

dunkermotoren

Instruction Manual

4-Quadrant Motor Controller

BGE 4015 + BGE 4015A

Item No. 4979757065

Please read this instruction manual thoroughly before
operating the motor controller!

Issue 11/93

1) General Description

The BGE 4015 is an analogue 4-quadrant motor controller designed for use with brushless DC motors type BG43, BG63 and BG83.

The controller consists of two circuit boards separated by spacers. The upper circuit board is constructed using SMT technology and contains the signal processing circuitry. The lower board contains the power devices.

The controller contains all the necessary components to control, commutate and drive a BG motor. The circuitry includes:

- determination of the exact motor speed
- internal or external pre-setting of the motor speed
- speed regulation with parallel current regulator
- 15V and 5V power supplies for the Hall sensors and a rotary encoder
- rotor position detection by quadrature evaluation from the Hall sensors
- power output stages for the 4 motor connections
- electronic ballast during braking

The upper regulator board contains a 30-pole unpluggable screw connector for the external signal connections.

The lower power section board contains screw terminals L1...L7 for the motor, power supply, and optional external ballast resistor.

Before operation, the various available modes of operation can be chosen by means of the selector switches U1...U12 on the upper regulator board. Each selector switch has two positions, which will be referred to as the left or the right position.

For each mode of operation, trimmers TR1...TR10 can be adjusted to achieve the desired regulation characteristics.

The BGE4015 requires a simple unstabilised 20V...50V DC power supply, with a residual ripple of $\leq 5\%$.

A simple regulator with limited dynamic characteristics (e.g. limited range, limited dynamics, relatively large overshoot with changes in input) can be realised without the use of a rotary encoder, by using the Hall sensor signals (operating mode A1).

In the case of increased dynamics and control range demands, a 2 channel rotary encoder (e.g. RE30/500 impulse or RE56/1000impulse) must be fitted (operating mode A2).

The most exact control of the dynamic characteristics can be obtained by fitting an analogue DC tachogenerator (e.g. TG52 with 10V/1000 rpm) (operating mode A3). The use of a DC tachogenerator is especially recommended for regulation at speeds of less than 50 rpm, or when a zero speed holding moment is required.

OPERATION INSTRUCTION BGE4015 (Nov.1993)

Mode of operation A1: Speed control with Hallsensors, without incremental encoder RE30/RE56

-For motor speeds exceeding $n=500U/\text{min}$

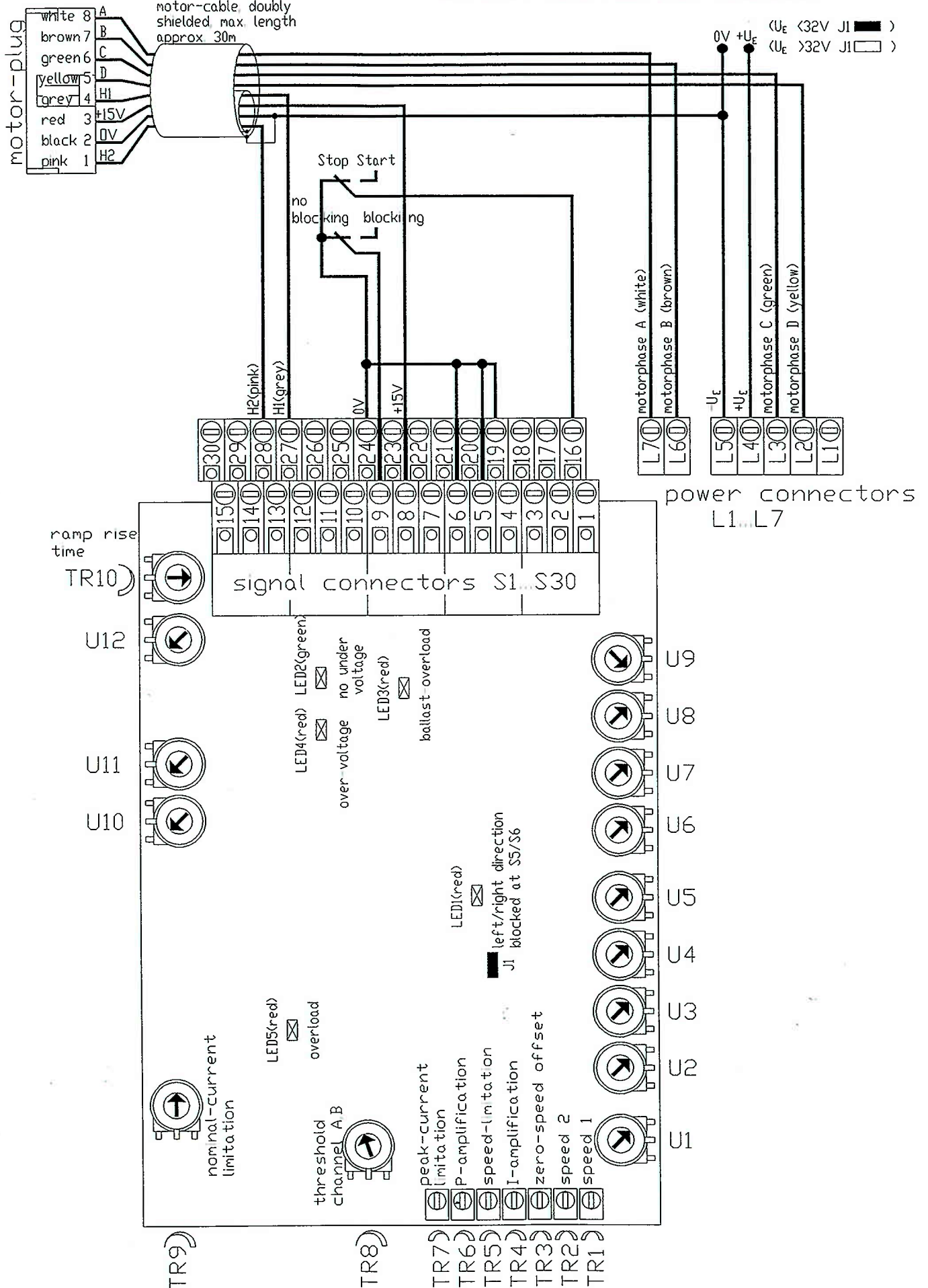
Setting of U1...U12:

- put changeovers U2, U3, U4, U8, U11 to the right (speed control with hallsensors)
- put changeovers U5 & U6 to the right (internal impulse multiplication *4)
- put U1, U7, U9, U10, U12 according to desired mode of use (see page 5).
in the figure on the next page, the following mode of use is set as an example:
 - speed is set internally using TR1 (U1 on right position, S18 is left open)
 - threshold level for the Hallsignals is set using TR8 (U7 on right position). For optimum performance turn TR8 on the "11 o'clock"-position (appr. 6V threshold voltage)
 - speed ramp is switched off (U9 on left position)
 - internal peak current limitation using TR7 (U10 on right position)
 - internal ballast circuit active (U12 on right position)
- when the supply voltage U_e exceeds +32V, pull short circuit plug J1 (near U4, see picture on the right hand)

Setting TR1...TR10:

- For internal speed control using TR1 (S18 n.c.) or TR2 (S18=0V) don't put TR1 or TR2 to the middle position (zero speed)! Only speeds $>500\text{rpm}$ are possible!
- set TR3 to approx. middle position
- turn TR4 about 7 full turns clockwise starting from the left end position (speed control with Hall-sensors requires a high I-amplification)
- TR5 is only active using external speed control. When TR5 is set to left end position, the full speed range is available.
- turn TR6 about 5 full turns clockwise starting from the from the left end position.
- set TR7 to approx. middle position, only when higher peak currents are necessary, TR7 can be turned more to the right. -TR8 should be put to about "11 o'clock-position". -TR9 should be set to the nominal current of the motor (see In on the motor label)
- TR10 is only active, if the internal ramp generator is active (U9 on the right).

Mode of operation A1: speed control with Hall-sensors, without incremental-encoder



OPERATION INSTRUCTION BGE 4015 (Nov. 1993)

Mode of operation A2: Speed control with incremental encoder RE30 or RE56

- For motor speeds exceeding $n=500/\text{min}$

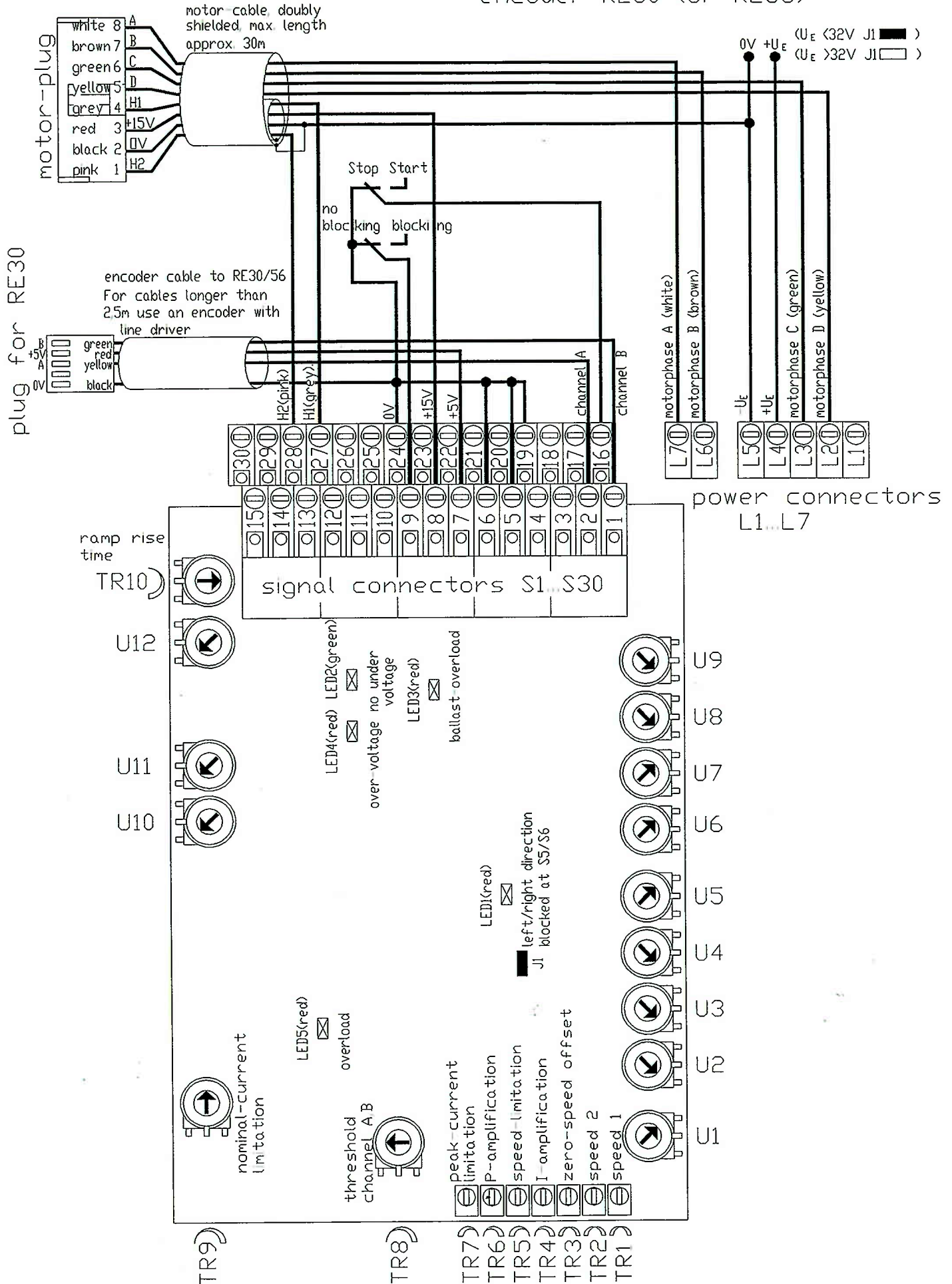
Setting of U1...U12:

- put changeovers U2, U3, U4, U8 to the left (speed control with incremental encoder)
- put U11 to the right (speed control with incremental encoder)
- put changeovers U5 & U6 to the right using an RE30 (internal impulse multiplication *4), put U5 to the left and U6 to the right using an RE56
- put U1, U7, U9, U10, U12 according to desired mode of use (see page 5).
In the figure on the next page, the following mode of use is set as an example:
- speed is set internally using TR1 (U1 on right position, S18 is left open)
- threshold level for the encoder signals is set using TR8 (U7 on right position). For optimum performance turn TR8 on the "9 o'clock-position" (approx. 2,5V threshold voltage)
- speed ramp is switched off (U9 on left position)
- internal peak current limitation using TR7 (U10 on right position)
- internal ballast circuit active (U12 on right position)
- when the supply voltage U_e exceeds +32V, pull short circuit plug J1 (near U4, see picture on the right hand)

Setting TR1...TR10:

- For internal speed control use TR1 (S18 n.c.) or TR2 (S18-0V).
- set TR3 to approx. middle position
- turn TR4 about 3 full turns clockwise starting from the left end position (speed control with encoder RE30 requires a small I-amplification)
- TR5 is only active using external speed control. When TR5 is set to left end position, the full speed range is available
- turn TR6 about 7 full turns clockwise starting from the left end position.
- set TR7 to approx. middle position, only if higher peak currents are necessary, TR7 can be turned more to the right
- TR8 should be put to about "9 o'clock-position". When using a line-driver with the RE30/RE56, set TR8 to the middle of the encoder signals (e.g. set TR8 to 12V using a 24V line driver)
- TR9 should be set to the nominal current of the motor (see in In on the rotor label)
- TR10 is only active, if the internal ramp generator is active (U9 on the right).

Mode of operation A2: speed control with incremental encoder RE30 (or RE56)



OPERATION INSTRUCTION BGE 4015 (Nov. 1993)

Mode of operation A3: Speed control with DC-tacho TG52.

- For motor speeds exceeding $n=200/\text{min}$

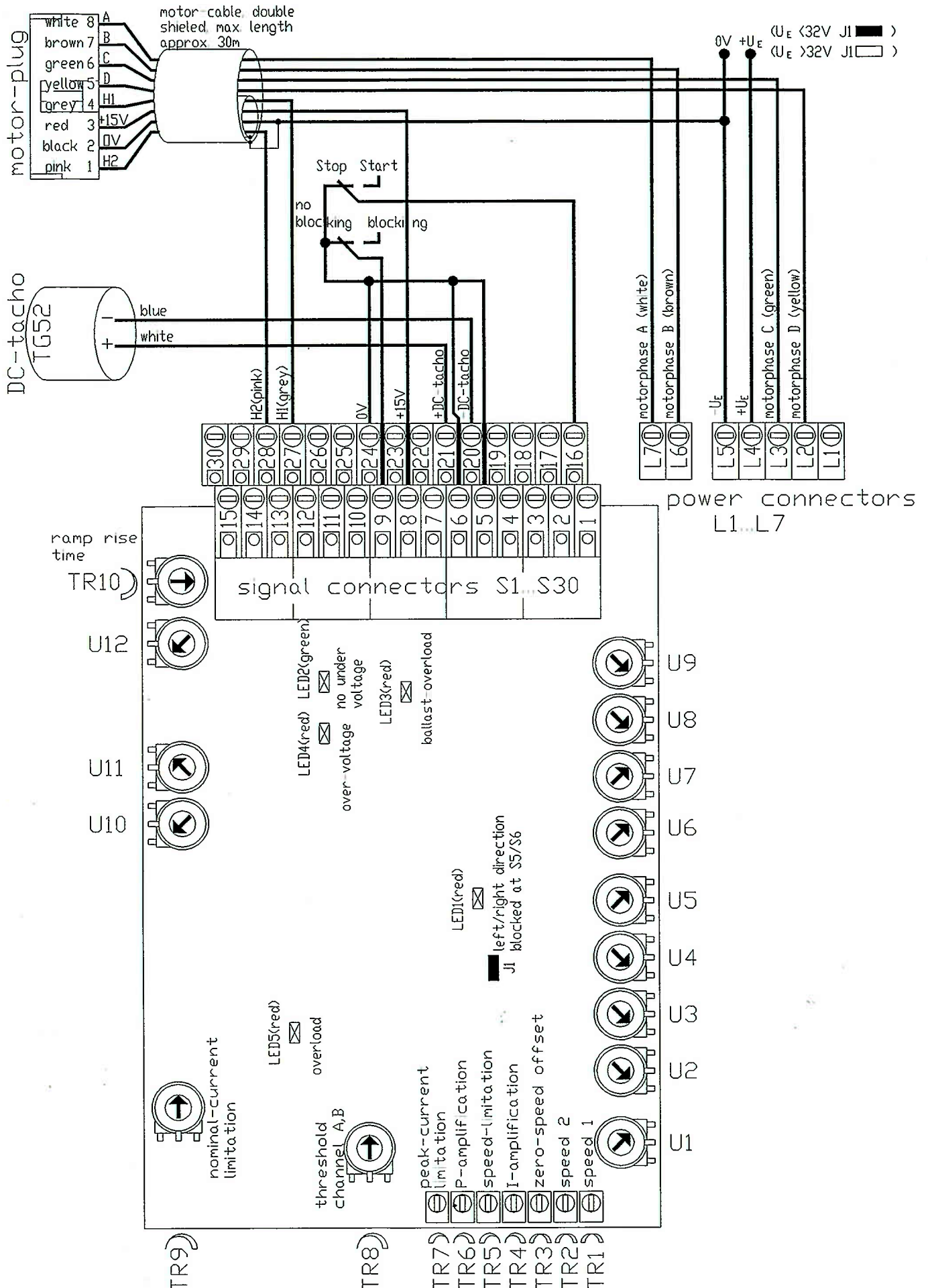
Setting of U1...U12:

- put U11 to the left (speed control with DC-tacho TG52), the position of the changeovers U2, U3, U4, U5, U6, U7, U8 does not matter.
- put U1, U9, U10, U12 according to desired mode of use (see page 5). In the figure on the next page, the following mode of use is set as an example:
- speed is set internally using TR1 (U1 on right position, S18 is left open)
- speed ramp is switched off (U9 on left position)
- internal peak current limitation using TR7 (U10 on right position)
- internal ballast circuit active (U12 on right position)
- when the supply voltage U_e exceeds +32V, pull short circuit plug J1 (near U4, see picture on the right hand)

Setting TR1...TR10:

- For internal speed control use TR1 (S18n.c.) or TR2 (S18=0V).
- set TR3 to approx. middle position
- turn TR4 about 2 full turns clockwise starting from the left end position (speed control with DC-tacho requires a small I-amplification)
- TR5 is only active using external speed control. When TR5 is set to left end position, the full speed range is available
- turn TR6 about 5 full turns clockwise starting from the left end position.
- set TR7 to approx. middle position, only if higher peak currents are necessary, TR7 can be turned more to the right.
- TR8 is not active in this mode of use.
- TR9 should be set to the nominal current of the motor (see in I_n on the motor label)
- TR10 is only active, if the internal ramp generator is active (U9 on the right).

Mode of operation A3: speed control with DC-tacho TG52



OPERATION INSTRUCTIONS BGE 4015

Signal connectors S1 ... S30

Pin Connection mark

S1 Incremental encoder channel B, input
S2 Incremental encoder channel A, input
S3 Switching level for channel B, input (0-15 V)
S4 Switching level for channel A, input (0-15 V)
S5 Blocking for sense of rotation 1, input (switch contact at 0V)
 (at S5 = 0V: no blocking, at S5 = open: blocking)

Connection proposal for S5:

S6 blocking for sense of rotation 2nd input (switch contact)
 (at S6 = 0V: no blocking, at S6 = open: blocking)

S7 + 5 V - supply for incremental encoder (approx. 100 mA maximum current)
S8 + 15 V - supply for hall sensor encoder (approx. 100 mA maximum current)
S9 regulator - unblocking/blocking input (switch contact)
 (at S9 = 0V unblocking at S9 open blocking)

Connection proposal for S9 see S5.

S10 external supply of control voltage, 24 V, input, optional for better
 efficiency and to minimize interference-induced errors, in particular
 at $U_E > 32$ V (at external 24-V-supply, disconnect jumper near to C2 on
 the card).

S11 fault signal "overvoltage", open-collector-output, low-active (at S11 =
 "low" overvoltage, at S11 = "high" no overvoltage)

Connection proposal for S12 see S11:

S12 status signal "no undervoltage", open-collector-output low-active (at
 S11 = "low" no undervoltage, at S11 = "high" undervoltage), connection
 proposal S12, see S11.

S13 fault signal "continuous overload (I_{xT} - or overtemperature limitation
 active)", open-collector-output, low-active (at S13="low" overload, at
 S13 "high" no overload) connection proposal for S13 see S11.

S14 fault signal "internal ballast resistor is overloaded", open-collector-
 output, low active (at S14 = "low" overloaded, at S14 = "high" not
 overloaded).

Connection proposal for S14 see S11.

- S15 limitation of peak current with external signal, input for U_{1max}
(0V...10V, 10V = 25A).
- S16 Start/stop-input (switch contact to 0V)
(at S16 = 0V: stop, at S16 = open: start)

connection proposal for S16 see S5.
- S17 throw-over-switch for sense of rotation, input (switch contact to 0V)
(at S17 = 0V sense of rotation 1, at S17 open sense of rotation 2)

connection proposal for S17 see S5.
- S18 throw-over switch for nominal value of speed 1/2, input (switch contact to 0V)
(at S18 = 0V nominal value trimmer TR2 active, at S18 open nominal value trimmer TR1 active)

connection proposal for S18 see S5.
- S19 nominal speed-regulator I-characteristic on/off, input (switch contact to 0V)
(at S19 = 0V I-characteristic on, at S19 open I-characteristic off)

connection proposal for S19 see S5.
- S20 DC-tacho-input (at TG 52, strand blue)
- S21 DC-tacho-input (at TG 52, strand white)
- S22 motor speed external, difference input 1
- S23 motor speed external, difference input 2
(input voltage between S22 and S23: -10...+10V)
- S24 0V, (reference voltage)
- S25 on/off-signal for optional external ballast switch, output (at S25 = 0V, on, at S25 = 15V off)
- S26 status signal "motor is rotating" ($n > 1200$ /min) open-collector-output, low-active (at S26-"low" rotates, at S26 - "high" (does not rotate)
switching proposal for S26 see S11
- S27 hall sensor 1, input
- S28 hall sensor 2, output
- S29 open-collector-output-for chanel A (incremental encodermode)
-for hall signal 1

connection proposal for S26 see S11.

S30 open-collector-output for chanel B (incremental encoder mode)
for hall signal 2 at hall

connection proposal for S26 see S11.

Power connectors L1 ... L7

Pin	name of connection
L1	Option external ballast resistor R_{Bext} (connection between L1 and L4).
L2	Motor phase D (strand yellow when using Dunker motor cable).
L3	Motor phase C (strand green when using Dunker motor cable).
L4	+ U_E = 24 V...50 V (plus pole of supply voltage)
L5	0V (minus pole of supply voltage)
L6	Motor phase B (strand brown when using Dunker motor cable).
L7	Motor phase A (strand white when using Dunker motor cable).

Changeovers U1 ... U12

U1	U1 left position U1 right position	: motor speed set externally by S22 & S23 : nominal value internal by TR1/TR2
U2	U2 left position U2 right position	: speed control with incremental encoder : speed control with hall sensors
U3	U3 left position U3 right position	: speed control with incremental encoder : speed control with hall sensors
U4	U4 left position U4 right position	: speed control with incremental encoder : speed control with hall sensors
U5/U6	internal impulse multiplication for higher resolution	
	U5 left position & U6 left position	*0,5 resolution
	U5 right position & U6 left position	*1
	U5 left position & U6 right position	*2
	U5 right position & U6 right position	*4
U7	internal/external voltage setting for the switching level of both feedback channels	
	U7 left position channels	: level externally set by S3 and S4 for both
	U7 right position	: level externally set by TR8.
U8	U8 left position U8 right position	: speed control with incremental encoder : speed control with hall sensors
U9	U9 left position U9 right position	: speed ramp switched off : speed ramp switched on
U10	U10 left position U10 right position	: external peak current limitation by S15 : internal peak current limitation by TR7
U11	U11 left position U11 right position	: DC-tacho TG 52 as speed encoder : incremental encoder or hall sensors as speed encoder.
U12	U12 left position U12 right position	: external ballast switch : internal ballast switch

The trimmers TR1 ... TR10

TR1	speed value 1
TR2	speed value 2
TR3	speed control offset
TR4	speed control 1 (integral amplification of PI-control)
TR5	limitation of max. speed, only active when speed value is set externally using S22 and S23 (U1 at left position).
TR6	speed control (proportional amplification of PI-control)
TR7	limitation of peak current (0...25 A)
TR8	voltage setting for switching level of both feedback channels (1...15V) (usually set at approx. 2,5 V)
TR9	limitation of nominal current (0...approx. 18A)
TR10	ramp time constant (50 ms ... 2,5 s)