Overview

The 2400 is an all-digital pulse-width-modulated (PWM) inverter that provides superior control of three-phase AC motors. Its revolutionary technology and modular design make it the optimum solution where superior performance, flexibility, and ease of operation are important.

Motor-Independent Design
A unique design incorporating a proprietary digital current regulator and a state-of-the-art controller allows the 2400 to operate any AC induction, AC synchronous, or brushless DC motor without the current-loop setup required by conventional drives. Digital space vector control can be selected for reduced motor noise and low current ripple.

Application Flexibility
The 2400 is extremely flexible and can accommodate a wide range of servo applications. It can be configured to control torque, velocity, or position in applications requiring either constant-, variable-, or extended-torque. Extensive controller options enable the analog and digital I/O, feedback, and serial communication capabilities of the drive to be tailored to the requirements of the application.

Auto Tuning
Once routine electrical connections have been made, simple-to-use auto-tuning features adjust virtually all motor and inertial parameters to the given motor and connected load. Simply enter a few values from the motor nameplate, and the advanced setup routines do the rest. The drive is completely tuned within minutes.

Modular Design
The modular bus design of the 2000 family provides space, cost, and energy savings in many applications. A 2400 drive system incorporates a separate 2490 converter unit that rectifies incoming AC power to provide a common DC bus. The converter is comprised of a full-wave diode or SCR bridge, a link choke, a bus-charging circuit, a dynamic braking circuit, and a capacitor bank. The 2400 consists of a six-IGBT, four-quadrant PWM amplifier that operates from the DC bus of the converter unit. Higher-power inverters are comprised of three separate poles. Two drive sections can be operated in tandem for applications requiring more than 1000 hp CT.

Energy Savings
Multiple inverter units can be operated from a single converter unit. This allows applications that naturally share regenerative energy, such as an uncoiler and recoiler, to reuse the energy, rather than dissipate it as heat through resistors. A much smaller converter is therefore needed than would be required using two integrated drives. Alternatively, an inverter can be used in place of the converter to regenerate power to the line. In cyclic applications, an optional capacitor bank can be used to store regenerated energy and to return stored energy to the load.
Overview

Power Quality
The 2490 converter unit incorporates a link choke that provides near-unity overall power factor and low harmonic line currents at all motor speeds. High-power units also offer a six-phase (twelve-pulse) configuration for further minimizing line harmonics in critical applications. When a regenerative inverter is used in place of the converter, a unity power factor is achieved and virtually all harmonic currents are eliminated.

Application-Specific Software
Application software determines the specific features and operation of the 2400. A wide variety of general-purpose and application-engineered software options enables each drive to be tailored to specific customer requirements. Software is available for such applications as test stands, elevators, press feeders, winders, rotary cutoffs, spindles, flying cutoffs, and wire drawing, to name a few. Further customization is possible with many programs using UEdit™, a Windows-based programming tool that allows users to extend an application using ladder diagrams and function blocks.

Optically Isolated Digital I/O
All digital inputs and outputs are optically isolated. Depending upon the controller, as many as 32 individually isolated digital I/O are locally provided, each of which can be programmed by the application to be an input or output. The voltage of each can be selected from a wide range of AC and DC values.

Transducer/Transducerless Design
The 2400 can operate with or without a feedback transducer. An incremental encoder is typically used for feedback, although absolute encoders, resolvers, and serial sincos encoders are also supported. Transducerless operation is offered for less demanding velocity-loop applications.

Features & Benefits

General
- All-digital control for zero drift and repeatable motor operation
- 24-bit DSP computational power for fast, dynamic response
- High-switching-frequency IGBT devices for quiet operation
- Digital current regulator for high-speed operation and fast response
- Digital space vector control for reduced motor noise and low current ripple
- Flux vector control for full torque from zero to rated speed
- Servo loop operation for precise velocity, position, or torque control
- Field weakening at constant horsepower up to four times base speed

Ease of Installation, Setup, and Maintenance
- Complete, self-contained package requires few option boards
- Identical control boards across full power range reduces spare parts
- Snap-in signal connections for ease of wiring
- Automated setup feature requires no chart recorders or meters
- Software calibration and adjustment eliminates tuning components
- Software input and output scaling eliminates potentiometers
- Automated hardware configuration check

Ease of Use
- Full keypad for easy entry of application-specific setup adjustments
- Two line by 24-character/line descriptive, plain-English display
- Process variable display in bar graph and engineering units
- Comprehensive plain-language, self-diagnostic message display
- Real-time motion information and historical fault log
- RS-232/422/485 for communication with process controllers
- Optional software for managing the drive from a personal or handheld computer

Reliable Operation
- Tolerant of AC line fluctuations
- Extensive electronic protection circuits reduce failures
- Optically isolated signals for high noise immunity
- S-curve acceleration reduces shock and extends equipment life
- Fiber-optics for noise-free serial communication
- Designed to meet or exceed accepted international standards
Specifications

**Electrical**

**Input Supply**
- **Line voltage:** 200 to 240, 380 to 480, or 500 to 600 V AC, three-phase
- **Phase sequence insensitive**
- **Voltage tolerance:** –10% of minimum, +10% of maximum
- **Frequency:** 47 to 63 Hz
- **Power factor:** Displacement: 1.00 at all loads and speeds
  - **Overall:** 0.94 at rated load

**Output Rating**
- **Voltage:** Zero to input voltage, three-phase
- **Frequency:**
  - Zero to 120 Hz without transducer
  - Zero to 480 Hz with transducer
- **Switching frequency:** Programmable from 2.0 to 12.0 kHz

**Service Conditions**
- **Efficiency:** 97% nominal at rated switching frequency
- **Overload current:**
  - Torque Overload (1 min) Maximum
    - Constant: 150% to 200% of rated
    - Variable: 120% to 150% of rated
    - Extended: 110% to 120% of rated
  - Maximum
    - 140% to 160% of rated

**Conversion**
- **Converter unit (2490):** Three-phase (6-pulse) standard; six-phase (12-pulse) available 75 hp (230 V)/150 hp (460 V) CT and above; twelve-phase (24-pulse) available using dual converters
- **Inverter unit (2400):** Six-IGBT, four-quadrant, PWM
- **Regeneration:** Dynamic braking transistor with resistors, capacitor bank energy storage, or regenerative inverter

**Environmental**
- **Operating temperature:** Control section: 32° to 131° F (0° to 55° C)
  - Heat sink: 32° to 131° F (0° to 55° C) through 100 hp CT, 32° to 104° F (0° to 40° C) 125 hp CT or more
- **Storage temperature:** –40° to 158° F (–40° to 70° C)
- **Relative humidity:** 95% maximum, noncondensing
- **Altitude:** To 3,300 ft. (1,000 m) without derating

**Performance**

**Position Control**
- **Bandwidth:** 50 Hz
- **Settle time:** 10 ms

**Velocity Control**
- **Bandwidth:**
  - 100 Hz with transducer
  - 10 Hz without transducer
- **Range:**
  - Base speed to 480 Hz at constant power with transducer
  - Base speed to 120 Hz at constant power without transducer
- **Regulation:** ±0.001% of base speed, down to zero, with transducer
  - ±0.8% of base speed, 2 Hz and above, without transducer

**Torque Control**
- **Bandwidth:**
  - 300 Hz with DCR control
  - 100 Hz with DSV control
- **Regulation:**
  - ±3.0% of maximum with transducer
  - ±10% of maximum without transducer

**Control Modules**

**Common Features:**
- Three ±10 V DC or 0 to 20 mA 12-bit analog inputs
- Two ±10 V DC 12-bit analog outputs
- Two programmable contact outputs
- Fiber-optic high-speed synchronous/asynchronous serial port with clock synchronization up to 1 Mbaud
- Fiber-optic synchronous serial port with clock synchronization at 2 Mbaud
- One optional communication interface provision
- Eight optional configurable I/O points
- One optional feedback interface provision
- One RS-422/485 asynchronous serial port up to 115.2 kbaud

**Standard Control Module:**
- One optional communication interface provision
- 16 or 32 optional configurable I/O points
- One incremental encoder interface
- Two optional feedback interface provisions
- Two RS-422/485 asynchronous serial ports up to 115.2 kbaud

**Expandable Control Module:**
- Two programmable isolated inputs
- One optional communication interface provision
- One optional feedback interface provision
- Two RS-422/485 asynchronous serial ports up to 115.2 kbaud
Specifications
(continued)

Communication Modules

Serial Communications:
• Two isolated RS-232/422/485 synchronous/asynchronous serial ports up to 1 Mbaud

Fiber-Optic Communications:
• One isolated fiber-optic synchronous/asynchronous serial port up to 1 Mbaud
• One RS-232/422/485 synchronous/asynchronous serial port up to 1 Mbaud

Remote I/O Communications:
• Dual Remote I/O interface

Modbus Plus Communications:
• Modbus Plus interface

ControlNet Communications:
• ControlNet interface

Profibus Communications:
• Profibus DP interface

Ethernet Communications:
• Ethernet interface

Transducer Options
A variety of motor-mounted transducers are available to provide feedback of motor position, velocity, and acceleration.

Incremental Encoder:
Two quadrature channels with marker pulse operating up to a maximum frequency of 300 kHz per channel

Single-Turn Resolver:
Up to 14-bit resolution

Multiturn Absolute Encoder:
24-bit resolution with RS-422/485 synchronous serial communication

Inputs and Outputs

Input Converters:
2.5 to 28 V DC @ 30 mA, 90 to 140 V AC @ 11 mA, or 180 to 280 V AC @ 5 mA

Output Converters:
5 to 60 V DC @ 3 A, 12 to 140 V AC @ 3 A, or 24 to 280 V AC @ 3 A

Relay Converters:
250 V AC @ 8 A, normally open or normally closed

Control Module Relay Contacts:
Form A 250 V AC @ 5 A

Optional Analog Interface Module:
Two ±10 V DC inputs and two ±10 V DC outputs

Protection

• Ground fault
• Drive thermal overload
• Software circuit breaker
• DC bus overvoltage
• DC bus undervoltage
• DC bus fuse and blown fuse
• Instantaneous overcurrent
• Motor thermal overload
• Braking unit overcurrent
• Heat sink overtemperature
• Phase loss
• Power transistor fault
• Control undervoltage
• Excessive position error
• Uncommanded motion
• Motor overspeed
• Feedback transducer failure
• Memory malfunction
• Processor not running fault
• Serial communication error

Power Range

<table>
<thead>
<tr>
<th>Input Voltage</th>
<th>Constant-Torque Applications</th>
<th>Variable-Torque Applications</th>
<th>Extended-Torque Applications</th>
</tr>
</thead>
<tbody>
<tr>
<td>230 V AC</td>
<td>112-75 hp (1.1-55 kW)</td>
<td>2-100 hp (1.5-75 kW)</td>
<td>—</td>
</tr>
<tr>
<td>380 V AC</td>
<td>112-1000 hp (1.1-750 kW)</td>
<td>2-1100 hp (1.5-825 kW)</td>
<td>—</td>
</tr>
<tr>
<td>460 V AC</td>
<td>112-2000 hp (1.1-1500 kW)</td>
<td>2-2000 hp (1.5-1500 kW)</td>
<td>25-2000 hp (18-1500 kW)</td>
</tr>
<tr>
<td>575 V AC</td>
<td>125-2200 hp (90-1650 kW)</td>
<td>150-2200 hp (110-1650 kW)</td>
<td>200-2200 hp (150-1650 kW)</td>
</tr>
</tbody>
</table>

Consult factory for other powers. Other voltages require appropriate derating or adjustment of the switching frequency.

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