MICROCHIP

Connectivity Solutions for Embedded Design

USB, Ethernet, Wi-Fi®, Bluetooth®, ZigBee®, MiWi™, CAN, LIN, IrDA® and RS-485 Protocols

Wired and Wireless Connectivity

USB · Wi-Fi® · ZigBee® · Bluetooth® · Ethernet · MiWi™ · CAN · LIN

Easy to use ▪ Low-cost ▪ Start designing today

www.microchip.com/connectivity

Scalable and Integrated Solutions
Full-Speed USB and USB On-the-Go

Consumers' desire for more engaging, easy-to-use and upgradeable products is driving embedded designers to add USB capabilities to their designs.

Microchip provides designers with a scalable choice of integrated USB solutions across 8-, 16- and 32-bit PIC® microcontrollers ranging from the space-saving 14-pin devices to the feature-rich 100-pin USB On-the-Go (OTG) products. This allows simple, compact designs to easily grow to more capable designs as requirements demand.

In addition, Microchip offers highly configurable stand-alone USB protocol converters that enable full-speed USB connectivity in applications with a UART or SPI interface.

Microchip provides free source code for USB software stacks and class drivers to shorten development time for USB applications, including thumb drive boot loaders and printer support. Supported classes include: audio, CDC, HID, MSD, printer and custom. Microchip's free USB host stack, device stack and class drivers are available at: www.microchip.com/usb.


PIC16F and PIC18F Family
- Full-speed USB Device mode
- 8–128 KB Flash, 512B-4 KB of RAM,
- Up to 16 MIPS 8-bit devices
- Up to 4 UARTs, 2 I²C™/SPI ports
- Available in 14/20/28/44/64/80/100-pin packages

PIC24E Family
- Full-speed USB Device, Host and OTG modes
- 256–512 KB Flash, 32-52 KB RAM, 70 MIPS 16-bit devices
- 4 UARTs, 2 I²C, 4 SPI ports with DMA
- Available in 64/100/144-pin packages

PIC32 Family
- Full-speed USB Device, Host and OTG Modes with dedicated DMA Channels
- 16–512 KB Flash, 4-128 KB RAM, 40 or 80 MHz MIPS® M4K® Core
- Up to 6 UARTs, 5 I²C and 4 SPI ports, up to 8 general purpose DMA channels
- Available in 28/36/44/64/100-pin packages
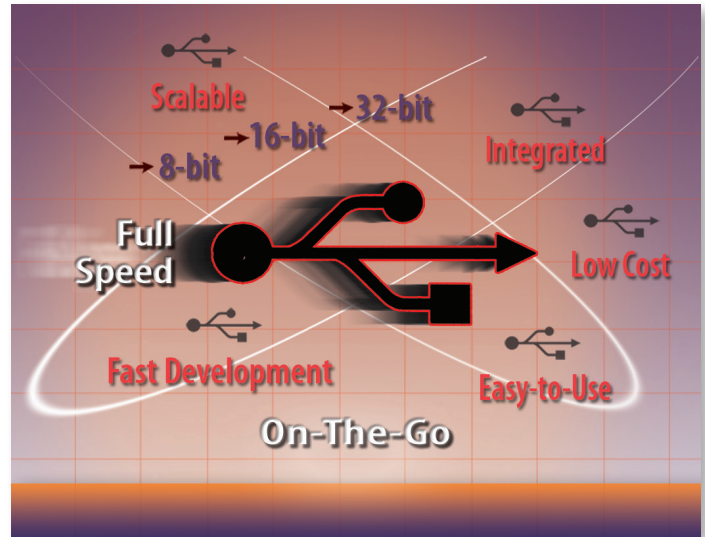
PIC24F Family
- Full-speed USB Device, Host and OTG modes
- 32–256 KB Flash, 8-96 KB RAM, 16 MIPS 16-bit devices
- Up to 4 UARTs, 3 I²C and 3 SPI ports, DMA interface for data RAM access, display drivers
- Available in 28/44/64/80/100-pin packages

dsPIC33E Family
- Full-speed USB Device, Host and OTG modes
- 256–512 KB Flash, 32-52 KB RAM, 70 MIPS 16-bit devices
- 4 UARTs, 2 I²C and 4 SPI ports with motor control and digital power peripherals
- Available in 64/100/144-pin packages

Stand-alone USB Controllers
- MCP2200 USB-to-UART Protocol Converter
- MCP2210 USB-to-SPI Protocol Converter
- USB 2.0 Full Speed
- On-board EEPROM, GPIO, highly configurable, small packaging

USB Development Tools and Software Support

Supporting USB Development from Concept to Prototype

Microchip's support for USB applications includes MPLAB® tools for all USB PIC MCUs, peripheral applications for the 8-bit PIC16F, PIC18F family, and device, embedded host and OTG applications for the 16-bit PIC24F, PIC24E and dsPIC33E and 32-bit PIC32 families. Designers can use Microchip's free USB stacks—including class drivers, 16- and 32-bit file system drivers and SCSI interface drivers—which are provided in source code form. More information is available at: www.microchip.com/usb.

Additional software support includes full C and RTOS development environments. Also available are: TCP/IP stacks, graphics libraries and ZigBee software stacks, which allow USB functionality to be combined with other capabilities to support a variety of designs. More information is available at: www.microchip.com/mla.

USB Starter Kits

These development kits provide an easy, low cost way to evaluate the functionality of Microchip's 8-, 16- and 32-bit USB microcontrollers. The all-inclusive kit contains the hardware, software and code examples necessary to take your next USB design from concept to prototype.

Low Pin Count USB Development Kit with PICkit™ 2 (DV164126)

This kit features the PIC18F14K50 and PIC18F13K50 20-pin USB MCUs. Hardware, software and code examples are included, as well as self-directed course and lab materials.

PIC18 Starter Kit (DM180021)

This kit features a PIC18F46J50 MCU and includes on-board debugger/programming capability as well as USB communication, a capacitive touch pad, potentiometer, acceleration sensor, MicroSD™ memory card and an OLED display. The board can function as a USB mouse, joystick or mass storage device (thumb drive) all using the on-board capacitive touch sense pads.

MPLAB Starter Kit for PIC24F (DM240011)

This kit provides an inexpensive way to evaluate the 16 MIPs PIC24FJ256GB110 with USB-OTG. Application demonstrations include mTouch™ capacitive sensing, driving an OLED display and USB-OTG to store data to a thumb drive.

### PIC32 USB Starter Kit II (DM320003-2)

This kit provides the easiest and lowest cost method to experience the USB and CAN functionality of the PIC32 microcontrollers. Users can develop CAN applications using PIC32 expansion boards. The board contains everything need to develop USB embedded Host/Device/OTG applications by combining this board with Microchip's free USB software.

## FS USB Plug-In Module (PIM) Demo Boards

These full-speed USB demonstration and development boards feature the PIC18FXXJ50 8-bit MCUs. The boards can be operated either standalone or as a PIM plugged into the PICDEM™ PIC18 Explorer board (DM183032).

PIC18F46J50 FS USB PIM Demo Board (MA180024)
PIC18F47J53 FS USB PIM Demo Board (MA180029)
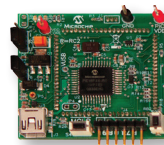
The PIC18F46J50 and PIC18F47J53 FS USB PIM demo boards are full speed USB demonstration and development boards featuring the PIC18F46J50 and PIC18F47J53 respectively.

PIC18F87J50 FS USB PIM Demo Board (MA180021)
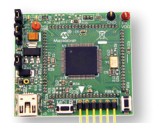
The PIC18F87J50 FS USB PIM demo board is a full speed USB demonstration and development board featuring the PIC18F87J50.

Explorer 16 Development Platform

Combine the Explorer 16, low-cost modular development board with the USB PICtail™ Plus daughter board for easy USB development with 16- and 32-bit MCUs. Several different PIMs are available that allow development with a variety of MCU platforms.

Explorer 16 Development Board (DM240001)

Use this efficient, low-cost development board to evaluate the features and performance of Microchip's 16-bit PIC24F and PIC24H MCU, dsPIC33 DSC and 32-bit PIC32MX families. Interface with the MPLAB ICD 3 In-Circuit Debugger or MPLAB REAL ICE™ In-Circuit Emulator to speed evaluation and prototyping of application circuitry.

USB PICtail Plus Daughter Board (AC164131)

This module enables USB hardware connectivity when using an Explorer 16 and USB-capable PIM. Provides support for USB Device, Host and OTG development.

Plug-in Modules

Various PIMs are available for use with the Explorer 16 development board. Individual PIMs feature different PIC24F, PIC24E and PIC32 microcontrollers and dsPIC33E digital signal controllers with USB modules.

MCP2210 Evaluation Kit (ADM00421)

The MCP2210 Evaluation Kit is a development and evaluation platform for the MCP2210 USB-to-SPI stand-alone device.

Ethernet Solutions with Integrated MAC and PHY

Offering the World's Smallest Embedded Ethernet Controller

A wide range of remote communication features are possible when Ethernet connectivity is added to embedded designs. For example, systems can be remotely monitored using a web browser or email notification can be sent; triggered by service alerts or low product inventory. End users benefit through cost and time savings since they can centrally monitor, control and service their embedded systems over the Internet instead of physically being there.

Microchip's Ethernet solutions address the growing demand for embedded Ethernet products, enabling easy network connectivity for cost-sensitive embedded designs.

- Free and robust TCP/IP stack optimized for the PIC18, PIC24 and PIC32 microcontroller and dsPIC digital signal controller families
- Supported protocols include: HTTP, SMTP, SNMP, FTP, SNTP, SSL, TCP, UDP, IP, DHCP, DDNS, ICMP and ARP

PIC18F97J60 Ethernet PIC Microcontroller

- PIC18F microcontroller with built-in Ethernet MAC and 10 Base-T PHY
- 8 KB dedicated Ethernet Buffer RAM
- Up to 128 KB Flash
- Advanced analog and communication peripherals
- Available in 64-, 80- and 100-pin TQFP

PIC32MX6XX, PIC32MX7XX Ethernet PIC Microcontroller

- Integrated 10/100 Mbit Ethernet MAC
- Dedicated DMA interface for direct access to the entire system RAM
- Industry standard RMII/MII interface to PHY
- Pre-programmed MAC address
- 80 MHz, up to 512 KB Flash, up to 128 KB RAM
- Available in 64-pin (TQFP, QFN) and 100-pin (TQFP, BGA)
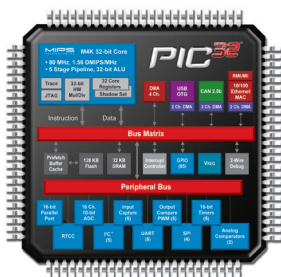
ENC624J600, ENC424J600 Embedded Ethernet Controllers

- Integrated MAC and 10/100 Base-T PHY
- 24 KB transmit/receive buffer SRAM
- MCU Interface supported: SPI and 8/16-bit parallel
- Cryptographic Security Engines
- Pre-programmed unique MAC address
- Available in 44-pin (TQFP, QFN) and 64-pin (TQFP)
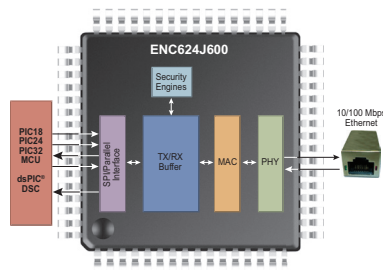
ENC28J60 Embedded Ethernet Controller

- Integrated MAC and 10 Base-T PHY
- 8 KB transmit/receive buffer SRAM
- MCU Interface Supported: SPI
- Available in 28-pin SPDIP, SSOP, SOIC and QFN packages
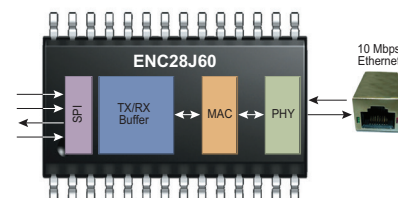
MAC Address Chips

- Pre-programmed EUI-48™ and EUI-64™ node address
- Up to 1.5 Kb Serial EEPROM functionality
  SPI: 25AA02E48
  I²C™: 24AA02E48
 UNI/O® : 11AA02E48
  www.microchip.com/MAC
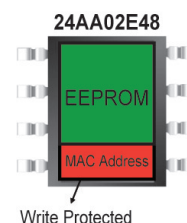
Development Tools Support

PICDEM.net™ 2 Development Board (DM163024)

This Ethernet development board supports both the ENC28J60 controller and the PIC18F97J60 MCU. With this board and Microchip's free TCP/IP stack, a web server can be developed showcasing the capability to remotely monitor and control embedded applications over the Internet.

PIC32 Ethernet Starter Kit (DM320004)
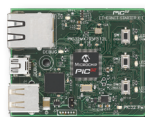
Contains everything needed to develop Ethernet or USB peripheral/Host/OTG applications using the PIC32. The kit contains free Microchip TCP/IP software and the necessary cables. There is an integrated debugger/programmer on the board as well as an expansion connector.

Fast 100 Mbps Ethernet PICtail Plus Daughter Board (AC164132)

Populated with the ENC624J600, this Ethernet board interfaces to the RJ-45 connector. It can be plugged into the Explorer 16 development board (DM240001) and the PIC18 Explorer board (DM183032) allowing connection to any of Microchip's 8-, 16- and 32-bit products.

Ethernet PICtail Plus Daughter Board (AC164123)

This board is populated with the 28-pin ENC28J60 Ethernet controller which interfaces to the RJ-45 connector. It can be plugged into the Explorer 16 development board (DM240001), allowing connection to any of Microchip's 16- and 32-bit products when used in conjunction with the free Microchip TCP/IP stack.

Wireless Solutions
Targeting the Need for Low Data Rate, Low Cost Wireless Sensor and Control Networks

Wireless communication technologies have been common place in homes and industry for many years. Recent Smart Grid initiatives have created a renewed demand for standardized, low data rate, low power, wireless technology in metering, home, business and industrial automation markets. As a result, Microchip offers many IEEE 802.11™, IEEE 802.15.4™ and ZigBee standard solutions along with our proprietary MiWi protocol for both 2.4 GHz and Sub-GHz to address this need.

Wi-Fi IEEE 802.11

MRF24WB0MA/MB, RN171/RN131 Modules

- IEEE 802.11 compliant wireless modules
- Compatible with b/g/n routers
- Supports infrastructure and ad hoc networks
- FCC, IC, Wi-Fi certified, ROHS, CE and ETSI compliant, providing considerable cost savings and quick time-to-market
- Supports WEP, WPA and WPA2 security protocols
- License Free TCP/IP stack supporting a comprehensive suite of internet protocols

More information is available at: www.microchip.com/wifi.

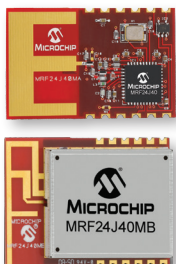## Bluetooth

RN41/RN42 Modules

- Ultra-low power embedded modules
- Bluetooth 2.1+ EDR module
- UART (SPP or HCI) and USB (HCI only)
- Onboard embedded Bluetooth stack
- Supports data link to iPhone/iPad/iPod Touch
- Auto-discovery/ paring

ZigBee IEEE 802.15.4: 2.4 GHz

MRF24J40/MA/MB/MC Modules

- 2.4 GHz IEEE 802.15.4 compatible transceiver and modules
- Integrated PCB antenna and matching circuit components
- FCC, IC and ETSI agency certified
- Surface-mountable PCB
- Supports ZigBee and MiWi development environment

Microchip offers ZigBee certified compliant platforms for ZigBee PRO and ZigBee RF4CE protocol stacks ensuring interoperability and reliable communication.

- ZigBee PRO Stack
- Smart Energy Profile
- ZigBee RF4CE and ZRC Profile

More information is available at: www.microchip.com/zigbee.

Sub-GHz Solutions: 433/868/915/950 MHz

MRF89XA/M8A/M9A Modules

- 868/915/950 MHz transceiver and modules
- Low receive current = 3 mA
- Transmit power = +12.5 dBm
- Receiver sensitivity: −107 dBm FSK/−113 dBm OOK
- Integrated PCB antenna and matching circuit components
- FCC, IC and ETSI agency certified
- Surface-mountable PCB
- Supports MiWi development environment

MiWi Development Environment

MiWi DE is designed to provide a smaller footprint, lower cost, communication protocol stack for peer-to-peer and mesh wireless networks. Intended for customers who desire robust communication in a closed or private wireless network at either 2.4 GHz or Sub-GHz operation frequency.

- MiWi P2P
- MiWi
- MiWi PRO

More information is available at: www.microchip.com/miwi.

Integrated MCU + RF

Low-power Sub-GHz transmitters with PIC MCUs in a single package for remote keyless entry, garage door openers, remote control and other one-way communication applications.

- PIC12F529T48A/39A
- PIC12LF1840T48A/39A

More inforamtion is available at: www.microchip.com/security.

The Wireless Development Studio (WDS)

The WDS is a Java based Graphic User Interface (GUI) which allows quick and easy development of wireless applications based on the MiWi protocols. It features a MiWi protocol sniffer for monitoring, debugging and gathering information and a configurator with a graphical user interface that enables the simple customization and configuration of wireless networks.
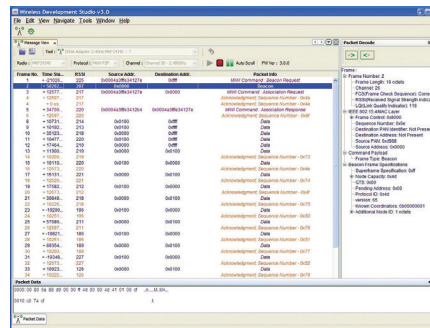
LIN and CAN Bus Solutions

Taking Communication and Connectivity in Deeply Embedded Designs to the Next Level

Local Interconnect Network (LIN)

LIN/J2602 is a communication standard designed to address low-cost networking within vehicles. LIN enables a cost-effective communication network for lower speed switch, smart sensor and actuator applications within the vehicle where the bandwidth and versatility of CAN is not required. LIN can be implemented on any PIC microcontroller (MCU) with a UART or USART interface. Microchip also offers a robust physical layer interface, data link layer implementation, LIN compliant drivers and a variety of development resources.

Standalone LIN Transceivers

The MCP2003/4(A) family of LIN transceivers offers a standalone LIN transceiver option. Both parts meet LIN bus specification versions 1.3, 2.0 and 2.1 and SAE J2602. The transceivers' EMC/ESD performance is among the best in the industry and meets all automotive requirements. The MCP2003A is available in an industry standard 8-pin SOIC pin out. The MCP2004A offers a TXE/Fault pin which allows users the ability to disable the transmitter in addition to providing data related to a fault condition.

LIN Transceivers With Voltage Regulator

The MCP202XA family of LIN transceivers integrates the LIN physical layer, 3.3V or 5V internal voltage regulator, with a maximum output current of 70 mA.
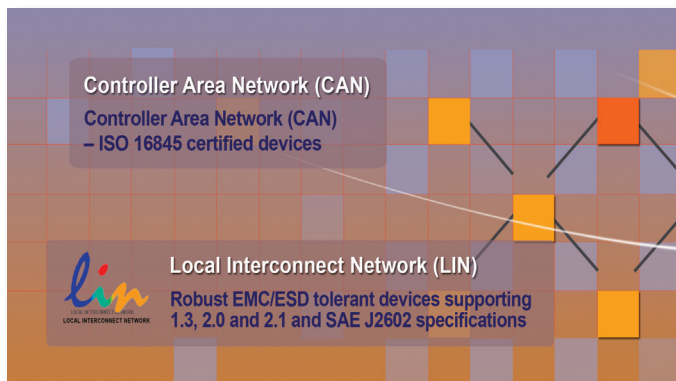
The devices support LIN bus specification versions 1.3, 2.0 and 2.1 and SAE J2602 and are designed to meet the stringent EMC/ESD requirements of the world's auto makers.

Microchip also offers the MCP2050 LIN Transceiver with Voltage regulator, windowed watchdog timer and ratio metric V_{BAT} pin that allows for monitoring battery levels by a MCU A/D converter.

Controller Area Network (CAN)

CAN is a serial communication protocol used extensively for high speed embedded applications where noise immunity and robustness is necessary. CAN protocol supports speeds up to 1 Mbps and is highly fault-tolerant, making it ideal for safety critical applications.

Microchip offers a complete line of products to meet the needs of high-performance embedded applications using the CAN protocol, including 8-, 16- and 32-bit microcontrollers and 16-bit digital signal controllers with integrated CAN, standalone CAN controllers, I/O expanders and CAN transceivers.

Controller Area Network (CAN)
Controller Area Network (CAN) – ISO 16845 certified devices

Local Interconnect Network (LIN)
Robust EMC/ESD tolerant devices supporting 1.3, 2.0 and 2.1 and SAE J2602 specifications

CAN MCUs and DSCs

The 8-bit PIC18F66K80 family offers the industry's best Sleep current of less than 20 nA, a wide operating voltage range of 1.8 to 5.5V and an advanced touch sensing interface. The 16-bit PIC24 and dsPIC33 families offer higher density Flash memories and high temperature operation of up to 150°C ambient. The 32-bit PIC32 family offers higher performance and better peripheral integration like Ethernet and USB.

At the heart of Microchip's CAN offering is the enhanced CAN module offered on-board many Microchip microcontrollers. Key features include:

- CAN 1.2, CAN 2.0A and CAN 2.0B support
- 32 buffers for TX/RX
- 32 acceptance filters
- 4 acceptance mask filters
- Time stamping
- DMA support in 16-bit PIC24H and PIC32 microcontrollers and dsPIC33F digital signal controllers
- DeviceNet™ support
- Legacy mode

Standalone CAN Controller

Microchip Technology's MCP2515 is a stand-alone Controller Area Network (CAN) controller that implements the CAN specification, version 2.0B. It is capable of transmitting and receiving both standard and extended data and remote frames. The MCP2515 interfaces with MCUs via an industry standard Serial Peripheral Interface (SPI) and can be used as an easy method to implement CAN in an existing system.

CAN Transceivers

The MCP2551 is a high-speed CAN device that serves as the interface between a CAN controller and the physical bus. The MCP2551 provides differential transmit and receive capability for the CAN protocol controller and is fully compatible with the ISO-11898 standard, including 24V requirements.

Development Resources and Other Options
Providing Comprehensive System Solutions

CAN/LIN Development Tools

With easy-to-use development systems and application notes, Microchip provides a total CAN/LIN solution that enables low-risk product development, lower total system cost and faster time to market for high performance embedded designs.

LIN Serial Analyzer Development System (APGDT001) CAN BUS Analyzer (APGDT002)

The LIN and CAN analyzer development tools enables a PC to communicate with the LIN and CAN buses. The PC program uses a graphical user interface to enter and display message frames occurring on the target bus, allowing for easy debug. The tools can also be used as an active node on a bus to send and receive messages, therefore reducing the application development time.

CAN/LIN PICtail Plus Daughter Board (AC164130-2)

This daughter board can be used with the Explorer 16 Development board and various PIMs featuring 16- and 32-bit MCUs with CAN peripherals, or the PIC18 Explorer board with the PIC18F66K80 PIM to facilitate rapid implementation and evaluation of CAN and LIN applications.

PICkit 28-pin LIN Demonstration Board (DM164130-3)
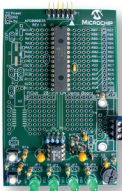
The PICkit 28-pin LIN demo board enables a quick start in developing and debugging applications with the LIN drivers. The kit includes a 28-pin socket which supports various PIC16F devices, includes a LIN transceiver, plus a generous prototype area with various indicator LEDs and buttons to support the test and debug of the application.

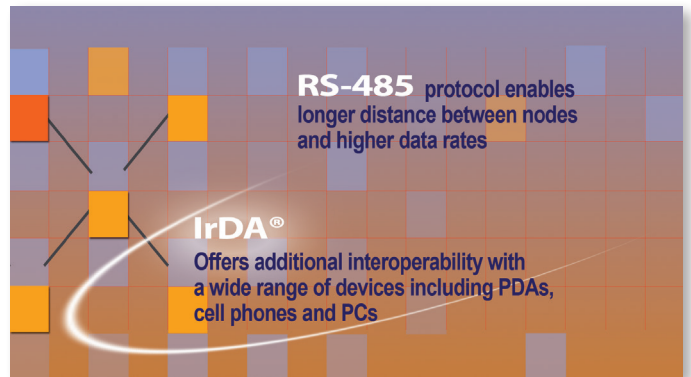### PICDEM CAN-LIN 3 Demonstration Board (DM163015)
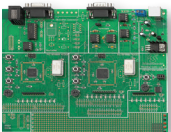
The PICDEM CAN-LIN 3 demo board is an easy way to discover the power of Microchip's CAN and LIN products. The board demonstrates the main features of the 64-pin TQFP PIC18F6680 and 80-pin TQFP PIC18F8680 devices, including those features of the integrated CAN module. In addition, the board employs a LIN sub-network using Microchip's 20-pin SSOP PIC18F1320 and MCP201 LIN Bus.

LIN Software Library

LIN Data Link Layer firmware can be downloaded free-of-charge from Microchip's web site. Many third party companies also offer LIN Data Link Layer firmware, providing additional design options.

RS-485 protocol enables longer distance between nodes and higher data rates

IrDA®
Offers additional interoperability with a wide range of devices including PDAs, cell phones and PCs

Other Connectivity Options

While the most sophisticated protocols and interfaces tend to garner a significant amount of attention, a number of simpler connectivity options are and will remain the embedded interconnects of choice for many deeply embedded applications. Microchip's focus on the embedded market ensures an ongoing commitment to support all of the connectivity solutions utilized by leading designers, including the microcontroller peripherals, application notes and software necessary to implement robust, highly reliable embedded networks.

RS-485 Protocol

The RS-485 protocol is typically used as a more feature-rich alternative to RS-232. The protocol enables longer distance between nodes and higher data rates. Any PIC microcontroller with an on-board UART can support RS-485 communication. Many PIC microcontrollers include enhanced peripherals with an RS-485 mode.

IrDA Protocol

The IrDA protocol provides many portable devices with an affordable, short distance optical data communications link. IrDA can be implemented on many Microchip MCUs using Microchip's free-of-charge IrDA software stack. In addition, Microchip offers UART to IrDA protocol converter products (MCP2140A, MCP2150) to enable any system to easily add IrDA wireless connectivity.

IrDA PICtail Plus Daughter Board (AC164124)

Enables IrDA connectivity when used with the Explorer 16 development board (DM240001).

MCP2140 Wireless Temperature Sensor Demonstration Board (MCP2140DM-TMPSNS)

Demonstrates the communication of temperature data to a primary device (PDA or PC with IR port) via IrDA.

Support

Microchip is committed to supporting its customers in developing products faster and more efficiently. We maintain a worldwide network of field applications engineers and technical support ready to provide product and system assistance. In addition, the following service areas are available at www.microchip.com:

- **Support** link provides a way to get questions answered fast: http://support.microchip.com
- **Sample** link offers evaluation samples of any Microchip device: http://sample.microchip.com
- **Forum** link provides access to knowledge base and peer help: http://forum.microchip.com
- **Buy** link provides locations of Microchip Sales Channel Partners: www.microchip.com/sales

Training

If additional training interests you, then Microchip can help. We continue to expand our technical training options, offering a growing list of courses and in-depth curriculum locally, as well as significant online resources – whenever you want to use them.

- Technical Training Centers: www.microchip.com/training
- MASTERs Conferences: www.microchip.com/masters
- Worldwide Seminars: www.microchip.com/seminars
- eLearning: www.microchip.com/webseminars
- Resources from our Distribution and Third Party Partners www.microchip.com/training

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