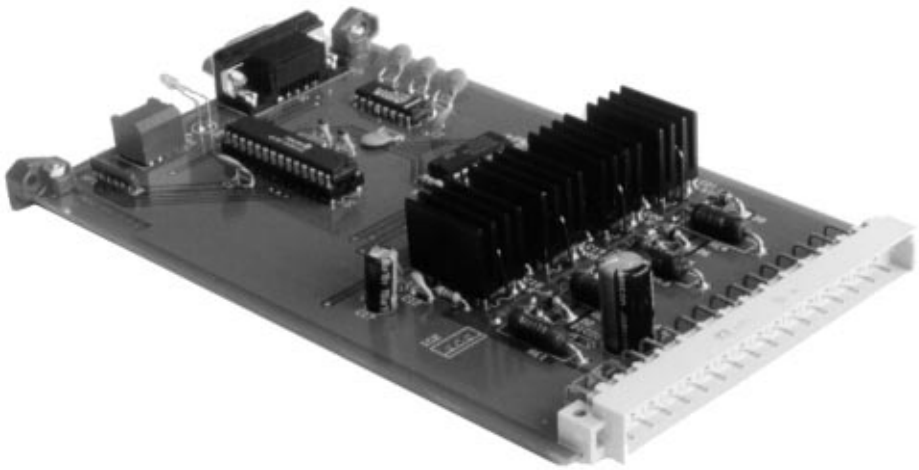


PWM3

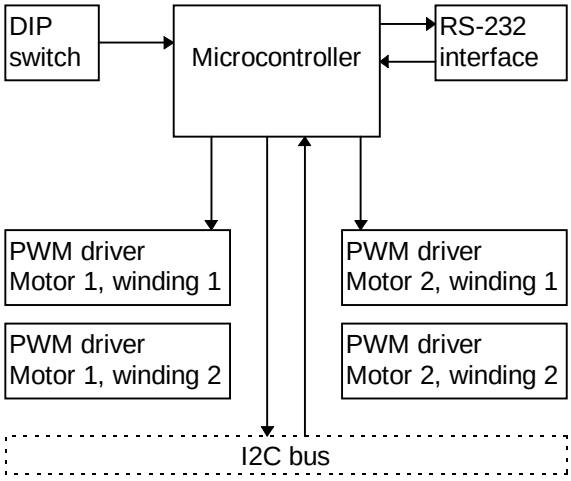
Dual Stepper Motor Card

Introduction

The PWM3 is Eurocard-sized and contains separate drive circuits for two bipolar stepper motors with two windings each. The winding currents are adjustable between 0.3-1.8 A for each motor, with a motor supply voltage of 10-40 V. The supply voltage can be unstabilized. A variant with built-in logic voltage supply is also available for single supply applications.

For communication with a control computer there is a RS232C-compatible asynchronous serial port. Up to five cards can easily be linked together with the integrated synchronous I2C-compatible bus.

The software delivered with the card consists of a stand alone program to control the motors, and subroutines callable from other programs (Windows DLLs and C-functions). The DLLs and subroutines handle all communication with the PWM3, and the user program does not need to handle any packet communication. In addition there are function for handling several commands in a row.



Key features

- Two separate motor drivers, four windings in all.
- RS232C-compatible serial port for control.
- Built-in I2C bus: Up to 5 cards linked to one computer.
- Smooth modified half-step operation.
- Programmable winding current 0.3-1.8 A.
- Up to 40 V unstabilized supply.
- Programmable acceleration ramps.
- 2000 steps per second, 8 million steps per command.
- Thermal overload protection.
- Variant available for single supply voltage.
- Eurocard 100x160mm with DIN41612 / D32 or screw terminal connectors.
- Software DLLs and subroutines for easy access to card features.
- Software included for Windows95, Windows NT, and Unix (Linux).
- Complete programs allows use of the card without programming.

Model	Connector	Logic Supply	Mounting
PWM3-10	DIN41612/D32	external +5V	Eurorack 3U
PWM3-11	DIN41612/D32	internal	Eurorack 3U
PWM3-20	Screw terminal	external +5V	Corner holes
PWM3-21	Screw terminal	internal	Corner holes

Table 1. Variants

Of course, it is also possible to write programs that communicate directly with the PWM3 using packets. The software platforms currently supported are Windows 95, Windows NT 4, and Unix (only C). To use the software read the readme files on the diskette.

Theory of Operation

The system uses current pulse width modulation (PWM). This gives a minimum of power dissipation and maximum torque. The used PWM switch frequency is approximately 32 kHz, well above the audible range. To maximize the torque of the stepper motor each step consists of a relatively steep current step.

A microcontroller takes care of step sequence generation, timing, communication with the host computer and other cards.The controlling host computer communicates with the PWM3 using packets over a RS232-compatible serial cable. All timing, ramp generation, and sequencing is done by the PWM3. Thus, the control computer does not have to do real-time processing.

Logic Supply Voltage

The logic supply voltage is used to generate the reference voltage used for current control. Therefore care must be taken to maintain a clean and stable voltage at 5.0 V. Although the circuit itself will work with a wide range of logic supply voltages, the winding currents will vary in proportion to the voltage. This can cause torque variations and circuit failures due to winding or drive circuit failure.

The PWM3-x1 variants with a built in logic supply voltage regulator are primarily designed for operation with supply voltages up to 12V. Although the circuit will work with voltages of up to 40V, the heat dissipation in the linear logic voltage regulator will necessitate forced cooling in order to avoid thermal protection shutdown.

Motor supply and logic voltage may be applied in any order.

Motor winding current A	Motor supply voltage V	Power per driver IC W
1.5	36	3.4
1.5	12	3.1
1.0	36	2.0
1.0	12	1.8
0.5	36	1.1
0.5	12	0.8

Table 2. Maximum dissipation power per driver IC at given currents and voltages.

DB9 Serial Port

The serial port is configured as female DCE. (For connection to a standard personal computer, use a straight through cable, also know as a modem cable.) The only pins actually used for communication are transmit data, receive data and signal ground. However, DTE ready (also know as DTR - Data Terminal Ready) is connected to DCE ready, clear to send, and carrier detect with a local loopback. This ensures that applications that require these additional control signals will have them present, as long as DTE ready is asserted.

The inputs are direct logic inputs with no optocouplers or other protection. Care must be taken to keep the ground of the controlling device at the same level as the PWM3. Otherwise the circuit may fail to function or be permanently damaged.

Thermal management

Operating temperature is 0°C to 70°C. Storage temperature is -55°C to 150°C. The motor drive circuits and the internal logic supply circuits have thermal overload protection. The type of heat dissipation system needed is strongly depended of the selected motor current and the applied voltage, see table 2.

For the default heatsinks, the maximum ambient operating temperature, and winding current is given in table 3.

If the internal logic supply is used the total heat dissipation for the circuit increases. The PWM3-x1 variants with a built in logic supply voltage regulator are primarily designed for operation with supply voltages up to 12V at an ambient temperature of 25°C. Although the circuit will work with voltages of up to 40V, the heat dissipation in the linear logic voltage regulator will necessitate forced cooling and/or a larger heatsink in order to avoid thermal protection shutdown.

Interference

One cause of interference is the resonance frequency of the stepper motor. When the modulation of the stepping signal is near the resonance frequency the motor will start oscillating. One way to avoid this is to make a jump in the modulation frequency close to the motor resonance frequency. For most motors this should cause no problem. Check the availble motor specifications from the manufacturer for the resonance frequency.

Power dissipation per driver IC W	Maximum ambient temperatur °C	Drive voltage V	Motor current A
3.4	70	36	1.5
5.0	25	36	1.8

Table 3. Maximum ambient temperature with default heatsinks.

Always use twisted pair cables for motor winding connection. This will minimize interference caused by the current switching. For compliance with EMC-directives the PWM3 and associated circuits must be mounted in an appropriate enclosure. The required type of enclosure is dependent on application, and EMC-compliance must be seperately verified for each enclosure type.

Commands

The following is a short description of the available commands. See the documentation on the program disk for a full description of command programming, packet format, and how to use the utility programs and library.

Move relative. Move the given number of steps relative to the current position. The data field contains the number of steps in 1 to 3 bytes using signed two complement representation, for more than 8 million steps in one command.

Set Current. Set the winding current in steps of 0.01 A. A data byte in the data field with the value of 100 decimal gives a motor current of 1.0A. Valid current range is 0.3-1.8 A. The power on default current is 0.3 A.

Go unlimited steps. This enables the motor to go an unlimed number of step in one direction with a given speed until another command is received.

Set speed and acceleration ramp. Selects the maximum speed and acceleration / deacceleration time for the Move and Go commands.

Reset. Stops all commands and initializes the controller to the power-on state.

I2C Bus, and Addressing

Each PWM3 card contains several subdevices, and several cards can be linked together on an I2C-bus. Therefore all commands must be correctly addressed: PWM3 addresses are 5 bits (unused bits in a byte must be zero): The two least significant bits select the subdevice on each card. 00_2 is the serial port, 01_2 is motor 1 and 10_2 is motor 2. The next three bits are the card address. Available addresses are 000_2 to 011_2 and 111_2, for a total of five addresses. E.g. to send a command motor 2 on card 3, the address 01110_2 or $0E_{16}$ should be used.

The controlling computer has the address of the serial port it is connected to: This address is used by PWM3 for acknowledge and status replies, and is usually not directly addressed by the control computer.

The card address is selected by the DIP-switch near the front of the card. Switch 1 is the LSB. Switch 3 and 4 select the most significant bit of the card address, and in addition enable the I2C-bus termination. One and only one card on each I2C-bus must be terminated. The only valid switch settings for a terminated card are all ON, for a base address of $1C_{16}$. It is an error to set any switch OFF if either switch 3 or 4 is ON. The factory default switch settings are OFF, for a card address of 00_{16}. See table 4.

Routing

The PWM3 does command packet routing over the I2C bus. Thus one control computer can send commands addressed to any card over the serial link and the command will automatically be forwarded to the correct card. Acknowledge replies from the cards are likewise forwarded to the control computer.

The routing uses a simple store and forward algorithm with no buffering. Therefore, do not send more than one command at a time, even if they are addressed to different cards: Each command must be acknowledged before the next is sent, otherwise commands and acknowledges will be lost.

Address base 2					Address base 16		Card	Subdevice	Comment
Card			Subdevice						
0	0	0	0	1	0	1	0	Motor 1	
0	1	1	0	0	0	C	3	RS232	
0	1	1	0	1	0	D	3	Motor 1	
0	1	1	1	0	0	E	3	Motor 2	
0	1	1	1	1	0	F	3	N/A	Invalid
1	1	0	0	0	1	8	N/A	N/A	Invalid
1	1	1	0	0	1	C	5	RS232	I2C-termination
1	1	1	0	1	1	D	5	Motor 1	I2C-termination
1	1	1	1	0	1	E	5	Motor 2	I2C-termination
1	1	1	1	1	1	F	5	N/A	Invalid

Table 4. Address Examples

Appendix A. Tables

Voltage	Min	Typ	Max	Unit
Logic Supply	0	+5.0	+5.5	V
Motor supply	0		+40	V
Serial Port	-30	+/-12V	+30	V
Current				
Logic Supply			1.0	A
Motor Supply			7.2	A
Motor Winding	0.3		1.8	A
Temperature				
Operating ambient temperature	0		+70	Celsius
Storage temperature	-55		+150	Celsius
Power				
Total power dissipation PWM3-x0	5		25	W
Total power dissipation PWM3-x1 (12V Supply)	12		32	W
Data Rate				
Serial	0.3	9.6	38.4	kbit/s
I2C	100.0	100.0	100.0	kbit/s

Table 5. Maximum ratings

Pin	Function
1,2	motor 1 winding 1 +
3,4	motor 1 winding 1 -
5,6	motor 1 winding 2 +
7,8	motor 1 winding 2 -
9,10	motor 2 winding 1 +
11,12	motor 2 winding 1 -
13,14	motor 2 winding 2 +
15,16	motor 2 winding 2 -
17,18	Motor supply voltage
19,20	Motor voltage ground
21,22	No Connection
23,24	No Connection
25,26	Logic supply voltage
27,28	Logic ground
29,30	I2C clock
31,32	I2C data

Table 6. Backplane/screw terminal connector

Pin	Signal name	Connection	Direction	Comment
1	Carrier Detect	Pin 4		
2	Receive Data	Serial out	Host <- PWM3	
3	Transmit Data	Serial in	Host - PWM3	
4	Data Terminal Ready	Pin 1, 6, 8	Host-PWM3	Pin 4 is ignored by PWM3, but is connected to the listed pins in order to provide expected control signals.
5	Signal Ground	Logic Ground	Host <- PWM3	
6	Data Set Ready	Pin4		
7	Request to Send	N/C		
8	Clear to Send	Pin 4		
9	Ring Indicator	N/C		

Table 7. Serial port connector