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Title	Static Converters – General Information

Summary	This document gives some general information to aid the correct choice and installation/connection of static converters

NOTE: Please read in conjunction with static converter user guides, installation & operating instructions.

Static Converters - Introduction

In a home workshop, farm, garage or small business environment there is often a requirement for the operation of machinery driven by 400V three phase induction motors where only a 230V single phase electricity supply is available.

The TRANSWAVE Converter provides an artificial means by which a three-phase motor can be operated from a single phase supply thereby offering a cost-effective solution to this dilemma. In most instances, no modification to the machine is necessary.

The **Static Converter** is designed to operate three phase motors with starting characteristics and duty cycles as generally experienced on machine tool applications (i.e. light to medium duty and relatively constant load conditions). This style of converter is typically used in single operator environments where only one machine is used at a time.

For specific single motor applications where equipment has a heavy starting load or is subjected to an abnormal surge current or high duty cycle, a high torque - heavy duty static converter is recommended. Compressors, Pumps, Extractor Fans and Vehicle Hoists fall into this category. It should be noted that converters are designed for applications with a cyclic duty (i.e. maximum 12 hour duty in any 24 hour period).

Operation

The Static Converter is a passive device that depends upon an interaction between the converter and the driven motor(s) to induce an artificial third phase.

Static Converter Rating
Each size of Static Converter has a minimum load, a maximum single-motor load (for starting reasons) and an overall multi-motor capacity. The minimum load corresponds to the smallest size of motor capable of operating independently from the Static Converter. Not every motor can induce a satisfactory electrical condition across the three phases. The maximum single motor load is approximately 60-70% of the overall capacity of the converter. This is a reflection of the starting losses incurred by the artificial supply.

Power Regulating Switch
The Static Converter incorporates a power-regulating switch below the on/off switch. The operator is invited to select the optimum power level to suit the particular motor or combination of motors in circuit. This switch controls both the starting and running modes of the motor.

Single or Multi-Motor operation
Any number of motors can be operated simultaneously from a Static Converter provided the converter rating is not exceeded, either on a single motor or multi-motor basis. When considering a Static Converter for the operation of a multi-motor application the use of a three-phase distribution board or similar is recommended. In such instances it is imperative that the largest motor is started first and switched off last.

Note: The setting of the power regulating switch may have to be adjusted in line with increases and decreases in load. If this is impractical, the use of a Rotary Converter is recommended.

The converter output takes the form of an industrial-style socket/plug (three-phase, neutral and earth). The output neutral facilitates the use of 240-volt control circuits and small auxiliary loads.

Starting Surge
All TRANSWAVE Converters automatically control the motor starting surge, maintaining the surge until the motor has attained its full running speed irrespective of time taken. The operator need not leave the driven machine to reset the converter for starting.

Voltmeter
The TRANSWAVE Static Converter incorporates a voltmeter indicating the voltage induced on the “artificial” phase. This helps greatly when commissioning and operating the driven equipment.

Special Applications
The use of a **Rotary Converter** is often recommended for three phase applications with small motors, motors of unusual magnetic characteristics (i.e. multi-speed) or motors subjected to abnormal short term overload conditions such as guillotines, power presses and hydraulically driven machines. This style of converter should also be considered for applications where the motor is frequently stopped and started or where the direction of the motor is constantly changed (e.g. screw-cutting).

Fractional Horsepower Motors

Where machinery incorporates ancillary motors of a fractional horsepower nature (e.g. suds/coolant pump; table traverse/feed; table rise/fall) these motors are likely to fall below the minimum load of a Static Converter. Under such circumstances, it is imperative that these motors are operated in conjunction with and not independently of the main drive motor. If this is impractical, the use of a Rotary Converter is recommended.

Technical Data

The static converter offers no inherent overload protection to either the circuit cable or the driven machinery. Adequate overload protection for both the motors in the driven machinery and the supply circuit to the converter is the responsibility of the customer. The customer should also ensure that the electricity system and cable supplying the converter is of sufficient capacity to allow the motor to start without causing undue supply disturbances as a consequence of voltage drop.

The customer must ensure that the output neutral from the converter is not connected to the electricity providers supply neutral or the supply neutral from a generator. The single phase neutral must be kept electrically separate from the converter output neutral to avoid damage to the converter.

Ensure that the details on the converter rating plate are compatible with the electricity supply system and the required motor loads.

The incoming supply should be connected to the converter via an isolator and protection device (i.e. fuse or type C "motor rated" circuit breaker). Recommended fuse ratings and cable sizes are indicated below. The output from the converter takes the form of an industrial-style three-phase neutral and earth socket (Notation: L1, L2, L3 and N reading clockwise from earth). All earth connections should be securely connected to a good earth point. Removal of either the socket or the terminal box (if applicable) will compromise any warranty offered by the manufacturers.

Static converter rating	STATIC CONVERTER Minimum Load Single Motor	STATIC CONVERTER Maximum Load Single Motor	STATIC CONVERTER Maximum Load Multi Motor	SINGLE PHASE SUPPLY 220/240V Fuse or Circuit Breaker	SINGLE PHASE SUPPLY 220/240V Cable*
1.1kW / 1.5HP	0.37kW / 0.5HP	0.75kW / 1.0HP	1.1kW / 1.5HP	13A	2.5mm^2
1.5kW / 2.0HP	0.37kW / 0.5HP	1.1kW / 1.5HP	1.5kW / 2.0HP	13A	2.5mm^2
2.2kW / 3.0HP	0.37kW / 0.5HP	1.5kW / 2.0HP	2.2kW / 3.0HP	13A	2.5mm^2
3.0kW / 4.0HP	0.55kW / 0.75HP	2.2kW / 3.0HP	3.0kW / 4.0HP	20A	2.5mm^2
4.0kW / 5.5HP	0.55kW / 0.75HP	3.0kW / 4.0HP	4.0kW / 5.5HP	25A	2.5mm^2
5.5kW / 7.5HP	0.75kW / 1.0HP	4.0kW / 5.5HP	5.5kW / 7.5HP	32A	4.0mm^2
7.5kW / 10.0HP	0.75kW / 1.0HP	5.5kW / 7.5HP	7.5kW / 10.0HP	40A	6.0mm^2
11kW / 10.0HP	1.5kW / 2.0HP	7.5kW / 7.5HP	11kW / 10.0HP	63A	10.0mm^2

* Minimum cable size for a run of up to 20m.

Technical Data

The Full Load running Current (FLC) of an induction motor operating on a single-phase supply is approximately 5 amps per kW. When operated in conjunction with a TRANSWAVE Converter, the starting current of a three-phase motor is limited to approximately 3 times its FLC. This is significantly lower than the motor starting current of an equivalent sized single-phase motor, which would typically draw between 6-8 times its FLC.

As the starting characteristics of a three-phase motor supplied by a converter are similar in nature to Star/Delta starting on a three-phase supply, significant reductions in starting torque are experienced when compared with direct on line starting on a three-phase supply.

Generally, when machinery is operated in conjunction with a TRANSWAVE Converter direct on line starting is recommend. For machinery fitted with a Star/Delta starter, the period in the star connection should be set as short as possible to ensure a successful start. This is not the case when machinery is operated on a mains three-phase supply.

Static converter supplying control circuitry

If the static converter is to supply a 415V to 230/110V transformer or some 415V control equipment within the machine, use L1 & L3 phases from the static converter. Phases L1 & L3 are the balanced output phases.

NOTE: As mentioned above, the balanced phases of the static converter are L1 & L3. This may not correspond to L1 & L3 of the machine if the control is connected between L2 & L3 for example. Therefore it is important to get the correct connections between the static converter and machine it is supplying.

There is also an output neutral to facilitate the use of 240V control circuits and small auxiliary loads. Connect between neutral and L1.

Before the output plug is inserted into the socket, switch the converter ON using the ON/OFF switch. **Note:** The 1.1kW and 1.5kW units do not have an ON/OFF switch. The “Supply On” light and the “Boost On” light should both come on. **Note:** If the open circuit voltages are checked at this point, phase to phase readings would be as follows:

- 400/420V between L1 and L3
- 400/420V or 560/580V between L2and L3
- No volts or 160V between L1 and L2

Note: The voltages do not relate to earth, as they would on mains three-phase electricity.
Switch the converter off and insert the output plug.

Care should be taken with the setting of the ‘Power-regulating switch’ which is located below the ON/OFF switch. The lowest setting corresponds to the minimum loading, the highest setting to the maximum loading of the converter.

The initial surge required to start the motor is provided by the boost circuit of the converter. The “boost on” light indicates the circuit is energised. The circuit is controlled automatically from within the converter, switching on whenever a motor is ready to start and switching off once the motor has attained its full running speed. If the setting of the switch is too low the motor will struggle to start

and the boost light will stay on. If the setting is too high the motor will sound rough when running, again the boost light may stay on.

The optimum setting for a given single or multi-motor application is determined by quantifying the phase to phase voltages at the motor/starter with the boost light out and the motor(s) running. The voltmeter fitted to the converter indicates the voltage drawn between L1 and L2. This is the "artificial" phase induced by the motor. When commissioning the driven machine, bear in mind that this voltage is only established once the boost light is out and the motor is running. Adjust the selector switch to the setting where this voltage is as close to 400/415 volt as possible. The best overall balance of voltages will correspond to the correct switch setting.

Note: The voltages do not relate to earth as they would on a main three-phase supply system. If the rotation of the driven machine motor is incorrect, ensure that the converter phases marked L1 and L3 are changed for 415-volt phase-phase control circuitry. For 240-volt phase-neutral control circuitry, ensure that phases L2 and L3 are changed

If the boost light does not go out within a few seconds the machine should be switched off to avoid the possibility of electrical damage to the motor. The reason for this condition should be checked and corrected before the motor is restarted. Generally, the setting for the start and run modes of the motor will coincide. However for certain applications particularly those with high torque starting requirements it may be necessary to trim the switch back from a higher to a lower setting once the boost light has gone out to ensure a satisfactory balance of voltages for the running condition. For a multi-motor load, the largest motor should always be started first. An increase or decrease in load may necessitate an adjustment on the selector switch setting to accommodate the load variation. The boost light may switch on and then off when an additional motor is started. This is normal and may be disregarded.

The motor starting current is limited to approximately three times the full load current of the motor. The starting characteristics of a three-phase motor supplied by a converter are similar in nature to Star/Delta starting on a three-phase system. Significant reductions in starting torque are experienced when compared with direct on line starting on a three-phase supply. For machinery supplied by a converter, direct-on-line starting is recommended. For machinery fitted with Star/Delta starters, the period in the star connection should be as short as possible to ensure a successful start.

Where machinery incorporates ancillary motors of a fractional horsepower nature (e.g. table traverse/feed, suds/coolant pump, table rise/fall) it is imperative that these motors are operated in conjunction with and not independent of the main drive motor. Starters should be interlocked accordingly.

When using a converter with multi-speed machines, care should be taken to allow the motor to slow down before switching from a high speed to a low speed. Failure to do this could damage both the converter and the motor. Similarly when reversing a motor, ensure the motor is allowed to come to rest before the rotation change is affected. If either of these conditions is unacceptable (i.e. frequent stop/start, frequent forward/reverse, screw cutting) the use of a pilot motor may offer a solution (see below). The use of the Rotary converter is also recommended as an alternative.

For some three phase applications with small motors, motors of unusual magnetic characteristics (i.e. multi-speed/reversing) or motors subjected to abnormal load conditions it may be necessary to connect a pilot motor in parallel to the driven machine to maintain a satisfactory artificial phase. In

these instances, the pilot motor should be at least equal in rating to the driven machine, preferably larger. The use of a 2-pole (2800rpm) motor fitted with a starter and overload protection device is recommended.

Static converters connected to phase detection equipment

Do not use a static converter in an application where the equipment requires a balanced 3 phase supply or if there is input phase measurement equipment installed which is expecting a balanced 3 phase supply.

In this case, a rotary converter must be used which has a balanced 3 phase output.

NOTE: The output from a TRANSWAVE Converter cannot be compared directly to a mains three-phase electricity supply. The TRANSWAVE Converter offers an artificial means by which a three-phase motor (or motors) can be operated from a single-phase electricity supply. The TRANSWAVE Converter cannot be made to work equally on all motors, even though the horsepower, speed and voltage ratings are the same. Motors of differing manufacture and motors designed for differing applications vary considerably in their electrical characteristics. Therefore it is not always possible to make a universally applicable converter to operate a motor of given horsepower and rating. TRANSWAVE Converters are not designed for use in conjunction with continuous duty application.

Proven examples of equipment operated in conjunction with Static Converters

Wood working machinery

Saws: Circular saw, band saw, rip saw, cross-cut saw, panel saw, wall saw, radial arm saw
Surface planers, planer/moulders, planer/thicknessers, four sided planers, spindle moulders, single-end tenoners, chisel mortisers, chain mortisers, wood turning lathes, copy lathes (electronic).
Sanders: single belt, wide belt, speed, pad, disk, edge & profile, borers, multi-borers, feed units.

Metal working machinery

Lathes, milling machines, pedestal drills, surface grinders, band saws, power hacksaws, polishers, shapers, deburring machines.

Miscellaneous applications

Printing presses, window making machinery, glass and uPVC cutting machinery, masonry saws, produce conveyors, grading equipment, rolling mill / mixing equipment, potting machinery.

Heavy duty – high torque Static converters are recommended for the following applications:
Dust extraction systems – extractor fans, pumps, roller shutter doors, compressors, vehicle hoists, brake testing equipment, spray booths, maceration equipment, agitators, refrigeration compressors, heat pumps, passenger lifts.

Rotary converters are recommended for the following:
Copy lathes (hydraulic), routers, edgbanders, dovetailers, guillotines & paper/card guillotines, metalworkers, power presses, cutting presses, wine presses, looms & weaving machinery, industrial sewing machines.

NOTE: The TRANSWAVE converters are not suitable for applications such as cookers & sunbeds or applications that include heater elements.

Dimensions & weights

	Nett - unpacked				Gross - packed			
Static converter rating	**Height mm**	**Width mm**	**Depth mm**	**Weight kg**	**Height mm**	**Width mm**	**Depth mm**	**Weight kg**
1.1kW / 1.5HP	300	460	310	16	310	470	320	18
1.5kW / 2.0HP	300	460	310	16	310	470	320	18
2.2kW / 3.0HP	300	460	310	20	310	470	320	23
3.0kW / 4.0HP	300	460	310	23	310	470	320	26
4.0kW / 5.5HP	300	460	310	23	310	470	320	26
5.5kW / 7.5HP	350	510	320	29	380	560	410	32
7.5kW / 10.0HP	350	510	350	35	380	560	410	38
11kW / 15.0HP	350	510	350	45	380	560	410	48