| General Purpose AC Drive Technical Information | | | |
|---|---|---|---|
| Classification | Application Note | Document No. | AN.AFD.15 |
| Title | Applying Drives to Single-Phase Input Applications | | |
| Applicable Products | E7, F7, P7 | | |

**SAFETY PRECAUTIONS AND INSTRUCTIONS FOR USE OF TECHNICAL INFORMATION**

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# INTRODUCTION

## VFD Use with Single-Phase Power Systems

Most commercial and industrial electrical equipment requires three-phase power based on electrical demand of heavy manufacturing population and general industry. In rural areas or commercial office buildings that were not originally designed to support heavy manufacturing, utilities do not install three-phase power because the cost is significantly more than single-phase installation.

For many years, people have been using different technology to generate three-phase power from single-phase sources. Common technologies include rotary phase converters, static phase converters and variable frequency drives (VFDs). As initial investment costs of VFDs have lowered and product reliability has increased, more users are turning to VFDs as the best solution to convert single-phase motor applications to three-phase, because their process demands have changed requiring variable speed control. Common applications utilizing VFDs with single-phase input are submersible well pumps, centrifugal pumps, irrigation systems, fountain systems, and pump jacks.

Using VFDs specifically designed for single-phase use is not always practical as manufacturers may offer single-phase models only in low horsepower ratings. Therefore, it may be necessary to apply a three-phase VFD in larger capacity single-phase situations. When applying single-phase power to a three-phase VFD, there are several constraints that need to be considered.

Standard Pulse-Width-Modulated (PWM) VFDs use a 6-pulse diode rectifier because of its simplicity and low cost structure. The 6-pulse rectification results in 360 Hz DC bus ripple when used with a three-phase 60 Hz supply. However, under single-phase use, the DC bus ripple becomes 120 Hz and the VFDs DC bus circuit is subject to higher stress in order to deliver equivalent power. Additionally, input currents and harmonics increase beyond those encountered with three-phase input. Input current distortion of 90% THD and greater can be expected under single-phase input, compared to approximately 40% with three-phase input as indicated in Figure 2.0. Therefore, single-phase use requires the three-phase VFD power rating be reduced (derated) to avoid over stressing the rectifier and DC link components.

**Figure 1.0 Typical Three-Phase Configuration**

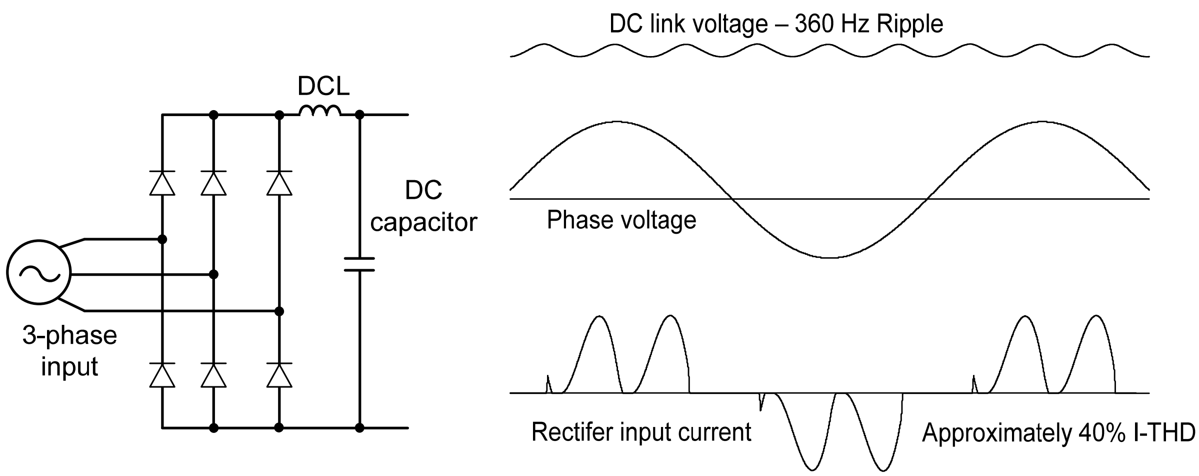
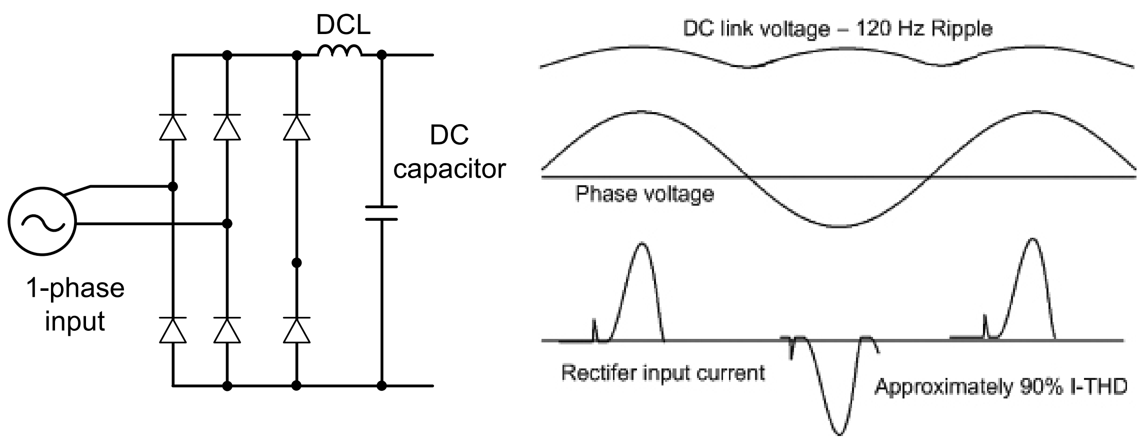



**Figure 2.0 Typical Single-Phase Configuration**



## Important Considerations When Using a Three-Phase Drive with Single-Phase Input

Yaskawa E7, F7, and P7 drives have been tested and UL approved for single-phase input power applications provided that an appropriate derate is applied. It is imperative that the guidelines outlined in this document are followed to determine the correct drive selection for the connected motor and load, ensuring satisfactory operation and drive longevity.

## Drive HP, Input Current and Output Current

When using a three-phase VFD with single-phase input, derating the drive's output current and horsepower will be necessary because of the increase in DC bus ripple voltage and current. In addition, the input current through the remaining two phases on the diode bridge converter will approximately double, creating another derating consideration for the VFD. The increase in input current is due to the conversion of three-phase to single-phase power (√ 3 factor) and the reduced overall power factor. Input current harmonic distortion will increase beyond that with a three-phase supply making the overall input power factor low. An overall power factor of 0.7 is typical with single-phase input on units incorporating the recommended DC link choke. A power factor of 0.9 is typical with units incorporating DC link chokes with three-phase input. Input current distortion over 100% is likely under single-phase conditions without a DC link choke. Therefore, **DC link chokes are always required.**

Use Table 1 to select the appropriate drive and DC link choke for the applied motor. As indicated in Table 1, Yaskawa VFDs larger than 18 kW incorporate built-in DC link chokes as standard. Therefore, these models will not require external DC link chokes.

Be sure to oversize the drive as necessary to accommodate for operating the motor into its service factor. **The selected drive ratings must meet or exceed both the motor nameplate HP and the motor nameplate full load amperage (FLA), along with satisfying any service factor HP and FLA requirements.** Selecting a drive that meets only one of these two requirements may result in poor performance, premature drive failure and void the factory warranty.

## Input Frequency and Voltage Tolerance

The drive ratings in Table 1 are valid for 60Hz input only. Operation at input frequencies other than 60Hz will require further review by the factory. The AC supply voltage must be within the required voltage range of **240/480Vac +10% to –5%** to maximize motor power production. Standard product with three-phase voltage input has an allowable range of +10% to –15%. Therefore, a stricter input voltage tolerance of +10 to –5% applies when using the drive with a single-phase supply.

The average bus voltage with single-phase input is lower than the equivalent of a three-phase input. Therefore, the maximum output voltage (motor voltage) will be lower with a single-phase input. The minimum input voltage must be no less than 228Vac for 240 volt models and 456Vac for 480 volt models, to ensure motor voltage production of 207Vac and 415Vac, respectively. Thus, if full motor torque must be developed near base speed (full power) it will be necessary to maintain a rigid incoming line voltage so that adequate motor voltage can be produced. Increasing the incoming voltage by tapping-up the supply transformer, will be advantageous, should rated motor HP be required. However, caution should be used to ensure the input voltage does not increase to damaging levels during periods of low demand such as off-peak and/or weekend hours.

Operating a motor at reduced speed (reduced power), or **using a motor with a base voltage that is lower than the incoming AC supply rating (ex. 208Vac motor with a 240Vac supply), will also minimize the effect of voltage deprivation.** Table 1 incorporates motors rated at 208Vac and 400Vac to help out with the selection process should optimum performance be required with low input voltage.

## DC Link Choke, Input Wiring, and Branch Circuit Protection

It is important that input wiring and branch circuit protection be selected based on the drive's single-phase input current rating indicated in Table 2. The single-phase input current after derating differs from the three-phase input indicated on the VFD nameplate.

Connect the AC single-phase supply to VFD terminals L1(R) and L2 (S) to accommodate models that have cooling fans and soft charge circuits that utilize the AC line supply. The drive's internal AC fan(s) and soft charge contactor are wired to terminals L1 (R) and L2 (S) from the factory.

As previously stated, external DC link chokes are required on ALL models that do not have them built-in as standard to limit the DC bus ripple, converter currents, and improve input power factor. Select DC link chokes are based on the information in Table 1. The DC link chokes incorporated in Table1 have been selected to optimize the VFD's output current and HP rating, while minimizing voltage drop. For this same reason, the use of three-phase line reactors is undesirable. The voltage drop associated with three-phase line reactors is significantly larger compared to that of the DC link choke. A large reduction in motor power generation may result when using a three-phase line reactor due to excessive drop in line/bus voltage. If power quality concerns such as line transients and notching dictate a three-phase line reactor must be used, consider using a reduced voltage motor (i.e. a 208V or 400V motor) to reduce the effect of voltage deprivation.

Table 3 contains information pertaining to the DC link choke specifications. Physically locate the DC link choke as close to the drive as possible to minimize the wire length. Use terminals +1 and +2 to connect the choke to the drive and remove the factory supplied shorting bar between these terminals prior to connecting the DC link choke.

⚠ **WARNING: The DC link chokes referred to in Table 1 and 3 are open chassis and are designed to be installed within an enclosure. Do not mount DC link chokes directly to any surface without the proper enclosure protection due to high DC bus voltage on power terminals. Failure to do so could result in death or serious injury.**

## VFD Overload Capacity

Under single-phase use the DC bus ripple will increase and the minimum bus level will decrease below what is normally generated with three-phase input. For this reason, any overload requirements must be fully identified and understood. **The VFD can supply 120% of the drive rated output current indicated in Table 1 for starting purposes (maximum one minute duration under non-repeating conditions).** The VFD will not generate overload in excess of 120%, except at low speeds where motor power production remains low. The DC bus voltage may drop beneath critical levels, when load in excess of 120% occurs at higher speeds. Therefore, be sure to select the drive anticipating no more than 120% of motor rated current for starting purposes only. Please consult the factory for additional guidance concerning repeating overloads (cyclic loads) or when overload in excess of 120% is required.

## Generator Applications

When used on generator sets, because of their non-linear load characteristics, many VFDs can induce distortion into the generator output voltage feeding the VFD. Typically, over sizing the generator will be required to prevent the generator from overheating due to increased harmonic currents and lower power factor induced by the VFD. When applying any VFD to a generator, it is recommended that the generator manufacturer be consulted to review the application and system loads to prevent any power issues.

## Single-Phase Drive Selection

The following tables must be used to ensure proper drive selection for single-phase input applications. Before you begin your selection, make sure you know the motor nameplate data including motor horsepower (HP) and the full load amps (FLA). The chosen drive ***must meet or exceed both the nameplate motor HP and nameplate motor FLA*** requirements**.** Account for any known operating conditions, such as operating the motor into its service factor by using the motor's service factor horsepower and amperage to make your selection.

The following tables must be adhered to, because the specifications below are unique to single-phase power system configuration and differ from the standard Yaskawa three-phase VFD specifications.

## Single-Phase Application Specification Summary

- Input Voltage: 240/480VAC +10% / -5%, 1 Phase, 60 Hz
- Drive Single-Phase Ratings must meet or exceed both motor HP and motor FLA (include service factor if applicable)
- DC Link Chokes must be used on all models below 4022 and 2022 (refer to Table 1 for proper selection) – consult factory if DC link chokes cannot be accommodated
- VFD Output Overload Capacity: 120% of drive rated output current maximum for 60 seconds, non re-occurring (starting motor only) – consult factory with cyclic loads or when overload in excess of 120% is required
- At rated motor HP and 228 VAC (456VAC) single-phase input, maximum motor voltage of 207Vac (415Vac) is to be expected. Recommended motor voltage when optimum performance is required near base speed: 240 VAC Input ➔ 208 V motor, 480 VAC input ➔ 400 V motor.
- Use of three-phase line reactors with DC Link chokes is not recommended as the three-phase line reactor will reduce available maximum output voltage that may result in increased motor current.

**NOTE: When using the Drive with single-phase input power the drive's input phase loss protection must remain enabled. If Input Phase Loss (PF) faults are encountered, be sure to check the load current and incoming voltage levels to ensure both are within specification as outlined in this document. Input phase loss faults generally indicate the drive is undersized for the applied load. Disabling input single-phase protection will result in permanent drive damage and void the warranty**.

### Table 1 – Single-Phase Ratings (240V / 60Hz Input) with DC Link Choke

| Model | Drive Single-Phase Rating | | | 208V Motor | | 230V Motor | | DC Link Choke | |
|---|---|---|---|---|---|---|---|---|---|
| E7/F7/P7 | Max. Output HP | Output Amps | Input Amps | HP* | Amps* | HP* | Amps* | YEA Part Number | Inductance (mH) |
| 20P4 | 0.33 | 1.8 | 2.0 | - | - | - | - | URX000041 | 12.0 |
| 20P7 | 0.63 | 2.4 | 3.8 | 0.5 | 2.4 | 0.5 | 2.2 | 05P00620-0111 | 7.5 |
| 21P5 | 1.39 | 4.6 | 8.4 | 1.0 | 4.6 | 1.0 | 4.2 | 05P00652-0213 | 4.0 |
| 22P2 | 1.76 | 5.4 | 10.6 | 1.0 | 4.6 | 1.0 | 4.2 | 05P00652-0213 | 4.0 |
| 23P7 | 2.92 | 8.4 | 17.6 | 2.0 | 7.5 | 2.0 | 6.8 | URX000048 | 2.8 |
| 25P5 | 3.87 | 11.5 | 23.3 | 3.0 | 10.6 | 3.0 | 9.6 | URX000052 | 1.75 |
| 27P5 | 5.80 | 17.0 | 35.0 | 5.0 | 16.7 | 5.0 | 15.2 | URX000053 | 1.28 |
| 2011 | 8.32 | 24.2 | 44.9 | 7.5 | 24.2 | 7.5 | 22.0 | URX000057 | 1.00 |
| 2015 | 11.2 | 30.8 | 60.5 | 10.0 | 30.8 | 10.0 | 28.0 | URX000064 | 0.61 |
| 2018 | 17.0 | 46.2 | 91.5 | 15.0 | 46.2 | 15.0 | 42.0 | URX000068 | 0.40 |
| 2022 | 12.9 | 35.4 | 69.6 | 10.0 | 30.8 | 10.0 | 28.0 | Built-In | |
| 2030 | 17.5 | 47.7 | 94.4 | 15.0 | 46.2 | 15.0 | 42.0 | | |
| 2037 | 21.6 | 60.1 | 116.5 | 20.0 | 59.4 | 20.0 | 54.0 | | |
| 2045 | 26.3 | 74.8 | 142.0 | 25.0 | 74.8 | 25.0 | 68.0 | | |
| 2055 | 32.2 | 89.4 | 173.5 | 30.0 | 88.0 | 30.0 | 80.0 | | |
| 2075 | 43.8 | 117.4 | 236.1 | 40.0 | 114.0 | 40.0 | 104.0 | | |
| 2090 | 52.6 | 143.5 | 283.3 | 50.0 | 143.0 | 50.0 | 130.0 | | |
| 2110 | 63.2 | 169.3 | 340.4 | 60.0 | 169.0 | 60.0 | 154.0 | | |

* Motor HP and Amps values based on NEC 2008 Table 430.250 with Amp values for 400V motors extrapolated from 460V motor data.

⚠ **WARNING: The DC link chokes referred to in Table 1 are open chassis and are designed to be installed within an enclosure. Do not mount DC link chokes directly to any surface without the proper enclosure protection due to high DC bus voltage on power terminals. Failure to do so could result in death or serious injury.**

**Table 1 – Single-Phase Ratings (480V / 60Hz Input) with DC Link Choke**

| Model | Drive Single-Phase Rating | | | 400V Motor | | 460V Motor | | DC Link Choke | |
|---|---|---|---|---|---|---|---|---|---|
| E7/F7/P7 | Max. Output HP | Output Amps | Input Amps | HP* | Amps* | HP* | Amps* | YEA Part Number | Inductance (mH) |
| 40P4 | 0.3 | 0.9 | 0.9 | - | - | - | - | URX000039 | 50.00 |
| 40P7 | 0.7 | 1.3 | 2.1 | 0.5 | 1.3 | 0.5 | 1.1 | URX000039 | 50.00 |
| 41P5 | 1.3 | 2.4 | 4.1 | 1.0 | 2.4 | 1.0 | 2.1 | URX000042 | 25.00 |
| 42P2 | 2.0 | 3.5 | 6.2 | 1.0 | 2.4 | 2.0 | 3.4 | 05P00620-0109 | 15.00 |
| 43P7 | 2.8 | 4.1 | 8.6 | 2.0 | 3.9 | 2.0 | 3.4 | 05P00620-0111 | 7.50 |
| 44P0 | 3.5 | 5.5 | 10.9 | 3.0 | 5.5 | 3.0 | 4.8 | 05P00620-0111 | 7.50 |
| 45P5 | 3.8 | 6.3 | 11.9 | 3.0 | 5.5 | 3.0 | 4.8 | URX000046 | 4.00 |
| 47P5 | 5.3 | 8.7 | 16.4 | 5.0 | 8.7 | 5.0 | 7.6 | 05P00652-0216 | 3.75 |
| 4011 | 7.6 | 12.2 | 21.3 | 5.0 | 8.7 | 7.5 | 11.0 | 05P00652-0216 | 3.75 |
| 4015 | 11.2 | 17.0 | 31.3 | 10.0 | 16.1 | 10.0 | 14.0 | URX000056 | 2.68 |
| 4018 | 13.6 | 21.0 | 37.9 | 10.0 | 16.1 | 10.0 | 14.0 | URX000061 | 1.35 |
| 4022 | 14.5 | 21.7 | 40.3 | 10.0 | 16.1 | 10.0 | 14.0 | Built-In | |
| 4030 | 19.9 | 29.2 | 55.5 | 15.0 | 24.2 | 15.0 | 21.0 | | |
| 4037 | 24.5 | 36.6 | 68.5 | 20.0 | 31.1 | 20.0 | 27.0 | | |
| 4045 | 29.2 | 43.4 | 81.4 | 25.0 | 39.1 | 25.0 | 34.0 | | |
| 4055 | 36.3 | 54.3 | 101.2 | 30.0 | 46.0 | 30.0 | 40.0 | | |
| 4075 | 49.7 | 73.0 | 138.5 | 40.0 | 59.8 | 40.0 | 52.0 | | |
| 4090 | 58.7 | 86.4 | 163.8 | 50.0 | 74.8 | 50.0 | 65.0 | | |
| 4110 | 71.0 | 102.6 | 198.2 | 60.0 | 88.6 | 60.0 | 77.0 | | |
| 4132 | 86.1 | 124.8 | 240.3 | 75.0 | 110.4 | 75.0 | 96.0 | | |
| 4160 | 105.5 | 147.4 | 294.3 | 100.0 | 142.6 | 100.0 | 124.0 | | |
| 4185 | 123.3 | 181.3 | 343.8 | 100.0 | 142.6 | 100.0 | 124.0 | | |
| 4220 | 146.6 | 247.9 | 408.8 | 125.0 | 179.4 | 125.0 | 156.0 | | |
| 4300 | 200.0 | 331.4 | 558.6 | 200.0 | 276.0 | 200.0 | 240.0 | | |

* Motor HP and Amps values based on NEC 2008 Table 430.250 with Amp values for 400V motors extrapolated from 460V motor data.

⚠ **WARNING: The DC link chokes referred to in Table 1 are open chassis and are designed to be installed within an enclosure. Do not mount DC link chokes directly to any surface without the proper enclosure protection due to high DC bus voltage on power terminals. Failure to do so could result in death or serious injury.**

**Table 2 – Wiring and Branch Circuit Recommendations (240V Single-Phase Input)**

| Model | Single-Phase | 208V Motor | | 230V Motor | | Wire Selection* | | Fuse Selection (Amps) ** | | CB Selection (Amps) |
|---|---|---|---|---|---|---|---|---|---|---|
| E7/F7/P7 | Input Amps | HP | Amps | HP | Amps | Single Conductor (AWG) | Multiple Conductor (AWG) | Time Delay Fuse (max.) | Non-Time Delay Fuse (max.) | Inverse Time Type or MCP Type (max.) |
| 20P4 | 2.0 | - | - | - | - | 14 | | 3.5 | 6 | 15 |
| 20P7 | 3.8 | 0.5 | 2.4 | 0.5 | 2.2 | 14 | | 7 | 12 | 15 |
| 21P5 | 8.4 | 1.0 | 4.6 | 1.0 | 4.2 | 14 | | 15 | 25 | 20 |
| 22P2 | 10.6 | 1.0 | 4.6 | 1.0 | 4.2 | 14 | | 20 | 30 | 20 |
| 23P7 | 17.6 | 2.0 | 7.5 | 2.0 | 6.8 | 10 | | 30 | 50 | 40 |
| 25P5 | 23.3 | 3.0 | 10.6 | 3.0 | 9.6 | 10 | | 40 | 70 | 50 |
| 27P5 | 35.0 | 5.0 | 16.7 | 5.0 | 15.2 | 8 | | 60 | 100 | 80 |
| 2011 | 44.9 | 7.5 | 24.2 | 7.5 | 22.0 | 6 | | 80 | 125 | 100 |
| 2015 | 60.5 | 10.0 | 30.8 | 10.0 | 28.0 | 4 | | 110 | 175 | 150 |
| 2018 | 91.5 | 15.0 | 46.2 | 15.0 | 42.0 | 2 | | 150 | 250 | 225 |
| 2022 | 69.6 | 10.0 | 30.8 | 10.0 | 28.0 | 3 | 8 AWG x 2P | 110 | 175 | 150 |
| 2030 | 94.4 | 15.0 | 46.2 | 15.0 | 42.0 | 1 | 4 AWG x 2P | 175 | 250 | 225 |
| 2037 | 116.5 | 20.0 | 59.4 | 20.0 | 54.0 | 1/0 | 3 AWG x 2P | 200 | 350 | 300 |
| 2045 | 142.0 | 25.0 | 74.8 | 25.0 | 68.0 | 3/0 | 2 AWG x 2P | 250 | 400 | 350 |
| 2055 | 173.5 | 30.0 | 88.0 | 30.0 | 80.0 | 4/0 | 1/0 x 2P | 300 | 500 | 450 |
| 2075 | 236.1 | 40.0 | 114.0 | 40.0 | 104.0 | 350 | 3/0 x 2P | 400 | 600 | 600 |
| 2090 | 283.3 | 50.0 | 143.0 | 50.0 | 130.0 | 500 | 4/0 x 2P | 500 | 800 | 700 |
| 2110 | 340.4 | 60.0 | 169.0 | 60.0 | 154.0 | 700 | 300 x 2P | 600 | 800 | 800 |

* Wire selection is based on 75°C Copper Wire per Table 28.1 of UL508A (multiple conductors selected at 80%).
** Refer to NEC 430 when selecting fuses for branch short circuit protection.

**Table 2 – Wiring and Branch Circuit Recommendations (480V Single-Phase Input)**

| Model | Single-Phase | 400V Motor | | 460V Motor | | Wire Selection* | | Fuse Selection (Amps) ** | | CB Selection (Amps) |
|---|---|---|---|---|---|---|---|---|---|---|
| E7/F7/P7 | Input Amps | HP | Amps | HP | Amps | Single Conductor (AWG) | Multiple Conductor (AWG) | Time Delay Fuse (max.) | Non-Time Delay Fuse (max.) | Inverse Time Type or MCP Type (max.) |
| 40P4 | 0.9 | - | - | - | - | 14 | | 2 | 2.5 | 15 |
| 40P7 | 2.1 | 0.5 | 1.3 | 0.5 | 1.1 | 14 | | 3 | 5 | 15 |
| 41P5 | 4.1 | 1.0 | 2.4 | 1.0 | 2.1 | 14 | | 6 | 10 | 15 |
| 42P2 | 6.2 | 1.0 | 2.4 | 2.0 | 3.4 | 14 | | 9 | 15 | 15 |
| 43P7 | 8.6 | 2.0 | 3.9 | 2.0 | 3.4 | 14 | | 15 | 25 | 20 |
| 44P0 | 10.9 | 3.0 | 5.5 | 3.0 | 4.8 | 14 | | 15 | 25 | 20 |
| 45P5 | 11.9 | 3.0 | 5.5 | 3.0 | 4.8 | 14 | | 20 | 30 | 30 |
| 47P5 | 16.4 | 5.0 | 8.7 | 5.0 | 7.6 | 10 | | 25 | 40 | 40 |
| 4011 | 21.3 | 5.0 | 8.7 | 7.5 | 11.0 | 10 | | 35 | 60 | 50 |
| 4015 | 31.3 | 10.0 | 16.1 | 10.0 | 14.0 | 8 | | 50 | 75 | 75 |
| 4018 | 37.9 | 10.0 | 16.1 | 10.0 | 14.0 | 8 | | 60 | 100 | 90 |
| 4022 | 40.3 | 10.0 | 16.1 | 10.0 | 14.0 | 6 | | 70 | 110 | 100 |
| 4030 | 55.5 | 15.0 | 24.2 | 15.0 | 21.0 | 4 | 8 AWG x 2P | 90 | 150 | 125 |
| 4037 | 68.5 | 20.0 | 31.1 | 20.0 | 27.0 | 3 | 6 AWG x 2P | 110 | 175 | 150 |
| 4045 | 81.4 | 25.0 | 39.1 | 25.0 | 34.0 | 3 | 6 AWG x 2P | 125 | 200 | 200 |
| 4055 | 101.2 | 30.0 | 46.0 | 30.0 | 40.0 | 2 | 4 AWG x 2P | 150 | 250 | 250 |
| 4075 | 138.5 | 40.0 | 59.8 | 40.0 | 52.0 | 1/0 | 3 AWG x 2P | 200 | 350 | 300 |
| 4090 | 163.8 | 50.0 | 74.8 | 50.0 | 65.0 | 3/0 | 2 AWG x 2P | 250 | 400 | 400 |
| 4110 | 198.2 | 60.0 | 88.6 | 60.0 | 77.0 | 4/0 | 1/0 x 2P | 300 | 450 | 450 |
| 4132 | 240.3 | 75.0 | 110.4 | 75.0 | 96.0 | 300 | 2/0 x 2P | 400 | 600 | 600 |
| 4160 | 294.3 | 100.0 | 142.6 | 100.0 | 124.0 | 500 | 4/0 x 2P | 500 | 700 | 700 |
| 4185 | 343.8 | 100.0 | 142.6 | 100.0 | 124.0 | 700 | 300 x 2P | 600 | 800 | 800 |
| 4220 | 408.8 | 125.0 | 179.4 | 125.0 | 156.0 | 700 | 300 x 2P | 700 | 900 | 1000 |
| 4300 | 558.6 | 200.0 | 276.0 | 200.0 | 240.0 | - | 4/0 x 4P | 900 | 1200 | 1200 |

* Wire selection is based on 75°C Copper Wire per Table 28.1 of UL508A (multiple conductors selected at 80%).
** Refer to NEC 430 when selecting fuses for branch short circuit protection.

## Drive Selection Example

A 240V single-phase submersible pump application incorporates a 7.5 HP, 230Vac pump assembly rated at 20A RMS with a service factor rating of 23A RMS. Determine the proper drive assuming:

A) No service factor operation is required
B) Service factor operation is required

Solution:

A) No service factor operation is required:
   Requirements: 7.5 HP
   20 Amps RMS
   Variable Torque (120% overload is sufficient)

   Selection: P7U2011 rated 24.2 A RMS and 8.32 HP
   with DC Link Choke URX000057

B) Service factor operation is required:
   Requirements: 8.6 HP (7.5 HP 23A/20A)
   23 Amps RMS
   Variable Torque (120% overload is sufficient)

   Selection: P7U2015 rated 30.8 A RMS and 11.2 HP
   with DC Link Choke URX000064

**Note: Depending on input line voltage level and maximum load HP required, it will be advantageous to consider using a 208Vac pump assembly to ensure adequate HP production for Solution A and Solution B.**

## DC Link Choke Data for Single-Phase Operation

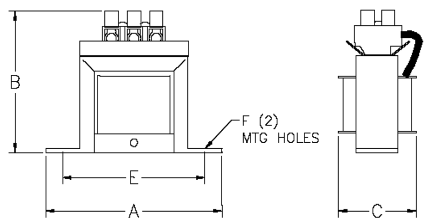


FIGURE 1

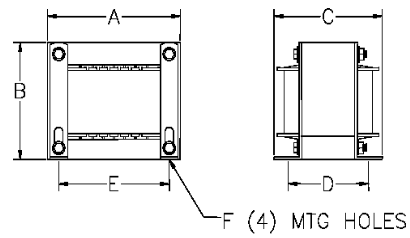


FIGURE 2

⚠ **WARNING: The DC link chokes referred to in Table 3 are open chassis and are designed to be installed within an enclosure. Do not mount DC link chokes directly to any surface without the proper enclosure protection due to high DC bus voltage on power terminals. Failure to do so could result in death or serious injury.**

### Table 3 – DC Link Choke Dimensions

| Model | Motor 208 VAC | Motor 230 VAC | DC Link Choke | | | DC Link Choke Dimensions (inches) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| E7/F7/P7 | HP | HP | YEA Part Number | Inductance (mH) | Figure | Length "A" | Depth "C" | Height "B" | Mtg Hole "D" | Mtg Hole "E" | Mtg Hole Diameter |
| 20P4 | - | - | URX000041 | 12.0 | 1 | 3.75 | 2 | 3.25 | N/A | 3.13 | .187 |
| 20P7 | 0.5 | 0.5 | 05P00620-0111 | 7.5 | 2 | 3.81 | 2.82 | 4.5 | 2 | 3.13 | .203 x .328 |
| 21P5 | 1.0 | 1.0 | 05P00652-0213 | 4.0 | 2 | 3.81 | 2.82 | 4.5 | 2 | 3.13 | .203 x .328 |
| 22P2 | 1.0 | 1.0 | 05P00652-0213 | 4.0 | 2 | 3.81 | 2.82 | 4.5 | 2 | 3.13 | .203 x .328 |
| 23P7 | 2.0 | 2.0 | URX000048 | 2.8 | 2 | 3.81 | 3.75 | 4.5 | 3 | 3.13 | .203 x .328 |
| 25P5 | 3.0 | 3.0 | URX000052 | 1.75 | 2 | 3.81 | 3 | 4.5 | 2.5 | 3.13 | .203 x .328 |
| 27P5 | 5.0 | 5.0 | URX000053 | 1.28 | 2 | 3.81 | 3.75 | 4.5 | 3 | 3.13 | .203 x .328 |
| 2011 | 7.5 | 7.5 | URX000057 | 1.00 | 2 | 4.63 | 4 | 5.25 | 2.5 | 3.75 | .203 x .328 |
| 2015 | 10.0 | 10.0 | URX000064 | 0.61 | 2 | 4.63 | 7.25 | 4 | 4 | 3.75 | .203 x .328 |
| 2018 | 15.0 | 15.0 | URX000068 | 0.40 | 2 | 4.63 | 6.5 | 4 | 4 | 3.75 | .203 x .328 |
| Model | Motor 400 VAC | Motor 460 VAC | DC Link Choke | | | DC Link Choke Dimensions (inches) | | | | | |
| E7/F7/P7 | HP | HP | YEA Part Number | Inductance (mH) | Figure | Length "A" | Depth "C" | Height "B" | Mtg. Hole "D" | Mtg. Hole "E" | Mtg. Hole Diameter |
| 40P4 | - | - | URX000039 | 50.00 | 1 | 3.75 | 2 | 3.25 | N/A | 3.13 | .187 |
| 40P7 | 0.5 | 0.5 | URX000039 | 50.00 | 1 | 3.75 | 2 | 3.25 | N/A | 3.13 | .187 |
| 41P5 | 1.0 | 1.0 | URX000042 | 25.00 | 2 | 3.81 | 2.82 | 4.5 | 2 | 3.13 | .203 x .328 |
| 42P2 | 1.0 | 2.0 | 05P00620-0109 | 15.00 | 1 | 3.75 | 2 | 3.25 | N/A | 3.13 | .187 |
| 43P7 | 2.0 | 2.0 | 05P00620-0111 | 7.50 | 2 | 3.81 | 2.82 | 4.5 | 2 | 3.13 | .203 x .328 |
| 44P0 | 3.0 | 3.0 | 05P00620-0111 | 7.50 | 2 | 3.81 | 2.82 | 4.5 | 2 | 3.13 | .203 x .328 |
| 45P5 | 3.0 | 3.0 | URX000046 | 4.00 | 2 | 4.63 | 3.5 | 5.25 | 2 | 3.75 | .203 x .328 |
| 47P5 | 5.0 | 5.0 | 05P00652-0216 | 3.75 | 2 | 4.63 | 4 | 5.25 | 2.5 | 3.75 | .203 x .328 |
| 4011 | 5.0 | 7.5 | 05P00652-0216 | 3.75 | 2 | 4.63 | 4 | 5.25 | 2.5 | 3.75 | .203 x .328 |
| 4015 | 10.0 | 10.0 | URX000056 | 2.68 | 2 | 4.63 | 5.25 | 5.25 | 3 | 3.75 | .203 x .328 |
| 4018 | 10.0 | 10.0 | URX000061 | 1.35 | 2 | 4.63 | 5.25 | 5.25 | 4 | 3.75 | .203 x .328 |

Note: Connect DC link chokes to drive terminals +1 and +2 after removing the factory supplied shorting bar.