

# 3 Phase Motor Selection: Duty, Frame, IP and IE Class | TECO

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Technical Articles

## Three-phase induction motor selection: frame size, duty, IP rating and efficiency class for Australian sites

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Specify and select a three phase motor in this order: load and duty, then the drive arrangement, then the site, and only then the efficiency class and the frame. Wrong selections usually consider this backwards, starting from the frame of the old motor or the IE class in the tender.

### Load and duty first: starts per hour and starting torque

Send us the load torque curve from standstill to full speed, the inertia on the shaft and the duty cycle. Our stock motors are rated S1 continuous duty to IEC 60034-1; for any other duty we size the motor from the load demand frequency, the torque required during acceleration, the load inertia and the type of braking.

Each direct on line start generates heat into the stator windings and more importantly the rotor assembly, therefore, starts per hour required are a sizing question. On the TECO MAXe3 the permitted number of starts depends on frame and load inertia, these are counted as equally spaced starts which includes the first cold start; beyond that we size the motor to the duty. The MAXe3 Mining also has as standard a 1.2 service factor at 40°C, this is the margin that a crusher or a conveyor restart draws upon.

Stock TECO motors are built to Design N to IEC 60034-12. If the load needs more torque at standstill, change the motor or the starting method ; a bigger frame on its own does not always fix it.

### Belt drive or direct coupling

Advise pulley sizes, belt tension and overhang on the enquiry, because they dictate the bearing arrangement in particular the drive end bearing . Apart from 2 Pole motors above frame D180, the TECO Te3 range is specified for direct coupling and vee belt drive, and we check the bearing against any belt load. The TECO MAXe3 range takes direct or belt drive from 4 Pole and larger up to D315MC, the Mining version on 250 frame and above has a roller bearing at the drive end. An excessive belt load on a ball bearing arrangement will eventually fail whatever the efficiency class.

## IEC frame size

Once kW and Poles are selected, so is the IEC frame. The TECO MAXeV4 keeps IEC 60072-1 mounting dimensions from frame 80 to 355L, so an IE4 upgrade goes onto the same feet, shaft height and coupling as the motor it replaces. Check the actual frame where the old motor sits to ensure it matches: on the TECO Te3, 110 kW 2 Pole and 75 kW and 110 kW 4 Pole use 250M and 280M frames, and the TECO AFJE/AFJN puts 250 kW to 315 kW in a special 315LL frame to match other motors in the market, complete with a Class B rise.

## Hot and high sites: temperature and altitude derating

Ratings assume 40°C and 1,000 m. Above either, multiply rated output by our temperature and altitude factors; for the TECO MAXe3 the altitude factor is 0.97 at 1,500 m, 0.945 at 2,000 m, 0.89 at 3,000 m and 0.74 at 4,500 m.

Temperature buffer is where the gap between insulation class and temperature rise matters. The TECO MAXe3 Mining is Class H with a rise under 80 K, with under 75 K on most frames, and holds full output up to 60°C ambient. The TECO Te3 is Class F with a Class B temperature rise and is rated from -20°C to +50°C; the Te3 Severe Duty is Class H. That gap is what a hot afternoon, direct sun exposure, a voltage dip or an overload uses up before it breaches the overall insulation thermal rating.

Decide winding protection at the same time: PTC thermistors from frame D160 on single speed TECO Te3 and TECO MAXe3, PTC 150°C from frame 160 on the TECO MAXeV4, and PT100 RTDs in the windings or bearings fitted by our TECO ModShop where the site standard asks for them, usually from 250 kW.

## Enclosure: IP55, IP66 or open drip proof

IP66 for washdown, coal dust and outdoor mining is provided on: TECO Te3 Severe Duty , TECO MAXe3 and TECO MAXeV4. Our open drip proof range (IP23, 7.5 kW to 765 kW) belongs indoors in clean air, where its cooling gives a thermal margin a totally enclosed frame of the same kW size cannot match. Specify the terminal box with the motor: the Te3, MAXe3 and MAXeV4 main terminal box has its own IP66 rating and rotates in 4 x 90° steps.

## IE3 or IE4 efficiency class

Every TECO three phase stock motor meets or exceeds MEPS and IEC 60034-30-1 standards where they apply. The TECO MAXe3 and Te3 are IE3; the TECO MAXeV4 is IE4 from 0.75 kW to 315 kW. Running hours decide: energy consumed is around 95% of a motor's lifetime cost, so on continuous pump, fan or conveyor duty the IE4 pays back in kilowatt-hours , and on a motor that runs a few hundred hours a year it does not. TECO stock both.

All three ranges run on a VSD within the torque and speed limits of the load: variable torque loads from 5 to 50 Hz without derating, inverter-rated insulation is provided as standard.

## Supply voltage and star or delta connection

Stock motors are wound for 380 V to 415 V at 50 Hz and suit 440 V to 480 V at 60 Hz; we wind to order up to 1,100 V. TECO Te3 motors up to 3 kW and TECO MAXe3 up to 4 kW, are star connected and can be reconnected to 240 V delta for single phase input drives, for TECO Te3 4 kW and TECO MAXe3 5.5 kW and above are delta connected. Check the nameplate before ordering a star-delta starter : the motor has to be delta rated at the supply voltage.

## **Common questions about three phase motors**

### ***What is a three phase motor?***

An AC motor supplied from three phases 120 degrees apart, which together produce a rotating field; the squirrel cage induction motor is the most common standard industrial type. TECO three phase motors run from 0.18 kW to 500 kW in the low voltage ranges.

### ***What is a squirrel cage induction motor?***

An induction motor whose rotor is a cage of conductor bars short-circuited by end rings, this is typically pressure die cast in aluminium on TECO low voltage motors. There is no electrical connection to the rotor, so there are no brushes and no slip rings to maintain.

### ***How do I size a three phase motor?***

From the load torque curve, the inertia and the duty cycle, then the ambient and altitude, then the drive arrangement; the kW rating and the frame follow. For duties other than S1, send us the load demand frequency, the torque required during acceleration, the load inertia and the type of braking.

### ***What is the difference between IE3 and IE4?***

These are two efficiency levels under IEC 60034-30-1. TECO MAXe3 and Te3 are IE3; the TECO MAXeV4 is IE4 from 0.75 kW to 315 kW. Both exceed the Australian and New Zealand MEPS minimum.

### ***IP66***

IP66 for washdown, coal dust, outdoor and mining duty, as on the TECO Te3 Severe Duty, MAXe3 and MAXeV4 range of motors.

### ***Can a three phase motor run on single phase?***

Not directly from a single phase 240V supply. It can run from a variable speed drive with single phase input and three phase output, such as the TECO E510s series drive on 200 V to 240 V from 0.37 kW to 2.2 kW. The motor then has to be connected for 240 V: TECO Te3 motors up to 3 kW and MAXe3 motors up to 4 kW are star connected for 415 V and can be reconnected to accept three phase 240 V when connected in delta.

### ***How do you calculate three phase motor current?***

Current equals output kW  $\times$  1,000 divided by ( $\sqrt{3} \times$  line voltage  $\times$  power factor  $\times$  efficiency). For a selection, take the full load current from the nameplate or our datasheet at the actual supply voltage, because power factor and efficiency change with the rating. Our stock motors are wound for 380 to 415 V at 50 Hz; size the cable, the overload and the drive from that current.

## **Talk to TECO about a motor selection**

Send the load data, the duty cycle, the site ambient and altitude and the drive arrangement through the [Contact us](#) page . These motors are stocked in Australia and New Zealand, and our TECO ModShop network modifies them locally, from terminal box orientation and shaft changes to heaters, RTDs and two-pack paint. The low voltage range is on the [TECO 3 phase electric motors](#) page, and the full range of TECO electric motors covers low, medium and high voltage.

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