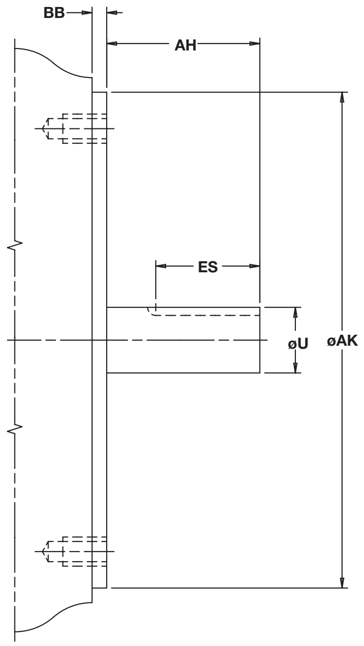
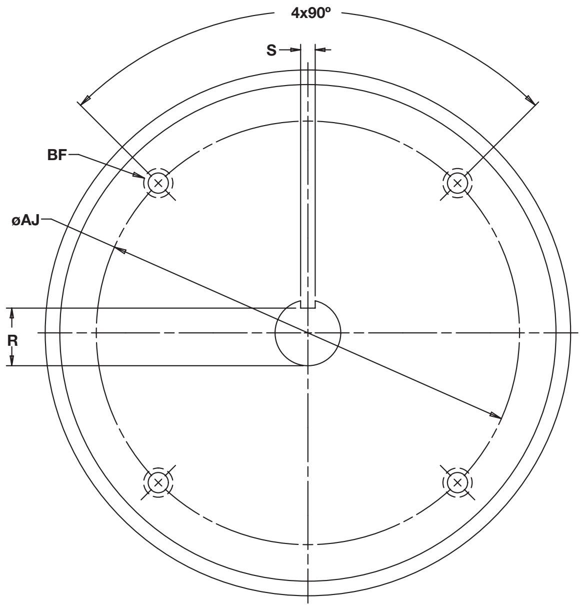
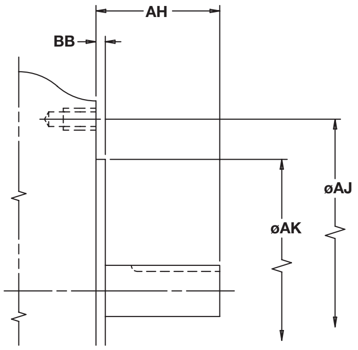
# Mechanical Data Application Engineering

# Standard NEMA Frame Dimensions Ordering Information







DIMENSIONS FOR
FRAMES WHERE AJ IS
GREATER THAN AK

## Specifications

| Module Size | NEMA Frame Size | AH | AJ | AK | BB | BF | ES | R | S | U |
|---|---|---|---|---|---|---|---|---|---|---|
| 50 | 56C/48Y | 2.06 | 5.875 | 4.500 | .16 MAX | 3/8-16 UNC | 1.41 MIN | 0.517 | 0.188 | 0.625 |
| 100 | 56C/48Y | 2.06 | 5.875 | 4.500 | .16 MAX | 3/8-16 UNC | 1.41 MIN | 0.517 | 0.188 | 0.625 |
| 180 | 143TC/145TC | 2.12 | 5.875 | 4.500 | .16 MAX | 3/8-16 UNC | 1.41 MIN | 0.771 | 0.188 | 0.875 |
| 210 | 182TC/184TC | 2.62 | 7.250 | 8.500 | .25 MIN | 1/2-13 UNC | 1.78 MIN | 0.986 | 0.250 | 1.125 |
| 215 | 213TC/215TC | 3.12 | 7.250 | 8.500 | .25 MIN | 1/2-13 UNC | 2.41 MIN | 1.201 | 0.312 | 1.375 |

Note: Warner Electric Modules are designed to comply with standard NEMA frame dimensions for mounting. Reference to each particular frame size is given in the individual selection tables for each type of Warner Electric module.

# Mechanical Data Dynamic Torque

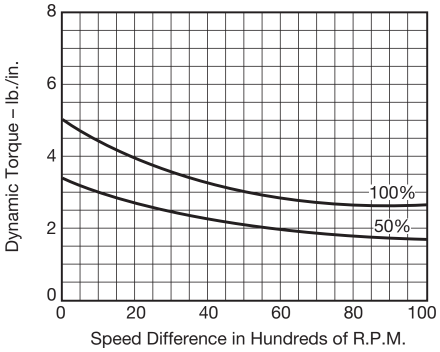
## NOTES:

Speed difference means the difference in speed between one friction face and the other at the moment of engagement. The intersection of the top curve and the speed difference is the maximum torque produced by the unit. When both friction faces are engaged and rotating at the same speed, the unit is said to be locked-in and produces the maximum static torque (zero speed difference).

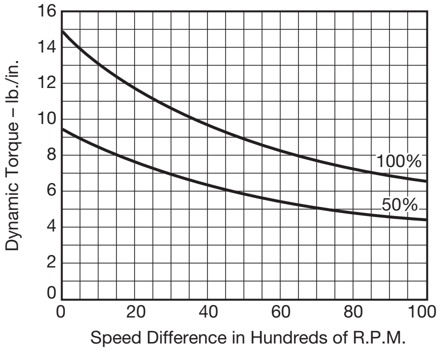
The % lines indicate the percentage of full voltage being used. Example: If 90 volt unit runs at 45 volts, use the 50% line.

Average Torque = Dynamic Torque at $^1/_2$ operating speed. Example: If operating speed is 1800, use dynamic torque at 900.

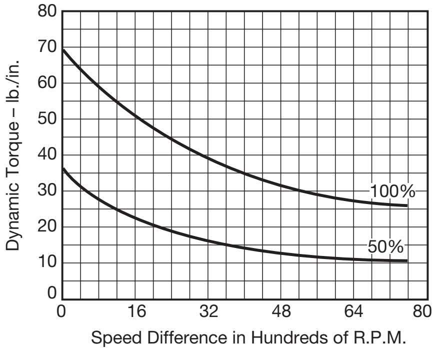
**Size 120** **Maximum Speed 10,000 rpm**
**Static Torque 5 lb./in.**



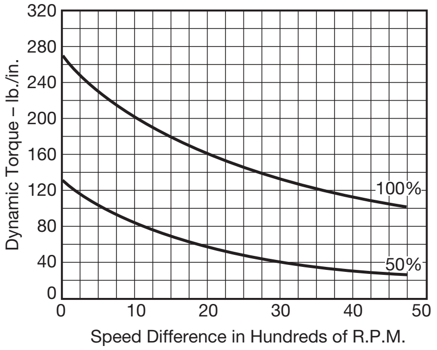
**Size 170** **Maximum Speed 10,000 rpm**
**Static Torque 15 lb./in.**



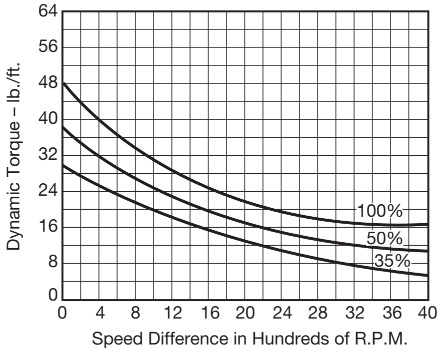
**Size 250** **Maximum Speed 7,500 rpm**
**Static Torque 70 lb./in.**



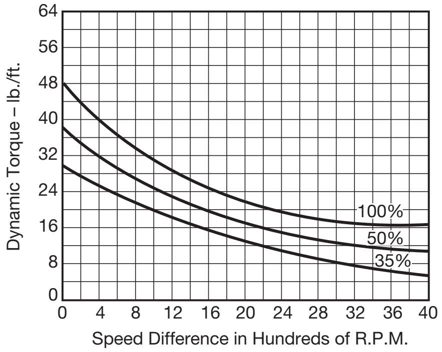
**Size 400** **Maximum Speed 4,500 rpm**
**Static Torque 270 lb./in.**



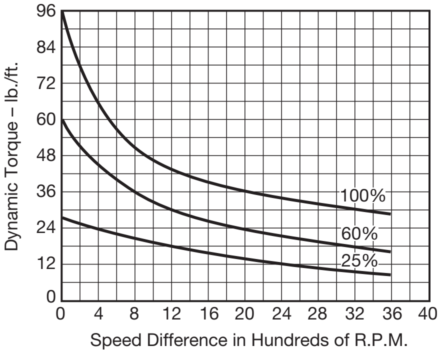
**Size 500-SF** **Maximum Speed 4,000 rpm**
**Static Torque 50 lb./ft.**



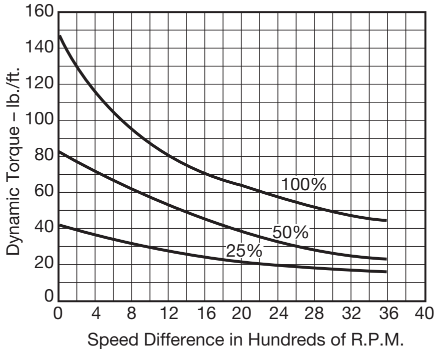
**Size 500-SF** **Maximum Speed 4,000 rpm**
**Static Torque 50 lb./ft.**



**Size 650** **Maximum Speed 3,600 rpm**
**Static Torque 95 lb./ft.**



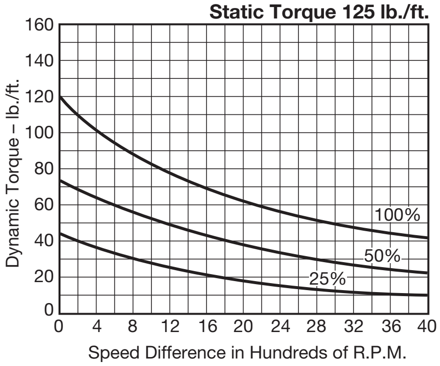
**Size 825-SF** **Maximum Speed 3,600 rpm**
**Brg. Mtd.** **Static Torque 150 lb./ft.**



NOTE: Torque values are in inch lbs. for size 400 and smaller, and in ft.lbs. for size 500 and larger.

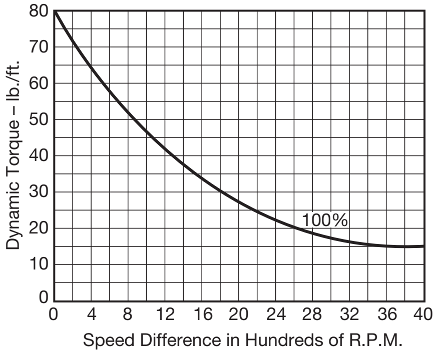
**Size 825**

**Maximum Speed 4,000 rpm**
**Electro-Pack 3,600 rpm**
**Static Torque 125 lb./ft.**



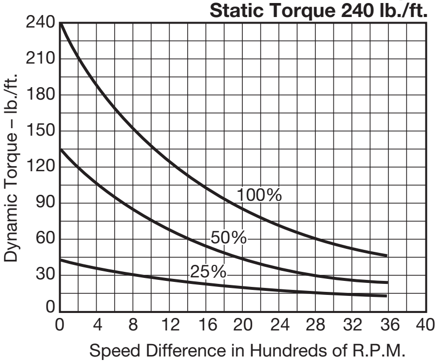
**Size 825-MB**

**Maximum Speed 4,000 rpm**
**Static Torque 80 lb./ft.**



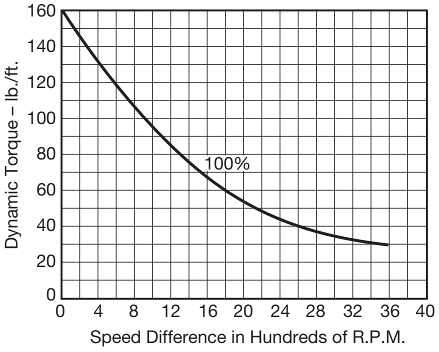
**Size 1000**

**Maximum Speed 3,600 rpm**
**Electro-Pack 3,000 rpm**
**Static Torque 240 lb./ft.**



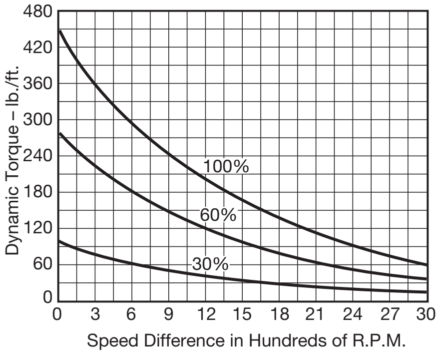
**Size 1000-MB**

**Maximum Speed 3,600 rpm**
**Static Torque 160 lb./ft.**



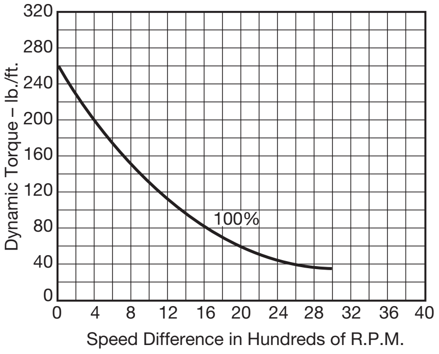
**Size 1225**

**Maximum Speed 3,000 rpm**
**Static Torque 465 lb./ft.**



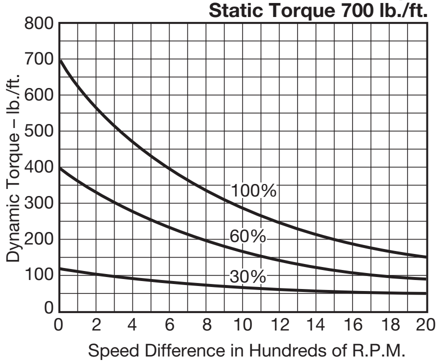
**Size 1225-MB**

**Maximum Speed 3,000 rpm**
**Static Torque 260 lb./ft.**



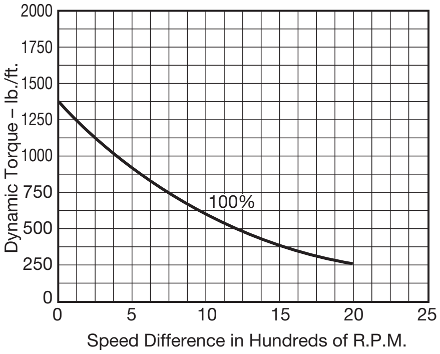
**Size 1525**

**Maximum Speed 2,000 rpm**
**Electro-Pack 1,800 rpm**
**Static Torque 700 lb./ft.**



**Size 1525-**
**Hi Torque**

**Maximum Speed 2,000 rpm**
**Static Torque 1,350 lb./ft.**



# Mechanical Data Rotational Speed

## Rotational Speed

Rotational speed of a clutch or brake is an important consideration when selecting a unit for a particular application. Numerous factors must be considered, such as the maximum rated speed of the clutch/brake unit, the dynamic torque required, the heat dissipation needed, the effect of speed on wear rate, and torque stability at very low speeds. Each of these issues are separate, and sometimes interrelated, but always important in selecting the right product for an application.

## Maximum RPM Rating

The most important rotational speed consideration is the maximum rated RPM capability of a unit. DO NOT exceed this rating. Exceeding the maximum RPM of a unit may cause personal injury and/or machine damage. Maximum rated speeds are based on the structural integrity of the rotating components and associated shaft and bearing capabilities. If the RPM rating is exceeded, structural failure may occur, or the unit may experience premature bearing failure and/or premature friction material wear out.

## Dynamic Torque

When determining the correct size clutch/brake for an application, dynamic torque at the highest slip speed is often the determining factor. As you can see by reviewing the dynamic torque curves for different units as shown starting on page 188, dynamic clutch/brake torque usually decreases with higher speeds. As slip RPM increases, the coefficient of friction of a unit decreases, causing a decrease in dynamic torque availability. Be careful to consider this when selecting the appropriate unit size needed.

## Heat Dissipation

Heat dissipation is inversely related to dynamic torque. As RPM increases, the heat dissipation ability of a unit increases. When an armature is rotating, the heat dissipation rate is proportional to the aerodynamic fan effect of the rotating armature. The faster the armature rotates, the greater the heat dissipation. This is illustrated with a typical catalog curve as shown in Figure 1. It's interesting to note that, at zero RPM, the unit still has some heat dissipation capability. This is due to convection and radiation, but is usually not an important consideration.

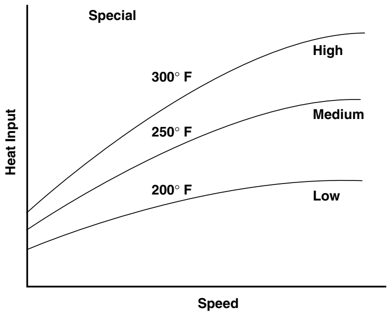


**Figure 1:** Typical Heat Dissipation Characteristics

## Wear Rate

The wear rate of friction surfaces is dependent on the clamping pressure of the mating surfaces as well as the surface velocity between the wearing surfaces. Many variables are involved in predicting wear life, of which RPM is probably the most influential. Typically, the wear rate will increase directly with the rubbing velocity distance. Another way of stating this is the higher the relative engagement speeds of two rotating parts, the longer they are allowed to slip against each other and the faster the wear rate.

## Low Speed Operation

The effect of low speed useage should also be considered in applications. Performance of clutch/brake units at less than 100 RPM may be very different than at higher RPM. This is due to "burnish" characteristics of friction surfaces.

## Wear In

"Burnish" is the wear in, or mating of two surfaces. When new, these surfaces have manufacturing features which include roughness and waviness. When these surfaces come into initial contact, only the high spots actually meet. See Figure 2. This results in only a small surface area in contact, while the non-contact surface area is "air." The result is low torque. As the mating surfaces continue to engage and slip against each other, the high spots are worn down and more surface area is in contact, thus increasing torque capability. This wear in period, or burnish, typically occurs in the first few hundred cycles of a clutch/brake's life. Faster slip speeds and higher loads mean fewer cycles needed to complete the burnish process. For applications where the speed is less than 100 RPM, the required application torque should be doubled to compensate for the low speed "burnish" that the unit experiences. A low speed burnish will require many cycles before full torque and stability are achieved. For example, if an application is determined to need 20 ft.lbs. of static torque, an SF-400 clutch could be selected. But, if the application is only 100 RPM or less, then an SF-500 unit should be the choice to compensate for the low RPM useage, as indicated on the selection chart found on page 188.

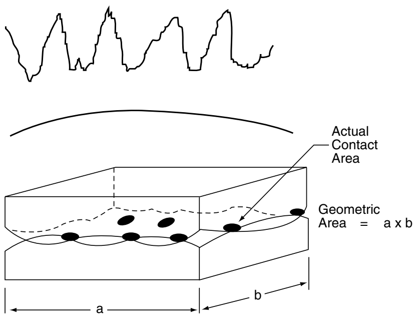


**Figure 2:** Unburnished Contact Areas

Careful consideration of rotating speeds will help the selection process of an application. Follow these guidelines and the proper clutch/brake selected will provide troublefree operation.

# **Mechanical Data** Clutch Field Restraining Devices

Many Warner Electric clutch assemblies have a bearing mounted stationery field. By design the bearing maintains its proper position between the field and rotor making it easy for the cutomer to mount the field-rotor assembly. However, the bearing has a slight drag which tends to make the field rotate if not restrained. And, since the field has lead wires attached, it must be restrained to prevent rotation and pulling of these wires. To counteract this rotational force, the field has a "torque tab" to which the customer must attach an appropriate anti-rotational restraint.

A few hints regarding proper torque tab restraints are in order. First and foremost, it is important to recognize that the force to be overcome is very small and the tab should not be restrained in any manner which will preload the bearing. For example, if the clutch is mounted with the back of the field adjacent to a rigid machine member the customer should not attach a capscrew tightly between the tab and the machine member. This may pull the tab back against the rigid member as shown in Figure 1 and preload the bearing. The recommended methods are illustrated in Figures 2, 3, and 4. The method selected is primarily a matter of customer preference or convenience.

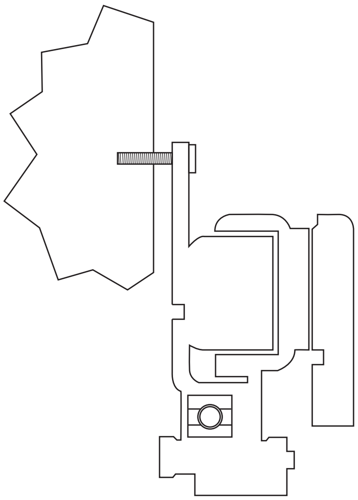


**Figure 1:**
Rigid member

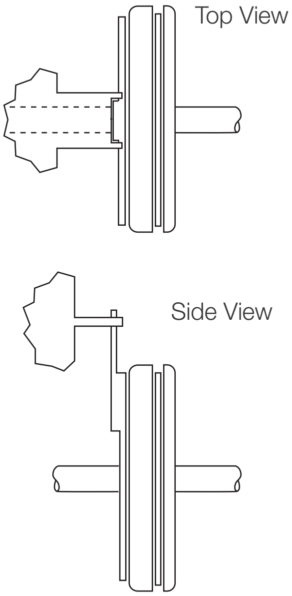


**Figure 2:**
Rigid Member with Slot
Straddling Tab
(Preferred)

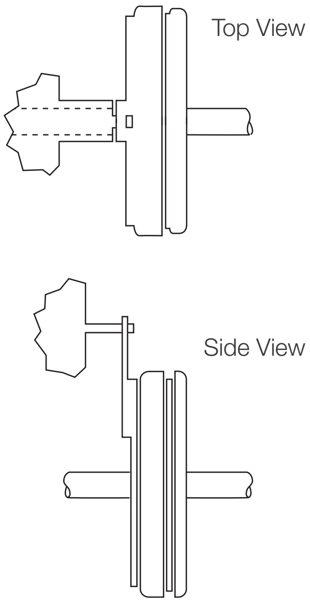


**Figure 3:**
Pin in Hole
Loosely
(Preferred)

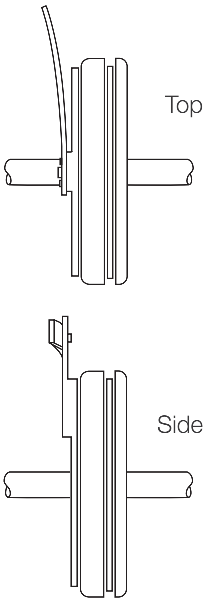


**Figure 4:**
Flexible Strap
(Preferred)

# Electrical Data Coil Ratings

| EC/EB-375 |  | EC |  |  | EB |  |
|---|---|---|---|---|---|---|
| Voltage – DC | 90 | 24 | 6 | 90 | 24 | 6 |
| Resistance @ 20° C – Ohms | 453.5 | 29.3 | 2.10 | 446.8 | 29.3 | 1.96 |
| Current – Amperes | .198 | .82 | 2.85 | .201 | .82 | 3.07 |
| Watts | 17 | 20 | 17 | 18 | 20 | 18 |
| Coil Build-up – milliseconds | 62 | 60 | 59 | 50 | 60 | 52 |
| Coil Decay – milliseconds | 13 | 14 | 15 | 8 | 14 | 10 |

| EC/EB-475 |  | EC |  |  | EB |  |
|---|---|---|---|---|---|---|
| Voltage – DC | 90 | 24 | 6 | 90 | 24 | 6 |
| Resistance @ 20° C – Ohms | 368.9 | 37.8 | 2.32 | 443.1 | 28.8 | 2.05 |
| Current – Amperes | .244 | .64 | 2.58 | .203 | .88 | 2.93 |
| Watts | 22 | 15 | 16 | 18 | 21 | 18 |
| Coil Build-up – milliseconds | 92 | 91 | 90 | 80 | 75 | 70 |
| Coil Decay – milliseconds | 18 | 17 | 16 | 8 | 9 | 9 |

| EC/EB-650 |  | EC |  |  | EB |  |
|---|---|---|---|---|---|---|
| Voltage – DC | 90 | 24 | 6 | 90 | 24 | 6 |
| Resistance @ 20° C – Ohms | 225 | 17.7 | 1.16 | 257.2 | 18.3 | 1.24 |
| Current – Amperes | .4 | 1.36 | 5.19 | .35 | 1.3 | 4.84 |
| Watts | 36 | 33 | 31 | 32 | 31 | 29 |
| Coil Build-up – milliseconds | 120 | 115 | 110 | 112 | 108 | 105 |
| Coil Decay – milliseconds | 20 | 20 | 20 | 12 | 13 | 14 |

| FB/ER-375, 475, 650 |  | FB-375 |  |  | FB-475FB-650 |  |
|---|---|---|---|---|---|---|
| Resistance @ 20° C – Ohms | 446 | 29 | 310 | 22 | 235 | 16 |
| Current – Amperes | .201 | .822 | .300 | 1.09 | .380 | 1.426 |
| Watts | 18 | 19 | 27 | 26 | 34 | 34 |
| Coil Build-up – milliseconds | 40 | 40 | 80 | 80 | 90 | 90 |
| Coil Decay – milliseconds | 5 | 10 | 8 | 10 | 10 | 10 |

| ER-825, 1225 | ER-825 | ER-1225 |
|---|---|---|
| Voltage – DC | 90 | 35-75 |
| Resistance @ 20° C – Ohms | 304 | 235 |
| Current – Amperes | .29 | .383 |
| Watts | 26 | 35 |
| Coil Build-up – milliseconds | 400 | 700 |
| Coil Decay – milliseconds | 20 | 20 |

| EC/EB-825 |  | EC |  |  | EB |  |
|---|---|---|---|---|---|---|
| Voltage – DC | 90 | 24 | 6 | 90 | 24 | 6 |
| Resistance @ 20° C – Ohms | 221 | 20.9 | 1.098 | 223.3 | 20.4 | 1.27 |
| Current – Amperes | .407 | 1.15 | 5.464 | .4 | 1.18 | 4.74 |
| Watts | 37 | 28 | 33 | 36 | 28 | 28 |
| Coil Build-up – milliseconds | 225 | 200 | 180 | 170 | 170 | 170 |
| Coil Decay – milliseconds | 130 | 122 | 115 | 80 | 75 | 70 |

| EC/EB-1000 |  | EC |  |  | EB |  |
|---|---|---|---|---|---|---|
| Voltage – DC | 90 | 24 | 6 | 90 | 24 | 6 |
| Resistance @ 20° C – Ohms | 248.7 | 19.7 | 1.23 | 248.7 | 19.7 | 1.23 |
| Current – Amperes | .36 | 1.22 | 4.87 | .36 | 1.22 | 4.87 |
| Watts | 33 | 29 | 29 | 33 | 29 | 29 |
| Coil Build-up – milliseconds | 250 | 235 | 220 | 235 | 220 | 205 |
| Coil Decay – milliseconds | 70 | 75 | 80 | 70 | 75 | 80 |

| EC/EB-1225 |  | EC |  |  | EB |  |
|---|---|---|---|---|---|---|
| Voltage – DC | 90 | 24 | 6 | 90 | 24 | 6 |
| Resistance @ 20° C – Ohms | 207.3 | 15.1 | 1.04 | 261.7 | 22.3 | 1.33 |
| Current – Amperes | .43 | 1.59 | 5.79 | .34 | 1.08 | 4.5 |
| Watts | 39 | 38 | 35 | 31 | 26 | 27 |
| Coil Build-up – milliseconds | 500 | 490 | 480 | 460 | 445 | 435 |
| Coil Decay – milliseconds | 220 | 230 | 240 | 190 | 160 | 140 |

| ATC, ATTC, ATB, ATTB-25 |  | ATC |  |  | ATB |  |
|---|---|---|---|---|---|---|
| Voltage – DC | 6 | 24 | 90 | 6 | 24 | 90 |
| Resistance @ 20° C – Ohms | 1.37 | 20.2 | 290 | 1.37 | 20.2 | 290 |
| Current – Amperes | 4.38 | 1.19 | .31 | 4.38 | 1.19 | .31 |
| Watts | 26.3 | 28.6 | 27.9 | 26.3 | 28.6 | 27.9 |
| Coil Build-up – milliseconds | 145 | 145 | 145 | 145 | 145 | 145 |
| Coil Decay – milliseconds | 8 | 8 | 8 | 9 | 9 | 9 |

| ATC, ATTC, ATB, ATTB-55 |  | ATC |  |  | ATB |  |
|---|---|---|---|---|---|---|
| Voltage – DC | 6 | 24 | 90 | 6 | 24 | 90 |
| Resistance @ 20° C – Ohms | 1.21 | 19.6 | 230 | 1.21 | 19.6 | 230 |
| Current – Amperes | 4.96 | 1.22 | .39 | 4.96 | 1.22 | .39 |
| Watts | 29.8 | 29.3 | 35.2 | 29.8 | 29.3 | 35.2 |
| Coil Build-up – milliseconds | 200 | 200 | 200 | 210 | 210 | 210 |
| Coil Decay – milliseconds | 20 | 20 | 20 | 35 | 35 | 35 |

| ATC, ATTC, ATB, ATTB-115 |  | ATC |  |  | ATB |  |
|---|---|---|---|---|---|---|
| Voltage – DC | 6 | 24 | 90 | 6 | 24 | 90 |
| Resistance @ 20° C – Ohms | 1.02 | 16.5 | 182 | 1.02 | 16.5 | 182 |
| Current – Amperes | 5.91 | 1.46 | .50 | 5.91 | 1.46 | .50 |
| Watts | 35.4 | 35 | 44.6 | 35.4 | 35 | 44.6 |
| Coil Build-up – milliseconds | 145 | 145 | 145 | 150 | 150 | 150 |
| Coil Decay – milliseconds | 40 | 40 | 40 | 45 | 45 | 45 |

# **Electrical Data** Coil Ratings

**(Blue shaded areas indicate GEN 2 design)**

| UM/EM/UMFB/EMFB | | Clutch | UM/EM Brake | Clutch | UM/EM Brake | Clutch | UM/EM Brake | UMFB/EMFB Brake | UMFB/EMFB Brake |
|---|---|---|---|---|---|---|---|---|---|
| Voltage – DC | | 90 | 90 | 24 | 24 | 6 | 6 | 24 | 90 |
| Resistance (ohms) | EM-50 | 452 | 429 | 31.8 | 28.8 | 1.9 | 1.9 | 28.8 | 429 |
| | EM-100 | 392 | 392 | 26.7 | 26.7 | 1.8 | 1.8 | 21.7 | 308 |
| | EM-180 | 392 | 392 | 26.7 | 26.7 | 1.8 | 1.8 | 21.7 | 308 |
| | EM-210/215 | 248 | 248 | 17.9 | 17.9 | 1.22 | 1.22 | 13.3 | 205 |
| Amperes | EM-50 | .20 | .21 | .76 | .83 | 3.2 | 3.2 | .83 | .21 |
| | EM-100 | .23 | .23 | .90 | .90 | 3.3 | 3.3 | 1.1 | .29 |
| | EM-180 | .23 | .23 | .90 | .90 | 3.3 | 3.3 | 1.1 | .29 |
| | EM-210/215 | .36 | .36 | 1.3 | 1.3 | 4.9 | 4.9 | 1.8 | .38 |
| Watts | EM-50 | 18 | 19 | 19 | 20 | 20 | 20 | 20 | 19 |
| | EM-100 | 21 | 21 | 22 | 22 | 20 | 20 | 27 | 27 |
| | EM-180 | 21 | 21 | 22 | 22 | 20 | 20 | 27 | 27 |
| | EM-210/215 | 33 | 33 | 32 | 32 | 30 | 30 | 43 | 34 |
| Build-up (millisecond) | EM-50 | 52 | 53 | 52 | 53 | 52 | 53 | 40 | 40 |
| | EM-100 | 72 | 75 | 72 | 75 | 72 | 70 | 80 | 80 |
| | EM-180 | 72 | 75 | 72 | 75 | 72 | 70 | 80 | 80 |
| | EM-210/215 | 120 | 100 | 120 | 100 | 110 | 100 | 90 | 90 |
| Decay (millisecond) | EM-50 | 6 | 5 | 6 | 5 | 6 | 5 | 5 | 5 |
| | EM-100 | 12 | 10 | 12 | 10 | 12 | 10 | 8 | 8 |
| | EM-180 | 12 | 10 | 12 | 10 | 12 | 10 | 8 | 8 |
| | EM-210/215 | 20 | 10 | 20 | 10 | 20 | 10 | 10 | 10 |

# **Electrical Data** Coil Ratings

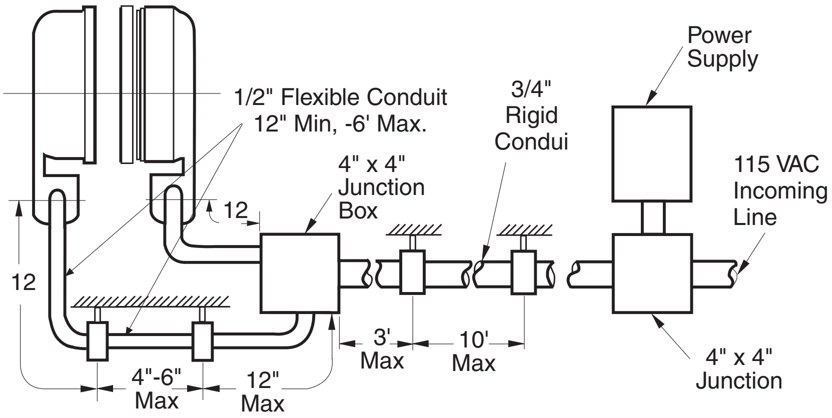
| Unit Size | SF/PB 120 | | | SF/PB 170 | | | SF/PB 250 | | |
|---|---|---|---|---|---|---|---|---|---|
| Voltage – DC | 6 | 24 | 90 | 6 | 24 | 90 | 6 | 24 | 90 |
| Resistance @ 20°C – Ohms | 6.32 | 104 | 1386 | 6.96 | 111.2 | 1506 | 5 | 76.4 | 1079 |
| Current – Amperes | .949 | .230 | .065 | .861 | .215 | .060 | 1.2 | .314 | .084 |
| Watts | 5.69 | 5.52 | 5.85 | 5.85 | 5.16 | 5.37 | 7.2 | 7.5 | 7.51 |
| Coil Build-up – milliseconds | 12 | 12 | 11 | 17 | 17 | 16 | 48 | 48 | 44 |
| Coil Decay – milliseconds | 8 | 8 | 7 | 8 | 7 | 6 | 15 | 15 | 13 |

| Unit Size | SF/PB 400 | | | SF-500 | | | PB & PC 500 | | | SF-650 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Voltage – DC | 6 | 24 | 90 | 6 | 24 | 90 | 6 | 24 | 90 | 6 | 24 | 90 |
| Resistance @ 20°C – Ohms | 4.88 | 73 | 1087 | 1.076 | 14.9 | 206.1 | 1.36 | 23.8 | 251.1 | 1.16 | 17.7 | 225 |
| Current – Amperes | 1.23 | .322 | .083 | 5.58 | 1.61 | .44 | 4.4 | 1.01 | .36 | 5.19 | 1.36 | .4 |
| Watts | 7.39 | 7.96 | 7.45 | 34 | 39 | 39 | 26 | 24 | 32 | 31 | 33 | 36 |
| Coil Build-up – milliseconds | 154 | 154 | 154 | 82 | 85 | 90 | 84 | 87 | 93 | 110 | 115 | 120 |
| Coil Decay – milliseconds | 62 | 60 | 55 | 40 | 40 | 40 | 38 | 35 | 30 | 50 | 50 | 50 |

| Unit Size | PB-650 | | | SF-825 | | | SF-825 Brg | | | PB & PC 825 | | | SF-1000 | | | PB & PC 1000 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Voltage – DC | 6 | 24 | 90 | 6 | 24 | 90 | 6 | 24 | 90 | 6 | 24 | 90 | 6 | 24 | 90 | 6 | 24 | 90 |
| Resistance @ 20°C – Ohms | 1.24 | 18.3 | 257.2 | 1.23 | 20.9 | 267.0 | 1.098 | 14.6 | 221 | 1.27 | 20.4 | 223.3 | 1.07 | 14.4 | 214.4 | 1.23 | 19.7 | 248.7 |
| Current – Amperes | 4.84 | 1.31 | .35 | 4.9 | 1.15 | .34 | 5.464 | 1.65 | .407 | 4.74 | 1.18 | .4 | 5.61 | 1.67 | .42 | 4.87 | 1.22 | .36 |
| Watts | 29 | 31 | 32 | 29 | 28 | 30 | 33 | 40 | 37 | 28 | 28 | 36 | 34 | 40 | 38 | 29 | 29 | 33 |
| Coil Build-up – milliseconds | 100 | 105 | 110 | 222 | 200 | 245 | 180 | 200 | 225 | 170 | 170 | 170 | 256 | 275 | 283 | 205 | 220 | 235 |
| Coil Decay – milliseconds | 50 | 50 | 50 | 105 | 120 | 100 | 115 | 120 | 130 | 70 | 75 | 80 | 123 | 105 | 90 | 70 | 75 | 80 |

| Unit Size | SF-1225 | | | PB & PC 1225 | | | SF-1525 | | | PB & PC 1525 | | | SF-1525 H.T. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Voltage – DC | 6 | 24 | 90 | 6 | 24 | 90 | 6 | 24 | 90 | 6 | 24 | 90 | 6 | 90 |
| Resistance @ 20°C – Ohms | 1.21 | 19.5 | 268.3 | 1.33 | 22.3 | 261.7 | 1.11 | 15.5 | 239.1 | 1.45 | 19.8 | 258.4 | 55 | 113.4 |
| Current – Amperes | 4.97 | 1.23 | .34 | 4.5 | 1.08 | .34 | 5.41 | 1.55 | .38 | 4.13 | 1.21 | .35 | 10.83 | .794 |
| Watts | 30 | 30 | 30 | 27 | 26 | 31 | 32 | 37 | 34 | 25 | 29 | 31 | 65 | 72 |
| Coil Build-up – milliseconds | 475 | 490 | 510 | 300 | 320 | 350 | 505 | 535 | 575 | 470 | 490 | 512 | 480 | 560 |
| Coil Decay – milliseconds | 240 | 230 | 220 | 190 | 190 | 190 | 230 | 237 | 215 | 200 | 170 | 140 | 210 | 160 |

NOTES: Build-up time equals current to approximately 90% of steady state value and flux to 90%. Decay time equals current to approximately 10% of steady state value and flux to 10%. Approximately because current leads or lags flux by a small amount.



## Recommended Electrical Installation Procedure for Warner Electric Clutches and Brakes

Warner Electric clutches and brakes conform to UL (Underwriters Laboratories) requirements. All packaged products come with conduit boxes or are enclosed in housings with provision for electrical conduit connection. All sizes 400 and larger SF clutch fields and brake magnets accept UL conforming conduit boxes avaliable from Warner Electric.

The National Electrical Code (NEC) requires that conductors subject to physical damage be adequately protected. When electrical conduit is used, a minimum of 12" of 1/2" flexible conduit is to be used between each brake and/or clutch and its box. This construction will prevent improper bearing loading in bearing mounted units and ease field and magnet assembly and disassembly.

Refer to the information below for proper installation practices and wire sizes.

Notwithstanding the above recommendations, all electrical installations should conform to NEC and/or other governing electrical codes.

## Recommended wire size versus maximum distance

|  | Fractional Horsepower Sizes 170-400 |  |  | Integral Horsepower Sizes 500-1525 |  |  |
|---|---|---|---|---|---|---|
| Wire Size | Distance (feet) |  |  | Distance (feet) |  |  |
| AWG | 6 Volt | 24 Volt | 90 Volt | 6 Volt | 24 Volt | 90 Volt |
| 18 | 20 | 280 | 1000 | 4 | 65 | 700 |
| 16 | 30 | 430 |  | 6 | 95 |  |
| 14 | 50 | 720 |  | 10 | 160 |  |
| 12 | 75 | 720 |  | 10 | 160 |  |
| 10 | 125 |  |  | 25 | 400 |  |
| 8 | 200 |  |  | 40 |  |  |

General construction wire type MTW or THW recommended.
#6 terminal screws (size 400 and smaller) are to be torqued to 15 in.lb.
#8 terminal screws (size 500 and larger) are to be torqued to 20 in.lb.

# Electrical Data Coil Suppression & Clutch/Brake Overlap

Users of electric clutch and brake systems are sometimes concerned that a clutch and brake will oppose each other or “overlap”during switching, i.e., when the clutch is switched off and the brake is switched on, or vice versa. This concern relates primarily to dual armature type clutch/brakes similar to the Warner Electric Electro Module product line, as compared to shuttle armature clutch/brakes.

In use, Warner Electric clutches and brakes are not subject to overlap when simple coil suppression techniques are applied to the clutch/brake control. All Warner Electric clutch/brake controls use suppression to eliminate any overlap situations.

The charts below graphically display clutch current decay and the current rise of the brake with and without current suppression. In Chart 1, which shows brake and clutch operation with suppression, the “Overlap Area” below the intersection of the brake and clutch current lines shows potential for the devices to fight one another. But this intersection occurs at an extremely low current level and the armature Autogap™ springs keep the friction surfaces of the brake armature and magnet separate at such low currents. Even though there is the appearance of a minor clutch/brake overlap in this instance, the brake armature has not yet contacted the brake magnet. Chart 2 shows a much larger overlap area since no coil suppression is used in this circuit. Clutch current has not decayed fully as the brake is engaged and the load is brought to zero speed.

Clutch and brake coils are inductors. Inductance is the electrical equivalent to mechanical inertia and an energized coil dissipates its energy when turned “off.” Upon removal of power, polarity across an inductor reverses and current flows in the opposite direction. Without suppression in the control circuit, an arc can result from the strength of this current flow which can damage the electrical switching contacts.

Consequently, suppression circuitry has two major benefits:

- Protects the switching contacts
- Hastens coil decay

The schematics below show circuits with no suppression and both diode and zener suppression types.

The rapid coil decay of suppression circuitry lets users enjoy the major advantages which dual armatures have over single, “shuttle” armatures. These include:

- Better heat dissipation – greater area to give off heat and more “off” time
- Longer life – two armatures absorb wear
- Self adjusting for the life of the unit
- Enhanced repeatability – armatures may remain in light contact with their mating surface, eliminating armature movement time and reducing noise and spline wear.

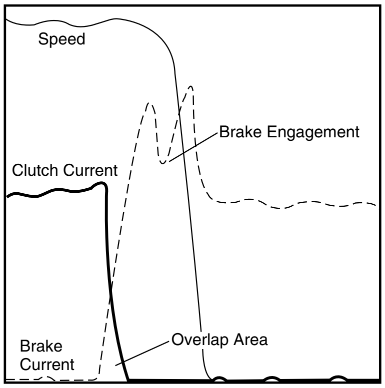


**Chart 1**

## Brake Engagement with Zener Diode Suppression

Clutch current decay and brake current rise overlap, but the brake armature is not engaged until well past the overlap point. Note that the "blip" in the brake current trace coincides with the sharp decline in the "speed" trace, indicating brake armature engagement at that point.

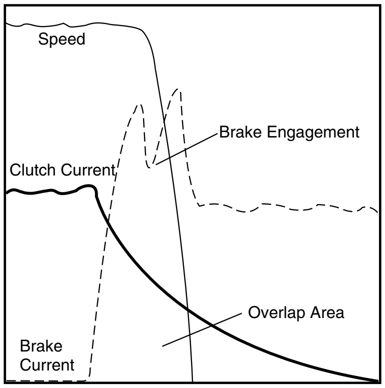
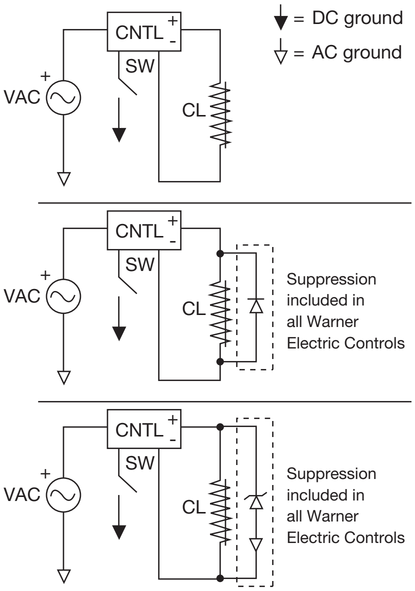


**Chart 2**

## Brake Engagement with No Suppression

Clutch current decay is much slower than with suppression as shown in Chart 1, greatly increasing the overlap area. The currrent level in the clutch coil is much higher at the point of brake engagement than with the suppression circuit.

VAC = AC power source
SW = Clutch selector switch
CL = Clutch
CNTL = Clutch/brake control module



Overexcitation is a technique which makes a clutch or brake engage faster and have greatly improved starting and stopping accuracy. It involves applying over voltage to the clutch or brake coil to reduce current build up time, thereby reducing the magnetizing time.

The graphs below show current rise and shaft speed for an identical system using a Warner Electric EP-400 clutch/brake both with and without overexcitaton. The effect of overexcitation is to reduce the time needed to achieve full current and thereby reduce the time required to achieve full speed with a clutch or zero speed with a brake. In the example below, “time to start” is approximately 70 ms without overexcitation. This is reduced to 30 ms when overexcitation is applied. This time is comparable to the coil buildup times stated on page 194. The “time to stop” has been similarly reduced; the nominally excited system requires about 110 ms to stop the load, while this is accomplished in only 50 ms with overexcitation.

Overexcitation does not increase torque. Rather, the reduction in start-stop times comes from reduced coil current build up times (or “time to current”). For many common industrial applications, the reduction in “time to speed” and “time to stop” is one half when using overexcitation.

The use of overexcitation on a clutch/brake system does not increase system wear. In fact, the clutch/brake wear rate may be reduced because slippage and energy dissipation is marginally reduced in the clutch/brake. Compliance in the drivetrain may absorb some of the start/stop inertia or wear may be observed in other drivetrain components. Whenever overexcitation is used, adequate coil suppression must be employed. Please refer to “Coil Suppression and Clutch/Brake Overlap” on page 196.

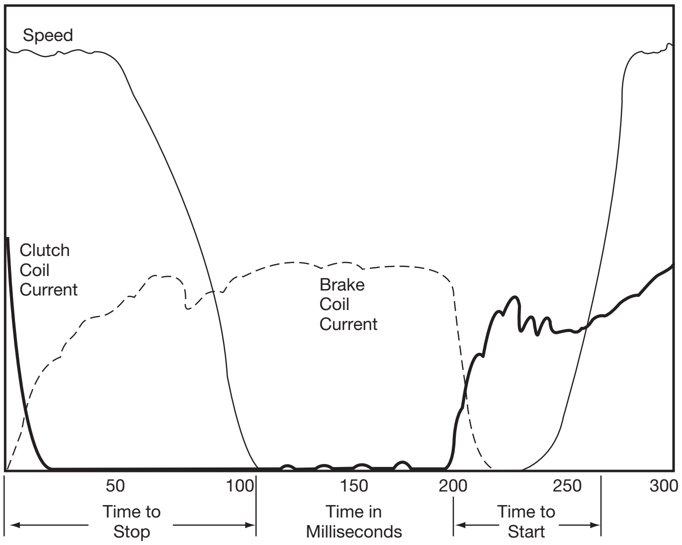


**Chart 1**

### Without Overexcitation

Current/speed trace of EP400 clutch/brake being run through a single stop/start cycle. Note that 110 milliseconds is required to stop from the time the clutch coil is de-energized and the brake coil is energized. At the 200 milliseconds point on the graph the clutch coil is energized and the load is at speed 70 milliseconds later. Note that the coil current is still increasing after the load is at full speed.

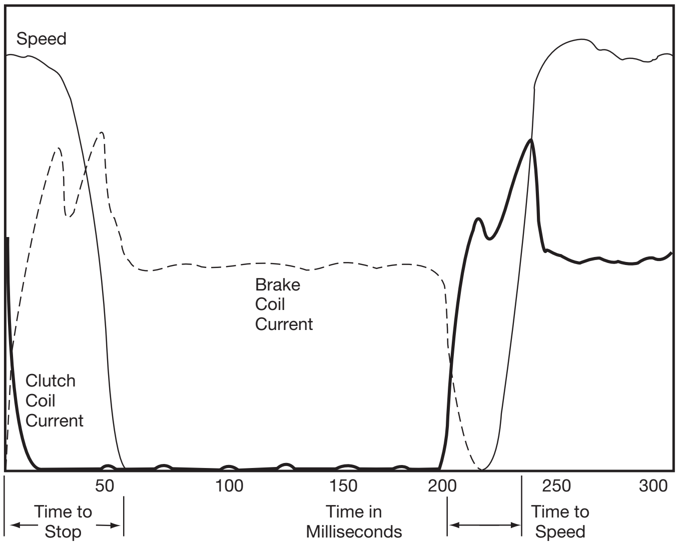


**Chart 2**

### With Overexcitation

Current/speed trace of EP400 clutch/brake being run through a single stop/start cycle. With overexcitation, both brake and clutch coil currents build much faster with concurrent reductions in both stop and start times, when compared with Chart 1.