CH505 & CH505C

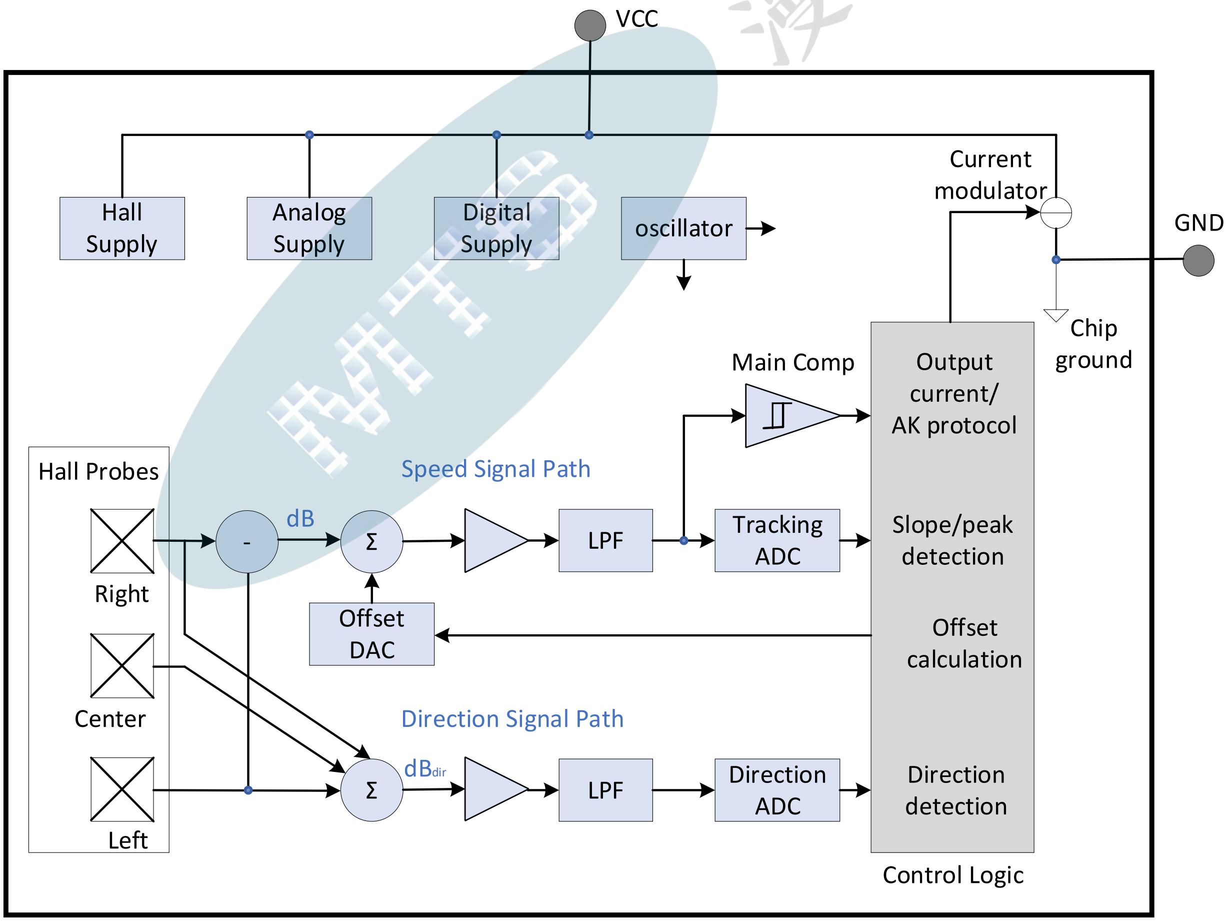
Differential Wheel Speed Sensor IC with AK Protocol

Features

- Two-wire current interface according AK protocol
- Integrated capacitor: 1-nF (C version)
- On-chip EEPROM with factory-programming options to optimize performance
- 2-mm distance between two outer hall elements with the 3rd element in the middle
- Wide operating range: 6.5V to 20V
- Detection of speed, rotation direction, airgap, etc.
- Magnetic pre-induction possible
- Wide temperature range: -40°C to 150°C
- Other variants available in the sensor family:
  - CH503 & CH503C: Single pulse (standard protocol)
  - CH504 & CH504C: PWM protocol

Package

Functional Block Diagram



Description

The CH505(C) hall-based wheel speed sensor has a two-wire current-interface with AK protocol. It provides not only speed information but also direction of wheel rotation and air gap information for vehicle & motorcycle dynamics control systems and Anti-Lock Braking Systems (ABS).

The sensor features a fast power-up time of typical 210us, high sensitivity and excellent jitter performance, enabling secure measurement. The device is specified over a wide temperature range of -40 to 150ºC, and is designed to meet harsh automotive environment with optimized ESD and EMC performance. For best BCI performance, the CH505C is provided with a 1-nF integrated capacitor.

Revision History

Date	Revision	Change
April 2022	0.1	Preliminary

Table of Contents

1 Product Family Members

Part No.	Marking	Description
CH505	C505	Two-wire AK protocol, CSO-2 package, packing blister carrier tape, QTY TBD, without integrated capacitor
CH505C	C505C	Two-wire AK protocol, CSO-2 package, packing blister carrier tape, QTY TBD, with integrated capacitor

*See separate datasheets for CH503 and CH504. *目前处于前期样片阶段，为方便备样，丝印暂时是统一的，但会做标签区分。请以原厂沟通的信息为准。

2 Pin Definitions and Descriptions

Pin No.	Name	Type	Function
1	VDD	Supply	Supply voltage
2	GND	Ground	Connect to ground

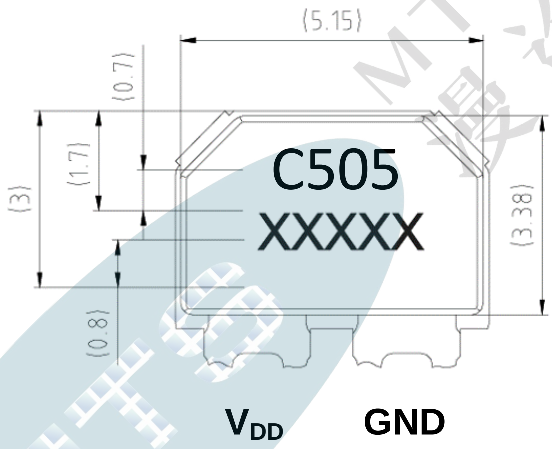


Figure 1 Pin Assignment and Top-Side-Marking of CSO-2 Package

3 Absolute Maximum Ratings

T_J= – 40℃ to 150℃, 4.5 V ≤ V_{DD} ≤ 20 V unless otherwise noted.

Parameter	Symbol	Note / Test Condition	Values		Unit
			Min	Max	
Supply voltage	V_{DD}	T_J ≤ 80°C	-0.3	-	V
		T_J ≤ 150°C		20	
		t=10 x 5min		22	
		t=10 x 5min, R_M ≥ 50Ω		24	
		t=2min; T_J= -40°C to 60°C		24	
		t=400ms, R_M ≥ 50Ω included in V_{DD}		26	
Junction temperature[1]	T_J; Either	12500h	-40	110	°C
	OR	10000h		125	

[1] Lifetime data pending on Cosemitech's qualification test results.

	OR	5000h		150	
	OR	2500h		160	
	OR	500h		170	
	Additional	4h, V_{DD}<16.5V		190	
Reverse polarity voltage		R_M = 50Ω included in V_{DD} t<1h	-16		V
Reverse polarity current		External current limitation required, t<4h		200	mA
		External current limitation required, t<1h		300	mA
		External current limitation required, t<10h, T=25°C		200	mA
Package thermal resistance	R_{thJA}			[2]TBD	K/W
Number of power on cycles			500		cycles
Immunity to external fields		Equivalent to 1600kA/m[3]; T_J = -40 to 175°C		2	T
Passive lifetime[1]		T_J ≤ 50°C, U=0V	TBD		a
Processability		After Datecode	TBD		a

[2] Pending on Cosemitech's data of CSO-2 package
[3] Conversion: B= μ*H (μ=4*π*10^{-7}).

4 ESD Protections

ESD values below are to be updated after ESD report ready

Parameter	Test Result	Classification level	Notes
HBM	TBD	AEC-Q100-002, H3B	R = 1.5 kΩ, C =100 pF
CDM	TBD	AEC-Q100-011, C4	

Results below are tested by a leading sensor Tier1 customer.

工作状态	放电位置	放电类型	放电网络	电压等级	功能状态要求	CH505	CH505C
断电	引脚	接触放电	C=150pF, R=330Ω	±4KV	Ⅰ	Pass	Pass
	导体外壳	接触放电	C=150pF, R=330Ω	±6KV	Ⅰ	Pass	Pass
	非导体外壳	空气放电	C=330pF, R=2kΩ	±8KV	Ⅰ	Pass	Pass
通电	传导位置	接触放电	C=150pF, R=330Ω	±8KV	Ⅰ	Pass	Pass
	传导与非传导位置	空气放电	C=330pF, R=2kΩ	±8KV	Ⅰ	Pass	Pass
			C=330pF, R=2kΩ	±20KV	Ⅲ	Pass	Pass

5 Specification

5.1 Test Circuit

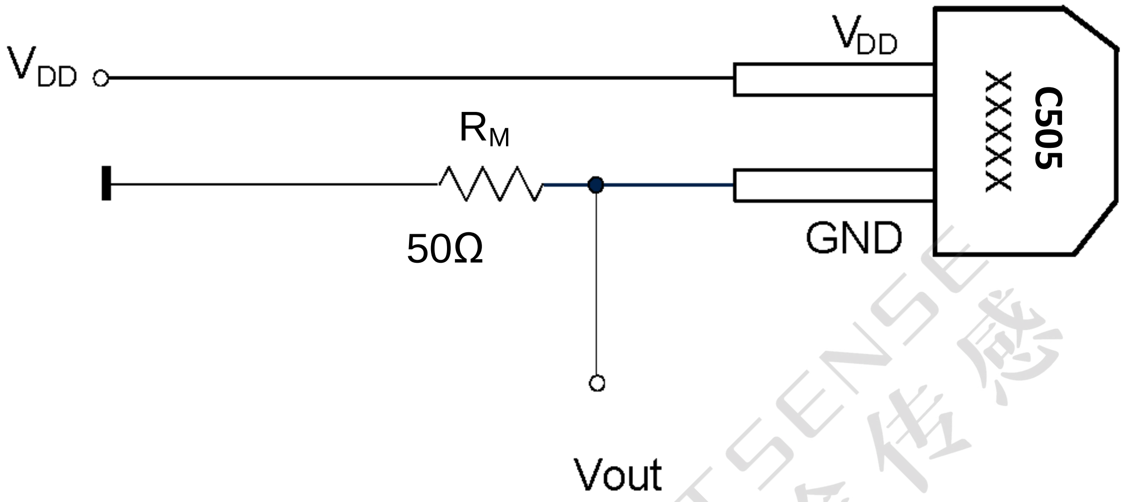


Figure 2 Test Circuit

5.2 Operating Range

Specifications below refer to these operating conditions unless otherwise noted.

Parameter	Symbol	Note / Test Condition	Values Min	Values Typ	Values Max	Unit
Supply voltage	V_{DD}	Directly on IC leads; voltage drop at R_M not included	6.5	–	20	V
V_{DD} Hysteresis	V_{res}	AK: reset voltage	4.0	4.2	4.5	V
	V_{hys}		1.6	1.8	2.3	V
	V_{rel}	AK: return voltage	5.8		6.5	V
Supply voltage modulation	V_{AC}	V_{DD} =13V; 0 < f_{mod} <150kHz[1]			6	V_{pp}
Junction temperature	T_J	12500h[2]	-40		110	°C
		10000h[2]			125	°C
		5000h			150	°C
		2500h			160	°C
		500h			170	°C
Pre induction	B_o		-500		500	mT
Temperature change per magnetic period for valid	dT_{j_Dir}	[3]Valid for dB_{dir} >1.9mT	-7.5		7.5	K
Temperature change at standsill	dT_{j_Speed}	[4]Valid for dB>3mT	-150		50	K

[1] Sine wave

[2] Lifetime data pending on Cosemitech's qualification test results.

[3] The permissible change of the temperature is, e.g. 7.5K per one magnetic period. For example a magnetic signal of 10Hz (T_{mag} = 0.1s) results in a max change of temperature = 7.5K / 0.1s = 75K / s. A wrong direction info may occur if dT_{j_Dir} is exceeded.

Pre induction offset between outer probes	$B_{stat\ l/r}$		-30		30	mT
Differential induction	dB		-120		120	mT
Pre-induction offset between mean of outer probes and center probe	$B_{stat\ m/o}$		-30		30	mT
Signal frequency	f		0		5[5]	kHz
Minimum magnetic frequency for direction detection	f_{dir_min}		0.54	0.66	0.83	Hz

[4] More than 2 speed protocols might be lost if the temperature change during standstill is exceeded at re-drive.
[5] 5kHz electric signal frequency are equal to 2.5kHz magnetic signal frequency (one sin period has two increments).

5.3 Electrical Specification

Specified at constant amplitude and offset of input signal, over operating range, unless otherwise noted.
Typical values correspond to VDD=12V and TA=25°C.
All parameters refer to test circuit in Figure2.

Parameter	Symbol	Note / Test Condition	Values			Unit
			Min	Typ	Max	
Supply current low	I_{low}		5.9	7	8.4	mA
Supply current mid	I_{mid}		11.8	14	16.8	mA
Supply current high	I_{high}		23.6	28	33.6	mA
Supply current ratio	I_{mid}/I_{low}		1.8	2.0	2.6	
Supply current ratio high/low	I_{high}/I_{low}		3.6	4.0	5.0	
Supply current @ $V_{DD} \geq V_{res\_min}$		[1]	1			mA
Line regulation	dIx/dV_{DD}	[1]			90	µA/V
Number of pulses suppressed		After power on and internal reset[1]			0	
Magnetic edges required for first output pulse		[1]			1	edge
Number of pulses required for initial offset calibration	n_{start}	5th "pulse" is offset corrected[2,1]			4	edges
Number of pulses required for initial LM measurement		[1]	3		4	pulses
Number of pulses required for initial valid direction detection[3]	$n_{DR\text{-}start}$	4th pulse has valid direction info, $dB_{dir} \geq 2{*}dB_{dirmin}$[4,1]			4	pulses

[1] Verified by design/characterization only.
[2] After power on or chip reset.
[3] Assume same direction.
[4] After power, chip reset, or direction reset (after timer watchdog).

		7th pulse has valid direction info, $2*dB_{dirmin} > dB_{dir} \geq dB_{dirmin}$[14]			7	pulses
Valid direction after change of direction[5]		3rd pulse has valid direction info, $dB_{dir} \geq 2*dB_{dirmin}$[14]			3	pulses
		6th pulse has valid direction info, $2*dB_{dirmin} > dB_{dir} \geq 1.8*dB_{dirmin}$[14]			6	pulses
		7th pulse has valid direction info, $1.8*dB_{dirmin} > dB_{dir} > dB_{dirmin}$[14]			7	pulses
Frequency limit for direction information availability	$f_{dir\text{-}limit}$	due to bit stump suppression		2700[6][1]		Hz
Power up time		time for stable current			1	ms
Initial calibration delay time	$t_{d,input}$	additive to power up time		220	300	us
Duty cycle in calibrated	DC_{cal}	dB >=2mT sine wave	40	50	60	%
Duty cycle in uncalibrated	DC_{uncal}	dB >=2mT sine wave	20		80	%
Jitter, 1Hz < f < 5kHz	$S_{jit\text{-}close}$	$T_J \leq 150^oC$, dB >=2mT; 1σ value[7]			±2	%
		$T_J \leq 170^oC$, dB >=2mT; 1σ value			±3	%
Jitter, 1Hz < f < 5kHz	$S_{jit\text{-}far}$	$T_J \leq 150^oC$, 2mT > dB > dB_{limit}; 1σ value			±4	%
		$T_J \leq 170^oC$, 2mT > dB > dB_{limit}; 1σ value			±6	%
Jitter for speed pulse		rising edge of speed pulse relative to magnetic edge change[1]	0		0.7	us
Jitter @ board net ripple f<5kHz	$S_{jit\text{-}AC}$	$V_{DD}=13V \pm 6V_{pp}$; $0<f_{mod}<150kHz$; dB=15mT			±0.5	%
Current ripple @ ΔV_{DD} =0V	dI @dV=0V	pulse shape: triangular[1]				
	pulse height				1	mA
	pulse length				400	ns
Pulse width for speed pulse	t_p	Trigger level=10.5mA[1]	40	50	60	µs
Pulse width for data bits	t_p	[1]	40	50	60	µs
Standstill time	t_{stop}	[1]	120	150	180	ms

[5] Assume change of direction of rotation only once.
[6] Direction info is updated at every speed protocol. The direction bit corresponds in any case with the physical reality of the direction of rotation
[7] If no switching of sensor is detected during 750ms (+/-20%) signal watchdog is activated and direction detection is reset (GDR=0). After 16 edges (detected with dB_2 x dB_{limit}) sensor resets itself and goes into uncalibrated mode.

Pulse width $t_p/2$ for initial bit	$t_{p/2}$	[1]	20	25	30	µs
Pulse width t_p for time output offset due to bit stump suppression	$t_{p\_Bit\_supp}$	[1]	40	50	60	µs
Systematic phase error of output edges during start-up and uncalibrated mode		Systematical phase error of “uncal” edge; nth vs. (n+1)th edge (random phase error not included) [1]	-90		90	°
Phase shift from uncalibrated to calibrated			-10		10	°
Current slew rate	SR_r, SR_f	*10% and 90% value* R_M=50Ω, T_J<170°C	8		26	mA/µs
Signal watchdog reset	n_{swd}	[18]	16		16	edges

[8] If no switching of sensor is detected during 750ms (+/-20%) signal watchdog is activated and direction detection is reset (GDR=0). After 16 edges (detected with dB_2 x dB_{limit}) sensor resets itself and goes into uncalibrated mode.

5.4 Magnetic Characteristics

Parameter	Symbol	Note / Test Condition	Values			Unit
			Min	Typ	Max	
Limit threshold[1,2]	dB_{limit}	99% criteria (1 of 96)[3]	0.3	0.8	1.34	mT
Limit threshold drift	$dB_{limit:Drift}$	Additional drift over lifetime at 25°C for one and the same sensor	-5		+3	%
Limit range Bit[1]	dB_{LR}	+/-36%, 99% criteria	1.02	1.6	2.18	mT
		T_J=10 to 40°C, 99% criteria	1.28	1.6	1.92	mT
Limit range bit drift	dB_{LR_Drift}	Additional drift over lifetime at 25°C for one and the same sensor	-5		+3	%
Ratio dB_{LR} / dB_{limit}			1.7	2.0	2.5	
Minimum signal for direction detection	dB_{dirmin}	Valid for GDR=0; dB_direction=center-(left+right)/2; cal mode, 99% criteria	0.4	0.8	1.44[1]	mT
Validity of signal amplitude measurement	SLM	“0” = valid, invalid after under-voltage and initial value after power up				
Signal amplitude (Level in relation to LR)	LM=0	99% criteria, according to AK	<0.8	<=1	<=1.2	
	LM=1		>0.8	>1	>1.2	
	LM=2		>1.48	>1.75	>2.1	
	LM=3		>2.5	>2.95	>3.6	
	LM=4		>4.2	>4.95	>6.0	

[1] Value tested at 0h (to be updated with Cosemitech’s actual characterization data; currently design spec only)
[2] Valid and characterized for f >1Hz (to be updated with actual characterization data; currently design spec only)
[3] 50% criterion has typical value of 0.7mT; to be updated

	LM=5		>7.0	>8.25	>9.9	
	LM=6		>12.0	>14.2	>17.1	
	LM=7		>21.0	>24.7	>29.7	

Note: All magnetic values are calculated out of measured sensitivity of each single Hall element.

5.5 Degradation of Direction Signal

With the two outer hall elements distance being 2mm, the direction signal **dB_direction** (= center - (left + right) / 2) is optimized for a target wheel pitch of 4 mm. Increase the magnetic input signal to compensate signal loss for pitches other than 4 mm. With an ideal pitch of 4 mm, the absolute speed signal is 2 x higher than direction signal due to differential principle. Both speed and direction signals in **Figure 3** are normalized to magnetic speed signal for an ideal pitch of 4 mm.

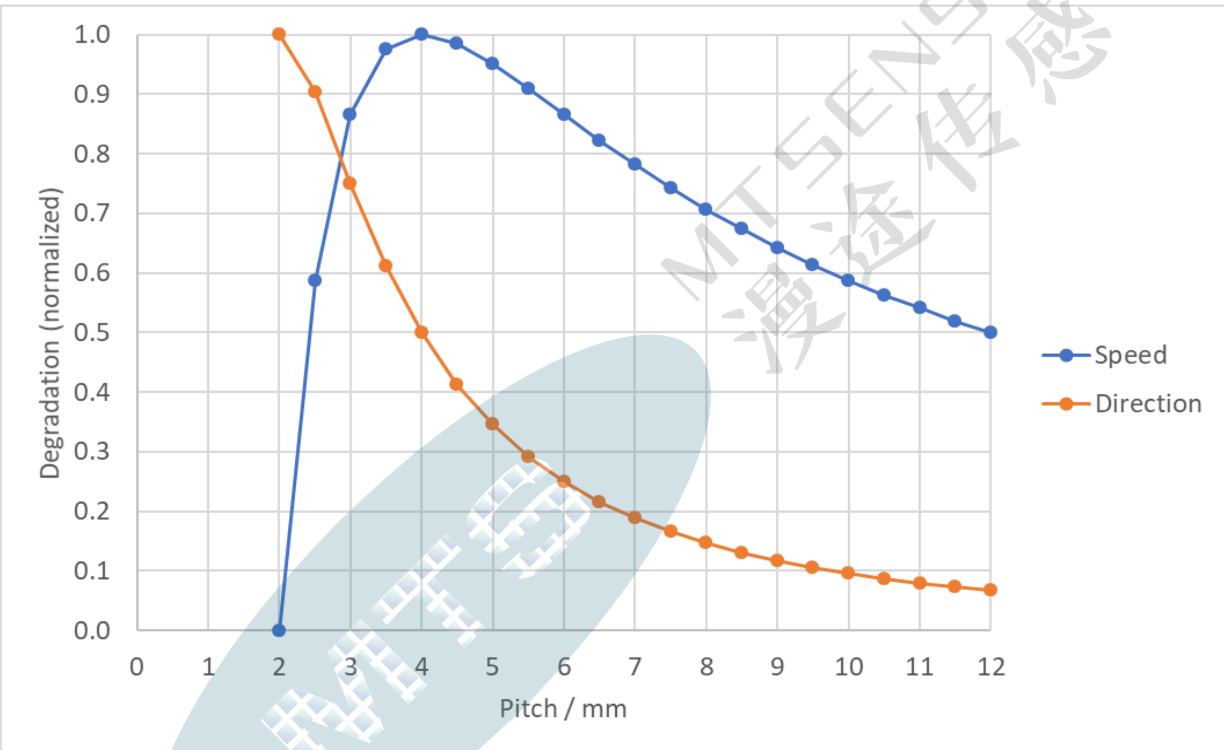


Figure 3 Degradation of speed and direction signal dependent on pitch of the wheels

6 Function Description

6.1 General

The CH505(C) detects the motion of active wheels (multiple encoder) and passive wheels (i.e., having ferromagnetic teeth) by measuring the differential flux density of the magnetic field. A back-biasing permanent magnet must be used when pairing with passive wheels. Either south or north pole of the magnet can be attached to the back side of the IC package.

Featured with AK protocol, the device provides speed, direction of rotation, and the quality of the magnetic signal. This is accomplished with three equally-spaced Hall elements, integrated on the IC. The two outer Hall elements have a distance of 2 mm, generating a differential signal that derives the speed of the wheels. The 3rd Hall element is placed in the middle, and together with the outer ones for direction detection.

The device is designed with a dynamic self-calibration algorithm to cancel magnetic offset up to ± 30mT. Only a few magnetic edges after start-up (uncalibrated mode) are necessary for self-calibration. Independent of the mode every increment of the encoder triggers a signal output (**Figure 4**). The output signal frequency represents the increment frequency. The frequency of the magnetic signal is half of the output signal frequency.

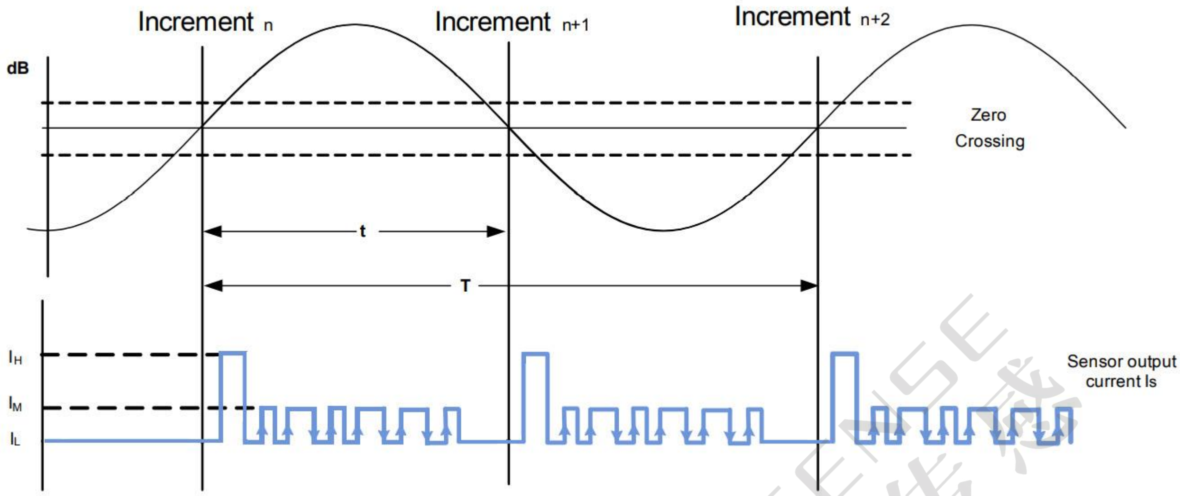


Figure 4 Definition of increment

6.2 Functional Block

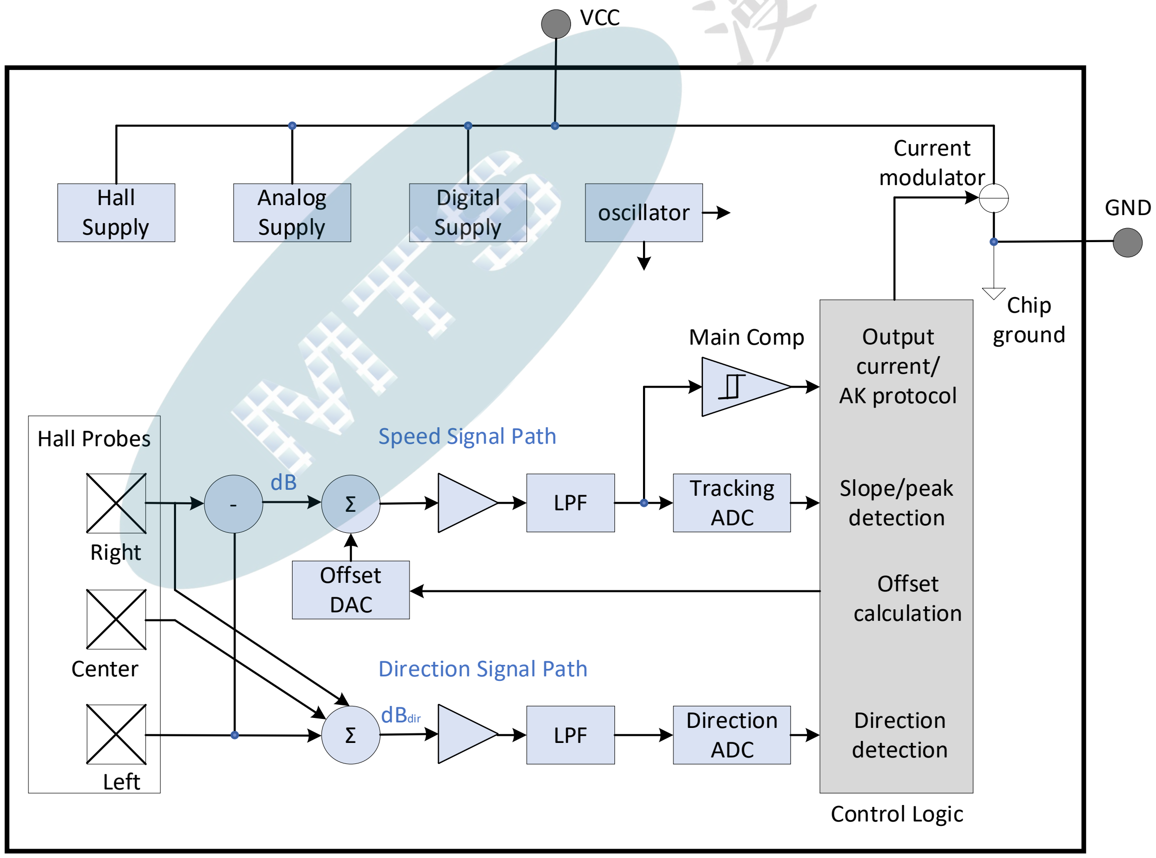


Figure 5 Block Diagram

CH505(C) main blocks are as follows.

- Three Hall elements (left, center, right)
- Speed signal (**dB**) path: Pre-amplifier, Low-pass filter (LPF), Main Comparator, Tracking ADC, Offset DAC
- Direction signal (**dB_{dir}**) path: Pre-amplifier, Low-pass filter (LPF), Direction ADC

- Digital Core (Control logic)
- Current modulator
- Supplies for Hall, analog & digital

The direction signal (**dB**) is calculated as Equation (1), amplified, filtered and then digitized by the tracking ADC.

$$\mathbf{dB = Right - Left} \qquad (1)$$

Peak detection and offset calculation are done in the digital core. The calculated offset (($dB_{max} + dB_{min}$)/2) is fed back into the speed signal path with a 14-bit DAC to correct any offsets. The main comparator compares the speed signal with zero value. In uncalibrated mode, output of speed pulse is triggered in the digital core by exceeding a certain threshold (2 x dB_{limit}). The speed pulse of the output protocol is issued by zero crossing.

The direction signal $\mathbf{dB_{dir}}$ is calculated as Equation (2), amplified, filtered and digitized. The direction information, together with other data bits are determined by the digital core which then issues the AK protocol.

$$\mathbf{dB_{dir} = Center - (Left + Right)/2} \qquad (2)$$

6.3 AK Protocol

The CH505(C) is compliant with: “Requirement Specifications for Standardized Interface for Wheel Speed Sensors with Additional Information ‘AK-Protocol’ Version: 4.0” by Daimler.

The assignable bits are described in **Figure 6** and **Table 1**.

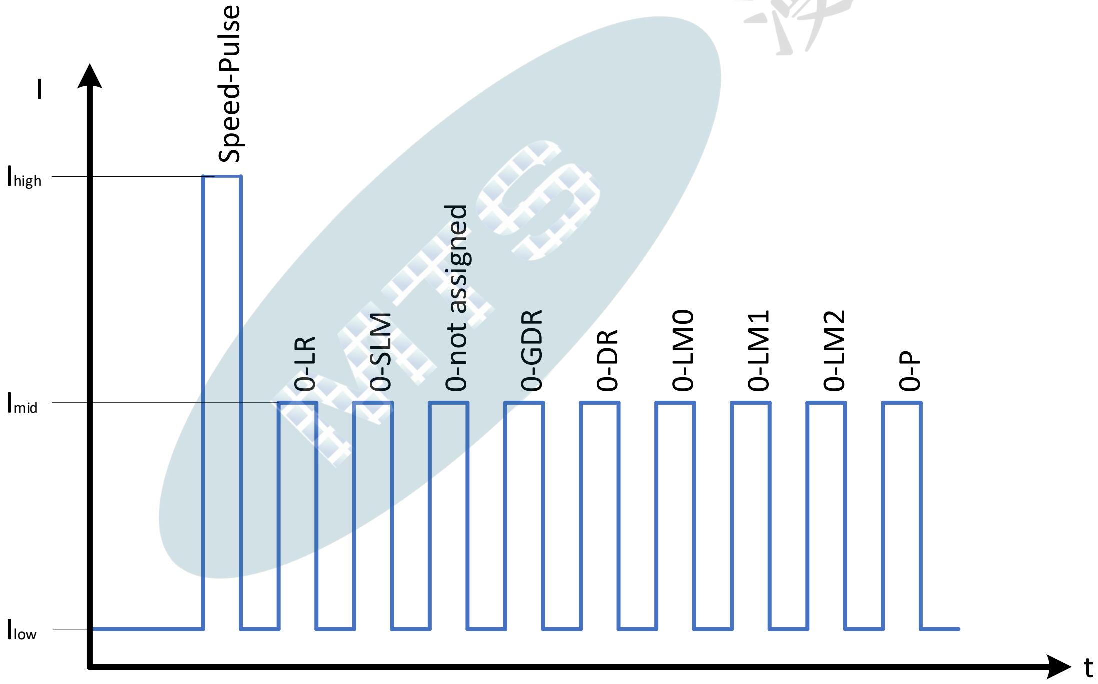


Figure 6 Coding of data bits

Table 1 AK protocol content

Bit #	Name	Meaning	Value after power up / under voltage	Condition
0	LR	Error bit, Airgap reserve	0	“1” if dB<dB_{LR} (1=error)
1	SLM	Validity of signal amplitude measurement	1	0=measurement of LM0, LM1, LM2 is valid; 1=invalid
2		not assigned	0	

3	GDR	Direction validity	0	"1" = valid, "0" = invalid
4	DR	Direction of rotating information	0	"0" =direction positive
5	LM0	Air gap gauge	0	LSB of airgap gauge
6	LM1		0	
7	LM2		0	MSB of airgap gauge
8	P	Parity	to be currently calculated	Always set to get even parity (inclusive Parity bit itself)

6.3.1 Operation at Normal Speed

When a zero-crossing of the sensor signal is detected, a wheel speed pulse is generated. The pulse duration is $\mathbf{t_p}$. Before and after a speed pulse, there is always an initial or pre-bit send with length of $\mathbf{t_p/2}$ at a level of I_{low}. After that the data protocol is sent. (Figure illustration to be added).

FIGURE

Figure 7 Operation at Normal Speed

6.3.1 Operation at High Speed

For higher frequency (>1818Hz electric signal frequency, or > 909Hz magnetic frequency), the time between two speed pulses is too short to send all data bits, thus the protocol is truncated. But to be noted, a data bit itself is not truncated during transmitting the protocol (called "bit stumps suppression"). Instead of the bits affected by the shortening, the current level $\mathbf{I_{low}}$ must be output. The suppression does function reliably in all speed ranges and in all regular operating states of the sensor including the standstill protocol. **Table 2** shows how many bits are transmitted at different signal frequencies.

Table 2 Transmitted bits at electric signal frequency

Electric Signal Frequency[21]	**Typical Number of Data Bits Transmitted**
< 1818Hz (1800Hz)	9 (bit0-bit8)
< 2000Hz (2000Hz)	8 (bit0-bit7)
< 2222Hz (2200Hz)	7 (bit0-bit6)
< 2500Hz (2400Hz)	6 (bit0-bit5)
< 2857Hz (2800Hz)	5 (bit0-bit4)
< 3333Hz (3200Hz)	4 (bit0-bit3)
< 4000Hz (4000Hz)	3 (bit0-bit2)
< 5000Hz (5000Hz)	2 (bit0-bit1)

[21] Electric signal frequency = 2x magnetic frequency. Frequencies in brackets are according AK specification

6.3.2 Operation at Very Low Speed and Standstill

If no increment is recognized for longer than standstill time (**t_{stop}**), the IC sends the standstill-protocol, at every 150ms (typ). In this protocol the speed-pulse is set to **I_{mid}**. During standstill of the wheel, the AK protocol bits are frozen and reflect the status of the last AK protocol before standstill. At very slow speed, more than one standstill protocol can be issued between consecutive speed pulses.

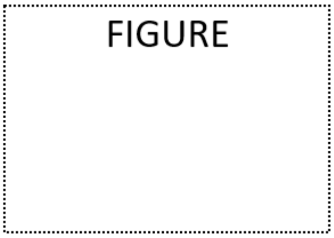


Figure 8 Operation at Standstill

(Figure illustration to be added).

6.4 Typical Application Circuit

Figure 9 shows the recommended application circuit with reverse bias and overvoltage protection.

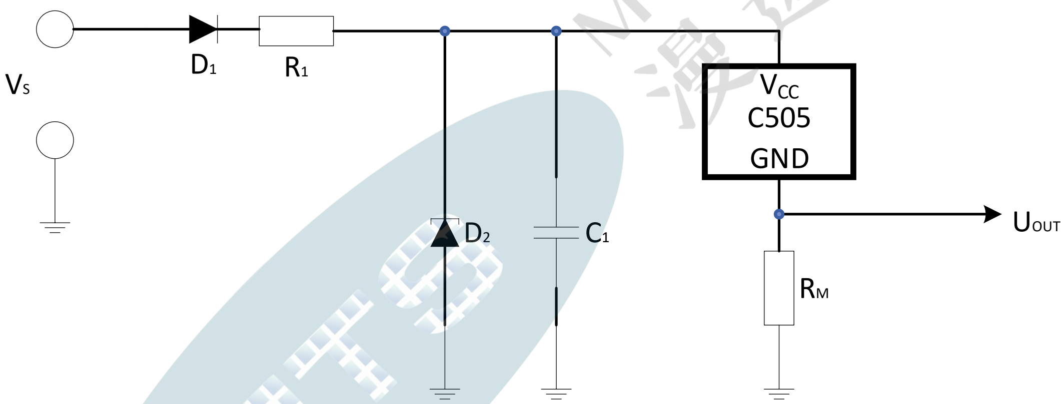


Figure 9 Application circuit

6.5 Definition of Rotation Direction

The direction definition of active wheels and passive wheels are illustrated in **Figure 10** and **Figure 11** respectively. For positive direction of rotation, the direction of rotation bit (**DR**) is set to "0".

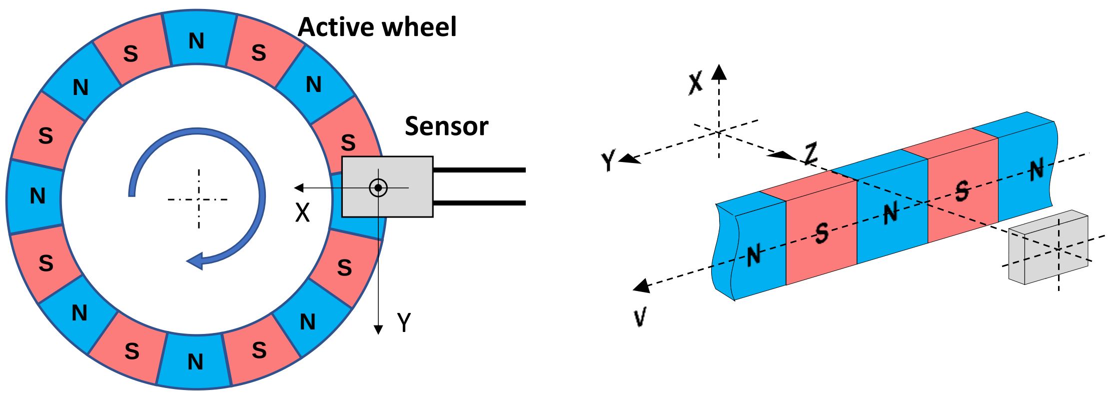


Figure 10 Definition of rotation direction, sensor frontside towards the active wheel

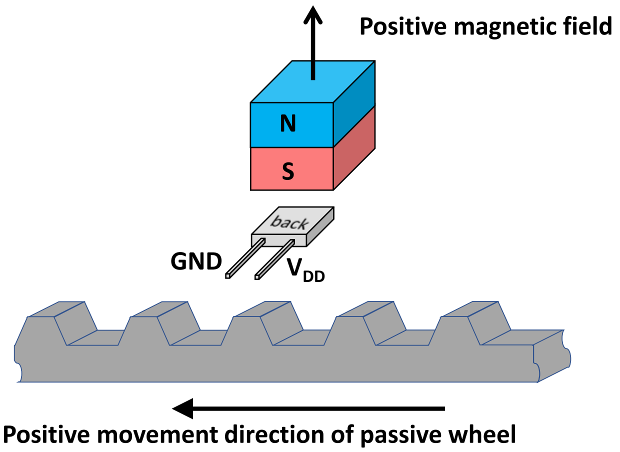


Figure 11 Definition of rotation direction, sensor frontside towards the passive wheel

6.6 Operating Modes and States

The CH505(C) provides information of speed, direction and signal quality. Its functionality can be distinguished in uncalibrated mode and calibrated mode.

6.6.1 Uncalibrated and Calibrated Mode

Speed detection

After an initial calibration delay time ($\mathbf{t}_{d\_input}$), the differential magnetic signal dB is tracked by an ADC and monitored within the digital core. To detect the signal, an internal threshold DNC (digital noise constant) needs to be exceeded. The DNC value is determined by the signal amplitude (indicated as arrows in **Figure 12**).

- The first DNC is 2 x $\mathbf{dB}_{limit}$. When the signal slope is identified as a falling (or rising) edge and the signal change exceeds the DNC, the first extrema is located and first output pulse is triggered.
- A second output is triggered when the signal change exceeds a new DNC value of (min1 + max1)/2 in the following rising (respectively falling) edge.
- When a maximum and minimum was found an offset correction will take place. This leads to a phase shift of output signal and the sensor enters the calibrated mode.

In calibrated mode switching is triggered by the zero crossing of the differential magnetic signal. The min/max detection is reduced to 1/4 of peak - peak. In calibrated mode minimal DNC is 2 x $\mathbf{dB}_{limit}$. Out of this consecutive speed pulses have a nominal delay of about 180°.

Information of other bits in uncalibrated and calibrated mode:

- Signal amplitude measurement: SLM is valid if two valid extrema are found (the first extrema after power on is invalid). Latest with 4^{th} protocol SLM is valid.
- Startup at high speeds could lead to truncated protocol as explained in **6.3.2**.

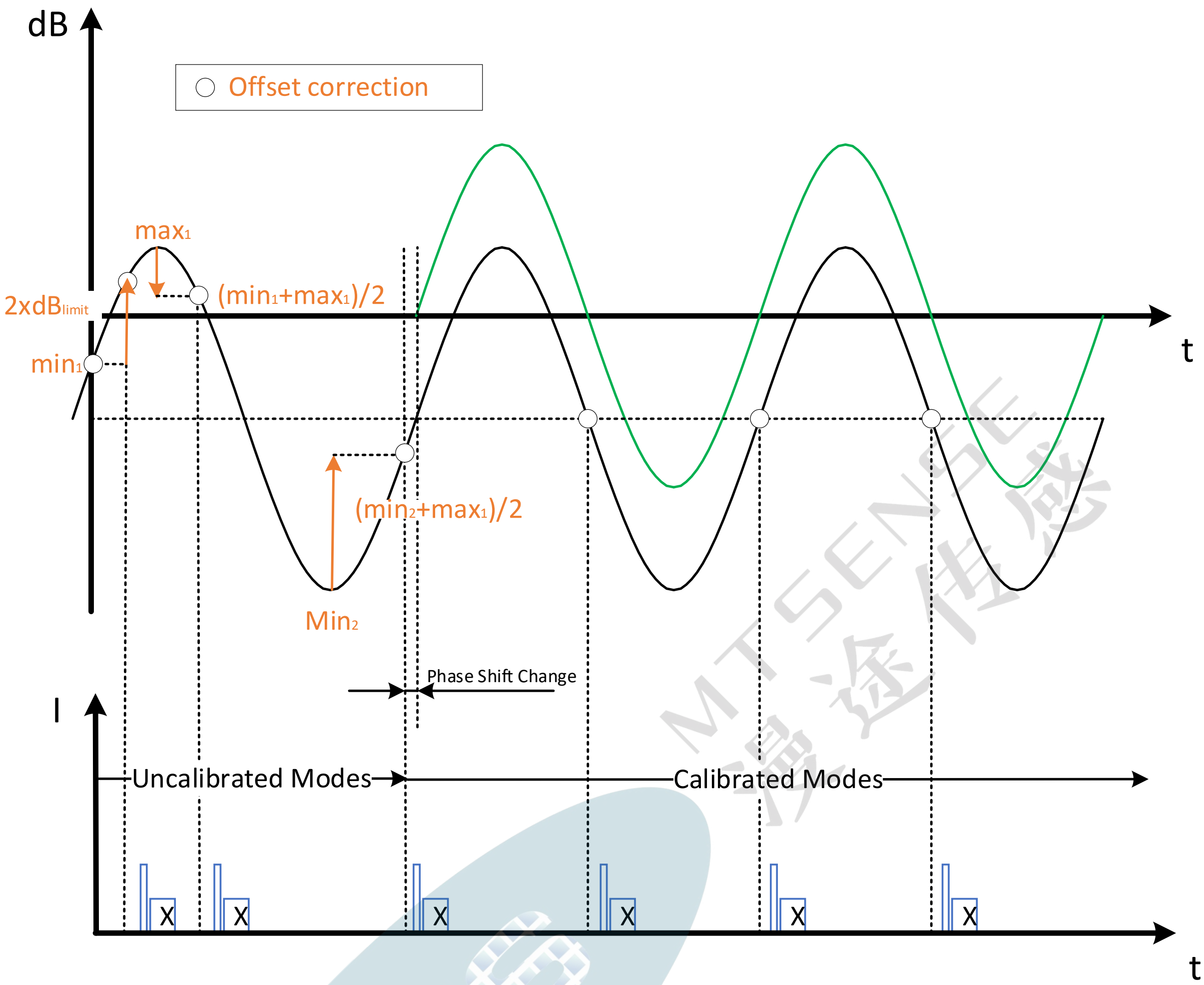


Figure 12 Transition from uncalibrated into calibrated mode

Direction detection

Direction signal is always sampled with the main comparator switching (75µs typ) before the speed protocol. After two consecutive samples of the direction signal, offset of them is calculated and then the third sample is compared with the offset value. The direction is given by the sign of the third sample direction signal and the direction of the edge (rising or falling) of the magnetic speed signal. See **Figure 13**.

Using this direction detection method, detected direction is valid latest with the 4th output speed protocol. GDR bit gives the information if the detected direction is valid.

On CH505(C) the direction detection is valid if the difference between the two consecutive samples of the direction signal is greater than 2x $\mathbf{dB_{dirmin}}$ and speed signal is 4x greater than $\mathbf{dB_{limit}}$.

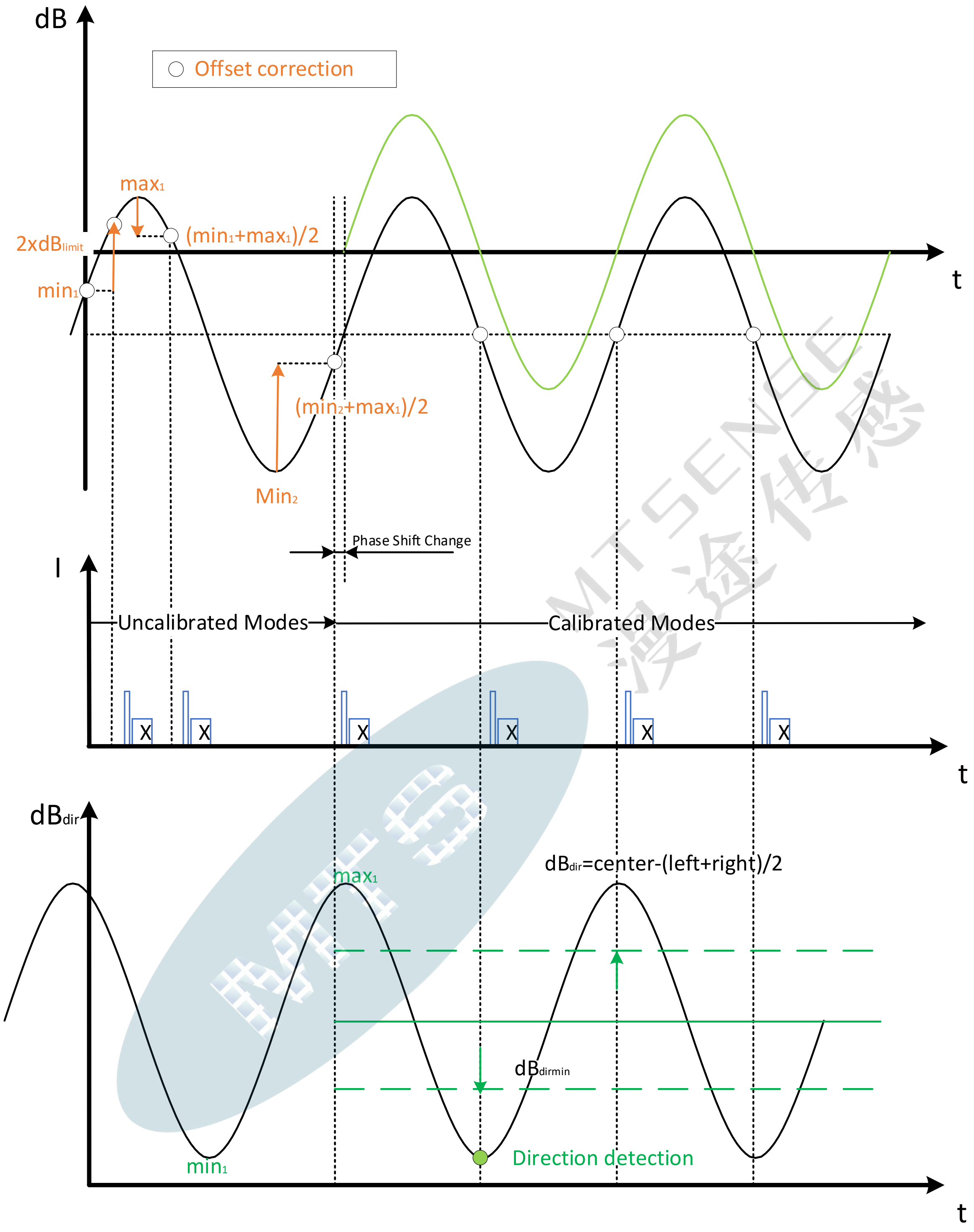


Figure 13 Output triggering in calibrated mode and direction detection

6.6.2 Start-Up and Under-Voltage Behavior

The IC stays functional when supply voltage $\mathbf{V_{DD}}$ ramps down, until the $\mathbf{V_{DD}}$ drops below the supply voltage reset level $\mathbf{V_{res}}$. In this case, the supply current drops down and the IC delivers no more output signal. Increasing $\mathbf{V_{DD}}$ again above the supply release level $\mathbf{V_{rel}}$, the IC starts sending output again.

A minimum hysteresis $\mathbf{V_{hys}}$ (= $\mathbf{V_{rel}}$ - $\mathbf{V_{res}}$) is implemented to avoid a toggling of the output when $\mathbf{V_{DD}}$ is modulated due to the additional voltage drop at R_M when switching from low to high current level at V_{DD} = 4.5V (with R_M=50).

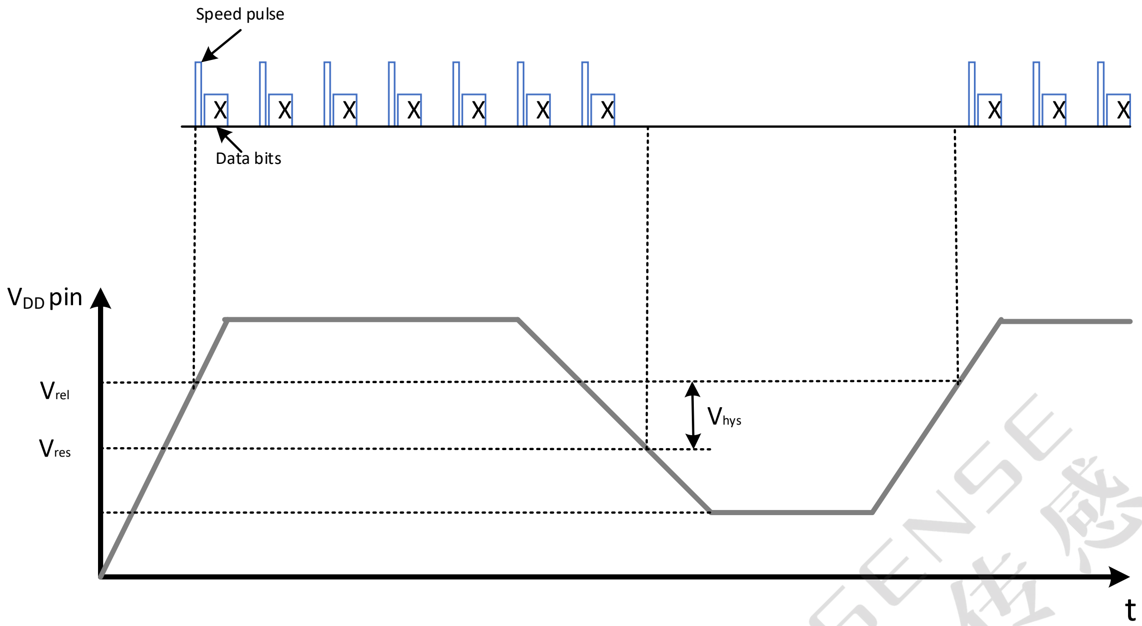


Figure 14 Start-up and under-voltage behavior

6.7 Change of Direction of Encoder

Rotation direction change can lead to a local extremum (maximum or minimum) of the magnetic input signal. This local extremum could be detected and incorrectly used for offset calibration. A local extremum is detected when the extremum exceeds the value of half of the difference between the two previous extrema (**dB** > 0.25***dB**$_{pp}$). As worst case, a duty cycle up to max 15% to 85% could occur for a few pulses. As a result, the sampling points for direction detection are also at unusual signal phase angles. Typically, after 2-3 zero crossings, a re-calibration takes place, and the offset will be then correct and hence the duty cycle.

When rotation direction changes in calibrated mode,

- Two consecutive samples of **dB**$_{dir}$ have the same sign thus direction detection is set to “invalid”. To guarantee a valid direction, the next zero crossings after direction change are used to detect direction.
- The validity of the direction information at those two speed pulses is set to “invalid”, and rotation direction is set to default.
- The validity of signal amplitude measurement is set to “invalid”, and signal amplitude contains default values and **LR** is set to 0.

At the latest with the 3rd pulse after direction change, direction information is valid and direction is issued again. Signal amplitude validity is set to valid and its according signal amplitude measurement and **LR** is issued after two new valid extrema are found.

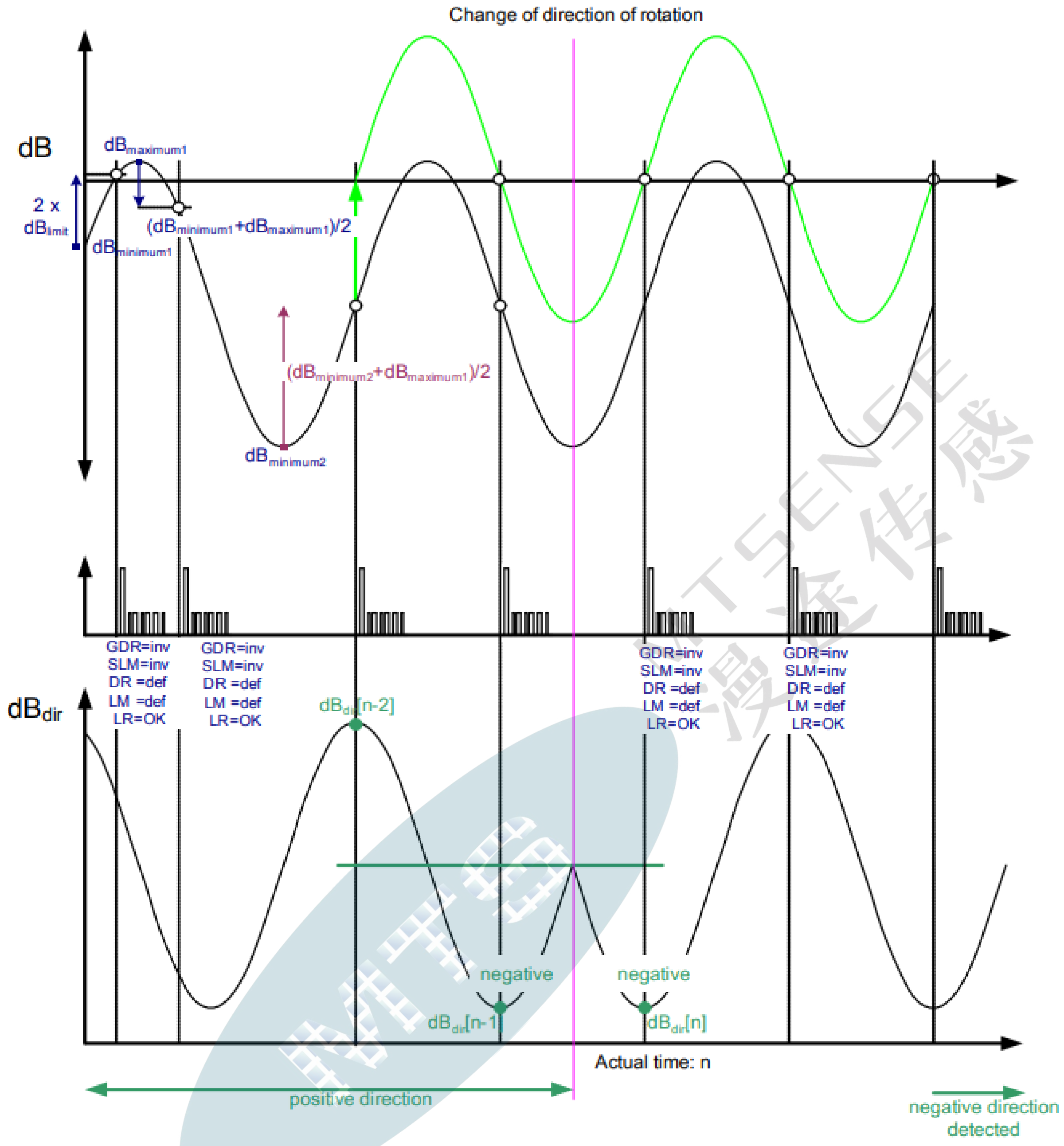


Figure 15 Signal behavior when direction of rotation changes

6.8 Watchdog Reset after Offset Jump

As shown in **Figure 16,** when an offset jump greater than the magnetic speed signal occurs, no more zero-crossing will be passed and thus the IC sends no speed pulse. Instead, standstill protocol is issued.

- After transmitting 5 standstill protocols (750ms typ), the signal watchdog starts.
- If still no speed pulse output, the IC starts to detect extreme with minimum DNC.

- Internal reset is triggered after n_{swd} edges, and uncalibrated mode starts. With that, validity of direction, direction information, validity of airgap and airgap measurement are set to default values. This represents the same status as after power on. Therefore, offset calibration starts again.

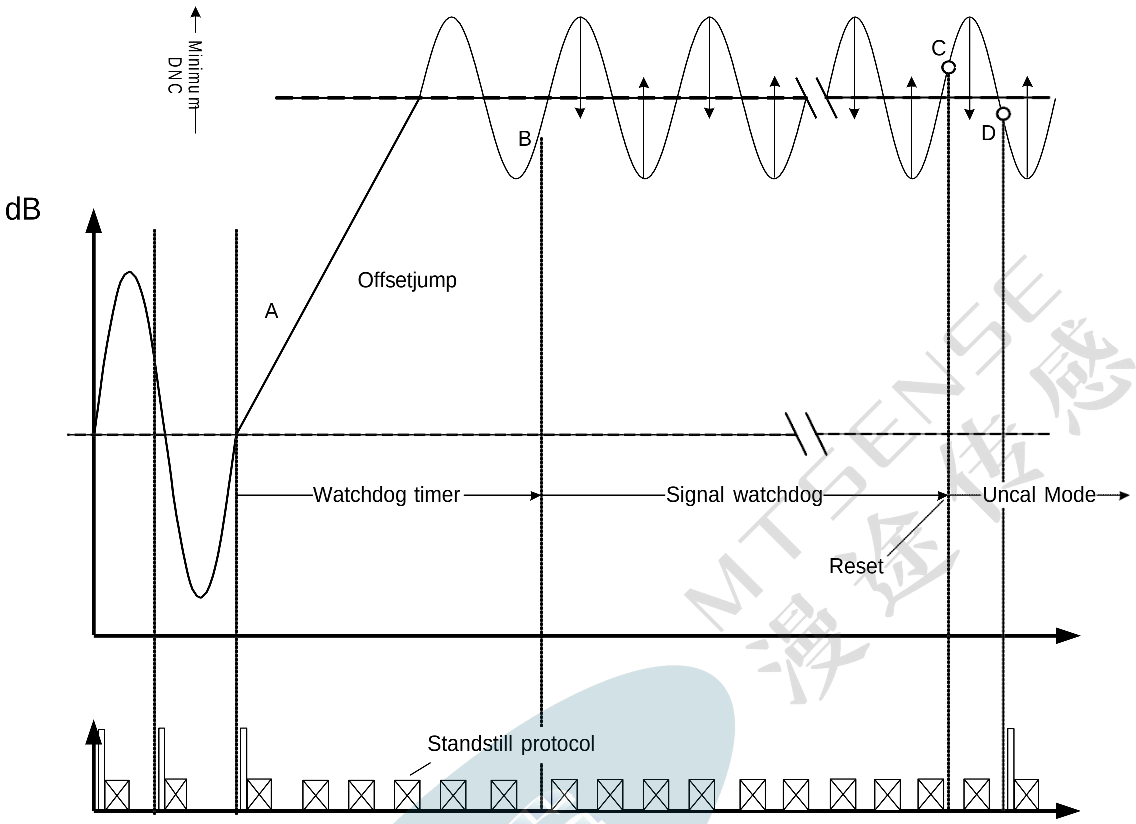


Figure 16 Reset is triggered after watchdog delay time and signal watchdog

7 Electro Magnetic Compatibility (EMC)

7.1 EMC Test Circuit

Suggested EMC test circuit, see **Figure 17**. External components can vary depending on the device version (with or without capacitor inside). Results are dependent on R_M!

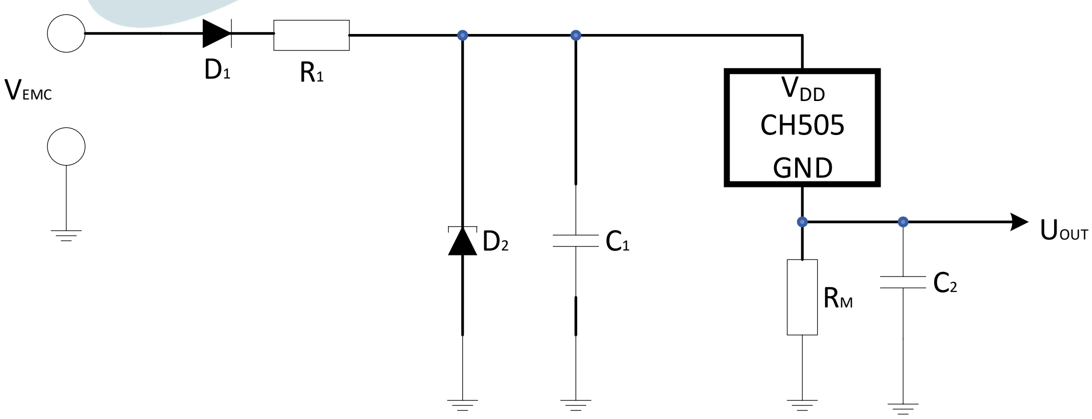


Figure 17 Recommended EMC Test Circuit

7.2 EMC Results (to be added)

7.2.1 Emission

Table 3 EMC – ICC Test Results

Table 4 EMC – CCC Test Results

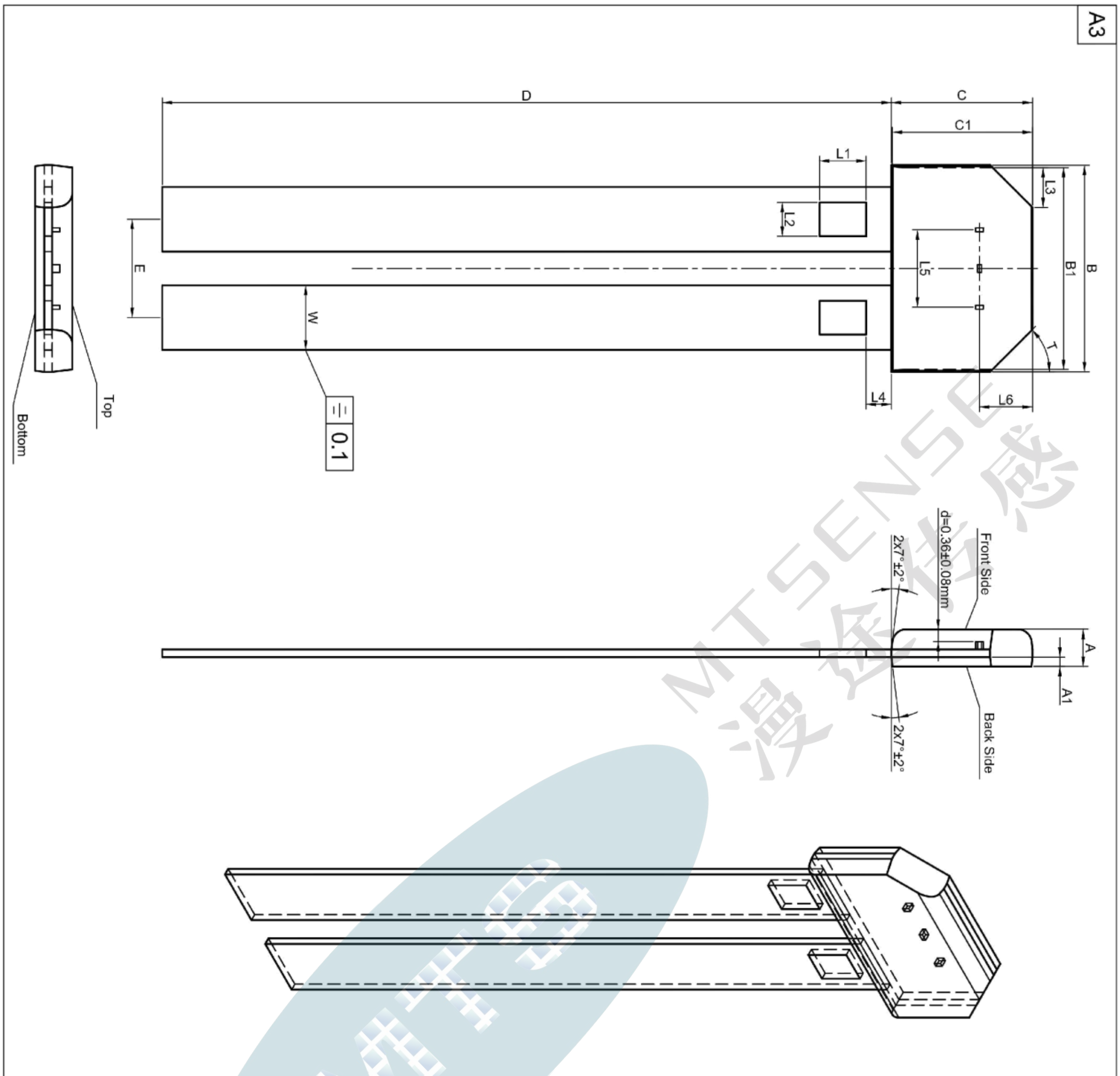
7.2.2 Immunity to radiated disturbances

Table 5 EMC - BCI Test Results

8 Package Information

For CH505 and CH505C, the L6 in POD dimension is different.
See details in **Figure 18** and **Figure 19.**

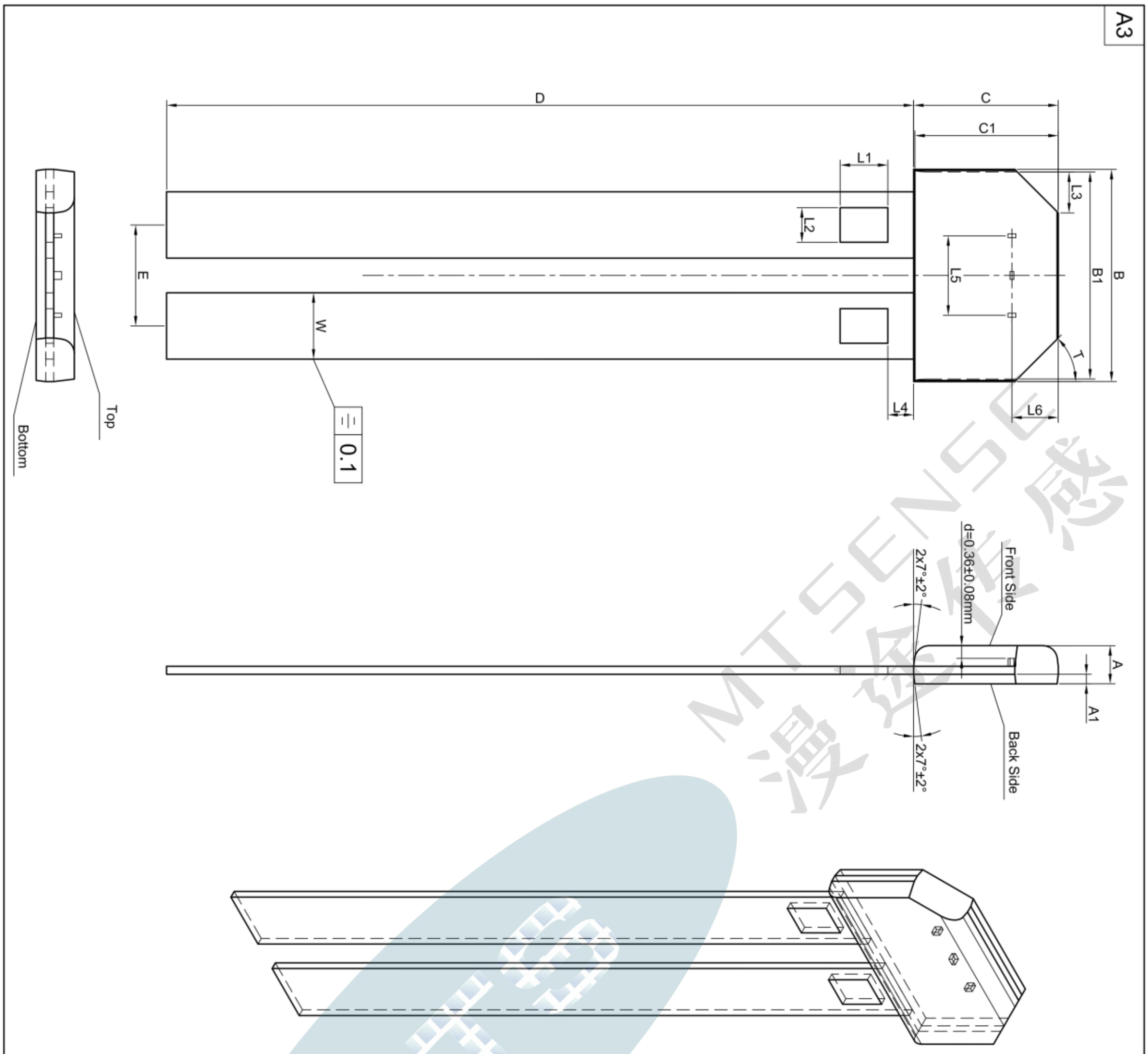
Part Number	Package	Package Dimensions
CH505	CSO-2	Figure 18
CH505C	CSO-2	Figure 19



SYMBOL	MIN	NOM	MAX
A	0.910	0.960	1.010
A1	0.190	0.240	0.290
B	5.290	5.340	5.390
B1	5.070	5.150	5.230
C	3.520	3.640	3.760
C1	3.300	3.380	3.460
D	18.600	18.800	19.000
E	2.490	2.540	2.590
F	0.192	0.200	0.208
L1	1.150	1.200	1.250
L2	0.820	0.870	0.920
L3	0.900	1.000	1.100
L4	0.550	0.650	0.750
L5		2.000	
L6	1.267	1.367	1.467
W	1.620	1.670	1.720
T		45°	

产品图	
比例	10:1

Figure 18 CH505 POD



SYMBOL	MIN	NOM	MAX
A	0.910	0.960	1.010
A1	0.190	0.240	0.290
B	5.290	5.340	5.390
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C1	3.300	3.380	3.460
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L1	1.150	1.200	1.250
L2	0.820	0.870	0.920
L3	0.900	1.000	1.100
L4	0.550	0.650	0.750
L5		2.000	
L6	1.067	1.1670	1.2670
W	1.620	1.670	1.720
T		45°	

Figure 19 CH505C POD