SNR ROULEMENTS

MPS40S datasheet

Integrated Hall IC for
Linear and Rotary Motion Detection

Preliminary datasheet

Benefits

- Complete system-on-chip in a small TSSOP-20 package
- High reliability due to non-contact sensing
- Extended temperature range: -40° to +125°C
- Suitable for use in harsh environments. AECQ100 qualified
- Robust against external magnetic stray fields

Key Features

- High speed, up to 20m/s
- Down to 14µm resolution
- Programmable pole length
- Index pulse for absolute position measurement
- 40 pulses per magnetic period
- Linear & circular off-axis movement measurement
- 4.5 to 5.5V operating voltage
- Magnetic field strength indicator

1 General Description

The MPS40S is a single-chip IC with integrated Hall elements for measuring linear or rotary motion using multi-pole magnetic strips or rings.

High Resolution Speed

MPS40S can be used in off-axis applications, underneath a multipolar magnetic ring or strip, and provides a quadrature incremental output with up to 40 pulses per period at speeds of up to 20m/sec. For example, with a 36 pole-pair magnetic ring

- Resolution = 1440 pulses/rev = 5760 positions/rev = 12.5 bit
- Max speed = 8330 rpm

Programmable pole length

The chip accepts a wide range of pole lengths, from 1.13 to 5.91mm, with magnetic field strength down to 5mT. The pole length can be adjusted by programming.

Example: a minimum pole length of 1.13mm allows a resolution of 14.125µm per position step.

Absolute angle

In addition to the multi-pole high resolution track, the MPS40S can read a second multi-pole reference track that generates single or multiple reference index pulses per revolution, for absolute position identification

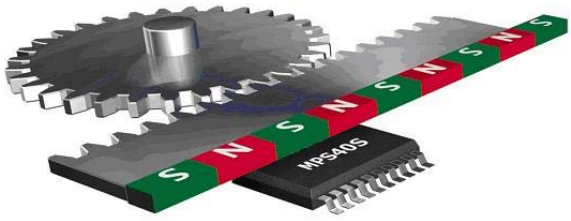

Figure 1: MPS40S with magnetic multipole strip for linear motion measurement

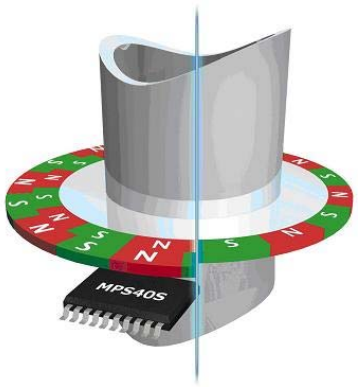

Figure 2: Two different configurations of MPS40S with single or double track multipole ring magnet

2 Functional Description

The MPS40S requires a multi-pole magnetic strip or ring with a typical pole length of 2mm (4mm pole pair length). Other pole lengths may also be used, the pole pitch can be configured by programming.

The magnetic field strength of the multi-pole magnet should be in the range of 5 to 90mT at the chip surface.

The Hall elements on the MPS40S are arranged in a linear array of up to 16 sensors. In addition a smaller, second array is available to read a reference track for generating index pulses. These index pulses allow absolute position measurement, e.g. by resetting a counter with these index pulses and counting the A and B pulses from that position (see Figure 5).

By moving the multi-pole magnet over the Hall array, a sinusoidal signal (SIN) is generated internally. With proper configuration of the Hall elements, a second 90° phase shifted sinusoidal signal (COS) is obtained. Using an interpolation circuit, the length of a pole pair is divided into 160 positions and further decoded into 40 quadrature pulses. The quadrature outputs A and B as well as the reference Index output are programmable as either push/pull or open drain outputs.

An Automatic Gain Control provides a large dynamic input range of the magnetic field.

A programmable Analog output pin allows access to signals like a magnetic field strength indicator or the raw SIN and COS signals.

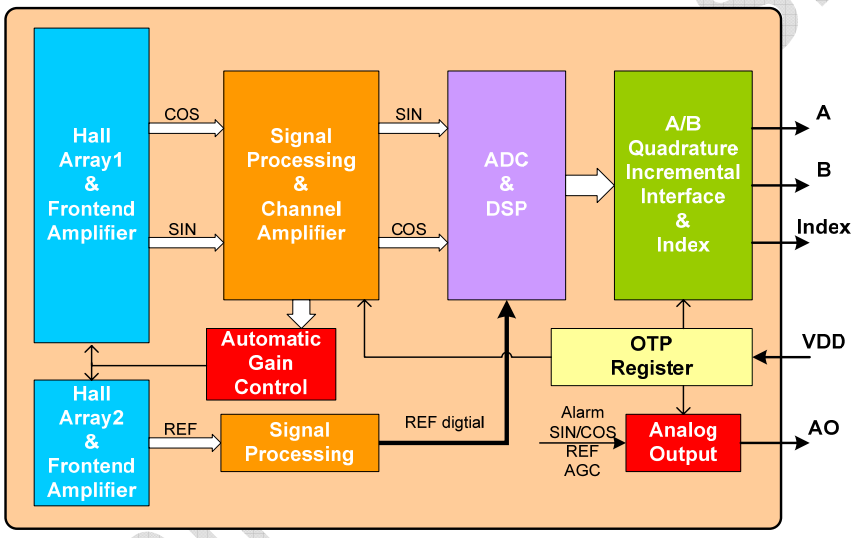

Figure 3 MPS40S Block Diagram

3 Sensor Placement in Package

TSSOP20 / 0.65mm pin pitch

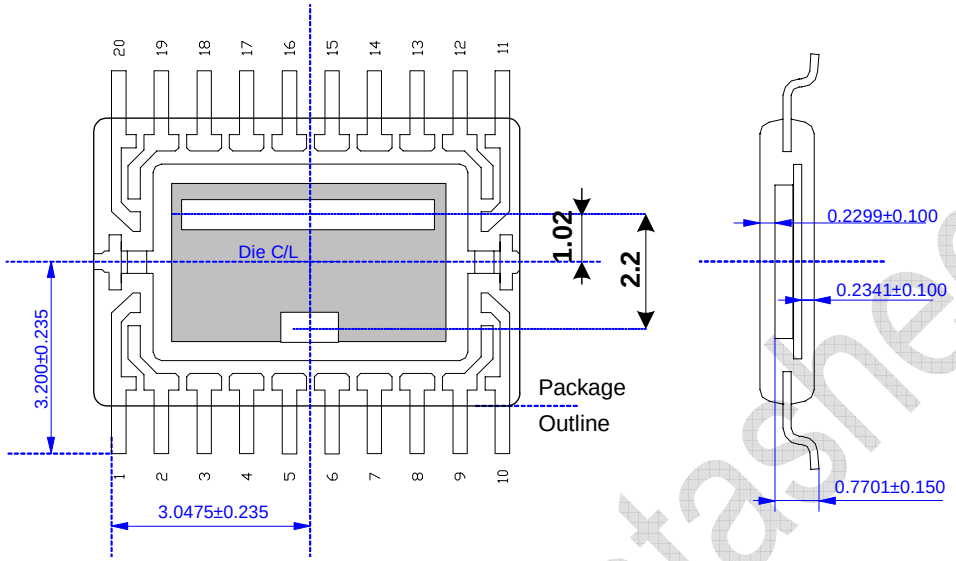

Figure 4: Sensor in Package

Die Tilt Tolerance ±1°

3.1 PIN DESCRIPTION

Pin	Pin Name	Pin Type	Notes
1	VSS	S	Supply ground
2	A	DO_OD	Incremental quadrature position output A. Short circuit current limitation
3	VDDP	S	Peripheral supply pin, connect to VDD
4	B	DO_OD	Incremental quadrature position output B. Short Circuit Current Limitation
5,12,13, 14,17,18,19	TEST	AIO	test pins, must be left open
6	AO	AO	Analogue Output of internal SIN, COS, REF signal for evaluation purpose and digital ALARM output.
7	VDD	S	Positive supply pin
8	INDEX	DO_OD	Incremental Reference Position Output (Active High) Short Circuit Current Limitation
9,10,11	NC		
15	TEST_GND	S	test pin, must be connected to VSS
16	VDDA Hall	S	Hall Bias Supply Support (connected to VDD)
20	ZPZmskdis	DI	Retest Input, connect to VSS during operation

PIN Types:

S	supply pin	AO	analogue output
AIO	analog input / output	DI	digital input
DO	digital output	NC	Not Connected
DO_OD	digital output push pull or open drain (programmable)		

3.2 Electrical connection

The supply pins VDD, VDDP and VDDA are connected to +5V. Pins VSS and TEST_GND are connected to the supply ground. An 100nF decoupling capacitor close to the device is recommended.

The default configuration of the MPS40S is a pole pair period of 4mm (2mm pole length) and a resolution of 40 pulses per pole period at the quadrature outputs A and B. The Index pulse output is enabled. The Analog Output (AO) is disabled.

3.3 Incremental Quadrature AB / Index Output

The digital output is compatible to optical incremental encoder outputs. Direction of rotation is encoded into two signals A and B that are phase-shifted by 90°. Depending on the direction of rotation, A leads B (CW) or B leads A (CCW), see Figure 5.

A reference signal (Index) is added if the magnetic input field is positive at the positive zero crossing of the high resolution magnetic input. As shown in Figure 5, the S/N-transition of the interpolation track in clockwise direction always occurs at a S-pole of the reference track , except at the Index position (in the center of the picture), where the S/N transition coincides with a N-Pole of the reference track. This unique configuration is detected and an index pulse is generated at this position.

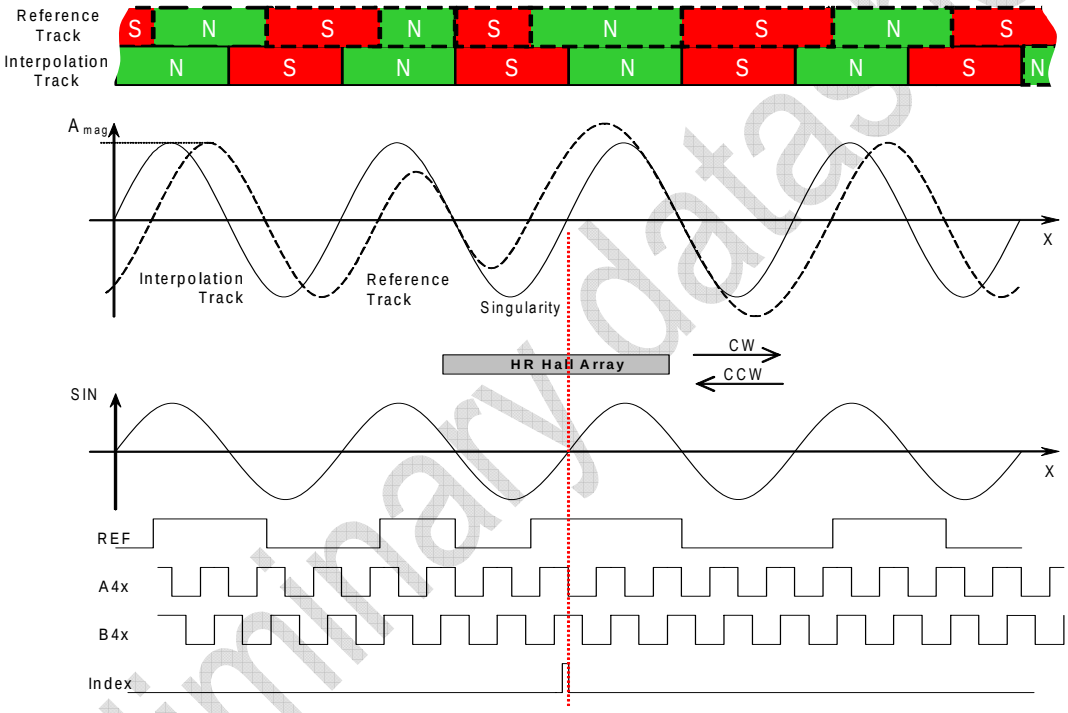

Figure 5 Incremental A/B Output with reference pulse C (shown are 4 pulses per period for clarity)

4 Device Programming

The MPS40S does not require any additional pin for programming. It is programmed by modulating the voltage at the supply pins.

The following parameters are programmable:

- Pole length: 1.13mm to 2.95mm (Full period mode) and even to 5.90mm (Half Period mode)
- Function of Common Analog Output (CAO); 1 of 5 options: Magnetic field strength, SIN, COS, REF, Alarm
- Interpolation factor: 40, 20,10, 5, 32,16,8,4 pulses per pole pair.
- Programming lock (inhibits further programming)
- Digital outputs A,B,Index: push/pull or open drain

5 GENERAL DEVICE SPECIFICATIONS

5.1 ABSOLUTE MAXIMUM RATINGS (NON OPERATING)

Stresses beyond those listed under “Absolute Maximum Ratings“ may cause permanent damage to the device.

PARAMETER	SYMBOL	MIN	MAX	UNIT	NOTE
Supply	VDD	-0.3	7	V	Except ZPZ programming
Input Pin Voltage	V_{in}	VSS-0.5	VDD+0.5	V	
Input Current (latchup immunity)	I_{scr}	-100	100	mA	Norm: Jedec 18
ESD		+/-2		kV	Norm: MIL 883 E method 3015
Package Thermal Resistance	Θ_{JA}		114.5	°C /W	Still Air / Single Layer PCB
Storage Temperature	T_{strg}	-55	175	°C	
Soldering conditions	T_{lead}		260	°C	Norm: IPC/JEDEC J-STD-020C
Humidity non-condensing		5	85	%	

5.2 OPERATING CONDITIONS

PARAMETER	SYMBOL	MIN	MAX	UNIT	NOTE
Positive Supply Voltage	VDD	4.5	5.5	V	Except ZPZ programming
Negative Supply Voltage	VSS	0.0	0.0	V	
Power Supply Current	IDD		40	mA	A/B/C CAO unloaded
Ambient Temperature	T_{amb}	-40	125	°C	

5.3 System parameter

PARAMETER	SYMBOL	MIN	MAX	UNIT	NOTE
Power Up Time	T_{PwrUp}		500	µs	Amplitude within valid range / Interpolator locked, A B C enabled
Propagation Delay	T_{Prop}		20	µs	Time between change of input signal to output signal

5.4 A / B / Index Push/Pull or Open Drain Output

Open Drain Mode programmable over ZPZ fuse. Default: Push Pull Mode.

PARAMETER	SYMBOL	MIN	TYP	MAX	UNIT	NOTE
High Level Output Voltage	V_{OH}	0.8 VDD			V	Push/Pull mode
Low Level Output Voltage	V_{OL}			0.4 + VSS	V	
Current Source Capability	I_{LOH}	12	14		mA	Push/Pull mode
Current Sink Capability	I_{LOL}	13	15		mA	
Short Circuit Limitation Current	I_{Short}		25	39	mA	Reduces maximum Operating Temperature
Rise time	t_R			1.2	µs	Push/Pull mode
Fall Time	t_F			1.2	µs	

5.5 Magnetic Input

Sinusoidal characteristics of the magnetic Encoder Ring apply to Interpolation and Reference Track.

The magnetic pole length must be adjusted via programming. Default operating pole length is 2mm.

PARAMETER	SYMBOL	MIN	MAX	UNIT	NOTE
Magnetic Pole length	L_{P_FP}	1.13	2.95	mm	Default: 2mm (2)
Magnetic Pole length	L_{P_HP}	3.02	5.90	mm	(2)
Magnetic period length	T_{FP}	2.26	5.90	mm	$T_{mag} = 2 \times L_{Pmag}$
Magnetic period length	T_{HP}	6.04	11.80	mm	$T_{mag} = 2 \times L_{Pmag}$
Magnetic Amplitude	A_{mag}	5	60	mT	(1) (2) (3)
		7	90	mT	Reduced HallBias (zBit)
		10	90	mT	Half Period
Operating Dynamic Input Range		1:12	1:24		1:3 for interpolator input 1:4 for AGC loop (1:8)
Magnetic Offset	Off_{mag}		±0.5	mT	
Magnetic Temperature Drift	T_{dmag}		-0.2	%/K	
Input Frequency	f_{mag}	0	5	kHz	

Notes:

(1) Absolute magnetic input minimum over all parameters 5mT.

(2) The magnetic input minimum amplitude increases with increasing pole length L_{Pmag} :

Pole Length	1.51 to 2.95	1.13 to 2.15	1.51 to 2.5	2.5 to 2.95	3.02 to 5.91	mm
Min. Magnetic Amplitude	10	7	5	7.5	10	mT
Hall cell number	8 FPIp	12 FP	16 FP	16 FP	16 HP	

(3) The minimum magnetic field of the magnetic singularity can go down to 70% of the min. magnetic amplitude of the Interpolation Track.

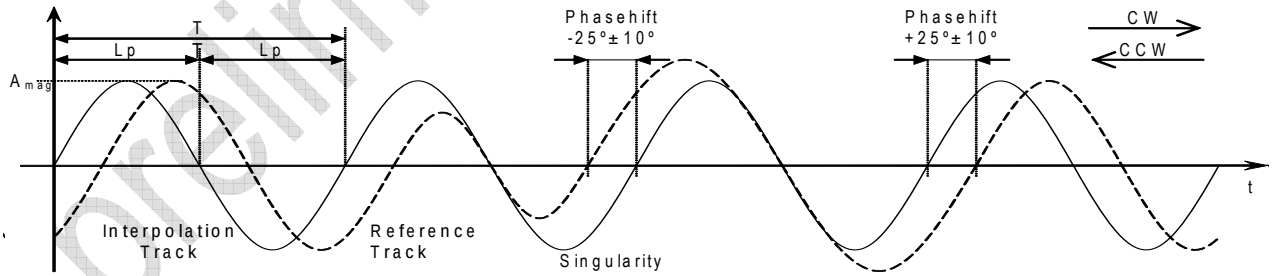

Figure 6 High Resolution and Reference Pulse Magnetic Field distribution

At the singularity the Reference Track changes the sign of the phase shift

PARAMETER	SYMBOL	MIN	TYP	MAX	UNIT	NOTE
Interpolation / Reference Track Separation			2.2		mm	see Figure 4
Interpolation / Reference Track Phase Shift	P_{shift}	(+/- 18.5)	±25	±35	°	Sign depends on direction of rotation