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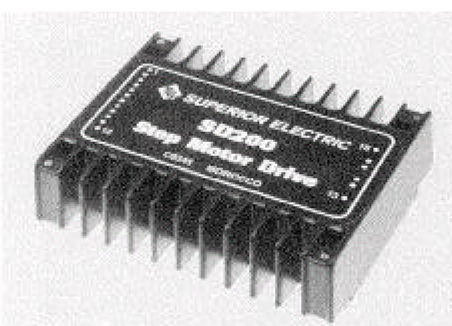
SLO-SYN Bipolar Model SD200 Step Motor Drive Module Installation Instructions



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Record of Manual Revisions

ISSUE NO.	DATE	BRIEF DESCRIPTION OF REVISION
A	06/26/99	Initial release
B	02/10/00	Revise corporate identity
C	10/05/01	Revise corporate identity
F	07/31/03	Updated contact information and revise corporate identity
G	09/10/03	Updated contact information and revise corporate identity

SAFETY

The equipment described herein has been developed, produced, tested and documented in accordance with the corresponding standards. During use conforming with requirements, the equipment is not dangerous for people or equipment. Use conforming with requirements means that the safety recommendations and warnings detailed in this manual are complied with and applicable regulations for safety (machine directives, etc.) and noise suppression (EMC Directives) are observed while operating the drive. At the end of its lifetime, dispose of or recycle the drive according to the applicable regulations.

Installation and wiring of the drive must be completed only by qualified personnel having a basic knowledge of electronics, installation of electronic and mechanical components, and all applicable wiring regulations.

Commissioning of the machine utilizing the drives must be done only by qualified personnel having a broad knowledge of electronics and motion control technology.

As the user or person applying this unit, you are responsible for determining the suitability of this product for the application. In no event is Danaher Motion responsible or liable for indirect or consequential damage resulting from the misuse of this product.

Comply with the applicable European standards and Directives.

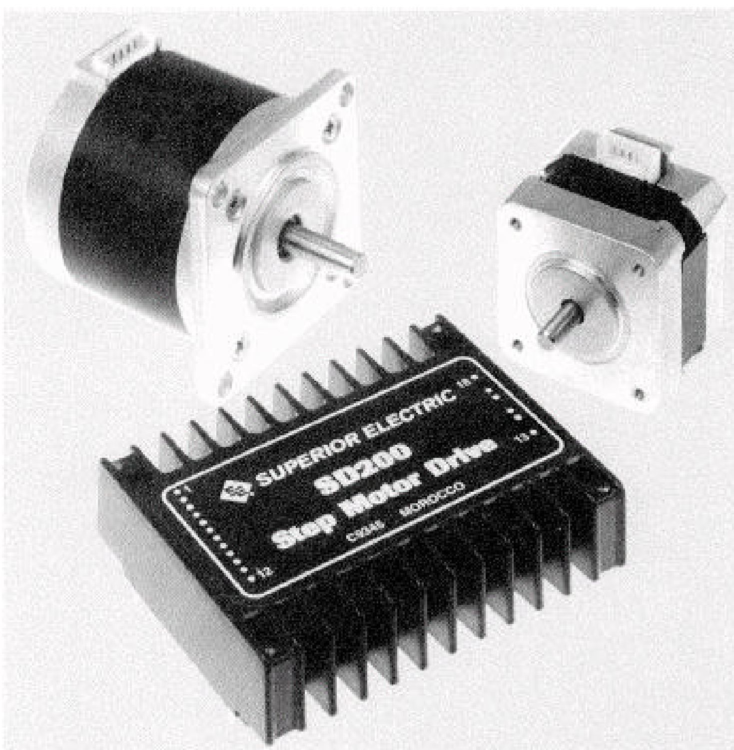
Table of Contents

1. INTRODUCTION

1.1. This Manual

It is important that you understand how the Step Motor Drive Module is installed and operated prior to attempting to use it. **Read this manual completely before proceeding with the installation of this Module**.

This manual is an installation and operating guide for the SD200 Step Motor Drive Module. Section 1 provides an overview of the drive module and its features. Section 2 describes the minimum steps necessary to place the drive module into operations. General wiring guidelines as well as physical mounting of the module, including Printed Circuit Board connections and motor output wiring are covered in Section 3.



1.2. Features

The SD200 Drive Module is a bipolar Step Motor Drive Module that directly interfaces a microprocessor to a two-phase, bipolar, permanent magnet step motor. The phase current is chopper-controlled. The use of internal phase sequence generation reduces the burden on the controller and simplifies control software development. Some notable features of the SD200 Step Motor Drive Module are:

- Wide Supply voltage range
- Full/Half step drive capability
- Adjustable motor phase current and chopper frequency
- Selectable Slow/Fast current decay
- Synchronization for multimotor applications
- Remote shut-down
- Home Position indication

2. EXPRESS START-UP

The following instructions describe the minimum steps necessary for the Drive Module to become operational. **FAILURE TO PERFORM THESE STEPS MAY RESULT IN DAMAGE TO THE UNIT.**

This Drive Module manual MUST BE READ COMPLETELY to correctly operate the Drive Module. The Express Start-up procedure only highlights the important items necessary to ensure correct Drive operation.

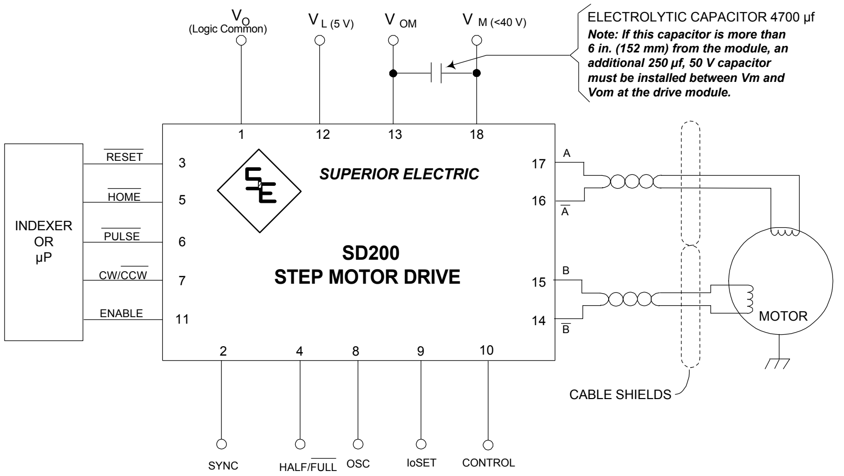
1) Mount the Drive Module to the customer-supplied motherboard as described in Section 3.2.

2) Verify that the motor being driven is compatible with the Drive Module. Refer to Section 4.4 for a compatible motor listing.

3) Ensure that the appropriate signal interface lines are provided to the drive module. Section 4.6 describes each of the input/output signals.

4) Connect the motor to the drive interface as defined in Section 3.3.

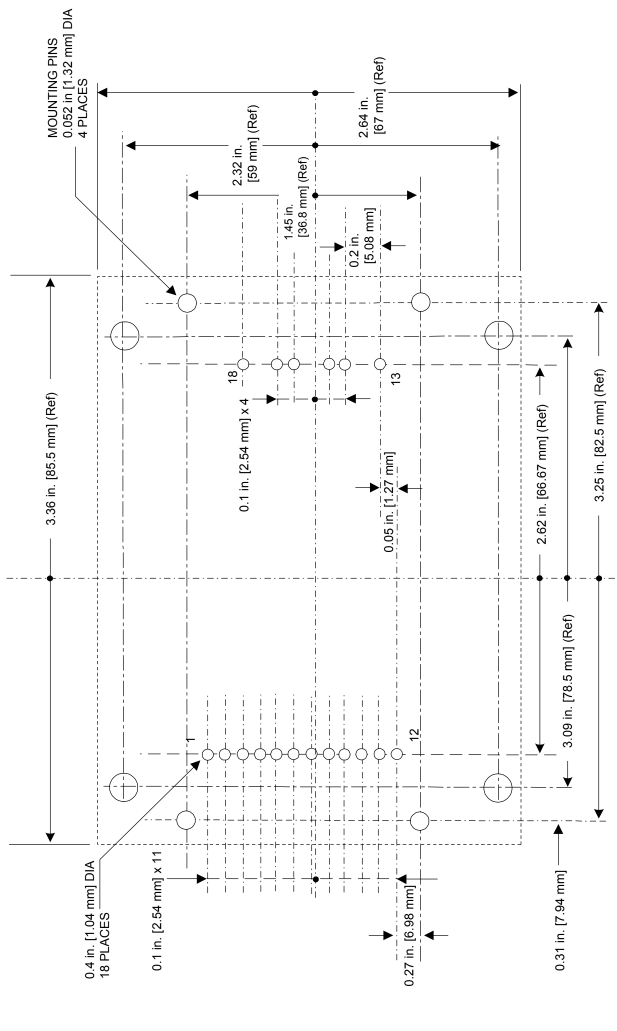
5) Connect supply voltages V_M and V_L as specified in Section 4.2. Ensure voltages do not exceed the specified maximum limits and that the correct "Power Up/Power Down" sequence is being used.


V O (Logic Common)
V L (5 V)
V OM
V M (<40 V)
ELECTROLYTIC CAPACITOR 4700 µf
Note: If this capacitor is more than 6 in. (152 mm) from the module, an additional 250 µf, 50 V capacitor must be installed between Vm and Vom at the drive module.
1
12
13
18
INDEXER OR µP
RESET
HOME
PULSE
CW/CCW
ENABLE
3
5
6
7
11
SUPERIOR ELECTRIC
SD200
STEP MOTOR DRIVE
17
16
15
14
A
A
B
B
MOTOR
2
4
8
9
10
CABLE SHIELDS
SYNC
HALF/FULL
OSC
IoSET
CONTROL

3. INSTALLATION

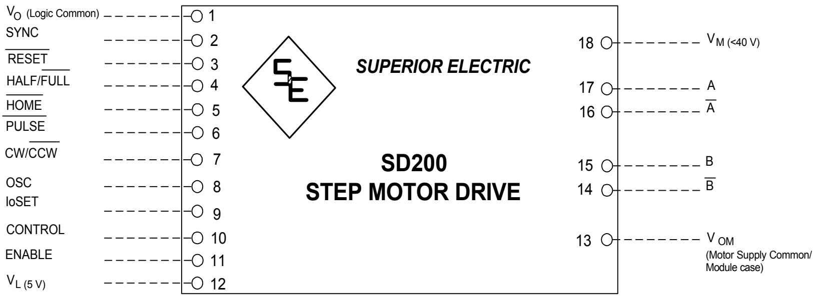
3.1. Mounting

The SD200 Drive Module is designed to be mounted to the purchaser's Printed Circuit board, which in turn, provides the connection interface to the module. PC board layout information, including pin placement, hole drill size, and quantity are given in the following figure.



3.2. I/O Location and Pin Assignments

Input and Output pin locations are shown below. A complete description of each I/O point is given in Section 4.6.



3.2.1. I/O Connections

Input and Output connections are made through the purchaser's PC board interface on which the SD200 is mounted. When cabling is required for maximum noise immunity, use a shielded, twisted cable.

3.2.2. Signal Inputs/Outputs

Pin #	Signal Name
2	SYNC
3	RESET (active low)
4	Half/Full (Full, active low)
5	Home (active low)
6	Pulse (active low)
7	CW/CCW (CCW, active low)
8	Oscillator
9	IoSet
10	Control
11	Enable

3.2.3. Power Supply Input

The module requires two DC input power supply connections. One is the 5 VDC logic power supply. The other is the Module/Motor supply.

Pin #	Signal Name
1	V_{O1} Logic supply common
12	V_{L1} 5 VDC logic supply
13	V_{OM1} Motor supply common
18	V_{M1} Motor supply

The Module case is internally connected to pins 1 and 13. To obtain the added EMI shielding, the printed circuit board area below where the module is mounted could be used as an effective sixth side shield.

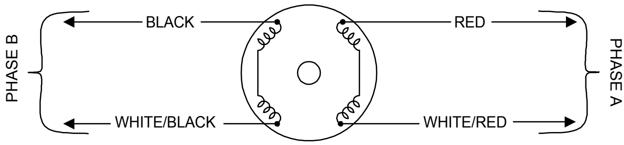
The Module has an internal capacitor connected across the motor/module supply pins (13 and 18) to assure circuit stability. This capacitor cannot handle high values of ripple current, which may lead to permanent damage if the primary source impedance is not adequate. It is recommended that a low ESR, high ripple current 4700 µf capacitor be located as close to the module as possible. If this capacitor is more than 6 inches (152 mm) from the module, an additional 250 µf, 50 V capacitor must be installed at the module between V_M and V_{OM}. Suitable capacitors are the SPRAGUE type 672D and 678D, the RIFA type PEC 126 or an equivalent. If space is limited, a 22 µf ceramic, multilayer capacitor can be used.

3.2.4. Motor Outputs

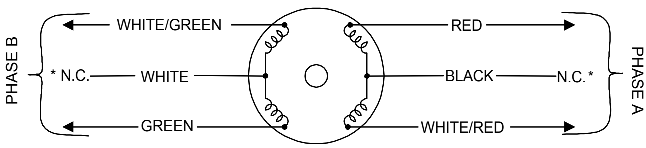
The module outputs are protected against the occasional and permanent short-circuits between the output pins. When th emaximum current limit is exceeded, the output is automatically disabled. To restart the module, it is necessary to disable it by either bringing pin 11 (Enable) low or by switching the power supply voltage off for a minimum of 100 ms.

Pin #	Signal Name
14	$\overline{B}$ Output
15	B Output
16	$\overline{A}$ Output
17	A Output

Since the motor is normally quite far from the drive module, cabling from the drive module motor interface to the motor should be a shielded, twisted pair type cable with appropriate cross-section for each motor phase. This will help minimize DC losses and RFI problems. As a guideline, the wires should be twisted about six times per foot.

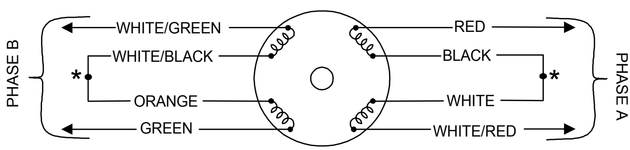


4-LEAD MOTORS

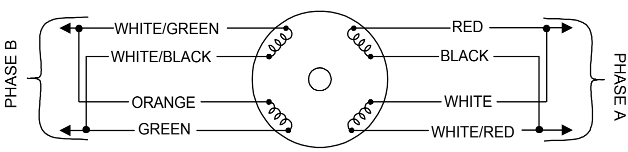


6-LEAD MOTORS

NOTE: NC = NO CONNECTION



8-LEAD MOTORS, SERIES CONNECTIONS

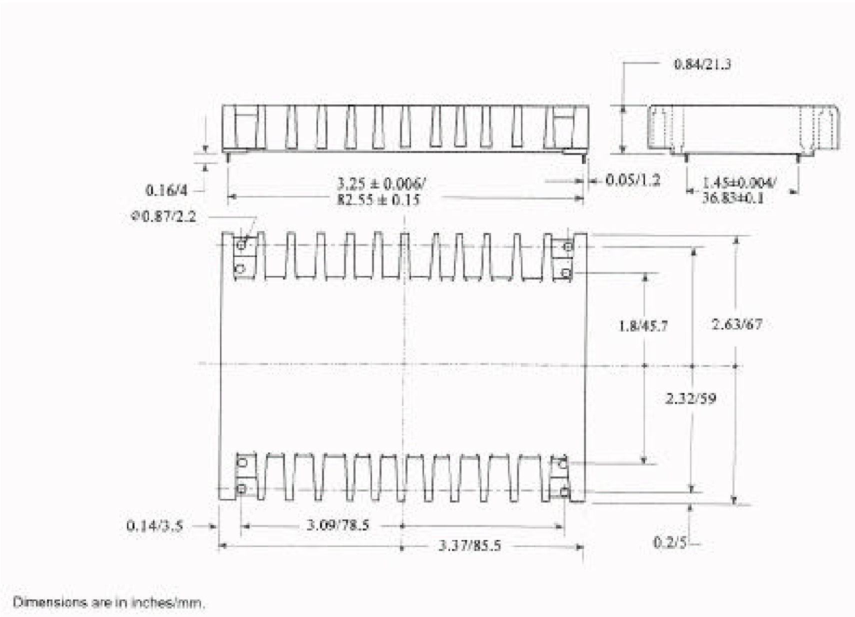


8-LEAD MOTORS, PARALLEL CONNECTIONS

4. SPECIFICATIONS

4.1. Mechanical

The overall dimensions of the SD200 Step Motor Drive Module are given in the figure below. The weight of the module is 6.7 ounces.



4.2. Electrical

5 VDC Logic Supply (V_L)	5 VDC ± 5% 60 mA, typical
Motor/Module Supply (V_M)	12 to 40 VDC max.
Phase Current	2.0 A nominal (0.5 to 2.5)
Voltage Drop	2.5 VDC max.

The recommended maximum operating supply voltage must include the ripple voltage for the V_M rail, and the 5 VDC ± 5% V_L line. The two supply voltages must be correctly sequenced to avoid any possible erroneous positioning of the power stages.

Power-Up

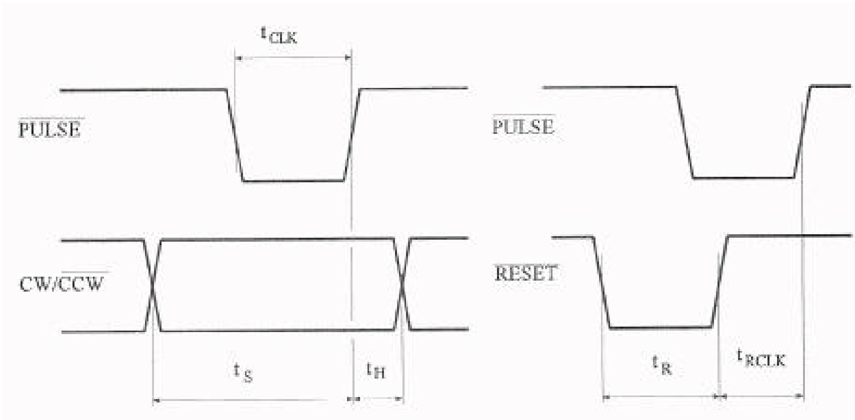
1) Apply V_L (5 V) with Enable (pin 11) low.
2) Apply V_M (motor supply voltage).
3) Bring Enable (pin 11) high.

Power-Down

1) Bring Enable (pin 11) low.
2) Switch V_M off.
3) Switch V_L off.

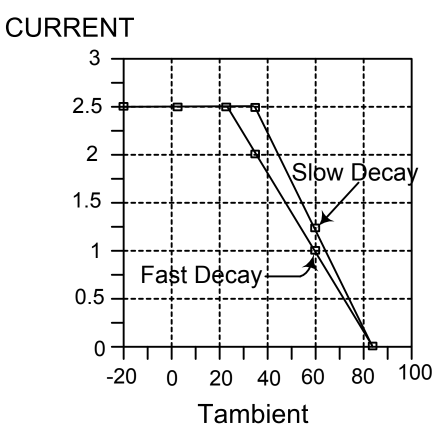
Electrical characteristics for the SD200 signals, including signal timing:

Parameter		Test Conditions		Value Min	Value Typ	Value Max	Unit
I_S	Quiescent supply current	Pin 18				20	mA
I_{SS}	Quiescent logic supply current	Pin 12			60		mA
V_I	Input voltage	Pin 3, 4, 6, 7, 10, 11	low			0.8	
			high	2		V_L	V
I_I	Input current	Pin 3, 4, 6, 7, 10	V_I=low			0.6	mA
			V_I=high			10	µA
		Pin 11	V_I=low			10	mA
			V_I=high			10	µA
V_{SAT}	Source/Sink saturation voltage	Pin 14, 15, 16, 17				1.8	V
F_C	Chopper frequency				17		kHz
t_{CLK}	PULSE width	Pin 6 see next figure.		0.5			µs
t_S	Set up time	Pin 6 see next figure.		1			µs
t_H	Hold time	Pin 6 see next figure.		1			µs
t_R	Reset width	Pin 6 see next figure.		1			µs
t_{RCLK}	Reset to PULSE set up time	Pin 6 see next figure.		1			µs



4.3. Thermal

The case to ambient thermal resistance of the module is 5° C/watt. This produces a 50° C temperature increase on the surface of the module for every 10 watts of internal heat dissipation. Accordingly, an additional heatsink or forced ventilation may be required to keep the case temperature below 85° C during operation. Section 6.5 contains instructions on how to determine the ambient case temperature. The operating case temperature range is –20 to +85° C. The module storage temperature range is –40 to +105° C. The next figure is the derating curve for the module based on the case temperature in free air ambient.



4.4. Motor Capability

Motor Types	Superior Electric MO61-63 and MO91 & 92
Frame Sizes	17, 23, and 34
Number of Connections	4, 6, 8

Do not use larger frame size motors than those listed or the drive module may be permanently damaged.

4.5. Phase Current

The phase current output of the SD200 drive module is factory set at 2 A. The current rating of the module is 2.5 A maximum. The current can be changed with the addition of a resistor of the appropriate value. See the previous figure. The maximum phase current must be limited to 2.5 A to avoid permanent damage to the module.

4.5.1. Decreasing Current

If a lower input current is desired, a resistor (R_{DEC}) must be connected between I_{OSet} (pin 0) and V_O (pin 1). To calculate the value for an appropriate resistor, use the following formula:

$$R_{DEC} = \frac{I_O}{3.03\ (1.43 * I_O)}$$

Where R_{DEC} = resistor (k Ohm) to decrease current to a desired I_O

I_O = desired output current (A)

4.5.2. Increasing Current

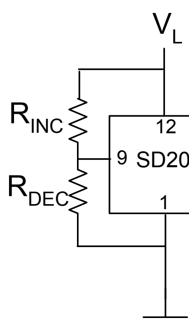
If a higher output current is desired, a resistor (R_{INC}) must be connected between I_{OSet} (pin 9) and V_L (pin 12). An appropriate resistor can be calculated using the following formula:

$$R_{INC} = \frac{10 - (0.33 * I_O)}{(0.473 * I_O) - 1}$$

Where R_{INC} = resistor (k Ohm) to increase current to a desired I_O,
$R_{INC} \geq$ 50 K Ohm.

The following is a table of R values for common current settings:

Motor Current (A)	R_{DEC} **k** W	R_{INC} **k** W
0.5	0.215	N/A
1.0	.0625	N/A
1.5	1.690	N/A
2.0	N/A	N/A
2.5	N/A	50.3



4.6. Signal Descriptions

V_O (Pin 1) **Logic Common**

Return line for the low power logic supply voltage. This pin is internally connected to pin 13 (V_{OM}).

SYNC (Pin 2) **Chopper Oscillator Output**

For multi-axis applications, several modules can be synchronized by connecting together all SYNC pins. This pin can also be used as the input for an external clock source.

$\overline{\text{RESET}}$ **(Pin 3)** **Asynchronous Reset Input**

An active low pulse on this input sets the internal logic to its initial state.

HALF/$\overline{\text{FULL}}$ **(Pin 4)** **Half/Full Step Selection Input**

A high (or unconnected) state selects Half step operation. When this input is forced low, Full step operation is selected.

$\overline{\text{HOME}}$ **(Pin 5)** **Internal Counter State Output**

When this output is low, it indicates that the internal counter is in its initial state. This signal should be ANDed with the output of a mechanical switch to be used as a System HOME indication.

$\overline{\text{PULSE}}$ **(Pin 6)** **Pulse Clock Input**

A pulse on this input increments the motor one step on the rising edge of this signal.

CW/$\overline{\text{CCW}}$ **(Pin 7)** **Direction Control Input**

This input selects the direction of the motor shaft rotation as viewed from the label end of the motor. When this input is high (or unconnected), clockwise rotation is selected. When this input is forced low, counter-clockwise rotation is selected.

OSC (Pin 8) Chopper Oscillator Frequency

The chopper oscillator is internally fixed at 17 kHz. The chopper frequency can be increased by connecting a resistor between this pin and V_{SS}. Connecting a capacitor between this pin and V_O decreases the chopper frequency. The oscillator input must be ground when using the module in a multi-axis configuration.

I_{OSET} (Pin 9) Phase Current Setting Input

The module current is factory set to 2 A per phase. The phase currernt can be decreased by connecting a resistor between this pin and V_O or increased by connecting a resistor between this pin and V_L. *The recommended output current is minimum 1 A and maximum 2.5 A.*

CONTROL (Pin 10) Phase Current Decay Input

Logic input for phase current decay mode selection. A high or unconnected selects recirculating or slow decay mode. A low input selects non-recirculating or fast decay mode.

ENABLE (Pin 11) AWO (All Windings Off)

This is the module enable input. When this input is high (or unconnected), normal module operation is selected. When this input is low, it turns off all power to the motor windings enabling manual positioning of the motor. This input must be LOW during power-up and power-down sequence, and HIGH during normal operation.

NOTE: ***This signal line is clamped low (to V_O) when the short-circuit protection is active. Be sure that any external circuitry tied to this pin can tolerate being clamped low.***

V_L (Pin 12) Logic Supply Input

The 5 VDC Logic Supply Input. Tolerance is ± 5%.

V_{OM} (Pin 13) V_M Return

This is the return line for the high power motor supply (< 40 VDC). This pin is internally connected to pin 1 (V_O).

B (Pin 15)	Motor Phase B Output
$\overline{B}$ (Pin 14)	Motor Phase $\overline{B}$ Output
A (Pin 17)	Motor Phase A Output
$\overline{A}$ (Pin 16)	Motor Phase $\overline{A}$ Output
V_M (Pin 18)	Module/Motor Supply Input

The maximum voltage on the module and motor supply input must not exceed 40 VDC.

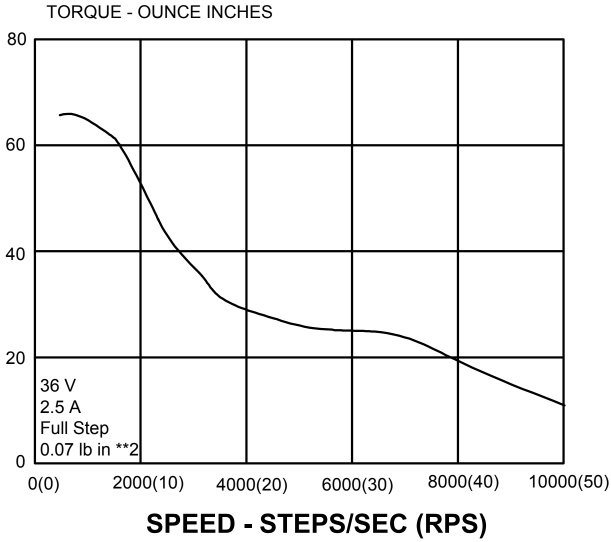
4.7. Torque Versus Speed Characteristics

All stepper motors exhibit instability at their natural frequency and harmonics of that frequency. Typically, this instability occurs at speeds between 50 and 500 full steps per second and, depending on the dynamic motor load parameters, can cause excessive velocity modulation or improper positioning.

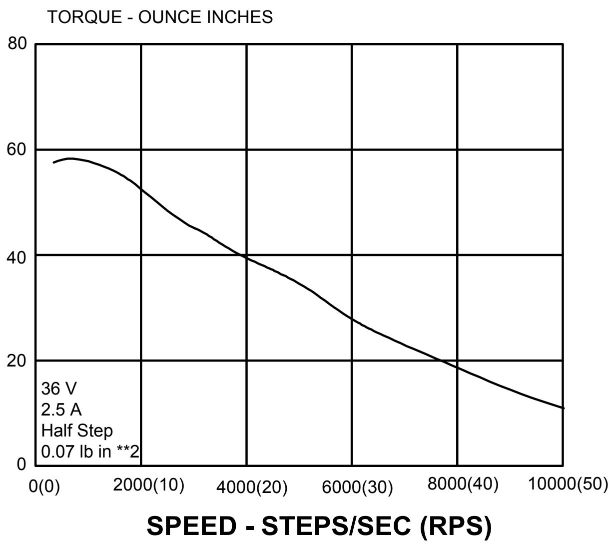
Techniques to reduce velocity modulation problems are:

1) Avoid constant speed operation at the motor unstable frequencies. Select a base speed that is above the motor's resonant frequencies and adjust acceleration and deceleration to move the motor through unstable regions quickly.
2) Reduce the motor winding current. Lowering the current proportionally reduces torque. The reduced energy delivered to the motor can decrease velocity modulation.
3) Use the half-step mode of operation to provide smoother operation.

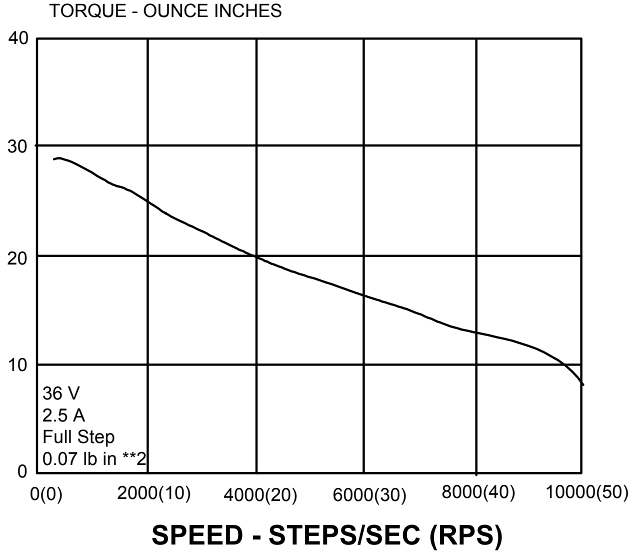
M061 WITH 08 WINDING SERIES CONNECTED



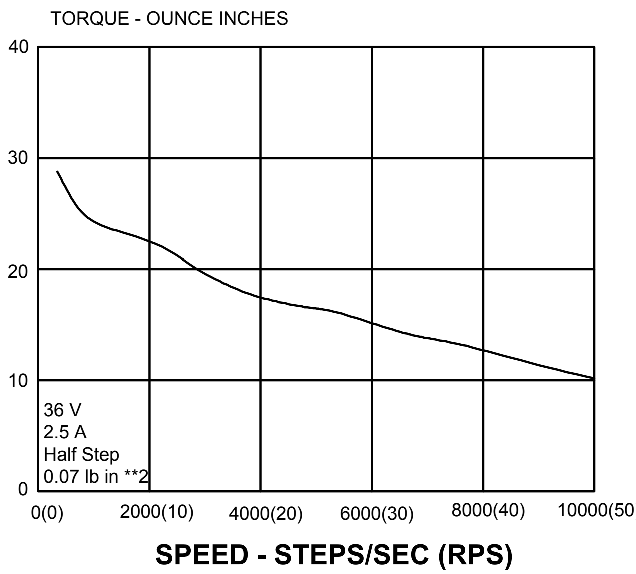
M061 WITH 08 WINDING SERIES CONNECTED



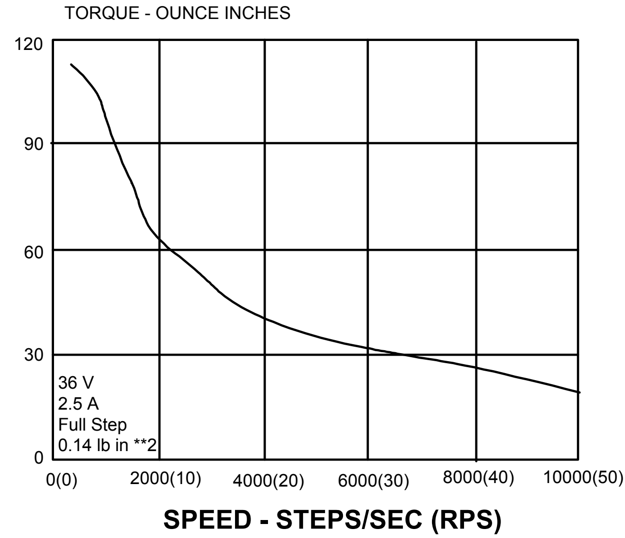
M061 WITH 08 WINDING PARALLEL CONNECTED



M061 WITH 08 WINDING PARALLEL CONNECTED



M062 WITH 09 WINDING SERIES CONNECTED



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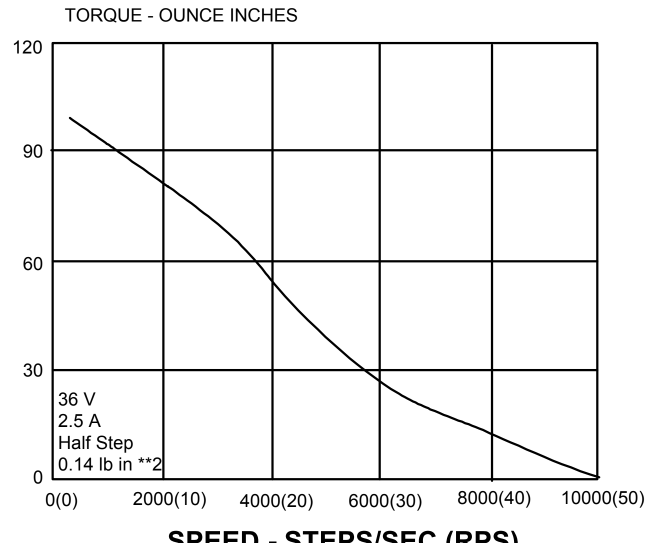

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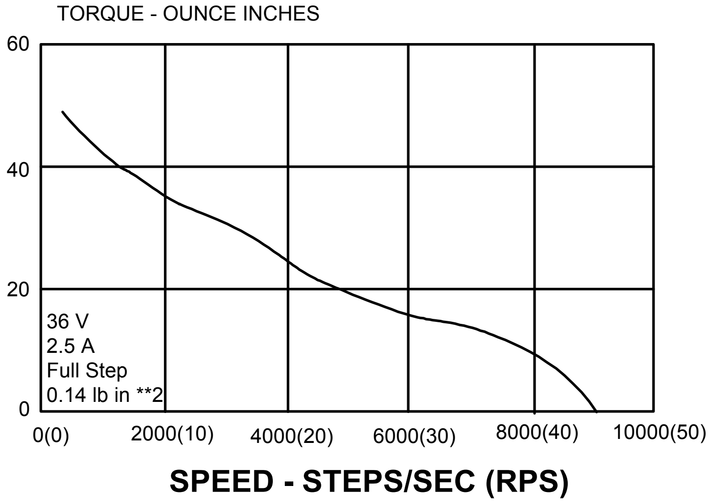
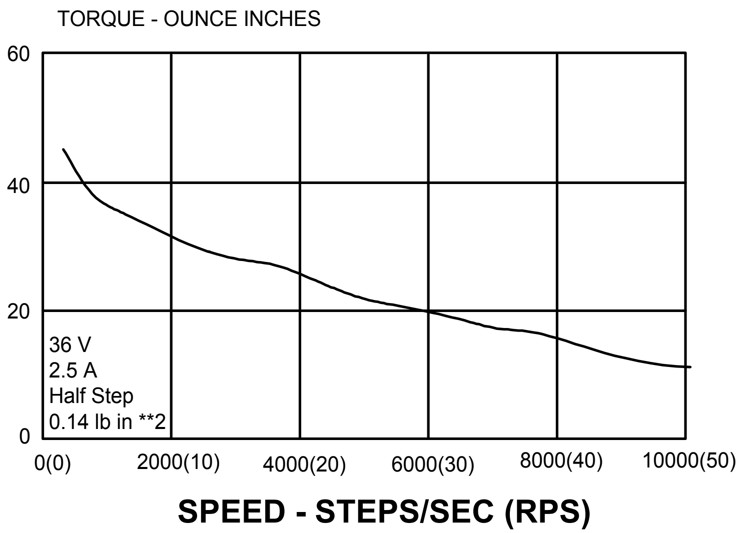


M062 WITH 09 WINDING PARALLEL CONNECTED



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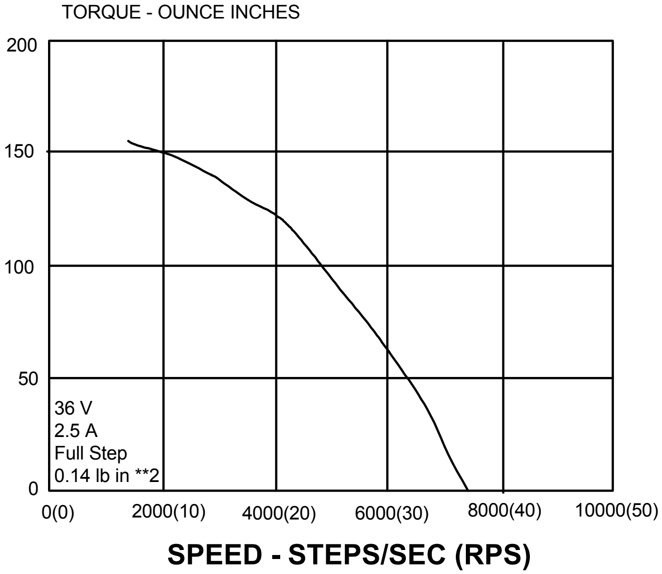

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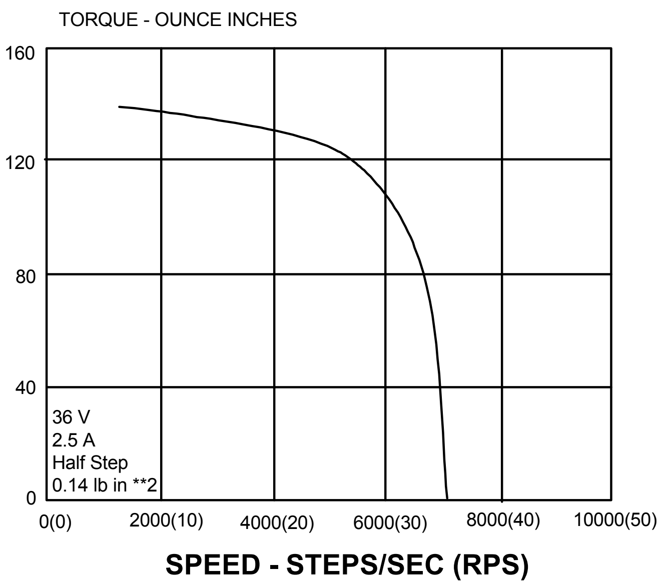
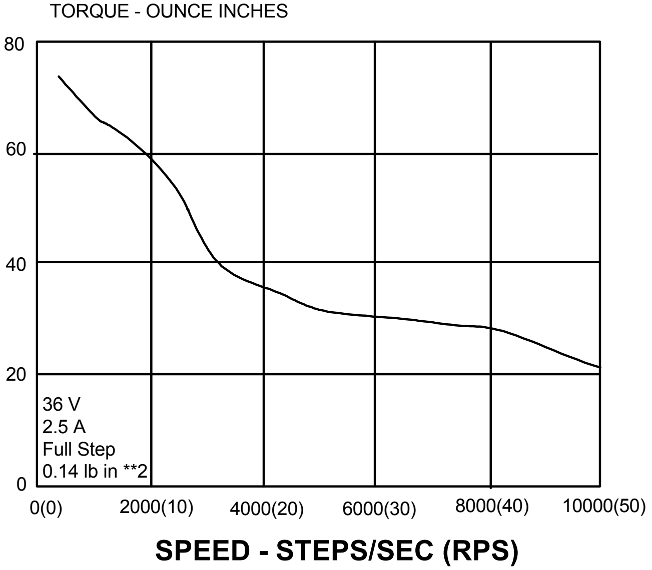
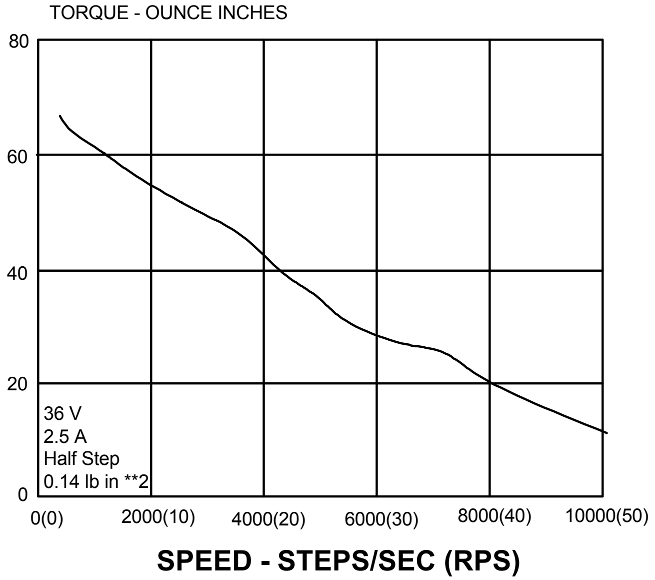


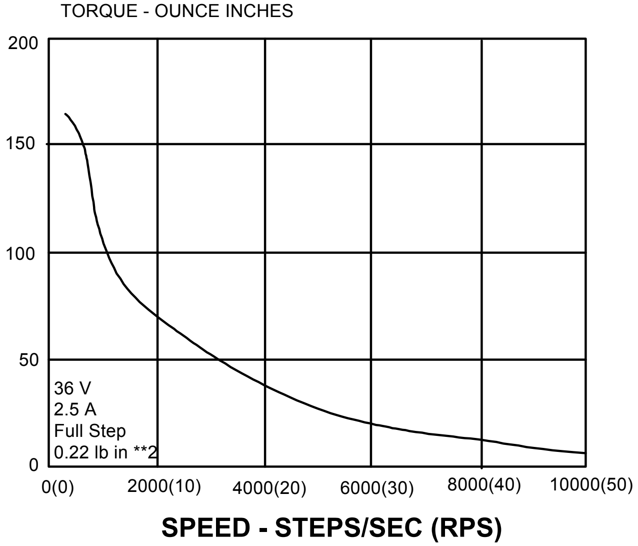
M063 WITH 09 WINDING PARALLEL CONNECTED



M063 WITH 09 WINDING PARALLEL CONNECTED



M091 WITH 09 WINDING SERIES CONNECTED



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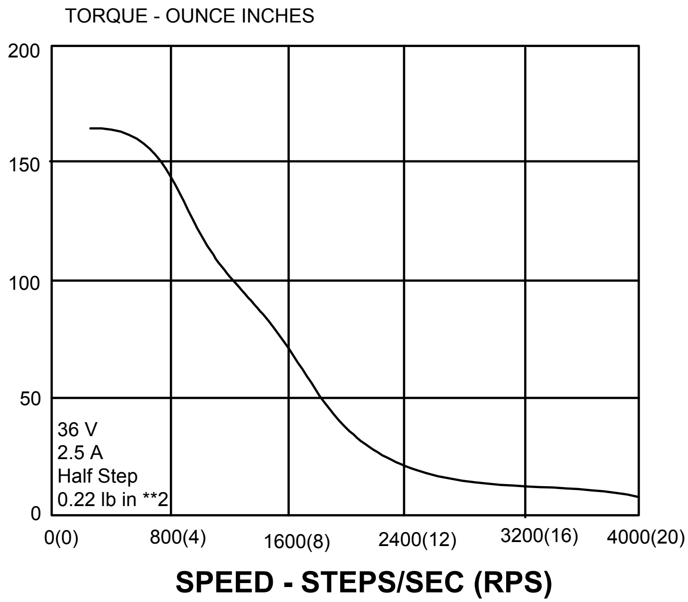
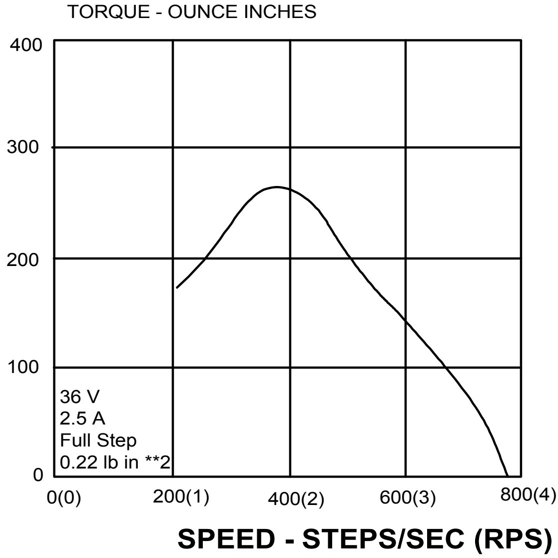
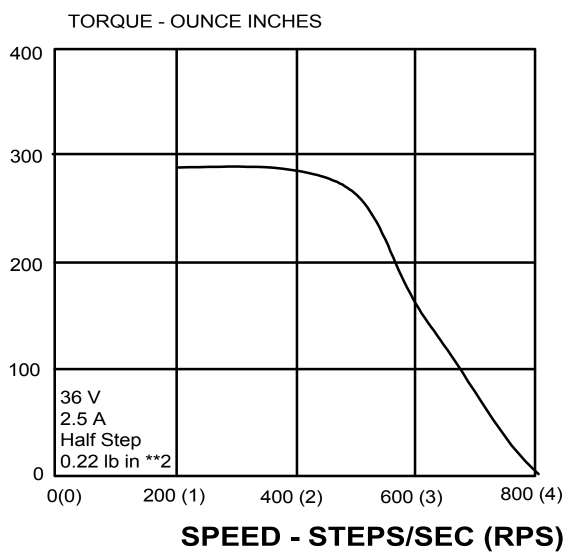


M092 WITH 09 WINDING SERIES CONNECTED



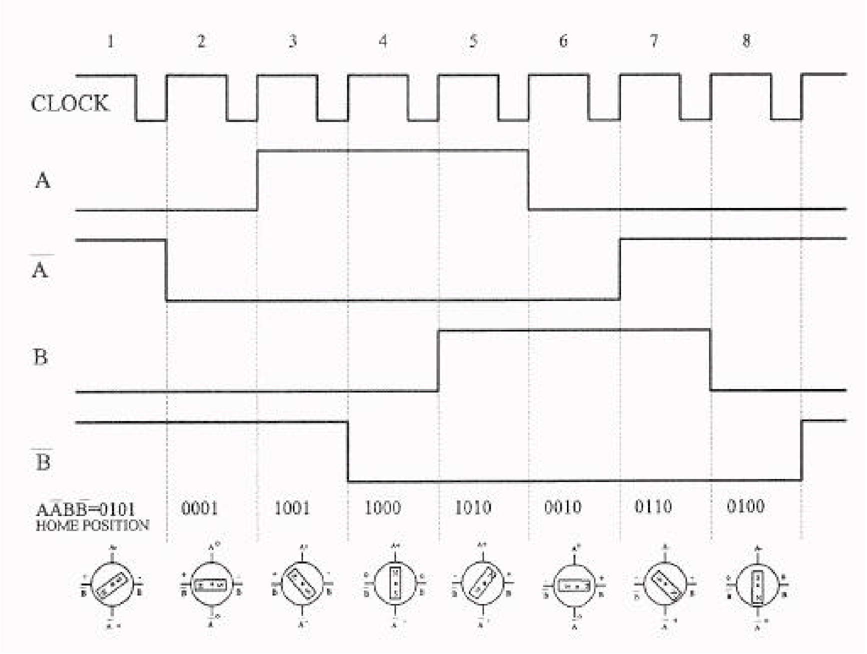
M092 WITH 09 WINDING SERIES CONNECTED



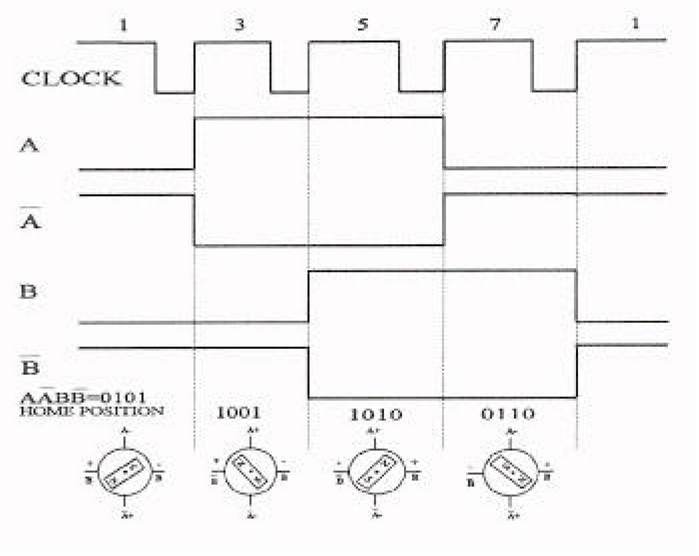
5. OPERATION GUIDE

5.1. Phase Sequence Generation

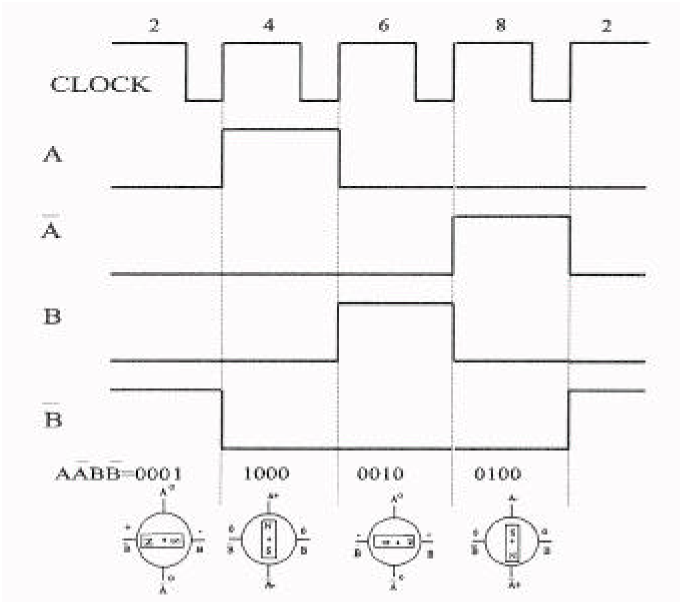
The module contains a three-bit counter and combinational logic, which generates suitable phase sequences for half step, wave, and normal full-step drives. The three-bit counter generates a basic either step Gray code master sequence (shown in next figure). To select this sequence (corresponds to half-step mode), the Half/Full input (pin 4) must be high or unconnected.



The Full step mode (normal and wave drive) are both obtained from the eight step master sequence by skipping alternate states. This is achieved by forcing the step clock to bypass the first stage of the three-bit counter. The least significant bit of this counter is not affected and the generated sequence depends on the start of the counter when full step mode is selected by forcing pin 4 (Half/Full) low. If full step is selected when the counter is at any odd numbered state, the two-phase ON (normal mode) is implemented. (see next figure)



If the full mode is selected when the counter is at an even numbered state, the one-phase ON (wave drive) is implemented (see next figure).



5.2. Motor Current Regulation

The two bipolar winding currents are controlled by two internal choppers to obtain consistent speed and torque characteristics. An internal oscillator supplies pulses at the chopper frequency to both choppers.

When the outputs are enabled, the current through the windings rises until a peak value set by I_{OSET} and R_{SENSE} is reached. At this moment, the outputs are disabled and the current decays until the next oscillator pulse arrives.

The decay time of the current is selected by the CONTROL input (pin 10). If the CONTROL input is kept high or open, the decay is slow. When the CONTROL input is forced low, the decay is fast.

5.3. Chopper Frequency Adjustment

The chopper frequency is internally set to 17 kHz, which can be adjusted by adding external components as follows. To increase the chopper frequency, connect a resistor between the oscillator (pin 8) and V_L (pin 12). The resistor value is calculated as:

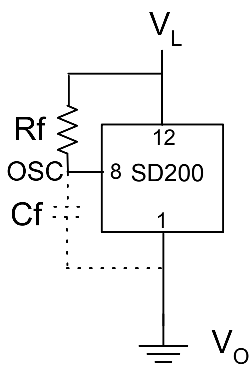
Rf = 360/(fc-17) = kΩ

where fc = kHz, Rf $\geq$ 18 kΩ

To decrease the chopper frequency, connect a capacitor between the oscillator (pin 8) and V_O (pin 1). The capacitor value is calculated as:

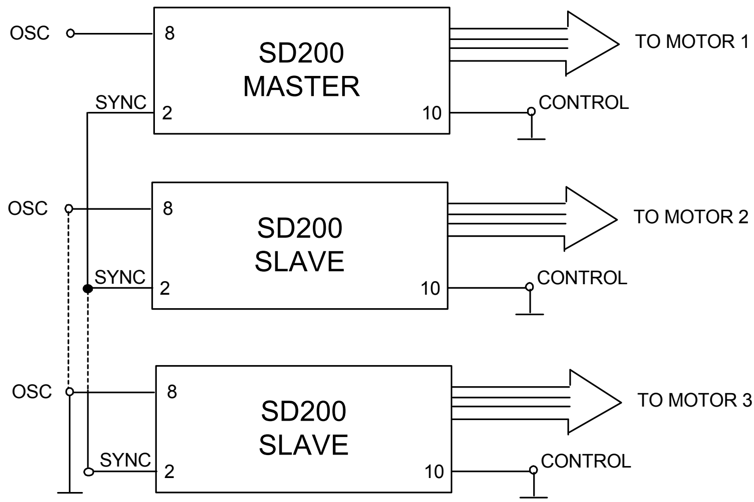
Cf = (80.5 – 4.7 fc) / fc = nF

where fc = kHz



5.4. Multi-Module Applications

In complex systems, many motors must be controlled and driven. In these cases, more than one drive module must be used. To avoid problems associated with chopper frequency noise, synchronize the beats of all the modules. The figure below shows how to synchronize several motors.

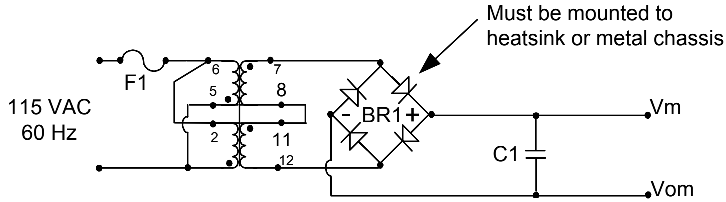


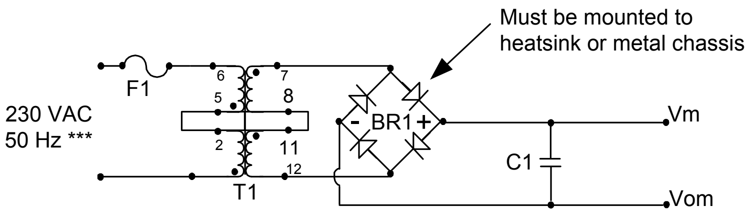
5.5. Recommended Power Supply Configurations

The SD200 drive module requires an external motor control power supply input. This power supply can be configured to provide power to one SD200 drive module or to multiple modules simultaneously. The following are recommended power supply configurations for use with the SD200 drive module.

5.5.1. Single Drive Application

The next figure contains information on the recommended power supply configuration to use when powering one drive module from a single power supply.





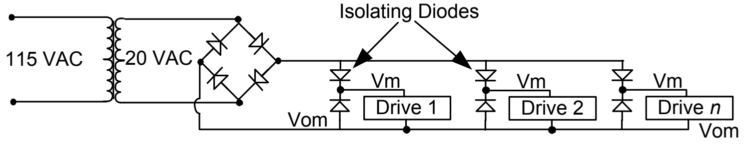
*** For 230 VAC, 50 Hz operation, connect T1 primary windings in series (rest of circuit remains the same)

Parts List			
Item	**Type**	**Ratings**	**Typ. Mfgr & Part No.**
F1	Fuse	3 A,250 V, Slow-blow	BUSSMAN MDA-3
T1	Transformer	130 VA, 115/230 V, Primary 20 CT. Secondary	SIGNAL A41-130-20
BR1	Rectifier, Bridge	30 A, 200 V	VARO VK248
C1	Electrolytic Capacitor	4700 µf, 63 VDC 3.33 ARMS	SPRAGUE 530472G063JP6

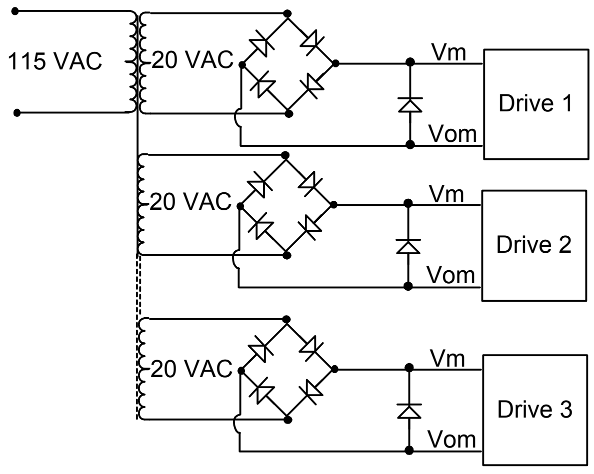
5.5.2. *Multiple Drive Application*

The next figure shows three configurations that can be used when connecting multiple drive modules to a single power supply. These configurations, in addition to the synchronization of multiple drives, are used to reduce chopping interference between drives.

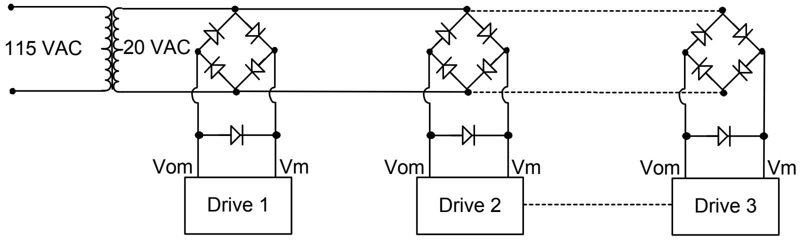
Method 1 – Diode Isolation



Method 2 – Separate Transformer Windings



Method 3 – Separate Bridge Rectifiers



5.6. Thermal Operations Conditions Calculation

In most cases, the SD200 drive module does not require additional cooling because the dimensions and shape of the case are designed to offer the minimum possible thermal resistance, case-to-ambient for a given volume.

Remember that the module is a power device and, depending on ambient temperature, an additional heatsink or forced ventilation or both may be required to keep the unit within a safe operating temperature range ($TCASE_{MAX}$ < 85° C during operation.

To calculate the maximum case temperature of the module in a particular environment, the system designer must know:

- Input voltage (V_{IN})
- Motor phase current (I_{PH})
- Motor phase resistance (R_{PH})
- Maximum ambient temperature (T_{AMB})

From this data, it is possible to determine whether an additional heatsink is required or not and the relevant size (thermal resistance)

Example

V_{IN} = 40 VDC

I_{PH} = 1 A

R_{PH} = 10 Ω, max.

T_{AMB} = 50° C

Calculate the power dissipated from the indexer logic and the level shifter (see Electrical Specifications).

$$P_{LOGIC} = (5\text{ V} * 60\text{ mA}) + (40\text{ V} * 20\text{ mA}) = 1.1\text{ watt}$$

Calculate the average voltage across the windings resistance.

$$V_{WIND} = (R_{PH} * I_{PH}) = 10\ \Omega * 1\text{ A} = 10\text{ V}$$

Calculate the required ON duty cycle (D.C.) of the output stage to obtain the average voltage (this DC is automatically adjusted by the module).

$$DC = V_{WIND} + V_{IN} = 10 \div 40 = 0.25$$

Calculate the power dissipation of the output power stage. The power dissipation depends on two main factors:

The selected operating mode (Fast or Slow Decay)
The selected drive sequence (Wave, Normal, Half Step)

FAST DECAY For this mode of operation, the internal voltage drop is $VSAT_{SOURCE} + VSAT_{SINK}$ during the ON period (25% of the time). During the recirculation period (75% of the time), the current recirculates on two internal diodes that have a voltage drop V_D = 1 V and the internal sense resistor or 0.5 Ω. In this example, maximum values are assumed for conservatism. The power dissipation during one cycle is:

P_{DIS} = 1.1 * [(2 V_{SAT} * I_{PH} * DC) + (2 V_D * I_{PH} * (1-DC)) + (0.5 * I_{PH})]

P_{DIS} = 1.1 * [(2 * 1.8 * 1 * 0.25) + (2 * 1 * 1 * 0.75) + (0.5 * 1)]

P_{DIS} = 1.1 * [0.9 + 1.5 +0.5] = 3.19 watts

The factor 1.1 takes into account the power dissipation during the switching transient.

SLOW DECAY The power dissipation during the ON time is the same. The recirculation is made internally through a power transistor ($VSAT_{SINK}$) and a diode. The power dissipation is:

P_{DIS} = 1.1 * [(2 V_{SAT} * I_{PH} * DC) + (V_{SAT} * V_D) * I_{PH} * (1-DC))]

P_{DIS} = 1.1 * [(2 * 1.8 * 1 * 0.25) + ((1.8 + 1) * 1 * (0.75))]

P_{DIS} = 1.1 * [0.9 + 2.1] = 3.3 watts

WAVE MODE When operating in this mode, the power dissipation is given by values of FAST and SLOW DECAY modes because one phase is always energized at any given time.

NORMAL MODE At any given time, two windings are always energized. The power dissipation of the power output stage is multiplied by a factor of 2.

HALF STEP The power sequence, one-phase-ON, two-phase-ON forces the power dissipation to be 1.5 times higher than WAVE MODE when the motor is running. In stall conditions, the worse case for power dissipation is with two-phase-ON (NORMAL MODE).

The following table summarizes the power dissipations of the output power stage for this example.

	WAVE	NORMAL	HALF STEP
FAST DECAY	3.19 W	6.38 W	6.38 W
SLOW DECAY	3.30 W	6.60 W	6.60 W

Calculate the total power dissipation.

$$PDIS_{TOTAL} = P_{LOGIC} + P_{DIS}$$

In this example for SLOW DECAY and NORMAL MODE, the total power dissipation is:

$$PDIS_{TOTAL} = 1.1 + 6.6 = 7.7 \text{ watts}$$

From this information, the case temperature can now be calculated as:

$$\begin{aligned} T_{CASE} &= T_{AMB} + (PDIS_{TOTAL} * R_{TH}) \\ &= 55 + (7.7 * 5) \\ &= 93.5° \text{ C} \end{aligned}$$

If the calculated case temperature exceeds the maximum allowable case temperature, an external heatsink is required and the thermal resistance is calculated as:

$$\begin{aligned} RTH_{TOT} &= (TCASE_{MAX} - T_{AMB}) / PDIS_{TOTAL} \\ &= (85 - 55) / 7.7 \\ &= 3.9° \text{ C} \end{aligned}$$

And…..

$$\begin{aligned} RTH_{HS} &= (R_{TH} * RTH_{TOT}) / (R_{TH} – RTH_{TOT}) \\ &= (5 * 3.9) / (5 – 3.9) \\ &= 17.7° \text{ C} \end{aligned}$$

The following table gives the thernal resistance of some commercially available heatsinks that fit on the SD200 module.

Manufacturer	Part No.	RTH (° C/W)	Mounting
Thermalloy	6177	3	Horizontal
Thermalloy	6152	4	Vertical
Thermalloy	6111	10	Vertical
Fischer	SK18	3	Vertical
Assman	V5440	4	Vertical
Assman	V5382	4	Horizontal

5.7. Warranty and Limitation of Liability

Danaher Motion carrants to the first end user purchaser (the purchaser) of the equipment manufactured by Danaher Motion that such equipment, if new, unused and in original unopened cartons at the time of purchase, are free from defects in material and workmanship under normal use and service for a period of one year from date of shipment from Danaher Motion or a warehouse of Danaher Motion in the event that the equipment is purchased from Danaher Motion or for a period of one year from the date of shipment from the business establishment of an authorized distributor of Danaher Motion in the event that the equipment was purchased from an authorized distributor.

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Danaher Motion sales engineers are conveniently located to provide prompt attention to customers' needs. Call the nearest office listed for ordering and application information or for the address of the closest authorized distributor.

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