CEL California Eastern Laboratories

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MESHCONNECT™ MODULE

ZICM2410P0-1

THEORY OF OPERATION

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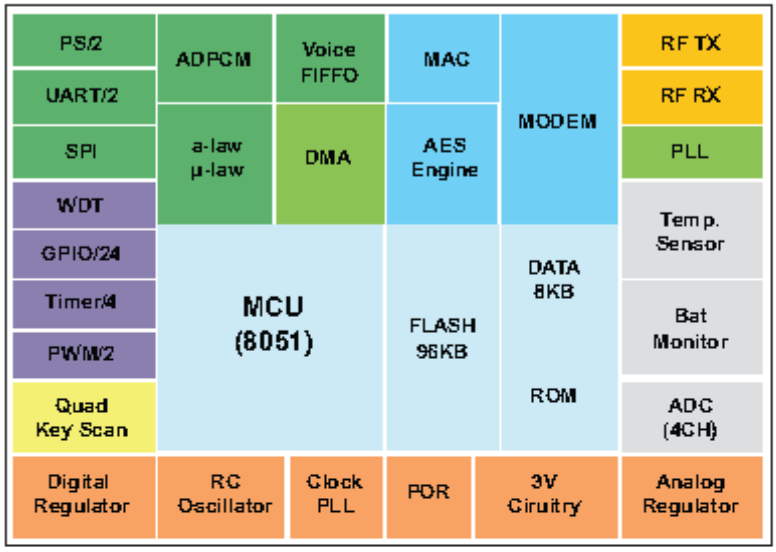
TRANSCEIVER IC

A true monolithic solution, the CEL ZIC2410 IEEE 802.15.4/ZigBee IC incorporates the RF transceiver with baseband modem, a hardwired MAC, and an embedded 8051 microcontroller, offering an excellent low cost high performance solution for all IEEE 802.15.4 / ZigBee applications.



With an industry best +6 dBm output power, the ZIC2410 will support a wide a variety of applications without the need for external amplification. Combined with a highly sensitive -97 dBm receiver the ZICM2410P0 leads the industry with 103 dB link budget.

In addition to excellent RF performance at ZigBee (250 kbps) data rates, the ZIC2410 adds high speed modes, Turbo (500 kbps) and Premium (1 Mbps), for networks looking for increased throughput. The device provides numerous general-purpose I/O pins, peripheral functions such as timers and UART and is one of the first devices to provide an embedded Voice CODEC.

CEL provides its customers with the CEL ZigBee Stack as part of the software library. Also available are the hardware & software tools required to develop custom applications.

The combination of industry leading link budget, high speed RF, and integrate voice CODEC make the ZIC2410 a truly distinct single chip solution.

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ANTENNA

CEL's MeshConnect modules include an integrated Printed Circuit Board (PCB) trace antenna. An optional u.FL connector can be specified, providing connection to a 50-ohm external antenna of the user's choice. See Ordering Information on page 1.

The PCB antenna employs an F-Antenna topology that is compact and supports an omni-directional radiation pattern. To maximize antenna efficiency, an adequate ground plane must be provided on the host PCB. Correctly positioned, the ground plane on the host PCB (but not directly under the F-Antenna). Correctly positioned, the ground plane on the host PCB board under the module will contribute significantly to the antenna performance. The position of the module on the host board and overall design of the product enclosure contribute to antenna performance. Poor design affects radiation patterns and can result in reflection, diffraction, and/or scattering of the transmitted signal.

Here are some design guidelines to help ensure antenna performance:

- Never place the ground plane or route copper traces directly underneath the antenna portion of the module.
- Never place the antenna close to metallic objects.
- In the overall design, ensure that wiring and other components are not placed near the antenna.
- Do not place the antenna in a metallic or metalized plastic enclosure.
- Keep plastic enclosures 1cm or more from the antenna in any direction.

For optimum antenna performance, the MeshConnect modules should be mounted with the PCB trace antenna overhanging the edge of the host board. To further improve performance, a ground plane may be placed on the host board under the module, up to the antenna. The installation of an uninterrupted ground plane on a layer directly beneath the module will also allow you to run traces under this layer. CEL can provide assistance with your PCB layout.

MODES OF OPERATION

There are three power down modes in the ZIC2410. Each mode can be set using the PDMODE [1:0] bits in the PDCON register and power down modes can be started by setting the PDSTART bit to 1. Each mode has a different current consumption and wake-up sources, please refer to the ZIC2410 datasheet for further information on the available power down modes.. Table 8 describes the three power down modes.

Table 8 – Power Down Modes

PDMODE [1:0]	Deecription	Wake-Up Source	Regulator for Digital block
0	Active (Normal Operation)	-	-
1	PM1 mode	Hardware Reset, Sleep Timer interrupt, External interrupt	ON
2	PM2 mode	Hardware Reset, Sleep Timer interrupt, External interrupt	OFF (After wake-up, register configuration is required)
3	PM3 mode	Hardware Reset, External interrupt	OFF (After wake-up, register configuration is required)

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POWER AMPLIFIER

The MeshConnect module does not incorporate an external Power Amplifier and therefore the RF output port is connected directly (through matching components) to the RF antenna. As CEL's ZIC2410 IEEE 802.15.4 / ZigBee transceiver already offers the industry's best link budget at 106 dB, even without an external PA the MeshConnect can maintain wireless connection over long distance (3000 ft line-of-sight).

INTERFACE

The MeshConnect has all major communication interfaces routed from the ZIC2410 to the module edge connectors:

- UART 1 & UART 2
- I2S
- SPI

VOICE CODEC

ZIC2410 includes three voice codec algorithms: μ-law, a-law and ADPCM.

The μ-law algorithm is a companding algorithm primarily used in the digital telecommunication systems of North America and Japan. As with other companding algorithms, its purpose is to reduce the dynamic range of an audio signal. In the analog domain this can increase the signal-to-noise ratio (SNR) achieved during transmission and in the digital domain, it can reduce the quantization error (hence increasing signal to quantization noise ratio). These SNR improvements can be traded for reduced bandwidth and equivalent SNR instead. The a-law algorithm is a standard companding algorithm used in European digital communications systems to optimize/modify the dynamic range of an analog signal for digitizing.

The a-law algorithm provides a slightly larger dynamic range than the μ-law at the cost of worse proportional distortion for small signals.

Adaptive DPCM (ADPCM) is a variant of DPCM (Differential (or Delta) pulse-code modulation) that varies the size of the quantization step, to allow further reduction of the required bandwidth for a given signal-to-noise ratio. DPCM encodes the PCM values as differences between the current and the previous value. For audio this type of encoding reduces the number of bits required per sample by about 25% compared to PCM.

SOFTWARE TOOLS

CEL offers complete SW tools for MeshConnect that customers need to create their ZigBee application.

PROFILE BUILDER

- Profile Builder allows for easy creation of custom ZigBee profiles for use in end-user applications.
- Uses the input requirements to modify a set of 'C' source files which include the necessary ZigBee functions.
- Output files will contain the ZigBee Device Object (ZDO) descriptors and the ZigBee Device Profile (ZDP) descriptors.
- The ZDO and ZDP define the ZigBee node and functionality.

The output files can be seamlessly integrated with the CEL ZigBee stack libraries.

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SOFTWARE TOOLS *(Continued)*

DEVICE PROGRAMMER

- Device Programmer is used to program the application firmware to the on-chip Flash program memory of the ZIC2410 device.
- Device Programmer supports:
  - ISP Mode: Download the firmware from the host PC via serial communication through the ZIC2410's UART1 interface.
    - The evaluation boards utilize a USB -> Serial converter
  - OTA Mode: Download the firmware from the host PC using wireless communication (Over-The-Air)
    - Requires two nodes, the host (connected to a PC) and the target device to be programmed

Device Programmer can read / write hardware information (i.e. IEEE Address, Channel #, etc) directly via the aforementioned communication modes.

PROFILE SIMULATOR

- Profile Simulator is used to simulate and test a ZigBee network consisting of a coordinator, router and / or end devices.
- Profile Simulator includes:
  - Device Manager: Setting parameters of a ZigBee node.
  - Bind Manager: Managing "bindings" in a ZigBee network.
  - ZStack manager: Setting parameters of a ZigBee network.
  - ZigBee Device Wizard: Selects network configuration during ZigBee network formation.

Can be used to generate ZigBee standard primitive functions for MAC, NWK and APS layers and the ZDO and APP.

PACKET ANALYZER AND WIRELESS NETWORK ANALYZER

- Packet Analyzer monitors traffic over a wireless network channel by capturing RF packet data in real-time.
- Packet Analyzer requires the Wireless Network Analyzer to "sniff" the RF packets.
- Also includes diagnostic tools:
  - Energy Scan: Evaluates the received signal power within the bandwidth of an IEEE 802.15.4 channel yielding available channels.
  - Active Scan: Scanning for active Coordinators and Routers broadcasting a Beacon frame.
- Packet Analyzer is capable of displaying network configuration (i.e. tree vs. star), network nodes, packet details, etc.
- Can be used in conjunction with any IEEE 802.15.4 or ZigBee network.

KEIL 8051 DEVELOPMENT TOOLS (Not provided with the kit).

- Supports all 8051 derivatives and variants.
- Easy-to-Use µVision Integrated Development Environment (IDE) supports the complete development cycle.
- Supports memory banking for CODE and variables beyond the 64 k byte threshold.

Numerous optimization levels yield the ability to place more features into less memory providing the utmost code density.

Filename: MeshConnect Theory of Operation_letterhead.doc
Directory: C:\Documents and Settings\jtenedo\Desktop\ZICM2410P0 FCC Cert related\Docs to LSR\April_6_09_corrections
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