
Section 26. 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. For the most current information and availability of each product, check the Microchip web site (www.microchip.com), or your local Microchip sales office.

26.1 INTRODUCTION

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

26.2 dsPIC33F SOFTWARE AND HARDWARE DEVELOPMENT TOOLS

This section briefly describes some of the software and hardware development tools that are available for dsPIC33F 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 (www.microchip.com).

The Microchip tools proposed include:

- MPLAB® Integrated Development Environment (IDE)
- dsPIC DSC 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

26.2.1 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 REAL ICE emulator, MPLAB PM3 programmer, and MPLAB ICD 2 In-Circuit Debugger.

The MPLAB IDE allows the user to:

- Edit source files in either Assembly or C
- Use one-touch compile and download to dsPIC DSC program memory on emulator or simulator (all project information is updated)
- Debug using:
 - 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 requires minimal effort.

26.2.2 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.

26.2.3 MPLAB ASM30 Assembler, Linker and Librarian

MPLAB ASM30 Assembler produces relocatable machine code from symbolic assembly language for dsPIC DSC 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.

26.2.4 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.

26.2.5 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 IDE Integrated Development Environment project.

26.2.6 Data Monitoring and Control Interface (DMCI)

Note: This product is included with MPLAB IDE.

DMCI provides dynamic access 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:

- **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 re-use and portability.

26.2.7 MPLAB REAL ICE In-Circuit Emulator System

MPLAB REAL ICE In-circuit Emulation System is Microchip's next generation emulation and debugging system. Initially supporting the dsPIC30F601XA, dsPIC33F, PIC24H and PIC24F 16-bit devices, 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.

26.2.8 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 ICSP™ protocol, offers cost-effective, in-circuit debugging from the graphical user interface (GUI) 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.

26.2.9 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.

26.3 dsPIC33F DEVELOPMENT BOARDS

A full suite of cost-effective hardware development boards is available to support the dsPIC33F product family. This section provides a brief overview of these boards and their features. For additional information, refer to *“Tools and Solutions for the 16-bit Designer”* (DS01033), available from the Microchip web site (www.microchip.com).

26.3.1 Explorer 16 Development Board

This development board offers an economical way to evaluate both the PIC24F and PIC24H microcontrollers, as well as the dsPIC33F 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 Explorer 16 Development Board include:

- A 100-pin dsPIC33F General Purpose (MA330011) and 100-pin PIC24F (MA240011) plug-in modules
- Supports 100-pin PIC24H (MA240012) plug-in module
- Supports the dsPIC33FJ256GP710 and the PIC24FJ128GA010
- Modular design for plug-in demonstration boards, expansion header
- RS-232 serial channel
- MPLAB ICD 2 support ready
- 2x16 LCD
- LEDs, switches and potentiometer

26.3.2 PICtail™ Plus Daughter Boards

The Explorer 16 board has been designed with the PICtail Plus modular expansion interface, allowing the board to provide basic generic functionality and still be easily extendable to new technologies as they become available.

PICtail Plus is based on a 120-pin connection divided into three sections of 30 pins, 30 pins and 56 pins. The two 30-pin connections have parallel functionality. For example, pins 1, 3, 5 and 7 have SPI1 functionality on the top 30-pin segment, with similar SPI functionality on the corresponding pins in the middle 30-pin segment.

Each 30-pin section provides connections to all of the serial communication peripherals, as well as many I/O ports, external interrupts and A/D channels. This provides enough signals to develop many different expansion interfaces, such as Ethernet, ZigBee™ Technology, IrDA® Protocol and so on. The 30-pin PICtail Plus daughter boards can be used in either the top or middle 30-pin sections.

The Explorer 16 board provides footprints for two edge connectors for daughter boards, one populated (J5, Samtec # MEC1-160-02-S-D-A) and one unpopulated (J6). The board also has a matching male edge connection (J9), allowing it to also be used as an expansion card.

- SD/MMC PICtail™ Plus Daughter Board (AC164122)
- Ethernet PICtail™ Plus Daughter Board (AC164123)
- Motor Control Interface PICtail™ Plus Daughter Board (AC164128)
- Speech Playback PICtail™ Plus Daughter Board (AC164125)
- IrDA® Protocol PICtail Plus Daughter Board (Future)
- CompactFlash PICtail™ Plus Daughter Board (Future)
- Wireless Communications PICtail™ Plus Daughter Board (Future)
- ADC/PWM Audio PICtail™ Plus Daughter Board (Future)

26.3.3 dsPICDEM 80-pin Starter Development Board

This development board offers an economical way to evaluate both the PIC24 and dsPIC 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:

- An 80-pin dsPIC30F6014A plug-in module (MA300014)
- A 100- to 80-pin adapter dsPIC33F plug-in module (MA330012) (uses 3.3V V_{DD} solution)
- Power input from 9V supply
- Selectable voltage regulator outputs of 5V and 3.3V
- LEDs, switches, potentiometer, 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 V_{DD} solution)

26.3.4 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 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.

Key features of the dsPICDEM 1.1 Plus Development Board include:

- 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

26.3.5 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 28-pin devices. The following capabilities are provided:

- Development Board Power
 - On-board +5V regulator or +3.3V regulator for V_{DD} and AV_{DD}
 - 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

26.4 dsPIC33F SOFTWARE APPLICATION LIBRARIES AND UTILITIES

This section provides brief descriptions of application libraries and utilities available for use with dsPIC33F devices. For additional information, please refer to “*Tools and Solutions for the 16-bit Designer*” (DS01033), which is available from the Microchip web site (www.microchip.com).

26.4.1 Peripheral Library

The PIC24H/dsPIC 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 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)
- Analog-to-Digital converter
- ECAN
- Direct Memory Access (DMA)
- Peripheral Pin Select
- Functions for controlling an external LCD through configurable I/O port pins are also provided

26.4.2 Math Library

The PIC24/dsPIC 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:

- Math Library that is callable 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
- Compatibility with MPLAB ASM30 and MPLAB LINK30, which are available at no charge from www.microchip.com

26.4.3 DSP Library

The dsPIC 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

26.4.4 Soft Modem Library

The dsPIC 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 orientated-based applications such as, but not limited to:

- 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

26.4.5 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 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 occurs. 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:

- 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

26.4.6 FAT16 File System Library

The FAT 16 File System Library allows the designer to easily integrate a removable Flash-based media card up to 2 gigabytes into their application. The FAT16 File System Library is modular and provided in C source code to easily integrate 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:

- 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

26.4.7 Noise Suppression Library

The dsPIC 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:

- 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:

- Ability to call all functions 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 included for library evaluation
- Comprehensive user's guide to assist in utilizing the library
- Demo application source code

26.4.8 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 following applications:

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

Key features of the AEC Library include:

- Ability to call all functions 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 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 utilizing the library
- Demo application source code

26.4.9 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 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:

- Simple user interface – only one library file and one header file
- Ability to call all functions 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 to assist in utilizing the library
- Demonstration application source code

26.4.10 G.711 Speech Encoding/Decoding Library

The PIC24/dsPIC 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:

- 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:

- 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 utilizing the library

26.4.11 G.726A Speech Encoding/Decoding Library

The dsPIC 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 and 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:

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

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

- 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 to assist in utilizing the library

26.4.12 Speex Speech Encoding/Decoding Library

The dsPIC 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:

- 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:

- Fixed 8 kHz sample rate
- Fixed 8 kbps output rate
- PESQ-based Mean Opinion Score: 3.7 – 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 to assist in utilizing the library

26.4.13 Speech Recognition Word Library

The dsPIC 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:

- 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 to assist in utilizing the library

26.4.14 Symmetric Key Encryption Library

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

The Symmetric Key Library features:

- 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:

- 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 to assist in utilizing the library
- Several examples of use are provided for each library function

26.4.15 Asymmetric Key Embedded Encryption Library

Microchip offers a reliable security solution for embedded applications built on the dsPIC 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:

- 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

26.4.16 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:

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

Encryption library features include:

- 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

26.4.17 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 DSCs. It provides an extensive number of functions encompassing:

- 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:

- Wide variety of signal generators: sine, square, triangular, window functions, noise
- Extensive DSP functions: FFT, DCT, filtering, convolution, interpolation
- Extensive arithmetic functions: algebraic expressions, datascaling, 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 dsPIC33F RAM

26.4.18 Digital Filter Design

The Digital Filter Design tool for the 16-bit dsPIC 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. 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:

- 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:

- 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

26.5 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 dsPIC33F device family, but the concepts are pertinent and could be used with modification and possible limitations. The current application notes related to the Development Tool Support are:

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

Note: For additional Application Notes and code examples for the dsPIC33F family of devices, visit the Microchip web site (www.microchip.com).

26.6 REVISION HISTORY

Revision A (March 2007)

This is the initial released version of the dsPIC33F Development Tool Support section.

Revision B (April 2007)

Minor updates were made to this document.

NOTES: