



# ENDEAVOR™ Variable Frequency Crane Control

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The Electric Controller and  
Manufacturing Company, LLC

# VARIABLE FREQUENCY CRANE CONTROL

## GENERAL INFORMATION

### OPEN OR CLOSED LOOP VECTOR CONTROL HOIST AND TRAVEL

#### **CLASS 6417 ENDEAVOR™ AC VARIABLE FREQUENCY OPEN LOOP SYSTEMS**

For use with AC squirrel cage or wound rotor induction motors. They may be used for all crane travel motions and for hoists without overhauling loads (hoists with a worm gear or mechanical load brake gearbox). All drive systems can be used with AC solenoid or rectifier operated brakes, and with power and control circuit limits switches. When used with a power limit switch, a control signal contact is required, which opens just prior to the operation of the main power limit switch contacts. Controls are rated for 50°C as standard. Class 6417 ENDEAVOR™ AC drive systems are suitable for new installations or for retrofit of existing electromechanical controls.

#### **CLASS 6418 ENDEAVOR™ AC VARIABLE FREQUENCY CLOSED LOOP SYSTEMS**

For use with AC squirrel cage or wound rotor induction motors for crane hoist motions with overhauling loads (hoists with standard gear arrangements). They are also used for travel motion applications that might skew the crane bridge without feedback; or applications which require a hydraulic brake with drive re-acceleration. Closed loop systems are required for most hoist applications to meet AIST standards. All drive systems can be used with AC solenoid or rectifier operated brakes, and power and control circuit limit switches. Closed loop systems require a motor mounted encoder for feedback. When used with a power limit switch, a control signal contact is required, which opens just prior to the operation of the main power limit switch contacts. Panels are rated 50°C as standard. Class 6418 ENDEAVOR™ AC drive systems are suitable for new installations or for retrofit of existing electromechanical controls.

#### **The standard single motor control panel includes:**

- 1—Type SP inverter unit, programmed for crane application
- 1—Three pole, fused, main line disconnect switch (MCB)
- 1—Two pole control circuit breaker (CCB)
- 1—Transformer, 120VAC secondary (CTR)
- 1—Two pole brake contactor (BRC)

#### **Type SP Inverter unit is complete with the following:**

- 120VAC, five-speed point, optically isolated interface
- Crane application specific software
- Torque proving (see **Ratings and Features**, pg.7)
- Stationary motor auto-tune
- Keypad or PC interface for simple set-up and adjustments
- Onboard diagnostics and fault history
- SMARTCARD storage of parameters (removable)
- Multiple level parameter security
- Windows® - based software for parameter monitoring and adjustment.
- Micro-speed / load float function (Hoists): Reduces speed points to 10% of existing parameter values, or activates load float in OFF position. Requires separate input signal closure for activation (see page 6). Resets to normal operation upon open input signal and return to the OFF position.

#### **Available Motor Configurations:**

- Simplex System** - Single inverter controlling one motor
- Duplex System** - Single inverter controlling two motors
- Multi-inverter System** - Multi-motor motion control system, each motor controlled by a separate inverter

6418 Hoist controller

Type SP Inverter unit



# ENDEAVOR™

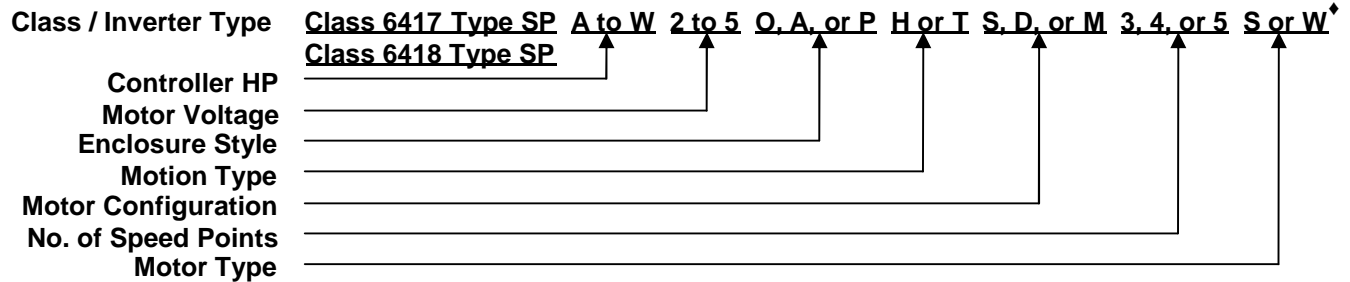
## VARIABLE FREQUENCY CRANE CONTROL

### DRIVE SYSTEM SELECTION

CLASS  
6417  
6418

ENDEAVOR™ AC Variable Frequency Controller part numbers conform to the following codes.  
See below for proper selection.

#### CONTROL PANEL CODES



#### CONTROL PANEL SELECTION

To make a control panel selection:

- Begin with the application's Motor Full Load Current rating (FLC or FLA)
- Select Drive from page 4 with equal or higher current rating and note the Drive Type Code
- Use the chart below to complete the part number selection:

CONTROL PANEL SELECTION TABLE																
Inverter TYPE	Controller HP <sup>A</sup>		Motor Voltage (AC, 3Ø, 50/60Hz)		Enclosure		Motion Type		Motor Configuration		No. of Speed Points	Motor Type				
	Code	HP	Code	Motor Voltage	Style	Code	Hoist / Travel	Code	Simplex or Multi-inverter	Code	No. of Speeds / Code	Motor Type	Code			
Class 6417 Open Loop Type SP	1	A	208 - 230V	2	Open Panel	O	HOIST	H	Simplex	S	3	Inverter-duty Squirrel Cage Motor	S			
	2	B														
	3	C														
	5	D														
	7.5	E														
	OR Class 6418 Closed Loop Type SP	10	F	380V	3	NEMA 12 Dusttight		A	TRAVEL	T	Duplex*		D	4	♦ Wound Rotor or Standard Squirrel Cage Motor	W
		15	G													
		20	H													
		25	J													
		30	K													
Class 6418 Closed Loop Type SP		40	L	460V	4	Spare Drive	P	TRAVEL	T	Multi-Inverter*	M	5	♦ Wound Rotor or Standard Squirrel Cage Motor	W		
		50	M													
		60	N													
		75	P													
		Class 6418 Closed Loop Type SP	100	R	575V	5	Spare Drive	P	TRAVEL	T	Multi-Inverter*	M		5		♦ Wound Rotor or Standard Squirrel Cage Motor
	125		S													
	150		T													
	200		U													
250	V															
300	W															
350	X															

▲ Select Drive HP Code based on Motor Full Load Current nameplate data, not motor nameplate HP or kW. See page 4 for more information  
 ♦ Wound rotor motors and standard duty squirrel cage motors require a load filter. See page 6 for more information.  
 • For Duplex or Multi-inverter systems, advise each motor HP or kW, and full load current rating.

VARIABLE FREQUENCY CRANE CONTROL

DRIVE SYSTEM SELECTION

DRIVE SELECTION TABLES

TYPE Code ■ (460V code shown)	Nominal HP	Drive Current Rating at 50°C Altitude <1000m	TYPE Code ■ (460V code shown)	Nominal HP	Drive Current Rating at 50°C Altitude <1000m
SPA4	1	2.1	SPN4	60	68
SPB4	2	3.0	SPP4	75	86
SPC4	3	5.8	SPR4	100	113
SPD4	5	9.5	SPS4	125	140
SPF4	7.5 - 10	15.5	SPT4	150	210
SPH4	15 - 20	22.3	SPU4	200	Consult Factory
SPJ4	25	32	SPV4	250	
SPK4	30	46	SPW4	300	
SPM4	40-50	60	SPX4	350	

**Example:** Motor Full Load Current (FLC) must be less than Drive Current Rating. To select a drive system for a 65A FLC motor (nominal 50HP at 460VAC), NEMA 12 enclosed, travel motion, simplex, with 5-speed interface, inverter-duty rated squirrel cage motor, the selection is: **Class 6417 Type SPN4ATS5S** (60HP nominal drive).

■ For 380VAC systems, change type number voltage code from 4 to 3, e.g. 6417 Type SPN4ATS5S becomes 6417 Type SPN3ATS5S

TYPE Code (230V code shown)	Nominal HP	Drive Current Rating at 50°C Altitude <1000m	TYPE Code	Nominal HP	Drive Current Rating at 50°C Altitude <1000m
SPA2	1	4.3	SPF2	10	31
SPB2	2	7.5	SPG2	15	42.0
SPC2	3	12.6	SPH2	20	56.0
SPD2	5	17.0	SPJ2	25	68.0
SPE2	7.5	19.2	SPK2	30	80.0

TYPE Code (575V code shown)	Nominal HP	Drive Current Rating at 50°C Altitude <1000m	TYPE Code	Nominal HP	Drive Current Rating at 50°C Altitude <1000m
SPB5	1 - 2	4.1	SPM5	50	51.9
SPC5	3	5.4	SPN5	60	63
SPD5	5	6.1	SPP5	75	84
SPE5	7.5	9.5	SPR5	100	100
SPF5	10	12.0	SPS5	125	125
SPG5	15	18.0	SPT5	150	Consult Factory
SPH5	20	22.0	SPU5	200	
SPJ5	25	27.0	SPV5	250	
SPK5	30	36.0	SPW5	300	
SPL5	40	43.0	SPX5	350	

DUPLEX (TWO MOTORS PER EACH DRIVE) AND MULTI-INVERTER DUPLEX (ONE DRIVE PER MOTOR) SYSTEM RATINGS AVAILABLE – CONSULT FACTORY FOR DETAILS



## VARIABLE FREQUENCY CRANE CONTROL DYNAMIC BRAKING RESISTORS

Drive systems require a set of dynamic braking resistors, selected to match each controller inverter unit's nominal horsepower rating. The resistors listed below are mill duty rated for maximum duty cycle

To specify a Mill duty resistor set for a controller, complete the following Class and Type number:

### TYPE SP INVERTER DYNAMIC BRAKING RESISTORS

Class	Type	Enclosure Style	Motor Voltage Code	Nominal Inverter HP Rating
<b>6715</b>	<b>DBSP</b>	<b>N,O,G,W, or C</b>	<b>2,3,4, or 5</b>	<b>1 through 350</b>

#### Enclosure Style

To specify resistor enclosures, select one of the following codes and add to the type number:

**N**-No Enclosure, Open resistors only

**O**-Open style enclosures

**G**-NEMA 1 Enclosures

**W**-NEMA 3R enclosures

**C**-NEMA 1 enclosures with screen covers

#### Motor Voltage Code

**2**- 208/230V

**3**- 380V

**4**- 460V

**5**- 575V

#### Multi-Motor Applications:

For Duplex or Multi-inverter applications, each inverter requires a resistor set, sized for each inverter.

#### Duplex Example:

Consider a 460V duplex travel controller, sized for two-40HP motors, each motor with full load current of 52.0 Amperes. A single inverter must be selected, sized for current greater than 104.0 Amperes. From page 4, the selected controller would be the Class 6417 Type SPR4, rated 113 Amperes. The nominal horsepower of this inverter unit is 100HP. For this example, the resistor set needed (NEMA 1 enclosed) is **Qty (1) Class 6715 Type DBSPG4100.**

#### Multi-inverter Example:

Consider a 460V Multi-inverter travel controller, sized for two-40HP motors, each motor with full load current of 52.0 Amperes. The controller will consist of two inverters, each selected for current greater than 52.0 Amperes. From page 4, the selected inverter would be the Class 6417 Type SPM4, rated 60 Amperes. The nominal horsepower of this inverter unit is 40-50HP. One resistor set is required per inverter. For this example, the resistor sets needed (NEMA 1 enclosed) are **Qty (2) Class 6715 Type DBSPG450.**



# VARIABLE FREQUENCY CRANE CONTROL

## LOAD FILTERS AND MASTER SWITCHES

### MOTOR LOAD FILTERS

Load filters provide protection from the transients produced on the output of variable frequency controllers. Non-inverter-duty induction motors such as wound rotor motors and standard duty squirrel cage motors require this protection. Inverter-duty rated motors do not require this protection. For the best protection, load filters should be mounted and wired as close to the motor as possible. Therefore, the filters listed are for separate mounting, and are ordered separately.

Each motor in a variable frequency system requires a separate load filter. Select each load filter part number based on each motor's full load current rating. (Horsepower at 460V is shown for reference only).

### MOTOR LOAD FILTERS

Part Number <sup>•</sup>	Rated Current	HP at 460VAC (Reference only)	Part Number <sup>•</sup>	Rated Current	HP at 460VAC (Reference only)
KLC4BE	4	1 - 2	KLC110BE	110	75
KLC6BE	6	3	KLC130BE	130	100
KLC12BE	12	5	KLC160BE	160	125
KLC16BE	16	7.5 - 10	KLC200BE	200	150
KLC25BE	25	15 -20	KLC250BE	250	200
KLC35BE	35	25	KLC300BE	300	250
KLC45BE	45	NA	KLC360BE	360	300
KLC55BE	55	30	KLC420BE	420	350
KLC80BE	80	40 - 60	KLC480BE	460	400

• NEMA 1 enclosed, for separate mounting and wiring

### MASTER SWITCHES

CLASS 9004 VM OR CM MILL DUTY MASTER SWITCHES					
Drive	Speed Points	Class	Type	Control Type	Form <sup>+</sup> (Optional)
Bridge or Trolley	3-5	9004	VG9	U5	N/A
			CG8		
Hoist			VG9	W1-5	B
			CG8		

<sup>+</sup> **Form B:** Adds a N.O. pushbutton in the master switch handle, which may be used to activate micro-speed for hoist drives. (Travel drives do not have micro-speed as a standard option) See page 2, Type SP Inverter unit description.

**Master Switch Example:** Class 9004 Type VG9W1-5 Form B



Class 9004  
Type CG8  
Master Switch



Class 9004  
Type VG9  
Master Switch

# VARIABLE FREQUENCY CRANE CONTROL MODIFICATIONS, RATINGS and FEATURES

## CONTROLLER MODIFICATIONS

Code†	Description	Function
D6	Motor Isolation Switches	Disconnects each motor from the inverter module
E19	Special Height Enclosures	Special design cabinets (advise dimensions of maximum space available)
G8	Power Terminal Boards	Terminals for customer power connection, separate from the inverter
G22	Interior Inspection Lights	Cabinet inspection light with toggle switch
H19	Space Heater with Thermostat	Anti-condensation heaters, thermostatically controlled
M6	Bypass Contactor for Power Limit Switch	For lowering out of tripped, separately supplied hoist power limit switch
R1722	IEC Control Relay (specify coil voltage)	2 N.O. and 2 N.C. contacts, contacts and relay coil wired to terminal boards
W3	Hoist Control Limit Switch	Wiring provisions for hoist control limit switch
W4	Lower Control Limit Switch	Wiring provisions for lower control limit switch
W20	First Come / First Serve Master Switches	Dual master switch operation, isolation via N.C. master switch contacts
W24	Slowdown Travel Switch	Switch inputs for slowdown, customer defined
Y4	Line Reactor	Reduces noise on AC source
Y5	Infinitely Variable Speed Control	Variable speed reference input (supplied separately), substitutes for standard 120VAC input contacts
Y6	Custom Software	Customer to advise requirements
Y7	5-year Warranty	Increases limited warranty for SP inverter module from 2 years to 5 years

† Several FORMS require additional panel space. Consult factory for dimensions.

## RATINGS and FEATURES

### Hoist Power Limit Switch:

All hoist controllers with power limit switches require FORM M6, and a power limit switch with control circuit contacts that open just prior to the operation of the power limit switch main contacts. Reference Class 6170 YOUNGSTOWN® Power Limit Switch Catalog, FORM X122 for more information.

### Service Classes:

Suitable for all crane service classes:  
AIST Technical Report #6, Classes 1 to 4  
NEMA Service Classes I and II  
CMAA Classes A through F

### Temperature and Altitude ratings:

Panels are rated 50°C, without air conditioning, at altitude less than 1000m (3300ft).  
Derate for high altitude available upon request, consult factory.

### Speed / Torque Range:

100% torque delivered 1Hz-60Hz in open loop vector mode  
100% torque delivered 4Hz-60Hz in Volts / Hertz mode (typical for Duplex Travel controls)  
100% torque delivered 0Hz-60Hz in closed loop vector mode

### Torque Proving:

Drive confirms motor torque availability prior to brake release

### Encoder Specifications for Closed Loop Drive Systems:

(Note that encoder is not included in control panel)  
Encoder supply (supplied by drive): 5V, 8V, or 15VDC  
Encoder max current: 300mA for 5V and 8V; 200mA for 15V  
Encoder type: Quadrature incremental  
Output type: Differential Line driver  
Pulse code: A, /A, B, /B  
Encoder lines per revolution: 60, 125, 256, 512, or 1024



**VARIABLE FREQUENCY CRANE CONTROL**  
**AC CONTACTOR CONTROL vs. DRIVES**

System		AC Contactor Control	Variable Frequency Drive
<b>Crane Components</b>		Wound rotor motor, rectifier operated brake(s), control circuit and / or power limit switches, master switch, pendant or radio control. <u>Reversing hoists</u> require worm gear or mechanical load brake gearbox. <u>All other hoist styles</u> require standard gearbox. Best and critical positioning control requires eddy-current load brake	Inverter-duty squirrel cage, wound rotor, or standard duty squirrel cage motor, rectifier operated brake(s), control circuit and / or power limit switches, master switch, pendant or radio control. <u>Open loop hoist controls</u> require worm gear or mechanical load brake gearbox. <u>Closed loop hoist controls</u> require standard gearbox, but with motor encoder feedback.
<b>Resistors</b>		Acceleration resistor set required, Size based on HP & duty cycle.	Dynamic braking resistor set only, sized based on inverter size, fewer resistor banks required.
<b>Motor Performance</b>	<b>General</b>	Velocity and acceleration is load dependant.	Velocity and acceleration are minimally (open loop) or not (closed loop) load dependant.
		Resistor tap and wiring changes are required to adjust speeds in the field.	Velocity & acceleration are programmed for each speed point, field adjustable through keypad or PC
		More abrupt speed point transitions.	Smooth speed point transitions.
	<b>Slowdown</b>	<u>Travel:</u> Slowdown via Reverse Plugging deceleration, relay controlled, with resistors to limit current and torque. <u>Hoist:</u> OFF point slowdown and braking with Eddy-current brake, Contra-Torque® or DB circuitry	Slowdown via DB resistors on DC bus, with programmable deceleration ramp
	<b>OFF Point</b>	<u>Travel:</u> No OFF point braking via control <u>Hoist:</u> OFF point braking by Eddy-current brake, Contra-Torque® or DB circuitry	OFF point Dynamic Braking (DB), with programmable deceleration ramp between all points, with load floating to resume motion without waiting for brake to release
<b>Reversing</b>	<u>Travel:</u> Reversing plugging deceleration, relay controlled, with resistors to limit current and torque. Allows re-acceleration after relay operation. <u>Hoist:</u> Drive is stopped before each change in direction	Slowdown with DB (see Slowdown & OFF). Reversing and re-acceleration occur after zero speed achieved.	
<b>Power Consumption</b>		Power dissipated in rotor resistors in low speed points	Uses less power at reduced velocity, and during acceleration
<b>Component Wear</b>		Acceleration contactors make & break rotor current at each speed change. Directional contactors make & break stator current when starting & reversing. Contactors, tips, coils, etc. require periodic inspection and replacement	Power contactors eliminated. Motor current switched by solid-state components. Spare drive recommended.
<b>Motors / Encoders</b>		Requires wound rotor motor. No encoder feedback required	Inverter-duty squirrel cage motor preferred. Load filter required for use with wound rotor or standard duty squirrel cage motors. AIST Hoists (closed loop) use motor encoder feedback for precise handling,
		Motor blower not typically required for operation at reduced motor velocity, as full torque is not available at zero speed	Full torque (full current) at slow and zero velocity is possible. As a result, motor blower may be required when operating at reduced velocity with full load and high duty cycles.

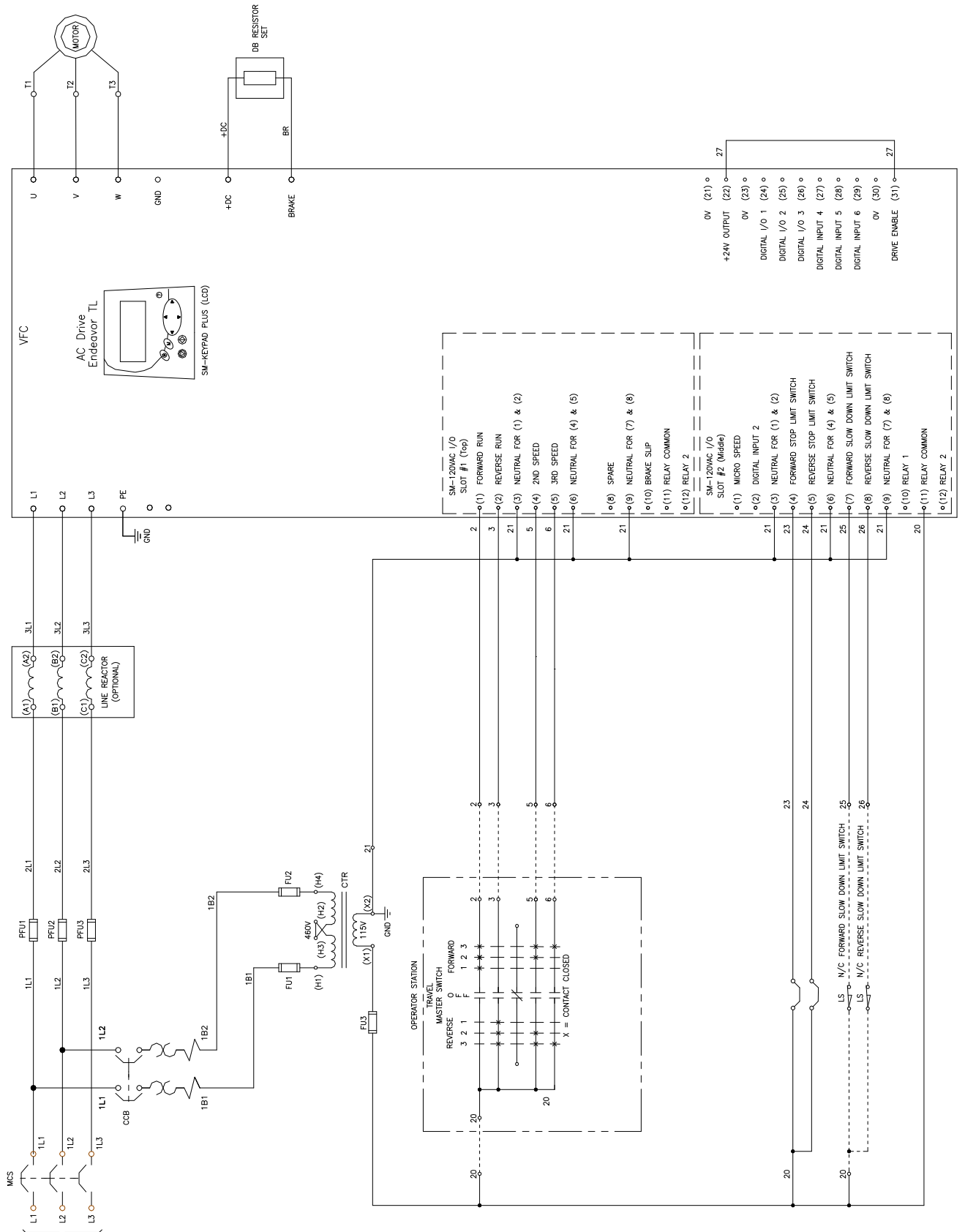




# ENDEAVOR™

## VARIABLE FREQUENCY CRANE CONTROL

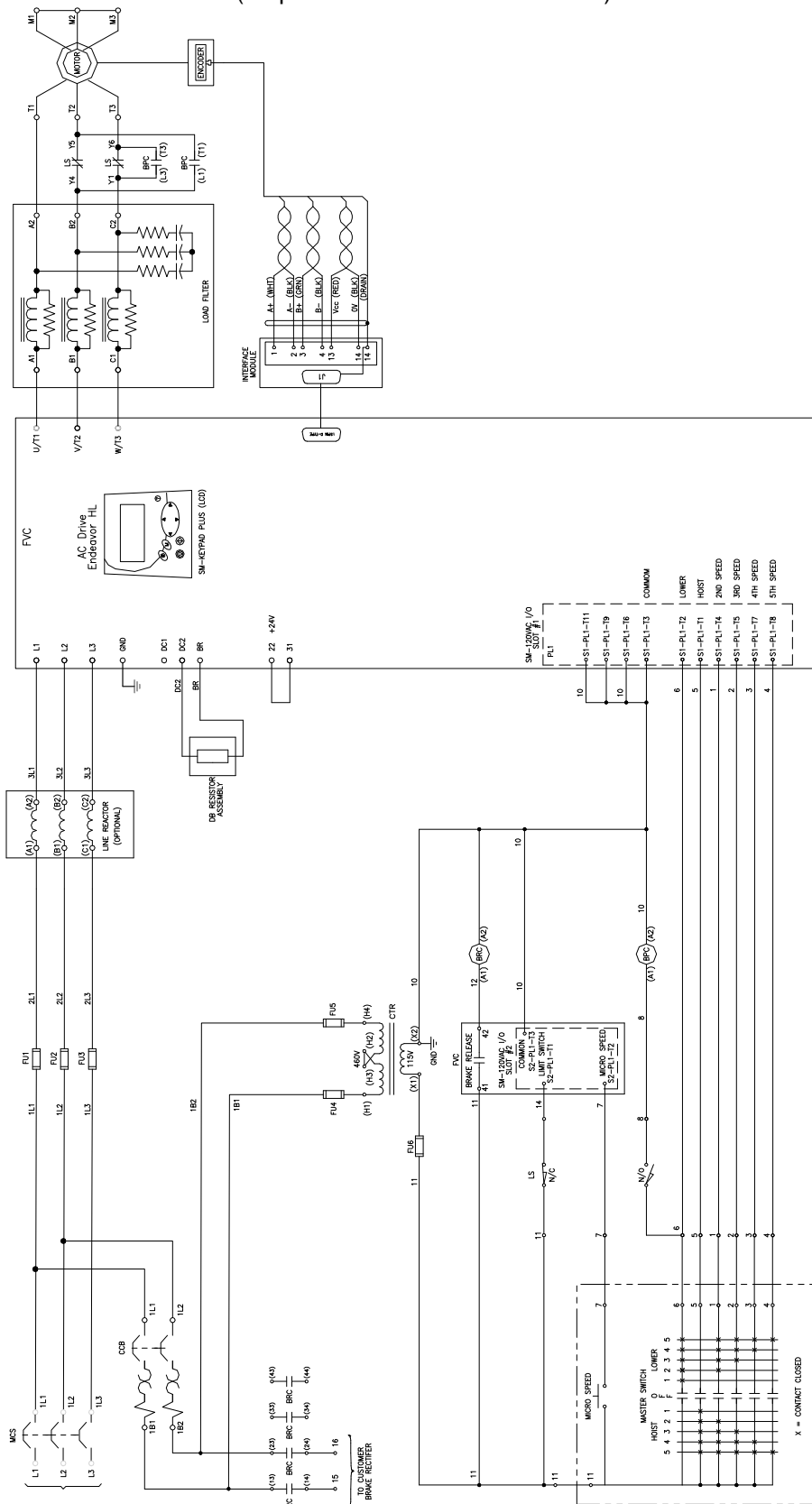
### OPEN LOOP ELEMENTARY DIAGRAM



# VARIABLE FREQUENCY CRANE CONTROL

## CLOSED LOOP ELEMENTARY

(5-speed shown with modifications)



# Crane Control Selection Guide

For more details, please see our crane control catalog, on-line at [www.ECandM.net](http://www.ECandM.net)

## CLASS 5010 WB DRUM BRAKES

- AIST rated and suitable for all crane classes
- Spring set, electrically released, DC drum type
- Available for AC operation with brake rectifier controller
- Hold drive stationary when motor is off
- Available in 8" to 30" wheel diameters
- Torque ratings 100 through 9000 ft-lbs
- Corrosion resistant pins are standard on all brake sizes
- Grease fittings are standard on 19", 23" and 30" brake sizes
- Available with optional self-adjuster



## CLASS 5060 ADJUSTABLE TORQUE DRUM BRAKES

- AIST rated and suitable for all crane classes
- Used on bridge and trolley (horizontal travel) drives
- Provide fixed holding torque for parking
- Provide electrically controlled adjustable torque for stopping
- Available in 10", 13", and 16" wheel diameters
- Parking torque ratings up to 200, 550 and 1000 ft-lbs respectively
- Stopping torque ratings up to 300, 850 and 1500 ft-lbs respectively
- Available for AC or DC control systems



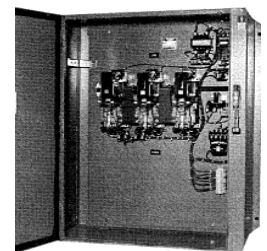
## CLASS 6420 to CLASS 6426 AC CONSTANT POTENTIAL (Contactor) CONTROLS

- Hoist drive styles include Eddy-Current Brake, Contra-Torque<sup>®</sup>, AC Dynamic Lowering, and Reversing Hoist controls
- Reversing Plugging control for bridge and trolley (travel) drives
- Meets NEMA Service Classification I
- Available in NEMA contactor sizes 2 through 6, through 300HP for single or multiple motors
- Numerous modifications available
- Uses Class 8503 Type M LineARC<sup>®</sup> contactors, static timers and frequency relays for acceleration
- Industrial duty contactor versions available to meet NEMA Service Classification II



## CLASS 6440 AC MANUAL MAGNETIC DISCONNECT SWITCHES

- Meet OSHA& NEC requirements for AC crane disconnect switch
- Available in continuous ratings of 150 to 1350 Amperes
- Operated remotely by pushbutton or by the enclosure handle
- Mechanical & electrical interlocks prevent switch operation with handle in the OFF position



## CLASS 6170 YOUNGSTOWN<sup>®</sup> HOIST POWER LIMIT SWITCHES

- Final safety limits for hoist upper travel
- Interrupts motor power directly
- Available in ratings up to 500HP at 230VDC, or up to 400HP at 460VAC and 550VAC
- Available auxiliary contacts set to operate prior to main contacts, for variable frequency hoist applications



Please visit our website for additional details on:  
**DC MILL DUTY CONTACTOR CONTROL, DIGITAL DC DRIVES,  
DC DISCONNECT SWITCHES, DC MAGNET CONTROL, DC REDUCED VOLTAGE STARTERS,  
MASTER SWITCHES, MILL DUTY RELAYS, OVERLOAD RELAYS, AC CONTACTORS,  
AND OTHER MILL DUTY CONTROL COMPONENTS**



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