

ELEVATOR WORLD



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Magnetek
Elevator Products

N50 W13605 Overview Drive
Menomonee Falls, WI 53051
(800) 236-1705
(262) 252-6999
Fax (262) 790-4143
www.elevatordrives.com

AC, DC AND HYDRAULIC ELEVATOR DRIVES

by Magnetek Elevator Products

INSTALLATION AND START-UP OF CLOSED-LOOP AC ELEVATOR DRIVES, SPECIFICALLY, MAGNETEK'S HPV 900

by Tony Frey, Senior Application Engineer

The proper installation and adjustment of the elevator drive is an important component of any new or modernization elevator project. First introduced in 1997, Magnetek's HPV 900 has become a premier AC elevator drive with over 5,000 units running in the field. Although HPV 900 drive software eases much of the setup issues, it is recommended that a logical set of steps be followed.



Figure 1: HPV 900 AC elevator drive

Installation Verification

Before beginning the startup, it is important to verify the physical installation of the drive, as well as review any technical documentation that was included with the drive (i.e., *HPV 900 Technical Manual*).

1. First, look over the drive installation and verify that the drive has been installed without shipping and installation damage.
2. The location of the drive is im-

portant for proper operation of the drive and normal life expectancy. Therefore, verify that the drive has been installed in accordance with the following:

- ◆ DO NOT mount in direct sunlight, rain or extreme (condensing) humidity.
- ◆ DO NOT mount where corrosive gases or liquids are present.
- ◆ AVOID exposure to vibration, airborne dust or metallic particles.
- ◆ DO NOT allow the ambient temperature around the control to exceed the ambient temperature rating of the drive (55°C/130°F).
- ◆ Mount control vertically using mounting holes provided on the drive chassis.
- ◆ Allow at least 7cm (2.5in.) clearance above and at least 7 to 13cm (2.5 to 5in.) clearance below the unit.
- ◆ Allow 3cm (1in.) clearance to either side of the drive and allow 6cm (2.5in.) clearance for opening of the door.
- ◆ Separate grounded metal conduit is required for input, output and control wiring.

3. Because proper encoder speed feedback is so essential for a drive to provide proper motor control, it is important to avoid common problems associated with electrical interference and mechanical speed modulations. To help avoid these common problems, the following are suggested:

- ◆ If possible, insulate both the encoder case and shaft from the motor.
- ◆ The encoder wiring should use twisted pair cable with shield tied to chassis ground at drive end.
- ◆ The encoder electronics should use limited slew rate differential line drivers.
- ◆ The encoder electronics should not allow capacitors from internal encoder electronics to case.
- ◆ When operating the encoder, do not exceed the operating specification of the encoder/drive.
- ◆ The encoder power supply voltage should use the proper voltage and use the highest possible voltage available (i.e., HPV 900 – 12VDC preferred).
- ◆ When mounting the encoder, use direct motor mounting without couplings.
- ◆ The selected encoder should be a hub or hollow shaft encoder with concentric motor stub shaft.
- ◆ If possible, the encoder should use a mechanical protective cover for exposed encoders.

Pre-Power Checks

Before applying power to the drive, verify the following:

1. Inspect the security and accuracy of the supply line power, ground connections and all control circuit connections. Note: The individual terminal torque specification is listed in the *HPV 900 Technical Manual*.
2. Ensure that the main circuit input/output precautions are observed.
 - ◆ Use 600V vinyl-sheathed wire or equivalent. Wire size should be determined considering voltage drop of leads.
 - ◆ Never connect main AC power to the output terminals: U, V or W.
 - ◆ Never allow wire leads to contact metal surfaces. Short circuit may result.
 - ◆ The size of wire must be suitable for Class I circuits.
 - ◆ The motor lead length should not exceed 45m (150ft) and motor wiring should be run in a separate conduit from the power wiring. If lead length must exceed this distance, contact Magnetek for proper installation procedures.
 - ◆ Use UL/CSA-certified connectors sized for the selected wire gauge. Install connectors using the specified crimping tools specified by the connector manufacturer.
3. Ensure that the control circuit precautions are observed.

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◆ Use twisted shielded or twisted-pair shielded wire for control and signal circuit leads. The shield sheath **MUST** be connected at the HPV 900 **ONLY**. The other end should be dressed neatly and left unconnected (floating). Wire size should be determined considering the voltage drops of the leads.

◆ Lead length should not exceed 45m (150ft). Signal leads and feedback leads should be run in separate conduits from power and motor wiring.

◆ Use UL/CSA-certified connectors sized for the selected wire gauge. Install connectors using the crimping tools specified by the connector manufacturer.

4. Verify that the input voltage matches the drive's rating by comparing the three-phase AC input voltage with the drive's nameplate data.

5. Verify that the motor is wired for the application voltage and amperage by comparing the motor's nameplate data with the drive's nameplate data.

6. Tighten all of the three-phase power and ground connections. Please check that all control and signal terminations are also tight, as they sometimes come loose during the shipment process. Note: The individual terminal torque specification is listed in the *HPV 900 Technical Manual*. **IMPORTANT:** Double-check all the power wires and motor wires (R/R1, S/S1, T/T1, U, V, and W) to make sure that they are securely tightened down to their respective lugs (loose wire connections may cause problems at any time). **IMPORTANT:** Insure the incoming line supply IS CONNECTED to the drive INPUT TERMINALS R/R1, S/S1 and T/T1 and NOT to the output motor terminals U,V and W.

7. Insure the DC Choke link is in place, if a DC choke is NOT used. Also, insure the links are in place between R and R1, S and S1, and T and T1, if a 12-pulse transformer is NOT used.

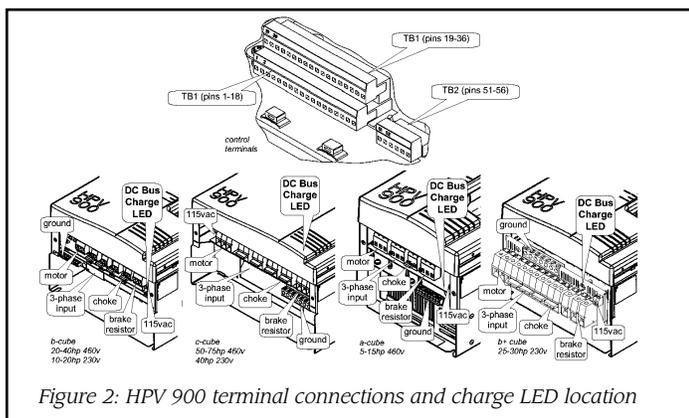


Figure 2: HPV 900 terminal connections and charge LED location

8. Insure a Dynamic Braking Resistor is connected to the drive at terminals +3 and +4. Note: Recommended values for the DB resistor are listed in the *HPV 900 Technical Manual*.

Apply Control Power

Apply Control Power to the drive (115VAC).

1. Once the control power is applied, verify the fan(s) are operating.



Figure 3: HPV 900 digital operator

2. Familiarize yourself with the digital operator and the parameter menu tree. (Consult the *HPV 900 Technical Manual*.)

3. Verify the accuracy of the drive's input line-to-line voltage in parameter INPUT L-L VOLTS (A4). Note: The INPUT L-L VOLTS parameter helps to determine the DC bus under voltage alarm/fault level.

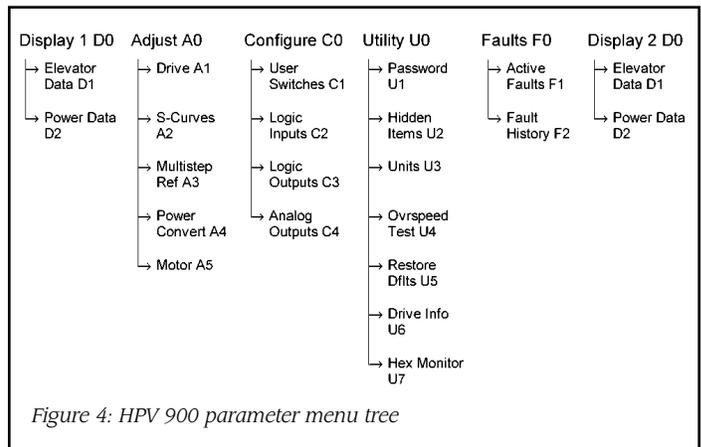


Figure 4: HPV 900 parameter menu tree

4. Enter/Verify the encoder pulses entered in the ENCODER PULSES (A1) parameter matches the encoder's nameplate.

5. Select one of the two default motors (either four- or six-pole) for the MOTOR ID (A5) parameter (or select a valid motor ID, if available).

6. Enter/Verify the following (A5) parameters from the motor's nameplate:

- ◆ Motor HP or KW rating (RATED MTR POWER)
- ◆ Motor Voltage (RATED MTR VOLTS)
- ◆ Motor Excitation Frequency in Hz (RATED EXCIT FREQ)
- ◆ Rated Motor current (RATED MOTOR CURR)
- ◆ Number of Motor Poles (MOTOR POLES)
- ◆ Rated Motor Speed at full load in RPM (RATED MTR SPEED)

7. Enter/Verify the hoistway parameters:

◆ CONTRACT CAR SPD (A1) – parameter programs the elevator contract speed in fpm or mps.

◆ CONTRACT MTR SPD (A1) – parameter programs the motor speed at elevator contract speed in RPM. Note: The above two parameters create the interaction that allow engineering units to be used throughout the HPV 900 software.

Apply Three-Phase Power

Apply three-phase power to the drive.

1. Measure and verify transformer primary and secondary volts.

2. Check for balanced VAC from each phase to ground.

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Low-Speed Operation Checks

Run the drive in low-speed inspection mode with default values for INERTIA (A1) and % NO LOAD CURR (A5) parameters.

1. Verify encoder polarity – the motor phasing should match the encoder phasing. (Common failure mode: Encoder Fault with Torque Limit LED [corrected by swapping A and /A or switching two motor phases].)
2. Verify proper hoistway direction – can be reversed with the MOTOR ROTATION (C1) parameter.
3. Verify that the Safety Chain/Emergency Stop works.

High-Speed Operation Checks

Run the drive in high-speed mode and follow the Adaptive Tune and Estimating System Inertia procedures.

Adaptive Tune Procedure

Initial Setup:

1. Select a valid Motor ID or one of the two default motors (either four- or six- pole) for the MOTOR ID parameter. Note: The default motor selections for the motor ID will place a zero value in the motor nameplate parameters. This selection will also load nominal values for the other motor parameters.
2. Now, verify the motor nameplate data is correctly entered into the motor nameplate parameters.

Tuning Motor No-Load Current

3. With a balanced car, run the car at 70% contract speed from top floor to the bottom floor then back to the top floor.
4. During these runs, verify under DISPLAY MENU – POWER DATA D2 that the MOTOR TORQUE is between $\pm 15\%$. If the value is larger than $\pm 15\%$ the car is not balanced correctly. Note: If you are having problems getting the motor torque under 15%, the cause may be:

- ◆ No compensation chains. If the elevator system has no compensation chains, achieving balanced condition may be difficult. In that case, the MOTOR TORQUE should be between $\pm 15\%$ for as much of the run as possible.

- ◆ High elevator system friction. If the elevator system has high friction, achieving motor torque of under 15% may be difficult. In that case, have less than the balance car weight in the car, thus letting the counterweight help to overcome the frictional losses. In this case, you should look only at the estimated values in the up direction and run the car in the up direction a number of times before changing any parameter settings.

5. Also, verify that the FLUX REFERENCE is 100%. If the value is not equal to 100%, reduce the speed to less than 70% contract speed and check again.

6. While still performing these top/bottom runs observe under DISPLAY MENU – POWER DATA D2 the EST NO LOAD CURR value.

7. Enter this estimated value into the motor parameter.
8. Continue iterating the above two steps until the two values are within 2%. If the values do not converge after two iterations, verify the information entered in the initial setup is correct.
9. After the values converge, again verify the MOTOR TORQUE < 15% and the FLUX REFERENCE = 100%.

Tuning Motor's Flux Saturation Curve

10. With a balanced car, run the car at 100% contract speed from top floor to the bottom floor then back to the top floor.

11. During these top/bottom runs observe under DISPLAY MENU – POWER DATA D2 the EST NO LOAD CURR value.
12. Compare the displayed value EST NO LOAD CURR with the value entered for % NO LOAD CURR under the ADJUST MENU – MOTOR A5.
13. If the EST NO LOAD CURR is 2% larger than the % NO LOAD CURR then, decrease the FLUX SAT SLOPE 2 by 10%.
14. If the EST NO LOAD CURR is 2% smaller than the % NO LOAD CURR then, increase the FLUX SAT SLOPE 2 by 10%. Note: If the EST NO LOAD CURR and % NO LOAD CURR are within 2% of each other, then continue on to Tuning the Rated Motor RPM (5.5.1.3).
15. Continue iterating FLUX SAT SLOPE 2 in 10% increments until the EST NO LOAD CURR and % NO LOAD CURR are within 2% of each other. Note: Remember change only the FLUX SAT SLOPE 2 parameter DO NOT change any other parameter (these were fixed in the previous steps).

Tuning Rated Motor RPM

16. With a full-load car, run the car at 100% contract speed from top floor to the bottom floor then back to the top floor.

17. During these top/bottom runs, observe under DISPLAY MENU – POWER DATA D2 the EST RATED RPM value.
18. Enter this estimated value into the motor parameter.
19. Continue iterating the above steps until the two values are within 3RPM. Note: Remember change only the RATED MTR SPEED parameter DO NOT change any other parameter (these were fixed in the previous steps).

Estimating System Inertia Procedure

1. With a balanced car, run the car at 100% contract speed from top floor to the bottom floor then back to the top floor.
2. Observe the EST INERTIA under DISPLAY MENU – ELEVATOR DATA D1 for both the down and up direction.
3. Average the two values and enter the DRIVE A1 parameter.

OPERATIONAL TOOLS AND SOLVING COMMON ISSUES WITH MAGNETEK'S HPV 900 AC ELEVATOR DRIVES

by Tony Frey, Senior Application Engineer

Although the HPV 900 high-performance elevator drive software enhances overall ride quantity and system performance, the software also facilitates installation, setup, maintenance and testing. Many tools exist in the HPV 900 software to help make it easy to monitor the operation of the drive, as well as operator messages to help diagnose particular elevator drive issues.

Operational Tools

Along with the digital operator, the HPV 900 has five Status LEDs on front of drive that show the current operational status of the drive. The meaning of the HPV 900's Status LEDs are as follows:

- ◆ READY – drive is ready to run.
- ◆ RUN – drive is in operation.
- ◆ PROGRAM INVALID – not sensing any valid software in the drive's control board.
- ◆ FAULT – drive has declared a fault.
- ◆ TORQUE LIMIT – drive has reached its torque limit.

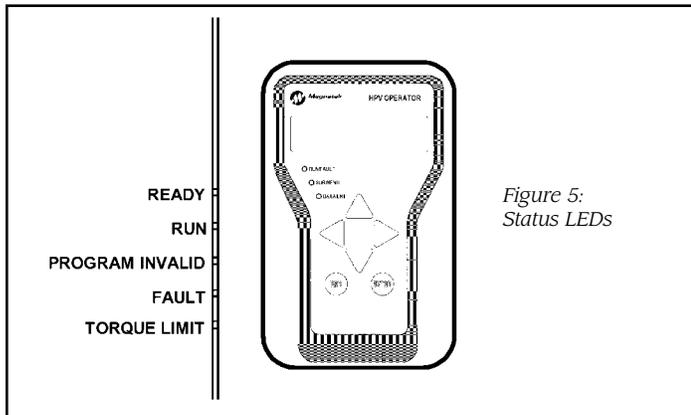


Figure 5: Status LEDs

The digital operator allows monitoring of the drive's display parameters. These display parameters can monitor many different operation values including: speed command, speed reference, speed feedback, motor current, motor voltage, DC bus voltage and logic input/output status. For the complete list of display parameters, see Figure 6.

Solving Common Issues

The following is a list of common HPV 900 issues and possible solutions.

Encoder Flt

The drive is in a run condition and the encoder is: not functioning, not connected or phasing is not proper with the motor.

- ◆ Encoder Should Match Motor Phasing: Switch either two motor phases or swap two encoder wires (A and /A).

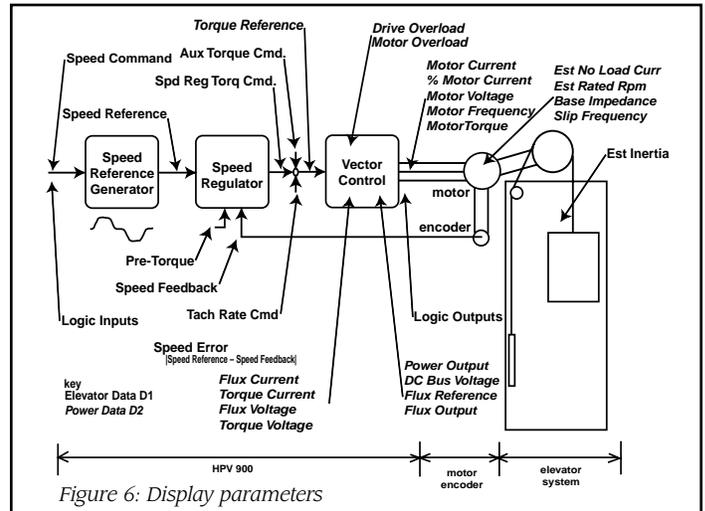


Figure 6: Display parameters

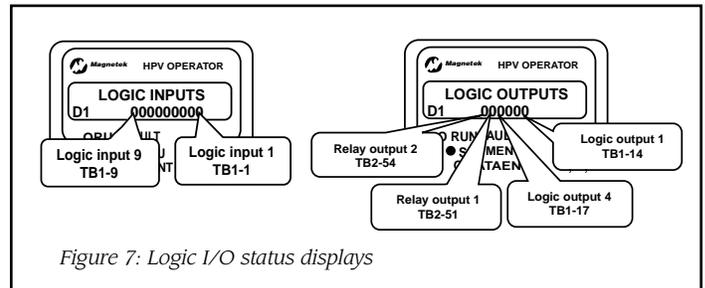


Figure 7: Logic I/O status displays

- ◆ Encoder Power Supply Loss: Check 12- or five-volt encoder supply on terminal strip.
- ◆ Accurate Motor Parameters: Verify motor nameplate values are entered correctly; complete Adaptive Tune and Inertia procedure.
- ◆ Response of Speed Regulator: Enter accurate INERTIA (A1) parameter; increase RESPONSE (A1) parameter.
- ◆ Encoder Coupling Sloppy or Broken: Check encoder-to-motor coupling.
- ◆ Excessive Noise on Encoder Lines: Check encoder connections; separate encoder leads from power wiring (cross power lead at 90°).
- ◆ Possible Motor Phase Loss: Check motor contactor, motor wires and motor connections.

Speed Dev

The speed feedback is failing to properly track the speed reference.

- ◆ Check Parameters Settings: Verify SPD DEV HI LEVEL (A1) is set to the proper level.

- ◆ Torque Limit LED lite: If torque limit LED lite during running, verify the Fault LED is NOT lite and increase the torque limit parameters MTR TORQUE LIMIT/REGEN TORQ LIMIT (A1) – maximum 250%.

Phase Flt

The drive senses an open motor phase. The drive senses more than one motor phase crossing zero at the same time.

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◆ **Motor Problem:** Check motor wiring; check for motor failure; check for bad contactor or contactor timing issue.

Ground Fault

The sum of all phase currents has exceeded 50% of the rated amps of the drive.

- ◆ **Improper Wiring:** Check system grounding.
- ◆ **Motor Issue:** Possible short between the motor windings and chassis.
- ◆ **Drive Hardware Issue.**

Undervolt Flt

Generated when the DC bus voltage drops below the user specified percent of the input line-to-line voltage.

- ◆ **Low Input Voltage:** Check INPUT L-L VOLTS (A4) and UV FAULT LEVEL (A4) parameters; disconnect Dynamic Braking resistor and re-try; verify proper input voltage and increase; check for a missing input phase; check power line disturbances due to starting of other equipment.
- ◆ **Drive Accurately Reading the DC Bus:** Measure the DC bus with a meter across terminals (+3) and (-) and compare that with the value on the digital operator, DC BUS VOLTAGE (D2).
- ◆ **Drive Hardware Issue.**

Charge Fault

The DC bus voltage has not stabilized above the voltage fault level within two seconds or the charge contactor has not closed after charging.

- ◆ **DC Choke Connection:** Check that the DC choke link is present or if using DC choke; check DC choke connections.
- ◆ **DC Bus Low Voltage:** Increase input AC voltage with the proper range; check wiring and fusing between main AC contactor and the drive.

Torque Limit (Status LED)

The drive has reached its torque limit.

- ◆ **Incorrect Wiring:** Motor phasing should match the encoder feedback phasing. Switch either two motor phases or swap two encoder wires (A and/A).
- ◆ **Drive and/or Motor is Undersized:** Verify drive and/or motor sizing. May need a larger capacity HPV 900 and/or motor.
- ◆ **Check Parameter Settings:** Check the torque limit parameters MTR TORQUE LIMIT and REGEN TORQ LIMIT (A1) – maximum 250%; check speed regulator parameters RESPONSE and INERTIA (A1).

COMMISSIONING OF THE MAGNETEK DSD 412 DC ELEVATOR DRIVE

by Mark Kobiske, Senior Application Engineer

The Magnetek DSD 412 is one of the world's most widely used DC elevator drives. Its applications range from low-speed geared to high-speed gearless such as the Sky View observation deck at the Sears Tower. Whether fast or slow, geared or gearless, it is crucial to follow proper guidelines that will ensure years of trouble-free operation.



Figure 8: Pre-power checks

Verify Wiring

◆ Wire sizes are required to comply with NEC, UL, CSA and other applicable codes for power distribution safety.

◆ **Verify Wiring:** The wiring between the DSD 412 and the motor should be checked to determine that no insulation has been damaged during the installation. This check should be done at the drive end of the power

wires. Disconnect the shunt field wires F1 and F2 from the field interface board (A3) terminal TB4. Attach the field wires temporarily to the load side of the armature contactor A1 and A2. Remove the wires from the armature interface board A2TB5-1 and A2TB5-2 and isolate them from the ground. With the power wiring now isolated from the drive, "megger" from the load side of the armature contactor to ground. If a problem is detected, the source of the ground fault must be determined and resolved prior to proceeding further.

◆ **Signal wire:** Each signal wire located on the main control board TB1 must be checked for isolation from ground. Verify it is installed in the correct terminal and that the terminal is tight (3.5in.-lb maximum). All low-power, low-voltage wiring should be run separate from 120VAC, three-phase AC, DC armature and field wires. These include:

- Encoder Wiring
- Speed Reference Wiring
- Pre-torque Reference Wiring
- 24VDC Logic Inputs
- Open Collector Outputs

To avoid noise pick-up, shielded cable should always be used for these signals.

◆ **Control Wire:** The control wiring located on the power supply (A4) TB3-1 through TB3-8 should be checked to verify connections are correct and tight.

Verify Motor Data

◆ **Field Coil Checks:** Prior to re-attaching the F1 and F2 wires to A3 TB4-F2(-) and TB4-F1(+), record the resistance of the field coil. In most cases, the motor nameplate states the Full Field Voltage or Full Field Current. A quick calculation can verify what AC voltage must be applied to the Field Interface Board (A3) to achieve Full Field Current. The calculation below will provide the minimum acceptable level, however, typically the level could be in the range 1.5 to 2.5 times VAC(min). $VAC(min) = VDC10.9$ or $(Full\ Field\ Current * Field\ Resistance)/0.9$. If the actual value for VAC drops below this point during the operation of the elevator motor, torque may be affected which will result in higher than expected armature current.

◆ **Motor Field Board Setup:** The DSD 412 can operate motor fields in the range 0.2 to 40.0ADC as standard. Connection on the field interface board for the motor field is TB4. Common connection point is F2(-). The maximum range of the motor field current determines which terminal F1(+) should be connected. For the drive to recognize the selected current range "S1" must be set correctly. The figure below identifies the terminal locations and proper switch positions for "S1." In some models of the DSD 412, switch "S1" is a *rocker type*. A rocker switch is *closed* when it is pushed "in" on the top and a rocker switch is *open* when it is pushed "in" on the bottom. Newer models of the DSD 412 will be *slide type* (see Figure 9). Move the slide actuator of "S1" or press the rocker switch actuator in as indicated to coordinate the position of "S1" with the ampere range connected at TB4. The AC voltage is the next consideration when approaching this part of the setup. Typically, the DSD 412 comes wired from the factory with the AC voltage derived from the L1 and L2. If the three-phase voltage fails to meet the criteria defined above, it will be necessary to supply an alternate AC voltage.

◆ **Setup of Alternate AC Voltage to the Motor Field Board (Optional):** If the three-phase voltage fails to meet the criteria defined above, it will be necessary to supply an alternate AC voltage. This is done by using a single-phase transformer. The DSD 412 factory wire should be moved from AC1 to L1A on TB1. Connect H1 on the transformer to L1A on TB1. Move the factory wire on AC2 to L2A on TB1. Connect H2 on the transformer to L2A on TB1. This will provide voltage to the primary side of the transformer. Connect X1 on the transformer to AC1 of TB1. Connect X2 on the transformer to AC2 of TB1. This completes the wiring of the alternate single-phase transformer. *Install semiconductor fuses between secondary of the transformer (X1, 2) and the TB1 (AC1, 2).*

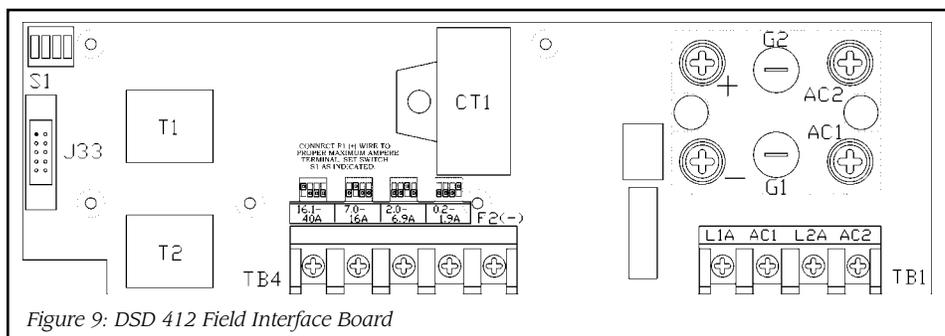


Figure 9: DSD 412 Field Interface Board

Recording Motor Data

◆ Record the remaining information from the nameplate of the motor: Rated Motor Amps, Rated Armature Voltage, Rated Motor RPM, Full Field Current, Weak Field Current. Record Encoder Pulses Per Revolution, Rated Car Speed. These numbers will need to be entered into the DSD 412 drive as parameters later in the startup.

◆ **Input Isolation Transformer/Control Transformer:** Transformer taps need to be set so the secondary voltage is equal to or exceeds the anticipated DC armature voltage at rated car speed. The control transformer, if used, should be checked to verify it is wired to provide 120VAC on the secondary when the power is turned on.

◆ **Encoder Considerations:** The preferred method of mounting the encoder is inline with the motor armature; precision alignment is crucial to stability of the DSD 412 speed regulator. The body and shaft of the encoder should be electrically isolated from the motor frame to prevent electrical noise from causing interference. Digital encoders that operate with this product will require a shielded cable with three twisted pairs. The pairs should be made up of A and A-, B and B-, +5VDC and common. The shield should be insulated from the encoder case and only connected at the drive end. The maximum frequency of the encoder at rated car speed should not exceed 300kHz.

Grounding

◆ **Grounding Considerations:** Ground bonding wire sizes are required to comply with NEC, UL, CSA and other applicable codes for safety. Provide ground bonding wires as indicated. Do not rely on metal conduit or building steel connections to perform this function. Drive enclosures should have an electrically bonded ground stud or bus bar contained within its construction. The following items should be connected to the enclosure ground point, *each with its own bonding wire*: DSD 412 drive ground lug, the sub panel (which the DSD 412 is mounted), motor frame, isolation transformer frame, inductor frame of the armature ripple filter (if used). The secondary of the isolation transformer should remain ungrounded. The building ground should be tied to the enclosure ground point.

On the DSD 412 drive, the low-voltage circuit common should be grounded by connecting A1TB1-44 to A1TB11.

Power Up

◆ Apply the control and three-phase power: Verify that the control voltage is between 103VAC and 126VAC. Check for balanced VAC from each phase to ground. Measure the

voltage line to line. Verify the voltage is in the range that was determined previously. Enter into the DSD 412 the motor parameters, line voltage and other specific parameters that will allow the elevator to operate as it was designed.

◆ **Advanced Diagnostics:** Prior to operating the motor, the DSD 412 has two automatic routines which need to be

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performed. To perform these tests, it is crucial that the DSD 412 has control of the armature contactor. Placing a jumper from TB3-3 to TB3-6 on the DSD 412 typically does this. *Once these tests are complete the jumper must be removed.* The first of these tests is called "drive diagnostics" F998, this routine will verify the power components within the drive and some of the critical wiring. The second routine is called "self tune" F997, this step calculates critical motor parameters that are required for proper speed regulation. If either of these tests fail, the problem must be resolved prior to proceeding further.

◆ **Verifying Field Current:** The most critical step once the startup has reached this point is to verify functions to ensure the controller is performing as expected. The motor field control on the controller can be easily verified to determine proper setup. Set up the elevator to run at zero speed. Do not lift the brake on the drive monitor function #612 (field current feedback). With an external monitoring device, such as an amp probe, measure the actual field current. Verify that these two readings match. If the only tool available is DVOM, measure the voltage and calculate the actual field current: $I = V_{\text{shunt field}} / R_{\text{shunt field}}$ (recorded previously).

◆ **Operating the Motor:** Set the expected car speed to 5% of rated speed, run the drive, verify that the elevator is moving in the correct direction and correct speed. Repeat check for the opposite direction. The Rated Car Speed can be monitored on function #600. Set the rated car speed to 100%. Make multi-floor runs. Monitor the armature voltage feedback on parameter #610. This number should be equal to or less than the AC line voltage feeding the drive. If the armature voltage is greater than the line voltage drive then the motor needs to have less field current at top speed. This is done by a technique referred to as field weakening.

SOLVING COMMON STARTUP ISSUES WITH MAGNETEK'S DSD 412 DC ELEVATOR DRIVES

by Donald Vollrath, Principal Engineer

Thousands of DSD 412 DC drives have been installed on freight and passenger elevators in North America. Even though the basic DC drive may be the same, each installation from building to building is slightly different. Every brand of elevator car controller interfaces to the drive in a slightly different manner. Pre-wired control panels are designed and assembled by a different company. A different crew installs the site equipment and wiring. And for modernization projects, some of the equipment to be re-used may

actually need repairs before putting it back in service. Consequently, there will always be sites where startup issues exist. Most of the time, solving a single issue is relatively straightforward, once you understand what can cause the particular symptoms. However, recognizing seemingly unrelated causes and having more than one issue can often create misleading symptoms making troubleshooting more difficult. This can be frustrating to an adjuster as "nothing seems to help."



Figure 10: DSD 412 operator interface

The following list of drive trouble symptoms and possible associated root causes has been accumulated over many years of troubleshooting experience. Use this list as a quick guide for what to look for when things go wrong. These are listed more or less in an historical likelihood of occurrence order. Refer to the technical manual furnished with the drive and/or elevator car controller for detailed wiring configurations and adjustment procedures.

1. Drive runs poorly or trips on F97(overspeed fault), F98(tach loss fault), F99(reverse tach fault) or has excessive speed errors.

Causes: Poor encoder wiring. Encoder doesn't have differential line driver outputs. Missing or broken encoder wires or connections. Reversed encoder wires. Shield on cable touching ground at machine end or intermittent grounding of wiring shield. Encoder not electrically isolated from elevator machinery.

2. Drive trips on F900(PCU loop fault), F402(loop contactor failure fault) or F405(safety circuit fault).

Causes: Missing, or poor mechanical alignment, or dirty contactor auxiliary feedback contact. Elevator control relay logic interferes with receipt of contactor acknowledge feedback contact at drive. Safety-chain circuit open when drive is told to start or opens before drive tells contactor to drop.

3. Drive declares F98(tach loss fault) or F901(pcu ist fault) when told to start.

Causes: Contactor acknowledge feedback contact to TB1(7) closes before motor armature power poles. Drive output voltage immediately rises to cause armature cur-

rent, but there is no path. This enables Tach Loss sensing to trip or causes a burst of excessive current when the main poles do close.

4. Drive causes severe vibrations or blows fuses in middle of a run.

Causes: Reversed or missing armature voltage feedback wires. Performing Self-Diagnostics, Fctn 998, will reveal this problem as an F917(reverse armature polarity fault). Possible poor encoder mounting causing sympathetic vibrations (also see #6).

5. Drive won't self-tune.

Causes: Incorrectly entered drive and motor size data creates "SFLt" (Severe Fault) or F915(parameter setup fault) display. Re-enter correct drive/motor set-up data. Remember to Save the data to NVRAM (Fctn 994). Possible misoperation of motor field regulator (also see #10). Run Self-Diagnostics first to ensure that the drive is working properly. Will not Self-Tune if memory protect switch is ON. Cycle power OFF for five seconds then back ON to clear all faults. Close Safety Chain before starting Self-Tune.

6. Drive has F407(dcu cemf fault) or trips on F408 (pcu cemf fault).

Causes: Indicates that motor CEMF is too high for available VAC input. Verify settings for input VAC. Verify motor field winding connections and rated volts and amps. Verify that field regulator is producing the expected motor field current by separate measurement. Adjust drive to weaken motor field at high speed (also see #7 and #10).

7. Drive trips on F903 (line sync fault) or F904, or shows F406 (10% low line fault).

Causes: Indicates poor quality input power or weak power line capacity. Look for loose connections in feeder wiring. Monitor and repair primary voltage sag with current demand. Undersized or faulty power transformer. Monitor primary side power to verify.

8. Drive trips on F926 (pcu watchdog fault) or F232 (unknown bus error fault).

Causes: Severe electrical noise interference. Missing or poor grounding of drive chassis. Missing grounding wire from TB1(43 or 44) to TB11. No R-C suppression on customer supplied relay coils. (Use R-C networks instead of other transient suppressors.)

9. Difficult tuning of velocity regulator.

Causes: Elevator Inertia adjustment not correct. Raise Inertia setting if car speed tends to overshoot. Lower the setting if speed hesitates or undershoots. Poor encoder mounting.

10. Drive won't Pass Self-Diagnostics (Fctn 998) or Self-Tune (Fctn 997), F401 (excess field current fault) or F905 (field loss fault) faults.

Causes: Improper setup of motor field regulator. Verify motor field winding connections and rated volts and amps. Measure and verify motor field ohms. Verify that the proper tap at TB4 is being used and that SW1 is set corresponding to

the correct ampere range. Verify that field regulator is producing the expected motor field current by separate measurement. Verify that there is adequate voltage available to achieve rated DC field amps. Verify that the VAC input to the field regulator circuit is phased properly.

11. Drive Start or Stop is not smooth.

Causes: Elevator brake lifts after drive velocity reference has moved away from zero speed. Poor adjustment or no pre-torque control. Elevator brake drops before drive has stopped. Correct brake relay timing. Ensure that brake is not binding.

12. Drive drifts at zero speed.

Causes: Poor grounding practice for wiring of analog signal lines. Ensure that drive chassis is grounded and ground bonded to car controller. Ensure that a wire grounds circuit common from TB1(43 or 44) to TB11. Ensure that analog signals for speed or torque commands are wired as differential (two wire) signals through shielded cable, with the shield tied to the designated terminal only at the drive end.

13. Drive causes motor "growling" or severe low-frequency vibration.

Causes: Improper tuning of current regulator. Saturation of motor armature choke with large values of current. Be sure tuning values for motor R and L make sense. Remember to save parameter settings after adjusting them. Verify current saturation characteristics of ripple choke with supplier.

14. Drive indicates blown fuses or trips on F904 (low-line voltage fault) or F901 (pcu ist fault) on power up, but power seems normal.

Causes: Faulty power supply or current transducer. Low voltage output from internal power supply causes errant circuit readings. A faulty CT can cause the power supply to lower output voltages for self-protection. Verify +/-15V P.S. voltages at test points near top of main PCB. Unplug CT cable to isolate problem (but do not attempt to run drive with the CT unplugged).

APPLICATION OF THE MAGNETEK HPV 100 HYDRAULIC ELEVATOR SOFT STARTER

by Jerry Reichard, Principal Engineer

The Magnetek HPV 100 soft starter provides a controlled soft start to the standard three-phase induction motors used to drive hydraulic elevator pumps. The soft starter is an alternative to direct line starting or traditional star-delta reduced voltage starters as it eliminates current surges and associated torque transients. Some of the advantages of this soft start are:

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- ◆ Reduced operational cost.
- ◆ Increased motor and equipment life.
- ◆ Increased system reliability.
- ◆ Minimized service and maintenance costs.
- ◆ Reduced required power distribution and electrical interference.

In comparison to lower-performance voltage-control starters, the setup of the HPV 100 is simplified because of digital current control. The installer need only set the desired motor overload current for thermal protection and the desired starting current to achieve optimum motor starting characteristics regardless of fluctuations in the line voltage. HPV 100 starters range in size from 23A to 130A in either 200/230VAC or 460/575VAC. All are CSA listed.

How It Works

To regulate the motor current, the HPV 100 phase controls the incoming line voltage to control motor voltage. When a start is initiated, the motor current reaches the set starting current within a few line cycles and is regulated until the motor accelerates to rated speed. At this point, the HPV 100 continues to monitor motor current to provide protection from phase loss (single phasing), thermal protection and surge currents. Up to speed is then acknowledged through a dedicated 120VAC, N.O. output contact. This signal can optionally be used in multiple motor/starter applications to initiate starting a subsequent motor. Additional diagnostics include a check of line phase rotation, starter temperature and status of the power semiconductors. In the event of a fault condition, the HPV 100 removes motor power through an integral output contactor.

Magnetek offers the HPV 100 configured for either three-wire or 6/12-wire motors. The 6/12-wire motor is delta connected with the starter wired electrically inside the delta. While this arrangement requires three extra motor wires (six total), the motor current sums to 173% times the starter current or conversely, the starter need only supply 58% of the rated motor current. If the starter is configured for a three-wire motor, a larger starter must be specified to supply rated motor current. However, this allows the flexibility to use an existing standard wye or delta wound motor.

Setup

The HPV 100 has two current adjustments, starting current and overload current. These are expressed as a percent of the starter's rating. For example, a 130A rated starter with the starting current set to position 9, or 250% will deliver $2.50 \times 130A = 325A$ starting current.

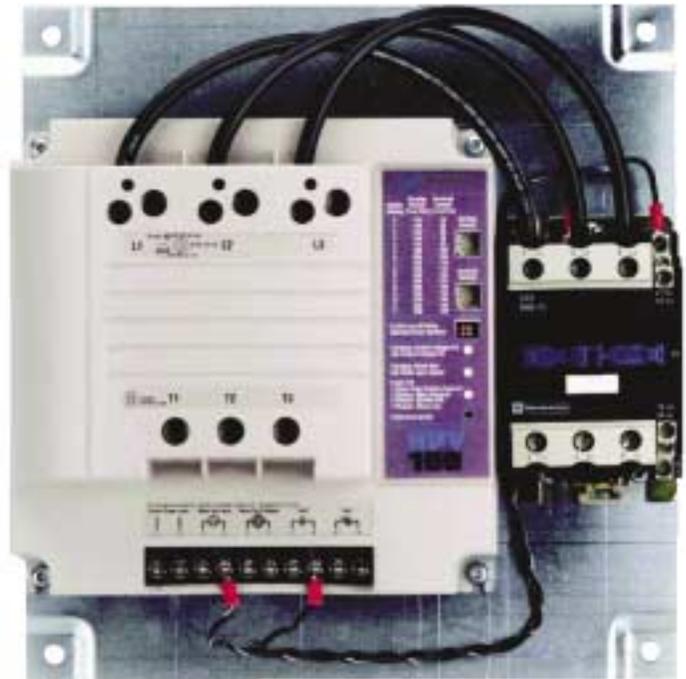


Figure 11: HPV 100 hydraulic elevator soft starter

Starting Current Adjustment

The starting current adjustment sets the level of current used to accelerate the motor up to speed. The starter will maintain this current for up to three seconds. If the motor has not started after three seconds the HPV 100 goes into Stall Prevention. Stall Prevention is a feature unique to the Magnetek soft starter, which ramps up the starting current to as much as 340% in the event of a stalled motor. This feature potentially eliminates a service call on cold days where the hydraulic oil is unusually thick. It is recommended that the starting current initially be set to 250% and after installation readjusted to achieve a specific starting time or current.

Overload Current Adjustment

The overload current adjustment sets the level of current used for motor thermal protection. It is the maximum current the starter will allow the motor to operate at continuously. If the motor current exceeds this setting, the starter applies a time-versus-current-squared limit to prevent overheating the motor. Initially the overload current adjustment should match the motor FLA rating. For example, if the load motor is rated at 110 FLA and the starter is rated at 130A the overload adjustment should be set to $100\% \times 110/130 = 84.6\%$. The closest position that will satisfy this current is position 2, 85% of the starter rating. After installation this can be fine-tuned for specific starting/load conditions.

Motor-Off Delay Selection

The motor-off delay selection switch sets the time that the starter continues to run after the run signal is removed. The factory default is set to zero seconds. This

means that the starter stops running the moment the run signal is removed. Optionally, this switch can be set for 0.5 seconds to allow the starter to continue to run for half of a second after the run signal is removed.



Figure 12: User interface

ABC/CBA Phase Rotation Selection

The ABC/CBA phase rotation selection switch sets the expected phase rotation of the incoming power source. This is factory set to the ABC position. If the actual phase rotation sequence is known, this switch can be set accordingly, otherwise it can be set later, during initial startup in the event of a phase-rotation fault. Once the phase rotation has been established, the phase-rotation check guarantees the incoming power always follows the preset sequence and thus establishes the direction the motor will turn even if the equipment is rewired in the future.

Installation

The soft-starter connections to incoming power and to the load motor depend on whether it is a three- or six-wire configuration. Incoming power wiring must be fused and of sufficient gauge and voltage rating to supply the load motor FLA. If applicable, the user will also need to supply high-speed semiconductor-type fusing to comply with CSA short-circuit testing. Contact the factory for specific applications. Torque the starter power terminals L1, L2, L3, T1, T2 and T3 to 50-60in.-lbs. Refer to the HPV 100 technical manual for specific output contactor terminal torque.

The soft starter control also requires 120VAC (5VA). This should be fused per the gauge of control wiring and connected to terminals 1 and 2 of the control terminal block. The motor run input, terminals 3 and 4, is rated at 120VAC but only requires a few milliamps of current. The starter will turn on when voltage is applied to the input. If the system uses a pilot relay for the run input, it should be designed for low currents, preferably with gold plated or flashed contacts to assure a reliable and continuous run command (see six-flash fault). A normally open, up-to-speed contact is provided on terminals 5 and 6. This contact closes after the motor comes up to speed and will remain closed for the duration of the run. It will open if the run signal is removed or if a fault condition is present. The up-to-speed output is rated for 120VAC at 1A.

A normally open fault contact is provided on terminals 7 and 8 and a normally closed contact on terminals 9 and 10. These contacts will be in their default state when a fault is present. The N.O. contact is prewired to the integral fault contactor and will cause it to close if the starter is ready to run. These contacts are rated for 120VAC at 3A.

Verify power, motor and control wiring before powering up the starter.

Initial Startup

When initially powering up the soft starter the user can verify the status of the starter through LEDs displayed in the front cover. The topmost green LED should be on continuously. This indicates that control power has been applied and that internal voltages are correct. If the control voltage is too low, this indicator will not light or will flash.

The bottom LED (just above the fault reset button) should not be lit. If it is on continuously, the starter is indicating that at least one of the incoming power phases is not present. If it is flashing a code, count the number of flashes per sequence and observe which fault is present. If the ABC/CBA phase rotation was not preset and the rotation sequence unknown, then a single flash fault is likely to occur (see one-flash fault). The user can simply move the ABC/CBA Phase Rotation switch to the alternate position.

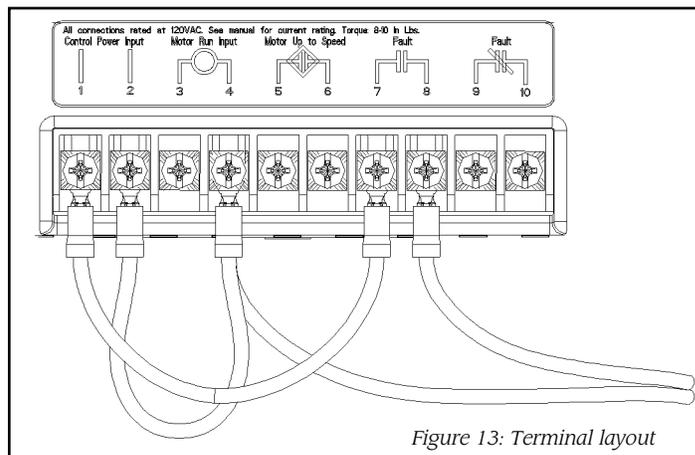


Figure 13: Terminal layout

If no faults exist and control power is adequate the starter is ready to run. Verify that the fault contactor has closed. At this point, the starter will accept a run signal. When the run signal is applied, the middle green LED will flash as the motor starts and stay lit continuously when the motor is up to speed. If the LED immediately lights continuously, but the motor does not start, check the motor wiring (see six-flash fault).

Fault Conditions

The HPV 100 has seven fault conditions derived from the various motor protections and system diagnostics. In the event of a fault, the starter displays the cause through an LED on the front cover by flashing a certain number of times, pausing, and then repeating the previous flash sequence. It will continue flashing this fault code until it is

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reset. To reset any of the starter faults, cycle control power or push the fault reset button. Alternately, in the case of a Motor Overload, Over Temperature or Over Current Fault, remove the run signal and wait for one minute before applying the run signal. In all cases, the run signal should be removed prior to resetting a fault, otherwise the starter will immediately attempt to restart the motor. A fault causes the starter to open the fault contactor and thus removes power to the load motor. The fault codes are as follows:

Indicator on Continuously: No Line Sync

This fault occurs if the starter does not detect all three phases of the incoming power. Use a voltmeter to check the power connections phase to phase for proper input voltage. Check for loose or broken wiring. Check line fuses for continuity.

One-Flash: Phase Rotation Incorrect

This fault will occur if upon powering-up the incoming power has a phase rotation different than the selected sequence. To satisfy this condition, the user can either move the ABC/CBA phase rotation selection switch to the alternate position or interchange two legs of the incoming power connection.

Two-Flash: Motor Overload

The motor overload fault occurs when motor current exceeds the overload set level for too much time (I^2t curve). If this fault occurs, first verify that the overload current adjustment has been set correctly to the load motor FLA. If the fault still occurs it indicates excessive motor loading or insufficient motor torque for the applied current.

Three-Flash: Shorted SCR

The shorted SCR fault indicates that there is motor current in at least one of the phases when the run signal is not present. Verify that the starter is wired correctly. If the fault still occurs this indicates a shorted SCR in the starter.

Four-Flash: Phase Loss

The phase-loss fault occurs if the soft starter detects a single-phase condition on the load motor. The first step to diagnosing this condition is to check the motor wiring for loose or broken connections. With the power off, verify continuity from phase to phase. Manually actuate the fault contactor and verify continuity.

Five-Flash: Over Temperature

Over temperature indicates that the starter heatsink temperature has exceeded design limits. Check to make sure that the ambient temperature is not greater than 50°C (122°F). If the unit is equipped with a cooling fan, verify that it is not jammed or plugged by debris. Verify that the heatsink is not fouled with debris. Finally, verify that the load motor current or duty cycle does not exceed the starter's rating.

Six-Flash: Over Current

The over-current fault can occur for a variety of conditions. If the unit is a six-wire configuration, it can indicate that the load motor has been incorrectly wired. If the motor is mis-wired, it will appear to run properly but will initially exceed the starting current set level. This specific condition will cause a six-flash fault. Check the motor wiring per the starter manual. If the wires on the load motor are not marked or if the markings could be wrong because the motor was rewound, then swap the positions of two motor wires going to the fault contactor. Verify that the wires common to an incoming phase are not from the same motor winding, otherwise no motor current will flow. The second reason for a six-flash fault is an instantaneous overcurrent. This fault is common to three- or six-wire units and indicates a very large surge of motor current. First, verify motor wiring for shorts phase to phase or to ground. Megger or Hi-pot the motor to ground at the proper voltage level. Verify that all connections are tight. Verify proper motor impedance phase to phase.

It is also possible to cause this fault by rapidly toggling the run signal. The run input is rated for 120VAC but has very low current draw. Verify that any relay used in the run input is rated for low current; gold-plated or flashed contacts are preferred. Verify that all control wiring is secure and that the run signal is continuous for the duration of the run period.

Conclusion

Whether refurbishing an existing system or installing new equipment, the HPV 100 soft starter is easy to setup and will provide many years of trouble-free operation. For additional information, please refer to the HPV 100 technical manual. This and other Magnetek product information can be found at website: www.elevatordrives.com. 

Tony Frey is a senior application engineer for the Magnetek Elevator Products Division. He received an MS degree from the University of Wisconsin-Stout. Frey worked for Cray Research prior to coming to Magnetek in 1995.

Mark Kobiske is a senior application engineer with the Elevator Products Division of Magnetek. A graduate of the Milwaukee School of Engineering, he started his career with Magnetek in 1990.

Donald Vollrath is a principal engineer for the Magnetek Elevator Products Division with 35 years of related experience with EC, AC and DC motor controls. He has worked to perfect motor drive applications on elevators for nearly 20 years. He has a BSEE graduate of the University of Illinois.

Jerry Reichard is a principal engineer with the Magnetek Elevator Products Division. He is a graduate of University of Wisconsin-Milwaukee. Prior to coming to Magnetek in 1999, Reichard worked for Square D Company, A.O. Smith, Corporate Technology Center and Thor Technology Corp.