ServoPac GDPS

Power supply unit

WARNING

This is a general manual describing a series of power supplies having output capability suitable for powering servo drives.

Instructions for storage, use after storage, commissioning as well as all technical details require the MANDATORY reading of the manual before getting the drives operational.

Maintenance procedures should be attempted only by highly skilled technicians having good knowledge of electronics and servo systems with variable speed (EN 60204-1 standard) and using proper test equipment.

The conformity with the standards and the "CE" approval is only valid if the items are installed according to the recommendations of the drive manuals. Connections are the user's responsibility if recommendations and drawings requirements are not met.

CAUTION
Any contact with electrical parts, even after power down, may involve physical damage.
Wait for at least 10 minutes after power down before handling the devices (a residual voltage of several hundreds of volts may remain during a few minutes).

ESD INFORMATION (ElectroStatic Discharge)
TRANSTECHNIK drives are conceived to be best protected against electrostatic discharges. However, some components are particularly sensitive and may be damaged if the drives are not properly stored and handled.

STORAGE

- The devices must be stored in their original package.
- When taken out of their package, they must be stored positioned on one of their flat metal surfaces and on a dissipating or electrostatically neutral support.
- Avoid any contact between the device connectors and material with electrostatic potential (plastic film, polyester, carpet …).

HANDLING

- If no protection equipment is available (dissipating shoes or bracelets), the devices must be handled via their metal housing.
- Never get in contact with the connectors.

ELIMINATION
In order to comply with the 2002/96/EC directive of the European Parliament and of the Council of 27 January 2003 on waste electrical and electronic equipment (WEEE), all TRANSTECHNIK devices have got a sticker symbolizing a crossed-out wheel dustbin as shown in Appendix IV of the 2002/96/EC Directive.
This symbol indicates that TRANSTECHNIK devices must be eliminated by selective disposal and not with standard waste.

TRANSTECHNIK does not assume any responsibility for any physical or material damage due to improper handling or wrong descriptions of the ordered items.
Any intervention on the items, which is not specified in the manual, will immediately cancel the warranty.

TRANSTECHNIK reserves the right to change any information contained in this manual without notice.

Issue: **2.5**

Content

Page

Chapter 1 - Specifications

1.1– INTRODUCTION

The external ServoPac GDPS-400/xx power supply unit is the multi-axis power supply intended for use with the ServoPac and ServoPac-B actuators. For the various configurations, see the ServoPac Installation manual.

NOTE

The ServoPac GDPS -400/xx power supply unit operates within a wide voltage range between 230 and 480 V_{AC}.
Consequently, the output power will depend on the input voltage.
The specified power values are given for a maximum voltage of 480 V_{AC}.

1.2 – ORDERING CODE

1.2.1 – ServoPac GDPS power supply unit

ServoPac GDPS – 400 / pp - xx

Voltage: 400 V_{AC}

Rated power: 16 or 32 kW

xx: Delivered with or without power connector
00: Without connector set
FC: With power (X1) + auxiliary (X2) connector set

1.2.2 – Accessories

Connector kit

FC-GDPS

This connector set includes power (X1) and auxiliary (X2) connectors.

Braking resistors

The choice of the braking resistor should be the result of the method described in *Chapter 1.5.2: Braking system*.
However, the following references are recommended in most applications:

- dp 16.5/560 to be connected to a GDPS 400/32
- dp 33/280 to be connected to a GDPS 400/16.

In any case, the connection of a braking resistor is required.

1.3 – MAIN TECHNICAL DATA

		Operating voltage 400 V_{AC}	**Operating voltage 230 V_{AC}**
Mains operating voltage		400 - 480 V_{AC} +10 % / -15 %*	230 V_{AC} +10 % / -15 %
Mains specifications		Three-phase, 50 to 60 Hz, TN or TT system with grounded neutral point. IT system supported but not recommended (phase-ground voltage must be balanced)	
Voltage unbalance		Max. 3 % of the mains voltage fundamental	
Mains filter		integrated	
Peak output power	GDPS 16 kW GDPS 32 kW	45 kW 90 kW	25 kW 45 kW
Rated output power	GDPS 16 kW GDPS 32 kW	16 kW 32 kW	8 kW 16 kW
Static output DC voltage		$V_{DC} = \sqrt{2} \times V_{AC}$	$V_{DC} = \sqrt{2} \times V_{AC}$
Dynamic output DC voltage according to the mains voltage / regenerative phase		480 - 800 V_{DC}	275 - 400 V_{DC}
Triggering threshold of the braking system		790 V ±5 %	390 V ±5 %
Minimum braking resistor value	GDPS 16 kW GDPS 32 kW	33 Ω 16.5 Ω	16.5 Ω 7.5 Ω
Peak power of the braking system	GDPS 16 kW GDPS 32 kW	20 kW 40 kW	10 kW 20 kW
Maximum continuous power of the braking system (I^2t limited)	GDPS 16 kW GDPS 32 kW	4 kW 8 kW	2 kW 4 kW
Undervoltage threshold		200 V ± 5 %*	100 V ± 5 %
Overvoltage threshold		950 V ± 5 %	450 V ± 5 %
Maximum surrounding air temperature		- operation: +5°C to +50°C (from 40°C, the rated power must be reduced by 3 % per additional °C) - storage: -20°C to +70°C.	

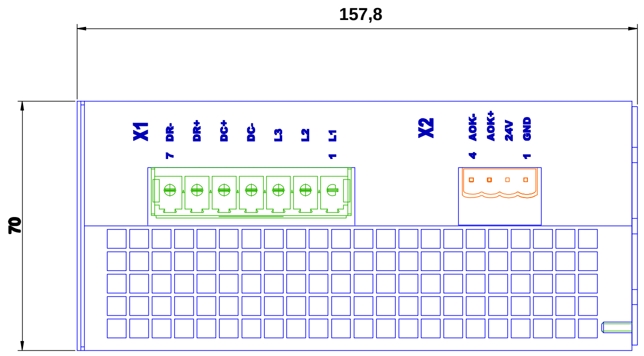
* For special applications, the input voltage range can be extended to 230 Vac - 480 Vac (see chapter 2.4 for reducing the undervoltage threshold to 100 Vdc).

1.4 – MECHANICAL DIMENSIONS

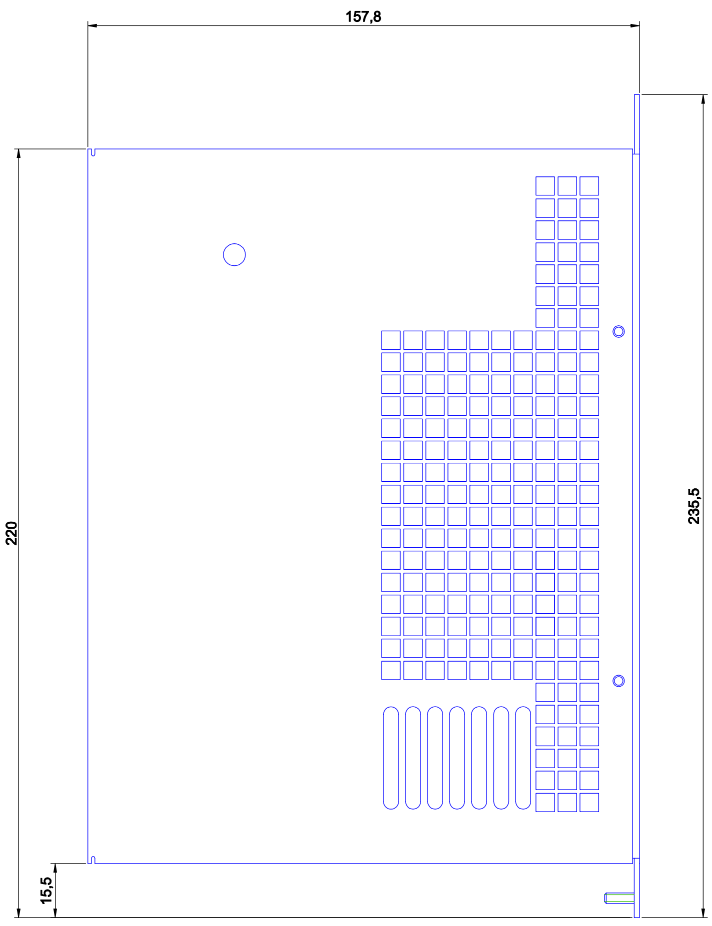
Dimensions are given in mm.

VERTICAL MOUNTING IS MANDATORY

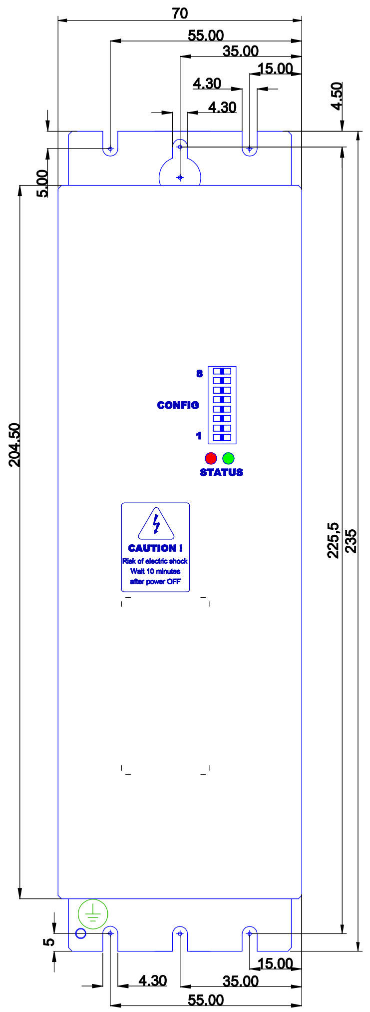
BOTTOM VIEW



SIDE VIEW



FRONT VIEW



1.5 – SIZING OF THE POWER SUPPLY

1.5.1 – CONTINUOUS POWER

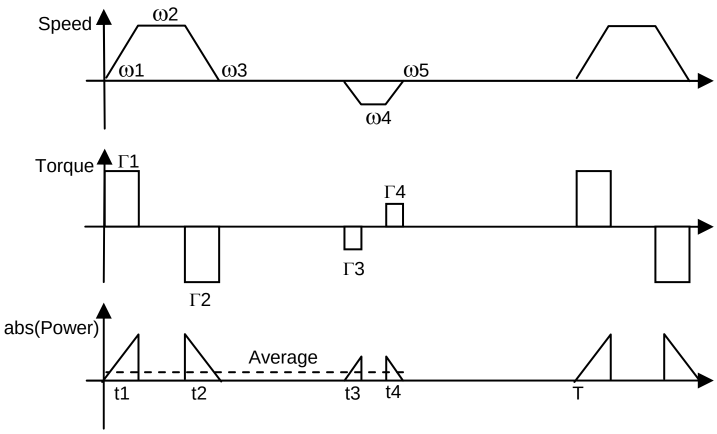
For a reliable and safe operation of the installation, the continuous average power needs to be evaluated for all axes.
Various ways to proceed for evaluating the continuous power of a machine are listed below:

Accurate method:

The power can be calculated by the absolute value average of the mechanical power for each axis.

$$P_{average.GDPS} = \sum_1^N < Abs(P_{mechanical.axis.n}) >$$

Example for one axis:



$$E_{GDPS} = \frac{1}{2}.\Gamma1.(\omega2+\omega1).t1 + \frac{1}{2}.\Gamma2.(\omega3+\omega2).t2 + \frac{1}{2}.\Gamma3.(\omega4+\omega3).t3 + \frac{1}{2}.\Gamma4.(\omega5+\omega4).t4$$

$$P_{average.GDPS} = \frac{E_{GDPS}}{T}$$

With:		
	Γ:	Torque value in Nm (positive when the speed increases)
	ω:	Speed value in rad/s
	t:	Duration of the deceleration or acceleration phase
	T:	Period of the whole cycle

Simplified method 1:

If the continuous average power cannot be evaluated by the "accurate method", it may be convenient to use the power of the application motors.
The electrical power can be evaluated by the mechanical power divided by the electromechanical efficiency.
If motors have been correctly sized, the average power can be evaluated by means of the following formula:

$$P_{average.GDPS} = \sum_1^N \frac{P_{rated.motor.n}}{\eta_N}$$ With $\eta \approx 0.9$

Simplified method 2:

If the continuous average power cannot be evaluated by the "accurate method", it may be convenient to define a service ratio (K_S) for each drive.
In this case, the average power can be evaluated by means of following formula:

$$P_{average.GDPS} = \sum_1^N K_S \times P_{rated.axis.n}$$ With: $K_S \geq 0.4$

$$P_{rated.axis.n} = \sqrt{3} \times U \times I_{rated.axis.n}$$

1.5.2 – Peak power

The sum of the electrical power of all axes must not exceed the power ability of the GDPS supply unit at any moment.
The maximum power of a servo-axis is generally reached at the end of the acceleration phase.

1.5.3 – Braking system

The braking I²t function defines the conduction time of the braking transistor over 1 second horizon time.
Two different quantities are necessary to completely define an application:

- The peak power:
  - It defines the deceleration energy,
  - It is limited by the braking transistor current.
- The average power:
  - It defines the heat dissipation

Method for the design of the braking system:

1. Estimation of the regenerative power

The regenerative power must be calculated for each deceleration phase of each motor.

$$P_{LOAD} = \frac{J_{TOTAL}.(n_1^{\ 2} - n_2^{\ 2})}{180.t_{DEC}} - \frac{T_{LOAD}.(n_1 + n_2)}{19}$$

$$P_{MOTOR} = P_{LOAD}.\eta_{COUPLING}$$

$$P_{JOULE} = \frac{3}{2} R_{MOTOR}.I_{MOTOR}^{\ \ 2}$$

$$P_{ELEC} = P_{MOTOR} - P_{JOULE}$$

With :
- P_{LOAD}: Power regenerated by the load during the deceleration phase in W
- J_{TOTAL}: Motor + load inertia of the axis reflected to the motor shaft in kg.m²
- n_1: Rotation speed at the beginning of the deceleration phase in RPM
- n_2: Rotation speed at the end of the deceleration phase in RPM
- t_{DEC}: Deceleration time in s
- T_{LOAD}: Torque applied by the load on the motor shaft at the beginning of the deceleration phase in Nm
- P_{MOTOR}: Power regenerated on the motor shaft in W
- $\eta_{COUPLING}$: Efficiency of the mechanical coupling (gearbox). If no gearbox is used $\eta_{COUPLING} \approx 1$
- P_{JOULE}: Losses in the motor windings in W
- R_{MOTOR}: Winding resistance measured between two phases of the motor in Ω
- I_{MOTOR}: Average current in one phase of the motor during the deceleration phase in A
- P_{ELEC}: Average power managed by the drive during the deceleration phase in W

2. Choice of the ohmic value

$$R_{MIN} \leq R_{BRAKING} < \frac{U_{BRAKING}^{2}}{2.\hat{P}_{ELEC}}$$

With:
- R_{MIN}: Minimum braking resistor value in Ohm according to section "Main technical data".
- $U_{BRAKING}$: Triggering threshold of the braking system in V.
- $R_{BRAKING}$: Braking resistor in Ω.
- $\hat{P}_{ELEC}$: Maximum of all P_{ELEC} calculated for all motors and for all deceleration phases in W.

3. Average power

The required average power must be calculated to correctly choose the size of the braking resistor and to take into account the heat dissipation effect into the near environment.

$$P_{AVERAGE} = \frac{\sum_{1,1}^{N,P} P_{ELEC}(n,p) \times T_{DEC}(n,p)}{T_{CYCLE}}$$

With: P_{ELEC}: Power managed by the drive axis n during the deceleration phase p in W

4. Braking I²t setup

$$P_{I^2t} = \frac{t_{ON}}{1000} \cdot \frac{U^2_{BRAKING}}{R_{BRAKING}}$$

With:
- P_{I^2t}: Maximum average power allowed by the braking I²t function in W
- t_{ON}: Conduction time allowed by the braking I²t function in ms
- $U_{BRAKING}$: Triggering threshold of the braking system in V
- $R_{BRAKING}$: Braking resistor in Ω

5. Connection of the braking resistor

The braking resistor MUST be mounted out of range of heat sensitive and inflammable elements (plastic, cable sleeves, etc.).

In order to avoid any EMC or electrical problem, some rules must be observed:

- heat must be evacuated,
- shielded cable or at least twisted wires must be used,
- wires must bear high voltage and high temperature (recommended type: UL1015, AWG 14)
- wires must be as short as possible (max. 1 m).

Chapter 2 – Inputs - Outputs

2.1 – X1 CONNECTOR: POWER CONNECTOR

Manufacturer: Phoenix contact
Type: PC 5/ 7-G-7.62
Reference: 1720518
Tightening torque: 0.7 to 0.8 Nm

PIN	SIGNAL	I/O	FUNCTION	DESCRIPTION
1	L1	I	Mains input supply	Integrated EMI filter. Grounding by means of a screw with nut on the bottom plate.
2	L2	I		
3	L3	I		
4	DC-	I/O	DC bus negative voltage output	Output to power drives. Recommended wire section: - AWG10 / 105°C for GDPS 32 kW - AWG12 / 105°C for GDPS 16 kW Maximum length: 200 mm
5	DC+	I/O	DC bus positive voltage output	
6	DR+	O	Braking resistor connection	Recommended wire section: 2.5 mm² or AWG14. Braking resistor is required.
7	DR-	O		

The DC+/DC- polarity between the multiaxis power supply unit and the drives MUST be observed.

2.2 – X2 CONNECTOR: AUXILIARY POWER SUPPLY AND AOK CONNECTOR

Manufacturer: Weidmuller
Type: BLZ 5.08 / 4B
Reference: 152896
Tightening torque: 0.4 to 0.5 Nm

PIN	SIGNAL	I/O	FUNCTION	DESCRIPTION
1	0V = GND	I	Mains isolated 24 Vdc auxiliary supply 0 V input referenced to the GND potential of the amplifier housing	24 Vdc supply: +/- 10% Consumption: 0.320 A
2	24 V	I		
3	AOK+	O	Shut down the mains in case of power component failure	OptoMos relay: high output impedance if fault Umax = 50 V , Imax = 300 mA Polarity must be observed: AOK+ = positive potential AOK- = negative potential
4	AOK-	O		

Providing the +24 V auxiliary power supply is MANDATORY.

Powering the GDPS module with the mains but without the auxiliary power supply will destroy it.

2.3 – LEDS

The ServoPac GDPS unit cannot be reset.
If a fault has been detected, the user has to identify the origin of the problem.
Once the origin of the problem solved, the auxiliary power supply of the ServoPac GDPS unit has to be switched off/on.

LEDs available on the front panel are used to display the ServoPac GDPS unit status:

RED LED	GREEN LED	AOK	DESCRIPTION
X	○	OPEN	+24 V_{DC} auxiliary power supply is off
X	— —		Power supply is off: undervoltage fault
X	●		Power supply is on
○	X	CLOSE	No fault detected
- -	X	OPEN	Overvoltage fault
- - - -	X	OPEN	Braking transistor fault
●	X	OPEN	Configuration fault

Legend:

X	No influence on the status described
○	LED is off
●	LED is on
— —	regular blink
- -	one flash
- - - -	two flashes

2.4 – SW1 MINISWITCH

The miniswitch available on the front panel is used to configure the operation mode of the GDPS unit:

MINISWITCH								DESCRIPTION
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	
0	0	0	0	X	X	X	X	Operating voltage = 400 V_{AC} (default configuration)
1	1	0	0	X	X	X	X	Operating voltage = 400 V_{AC} with undervoltage threshold reduced to 100 V_{DC}
1	1	1	1	X	X	X	X	Operating voltage = 230 V_{AC}
X	X	X	X	0	0	0	0	Braking I^2t = 200 ms (default configuration)
X	X	X	X	1	1	1	1	Braking I^2t = 100 ms

The configuration of the ServoPac GDPS unit is read only at power up.

If the configuration has to be changed, proceed as described below:
1. Switch off all power supplies (mains and auxiliary power supplies)
2. Change the miniswitch code
3. Switch on the auxiliary power supply
4. Verify that no configuration fault is detected.

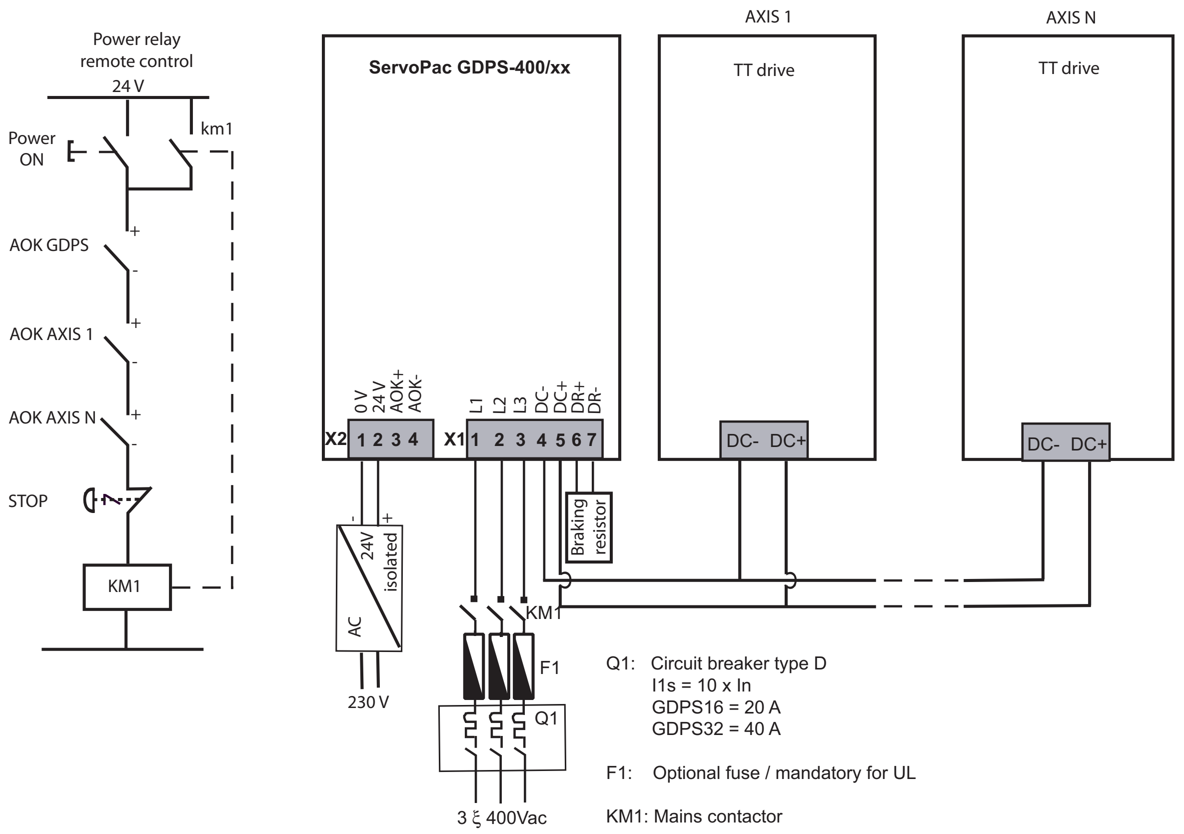
IMPORTANT:
When the operating voltage is 230 V, make sure that it is correctly set up in the GDPS power supply unit **AND** in the drive.

RISK OF ELECTRIC SHOCK

The ServoPac GDPS unit is IP20 classified. Since the miniswitch configuration requires a little screwdriver, the SW1 miniswitch must always be handled with power off.

Chapter 3 – Connection

3.1 – CONNECTION DIAGRAM



Polarity DC+ and DC- between drives and the GDPS power supply unit must be observed. Otherwise, drives will be immediately destroyed.

AOK input must be wired in order to reduce the risk of fire.

3.2 – UL FUSE RATING

For the ServoPac GDPS - 400/xx multi-axis power supply unit:

ServoPac GDPS	400/16	400/32
FERRAZ	A60Q20-2	A60Q40-2

Chapter 4 – Troubleshooting

Attention: The opening of the branch-circuit protective device may be an indication that a fault has been interrupted. To reduce the risk of fire or electric shock, current-carrying parts and other components of the controller should be examined.

4.1 – UNDERVOLTAGE FAULT

When switching on the auxiliary 24 VDC supply, the ServoPac GDPS unit always displays the undervoltage fault.
The undervoltage fault will go out when switching on the power voltage, after a few seconds time delay that corresponds to the soft start of the power capacitors.
The soft start system will be activated again when the voltage will drop below the undervoltage threshold.
If the fault display remains after switching on the power supply:

- Check that the power supply is actually on and the actual voltage value. The DC bus voltage value can be measured by means of the digitizing oscilloscope.

4.2 – OVERVOLTAGE FAULT

The overvoltage fault is used to protect the drive against high voltage values on the DC bus.
This fault can have different origins:

- Check that the braking resistor is not open.
- Check that the operating voltage is correctly set up according to the mains voltage (SW1 configuration).
- When the braking I^2t protection becomes active, it prevents the braking resistor from switching.
  Check that the braking ability is sufficient for the application.
  In this case, a lower ohmic value may solve the problem.

4.3 – BRAKING TRANSISTOR FAULT

The braking transistor fault is used to protect the ServoPac GDPS unit and the braking resistor against a short circuited transistor.
This fault can have two different origins:

- If no braking resistor is connected, the fault will be displayed.
  Check that a braking resistor is connected and not opened.
- Else the braking transistor has been destroyed. In this case, the ServoPac GDPS unit must be repaired.

4.4 – CONFIGURATION FAULT

The configuration fault is used to prevent a wrong configuration by means of the SW1 miniswitch.

- Check the SW1 miniswitch code in the table.