AutomationDirect AC Motors Selection Overview

EPAct, High and Premium Efficiency What does it all mean?

EPAct (1992)

In 1992, the U.S. Congress passed legislation requiring that general purpose Design A & B motors meet minimum efficiency requirements, and this legislation was called the Energy Policy Act of 1992. Previously, there had been no U.S. standards set forth for motor energy efficiency. Since 1997 (when EPAct '92 was first enforced), two-, four-, and six-pole general purpose Design A & B motors had to meet EPAct guidelines. Since then, most general purpose motors manufactured and/or sold in the U.S. have met these requirements.

Premium Efficiency (EISA 2007)

In December 2010, a new level of energy efficiency mandate went into effect. The Energy Independence and Security Act of 2007 mandated that all AC industrial motors as described below must meet Premium Efficiency standards. The NEMA trade group was instrumental in getting this legislation passed, so many people refer to the high efficiency motors by their nickname – NEMA Premium®. All applicable motors manufactured or imported into the U.S. after December 2010 must meet the Premium Efficiency guidelines.

Motors Covered Under EISA 2007 (Premium Efficiency Mandate)
Included – must meet the new Premium Efficiency standards – Industrial AC electric squirrel-cage general-purpose motors as follows:
Single speed; Polyphase; 1–200 hp with 3-digit frame sizes; 2, 4, & 6 pole (3600, 1800, & 1200 rpm); NEMA design A & B (including IEC equivalent); Continuous rated
Not Included in Premium Efficiency standards, but must now meet EPAct standards:
JM; JP; Round body (footless); 201–500 hp; Fire pump; U-frame; Design C; 8-pole

Certain motors (Inverter/Vector Duty, NEMA design D, etc.) are not covered by EISA 2007.
For full text, visit www.energy.senate.gov and click "ENERGY INDEPENDENCE & SECURITY ACT OF 2007".

Nominal Full-Load Efficiency Standards Comparisons (%)

Enclosed Electric Motors, Random Wound, 60 Hz, 600V or Less

Motor hp	1200 rpm [6-pole]		1800 rpm [4-pole]		3600 rpm [2-pole]	
	EPAct	Premium Efficiency	EPAct	Premium Efficiency	EPAct	Premium Efficiency
1	80.0	82.5	82.5	85.5	75.5	77.0
1.5	85.5	87.5	84.0	86.5	82.5	84.0
2	86.5	88.5	84.0	86.5	84.0	85.5
3	87.5	89.5	87.5	89.5	85.5	86.5
5	87.5	89.5	87.5	89.5	87.5	88.5
7.5	89.5	91.0	89.5	91.7	88.5	89.5
10	89.5	91.0	89.5	91.7	89.5	90.2
15	90.2	91.7	91.0	92.4	90.2	91.0
20	90.2	91.7	91.0	93.0	90.2	91.0
25	91.7	93.0	92.4	93.6	91.0	91.7
30	91.7	93.0	92.4	93.6	91.0	91.7
40	93.0	94.1	93.0	94.1	91.7	92.4
50	93.0	94.1	93.0	94.5	92.4	93.0
60	93.6	94.5	93.6	95.0	93.0	93.6
75	93.6	94.5	94.1	95.4	93.0	93.6
100	94.1	95.0	94.5	95.4	93.6	94.1
125	94.1	95.0	94.5	95.4	94.5	95.0
150	95.0	95.8	95.0	95.8	94.5	95.0
200	95.0	95.8	95.0	96.2	95.0	95.4

AutomationDirect AC Motors Selection Overview

General-purpose or inverter-duty motor?

How to choose a general purpose motor vs. an inverter-duty motor

General purpose motors have been around for many years. They are the workhorse of almost every industry. As the use of VFDs (inverters or AC drives) has become commonplace in industry, the construction of general purpose motors was improved to handle many applications. All ADC General purpose 3 phase motors are inverter rated and can withstand the higher voltage spikes produced by all VFDs (amplified at longer cable lengths).

If an application requires precise speed control or high loads at lower speed, a high performance inverter duty motor may be required. These motors are designed run at very slow speeds without overheating. This performance comes at a cost: high performance inverter-duty motors can be much more expensive than general purpose inverter rated motors. Guidelines for choosing an IronHorse general purpose motor vs. a high performance inverter duty motor are given below. If your application falls within the guidelines below, there is no need to apply a high performance inverter-duty motor.

NOTE: Marathon high performance, inverter duty motors have limitations as well. Please see the Marathon section for more details.

Background: For many years, AC motors were driven by across-the-line contactors and starters. The electricity sent to the motor was a very clean sine wave at 60Hz. Noise and voltage peaks were relatively small. ***However, there were drawbacks***: they only ran electrically at one speed (speed reduction was usually handled by gearboxes or some other, usually inefficient, mechanical means) and they had an inrush of electrical current (when the motor was first turned on) that was usually 5 to 6 times the normal current that the motor would consume. The speed reduction apparatus was expensive and bulky, and the inrush would wreak havoc with power systems and loading (imagine an air conditioning system in an old house - when the compressor would kick on, the lights would dim; now imagine the same circumstances with a motor the size of a small car).

Note: The following discussion applies only to 3-phase motors.

Enter the VFDs (variable frequency drives): Drives were introduced to allow the speed of these motors to be changed while running and to lessen the inrush current when the drive first starts up. To do this, the drive takes the incoming 60Hz AC power and rectifies it to a DC voltage (every drive has a DC bus that is around 1.414 (sqrt of 2) * incoming AC Line Voltage).

This DC voltage is then "chopped" by power transistors at very high frequencies to simulate a sine wave that is sent to the motor [see Figure 1]. By converting the incoming power to DC and then reconverting it to AC, the drive can vary its output voltage and output frequency, thus varying the speed of a motor. Everything sounds great, right? We get to control the frequency and voltage going out to the motor, thus controlling its speed.

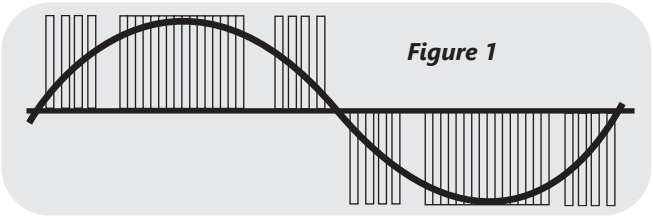


Figure 1

Some things to watch out for: A VFD-driven general purpose motor can overheat if it is run too slowly. (Motors can get hot if they're run slower than their rated speed.) Since most general purpose motors cool themselves with shaft-mounted fans, if the motor overheats, bearing and insulation life will be reduced. Therefore there are minimum speed requirements for all motors.

The voltage "chopping" that occurs in the drive actually sends high-voltage spikes (at the DC bus level) down the wire to the motor. If the system contains long cabling, there are actually instances where a reflected wave occurs at the motor. The reflected wave can effectively double the voltage on the wire. This can lead to premature failure of the motor insulation. Long cable lengths between the motor and drive increase the harmful effects of the reflected wave, as do high chopping frequencies (listed in drive manuals as carrier frequencies). Line reactors, 1:1 transformers placed at the output of the drive, can help reduce the voltage spikes going from the drive to the motor. Line reactors are used in many instances when the motor is located far from the drive [see Figure 2].

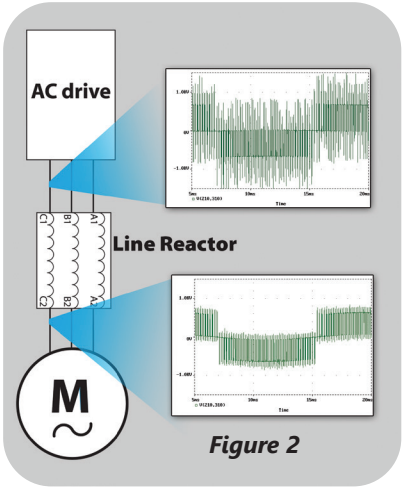


Figure 2

In summary, all ADC general purpose motors are inverter rated and can be run with drives in many applications; however high performance, inverter-duty motors are designed to handle much lower speeds without overheating and they are capable of withstanding higher voltage spikes without their insulation failing. With the increased performance comes an increase in cost. This additional cost can be worth it if you need greater performance.

The considerations for applying IronHorse motors are given below.

Heat considerations

	IronHorse speed ratio	For an 1800 rpm motor, minimum IronHorse speed is:
Variable Torque applications (fans, centrifugal pumps, etc.)	5:1 (EPAct motors) 10:1 (PE motors)	1800/5 = 360RPM 1800/5 = 180RPM
Constant Torque Applications (conveyors, extruders, etc.)	2:1 (EPAct motors) 4:1 (PE motors)	1800/2 = 900RPM 1800/4 = 450RPM

Voltage Spike considerations

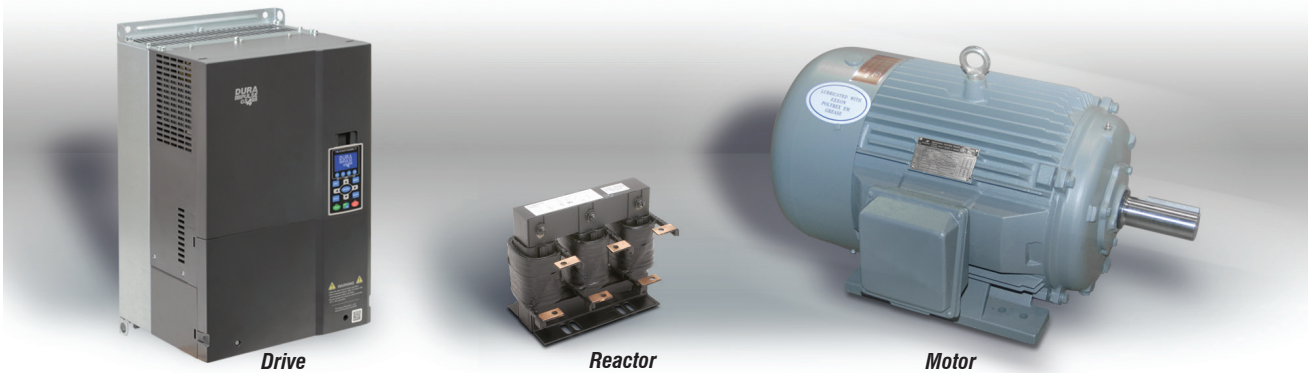
	Max cable distance from drive to IronHorse motor	Max cable distance with a 3% line reactor between drive and IronHorse motor
For use with 230V and 460V VFDs*	125 ft	250 ft

* *Up to 6kHz carrier frequency*

IRONHORSE®

General-Purpose AC Motors

Using IronHorse General-Purpose Motors with AC Drives



Drive Reactor Motor

AC drive motor control vs. across-the-line motor control

General purpose AC induction motors are typically controlled by across-the-line starters, i.e. contactors, manual motor starters, etc. However, 3-phase general purpose motors can also be controlled by AC drives under certain conditions. (1-phase AC motors cannot be controlled by typical 3-phase AC drives.)

Across-the-line control applies full voltage to the motor at startup, and has several disadvantages.

- High inrush current - startup inrush current is typically 5-6 times the normal motor full load current, and can significantly increase utility bills.
- Inability to change speeds - the motor runs only at its rated speed.
- Inefficiency in some applications - fan and pump applications require ON/OFF control or valves/dampers to control flow.
- Contact maintenance - arcing caused by high inrush and breaking currents significantly reduce the motor starter's life span.

Many applications can use AC drive control for 3-phase AC induction motors, which has several advantages:

- Lower inrush current at motor startup
- Ability to change motor speed
- Greater efficiency in some applications. - fan and pump applications can use the AC drive to provide both motor control and flow control. The drive can control the flow by varying the motor speed, and therefore eliminate the need for inefficient valves/dampers.
- Solid state power delivery; minimal maintenance.

NOTE: AC drive (VFD) control is applicable only for 3-phase AC motors (3-phase AC drives cannot be used to control 1-phase motors)

General purpose AC induction motors are not designed specifically for use with AC drives, so there are three major considerations for AC drive control of 3-phase general purpose motors:

1. Heat considerations for AC drive control

Fan-cooled motors are designed to provide sufficient insulation cooling when the motors run at rated speed. The cooling ability of fans is reduced when motors run at lower speeds, and the insulation in general purpose motors is not designed for this condition. Therefore, there are limitations on how slowly general purpose motors can be continuously run without prematurely causing motor insulation failure.

- **Constant Torque (CT) Applications**
  PE motors: 4:1 (1/4 rated speed)
  EPAct motors: 2:1 (1/2 rated speed)
  The CT minimum continuous speed for an IronHorse general purpose motor is either one quarter or one half of its rated speed, as shown in the motor Performance Data tables. (Constant torque loads require the same amount of torque from the motor regardless of speed; e.g., conveyors, cranes, machine tools.)
- **Variable Torque (VT) Applications**
  PE motors: 10:1 (1/10 rated speed)
  EPAct motors: 5:1 (1/5 rated speed)
  The VT minimum continuous speed for an IronHorse general purpose motor is either one tenth or one fifth of its rated speed, as shown in the motor Performance Data tables. (Variable torque loads require less torque at lower speeds, resulting in less heat generated by the motor; e.g., fans, centrifugal pumps.)

If your application requires motors to run at speeds below those described above, use our Marathon inverter duty motors. Inverter duty motors can run fully loaded at very low speeds without being damaged by overheating.

2. Voltage spike considerations for AC drive control

All AC drives cause large voltage spikes between the drive and the motor, and long cable distances increase these spikes even more. Therefore, there are maximum cable lengths that can be run between the drive and the motor. Line (load) reactors can be installed near the drive output to reduce the voltage spikes.

- 230V and 460V **Without Reactor – 125 ft maximum cable length** between drive and motor
- 230V and 460V **With Reactor – 250 ft maximum cable length** between drive and motor

If your application requires cable lengths longer than those described above, please use our Marathon high performance, inverter-duty motors.

3. Carrier frequency limitation for AC drive control

The AC Drive carrier frequency should be set to 6kHz or less.

AC Motor Selection – General Purpose Motors

IronHorse® 1-Phase Motor Selection			
Motor Series	***MTR2***	***MTRJ***	***MTF2***
Paint Color	***Black***	***Black***	***Green***
Main Characteristics	***General Purpose Rolled Steel***	***Jet Pump***	***Farm Duty Rolled Steel***
Electrical Characteristics			
Horsepower range	1/3 - 2	1/3 - 2	2 | 7 1/2
Base speed	1800; 3600	3600	1800
Standard Voltage	115/208–230 VAC; 115/230 VAC	115/230 VAC	208–230 VAC
Phase / Base Frequency	1-phase / 60 Hz		
Service Factor	1.15		
Design Code (NEMA)	L or N (by model)	L or N (by model)	L
Insulation Class	Class F		
Insulation System	Dip and Bake Twice		Double VPI
Duty Cycle	Continuous		
Thermal protection	None	Automatic	Manual
Hazard Classification	None		
Mechanical Characteristics			
Frame size	56C or HC	56J	182T - 215T
Enclosure	TEFC	TEFC	TEFC
Enclosure Rating	IP43		IP55
Frame material	Rolled Steel		
End bracket material	Aluminum		
Junction box material	Steel		
Fan guard material	Steel		
Fan material	Polypropylene Plastic	Plastic	
Lead termination	Junction Box		
Standard mounting	C-Face with Removable Rigid Base		Rigid Base
Drive end shaft slinger	Yes		V-ring seal
Bearings	Ball		
Grease	Mobil Polyrex EM		NS7 ENS
Standard junction box assembly position	F1		
Performance Characteristics			
Constant Torque speed range	N/A		
Variable Torque speed range	N/A		
Constant Horsepower speed range	N/A		
Temperature rise	B		
Encoder provisions	None		
Other Characteristics			
Warranty*	2 Years		
Agency Approvals **	CSA, CE		CE, UR

*** See Terms and Conditions for motor warranty explanation.**
1) For warranty on IronHorse motors below 50hp, warranty service can be arranged through AutomationDirect.
2) For warranty on IronHorse motors 50hp and above, motors must be inspected by a local EASA motor repair or service center; (see AutomationDirect Terms & Conditions).
**** To obtain the most current agency approval information, see the Agency Approval Checklist on the specific part number's web page.**
***** 56HC motors are capable of 56C C-face mounting, and are also compatible with 56, 143T, and 145T foot mounting dimensions.**

AC Motor Selection – General Purpose Motors

IronHorse® 3-Phase Motor Selection					
Motor Series	**MTR2/MTRP**	**MTRJ/MTRJP**	**MTDP**	**MTSP/MTSN**	**MTCP2**
Paint Color	**Black**	**Black**	**Blue**	**Stainless**	**Gray**
Main Characteristics	**General Purpose Rolled Steel**	**Jet Pump**	**Rolled Steel Open Drip Proof**	**Stainless Steel Premium Efficiency IP69K**	**Cast-Iron Hazardous Duty**
Electrical Characteristics					
Horsepower range	1/3 - 3	1/3 - 3	1 - 50	1 - 20	1 - 300(T) 1 - 30(TC)
Base speed	1800; 3600	3600	1800; 3600	1200; 1800; 3600	1200; 1800; 3600
Standard Voltage	208–230/460 VAC; 230/460 VAC	208–230/460 VAC; 230/460 VAC	208–230/460 VAC	208–230/460 VAC	208-230/460 VAC; 460 VAC
Phase / Base Frequency (Hz)	3-phase / 60 Hz				
Service Factor	1.15	1.15	1.15 (sine), 1.0 (drive)		1.25 (1-200) 1.15 (250-300) 1.0 (all w/ drive)
Design Code (NEMA)	B				
Insulation Class	Class F				
Insulation System	Dip and Bake	Dip and Bake Twice	VPI	Dip and Bake	Vacuum Impregnation
Duty Cycle	Continuous				
Thermal protection	None				
Hazard Classification	None			Class 1 / Div 2	
Mechanical Characteristics					
Frame size	56C or HC - 326T	56J	56C - 326T	56C - 256TC	143T/TC - 449T
Enclosure	ODP / TEFC	TEFC	ODP / TEFC	TEFC / TENV	TEFC
Enclosure Rating	IP43		IP23	IP69K	IP55
Frame material	Rolled steel		Rolled steel	304 Stainless steel	Cast iron
End bracket material	Aluminum	Aluminum	≤256 frame- Aluminum >256- Cast iron	304 Stainless steel	Cast iron
Junction box material	Steel	Steel	Steel	304 Stainless steel	Cast iron
Fan guard material	Steel	Steel	N/a	304 Stainless steel	Steel
Fan material	Polypropylene plastic	Plastic	N/a	Heat-Resistant Polyethelene	Plastic
Lead termination	Junction Box				
standard mounting	C-face with removable rigid base		Rigid base	C-face round body and C-face with rigid base	Rigid base, c-face with rigid base (1-100 hp)
Drive end shaft slinger	Yes	Yes	None	Yes	Yes
Bearings	Ball				1-300 hp - 2p, 1-75 hp - 4p & 6p: Ball 100-300 hp - 4p & 6p: Roller
Grease	Mobil Polyrex EM		NS7 ENS	Mobil Polyrex EM	
Standard junction box assembly position	F1				F1 (field convertible F2)
Performance Characteristics					
Constant Torque speed range	4:1	4:1	10:1	10:1	10:1
Variable Torque speed range	10:1	10:1	20:1	20:1	20:1
Constant Horsepower speed range	1.5:1	1.5:1	1.5:1	1.5:1	1.5:1
Temperature rise	B				
Encoder provisions	None				
Other Characteristics					
Warranty*	2 years	2 years	2 years	1 year	2 years
Agency Approvals **	CSA, CE	CSA,CE	CSA	NEMA, CSA, UR, CE, BISCC	CSA, ISO9001, CE

*** See Terms and Conditions for motor warranty explanation.**
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**** To obtain the most current agency approval information, see the Agency Approval Checklist on the specific part number's web page.**
***** 56HC motors are capable of 56C C-face mounting, and are also compatible with 56, 143T, and 145T foot mounting dimensions.**

IRONHORSE®

Model Overview

IronHorse motors are manufactured by leading motor suppliers with over 20 years experience delivering high-quality motors to the demanding U.S. market. Our suppliers produce motors in IS09001 facilities, and test the motors during production and after final assembly. This is how we can stand behind our IronHorse motors with a two-year warranty (one year for Stainless Steel).

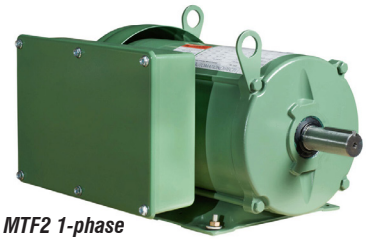
The IronHorse® line of motors includes:

1 - Phase

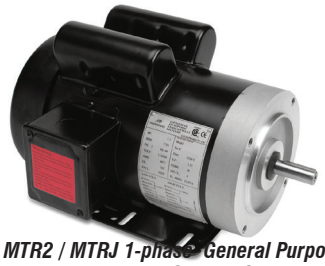
- **MTR2 Series:** TEFC 56(H)C-frame AC motors with rolled-steel frames; flange mount and removable mounting feet; 0.33–2 hp
- **MTF2 Series:** TEFC T-frame Farm-Duty AC motors with rolled-steel frames and mounting feet; 2–10 hp
- **MTRJ Series:** TEFC 56J frame. Jet Pump AC Motors. Flange mount and removable mounting feet. 1/3hp - 2hp

3 - Phase

- **MTR2 Series:** TEFC 56C-frame AC motors with rolled-steel frames; flange mount and removable mounting feet; 0.33–0.75 hp
- **MTRP Series:** TEFC 56C/HC-frame AC motors with rolled-steel frames; removable base and C-face mount; 1–3 hp
- **MTRJ Series:** TEFC 56J frame. Jet Pump AC Motors. Flange mount and removeable mounting feet. 1/3hp - 3hp
- **MTSP/MTSN Series:** TEFC/TENV 56C-284t frame AC motors with stainless steel frames; IP69K; flange mount and round bodies or flange mount with rigid mounting feet; 0.33–20 hp
- **MTCP2 Series:** TEFC T-frame Premium Efficiency AC motors with cast-iron frames and mounting feet; 1–300 hp (TC-frame [C-face] 1–30 hp)
- **MTDP Series:** Open Drip-Proof Premium Efficiency AC motors with rigid base mount; motor rating range - 1 to 50 hp.
- Replacement switches, junction boxes, and start and run capacitors available for IronHorse 1-phase motors
- Replacement bases, fans, and fan shrouds available for many IronHorse motors
- Accessory C-flange kits available for flange mounting of IronHorse 3-phase cast-iron and rolled steel T-frame Premium Efficiency motors
- STABLE motor slide bases for adjustable mounting of NEMA motors from 56 to 449T (adjustable stainless steel bases not available)



MTF2 1-phase Farm Duty T-Frame



MTR2 / MTRJ 1-phase General Purpose or Jet Pump Rolled Steel 56C Frame



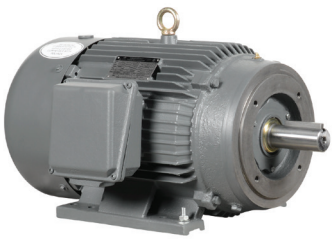
MTR2 / MTRP / MTRJ 3-phase General Purpose or Jet Pump Rolled Steel 56C Frame



MTSP / MTSN 3-phase Stainless Steel 56C – Rigid Base or Round Body



MTDP 3-phase Premium Efficiency Rolled Steel Open Drip-Proof



MTCP2 3-phase Premium Efficiency Cast-iron TC & T Frame