OPERATOR'S MANUAL
FOR THE
DM4005, DM4003, DM4001 & DM1501
STEPPING TRANSLATORS
& 1MR BOARD

PN: EDA111

Patent No. 4,652,806

AEROTECH®

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DISCLAIMER:

The information contained in this manual is subject to change due to improvement in design.

Though this document has been checked for inaccuracies, Aerotech does not assume responsibility for any errors contained herein.

WARNING: SEE SECTION 4-4 BEFORE APPLYING INPUT POWER TO THE DM4005/4003/4001/1501.

NOTE: The DM4005, DM4003, DM4001 and DM1501 stepping translators are referred to as one entity. Differences are noted when necessary.

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CHAPTER 1: GENERAL DESCRIPTION

SECTION 1-1 INTRODUCTION

This manual describes the Dynacron DM4005, DM4003, DM4001 and the DM1501 Stepping Translators. They are each a totally self-contained micro-stepping translator containing all of the necessary hardware to drive stepping motors up to 100 oz-in. All power supplies are integral to the unit. Stepping resolution can be selected from 200 step/rev to 50,000 step/rev in 200 step increments, using a standard 50 pole stepping motor. The DM4005/4003/4001/1501 needs only a single 115VAC or 230 VAC, 50 or 60 Hz (nominal) input power connection for operation.

The translator power bridge operates in the unipolar mode, requiring a six-wire type stepping motor interface. Control power supplies of ±12VDC and +5VDC, and a +40VDC translator power bridge supply are all generated from the unit itself.

The DM4005/4003/4001/1501 offers various modes of control for local and remote operation. The remote mode provides an interface for an external controller through separate "clock" and "direction" input connections. The local mode allows manual control through separate "slew", "single step" and "direction" input connections. A field adjustable clock oscillator (integral to the DM4005/4003/4001/1501) provides speed control for the "slew" input control in the local mode. The slew clock oscillator can also be controlled externally by a potentiometer connected to two input connections on the DM4005/4003/4001/1501. The local mode can be altered (through in-

tegral programming jumper selection) to allow separate connections to be used for joystick clock and direction control.

Separate input connections for "CW limit", "CCW limit" and "home limit" are also provided on the DM4005/4003/4001/1501 to control motor travel. Separate programming jumpers on the DM4005/4003/4001/1501 can be altered to set these inputs for normally open or normally closed logic sense. These inputs are fully buffered and "debounced" on the DM4005/4003/4001/1501. Furthermore, each of these limit inputs are double buffered and sent out of the DM4005/4003/4001/1501 as logic outputs to be used for external control status indicators. An additional "ORed" limit output connection is provided for a CW or CCW limit condition.

A reset input connection also provided on the DM4005/4003/4001/1501 to this input can be used to "freeze" operation in the local or remote modes, regardless of the presence of input or slew clock pulses.

The input "Marker" connections (differential) are provided for accurately positioning the stepping motor in the "home" mode (described below). These differential inputs can accept TTL or analog marker signals.

The DM4005/4003/4001/1501 also provides for a "Go Home" input connection (home mode), which can execute a home cycle in the local or remote mode. This home mode can be used to accurately position the motor on any of three limit switches (CW limit, CCW limit or home limit) or the marker signal described above. An "at home" output signal is provided to indicate to an external controller that a "successful" go home cycle has been completed.

For ease in interfacing to an external tracking display, separate buffered output connections ("clock", "direction" and "reset") are provided. The "clock" and "direction" outputs provide tracking information in either the local (step, slew or joystick) or remote mode (described above). The output reset connection reflects the state of

the input reset connection. In addition, this reset output connection also provides a single output pulse at the end of a "home" cycle to automatically clear the external tracking display.

The DM4005/4003/4001/1501 also provides a "hi/lo" input connection for controlling the current to the stepping motor. This control allows the motor current to be decreased during a stand-by condition in order to minimize motor heating.

An optional ramper card (1 MR) can be mounted to the DM4005/4003/4001/1501 to provide controlled acceleration and deceleration to the stepping motor. This card is capable of operating up to 1MHz clock rate. If desired, the ramper card can be selected (through a programming jumper) to automatically control the lo/hi current control described above. The ramper card also provides an output signal indicating "move complete" ("count zero"), so that an external controller can be properly synchronized to the ramp.

All input and output connections described above are fully buffered, requiring no additional interfacing circuitry.

Seven LEDs are provided on the DM4005/4003/4001/1501 to indicate status conditions (previously described) such as CW limit, CCW limit, marker, local mode, remote mode, reset and count zero (move complete).

The DM4005/4003/4001/1501 package is designed to the international DIN 41612 6U specifications. This standard allows the flexibility of choosing a multitude of packaging options to be used when designing a system around the DM4005/4003/4001/1501.

CHAPTER 2: ELECTRICAL SPECIFICATIONS

Following are the electrical specifications for the DM4005/4003/4001/1501 stepping translators.

ELECTRICAL RATINGS

Power Connections

Input Connections			
	115VAC Operation:		
		VAC (Min)	95VAC 50 or 60 Hz
		VAC (Max)	125VAC 50 or 60 Hz
	230VAC Operation:		
		VAC (Min)	190VAC 50 or 60 Hz
		VAC (Max)	250VAC 50 or 60 Hz
Output Connections			
	Motor Inductance (Min)		.5mH/phase
	Output Power (Max)		DM1501/DM4001 20 Watts
			DM4003 40 Watts
			DM4005 80 Watts

Logic Input Connections

Voltage (Min)	1 Volt	(logic low)
Voltage (Max)	15 Volts	(logic high)

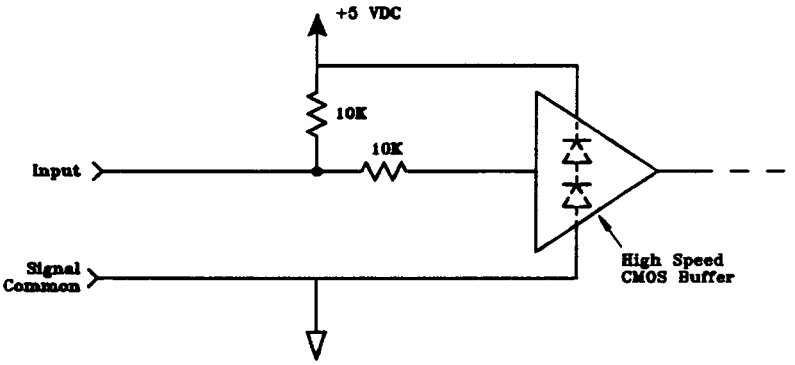
Temperature Ratings

Operating Temperature Range:	0°C to 50°C
Storage Temperature Range:	-30°C to 85°C

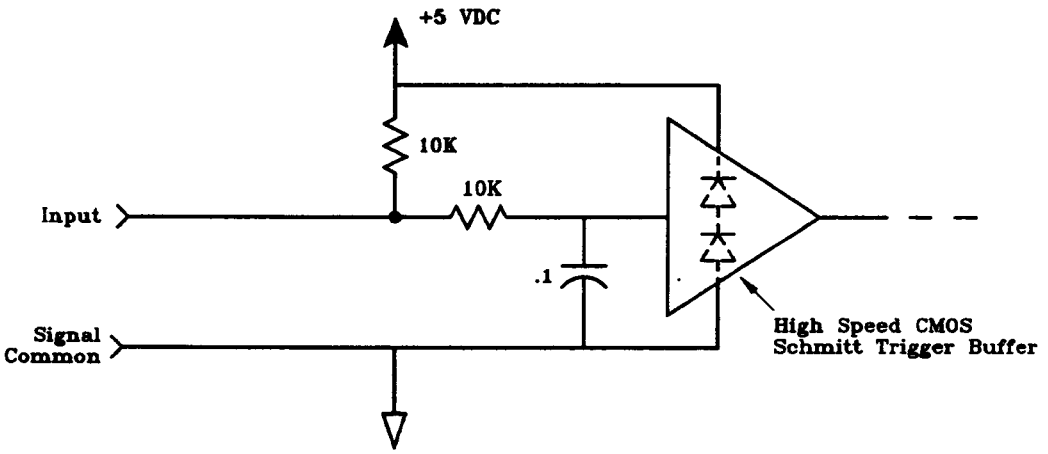
5 volt logic is recommended for all logic inputs. TTL, CMOS or open-collector types can all be used. All inputs are protected against accidental application of negative voltage for up to -20 volts.

The typical buffered input circuitry for logic inputs are as follows:

Inputs for: "/slew", "step N.O.", "step N.C.", "remote clock", "remote direction", "local direction", "joystick clock", "joystick direction", "/go home", "/reset" (in), "local-/remote" and "lo-/hi":



Inputs for: "CW limit", "CCW limit" and "Home limit":

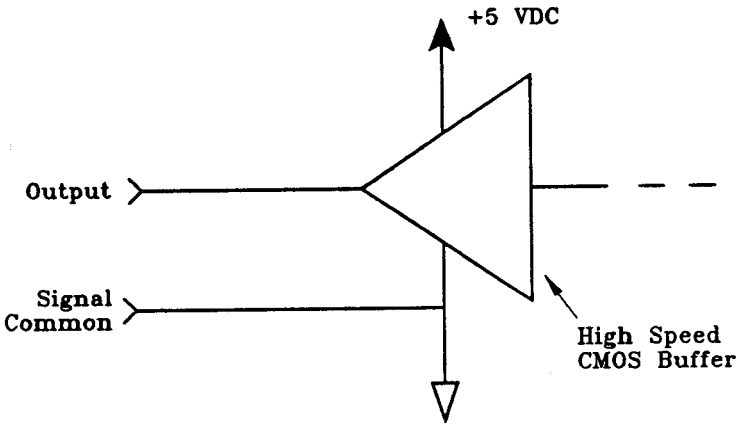


Logic Output Connections

Maximum current sourcing	+20mA
Maximum current sinking	-20mA
Unloaded logic levels	+5VDC (logic high) 0VDC (logic low)
Loaded logic levels (@ ±5mA sourcing or sinking)	+4.8VDC (logic high) +.18VDC (logic low)

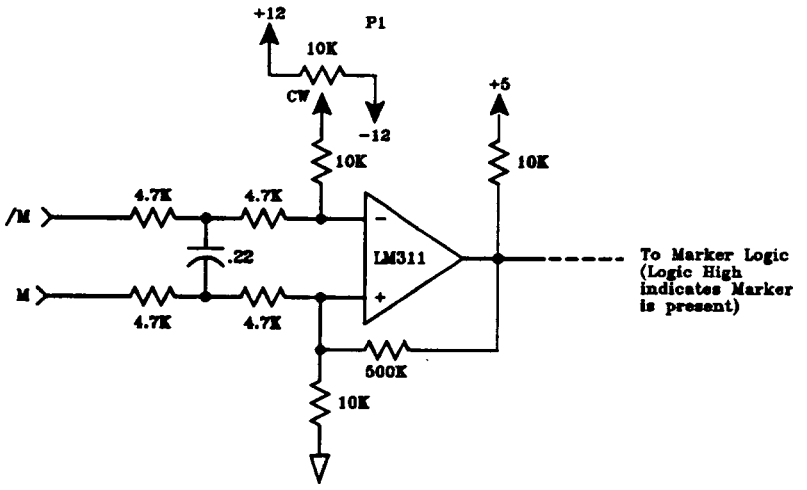
The typical buffered output circuitry for the logic outputs are as follows:

Outputs for: "at home", "count zero", "/reset", "/CW limit", "/CCW limit", "/home limit" and "/limit":



Differential Marker Input Connections

Shown below is a circuit diagram of the differential input marker circuit.



Potentiometer P1 in the circuit diagram above allows the threshold of the marker input signal to be adjusted. The threshold level is increased by turning P1 CW. To activate the marker logic, the voltage signal at "M" must rise slightly higher than the voltage signal at "/M", plus the threshold setting at P1. In other words,

M > /M + P1 (threshold)

For a TTL marker connection, the signal common of the TTL circuit should be tied to signal common of the DM4005/4003/4001/1501 with the marker tied to "M". Also, pot P1 must be adjusted for the marker threshold. Manually position the table (or other mechanical system being used) to the marker. Slowly turn P1 CCW until the marker LED energizes.

Pin-out definitions for power connections and all logic input and output connections are explained in chapter 3, Circuit Description.

CHAPTER 3: CIRCUIT DESCRIPTION

The DM4005/4003/4001/1501 is designed to accurately control a standard unipolar stepping motor by utilizing a unique sin/cos translator control. This control is capable of dividing a full-step size into 1000, evenly spaced micro steps. For a 50 pole (standard) stepping motor, this subdivision of a full step provides electrical resolutions of up to 50,000 steps per revolution. This sin/cos translator control, as mentioned in the introduction, can be easily altered to provide other step sizes. By simply programming two IC chips, a host of other incremental step sizes can be chosen, ranging from 200 steps/rev (full step) up to 50,000 steps/rev in 200 step intervals. In other words, there are 250 choices of stepping resolutions.

Another feature unique to the DM4005/4003/4001/1501 is its totally integral power supply circuit. Stepping motor voltages as well as all logic control voltages (+5 and ±12VDC) are all generated on the DM4005/4003/4001/1501. The only incoming power connection necessary is a standard 115VAC 50/60 Hz (nominal) or a 230VAC 50/60 Hz line connection.

A block diagram of the entire DM4005/4003/4001/1501 circuit is illustrated in figure 3-1. A simplified assembly outline of the DM4005/4003/4001/1501 is shown in figure 3-2. This outline shows the locations of user-oriented components described in figure 3- 1.

Referring to figure 3-1 and 3-2, all input and output control connections are made at connector J1. Connector J1 can be supplied in two styles: a 64 pin, DIN 41612 connector (standard) or dual row-locking header. All power input and stepping motor output connections are made at connector J3. Connector J3 can also be supplied in two styles: a 15 pin, DIN 41612 connector (standard) or individual quick connect termination. (See chapter 4, Installation and Start-up, for J1 and J3 mechanical specifications.)

The following section describes the pin-out definitions for the DIN control connector J1. In this table, each input and output pin is described with reference to its function on the DM4005/4003/ 4001/1501. (Refer also to figure 3-1 and figure 3- 2.)

SECTION 3-1 J1 INPUT AND OUTPUT DEFINITIONS

1. Local - /Remote (pin 23A)

This input connection allows system operation in either the local or remote mode. Logic high denotes "local", logic low denotes "remote". In the remote mode, connection "remote clock" (pin 5A) is channeled through the control logic decoder to the sin/cos multiplexing logic to control the stepping angle. The remote direction (pin 2C) input is also channeled in the same manner, in order to control the direction of the angle generated by the remote clock.

In the local mode, stepping angle control can be transferred in two ways, depending on the programming jumper position defined by points 9, 10, 11 and 12 of the control logic decoder.

With the jumper position set between 9 to 10 and 11 to 12, manual controls such as pot speed (pins 27A, C), slew (pin 29A), step (pins 28 A, C) and local direction (pin 30C) are channeled from the manual control logic, through the control logic decoder, to the sin/cos multiplexing logic. These controls are described in detail below.

With the jumper set between 9 to 11 and 10 to 12, joystick clock (pin 31C) and joystick direction (pin 30A) are channeled to the sin/cos multiplexing logic. These controls are also described later in item 11.

2. Remote Clock (pin 5A) and Remote Direction (pin 2C)

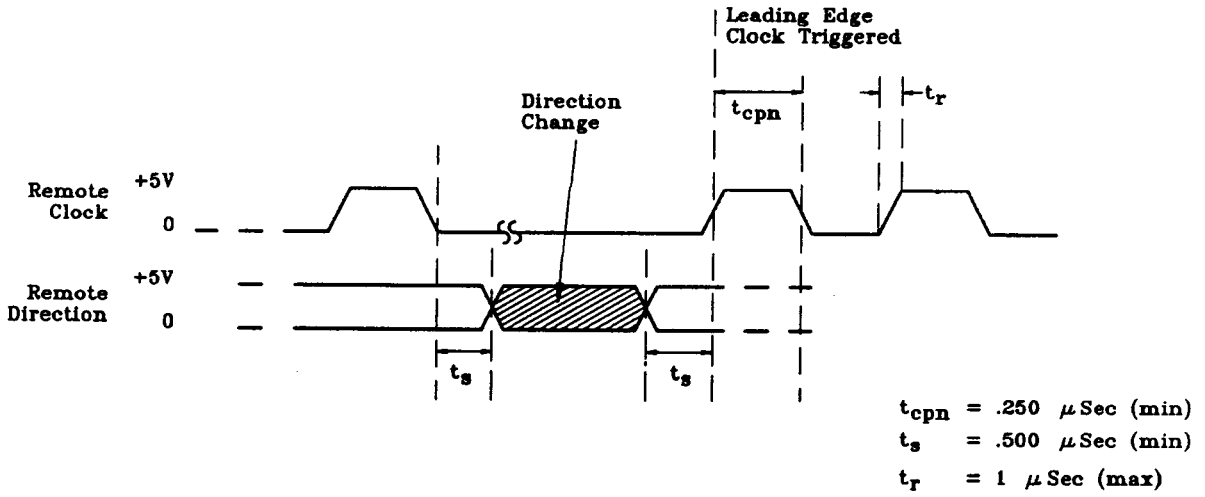
The remote clock connection is capable of accepting a 0 to 3MHz clock rate (see also item 1 above).

The remote direction connector, when in the logic high state, produces a CW shaft rotation (looking into the shaft of the stepping motor). For the logic low state, the rotation is CCW. This relationship applies only to stepping motors utilizing the standard motor color-coded wiring, illustrated in figure 3-1, and applies only if jumpers 20, 21, and 22 are configured as "standard" as shown below.

(Standard) "+" = CW, "-" = CCW - Jumper 21-22, Remove 20-21
(Optional) "-" = CW, "+" = CCW - Jumper 20-21, Remove 21-22

Following is the timing diagram for remote direction and remote clock signals.

NOTE: **The direction cannot be changed while clock pulses are being applied.**



3. /Reset (in) (pin 23C)

This input allows the DM4005/4003/4001/1501 to be reset from an external device. A logic low activates a reset. An active reset initiates the following functions:

- Inhibits local and remote clock and direction controls. However, holding torque to the stepping motor is present.
- If activated during a "go home" cycle (explained in item 8), the "go home" cycle is cancelled. (The go home" cycle does not continue if the reset is removed.)
- If the optional 1MR ramping card (explained in the last section) is being used, the accumulated data in the ramping board is reset to zero.
- The /reset (out) connection (pin 4C) goes to the logic low state.

4. Clock (out) (pin 3A) and Direction (out) (pin 3C)

Clock and direction signals channeled to the sin/cos multiplexer logic from the control logic decoder (generated by either the remote mode or local mode described in item 1) are buffered and sent back out to the DM4005/4003/4001/1501 through these connections. The logic states for these outputs are the same as their input counterparts.

These outputs can be used for driving external tracking displays.

Programming jumper 35 to 36 must be inserted (36 to 37 open) for the clock (out) to be active.

5. /Reset (out) (pin 4C)

As described in item 3 above, the /Reset out connection goes to the logic low state when an input reset (pin 23C) is applied.

This output will also pulse low for 1 mSec after the completion of a "home" cycle described later in item 8.

This output, when used in connection with a tracking display described in item 4 above, will automatically reset these displays after the completion of a "go home" cycle.

Programming jumper 32 to 33 must be inserted (33 to 34 open) for this output to be active.

6. Signal Common (pins 5C, 21A, 21C, 22A, 22C)

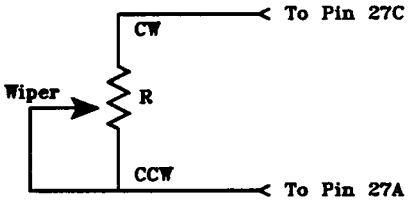
All logic input and output connections are referenced to these pins.

7. Local Direction (pin 30C), Slew (pin 29A), Step N.O. (pin 28A), Step N.C. (pin 28C), and Pot Speed (pin 27C and 27A)

These input connections are dedicated to manual control of the DM4005/4003/4001/1501 when the local mode of operation is selected (see item 1).

The /slew input when pulled to logic low, "jogs" the stepping motor at a constant speed. The direction in which the stepping motor turns depends on the logic state of the local direction input. For a logic high state on this input, the shaft rotation is CW. For a logic low state, the rotation is CCW.

The /Slew speed can be set in two ways. First, by changing the value of a resistor (RCN1 10-7) in the personality module, RCN1. The personality module is discussed in detail in section 3-3. This method provides a fixed slew clock frequency. Another method is to connect an external potentiometer to the pot speed connections, pins 27C and 27A, in the manner shown below. This method provides external adjustment of the slew clock oscillator.



The table on the following page illustrates the slew clock oscillator adjustment ranges for various values of potentiometer R in conjunction with the selected fixed R settings of resistor RCN1 10 - 7.

Potentiometer R (Ohms)	RCN1 10-7 (Ohms)	Max Slew Clock Frequency (R Full CW)	Min Slew Clock Frequency (R Full CCW)
5K	3.3K	322KHz	128KHz
10K	6.8K	156KHz	63KHz
50K	33K	32KHz	12.8KHz
100K	68K	15KHz	6.3KHz

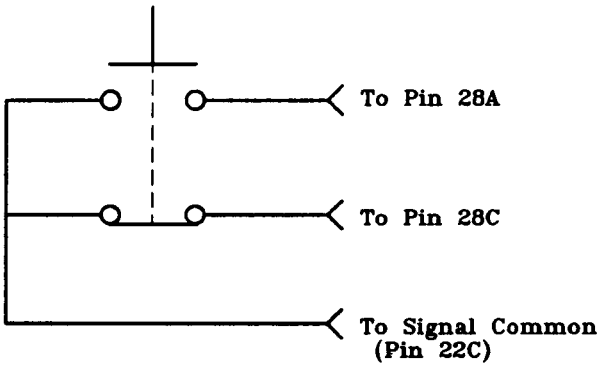
NOTE: When using the external pot speed control, jumper 7 to 8 must be removed (see figure 3-2) and jumpers 38-39, 40-41 must be installed.

An important thing to remember is that for a given slew clock frequency, the rotational speed of the stepping motor depends on the stepping resolutions selected. (The selection of stepping motor resolution is discussed in section 3-2.)

The step N.O. and step N.C. connections allows manual single step control of the DM4005/4003/4001/1501. As is the case with the /Slew input discussed above, the DM4005/4003/4001/1501 must be set in the local mode. The "local direction" input allows selection of the direction in which the DM4005/4003/4001/1501 is to step, just as in the case with the slew input.

To provide "debouncing" for the single step control, a form "C" switch is required. The connecting of this switch follows.

NOTE: Pin 28C should be tied to signal common when not using the step N.O. and step N.C. inputs.



8. At Home (pin 1A), /Go Home (pin 1C), Marker (pin 31A), and /Marker (pin 32A)

This set of inputs and outputs is responsible for controlling the "home" cycle. The home cycle can be initiated in either the local mode or remote mode, discussed in item 1.

All DM4005/DM4003/DM4001 and DM1501 are capable of generating a cold start reference position, which is the "home" position. The basic home cycle involves the following series of events. When the "go home" command has been issued, the motor will turn CCW (standard) or CW (optional) until a "home limit switch" activation occurs.

NOTE: **The CCW and CW rotational references are viewed looking into the motor mounting flange.**

Upon "home limit switch" activation, the motor will reverse and rotate in the opposite direction until the switch deactivates. If no "marker" pulse option exists, the motor will stop immediately, assuming P1 is properly adjusted (see chaper 2). If a "marker" pulse option does exist, the motor

will continue to rotate until the "marker" pulse is present. At this time, motion ceases.

The speed at which the home cycle occurs is factory set at 120 RPM. If a different speed is required, see section 3-3 for appropriate personality module changes.

For most rotary motion stages, the "home limit switch" referenced above is an independent switch incorporated specifically for the "home" cycle. For linear motion stages, the "home limit switch" could be an independent switch as well. However, in most cases, the CCW or CW limit switches perform "double duty" and act as the "home limit switch". Note that the process of putting the "home limit switch" input in parallel with the CCW or CW limit switch input is standardly done at the motor/stage, external to the DM4005/4003/4001/1501.

If it is not possible to use the "home limit" input at Pin 29C, the "CCW" or "CW limit" input may be paralleled to the "home limit" input by reconfiguring jumpers 16 through 19 on the DM4005/4003/4001/1501 PC board. Note that this scheme is possible only with linear stages and not with rotary stages. The jumper definition follows:

Home Limit Source:

(Standard) From Home Limit Input: Jumper 17-19, Remove 16-19, 18-19
(Optional) From CCW Limit Input: Jumper 16-19, Remove 17-19, 18-19.
(Optional) From CW Limit Input: Jumper 18-19, Remove 16- 19, 17-19.

See figure 3-2 for jumper locations.

When the home command is issued, the standard direction of motor rotation is CCW. If CW rotation is required, jumpers 23-24-25 on the DM4005/4003/4001/1501 board must be reconfigured. The jumper definition follows:

(Standard) CCW Home - Jumper 23-24, Remove 24-25.
(Optional) CW Home - Jumper 24-25, Remove 23-24.

See figure 3-2 for jumper locations.

The "Go Home" input connection is used to initiate the go home cycle. This input needs only to go logic low for a minimum of 1mSec in order to trigger the home cycle. A longer duration of the input signal is acceptable. However it should be noted that if a logic level is used instead of a logic pulse, a retriggered condition of the home cycle may occur if the "logic low" level is removed after the home cycle has been completed.

The "At Home" output connection has two purposes. When using the marker input and a home cycle is not active, this connection will go logic high when the marker is encountered on each revolution of the motor. This is true for both the local and remote modes of operation of the DM4005/4003/ 4001/1501. However, when in an active home cycle, this output will be "masked" (will stay logic low even if the marker is encountered) until the completion of the home cycle. The mask will then be removed, allowing the marker to be identified.

When a marker is not used, this output should be high at all times (pot P1 full CCW). The output will go low only during a home cycle, returning to logic high when the home cycle is complete. For "at home" to be present at pin 1A, points 26-27 must be jumpered (27 to 28 removed).

9. CW Limit (in) (pin 25A), CCW Limit (in) (pin 24A), Home Limit (in) (pin 29C)

The three limit input connections are made here. As well as providing a means of indicating a home position, as was discussed in item 8, the CW limit and CCW limit play

an even more important role. They provide a means of unconditionally stopping the travel of a mechanical system. Unlike the home limit switch which is active only in the "home" mode, the CW and CCW limit switches are active at all times (local and remote modes) providing a means of stopping the stepping motor if a travel limit is exceeded.

The DM4005/4003/4001/1501 can be set to accept either normally closed (N.C.) or normally open (N.O.) CW and CCW limit switch inputs.

For the CW limit switch:

- Jumper point 6 to 5 when using a normally open CW limit switch (logic low initiates limit)
- Jumper point 5 to 4 when using a normally closed CW limit switch (logic high initiates limit)

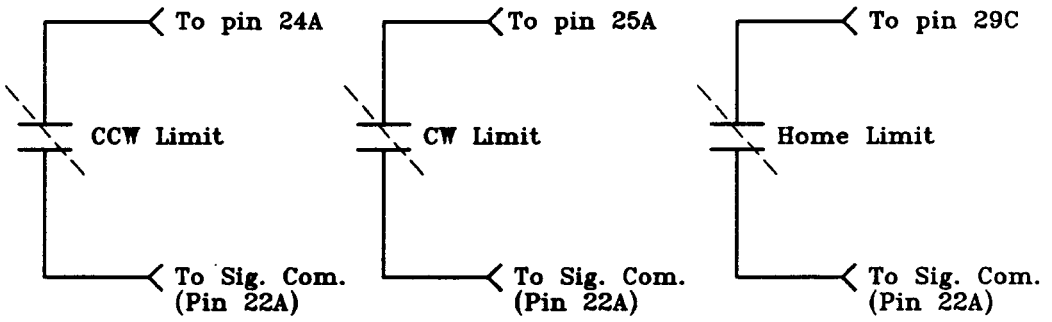
For the CCW limit switch:

- Jumper point 1 to 2 when using a normally open CCW limit switch (logic low initiates limit).
- Jumper point 2 to 3 when using a normally closed CCW limit switch (logic high initiates limit).

For the Home Limit:

- For N.O. (normally open) home limit switch, jumper 13-14, remove 14-15.
- For N.C. (normally closed) home limit switch, jumper 14-15, remove 13-14.

The method in which to connect the limit switches is shown below:



10. /CW Limit (out) (pin 25C), /CCW Limit (out) (pin 24C), /Home Limit (out) (pin 26C) and /Limit (out) (pin 2A)

The DM4005/4003/4001/1501 provides various buffered output connections for limit statuses. "CW limit", "CCW limit" and "Home limit" input connections described in item 9 above, are brought back out as status indicators. In addition to this, a "/limit" output connection is provided which "ORs" the CW limit and CCW limit inputs. All four output connections are fully buffered.

For all four output connections, a logic low level indicates a limit condition. This is regardless of what polarity has been chosen for their respective inputs (i.e., N.O. or N.C.).

11. Joystick Clock (pin 31C), Joystick Direction (pin 30A)

As discussed in item 1, DM4005/4003/4001/1501 can be set to accept joystick clock and direction input signals in the local mode. Obviously the use of three input sig-

nals need not be limited to joystick clock and direction. They can be used as additional sets of clock and direction inputs for the local mode, just as the remote clock and remote direction input are used in the remote mode (see item 2). The required set-up times for these inputs are the same as the set-up times shown in item 2 for remote clock and remote direction.

As mentioned in item 1, to use these inputs, programming jumpers 9 to 11 and 10 to 12 must be set. Also, the DM4005/4003/4001/1501 must be selected for local mode operation.

12. Zero (pin 26A) and Lo/Hi (pin 4A)

The lo - /hi (current low - current /high) input control connection allows the stepping motor current to be set for full rated current (when the motor is running) and standby current (when the motor is at rest). The level settings for full current and standby current are selected in personality module RCN1 (discussed later). For this input, a logic high selects the low (or standby) current (zero LED is energized) while a logic low selects the high (or running) current levels (zero LED is deenergized). If desired, this input need not be used if the high (or running) current level does not exceed the continuous rating of the stepping motor.

WARNING: The lo - /hi input connections must never be used if the optional 1MR is connected to the DM4005/4003/4001/1501.

The zero output connection is used in conjunction with the optional 1MR ramping board (discussed in more detail later). When using the 1MR ramping board, a lag exists between the clock rate (either input remote clock, slew or joystick clock) and the output clock of the 1MR ramper. The zero output connection is used to provide an indication to an external controller that the 1MR has output all of its clock pulses. Logic high on this output indicates the last clock pulse (or zero count).

The 1MR ramper board also has the ability to control the lo - /hi current control automatically. When one or more counts accumulate in the 1MR, the current will automatically increase to the high (or running) level. When all counts have been output, the current will automatically be released (standby level). If desired, this "auto" lo/hi control can be defeated by placing a programming jumper between points 30 to 31 (29 to 30 is open). This will set the DM4005/4003/4001/1501 for a continuous high current level.

There are seven LED indicators associated with the DM4005/4003 /4001/1501 (see figures 3-1 and 3-2). The local LED and remote LED indicates the mode in which the DM4005/4003/4001/1501 is operating, as described in item 1 of this section. The zero LED indicates if the optional ramper board has output all accumulated pulses as described in item 12. The CW limit and CCW limit LEDs indicate if the DM4005/4003/4001/1501 is in a limit as described in item 9. The reset LED indicates either an internal or external reset condition as described in item 3. The marker LED indicates the system is positioned over a marker as described in item 8.

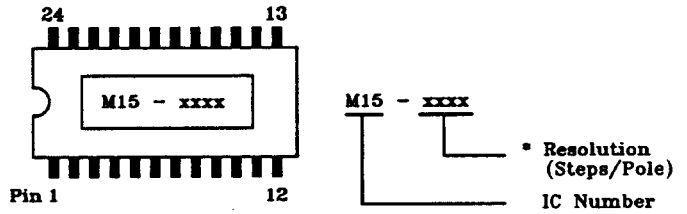
SECTION 3-2 STEPPING MOTOR RESOLUTION

The DM4005/4003/4001/1501 can be programmed to drive a stepping motor at 250 different stepping resolutions. As was described in section 1-1, *Introduction*, a stepping resolution range can be selected between 200 steps/rev and 50,000 steps/rev inclusive, in increments of 200 steps (i.e., 200, 400, 600,....., 49,600, 49,800 and 50,000 steps/rev).

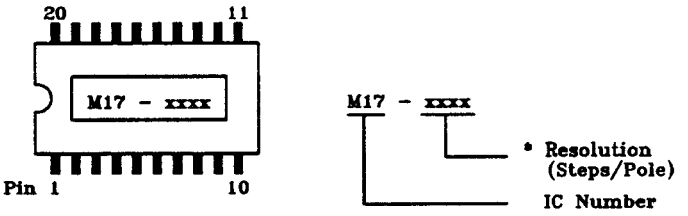
The changing of resolution on the DM4005/4003/4001/1501 involves the programming of two IC chips, M15 and M17 (see figure 3-1 and 3-2). This programming can not be done in the field. However, M15 and M17 can be changed very easily in the field since both ICs are mounted on IC sockets.

The part numbering system for M15 and M17 is shown below. These part numbers must be used when ordering different control resolutions.

For IC M15:



For IC M17:



* NOTE: This number defines the resolution (in steps/pole).

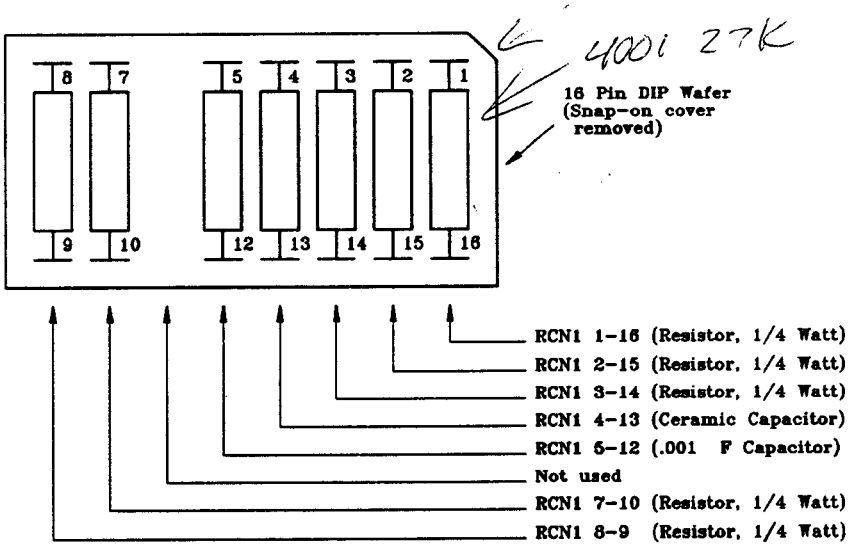
For example:

Pole Resolutions (Steps/Pole)			
1000	→	50000 Steps/Rev	For standard 1.8° /pole motors
720	→	36000 Steps/Rev	
80	→	4000 Steps/Rev	
16	→	800 Steps/Rev	

As was mentioned in the introduction to this manual, the step/rev numbers listed above apply to a 50-pole 1.8 degree per full step stepping motor. When determining Step/Rev for other multiple pole motors, multiply the given Steps/Pole resolution by the number of poles for the given stepping motor. The resulting number will then be the Step/Rev resolution for that motor.

SECTION 3-3 PERSONALITY MODULE (RCN1)

The personality module is a 16-pin DIP wafer consisting of 5 resistors and 2 capacitors. This module contains all of the parameters used to match a given stepping motor with a given resolution for the DM4005/4003/4001/1501. A representation of a personality module follows (see also figures 3-1 and 3- 2).



The parameter settings of RCN1 are covered in the following sub-sections.

A. RCN1 7-10, /SLEW CLOCK OSCILLATOR ADJUSTMENT

As mentioned in item 7 of section 3-1, the internal slew clock oscillator frequency can be set by manipulating the value of RCN1 7-10. With programming jumper 7 to 8 inserted (this jumper removed for external pot speed control; see item 7 of section 3-1), the value of RCN1 7-10 can be determined for a given slew clock frequency as:

$$\text{Slew Clock Frequency (Hz)} \approx \frac{1}{2\,(\text{RCN1}_{7-10})\,(470 \times 10^{-12})}$$

where RCN1_{7-10} is in ohms

B. RCN1 8-9, HOME CLOCK OSCILLATOR ADJUSTMENT

The adjustment for the oscillator which sends the stepping motor into a limit involves RCN1 8-9. This value can be determined as follows:

$$\text{Home Clock Frequency (Hz)} \approx \frac{1}{1.5\ (.001 \times 10^{-6})\ (RCN1_{8-9})}$$

where $RCN1_{8-9}$ is in ohms

C. RCN1 3-14 & 2-15, LO - /HI CURRENT ADJUSTMENT

(See Item 12 of Section 3-1)

The low current level (standby current) is set by RCN1 2-15. This value of current can be calculated as follows:

$$\text{Standby Current Level (amps)} = N \left(\frac{10000 \times 1 \times 10^{4}}{RCN1_{2-15}} \right)$$

where $RCN1_{2-15}$ is in ohms

N = 1 for DM4001
N = 3 for DM4003
N = 5 for DM4005
N = 1 for DM1501

The high current level (running current) involves the selection of RCN1 3-14 and RCN1 2-15 (determined above). The value can be calculated as follows:

$$\text{Running Current Level (amps)} = N \left(\frac{1 \times 10^4}{RCN1_{2-15}} + \frac{1 \times 10^4}{RCN1_{3-14}} \right)$$

where $RCN1_{2-15}$ and $RCN1_{3-14}$ is in ohms

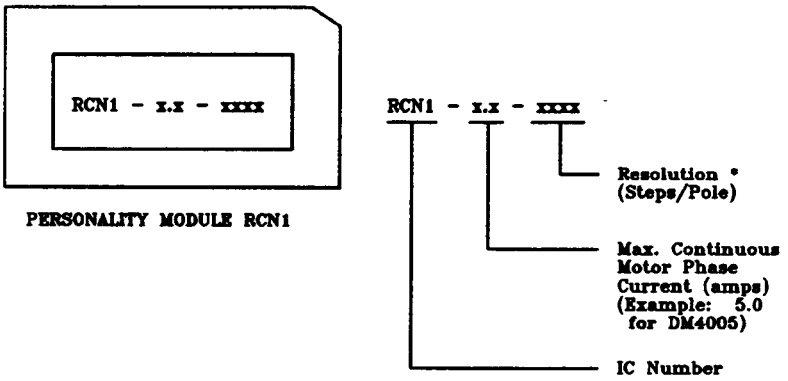
N = 1 for DM4001
N = 3 for DM4003
N = 5 for DM4005
N = 1 for DM1501

NOTE: RCN1 1-16, RCN1 4-13 and RCN1 5-12 are factory selected for the DM4005/4003/4001/1501. These components should *never* be changed by the user.

The DM4005/4003/DM4001/1501 stepping translators are shipped with standard personality modules, which are defined by the resolution and rated phase current of the stepping motor being used. If the DM4005/4003/DM4001/1501 is being used with a standard Aerotech stepping motor, the user need only define the desired resolution in which the motor is to operate. If the DM4005/4003/DM4001/1501 is not being used with a standard Aerotech motor, the user must define the type of stepping motor being used, with its rated phase current, as well as the DM4005/4003/DM4001/1501 resolution in which it is to operate.

A list of personality modules used with standard Aerotech stepping motors is listed after the next illustration. The label on the personality module defines the resolution (of the internal oscillators) and motor phase current parameters for that module. If Aerotech motors are not being used, a custom personality module can be ordered, using the

part numbering format shown below. Given the rated current and resolution information for a particular motor, Aerotech will set the slew oscillators, the home oscillator and the Run/Standby phase current levels. Although it is not generally recommended, the user also has the option of changing the parameters of the personality module him or herself, by using the equations listed in sections 3-3A, B & C.



* This number defines the resolution (in steps per pole), for which the slew and home oscillator, as well as the current levels of the personality module, are "tailored" to operate.

Recommended standard RCN1 modules for the DM4005/4003/DM4001/1501 are:

Aerotech Translator	Motor	Phase-Current (amps)	Torque (oz-in)	Recommended Personality Module (RCN1)
DM4001	50SM	1	38	RCN1 1.0 - xxxx
DM4003	100SM	2.9	90	RCN1 3.0 - xxxx
DM4005	101SM	4.6	90	RCN1 5.0 - xxxx
DM1501	Phytron *	1	13	RCN1 1.0 - xxxx

Contact Aerotech for Customized Personality Modules.

* Phytron part number ZSS 33-200-1.2

SECTION 3-4 DM4005/3/1/1501 POWER CONNECTIONS

Input power and motor connections to the DM4005/4003 /DM4001/1501 are made on connector J3 (see figures 3-1 and 3-2). These connections feed an isolated power supply which in turn generates all necessary voltages for operating the DM4005/4003/ 4001/1501. Specifically, input power can be of either two types: 115 VAC (50/60 Hz) or 220 to 240 VAC (50/60 Hz). Germany requires 220 VAC 50 Hz. The United Kingdom requires 240 VAC 50 Hz.

The connections for both types of voltages are shown in figure 3- 1. Input power fuse F2 and F3 are provided solely for catastrophic internal short circuit protection in the DM4005/4003/4001/1501. These fuses cannot be replaced in the field.

Stepping motor connections are also made at connector J3. The driving bridge of the DM4005/4003/4001/1501 is of the unipole type, utilizing four power mosfet switches S1, S2, S3 and S4. All magnetically "coupled" energies stored in phase A, A' and B, B' of the stepping motor are either channeled through mosfet Q1 or Flyback Diode D2 of the appropriate switch. Energies in a given phase which are "not coupled" in phase A, A' and B, B' (i.e., stray inductances associated with the motor cable as well as leakage inductances of the motor itself), are deflected through diode D1 of the appropriate switch. These energies are "clamped" by a regenerative power supply which in turn transfers the energy back to the translator bus power supply through transformer X2.

Circuitry is incorporated in the isolated power supply section to provide short circuit protection to ground on the stepping motor output connections. If a short occurs, the power supply will "latch" off, inhibiting all power to the DM4005/4003/4001/1501. Resetting is accomplished by removing the AC input power for 30 seconds, and then reapplying power.

A color code for the stepping motor wiring is shown in figure 3-1. Typically, a stepping motor manufacturer uses the same wiring color code. Information provided in section 3-1 for CW and CCW rotation

control of the stepping motor is with respect to these particular color coded connections. Obviously, reversing the wiring of any of the phases (phase A, A', B, B') will result in the inverse of the expressed rotational direction.

The DM4005/4003/4001/1501 controls current flow in each of the motor phases through a control means known as pulse width modulation (PWM). The PWM function involves the control of switches S1 through S4. The nominal switching speed is 35 KHz, which makes the DM4005/4003/4001/1501 inaudible.

Switching control is done through the comparison of sin current and cos current command/feedback signals (A1, A2, A3 and A4). Through these comparisons, a set of error signals (+ error and - error) is generated for each phase. These errors (which are actually voltage commands for each phase) are compared with a triangle wave signal running at 35KHz (A5, A6, A7 and A8).

The outputs of A5 through A8 are logic signals which are amplified through drive networks to control switches S1, S2, S3 and S4, respectively.

It can be seen from this, that incremental movements of the stepping motor results from the incremental change in amplitude of the sin and cos current command signals. The incremental size of the sin and cos current commands is dependent on the "programmed" information stored in ICs M15 and M17.

SECTION 3-5 1MR RAMPER BOARD (OPTIONAL)

The DM4005/4003/4001/1501 is designed to accept an optional ramping control board known as the 1MR (1 "megahertz ramper"). This board is designed to attach to the DM4005/4003/4001/1501 with four standoffs. A single 10 pin ribbon cable interfaces the 1MR to the

DM4005/4003/4001/1501. All control signals and logic supply voltages for the 1MR (±12VDC and +5VDC) are supplied by the DM4005/4003/4001/1501 through this ribbon cable. This cable connection is made between J4 of the DM4005/4003/4001/1501 (see figures 3-1 and 3-2) and connector J2 of the 1MR. A functional diagram of the 1MR ramper circuit is shown in figure 3-3. An outline of the 1MR PC board is shown in figure 3-4.

As its name implies, the 1MR is capable of generating a ramped output clock "train" at a frequency of up to 1 MHz. Since the DM4005/4003/4001/1501 can be set to operate at a multitude of different resolutions, the 1MR has 9 adjustable scale factors for optimizing a host of ramped frequency ranges. These scale factors allow the selection of various storage counter sizes (from 12 bit to 20 bit inclusive). For all scale factor settings, only the 8 most significant bits (bitN-1 through bitN- 8) of the selected counter size controls the ramp.

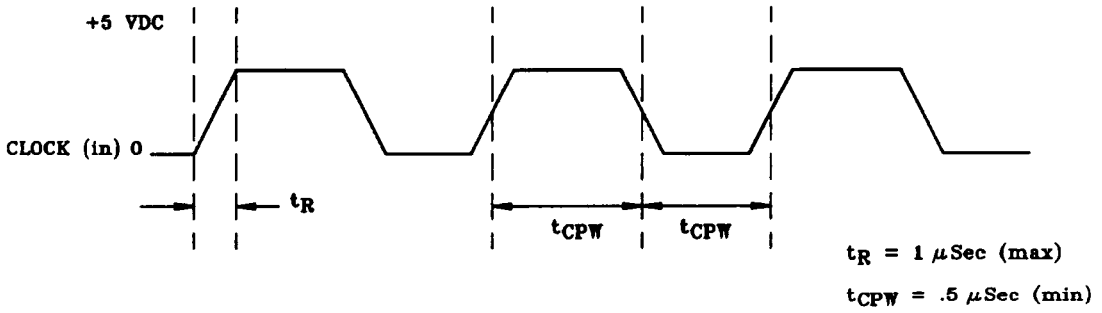
The following subsection describes the pin-out definitions for the DIN control connector J1. The mechanical specifications of this connector are similar to connector J1 of the DM4005/4003/4001/1501 (figure 3-2). When the 1MR board is used for convenience with the DM4005/4003/4001/1501, the interface is made through the 16-pin connector J2. When the 1MR is used as a stand-alone control (for other controllers), the optional J1 DIN connector is used as an interface connector.

A. CONNECTORS J1 AND J2 INPUTS AND OUTPUTS

1. CLOCK (IN) (PIN 5A, J1) (PIN 1, J2)

Input clock pulses are brought into this connection. The input buffer circuitry for this input is similar to the specifications described in chapter 2, *Logic Input Connections*, for the DM4005/4003/4001/1501.

A timing diagram for this input is shown below:



The maximum input frequency is 1 MHz. An input rate higher than 1MHz may cause "missed" clock pulses in the synchronizing logic circuit.

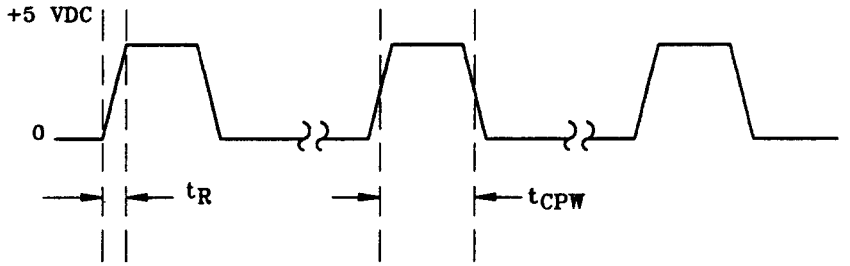
The input clock is leading edge trigger.

2. CLOCK (OUT) (PIN 3A, J1) (PIN 2, J2)

The ramped output clock pulses are brought out on this connection. The driving characteristics of this output connection is similar to the specifications described in section 2-1 D, Logic Output Connections for the DM4005/4003/4001/1501.

The 1MR has an input/output frequency range of 0 to 1MHz, the output clock pulses are of a defined width regardless of the input frequency.

A timing diagram of this output is shown below:



t_R = 25 nSec (typical)

t_{CPW} = .2 μSec (min)

3. *RESET (PIN 29C, J1) (PIN 3, J2)*

A reset input connection is provided to reset the internal up/down counter. When used with the DM4005/4003/4001/1501, this input is activated for all reset conditions described in item 3 and item 5 of section 3-1. A logic high initiates a reset.

The buffer circuitry for this input connection is described in chapter 2, *Logic Input Connections*.

4. *ZERO (PIN 26A, J1) (PIN 5, J2)*

This output connection provides an indication that "all" accumulated counts in the up/down counter circuit have been decremented. In essense, this means that the number of counts applied at the clock in connection (fi) have all been output on the clock out connection (fo) (in a ramped format). A logic high indicates all counts have been output.

When one or more counts are accumulated, the output connection immediately goes logic low. However, after the last count has been output, a delay of 25 mSec will elapse before the output goes logic

high. The buffer circuitry for this output connection is described in section 2-1 D, Logic Output Connections.

5. *DW/DT COMPENSATION (PIN 29A)*

This input connection will be discussed below. This is an analog rather than a logic input connection and is primarily intended for stepping motor stabilization at high speeds.

6. *CONTROL AND LOGIC POWER SUPPLY VOLTAGES*

Control and logic power supply voltage, and signal common are made at the following connections:

+12 VDC (PIN 31A & 31C,J1)(PIN 10,J2),
-12 VDC (PIN 32A & 32C,J1) (PIN 7, J2),
+5 VDC (PIN 30A & 30C, J1) (PIN 8, J2),
SIGNAL COMMOM (PIN 5C, 10C, 15C, 20C, 21A, 21C, 22A, 22C, J1) (PIN 9, J2)

NO ENCODER 200mA

The 1MR will draw a maximum of 25mA on the +5VDC connection. The draw on the ±12VDC connections will be no more than + or - 10mA respectively.

SECTION 3-6 THEORY OF 1MR OPERATION

A. GENERAL INFORMATION

The 1MR ramper is comprised of an oscillator whose output frequency is determined by the count in an up/down counter. The input clocks (clock in) to the ramper cause the counter to count up while the output clocks (clock out) from the ramper cause the counter to count down. The circuits are arranged so that larger counts (most significant bits) in the counter (bits N-0 to N-7) cause the oscillator to output higher frequencies. As a consequence, there is a negative feedback of output frequency as compared to input frequency and the output frequency will follow the input frequency.

Due to the action of the counter, however, following is not instantaneous. If the input frequency changes suddenly (say from zero to some constant value), the output will change gradually, producing the desired ramping effect. Synchronizing logic and a control gate (stop) on the output clocks insure that the total number of output clocks ultimately produced is exactly equal to the number of input clocks received.

B. DETAILED THEORY

The oscillator in the 1MR ramper is a VCO (voltage controlled oscillator) whose control voltage is produced by a DAC (digital to analog converter). The DAC is fed by the up/down counter's 8 most significant bits, whose instantaneous count is the difference between the counts received and the counts produced. From a frequency standpoint, the instantaneous count in the counter is the time integral of the difference between the input frequency and the output frequency. Because integration is done in a counter, it is exact.

The feedback connection therefore causes the output frequency of the VCO, "fo" to be proportional to the time integral of the difference fi - fo, where fi is the input frequency or:

$$fo = 1/T\ (fi\text{-}fo/S)\ (Hz)$$

The constant of proportionality is written as 1/T (reciprocal time) to denote its proper dimensions.

Solving 3.1 for fo,

$$fo = fi/(ST+1)\ (Hz)$$

Thus the ramper introduces a single pole between the input frequency and the output frequency.

To determine T, we note that, in the steady state (fo = fi) the total number of counts in the counter, M is:

$$M = T\ fi\ (counts)$$

Moreover, if the counter is N bits wide,

$$fo = M/2^{N}\text{-}1)\ f_{top}\ (Hz)$$

where "ftop" is the top frequency of the VCO, the frequency it will have when M = 2 - 1. Again, in the steady state, substitute M from 3.3 into 3.4 and note that fi = fo. Solve for T:

$$T = 2^{N}\text{-}1/f_{top}$$

Actual values for T can be determined quite easily by making a single measurement on the 1MR, when in the set-up mode.

First, without taking any measurements, the absolute minimum value for T on the 1MR can be determined by noting two basic parameters: Maximum Frequency and Minimum Count Size.

The minimum counter size that can be selected is 12 bits (N = 12). The maximum usable output frequency (without losing counts through the synchronizing logic) of the VCO is 1MHz (f_{top} = 1MHz). Thus, from 3.5, T min = 4 mSec.

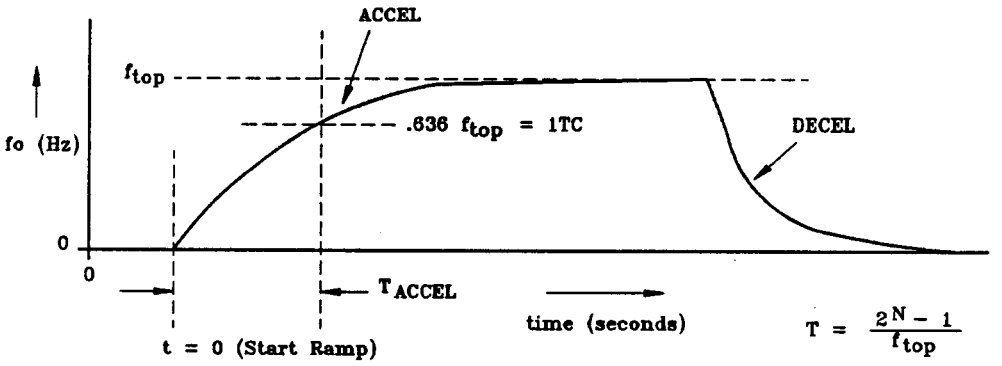
Two potentiometers P2 (gain) and P1 (start/stop) are provided on the 1MR. P2 is used to adjust ftop. With a given counter size selected, N = 12 to N = 20 (the method for selecting the counter size is described below), a varity of T values can be selected by adjusting P2.

To adjust ftop, remove programming jumper points 6 to 5 and insert it into points 5 to 4. Initiate a manual reset on the 1MR (see table 3-1, item 3 and/or table 3-2, item 3). This will set the last most significant bits (bitN-1 through bitN-8) of the up/down counter to logic high. The DAC will then be selected for its maximum output to the VCO.

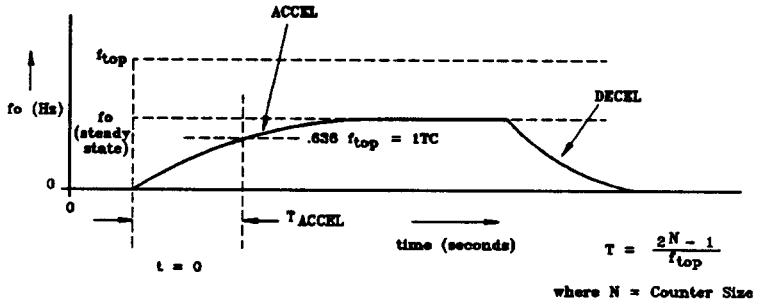
Temporarily turn pot P1 (start/stop) for CCW. With an oscilloscope, monitor testpoints TP2 with respect to TP1 (signal common). Adjust P2 until the desired ftop is achieved (turning P2 CW increases the frequency).

Since the 1MR produces essentially an exponential ramp (equation 3.2), it is necessary to provide a start/stop frequency (f s/s) to "hurry" the ramp into its deceleration phase. Potentiometer P2 is used to adjust this start/stop frequency.

To adjust the start/stop frequency, maintain a reset on the 1MR. Return the programming jumper to points 5 to 6. The DAC will now be loaded with all zeros. Monitoring TP2 with the scope, turn P1 CW to the desired start/stop frequency. The following figures shows typical ramp profiles for typical ftop and fs/s.



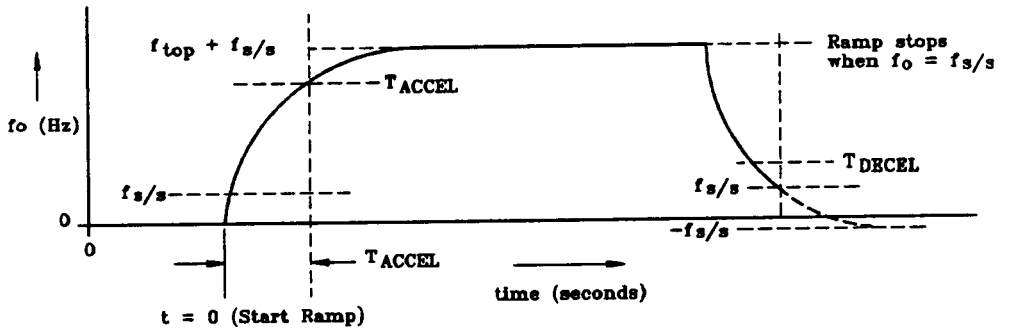
A. RAMP PROFILE: fi = ftop, fs/s = 0



B. RAMP PROFILE: fi = 1/2 ftop, fs/s = 0

FOR BOTH RAMP PROFILES, A AND B:

$T_{accel} = T_{decel}$ if N and P1 adjustments are unchanged.



$$T_{ACCEL} = \frac{2^N - 1}{f_{top} - f_{s/s}}$$

- $f_o = .636\ (f_{top} - f_{s/s})$

$$T_{DECEL} = \frac{2^N - 1}{f_{top} + f_{s/s}}$$

- $f_o = (1 - .636)\ (f_{top} + f_{s/s})$

C. RAMP PROFILE: $f_i + f_{top}$, $f_{s/s} = 1/6\ f_{top}$

TYPICAL RAMP PROFILES

C. MOTOR STABILIZATION AT HIGH SPEEDS

Stepping motor resonance problems at low speeds are essentially eliminated when micro stepping at resolutions greater than 2000 step/rev. However, microstepping will not usually eliminate high speed motor resonances simply because standard stepping motors will often "saturate" after a few hundred RPMs. In other words, motor inductance limitations will cause the translator current regulators to saturate, "forcing' the control to essentially run in the full step mode at higher motor speeds.

Motor stabilization at high speeds can be implemented by sampling current feedback in both phases (A, A' and B, B') of the motor and feeding this signal back to the VCO of the 1MR ramper. This feedback connection (labeled dw/dt compensation) is shown in figure 3-3.

Essentially what happens is that in unstable regions of motor speed, motor current will fluctuate. In this region, dynamically increasing motor current means that the motor is beginning to "lag" the control frequency (fo). Thus, the VCO frequency (fo) would be instantaneously decreased. Conversely, decreasing motor current means the motor is beginning to "lead" the control frequency. Thus, the VCO frequency would be instantaneously increased.

Adjustment of the dw/dt compensation feedback signal is made through resistor R3 and capacitor C1.

D. RECOMMENDED COUNTER SIZES

Table 3-1 (following) lists the means by which to select the counter size of the 1MR. Selected for each counter size is the recommended DM4005/4003/4001/1501 operating resolution. Recommended dw/dt compensation values of R3 and C1 for each operation resolution is also listed.

NOTE: **Normally, when the 1MR is ordered with the DM4005/4003/4001/1501, 1MR count size and dw/dt compensation is already factory selected. The customer need only specify the operating resolution of the DM4005/4003/4001/1501.**

Counter Size (Bits)	Recommended * (Steps/Rev) Resolution	Jumper Position	SIP Position	Recommended R3 (ohms)	Recommended C1 (μf)
12	200 and 400	1 to 2	RN9 & RN10	10K	.47
13	600 and 800	1 to 2	RN7 & RN8	10K	.47
14	1000 to 1800	1 to 2	RN5 & RN6	10K	.47
15	2000 to 4000	1 to 2	RN3 & RN4	10K	.47
16	4200 to 8000	2 to 3	RN9 & RN10	10K	.47
17	8200 to 18000	2 to 3	RN7 & RN8	10K	.47
18	18200 to 50000	2 to 3	RN5 & RN6	10K	.47
19	----	2 to 3	RN3 & RN4	---	---
20	----	2 to 3	RN1 & RN2	---	---

* Resolution based on standard 50 pole motor

Table 3-1: Counter Size Selection of 1MR

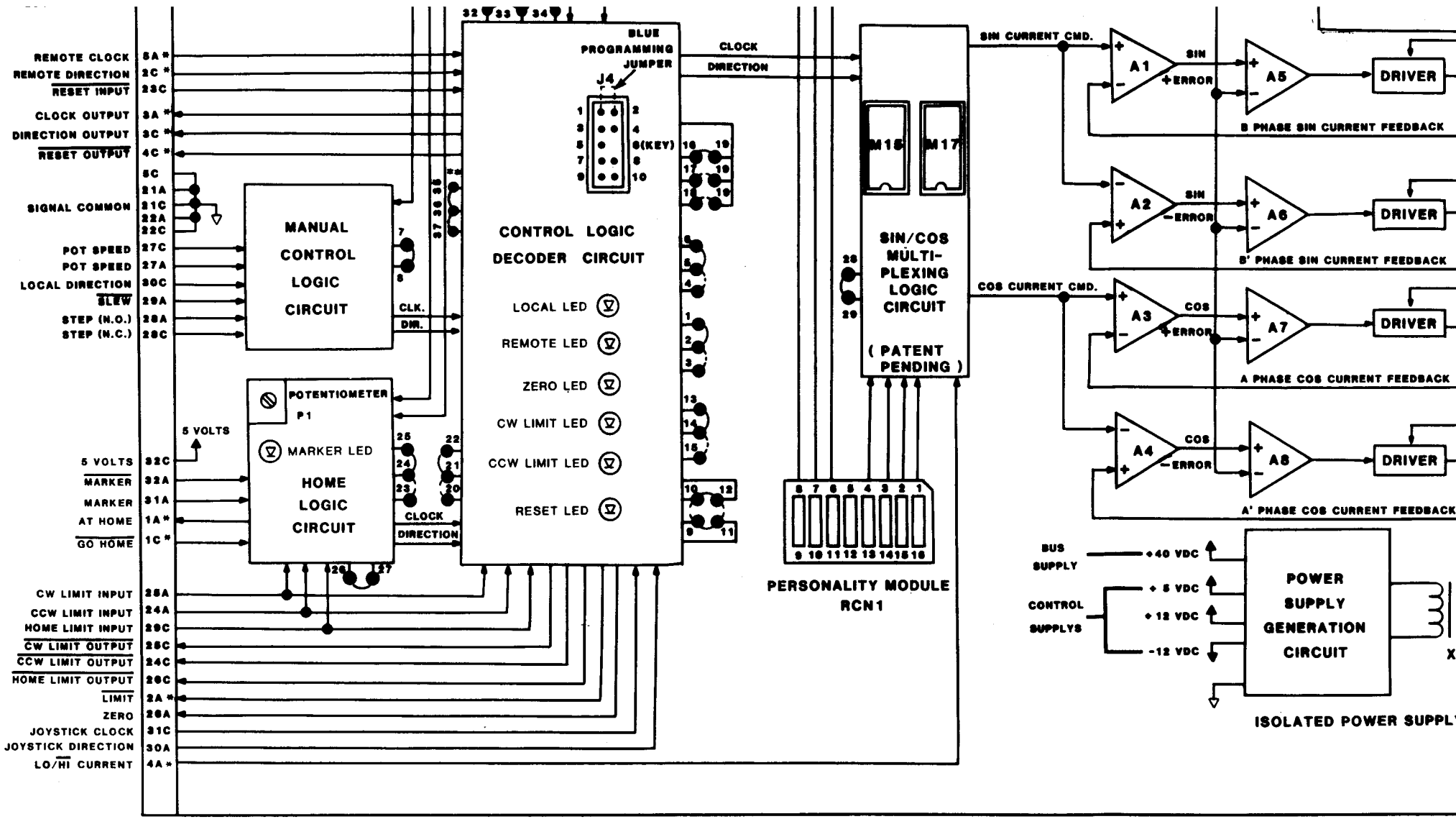


FIG. 3-1 : CIRCUIT BLOCK DIAGRAM OF DM4000 SERIES

** PROGRAMMING JUMPERS FOR AEROTECH SYSTEM USE (SEE ITEM 4 AND ITEM 5 OF TABLE 3-1)

* FOR AEROTECH SYSTEM USE, THE FOLLOWING CONNECTIONS ARE DAISY CHAINED.

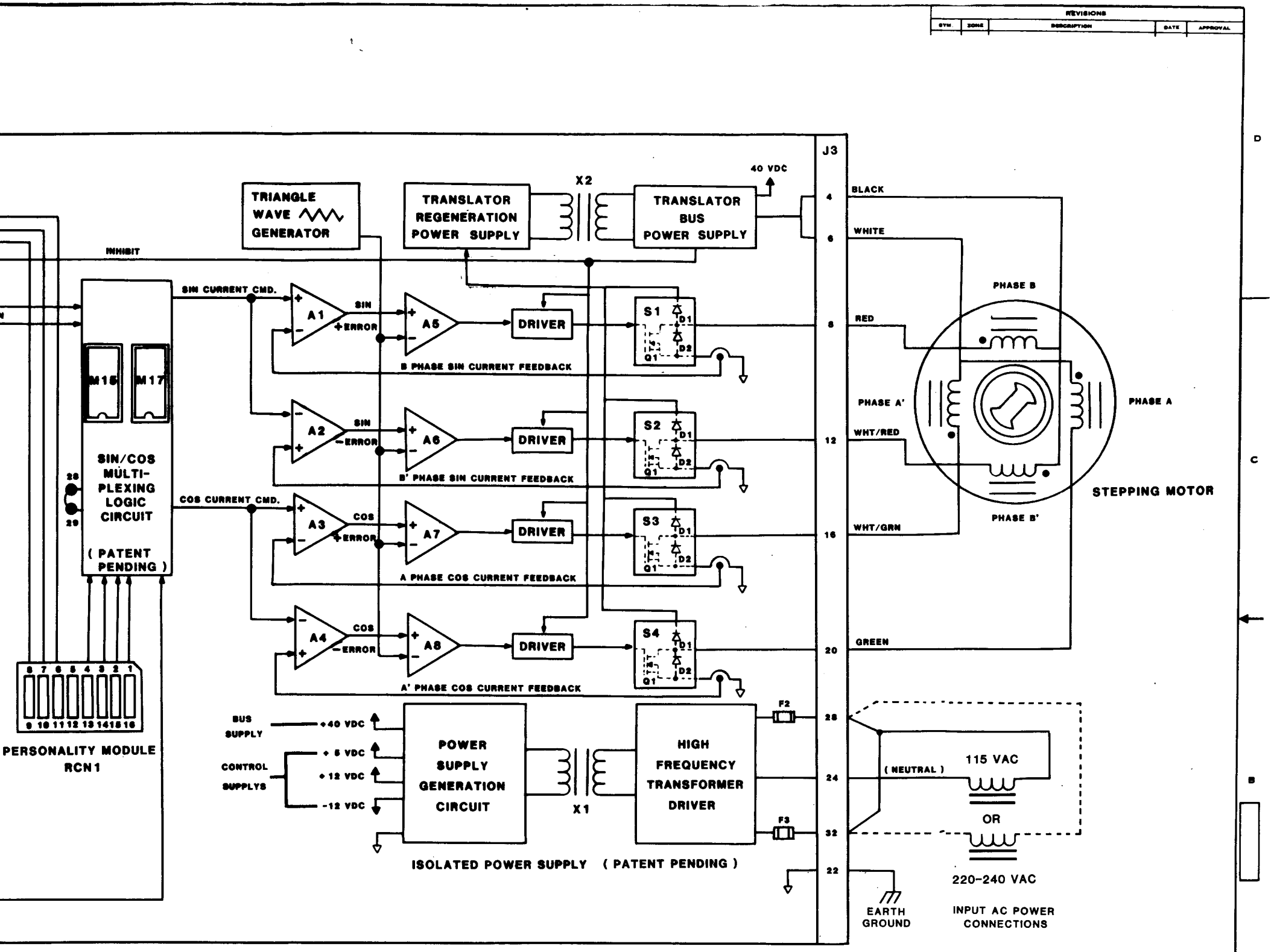
1C,6C,11C,16C
1A,6A,11A,16A
2C,7C,12C,17C
2A,7A,12A,17A
8C,8C,13C,18C
8A,8A,13A,18A
4C,9C,11C,19C
4A,9A,11A,19A
5C,10C,15C,20C
5A,10A,15A,20A

(CONNECTIONS DAISY CHAINED INTERNALLY ON THE DM4003 THROUGH J1)

DASH NO	NEXT ASSY	USED ON	NEXT ASSY	FINAL ASSY
APPLICATION			QTY REQD	

BRUNING 44-131 28187-5

6 5 4 3


REVISIONS
SYM
ZONE
DESCRIPTION
DATE
APPROVAL
TRIANGLE WAVE GENERATOR
TRANSLATOR REGENERATION POWER SUPPLY
X2
TRANSLATOR BUS POWER SUPPLY
40 VDC
J3
INHIBIT
SIN CURRENT CMD.
COS CURRENT CMD.
A1
A2
A3
A4
A5
A6
A7
A8
SIN
COS
+ERROR
-ERROR
DRIVER
S1
S2
S3
S4
D1
D2
Q1
B PHASE SIN CURRENT FEEDBACK
B' PHASE SIN CURRENT FEEDBACK
A PHASE COS CURRENT FEEDBACK
A' PHASE COS CURRENT FEEDBACK
M16
M17
SIN/COS MULTI-PLEXING LOGIC CIRCUIT
(PATENT PENDING)
28
29
8 7 6 5 4 3 2 1
9 10 11 12 13 14 15 16
PERSONALITY MODULE RCN1
BUS SUPPLY
+40 VDC
CONTROL SUPPLYS
+ 5 VDC
+ 12 VDC
-12 VDC
POWER SUPPLY GENERATION CIRCUIT
X1
HIGH FREQUENCY TRANSFORMER DRIVER
F2
F3
ISOLATED POWER SUPPLY (PATENT PENDING)
4
6
8
12
16
20
24
28
32
22
BLACK
WHITE
RED
WHT/RED
WHT/GRN
GREEN
PHASE B
PHASE A'
PHASE A
PHASE B'
STEPPING MOTOR
(NEUTRAL)
115 VAC
OR
220-240 VAC
EARTH GROUND
INPUT AC POWER CONNECTIONS
D
C
B

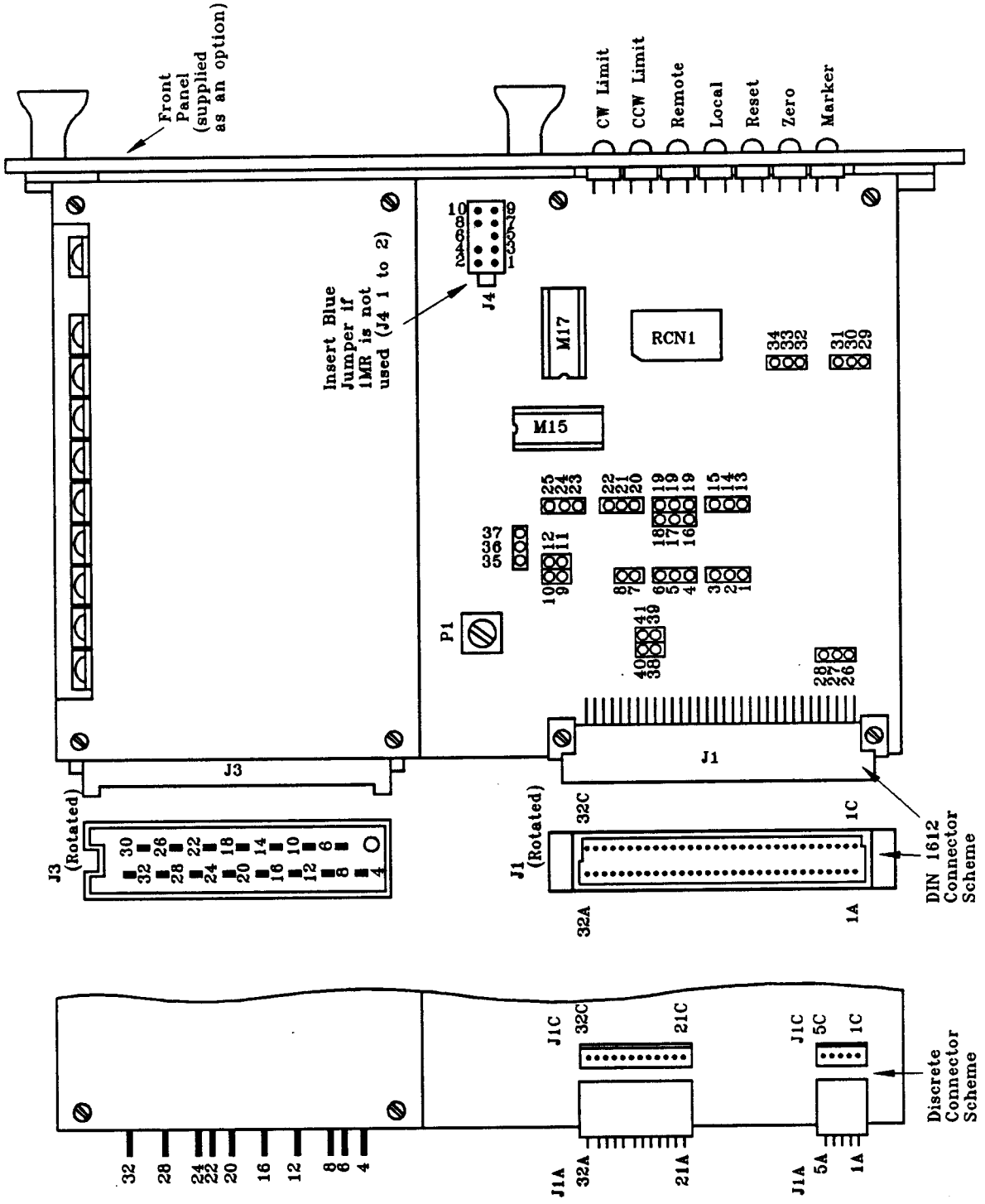


Figure 3-2: Assembly Outline of DM4005/4003/4001/1501

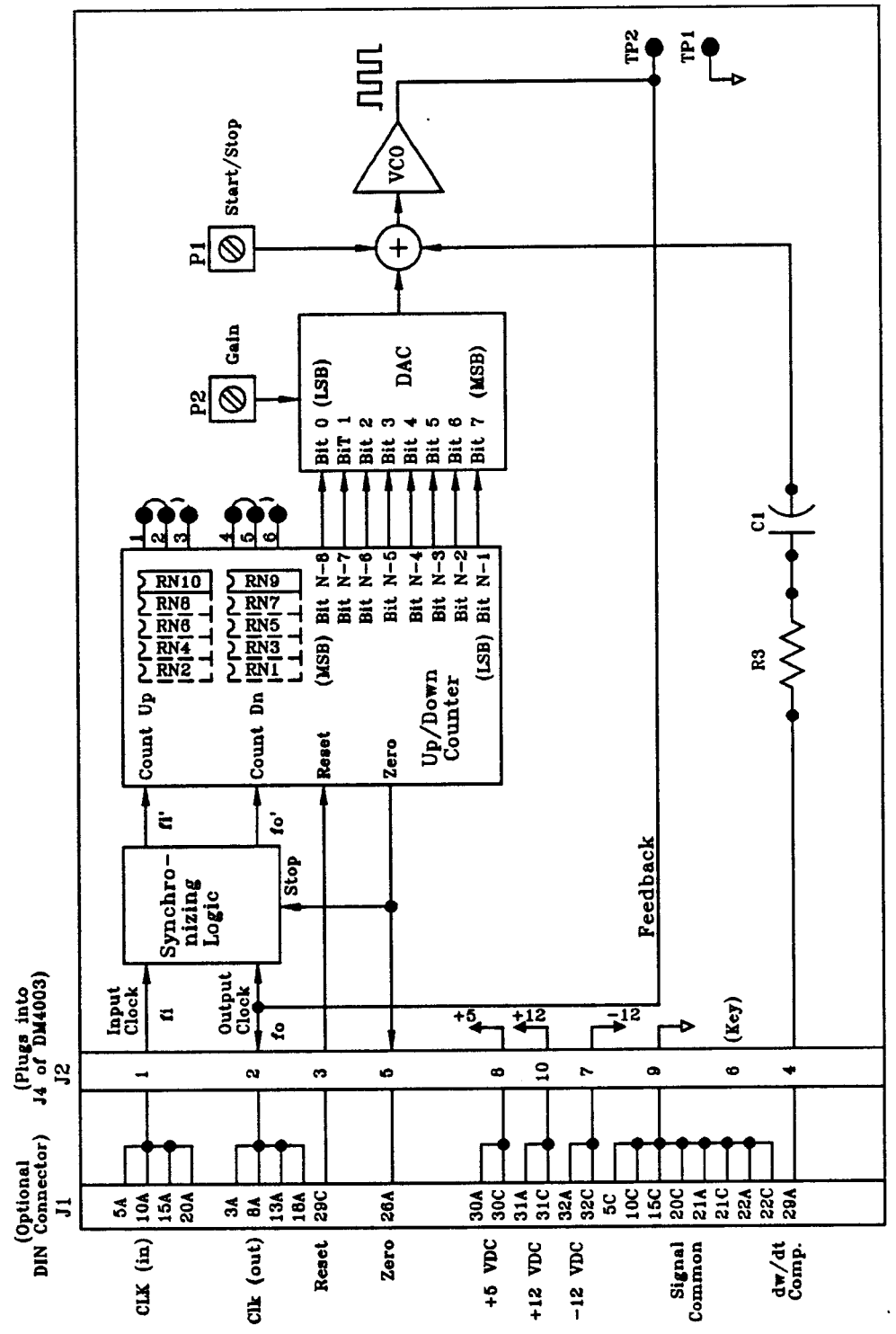


Figure 3-3: Block Diagram of 1MR Circuit

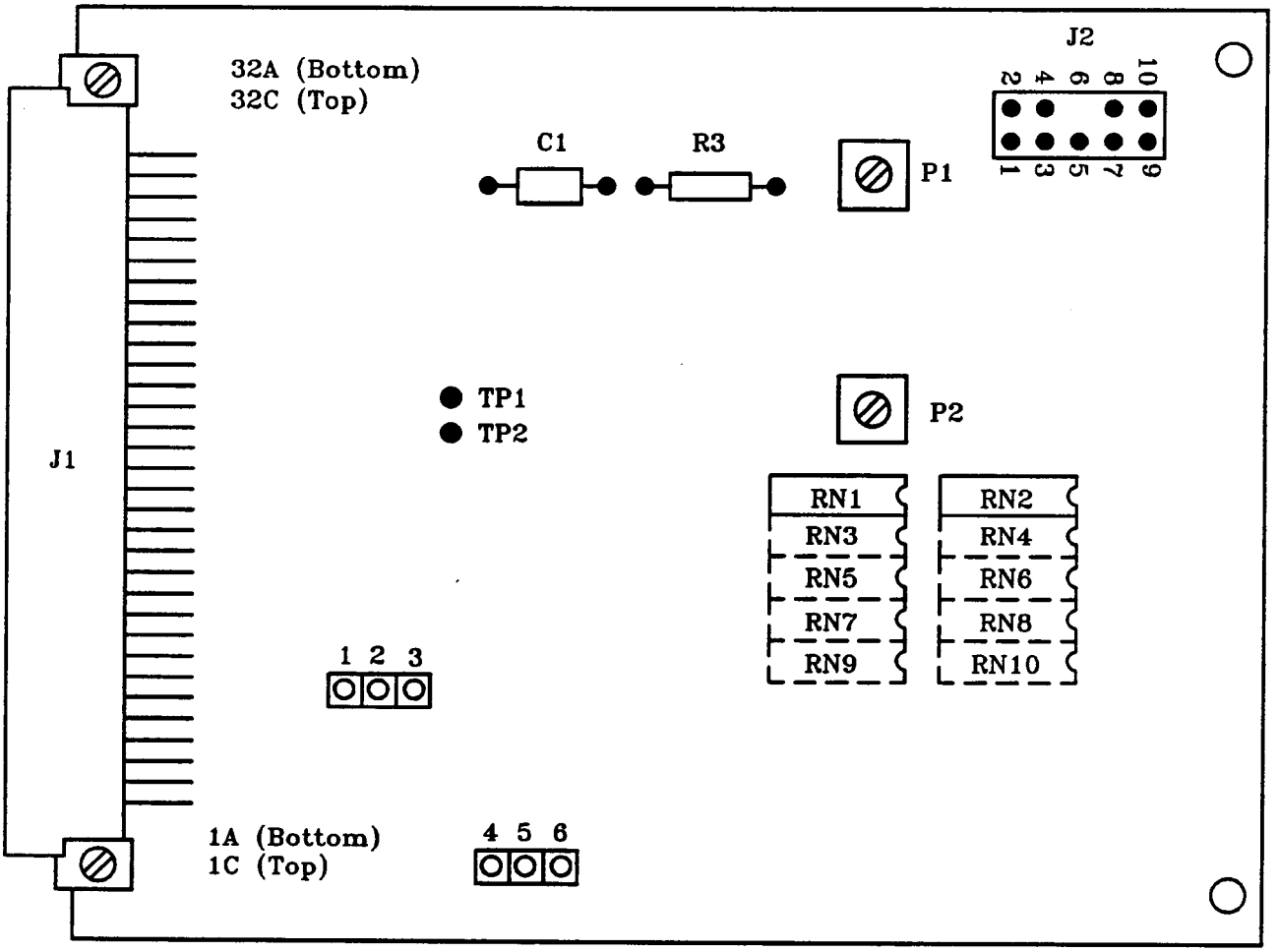


Figure 3-4: Assembly Outline of 1MR

CHAPTER 4: INSTALLATION AND START-UP

SECTION 4-1 CONNECTOR MATES FOR J1 AND J3

The DM4005/4003/4001/1501 translator card is designed to be compatible with all DIN 41612, 6U card rack systems. The section will list some appropriate interfacing methods using mass termination or discrete wire interfacing.

For non-DIN 41612 interfacing, Aerotech can provide inexpensive terminating connectors for J1 and J3. Figure 3-2, *DM4005/4003/4001/1501 Outline*, shows a "discrete" connector scheme for the control (J1) and power (J3) connections. Aerotech can supply, upon request, a means of terminating wiring to J1 and J3 that requires no special "mother" board or elaborate ribbon cable interfaces. The discrete wire terminations for J2 are four (4) "locking" type header systems (J1A and J1C, supplied with mates) for attaching #28 through #22 gauge wire. Alternately, power connections to J3 can be supplied as "quick connect" tabs (.250 style) which attach directly to the DM4005/4003/4001/1501.

For DIN 41612 interfacing, the choices become much more versatile. The customer can select the connector arrangement that best suits his needs. Some examples of the many different types of DIN connector mates for J1 and J3 are as follows. For J1, mating connectors such as wire wrap, solder tab, ribbon and solder pin types, can be used. Solder pins are used when interfacing to a PC board back plane. Ribbon type connections utilize 64 pin, .05 displacment cable when mass termination is required without the use of a mother board back plane. Solder tab termination is mainly suitable for connecting discrete wires when mother board back planes and ribbon cables cannot be used. Wire-wrap terminations can be used for system prototyping.

Various mates for J3 are connectors such as screw terminal, quick-connect (.250 tabs), or as in the case of J1, solder pin for motherboard PC back planes and solder tab for discrete wire termination. Quick connect and screw terminal types provide an easy way of "terminating" discrete power connections.

Solder pin styles, as was the case for J1, are mainly suitable for a P.C. board back plane interfacing. Solder tab termination provides a neat and inexpensive means of permanently terminating discrete wiring.

Since the mating connectors for J1 and J3 are of the DIN standard, many manufacturers supply the type of mating listed above for J1 and J3. Some examples of manufacturers that provide these types of mates for J1 and J3 listed above are:

2E Rolf Hiller, GMBH and Co. (Germany)
Bicc-Vero Electronics Inc., 40 Lindeman Drive, Trumbull, CT 06611
3-M Electronics Product Division 225-1N 3M Center, St. Paul, MN 55144.

The part numbers for some of the connector mates listed above is shown below:

LIST OF DIN CONNECTOR MATES FOR J1 AND J3

	2E Rolf Hiller	Bicc-Vero	3M
J3, QUICK CONNECT	05 H15FFA	17-24300J	
J3, SCREW TERMINAL	05H15FSRRU		
J3, SOLDER TAB	05H15FLRU		
J3, SOLDER PIN	05H15FT4RU		
J1, RIBBON			3553-001
J1, WIRE WRAP	02CF64WW2A+C	905-721864	
J1, SOLDER TAP	02CF64L2A+C		
J1, SOLDER PIN	02CF64T42A+C	905-721856	

Aerotech will supply as an option solder tab type mates for J1 and J3. An outline of their mating connectors is shown in figure 4-1.

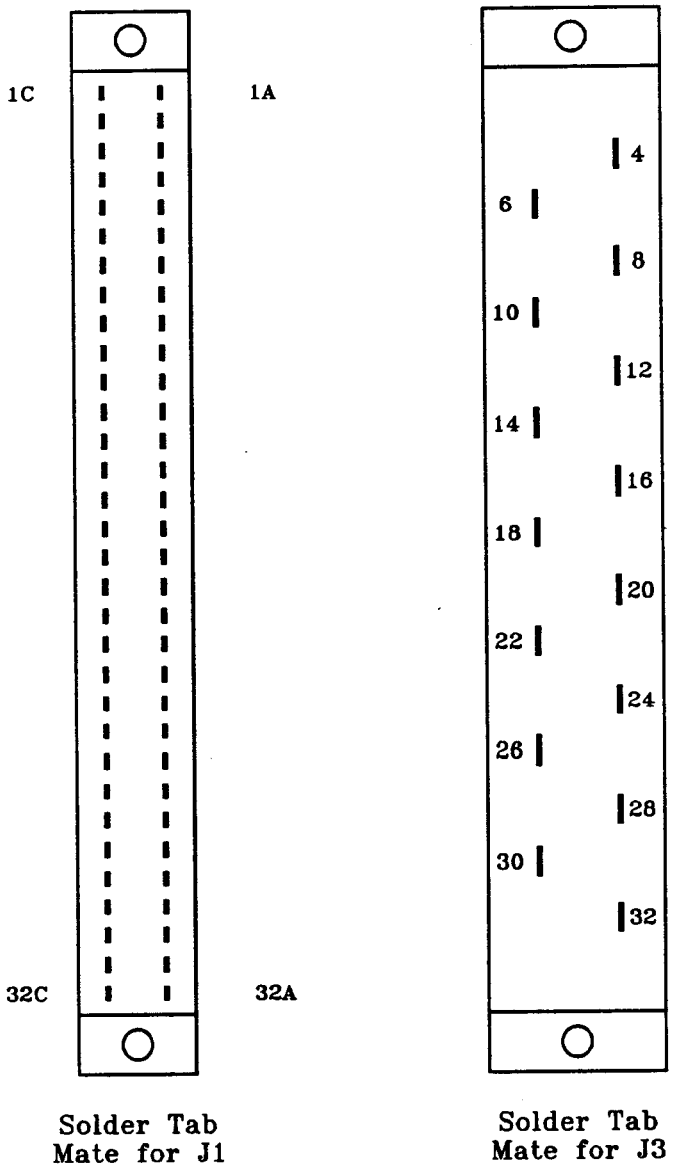


Figure 4-1: J1 and J3 Mating Solder Tab Connectors

SECTION 4-2 CARDRACK OR PANEL MOUNTING

The DM4005/4003/DM4001/1501 is designed to mount in any standard DIN 41612 6U cardrack. Figure 4-2 shows a typical cardrack configuration. Connector mate J1 and J3 can be any of the 3 types listed in section 4-1.

Some examples of manufacturers of the DIN 41612, 6U cardrack are as follows:

BICC-VERO	40 Lindeman Drive Trumbull, CT 06611 (USA)
SCHROFF	179 Commerce Drive Warwilk, RI 02886 (USA)
KNURE AG	USA Representative Panel Components Corp. 335 Tesconi Circle Santa Rosa, CA 95406

The suppliers listed above are examples of the many manufacturers that supply DIN 41612 style cardracks, integrated cardracks, cabinets, and other accessories for accommodating 6U cards like the DM4005/4003/4001/1501.

If desired, Aerotech can supply an optional mounting bracket for fastening up to two DM4005/4003/4001/1501 stepping translators to any panel surface. This bracket includes a ventilating fan with mating J1 and J3 and solder-tab connectors described in figure 4-2. This mounting bracket is illustrated in figure 4-3.

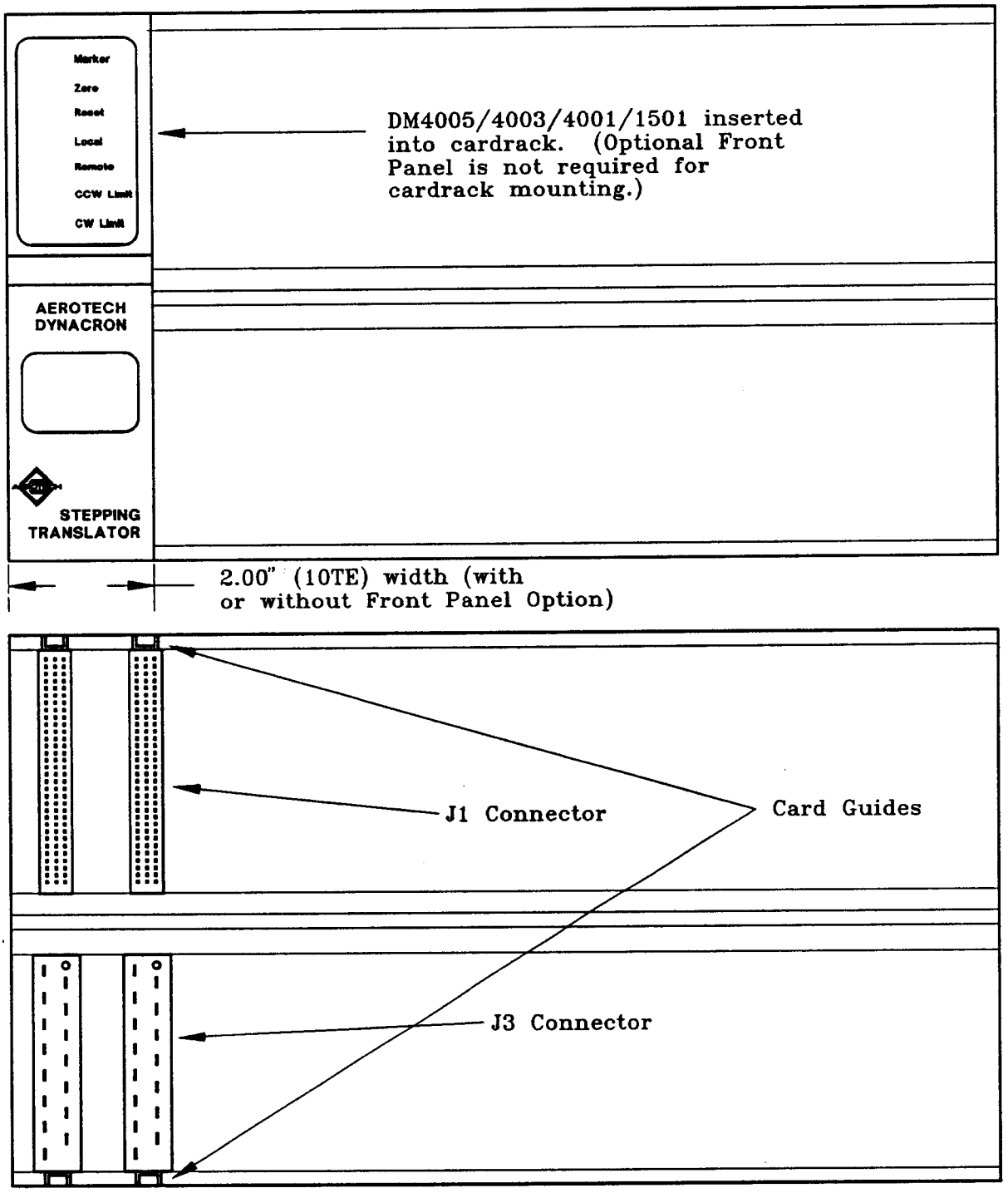


Figure 4-2: Typical 6U Cardrack Mounting of DM4005/4003/4001/1501

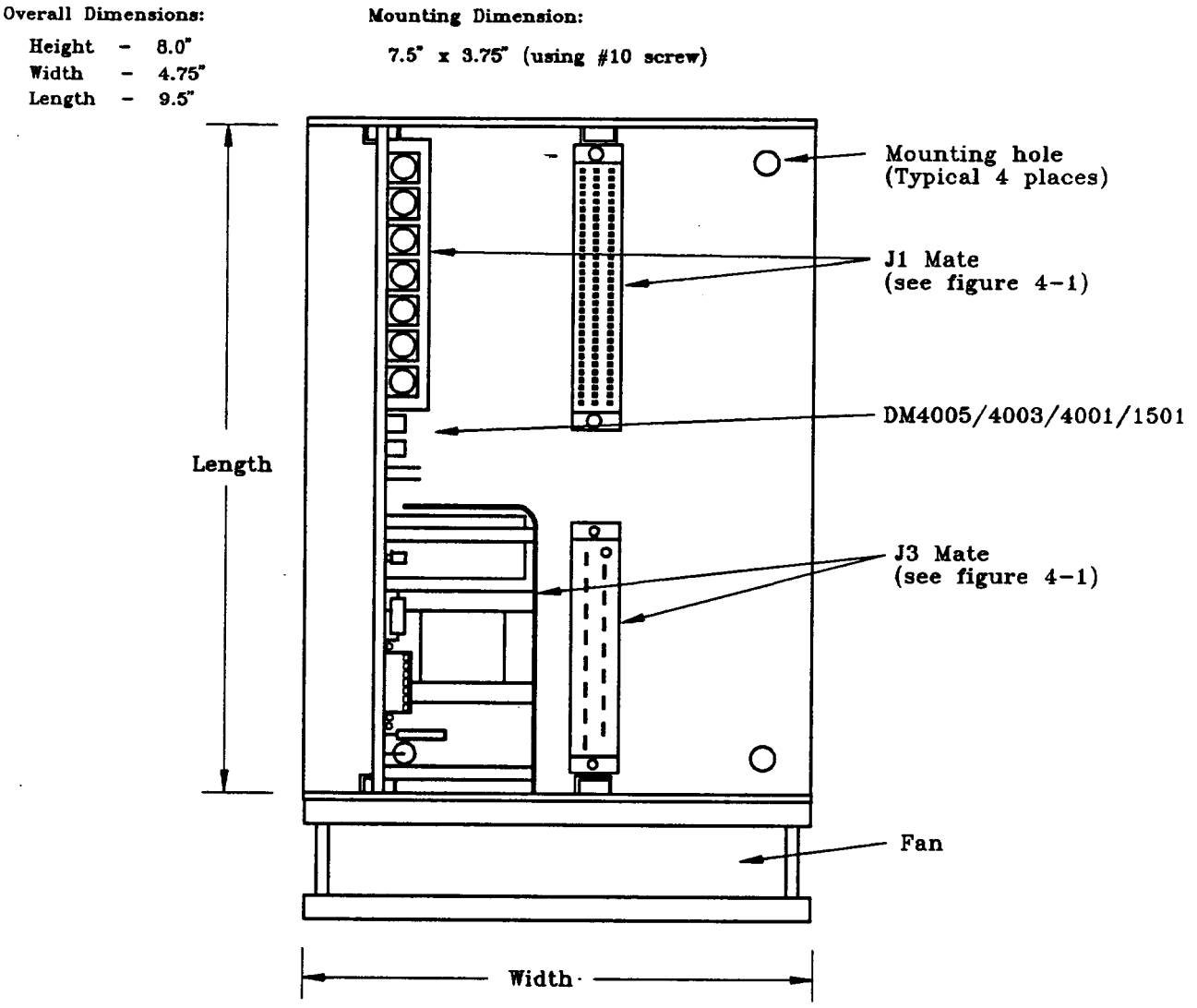


Figure 4-3: Panel Mounting Bracket

SECTION 4-3 FORCED AIR COOLING

It is necessary that the DM4005 and DM4003 be forced air cooled for stepping motor phase current greater than 1.5 amps (for the DM4003) and 3 amps (for the DM4005). The DM4001 and DM1501 do not require a fan. Figure 4-4 shows two possible placements for fan flow. The fan should have at least an 80 CFM flow rate.

SECTION 4-4 HIGH VOLTAGES - DM4005/4003/4001/1501

DANGER: LETHAL VOLTAGES EXIST ON THE DM4005/4003/4001/1501 WHEN 115 OR 230 VAC INPUT POWER IS APPLIED AT CONNECTOR J3. SEE FIGURE 4-5.

The DM4005/4003/4001/1501 should never be laid on any type of conductive surface when input power is supplied. When mounted in a 6U cardrack or panel mounted with the optional mounting bracket shown in figure 4-3, it is the user's responsibility to provide protective barring to inhibit end-user accessibility.

AEROTECH DOES NOT ASSUME LIABILITY FOR INADEQUATELY PROTECTED HOUSING FOR THE DM4005/4003/4001/1501.

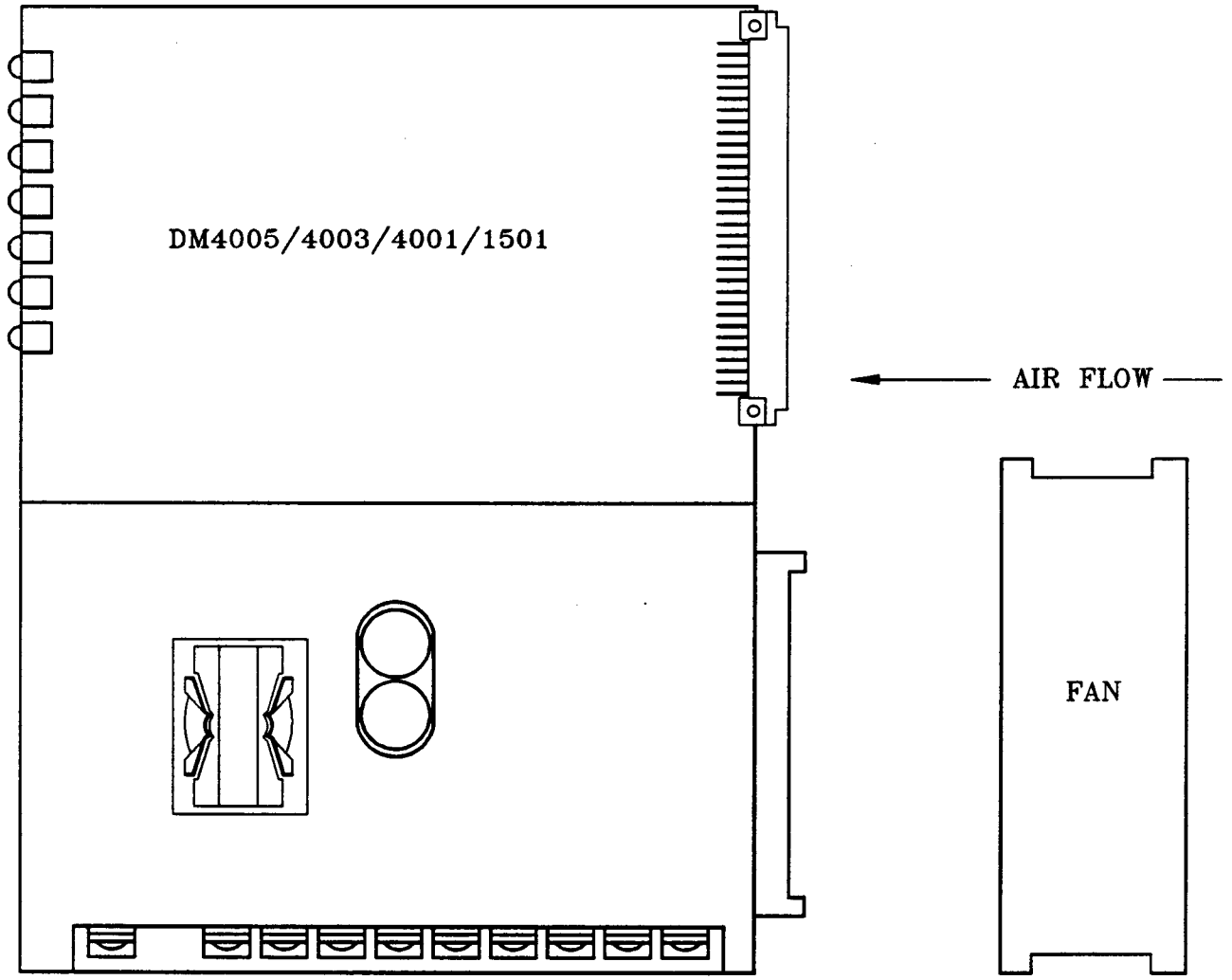


Figure 4-4 (A): Position of Fan for Forced Air Cooling

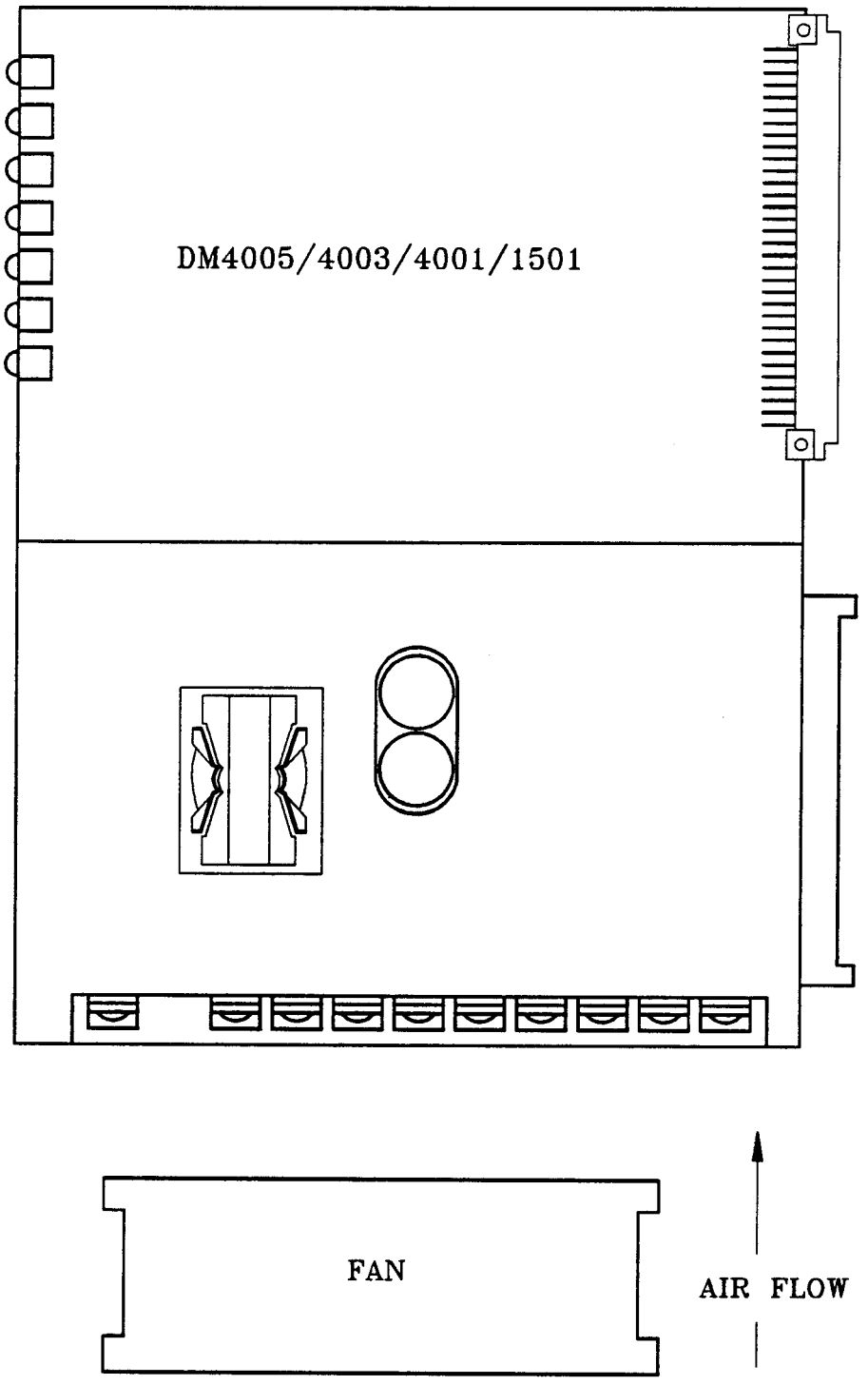


Figure 4-4 (B): Position of Fan for Forced Air Cooling

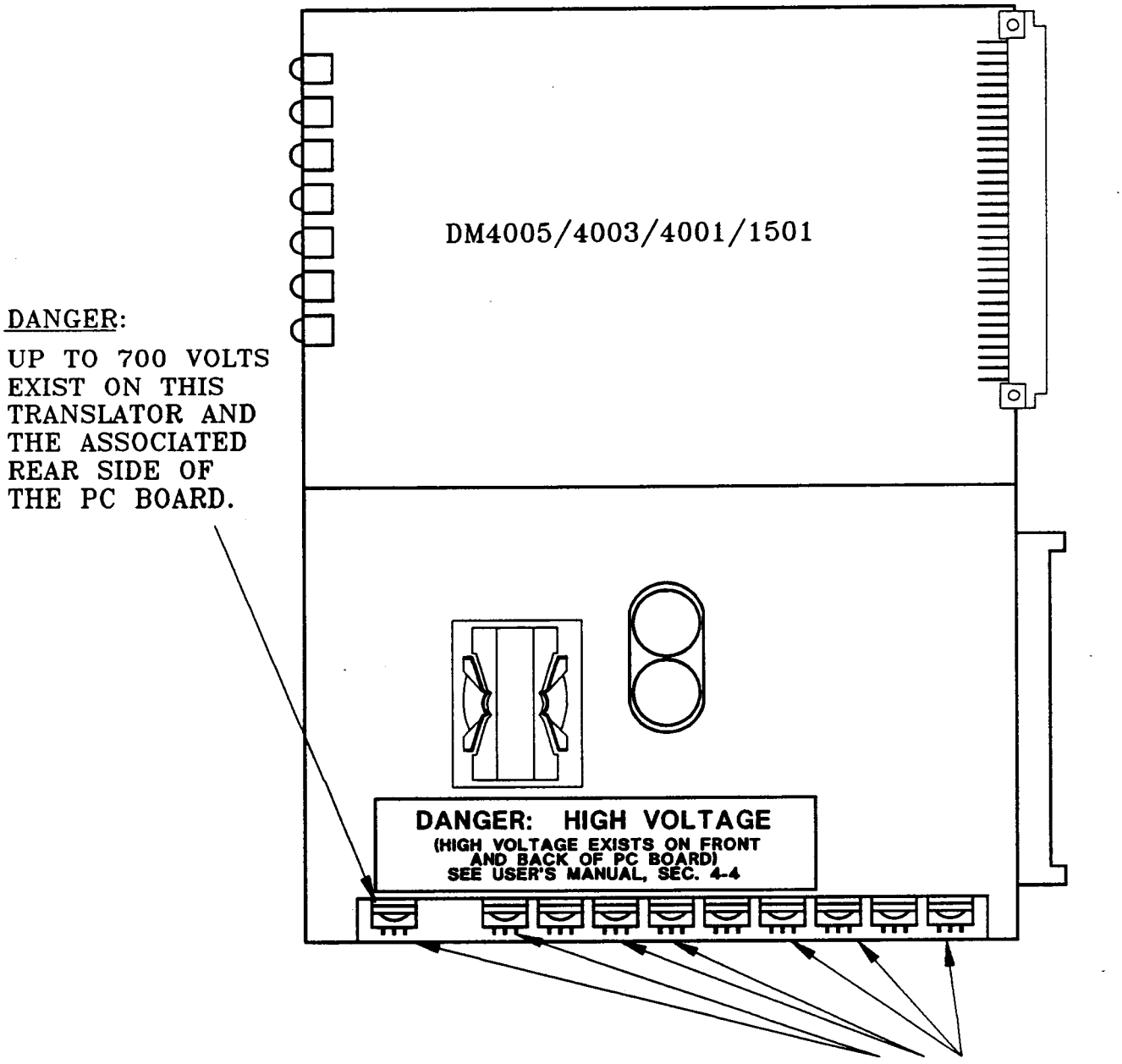


Figure 4-5: Locations of Lethal Voltage

SECTION 4-5 MOUNTING THE 1MR (OPTIONAL)

The 1MR ramper board attaches to the DM4005/4003/4001/1501 with 4 stand-offs.

When the 1MR option is ordered with the DM4005/4003/4001 /1501, the mounting is done by Aerotech.

If the 1MR is ordered separately, all necessary mounting hardware and connecting ribbon cable will be included.

SECTION 4-6 POWERING UP

At this point, it is assumed that the user has read in detail sections 2-1, Electrial Specifications, and section 3-1, Circuit Description. It is also assumed that all wiring and mounting considerations for the DM4005/4003/4001/1501 described at the beginning of this section have been addressed.

Apply input power to the DM4005/4003/4001/1501 and observe the following:

- The local or remote LED should be energized. See item 1 of section 3-1 for local/remote control.
- The reset LED should be deenergized. See item 3 and item 5 of section 3-1.
- The CW limit and CCW limit LEDs should be deenergized. See item 9 of section 3-1.

- The zero (count zero) LED should be energized. See item 12 of section 3-1.

- The marker LED may or may not be energized, depending on the state of marker input. See chapter 2, and item 8 of section 3-1.

Place the DM4005/4003/4001/1501 in the local mode (item 1 of section 3-1). Manually slew (item 7 of section 3-1) the stepping motor into the CW limit. Then change the direction and slew into the CCW limit. If, once in a limit, the DM4005/4003/4001/1501 "latches" up and is unable to be moved out of the limit, the CW and CCW limit input connections are reversed with respect to the direction command input.

If the optional 1MR ramping board is being used (see section 3-5), check to see if the zero LED is deenergized when slewing the stepping motor. This LED should then energize when the motor comes to a stop (see item 12 of section 3-1).

NOTE: **The blue programming jumper (supplied with DM4005/4003/4001/1501) must be inserted between pin 1 and 2 of J4 on the DM4005/4003/4001 /1501 if the 1MR ramping board is not used. (see figure 3-1 and 3-2).**

The optional 1MR, when supplied with the DM4005/4003/4001 /1501, should already be adjusted for the given resolution of the DM4005/4003/4001/1501. The 1MR can be easily adjusted by the user (see section 3-5 and 3-6) by the following method:

- Turn potentiometer P1 on the 1MR full CCW (see figure 3-3 and 3-4), and then slightly CW (approximately 1/8 turn).

- Manually slew the stepping motor back and forth, adjusting potentiometer P2 slowly CW until the desired accel/decel rate is achieved (excessive accel/decel will stall the motor). If the DM4005/4003/4001/1501 takes too long to stop, turn P1 slightly more CW. Before proceeding, it is assumed that the slew frequency represents the maximum frequency desired (see item 1 and item 7 of table 3-1). If this is not the case, frequency control may have to be done through the remote clock and remote direction inputs (item 2 of table 3-1). After the desired accel/decel rate has been achieved, slowly turn P1 CW until the desired start/stop speed has been achieved. (Excessive start/stop will also stall the motor.)

If the optional 1MR board is not being used, the zero LED will stay energized at all times unless programming jumper 30 to 31 is inserted, or the lo/hi input control is logic low (see item 12, table 3-1). Remember, when the zero LED is energized, the "lo" current or "stand-by" current level to the stepping motor is set (see also section 3-3 C). This level may be insufficient for rotating the stepping motor during slew or remote operation.

At this point the user should check all local and/or remote input and output connections pertaining to his system as outlined in items 1 through 7 and 9 through 12 of section 3-1.

CHAPTER 5: TROUBLESHOOTING

If after following through the powering-up procedure of section 4-5, inconsistent operation is observed for the DM4005/4003/4001/1501 and/or 1MR ramper, review the following check list shown below. For general reference to this check list, refer to figure 3-1, 3- 2, 3-3, and 3-4 or as specified in the check list itself.

CONDITION	POSSIBLE CAUSE	SOLUTION
All LED indicators are blank when input power is applied.	Short circuit on motor wiring of DM4005/4003/ 4001/1501 (current trip)	Remove motor connection and reapply power (see section 3-4)
	Improper input power at J3 of DM4005/4003/ 4001/1501	See section 3-4
Local or remote LED is energized, but DM4005/ 4003/4001/1501 will not respond to slew, step or remote input clock pulses	Reset input connection is logic low	See item 3 of section 3-1
	RCN1 2-15 and/or RCN1 3-14 not properly selected	See section 3-3C
	Programming jumper between pin 1 and 2 of J4 on DM4005/4003/ 4001/1501 is not inserted	See figure 3-2

CONDITION	POSSIBLE CAUSE	SOLUTION
DM4005/4003/4001/1501 will run stepping motor into a CW or CCW limit, but will not move motor out of limit	CW and CCW limit input connections are reversed	See item 9 of section 3-1
Reset LED remains energized	Reset input connection is pulled low	See item 3 of section 3-1
	Low input power supply voltages on connector J3 of DM4005/4003/ 4001/1501	See section 3-4
Stepping motor stalls or does not seem to have sufficient holding torque	RCN1 2-15 and/or RCN1 3-14 not properly selected	See section 3-3C
	Lo-/hi input logic high	See item 12 of section 3-1
Manual slew, step and local direction inputs do not function in local mode	Programming jumper 9 to 10 and 11 to 12 may not be inserted	See item 1 of section 3-1
Joystick clock and direction input connections do not function in local mode	Programming jumpers 9 to 11 and 10 to 12 may not be inserted	See item 1 of section 3-1
Manual slew command stalls stepping motor	RCN1 7-10 may not be properly selected	See section 3-3A
Go home command stalls stepping motor	RCN1 8-9 may not be properly selected	See section 3-3B

CONDITION	POSSIBLE CAUSE	SOLUTION
External pot speed control does not adjust slew speed	Programming jumper 7 to 8 on DM4005/4003/ 4001/1501 is not removed	See item 7 of section 3-1
1MR ramper board (optional) cannot be successfully adjusted for desired accel/ decel ramp	Improperly selected counter size for given DM4005/4003/4001/1501 resolution	See section 3-5
DM4005/4003/4001/1501 goes home to proper limit switch, changes direction, but does not stop (limit switch home)	Potentiometer P1 on DM4005/4003/4001/1501 is not turned full CCW	See item 8 of section 3-1
DM4005/4003/4001/1501 goes home to proper limit switch, changes direction, but does not stop on marker (marker home)	Threshold level for marker input selected is not properly adjusted with potentiometer P1 of DM4005/4003/ 4001/1501	See item 8 of section 3-1
Stepping motor becomes unstable and drops out at high speeds	Improper or nonexistent stability feedback compensation (optional 1MR ramper required for stability feedback compensation)	See sections 3-5 and 3-6C

CHAPTER 6: SERVICE AND REPAIR

SECTION 6-1 REPAIR

General repair of equipment consists entirely of solutions listed in section 5-1 on Troubleshooting, or the removal and replacement of the DM4005/4003/4001/1501 or 1MR, should the need arise.

If under warranty, repairs of defective electrical components of the DM4005/4003/4001/1501 and 1MR should not be attempted, SINCE TO DO SO WOULD VOID THE ENTIRE WARRANTY.

If necessary, any on-site service should be performed by an experienced electronic technician, preferably trained by Aerotech, Inc.

SECTION 6-2 PARTS LIST

COMPONENT DESCRIPTION	AEROTECH PART NUMBER
DM4001 stepping translator	EFA 114
DM4003 stepping translator	EFA 107
DM4005 stepping translator	EFA 110
DM1501 stepping translator	EFA 117
1MR Ramping Board	EFF 123
Personality Module RCN1	RCN1 x.x - xxxx (see section 3-3)

M15	M15 - xxxx (see section 3-2)
M17	M17 - xxxx (see section 3-2)

SECTION 6-3 SHIPMENT

The procedure for shipping equipment back to Aerotech for repair is shown below. This procedure pertains to warranty as well as non-warranty repairs of equipment.

1. Before shipping any equipment back to Aerotech, the person making the return must call ahead for a "*Return Authorization Number*". *(Have your serial number on hand when calling.)*

2. The equipment being returned must be encased in a proper cushioning material and enclosed in a cardboard box.

Call for a "Return Authorization Number" if it is necessary to ship any part to the factory.

Warning: Damage due to improper packaging voids warranty!

Aerotech Sales and Service offices are listed on the following pages. For service and information, contact the office servicing your area.

AEROTECH, INC. SALES OFFICES

World Headquarters
AEROTECH, INC.

101 Zeta Drive
Pittsburgh, PA 15238

Phone (412) 963-7470
FAX (412) 963-7459
TWX (710) 795-3125

AEROTECH, CENTRAL-EAST
856 Cottonwood Drive
Monroeville, PA 15146

Phone (412) 373-4160
FAX (412) 373-4163
WV, western PA, western NY, eastern OH

AEROTECH WEST

Suite 217
7002 Moody Street
La Palma, CA 90623
Phone (213) 860-7470
FAX (213) 860-4639
AZ, southern CA

AEROTECH NORTHEAST
Executive Suite 120
270 Farmington Avenue
Farmington, CT 06032
Phone (203) 673-3330
or (203) 673-2503
FAX (203) 674-1536

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6001 Village Glen Drive
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Dallas, TX 75206
Phone (214) 987-4556
FAX (214) 987-4706
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King of Prussia, PA 19406

Phone (215) 265-6446
FAX (215) 265-3566
MD, DC, DE, NJ, northern VA, eastern PA

AEROTECH CENTRAL-WEST

26791 Lake Vue Drive #8
Perrysburg, OH 43551
Phone (419) 874-3990
FAX (419) 874-4280
MI, IN, KY, western OH

AEROTECH NORTHWEST

444 Castro Street
Suite 400
Mountain View, CA 94041
Phone (415) 967-4996
FAX (415) 967-4998
northern CA, OR, WA, NV

AEROTECH SOUTH ATLANTIC
8804 Lomas Court
Raleigh, NC 27615
Phone (919) 848-1965
FAX (919) 848-3393
NC, TN, southern VA, AL, FL, GA, SC, MS

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TLX 847228
FAX (0734) 815022

AEROTECH GMBH
Neumeyerstrasse 90
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West Germany
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TLX 622474
FAX (0911) 521235

AEROTECH AUSTRALASIA
224 Carr Street
Suite 7
Leederville 6007
Western Australia
Phone (619) 227-6772
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Rua Americo Brasiliense, 2069
Chacara Santo Antonio
Cep 04715 - Sao Paulo - SP
Brazil
Phone (5511) 523 4044
TLX 1130691 BRTC
FAX (5511) 521 0221

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PO Box 18125
Tel Aviv 61181
Israel
Phone (9723) 7515007
or (9723) 7513268
TLX 342436 BMS IL
FAX (9723) 727319

SIMCO
248, Hauz Rani Market
Opposite Press Enclave
New Delhi 110 017 India
Phone 6443684
TLX 031-62176 HARS IN
FAX (9111) 510697

OPTIKON CORPORATION LTD.

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Waterloo, Ontario
Canada, N2L 4E2
Phone 519-885-2551
FAX 519-885-4712

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Rm 903, Kwang Sung Bldg.
831-47 Youksamdong
Kangnam-Ku, Seoul, Korea
Phone (822) 556-2292
FAX (822) 556-2902
TLX 29734 DONG DO

TOKYO INSTRUMENTS INC.

Asahi-Seimei Bldg.
6-8-10 Nishikasai
Edogawa-Ku
Tokyo 134 Japan
Phone (813) 686-4711
FAX (813) 686 0831

HISCO (MALAYSIA) SDN.BHD.

1 Lorong SS13/6A
Subang Jaya Indust. Estate
47500 Petaling Jaya
Selanger, Malaysia
Phone (603) 733-4236
FAX (603) 733-6281
TLX 36226 HISCO MA

HADLAND PHOTONICS PTY. LTD.
19A Hampshire Road
Glen Waverley
Victoria, 3150, Australia
Phone (613) 560 2366
FAX (613) 560 8402
TLX AA 35670

Index

Addendum 1

Alternative Dynacron Packaging

Addendum 1

Alternatate Dynacron Packaging

Any of the DM4005/4003/DM4001/1501 stepping translators can be optionally packaged in a Dynacron Panel/Desktop Enclosure.

All power and signal connections are then made via various connectors on the enclosure rather than at J1 and J3 on the translator itself. These connectors are labeled "Port A", "Port B", "Port C" and "Motor Power". Figures 1 and 2 of this addendum cross reference these connectors with the translator J1 and J3 connectors. This enables you to use the input and output information given in chapter 3 of this manual.

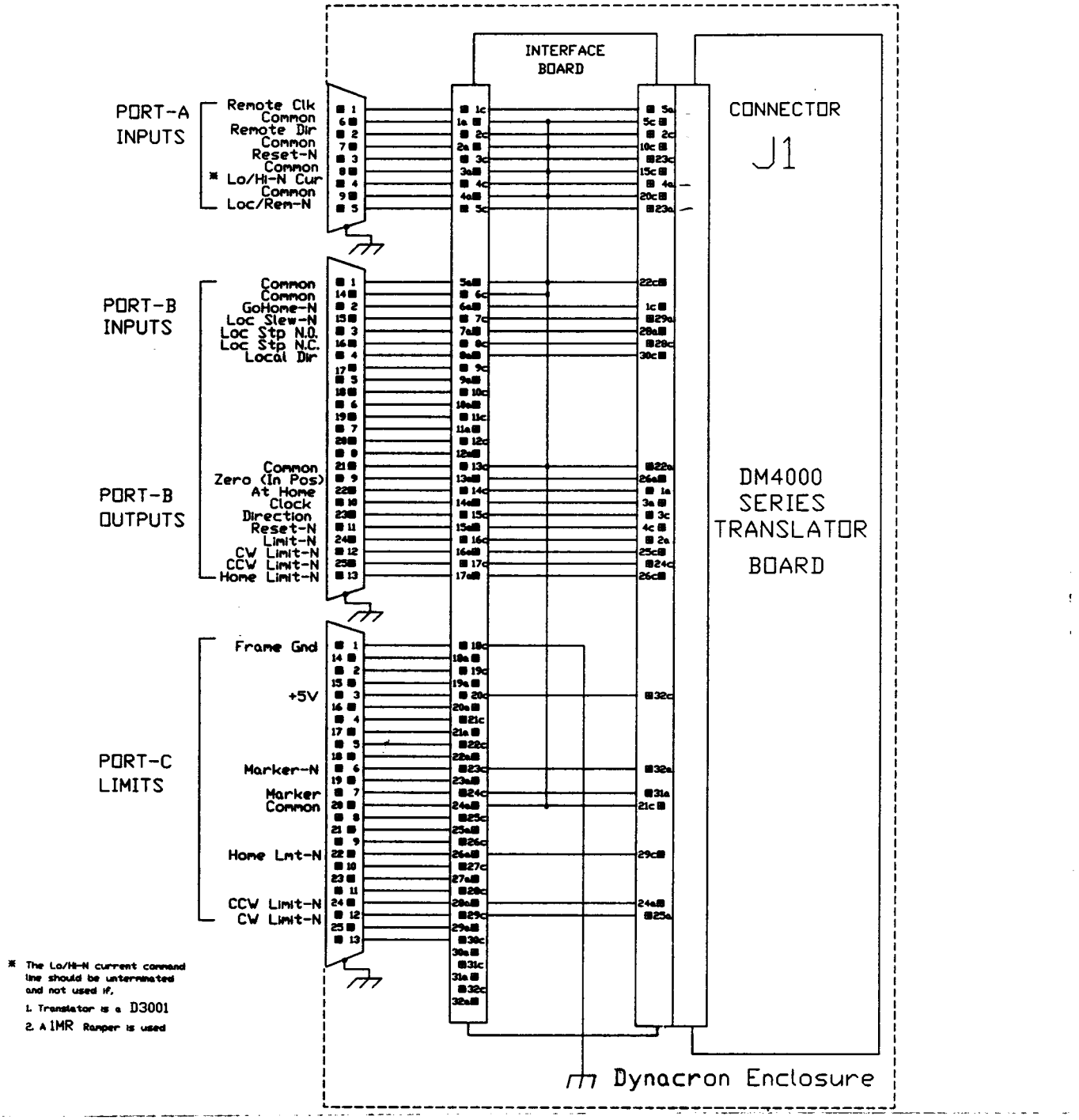

Figure 1: Dynacron Inputs and Outputs

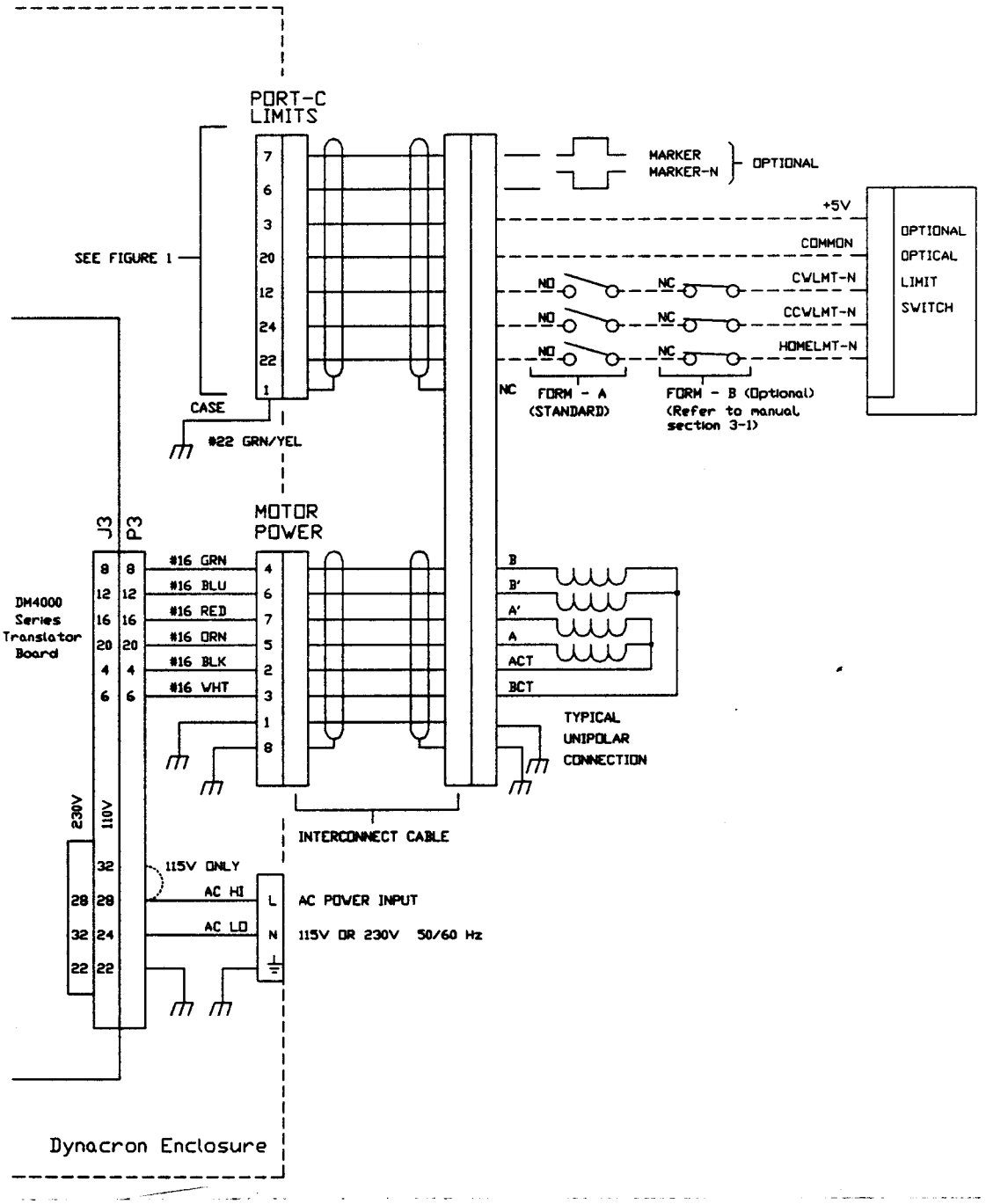

Figure 2: Dynacron Limits and Motor Wiring

Warranty and Field Service Policy

Aerotech, Inc. warrants its products to be free from defects caused by faulty materials or poor workmanship for a minimum period of one year from date of shipment from Aerotech. Aerotech's liability is limited to replacing, repairing or issuing credit, at its option, for any products which are returned by the original purchaser during the warranty period. Aerotech makes no warranty that its products are fit for the use or purpose to which they may be put by the buyer, whether or not such use or purpose has been disclosed to Aerotech in specifications or drawings previously or subsequently provided, or whether or not Aerotech's products are specifically designed and/or manufactured for buyer's use or purpose. Aerotech's liability on any claim for loss or damage arising out of the sale, resale or use of any of its products shall in no event exceed the selling price of the unit.

Laser Product Warranty

Aerotech, Inc. warrants its laser products to the original purchaser for a minimum period of one year from date of shipment. This warranty covers defects in workmanship and material and is voided for all laser power supplies, plasma tubes and laser systems subject to electrical or physical abuse, tampering (such as opening the housing or removal of the serial tag) or improper operation as determined by Aerotech. This warranty is also voided for failure to comply with Aerotech's return procedures.

Return Products Procedure

Claims for shipment damage (evident or concealed) must be filed with the carrier by the buyer. Aerotech must be notified within (30) days of shipment of incorrect materials. No product may be returned, whether in warranty or out of warranty, without first obtaining approval from Aerotech. No credit will be given nor repairs made for products returned without such approval. Any returned product(s) must be accompanied by a return authorization number. The return authorization number may be obtained by calling an Aerotech service center. Products must be returned, prepaid, to an Aerotech service center (no C.O.D. or Collect Freight accepted). The status of any product returned later than (30) days after the issuance of a return authorization number will be subject to review.

Returned Product Warranty Determination

After Aerotech's examination, warranty or out-of-warranty status will be determined. If upon Aerotech's examination a warrantied defect exists, then the product(s) will be repaired at no charge and shipped, prepaid, back to the buyer. If the buyer desires an air freight return, the product(s) will be shipped collect. Warranty repairs do not extend the original warranty period.

Returned Product Non-Warranty Determination

After Aerotech's examination, the buyer shall be notified of the repair cost. At such time the buyer must issue a valid purchase order to cover the cost of the repair and freight, or authorize the product(s) to be shipped back as is, at the buyer's expense. Failure to obtain a purchase order number or approval within (30) days of notification will result in the product(s) being returned as is, at the buyer's expense. Repair work is warranted for (90) days from date of shipment. Replacement components are warranted for one year from date of shipment.

Rush Service

At times, the buyer may desire to expedite a repair. Regardless of warranty or out-of-warranty status, the buyer must issue a valid purchase order to cover the added rush service cost. Rush service is subject to Aerotech's approval.

On-Site Warranty Repair

If an Aerotech product cannot be made functional by telephone assistance or by sending and having the customer install replacement parts, and cannot be returned to the Aerotech service center for repair, and if Aerotech determines the problem could be warranty-related, then the following policy applies.

Aerotech will provide an on-site field service representative in a reasonable amount of time, provided that the customer issues a valid purchase order to Aerotech covering all transportation and subsistence costs. For warranty field repairs, the customer will not be charged for the cost of labor and material. If service is rendered at times other than normal work periods, then special service rates apply.

If during the on-site repair it is determined the problem is not warranty related, then the terms and conditions stated in the following "On-Site Non-Warranty Repair" section apply.

On-Site Non-Warranty Repair

If an Aerotech product cannot be made functional by telephone assistance or purchased replacement parts, and cannot be returned to the Aerotech service center for repair, then the following field service policy applies.

Aerotech will provide an on-site field service representative in a reasonable amount of time, provided that the customer issues a valid purchase order to Aerotech covering all transportation and subsistence costs and the prevailing labor cost, including travel time, necessary to complete the repair.

AEROTECH, Inc., 101 Zeta Drive, Pittsburgh, Pennsylvania 15238

Phone (412) 963-7470 • TWX 710-795-3125 • FAX (412) 963-7459