

# Data Sheet

## StepperChip-Vx1

**High Performance**

**Controller for 2(3)-Phase Stepper Motors**



Actual Size

Revision: 35/2008 subject to change without prior notice

## Product Features

- **Controller-Chip for 2(3)-phase stepper motors**
- **A multitude of onboard functionality**
- **From 200 to 10000 steps/revolution**
- **Automatic motor set up at power on**
- **Automatic operating parameter adjustment**
- **Highly precise current controller for high and constant torque from step to step**
- **Variable boost function at acceleration**
- **Stand-By Mode (very low noise emission)**
- **Automatic current reduction at stand still**
- **Active ballast circuit protects from over-voltage**
- **Extensive device status information**
- **Inputs: (digital: CMOS 3.3V to 5V)**  
PULSE, DIRECTION, IN1[Off, Reset, Gate]  
4 Bit Set phase current  
3 Bit Steps/revolution  
1 Bit Current reduction at stand still (on/off)  
1 Bit Over current (short circuit) detection
- **Inputs: (analog: 0V bis 3.3V)**  
Set current value for phase A and B  
Supply voltage, temperature
- **Outputs: (CMOS 3.3V)**  
READY, BALLAST, DIAGNOSTICS  
PWM for power drive stage
- **32 Pin LQFP Housing**

## Variants / Order Code:

StepperChip-Vx1

### Motor type:

- |   |                 |
|---|-----------------|
| 2 | 2-Phase Stepper |
| 3 | 3-Phase Stepper |

### Chip type:

- |   |                                    |
|---|------------------------------------|
| 1 | Controller Chip for external drive |
|---|------------------------------------|

## Accessories:

- Current Sensing Module (available soon)
- Driver Block (available soon)

## Chip with Stepper Motor Know How

The StepperChip sets new standards for the digital control of stepper motor drives. Utilizing a state-of-the-art digital signal processor (DSP) made it possible to develop new procedures and control technologies. All necessary functionality to operate a stepper motor are on board the chip. So even without having specific know how it is now possible to simply design a high performance stepper drive. The StepperChip is a series product already implemented in a complete line of digital power drives. The application field of the chip are OEM-markets that design their own stepper drives. The target sales groups are high volume OEMs or manufacturers of application oriented controls such as hose pumps, pin stampers, lab and measuring devices etc.

**Automatic Controller Setup** At power on, the drive electronically analyzes the motor. Next the operating parameters are automatically tuned to achieve optimal dynamic and smooth run drive performance. Consequently the power drive adjusts itself to the respective motor. Specific power drive know how is therefore not required.

**Boost and Current Reduction** A variable boost function is enabled depending on the actual acceleration rate, i.e. an additional current offset is added to the set current value. With this, higher acceleration rates are possible. The current reduction reduces the motor current at stand still to 60% of the set current value.

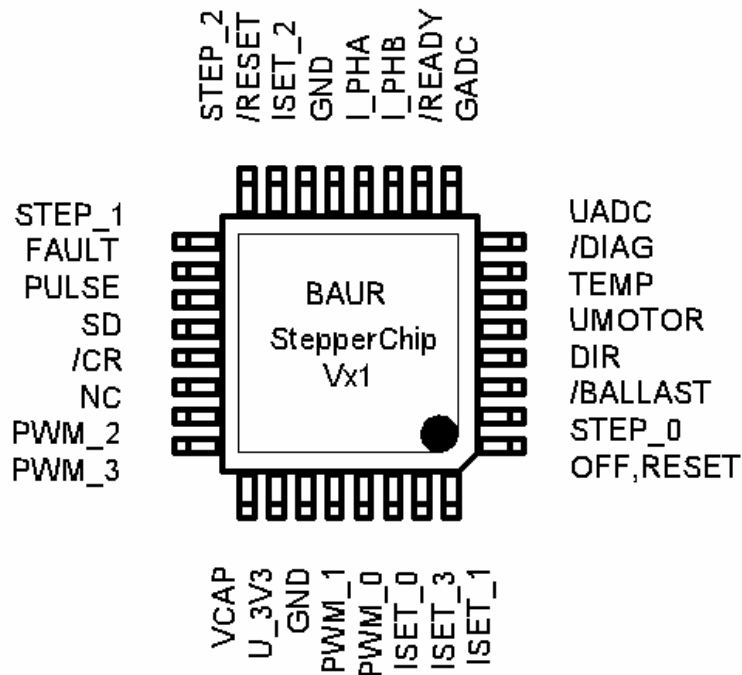
### Dynamic Operating Parameter Adjustment

Several conditions are continuously monitored during operation and the operating parameters are automatically adjusted. As a result the constant motor torque range stretches and dynamic positioning moves are also possible in the higher speed range.

**StandBy Mode** With lower speeds down to stand still the power drive gradually switches to the stand by mode. The motor is absolutely quiet and this with full torque. A big advantage for office and lab environments.

**Digital Phase Current Controller** The power drive design is fully digital and the phase current is measured directly in the motor windings. The strict focus was here to achieve optimal operating performance such as low resonance run, high step angle accuracy and high and constant torque from step to step.

## Pin Layout:

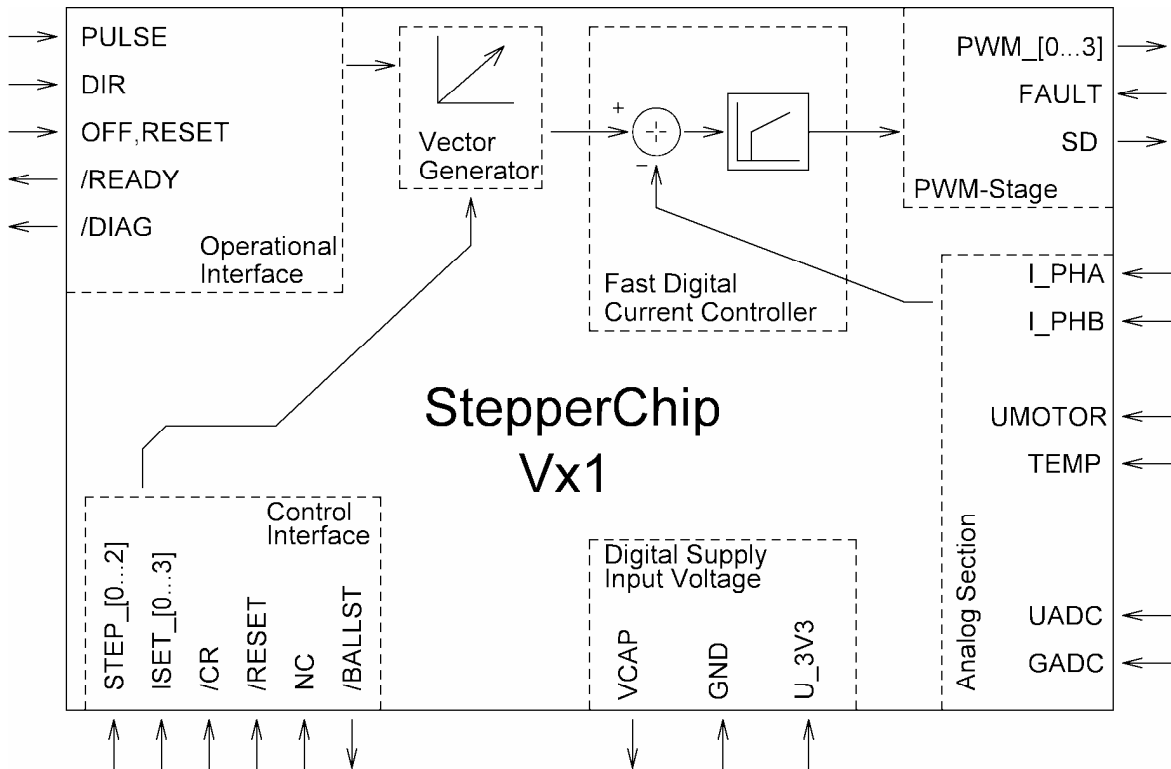


## Pin Assignment:

/Name= low active

Pin	Name	Description
26	U_3V3	Logic supply voltage, 3,3V, 42mA max.
13, 27	GND	Logic supply voltage, Ground
25	VCAP	Stabilizing capacitor Tantalum 10µF/6V, Bypass 100nF/10V Multi Layer Ceramic
8	UADC	Analog supply voltage, 3,3V, 13,5mA max.
9	GADC	Analog supply voltage, Ground
19	PULSE	Input digital: Pulse for step/direction, 5Vmax.
4	DIR	Input digital: Direction for motor, 5Vmax.
1	OFF,RESET	Input digital: Control input for function OFF (motor zero current) works also as fault RESET
18	FAULT	Input digital: Fault input, e.g. short circuit of the power drive stage, sets the output SD immediately 5Vmax.
15	/RESET	Input digital: Chip-Reset, with PullUp= 10kOhm at U_3V3
10	/READY	Output: Ready, 3,3V, 4mA
7	/DIAG	Output: Diagnostics, 3,3V, 4mA
3	/BALLAST	Output: Active at over voltage, 3,3V, 4mA
20	SD	Output: Shut down drive
29,28,23,24	PWM[0...3]	Output: PWM-Signals for drive, 3,3V, 4mA
12,11	I_PHA, I_PHB	Input analog: Phase current measurement, 0...UADC, UADC/2= 0Ampere
5	UMOTOR	Input analog: Motor voltage measurement, 0...UADC
6	TEMP	Input analog: Drive temperature measurement, 0...UADC
30,32,14,31	ISET_[0...3]	Input digital: Current setting 16 values, 5Vmax.
21	/CR	Input digital: Current reduction at stand still, 5Vmax.
2,17,16	STEP_[0...2]	Input digital: Step resolution 8 values, 5Vmax.
22	NC	Reserve: do not connect

## Block Diagram



## Functional Description

### Operational Interface

#### PULSE:

A step is executed with each positive signal edge. The power drive exclusively reacts on signal edges. In case of an active current reduction (Pin CR „current reduction“ low) and pulse pauses greater than approx. 2s, the motor current is reduced to approx. 60% of the set value.

#### DIR: (Direction)

The direction signal defines the sense of motor rotation.

#### OFF, RESET:

Input OFF,RESET switches the motor current off. The current chopper is switched off. This feature is occasionally used in measuring equipment to be able to measure even the smallest signal amplitudes without interference. This condition allows to move the motor manually.

At fault condition the fault can be reset and the controller can be switched back to the operational mode.

#### /READY: (READINESS)

This output is low active when the drive is ready. At fault condition the output level is high (3,3V)

#### /DIAG: (DIAGNOSTICS)

For use in combination with a LED as status display  
Ready: LED on continuously

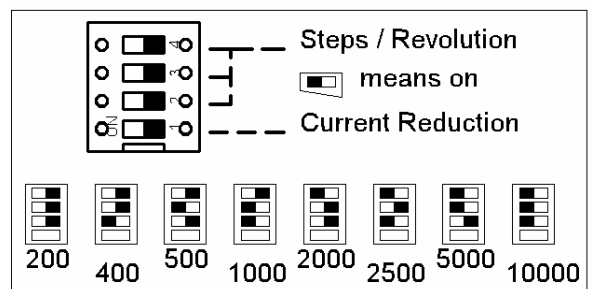
Error: LED flashes (see below):  
2x Low-voltage occurred  
3x Over-temperature  
4x Over-current detected

The fault state can be reset with input IN1.

### Control Interface

#### STEP\_[0...2]: (Step resolution)

The step resolutions are valid for 50 pole pair hybrid stepper motors. The following steps per revolution can be set (see graphic below), if STEP\_[0..2] would be connected to DIP switch 2, 3 and 4.



**Running performance:**

☺ less than 400      ☹ 400      ☺ more than 400

The step performance improves with higher motor current (set nominal motor current)

**ISET\_[0...3]: (Motor current setting)**

I<sub>motor</sub>[mA]

The motor current value can be set directly at the pins e.g. with a rotary hex-switch. The following table lists possible current values in mA with the assumption that the max. motor current value is scaled to 8A. (also dependent on the current measurement circuit)

0	1500	4	1750	8	2000	C	2250
1	2500	5	3000	9	3500	D	4000
2	4500	6	5000	A	5500	E	6000
3	6500	7	7000	B	7500	F	8000

The set motor current value represents the peak current  $I_{PEAK}$  of one phase. The calculate RMS current per phase is  $I_{RMS} = I_{PEAK}/\sqrt{2}$ . The effective motor phase current  $I_m$  generating the motor torque results from the geometrically added phase currents  $I_a$  and  $I_b$ :  $I_m = \sqrt{(I_a^2 + I_b^2)}$

**/CR: (current reduction)**

/CR activates the automatic current reduction. The motor current is reduced to approximately 60% of the set motor current. The losses in the motor as well as in the drive can therefore be significantly reduced.

! Current reduction reduces holding torque. Assure the resulting holding torque is acceptable for your application.

The current reduction is activated, if the pulse input is inactive for more than approx. 2s.

At pulse frequencies less than 2 Hz it can happen that the current reduction is briefly switched on. To avoid this effect the start/stop-frequency should be set significantly higher than 1 Hz. Immediately after detecting an active pulse input nominal current is restored.

It is recommended to generally activate the current reduction. Practical experience values show that the temperature can be reduced more than 10°C

**/RESET:**

The input must be connected with a pull-up resistor 10kohm to U\_3V3. The external chip-reset is under normal operating conditions not required.

**NC:**

Not connected. The pin must remain open.

**/BALLAST:**

The motor voltage is continuously monitored. Should it rise too high (e.g. when motor brakes) the output is active for the duration of the over-voltage condition. With an external switching transistor and ballast resistor the over-voltage can be dissipated.

**Digital Supply Input Voltage: (Chip-Supply)****U\_3V3:**

Supply voltage with 3,3V for the chip.

**GND:**

Logic ground for the chip.

**VCAP:**

Stabilizing capacitor for the chip internal voltage regulator.

**Between U\_3V3 and GND as well as VCAP and GND a Tantal. 10µF/6V and Bypass 100nF/10V must be connected.**

**Analog Part:****UADC:**

Supply voltage with 3,3V for the analog part

**GADC:**

Reference potential for the analog part

**Between UADC and GADC a Tantal. 10µF/6V and Bypass 100nF/10V must be connected for decoupling.**

**TEMP: (Temperature Monitoring)**

The drive temperature is continuously monitored. If it exceeds a threshold the drive is switched off.

**UMOTOR: (Voltage Monitoring)**

The motor voltage is continuously monitored. If it exceeds a threshold the output „BALLAST“ is active for the duration of the over-voltage condition.

**I\_PHA, I\_PHB: (Motor current detection)**

The current signal must be continuously connected to the motor current inputs. Ideally a current converter is used for his task to directly measure the phase current in the motor windings. The level UADC/2 relates to zero milliamps. A level higher than UADC/2 corresponds to a positive current and consequentially a level lower than UADC/2 is a negative current. The max. absolute current level is also UADC/2.

**PWM-Stage:****PWM\_[0...3]: (Power Drive Stage Control)**

The stepping motor is operated in bipolar operation. Per motor phase two half-bridges are required. PWM\_[0...1] for Phase A and PWM\_[2...3] for Phase B. PWM\_x high level means here half-bridges high level.

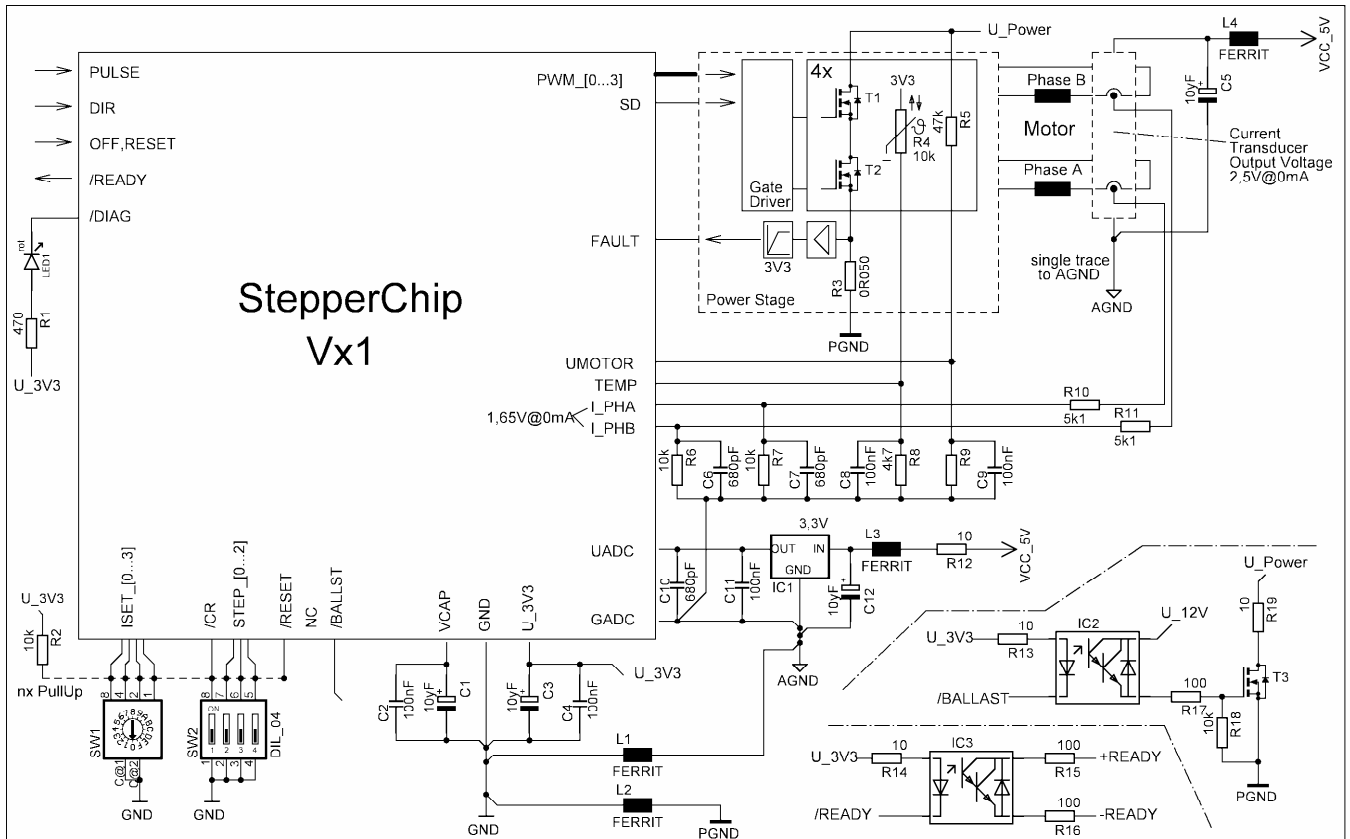
**FAULT: (Power Drive Fault)**

Drive over-current condition (short circuit) is indicated at the FAULT-Input. The output SD (shut down) is then immediately set and the power drive stage can be switched off with the signal.

**SD: (Power Drive Shut Down)**

The output SD (Shut Down) is immediately set as a reaction to the active FAULT-Input and is used to switch off the power drive stage at fault condition.

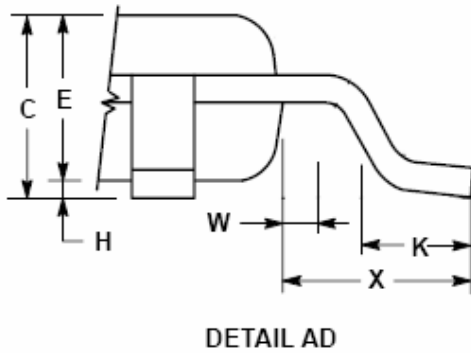
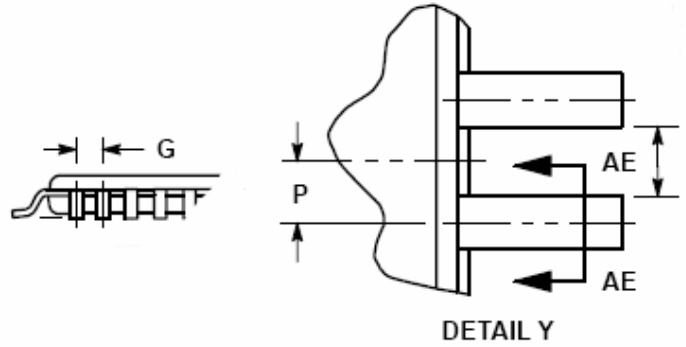
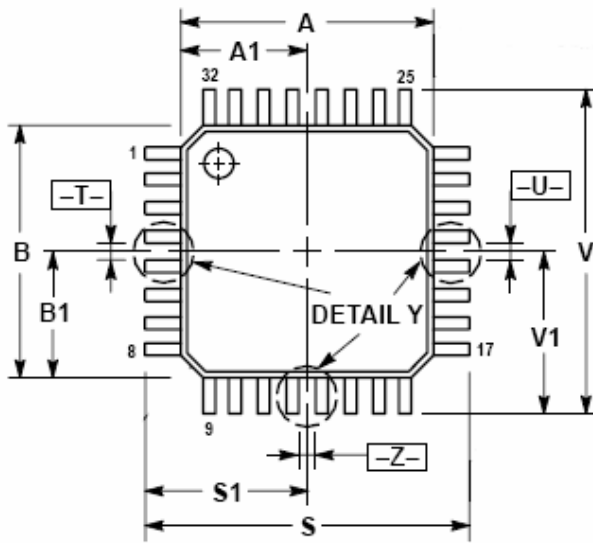
**Circuit Diagram:**



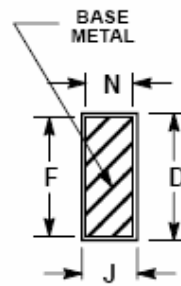
**Design-Requirements:**

- C1...C4 to be placed as close to the chip as possible
- AnalogGround AGND, PowerGround PGND and DigitalGround GND must be isolated with a FERRIT choke (L1 and L2)
- Analog supply UADC and current measurement unit must be isolated with a FERRIT choke (L3 and L4)
- C10 be placed as close to the chip as possible
- The component group R6...R9 and C6...C9 must be placed on ground „island“ (area) near the chip and it must be connected with a single wire to GADC
- AGND of the current measurement unit must be connected with a single wire to GADC
- The scaling of the current measurement unit should be 185mV/A
- The signal of the over-current detection at R3 must not exceed 5V at the FAULT- Input
- The signal inputs PULSE, DIR and OFF.RESET are must be isolated via Schmitt-Trigger (74HC14[opto-isolator]) from the process
- PowerGround PGND should be a closed ground area
- R9 sets the threshold of the over-voltage detection.
- R8 sets the threshold of the over-temperature detection.

Dimensions



DETAIL AD



SECTION AE-AE

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	7.000 BSC		0.276 BSC	
A1	3.500 BSC		0.138 BSC	
B	7.000 BSC		0.276 BSC	
B1	3.500 BSC		0.138 BSC	
C	1.400	1.600	0.055	0.063
D	0.300	0.450	0.012	0.018
E	1.360	1.450	0.053	0.057
F	0.300	0.400	0.012	0.016
G	0.800 BSC		0.031 BSC	
H	0.060	0.150	0.002	0.006
J	0.090	0.200	0.004	0.008
K	0.500	0.700	0.020	0.028
N	0.090	0.160	0.004	0.006
P	0.400 BSC		0.016 BSC	
S	9.000 BSC		0.354 BSC	
S1	4.500 BSC		0.177 BSC	
V	9.000 BSC		0.354 BSC	
V1	4.500 BSC		0.177 BSC	
W	0.200 REF		0.008 REF	
X	1.000 REF		0.039 REF	

**Technical Specifications:**

Name	Symbol	Notes	Min	Typ	Max	Unit
Digital Supply Voltage	U <sub>3V3</sub>		3	3,3	3,6	V
Digital Supply Current	I <sub>U_3V3</sub>		-	42	-	mA
Input Voltage High (digital)	V <sub>IH</sub>	PinGroup 1	2	-	5,5	V
Input Voltage Low (digital)	V <sub>IL</sub>	PinGroup 1	-0,3	-	0,8	V
Input Current High (digital)	I <sub>IH</sub>	PinGroup 1	-	0	2,5	μA
Input Current Low (digital)	I <sub>IL</sub>	PinGroup 1	-15	-30	-60	μA
Output Voltage High @I <sub>OH</sub>	V <sub>OH</sub>	PinGroup 2	2,4	-	-	V
Output Voltage Low @I <sub>OL</sub>	V <sub>OL</sub>	PinGroup 2	-	-	0,4	V
Output Source Current High	I <sub>OH</sub>	PinGroup 2	-	-	4	mA
Output Source Current Low	I <sub>OL</sub>	PinGroup 2	-	-	4	mA
Analog Supply Voltage	U <sub>A</sub>		3	3,3	3,6	V
Analog Supply Current	I <sub>U<sub>A</sub></sub>		-	13,5	-	mA
Input Current High (analog)	I <sub>IHA</sub>	PinGroup 3	-	0	10	μA
Input Current Low (analog)	I <sub>ILA</sub>	PinGroup 3	-	0	10	μA
Internal Oscillator Frequency	F <sub>OSC</sub>		-	32	-	MHz
Ambient Operating Temperature	T <sub>A</sub>		-40	-	105	°C
PULSE Counter Input Frequency	P <sub>CIF</sub>		-	-	250	kHz
PULSE Counter Input HIGH/LOW Time	P <sub>CHLT</sub>		100	-	-	ns
PULSE Counter DIR before PULSE Time	P <sub>CDPT</sub>		60	-	-	ns
PULSE Counter DIR after PULSE Time	P <sub>CPDT</sub>		60	-	-	ns
Internal Vector Generator Amplitude	V <sub>GEN<sub>AMPL</sub></sub>		-20000	-	20000	Digits
Current Measure Unit Operation Area	CMU <sub>OA</sub>		0,65	-	4,35	V
Current Controller Period	CCTRL <sub>PER</sub>		-	31,25	-	μs
PWM-Frequency	PWM <sub>FREQ</sub>		-	16	-	kHz
PWM-Duty	PWM <sub>DUTY</sub>		3	-	97	%
PWM-ShutDown @Short Circuit on FAULT	PWM <sub>SD</sub>		-	-	2	μs
PWM-OFF @OFF,RESET active	PWM <sub>OFF</sub>		-	-	25	μs
PWM-ON @OFF,RESET deactivate	PWM <sub>ON</sub>		-	-	25	μs
/READY active after PowerOn	/READY <sub>ACT</sub>		-	-	800	ms
/READY not active after FAULT	/READY <sub>NOT</sub>		-	-	25	μs
Current Reduction active after last PULSE	/CR <sub>ACT</sub>		-	-	2	s
Current Reduction deactivate after PULSE	/CR <sub>NOT</sub>		-	-	25	μs
Over Voltage Triple Point	OV <sub>TRIP</sub>		-	1,78	-	V
Over Temperature Triple Point	OT <sub>TRIP</sub>		-	2,66	-	V
Step Accuracy	STEP <sub>ACC</sub>	4	200	-	10000	Steps
Current Adjust	C <sub>ADJUST</sub>	5	1000	-	10000	mA

**Notes:**

PinGroup 1: PULSE, DIR, OFF,RESET, FAULT, /RESET, SD, ISET[], CR, STEP[]

PinGroup 2: /READY, /DIAG, /BALLAST, SD

PinGroup 3: I\_PHA, I\_PHB, UMOTOR, TEMP

4: 8 Settings @Hybrid-Stepper-Motor with 50 Poles

5: 16 Settings, Value depends on the Current Measurement Unit