Accutrol 110 General Purpose Adjustable Frequency Motor Control

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General Information

Motor speed is adjusted by controlling both the output voltage and frequency from the Accutrol 110 output. This is accomplished by a full wave diode bridge AC to DC section that converts 3-phase input power into a fixed DC potential. The DC power is then transformed into an adjustable frequency and voltage AC waveform in the inverter section to power any AC squirrel cage induction motor. The DC to AC inverter section utilizes sine-coded pulse-width modulation switching techniques via power Darlington transistor modules. The pulse-width modulated (PWM) waveform provides constant volts per hertz excitation to the motor up to 60 Hz. Above 60 Hz, the voltage remains constant at rated volts. In this way energy efficient low loss speed control is obtained in the range from 6-120 hertz. For example an 1800 RPM motor can run from 180-3600 RPM when used with Accutrol 110.

Design Features

High speed microprocessor based control logic provides superior performance and operator diagnostic annunciation. The basic chassis unit is provided in a NEMA 1 general purpose enclosure and includes a digital monitor/fault display and operator keypad as standard. For applications requiring optional power and logic control equipment, a modification enclosure can be provided containing the basic chassis Accutrol 110 with operator keypad plus an input thermal-magnetic circuit breaker, bypass contactors, or many other options required for the application.

Accutrol 110 Standard Features

- NEMA 1 enclosure.
- Electronic reversing.
- Digital Operator Keypad with 16 character LCD display.
- Linear, independent, timed acceleration and deceleration adjustable from 1 to 3000 seconds (for 60 Hz). Factory set at 30 seconds.
- 150% overload rating for 60 seconds.
- High speed, digital-based logic control, protective and regulator functions.
- 6 to 60 Hz constant torque and 60 to 120 Hz constant horsepower ranges.
- Frequency stability of ±0.5%.
- Process controller speed reference input: 0-5 Vdc, 0-10 Vdc or 4-20 mAdc signal input.
- Digital frequency and fault indication display.
- Transistor inverter power section.
- Sine coded PWM output waveform.
- Multiple attempt restart.
- Motor slip-dependent speed regulation, 3% typical for NEMA B induction motor.
- Start into a spinning motor.
- ETL and CSA listing.

Standard Protective Features

- Instantaneous power failure protection. The controller will trip if power outage exceeds 15 milliseconds.
- Electronic instantaneous overcurrent protection.
- Electronic inverse time overload protection.
- Undervoltage protection.
- Dc bus overvoltage protection.
- Controller overtemperature protection.
- Stall Protection. If necessary, the controller will automatically extend the acceleration or deceleration time in an effort to avoid an overcurrent trip during acceleration, or overvoltage trip during deceleration of the load.
- Ground fault protection.
- Able to withstand output terminal line-to-line short circuits without component failure.
- Surge protection from input Ac line transients.
- Electrical isolation between the power and logic circuits.
- LCD fault display.
- Form C relay output to indicate protective trip-out.

Standard Adjustments

- Minimum speed.
- Maximum speed.
- Acceleration time (2).
- Deceleration time (2).
- Low frequency voltage boost.
- Dwell time.
- Maximum Frequency Setting.
- Minimum Frequency Setting.
- Three Setpoint Frequencies.
- Linear or S-Curve Acceleration.
- Linear or S-Curve Deceleration.
- Dc Brake Power (Voltage).
- Dc Brake Time.
- Restart.
- Volts per Hz characteristic. (36 patterns)
- Critical frequency lockout (3 Bands).
- Carrier frequency.
- Electronic thermal level.
- Overload alarm level.

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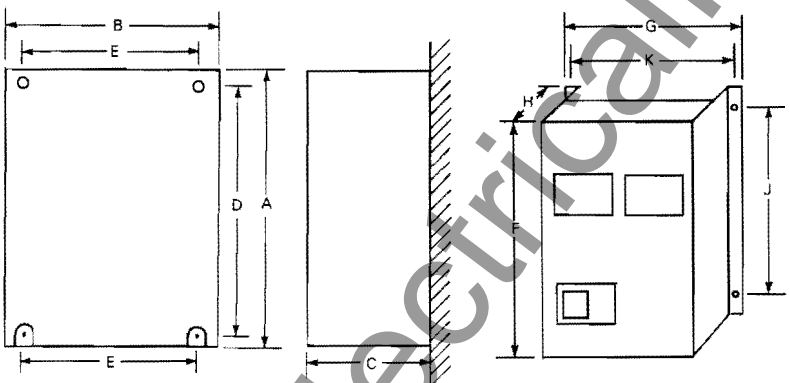
Table 1 – Catalog Numbers – NEMA 1 Enclosure

Nominal Hp①	Catalog Number	Input② Volts (50/60 Hz)	Output Volts (6-120 Hz)	Output Max. Cont. Amps
1	CT2011	3PH 208/230V	3 PH 0-208/230V	4.5
2	CT2021	3PH 208/230V	3 PH 0-208/230V	6.8
3	CT2031	3PH 208/230V	3 PH 0-208/230V	9.5
5	CT2051	3PH 208/230V	3 PH 0-208/230V	15.0
7½	CT2071	3PH 208/230V	3 PH 0-208/230V	21.8
10	CT2101	3PH 208/230V	3 PH 0-208/230V	29.1
15	CT2151	3PH 208/230V	3 PH 0-208/230V	41.8
20	CT2201	3PH 208/230V	3 PH 0-208/230V	58.2
30	CT2301④	3PH 208/230V	3 PH 0-208/230V	86.4
40	CT2401③	3PH 208/230V	3 PH 0-208/230V	110.0
50	CT2501③	3PH 208/230V	3 PH 0-208/230V	131.8
60	CT2601③	3PH 208/230V	3 PH 0-208/230V	165.5
75	CT2751③	3PH 208/230V	3 PH 0-208/230V	200.0
2	CT4021	3PH 380/415/460	3 PH 380/415/460	3.5
3	CT4031	3PH 380/415/460	3 PH 380/415/460	4.8
5	CT4051	3PH 380/415/460	3 PH 380/415/460	7.8
7½	CT4071	3PH 380/415/460	3 PH 380/415/460	11.8
10	CT4101	3PH 380/415/460	3 PH 380/415/460	14.5
15/20	CT4151	3PH 380/415/460	3 PH 380/415/460	21.8/24.5
20/25	CT4201	3PH 380/415/460	3 PH 380/415/460	29.1/32.7

① Nominal hp rating is for reference only. Controller should be selected by maximum continuous amps rating as explained in Note 2.
② For 380V applications select appropriate HP of inverter based upon maximum continuous output amperes required.
③ Open chassis design.

Table 2 – Dimensions and Weights

Approximate only. Not to be used for construction purposes unless approved.



Standard Enclosure

When mounting, maintain 2 in. clearance along sides and 4 in. clearance from top and bottom edges.

Modification Enclosure

Volts	Accutrol 110 HP	Dimensions (Inches) A	B	C	D	E	F	G	H	J	K	Chassis Wt. (Lbs.)④
230	1, 2, 3	11.81	8.66	6.89	1.02	7.87	33.75	23.5	13	30.5	21.25	13.5
230	5	11.81	8.66	6.89	11.02	7.87	33.75	23.5	13	30.5	21.25	14.5
230	7.5	17.32	9.84	7.68	16.54	9.06	33.75	23.5	13	30.5	21.25	27.0
230	10	17.32	9.84	7.68	16.54	9.06	33.75	23.5	13	30.5	21.25	30.0
230	15	17.32	9.84	7.68	16.54	9.06	33.75	23.5	13	30.5	21.25	31.0
230	20	17.72	12.8	9.45	16.93	10.04	42.75	27.25	14.5	39.5	25.25	49.0
230	30③	19.69	15.35	10.63	18.9	11.81	42.75	27.25	14.5	39.5	25.25	58.0
230	40③	24.4	15.4	10.6	23.6	11.8	Not Available					66.0
230	50③	24.4	15.4	10.6	23.6	11.8						88.0
230	60, 75③	31.5	18.9	10.6	30.7	15.0						128.0
460	2, 3, 5	11.81	8.66	6.89	11.02	7.87	33.75	23.5	13	30.5	21.25	17.0
460	7.5, 10	17.32	9.84	7.68	16.54	9.06	33.75	23.5	13	30.5	21.25	19.0
460	15, 20	17.72	12.8	9.45	16.93	10.34	42.75	27.25	14.5	39.5	25.25	54.0

④ Consult factory for additional weight of Modification Enclosure and Options.

WARNING: This literature is a general description of the equipment only. For proper installation, operation and maintenance of the equipment, consult the Instruction Manual. This should not be considered all inclusive. Improperly installing and maintaining these products can result in death or serious personal injury. Before attempting installation or maintenance, read and understand all instructional materials related to the product. If further information is required, you should consult Westinghouse Electric Corporation.

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Standard Specifications

Item			Specification	
Input power supply 3-phase			220~220/200~230V + −10%, 50/60 Hz + −5% 380~415/400~460V + −10% 50/60 Hz + −5%	
Output voltage (Max.) 3-phase			208-230V (For 208V. or 230V. Input)	380-460V (For 380V. or 460V. Input)
Control system			Voltage source type, sine coded PWM	
Output frequency range			1 ~ 120 Hz (0.5 Hz start)	
Frequency accuracy			+ −0.5% (25 + −10°C) of the maximum frequency	
Voltage/frequency characteristics			36 types set-up selectable (See Table 5)	
Overcurrent capacity			150% for 60 seconds (every 10 minutes)	
Acceleration/deceleration time (Soft start/stop)			Individual setting can be made for acceleration and deceleration: Linear acceleration/deceleration: 0.1 ~ 2999.9 seconds Curved acceleration/deceleration: 0.1 ~ 230 seconds	
Torque boost			Manual and automatic, set-up selectable	
Frequency resolution			0.01 Hz	
Braking torque	Regenerative braking		Approx. 10 ~ 20% (Regenerative braking by feedback to capacitor)	
	Dynamic DC braking		Available below the minimum frequency (Minimum frequency, braking time and brake are adjustable.)	
Protective functions	Overcurrent		Overcurrent at acceleration, constant speed and deceleration	
	Overvoltage		Trip at approx. 400V of converter output voltage for 200V class, approx. 800V for 400V class	
	Overload		Protection using electronic thermal relay (can be set from 50 to 100%)	
	Heat sink overheat		Protection using thermal relay (fan cooled units only)	
	Undervoltage		Trip at less than 150 to 160V of input voltage for 200V class	Trip at less than 280 to 320V of input voltage for 400V class
	Instantaneous power failure		Ride thru occurs for 15 ms during power failure (When auto restart function is selected, restart will occur if power failure is less than .3 to 3 sec. (selectable) and 0.3 sec. for 200V and 400V classes respectively.)	
	Stall prevention		Stall prevention is provided during overcurrent and regeneration	
	Overload limit		Inverter output current is detected, and current limit control is performed.	
General Specifications	Ambient temperature		10 ~ 40°C (−10 ~ 50°C without terminal cover)	
	Humidity		20 ~ 90% RH (Non condensing)	
	Ambient conditions		1,000m or less in altitude, indoors (free of corrosive gas and dust or dirt)	

Item			Specification
Input signal	Speed setting	Internal keypad	▶ ▲ ▼ Key operation
		External signal	500 ~ 2 KΩ potentiometer, 0 ~ 5VDC (input impedance 15KΩ), 0 ~ 10VDC (input impedance 30KΩ), 4-20 mA (input impedance 250Ω)
	Forward/reverse operation stop	Internal keypad	FWD RUN Forward operation; REV RUN Reverse operation; STOP Stop operation
		External signal	Forward operation/stop (contact command) Reverse operation/stop (contact command)
	Reset		Fault reset, Instantaneous cut-off of output (contact command or reset button on unit PCB)
	Free-run stop		Elimination of deceleration control (contact command)
	Jogging operation		Adjustable between 0.5 and 9.9 Hz (contact initiated)
	Multistage speed operation		Up to 4 stages can be pre-set (2 contact control)
	2-stage acceleration/deceleration		2-stage command of acceleration/deceleration time (contact initiated)
Output signal	Frequency arrival signal		ON at frequency arrival (Open collector output 27V, 40 mA max.)
	Running signal		ON during running (Open collector output 27V, 40 mA max.)
	Frequency monitor		Digital pulse or analog (selectable) 0 to 10V DC, 1 mA full scale
	Fault/alarm contacts		Relay energized when power is on and unit is not faulted (1 form C contact pair, 2.5A 230V)

Accutrol 110

Factory Modifications

A number of factory modifications are available for the Accutrol 110 product to meet nearly every specific application need in the industry. After selecting the basic controller from Table 1 on page 2 to match the voltage, current and horsepower requirements of the application, add factory modifications shown below as required. The specified equipment should include a complete assembly consisting of a basic controller with selected factory options listed below.

List of Available Modifications

Catalog Number Suffix	Description
	Instruction Manuals Specify Instruction Manual IM8710 The basic controller price includes one instruction manual shipped with the controller. Additional manuals can be ordered as required with this modification. **Special Drawings, Approval or Reproducible** Specify by description When drawing approval of the external connection or outline drawings are required by the purchaser, material procurement and manufacture will be held until final drawing approval is received at the factory.
Z	**Modification Enclosure** HP / Voltage / Type 1-10 / 208/230/460 / NEMA 12 15 / 208/230 / NEMA 12 15-20 / 460 / NEMA 1 20-30 / 208/230 / NEMA 1 40-75 / 208/230 / Consult Factory The modification enclosure is required if any of the controller mounted options listed below are selected. This option consists of a wall-mounted enclosure (NEMA 12 for 1-15 hp 230V, and 1-10 hp 460V. NEMA 1 for 20-30 hp 230V, and 15-20 hp 460V) that is sufficient size to house both the Accutrol 110 controller chassis plus any additional optional circuit boards, circuit breaker, bypass contactors, etc.
C	**AC Input Circuit Breaker**① 2-20 HP — 460V 1-30 HP — 208/230V 40-75 HP — 208/230V — Consult Factory Accutrol 110 is provided as standard without an AC line disconnect. In some applications, this must be provided to meet applicable electrical codes. This option includes a Westinghouse Series C thermal-magnetic circuit breaker with padlockable door interlocking mechanism to be mounted in the Modification Enclosure.
D	**AC Output Contactor**①② 2-20 HP — 460V 1-30 HP — 208/230V 40-75 HP — 208/230V — Consult Factory The AC output contactor option provides a means for positive disconnection of the controller output from the motor terminals. The contactor coil is controlled by the Accutrol 110 run relay.
I2	**Contactor Bypass with Input Disconnect and Overcurrent Relay**①② 2-20 HP — 460V 1-30 HP — 208/230V 40-75 HP — 208/230V — Consult Factory

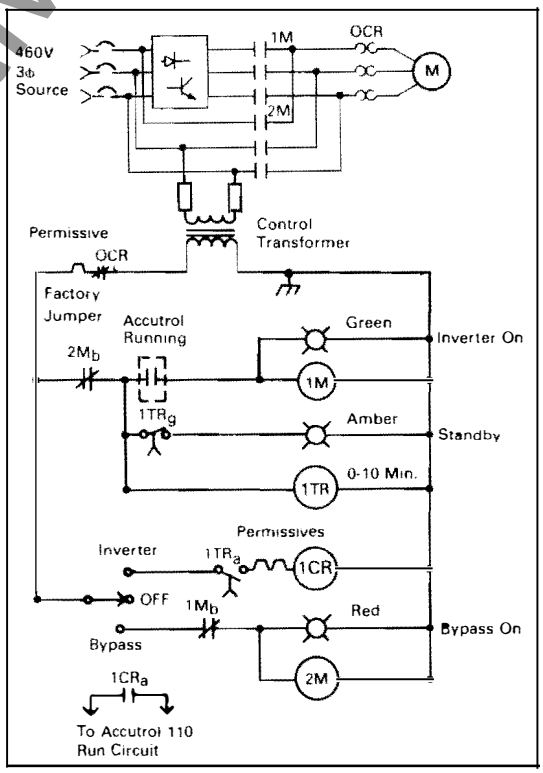

Figure 1: Manual Electric Bypass Option Schematic

This option provides a means of bypassing the Accutrol 110 when the motor is at a standstill for purposes of servicing. It includes an input disconnect, a controller output contactor, bypass contactor, motor overcurrent relay, fused control power transformer, indicating lights and a restart time delay relay as shown in Figure 1. Contactors are mechanically and electrically interlocked. All components are mounted and wired in the Modification Enclosure.

① Requires Modification Enclosure (Z).
② Requires run relay (Y4).

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Catalog Number Suffix	Description
X2	**Automatic Electric Contactor Bypass**① The Automatic Electric Bypass provides an automatic transfer of the load to across the line operation after an Accutrol 110 trip.
M	**3-15 PSIG Pneumatic Process Signal Follower**① In some applications it may be desirable for the Accutrol 110 to follow a 3-15 PSIG pneumatic control signal. This modification includes a printed circuit board with a pneumatic transducer which converts 3-15 PSIG to 0-10 Vdc to interface with the standard Accutrol 110. This signal can be either direct or reverse acting. The printed circuit board mounts inside the Modification Enclosure and includes zero and span potentiometer adjustments.
M1	**Floating Point Process Signal Follower**① **Electronic Potentiometer** Low cost, reliable floating point control can be achieved by the addition of this electronic potentiometer printed circuit board. This option allows the Accutrol 110 to follow an increase or decrease contact closure to maintain a setpoint variable. The electronic floating point follower enables the Accutrol 110 to follow discrete contact closures which tells the Accutrol 110 to accelerate or decelerate motor speed.
M2	**4-20mA Signal Proportional to Output Frequency**① This option provides a current signal proportional to the output frequency of the drive. The transducer mounts within the modification enclosure and provides a 4 mA signal at 0 Hz. and a 20 mA signal at 60 Hz. The load resistance range is 0 to 250 ohms. This signal is available either at TB20 or between terminals 1(+) and 3(−) of the transducer socket. The option also provides a 0 to 10 Vdc output available at pins 10 (−) and 12(+) of the transducer socket. The voltage signal can source a maximum of 10 mA.
N	**Special Customer Nameplate**① Specify required engraving. This modification includes a laminated plastic (N1) or stainless steel (N2) nameplate which may be engraved with the user's identification number. This nameplate is affixed to the modification enclosure door. Specify the engraving required, maximum of two lines, fifteen characters each.
V	**Run Relay/DC Brake/Status Board**③ The option provides one set of form C contacts rated 250 Vac, 2.5A to indicate run, up to speed and overload alarm as well as a 0-4V signal based on output current, a power switchover circuit and DC braking from 15 Hz.
W	**Run Relay/Status Board**③ The option provides one set of form C contacts rated for 250 Vac, 2.5A to indicate run, up to speed and overload alarm. There is also a 0-5 volt signal corresponding to output current.
X	**Run Relay/Remote Interface Board**③ This option provides two normally open contacts rated 250 Vac, 2.5A which change state when the Accutrol 110 is running the motor. This card also enables the Accutrol 110 to interface with remote 120 volt contacts and two or three-wire control. Provisions for two run permissive contacts are also provided.
Y	**Auxiliary Run Relay**① Included is a Modification Enclosure mounted relay with 3 form C contacts (3 normally open and 3 normally closed) rated for 3.0 amp, 115 Vac switching. This relay is provided for the customer's use with the 115 Vac coil prewired to the customer connection terminal block.
Y1	**Auxiliary Trip Relay**① This modification is to provide additional trip contacts by wiring the coil of the auxiliary relay into the trip contact.
Y4	**Motor Overcurrent Relay**① The motor overcurrent relay option provides motor overcurrent sensing of a preset level of load current. This provides a somewhat closer motor overcurrent protection than the built in electronic inverse time overload trip provided as standard in the Accutrol 110. The relay is adjustable allowing protective settings for the specific motor load. Since the motor will not cool itself as well at lower speeds, the recommended protection for all motor types over all speed ranges is an internal thermal sensor.
	Door Mounted Operator Devices
H	**Elapsed Time Meter**①② A five digit non-resettable meter to indicate hours of adjustable speed operation.
R	**Reset Pushbutton**① The standard Accutrol 110 has a control board mounted reset button. This option provides a door mounted reset pushbutton for internal AFC faults only.
I5	**External Manual Mechanical Bypass (Separate Mounting)**

2-20 HP	460V	
1-30 HP	208/230V	
40-75 HP	208/230V	Consult Factory

① Requires Modification Enclosure (Z).
② Requires run relay (Y4).
③ Only one run relay option (Y4) may be provided.

Accutrol 110

Catalog Number Suffix	Description

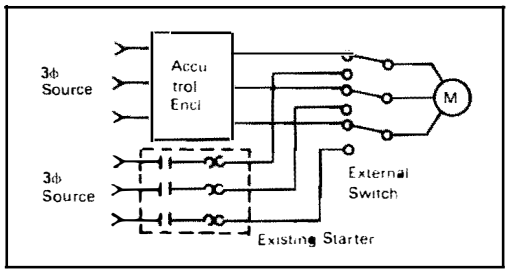

Figure 2: External Mechanical Bypass Option Schematic

The Manual Mechanical bypass utilizes a manual transfer switch to allow the motor to be fed from either the bypass source or the Accutrol 110. A motor protection circuit is not provided. It is required that a standard motor starter be used to feed the bypass line side of the transfer switch to achieve the required protection. The transfer switch is provided in a separate NEMA 1 wall mounted enclosure.

Input Power Isolation Transformer and Line Reactors

Accutrol 110's are capable of operation on a properly rated AC line without use of an isolation transformer or an AC line reactor. In some applications, the use of a separately mounted isolation transformer or AC line reactor is recommended.

Line Reactors (Separate Mounting)
Specify Catalog Number by rating as follows

HP	Voltage	Catalog Number
1-5	208/230	LR3010
7½-10	208/230	LR3020
15-20	208/230	LR3050
30	208/230	LR3075
40-50	208/230	LR3100
60	208/230	LR3125
75	208/230	LR3200
2-10	460	LR3010
15-20	460	LR3020

AC line reactors are often used for Accutrol 110 controllers when additional line side impedance is desired to reduce high peak currents. **This can occur when the source KVA is larger than 500 KVA or when AC line voltage unbalance is greater than 2%.** Reactors are provided in separate NEMA 1 enclosures.

Catalog Number Suffix	Description

Isolation Transformers (Separate Mounting)

Isolation transformers provide additional line impedance similar to line reactors and are recommended:

- If required by local codes or the customer specifications.
- To reduce electrical hazards caused by inadvertent or accidental grounding.
- Voltage unbalance is 3% or higher

  $$\text{Voltage unbalance} = \frac{\text{Max. Deviation}}{\text{Mean Voltage}} \times 100$$

  If V/A,B = 450 Mean Voltage = 440V
  V/B,C = 440 Max. Deviation from Mean = 10V
  V/C,A = 430

  $$\text{Unbalance} = \frac{10}{440} \times 100 = 2.27\%$$

  Therefore no isolation transformer is required for voltage unbalance.

- Power supply capacity is 10 times or greater than individual Accutrol 110 capacity and exceeds 500KVA.

- Abrupt changes in power supply voltage are expected:
  Example:
  - Multiple adjustable frequency controllers are connected to a short bus.
  - Other solid state controllers (D.C. Drive, Solid State Starters, Power Controls, etc) connected with adjustable frequency controller on a short bus.
  - Power factor correction capacitors being opened and closed on the same bus.

Isolation transformers can be provided in 460 or 230 volt ratings. Specify catalog number by rating as follows:

HP	Voltage	KVA	Catalog Number
2	460	7.5	M1004005A
3	460	7.5	M1004005A
5	460	7.5	M1004005A
7.5	460	10	M1004007A
10	460	14	M1004010A
15	460	20	M1004015A
20	460	27	M1004020A
1	208/230	7.5	M1004005E
2	208/230	7.5	M1004005E
3	208/230	7.5	M1004005E
5	208/230	7.5	M1004005E
7.5	208/230	11	M1004007E
10	208/230	14	M1004010E
15	208/230	20	M1004015E
20	208/230	27	M1004020E
30	208/230	40	M1004030E
40	208/230	51	M1004040E
50	208/230	63	M1004050E
60	208/230	75	M1004060E
75	208/230	93	M1004075E

Accutrol 110

Accutrol Adjustable Frequency Controllers
460 Volt 2 Hp to 20 Hp
208/230 Volt 1 Hp to 75 Hp

Specification

1.0 Scope

1.1 The controllers with all options shall be CSA and ETL listed as a complete assembly and shall be built in compliance with the latest standards of ANSI, IEEE, NEMA and the National Electric Code.

1.2 The AFC shall be furnished by a single vendor who has actively been manufacturing Adjustable Frequency Controllers for a period of ten years.

2.0 Construction

2.1 The conversion of the fixed frequency input to an adjustable frequency output is achieved as follows: The rectifier converts incoming AC supply voltage to a fixed potential DC bus level. The DC voltage is in turn inverted by a three phase, pulse-width-modulated inverter section to an adjustable frequency output whose voltage is also adjusted proportionately to the frequency to provide excitation to the motor terminals up to 60 Hz. In this way energy efficient speed control is obtained in the range from 0.5 to 120 Hertz. AFC's utilizing a third power section are not acceptable

2.1.1 Efficiency shall exceed 96% at 100% speed/load.

2.1.2 The AFC shall be rated for 150% current for one minute.

2.2 The AFC shall be housed in a NEMA 1 enclosure.

2.3 Standard Operating Conditions Shall Be:
- a) Incoming three phase "—" volt ac power, ±10%, 50 or 60 Hz.
- b) Humidity 0 to 95% (noncondensing & noncorrosive).
- c) Altitude 0 to 3,300 feet above sea level.
- d) Ambient temperature −10 C to 40 C.
- e) Storage temperature −10 C to 70 C.
- f) AC line frequency variation ±5%
- g) Frequency resolution .01 Hz.

2.4 AFC's shall include the following system interfaces:
- a) Process control speed reference interface to receive a 0-10V, 0-5V or 4-20 mA DC signal.
- b) Fault relay with form C contacts, 2.5A 230V.
- c) Dedicated terminal block for interface with remote start contact.
- d) Remote contacts must be suitable for 120VDC, low energy circuit. Shielded wires shall be used 60 ft of length or less.

2.5 Standard Controller Functions: The following functions are included as standard features in the Adjustable Frequency Controller.
- a) Electronic reversing.
- b) Individual settings for acceleration and deceleration: Linear accel/decel (0.1 - 2999.9 sec), "S" Curved accel/decel (0.1 - 230 seconds).
- c) 150% rating for one minute.
- d) High speed, digital-based logic control, protective and regulator functions.
- e) 0.5 to 60 Hz constant torque and 60 to 120 Hz constant horsepower ranges.
- f) Frequency stability of ±0.5%.
- g) Frequency monitor signal, digital pulse/analog (selectable).
  Analog: 0-10 VDc, 1 mA full scale.
  Digital: 1 pulse per hertz, 10V amplitude square wave.
- h) Digital operator keypad with forward run, reverse run and stop buttons, digital display, selector buttons for monitor mode, function selector and storage buttons, and data select buttons for cursor positioner, increase and decrease.
- i) Alphanumeric monitor and fault indication display.
- j) Transistor inverter power section.
- k) Sine coded PWM output waveform.
- l) Unattended start protection on return of power following a utility outage, customer defeatable.
- m) Motor slip dependent speed regulation, 3% typical for Nema B induction motor.
- n) Constant or reduced torque characteristics (volts/Hz) selected from 36 parameter choices.
- o) Free run (coast) stop, contact commanded.
- p) Internal software lock switch to prevent unauthorized changes to programmed parameters.

2.6 Standard Protective Functions:
- a) Instantaneous power failure protection, to trip if power outage exceeds 15 milliseconds.
- b) Adjustable electronic instantaneous overcurrent protection.
- c) Adjustable electronic overload protection, including reduced speed compensation.
- d) Undervoltage protection, to trip at values less than 150 to 160V of input voltage for the 208/230V class and values of 108 to 320V of input voltage for 460V class.
- e) DC bus overvoltage protection (770VDc on 460V class and 400VDc on the 208V class).
- f) Controller overtemperature protection, (fan cooled units).
- g) Torque (Current) Limit Protection, to automatically extend the acceleration or deceleration time in an effort to avoid an overcurrent trip during acceleration or overvoltage trip during deceleration of the load. When running under steady state conditions current limit will reduce output frequency when the limit is exceeded. Adjustment 50% to 150% of controllers continuous current rating.
- h) Electronic ground fault protection.
- i) Able to withstand output terminal line to line short circuits without component failure.
- j) Electrical isolation between the power and logic circuits.
- k) A digital fault/alarm message shall be displayed for the following abnormal conditions: instantaneous overcurrent, overvoltage, instantaneous power failure, overcurrent during acceleration or deceleration, overcurrent during running, heat sink overheating (fan units), overcurrent on power up, CPU error, ground fault, undervoltage.
- l) Fault alarm contact, form C, rated 230V, 2.5A.

2.7 Operation From Operator Keypad in Monitor Mode shall control/display:
- a) Actual controller output frequency.
- b) Controller output frequency setpoint.
- c) Whether the output frequency is to be commanded by the operator keypad or external I/O terminal.
- d) Whether the forward run/stop and reverse run/stop is to be controlled by the operator keypad or external I/O terminal.
- e) Motor speed in rpm.
- f) Output current.
- g) Jogging frequency setpoint (0.5 to 9.9 Hz).
- h) Manual torque boost adjustment (0 to 18%).
- i) Output voltage gain adjustment (50 to 100%).
- j) Fault display.

2.8 Adjustments from Operator Keypad in Function Program mode include:
- a) Voltage-Frequency (V/Hz) choose from 36 different patterns.
- b) Acceleration time 1 (0.1-2999.9s at Linear acceleration, 0.1-230.0s at S-curved acceleration).
- c) Deceleration time 1 (0.1-2999.9s at Linear acceleration, 0.1-230.0s at S-curved acceleration).

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d) Maximum Output Frequency Increase bias 0-15 (Hz).
e) Minimum Starting Output Frequency 0.5-5.0 (Hz).
f) Output Frequency Upper (High) and Lower (low) Limit 0-135 (Hz) each.
g) Three Jump Frequencys 0-135 (Hz) each 0.6 Hz wide.
h) Carrier Frequency Adjustment to minimize motor noise.
i) Dwell Time of Output Frequency on Start-up 0-15 (S).
j) Three Preset Speed (output frequency) Setpoints 0-135 (Hz) each.
k) Acceleration Time stage two.
l) Deceleration Time stage two.
m) DC Brake Power (voltage) Adjustments 00-20.
n) DC Brake Time 00-15 (S).
o) Electronic Thermal Level Adjustment 100-50 (%).
p) Overload Alarm Level Adjustments 100-150 (%).
q) Automatic Torque (Voltage) Boost Adjustment 0 to 10%.
r) Instantaneous Power Failure duration (time) within which an auto-restart should be initiated 0.3-3.0 (S).
s) Wait (Stand by) time before initiating re-start after power is restored 0.3 to 30 (S).
t) Overload Limit Reaction Rate.

3.0 Service

3.1 The AFC manufacturer shall provide to the owner a start-up service package for all AFC's provided. Service shall include inspection, operational checks, final adjustments, and a final report for record purpose. The service package shall include a 90 day labor warranty from date of start-up and be preformed by local factory employed service engineers. The service center must be permanently located within 250 miles of the jobsite.

4.0 Acceptable Manufacturers

4.1 Adjustable Frequency Controllers are specified on the basis of WESTINGHOUSE ACCUTROL 110 product line for function and quality. Products which are in compliance with the specification and manufactured by others with ten years of experience manufacturing AFC's will be considered only if pre-approved.

5.0 Optional Features

**(Note to spec writer) The following is a list of options which are available for the Accutrol 110 product line. Please select the appropriate options for your application.

5.1 Line Reactors (separate mounted).

5.2 Isolation Transformers (separate mounted).

5.3 Ac Input Circuit Breaker with padlockable, door interlocking handle mechanism.

5.4 Output Contactor to provide electrical output isolation when the AFC is not running.

5.5 Motor Overcurrent relay.

5.6 3-15 psig signal follower for applications with pneumatic control systems.

5.7 Electronic potentiometer to allow AFC to follow discrete increase speed and decrease speed contact closures.

5.8 Contactor bypass which includes an output contactor electrically and mechanically interlocked with a bypass contactor, run relay including control logic, status lights and a motor overcurrent relay. The complete bypass system and Inverter-Off-Bypass selector switch shall be packaged in the AFC's enclosure.

5.9 Automatic contactor bypass which will transfer the motor to full speed across the line operation in the event of an AFC trip. This option includes an output contactor electrically and mechanically interlocked with a bypass contactor, run relay including control logic, status lights and a motor overcurrent relay. The complete bypass system and Inverter-Off-Bypass selector switch shall be packaged in the AFC's enclosure.

5.10 External manual mechanical bypass switch featuring a separately mounted no load break switch which will be used in conjunction with an existing starter.

5.11 Elapsed time meter five digit non-resettable, door mounted.

5.12 Reset push button, door mounted for internal AFC faults only.

5.13 Run Relay/Status board shall include one set of form C contacts rated for 250 Vac, 2.5A to indicate run, up to speed and overload alarm. There is also a 0-5 volt signal corresponding to output current.

5.14 Run Relay/Interface board shall include two normally open contacts rated 250 Vac, 2.5A. This card also enables the unit to interface with remote 120 volt contacts and two or three-wire control. Provisions for two run permissives shall be provided.

5.15 Auxiliary Relay shall include a relay with 3 form C contacts (3 normally open and 3 normally closed) rated for 3.0 amp, 115 Vac switching. This relay is provided for the customer's use with the 115 Vac coil prewired to the customer connection terminal block.

5.16 Auxiliary Trip Relay shall include additional trip contacts by wiring the coil of the auxiliary relay into the trip contact.

5.17 Special Customer Nameplate shall include a laminated plastic nameplate which may be engraved with the user's identification number. This nameplate is affixed to the modification enclosure door. Specify the engraving required, maximum of two lines, fifteen characters each.

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