
Section 25. Development Tool Support

HIGHLIGHTS

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Note: Some development tools described in this section are not available at the time of this writing; however, they are currently under development. Some of the product details may change. Please check the Microchip web site or your local Microchip sales office for the most current information and the availability of each product.

25.1 Introduction

Microchip offers a comprehensive package of development tools and libraries to support the dsPIC architecture. In addition, the company is partnering with many third party tool manufacturers for additional dsPIC device support.

25.2 dsPIC30F Software and Hardware Development Tools

This section briefly describes some of the software and hardware development tools that are available for dsPIC30F family devices. For additional information, please refer to *“Tools and Solutions for the 16-bit Designer”* (DS01033), which is available from the Microchip web site.

The Microchip tools proposed include the following:

- MPLAB® Integrated Development Environment (IDE)
- dsPIC Language Suite, including MPLAB C30 C Compiler, Assembler, Linker and Librarian
- Data Monitoring and Control Interface (DMCI)
- MPLAB SIM Software Simulator
- MPLAB Visual Device Initializer (VDI)
- MPLAB REAL ICE™
- MPLAB ICD 2 In-Circuit Debugger
- MPLAB PM3

25.2.1 MPLAB Integrated Development Environment Software

Note: This product is currently available on Microchip's web site, www.microchip.com.

The MPLAB Integrated Development Environment (IDE) is available at no cost. MPLAB IDE software is a desktop development environment with tool sets for developing and debugging a microcontroller or digital signal controller design application. MPLAB IDE allows quick changes between different development and debugging activities. Designed for use with the Windows® operating environment, it is a powerful, affordable, run-time development tool. It is also the common user interface for Microchip's development systems tools, including MPLAB Editor, MPLAB ASM30 Assembler, MPLAB SIM software simulator, MPLAB LIB30 Library, MPLAB LINK30 Linker, MPLAB ICE 4000 and MPLAB REAL ICE In-Circuit Emulators, MPLAB PM3 programmer, and MPLAB ICD 2 In-Circuit Debugger.

The MPLAB IDE gives users the flexibility to edit, compile and emulate – all from a single user interface. Engineers can design and develop code for the dsPIC devices in the same design environment that they have used for PICmicro® microcontrollers.

The MPLAB IDE is a 32-bit, Windows-based application. It provides many advanced features for the engineer in a modern, easy-to-use interface. MPLAB IDE integrates the following:

- Full featured, color coded text editor
- Easy-to-use project manager with visual display
- Source level debugging
- Enhanced source level debugging for 'C'
 - (Structures, automatic variables, etc.)
- Customizable toolbar and key mapping
- Dynamic status bar that displays processor condition at a glance
- Context sensitive, interactive on-line help
- Integrated MPLAB SIM instruction simulator
- Integrated MPLAB Visual Device Initializer (VDI) plug-in tool
- Integrated Data Monitoring and Control Interface (DMCI)
- User interface for MPLAB PM3 device programmers (sold separately)
- User interface for MPLAB REAL ICE emulation tool (sold separately)
- User interface for MPLAB ICD 2 In-Circuit Debugger (sold separately)

The MPLAB IDE allows the engineer to do the following:

- Edit source files in either assembly or 'C'.
- Perform a one-touch compile and download to dsPIC program memory on an emulator or simulator.
All project information is updated.
- Debug using the following:
 - Source files
 - Machine code
 - Mixed mode source and machine code

The MPLAB IDE supports multiple development tools with a single user interface. This means that if new tools are required in the development life-cycle, moving from the free simulator to a full-featured hardware debugger will require minimal effort.

25.2.2 MPLAB C30 C Compiler

The MPLAB C30 C compiler is a fully ANSI-compliant product with standard libraries for Microchip's 16-bit architectures. It is highly optimized and takes advantage of many dsPIC DSC-specific features to provide efficient software code generation. The MPLAB C30 C compiler also provides extensions that allow for excellent support of the hardware, such as interrupts and peripherals. It is fully integrated with the MPLAB IDE for high-level source debugging.

25.2.3 MPLAB ASM30 Assembler, Linker and Librarian

MPLAB ASM30 Assembler produces relocatable machine code from symbolic assembly language for dsPIC devices. MPLAB C30 C Compiler uses the assembler to produce its object file. The assembler generates relocatable object files that can then be archived or linked with other relocatable object files and archives to create an executable file.

25.2.4 MPLAB SIM Software Simulator

Note: This product is included with MPLAB IDE.

The MPLAB SIM Software Simulator allows code development in a PC-hosted environment by simulating dsPIC DSCs and PIC MCUs on an instruction level. On any given instruction, the data areas can be examined or modified and stimuli can be applied from a comprehensive stimulus controller. Registers can be logged to files for further run-time analysis. The trace buffer and logic analyzer display extend the power of the simulator to record and track program execution, actions on I/O, most peripherals and internal registers.

25.2.5 MPLAB Visual Device Initializer (VDI)

Note: This product is included with MPLAB IDE.

Configuring a powerful 16-bit digital signal controller or MCU can be a complex and challenging task. MPLAB Visual Device Initializer (VDI) allows users to configure the entire processor graphically, and automatically generate code usable in assembly or C programs.

MPLAB VDI does extensive error checking on assignments and conflicts on pins, memories, interrupts, and operating conditions. The generated code files are integrated with the rest of the application code through the MPLAB Integrated Development Environment project.

25.2.6 Data Monitoring and Control Interface (DMCI)

Note: This product is included with MPLAB IDE.

DMCI provides dynamic access to and control of software variables. It is useful for tuning application parameters and viewing run-time application data graphically. Software parameter changes are updated at run-time. No recompiling is required between debug sessions.

Feature highlights include the following:

- **MPLAB Project Aware** – The current device and software variables are recognized automatically by DMCI. Configuration is easy using property dialogs that simplify the details of attaching a variable to a particular control.
- **Compiler Independent** – All Microchip C compiler tool suites are supported. Programs written in assembly language can be controlled as well.
- **Debug Tool Independent** – DMCI works with all Microchip debug tools including the MPLAB SIM simulator.
- **Provides Effortless Graphical Analysis of Application Historical Data** – Application data is accessed directly within MPLAB. Data can be easily plotted to any of 4 graphs for visual analysis. The application developer is required to develop code to export and view the data via alternative means such as an oscilloscope or external applications.
- **Configuration Management** – All DMCI control settings can be saved to a configuration file for easy reuse and portability.

25.2.7 MPLAB REAL ICE In-Circuit Emulator System

MPLAB REAL ICE In-circuit Emulation System is Microchip's next generation emulation and debugging system. This in-circuit emulation system provides a powerful in-circuit emulation platform for easy and rapid application development and debugging. The emulation is performed using special hardware logic on the target device, eliminating the need for a separate emulator device as well as ensuring that the emulator is the same as the target device. The REAL ICE system supports full-speed emulation, communicating with the target device through a traditional In-Circuit Serial Programming™ (ICSP™) interface (standard) or a high-speed, low-voltage differential signaling connection (for high noise immunity with longer cable lengths, especially for in-system emulation). Communication with MPLAB IDE on the host workstation is handled through a high-speed USB 2.0 interface.

25.2.8 MPLAB ICD 2 In-Circuit Debugger

Microchip's In-Circuit Debugger, MPLAB ICD 2, is a powerful, low-cost, hardware debugger, connecting to the host PC via an RS-232 or high-speed USB interface. The MPLAB ICD 2 utilizes the in-circuit debugging capability built into Microchip's Flash devices. This feature, along with Microchip's In-Circuit Serial Programming™ (ICSP™) protocol, offers cost-effective, in-circuit debugging from the graphical user interface of the MPLAB Integrated Development Environment. A designer can set breakpoints, single step and watch variables, CPU status, and peripheral registers. Hardware and applications can be tested in real time while running at full speed. MPLAB ICD 2 also serves as a development programmer for selected PIC devices.

25.2.9 MPLAB PM3 Device Programmer

MPLAB PM3 Device Programmer is a universal, CE-compliant device programmer with programmable voltage verification at VDDMIN and VDDMAX for maximum reliability. It features a large LCD display (128 x 64) for menus and error messages and a modular, detachable socket assembly to support various package types. The ICSP™ cable assembly is included as a standard item.

In Stand-Alone mode, MPLAB PM3 Device Programmer can read, verify and program DSC and MCU devices without a PC connection. It can also set code protection in this mode. MPLAB PM3 connects to the host PC via an RS-232 or USB cable. MPLAB PM3 has high-speed communications and optimized algorithms for quick programming of large memory devices and incorporates an SD/MMC card for file storage and secure data applications.

25.3 dsPIC30F DEVELOPMENT BOARDS

A full suite of cost-effective hardware development boards is available to support the dsPIC30F product family. This section provides a brief overview of these boards and their features. For additional information, please refer to *“Tools and Solutions for the 16-bit Designer”* (DS01033), which is available from the Microchip Web site.

25.3.1 dsPICDEM™ 2 Development Board

The dsPICDEM 2 Development Board is a development and evaluation tool that helps create embedded applications using dsPIC Digital Signal Controllers (DSCs). Sockets are provided for 28- and 40-pin devices in the dsPIC30F Motor Control Family and 18-, 28- and 40-pin devices in the dsPIC30F General Purpose and Sensor Family.

The board includes a sample dsPIC30F4011 in the 40-pin motor control socket, a power supply regulator, crystal oscillators for each set of sockets, an ICD connector for the MPLAB® ICD 2 In-Circuit Debugger and both RS-232 and CAN ports for external communication.

In addition, the board is populated with prototyping hardware, including LED indicators, push button switches, a potentiometer, a temperature sensor and a 2 x 16 LCD screen. All pins on all of the device sockets are accessible through headers.

Key features of the dsPICDEM 2 Development Board include the following:

- Multiple sockets for 18-, 28- and 40-pin PDIP and SPDIP devices
- Sample application programs complete with MPLAB IDE workspace and project files provided for supported dsPIC30F devices
- A dsPIC30F4011 40-pin PDIP sample device installed on the board
- 5V regulator that provides VDD and AVDD from a 9V DC power supply
- MPLAB ICD 2 in-circuit debugger-ready, with options for selecting alternate debugging channels
- RS-232 interface
- Controller Area Network (CAN) interface
- Temperature sensor and analog potentiometer to simulate A/D inputs
- 2 push button switches and 2 LED indicators to simulate digital input and output
- 2 x 16 ASCII character LCD with SPI interface
- Access to all pins on the dsPIC30F device sockets via 2 x 40-pin headers
- CD with documentation and ample application programs
- A sample pack containing dsPIC30F3012 and dsPIC30F4013 devices

25.3.2 dsPICDEM™ MC LV Development Board

The dsPICDEM MC LV Development Board is an easy-to-use, ready-to-use motor control hardware platform built around the dsPIC30F2010, dsPIC30F3010 and dsPIC30F4012 (along with the PIC18F2431/2331). The dsPICDEM MC LV board has a control section around the onboard dsPIC Digital Signal Controller (DSC) or the PIC microcontroller, 3-phase voltage source inverter, fault-monitoring circuit, temperature sensor, monitoring LEDs, serial interface for PC connection, and In-Circuit Serial Programming™ (ICSP™) connector for programming and debugging. In addition, the board has hardware interfaces that make it easy to implement sensed or sensorless control of a BLDC motor using the dsPIC30F2010, dsPIC30F3010 or dsPIC30F4012. The dsPICDEM MC LV Development Board has all of the necessary hardware to support a direct drive to a 10- to 48-VDC BLDC (up to 2.2A max.) motor using a sensed or sensorless algorithm.

The dsPICDEM MC LV Development Board features the following:

- A 3-phase voltage source inverter bridge
- Motion sensor inputs
- Over-current protection (level is programmable using potentiometer)
- Temperature sensor with I2C™ interface
- Test points for motor current and back EMF sensing
- Speed control potentiometer
- Example software and documentation available on CD
- 24V external power supply (optional)
- A 3-phase, 24V BLDC low-voltage motor (optional)

25.3.3 dsPICDEM™ SMPS Buck Development Board

This development board serves as a simple DC-DC Switch Mode Power Supply (SMPS) reference design and a good starting point for designers new to SMPS design. This board is an ideal prototyping tool to help you quickly develop and validate key design requirements.

Key features of the dsPICDEM SMPS Buck Development Board include the following:

- Dual independent Buck converters demonstrate the SMPS dsPIC Digital Signal Controllers' (DSC) capabilities to control multiple SMPS circuits
- A dsPIC30F2020 device installed on the board
- Supports all dsPIC30F SMPS Family devices
- Buck converters can operate in Synchronous or Asynchronous modes
- Input voltage range 7V to 15V (nominal 9V)
- User can enable a dynamic output load to investigate transient response
- User potentiometers to simulate application features such as voltage trim, remote voltage sense, voltage tracking, current sharing, and so on
- MPLAB® ICD 2 support ready
- RS-232 serial channel

25.3.4 dsPICDEM™ MC1 Motor Control Development System

The dsPICDEM MC1 Motor Control Development System provides the application developer with three main components for quick prototyping and validation of BLDC, PMAC and ACIM applications. The three main components include the dsPICDEM MC1 Motor Control Development Board, the dsPICDEM MC1L 3-phase low-voltage power module and the dsPICDEM MC1H 3-phase high-voltage power module.

The dsPICDEM MC1 Motor Control Development System contains the dsPIC30F6010A, but supports all 80-pin dsPIC Digital Signal Controller (DSC) motor control variants, various peripheral interfaces and a custom interface header system, which allows different motor power modules to be connected to the PCB. The control board also has connectors for mechanical position sensors (such as incremental rotary encoders and hall effect sensors) and a breadboard area for custom circuits. The main control board receives its power from a standard plug-in transformer.

The dsPICDEM MC1L 3-phase low-voltage power module is optimized for 3-phase motor applications that require a DC bus voltage less than 50 volts and can deliver up to 400 W power output. The 3-phase low-voltage power module is intended to power BLDC and PMAC motors.

The dsPICDEM MC1H 3-phase high-voltage power module is optimized for 3-phase motor applications that require DC bus voltages up to 400 volts and can deliver up to 1 kW power output. The high-voltage module has an active power factor correction circuit that is controlled by the dsPIC DSC. This power module is intended for AC induction motor and power inverter applications that operate directly from the AC line voltage.

Two compatible motors are available for the dsPICDEM MC1 Motor Control Development System.

The dsPICDEM MC1 Motor Control Development System features a dsPIC30F6010A Motor Control microcontroller-based board.

The optional power modules provide the following:

- Heatsink for ambient cooling of power sections
- Full automatic protection of power circuits
- Electrical isolation from power circuits
- Many options for motor feedback signals

25.3.5 dsPICDEM.net™ 1 and dsPICDEM.net™ 2 Connectivity Development Boards

The dsPICDEM.net 1 and dsPICDEM.net 2 Connectivity Development Boards provide the application developer a basic platform for developing and evaluating both connectivity and non-connectivity based requirements.

The dsPICDEM.net boards provide the hardware circuitry for supporting both the Public Switched Telephone Network (PSTN) and 10-Base T MAC/PHY interfaces.

- The PSTN interface hardware on the dsPICDEM.net 1 board is suited for FCC/JATE compliancy
- The PSTN interface hardware on the dsPICDEM.net 2 board is suited for CTR-21 compliancy

The board comes with an ITU-T compliant V.22bis/V.22 modem development module pre-programmed on the installed dsPIC30F6014A device. This demo provides full source code to connect and transfer data between the dsPIC Digital Signal Controller (DSC) Soft Modem (dsPIC DSC SM) and an ITU-T compliant reference modem. The modem can be configured for either the Originate or Answer mode of operation.

Configuration and control of the dsPIC30F Soft Modem demo is supported with an optimized AT command set, which is entered into a suitable communication program running on the PC, such as HyperTerminal™, and communicated to the dsPIC DSC over a RS-232 serial channel.

Also included are the CMX-MicroNet™ web and FTP Server programs, which demonstrate two TCP/IP protocol-based applications over the 10-Base T Ethernet datalink layer.

Key features of the dsPICDEM.net 1 and dsPICDEM.net 2 Connectivity Development Boards include the following:

- dsPIC30F6014 plug-in module (MA300011)
- 10-Base T Ethernet MAC and PHY interface
- PSTN interface with DAA/AFE chipset
- Serial communication channels interface (UART and CAN)
- External I²C™ EEPROM memory for storing constants
- External 64K x 16 RAM memory
- General purpose prototyping area with expansion header
- Dual channel digital potentiometer
- 2 x 16 LCD display
- LEDs, switches and potentiometers
- Temperature sensor
- Full suite of development code
 - Getting Started tutorial
 - Full-featured dsPICDEM.net board configuration and control demo
 - V.22bis Soft Modem (full source code provided)
 - CMX-MicroNet Web Server
 - CMX-MicroNet FTP Server
- Comprehensive User's Guide describing development code

25.3.6 dsPICDEM 80-pin Starter Development Board

This development board offers an economical way to evaluate both the PIC24 and dsPIC Digital Signal Controller (DSC) General Purpose and Motor Control families. This board is an ideal prototyping tool to help you quickly develop and validate key design requirements.

Key features of the dsPICDEM 80-pin Starter Development Board include the following:

- An 80-pin dsPIC30F6014A plug-in module (MA300014)
- A 100- to 80-pin adapter dsPIC33F plug-in module (MA330012) containing a dsPIC33FJ256GP710 device
- Power input from 9V supply
- Selectable voltage regulator outputs of 5V and 3.3V
- LEDs, switches, potentiometer and UART interface
- A/D input filter circuit for speech band signal input
- On-board DAC and filter for speech band signal output
- Circuit prototyping area
- Assembly language demonstration program and tutorial
- Can accommodate 80-pin dsPIC30F6010A plug-in module (MA300015) – sold separately
- Can accommodate 100- to 80-pin adapter PIC24H plug-in module (MA33001X) – sold separately (uses 3.3V VDD solution)

25.3.7 dsPICDEM 1.1 Plus Development Board

The dsPICDEM™ 1.1 Plus Development Board provides the application designer with a low-cost development tool to become familiar with the dsPIC Digital Signal Controller (DSC) 16-bit architecture, high-performance peripherals, and powerful instruction set.

The development board serves as an ideal prototyping tool to quickly develop and validate design requirements. It supports all 80-pin dsPIC/PIC24 devices.

Key features of the dsPICDEM 1.1 Plus Development Board include the following:

- dsPIC30F6014A plug-in sample (MA300014)
- Serial communication channels interface (two UARTs, SPI, CAN, RS-485)
- Si3000 voice-band codec with mic in/speaker jacks
- General purpose prototyping area with expansion header
- 122 x 32 dot addressable LCD
- MPLAB ICD 2 and MPLAB ICE 4000 emulator support
- LEDs, switches and potentiometers
- Temperature sensor
- Separate digital and analog voltage regulators
- Digital potentiometer for DAC capability

25.3.8 16-bit 28-pin Starter Development Board

The 16-bit 28-pin Starter Development Board is an easy-to-use tool that allows you to begin development with all 16-bit dsPIC DSC and PIC24 MCU 28-pin devices. The following capabilities are provided:

- Development Board Power
 - On-board +5V regulator or +3.3V regulator for VDD and AVDD
 - USB power source or 9V DC power source input jack
 - Power-on indicator LED
- MPLAB ICD 2 programming connector
- Single UART communication channel via USB bridge
- 7.37 MHz crystal device clocking
- Reset push button for resetting the device
- Four LEDs for status indicators
- Push button switch (SW1)
- Potentiometer (RP1) for use with ADC
- All device I/O pins are brought out to a header for test point and prototyping access

25.4 dsPIC30F SOFTWARE APPLICATION LIBRARIES AND UTILITIES

This section provides brief descriptions of application libraries and utilities available for use with dsPIC30F devices. For additional information, please refer to “*Tools and Solutions for the 16-bit Designer*” (DS01033), which is available from the Microchip Web site.

25.4.1 Peripheral Library

The PIC24H/dsPIC Digital Signal Controller (DSC) Peripheral Library provides a set of functions for setting up and controlling the operation of all the peripheral modules available in the PIC24H microcontrollers and dsPIC DSCs, as well as functions for interfacing with an external LCD. The dsPIC30F Peripheral Library serves as a convenient layer of abstraction over the specific details of the peripherals and their associated control and status registers.

The PIC24H/dsPIC DSC Peripheral Library supports the following hardware peripheral modules:

- Timers
- Input Capture
- Output Compare
- Quadrature Encoder Interface (QEI)
- Motor Control PWM
- Real Time Clock Calendar (RTCC)
- Cyclic Redundancy Check (CRC)
- I/O ports and external interrupts
- Reset
- UART
- SPI
- I²C™
- Data Converter Interface (DCI)
- 10-bit Analog-to-Digital Converter
- 12-bit Analog-to-Digital Converter
- CAN
- SMPS Analog-to-Digital Converter
- SMPS PWM
- SMPS Analog Comparator
- Functions for controlling an external LCD through configurable I/O port pins are also provided

25.4.2 Math Library

The PIC24/dsPIC Digital Signal Controller (DSC) Math Library is the compiled version of the math library that is distributed with the highly optimized, ANSI-compliant MPLAB C30 C Compiler (SW006012). It contains advanced single- and double-precision floating-point arithmetic and trigonometric functions from the standard C header file `<math.h>`. The library delivers small program code size and data size, reduced cycles and high accuracy.

Features include the following:

- Math Library can be called from either MPLAB C30 or PIC24/dsPIC DSC Assembly language
- IEEE-754 compliant functions with signed zero, signed infinity, NaN (Not a Number) and denormal support and operated in the “round to nearest” mode
- Compatible with MPLAB ASM30 and MPLAB LINK30, which are available at no charge from www.microchip.com

25.4.3 DSP Library

The dsPIC Digital Signal Controller (DSC) DSP Library provides a set of speed optimized functions for the most common digital signal processing applications. The dsPIC DSC DSP Library provides significant performance savings over equivalent functions coded in C and allows developers to dramatically shorten their development time. The dsPIC DSC DSP library may be used with any dsPIC DSC variant.

The dsPIC DSC DSP Library is written predominantly in Assembly language and makes extensive use of the dsPIC DSC DSP instruction set and hardware resources, including X and Y memory addressing, modulo addressing, bit-reversed addressing, 9.31 saturation and `REPEAT` and `DO` loops.

The dsPIC DSC DSP Library provides functions for the following:

- Vector operations
- Matrix operations
- Filtering operations
- Transform operations
- Window operations

25.4.4 Soft Modem Library

The dsPIC Digital Signal Controller (DSC) Soft Modem Library is composed of ITU-T compliant algorithms for V.21, V.22, V.22bis, V.23, V.32 and V.32bis modem recommendations. Bell standard 103 is also included in this library.

V.21, V.23 and Bell 103 are Frequency Shift Keying (FSK) modems.

V.32, V.32bis and V.22bis are Quadrature Amplitude Modulated (QAM) modems. V.22 is a Quadrature Phase Shift Keyed (QPSK) modem. V.21, V.22, V.22bis, V.32 and V.32bis are all 2-wire, full-duplex modems. V.23 is full-duplex when it operates with a 75 bps backwards channel.

V.22bis includes fallback to V.22, V.23 and V.21 standards. V.32bis optionally falls back to V.22bis, V.22, V.23 and V.21 standards.

The dsPIC DSC Soft Modem Library is well suited for small transaction-based applications such as, but not limited to, the following:

- POS terminals
- Set top boxes
- Drop boxes
- Fire panels
- Internet-enabled home security systems
- Internet-connected power, gas and water meters
- Internet-connected vending machines
- Smart appliances
- Industrial monitoring

25.4.5 Microchip TCP/IP Stack

Communication over the Internet is accomplished by implementing the TCP/IP protocol. Microchip offers a free TCP/IP software stack optimized for the PIC18 microcontroller family and all 16-bit devices. The stack is a suite of programs that provide services to all TCP/IP-based applications. Users do not need to know all the intricacies of the TCP/IP specifications in order to use the stack. Based on the TCP/IP reference model, the stack is divided into multiple layers, where each layer accesses services from one or more layers directly below it. Per specifications, many of the TCP/IP layers are “live,” in the sense that they not only act when a service is requested, but also when events (like time-out or new packet arrival) occur. The stack is modular in design and is written in the ‘C’ programming language. Effective implementations can be accomplished in roughly 20 Kbytes of code, leaving plenty of code space available for the user’s application.

Key features of the Microchip TCP/IP Stack (ENC28J60 Driver) include the following:

- Available free for use on Microchip microcontrollers
- Socket support for TCP and UDP
- Portable across all PIC18, PIC24, dsPIC30F and dsPIC33F products
- Support for MPLAB C18, MPLAB C30 and Hi-TECH PIC-18 C compilers
- RTOS independent
- Full TCP state machine
- Modular design
- Supported by Ethernet PICtail™ Plus Daughter Board (AC164123)
- Supports the ENC28J60 Ethernet controller

25.4.6 FAT16 File System Library

The FAT16 File System Library allows the designer to easily integrate a removable Flash-based media card of up to 2 gigabytes into their application. The FAT16 File System Library is modular and provided in C source code to easily integrate it into any application. This library requires 16 Kbytes of program memory to implement all the standard FAT16 functions: *fopen*, *fread*, *fwrite*, *fseek*, among others. The library also requires 1.5 Kbytes of RAM for the heap, read/write buffer, disk structures, and so on.

Key features of the FAT16 File System Library include the following:

- Available free for use on Microchip microcontrollers
- Portable across all PIC18, PIC24 and dsPIC DSC products
- Support for MPLAB C18 C Compiler and MPLAB C30 C Compiler
- Supports SD/MMC and CompactFlash memory cards
- Supports up to 2 GB
- Supported by SD/MMC PICtail™ Plus Daughter Board (AC164122) and future CompactFlash PICtail™ Plus Daughter Board
- 16 Kbytes of program memory, 1.5 Kbytes of RAM

25.4.7 Noise Suppression Library

The dsPIC Digital Signal Controller (DSC) Noise Suppression (NS) Library provides a function to suppress the effect of noise interfering with a speech signal. This function is useful for microphone-based applications, which have a potential for incoming speech getting corrupted by ambient noise captured by the microphone. It is especially suitable for systems in which an acoustically isolated noise reference is not available, such as the following:

- Hands-free cell phone kits
- Speakerphones
- Intercoms
- Teleconferencing systems
- Headsets
- A front-end to a speech recognition system
- Any microphone-based application that needs to eliminate undesired noise

Key features of the Noise Suppression Library include the following:

- All functions can be called from either a C or assembly application program
- Full compliance with Microchip's MPLAB C30 C compiler, assembler and linker
- Simple user interface – one library file and one header file
- Highly optimized assembly code utilizing DSP instructions and advanced addressing modes
- Audio bandwidth: 0 to 4 kHz at 8 kHz sampling rate
- 10-20 dB noise reduction, depending on type of noise
 - Several speech recordings corrupted by babble, car cabin, white and narrowband noise are included for library evaluation
- Comprehensive user's guide is included to assist in using the library
- Demo application source code is provided

25.4.8 Acoustic Echo Cancellation Library

The dsPIC Digital Signal Controller (DSC) Acoustic Echo Cancellation (AEC) Library provides a function to eliminate echo generated in the acoustic path between a speaker and a microphone. This function is useful for speech and telephony applications in which a speaker and a microphone are located in close proximity to each other and are susceptible to signals propagating from the speaker to the microphone resulting in a perceptible and distracting echo effect at the far end. It is especially suitable for these applications:

- Hands-free cell phone kits
- Speakerphones
- Intercoms
- Teleconferencing systems

Key features of the Acoustic Echo Cancellation Library include the following:

- All functions can be called from either a C or Assembly application program
- Full compliance with the Microchip MPLAB C30 C compiler, assembler and linker
- Simple user interface – one library file and one header file
- Highly optimized assembly code utilizing DSP instructions and advanced addressing modes
- Echo cancellation for 16, 32 or 64 ms echo delays or ‘tail lengths’ (configurable)
- Fully tested for compliance with G.167 specifications for in-car applications
- Audio bandwidth: 0 to 4 kHz at 8 kHz sampling rate
- Convergence rate: up to 43 dB/second (typically greater than 30 dB/second)
- Echo cancellation: up to 50 dB (typically greater than 40 dB)
- Can be used together with the Noise Suppression (NS) Library, since the same processing block size (10 ms) is used
- Comprehensive user’s guide is included to assist in using the library
- Demo application source code is provided with the library

25.4.9 Line Echo Cancellation Library

Line echo cancellation eliminates echoes generated in the electrical path between the transmitter and receiver in a communication device. Typically, echoes are the result of signal reflection caused by impedance mismatch in telephone hybrids and other network components. This “far-end” line echo results in a perceptible and distracting echo effect at the near end.

Line echo cancellation is useful for telephony applications that involve transmitting and receiving signals through a telephone hybrid. It is also useful for digital network applications, such as cellular telephony and voice-over-internet protocol. Though the dsPIC Digital Signal Controller (DSC) Line Echo Cancellation Library is targeted to eliminate far-end echo (as demonstrated by the demo application), the library functions are equally applicable to eliminating near-end echo.

Key features of the Line Echo Cancellation Library include the following:

- Simple user interface – only one library file and one header file
- All functions can be called from a C application program
- Full compliance with the Microchip MPLAB C30 C compiler, assembler and linker
- Functions predominantly written in highly optimized assembly code that uses DSP instructions and advanced addressing modes
- Echo cancellation for 16, 32 or 64 ms echo delays or tail lengths (configurable)
- Speech processing interval of 5, 10 or 20 ms (configurable)
- Fully tested for compliance with ITU-TG.168 specifications for digital network echo cancellers
- Audio Bandwidth: 0 to 4 kHz at 8 kHz sampling rate
- Convergence Rate: up to 60 dB/second (typically greater than 30 dB/second)
- Echo Cancellation: up to 70 dB (typically greater than 40 dB)
- Can be used together with the dsPIC DSC Noise Suppression Library, since the same processing block size (10 ms) can be used
- Comprehensive user’s guide is included to assist in using the library
- Demonstration application source code is provided with the library

25.4.10 G.711 Speech Encoding/Decoding Library

The PIC24/dsPIC Digital Signal Controller (DSC) G.711 Speech Encoding/Decoding Library performs toll-quality voice compression and voice decompression. The library is an implementation of the ITU-T G.711 standard on the dsPIC DSC. The encoding algorithm used is either A-law or μ -law companding (user-selectable), and features a 2:1 compression ratio. G.711 uses minimal computational resources, and a well-defined API makes it easy to integrate with the application.

The G.711 library can be used for both half-duplex and full-duplex systems. However, due to its high output data rate, it is most suitable for full-duplex communications applications that do not need to store the encoded speech for subsequent playback. Some target applications include the following:

- Intercoms
- Emergency phones
- Walkie-talkies
- Mobile hands-free kits
- Digital radios
- Voice-over-IP (VoIP) telephony

Key features of the G.711 Speech Encoding/Decoding Library include the following:

- Fixed 8 kHz input sample rate
- Fixed 64 kbps output data rate
- PESQ-based Mean Opinion Score (MOS): 4.3 to 4.5 (out of 5.0)
- A-law or μ -law based coding
- Two analog input interfaces – codec or on-chip ADC
- Two analog output interfaces – codec or on-chip PWM
- Playback-only applications benefit from the Speech Encoder Utility. Encoded files can be created from the desktop using a PC microphone or WAV file.
- Storing compressed speech requires 8 KB of memory per second of speech
- FREE library
- Full compliance with Microchip's MPLAB C30 C compiler language tools
- Comprehensive user's guide is included to assist in using the library
- Designed to run on dsPICDEM™ 1.1 Plus Development Board

25.4.11 G.726A Speech Encoding/Decoding Library

The dsPIC Digital Signal Controller (DSC) G.726A Speech Encoding/Decoding Library performs toll-quality voice compression and voice decompression. The library is an implementation of the ITU-T G.726 (Annex A) standard on the dsPIC DSC. The encoding algorithm used is Adaptive Differential Pulse Code Modulation (ADPCM). The compression can be configured by the user to be either 3.2:1, 4:1, 5.33:1 or 8:1, corresponding to output data rates of 40, 32, 24 and 16 kbps respectively. A well-defined API makes the library easy to integrate with the application.

The G.711 library is suitable for both half-duplex and full-duplex systems. Some key applications include the following:

- Intercoms
- Emergency phones
- Walkie-talkies
- Mobile hands-free kits
- Digital radios
- Voice-over-IP (VoIP) telephony
- Building and home safety systems
- Smart appliances
- Voice recorders
- Answering machines

Key features of the G.726A Speech Encoding/Decoding Library include the following:

- Fixed 8 kHz input sample rate
- User-selectable output data rate of 40, 32, 24 or 16 kbps
- PESQ-based Mean Opinion Score (MOS): 4.3 to 4.5 (out of 5.0)
- Adaptive Differential Pulse Code Modulation (ADPCM)-based coding
- Two analog input interfaces: codec or on-chip ADC
- Two analog output interfaces: codec or on-chip PWM
- Playback-only applications benefit from the Speech Encoder Utility. Encoded files can be created from the desktop using a PC microphone or WAV file.
- Storing compressed speech requires 5, 4, 3 or 2 KB of memory per second of speech
- Royalty-free, one-time only license fee
- Full compliance with Microchip's MPLAB C30 C compiler language tools
- Comprehensive user's guide is included to assist in using the library

25.4.12 Speex Speech Encoding/Decoding Library

The dsPIC Digital Signal Controller (DSC) Speex Speech Encoding/Decoding Library performs toll-quality voice compression and voice decompression. The library is a modified version of the Speex speech coder made specifically for the dsPIC DSC families and features a 16:1 compression ratio. Encoding uses Code Excited Linear Prediction (CELP), which is a popular coding technique. CELP provides a reasonable trade-off between performance and computational complexity.

The library is appropriate for both half-duplex and full-duplex systems. With its small footprint and low output data rate, it is also ideal for playback-only applications that require storage of encoded speech.

Some key applications include the following:

- Answering machines
- Building and home safety systems
- Intercoms
- Smart appliances
- Voice recorders
- Walkie-talkies
- Any application using message playback

Key features of the Speech Encoding/Decoding Library include the following:

- Fixed 8 kHz sample rate
- Fixed 8 kbps output rate
- PESQ-based Mean Opinion Score: 3.7 to 4.2 (out of 5.0)
- CELP-based coding
- Two analog input interfaces – codec or on-chip 12-bit ADC
- Two analog output interfaces – codec or on-chip PWM
- Optional voice activity detection
- Playback-only applications benefit from the Speech Encoder utility. Encoded speech files can be created from the desktop using a PC microphone or WAV file.
- Storing compressed speech requires 1 KB of memory per second of speech
- Off-chip support for playback of long speech samples
- Royalty free, one-time only license fee
- Full compliance with Microchip MPLAB C30 Language Tools
- Comprehensive user's guide is included to assist in using the library

25.4.13 Speech Recognition Word Library

The dsPIC Digital Signal Controller (DSC) Speech Recognition Word Library provides voice control of embedded applications with isolated, speaker-independent word recognition of US English. It allows control of an application through a set of fixed voice commands. The library has already been pre-trained by a demographic cross-section of male and female US English speakers. Conveniently, no training is required for end-users of the product.

This library is an ideal front-end for hands-free products such as modern appliances, security panels and cell phones.

Key features of the dsPIC30F Speech Recognition Word Library include the following:

- US English language support
- Speaker-independent recognition of isolated words
- No speaker training is required
- Hidden-Markov Model-based recognition system
- Recognition time less than 500 ms
- Master Library of 100 common words
- Windows® operating system-based utility creates a custom library from the master library
- Additional words can be added to the master library (fee-based)
- Data tables can be stored in external memory
- Optional keyword activation and silence detection
- Optional system self-test using a predefined keyword
- Flexible API
- Full compliance with MPLAB C30 Language Tools
- Comprehensive user's guides are included to assist in using the library
- Designed to run on dsPICDEM™ 1.1 Plus Development Board

25.4.14 Symmetric Key Encryption Library

Microchip offers a reliable security solution for embedded applications built on the dsPIC Digital Signal Controller (DSC) platform. This solution is provided by means of two libraries – Symmetric Key and Asymmetric Key Embedded Encryption Libraries.

The Symmetric Key Library features the following:

- Hash functions
 - SHA-1 secure hash standard
 - MD5 message digest
- Symmetric key encryption/decryption functions
 - Advanced Encryption Standard (AES)
 - Triple Data Encryption Algorithm (Triple-DES)
- Random number generator functions
 - Deterministic Random Bit Generator ANSI X9.82

Encryption library features include the following:

- C-callable library functions developed in MPLAB ASM30 Assembly language
- Optimized for speed, code size and RAM usage:
 - RAM usage below 60 bytes
- Library functions extensively tested for adherence to applicable standards
- Symmetric key encryption/decryption functions support multiple modes of operation:
 - Electronic Code Book (ECB) mode
 - Cipher Block Chaining with Message Authentication (CBC-MAC) mode
 - Counter (CTR) mode
 - Combined CBC-MAC and Counter (CCM) mode
- Comprehensive user's guide is included to assist in using the library
- Several examples of use are provided for each library function

25.4.15 Asymmetric Key Embedded Encryption Library

Microchip offers a reliable security solution for embedded applications built on the dsPIC Digital Signal Controller (DSC) platform. This solution is provided by means of two libraries – Symmetric Key and Asymmetric Key Embedded Encryption Libraries.

The Asymmetric Key Library implements the following:

- Public key encryption/decryption functions: RSA (1024- and 2048-bit)
- Key agreement protocol: Diffie-Hellman (1024- and 2048-bit)
- Signing and verification:
 - DSA (1024-bit)
 - RSA (1024- and 2048-bit)
- Hash and message digest functions:
 - SHA-1
 - MD5
- Random Number Generator (RNG): ANSI X9.82

Encryption library features include the following:

- C-callable library functions developed in MPLAB ASM30 Assembly language
- Optimized for speed, code size and RAM usage (below 100 bytes)
- Library functions extensively tested for adherence to applicable standards
- Comprehensive user's guide is included to assist in using the library
- Several examples of use provided for each library function

25.4.16 Triple DES/AES Encryption Libraries

Microchip offers a reliable security solution for embedded applications built on the 16-bit microcontroller platform. This solution is provided by means of a single library. This library features the symmetric key encryption/decryption functions Advanced Encryption Standard (AES) and Triple-Data Encryption Algorithm (Triple-DES).

This solution is provided by means of two libraries – Symmetric Key and Asymmetric Key Embedded Encryption Libraries.

The Symmetric Key Library features the following:

- Hash functions:
 - SHA-1 secure hash standard
 - MD5 message digest
- Symmetric key encryption/decryption functions:
 - Advanced Encryption Standard (AES)
 - Triple-Data Encryption Algorithm (Triple-DES)
- Random number generator functions: Deterministic Random Bit Generator ANSI X9.82

Encryption library features include the following:

- Optimized for speed, code size and RAM usage
- Library functions tested for adherence to applicable standards
- Application note describing APIs
- Several examples of use are provided for each library function

25.4.17 dsPICworks™ Data Analysis and DSP Software

dsPICworks Data Analysis and DSP Software is an easy-to-use data analysis and signal processing package for designs using dsPIC Digital Signal Controllers (DSCs). It provides an extensive number of functions, including the following:

- Signal generation
- Arithmetic operations and digital signal processing
- One, two and three-dimensional display and measurement capabilities
- Data import/export compatible with MPLAB IDE and MPLAB ASM30 assembler

Key features of the dsPICworks Data Analysis and DSP Software include the following:

- Wide variety of signal generators: sine, square, triangular, window functions, noise
- Extensive DSP functions: FFT, DCT, filtering, convolution, interpolation
- Extensive arithmetic functions: algebraic expressions, data scaling, clipping, etc.
- One-, two- and three-dimensional displays
- Multiple data quantization and saturation options
- Multi-channel data support
- Automatic script file-based execution options available for any user-defined sequence of dsPICworks data analysis and DSP software functions
- File import/export interoperable with MPLAB IDE
- Digital filtering options support filters generated by dsPIC DSC Digital Filter Design
- MPLAB ASM30 assembler file option to export data tables into dsPIC30F RAM

25.4.18 Digital Filter Design

The Digital Filter Design tool for the 16-bit dsPIC Digital Signal Controller (DSC) makes designing, analyzing and implementing Finite Impulse Response (FIR) and Infinite Impulse Response (IIR) digital filters easy, through a menu-driven and intuitive user interface. The filter design tool performs complex mathematical computations for filter design, provides superior graphical displays and generates comprehensive design reports.

Desired filter frequency specifications are entered and the tool generates the filter code and coefficient files ready to use in the MPLAB IDE Integrated Development Environment. System analysis of the filter transfer function is supported with multiple generated graphs, such as magnitude, phase, group delay, log magnitude, impulse response and pole/zero locations.

Finite Impulse Response Filter Design features include the following:

- Design method selection
 - FIR window design
 - FIR equiripple design (Parks-McClellan)
- Low-pass, high-pass, band-pass and band-stop filters
- FIR filters can have up to 513 taps
- Several window functions are supported
- Reports provide design details such as window coefficients and impulse response prior to multiplying by the window function

Infinite Impulse Response Filter Design features include the following:

- Low-pass, high-pass, band-pass and band-stop filters
- Filter orders up to 10 for low-pass and high-pass filters
- Filter orders up to 20 for band-pass and band-stop filters
- Five analog prototype filters are available
- Digital transformations are performed by bilinear transformation method
- Reports show design details such as all transformations from normalized low-pass filter to desired filter

A cost-effective edition of the tool, known as Digital Filter Design Lite, is also available. This edition supports FIR filters having up to 64 taps, and IIR filters up to 4th order for low-pass and high-pass and 8th order for band-pass and band-stop.

25.5 Related Application Notes

This section lists application notes that are related to this section of the manual. These application notes may not be written specifically for the dsPIC30F Product Family, but the concepts are pertinent and could be used with modification and possible limitations. The current application notes related to Development Tool Support include the following:

Title	Application Note #
No related application notes at this time.	

Note: Please visit the Microchip web site (www.microchip.com) for additional Application Notes and code examples for the dsPIC30F Family of devices.

25.6 Revision History

Revision A

This is the initial released revision of the dsPIC30F Development Tool Support description.

Revision B

There were no technical content or editorial revisions to this section of the manual; however, this section was updated to reflect Revision B throughout the manual.

Revision C

There were no technical content revisions to this section of the manual; however, this section was updated to reflect Revision C throughout the manual.

Revision D

Technical content revisions were made to bring existing tool descriptions up to date. Other sections were added to include new development tools.

NOTES: