YODA
User Manual

An Intelligent RF module combining a 2.4 GHz IEEE Std. 802.15.4™ 20dBm RF Transceiver and a 16-bit MCU

Rev 1.2

Programmable intelligent RF module combining a 2.4 GHz IEEE Std. 802.15.4™ 20dBm RF Transceiver and a 16-bit MCU

Introduction:

Yoda, the intelligent RF module, combines a 2.4GHz radio transceiver module with a 16-bit MCU. The radios provide industry standard RF performance with excellent sensitivity and transmit power for long range. Designed specifically using extreme low power microcontroller and a Zigbee protocol stack on IEEE802.15.4 standards, Yoda is ideal for designs requiring long battery life, flexible application integration, and a reliable, proven, best-in-class networking solution.

Key Features:

- On board 16-bit PIC microcontroller allows application software integration on Yoda
- Built-in RF antenna
- IEEE Std. 802.15.4™ Compliant RF Transceiver
- Flexible communication interfaces – UART, I2C bus and remap able SPI bus
- Supports RS-485, RS-232, LIN/J2602 protocols and IrDA®
- Integrated 8MHz(primary) and 32.7KHz(secondary) oscillators(optional)
- 64 KB integrated EEPROM
- Integrated Zigbee Pro, ZigbeeRF4CE and Zigbee residential protocol stack
- Supports up to 64 coordinators, up to 65 hops and up to eight thousand nodes for a large network
- 8 Analog and 10 Digital multiplexed ports for MCU for faster system development.
- Analog-to-Digital Converter at 500 ksps
- No configuration needed for out-of-the-box RF communications
- Easy Integration into Final Product – Minimize Product Development, Quicker Time to Market
- Plug-in / Surface mount options
- RF range: Up to 2000 Feet
- Small size: 38mm X 25mm

Operational:

- Operating Voltage: 3.3V Typical
- Temperature Range: -40 ^{o}C to +85^{o}C
- Low current consumption:
    - Max : 150mA
    - Sleep Mode: 1 uA (typical)

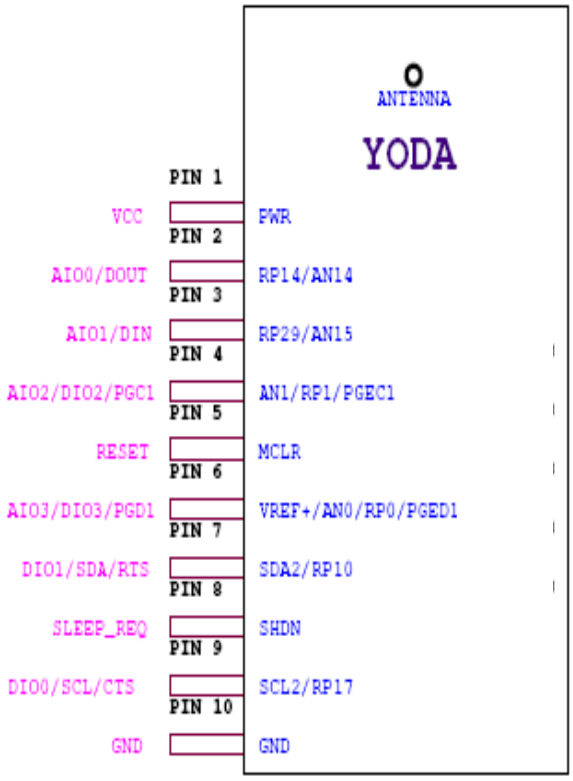
RF / Analog Features:

- ISM band 2.405– 2.475GHz Operation
- Data rate: 250 Kbps
- -102dBm typical sensitivity with -23dBm maximum input level
- +10dBm typical output power
- Integrated low phase noise VCO, frequency synthesizer and PLL Loop filter
- Digital VCO and Filter Calibration
- Integrated RSSI ADC and I/Q DACs
- Integrated LDO
- High receiver and RSSI dynamic range.

MCU Features:

- High performance 16-Bit PIC MCU
- Up to 16MIPS operation at 32MHz
- Idle, Sleep and doze modes with fast wake-up and two-speed start-up
- Low power consumption
- MCU Analog features
- 10Bit, up to 16 Ch A/D converter at500Ksps
- Analog comparators with
- Low power consumption
- Power-on Reset (POR), Power-up Timer (PWRT), Low-Voltage Detect (LVD) and Oscillator Start-up Timer (OST)

Pin diagram:

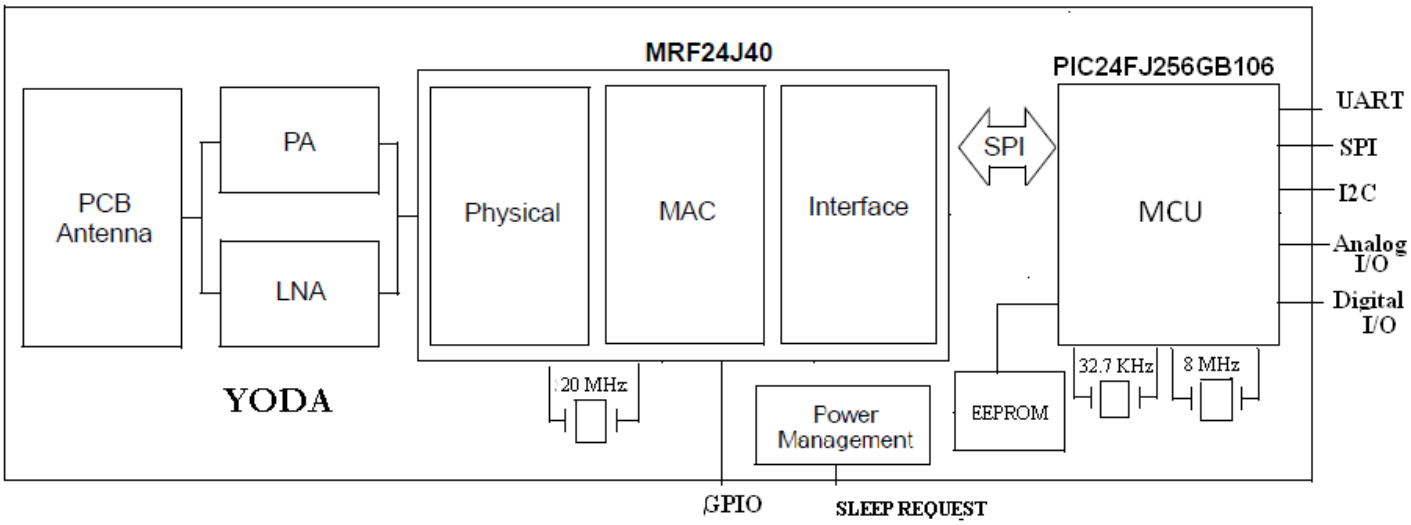


10 pin Male Berg 2mm Pitch

Pin Table:

Pin #	Name	Direction	Description
1	VCC	Pwr	Power Supply
2	AIO0/DIO0/DOUT	Either	Analog I/O 0, Remappable I/O 0, UART Data Out
3	AIO1/DIO1/DIN	Either	Analog I/O 1, Remappable I/O 1,UART Data In
4	AIO2/DIO2/	Either	Analog I/O 2, Remappable I/O 2,P
5	MCLR	Input	Reset (option to connect SLEEP)
6	AIO3/DIO3/	Either	Analog I/O 3, Remappable I/O 3,PGED
7	DIO4/SDA/RTS	Either	Remappable I/O 4, I2C Data I/O, UART RTS
8	DIO5/SCL/CTS	Either	Remappable I/O 5, I2C Clock I/O, UART CTS
9	SLEEP_REQ#	Input	Sleep mode enable (Active low)
10	GND	Gnd	Ground

Block Diagram:



Module Overview:
YODA is a 2.4 GHz IEEE Std. 802.15.4™ compliant, module with integrated PIC micro controller, crystal, internal voltage regulator, matching circuitry, Power Amplifier, Low Noise Amplifier and PCB antenna. The Module operates in the non-licensed 2.4 GHz frequency band. The integrated module design frees the integrator from extensive RF and antenna design, and regulatory compliance testing, allowing quicker time to market.
The module is compatible with Microchip's ZigBee®, MiWi™ and MiWi P2P software stacks.
SLEEP MODE: The module has sleep request pin. Active low signal on this pin makes the device on sleep mode. The pin needs to tie to VDD if not used.
PIC POWER-SAVING TECHNOLOGY
The MCU of the module incorporate a range of features that can significantly reduce power consumption during operation. Key items:
• **On-the-Fly Clock Switching:** The device clock can be changed under software control to the Timer1 source or the internal, Low-Power RC Oscillator during operation, allowing the user to incorporate power-saving ideas into their software designs.
• **Doze Mode Operation:** When timing-sensitive applications, such as serial communications, require the uninterrupted operation of peripherals, the CPU clock speed can be selectively reduced, allowing incremental power savings without missing a beat.
• **Instruction-Based Power-Saving Modes:** The microcontroller can suspend all operations, or selectively shut down its core while leaving its peripherals active, with a single instruction in software.

Other Special Features of MCU:
• **Peripheral Pin Select:** The Peripheral Pin Select (PPS) feature allows most digital peripherals to be mapped over a fixed set of digital I/O pins. Users may independently map the input and/or output of any one of the many digital peripherals to any one of the I/O pins.
• **Communications:** The PIC incorporates a range of serial communication peripherals to handle a range of application requirements. There are three independent I2C modules that support both Master and Slave modes of operation. Devices also have, through the Peripheral Pin Select feature, UARTs with built-in IrDA encoder/decoders and SPI modules.
• **Analog Features:** A 10-bit A/D Converter module and a triple comparator module. The A/D module incorporates acquisition time, allowing for a channel to be selected and a conversion to be initiated without waiting for a sampling period, as well as faster sampling speeds. The comparator module is configurable for a wide range of operations.
• **CTMU Interface:** In addition to their other analog features, MCU include the brand new CTMU interface module. This provides a convenient method for precision time measurement and pulse generation, and can serve as an interface for capacitive sensors.
• **Parallel Master/Enhanced Parallel Slave Port:** One of the general purpose I/O ports can be reconfigured for enhanced parallel data communications. In this mode, the port can be configured for both master and slave operations, and supports 8-bit and 16-bit data transfers with up to 16 external address lines in Master modes.
• **Real-Time Clock/Calendar:** This MCU implements a full-featured clock and calendar with alarm functions in hardware for use of the core application.

Integrated Oscillators:
Integrated 8MHz crystal (connect to primary) and 32.7 KHz crystal (connect to secondary) used for MCU. Another integrated 20 MHz crystal connects to the RF section.

FCC Compliance Statements

This device complies with Part 15 of the FCC Rules.
Operation is subject to the following two conditions:
(1) This device may not cause harmful interference, and
(2) This device must accept any interference received, including interference that may cause undesired operation.
NOTE: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

CAUTION: Any changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.
This equipment should be installed and operated with minimum distance 20 cm between the radiator & your body.

End Product Labeling
This Module is labeled with its own FCC ID. If the FCC ID Certification Number is not visible while installed inside another device, then the device should display the label on it referring the enclosed module. In that case, the final end product must be labelled in a visible area with the following:
"**Contains Transmitter Module FCC ID: 2AAGG-YODA2P1"**
OR
"**Contains FCC ID: 2AAGG-YODA2P1"**
The OEM should not provide information to the end user regarding installation or removal of this RF module or change RF related parameters in the user manual of the end product.

The OEM integrator is still responsible for testing their end-product for any additional compliance requirements required with this module installed (for example, digital device emissions, PC peripheral requirements, etc.).

To meet FCC requirements, the following settings were used.
The tranceiver MRF24J40 transmit power setting (RFCON3 0x203) was -10dB.
Only channels 11 through 25 were selected.

The integrator of the module will not have access to change any of the above settings.

Product Photos

TOP

Bottom
Electrical Characteristics

RECOMMENDED OPERATING CONDITIONS

Parameters	Min	Typ	Max	Units
Ambient Operating Temperature	-40	—	85	°C
Supply Voltage (VDD)	3.0	—	3.6	V
Input High Voltage (VIH)	0.5 x VDD	—	VDD + 0.3	V
Input Low Voltage (VIL)	-0.3	—	0.2 x VDD	V

CURRENT CONSUMPTION

(TA = 25°C, VDD = 3.3V)

Chip Mode	Condition	Min	Typ	Max	Units
Sleep Mode			1		uA
TX	Maximum Output Power 20dB		120	150	mA
RX			TBD	130	mA

CAPACITIVE LOADING REQUIREMENTS ON OUTPUT PINS

Parameters	Condition	Min	Typ	Max	Units
All I/O pins	EC mode.	—	—	50	pF
SCL, SDA	In I2C mode.	—	—	400	pF

ADC SPECIFICATION

Parameters	Condition	Min	Typ	Max	Units
Reference Voltage High		AVSS + 1.7	—	AVDD	V
Reference Voltage Low		AVSS	—	AVDD – 1.7	V
Absolute Reference Voltage		AVSS – 0.3	—	AVDD + 0.3	V
Absolute Input Voltage		AVSS – 0.3	—	AVDD + 0.3	V
Impedance for Analog Voltage Source	10-bit	—	—	2.5K	ohm
Resolution		—	10	—	bits
Gain Error	VINL = AVSS = VREFL = 0V, AVDD = VREFH = 3V	—	±1	±3	LSb
Offset Error	VINL = AVSS = VREFL = 0V, AVDD = VREFH = 3V	—	±1	±2	LSb

ADC CONVERSION TIMING REQUIREMENTS

Parameters	Condition	Min	Typ	Max	Units
Conversion Time		—	12	—	TAD
Throughput Rate	AVDD > 2.7V	—	—	500	ksps
Sample Time		—	1	—	TAD

SLEEP MODE CHARACTERISTICS

Parameters	Condition	Min	Typ	Max	Units
OFF State Leakage Current	VIN = 3.3V, VEN = 0V		50nA	1	µA
Turn-On Delay Time	VIN = +3.3V, ID = –100mA		0.85	1.5	µs
Turn-On Rise Time	VIN = +3.6V, ID = –100mA	0.5	1	5	µs
Turn-Off Delay Time	VIN = +3.6V, ID = –100mA		100	200	ns
Turn-Off Fall Time	VIN = +3.6V, ID = –100mA		60	100	ns

RF RECEIVER AC CHARACTERISTICS

Typical values are at TA = 25°C, VDD = 3.3V, LO Frequency = 2.445 GHz

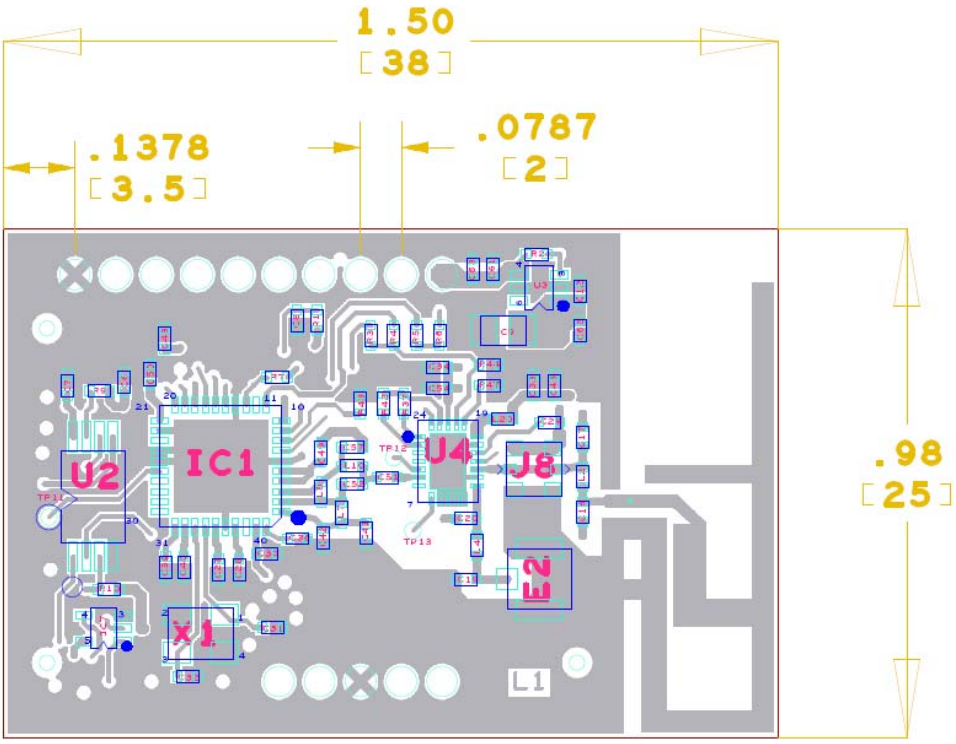
Parameters	Condition	Min	Typ	Max	Units
RF Input Frequency	Compatible toIEEE Std. 802.15.4	2.405	—	2.48	GHz
RF Sensitivity		—	`-102	—	dBm
Maximum RF Input -23 — — dBm		-23	—	—	dBm
LO Leakage	Measured at Balun Matching Network Input at Frequency,2.405-2.48 GHz	—	-60	—	dBm
Input Return Loss		-8	-12	—	dBm
Noise Figure	(including matching)	—	1.9	—	dBm
Adjacent Channel Rejection	@ +/-5 MHz	30	—	—	dBm
Alternate Channel Rejection	@ +/-10 MHz	40	—	—	dBm
RSSI Range			50	—	dBm
RSSI Error		-5		5	dBm

RF TRANSMITTER AC CHARACTERISTICS

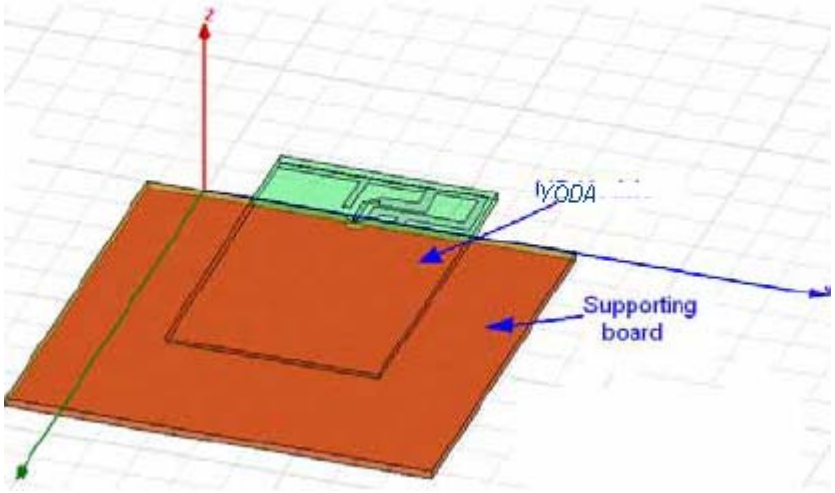
Typical values are at TA = 25°C, VDD = 3.3V, LO Frequency = 2.445 GHz

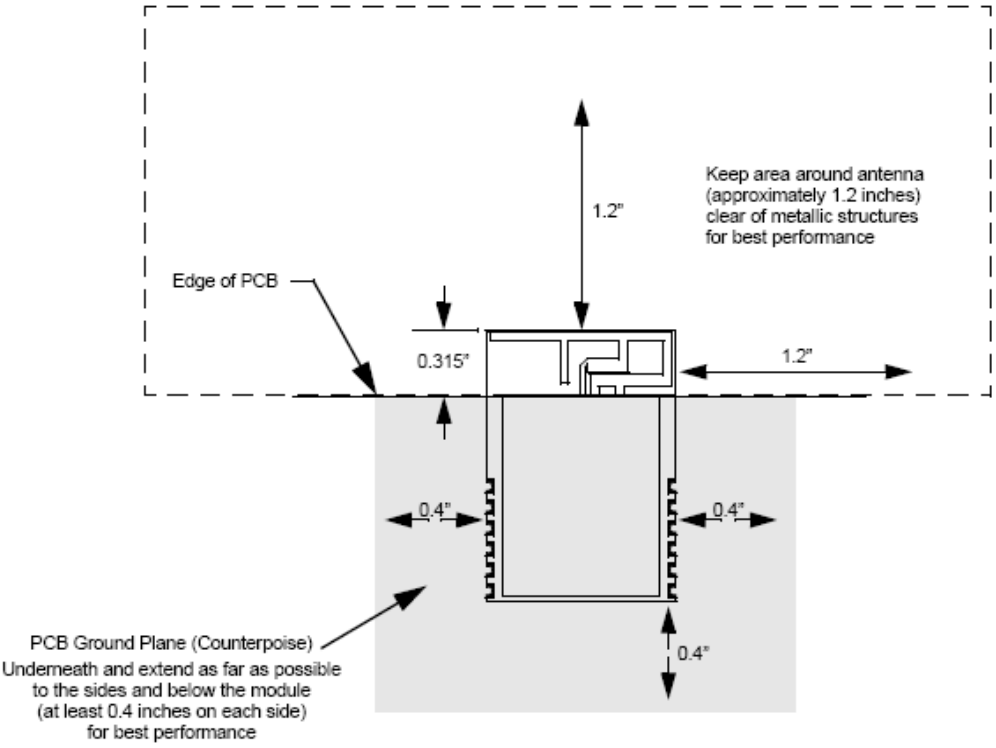
Parameters	Condition	Min	Typ	Max	Units
RF Carrier Frequency		2.405	—	2.475	GHz
Maximum RF Output Power		—	+10dBm	—	dBm
RF Output Power Control Range		—	56	—	dB
TX Gain Control Resolution		—	1.25	—	dB
Carrier Suppression		—	-30	—	dB
TX Spectrum Mask for O-QPSK Signal	Offset Frequency > 3.5 MHz, at 0 dBm Output Power	-33	—	—	dB
TX EVM		—	15	—	%

Module mounting details:
Foot print

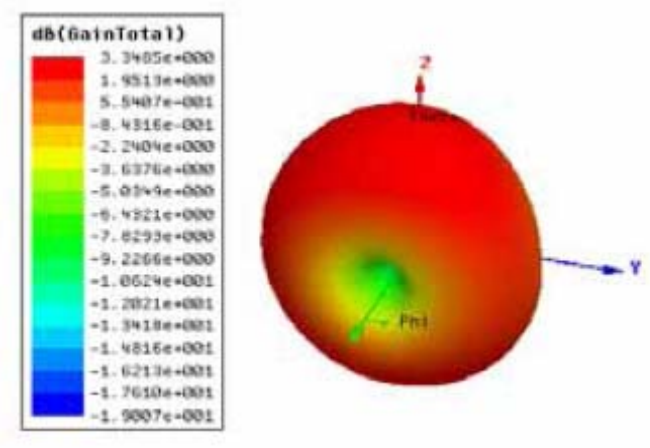


PCB Antenna simulation setup / drawing





Simulated 3D radiation pattern



Notes: