YORK A JOHNSON CONTROLS COMPANY	AYK 550 AIR MODULATORS	
ENGINEERING GUIDE	Supersedes: Form 100.42-EG1 (704)	Form 100.42-EG1 (506)

1 - 75HP 208 - 240VAC
1.5 - 150HP 380 - 480VAC
2 - 150HP 500 - 600VAC

Table of Contents

Air-Modulator

YORK has led the HVAC industry in variable speed drive (VSD) technology since 1979 with the introduction of the Turbo-Modulator – the variable speed drive specifically designed for centrifugal chiller application. The YORK involvement in applying electronics to HVAC technology exceeds that of any other company either in the HVAC industry or the electronics industry. Since 1983, when the Air-Modulator was introduced, YORK has successfully applied thousands of these drives to fans, pumps, and cooling towers providing exceptional energy savings, high-reliability, and performance.

This Air-Modulator guide is intended as a reference to application and installation information for the HVAC design engineer. The content of this guide provides general theory of operation, application information, key design parameters, and complete specifications.

Why Variable Speed?

Centrifugal fans and pumps are commonly used in HVAC equipment. Because of their centrifugal design, any reduction in the speed at which the fan or pump operates causes a cubic reduction in the horsepower the motor requires. This is represented by the following equation:

$$\frac{(RPM_2)^3}{(RPM_1)^3} = \frac{(HP_2)}{(HP_1)}$$

EXAMPLE:

SPEED %	HP %
100%	100%
90%	73%
80%	51%
70%	34%
60%	22%
50%	13%
40%	7%
30%	3%

This shows that a 10% reduction in the RPM of the fan or pump results in a 27% reduction in horsepower required. Therefore, a means by which the RPM or speed of the fan or pump could be reduced would produce significant energy savings. The Air-Modulator provides such a means by varying the speed of the fan or pump motor.

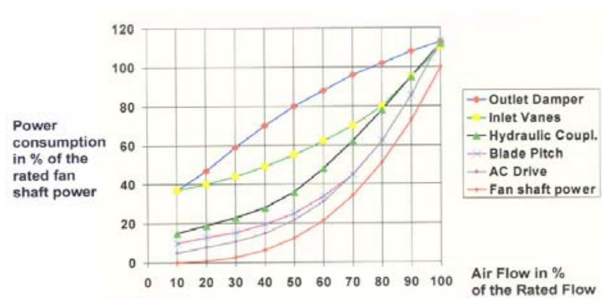
What is a Variable Speed Drive?

A variable speed drive is an electronic device which changes the speed of a motor by changing the frequency and voltage fed to the motor. An AC motor runs at a speed proportional to the frequency applied, as described in the following formula:

$$\text{Synchronous motor speed} = \frac{120 \times \text{frequency}}{\text{Number of motor poles}}$$

The speed is dependent on the frequency; a change in frequency will change the motor speed. The AC motor, however, must also have the voltage vary in the same proportion as the frequency to maintain full torque capabilities throughout the speed range. Therefore, a variable speed drive must change both the frequency and the voltage of the power fed to the motor to vary speed while maintaining torque for the required load.

Fan Power with Different Air Volume Control Methods



GENERAL APPLICATION CONSIDERATIONS

Horsepower Range

The YORK Air-Modulator is a complete product line covering the nominal horsepower sizes from 1 HP to 150 HP for 380 to 480V/3-Phase, and 1 HP to 75 HP for 208V to 240V/3-Phase. This one product line can be used for the smallest return fan or the largest chilled water pump. The critical sizing parameter is the output current rating of the drive (listed on pages 15-17). The nameplate FLA rating of the motor(s) should not exceed the output current rating of the drive at 208, 230, 380, or 480VAC.

Air-Modulators are designed with sufficient current capacity to be applied to high efficiency motors. The current capacity complies with the industry's Energy Policy Act (EPACT) motor full load amp ratings. Air-Mod FLA output ratings meet or exceed Table 430-150 of the National Electric Code® 1993.

Power Supply

The Air-Modulator is designed for nominal 380V to 480V (+10%), 48-63 Hz input power, or 208V to 240V (-15%), 48-63 Hz. For other power supply systems, a step transformer should be used. The minimum required kVA rating of the transformer must be calculated as follows:

$$\text{Transformer kVA} = \frac{1.5 \times \sqrt{3} \times Vs \times FLA\ @\ Vs}{1000}$$

Vs = Supply Voltage

Power factor correction capacitors are not required as the Air-Modulator maintains a .98 power factor at nominal load.

Location

Air-Modulators are designed for indoor location, in a NEMA-1 classification area, having 5°F to 104°F (-15°C - 40°C) ambient temperature limits. The relative humidity of the area should be between 0% to 90% non-condensing.

Sufficient clearance (as noted in the dimensional section) to permit normal servicing and maintenance should be provided around the entire unit.

Power Wiring

The Air-Modulator is equipped with power lugs for easy connection of power wiring. Maximum wiring size for each Air-Modulator is listed in the power and control wiring drawing, Form 100.04-PA1.2. A single point ground connection is provided in the Air-Modulator. Power wiring should be sized and installed in accordance with the National Electrical Code (N.E.C.). Copper wire is required for all power wiring connections to the Air-Modulator.

DO NOT USE ALUMINUM WIRE

Air-Mod Terminals Are Not Rated For Use With Aluminum Wire

For wiring and fuse sizing purposes, follow the guidelines for Rated Input Current and Max Prefuse Amps listed in Performance Data.

The Air-Modulator is designed with electronic I^2t U.L. Listed overload protection which limits the current to 100% of the motor rated current eliminating the need for thermal overload relays. This is in compliance with section 430-2 of the N.E.C.

Control Wiring / Interface

YORK provides as standard on Air-Modulators a single point control interface which accepts standard control signals (4-20mA, 0-5VDC, 0-10VDC) mounted in the unit. Also available for factory mounting is a pneumatic control interface which accepts a standard 3-15 PSIG control signal.

NOTE:
For 380V, 50Hz applications, size VFD for FLA that meet or exceed motor FLA.

FAN APPLICATIONS

Theory of Operation

Variable Air-Volume (VAV) systems have long been accepted as the energy efficient air distribution method. YORK and other HVAC suppliers have, traditionally, offered Variable Inlet Vanes (VIV) on air handling units to provide this variable air volume capability. VIVs unload the fan by adding a pre-swirl to the air as it enters the fan in such a way as to provide a reduction in head pressure across the fan and a decrease in air flow rate. This causes a change in the operating point of the fan on the system curve (Fig. 1) and a subsequent reduction in the horsepower drawn by the fan motor.

Alternatively, the Air-Modulator unloads the fan by slowing it down. This shifts the RPM curve on which the fan operates. By reducing the RPM curve, the operating point now requires significantly less brake horsepower than a system using VIVs. This is shown in Fig. 2. The part load performance comparison is shown in Fig. 3.

Application

Variable speed drives can be applied to forward-curved, airfoil or backward-inclined centrifugal fans. When retrofitting the Air-Modulator to a fan with existing VIVs, the VIVs should either be removed or locked into the wide open position. Leaving the vanes on the fan will require the fan to use more power than if they were removed. The power penalty can range from 5% to 25% of FLA depending on fan size and velocity of air across the vanes. The smaller the fan, the higher the penalty.

Sequence of Operation

The typical variable speed air system is depicted in Fig. 4. It consists of an air handling unit being controlled by an Air-Modulator, ductwork, and standard temperature controls. Under full load conditions, the fan is running at full speed and the discharge dampers are fully open, allowing the maximum amount of cooling into the space. As the cooling diminishes, the temperature controls send a signal to the dampers to close; this increases the static pressure in the ductwork. A static pressure sensor in the ductwork sends a signal through a receiver/controller to the Air-Modulator, telling it to slow down the motor proportionally.

The reduced motor and fan speed matches the air flow to the space temperature. As the space temperature rises, the dampers open lowering the duct static pressure. A reduction in static pressure will cause the Air-Modulator to increase the speed of the motor, again matching the air flow to the space temperature.

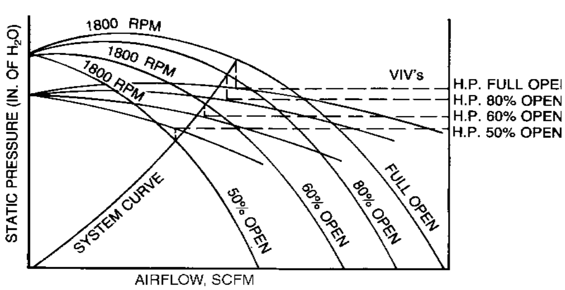


FIG. 1 – FAN CURVES WITH INLET VANE CONTROL

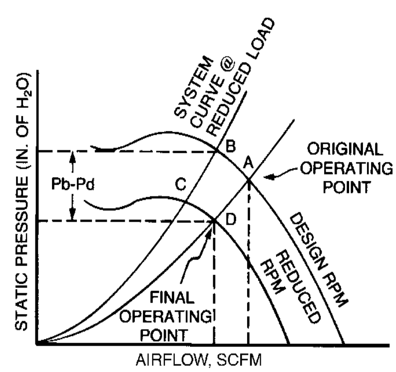


FIG. 2 – FAN CURVES WITH VARIABLE SPEED CONTROL

Fan Power with Different Air Volume Control Methods

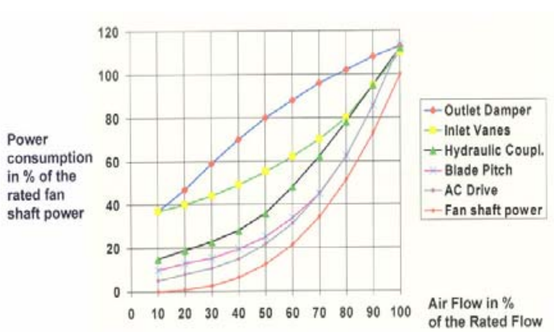


FIG. 3 – AIR-MOD PART LOAD PERFORMANCE

VAV Variable Speed Fans - Control

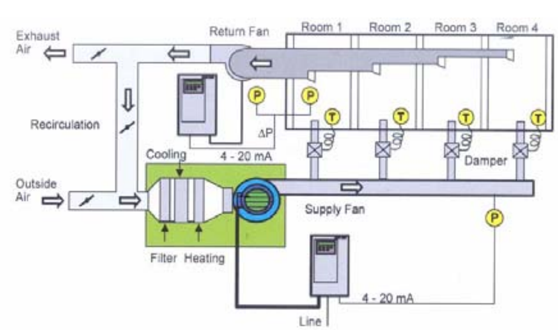


FIG. 4 – TYPICAL VAV SYSTEM

RETROFIT FAN APPLICATIONS

Mechanical Volume Control Retrofit

The Air-Modulator can be easily retrofitted into existing systems. The exisiting starter controls can be integrated into the Air-Modulator as well as the existing transducer can be fed into the Air-Mod's PI controller for set-point control. The existing volum controls (ie: inlet guide vane, discharge damper, etc) can be removed or locked in the full open position. See Fig 5.

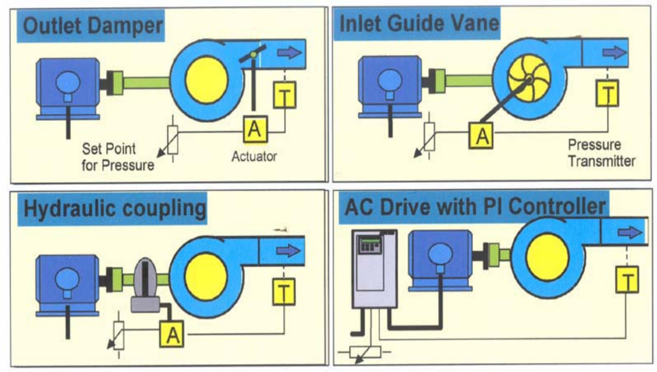


FIG. 5 – AIR VOLUME CONTROL OF THE CENTRIFUGAL FAN

Constant Volume Retrofit

The simplest of all air conditioning systems is a supply fan unit serving a single zone with constant air volume as shown in Fig.5. Typically, this system is controlled by a automatic temperature control (ATC) panel that cycles the AHU starter ON/OFF based on a temperature of a single zone. This is very inefficient and can be converted to variable volume with an air modulator which monitors room temperature and discharge temperature to automatically control fan speed by adjusting the frequency output to the motor.

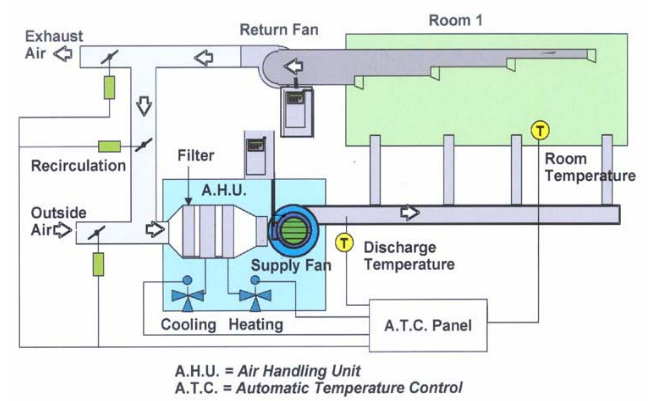


FIG. 6 – CONSTANT VOLUME SYSTEM - RETROFIT

Direct Expansion VAV System

Air-Modulators can also be used on DX systems. The Air-Modulator can be used to control the supply fan to reduce coil freezing or to control condenser fan speed to optimize head pressure.

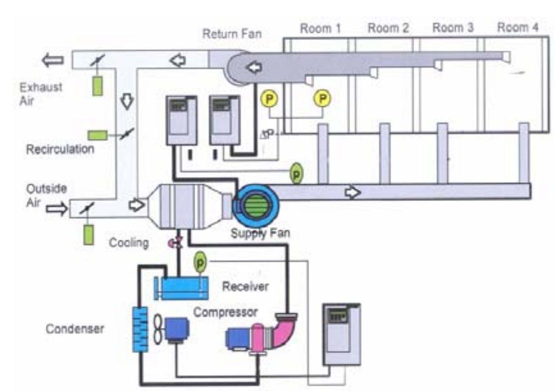


FIG. 7 – DIRECT EXPANSION VAV SYSTEM

PUMP APPLICATIONS

Theory of Operation

YORK has extensive experience in variable speed pumping and has performed testing in optimum combinations of variable speed pumping. We have found many applications which can benefit from variable speed pumping. We have also found that very few chiller plants benefit from variable condenser water flow control. This section will deal with chilled water systems only.

Though there are many different configurations for chilled water pumping systems, they generally consist of throttling (2-way) valves around the chilled water coils and a bypass around the pump/chiller loop (Fig.8). As cooling needs reduce, the valves are controlled to throttle the water flow to their individual coils. As the valves close, the system pressure increases. A pressure sensor sends a signal to open the bypass valve - maintaining constant flow through the pump and chiller circuit. The result is that full input energy to the motor occurs at all times.

An Air-Modulator pumping system eliminates the need for a bypass circuit because it slows down the pump in response to the system pressure increase caused by the throttling valves closing. The input energy to the pump motor is reduced significantly as the pump operates at part load conditions and the system pressure is maintained. See Fig.10 on Page 8.

Application

In applications where a low night load or wide variations in cooling load occur, variable speed pumping can provide significant energy savings. In large centrifugal chiller plants with three or more chillers, and/or with a primary/secondary chilled water loop design, variable speed pumping should be considered.

In all variable speed pumping applications, the following must be addressed:

- Chilled water flow and load variations
- Worst case flow/head requirements of a remote water coil or loop
- Minimum chiller water velocity of 3.33 ft./second for proper heat transfer
- Maximum chiller water velocity of 12 ft./second to prevent tube erosion
- Minimum head requirements and pump curve characteristics of the individual pumps
- Potential energy savings

In all cases, the chilled water flow through the cooler must not be allowed to go below the minimum GPM recommended. This corresponds to a tube velocity of 3.33 FPS for most cases. For applications using chilled water below 42°F, the minimum water velocity cannot go below 4.75 FPS. This is a precaution against freezing water inside the cooler tubes.

Sequence of Operation

The sequence of operation of a variable speed pump is similar to the variable speed fan sequence of operation. As cooling load is reduced, throttling valves begin to close off flow to their coils which creates an increase in system pressure. A differential pressure sensor, located in the system, senses this change in pressure and transmits a control signal through a controller to the Air-Modulator to slow down the pump. As the discharge temperature rises, the throttling valve control will open the valve causing the system differential pressure to drop. The differential pressure control will then increase the speed signal to the Air-Modulator, increasing the pump discharge pressure to match the system requirements.

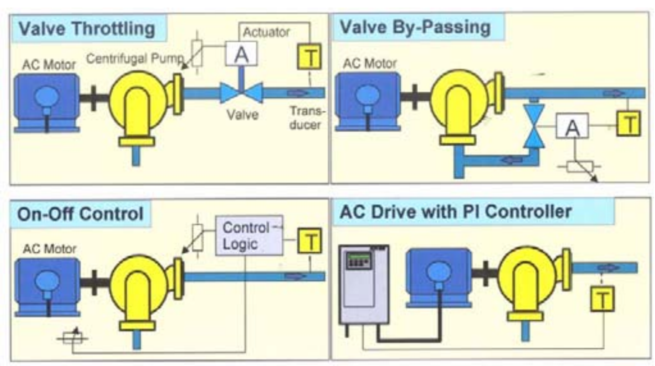


FIG. 8 – VFD APPLICATIONS - PUMPS

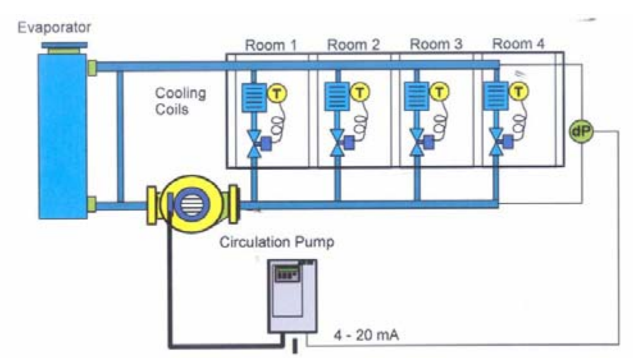


FIG. 9 – VARIABLE FLOW CHILLED WATER SYSTEM

PUMP AND FAN CONTROL

Theory of Operation

The pump and fan control macro (HVAC PFC) of the Air-Mod provides on/off commands to control up to three constant speed pumps or fans operating in parallel with the pum or fan controlled by the Air-Mod. The PID Setpoint Controller in the Air-Mod controls the proces pressure or flow by controlling the speed of the motor connected to the Air-Mod and starting additional constant speed motors whenever maximum speed operation of the adjustable speed motor is not sufficient to satisfy the process requirement. This feature can eliminate the need for a PLC or pump sequencer.

Adjustments are provided for start and stop points and delay timers. Three step adjustments to the reference and two groups of PID settings can be applied to accommodate different operating characteristics with various numbers of parallel units in operation. An automatic sequence change feature helps ensure equal duty time for all of the motors. Instead of using the PID controller of the Air-Mod to regulate the process, an open-loop capacity output command can be used to directly set the flow provided by the parallel combination of pumps or fans.

When the pump and fan control feature is used, the adjustable speed motor is connnected to a drive output or optional output contactor and the constant speed motor(s) is connected to a motor starter(s). The optional output contactor and starter(s) are controlled using Air-Mod digital (relay) outputs and interlock inputs. Optional digital I/O modules may be required.

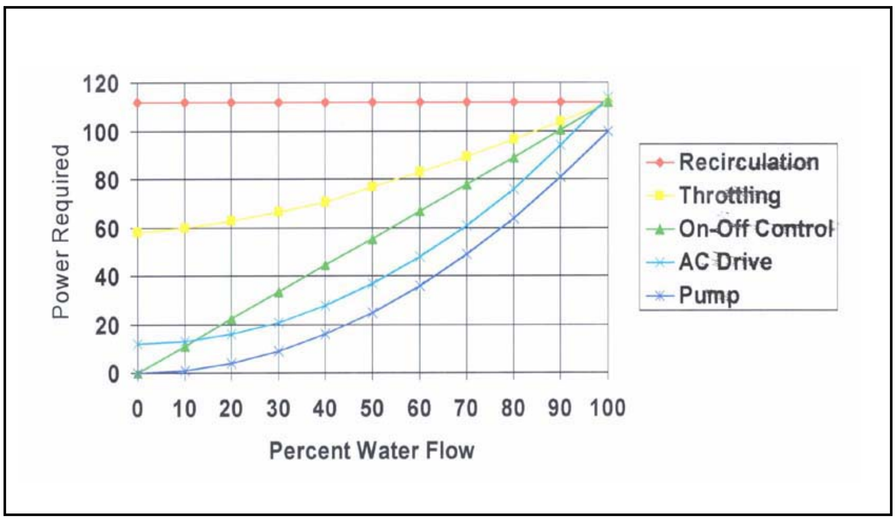


FIG. 10 – POWER CONSUMPTION WITH DIFFERENT FLOW CONTROLS

COOLING TOWER APPLICATIONS

Theory of Operation

Typical cooling tower controls reduce capacity at low loads by turning off tower fans. Reducing the fan capacity lowers fan power consumption but could increase condenser water temperature, thus increasing chiller power consumption.

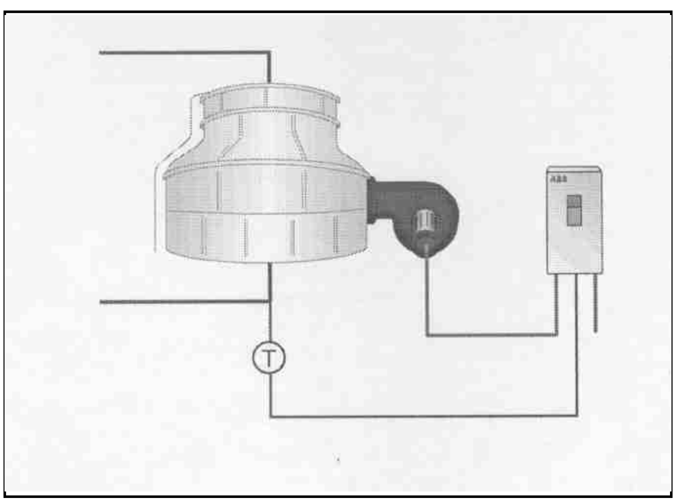
Application

YORK's extensive experience in optimizing cooling tower performance and chiller performance has taught us that optimum chiller plant power consumption is achieved by minimizing entering condenser water temperature, therefore, tower fans are employed over a large portion of the operating hours. Energy savings can be achieved where:

- Wide swings occur in outdoor ambient or chiller loads
- Chiller is limited to high entering condenser water temperatures.
- Low chiller loads occur
- 24-hour operation with previously mentioned conditions occur

In addition, Air-Modulator control has been used for soft start and soft cycling of the tower fans to eliminate excessive tower gearbox failure.

When using an Air-Modulator on a cooling tower fan, condenser water temperature or chiller condenser pressures are generally used to control the speed of the fan. The application can be simplistic, involving a single control parameter or complicated, involving multiple control parameters and vibration sensors tied into the control circuit to de-energize the system upon sensing excessive tower vibration. The needs of each application must be analyzed on an individual basis.



TYPICAL COOLING TOWER APPLICATION

Dimensions

AYK 550 Frame Size Chart

Use the chart below to determine overall dimensions based on HP, voltage, and package configuration.[2]

HP	208V			230V			460V			575V	
	OO	AO	CM	OO	AO	CM	OO	AO	CM	CM	OO, AO
1	R1	R1	1	R1	R1	1	--	--	--	R2	R2
1.5	R1	R1	1	R1	R1	1	R1	R1	1	R2	R2
2	R1	R1	1	R1	R1	1	R1	R1	1	R2	R2
3	R1	R1	1	R1	R1	1	R1	R1	1	R2	R2
5	R1	R1	1	R1	R1	1	R1	R1	1	R2	R2
7.5	R2	R2	2	R2	R2	2	R1	R1	1	R2	R2
10	R2	R2	2	R2	R2	2	R2	R2	2	R2	R2
15	R3	R3	3	R3	R3	3	R2	R2	2	R2	R2
20	R3	R3	3	R3	R3	3	R3	R3	3	R3	R3
25	R4	$R4_2$	4	R4	$R4_2$	4	R3	R3	3	R3	R3
30	R4	$R4_2$	5	R4	$R4_2$	4	R4	$R4_1$	4	R4	R4
40	R4	$R4_2$	5	R4	$R4_2$	5	R4	$R4_1$	4	R4	R4
50	R6	R6	6	R6	R6	6	R4	$R4_1$	4	R4	R4
60	R6	--	6	R6	--	6	R5	R5	5	R5	R6
75	R6	--	6	R6	--	6	R5	R5	5	R5	R5
100	--	--	--	--	--	--	R6	R6	5	R5	R6
125	--	--	--	--	--	--	R6	--	6	R5	R6
150	--	--	--	--	--	--	R6	--	6	R6	--

OO Base Drive with Conduit Box

AO Base Drive with Fused Input Disconnect Switch

CM Base Drive with Fused Input Disconnect, 2 Contactor Bypass, Drive Input Service Disconnect Switch

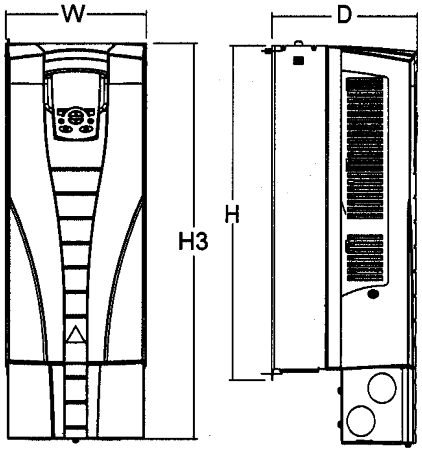
Note 1: When mounting drives side by side, allow 2" (50.8mm) on each side to provide clearance for door swing and cooling.

Note 2: OO, AO are applicable to Solution as well as field mounted shipped loose.

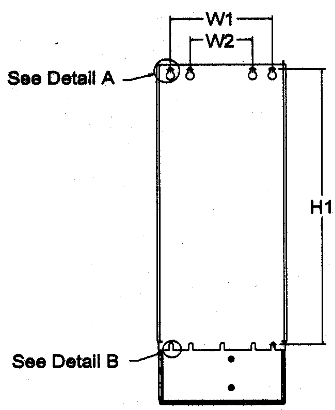
CM applies only to field mounted shipped loose.

Outside Dimensions - Base Drive OO

Outside dimensions depend on frame size and enclosure type, as defined below.

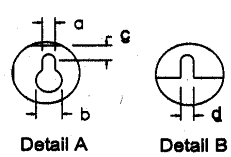


IP 21 / UL Type 1 - Outside Dimensions by Frame Size												
Ref.	R1		R2		R3		R4		R5		R6	
	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in
W	125	4.9	125	4.9	203	8.0	203	8.0	265	10.4	300	11.8
H	330	13.0	430	16.9	490	19.2	596	23.4	602	23.7	700	27.6
H3	369	14.5	469	18.5	583	23.0	689	27.1	736	29.0	880	34.6
D	212	8.3	222	8.7	231	9.1	262	10.3	286	11.3	400	15.8



IP 21 / UL Type 1 - Dimensions for each Frame Size												
Ref.	R1		R2		R3		R4		R5		R6	
	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in
W1*	98.0	3.9	98.0	3.9	160	6.3	160	6.3	238	9.4	263	10.4
W2*	--	--	--	--	98.0	3.9	98.0	3.9	--	--	-	--
H1*	318	12.5	418	16.4	473	18.6	578	22.8	588	23.2	675	26.6
a	5.5	0.2	5.5	0.2	6.5	0.25	6.5	0.25	6.5	0.25	9.0	0.35
b	10.0	0.4	10.0	0.4	13.0	0.5	13.0	0.5	14.0	0.55	14.0	0.55
c	5.5	0.2	5.5	0.2	8.0	0.3	8.0	0.3	8.5	0.3	8.5	0.3
d	5.5	0.2	5.5	0.2	6.5	0.25	6.5	0.25	6.5	0.25	9.0	0.35
Mounting Hardware												
	M5	#10	M5	#10	M5	#10	M5	#10	M6	1/4	M8	5/16

* Center to center dimension



Weight

The following table lists typical maximum weights for each frame size. Variations within each frame size (due to components associated with voltage/current ratings, and options) are minor.

Weight												
Enclosure	R1		R2		R3		R4		R5		R6	
	kg	lb.	kg	lb.	kg	lb.	kg	lb.	kg	lb.	kg	lb.
IP 21 / UL Type 1	6.5	14.3	9.0	19.8	16	35.0	24	53.0	34	75	69	152

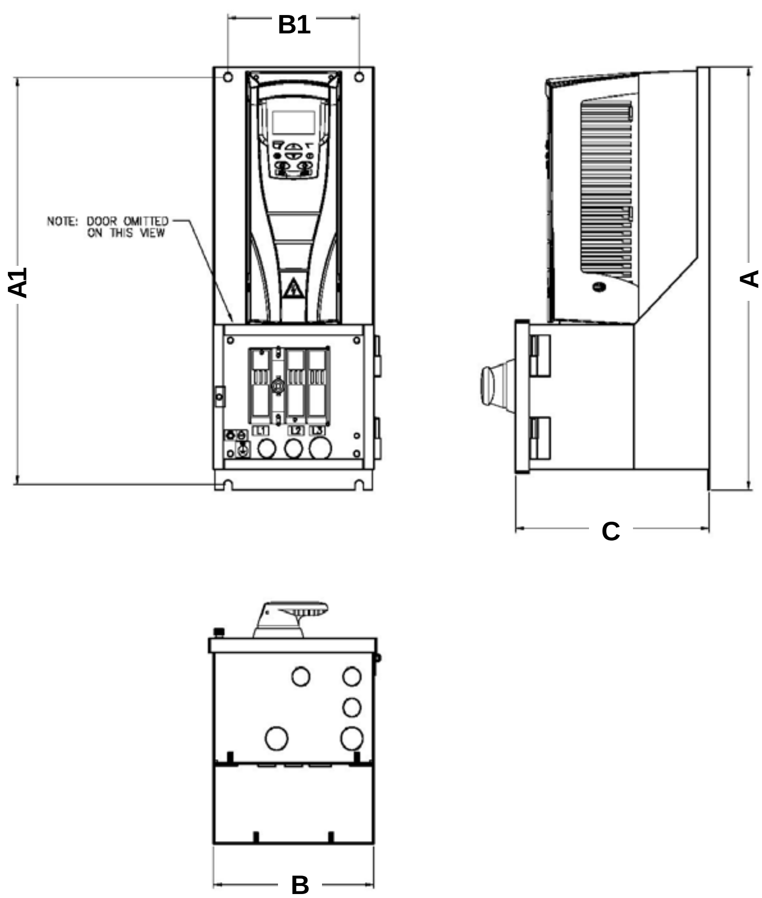
Dimensions *(continued)*

Base Drive with Fused Disconnect
AO Option

Used on: Factory Mounted Solution XTI AHU, Shipped Loose

VFD FRAME SIZE	A	A1	B	B1	C	WEIGHTS lb (kg)
R1	20.50 (521)	19.75 (502)	8.25 (210)	6.75 (172)	9.98 (254)	25 (11.35)
R2	24.75 (629)	27.75 (705)	8.25 (210)	6.75 (172)	10.4 (264)	33 (15)
R3	32.5 (826)	31.5 (800)	9.0 (229)	7.5 (191)	10.2 (259)	56 (25.4)
$R4_1$	36.25 (921)	35.2 (895)	9.0 (229)	7.5 (191)	11.48 (292)	75 (34)
$R4_2$	40.5 (1029)	39.5 (1003)	12.0 (305)	10.5 (263)	13.48 (342)	75 (34)
R5	43 (1092)	42.1 (1070)	12.0 (305)	10.5 (263)	15.1 (384)	115 (52.2)
R6	48 (1219)	46.5 (1181)	16.0 (406)	16.0 (406)	18.6 (472)	150 (68.1)

Dimension Inches (mm)



Base Drive, 2 Contactor Bypass, Drive Input Service Disconnect Switch, Main Fused Disconnect Switch CM Option

Enclosures #1 thru #6

FRONT VIEW

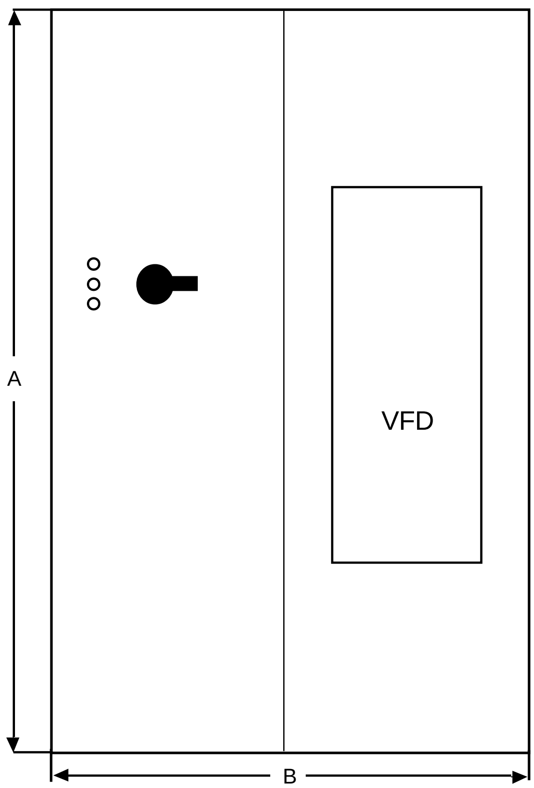


FIG. 11 – FRONT VIEW

SIDE VIEW

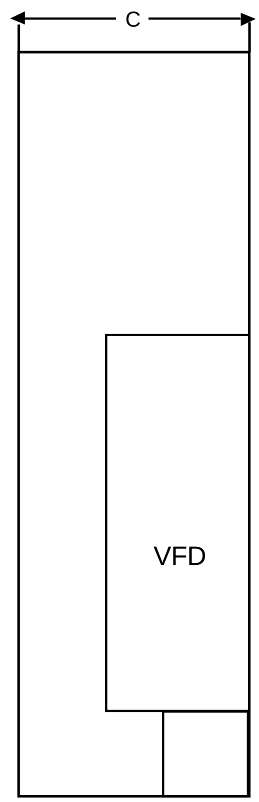


FIG. 12 – SIDE VIEW

DOOR SWING

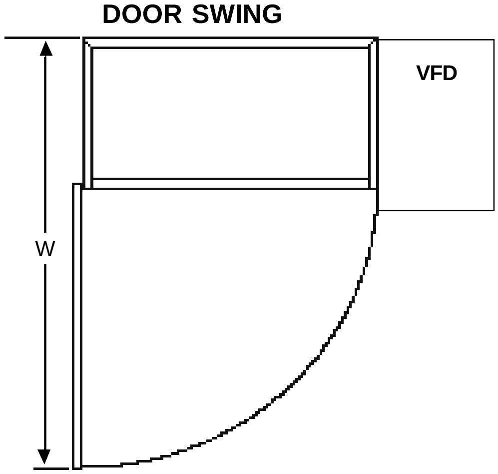


FIG. 13 – DOOR SWING

CONDUIT LOCATION TOP & BOTTOM

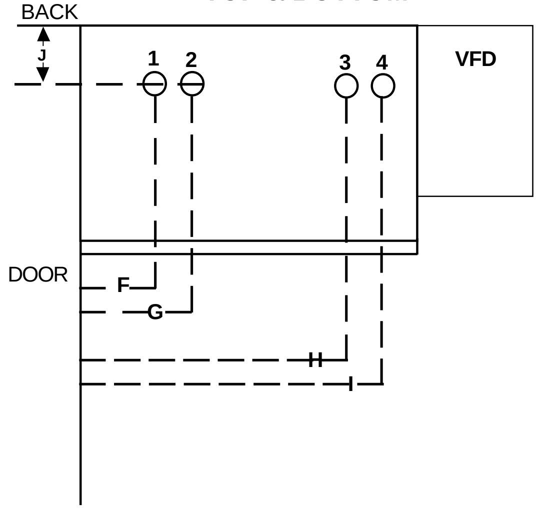


FIG. 14 – CONDUIT LOCATION

CM Option

Enclosures #1 thru #6 Dimensions

(Dimensions shown below are for Options CM)

TABLE 1 – DIMENSIONS (See Fig. 11, Page 13)

Inches - (mm)			
ENCLOSURE	A (H)	B (W)	C (D)
1	26.5 (673)	20.25 (514)	9.5 (241)
2	32.5 (826)	20.25 (515)	10 (254)
3	32.5 (826)	24.25 (616)	10.5 (267)
4	42.5 (1080)	27.25 (693)	11.5 (292)
5	47.5 (1207)	30.25 (769)	16.122 (409)
	57.0 (1448)	36.25 (921)	18.290 (465)

NOTE: Allow min. 8" (203) on top, 2" (50.8) on right side

TABLE 2 – CONDUIT KNOCKOUT DIMENSIONS (See Fig. 14, Page 13)

Inches - (mm)	Dimension Reference						
ENCLOSURE	F	G	H	I	J	Conduit Size 1 & 2	Conduit Size 3 & 4
1	1.5 (38.1)	3 (76.2)	10 (254)	12 (304.8)	2.5 (63.5)	1/2 (12.7)	1/2 & 3/4 (12.7 & 19.1)
2	1.5 (38.1)	3 (76.2)	10 (254)	12 (304.8)	2.5 (63.5)	1/2 (12.7)	1/2 & 3/4 (12.7 & 19.1)
3	1.5 (38.1)	3 (76.2)	10.5 (267)	13.25 (337)	2.5 (63.5)	1/2 (12.7)	3/4, 1, 1-1/4 (19.1, 25.4, 31.75)
4	1.5 (38.1)	3 (76.2)	10.5 (267)	14.25(362)	3 (76.2)	1/2 (12.7)	1, 1-1/4, 1-1/2 (25.4, 31.75, 38.1)
5	1.5 (38.1)	3 (76.2)	11.5 (292.1)	15 (381)	3 (76.2)	1/2 (12.7)	1-1/4 & 1-1/2 (31.75 & 38.1)
6	1.5 (38.1)	3 (76.2)	15 (381)	20.5 (521)	4 (102)	1/2 (12.7)	1-1/2 & 2 (38.1 & 50.8)

TABLE 3 – APPROXIMATE SHIPPING WEIGHT DRIVE WITH OPTION CM

ENCLOSURE	lbs (kg)
1	100 lbs (45)
2	160 lbs. (73)
3	184 lbs. (84)
4	225 lbs. (102)
5	340 lbs. (154)
6	385 lbs. (175)

* C/F = Consult Factory

* Enclosure selection subject to change depending on internally mounted options

TABLE 5 – DOOR SWING (See Fig. 13, Page 13)

ENCLOSURE	W in (mm)
1	21.25 (540)
2	21.75 (553)
3	22.5 (572)
4	26 (661)
5	28 (771)
6	33 (838)

TABLE 4– MOUNTING HOLES

ENCLOSURE	DIA. in. (mm)	# of
1, 2, 3	3/8 (9.5)	4
4, 5, 6	3/8" (9.5)	6

Note: Mounting holes located external at top and bottom.

TABLE 6 – CONDUIT SIZE in. (mm) (See Fig. 14, Page 13)

ENCLOSURE	# 1 AND 2 HOLE	# 3 AND 4 HOLE
1 & 2	1/2 (12.7)	1/2, 3/4 (12.7), (19.1)
3	1/2 (12.7)	3/4, 1, 1-1/4 (19.1), (25.4), (31.75)
4	1/2 (12.7)	1, 1-1/4, 1-1/2 (25.4), (31.75), (38.1)
5	1/2 (12.7)	1-1/4 & 1-1/2 (31.75), (38.1)
6	1/2 (12.7)	1-1/2 & 2 (38.1), (50.8)

Performance Data

208-240 VAC (04A6-2 to 031A-2)

YORK Model	AYK 550-UH	AYK 550-UH	AYK 550-UH	AYK 550-UH	AYK 550-UH	AYK 550-UH	AYK 550-UH
Series	-04A6-2+K465	-06A6-2+K465	-07A5-2+K465	-012A-2+K465	-017A-2+K465	-024A-2+K465	-031A-2+K465
Motor Horsepower	**1**	**1.5**	**2**	**3**	**5**	**7.5**	**10**
Motor kW	1.1	1.5	2.2	3	4	5.5	7.5
Drive Frame Size	R1	R1	R1	R1	R1	R2	R2
Rated Input Current Amps @ 40'C	4.6	6.6	7.5	11.8	16.7	24.2	30.8
Output Current Amps@ 40'C	**4.6**	**6.6**	**7.5**	**11.8**	**16.7**	**24.2**	**30.8**
Overload Current Rating 10% for 1 min per 10 minutes	5.06	7.26	8.25	12.98	18.37	26.62	33.88
Rated Input Voltage	208/220/230/240 VAC 3 phase (or 1-phase with derate) +10% -15%						
Input Frequency	48-63 Hz						
Imbalance	maximum +/- 3% of nominal phase to phase input voltage						
Fundamental Power Factor (cos phi)	0.98 at nominal load						
Max Output Voltage	0 to voltage input max						
Frequency Resolution	0.01Hz						
Recommended Maximum Class JJS Fuse Size Amps for VFD only	10	10	10	15	25	30	40
Maximum Power Cable Lug Size AWG for VFD only per ph.	8	8	8	8	8	6	6
Maximum motor cable length	100 meters (330 feet) max without output filters						
Heat Loss in watts 100 % load	55	55	73	116	161	227	285
Heat Loss in BTU/Hr 100 % load	189	189	249	404	551	776	373
Air Flow m3/h	44	44	44	44	44	88	88
Air Flow ft3/min	26	26	26	26	26	52	52
Efficiency: Approximately 98% at nominal load	Approximately 98% at nominal load						
Environment							
Ambient Temperature -15'C ... 40'C (5..104'F)	Ambient Temperature -15'C ... 40'C (5..104'F)						
Storage Temperature -40'C…70'C (-40'F….158'F)	Storage Temperature -40'C…70'C (-40'F….158'F)						
Humidity <95% non condensing	Humidity <95% non condensing						
Altitude up to 1000m(3300 feet) without derate	Altitude up to 1000m(3300 feet) without derate						
Enclosure Nema 1	Enclosure Nema 1						
Sinusoidal Vibration (IEC 60068-2-6)	Mechanical conditions:Class 3M4 (IEC60721-3-3) , 2….9Hz 3.0mm (0.12in) , 9…200Hz 10m/s2 (33 ft/s2)						
Weight Lbs approximate	13.4	13.4	13.4	13.4	13.4	19.5	19.5
Weight kg approximate	6.09	6.09	6.09	6.09	6.09	8.85	8.85
Output Current Derating							
Temperature 1% per degree C above 40'C IE: 50'C=output* 0.90	Temperature 1% per degree C above 40'C IE: 50'C=output* 0.90						
Altitude: 1% of output for every 100meters above 1000	Altitude: 1% of output for every 100meters above 1000						
Single Phase supply for 208-240v drives derate output by 50%	Single Phase supply for 208-240v drives derate output by 50%						
Switching Freq if 8KHZ is used derate output current to 80%	Switching Freq if 8KHZ is used derate output current to 80%						

Note: Single phase 208-240 VAC input available on base drive only.
Output will be 3 phase to motor. Bypass will not work on single phase input.
Consult YORK Marketing for single phase applications.

Performance Data *(continued)*

208-240 VAC (046A-2 to 221A-2)

YORK Model	AYK 550-UH	AYK 550-UH	AYK 550-UH	AYK 550-UH	AYK 550-UH	AYK 550-UH	AYK 550-UH	AYK 550-UH
Series	-046A-2+K465	-059A-2+K465	-075A-2+K465	-088A-2+K465	-114A-2+K465	-143A-2+K465	-178A-2+K465	-221A-2+K465
Motor Horsepower	**15**	**20**	**25**	**30**	**40**	**50**	**60**	**75**
Motor kW	11	15	18.5	22	30	37	45	55
Drive Frame Size	R3	R3	R4	R4	R4	R6	R6	R6
Rated Input Current Amps @ 40'C	46.2	59.4	74.8	88	114	143	178	221
Output Current Amps@ 40'C	**46.2**	**59.4**	**74.8**	**88**	**114**	**143**	**178**	**221**
Overload Current Rating 10% for 1 min per 10 minutes	50.82	65.34	82.28	96.8	125.4	157.3	195.8	243.1
Rated Input Voltage	208/220/230/240 VAC 3 phase (or 1-phase with derate) +10% -15%							
Input Frequency	48-63 Hz							
Imbalance	maximum +/- 3% of nominal phase to phase input voltage							
Fundamental Power Factor (cos phi)	0.98 at nominal load							
Max Output Voltage	0 to voltage input max							
Frequency Resolution	0.01Hz							
Recommended Maximum Class JJS Fuse Size Amps for VFD only	60	80	100	110	150	200	250	300
Maximum Power Cable Lug Size AWG for VFD only per ph.	3	3	1/0	1/0	1/0	350MCM	350MCM	350MCM
Maximum motor cable length	100 meters (330 feet) max without output filters							
Heat Loss in watts 100 % load	420	536	671	786	1014	1268	1575	1952
Heat Loss in BTU/Hr 100 % load	1434	1829	2290	2685	3463	4431	5379	6666
Air Flow m3/h	134	134	280	280	280	405	405	405
Air Flow ft3/min	79	79	165	165	165	238	238	238
Efficiency: Approximately 98% at nominal load	Approximately 98% at nominal load							
Environment								
Ambient Temperature -15'C ... 40'C (5..104'F)	Ambient Temperature -15'C ... 40'C (5..104'F)							
Storage Temperature -40'C…70'C (-40'F….158'F)	Storage Temperature -40'C…70'C (-40'F….158'F)							
Humidity <95% non condensing	Humidity <95% non condensing							
Altitude up to 1000m(3300 feet) without derate	Altitude up to 1000m(3300 feet) without derate							
Enclosure Nema 1	Enclosure Nema 1							
Sinusoidal Vibration (IEC 60068-2-6)	Mechanical conditions:Class 3M4 (IEC60721-3-3) , 2….9Hz 3.0mm (0.12in) , 9…200Hz 10m/s2 (33 ft/s2)							
Weight Lbs approximate	32.4	32.4	49.5	49.5	49.5	132	132	132
Weight kg approximate	14.73	14.73	22.45	22.45	22.45	59.88	59.88	59.88
Output Current Derating								
Temperature 1% per degree C above 40'C IE: 50'C=output* 0.90	Temperature 1% per degree C above 40'C IE: 50'C=output* 0.90							
Altitude: 1% of output for every 100meters above 1000	Altitude: 1% of output for every 100meters above 1000							
Single Phase supply for 208-240v drives derate output by 50%	Single Phase supply for 208-240v drives derate output by 50%							
Switching Freq if 8KHZ is used derate output current to 80%	Switching Freq if 8KHZ is used derate output current to 80%							

Note: Single phase 208-240 VAC input available on base drive only.
Output will be 3 phase to motor. Bypass will not work on single phase input.
Consult YORK Marketing for single phase applications.

Performance Data *(continued)*

380-480 VAC (03A3-4 to 038A-4)

YORK Model	AYK 550-UH	AYK 550-UH	AYK 550-UH	AYK 550-UH	AYK 550-UH	AYK 550-UH	AYK 550-UH	AYK 550-UH	AYK 550-UH
Series	-03A3-4+K465	-04A1-4+K465	-06A9-4+K465	-08A8-4+K465	-012A-4+K465	-015A-4+K465	-023A-4+K465	-031A-4+K465	-038A-4+K465
Motor Horsepower	**1.5**	**2**	**3**	**5**	**7.5**	**10**	**15**	**20**	**25**
Motor kW	1.1	1.5	3	4	5.5	7.5	11	15	18.5
Drive Frame Size	R1	R1	R1	R1	R1	R2	R2	R3	R3
Rated Input Current Amps @ 40'C	3.3	4.1	6.9	8.8	11.9	15.4	23	31	38
Output Current Amps@ 40'C	**3.3**	**4.1**	**6.9**	**8.8**	**11.9**	**15.4**	**23**	**31**	**38**
Overload Current Rating 10% for 1 min per 10 minutes	3.63	4.51	7.59	9.68	13.09	16.94	25.3	34.1	41.8
Rated Input Voltage	380/400/415/440/460/480 +10% -15% VAC 3 phase								
Input Frequency	48-63 Hz								
Imbalance	maximum +/- 3% of nominal phase to phase input voltage								
Fundamental Power Factor (cos phi)	0.98 at nominal load								
Max Output Voltage	0 to voltage input max								
Frequency Resolution	0.01Hz								
Recommended Maximum Class JJS Fuse Size Amps for VFD only	10	10	10	15	15	20	30	40	50
Maximum Power Cable Lug Size AWG on VFD only per ph.	8	8	8	8	8	6	6	3	3
Maximum motor cable length	100 meters (330 feet) max without output filters								
Heat Loss in watts 100 % load	40	52	73	127	172	232	337	457	562
Heat Loss in BTU/Hr 100 % load	137	177	249	433	587	792	1150	1560	1918
Air Flow m3/h	44	44	44	44	44	88	88	134	134
Air Flow ft3/min	26	26	26	26	26	52	52	79	79
Efficiency: Approximately 98% at nominal load	Efficiency: Approximately 98% at nominal load								
Environment									
Ambient Temperature -15'C ... 40'C (5..104'F)	Ambient Temperature -15'C ... 40'C (5..104'F)								
Storage Temperature -40'C…70'C (-40'F….158'F)	Storage Temperature -40'C…70'C (-40'F….158'F)								
Humidity <95% non condensing	Humidity <95% non condensing								
Altitude up to 1000m(3300 feet) without derate	Altitude up to 1000m (3300 feet) without derate								
Enclosure Nema 1	Enclosure Nema 1								
Sinusoidal Vibration (IEC 60068-2-6)	Mechanical conditions:Class 3M4 (IEC60721-3-3) , 2….9Hz 3.0mm (0.12in) , 9…200Hz 10m/s2 (33 ft/s2)								
Weight Lbs approximate	13.4	13.4	13.4	13.4	13.4	19.5	19.5	32.4	32.4
Weight kg approximate	6.09	6.09	6.09	6.09	6.09	8.85	8.85	14.73	14.73
Output Current Derating									
Temperature 1% per degree C above 40'C IE: 50'C=output* 0.90	Temperature 1% per degree C above 40'C IE: 50'C=output* 0.90								
Altitude: 1% of output for every 100meters above 1000	Altitude: 1% of output for every 100meters above 1000								
Switching Freq if 8KHZ is used derate output current to 80%	Switching Freq if 8KHZ is used derate output current to 80%								

380-480 VAC (044A-4 to 180A-4)

YORK Model	AYK 550-UH	AYK 550-UH	AYK 550-UH	AYK 550-UH	AYK 550-UH	AYK 550-UH	AYK 550-UH	AYK 550-UH
Series	-044A-4+K465	-059A-4+K465	-072A-4+K465	-077A-4+K465	-096A-4+K465	-124A-4+K465	-157A-4+K465	-180A-4+K465
Motor Horsepower	**30**	**40**	**50**	**60**	**75**	**100**	**125**	**150**
Motor kW	22	30	37	n/a	45	55	75	90
Drive Frame Size	R4	R4	R4	R5	R5	R6	R6	R6
Rated Input Current Amps @ 40'C	44	59	72	77	96	124	157	180
Output Current Amps@ 40'C	**44**	**59**	**72**	**77**	**96**	**124**	**157**	**180**
Overload Current Rating 10% for 1 min per 10 minutes	48.4	64.9	79.2	84.7	105.6	136.4	172.7	198
Rated Input Voltage	380/400/415/440/460/480 +10% -15% VAC 3 phase							
Input Frequency	48-63 Hz							
Imbalance	maximum +/- 3% of nominal phase to phase input voltage							
Fundamental Power Factor (cos phi)	0.98 at nominal load							
Max Output Voltage	0 to voltage input max							
Frequency Resolution	0.01Hz							
Recommended Maximum Class JJS Fuse Size Amps for VFD only	60	80	90	100	125	175	200	250
Maximum Power Cable Lug Size AWG on VFD only per ph.	1/0	1/0	1/0	2/0	2/0	350MCM	350MCM	350MCM
Maximum motor cable length	100 meters (330 feet) max without output filters							
Heat Loss in watts 100 % load	667	907	1120	1295	1440	1940	2310	2810
Heat Loss in BTU/Hr 100 % load	2276	3096	3820	4420	4915	6621	7884	9590
Air Flow m3/h	280	280	280	168	168	405	405	405
Air Flow ft3/min	165	165	165	99	99	238	238	238
Efficiency: Approximately 98% at nominal load	Efficiency: Approximately 98% at nominal load							
Environment								
Ambient Temperature -15'C ... 40'C (5..104'F)	Ambient Temperature -15'C ... 40'C (5..104'F)							
Storage Temperature -40'C…70'C (-40'F….158'F)	Storage Temperature -40'C…70'C (-40'F….158'F)							
Humidity <95% non condensing	Humidity <95% non condensing							
Altitude up to 1000m(3300 feet) without derate	Altitude up to 1000m (3300 feet) without derate							
Enclosure Nema 1	Enclosure Nema 1							
Sinusoidal Vibration (IEC 60068-2-6)	Mechanical conditions:Class 3M4 (IEC60721-3-3) , 2….9Hz 3.0mm (0.12in) , 9…200Hz 10m/s2 (33 ft/s2)							
Weight Lbs approximate	49.5	49.5	49.5	66	66	132	132	132
Weight kg approximate	22.45	22.45	22.45	29.94	29.94	59.88	59.88	59.88
Output Current Derating								
Temperature 1% per degree C above 40'C IE: 50'C=output* 0.90	Temperature 1% per degree C above 40'C IE: 50'C=output* 0.90							
Altitude: 1% of output for every 100meters above 1000	Altitude: 1% of output for every 100meters above 1000							
Switching Freq if 8KHZ is used derate output current to 80%	Switching Freq if 8KHZ is used derate output current to 80%							

Performance Data *(continued)*

500-600 VAC (02A7-6 to 027A-6)

York Model Series	AYK550-UH-02A7-6+K465	AYK550-UH-03A9-6+K465	AYK550-UH-06A1-6+K465	AYK550-UH-09A0-6+K465	AYK550-UH-011A-6+K465	AYK550-UH-017A-6+K465	AYK550-UH-022A-6+K465	AYK550-UH-027A-6+K465
Motor Horsepower	**2**	**3**	**5**	**7.5**	**10**	**15**	**20**	**25**
Motor kW	1	2	4	6	7	11	15	19
Drive Frame Size	R2	R2	R2	R2	R2	R2	R3	R3
Rated Input Current Amps @ 40'C	2.7	3.9	6.1	9	11	17	22	27
Output Current Amps@ 40'C	**2.7**	**3.9**	**6.1**	**9**	**11**	**17**	**22**	**27**
Overload Current Rating 10% for 1 min per 10 minutes								
Rated Input Voltage	500/525/575/600 +10% -15% VAC 3 phase							
Input Frequency	48-63 Hz							
Imbalance	maximum +/- 3% of nominal phase to phase input voltage							
Fundamental Power Factor (cos phi)	0.98 at nominal load							
Max Output Voltage	0 to voltage input max							
Frequency Resolution	0.01Hz							
Recommended Maximum Class JJS Fuse Size Amps for VFD only	10	10	10	15	15	25	25	40
Maximum Power Cable Lug Size AWG on VFD only per ph.	6	6	6	6	6	6	3	3
Maximum motor cable length	100 meters (330 feet) max without output filters (filters recommended for motor dv/dt protection)							
Heat Loss in watts 100 % load	46	68	124	170	232	337	457	562
Heat Loss in BTU/Hr 100 % load	157	232	423	581	792	1150	1560	1918
Air Flow m3/h	88	88	88	88	88	88	134	134
Air Flow ft3/min	52	52	52	52	52	52	79	79
Efficiency: Approximately 98% at nominal load								
Environment								
Ambient Temperature -15'C ... 40'C (5..104'F)								
Storage Temperature -40'C…70'C (-40'F….158'F)	Storage Temperature -40'C…70'C (-40'F….158'F)							
Humidity <95% non condensing	Humidity <95% non condensing							
Altitude up to 1000m(3300 feet) without derate	Altitude up to 1000m(3300 feet) without derate							
Enclosure Nema 1	Enclosure Nema 1							
Sinusoidal Vibration (IEC 60068-2-6)	Mechanical conditions:Class 3M4 (IEC60721-3-3) , 2….9Hz 3.0mm (0.12in) , 9…200Hz 10m/s2 (33 ft/s2)							
Weight Lbs approximate	19.8	19.8	19.8	19.8	19.8	19.8	35	35
Weight kg approximate	9	9	9	9	9	9	16	16
Output Current Derating								
Temperature 1% per degree C above 40'C IE: 50'C=output* 0.90	Temperature 1% per degree C above 40'C IE: 50'C=output* 0.90							
Altitude: 1% of output for every 100meters above 1000	Altitude: 1% of output for every 100 meters above 1000							
Switching Freq if 8KHZ is used derate output current to 80%	Switching Freq if 8KHZ is used derate output current to 80%							

500-600 VAC (032A-6 to 144A-6)

York Model Series	AYK550-UH-032A-6+K465	AYK550-UH-041A-6+K465	AYK550-UH-052A-6+K465	AYK550-UH-062A-6+K465	AYK550-UH-077A-6+K465	AYK550-UH-099A-6+K465	AYK550-UH-125A-6+K465	AYK550-UH-144A-6+K465
Motor Horsepower	**30**	**40**	**50**	**60**	**75**	**100**	**125**	**150**
Motor kW	22	30	37	45	56	75	93	112
Drive Frame Size	R4	R4	R4	R4	R6	R6	R6	R6
Rated Input Current Amps @ 40'C	32	41	52	62	77	99	125	144
Output Current Amps@ 40'C	**32**	**41**	**52**	**62**	**77**	**99**	**125**	**144**
Overload Current Rating 10% for 1 min per 10 minutes								
Rated Input Voltage	500/525/575/600 +10% -15% VAC 3 phase							
Input Frequency	48-63 Hz							
Imbalance	maximum +/- 3% of nominal phase to phase input voltage							
Fundamental Power Factor (cos phi)	0.98 at nominal load							
Max Output Voltage	0 to voltage input max							
Frequency Resolution	0.01Hz							
Recommended Maximum Class JJS Fuse Size Amps for VFD only	40	50	60	80	100	150	175	200
Maximum Power Cable Lug Size AWG on VFD only per ph.	1/0	1/0	1/0	1/0	350MCM	350MCM	350MCM	350MCM
Maximum motor cable length	100 meters (330 feet) max without output filters (filters recommended for motor dv/dt protection)							
Heat Loss in watts 100 % load	667	907	1120	1295	1504	1821	2442	2813
Heat Loss in BTU/Hr 100 % load	2256	3096	3820	4420	5136	6219	8339	9607
Air Flow m3/h	280	280	280	280	405	405	405	405
Air Flow ft3/min	165	165	165	165	238	238	238	238
Efficiency: Approximately 98% at nominal load								
Environment								
Ambient Temperature -15'C ... 40'C (5..104'F)								
Storage Temperature -40'C…70'C (-40'F….158'F)	Storage Temperature -40'C…70'C (-40'F….158'F)							
Humidity <95% non condensing	Humidity <95% non condensing							
Altitude up to 1000m(3300 feet) without derate	Altitude up to 1000m(3300 feet) without derate							
Enclosure Nema 1	Enclosure Nema 1							
Sinusoidal Vibration (IEC 60068-2-6)	Mechanical conditions: Class 3M4(IEC60721-3-3) , 2….9Hz 3.0mm (0.12in) , 9…200Hz 10m/s2 (33 ft/s2)							
Weight Lbs approximate	53	53	53	53	152	152	152	152
Weight kg approximate	24	24	24	24	69	69	69	69
Output Current Derating								
Temperature 1% per degree C above 40'C IE: 50'C=output* 0.90	Temperature 1% per degree C above 40'C IE: 50'C=output* 0.90							
Altitude: 1% of output for every 100meters above 1000	Altitude: 1% of output for every 100meters above 1000							
Switching Freq if 8KHZ is used derate output current to 80%	Switching Freq if 8KHZ is used derate output current to 80%							

TABLE 7 – TEMPERATURE DERATING CHART

AMBIENT TEMP.		PERCENT DERATING
°F	°C	
104	40	0%
113	45	5%
122	50	10%

Temperature Derate example:

A 5HP, 460V at 122°F (50°C)
Drive FLA=8.8 x 0.90=7.92 amps

Note: Max Ambient Temperature
122°F (50°C) with a derate of 10%

TABLE 8 – ALTITUDE DERATING CHART

ALTITUDE		PERCENT DERATING Of Drive Output Amps
FEET	METERS	
3280	1000	0%
4920	1500	5%
6560	2000	10%

Altitude Derate Calculation Example:

A 5HP, 460V rated at 8.8 installed at
6560 ft. (2000m) altitude.
8.8 x 0.90 = 7.92 Amps

Derate 1% for each additional 330 feet (100m) above 3280 ft (1000m)

Carrier Frequency De-Rate:

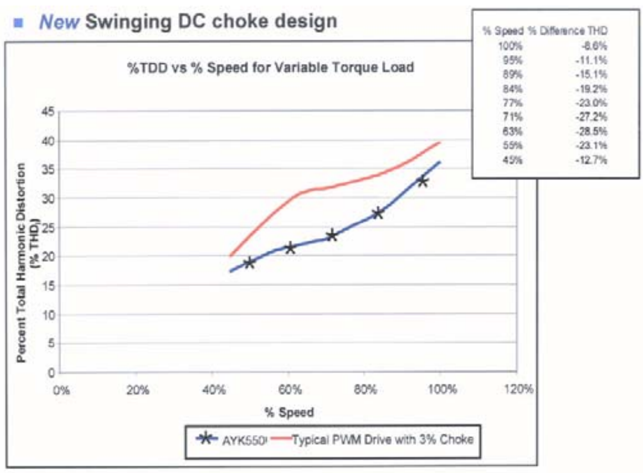
1-150HP
Default Setting: 4kHZ
Low Noise 8kHZ w/ 20% De-Rate

Example: VFD Output Current * .80
10HP, 460V, 15.4 amps x .80=12.32A
When Carrier Frequency Set for 8kHZ.

Top 10 Selling Features

The following key points are unique selling features to the YORK AYK550 Air-Modulator. These features should be emphasized to consultants, engineers, architects, and end users as they provide exceptional value and reliability compared to other VFDs on the market.

#1 New "Swinging DC Line Choke"
- Equivalent to 5% Input Line Reactor
- Designed to reduce harmonics at full and partial loads
- Perfect for variable torque centrifigual loads
- More inductance per volume/weight



#2 Improved Built-In RFI/EMI Filter
- Meets EMC EN61800-3 for First Environment restricted distribution 30 meter cable length
- CE marked for EMC compliance

#3 High Input Transient Protection
- 4 MOVs ahead of diode bridge for surge suppression
- 120 Joule rated 1600V diode module.
- Complies with UL 1449 ANSI 61.4

#4 New Current Measurement Technique
- More accurate signal for kW, Amps, kWHr
- More accurate metering at low loads

#5 Enhanced Control Board
- Fireman's override circuit for tie in to building fire management systems
- 2 programmable analog outputs
- 6 programmable digital inputs
- 3 programmable relay outputs (Form C)
- More EEPROM memory with enhanced software
- Faster responding analog and digital inputs
- Standard run permissive circuit to operate dampers before motor operation

#6 Advanced Numeric Keypad with:
- Start up, diagnostic and maintenance assistants
- Real-time clock
- Full graphic display with big bold letters
- Displays 3 process variables for monitoring
- Dedicated HELP key
- Backup and restore copy function
- Hand - OFF - Auto and Speed Up/Down buttons
- Intuitive to operate

#7 New Fault Logger
- Real-time "snapshot" of last 3 faults
  - fault name, time, speed, frequency, voltage, current, torque, DI status
- Logs up to 10 faults with fault name only

#8 Built-in Serial Communication Protocols
- Siemen's FLN, Johnson N2, Modbus RTU All embeded in firmware
- BACnet MS/TP, LONworks available as standard options

#9 Optimized Cooling Fan Design
- Logic controlled on/off operation tied to VFD operation
- Easily removable with one connection
- Complete fan change out in less than 1 minute

#10 High Fault Current
- UL rated to 100,000 AIC at 460VAC
- Package will meet demands of today's electrical systems
- Applies to Base Drive, AO, and CM options only. Factory mounted drive packages require SQ from YORK Marketing for High Fault Withstand.

YORK Package Configurations

The following Air-Mod configurations are available as standard product offerings:

Base Drive

"OO" Configuration

- AYK550 VFD
  NEMA 1 Rated
- NEMA 1 Conduit Box
- 100,000 AIC Fault
  Current Rated

Base Drive with Fused Disconnect

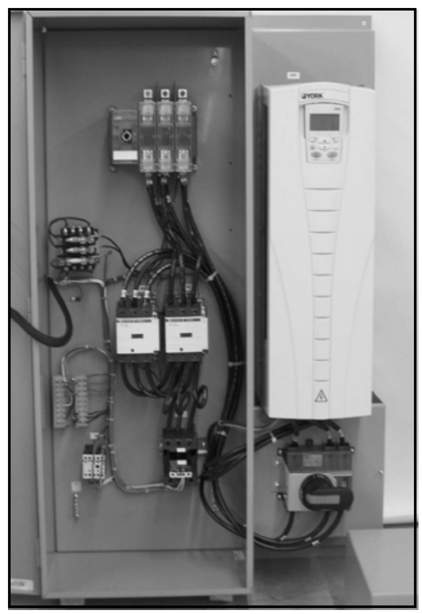
"AO" Configuration

- AYK550 VFD
  NEMA 1 Rated
- Fused Main Disconnect
  with Pad Lockable Handle
- 100,000 AIC Fault
  Current Rated

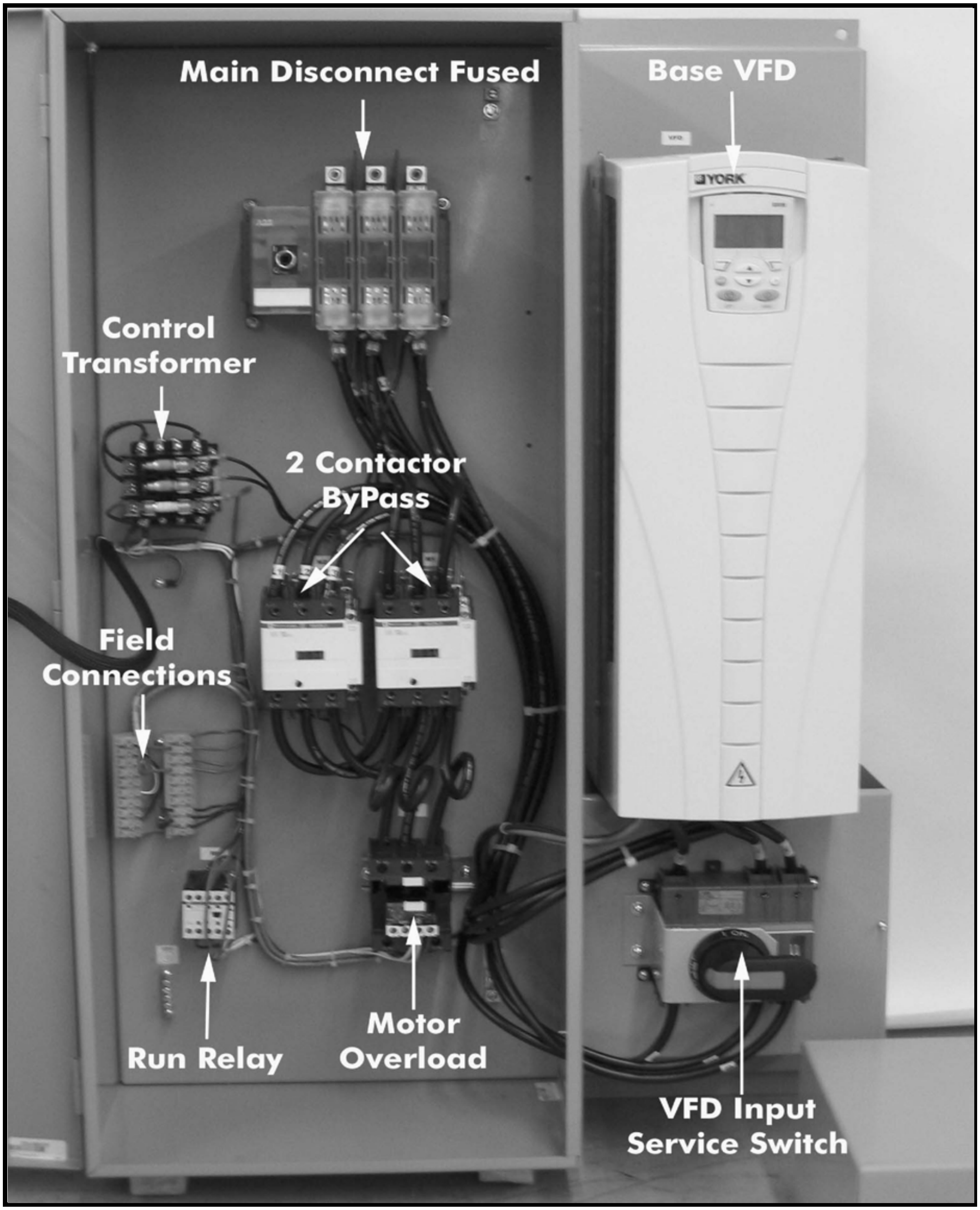
Base Drive with Bypass, VFD Service Disconnect, Main Fused Disconnect

"CM" Configuration

- AYK550 VFD NEMA 1 Rated
- Main Fused Disconnect Switch
  with Pad Lockable Handle
- VFD Input Service Disconnect Switch
  for Isolation During Repair
- 2 Contactor ByPass
- Class 20 Motor Overload
- Control Transformer
- VFD/Off/ByPass Selector
- Power On/Bypass On Pilot Light
- 100,000 AIC Fault Current Rated



"CM" Package with 2 Contactor Bypass, VFD Service Disconnect



SHOWN WITH COVERS REMOVED

Accessories and Options

Harmonic Mitigation

All Air-Mods come standard with a 5% equivalent input line reactor internal for the base VFD. In some installations with multiple drives and small source transformers, it may be necessary to add additional Harmonic Filters to limit distortion to levels outlined in IEEE519. YORK can perform a computer generated harmonic analysis to determine the harmonic impact of Air-Mods at a particular site. The MTE Matrix Filter can be used if required to mitigate harmonics. This filter ships loose in a NEMA 1 enclosure.

Harmonic Distortion Calculation

To calculate harmonics of a system, the following data must be supplied:

1) Source transformer kVA, impedance, and short circuit capacity
2) Total quantity of VFDs, HP, and voltage fed from source.
3) Total HP of other non-VFD loads (ie: full voltage starters)
4) If multiple source transformers are used to feed groups of VFDs, then a breakdown of HP groupings is required.
5) An electrical one-line diagram of distribution system.

MTE

MTE Matrix Filters solve the problem of harmonic distortion on virtually any kind of six pulse rectifier. These power supplies are commonly found in three phase electronic equipment such as adjustable speed motor drives, uninterruptable power supplies (UPS), welders, battery chargers, servo drives and other equipment.

UL Listed (UL-508C)

Matrix Harmonic Filters are UL Listed (File E180243) for both USA and Canada.

c UL us
LISTED
IND. CONTROL. EQ.
34HL

Meets International Power Quality Standards

IEEE-519, BS G5/4, AS2279,EN61000

Harmonics are a problem

Harmonic distortion has become an increasing concern for facility managers, users of automation equipment and specifying engineers alike. Harmonics not only waste energy, but they reduce equipment life, electrical system reliability, system efficiency and equipment productivity.

Guaranteed results

Unlike other harmonic filter technologies, the performance of MTE Matrix Harmonic Filters is guaranteed! On AC variable frequency, variable torque drive applications (fans & pumps), Matrix filters will meet the guaranteed maximum levels of THID (total harmonic current distortion) all the way from no load to full load. Additionally, Matrix filters will not cause power system resonance nor attract harmonics from other non-linear loads. No system analysis is required to select and apply Matrix Filters.

Convert 6-Pulse Drives to Multi-Pulse Harmonic Performance

Matrix filters allow users to achieve attenuation of harmonics to levels below that previously attainable only by using 12-pulse or 18-pulse rectification methods. Use standard 6-pulse drives and our M5 Series Matrix Filters in place of 18-pulse rectifiers and use our M8 Series in lieu of 12-pulse rectifiers.

Why are Matrix Filters Necessary?

They Increase Reliability

Matrix Filters reduce the burden on electrical equipment by reducing TRUE RMS (trms) current, peak current and harmonic frequency distortion. The series impedance included in the Matrix Filter also absorbs transient over voltages just like a line reactor, to prevent over voltage trips and rectifier damage. Increased system reliability means higher productivity.

They Increase Equipment Life

Matrix Filters reduce the trms current that flows through equipment feeding non-linear loads. This reduces the amount of heat generated by upstream equipment (such as transformers, disconnects, fuses, circuit breakers and conductors), thus extending their life expectancy.

They Reduce System Harmonics

Matrix Filters can reduce adjustable speed drive system harmonics to negligible levels.

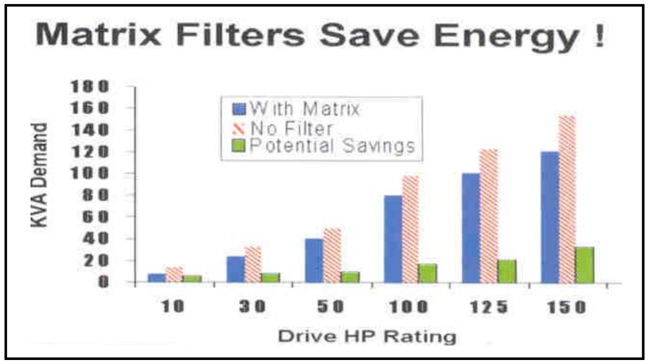
They Reduce Current Waveform Distortion

Matrix Filters improve the input current waveforms of non-linear loads to nearly sinusoidal. This results in lower peak current and trms current demands while achieving a cleaner power supply.

Internal Matrix Filter Components

They Save Energy!

By nearly eliminating the wasted energy associated with harmonics, Matrix Filters reduce the trms KVA demanded from a power source.



They Meet IEEE-519

Matrix Filters allow you to meet the voltage and current distortion limits of IEEE-519, EN61000, AS2279 and BS G5/4.

IEEE-519 Current Distortion Limits

I_{SC} / I_L	TDD (total demand distortion)
<20	5%
20<50	8%
50<100	12%
100<1000	15%
>1000	20%

where I_{SC} = short circuit current
I_L = load current

IEEE-519 Voltage Distortion Limits

Special applications (hospitals, airports)	3%
General systems applications	5%
Dedicated systems (100% converter load)	10%

M5 Series (5% THID)

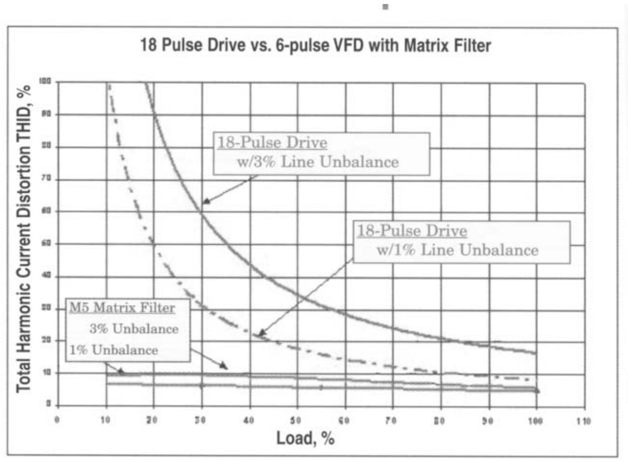
The M5 Series Matrix Filters typically achieve 5% THID at full load and guarantee worst case current distortion at any load between 0% and 100%, will be 8% THID or less at the filter input terminals. The M5 Series is typically used in applications requiring harmonic mitigation associated with 18-pulse rectifiers. The chart on the right compares the performance of Matrix Filters (M5 Series) to 18-pulse rectifiers in real world applications which include line voltage unbalance of 1% to 3% and loading conditions from 0% to 100%.

M5 Real World THID Comparison

1% & 3% Line Voltage Unbalance

0% to 100% Load conditions

Matrix vs. 18-pulse



M8 Series (8% THID)

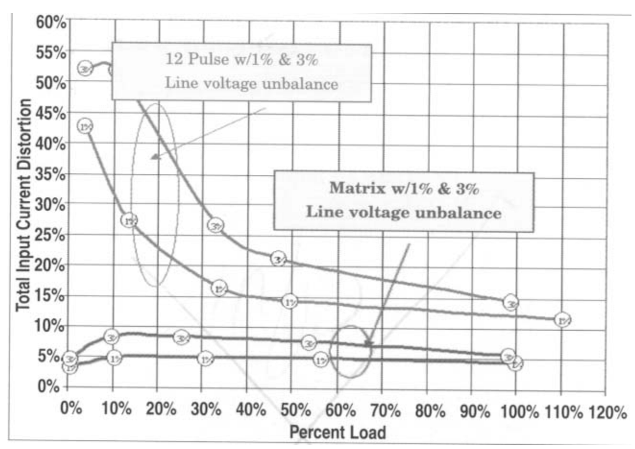
The M8 Series Matrix Filters typically achieve 8% THID at full load and guarantee worst case current distortion at any load between 0% and 100% will be 12% THID or less at the filter input terminals. The M8 Series is typically used in applications requiring harmonic mitigation associated with 12-pulse drives. The chart on the right compares the performance of Matrix Filters to 12-pulse rectifiers in real world applications which include line voltage unbalance of 1% to 3% and loading conditions from 0% to 100%.

M8 Real World THID Comparison

1% & 3% Line Voltage Unbalance

0% to 100% Load conditions

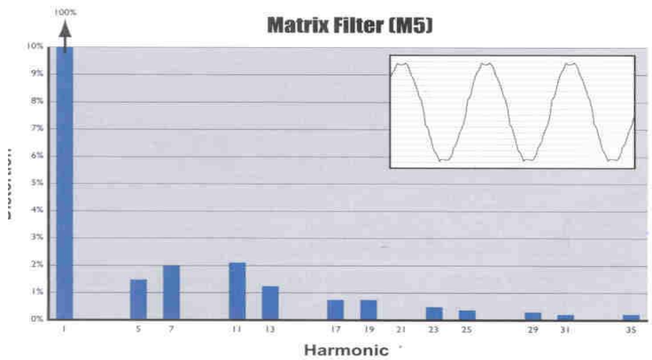
Matrix vs. 12-pulse



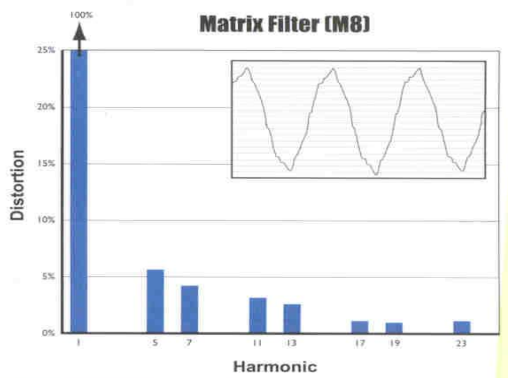
Matrix Filters Outperform Alternatives

Matrix Harmonic Filters can meet or exceed the harmonic mitigation performance of other common filtration methods. Unlike alternative solutions, Matrix Filters come with a performance guarantee. Compare the difference in waveform and harmonic spectrum for real life tests performed at full load conditions.

M5 Matrix Filters

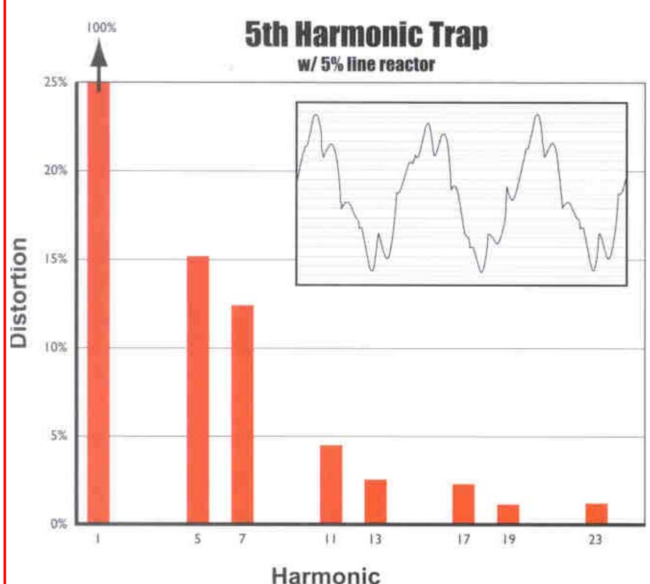


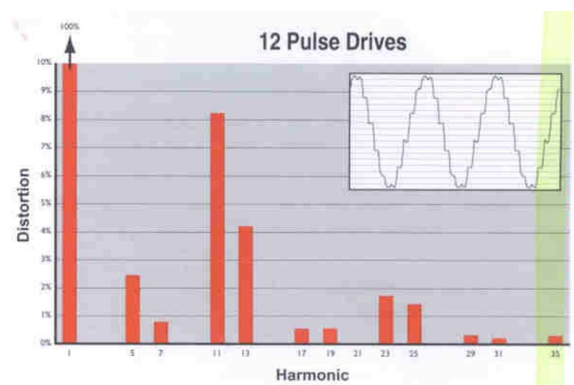
M8 Matrix Filters

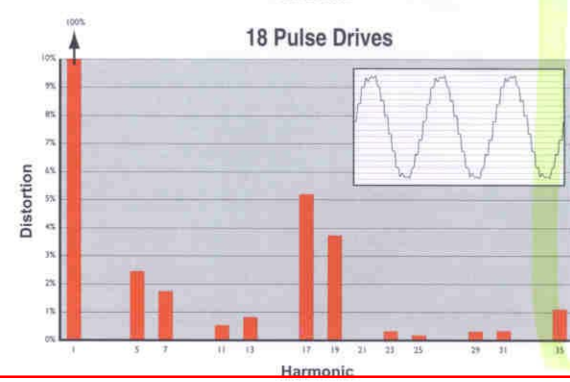


Performance of Alternative Methods

Matrix Filters attenuate harmonics better than these alternative filtering techniques. (Based on actual tests at full load)







12 Pulse and 18 Pulse Drives

Some consulting engineers specify 12 or 18 pulse VFDs in their systems to reduce harmonics. When a large number of drives are on a common source transformer, the level of harmonic distortion on the supply network can become unacceptable. 5% line reactors or Matrix Filters can be used to reduce harmonic distortion, but the 12 pulse rectifier also presents a solution. The 12 pulse VFD system consists of 2-pulse rectifiers, a custom phase shift input transformer, and an output IGBT module.

Although effective, they are generally very large and expensive compared to a standard Air-Mod with Matrix Filter Solution.

Note: These drives available by SQ request from YORK Marketing.

Isolation Transformers (IT) (Optional)

Isolation transformers or step transformers provide step-up or step-down capability to or from the drive and are available with primary voltages of 208V, 230V, 460V, and 575V. Isolation Transformers are shipped separate for field installation, NEMA 1 enclosed. Ratings are 150°C rise, 220°C insulation class, aluminum wound. Refer to Isolation Transformer Dimension Drawing, Form 100.04-PA1.6. For additional information, refer to YORK AIR MOD Power Conditioning Solutions Guide.

Pneumatic Interface

Alows the Air-Modulator to accept a standard 3-15 psi pneumatic control signal from the process controller. Device will be factory mounted into the "CM" option cabinet. Ships loose on OO, AO configurations.

AC Output Load Reactors

Output Load Reactors are used on installations requiring long motor lead lengths between 100-1000 ft. The output reactor is installed between the inverter and motor to reduce dV/dt and motor peak voltage. The use of an output load reactor also protects the inverter drive from a surge current caused by a rapid change in the load and even from a short circuit. For additional information, refer to YORK AIR MOD Power Conditioning Solutions Application Guide Form 100.40-EG1.1. Output load reactors will always ship loose in a NEMA 1 enclosure for field mounting. Reactor should be wired on VFD output circuit only.

RFI EMI Filters

Standard in all Air-Mods. The filters are internal in the base VFD and are designed to meet EMC Standard 61800-3 for first environment. Air-Mods carry the CE Mark for compliance to EU EMC directive.

Federal Communications Commission Regulations, Part 15, Requirements for Class A Digital Devices

As a means of minimizing possible problems due to radio frequency emissions from drives, specifiers sometimes require drives to comply with the requirements for Class A digital devices (computing devices) in Part 15 of the FCC regulations. Drives are not legally subject to the requirements of Part 15 because they are "exempted devices" as defined in Part 15. Since the specific requirements of Part 15 were designed to be applied to computers, calculators, electronic games and similar small equipment, they are not suitable for application to drives and other high power equipment. In particular, Part 15 does not include test methods and installation requirements that are suitable for high power equipment. Considering these limitations, better EMC compatibility is probably obtained by specifying CE marked equipment and assuring that it is installed according to the requirements for conformance with the EU EMC Directive. Contact YORK for installation instructions.

Serial Communication Protocols

All Air-Mods ship with standard embedded BACnet Siemens FLN, Johnson N2, and Modbus RTU.
- LonWorks Adapter (LON) - 78kBit/s free topology interface module for communications to a LonWorks network. The module uses a transceiver that is compatible with Echelon's Link Power FTT-10 Transceiver. The module plugs into an option slot on the base VFD. All protocols transmit data via RS485 twisted pair cables terminated to the base VFD.

Specifications

Common Performance Specifications

1. U.L., cU.L. Approved and CE Marked
2. Integral Input Line Reactor(s)
   Equivalent 5% Impedance
3. Integral RFI/EMI Filtering to Meet EMC
   EN61800-3
   First Environment
4. Multi-Character, 5-Line Multi-Lingual Alphanumeric Display for Operator Control, Parameter Set-up and Operating Data with Hand-Off-Auto Key and Speed Selection
5. Display:
   - Real Time Clock
   - Speed (RPM)
   - Output Frequency (Hz)
   - Motor Current
   - Calculated % Motor Torque
   - Calculated Motor Power (kW)
   - DC Bus Voltage
   - Output Voltage
   - Heatsink Temperature
   - Elapsed Time Meter (re-settable)
   - kWh Counter (resettable)
   - Input / Output Terminal Monitor
   - Analog Input Reference in %
   - Relay Output Status
   - PID Actual Value (Feedback) & Error
   - Fault Text
   - Warning Text
   - Scalable Process Variable Display
6. RS-485 Communications with Siemens FLN, Johnson N2, Modbus RTU Embedded in Firmware
7. Two (2) Analog Inputs
8. Six (6) Prorammable Digital Inputs
9. Two (2) Programmable Analog Output
   0(4)-20mA
10. Three (3) Programmable Digital Relay Outputs (Form C)
11. Adjustable Filters on Analog Inputs and Outputs
12. Input Speed Signals:
    - Current 0 (4) - 20 mA
    - Voltage 0 (2) - 10VDC
    - Accel/Decel Contacts (Floating Point Control)
    - RS-485 Communications
13. Start/Stop
    - 2 Wire (Dry Contact Closure)
    - 3 Wire (Momentary Contacts)
    - Application of Input Power
    - Application of Reference Signal
    - PID Sleep/Wake-up
14. Operator Panel Download Function (read/write)
15. All Control Inputs Isolated from Ground and Power
16. Protection Circuits
    - Overcurrent
    - Ground Fault
    - Overvoltage
    - Undervoltage
    - Overtemperature
    - Input Power Loss of Phase
    - Loss of Reference / Feedback
    - Adjustable Current Limit Regulator
    - UL508C Approved Electronic Motor Overload (I2t)
    - DC Bus Overvoltage
    - Overload
17. Premagnetization on Start
18. DC Braking / Hold at Stop
19. Auto Restart-Customer Selectable and Adjustable
20. Two (2) Sets of Independently Adjustable Accel and Decel Ramps
21. Linear or "S" Curve Accel/Decel Ramps
22. Ramp or Coast to Stop
23. Programmable Maximum Frequency to 500 Hz
24. Two (2) Integral PID Setpoint Controller(s)
25. Seven (7) Preset Speeds
26. Three (3) Critical Frequency Lockout Bands
27. V/Hz Shape, Linear or Squared
28. Start Functions
    - Ramp
    - Flying Start
    - Automatic Torque Boost
    - Automatic Torque Boose with Flying Start
29. IR Compensation
30. Slip Compensation
31. Automatic Extended Power Loss Ride Through (selectable)
32. Optional Serial Communication Protocols
    - BACnet MS/TP
    - LonWorks

Specifications *(continued)*

Input Connection	
Voltage (V_{IN})	3 phase, 208 ... 240VAC +10% -15% 3 phase, 380 ... 480VAC +10% -15% 3 phase, 500 ... 600VAC +10% -15%
Frequency	48 ... 63Hz
Power Factor: For Fundamental	~0.98
Efficiency	<97%
Motor Connection	
Output Voltage	3Ø 0 to V_{IN} (V_{max} at field weakening point)
Output Frequency	0 to 500Hz
Frequency Resolution	0.01Hz Digital analog input 1 & 2 resolution 0.1%
Switching Frequency f_s (20% derate @ 8 kHZ)	4.0, 8.0 kHz
Continuous Output Current:	
Variable Torque	Rated I_N (Nominal rated current, Variable Torque)
Overload Capacity:	
Variable Torque	1.1 x I_N, for 1 min every 10 min
Field Weakening Point	30 to 500Hz
Acceleration Time	0.1 to 1800 sec.
Deceleration Time	0.1 to 1800 sec.
Enclosure	UL / NEMA Type 1
Environmental limits:	
Ambient Operating Temperature (f_s=4 kHz):	40°C Continuous Max 50° C with 10% derate
Variable Torque NEMA Type 1	5 to 104° F (-15 to 40° C)
Storage Temperature	-40° to +158° F (-40C° to 70° C)
Cooling Method	Integral fan(s)
Relative Humidity	max 95%, no condensation allowed
Altitude: Maximum	3300 ft. (1000 m) above sea level (100% load) 1% derating every 330 ft. above 3300 ft.
Agency Approval	UL, cUL, CE
External Control Connections	
Two Programmable Analog Inputs:	
Voltage Reference	0 (2) to 10V, 312k ohm single ended
Current Reference	0 (4) to 20 mA, 100 ohms single ended
Potentiometer	10 VDC, 10 mA (1K to 10K ohms)
Auxiliary Voltage	+24 VDC, max 250mA
Six Programmable Digital Inputs	24 VDC
Response Delay	<8ms
Two Programmable Analog Output	0 (4) to 20 mA, 500 ohms max.
Three Programmable Relay (Form C) Outputs:	
Max Voltage	30 VDC / 250 VAC
Max Contact Current	6 A / 30 VDC, 1500 VAC/250VAC
Max Switching Power	1500 VA / 250 VAC
Max Continuous Current	2A rms
Response Delay	<10ms
Protections:	
Overcurrent Trip Limit	3.5 x I_N instantaneous
Adjustable Current Regulation Limit	1.1 x I_N (RMS) max.
Overvoltage Trip Limit	1.35 x V_R
Undervoltage Trip Limit	0.65 x V_N
Overtemperature (Heatsink)	+203°F (+95°C) max freq foldback @ 140° F 60° C
Auxiliary Voltage	Short Circuit Protected
Ground Fault	Protected
Short Circuit	Protected
Microprocessor Fault	Protected
Motor Stall Protection	Protected
Motor Overtemperature Protection (I^2t)	Protected
Input Power Loss of Phase	Protected
Loss of Reference	Protected
Short Circuit Current Rating	100,000 RMS Symmetrical Amperes
Input Line Impedance	5% with Standard Internal Reactors

Specifications are subject to change without notice. Please consult the factory when specifications are critical.

Guide Specifications

PART 1-GENERAL

1.01 DESCRIPTION

A. This specification is to cover a complete Variable Frequency motor Drive (VFD) consisting of a pulse width modulated (PWM) inverter designed for use on a standard NEMA Design B induction motor. It is required that the drive manufacturer have an existing:
   - Sales representative exclusively for HVAC products, with expertise in HVAC systems and controls.
   - An independent service organization.

B. The drive manufacturer shall supply the drive and all necessary controls as herein specified. The manufacturer shall have been engaged in the production of this type of equipment for a minimum of twenty years.

1.02 QUALITY ASSURANCE

A. Referenced Standards:
   1. Institute of Electrical and Electronic Engineers (IEEE)
      a) Standard 519-1992, IEEE Guide for Harmonic Content and Control.
   2. Underwriters laboratories
      a) UL508C
      b) UL508A
   3. National Electrical Manufacturer's Association (NEMA)
      a) ICS 7.0, AC Variable Speed Drives
   4. IEC 16800 Parts 1 and 2

B. Qualifications:
   1. VFDs and options shall be UL listed as a complete assembly. VFD's that require the customer to supply external fuses for the VFD to be UL listed are not acceptable. The base VFD shall be UL listed for 100 KAIC at 480VAC max without the need for input fuses.
      a) (OPTION) The VFD shall have an option for a main fused disconnect switch with a pad lockable handle UL type 1 enclosed with a coordinated package withstand rating of 100 KAIC at 480VAC max and shall be UL labeled as such.
      b) (OPTION) The VFD shall have an option for a main fused disconnect switch with a pad lockable handle, a VFD service disconnect switch to isolate the VFD input and a 2 contactor bypass with motor overload protection in a UL Type 1 enclosure with a coordinated package withstand rating of 100 KAIC at 480VAC max and shall be UL labeled as such.
   2. CE Mark – The VFD shall conform to the European Union ElectroMagnetic Compatibility directive, a requirement for CE marking. The VFD shall meet product standard EN 61800-3 for the First Environment restricted level.
   3. Acceptable Manufactures
      a) YORK AYK Series.
      b) Engineer approved within 2 weeks of bid. Approval does not relieve supplier of specification requirements.

1.03 SUBMITTALS

A. Submittals shall include the following information:
   1. Outline dimensions, conduit entry locations and weight.
   2. Customer connection and power wiring diagrams.
   3. Complete technical product description include a complete list of options provided
   4. Compliance to IEEE 519 – harmonic analysis for particular jobsite including total harmonic voltage distortion and total harmonic current distortion (TDD).
      a) The VFD manufacture shall provide calculations, specific to this installation, showing total harmonic voltage distortion is less than 5%. Input line filters shall be sized and provided as required by the VFD manufacturer to ensure compliance with IEEE standard 519. All VFD's shall include a minimum of 5% impedance reactors, **no exceptions**.

PART 2 – PRODUCTS

2.01 VARIABLE FREQUENCY DRIVES

A. The VFD package as specified herein shall be enclosed in a UL Listed Type 1 enclosure, completely assembled and tested by the manufacturer in an ISO9001 facility. The VFD tolerated voltage window shall allow the VFD to operate from a line of +30% nominal, and -35% nominal voltage as a minimum.
   1. Environmental operating conditions: 0 to 40°C continuous. VFD's that can operate at 40° C intermittently (during a 24 hour period) are not acceptable and must be oversized. Altitude 0 to 3300 feet above sea level, less than 95% humidity, non-condensing.
   2. Enclosure shall be rated UL type 1 and shall be UL listed as a plenum rated VFD. VFD's

without these ratings are not acceptable.

3. An optional UL Type 3R outdoor weatherproof enclosure option shall be available as a standard offering.
4. An optional UL Type 12 enclosure option shall be available as a standard offering.

B. All VFDs shall have the following standard features:

1. All VFDs shall have the same customer interface, including digital display, and keypad, regardless of horsepower rating. The keypad shall be removable, capable of remote mounting and allow for uploading and downloading of parameter settings as an aid for start-up of multiple VFDs.
2. The keypad shall include Hand-Off-Auto selections and manual speed control. The drive shall incorporate "bumpless transfer" of speed reference when switching between "Hand" and "Auto" modes. There shall be fault reset and "Help" buttons on the keypad. The Help button shall include "on-line" assistance for programming and troubleshooting.
3. There shall be a built-in time clock in the VFD keypad. The clock shall have a battery back up with 10 years minimum life span. The clock shall be used to date and time stamp faults and record operating parameters at the time of fault. If the battery fails, the VFD shall automatically revert to hours of operation since initial power up. The clock shall also be programmable to control start/stop functions, constant speeds, PID parameter sets and output relays. The VFD shall have a digital input that allows an override to the time clock (when in the off mode) for a programmable time frame. There shall be four (4) separate, independent timer functions that have both weekday and weekend settings.
4. The VFD's shall utilize pre-programmed application macro's specifically designed to facilitate start-up. The Application Macros shall provide one command to reprogram all parameters and customer interfaces for a particular application to reduce programming time. The VFD shall have two user macros to allow the end-user to create and save custom settings.
5. The VFD shall have cooling fans that are designed for easy replacement. The fans shall be designed for replacement without requiring removing the VFD from the wall or removal of circuit boards. The VFD cooling fans shall operate only when required. To extend the fan and bearing operating life, operating temperature will be monitored and used to cycle the fans on and off as required.
6. The VFD shall be capable of starting into a coasting load (forward or reverse) up to full speed and accelerate or decelerate to setpoint without safety tripping or component damage (flying start).
7. The VFD shall have the ability to automatically restart after an over-current, over-voltage, under-voltage, or loss of input signal protective trip. The number of restart attempts, trial time, and time between attempts shall be programmable.
8. The overload rating of the drive shall be 110% of its normal duty current rating for 1 minute every 10 minutes, 130% overload for 2 seconds. The minimum FLA rating shall meet or exceed the values in the NEC/UL table 430-150 for 4-pole motors.
9. The VFD shall have an integral 5% impedance line reactors to reduce the harmonics to the power line and to add protection from AC line transients. The 5% impedance may be from dual (positive and negative DC bus) reactors, or 5% AC line reactors. VFD's with only one DC reactor shall add AC line reactors.
10. The VFD shall include a coordinated AC transient protection system consisting of 4-120 joule rated MOV's (phase to phase and phase to ground), a capacitor clamp, and 5% impedance reactors.
11. The VFD shall be capable of sensing a loss of load (broken belt / broken coupling) and signal the loss of load condition. The drive shall be programmable to signal this condition via a keypad warning, relay output and/or over the serial communications bus. Relay outputs shall include programmable time delays that will allow for drive acceleration from zero speed without signaling a false underload condition.
12. If the input reference (4-20mA or 2-10V) is lost, the VFD shall give the user the option of either (1) stopping and displaying a fault, (2) running at a programmable preset speed, (3) hold the VFD speed based on the last good reference received, or (4) cause a warning to be issued, as selected by the user. The drive shall be programmable to signal this condition via a keypad warning, relay output and/or over the serial communication bus.
13. The VFD shall have programmable "Sleep" and "Wake up" functions to allow the drive to be started and stopped from the level of a process feedback signal.

D. All VFDs to have the following adjustments:
1. Three (3) programmable critical frequency lockout ranges to prevent the VFD from operating the load continuously at an unstable speed.
2. Two (2) PID Setpoint controllers shall be standard in the drive, allowing pressure or flow signals to be connected to the VFD, using the microprocessor in the VFD for the closed loop control. The VFD shall have 250 ma of 24 VDC auxiliary power and be capable of loop powering a transmitter supplied by others. The PID setpoint shall be adjustable from the VFD keypad, analog inputs, or over the communications bus. There shall be two parameter sets for the first PID that allow the sets to be switched via a digital input, serial communications or from the keypad for night setback, summer/winter setpoints, etc. There shall be an independent, second PID loop that can utilize the second analog input and modulate one of the analog outputs to maintain setpoint of an independent process (ie. valves, dampers, etc.). All setpoints, process variables, etc. to be accessible from the serial communication network. The setpoints shall be set in Engineering units and not require a percentage of the transducer input.
3. Two (2) programmable analog inputs shall accept current or voltage signals.
4. Two (2) programmable analog outputs (0-20ma or 4-20 ma). The outputs may be programmed to output proportional to Frequency, Motor Speed, Output Voltage, Output Current, Motor Torque, Motor Power (kW), DC Bus voltage, Active Reference, and other data.
5. Six (6) programmable digital inputs for maximum flexibility in interfacing with external devices, typically programmed as follows:

   There shall be a run permissive circuit for damper or valve control. Regardless of the source of a run command (keypad, input contact closure, time-clock control, or serial communications) the VFD shall provide a dry contact closure that will signal the damper to open (VFD motor does not operate). When the damper is fully open, a normally open dry contact (end-switch) shall close. The closed end-switch is wired to an VFD digital input and allows VFD motor operation. Two separate safety interlock inputs shall be provided. When either safety is opened, the motor shall be commanded to coast to stop, and the damper shall be commanded to close. The keypad shall display “start enable 1 (or 2) missing”. The safety status shall also be transmitted over the serial communications bus. All digital inputs shall be programmable to initiate upon an application or removal of 24VDC.
6. Three (3) programmable digital Form-C relay outputs. The relays shall include programmable on and off delay times and adjustable hysteresis. Default settings shall be for run, not faulted (fail safe), and run permissive. The relays shall be rated for maximum switching current 8 amps at 24 VDC and 0.4 A at 250 VAC; Maximum voltage 300 VDC and 250 VAC; continuous current rating 2 amps RMS. Outputs shall be true form C type contacts; open collector outputs are not acceptable.
7. Seven (7) programmable preset speeds.
8. Two independently adjustable accel and decel ramps with 1 – 1800 seconds adjustable time ramps.
9. The VFD shall include a motor flux optimization circuit that will automatically reduce applied motor voltage to the motor to optimize energy consumption and audible motor noise.
10. The VFD shall include a carrier frequency control circuit that reduces the carrier frequency based on actual VFD temperature that allows the highest carrier frequency without derating the VFD or operating at high carrier frequency only at low speeds.
11. The VFD shall include password protection against parameter changes.

E. The Keypad shall include a backlit LCD display. The display shall be in complete English words for programming and fault diagnostics (alpha-numeric codes are not acceptable). The keypad shall utilize the following assistants:
1. Start-up assistants.
2. Parameter assistants
3. Maintenance assistant
4. Troubleshooting assistant

F. All applicable operating values shall be capable of being displayed in engineering (user) units. A minimum of three operating values from the list below shall be capable of being displayed at all times. The display shall be in complete English words (alpha-numeric codes are not acceptable):

   Output Frequency
   Motor Speed (RPM, %, or Engineering units)

Motor Current
Calculated Motor Torque
Calculated Motor Power (kW)
DC Bus Voltage
Output Voltage

G. The VFD shall include a fireman's override input. Upon receipt of a contact closure from the fireman's control station, the VFD shall operate at an adjustable preset speed. The mode shall override all other inputs (analog/digital, serial communication, and all keypad commands) and force the motor to run at the adjustable, preset speed. "Override Mode" shall be displayed on the keypad. Upon removal of the override signal, the VFD shall resume normal operation.

H. Serial Communications
1. The VFD shall have an RS-485 port as standard. The standard embedded protocols shall be BACnet, Modbus, Johnson Controls N2 bus, and Siemens Building Technologies FLN.
2. Optional protocols for LonWorks and Ethernet shall be available. Each individual drive shall have an option slot for the protocol in the base VFD. The use of third party gateways and multiplexers is not acceptable. All protocols shall be "certified" by the governing authority. Use of non-certified protocols is not allowed.
3. Serial communication capabilities shall include, but not be limited to; run-stop control, speed set adjustment, proportional/integral/ derivative PID control adjustments, current limit, accel/decel time adjustments, and lock and unlock the keypad. The drive shall have the capability of allowing the DDC to monitor feedback such as process variable feedback, output speed / frequency, current (in amps), % torque, power (kW), kilowatt hours (resettable), operating hours (resettable), and drive temperature. The DDC shall also be capable of monitoring the VFD relay output status, digital input status, and all analog input and analog output values. All diagnostic warning and fault information shall be transmitted over the serial communications bus. Remote VFD fault reset shall be possible. The following additional status indications and settings shall be transmitted over the serial communications bus – keypad "Hand" or "Auto" selected, the ability to change the PID setpoint. The DDC system shall also be able to monitor if the motor is running in the VFD mode over serial communications. A minimum of 15 field parameters shall be capable of being monitored.
4. The VFD shall allow the DDC to control the drive's digital and analog outputs via the serial interface. This control shall be independent of any VFD function. For example, the analog outputs may be used for modulating chilled water valves or cooling tower bypass valves. The drive's digital (relay) outputs may be used to actuate a damper, open a valve or control any other device that requires a maintained contact for operation. In addition, all of the drive's digital and analog inputs shall be capable of being monitored by the DDC system.
5. The VFD shall include an independent PID loop for customer use. The independent PID loop may be used for cooling tower bypass value control, chilled water value control, etc. Both the VFD control PID loop and the independent PID loop shall continue functioning even if the serial communications connection is lost. The VFD shall keep the last good set-point command and last good DO & AO commands in memory in the event the serial communications connection is lost.

I. EMI / RFI filters. All VFD's shall include EMI/RFI filters. The onboard filters shall allow the VFD assemble to be CE Marked and the VFD shall meet product standard EN 61800-3 for the First Environment restricted level.

J. All VFD's through 50HP shall be protected from input and output power mis-wiring. The VFD shall sense this condition and display an alarm on the keypad.

K. OPTIONAL FEATURES – Optional features to be furnished and mounted by the drive manufacturer. All optional features shall be UL Listed by the drive manufacturer as a complete assembly and carry a UL label.

(PICK ONE **)**
1. (OPTIONAL) A VFD with door interlocked, pad lockable fused disconnect that will disconnect all input power from the drive and all internally mounted options. Disconnect shall be mounted in a UL Type 1 enclosure.
2. (OPTIONAL) A complete factory wired and tested bypass system consisting of: A VFD output contactor and full voltage bypass contactor mechanically interlocked. Motor overload protection shall be provided in both VFD or bypass mode. A main disconnect

switch with fuses and thru the door pad lockable handle. A VFD input disconnect service switch to isolate the drive for maintenance or repair shall be included in the bypass package . Bypass components shall be mounted in a UL Type 1 enclosure.

3. The following operators shall be provided:
   a. Drive mode selector on keypad
   b. Bypass mode selector
4. The following indicating lights shall be provided on drive keypad.
   a. Power-on (Ready)
   b. Drive running on keypad
   c. Drive fault on keypad
5. The following relay (form C) outputs shall be provided:
   a. System started
   b. System running
   c Drive fault

The digital inputs for the system shall accept 24V.
Customer Terminal Strip – provide a separate terminal strip for connection of freeze, fire, smoke contacts, and external start command. All external safety interlocks shall remain fully functional whether the system is in Hand, Auto, or Bypass modes. The remote start/stop contact shall operate in VFD and bypass modes.
The VFD shall include a “run permissive circuit” that will provide a normally open contact whenever a run command is provided (local or remote start command in VFD mode). The VFD system shall not operate the motor until it receives a dry contact closure from a damper or valve end-switch. When the VFD system safety interlock (fire detector, freezestat, high static pressure switch, etc) opens, the motor shall coast to a stop and the run permissive contact shall open, closing the damper or valve.

PART 3 – EXECUTION

11.01 INSTALLATION

A. Installation shall be the responsibility of the mechanical contractor. The contractor shall install the drive in accordance with the recommendations of the VFD manufacturer as outlined in the installation manual.
B. Power wiring shall be completed by the electrical contractor. The contractor shall complete all wiring in accordance with the recommendations of the VFD manufacturer as outlined in the installation manual.

11.02 START-UP

A. Certified factory start-up shall be provided for each drive by a factory authorized service center. A certified start-up form shall be filled out for each drive with a copy provided to the owner, and a copy kept on file at the manufacturer.

11.03 PRODUCT SUPPORT

A. Factory trained application engineering and service personnel that are thoroughly familiar with the VFD products offered shall be locally available at both the specifying and installation locations. A 24/365 technical support line shall be available on a toll-free line.

11.04 WARRANTY

A. Warranty shall be 24 months from the date of certified start-up, not to exceed 30 months from the date of shipment. The warranty shall include all parts, labor, travel time and expenses. There shall be 365/24 support available via a toll free phone number.

Glossary

Ambient Temperature — The air temperature in the chamber in which a powered electronic unit resides. A unit's heat sinks rely on a lower ambient temperature in order to dissipate heat away from sensitive electronics.

Auto-tuning — The ability of a controller to execute a procedure that interacts with a load to determine the proper coefficients to use in the control algorithm. Auto tuning is a common feature of process controllers with PID loops.

Base Frequency — The power input frequency for which an AC induction motor is designed to operate. Most motors will specify a 50 to 60 Hz value. The YORK inverters have a programmable base frequency, so you must ensure that parameter matches the attached motor. The term *base frequency helps* differentiate it from the carrier frequency. See also *carrier frequency and frequency setting.*

Braking Resistor — Some variable speed drives can cause the motor to develop decelerating torque by switching motor wiring so the motor becomes a generator, connected to an energy-absorbing resistor. See also f*our-quadrant operation* and *dynamic braking.*

Break-away Torque — The torque a motor must produce to overcome the static friction of a load, in order to start the load moving.

Brushes — A sliding electrical connection between a fixed post inside the motor housing and a ring on the motor shaft. Typically used in DC motors or low-cost AC motors, brushes route current to windings on the rotor. AC induction motors with a squirrel-cage design do not have the need for brushes. See also *commutation* and *squirrel cage.*

Carrier Frequency — The frequency of the constant, periodic, switching waveform that the inverter modulates to generate the AC output to the motor. See also *PWM.*

CE — A regulatory agency for governing the performance of electronic products in Europe. Drive installations designed to have C.E. approval must have particular filter(s) installed in the application.

Choke — An inductor which is tuned to react at radio frequencies is called a choke, since it attenuates (chokes) frequencies above a particular threshold. Tuning is often accomplished by using a movable magnetic core. In variable-frequency drive systems, a choke positioned around high-current wiring can **help attenuate harmful** harmonics and protect equipment. See *also harmonics.*

DC Braking — The inverter DC braking feature stops the AC commutation to the motor, and sends a DC current through the motor windings in order to stop the motor. Also called "DC injection braking," it has little effect at high speed, and is used as the motor is nearing a stop.

Dead Band — In a control system, the range of input change for which there is no perceptible change in the output. In PID loops, the error term may have a dead band associated with it. Dead band may or may not be desirable; it depends on the needs of the application.

Diode — A semiconductor device which has a voltage-current characteristic that allows current to flow only in one direction, with negligible leakage current in the reverse direction. See also *rectifier.*

Duty Cycle — 1. The percent of time a square wave of fixed frequency is on (high) versus off (low). 2. The ratio of operating time of a motor, braking resistor, etc. to its resting time. This parameter usually is specified 0 in association with the allowable thermal rise for the device.

Dynamic Braking — The optional dynamic braking unit shunts the motor-generated EMF energy into a special braking resistor. The added dissipation (braking torque) is effective at higher speeds, having almost no effect as the motor nears a stop.

Error	In process control, the error is the difference between the desired value or setpoint (SP) and the actual value of a the process variable (PV). See also *process variable* and *PID Loop.*
EMI	Electromagnetic Interference – In motor/drive systems, the switching of high currents and voltages creates the possibility of generating radiated electrical noise that may interfere with the operation of nearby sensitive electrical instruments or devices. Certain aspects of an installation, such as long motor lead wire lengths, tend to increase the chance of EMI.
Four-quadrant operation	Referring to a graph of torque versus direction, a four-quadrant drive can turn the motor either forward or reverse, as well as decelerate in either direction (see also *reverse torque).* A load that has a relatively high inertia and must move in both directions and change directions rapidly requires four-quadrant capability from its drive.
Free-run Stop	A method of stopping a motor, caused when the inverter simply turns off its motor output connections. This may allow the motor and load to coast to a stop, or a mechanical brake may intervene and shorten the deceleration time.
Frequency Setting	While frequency has a broad meaning in electronics, it typically refers to motor speed for variable-frequency drives (inverters). This is because the output frequency of the inverter is variable, and is proportional to the attained motor speed. For example, a motor with a base frequency of 60 Hz can be speed controlled with an inverter output varying form 0 to 60 Hz. See also *base frequency, carrier frequency,* and *slip.*
Harmonics	According to Fourier Series mathematics, a periodic (repeating) function (waveform) can be expressed as a the summation of a series of pure sine waves of related frequencies. The lowest frequency is the fundamental, while all the other wave components are called *harmonics. The* square waves used in inverters produce high-frequency harmonics, even though the main goal is to produce lower-frequency sine waves. These harmonics can be harmful to electronics (including motor windings) and cause radiated energy that interferes with nearby electronic devices. A choke is sometimes used to suppress the transmission of harmonics in an electrical system. See also *choke.*
Horsepower	A unit of physical measure to quantify the amount of work done per unit of time. You can directly convert between horsepower and Watts as measurements of power.
IEEE 519	An industry standard which specifies allowable current and voltage distortion levels in an electrical distribution system. The current distortion levels are defined by the ratio of I_{SC} / I_L. Where I_{SC} is the short circuit current available from the source transformer and I_L is the maximum load demand current. The resulting ratio defines the allowable TDD total demand distortion which ranges from 5% to 20%. The standard also defines the maximum allowable voltage distortion limits defined as 3% for special applications and 5% for general systems.
IGBT	**Insulated Gate Bipolar Transistor** (IGBT) – a semiconductor transistor capable of conducting very large currents when in saturation and capable of withstanding very high voltages when it is off. This high-power bipolar transistor is the type used in YORK inverters.
Inertia	The natural resistance a stationary object to being moved by an external force. See also *momentum.*
Intelligent Terminal	A configured input or output logic function on the YORK inverters. Each terminal may be assigned one of several functions.

Glossary *(continued)*

Inverter — A device that electronically changes DC to AC current through a alternating process of switching the input to the output, inverted and non-inverted. A variable speed drive such as the YORK AirMod is also called an inverter, since it contains three inverter circuits to generate 3-phase output to the motor.

Isolation Transformer — A transformer with 1:1 voltage ratio that provides electrical isolation between its primary and secondary windings. These are typically used on the power input side of the device to be protected. An isolation transformer can protect equipment from a ground fault or other malfunction of nearby equipment, as well as attenuate harmful harmonics and transients on the input power.

Jogging Operation — Usually done manually, a jog command from an operator's panel requests the motor/drive system to run indefinitely in a particular direction, until the machine operator ends the jog operation.

Matrix Filter — A passive filter used to mitigate harmonics on the line side of a drive system.

Momentum — The physical property of a body in motion that causes it to continue to move in a straight line. In the case of motors, the armature and shaft are rotating and possesses angular momentum.

Multi-speed Operation — The ability of a motor drive to store preset discrete speed levels for the motor, and control motor speed according to the currently selected speed preset.

Motor Load — In motor terminology, motor load consists of the inertia of the physical mass that is moved by the motor and the related friction from guiding mechanisms. See also *inertia.*

N.E.C — The National Electric Code is a regulatory document that governs electrical power and device wiring and installation in the United States.

NEMA — The National Electric Manufacturer's Association. NEMA Codes are a published series of device ratings standards. Industry uses these to evaluate or compare the performance of devices made by various manufacturers to a known standard.

Power Factor — A ratio that expresses a phase difference (timing offset) between current and voltage supplied by a power source to a load. A perfect power factor = 1.0 (no phase offset). Power factors less than one cause some energy loss in power transmission wiring (source to load).

PID Loop — Proportional - Integral - Derivative – a mathematical model used for process control. A process controller maintains a process variable (PV) at a setpoint (SP) by using its PID algorithm to compensate for dynamic conditions and vary its output to drive the PV toward the desired value. For variable-frequency drives, the process variable is the motor speed. See also *error.*

Process Variable — A physical property of a process which is of interest because it affects the quality of the primary task accomplished by the process. For an industrial oven, temperature is the process variable. See also *PID Loop* and *error.*

PWM — Pulse-width modulation: A type of AC adjustable frequency drive that accomplishes frequency and voltage control at the output section (inverter) of the drive. The drive output voltage waveform is at a constant amplitude, and by "chopping" the waveform (pulse width-modulating), the average voltage is controlled. The chopping frequency is sometimes called *the carrier frequency.*

Reactance — The impedance of inductors and capacitors has two components. The resistive part is constant, while the reactive part changes with applied frequency. These devices have a complex impedance (complex number), where the resistance is the real part and the reactance is the imaginary part.

Rectifier	An electronic device made of one or more diodes which converts AC power into DC power. Rectifiers are usually used in combination with capacitors to filter (smooth) the rectified waveform to closely approximate a pure DC voltage source.
Regenerative Braking	A particular method of generating reverse torque to a motor, an inverter will switch internally to allow the motor to become a generator and will store the energy internally and/or deliver the braking energy back to the power input mains.
Regulation	The quality of control applied to maintain a parameter of interest at a desired value. Usually expressed as a percent (+/-) from the nominal, motor regulation usually refers to its shaft speed.
Reverse Torque	The force of available from some types of inverters to change the direction of rotation of a motor shaft. As such, reverse torque is a decelerating force on the motor and its external load.
Rotor	The windings of a motor that rotate, being physically coupled to the motor shaft. See also *stator*
Saturation Voltage	For a transistor semiconductor device, it is in saturation when an increase in input (gate) current no longer results in an increase in the output (source/drain) current. The saturation voltage is the voltage from the power source to the transistor output (Vsource to Vdrain). The ideal saturation voltage is zero.
Sensorless Vector Control	A technique used in variable-frequency drives to rotate the force vector in the motor without the use of a shaft position sensor (angular). Benefits include an increase in torque at the lowest speed and the cost savings from the lack of a shaft position sensor.
Setpoint (SP)	The setpoint is the desired value of a process variable of interest. See also *Process Variable (PV)* and *PID Loop.*
Single-phase	An AC power source consisting of Hot and Neutral wires. An Earth Ground connection usually accompanies them. In theory, the voltage potential on Neutral stays at or near Earth Ground, while Hot varies sinusoidally above and below Neutral. This power source is named Single Phase to differentiate it from three-phase power sources. Some inverters can accept single phase input power, but they all output three-phase power to the motor. See also *three-phase.*
Slip	The difference between the theoretical speed of a motor at no load (determined by its inverter output waveforms) and the actual speed. Some slip is essential in order to develop torque to the load, but too much will cause excessive heat in the motor windings and/or cause the motor to stall.
Squirrel Cage	A “nickname” for the appearance of the rotor frame assembly for an AC induction motor.
Stator	The windings in a motor that are stationary and coupled to the power input of the motor. See also *rotor*.
Tachometer	1. A signal generator usually attached to the motor shaft for the purpose of providing feedback to the speed controlling device of the motor. 2. A speed-monitoring test meter which may optically sense shaft rotation speed and display it on a readout.
Thermal Switch	An electromechanical safety device that opens to stop current flow when the temperature at the device reaches a specific temperature threshold. In variable-speed drive systems, thermal switches are typically installed at or near the motor, in order to protect the windings from heat damage.

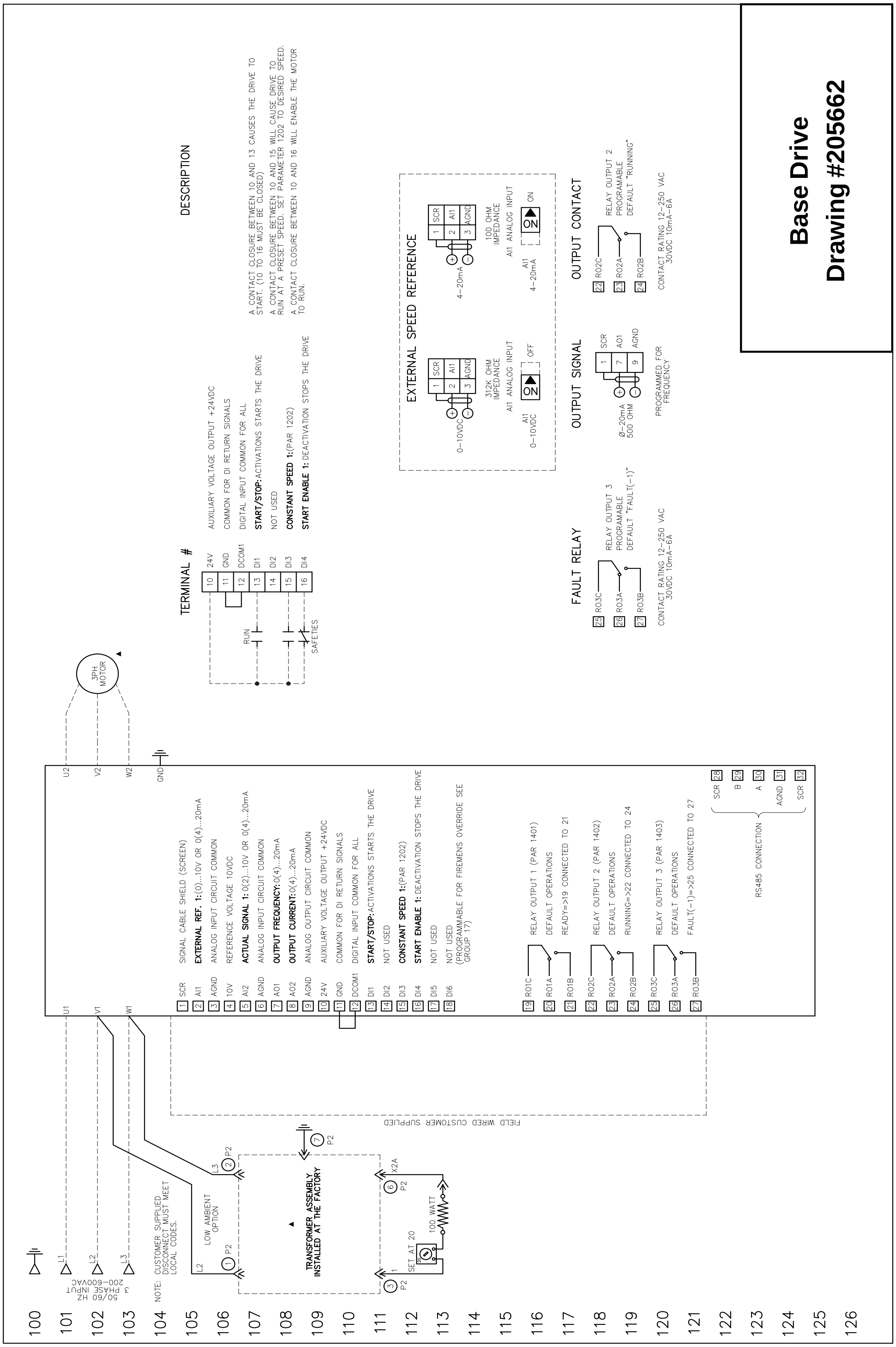
Transistor
A solid state, three-terminal device that provides amplification of signals and can be used for switching and control. While transistors have a linear operating range, inverters use them as high-powered switches. Recent developments in power semiconductors has produced transistors capable of handling hundreds of volts and tens of Amperes or more, all with high reliability. The saturation voltage has been decreasing, resulting in less heat dissipation. YORK AirMod inverters use state-of-the-art semiconductors to provide high performance and reliability, all in a compact package. See also *IGBT* and *saturation voltage.*

Trip
An event which causes the inverter to stop operation is called a “trip” event (as in*tripping* a circuit breaker). The inverter keeps a history log of trip events. They also require an action to clear.

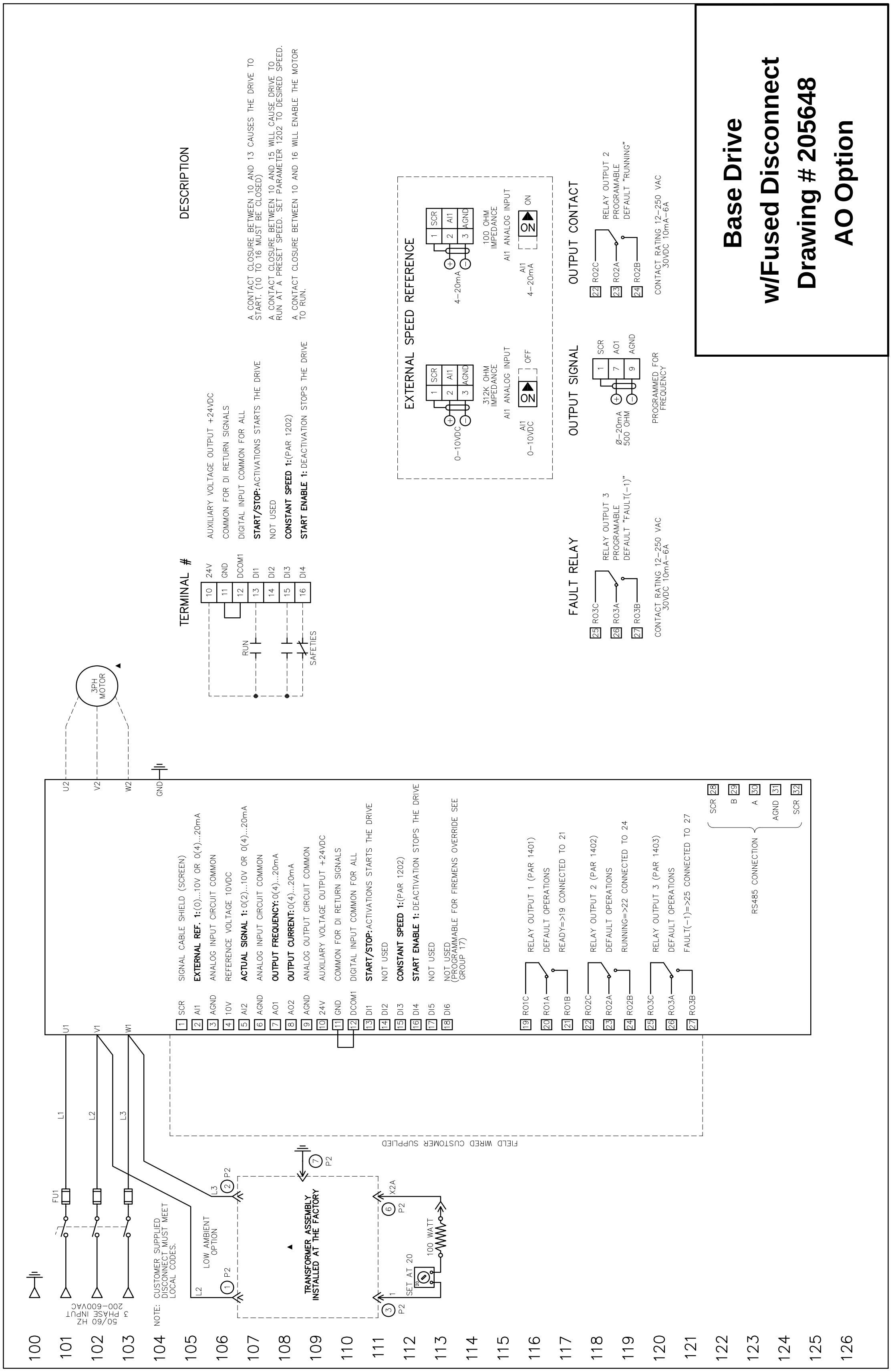
Twelve Pulse
A type of drive system consisting of a phase shift input transformer, (2) six-pulse diode module front ends and an inverter section, used to control a motor and reduce input side line harmonics.

Appendix A

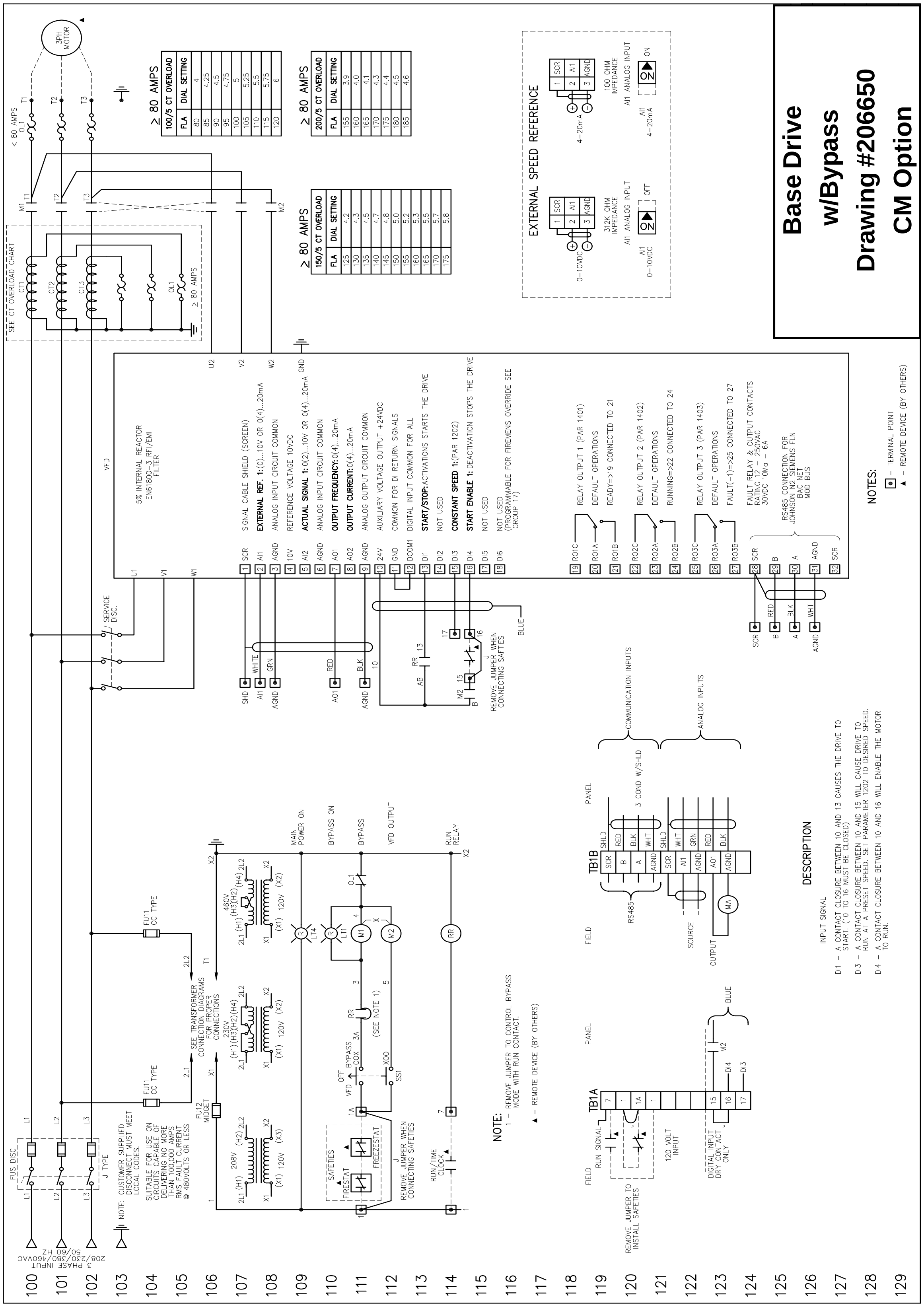
Wiring Diagrams



Base Drive
Drawing #205662
DESCRIPTION
TERMINAL #
10 24V AUXILIARY VOLTAGE OUTPUT +24VDC
11 GND COMMON FOR DI RETURN SIGNALS
12 DCOM1 DIGITAL INPUT COMMON FOR ALL
13 DI1 START/STOP: ACTIVATIONS STARTS THE DRIVE
14 DI2 NOT USED
15 DI3 CONSTANT SPEED 1: (PAR 1202)
16 DI4 START ENABLE 1: DEACTIVATION STOPS THE DRIVE
A CONTACT CLOSURE BETWEEN 10 AND 13 CAUSES THE DRIVE TO START. (10 TO 16 MUST BE CLOSED)
A CONTACT CLOSURE BETWEEN 10 AND 15 WILL CAUSE DRIVE TO RUN AT A PRESET SPEED. SET PARAMETER 1202 TO DESIRED SPEED.
A CONTACT CLOSURE BETWEEN 10 AND 16 WILL ENABLE THE MOTOR TO RUN.
RUN
SAFETIES
3PH MOTOR
EXTERNAL SPEED REFERENCE
0-10VDC
4-20mA
312K OHM IMPEDANCE
100 OHM IMPEDANCE
AI1 ANALOG INPUT
OFF
ON
OUTPUT SIGNAL
Ø-20mA 500 OHM
PROGRAMMED FOR FREQUENCY
OUTPUT CONTACT
RELAY OUTPUT 2 PROGRAMABLE DEFAULT "RUNNING"
FAULT RELAY
RELAY OUTPUT 3 PROGRAMABLE DEFAULT "FAULT(-1)"
CONTACT RATING 12-250 VAC 30VDC 10mA-6A
1 SCR SIGNAL CABLE SHIELD (SCREEN)
2 AI1 EXTERNAL REF. 1: (0)...10V OR 0(4)...20mA
3 AGND ANALOG INPUT CIRCUIT COMMON
4 10V REFERENCE VOLTAGE 10VDC
5 AI2 ACTUAL SIGNAL 1: 0(2)...10V OR 0(4)...20mA
6 AGND ANALOG INPUT CIRCUIT COMMON
7 AO1 OUTPUT FREQUENCY: 0(4)...20mA
8 AO2 OUTPUT CURRENT: 0(4)...20mA
9 AGND ANALOG OUTPUT CIRCUIT COMMON
10 24V AUXILIARY VOLTAGE OUTPUT +24VDC
11 GND COMMON FOR DI RETURN SIGNALS
12 DCOM1 DIGITAL INPUT COMMON FOR ALL
13 DI1 START/STOP: ACTIVATIONS STARTS THE DRIVE
14 DI2 NOT USED
15 DI3 CONSTANT SPEED 1: (PAR 1202)
16 DI4 START ENABLE 1: DEACTIVATION STOPS THE DRIVE
17 DI5 NOT USED
18 DI6 NOT USED (PROGRAMMABLE FOR FIREMENS OVERRIDE SEE GROUP 17)
19 RO1C 20 RO1A 21 RO1B RELAY OUTPUT 1 (PAR 1401) DEFAULT OPERATIONS READY=>19 CONNECTED TO 21
22 RO2C 23 RO2A 24 RO2B RELAY OUTPUT 2 (PAR 1402) DEFAULT OPERATIONS RUNNING=>22 CONNECTED TO 24
25 RO3C 26 RO3A 27 RO3B RELAY OUTPUT 3 (PAR 1403) DEFAULT OPERATIONS FAULT(-1)=>25 CONNECTED TO 27
RS485 CONNECTION
FIELD WIRED CUSTOMER SUPPLIED
50/60 HZ 3 PHASE INPUT 200-600VAC
NOTE: CUSTOMER SUPPLIED DISCONNECT MUST MEET LOCAL CODES.
LOW AMBIENT OPTION
TRANSFORMER ASSEMBLY INSTALLED AT THE FACTORY
SET AT 20
100 WATT



Base Drive
w/Fused Disconnect
Drawing # 205648
AO Option
DESCRIPTION
TERMINAL #
EXTERNAL SPEED REFERENCE
OUTPUT SIGNAL
OUTPUT CONTACT
FAULT RELAY
3PH MOTOR
TRANSFORMER ASSEMBLY INSTALLED AT THE FACTORY
FIELD WIRED CUSTOMER SUPPLIED


Base Drive
w/Bypass
Drawing #206650
CM Option

Wire Sizes

208 VOLT • 3PH • 60HZ

HP	AO & CM OPTION INCOMING WIRE RANGE	CM OPTION OUTGOING* WIRE RANGE	FUSED DISC SIZE
1	# 18 - 8 GA. CU	# 14 - 8 GA. CU	30
1.5	# 18 - 8 GA. CU	# 14 - 8 GA. CU	30
2	# 18 - 8 GA. CU	# 14 - 8 GA. CU	30
3	# 18 - 8 GA. CU	# 14 - 8 GA. CU	30
5	# 18 - 8 GA. CU	# 14 - 8 GA. CU	30
7.5	# 14 - 4 GA. CU	# 14 - 8 GA. CU	60
10	# 14 - 4 GA. CU	# 10 - 1/0 GA. CU	60
15	#14 - 2/0 GA. CU/AL	# 10 - 1/0 GA. CU	100
20	#14 - 2/0 GA. CU/AL	# 10 - 1/0 GA. CU	100
25	(1) #6 - 300 MCM CU/AL	# 10 - 1/0 GA. CU	200
30	(1) #6 - 300 MCM CU/AL	# 6 - 3/0 GA. CU	200
40	(1) #6 - 300 MCM CU/AL	# 6 - 3/0 GA. CU	200
50	(2) #2 - 500MCM CU/AL	# 6 - 3/0 GA. CU	400
60	(2) #2 - 500MCM CU/AL	# 6 - 300 MCM. CU	400

230 VOLT • 3PH • 60HZ

HP	AO & CM OPTION INCOMING WIRE RANGE	CM OPTION OUTGOING* WIRE RANGE	FUSED DISC SIZE
1	# 18 - 8 GA. CU	# 14 - 8 GA. CU	30
1.5	# 18 - 8 GA. CU	# 14 - 8 GA. CU	30
2	# 18 - 8 GA. CU	# 14 - 8 GA. CU	30
3	# 18 - 8 GA. CU	# 14 - 8 GA. CU	30
5	# 18 - 8 GA. CU	# 14 - 8 GA. CU	30
7.5	# 14 - 4 GA. CU	# 14 - 8 GA. CU	60
10	# 14 - 4 GA. CU	# 10 - 1/0 GA. CU	60
15	# 14 - 4 GA. CU	# 10 - 1/0 GA. CU	100
20	#14 - 2/0 GA. CU/AL	# 10 - 1/0 GA. CU	100
25	#14 - 2/0 GA. CU/AL	# 10 - 1/0 GA. CU	200
30	(1) #6 - 300 MCM CU/AL	# 10 - 1/0 GA. CU	200
40	(1) #6 - 300 MCM CU/AL	# 6 - 3/0 GA. CU	200
50	(1) #6 - 300 MCM CU/AL	# 6 - 3/0 GA. CU	400
60	(2) #2 - 500MCM CU/AL	# 6 - 3/0 GA. CU	400

460 VOLT • 3PH • 60HZ

HP	AO & CM OPTION INCOMING WIRE RANGE	CM OPTION OUTGOING* WIRE RANGE	FUSED DISC SIZE
1	# 18 - 8 GA. CU	# 14 - 8 GA. CU	30
1.5	# 18 - 8 GA. CU	# 14 - 8 GA. CU	30
2	# 18 - 8 GA. CU	# 14 - 8 GA. CU	30
3	# 18 - 8 GA. CU	# 14 - 8 GA. CU	30
5	# 18 - 8 GA. CU	# 14 - 8 GA. CU	30
7.5	# 18 - 8 GA. CU	# 14 - 8 GA. CU	30
10	# 18 - 8 GA. CU	# 14 - 8 GA. CU	30
15	# 18 - 8 GA. CU	# 14 - 8 GA. CU	30
20	# 14 - 4 GA. CU	# 10 - 1/0 GA. CU	60
25	# 14 - 4 GA. CU	# 10 - 1/0 GA. CU	60
30	# 14 - 4 GA. CU	# 10 - 1/0 GA. CU	60
40	#14 - 2/0 GA. CU/AL	# 10 - 1/0 GA. CU	100
50	#14 - 2/0 GA. CU/AL	# 10 - 1/0 GA. CU	100
60	(1) #6 - 300 MCM CU/AL	# 10 - 1/0 GA. CU	200
75	(1) #6 - 300 MCM CU/AL	# 6 - 3/0 GA. CU	200
100	(1) #6 - 300 MCM CU/AL	# 6 - 3/0 GA. CU	200
125	(2) #2 - 500MCM CU/AL	# 6 - 3/0 GA. CU	400
150	(2) #2 - 500MCM CU/AL	# 6 - 300 MCM. CU	400

575 VOLT • 3PH • 60HZ

HP	AO & CM OPTION INCOMING WIRE RANGE	CM OPTION OUTGOING* WIRE RANGE	FUSED DISC SIZE
1	# 18 - 8 GA. CU	# 14 - 10 GA. CU	30
1.5	# 18 - 8 GA. CU	# 14 - 10 GA. CU	30
2	# 18 - 8 GA. CU	# 14 - 10 GA. CU	30
3	# 18 - 8 GA. CU	# 14 - 8 GA. CU	30
5	# 18 - 8 GA. CU	# 14 - 8 GA. CU	30
7.5	# 18 - 8 GA. CU	# 14 - 8 GA. CU	30
10	# 18 - 8 GA. CU	# 14 - 8 GA. CU	30
15	# 18 - 8 GA. CU	# 14 - 8 GA. CU	30
20	# 18 - 8 GA. CU	# 14 - 8 GA. CU	30
25	# 14 - 4 GA. CU	# 14 - 8 GA. CU	60
30	# 14 - 4 GA. CU	# 14 - 8 GA. CU	60
40	# 14 - 4 GA. CU	# 10 - 1/0 GA. CU	60
50	#14 - 2/0 GA. CU/AL	# 10 - 1/0 GA. CU	100
60	#14 - 2/0 GA. CU/AL	# 10 - 1/0 GA. CU	100
75	(1) #4 - 300 MCM CU/AL	# 10 - 1/0 GA. CU	200
100	(1) #4 - 300 MCM CU/AL	# 6 - 3/0 GA. CU	200
125	(1) #4 - 300 MCM CU/AL	# 6 - 3/0 GA. CU	200
150	(1) #4 - 300 MCM CU/AL	# 6 - 300 MCM. CU	200

* Base drive and AO Use Wire Size Listed in Performance Data
Data Applies to CM Option Only

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Form 100.42-EG1 (506)
Supersedes Form 100.42-EG1 (704)