Benshaw EMX4i Soft Starters

The **Benshaw EMX4i** series of low-voltage soft starters is a flagship line of solid-state motor controllers designed for smooth **motor starting**, stopping, and protection in industrial applications. These advanced soft starters allow three-phase induction motors to ramp up gradually, dramatically reducing the inrush current and mechanical shock associated with direct-on-line starts. By limiting start-up current (often 6–7× motor full-load current) to much lower levels, a soft starter like the EMX4i minimizes voltage dips and stress on electrical systems. For example, a case study showed that using a soft starter on large compressors reduced inrush currents by about **60%** without sacrificing start time [1], resulting in less wear on both the motor and the driven equipment. The EMX4i series combines this kind of performance benefit with a comprehensive feature set including built-in bypass contactors, configurable control interfaces, and robust motor protection functions.

Figure: The Benshaw EMX4i soft starter (front view) features a built-in multi-language graphical display and keypad for configuration and monitoring. These compact devices support motor currents up to 1,200 A (≈900 HP at 460 V) in a single unit. The EMX4i's modular design with pluggable terminals and optional expansion cards simplifies installation and integration into control systems.

Benshaw's EMX4i is a **full-featured soft starter** with standard and heavy-duty ratings up to 1200 A, yet it comes in **one of the smallest footprints on the market** [2]. This compact size makes it easier to retrofit into existing panels or motor control centers. Importantly, the EMX4i doesn't skimp on capabilities despite its size – an **integral bypass** contactor is built in on most models, meaning once the motor reaches full speed the starter bypasses the power electronics to reduce heat and save energy [2]. Full motor protection is also standard, so there is often no need for external overload relays. Benshaw has engineered an intuitive user experience as well: the **on-board graphical display** (with multiple language support) and **quick setup**

menus allow fast commissioning and simplify access to performance data [3] [4]. For instance, users can navigate through parameter menus and diagnostics via the front keypad/HMI, or use the **built-in USB port** to upload/download configurations and retrieve logged data without special cables [3] [5]. Overall, the EMX4i soft starter is designed to make life easier for engineers and operators by providing advanced functionality in a user-friendly, **"smart" soft starter** package [2].

Key Features and Benefits

The Benshaw EMX4i delivers a wide range of features that enhance motor control, protection, and ease of use. Some of the key features and their benefits include:

- **Advanced starting & stopping control:** Supports multiple ramp profiles such as **constant current start**, **current ramp start**, and **Adaptive Acceleration Control** for customized acceleration and deceleration profiles [6] [7]. This adaptive control feature can self-tune to the motor and load, allowing gentle starts and stops tailored to the application (for example, a pump can be soft-stopped to prevent water hammer surges). The EMX4i also offers a **kickstart** option for extra torque on tough loads and can perform **soft stopping** via timed voltage ramp or adaptive deceleration to smoothly bring high-inertia machines to rest [8] [9]. For stopping heavy loads quickly, an integrated **DC injection brake** function is available, and even an optional **soft brake** feature can be configured using an external contactor to rapidly halt motors by controlled reverse torque application [10]. These capabilities ensure minimal mechanical stress on belts, gears, and driven equipment during both start and stop cycles.

- **Dual motor set profiles:** The EMX4i can store **two separate motor parameter sets**, allowing one soft starter to be used for different motors or distinct operating conditions [11]. Operators can switch between Motor Set A and B (via a digital input or command) to accommodate, for example, two motors of different sizes or a single motor operating under two modes. This adds flexibility in systems where one standby motor might be rotated in, or where seasonal load differences require adjusted starting settings.

- **Jog operation (slow speed control):** For maintenance and positioning tasks, the EMX4i provides a **slow-speed jog** function in **forward or reverse** direction [12] [13]. This feature lets users inch the motor at a reduced voltage (typically ~10–15% of full speed) to align machine components or perform test rotations. Reverse jog is implemented via coordinated control of an external reversing contactor, and the EMX4i includes built-in logic to control a forward/reverse contactor pair if needed [14] [15]. Soft jog capability is valuable in applications like conveyor belt maintenance or pump and fan cleaning cycles.

- **Integrated bypass and minimal heat dissipation:** Most EMX4i models include an **internal bypass contactor**, which automatically closes after the motor is up to speed [2]. The built-in bypass drastically reduces the heat generated during run at full voltage, since the SCRs (thyristors) are no longer carrying load current. During the initial ramp, the EMX4i's SCR power devices handle the starting current (rated up to 350% of motor FLA for 30 seconds in standard duty, or 450% for 30 seconds in heavy-duty mode [16]). After transition to bypass, the **heat dissipation** drops to a low level (e.g. only tens of watts), improving efficiency. For the largest EMX4i frame sizes (above roughly 500 A), an external bypass contactor is used instead (the starter provides dedicated bypass control

outputs in those cases) [17] [18]. Either way, the EMX4i's bypass design means a more compact installation and reduced cooling requirements compared to non-bypassed soft starters.

- **Comprehensive motor and system protection:** The EMX4i acts as a full motor protection relay, with an extensive list of built-in **protective functions**. It models the motor's thermal capacity to provide **electronic overload protection** (class 10, 20, or user-defined trip curves) and includes a direct input for a motor **PTC thermistor** for temperature sensing [19] [20]. The starter will trip on **excess start time** if the motor fails to reach speed in a set time, preventing overheating in stalled conditions. It also monitors for **current imbalance** between phases, **phase loss**, and incorrect **phase sequence** wiring [20] [21]. Supply conditions are watched with **undervoltage** and **overvoltage** trips, as well as **underpower** or **dry-run** protection (to detect loss of load on pumps) and **overpower** warnings for overload conditions [22]. The EMX4i's ground-fault protection can detect leakage or phase-to-ground faults (this may require an add-on module on low-voltage units, which integrates a sensitive ground fault CT). If enabled, a ground fault trip can shut down the starter quickly to minimize damage. All protection events activate corresponding **alarm outputs/LEDs** and are recorded in the event log for review. This comprehensive protection suite helps **safeguard the motor and the soft starter** itself from damage, often eliminating the need for separate motor protection relays [23].

- **"PowerThrough" fault-tolerant mode:** For critical must-run applications, the EMX4i offers a unique **PowerThrough** feature that can keep the motor running even if one of the starter's SCR pairs fails shorted [24] [25]. In the event of an SCR failure on one phase, the EMX4i will automatically switch to a **two-phase control** algorithm to continue soft starting and running the motor on the remaining healthy phases [24]. This allows production to continue (at reduced performance) until maintenance can be scheduled. While in PowerThrough mode, the unit flashes a warning ("2 Phase - Damaged SCR") on the display to alert technicians [26] [27]. PowerThrough is available in in-line installations and is intended to **minimize downtime on-site** by providing a limp-through operation instead of an immediate total failure. Operators should still replace the faulty unit as soon as possible, but this feature adds a layer of fault tolerance not found in standard soft starters.

- **Emergency Run (Fire Mode):** In emergency scenarios where continued operation is paramount (such as fire pump or smoke extraction fan applications), the EMX4i can be put into **Emergency Run mode** via a digital input command [28] [29]. Emergency mode will **override all trip conditions and warnings**, allowing the motor to run to destruction if necessary in order to perform its emergency duty [30] [31]. This "Fire Mode" is often required by building codes for life-safety systems. The EMX4i's implementation ensures the starter ignores overloads, overtime, or other faults and keeps the motor running until a stop command is given or the motor can no longer run. (Using Emergency mode will bypass protections and thus is not intended for normal operation – prolonged use can compromise the starter or motor, and it voids the warranty [32]. However, in emergencies, this feature can be life-saving.)

- **Automatic restart and recovery features:** The starter can be programmed for auto-reset or auto-restart after certain trip conditions, which is useful for unmanned or remote installations. An internal **real-time clock with schedulers** allows the EMX4i to perform **scheduled starts/stops** or other control functions at preset times of day or week [33]. This built-in scheduler means simple applications can be automated without an external PLC – for example, a pump could be set to start and stop at specific daily intervals. The clock is also used to timestamp events in the log. Additionally,

a **simulation mode** is available to test control logic and sequencing without energizing the main power circuit [34]. In simulation mode, the starter will run through a virtual start/stop cycle using a low-power test or purely via internal simulation, verifying that the control wiring and configurations are correct before you apply full power. This helps in safely commissioning systems and training operators.

- **User-friendly interface and data logging:** A **multi-language graphical LCD** display is built into every EMX4i, providing clear readouts of status, metered values (e.g. line voltage, current, power factor), and configuration menus [23]. The display and **navigation keypad** allow local control and troubleshooting; status LED indicators (Ready, Run, Trip, Local) give at-a-glance insight into the starter's state【22†】. The EMX4i keeps extensive **historical logs**: it records cumulative run hours, number of starts, and the *last 384 events* with time/date stamps [35] [36]. When a fault occurs, the starter captures key parameters (current, voltage, etc.) at the moment of trip for later analysis [35]. This detailed event logging aids in diagnosing problems and optimizing performance. For configuration management, users can save or clone settings via the USB port – profiles can be exported to a USB flash drive at the front port, then reloaded into other starters or kept as backups [37] [38]. This makes it convenient to commission multiple units with identical settings or recover configurations after service.

- **Communications and expandability:** The EMX4i is **automation-ready**. Optional communication cards enable seamless integration with plant control networks – protocols supported include **Modbus RTU**, **Modbus TCP/IP**, **Profibus-DP**, **PROFINET**, **DeviceNet**, and **EtherNet/IP** [39] [40]. By installing one of these plug-in interface cards, the soft starter can be monitored and controlled from a PLC or SCADA system just like a smart VFD or overload relay. The network connectivity allows reading status, changing start/stop commands, adjusting settings, and receiving diagnostic alarms remotely. All accessory cards are **hot-swappable** and designed to fit into the starter without increasing its physical footprint [41] [42]. In addition to network comms, the EMX4i supports **expansion I/O** modules and specialized "**Smart Cards**." For example, a **Pumping Smart Card** can be added to provide industry-specific functions for pump control (like anti-jam routines, pump clean cycles, level control logic, etc.) [43] [44]. With a smart card installed, the EMX4i can act as a dedicated controller for a pump system, handling not just motor starting but also application logic – this can eliminate separate pump controllers or PLC programming in some cases. A **remote keypad/display** is another accessory, allowing the EMX4i's HMI to be door-mounted or located up to several meters away (useful when the starter is mounted inside a cabinet) [45]. All these options make the EMX4i highly adaptable to different integration requirements.

- **Rugged design and certifications:** The EMX4i soft starters are built for harsh industrial environments. They use heavy-duty SCRs with high voltage ratings (at least 1600 V PIV) to tolerate power transients [46]. The control boards are conformally coated for protection against dust, moisture, and corrosion [47] [48]. The devices carry global certifications: **CE** and **UKCA** marking for EU directives, **cULus** listing (UL 60947-4-2 for motor controllers) for North America, and compliance with IEC 60947-4-2 (Low-Voltage Soft Starters standard) [49]. They are designed for **Type 2 coordination** with semiconductor fuses – meaning if a short-circuit occurs and proper fuses are in place, the starter will not be damaged (no extensive repair needed) [50]. The EMX4i also holds **marine approvals** from Lloyd's Register and ABS, qualifying it for use on board ships and offshore platforms [51]. Environmental ratings include operation from **-10 °C to +60 °C** ambient (with derating above 40 °C) and up to 1000 m altitude (higher with derating) [52]. Smaller units (up to ~135 A) have **IP20**

finger-safe enclosures, while larger frame sizes are open **IP00** style (often installed in IP54 or NEMA 12 cabinets with optional terminal covers available for touch safety) [53]. These design features ensure the EMX4i can **withstand demanding conditions** and deliver reliable performance over a long service life. Benshaw backs the quality with an **extended warranty (3 years)** on EMX4i units [54].

Technical Specifications

Below is a summary of the technical specifications for Benshaw EMX4i soft starters (low-voltage series):

- **Motor rating range:** 23 A to 1,220 A (nominal continuous current) across the EMX4i lineup, supporting approximately **5 HP up to 900–1000 HP** low-voltage motors (depending on voltage and duty) [2]. Models are available for standard duty and heavy duty applications – for example, a frame rated 515 A can handle ~400 HP @ 460 V in standard duty or 300 HP @ 460 V in heavy-duty use [55]. All sizes use three-phase fully controlled SCR bridges for smooth voltage control on each phase.

- **Line voltage:** Two voltage ranges are offered. **V5 models** cover **200–525 VAC** systems (suitable for 208 V, 240 V, 480 V etc.) and **V7 models** cover **380–690 VAC** for use on 400 V, 575 V or 600 V networks [56]. This spans the typical global low-voltage supply standards. The frequency range is 45–66 Hz (works with 50 Hz or 60 Hz systems automatically) [57].

- **Control power:** Available with different control supply options. A **C1 suffix** denotes units that accept **110–120 VAC or 220–240 VAC** control power (dual tapping), while **C2 suffix** units use **24 VAC/VDC** low-voltage control power input [58]. For example, an EMX4i-...-C1 model might be powered from a plant 120 VAC control source, whereas a -C2 model can be powered by 24 V from a DC supply or transformer. Control power draws are typically around 600 mA for AC inputs or up to 2.8 A for 24 V supply [58].

- **Overload capacity: 350% of FLA for 30 seconds** (standard duty rating) or **450% for 30 seconds** (heavy duty) is supported to start high-inertia loads [16]. The EMX4i's programmable motor thermal model can be set to trip at 105% of motor full-load current (class 10) by default [19], or adjusted to other tripping classes as needed. It can also deliver up to 500%+ current for shorter durations (e.g. 5–10 seconds) for very heavy starts, within the device's safe operating area. The maximum starts-per-hour and cool-down times depend on the load and model, and Benshaw provides guidelines to ensure the SCRs and bypass do not overheat.

- **Built-in bypass:** All **EMX4i up to 580 A** include an internal bypass contactor that closes after ramp-up [59]. Larger sizes (approximately 735 A and above, designated with a "C" in the model code) require an **external bypass** – these models have terminals to drive an external bypass contactor or breaker and are designed for continuous SCR conduction if no bypass is used [60] [18]. When internally bypassed, the starter's power loss is about **1.5–5 watts per amp** during ramp and only tens of watts when running, whereas non-bypassed operation dissipates roughly **4.5 W per amp** continuously as heat through the SCRs [61] [59]. The internal bypass is rated for **100,000 operations** mechanical life, ensuring longevity for frequent start/stop cycles [17] [59].

- **Control I/O:** The EMX4i provides an array of control inputs and outputs. Standard terminals typically include **2 fixed inputs** (for Start and Stop or 2-wire control) plus **2 programmable digital inputs** that can be assigned to functions like Reset, Motor Set select, Emergency Run, etc. [62] . There are **3 programmable relay outputs**: usually one dedicated Form C relay for run/fault indication, and two additional (Form A and Form C) relays that can be assigned to events (like at full speed, trip conditions, alarm warning) [63] [64] . Each relay is rated ~5–10 A at 250 VAC for switching duty [65] . An **analog output** (4–20 mA or 0–20 mA) is included for telemetry of motor current, power, or other parameters to external meters or PLC analog inputs [66] . The front USB port (Type B or mini) allows PC connection for configuration via Benshaw/AuCom software and supports data logging to USB sticks as described. Optionally, expansion analog and digital I/O modules can be added via the smart card slot for more complex installations.

- **Monitoring and interface:** The local HMI is a **4-line, 16-character backlit LCD** along with 4 navigation buttons [67] . It supports English, Spanish, Chinese, French, German, Portuguese, Russian, Italian and other languages for text prompts [68] [69] . Status LEDs on the keypad show Ready, Running, Tripped, and Local/Remote mode. The unit's menu structure organizes parameters into easy groups (quick setup, motor data, start/stop settings, protection, communications, etc.), and a copy function lets one quickly clone settings from unit to unit using the USB. For remote visualization, the display data can also be read over communications or duplicated on the optional remote keypad.

- **Environmental ratings:** Operating ambient temperature is **-10 °C to +60 °C**; above +40 °C the output current must be derated or an enclosure fan used to dissipate heat [52] . Storage temperature range is -25 °C to +60 °C. The permissible altitude is **up to 1000 m** without derating; above 1000 m, cooling is reduced so a derate of roughly 1% per 100 m applies (up to a maximum of 2000 m altitude) [70] . The design is rated **Pollution Degree 3** (suitable for industrial environments with non-conductive pollution) [71] . Vibration and shock resistance meet IEC 60068 standards for industrial equipment. The control electronics are protected against surges and voltage transients as per IEC 60947-4-2. Noise immunity and emissions meet EMC Category **Class B** requirements [72] , meaning the EMX4i's emissions are low enough for use in residential/light industrial environments as well (Class B is more stringent than Class A).

- **Standards and certifications:** Complies with **IEC 60947-4-2** (Low-voltage semiconductor motor controllers/starters) and is **UL listed** and **cUL certified** per UL 60947-4-2 / CSA C22.2 No. 60947-4-2 (these standards supersede older UL508 for this type of device) [49] . CE compliance covers the Low Voltage Directive and EMC Directive (immunity and emission per IEC standards). The product line is also certified for use in marine applications by **Lloyd's Register** (LR) and **American Bureau of Shipping** (ABS), indicating robust design for shipboard vibration and environmental conditions [51] . Additionally, the EMX4i is **RoHS compliant** (restriction of hazardous substances) and manufactured under ISO 9001 quality management. Short-circuit rating: when protected by recommended semiconductor fuses, the assembly achieves **Type 2 coordination** up to a specific prospective fault level (often 5 kA or more for low-voltage models) [50] – meaning the starter can sustain a short-circuit event without damage, needing only fuse replacement afterward. Detailed coordination tables are provided in the user manual for various supply voltages and fuse types.

Applications and Use Cases

Soft starters like the Benshaw EMX4i are used anywhere a controlled motor start or stop is beneficial. Common **applications** include pumps, fans, compressors, conveyors, crushers, mixers, and HVAC systems, among many others. In these applications, the EMX4i's ability to reduce starting current and smoothly ramp torque offers several practical benefits:

- **Reduced electrical stress:** By cutting peak start current by 50–60% or more in many cases, the EMX4i helps avoid nuisance trips of upstream breakers and limits voltage sag on the supply. This is crucial in facilities with limited power capacity or weak grids. For instance, high-power air compressor motors can draw 6–7 times their rated current across the line, but with a soft starter, the peak may be only ~3× FLA. The resulting reduction in **voltage drop** keeps other equipment on the line from seeing dimming or faults. As noted earlier, one case saw ~60% lower starting amps on HVAC compressors using soft starters [1]. Utilities sometimes require soft starters to mitigate large motor starts, and using EMX4i can help meet those requirements and possibly reduce demand charges.

- **Mechanical relief and longer lifespan:** The controlled acceleration provided by EMX4i significantly **reduces mechanical shock** to drive trains and machinery. Pumps ramp up without the pressure spikes that hammer pipes and valves; belts on conveyors or fans are less likely to slip or snap; gearbox torque surges are smoothed out. This translates to fewer breakdowns and longer life for motors, couplings, gears, and bearings. Even stopping can be gentle – **soft stopping** prevents the sudden flow reversal or hammering in fluid systems. A pump stopped with an EMX4i's decel ramp avoids the **water hammer** effect (a rapid pressure spike) that would otherwise occur with an abrupt stop, thereby protecting pipelines and fittings. Similarly, gradually decelerating a high-inertia fan or centrifuge can prevent strain on the system and avoid product spillage or safety hazards caused by abrupt halts. In sum, processes experience less downtime and maintenance expense due to the soft starter's mitigating impact on mechanical stress.

- **Process control and specialty functions:** The EMX4i's advanced features enable creative solutions to application-specific problems. The **Pump Clean** function, for example, can momentarily run a pump in reverse at low speed to **flush out debris** from an impeller before normal forward start [73] [74]. This is highly useful in wastewater and slurry pumping where clogs are common – the soft starter essentially provides a built-in anti-jam routine. The **DC braking** and **soft braking** capabilities allow quicker stopping of saws, mills, or flywheel-driven machines where coasting is undesirable, without needing a full variable-frequency drive. In conveying systems, the EMX4i can be configured to **slow-jog** a belt for inspection or positioning of products, and its schedulers can automate routine operations (e.g., starting a ventilation fan at 8:00 AM every day). With network communications, these starters easily integrate into plant-wide control schemes – operators can remotely start/stop motors, adjust ramp settings for different product runs, or receive alerts if a motor is overheating or drawing unusual current. The **dual motor set** capability is useful in scenarios like backup pump systems (lead/lag pump configurations) or where a single soft starter is switched between two motors via a transfer switch – the EMX4i can adapt to each motor's parameters at the flick of a digital input.

- **Critical infrastructure and safety systems:** Thanks to features like Emergency Run mode and high reliability, EMX4i soft starters are well-suited for critical applications such as fire pumps, emergency

generators (where allowed by code), or marine and offshore machinery. In a fire pump application, the EMX4i could be signaled to emergency mode upon fire alarm, ensuring the pump keeps running no matter what – overriding thermal trips that might otherwise stop it after prolonged operation. The **PowerThrough** feature similarly offers peace of mind in facilities where an unexpected failure of a motor starter cannot be allowed to interrupt operations (for example, in a mine dewatering pump or an air circulation fan in a tunnel). Even if a power device inside the soft starter fails, the motor can still be brought online to avert flooding or maintain ventilation until a scheduled repair. This level of fault tolerance and intelligent control is a key differentiator for the EMX4i in high-stakes uses. Additionally, marine-certified starters like EMX4i are employed on ships for ballast pumps, bow thrusters, and winches – the soft start prevents generators on board from seeing large transient loads and avoids lights flickering when heavy motors start up.

Real-world example: A water treatment plant modernized its pump station by replacing across-the-line starters with Benshaw EMX4i soft starters. Before, the pumps' abrupt starts were causing pressure surges (water hammer) that led to frequent pipe leaks and valve damage, and the high inrush currents sometimes tripped the supply feeder. After the retrofit, the pumps now ramp up over several seconds and soft-stop, completely eliminating water hammer incidents. The inrush current is limited to about 300% of FLA (down from nearly 600%), keeping the supply stable. The maintenance manager reported a noticeable drop in mechanical issues and estimated a **50% reduction in maintenance costs** on the pumping system over the first year. Furthermore, the built-in pump clean function allowed operators to dislodge clogging materials by jogging the pumps in reverse periodically, improving reliability of the system during heavy storm events. This example illustrates how the EMX4i can **solve operational problems and extend equipment life** in demanding settings.

Conclusion

The Benshaw EMX4i soft starter stands out as a **comprehensive motor starting solution** that combines advanced control algorithms, extensive protective features, and user-oriented design. It brings many of the benefits of sophisticated motor drives (like smooth acceleration, customizable control, and communication ability) in a cost-effective package for fixed-speed motors. By using an EMX4i, industries can **protect their motors and mechanical equipment, reduce downtime, and optimize energy use** during starting. At the same time, the intuitive interface, flexible connectivity, and smart add-ons (such as application-specific smart cards and scheduling functions) make it straightforward to implement and maintain. In summary, the EMX4i series delivers **intelligent, reliable soft start performance** that helps customers **solve motor starting challenges** — from preventing electrical infrastructure stress to prolonging the life of critical machinery — all backed by Benshaw's robust design and support. This makes the EMX4i a compelling choice for any operation seeking to upgrade to modern soft start technology and improve the overall efficiency and safety of their motor control systems.

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