Compumotor

852 User Guide

Compumotor Division
Parker Hannifin Corporation
P/N 88-001584-01 D

COMPUMOTOR CORPORATION

MODEL 852 JOYSTICK OPERATOR'S MANUAL

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Compumotor P/N 88-01584-01 Rev. C.

Introduction

The model 852 Joystick is a microcomputer based controller which allows manipulation of two motor driven axes.

The 852 will directly drive Compumotor microstepping motors and standard stepping motor translators. These motors may also be driven indirectly from the 852 by way of an interface to the Compumotor Model 2100 Preset Indexer. This feature allows the addition of interactive manual control to Compumotor's computerized controller. See Section 3.2 below and Appendix B, excerpted from the Model 2100 Preset Indexer Operator's Manual, for more information concerning use of the Joystick with the Model 2100.

Either channel of the 852 Joystick functions like a voltage-to-frequency converter, but does not contain a voltage controlled oscillator. D.C. control voltages produced by the manual joystick are digitized and read by the resident microcomputer which converts them to frequency via rate-multipliers. Each channel receives a velocity update almost 200 times a second, fast enough for velocity changes to appear continuous to the eye and beyond the frequency response of the motor.

The 852 also includes motor output circuitry for a third axis controlled by a two phase quadrature signal developed, typically, from an incremental encoder. This third axis, called the Z axis channel of the 852, can be used when simple motor position control may be required. The 852 will supply power to, and take two phase quadrature inputs from, an incremental encoder with TTL outputs. Pulses from that encoder are buffered and routed directly to the motor so that the motor will move back and forth as the encoder is rotated back and forth. This feature can be used as a 'power focus' control in an optical system. (See Appendix A for details on implementation of the Z axis).

OPERATION

Set-up:

To set up the 852 to drive a Compumotor directly, plug in the supplied motor/driver cable (with the 9 pin D connector) to the "X MOTOR DRIVER" or the "Y MOTOR DRIVER" connector on the rear of the 852. The other end of the cable plugs into the motor driver. Alternately, the supplied cables with the 15 pin D connectors may be plugged into the "X 2100" or the "Y 2100" connector of the 852, and into the "JOYSTICK" connector on the rear panel of the 2100 indexer. Of course, it will be necessary to plug the power cord into a 117 VAC outlet.

Limit Switches:

Limit switches can be connected to the 852 to prevent the motors from running beyond their desired end of travel. The 852 is shipped with internal jumpers that defeat these limits. These jumpers are easily accessed inside the left side cover. Refer to Appendix D for jumper location, and to Appendix C for limit switch connections. <u>If the 2100 interface is in use, the 2100 limit switch inputs should be used.</u> Opening either normally closed limit switch will halt and inhibit further motion of the motor in the direction named by the input, as well as turn off the front panel control LED for that axis.

Controls:

External controls and indicators on the Model 852 include status indicator LED's for X and Y, the speed range switch (HI/MED/LO), the status control switch (DISABLE/ENABLE/SHUTDOWN), and the joystick itself.

a. Joystick

Motor movement is implemented by deflection of the joystick. Motor velocity is proportional to the angle of deflection of the joystick. Right and left deflection yields movement of the X channel motor; forward and backward deflection moves the Y motor. Deflection to the right is "positive", yielding clockwise rotation of the X motor as the default direction. Forward deflection gives the same result for the Y motor. (See Appendix D for a discussion of changing the default operating parameters via internal jumpers).

b. Acceleration

The rate of change of the motor velocity is limited by the microcomputer to a default value of 2,500,000 pulses per second per second (equal to 100 revs/sec/sec for a standard 25,000 pulse per revolution Compumotor).

c. Velocity

Full scale velocity may be set to one of three switch selectable ranges via the HI/MED/LO switch. For direct driving of standard Compumotor microsteppers the default values for full scale deflection are 10 RPS (revolutions per second), 1 RPS and 0.1 RPS for HI, MED and LO respectively (250 KHz, 25 KHz, and 2.5 KHz). The joystick (or control voltage) must be returned to the midpoint "zero" position in both axes to realize a velocity range change.

d. Status Control Switch

The status control switch must be in the ENABLE position for any motor movement to take place. If the 852 is enabled and no external conditions are inhibiting motor function, the status indicator LED for both channels will turn green. Even so, no pulses will be sent to the motor unless the joystick (or the control voltage) has been returned to the midpoint after the unit has been enabled. In the case of a remote enable, or the clearing of a limit condition, only the affected axis must be returned to zero.

If the status switch is in the DISABLE position, one of the limit switch inputs is activated, or a remote disable signal is received (e.g., from the 2100), the indicator LED for that channel will be off and motor pulse output will be inhibited. Placing the status switch in the SHUTDOWN position causes the remote power shutdown output to the motor and the shutdown request output to the 2100, to be activated, and the LED status indicators turn red. The remote power shutdown function was an option on early Compumotors and is now standard; this feature causes the current to be removed from the motor windings, halting heat dissipation and removing the holding torque otherwise applied by the motor.

Caution: When the motor is shutdown precise motor position may be lost, as the motor has no holding torque during this period.

(See Appendix D regarding the automatic timed-power-shutdown option).

2100 INTERFACE

a. Front Panel Control:

Interfacing the 852 to the 2100 Preset Indexer takes on various forms. The simplest interface involves two motor/drivers, two 2100 indexers operated from their front panels, and a single 852 plugged into the two 2100 indexers. In this configuration a 2100 yields control of its motor to the 852 when the 852 is switched to ENABLE and the 2100 is not busy. The 852 Joystick's LED status indicator will turn green and all three of the 2100 front panel motion indicators will come on.

The motor direction may be reversed by switching S4 #6 ON, in the 2100. The motor velocity generated by the 852/2100 interface will be the same as direct driving the motor with an 852 unless the 2100 is switched internally for Joystick velocity scaling (S4 #7 OFF).

Velocity scaling involves dividing the Joystick input frequency by a factor inversely proportional to the current 2100 maximum velocity parameter, whether it is a front panel value, or a value programmed via the 2100's serial interface link (RS-232C). When the 2100 velocity parameter is at its maximum of 20 RPS, the circuit divides the input frequency by two. At the 852 Joystick's default HI range maximum frequency of 250 KHz (full deflection) the scaled 2100 output frequency will be 125 KHz (5 RPS). At lower velocity settings, the 2100 divides by proportionately more than two. So, if the 2100 velocity parameter is lowered to 10 RPS, the scaled output for full deflection will be 1/4 of the input, or 62.5 KHz (5 RPS).

Because of this "divide by two" characteristic of the 2100, the 852 is supplied with a doubled output frequency jumper option (20 RPS max., or 500 KHz. See Appendix D). This allows the 852 user to get the nominal 10 RPS at full deflection when the 2100 is set for 20 RPS with the velocity scaling feature enabled.

NOTE: In order for the 2100 to recognize any change in its maximum velocity parameter the 852 must be momentarily disabled via the DISABLE switch on the control panel.

b. RS-232C Interface Control

Using the Joystick while the 2100 is under RS-232C control is somewhat more involved. While ON-LINE the 2100 will not respond to the 852 ENABLE switch unless given the J1 command via the interface. The operator may request the 2100 Indexer's status to determine whether or not the 852 is requesting motor control (see Appendix B). The J0 command restores normal 2100 control of the motor. The 2100 treats an interval of Joystick control just like a move, so that buffered RS-232C commands received while in Joystick Mode will be executed after the J0 command is received.

An important feature of this mode is the ability of the 2100 to maintain accurate track of the position of the motor following Joystick maneuvers. The P and X commands will return the cumulative position of the motor when Joystick mode is exited. The X position data (absolute position) will be cumulative relative to the motor position when the 2100 position counter was last reset. The P position report is referenced to the position of the motor at the time the Joystick Mode was entered.

Position data may also be obtained from the 2100 while in Joystick Mode using the W command. This command, however, reports in hexidecimal numbers for the benefit of computers. This command yields cumulative position data referenced to motor position at the time Joystick Mode was entered if the motor is stopped. If the motor is moving, the W command will give the instantaneous distance from the last position at which the motor was stopped.

Additionally the SJ command is available to request joystick status. This returns a four digit number. All four digits will be either 1 or 0 and will indicate: whether or not an ENABLE request is active, Joystick direction, whether or not the Joystick is AT ZERO, and whether or not the shutdown output is active. Refer to Appendix B for details.

NOTE: **The P, X, W, and SJ commands all require a preceding numerical device identifier which matches the 2100 device address. The proper formats for the X and W commands are X1 and W2 in order to get ASCII characters. The X2 and W1 (and PB) commands return binary data requiring special processing.**

Specifications

Power:

117VAC, 50-60Hz, 0.2 A

Control Inputs:

CONTROL VOLTAGE IN - 0 V to 1 V DC covers the entire velocity range in both directions of either the X or Y axis. This control voltage is normally provided by the potentiometer in the joystick assembly. If the joystick assembly is not connected, the input impedance exceeds 1 Mohm. Otherwise the joystick is connected in parallel and the input impedance is approximately 450 ohms to ground and 4550 ohms to the +5 VDC supply when the joystick is at its midpoint.

CW, CCW LIMIT IN - requires releasing a (normally closed) 0.1 mA switch to ground to stop motor pulse output if factory jumpers disbling this function are removed.

X, Y DISABLE - An 0.1 mA switch to GND inhibits output from the named channel. These inputs appear on the Z ENCODER IN connector.

Motor Driver Outputs:

X, Y MOTOR STEP PULSE - 0 to 1 MHz TTL at +/- 50 mA; the pulse frequency is proportional to the control voltage (joystick deflection angle). The minimum pulse width is 498 nanosec with a minimum 3 V peak. Output low is a maximum 0.5 V. The maximum rate of change of frequency is 2.5 MHz/sec.

X, Y SHUTDOWN - +/-50 mA TTL level as above when activated.

X, Y DIRECTION - +50 mA maximum source for positive control voltage deviation from the midpoint; -50 mA sink for negative deviation. Positive joystick deflection is forward for the Y axis and tot he right for the X axis and normally yields clockwise rotation of the motor.

CLOCKWISE STEP PULSE - Open collector output sinks 300 mA maximum to ground for "positive" direction. The pulse width and frequency match the motor step pulse above, but the polarity is reversed (X, Y MOTOR DRIVER).

COUNTERCLOCKWISE STEP PULSE - As above for "negative" direction.

NOTE: All of the above signals except CONTROL voltage are TTL compatible. See Appendices A and C for connector assignments.

2100 Isolated Interface Inputs and Outputs:

2100 +5 VDC, 2100 GND - power and ground at 25 mA max per input/output channel for either X or Y. Used inside 852 in conjunction with the opto-isolated interface between the 852 and the 2100.

2100 DISABLE IN - this active low signal requires 10 mA switched to isolated ground (2100 GND) to inhibit output from either channel.

2100 STEP PULSE OUT - source 10 mA, sink 50 mA at the above motor pulse frequency. The minimum pulse width is 500 nanosec. The maximum cable length is 10 ft.

2100 DIRECTION OUT - sink 2 mA. This signal is used with the above step pulse output.

2100 SHUTDOWN OUT - sink 2 mA. The polarity of this signal is opposite the SHUTDOWN signal above (SHUTDOWN switch).

2100 AT ZERO OUT - sink 2 mA. Sinks current if the control voltage is outside of the deadband region.

2100 JOYSTICK REQUEST OUT - (Enable Request) Sink 2 mA. Sinks current when requesting joystick control (ENABLE switch).

Z Channel Signals:

CHANNEL A+, CHANNEL B+ IN - these two-phase quadrature incremental encoder signals each drive 2 LSTTL loads; (source 60µ, sink 2.5 mA).

Z ENCODER POWER - +5 VDC and ground at 150 mA maximum (Z ENCODER IN).

Z MOTOR STEP PULSE - open collector 30 mA maximum. The frequency is limited only by the Z encoder's frequency response.

Z MOTOR DIRECTION - open collector 30 mA maximum. CHB+ directly to the motor so that motor responses will equal the encoder resolution divided by the motor resolution.

APPENDIX A

Z Axis Description

The Z axis channel of the Model 852 is intended for use when a simple third axis motor position control may be required. The circuit will supply power to and take input quadrature signals from, a two-phase incremental encoder which has TTL outputs. Pulses from the encoder are buffered and routed directly to the motor so that motor response will equal the encoder resolution divided by the motor resolution.

Z ENCODER IN

Pin Number	Function
1	CHANNEL A+
2	CHANNEL B+
3	(NC)
4	(NC)
5	Shield
6	X CHANNEL DISABLE
7	+5 VDC Supply (150 mA)
8	Y CHANNEL DISABLE
9	GND

Z MOTOR DRIVER

Pin Number	Function
1	STEP CURRENT SOURCE (60 mA)
2	DIRECTION CURRENT SOURCE (60 mA)
3	(NC)
4	(NC)
5	SHIELD
6	STEP OPEN COLLECTOR
7	DIRECTION OPEN COLLECTOR
8	(NC)
9	GND

NOTE: Signals with a bar over the signal name are active Low.

APPENDIX B

800 Series Joystick Commands

If the Joystick Option is to be used, the Joystick must be remotely enabled when the 2100 is under control of a host device. The host must periodically interrogate the Joystick Status to determine if an operator is requesting control. The Special Status Request Command is described in more detail below, but the first bit in the reply indicates whether or not there is a Joystick Enable Request. The command, RB, is the Special Status Request:

(D)RB (followed by a "space" or "carriage return", <CR>)
where D = device number (1 through 16 inclusive)

The reply is an ASCII character followed by a <CR>. If Bit 0 = 0 the Joystick Enable Request is "Low" or not asserted; if Bit 0 = 1, it is asserted or "High".

The following return characters indicate an active request:

A, C, E, G, I, M

The host may either enable the Joystick or ignore the request:

J<num>(space) or J<num><CR>)
where <num> = 0 disable the Joystick
1 enable the Joystick

The Joystick Status request amplifies Joystick status:

(D)SJ(space) or (D)SJ<CR> immediately returns bbbb<CR> where bits* (b) 1 through 4 from left to right are 1 or 0 as follows:

1/0	1. Enable switch	ON/OFF
	2. Remote direction	CW/CCW
	3. Joystick	not at zero/at zero
	4. Shutdown switch	ON/OFF

6 Each "bit" is sent as an ASCII 0 or 1.

APPENDIX C

Connector Listing

X MOTOR DRIVER, Y MOTOR DRIVER

Pin Number	Output Function
1	STEP PULSE
2	DIRECTION (CW/CCW)
3	CLOCKWISE STEP PULSE
4	COUNTERCLOCKWISE STEP PULSE
5	SHIELD
6	STEP RETURN (GND)
7	DIRECTION RETURN (GND)
8	SHUTDOWN
9	SHUTDOWN RETURN (GND)

X 2100, Y 2100

Pin Number	Function
1	2100 ENABLE REQUEST OUT
2	2100 DIRECTION OUT
3	2100 AT ZERO OUT
4	2100 STEP PULSE OUT
5	CONTROL VOLTAGE IN
6	2100 DISABLE IN
7	2100 SHUTDOWN OUT
8	GND
9	2100 GND
10	2100 GND
11	2100 +5VDC
12	(NC)
13	(NC)
14	COUNTERCLOCKWISE LIMIT IN
15	CLOCKWISE LIMIT IN

NOTES: 1. Signals above preceded by "2100" are optically isolated from other 852 signals.

2. Signals with a bar over the signal name are active Low.

APPENDIX D

852 Circuit Board Jumpers

There are ten jumpers on the 852 board. Jumpers JU1 through JU6 affect Joystick velocity ranges, direction polarity, and the timed remote shutdown feature. JU7 through JU10 are the limit switch defeat jumpers. Jumpers JU1 through JU6 are installed in the inactive position at the factory. It is important to note that changes on JU1 through JU6 will be noticed by the Joystick on power up only!

To identify the jumpers, orient the Joystick so the D- connectors are on the far edge of the Joystick box. The jumpers are located on the left edge of the board and can be accessed by removing the left panel of the Joystick box.

JU1 enables the timed-remote-power-shutdown feature. If the Joystick (or control voltage) remains at the zero point for 10 seconds, the remote power shutdown output for the at zero axis will be activated. (Other shutdown delay times are available as explained in Appendix E.)

JU2 and JU3 invert the motor direction for the X and Y axes, respectively.

JU4, 5, and 6 select one of the following eight motor speed ranges (a "0" means no jumper is installed):

Range	JU4	JU5	JU6	HI	MED	LO
1	0	0	0	500.0 KHz	50.0 KHz	5.0 KHz
2*	1	0	0	250.0 KHz	25.0 KHz	2.5 KHz
3	0	1	0	100.0 KHz	10.0 KHz	1.0 KHz
4	1	1	0	250.0 KHz**	12.5 KHz	125.0 Hz
5	0	0	1	50.0 KHz	5.0 KHz	500.0 Hz
6	1	0	1	10.0 KHz	2.0 KHz	200.0 Hz
7	0	1	1	5.0 KHz	1.0 KHz	125.0 Hz
8	1	1	1	1.0 MHz	100.0 KHz	10.0 KHz

* Factory Setting after Aug. 1, 1983. Prior to that date, units were set to Range 1 at the factory.

** 500 KHz prior to August 1, 1983.

APPENDIX D (Continued)

Range One of the above table is intended for use with the velocity scaling feature of the Compumotor 2100 preset indexer. Range table is the factory default setting; it is intended for direct driving Compumotors. Ranges Three and Four are also intended for direct driving Compumotors, but at slower rates. Range Five is intended for direct driving 1000 pulse per revolution motors (resulting in velocities of 50 RPS, 5 RPS, and 0.5 RPS). Range Six is intended for direct driving 400 pulse per revolution motors (resulting in velocities of 25 RPS, 5 RPS, and 0.5 RPS).

Range Seven is intended for direct driving 200 pulse per revolution motors (resulting in velocities of 25 RPS, 5 RPS and 0.625 RPS). Range Eight is reserved for optional use with the velocity scaling feature of the Compumotor 2100 Preset Indexer. Of course, one may use any velocity range and motor combination desired.

JU7, 8 and 9

The 852 is supplied with the limit switch jumpers installed so it may be operated immediately out of the box. The limit switch jumpers must be removed to implement the end of the travel limit function with external limit switches. Limit switch hardware is connected between Pins 14 and 15 and ground on the 2100 connectors (see Appendix C for connector pinout). Normally closed momentary switches or normally-on optical interruptors or reflectors should be used. The limit switch jumpers are located on the left edge of the board inside the left panel of the joystick box.

JU7	Y counterclockwise limit defeat
JU8	X counterclockwise limit defeat
JU9	Y clockwise limit defeat
JU10	X clockwise limit defeat

APPENDIX E

Factory Adjustment Options

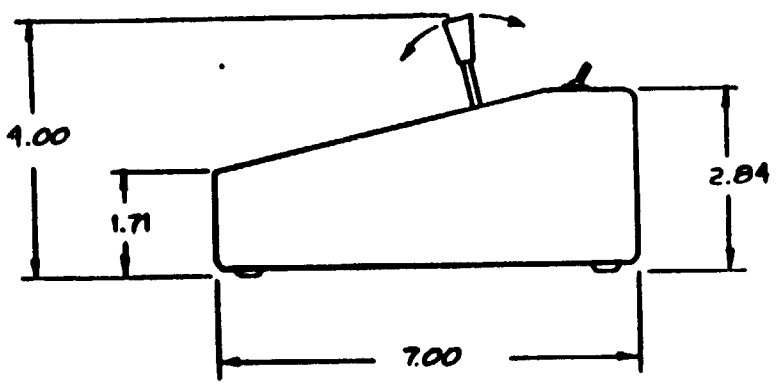
There are three channels into the Analog-to-Digital converter which establish motor control parameters. These parameters are Acceleration Limit, Deadband, and Shutdown Delay. Fixed resistors on the standard 852 define the default values. There are five values each parameter may be set to if the resistors are replaced with potentiometers. The following table defines the available parameter values; default values are denoted by asterisks.

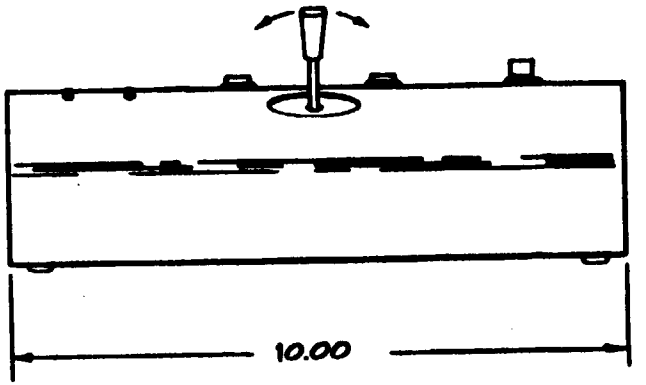
Volts	Accel (MHZ/SEC)	Deadband (% Full Scale)	Timed Shutdown Delay (SEC)
3.00-3.75	25	20	300
2.25-3.00	12.5	15	60
1.50-2.25	2.5*	10*	10*
0.75-1.50	1.25	5	5
0.00-0.75	0.25	0	0

These parameters are factory adjustable only. They are available by special order.

* Factory default setting

LTR	DESCRIPTION	DATE	APPROVED
A	ECR # 173		





TOLERANCES UNLESS OTHERWISE SPECIFIED FRACTIONS ± DEC ± ANGLES ±	COMPUMOTOR CORPORATION	
APPROVALS	DATE	DIMENSIONAL DWG, JOYSTICK @
DESIGN HFQ	7/12/93	
CHECKED		SCALE
		SIZE B
		DRAWING NO. 88-002881-01
		DO NOT SCALE DRAWING
		SHEET 1