motorBench 2.50.0 Release Notes

READY

30 Apr 2025

Table of contents:

Overview of motorBench® Development Suite

motorBench® Development Suite is a graphical, interactive development environment designed to help motor control engineers to design and implement motor control systems on Microchip dsPIC® Digital Signal Controllers. motorBench provides features to:

- Select between start-up methods, rotor position feedback options and additional control features supported by the MCAF
- Measure and report the electrical parameters for the motor and the mechanical parameters for the system
- Quickly get stable Proportional Integral (PI) control loop gains for velocity, flux and torque
- See how the control loop gains affect the system through Bode plots
- Generate code straight into an MPLAB X IDE project to spin the motor

What's New

Motor Control Application Framework (MCAF) R8 — see MCAF User's Guide[1] for more information.

1. Support for custom boards with dsPIC33CK family of devices, including boards that feature MCP802x three-phase MOSFET gate drivers
2. Support for dsPIC® DSCs with integrated three-phase MOSFET gate drivers[2]
    a. dsPIC33CDV, dsPIC33CDVC and dsPIC33CDVL SiP devices
3. Usability improvements to the Configure page, including a new inductance calculator widget
4. Selective measurements feature for motor parameter measurement (Self-Commissioning)
5. Bug fixes and improvements

System Requirements

This release of motorBench® Development Suite has been tested with the following versions of development tools.

- MPLAB X v6.25
- Compiler: XC16 v2.10 and XC-DSC v3.21

MPLAB Code Configurator® (MCC) Components	**Version**
MCC plugin	5.5.2
MCC core	5.7.1
MCC content manager	5.0.1
MCC Melody core	2.8.1

MCC Content Manager Components	
Drivers	**Version**
ADC Multicore	2.1.4
UART	1.10.2
PLIB	**Version**
ADC Multiple SARs	2.4.3
CMP DAC	1.4.2

1 https://microchiptech.github.io/mcaf-doc/latest/
2 https://www.microchip.com/en-us/products/microcontrollers-and-microprocessors/dspic-dscs/integrated-motor-drivers

MCCP/SCCP	1.6.5
OPA	1.4.1
PWM	2.5.0
QEI	1.4.2
Timer	1.5.4
UART	1.5.1
Hardware Peripherals	**Version**
PIC24/dsPIC Hardware Peripheral	1.0.0
System	**Version**
Clock	1.2.1
Clock PLIB	1.4.2
Configuration Bits	1.2.3
DMT	1.0.7
DMT PLIB	1.1.1
ICD	1.0.3
Interrupt	1.4.0
Main	1.1.3
Pins	1.3.1
Pins View	3.9.1
Reset	1.1.0

Watchdog Timer	1.0.9
Watchdog Timer PLIB	1.2.1
Devices	**Version**
PIC24/dsPIC devices	5.12.6
Libraries	**Version**
MCP802x driver	1.2.0
MCP802x PLIB	1.2.0

Supported Hardware

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

> **Note**
>
> Motor parameter measurement (Self-Commissioning) is supported only on dsPIC33EP256MC506 External Op Amp Motor Control PIM and MCLV-2 / MCHV-2 / MCHV-3 development boards.

Supported Processor Plug-In Modules

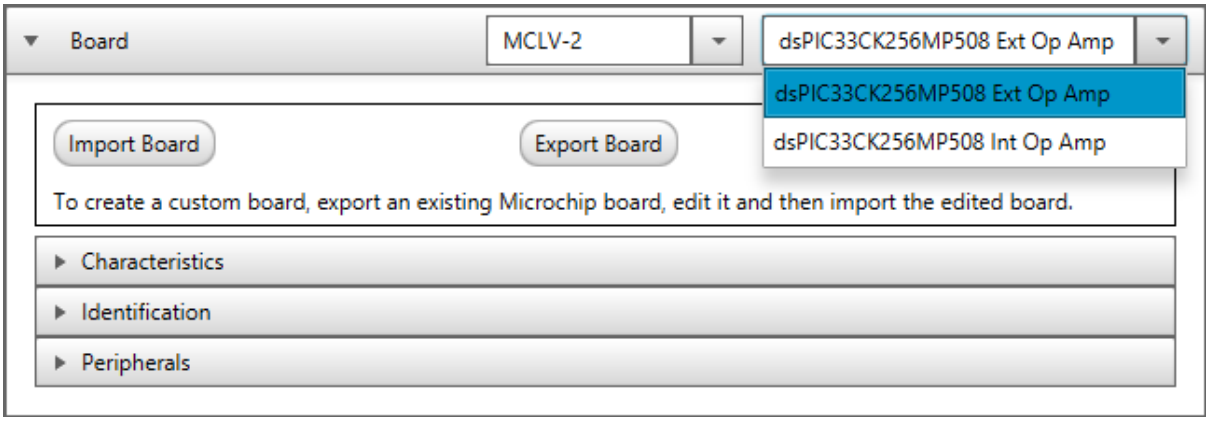
- dsPIC33EP256MC506 External Op Amp Motor Control PIM [Part Number: MA330031-2[3]] with silicon revision A8
- dsPIC33CK256MP508 External Op Amp Motor Control PIM [Part Number: MA330041-1[4]]
- dsPIC33CK256MP508 Internal Op Amp Motor Control PIM [Part Number: MA330041-2[5]]
- dsPIC33CK64MP105 External Op Amp Motor Control PIM [Part Number: MA330050-1[6]]
- dsPIC33CK64MP105 Internal Op Amp Motor Control PIM [Part Number: MA330050-2[7]]
- dsPIC33CK64MC105 External Op Amp Motor Control PIM [Part Number: MA330051-1[8]]
- dsPIC33CK64MC105 Internal Op Amp Motor Control PIM [Part Number: MA330051-2[9]]
- dsPIC33CK256MP508 Motor Control DIM [Part Number: EV62P66A[10]]
- dsPIC33CK64MC105 Motor Control DIM [Part Number: EV03J37A[11]]

---

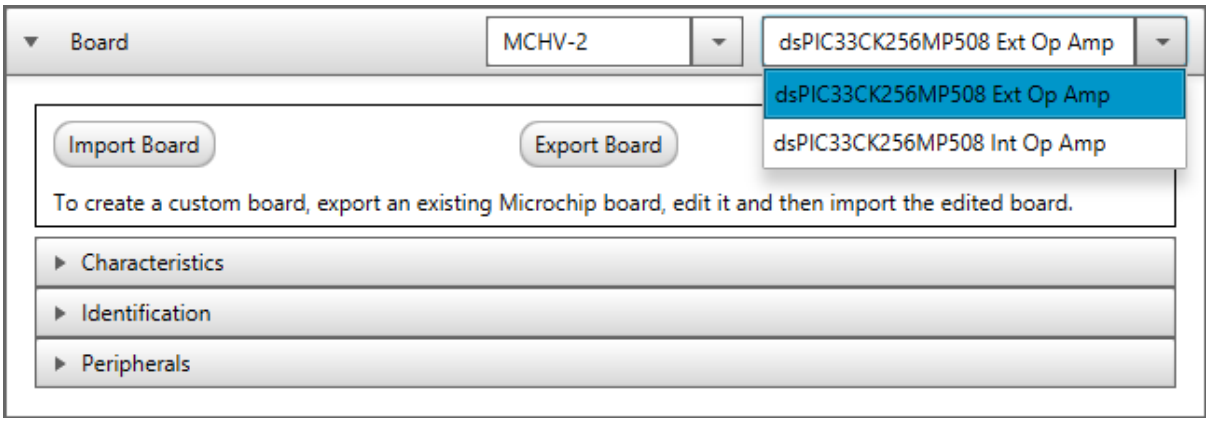
3 https://www.microchip.com/en-us/development-tool/MA330031-2
4 https://www.microchip.com/en-us/development-tool/MA330041-1
5 https://www.microchip.com/en-us/development-tool/MA330041-2
6 https://www.microchip.com/en-us/development-tool/MA330050-1
7 https://www.microchip.com/en-us/development-tool/MA330050-2
8 https://www.microchip.com/en-us/development-tool/MA330051-1
9 https://www.microchip.com/en-us/development-tool/MA330051-2
10 https://www.microchip.com/en-us/development-tool/EV62P66A
11 https://www.microchip.com/en-us/development-tool/EV03J37A

Support for internal op amp PIMs

motorBench® Development Suite supports internal and external op amp PIMs in the dsPIC33CK series. The internal or external op amp PIM for the given board can be selected in the `Board` section in the `Configure` page of motorBench® Development Suite.



When an internal op amp PIM from the Supported PIMs is used with an MCHV-2 or MCHV-3 development board, due to increased op amp gain configuration on the PIM, the full scale current reading of the board configuration should be changed to 11.0A to match the hardware configuration. Select the MCHV-2 and the desired internal op amp PIM and **Export** the board.

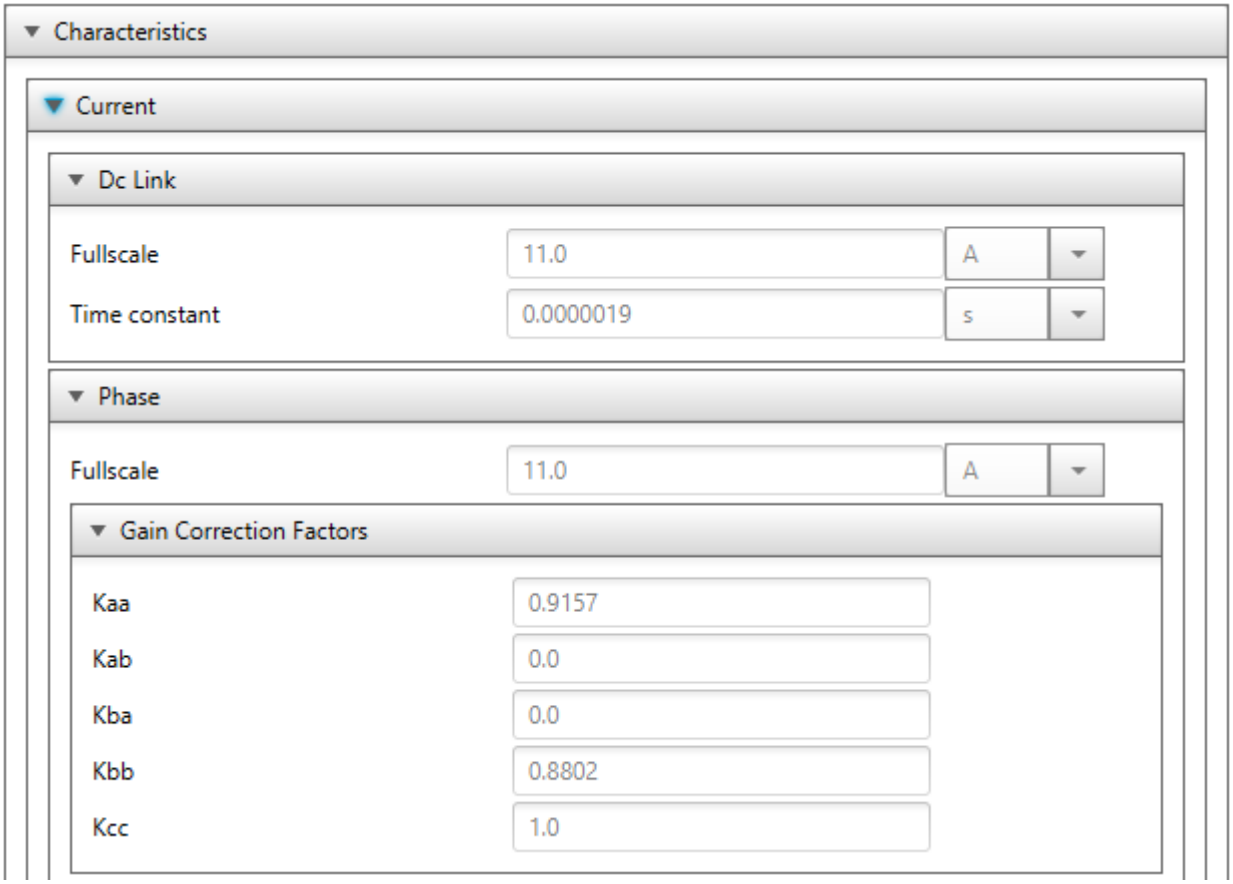


Open the exported YAML file and change the DC link and Phase current full scale values as shown. Save and **Import** the file.

```
characteristics:
  current:
    dcLink:
      fullscale: 11.0
      timeConstant: 1.9E-6
    phase:
      fullscale: 11.0
      gainCorrectionFactors:
        Kaa: 0.9157
        Kab: 0.0
```

```
    Kba: 0.0
    Kbb: 0.8802
    Kcc: 1.0
  maximum:
    continuous: 8.83
  timeConstant: 1.9E-6
```

Verify the changes to the DC link and Phase current full scale values in the new board configuration under `Characteristics`.



Low-voltage hardware

1. One of the following development boards
   a. dsPICDEM MCLV-2 Development Board [Part Number: DM330021-2[12]]
      i. Any of the Plug-In Modules supported by motorBench® Development Suite.
   b. dsPIC33CK Low Voltage Motor Control Board [Part Number: DM330031[13]]
   c. MCS MCLV-48V-300W development board [Part Number: EV18H47A[14]]
      i. Any of the DIMs supported by motorBench® Development Suite.

12 https://www.microchip.com/en-us/development-tool/DM330021-2
13 https://www.microchip.com/en-us/development-tool/DM330031
14 https://www.microchip.com/en-us/development-tool/EV18H47A

2. A three phase PMSM or BLDC motor that is compatible with 24V, such as the Hurst 24V BLDC motor DMA0204024B101 [Part Number: AC300022[15]].
3. 24V power supply [Part Number: AC002013[16]] - 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[17]] or dsPICDEM MCHV-3 Development Board [Part Number: DM330023-3[18]]
    a. 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[19]].

Development board selection guide

There are certain reasons to prefer specific low-voltage development boards for given tasks. In brief:

- Prefer MCLV-2 for low-current motors like the AC300020[20] which utilize only a small fraction of the development board's output current range — otherwise the motor and drive are mismatched.
- Otherwise prefer one of the other boards. Certain algorithms such as ZS/MT have improved performance when using the capabilities of these boards, namely sensing all three phase currents and using shorter dead times.

	Output current*			
Board	**Range**	**Channels**	**Module**	**Other features / comments**
MCLV-2[21]	2.29 A	A, B, DC	100-pin PIM	Layout issue with current sense traces impacts current sense gains (see MCAF User's Guide)
dsPIC33CK LVMC[22]	14.1 A	A, B, C, DC	—	Temperature sensor, sub-microsecond dead time. A fixed dsPIC33CK256MP508[23] device is soldered directly to the board.
MCLV-48V-300W[24]	16.8 A	A, B, C, DC	120-pin DIM	Temperature sensor, sub-microsecond dead time

15 http://www.microchip.com/AC300022
16 https://www.microchip.com/AC002013
17 http://www.microchip.com/DM330023-2
18 http://www.microchip.com/DM330023-3
19 http://www.microchip.com/AC300025
20 https://www.microchip.com/en-us/development-tool/AC300020
21 https://www.microchip.com/en-us/development-tool/dm330021-2
22 https://www.microchip.com/en-us/development-tool/DM330031
23 http://www.microchip.com/wwwproducts/en/dsPIC33CK256MP508
24 https://www.microchip.com/en-us/development-tool/EV18H47A

*Current is maximum continuous motor phase current when used with motorBench® Development Suite and MCAF.

Other required hardware

MCLV-2/MCHV-2/MCHV-3 development boards:

1. A USB-to-logic-level-UART converter from the following list:
    a. Saelig USB-COM-U[25] or USB-COM-U13[26]
    b. TRENDnet TU-S9[27] v2.0
2. Programming tool - one of the following tools for MCLV-2 boards: ICD4, PICkit4
3. Board calibration load resistors - this is optional, please see motorBench® Development Suite User's Guide for more details

Installing motorBench ® Development Suite v2.50.0

For installation instructions please see the motorBench ® User's Guide on the motorBench release repository[28].

Changes in MCAF

MCAF has been updated to R8, 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)

25 http://www.saelig.com/product/USSP004.htm
26 http://www.saelig.com/USSP/USSP005.htm
27 https://www.trendnet.com/products/USB-adapters/TU-S9
28 https://github.com/microchip-pic-avr-solutions/motorbench-release-collateral

    - Added Motion Control API (MCAPI)
    - Added dead-time compensation
    - Other minor fixes
- Changes in R7:
    - Added hardware abstraction layer support for MCC Melody
    - Added support for single channel current measurement
    - Added support for Zero-speed Maximum Torque (ZS/MT) sensorless estimator for motors with rotor saliency
    - Added support for outer loop voltage control
    - Added closed-loop stopping methods
    - Added support for dsPIC33CK Low Voltage Motor Control Board
    - Added support for MCLV-48V-300W Inverter Board
    - Added support for internal op amps
    - Other minor fixes
- Changes in R8:
    - Added support for custom boards
    - Added support for all dsPIC33CKxxxMP/MCxxx devices
    - Added support for dsPIC33CDV, dsPIC33CDVC and dsPIC33CDVL SiP devices
    - Added support for MCP8021, MCP8022 and MCP8027 three phase gate driver devices
    - Added Customize page option for disabling X2Cscope real-time debugging
    - Bug fixes and improvements

Fixed Issues

Address Trap advisory for MCAF R6 and MCAF R7

MCAF R8 fixes issue DB_MC-5517 (ERR_ADDRESS_ERROR trap while using XC-DSC 3.21 with motorBench 2.45 and MCLV-48V-300W board). This was an error in inline assembly interfacing with the `UTIL_DivQ15SatPos()` function in util.h:

excerpt from util.h, MCAF R6 and MCAF R7

```
inline static int16_t UTIL_DivQ15SatPos(int16_t num, int16_t den)
{
    int16_t quotient;

    asm (
        "    ;UTIL_DivQ15SatPos\n"
        "    repeat  #__TARGET_DIVIDE_CYCLES\n"
        "    divf    %[num],%[den]\n"
        "    btsc    SR,#2\n"            // OV = bit 2
        "    mov     #0x7fff, %[quotient]"
        : [quotient]"=a"(quotient)
        : [num]"r"(num), [den]"e"(den)   // den restricted to R2-R14 for DIVF
    );
    return quotient;
}
```

This did not correctly notify the compiler of the required register usage including the division remainder. In some cases, when this register was used by the compiler as a pointer, an error trap occurred when compiled with XC-DSC 3.21.

Please take one of the following actions:

- Upgrade to MCAF R8
- If remaining with MCAF R6 or R7 is required, please make sure util.h is updated to the following content:

excerpt from util.h, MCAF R8

```
inline static int16_t UTIL_DivQ15SatPos(int16_t num, int16_t den)
{
    int16_t quotient;
    int16_t remainder;  // unused, but part of DIVF operation

    asm (
        "    ;UTIL_DivQ15SatPos\n"
        "    repeat  #__TARGET_DIVIDE_CYCLES\n"
        "    divf    %[num],%[den]\n"
        "    btsc    SR,#2\n"            // OV = bit 2
        "    mov     #0x7fff, %[quotient]"
        : [quotient]"=a"(quotient), [remainder]"=&b"(remainder)
        : [num]"r"(num), [den]"e"(den)   // den restricted to R2-R14 for DIVF
        : "cc", "RCOUNT"
    );
    return quotient;
}
```

Known Issues

motorBench Issues

Issue Key	Summary	Workaround
MBPLAN-673	Serial port does not get closed programmatically if MPLAB X IDE closes unexpectedly during motor parameter measurement	-
MBPLAN-837	"Project reference must not be null" error when building firmware during motor parameter measurement.	-
MBPLAN-872	Right-clicking on fields causes display of two popup menus	-

Issue Key	Summary	Workaround
MBPLAN-876	Number of pole pairs is a positive integer; the Configure page for motor allows any non-negative floating-point	-
MBPLAN-935	Motor parameter measurement may terminate the serial port connection after a certain period of time if the user does not respond to a fault dialog box	Restart the parameter measurement
MBPLAN-941	MCC help menu appears in place of motorBench	-
MBPLAN-1095	motorBench generates code into the wrong project if the user switches the main project after loading	-
MBPLAN-1160	"Import Motor" and "Export Motor" buttons can be clicked multiple times, opening multiple dialog boxes	-
MBPLAN-2030	MPLAB X IDE crashes while using motorBench on Mac OS	-
MBPLAN-2035	Board compare feature fails to launch if the project is set up to use a device that does not match the following - dsPIC33EP256MC506, dsPIC33CK256MP508, dsPIC33CK64MC105, dsPIC33CK64MP105	-
MBPLAN-2036	File path to diff/compare tool used for board compare feature is incorrectly saved within the loaded project rather than on a per-user basis	-

Motor Control Issues

Issue Key	Summary	Workaround
DB_MC-560	Speed controller exhibits chattering behavior at voltage saturation hysteresis boundary (MCAF)	-
DB_MC-1092	PLL estimator may not always 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)	Use ATPLL estimator

Issue Key	Summary	Workaround
DB_MC-1521	Velocity loop step response test exhibits more than expected overshoot with MCHV2 and Leadshine400 motor	-
DB_MC-1922	LED patterns not displayed when in the TEST_DISABLE or TEST_ENABLE states	-
DB_MC-2275	Large current ramp up times may not start (STARTUP_TORQUE_RAMPUP_RATE = 0)	-
DB_MC-2323	Active damping is incorrectly enabled during Weathervane startup transition state	-
DB_MC-2742	ATPLL not robust to speed commands near zero; runs away to full negative speed	-
DB_MC-2794	Default current loop bandwidth not high enough to reject disturbances caused by backemf harmonics and dead-time distortion	-
DB_MC-2873	Current loop autotune input-output delay incorrectly underestimated as 1 sample instead of 1.5 or 2 samples	-
DB_MC-3127	ADC current offset calibration process leaves behind a small amount of residual offset error	-
DB_MC-3414	Potential for integer overflow in stall_detect.c → MCAF_LowSpeedDetectInit()	-
DB_MC-3425	AN1292 PLL may not lock reliably under rapid acceleration when used as a secondary estimator	-
DB_MC-3432	ZS/MT can lock onto the wrong angle during flying start	-
DB_MC-3559	Parameter conversion to fixed-point integer does not warn if gains are zero	-
DB_MC-3734	Possible bug: incompatibility between ZSMT IPC startup method and QEI synchronization	-

Issue Key	Summary	Workaround
DB_MC-4363	Operation of the AN1292 PLL estimator and the ATPLL estimator may not be robust for certain motors at the default values of minimum and startup speed.	Increase the values of minimum and startup speed in the Customize page until motor operation is reliable.
DB_MC-4423	Customize UI groups may overlap on each other in certain cases	-
DB_MC-4559	Active damping maximum current amplitude I_delta is not constrained to less than startup current Iq0	-
DB_MC-4670	ZS/MT hybrid estimator transition delay counter starts before both estimators converge	-
DB_MC-4751	Inaccurate doc comment in PI controller step function	-
DB_MC-5542	Current offset calibration fails silently for offset values outside the allowable range of +/-1/32	-
DB_MC-5549	MCAF_MainInit() has an unbounded while loop dependent on conditions outside the microcontroller	-
DB_MC-5612	dsPIC may not respond after power cycling MCHV-3 board	Press the reset button
DB_MC-5640	MCLV-2 board starts with a hardware over-current fault at every power up event	-
DB_MC-5652	Diagnostic UART does not configure TX pin to start high	-

Limitations

Software Limitations

motorBench® Development Suite is tested for serial communication using Windows 7, Windows 10 and Windows 11 platforms. Other platforms may work with standard baud rates, but this operation has not been verified.

Backward compatibility

Projects created with earlier versions of motorBench® Development Suite *may be* compatible with version 2.50.0, however this is not fully tested. After migrating an existing project to use motorBench v2.50.0, please verify the motorBench configuration - especially parameters in the Customize page.

Motor Control Limitations

Listed below 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 (not updated for LVMC/MCLV-48V-300W):
   The reference motor is the Nidec Hurst motor DMA0204024B101 (MicrochipDirect part number AC300022[29]). 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	
				10^{-2} 10^{-1} 10^{0} 10^{1} 10^{2} 10^{3}

(Note: Mechanical time constant (2/3)×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) × 0.007796968)

MCHV-2/MCHV-3:
The reference motor is the Leadshine 400W motor EL5-M0400-1-24 (MicrochipDirect part number: AC300025[30]). 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.

	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	
				10^{-2} 10^{-1} 10^{0} 10^{1} 10^{2} 10^{3}

Note

29 https://www.microchip.com/DevelopmentTools/ProductDetails/ac300022
30 http://www.microchip.com/AC300025

> Motor parameter limits shown above are for guidance only, they are **not** absolute limits. Select an appropriate board, enter the parameters of your motor in motorBench and then generate code to know for sure if your motor is compatible with motorBench while using the selected board.

3. **Board** - see "Scope of hardware support" section of MCAF users guide chapter for more details.
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. **Current measurement** - The passive components for the DC link current op amp circuit are not populated by default on the dsPIC33CK256MP508 Internal Op Amp PIM (MA330041-2). Algorithms that require sampling of the DC link current, such as Single-channel current measurement, are available through the on board op amp instead.
6. **One algorithm** - FOC
7. **Estimators** - PLL, QEI, ATPLL, ZS/MT
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 $\alpha_J = JR/LK_m^2 > 10$, 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 either in `parameters/options.h` or project properties → xc16-gcc → Preprocessing and messages → Define C macros.

13. **Recommended compiler settings:**
    a. **Additional options**: `-Wundef` See MPLAB XC16 C Compiler User's Guide[31] (or MPLAB XC-DSC C Compiler User's Guide[32]) for more information.

Supported Motor Parameters

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

- **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 Microchip technical support for further guidance.

Supplemental Notes

Compiler warnings

Certain warnings may be reported in the MPLAB X IDE Output terminal when building a motorBench® project. These are only warnings, and do not affect code functionality.

Optimization may eliminate reads and/or writes to register variables

See GCC 4.5.1[33] for more information.

To suppress this warning, the following compiler flag should be added to the **Project Properties**:

31 https://ww1.microchip.com/downloads/aemDocuments/documents/DEV/ProductDocuments/UserGuides/50002071.pdf
32 https://ww1.microchip.com/downloads/aemDocuments/documents/DEV/ProductDocuments/UserGuides/MPLAB-XC-DSC-C-Compiler-User-Guide-DS50003589.pdf
33 https://gcc.gnu.org/onlinedocs/gcc-4.5.1/gcc.pdf

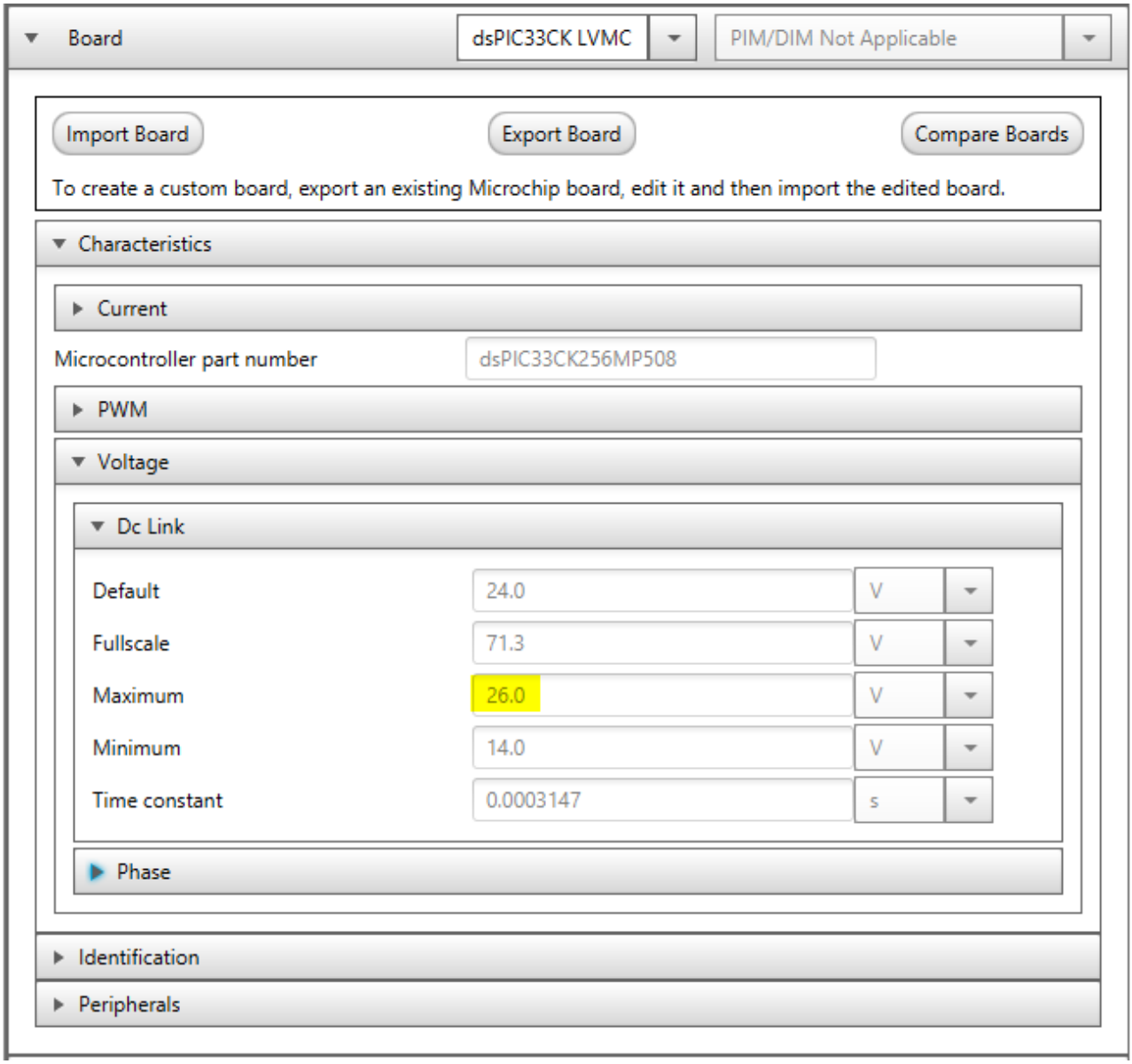
```
-Wno-volatile-register-var
```

To add this compiler flag to the project, go to **Project Properties** → **Conf:[default]** → **XC16** → **xc16-gcc** and add this compiler flag to **Additional options**.

Development board

dsPIC33CK LVMC development board

The maximum DC link voltage limit for this board (26V) was chosen to stay near the rating of the connector J1. Users may choose to increase this maximum voltage limit to support cases where they provide their own power supply via terminal block J2 and cut the "net tie" to decouple the control power supply from the inverter power supply. See User Guide document DS50002927A-page 15 for more information.



Customer 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[34]

34 http://support.microchip.com/