TB Wood's

BERGES

User Guide

Smart Drive
Smart Wireless Drive[+]

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1   General

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The manufacturer accepts no liability for any consequences resulting from inappropriate, negligent or incorrect installation, or adjustment of the optional operating parameters of the drive or from mismatching of the drive to the motor.

The contents of this User Guide are believed to be correct at the time of printing. In the interests of a commitment to a policy of continuous improvement, the manufacturer reserves the right to change the specification of the product or its performance or the contents of the User Guide without notice.

1.1   Important safety information

This variable speed drive product (SWP-Drive) is intended for professional incorporation into complete equipment or systems. If installed incorrectly it may present a safety hazard. The SWP-Drive uses high voltages and currents, carries a high level of stored electrical energy, and is used to control mechanical plant that may cause injury. Close attention is required to system design and electrical installation to avoid hazards in either normal operation or in the event of equipment malfunction.

System design, installation, commissioning and maintenance must be carried out only by personnel who have the necessary training and experience. They must carefully read this safety information and the instructions in this Guide and follow all information regarding transport, storage, installation and use of the SWP-Drive, including the specified environmental limitations. Please read the **IMPORTANT SAFETY INFORMATION** below, and all Warning and Caution information elsewhere.

Safety of machinery, and safety-critical applications

The level of integrity offered by the SWP-Drive control functions – for example stop/start, forward/reverse and maximum speed, is not sufficient for use in safety-critical applications without independent channels of protection. All applications where malfunction could cause injury or loss of life must be subject to a risk assessment and further protection provided where needed. Within the European Union, all machinery in which this product is used must comply with Directive 89/392/EEC, Safety of Machinery. In particular, the electrical equipment should comply with EN60204-1.

1.2   Electromagnetic compatibility (EMC)

SWP-Drive is designed to high standards of EMC. EMC data is provided in a separate EMC Data Sheet, available on request. Under extreme conditions, the product might cause or suffer disturbance due to electromagnetic interaction with other equipment. It is the responsibility of the installer to ensure that the equipment or system into which the product is incorporated complies with the EMC legislation of the country of use. Within the European Union, equipment into which this product is incorporated must comply with 89/336/EEC, Electromagnetic Compatibility.

When installed as recommended in this User Guide, the radiated emissions levels of all SWP-Drives are less than those defined in the Generic radiated emissions standard EN61000-6-4. Every SWP-Drive has a built-in filter to reduce conducted emissions. The conducted emission levels are less than those defined in the Generic radiated emissions standard EN61000-6-4 (class A) for the following cable lengths:

SWP-Drive sizes #1 to #3: up to 5 m of screened cable.
SWP-Drive sizes #4 to #6: up to 25 m of screened cable.

SWP-Drive sizes #1 to #3 can be fitted with an optional external SW EMC Filter (HF filter). When correctly fitted with this filter, the conducted emission levels are less than those defined in the Generic radiated emissions standard EN61000-6-3 (class B) for screened cable lengths up to 5 m and with EN61000-6-4 (class A) for screened cable lengths up to 25 m.

2 Mechanical Installation

2.1 General

- Carefully inspect the SWP-Drive before installation to ensure it is undamaged.

- Store the SWP-Drive in its box until required. Storage should be clean and dry and within the temperature range –40 °C to +60 °C.

- Install the SWP-Drive on a flat, vertical, flame-resistant, vibration-free mounting within a suitable enclosure, according to EN60529 if specific Ingress Protection ratings are required.

- Flammable material should not be placed close to the drive.

- The entry of conductive or flammable foreign bodies should be prevented.

- Max. operational ambient temperature 50 °C, min. 0 °C. Refer to rating tables in section 7.4.

- Relative humidity must be less than 95% (non-condensing).

- In case of size 1...3, the SW-Drive can be installed side-by-side with their heatsink flanges touching. Beginning with size 4 make sure to have a vertical spacing of min. 100 mm between each drive. If drives are mounted above another keep a distance of 300 mm (size 1 & 2) and min. 500 mm (Size 3....). The enclosure should either be force ventilated or large enough to allow natural cooling (allow 0.1 m^3 per kW of drive rating).

2.2 Mechanical dimensions and mounting
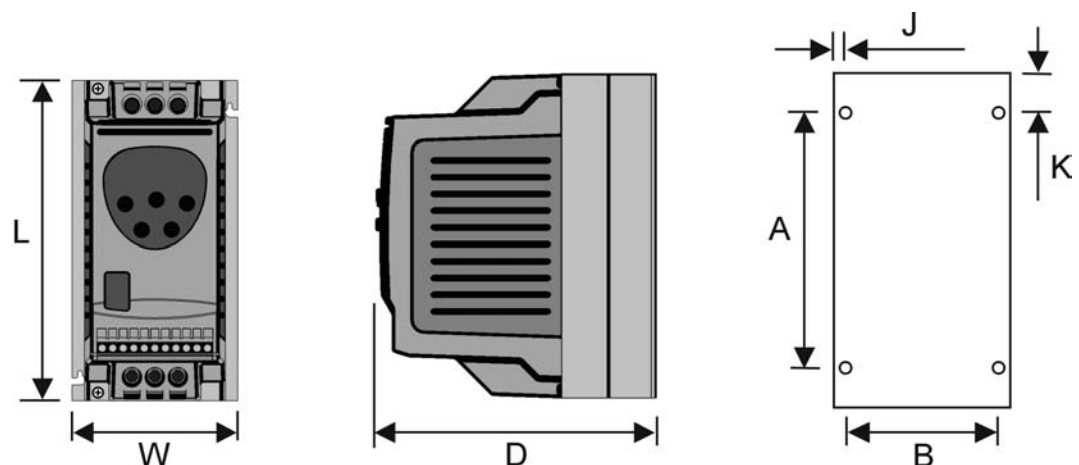
	Size 1	Size 2	Size 3	Size 4	Size 5	Size 6
Length/mm	155	260	260	520	[1] 1045–1100	
Width/mm	80	100	171	340	340	
Depth/mm	130	175	175	220	[1] 220–330	
Weight/ kg	1.1	2.6	5.3	28	68	
A/mm	105	210	210	420	945	
B/mm	72	92	163	332		
J/mm	4			9.5		
K/mm	25			50		
Fixings	2 × M4		4 × M4	4 × M8		
Power Terminal torque settings	1 Nm	1 Nm	1 Nm	4 Nm	8 Nm	8 Nm

[1] 45 kW.

2.3   Enclosure mounting and dimensions

For applications that require a higher IP rating than the IP20 offered by the standard drive, the drive must be mounted in an enclosure. The following guidelines should be observed for these applications:

- Enclosures should be made from a thermally conductive material, unless forced ventilation is used.
- When vented enclosures are used, there should be venting above the drive and below the drive to ensure good air circulation. Air should be drawn in below the drive and expelled above the drive.
- If the external environment contains contamination particles (eg dust), a suitable particle filter should be fitted to the vents and forced ventilation implemented. The filter must be serviced/cleaned appropriately.
- High moisture, salt or chemical content environments should use a suitably sealed (non-vented) enclosure.
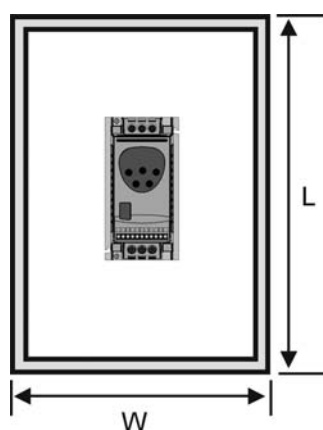
Enclosure Front View   **Enclosure Side View**
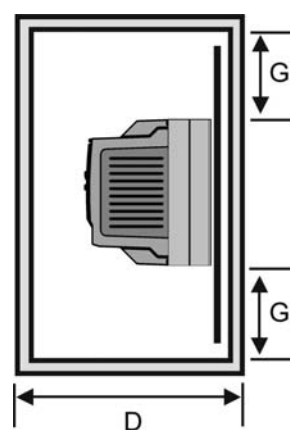
Non-Vented Enclosure Dimensions (mm)

Drive Power rating		L	W	D	G
Size 1	0.75 kW 230 V/400 V	300	250	200	50
Size 1	1.5 kW 230 V/400 V	400	300	250	75
Size 2	1.5 kW 230 V/2.2 kW 400 V	400	300	300	60
Size 2	2.2 kW 230 V/4 kW 400 V	600	450	300	100

Vented Enclosure Dimensions (mm)

Drive Power Rating		Free-Vented Unit				Force-Vented Unit				
		L	W	D	G	L	W	D	G	Air Flow
Size 1	(1.5 kW)	400	300	150	75	300	200	150	75	>15 m^3/h
Size 2	(4 kW)	600	400	250	100	400	300	250	100	>45 m^3/h
Size 3	(15 kW)	800	600	300	150	600	400	250	150	>80m^3/h
Size 4	(22 kW)	1000	600	300	200	800	600	300	200	>300m^3/h
Size 4	(37 kW)	–	–	–	–	800	600	300	200	>300m^3/h
Size 5	(90 kW)	–	–	–	–	1600	800	300	200	>900m^3/h
Size 6	(160 kW)	–	–	–	–	2000	800	300	200	>1000m^3/h

3 Electrical Installation

3.1 Safety

Electric shock hazard! Disconnect and **ISOLATE** the SWP-Drive before attempting any work on it. High voltages are present at the terminals and within the drive for up to 10 minutes after disconnection of the electrical supply.

- SWP-Drives should be installed only by qualified electrical persons and in accordance with local and national regulations and codes of practice.

- The SWP-Drive has an Ingress Protection rating of IP20. For higher IP ratings, use a suitable enclosure.

- Where the electrical supply to the drive is through a plug and socket connector, do not disconnect until 10 minutes have elapsed after turning off the supply.

- Ensure correct earthing connections, see diagram below.

- The earth cable must be sufficient to carry the maximum supply fault current which normally will be limited by the fuses or MCB.

3.2 Precautions

- Ensure that the supply voltage, frequency and number of phases (single or three phase) correspond to the rating of the SWP-Drive as delivered.

- An isolator or similar should be installed between the power supply and the drive.

- Never connect the mains power supply to the SWP-Drive output terminals U V W.

- Protect the drive by using slow-blow HRC fuses or an MCB located in the mains supply to the drive.

- Do not install any type of automatic switchgear between the drive and the motor.

- Wherever control cabling is close to power cabling, maintain a minimum separation of 100 mm and arrange crossings at 90°.

- Ensure that screening or armouring of power cables is effected in accordance with the connections diagram below.

- Ensure that all terminals are tightened to the appropriate torque (see table, left).

Connect drive according to the following diagram, ensuring that motor terminal box connections are correct. There are two connections in general: Star and Delta. It is essential to ensure that the motor is connected in accordance with the voltage at which it will be operated. For more information, refer to the following diagram.

For recommended cabling and wiring sizing, refer to section 7.4.

It is recommended that the power cabling should be 3-core or 4-core PVC-insulated screened cable, laid in accordance with local industrial regulations and codes of practice.

The ground terminal of each SWP-Drive should be individually connected DIRECTLY to the site earth (ground) busbar (through the filter if installed) as shown. SWP-Drive ground connections should not loop from one drive to another, or to, or from any other equipment. Ground loop impedance must conform to local industrial safety regulations. To meet UL regulations, UL approved ring crimp terminals should be used for all earth wiring connections.

3.3   Drive and motor connection
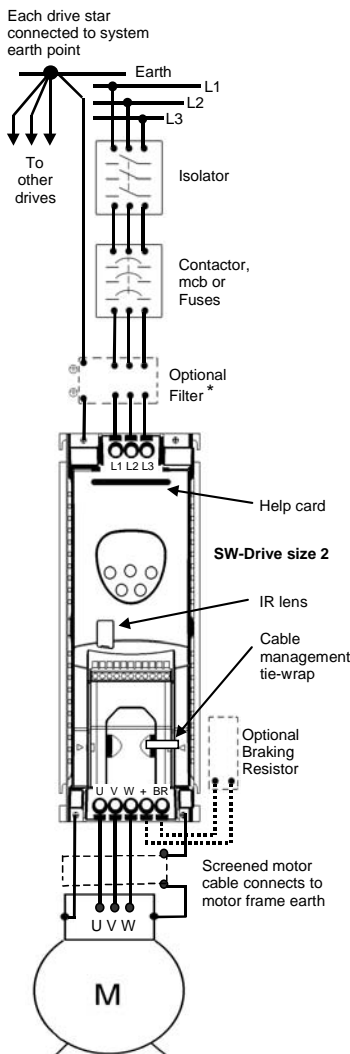
* If fitted, a filter should be mounted physically close to the Drive. For maximum effectiveness, the metal case of the filter and the heat sink of the drive should be electrically connected, ie screw both to a metal back plate and ensure metal-to-metal contact.

Motor terminal box connections

Most general purpose motors are wound for operation on dual voltage supplies. This is indicated on the nameplate of the motor.

This operational voltage is normally selected when installing the motor by selecting either STAR or DELTA connection.
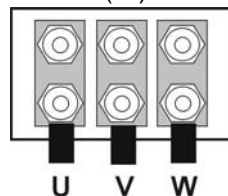
STAR always gives the higher of the two voltage ratings.

Typical ratings are:

400/230 ($\perp$ / $\triangle$)
690/400 ($\perp$ / $\triangle$)

DELTA ($\triangle$) Connection

STAR ($\perp$) Connection
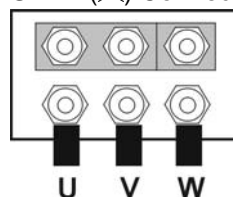
3.4   Control Terminal Connections

The User Control terminals are available via an 11-way pluggable connector. All terminals are galvanically isolated, allowing direct connection to other equipment.

Do not connect mains supply voltages to any terminals other than the User relay output. Permanent damage will otherwise result.

All other inputs will withstand up to 30 VDC without damage.

The functionality of the inputs and outputs is user configurable. All operating modes are set up via the parameter set.

Up to 100 mA can be sourced from the User +24 V output and up to 20 mA from the analog output.

The control terminals are defined as follows:

Terminal	Description
1	+24 V, 100 mA output. Connected to terminal 5
2	Digital input, positive logic. Active when 8 V <Vin <30 V
3	Digital input, positive logic. Active when 8 V <Vin <30 V
4	Unipolar analog input, 10-bit (0.1%). 0...10 V, 0...20 mA, 4...20 mA. Digital input, positive logic. Active when 8 V <Vin <30 V
5	+24 V, 100 mA output. Connected to terminal 1
6	Bipolar analog input, +/-12-bit (0.025%). 0...24 V, 0...10 V,–10 V...10 V
7	0 V (User GND). Connected to terminal 9
8	Analog output, 8-bit (0.25%). 0...10 V, 4...20 mA. Digital output: 0 / 24 V
9	0 V (User GND). Connected to terminal 7
10	User relay output. Potential free contacts. 30 VDC 5 A, 250 VAC 6 A
11	User relay output. Potential free contacts. 30 VDC 5 A, 250 VAC 6 A

Key control terminal information:

- Maximum input voltage on any terminal 30 VDC.
- All outputs short circuit proof.
- Recommended potentiometer resistance 2k2…10 kOhm.
- Digital input response time <8 ms.
- Bipolar analog input response time <16 ms. Resolution ±12 bit (0.025%).
- Second analog input response time <16 ms. Resolution +10-bit (0.1%).
- Analog/Digital output response time <16 ms. Resolution 8-bit (0.25%).

4   Operation

4.1   Managing the keypad

The drive is configured and its operation monitored via the keypad and display.

⊖ **NAVIGATE:**
Used to display real-time information, to access and exit parameter edit mode and to store parameter changes.

▲ **UP:**
Used to increase speed in real-time mode or to increase parameter values in parameter edit mode.

▼ **DOWN:**
Used to decrease speed in real-time mode or to decrease parameter values in parameter edit mode.

▼ **RESET/STOP:**
Used to reset a tripped drive. When in Keypad mode (see below and P1-12 in the parameter section) is used to Stop a running drive.

◇ **START:**
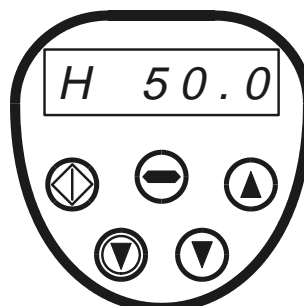When in keypad mode, used to Start a stopped drive or to reverse the direction of rotation if bi-directional keypad mode is enable see P1-12 in the parameter section).

To change a parameter value press and hold the NAVIGATE key for >1 s whilst the drive displays STOP. The display changes to P1-01, indicating parameter 01 in parameter group 1. Press and release the NAVIGATE key to display the value of this parameter. Change to the required value using the UP and DOWN keys. Press and release the NAVIGATE key once more to store the change. Press and hold the NAVIGATE key for >1 s to return to real-time mode. The display shows STOP if the drive is stopped or the real-time information (e.g. speed) if the drive is running.

To change parameter group, ensure that extended menu access is enabled then press NAVIGATE, simultaneously pressing and releasing the UP key until the required parameter group is displayed.

4.2   Easy startup

To operate in keypad mode, change P1-12 to 1 (uni-directional) or 2 (bi-directional). Place a wire link or switch between terminals 1 and 2 on the user terminal block to enable the drive. Now press START. The drive enables at 0.0 Hz. Press the UP button to increase speed.

To stop the drive, press the STOP button. If START is pressed once more, the drive will return to its original speed, unless configured to start from zero speed (see P2-19). If bi-directional mode is enabled (P1-12 = 2), pressing START reverses direction.

The desired target speed can be preset by pressing STOP whilst the drive is stopped. When the START key is subsequently pressed, drive will then ramp to this speed.

To operate in terminal mode (default setting), connect a switch between terminals 1 and 2 on the user terminal block. Connect a potentiometer (2k2 to 10k) between terminals 5, 6 and 7 with the wiper connected to pin 6.

Close the switch to enable the drive. Adjust speed with the potentiometer.

Key Parameters

- Adjust the maximum/minimum speed limit using P1-01 and P1-02.

- Adjust the acceleration and deceleration times using P1-03 and P1-04.

- Set up the motor nameplate data in parameters P1-07 to P1-10.

5   Parameter Overview

5.1   Basic Parameters

Para-meter	Description	Range	Default	Explanations	Set to
P1-01	Max speed limit	P1-02 to P1-09 $\times$ 5 (up to 2000 Hz max)	50 Hz	Sets the maximum speed limit. Display of Hz or rpm dependent on P1-10. Maximum speed limit dependent on switching frequenc: Max Limit = P2-24/16.	
P1-02	Min speed limit	0 to P1-01	50 Hz	Max speed limit. Hz or rpm display depending on P1-10.	
P1-03	Accel ramp time	0 to 3000 s	5.0 s	Time to ramp from 0 to rated frequency (P1-09).	
P1-04	Decel ramp time	0 to 3000 s	5.0 s	Time to ramp from rated frequency (P1-09) to 0.	
P1-05	Stop mode select	0: Ramp to stop 1: Coast to stop 2: Ramp to stop	0	If the supply is lost and P1-05 = 0 then the drive will try to continue running by reducing the speed of the load using the load as a generator. If P-05 = 2, the drive ramps on 2nd decel ramp P2-25 to stop.	
P1-06	Energy optimisation	0: Disable 1: Enable	0	Dynamically reduces motor power on light load. Use for fan or similar loads.	
P1-07	Motor rated voltage	20 V to 250 V 20 V to 500 V	230 V 400 V (460 V)	Set to motor rated voltage from nameplate. Range limited to 250 V for 230 V drives.	
P1-08	Motor rated current	20% to 100% of drive rated current	Drive rating	Set to motor rated current from nameplate (Amps).	
P1-09	Motor rated frequency	25 to 2000 Hz	50 Hz (60 Hz)	Set to motor rated frequency from nameplate (Hz). Maximum limit dependent on switching frequency: Max Limit = P2-24/16.	
P1-10	Motor rated speed	0 to 60,000 rpm	0	When 0, drive operates in Hz. Upper limit set to 60 $\times$ P1-09 (motor synchronous speed).	

Para-meter	Description	Range	Default	Explanations	Set to
P1-11	Preset speed 1	P1-02 to P1-01	50 Hz (60 Hz)	Sets jog/preset speed at which drive runs when preset speed 1 selected via digital inputs (see also P2-01).	
P1-12	Terminal/Keypad control of drive	0: Terminal control 1: Keypad control 2: Keypad control 3: Enable User PID	0	Set to 1 for uni-direction keypad control. Set to 2 for bi-directional keypad control. User PID (feedback control) set in parameter group 3.	
P1-13	Trip Log	Last 4 trips stored	–	Latest 4 trips stored. Most recent displayed first.	
P1-14	Extended Menu Access code	0 to 9999	0	Permits access to extended menu when P1-14 = P2-37. Default access value = 101.	

NOTE: Default parameter values for Horse Power rated drives are shown in brackets.

5.2 Extended Parameters

Parameter	Description	Range	Default	Explanations	Set to
P2-01	Digital input function select	0 to 20	0	Defines the function of the digital inputs. See section 5.5.	
P2-02	Preset speed 2	P1-02 to P1-01	0 Hz	Sets jog/preset speed at which drive runs when preset speed 2 selected via digital inputs (see P2-01).	
P2-03	Preset speed 3	P1-02 to P1-01	0 Hz	Sets jog/preset speed 3.	
P2-04	Preset speed 4	P1-02 to P1-01	0 Hz	Sets jog/preset speed 4.	
P2-05	Preset speed 5	P1-02 to P1-01	0 Hz	Sets jog/preset speed 5.	
P2-06	Preset speed 6	P1-02 to P1-01	0 Hz	Sets jog/preset speed 6.	
P2-07	Preset speed 7	P1-02 to P1-01	0 Hz	Sets jog/preset speed 7.	
P2-08	Preset speed 8	P1-02 to P1-01	0 Hz	Sets jog/preset speed 8.	
P2-09	Skip frequency	P1-02 to P1-01	0	Centre point of skip frequency band set up in conjunction with P2-10.	
P2-10	Skip frequency band	P1-02 to P1-01	0 (disable)	Width of skip frequency band centred on frequency set in P2-09.	
P2-11	Analog output function select	Digital output mode: 0: Drive Enabled 1: Drive healthy 2: Motor at target speed 3: Motor speed >0 4: Motor speed >limit 5: Motor current >limit 6: PID Analog in >limit Analog output mode: 7: Motor speed 8: Motor current 9: Motor power (kW)	7	For values 0 to 6, analog output functions as a digital output (0 V or 24 V). The limit used for settings 4, 5 and 6 is defined in P2-12. For values between 7 and 9, the output is analog, operating between 0–10 V or 4–20 mA (as set in P2-36). Full scale analog output results at max speed, 2 × rated current (P1-08) or rated power.	

Parameter	Description	Range	Default	Explanations	Set to
P2-12	Limit for digital output control	Speed, Power: 0–100% Current: 0–150% (100% = P1-08)	100%	Limit relates to speed if P2-11 = 4, to current if P2-11 = 5 or to power if P2-11 = 6.	
P2-13	User relay output function select	0: Drive Enabled 1: Drive healthy 2: Motor at target speed 3: Motor speed >0 4: Motor speed >limit 5: Motor current >limit 6: PID Analog in >limit	1: (Drive healthy)	If P2-15 = 0 (Normally Open), the relay contacts are closed when the selected condition is fulfilled. If P2-15 = 1 (Normally Closed), the relay contacts are open when the selected condition is fulfilled.	
P2-14	Limit for user relay output control	Speed, Power: 0–100% Current: 0–150% (100% = P1-08)	100%	Limit relates to speed if P2-13 = 4, to current if P2-13 = 5 or to power if P2-13 = 6.	
P2-15	Relay output mode	0: Normally Open (NO) 1: Normally Closed (NC)	0 (N.O.)	The drive must be powered up for the relay contacts to be closed.	
P2-16	Zero Speed holding time	0–60 s	0	Determines the time for which the zero speed is held on the output before disabling the drive.	
P2-17	Start mode select	Edgr-r: Close digi in 1 *after* power up to start drive. Auto-0: drive runs when Ever digi in 1 is closed. Auto-1..5: as Auto-0, except 1–5 attempts to restart after a trip.	Auto-0	When set to Edge-r, if drive is powered up with digital Input 1 closed (enabled), drive will not run. The switch must be opened & closed after power up or after a clearing a trip for the drive to run. When set to Auto-0, drive will run whenever digital input 1 is closed (if not tripped). Auto-1..4 makes 1–5 attempts to automatically restart after a trip (20 s between attempts). Drive must be powered down to reset the counter.	
P2-18	Spin Start Enable	0: Enable 1: Disable	0	When enabled, drive detects motor speed and starts driving the motor from this speed. A short delay of approx 1 s will result after enabling the drive before speed is detected.	
P2-19	Keypad restart mode	0: 0 Hz 1: previous speed	1	If set to zero, drive will always start from zero speed. If set to 1, drive ramps up to the operating speed prior to the STOP command.	
P2-20	Standby mode	0: Disable 1–60 s	0	If P2-20 >0, drive enters standby mode (disables output) if zero speed is maintained for the time specified in P2-20. If P2-16 >0, this function is disabled.	

Parameter	Description	Range	Default	Explanations	Set to
P2-21	Display scaling factor	0.000 to 30.000	0.000	Disabled if zero. The variable selected in P2-22 is multiplied by this factor and displayed as a real-time value on the drive, in addition to speed, current and power.	
P2-22	Display scaling source	0: 2nd analog input 1: Speed	0	Selects the variable to be scaled by the factor set in P2-21.	
P2-23	Brake circuit enable	0: Disable 1: Enable + lo power 2: Enable + hi power 3: Enable, no protection	0	Activates the internal brake chopper. Internal software overload protection when set to 1 and 2. See rating tables for resistor sizing guidelines.	
P2-24	Effective switching frequency	S1, 2S 230 V: 4–32 kHz S2, S2 400 V: 4–32 kHz S3 400V: 4–32 kHz S4–S6 400 V: 4–16 kHz	16 kHz 8 kHz 4 kHz 4 kHz	Effective power stage switching frequency. Improved acoustic noise and output current waveform occurs with increasing switching frequency at the expense of increased losses within the drive.	
P2-25	Second deceleration ramp time	0–3000 s	30 s	Selected automatically on mains loss if P-05 = 0 or 2. Can also be selected via digital inputs during operation (see section 5.5).	
P2-26	S-ramp accel/decel time	0: Disabled 1–50 Hz s^{-2}	0	Determines the rate of increase of acceleration/deceleration. Used to give smoother speed transitions. When 2nd decel ramp (P2-25) selected, automatically adjusts S-ramps to proportionally match the 1st decel: 2nd decel ramp time ratio.	
P2-27	Drive communication address	0: Disable 1–63	1	Distinct drive address used for all drive serial communications.	
P2-28	Master/Slave mode select	0: Slave mode 1: Master mode	0	When in Master mode, drive transmits its operational status via the communication link. Used to control other (slave) drives via the serial communication link.	
P2-29	Speed scaling factor	0…500%, steps of 0.1%	100%	The speed reference input to the drive is scaled by this factor. Operates on both analog and digital references. Can be used as an electronic gearbox for Master/Slave applications.	
P2-30	Bipolar analog input format	0–24 V, 0–10 V, –10...10 V	0–24 V	Configures the analog input format to match that of the ref signal.	
P2-31	Bipolar analog input scaling	0–500%	100%	Scales the analog input by this factor. Set to 200% to give full speed range control with 0–5 V in.	

Parameter	Description	Range	Default	Explanations	Set to
P2-32	Bipolar analog input offset	0–50.0%	0%	Allows the input voltage at which speed starts to ramp up to be off-set from zero. Is a percentage of the full scale input voltage.	
P2-33	2nd analog input for-mat	0/24 V (digital input) 0–10 V 4–20 mA, 0–20 mA	0/24 V	Determines the format of the 2nd analog input. Selecting 0/24 V sets up the input as a digital in-put.	
P2-34	2nd analog input scaling	0–500%	100%	Scales the 2nd analog input by the factor set in this parameter.	
P2-36	Analog output for-mat	0–10 V, 4–20 mA	0–10 V	Determines the analog output format. Min load impedance in voltage mode 1 kOhm. Max load impedance in current mode 1 kOhm.	
P2-37	Extended menu ac-cess code define	0…9999	101	Defines the extended menu ac-cess code used in P1-14.	
P2-38	Parameter Lock	0: Unlocked 1: Locked	0	When locked, all parameter changes are prevented.	
P2-39	Hours run clock	0 to 99999 hours	Read only	Indicates the number of hours the drive has been running since new.	
P2-40	Drive type/rating	"1 0.37": 110 V 0.37 kW "2 0.75": 230 V 0.75 kW "4 18.5": 400 V 18.5 kW	Read only	Indicates the drive voltage and power rating. Fixed by the drive hardware.	

5.3   User feedback control (PID control)

P3-01	User PID controller Pro-prtional Gain	0.1–10	2	Higher value used for high inertia. Too high a value gives instability.	
P3-02	User PID controller In-tegral Gain	0.1–10 s	1 s	Higher value gives slower, more damped response.	
P3-03	User PID controller Dif-ferential Gain	0.01–0.1 s	0	Set to zero (disabled) for most applications.	
P3-04	User PID controller op-erating mode	0: Direct 1: Inverse	0	If an increasing feedback signal should increase the speed of the motor, set to 'inverse' mode.	
P3-05	User PID controller ref-erence select	0: Digital 1: Analog	0	Sets the source for the regulator reference signal. When set to 1, the bipolar analog input is used.	
P3-06	User PID digital refer-ence	0–100%	0	Sets the preset reference used when P3-05 = 0.	
P3-07	User PID controller out-put high limit	P3-08 to 100% of control range	100%	Preset PID controller output upper (speed) limit. P1-01 = 100%.	
P3-08	User PID controller out-put low limit	0 to P3-07	0	Preset PID controller output lower (speed) limit. P1-01 = 100%.	

5.4 High performance Motor control

P4-01	Control mode	0: Speed control (vector) 1: Torque control (vector) 2: Speed control (V/F)	2	When selecting vector mode, ensure that an Auto-tune (P4-02) is carried out before operation.
P4-02	Motor parameter auto-tune	0: Disable 1: Enable	0	When enabled, drive carries out a static (non-rotating) parameter measurement operation to configure the motor parameters when the next run signal is applied.
P4-03	Speed controller Proprtional Gain	0–4096 (internal value)	100	Higher value used for high inertia. Too high a value gives instability.
P4-04	Speed controller Integral Gain	0.000–1.000 s	0.04 s	Higher value gives slower, more damped response.
P4-05	Speed controller Differential Gain	0.001–0.100 s	0.001 s	Set to minimum for most applications.
P4-06	Torque limit reference select	0: Preset value 1: Bipolar analog input 2: 2nd analog input	0	Used when in vector speed control mode to set a maximum torque limit.
P4-07	Torque limit preset value	0–100%	100%	Preset value used when P4-06 = 0. 100% is rated motor torque.
P4-08	V/F characteristic adjustment frequency	0–P1-09	0	Sets the frequency at which the gain factor (P4-09) is applied.
P4-09	V/F characteristic adjustment factor	20–500%	100%	Adjusts the motor voltage by this factor at frequency set in P4-08.

5.5 Digital input configuration – terminal mode

P2-01	Digi input 1 function	Digi input 2 function	Digi input 3 function	Analog input function	
0	O: Stop (Disable) C: Run (Enable)	O: Analog input C: Speed Preset 1	O: Speed Preset 1 C: Speed Preset 2	Analog input value	
1	O: Stop (Disable) C: Run (Enable)	O: Speed Preset 1 C: Speed Preset 2	O: Speed Preset 1, 2 C: Speed Preset 3	O: Speed Preset 1, 2, 3 C: Speed Preset 4	
2	O: Stop (Disable) C: Run (Enable)	**Digi input 1**	**Digi input 2**	**Analog input**	**Preset value**
		Open	Open	Open	Preset speed 1
		Closed	Open	Open	Preset speed 2
		Open	Closed	Open	Preset speed 3
		Closed	Closed	Open	Preset speed 4
		Open	Open	Closed	Preset speed 5
		Closed	Open	Closed	Preset speed 6
		Open	Closed	Closed	Preset speed 7
		Closed	Closed	Closed	Preset speed 8
3	O: Stop (Disable) C: Run (Enable)	O: Forward C: Reverse	O: Analog Input C: Speed Preset 1	Analog input value	
4	O: Stop (Disable) C: Run (Enable)	O: Forward C: Reverse	O: Speed Preset 1 C: Analog Input	Analog input value	

P2-01	Digi input 1 function	Digi input 2 function	Digi input 3 function	Analog input function	
5	O: Stop (Disable) C: Run (Enable)	O: Forward C: Reverse	O: Speed Preset 1 C: Speed Preset 2	O: Speed Preset 1, 2 C: Speed Preset 3	
6	O: Stop (Disable) C: Run (Enable)	O: Forward C: Reverse	External trip input: O: trip C: OK	Analog input value	
7	O: Stop (Disable) C: Run Forward	O: Stop (Disable) C: Run Reverse	O: Analog Input C: Speed Preset 1	Analog input value	
8	O: Stop (Disable) C: Run Forward	O: Stop (Disable) C: Run Reverse	O: Speed Preset 1 C: Analog Input	Analog input value	
9	O: Stop (Disable) C: Run Forward	O: Stop (Disable) C: Run Reverse	O: Speed Preset 1 C: Speed Preset 2	O: Speed Preset 1, 2 C: Speed Preset 3	
10	O: Stop (Disable) C: Run Forward	O: Stop (Disable) C: Run Reverse	External trip input: O: trip C: OK	Analog input value	
11	O: Stop (Disable) C: Run (Enable)	O: Analog Input C: Speed Preset 1	External trip input: O: trip C: OK	Analog input value	
12	O: Stop (Disable) C: Run (Enable)	O: Speed Preset 1 C: Analog Input	External trip input: O: trip C: OK	Analog input value	
13	Normally Closed (NC) Momentarily Open to Stop	Normally Open (NO) Momentarily Close to Run	O: Analog Input C: Speed Preset 1	Analog input value	
14	Normally Closed (NC) Momentarily Open to Stop	Normally Open (NO) Momentarily Close to Run Forward	Normally Open (NO) Momentarily Close to Run Reverse	Analog input value	
15	O: Stop (Disable) C: Run (Enable)	O: Forward C: Reverse	O: Decel ramp 1 C: Decel ramp 2	Analog input value	
16	O: Stop (Disable) C: Run (Enable)	O: Forward C: Reverse	O: Decel ramp 1 C: Decel ramp 2	O: Speed Preset 1 C: Speed Preset 2	
17	O: Stop (Disable) C: Run (Enable)	O: Forward C: Reverse	O: Terminal mode C: Keypad mode	Analog input value (when terminal mode)	
18	O: Stop (Disable) C: Run (Enable)	**Digi input 2**	**Digi input 3**	**Preset value**	O: Terminal mode C: Keypad mode
		Open	Open	Preset speed 1	
		Closed	Open	Preset speed 2	
		Open	Closed	Preset speed 3	
		Closed	Closed	Preset speed 4	
19	O: Stop (Disable) C: Run (Enable)	O: Analog input 1 C: Analog input 2	Analog input value	Analog input value	
20	O: Stop (Disable) C: Run (Enable)	2nd digital output: Drive healthy = +24 V	O: Analog Input C: Speed Preset 1	Analog input value	

NOTE: When P2-01 = 20, the 2nd digital input is configured as an output, which outputs +24 V when the drive is healthy, otherwise 0 V.

5.6 Digital input configuration – keypad mode

The following table defines the function of the digital inputs when the drive is in keypad mode (set using P1-12).

P2-01	Digi input 1 function	Digi input 2 function	Digi input 3 function	Additional information
* 0	O: Stop (Disable) C: Run (Enable)	Closed: Remote push-button UP	Closed: Remote push-button DOWN	When drive is stopped, closing digi input 2 & 3 together starts drive. Analog input has no effect.
* 1–10, 13, 14, 16–20	O: Stop (Disable) C: Run (Enable)	Closed: Remote push-button UP	Closed: Remote push-button DOWN	When drive is stopped, closing digi input 2 & 3 together starts drive. Analog input >5 V starts the drive
11	O: Stop (Disable) C: Run (Enable)	O: Analog Input C: Speed Preset 1	External trip input: O: trip C: OK	Allows connection of motor thermistor.Analog input >5 V reverses rotation.
12	O: Stop (Disable) C: Run (Enable)	O: Speed Preset 1 C: Analog Input	External trip input: O: trip C: OK	Allows connection of motor thermistor.Analog input >5 V reverses rotation.
15	O: Stop (Disable) C: Run (Enable)	O: Forward C: Reverse	O: Decel ramp 1 C: Decel ramp 2	Analog input >5 V reverses rotation.
20	O: Stop (Disable) C: Run (Enable)	2nd digital output: Drive healthy = +24 V	O: Analog Input C: Speed Preset 1	Analog input >5 V reverses rotation.

NOTE:

In addition to the speed being set using the pushbuttons on the front of the drive, the settings designated with " * " allow the speed to be controlled remotely using remote pushbuttons connected to digital inputs 2 and 3.

5.7 Digital input configuration – User PID mode

The following table defines the function of the digital inputs when the drive is in User PID control mode (set using P1-12).

P2-01	Digi input 1 function	Digi input 2 function	Digi input 3 function	Additional information
0–10, 13, 14, 16–20	O: Stop (Disable) C: Run (Enable)	No effect	No effect	Digital input 1 must be closed to enable the drive.
11	O: Stop (Disable) C: Run (Enable)	O: PID control C: Speed Preset 1	External trip input: O: trip C: OK	Allows connection of motor thermistor.
12	O: Stop (Disable) C: Run (Enable)	O: Speed Preset 1 C: PID control	External trip input: O: trip C: OK	Allows connection of motor thermistor.
20	O: Stop (Disable) C: Run (Enable)	2nd digital output: Drive healthy = +24 V	O: Analog Input C: Speed Preset 1	Preset speed overrides PID control.

5.8 Real-time monitoring parameters

Parameter group zero provides access to internal drive parameters for monitoring purposes. These parameters cannot be adjusted.

Para-meter	Description	Display range	Explanation
P0-01	Bipolar analog input value	–100%...100%	100% = max input voltage
P0-02	2nd analog input value	0–100%	100% = max input voltage
P0-03	Speed controller reference	–100%...100%	100% = max speed (P1-01)
P0-04	Digital speed ref (digi pot)	–100%...100%	100% = max speed (P1-01)
P0-05	Torque controller reference	–200%...200%	100% = motor rated torque
P0-06	User PID ref input	0–100%	PID controller reference value
P0-07	User PID feedback	0–100%	PID controller feedback value
P0-08	User PID error input	0–100%	Reference – Feedback
P0-09	User PID P-term	0–100%	Proportional component
P0-10	User PID I-term	0–100%	Integral component
P0-11	User PID D-term	0–100%	Differential component
P0-12	User PID output	0–100%	Combined output
P0-13	Motor voltage	V rms, ph-ph	Motor terminal voltage, ph-ph
P0-14	Magnetising current	A rms	Magnetising current in A rms
P0-15	Rotor current	A rms	Rotor current in A rms
P0-16	Field strength	0–100%	Magnetic field strength
P0-17	Stator resistance	Ohm	Phase – Phase stator resistance
P0-18	Stator inductance	H	Stator inductance in Henry
P0-19	Rotor resistance	Ohm	Calculated rotor resistance
P0-20	DC bus voltage	VDC	Internal DC bus voltage
P0-21	Drive temperature	°C	Internal drive temperature
P0-22	Supply voltage L1 – L2	V rms, ph-ph	Phase – phase supply voltage
P0-23	Supply voltage L2 – L3	V rms, ph-ph	Phase – phase supply voltage
P0-24	Supply voltage L3 – L1	V rms, ph-ph	Phase – phase supply voltage
P0-25	Estimated Rotor speed	Hz or rpm	Applies to vector modes only
P0-26	kWh meter	0.0–999.9 kWh	Cumulative energy consumption
P0-27	MWh meter	0.0–60000 MWh	Cumulative energy consumption
P0-28	Software ID, IO processor	e.g. "1.00", "493F"	Version number and checksum
P0-29	Software ID, Motor control	e.g. "1.00", "7A5C"	Version number and checksum
P0-30	Drive serial number	000000–999999 00-000–99-999	Unique drive serial number e.g. 980102/24/003

6   Troubleshooting

6.1   Fault-finding chart

Symptom	Cause and Solution
Overload or over-current trip on unloaded motor during acceleration	Check Star/Delta terminal connection in motor. Rated operating voltage of drive and motor should match. The Delta connection always gives the lower voltage rating of a dual voltage motor.
Overload or over-current – motor does not spin	Check for locked rotor. Check that the mechanical brake is released (if fitted).
Drive will not enable – display remains on StoP	Check that the hardware enable signal is applied to digital input 1. Ensure that the User +24 V output voltage (terminal 1 or 5) is correct. If not, check wiring to user terminal strip. Check P1-12 for terminal/keypad mode. If keypad mode selected, press the START button.Check that supply voltage is within specification.
Drive runs incorrectly when in vector mode	Ensure that the motor name plate data has been entered into P1-07, P1-08, P1-09 and that the parameter auto-tune function has been carried out. Set P4-02 = 1 and enable the drive to carry out auto-tune.
In very cold ambient conditions, drive will not power up	If the ambient temperature is less than –10 °C, the drive may not power up. Ensure that a local heating source keeps the ambient above 0 °C in these conditions.
Speed limit or rated frequency parameters cannot be set above 250 Hz, 500 Hz or 1000 Hz	The maximum output motor frequency is limited by the switching frequency. Ensure that P2-24 is at least $16 \times$ greater than the required motor output frequency before setting the required maximum or rated output frequency parameters.
Extended menus cannot be accessed	Ensure that P1-14 is set to the extended access code. This is "101" unless the code in P2-37 has been changed by the user.

6.2   Fault messages

Trip message	Explanation
P-deF	Default parameters loaded, usually after pressing STOP, UP & DOWN keys for 1 s. Press STOP to reset the trip. Display then reads "StoP".
O-I	Over-current on drive output to motor. Trip on drive enable: check for wiring error or short circuit. Trip on motor starting: check for stalled or jammed motor. Trip during operation: check for sudden overload or malfunction.
I.t-trP	Drive overload trip, occurring when the drive has been delivering >100% rated current (set in P1-08) for a period of time. The display flashes to indicate an overload condition.
O-Uolt	Over-voltage on DC bus. Check supply voltage is within limits. If trip occurs on deceleration, reduce deceleration time or fit braking resistor.
U-Uolt	Under-voltage trip. Happens routinely when drive powered down. If it occurs whilst running, check supply voltage.
OI-b	Over current in the brake resistor circuit. Check cabling to brake resistor.

Trip message	Explanation
OL-br	Brake resistor overload. Increase deceleration time, reduce load inertia or add further brake resistors in parallel. Ensure minimum resistance values from ratings tables in section 7.4 are observed.
O-t	Over-temperature trip. Check drive cooling and possible enclosure dimensions.
U-t	Under-temperature trip. Trip occurs if ambient is less than 0 °C. Drive ambient temperature must be raised above zero in order to start the drive.
PS-trP	Trip on drive enable: check for wiring error or short circuit. Trip during operation: check for sudden overload or over-temperature.
dAtA-F	Occurs routinely after Flash upgrade. Reset using the STOP button or after a power down cycle. All parameters set to default after an upgrade.
P-LOSS	If a drive intended for use with a 3-phase supply has one phase removed. Condition must persist for >15 s before a trip occurs.
Ph-Ib	Phase imbalance. Trips if the phase imbalance exceeds 3%. Condition must persist for >30 s before a trip occurs.
SC-trP	Check SmartLink (communication link) integrity between drives interconnected optically. Check that each drive in a network has a unique drive address (P2-27).
E-triP	External trip (connected to digital input 3). Check motor thermistor (if connected).

7 Technical data

7.1 User interface

Bipolar Analog Input:	Resolution = ±12-bits (0.025%), 16 ms sampling time Range settings: 0–10 V, 0–24 V, –10...10 V Max input voltage = 30 VDC
2nd Analog input:	Resolution = +10-bits (0.1%), 16 ms sampling time Range settings: 0–10 V, 4–20 mA, 0–20 mA Max input voltage = 30 VDC
Digital inputs:	Positive logic only. Sampling interval: 8ms sampling time "Logic 1" input voltage range: 8–30 VDC. "Logic 0" input voltage range: 0–4 VDC.
User +24V output:	Output regulation ±2.5% over full load range. Max output current = 100 mA total. Short circuit proof.
Analog output:	Resolution = 8-bits, 16 ms update cycle time Output formats: 0…10 V, 4…20 mA. Max current = 20 mA. Short circuit proof.
User relay:	Contact rating: 250 VAC, 5A; 30 VDC, 5A.

7.2 Power stage protection

- Output short-circuit, phase-to-phase, phase-to-earth.
- Output over-current. Trip set at 180% of rated drive current.

- Overload protection. Drive delivers 150% of rated motor current for 60 s.

- Braking transistor protected against short-circuit.

- Braking resistor overload (when enabled).

- Over-voltage trip. Set at 123% of drive maximum rated supply voltage.

- Under-voltage trip.

- Over temperature trip.

- Under temperature trip. (Drive will trip if enabled below 0 °C).

- Supply Phase imbalance. A supply imbalance of >3% persisting for more than 30 s will trip a running drive.

- Supply Phase loss. If one phase of a 3-phase supply is lost for more than 15 s, a running drive will trip.

7.3   Environmental

- Operational temperature range: 0–50 °C.

- Storage temperature range: –40...60 °C.

- Maximum altitude 2000 m. Derate above 1000 m 1%/100 m.

- Maximum humidity: 95%, non-condensing.

7.4   Drive rating tables

SWP-Drive Size 1

Model	SWP-xxxxx					
Supply voltage	±10%	220–240			380–480	
Phases		1 or 3			3	
Motor output rating	kW HP	0.37 0.5	0.75 1.0	1.5 2.0	0.75 1.0	1.5 2.0
Output current	A	2.3	4.3	7.0	2.2	4.1
Fuse or MCB rating	A	10	10	20	5	10
Max ambient temperature	°C 8 kHz °C 16 kHz °C 32 kHz	50 50 50	50 40 30	50 40 30	50 40 30	50 40 30
Motor cable size, Cu 75 °C	mm^2	1.0				
Max motor cable length	m	25			10	

SWP-Drive Size 2 (Integral Braking Transistor)

Model	SWP-xxxxx						
Supply voltage	±10%	220–240		380–480			
Phases		1 or 3		3			
Motor output rating	kW HP	1.5 2	2.2 3	0.75 1	1.5 2	2.2 3	4 5.5
Output current	A	7	10.5	2.2	4.1	5.8	9.5
Fuse or MCB rating	A	20	30	5	10	10	16
Max ambient temperature	°C 8 kHz °C 16 kHz °C 32 kHz	50 50 40	50 40 30	50 50 50	50 40 30	50 50 40	50 40 40
Motor cable size, Cu 75 °C	mm^2	1.5	1.5	1.0	1.0	1.5	1.5
Max motor cable length	m	100	100	50	100	100	100
Min brake resistor	Ω	33	22	47	47	47	33

SWP-Drive Size 3 (Integral Braking Transistor)

Model	SWP-xxxxx						
Supply voltage	±10%	220–240		380–480			
Phases		3 (1ϕ 50% derating)		3			
Motor output rating (industrial 150%)	kW HP	4.0 5.5	5.5 7.5	5.5 7.5	7.5 10	11 16	15 20
Output Amps (industrial)	A	18	25	14	18	25	29.5
Motor output (HVAC 110%)	kW	5.5	7.5	7.5	11	15	–
Output Amps (HVAC)	A	25	29.5	18	25	29.5	–
Fuse or MCB rating	A	32	40	20	32	40	40
Max ambient temperature	°C 8 kHz °C 16 kHz °C 32 kHz	50 40 30	50 40 –	50 40 30	50 30 20	40 30 –	40 30 –
Motor cable size, Cu 75 °C	mm^2	2.5	4.0	2.5	2.5	4.0	6.0
Max motor cable length	m	100					
Min brake resistor	Ω	15		22			

SWP-Drive Size 4 (Integral Line Choke, RFI Filter & Braking Transistor)

Model	SWP-xxxxx								
Supply voltage	±10%		220–240				380–480		
Phases			3 (1φ 50% derating)				3		
Motor output rating (industrial 150%)	kW HP	7.5 10	11 16	15 20	18.5 25	18.5 25	22 30	30 40	37 50
Output Amps (industrial)	A	39	46	61	72	39	46	61	72
Motor output (HVAC 110%)	kW	11	15	18.5	22	22	30	37	45
Output Amps (HVAC)	A	46	61	72	89	46	61	72	89
Fuse or MCB rating	A	50	60	80	100	50	60	80	100
Max ambient temperature	°C 4 kHz °C 8 kHz	50 40	50 30	50 –	40 –	50 40	50 30	50 –	40 –
Motor cable size, Cu 75 °C	mm^2	10	10	16	16	10	10	16	16
Max motor cable length	m				100				
Min brake resistor	Ω		6				12		

SWP-Drive Size 5 (Integral Line Choke, RFI Filter & Braking Transistor)

Model	SWP-xxxxx								
Supply voltage	±10%		220–240				380–480		
Phases			3 (1φ 50% derating)				3		
Motor output rating (industrial 150%)	kW HP	22 30	30 40	37 50	45 60	45 60	55 75	75 100	90 120
Output Amps (industrial)	A	89	110	150	180	89	110	150	180
Motor output (HVAC 110%)	kW	30	37	45	–	55	75	90	–
Output Amps (HVAC)	A	110	150	180	–	110	150	180	–
Fuse or MCB rating	A	150	180	220	220	150	180	220	220
Max ambient temperature	°C 4 kHz °C 8 kHz	50 50	50 40	50 30	40 20	50 50	50 40	50 30	40 20
Motor cable size, Cu 75 °C	mm^2	25	35	55	70	25	55	55	70
Max motor cable length	m				100				
Min brake resistor	Ω		3				6		

SWP-Drive Size 6 (Integral Line Choke, RFI Filter & Braking Transistor)

Model	SWP-xxxxx					
Supply voltage	±10%	220–240		380–480		
Phases		3 (1φ 50% derating)		3		
Motor output rating (industrial 150%)	kW HP	55 75	75 100	110 145	132 175	160 210
Output Amps (industrial)	A	240	300	202	240	300
Motor output (HVAC 110%)	kW	75	–	132	160	–
Output Amps (HVAC)	A	300	–	240	300	–
Fuse or MCB rating	A	400	400	400	400	400
Max ambient temperature	°C 4 kHz °C 8 kHz	50 40	40 30	50 50	50 40	40 30
Motor cable size, Cu 75 °C	mm^2	120	170	90	120	170
Max motor cable length	m	100				
Min brake resistor	Ω	3		6		

7.5 General Technical Data

- Supply frequency 48 to 62 Hz.
- Max. permissible 3-phase supply imbalance 3%.
- Max. ambient temperature 50 °C.
- Max. altitude 2000 m.
- Derate above 1000 m, 1%/100 m.
- Derate output current 5%/°C above max. ambient temp up to 55 °C.
- I $\times$ t protection above 100% output current.
- 150% overload protection for 60 sec.
- 175% overload allowable for 2 sec.
- Storage temperature –40 to +60 °C.

Further Information

Website: www.bergeselectronic.com

Additional filters in separate documentation.

TB Wood's

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