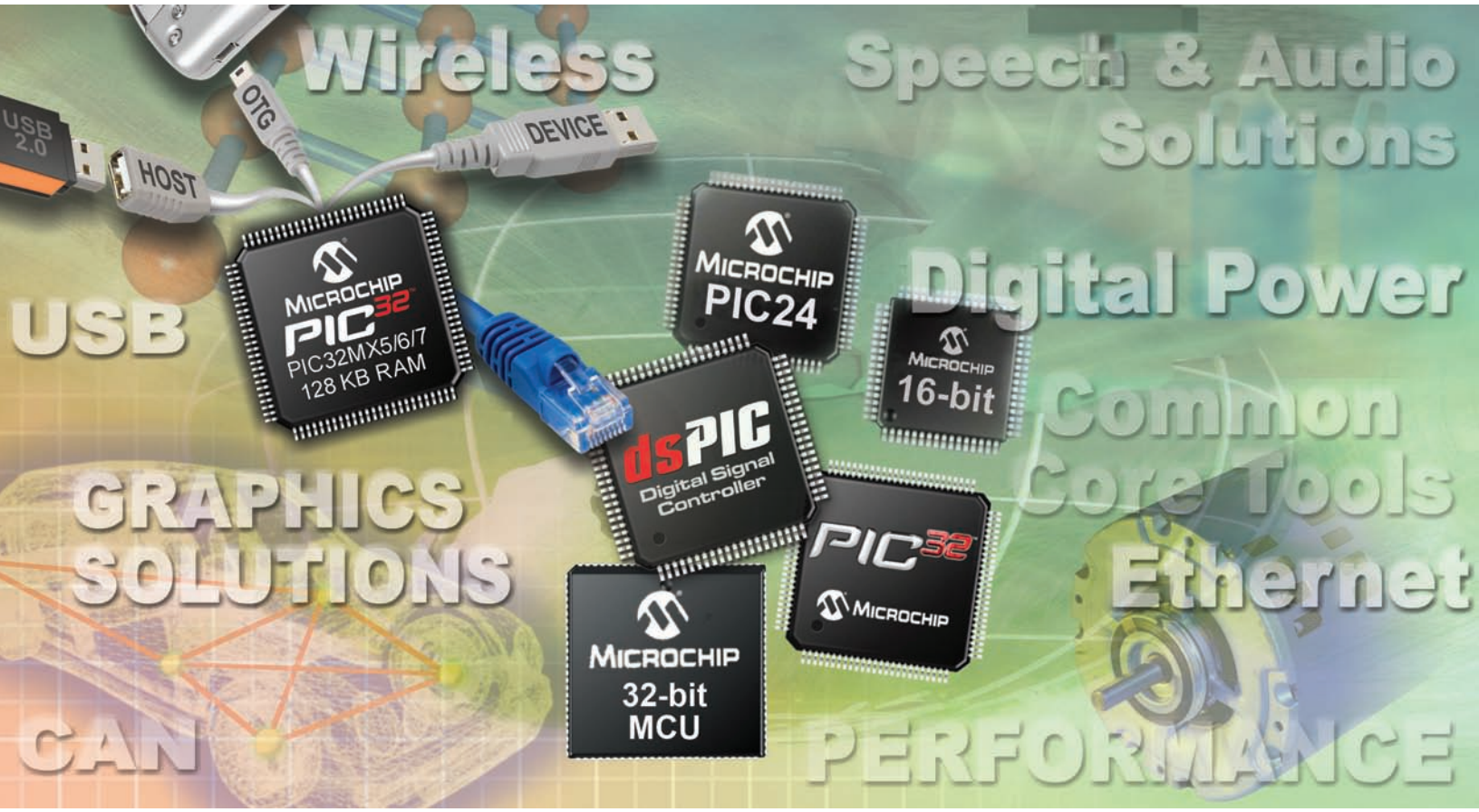
16-bit and 32-bit Controllers
Software Resources

January 2010

MICROCHIP

Software Solutions for the 16-bit and 32-bit Designer

A comprehensive overview of software libraries, application solutions and software development tools for Microchip's PIC24, dsPIC® and PIC32 embedded control product families.



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Software Solutions and Tools for the 16-bit and 32-bit Designer

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Software Application Library Overview

A suite of advanced solution libraries have been developed and are available for your application requirements. The table below presents a summary of the libraries available for the PIC24 Microcontroller (MCU), dsPIC® Digital Signal Controllers (DSC) and PIC32 MCU. Additional information on the specific library is provided within this section. Some of the benefits of the libraries are:

- Comprehensive library suite for 16-bit and 32-bit product family
- Reduce development time by using ready-made libraries
- No royalties for libraries and only a one-time license fee per project lifetime for some libraries
- Free and low cost evaluation and development support:
  - Many libraries are free downloads
  - Evaluation versions are free for development
  - Encryption libraries are handling cost only

Application	Application Library	Device Support					Part Number	Price
		PIC24F	PIC24H	dsPIC30F	dsPIC33F	PIC32		
Speech, Audio and Communication	dsPIC® DSC Soft Modem Library			✓			–	Free
	dsPIC® DSC Noise Suppression Library			✓	✓		SW300040-5K*	2500
							SW300040-EVAL	Free
	dsPIC® DSC Acoustic Echo Cancellation Library			✓	✓		SW300060-5K*	$2500
							SW300060-EVAL	Free
	dsPIC® DSC Line Echo Cancellation Library			✓	✓		SW300080-5K*	$2500
							SW300080-EVAL	Free
	dsPIC® DSC Equalizer Library			✓	✓		–	Free
	dsPIC® DSC Automatic Gain Control Library			✓	✓		–	Free
	PIC24/dsPIC® DSC G.711 Speech Encoding/Decoding Library	✓	✓	✓	✓		SW300026	Free
	dsPIC® DSC G.726A Speech Encoding/Decoding Library			✓	✓		SW300090-5K*	$2500
							SW300090-EVAL	Free
	dsPIC® DSC Speex Speech Encoding/ Decoding Library			✓	✓		SW300070-5K*	$2500
							SW300070-EVAL	Free
	ADPCM and Speex (Audio) Library for PIC32 MCUs					✓	–	Free
Encryption and Security	dsPIC® DSC Symmetric Key Embedded Encryption Library			✓	✓		SW300050-5K*	$2500
							SW300050-EVAL	$5
	dsPIC® DSC Asymmetric Key Embedded Encryption Library			✓	✓		SW300055-5K*	$2500
							SW300055-EVAL	$5
	Triple DES/AES Encryption Libraries	✓	✓	✓	✓	✓	SW300052	$5
DSP and Math	dsPIC® DSC DSP Library			✓	✓		Included in MPLAB C Compiler	Free
	PIC32 DSP Library					✓	Included in MPLAB C Compiler	Free
	PIC24/dsPIC® DSC Floating Point Math Library	✓	✓	✓	✓		Included in MPLAB C Compiler	Free
	PIC24/dsPIC® DSC Fixed Point Math Library	✓	✓	✓	✓		Included in MPLAB C Compiler	Free
	PIC32 Floating Point Math Library					✓	Included in MPLAB C Compiler	Free

Note: Evaluation versions are complete libraries and are available for free or the cost of materials for evaluation and development.

*Software library license up to 5K units.

Software Application Library Overview

Application	Application Library	Device Support					Part Number	Price
		PIC24F	PIC24H	dsPIC30F	dsPIC33F	PIC32		
Peripherals	PIC24/dsPIC® DSC Peripheral Library	✓	✓	✓	✓		Included in MPLAB C Compiler	Free
	PIC32 Peripheral Library					✓	Included in MPLAB C Compiler	Free
Graphics	Microchip Graphics Library	✓	✓		✓	✓	–	Free
Wired and Wireless Connectivity	Microchip TCP/IP Stack	✓	✓		✓	✓	–	Free
	Microchip USB Framework	✓				✓	–	Free
	IEEE-802.15.4: MiWi™ and MiWi P2P	✓	✓		✓	✓	–	Free
	IEEE-802.15.4: ZigBee®, ZigBee PRO, ZigBee Smart Energy Profile Suite	✓	✓		✓	✓	–	Free
	PIC32 CAN Library Using MCP2515 CAN Controller					✓	–	Free
File System and Memory	Microchip FAT File System for PIC24 & PIC32 MCUs and dsPIC® DSCs	✓	✓		✓	✓	–	Free
	FATFs File System for PIC32 MCUs					✓	–	
	Data EEPROM Emulation for PIC18, PIC24 & PIC32 MCUs and dsPIC® DSCs	✓	✓		✓	✓	–	Free
Other	PMBus Stack				✓		–	Free
	Class B Safety Software Library for PIC® MCUs and dsPIC® DSCs	✓	✓		✓		–	Free

Note: Evaluation versions are complete libraries and are available for free or the cost of materials for evaluation and development.

*Software library license up to 5K units.

FREE dsPIC® DSC Soft Modem Library Part Number: SW300002

Summary

The dsPIC® DSC Soft Modem Library is composed of ITU-T compliant algorithms for V.21, V.22, V.22bis and V.23. Bell standard 103 is also included in this library. V.22 is a Quadrature Phase Shift Keyed (QPSK) modem. V.21, V.22 and V.22bis 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.22bis/V.22 offered free with full source code, includes:
  - V.22bis/V.22, V.23, V.21/Bell 103, V.42, DP and V.42 API, AT command set

Key Features

- Fallback data pump modulations down to V.21
- HDLC Protocol support
- All dsPIC DSCs with a DCI (codec) Interface are supported
- Comprehensive documentation and source code
- APIs are based on C language
- Data pump modulations developed in ASM30 to yield optimum code size

Applications

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
- Internet-connected meters
- Internet-connected vending machines
- Smart appliances
- Industrial monitoring

Features and Performance of Data Modems

Algorithm(1)	Data Rate (Kbps)	Half/Full Duplex	Mod.	Program Memory(2) (Kbytes)	Data Memory(2) (Kbytes)	MIPS
V.21/Bell 103(4)	0.3	Full	FSK	13	1.0	4.5
V.22/V.22bis	1.2	Full	PSK/QAM	22	1.7	7
	2.4					
V.23(4)	1.2	Half	FSK	15	1.0	4.5
	0.6					
V.42		–		14	2.0	1.5
DP + V.42 API(3)		–		7	1.2	–
AT Command Set(3)		–		8	0.15	–

Notes:
1. Data pump modules, V.21, V.22, V.22bis, V.23 and Bell 103 are implemented in Assembly language; V.42, data pump; AT command APIs are implemented in C language.
2. The program/data memory usage for the V-series data pumps is NOT cumulative, due to the sharing of components internally.
3. Memory size does not account for applications combining data pump, V.42 and AT commands (if required).
4. V.21/Bell 103 and V.23 data pumps do not require V.42.

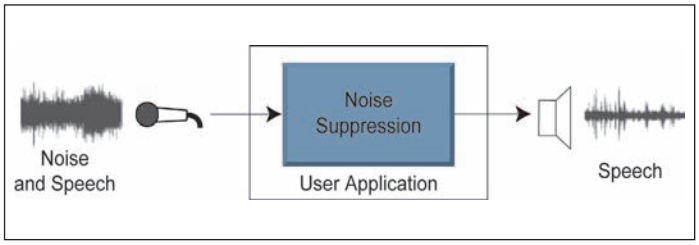
dsPIC® DSC Noise Suppression Library Part Number: SW300040

Summary

The dsPIC® DSC Noise Suppression Library provides a function to suppress the effect of noise in a speech signal. This function is useful for microphone-based applications that have a potential for incoming speech corruption from ambient noise. It is especially suitable for systems where an acoustically isolated noise reference is not available. The noise suppression library removes noise from a 10 ms block of 16-bit speech data sampled at 8 kHz. Fast Fourier Transform (FFT) is performed on each 10 ms block of data to analyze the frequency components of the signal. The library, adapts to changes in the nature and level of noise, and does not require a separate noise reference input.

Key Features

- 0 dB to 44 dB noise reduction
- Audio Bandwidth: 0-4 kHz at 8 kHz sampling rate
- Simple user interface – only one library file and one header file
- All functions called from a C application program
- Full compliance with the MPLAB C Compiler, Assembler and Linker



- Highly optimized assembly code that uses DSP instructions and advanced addressing modes
- Comprehensive API provides parametric control of the Noise Suppression Engine
- Supported by Microchip SAFF Tool

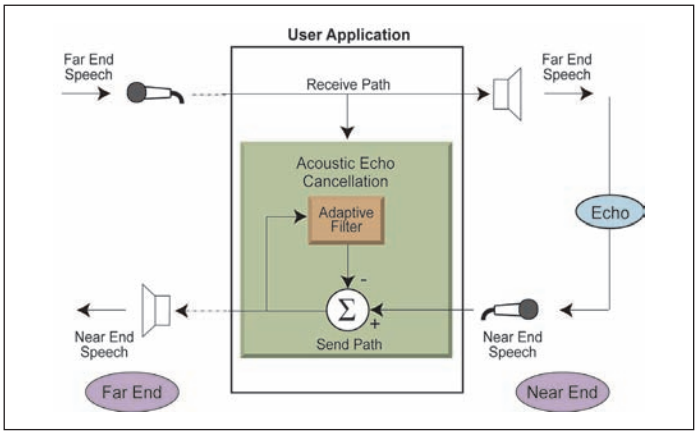
Applications

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

dsPIC® DSC Acoustic Echo Cancellation Library Part Number: SW300060

Summary

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.



Key Features

- Compatible with G.167 specifications for in-car applications
- Audio Bandwidth: 0 to 4 kHz at 8 kHz sampling rate
- Convergence Rate: Up to 47 dB/sec., typically greater than 30 dB/sec
- Acoustic Echo Cancellation: Up to 50 dB, typically > 40 dB
- Can be used together with the Noise Suppression (NS) Library
- Adjustable NLP attenuation level
- Can be instantiated multiple times to support multiple input audio streams
- Simple user interface – only one library file and one header file
- Highly optimized assembly code that uses DSP instructions and advanced addressing modes
- Supported by Microchip SAFF Tool

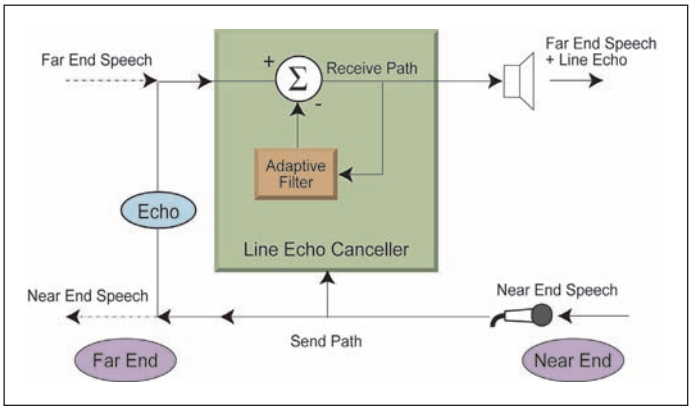
Applications

- Automobile hands-free cell phone kits
- Speaker phones
- Intercoms
- Teleconferencing systems

dsPIC® DSC Line Echo Cancellation Library Part Number: SW300080

Summary

The dsPIC® DSC Line Echo Cancellation (LEC) Library is compatible with the ITU-T G.168 standard. It provides a function to eliminate echo generated in telephone or digital network components. LEC library functions can be used to eliminate far-end as well as near-end echo.



Key Features

- Line echo cancellation for 16, 32, 64 or 128 ms echo delays
- Audio Bandwidth: 0 to 4 kHz at 8 kHz sampling rate
- Convergence Rate: Up to 60 dB/sec., typically greater than 30 dB/sec
- Can be used together with the Noise Suppression (NS) Library
- Can be instantiated multiple times to support multiple input audio streams
- Line Echo Cancellation adaptation can be force-enabled or disabled by the user application
- Tone detection for disabling LEC during test or measurement processes
- Run-time control of key algorithm parameters is provided
- Supported by Microchip SAFF Tool

Applications

- Hands-free cell phone kits
- Speaker phones
- Intercoms
- Teleconferencing systems
- Voice over internet protocol

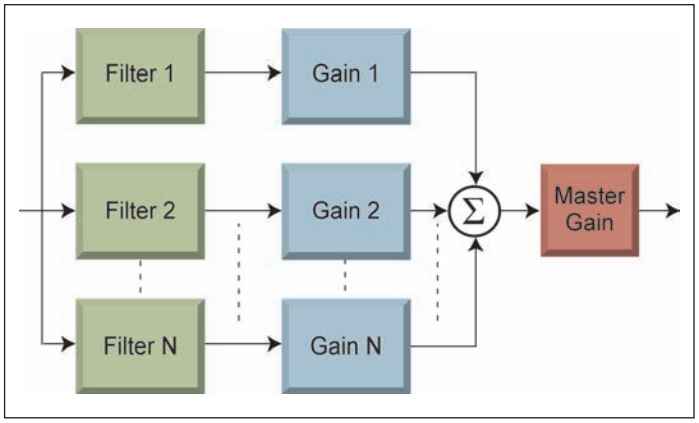
FREE dsPIC® DSC Equalizer Library

Summary

The dsPIC® DSC Equalizer Library provides functionality to adjust the spectral characteristics of a voice band signal. The Equalizer library enables compensation for the changes in total properties of the voice signal resulting because of signal processing and mechanical limitations of Input-Output devices. Equalizer library enables user to modify the spectral characteristics of the signal.

Key Features

- Audio Bandwidth sampling rate at 8 KHz
- Quality factor of 1.4 for each band-pass filter
- Individual band gain control from 0-18 dB
- Master gain control from 0-12 dB
- Can be integrated with the dsPIC DSC Noise Suppression, Acoustic Echo Cancellation and Line Echo Cancellation libraries
- Can process multiple audio streams
- Simple user interface – only one library file and one header file
- Supported by Microchip SAFF Tool



Applications

- Hands-free cell phone kits
- Speaker phones
- Intercoms
- Teleconferencing systems

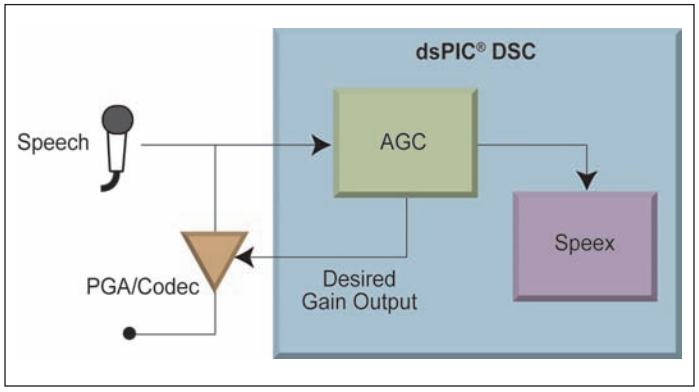
FREE dsPIC® DSC Automatic Gain Control Library

Summary

The dsPIC® DSC Automatic Gain Control Library automatically adjusts the amplitude of a speech signal to match a set level. This is useful in speech applications where the distance between the speech source and the microphone is not fixed. The Automatic Gain Control Library can be used readily with Microchip's Speech and Audio Solutions for speech signal pre-processing.

Key Features

- Input signal clip detection
- Hooks to control gain of external codec
- Gain attack, release and leakage rate controls
- Audio bandwidth: 8-48 kHz sampling rate
- All functions called from a C application program
- Full compliance with the Microchip MPLAB C Compiler, Assembler and Linker
- Highly optimized assembly code that uses the DSP instructions and advanced addressing modes
- Comprehensive API provides parametric control of the AGC engine



Applications

- Hands-free cell phone kits
- Speaker phones
- Intercoms
- Headsets
- Front-end to a speech recognition system or speech encoding algorithm

PIC24/dsPIC® DSC G.711 Speech Encoding/Decoding Library Part Number: SW300026

Summary

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 and PIC24 MCU. The encoding algorithm used is either A-law or µ-law companding (user-selectable), and features a 2:1 compression ratio. The G.711 library can be used for both half-duplex and full-duplex systems.

Key Features

- A-law or µ-law based coding
- Playback-only applications benefit from the Speech Encoder Utility. Encoded files can be created from the desktop using a PC microphone or WAV file

G.711

Compression Ratio	2:1
Sampling Frequency	8 KHz
Output Data Rate	64 Kbps
MIPS	1
MOS	4-4.5
Memory	8 KB/Sec of Speech

Applications

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

dsPIC® DSC G.726A Speech Encoding/Decoding Library Part Number: SW300090

Summary

The dsPIC® DSC G.726A Speech Encoding/Decoding Library performs toll-quality voice compression and voice decompression. 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. The G.726A library is suitable for both half-duplex and full-duplex systems

Key Features

- Adaptive Differential Pulse Code Modulation (ADPCM) – based coding
- Playback-only applications benefit from the Speech Encoder Utility. Encoded files can be created from the desktop using a PC microphone or WAV file.

G.726A

Compression Ratio	3.2:1 to 8:1
Sampling Frequency	8 KHz
Output Data Rate	16-40 Kbps
MIPS	15
MOS	3.5-4.5
Memory	2-5 KB/Sec of Speech

Applications

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

dsPIC® DSC Speex Speech Encoding/Decoding Library Part Number: SW300070

Summary

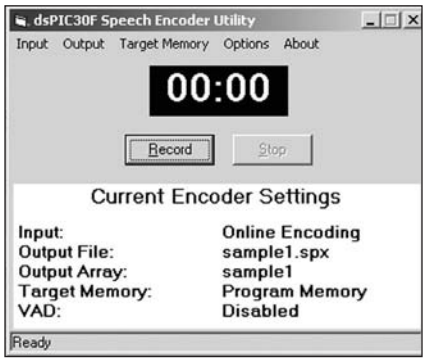
The dsPIC® DSC Speex Speech Encoding/Decoding Library performs toll-quality voice compression and voice decompression. The library is a modified version of the Speex speech coder made specifically for the dsPIC DSC families and features a multiple compression ratio. Encoding uses popular Code Excited Linear Prediction (CELP) techniques. The library is appropriate for both half-duplex and full-duplex systems.

Key Features

- Multiple encoders and/or decoders can be instantiated
- Full-duplex and half-duplex operations
- Compact and concise API for easier integration with application

Compression Ratio	16:1 /11.6:1	26:1/20:1
Sampling Frequency	8 KHz	16 KHz
Output Data Rate	8 Kbps/11 Kbps	9.8/12.8 Kbps
MIPS	20	30
MOS	3.7-4.2	3.5-4

PC-based Speech Encoder Utility Program



Applications

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

ADPCM and Speex (Audio) Library for PIC32 MCUs

Summary

The audio library for PIC32 MCUs consists of APIs for Pulse Code Modulation, Adaptive Differential Pulse Code Modulation and Speex encoding and decoding algorithms. Speex is an Code Excited Linear Prediction (CELP) based open source patent-free audio compression format designed for speech. The ADPCM algorithm takes advantage of the high correlation between consecutive speech samples, which enables future sample values to be predicted.

Key Features

- Free software/open-source, patent and royalty-free
- Portable across all PIC32 microcontrollers
- Supported encoding formats: PCM (raw, uncompressed), IMA ADPCM, Speex
- Implements an audio player behavior with play, record, pause, stop functionality
- Supports standard input/output stream formats: Wave, Ogg for Speex, as well as a raw format containing just data
- Supports various sampling rates in both play and record mode
- Supports narrowband (8 KHz) and wideband (16 KHz) bit-streams for Speex
- Provides information about the missed samples
- User selectable ratio between the sampling frequency and the play/record frequency

Applications

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

dsPIC® DSC Symmetric Key Embedded Encryption Library Part Number: SW300050

Summary

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 Symmetric Key Encryption Library.

Key Features

- 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
- C-callable library functions developed in MPLAB® ASM30 Assembly language
- Optimized for speed, code size and RAM usage
- Library functions extensively tested for adherence to applicable standards

Applications

- Mobile and wireless devices, PDAs
- Secure banking and web transactions
- ZigBee® technology and other monitoring and control applications
- Smart card readers/trusted card readers
- Friend/foe identification
- Secure devices and peripherals interoperating with TCG and NGSCB PCs

Cryptographic Functions

Cryptographic Algorithm	Applicable Specification	Cryptographic Function(2)	Code Size (bytes)	Data Rate(4) (Kbps)
RNG	ANSI X9.82, FIPS 180-2	Deterministic Random Bit Generator	1353	–
SHA-1	FIPS 180-2	Secure Hash Algorithm – 160-bit	909	563
MD5	RFC 1321	Message Digest – 128-bit	1428	872
T-DES	FIPS 46-3	Basic Encryption and Decryption	8892	65(3)
	FIPS 46-3	ECB Wrapper(1)	123	
	NISTSP 800-38A	CBC Wrapper(1)	903	
	NISTSP 800-38A	CTR Wrapper(1)	348	
AES (128-bit)	FIPS 197	Basic Encryption	2505	309(3)
	FIPS 197	Basic Decryption	2895	
	FIPS 197	ECB Wrapper(1)	234	
	FIPS 113	CBC-MAC Encryption Wrapper(1)	663	
	NISTSP 800-38A	CBC Decryption Wrapper(1)	357	
	NISTSP 800-38A	CTR Wrapper(1)	348	
	IEEE-802.11i	CCM Wrapper(1)	930	

Notes:
1. Wrapper functions are used in combination with the underlying basic encryption and/or decryption functions for the respective algorithm (AES,T-DES).
2. All library functions use the stack and require input and output message buffers to be set up by the calling application, stack usage is below 60 bytes of RAM.
3. AES and T-DES data rate represents the average of the data rates for performing basic encryption and decryption functions for a single block of data.
4. All data rate statistics shown here assume device operation of 40 MIPS.

dsPIC® DSC Asymmetric Key Embedded Encryption Library Part Number: SW300055

Summary

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 Asymmetric Key Encryption Library.

Key Features(4)

- SC-callable library functions developed in MPLAB® ASM30 Assembly language
- Optimized for speed, code size and RAM usage
  - RAM usage below 100 bytes
- Library functions extensively tested for adherence to applicable standards
- Fast execution of algorithms
- RSA Encryption and Verification functions execute in 3.95 ms for a 17-bit exponent
- RSA Decryption and Signing functions execute in 85.71 ms for a 17-bit exponent
- DSA Signing function executes in 45 ms
- DSA Verification function executes in 85.71 ms
- Diffie-Hellman key agreement executes in:
  - 44.36 ms for 160-bit key
  - 275.18 ms for 1024-bit key

Applications

- Mobile and wireless devices, PDAs
- Secure banking and web transactions
- ZigBee® technology and other monitoring and control applications
- Smart card readers
- Friend/foe identification
- Peripherals interoperating with TCG and NGSCB PCs

Cryptographic Functions

Cryptographic Algorithm	Applicable Specification	Cryptographic Function(1)	Security Strength (in bits)	Code Size(2) (bytes)
Primary Functions				
RSA	PKSC#1 v1.5	Encryption/Decryption	1024, 2048	2574
RSA	PKSC#1 v1.5	Signing/Verification	1024, 2048	2658
Diffie-Hellman	PKCS#3	Key Agreement Protocol	1024, 2048	2067
DSA	FIPS 186-2	Signing/Verification	1024	4341
Auxillary Functions				
Big Integer(3)	–	Modulus Arithmetic Functions Inverse Modulus Arithmetic Montgomery Arithmetic	– – –	927 495 552
Deterministic	ANSI X9.82	Random Number Generator	–	1353
SHA-1	FIPS 180-2	Secure Hash Algorithm	160	912
MD5	RFC 1321	Message Digest MD5	128	1428

Notes:
1. Wrapper functions are used in combination with the underlying basic encryption and/or decryption functions for the respective algorithm (AES,T-DES).
2. All library functions use the stack and require input and output message buffers to be set up by the calling application, stack usage is below 60 bytes of RAM.
3. AES and T-DES data rate represents the average of the data rates for performing basic encryption and decryption functions for a single block of data.
4. All data rate statistics shown here assume device operation of 40 MIPS.

Triple DES/AES Encryption Libraries Part Number: SW300052

Summary

Microchip offers a reliable security solution for embedded applications built on the 16-bit and 32-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). These algorithms are also recommended by most Internet Engineering Task Force (IETF), Federal Information Processing Standards (FIPS) and IPSec standards.

Key Features

- 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

Applications

- Web access
- E-mail
- Secure XML transactions
- Virtual Private Networks (VPN)
- Secure transfer of stored calibration data

Cryptographic Functions: 16-bit MCUs and DSCs

Cryptographic Algorithm	Applicable Specification	Cryptographic Function(1)	Code Size (bytes)	Data Rate(2) (Kbps)
T-DES	FIPS 46-3	Basic Encryption and Decryption	7500	19.8 (16 MIPs) 49.5 (40 MIPs)
AES (128-bit)	FIPS 197	Basic Encryption	3018	74.1 (16 MIPs) 184.7 (40 MIPs)

Notes: 1. Wrapper functions are used in combination with the underlying basic encryption and/or decryption functions for the respective algorithm (AES,T-DES).
2. AES and T-DES data rate represents the average of the data rates for performing basic encryption and decryption functions for a single block of data.

Cryptographic Functions: 32-bit MCUs

Cryptographic Algorithm	Cryptographic Function	CPU Cycle Times in µSecs(1,2)	Throughput (Kbytes/Sec)
AES (128-bit)	Create Session Key	40.45	764
	Encrypt Block	20.45	
	Decrypt Block	20.45	
AES (128-bit)	Create Session Key	48.83	634.4
	Encrypt Block	24.63	
	Decrypt Block	24.63	
AES (128-bit)	Create Session Key	57.68	544.4
	Encrypt Block	28.70	
	Decrypt Block	28.70	

AES Library for PIC32 MCUs Memory Usage:
With MIPS32 Instructions: 14.9 KB
With MIPS16 Instructions: 13.9 KB

Notes: 1. Speed (Time) optimized -03 loops unrolled.
2. PIC32 running at 80 MHz.

FREE dsPIC® DSC DSP Library

Summary

The dsPIC® DSC DSP Library provides a set of speed optimized functions for the most common digital signal processing applications. This 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 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.

Key Features

- 49 total functions
- Full compliance with the Microchip MPLAB® C Compiler for PIC24 MCUs and dsPIC DSCs, assembler and linker
- Functions are both C and assembly callable
- FIR filtering functions include support for lattice, decimating, interpolating and LMS filters
- IIR filtering functions include support for canonic, transposed canonic and lattice filters
- FIR and IIR functions may be used with the filter files generated by the dsPIC® DSC Digital Filter Design Tool
- Transform functions include support for in-place and out-of-place DCT, FFT and IFFT transforms
- Window functions include support for Bartlett, Blackman, Hamming, Hanning and Kaiser windows
- Support for program space visibility
- Complete function profile information including register usage, cycle count and function size information

The dsPIC DSC DSP Library provides functions for the following:

- Vector operations
- Matrix operations
- Filtering operations
- Transform operations
- Windows operations

Function	Cycle Count Equation	Conditions*	Number of Cycles	Execution Time @40 MIPS
16-bit Complex FFT**	–	N=64	3739	93.5 µs
16-bit Complex FFT**	–	N=128	8485	212.1 µs
16-bit Complex FFT**	–	N=256	19055	476.4 µs
32-bit Complex FFT**	–	N=64	14293	357.325 µs
32-bit Complex FFT**	–	N=128	32781	819.525 µs
32-bit Complex FFT**	–	N=256	74181	1854.525 µs
Single Tap FIR	–	–	1	25 ns
Block FIR	53+N(4+M)	N=32, M=32	1205	30.2 µs
Block FIR Lattice	41+N(4+7M)	N=32, M=32	7337	183.5 µs
Block 16-bit IIR Canonic	36+N(8+7S)	N=32, S=4	1188	29.7 µs
Block 32-bit IIR Canonic	43+N(49+197S)	N=32, S=4	26827	670.7 µs
Block IIR Lattice	46+N(16+7M)	N=32, M=8	2350	58.7 µs
Matrix Add	20+3(C*R)	C=8, R=8	212	5.3 µs
Matrix Transpose	16+C(6+3(R-1))	C=8, R=8	232	5.8 µs
Vector Dot Product	17+3N	N=32	113	2.9 µs
Vector Max	19+7(N-2)	N=32	229	5.7 µs
Vector Multiply	17+4N	N=32	145	3.6 µs
Vector Power	16+2N	N=32	80	2.0 µs

*C = # columns, N = # samples, M = # taps, S = # sections, R = # rows
**Complex FFT routine inherently prevents overflow.
1 cycle = 25 nanoseconds @ 40 MIPS

FREE PIC32 DSP Library

Summary

Microchip's new PIC32 DSP Library enables developers to add DSP capabilities to many applications by taking advantage of the highly optimized hardware features inside the PIC32 MCU, including its multiply-accumulate, math unit with parallel execution and two full sets of CPU registers. Additionally, this DSP Library's use of a RADIX-2 based FFT provides more options for sample size than the RADIX-4 designs. The PIC32 DSP Library allows users to select from the common 64-, 128-, 256-, 512- and 1024-point FFTs, as well as other sizes. Microchip's PIC32 DSP Library also includes support for 32-bit FFTs. PIC32 DSP Library is a part of Microchip's free DSP Library package in MPLAB C Compiler for PIC32 MCUs.

Key Features

- C callable DSP functions written in assembly using the standard MIPS DSP library APIs
- Easier FFT – eliminates setup function
- Complete function profile information including register usage, cycle count and function size information

FFT Benchmarks (Radix-2)
Measured on PIC32 MCUs @ 80 MHz

16-bit, 256 point	283 µS
16-bit, 512 point	630 µS
16-bit, 1024 point	1.39 mS
32-bit, 512 point	617 µS

The PIC32 DSP Library provides functions for the following:

- 16- and 32-bit Vector Math
- Finite Impulse Response (FIR) Filter
- Infinite Impulse Response (IIR) Filter
- Least Mean Squares (LMS) Filter
- 16- and 32-bit Fast Fourier Transforms (FFTs)

FREE PIC24/dsPIC® DSC Floating Point Math Library

Summary

The PIC24/dsPIC® DSC Math Library is the compiled version of the math library that is distributed with the highly optimized, ANSI-compliant MPLAB® C Compiler for PIC24 MCUs and dsPIC DSCs (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.

Key Features

- The PIC24/dsPIC DSC Math Library is callable from either MPLAB C Compiler or PIC24/dsPIC DSC Assembly language
- The functions are IEEE-754 compliant, 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

Math Table

Function Group	Function	Performance (Cycles)(1, 2, 3)
Basic Floating Point	add	101
	sub	121
	mul	81
	div	197
Trigonometric and Hyperbolic	sinf	645
	sinhf	1817
	asinf	647
	cosf	634
	acosf	701
	coshf	3593
	tanf	2795
	tanhf	1070
	atanf	585
	atan2f	2719
Logarithmic and Exponential	logf	661
	log10f	713
	expf	617
	frexpf	39
	ldexpf	44
Power Functions	powf	7494
	sqrtf	492
Rounding Functions	floorf	128
	ceilf	199
Absolute Value Functions	fabsf	5
Modular Arithmetic Functions	fmodf	159
	modff	257

Notes: 1. Results are based on using the MPLAB C Compiler (SW006012) version 3.21 and represent an average.
2. All performance statistics represented here are for 32-bit IEEE-754 floating-point input and output data types.
3. Performance listed represent an average number of instruction cycles required to perform the floating-point operation.

FREE PIC24/dsPIC® DSC Fixed Point Math Library

Summary

TThe Fixed Point Math library provides mathematical functions useful in for wide range of applications including Motor Control, Digital Power Control, Digital Signal Processing and General purpose real-time control using fractional data types. The Fixed Point math library includes over 65 general-purpose functions composed of twenty eight functions supporting Q15 math and thirty seven functions supporting Q16 math.

Key Features

- Integrated with MPLAB C Compiler for PIC 24 MCUs and dsPIC DSCs
- Q15 (0.15) and Q16 (15.16) formats are provided in library
- Q15 format supports numerical data ranges from -32768 to 32767
- Q16 format supports numerical data ranges from -2147483648 to 2147483647
- The IQ math functions are callable from both ‘C’ and Assembly

FREE PIC32 Floating Point Math Library

Summary

The optimized PIC32 Math Library is packaged within the MPLAB C Compiler for PIC32 MCUs. The floating-point math library provided with the compiler has been significantly optimized to take full advantage of the PIC32 MCU instruction set. Single-precision and double precision math library functions are now available, giving users a choice between double- and single-precision operations. The library provides the greatest benefit for the more complex operations offering a greater than 5x performance improvement over the previous versions of library for many operations.

Key Features

- 22 optimized math library functions for faster execution and less power consumption
- Available in single or double precision
- The functions are ANSI-89 compliant
- IEEE-754 Compliant

FREE PIC24/dsPIC® DSC Peripheral Library

Summary

The PIC24/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 PIC24 microcontrollers and dsPIC DSCs, as well as functions for interfacing with an external LCD.

Key Features

- A library file for each device from the PIC24/dsPIC DSC families, including functions corresponding to peripherals present in that particular device.
- C include files that enable pre-defined constants for passing parameters to various library functions, as well as a file for each peripheral module.
- Functions in pre-compiled libraries that may be called from an application program written in either MPLAB® C Compiler for PIC24 MCUs and dsPIC DSCs or PIC24/dsPIC DSC assembly languages.
- C source code is included to customize functions to specific application requirements.
- Pre-defined constants in the C include files eliminate the need to refer to the details and structure of every special function register, while initializing peripherals or checking status bits.
- API Compatible with PIC32

The PIC24/dsPIC DSC Peripheral Library supports the following hardware peripheral modules:

- Timers
- Input capture and Output compare
- Quadrature Encoder Interface (QEI)
- Power Supply and 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/12-bit A/D converter
- Digital-to-Analog Converter (DAC)
- Analog Comparator
- CAN
- Functions for controlling an external LCD through configurable I/O port pins are also provided
- Parallel Master Port

FREE PIC32 Peripheral Library

Summary

PIC32 Peripheral Library provides functions and macros for setting up and controlling the 32-bit peripherals. Applications wishing to use peripheral libraries need to include one single file in their source file <plib.h> to access any of the supported functions and macros.

The PIC32 Peripheral Library supports the following peripheral module functions:

- System level fuction
- Prefetch cache
- DMA
- Bus matrix function
- Reset/control, power saving functions
- Oscillator, Timer, Input Capture/Output Compare
- I/O ports and external interrupts
- PMP function
- UART, SPI, I²C™, CAN, Ethernet and USB functions
- RTCC functions
- 10-bit/A/D converter
- Comparator, Watch dog
- CVREF
- Watchdog timer

Key Features

- Peripheral Library is optimized for faster execution and lower code memory
- One single peripheral library file to access many peripheral module functions
- C include files that enable pre-defined constants for passing parameters to various library functions, as well as a file for each peripheral module
- Functions in pre-compiled libraries that may be called from an application program written in either MPLAB C Compiler for PIC32 MCUs or PIC32 assembly languages
- C source code is included to customize functions to specific application requirements
- Pre-defined constants in the C include files eliminate the need to refer to the details and structure of every special function register, while initializing peripherals or checking status bits
- API Compatible with 16-bit devices

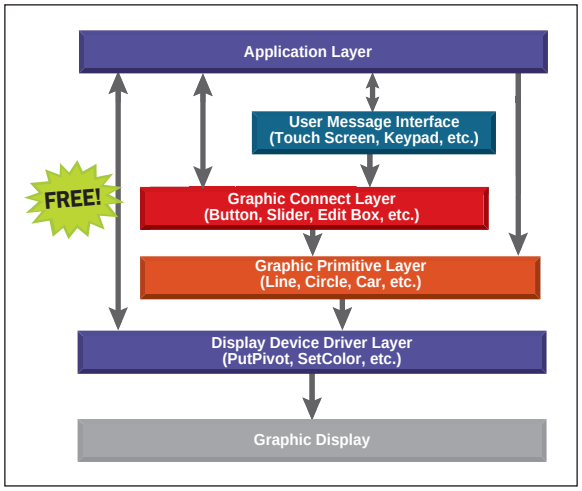
FREE Microchip Graphics Library

Summary

Microchip provides a complete Graphics Library that allows users to quickly and easily implement a Graphical User Interface (GUI) on small color touch screen displays. The complete graphics display solution that will enable designer to quickly evaluate a graphics display solution at minimal cost. Graphics Library is highly modular and is optimized for Microchip's 16- and 32-bit microcontrollers (PIC24F, PIC24H, dsPIC33 and PIC32 MCUs).

Key Features

- Up to 16-bit or 65K colors
- 2D objects such as line, circle, text, rectangle, polygon, bar
- 3D objects such as buttons, panels, window, group box, slider
- Image, animation
- Resistive touch screen, keypad
- Multiple fonts



Applications

- MIMIC panels
- Hand-held devices
- Many other applications that require front-end graphics display

FREE Microchip TCP/IP Stack

Summary

Communication over the Internet is accomplished by implementing the TCP/IP protocol. Microchip offers a free TCP/IP software stack that is optimized for the PIC18, 16-bit and 32-bit device family. 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. Microchip's TCP/IP stack supports the PIC32MX6/7 32-bit MCU family with Ethernet MAC and the PIC18F97J60 family of 8-bit microcontrollers with Ethernet MAC and PHY and ENC28J60/ENC624J600 stand alone Ethernet controllers.

Key Features

- Socket support for TCP and UDP
- Portable across all PIC18, PIC24, dsPIC30F, dsPIC33F and PIC32MX products
- Support for MPLAB C compilers and HI-TECH C®, HI-TECH PICC-18® and HI-TECH PRO compilers
- RTOS independent
- Full TCP state machine
- Modular design

Supported Protocols

- ARP
- ICMP
- TCP
- SNMP
- Telnet
- SMTP
- DHCP
- NBNS
- IP
- UDP
- Shout Cast
- HTTP
- SNTP
- DNS
- FTP
- TFTP

Additional Algorithm Support

- MD5 and SHA-1 Hashing
- MIME
- MPFS
- Base 64
- Secure Random Number

Applications

- Streaming MP3 internet radio
- UART to TCP bridge
- Ethernet/Internet bootloader
- Web monitorable and configurable vending machine
- Remote Sensor Monitoring and Control

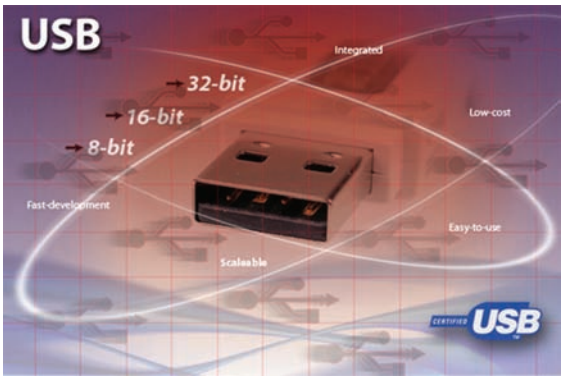
Microchip USB Framework

Summary

Microchip's USB software supports USB on 8-, 16- and 32-bit MCUs. This software is royalty free source code and also includes example projects. The 8-bit PIC18 family supports USB device mode. The 16-bit PIC24F and 32-bit PIC32 products with USB support device mode, embedded host and On-The-Go.

Key Features

- Supports 8-bit, 16-bit and 32-bit PIC® MCUs
- Includes related drivers and resources to use with PC
- Includes various demonstration examples
- Includes class driver examples for:
  - HID
  - Mass Storage
  - CDC
  - Audio
  - Printer
  - Charger
  - Custom



Applications

- USB mouse and keypad
- Thumb drive data logger
- Mass storage devices
- Printers
- Bar code scanner
- CDC serial emulator

IEEE-802.15.4: Microchip MiWi™ and MiWi P2P Protocol

Summary

MiWi™ and MiWi P2P are proprietary protocol stacks developed by Microchip for short-range wireless networking applications based on the IEEE-802.15.4™ wireless personal area network (WPAN) specification. The MiWi protocol stacks are optimized for low-power, low data rate, cost sensitive application and offer a small foot-print alternative to the standard based ZigBee® compliant protocol stack. This protocol stack supports 8-bit, 16-bit and 32-bit PIC® MCUs and dsPIC DSCs.

MiWi

- Microchip wireless proprietary protocol stack
- Based on IEEE-802.15.4 standard
- Small footprint, highly optimized Mesh and Star network protocol

MiWi™

Your wireless connectivity made simple.

MiWi P2P

- Microchip wireless proprietary peer-to-peer protocol stack
- Based on IEEE-802.15.4 standard
- Ultra-Small footprint (3 KB), Peer-to-Peer network protocol

Applications

- Data loggers
- Security systems
- Display controllers
- Photo display frames

IEEE-802.15.4: ZigBee® , ZigBee PRO and ZigBee Smart Energy Profile Suite

Summary

As a member of the ZigBee Alliance, Microchip offers certified ZigBee Compliant Platform (ZCP) for the ZigBee® 2006, ZigBee PRO and ZigBee Smart Energy Suite protocol stacks.

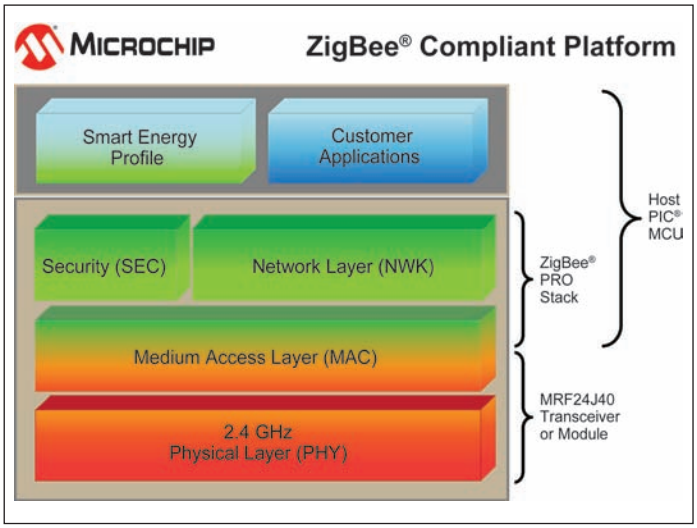
Key Features

ZigBee Smart Energy Profile Suite

- Support for the following Smart Energy devices:
  - Energy Service Portal (ESP)
  - Meter(MTR)
  - In Premise Display (IPD)
  - Load Control Device (LCD)
  - Programmable Communicating Thermostat (PCT)
  - Smart Appliance (SAP)
  - Range Extender (RED)
- Support for Certificate Based Key Exchange (CBKE) Security Mechanism.
- The ZigBee Cluster Library (ZCL) (SE Profile clusters only)
- Support for Commissioning via the Startup Attribute Set (SAS)
- Portable across the PIC24, PIC32MX MCUs and dsPIC DSCs

ZigBee PRO

- Microchip's Certified ZigBee PRO Compliant Platform (ZCP)
  - Certified ZigBee PRO Stack
  - PIC24 MCUs or dsPIC® DSC family of microcontrollers
  - MRF24J40, MRF24J40MA, MRF24J40MB 2.4 GHz IEEE-802.15.4 transceiver/modules
- Full Featured, Interoperable, Mesh and Star Network protocol



ZigBee 2006

- Zero-cost-license and royalty-free ZigBee 2006 protocol stack.
- Microchip's Certified ZigBee 2006 Compliant Platform (ZCP)
  - Certified ZigBee 2006 Stack
  - PIC18 or PIC24 MCUs or dsPIC DSCs
  - MRF24J40, MRF24J40MA, MRF24J40MB 2.4 GHz IEEE-802.15.4 transceiver/modules
- Full Featured, Interoperable, Mesh and Star Network protocol

Applications

- Data loggers
- Security systems
- Display controllers
- Photo display frames

PIC32 CAN Library Using MCP2515 CAN Controller*

Summary

PIC32 CAN library is based on the MCP2515 CAN controller. The MCP2515 is connected to the PIC32 microcontroller via SPI port. The Library provides seamless access to the CAN controller over the SPI bus.

Key Features

- Library provides enumerated interface
- Well-documented API functions
- The library supports 125 kbps, 250 kbps and 500 kbps bus speeds.
- The MCP2515 support max SPI clock speed of 10 MHz

Applications

- Automotive applications
- Data loggers
- Physical layer for custom communication protocols

**This library is not for use with PIC32 MCUs with integrated CAN controllers. The CAN APIs for integrated CAN controllers are available in the MPLAB C Compiler.*

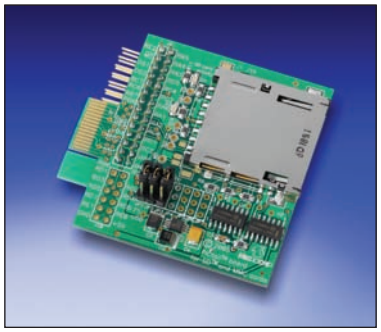
Microchip FAT File System for PIC24 & PIC32 MCUs and dsPIC® DSCs

Summary

Microchip's FAT file system interface library brings the ability to transfer and share portable memory devices between and embedded system and a personal computer. Most SD cards, CF cards and MultiMedia Cards (MMCs), particularly those sized below 2 GB, use the FAT16 standard. The FAT32 standard can be used to address memory sized between 2 GB and 2 terabytes. This library with complimentary application note provides a method to read and/or write to these storage devices through a microcontroller. The data of these storage devices can be read by a PC, and the data written by a PC can be read by a microcontroller. Most operating systems (i.e., Windows® XP) support the FAT16 and FAT32 file systems.

Key Features

- Based on ISO/IEC 9293 specifications
- Provides a method of interfacing to files and directories on FAT12, FAT16 and FAT32 file systems.
- FAT16 and FAT32 allow access to up to 2 GB and 2 terabytes of memory, respectively



PICtail Plus Daughter Board for SD & MMC Cards
Part Number: AC164122

- Most popular file system with SecureDigital (SD) cards, CompactFlash® (CF) cards and USB thumb drives
- Hardware evaluation supported by PICtail Plus® SD & MMC Daughter Card and USB PICtail Plus Daughter Card

Applications

- Data loggers
- Security systems
- Display controllers
- Photo display frames

FREE FATFs File System for PIC32 MCUs

Summary

FATFs is an open source file system software stack designed for microcontrollers to easily access multiple media sources during run-time. This small footprint low-overhead software supports FAT 32, FAT 16 and FAT 12 formats using an 8.3 file name format. FatFs can be modified to use multiple media sources (ATA, USD, SD Card, etc.). FatFs is an open source module that can be used, modified, and/or republished for personal, non-profit, education, R&D or commercial use without any restriction.

Key Features

- Large number of media drive support and easy drive addition
- Write buffer flushing
- Compile time options to minimize memory footprint
- Simultaneous multiple media access
- Application software control of file structure
- No pre-defined limit to the number of files structures that can be used

Applications

- Data loggers
- Security systems
- Display controllers
- Photo display frames

FREE Data EEPROM Emulation for PIC18, PIC24 & PIC32 MCUs and dsPIC® DSCs

Ref Application Note: AN1095 · Ready-to-Use Solution

Summary

Microchip has expanded its product portfolio to include a wide variety of cost-effective PIC® microcontrollers without an internal data EEPROM. Many applications store non-volatile information in the Flash program memory using table write and read operations. Applications that need to frequently update this data may have greater endurance requirements than the specified Flash endurance for the device. The alternate solution of using an external, serial EEPROM device may not be appropriate for cost-sensitive or pin-constrained applications. This application library presents a third alternative that addresses these issues. This algorithm features an interface similar to an internal data EEPROM, uses available program memory and can improve endurance by a factor as high as 500.

Key Features

- Easy to use application interface
- Memory sizes of 0 to 255 words per block
- Total EEPROM memory size limited only by Flash size
- Endurance increased by a factor of up to 500
- Endurance can be further increased by allocating additional program memory

Applications

- Applications which require to store user definable parameters
- Frequently updated calibration or adjustable parameters
- Saving critical data due to power failure

PMBus Stack

Summary

Microchip PMBus stack implements the PMBus protocol over the traditional I²C™ communication interface for dsPIC® SMPS Digital Signal Controllers from dsPIC33F "GS" family and Mid-Range PIC® microcontrollers from the PIC16F88X family. PMBus is an open standard protocol that was defined as a means of communication with power conversion and other devices, thus creating the first open communications standard in the world of digital control over power devices and systems. PMBus is a superset of the System Management Bus (SMBus™), an industry standard serial communication interface.

Key Features

- Modular software and easy integration with application code
- On/Off control
- Sequencing: event driven and time driven status reporting
- Fault management

Applications

- Communication between two power stages
- Communication interface for external world
- AC-DC power supply
- Isolated/Non isolated DC-DC power supply
- Power factor correction
- Fan controllers, temperature sensors

Class B Safety Software Library for PIC® MCUs and dsPIC® DSCs

Ref Application Note: AN1229 · Ready-to-Use Solution

Summary

The Class B Safety Software Library routine detects the occurrence of Faults in a single channel CPU. These routines have been developed in accordance with the IEC 60730 standard to support the Class B certification process. These routines can be directly integrated with the end user's application to test and verify the critical functionalities of a controller without affecting the end user's application. The Application Note, AN1229 describes the Application Programming Interface (API) functions that are available in the Class B Safety Software Library.

Key Features

The following tests can be implemented using this library:

- CPU Register Test
- Program Counter Test
- Variable Memory Test
- Invariable Memory (Flash/EEPROM) Test
- Interrupt Test
- Clock Test

Applications

- Automotive applications
- Home appliances
- Home security devices

Application Solutions

Application	Document Title	Application Note Number
Motor Control	Sensorless BLDC Motor Control Using the dsPIC30F or dsPIC33F	AN901
	Using the dsPIC30F or dsPIC33F for Vector Control of an ACIM	AN908
	Sensored BLDC Motor Control Using the dsPIC30F or dsPIC33F	AN957
	Introduction to AC Induction Motor Control Using the dsPIC30F or dsPIC33F	AN984
	Using the dsPIC30F for Sensorless BLDC Motor Control	AN992
	Sinusoidal Control of PMSM Motors with dsPIC30F or dsPIC33F	AN1017
	Sensorless BLDC Control with Back EMF Filtering Using dsPIC® DSC	AN1083
	Sensorless Field-oriented Control for PMSM Motors	AN1078
	Power Factor Correction Using dsPIC® DSC	AN1106
	Sensorless BLDC Control with Back EMF Filtering Using a Majority Function	AN1160
	Sensorless Field Oriented Control (FOC) of an AC Induction Motor (ACIM)	AN1162
	Sensorless Field Oriented Control (FOC) of an AC Induction Motor (ACIM) Using Field Weakening	AN1206
	Integrated Power Factor Correction (PFC) and Sensorless Field Oriented Control (FOC) System	AN1208
	Sensorless Field Oriented Control for a Permanent Magnet Synchronous Motor (PMSM) Using PLL Estimator and Field Weakening	AN1292
	Single-Shunt Three-Phase Current Reconstruction Algorithm for Sensorless FOC of a PMSM	AN1299
	Stepper Motor Control with dsPIC® DSCs	AN1307
Wired and Wireless Connectivity	HTTP Server Using BSD Socket API for PIC32MX	AN1107
	Microchip TCP/IP Stack with BSD Socket API	AN1108
	SNMP Agent Using BSD Socket API for PIC32MX	AN1109
	FTP Server Using BSD Socket API for the PIC32MX	AN1111
	ECAN Operation with DMA on dsPIC33F and PIC24H Devices	AN1249
	IrDA® Standard Stack	AN1071
Digital Power	AC-DC Reference Design	User's Guide: DS70320 AN1114, AN1207
	Offline UPS Reference Design	AN1279
	Digital Power Interleaved PFC Reference Design	AN1278
Boot Loader	Bootloader for dsPIC30F/33F and PIC24F/24H Devices	AN1094
	Serial Boot Loader for PIC32 MCUs	Ref: AN851
Graphics	Graphics Display Solution	AN1136
General Purpose	Implementing Digital Lock-In Amplifiers Using the dsPIC® DSC	AN1115
	File I/O Functions Using Memory Disk Drive File System Library	AN1045

Application Solution: Sensorless BLDC Motor Control Using the dsPIC30F or dsPIC33F

Application Note: AN901 · Ready-to-Use Solution

Proven Software Source Code

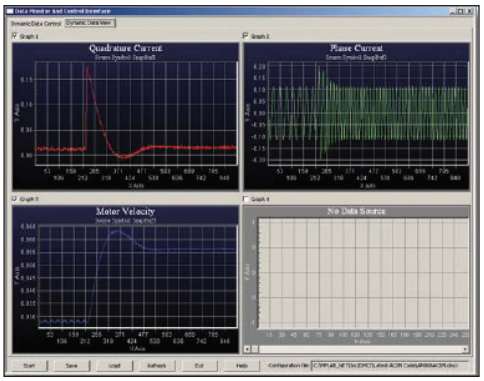
Summary

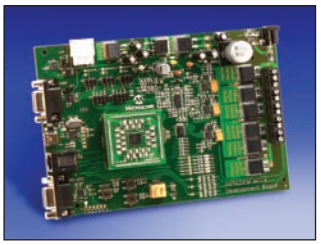
Microchip provides a proven, fully functional and highly flexible solution for using the dsPIC30F/33F to control Brushless DC (BLDC) motors without Hall-effect position sensors. The software makes extensive use of dsPIC30F/33F peripherals for motor control. The algorithm implemented for sensorless control is particularly suitable for use on fans and pumps. The program is written in C and has been specifically optimized and well-annotated for ease of understanding and program modification/configuration.

Capabilities of this Application Solution:

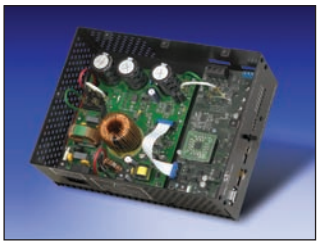
- Current control and speed control modes
- Back EMF zero-crossing routine precludes the need for position sensing components
- Good transient response
- Can run the motor as low as 200 RPM
- Supports breaking features
- Remote control through UART
- Program code size: 15 KB of program Flash memory
- RAM size: 276 bytes of data RAM memory

DMCI Graphical Data Display





dsPICDEM™ MCLV Development Board
Part Number: DM330021



dsPICDEM™ MCHV Development Board
Part Number: DM330023

Application Solution: Using the dsPIC30F or dsPIC33F for Vector Control of an ACIM

Application Note: AN908 · Ready-to-Use Solution

Proven Software Source Code

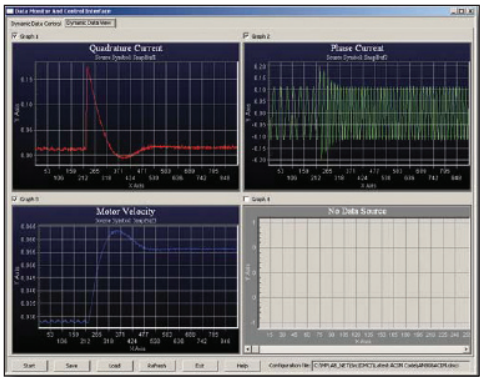
Summary

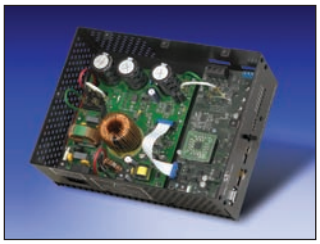
Microchip's AC Induction Motor (ACIM) vector control solution is written for the dsPIC30F/33F family of devices. The software makes extensive use of dsPIC30F/33F peripherals for motor control. The software implements vector control of an ACIM, using the indirect flux control method. The program is written in C and has been specifically optimized and well annotated for ease of understanding and program modification.

Capabilities of this Application Solution:

- 50 µsec control loop period
- Requires approximately 9 MIPS of CPU usage (less than one-third of the total available CPU)
- Optional diagnostic mode can be enabled to allow real time observation of internal program variables on DMCI/RTDM
- Easy control loop adjustment through DMCI/RTDM
- Program code size: 8 KB of program Flash memory
- RAM size: 512 bytes of data RAM memory

DMCI Graphical Data Display





dsPICDEM™ MCHV Development Board
Part Number: DM330023

Application Solution: Sensored BLDC Motor Control Using the dsPIC30F or dsPIC33F

Application Note: AN957 · Ready-to-Use Solution

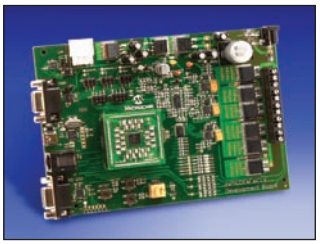
Proven Software Source Code

Summary

Microchip provides a fully working and highly flexible solution to control Brushless DC (BLDC) motors with Hall-effect position sensors. The software makes extensive use of dsPIC30F/33F peripherals for motor control. The program is written in C and has been specifically optimized and well annotated for ease of understanding and program modification.

Capabilities of this Application Solution:

- Source code provides both open-loop control and closed-loop control algorithms
- Potentiometer for speed control
- Program code size: 2 KB of program Flash memory
- RAM size: 180 bytes of data RAM memory



dsPICDEM™ MCLV Development Board
Part Number: DM330021

dsPICDEM™ MCHV Development Board
Part Number: DM330023

Application Solution: An Introduction to AC Induction Motor Control Using the dsPIC30F or dsPIC33F

Application Note: AN984 · Ready-to-Use Solution

Proven Software Source Code

Summary

This application solution demonstrates how to use the dsPIC30F/33F to control an AC Induction Motor (ACIM). The solution presented requires a basic understanding of ACIM characteristics and is based on the dsPICDEM™ MCHV Development Board. The program is written in assembly code and has been specifically optimized and well annotated for ease of understanding and program modification. It provides basic variable speed control of an ACIM in open-loop Volts/Hertz mode.

Capabilities of this Application Solution:

- Supports Sinusoidal waveforms for motor drive
- Provides volts-hertz drive operation for various torque profiles
- Program code size: 1200 bytes of program Flash memory
- RAM size: 86 bytes of data RAM memory

dsPICDEM™ MCHV Development Board
Part Number: DM330023

Application Solution: Using the dsPIC30F for Sensorless BLDC Motor Control

Application Note: AN992 · Ready-to-Use Solution

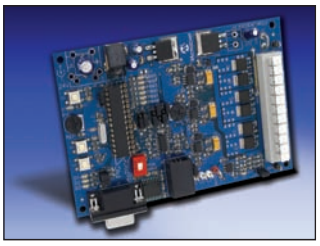
Proven Software Source Code

Summary

This application note provides a fully working and highly flexible solution for using the dsPIC30F2010, dsPIC30F3010 or dsPIC30F4012 to control BLDC sensorless motors without mechanical position sensors. The software makes extensive use of dsPIC30F peripherals for motor control. The algorithm implemented for sensorless control is particularly suitable for use on fans and pumps. The program is written in C and has been specifically optimized and well annotated for ease of understanding and programming.

Capabilities of this Application Solution:

- Based on Application Note AN901
- Uses a potentiometer to select the motor speed



PICDEM™ MC LV Motor Control Development Board
Part Number: DM183021

- A user interface is available to provide control of up to 45 control parameters
- Program code size: 10 Kbytes of program Flash memory
- RAM size: 300 bytes of data RAM memory

Application Solution: Sinusoidal Control of PMSM Motors with dsPIC30F or dsPIC33F

Application Note: AN1017 · Ready-to-Use Solution

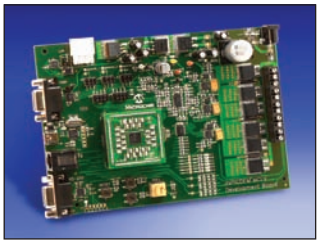
Proven Software Source Code

Summary

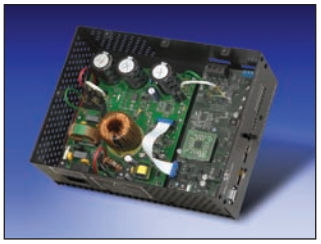
Application note AN1017 provides a fully working and highly flexible solution for using the dsPIC® Motor Control DSCs to control Brushless DC (BLDC) motors with the use of Hall-effect position sensors and sinusoidal commutation. The software makes extensive use of dsPIC30F/dsPIC33F peripherals for motor control. The program is written in C and has been specifically optimized and well annotated for ease of understanding and program modification.

Capabilities of this Application Solution:

- Potentiometer for speed control
- Sinusoidal control with Space-Vector Modulation (SVM)
- Optimized PID implementation
- Program code size: 2 KB of program Flash memory
- RAM size: 180 bytes of data RAM memory



dsPICDEM™ MCLV Development Board
Part Number: DM330021



dsPICDEM™ MCHV Development Board
Part Number: DM330023

Application Solution: Sensorless BLDC Control with Back EMF Filtering Using dsPIC® DSC

Application Note: AN1083 · Ready-to-Use Solution

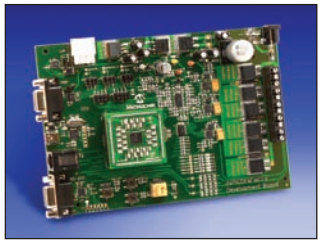
Proven Software Source Code

Summary

This application note describes a sensorless brushless DC (BLDC) motor control algorithm, implemented using the dsPIC® DSC. Back EMF signals are digitally filtered to have a smoother signal used to commutate the motor. This solution is suitable for high speed BLDC applications.

Capabilities of this Application Solution:

- Sensorless BLDC operation with six step control
- Back EMF filtering with 10th order software IIR
- Implementation on dsPIC30F and dsPIC33F family of products
- Highly flexible start-up sequence
- Speed closed loop operation with PI control
- Program code size: 6 Kbytes
- RAM used: 280 bytes
- CPU usage: 21 MIPS



dsPICDEM™ MCLV Development Board
Part Number: DM330021

Application Solution: Sensorless Field-Oriented Control for PMSM Motors

Application Note: AN1078 · Ready-to-Use Solution

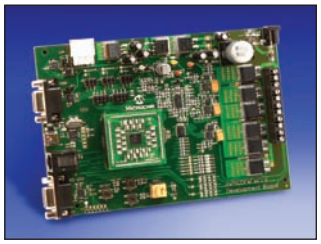
Proven Software Source Code

Summary

The implementation of advanced, cost-effective motor control is made easy with dsPIC Digital Signal Controllers (DSCs). This solution presents a Sensorless FOC control for PMSM motors and helps to develop energy efficient air conditioners, washing machines and other home appliances.

Capabilities of this Application Solution:

- Position and speed estimation using slide mode controller
- Low cost current sensing using two shunt resistors
- 8 kHz and 20 kHz PWM switching frequency
- Implementation on dsPIC30F and dsPIC33F family of products
- Angle estimation compensation
- Field weakening enables higher speed operation



dsPICDEM™ MCLV Development Board Part Number: DM330021

dsPICDEM™ MCHV Development Board Part Number: DM330023

- Three PI control loops for speed and current components for torque and flux
- Program code size: 6 Kbytes
- RAM used: 0.5 Kbytes
- CPU usage: 11 MIPS with control loops at 8 kHz, and 21 MIPS with 20 kHz control loops

Application Solution: Power Factor Correction Using dsPIC® DSC

Application Note: AN1106 · Ready-to-Use Solution

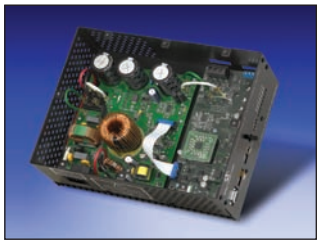
Proven Software Source Code

Summary

Many applications in the areas of motor control, power control, Uninterruptible Power Supplies (UPS) and Switched Mode Power Supplies (SMPS) demand a stable, regulated DC power source with reduced input current harmonic content and better power factor. The application solution describes the efficient Average Current Mode Control using a dsPIC® DSC to implement Power Factor Correction (PFC).

Capabilities of this Application Solution:

- Power factor correction up to 0.99
- Implementation using Output Compare or Motor Control PWM modules
- Implementation on dsPIC30F and dsPIC33F family of products
- Voltage feed forward compensator implementation to improve stability
- Voltage and current PI control loops for better dynamic response



dsPICDEM™ MCHV Development Board Part Number: DM330023

- User configurable switching frequency, default frequency of 80 kHz
- Synchronization of PWM and ADC allowing low cost current sensing
- Program code size: 2 Kbytes
- RAM used: 142 bytes
- CPU usage: 10 MIPS

Application Solution: Sensorless BLDC Control with Back EMF Filtering Using a Majority Function

Application Note: AN1160 · Ready-to-Use Solution

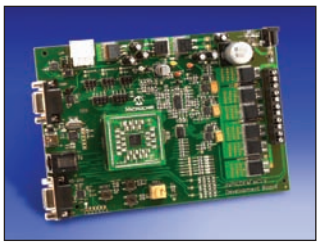
Proven Software Source Code

Summary

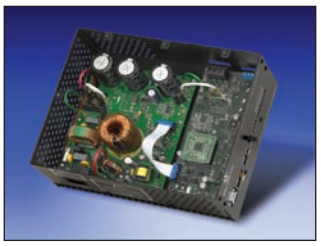
This application note describes a sensorless Brushless Direct Current (BLDC) motor control algorithm that is implemented using a dsPIC® DSC. The algorithm works utilizing a majority function for digitally filtering the Back-Electromotive Force (BEMF). Each phase of the motor is filtered to determine when to commutate the motor drive voltages. This control technique excludes the need for discrete, low-pass filtering hardware and off-chip comparators.

Capabilities of this Application Solution:

- Sensorless motor control
- Simple and easy to implement and lower board cost
- Can run the motors at very low speed



dsPICDEM™ MCLV Development Board Part Number: DM330021



dsPICDEM™ MCHV Development Board Part Number: DM330023

- Majority function helps to improve transient response of motor
- Majority detect algorithm greatly eases motor tuning process

Application Solution: Sensorless Field Oriented Control (FOC) of an AC Induction Motor (ACIM)

Application Note: AN1162 · Ready-to-Use Solution

Proven Software Source Code

Summary

Where efficiency and low cost control of the induction motor drive is a concern, the sensorless Field Oriented Control (FOC), also known as vector control provides the best solution. This application note provides a solution for sensorless Field Oriented Control (FOC) of induction motors using a dsPIC® Digital Signal Controller (DSC).

Capabilities of this Application Solution:

- FOC control of AC induction motor provides an improved transient response
- Sensorless FOC reduces cost of hardware and increases reliability
- FOC algorithm maintains a tighter control on performance of motor and hence preferred over simple V/F control

dsPICDEM™ MCHV Development Board
Part Number: DM330023

- Use of PLL estimator enables very low speed of operation of motor
- Improves efficiency of the system and reduces disturbances on the supply line

Application Solution: Sensorless Field Oriented Control (FOC) of an AC Induction Motor (ACIM) Using Field Weakening

Application Note: AN1206 · Ready-to-Use Solution

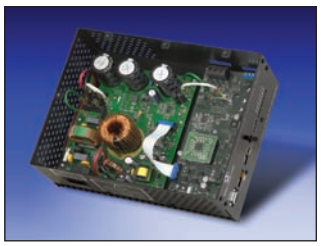
Proven Software Source Code

Summary

This application note describes sensorless Field oriented control with field weakening of an AC Induction motor using a dsPIC® Digital Signal Controller (DSC). This application note is an extension of AN1162: Sensorless Field Oriented Control (FOC) of an AC Induction Motor (ACIM).

Capabilities of this Application Solution:

- FOC control of AC induction motor provides an improved transient response
- Sensorless FOC reduces cost of hardware and increases reliability
- FOC algorithm maintains a tighter control on performance of motor and hence preferred over simple V/F control



dsPICDEM™ MCHV Development Board
Part Number: DM330023

- Use of PLL estimator enables very low speed of operation of motor
- Improves efficiency of system and reduce disturbance on supply line
- The motor can be run at speeds higher than nominal values

Application Solution: Integrated Power Factor Correction (PFC) and Sensorless Field Oriented Control (FOC) System

Application Note: AN1208 · Ready-to-Use Solution

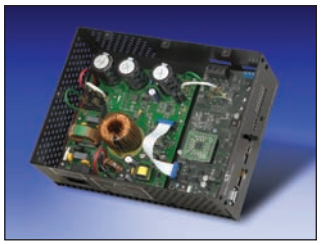
Proven Software Source Code

Summary

This application note describes the process of integrating two complex applications: PFC and Sensorless FOC. Harmonic content in input current can be reduced by implementing Power Factor Correction and efficient control of a motor can be realized using Sensor less Field Oriented Control (FOC) techniques. These applications are implemented on a Permanent Magnet Synchronous Motor. In addition, this application notes also describes the integration of algorithms, lists the necessary hardware requirements, and provides guide lines to optimize the development procedure.

Capabilities of this Application Solution:

- PFC Implemented to improve overall efficiency
- Reduced harmonics
- FOC control of AC induction motor provides an improved transient response



dsPICDEM™ MCHV Development Board
Part Number: DM330023

- Sensorless FOC reduces cost of hardware and increases reliability
- FOC algorithm maintains a tighter control on performance of motor and hence preferred over simple V/F control
- Uses a SMO estimator which is more tolerant to motor parameter variations than a PLL
- Improves efficiency of system and reduces disturbance on supply line

Application Solution: Sensorless Field Oriented Control for Permanent Magnet Synchronous Motor Using a PLL Estimator and Field Weakening

Application Note: AN1292 · Ready-to-Use Solution

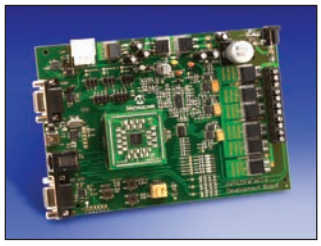
Proven Software Source Code

Summary

Application note presents a sensorless Field Oriented Control (FOC) for Permanent Magnet Synchronous Motor (PMSM) using a PLL type estimator. The novelty about this sensorless control approach is the speed and angle estimator implementation, with a simple but robust and versatile design, making it suitable for most of the PMSM motors. The estimation requires only 2 current shunts measurement, while the FOC assures separate control of torque and field current components – permitting Field Weakening (FW) technique to be applied.

Capabilities of this Application Solution:

- Use of PLL estimator enables very low speed of operation of motor
- Sensorless FOC reduces cost of hardware and increases reliability



dsPICDEM™ MCLV Development Board
Part Number: DM330021

dsPICDEM™ MCHV Development Board
Part Number: DM330023

- FOC algorithm maintains a tighter control on the performance of motor
- Use of field weakening extends the usable speed range of PMSM

Application Solution: Single-Shunt Three-Phase Current Reconstruction Algorithm for Sensorless FOC of a PMSM

Application Note: AN1299 · Ready-to-Use Solution

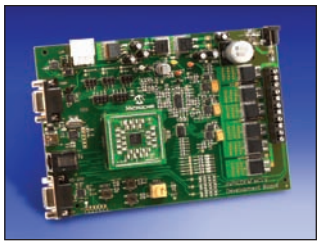
Proven Software Source Code

Summary

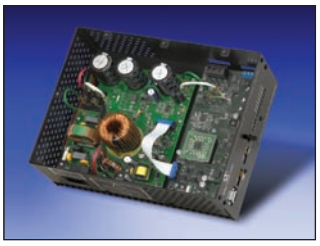
This dsPIC33F application note describes a motor control technique where a single-shunt resistor circuit used to measure the motor phase current. The algorithm reconstructs all three phase currents which are then used to estimate the rotor position in Sensorless Field Oriented Control (FOC) of Permanent Magnet Synchronous Motors (PMSM). This algorithm also corrects the PWM waveforms to compensate for the changes made to take the phase current readings.

Capabilities of this Application Solution:

- Lowest-cost FOC Sensorless PMSM solution
- Optimized torque response and energy efficiency benefits of FOC
- Trades off sensor cost for a slight decrease in efficiency



dsPICDEM™ MCLV Development Board Part Number: DM330021



dsPICDEM™ MCHV Development Board Part Number: DM330023

Application Solution: Stepper Motor Control with dsPIC® DSCs

Application Note: AN1307 · Ready-to-Use Solution

Proven Software Source Code

Summary

This application note describes how to drive a stepper motor with a dsPIC33F motor control family DSC. PWM outputs are used to control both unipolar and bipolar stepper motors. Full stepping, half-stepping or variable micro-stepping is supported, in open or closed loop mode with a variety of decay modes. The application note software includes a MPLAB IDE DMCI /RTDM file that providing an easy to use GUI for selecting the stepping mode, open or closed loop operation, the decay mode and a “step to position” command.

Capabilities of this Application Solution:

- Supports both unipolar and bipolar motor operation
- Open loop control (fixed current or fixed voltage)
- Closed loop PI current control
- Full-, half- and micro-stepping modes
- Supports multiple decay modes (fixed/alternating)
- Stepper motor control user GUI included

dsPICDEM™ MCSM Development Board	Part Number: DM330022
dsPICDEM™ MCSM Stepper Motor Development Board Kit	Part Number: DV330021

Application Solution: HTTP Server Using BSD Socket API for PIC32MX

Application Note: AN1107 · Ready-to-Use Solution

Proven Software Source Code

Summary

An embedded HTTP (Hyper Text Transfer Protocol) server, or web server is an excellent addition to any network-enabled device. HTTP server capability allows an embedded device to be monitored and controlled remotely using any standard, off-the-shelf Internet browser. Owing to the ubiquitous deployment of Internet browsers, a web-enabled device can be accessed from almost any computer – desktop or mobile. This Microchip HTTP server application note and the included FAT16 module, supplemented by the TCP/IP application note AN1108, "Microchip TCP/IP Stack with BSD Socket API", provide an HTTP Server module that can be integrated with almost any application on a Microchip 32-bit microcontroller product.

Capabilities of this Application Solution:

- Provides portability across the 32-bit family of PIC® microcontrollers
- HTTP Server APIs compatible with PIC18/PIC24 Microchip HTTP Server APIs

PIC32 Ethernet Starter Kit
Part Number: DM320004

- Supports multiple HTTP connections
- Automatic interaction with the FAT16 file system
- Supports the HTTP methods: GET, HEAD, POST and PUT
- Supports "continue" response that may be requested by the client
- Supports a modified Common Gateway Interface (CGI) to invoke predefined functions from within the remote browser
- Supports dynamic web page content generation
- Supports HTTP web page authentication

Application Solution: TCP/IP Stack with BSD Socket API

Application Note: AN1108 · Ready-to-Use Solution

Summary

This application note describes the Microchip TCP/IP stack with BSD Socket (Berkley Socket Distribution) API and provides the socket library for Internet TCP/IP communications. Many popular operating systems and many commercial TCP/IP stacks support BSD socket API. With a common programming interface, applications can now be ported easily across completely different platforms. For example, network applications written for a PC environment can also be compiled in an embedded environment, provided the embedded platform supplies the BSD library API. The demo applications included with this application note provide example client and server applications that use stream socket.

Capabilities of this Application Solution:

- Creating client/server applications in an embedded environment
- TCP/IP stack components and design

PIC32 Ethernet Starter Kit
Part Number: DM320004

- Socket functions included in the API
- Application can be a server or a client, or both
- Full duplex communication
- Stream and datagram socket support
- IP address resolution done in background
- Can be used with or without a kernel/RTOS

Application Solution: SNMP Agent Using BSD Socket API for PIC32MX

Application Note: AN1109 · Ready-to-Use Solution

Proven Software Source Code

Summary

This Microchip SNMP agent application note and the included FAT16 module, supplemented by the TCP/IP application note AN1108, “Microchip TCP/IP Stack with BSD Socket API”, provide an SNMP agent that can be integrated with almost any application on a Microchip 32-bit microcontroller products. The TCP/IP application note and the FAT16 module are required to compile and run the SNMP agent module. The software in the installation files includes a sample application that demonstrates all of the features offered by this SNMP agent module.

Capabilities of this Application Solution:

- Provides portability across the 32-bit family of PIC® microcontrollers
- SNMP agent APIs (Application Program Interfaces) are compatible with PIC18/24 SNMP agent APIs
- Functions independently of RTOS or application
- Supports Microchip’s MPLAB® C32 C Compiler
- Supports SNMP version 1 over UDP
- Supports Get, Get-Next, Set and Trap PDUs

PIC32 Ethernet Starter Kit
Part Number: DM320004

- Automatically handles access to constant OIDs
- Supports up to 255 dynamic OIDs and unlimited constant OIDs
- Supports sequence variables with 7-bit index
- Supports enterprise-specific trap with one variable information
- Uses an MIB that can be stored using FAT16
- Includes a PC-based MIB compiler
- Does not contain built-in TCP/UDP/IP statistics counters (user application must define and manage the required MIB)

Application Solution: FTP Server Using BSD Socket API for PIC32MX

Application Note: AN1111 · Ready-to-Use Solution

Proven Software Source Code

Summary

An embedded FTP (File Transfer Protocol) server is an excellent addition to any network-enabled device. FTP server capability facilitates the uploading of files to, and downloading of files from, an embedded device. Almost all computers have, at the very least, a command line FTP client that will allow a user to connect to an embedded FTP server. This Microchip FTP server application note and the included FAT16 module, supplemented by the TCP/IP application note AN1108, "Microchip TCP/IP Stack with BSD Socket API", provide an FTP Server module that can be integrated with almost any application on a Microchip 32-bit microcontroller product.

Capabilities of this Application Solution:

- Provides portability across all 32-bit PIC® microcontrollers
- FTP Server APIs are compatible with PIC18 and PIC24 Microchip FTP Server APIs
- FTP connection is authenticated by your application
- Automatic interaction with the FAT16 file system

PIC32 Ethernet Starter Kit
Part Number: DM320004

- Upload files to the server using the PUT command
- Download file to the client using the GET command
- Supports the FTP NOOP command
- Supports the PORT command, allowing you to change the data port
- FTP Server APIs compatible with older Microchip FTP Server APIs

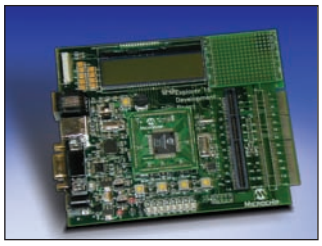
Application Solution: ECAN™ Operation with DMA on dsPIC33F and PIC24H Devices

Application Note: AN1249 · Ready-to-Use Solution

Proven Software Source Code

Summary

This application note is focused on helping designers understand the role of Direct Memory Access (DMA) in implementing the functionality of the Enhanced Controller Area Network (ECAN™) module. The ECAN module works in conjunction with the DMA controller in dsPIC33F and PIC24H devices. The DMA controller allows data transfer from RAM to a peripheral and vice versa without any CPU assistance, and operates across its own data bus and address bus with no impact on CPU operation.



Explorer 16
Development Board
Part Number: DM240001

ECAN/LIN PICtail Plus
Daughter Board
Part Number: AC164130

Application Solution: IrDA® Standard Stack

Application Note: AN1071 · Ready-to-Use Solution

Proven Software Source Code

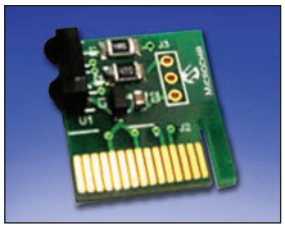
Summary

Infrared communication is a low-cost method of providing wireless, point-to-point communication between two devices. A wide variety of devices implement the IrDA standard specification, including computers, printers, PDAs, cell phones, watches and other instruments. AN1071 implements a complete IrDA® Standard Stack on Microchip's PIC24 and PIC32 microcontrollers and dsPIC DSCs. With the free source code these low-cost microcontrollers, with their built-in IrDA standard support, provide an inexpensive solution with plenty of computing power.

Capabilities of this Application Solution:

The stack layers perform the following functions:

- Driver
- Framer



IrDA PICtail Plus Daughter Board
Part Number: AC164124

- IrLAP (Infrared Link Access Protocol)
- IrLMP (Link Management Protocol)
- IAS (Information Access Service)
- TinyTP (Tiny Transport Protocol)
- IrCOMM 3-Wire Raw
- IrCOMM 9-Wire Cooked
- OBEX

Application Solution: AC-DC Reference Design

User's Guide DS70320, Application Note: AN1114 & Application Note: AN1207 · Ready-to-Use Solution

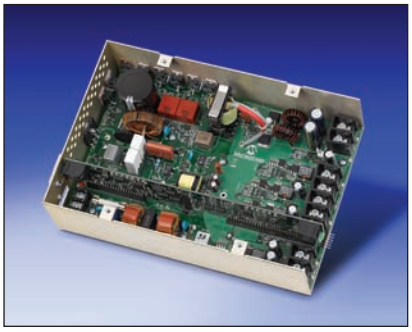
Proven Software Source Code

Summary

This reference design provides an easy method to evaluate the performance and features of SMPS dsPIC® DSCs for high wattage AC-DC conversion application. Discover the many benefits of digital power control implementation in this reference design. The SMPS AC-DC Reference Design unit works with universal input voltage range, and produces multiple DC outputs.

Capabilities of this Application Solution:

- Operates at universal input voltage (85-265 VAC, 45-65 Hz)
- Operates up to 300W sustained output
- Full Load operation on 3.3V and 5V outputs when loaded individually and/or simultaneously
- Power Factor Performance of 0.99 at full load (110 VAC/220 VAC)



Digital Power AC/DC Reference Design

- Fault Indication and Protection
- Excellent Dynamic Load Performance and Output Sequencing
- Modular and optimized software design
- Separate boards, one for digital signals (signal board) and the other for the Power stages (power board)
- Signal Board has two dsPIC33F16GS504 devices controlling different power stages

Application Solution: Offline UPS Reference Design

Application Note: AN1279 · Ready-to-Use Solution

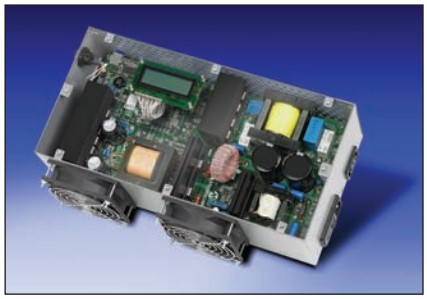
Proven Software Source Code

Summary

The application note describes the design of an Offline Uninterruptible Power Supply (UPS) using a Switch Mode Power Supply (SMPS) dsPIC® Digital Signal Controller (DSC). This reference design demonstrates how digital-power techniques when applied to UPS applications enable easy modifications through software, the use of smaller magnetics, intelligent battery charging, higher efficiency, compact designs, reduction in audible and electrical noise via a purer sine-wave output, USB communication and low-cost overall bill of materials.

Capabilities of this Application Solution:

- High-frequency design
- Input Range AC
  - 95-135V, 60 Hz (110V design)
  - 210-242V, 50 Hz (220V design)
- Output Voltage AC
  - 110V @ 60 Hz (110V design)
  - 230V @ 50 Hz (220V design)



Digital Pure Sine Wave UPS Reference Design

- Rating
  - 1000 VA Steady-State Output Power
  - 1350 VA Peak Power (Surge)
- 36V battery input
- Adjustable charging current
- Efficiency of 84%
- Pure sine wave output with THD <3%
- Mains to battery transfer time < 10 ms
- Supports crest factor of 3:1
- Fault indications
- USB communication with PC
- LCD front panel

Application Solution: Digital Power Interleaved PFC Reference Design

Application Note: AN1278 · Ready-to-Use Solution

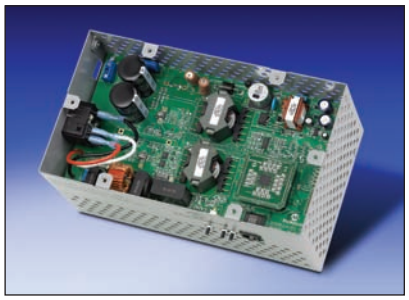
Proven Software Source Code

Summary

The application note describes the design of an Digital Power Interleaved PFC (IPFC) using a Switch Mode Power Supply (SMPS) dsPIC® Digital Signal Controller (DSC). This reference design provides an easy method to evaluate the performance and features of SMPS dsPIC DSCs for an Interleaved Power Factor Correction application. The Interleaved PFC reference design unit works with universal input voltage range, and produces a single high voltage DC output up to 350W of power.

Capabilities of this Application Solution:

- Operates at universal input voltage (85-265 VAC, 45-65 Hz)
- Operates up to 350W sustained output
- Output voltages up to 400 VDC



Digital Power Interleaved PFC Reference Design

- Power factor correction of 0.998 at full load and 120 VAC input
- Current Total Harmonic Distortion (ITHD) of 3% at full load and 120 VAC input
- Fault protection

Bootloader for dsPIC30F/33F and PIC24F/24H Devices

Application Note: AN1094 · Ready-to-Use Solution

Proven Software Source Code

Summary

The bootloader for dsPIC30F/33F and PIC24H/24F devices is used to load a user application on the target device without using external programmer. The bootloader consists of two applications:

1. Target side bootloader application which must be programmed into dsPIC30F/33F or PIC24F/24H program memory prior to bootloader operation.
2. Host PC bootloader application which communicates with the target side boot loader.

Capabilities of this Application Solution:

Communication channels for firmware upgrade include: UART, SPI, I^2C, CAN, Ethernet, USB etc. The example in this application note uses the UART channel.

Serial Boot Loader for PIC32 MCUs

Ref Application Note: AN851 · Ready-to-Use Solution

Proven Software Source Code

Summary

The Serial Boot Loader for PIC32 MCUs is used to program the user application to the Program Flash Memory (PFM) using the UART serial port. The software comes with a PC application that reads the user provided HEX file and writes the program flash contents to the PIC32. This PC application works in conjunction with the boot loader (BL) firmware installed on the PIC32 MCU.

Capabilities of this Application Solution:

- RS-232 based
- Auto baud detection
- Checksum validation of application code
- Boot loader located in protected Flash
- Graphical user interface provided
- Application code is located exclusively in program Flash
- Simple development system

Application Solution: Graphics Display Solution

Application Note: AN1136 · Ready-to-Use Solution

Proven Software Source Code

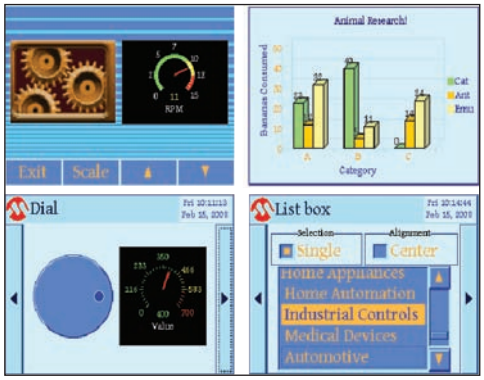
Summary

This application note describes How to Use Widgets in Microchip Graphics Library and also acts as a guide to the use of Microchip's graphics display solution which consists of the Explorer 16, a Graphics PICtail™ Plus (AC164127) daughter card, and a free Graphics Library. The graphics display solution allows a designer to quickly implement a graphical user interface on a display. The library also includes the software need to quickly implant a touch screen display, turning the display into a modern user interface.

Capabilities of this Application Solution:

- Up to 16-bit or 65K colors
- 2D objects such as line, circle, text, rectangle, polygon, bar
- 3D objects such as buttons, panels, window, group box, slider
- Image, animation
- Resistive touch screen, keypad
- Multiple fonts

Graphics Screen Display



Graphics PICtail Plus Daughter Board with 3.2″ Display Kit
Part Number: AC164127-3

Application Solution: Implementing Digital Lock-In Amplifiers Using the dsPIC® DSC

Application Note: AN1115 · Ready-to-Use Solution

Proven Software Source Code

Summary

Conventionally, lock-in amplifiers use complicated (and expensive) analog circuitry to perform the phase sensitive detection and filtering. However, modern DSCs, such as the dsPIC30F and dsPIC33F families, can be used to remove large amounts of the analog circuitry by performing the necessary operations in software. This capability provides a number of additional benefits including increased reliability, resistance to temperature and aging effects, and the ease with which the system can be modified in the field. By using the built-in signal processing capabilities of the dsPIC33F, it is possible to perform high-speed, high-accuracy measurements on sensors such as strain gauges. The same technique can be applied to other noisy systems such as capacitive sensors or the measurement of modulated light levels.

Capabilities of this Application Solution:

- Useful for measuring small signals
- Avoids noise introduced at DC and low frequencies
- Measures signal changes caused by devices with complex impedances, such as capacitive sensors
- Signal processing is performed in the digital domain
- Minimum external components

Application Solution: File I/O Functions Using Memory Disk Drive File System Library

Application Note: AN1045 · Ready-to-Use Solution

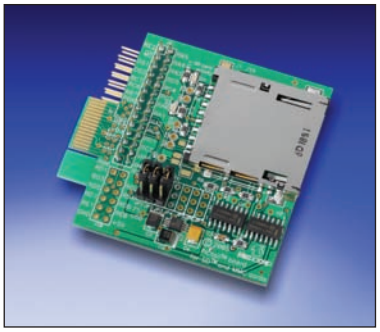
Proven Software Source Code

Summary

Microchip's application note AN1045 covers the implementation of a Memory Disk Drive File System on Microchip's 16-bit families. Microchip's Memory Disk Drive File System allows a designer to easily implement a removable Flash-based media card of up to 2 GB into their application. Applications that require data logging or retrieval of large blocks of data such as fonts or bitmaps are often taking advantage of removable Flash-based memory cards. The Memory Disk Drive File System Library is modular and provided in "C" source to easily integrate into any application.

Capabilities of this Application Solution:

- Developed based on ISO/IEV9293 specification
- Known as FAT 16 File System used on early DOS operating systems by Microsoft® Corporation
- Most popular files system with SD cards, CF cards and USB thumb drives



PICtail Plus Daughter Board for SD & MMC Cards
Part Number: AC164122

- Provides directory manipulation support
- Provides file/directory search support
- Easy-to use standard I/O style functions
- Available free for use on Microchip microcontrollers
- Portable across PIC18, PIC24 and dsPIC® DSC devices
- Supports up to 2 GB

Software and Application Development Tools

Software and Application Development Tool	Part Number	List Price
MPLAB® IDE		Free
MPLAB® C Compiler for PIC24 MCUs and dsPIC® DSCs	SW006012	$895
MPLAB® C Compiler for dSPIC DSCs*	SW006013	$495
MPLAB® C Compiler for PIC24 MCUs*	SW006014	$495
MPLAB® C Compiler for PIC32 MCUs*	SW006015	$895
HI-TECH C® Compiler for PIC24 MCUs and dsPIC DSCs	SW500009 SW500006	$895
HI-TECH C® Compiler for PIC32 MCUs -PRO	SW500011	$1495
HI-TECH C® Compiler for PIC32 MCUs -Standard	SW500012	$895
dsPICworks™ Data Analysis and DSP Software	SW300021	Free
The Digital Filter Design Tool	SW300001	$249
The Digital Filter Design Lite	SW300001-LT	$29.99
Real-Time Data Monitoring Tool	MPLAB Plug-in	Free
Mindi™ Power Design and Simulation Tool	–	Free
dsPIC® DSC Speech and Audio Fast Forward (SAFF) Tool	Included in MPLAB IDE	Free
Microchip Graphic Display Designer	Included in MPLAB IDE	Free

*Free evaluation copy can be downloaded.

MPLAB® IDE (Integrated Development Environment) Tools

Summary

All of Microchip's MCU and DSC tools operate cohesively under the MPLAB IDE umbrella. The powerful and easy-to-use MPLAB IDE includes a host of free software components for fast application development and super-charged debugging. MPLAB IDE integrates not only software, but all of Microchip's hardware tools and many third party tools.

Key Features

- Project build and management
- Source level debug in ASM and C
- Flexible watch windows
- Searchable trace buffers
- Mouse over variable inspection
- Version control integration
- MATLAB Device Blocks for MPLAB IDE (for dsPIC30 and dsPIC33 DSCs)
- Real-time data monitoring
- Supports ALL 600+ MCUs and DSCs

Available for MPLAB IDE

Assembler/Linker/Librarian

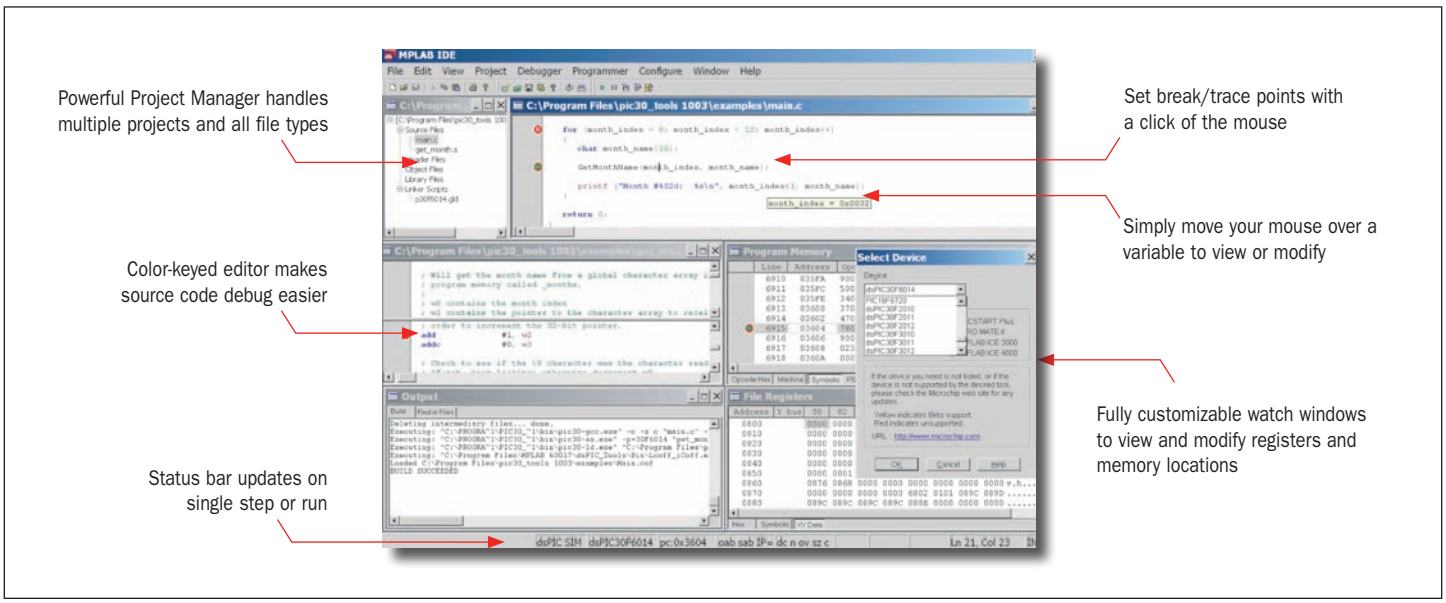
The MPLAB ASM30 is a full-featured macro assembler. User defined macros, conditional assembly and a variety of assembler directives make the MPLAB ASM30 a powerful code generation tool.

MPLAB SIM Software Simulator

The MPLAB SIM Software Simulator is a full-featured, cycle accurate software simulator. In addition to simulating the CPU and the instruction set, it also supports key peripherals.

MATLAB/Simulink Device Blocks for dsPIC3X

The Microchip Device Blocksets for MATLAB Simulink provide a set of interface-compliant configuration and run-time peripheral blocks for the dsPIC30 and dsPIC33 DSCs. Complete applications can be created in the form of a MATLAB/SIMULINK model using blocksets provided by Microchip and Simulink. C code for the application will be generated. These blocksets are compatible with the MATLAB plug-in available in MPLAB IDE.



MPLAB® C Compiler for PIC24 MCUs and dsPIC® DSCs

Part Number: SW006012

Summary

The MPLAB® C Compiler for PIC24 MCUs and dsPIC® DSCs (also known as MPLAB C30) is a full-featured ANSI-compliant C compiler for the Microchip 16-bit devices: PIC24, dsPIC30F and dsPIC33F. It is highly optimized and takes advantage of many PIC24/dsPIC DSC-specific features to provide efficient software code generation. 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 level debugging with the hardware debugging tools. This compiler comes complete with its own assembler, linker and librarian to write mixed mode C and assembly programs and link the resulting object files into a single executable file. The compiler is also available separately for PIC24 MCUs and dsPIC DSCs. A free evaluation version is available for download, and is fully functional for 60 days. After the evaluation period, certain optimization levels are disabled. The Evaluation Edition has no code size limit.

Key Features

- ANSI-compliant with standard, math, memory, data conversion and math libraries
- Generates relocatable object modules for enhanced code reuse
- Optimized to generate as much as 30% less code than other 16-bit MCU compilers
- Strong support for in-line assembly when total control is absolutely necessary
- Peripheral library for quick coding using Microchip device peripherals
- Allows code and data to be located at absolute addresses
- Supports advanced code size optimizations
- Support for DSP accumulator registers from the C language (dsPIC devices only)
- Support for DSP intrinsincs (functions) from the C language. DSP intrinsics map directly to native dsPIC assembly language instruction (dsPIC devices only)
- Free unrestricted Evaluation Version of the C compiler

Compiler	Part Number	Price
MPLAB C Compiler for PIC24 MCUs and dsPIC DSCs*	SW006012	$895
MPLAB C Compiler for dSPIC DSCs*	SW006013	$495
MPLAB C Compiler for PIC24 MCUs*	SW006014	$495

*Free evaluation copy can be downloaded.

MPLAB® C Compiler for PIC32 MCUs* Part Number: SW006015

Summary

The MPLAB® C Compiler for PIC32 MCUs is a full-featured ANSI-compliant C compiler for Microchip's 32-bit microcontrollers. A free evaluation version is available for download, and is fully functional for 60 days. After the evaluation period, certain optimization levels are disabled. The Evaluation Edition has no code size limit, and is fully compatible with Microchip's MPLAB IDE and other popular third party IDEs.

Key Features

- DSP Library – C callable DSP functions written in assembly using the standard MIPS DSP library APIs. A future compiler release will contain a second set of APIs that are compatible with Microchip's 16-bit compilers.
- Quick Migration – Complete run-time optimized peripheral libraries that are API compatible with Microchip compiler libraries for 16-bit products.
- Includes Floating Point Math Library
- Even Smaller Code Size – Use 16-bit instruction mode for up to 40% code size reduction
- Small and Fast – Mix 16- and 32-bit instruction types in the same source file: 32-bit instructions for performance critical code and 16-bit instructions for size reduction
- ANSI-compliant with standard, math, memory, and data conversion libraries
- New highly optimized math library functions in v1.03 and later
- Supports in-line assembly
- Single and multi-vector interrupt support
- Generates relocatable object modules for enhanced code reuse
- Allows code and data to be located at absolute addresses

**MPLAB Compiler for PIC32 MCU family in LITE mode and Standard Eval Version are available for free download.*

HI-TECH C® Compiler for PIC24 MCUs and dsPIC® DSCs

Part Number: SW500009 & Part Number: SW500006*

Summary

HI-TECH C® compiler for PIC24 MCUs and dsPIC® DSCs (Standard) is a full-featured ANSI C compiler for Microchips 16-bit microcontrollers and digital signal controllers. This compiler offers the C programmer a powerful, yet easy-to-use environment for code development.

Key Features

- ANSI C, full featured and portable, supporting all standard data types (IEEE floating point, long data types, etc.)
- Reliable – based on mature, field-proven technology used in our PICC™ and PICC-18™ compilers
- Unlimited number of source files
- Multiple optimization levels and types
- Comprehensive C library with all source code provided
- Mixed C and assembler programming
- Listings showing generated assembler
- Optimizing assembler
- Compatible – integrates into the MPLAB® IDE
- Includes Native Trace support for MPLAB REAL ICE™
- Runs on multiple platforms: Windows®, Linux and Mac OS X

Free evaluation copy can be downloaded.

Part Number: SW500006
The HI-TECH C Compiler Enterprise Edition is a comprehensive compiler package that supports the entire range of Microchip PIC® MCUs and dsPIC® DSCs.

HI-TECH C® Compiler for PIC32 MCUs Part Number: SW500011 & SW500012*

Summary

HI-TECH C® compiler for PIC32 MCUs fully implements the optimizations of Omniscient Code Generation™ – a whole-program compilation technology – to provide denser code and better performance for development on PIC32 MCUs. This ANSI C compiler integrated into Microchip's MPLAB® IDE, is compatible with all Microchip debuggers and emulators, and runs on Windows, Linux and Mac OS X.

Key Features

- ANSI C, full featured and portable, supporting all standard data types (IEEE floating point, long data types, etc.)
- Reliable – based on mature, field-proven technology used in our PICC® and PICC-18® compilers
- Unlimited number of source files
- Multiple optimization levels and types
- Comprehensive C library with all source code provided
- Mixed C and assembler programming
- Listings showing generated assembler
- Optimizing assembler
- Compatible – integrates into the MPLAB IDE
- Includes Native Trace support for MPLAB REAL ICE™
- Runs on multiple platforms: Windows® , Linux and Mac OS X

HI-TECH C PRO for PIC32 MCU family in LITE Mode is available for free download.

Standard mode compiler with or without High Priority Access.

dsPICworks™ Data Analysis and DSP Software

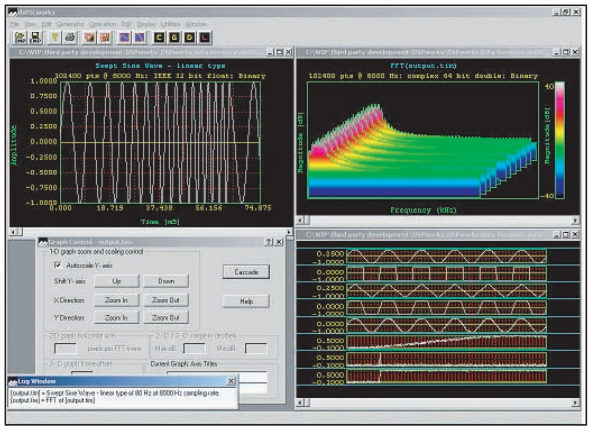
Part Number: SW300021

Summary

dsPICwork Data Analysis and DSP Software tool is an easy-to-use data analysis and signal processing package for designs using dsPIC® Digital Signal Controllers (DSCs). This software supports an extensive number of functions which include signal generation, arithmetic operations, digital signal processing, up to 3 dimensional display and data import/export capabilities with MPLAB IDE and MPLAB ASM30.

Key Features

- 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 and dsPIC33F RAM

Digital Filter Design/Digital Filter Design Lite Part Number: SW300001

Summary

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.

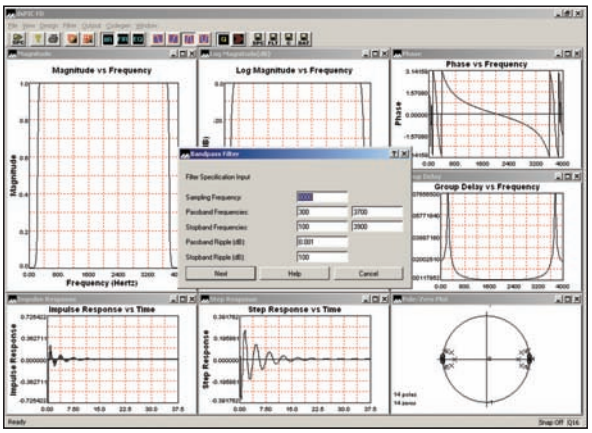
Key Features

Finite Impulse Response Filter Design

- 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
- Various 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

- 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:
  - Butterworth
  - Tschebyscheff
  - Inverse Tschebyscheff
  - Elliptic
  - Bessel



- Digital transformations are performed by bilinear transformation method
- Reports show design details such as all transformations from normalized low-pass filter to desired filter

Code Generation Features

- Generated files are compliant with Microchip's MPLAB C Compiler, assembler and linker
- Choice of placement of coefficients in program space or data space
- C wrapper/header code generation

Graphs

- Magnitude response vs. frequency
- Log magnitude vs. frequency
- Phase response vs. frequency
- Group delay vs. frequency
- Impulse response vs. time (per sample)
- Step response vs. time (per sample)
- Pole and zero locations (IIR only)

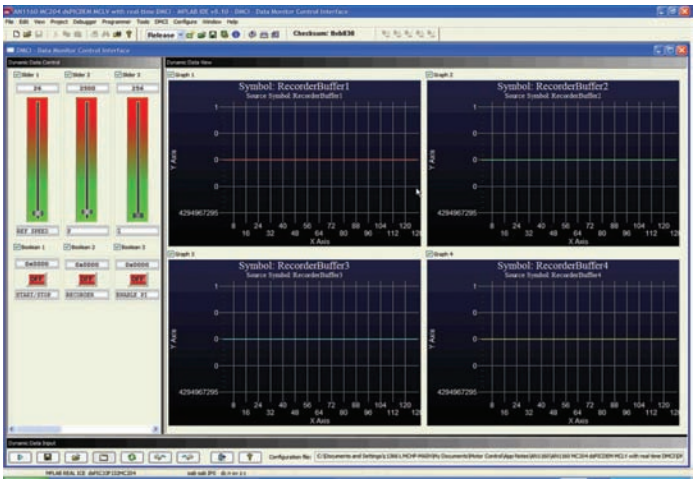
Real-Time Data Monitoring Tool

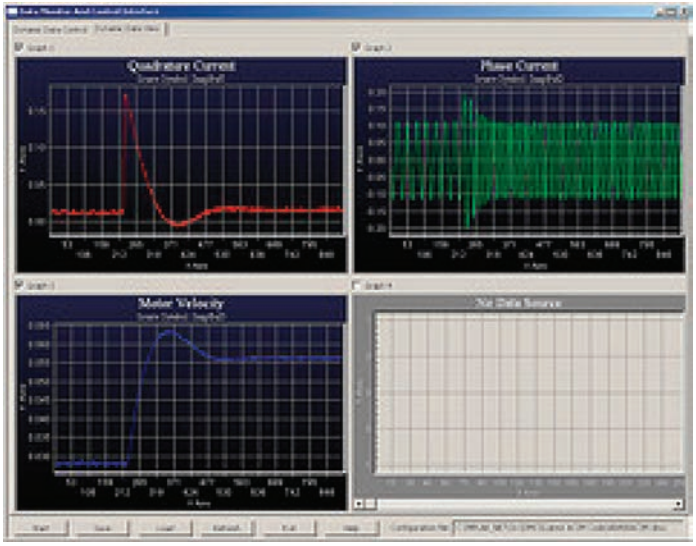
Summary

Applications such as motor control and power conversion require high-speed data monitoring from MPLAB® DMCI. Achieving such tasks with the existing debugging tools and the on-chip debugging module, requires the use of an additional communication link between a host PC and a target device. RTDM, along with MPLAB DMCI (MPLAB 8.10 or higher), creates an alternative link between a host PC and a target device for debugging applications in real time.Using these tools for getting data in and out of the target device allows developers to run their applications, while providing the ability to tune the variables and immediately see the effect without halting the application.

Key Features

- Runs under Debug mode or user's application
- Fully compatible with MPLAB DMCI
- Provides dynamic access to control and monitor software variables without halting program execution
- No recompiling is required between debug sessions
- Ability to control or view any global variable defined by the target application code
- Provides an alternative link to read/write data from/to the target device
- Uses the RS-232 standard protocol as the primary communication link between the host PC and target device
- Maximum baud rate: 460800 bps
- Configurable to use the UART1 or UART2 modules on the target device
- Supported by all dsPIC30F, dsPIC33F and PIC24H devices

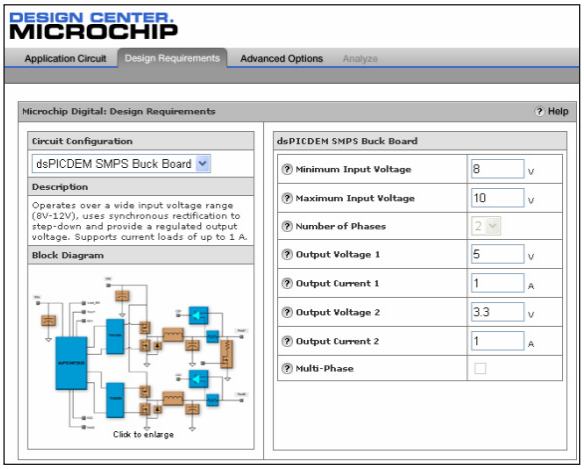




Mindi™ Power Design and Simulation Tool

Summary

Microchip's Mindi™ Simulator Tool aids in the design and analysis of various analog and digital circuits used in power management and linear applications. This interactive simulator tool enables designers to quickly generate circuit diagrams, generate code, simulate circuits and specify passive components for a variety of power, battery-charger and linear applications.



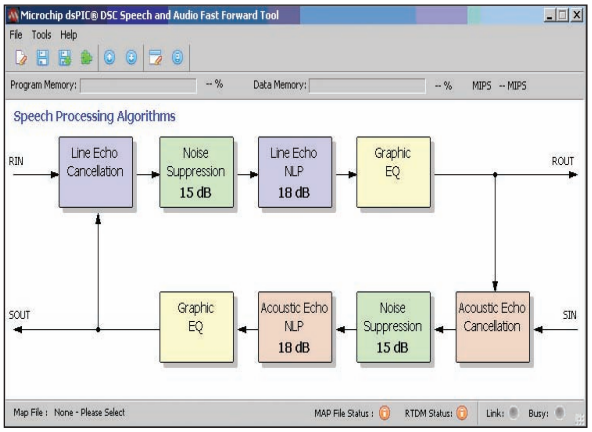
Key Features

- Applications supported include:
  - DC-DC Converter
  - Battery Chargers
  - Active Filters
  - Linear Amplifier
- Three easy steps to follow: Input requirements, Analyze and BOM
- Easy to make modifications of adding or deleting components and connections
- Ensure stability of circuit with transient analysis, Steady-state analysis and AC analysis

dsPIC® DSC Speech and Audio Fast Forward (SAFF) Tool

Summary

The SAFF is a PC-based application GUI simplifies speech and audio application development. The SAFF tool communicates with the target hardware via Microchip's Real-Time Data Monitoring (RTDM) protocol over an RS-232 or USB link. User can select several audio functions to implement and user has flexibility in choosing the speech/audio path (send or receive) to implement them in actual applications. The SAFF GUI tool is ready to use with Microchip's development boards and also on custom dsPIC30F/dsPIC33F hardware platform. The GUI has unique feature of generating code for selected controller platforms. This also can be used to tune algorithm parameters in addition to enable or disable algorithms for intended operation.



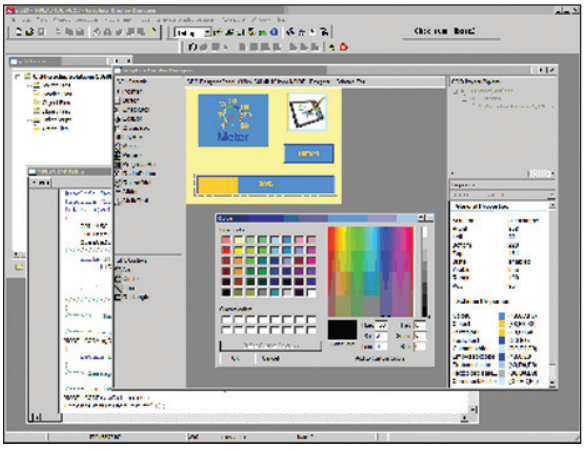
Key Features

- Supports Microchip's dsPIC® DSC Acoustic Echo Cancellation, Line Echo Cancellation, Noise Suppression and Equalizer Libraries
- Implements typical full duplex communication signal processing chain with optimal arrangement of algorithms
- All algorithm parameters can be controlled in real time via RTDM
- The generated code from GUI tool can be ported to custom dsPIC DSC hardware
- Quick Start Demonstration included with installation
- Supports multiple serial communication rates for communicating with target dsPIC DSC
- Uses UART and Timer peripheral on the dsPIC DSC device to implement RTDM and MIPS measurement
- Parameters on target device can be update individually or in groups
- Simplifies the algorithm parameter tuning process generates code for selected hardware

Microchip Graphic Display Designer

Summary

The Microchip Graphics Display Designer (GDD) is an MPLAB® IDE plug-in and a visual design tool that provides users with a quick and easy way of creating graphical user interface (GUI) screens for embedded applications on Microchip MCUs. The GDD is a design tool created for use with the Microchip Graphics Library. For users who are familiar with MPLAB IDE, PIC® MCUs, Microchip Graphics Library and MPLAB C Compilers, the GDD simplifies coding for the GUI screens. Users can draw, move, resize, and delete screen objects, create multiple static screens, assign an LCD controller, select graphics-related configurations, and generate output source files. These source files can be compiled with the Microchip Graphics Library using the Microchip C compilers for PIC24 and PIC32 MCUs and dsPIC® DSCs.



Key Features

- No Manual X/Y coordinates calculation required
- All the graphical objects (widgets) from the Microchip Graphics Library are supported
- Graphical resources can be imported into GDD (Custom fonts, bit map images)
- Generates ANSI C code for PIC24 and PIC32 MCUs and dsPIC DSCs

Third Party Software Tools, RTOS and Libraries

Third Party 16-bit Software Tools

Vendor	IDE	Compilers	Supports
IAR SYSTEMS	IAR Embedded Workbench	C/EC++	PIC24 MCU dsPIC DSC
CCS inc Custom Computer Services, Inc.	C Windows IDE	C	PIC24 MCU dsPIC® DSC
Green Hills SOFTWARE INC.	Multi IDE	MPLAB® C	MPLAB® C IDE

Third Party 16-bit Libraries and RTOS Support

	Library/Tool Name	dsPIC33F	PIC24H	PIC24F
RTOS	CMX-Tiny+™	✓	✓	✓
	CMX-RTX™	✓	✓	✓
	CMX-Scheduler™	✓	✓	✓
	Micrium - µCOS II	✓	–	✓
	freeRTOS™	✓	✓	✓
	Segger – embOS	✓	✓	✓
	Express Logic – ThreadX®	✓	✓	✓
	AVIX-RT	✓	✓	✓
Connectivity	TCP/IP (CMX)	✓	✓	✓
	CANbedded (Vector-Informatik)	✓	✓	–
	OsCAN (Vector-Informatik)	✓	✓	–
Graphics	Segger – emWIN	✓	✓	✓
	RamTeX – GUI Lib	✓	✓	✓

Third Party Software Tools, RTOS and Libraries

PIC32 Third Party Software Options

Vendor	RTOS	GUI	TCP/IP	USB	Example Projects	Application Note	MPLAB IDE RTOS Viewer
AVIX-RT	✓	–	–	–	✓	✓	✓
CMX SYSTEMS	✓	–	✓	–	–	–	✓
expresslogic	✓	–	–	✓	–	✓	✓
Micrium Empowering Embedded Systems	✓	–	–	–	✓	✓	✓
freeRTOS	✓	✓	✓	–	✓	✓	✓
PUMPKIN REAL-TIME SOFTWARE	✓	–	–	–	–	–	–
RoweBots	✓	–	✓	✓	✓	✓	–
SEGGER	✓	✓	–	–	✓	–	✓
easyGUI	–	✓	–	–	–	–	–
RAMTEX	–	✓	–	–	–	–	–

PIC32 C++ and Eclipse Options from Third Parties

Vendor	IDE	Compilers	Debug Hardware
ASHLING THE DEVELOPMENT SYSTEMS COMPANY	Customized Eclipse	GNU C/C++ Microchip C	Ashling JTAG
Green Hills SOFTWARE INC.	Multi IDE	Green Hills C/C++	Green Hills JTAG
LAUTERBACH	Trace32 IDE	GNU C/C++ Microchip C	Lauterbach JTAG
Macraigor Systems Complete JTAG Debug Support	Standard Eclipse	GNU C/C++ Microchip C	Macraigor JTAG (3 models)

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Microchip Technology Inc.
2355 W. Chandler Blvd.
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