 or Debug CLK
10	MODE1	DI/DO	General Purpose Digital I/O Port 2_1 or Debug DATA (DD)
11	MODE2	DI/DO	General Purpose Digital I/O Port 2_0
12	P1_7	DI/DO	General Purpose Digital I/O Port 1_7
13	P1_6	DI/DO	General Purpose Digital I/O Port 1_6
14	TXD	DI/DO	General Purpose Digital I/O Port 1_5 or Application Transmit Data Output
15	RXD	DI/DO	General Purpose Digital I/O Port 1_4 or Application Receive Data Input
16	P1_3	DI/DO	General Purpose Digital I/O Port 1_3
17	GROUND	GND	Ground
18	P1_1	DI/DO	General Purpose Digital I/O Port 1_1, 20mA drive capability
19	P1_0	DI/DO	General Purpose Digital I/O Port 1_0, 20mA drive capability
20	RESET	DI	Reset, active low
21	P0_0	DI/DO/AI	General Purpose Digital I/0 Port 0_0 or ADC input 0 Optional on-board Green LED
22	P0_1	DI/DO/AI	General Purpose Digital I/0 Port 0_1 or ADC input 1Optional on-board Red LED
23	VDD	PI	Power Supply Input
24	GROUND	GND	Ground

Unused I/O pins should be left unconnected and the pin state set via the Host Protocol.

DI = Digital Input
DO = Digital Output
AI = Analog Input
AO = Analog Output
PI = Power Input
GND = Ground

ANTENNA

The Matrix module includes an integrated PCB trace antenna. An optional configuration with a MMCX connector is also available. The module regulatory certification has been completed with the PCB trace antenna and also with a Nearson (part# S131CL-5-RMM-2450S) dipole antenna on a 5 inch cable using the MMCX connection.

The integrated PCB antenna topology is an F-antenna. This antenna is used because it is reasonably compact, has a fairly omni-directional radiation pattern, good efficiency, and is very simple. An adequate ground plane directly beneath the module but not under the antenna is necessary to provide good efficiency.

The antenna radiation patterns are dependent upon the carrier board the Matrix module is placed upon. Measured radiation patterns of the module alone are available by contacting LS Research.

The environment the module is placed in will dictate the range performance. The non-ideal characteristics of the transmission channel result in the transmitted signal producing reflection, diffraction, and/or scattering. All of these factors randomly combine to create extremely complex scenarios.

It is also best to keep some clearance between the antenna and nearby objects. This includes how the module is mounted in the product enclosure. Unless the items on the following list of recommendations are met, the radiation pattern can be heavily distorted.

- Never place ground plane or copper trace routing underneath the antenna.
- Never place the antenna very close to metallic objects.
- In the final product, ensure that any wiring or other components do not get too close to the antenna.
- The antenna will need a reasonable ground plane area on the mother board area to be efficient.
- Do not use a metallic enclosure or metallized plastic for the antenna.
- Try to keep any plastic enclosure greater than 1 cm from the antenna in any orientation.

POWER AMPLIFIER

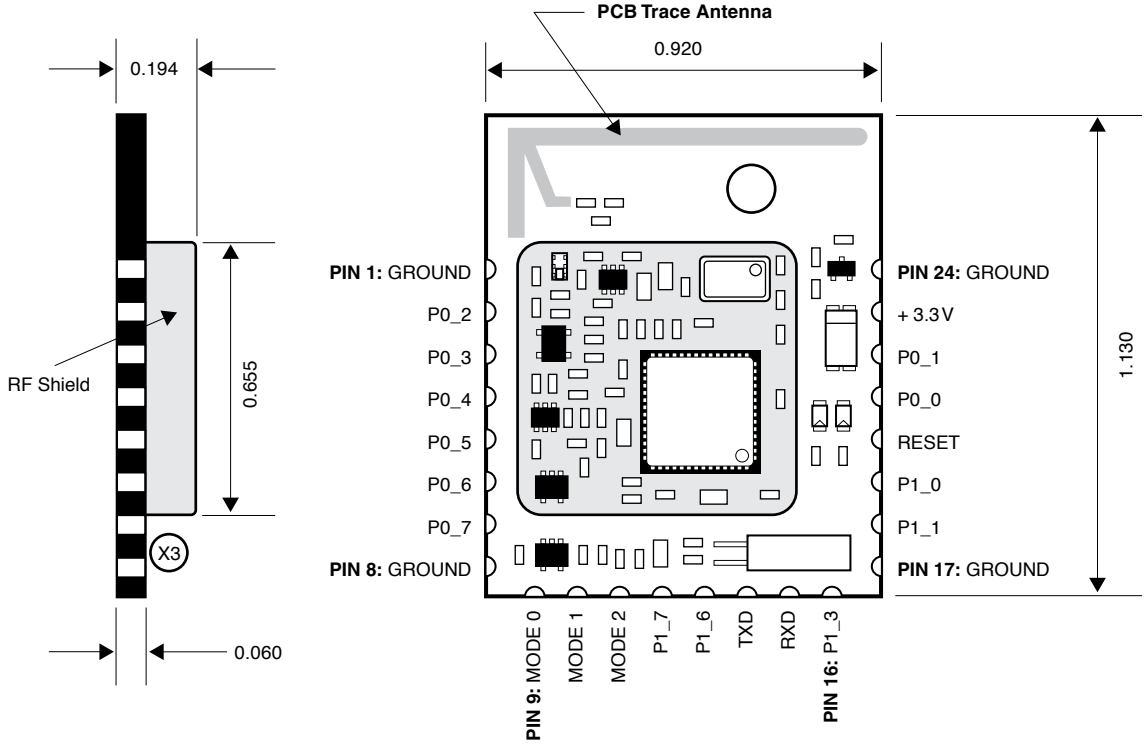
Both variants of the Matrix modules contain a Power Amplifier. The Matrix 10 mW (ZMXM-400) has a maximum Power Out of 10 mW, while the Matrix 100 mW has a maximum Power Out of 100 mW.

The Power Amplifier is controlled via the P1_2 General Purpose I/O (GPIO) of the Texas Instruments CC2430. As such, the P1_2 GPIO needs to be configured as an output in the application source code to enable control the Power Amplifier.

When P1_2 drives LOW (i.e. logic level ‘0’) the Power Amplifier is disabled and maximum Power Out is 1 mW regardless of module in use. When P1_2 drives HIGH (i.e. logic level ‘1’) the Power Amplifier is enabled and maximum Power Out is either 10 mW or 100 mW depending upon which variant of the Matrix module is in use. Intermediate power level settings (i.e. between 1 mW and 10 or 100 mW) may be achieved by enabling the power amplifier and then varying the Power Out of the CC2430.

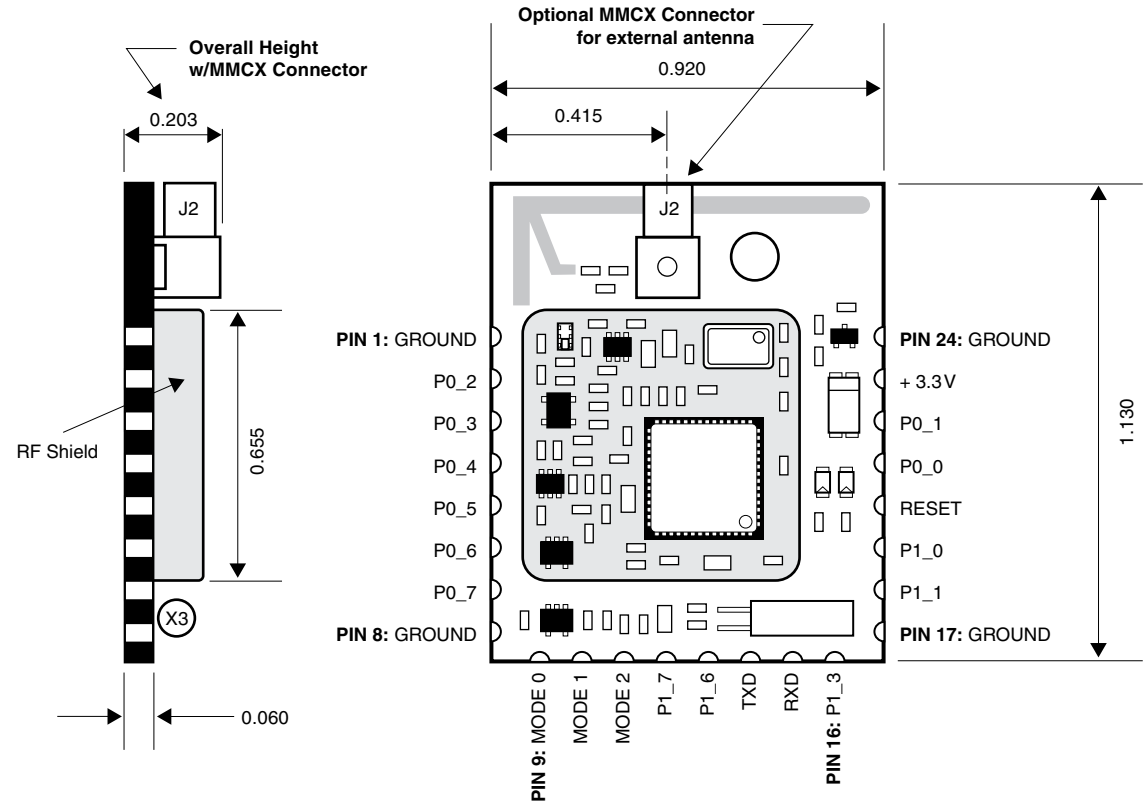
DIMENSIONS: ZMXM-400-1 Matrix Module 10mW

Dimensions in inches. Tolerances = +/-0.005" unless otherwise noted.



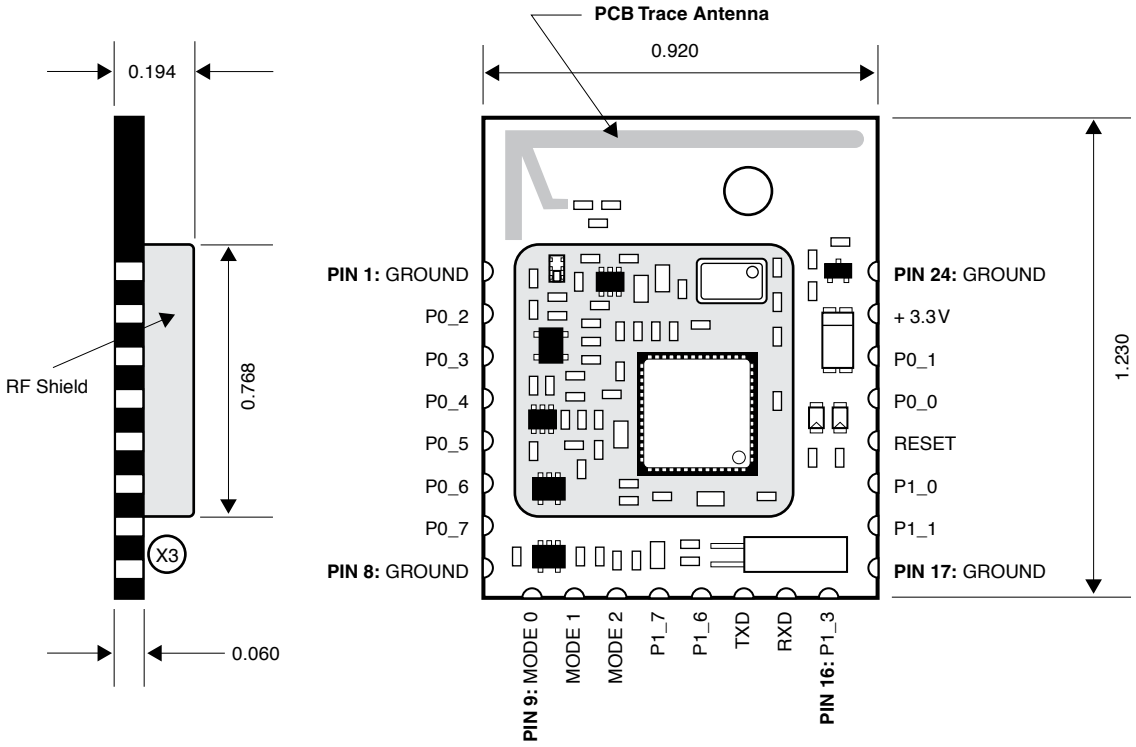
DIMENSIONS: ZMXM-400-1C Matrix Module 10mW *with Optional MMCX Connector*

Dimensions in inches. Tolerances = +/-0.005" unless otherwise noted.



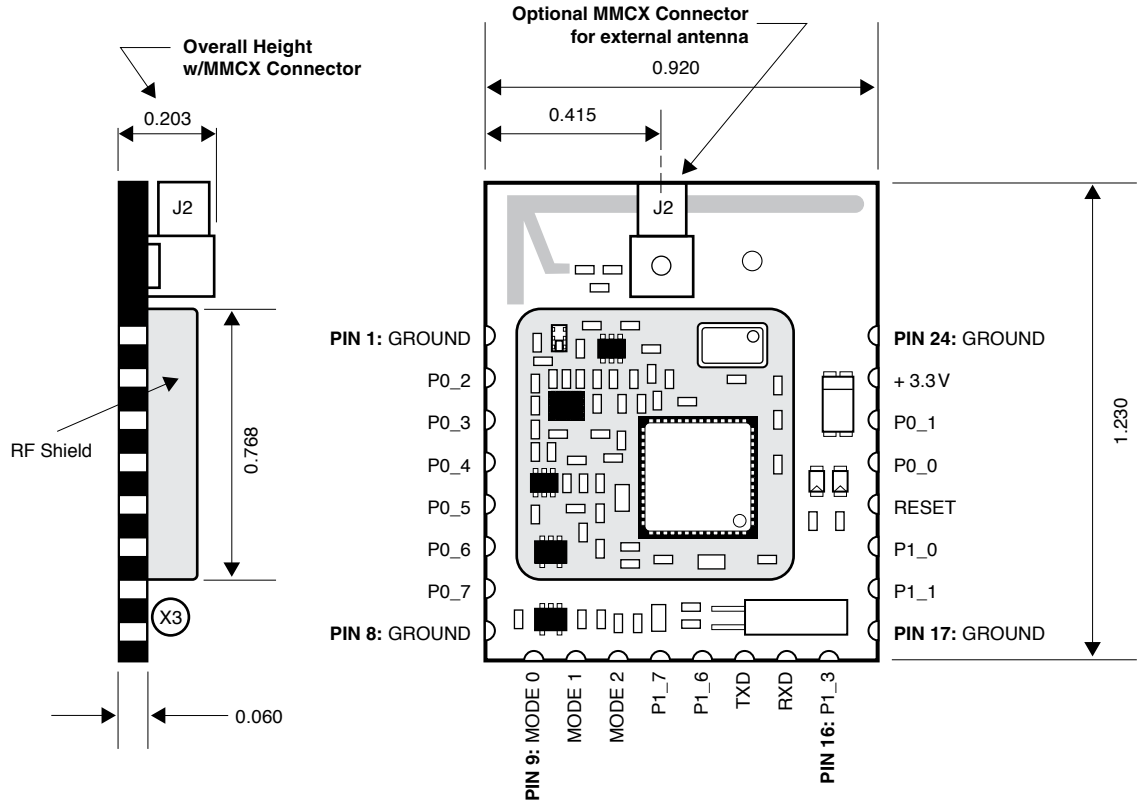
DIMENSIONS: ZMXM-401-1 Matrix Module 100mW

Dimensions in inches. Tolerances = +/-0.005" unless otherwise noted.

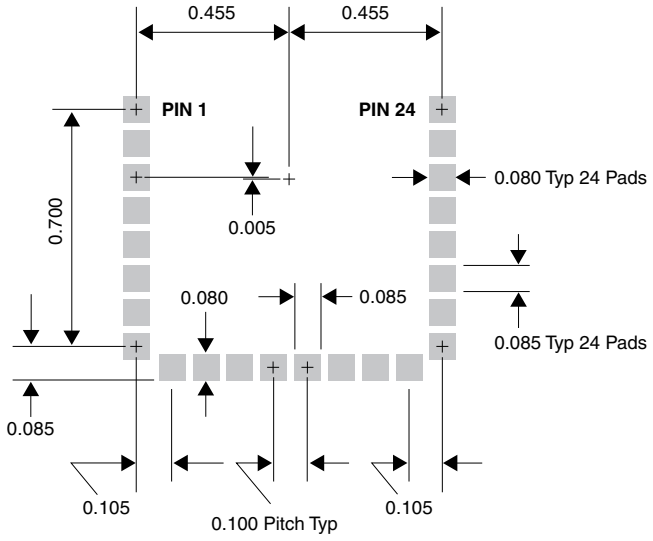


DIMENSIONS: ZMXM-401-1C Matrix Module 100mW *with Optional MMCX Connector*

Dimensions in inches. Tolerances = +/-0.005" unless otherwise noted.

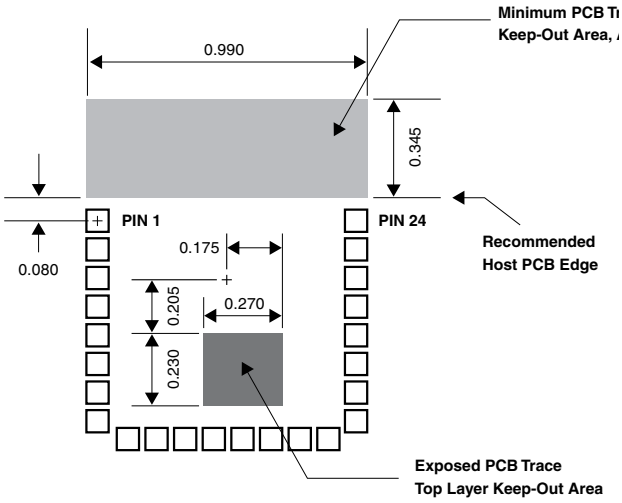


PCB PAD LAYOUT *Dimensions in inches. Tolerances = +/-0.005" unless otherwise noted.*

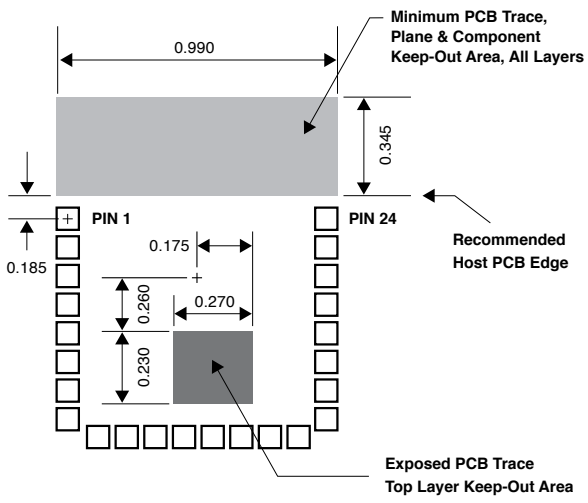


PCB KEEP-OUT AREAS *Dimensions in inches. Tolerances = +/-0.005" unless otherwise noted.*

Matrix Module 10mW



Matrix Module 100mW



Note: Matrix modules should be mounted so the antenna is overhanging the board edge. This will provide the best antenna performance for the PCB trace antenna. It is also recommended to have a ground plane on the host board underneath the rest of the module, up to the recommended PCB edge. This will improve the antenna performance by increasing the overall ground plane.

Traces can be run underneath the Matrix module on the host PCB as long a there is an uninterrupted ground plane on one layer as well. CEL can arrange guidance and help with the host PCB layout.

AGENCY SAFETY CERTIFICATIONS

FCC Part 15.247 Module Certified (Portable)

The Matrix modules comply with Part 15 of the Federal Communications Commission rules and regulations. To meet the FCC Certification requirements, the user must meet these regulations.

- The text on the FCC ID label provided with the module is placed on the outside of the final product.
- The modules may only use the antennas that have been tested and approved with this module.
  - — The on-board PCB trace antenna
  - — Nearson S131CL-5-RMM-2450S antenna.

Per section 2.1091, the Matrix module has been certified by the FCC for use with other products without additional certification. Any modifications to this product may violate the rules of the Federal Communications Commission and make operation of the product unlawful.

Per sections 15.107 and 15.109, the user's end product must be tested to comply with unintentional radiators for compliance.

Per Section 47 C.F.R. Sec.15.105(b), the Matrix module is certified as a portable device for the FCC radiation exposure limits set forth for an uncontrolled environment. The antenna used with this module must be installed to provide a separation distance of at least 8 inches (20cm) from all persons. If the module is to be used in a handheld application, the user is responsible for passing the additional FCC part 2.1091 rules (SAR) and FCC Guidelines for Human Exposure to Radio Frequency Electromagnetic Fields, OET Bulletin and Supplement C.

IC Certification — Canada

Matrix modules are IC certified. The labeling requirements for Industry Canada are similar to those of the FCC. A visible label on the outside of the final product must display the IC labeling. The user is responsible for the end product to comply with IC ICES-003 (Unintentional radiators).

CE Certification — Europe

Matrix modules are EN 300-328-1 certified in Europe. The user must ensure compliance of the final product with the European harmonized EMC and safety standards. Annex II of the R&TTE Directive provides the requirements for the issuance of a Declaration of Conformity. The CE marking must be affixed legibly and indelibly to a visible location on the user's product.

FCC Approved Antennas

- **Integrated PCB trace antenna**
- **Nearson S131CL-5-RMM-2450S –** A 2.4GHz Dipole antenna with a 5 inch cable and a right angle MMCX connector.

SHIPMENT, HANDLING, AND STORAGE

Shipment

Matrix Modules are delivered in single piece, or 50 piece cartons in individual anti-static bags.

Handling

Matrix Modules are designed and packaged to be processed in an automated assembly line.

!Warning Matrix Modules contain highly sensitive electronic circuitry. Handling without proper ESD protection may destroy or damage the module permanently.

!Warning According to JEDEC ISP, Matrix Modules are moisture sensitive devices. Appropriate handling instructions and precautions are summarized in Section 2.1. Read carefully to prevent permanent damages due to moisture intake.

Moisture Sensitivity Level (MSL)

MSL 3, per J-STD-033

Storage

Storage/Shelf life in sealed bags is 12 months at <40ºC and <90% relative humidity.

PROCESSING

Reflow Soldering

A convection soldering oven is recommended over the infrared radiation type oven. Convection ovens allow more precise temperature control, and more even heating of parts regardless of material composition, thickness, or color.

Preheat Phase

Initial heating of component leads and solder paste balls, for removal of residual humidity.

Note: The preheat phase is not intended to replace prior baking procedures.

- Temperature rise rate: 0.8-1.7ºC/sec

Note: Excessive slumping can result if the temperature rise is too rapid.

- Time: 60-120 seconds

Note: If the preheat is insufficient, large solder balls tend to be generated. Conversely, if preheat is excessive, small and large balls will be generated in clusters.

- End Temperature: 150-200ºC

Heating/Relow Phase

The temperature rises above the liquidus temperature of the solder paste selected.
Avoid a sudden rise in temperature as any slump of the solder paste could become worse.

- Limit time above liquidus temperature to 35-90 seconds.
- Peak reflow temperature: 230-250ºC

PROCESSING (Continued)

Cooling Phase

A controlled cooling phase avoids unwanted metallurgical effects of the solder, and possible mechanical tensions in the products. Controlled cooling helps achieve the brightest possible solder fillets with a good shape and low contact angle.

- Temperature fall rate: max 3ºC/sec

Pb-Free Soldering Paste

Use of “No Clean” soldering paste is strongly recommended, as it does not require cleaning after the soldering process. The pastes listed in the examples below meet these criteria.

Soldering Paste: Indium 5.1 (Indium Corporation of America)
Alloy Specification: SAC305 - Sn Zinc 96.5%/Ag Silver 3.0%/Cu Copper 0.5%
Alloy Specification: SAC387 - Sn Zinc 95.5%/Ag Silver 3.8%/Cu Copper 0.7%
Melting Temperature: 217ºC

Soldering Paste: LFSOLDER TLF-206-93F (Tamura Kaken [UK] Ltd.)
Alloy Specification: Sn Zinc 95.5%/Ag Silver 3.9%/Cu Copper 0.6%
Melting Temperature: 216-221ºC

The final choice of the soldering paste depends on individual factory approved manufacturing procedures.
Stencil Thickness: 150 μm for host boards

Note: The quality of the solder joints on the castellations (‘half vias’) where they contact the host board should meet the appropriate IPC specification. See **IPC-A-610-12.2.4.**

Cleaning

In general, cleaning the populated modules is strongly discouraged. Residuals under the module cannot be easily removed with any cleaning process.

- Cleaning with water can lead to capillary effects where water is absorbed into the gap between the host board and the module. The combination of soldering flux residuals and encapsulated water could lead to short circuits between neighboring pads. Water could also damage any stickers or labels.
- Cleaning with alcohol or a similar organic solvent will likely flood soldering flux residuals into the two housings, which is not accessible for post-washing inspection. The solvent could also damage any stickers or labels.
- Ultrasonic cleaning could damage the module permanently.

The best approach is to consider using a “no clean” soldering paste and eliminate the post soldering cleaning step.

PROCESSING (Continued)

Optical Inspection

After soldering the Module to the host board, consider optical inspection to check the following:

- Proper alignment and centering of the module over the pads.
- Proper solder joints on all pads.
- Excessive solder or contacts to neighboring pads, or vias.

Repeating Reflow Soldering

Only a single reflow soldering process is encouraged for host boards.

Wave Soldering

If a wave soldering process is required on the host boards due to the presents of leaded components, only a single wave soldering process is encouraged.

Hand Soldering

Hand soldering is possible. Use a soldering iron temperature setting equivalent to 350ºC, follow IPC recommendations/ reference document IPC-7711.

Rework

Matrix Modules can be unsoldered from the host board. Use of a hot air re-work tool and hot plate for pre-heating from underneath is recommended. Avoid overheating.

!Warning - Never attempt a rework on the module itself, e.g. replacing individual components. Such actions will terminate warranty coverage.

Additional Grounding

Attempts to improve module or system grounding by soldering braids, wires, or cables onto the module RF shield cover is done at the customers own risk. The numerous ground pins at the module perimeter should be sufficient for optimum immunity to external RF interference.

Conformal Coating

Conformal coating may be necessary in certain applications. Please note that the RF shield and the sticker prevent optimum inflow of liquids or aerosols.

REVISION HISTORY & DISCLAIMER

Revision History

Previous Versions	Changes to Current Version	Page
0004-00-07-00-000 (Issue B) (Preliminary) May 07, 2008	Initial advance datasheet.	N/A
0004-00-07-00-000 (Issue C) December 4, 2009	Updated Miniature Footprint dimensions for 100mW on front page and dimension drawings for 100mW, corrected the certification status under features, corrected J1 to J2 in the ordering information section, updated reflow soldering process specs (temperature rise time and limit time above liquius temerature), add Power Ampifier section on page 5, updated published date and Issue to C, removed preliminary datasheet from front page and added revision history and disclaimer to last page of datasheet.	1,5,7, 10,13

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