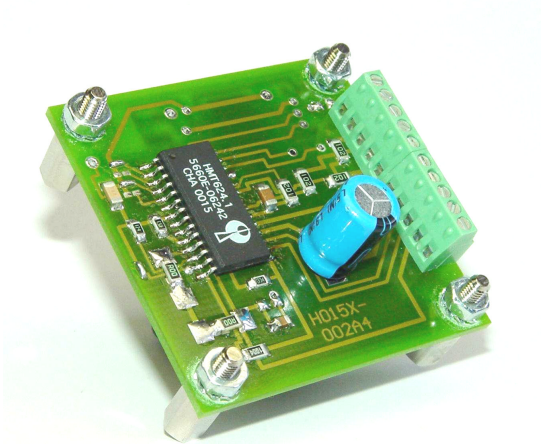
Evaluation Board
Order number H015X-520A9

Operating Instructions — May 2000 edition

The smart solution for Motor and Fan applications

The AECS (Analogue EC Controller Sensorless) is a 1-quadrant EC amplifier for controlling electronically commutated (brushless) DC motors. Rotor position sensors (Hall sensors) are not required.

- The electronics are flexible to use due to their wide input voltage range (5…35VDC).
- A fixed current limitation restricts motor current to 2.5A max.
- Motor speed is regulated and if required, can be adjusted by potentiometer.
- Speed can be monitored through the speed monitor output.
- A "/Brake" input allows the motor to stop immediately.
- The "Direction" input adjusts motor direction.
- The current rotor position is evaluated by using the back-EMF sensing technique.
- The integrated power MOS-FET power stage produces a high efficiency level.



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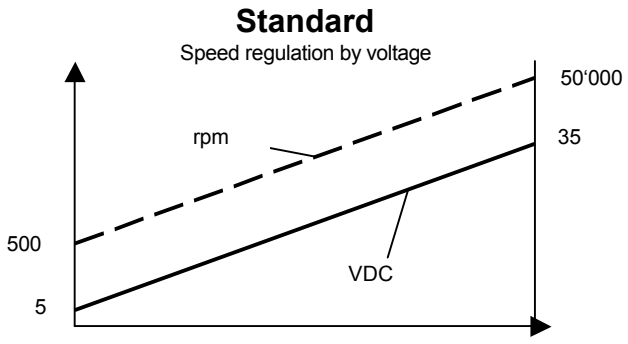
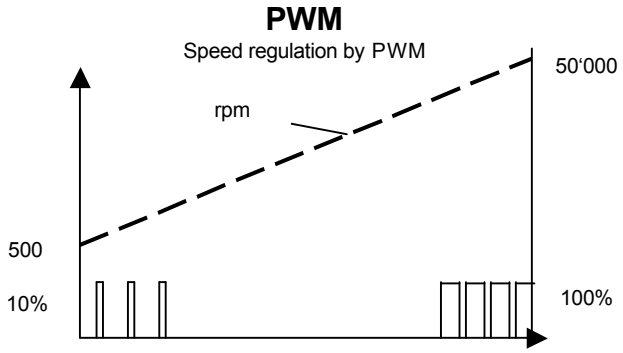
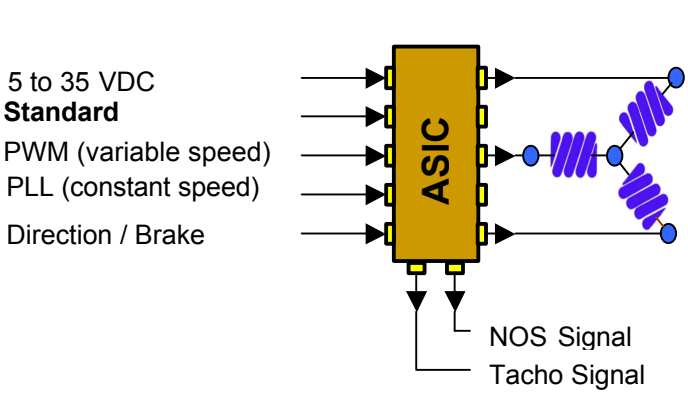
1 Features

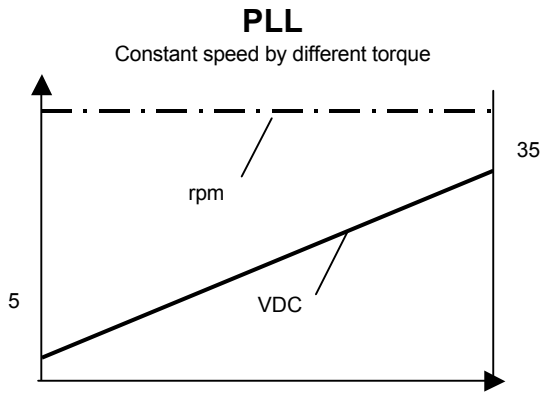
Features for Brushless Motors

- Sensorless (back EMF)
- Low noise function
- Integrated driver
- Interface for external power driver
- Temp. dependence rpm control
- Current protection
- Brake function









2 Circuit description

The ASIC is used for driving three - phase sensorless, brushless DC motors using the BEMF signals for the commutation timing.

POWER APPLICATION
The ASIC has an integrated Driver for medium power applications and an interface for driving ST's L6234 power Driver for applications that requires higher motor currents.

The startup is performed in a stepper motor configuration. As soon as sufficient BEMF is detected, the controller switches into the regular commutation mode.

The circuit is able to perform a PWM (Pulse-width-modulation) which allows control of the speed with 2 external resistors.

The duty cycle can be controlled by an external control voltage connected to Pin 11 or by using the integrated PLL circuit for speed control.

SPECIAL DESIGN FOR LOW NOISE APPLICATION
For low noise application such as Micronel ultra-slim-fans, a sine wave PWM-mode generates motor current with low distortion and therfore low audio noise.

3 Configuration / Connections

Quick Reference data

Symbol	conditions	min.	typ.	max.	unit
Supply voltage		4.75	12	35	[V]
Power dissipation				500	[mW]

- Connections are shown on the Layout diagram
- Modes can be selected with SEL 0 - 2: Type of Driver, Sinusapproximation yes/no, Currentlimiting yes/no
- If the internal Driver is selected, then R20 - R22 have to be 0Ω (Parts for the L6234 are not assembled)
- Using an external NMOS Driver, the signals EN + IN (5 V level) have to be reconfigured according to the table below
- Use ST4 (shortingbridge) for changing the direction of rotation
- R41 is the shunt for the currentlimiter (SMD, wire resistor across R-Shunt)
- R1 (offset), R20 to R22 (Back-EMF), R40/C40 (shuntfilter), R10/R11 (PWM Voltagedivider), R3 (Minimum of the PWM, have to be selected according to the application.
- R speed (R70) is the rated value for PLL
- The shortingbridge ST8 has to be closed if the PLL is not used. C10 and C11 are bridged with 0Ω Resistors.
- For adjustable PWM function use connection PWM Poti
- For a 100% PWM, R10 has to be => 15 kΩ (R11 = 10nF and R12 open)
- C10 + C11 are for PLL
- R12 + R71 are parallel resistors for a better fine tuning of the desired value
- OS means “Operating Signal“, that means the reverse of the NOS.
- V5V can be used to tap the 5V Voltage of the ASIC
- R50 – R52 are dampening resistors which are normally not installed

→ **The PCB is layed out for universal Application.**

→ **IF you want to use PLL, please ask Micronel for a schematic and calculating discription.**

SEL Decoder

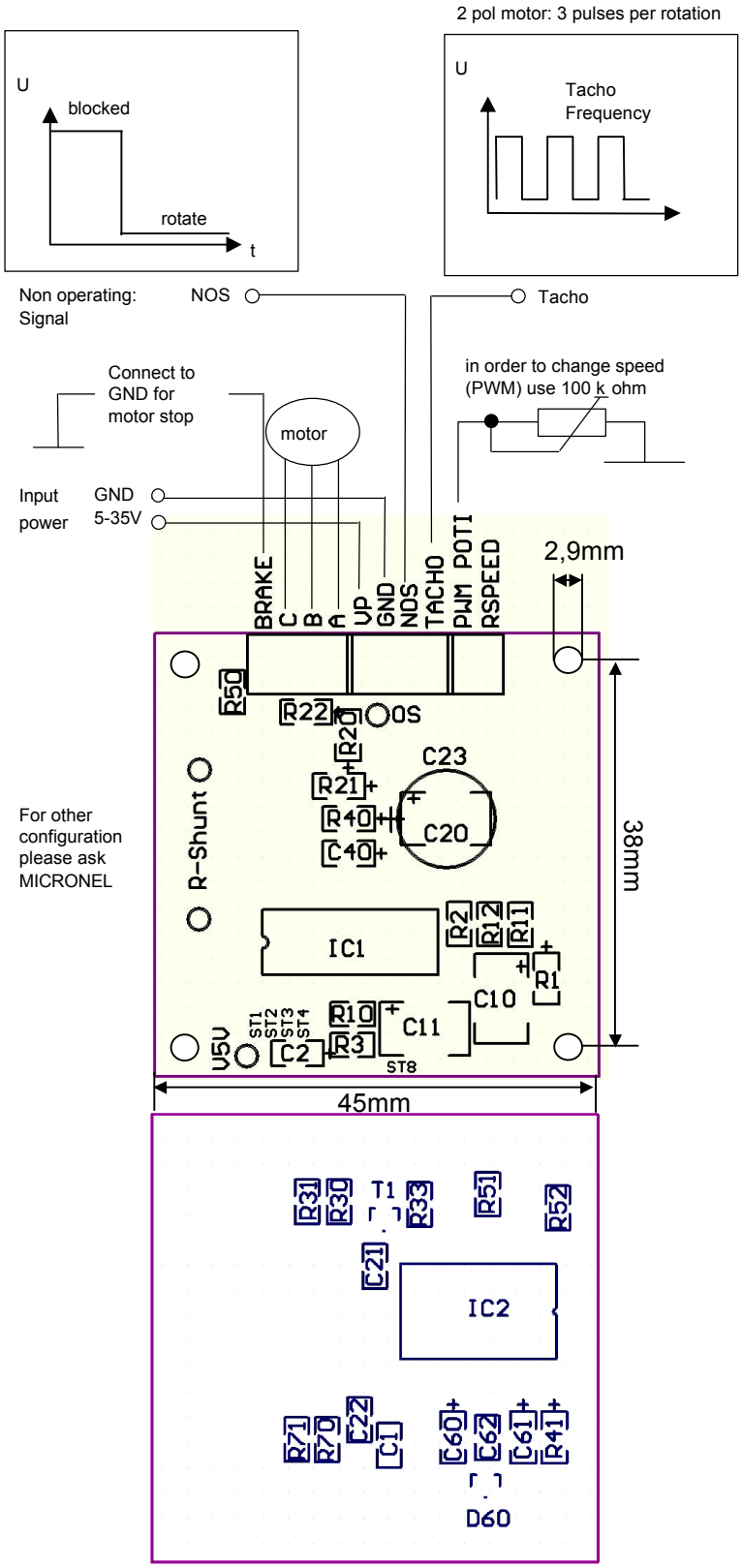
This block generates the operating configuration depending on the SEL input. SEL is a 3-Bit binary code.

ST1	ST2	ST3	SEL	Motor type	Interpolation	Driver	Startup Current Limit
'	'	'	0	-	do not use	-	-
	'	'	1	-	do not use	-	-
'		'	2	8/16 pol	normal	L6234	No
		'	3		normal	NMOS	Yes
'	'		4		sinewave	L6234	Yes
	'		5	Standard	Normal	L6234	Yes
'			6		sinewave	internal	Yes
			7		normal	internal	Yes

Tab. 1: SEL Truthtable

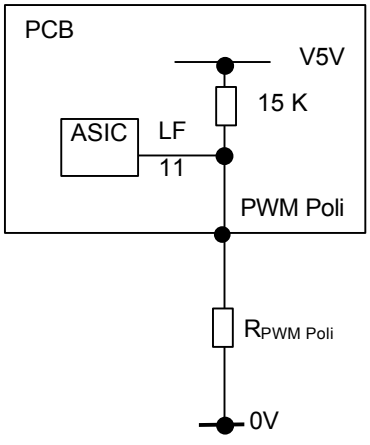
(1) (2) (4)
Short-Bridge to GND.

4 Layout diagram

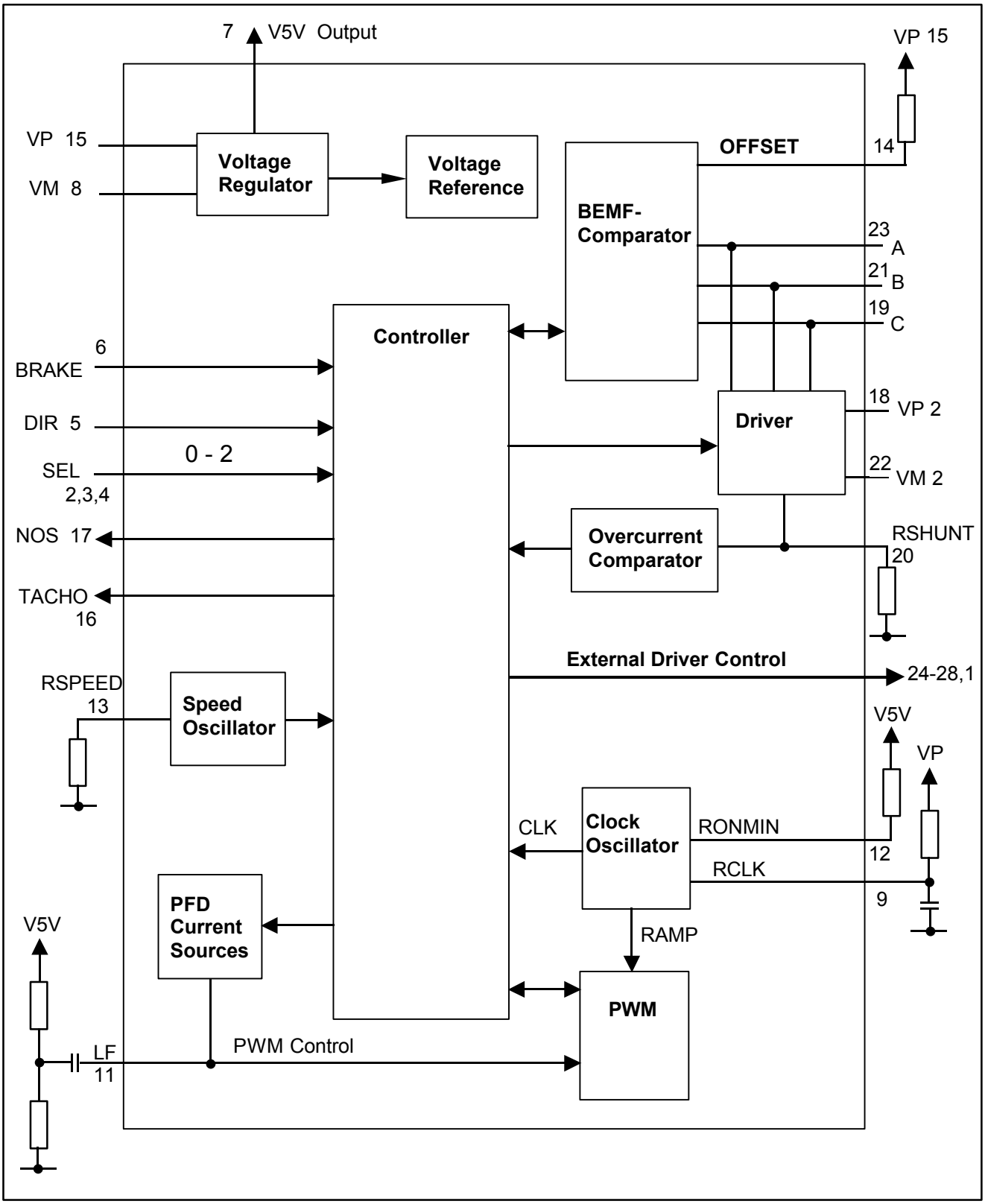


$$U_{V5V} = 5V$$

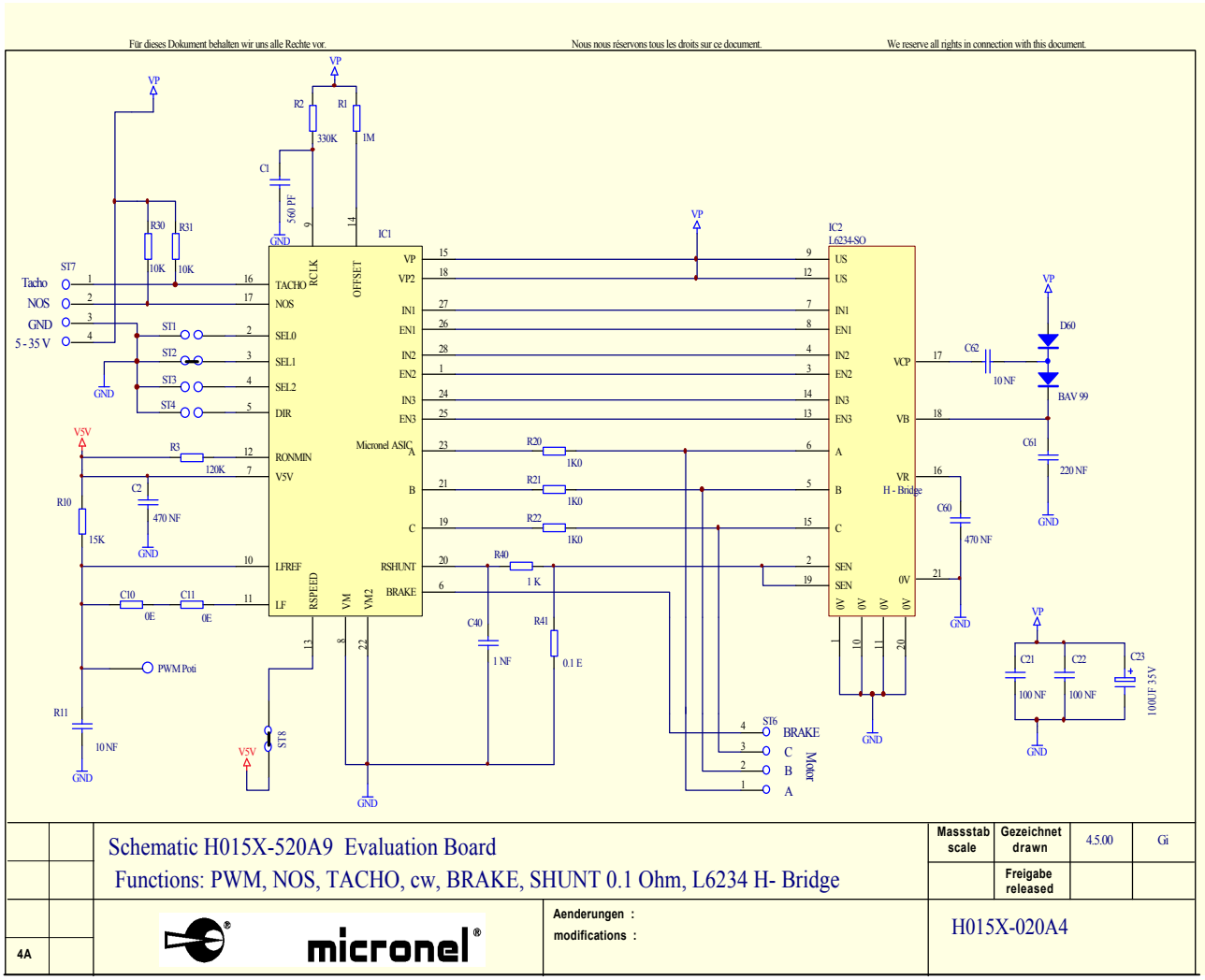
$$PWM\ U_{Motor} = \frac{U_{V5V} * R_{PWMPoti} * 8.75}{(15\,k\Omega + R_{PWMpoti})}$$



5 Blockdiagram



6 Schematic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Schematic H015X-520A9 Evaluation Board
Functions: PWM, NOS, TACHO, cw, BRAKE, SHUNT 0.1 Ohm, L6234 H- Bridge
Massstab scale
Gezeichnet drawn
4.5.00
Freigabe released
Aenderungen :
modifications :
H015X-020A4
4A
micronel®
IC1
IC2
L6234-SO
Micronel ASIC
H - Bridge
Tacho
NOS
GND
5 - 35 V
PWM Poti
BRAKE
Motor
BAV 99

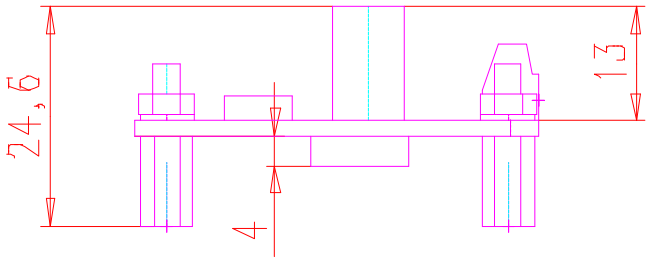
7 Partlist H015X-520A9

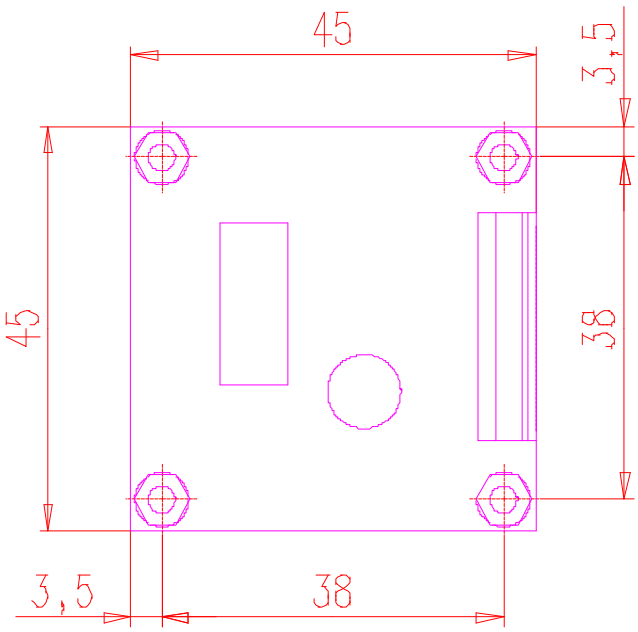
Part Type	*Designator*	*Description*
		ASIC print SMD
560 PF	C1	ceramic-capacitor SMD 560 PF / 50V / 5%
470 NF	C2, C60	ceramic-capacitor SMD 470 nF / 16V / 20%
0E	C10, C11	SMD chip-resistor 0E 5%
100 NF	C21, C22	ceramic-capacitor SMD 100 nF / 50V / 20%
100UF 35V	C23	ELRAD 100uF/35V 8 * 11.5 grid 3.5 YXF
1 NF	C40	ceramic-capacitor SMD 1 nF / 50V / 20%
220 NF	C61	ceramic-capacitor SMD 220 nF / 50V / 20%
10 NF	C62	ceramic-capacitor SMD 10 nF / 50V / 20%
BAV 99	D60	double diode fast
MICRONEL ASIC2	IC1	Micronel Motor Driver ASIC
L6234-SO	IC2	L6234PD
330K	R2	SMD chip-resistor 330K 1%
1 K	R20, R21 ,R22	SMD chip-resistor 1K0 1%
120K	R3	SMD chip-resistor 120K 1%
1K	R40	SMD chip-resistor 1K 1%
0.1E	R41	SMD chip-resistor 0.1E 5%
1 M	R1	CHIP R SMD 1%/1206 1M
15 K	R10	CHIP R 1% 0805 15K
10 NF	R11	ceramic-capacitor SMD 10 nF / 50V / 20%
10K	R30	SMD chip-resistor 10K 1%
10K	R31	SMD chip-resistor 10K 1%

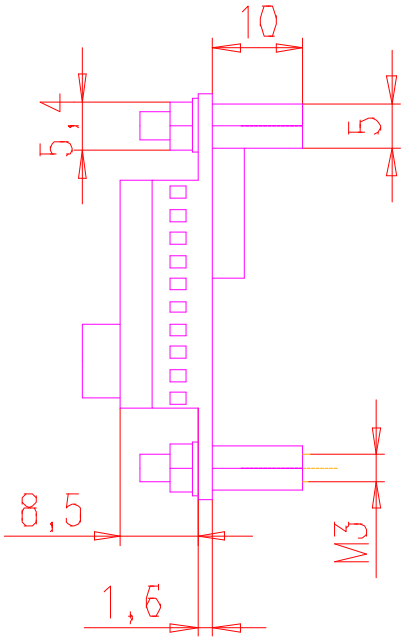
8 PLL

For PLL use more detailed information on request.

9 Drawing







10 Appendix (ASIC Configuration)

10.1 Speed Oscillator (Pin13, Rspeed R70)

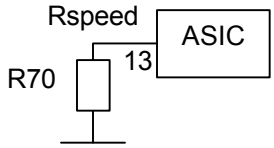
The speed oscillator is employed as face value for the PLL controller. Without PLL application Pin Rspeed will be connected to V5V (ST8 close).

$$f_{rot} = \frac{f_{Tacho}}{3}$$

The motor rolation speed can be calculated as $\text{Rspeed} = \frac{7.5 * 10^6}{f_{rot}} = \frac{K}{f_{rot}} = \ldots \; [\Omega]$

Speed Oscillator		Symbol	Min.	Typ.	Max.	Unit
Conversion factor		K	$6*10^6$	$7.5*10^6$	$9.2*10^6$	Hz*Ù
External resistance		R_{SPEED}	5	100	1000	KÙ
Motor rotation speed	360° electrical period	f_{rot}	10	75	1000	Hz

If required, a NTC thermistor can be used to set temperatur dependent speed.



10.2 Clock Oscillator (Pin9 R_{CLK})

$$\left.\begin{array}{l} R_{CLK} = 330K\Omega \;\; R2 \\ C_{CLK} = 560pF \;\; C1 \end{array}\right\} \Rightarrow \text{PWM frequency} = \underline{44kHz}$$

Clock Oscillator		Symbol	Min.	Typ.	Max.	Unit
Clock frequency	$R_{CLK} = 330K\Omega$ $C_{CLK} = 560pF$	f_{CLK}	40	44	50	KHz

PWM Minimal ON Time

$50k\Omega \;\hat{=}\; 1\mu s$

$\frac{\ldots k\Omega}{50\,k\Omega} = \frac{\ldots \mu s}{1\mu s}$ proportional

Pin12 RONMIN (R3)

$120k\Omega \;\hat{=}\; 2.4\mu s$

$f_{CLK} = 44\,kHz$
$\rightarrow T = 22.7\,\mu s$

$$\text{PWM Minimal ON} = \frac{2.4\,\mu s}{22.7\,\mu s} = 10\,[\%] \; (120\,k\Omega)$$

The clock oscillator generates a clock (CLK) which is used as main clock signal for the ASIC and a ramp signal (RAMP) for the PWM. The clock waveform is asymmetric; the shorter high time defines the minimal on-time of the PWM. The Amplitude of the generated ramp is proportional to the supply voltage (V_{VP}). The clock frequency is determined by an external RC connected to VP. An external resistor connected to V5V allows to adjust the minimal clock high time (the minimal on-time of the PWM).

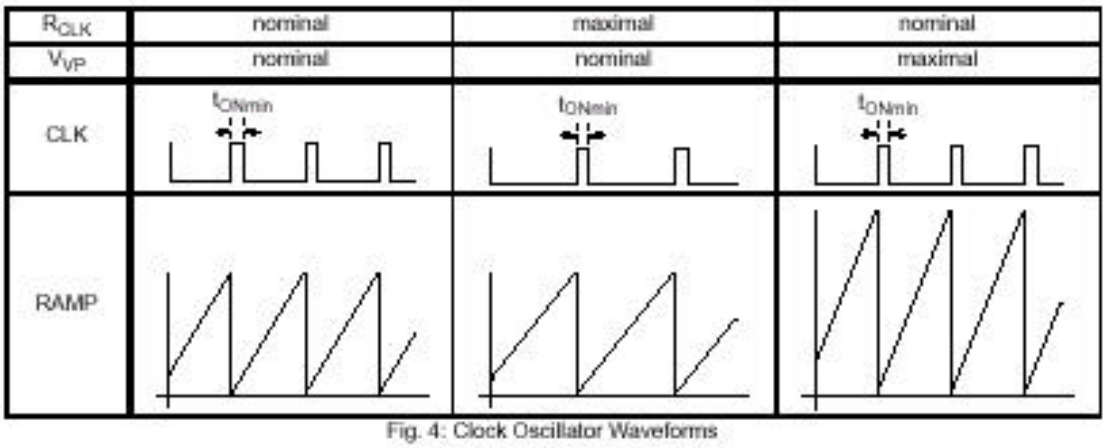
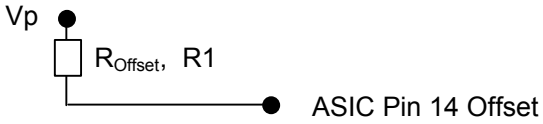


Fig. 4: Clock Oscillator Waveforms

10.3 Offset (Pin14 Offset, R1)

Proportional Offset (to the supply voltage)



R_{Offset}	=	470 kÙ	⟶	Offset ~1 % of Us
	=	1 MÙ	⟶	Offset ~0.5 % of Us
	=	2.2 MÙ	⟶	Offset ~0.25 % of Us
	=	180 kÙ	⟶	Offset ~2.6 % of Us

The Offset (V_{BECO}) is for detecting the minimum level of the BEMF voltage. This offset is proportional to the current flowing into pin “OFFSET“. Connecting a resistor from “OFFSET“ to “VP“ will make the offset proportional to V_{VP}; connecting the resistor to “V5V“ results in constant offset.

$$R\,Offset = \sim \frac{1\,[\%]}{\ldots[\%]} = \frac{\ldots[k\Omega]}{470\,[k\Omega]}$$

470 kÙ – 1MÙ is the most applicable value

$$Offset\,[V] = \frac{Us - 2.5\,V}{R_{Offset}} * 4.7k\Omega$$

10.4 Current limit (Pin20 R_{SHUNT}, R41)

$$I_{limit} = \frac{0.24V}{R_{Shunt}}$$

Overcurrent protection:
The overcurrent protection is a cycle by cycle protection. It turns the output stages OFF as soon as the overcurrent comparator detects an overcurrent. The Driver remains in the OFF state until the end of the actual clock period. During the HIGH phase of the clock, the overcurrent protection is disabled to allow a minimum ON time for the correct BEMF sensing (RONMIN).

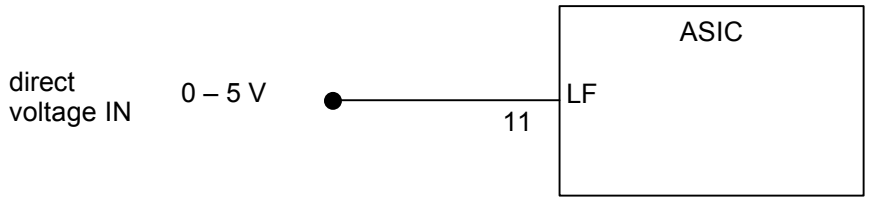
If an external Driver is used, the comparator input voltage may be filtered with a RC network to reject the spikes generated by the gate-source capacitance of the external power transistors. (R40 = 33 kΩ, C40 = 1 nF)

10.5 PWM (Pin11 LF)

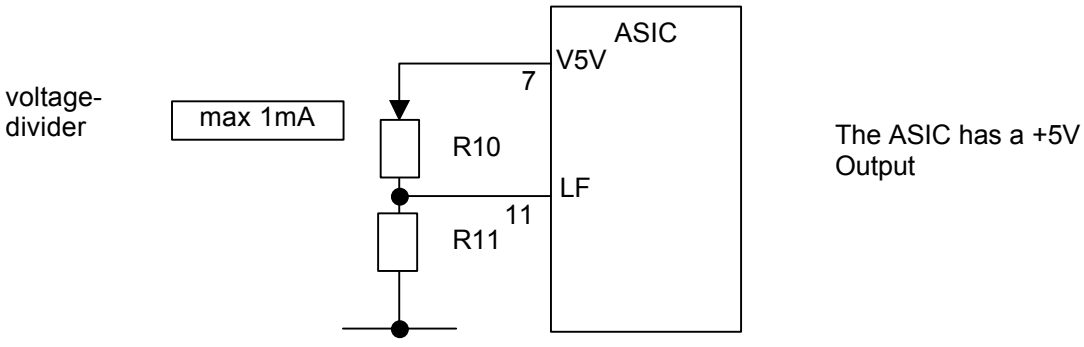
PWM		Symbol	Min.	Typ.	Max.	Unit
Gain	Pin LF to Driver out			8.75		
Input voltage range to use PWM	Pin LF		0		4.2	V

$U_{PinLF} * 8.75 = U_{Motor}$

Independent of supply voltage!



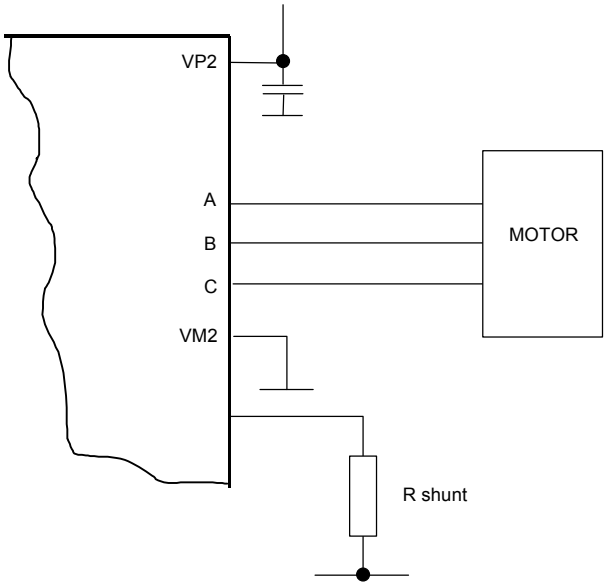
or



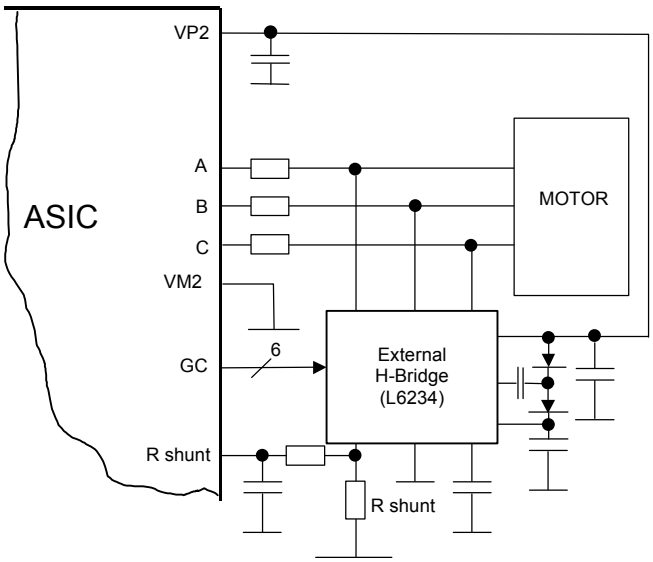
10.6 Driver

Internal

200 mA DC
400 mA Peak



External L6234



External Fet