EDP-AM-MC1 DC Brushed Motor Controller Application Module Manual

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This document contains information on the MC1 brushed motor controller module for the RS EDP system.

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1. DC Brushed Motor Controller

The motor controller module is designed to drive 12V DC brushed motors of up to 2A with 3A being permitted when the auxiliary power connector is used. Up to two motor control modules may be fitted to a single baseboard (see section on configuring module for use as a secondary drive). There is no intelligence contained within the module and software running on a CPU module is required to realise a useful motor drive.

It is based on the LM18200 full DMOS bridge controller and can be used in a variety of ways to realise different levels of current and speed control strategy. Current monitoring is possible via the CM's ADC and the device itself is protected by an over-temperature output which allows the drive to be deactivated under software control to prevent damage.

Warning: it is the user's responsibility to provide such software.

To allow the creation of a motor controller with practical applications, inputs are provided for the following:

Input Name	Default Input Type	Alternate Input Type	Comment
Open limit switch	Voltless contact to ground (1MOhm pull-up)	4K7 pull-up to VCC_CM	Extreme of travel if used as a servo
Closed limit switch	Voltless contact to ground (1MOhm pull-up)	4K7 pull-up to VCC_CM	Extreme of travel if used as a servo
Tachogenerator	0-10V	0-ADC VAREF voltage	Speed feedback as a voltage
Quadrature encoder/Hall sensor	1K pull-up to VCC_CM	None	Speed and direction feedback
Tacho pulses	4K7 pull-up to VCC_CM	None	Speed feedback
External fault	4K7 pull-up to VCC_CM	None	Emergency stop request from controlled plant
Fault reset	Voltless contact to ground (1MOhm pull-up)	4K7 pull-up to VCC_CM	Clear any faults and restart motor
Motor run/stop	Voltless contact to ground (1MOhm pull-up)	4K7 pull-up to VCC_CM	Start or stop motor
Motor direction	Voltless contact to ground (1MOhm pull-up)	4K7 pull-up to VCC_CM	Change motor direction of running
Vdclink	Analog 0-VCC_CM	None	Allows the motor drive voltage to be measured
Vsense	Analog 0-VCC_CM	None	Allows the motor current to be measured as a voltage (Rsense * 377uA per Amp)
Target current reached	Digital, 0-3V3	None	Interrupt request to CM when motor current reached target level set by CPU DACO0_GPIO17 during last chopping period

Software is required for the CM fitted to make full use of these inputs.

1.1 Mapping Of CPU Peripherals To Motor Control Module

The CPU peripheral pins on the CPU module are connected to the motor control module as shown below. The mapping shows the connections for the situation where two motor control modules are present. Only two CMs are shown here.
As Each CM is equipped with slightly different resources it is possible that one particular CM will provide more support for the MC1 motor drive module than others. Pretty much all of the CMs will provide basic support for the MC1 module in so much as a PWM will be available to drive the internal bridge, plus the brake and direction signals. The higher pin count MCUs should also provide support for the current monitoring and various switch inputs.

XC167 Pin Allocation	STR9 Pin Allocation	EDP-AM-MC1 Allocation
Vcc to BB	Vcc 3V3 or 5V, supplied by CM	Vcc 3V3 or 5V, supplied by CM
42 GUARD/AN GND	AVSS Analog GND	VAGND
92 P20.2	P8.0	GPIO0
8 P6.1/CC1IO	P4.7	EVG8_GPIO56
56 P2.15/CC15IO	P4.6	EVG7_GPIO54
55 P2.14/CC14IO	P4.5	EVG6_GPIO52
54 P2.13/CC13IO	P4.4	EVG5_GPIO50
53 P2.12/CC12IO	P4.3	EVG4_GPIO48
52 P2.11/CC11IO	P4.2	EVG3_GPIO46
51 P2.10/CC10IO	P4.0	EVG2_GPIO44
13 P6.6/CC6IO	P6.4	EVG18_GPIO66
12 P6.5/CC5IO	P6.3	EVG16_GPIO64
10 P6.3/CC3IO	P6.1	EVG12_GPIO60
50 P2.9/CC9IO	P4.1	EVG1_GPIO42
49 P2.8/CC8IO	P4.0	EVG0_GPIO40
Digital GND	Digital GND	Digital GND
37 AN8	NC	AN8
39 AN6	P4.6	AN6
33 AN4	P4.4	AN4
31 AN2	P4.2	AN2
45 AN14	NC	AN14
43 AN12	NC	AN12
35 AN10	NC	AN10
29 AN0	P4.0	AN0
Vcc 5V from reg	5V from baseboard regulator	5V from baseboard regulator
Vcc 3V3 from reg	3V3 from baseboard regulator	3V3 from baseboard regulator
12V Power GND	12V Power GND	12V Power GND
12V Power GND	12V Power GND	12V Power GND
+12V 2A	+12V 2A	+12V 2A
+12V 2A	+12V 2A	+12V 2A

XC167 Pin Allocation	STR9 Pin Allocation	EDP-AM-MC1 Allocation
Vcc to BB	Vcc 3V3 or 5V, supplied by CM	Vcc 3V3 or 5V, supplied by CM
GUARD/AN GND	AVSS Analog GND	VAGND
80 P4.0	P8.1	GPIO1
131 P1H.4/CC24IO	P6.7	EVM9_GPIO55
132 P1H.5/CC25IO	P6.6	EVM8_GPIO53
133 P1H.6/CC26IO	P7.7	EVM7_GPIO51
134 P1H.7/CC27IO	P7.6	EVM6_GPIO49
15 P7.4/CC28IO	P7.3	EVM5_GPIO47
16 P7.5/CC29IO	P7.2	EVM4_GPIO45
P7.7/CC31IO (CS8900A INT)	P7.0	EVM2_GPIO41_CAPADC
124 P1L.7/CTRAP	P6.7	EMG TRP
Digital GND	Digital GND	Digital GND
26 P9.5/CC21IO	P6.2	CPU DACO1_GPIO19
25 P9.4/CC20IO	P6.0	CPU DACO0_GPIO17
Vcc 5V from reg	5V from baseboard regulator	5V from baseboard regulator
Vcc 3V3 from reg	3V3 from baseboard regulator	3V3 from baseboard regulator
12V Power GND	12V Power GND	12V Power GND
12V Power GND	12V Power GND	12V Power GND
+12V 2A	+12V 2A	+12V 2A
+12V 2A	+12V 2A	+12V 2A

1.2 Characteristics Of Motor Controller

The LM18200 as deployed on the module can handle 12V - 24V motors at up to 3A continuous or 6A peak. However the EDP baseboard only allows a maximum of 2A. Therefore if your application is likely to require more than 2A, you must power the motor module directly through the screw terminals P302 – see below.

1.2.1 High Current Applications

If a motor of above 2A current rating is used, the auxiliary high current connector P302 must be used to supply 12V and ground otherwise the current limit of the EDP baseboard module connectors will be exceeded. You must also set jumper JP301 to position 2-3.

1.3 Controlling The DC Motor

There are two basic approaches to regulating motor torque and hence for a given load, its speed.

1.3.1 Simple Fixed-On Time Mode

The simplest way to configure the module is to set jumpers JP203 to 1-2, JP205 to 2-3 JP207 to 1-2. In this mode, the voltage applied to CPU DACO0_GPIO17 will set the maximum current in the motor windings. For a given load, the motor speed can therefore be controlled. The chopping frequency will be approximately 25kHz, as determined by the LM555 C204 and R204..

A pulse-width modulated (PWM) or true digital-to-analog conversion channel from the CM can be used to provide a DC level that is compared with the voltage level achieved across the current sense resistor (R219).

This strategy provides only a crude control over motor current and should only be used with CMs that have limited PWM capabilities.

1.3.2 Full PWM Control Mode

This mode allows the current in the motor to be controlled directly and allows a precise control of motor speed. The default jumper settings are intended for this mode of operation.

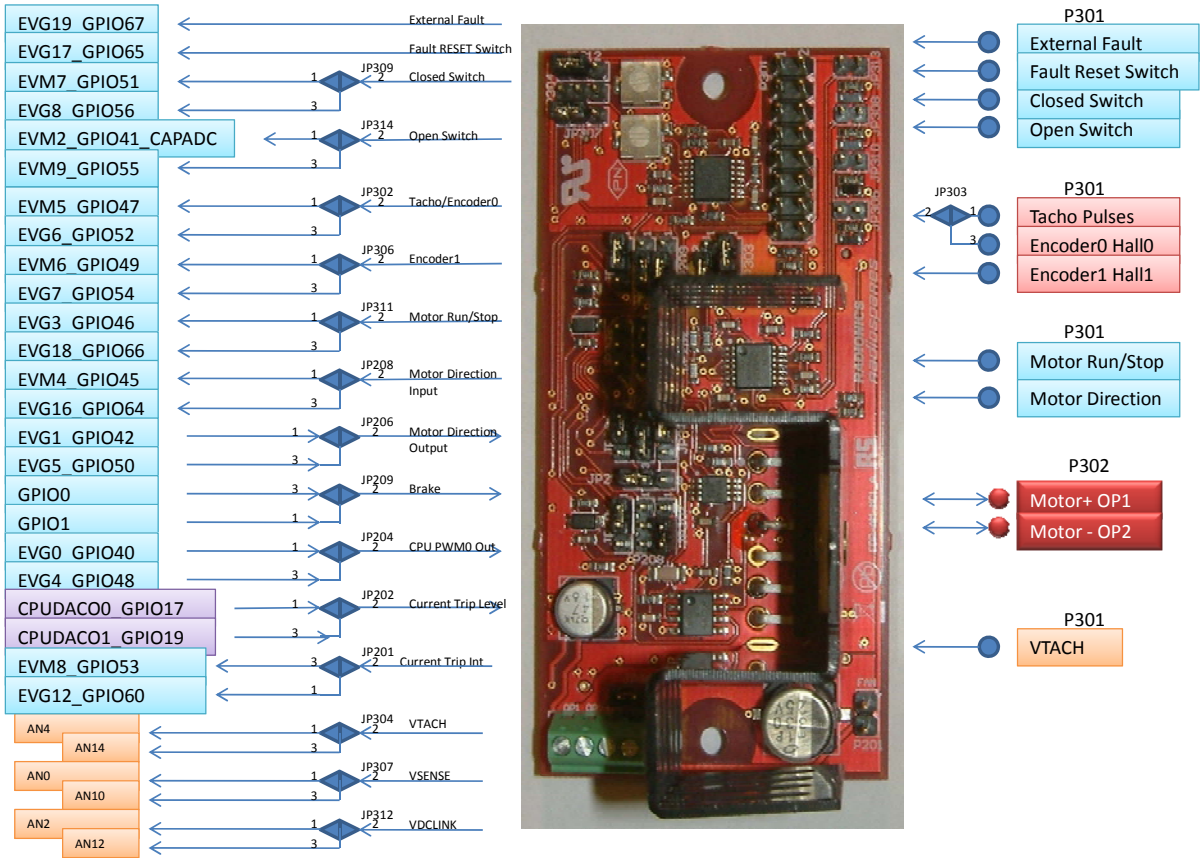
1.4 Hardware Protection

The LM18200T over current output is connected to the EDPCON EMGTRP line to allow software on the CM to switch the motor off.

2. Motor Controller User Options

There are a large number of user options for this module. The default settings assume the module will be used in a single motor system or as the first controller in a dual motor arrangement.

MC1 - Motor Drive Module to RS-EDP Backplane



Motor Control MC1 Mapping Aid

The above diagram shows how the MC1 Motor Drive AM is mapped to the back plane. There are several options which allow for the connection of the MC1 resources to the host controlling CM. There are some very important key options such as Motor Control PWM (CPU_PWM0_OUT), 'motor

direction output' and 'Brake', which are required for basic motor control. Some of the other ones are less important depending upon the setup. Most customers would probably want to access the motor current signal, and read the speed of the rotating motor as well. With this in mind it is important to map the MC1 module correctly to your system so allow the MCU on the CM to correctly control the motor. The PWM output is required for precision motor control and an input capture peripheral is required for rotational speed measurement.

A basic set of software drivers is provided for most of the CMs to allow it to control the MC1 unit. Some compromises are made and not all of the resources are available to all of the CMs. To check the availability of connection, consult the respective Mapping Aid document for the MCU, which at a glance should give you some indication as to what resources are available on the MCU to control the MC1 board.

2.1.1 Default (First Motor Controller)

Jumper	Type	Purpose	Default	Notes
JP201	3-way	Select CPU interrupt for current threshold reached	2-3	
JP202	3-way	Select source of current control voltage	1-2	
JP203	3-way	Enable LM555 control of motor current	2-3	LM555 disabled
JP204	3-way	Select source of PWM for direct motor current control	1-2	
JP205	3-way	Enable LM555 control of motor current	1-2	LM555 disabled
JP206	3-way	Select source for motor direction control	1-2	
JP207	3-way	Motor direction set by CPU pin or from P301 motor direction input	2-3	CPU controls direction
JP208	3-way	Select CPU input for P301 motor direction input	1-2	
JP209	3-way	Select CPU pin motor brake control	2-3	
JP210	2-way	Add 4K7 pull-up to Vcc_CM to motor direction input	Open	No pull-up
JP301	3-way	Allow LM18200 driver to be powered from external high current 12V supply	1-2	Motors > 2A must use 2-3
JP302	3-way	Select CPU pin for encoder0/tacho pulses input	1-2	
JP303	3-way	Enable tacho pulse input or encoder input 0	1-2	
JP304	3-way	Select CPU analog channel for Tacho voltage input	1-2	
JP305	2-way	Add 4K7 pull-up to Vcc_CM for P301 fault reset input	Open	Assume voltless contact to GND
JP306	3-way	Select CPU pin for encoder1 input	1-2	
JP307	3-way	Select CPU analog channel for motor current sense resistor voltage input	1-2	
JP308	2-way	Add 4K7 pull-up to Vcc_CM for P301 closed limit switch input	Open	Assume voltless contact to GND
JP309	3-way	Select CPU pin for P301 closed limit switch input	1-2	
JP310	2-way	Add 4K7 pull-up to Vcc_CM for P301 motor run/stop input	Open	Assume voltless contact to GND
JP311	3-way	Select CPU pin for motor run/stop input	1-2	
JP312	3-way	Select CPU analog channel for Tacho voltage input	1-2	
JP313	2-way	Add 4K7 pull-up to Vcc_CM for P301 open limit switch input	Open	Assume voltless contact to GND
JP314	3-way	Select CPU pin for P301 open limit switch input	1-2	
J301	solder	Connect pot VR301 to CPU ADC	closed	
J302	solder	Connect pot VR302 to CPU ADC	closed	

2.1.2 Jumper Settings As A Second Motor Controller

Jumper	Type	Purpose	Motor 2	Notes
JP201	3-way	Select CPU interrupt for current threshold reached	1-2	
JP202	3-way	Select source of current control voltage	2-3	
JP203	3-way	Enable LM555 control of motor current	2-3	LM555 disabled
JP204	3-way	Select source of PWM for direct motor current control	2-3	
JP205	3-way	Enable LM555 control of motor current	1-2	LM555 disabled
JP206	3-way	Select source for motor direction control	2-3	
JP207	3-way	Motor direction set by CPU pin or from P301 motor direction input	2-3	CPU controls direction
JP208	3-way	Select CPU input for P301 motor direction input	2-3	
JP209	3-way	Select CPU pin motor brake control	1-2	
JP210	2-way	Add 4K7 pull-up to Vcc_CM to motor direction input	Open	No pull-up
JP301	3-way	Allow LM18200 driver to be powered from external high current 12V supply	1-2	Motors > 2A must use 2-3
JP302	3-way	Select CPU pin for encoder0/tacho pulses input	2-3	
JP303	3-way	Enable tacho pulse input or encoder input 0	2-3	
JP304	3-way	Select CPU analog channel for Tacho voltage input	2-3	
JP305	2-way	Add 4K7 pull-up to Vcc_CM for P301 fault reset input	Open	Assume voltless contact to GND
JP306	3-way	Select CPU pin for encoder1 input	2-3	
JP307	3-way	Select CPU analog channel for motor current sense resistor voltage input	2-3	
JP308	2-way	Add 4K7 pull-up to Vcc_CM for P301 closed limit switch input	Open	Assume voltless contact to GND
JP309	3-way	Select CPU pin for P301 closed limit switch input	2-3	
JP310	2-way	Add 4K7 pull-up to Vcc_CM for P301 motor run/stop input	Open	Assume voltless contact to GND
JP311	3-way	Select CPU pin for motor run/stop input	2-3	
JP312	3-way	Select CPU analog channel for Tacho voltage input	2-3	
JP313	2-way	Add 4K7 pull-up to Vcc_CM for P301 open limit switch input	Open	Assume voltless contact to GND
JP314	3-way	Select CPU pin for P301 open limit switch input	2-3	
J301	solder	Connect pot VR301 to CPU ADC	open	Not for motor 2
J302	solder	Connect pot VR302 to CPU ADC	open	Not for motor 2

2.2 Using The Motor Control Module

2.2.1 Connecting The DC Motor

The connection example here is based on the 12A Crouzet motor (RS part no. 715-106) with optional 1 pulse-per-rev encoder kit (RS part no. 715-134). An example program is provided that allows a simple proportional-integral-derivative (PID) speed controller to be demonstrated.

2.2.2 Motor Controller Connectors

The 4-way miniature screw connector terminal P302 is used to connect the DC motor armature.

P302	Description
1	Motor +
2	Motor -
3	12V high current
4	12V ground

The 16-way pin header P301 is used to connect encoders, tachometers, limit switches, run/stop and direction inputs.

P301	Description	P301	Description
1	NC	2	Open limit switch
3	CPU Vcc	4	Closed limit switch
5	+3V3	6	Tacho pulses
7	+5V	8	Encoder 0
9	Motor Run/Stop	10	Encoder 1
11	Motor Direction	12	Fault reset in
13	Tacho Voltage	14	External fault in
15	Digital Ground	16	Digital Ground

2.2.3 Connecting The Crouzet Motor And Encoder

The encoder module requires a 5V supply which is derived from pin 7 of the 16-way pin header P301. The open collector output is connected to P302 pin 6 – R306 on the motor control module provides the necessary pull-up resistor to the positive supply rail.

P301	Encoder Connector	P301	Encoder Connector
1		2	
3		4	
5		6	4
7	2	8	
9		10	
11		12	
13		14	
15	3	16	

As the duty cycle of the encoder output is not guaranteed to be 50%, only one edge should be used to detect the motor speed. The example application supplied uses only the negative edge.

2.3 Using Two EDP-AM-MC1 Modules To Drive Two Motors

A second motor module can be added. This requires the jumpers to be changed from the default 1-2 position to 2-3, as shown below. Note: The CM must have sufficient IO to support two motors.

Jumper	Type	Purpose	Default	Notes
JP201	3-way	Select CPU interrupt for current threshold reached	1-2	
JP202	3-way	Select source of current control voltage	2-3	
JP204	3-way	Select source of PWM for direct motor current control	2-3	
JP206	3-way	Select source for motor direction control	2-3	
JP208	3-way	Select CPU input for P301 motor direction input	2-3	
JP209	3-way	Select CPU pin motor brake control	1-2	
JP302	3-way	Select CPU pin for encoder0/tacho pulses input	2-3	
JP304	3-way	Select CPU analog channel for Tacho voltage input	2-3	
JP306	3-way	Select CPU pin for encoder1 input	2-3	
JP307	3-way	Select CPU analog channel for motor current sense resistor voltage input	2-3	
JP309	3-way	Select CPU pin for P301 closed limit switch input	2-3	
JP311	3-way	Select CPU pin for motor run/stop input	2-3	
JP312	3-way	Select CPU analog channel for Tacho voltage input	2-3	
JP314	3-way	Select CPU pin for P301 open limit switch input	2-3	

3. Software Support

The RS-EDP platform has a host of CMs each of which has its own test suite of software. Contained in the software are a range of tests to fully exercise the MC1 motor drive module. The tests use the PWM and Input Capabilities of the MCU timers to control and measure the rotational speed. The test suites also provide the opportunity to change the direction of rotation and brake. Refer to the provided software suites for more information.