



Elevator Application Guide

Installation & Operating Manual

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Section 1

General Information

Introduction

Baldor Electric manufactures several different Drive types for the elevator industry. These drives are DC SCR (Thyristor), AC Inverter (VVVF) and AC Vector. Each drive type is best suited for a specific application in the elevator market. This manual provides information for selection and application of Baldor Drives for use in the elevator industry.

Drive Definition

Baldor's definition of a "Drive" includes both the Motor and the Control.

$$M + C = D \quad \text{Where: } M = \text{Motor} \\ C = \text{Control} \\ D = \text{Drive}$$

Because each application is different, Baldor makes it easy to customize drive characteristics to match the performance requirements of your application. Programmable flexibility allows Baldor controls to be customized using a standard keypad interface. This easy to use keypad and 32 character display give you total control of the drive. This standard interface provides a family of H series products that have a simple, easy to use, common sense language. These controls have the following characteristics:

1. Common Keypad
2. Common Language
3. Common Commands
4. Common family of expansion boards (I/O Interface)

This Elevator Guide is intended to assist with the following:

1. Selection of the proper drive for an elevator application.
2. Provide help with the set-up of the drive during installation.

Modernizations

In the United States, most controls sold for use in elevator applications are for modernizations. A modernization involves upgrading an existing elevator to meet present codes and performance levels. In these cases, usually only a control is sold. Existing motors are used. An encoder feedback device must be added when using Vector technology. An encoder feedback device must be added if using AC Vector technology.

For existing AC elevators, older two speed motors are connected to an Inverter or Vector control. For existing DC elevators, a DC motor generator set is replaced by a DC SCR control. The existing DC motor must be modified to accept an encoder or tachometer feedback device.

Limited Warranty

For a period of two (2) years from the date of original purchase, BALDOR will repair or replace without charge controls which our examination proves to be defective in material or workmanship. This warranty is valid if the unit has not been tampered with by unauthorized persons, misused, abused, or improperly installed and has been used in accordance with the instructions and/or ratings supplied. This warranty is in lieu of any other warranty or guarantee expressed or implied. BALDOR shall not be held responsible for any expense (including installation and removal), inconvenience, or consequential damage, including injury to any person or property caused by items of our manufacture or sale. (Some states do not allow exclusion or limitation of incidental or consequential damages, so the above exclusion may not apply.) In any event, BALDOR's total liability, under all circumstances, shall not exceed the full purchase price of the control. Claims for purchase price refunds, repairs, or replacements must be referred to BALDOR with all pertinent data as to the defect, the date purchased, the task performed by the control, and the problem encountered. No liability is assumed for expendable items such as fuses.

Goods may be returned only with written notification including a BALDOR Return Authorization Number and any return shipments must be prepaid.

Safety Notice

This equipment contains voltages that may be as great as 1000 volts! Electrical shock can cause serious or fatal injury. Only qualified personnel should attempt the start-up procedure or troubleshoot this equipment.

This equipment may be connected to other machines that have rotating parts or parts that are driven by this equipment. Improper use can cause serious or fatal injury. Only qualified personnel should attempt the start-up procedure or troubleshoot this equipment.

PRECAUTIONS

- ⚠ WARNING:** Do not touch any circuit board, power device or electrical connection before you first ensure that power has been disconnected and there is no high voltage present from this equipment or other equipment to which it is connected. Electrical shock can cause serious or fatal injury. Only qualified personnel should attempt the start-up procedure or troubleshoot this equipment.
- ⚠ WARNING:** Be sure that you are completely familiar with the safe operation of this equipment. This equipment may be connected to other machines that have rotating parts or parts that are controlled by this equipment. Improper use can cause serious or fatal injury. Only qualified personnel should attempt the start-up procedure or troubleshoot this equipment.
- ⚠ WARNING:** This unit has an automatic restart feature that will start the motor whenever input power is applied and a RUN (FWD or REV) command is issued and maintained. If an automatic restart of the motor could cause injury to personnel, the automatic restart feature should be disabled. Disable by changing the “Restart Auto/Man” parameter to MANUAL.
- ⚠ WARNING:** Be sure the system is properly grounded before applying power. Do not apply AC power before you ensure that all grounding instructions have been followed. Electrical shock can cause serious or fatal injury.
- ⚠ WARNING:** Do not remove cover for at least five (5) minutes after AC power is disconnected to allow capacitors to discharge. Dangerous voltages are present inside the equipment. Electrical shock can cause serious or fatal injury.
- ⚠ WARNING:** Improper operation of control may cause violent motion of the motor shaft and driven equipment. Be certain that unexpected motor shaft movement will not cause injury to personnel or damage to equipment. Peak torque of several times the rated motor torque can occur during control failure.
- ⚠ WARNING:** Motor circuit may have high voltage present whenever AC power is applied, even when motor is not rotating. Electrical shock can cause serious or fatal injury.
- ⚠ WARNING:** Dynamic Brake Hardware may generate enough heat to ignite combustible materials. Keep all combustible materials and flammable vapors away from Dynamic Brake Hardware.

Continued on Next Page

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- ⚠ Caution:** To prevent equipment damage, be certain that the electrical service is not capable of delivering more than the maximum line short circuit current amperes listed in the appropriate control manual, 230 VAC or 460 VAC maximum per control rating.
 - ⚠ Caution:** Disconnect motor leads (T1, T2 and T3) from control before you perform a “Megger” test. Failure to disconnect motor from the control will result in extensive damage to the control. The control is tested at the factory for high voltage / leakage resistance as part of Underwriter Laboratory requirements.

Section 2 Technologies

Overview

Baldor Electric manufactures six drive types for the elevator industry. Each drive type (Control and Motor) is best suited for a specific application. These Series “H” Controls are:

- 15H Inverter
- 17H Vector (Encoderless)
- 18H Vector
- 19H DC SCR
- 20H DC SCR (Line Regenerative)
- 21H Inverter (Line Regenerative)
- 22H Vector (Line Regenerative)

These Baldor Series “H” controls all use the same keypad and display interface. This makes it easy to become familiar with the programming and operation of the controls. Set-up time of the control and motor is greatly reduced due to the automated features “Auto-Tune” that are available within these controls.

The purpose of this section is to review each technology type to make it easier to choose a drive for an application. Table 2-1 provides a brief overview of drive performance for each technology type.

Table 2-1 Drive Performance Comparison

Feature	DC SCR	Inverter	Vector
Operating speed range (for elevators)	0 RPM to Base Speed	10% of Base Speed to Base Speed.	0 RPM to Base Speed
Relative constant torque speed range	Wide 20:1	Narrow 5:1 - 10:1	Widest Base Speed:1
Speed Control	Yes	Yes	Yes
Torque Control	Yes	No	Yes
Positioning ¹	Yes ² (Encoder or resolver feedback)	No	Yes ²
Speed regulation: Open Loop Closed Loop	± 1 - 2% of base speed ± 1% of set speed	± 3% of base speed ³ ± 1% of set speed	± 0.5 to 1% of set speed ± 0.05% of set speed
Continuous full rated torque at zero speed	No	No	Yes
Available peak torque	150% +	115 - 150%	150% +
Motor Brushes?	Yes	No	No

¹ Motion controller required for positioning.

² Requires encoder or resolver feedback.

³ Depends on motor size and percent slip.

DC SCR Control

NEMA Type C designation of electrical power source equipment for adjustable speed drives.

Series 19H DC SCR (not used in elevator applications)

Series 20H DC SCR (Line Regenerative)

DC SCR controls are used in elevator applications where speeds range from 50 to over 1000 FPM. The Baldor DC SCR (Thyristor) control is a three phase, full wave rectified, DC motor armature and field (where applicable) control. The SCR bridge converts three phase AC to DC power. This rectified DC provides power to the DC motor armature, and the reference transformer to operate power supplies and other circuits.

Armature or encoder feedback may be used with either control. DC tachometer or resolver feedback is available with the optional expansion board. A Series 20H control can be configured to check for torque output (torque proving) before a holding brake is released.

20H Control

The Series 20H is a standard line regenerative control. Regenerated power is applied back to the incoming power lines. External filters can improve the Total Harmonic Distortion (THD) of the AC waveform. This control is not designed for regenerative use with stabilized shunt or compound wound DC motors. If stabilized shunt or compound wound motors are to be used, the series field must be isolated and not connected. Contact the motor manufacturer for motor derating under these conditions.

Regulation from the Series 20H, using armature feedback, will be 2% of base speed. With DC tachometer feedback, the regulation will be 1% of set speed. Use of encoder or resolver feedback will provide 0.1% regulation.

Inverter

Series 15H Inverter
Series 21H Inverter (Line Regenerative) IEEE-519 Compliant

Typically Inverters are used in elevator applications where speeds up to 150 FPM are required.

The Baldor inverter converts the three phase AC line power to fixed DC power. The DC power is then pulse width modulated into synthesized three phase AC line voltage for the motor.

The rated horsepower of the control is based on a NEMA design B four pole motor and 60Hz operation at nominal rated input voltage. If any other type of motor is used, the control should be sized to the motor using the rated output current of the control.

Speed regulation of an Inverter Drive is dependant upon the slip of the AC induction motor. Typically this regulation will be 3% of base speed. Speed regulation can be increased to 1% of base speed by the addition of a DC tachometer for feedback.

The output of the inverter is a Sinewave of current to the motor. The more pure the Sinewave is, the less additional heat produced in the AC induction motor. If a motor produces less heat, more torque is available to drive the load. The PWM control method produces less heat and gives a better approximation of a Sinewave of current to the motor when compared to a Six-Step type of inverter.

15H Control

The Baldor Series 15H control may be programmed to operate in one of four operating zones; standard constant torque, standard variable torque, quiet constant torque or quiet variable torque. For elevator applications, only the quiet constant torque or quiet variable torque modes are used. It can also be configured to function in a number of operating modes for custom operation. These choices are programmed using the keypad as explained in the programming section of this manual.

Regenerated power from the motor is applied back to the DC bus and must be dissipated by REGEN Hardware (resistive load). The REGEN (or dynamic brake) hardware is selected based on the power to be dissipated. The amount of power, duration and frequency of the braking must be taken into consideration when sizing these resistors.

21H Control

The Series 21H Inverter is a line regenerative control. Regenerated power is applied back to the incoming power lines.

Regenerated power from the motor is applied to the incoming AC power lines. The Series 21H control meets IEEE 519 (1992) for total harmonic distortion. By returning the excess power back to the line, energy use is reduced for the building. The lower THD causes fewer power problems for sophisticated equipment on the same power grid. No external dynamic braking hardware is required.

Vector

Series 17H Encoderless Vector
Series 18H Vector
Series 22H Vector (Line Regenerative)

Vector drives are used in elevator applications where speeds range from 50 to over 700 FPM. Baldor is a pioneer in Flux Vector Technology and we continue to be the leader in new product development with our Series 18H Vector Drive, Series 22H Line REGEN Vector Drive and our recently introduced 17H Encoderless Vector Drive.

These are three phase, variable voltage and variable frequency controls. Like an inverter, the control converts AC input voltage to a fixed voltage DC bus supply. This bus is then converted into a synthesized AC Sinewave to the motor. The Vector control precisely controls current into the motor allowing the motor to produce less internal heating resulting in more continuous torque.

The name Vector Drive comes from the mathematical analysis of the electrical circuit formulas governing motor performance. This mathematical analysis uses a vector coordinate system. By monitoring the relative position of the motor's rotor with respect to the stator, the vector drive can determine how much of the applied AC stator current will produce torque and how much will produce heat. The vector drive continuously monitors the rotor position and changes the vector of applied stator voltage to maintain peak motor performance.

Vector drives sense the rotor position by monitoring a position feedback device (encoder) mounted or directly coupled to the motor shaft. The most common feedback device used with vector drives is an incremental encoder. Resolvers are sometimes used when environmental conditions are severe. Baldor vector drive motors are supplied with rugged H25 encoders that provide 1024 pulses per revolution (PPR) with quadrature.

Since the control uses standard encoder feedback (except 17H), regulation is very good at 0.1% of set speed. Full rated torque is available from base speed to zero speed. Since an AC induction motor is used, no brush maintenance is required as with a DC motor.

17H & 18H Controls

The control may be programmed to operate in one of four operating zones; standard constant torque, standard variable torque, quiet constant torque or quiet variable torque. For elevator applications, only the quiet constant torque or quiet variable torque modes are used. The control can also be configured to function in a number of operating modes for custom operation. These choices are programmed using the keypad as explained in the programming section of this manual.

Regenerated power from the motor is applied back to the DC Bus and must be dissipated by REGEN Hardware (resistive load). The REGEN hardware is selected based on the power to be dissipated. The amount of power, duration and frequency of the braking must be taken into consideration when sizing these resistors.

22H Control

The Series 22H Vector is a line regenerative control. Regenerated power is applied back to the incoming power lines.

Regenerated power from the motor is applied to the incoming AC power lines. The Series 22H control meets IEEE 519 (1992) for total harmonic distortion. By returning the excess power back to the line, energy use is reduced for the building. The lower THD causes fewer power problems for sophisticated equipment on the same power grid. No external dynamic braking hardware is required.

Section 3

Application Considerations

General Considerations

A good understanding of elevator applications and requirements is essential for proper selection of drive components. Several classifications or categories can be identified to make selection easier. These are:

1. The speed of the car in the hoistway. Generally speaking, there are low speed, medium speed and high speed elevators.
2. The type of hoisting drive used in the elevator. These include hydraulic, mechanical and electric.

Hydraulic & Mechanical Drives Hydraulic and mechanical drive designs are typically used in low to medium speed elevators.

A rack and pinion elevator is a low speed system. The elevator is on a rack and is driven vertically by a pinion. Speed range is in the 100 to 200 FPM range. In the past, these have been powered by two AC speed motors or DC with generators. They are being modernized and converted to DC SCR controls, Inverters or Vector drives.

Hydro elevators are powered by a submerged AC motor and hydraulic pump assembly. These are generally slow speed elevators operating at 25 to 200 FPM. A hydro elevator application is limited to low rise buildings. The AC motor used in a hydro elevator is fixed speed and doesn't require an adjustable speed control.

For two-speed cable traction elevators, Baldor offers a solid-state starter that allows a soft start and stopping action with an AC induction motor. This Multipurpose control has proven itself on many elevator applications. Contact Baldor for more information on this product.

Electric Drives

Electric drives overlap both of these technologies at their upper limits of speed and extend to elevator speeds of more than 700 feet per minute.

Cable traction elevators are suspended by cable which is wrapped around a drum. The elevator has a counter weight to eliminate having to dead lift the load as in a hoisting application. These cable drums traditionally have been driven by DC motors powered from a motor - generator set. With the introduction of SCR controls in the 60's, many of these were built with SCR controls. The DC motor offers high starting torques and good speed control. The SCR control is relatively simple and reliable in design.

Cable traction elevators can be further sub-divided based on how the torque is transmitted from the motor to the cable drum. These sub-groups are:

1. Worm gear driven at a speed of 50 to 450 FPM.
2. Helical gear driven at a speed of 200 to 500 FPM.
3. Gearless which operates at 400 to 700 FPM and above.

The most common types of elevators that use Baldor drives are cable traction elevators. The DC SCR control is used with many worm gear and gear-less elevators operating in the 350 FPM range. The Series 20H Digital DC SCR control is a good selection for use on gear-less and gear driven elevators. Typical motor requirements are 15 to 75 horsepower.

Inverters may be used on worm gear cable traction elevators operating at 100 to 150 FPM. These slower elevators typically require 7.5 to 10 horsepower motors.

AC powered elevators that operate above 150 FPM should use a Baldor Vector Drive. Vector drives perform well in the 150 to above 700 FPM range. Typical horsepower requirements are 15 to 50 HP.

There are several factors that contribute to a good elevator drive. The predominant requirement for a good elevator is smooth operation without any jerky movement. Another requirement is accurate floor leveling capability. Baldor's ability to offer better value is the reason many customers select Baldor products for their elevator applications.

Common Control Features

- Wide Input Voltage Range
 180 - 264 VAC 60 Hz 180 - 230 VAC 50 Hz
 340 - 528 VAC 60 Hz 340 - 460 VAC 50 Hz
- Keypad operation - A common keypad is used for all Baldor Series H Controls. The keypad is used to program and operate the control.
- Plain English display - The keypad has a 32 character alpha-numeric display. This display shows the control status and parameter settings in plain English.
- Common programming language and techniques are used for DC SCR, Inverter and Vector products.
- Adjustable features - S-Curve, acceleration and deceleration adjustments. Eliminates the need to purchase extra equipment for smooth starts and stops.
- Common expansion boards for convenient input/output connections.
- Matched Performance™ - The motor and control operate well together as a drive. We know how *our* motor will operate when used with *our* control.
- Stable supplier - Baldor's only business is motors and controls. Baldor Electric was formed in 1920 as a motor company and is a quality leader in this market.
- Service - Baldor has a world-wide network of sales and service offices.

Table 3-1 Available Operating Modes

Operating Mode	DC SCR	Inverter	Vector
Keypad	X	X	X
Standard Run, 3 Wire Control	X	X	X
2-Wire Control with 15 Preset Speeds	X	X	X
Bipolar Speed / Torque Control	X		X
Serial	X	X	X
Bipolar Hoist	X		
Fan Pump, 2-Wire Control		X	
Fan Pump, 2-Wire Control		X	
7 Speed Hoist, 2-Wire Control	X		
Process Mode	X	X	X

Elevator Motor Horsepower Selection

Selection of a motor and control for an elevator application is dependent upon several variables. The primary variable is the overall mechanical efficiency of the elevator. The efficiency of gear driven elevators varies from about 45 percent for slow moving cars to 70 percent for faster moving cars. On gear-less elevators, efficiency may be in the 90 percent range.

The horsepower required for a specific application can be calculated as follows:

US Measurement System

$$HP = \frac{LBS \times FPM \times [1 - (\frac{OCW}{100})]}{33,000 \times (\frac{\%EFF}{100})}$$

Where:

- LBS = Car capacity in pounds
- FPM = Car speed in feet per minute (FPM)
- OCW = Over counter weight in %(percent) of car capacity
- %EFF = Elevator mechanical efficiency (decimal)

Metric Measurement System

$$\text{Motor KW} = \frac{Kg \times m/s \times [1 - (\frac{OCW}{100})]}{102 \times (\frac{\%EFF}{100})}$$

Where:

- Kg = Car capacity in Kilograms
- m/s = Car speed in meters per second
- OCW = Over counter weight in %(percent) of car capacity
- %EFF = Elevator mechanical efficiency (decimal)

Table 3-2 can be used to determine the size control and motor to use for your application. Find the “Car Speed” column in the first row of the table. Follow that column down to find the “Car Capacity” row. Follow that row to the left and read the recommended HP/KW size of the motor.

Table 3-2 Motor Sizing

Car Speed Feet / Min.	100	150	200	250	300	350	400	500	700
Car Speed Meters / Sec.	0.5	0.75	1.0	1.25	1.5	1.75	2.0	2.5	3.5
Assumed Mechanical Efficiency	55%	58%	60%	62%	63%	64%	64%	67%	70%

Motor HP Motor kW	Car Capacity in Pounds								
	Car Capacity in Kilograms								
7.5	2300	1600	1250	1030	870	750	660	550	410
5.6	1045	727	568	468	395	341	300	250	186
10	3000	2150	1660	1370	1150	1000	880	740	550
7.5	1364	977	755	623	1150	455	400	336	250
15	4500	3200	2500	2060	1730	1500	1310	1100	410
11.2	2045	1455	1136	936	786	682	595	500	373
20	6050	4300	3300	2750	2300	2000	1750	1470	1090
14.9	2750	1955	1500	1250	1045	909	795	668	495
25	7500	5400	4150	3400	2880	2500	2190	1840	1370
18.6	3409	2455	1886	1545	1309	1136	995	836	623
30	9100	6400	4950	4000	3470	3000	2620	2210	1640
22.4	4136	2909	2250	1818	1577	1364	1191	1005	745
40	12100	8600	6650	5450	4620	4000	3500	2950	2180
29.8	5500	3909	3023	2477	2100	1818	1591	1341	991
50	15125	10700	8300	6840	5760	5000	4370	3670	2730
37.3	6875	4864	3773	2945	2618	2273	1986	1668	1241
60	18150	12870	9900	8200	6940	6000	5250	4430	3280
44.8	8250	5850	4500	3727	3155	2727	2386	2014	1491
75	22685	16090	12375	10300	8650	7500	6560	5520	4100
56	10311	7314	5625	4682	3932	3409	2982	2509	1864

Dynamic Brake Hardware Selection

15H and 18H Drives

Baldor Series 15H Inverters and Series 17H and 18H Vector Drives require optional dynamic brake hardware to dissipate regenerative power from the motor. The conditions causing regeneration for an elevator occur about 50 percent of the time the car is moving. This regenerative power is produced when:

1. When a lightly loaded car is being raised.
2. When a fully loaded car is being lowered.
3. Whenever the car is decelerated.

Regenerative power is calculated in the same way as the motor and drive horsepower except that efficiency losses decrease the amount of energy to be absorbed.

The watt rating of the Dynamic Brake (or REGEN) hardware required for a specific application can be calculated as follows:

US Measurement System

$$\text{Watts} = \left(\frac{\text{LBS} \times \text{FPM} \times \left[1 - \left(\frac{\text{OCW}}{100} \right) \right] \times \% \text{EFF}}{88} \right) \times 1.25$$

Where:

- LBS = Car capacity in pounds
FPM = Car speed in feet per minute (FPM)
OCW = Over counter weight in %(percent) of car capacity
%EFF = Elevator mechanical efficiency (decimal)

Metric Measurement System

$$\text{Watts} = \left(\frac{\text{Kg} \times \text{m/s} \times \left[1 - \left(\frac{\text{OCW}}{100} \right) \right] \times \% \text{EFF}}{0.202} \right) \times 1.25$$

Where:

- Kg = Car capacity in Kilograms
m/s = Car speed in meters per second
OCW = Over counter weight in %(percent) of car capacity
%EFF = Elevator mechanical efficiency (decimal)

The calculations show a value of 25% greater than the base calculation. This over sizing allows for normal variations in values and operating conditions. The resulting power value compensates for high ratio worm gear drives having substantially lower back driving efficiency than forward driving efficiency.

19H Drives

Not used in elevator applications.

20H, 21H and 22H Drives

No dynamic braking hardware is required for these drives.

Baldor's Series 20H DC SCR, Series 21H Inverter and Series 22H Vector Drives are all line regenerative drives. Excess energy is supplied back to the incoming AC power line.

Section 4

Hardware Information

General Considerations

All Baldor Series H drives are designed for ease of use. The keypad interface provides the same interface for each Series H control. In other words, if you are familiar with parameter set-up for one Series H drive type, the set-up for another Series H drive is similar.

Power and logic wiring are essentially the same. Depending on the technology, feedback wiring may be different.

For elevator applications, it is not possible to uncouple the load from the motor to “Auto-tune” the motor parameters. Therefore, the parameter values can be calculated and manually entered manually.

Encoder Retrofit

Use care when an encoder is to be installed on a motor that is not equipped with one. An encoder may be used with a DC SCR or Vector control and motor. Encoders cannot be used with inverter controls and motors. The encoder housing must be rigidly mounted to the existing motor case and an anti-backlash coupling must be used. Baldor offers a special encoder kit designed for modernization which includes the rugged 1024 PPR H25 encoder, adapter, special coupling, stub shaft, hardware and mounting template.

Electrical isolation of the encoder case and shaft from the motor is highly recommended to prevent capacitively-coupled motor noise from degrading the encoder signal. This feature is standard on Baldor’s Elevator Drive DC and Vector Drive motors. If the encoder added during the modernization is later found to have electrical noise because it couldn’t be electrically isolated, adding an Isolated Encoder expansion board may help with the electrical noise problems.

Cable Preparation

Encoder wiring must be shielded twisted pairs, #22 AWG (0.34mm²) minimum size, 200’ maximum length, with an insulated overall shield. Belden 9891 and Manhattan M4190 cables are suitable.

Control End (See Figure 3-1.)

1. Strip the outside jacket approximately 0.375” (9.5mm) from the end.
2. Solder a #22 AWG (0.34mm²) wire to the braided shield.
3. Connect all shields to J1-30. To do this, solder a “Drain Wire” from each shield to the wire soldered to the braided shield in step 2.
4. Insulate or tape off ungrounded end of shields to prevent contact with other conductors or ground.

Encoder End

1. Strip the outside jacket approximately 0.375” (9.5mm) from the end.
2. Identify each of the four twisted pair and label or use the color codes shown in Figure 3-2 for the optional Baldor Encoder Cable.
3. Insulate or tape off ungrounded end of shields and unused conductors to prevent contact with other conductors or ground.

⚠ CAUTION: Do not connect any shields to the encoder case or motor frame. The encoder +5VDC supply at J1-29 is referenced to circuit board common. Do not connect any shields to ground or another power supply or damage to the control may result.

Figure 3-1 Encoder Cables

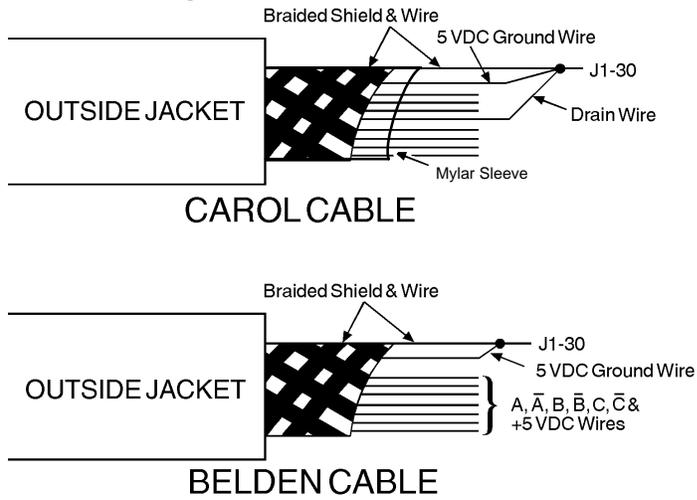
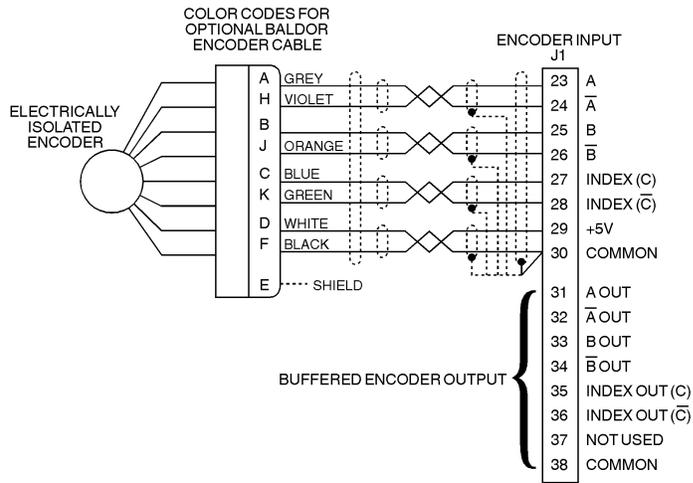


Figure 3-2 Encoder Connections



See Control manual for proper terminal tightening torque.

Encoder Cable Connection

Encoder cable must be separated by at least 3" from parallel runs of power wires. Encoder cables that cross power wires must cross at a 90° angle only. Encoder wires must be #22 AWG (0.34mm²) minimum, 200 feet maximum length and must have an overall shield.

Note: Be careful not to pinch the wires' insulation in terminal. If insulation is caught in screw terminal, proper electrical connection will not be made. Encoder will not operate properly.

1. Feed the control end of the cable through one of the holes in the control case so connections can be made inside the control.

2. **Differential Connections**

Connect the cable braided shield to J1-30 at control end.

Connect the cable ends as follows: (See Figure 3-2.)

<u>Encoder End</u>	<u>Control End</u>
A	J1-23 (A)
H	J1-24 (\bar{A})
B	J1-25 (B)
J	J1-26 (\bar{B})
C	J1-27 Index(C)
K	J1-28 Index(\bar{C})
D	J1-29 (+5VDC)
F	J1-30 (Common)
E	N/C

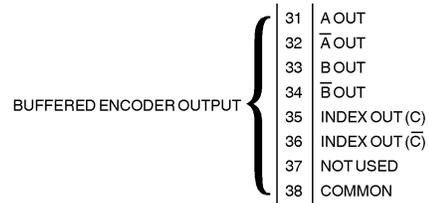
3. **Single Ended Connections**

Differential inputs are recommended for best noise immunity. If only single ended encoder signals are available, connect them to A, B, and INDEX (C) (J1-23, J1-25 and J1-27 respectively).

Buffered Encoder Output

The DC SCR and Vector controls provides a buffered encoder output on pins J1-31 to J1-38 as shown in Figure 3-3. This output may be used by external hardware to monitor the encoder signals. It is recommended that this output only drive one output circuit load. Driving multiple loads is not recommended.

Figure 3-3 Buffered Encoder Output



See Control manual for proper terminal tightening torque.

Section 5 Set-Up Information

DC SCR Controls

DC motors use voltage to obtain their speed and current to develop their output torque. A DC SCR control must be able to supply the required voltage and current to operate the motor under all conditions of load and speed.

Note: Do not assume that having the required horsepower is sufficient information to size the control. You will need to know the maximum voltage and current. The motor nameplate should be the source for the RMS (continuous) ratings but actual measurements should be made to determine the maximum required current and voltage with the elevator loaded to capacity.

Field Control

Remember that the Series 20H control's DC output is a maximum of 113% of input voltage for the armature and up to 85% of input voltage for the field. This means that if the field voltage is more than 195 volts for a 230 volt AC line, a single phase transformer must be used to boost the AC input to the field power module. Some gearless elevator DC motors have odd voltages which need to be supplied from special controls through isolation transformers.

All Series 20H field power modules can be operated from 480 VAC or less, regardless of the catalog or spec number of the control. The standard field power supply module is rated for 15 amps maximum, but a 40 amp field power module is available as an option.

Feedback

Most elevator DC controls operate closed loop which means that the motor speed is fed back to the control using a DC tachometer, encoder or resolver. The feedback device is usually coupled to the motor shaft but also may operate from a wheel on the sheave. A DC tachometer is the most common feedback device and this requires the EXB006A01 expansion board mounted in the Series 20H.

Gearless elevators often benefit from using encoder feedback due to the higher resolution of the feedback signal during low speed (leveling) conditions. The Encoder interface is built into in the Series 20H while a DC tach or resolver feedback requires an expansion board. A DC tach may be used on a gearless elevator but it should be optimized to give a high DC volts per RPM output.

Typical DC tachometers provide 50, 60, 100 or 200 volts DC output per 1000 RPM when coupled 1:1 to the motor. Encoders are usually 1000 or 1024 pulses per revolution (PPR).

Note: The boosted voltage must be in phase with the incoming lines L1 and L2.

Initial Installation and Startup

When installed in a panel, the Series 20H control should be located away from sources of heat and in an area where the keypad is visible and convenient to operate. See the Series 20H manual (MN720) for additional installation information, watts loss requirements, and other information regarding the selection of a mounting location. Any required expansion boards should be installed before applying power. Preliminary programming should include setting the following:

1. Level 1 Input Block, Operating Mode.
2. Level 1 Output Block, Opto Output values.
3. Level 1 DC Control Block, all parameters.
4. Level 2 Output Limits Block, all parameters.
5. Level 2 Motor Data Block, all parameters.

Other parameters will be set after final installation.

Note: In many elevator applications the BIPOLAR HOIST MODE is used with the elevator controller as well as an external S-Curve generator.

Final Installation

After the control has been mounted and wired, the final settings can be made.

1. The CALC PRESETS, CMD OFFSET TRIM (if using any analog mode), and CUR LOOP COMP auto tune tests should be performed. Close the armature contactor when doing the CUR LOOP COMP test.
2. The elevator should be operated at inspection speed to set the FEEDBACK DIRECTION and verify the jumper settings on the DC tachometer expansion board (if one is installed). The feedback direction is correct when the motor runs in both directions at a stable speed with an inspection speed command. If the motor attempts to “run away”, change the FEEDBACK DIRECTION parameter in the DC CONTROL block (or reverse the DC Tachometer leads at terminals 1 and 4 of the DC Tachometer expansion board).
3. When the motor can be rotated using automatic control, the field current and voltage should be measured and verified against the motor nameplate rating. Field Forcing, Running and Standing currents can be produced in only the two Hoist modes. Forcing the field is possible using an external input signal.
4. Operate the car at contract speed. Adjust the ACCEL, DECEL and S-CURVE parameter values as required for best ride.

Note: The BIPOLAR HOIST MODE is used in many applications with an external S-curve generator. In this case, Accel, Decel and S-Curve parameters should be set to 0.

5. In the DC CONTROL block, adjust the RATE PROP and RATE INT gains to provide the smoothest ride and best performance for empty car, balanced car and full capacity conditions.
6. When optimum conditions are achieved, set the following LEVEL 2, PROTECTION block parameters:
OVERLOAD = FAULT
FOLLOWING ERROR = ON
TORQUE PROVING = ON

Be certain to test these settings under empty car and full capacity conditions, and in both directions of travel. It may be necessary to increase the Level 1 OUTPUT block, At Speed Band parameter value to prevent a trip at capacity in the down direction. Torque proving may not be usable with low current motors.

Final Adjustments

Roughness and instability of motor operation are often the result of a loosely mounted feedback device. Incorrect adjustment of the Level 1 DC Control, ARM PROP GAIN parameter and/or the SPEED PROP GAIN can also cause speed instability and oscillation of the car.

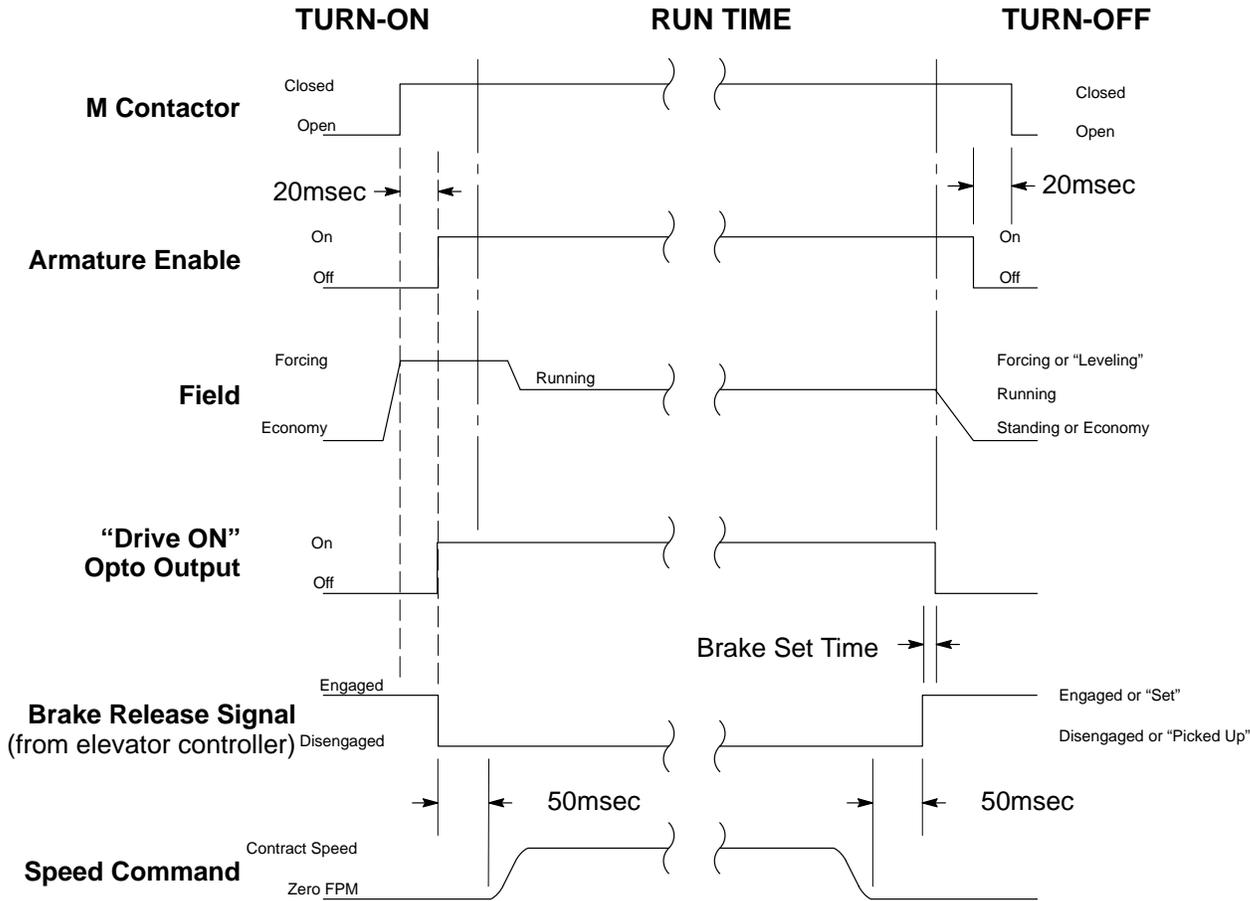
Note: It is desirable to have the ARM PROP GAIN as high as possible without oscillation and the SPEED PROP GAIN as low as possible without rollback or overshoot.

If adjustment of the SPEED PROP GAIN parameter does not help, check the feedback device for lost motion. Any lost motion from either the coupling or the mount will affect the motor's operation.

Recommended Power Up/Down Sequence for Elevators Using DC SCR Controls

The following is a recommended sequence for turning on and off the elevator drive and external OEM control. Figure 5-4 shows this sequence.

Figure 5-4 Typical Power Up/Down Sequence for DC SCR Controls.



Sequence:

1. Close the M Contactor. Approximately 20msec is required for the contacts to close and connect the Control to the Motor and complete the armature loop.
2. The field is controlled independently of the armature. The field can be at running voltage (or at forcing voltage) prior to actual commanding speed.
3. Armature enable (pin J1-8 of the DC SCR Control) allows the SCR's to begin firing.
4. The “Drive ON” Opto output from the DC SCR Control provides an indication (for the elevator control) that the drive is ready to act on Speed or Torque commands.
5. Zero speed command should be held until the brake has actually disengaged, allowing the car to move.

Inverter Controls

AC induction motors may have their speed adjusted by using an AC Inverter (VVVF) to change the voltage and frequency supplied to the motor. The motor speed will be relatively proportional to the frequency supplied. An AC Inverter must be able to supply the amount of current the motor requires both on a continuous and peak basis under all conditions of load and speed.

Note: Do not assume that having the required horsepower is sufficient information to size the control. You will need to know the maximum voltage and current. The motor nameplate should be the source for the RMS (continuous) ratings but actual measurements should be made to determine the maximum required current and voltage with the elevator loaded to capacity.

Initial Installation and Startup

When installed in a panel, the Series 15H control should be located away from sources of heat and in an area where the keypad is visible and convenient to operate. Refer to Series 15H manual (MN715) for installation information, watts loss requirements, and other information regarding the selection of a mounting location. Expansion boards should be installed before applying power.

Preliminary Programming After the control has been mounted and wired, the final settings can be made.

1. Level 1 Input Block, Operating Mode.
2. Level 1 Output Block, Opto Outputs.
3. Level 1 V/Hz and Boost, starting with:

CTRL BASE FREQ	60
TORQUE BOOST	5
DYNAMIC BOOST	10
SLIP COMP ADJ	2.0
V/HZ PROFILE	3PT
V/HZ 3 PT. VOLTS	10
V/HZ 3PT. FREQ	1.6
MAX OUTPUT VOLTS	100
4. Level 2 Output Limits Block, all parameters.

OPERATING ZONE	QUIET CT
PK CURRENT LIMIT	Set to max available
5. Level 2 Motor Data Block, all parameters.
6. Level 2 Brake Adjust, all parameters.
7. Set the following Level 2, Protection Block, EXTERNAL TRIP parameter to ON.
8. Calculate the size of the dynamic brake (DB) Hardware required. Refer to MN701 for sizing and selection information. Connect the DB hardware as described in MN715.
9. Operate the elevator at inspection speed. Check for correct operation of the elevator.
10. Operate the elevator at contract speed. Adjust the ACCEL, DECEL and S-CURVE parameter values as required for the best ride.

Note: In many elevator applications, the STANDARD RUN or 15 SPEED MODE is used depending on the elevator controller as well as an external S-curve generator.

Recommended Power Up/Down Sequence for Elevators Using Inverter Controls

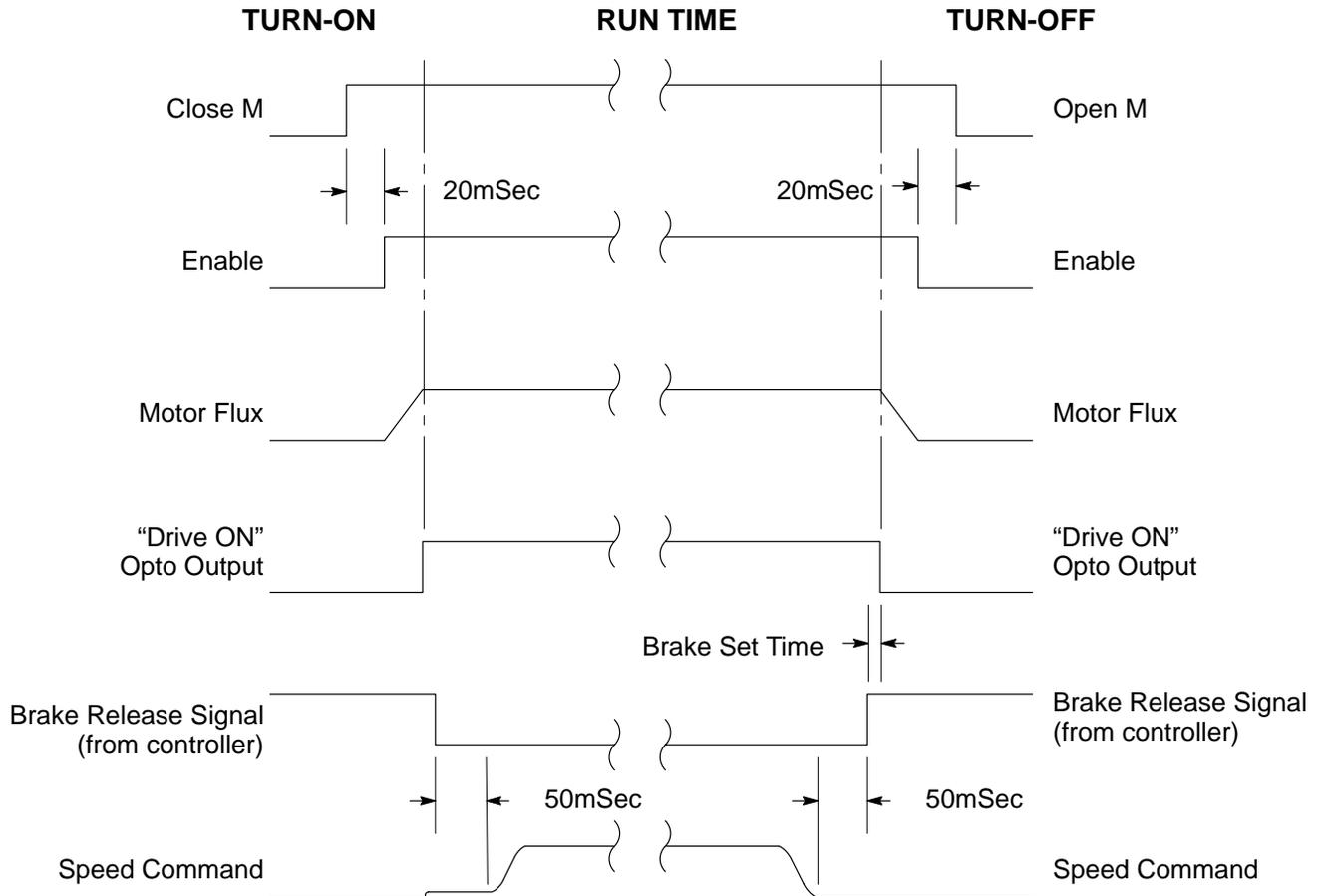
The following is a recommended sequence for turning on and off the elevator drive and external OEM controller. Figure 5-5 shows this sequence.

1. Close the M-Contactor.
2. Close the drive ENABLE.
3. Use the DRIVE ON opto output to energize an external coil for a relay to perform the following:
 - a. Signal the OEM elevator controller, computer or PLC to engage or disengage the holding brake and feed the speed command reference (pattern generator) signal into the drive. There should be a 50 mSec (milli-second) delay between the brake release signal and the speed command signal. This allows time to release the brake mechanically.
 - b. The time between DRIVE ON and the ENABLE signal allows flux to build up in the AC motor. This delay should be at least 20 mSec.
4. An inverter drive will not hold the car in position until the brake is set. When the car reaches the floor, open the J4-8 ENABLE and J4-11 STOP inputs at the same time.

Recommended Power Up/Down Sequence for Elevators Using Inverter Controls

The following is a recommended sequence for turning on and off the elevator drive and external OEM control. Figure 5-5 shows this sequence.

Figure 5-5 Power Up/Down Sequence for Inverter Controls.



Vector Controls

If this is a modernization, do not disconnect the old control from the motor. It is needed to operate the motor for some preliminary measurements before it is disconnected. See Modernization.

Equipment Required

The following equipment is required for this upgrade.

1. Elevator rated AC induction motor with encoder installed.
2. Baldor Series 18H or 22H Vector Control.
3. Elevator system controller (PLC-not supplied by Baldor). This controller will be connected to the Vector Control.
4. Clamp-On AC Amp Meter. (Voltage and Current range depend on the motor).

New Installations

For new elevator installations that are pre-configured by the OEM, perform the following: (Skip this procedure if this is a modernization).

1. Install the motor and Vector Control. Refer to the Installation and Operating Manual supplied with the control for mounting and wiring instructions.
2. Refer to the Installation and Operating manual. Perform the following parts of the Manual Tuning procedure: CALC Presets, CMD Offset Trim and CUR Loop Comp. Be sure the motor contactor is closed for the CUR Loop Comp test.
3. Apply power. Adjust the Level 1 Vector Control block, Current Prop Gain and Speed Prop Gain parameter values for best ride.

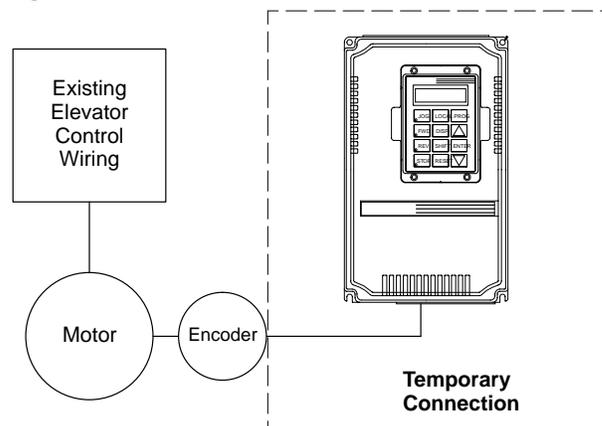
Modernization

For modernization of an existing installation, perform these steps **instead** of those for "New Installation":

⚠ Caution: Check the motor nameplate ratings and the input voltage at the power source and be sure that they match. If the measured input voltage is different than the rated voltage on the nameplate do not proceed. The Vector control ratings must match the motor ratings and the input line voltage. If the Vector Control nameplate shows the input voltage and frequency required for proper operation. Other input power may damage the control. Refer to the Vector Control manual for installation considerations.

1. Disconnect all elevator power.
2. Modify the existing motor and mount the encoder. Temporarily connect the encoder to the Vector control J1 terminals (***Do not connect the motor leads to the Vector Control***). See Figure 5-1. The existing elevator control will be used to drive the load for these tests. Encoder connections are describe in Section 4 of this manual.

Figure 5-1 Initial Vector Control Connection



Modernization Continued

3. Apply power to the existing elevator control wiring and the Vector Control.
4. Refer to Table 5-2 “Pre-Installation Tests”. Perform all tests with the elevator connected in this temporary configuration. It is important to record all information for future use. These tests are performed with the existing elevator control.
5. **Balanced Car Test**
 - a. A balanced elevator car is required for this test.
 - b. Apply power to the Vector control and press the DISPLAY button until the motor speed RPM is displayed.
 - c. Operate the elevator at contract speed in both the up and down directions. Recording the AC line voltage, motor current and motor speed in both directions of travel.

Note: If the RPM display is erratic or varies more than 10 RPM at contract speed, there may be a problem involving the encoder mounting, wiring or shielding. Eliminate the problem and rerun the test.

6. **Full Load Test**
 - a. Load the elevator car to its rated capacity. (Use a distributed load, not a point load).
 - b. Operate the elevator at contract speed in both the up and down directions. Recording the AC line voltage, motor current and motor speed in both directions of travel.
 - c. Verify the motor current under full load at contract speed does not exceed the rating of the Vector Control. If the measured current exceeds the motor’s nameplate rating, then the motor and Vector control may be undersized for the application. This must be evaluated and corrected before continuing with the Vector control installation.
 - d. AC line voltages recorded during the tests should be within the operating range for the Vector control as specified in the Installation and Operating Manual that is supplied with the control.

 **Caution:** If the full load measurements exceed the ratings stated on the motor or control nameplates, do not proceed. A correctly sized Vector Control and Motor must be installed. Otherwise, equipment damage may result.

Final Wiring Connections

1. Disconnect all electrical power to all controls.
2. Disconnect the temporary wiring that was used for the Pre-Installation tests from the Vector control.
3. Connect the Vector control to the AC line, motor and encoder as shown in the Installation and Operating Manual supplied with the Vector control.
Refer to the sections in that manual for recommendations on wire size, terminal torques, grounding, noise and other pertinent information.
4. Connect the elevator system controller to the Vector control as described in Section 3 of the Series 18H manual MN718. Use the configuration described for the Bipolar Speed or Torque Control Mode.

Note: Refer to the diagram supplied by the elevator controller manufacturer for specific instructions.

Series 18H Control Considerations:

If using a Baldor Series 18H Vector control, be sure to calculate the appropriate wattage of braking hardware as calculated in Dynamic Braking (DB) Hardware manual MN701. The dynamic brake hardware is available from your Baldor distributor. Additional brake hardware installation information is provided in MN718.

Initial Set-up

If the Vector control has already been programmed by the OEM, the correct motor data has been installed. If this information has not been programmed, set the correct parameter values (refer to the interface specifications from the elevator controller OEM).

You will need the following information to perform the initial setup:

- The information obtained and recorded in Table 5-2 for the following steps:
- Interface Specifications, Operating mode and data from the elevator OEM.
- The Installation and Operator manual for the Vector Control.

Procedure:

1. Verify that all wiring is correct before you proceed.
2. Apply power to the Vector control.
3. Program (or verify OEM programming) the Vector control as follows:
(Be sure to record your settings in the Parameter Block Values table of the Vector Control manual.)
 - a. Set Level 1 PRESET SPEEDS as desired.
 - b. Set Level 1 ACCEL/DECEL Rate Block, ACCEL TIME #1 as desired.
 - c. Set Level 1 ACCEL/DECEL Rate Block, DECEL TIME #1 as desired.
 - d. Set Level 1 ACCEL/DECEL Rate Block, S-CURVE #1 as desired.
 - e. Set Level 1 INPUT Block, OPERATING MODE as desired.
 - f. Set Level 1 OUTPUT Block, OPTO OUTPUTs #1 to #4 as desired.
Be sure to set on of the OPTO OUTPUTS to "DRIVE RUN".
 - g. Set Level 1 VECTOR CONTROL Block, FEEDBACK ALIGN as desired.
Improper setting will result in peak motor current and slow or jerky operation.
 - h. Set Level 1 VECTOR CONTROL Block, SPEED PROP GAIN as desired.
Begin with a value of 20 and increase or decrease value for best performance.
 - i. Set Level 1 VECTOR CONTROL Block, SPEED INT GAIN as desired.
This value is normally set to 1. Change this value if the car is not aligned with the floor at the end of deceleration.

Initial Set-up

Continued

- j. Set Level 1 VECTOR CONTROL Block, SLIP FREQUENCY as desired. This value can be calculated from the values recorded previously in Table 5-2. Record these calculated values in Table 5-3.

Calculate the Slip RPM of the motor:

$$\text{Slip RPM} = (\text{RPM of Balanced Car}) - (\text{RPM of Fully Loaded Car})$$

Calculate the % of Motor Loading:

$$\% \text{ Rated Motor Load} = \left(\frac{\text{Full Load AC Motor Current}}{\text{Rated Motor Amps}} \right) \times 100\%$$

Determine the Slip Adjustment Value from Table 5-1.

Table 5-1 Slip Adjustment Value.

% Rated Motor Load	Slip Adjustment Value
100 - 110%	1.0
90 - 100%	1.1
80 - 90%	1.3
70 - 80%	1.5

Calculate the Slip Frequency parameter value:

$$\text{Slip Frequency} = \frac{\text{Line Frequency} \times \text{Slip RPM} \times \text{Slip Adjustment Value}}{\text{RPM of Balanced Car}}$$

- k. Set Level 2 Operating Zone as desired (usually Quiet Constant Torque).
- l. Set Level 2 Output Limits block, MIN OUTPUT SPEED parameter.
- m. Set Level 2 Output Limits block, MAX OUTPUT SPEED parameter.
- n. Set Level 2 MOTOR DATA block parameters:
Motor Voltage (input)
Motor Rated Amps (FLA)
Motor Rated Speed (Base Speed)
Motor Rated Frequency
Motor Mag Amps (no load current)
4. Manual Tuning Method - Because the load cannot be uncoupled from the motor shaft, proceed with the manual tuning procedure. The manual tuning procedure is provided in MN718 for the Series 18H Vector Control.

Final Set-up

After Initial Set-up is complete, operate the elevator using the Vector control and make any final adjustments. Accel, Decel and S-Curve values may need adjustment for smooth operation.

Recommended Power Up/Down Sequence for Elevators Using Vector Controls

The following is a recommended sequence for turning on and off the elevator drive and external OEM control. Figure 5-2 shows this sequence.

1. Close the M-Contactor.
2. After a 20mSec minimum delay (to ensure the M Contactor is closed), close the drive ENABLE input. This will allow current to flow and the IGBT's to begin switching.
3. The "Drive ON" Opto output will be active when the Motor MAG AMPS have reached the programmed value. Use the Drive ON opto output to energize an external coil for a relay to perform the following:
 - A. Signal the OEM elevator controller, computer or PLC to engage or disengage the holding brake and feed the speed command reference (pattern generator) signal into the drive. There should be a 50 milli-seconds delay between the brake release signal and the speed command signal. This allows time to release the brake mechanically.
 - B. The time between DRIVE ON and the ENABLE signal allows flux build-up in the AC motor. This delay should be no less than 20 mS. The TORQUE PROVING fault will prevent a DRIVE ON output if the Vector drive is not applying current to the motor due to an open contactor, broken motor lead or open motor winding. If during operations a fault occurs, then the DRIVE ON and READY both go inactive, engage the brake and open the motor contactor.
4. Once the elevator reaches the floor, a zero speed command should be held until the brakes are set.
5. Disable the Vector drive after the brake is set, and then open the M-Contactor.

Figure 5-2 Power Up/Down Sequence for Vector Controls.

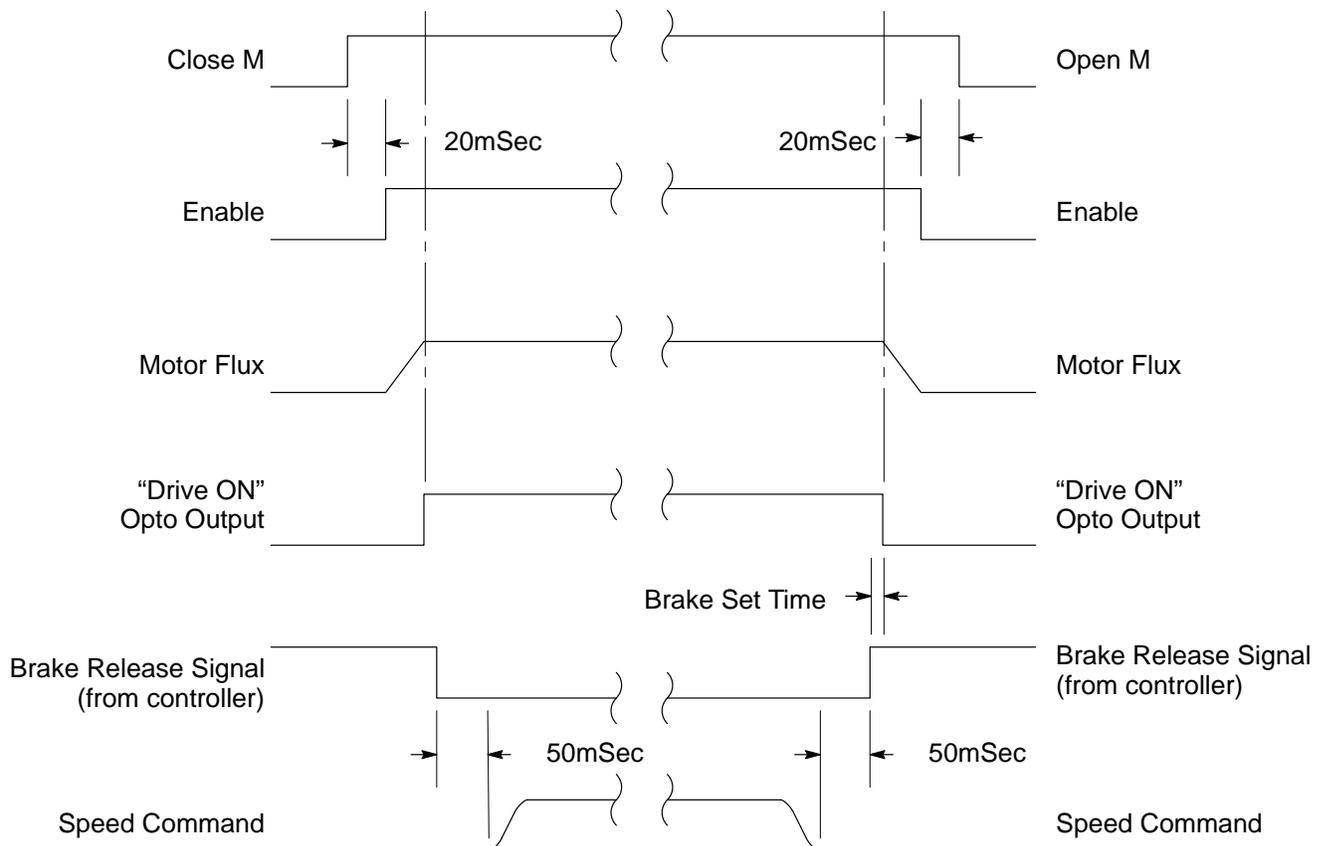


Table 5-2 Pre-Installation Tests

Date: _____

Customer:		
Address:		
Elevator Location:		
Address:		
Motor Ratings (From Nameplate)		
Rated Voltage:	Rated Current:	
Rated Speed (RPM):	Rated Frequency:	
Installation Data		
Encoder Counts (PPR):	Operating Mode:	
Dynamic Operating Conditions		
Balanced Car Test	UP	DOWN
AC Line Voltage		
AC Motor Current		
Speed (RPM)		
Full Load Test	UP	DOWN
AC Line Voltage		
AC Motor Current		
Speed (RPM)		

Table 5-3 Vector Control Worksheet

Date: _____

Catalog Number:	Rated Voltage:
Rated Horse Power:	Rated Current:
Slip RPM:	% Rated Motor Load:
Slip Adjustment Value:	Slip Frequency:
Installed by: _____	
Date: _____	

Section 6 Troubleshooting

DC SCR Control

Roughness of car ride quality and instability of motor operation are often a result of poor mounting of the feedback device. Incorrect adjustment of the ARM GAIN and/or the RATE PROP GAIN can also cause speed instability and oscillation of the car. If adjustment of RATE PROP GAIN does not help, check the feedback device for misalignment, slippage, sensitivity to mechanical vibration. Any of these problems in the coupling or the mount will affect the motor's operation. Running feedback wiring too close to the AC or DC power wiring will also cause roughness. Switching parameter tables or ACC/DEC tables while the speed is changing may also cause a bump in the car travel due to a recalculation of the slope, required to prevent excessive jerk.

If wires for the feedback device are placed too close to AC or DC power wires, roughness of motor operation may result. This is due to the induced noise from the power wires. Other causes could be 1.) selecting a different parameter table or 2.) selecting a different ACC/DEC table while motor speed is changing. Either of these changes may also cause a bump in the car travel due to a recalculation of the slope.

Noisy motors often result from insufficient filtering of the 360 Hz AC ripple of the DC output voltage. An SCR based control is not capable of producing "generator quality" DC voltages, so a filter assemble (made from a DC-rated inductor and non-polarized capacitors) on the DC loop is often used to reduce or eliminate noise.

Fuse blowing may result if the ARM GAIN setting is too high for the application. Reduce the ARM GAIN by 50% and verify proper operation.

Other problems should result in a fault displayed as an entry in the Fault Log. Refer the the Series 20H manual on how to access and interpret these faults. Additional troubleshooting information is also in this manual.

Electrical Noise Considerations All electronic devices including a Series H Control are vulnerable to significant electronic interference signals (commonly called “Electrical Noise”). At the lowest level, noise can cause intermittent operating errors or faults. From a circuit standpoint, 5 or 10 millivolts of noise may cause detrimental operation. For example, analog speed and torque inputs are often scaled at 5 to 10 VDC maximum with a typical resolution of one part in 1,000. Thus noise of only 5 mv represents a substantial error.

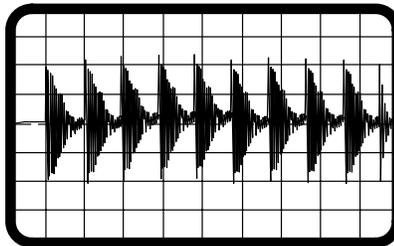
At the extreme level, significant noise can cause damage to the drive. Therefore, it is advisable to prevent noise generation and to follow wiring practices that prevent noise generated by other devices from reaching sensitive circuits. In a control, such circuits include inputs for speed, torque, control logic, and speed and position feedback, plus outputs to some indicators and computers.

Causes and Cures

Unwanted electrical noise can be produced by many sources. Depending upon the source, various methods can be used to reduce the effects of this noise and to reduce the coupling to sensitive circuits. All methods are less costly when designed into a system initially than if added after installation.

Figure 6-1 shows an oscilloscope trace of noise induced (as the coil circuit is opened) in a 1-ft. wire located next to a lead for a Size 2 contactor coil. Scope input impedance is 10K Ω for all scope traces. Maximum peak voltage is over 40V. Unless well filtered this is often enough noise to ruin the output of a productive machine.

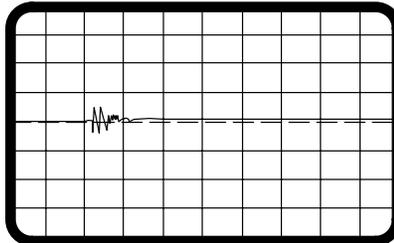
Figure 6-1 Electrical Noise Display



Relay and Contactor Coils Among the most common sources of noise are the ever-present coils of contactors and relays. When these highly inductive coil circuits are opened, transient conditions often generate spikes of several hundred volts in the control circuit. These spikes can induce several volts of noise in an adjacent wire that runs parallel to a control-circuit wire.

To suppress noise in these AC coils, add an R-C snubber across each relay and contactor coil. A snubber consisting of a 33K Ω resistor in series with a 0.47 μ f capacitor usually works well. The snubber reduces the rate of rise and peak voltage in the coil when current flow is interrupted. This eliminates arcing and reduces the noise voltage induced in adjacent wires. In our example, the noise was reduced from over 40 V zero-to-peak (VOP) to about 16 VOP as shown in Figure 6-2.

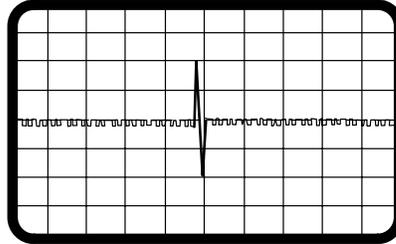
Figure 6-2 R-C Snubber Circuit



Electrical Noise Considerations Continued

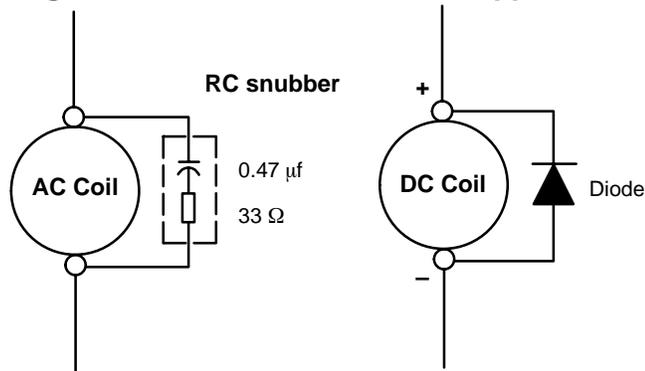
Combining an R-C snubber and twisted-pair shielded cable keeps the voltage in a circuit to less than 2 V for a fraction of a millisecond. The waveform shown in Figure 6-3 in addition to the snubber across the coil, the adjacent wire is grounded in a twisted-pair, shielded cable. Note that the vertical scale is 1 V/div., rather than the 20 V/div. in figures 6-1 and 6-2. This shows that snubbers and twisted-pair shielded wire should be used for sensitive circuits located adjacent to coil wires.

Figure 6-3 R-C Snubber Circuit & twisted-pair



A reverse biased diode across a DC coil achieves the same result as adding an R-C snubber across an AC coil, Figure 6-4.

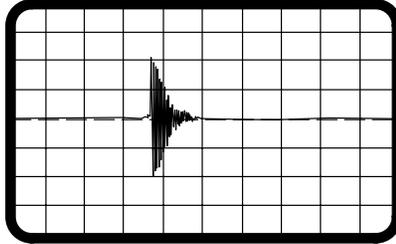
Figure 6-4 AC & DC Coil Noise Suppression



Wires between Controls and Motors

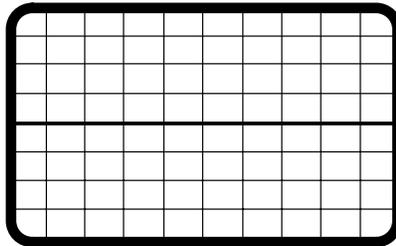
Output leads from a typical 460 VAC drive controller contain rapid voltage rises created by power semiconductors switching 650V in less than a microsecond, 1,000 to 10,000 times a second. These noise signals can couple into sensitive drive circuits as shown in Figure 6-5. For this waveform, a transient induced in 1 ft. of wire adjacent to motor lead of a 10 hp, 460 VAC drive. Scope is set at 5 V/div. and 2 μ sec/div.

Figure 6-5 10HP, 460VAC Drive



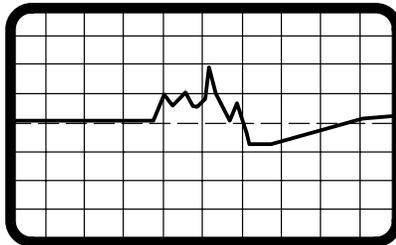
If the shielded pair cable is used, the coupling is reduced by nearly 90%, Figure 6-6.

Figure 6-6 10HP, 460VAC Drive, Shielded



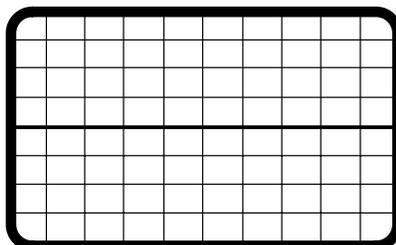
The motor leads of DC motors contain similar voltage transients. The switching rate is about 360 times a second. These noise transients can produce about 2V of noise induced in a wire adjacent to the motor lead. A 30HP, 500VDC Drive, as shown in Figure 6-7. Scope is set at 1 V/div. and 5 μ sec/div.

Figure 6-7 30HP, 500VDC Drive



Again, Replacing a single wire with a shielded pair cable reduces the induced noise to less than 0.3 V, Figure 6-8.

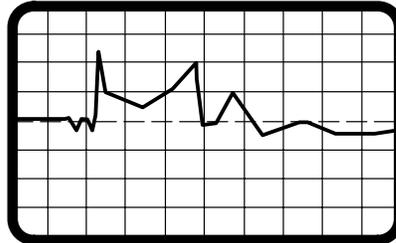
Figure 6-8 30HP, 500VDC Drive, Shielded



Electrical Noise Considerations Continued

Even input AC power lines contain noise and can induce noise in adjacent wires. This is especially severe with SCR controlled DC drives, current-source and six-step inverters. Figure 6-9 shows a transient induced in 1-ft. wire adjacent to AC input power wire to 20 hp, DC drive. Scope is set at 500 mV/div. and 2 μ sec/div.

Figure 6-9 30HP, 500VDC Drive, Shielded



To prevent induced transient noise in signal wires, all motor leads and AC power lines should be contained in rigid metal conduit, or flexible conduit. Do not place line conductors and load conductors in same conduit. Use separate conduit for 3 phase input wires and motor leads. The conduit should be grounded to form a shield to contain the electrical noise within the conduit path. Signal wires - even ones in shielded cable should never be placed in the conduit with motor power wires.

If flexible conduit is required, the wires should be shielded twisted-pair. Although this practice gives better protection than unshielded wires, it lacks the protection offered by rigid metal conduit.

Special Drive Situations For severe noise situations, it may be necessary to reduce transient voltages in the wires to the motor by adding load reactors. Load reactors are installed between the control and motor. These are often required where a motor housing lacks the necessary shielding (typically linear motors mounted directly to machine frames) or where the power wires to motors are contained in flexible cables.

Reactors are typically 3% reactance and are designed for the frequencies encountered in PWM drives. For maximum benefit, the reactors should be mounted in the drive enclosure with short leads between the control and the reactors. Baldor offers a complete line of line and load reactors that will reduce ripple current and improve motor life.

Drive Power Lines

The same type of reactor as installed on the load side of the control can also suppress transients on incoming power lines. Connected on the line side of the drive, the reactor protects the adjustable-speed drive from some transients generated by other equipment and suppresses some of the transients produced by the drive itself.

Radio Transmitters

Not a common cause of noise, radio frequency transmitters, such as commercial broadcast stations, fixed short-wave stations, and mobile communications equipment (including walkie talkies) create electrical noise. The probability of this noise affecting an adjustable-speed drive increases with the use of open control enclosures, open wiring, and poor grounding.

Electrical Noise Considerations Continued

Control Enclosures

Motor controls mounted in a grounded enclosure should also be connected to earth ground with a separate conductor to ensure best ground connection. Often grounding the control to the grounded metallic enclosure is not sufficient. Usually painted surfaces and seals prevent solid metallic contact between the control and the panel enclosure. Likewise, conduit should never be used as a ground conductor for motor power wires or signal conductors.

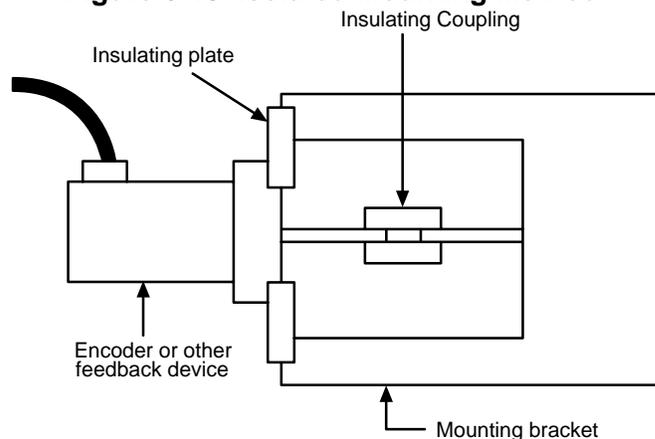
Special Motor Considerations

Motor frames are also on the required grounding list. As with control enclosures, motors should be grounded directly to the control and plant ground with as short a ground wire as possible. Here's why. Capacitive coupling within the motor windings produces transient voltages between the motor frame and ground. The severity of these voltages increases with the length of the ground wire. Installations with the motor and control mounted on a common frame, and with heavy ground wires less than 10 ft. long, rarely have a problem caused by these motor-generated transient voltages.

Another cure may be needed when the motor frame transient voltages are capacitively coupled to feedback devices mounted on the motor shaft. Especially with optical encoders, these transients create noise on the signal leads and disrupt drive operation.

To prevent this problem, add electrical isolation between the motor and the feedback device to stop the current flow and the resulting transients. The most simple isolation method, shown in Figure 6-10, has two parts: 1) A plate of electrical insulating material placed between the motor mounting surface and the feedback device. 2) An insulating coupling between motor shaft and the shaft of the feedback device.

Figure 6-10 Isolated Mounting Method



Wiring Practices

The type of wire used and how it is installed for specific applications makes the difference between obtaining reliable operation and creating additional problems.

Power Wiring

Conductors carrying power to anything (motor, heater, brake coil, or lighting units, for example) should be contained in conductive conduit that is grounded at both ends. These power wires must be routed in conduit separately from signal and control wiring.

Control–logic Conductors Typically, operator’s controls (push buttons and switches), relay contacts, limit switches, PLC I/O’s, operator displays, and relay and contactor coils operate at 115VAC or 24VDC. Although these devices usually operate at low current levels, they contain switching noise caused by contact open/closure and solid–state switch operations. Therefore, these wires should be routed away from sensitive signal wires and contained within conduits or bundled away from open power and signal wires.

DC Tachometer Circuits Among the most sensitive circuits is the DC Tachometer. Reliability of a DC tachometer circuit is often improved by the following noise reduction techniques:

- Connect a 0.1 μf capacitor across the tachometer terminals to suppress AC noise.
- Use twisted-pair shielded wires with the shield grounded at the control end only. You should avoid grounding the shield to the tachometer case or conduit.
- Follow the practices for analog signal wiring.

Analog Signal Wires

Analog signals generally originate from speed and torque controls, plus DC tachometers and process controllers. Reliability is often improved by the following noise reduction techniques:

- Use twisted-pair shielded wires with the shield grounded at the drive end only.
- Route analog signal wires away from power or control wires (all other wiring types).
- Cross power and control wires at right angles (90°) to minimize inductive noise coupling.

Encoder Circuits

Adjustable speed drives are especially sensitive to high frequency noise on encoder signal lines. Because these input signals cannot be heavily filtered special care must be taken to avoid transient noise from entering these signal lines. Drive reliability can be greatly improved by using the following noise reduction techniques:

- Use line driver output encoders to reduce the encoder output impedance.
- Select line driver inputs on the adjustable speed drive.
- Install twisted-pair shielded wire for power to the encoder and having each output with its own return. (Avoid common conductors with multiple outputs or with an output and the power source.)
- Never connect the encoder ground to the power ground terminal of the control.
- Run all encoder wires independently from all other power wires.

Serial Communication Conductors Standard serial communication cables are usually made with a shield that is connected to the connector shell at both ends. This usually grounds the data source to the grounded drive chassis. If the data source is floating, such a connection offers good data transmission. However, if the data source is grounded, adding a heavy ground wire (#14 or larger) in parallel with the communication cable between the source and the drive chassis usually reduces noise problems.

Optical Isolation

Isolating electrical circuits with some form of light transmission reduces the electrical noise that is transmitted from one part of a circuit to another. That is, an electrical signal is converted to a light signal that is transmitted to a light receiver. This converts the light back to an electrical signal that has less noise than the input. Two methods are commonly used; optical couplers and fiber optics.

Optical Couplers

Optical couplers, often referred to as opto couplers use a light transmitter and light receiver in the same unit to transmit data while electrically isolating two circuits. This isolation rejects some noise. The magnitude of noise rejection is usually specified by the "common mode rejection, dv/dt rating". Typically, low cost opto couplers have a common mode rejection of 100 to 500 V/ μ sec, which is adequate for most control logic signals. High performance opto couplers with common mode ratings up to 5,000 V/ μ sec are installed for the most severe noise environments.

Fiber Optics

Special plastic fiber strands transmit light over long as well as short distances. Because the fibers are immune to electromagnetic energy, the use of fiber optic bundles eliminate the problem of coupling noise into such circuits. These noise-free fiber optic cables can be run with power or motor conductors because noise cannot be inductively or capacitively coupled into the fiber optic stands.

Plant Ground

Connecting electrical equipment to a good ground is essential for safety and reliable operation. In many cases, what is perceived as a ground isn't.

Result: equipment malfunctions or electrical shock hazard exists.

It may be necessary to retain the services of an electrical consultant, who is also a licensed professional engineer experienced in grounding practices to make the necessary measurements to establish if the plant ground is really grounded.

Appendix A

Load Weighing / Torque Feed Forward

In many advanced elevator applications, the system is designed to weigh the elevator load to offset the counterweight of the car. We also refer to this as a torque feed forward application. Both the Baldor AC Vector (Series 18H and 22H) and Series 20H SCR Controls can be programmed to use the torque feed forward option (Level 1 Input block; Command Select parameter, 10V w/Torq FF).

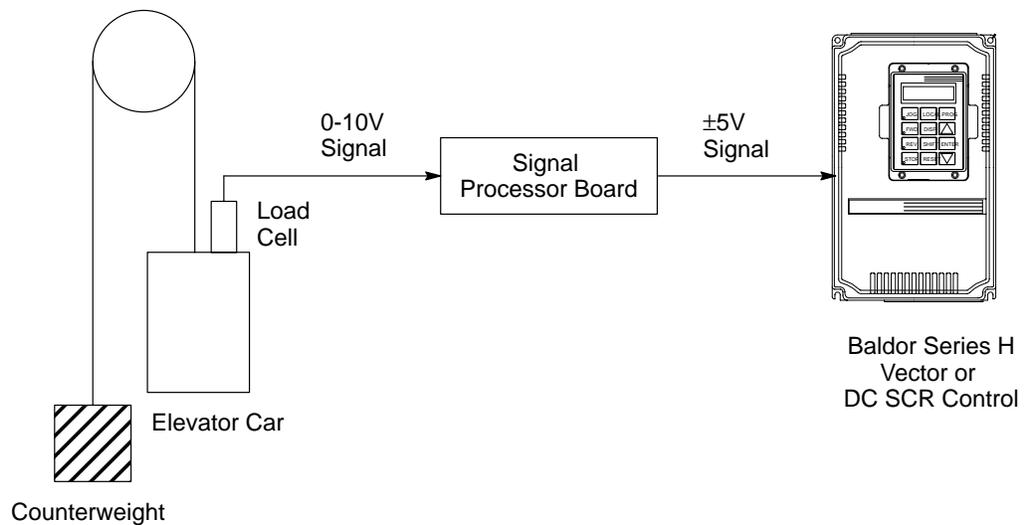
In a typical installation, a car is balanced with a 40% load. In order to move the car in the up direction, the drive should receive a forward speed command. If the car is full, then it would have to generate positive torque in order to move the car forward or in the up direction.

A load cell is installed on the car to measure the loading of the car. Typically, 10 volts output from the load cell equals a full car and 0 volts equals an empty car. This means that 10 volts equals a value of positive torque and 0 volts equals a smaller absolute value of negative torque.

Since the output of the control requires the torque feed forward signal to be bipolar, then the load cell voltage needs to be scaled properly in order to generate the appropriate values of torque. A customer supplied signal processor board can be used for this purpose (the load cell could have this feature built in).

In a typical elevator application, the accelerating torque is significantly greater than the holding torque (or torque required at zero speed), which means that it is not necessary to use the full range (± 10 volt) capability of the torque feed forward. This is shown in Figure A-1. A ± 5 volt output of the signal processor board is probably adequate for most typical elevator applications.

Figure A-1 Typical Elevator Application



The parameters and inputs used for torque feed forward are indicated in the Table A-1. For a Vector control, the OPERATING MODE selected will be BIPOLAR or 15 SPEED. For a Series 20H DC SCR control, BIPOLAR HOIST or 7 SPEED HOIST should be selected.

Table A-1

Analog Command Select Parameter	Input Terminal Location	Input Range and Type	Description
10V W/TORQ FF	J1-4, 5 (J4-4, 5 for Inverter)	-10 to +10VDC Differential	This input is bipolar. The polarity of the signal selects the direction and speed of travel.
	J1-2 (J4-2 for inverter)	-10 to +10VDC	This input is bipolar and controls the Torque Feed Forward value. Torque is proportional to current. The input voltage is scaled to the PK Current Limit value of the control. +10VDC = PK Current Limit parameter value for positive torque, +5VDC= 1/2 the PK Current Limit parameter value and 0VDC= zero current. Negative input voltages represent negative torque.
	J1-1 (J4-1 for inverter)	common	Input reference (J1-2 or J4-2).

Note: It may be necessary to connect J1-4 or J1-5 to J1-1 (ground). This will provide a single ended input range of 0 to 10VDC or 0 to -10VDC.

Description of Operation

This input signal should be applied to the control prior to the control ENABLE signal and the release of the holding brake. The control will then generate the commanded torque when the control is enabled and the holding brake is released. This occurs because the initial current will be greater than the MAG AMPS value. This will generate torque and because it is directly proportional to the measured load, it will prevent roll back. It is not necessary to remove this input during normal operation.

Appendix B

Serial Communications

Baldor's Series 15H and 21H Inverters, 20H DC SCR or 18H and 22H Vector controls may be monitored or operated remotely by a modem and a Serial Communication expansion board on the control. By using either the EXB001A01 or EXB002A01 Serial Communications boards for RS-232 communications, the control parameters and diagnostic menus may be viewed and parameter values changed from a remote computer.

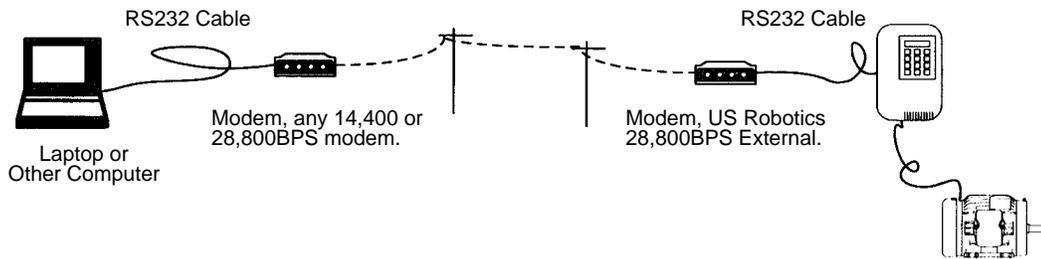
Note: Operating the Baldor control from a remote location is only possible if the the Level 1 Input block, Operation Mode parameter is changed to Serial. Refer to MN1310 for more details on Serial Communication and serial operation of Baldor controls.

⚠ WARNING: Use extreme care when in the Remote mode. You can gain complete control of the Series H control and motor operation from any phone line available. You can initiate an operation that could be hazardous to personnel or equipment from a remote location. Baldor assumes no liability for use, installation or application of the information contained in this document.

⚠ WARNING: Using the elevator with the control in the Serial operating mode should only be done when the elevator is not occupied and an authorized and competent elevator operator is next to the control to take over manually if necessary. When Serial communications is finished, the serial communications equipment should be disconnected and operation should be returned to the elevator controller.

Figure B-1 shows the overall concept of Serial Communications for operating a control from a remote location. Refer to MN1310 Serial Communications for more information regarding this operating mode.

Figure B-1 Remote Communications



Appendix C

Elevator Industry Glossary

- Adjusters** – The elevator mechanic who does advanced maintenance or supervisory functions in conjunction with mechanics.
- Approach Speed** – A fixed speed sometimes used on high speed elevators as an intermediate speed for the last few feet before switching to the leveling speed.
- Balanced Car** – A condition where the elevator car is balanced by adding weights into the car equal to the counterweight. Under this condition, the car neither falls or rises in the shaft if the brake is released and the drive disabled.
- Brake** – Elevators use a spring set brake consisting of a drum acted upon by brake friction shoes. Some modern elevators now have disc brakes.
- Braking Resistors** – Large resistors added externally to the motor control to absorb excess energy generated during regeneration or overhauling loads.
- Braking Transistor** – Usually added to the motor control which can be switched on when a high bus is detected to bleed off excess energy to external braking resistors.
- Capacity** – The load of the car expressed in pounds or kilograms (does not include car or cable weight).
- Car** – The cab of the elevator which is raised or lowered in the hoist way.
- Commissioning** – The procedure of testing the elevator at all conditions and full loads to ensure that it meets the design criteria specified by the consultant.
- Consultant** – An individual who aids building owners and architects in the design and specifications of elevators by writing performance specifications. Usually a member of NAVTP (National Association of Vertical Transportation Professionals).
- Contract Speed** – The maximum speed in Feet per minute (FPM) or Meters per second (M/S) an elevator runs. Usually specified in the initial contract for the job.
- Contractor** – A company which performs installation and maintenance of elevators. Usually a member of NAEC (National Association of Elevator Contractors).
- Controller** – This is the computer or PLC which commands the drives. It performing the logic and sequencing for each elevator. It dispatches elevators based on call requests and provides for fault safety protection.
- Controller Manufacturer** – The company which engineers the complete elevator drive system including dispatcher, computer or PLC, software, motor and control. This is usually provided as a panel for local installation.
- Counterweight** – Weight added to counterbalance the elevator, usually when it is loaded to 40% of its maximum capacity.
- Efficiency** – Usually the efficiency of gearing on geared elevators.
- Elevator Room** – With traction machines, this is located above the hoist ways and contains the motors and controls for the elevators. With hydros, the elevator room may be located on the lowest floor, adjacent to the elevators and containing the hydraulic pumps and elevator controls.
- Field Forcing** – On a DC motor and control, the motor field may be supplied with more than rated voltage to over-saturate the field providing quick response.
- Floor to Floor Time** – A specification of the time it would take an elevator to go from one floor to the next or multiple floors.
- Following Error** – The difference between the commanded speed and the actual speed of the elevator car.

Gearless Elevator – An elevator powered by a low speed motor (usually DC) which has the drive sheave mounted directly on the motor shaft. It uses no gearbox. These are used in high speed elevators. Typical motor speeds are 70 -150 RPM at contract speed.

Governor – A mechanical speed measuring device propelled by a cable suspended from the elevator. As speed increases, centrifugal force causes counterweights to move and signal the controller of a fault condition. Eventually, the brake is activated to stop the elevator movement if a predetermined car speed limit is exceeded.

Hoist way – The elevator shaft.

Hydraulic Elevator – An elevator raised and lowered by a hydraulic cylinder. Limited to fairly slow speeds and a low number of stops. Also called a hydro.

Inspection – The act of visual and functional testing of the elevator. May be performed by contractors or city/state inspectors.

Inspection Speed – A fixed low speed (about 10 ft/min) used to move the elevator car for inspection purposes. Similar to a jog speed in an industrial application.

Jerk – Represents the rate of change of acceleration or deceleration during an S-curve.

Leveling – The act of aligning the elevator car with the floor. Current elevator code requires this to be within $\pm 1/4$ inch.

Leveling Field – On a DC control, the field voltage setting which provides more than rated voltage to over-excite the motor field used during the leveling process.

Leveling Speed – A fixed low speed used to move the elevator the final two feet allowing precision floor leveling.

M-Contactor – Provides a positive disconnect of the motor from electrical power. Most elevator codes require one or two M-Contactors between the motor and control.

Mechanic – An electrically operated device that provides a positive disconnect of the motor from the control. Elevator codes vary but most require one or two M-Contactors be installed between the motor and control.

Modernization – Updating of an old elevator with new drives and controls to meet current codes.

Motor-Generator Set – On older DC elevators, an AC motor powers a DC generator supplying DC power to operate the DC traction motor. By varying the field excitation of the DC generator, the power supplied to the DC motor may be adjusted. Also known as a Ward-Leonard set.

NAEC – National Association of Elevator Contractors, the trade organization of contractors, suppliers and consultants for the elevator industry in the US.

NAVTP – National Association of Vertical Transportation Specialists, the trade organization of elevator consultants.

Overhead – The area above the elevator at the top of the hoist way.

Overhauling Load – When a load requires more torque than the motor can provide, the motor may exceed the commanded speed. This is an overhauling load. Braking is used to prevent the load (car) from falling. The brake may be mechanical or electrical (dynamic or regenerative). Ultimately a mechanical brake must be set to hold the load in case of a power failure or when the drive is not enabled. Baldor Line Regenerative controls provide reverse torque to hold the load and prevent a run away over speed condition.

Pattern Generator – An external circuit board used to generate an adjustable S-curve speed command for smooth acceleration and deceleration. This signal is used by the motor control instead of any on-board S-curve. It uses feedback from the elevator by means of a DC tach or encoder.

Pit – The area below the elevator at the bottom of the hoist way. It usually contains a buffer or other means of stopping the car during emergencies.

Rails – The steel tracks which guide the elevator in the hoist way.

Rollback – A condition where the holding brake is released and the elevator car rolls slightly in the hoist way before the control is able to hold it steady prior to moving to the next stop.

Ropes – The steel cables used to suspend the car and counterweights.

Running Field – On a DC control, the normal field voltage setting which provides rated field voltage to the motor for most conditions.

Sheave – A drum mounted on the output shaft of the traction machine gearbox or the armature of a gearless motor on which the cables holding the elevator are wrapped. This rotates to drive the elevator.

Standby Field – On a DC control, the field voltage setting which provides a reduced field voltage to the motor allowing the field to be continuously energized. It is the same as field economy in industrial applications, usually 67% of rated field voltage.

Stop – The number of floors in the building where the elevator may be boarded.

Tape – A punched tape (similar to a NC machine programming tape) which is attached in the hoist way providing actual elevator position to the controller.

Torque Feed Forward – A control scheme where the elevator weight is sensed and a voltage is provided to the motor control as a trim to eliminate any rollback of the car when the brake is released.

Torque Proving – After closing the motor contactors, the motor control checks for continuity with the motor before releasing the brake and providing full power to the motor.

Tracking – The act of the control following the commanded signal.

Traction Elevator – A geared elevator in which a motor drives either a right angle worm gearbox or an inline gearbox for speed reduction and torque multiplication. “Traction” comes from the friction of the ropes gripping the sheave and preventing slippage. The ropes usually have a number of turns around the sheave to increase the traction.

Turned Over – The final step in commissioning the elevator system for normal passenger use.

VVVF – Variable voltage, variable frequency control – usually an AC inverter.

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