

**DESCRIPTION**

The 1830 Motor Controller is a member of a family of motor controllers which are built to be inserted into any VMEbus compatible computer which has double height slots. The Controller consists of two printed circuit cards on which are mounted an Intel 8088 microprocessor, an AMD 9513 counter/timer, a variety of interface circuitry and, of course, the VMEbus interface. Although the 1830 has its own microprocessor and memory it still requires a host processor in the system to allow it to operate. It cannot operate as a stand-alone device, although it does support joystick and jog control. The host processor will typically take the form of another card plugged into the VMEbus backplane.

The 1830 unit is designed to control a single motor by issuing pulses to attain motor motion. The 1830 Motor Controller issues pulses from the motor driver output to control the position, velocity, and acceleration of the motor. Certain motion control commands allow the use of an incremental encoder to monitor the motor motion and position. This feedback comes to the 1830 via the encoder connector.

The 1830 relieves the host of the tasks of controlling velocity, distance and linear acceleration parameters as well as monitoring end-of-travel limit switches and trigger inputs. It will perform a sequence of moves and remember that sequence for later execution upon issuance of a single command. The host may also directly control the motion algorithm to achieve sculptured acceleration profiles for applications that require contouring. All velocity, acceleration and distance parameters are given to the Motor Controller in binary bytes representing numbers of pulses (per second, per second squared, etc...). This allows the 1830 to control motors of virtually any resolution.

**Board revision level**

When reading this manual, please note which revision levels your 1830 Motor Controller boards are. You will find a "dash" number at the end on the board part number (61-004135-XX) As of this writing the dash number will be -01 or higher. Changes made after this writing will be noted in a sheet of errata appended to the manual.

**INSPECTION**

Your Model 1830 Motor Controller should be inspected upon receipt for obvious damage to its shipping container. Report any such damage to the shipping company as soon as possible, as Compumotor cannot be held responsible for damage incurred in shipment. The 1830 should then be carefully unpacked and inspected for the following items to be present and in good condition.

1. 1830 Printed Circuit Assembly
2. Cable: P/N 71-2489-01
3. Connector: 25 pin D, solder type with shell
4. 1830 Motor Controller Operator's Manual

**WARRANTY INFORMATION**

Your Model 1830 Motor Controller is warranted against manufacturing defects for one year from the date of purchase. Should you have questions about operating the 1830, your Compumotor representatives and distributors stand ready to support your individual needs.

Should return of your Motor Controller be required to effect repairs or upgrades, do the following.

1. Get the serial number of the defective unit and a purchase order if the unit is out of warranty.
2. Call Compumotor for a Return Material Authorization Number (RMA) at (800) 358-9068 except in California. The number in California is (707) 778-1244.
3. Ship the unit to:  
Parker Compumotor  
5500 Business Park Drive  
Rohnert Park, CA 94928  
(707) 584-7558 (800) 358-9068  
RMA # \_\_\_\_\_

Compumotor Corporation is dedicated to being a leader in digital motion control. We invite you to tell us about your application problems, questions or comments.

Since all of our indexer products are microprocessor based, significant departures from the operating parameters outlined here are possible. If you have a volume requirement for our products (over 250/yr, for example), we would like to discuss your specific needs. Call the Applications Engineer assigned to your geographic area at (800) 358-9068, except in California, (707) 778-1244.

**FUNCTIONAL CHECK**

The 1830 Motor Controller may be installed and functionally tested for proper operation very simply without instructions from the host processor card. If the 1830 is to control a Compumotor Motor-Driver having 25,000 steps per revolution, do the following.

1. Remove power from the VMEbus computer.
2. Ensure that switch S2-4 is off and S7-2,3 are on; then insert the 1830 into an open slot in the VMEbus computer.
3. Attach a D-end of the Motor-Driver cable to the Motor-Driver connector on the 1830.
4. Set up the Compumotor Motor-Driver in accordance with the Motor-Driver Operator's manual.
5. Apply power to both the Motor-Driver and the VMEbus Computer.  
Important: Ensure that the Compumotor is free to rotate a full revolution in either direction for this test.
6. The Compumotor Motor-Driver and the 1830 Motor Controller are now ready for self testing.

Depress the self-test button (switch S1). S1 is the only button accessible from the front panel. It is recessed slightly to avoid accidental depression.

The Compumotor should rotate one full revolution in the counter-clockwise direction, stop, and rotate one revolution in the clockwise direction and stop; the Board Monitor Alarm - the red LED next to S1 - will come on.

If the motor does not rotate as predicted the problem will probably be found in one of the following areas.

1. The Motor Controller:
  - a. The Motor Controller is not powered. Check for 5 Volts DC on J3, pin 22, the Auxiliary Connector. Ground may be found on J3, pin 16, to reference the 5 volts. If 5 volts is not present the 1830 is not being powered by the VMEbus backplane.
  - b. The limit switches are not connected and not bypassed. Ensure that switches S7-2,3 are on for this test.
2. The Motor-Driver cable:

Inspect the cable to ensure that it is not frayed or cut, and that it is securely fastened at each end and

at its connecting point.

3. The Motor-Driver:

- a. Ensure that the motor cable is securely fastened to the Driver.
- b. Check to see if the motor has torque. It should have torque any time it is powered.

If the motor the 1830 is controlling is not a standard 25,000 steps-per-revolution Compumotor the self-test function may still be performed, but the motor will probably not turn exactly one revolution. The 1830 issues 25,000 pulses at a rate of 5,000 Hertz with the direction output held low (CCW) and then repeats the process with the direction output held high (CW). The direction output is found in the Motor Driver connector. A 50,000 steps-per-revolution motor would turn only one-half a revolution and a 200 steps-per-revolution motor would rotate 125 revolutions under these conditions, for example. **A word of warning about a 200 steps-per-revolution motor and this test: The motor velocity will be 25 revolutions per second without the benefit of acceleration ramping and the motor might well stall.**

To verify board operation without a motor, the user may connect an oscilloscope to J4, pin 1, Step Output (step return may be found on J4, pin 14). Each motor pulse will be seen as a one to two microsecond, high going, pulse.

After the self test has been performed the board must be RESET before normal operation may be assumed. Reset may be accomplished by cycling the power to the 1830, issuing it a bus reset or by setting the reset bit in the 1830's Control Byte.

**INSTALLATION**

**A. Configuration Switches**

Installation of the 1830 Motor Controller is a straight-forward process that may be quickly and easily accomplished provided the Controller is properly configured prior to attempting to operate it.

The first step in configuring the Controller is to set the configuration DIP switches. These switches are of three basic types:

- VMEbus interrupts
- VMEbus addressing
- Limit switch bypass

**1. VMEbus Interrupts**

Use of interrupts on the 1830 Motor Controller is optional. Until appropriate software has been written to handle interrupts, they should be disabled. The standard factory setting of S2 is all interrupts disabled.

There are three basic interrupts:

<u>Interrupt</u>	<u>Switch</u>	<u>Status Bit</u>
Message ready (MR)	S2-2	5
Input ready (IR)	S2-3	4
Controller failed (CF)	S2-1	7

Any of these interrupts may be directed to any of the VMEbus interrupt lines, IRQ1/-IRQ7/, selected by S6-1,2,3. (A signal name followed by a slash (/) indicates that the signal is low true.) The following table shows how to select a VMEbus interrupt level for the 1830 combined interrupt signal. Here "0" means "ON" and "1" means "OFF."

<u>S6-3</u>	<u>2</u>	<u>1</u>	<u>IRQ Level</u>
0	0	0	None
0	0	1	IRQ 1
0	1	0	IRQ 2
0	1	1	IRQ 3
1	0	0	IRQ 4
1	0	1	IRQ 5
1	1	0	IRQ 6
1	1	1	IRQ 7

The three Controller interrupts are wire ORed together so that any combination of the interrupts may be installed (see Appendix F), but the interrupt which goes active first masks any further interrupts in the Status Byte until the previous condition is cleared (see the sections "Programming, Interrupts" and "Programming, Reading and Writing" for details).

Only one of the VMEbus interrupt lines (IRQ1/-IRQ7/) may be used to interrupt the host processor if interrupts are enabled using switches as described above. The 1830 also requires you to enable interrupts from an 1830 via the "Interrupt Enable Bit" in the CONTROL BYTE (CONTROL BIT six). Generally, the only interrupt you will be interested in selecting will be the Message Ready interrupt.

If you choose to use interrupts from more than one of the status bits, an active status bit will mask other active status bits since all selected status bits are ORed into one interrupt line. Therefore, it would be advisable to use level sensitive interrupts in the host rather than edge sensitive interrupts if more than one status bit is selected to the IRQ/ line, since a currently active selected status bit will mask an active going status bit. If only one status bit is selected to the IRQ/ line, either edge triggered or level triggered interrupts may be used.

The VMEbus host responds to an interrupt from the 1830 by issuing an interrupt acknowledge cycle, during which time the 1830 will place a STATUS/ID byte on the bus. The value of this byte is user selectable via S5, 1-8 as defined by the following table. The sum of the switch's binary value will be the value of the STATUS/ID byte.

<u>S5#</u>	<u>Hex</u>	<u>S5#</u>	<u>Hex</u>
1	1H	5	10H
2	2H	6	20H
3	4H	7	40H
4	8H	8	80H

**2. VMEbus Addressing**

The 1830 supports the VME standard addressing and short addressing modes, configurable with S6-4. If S6-4 is on, short addressing is selected, and the 1830 will respond to address modifier codes 29H and 2DH. If S6-4 is off, standard addressing is selected and the 1830 responds to address modifiers 39H and 3DH. In both cases it occupies a 256 byte block and accepts byte wide data from the low order bits of the data bus. Word size data transactions or data transactions on the high order bits of the data bus will generate a bus error. The 1830 Motor Controller requires two address locations to access its data and command

registers. The data location is repeated 64 times at even word addresses (A1=0). The control/status location is repeated 64 times at odd word addresses (A1=1). The board's address is selected by selecting configuration switches which carry binary values. The sum of the switch values is equal to the board's base address.

<u>S3</u>	<u>Bit Number</u>	<u>Hex</u>
#1	- Address bit 8, value =	100h
#2	- Address bit 9, value =	200h
#3	- Address bit 10, value =	400h
#4	- Address bit 11, value =	800h
#5	- Address bit 12, value =	1000h
#6	- Address bit 13, value =	2000h
#7	- Address bit 14, value =	4000h
#8	- Address bit 15, value =	8000h

<u>S4</u>	<u>Bit Number</u>	<u>Hex</u>
#1	- Address bit 16, value =	10000h
#2	- Address bit 17, value =	20000h
#3	- Address bit 18, value =	40000h
#4	- Address bit 19, value =	80000h
#5	- Address bit 20, value =	100000h
#6	- Address bit 21, value =	200000h
#7	- Address bit 22, value =	400000h
#8	- Address bit 23, value =	800000h

### 3. Limit switch switches

Limited travel mechanisms such as X-Y tables require some means for stopping the motor should it attempt to move the load beyond the motion system's end of travel. The 1830 deals with this problem by using limit switches. The limit switch inputs (found on pins 13 and 10 of the Auxiliary Connector) use a normally-closed circuit to indicate to the motor controller that the system is operating properly. This way if one of the wires to the limit switches should be broken or cut the system stops instead of moving the load out of its range of travel.

Since not all applications require limit switches, the 1830 has two DIP switches which short across the the limit switch inputs to allow the board to operate the motor when the end of travel limits are not required. These switches are S7-2,3. To ensure proper motor operation they must be off when limit switches are used and they must be on when limit switches are not used.

If the limit switches are used, they may be configured to be optically isolated by setting switches S8-4, 6 to the "down" position and S8-5, 7 to the "up" position. "Up" means away from the printed circuit board.

## B. Limit Switch Inputs

The clockwise and counter-clockwise limit switch inputs on the 1830 are used to cause the 1830 to immediately discontinue sending pulses to a motor-driver in an emergency situation. The response of the motor is the same as it would be to that of the Kill command (78h). If the limit switch inputs are switched for optical isolation (by setting switches S8-4, 6 to the "on" position and S8-3, 5 to the "off" position), the limit switch would drive the limit switch inputs with a TTL high or +5V under normal operating conditions and allow the input to be open when the switch is activated. If the limit switch inputs are switched to not use optical isolation (by setting S8-4, 6 to the "down" position and S8-3, 5 to the "on" position), the limit switches provide a signal ground to the limit switch inputs (J3, pins 13 and 10) under normal operating conditions and allow the inputs to float high when the switch is activated. This way, should a wire break anywhere in the limit switch circuit, the motor would immediately stop, provided the motor was moving toward the open limit, and the 1830 would not allow the motor to move toward that limit switch until the open circuit condition (i.e., broken wire) is corrected.

In applications that do not require limit switches, switches S7-2 and S7-3 should be left "on" as the unit comes from the factory. For applications requiring limit switches, switches S7-2, 3 should be switched to the "off" position. With switches S7-2, 3 "on" the limits are defeated so that external limits will have no effect.

Note: External limits must be used if S7-2 and S7-3 are not switched to the "on" position. S7-2 defeats the CCW limit switch input and S7-3 defeats the CW limit switch input.

A limit switch normally takes the form of a closed single-pole-single-throw switch, a Hall effect proximity sensor or an optical interruptor which is placed sufficiently far from the load's end of travel to allow the load to stop from it's maximum running velocity without damage. For non-isolated operation, the switches should be able to provide the following:

1. 1 mA current sinking capability (1mA closure to ground)
2. Logic low no greater than 0.5 VDC
3. Logic high no greater than 5.5 VDC (unless open collector)
4. Minimum signal high duration of 200 microseconds

The limit switches are connected to the following pins of the Auxiliary connector.

Clockwise limit switch	J3, pin 10
Clockwise limit switch return (DC common)	J3, pin 23
Clockwise opto return	J3, pin 24
Counter-clockwise limit switch	J3, pin 13
Counter-clockwise limit switch return (DC common)	J3, pin 25

Counter-clockwise opto return

J3, pin 12

The limit switch returns (noted DC common) are the 1830's signal ground so care should be taken to not connect these lines to earth ground or use them for a shield, as this will greatly reduce the noise immunity of the 1830 and increase its susceptibility to damage as a result of voltage or current spikes on the power line.

For isolated operation, the switches must be able to provide 10 mA at 3 V for logic high. The switches should be connected to the connector inputs Limit Switch and Opto Limit Return.

The limit switch wires should be shielded to prevent voltages from being induced into them which could cause the limit switch inputs to be activated. An earth ground suitable for shielding purposes is found on J5, pin 20.

Suitable active switch types are:

Vane activated magnetic switch - Microswitch 4AV1C-T1  
Vane activated optical switch - Spectronics SPX2002  
Proximity sensor, Hall effect - Microswitch 205SR1A

Some limit switches require a power source. This is provided for in the 1830 on J3, pin 22. A maximum of 250 milliamps may be drawn from this connection. A word of warning about this power source: It comes straight from the VMEbus five volt power supply through a one ohm, quarter watt, resistor, and so should be used with caution. Signal common for the limit switches is found on J3, pins 24 and 25.

### C. Open Loop Home Position Sensor

Sometimes an absolute reference is required for the motion control system, so that a known position may be found upon applying power to the system or prior to attempting a very precise move. The 1830 allows this to be done by using a normally closed switch similar to the ones used as limit switches described above, as well as home reference marks on linear and rotary encoders.

The home position sensor is attached to J3, pin 21, the Home Limit input, and it must have all of the electrical characteristics described above for the limit switches (in non-isolated configuration). The Home Limit input is ignored when it is not being used as a position reference. Signal ground for the home position sensor is the same as that of the limit switches, auxiliary connector J3, pins 23 and 25. For open loop homing function, only the Home Limit Input is used. For closed loop homing function, both the Home Limit Input and the Z Channel inputs must

be connected to their respective external sensors. The closed loop homing inputs are found on the encoder connector J5.

#### **D. Encoder (if used)**

The encoder input uses a 25 pin D-connector which is compatible with all Compumotor motor mounted encoders. When using a Compumotor supplied encoder simply attach the 25 pin D-connector provided with the motor mounted encoder. For user provided encoders a two phase incremental quadrature type is required. It must be TTL compatible with actively driven outputs (i.e., not open collector).

The resolution of the encoder is important for successful operation of the motor with the position maintenance feature enabled. Please refer to the Operation section for more information.

#### **E. Earth Grounding**

The 1830 provides earth grounding to the front panel, which should be mounted securely to the VME computer chassis. It is important that the ground used here does not connect to the signal ground used for the VMEbus system or for any other electronic device. This earth ground is routed to the pins on the front panel connector that require a shield connection so that sensitive wires may be shielded without sacrificing noise immunity.