

motorBench 2.35.0 Release Notes

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Overview of motorBench® Development Suite

Microchip motorBench Development Suite is a graphical, interactive development environment designed to help motor control engineers to design and implement motor control systems, from very basic to very sophisticated ones.

motorBench® Development Suite allows the user to:

- configure a motor system
- measure motor parameters
- tune the controller gains
- generate code to spin the motor

What's New

1. Motor Control Application Framework (MCAF) R6 – see MCAF User's Guide for more information.
 - a. Added Motion Control API (MCAPI) and sample application
 - b. Added support for flux weakening (also known as field weakening)
 - c. Added support for Maximum Torque Per Ampere (MTPA) for interior permanent magnet motors
 - d. Added support for dead-time compensation
 - e. Changes in PWM frequency / control frequency are now permitted
2. Device Support
 - a. added support for dsPIC33CK64MP105, dsPIC33CK64MC105

System Requirements

- MPLAB X **5.30** or later.
- XC16 compiler version:
 - Firmware generated by motorBench® Development Suite has been tested with XC16 1.60.
 - 33EP devices: XC16 1.36 or later are expected to work with motorBench® Development Suite but have not been extensively tested.
 - 33CK devices: Either of the following is required:
 - XC16 1.50 or later
 - XC16 1.41 with DFP 1.2.66 or later
- MPLAB Code Configurator®(MCC) Plugin Version **4.0.1** or later
 - Core v5.0.1 or later
- PIC24/dsPIC33/PIC32MM library **1.169.2** or later

Supported Hardware

This release of motorBench® Development Suite supports both low-voltage and high-voltage setups.

Supported Processor Plug-In Modules

- dsPIC33EP256MC506 External Op Amp Motor Control PIM [Part Number: [MA330031-2](#)] with silicon revision A8
- dsPIC33CK256MP508 External Op Amp Motor Control PIM [Part Number: [MA330041-1](#)]
- dsPIC33CK64MP105 External Op Amp Motor Control PIM [Part Number: [MA330050-1](#)]
- dsPIC33CK64MC105 External Op Amp Motor Control PIM [Part Number: [MA330051-1](#)]

Low-voltage hardware

1. dsPICDEM MCLV-2 Development Board [Part Number: [DM330021-2](#)]
2. Any of the Plug-In Modules supported by motorBench® Development Suite.
3. A three phase PMSM or BLDC motor that is compatible with 24V, such as the Hurst 24V BLDC motor DMA0204024B101 [Part Number: [AC300022](#)].
4. 24V power supply [Part Number: [AC002013](#)] - ensure this connects to AC mains using a 2-prong cable. If you have an AC002013 with a 3-prong cable, please contact Microchip.

High-voltage hardware

1. dsPICDEM MCHV-2 Development Board [Part Number: [DM330023-2](#)] or dsPICDEM MCHV-3 Development Board [Part Number: [DM330023-3](#)]
AC mains voltages 120VAC 60Hz and 220VAC 50Hz have been tested.
2. Any of the Plug-In Modules supported by motorBench® Development Suite.
3. A three phase PMSM or BLDC motor that is compatible with rectified AC mains voltage, such as the Leadshine 400W BLDC motor EL5-M0400-1-24 [Part Number: [AC300025](#)].

Other hardware required with both low-voltage and high-voltage setups

1. A USB-to-logic-level-UART converter from the following list:
 - a. Saelig [USB-COM-U](#) or [USB-COM-U13](#)
 - b. [TRENDnet TU-S9 v2.0](#)
2. Programming tool - one of the following tools: Real ICE, ICD3, ICD4
 - a. **note:** ICD4 is required for programming dsPIC33CK64MC105 and dsPIC33CK64MP105 devices.
3. Board calibration load resistors - this is optional, please see motorBench® Development Suite User's Guide document for more details

Please note:

- We do not recommend using the MCP2200 USB to RS232 Demo Board [Part number: [MCP2200EV-VCP](#)] with this release of motorBench® Development Suite. While testing, we have observed more frequent occurrence of a serial communication timeout issue while running motor parameter measurement using this cable. See [Known Issues](#) section of this document for more information (MCGUI-1141)
- Motor parameter measurement is only supported on dsPIC33EP256MC506 device.

Installing motorBench® Development Suite 2.35.0

To install the MPLAB® Code Configurator v3.95 Plugin

1. In the MPLAB® X IDE, select **Plugins** from the Tools menu
2. Select the **Available Plugins** tab
3. Check the box for the MPLAB® Code Configurator v3, and click on **Install**

To install different peripheral library version or motorBench® Development Suite version when connected to internet

1. Create a project with any of the [Supported Devices](#), or use the sample project.
2. Open MPLAB® Code Configurator
3. In the Versions tab under **PIC24/dsPIC33/PIC32MM** MCUs, find the multiple library versions (loaded version is indicated by the green check mark)
4. Right-click on the required version of the library and select **Mark for Load**
5. In the Versions tab under **motorBench® Development Suite** find the multiple library versions (loaded version is indicated by the green check mark)
6. Right-click on the 2.35.0 version of the library and select **Mark for Load**
7. Click on **Load Selected Libraries** button to load the marked libraries.

To install different peripheral library version or motorBench® Development Suite version when not connected to internet

1. In the MPLAB® X IDE, select **Options** from the **Tools** menu
2. Select **Plugins** tab
3. Click on **Install Library**
4. Add [pic24-dspic33-pic32mm_v1.169.2.mc3lib](#)
5. Add [motorBench_2.35.0.mc3lib](#)
6. Restart MPLAB® X IDE

Repairs

Motor Control Fixed Issues

Changes since revision 2.25

The following aspects of motorBench® Development Suite and the Motor Control Application Framework (MCAF) have been updated:

- MCAF has been updated to R6, including
 - Changes in R2:
 - Support for DC link compensation
 - Support for overmodulation
 - Support for wider range of low-voltage motors
 - Updated HAL for future MCHV2 support
 - Updated Motor Control Library
 - Numerous minor fixes
 - Changes in R3:
 - MCC system module compatibility
 - MCHV-2 and MCHV-3 support
 - Inverter maximum current now has a 1:1 ratio with the maximum commanded dq-frame current of the drive, operating in FOC (in R2 this incorporated a derating factor)
 - Other minor fixes
 - Changes in R4:
 - MCC peripheral support
 - Parameter customization
 - Quadrature encoder support
 - Added new startup method (Weathervane startup)
 - Other minor fixes
 - Changes in R5:
 - Added device support for dsPIC33CK256MP508
 - Added Angle-tracking PLL (ATPLL) sensorless estimator
 - Improved motorBench Customize page support
 - Other minor fixes
 - Changes in R6
 - Added device support for dsPIC33CK64MC105, dsPIC33CK64MP105
 - Added flux control module with flux weakening (FW) and maximum torque per ampere (MTPA)
 - Added Motion Control API (MCAPI)
 - Added dead-time compensation
 - Other minor fixes

- Motor parameter measurement
 - Improvements to support motors with continuous rated current of less than ~1.5A
 - Bug fixes in the measurement process
- Sections in this release notes affected:
 - Other Requirements
 - Limitations
 - Supported Motor Parameters

Known Issues

Issue Key	Summary	Workaround
MBPLAN-673	Serial port does not get closed programmatically when MCC exits during motor parameter measurement	If you exit SC during execution, restart MPLAB X.
MBPLAN-932	Exception during attempted creation of a runtime properties class	No workaround needed, this issue doesn't have an impact on the functionality.
MBPLAN-984	Improve error reporting for SC build errors in the event of a code generation failure	
MBPLAN-1095	Switching projects after loading motorBench erroneously allows motorBench code to generate for new project	
MBPLAN-1160	"Import Motor" and "Export Motor" buttons can be clicked multiple times, opening multiple dialog boxes	
MBPLAN-935	Self-Commissioning: keep serial communication link active when waiting for user response to a fault message	
MBPLAN-856	Self-Commissioning: trigger conditions for SC build needs to be fine tuned	
MBPLAN-932	Exception during attempted creation of a runtime properties class	
MBPLAN-749	Need a method/feature to handle different AC input voltage for MCHV-2 board	
MBPLAN-837	"Project reference must not be null" error when building sc firmware.	
MBPLAN-1287	Possible bug: Removing motorBench 2.15.9 from MCC project and adding it retains old state	
MBPLAN-941	MCC help menu appears in place of motorBench	
MBPLAN-1245	XC16SelectedProperties class not found when selecting a tool	

Motor Control Issues

Issue Key	Summary
DB_MC-411	Current calibration happens only once (at part reset) rather than upon entry to MCSM_RESET state
DB_MC-560	Speed controller exhibits chattering behavior at voltage saturation hysteresis boundary (MCAF)
DB_MC-978	"Soft start" gate drive in board_service.c has duty cycle that is too small
DB_MC-1092	PLL estimator may not converge into rotor reference frame while using the Classic startup method in MCAF
DB_MC-1396	PLL calculations in code generation do not allow motor.velocity.nominal to be more than 1250Hz electrical (=20kHz/8/2)
DB_MC-1415	With some motors and 12V operation, increased velocity margin improves startup but creates unstable estimator
DB_MC-1430	Quantum MT4012 unstable in closed-loop operation at 4200 RPM speed and above
DB_MC-1491	With Quantum MT4012, MCAF may not detect stall
DB_MC-1492	Quantum MT4012 Stalls on pressing 'S3'(reverse) at low speeds and on changes to speed command potentiometer
DB_MC-1495	Anaheim BLY342D-24V-3000, BLY342D-48V-3200 motors creates hardware over-current during stall-detect testing
DB_MC-1521	Closed loop speed step response overshoot - MCHV2, Leadshine 400
DB_MC-1892	Some motors with extreme parameters may produce out-of-range error for stall_detect.group.timerCountsVarianceDetect (detected in Monte Carlo analysis)
DB_MC-1922	LED patterns not displayed when in the TEST_DISABLE or TEST_ENABLE states
DB_MC-2122	BLWS232D motor startup in QEI mode causes a false detect for stall-detection
DB_MC-2213	Deadtime needs to be changed in both MCC and motorBench to affect code
DB_MC-2275	Large current rampup times may not start (STARTUP_TORQUE_RAMPUP_RATE = 0)
DB_MC-2323	Weathervane transition state should not have active damping enabled

Issue Key	Summary
DB_MC-2387	DC link voltage measurement may have too much phase delay for MCAF DC link compensation to work effectively
DB_MC-2716	incorrect units in generated operating parameters
DB_MC-2741	Estimators should not rely on motor.ui.direction
DB_MC-2794	Default current loop bandwidth not high enough to reject disturbances caused by backemf harmonics and dead-time distortion
DB_MC-2871	Noisy transition from rated to flux weakening region
DB_MC-2873	Current loop autotune input-output delay incorrectly underestimated as 1 sample instead of 1.5 or 2 samples
DB_MC-2978	MCAP1 fault handler may drop faults in some corner cases
DB_MC-3003	8% increase in CPU usage from MCAF R5 to R6
DB_MC-3012	MCAP1 will not clear certain fault flags when other fault flags are active
DB_MC-3021	Operating parameters header file includes a doc comment with code generation object reference

Limitations

Supported Devices

motorBench® Development Suite supports these devices:

1. dsPIC33EP256MC506
2. dsPIC33CK256MP508
3. dsPIC33CK64MP105
4. dsPIC33CK64MC105

Software Limitations

motorBench® Development Suite is tested for serial communication using Windows 7 and Windows 10 platforms. Other platforms may work with standard baud rates, but this operation has not yet been verified.

Motor Control Limitations

Following are the known limitations for this release of motorBench® Development Suite:

1. **One mechanical load** - constant load. This represents a mechanical load with constant inertia, viscous damping, and friction. The velocity control loop can generally reject external disturbance torques, within the rated current of the motor and board, and within the bandwidth of the velocity control loop. Mechanical loads with time-varying or angle-varying inertia, viscous damping, and friction, such as a blower, compressor, or pump, are currently not supported.
2. **One motor type** - PMSM

MCLV-2:

The reference motor is the Nidec Hurst motor DMA0204024B101 (MicrochipDirect part number [AC300022](#)). Microchip has also validated motorBench® Development Suite (including motor parameter measurement) with motors with parameters plotted below. Please also read the following section on Supported Motor Parameters. If motorBench® Development Suite is unable to spin a motor successfully, please contact Microchip staff for additional assistance.

	units	min	max	plot
Resistance (R)	ohms (line-line)	0.1714	5.664	
Inductance, q-axis (Lq)	mH (line-line)	0.02982	5.269	
Inductance, d-axis (Ld)	mH (line-line)	0.03576	5.172	
Back-emf (Ke)	Vrms/KRPM (line-line)	0.8808	6.49	
Friction (Tf)	mNm	0.556	54.03	
Viscous damping (B)	uNm/(rad/s)	1.012	196.9	
Inertia (J)	uNm/(rad/s ²)	0.362	1162	
Electrical time constant L/R	ms	0.1913	3.889	
Mechanical time constant 2/3 JR/Ke ²	ms	2.27	47.25	

(Note: Mechanical time constant $(2/3) \times JR/Ke^2$ represents the time constant of velocity acceleration under an open-loop synchronous-frame voltage step, neglecting the effects of inductance, with J, R, and Ke expressed in canonical metric units. R is expressed as line-neutral resistance = half of line-line resistance, and Ke is expressed as V/(rad/s) line-neutral zero-peak = Vrms/KRPM (line-line) \times 0.007796968)

MCHV-2/MCHV-3:

The reference motor is the Leadshine 400W motor EL5-M0400-1-24 (MicrochipDirect part number: [AC300025](#)). Microchip has validated motorBench® Development Suite (including motor parameter measurement) with motors with parameters plotted below. Please also read the following section on Supported Motor Parameters. If motorBench® Development Suite is unable to spin a motor successfully, please contact Microchip staff for additional assistance.

	units	min	max	plot
Resistance (R)	ohms (line-line)	1.514	13.02	
Inductance, q-axis (Lq)	mH (line-line)	3.474	42.19	
Inductance, d-axis (Ld)	mH (line-line)	3.176	37.47	
Back-emf (Ke)	Vrms/KRPM (line-line)	21.2	39.23	
Friction (Tf)	mNm	7.812	66.53	
Viscous damping (B)	uNm/(rad/s)	17.91	108.4	
Inertia (J)	uNm/(rad/s ²)	16.21	240	
Electrical time constant L/R	ms	0.9745	3.059	
Mechanical time constant 2/3 JR/Ke ²	ms	0.8905	2.797	

- a. **dsPICDEM™ MCLV-2 development board.** This release of motorBench® Development Suite is compatible with modifications to the board to alter its rated current or voltage. Please refer to the document "Using MCLV-2 with motorBench® Development Suite to support alternative current and/or voltage ratings", on www.microchip.com/motorbench for guidance in making such modifications. Other modifications may not be compatible.
 - b. **dsPICDEM™ MCHV-2 and MCHV-3 development boards.** This release of motorBench® Development Suite is compatible with unmodified MCHV-2 and MCHV-3 development boards.
4. **Motors should be well-matched to the board and operating voltage.** The nominal DC link voltage of the MCLV-2 board is 24V. This voltage can be changed by cutting jumper J6 and using an appropriate power supply connected to the appropriate terminals of J7. Use of a mismatched motor (for example, a 12V motor used with a 24V DC link voltage) may cause a hardware over-current fault; in this case motor parameter measurement may fail with the message "Fault Code #10: Undefined Fault". Retry with an appropriate DC link voltage.
 5. **Four PIMs and Four devices** - This release of motorBench® Development Suite only supports the [Supported PIMs](#) and [Supported Devices](#). (Please see the Hardware Setup section of the motorBench User's Guide for important modifications to dsPIC33EP256MC506 External OpAmp PIM for use in MCHV-2 and MCHV-3.)
 6. **One algorithm** - FOC
 7. **Estimators** - PLL, QEI, ATPLL
 8. **Motor parameter measurement:**
 - a. **Performance criteria adjustment is not presently supported.** This includes adjustment of phase margin and PI phase lag at crossover in the current loop; Microchip has not completed validation and documentation of these adjustments.
 9. **Autotuning:**
 - a. **Performance criteria adjustment of the current loop is documented in the MCAF User's Guide. Validation of any changes from default values is required, however.** Default values are generally adequate for most motors. For more information, see "Current Loop Tuning" in the MCAF User's Guide.
 - b. **Use of performance criteria adjustment of the velocity loop is not fully documented or tested.** We recommend not adjusting phase margin or PI phase lag unless necessary; cases where this is likely to occur are large inertias where $\alpha_J = J R / L K_m^2 > 10$, for which an increase of phase margin is appropriate. Phase margin values between 70 and 85 degrees are recommended in this case, with larger values providing additional stability at the cost of lower velocity bandwidth.
 10. **Axis management not currently implemented** - supports only one axis.
 11. **Code generation:**
 - a. **PWM switching frequency is variable, but current control loop must be at the same rate** (the value entered under Board parameters PWM switching frequency must be the reciprocal of the current loop sampling rate)
 - b. **Integration with external user-supplied code may involve substantial changes.** Some guidelines for this are given in the documentation for the Motor Control Application Framework. While it is possible to integrate the code generated from motorBench® Development Suite with external code, it is the responsibility of the end user to validate this combination.
 12. **Required compiler settings:**
 - a. **Optimization**
 - `-O1` or greater; `-O0` and `-Os` will both compile without errors but do not execute fast enough to complete within the 50 microsecond ADC ISR. Note: at higher optimization levels, in-circuit debugging using MPLAB X will behave unreliably with respect to breakpoints and single-stepping through C code.
 - The "Omit frame pointer" and "Unroll loops" settings must be enabled.
 - b. **Memory model:**
 - Large data model (handles using pointers, not direct addressing, to allow for more than 8K of program variables)
 - Small scalar model
 - c. **Additional options:** `-Wno-volatile-register-var -finline`
 - d. **Test harness:** In order for the test harness to be enabled, the symbols `MCAF_TEST_PROFILING` and `MCAF_TEST_HARNESS` should be defined.
 13. **Recommended compiler settings:**
 - a. **Additional options:** `-Wundef`

Supported Motor Parameters

Since version 2.15, motorBench® Development Suite supports a wide range of motors, subject to the following notes:

- **Ranges of motor parameters** (including rated values and computed metrics) **must be within the limits noted in either [range-limits-mclv2.html](#) or [range-limits-mchv2.html](#).** These ranges were tested to ensure that code generation produced firmware constants that were within bounds.
- **Motor parameter measurement does not need to complete successfully but valid motor parameters are required.** Some motors may have too low of an inductance or resistance, and may fail motor parameter measurement.
- **Other particular issues that may cause incompatibility with motorBench® Development Suite include**
 - **Large inertia values** – in this case, increasing voltage loop phase margin may prevent stability problems. (See "Autotuning" in the Limitations section of this document.)
 - **Large back-EMF harmonics** – a quasi-sinusoidal back-emf is assumed
 - **Issues involving individual motor control algorithms**, such as PLL estimator, motor startup, or stall detection
 - **High cogging torque**
 - **Mismatch between motor and drive** (namely using a motor with current and/or voltage requirements significantly different from that of the hardware)
- **Microchip cannot guarantee that motorBench® Development Suite will work correctly with all motors.** If a particular motor does not work properly, please contact the MCU16 Motor Control Team for further guidance.

Customer Support

The Microchip Web Site

Microchip provides online support via our web site at <http://www.microchip.com>. This web site is used as a means to make files and information easily available to customers. Accessible by using your favorite Internet browser, the web site contains the following information:

- Product Support – Data sheets and errata, application notes and sample programs, design resources, user's guides and hardware support documents, latest software releases and archived software
- General Technical Support – Frequently Asked Questions (FAQs), technical support requests, online discussion groups/forums (<http://forum.microchip.com>), Microchip consultant program member listing
- Business of Microchip – Product selector and ordering guides, latest Microchip press releases, listing of seminars and events, listings of Microchip sales offices, distributors and factory representatives

Additional Support

Users of Microchip products can receive assistance through several channels:

- Distributor or Representative
- Local Sales Office
- Field Application Engineering (FAE)
- Technical Support

Customers should contact their distributor, representative or field application engineer (FAE) for support. Local sales offices are also available to help customers. A listing of sales offices and locations is available on our web site.

Technical support is available through the web site at: <http://support.microchip.com>

No labels

