BAUTZ

ZMP 92-70

ZMP MINI 92-70

ZMP 182-140

ZMP MINI 182-140

Bipolar stepper motor power stages

MA 2052-A002 GB

Contents

1 Description

1.1 General

ZMP power stages are used for the bipolar control of two-phase stepper motors.

The smaller unit, ZMP 92-70, delivers phase currents between 1 and 6,5 A_{rms}. The most powerful model, ZMP 182-140, delivers phase currents between 2 and 13 A_{rms}.

Both models are available in the full step/half step version as well as in the MINISTEP version. If, for example, the motor connected to the power stage is a 200 steps/rev. motor, the following step resolutions can be selected:

- *ZMP Version "full step/half step": 200 and 400 steps/rev.*
- *ZMP Version "MINI": 500 and 1000 ministeps/rev. (1/2,5 or 1/5 step mode)*

It is also possible to connect motors having a different number of steps/rev. In this case, the resulting step resolution differs, depending of the operating mode selected.

In order to drive the stepper motor, ZMP power stages require:

- *a supply voltage of 70 or 140 V_{DC} and*
- *input signals from a control unit: control pulses, rotating direction, boost, deactivation and reset.*

The input signal logic can be set to positive or negative logic, by means of a jumper. This enables the ZMP power stages to be driven from various control units including a stepper motor interface.

Another input signal sets the step resolution.

All ZMP power stages have a common error output which can be selected as an opening or closing type contact, as well as a "basic position" output.

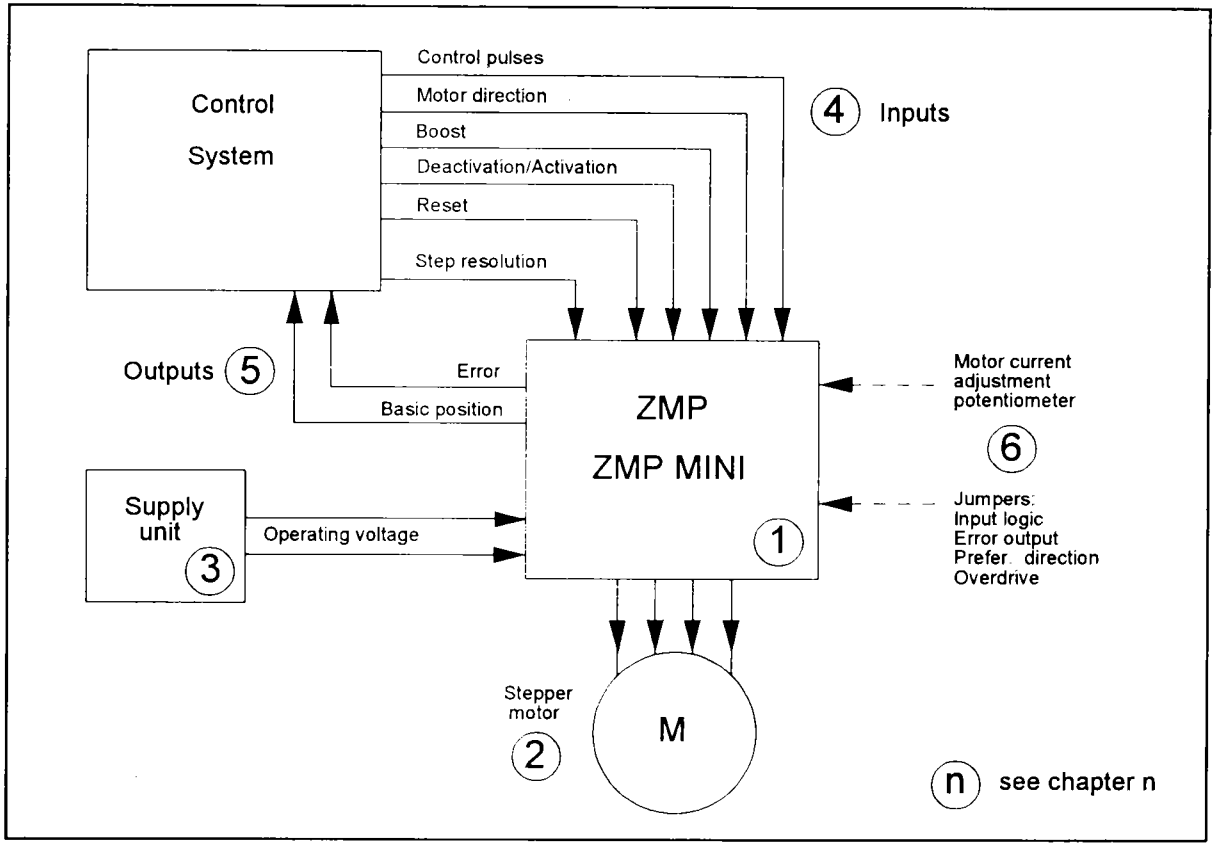


Fig. 1: Connecting diagram for ZMP power stages

1.2 New features

- ZMP and ZMP MINI operate on the patented SYNCHROCHOP principle which enables the regulation of the motor current for both motor phases, synchronized with the rotating field. The SYNCHROCHOP principle reduces resonance and motor noise during operation.

- The run current is set by means of a scaled potentiometer.

  ZMP power stages automatically switch to the stop current (50 % of run current) if the control pulses are interrupted during more than 40 msec.

- For speeds over 5 rev./sec (for a 200-step motor), the chopper frequency is automatically increased from 20 KHz to 40 KHz, to avoid high motor current ripples at high speeds.

  High ripples may provoke torque drop and temperature increase of the motor.

- The input signal's logic can be set either positive or negative via a jumper.

- Input voltages in a wide range up to 30 V are permissible.

- The "Error" output can be either an opening or closing contact, selected by a jumper.

- A multi-colour LED indicates the power stage status.

1.3 Technical characteristics

Type	ZMP 92-70	ZMP MINI 92-70	ZMP 182-140	ZMP MINI 182-140
Stepper motor	Two-phase 4-, 6- or 8-lead stepper motors It is not permitted to connect 5-lead stepper motors to the unit. Minimum inductance of a motor phase: 0.5 mH.			
Phase currents	1 - 5 A_{rms} (with Boost:1.3 - 6.5 A_{rms}) I_{max} = 9.1 A		2 - 10 A_{rms} (with Boost:2.6 - 13 A_{rms}) I_{max} = 18.2 A	
	The motor current adjusting potentiometer can only be accessed after removal of the front panel.			
Operating voltage	Nominal: + 70 V_{DC} Permissible range: + 40 to + 80 V_{DC} **Caution:** Voltages above 100 V_{DC} - even for a short time (µsec range) - provoke the destruction of the power stage.		Nominal: + 140 V_{DC} Permissible range: + 40 bis + 160 V_{DC} **Caution:** Voltages above 200 V_{DC} -even for a short time (µsec range) provoke the destruction of the power stage.	
Chopper	20 KHz synchronized with the rotating field, alternately chopped. For speeds above 5 rev./sec (for a 200-step motor), the chopper frequency is increased to 40 KHz.			

Type	ZMP 92-70	ZMP MINI 92-70	ZMP 182-140	ZMP MINI 182-140
Inputs	*Permissible input voltage range: 0 to 30 V_{DC}* *The following input signal logic can be selected by means of a jumper: control pulses, boost, deactivation and reset:* *0 to 2 V = LOW level* *3 to 30 V = HIGH level*			
Control pulses	*Maximum frequency of the drive pulses: 100 KHz* *Minimum pulse width: 5 µsec*			
Motor direction	*When this input is activated, the motor direction is reversed.* ***Caution:*** *The "Motor direction" input must only be activated when the motor is at a standstill.*			
Boost	*When this input is activated, the phase currents are increased by 30 %.*			
Deactivation	*When this input is activated, both motor phases are deactivated (the motor current is off).*			
Reset	*A reset sets the power stage to a defined status.* *Each Reset generates a "Basic position" output signal.*			

Type	ZMP 92-70	ZMP MINI 92-70	ZMP 182-140	ZMP MINI 182-140
Step resolution	When this input is activated, the number of steps per revolution is divided by two. **Do not change the step resolution during operation of the power stage!** The following values apply to a 200 steps/rev. motor:			
Input activated	200 (Full step)	500	200 (Full step)	500
Input deactivated or not connected	400 (Half step)	1000	400 (Half step)	1000
Outputs	Open collector output, 0.2 A for $U_{CE\ sat} \leq 1$ V; $U_{max} = 40\ V_{DC}$			
Basic position	Zero indication of the internal ring counter. This signal is active at low level.			
Full step Half step 1/2.5 step 1/5 step	Basic position every 4th control pulse Basic position every 8th control pulse Basic position every 10th control pulse Basic position every 20th control pulse			
Error	Common error output By a jumper this output can be set to an opening or closing-type contact.			
	Error signal if motor current > 14 A		Error signal if motor current > 25 A	
	Error signal if operating voltage < 40 V Error signal if heat sink temperature > 85 °C			

Type	ZMP 92-70	ZMP MINI 92-70	ZMP 182-140	ZMP MINI 182-140
Jumpers	Input logic: positive/negative Error output: Closing or opening contact Motor direction: +/- Overdrive: ON/OFF		**Remark:** Before changing the jumper positions 1. Switch off the supply voltages 2. Unscrew the module's front panel	
Multi-colour LED	green: yellow: red: Diode does not light:		Ready Busy Fault Reset, Deactivation, Power off	
Permissible ambient temperature	0 to 40 °C			
Permissible heat sink temperature	85 °C max. If the heat sink temperature rises above the permissible temperature, the power stage is deactivated. The LED goes red (Error).			
Permissible motor cable length	50 m max.			
Recommended cable cross section	1 mm^2 min.		1.5 mm^2 min.	

Type	ZMP 92-70	ZMP MINI 92-70	ZMP 182-140	ZMP MINI 182-140
Connector	32-pin connector according to DIN 41 612, Version D			
Weight, front panel included	0.4 kg		1 kg	

1.4 Dimensions

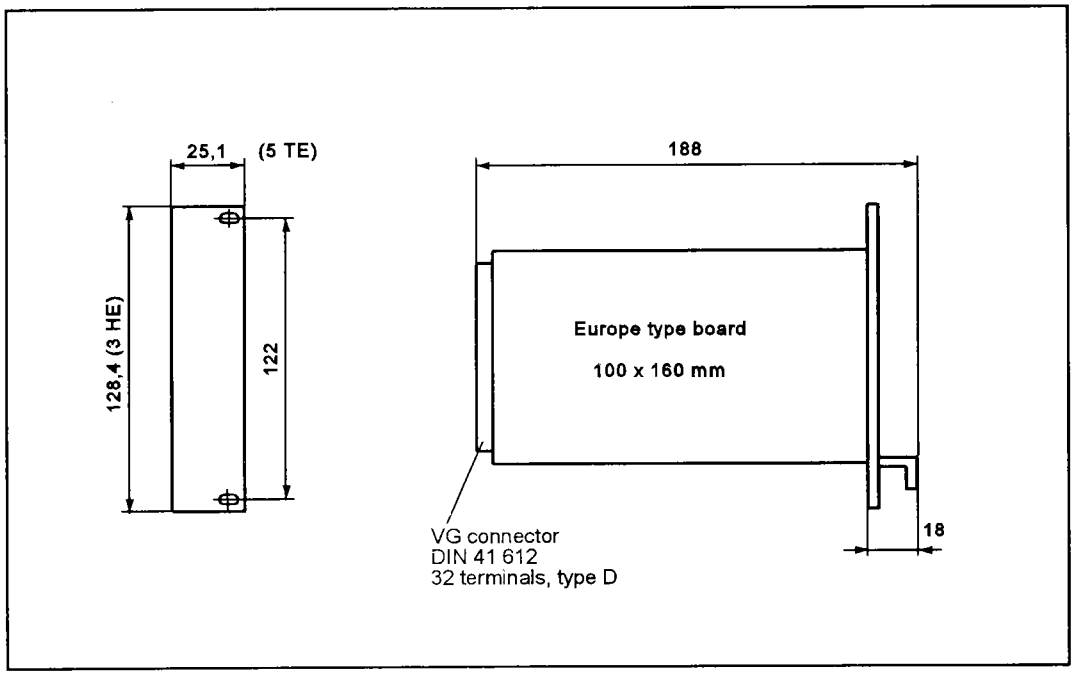


Fig. 2: Dimensions ZMP 92-70 and ZMP MINI 92-70

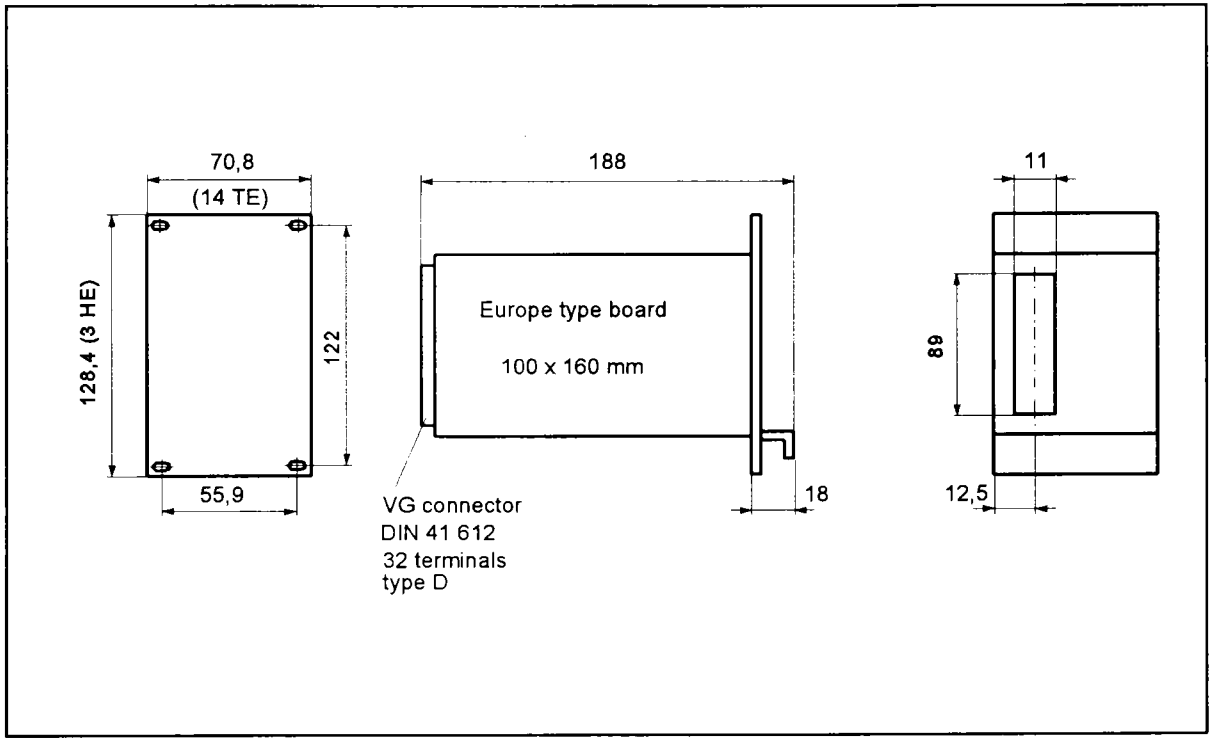
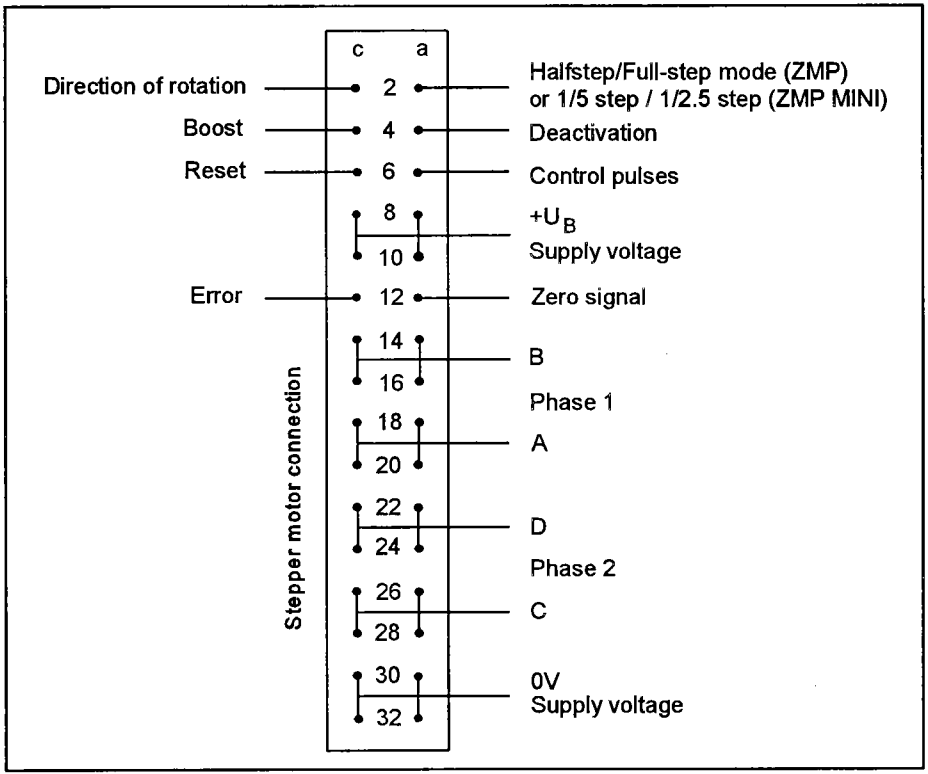


Fig. 3: Dimensions ZMP 182-140 and ZMP MINI 182-140

1.5 Connector assignment



32-pin connector according to DIN 41612, Version D

The connector is shown with a view on the terminals.

Fig. 4: Connector assignment

1.6 Block diagram

The block diagram on the next page shows the operating principle of the ZMP power stage:

- *A special IC integrates the input logic, the ring counter for the half step / full step or 1/5 - 1/2.5 steps MINISTEP mode as well as the current regulation circuits.*

  This subassembly also includes the current adjustment and monitoring circuits.

- *Both power stages contain bridge circuits, equipped with POWER-MOSFET transistors, various drivers, protective diodes and current sensors.*

- *The supply unit generates all operating voltages for the logic circuits from the unstabilized motor voltage.*

ZMP 92-70 and ZMP MINI 92-70 power stages include a linear supply module.

Due to the higher supply voltage, versions 182-140 include a switching type supply module.

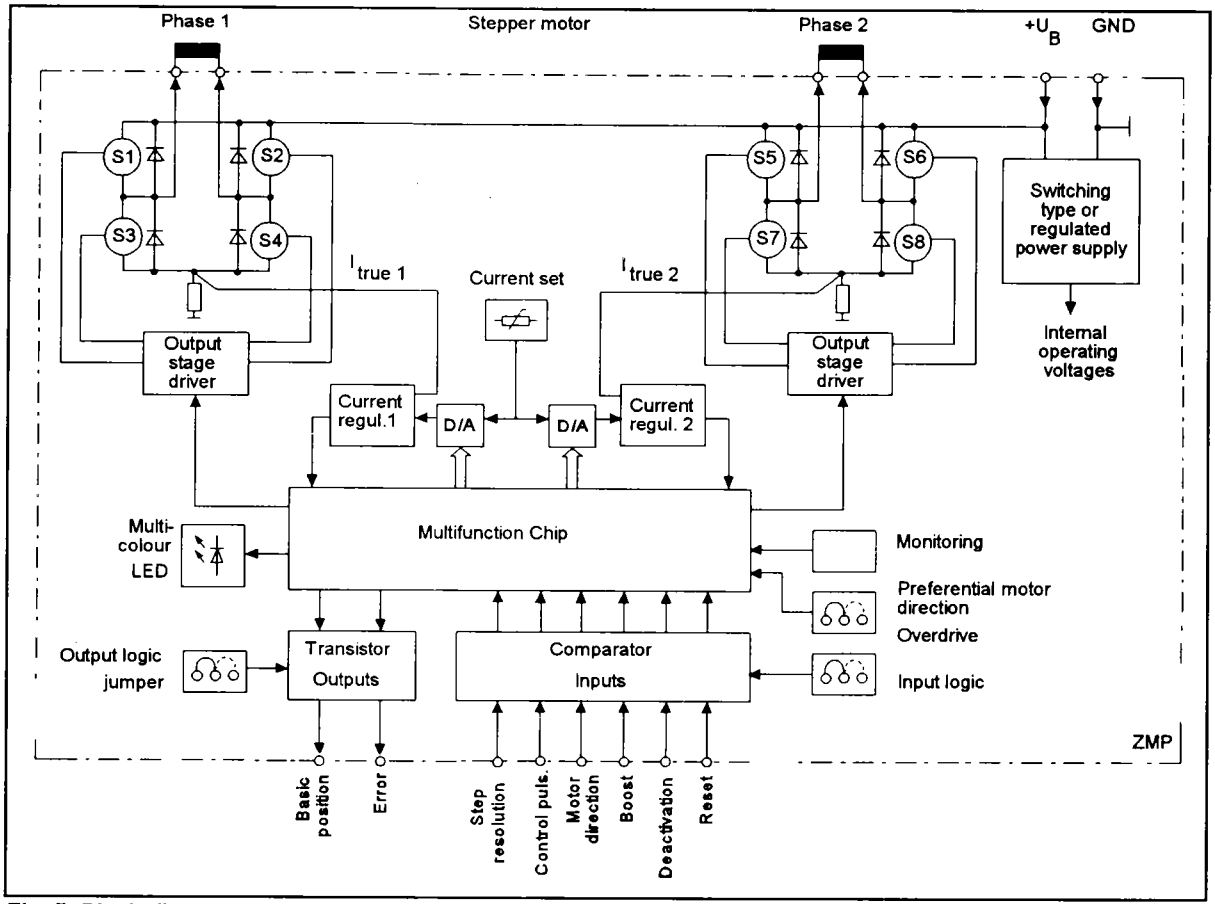


Fig. 5: Block diagram

1.7 Full step / Half step mode

The "full step" mode is the operating mode in which a 200-step motor, for example, drives 200 steps per revolution. Therefore, a 500-step motor drives 500 steps per revolution in the full step mode.

In the full step mode, both stepper motor phases are permanently energized.

The motor step resolution can be electronically multiplied by 2 by alternately energizing the stepper motor's phases 1, 1+2, 2 etc.: this is the "half step" mode. This means that a 200-step motor executes 400 true steps per revolution and a 500-step motor executes 1,000 true steps per revolution.

Compared to the full step mode, the half step mode reduces the output torque by a factor of approximately 1/√2, since all motor phases are not permanently energized.

To compensate this lack of torque, ZMP power stages use the "half step mode with torque compensation": as long as only one motor phase is energized, the current is increased by √2. Compared to the full step mode, the torque delivered is almost the same, however, most of the resonance of the full step mode is suppressed.

The figure shows the phase currents for the full step mode and those of the half step mode with torque compensation.

ZMP 92-70 and ZMP 182-140 operate in the half step mode.

The "step resolution" input activation switches the unit to the full step mode.

Caution:

It is not permitted to change the step resolution during operation (please refer to page 77).

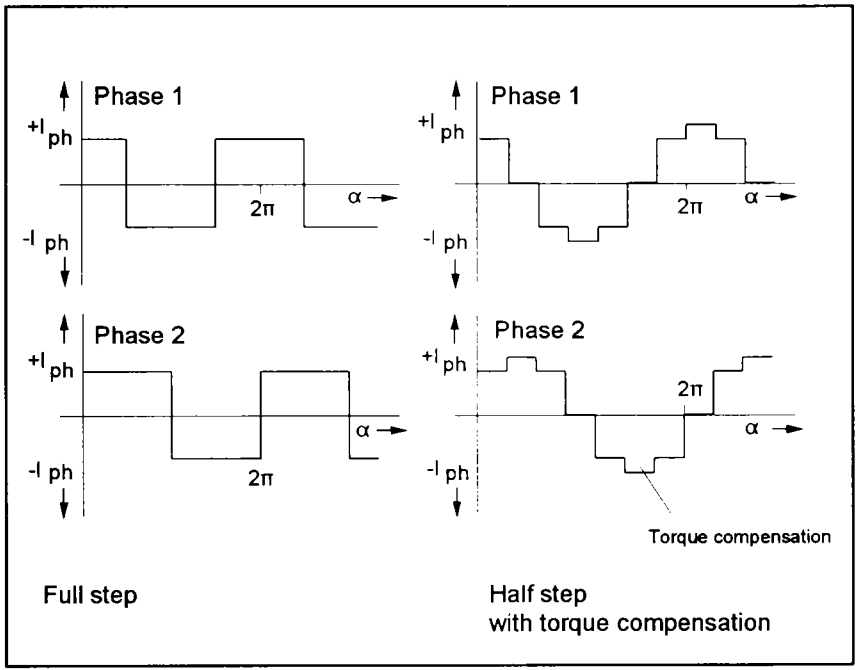


Fig. 6: Phase currents in the full step and the half step mode

Remark:

In general, the current and loss values on the motor data sheets apply to a stepper motor with both phases energized.

1.8 MINISTEP mode

ZMP MINI power stages increase the step resolution by a factor 5 or 2.5: this is the ministep mode.

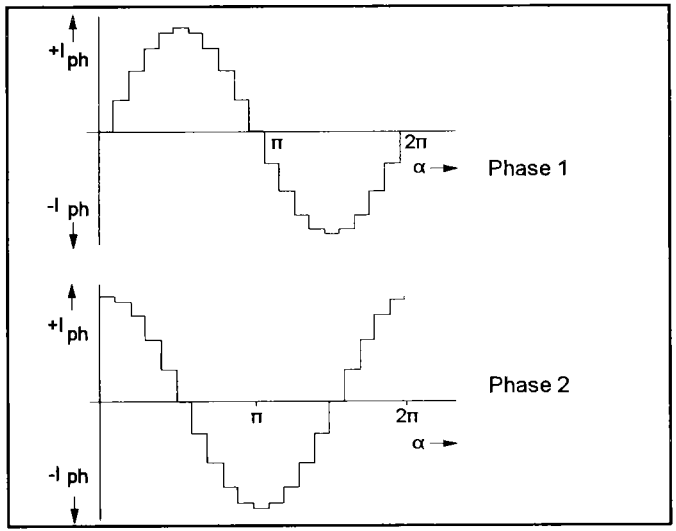


Fig. 7: Phase current in the ministep mode 1/5-step

Various advantages are obtained by the almost sine-shaped ministep mode current:

- *The torque undulation decreases when the number of ministeps is increased.*
- *Resonance and overshoot are greatly reduced.*
- *The motor noise also drops when the number of ministeps is increased.*

ZMP MINI 92-70 and ZMP MINI 182-140 operate in the 1/5 step mode.

The "Step resolution" input activation makes it possible to switch to the 1/2.5 step mode.

Caution:

It is not permitted to change the step resolution during operation (please refer to page 77).

1.9 Boost

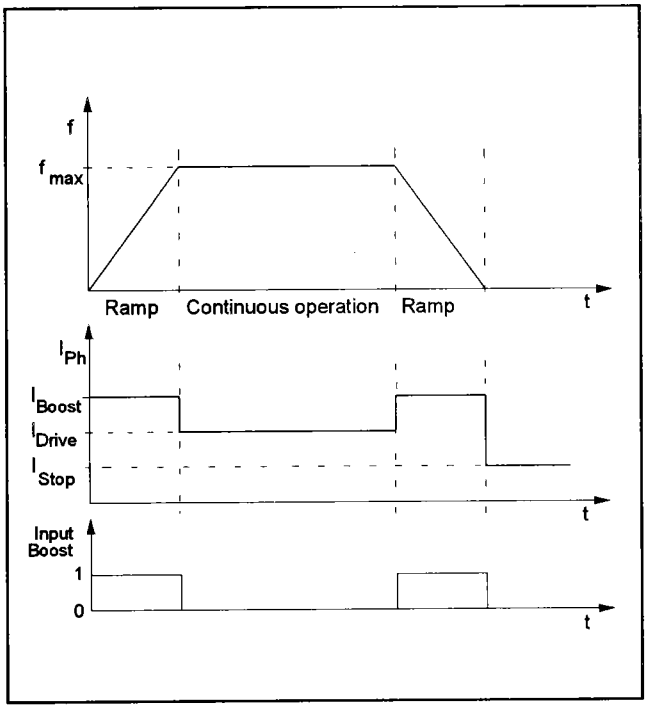


Fig. 8: Boost

The "Boost" function, which increases the motor current approx. by 30 %, can be switched on or off as requested:

The motor torque required during acceleration and deceleration (ramps) is higher than that required during continuous motor operation (f_{max}).

During continuous operation at f_{max}, the motor current can be reduced to avoid unnecessary heating of the motor.

In order to get the maximum available torque during the ramps, you can increase the motor current by switching on the "Boost" function.

The "Boost" function is switched on by activation of the "Boost" input.

1.10 Overdrive

In adddition to the standard Boost function, the ZMP power stages include a dynamic Boost function: "Overdrive".

The "Overdrive" function compensates the current/time area in the higher frequencies which is due to motor inductivity and the increasing generator effect.

To increase the torque, the r.m.s. phase current is automatically increased by a factor of 1.4 for speeds above 5 rps (for a 200-step motor). This function is simplifying the current shape, too.

The "Overdrive" function is activated or deactivated by a jumper.

2 Motor connection

2.1 Different types of motors

Type ZMP power stages can be used to drive various types of two-phase stepper motors.

For 8-lead stepper motors, two types of connections can be used: parallel (1) or series (2) winding connection of the motors.

For 6-lead stepper motors, we recommend connection (3) with the motor windings in series. If the motor cannot be connected as per figure (3), it can be be used by connecting only 2 windings, as shown in (4).

Caution:

It is not permitted to connect 5-lead stepper motors to ZMP power stages.

The power stage might be destroyed if 5-lead stepper motors are connected.

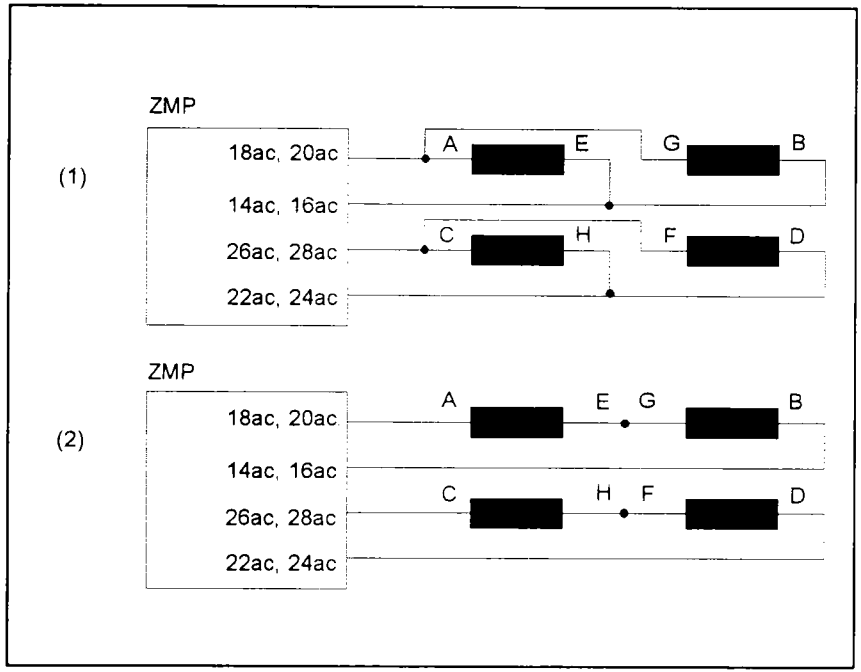
The figures on the following pages show the connection of various types of stepper motors to the ZMP power stages.

Letters A to H refer to the connecting diagrams in the motor data sheets for stepper motors types ZSS, ZSH, RSS and RSH.

Notice:

The stepper motor leads may be marked differently, depending of the type of motor used.

Before connecting the motor, you must check the motor plate (voltage/current values) and the connecting diagram included with the motor.



(1) 8-lead stepper motor connected as a 4-lead stepper motor

Windings connected in parallel (standard)

(2) 8-lead stepper motor connected as a 4-lead stepper motor

Windings connected in series

Fig. 9: 8-lead motor connection

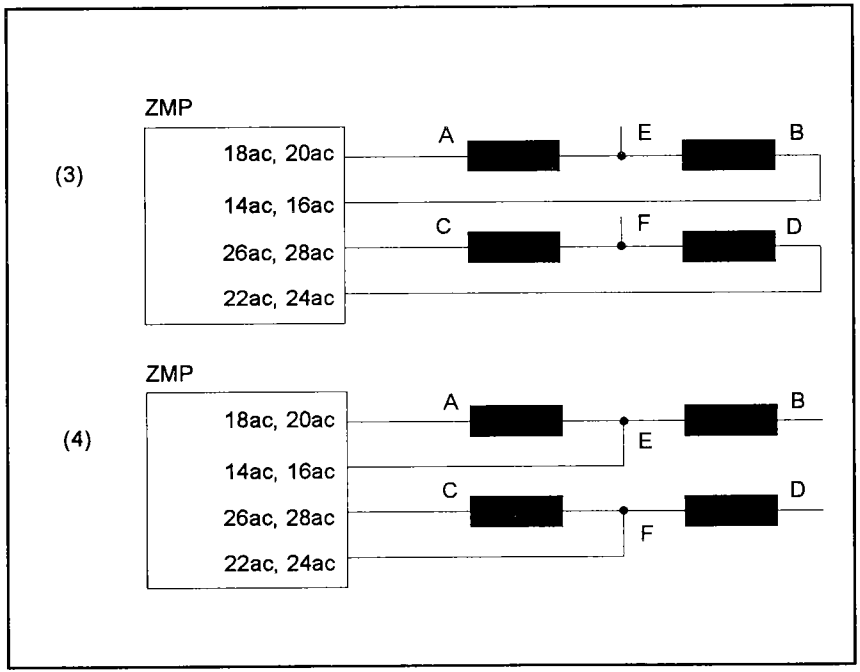


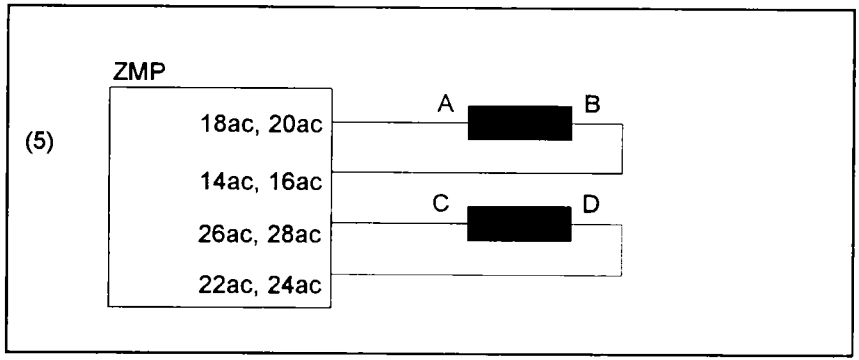
Fig. 10: 6-lead motor connection

(3) 6-lead stepper motor

Windings connected in series

(4) 6-lead stepper motor

Used with 2 windings if connection (3) can not be effected



(5) 4-lead stepper motor

Fig. 11: 4-lead motor connection

2.2 Motor cables

	Minimum cable cross section	Maximum cable length
ZMP 92-70 ZMP MINI 92-70	1 mm²	50 m
ZMP 182-140 ZMP MINI 182-140	1,5 mm²	

Notice: *All unused motor wires must be insulated individually (motor connections (3) and (4)).*

2.3 Shielding

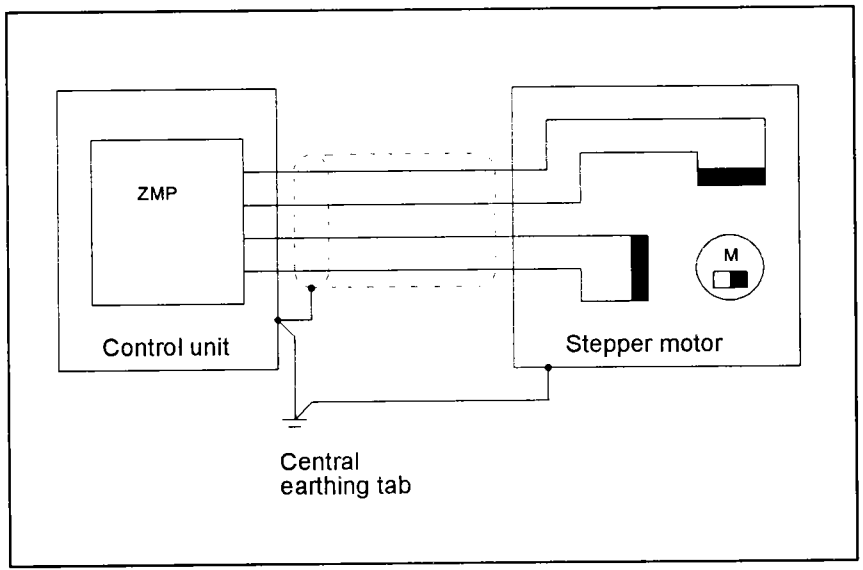


Fig. 12: Motor lead shielding

To avoid disturbances affecting the wires and instruments installed close to the drive system, we recommend to use shielded cables.

The cable shielding must be connected at one end to the ground (PE) of the control unit. The motor and/or the mechanical system are connected to the ground by a central earthing tab.

Remark:

*ZMP power stages **have no** electrical isolation between the motor voltage and the control voltage.*

3 Supply unit

3.1 Mains supply

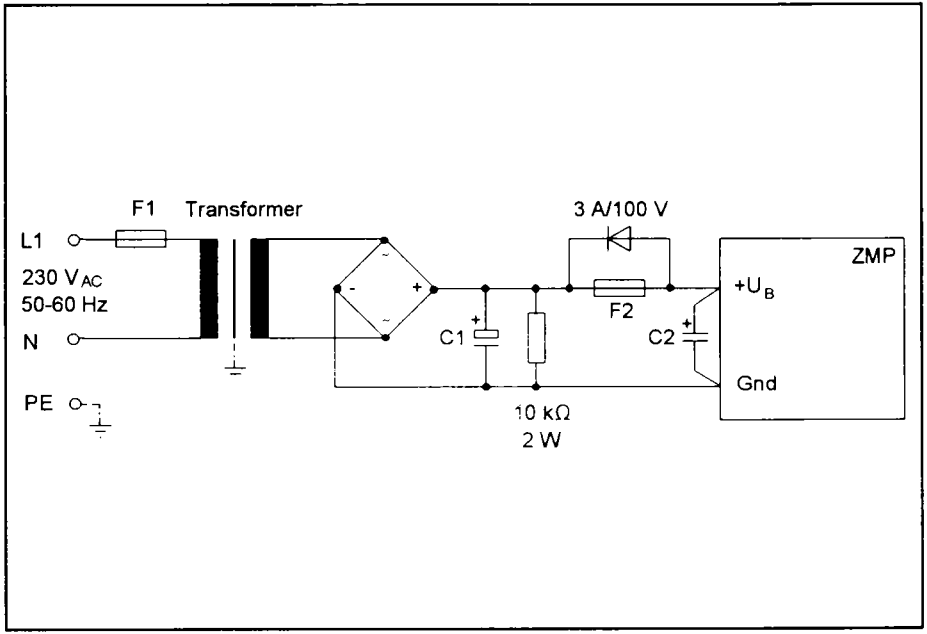


Fig. 13: Example of supply unit

The ZMP and the motor can be supplied by means of an unregulated filtered DC voltage:

ZMP/ZMP MINI 92-70: +70 V_{DC}

ZMP/ZMP MINI 182-140: +140 V_{DC}

Caution:

Do not exceed the operating voltage ranges. Refer to page 51.

The following paragraph concerns the calculation and the connection of the supply unit.

3.2 Calculation and connection

For calculation and connection of the supply unit, the following instructions must be followed:

1. ***All** mating connector terminals indicated in the connecting diagram must be connected to the cable.*

   Example: + U_B must be connected to terminal 8a, 8c, 10a and 10c.

2. *The cable coss section of the supply wires must not be under 1 mm^2.*

   If possible, twist into pairs the mains supply leads and the phase leads.

3. *If you connect several ZMP power stages to a single supply unit, the wire cross section must be calculated so that the current in the wire never exceeds a load of 10 A per mm^2.*

4. *If the supply leads between the mains and the ZMP module are longer than 500 mm, connect a capacitor (C2, approx. 47 µF/200 V - refer to figure 13) as close as possible to the connector.*

   This capacitor must be adapted for switching applications and have a low ESR factor (e.g.: Roederstein type EKM 47 µF/200 V).

   By this measure perturbations fed through the supply leads are avoided,which might cause a "Supply error" message.

5. *Protective diode*
   If you install a fuse (F2) behind electrolytic load capacitor C1, you must connect a protective diode in parallel.

   If the fuse blows, the energy accumulated in the motor flows back to the capacitor in the supply unit.

6. *Transformer, load capacitor*

	ZMP 92-70 ZMP MINI 92-70	ZMP 182-140 ZMP MINI 182-140
Transformer U I	50 V_{AC} 5 A	100 V_{AC} 10 A
Load capacitor C1	4,700 µF	10,000 µF

The power indications for the transfomer and the load capacitor are "worst-case" values, i.e.: computed for a maximum motor power, permanent "Boost" function activation and a 100 % load factor. The true values must be determined in function of the real operating conditions.

For the load capacitor, a value of 1,000 µF per Amp of motor current can be used.

The thermal limit values of the transformer must never be exceeded.

The regulaton (stiffness) of the supply module must be good enough to avoid that the DC voltage drops more than 15 % below the peak value, at maximum load.

7. *Rectifier*
The rectifier must be adapted to dissipation losses up to 2 Watts per Amp. If necessary, mount a heat sink.

4 Inputs

- *Step resolution*
  ZMP 92-70 and ZMP 182-140: Half step / Full step
  ZMP MINI 92-70 and 182-140: 1000/500 steps per revolution (for a 200-step motor)
- *Control pulses*
- *Motor direction*
- *Boost*
- *Deactivation*
- *Reset*

The input signal logic for signals "Control pulses", "Boost", "Deactivation" and "Reset" can be reversed by a jumper.

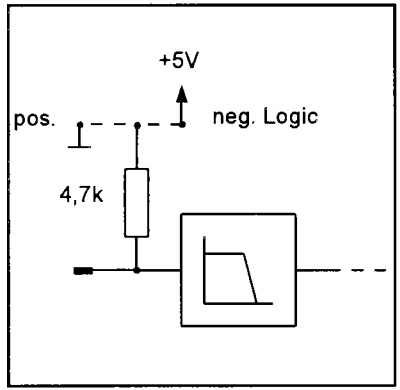


Fig. 14: Input connection

On delivery, the power stage is preset to positive logic (input signals active at high level). The input signal voltages are in the following range:

$$0\ V \leq low \leq 2\ V$$
$$3\ V \leq high \leq 30\ V$$

4.1 Step resolution

Caution:

When switching on or resetting the power stage, the step resolution must only be changed ***before*** *the first clock pulse has arrived.*

Changing the step resolution during operation might destroy the power stage!

This input has various functions, depending on the power stage type:

ZMP 92-70 and ZMP 182-140:
The signal switches between the full step and the half step modes:

Half step	=	*Input deactivated*
Full step	=	*Input activated*

ZMP MINI 92-70 and ZMP MINI 182-140:
The signal switches between the modes 1/5 step and 1/2.5 step. For a 200-step motor, this corresponds to switching between 1,000 and 500 ministeps per revolution.

1/5 step	=	*Input deactivated*
1/2.5 step	=	*Input activated*

4.2 Control pulses

One >5 µs pulse triggers one motor step. The first control pulse switches the motor from the stop to the run current and the step is executed. If the time lapse between pulses is above 40 ms, the motor automatically switches back to the stop current.

The maximum control pulse frequency is 100KHz.

Remark:
There must be no sudden interruption of the control pulses for frequencies above the start-stop frequency. This would cause mispositioning of the motor and/or an error signal.

Start-stop frequency:

The start-stop frequency corresponds to the maximum frequency at which a stepper motor at standstill can be started without mispositioning.

4.3 Motor direction +/-

This signal sets the direction of rotation of the motor.

Preferential motor direction = *input deactivated*

Reverse direction = *input activated*

Caution:

1. *This signal must only be modified when the motor is at a standstill. Changing the motor direction when the motor is running will cause step losses and/or stop the motor.*

2. *The rotating direction must not be changed 5 µs before and after the control pulse.*

The "preferential motor direction" jumper changes the initial motor direction, as compared to the logic signal level.

4.4 Boost

The "Boost" function increases the motor current by approximately 30 %. The resulting torque increase is used, for example, during motor acceleration (please refer to the "Boost" description on page 66).

There is no time limit for the use of the Boost function.

Boost OFF = *Input deactivated*

Boost ON = *Input activated*

4.5 Deactivation

If this input is activated, the motor current is ***switched off****.*

Deactivation = Input activated
Motor activated = Input deactivated

This input is useful, for instance, during maintenance operations to switch the power stage off, without having to disconnect it physically from the mains.

It is then possible to ***slowly*** *rotate the motor by hand. Never try to rotate the motor externally at high speed. In this case, it operates as a generator and returns energy to the power stage.*

The deactivation input is also useful when highly sensitive instruments are installed close to the drive system. The magnetic disturbances generated by the power stage can thus be suppressed during measurements.

Caution:

The "Deactivation" input must only be activated when the motor axis is at a standstill.

Warning:

The "Deactivation" input is not in conformance with professional emergency stop circuit requirements.

4.6 Reset

The Reset function sets the power stage to a given initial status.

Reset = Input activated
Operation = Input deactivated

The activation of this input initializes the monitoring circuits and the internal ring counter is set to zero. When the Reset signal is suppressed, a time lapse of approx. 500 ms is necessary before the power stage returns to the "Ready" status.

5 Outputs

Open collector outputs, active at low level
0.2 A, maximum switching voltage 40 V

Caution:
In case of connection of highly inductive equipment (e.g. a relay or motor brake), a protective diode must be connected to these outputs.

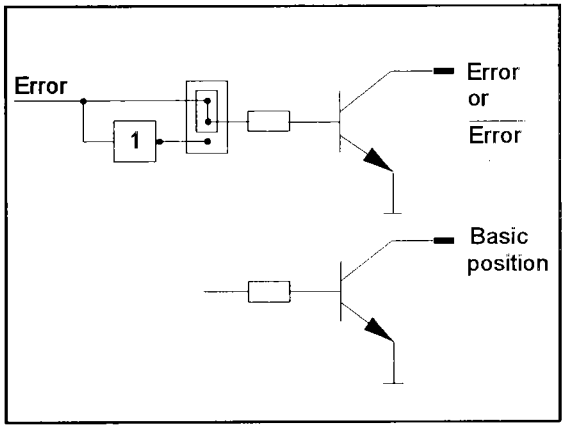


Fig. 15: Output connection

5.1 Basic position

This signal is generated when the internal ring counter passes through zero, after the unit is switched on and after a Reset function.

If the motor is deactivated, the basic position signal is not generated.

This signal is activated

- *every 8th step in the half step mode (ZMP),*
- *every 4th step in the full step mode (ZMP),*
- *every 20th step in the 1/5-step ministep mode (ZMP MINI)*
- *or every 10th step in the 1/2.5-step ministep mode (ZMP MINI).*

The basic position signal can be used in combination with an end of run limit switch to determine the machine's zero.

5.2 Error

"Error" is a common output for all error signals generated by the ZMP power stage. This output can be programmed as a closing type or opening type contact:

Closing contact = active at low level if an error occurs

Opening contact = active at low level if the power stage is operating correctly

The setting to "Opening contact" has the advantage of detecting a power interruption or cable breakage.

This output is activated if certain thresholds are exceeded. To avoid damaging the motor, the latter is deactivated. The front panel multi-colour LED turns red.

To reset the error signal, you must activate the Reset input or switch the mains off for a short lapse of time.

Applicable thresholds for the "Error" signal:

	ZMP 92-70 ZMP MINI 92-70	ZMP 182-140 ZMP MINI 182-140
Motor current	> 14 A	> 25 A
Operating [1] voltage	< 40 V	
Heat sink temperature	> 85 °C	

If the Error message has been caused by overheat, the unit must be switched on again only after cooling.

The "Error" signal can also be due to the following causes:
- *Short-circuit in the motor*
- *Deceleration ramp too high*
- *Incorrect layout or connection of the supply unit. Please, refer to page 73 - 75.*

[1] *Remark: In special cases, voltage monitoring can be deactivated.*

6 Front panel controls

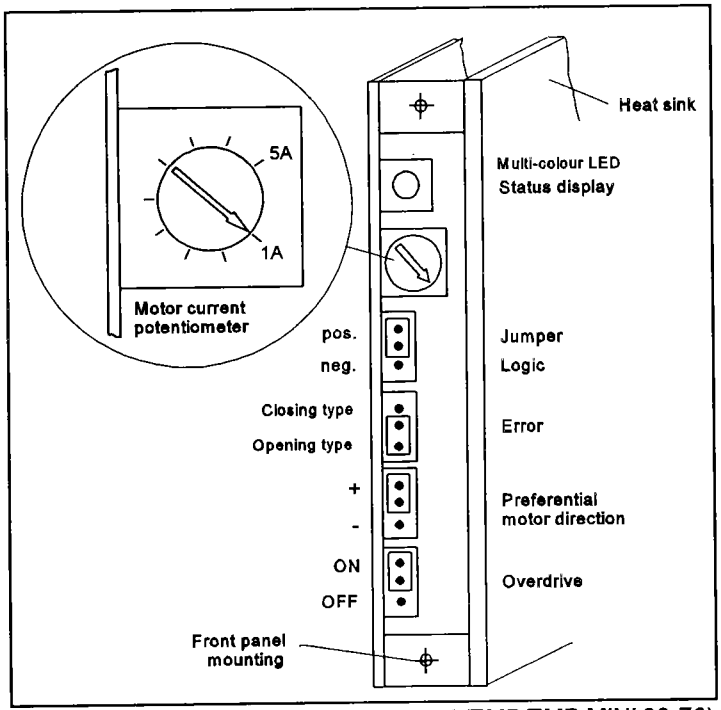


Fig. 16: Front view - front panel removed (ZMP/ZMP MINI 92-70)

6.1 Current adjustment

The motor run current is set by means of a scaled potentiometer which can be accessed after removal of the ZMP module's front panel.

If the control pulses are interrupted for a lapse of time >40 ms [1], the power stage automatically switches to the stop current. The stop current is set to 50 % [1] of the adjusted run current.

Range of motor currents:

ZMP/ZMP MINI 92-70	*ZMP/ZMP MINI 182-140*
1 - 5 A_{rms}	*2 - 10 A_{rms}*
with Boost: 1,3 - 6,5 A_{rms}	*with Boost: 2,6 - 13 A_{rms}*

[1] *Remark: In special cases, these values can be modified.*

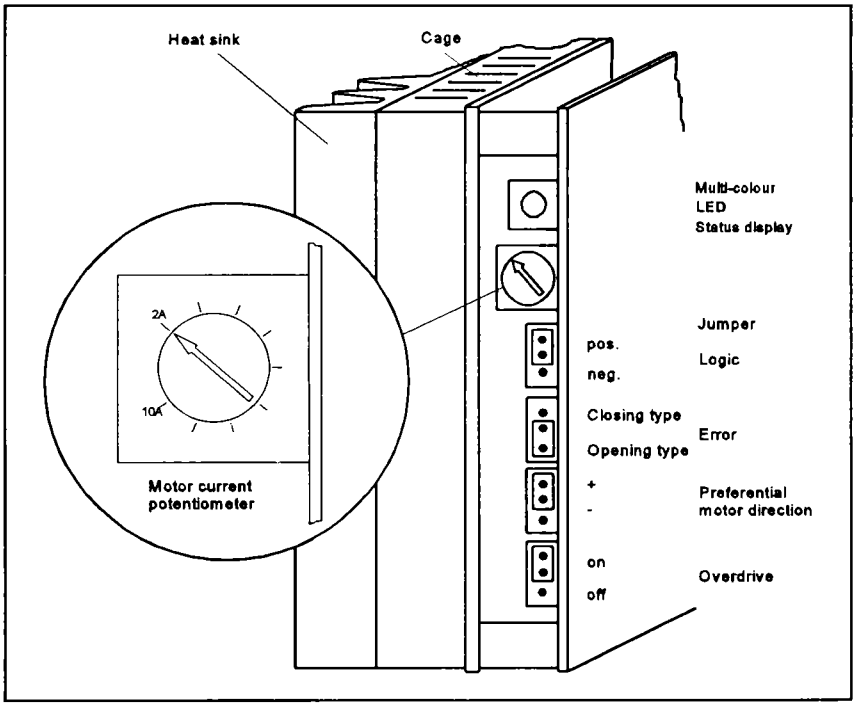


Fig. 17: Front view - front panel removed (ZMP/ZMP MINI 182-140)

Peak values:

The maximum phase current I_{max} circulates if only one phase is activated in the half step mode or in the ministep mode (refer to chapter 1.7, phase current diagram).

ZMP 92-70 *ZMP MINI 92-70*
I_{max} = 9,1 A

ZMP 182-140 *ZMP MINI 182-140*
I_{max} = 18,2 A

6.2 Jumpers

The jumpers can be accessed after removal of the module's front panel:

Jumper		Position on delivery
Logic	positive negative	Positive logic
Error	Closing type contact Opening type contact	Opening type contact
Prefer. motor direction	+	+
Overdrive	ON OFF	ON

Caution:

The jumpers must only be set when the operating voltage is off.

6.3 LED

The multi-colour LED changes colour to indicate the status of the power stage:

Green	Ready The power stage is ready to operate.
Yellow	Busy The power stage receives pulses from the control system.
Red	Fault (Error) One of the monitoring circuits has sent an error signal.
LED off	Reset/Deactivation/Power off A Reset has occurred or the input "Deactivation" has been activated or the supply voltage is interrupted.

7 Putting-Into-Service

1. *Check the supply unit's output voltage.*

2. *You must switch the supply off before insertion or removal of the ZMP board.*

3. *Never disconnect the board from the connector as long as the LED is not off.*

4. *The jumpers must only be inserted or removed after having switched off the supply voltage.*

5. *If the motor stops during acceleration, reduce the acceleration and/or maximum frequency values. This problem may also be caused by incorrect setting of the motor's rated current.*

6. *If the motor gets too hot, the motor current has probably been ajusted too high. Excessive motor heating may also be caused by continuous use of the "Boost" function.*

7. *If the motor shows high resonances, select a higher step resolution or modify the control pulse frequency and/or the acceleration.*

   Resonances can also be generated if the motor rotates with ***too high*** *current. Reduce the motor current, if necessary.*

8. *If the motor does not position correctly, it is possible that there are disturbances on the control pulse input. Also check that the acceleration and deceleration ramps are not programmed too high. Please refer to the remark on page 77.*

   Too high deceleration may cause mis-positioning of the motor by multiples of 4 or 8 steps, or by multiples of 5 or 10 steps for the ZMP MINI power stage (desynchronisation effect).

9. *The use of a regulated transformer whose voltage rises too slowly may cause an error signal, such as the use of a regulated power supply module with a current limiter.*

8 ESD protective measures

All the products which we deliver have been carefully checked and submitted to a long-term test. To avoid the failure of components sensitive to electrostatic discharge (ESD), we apply a great number of protective measures during manufacturing, from the component input check until the delivery of the finished products.

Caution:

Manipulation of ESD modules must be effected by respecting special protective measures (e.g. CECC 00 015 Version 1). Only return the modules or boards in adapted packaging.

Phytron's warranty is cancelled in case of damages arising from improper manipulation or transportation of ESD modules and components.

9 Quality assurance system

The Eduard Bautz GmbH, drive technology - motors and controls has been working with the principle of the quality assurance for many years.

Presently this quality system is prepared after the requirements of the DIN / EN / ISO 9001 (quality system in design / development, production, mounting and after-sales-service) for the certification.

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