# 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-475 | | FB-650 | |
|---|---|---|---|---|---|---|
| Voltage – DC | 90 | 24 | 90 | 24 | 90 | 24 |
| 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 | 24 | 35-75 |
| Resistance @ 20° C – Ohms | 305 | 21.5 | 235 |
| Current – Amperes | .29 | 1.1 | .383 |
| Watts | 26 | 27 | 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 |

| 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

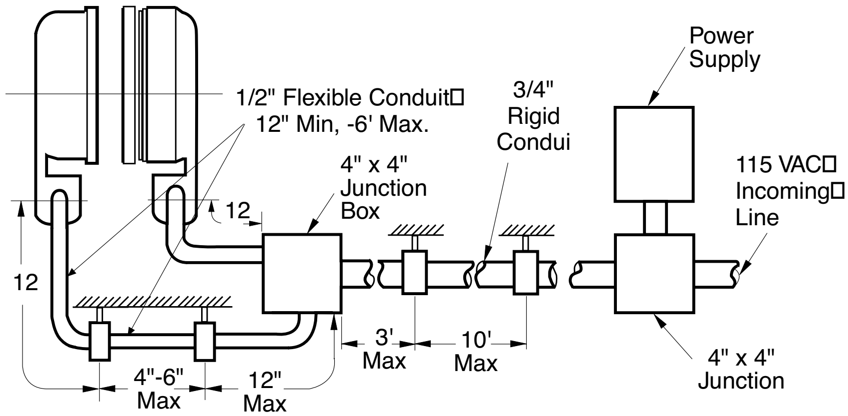
| Unit Size | SF/PB 120 | | | SF/PB 170 | | | SF/PB 250 | | |
|---|---|---|---|---|---|---|---|---|---|
| Voltage – DC | 6 | 24 | 90 | 6 | 24 | 90 | 6 | 24 | 90 |
| Resistance @ 20°C – Ohms | 6.32 | 104 | 1386 | 6.96 | 111.2 | 1506 | 5 | 76.4 | 1079 |
| Current – Amperes | .949 | .230 | .065 | .861 | .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

| Wire Size AWG | Fractional Horsepower Sizes 170-400 Distance (feet) 6 Volt | 24 Volt | 90 Volt | Integral Horsepower Sizes 500-1525 Distance (feet) 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 Zener diode coil suppression techniques are applied to the clutch/brake control. All Warner Electric clutch/brake controls use Zener diode suppression to eliminate any overlap situations.

The charts below graphically display current decay of the clutch and current rise of the brake with Zener diode and with straight diode suppression. In Chart 1, which shows brake and clutch operation with Zener diode 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 straight diode 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, voltage across an inductor reverses and current continues to flow in the same direction until the energy is fully dissipated. Without suppression in the control circuit, an arc can result from this potentially very large reverse voltage which can damage the electrical switching contacts.

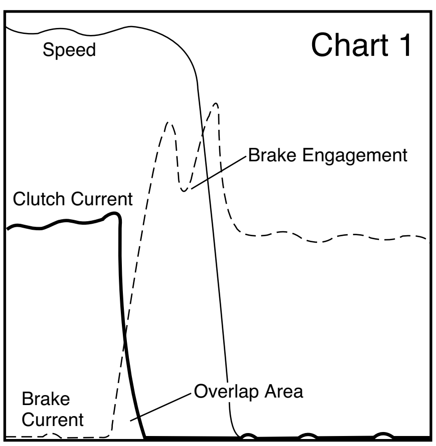
Consequently, Zener diode suppression circuitry, by limiting the reverse voltage to a sufficiently high but safe level, has two major benefits:

- Hastens coil decay
- Protects the switching contacts

The schematics below show circuits with no suppression and both straight diode and Zener diode suppression.

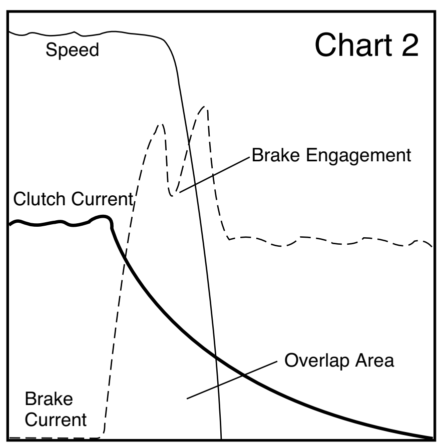
The rapid coil decay of Zener diode suppression lets users enjoy the major advantages which dual armatures have over single, "shuttle" armatures. These include:

- Better heat dissipation – greater area to give off heat and more "off" time.
- Longer life – two armatures absorb wear.
- Armature Autogap® self adjusting for the life of the unit
- Enhanced repeatability and controllability with the use of a light preload spring to keep the armatures in light contact with their mating surfaces, eliminating armature movement time and reducing noise and spline wear. Warner Electric utilizes this preload spring in some packaged clutch/brake models including ceramic EPs and Unimodules and Smooth Start Unimodules.




## Brake Engagement with Zener Diode Suppression

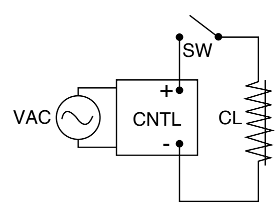
Clutch current decay and brake current rise overlap, but the brake armature is not engaged until well past the overlap point. Note that the "blip" in the brake current trace coincides with the sharp decline in the "speed" trace, indicating brake armature engagement at that point.



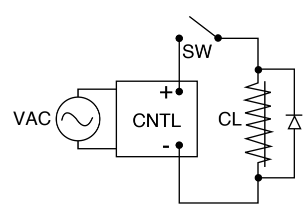

## Brake Engagement with Straight Diode Suppression

Clutch current decay is much slower than with Zener diode 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 Zener diode suppression.

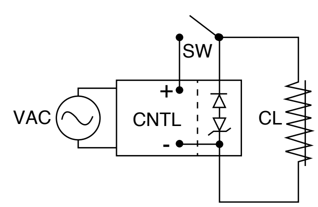
VAC = AC power source
SW = Clutch selector switch
CL = Clutch
CNTL = Control module




Simple control or rectifier with no suppression.




Simple control or rectifier with add-on straight diode suppression.



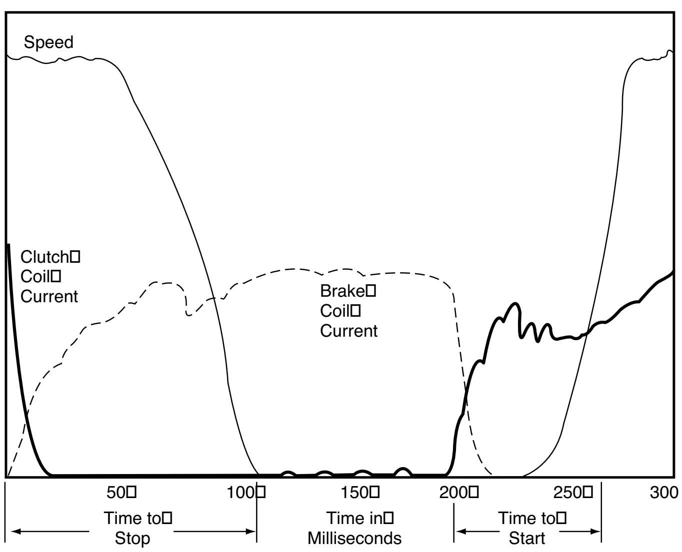

Warner control with built-in Zenner diode suppression.

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 G-10. 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.

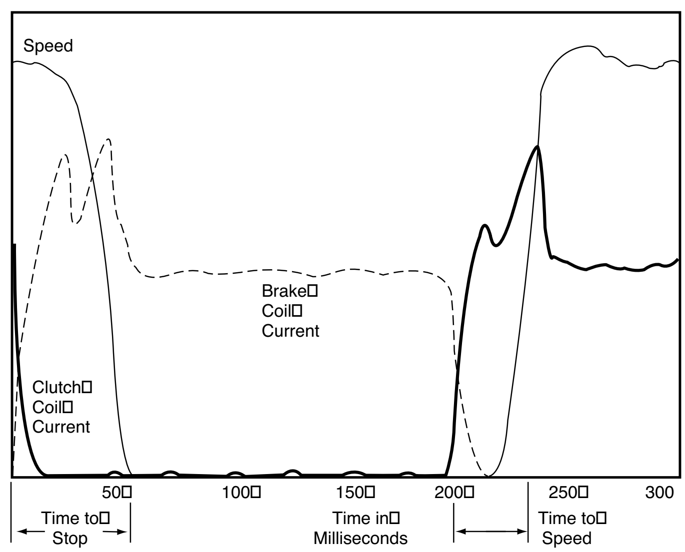
The use of overexcitation on a clutch/brake system does not increase system wear. In fact, the clutch/brake wear rate may be reduced because slippage and energy dissipation is marginally reduced in the clutch/brake. Compliance in the drivetrain may absorb some of the start/stop inertia or wear may be 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 G-12.




## 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.

# Notes