MC110 Software Manual

Release 7.4/1.0

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Contents

Scope of Changes

- Version 1.0
  - Added:
    - First version issued

Software applications

To properly connect and configure a **MC110 unit**, **Veronte Link** and **MC110 PDI Builder** are required.

Veronte Link

Veronte Link establishes communication between a computer and any Veronte product by creating a VCP bridge. It allows to use multiple control stations and autopilots to be interconnected, operating simultaneously. **Veronte Link** also includes a post-flight viewer, to reproduce all recorded data from previous flights and generate plots and reports.

For more information, visit the Veronte Link user manual.

MC110 PDI Builder

This tool is used to set all the configurable parameters. Here the user can set, tune and define the motor, control systems and sensors that are going to be used alongside the ESC.

For more information, visit the MC110 PDI Builder user manual.

> ⓘ **Note**
>
> Users can find detailed information on how to perform Tuning of the MC110 in the Tuning section of the **MC110 PDI Builder** user manual.

List of Variables

This section shows the variables employed exclusively by **Veronte MC110**. The rest of variables can be read in the Lists of Variables - Lists of interest section of **1x Software Manual**.

BIT Variables

ID	Name	Description
4	No Writing Telemetry	Telemetry is properly sending/receiving - 0 for no, 1 for yes
6	File System ERROR	System file manager - Dependent on **File system status (UVar 96)** • 0 for Error: if File system status > 0 • 1 for running OK: if File system status == 0
7	System ERROR	This bit checks whether the system is running properly. 0 for system error, 1 for system OK
8	Memory allocation ERROR	RAM allocation - 0 for Error, i.e. trying to use more than available memory, 1 for memory allocation ok

ID	Name	Description
9	PDI ERROR	PDI files - Dependent on **PDI error source (UVar 50)** • 0 for wrong PDI configuration: if PDI Error Source > 0 • 1 for running OK: if PDI Error Source == 0
12	System Power Up ERROR	Power up - 0 for Error, 1 for OK
16	Stack C1 usage FAIL	0 for Fail, i.e. stack overflow of Core 1, 1 for OK
400	C1 Low Frequency Fail	C1 Low Frequency - Dependent on **CIO Running Frequency (RVar 2057)** (C1 low frequency) • 0 for Fail → CIO Running Frequency < 10 Hz • 1 for OK → CIO Running Frequency > 10 Hz
402	Acquisition Step Missed	

ID	Name	Description
		• 0 for Acquisition step missed → C1 hi frequency fluctuation is higher than permitted (1%). • 1 for Acquisition Task OK → C1 hi frequency fluctuation is under set limits (1%).
406	CPU2 low priority task error	0 for Error, 1 for OK
480	MC01 Stepper direction output ERROR	0 for Error, 1 for OK
481	MC01 Brushless driver fault	0 for driver fault, 1 for driver OK
482	MC Hall Sensor ERROR	0 for Error, 1 for OK
483	MC Sin/Cos Sensor ERROR	0 for Error, 1 for OK
484	MC General health ERROR	0 for health Error, 1 for status OK
485	MC Current sensing ERROR	0 for Error, 1 for OK
486	MC Phase U Current	ADC phase U calibration status - 0 for not

ID	Name	Description
	Calibration ERROR	calibrated, 1 for calibration OK
487	MC Phase V Current Calibration ERROR	ADC phase V calibration status - 0 for not calibrated, 1 for calibration OK
488	MC Phase W Current Calibration ERROR	ADC phase W calibration status - 0 for not calibrated, 1 for calibration OK
489	MC Maximum Temperature ERROR	Maximum power module temperature exceeded - 0 for Error (exceeded), 1 for OK
490	MC Phase ERROR	Power module driver phase error reported - 0 for Error, 1 for OK
491	MC General Driver ERROR	Power module driver error reported - 0 for Error, 1 for OK
492	MC Over-current AC	Current AC side limit exceeded - 0 for Error (exceeded), 1 for OK
493	MC Over-voltage Advertisement	Over-voltage DC side limit advertisement exceeded - 0 for Error (exceeded), 1 for OK

ID	Name	Description
494	MC Over-voltage Caution	Over-voltage DC side limit caution exceeded - 0 for Error (exceeded), 1 for OK
495	MC Under-voltage Latching	Critical under-voltage DC side limit violation - 0 for Error, 1 for OK
496	MC Under-voltage ON Latching	Non critical under-voltage DC side limit violation - 0 for Error, 1 for OK
497	MC RMS imbalance	Current AC side imbalance - 0 for Error, 1 for OK
498	MC Open DC fault	Open-circuite DC side fault - 0 for Error, 1 for OK
499	MC Over-current DC	Current DC side limit exceeded - 0 for Error (exceeded), 1 for OK
732-733	Phase U-W ERROR	0 for Error, 1 for OK
734	HW DC link ERROR	0 for Error, 1 for OK
735-736	HW over-current AC-DC ERROR	0 for Error, 1 for OK
737	HW Ground Fault Detection ERROR	0 for HW Ground Fault Detection Error, 1 for HW Ground Fault Detection OK

ID	Name	Description
738	HW Power Regulator ERROR	0 for HW Power Regulator error, 1 for HW Power Regulator OK
739	HW trip PWM ERROR	0 for HW general error to trip PWM, 1 for HW general to trip PWM OK
740	Disconnected HW battery	0 for Battery disconnected, 1 for Battery connected
741	DC current calibration ERROR	0 for DC current calibration Error, 1 for DC current calibration OK
742	Estimation Position ERROR	0 for estimation position Error, 1 for estimation position OK
743	Speed reference tracking ERROR	0 for speed reference tracking Error, 1 for speed reference tracking OK
744	Positon Sensor ERROR	0 for position sensor Error, 1 for position sensor OK
745-746	SIN/COS 1-2 Calibration ERROR	0 for SIN/COS calibration Error, 1 for SIN/COS calibration OK
747	Low energy ERROR	0 for low energy Error, 1 for low energy OK

Real Variables (RVar) - 32 bits

ID	Name	Units/ Values	Description
51	CAN-B Tx Rate	pkts/s	CAN-B transmission packet rate
53	CAN-B Tx skip Rate	pkts/s	CAN-B messages delayed because no mailbox is available for sending
54	CAN-FD-A Tx rate	pkts/s	CAN-FD-A transmission packet rate
55	CAN-FD-A Tx skip rate	pkts/s	CAN-FD-A messages delayed because no mailbox is available for sending
300	Relative Timestamp	s	Time spent since power-on of the system
400	Power Input	V	Voltage received by Veronte
1450	Captured Pulse 0	customType	Input values from pulses
2048		s	

ID	Name	Units/ Values	Description
	Acquisition Task Maximum Timestep		Maximum period to execute the acquisition thread
2051	Acquisition Task Maximum CPU Ratio	%	Maximum % of CPU time spent in the acquisition thread
2057	CIO Running Frequency	Hz	C1 low priority task running frequency
2058	MC CIO Min Running Frequency	Hz	Minimum assured frequency of low priority task
2092	CPU2 Low priority current frequency	Hz	Current operating frequency of CPU2 low priority tasks
2093	CPU2 Low priority min frequency	Hz	Minimum assured frequency of CPU2 low priority task
2330	Control Loop Period	s	MC control loop period
2331	Control Loop Maximum Period	s	MC maximum control loop period

ID	Name	Units/ Values	Description
2332	Control Loop Duration	s	MC control loop average execution time
2333	MC Control Loop Maximum Duration	s	MC control loop maximum average execution time
2334	Control Loop CPU Usage Ratio	%	MC CPU usage ratio
2335	MC Control Loop Maximum CPU Usage Ratio	%	MC maximum CPU usage ratio
2336-2338	MC U-V-W Phase Current	A	MC U-V-W phase current
2339	MC Electrical Angle	rad	MC electrical angle
2340	MC01 Mechanical Angle	rad	MC mechanical angle
2341	MC Mechanical	rad/s	MC mechanical angular speed

ID	Name	Units/ Values	Description
	Angular Speed		
2342	MC01 Desired Mechanical Angle	rad	MC desired mechanical angle
2343	MC01 Position Controller Output	rad/s	MC position PDI output
2344	MC Desired Mechanical Angular Speed	rad/s	MC desired mechanical angular speed
2345	MC Desired Mechanical Angular Speed After Speed Limiter	rad/s	MC desired mechanical angular speed after speed limiter
2346	MC Speed Controller Output	A	MC speed PDI output
2347-2348	MC Alpha-Beta Current	A	MC alpha-beta current after Clarke transformation

ID	Name	Units/ Values	Description
2349-2350	MC Actual Direct-Quadrature Current	A	MC actual direct-quadrature currents
2351-2352	MC Desired Direct-Quadrature Current	A	MC desired direct-quadrature currents
2353-2354	MC Direct-Quadrature Voltage From Controller Output	V	MC direct-quadrature voltage from PIDs outputs
2355-2356	MC Alpha-Beta Voltage From Current Controller Output	V	MC Alpha-Beta voltage from current controller output
2357-2358	MC01 Desired Clarke Alpha-Beta current	customType	MC01 desired Clarke alpha-beta currents
2359-2361	MC01 U-V-W Phase	customType	MC01 phase time constants

ID	Name	Units/ Values	Description
	Space Vector Generator Output		
2362-2364	MC U-V-W Phase PWM Duty Cycle	%	MC U-V-W Phase PWM duty cycle outputs
2365	MC01 Encoder Raw Angle	rad	MC01 encoder raw measured angle
2366	MC01 Stepper Output Frequency	Hz	MC01 stepper output frequency
2367	MC Mechanical Angle Error	rad	MC mechanical angle error
2368-2370	MC U-V-W Phase BEMF	V	MC U-V-W phase electromechanical force
2371	MC Input Current DC side	A	DC bus current
2372	MC Input Normalized Command Speed	customType	Speed input rate from source (CAN or PWM)

ID	Name	Units/ Values	Description
2373-2374	MC ADC in 0-1	V	**Note** System reserved Variables
2375	MC Logic Board Temperature	K	Board temperature
2376	MC Power Module Temperature	K	IGBT filtered temperature
2377	MC Motor Temperature	K	Motor temperature
2378	MC Input Voltage DC side	V	DC bus voltage
2381	MC Virtual and estimator angle difference	rad	Angle offset value from estimated and commanded angle to close control loop
2382	MC Low speed estimator angle	rad	Low speed observer estimated angle
2383	MC High speed	rad	

ID	Name	Units/ Values	Description
	estimator angle		High speed observer estimated angle
2384	MC Low speed estimator speed	rad/s	Low speed observer estimated mechanical speed
2385	MC High speed estimator speed	rad/s	High speed observer estimated mechanical speed
2386	String DC current	A	String direct current (DC)

Integer Variables (UVar) - 16 bits

ID	Name	Description
50	PDI error source	Index for PDI error source identification. For further information, consult the **List of PDI errors - 1x Software Manual**
95	UAV hardware adress	UAV address
96		State error for DFS2 FS

ID	Name	Description
	File system status	For further information, consult the **List of File System Errors - 1x Software Manual**
454-456	CAN to Serial 0-2 frames dropped	Lost messages during CAN to Serial transformations
495-496	Global configuration state (crc) of files-memory (Higher-Lower 16 bits)	Global configuration state (crc) of files and memory
498-499	Global configuration state (crc) of files-memory	Global configuration state (crc) of files and memory
800	MC Fault Id	Index of the MC error **Warning** **Deprecated variable**
801	MC Input Control Mode	Index of the MC control input mode:

ID	Name	Description
		• 1: PPM • 2: CAN • 3: both modes active (CAN priority)
802	MC Actual Control Machine State	State of motor controller: • 0: Motor stop and driver disabled • 1: Calibration of ADC reading • 2: Initial alignment procedure • 3: Open loop procedure • 4: Speed mode

CAN Bus protocol

CAN Commands to MC110

MC110 can receive commands from any CAN device. All CAN messages for **MC110** follow the same structure, a string of bits divided in two groups:

Group	Name	Size	Description
1	CAN Id	11-bits: standard 29-bits: extended	If the **CAN Id** matches with the Id of a **MC110** input filter (a type of CAN consumer), the message will be correctly read by the MC speed filter consumer. Otherwise, it will be ignored.
2	Payload	4 bytes	**Speed** must be represented with a **compressed 32-bit signed** variable with little endian format. The values of this variable should be in the range [**0 to maximum RPM** (speed)] or [**-maximum RPM to maximum RPM**], depending on whether users want to allow negative commands.

Group	Name	Size	Description
			Note Negative values command the opposite movement to positive ones. Therefore, the maximum value corresponds with the maximum speed and the maximum negative value corresponds with the maximum reversed speed.

The parameter that is configured in the **MC110** to receive these CAN commads is the **CAN Id** of **Input filter** producer, which has to be linked to the **CAN Cmd** consumer. To know more, read the CAN I/O - Input/Output section of the **MC110 PDI Builder** user manual.

An example for sending commands from **Veronte Autopilot 1x** to a **MC110** unit is explained in the MC110/MC24 - Integration examples section of the **1x PDI Builder** user manual.

Telemetry messages from MC110

Telemetry messages can be transmitted from the **MC110** unit to provide information of interest to the user, such as the board temperature or the input command values.

CAN messages sent by **MC110** have also the structure:

1. **CAN Id**: It can be in standard frame format (11-bits) or in extended frame format (29-bits). The CAN Id frame format will depend on the CAN protocol of the receiving device.
2. **Variable**: Users can send as telemetry the variable they want to know information about. All the variables available to be sent from the **MC110** unit can be consulted in the lists of variables section of this manual.
   The format in which these variables must be sent will depend on the CAN protocol of the device that will read the message.

Detailed information on **how to build CAN messages** can be consulted in the Custom Messages types - Input/Output section of the **1x PDI Builder** user manual.

Firmware Changelog

This section presents the changes between firmware versions of MC110.

7.4.6

This section presents the firmware changelog of the release **v.7.4.6**. For further details, please consult the Service Bulletin nº 00010.

Added

- New control states from the motor controller: Hold Zero RPM (set zero speed), Zero Current (be windmilling).
- New current limiter implemented in D-Q axis for sensored mode. Optional regenerative current limiter to prevent over-voltage. Optional output power limitation when DC voltage drops below threshold values.
- Support and calibration for Sin-Cos sensors.
- CAN-FD support
- A new High Frequency Diagnostics Data recording message enables logging of potential faults during flight.
- New FW updating feature: Serial Over CAN using CAN 2.0.
- New application alert when 90% of consumption is reached on either C1 or C2 high-priority task.
- New fault detection for low energy detection.
- STANAG support included.
- The speed controller now has tracking signal feedback scaled by a configurable gain in order to prevent wind-up and improve signal tracking. The current controller now recalculates its integral gain to compensate for motor temperature variations.

Removed

- The minimum speed and time for going to IDLE mode have been removed from the Control configuration, as it is possible to implement that externally.

Improved

- Non-latching under-voltage protection is now triggered with the correct time configuration, instead of with the latching under-voltage timing.
- Caution/Advertisement over-voltage protections are now unified into a single protection.
- Power module temperature is now filtered using a second order Butterworth filter and computed in the high-priority task.
- SW architecture updated from single-core to dual-core for faster control execution.