



BENSHAW
Applied Motor Controls

Product Catalog



FEBRUARY 2023 Edition

Medium Voltage Soft Starters, Drives, and Controls

Rapid | Rugged | Global

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Introduction

As a global leader in 2,300 V to 15,000 V solid state control, Benshaw has pioneered virtually every major innovation in medium voltage power electronics.

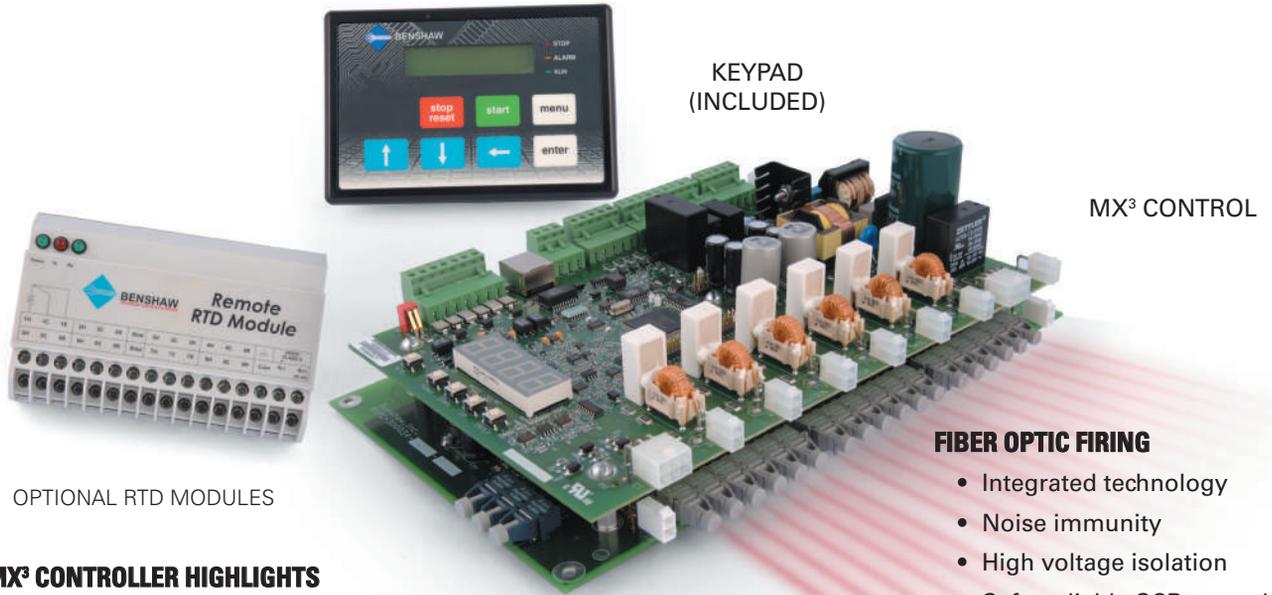
Benshaw provides a full line of application solutions for motors ranging from 2.3 through 15 kV Class up to 25,000 HP. Applications for our medium voltage product line range from pumps, compressors and chillers to fans and blowers, crushers, chippers and conveyors; for every motor type: Induction, synchronous, two-speed, reversing, wound rotor and more.

As an industry leader in motor control, Benshaw is known for their offering of standard and custom engineered products. If an off-the-shelf unit does not meet your needs, our dedicated engineered team can design the custom-engineered medium voltage control system you need.



MX³ CONTROLLER

NEXT GENERATION INTELLIGENT MOTOR CONTROL



MX³ CONTROLLER HIGHLIGHTS

Next generation MX³ technology forms the backbone of Benschaw's entire line of intelligent medium voltage motor controls.

With fiber optic firing, enhanced programming capabilities, ease of use and a unique, flexible architecture — Benschaw's MX³ controller delivers unprecedented functionality and all of the rugged, dependable performance you've come to expect from the world leader in solid state motor controls and drives.

MX³ controllers, power components, software and sensors are all designed, built and tested to perform as an integrated control system, eliminating the coordination and performance problems inherent in other forms of reduced voltage starting.

With more built-in features, more configurable options, greater expandability and a broader communications capability than any other motor control on the market, Benschaw's next generation MX³ technology will shorten your commissioning times, improve motor performance and protection, enhance diagnostic capability and streamline many electrical system monitoring and maintenance tasks.

KEY FEATURES:

- High performance motor control with multiple starting modes built in
- Patented CYCLO converter control from 1 to 40% speed
- Flexible, programmable I/O
- Integrated motor protection
- Line and motor metering
- Diagnostic capabilities with event log and real-time clock
- CE, UL, CUL, NEC, NEMA compliance
- Built-in remote self-testing (BIST)
- Expanded communications capabilities
- Intelligent SCR power poles
- Intelligent MV MCC integration

MEDIUM VOLTAGE MX³ CONTROL FEATURES

MULTIPLE STARTING MODES:

- Voltage ramp
- Current ramp
 - Adjustable initial current
 - Adjustable maximum current
 - Adjustable ramp time
- Torque ramp (TruTorque)
 - Adjustable initial torque
 - Adjustable maximum torque
 - Adjustable ramp time
- Power ramp
 - Adjustable initial torque
 - Adjustable maximum torque
 - Adjustable ramp time
- Linear/tach feedback control
- CYCLO converter control

MOTOR PROTECTION:

- Motor thermal overload
- Independent starting and running OLs
- Up to speed timer exceeded
- Low line voltage
- Low line frequency
- High line frequency
- Phase reversal
- Phase loss
- Instantaneous overcurrent
- Overcurrent
- Undercurrent
- Current imbalance
- Ground fault (residual or zero sequence)
- Shorted or open SCR
- Disconnect fault
- Inline contactor fault
- Control power low
- Stack over temperature
- Motor PTC input
- RTD modules

METERING:

- Accuracy:
 - 3% out-of-box
 - 2% factory calibrated
- Average current
- L1 current
- L2 current
- L3 current

- Current imbalance %
- Ground fault current
- Average volts
- L1 — L2 voltage
- L2 — L3 voltage
- L3 — L1 voltage
- Overload %
- Power factor
- Watts
- VA
- VARS
- KW hours
- MW hours
- Phase order
- Line frequency
- Analog input
- Analog output
- Run time — days
- Run time — hours
- # of starts
- TruTorque %
- Power %
- Peak starting current
- Last starting duration
- RTD temperatures
- Real-time clock

8 DIGITAL INPUTS CONFIGURABLE TO:

- Stop
- Fault
- Fault reset
- Bypass/inline confirm
- OL reset
- Local/remote selection
- Heater enable
- Heater disable
- Dual ramp selection
- 1 dedicated start input
- Disconnect
- Slow speed
- Brake enable
- Brake disable

6 RELAY OUTPUTS CONFIGURABLE TO:

- Faulted
- Running
- Up to speed

- Alarm condition
- Ready condition
- Locked out
- Overcurrent
- Undercurrent
- OL alarm
- Shunt trip
- Ground fault
- Energy saver indication
- Heating indication
- Slow speed forward/reverse
- DC braking
- Cooling fan

1 ANALOG 4–20 MA/0–10 VDC INPUT CONFIGURABLE TO:

- Trip high level
- Trip low level

1 ANALOG 4–20 MA/0–10 VDC OUTPUT CONFIGURABLE TO:

- Current (0–200%/0–800%)
- Voltage (0–150%)
- OL (0–150%)
- KW (0–10 KW/0–100 KW)
- MW (0–1 MW)
- Analog input (0–100%)
- Firing (0–100%)
- Calibration

USER INTERFACE:

- Event log (99 events)
- Door-mounted LCD display
 - Set/examine operating parameters
 - View status information, line current, voltage and frequency
 - Start and stop the solid state starter

1 COMMUNICATION PORT:

- Modbus/RS485

ADVANCED FUNCTIONALITY:

- Dual ramp selection
- Adjustable kick current
- Programmable decel modes
- MV BIST test (built-in self test)

PREPACKAGED SOLID STATE STARTERS WITH ATL BYPASS



MVRXE SERIES — SEVERE DUTY WITH ACROSS-THE-LINE BYPASS

MVRXE SERIES PRODUCT HIGHLIGHTS:

The Benshaw Medium Voltage Starter is a microprocessor-controlled solid state reduced voltage starter for three-phase induction motors. The starter provides a closed-loop current ramp for smooth stepless motor acceleration. Supplied in a free-standing enclosure.

Enclosures are available in NEMA 12 or NEMA 3R configurations. The medium voltage enclosure consists of two distinct compartments. The medium voltage or power pole section is located in the main body of the enclosure, whereas the low voltage section containing the control logic is located behind the door as an isolated compartment.

Each starter is supplied with a load break isolation switch, Class "R" motor fuses, inline vacuum contactor, solid state power poles and a vacuum bypass contactor, which is used to bypass the SCR power poles once the motor is up to full speed.

The logic control incorporates the MX³ computer that has all the circuitry required to drive the power semiconductors, which are located in the power section.

MVRXE starters provide solid state reduced voltage starting for normal operation and full voltage emergency back-up starting, with complete electronic motor protection at the flip of a switch.

This unique redundant design is ideal for critical applications where downtime is extremely disruptive and cannot be tolerated.

MX³ solid state controls provide precise digital starting and stopping, motor protection, metering, diagnostics and communications standard.



MVRXE starter with load break fusible disconnect and emergency ATL bypass

Guaranteed ... for three full years.

Only Benshaw has a three year guarantee.

Every Benshaw solid state starter is guaranteed for three full years. Other manufacturers limit their warranties to just one year. But at Benshaw, we believe that, because we build them better, we can guarantee them longer.



*3 year warranty requires authorized startup — 1 year warranty without authorized startup

PREPACKAGED SOLID STATE STARTERS WITH ATL BYPASS

MVRXE SERIES — SEVERE DUTY WITH ACROSS-THE-LINE BYPASS

STANDARD FEATURES:

- NEMA 12, solid state starter, UL347 listed, Class E-2.
- 45 kV BIL
- 50 KAIC (4800 VAC)/ 50 KAIC (2600 VAC) short circuit fault rated
- 500% — 30 seconds rated solid state starter — UL347 certified and listed.
- 8,000 PIV — UL347 certified and listed at 2.4 kV
- 12,000 PIV — UL347 certified and listed at 4.2 kV
- Fiber optic firing
- Selectable solid state or emergency full voltage operation via selector switch mounted inside of LV compartment
- Load matched Class R fusing with blown fuse indication
- 400 A load break, 600 A continuous, 5 kV rated disconnect switch, with viewing window, grounding assembly and lockable handle mechanism; mechanically interlocked for safety
- Fixed mounted, start duty rated vacuum contactors for isolation and SCR bypass, wired for normal bypass operation and full voltage start operation, with 2 NO and 2 NC auxiliary contacts

- Separately mounted “SPE” series electronic overload device has the following standard features:
 - Class 10–30 adjustable
 - Phase imbalance protection
 - 1 NO/1 NC trip contact
 - Phase reversal protection
 - “Trip-free” design
 - Phase loss protection
- Built-in self test (BIST) features for “quick commissioning”
- 120 VAC, 1000 VA CPT with primary and secondary fusing, with 500 VA available for customer use
- Door-mounted start and stop push-buttons.
- Door-mounted LCD keypad
- Door-mounted run indication light
- Door-mounted local-off-remote switch
- Door-mounted reset button
- Terminal strip mounted inside LV compartment for:
 - Remote start/stop control
 - Remote up-to-speed indication
 - Remote run indication
 - Remote fault indication
- Benshaw MX³ controller with complete soft start, soft stop and motor protection capabilities
- 485 communications capabilities — local through-door connection or remote from starter (optional)
- Modbus communications standard

KEY ADVANTAGES:

- NEMA 12, UL 347 listed
- 45 kV BIL
- Service entrance labeled (optional)
- Built-in self test (BIST) features for “quick commissioning”
- Solid state reduced voltage starting — normal operations
- 400 amp load break/600 amp continuous fused disconnect switch
- Switch selectable emergency back-up full voltage starter
- MX³-embedded digital control
- Fiber optic firing
- Advanced motor protection
- Advanced metering
- Power quality protection
- Diagnostics and Modbus RTU485 communications standard

PREPACKAGED SOLID STATE STARTERS WITH ATL BYPASS



MVRXE SERIES — SEVERE DUTY WITH ACROSS-THE-LINE BYPASS AND LOAD BREAK FUSIBLE DISCONNECT

THE UPGRADED/ENHANCED DESIGN OF BENSHAW'S LEGACY PRODUCT THAT ESTABLISHED INDUSTRY STANDARDS FOR PERFORMANCE AND RELIABILITY.

KEY ADVANTAGES:

- NEMA 12, UL 347 listed
- 45 kV BIL
- Built-in self test (BIST) features for “quick commissioning”
- 425 A load break
- Switch-selectable emergency back-up full voltage starter
- MX³ embedded digital control

STANDARD FEATURES:

- 50 KAIC (4800 VAC)/ 50 KAIC (2600 VAC) short circuit fault rated
- 500%–30 seconds rated solid state starter — UL 347 certified and listed
- “R” class fusing protection
- Door-mounted controls
- Modbus communications standard



MVRXE12 - 2300 V

Model Number	HP	Dimensions (in.)				Weight (lbs.)
		A	H	W	D	
MVRXE12-550-2300**	550	131	92	36	32	1,800
MVRXE12-750-2300** †	750	200	92	36	32	1,800
MVRXE12-900-2300**	900	225	92	36	32	1,800
MVRXE12-1500-2300** †	1500	330	92	36	32	1,800

MVRXE18 - 4160 V

Model Number	HP	Dimensions (in.)				Weight (lbs.)
		A	H	W	D	
MVRXE18-1000-4160**	1000	131	92	36	32	2,000
MVRXE18-1500-4160** †	1500	200	92	36	32	2,000
MVRXE18-1700-4160**	1700	225	92	36	32	2,000
MVRXE18-3000-4160**†	3000	330	92	36	32	2,000

Starters are top entry/bottom exit — top exit available upon request. Dimensions and weights are approximate.

** Insert appropriate option code as shown: NEMA 12 = 12/NEMA 3R = 3R

† Only 350% for 30 Seconds

MODULAR OPTIONS

Option	Description
02	8-Channel RTD Module, 100 ohm Platinum (Also Available for Remote Mounting)
16	Ground Fault CT, 2000:1, 4.0:Dia. (For MX ³ Use)

Power fuses ship loose. Must provide motor full load amps at time of order for proper fuse sizing.



SPARE PART KITS

**WANT TO MINIMIZE DOWNTIME LOSS OF PRODUCTION?
TAKE ADVANTAGE OF BENSHAW'S SPECIAL PRICING ON OUR NEW SPARE PARTS
KIT PACKAGES WHEN PURCHASED WITH AN MVRXE AND/OR BTO STARTER.**

RECOMMENDED SPARE PARTS KITS INCLUDE THE FOLLOWING:

- Power phase/stack assembly (x1)
Includes the following packaged heat sink assembly:
 - Fiber optic SCR firing card
 - SCRs (x6)
 - dV/dt filter cards (x3)
- Main control board
- Voltage divider board
- "R" class line fuses (x3)
- Primary fuses for CPT (x2)
- Secondary fuses for CPT (x3)
- Door-mounted keypad
- Door-mounted pilot lights, push-buttons and switches
- Overload relay
- Control relays



Model Number	Motor Amps
1000 HP STARTERS	
MVRXE-400101-SP	46 to 55 A
MVRXE-400102-SP	56 to 75 A
MVRXE-400103-SP	76 to 90 A
MVRXE-400104-SP	91 to 131 A
1700 HP AND 3000 HP STARTERS	
MVRXE-400107-SP	46 to 55 A
MVRXE-400108-SP	56 to 75 A
MVRXE-400109-SP	76 to 90 A
MVRXE-400110-SP	91 to 131 A
MVRXE-400111-SP	132 to 180 A
MVRXE-400112-SP	181 to 270 A
MVRXE-400113-SP	271 to 361 A

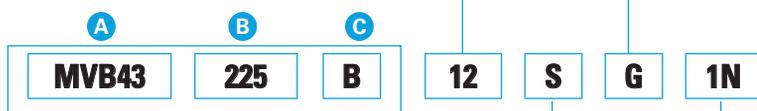
*Amp range not shown; consult factory.

Price effective February 15, 2023

DESIGN YOUR CUSTOMIZED STARTER TO SHIP IN 1 WEEK OR LESS

Only one option can be selected from each group, with the exception of the "Control Options" section. Add the appropriate code for the options chosen to the code string across the center of the page.

Choose Enclosure Options	
12	NEMA 12
SH	NEMA 12 with Space Heater
3R	NEMA 3R with Space Heater



0 to 1,000 HP		
A	B	C
Choose Core Unit	Choose Motor Current (A)**	Choose Exit/Landing Option***
MVB41	025	T
MVB41	025	B
MVB41	025	C
MVB41	045	T
MVB41	045	B
MVB41	045	C
MVB41	055	T
MVB41	055	B
MVB41	055	C
MVB41	080	T
MVB41	080	B
MVB41	080	C
MVB41	090	T
MVB41	090	B
MVB41	090	C
MVB41	133	T
MVB41	133	B
MVB41	133	C

1,001 to 3000 HP		
A	B	C
Choose Core Unit	Choose Motor Current (A)**	Choose Exit/Landing Option***
MVB43	170	T
MVB43	170	B
MVB43	170	C
MVB43	225	T
MVB43	225	B
MVB43	225	C
MVB43	330 †	T
MVB43	330 †	B
MVB43	330 †	C
MVB43	360 †	T
MVB43	360 †	B
MVB43	360 †	C

† Only 350% for 30 Seconds

Choose Service Entrance Rated (for stand-alone single units)	
S	Yes
N	No

Choose Bus Options+	
8N	800 A Non-Insulated Bus
8I	800 A Insulated Bus
1N	1,200 A Non-Insulated Bus
1I	1,200 A Insulated Bus
2N	2,000 A Non-Insulated Bus
2I	2,000 A Insulated Bus
NR	None Required

+Bus not required for single stand-alone unit.

Bus is required for connection of 2 or more units.

Any unit with bus will require additional MLO section. Please contact the factory for pricing and delivery.

***Exit/Landing Options

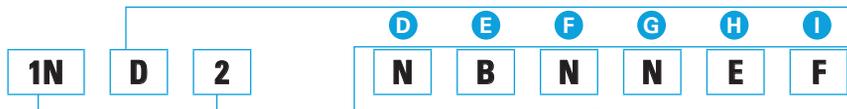
T	Top Exit with Landing Pad
B	Bottom Exit with Landing Pad
C	Top or Bottom Exit Landing on Bypass Contactor

Choose Option Zero Sequence Ground Fault CT 2000:1 (Residual included)

G	Yes
N	No

Choose Communications Options (RS-485 Modbus RTU standard)

D	DeviceNet
E	Ethernet
P	Profibus
N	None



Choose RTD Options (100 ohm platinum)

2	8-Channel RTD
4	16-Channel RTD
N	None

Choose Control Options — Choose one option for each item below

D	A	ATL option*	D	N	None
E	B	Green Start Push-Button and Red Stop Extended Push-Button*	E	N	None
F	C	Red Run Light and Green Stop Light	F	N	None
G	D	Amber Fault Light and Black Reset Push-Button	G	N	None
H	E	Local-Off-Remote 3-Position Switch	H	N	None
I	F	Emergency Stop Push-Button	I	N	None

Choose Bus Splice Options (must match bus option selected)

8N	800 A Non-Insulated Bus Splice
8I	800 A Insulated Bus Splice
1N	1,200 A Non-Insulated Bus Splice
1I	1,200 A Insulated Bus Splice
2N	2,000 A Non-Insulated Bus Splice
2I	2,000 A Insulated Bus Splice
NR	None Required

* ATL option comes with start and stop push-buttons (i.e., start stop push-buttons cannot be selected).

No selection = keypad control.

Recommend E-stop option be selected.

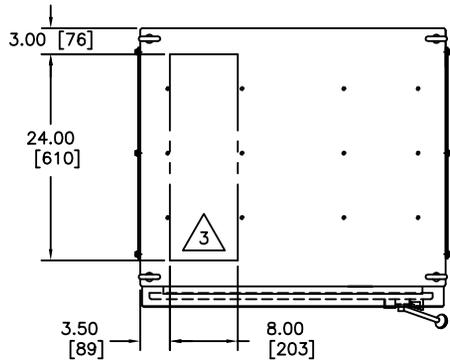
****Motor currents vs. HP are typical; confirm actual motor current. Service factor not accounted for; adjust if required.**

Example: A 3,000 HP (MVB43), 360 A (360) unit with the following options: bottom exit with landing pad (B), NEMA 12 enclosure (12), service entrance rated (S), with ground fault (G), 1,200 A non-insulated bus (1N), 1,200 A non-insulated bus splice (1N), with DeviceNet (D), 8-channel RTD (2), without ATL option (N), with start and stop buttons (B), without run and stop lights (N), without fault and reset lights (N), with a local-off-remote switch (E), with emergency stop push button (F), would build the following code string: MVB43360B12SG1N1ND2NBNNEF

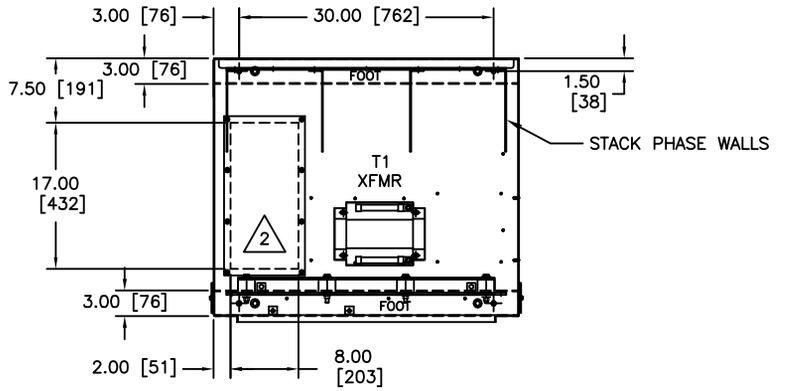
Need help sizing your Soft Starter?

Soft Starter sizing guide available on benshaw.com, or call an Application Engineer at 412-968-0100.

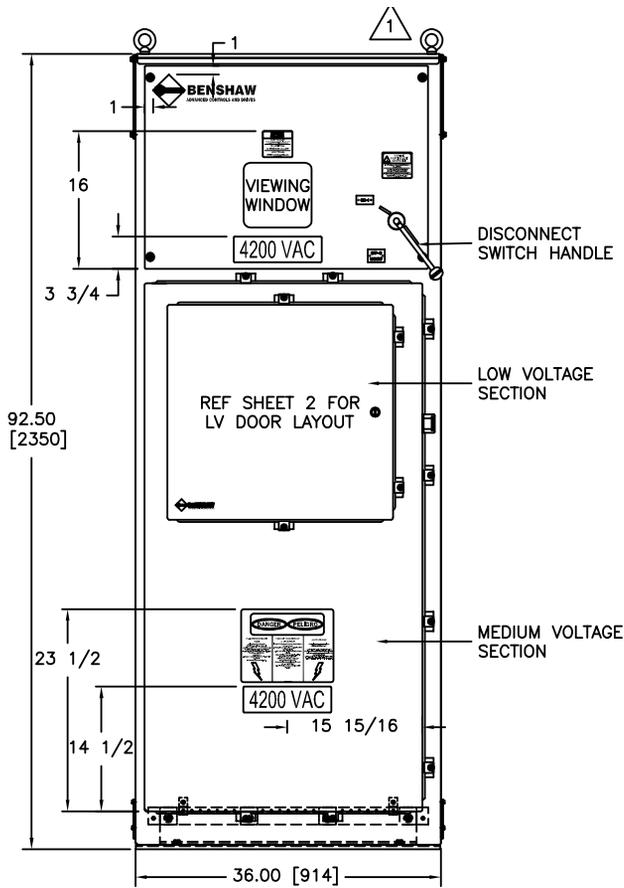
DRAWINGS



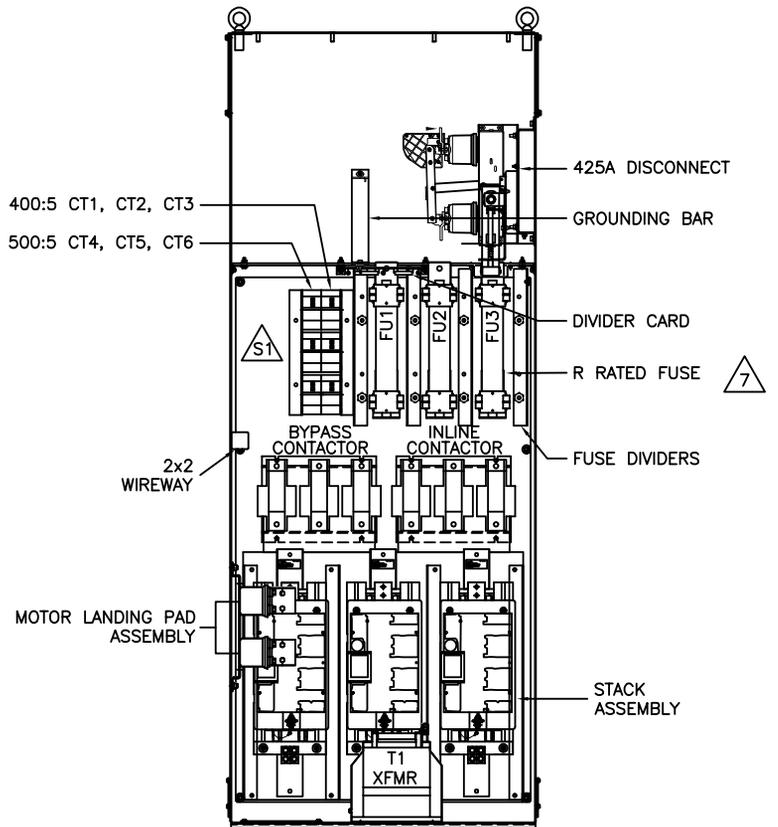
TOP VIEW



FRONT OF ENCLOSURE
PLAN VIEW

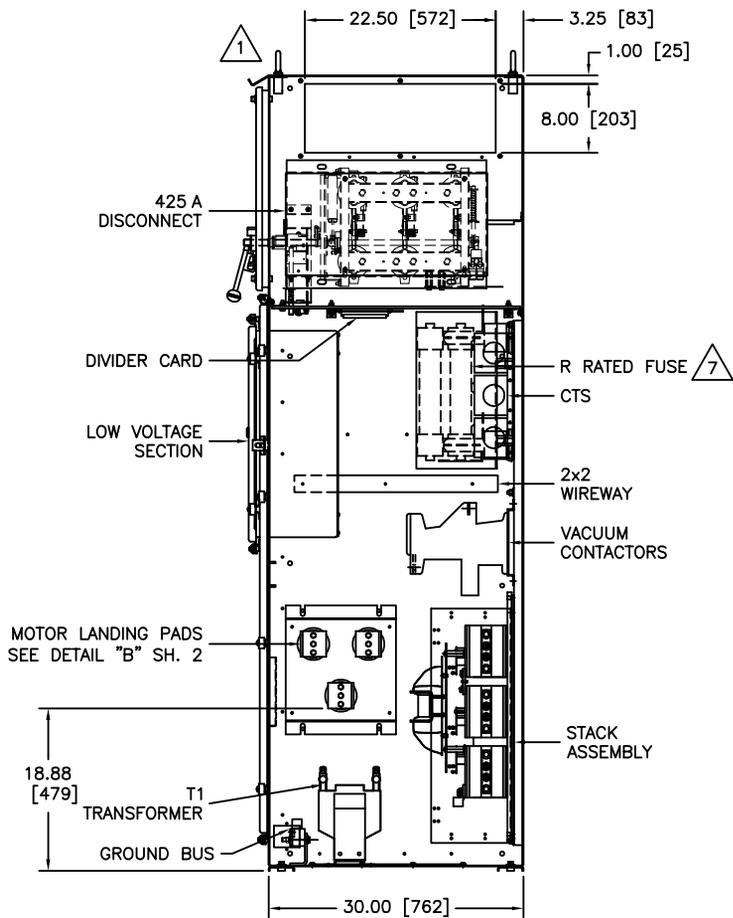


FRONT VIEW



FRONT INTERIOR VIEW

All drawings packages are available on BenshawExpress.com.



RIGHT SIDE INTERIOR VIEW

Notes:

- △1 Removable lifting eyebolts.
- △2 Cable entry /exit area. Cutout with cover plate supplied.
- △3 Cable entry/exit area. No cutout supplied. Customer to cut as required.
- 4. Enclosure color: ANSI 61 grey.
- 5. Tighten bolts per chart below.

Steel bolt – Torque in pound-foot [Newton-Meter]

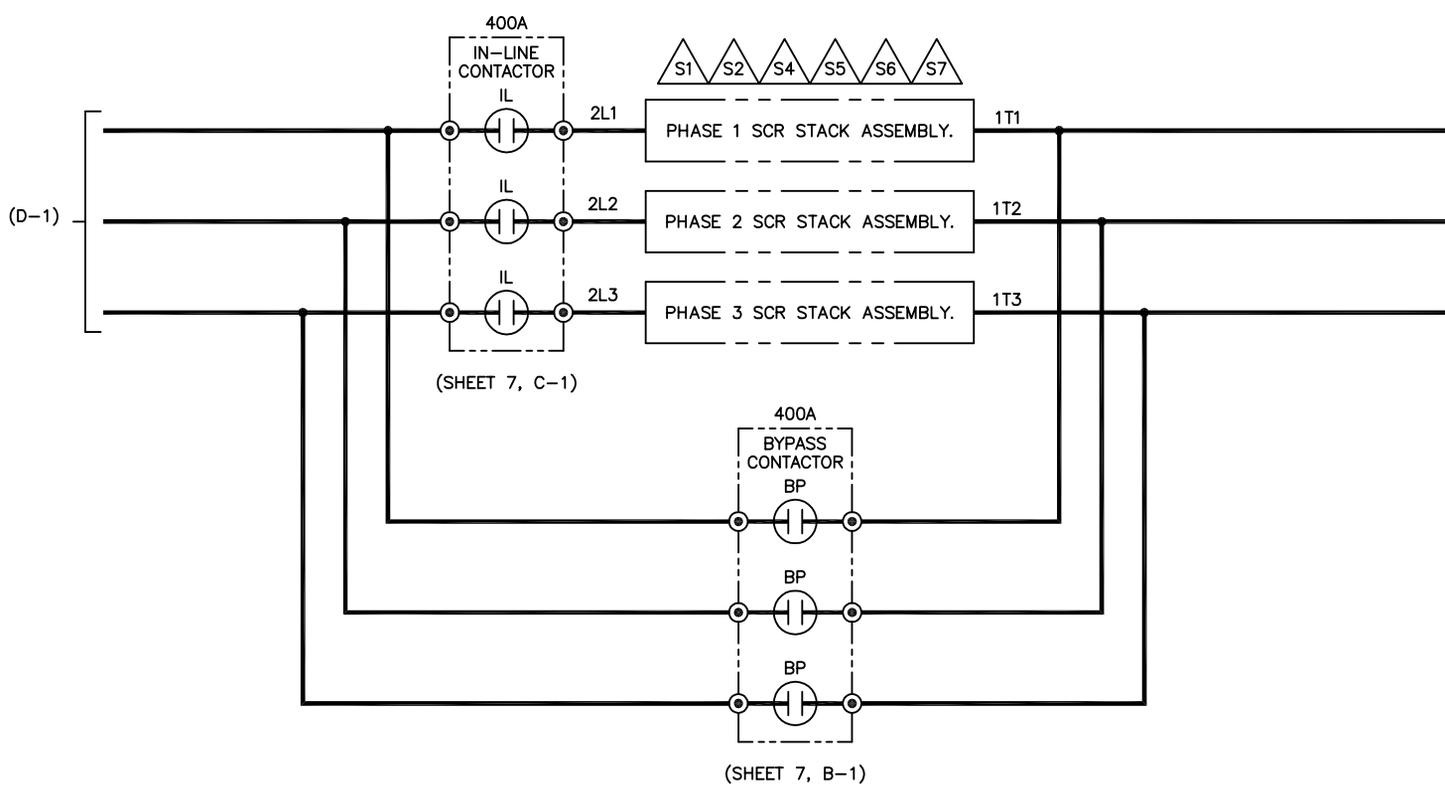
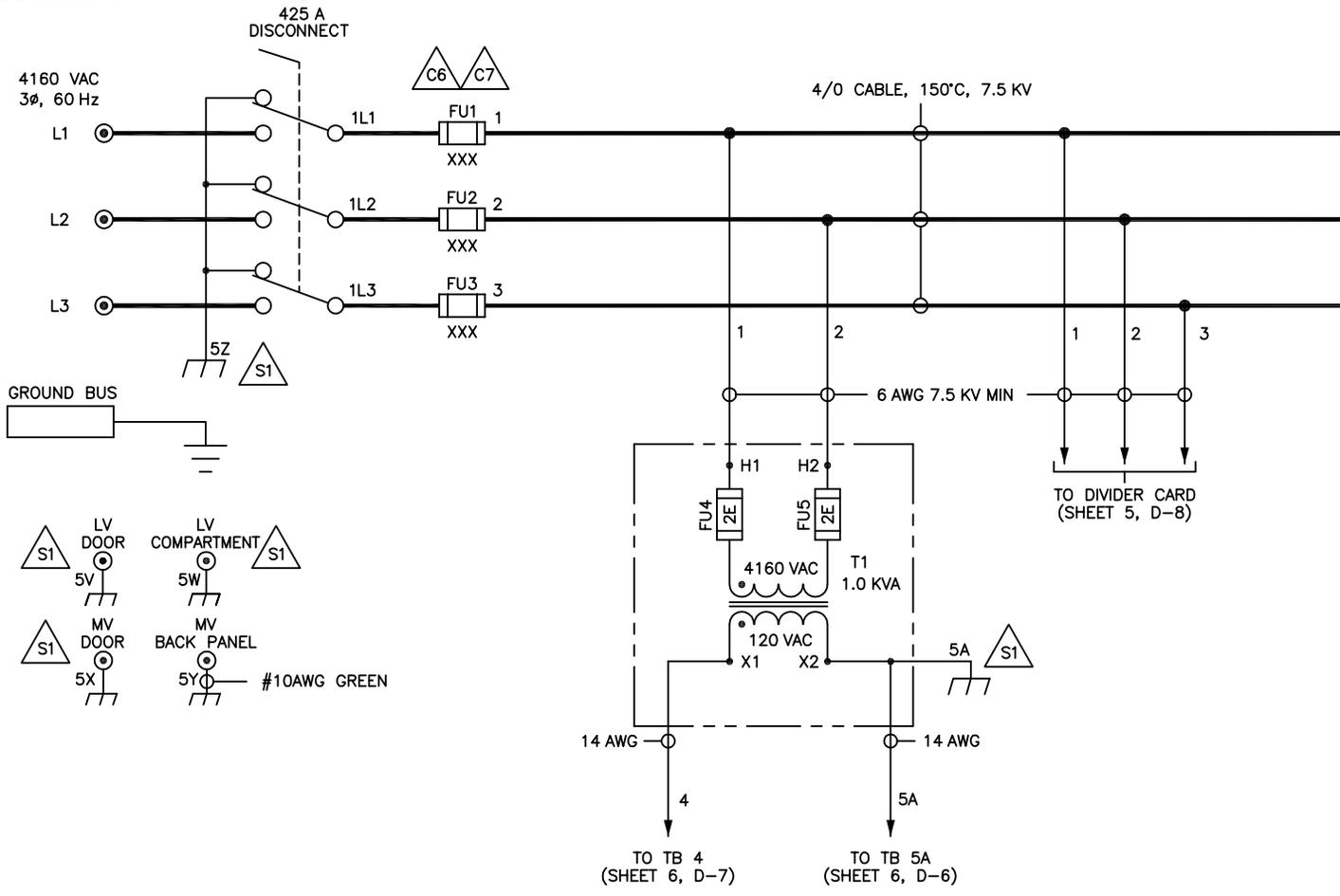
1/4-20	5/16-18	3/8-16	1/2-13	5/8-11
5 (6.8)	12 (16.3)	20 (27)	50 (67.8)	95 (128.8)

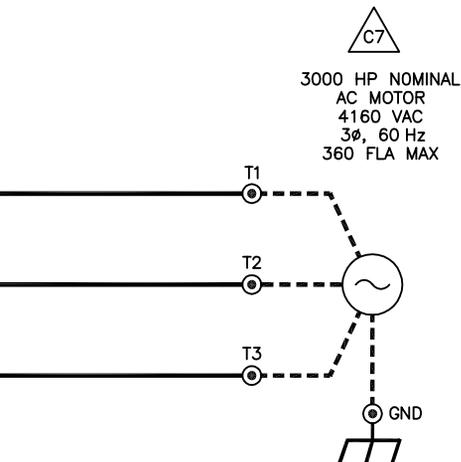
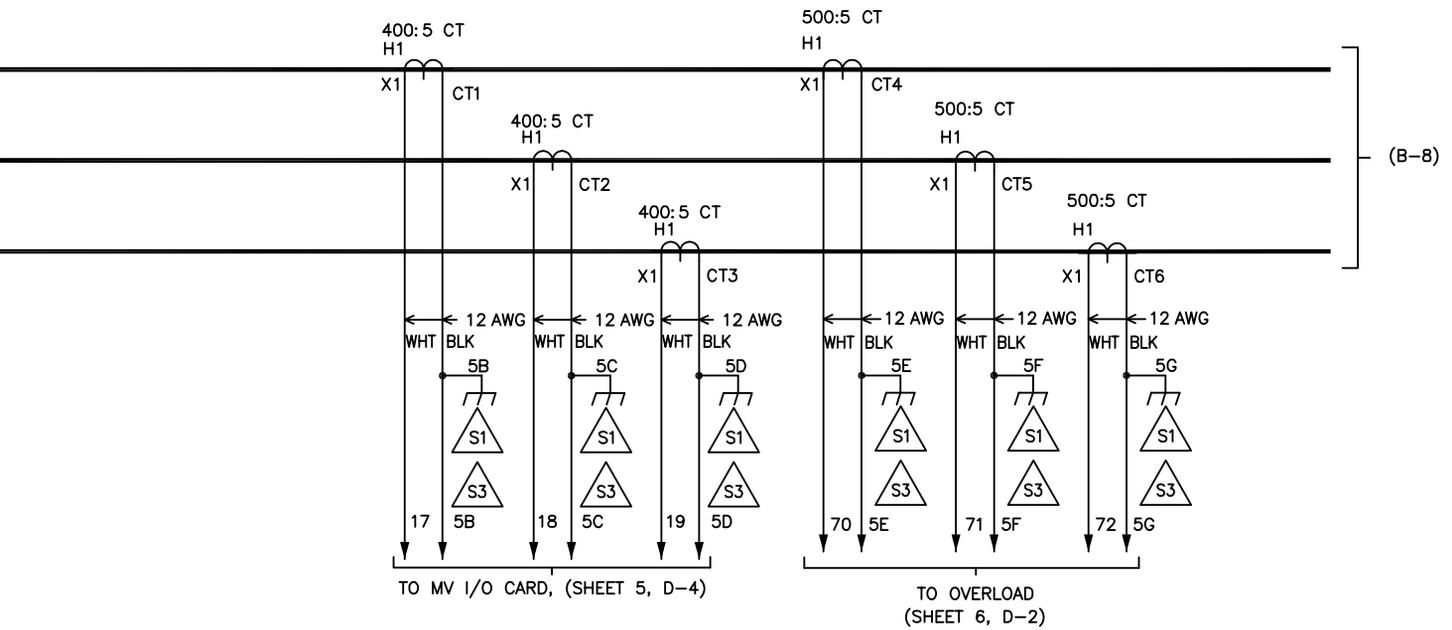
6. Approximate weight is 1600 lbs (726 kg).

- △7 R-fuses shown for reference. Reference sales order for fuse size.

All drawings packages are available on BenshawExpress.com.

DRAWINGS





CAUTION:
SEVERE DAMAGE MAY RESULT IF SURGE CAPACITORS, LIGHTNING ARRESTERS, OR POWER FACTOR CORRECTION CAPACITORS ARE CONNECTED TO THE LOAD SIDE OF THE SOLID STATE STARTER. CONSULT FACTORY BEFORE USING ANY OF THESE POWER QUALITY ENHANCEMENT DEVICES.

All drawings packages are available on BenshawExpress.com.

MVE MEDIUM VOLTAGE SOFT STARTERS

2.3 KV - 15 KV, UP TO 1200 A MVE DESIGN



NEMA 12 enclosed E2 starter

NEMA 3R outdoor rated starter

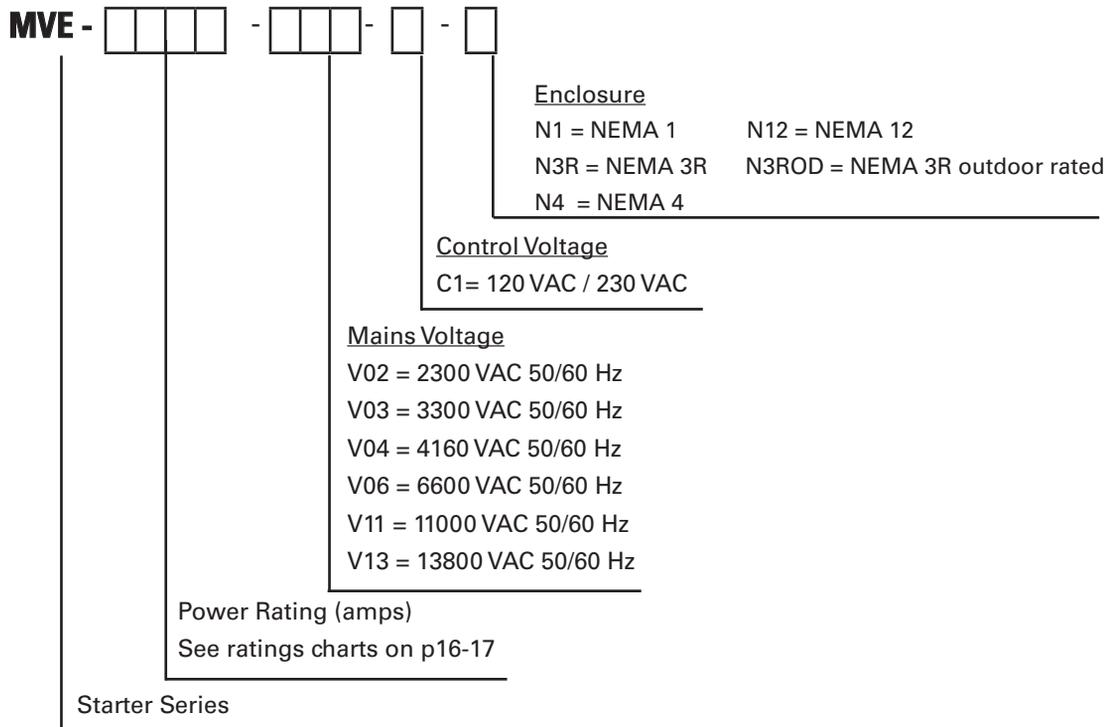
MVE gets your motor up and running smoothly and reliably, while providing all the motor and load protection features you would expect in a medium voltage soft starter. Our fully enclosed MVE is a complete E2 starter offering which includes a load break disconnect switch, in-line vacuum contactor and fully rated bypass vacuum contactor, and motor overload protection.

MVE soft starters are just one of Benshaw's medium voltage solutions we now offer since the merger with AuCom.

MVE MEDIUM VOLTAGE SOFT STARTERS

SPECIFICATIONS

Part Number Description



Specifications

Main voltage	2.3 kV ~ 15 kV (±10%)
Control voltage	120 VAC or 230 VAC
Current range	110 A ~ 1200 A (nominal)
Rated frequency (fr)	50/60 Hz
Max start current	400% FLC
Max start time	30 seconds at 400% FLC
Operating temperature	-10°C to +50°, max + 60°C with derating
Storage temperature	-25°C to +70°C
Altitude	1000 m ASL, higher with derating
Relative humidity	5% to 95%, non-condensing
Approvals/certifications	UL/cUL

MVE MEDIUM VOLTAGE SOFT STARTERS

RATINGS - 2.3 KV - 6.6 KV

System Voltage	Starter Current	Motor HP	Motor kW	Dimensions and Weights:			Wgt. (lbs.)
				N1, 4/3R* Class E2 Starter			
				H	W	D	
2.3 kV							
	110	500	360	93	36	30	1100
	200	900	660	93	36	30	1100
	400	1750	1330	93	36	30	1250
	600	2500	2000	93	72	30	2400
	800	3425	2660	93	96	36	3500
	1000	4275	3330	93	96	36	3500
3.3 kV							
	110	675	520	93	36	30	1250
	200	1225	950	93	36	30	1250
	400	2500	1910	93	36	30	1260
	500	3000	2340	93	72	30	2400
	600	3675	2850	93	72	30	2400
	800	4900	3820	93	78	36	2800
	1000	6125	4780	93	96	36	3500
4.2 kV							
	60	500	360	93	36	30	1250
	110	900	660	93	36	30	1250
	200	1500	1200	93	36	30	1250
	360	3000	2238	93	36	30	1300
	400	3250	2400	93	36	30	1300
	500	4000	3000	93	72	30	2400
	600	4500	3610	93	72	30	2400
	800	6175	4820	93	109	36	2800
	1000	7725	6030	93	109	36	3500
6.6 kV							
	70	850	670	93	36	30	1300
	140	1725	1340	93	36	30	1300
	250	3000	2390	93	45	30	1750
	300	3500	2870	93	45	30	1750
	400	5000	3820	93	72	30	1750
	500	6000	4700	93	72	30	2600
	600	6750	5600	93	109	44	3100
	700	8575	6740	93	109	44	3500
	800	9800	7650	93	109	44	3500
	1000	12250	9570	93	109	44	3500
	1200	14700	11500	93	109	44	4000

MVE MEDIUM VOLTAGE SOFT STARTERS

RATINGS - 11.0 KV - 13.8 KV

Dimensions and Weights:

System Voltage	Starter Current	Motor HP	Motor kW	N1, 4/3R* Class E2 Starter			Wgt. (lbs.)
				H	W	D	
11 kV	70	1500	1100	96	126	44	4650
	140	3000	2200	96	126	44	4650
	250	5100	4000	96	126	44	4650
	300	6125	4800	96	126	44	4650
	400	8175	6300	96	126	44	4650
	700	14300	11200	96	138	55	6000
	800	16350	12800	96	138	55	6000
	1000	20425	1600	96	138	55	6200
	1200	24525	19200	96	138	55	6200
13.8 kV	70	1800	1400	96	126	44	6200
	140	3600	2800	96	126	44	6200
	250	6400	5000	96	126	44	6200
	300	8000	6000	96	126	44	6200
	400	10000	8000	96	126	44	6200
	700	18000	14000	96	126	55	6400
	800	20000	16000	96	166	55	6400
	1000	25000	20000	96	166	55	7000
	1200	30000	24000	96	166	55	7000

Contact factory for pricing and availability of standard units and custom line-ups.



*NEMA 3R outdoor rated (door-in-door) model also available. Contact us for dimensions and further information.

MEDIUM VOLTAGE SOFT STARTERS REQUEST FORM

Please supply ALL the following information, so we can accurately select a starter for your application.

Type of application (pump, compressor, conveyor, etc.) _____

Motor rated power (KW or HP) _____

Motor nominal voltage (V) _____

Motor current vs. speed curve or I_{st}/I_n (% or Per Unit) _____

Rotor inertia J=GD²/4 (kgm) _____

Load inertia J=GD²/4 (kgm) at motor speed _____

Starts per hour _____

Cabinet degree of protection (1PXX/NEMA) _____

Ambient temperature (operating & storage) requirement _____

Power cables entry (top or bottom) _____

Soft starter only (IEC style) or standard unit with load break switch and power fuses/VCB _____

Max. shipping split dimensions (WxHxD) _____

Additional notes / requirements: _____

Motor Full Load Current (FLA) _____

Motor synchronous speed (RPM) _____

Motor speed/torque curve or T_{max}/T_n (% or Per Unit) _____

Load speed/torque curve (% or per unit) _____

Time between starts _____

Altitude (meters or feet above sea level) _____

of units (single, multiple in line up) _____

If line-up of multiple units, how many per line-up (required for sizing horizontal/overhead bus). _____

If your application involves a synchronous motor (soft starter with synchronous exciter), please also indicate:

Type of exciter (rotating or static) _____

Full nameplate data of motor and exciter _____

For rotating exciter: DC voltage, DC current of the exciter generator field _____

If retrofit application, will the existing static exciter field starting /discharge resistor be used? If not, is this within soft starter manufacturer's scope of supply? _____

Additional notes / requirements: _____

New or refurbished motor? _____

Data for existing / old excitation system _____

For static exciter: DC voltage, DC current of motor field _____

For static exciter: full data of field starting / discharge resistor _____

Availability of LV 3 phase supply KVA required: 250V x IDC x 3 phase x 1.3. _____

Advise voltage and frequency. _____

MEDIUM VOLTAGE ENGINEERED PRODUCTS

PRODUCT OVERVIEW

Benshaw has developed advanced engineering, drafting, materials management and quality systems focused on designing and building customer solutions. This “Build to Order” capability combined with an extensive inventory of control components, protective relays, circuit breakers, contactors, enclosures and other electrical/electronic devices provides our customers with the quickest shipment of engineered products in the industry.

CONTROL MODIFICATIONS — WHATEVER YOU SPECIFY

- Unlimited modifications and accessories are available, including: pilot devices, PLCs, control power transformers, switches, meters, relays, space heaters, protective devices, power factor correction capacitors, surge arrestors and line reactors.

COMBINATION STARTERS TO MEET YOUR REQUIREMENTS

- Solid state reduced voltage
- Standard full voltage
- Smart full voltage
- Solid state with full voltage bypass

POWER RATINGS TO FIT YOUR APPLICATION

- 5 kV Class to 10,000 HP
- 7.2 kV Class to 16,000 HP
- 15 kV Class to 25,000 HP

ENCLOSURES TO MATCH YOUR ENVIRONMENT

- Standard designs — NEMA 1, 12, 3R
- Custom enclosures including stainless steel
- NEMA 4, 4X and insulated enclosures
- Motor control centers

COMMUNICATION

- Modbus/RS485 — Standard
- Profibus
- Ethernet
- DeviceNet



SOLID STATE REDUCED VOLTAGE STARTERS

MVRMX SERIES — 5 KV/7.2 KV/15 KV ... TO 25,000 HP

MVRMX SERIES PRODUCT HIGHLIGHTS

Only Benschaw has designed, built and supports more than 40,000 solid state starters, from 2,300 volts to 15kV, for applications ranging from pumps, compressors and chillers to fans and blowers, crushers, chippers and conveyors; for every motor type: induction, synchronous, two-speed, reversing and wound rotor.

The RediStart CFMVRMX series with MX³ technology is a fully integrated, programmable family of Class E2 load break/combination solid state starters. This integrated design includes control and power electronics, bypass and isolation contactors that reduce maintenance and operating costs when compared to other methods.

KEY ADVANTAGES:

Protect machinery from failure and excessive maintenance caused by mechanical shock during starting or stopping. The RediStart MVRMX provides smooth, stepless acceleration and controlled deceleration.

Protect electrical systems from disruptive voltage drops and power outages caused by motor locked rotor inrush current. The RediStart MVRMX starter precisely controls the current ramp during start up.

Protect mission-critical motors from failure or unscheduled outages caused by machine or electrical system faults. The RediStart MVRMX starter provides complete, high performance, coordinated line monitoring, motor control and protection.



Guaranteed ... for three full years.

Only Benschaw has a three year guarantee.

Every Benschaw solid state starter is guaranteed for three full years. Other manufacturers limit their warranties to just one year. But at Benschaw, we believe that, because we build them better, we can guarantee them longer.



*3 year warranty requires authorized startup — 1 year warranty without authorized startup

COMBINATION SOLID STATE STARTERS 7.2 KV/15 KV CLASS

CBMVRX SERIES — MEDIUM VOLTAGE STARTERS —
BENSHAW JUMBO SOLUTION FOR LARGE MOTORS



Only Benshaw has a solution for your largest motor needs, up to 16,000 HP at 6900 V and 25,000 HP at 13800 V. For the largest motor starting applications, Benshaw provides a circuit breaker solution for isolation and protection for the motor. Benshaw's team of engineers will develop a custom solution for the application. Benshaw provides the flexibility of using existing switchgear, or will source new switchgear from any major vendor, which provides a seamless transition for maintenance personnel. Customers must provide single-phase control power for controls in this configuration.

SMART FULL VOLTAGE ACROSS-THE-LINE STARTERS

CFMVRMXATL SERIES

The “Smart” Medium Voltage “ATL” package includes the addition of the RediStart MX³ control package for additional branch circuit monitoring motor protection, metering, diagnostics and communication. Refer to MVRMX RediStart MX³ specification for complete details. A sampling of the enhanced features includes:

PROTECTION (ANSI STANDARD NUMBERS GIVEN)

- 51 — Electronic motor overload, Class 1 to 40
- 86 — Overload lockout
- 48 — Adjustable up-to-speed timer (off; 0 to 300 seconds)
- 59/27 — Adjustable over/under voltage protection
- 46 — Adjustable line to average current imbalance
- 81 — Adjustable high and low frequency protection
- Single-phase protection
- 66 — Adjustable starts per hour (off or 1 to 20 starts)
- Adjustable time between starts (off or 1 to 600 minutes)
- Backspin timer (off or 1 to 200 minutes)
- 51 — Overcurrent detection (off or 50 to 800%) and time (0.1 to 90.0 sec. in 0.1 sec. intervals)
- 37 — Undercurrent detection (off or 10 to 100% and time (0.1 to 90.0 sec. in 0.1 sec. intervals)
- 51G — Ground fault detection (off or 1 to 100 amps) and time (0.1 to 90.0 sec. in 0.1 sec. intervals)
- Overcurrent, undercurrent and ground fault can each be set to trip or activate a relay

- 50 — Instantaneous electronic overcurrent trip
- 47 — Phase rotation selectable ABC, CBA or Ins (insensitive)
- 38/49 — Remote mountable RTD protection package, 8 or 16 RTD inputs (optional)

CONTROL

- Local start/stop controls
- Emergency reset capability

INPUT/OUTPUT AND DISPLAY

- Plain English operation via back-lit LCD display interface
- LCD and LED status and diagnostics (full fault annunciation)
- Programmable metering (amps, volts, frequency, overload, power factor, elapsed time, watts, VARs, watt hours, VA, current imbalance, ground fault current, RTD temperatures with optional RTD module)
- Programmable relay outputs
- Latched fault relay output
- Real-time clock
- Time stamped event recorder
- Password protection
- Battery backed-up starter parameters and lockout times



5 kV Class Smart ATL

MX³ CONTROL FEATURES (SMART ACROSS THE LINE)

MOTOR PROTECTION:

- Motor thermal overload
- Independent starting and running OLs
- Up to speed timer exceeded
- Low line voltage
- Low line frequency
- High line frequency
- Phase reversal
- Phase loss
- Instantaneous overcurrent
- Overcurrent
- Undercurrent
- Current imbalance
- Ground fault (residual or zero sequence)
- Disconnect fault
- Inline contactor fault
- Control power low
- Motor PTC input
- RTD modules

METERING:

- Accuracy:
 - 3% out-of-box
 - 2% factory calibrated
- Average current
- L1 current
- L2 current
- L3 current
- Current imbalance %
- Ground fault current
- Average volts
- L1 – L2 voltage
- L2 – L3 voltage
- L3 – L1 voltage
- Overload %
- Power factor
- Watts
- VA
- VARS

- KW hours
- MW hours
- Phase order
- Line frequency
- Analog input
- Analog output
- Run time – days
- Run time – hours
- # of starts
- TruTorque %
- Power %
- Peak starting current
- Last starting duration
- RTD temperatures
- Real-time clock

8 DIGITAL INPUTS CONFIGURABLE TO:

- Stop
- Fault
- Fault reset
- Bypass/inline confirm
- OL reset
- Local/remote selection
- 1 dedicated start input
- Disconnect

6 RELAY OUTPUTS CONFIGURABLE TO:

- Faulted
- Running
- Up to speed
- Alarm condition
- Ready condition
- Locked out
- Overcurrent
- Undercurrent
- OL alarm
- Shunt trip
- Ground fault
- Cooling fan

1 ANALOG 4–20 MA/0–10 VDC INPUT CONFIGURABLE TO:

- Trip high level
- Trip low level

1 ANALOG 4–20 MA/0–10 VDC OUTPUT CONFIGURABLE TO:

- Current (0–200%/0–800%)
- Voltage (0–150%)
- OL (0–150%)
- KW (0–10 KW/0–100 KW)
- MW (0–1 MW)
- Analog input (0–100%)
- Firing (0–100%)
- Calibration

USER INTERFACE:

- Event log (99 events)
- Door-mounted LCD display
 - Set/examine operating parameters
 - View status information, line current, voltage and frequency
 - Start and stop the starter

1 COMMUNICATION PORT:

- Modbus/RS485

FULL VOLTAGE ACROSS-THE-LINE STARTERS

CFMVATL SERIES

CFMVATL SERIES PRODUCT HIGHLIGHTS

CFMVATL medium voltage across-the-line starters are full voltage controllers for three-phase induction motors. The RediStart MX³ control package can be added as an option to provide a “Smart” CFMVRMXATL package.

Combination CFMVATL starters are supplied in a free-standing enclosure. Enclosures are available in NEMA 1, NEMA 12 and NEMA 3R configurations. Enclosure consists of two distinct compartments. The medium voltage section is located in the main body of the enclosure, and the low voltage section containing the control logic is located behind the door in an isolated compartment.

Standard combination CFMVATL starters are supplied with a load break/fault make disconnect isolation switch, Class “R” motor current limiting fuses, vacuum motor starting contactor and the “SPE” SureProtex electronic overload protection. Refer to the CFMVRMXATL series for the RediStart MX³ control package for additional branch circuit monitoring, motor protection, metering, diagnostics and communication.

STANDARD FEATURES:

The standard medium voltage combination “ATL” package includes:

- NEMA 1,12, 3R enclosure
- Disconnect switch
 - Load break/fault make
 - Grounding bar
 - Viewing window
- Motor fusing
 - Class “R”
 - Current limiting
- Vacuum motor starting contactor
- Start/stop push-buttons
- “SPE” overload protection
 - Class 10–30 adjustable
 - 1 NO, 1 NC trip contact
 - “Trip-free” design
 - Phase imbalance protection
 - Phase reversal protection
 - Phase loss protection
 - Test function/trip indication
 - Fault indication



DUAL FULL VOLTAGE ACROSS-THE-LINE STARTERS

2300V / 4160V / 7200V

CFMVMXATL2H SERIES

CFMVMXATL2H SERIES PRODUCT HIGHLIGHTS

Benshaw is now able to offer the same rugged and reliable starter design and protection, but in a smaller package for your multiple motor needs.

The dual starters are supplied in a free-standing enclosure, available in NEMA 1, NEMA 12 and NEMA 3R configurations. The enclosure consists of four distinct compartments with two separate medium voltage sections and two low voltage sections. Standard combination CFMVMXATL2H starters are supplied with individual load break/fault make disconnect isolation switches, Class "R" motor current limiting fuses, Class "R" motor current limiting fuses, vacuum motor starting contactors and the MX³ motor protection and controls.

STANDARD FEATURES:

The standard dual medium voltage combination "ATL2H" package includes:

- NEMA 1, 12, 3R enclosure
- Two disconnect switches:
 - Flange handle
 - Load break/fault make
 - Grounding bar
 - Viewing window
- Individual motor fusing
 - Class "R" up to 24R max.
 - Current limiting
- Two vacuum motor starting contactors
- Start/stop push-buttons
- Control power transformer rated 1 kVA
- MX³ controls for protection and monitoring



MAIN LUG ONLY (MLO)

MLO SERIES

MLO SERIES PRODUCT HIGHLIGHTS

Benshaw's Main Lug Only (MLO) section provides a full height and depth NEMA rated enclosure for use as a convenient area to land the line or load cable connections while providing a transition area for a disconnect switch, starter or MCC. Required for Benshaw line-ups with bus.

The MLO can be configured for top or bottom cable access (specify when ordering). Customized MLO sections are available — just contact Benshaw's factory with your requirements.

KEY ADVANTAGES:

- Landing pad for input cable
- Optional feed-through bus to Benshaw line up
- Top or bottom cable entry
- NEMA 1, 12 or 3R enclosure configurations
- Transition from other manufacturers' line up
- Configure to match up to existing bus network (optional)
- Optional control transformers and metering can be added
- Bottom entry standard — top entry requires upsizing to 36" W

STANDARD FEATURES:

The MLO Series includes:

- Landing pad for cabling
- NEMA 1/12 construction
- ANSI 61 grey
- 11 gauge steel construction
- Super durable polyurethane TGIC powder paint
- Tin-plated copper bus
- Paint finish meets ASTM A252-9 or A525-83
- UL/cUL listed 5 kV Class
- 18" MLO not UL

OPTIONS:

- Lockable front panel
- Bus entry, left or right
- Control wireway



LOAD BREAK INTERRUPTER SWITCH

CFMVDISC SERIES

MVDISC SERIES PRODUCT HIGHLIGHTS

Benshaw's free-standing medium voltage load break interrupter switch is the latest design in medium voltage high current switching equipment for a wide range of applications. The fused interrupter switch provides an economical means of disconnect and short circuit protection for medium voltage loads such as transformers, single circuit or multi-circuit systems.

The switch is provided in a NEMA rated enclosure configured for use as a standalone unit, in an equipment line-up or MCC.

KEY ADVANTAGES:

- Bolts directly to Benshaw MCC line-up or starter
- UL labeled up to 4800 volts
- Available in 400, 600 and 1200 amp ratings
- Available up to 13800 volts
- Class E fusing included*
- Configurable with added options
- Load break rated
- Operating mechanism lockable in the off position
- Load side grounding in off position
- Blown fuse indication
- Welded 11 gauge steel construction
- Enclosure finish meets ASTM A252-9 or A525-83, G-90 designation
- Line and load landing pads with NEMA bolt pattern

STANDARD FEATURES:

- Load break fault make
- 60 kV BIL up to 7.2 kV, 90 kV BIL for 15 kV
- Symmetric fault ratings of 50 kA for 5 kV — 7.2 kV 45 kA for 2.4 kV
- NEMA 12 enclosure
- Viewing window to verify switch position
- Enclosure MV door interlocked with switch mechanism to prevent access while switch is on

OPTIONS:

- Lockable front panel
 - Bus entry, left or right
- * For use on motor loads, Class R fuse will be provided and must be specified by customer



LOW PROFILE LOAD BREAK INTERRUPTER SWITCH

FVMD SERIES

FVMD SERIES PRODUCT HIGHLIGHTS

Benshaw has developed a small footprint load break disconnect switch that is ideal for servicing your existing equipment. Benshaw's cost effective solution allows customers to put a maintenance disconnect directly next to the equipment using the smallest footprint. Maintenance and service employees will have line-of-sight to ensure that power is off and the equipment is safe to service. The low profile design is also ideal for environments where height is a concern, particularly in mining. The option also allows for up to 1200 A bus.

KEY ADVANTAGES:

- Compact design saves space
- Available up to 600 A full rated amps
- Class E fusing included
- Load break rated
- Bus available for line-ups

STANDARD FEATURES:

The standard medium voltage combination "FVMD" package includes:

- Load break fault make
- 60 kV BIL
- Symmetric fault rating of 50 kA for 5 kV Class, 45 kA for 2.4 kV Class
- NEMA 12 or 3R Enclosure
- Top cable entry/bottom cable exit
- Disconnect switch:
 - Flange handle
 - Load break/fault make
 - Grounding bar
 - Viewing window
- Individual fusing
 - Class "E"
 - Blown fuse indication



DUAL LOAD BREAK INTERRUPTER SWITCHES

CFMVDISC2H SERIES

CFMVDISC2H SERIES PRODUCT HIGHLIGHTS

Benshaw is now able to offer the same rugged and reliable disconnect design, but in a smaller package for your smaller current needs.

Enclosures are available in NEMA 1 and NEMA 12 configurations.

The enclosure consists of two distinct compartments that are completely isolated for maintenance. Standard combination CFMVDISC2H dual load break interrupter switches are supplied with individual load break/fault make disconnect isolation switches, and Class “E” fuses available up to 200E.

KEY ADVANTAGES:

- Bolts directly to Benshaw MCC line-up or starter
- Available up to 200 A full rated amps
- Class E fusing included
- Load break rated
- Compact designs saves space

STANDARD FEATURES:

The standard dual medium voltage combination “DISC2H” package includes:

- Load break fault make
- 60 kV BIL
- Symmetric fault rating of 50 kA for 5 kV Class, 45 kA for 2.4 kV Class
- NEMA 12 enclosure
- Two disconnect switches:
 - Flange handle
 - Load break/fault make
 - Grounding bar
 - Viewing window
- Individual fusing
 - Class “E” up to 200E max.
 - Blown fuse indication

TRANSFORMERS FEEDERS

CFMVTF SERIES

CFMVTF SERIES PRODUCT HIGHLIGHTS

Benshaw is now able to offer the same rugged and reliable product design as a cost-effective alternative to support transformer feeds. Enclosures are available in NEMA 1, NEMA 12 and NEMA 3R configurations. The enclosure consists of two distinct compartments with separate medium voltage and low voltage sections. Standard combination CFMVTF transformer feeds are supplied with individual load break/fault make disconnect isolation switches, Class “E” current limiting fuses, vacuum isolation contactors for shunt protection and a customer-selected feeder protection relay.

STANDARD FEATURES:

The standard transformer feeder combination “CFMVTF” package includes:

- NEMA 1, 12, 3R enclosure
- Disconnect switches:
 - Rotary or flange
 - Load break/fault make
 - Grounding bar
 - Viewing window
- Individual line fusing
 - Class “E”
 - Current limiting
- Vacuum isolation contactor for fault shunt
- Red ON and Green OFF pilot lights
- Amber FAULT pilot light
- Customer-specified feeder protection relay with CTs and ground fault CT

DUAL TRANSFORMERS FEEDERS

CFMVTF2H SERIES

CFMVTF2H SERIES PRODUCT HIGHLIGHTS

Benshaw is now able to offer the same rugged and reliable product design, but in a smaller package for smaller load requirements. Enclosures are available in NEMA 1, 12 or 3R configurations. The enclosure consists of two distinct isolated compartments for medium voltage. Standard combination CFMVDISC2H transformer feeds are supplied with two individual load break/fault make disconnect isolation switches, individual Class “E” current limiting fuses up to 200E, individual vacuum isolation contactors for shunt protection and a customer-selected feeder protection relay.

STANDARD FEATURES:

The standard dual transformer feeder combination “CFMVTF2H” package includes:

- NEMA 12
- Individual disconnect switches:
 - Flange
 - Load break/fault make
 - Grounding bar
 - Viewing window
- Individual line fusing
 - Class “E”
 - Max. rating 200E
- Individual vacuum isolation contactor for fault shunt
- Red ON and Green OFF pilot lights
- Amber FAULT pilot light
- Customer-specified feeder protection relay with CTs and ground fault CT for each section



MEDIUM VOLTAGE APPLICATION-SPECIFIC PRODUCTS

PRODUCT OVERVIEW

Benshaw is the trusted expert for any AC motor application. Benshaw provides a full line of application solutions for motors ranging from 2.3 through 15 kV Class up to 25,000 HP. Application-specific motor starters include Reversing, DC Injection Braking, Wound Rotor, Two-Speed/PAM, Synchronous, Multiple Motor, Capacitor Start/Switching Controls, Mine Duty Skid-Mounted and more.

15 KV CLASS SOLID STATE STARTERS

- 10,000, 11,000, 13,800 volt nominal operating voltages
- Up to 30,000 HP
- Combination or non-combination configurations
- Stand-alone or motor control center lineups
- Custom enclosures and transition sections

SYNCHRONOUS MOTOR SOLID STATE STARTERS

- Soft start stator control
- Synchronous speed monitoring package
- Solid state DC field excitor
- Applications include chillers, compressors, pumps, ball mills, chippers and more

SYNCHRONOUS MOTOR DC POSITIONING CONTROLS

- Integrated synchronous motor starter
- Solid state positioning control
- Applications include cement plant ball mills, rubber mills and more

TWO-SPEED/PAM MOTOR STARTERS

- Solid state starter
- Vacuum contactors for speed changing
- Applications include power generation plant I.D. fans, F.D. fans, Banbury mixers and more

REVERSING MOTOR STARTERS

- Solid state starter
- Vacuum contactors for motor reversing
- Applications include aggregate crushers, shredders, rubber mills, coal mills and more

WOUND ROTOR MOTOR STARTERS

- Solid state starter
- Rotor resistors, shorting contactors and interface
- Applications in aggregate, steel, mining, paper, power generation industries and more

MULTIPLE MOTOR STARTING

- Solid state starter
- Individual motor protection
- Applications include aggregate and coal conveyors, crushers, grinders, shredders and more

FOR ANY INDUSTRY

2300 V TO 13,800 V



Low profile skid-mount mining packages



Custom enclosures with transitions



15 kV Class non-combination and combination solid state starters

INTELLIGENT MV MOTOR CONTROL CENTERS/LINEUPS



INCOMING SECTION(S)

- Main breakers or disconnects
- Main–tie–main (MTM) arrangements
- Main lug only sections
- 400, 600 or 1200 amp load break fault make disconnects
- Surge protection devices
- Metering and communications

CUSTOM CONFIGURED MULTIPLE UNIT MOTOR CONTROL CENTER (MCC) LINEUPS

- Transition sections to third party equipment
- 800/1200/2000/3000 amp horizontal bus
- Reduced voltage/full voltage/feeder controls
- Back-to-back construction

INTELLIGENT MCC INTEGRATION

- Easy MCC networking
- MTM, disconnects, feeders; SSRV, ATL, two-speed starters
- Diagnostics and communications
- Intelligent SSRVS power poles

MAIN-TIE-MAIN ARRANGEMENTS

FIXED MOUNT

- Vacuum circuit breakers
- 46" deep



FIXED MOUNT

- Fused disconnect switches
- 36" deep



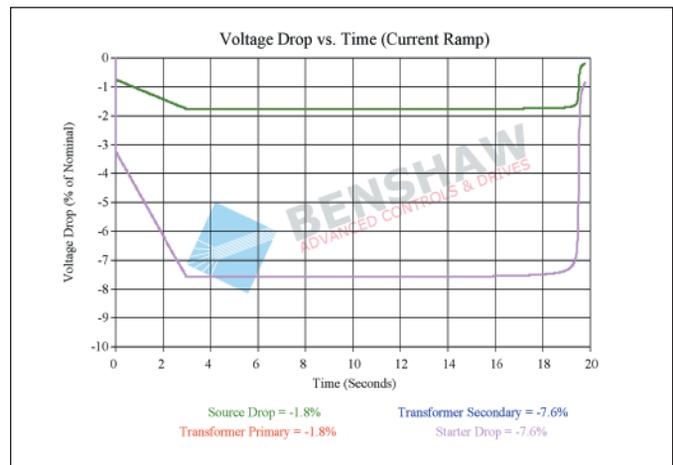
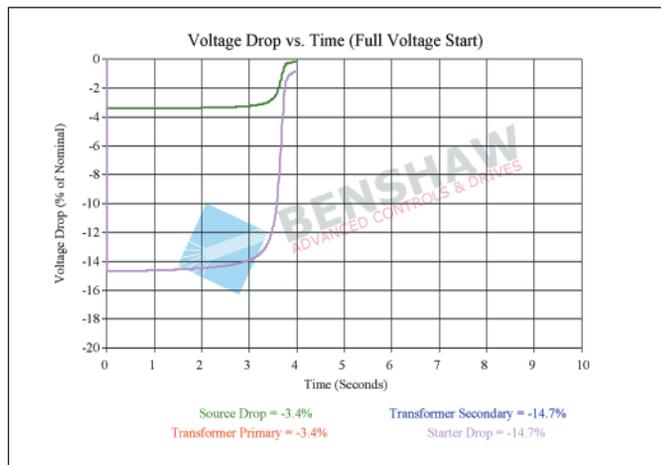
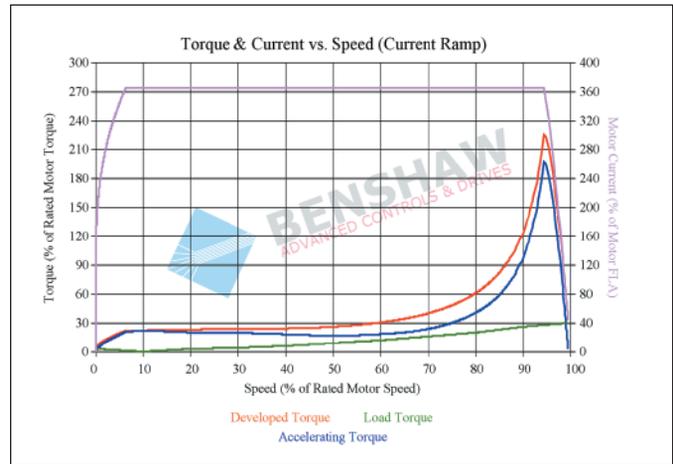
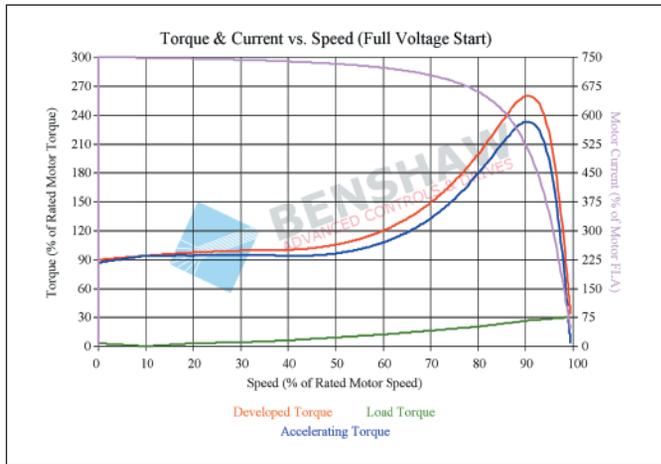
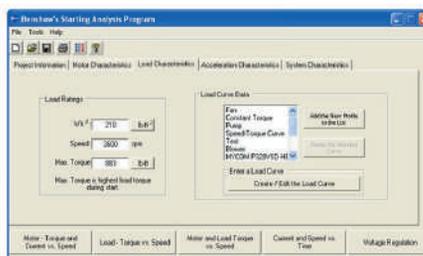
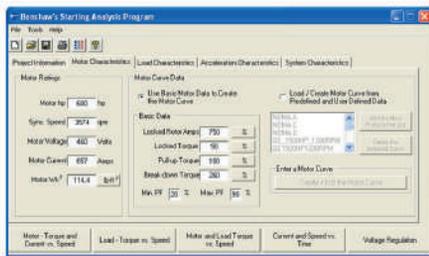
DRAW OUT

- Vacuum circuit breakers
- 91" deep



MEDIUM VOLTAGE ENGINEERING SERVICES

- Motor starting analysis
- System voltage drop analysis



SPECIAL APPLICATION SOLUTIONS

SYNCHRONOUS MOTOR STARTERS

WHAT IS A SYNCHRONOUS MOTOR?

The synchronous motor functions as an induction motor during acceleration.

Once the motor approaches full synchronous speed, the exciter induces a constant polarity to the rotor, causing the motor to lock into sync. Because the rotor's field is constant and separately excited, no slip is required to produce torque, as with an induction motor. This allows the motor to run at synchronous speed.

BENEFITS OF A SYNCHRONOUS MOTOR:

Synchronous motors are used for a numbers of reasons, including applications that require precise motor speed, to obtain increased efficiency or for power factor correction.

Since synchronous motors can be operated at leading power factor, they are used to correct a facility's lagging power factor created by other induction motors operating at the facility. This correction reduces the penalty a customer pays the utility company for poor power factor.

WHY CHOOSE THE BENSHAW SYNCHRONOUS EXCITATION PACKAGE?

The Benshaw Synchronous Excitation Package (SEP) uses Benshaw's MX² software and integrates easily with either Benshaw Controls (MX² or MX³) or any existing controller. The MX² SEP can be used with a reduced voltage solid state starter or a full voltage starter. The SEP is available for both brush-type and brushless synchronous motors.

The MX² SEP solid state synchronous control provides advanced synchronous motor protection with Modbus communication. It allows for a reduced footprint compared to existing field controls, making it beneficial for retrofit opportunities.



SPECIAL APPLICATION SOLUTIONS

SYNCHRONOUS MOTOR STARTERS

SYNCHRONOUS MOTOR STARTER CHECKLIST

For a quotation on a synchronous motor starter, please complete the checklist below. The SEP can be provided as a standalone section for use with an existing starter, or can be provided as a package with a Benshaw starter. Refer to the appropriate starter section (MV or LV, RVSS or ATL) for options available on the starter section.

Horsepower _____

Voltage _____

FLA _____

Secondary Voltage: _____

Secondary Amps _____

Type: Brushless or Brush Type

Incoming Line Power
(if different from motor voltage): _____

FOR EXISTING SYSTEMS:

Serial Number (if Benshaw): _____

Available Footprint:

H _____ W _____ D _____

*For Brush Type only, rating of existing Field Discharge

Resistor: _____ ohms



Benshaw's MX2SEP synchronous motor control

SPECIAL APPLICATION SOLUTIONS

WOUND ROTOR STARTERS

WHAT IS A WOUND ROTOR MOTOR?

Wound rotor motors are typically used in applications requiring high starting torques, a limited number of operating speeds or a stepped acceleration to achieve a soft start. Typical existing applications use an electromechanical starter on the stator and introduce multiple stages of resistance in the rotor via contactor arrangements to achieve a soft ramp.

THE BENSHAW SOLUTION:

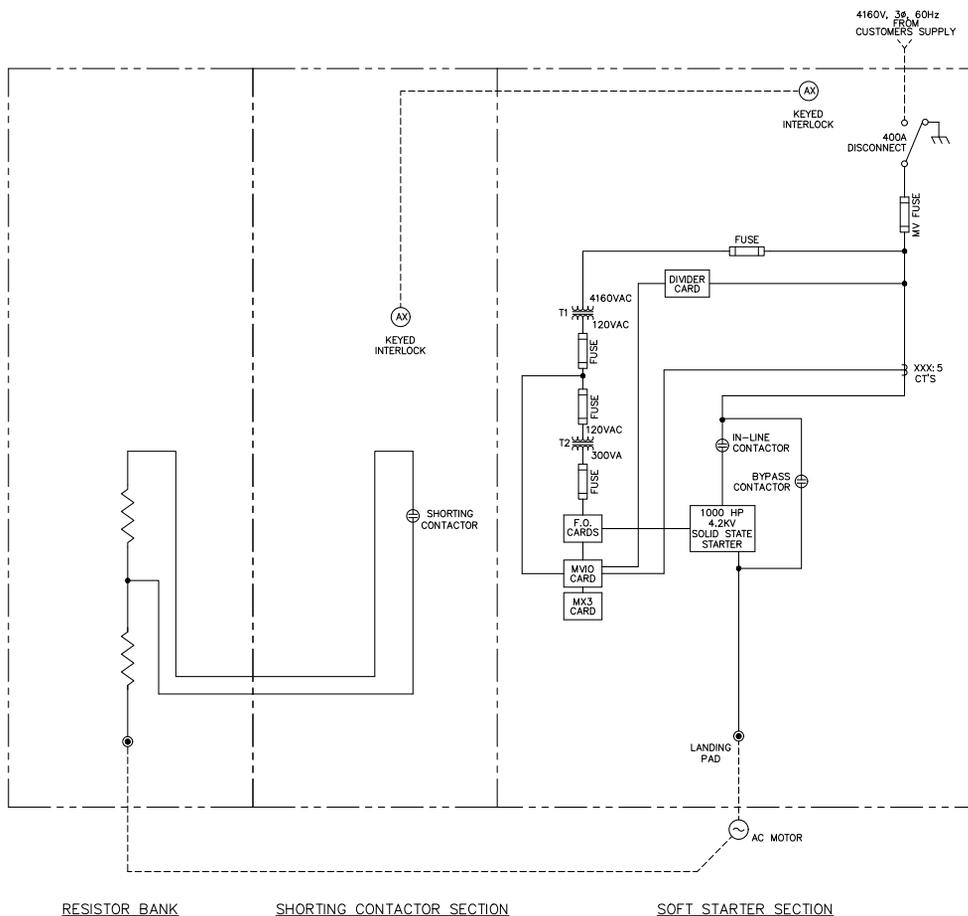
With the Benschaw MX³ Solid State Starter, wound rotor control is greatly simplified. The Benschaw starter consists of two parts: a solid state starter for stator control, and a resistor bank with shorting contactors for the rotor circuit. This achieves the high torque required, with low inrush, while providing a smooth stepless start.

Single-Step Rotor Control:

The solid state starter is wired to the motor stator circuit, and the resistor and shorting contactor are wired to the motor rotor circuit. The solid state starter accelerates the motor to slip speed (as determined by the resistance value) and then activates the contactor to short the rotor. This allows the motor to accelerate to full speed.

Multiple-Step Rotor Circuit:

Wound Rotor RVSS starters can be supplied with multiple stages of rotor resistors and contactors. This multiple step arrangement may be necessary for starting of extremely high inertia loads, or for continuous operation at multiple speeds.



SPECIAL APPLICATION SOLUTIONS

WOUND ROTOR STARTERS

WOUND ROTOR CHECKLIST:

New or Replacement

Refer to appropriate section below (new or replacement). For additional starter options, refer to appropriate checklist (MV or LV, RVSS or ATL).

FOR NEW INSTALLATIONS:

Horsepower _____

Voltage _____

FLA _____

Secondary Voltage: _____

Secondary Amps _____

Application: _____

Desired Controller Type (select one):

RVSS or ATL

(Optional) Number of Steps Needed: _____

FOR REPLACEMENT UNITS:

Horsepower _____

Voltage _____

FLA _____

Secondary Voltage: _____

Secondary Amps _____

Application: _____

Current System Info:

Controller Type (select one):

RVSS or ATL or VFD

Number of Steps: _____

Ratings and Timing of Resistors: _____

SPECIAL APPLICATION SOLUTIONS

TEST STANDS

Benshaw offers medium and low voltage test stands for your facility's needs.

Test stands are available with the following features:

- Full Voltage (ATL): Good for testing of motor with a starter or VFD
- Soft Starter (RVSS): Good for motor testing
- Medium or Low Voltage
- Single or Multiple Incoming Voltages
- Single or Multiple Output Voltages

CHECKLIST:

Please complete this checklist for Application Engineering to determine the best test standard configuration for your facility's needs.

For additional starter options, refer to starter checklist.

Function of Test Stand: _____

Horsepower and Voltage Range (specify the min. and max. HP for each voltage):

Desired Controller Type (select one):

RVSS or ATL

Incoming Line (select one):

One Input Line (adjustable upstream voltage) or One Line per Voltage Rating

Requirements (select one):

None or Input Isolation (Circuit Breaker for LV, Fused Disconnect for MV)

Enclosure Type (select one):

12 3R 4 Other (specify): _____

Maximum Available Footprint:

H _____ W _____ D _____

For Replacement of Existing:

Existing Type (select one):

ATL RVSS Other (specify): _____

Describe any specific functionality, controls, run time, etc. _____

SPECIAL APPLICATION SOLUTIONS

DUAL OUTPUT STARTERS

Dual output starters enable the use of a single SCR power section to start and stop two motors. Two versions of dual starters are available — the first has one controller, such that both motors are started and stopped at the same time, while the second has two separate MX³ controllers, allowing each motor to be started and stopped separately.

This solution can provide savings from a cost and/or footprint perspective, and can be used for any voltage class.

WHICH IS BEST FOR MY APPLICATION?

SINGLE CONTROLLER:

- Low horsepower ratings
- Application that requires both motors always run together
- Simple controller (no PLC coordination required)
- Identical motors

DUAL CONTROLLER:

- High horsepower ratings
- Application that requires one motor to start, then second motor to start after a certain amount of time
- High voltage (ideal for 15 kV Class gear)
- Motors can be of different horsepower and FLA

CHECKLIST:

For base options and controls, refer to starter checklist.

Controller Type (select one):

Single Controller or Dual Controller

Footprint Restrictions:

H _____ W _____ D _____

Application: _____

Average Starts per Hour: _____

SPECIAL APPLICATION SOLUTIONS

BALL MILL INCHING SOLUTION

WHAT IS A BALL MILL?

Ball mills are used in many industries to grind coarse material into a finer powder. A ball mill typically consists of a horizontal cylinder, partly filled with steel balls, that rotates on its axis, imparting a tumbling and cascading action to the balls.

CHALLENGE:

When it comes time to service the mill, an access hatch must be positioned to allow technicians to enter the mill and for the ball charge to be changed. Positioning a hatch is accomplished by a process known as spotting or inching. Without a dedicated inching system, it can be difficult to precisely position the mill, since the technician has no way to accurately and effectively apply torque to the motor directly from the power system.

Traditional positioning technology involves delivering a switched DC current to the stator windings in a specific pattern to simulate the sinusoidal AC wave form applied during normal operation while keeping the field excited. In addition to the issue of precisely moving the bulky mill, the cogging or abrupt starting and stopping of the motor can cause mechanical and electrical damage to the equipment. This, along with full voltage starting, stresses the overall electromechanical system and can cause excessive downtime, interfering with production.

SOLUTION:

Benshaw has applied low voltage AC Variable Frequency Drives to replace DC contactors and cam switch for positioning. The low voltage AC VFD has the capability to provide full torque at zero speed to start and rotate the mill during the positioning process. The use of a drive also provides speed adjustability to a maximum speed of 2–12 Hz depending on motor voltage. This allows the maintenance setup and process time to be significantly reduced. The drive replaces the obsolete and unsupported cam switch, and eliminates DC contactors and associated contact maintenance.

Due to Benshaw's full portfolio of low and medium voltage VFDs, solid state and full voltage starters, Benshaw is able to provide a full solution to replace obsolete ball mill controls. This includes a solid state or full voltage starter, all necessary isolation and the low voltage VFD for inching.

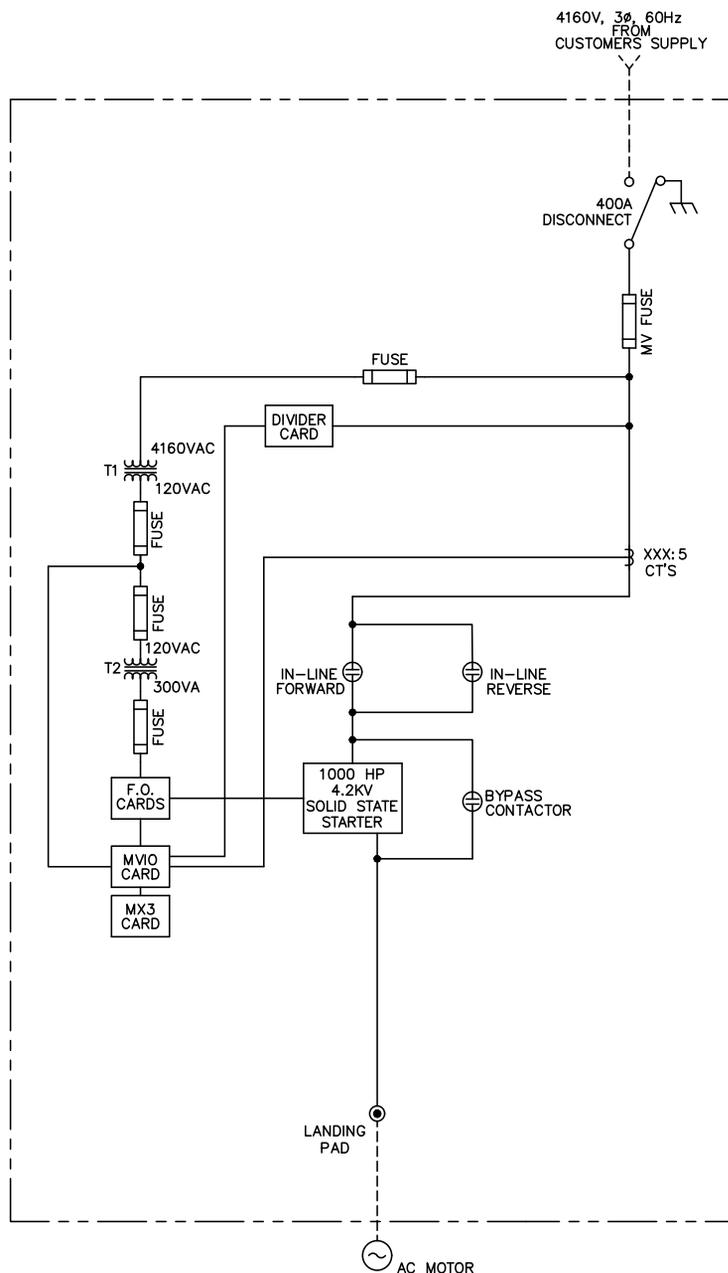
SPECIAL APPLICATION SOLUTIONS

REVERSING STARTERS

WHAT IS A REVERSING STARTER?

A reversing starter is used for applications with forward/backward or upwards/downwards movement needed for operation. The reversing starter contains two contactors — labeled or defined as “Forward” and “Reverse”. It includes a selector switch for Forward or Reversing. The starter accelerates via the SCR power stacks and then transfers to the bypass contactor for running, in the same manner as the non-reversing starter.

When requesting a quotation, you must specify reversing capability to have the additional contactor included.



SPECIAL APPLICATION SOLUTIONS

TWO-SPEED AND PAM MOTORS

WHAT IS A TWO-SPEED OR PAM MOTOR?

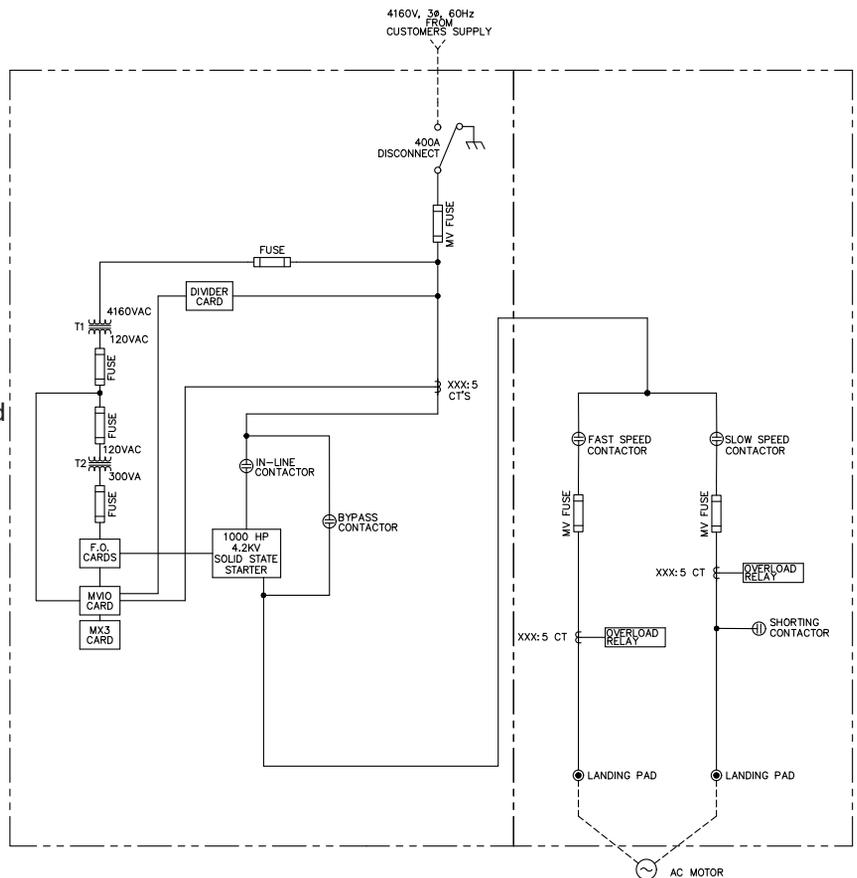
A two-speed motor is a type of induction motor with one or two windings that can operate at two different speeds. A PAM motor is a type of two-speed motor with one winding.

WHAT ADDITIONAL CONTROLS ARE NEEDED?

The starter requires the addition of a fast speed and slow speed contactor plus additional controls for each speed mode (fast and slow).

The fast and slow speed contactors are interlocked so that only one can operate at any time. This can easily be added to Benshaw's solid state starter.

Depending upon size, this can be included in the starter enclosure or mounted in a separate enclosure.



CHECKLIST:

For base starter options, refer to starter checklist.

In addition to the standard starter checklist, the following additional information is required for two-speed motor starters:

Voltage: _____

Slow Speed:

Horsepower: _____

RPM: _____

FLA: _____

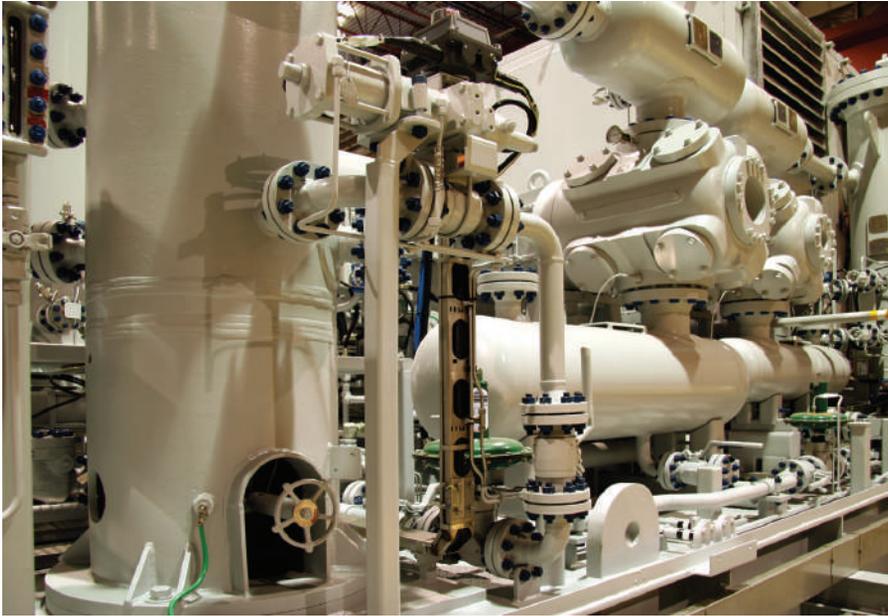
Fast Speed:

Horsepower: _____

RPM: _____

FLA: _____

BENEFITS OF RETROFITTING



Benshaw offers a wide variety of solutions to all of your retrofit needs. Our team of Application Engineers and Service Technicians will review your current equipment and provide recommendations to upgrade your existing equipment with minimal cost and impact. Benshaw is able to reuse existing equipment, enclosures and stub-ups from a variety of different manufactures. For very intricate projects, Benshaw will send an engineering or technical representative to your site to obtain full measurements and understand the scope. Benshaw will then design a custom retrofit to fit your needs and your budget. Before you spend significant money to replace existing working equipment, contact Benshaw to see what our team can do for you.

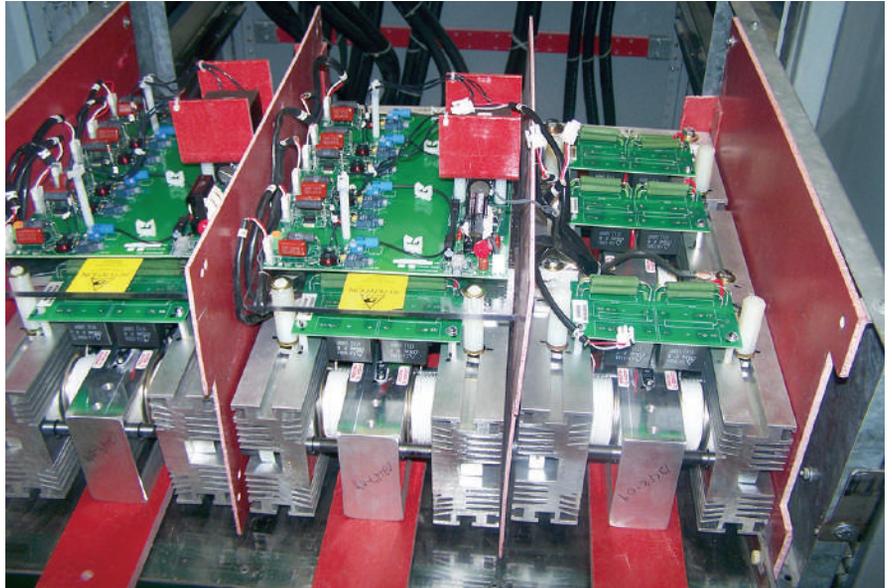
Equipment in heavy industry is expected to work for 20+ years. While it is often the case that medium voltage equipment can operate for long periods of time, many other factors change during that time period. Electrical costs and penalties go up, requiring more efficient equipment. Innovation in monitoring and protection features makes modern equipment safer for personnel and for mechanical equipment. Maintenance parts become more expensive and obsolete to the point where critical operations could face significant downtime due to a minor part failure. Full replacements of large equipment are significantly more expensive than just cost of disposal,

new installation and wiring can cause the scope to creep up to 3x or more the cost of the equipment alone. Starters, switchgear and MCCs include many expensive power components, and it's wasteful to throw out working, operational equipment to gain new features. Often, the entire factory or equipment room was designed around the existing equipment. Putting in a brand-new line-up could be a logistical nightmare. Benshaw understands the need to upgrade equipment for modern features and serviceability, without investing in a large CapEx project.



EMERGENCY RETROFITS — MX³ UPGRADES

Benshaw stocks standardized low and medium voltage kits for retrofits to upgrade your equipment in an emergency situation to the latest MX³ technology, and offers engineered retrofits for units that do not require the time-sensitive urgency of emergency kits. Benshaw’s qualified team of Application Engineers will review your equipment and verify that the quick-ship retrofit will work in your situation. For situations where a customized solution better fits your needs, the Application Team will provide a quote to meet your specifications.



The emergency quick-ship retrofit is available for both low and medium voltage starters, but at this time is not available for all product types.

It is intended to replace:

- Benshaw soft starters using the following control board platforms: AK, DMS, Micro II and MX
- Examples of part numbers begin with:
 - LV: RSM6, RS6, RSD6, RSE6, RXE6, RCM, RBM1, RBM2, RBM3, RC2, TBX, TCX, RBX, MXPC, MXPB, RBX2, RBX3,
 - MV: MVR512, MVR518, MVRSE12, MVRSE18, MVRSM12, MVRSM18

It is not intended to replace:

- OEM specialty product lines
- Synchronous motor starters utilizing Benshaw supplied field controls
- Enclosures less than 36" wide (for MV)
- DC injection braking or reversing units

Note: These products can be retrofitted with Benshaw’s engineered retrofit solution.

Note: This is not a complete list of model numbers. Additional model numbers may qualify.

EMERGENCY RETROFITS — MX³ UPGRADES

To determine if your starter is applicable, please complete the checklist and contact the Benschaw Inside Sales Team.

EXISTING STARTER INFORMATION:

SERIAL NUMBER: _____

MODEL NUMBER: _____

HORSEPOWER: _____

VOLTAGE: _____

ENCLOSURE SIZE: _____ H: _____ W: _____ D: _____

- Y N** Verify available depth from the existing control board mounting surface to the inside of the enclosure door. Approximately four inches (4") is required for the MX³ control boards.
- Y N** Verify if Benschaw BIBPC-720LT (L or T) integral contactors are included in chassis. (LV only)

Notes:

If enclosure does not have sufficient depth, the MX³ control boards may be mounted in another location. SCR leads may be extended to a maximum of 6 feet. MX³ control board must be located in an enclosure section that contains only low voltage power. MX³ control board should not be mounted in sections with medium voltage power.

If possible, take photos of the control boards and heatsink/CR assemblies.

If yes to BIBPC contactors, customer can replace entire chassis, or purchase a separate definite purpose or full rated contactor for separate mounting (space permitting).

ADDITIONAL CUSTOMER NOTES: _____

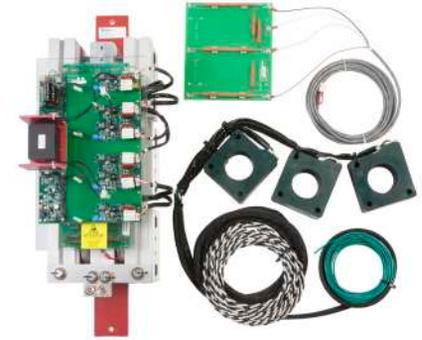
EMERGENCY QUICK-SHIP RETROFITS — MX³ UPGRADES



Low Voltage Retrofit Kit



Medium Voltage Control Section



Medium Voltage Power Section

KIT COMPONENTS:

RTFT-490000-00 LV RETROFIT KIT ASSEMBLY

- NEMA 3R keypad
- Keypad mounting plate
- Keypad 3 meter cable with ferrite
- MX³ control card on Lexan[®] mounting plate
- MX³ LV manual
- MX³ LV installation guide

RTFT-490001-00 MV RETROFIT KIT ASSEMBLY

- NEMA 3R keypad
- Keypad mounting plate
- Keypad 3 meter cable with ferrite
- MX³ control card on Lexan[®] mounting plate
- 415 A power stacks (qty. 3)
- Terminal strip with terminals, relays and wiring
- 120:24 VAC control power transformer
- Fiber optic kit
- CT assembly (see following page for part numbers)
- MX³ MV manual
- MX³ MV installation guide

AVAILABLE KITS

Part Number	Description
RTFT-490000-00	LV Retrofit Kit Assembly
RTFT-490001-00	MV Retrofit Kit Assembly

EMERGENCY RETROFITS — MX³ UPGRADES

LV CURRENT TRANSFORMER (CT) KITS - REQUIRED WHEN REPLACING RS6AK CONTROL BOARD

Part Number	Description	Motor FLA
CT-420000-00	288:1 with Plug-in Connector	15–64
CT-420000-01	864:1 with Plug-in Connector	45–190
CT-420000-02	2640:1 with Plug-in Connector	135–590
CT-420000-03	5760:1 with Plug-in Connector	295–1285

Each CT kit includes a set of three CTs.

MV CT ASSEMBLIES

Part Number	Description	Motor FLA
CT-450001-01	50:5 with MV Sleeving	11–45
CT-450002-01	150:5 with MV Sleeving	46–135
CT-450003-01	250:5 with MV Sleeving	136–225
CT-450009-01	400:5 with MV Sleeving	226–360
CT-450010-01	600:5 with MV Sleeving	361–540

Each kit includes three CTs.

CTs do not need to be ordered separately.

ENGINEERED RETROFITS

For units that do not qualify for the Emergency Quick-Ship Retrofit program, Benshaw also offers engineered retrofit solutions. Engineered retrofits allow for full customization, which can provide expedited installation time, add or change the control logic, or even retrofit non-Benshaw units.

UNITS THAT QUALIFY FOR THE ENGINEERED RETROFIT PROGRAM:

- Synchronous starters using Benshaw-supplied field controls
- Benshaw starters rated above 4800 V
- Benshaw starters rated for greater than 3000 HP at 4160 V
- Non-Benshaw starters

PROCESS:

To receive a quotation, please provide the following information to the Benshaw Sales Team:

- Serial number (for Benshaw units)
- Drawings (for non-Benshaw units)
- Model number
- Equipment rating (HP, voltage, FLA)

Upon review by the Benshaw Inside Sales and/or Application Engineering team, a quotation will be issued, or a site visit will be requested if additional details are needed.



MEDIUM VOLTAGE SWITCHGEAR

MVCB SERIES

MVCB SERIES PRODUCT HIGHLIGHTS

Benshaw's free-standing medium voltage switchgear is the newest product in our portfolio, offering the same rugged and reliable design and performance of all our medium voltage products. To ensure the safety of personnel servicing the equipment, all Benshaw's medium voltage switchgear offerings include a rack-out circuit breaker design.

A remote breaker control panel and arc flash sensing options are also available to further enhance personnel safety. In addition, Benshaw offers a full metal-clad switchgear solution.

The switchgear is provided in a NEMA-rated enclosure configured for use as a stand-alone unit, in an equipment line-up or an MCC. Benshaw switchgear connects seamlessly to the rest of the Benshaw MCC for a space-saving design to feed line-ups or in jumbo starter solutions.

The Benshaw Application and Engineering Support team is available to customize switchgear designs to meet customers' specific application needs without extended lead times.



KEY ADVANTAGES:

- Bolts directly to Benshaw MCC line-up or starter
- CSA special inspection
- Available in 1200 A or 2000 A standard (3000 A option is custom)
- Feeder protection included as standard — customer to specify manufacturer
- Available up to 13.8 kV
- Configurable with added options
- Rack-out design standard
- Remote breaker control panel

STANDARD FEATURES

- 40 kA fault rated
- Rack-out design
- NEMA 1A indoor enclosure
- Welded 11 gauge steel construction
- Feeder protection with CPT and PT
- Green open pilot light
- Red closed pilot light
- Amber trip pilot light
- Open push-button
- Closed push-button
- Manual racking device
- Bus rated to CB size
- Line power top entry standard
- Load power top exit

Options — see page 56

5 KV CLASS SWITCHGEAR

MVCB SERIES

The MVCB series of switchgear features a draw-out circuit breaker design.

2300 V

Model Number	Description	Volts	CB Frame	Dimensions (in.)		
				H	W	D
MVCB-1200-2300-**	MV CB 1200 A Top Entry/Top Exit	2300	1200	92.5	64	62
MVCB-2000-2300-**	MV CB 2000 A Top Entry/Top Exit	2300	2000	92.5	64	62

** Insert appropriate option code as shown below:

- NEMA 1 = 1
- NEMA 12 = 12
- NEMA 3R = 3R

3300 V

Model Number	Description	Volts	CB Frame	Dimensions (in.)		
				H	W	D
MVCB-1200-3300-**	MV CB 1200 A Top Entry/Top Exit	3300	1200	92.5	64	62
MVCB-2000-3300-**	MV CB 2000 A Top Entry/Top Exit	3300	2000	92.5	64	62

** Insert appropriate option code as shown below:

- NEMA 1 = 1
- NEMA 12 = 12
- NEMA 3R = 3R

4160 V

Model Number	Description	Volts	CB Frame	Dimensions (in.)		
				H	W	D
MVCB-1200-4106-**	MV CB 1200 A Top/Bottom Entry/Top Exit	4160	1200	92.5	64	62
MVCB-2000-4106-**	MV CB 2000 A Top/Bottom Entry/Top Exit	4160	2000	92.5	64	62

** Insert appropriate option code as shown below:

- NEMA 1 = 1
- NEMA 12 = 12
- NEMA 3R = 3R

METAL-CLAD SERIES - SINGLE UNITS

MVCB-MC SERIES

Benshaw can provide a complete draw-out metal-clad design requiring rear access. For the single units, a draw-out CPT and PT are located in the top section, and the circuit breaker is located in the bottom section. The design allows for top or bottom entry and center exit bus. Custom 300 A breakers are available by request. For all other configurations, consult Benshaw.

2300 V

Model Number	Description	Volts	CB Frame	Dimensions (in.)		
				H	W	D
MVCB-1200-2300-MC	MV CB 2300 V 1200 A	2300	1200	95	36	91
MVCB-2000-2300-MC	MV CB 2300 V 2000 A	2300	2000	95	36	91

4160 V

Model Number	Description	Volts	CB Frame	Dimensions (in.)		
				H	W	D
MVCB-1200-4160-MC	MV CB 4160 V 1200 A	4160	1200	95	36	91
MVCB-2000-4160-MC	MV CB 4160 V 2000 A	4160	2000	95	36	91

6600 V

Model Number	Description	Volts	CB Frame	Dimensions (in.)		
				H	W	D
MVCB-1200-6600-MC	MV CB 6600 V 1200 A	6600	1200	95	36	91
MVCB-2000-6600-MC	MV CB 6600 V 2000 A	6600	2000	95	36	91

13800 V

Model Number	Description	Volts	CB Frame	Dimensions (in.)		
				H	W	D
MVCB-1200-13800-MC	MV CB 13800 V 1200 A	13800	1200	94	36	94
MVCB-2000-13800-MC	MV CB 13800 V 2000 A	13800	2000	94	36	94

METAL-CLAD SERIES - DUAL UNITS

MVCB-MC SERIES

Benshaw’s dual unit design allows the customer to stack circuit breakers two high. The design includes two enclosures sized at 36"W. The CPTs and the PTs will be in the second enclosure. The switchgear is a fully draw-out metal-clad design requiring rear access. The design allows for top or bottom entry and center exit bus. For other configurations, consult Benshaw.

2300 V

Model Number	Description	Volts	CB Frame	Dimensions (in.)		
				H	W	D
MVCB-1200/1200-2300-MC	MV CB 2300 V 1200 A Top/CB 1200 A Bottom	2300	1200/1200	95	72	91
MVCB-1200/2000-2300-MC	MV CB 2300 V 1200 A Top/CB 2000 A Bottom	2300	1200/2000	95	72	91
MVCB-2000/2000-2300-MC	MV CB 2300 V 2000 A Top/CB 2000 A Bottom	2300	2000/2000	95	72	91

4160 V

Model Number	Description	Volts	CB Frame	Dimensions (in.)		
				H	W	D
MVCB-1200/1200-4160-MC	MV CB 4160 V 1200 A Top/CB 1200 A Bottom	4160	1200/1200	95	72	91
MVCB-1200/2000-4160-MC	MV CB 4160 V 1200 A Top/CB 2000 A Bottom	4160	1200/2000	95	72	91
MVCB-2000/2000-4160-MC	MV CB 4160 V 2000 A Top/CB 2000 A Bottom	4160	2000/2000	95	72	91

6600 V

Model Number	Description	Volts	CB Frame	Dimensions (in.)		
				H	W	D
MVCB-1200/1200-6600-MC	MV CB 6600 V 1200 A Top/CB 1200 A Bottom	6600	1200/1200	95	72	91
MVCB-1200/2000-6600-MC	MV CB 6600 V 1200 A Top/CB 2000 A Bottom	6600	1200/2000	95	72	91
MVCB-2000/2000-6600-MC	MV CB 2300 V 2000 A Top/CB 2000 A Bottom	6600	2000/2000	95	72	91

13800 V

Model Number	Description	Volts	CB Frame	Dimensions (in.)		
				H	W	D
MVCB-1200/1200-13800-MC	MV CB 13800 V 1200 A Top/CB 1200 A Bottom	13800	1200/1200	95	72	91
MVCB-1200/2000-13800-MC	MV CB 13800 V 1200 A Top/CB 2000 A Bottom	13800	1200/2000	95	72	91
MVCB-2000/2000-13800-MC	MV CB 13800 V 2000 A Top/CB 2000 A Bottom	13800	2000/2000	95	72	91

MEDIUM VOLTAGE SWITCHGEAR OPTIONS

Benshaw’s in-house capabilities allow for customization of switchgear without extended lead time. Our team of application and production engineers is available to fully support custom projects tailored to meet your application and specifications. A list of standard options for switchgear is available below. For other options, consult Benshaw.



PILOT DEVICES

Catalog Number	Description
B100	Green Open Pilot Light
B101	Red Closed Pilot Light
B102	Amber Trip Pilot Light
B103	Open Push-Button Raised
B104	Closed Push-Button Flush
B105	Fault Reset Push-Button
B110	Hand-Off-Auto Selector Switch
B111	Local-Off-Remote Selector Switch
B112	Key Operated Hand-Off-Auto Selector Switch

CB ACCESSORIES

Catalog Number	Description
B120	Breaker Lift Truck
B121	Breaker Test Cabinet
B122	Remote Racking Device

BUS/LINE OPTIONS

Catalog Number	Description
B130	Mimic Bus
B131	Insulated Bus Covering — 1200 A Rated
B132	Insulated Bus Covering — 2000 A Rated
B133	Ground Balls
B134	Live Line Indications
B140	Surge Arrestors, 2300 VAC
B141	Surge Arrestors, 4160 VAC
B142	Surge Arrestors, 6900 VAC
B143	Surge Arrestors, 12000 VAC

MEDIUM VOLTAGE SWITCHGEAR OPTIONS

Benshaw’s engineering team has experience working with all major relay suppliers. Benshaw will seamlessly integrate any protective relay into the system with any PTs or CTs required for operation. Please provide the full part number of the meter when ordering equipment.

PROTECTION RELAYS

Catalog Number	Description
B200	Mutlilin 850 — Feeder Protection
B201	Multilin PQM — Power Quality Monitoring
B202	Multilin 845 – Transformer Feeder Protection
B203	Multilin 369 — Motor Protection
B204	Multilin 869 — Advanced Motor Protection
B205	Schweitzer SEL-751 — Feeder Protection
B206	Schweitzer SEL-735 — Power Quality Monitoring
B207	Schweitzer SEL-787 — Transformer Feeder Protection
B208	Schweitzer SEL-849 — Motor Protection
B209	Schweitzer SEL-710 - Advanced Motor Protection

Other options are available. Please contact the Benshaw Application Engineering team.
 Benshaw installs but does not program any third party relays.

Benshaw’s equipment is designed to be rugged, reliable and, above all, safe. We are proud to be able to offer some of the latest safety technology available on the market and incorporate it into solutions to meet your needs.

ENHANCED SAFETY FEATURES

Catalog Number	Description
B300	Thermal Viewing Windows
B301	Ultrasonic Ports
B302	Arc Flash Sensing – Multilin*
B303	Arc Flash Sensing — Schweitzer*
B305	Remote Breaker Control Panel

*Arc Flash Sensing is an option for protection relays.
 The relay option is required for Arc Flash Sensing.

BENSHAW MEDIUM VOLTAGE COMPLETE PRODUCT SOLUTIONS

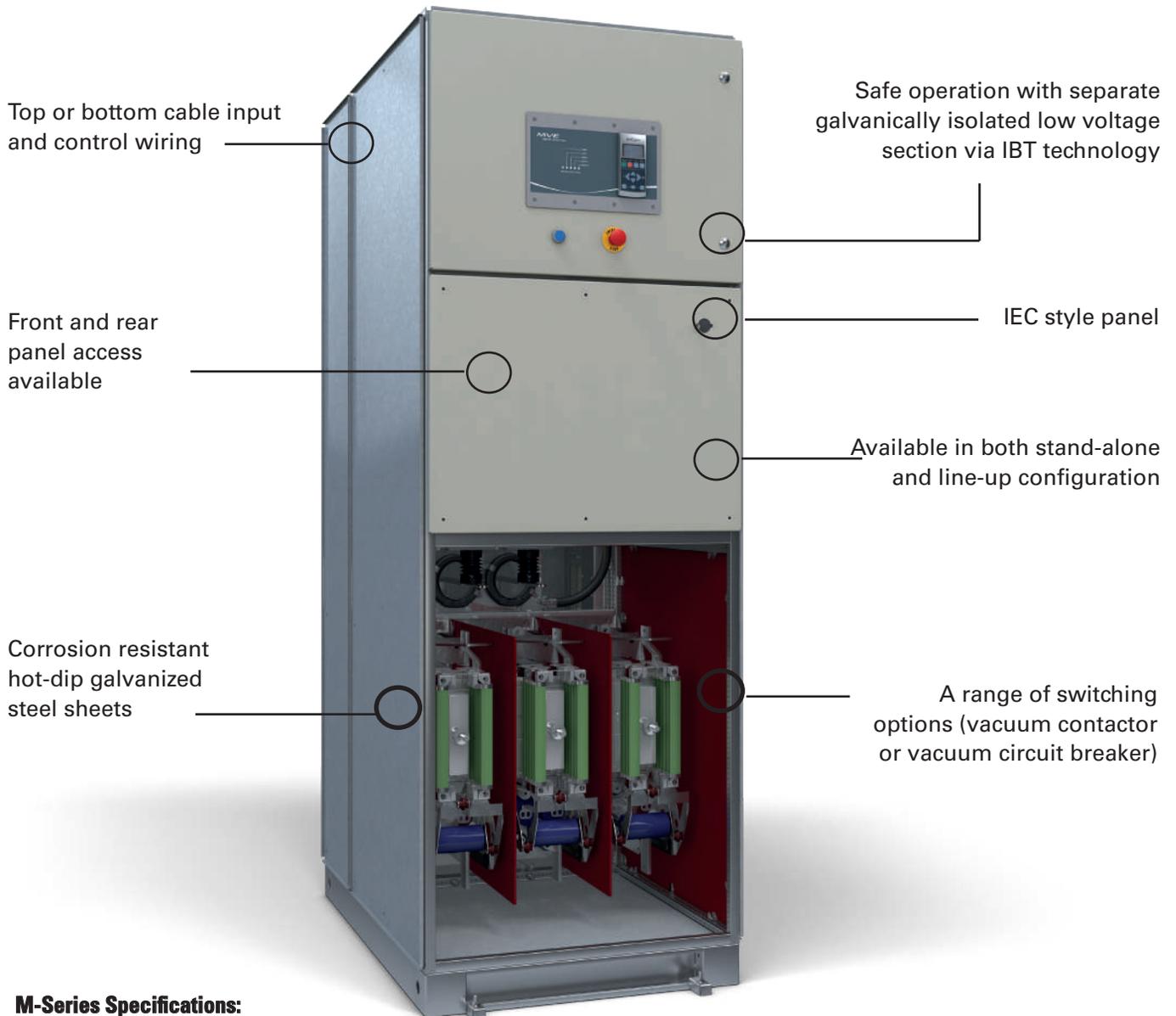
Benshaw provides complete product solutions tailored to customer's needs with some of the most competitive lead times in the industry. Customers rely on Benshaw for full turn-key medium voltage MCC solutions that are designed for rugged and reliable operation in the toughest applications. Every Benshaw medium voltage MCC solution is reviewed by the application engineering team in the quotation phase to ensure that customers receive the right solution for their application with the latest and most cost-competitive options available. All orders are then engineered in-house to meet the customer's expectations with close coordination between the application and production engineering teams to ensure the product meets specifications. When you purchase a Benshaw medium voltage MCC solution, you'll have the peace of mind that you're receiving some of the best equipment in the industry.



M - SERIES MVE

IEC STYLE SOFT STARTER

Benshaw's M-Series MVE medium voltage soft starters are an integrated solution for motor control and protection. MVE starters combine advanced soft start and soft stop functionality with extensive motor and system protection, plus a user-friendly interface and complete commissioning diagnostics.



M-Series Specifications:

- Rated voltage
- Rated busbar current: up to 630 A
- Rated short time withstand current / peak: up to 31.5 kA for 1 seconds / up to 82 kA
- Partition classification: PI
- Loss of service continuity: LSC1 / LSC2
- IP4X protection rating (IP54 optional)
- Altitude: < 1000 m (higher with derating)
- Ambient temperature: -10 °C to 60 °C (above 50 °C with derating)
- Color painting: RAL7032 (other colors optional)

M - SERIES MVE

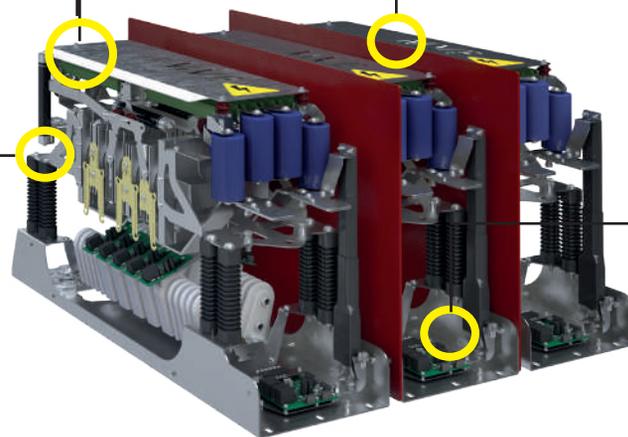
POWERFUL AND RELIABLE

Every application is different, and selecting the right starter for the job can sometimes seem like a daunting task. Variables such as altitude, ambient temperature, load and starts per hour all affect selection of the ideal motor starting solution.

At Benschaw, we employ sophisticated engineering tools to help you select the right MVE starter for your site conditions. No matter the application, you can trust our team of experienced motor control professionals to get your motor running smoothly.

A designed based on standard components reduces the need for spare parts and simplifies support

Ultra-compact form factor supports vertical or horizontal integration of power electronics, saving valuable space



Individually removable phase arm design allows for simple installation, service or replacement

Conformal coating on PCBs for protection in environments up to pollution degree 3

TECHNICAL DATA

Motor voltage:	2.3 - 13.8 kV (maximum 11 kV in M-Series Panel)
Control voltages:	85 - 264 VAC or 90 - 350 VDC
Frequency:	45/66 Hz (autotrigger)
Starter current:	70 A - 1700 A (maximum 540 A in M-Series Panel)
Starting time (max):	1 second - 30 seconds (180 seconds)
Ambient temp. (max):	-10°C to 60 °C (above 50 °C with derating)
Maximum altitude:	1000 m (higher with derating)
IP rating (power assembly):	IP00
IP rating (controller):	IP54 / NEMA12
CT type:	Standard MV CTs (adjustable ratio)
VT type:	EPT type
MV/LV isolation:	100% fiber optic connection
Digital input	3 fixed (start, stop, reset), 2 programmable (A,B)
Relay output:	4 fixed, 3 programmable (A,B,C)
Analog output:	1 analog output
Communications I/O:	Modbus RTU, Modbus TCP, Profibus, Profinet, DeviceNet, Ethernet/IP, USB

M - SERIES MVE

TAKE CONTROL FROM THE START

Medium voltage installations are complex enough without making the starter hard to use as well.

MVE is packed with features designed to make your life easier, including real-language feedback messages, so you don't have to look up codes to know what's happening.

Built-in monitoring and indicators, and extensive on-board input and output functionality reduce the need for space and avoid the cost of auxiliary equipment, while simplifying installation.

Real-time graphs of motor operating performance and current quickly and clearly illustrate exactly how your motor is performing.

No fuss, no trouble - a smoother start in every sense.

The MVE controller features simple, plain language feedback on the soft starter's operation and events - no need for trip code look-ups.

METERING FUNCTIONALITY:

- Motor current
- Motor voltage
- Mains frequency
- Motor pd
- Motor kW
- Motor HP
- Motor temperature
- kWh
- Hours run
- Real-time graphs



M - SERIES MVE

RELY ON MVE

Feature	Benefit
Quick Application Setup	Easy commissioning
Multi-language Graphical Display	Ease of use and communication
Dual Motor Set	Allows for two different starting and stopping motor data sets
Starting and Stopping Options	A range of starting methods including current based torque control make the MVE soft starter suitable for all applications
Simulation Mode	Fast and easy testing during installation and commissioning without the need for a mains supply or motor
Real-time Performance Graph	Real-time graphs of motor performance and current quickly and clearly illustrate how your motor is performing
Diagnostic Tool	Recorded waveforms can help diagnose conditions interfering with operation
LV/MV Isolation via IBT Technology	Benshaw IBT Interface Board Technology isolates the core starter control system and HMI from the MV power section, creating a safer work environment
LV Motor Test	Conduct factory testing of motor protections via an external system such as Omicron
Secondary Injection Testing	Allows full testing of motor protections via an external system such as Omicron
Complete Motor Protection	A wide range of protection features including ground fault protection ensure that your equipment can operate safely even in the most demanding environments
DOL+Mode	Protects your motor even while operating in bypass mode
Advanced Thermal Modeling	Intelligent thermal modeling allows the soft starter to dynamically calculate motor temperature and determine whether the motor can start successfully

M - SERIES MVE

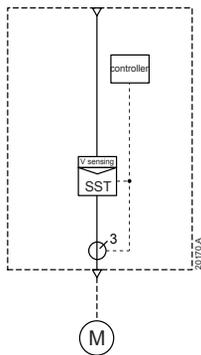
PROTECTION FUNCTIONALITY

Description	Built-in Protection	ANSI Code
Maximum start time	Excess start time	48
Too many starts	Restart delay and dynamic thermal model	66
Undercurrent	Undercurrent	37
Overcurrent - jam	Instantaneous/time-delay overcurrent	50/51/51R
(Locked rotor, load increase)		
Overcurrent - (short circuit)	Instantaneous /time-delay overcurrent (stage 2)	50/51
Checking or Interlocking relay	Shorted SCR	3
Thermal overload	Thermal overload - dynamic model	49/51
Current imbalance	Current imbalance	46
Undervoltage	Undervoltage	27
Overvoltage	Overvoltage	59
Phase loss	Phase loss	47
Phase sequence	Phase sequence	47
Power loss	Power loss	32
Ground fault	Ground fault	50G
Mains frequency	Frequency check, frequency variation	81
External communications failure	Communication failure	85
Ext. fault 1/code - 1	Auxiliary trip A	94/95
Ext. fault 2/code - 2	Auxiliary trip B	94/95
Motor overtemperature	Thermistor protection*	23
Stator winding overtemperature	Thermistor protection*	49

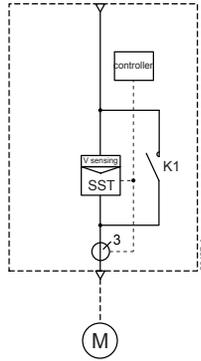
*RTD Relay is optional.

M - SERIES CONFIGURATIONS AND DIMENSIONS

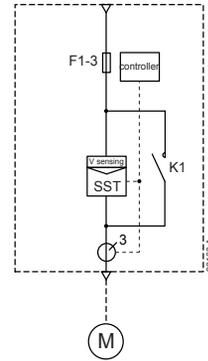
E0
Soft starter only



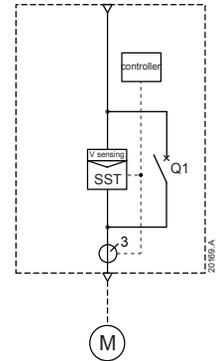
SST + VC



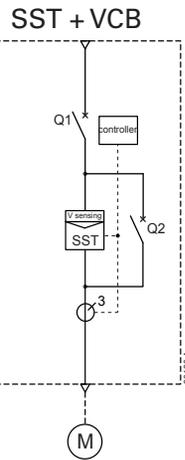
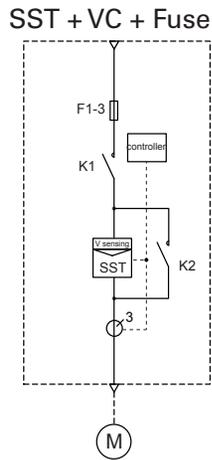
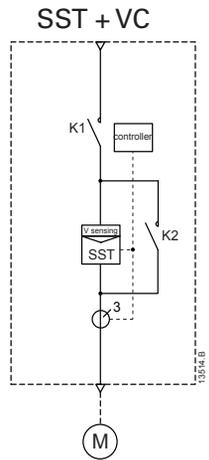
E1
SST + VC + Fuse



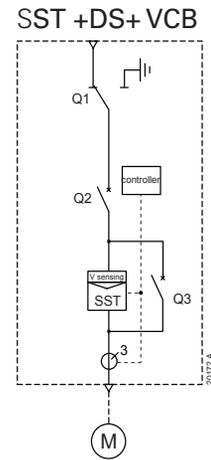
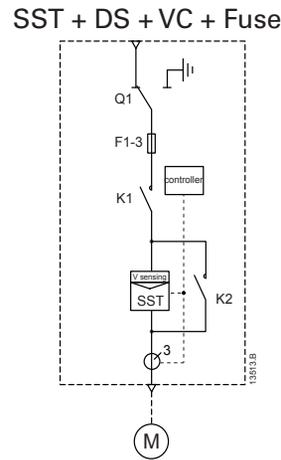
SST + VCB



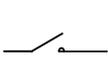
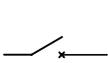
E2



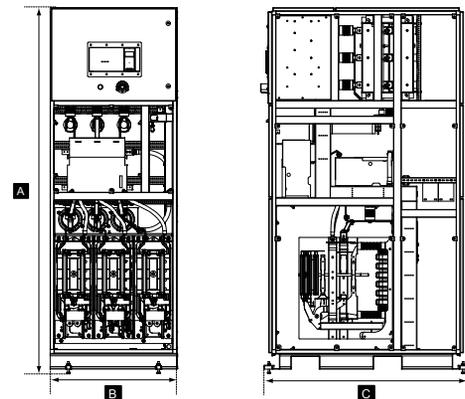
E3



LEGEND

- Controller**  Controller
- F**  MV Fuses
- MVE**  MVE soft starter with voltage sensing
- K**  Vacuum contactor
- Q**  Vacuum circuit breaker
- Q**  Disconnecting switch
- L**  3 current transformer
- L**  Inrush current limiter
- C**  Capacitors

DIMENSIONS



Model	Height (A) (mm) [max]	Width (B) (mm)	Depth (C) (mm)	E1/E2	E3
M-MVE-XXXX-V02~06	2320 [2350]	800	1200	1400	
M-MVE-XXXX-V11	2200 [2233]	1150	1400	N/A	

L - SERIES MVE

IEC TYPE TESTED SOFT STARTER

The Benshaw MVE L-Series soft starter is a powerful and reliable solution for your arc resistant, Type tested IEC application requirements.

Extensive personal safety features, an easy-to-use graphical interface, and comprehensive built-in motor/load protection make this a well balanced solution for your medium voltage needs.

MVE brings together sophisticated soft start motor control functionality in a robust yet compact physical configuration.

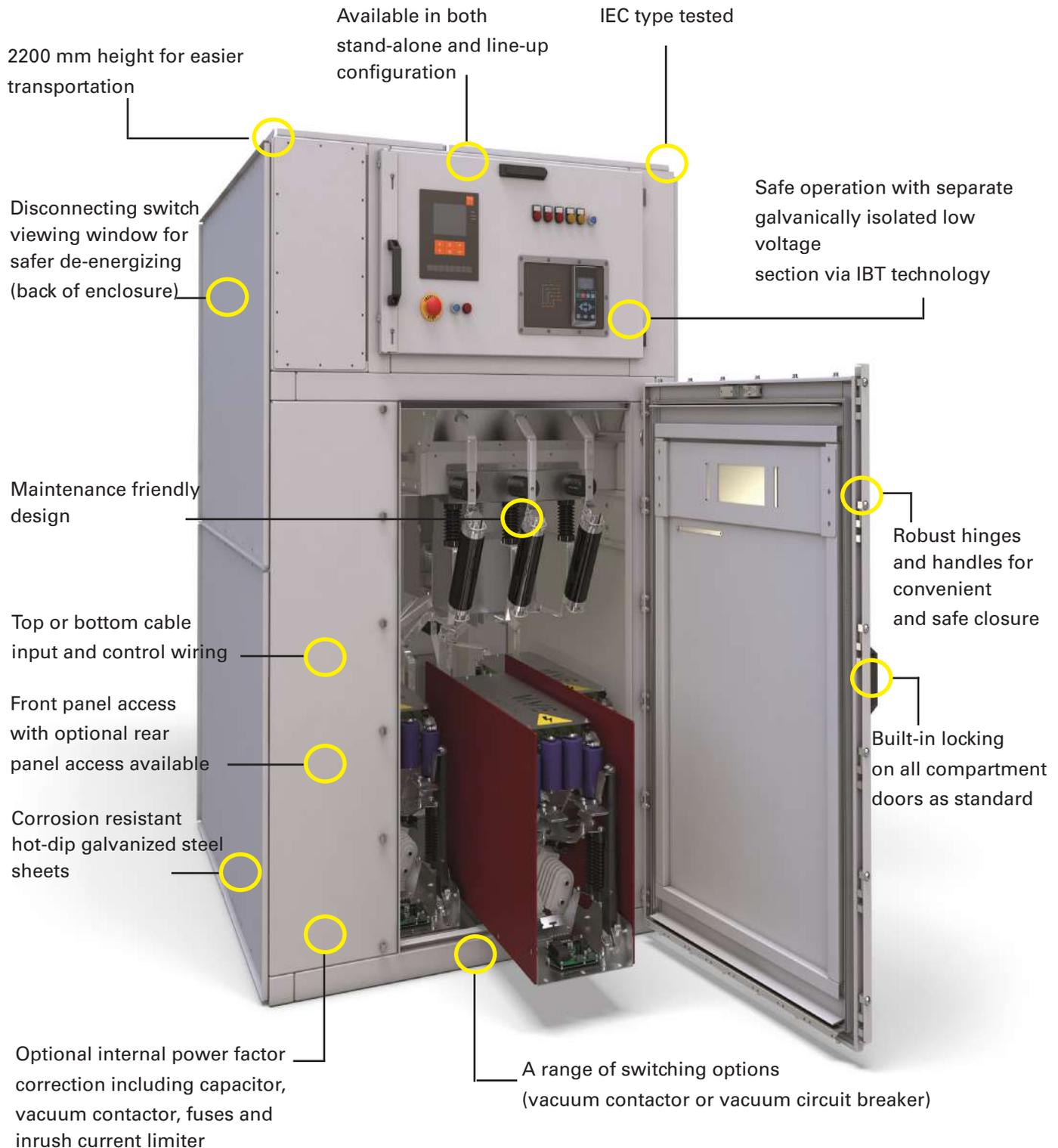
MVE is available as a fully-furnished, Type tested cabinet. In addition to standard packages, we can supply a complete line-up to meet your requirements.

L - SERIES SPECIFICATIONS

- Rated voltage: 3.6 kV - 17.5 kV
- Rated busbar current: Up to 2000 A
- Rated short time withstand current / peak:
 - Up to 40 kA for 1 second / 104 kA
- Internal arc fault IAC classification:
 - AFL 31.5 kA for 1 second
 - Partition classification: PM
- Loss of service continuity: LSC1 / LSC2 / LSC2B
- IP4X protection rating (IP54 optional)
- Altitude: < 1000 m (higher with derating)
- Ambient temperature: -10 °C - 60 °C (above 50 °C with derating)
- Color painting: RAL7035 (other colors optional)

L - SERIES MVE

IEC TYPE TESTED SOFT STARTER



L - SERIES MVE

ARC FAULT

An arc fault is a high power discharge of electricity between two or more conductors. Such arc events can reach temperatures of over 10,000 °C - hot enough to liquefy ceramics, plastics and metal. During an arc event, the arc fault causes a sudden increase in pressure, followed by an expansion and emission phase and, finally, a thermal phase. This combination of pressure and heat can blast debris and combustible gas outward with extreme force.

The internal pressure against the weakest points of the enclosure (e.g. windows, hinges and joints) can destroy an electrical enclosure and may cause serious or fatal injury to nearby personnel.

Arc faults can occur for a number of reasons including overvoltage, faulty insulation, mechanical failure or failure of a fuse.

Due to the significant risk of serious injury or death that an arc fault presents, responsible specifiers should ensure that they require all switchgear to meet the IEC 62271-200 standard.



L - SERIES ARC FAULT PROTECTION

If an arc event occurs within a Benshaw L-Series starter, the arc fault is contained by solid locking doors and heavy double layer compartment panels.

During the emission phase, the pressure is safely released using discharge flaps on the top of the panel (or optional ducts), which direct the explosion upwards or vent it safely outside.

Fully type tested.

Benshaw L-Series panels are fully type tested according to IEC 62271-200:

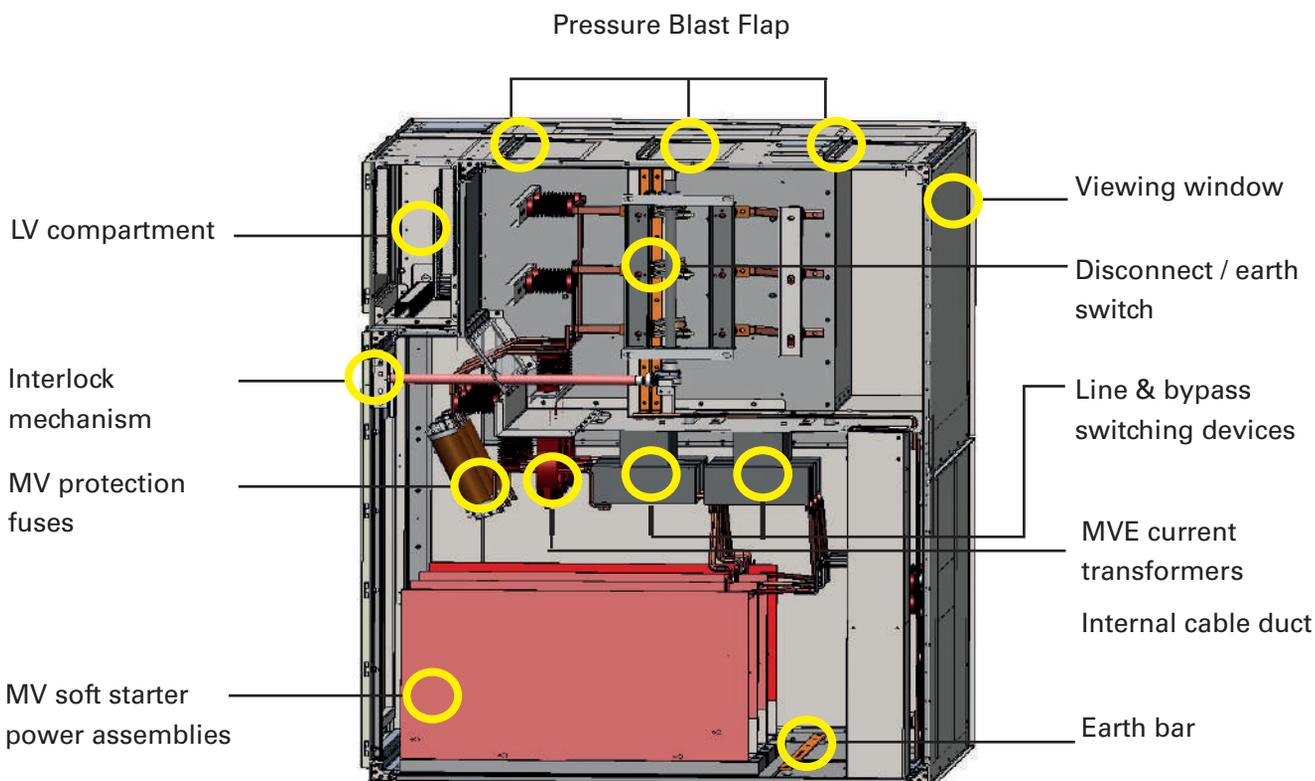
- **Short time withstand current**
- **Peak withstand current**
- Internal arc fault {IAC classification: ALF 31.5 kA for 1 second}
- Dielectric test on main and auxiliary circuits
- IP rating
- Temperature rise test related to 50 °C ambient temperature and main circuit resistance

Certificates are available from Benshaw on request.

L - SERIES MVE

DESIGN DETAILS

L - Series MVE design is available in either IP4X or IP54 panel, with options for line and bypass devices, earthing and isolation switches. Benshaw can also design and build panels to meet particular specifications, and we offer full application engineering support at all stages of the design process.

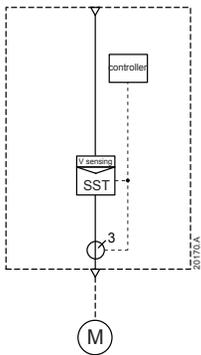


	Height (mm)	Width (mm)		Depth (mm)		
		E1/E2	E3	E1/E2	E3	E3 + PFC
L-MVE-XXXXX-V02	2200	1000	1200	1400	1600	1600
L-MVE-XXXXX-V03						
L-MVE-XXXXX-V04						
L-MVE-XXXXX-V06	1150	1400	1400	1600	1600	1600
L-MVE-XXXXX-V11						
L-MVE-XXXXX-V13						

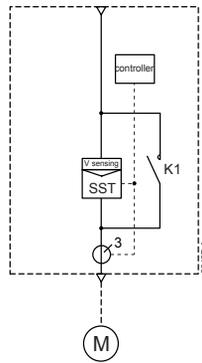
L - SERIES MVE CONFIGURATIONS

E0

Soft starter only

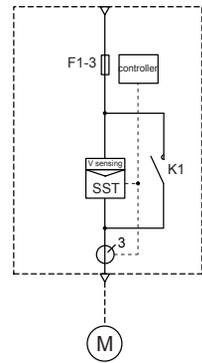


SST + VC

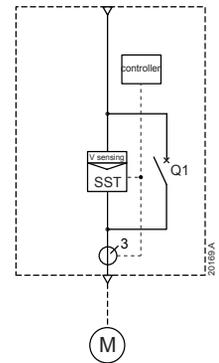


E1

SST + VC + Fuse

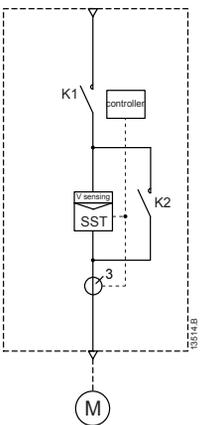


SST + VCB

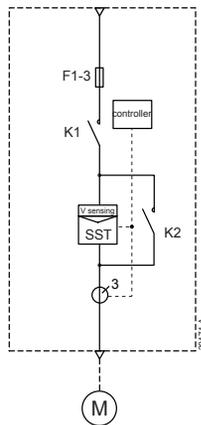


E2

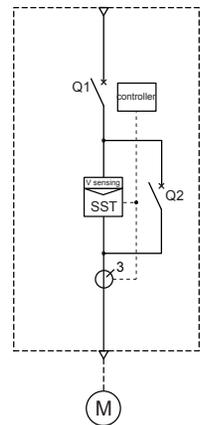
SST + VC



SST + VC + Fuse

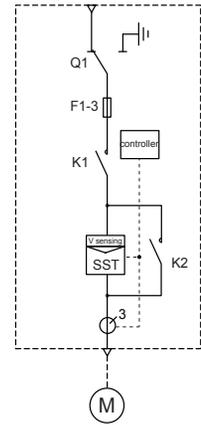


SST + VCB

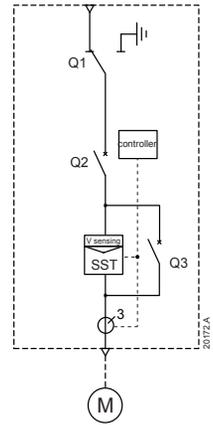


E3

SST + DS + VC + Fuse

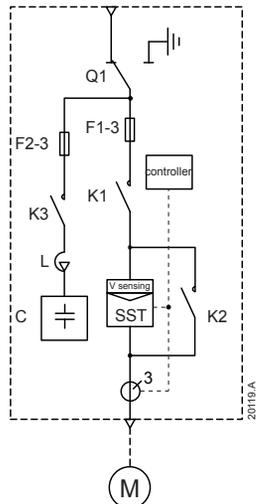


SST + DS + VCB

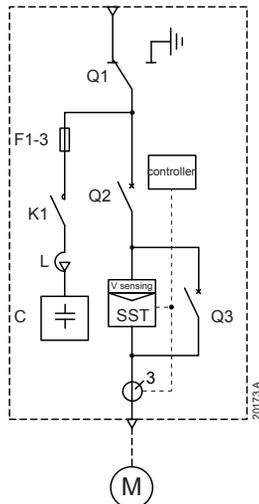


E3

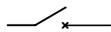
SST + DS + VC + Fuse + PFC



SST + DS + VCB + PFC



LEGEND

Controller		Controller
F		MV Fuses
MVE		MVE soft starter with voltage sensing
K		Vacuum contactor
Q		Vacuum circuit breaker
Q		Disconnecting switch
L		Inrush current limiter
C		Capacitors

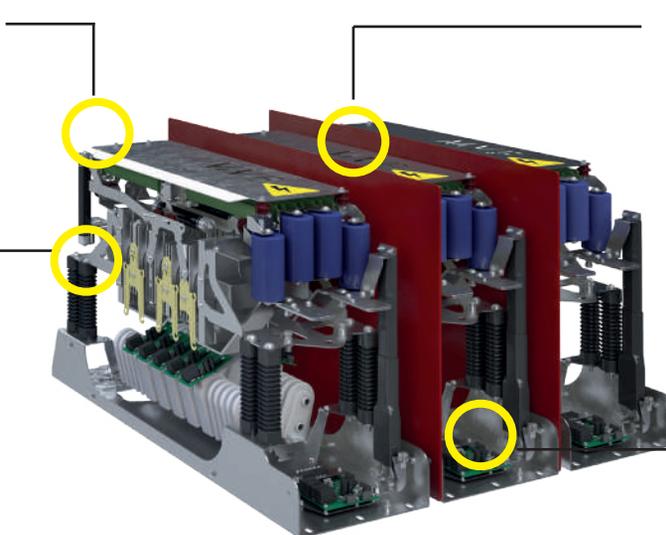
L - SERIES MVE

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TECHNICAL DATA

Motor voltage:	2.3 - 13.8 kV
Control voltages:	85 - 264 VAC or 90 - 350 VDC
Frequency:	45/66 Hz (autotrigger)
Starter current:	70 A - 1700 A
Starting time (max):	1 second - 30 seconds (180 seconds)
Ambient temp. (max):	-10°C to 60 °C (above 50 °C with derating)
Maximum altitude:	1000 m (higher with derating)
IP rating (power assembly):	IP00
IP rating (controller):	IP54 / NEMA12
CT type:	Standard MV CTs (adjustable ratio)
VT type:	EPT type
MV/LV isolation:	100% fiber optic connection
Digital input	3 fixed (start, stop, reset), 2 programmable (A,B)
Relay output:	4 fixed (line, bypass, PFC, PAPS), 3 programmable (A,B,C)
Analog output:	1 analog output
Communications I/O:	Modbus RTU, Modbus TCP, Profibus, Profinet, DeviceNet, Ethernet/IP, USB

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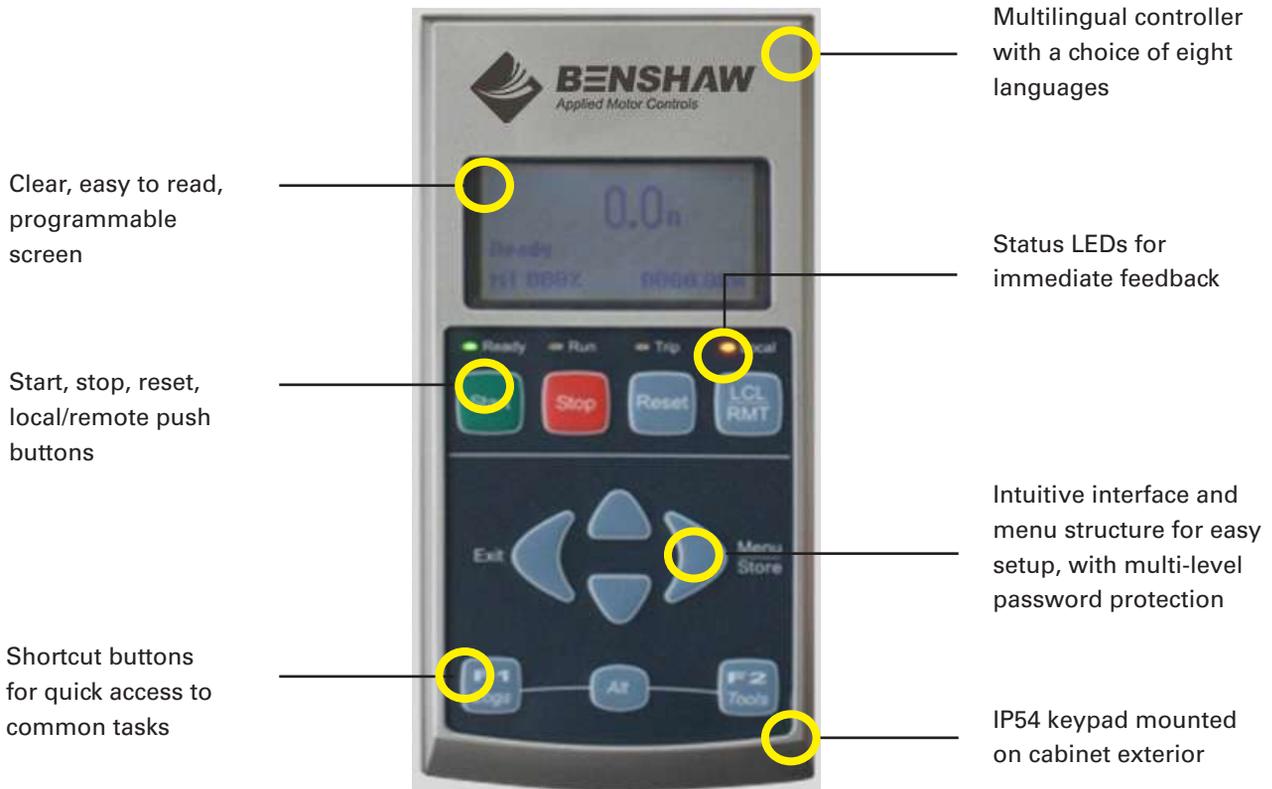
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METERING FUNCTIONALITY:

- Motor current
- Motor voltage
- Mains frequency
- Motor pd
- Motor kW
- Motor HP
- Motor temperature
- kWh
- Hours run
- Real-time graphs



L - SERIES MVE

RELY ON MVE

Feature	Benefit
Quick Application Setup	Easy commissioning
Multi-language Graphical Display	Ease of use and communication
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Advanced Thermal Modeling	Intelligent thermal modeling allows the soft starter to dynamically calculate motor temperature and determine whether the motor can start successfully

L - SERIES MVE

PROTECTION FUNCTIONALITY

Description	Built-in Protection	ANSI Code
Maximum start time	Excess start time	48
Too many starts	Restart delay and dynamic thermal model	66
Undercurrent	Undercurrent	37
Overcurrent - jam	Instantaneous/time-delay overcurrent	50/51/51R
(Locked rotor, load increase)		
Overcurrent - (short circuit)	Instantaneous /time-delay overcurrent (stage 2)	50/51
Checking or Interlocking relay	Shorted SCR	3
Thermal overload	Thermal overload - dynamic model	49/51
Current imbalance	Current imbalance	46
Undervoltage	Undervoltage	27
Overvoltage	Overvoltage	59
Phase loss	Phase loss	47
Phase sequence	Phase sequence	47
Power loss	Power loss	32
Ground fault	Ground fault	50G
Mains frequency	Frequency check, frequency variation	81
External communications failure	Communication failure	85
Ext. fault 1/code - 1	Auxiliary trip A	94/95
Ext. fault 2/code - 2	Auxiliary trip B	94/95
Motor overtemperature	Thermistor protection*	23
Stator winding overtemperature	Thermistor protection*	49

*RTD Relay is optional.

MVH2 SERIES

MEDIUM VOLTAGE VARIABLE FREQUENCY DRIVES

Benshaw MVH2 Series Medium Voltage VFDs utilize H-Bridge multi-level and overlapping wave technology for low harmonic content and a nearly perfect sine wave output. Full-size performance ... in a compact design!

The latest in phase-locked loop technology is used to adjust drive output ... providing an ideal solution for soft start, speed control, energy savings and intelligent control of any MV induction or synchronous motor.

Offering the performance of a full-size standard drive in a small footprint layout, MVH2 Series drives are ideal for retrofit projects or any installation with space constraints.

- UL Listed to 1200HP @ 4160V
- NEMA 1 forced air, front access, welded enclosure
- Fully integrated, packaged VFD:18 pulse design; Load break fused disconnect; Inline contactor; built in dry type transformer
- Door-mounted touch screen HMI
- IEEE 519 compliant, 18 pulse design
- Standalone or integrated into an MCC (optional)
- V/Hz, open or closed loop, vector control
- No cable length restrictions

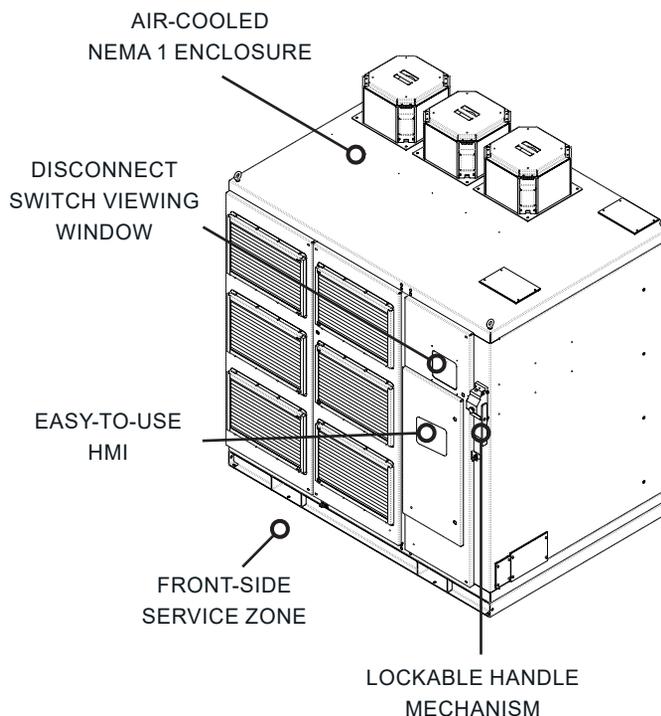
MVH2 Series VFDs can be used standalone (standard configuration) or integrated into an MCC (optional).

KEY FEATURES

- Fully integrated, packaged drive
- 50 KAIC short circuit fault rating
- 400 A load break, 5kV rated disconnect switch, mechanically interlocked
- Standalone or integrated into an MCC
- Top or bottom entrance for both incoming and outgoing power
- Voltage source multi-cell inverter
- Modbus RTU standard, DeviceNet, Profibus, Ethernet optional
- Class H dry type transformer (Al windings) with embedded RTDs

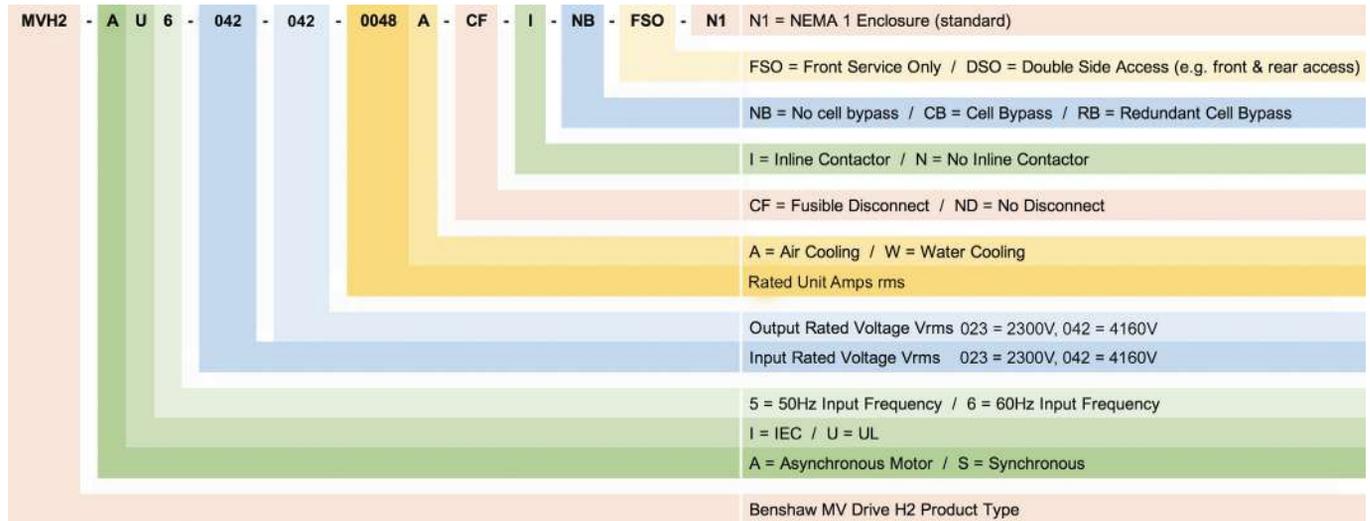
COMMON APPLICATIONS

- Pumps
- Blowers
- Fans
- Compressors
- Chillers
- Test stands
- Kiln drives
- Conveyors



MVH2 SERIES

PART NUMBER ASSEMBLER



PRICING

2300 V

Model Number	Voltage	Approx		Dimensions (in.)**		
		Max HP*	FLA	H	W	D
MVH2-AU6-023-023-0086A-CF-I-NB-FSO-N1	2300	300	77	91.5	86	60
MVH2-AU6-023-023-0154A-CF-I-NB-FSO-N1	2300	600	154	91.5	86	60

4160 V

Model Number	Voltage	Approx		Dimensions (in.)		
		Max HP	FLA	H	W	D
MVH2-AU6-042-042-0031A-CF-I-NB-FSO-N1	4160	200	31	91.5	86	60
MVH2-AU6-042-042-0040A-CF-I-NB-FSO-N1	4160	300	40	91.5	86	60
MVH2-AU6-042-042-0048A-CF-I-NB-FSO-N1	4160	350	48	91.5	86	60
MVH2-AU6-042-042-0061A-CF-I-NB-FSO-N1	4160	450	61	91.5	86	60
MVH2-AU6-042-042-0077A-CF-I-NB-FSO-N1	4160	600	77	91.5	86	60
MVH2-AU6-042-042-0096A-CF-I-NB-FSO-N1	4160	700	96	91.5	86	60
MVH2-AU6-042-042-0104A-CF-I-NB-FSO-N1	4160	800	104	91.5	86	60
MVH2-AU6-042-042-0115A-CF-I-NB-FSO-N1	4160	850	115	91.5	86	60
MVH2-AU6-042-042-0130A-CF-I-NB-FSO-N1	4160	1000	130	91.5	86	60
MVH2-AU6-042-042-0154A-CF-I-NB-FSO-N1	4160	1200	154	91.5	86	60

Note: 4160V models UL listed. UL testing of 2300V units TBD.

* Approx. Max HP based on a 4-pole motor. Size according to actual motor FLA.

** Overall dimensions. Height includes fans.

MVH2 SERIES

TECHNICAL DATA

Feature	Specification/Rating	
Main Power Supply	Voltage	2300 or 4160V (+5%, -20% with output power derating)
	Frequency	50 or 60Hz (+/- 10%)
	Phase Unbalance	Less than 5%
	True Power Factor	>0.96
Control Power Supply	Voltage	230V single phase
	Frequency	50 or 60Hz
Enclosure	Standard	NEMA 1
Control	Control Type	Sinusoidal multilevel PWM
		Fully digital
	Control Mode	Open and closed loop V/F and vector control
	Switching Mode	Multilevel IGBT
	Frequency Mode	0 ... 80HZ
	Overload Capacity	150% instantaneous
		120% for 120 seconds, every 15 minutes
Efficiency	≥ 96%	
Performance	Speed Control	0.1% closed loop, 0.5% open loop
		Resolution: 1 RPM
Control Inputs	Analog	2 x Programmable isolated input: 4-20mA, 2-10V
		1 x Excitation feedback 4-20mA, 2 -10V
	Digital	14 Isolated inputs: 24Vdc
Control Outputs	Analog	2 Fixed outputs: 4-20mA / 2-10V
		2 Programmable outputs: 4-20mA / 2-10V
	Relay	22 Isolated outputs with dry contacts
Communication	Fieldbus Communication	Standard Modbus RTU
		DeviceNet / Profibus / Ethernet IP (optional)
Power Cell Bypass Function (86A and below)	Allows for continued operation with 1 or 2 failed cells	
	Failed cells are bypassed automatically without interruption of equipment process	
	Failed cells can be replaced quickly due to draw-out construction of power cell	
	High productivity and low mean time to repair (MTTR)	

Future options: Cell bypass above 86A, horizontal bus, NEMA 3R

MVH2 SERIES

TECHNICAL DATA

Feature		Specification/Rating
Safety	Protections (Storage of last 100 faults/ alarms with date and time)	DC Link overvoltage
		Drive and transformer overtemperature
		Output overcurrent
		Motor overload
		Output short circuit
		Output ground fault
		Internal fault
		External fault
		Serial communication fault
		Power supply phase loss
		Overvoltage
		Undervoltage
		Over speed
Ambient	Temperature	23°F ... 104°F (-5°C ... -40°C)
	Humidity	< 95% non-condensing
	Altitude	0 ... 5000 ft (above 3300 ft - 1% de-rating for every additional 330 ft)
Finishing	Color	ANSI 61 Gray
		Special paint color optional
Conformities Standards	Electromagnetic Compatibility	IEEE 519-2014
		IEC 61800-3
		UL/cUL (up to 154A)
Flying Start	Starting into spinning motor	
High Performance	Vector control, open & closed loop for superior dynamic speed accuracy & torque control	
Motor and System Protections	Motor Overload	Overvoltage
	Overcurrent	Current limit
	Phase loss	Over temperature
	Ground fault	Cabinet door interlock (optional)
Standards and Approvals	IEC 60038	IEC 61000
	IEC 60050-151, -551	IEC 61800-3
	IEC 60076	IEC 60757
	IEC 60721, relevant chapters	IEC 106
	UL 347A	UL 508A

M2L SERIES

M2L MEDIUM VOLTAGE VARIABLE FREQUENCY DRIVE

Our M2L Medium Voltage Variable Frequency Drive family provides the utmost in performance, reliability, serviceability and safety. The M2L Series is designed for versatility, with numerous installation configurations available to suit environmental conditions, providing significant cost savings and reduced total cost of ownership.

Benshaw M2L Medium Voltage Variable Frequency Drives feature a unique, patented topology, with independent transformer, rectifier and inverter sections, allowing Benshaw to offer flexible packaging options to accommodate a wide range of project-specific requirements and limitations.

Benshaw's modular, power-cell-based M2L inverters use the most reliable components available ... such as low voltage IGBT and dry-type film capacitors ... and they are equipped with the latest in safety features, including a fast and reliable arc flash detection system. This topology, along with the M2L's advanced remote monitoring system, helps minimize down-time and simplify integration with other drive system components.

The M2L Medium Voltage Variable Frequency Drive family spans a power range from 300 HP to 12,000 HP, operating at industry-standard medium voltages up to 7.2kV and accepting up to 35kV input. Redundant fans are included in the standard design.

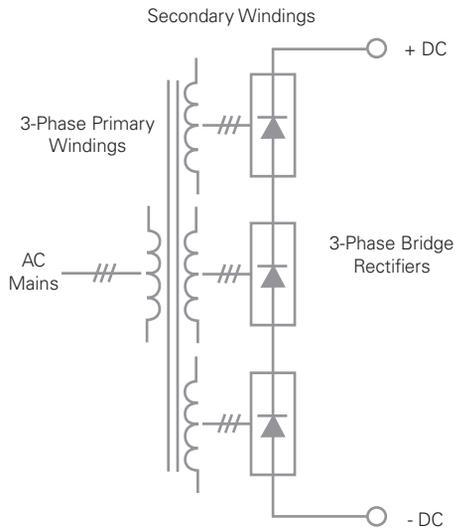
- Patented topology
- Flexibility of installation
- Industry-leading performance
- Enhanced reliability and efficiency
- Reduced cost of ownership
- Simplified serviceability
- Dependable safety



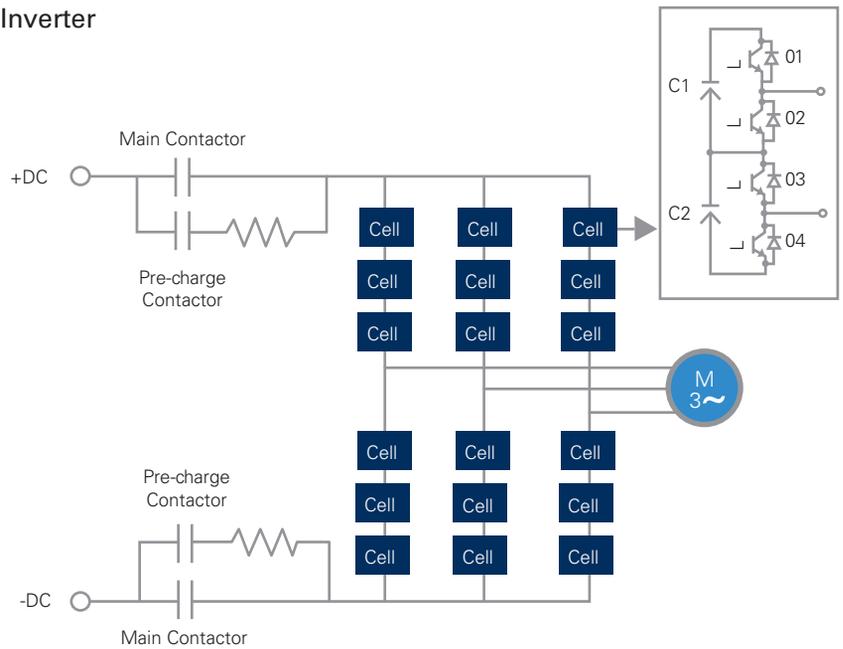
M2L MEDIUM VOLTAGE DRIVE

TECHNICAL DATA

Transformer/Rectifier



Inverter



INPUT LINE SPECIFICATION

- Input Voltage¹
 - 3Ø, 380 V–35 kV ±10%
- Input Frequency
 - 50 or 60 Hz ±5%

MOTOR-SIDE SPECIFICATION

- Output Voltage¹
 - 3Ø, 0–2300 V
 - 3Ø, 0–4160 V
 - 3Ø, 0–7200 V
- Output Current
 - 0–770 A Single Inverter
 - 0–1500 A Parallel Inverters
- Output Frequency²
 - 0–90 Hz
- Output Power³
 - Up to 12,000 HP

INPUT TRANSFORMER

- 6–36-Pulse
- Air-cooled or Oil-filled
- Indoor or Outdoor Installation

RECTIFIER

- 6–36-Pulse
- Diode Front End
- Indoor or Outdoor Installation

INVERTER

- Multi-Level PWM
- LV IGBT Power Cells
- Indoor Installation

CONTROL METHODS

- Volts/Hertz (V/Hz)
- Sensorless Vector Control (SVC)

EFFICIENCY

- Inverter
 - >99.5%
- Drive System
 - >97%

¹ Consult factory for voltages other than specified ranges.

² Consult factory for higher output frequency requirements.

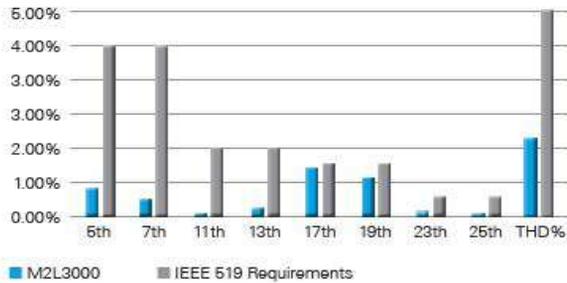
³ Consult factory for higher power requirements.

M2L MEDIUM VOLTAGE DRIVE

PERFORMANCE

SUPERIOR UTILITY-FRIENDLY INPUT POWER QUALITY

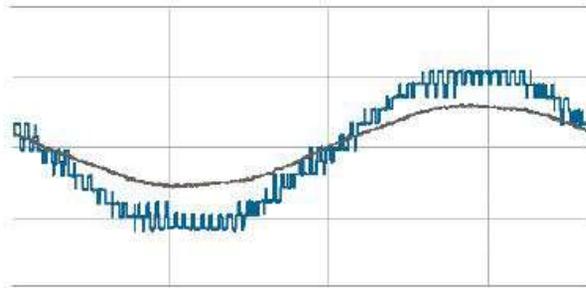
Example of Input Current Harmonic Spectrum



- Input currents and voltages meet/exceed IEEE 519 requirements
- Input PF > 0.95
- Input filter not required

SUPERIOR MOTOR-FRIENDLY OUTPUT WAVEFORM QUALITY

Example of Output Line-To-Line Voltage and Current



- Motor-friendly 13-level line-to-line output voltage
- Low harmonics and low dV/dT
- Output filter not required (cables up to 1000 ft.)



RELIABILITY

Availability of operations is ensured through simple and well-proven design. Utilizing simple and standard transformer and rectifier minimizes the component count as well as cable connections. True power-cell-based inverter design creates the most modular inverter design in industry while enabling use of highly reliable components such as dry-type film capacitors and LV IGBTs. Redundant fans are included in the standard design.

SAFETY

Workforce, application and equipment are protected through safe design with reduced arc flash footprint and unique and standard arc flash detection system. Remote HMI allows personnel to operate the drive while away from medium voltage.

SERVICEABILITY

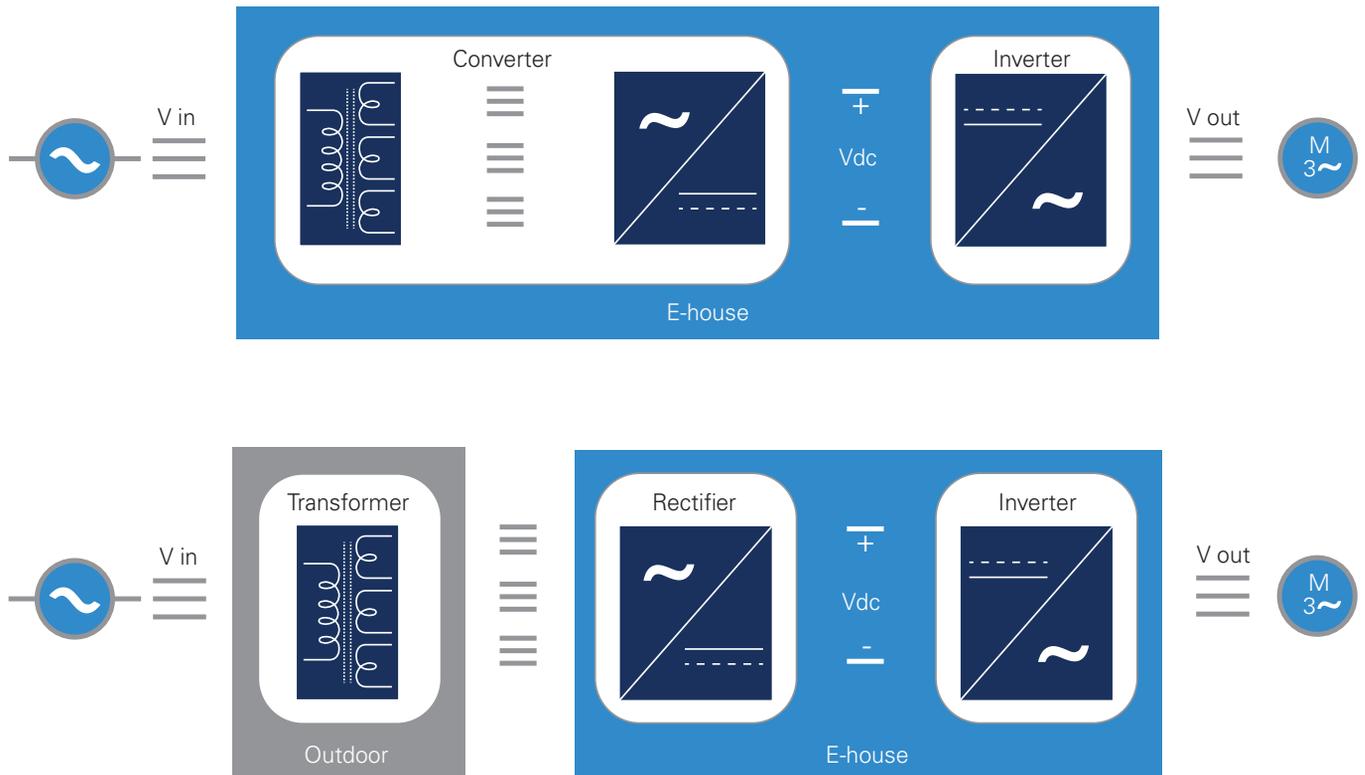
Simple and fast maintenance is ensured through front access only design and advanced diagnostic tools such as Benschaw Connect. Benschaw Connect provides intuitive, user-friendly access to operational and conditional data, trends and events log as well as control and motor parameters.

M2L MEDIUM VOLTAGE DRIVE

FLEXIBILITY OF INSTALLATION

FLEXIBILITY OF INSTALLATION

Great versatility provides various configuration and installation options to make the solution suitable for operation in different environmental conditions while providing significant cost savings and reduced total cost of ownership.



M2L MEDIUM VOLTAGE DRIVE

TOTAL COST OF OWNERSHIP

SIGNIFICANT SAVING ON YOUR AIR-CONDITIONING COST

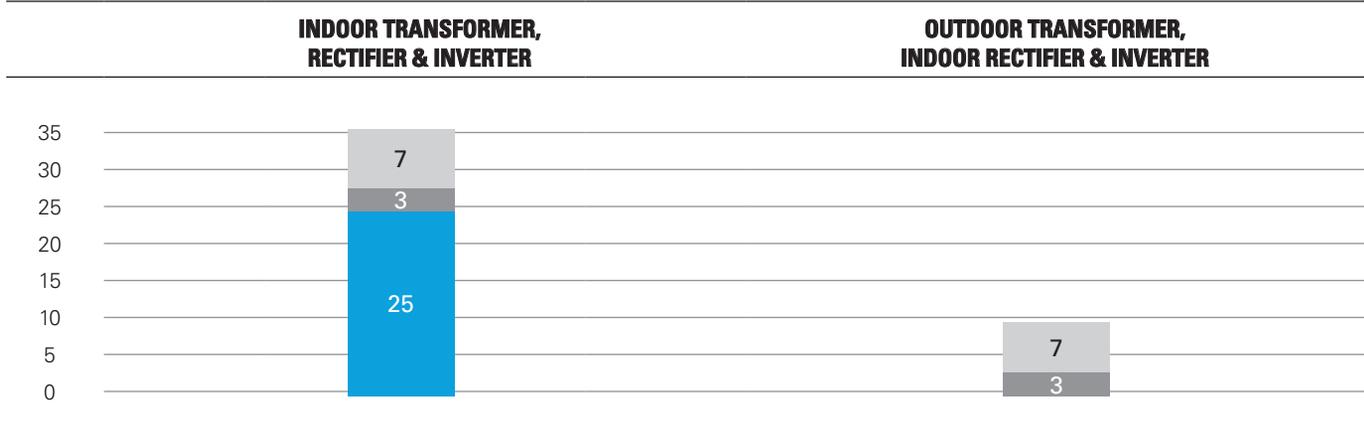
Significant savings on initial investment, operating cost and maintenance costs of air-conditioning system by moving majority of heat load outdoors.

HEAT LOAD ANALYSIS

Example shown for a typical 5000 HP MV drive with 97% overall efficiency

Power Loss and Heat Load		
	POWER LOSS (kW)	HEAT LOAD (BTU/HR)
Transformer	80	275,000
Rectifier	10	34,000
Inverter	25	85,000
Drive	115	394,000

Required Air-Conditioning Tonnage to Dissipate Heat from E-House



Yearly Operating Cost	\$37,000	\$11,000
20-Year Operating Cost	\$788,000	\$225,000

¹Calculations above do not include redundant HVAC capacity and installation and maintenance cost of HVAC units.

M2L MEDIUM VOLTAGE DRIVE

SPECIAL APPLICATIONS

SYNCHRONOUS TRANSFER

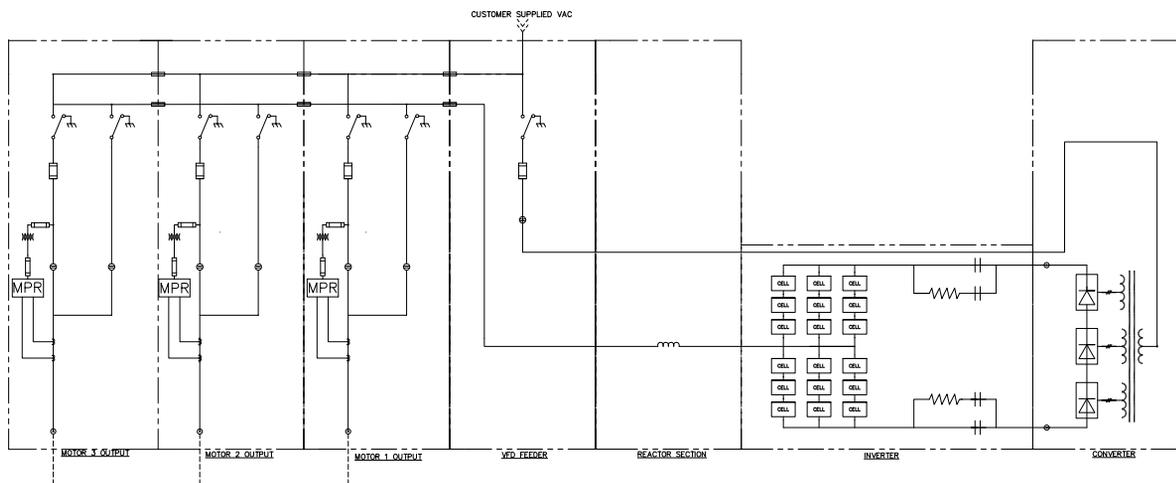
Advanced synchronous transfer setup allows the motor to be transferred to the supply line after the motor voltage magnitude and phase angles at the motor terminals are synchronized and matched with the ones at the supply line terminals. Advanced synchronous transfer controller provides “bump-less” transfer of the motor, which ensures minimized stress on the motor and driven system.

Benshaw offers all the isolation disconnects, contactors, sync reactor and synchronous controller as well as the M2L MV drives, providing an easy, fast and smooth one- stop shop experience.

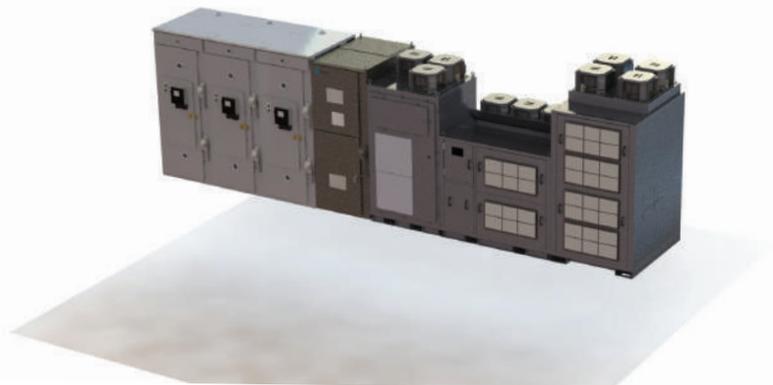
Single VFD with Single Motor — Single motor setup provides the ability to soft start a motor and eliminate any inrush current, thus reducing the impact on the power system. The motor may be operated at variable speeds using the M2L MV drive or transferred across the line to operate at full speed.

Single VFD with Multiple Motors — Multiple motors setup provides the ability to soft start any of the motors and eliminate any inrush current, thus the reducing impact on the power system. Some or all the motors may be synchronized with the utility supply and be operated at full speed. One motor may be operated at variable speeds using the M2L MV drive for load trimming purposes.

One-Line Diagram 1 VFD — 3 Motor



Line-Up Diagram 1 VFD — 3 Mc



M2L MEDIUM VOLTAGE DRIVE

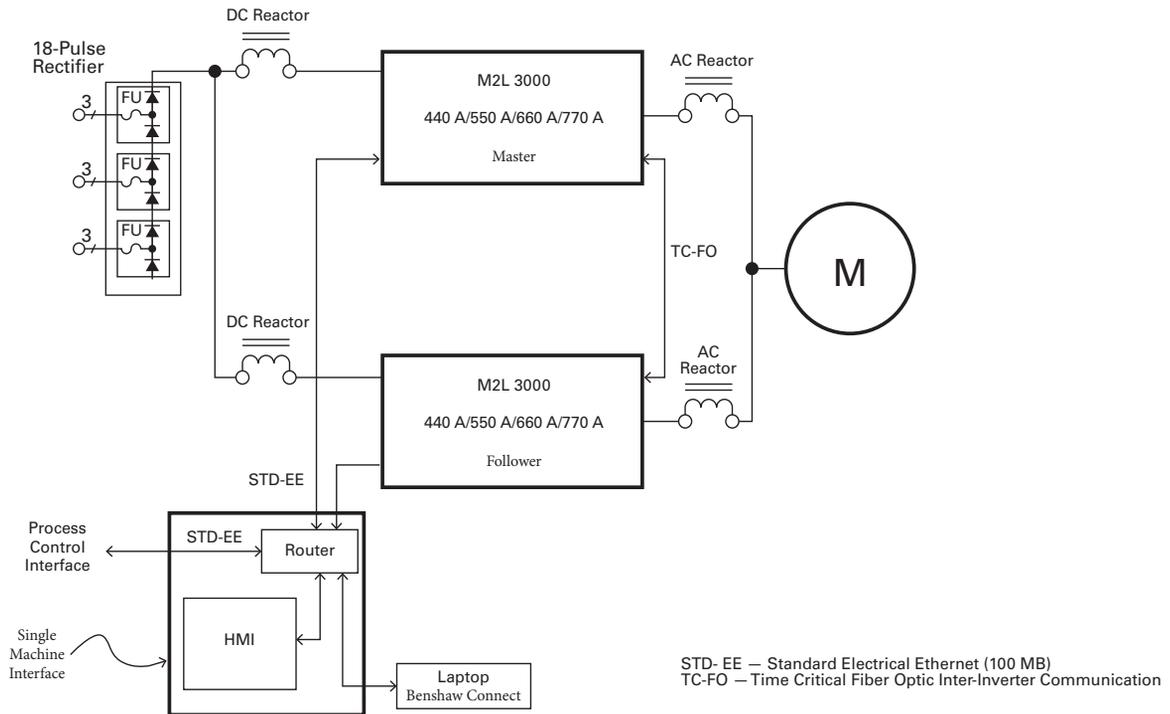
SPECIAL APPLICATIONS

PARALLEL DRIVE

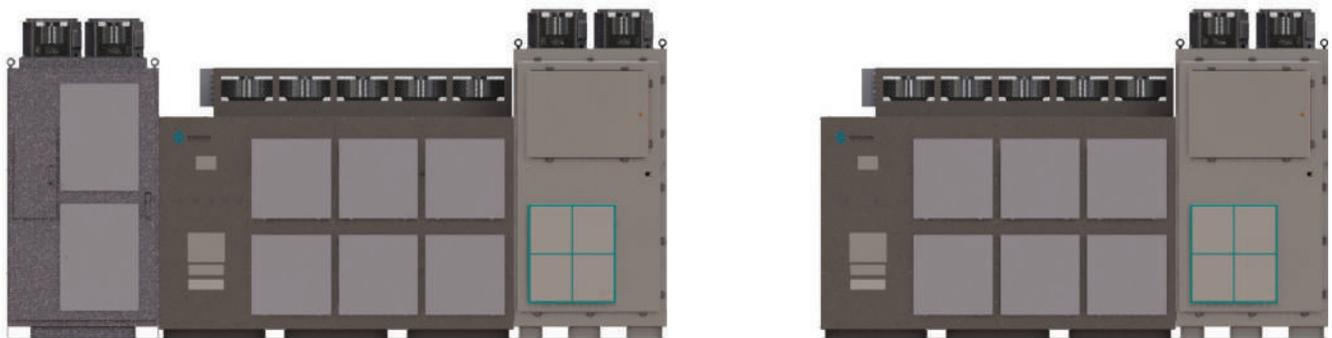
The modular and flexible design of the M2L MV drive provides the ability to utilize two inverters in parallel and expand the HP rating of a fully air-cooled solution to beyond 10,000 HP range. An air-cooled solution at this HP range eliminates cumbersome piping and complex and unreliable liquid-cooling systems, thus offering significant cost savings during initial investment, installation and operation of the drive.

The 2ML design utilizes modular building blocks; therefore, the same components are used to achieve higher horsepower ratings. Using modular building blocks allows the customer to standardize on lower-cost spare parts, minimizing downtime and maintenance costs.

One-Line Diagram with Parallel Drive and Outdoor Transformer



Line-Up for 8000 HP 4160 V Parallel Drive with Outdoor Transformer



MEDIUM VOLTAGE DRIVE FEEDER

DRIVE FEEDER NON-BYPASSED

Shunt isolation is required in order to protect the VFD from line power in the case of the fault. Load-break isolation is required to be able to safely perform maintenance on drive solutions. Benschaw provides standard solutions for isolation drive systems utilizing load-break disconnect switches and contactors. The Benschaw drive solutions are designed to seamlessly integrate into existing Benschaw medium voltage line-ups.

VFD FEEDER

The VFD Feeder provides input isolation to the VFD, but does not allow for bypass. The contactor will open, isolating the VFD, should a fault appear.

Each VFD Feeder includes the following:

- 5 kV vacuum contactor
- 4.76 kV disconnect
 - Load break/fault make
 - Grounding bar
 - Viewing window
- Class E rated fuses
- NEMA 12 enclosure

Model Number	Voltage	Approximate maximum HP (kW)	FLA	Dimensions (in.)			Disconnect Rating	Disconnect Type
				H	W	D		
CFMVM2LDISC-160A-2300-12	2300	700 (500)	160 and below	92.5	24	36	400 A load break and 600 A continuous	Rotary handle
CFMVM2LDISC-160A-4160-12	4160	1300 (950)	160 and below	92.5	24	36	400 A load break and 600 A continuous	Rotary handle

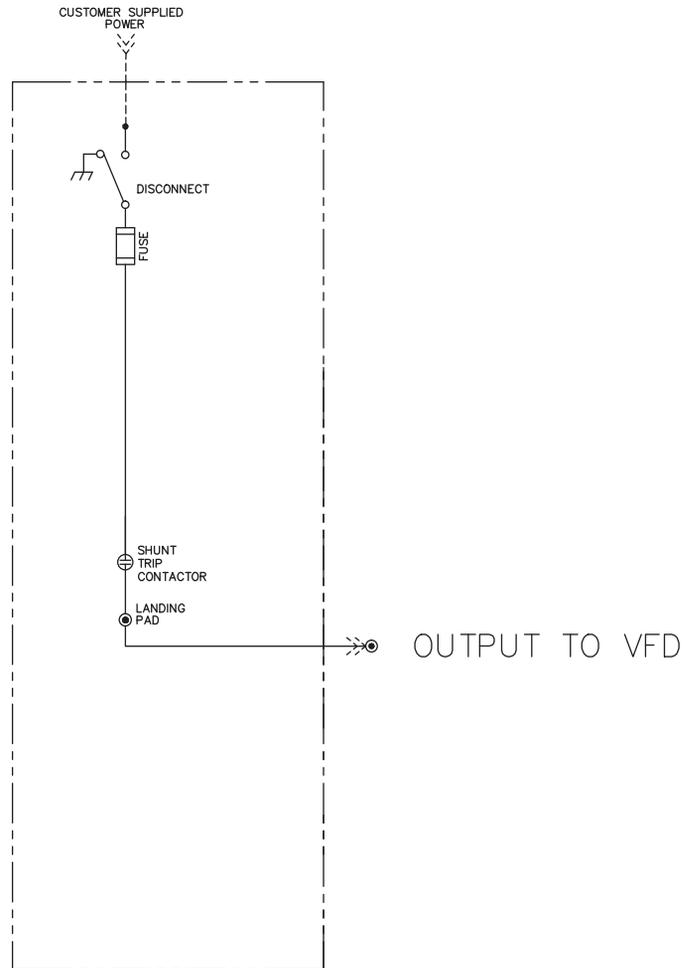
*The FLA of the system must include any safety factor of the motor, and should be sized to the maximum full load current at which the motor will operate.

*All dimensions above assume top entry and a pass-through exit to the neighboring converter or bottom exit. Contact Benschaw for additional entry/exit options.

*Consult factory for larger sizes or alternate enclosure ratings.

MEDIUM VOLTAGE DRIVE FEEDER

DRIVE FEEDER NON-BYPASSED



MEDIUM VOLTAGE DRIVE FEEDER

DRIVE FEEDER WITH ATL BYPASS

VFD FEEDER WITH ATL BYPASS

Having the option for ATL bypass allows for operation of the motor if the drive fails. Power is applied through the closure of a vacuum contactor and disconnect switch, bypassing the VFD, and connecting the motor directly to the line. This solution is highly recommended for critical applications that can't afford any downtime.

Each VFD Feeder with ATL Bypass includes the following:

ATL STARTER SECTION

- 4.76 kV disconnect
 - Load break/fault make
 - Grounding bar
 - Viewing window
- Class R rated fuses
- (2) 5 kV vacuum contactors — one for line isolation and one for VFD output isolation
- NEMA 12 enclosure
- MX³ protection
 - (3) phase current transformers
 - MV divider card
 - MX³ keypad
 - MX³ control board

MAIN VFD DISCONNECT

- 4.76 kV disconnect
 - Load break/fault make
 - Grounding bar
 - Viewing window
- Class E rated fuses
- 5 kV VFD input vacuum contactor
- NEMA 12 enclosure

Model Number	Voltage	Approximate maximum HP (kW)	FLA	Dimensions (in.)			Disconnect Rating	Disconnect Type
				H	W	D		
CFMVM2LBYP-160A-2300-12	2300	700 (500)	160 and below	92.5	60	36	400 A load break and 600 A continuous	Rotary handle
CFMVM2LBYP-160A-4160-12	4160	1300 (950)	160 and below	92.5	60	36	400 A load break and 600 A continuous	Rotary handle

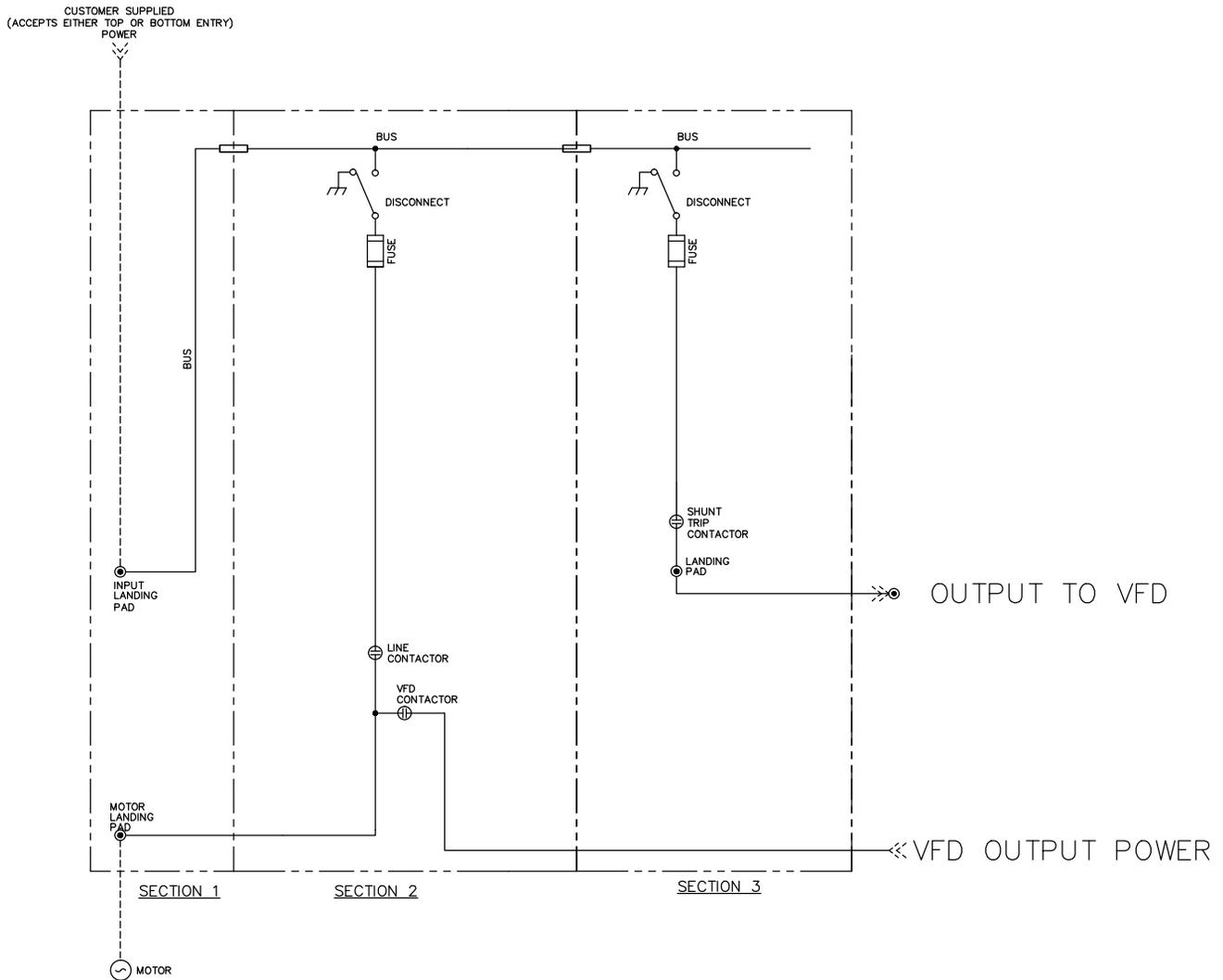
*The FLA of the system must include any safety factor of the motor, and should be sized to the maximum full load current at which the motor will operate.

*All dimensions above assume top entry and a pass-through exit to the neighboring converter or bottom exit. Contact Benschaw for additional entry/exit options.

*Consult factory for larger sizes or alternate enclosure ratings.

MEDIUM VOLTAGE DRIVE FEEDER

DRIVE FEEDER WITH ATL BYPASS



Note that to run in ATL mode, the ATL disconnect must be closed and the VFD disconnect must be opened.

*With the standard configuration, two load side connection points are required — one to the ATL Starter Section and one to the Main VFD Disconnect Section. This option includes the following in order have only one load power connection point for CFMVM2LBYP-160A-2300/4160-12.

- NEMA 12 Enclosure approx. 92.5”H x 18”W x 36”D
- Motor Landing Pad
- 800 A Non-insulated Bus

MEDIUM VOLTAGE DRIVE FEEDER

DRIVE FEEDER WITH FULLY ISOLATED ATL BYPASS

VFD FEEDER WITH FULLY ISOLATED ATL BYPASS

To continuously run a motor even during servicing of the medium voltage drive, an additional disconnect switch is required. This solution allows the motor to run through the bypass starter while the drive can be safely worked on. This is recommended for highly critical applications where no downtime can be tolerated.

Each VFD Feeder with Fully Isolated ATL Bypass includes the following:

(2) HIGH ATL STARTER/VFD OUTPUT ISOLATION SECTIONS

- (2) 4.76 kV disconnects — one for line isolation and one for VFD output isolation
 - Load break/fault make
 - Grounding bar
 - Viewing window
- Class R rated fuses
- (2) 5 kV vacuum contactors — one for line isolation and one for VFD output isolation
- NEMA 12 enclosure
- MX³ protection
 - (3) phase current transformers
 - MV divider card
 - MX³ keypad

MAIN VFD DISCONNECT

- 4.76 kV disconnect
 - Load break/fault make
 - Grounding bar
 - Viewing window
- Class E rated fuses
- 5 kV VFD input vacuum contactor
- NEMA 12 enclosure

Model Number	Voltage	Approximate maximum HP (kW)	FLA	Dimensions (in.)			Disconnect Rating	Disconnect Type
				H	W	D		
CFMVM2LFBYP-160A-2300-12	2300	700 (500)	160 and below	92.5	60	36	400 A load break and 600 A continuous	Rotary or Flange Handle
CFMVM2LFBYP-160A-4160-12	4160	1300 (950)	160 and below	92.5	60	36	400 A load break and 600 A continuous	Rotary or Flange Handle

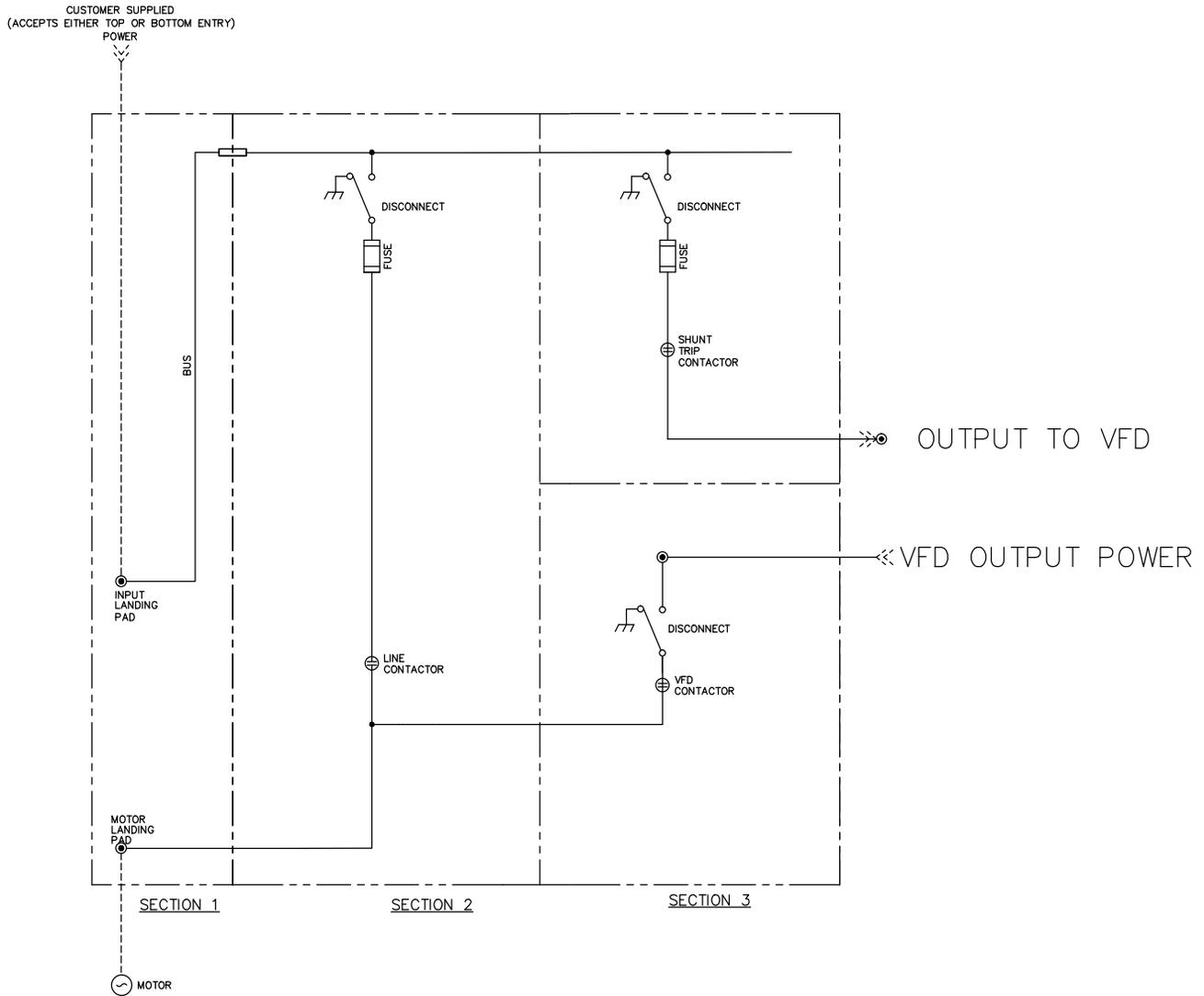
*The FLA of the system must include any safety factor of the motor, and should be sized to the maximum full load current at which the motor will operate.

*All dimensions above assume top entry and a pass-through exit to the neighboring converter or bottom exit. Contact Benschaw for additional entry/exit options.

*Consult factory for larger sizes or alternate enclosure ratings.

MEDIUM VOLTAGE DRIVE FEEDER

DRIVE FEEDER WITH FULLY ISOLATED ATL BYPASS



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