TRANS-5, 3-PHASE MICRO-STEPPING TRANSLATORS

220 V AC INPUT, 2.75 Aeff/PHASE MOTOR CURRENT

Contents

E.I.P. SA MARCH 1997

TRANS-5, 3-PHASE MICRO-STEPPING TRANSLATOR

TRANS-5 is a micro-stepping power stage to drive the BERGER 3-phase motors with a high voltage winding. The TRANS-5 is powered directly from the 220/240 V AC mains. Eight selectable stepping ratios -from 500 to 6000 steps/revolution- are standard.

Suitable BERGER Motors:

- VRDM 397, max. torque 2 Nm, 1.75 Aeff/phase
- VRDM 3910, max. torque 4 Nm, 2.0 Aeff/phase
- VRDM 3913, max. torque 6 Nm, 2.25 Aeff/phase

TRANS-5 is available with an optionnal **Rotation Check**. The signals delivered by an encoder mounted into the terminal box are compared with the commanded rotor position, a discrepancy of maximum 15° is flagged as a rotation error. Motors with rotation check must be ordered from E.I.P. SA.

A 3-phase IGBT bridge and a "servo type" current control are used to provide low motor current ripple. Automatic current reduction at rest is standard (60 % of set value). For critical machining operations, especially with grinding machines, an adjustable current reduction can be ordered by a control input.

Two versions of pulse input are available: Version A: Pulse and Direction,

Version B: Forward Pulse and Backward Pulse.

Stepping on the leading or the trailing edge of the pulse is selected by a jumper. This is of importance to avoid false counting when the direction changes. A flexible control input scheme accepts almost all signal sources, see section 7.

Extensive protection circuitry have been designed into the translator:

- Over- and Under-Voltage,

- Over Current or Short Circuits,

- Over-Temperature

- Limit Switch Inputs for both travel directions.

Tripping of a protective circuit lights the proper LED and sets the FAULT output.

Thermal Design: TRANS-5 is designed to be mounted on a heat sinking cabinet wall. A wide extruded dissipator in the rear wall of the electrical enclosure is a low cost alternative to heat exchangers when a tight enclosure is required. At medium current, extra heat sinking is not required, see section 12. A dissipator to be affixed to the TRANS-5 is available as an accessory.

1. WARNING

- The TRANS-5 translator is powered directly from the AC mains. Dangerous AC and DC voltages are present inside the case **and at the motor leads and terminals**.
- TRANS-5 may only be installed by skilled electricians after careful reading of these instructions.
- Local regulations concerning the prevention of accidents, the installation of electrical systems, the emission of radio frequency energy must be observed.
- The TRANS-5 casing contains no user serviceable parts.

2. AVAILABLE MODELS and ORDERING KEY:

```
TRANS-5 A RC BR
        | |  |
        | |  +------  With BRaking Circuit
        | +---------  With Rotation Check
        +-----------  A: Pulse and Direction Inputs
                      B: Forward and Backward Pulses
```

2.1. Available Accessories

ACC-10: Extruded Dissipator, thermal resistance 1.2 °C/W, dimensional sketch at the end of the leaflet.

ACC-15: Cable Adapter to be used with our E-600 and N-200 Controllers

ACC-20: Copper bracket for shield clamps, up to 4 can be installed

ACC-21: Shield clamp for two cable 5 mm diameter

ACC-22: Shield clamp for one cable 8 mm diameter

3. TERMINAL DESCRIPTION

3.1. JPWR, Power Connector

TERMINAL	SIGNAL	FUNCTION
JPWR-1	PE	Protective Ground of the Motor Cable
JPWR-2	Phase W	Motor Cable
JPWR-3	Phase V	Motor Cable
JPWR-4	Phase U	Motor Cable
JPWR-5	BR, Brake Resistor	External Brake Resistor, see section 14.
JPWR-6	DC IN	DC-Rail Input to Power Circuitry
JPWR-7	DC OUT	DC-Rail from Rectifier
JPWR-8	L	AC-Mains Input, Active Lead
JPWR-9	N	AC-Mains Input, Neutral Lead
JPWR-10	PE	Protective Ground of the Mains Cable

3.2. J1, Signal Connector

TERMINAL	SIGNAL	FUNCTION
J1 1 **J1-2**	PULSE- PULSE+	Symetrical Step Pulse Input. Use PULSE+ for single ended signal source and leave PULSE- unconnected.
J1-3 **J1-4**	DIR- DIR+	Symetrical Direction Input. Use DIR+ for single ended signal source and leave DIR- unconnected. With the "B" option, this input is "Backward Step Pulse". Backward Pulse input for the B-version.
J1-5	GND	Signal Ground, Return Line for all Command Signals. Isolated from the mains and from the protective ground.
J1-6	/RESET	Reset input. RESET clears the Fault latches and resets the field generator. The motor current is zero while RESET is active. Active state of this pin is "low".
J1-7	+15 V OUT	+ 15 V to power proximity switches or other signal sources, 50 mA, not short proof.
J1-8	I RED.	When this input is active, the current is reduced to 75..50 % of its set value. The reduction ratio is set by the trim-potentiometer. Active state of this pin is "high".
J1-9 **J1-10**	− FAULT + FAULT	A fault condition or an active limit switch with the proper direction activates the FAULT output. + terminal is the collector, - terminal is the emitter of an n-p-n Darlington opto-isolator
J2-11 **J2-12**	/FDLIM /BKLIM	Forward Limit Switch, Backward limit Switch. The limit switch input inhibits a motion in the designated direction; motion in opposite direction is still possible. The FAULT output is activated when the motion is inhibited. For normal operation, these pins must be in the "high" state.

4. MAINS WIRING

The translator module TRANS-5 must be powered by the AC mains with a nominal voltage of 220 to 240 Volts. A fuse or a circuit breaker of maximum 6 A must be installed in front of the module.

In order to comply with the regulations concerning the radiated emissions, **a mains filter** must be installed in front of the translator. A common filter with sufficient current rating can be used for several translators, 2.5 to 3 Amp per translator will be sufficient. If the interference filter is installed more than 30 cm from the module, a shielded cable between the filter and the module will help reduce the radiated power. A ground clamp (see accessories, sect 2.1.) to earth the shield will produce an orderly wiring. A range of interference filters suitable for cabinet mounting is available from TIMONTA, distributed by ELBATEX AG, CH 5430 Wettingen.

Connect the mains at L, N, PE (pins 8, 9, 10 of the JPWR connector). "L" is the active lead, "N" the neutral and "PE" is the protective ground. The JPWR connector **must be screwed to the module** and disconnection is allowed only after switching the mains off **and waiting till the LED is completely off.**

Inobservance of this rule will result in dangerous voltages on the pins "DC OUT", "DC IN", "U,V,W".

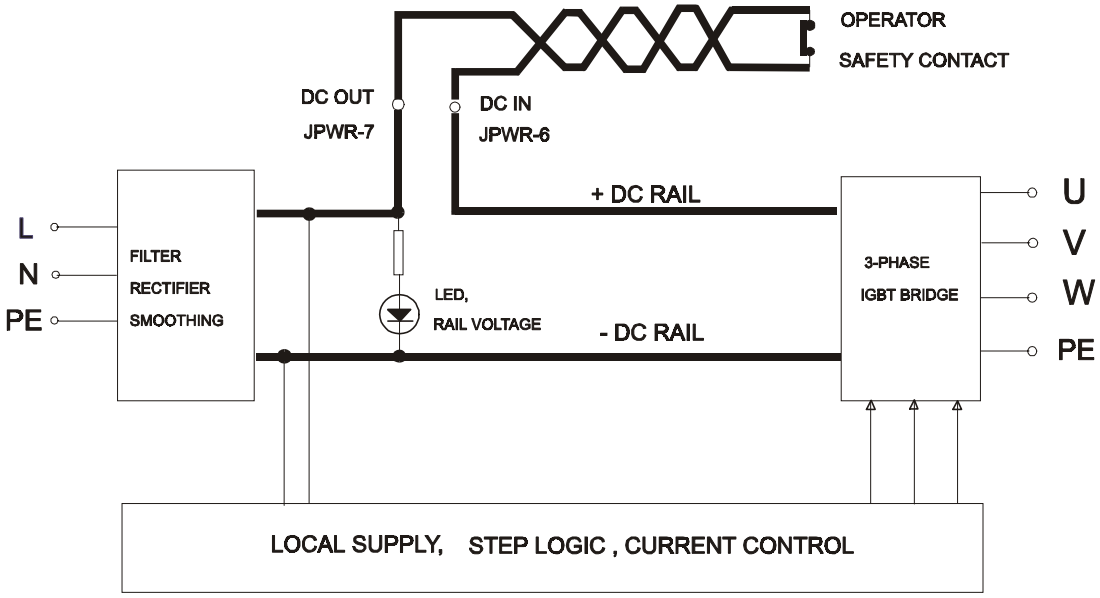


Figure 4: DC-Rail Arrangement

5. MACHINE OPERATOR SAFETY

If required by machine safety regulations, the supply of the motor bridge can be switched off while maintening the translator logic powered, i.e. while preserving the motor field position. A normally open contact of a forced operation relay is wired between "DC OUT" and "DC IN" (pins 7 and 6 of JPWR). This contact is opened by the machine safety logic whenever the operator has access to the moving parts. A separate contact is required for each TRANS-5 module. The length of the wiring to the safety contact must be kept as short as possible, (50 cm max.) and must be made of a drilled pair of wires to mimimize the loop inductance.

In the absence of safety considerations, DC OUT is simply strapped to DC IN.

6. MOTOR CONNECTION

Connect the TRANS-5 terminals U, V, W to the motor terminals 1, 2 ,3 respectively , if the motor is an original BERGER with screw terminals. Motors fitted by E.I.P. SA with the rotation check option have spring terminals labelled U, V, W. (WAGO spring terminal block). The ground lead, from the earth screw in the motor housing to JPWR/1, is mandatory for the safety.

Interchanging two motor wires is the natural way to select the direction of rotation. With the rotation check option, the wiring of the encoder has to be changed, see section 13.

The motor cable must be shielded to reduce the radiated emissions. The shield has to be connected to

the earthed cabinet and to the earthed motor. Inside the cabinet, the shield can be connected to the TRANS-5 using the accessories of section 2.1. If shielding inside the cabinet is not possible, keep the motor cable in a separate duct, at least 30 cm from other sensitive wiring.

7. COMMAND INPUTS

TRANS-5 accepts a large variety of command signals with the proper setting of the personality socket. The personality socket is accessed by removing the small cover at the right side of the module.

The command inputs and the limit switch inputs share a common ground at terminal J1/5. This terminal is the ground of the logic of the TRANS-5 module. It is isolated from the power part and may float +/- 60 V from the case potential. **The terminal J1/5 must be grounded (earthed) at the signal source.**

The **PULSE** and **DIR** inputs have RS422 line recievers as input circuits. Thus, they are designed for fast signals with the best possible noise rejection. Single ended signal sources are also accepted; the + terminal is used as the input and the - terminal, left unconnected, is biased internally at approx. 2.5 V.
Remember that the DIR input is "BACKWARD PULSE" with the B-version. The minimum pulse width depends upon the setting of the personality socket but **the pulse and/or the pause must be at least 1,5 μs in width.**

/RESET and **I-RED** use Schmitt-trigger input stages with a voltage divider. PULSE+, DIR+, RESET and I-RED have pull-up -or pull-down- resistors, which can be tied at 0, +5 or +15 V. /RESET is active when low. The width of /RESET in its active state (low voltage) must be **at least 20 μs**.
I-RED is active, i.e. the current is reduced, when tied high.

See the schematic " **3-PHASE LOGIC**, COMMAND INPUTS " for more information. The personality socket depicted in Figure 7 holds the components required to accept different signal sources. The resistors and the bridges to be plugged into the personality socket must be bent to 10 mm width and the wires must be 0.5 to 0.6 mm in diameter.

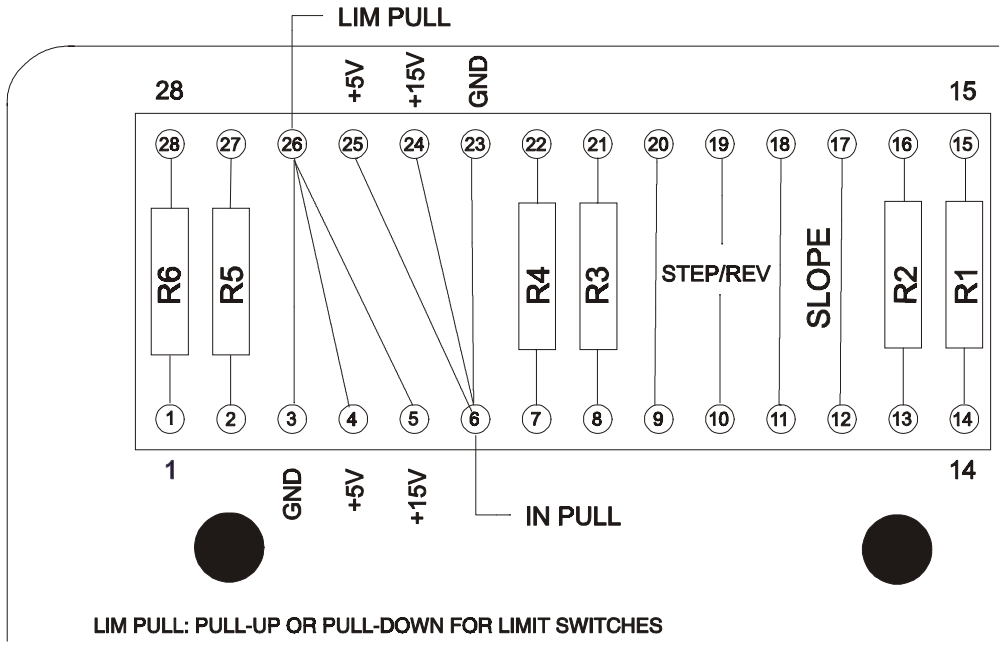


Figure 7: the Personality Socket

7.1. Line Driver as Signal Sources

RS 422 Line driver signal source applies to PULSE and DIR only. Make the wiring suggested by figure 7.1. On the personality socket, set R1 = R2 = 330 Ω. The potential at the IN PULL-line is irrelevant as the line driver will overdrive the pull-up.

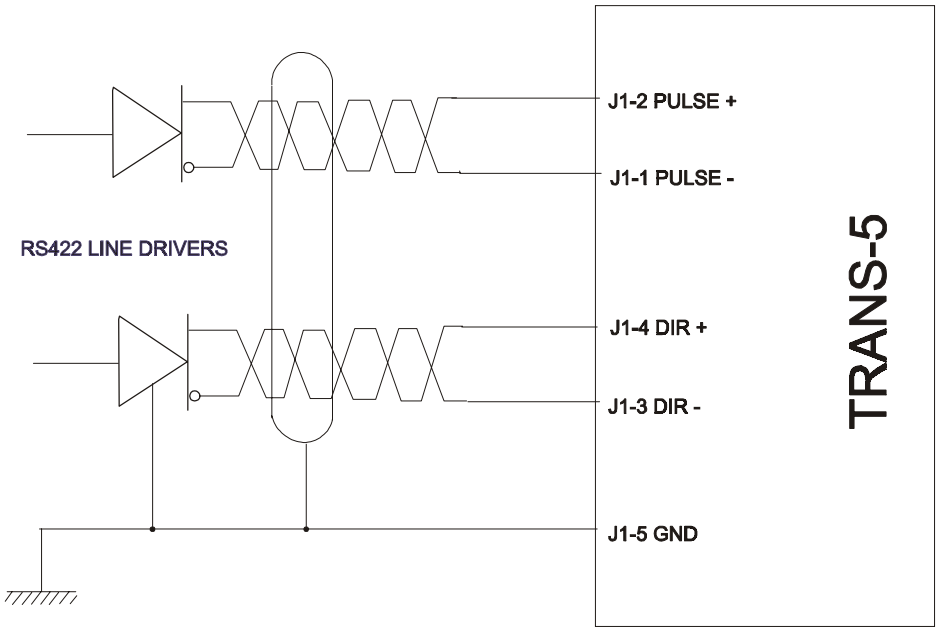


Figure 7.1: Line Drivers for PULSE and DIR

7.2. Sink Drivers as Signal Sources

Open-collector n-p-n transistors or Darlington are often encountered as signal sources. Make the connections as per Figure 7.2.

Personality socket: R1 = R2 = 3.3 kΩ,
R3 = R4 = 15 kΩ,
IN PULL at 15 V (jumper between pins 6 - 24)

The optional pull-up resistors in figure 7.2 may prove useful to avoid signal distorsion if the length of the signal lines exceeds 2 m. The current through these pull-up resistors must not exceed the drive capability of the transistor drivers.

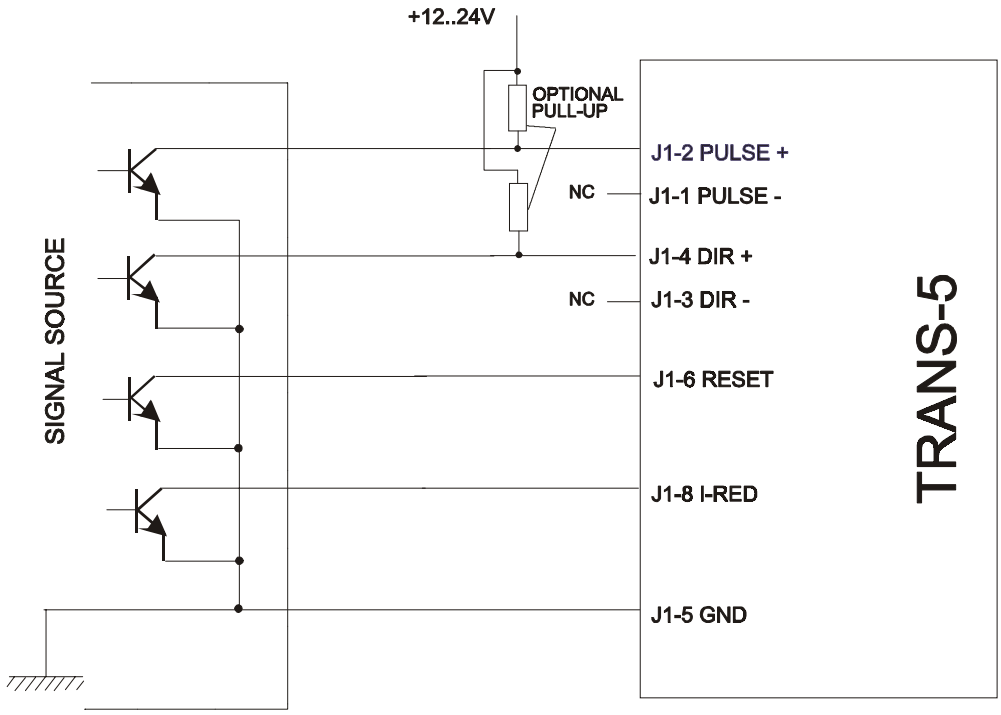


Figure 7.2: Sink Drivers as Signal Sources

7.3. Source Drivers as Signal Sources

Make the connections as per Figure 7.3. The optional pull-down resistors deserve the same function as above. The value of the serie resistors of the personality socket are dependant upon the value of the source voltage US.

Personality socket:

Source Voltage	US = 5 V	US = 12 V	US = 15 V	US = 24 V
R1, R2	330 Ω	4.7 kΩ	6.8 kΩ	12 kΩ
R3, R4	330 Ω	12 kΩ	18 kΩ	33 kΩ

IN PULL: Tied at 0V, jumper between pins 6 and 23.

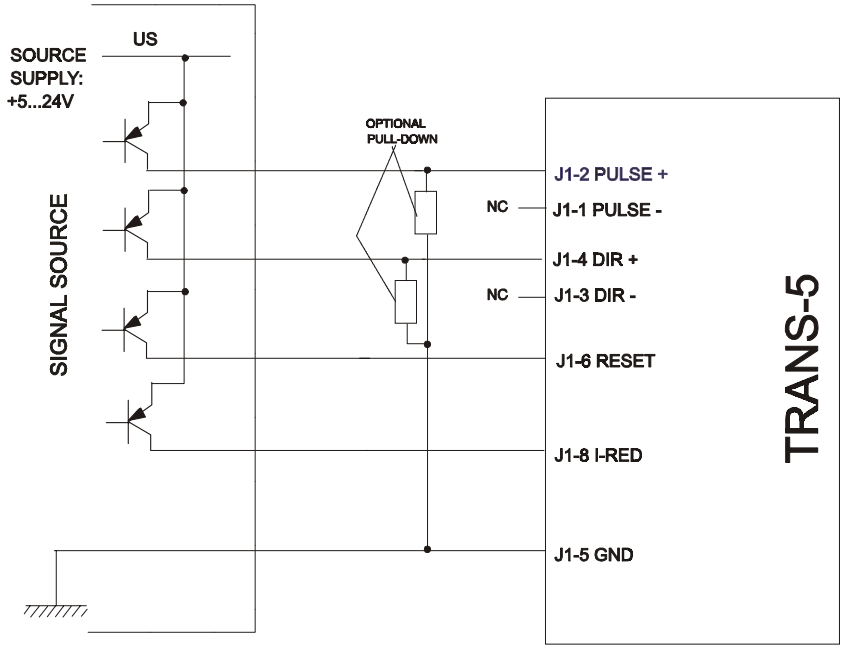


Figure 7.3: Source Drivers as Signal Sources

7.4. Totem Pole TTL Signal Sources

Make the connections as per Figure 7.4.

Personality socket: R1 = R2 = 330 Ω,
R3 = R4 = 330 Ω,
IN PULL at 5 V, jumper between pins 6 and 25.

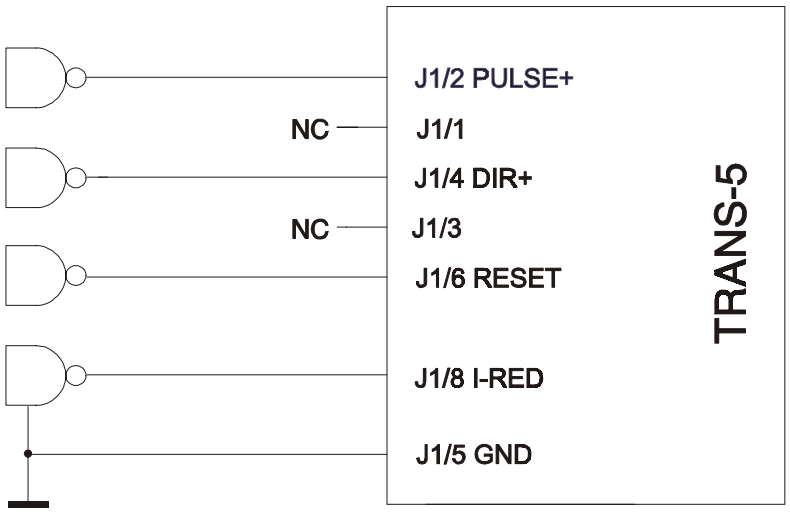


Figure 7.4: TTL as Signal Sources

7.5. Command Pulse Polarity

The active edge of the command pulse depends upon the "SLOPE"-jumper on the personality socket. The active edge must be selected according to the logic of the pulse source in order to avoid false counting at reversals. Figure 7.5.1 gives the timing diagram with the SLOPE-jumper removed, Figure 7.5.2 with the jumper on. Please notice that a set-up and a hold time of 1.5 to 2 μs are required to insure perfect counting.

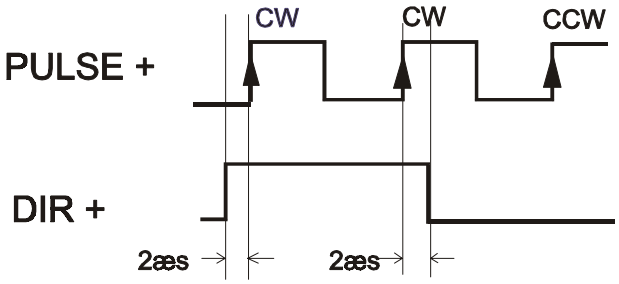


Figure 7.5.1: SLOPE-Jumper Removed

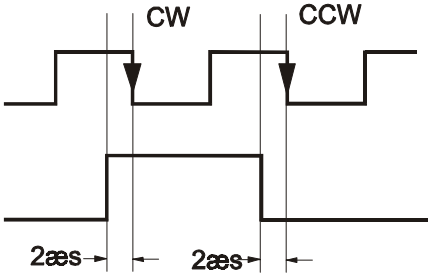


Figure 7.5.2: SLOPE-Jumper On

7.6. /RESET and I-RED

/RESET clears the fault conditions and defines a fixed stator field position. I-RED activates the current reduction set by the potentiometer. The current reduction is effective to get smooth motion, for example for grinding operations or to reduce the acoustical noise.

When /RESET and/or I-RED are not used and their input terminals are left unconnected, the function will be dependant upon the voltage at IN PULL, Figures 7.2 to 7.4. To make I-RED inactive, omit R4. /RESET, if unconnected, is inactive with IN PULL at a positive voltage; with IN PULL at GND, /RESET must be tied to a positive voltage, for example at pin 7.

8. LIMIT SWITCHES

/FDLIM and /BKLIM are direction dependant travel limit inputs. When a limit switch input is active, a step pulse in the designated direction shuts the current down and activates the FAULT output. Motion in the opposite direction is still possible and FAULT goes to zero when the slide is within the travel limits again.

The limit switch inputs are designed to accept normally closed switches or proximity detectors. The personality socket can be configured for switches with a common ground return, figure 8.1, or for switches with a common tied to a positive voltage, figure 8.2. The positive supply voltage can be derived from TRANS-5 at terminal J1/7, as in Fig. 8.2. or it can be supplied by an external source. See also the schematic "3-PHASE STEP LOGIC, LIMIT INPUTS".

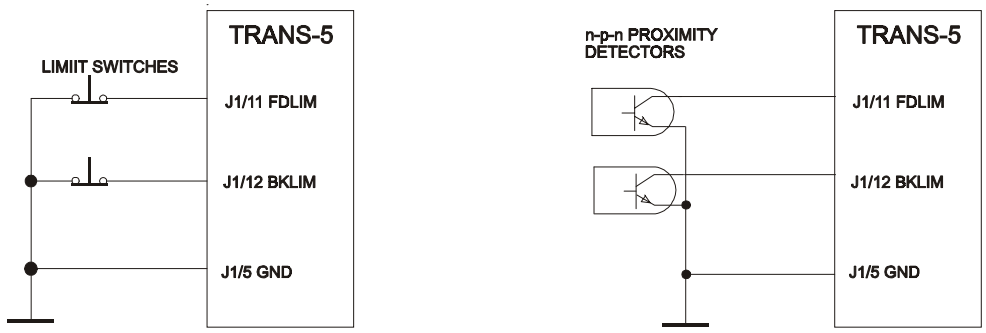


Figure 8.1. Ground Referenced Limit Switches

With ground referenced limit switches, figure 8.1., set the personality socket as follows:

R5 = R6 = 15 kΩ, LIM PULL at + 15 V (jumper 26 - 5)

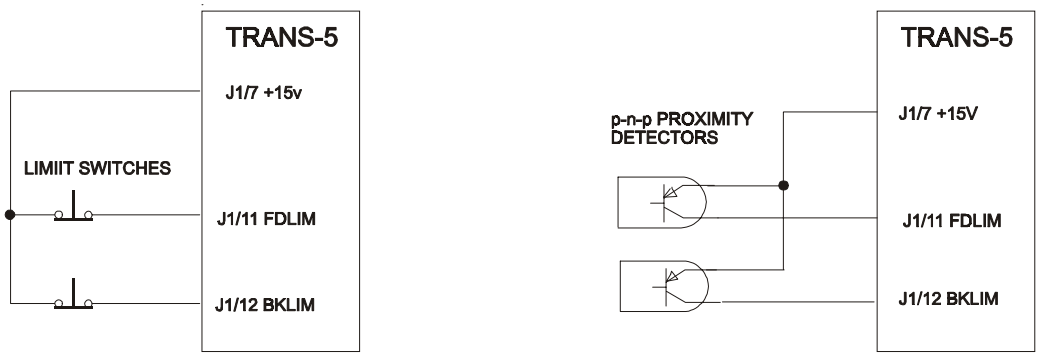


Figure 8.2. Limit Switches Returned to a Positive Voltage

With limit switches returned to a positive voltage, figure 8.2., the settings are:

R5 = R6 = 18 kΩ for 15 V, LIM PULL at GND (jumper 26 - 3)
R5 = R6 = 33 kΩ for 24 V, LIM PULL at GND (jumper 26 - 3)

When not used, the limit switch inputs must be tied to the proper voltage (either ground or +15V) according to the setting of the personality socket. Removing R5 and R6 from the personality socket and

setting the jumper at pins 26 - 5 is just another possibility to desactivate the limit switch inputs.

9. STEPS PER REVOLUTION

The number of steps per revolution is set by three wire jumpers at the personality socket, see the schematic "3-PHASE STEP LOGIC, LIMIT INPUTS".

JUMPER 9 -20	off	on	off	on	off	on	off	on
JUMPER 10 - 19	off	off	on	on	off	off	on	on
JUMPER 11 - 18	off	off	off	off	on	on	on	on
STEPS/REVOL.	6000	3000	1800	600	5000	2500	1000	500

Upon request, special numbers of steps per revolution can be made available, with a maximum of 6144 steps/revolution.

10. CURRENT SETTING and CURRENT REDUCTION

The RMS value of the sinusoidal winding current is set via 4 switches labelled "CURRENT". The switches are binary weighted and are set according to the table below. It is not advisable to run a motor at a current higher than its nominal value, but in many case, operation at lower current, even at 50 %, may be practical. The motor will run cool and quiet.

SWITCH 1 2 3 4	CURRENT A RMS NOMINAL	MOTOR
OFF OFF OFF OFF	0	
ON OFF OFF OFF	0.18	
OFF ON OFF OFF	0.37	
ON ON OFF OFF	0.55	
OFF OFF ON OFF	0.73	
ON OFF ON OFF	0.92	
OFF ON ON OFF	1.10	
ON ON ON OFF	1.28	
OFF OFF OFF ON	1.47	
ON OFF OFF ON	1.65	
OFF ON OFF ON	1.83	VRDM 397/50 LW
ON ON OFF ON	2.02	VRDM 3910/50 LW
OFF OFF ON ON	2.2	
ON OFF ON ON	2.38	VRDM 3913/50 LW
OFF ON ON ON	2.57	
ON ON ON ON	2.75	

10.1. Current Economy

If the switch #5 -labelled ECONOMY- is ON, the winding current is reduced to about 60 % of its set

value when the step frequency approches zero. At step frequency below a few Hertz, the current rises to the set value at each pulse for about 200 ms. This function should be used whenever the full holding torque is not required at rest.

10.2. Current Reduction

The trim-potentiometer set the percentage of current reduction when the "I RED" input is energized. Turning the pot full CW gives a reduction of 25 %, full CCW gives a reduction of 50 %. If this function is not used, refer to section 7.6.

11. PROTECTIVE CIRCUITS, LED INDICATORS and FAULT CONDITIONS

The under-voltage, over-voltage and over-temperature conditions are signalled by the LED "VOLT/TEMP". An over-volt may happen during regenerative braking of large inertial loads. The braking circuit option may be advisable, see section 14. The over-temperature fault goes on when the temperature of the mounting plate is about 75 ◦C. During a voltage or a temperature fault, the status of the system is sampled every 2 seconds and the fault conditions eventually resets.

The over-current detector is tripped by any short circuit condition in the motor leads or by a defective current control inside the module. This fault is latched and lights the "CURRENT" LED.

The fault conditions above shut the current down and turn the FAULT output on. The FAULT output is an uncommitted Darlington opto-isolator; it can directly drive a small relay or, whith a suitable load resistor, it can be configured to drive the input of a controller either as a source or sink driver, see Figure 11 for some examples. Maximum applied voltage J1/10 to J1/9: 35 V, maximum current: 30 mA.

The RESET input clears the fault latches. The motor current is held at zero when RESET is active.

The fault latch can also be resetted by switching the primary power off and on again.

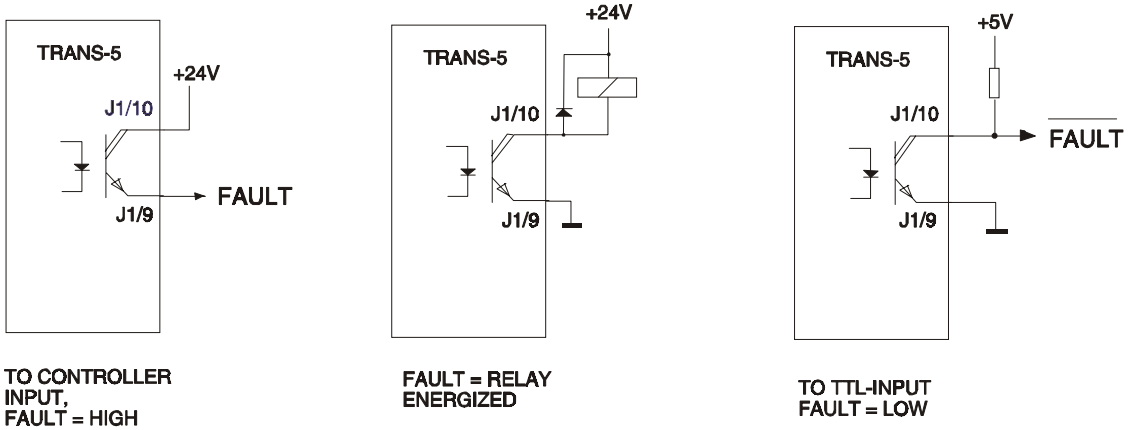


Figure 11. Using the FAULT Output

12. MOUNTING, COOLING and HEAT SINK HINTS

The TRANS-5 driver must be mounted vertically. A least 50 mm of free space must be allocated over and under the module to allow air circulation. The mounting requires two M5-tapped holes 175 mm apart, see the dimensional sketch.

When installing TRANS-5 modules on a cooling wall, take care to have a good thermal contact: the monting surface must be plane and burr free, the screws must be firmely tightened. Contact grease is not necessary.

The cooling requirements strongly depend upon the current and the duty cycle. With the dissipator, accessory ACC-10, forced air cooling is not necessary up to a cabinet temperature of 45 °C.

A measurement of the resulting temperature in real operating conditions is always mandatory to check the margin.

13. USING THE ROTATION CHECK (Option)

To use the Rotation Check option, the motor must be fitted with an optical encoder. Make the wiring according to Figure 13.1 or 13.2. A shielded cable is mandatory, cross section of the individual leads: 0.2 mm2 up to 15 m, 0.5 mm2 up to 30 m.

To connect the cable into the encoder housing, remove the plastic cover and use a #0-screw driver to open the terminal springs (WAGO spring terminal block). Be sure to replace the plastic cover as this cover is essential to get a safe separation between the power and the logic circuits.

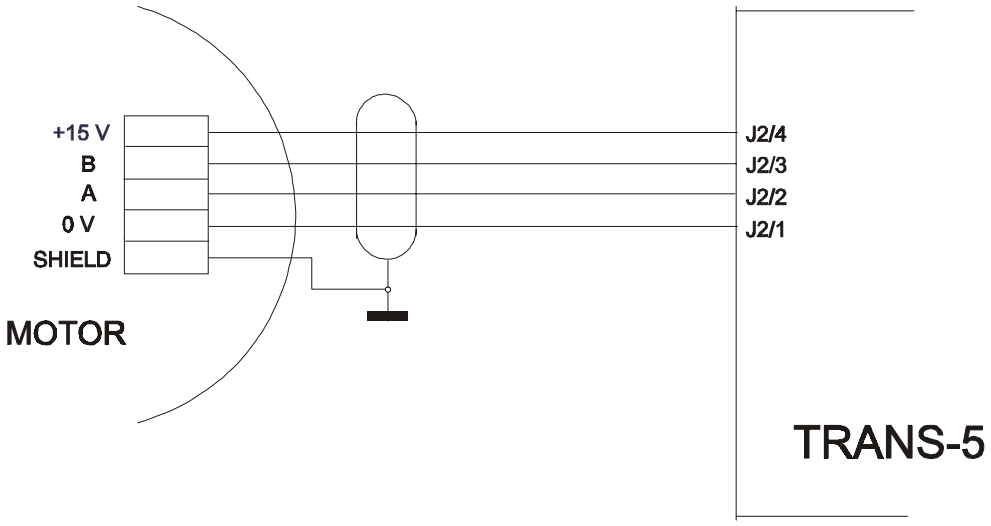


Figure 13.1: Encoder Wiring, CCW Rotation

15. DIMENSIONAL SKETCHES

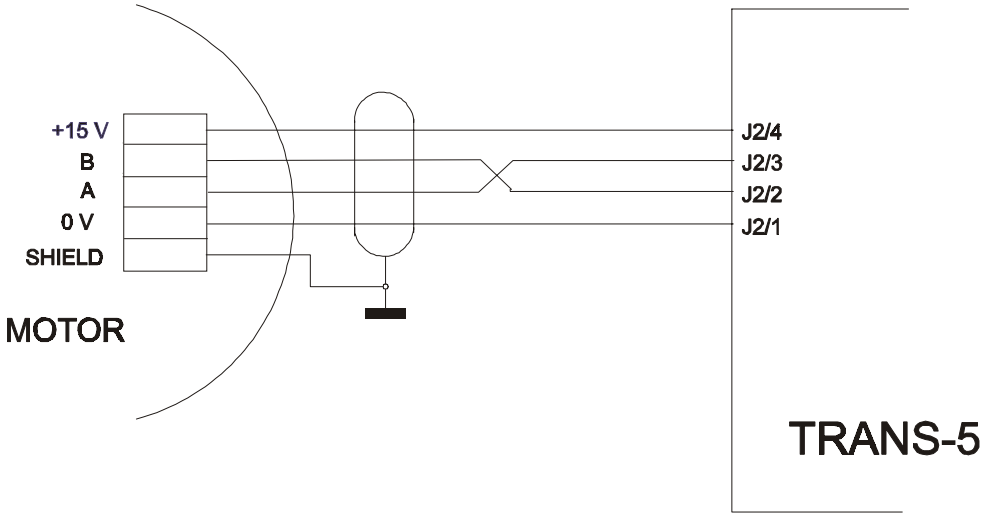


Figure 13.2: Encoder Wiring, CW Rotation

The rotation check circuit continuously monitors the command pulses and the rotor position. A discrepancy of 15 ◦ lights the LED "ROT.ERR" and energizes the FAULT output. A rotation error **does not suppress the motor current**; the host controller has to take the appropriate action. A rotation fault can be reset by the RESET input.

If the rotation check has to be disabled, especially during the trial runs, simply set the switch #6 - ROT.ERR" off. (The logic monitors the rotation even if switch #6 is off; thus, it may be advisable to make a reset or a cold start before switching ROT.ERR on again.)

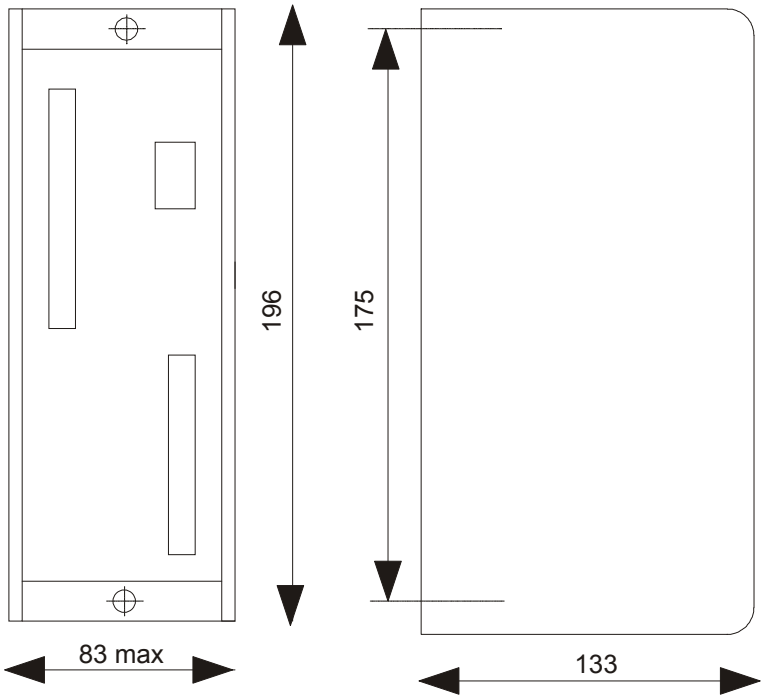
14. BRAKING CIRCUIT (Option)

A TRANS-5 with the Braking option will be able to dissipate 25 W (mean value) of regenerative energy into its internal resistor. A multiple of this value can be handled by an external resistor.

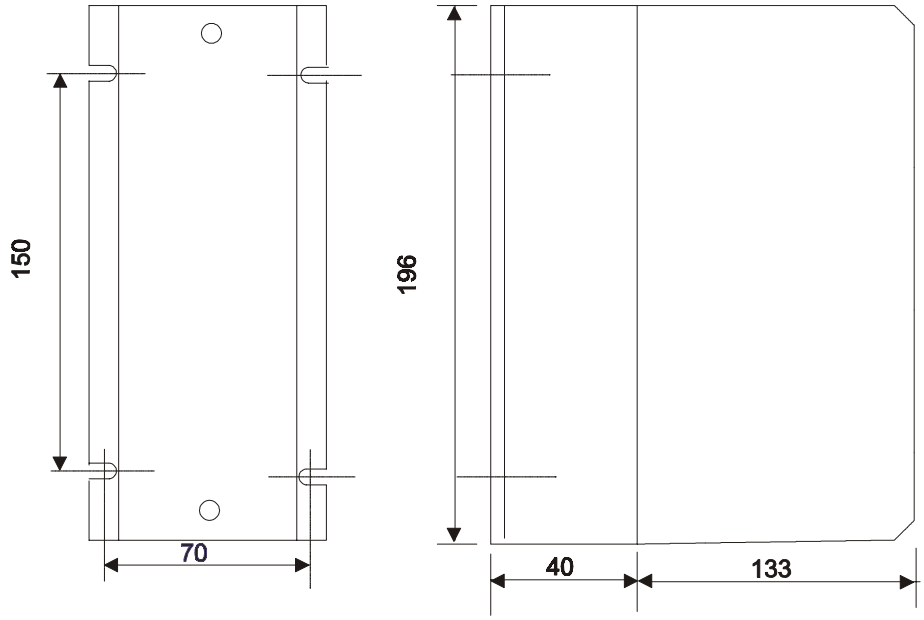
The braking option is required when the over-voltage fault occurs during the slow-down. Large inertial loads or vertical axes with reversible transmission are situations where the bracking option is required. The bracking power must be taken into account while estimating the cooling requirements.

Please ask E.I.P.SA when accute bracking problems are encountered.

15. DIMENSIONAL SKETCHES



TRANS-5:
DIMENSIONS



DISSIPATOR, ACC-10