Inductive Position Sensor IC

1. Features

- Compliant to AEC-Q100
- Compliant to ISO26262 up to ASIL-B
- Inductive encoder - based signal processing IC, enabling through barrier operation.
- Ambient Operating Temperature Range from -40℃ to 150℃
- High Breakdown Voltage: 40V
- Selectable outputs: Analog, PWM, SPI and SAE J2716 - compliant SENT
- Programmable linear transfer characteristics (supports 4 - point/8 - point, or 16 - segment/32 - segment curves)
- Integrated sine - cosine signal self - calibration
- 32 bit programmable user ID.
- Rich on - chip diagnostics
- Open wire detection (VDD/VSS open - circuit)
- Overcurrent and overvoltage protection; undervoltage detection
- TSSOP-16 Package RoHS Compliant

2. Application Examples

- Non contact absolute position detection
- Electronic throttle pedal sensor
- EPS torque sensor
- Brake-by-wire sensor
- Throttle and EGR valve angle position detection
- Vehicle height sensor

3. Description

SC69510 is an AEC-Q100 qualified, high-precision inductive position sensor IC with through-shaft capability. Paired with optimized coil designs, it calculates absolute angular (e.g., 0–360°) or linear positions for non-contact sensing in automotive and industrial applications.

SC69510 offers versatile output interfaces, including 12-bit Analog, 16-bit PWM, and SAE J2716-compliant SENT.

SC69510, designed for automotive applications, integrates comprehensive on-chip diagnostics. Developed in compliance with ISO 26262, it achieves ASIL-B functional safety integrity.

SC69510 is packaged in TSSOP-16 with a matte tin-plated finish and halogen-free green materials, meeting environmental standards.

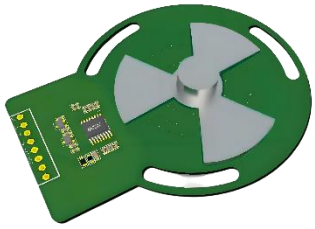


Fig.1 Rotary sensing modes

Copyright © 2025 Semiment Technology Inc.

Contents

4. Pin Definition

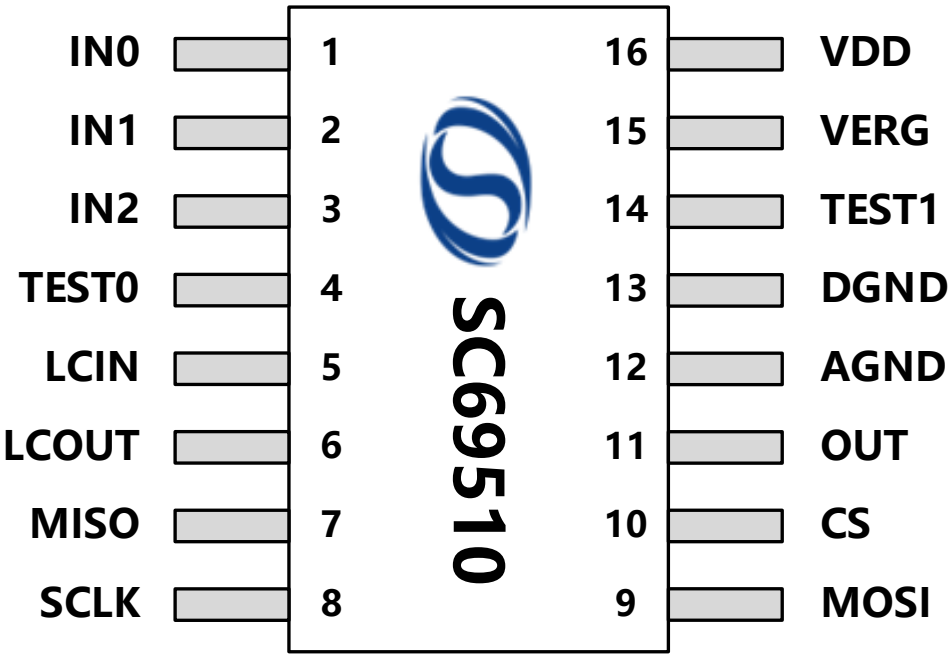


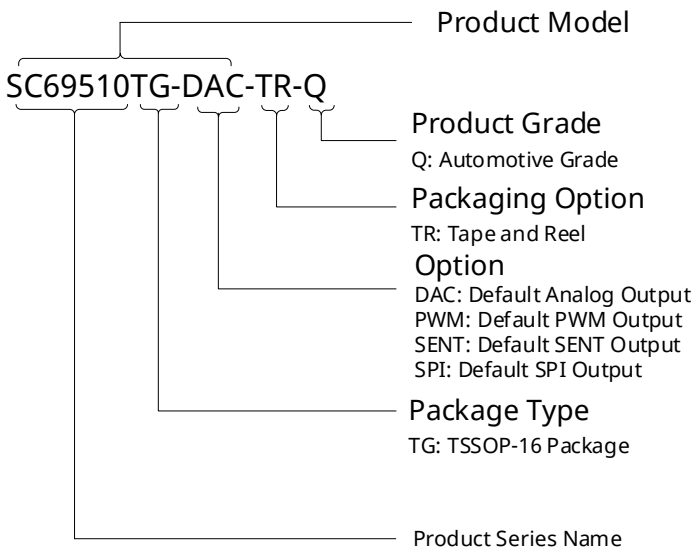
Fig.2 TSSOP16 Pin Definition

Pin		I/O type	Description
Name	Num		
IN0	1	Coil Input	Receives coil input signal IN0
IN1	2	Coil Input	Receives coil input signal IN1
IN2	3	Coil Input	Receives coil input signal IN1
TEST0	4	Test	Test pin, grounded during normal use
LCIN	5	Coil Input	Coil excitation signal input
LCOUT	6	Coil Output	Coil excitation signal output
MISO	7	SPI Communication	Sent from slave, received by master
SCLK	8	SPI Communication	SPI communication clock signal
MOSI	9	SPI Communication	Sent from master, received by slave
CS	10	SPI Communication	SPI communication enable pin
OUT	11	Output	Angle signal output
AGND	12	Ground	Analog ground
DGND	13	Ground	Digital ground
TEST1	14	Test	Test pin, grounded during normal use
VERG	15	Output	Internal LDO output of the chip, with an external 100nF decoupling capacitor
VDD	16	Power	Power supply

5. Ordering Information

Ordering Code	Silkscreen	Option	Grade	Temperature(℃)	Package	Packing	Number
SC69510TG-DAC-TR-Q	69510	DAC	Q	-40~150	TSSOP-16	Tape and Reel	3000 pcs/reel
SC69510TG-DAC-TR	69510	DAC	-	-40~150	TSSOP-16	Tape and Reel	3000 pcs/reel
SC69510TG-PWM-TR-Q	69510	PWM	Q	-40~150	TSSOP-16	Tape and Reel	3000 pcs/reel
SC69510TG-PWM-TR	69510	PWM	-	-40~150	TSSOP-16	Tape and Reel	3000 pcs/reel
SC69510TG-SENT-TR-Q	69510	SENT	Q	-40~150	TSSOP-16	Tape and Reel	3000 pcs/reel
SC69510TG-SENT-TR	69510	SENT	-	-40~150	TSSOP-16	Tape and Reel	3000 pcs/reel
SC69510TG-SPI-TR-Q	69510	SPI	Q	-40~150	TSSOP-16	Tape and Reel	3000 pcs/reel
SC69510TG-SPI-TR	69510	SPI	-	-40~150	TSSOP-16	Tape and Reel	3000 pcs/reel

Ordering Code



6. Absolute Maximum Ratings

Within the natural operating temperature range (unless otherwise specified)

Symbol	Parameter	Test Condition	Min.	Max.	Unit
V_{DD}	Power Supply Terminal Withstand Voltage	Continuous	-14	30	V
	Power Supply Terminal Withstand Voltage	t＜60s	-14	40	
V_{LCP},V_{LCN}	Excitation Pin Withstand Voltage		-2	12	V
V_{INX}	Coil Input Pin Withstand Voltage		-0.3	5.5	V
V_{OUT}	Signal Output Terminal Withstand Voltage	Continuous	-18	30	V
V_{T0}/V_{T1}	Test Pin Withstand Voltage (T0/T1)		-0.3	5.5	V
T_{EEPROM}	EEPROM Read - Write Temperature		-40	125	℃
T_A	Operating Temperature		-40	150	℃
T_{STG}	Storage Temperature		-40	150	℃
T_J	Maximum Junction Temperature		-40	170	℃

Notes:
Stresses higher than those listed herein may cause permanent damage to the device. Prolonged exposure to absolute maximum rated conditions may affect the reliability of the device.

7. Electrostatic Protection

Symbol	Parameter	Test Condition	Min.	Max.	Unit
V_{ESD_HBM}	HBM	According to AEC-Q100-002E HBM,R=1.5kΩ,C=100pF	-6	6	kV
V_{ESD_CDM}	CDM	According toAEC-Q100-011C CDM	-750	750	V

The Human - Body Model (HBM) test is in accordance with EIA/JESD22 - A114 - B HBM.

8. General Electrical Specification

The operating conditions for the following parameters: T_{AMB} = -40~150 ℃,V_{DD} = 4.5~5.5V,unless otherwise specified.

Electrical Parameter

Symbol	Parameter	Test Condition	Min.	Typ.	Max.	Unit
V_{DD_AN}	Operating Voltage		4.5	5	5.5	V
I_{DD}	Operating Current	V_{DD}=4.5~5.5V,no coil	-	5	8	mA
		V_{DD}=4.5~5.5V,with coil	-	7	10	mA
I_{OCP}	Overcurrent Alarm	V_{DD}=4.5~5.5V	-	25	35	mA
V_{REG}	Internal Regulator Voltage		3.8	4.0	4.2	V
V_{REGOVP}	Internal Regulator Overvoltage Detection		4.3	4.4	4.5	V
V_{REGUVL}	Internal Regulator Undervoltage Detection		3.4	3.5	3.6	V
$V_{DDstart}$	Start up Voltage		3.8	3.9	4.0	V
$V_{DDstartHYS}$	Start up Voltage Hysteresis			200		mV
V_{UVLO}	Brown out Detection Voltage		3.7	3.9	4.1	V
$V_{UVLOHYS}$	Brown - out Detection Hysteresis		50	100	200	mV
V_{OVP}	Overvoltage Protection Voltage		6	6.2	6.4	V
$V_{OVPHYST}$	Overvoltage Detection Hysteresis		50	100	200	mV
I_{short}	Output Short - circuit Current	Short to ground, analog output	-	-	15	mA
		Short to ground, PWM/SENT output	-	-	30	mA
		Short to power supply, analog output	-	-	15	mA
		Short to power supply, PWM/SENT output	-	-	30	mA
Clamp_lo	Programmable Clamp Voltage	Programmable	0	-	100	%V_{DD}
Clamp_hi		Programmable	0	-	100	%V_{DD}
V_{clamp}	Clamp Voltage Accuracy		-	5	10	mV

Notes:

The output range of the typical application of SC69510 is as shown in Fig.3.

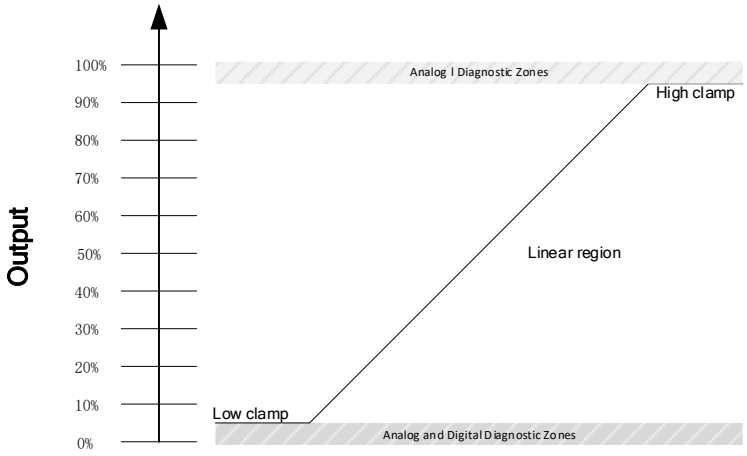


Fig.3 Output Range of Typical Application

Excitation Characteristics

Symbol	Parameter	Test Condition	Min.	Typ.	Max.	Unit
f_{tx}	Excitation Oscillation Frequency Range		2.0	-	5.0	MHz
V_{COMTX}	Oscillation Common - Mode Voltage		-	2	-	V
V_{PPTX}	Oscillation Amplitude			2.4		V
$V_{PPdrift}$	Oscillation Amplitude Temperature Drift	T_A = -40℃~150℃	-50	-	50	mV
L_{TX}	Excitation Coil Inductance Value		1	4	10	uH
R_{TXDC}	Excitation Coil Resistance Value		-	5	-	Ω
Q_{TX}	Excitation Coil Q Factor	$Q_{TX}=2PI*f_{TX}*L_{TX}/R_{TXDC}$	-	18	-	
I_{VS_TX}	Excitation Coil Current Consumption		-	3	-	mA

Reception Characteristics

Symbol	Parameter	Test Condition	Min.	Typ.	Max.	Unit
V_{RX}	Amplitude of Received Signal		2.0	-	200	mV_{PP}
V_{COMRX}	Common - Mode Voltage of Received Signal		$-10 \cdot V_{RX}$	-	$10 \cdot V_{RX}$	V
V_{ASYMRX}	Asymmetric Voltage of Received Signal		$-\min(10mV, 0.7 \cdot V_{RX})$	-	$-\min(10mV, 0.7 \cdot V_{RX})$	V
f_{RX}	Frequency of Received Signal		-100	-	100	Hz

9. Timing Specification

Basic Timing

Symbol	Parameter	Test Condition	Min.	Typ.	Max.	Unit
F_{CK}	Main Clock Frequency	Full-temperature test	7.8	8.2	8.5	MHz
F_{CK_T}	Main Clock Frequency Temperature Drift		-3	-	3	%F_{CK}
T_{per}	Data Refresh Frequency		-	200	250	μs
T_S	Step Response Time	Filter=0	-	400	500	μs
		Filter=1	-	600	800	μs
		Filter=2	-	656	-	μs
Q_{TX}	Power on Reset		-	40	-	μs
I_{VS_TX}	Initialization Time		-	3	5	ms

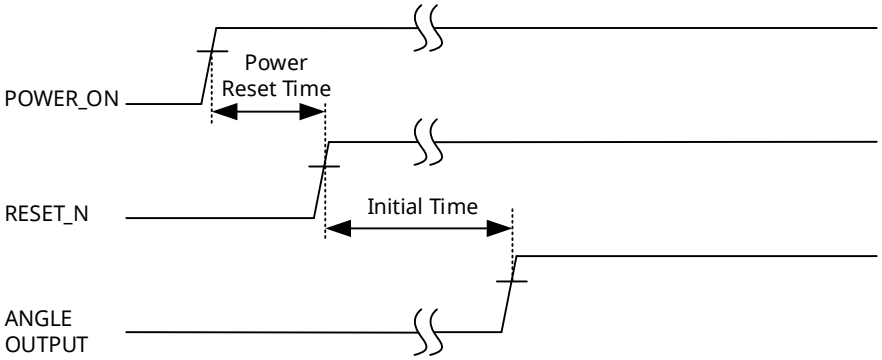


Fig.4 Power-on Reset Timing

EEPROM Timing

Symbol	Parameter	Test Condition	Min	Typ.	Max	Unit
t_{PS}	Power on Rset time		-	100	-	μs
t_{PW}			-	100	-	μs
TIDLE	Standby Time		-	20	-	ms

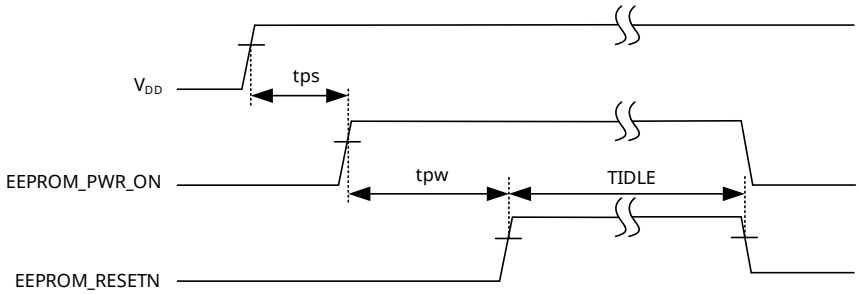


Fig.5 EEPROM Timing

PWM Output

Symbol	Parameter	Test Condition	Min.	Typ.	Max.	Unit
F_{PWM}	PWM Frequency	Frequency Base Range	100		2000	Hz
F_{PWM_INIT}	PWM Frequency Accuracy	25℃	-	-	±2%	F_{PWM}
F_{PWM_EOL}		25℃			±1%	F_{PWM}
ΔF_{PWM}	PWM Frequency Temperature Drift	PWM Frequency Temperature Drift	-	-	±3%	F_{PWM}
T_{rise_LSD}	PWM Output Rise Time (Open - Drain Output)	4.7nF,R_L=1kΩ Pull up	-	2	-	μs
		10nF,R_L=1kΩ Pull up	-	4	-	μs
T_{rise_PP}	PWM Output Rise Time (Push - Pull Output)	4.7nF,R_L=1kΩ Pull up	-	3	-	μs
		10nF,R_L=1kΩ Pull up	-	4	-	μs
T_{fall_LSD}	PWM Output Fall Time (Open - Drain Output)	4.7nF,R_L=1kΩ Pull up	-	1	-	μs
		10nF,R_L=1kΩ Pull up	-	2	-	μs
T_{fall_PP}	PWM Output Fall Time (Push - Pull Output)	4.7nF,R_L=1kΩ Pull up	-	2	-	μs
		10nF,R_L=1kΩ Pull up	-	4	-	μs

SENT Output

Symbol	Parameter	Test Condition	Min.	Typ.	Max.	Unit
$TICK_{time}$	TICK Time		1.5	-	6	μs
N_{nibble}	Nibble Data Quantity		3	6	-	
T_{rise}	SENT Edge Rise Time	1.1V to 3.8V	-	12.5	18	μs
T_{fall}	SENT Edge Fall Time	1.1V to 3.8V	-	5.3	6.5	μs
Npp	SENT Frame Period(No Pause Bit)		154	-	270	ticks
Ppc	SENT Frame Period(With Pause Bit)		282	-	922	ticks
T_{SENT_STD}	SENT Frame Period(Slow)	Standard Data Sequence(40 frames)	-	691	-	ms
T_{SENT_EXT}		Extended Data Sequence(24 frames)	-	415	-	ms

10. Resolution

Analog Output

Symbol	Parameter	Test Condition	Min.	Typ.	Max.	Unit
R_{ADC}	ADC Resolution		-	15	-	bits
R_{DAC}	Analog Output Resolution		-	12	-	bits
INL	DAC Integral Non Linearity Error		-4	-	4	LSB
DNL	DAC Differential Non Linearity Error		0.05	-	3	LSB
ΔE_{L_XY}	XY Intrinsic Linearity Error		-0.36	-	0.36	Deg
ΔE_{temp}	Angle Temperature Drift Error		-0.5	-	0.5	Deg
ΔE_{ratio}	Proportional Output Error	$4.5V \le V_{DD} \le 18V$	-0.05	0	0.5	$\%V_{DD}$
N_{pk-pk}	Output Pole Noise		-	0.05	0.2	Deg

PWM Output

Symbol	Parameter	Test Condition	Min.	Typ.	Max.	Unit
RSP	PWM Resolution		-	16	-	Bits
J_{DC_OD}	PWM % Duty Cycle Jitter (Open - Drain Output)	125Hz,4.7nF,R_L=1KΩ, Resistor Pull up	-	±0.003	±0.016	%DC
		250Hz,4.7nF,R_L=1KΩ, Resistor Pull up	-	±0.005	±0.02	%DC
		500Hz,4.7nF,R_L=1KΩ, Resistor Pull up	-	±0.009	±0.035	%DC
		1000Hz,4.7nF,R_L=1KΩ, Resistor Pull up	-	±0.003	±0.016	%DC
		2000Hz,4.7nF,R_L=1KΩ, Resistor Pull up	-	±0.005	±0.02	%DC
J_{DC_PP}	PWM % Duty Cycle Jitter (Push - Pull Output)	125Hz,4.7nF,R_L=1KΩ, Resistor Pull up	-	±0.003	±0.016	%DC
		250Hz,4.7nF,R_L=1KΩ, Resistor Pull up	-	±0.005	±0.02	%DC
		500Hz,4.7nF,R_L=1KΩ, Resistor Pull up	-	±0.009	±0.035	%DC
		1000Hz,4.7nF,R_L=1KΩ, Resistor Pull up	-	±0.003	±0.016	%DC
		2000Hz,4.7nF,R_L=1KΩ, Resistor Pull up	-	±0.005	±0.02	%DC
J_{PWM_OD}	PWM Frequency Jitter (Open - Drain Output)	125Hz-2000Hz,4.7nF,R_L=1KΩ, Resistor Pull up		±0.04	±0.15	Hz
J_{PWM_PP}	PWM Frequency Jitter (Push - Pull Output)	125Hz-2000Hz,4.7nF,R_L=1KΩ, Resistor Pull up		±0.04	±0.15	Hz

Note:
The jitter of SC69510 is defined 3σ,where σ is the standard deviation of 1000 normal waveforms.%DC：%Duty Cycle

11. Functional Block Diagram

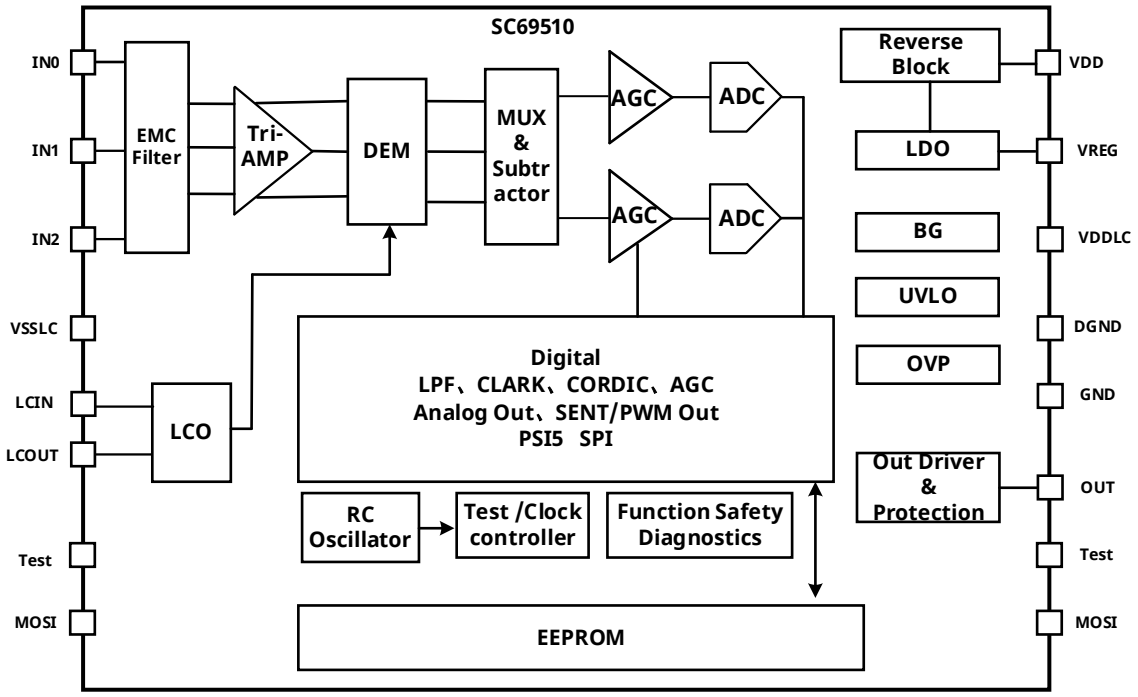


Fig.6 Functional Block Diagram

12. Functional Description

12.1 User Programable Parameters

Parameters	Description	Default	Bit Length
General Parameter Settings			
Filter	Filter Selection	2	2
OUT mode	Output Mode	0	3
PWM POL	PWM Polarity	0	1
PWMT	PWM Frequency	0	16
OUT_CONFIG	PWM Output Configuration	0	2
GAIN_G	Analog Op-Amp First - Stage Gain Setting	0	2
AGC	Analog Op-Amp Second - Stage Automatic Gain Control	1	1
GAIN_F	Analog Op-Amp Second - Stage Gain Setting	1	5
USER_ID1	User ID	0	8
USER_ID2	User ID	0	8
USER_ID3	User ID	0	8
USER_ID4	User ID	0	8

Parameters	Description	Default	Bit Length
EEPROM_LOCK_CODE	EEPROM_LOCK Bit Valid Judgment Code	0	7
EEPROM_LOCK	EEPROM Lock Position	0	1
SENT Configuration Parameters			
SENT_FC_FORMAT	SENT Frame Data Format Selection	1	1
SENT_CH2_DATA	Channel 2 Data Configuration	2	2
SENT_INIT_DATA	SENT Startup Initialization Data Configuration	0	1
SENT_NIBBLE_NUMBER	Channel 2 Data Nibble Count Selection	1	1
SENT_TICK_TIME	SENT Tick Time Configuration	0	3
SENT_LEGACY_CRC	CRC Calculation Selection	0	1
SENT _SERIAL_CONFIG	Enhanced Serial Message Selection	1	1
SENT_SLOW_EXTENDED	Serial Information Sequence Selection	0	1
SENT_PAUSE_OPTION	Select Measurement Mode and Corresponding Output Protocol	1	1
SENT_REV	SENT Version	4	3
SENT_MAN_CODE	Factory Code	0	12
SENT_FRAME_LENGTH	Frame Length	297	10
SENT_ SERIALERROR	Report Diagnostics via Fast Channel	0	3
SENT_SENSOR_TYPE	Sensor Type	0x050	8
SENT_CHANNEL_X1	CHANNEL X1	0	12
SENT_CHANNEL_X2	CHANNEL X2	0	12
SENT_CHANNEL_Y1	CHANNEL Y1	0	12
SENT_CHANNEL_Y2	CHANNEL Y2	0	12
SENT_SENSOR_ID1	Sensor ID1	0	12
SENT_SENSOR_ID2	Sensor ID2	0	12
SENT_SENSOR_ID3	Sensor ID3	0	12
SENT_SENSOR_ID4	Sensor ID4	0	12
SENT_OEM_CODE1	OEM Code 1	0	12
SENT_OEM_CODE2	OEM Code 2	0	12
SENT_OEM_CODE3	OEM Code 3	0	12
SENT_OEM_CODE4	OEM Code 4	0	12
SENT_OEM_CODE5	OEM Code 5	0	12
SENT_OEM_CODE6	OEM Code 6	0	12
SENT_OEM_CODE7	OEM Code 7	0	12
SENT_OEM_CODE8	OEM Code 8	0	12

Parameters	Description	Default	Bit Length
Diagnostic Function Settings			
DIAG_EN	Diagnostic Enable Bit	1	1
DIAG_MASK	Diagnostic Mask Register	128	8
DC_FAULT	PWM Output Duty Cycle When Power Supply Voltage Is Too Low	0	8
GAIN_THRESHOLD_LOW	Low Threshold of Second - Stage Gain of Analog Operational Amplifier	0	5
GAIN_THRESHOLD_HIGH	High Threshold of Second - Stage Gain of Analog Operational Amplifier	31	5
TEMPTHRESHOLD_LOW	Low Temperature Threshold	0	7
TEMPTHRESHOLD_HIGH	High Temperature Threshold	127	7
DIAG_DEBOUNCE	Diagnostic Debounce Time	0	3
Linear Transmission Curve Setting Parameters			
OUTSLOPE_COLD	Low Temperature Angle Compensation Coefficient	0	8
OUTSLOPE_HOT	High Temperature Angle Compensation Coefficient	0	8
CLAMP_HIGH	Output High Clamp	60296	16
CLAMP_LOW	Output Low Clamp	6653	16
DP	Break Point / Zero Point	0	16
CW	Rotation Direction	0	1
WORK_RANGE_GAIN	32 Point Calibration Working Angle Range (Degree)	360	16
LNR_DELTAYn	32 Point Calibration, Y Axis Coordinate (Deviation Percentage) (n = 0~31)	0	32x8
LNR_DELTA_Y_EXPAND	32 Point Calibration, Y Axis Coordinate Deviation Range Setting	3	2

12.2 Output Mode

The SC69510 provides 4 output modes: proportional analog output, PWM output, SENT output, and SPI bus output. PWM and SENT support open - drain output and push - pull output, while SPI only supports push - pull output.

Analog Output Mode

Parameters	Value	Description
OUT mode【2:0】	0	SPI
	1	Analog
	2	SENT
	3	PWM
	4	Reserved
	5	SPI
	6	SPI
	7	SPI

PWM Output Mode

Output Polarity Setting

Parameters	Value	Description
PWM POL	0	High Voltage Active
	1	Low Voltage Active

Output Frequency Setting

Parameters	Value	Description
PWMMT【15:0】	2000 - 40000	100 - 2000Hz

PWM,SENT Output Mode Setting

Parameters	Value	Description
OUT_CONFIG【1:0】	0	Digital High Impedance State Output
	1	Digital Output NMOS Open Drain
	2	Digital Output PMOS Open Drain
	3	Digital Push - Pull Output

PWM Output Wave

When PWM is set as PWM_POL=0 and PWMT=011, the PWM output waveform with an output duty cycle of 0.0244%

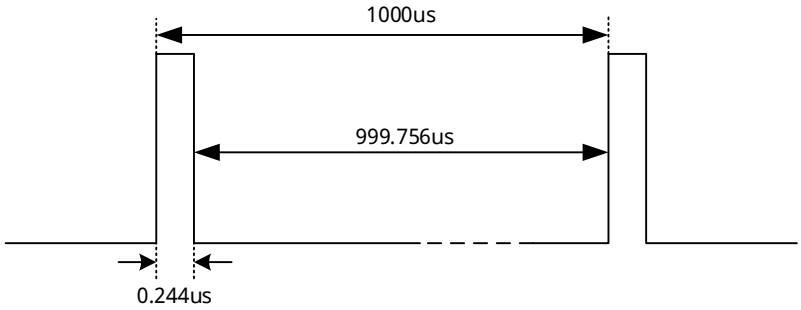


Fig.7 PWM Output Waveform When PWM_POL=0

When PWM is set as PWM_POL=1 and PWMT=011, the PWM output waveform with an output duty cycle of 0.0244%:

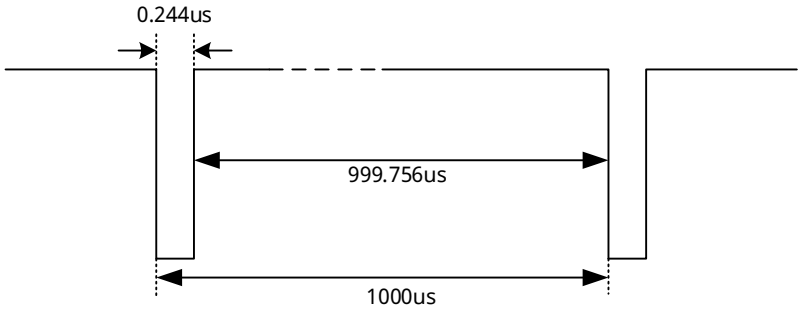


Fig.8 PWM Output Waveform When PWM_POL=1

SENT Output Mode

SC69510's digital SENT output is compatible with SAE J2716 APR2016.

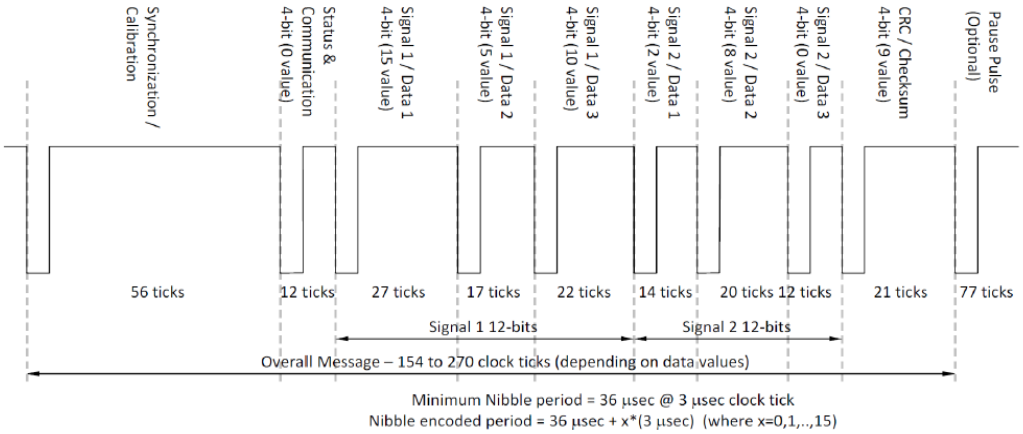


Fig.9 2-channel, 12-bit SENT Data Message Format

Selection of SENT Fast Frame Data Format

Parameters	Value	Description
SENT_FC_FORMAT【0】	0	Dual Throttle Position Sensor
	1	Single-channel Safety Position Sensor

A.1 Data Frame of Dual Throttle Position Sensor

SC69510 ends a sequence of data bytes according to the dual throttle position sensor defined in Annex A.1 of SAE J2716. CH1 always sends 12-bit sensor data, and the content of CH2 channel is set by SENT CH2 DATA.

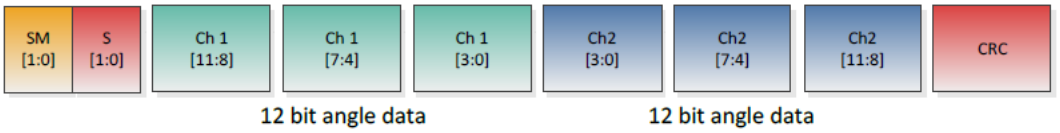


Fig.10 A.1 Data Frame of Dual Throttle Position Sensor

Number of Nibbles for Channel 2 Configuration

Parameters	Value	Description
SENT_NIBBLE_NUMBER【0】	0	3 nibbles
	1	6 nibbles

Channel 2 Configuration Data

Parameters	Value	Description
SENT_CHE_DATA【1:0】	0	12-bit temperature sensor data
	1	0xFF9(4089)-CH1
	2	12-bit user-defined data
	3	0xFFF(4095)-CH1

A.3 Data Frame of Single-channel Safety Position Sensor

SC69510, in accordance with the single-channel safety position sensor defined in Annex A.3 of SAE J2716, transmits data that includes the 12-bit sensor angle data of the CH1 channel, the rolling counter, and the 4-bit inverted data of the high portion of the angle data.

Fig.11 A.3 Data Frame of Single-channel Safety Position Sensor

Initialization Start Frame

Parameters	Value	Description
SENT INIT DATA 【1:0】	0	SAE Compatible - 0x000
	1	OEM Requirement - 0xFFF

SENT tick Time Configuration

Parameters	Value	Description
SENT_TICK_TIME 【2:0】	0	3.0us Standard SENT
	1	0.5us Not Recommended
	2	1.0us Not Recommended
	3	1.5us Fast SENT
	4	2.0us Not Recommended
	5	2.5us Not Recommended
	6	6.0us Slow SENT
	7	12us Not Recommended

Frame Length Setting

Parameters	Value	Description
SENT_FRAME_LENGTH 【9:0】	Default 297 ticks	Frame length setting

SENT Version Selection

Parameters	Value	Description
SENT_REV【2:0】	0	No version specified
	1	2007
	2	2008
	3	2010
	4	2016

12.3 Enhanced Serial Message

The enhanced serial message is a communication protocol capable of transmitting large volumes of data and information IDs. Serial data is transmitted via the 2nd and 3rd bits (SM [1:0]) of the status and communication nibble. As shown in the figure, a serial message frame consists of 18 consecutive SENT data messages. All 18 frames must be successfully received (without errors such as calibration pulse changes, data byte CRC errors, etc.).

The enhanced serial message contains 12-bit data and an 8-bit information ID. SM[0] includes a 6-bit CRC, followed by 12-bit data. The content of the message is defined by the 8-bit information ID transmitted in the SM[1] channel. By default, a short sequence composed of 24 data items is transmitted. An extended sequence can be optionally used to transmit a cycle containing 40 data items.

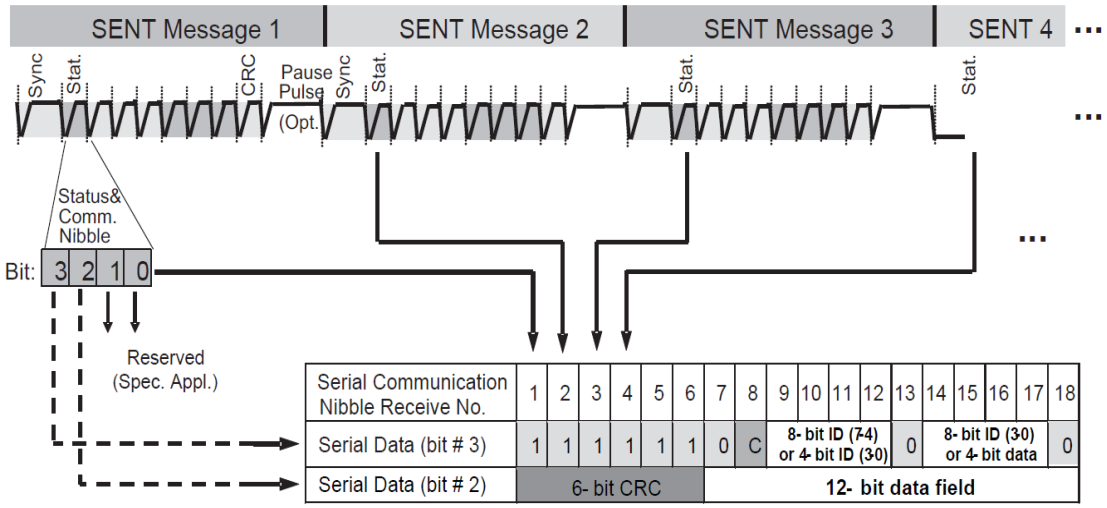


Fig.12 Data Format of Enhanced Serial Message

Serial Number	8-bit ID	Content	Description
Standard Sequence			
1	0x01	Diagnostic error code	Diagnostic register
2	0x06	SENT standard revision	SENT_REV
3	0x01	Diagnostic error code	Diagnostic register
4	0x05	Manufacturer code	SENT_MAN_CODE
5	0x01	Diagnostic error code	Diagnostic register
6	0x03	Channel 1 / 2 Sensor type	SENT_SENSOR_TYPE
7	0x01	Diagnostic error code	Diagnostic register
8	0x07	Fast channel 1: X1	SENT_CHANNEL_X1
9	0x01	Diagnostic error code	Diagnostic register
10	0x08	Fast channel 1: X2	SENT_CHANNEL_X2
11	0x01	Diagnostic error code	Diagnostic register
12	0x09	Fast channel 1: Y1	SENT_CHANNEL_Y1
13	0x01	Diagnostic error code	Diagnostic register

Serial Number	8-bit ID	Content	Description
14	0x0A	Fast channel 1: Y2	SENT_CHANNEL_Y2
15	0x01	Diagnostic error code	Diagnostic register
16	0x23	(Internal) temperature	Temperature Register
17	0x01	Diagnostic error code	Diagnostic register
18	0x29	Sensor ID #1	SENT_SENSOR_ID1
19	0x01	Diagnostic error code	Diagnostic register
20	0x2A	Sensor ID #2	SENT_SENSOR_ID2
21	0x01	Diagnostic error code	Diagnostic register
22	0x2B	Sensor ID #3	SENT_SENSOR_ID3
23	0x01	Diagnostic error code	Diagnostic register
24	0x2C	Sensor ID #4	SENT_SENSOR_ID4
Extended Sequence			
25	0x01	Diagnostic error code	Diagnostic register
26	0x90	OEM Code #1	SENT_OEM_CODE1
27	0x01	Diagnostic error code	Diagnostic register
28	0x91	OEM Code #2	SENT_OEM_CODE2
29	0x01	Diagnostic error code	Diagnostic register
30	0x92	OEM Code #3	SENT_OEM_CODE3
31	0x01	Diagnostic error code	Diagnostic register
32	0x93	OEM Code #4	SENT_OEM_CODE4
33	0x01	Diagnostic error code	Diagnostic register
34	0x94	OEM Code #5	SENT_OEM_CODE5
35	0x01	Diagnostic error code	Diagnostic register
36	0x95	OEM Code #6	SENT_OEM_CODE6
37	0x01	Diagnostic error code	Diagnostic register
38	0x96	OEM Code #7	SENT_OEM_CODE7
39	0x01	Diagnostic error code	Diagnostic register
40	0x97	OEM Code #8	SENT_OEM_CODE8

SENT@ ID 23 = 8 * (T[C] – 35[C]) + 865 LSB12

Selection of Slow Channel for Enhanced Serial Message

Parameter	Value	Description
SERIAL_CONFIG【0】	0	Disable slow channel of enhanced serial message
	1	Enable slow channel of enhanced serial message

Selection of Enhanced Serial Message Sequence

Parameter	Value	Description
SENT_SLOW_EXTENDED【0】	0	Select short-sequence serial message
	1	Select extended-sequence serial message

PAUSE Configuration

Parameter	Value	Description
SENT_PAUSE_OPTION【0】	0	Continuous asynchronous angle acquisition, SENT without pause bit
	1	Continuous synchronous angle acquisition, SENT with pause bit

Fast Channel Diagnostic Report Configuration

Parameter	Value	Description
SENT_SERIALERROR【2：0】	0	Do not report diagnostics
	other	4088+ SENT_SERIALERROR

12.4 Sensor Front End Settings

First Stage Gain Setting

Parameter	Value	Description
GAIN_G【2:0】	0	2.5
	1	5
	2	10
	3	15

Second Stage Gain Setting

AGC Enable is used to control the automatic gain control for the second-stage gain. When AGC is set to 1, the automatic gain control is enabled; when set to 0, it is disabled. If the AGC control bit is disabled, the second-stage gain can be directly configured via the register.

Parameter	Value	Description
AGC	0	Disable automatic gain control
	1	Enable automatic gain control
GAIN_F【4:0】	0	1
	1	1.1
	2	1.21
GAIN_F【4:0】	...	...
	29	15.86
	30	17.4
	31	19.2

12.5 Traceable Information

At the time of factory shipment, each device includes both a factory ID assigned by SemiMEnt and a user ID for traceability purposes.

Parameter	Value
SEMI_ID1【7:0】	0-255
SEMI_ID2【7:0】	0-255
SEMI_ID3【7:0】	0-255
SEMI_ID4【7:0】	0-255
USER_ID1【7:0】	0-255
USER_ID2【7:0】	0-255
USER_ID3【7:0】	0-255
USER_ID4【7:0】	0-255

12.6 EEPROM Write Protection

Parameter	Value	Description
EEPROM_LOCK_ CODE【6:0】	0x3A	EEPROM_LOCK bit is valid
	其他值	EEPROM_LOCK bit is invalid
EEPROM_LOCK	0	EEPROM can be read, written, and erased
	1	EEPROM is read-only

12.7 Diagnostics

Diagnostic Enable

Parameter	Value	Description
DIAG_EN	0	Enable diagnostics
	1	Disable diagnostics

Diagnostic Mask Register

When the corresponding mask bit is set to 0, the fault will not trigger diagnostics; when set to 1, the fault will trigger diagnostics.

BIT7	BIT6	BIT5	BIT4	BIT3	BIT2	BIT1	BIT0
CRC Check Error	GAINF Overflow	Current Diagnosis	Supply Voltage Diagnosis	CORDIC Overflow	Receive Coil Open Circuit	ADC Overflow	Temperature Overflow

Diagnostic Thresholds

Diagnostic Thresholds	Value	Description
GAIN_THRESHOLD_LOW【4:0】	0-31	Low threshold of second-stage analog op-amp gain
GAIN_THRESHOLD_HIGH【4:0】	0-31	High threshold of second-stage analog op-amp gain
TEMPTHRESHOLD_LOW【6:0】	0-127	Low temperature threshold
TEMPTHRESHOLD_HIGH【6:0】	0-127	High temperature threshold

Setting of Diagnostic Debounce Time

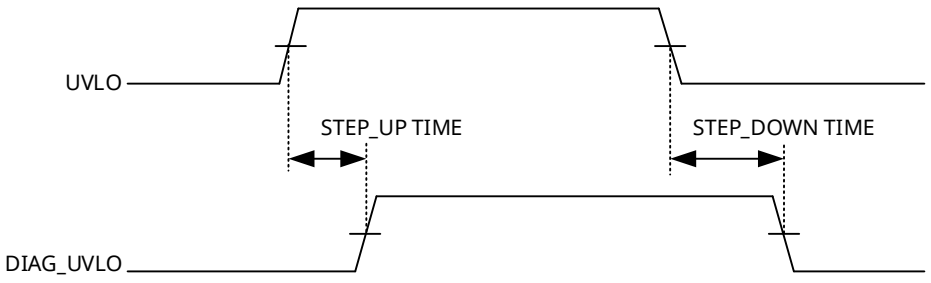


Fig.13 Diagnostic Debounce Timing

Parameter	Value	STEP_UP TIME(ms)	STEP_DOWN TIME(ms)
DIAG_DEBOUNCE【2:0】	0	20	20
	1	20	30
	2	20	40
	3	40	40
	4	60	80
	5	80	100
	6	100	120
	7	120	140

12.8 Output Parameter Setting

Breakpoint/Zero Point - DP

The breakpoint and zero point of SC69510 are the same point, which can be programmed at any position on the circumference. All angles are referenced to the breakpoint or zero point. DP is the transition point between 0° and 360°. For applications with a stroke less than 360°, DP should not be set at the same position as the start point of the working stroke; it must be set outside the working stroke.

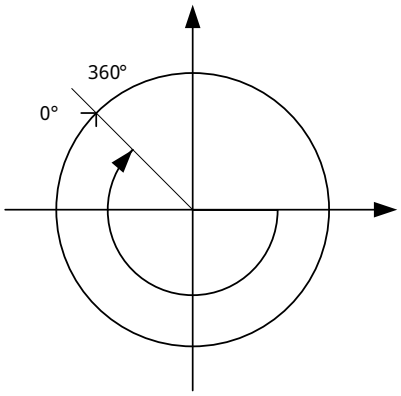


Fig.14 Schematic Diagram of DP Point

Parameter	Value	Description
DP	0-360	Breakpoint/Zero Point – DP

12.9 Output Clamp Setting

The output clamp setting is used to limit the output voltage range. CLAMP_LOW sets the minimum output voltage, and CLAMP_HIGH sets the maximum output voltage. These two parameters are effective for 4-point, 8-point, 16-point, and 32-point correction modes.

Parameter	Value	Description
CLAMP_LOW	0-100	Low clamp
CLAMP_HIGH	0-100	High clamp

4 Point Calibration Mode

SC69510 allows users to use the 4-point calibration mode to divide the output curve into a maximum of 5 segments via 4 points, and the number of calibration points can be reduced to 2 or 3. The Y-coordinates (-50% to 100%) and X-coordinates (0° to 360°) of the 4 calibration points, as well as the 5 segment slopes (LNR_S0, LNR_S1, LNR_S2, LNR_S3, LNR_S4), are completely set by the user. To calculate the slopes, the two endpoints of the curve at 0° (start) and 360° (end) are required to calculate LNR_S0 and LNR_D_S.

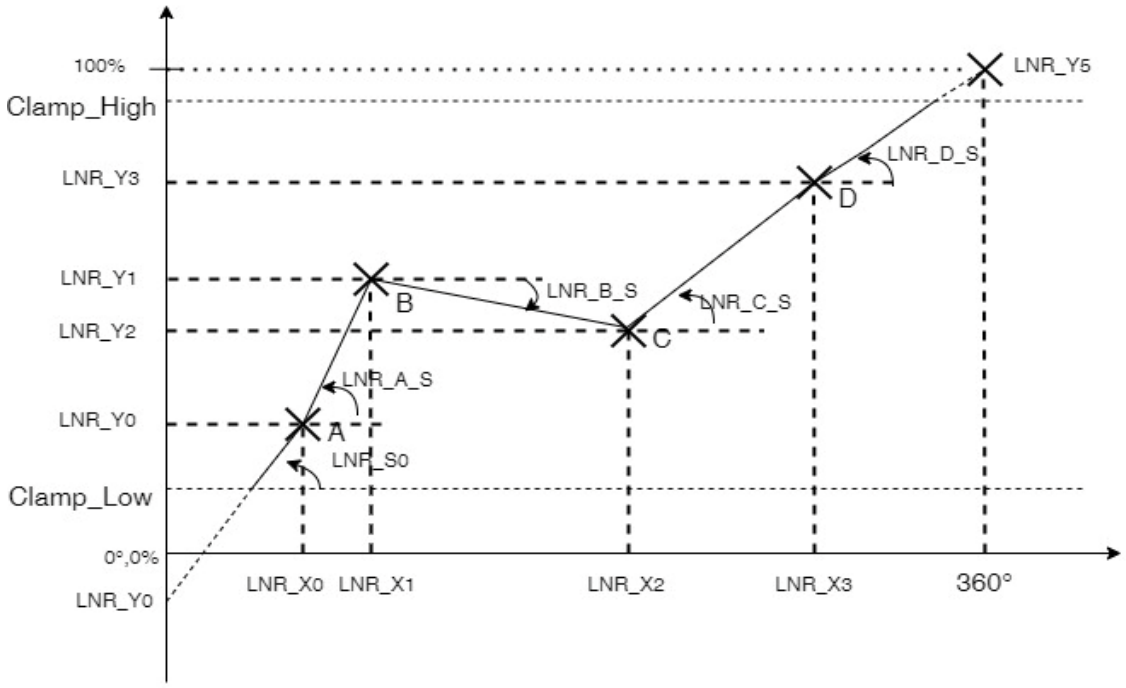


Fig.15 4-Point Calibration Curve

8-Point Arbitrary Point Calibration Mode

SC69510 allows users to program the required output curve by customizing the X-coordinates (0°-360°) and Y-coordinates (0%-100%) of any 8 calibration points. However, the slopes cannot be set and can only be calculated from two adjacent points. In addition, a default fixed calibration point [0°, 0%] is required as the starting point.

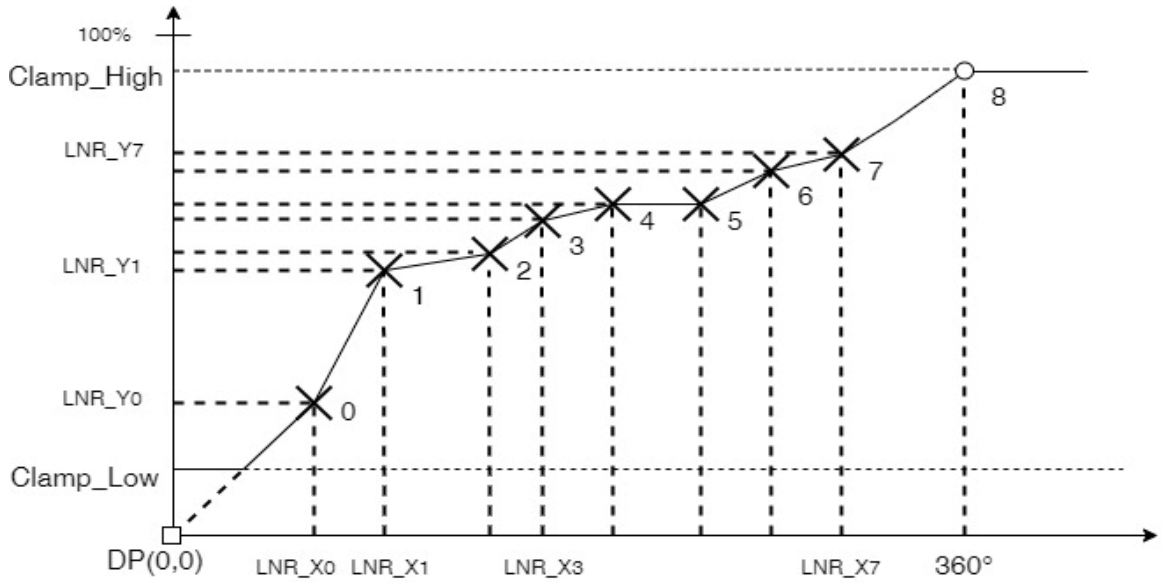


Fig.16 8-Point Arbitrary Point Calibration Mode

16-Point Calibration Mode

SC69510 only allows users to set the Y-axis values of the coordinate points. The X-axis coordinates are defined by the W value and are evenly divided into 16 segments within the WORK_RANGE. The allowable range for the Y-point coordinates is -50% to +150% of the clamp voltage, which can make the clamp voltage fall between certain segments (as shown in the Fig.below). However, the output remains the clamp voltage.

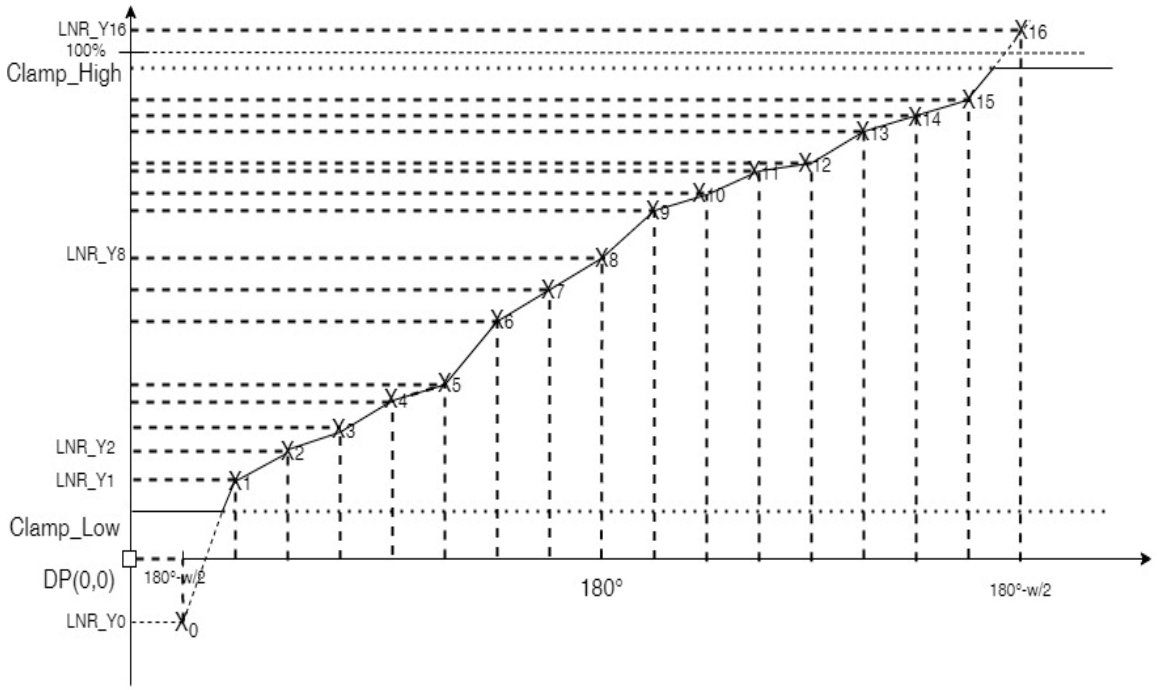


Fig.17 16-Point Calibration Curve

32-Point Calibration Mode

The working interval W is defined by WorkRange and is equally divided into 32 segments with 180° as the center. The Y-axis coordinate is only composed of 8-bit data, so it is not an absolute coordinate value but a coordinate increment. An ideal curve is determined with the two endpoints being (180°-w/2, 0%) and (180°+w/2, 100%), and ΔY is the fine-tuning value of Y corresponding to the abscissa X.

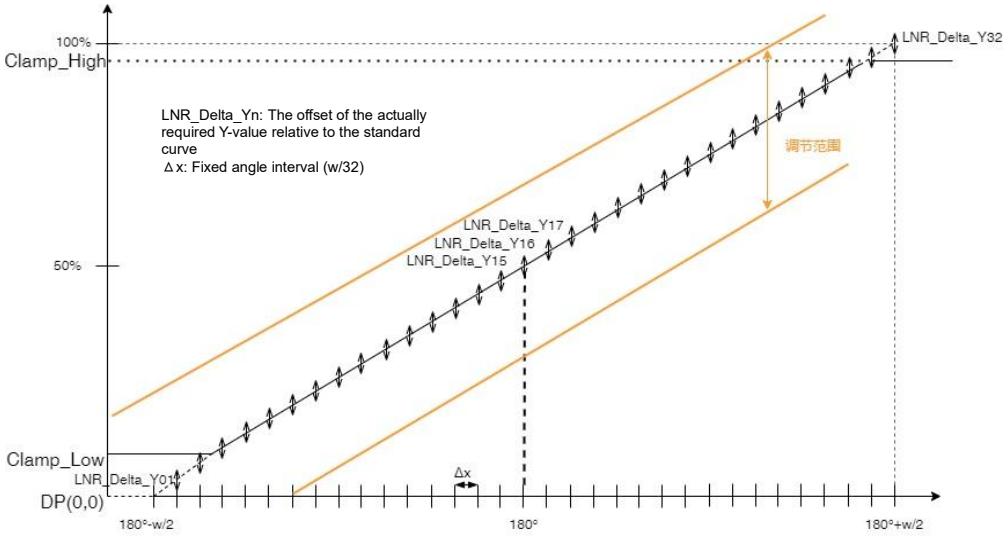


Fig.18 32-point calibration curve graph

32-Point Calibration, Y-Axis Coordinate Deviation Range Setting

Parameter	Value	Description
LNR_DELTA_Y_EXPAND【1:0】	0	Error range±3.125%
	1	Error range±6.25%
	2	Error range±12.5%
	3	Error range±25%

12.10 Angle Range Selection

$$w = \frac{WORK\_RANGE\_GAIN \times 360°}{0XFFFF}$$

Angle range: $\theta_{min} = \frac{360°-w}{2}$ $\theta_{max} = \frac{360°+w}{2}$

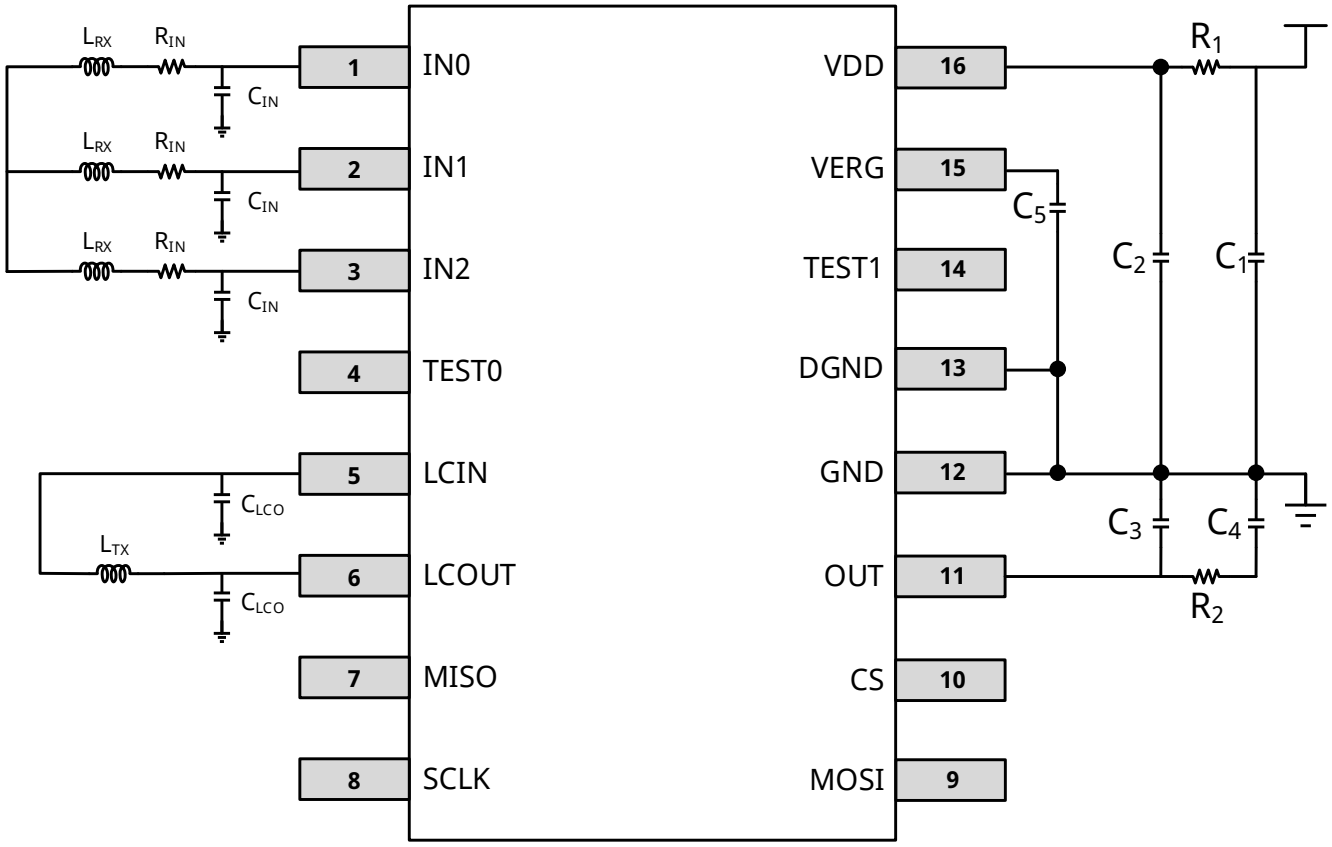
θmin represents the angle when the output is 0%, and *θmax* represents the angle when the output is 100%. To ensure the normal output of correction, the angle range needs to be set to an integer multiple greater than 16.

Example of Angle Range Setting:

WORK_RANGE_GAIN	W(°)	Θ_{min}(°)	Θ_{max}(°)	△X,16pts(°)	△X,32pts(°)
0x1000	22.50034	168.7498	191.2502	1.406271	0.703136
0x1100	23.90661	168.0467	191.9533	1.494163	0.747082
0x1200	25.31289	167.3436	192.6564	1.582055	0.791028
0x1300	26.71916	166.6404	193.3596	1.669947	0.834974
0x2000	45.00069	157.4997	202.5003	2.812543	1.406271
0x2100	46.40696	156.7965	203.2035	2.900435	1.450217
0x2200	47.81323	156.0934	203.9066	2.988327	1.494163
0x2300	49.2195	155.3902	204.6098	3.076219	1.538109
0x3000	67.50103	146.2495	213.7505	4.218814	2.109407
0x3100	68.9073	145.5463	214.4537	4.306706	2.153353
0x3200	70.31357	144.8432	215.1568	4.394598	2.197299
0x3300	71.71984	144.1401	215.8599	4.48249	2.241245
0x4000	90.00137	134.9993	225.0007	5.625086	2.812543
0x4100	91.40764	134.2962	225.7038	5.712978	2.856489
0x4200	92.81392	133.593	226.407	5.80087	2.900435
0x4300	94.22019	132.8899	227.1101	5.888762	2.944381
0xFA00	351.5679	4.216068	355.7839	21.97299	10.9865
0xFB00	352.9741	3.512932	356.4871	22.06088	11.03044
0xFC00	354.3804	2.809796	357.1902	22.14878	11.07439
0xFD00	355.7867	2.106661	357.8933	22.23667	11.11833
0xFE00	357.193	1.403525	358.5965	22.32456	11.16228
0xFF00	358.5992	0.700389	359.2996	22.41245	11.20623
0xFFFF	360	0	360	22.5	11.25

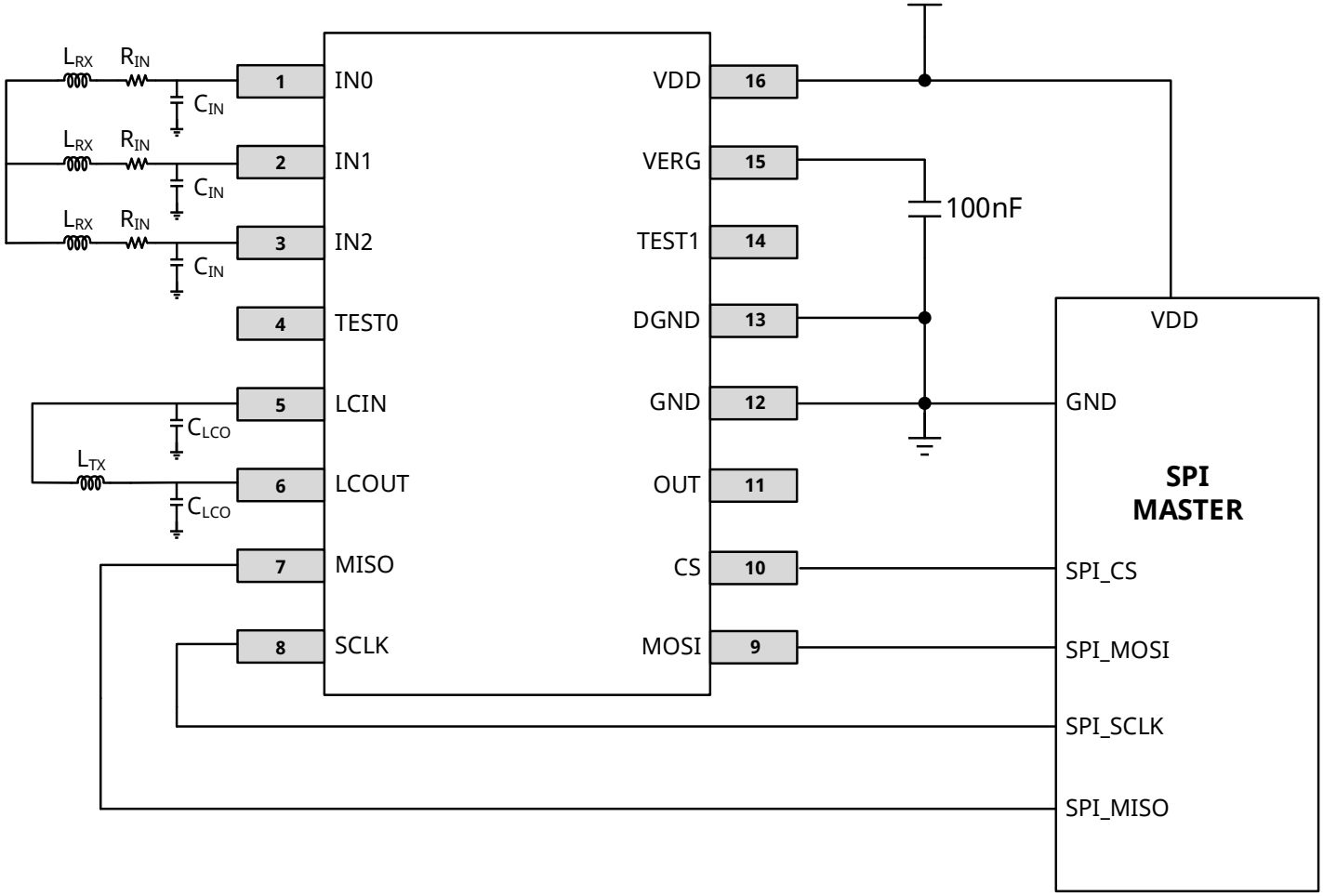
13. Typical Application

Analog Output TSSOP-16 Reference Circuit

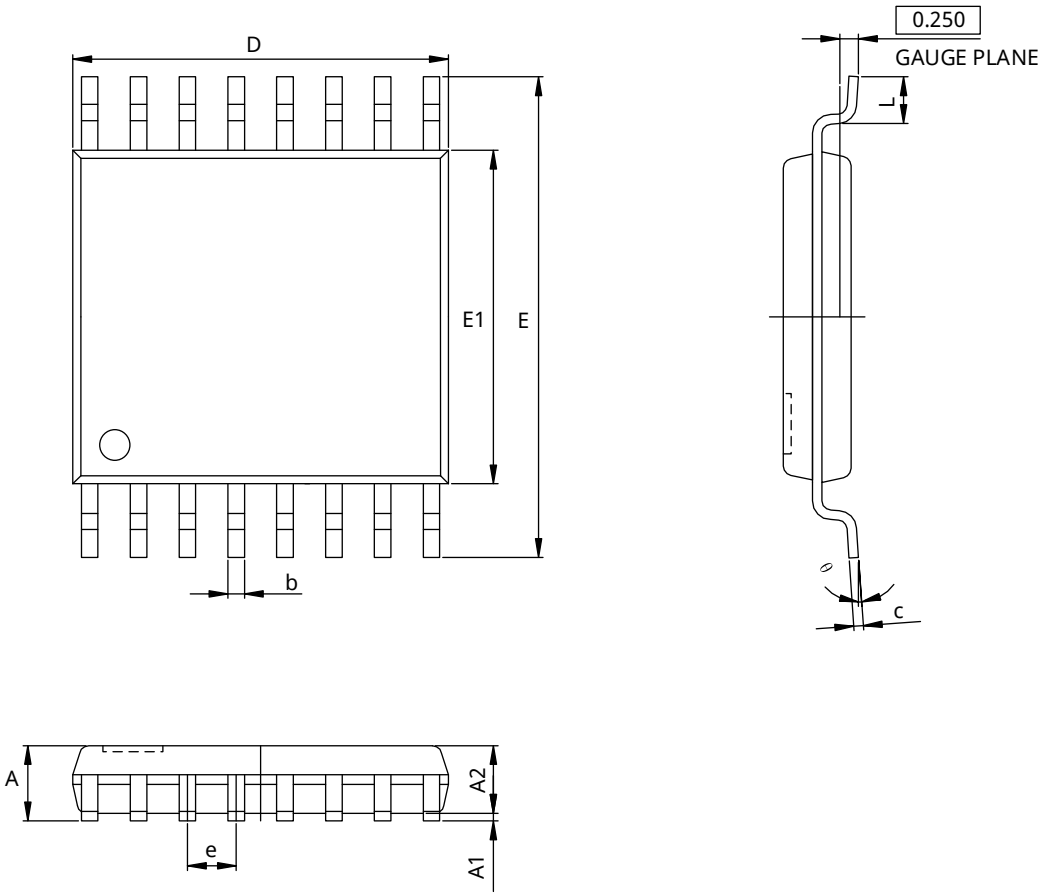


Component	Min.	Typ.	Max.	Description
R_1	-	0Ω	10Ω	Reduce EMC impact and increase measurement error
R_2	-	0Ω	51Ω	Reduce EMC impact and increase measurement error
C_1	-	1nF	10nF	Reduce EMC impact and place near the connector end
C_2	100nF	100nF	-	Place near the pin
C_3	47nF	100nF	-	Place near the pin
C_4	-	1nF	10nF	Reduce EMC impact and place near the connector end
C_5	47	100nF	220nF	Place near the pin

SPI TSSOP-16 Reference Circuit



14. Package Information



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min.	Max.	Min.	Max.
A	-	1.200	-	0.047
A1	0.050	0.150	0.002	0.006
A2	0.800	1.000	0.031	0.039
b	1.900	0.300	0.007	0.012
c	0.090	0.200	0.004	0.008
D	4.900	5.100	0.193	0.201
E	6.250	6.550	0.252(BSC)	
E1	4.300	4.500	0.169	0.177
e	0.650(BSC)		0.026(BSC)	
L	0.500	0.700	0.020	0.028
θ	1°	7°	1°	7°

15. Revision History

Revision	Date	Description
Rev.V0.1	2025-08-26	Initial version