Design ideas in this guide are based on many of the interface devices available from Microchip Technology. A complete device list and corresponding data sheets for these products can be found at www.microchip.com

**Stand-alone CAN Controller**
MCP2515

**CAN Transceiver**
MCP2551

**CAN I/O Expander**
MCP250xx

**LIN Transceiver**
MCP201

**General Purpose I/O Expander**
MCP23016

**Microcontrollers**
PIC12F675
PIC18F6680

**IrDA® Encoder/Decoder**
MCP2120

**IrDA® Protocol Handler**
MCP2140
MCP215x
**Controller Area Network (CAN)**

**CAN Design Example: Simple Sensor Node**

The CAN bus (Controller Area Network) protocol was designed to be a high-speed, reliable communication protocol for command and control network applications. Microchip offers a complete line of products to meet the needs of high-performance embedded applications using the CAN protocol, including 8- and 16-bit microcontrollers (MCUs) with integrated CAN, stand-alone CAN controllers, CAN I/O expanders, and CAN transceivers.

As CAN continues to grow and proliferate into other markets, the need to add CAN to simple sensor circuits increases. In some applications, a simple CAN sensor node can be cost prohibitive due to the higher cost of using a microcontroller with integrated CAN modules. Often the microcontrollers with integrated CAN have extra peripherals, program memory, RAM, etc. which the simple sensor application does not need.

In addition to MCUs with integrated CAN, Microchip offers a low cost stand-alone CAN controller with SPI interface (MCP2515) which can be paired up with the desired MCU to create an optimized CAN node. The designer does not have to settle for the peripherals offered by an MCU with integrated CAN, but rather the designer can choose the MCU which best matches the application.

Additionally, the four pins used by the MCU for SPI can be regained by using the general purpose inputs and outputs on the MCP2515. The schematic shown below represents a very simple, low cost CAN solution.

**Simple Sensor Node using MCP2515 Stand-alone CAN Controller**

**MCP2515 Stand-alone CAN Controller Features:**

- Implements CAN V2.0B at 1Mb/s
- Masks and filters to filter out unwanted messages
- Two receive buffers
- Three transmit buffers
- High speed SPI™ interface (10 MHz)
- Low voltage operation (2.7 V – 5.5 V)
- One shot mode to ensure a message transmission is only attempted once
- Start-of-frame (SOF) signal pin to detect CAN start-of-frame
- Data byte filtering of the first two data bytes
- Clock out pin with prescaler can be used as a clock source
- Interrupt output pin with selectable interrupt enables
- Two buffer full pins (can be used as general purpose outputs)
- Three request-to-send pins (can be used as general purpose inputs)
- 18-pin PDIP and SOIC, 20-pin TSSOP

**Product specifications can be found on page 10**

2 Interface Products Design Guide
**Controller Area Network (CAN)**

**CAN Design Example: Adding CAN to Existing Applications**

Existing applications that require the addition of CAN will find that the MCP2515 can be used to add CAN connectivity to any application ranging from low-end simple sensor applications, to high-end DSP, 32-bit MCU, ASIC, etc.

The diagram shows CAN added to a high-end application, as many high-end processors do not have embedded CAN peripherals.

**Dual CAN Node**

The MCP2515 can be used to easily add dual CAN capabilities for a given node.
Controller Area Network (CAN)

CAN Design Example: Simple Sensor Network using CAN I/O Expander

MCP250xx CAN I/O Expander

The MCP250xx devices operate as I/O expanders for a CAN system. These devices feature several peripherals including eight digital I/O, four 10-bit A/D converters, and two 10-bit PWM channels. In addition, the MCP250xx can automatically send messages when an input changes state, including when an analog channel exceeds a preset threshold. The device can also be configured to send A/D and digital I/O messages at regular intervals. Three bits (plus the RTR bit or one more ID bit for direction) are reserved in the identifier/arbitration field of the CAN message to communicate with the MCP250xx. This allows a master CAN node to communicate/control the CAN I/O Expanders via the CAN bus.

Simple Sensor Network

The MCP250xx is ideal for simple, low cost sensor networks. Particularly where the higher layers are proprietary so the system designer can maximize the MCP250xx features. The diagram below shows a four-node sensor network using only one MCU.

Product specifications can be found on page 10
MCP2551 CAN Transceiver

The MCP2551 is a high speed CAN transceiver which serves as an interface between the CAN bus and the CAN controller. The MCP2551 implements the ISO 11898-2 physical layer requirements which is by far the most common physical layer for CAN.

The MCP2551 converts between logic levels generated by the CAN controller and differential signal levels on the bus. The differential signal is less prone to electrical disturbances. The MCP2551 protects the CAN controller from electrical anomalies such as voltage spikes, short circuits, and other electrical transients on the bus.

The diagram below shows the basic connections for connecting the MCP2551.

MCP2551 CAN Transceiver Features:
- Implements ISO 11898-2 physical layer requirements
- Suitable for 12 V and 24 V systems
- ±40 V short circuit protection on the bus pins
  - Automatic thermal shutdown protection
- ±250 V transient protection on the bus pins
- Ground fault (permanent dominant) detection on the transmit input pin
  - Keeps faulty transmitters from bringing down the bus due to a permanent dominant condition
- Externally controlled slope on the bus pins to reduce RFI emissions
- Power on reset and brown out detection
- Unpowered nodes will not disturb the bus
- Up to 112 nodes can be connected

Product specifications can be found on page 10
Local Interconnect Network (LIN)

Example Designs: Typical Applications using LIN Transceiver

MCP201 LIN Transceiver
LIN is a low speed network (20 kbaud) intended for automotive and industrial applications where the speed and robustness of CAN is not needed and where low cost is essential. The MCP201 is a LIN transceiver which provides the interface between the LIN bus and the LIN controller. The MCP201 converts between CMOS/TTL levels and LIN levels.

The diagram shows a typical implementation of a LIN node using the MCP201.

Typical MCP201 Application

MCP201 LIN Transceiver Features:
- Supports LIN rates up to 20 kbaud
- 40 V load dump protected
- Operates from 6 V to 18 V
- Robust LIN bus pin
  - Protected against ground shorts
  - Protected against loss of ground
  - Automatic thermal shutdown
  - High current drive (40 mA to 200 mA)
- Built in voltage regulator (LDO)
  - 5 V output (±5 % tolerance)
  - 50 mA maximum output current
- Internal thermal overload protection
- Internal short circuit protection

Typical LIN Network Configuration

Note 1: Cg is the load capacitor for the internal voltage regulator.
Note 2: Cf if the filter capacitor for the external voltage supply.
MCP2150 and MCP2155 IrDA® Protocol Stack Controller

The MCP215x devices allow an embedded systems designer to interface to popular IrDA standard devices (such as PDAs and PCs) using the embedded systems host controller UART and some I/O pins.

The MCP215x implements the IrDA standard stack. At the application layer, the IrCOMM protocol (9-wire “cooked” service class) is the IrDA standard replacement for the serial cable. Thus the embedded systems designer will interface to the MCP215x as if it was a serial cable. The MCP215x does not implement the IR transceiver of the physical layer.

The diagram below shows a typical system block diagram.

MCP215x Features:

- Implements the IrDA standard including:
  - IrLAP
  - IrLMP
  - IAS
  - TinyTP
  - IrCOMM (9-wire “cooked” service class)
- UART to IrDA standard encoder/decoder
  - Interfaces with UARTs and infrared transceivers
- UART support to Data Terminal Equipment (DTE) interfaces (MCP2150) or Data Communication Equipment (DCE) interfaces (MCP2155)
- Supports 1.63 μs bit width for transmit/receive
- Independent UART and IR baud rates
- UART baud rates:
  - 906 kbaud
  - 19.2 kbaud
  - 57.6 kbaud
  - 115.2 kbaud
- IrDA baud rates:
  - 906 kbaud
  - 19.2 kbaud
  - 38.4 kbaud
  - 57.6 kbaud
  - 115.2 kbaud
- 64 byte data packet
- Programmable device ID
- Operates as a Slave Device
- Hardware pin for low power mode

Note 1: The CD and RI signals have different directions (and functions) between the MCP2150 and the MCP2155.
Note 2: Please refer to MCP2150 Data Sheet (DS21655) or MCP2155 Data Sheet (DS21690) for the function of the Host UART signals (TX, RX, RTS, CTS, DSR, CD, and RI). Not all signals may be required in your application (see AN858)
IrDA Protocol Stack Controller

Example Designs: Using 9600 Baud IrDA Protocol Stack Controller

MCP2140 IrDA Protocol Stack Controller
MCP2140 has all of the same features as the MCP2150 except:
- Supports discrete IR circuitry instead of integrated infrared transceivers

Host UART and IR interface fixed at 9600 baud
- Fixed device ID
- Wake-up on IR detect

The diagram below shows a typical system block diagram and typical discreet IR transceiver.

MCP2120 Infrared Encoder/Decoder
Unlike the MCP2150 and MCP2140 which implement the IrDA stack, the MCP2120 is simply an encoder/decoder. This allows the application processor to implement all or part of the IrDA stack, or implement a custom protocol using IR.

The diagram below shows a typical system block diagram.

MCP2120 Features:
- UART to IrDA encoder/decoder
- Supports IrDA physical layer specification (v.1.3)
- Interfaces with IrDA compliant transceivers

Product specifications can be found on page 10
General Purpose I/O Expanders

Example Designs: Using General Purpose Parallel I/O Expanders

The MCP23016 provides 16-bit, general purpose parallel I/O expansion for \( \text{I}^2\text{C} \)™ applications. The MCP23016 is an ideal solution when additional I/O are needed for power switches, sensors, push buttons, LEDs, etc.

The diagram shows a typical use for an MCP23016 GPIO Expander

**Typical Application using the MCP23016 GPIO Expander**

---

**MCP23016 Features:**

- \( \text{I}^2\text{C} \)™ interface to connect to a microcontroller
- 400 kHz max
- Three hardware address pins for up to eight devices on the bus
- High current drive for each output
- 25 mA max
- Sixteen individually selectable I/O pins
- Interrupt capture register to capture interrupt conditions on the I/O
- Polarity inversion register to configure the polarity of each input
- Interrupt output

---

*Product specifications can be found on page 10*
## Interface Products

### Selected Product Specifications

See Microchip Product Selector Guide for complete product selection and specifications

#### Stand-alone Controller Area Network (CAN) Products

<table>
<thead>
<tr>
<th>Device</th>
<th>Oper. Volt. (V)</th>
<th>Temp. Range (°C)</th>
<th>Unique Features</th>
<th>Package</th>
</tr>
</thead>
<tbody>
<tr>
<td>MCP2510</td>
<td>2.7 to 5.5</td>
<td>-40 to +125</td>
<td>CAN 2.0B Active controller with SPI interface to MCU, 3 transmit buffers, 2 receive buffers, HW and SW message triggers</td>
<td>18-Pin PDIP, 18-Pin SOIC, 20-Pin TSSOP</td>
</tr>
<tr>
<td>MCP2515</td>
<td>2.7 to 5.5</td>
<td>-40 to +125</td>
<td>MCP2510 pin compatible upgrade with enhanced features including higher throughput and data byte filtering</td>
<td>18-Pin PDIP, 18-Pin SOIC, 20-Pin TSSOP</td>
</tr>
<tr>
<td>MCP25020</td>
<td>2.7 to 5.5</td>
<td>-40 to +125</td>
<td>CAN 2.0B Active I/O Expander, Configurable I/O, 2 PWM outputs</td>
<td>14-Pin PDIP, 14-Pin SOIC</td>
</tr>
<tr>
<td>MCP25025</td>
<td>2.7 to 5.5</td>
<td>-40 to +85</td>
<td>CAN 2.0B Active I/O Expander, Configurable I/O, 2 PWM outputs, One-wire CAN option</td>
<td>14-Pin PDIP, 14-Pin SOIC</td>
</tr>
<tr>
<td>MCP25050</td>
<td>2.7 to 5.5</td>
<td>-40 to +125</td>
<td>Mixed-Signal CAN 2.0B Active I/O Expander, Configurable I/O, 4 10-bit ADCs, 2 PWM outputs</td>
<td>14-Pin PDIP, 14-Pin SOIC</td>
</tr>
<tr>
<td>MCP25055</td>
<td>2.7 to 5.5</td>
<td>-40 to +85</td>
<td>Mixed-Signal CAN 2.0B Active I/O Expander, Configurable I/O, 4 10-bit ADCs, 2 PWM outputs, One-wire CAN option</td>
<td>14-Pin PDIP, 14-Pin SOIC</td>
</tr>
<tr>
<td>MCP2551</td>
<td>4.5 to 5.5</td>
<td>-40 to +125</td>
<td>High-Speed CAN Transceiver (1 Mbps max. CAN bus speed), ISO11898 compatible, Industry standard pinout</td>
<td>8-Pin PDIP, 8-Pin SOIC</td>
</tr>
</tbody>
</table>

(1) Not recommended for new designs, use MCP2515

#### Infrared Products

<table>
<thead>
<tr>
<th>Part #</th>
<th>Operating Voltage (V)</th>
<th>Operating Temp. Range (°C)</th>
<th>Min./Max. Baud Rate (Kbaud)</th>
<th>Unique Features</th>
<th>Packages</th>
</tr>
</thead>
<tbody>
<tr>
<td>MCP2120</td>
<td>2.5 to 5.5</td>
<td>-40 to +85</td>
<td>0/325</td>
<td>UART to IR encoder/decoder with both hardware and software baud rate selection</td>
<td>14-Pin PDIP, 14-Pin SOIC</td>
</tr>
<tr>
<td>MCP2140</td>
<td>2.7 to 5.5</td>
<td>-40 to +85</td>
<td>-/9.6</td>
<td>IrDA® protocol handler plus bit encoder/decoder, Fixed baud rate, Low power, Low cost</td>
<td>18-Pin PDIP, 18-Pin SOIC, 20-Pin SSOP</td>
</tr>
<tr>
<td>MCP2150</td>
<td>3.0 to 5.5</td>
<td>-40 to +85</td>
<td>9.6/115.2</td>
<td>IrDA® Standard protocol handler plus bit encoder/decoder on one chip for DTE applications, Programmable device ID</td>
<td>18-Pin PDIP, 18-Pin SOIC, 20-Pin SSOP</td>
</tr>
<tr>
<td>MCP2155</td>
<td>3.0 to 5.5</td>
<td>-40 to +85</td>
<td>9.6/115.2</td>
<td>IrDA® Standard protocol handler plus bit encoder/decoder on one chip for DCE applications, Programmable device ID</td>
<td>18-Pin PDIP, 18-Pin SOIC, 20-Pin SSOP</td>
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#### LIN bus Transceiver

<table>
<thead>
<tr>
<th>Part #</th>
<th>Description</th>
<th>Vreg Output Voltage (V)</th>
<th>Operating Temperature Range (°C)</th>
<th>Vreg Output Current (mA)</th>
<th>Vcc Range (V)</th>
<th>Max Baud Rate</th>
<th>LIN Specification Supported</th>
<th>Packages</th>
</tr>
</thead>
<tbody>
<tr>
<td>MCP201</td>
<td>LIN Transceiver with integrated V_{REG}</td>
<td>4.75 TO 5.25</td>
<td>-40 TO +125</td>
<td>50(1)</td>
<td>6.0 to 18(2)</td>
<td>20 Kbaud</td>
<td>Revision 1.2</td>
<td>8-pin PDIP, 8-pin SOIC</td>
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</tbody>
</table>

Notes 1: Output current can be increased with external pass transistor.
Note 2: Can withstand 40V load dump.

#### Serial Peripherals

<table>
<thead>
<tr>
<th>Part #</th>
<th>Description</th>
<th>Operating Voltage (V)</th>
<th>Operating Temperature Range (°C)</th>
<th>Bus Type</th>
<th>Max. Bus Frequency (kBits/s)</th>
<th>Features</th>
<th>Packages</th>
</tr>
</thead>
<tbody>
<tr>
<td>MCP23016</td>
<td>16-bit I/O Port Expander</td>
<td>2.0 to 5.5</td>
<td>-40 to +85</td>
<td>I2C™</td>
<td>400</td>
<td>3 H/W address inputs, H/W interrupt, 25 mA source/sink capability per I/O</td>
<td>28-Pin PDIP, 28-Pin SOIC, 28-Pin SSOP</td>
</tr>
</tbody>
</table>
Interface Products

Related Application Notes

Complete Application Note library is available on the Microchip website: www.microchip.com

CAN Communications

AN212: Smart Sensor CAN Node Using the MCP2510 and PIC16F876. Demonstrates a way to implement a simple input pressure switch connected to a node board, along with a visual light source to display the value in terms of brightness. Several uses for different types of inputs and outputs can be implemented by using the basic techniques from this design.

AN215: A Simple CAN Node Using the MCP2510 and PIC12C67X. Describes the design, development and implementation of a smart, low cost, stand-alone Controller Area Network (CAN) node. Combines the 8-pin PIC12C672 with the 18-pin MCP2510 stand-alone CAN controller to create a fully autonomous CAN node, which supports both “time-based” and “event driven” message transmission.

AN226: A CAN Physical Layer Discussion. A discussion of the many network protocols which are described using the seven layer Open System Interconnection (OSI) model.

AN393: An In-Depth Look at the MCP2510. Focuses on “using” the MCP2510 including the minimal configuration necessary to enable the CAN node, features and implementation, a detailed discussion of many of the registers and potential pitfalls during implementation.

AN754: Understanding Microchip’s CAN Module Bit Timing. Investigates the relationships between bit timing parameters, the physical bus propagation delays, and oscillator tolerances throughout the system as they pertain to Microchip’s CAN module and assists in optimizing the bit timing for given physical system attributes.

AN816: A CAN System Using Multiple MCP25025 I/O Expanders. Describes a control system for a scissor-lift, which is essentially a mobile work platform enabling the user to reach relatively high places. All of the operations and movements use one Master Node and three I/O Expander Nodes.

AN872: Upgrading from the MCP2510 to the MCP2515. This application note discusses the differences between the MCP2510 and MCP2515 (and possible impact of these differences) in an effort to assist with the upgrade process.

AN873: Using the MCP2515 Developer’s Kit. Serves as a three-part tutorial for the MCP2515/2510 developer’s kit and discusses the three software templates in detail as well as the important menu items.

Infrared Communications

AN858: Interfacing The MCP215X to a Host Controller. Discusses the operation of the MCP215X Host UART interface, implements an embedded system (as an IrDA® Standard Secondary device), and describes the setup of PDA devices to operate as the IrDA Standard Primary device.

AN988: Programming the PIC16F877A for Embedded IR Applications. Strives to impart core fundamental programming concepts and design considerations for the development of Palm OS application programs. Attention is given to each of the fundamental areas of Palm OS application development in the “C” programming language.

AN926: Programming the Pocket PC™ OS for Embedded IR Applications. This application note details the tools, supporting technologies and procedures for the development of infrared applications on Windows Mobile™ based devices.

AN927: Data Throughput and the MCP215x. Discusses techniques that will improve the data transfer throughput between IRDA standard Primary Device and embedded system.

AN243: Fundamentals of the Infrared Physical Layer. Describes the fundamentals of the infrared physical layer, the IrDA standard and selecting the proper discrete emitter and photodiode components for circuit implementation.

TB073: Selecting an MCP21XX Device for IrDA® Applications. This document will help you select which MCP21xx family device is a good fit for your application.

AN923: Using the MCP2120 Developer’s Board for “IR Sniffing.” Discusses the implementation of an “IR Sniffer” using the MCP2120 Developer’s board connect to a PC running a program call “Listen32.”

AN756: Using the MCP2120 for Infrared Communications. A discussion regarding the encoding/decoding function in the MCP2120 which is performed as specified in the physical layer component of the IrDA® standard known as the “IrPHY.”

TB059: Using The MCP2150 Developer’s Board With The MCP2155. This Technical Brief describes how the MCP2150 Developer’s Board can be used for development of MCP2155 applications, and focuses on the Host UART signals from the U2 socket (MCP2150/MCP2155 ) to the MAX3238 device (U1) and the Header (J1).

AN758: Using the MCP2150 To Add IrDA® Standard Wireless Connectivity. Microchip’s MCP2150 provides support for the IrDA standard protocol stack plus bit encoding/decoding. This application note discusses the encoding/decoding functionality of this device.

TB048: Connecting the MCP2150 to the Palm® Operating System. Since the MCP2150 is a protocol handler supporting IrDA® standards plus an encoder/decoder, it can be used as a “Virtual Connector,” a wireless link between an embedded application and an IrDA standard host. This host can be a handheld device using the Psion OS. The Psion OS is generally used for small Personal Digital Assistants (PDA) devices.

TB047: Connecting the MCP2150 to the Windows® CE Operating System. Similar to TB048 but using a Microsoft® Windows® CE Operating System (OS). Windows CE is an excellent host platform for use with the MCP2150 because of the light weight, low cost, ease of use, and portability of these devices. Microsoft Windows includes a terminal client that can easily be used to demonstrate the capabilities of the MCP2150.

TB049: Connecting the MCP2150 to the Palm™ Operating System. Similar to TB046 but using the Palm Operating System (OS) Personal Digital Assistants (PDA) devices are an excellent host platform for use with the MCP2150 because of the light weight, low cost, ease of use, and portability of these devices.

I/O Expander

AN245: Interfacing the MCP23016 I/O Expander with the PIC16F877A. This application note describes how to use a PIC16F877A as an I²C™ master to communicate with the Microchip MCP23016 I2C I/O Expander slave device. An I/O Expander can also be used to monitor switches and/or sensors, drive LEDs and/or relays, as well as other general-purpose I/O functions.

LIN Bus Communications

AN249: LIN Protocol Implementation Using PICmicro® MCUs. This Application Note is intended to provide a broad overview of the LIN bus and provide a high level look at how it works, how to implement a Slave node on a PICmicro device and what it’s designed to do.

AN829: LightKeeper Automotive Lighting Control Module. This Application Note describes an automotive exterior lighting control module using a PIC16C433.
**Devices for use with Sensors**

**Microchip Technology’s Analog & Interface Product Families**

<table>
<thead>
<tr>
<th>Thermal Management</th>
<th>Power Management</th>
<th>Interface</th>
<th>Mixed-Signal</th>
<th>Linear</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature Sensors</td>
<td>LDO &amp; Switching Regulators</td>
<td>CAN Peripherals</td>
<td>A/D Converter Families</td>
<td>Op Amps</td>
</tr>
<tr>
<td>Fan Controllers/Fan Fault Detectors</td>
<td>Charge Pump</td>
<td>Infrared Peripherals</td>
<td>Digital Potentiometers</td>
<td>Programmable Gain Amplifiers</td>
</tr>
<tr>
<td></td>
<td>DC/DC Converters</td>
<td>LIN Transceiver</td>
<td>System D/A Converters</td>
<td>Comparators</td>
</tr>
<tr>
<td></td>
<td>Power MOSFET Drivers</td>
<td>Serial Peripherals</td>
<td>V/F and F/V Converters</td>
<td>Linear Integrated Devices</td>
</tr>
<tr>
<td></td>
<td>System Supervisors</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Voltage Detectors</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Voltage References</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Battery Management**

| Li-Ion Battery Chargers |
| Smart Battery Managers |

Microchip Technology Inc. is a leading provider of microcontroller, analog and memory products that provide risk-free product development, lower total system cost and faster time to market for thousands of diverse customer applications worldwide. Microchip's commitment to quality and innovation coupled with world-class development tools, dependable delivery and outstanding technical support sets us apart.

**Analog & Interface Attributes**

**Robustness**
- MOSFET Drivers lead the industry in latch-up immunity/stability

**Low Power/Low Voltage**
- Op Amp family with the lowest power for a given gain bandwidth
- 600nA/1.4V/10kHz bandwidth Op Amps
- 1.8V charge pumps and comparators
- Lowest power 12-bit ADC in SOT-23 package

**Integration**
- One of the first to market with integrated LDO with Reset, and Fan Controller with temperature sensor
- PGA integrates MUX, resistive ladder, gain switches, high-performance amplifier, SPI™ interface

**Space Savings**
- Resets and LDOs in SC-70, ADCs in 5-lead SOT-23
- CAN and IrDA® Standard protocol stack embedded in an 18-pin package

**Accuracy**
- Offset trimmed after packaging using non-volatile memory

**Innovation**
- Low pincount embedded IrDA Standard stack, FanSense™ technology
- SelectMode™ operation

For more information, visit the Microchip website at www.microchip.com