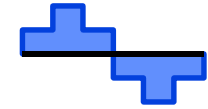


Selecting AF Drive Controllers

AF Drive Controller Selection – Interpreting Specifications

- Selecting an adjustable frequency controller is mostly a matter of interpreting manufacturer's product specifications and selecting a product that has specifications that assure that it is suitable for the application.
 - Output power specifications suitable for the motor
 - Input power specifications suitable for the available supply
 - Enclosure and environmental specifications suitable for the installation environment
 - Performance and control feature specifications suitable for the requirements of the driven machine and process
 - Input/output interface suitable for connection to external operator and supervisory control equipment
 - Select optional features and accessory equipment to cover any requirements not covered by standard product specifications.



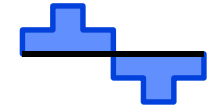
Selecting AF Drive Controllers

AF Drive Controller Selection – Interpreting Specifications

■ Output Power Specifications

● Voltage

≡ The maximum output voltage is generally equal to the input voltage.



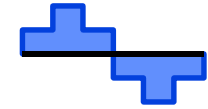
Selecting AF Drive Controllers

AF Drive Controller Selection – Interpreting Specifications

■ Output Power Specifications

● Current

- ≡ The output current determines the load horsepower capacity
- ≡ Drives do not usually have a horsepower rating
- ≡ Horsepower designations assigned to models are generally the nominal horsepower capacity based on the current requirements of typical 4-pole motors.



Selecting AF Drive Controllers

AF Drive Controller Selection – Interpreting Specifications

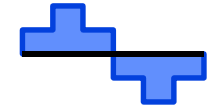
■ Output Power Specifications

● Frequency Range

≡ 0 to 60 Hz is adequate for most applications.

≡ Although 0 Hz is listed in most specifications, the actual minimum is between 0 and 1 Hz.

≡ Motors require slip to produce torque and therefore do not produce sufficient torque to operate when the applied frequency is less than about 1 Hz.



Selecting AF Drive Controllers

AF Drive Controller Selection – Interpreting Specifications

■ Input Power Specifications

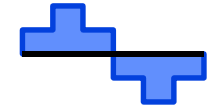
● Voltage and tolerance

≡ Typical ratings are 200-240V, 380-480V and 600V

≡ Tolerance is generally +/-10% for normal operation.

≡ Over voltage and under voltage trip levels are often set at +15% or slightly higher and -15% or much lower.

≡ Drives are not expected to fully perform to specifications beyond the +/-10% tolerance.



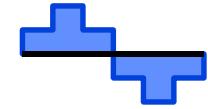
Selecting AF Drive Controllers

AF Drive Controller Selection – Interpreting Specifications

■ Input Power Specifications

● Current

≡ The maximum output current is generally equal to the input current unless harmonic content is high.



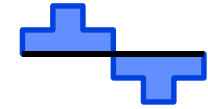
Selecting AF Drive Controllers

AF Drive Controller Selection – Interpreting Specifications

■ Input Power Specifications

● Harmonic content, power factor, efficiency

- ≡ All of these are largely determined by external factors.
- ≡ Harmonic content is very much dependent on source impedance.
- ≡ Displacement power factor is about .96 for a PWM drive, but total power factor depends on harmonic content.
- ≡ The efficiency of the adjustable frequency controller is typically about 96% at maximum frequency with a fully loaded motor.
- ≡ Motor power factor and various operating conditions can cause controller efficiency variations.
- ≡ At full load and full speed, the motor efficiency will be only slightly lower than the published value for sine wave operation.



Selecting AF Drive Controllers

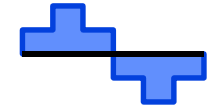
AF Drive Controller Selection – Interpreting Specifications

■ Enclosure & Environment

● Enclosure Type

≡ NEMA 1 is most common base offering.

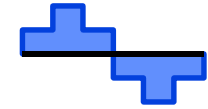
≡ NEMA 12 and others are often available as options.



Selecting AF Drive Controllers

AF Drive Controller Selection – Interpreting Specifications

- NEMA enclosure types often used with drives
 - NEMA 1
 - ≡ Indoor enclosure, protects against contact with contents
 - NEMA 3R
 - ≡ Outdoor enclosure, some degree of weather protection
 - NEMA 4 and 4X
 - ≡ Indoor/outdoor enclosure, protection from weather, water splashing and spray
 - ≡ 4X is corrosion resistant
 - NEMA 12 & 13
 - ≡ Indoor, protection from dust, falling dirt and dripping liquids
 - NEMA 13
 - ≡ Indoor, protection from dust and spraying liquids

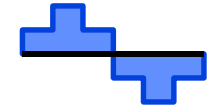


Selecting AF Drive Controllers

AF Drive Controller Selection – Interpreting Specifications

■ IEC Enclosure Types

- The degrees of protection is specified by listing the IEC standard IP (Ingress Protection) number.
 - ≡ The first digit specifies the protection against solid objects and dirt.
 - ≡ The second digit specifies the protection against liquids.
- Comparison with NEMA Types
 - ≡ IP 00 is an open chassis.
 - ≡ IP 20 and IP 33 are comparable to NEMA 1.
 - ≡ IP 32 are comparable to NEMA 3R.
 - ≡ IP 54 and IP 65 are comparable to NEMA 12 and NEMA 13.
 - ≡ IP 65 and IP 66 are comparable to NEMA.



Selecting AF Drive Controllers

AF Drive Controller Selection – Interpreting Specifications

■ Enclosure & Environment

● Maximum ambient temperature

≡ 40°C is the generally accepted standard

≡ Some manufacturers publish derating curves or derating factors such as:

“Maximum output current must be reduced 5% for every 1°C above 40°C.”

≡ If the information is not published, it should be obtainable.

≡ Derating information may be available for operating at higher ambient temperature based on derating the maximum altitude.

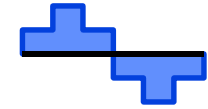
● Maximum storage temperature

≡ Since there is no internally generated heat when a drive is not running, a drive's maximum storage temperature is considerably higher than the maximum operating temperature.

● Minimum temperature

≡ Drives should be protected from freezing during storage.

≡ Drives usually generate sufficient heat to prevent freezing while running.



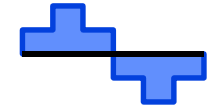
Selecting AF Drive Controllers

AF Drive Controller Selection – Interpreting Specifications

■ Enclosure & Environment

● Maximum elevation

- ≡ 1000 m or 3300 ft is the generally accepted standard
- ≡ Some manufacturers publish derating curves or derating factors such as:
“Maximum output current must be reduced 5% for every 1000 feet above 3300 ft.”
- ≡ If the information is not published, it should be obtainable.
- ≡ Derating information may be available for operating at higher altitude based on derating the maximum ambient temperature.



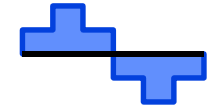
Selecting AF Drive Controllers

AF Drive Controller Selection – Interpreting Specifications

■ Enclosure & Environment

● Maximum Humidity

- ≡ About 95% is the generally accepted standard.
- ≡ There must be no condensation inside the unit.

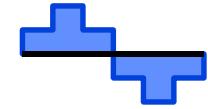


Selecting AF Drive Controllers

AF Drive Controller Selection – Interpreting Specifications

■ Enclosure & Environment

- Shock & vibration
- IEC and/or other standards may be cited
- It is best to select a mounting location that is not subject to shock and vibration



Selecting AF Drive Controllers

AF Drive Controller Selection – Interpreting Specifications

■ Enclosure & Environment

● Air Contaminants

≡ Dust and dirt

Ingress should be prevented by proper enclosure selection.

May prevent proper cooling, cause bad connections or interfere with operation of electro-mechanical devices.

≡ Liquids

Ingress should be prevented by proper enclosure selection.

≡ Conductive material

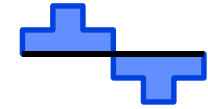
Ingress should be prevented by proper enclosure selection.

≡ Corrosive gases

May be difficult to prevent ingress.

Protective coatings may be available.

Purging enclosure with clean air may be necessary.



Selecting AF Drive Controllers

AF Drive Controller Selection – Interpreting Specifications

■ Enclosure & Environment

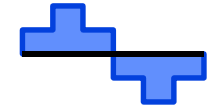
● Air Contaminants

≡ Explosive gases

National Electrical Code states requirements for equipment installed in hazardous areas.

Approved enclosures suitable for drives are not generally available.

Purging and pressurizing enclosure with clean air may be a viable option.

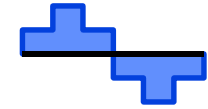


Selecting AF Drive Controllers

AF Drive Controller Selection – Interpreting Specifications

■ Motor Performance

- Output Frequency Accuracy
 - ≡ Usually specified for V/Hz drives.
- Speed Regulation
 - ≡ May be specified for vector, sensorless & slip comp drives.
- Starting Torque
 - ≡ May be specified for vector, sensorless & IR comp drives.
- Dynamic Performance
 - ≡ May be specified for vector drives.

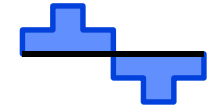


Selecting AF Drive Controllers

AF Drive Controller Selection – Interpreting Specifications

■ Protective Features

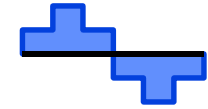
- Input line fuses or circuit breaker - mostly to back up electronic protection
- Line voltage transient protection - metal oxide varistors (MOVs)
- Input overvoltage, undervoltage, phase loss fault trips
- DC bus overvoltage trip and/or regeneration limit regulation
- Drive (heatsink) overtemperature protection
- Output overcurrent, ground fault, short circuit, phase loss fault trips
- Motor current or torque limit regulation
- Motor overload protection
 - ≡ Electronic overload relay (I^2t trip)
 - ≡ Interface for motor thermostat or thermister



Selecting AF Drive Controllers

AF Drive Controller Selection – Interpreting Specifications

- Control Functions and Adjustments
 - Start/Stop control
 - ≡ 2-wire, 3-wire, ramp/coast/brake etc.
 - Acceleration control
 - Speed control
 - ≡ Limits, presets, performance enhancements
 - Output control
 - ≡ Voltage vs. frequency
 - ≡ Current limit
 - ≡ Performance enhancements



Selecting AF Drive Controllers

AF Drive Controller Selection – Interpreting Specifications

■ Operator Interface

- Keypad/Display Units

- ≡ Display setup, monitor and control parameters

- ≡ Keys for operator control, menu navigation and parameter setting

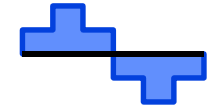
- Conventional Operator Stations

- ≡ Meters

- ≡ Pilot lights

- ≡ Potentiometers

- ≡ Pushbuttons

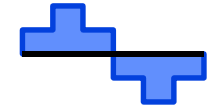


Selecting AF Drive Controllers

AF Drive Controller Selection – Interpreting Specifications

■ Input/Output Terminals

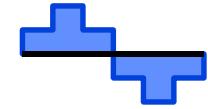
- Operator and supervisory control inputs
- Feedback signal inputs
- Outputs for indicating drive status
- Power supplies for control devices
- Discrete (digital) I/O
 - ≡ On or off, open or closed contacts, high or low voltage etc.
- Digital I/O
 - ≡ Serial or parallel communications
 - ≡ Pulse train signals
- Analog I/O
 - ≡ Voltage or current proportional to drive or process parameters
- Transmitter vs. receiver compatibility



Selecting AF Drive Controllers

AF Drive Controller Selection – Selecting Optional Features

- Alternatives to Basic Specifications – Installation Compatibility
 - NEMA 12 enclosure
 - Increased ambient temperature rating

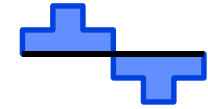


Selecting AF Drive Controllers

AF Drive Controller Selection – Selecting Optional Features

■ Power Circuit Options

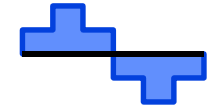
- Most could be furnished as external accessories
- Dynamic braking
- Input or output reactors or filters



Selecting AF Drive Controllers

AF Drive Controller Selection – Selecting Optional Features

- Control Feature Options
 - Process regulator, PI or PID



Selecting AF Drive Controllers

AF Drive Controller Selection – Selecting Optional Features

■ Input/Output Enhancements

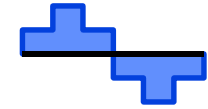
- Additional discrete or analog I/O

- ≡ A basic drive requires only a start/stop input and a speed setting input

- ≡ Additional requirements might include external fault interlock or forward/reverse inputs

- ≡ Instrumentation and annunciation outputs

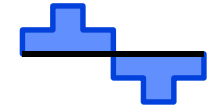
- Communications interface



Selecting AF Drive Controllers

AF Drive Controller Selection – Selecting Optional Features

- Performance Enhancements
 - Tach or encoder feedback
 - Torque regulation



Selecting AF Drive Controllers

AF Drive Controller Selection – Selecting Accessories

- Bypass motor starter
- Input or output reactors or filters