EMERSON
Industrial Automation

# Application Note
# CTAN #199

The Application Note is pertinent to the Quantum III Family

## Specifying Quantum III Drives

We take many calls in the support group answering questions that start out, "***Which Quantum model would I need for a motor with…..*** " or "***We want to replace and old analog DC Drive with a Quantum III, what do we need to look for ?***" This application note will attempt to provide some guidance in this area.

### Motor Nameplate Data

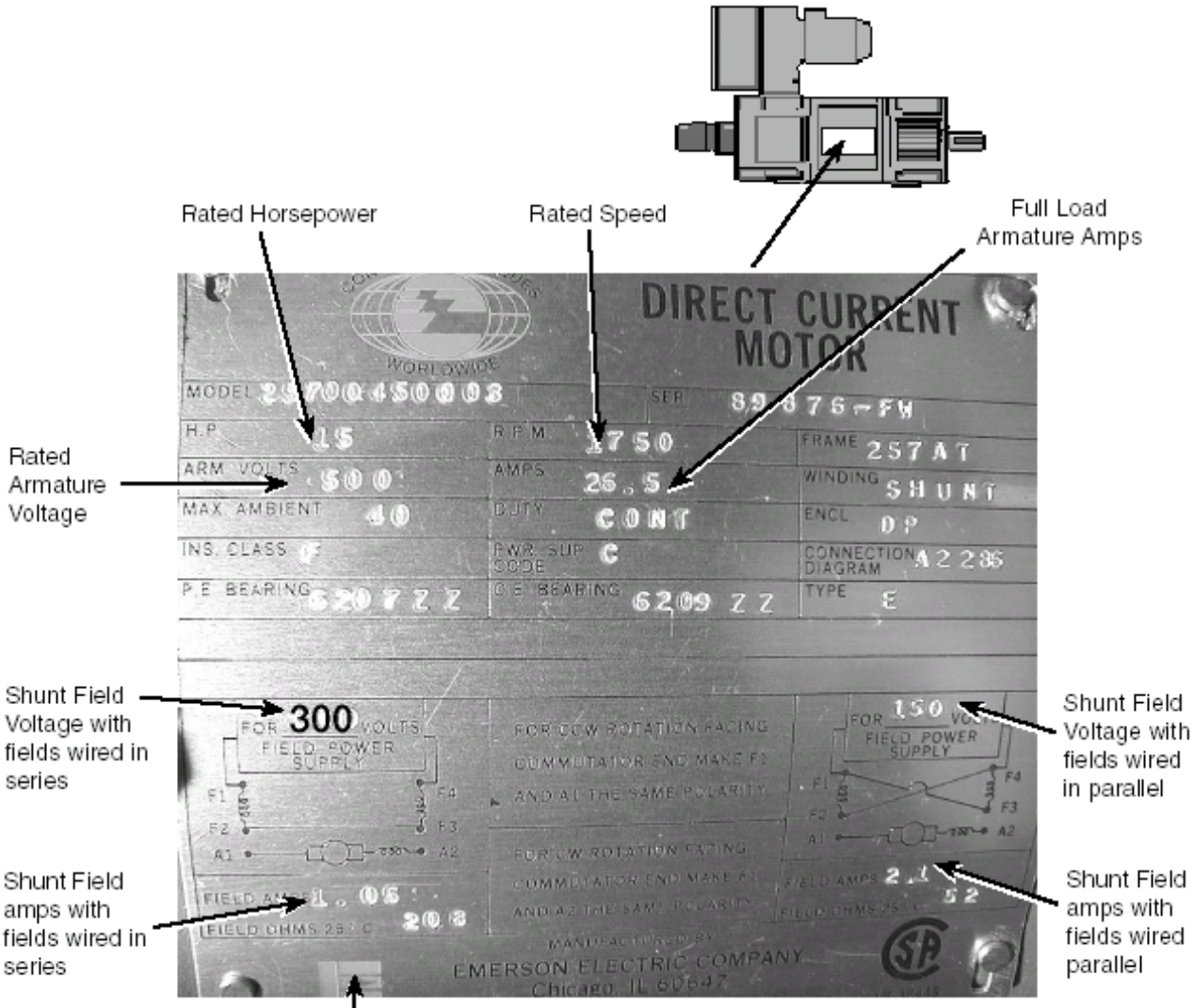
Most of the information you will need can be found from the intended motors nameplate. The most important parts of that nameplate are:

Armature Voltage
Armature Current ( Amps )
Field Voltage(s)
Field Current(s)
Motor Speed(s)
Motor HP ( for reference only )
Field ohms ( would be nice )

When specifying a Quantum III drive the most important motor parameter is Armature amps. Most people merely look at the Horsepower, but HP is varies for different armature voltages. Specifying a Quantum III by just HP will eventually cause you a problem.

***Select the Quantum III by DC output amps ( as required by motor )- not Horsepower !***

# Typical 500VDC Motor Nameplate




Typically for a 500v motor (armature) the shunt field windings should be wired for a series connection for 300 VDC supply

**Note:** This motor is not designed for extended speed range as it does not indicate 2 RPM values.

Typically for 500v motors we would supply the 300v field ( series connection )

## RATING TABLE

| | Drive Model No. | Typical DC Motor Rating at 240V/500V Arm | | Drive Type | Heat Loss Max. Watts (2) (3) | (1) Maximum Continuous Current Rating @55C | | Cooling | | Approx. Weight | SIZE |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | HP | KW | | | AC Input | DC Output | Method | Air Flow (CFM) | (lbs/kg) | |
| Non-Regenerative | 9500-8302 | 10/20 | 9.1/19 | 1 Quadrant | 123 | 31 | 38 | Nat. Conv. | - | 44/20 | 1 |
| | 9500-8303 | 15/30 | 13.2/27.5 | 1 Quadrant | 179 | 45 | 55 | Nat. Conv. | - | | |
| | 9500-8305 | 30/60 | 25.5/53.2 | 1 Quadrant | 387 | 87 | 106 | Built-in Fan | 200 | 71/32 | |
| | 9500-8306 | 50/100 | 41.8/87 | 1 Quadrant | 552 | 141 | 172 | Built-in Fan | 200 | | |
| | 9500-8307 | 75/150 | 62/129 | 1 Quadrant | 758 | 209 | 255 | Built-in Fan | 500 | 110/50 | 2 |
| | 9500-8308 | 100/200 | 83/172 | 1 Quadrant | 968 | 277 | 338 | Built-in Fan | 500 | | |
| | 9500-8309 | 125/250 | 102/213 | 1 Quadrant | 1216 | 351 | 428 | Built-in Fan | 750 | | |
| | 9500-8310 | 150/300 | 121/253 | 1 Quadrant | 1400 | 417 | 508 | Built-in Fan | 750 | 155/70 | |
| | 9500-8311 | 200/400 | 158/329 | 1 Quadrant | 1743 | 554 | 675 | Built-in Fan | 750 | | |
| | 9500-8315 | 500 | 197/410 | 1 Quadrant | 2084 | 672 | 820 | Built-in Fan | 760 | 397/180 | 3 |
| | 9500-8316 | 600 | 236/493 | 1 Quadrant | 2436 | 808 | 985 | Built-in Fan | 760 | | |
| | 9500-8317 | 700 | 276/575 | 1 Quadrant | 2776 | 943 | 1150 | Built-in Fan | 760 | | |
| | 9500-8318 | 800 | 300/625 | 1 Quadrant | 2961 | 1025 | 1250 | Built-in Fan | 760 | 443/201 | |
| | 9500-8319 | 900 | 353/735 | 1 Quadrant | 3647 | 1205 | 1470 | Built-in Fan | 760 | | |
| | 9500-8320 | 1000 | 389/810 | 1 Quadrant | 4000 | 1328 | 1620 | Built-in Fan | 760 | | |
| Reversing / Regenerative | 9500-8602 | 10/20 | 9.1/19 | 4 Quadrant | 123 | 31 | 38 | Nat. Conv. | - | 55/25 | 1 |
| | 9500-8603 | 15/30 | 13.2/27.5 | 4 Quadrant | 179 | 45 | 55 | Nat. Conv. | - | | |
| | 9500-8605 | 30/60 | 25.5/53.2 | 4 Quadrant | 387 | 87 | 106 | Built-in Fan | 200 | 75/34 | |
| | 9500-8606 | 50/100 | 41.8/87.4 | 4 Quadrant | 552 | 141 | 172 | Built-in Fan | 200 | | |
| | 9500-8607 | 75/150 | 62/129 | 4 Quadrant | 758 | 209 | 255 | Built-in Fan | 500 | 120/54 | 2 |
| | 9500-8608 | 100/200 | 83/172 | 4 Quadrant | 968 | 277 | 338 | Built-in Fan | 500 | | |
| | 9500-8609 | 125/250 | 102/213 | 4 Quadrant | 1216 | 351 | 428 | Built-in Fan | 750 | | |
| | 9500-8610 | 150/300 | 121/253 | 4 Quadrant | 1400 | 417 | 508 | Built-in Fan | 750 | 165/75 | |
| | 9500-8611 | 200/400 | 158/329 | 4 Quadrant | 1743 | 554 | 675 | Built-in Fan | 750 | | |
| | 9500-8615 | 500 | 197/410 | 4 Quadrant | 2084 | 672 | 820 | Built-in Fan | 760 | 475/216 | 3 |
| | 9500-8616 | 600 | 236/493 | 4 Quadrant | 2436 | 808 | 985 | Built-in Fan | 760 | | |
| | 9500-8617 | 700 | 389/810 | 4 Quadrant | 2776 | 943 | 1150 | Built-in Fan | 760 | | |
| | 9500-8618 | 800 | 300/625 | 4 Quadrant | 2961 | 1025 | 1250 | Built-in Fan | 760 | | |
| | 9500-8619 | 900 | 353/735 | 4 Quadrant | 3647 | 1205 | 1470 | Built-in Fan | 760 | 525/288 | |
| | 9500-8620 | 1000 | 389/810 | 4 Quadrant | 4000 | 1328 | 1620 | Built-in Fan | 760 | | |

***Select the Quantum III by DC output amps ( as required by motor )- not Horsepower !***

**For example**: If your motor nameplate indicates 50A for armature amps, you would specify a 9500-8X03.

Also keep in mind that the application may not need the full torque which would be developed at full nameplate Armature current.

**For example**: If your motor nameplate indicates 115A for armature amps, a 9500-8X05 may suffice depending on the amount of torque needed from the motor for your particular application. In this example, a 9500-8X05 with this motor would be able to supply 92% of the motors available continuous torque and 138% peak torque for acceleration and starting etc.

## For Motors with Armature Currents of 172 Amps and Less


Motors with Armature amp requirements of 172A and below can be driven with Size 1 models. Size 1 models have a built-in Field Current Regulator that can supply up to 8A. The voltage will be adjusted automatically to achieve the field current settings.

Typical motors in the United States ( for 3 phase drives ) have the following:

| | |
|---|---|
| 500vdc Armatures<br>300vdc Fields | 240vdc Armatures<br>150vdc Fields |
| Intended for **460vac** Input Power | Intended for **230vac** Input Power |

For fields that require more that 8A is required for the field, an external FXM5 Field regulator can be used to provide up to 20A.

FXM5


## 180v Armatures w/200v Fields

Occasionally, you may run into 5-20HP DC motors that are rated at 180vdc with 200vdc fields. These motors were typically driven by drives operating from single phase 240vac. Size 1 Quantum III models have a built-in Field Current Regulator that can supply up to 8A which is usually more than enough for this size of motor. The field regulator can produce upwards of 215vdc for these 200v fields when operated from 240vac 3 phase supplies.

## AC Line Considerations

Quantum III drives require 3 phase power. Ideally this power is derived from a power transformer with a wye secondary. There must be sufficient but not excessive ampacity.

### 7.1.2 Power Distribution Requirements

When applying DC Drives to power systems it is important to insure that the power distribution ampacity is sufficient but not too excessive. In general, if a power distribution KVA capacity exceeds 7 times that of the smallest drive KW rating, an isolation transformer or line reactor should be employed to achieve a suitable impedance between the drive and the power lines to insure reliable operation. AC power lines offering between 1% to 6% impedance provide the best operating conditions for variable speed drives.

**Power Factor Corrected Lines**

Drive installation should be avoided on lines that are corrected for power factor. When the power distribution system contains power factor correction capacitors, drives should be installed as far way as possible from these correction capacitors so that the length of wire offers some protective impedance. If this is not possible a 3% line reactor or an isolation transformer is recommended to insure reliable operation.

| Size | Model | Line Voltage | | Max. Supply KVA | |
|---|---|---|---|---|---|
| | | 240 HP | 480 HP | @240 KVA | @480 KVA |
| 1 | 9500-8X02 | 10 | 20 | 90 | 180 |
| | 9500-8X03 | 15 | 30 | 131 | 262 |
| | 9500-8X05 | 30 | 60 | 253 | 506 |
| | 9500-8X06 | 50 | 100 | 410 | 820 |
| | 9500-8X07 | 75 | 150 | 607 | 1215 |
| | 9500-8X08 | 100 | 200 | 805 | 1610 |
| 2 | 9500-8X09 | 125 | 250 | 1020 | 2040 |
| | 9500-8X10 | 150 | 300 | 1212 | 2424 |
| | 9500-8X11 | 200 | 400 | 1610 | 3220 |
| | 9500-8X15 | | 500 | 1953 | 3906 |
| | 9500-8X16 | | 600 | 2348 | 4697 |
| 3 | 9500-8X17 | | 700 | 2741 | 5481 |
| | 9500-8X18 | | 800 | 2979 | 5958 |
| | 9500-8X19 | | 900 | 3502 | 7004 |
| | 9500-8X20 | | 1000 | 3860 | 7719 |

The KVA values above provide the minimum impedance required for di/dt limiting. They do not provide any protection from cross talk between multiple drives on a common supply. Individual line reactors will provide this protection in most instances.

For more information on this topic consult the following application note:

**http://www.emersonct.com/download_usa/appNotesPDF/ctan144.pdf**

In general, we would recommend the application of a 3% Input Line Reactor if the power source ampacity is unknown.

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For motors with armatures rated between 400v to 550vdc, 480vac +/-10% supplies would be indicated.

For motors with armatures rated between 180v to 240vdc, 240vac +/-10% supplies would be indicated.

**We do not recommend using 480vac to power Quantum III's for motors with armature voltages between 180v to 240vdc.**

A step down ( 480 to 240vac ) Isolation Transformer should be applied.
To select a suitable Isolation Transformer consult the link below:

http://www.emersonct.com/download_usa/literaturePDF/pdCatalog2003/PW_Sub_Sec_IsoTxfr.pdf

## Field Excitation Requirements

Many DC motors have dual field windings ( F1-F2 and F3 - F4 ). For instance, a motor with a 500vdc armature may have dual field windings and the nameplate may indicate 300v/150v. Placing the windings in series ( connecting F2 & F3 and exciting the field at F1 and F4 ) would require a nominal 300vdc supply. All Quantum III models operating from 460vac supplies can provide excitation for motor with such fields with the following current limitations.

Model Size

| Size | | |
|---|---|---|
| 1 | 8A current regulated, suitable for field weakening and field economy, on 5-100HP (9500-8X02 to 9500-8X06) | |
| 2 | 10A on 125-400 HP (9500-8X07 to 9500-8X11) | Fixed voltage supply |
| 3 | 20A on 500-1000 HP (9500-8315 to 9500-8320 and 9500-8612 to 9500-8620) | Rectified DC |

### What is the difference between Size 1 field supplies and the larger Size 2 & 3 models ?

Size 1 models have a built-in Field Regulator that regulates the field current compensating for line voltage variation, motor field temperature changes etc.

As can be seen from the table above, Size 2 & 3 Quantum's provide a fixed DC Voltage that is roughly 2/3 the AC supply input. So for 460vac they produce about 300vdc and at 230vac they produce about 150vdc.

## Do I need the FXM5 Field Regulator ?

Well, it is always nice to have a regulated field supply but not absolutely necessary unless Field Weakening is required with Size 2 & 3 models. Fixed field supply voltages tend to run a bit high which results in a higher than necessary field current and therefore cause higher than necessary power waste and heat dissipation. For example, a hot field might require only 250vdc for full nameplate current of say 6A. A fixed field would produce about 310vdc or 60v ( 24% ) more than necessary which would result in 24% more current or about 7A. This would result in 7A * 60v or about 400 wasted watts. On a continuous power consumption basis, the FXM5 field regulator could pay for itself rather quickly. Besides this savings during actual runtime, the FXM5 has built-in Field Economy that permits the quiescent or standby power to be reduced significantly ( down to 10-20% of normal which would again accelerate the payback ).

## Motors with 240vdc Fields

Older motors were sometimes designed for 240vdc Field Excitation. In this case, we can excite those as well but we will need to include a Boost Transformer typically ( 100VA per field amp). For more information on 240vdc Field Excitation consult the following application note:

http://www.emersonct.com/download_usa/appNotesPDF/ctan203.pdf

## Motor Speed Requirements

If a DC motor nameplate only has 1 speed listed you shouldn't have a problem. If the nameplate lists 2 speeds ( then there should also be 2 field currents corresponding to these speeds on the nameplate), then you will need to find out if the application needs to run the motor more than 5% above the lower of the 2 speeds. If so, a method known as Field Weakening is going to have to be used.

## Field Weakening

Size 1 Quantum III's can perform Field Weakening naturally due the the built-in Field Regulator.

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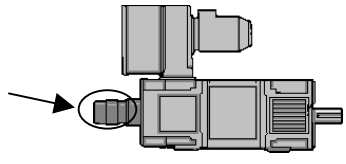
Size 2 & 3 Quantums require the FXM5 external Field Regulator -

In addition, Field weakening requires a motor mounted speed feedback device such as a :

AC Tach ( for non-regenerative drive applications only)
DC Tach
Encoder ( dual channel with differential outputs )



Quantum III can handle any of these feedback devices.

## Other Application Concerns

- Does the motor need to go in reverse occasionally? If yes…..

  **Use a Regenerative Model of Quantum**. Regen models have a P/N like 9500-**86**XX.

- Does the application have a high inertia content ( does it keep going long after power is removed ) ? If yes, you may need a regenerative drive in order to stop the machine more quickly than just coasting.

- Does the machine need to stop quickly in cases of Emergency?

You may need to consider the application of a DB resistor. Quantum III models up to and including 9500-8X09 have a built-in DB pole to accommodate Dynamic Braking.
To select a Dynamic Braking resistor consult the following link and look for DC E-Stop Resistors:

http://www.emersonct.com/download_usa/literaturePDF/pdCatalog2003/PW_Sub_Sec_DBR.pdf

## Example 1

**You are looking for a Quantum III to drive a 500v DC motor with the following nameplate data**:

60 HP FLA rating of 115A
300vfld Motor RPM 1150/1500
Field data is not readable ( rubbed off) no amp data on nameplate but field ohms measured 120 ohms cold
Motor has a DC tach that reads 50.2v/1000rpm
Application is a large grinder that spins the grinding wheel at 4000rpm and 3:1 belt ratio

Available power comes from an overhead bus (490vac) that comes from a 750KVA transformer

**Which Quantum would you specify ?**

At first glance, one might select a 9500-8x05 model. But with closer examination, one can see that the 8x05 model ( listed as 60HP ) can deliver up to 105A continuously. Your motor is 115A. You may decide that the application will not require the full motor torque continuously and 105A would be close enough otherwise you would need a 9500-8x06.

The 3:1 belt ratio means the motor will need to spin at 4000/3 or 1333rpm. This is more than 5% above the base speed ( 1150 ) of the motor therefore field weakening will need to be employed. Since all Size 1 Quantum III have the built-in field weakening regulator, it can be done ( as long as we have speed feedback – and we do have a DC tach ). Can the size 1 provide enough field current ? Well , 300v/120 ohms would be 2.5A well within the 8A max for this size.

Being a grinder, it may have a tendency to coast quite a long time due it's inherent inertia. Ask the customer how long the grinder tends to run from full speed following a coast stop- if he says it would run on for 45 seconds to a minute, then ask how quick he would like it to stop. If he says 5-10 seconds would be nice, then you would want to specify a regen model ( 9500-86XX ) in order to take the inertial energy of motion out of the machine and regenerate it back to the power line in order to stop in that kind of time frame.

As far as the power source, and reviewing the max ampacity chart, you would want to specify either a 75-100KVA isolation transformer or a 3% line reactor to provide adequate impedance buffering from their rather stiff power bus.

## Example 2

**You are looking for a Quantum III to drive a 240v DC motor with the following nameplate data**:

125 HP FLA rating of 410A
240vfld Motor RPM 1750/2500
Field Current 5.5/3.6

Motor has an AC tach that reads 46vac/1000rpm
Application is an extruder that has a gear box ratio of 32:1

Available power comes from 480vac power bus of 1000KVA

**Which Quantum would you specify ?**

First of all, extruder drives almost never need reverse so a Non-Regen model should do the trick. Checking the armature current column from the rating table, we find that the **9500-8309** will supply up to **428A** continuously.

They say that their Screw RPM must be 65 rpm and is within the limits of the extruder per the manufacturer.

For 65 Screw RPM the motor must spin at 65 * 32 or 2080rpm.

This is above the base motor speed of 1750RPM so field weakening is required. The 9500-8309 is a Size 2 Quantum III whereby the FXM5 would be used to provide Field Weakening. Luckily the motor is already equipped with a tachometer ( a requirement for Field Weakening ). Also since this is a non-regenerative application, the AC tach is fine.

For 240vdc armatures we need to supply 240vac. So we would need an step down isolation transformer. From our catalog we would select **8812-0145-3** 460pri/230sec 145KVA
http://www.emersonct.com/download_usa/literaturePDF/pdCatalog2003/PW_Sub_Sec_IsoTxfr.pdf

This field for this motor was specified as 240vdc. To achieve this higher voltage we would need a small boost transformer PN **BT48V10A-CR** as outlined by the following Application Note CTAN203:
http://www.emersonct.com/download_usa/appNotesPDF/ctan203.pdf

Is braking required ? Extruder loads are so viscous that upon a stop command the motor usually stops very quickly. So no, braking is natural by the application.

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*If you have an application and aren't quite sure that you've picked out the correct model, fill out the following Application Data Sheet and fax it into our Technical Support Center at 716-774-8949 with your contact information and we will assist you.*

**Questions ?? Ask the Author**:

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# Quantum III Application Check List

## Motor Nameplate Data

Rated Armature Voltage_____vdc
Rated Armature Amps _____Adc

Rated Speed_____RPM or _____/_____RPM

Field Voltage_____vdc
Field Amps _____Adc or _____/_____Adc
Field Ohms _____

Does motor have one or two field windings ? _____ F1 & F2 or F1, F2, F3, F4

Does motor have a series field ? _____ S1, S2

Do you need the FXM5 Field Regulator? _____

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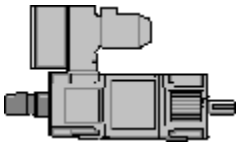

## Motor Feedback

Does the motor have a speed feedback device on the end of it ?_____

If Yes, is it an AC or DC Tach _____ and what is the output of it _____v/1K rpm
If it is an Encoder, what is the Pulses/Rev _____PPR and voltage rating ____vdc

## Application Information

What is the line voltage for the Drive ?_____vac
What is the Ampacity of Power Source _____kVA

Is an Isolation Transformer or Line Reactor indicated for this application ? _____

What kind of a machine is this being used on ? _____ ie Extruder, Lathe

_____

What is maximum motor speed required for this application ? _____RPM
Is reversing required ? _____ (Regen model indicated 9500-860X )

Is Field Weakening required ? _____

Is Dynamic Braking required ? _____ How often ? _____

Does machine have a high inertia content ? _____