Benshaw’s standard products are stocked in warehouses in the USA and Canada... ready for shipment to support your critical needs:

Benshaw.com
In the USA, call or fax
Phone: 412.968.0100
Fax: 412.968.5415
In Canada, call or fax
Phone: 519.291.5112
Fax: 519.291.2595
BenshawExpress.com
If you prefer to order online, BenshawExpress.com provides direct digital access to our complete inventory of standard controls, drives and spare parts - 24 hours a day, seven days a week, 365 days a year.

Save time with 24/7 online access at benshawexpress.com

Benshaw Express is a convenient, time-saving tool for Benshaw authorized distributors.
The Benshaw web store enables users 24/7 access to:

- Check price and availability
- Place orders
- Track open orders
- Obtain tracking for shipped orders
- View freight charges for recent shipments
- View invoices
- Customized levels of access

Access Benshaw Express by following the link on Benshaw.com or directly at BenshawExpress.com.
MEDIUM VOLTAGE SOLID STATE STARTERS

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MX³ CONTROLLER

NEXT GENERATION INTELLIGENT MOTOR CONTROL

MX³ CONTROLLER HIGHLIGHTS

Next generation MX³ technology forms the backbone of Benshaw’s entire line of intelligent medium voltage motor controls. With fiber optic firing, enhanced programming capabilities, ease of use and a unique, flexible architecture — Benshaw’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, Benshaw'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
  - Adjustable initial current
  - Adjustable maximum current
  - Adjustable ramp time
- Voltage ramp
  - Adjustable initial voltage
  - Adjustable maximum voltage
  - Adjustable ramp time
- 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

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

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.

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
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

<table>
<thead>
<tr>
<th>Model Number</th>
<th>HP</th>
<th>A</th>
<th>H</th>
<th>W</th>
<th>D</th>
<th>Weight (lbs.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MVRXE12-550-2300**</td>
<td>550</td>
<td>131</td>
<td>92</td>
<td>36</td>
<td>32</td>
<td>1,800</td>
</tr>
<tr>
<td>MVRXE12-750-2300**</td>
<td>750</td>
<td>200</td>
<td>92</td>
<td>36</td>
<td>32</td>
<td>1,800</td>
</tr>
<tr>
<td>MVRXE12-900-2300**</td>
<td>900</td>
<td>225</td>
<td>92</td>
<td>36</td>
<td>32</td>
<td>1,800</td>
</tr>
<tr>
<td>MVRXE12-1500-2300**</td>
<td>1500</td>
<td>330</td>
<td>92</td>
<td>36</td>
<td>32</td>
<td>1,800</td>
</tr>
</tbody>
</table>

MVRXE18 - 4160 V

<table>
<thead>
<tr>
<th>Model Number</th>
<th>HP</th>
<th>A</th>
<th>H</th>
<th>W</th>
<th>D</th>
<th>Weight (lbs.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MVRXE18-1000-4160**</td>
<td>1000</td>
<td>131</td>
<td>92</td>
<td>36</td>
<td>32</td>
<td>2,000</td>
</tr>
<tr>
<td>MVRXE18-1500-4160**</td>
<td>1500</td>
<td>200</td>
<td>92</td>
<td>36</td>
<td>32</td>
<td>2,000</td>
</tr>
<tr>
<td>MVRXE18-1700-4160**</td>
<td>1700</td>
<td>225</td>
<td>92</td>
<td>36</td>
<td>32</td>
<td>2,000</td>
</tr>
<tr>
<td>MVRXE18-3000-4160***</td>
<td>3000</td>
<td>330</td>
<td>92</td>
<td>36</td>
<td>32</td>
<td>2,000</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Model Number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A406</td>
<td>8-Channel RTD Module, 100 ohm Platinum</td>
</tr>
<tr>
<td></td>
<td>(Also Available for Remote Mounting)</td>
</tr>
<tr>
<td>A407</td>
<td>16-Channel RTD Module(s), 100 ohm Platinum</td>
</tr>
<tr>
<td></td>
<td>(Also Available for Remote Mounting)</td>
</tr>
<tr>
<td>A409</td>
<td>Service Entrance Label</td>
</tr>
<tr>
<td>A875</td>
<td>Ground Fault CT, 2000:1, 4.0:Dia. (For MX³ Use)</td>
</tr>
</tbody>
</table>

Power fuses ship loose. Must provide motor full load amps at time of order for proper fuse sizing.
WANT TO MINIMIZE DOWNTIME LOSS OF PRODUCTION?
TAKE ADVANTAGE OF BENSHEW’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

<table>
<thead>
<tr>
<th>Model Number</th>
<th>Motor Amps</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1000 HP STARTERS</strong></td>
<td></td>
</tr>
<tr>
<td>MVRXE-400101-SP</td>
<td>46 to 55 A</td>
</tr>
<tr>
<td>MVRXE-400102-SP</td>
<td>56 to 75 A</td>
</tr>
<tr>
<td>MVRXE-400103-SP</td>
<td>76 to 90 A</td>
</tr>
<tr>
<td>MVRXE-400104-SP</td>
<td>91 to 131 A</td>
</tr>
</tbody>
</table>

| **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.
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

<p>| | | |</p>
<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>12</td>
<td>NEMA 12</td>
<td></td>
</tr>
<tr>
<td>SH</td>
<td>NEMA 12 with Space Heater</td>
<td></td>
</tr>
<tr>
<td>3R</td>
<td>NEMA 3R with Space Heater</td>
<td></td>
</tr>
</tbody>
</table>

### Choose Service Entrance Rated (for stand-alone single units)

<p>| | |</p>
<table>
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<tr>
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<tbody>
<tr>
<td>S</td>
<td>Yes</td>
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<tr>
<td>N</td>
<td>No</td>
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### Choose Bus Options+

<p>| | |</p>
<table>
<thead>
<tr>
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<tbody>
<tr>
<td>8N</td>
<td>800 A Non-Insulated Bus</td>
</tr>
<tr>
<td>8I</td>
<td>800 A Insulated Bus</td>
</tr>
<tr>
<td>1N</td>
<td>1,200 A Non-Insulated Bus</td>
</tr>
<tr>
<td>1I</td>
<td>1,200 A Insulated Bus</td>
</tr>
<tr>
<td>2N</td>
<td>2,000 A Non-Insulated Bus</td>
</tr>
<tr>
<td>2I</td>
<td>2,000 A Insulated Bus</td>
</tr>
<tr>
<td>NR</td>
<td>None Required</td>
</tr>
</tbody>
</table>

† Only 350% for 30 Seconds

---

**Design Your Customized Starter to Ship in 1 Week or Less**

<p>| | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
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</thead>
<tbody>
<tr>
<td><strong>Choose Core Unit</strong></td>
<td><strong>Choose Motor Current (A)</strong></td>
<td><strong>Choose Exit/Landing Option</strong>*</td>
<td></td>
</tr>
<tr>
<td>MVB41</td>
<td>025</td>
<td>T</td>
<td></td>
</tr>
<tr>
<td>MVB41</td>
<td>025</td>
<td>B</td>
<td></td>
</tr>
<tr>
<td>MVB41</td>
<td>025</td>
<td>C</td>
<td></td>
</tr>
<tr>
<td>MVB41</td>
<td>045</td>
<td>T</td>
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<tr>
<td>MVB41</td>
<td>045</td>
<td>B</td>
<td></td>
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<tr>
<td>MVB41</td>
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<tr>
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<td>B</td>
<td></td>
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<tr>
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<tr>
<td>MVB41</td>
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<td>T</td>
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<td>090</td>
<td>C</td>
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<tr>
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<td>T</td>
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</tr>
<tr>
<td>MVB41</td>
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<td>B</td>
<td></td>
</tr>
<tr>
<td>MVB41</td>
<td>133</td>
<td>C</td>
<td></td>
</tr>
</tbody>
</table>

**Core Unit Options**

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>A</td>
<td>B</td>
</tr>
<tr>
<td>MVB43</td>
<td>225</td>
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</tbody>
</table>

**Motor Options**

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>B</td>
</tr>
<tr>
<td>MVB43</td>
<td>170</td>
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</tbody>
</table>

**Exit/Landing Options**

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>T</td>
<td>Top Exit with Landing Pad</td>
</tr>
<tr>
<td>B</td>
<td>Bottom Exit with Landing Pad</td>
</tr>
<tr>
<td>C</td>
<td>Top or Bottom Exit Landing on Bypass Contactor</td>
</tr>
</tbody>
</table>

---

**Bus Options**

- **+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.**
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

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

No selection = keypad control.

**Motor currents vs. HP are typical; confirm actual motor current.**

Service factor not accounted for; adjust if required.

Need help sizing your Soft Starter?
Soft Starter sizing guide available on benshaw.com, or call an Application Engineer at 412-968-0100.
All drawings packages are available on BenshawExpress.com.
All drawings packages are available on BenshawExpress.com.

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.

<table>
<thead>
<tr>
<th>Steel bolt — Torque in pound-foot [Newton-Meter]</th>
</tr>
</thead>
<tbody>
<tr>
<td>¼-20</td>
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<td>5</td>
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<td>(6.8)</td>
</tr>
</tbody>
</table>

6. Approximate weight is 1600 lbs (726 kg).
R-fuses shown for reference. Reference sales order for fuse size.
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**

MVE - [-] [-] [-] [-]  

**Enclosure**  
N1 = NEMA 1  
N12 = NEMA 12  
N3R = NEMA 3R  
N3ROD = NEMA 3R outdoor rated  
N4 = NEMA 4

**Control Voltage**  
C1 = 120 VAC / 230 VAC

**Mains Voltage**  
V02 = 2300 VAC 50/60 Hz  
V03 = 3300 VAC 50/60 Hz  
V04 = 4160 VAC 50/60 Hz  
V06 = 6600 VAC 50/60 Hz  
V11 = 11000 VAC 50/60 Hz  
V13 = 13800 VAC 50/60 Hz

**Power Rating (amps)**  
See ratings charts on p16-17

**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

<table>
<thead>
<tr>
<th>System Voltage</th>
<th>Starter Current</th>
<th>Motor HP</th>
<th>Motor kW</th>
<th>Dimensions and Weights:</th>
<th>Wgt. (lbs.)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N1, 4/3R* Class E2 Starter</td>
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<td>V</td>
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<tr>
<td><strong>2.3 kV</strong></td>
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<td>93</td>
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# MVE MEDIUM VOLTAGE SOFT STARTERS

## RATINGS - 11.0 KV - 13.8 KV

<table>
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<tr>
<th>System Voltage</th>
<th>Starter Current</th>
<th>Motor HP</th>
<th>Motor kW</th>
<th>Dimensions and Weights:</th>
<th>N1, 4/3R* Class E2 Starter</th>
<th>Wgt. (lbs.)</th>
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<td>7000</td>
</tr>
</tbody>
</table>

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.

<table>
<thead>
<tr>
<th>Type of application (pump, compressor, conveyor, etc.)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Motor rated power (KW or HP)</td>
<td>Motor Full Load Current (FLA)</td>
</tr>
<tr>
<td>Motor nominal voltage (V)</td>
<td>Motor synchronous speed (RPM)</td>
</tr>
<tr>
<td>Motor current vs. speed curve or lst/In (% or Per Unit)</td>
<td>Motor speed/torque curve or Tmax/Tn (% or Per Unit)</td>
</tr>
<tr>
<td>Rotor inertia J=GD2/4 (kgm)</td>
<td>Load speed/torque curve (% or per unit)</td>
</tr>
<tr>
<td>Load inertia J=GD2/4 (kgm) at motor speed</td>
<td></td>
</tr>
<tr>
<td>Starts per hour</td>
<td>Time between starts</td>
</tr>
<tr>
<td>Cabinet degree of protection (1PXX/NEMA)</td>
<td></td>
</tr>
<tr>
<td>Ambient temperature (operating &amp; storage) requirement</td>
<td>Altitude (meters or feet above sea level)</td>
</tr>
<tr>
<td>Power cables entry (top or bottom)</td>
<td></td>
</tr>
<tr>
<td>Soft starter only (IEC style) or standard unit with load break switch and power fuses/VCB</td>
<td></td>
</tr>
<tr>
<td>Max. shipping split dimensions (WxHxD)</td>
<td></td>
</tr>
<tr>
<td>Additional notes / requirements:</td>
<td></td>
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</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Type of exciter (rotating or static)</th>
<th>New or refurbished motor?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full nameplate data of motor and exciter</td>
<td>Data for existing / old excitation system</td>
</tr>
<tr>
<td>For rotating exciter: DC voltage, DC current of the exciter generator field</td>
<td>For static exciter: DC voltage, DC current of motor field</td>
</tr>
<tr>
<td>For static exciter: full data of field starting / discharge resistor</td>
<td></td>
</tr>
<tr>
<td>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?</td>
<td>Availability of LV 3 phase supply KVA required: 250V x IDC x 3 phase x 1.3.</td>
</tr>
<tr>
<td>Additional notes / requirements:</td>
<td>Advise voltage and frequency.</td>
</tr>
</tbody>
</table>
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.

**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

**COMBINATION STARTERS TO MEET YOUR REQUIREMENTS**
- Solid state reduced voltage
- Standard full voltage
- Smart full voltage
- Solid state with full voltage bypass

**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 Benshaw 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 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
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
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

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

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 COMMUNICATION PORT:
• Modbus/RS485

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

23
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 2300
V/4160 V/7200 V

CFMVMAXATL2H SERIES

CFMVMAXATL2H 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 CFMVMAXATL2H starters are supplied with individual load break/fault make disconnect isolation switches, 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

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
• 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

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 CFMVTX 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
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

**WOUND ROTOR MOTOR STARTERS**
- Solid state starter
- Rotor resistors, shorting contactors and interface
- Applications in aggregate, steel, mining, paper, power generation industries 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

**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

Custom enclosures with transitions

Low profile skid-mount mining packages

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
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 MX\textsuperscript{2} software and integrates easily with either Benshaw Controls (MX\textsuperscript{2} or MX\textsuperscript{3}) or any existing controller. The MX\textsuperscript{2} 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 MX\textsuperscript{2} 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 BENSHW SOLUTION:

With the Benshaw MX³ Solid State Starter, wound rotor control is greatly simplified. The Benshaw 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.

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![Diagram of Wound Rotor Starter System]

**Diagram Elements:**
- **Resistor Bank**
- **Shooting Contactor Section**
- **Soft Starter Section**
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: ____________________________________________
_________________________________________________________________
_________________________________________________________________
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  or  ❌ 3R  or  ❌ 4  or  ❌ Other (specify): _________________________________

**Maximum Available Footprint:**

H __________________ W __________________ D __________________

**For Replacement of Existing:**

**Existing Type (select one):**

- ✔ ATL  or  ❌ RVSS  or  ❌ Other (specify): _________________________________

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

____________________________________________________________________

____________________________________________________________________
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: ____________________________
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.
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.
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

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.

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.
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: MVRS12, MVRS18, MVRSE12, MVRSE18, MVRSM12, MVRSM18

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

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.
EMERGENCY RETROFITS — MX³ UPGRADES

To determine if your starter is applicable, please complete the checklist and contact the Benshaw 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 Benshaw 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

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

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>RTFT-490000-00</td>
<td>LV Retrofit Kit Assembly</td>
</tr>
<tr>
<td>RTFT-490001-00</td>
<td>MV Retrofit Kit Assembly</td>
</tr>
</tbody>
</table>
EMERGENCY RETROFITS — MX³ UPGRADES

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

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Description</th>
<th>Motor FLA</th>
</tr>
</thead>
<tbody>
<tr>
<td>CT-420000-00</td>
<td>288:1 with Plug-in Connector</td>
<td>15–64</td>
</tr>
<tr>
<td>CT-420000-01</td>
<td>864:1 with Plug-in Connector</td>
<td>45–190</td>
</tr>
<tr>
<td>CT-420000-02</td>
<td>2640:1 with Plug-in Connector</td>
<td>135–590</td>
</tr>
<tr>
<td>CT-420000-03</td>
<td>5760:1 with Plug-in Connector</td>
<td>295–1285</td>
</tr>
</tbody>
</table>

Each CT kit includes a set of three CTs.

**MV CT ASSEMBLIES**

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Description</th>
<th>Motor FLA</th>
</tr>
</thead>
<tbody>
<tr>
<td>CT-450001-01</td>
<td>50:5 with MV Sleeving</td>
<td>11–45</td>
</tr>
<tr>
<td>CT-450002-01</td>
<td>150:5 with MV Sleeving</td>
<td>46–135</td>
</tr>
<tr>
<td>CT-450003-01</td>
<td>250:5 with MV Sleeving</td>
<td>136–225</td>
</tr>
<tr>
<td>CT-450009-01</td>
<td>400:5 with MV Sleeving</td>
<td>226–360</td>
</tr>
<tr>
<td>CT-450010-01</td>
<td>600:5 with MV Sleeving</td>
<td>361–540</td>
</tr>
</tbody>
</table>

Each kit includes three CTs.
CTs do not need to be ordered separately.
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
The MVCB series of switchgear features a draw-out circuit breaker design.

### 2300 V

<table>
<thead>
<tr>
<th>Model Number</th>
<th>Description</th>
<th>Volts</th>
<th>CB Frame</th>
<th>Dimensions (in.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MVCB-1200-2300-**</td>
<td>MV CB 1200 A Top Entry/Top Exit</td>
<td>2300</td>
<td>1200</td>
<td>H: 92.5, W: 64, D: 62</td>
</tr>
</tbody>
</table>

** Insert appropriate option code as shown below:
- NEMA 1 = 1
- NEMA 12 = 12
- NEMA 3R = 3R

### 3300 V

<table>
<thead>
<tr>
<th>Model Number</th>
<th>Description</th>
<th>Volts</th>
<th>CB Frame</th>
<th>Dimensions (in.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MVCB-1200-3300-**</td>
<td>MV CB 1200 A Top Entry/Top Exit</td>
<td>3300</td>
<td>1200</td>
<td>H: 92.5, W: 64, D: 62</td>
</tr>
</tbody>
</table>

** Insert appropriate option code as shown below:
- NEMA 1 = 1
- NEMA 12 = 12
- NEMA 3R = 3R

### 4160 V

<table>
<thead>
<tr>
<th>Model Number</th>
<th>Description</th>
<th>Volts</th>
<th>CB Frame</th>
<th>Dimensions (in.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MVCB-1200-4106-**</td>
<td>MV CB 1200 A Top/Bottom Entry/Top Exit</td>
<td>4160</td>
<td>1200</td>
<td>H: 92.5, W: 64, D: 62</td>
</tr>
</tbody>
</table>

** 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

<table>
<thead>
<tr>
<th>Model Number</th>
<th>Description</th>
<th>Volts</th>
<th>CB Frame</th>
</tr>
</thead>
<tbody>
<tr>
<td>MVCB-1200-2300-MC</td>
<td>MV CB 2300 V 1200 A</td>
<td>2300</td>
<td>1200</td>
</tr>
</tbody>
</table>

Dimensions (in.): H 95, W 36, D 91

4160 V

<table>
<thead>
<tr>
<th>Model Number</th>
<th>Description</th>
<th>Volts</th>
<th>CB Frame</th>
</tr>
</thead>
<tbody>
<tr>
<td>MVCB-1200-4160-MC</td>
<td>MV CB 4160 V 1200 A</td>
<td>4160</td>
<td>1200</td>
</tr>
</tbody>
</table>

Dimensions (in.): H 95, W 36, D 91

6600 V

<table>
<thead>
<tr>
<th>Model Number</th>
<th>Description</th>
<th>Volts</th>
<th>CB Frame</th>
</tr>
</thead>
<tbody>
<tr>
<td>MVCB-1200-6600-MC</td>
<td>MV CB 6600 V 1200 A</td>
<td>6600</td>
<td>1200</td>
</tr>
</tbody>
</table>

Dimensions (in.): H 95, W 36, D 91

13800 V

<table>
<thead>
<tr>
<th>Model Number</th>
<th>Description</th>
<th>Volts</th>
<th>CB Frame</th>
</tr>
</thead>
<tbody>
<tr>
<td>MVCB-1200-13800-MC</td>
<td>MV CB 13800 V 1200 A</td>
<td>13800</td>
<td>1200</td>
</tr>
</tbody>
</table>

Dimensions (in.): H 94, W 36, D 94
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

<table>
<thead>
<tr>
<th>Model Number</th>
<th>Description</th>
<th>Volts</th>
<th>CB Frame</th>
<th>Dimensions (in.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MVCB-1200/1200-2300-MC</td>
<td>MV CB 2300 V 1200 A Top/CB 1200 A Bottom</td>
<td>2300</td>
<td>1200/1200</td>
<td>95 72 91</td>
</tr>
</tbody>
</table>

### 4160 V

<table>
<thead>
<tr>
<th>Model Number</th>
<th>Description</th>
<th>Volts</th>
<th>CB Frame</th>
<th>Dimensions (in.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MVCB-1200/1200-4160-MC</td>
<td>MV CB 4160 V 1200 A Top/CB 1200 A Bottom</td>
<td>4160</td>
<td>1200/1200</td>
<td>95 72 91</td>
</tr>
</tbody>
</table>

### 6600 V

<table>
<thead>
<tr>
<th>Model Number</th>
<th>Description</th>
<th>Volts</th>
<th>CB Frame</th>
<th>Dimensions (in.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MVCB-1200/1200-6600-MC</td>
<td>MV CB 6600 V 1200 A Top/CB 1200 A Bottom</td>
<td>6600</td>
<td>1200/1200</td>
<td>95 72 91</td>
</tr>
</tbody>
</table>

### 13800 V

<table>
<thead>
<tr>
<th>Model Number</th>
<th>Description</th>
<th>Volts</th>
<th>CB Frame</th>
<th>Dimensions (in.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MVCB-1200/1200-13800-MC</td>
<td>MV CB 13800 V 1200 A Top/CB 1200 A Bottom</td>
<td>13800</td>
<td>1200/1200</td>
<td>95 72 91</td>
</tr>
</tbody>
</table>
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

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

### CB ACCESSORIES

<table>
<thead>
<tr>
<th>Catalog Number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>B120</td>
<td>Breaker Lift Truck</td>
</tr>
<tr>
<td>B121</td>
<td>Breaker Test Cabinet</td>
</tr>
<tr>
<td>B122</td>
<td>Remote Racking Device</td>
</tr>
</tbody>
</table>

### BUS/LINE OPTIONS

<table>
<thead>
<tr>
<th>Catalog Number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>B130</td>
<td>Mimic Bus</td>
</tr>
<tr>
<td>B131</td>
<td>Insulated Bus Covering — 1200 A Rated</td>
</tr>
<tr>
<td>B132</td>
<td>Insulated Bus Covering — 2000 A Rated</td>
</tr>
<tr>
<td>B133</td>
<td>Ground Balls</td>
</tr>
<tr>
<td>B134</td>
<td>Live Line Indications</td>
</tr>
<tr>
<td>B140</td>
<td>Surge Arrestors, 2300 VAC</td>
</tr>
<tr>
<td>B141</td>
<td>Surge Arrestors, 4160 VAC</td>
</tr>
<tr>
<td>B142</td>
<td>Surge Arrestors, 6900 VAC</td>
</tr>
<tr>
<td>B143</td>
<td>Surge Arrestors, 12000 VAC</td>
</tr>
</tbody>
</table>
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

<table>
<thead>
<tr>
<th>Catalog Number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>B200</td>
<td>Multilin 850 — Feeder Protection</td>
</tr>
<tr>
<td>B201</td>
<td>Multilin PQM — Power Quality Monitoring</td>
</tr>
<tr>
<td>B202</td>
<td>Multilin 845 – Transformer Feeder Protection</td>
</tr>
<tr>
<td>B203</td>
<td>Multilin 369 — Motor Protection</td>
</tr>
<tr>
<td>B204</td>
<td>Multilin 869 — Advanced Motor Protection</td>
</tr>
<tr>
<td>B205</td>
<td>Schweitzer SEL-751 — Feeder Protection</td>
</tr>
<tr>
<td>B206</td>
<td>Schweitzer SEL-735 — Power Quality Monitoring</td>
</tr>
<tr>
<td>B207</td>
<td>Schweitzer SEL-787 — Transformer Feeder Protection</td>
</tr>
<tr>
<td>B208</td>
<td>Schweitzer SEL-849 — Motor Protection</td>
</tr>
<tr>
<td>B209</td>
<td>Schweitzer SEL-710 - Advanced Motor Protection</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Catalog Number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>B300</td>
<td>Thermal Viewing Windows</td>
</tr>
<tr>
<td>B301</td>
<td>Ultrasonic Ports</td>
</tr>
<tr>
<td>B302</td>
<td>Arc Flash Sensing – Multilin*</td>
</tr>
<tr>
<td>B303</td>
<td>Arc Flash Sensing — Schweitzer*</td>
</tr>
<tr>
<td>B305</td>
<td>Remote Breaker Control Panel</td>
</tr>
</tbody>
</table>

*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.
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 Benshaw, 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

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

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

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
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

Clear, easy to read, programmable screen

Start, stop, reset, local/remote push buttons

Shortcut buttons for quick access to common tasks

Multilingual controller with a choice of eight languages

Status LEDs for immediate feedback

Intuitive interface and menu structure for easy setup, with multi-level password protection

IP54 keypad mounted on cabinet exterior
## M - SERIES MVE

**RELY ON MVE**

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

### PROTECTION FUNCTIONALITY

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

*RTD Relay is optional.
## M - SERIES CONFIGURATIONS AND DIMENSIONS

### M-MVE-XXXX-V02~06

- **Model**: M-MVE-XXXX-V02~06
- **Height (A)**: 2320 [2350] mm
- **Width (B)**: 800 mm
- **Depth (C)**: 1200 mm

### M-MVE-XXXX-V11

- **Model**: M-MVE-XXXX-V11
- **Height (A)**: 2200 [2233] mm
- **Width (B)**: 1150 mm
- **Depth (C)**: 1400 mm

### 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
- **C**: Inrush current limiter
- **Capacitors**

### DIMENSIONS
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

- Available in both stand-alone and line-up configuration
- IEC type tested
- Safe operation with separate galvanically isolated low voltage section via IBT technology
- Robust hinges and handles for convenient and safe closure
- Built-in locking on all compartment doors as standard
- A range of switching options (vacuum contactor or vacuum circuit breaker)

- 2200 mm height for easier transportation
- Disconnecting switch viewing window for safer de-energizing (back of enclosure)
- Maintenance friendly design
- Top or bottom cable input and control wiring
- Front panel access with optional rear panel access available
- Corrosion resistant hot-dip galvanized steel sheets
- Optional internal power factor correction including capacitor, vacuum contactor, fuses and inrush current limiter
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.

<table>
<thead>
<tr>
<th>Height (mm)</th>
<th>Width (mm)</th>
<th>Depth (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>L-MVE-XXXXX-V02</td>
<td>E1/E2: 1150</td>
<td>E3: 1400</td>
</tr>
<tr>
<td>L-MVE-XXXXX-V03</td>
<td>E1/E2: 1400</td>
<td>E3: 1400</td>
</tr>
<tr>
<td>L-MVE-XXXXX-V04</td>
<td>E1/E2: 1400</td>
<td>E3: 1600</td>
</tr>
<tr>
<td>L-MVE-XXXXX-V06</td>
<td>E1/E2: 1400</td>
<td>E3: 1600</td>
</tr>
<tr>
<td>L-MVE-XXXXX-V11</td>
<td>E1/E2: 1400</td>
<td>E3: 1600</td>
</tr>
<tr>
<td>L-MVE-XXXXX-V13</td>
<td>E1/E2: 1400</td>
<td>E3: 1800</td>
</tr>
<tr>
<td>L-MVE-XXXXX-V02</td>
<td>E3: 1200</td>
<td>E3: 1400</td>
</tr>
<tr>
<td>L-MVE-XXXXX-V03</td>
<td>E3: 1400</td>
<td>E3: 1600</td>
</tr>
<tr>
<td>L-MVE-XXXXX-V04</td>
<td>E3: 1200</td>
<td>E3: 1400</td>
</tr>
<tr>
<td>L-MVE-XXXXX-V06</td>
<td>E3: 1400</td>
<td>E3: 1600</td>
</tr>
<tr>
<td>L-MVE-XXXXX-V11</td>
<td>E3: 1600</td>
<td>E3: 1600</td>
</tr>
<tr>
<td>L-MVE-XXXXX-V13</td>
<td>E3: 1600</td>
<td>E3: 1800</td>
</tr>
<tr>
<td>L-MVE-XXXXX-V02</td>
<td>2200</td>
<td>E3: 1600</td>
</tr>
<tr>
<td>L-MVE-XXXXX-V03</td>
<td>1000</td>
<td>E3: 1600</td>
</tr>
<tr>
<td>L-MVE-XXXXX-V04</td>
<td>1200</td>
<td>E3: 1600</td>
</tr>
<tr>
<td>L-MVE-XXXXX-V06</td>
<td>1400</td>
<td>E3: 1600</td>
</tr>
<tr>
<td>L-MVE-XXXXX-V11</td>
<td>1600</td>
<td>E3: 1800</td>
</tr>
<tr>
<td>L-MVE-XXXXX-V13</td>
<td>1800</td>
<td>E3: 1800</td>
</tr>
</tbody>
</table>
**L - SERIES MVE CONFIGURATIONS**

**E0**
Soft starter only

**E1**
SST + VC + Fuse

**E2**
SST + VC

**E3**
SST + VCB

**LEGEND**

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

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

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

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

### 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
L - 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

Clear, easy to read, programmable screen

Start, stop, reset, local/remote push buttons

Shortcut buttons for quick access to common tasks

Multilingual controller with a choice of eight languages

Status LEDs for immediate feedback

Intuitive interface and menu structure for easy setup, with multi-level password protection

IP54 keypad mounted on cabinet exterior
## L - SERIES MVE

RELY ON MVE

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

## PROTECTION FUNCTIONALITY

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

*RTD Relay is optional.
M2L MEDIUM VOLTAGE DRIVE

TECHNICAL DATA

Transformer/Rectifier

- 3-Phase Primary Windings
- 3-Phase Bridge Rectifiers
- AC Mains
- Secondary Windings

Inverter

- Main Contactor
- Pre-charge Contactor
- C1
- C2
- M

INPUT LINE SPECIFICATION

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

MOTOR-SIDE SPECIFICATION

- Output Voltage
  - 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 Frequency
  - 0–90 Hz
- Output Power
  - 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

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

SUPERIOR MOTOR-FRIENDLY OUTPUT WAVEFORM QUALITY

- 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 Benshaw Connect. Benshaw 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

<table>
<thead>
<tr>
<th>Power Loss and Heat Load</th>
<th>POWER LOSS (kW)</th>
<th>HEAT LOAD (BTU/HR)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transformer</td>
<td>80</td>
<td>275,000</td>
</tr>
<tr>
<td>Rectifier</td>
<td>10</td>
<td>34,000</td>
</tr>
<tr>
<td>Inverter</td>
<td>25</td>
<td>85,000</td>
</tr>
<tr>
<td>Drive</td>
<td>115</td>
<td>394,000</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>INDOOR TRANSFORMER, RECTIFIER &amp; INVERTER</th>
<th>OUTDOOR TRANSFORMER, INDOOR RECTIFIER &amp; INVERTER</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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.
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.

One-Line Diagram with Parallel Drive and Outdoor Transformer

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.

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. Benshaw provides standard solutions for isolation drive systems utilizing load-break disconnect switches and contactors. The Benshaw drive solutions are designed to seamlessly integrate into existing Benshaw 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

<table>
<thead>
<tr>
<th>Model Number</th>
<th>Voltage</th>
<th>Approximate maximum HP (kW)</th>
<th>FLA</th>
<th>Dimensions (in.)</th>
<th>Disconnect Rating</th>
<th>Disconnect Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>CFMVM2LDISC-160A-2300-12</td>
<td>2300</td>
<td>700 (500)</td>
<td>160 and below</td>
<td>92.5</td>
<td>24</td>
<td>36</td>
</tr>
<tr>
<td>CFMVM2LDISC-160A-4160-12</td>
<td>4160</td>
<td>1300 (950)</td>
<td>160 and below</td>
<td>92.5</td>
<td>24</td>
<td>36</td>
</tr>
</tbody>
</table>

*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 Benshaw for additional entry/exit options.

*Consult factory for larger sizes or alternate enclosure ratings.
MEDIUM VOLTAGE DRIVE FEEDER

DRIVE FEEDER NON-BYPASSED

CUSTOMER SUPPLIED POWER

DISCONNECT

SHUNT CONTACTOR

LANDING PAD

OUTPUT TO VFD
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

<table>
<thead>
<tr>
<th>Model Number</th>
<th>Voltage</th>
<th>Approximate maximum HP (kW)</th>
<th>FLA</th>
<th>Dimensions (in.)</th>
<th>Disconnect Rating</th>
<th>Disconnect Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>CFMVM2LBYP-160A-2300-12</td>
<td>2300</td>
<td>700 (500)</td>
<td>160 and below</td>
<td>92.5</td>
<td>60</td>
<td>36</td>
</tr>
<tr>
<td>CFMVM2LBYP-160A-4160-12</td>
<td>4160</td>
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<td>160 and below</td>
<td>92.5</td>
<td>60</td>
<td>36</td>
</tr>
</tbody>
</table>

*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 Benshaw for additional entry/exit options.

*Consult factory for larger sizes or alternate enclosure ratings.
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

<table>
<thead>
<tr>
<th>Model Number</th>
<th>Voltage</th>
<th>Approximate maximum HP (kW)</th>
<th>FLA</th>
<th>Dimensions (in.)</th>
<th>Disconnect Rating</th>
<th>Disconnect Type</th>
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MEDIUM VOLTAGE DRIVE FEEDER

DRIVE FEEDER WITH FULLY ISOLATED ATL BYPASS
Benshaw is dedicated to providing comprehensive 24-hour-a-day, 7-day-a-week phone support. Benshaw provides repair, spare parts, field engineering, retrofit and training services, when and where you need us. You can count on our experienced team, backed by the latest diagnostics and repair tools and an extensive part inventory to support your operations.

Call 1.800.203.2416

24/7 Hotline Support from our operations in Pittsburgh and Listowel (Canada):
• Technical phone support
• Overnight parts shipment
• 24-hour service dispatch
• Coordination of all service capabilities

Repairs are made on Benshaw equipment by trained, experienced personnel, using the latest diagnostic and test equipment.

Field Services are performed on-site by skilled technicians, engineers or complete team if needed, including:
• Start-up commissioning
• Field repairs
• Field analysis/data collection
• Preventative maintenance
• Retrofits

The Benshaw Product Line
A wide range of motor controls and drives is available.
• Solid-state starters fractional up to 30,000HP at 15kV
• LV AC drives to 2,000HP, MV AC drives to 10,000HP
• Electromechanical controls to 800A

Benshaw express is a 24/7 online inventory and order entry system for authorized Benshaw distributors:
• 24/7 shipment
• Air or truck delivery

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Pittsburgh, PA 15238
Phone: 412.968.0100

BENSHAW Canada
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Listowel, Ontario N4W 3W3
Phone: 519.291.5112
Fax: 519.291.2595

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