

Assembly Information
Stepper Motor Card >HP-Step<
Rev. 1.5b (last updated 27.12.2005)

Functional Description

HP-Step is a 1 channel stepping motor driver board that can drive step motors with a rating of up to 4 amperes in full, half, 1/4th and 1/8th step modes. To achieve this, an AVR microcontroller is used, which generates the set values for the current regulator via an external D/A converter. After power up the controller waits 2 seconds, to allow the power supply to reach a stable level, before the power amplifiers are switched on. At this point, the motor is driven by only 25% of the nominal current. After an additional 2 seconds the full power is switched on, so that the power supply is not overloaded when multiple outputs are switched on. To protect the amplifiers, a self resetting short circuit guard is integrated that also displays any faults with LEDs.

Exclusion of Liability, EMC (electromagnetic compatibility)

All parts of the circuit were carefully checked and tested. I still can't guarantee that everything will work. I especially take no responsibility for any damages caused by reproduction, reverse engineering or initial operation of the here described circuits.

The stepping motor power amplifier "HP-Step" is an OEM product made for use in industry, electronic trade and other EMC experienced sectors. According to EMVG §5, section 5 this product does not require CE qualification.

Cabling, used amplifiers, power supply and the surrounding environment are factors that influence the EMC properties of a device. A device using one or more step motor power amplifiers must of course be evaluated according to corresponding directives, when CE conformity must be documented. During development all possible means were used to conform to EMC regulations.

Fitting with Components

- Start with the small components (resistors, diodes, capacitors, ...)
- Be careful to assemble with correct polarity (diodes, electrolytic capacitors, resistor arrays, ...)
- The ICs should be mounted on sockets as a precaution. (Exception: L6203 !)
- The heat sink (type V6717Z, or SK96/84 -> only 84 mm wide) has fitted threads. Before soldering in the L6203, screw the heat sink onto the board, then align the ICs and screw them into the heat sink and finally solder the ICs to the board. For later corrections or tests, the heat sink can be removed.
- Before final mounting of the heat sink it is recommended to apply a thin(!) layer of heat conducting paste to the ICs, to promote heat dissipation.
- For motor voltages greater than 30V, replace R9 and R19 with 470 Ohm resistors.
- In use, depending on the environment, it may be necessary to use an additional fan for cooling. If the casing is already well ventilated, it may not be necessary to use an additional fan, if the board is mounted in the air-stream.

Initial Operation

Before first use, the assembly and all solder points should be carefully checked! Are all ICs mounted in the correct direction? All cables on CON1 and the solder points at the L6203 should be checked for short circuits.

The potentiometers and jumpers should be set to the default values as indicated in the assembly plan.

Start with only the 5V logic supply - without applying power to the motors or connecting the board to the PC.

Set the reference voltage for the Motor current with the R12 trimmer. The voltage can be measured between pin 2 of the TLC 5620 and Ground (pin 1). The measured voltage $V(\text{ref})$ depends on the motor current in the following way:

$V(\text{ref}) = I(\text{Motor}) * R(\text{sense})$ equals the set value for the line current.

$R(\text{sense})$ is the corresponding sense resistor (0,22 Ohm). For 3A, 0,66 Volt are to be set accordingly.

At Pin 3 of the L6506 the frequency of the current chopper can be measured. Be careful not to create a short circuit, when measuring! The default value (16-17kHz) can be modified, when problems are encountered with noise levels by changing the resistor R24. CAUTION: The higher the frequency, the greater the switching losses are at the power amplifying ICs!

When all of this has been tested and verified, the board can be tested with a motor. To do this, connect the board to the PC or microcontroller board. Always start up the PC first and then connect the power supply for the board! During boot up the power levels of some signal levels can change, that can cause undesired reactions. For tests a free demo (for example PCNC) or a small self written program is recommended.

If possible, start by applying a small voltage to the motor (15-20V), from a current limiting power supply.

Settings for Step divider

Jumper	JP1	JP0
Full steps	open	open
Half steps	open	closed
1/4 Steps	closed	open
1/8 Steps	closed	closed

Note: After applying changes the microcontroller must to be reset.

External Connections

- The motor is connected to the screw connectors X2 (1. Coil) and X3 (2. Coil). Alternatively a 9-pin D-SUB connector can be used. The rotational direction of the motor can be changed by reversing the polarity of one coil.

Center pins of unipolar motors (with 5 or 6 pins) are not connected. The pins must be insulated and may not be connected to the positive supply or ground in any case!

Bipolar motors with 8 pins provide the possibility to connect two coil pairs in series or in parallel. In series will always work. Connecting the coils in parallel may allow faster revolutions, however the current is doubled as well (in comparison with the serial setup). The coil resistance is halved in this case and the coil resistance should not be below 0,4 Ohms.

- The PROG connector is used to reprogram the firmware of the microcontroller. The free tool "Ponyprog" is available at <http://www.LancOS.com> and is compatible to the AVR - ISP Programming Board.

- To connect the board to the PC an interface board with a separate connection for Endpoint- and Emergency-Off-Switches is available. Alternatively an adapter cable can be used.

- The Emergency-Off signal must be connected over a switch (N.O. contact) to ground. When

the board detects a fault (for example a short circuit) the signal is pulled to ground, to signal a fault to the PC, therefor the pin may not be connected directly to +5V.

Pinout of CON1 (NCS-BUS)

1	not connected (n.c.)
2	/Clock (Clock signal, falling edge generates a step)
3	not connected (n.c.)
4	/CCW (rotational direction, counterclockwise at low-level)
5	/Emergency Off (at low-level)
6	/Sleep (current reduction to 25% of the nominal current at low-level)
7,8	VCC (+5 Volts)
9,10	Ground

Meaning of Buttons and LEDs

POWER: Turns on as soon as 5 Volts are applied to CON1

SIGNAL: Is on during the softstart phase and in use, at every 4th full step position (home position).

SHORT1&2: Light up at a short circuit at the corresponding driver.

The buttons START, +/CW and -/CCW are not used in the standard firmware. They are meant for use with self programmed extensions (i.e.: indexer, tracing, ...). RESET restarts the controller.

Power Reduction (Sleepmode)

There are 3 different power reduction modes.

- No power reduction: Leave /Sleep pin open or connected to VCC.

- Automatic Power Reduction: /Sleep is connected to ground. (not recommended for multiple axis configurations) 1-2 seconds after the last Clock signal, the current is reduced to 25%. At the next clock signal the circuit switches back to the nominal current.

- Power Reduction by Software: /Sleep input is set by software. /Sleep is pulled to ground by the PC software when all axis are idling (in multiple axis use). The power reduction is activated after a maximum of 1 sec. (or 2 seconds after the last clock signal). When using PCNC, set Power Reduction to "Inverted".

Hints for Troubleshooting

- If any part of the circuit does not work after first assembly, or when a failure occurs, find and fix the error, before connecting or running a motor with the circuit!

These additional hints may be of help:

- Is the processor running? If it is, the SIGNAL-LED should light up, 2 seconds after power up, or reset. If the processor is not running, check the Power Supply (5 Volt) and make sure the quartz is resonating. If this is the case: Is the processor correctly programmed?

- Check Pin 16 and 17 of the L6506 for the correct reference voltage. (Both should be between 0 and 1 Volts, they should never both be 0 Volts.) Otherwise check pins 3 and 5 of LM358N. If no reasonable reference voltage is available here, then either the DAC is broken, or is not being correctly initialised (for example because the processor is not working correctly).

- If the short circuit detection is reacting too sensitively, equip the board with the capacitors C32 and C33.

If these hints and the additional help at www.NC-Step.de don't answer all your questions, contact me for further help, by email. Please provide a detailed description of the problem and your configuration. (Power supply, used Software a.s.o.) -> E-Mail: Ostermann@NC-Step.de

Component List

Qty.	Value	Package	Library	Parts
2	0,1R/1W	0411/15	r	R7, R8
2	0,22R/2,5W	0617/22	r	R4, R5
4	15R	0207/10	r	R1, R2, R17, R22
4	100R	0207/10	r	R13, R18, R20, R27
2	220R	0207/10	r	R9, R19 - alternative: 470 R (see Assembly Instructions)
5	270R	0207/10	r	R6, R14, R16, R21, R29
1	5K6	0207/10	r	R11
2	10K	0207/10	r	R10, R28
2	22K	0207/10	r	R25, R26
1	47K	0207/10	r	R23
2	100K	0207/10	r	R3, R15
1	47K SIL5-4	SIL5	r-sil	RN1
1	1K	PT-SPIN	Spindletrim.	R12
1	20K	PT-SPIN	Spindletrim.	R24
4	33pF	C-2,5	Capacitor	C15, C16, C24, C25
1	1nF	C-2,5	Capacitor	C34
1	3,3nF 10%	C-2,5	Capacitor	C12
3	10nF	C-2,5	Capacitor	C27, C29, C30
6	22nF	C-2,5	Capacitor	C1, C2, C3, C4, C5, C6
6	100nF	C-5	Capacitor	C14, C17, C20, C21, C22, C26
2	100nF/MKS2	C-5	Capacitor	C9, C10
2	220nF	C-5	Capacitor	C7, C8
2	10µ/25V	ES-2,5	El-cap.	C19, C31
2	do not equip!		El-cap.	C18, C23
2	100µ/63V	ES-5	El-cap.	C11, C28
1	220µ/25V	E3, 5-8	El-cap.	C13
2	1N4148	DO35-10	DIODE	D2, D8
2	ZPD5,1	DO35Z10	DIODE	D4, D9
2	BAT42	DO35-10	DIODE	D3, D7
4	LED3	LED3	led	D1, D5, D10, D6 (2rt, 1ge, 1gn)
2	BC327	SOT54A	TRANS-SM	Q2, Q3
1	4MHz	HC49U	Quartz	Q1
4	10-XX	B3F-10XX	Digital-Push-Button	+ /CW, - /CCW, RESET, START
1	TLC5620	DIP-14	DAC	IC2
2	L6203	MULTI11	Bridge	IC3, IC4
1	L6506	DIP-18	Control	IC5
1	LM358N	DIL08	OP-AMP	U1
1	Mega8-16P_	DIP-28/3	AVR-MCU	IC1
1	7402	DIL14	74HCXX	IC7
1	74123	DIL16	74HCTXX	IC6
1	IC-SOCKET	DIL8		
2	IC-SOCKET	DIL14		
1	IC-SOCKET	DIL16		
1	IC-SOCKET	DIL18		
1	IC-SOCKET	DIL28/3 (small)		
1	PINHD-2X2	2X02	PINHEAD	MICROSTP
1	PINHD-2X3	CON06L	PINHEAD	PROG
1	Box Header 10pol.		CON10L	ribcon CON1
2	Female Header 10pol.			
3	Block Terminal		RM5,08	W237-132 WAGO508 SUPPLY, X2, X3
4	Screws	M3*6		
2	Jumper			
1	Heat Sink			
0,5m	Ribbon Cable 10 core			
	Optional: 10nF	C-2,5	Capacitor	C32, C33

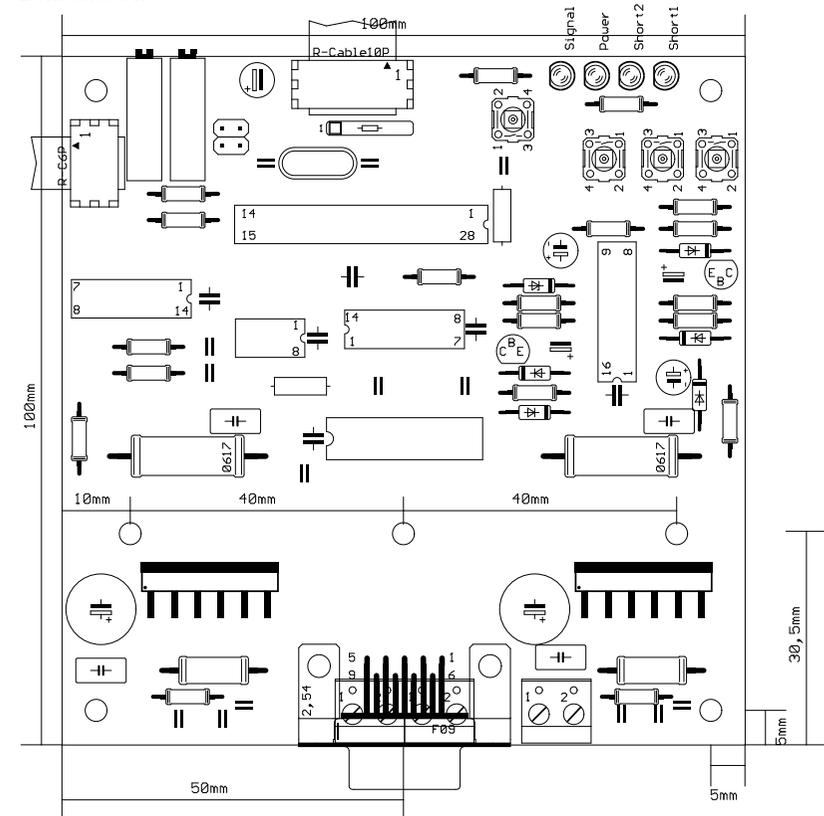
Additional Notes

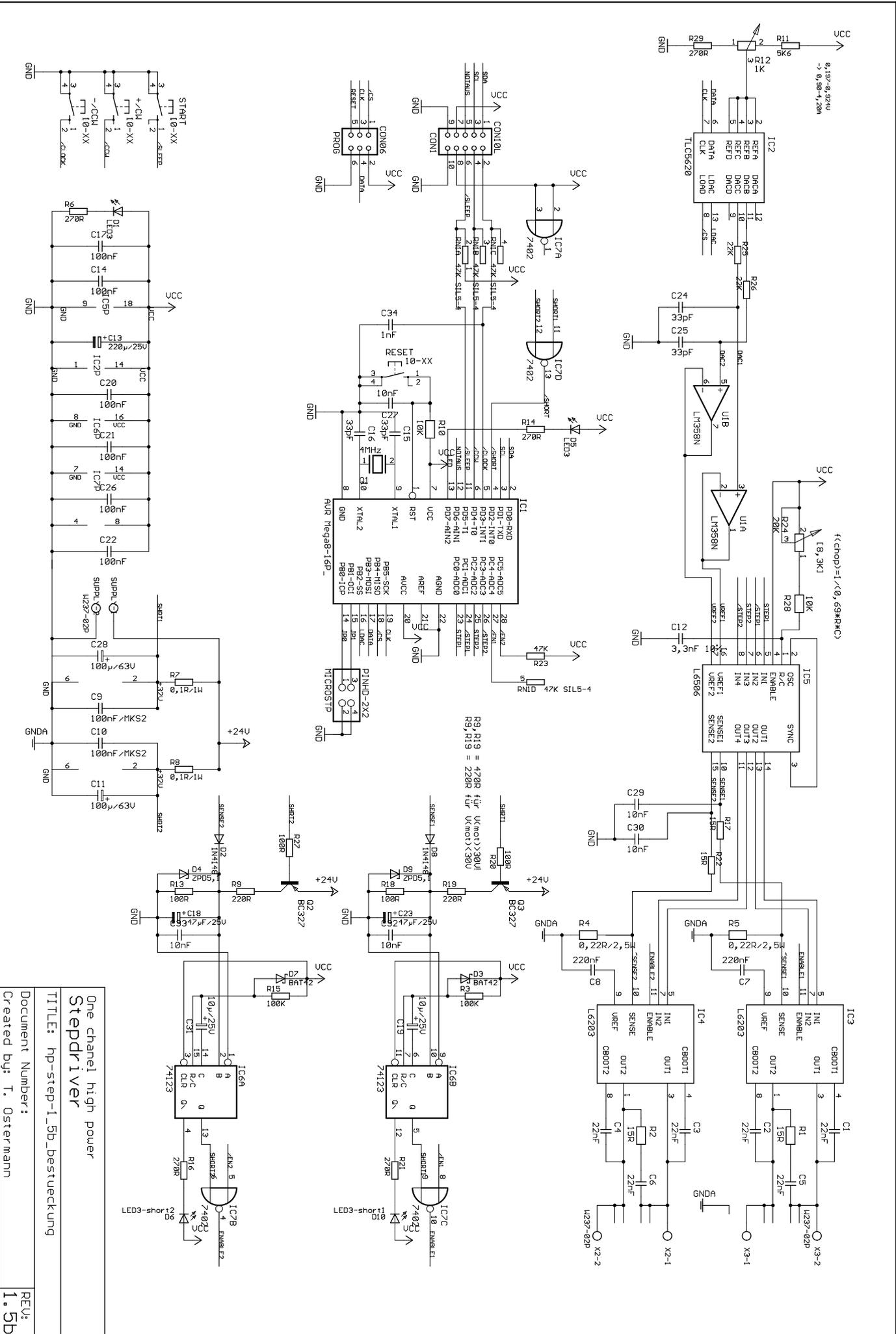
- A well stabilized motor voltage saves time and work, when searching for errors and reduces noise levels. (Rule of thumb: $10.000\mu\text{F}$ for 3 motors (a lot helps a lot ;-))
 - The 270 Ohm resistors (R6, R14, R16, R21) should be adjusted according to the used LEDs (Approximation: $(5V - U_{\text{Diode}}) / I_{\text{Diode}} = R$, z.B. $(5V - 1V) / 15\text{mA} = 270 \text{ Ohm}$). If no LEDs are used, the resistors are not needed.

Technical Data

Power Supply (Logic): 5 Volts +/- 5%
 Power Drain (Logic): typical 75mA, maximum 100mA
 Power Supply (Power Element): 15-45 Volts
 Power Drain (Power Element): dependent on Power Supply Voltage, Motor current and used Motor. Maximum Continuous Current: 4 Amperes.
 Control: Clock- and Direction signals, CMOS-compatible.
 Step Resolution: Full-, Half-, 1/4th and 1/8th-Steps
 Outputs: 1 stepping motor channel up to 4A per coil, short circuit protected

Dimensions





One channel high power
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