AsahiKASEI MICRODEVICES

AK9757W

IC for IR Sensor based thermometer

1. General Description

AK9757W is a non-contact infrared temperature sensor IC and is intended to be used in combination with AK9791W, which is an InfraRed(IR) sensor. There is a Built-in Temperature Sensor to measure the temperature of the AK9757W itself. Calculates the temperature in the FOV from IR sensor and Built-in Temperature Sensor outputs after AD convert. The parameter for temperature calculation are programmable and can be adjusted to suit the application. This device has an interrupt function and can be set to interrupt notification by INTN.

2. Features

- ☐ Non-contact temperature measurements using Quantum InfraRed sensor (IR sensor)
- ☐ Integrated Temperature sensor: measurements of the AK9757W
- ☐ AD Converter: 16-bit resolution
- ☐ Integrated FOV Temperature calculation circuit:
  Calculates the temperature in the FOV from IR sensor and Built-in Temperature Sensor outputs.
- ☐ Integrated Digital Filter: Cutoff frequency 1.12Hz (Output Data Rate 10Hz)
- ☐ I^2C interface: Standard Mode (100kHz) and Fast Mode (400kHz)
- ☐ Interrupt Function: Interrupt notification by INTN
- ☐ Power Supply: 1.65 to1.95V
- ☐ Low current consumption:
  1μA(Typ.)@Stand-By
  7μA(Typ.)@10Hz(Low power)
  88μA(Typ.)@10Hz(High SNR)
- ☐ Form of delivery : Wafer
- ☐ Class of Quality : Consumer product grade
- ☐ Size 8-pad / 1.1000mm x 1.1998mm
- ☐ Application Examples: Non-contact body surface temperature measurements, Attachment and removal detection of wearable devices

3. Table of Contents

4. Block Diagram and Functions

4.1. Block Diagram

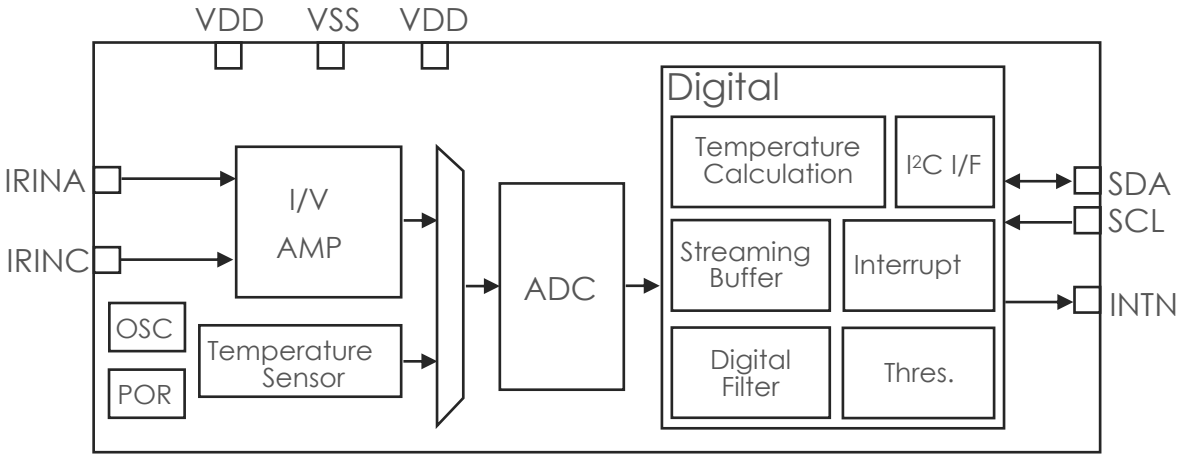

Figure 4.1. AK9757W Block Diagram

4.2. Functions

Table 4.1. Function

Block	Function
OSC	Built-in oscillator.
POR	Power-On Reset circuit.
Temperature Sensor (Temp. Sensor)	Built-in temperature sensor. Measure of the IC temperature.
I/V AMP	I/V AMP converts the output current of the IR sensor to voltage and adjust the gain and offset of the sensor output.
ADC	Converts the analog output of the IR sensor and the Temp. Sensor to digital signals.
Temperature Calculation (Temp. Calc.)	From the IR sensor output and the Temp. Sensor data AK9757W can calculate the FOV temperature. The result can be read via I^2C.
Streaming Buffer	Max. 10 data can be stored.
Digital Filter	Digital filter (LPF) for Temp. Calc. results and the Temp. Sensor. In addition, it is possible to bypass this filter.
Thres.	Threshold judgement Temp. Calc. results is compared with threshold levels.
Interrupt	Interrupt function INTN goes to active when data is ready to be read, when the calculation result exceeds the threshold when the streaming buffer becomes full, or when calculation data is overflow.
I^2C I/F	Interface to external host MCU. SCL and SDA are available for I^2C interface. Support Standard Mode (100kHz) and Fast Mode (400kHz).

5. PAD Configurations and Functions

5.1. PAD Configurations

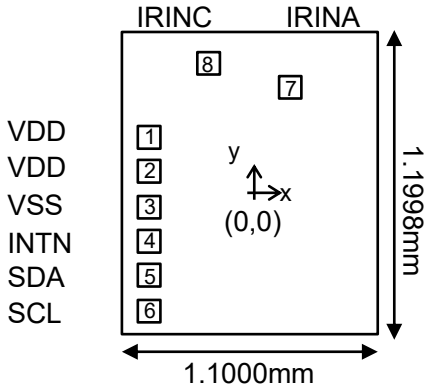

Figure 5.1. PAD Configurations

Table 5.1. PAD size and location

Chip size : 1.1000×1.1998mm Chip size includes 60μm of scribe width.

PAD No.	PAD Name	Size(x,y) [μm]	Location(x,y) [μm]
1	VDD	80, 80	-448.24, 178.31
2	VDD	80, 80	-448.24, 70.92
3	VSS	80, 80	-448.24, -35.12
4	INTN	80, 80	-448.24, -136.53

PAD No.	PAD Name	Size(x,y) [μm]	Location(x,y) [μm]
5	SDA	80, 80	-448.24, -274.98
6	SCL	80, 80	-448.24, -446.53
7	IRINA	80, 80	165.3, 294.61
8	IRINC	80, 80	-165.3, 453.6

5.2. Functions

Table 5.2 Functions

PAD No.	PAD Name	I/O	Function
1	VDD	-	Power Supply
2	VDD	-	Power Supply
3	VSS	-	GND
4	INTN	O	Interrupt It goes to “L” in the following case. (1) when measurement data is ready to read (2) when FOV temperature data exceeds the upper or lower threshold (3) when streaming buffer is full (4) when calculation data is overflow The INTN is an open drain output (N-type transistor). This pad must be connected to a pull-up resistor.
5	SDA	I/O	I^2C Data Input/Output It is composed of a signal input and an open drain output (N-type transistor). This pad must be connected to a pull-up resistor.
6	SCL	I	I^2C Clock Input Signal processing is executed on rising and falling edge of SCL clock. This pad must be connected to a pull-up resistor.
7	IRINA	I	Connection pad for Anode of IR element.
8	IRINC	I	Connection pad for Cathode of IR element.

6. Absolute Maximum Ratings

(VSS=0V)

Parameter	Symbol	Min.	Max.	Unit
Power Supply	VDD	-0.3	2.5	V
Input Current	Iin	-10	10	mA
Input Voltage	Vin	-0.3	2.5	V
Storage Temperature	Tst	-40	85	ºC

WARNING: Operation at or beyond these limits may result in permanent damage to the device.
Normal operation is not guaranteed at these extremes.

7. Recommended Operating Conditions

(VSS=0V)

Parameter	Symbol	Min.	Typ.	Max.	Unit
Power Supply	VDD	1.65	1.8	1.95	V
Operating Temperature	Ta	-30	25	85	ºC

8. Power Supply Conditions

(Unless otherwise specified, VDD=1.65 to 1.95V, Ta = -30 to 85ºC)

Parameter		Symbol	Min.	Typ.	Max.	Unit
Power Supply Rise Time (*1, *2)	Time until VDD is set to the operating voltage from 0.2V.	PSUP	1µ		50m	s
Power-On Reset Time (*1, *2)	Time until AK9757W becomes Stand-By Mode after PSUP.	PORT			100	µs
Shutdown Voltage (*2, *3)	Shutdown Voltage for POR re-starting.	SDV			0.2	V
Power Supply Interval Time (*1, *2, *3)	Voltage retention time below SDV for POR re-starting.	PSINT	100			µs

Note:
*1. Reference data only, not tested in production.
*2. Power-On Reset circuit detects rising edge of VDD, resets the internal circuit, and initializes the registers. After POR circuit works, the AK9757W is set to Stand-By Mode.
*3. Unless this condition is satisfied, reset may not be correctly performed.

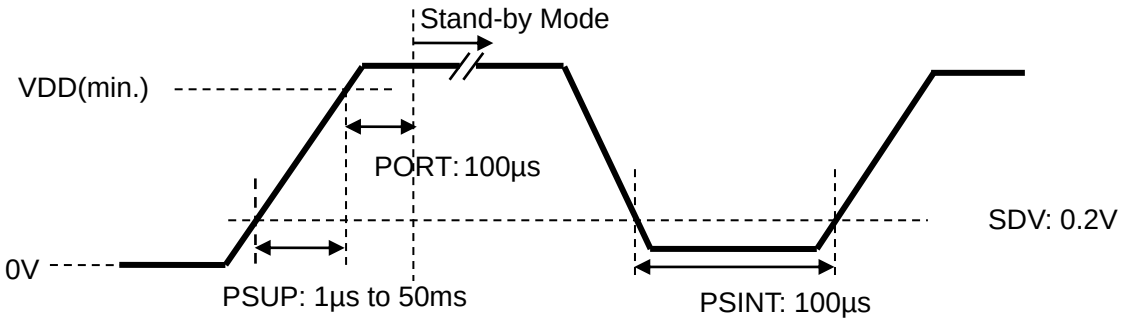

Figure 8.1. Power Supply Conditions

9. Electrical Characteristics

9.1. Total Characteristics

(Unless otherwise specified, Ta = 10 to 45ºC, VDD=1.8V)

Parameter		Symbol	Min.	Typ.	Max.	Unit
IR output resolution				16		bit
Built-in Temp. Sensor output resolution				16		bit
Temp. Calc. output resolution				16		bit
I/V AMP Input Range	I/V AMP Gain : x2	SIR0		± 2.08		nA
	I/V AMP Gain : x1	SIR1	± 2.91	± 4.15		
	I/V AMP Gain : 1/2	SIR2		± 8.31		
	I/V AMP Gain : 1/4	SIR3		± 16.6		
	I/V AMP Gain : 1/6	SIR4		± 24.9		
IR output Noise	Ta=35 ºC, ODR:10Hz I/V AMPGain:x1, AVN=1FH, LPF:off, IROFF="1"	SON			140	LSBrms
IR offset	Ta=35 ºC, I/V AMP Gain : x1 IROFF="1"	SO	-145		145	LSB
Built-in Temp. sensor output code	Ta = 35 ºC, OTS="0",GTS="0"	TOE	505	5041	9596	LSB
Built-in Temp. Sensor resolution (*5)	Calculated from output codes for Ta=10 ºC and Ta=45 ºC, GTS="0"	TSRES		1.98		mºC/ LSB
Built-in Temp. Sensor output Noise	Ta=35 ºC, ODR:10Hz, AVN=1FH, LPF:off	TON		15.1	25.2	LSBrms
Average Current Consumption	Stand-By Mode	ISB		1.0	3.0	µA
	Continuous Mode ODR:10Hz AVN=00H	IDD1		7.0	10.0	µA
	Continuous Mode ODR:10Hz AVN=13H	IDD2		88.0	100.0	µA

Note:

*4. Reference data only, not tested in production.

9.2. Digital Characteristics

9.2.1. DC Characteristics

(VDD=1.65 to 1.95V, Ta= -30 to 85ºC, unless otherwise specified)

Parameter			Symbol	Min.	Typ.	Max.	Unit
High level input Voltage		SCL, SDA	VIH	70%VDD			V
Low level input Voltage		SCL, SDA	VIL			30%VDD	V
Input current	Vin=VSS / VDD	All pad	IIN	-10		10	µA
Hysteresis Input Voltage (*5)		SCL, SDA	VHS	10%VDD			V
Low level output Voltage	IOL= 3mA	SDA	VOL			20%VDD	V
	IOL= 300µA	INTN					

Note:

*5 . Reference data only, not tested in production.

9.2.2. AC Characteristics (1): Standard Mode (100 kHz)

(VDD=1.65 to 1.95V, Ta= -30 to 85 ºC, unless otherwise specified)

Parameter		Symbol	Min.	Typ.	Max.	Unit
SCL Frequency		fSCL			100	kHz
SDA bus idle time to the next command input		tBUF	4.7			µs
Start condition Hold time		tHD:STA	4.0			µs
Clock Low period		tLOW	4.7			µs
Clock High period		tHIGH	4.0			µs
Start condition set-up time		tSU:STA	4.7			µs
Data hold time		tHD:DAT	0		3.45	µs
Data set-up time		tSU:DAT	250			ns
Rise time SDA, SCL (*6,*7)	SDA, SCL	tR			1.0	µs
Fall time SDA, SCL (*6,*7)	SDA, SCL	tF			0.3	µs
Stop condition set-up time		tSU:STO	4.0			µs

Note:

* 6. Reference data only, not tested in production.

* 7. CL≤400pF for SDA

9.2.3. AC Characteristics (2): Fast Mode (400 kHz)

(VDD=1.65 to 1.95V, Ta= -30 to 85 ºC, unless otherwise specified)

Parameter		Symbol	Min.	Typ.	Max.	Unit
SCL frequency		fSCL			400	kHz
Noise suppression time		tSP			50	ns
SDA bus idle time to the next command input		tBUF	1.3			µs
Start condition Hold time		tHD:STA	0.6			µs
Clock Low period		tLOW	1.3			µs
Clock High period		tHIGH	0.6			µs
Start condition set-up time		tSU:STA	0.6			µs
Data hold time		tHD:DAT	0		0.9	µs
Data set-up time		tSU:DAT	100			ns
Rise time (*8,*9)	SDA, SCL	tR			0.3	µs
Fall time (*8,*9)	SDA, SCL	tF			0.3	µs
Stop condition set-up time		tSU:STO	0.6			µs

Note:

* 8. Reference data only, not tested in production.
* 9. CL≤400pF for SDA

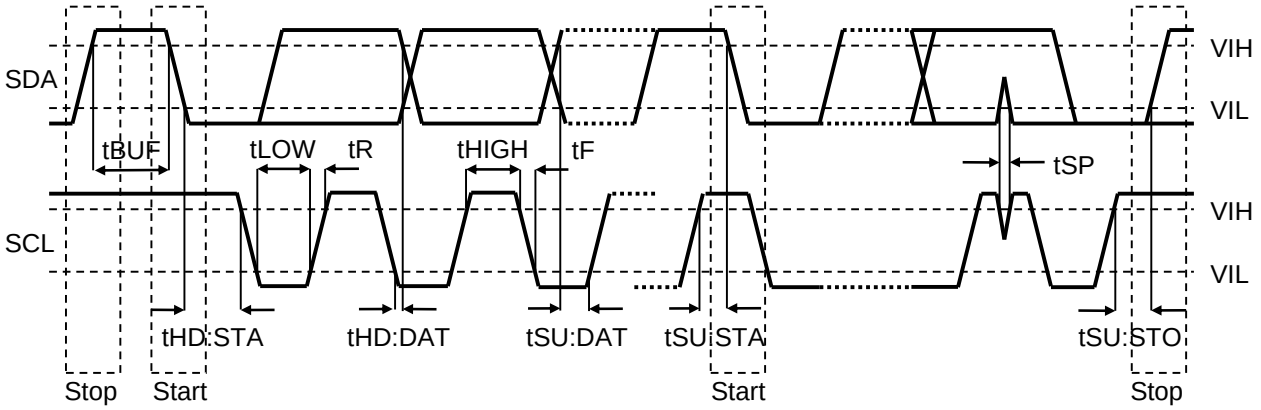

Figure 9.1. Bus Timing

9.2.4. AC Characteristics (3): INTN

(VDD=1.65 to 1.95V, Ta= -30 to 85ºC, unless otherwise specified)

Parameter		Symbol	Min.	Typ.	Max.	Unit
Rise time (* 10., * 11.)	INTN	tR			2	μs
Fall time (* 10., * 11.)	INTN	tF			0.25	μs

Note:

* 10. Reference data only, not tested in production.
* 11. When the load circuit of Figure 9.2 is connected.

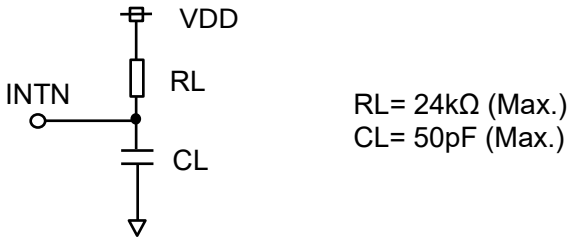

Figure 9.2. INTN Output Load Circuit

10. Functional Descriptions

10.1. System Configuration

AK9757W is intended to be used in combination with FOV Limiter, AK9791W, and Host MCU.
The incident light of AK9791W is limited by the FOV Limiter.

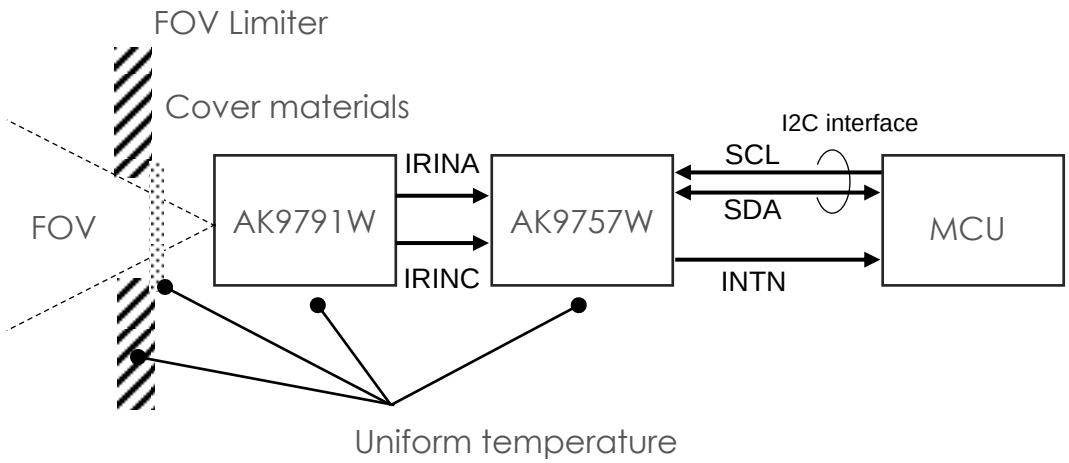

Figure 10.1.Connection Diagram

The calculation assumes that the temperatures of Field of View (FOV) Limiter, AK9791W and AK9757W are uniform. The AK9757W and a Host MCU should be connect by I^2C interface (SCL and SDA). Via I^2C interface, operating mode of the AK9757W is selected, and measurement data is read out.
The INTN output can be used as an interrupt control signal.
Refer to Recommended External Circuits (Figure13.1) for details.

Table 10.1. Temperature conditions

Parameter	Min.	Typ.	Max.	Unit
Recommended environmental temperature range	32		42	°C
Calculable environmental temperature range	0		50	°C
Temperature range of measurement object	32		42	°C
Measurement range of the built-in temperature sensor	-20		75	°C

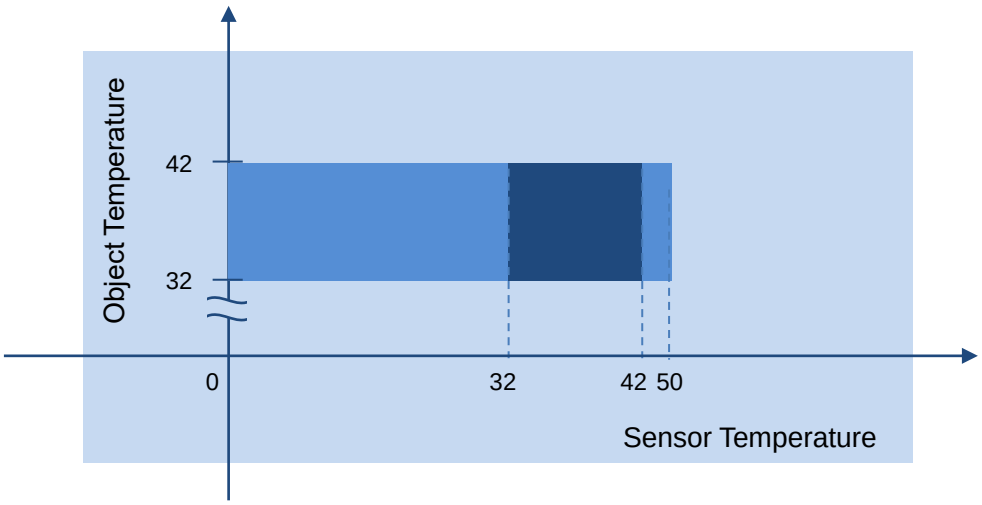

Figure 10.2. Temperature conditions

10.2. Reset function

The AK9757W is initialized in the following conditions,

10.2.1. Power-On Reset(POR)

When VDD turns on, the AK9757W is reset by the Power-On Reset (POR) circuit after VDD reaches operating voltage. After POR, the AK9757W enters Stand-By Mode and all registers are set to initial values.

10.2.2. Software Reset

The AK9757W is reset by writing Software Reset (SRST) register.
After writing "1" into *SRST* bit in *CNTL1*, the AK9757W returns acknowledgement, then the AK9757W enters Stand-By Mode and all registers are set to initial values.

10.3. Operating Mode

There are two operation modes.

10.3.1. Stand-By Mode (*MODE* = "0")

The AK9757W enters Stand-By Mode after reset (POR or Software RST) or *MODE* = "0". All circuits are powered down except for serial interface circuit. All registers can be accessed in this mode.
When the AK9757W enters Stand-By Mode (*MODE* ="0"), parameters and measurement data in registers are retained, and INTN is set to the initial state ("H") in this mode.

10.3.2. Continuous Mode (*MODE* = "1")

When Continuous Mode is selected, measurement is automatically repeated at a constant rate which is selected by ODR setting. The read-out registers will be updated after measurement is completed. When *MODE* = "0" is written during a measurement, the measurement is interrupted.
Then the last measurement data which is before interruption is retained in the registers.

10.4. ODR(Output Data Rate)

Output Data Rate(ODR) is selected by *ODR* register.
Average Number (AVN) is selected by *AVN* register.

The value of Average number is limited by the *ODR* setting. There is a trade-off between the average number and the current consumption, so choose the suitable setting for your application.
These registers should be written during *MODE* = "0"

10.5. I/V AMP, ADC

I/V AMP converts output current of IR sensor elements into voltage signals. Conversion gain is selected by *GAIN* register.
By setting the *IROFF* register, the input of I/V AMP can be disconnected from sensor and be shorted both inputs.

ADC has 16-bits of resolution. It converts voltage signal of I/V AMP and Built-in Temperature Sensor(Temp. Sensor) into signed 16-bit digital value.

Table 10.2. I/V AMP Gain

GAIN[2:0]	Gain
000	x2
001	x1
010	x1/2
011	x1/4
100	x1/6
101	Do not use
110	Do not use
111	Do not use

Table 10.3. I/V AMP Input

IROFF	Input
0	IR ON
1	IR OFF Short-circuit the IR sensor inputs, IRINA and IRINC, inside the AK9757W.

This register should be written during *MODE* = “0”

10.6. Built-in Temperature Sensor(Temp. Sensor)

Temp. Sensor measures the temperature of the AK9757W itself. The output signal is converted to AD. Measurement range of the built-in temperature sensor is -20 to 75 ºC.

10.7. correction circuit

Corrects the IR sensor output and TSENS output after AD conversion using a linear function. The correction parameters are selected by *GTS*,*OTS*,*GIT*,*GIR* and *OIR* registers.

TS' = (1 + **gts**) × TS + **ots**
GIR' = **git** × TS'
IR' = (**gir** + **gir** × GIR') × IR + **oir**

IR: IR sensor output after AD conversion
TS: Temp. Sensor output after AD conversion

Table 10.4. correction parameters

coefficient	Type	Register	Value	Description
gts	signed	*GTS[7:0]*	**gts** = GTS × 2^{-10} -0.125 to +0.124	TS Gain default : 0
ots	signed	*OTS[13:0]*	**ots** = OTS -8192 to +8191	TS Offset default : 0
git	signed	*GIT[7:0]*	**git** = GIT × 2^{-23} -1.526e-5 to +1.514e-5	Temperature dependent ingredient of IR gain default : 0
gir	unsigned	*GIR[15:0]*	**gir** = GIR × 2^{-14} 0 to 4	IR Gain default : 1.0
oir	signed	*OIR[11:0]*	**oir** = OIR -2048 to +2047	IR Offset default : 0

These registers should be written during *MODE* = "0"

10.8. Temperature Calculation(Temp. Calc.)

The temperature calculation result (TO) is obtained from IR' and TS'. IR' and TS' are the results of the correction circuit (10.7).
The flow of the calculation is shown below.

$F(TS') = \mathbf{fc4} \times TS'^4 + \mathbf{fc3} \times TS'^3 + \mathbf{fc2} \times TS'^2 + \mathbf{fc1} \times TS' + \mathbf{fc0}$
$G(TS') = \mathbf{gc4} \times TS'^4 + \mathbf{gc3} \times TS'^3 + \mathbf{gc2} \times TS'^2 + \mathbf{gc1} \times TS' + \mathbf{gc0}$
$IM(IR') = (IR' - F(TS')) \times G(TS')$

(uf6.10) $TO = \mathbf{xc4} \times IM^4 + \mathbf{xc3} \times IM^3 + \mathbf{xc2} \times IM^2 + \mathbf{xc1} \times IM + \mathbf{xc0}$

Table 10.5. Calculation coefficient

coefficient	Type	Register	Value
fc4,gc4,xc4 **fc3,gc3,xc3**	signed	*FC4[15:0], FC4EX[7:0]* : *XC3[15:0], XC3EX[7:0]*	**fc4** = *FC4*$\times 2^{-(15+FC4EX)}$, **fc3** = *FC3*$\times 2^{-(15+FC3EX)}$
fc2,gc2,xc2	signed	*FC2[15:0], FC2EX[5:0]* : *XC2[15:0], XC2EX[5:0]*	**fc2** = *FC2*$\times 2^{-(15+FC2EX)}$
fc1,gc1,xc1	signed	*FC1[15:0], FC1EX[4:0]* : *XC1[15:0], XC1EX[4:0]*	**fc1** = *FC1*$\times 2^{-(14+FC1EX)}$
fc0	signed	*FC0[15:0]*	**fc0** = *FC0*
gc0	signed	*GC0[15:0]]*	**gc0** = *GC0*$\times 2^{-14}$
xc0	unsigned	*XC0[15:0]*	**xc0** = *XC0*$\times 2^{-10}$

These registers should be written during *MODE* = “0”

The occurrence of overflow during a calculation is stored in the *OVF* of the ST register and TO= ”0xFFFF”.

Setting *CALC* = “1” enables Temperature calculation and setting *CALC* = "0" temperature calculation is bypassed. When *CALC* =”0”, IR(setting *THSEL* = “0”) or TS(setting *THSEL* =”H”) is stored in TO.

10.9. Threshold Jugement

Compare Temperature calculation result(TO) with the threshold levels.
The signal to be compared with the threshold is selected from differential of TOLPF and Stream Buffer data, TO or TOLPF.

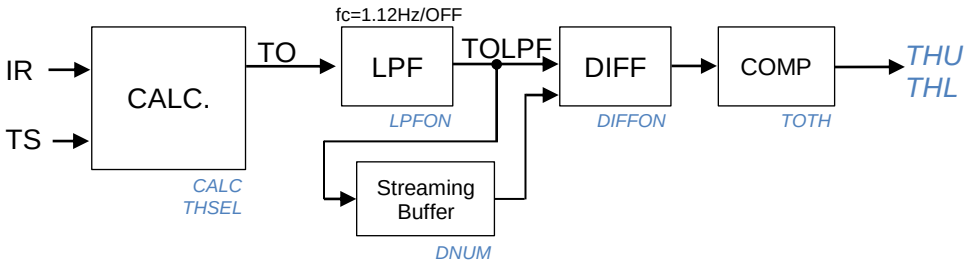

Figure 10.3. Threshold Judgment

Threshold Judgement makes two judgment. TO is changed from below *TOTH* to equal to or above *TOTH*, *THU* turns to “1”. TO is changed from above *TOTH* to equal to or below *TOTH*, *THL* turns to “1”. The threshold is set by the *TOTH* register.
By setting *LPFON*=”1”, LPF is applied to the calculate result. When *DIFFON*=”1”, the signal to be compared with the threshold is the difference between TOLPF and Streaming buffer data. The data of streaming buffer is selected by *DNUM*.
DIFFON=”0” : Threshold judgment is not performed for the first data after the *MODE*=”1”.
DIFFON=”1” : Threshold judgment is not performed for the number of times set by *DNUM* register.

CALC	*THSEL*	CALC output	Type	Data	Data(overflow)
0	0	IR[15:0]	signed	0x8001 - 0x7FFE	0x7FFF
0	1	TS[15:0]	signed	0x8001 - 0x7FFE	0x7FFF
1	X	TO[15:0]	unsigned	0x0001 - 0xFFFE	0xFFFF

When Temperature calculation is disable (*CALC*="0"), IR is stored in *TOUT* if *THSEL*="0", and TS is stored in *TOUT* if *THSEL*="1". When *CALC* is set to “0”, *LPFON* should be set to “0”.
The threshold judgment circuit will not make a judgment when TO=0x0000, 0xFFFF(*CALC*=”0” ,0x8000, 0x7FFF).

10.10. Streaming Buffer

AK9757W has a streaming buffer that can store10 samples of TO.
Write "1" to *BUFON* to start storing measurement data to the Streaming Buffer.

The streaming buffer update is stopped under the following conditions, and the data is transferred to the *SB0* to *SB9* registers.

- When *BUFON*=”0” is set.
- If an interrupt occurs when the *ITHU*,*ITHL*, or *IBFULL* register is set to "1".
  BUFON will be automatically set to "0".

To re-start the streaming buffer, set *BUFON*="1".
Stream Buffer data can be read out from *SB0* to *SB9* Registers. The latest data is stored in the *SB0* register.
BUFON register can be rewritten when either *MODE* = "0" or "1".
Streaming Buffer is reset when *BUFON*="1" and the first data is written. The value at reset is 0x8000 when *CALON* = "0", and 0x0000 when *CALON* = "1".

10.11. Interrupt Function

INTN output can be used as an interrupt control signal. INTN is an open drain output.
INTN outputs the interrupt result (“L”) by setting the interrupt setting register(address :23H).

Table 10.6. Interrupt source setting

Register	Address	Data	Description
CNTL4	23H	*IOVF*	Interrupt is asserted when overflow is occurred in calculation.
		ITHU	Interrupt is asserted when TO is changed from below *TOTH* to equal or above *TOTH.*
		ITHL	Interrupt is asserted when TO is changed from above *TOTH* to equal or below *TOTH.*
		IBFULL	Interrupt is asserted when streaming buffer is full.
		IDRDY	Interrupt is asserted when a measurement is finished and the AK9757W is ready to read out.

These registers should be written during *MODE* = “0”

When the calculate is completed, the data registers and status registers are updated and can be read out. At this time, if the interrupt setting is enabled, INTN goes to “L”
The INTN returns to “H”, after reading out *TOUTL*,*IRL*,*TSL* or *SB0L* registers.
When *ANG* =”1”, INTN will be automatically “L” even if there are no accesses to these registers until the next data update timing.

10.12. Measurement Data Read

Measurement data of IR sensors and Temp. Sensor, FOV Temperature calculation data and status data are stored in the following registers.
ST2 is a dummy register for data protect release.

Table 10.7. Measurement Data Registers

Register	Address	Data
ST	04H	*OVF, THU, THL, BFULL, DRDY*
TOUTL	05H	*TOUT[7:0]*
TOUTH	06H	*TOUT[15:8]*
TSL	07H	*TS[7:0]*
TSH	08H	*TS[15:8]*
IRL	09H	*IR[7:0]*
IRH	0AH	*IR[15:8]*
ST2	0BH	-

Table 10.8. Streaming Buffer Registers

Register	Address	Data
SB0L	0CH	*SB0[7:0]*
SB0H	0DH	*SB0[15:8]*
SB1L	0EH	*SB1[7:0]*
SB1H	0FH	*SB1[15:8]*
SB9L	1EH	*SB9[7:0]*
SB9H	1FH	*SB9[15:8]*

1.ST Register read out

Table 10.9. ST register

Register	Address	Data	Description
ST	04H	*OVF*	Indicates Overflow status. When an overflow occurs during a calculation, this bit turns to "1".
		THU	Indicate whether TO exceeds the preset threshold or not. When the TO is changed from below *TOTH* to equal to or above *TOTH*, this bit turns to “1”.
		THL	Indicate whether TO below the preset threshold or not. When the TO is changed from above *TOTH* to equal to or a below *TOTH*, this bit turns to “1”.
		BFULL	Indicate Streaming buffer status. When streaming buffer is full, this bit turns to "1".
		DRDY	Indicates Data Ready status. When the latest data is stored, this bit turns to “1”.

The status register is judged and updated at the end of the calculation.

The value of these bits are protected and not updated during data read. Data protection is released after reading the *ST2* register or when NACK is returned from the master IC after reading any of the *TOUTH*, *TSH*, *IRH* or *SB0H* registers.

Table 10.10. ST2 register

Register	Address	Data	Description
ST2	0BH	-	Register for data protection release

2.Measurement Data and Temperature calculation result read out.

Table 10.11 Measurement Data

Register	Address	Data	Description
TOUTL	05H	*TOUT[7:0]*	Indicate Temperature calculation result. When *TOUTLPF*=”1”,read the LPF output. Upper 6bit :integer ,Lower 10bit : decimal
TOUTH	06H	*TOUT[15:8]*	
TSL	07H	*TS[7:0]*	Measurement data of integrated Temperature Sensor. 16-bit data is stored in 2’s complement format.
TSH	08H	*TS[15:8]*	
IRL	09H	*IR[7:0]*	Measurement data of IR Sensor. 16-bit data is stored in 2’s complement format.
IRH	0AH	*IR[15:8]*	

These registers are updated at the end of the calculation.

These registers are protected and not updated during data read. Data protection is released after reading the *ST2* register or when NACK is returned from the master IC after reading any of the *TOUTH*, *TSH*,*IRH* or *SB0H*.
The value of TO is from 0x0001 to 0xFFFE(9.765e-4 to 63.999023 ºC). When an overflow occurs during the calculation, the value will be 0xFFFF.
The value of IR and TS is from 0x8001 to 0x7FFE.

10.13. Signal update timing

The ADC operates at the ODR cycle and the internal calculate circuit (CALC) operates when the ADC operation is completed. When the calculate is completed, the data registers and status registers are updated and can be read out. At this time, if the interrupt setting is enabled, INTN goes to “L”

The INTN returns to “H”, after reading out *TOUTL*, *IRL*, *TSL or SB0L* registers. When *ANG* =”1”, INTN will be automatically “L” even if there are no accesses to these registers until the next data update timing.

Data registers(address: 05H to 0AH) are protected and not updated during data read. Data protection is released after reading the *ST2* register or when NACK is returned from the master IC after reading any of the *TOUTH*,*TSH*,*IRH* or *SB0H* registers.

The Data protection of *ST* register is also cleared at the same time.

(Case1) Timing chart in byte read mode

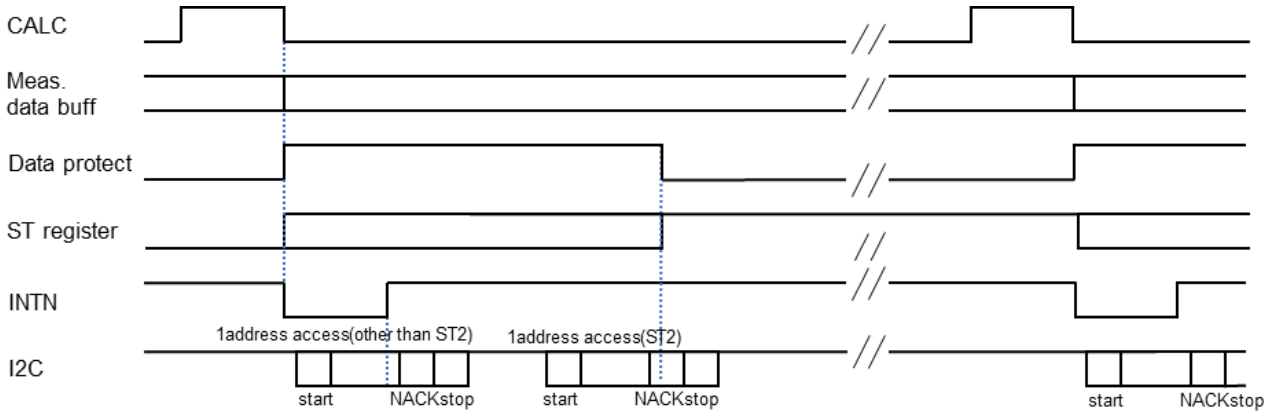

Figure 10.4. case1

(Case2) Timing chart in sequential read

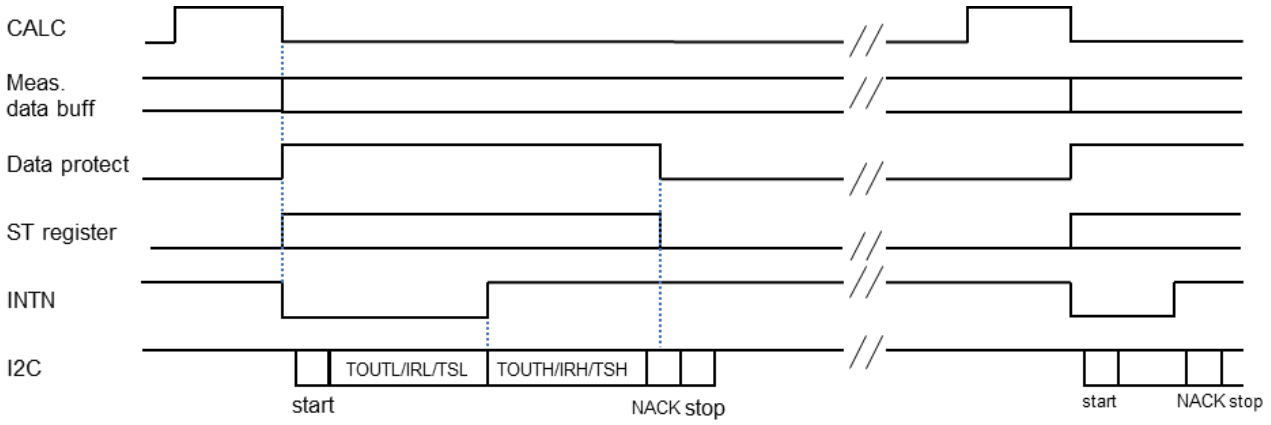

Figure 10.5. case2

(Case3) Timing chart when the read is skipped. (*ANG*="1")

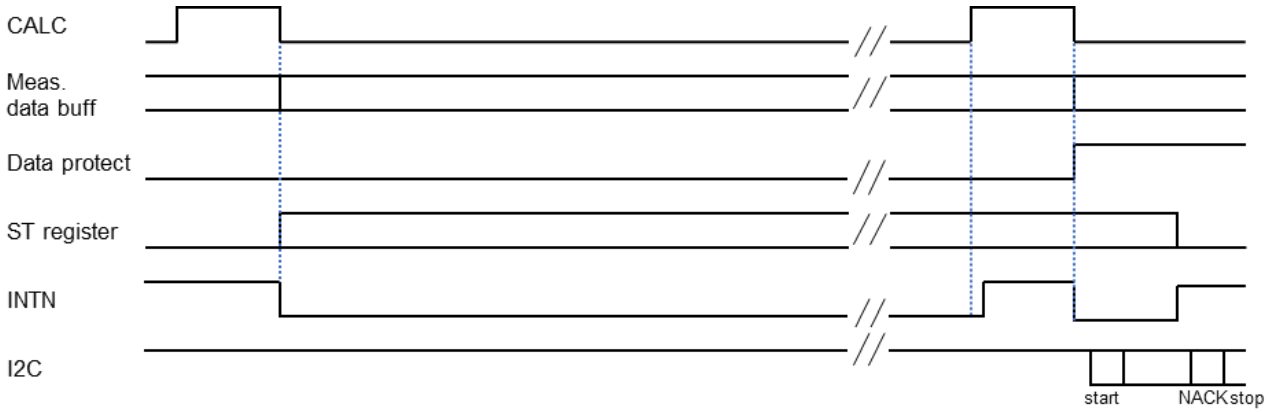

Figure 10.6. case3

11. Sirial Interface

The AK9757W supports I²C standard mode (max. 100kHz) and fast mode (max. 400kHz). The AK9757W operates as a slave device.

11.1. Data Transfer

Access to the AK9757W through I²C bus after POR.
The master device sends Start condition followed by Slave Address and R/W bit. Then Read/Write operation is executed. Read/Write operation is finished by Stop condition which is generated by the master device.

11.1.1. Changing state of SDA line

The SDA line state should be changed only while the SCL line is “L”. The SDA line state must be constant while the SCL line is “H”.

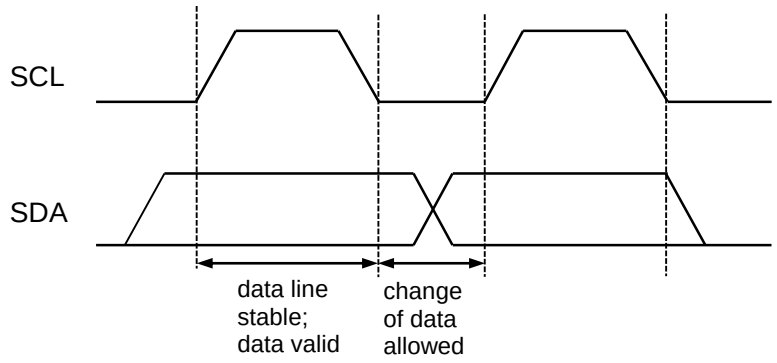

Figure 11.1. Changing state of SDA line

11.1.2. Start/Stop Conditions

All transactions begin with Start condition and finished by Stop condition.
Start condition is generated when the SDA line state is changed from “H” to “L” while the SCL line is “H”. Stop condition is generated when the SDA line state is changed from “L” to “H” while the SCL line is “H”.
Start/Stop condition are generated by the master device.

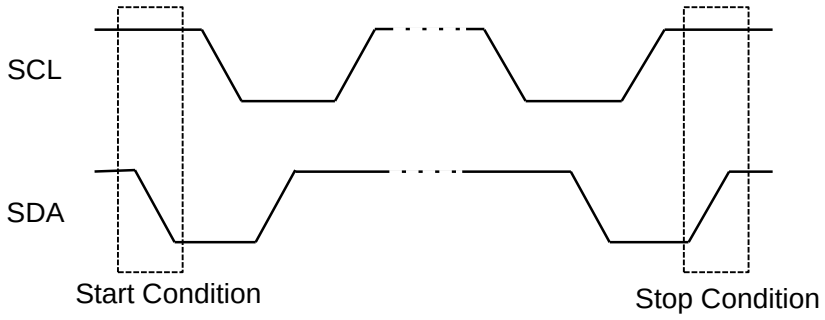

Figure 11.2. Start/Stop Conditions

11.1.3. Acknowledge

The transmitter releases the SDA line (SDA line state to “H”) after sending one byte of data. The receiver pulls the SDA line to “L” during the ninth clock pulse is “H”. This procedure is called “Acknowledge”. The Acknowledge signal indicates that every byte is successfully sent and received. The AK9757W sends Acknowledge after receiving Start condition and the first one byte (Slave Address and R/W bit).

In Write operation, the AK9757W sends Acknowledge after receiving each byte, as the receiver. If the master device sends Stop condition, Write operation is finished.
In Read operation, the AK9757W releases the SDA line after sending each byte and waits for Acknowledge from the master device. After receiving each Acknowledge, the AK9757W sends data. If the master device sends Stop condition, Read operation is finished.

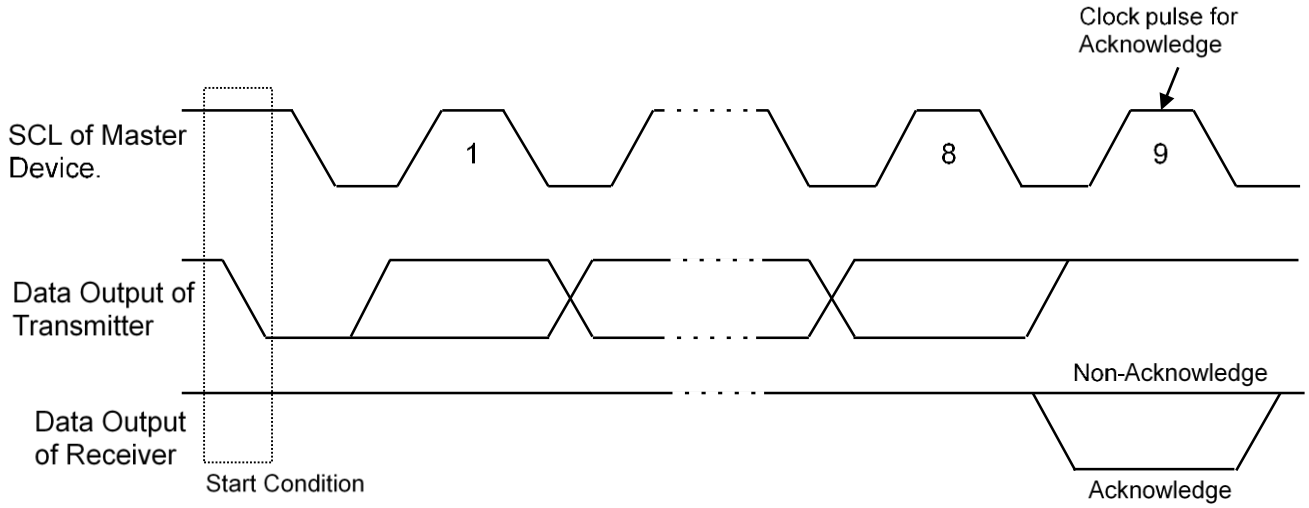

Figure 11.3. Acknowledge

11.1.4. Slave Address

The Slave Address of the AK9757W is 0x6C.
When the master device sends the first one byte (Slave Address and R/W bit) following to Start condition, the device which is specified by the Slave Address on the bus is selected. The device which is specified by the Slave Address sends Acknowledge and then executes command.
The R/W bit is set to “0”, Write command is executed. The R/W bit is set to “1”, Read command is executed.

MSB							LSB
1	1	0	1	1	0	0	R/W

Figure 11.4. Slave Address

11.1.5. WRITE Command

When R/W bit is set to “0”, the AK9757W executes Write operation. The master device sends the first one byte (Slave Address and R/W bit) following to Start condition and the AK9757W sends Acknowledge. Then the master device sends address of control register in the second byte. The address consists of 8-bit and MSB-first configuration. After receiving the second byte, the AK9757W sends Acknowledge.

MSB							LSB
A7	A6	A5	A4	A3	A2	A1	A0

Figure 11.5. Register Address

The master device specifies control data in the third byte. The control data consists of 8-bit and MSB-first configuration. The AK9757W sends Acknowledge after receiving the control data and increments the internal address counter automatically. When the master device sends Stop condition, data transfer is finished.

MSB							LSB
D7	D6	D5	D4	D3	D2	D1	D0

Figure 11.6. Control data

Two or more bytes of data can be written successively.
After receiving the third byte (control data), the AK9757W sends Acknowledge and increments the internal address counter automatically. When receiving the next data, the AK9757W writes data in the next address and increments the internal address counter. If the master device sends Stop condition, the AK9757W finishes Write operation.
For the automatic address increment, please refer Register map (Table 12.2)

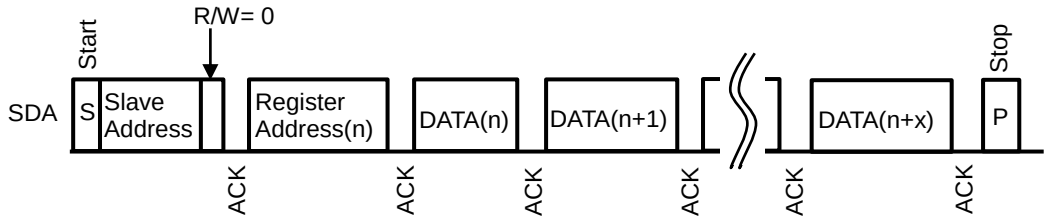

Figure 11.7. Write Operation

11.1.6. READ Command

When the R/W bit is set to “1”, the AK9757W executes Read operation.
In Read operation, the AK9757W receives Start condition and the first one byte (Slave address + R/W bit) and sends Acknowledge. Then the AK9757W sends data in the specified address. When the master device sends Stop condition, data transfer is finished.
The AK9757W can read out two or more byte successively. After the AK9757W sends data in the specified address, the master device sends Acknowledge. And the AK9757W sends the data in the next address and increments internal address counter. When the master device sends Stop condition, data transfer is finished.
For the automatic address increment, please refer register map (Table 12.2).
The AK9757W supports Current address read and Random read.

(1) Current Address Read

The AK9757W has the internal address counter. In Read operation, the AK9757W reads out the data which is specified by this counter.
The internal address counter retains the next address which is accessed lastly. For example, if the address which was accessed lastly is "n", the data in address "n+1" is read out by the current address Read operation.
After receiving the first one byte (slave address +R/W bit) following to Start condition, the AK9757W sends Acknowledge. The AK9757W sends 8-bit data specified by internal address counter at the next clock and increments the internal address counter by one. The AK9757W releases the SDA line after sending 8-bit data and waits for Acknowledge from the master device. After receiving Acknowledge, the AK9757W sends data in the next address and increments the internal address counter. If the master device sends Stop condition, Read operation is finished.

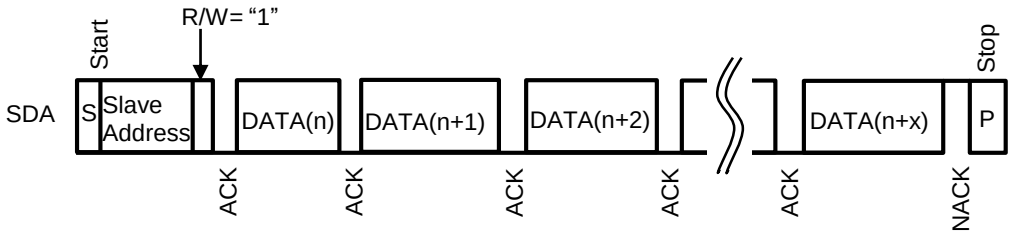

Figure 11.8. Current Address Read

(2) Random Read

Data in an arbitrary address can be read out.
Before sending Slave address and Read command (R/W = “1”), the master device should execute Write command to specify an address start to read out.
After receiving slave address and Write command (R/W = “0”) following to Start condition, the AK9757W sends Acknowledge. Second, the master device sends address to read out, and the AK9757W sends Acknowledge. Third, the master device sends Start condition and slave address of Read command (R/W = “1”). Then the AK9757W sends Acknowledge. Next, the AK9757W sends the data in the specified address and increments internal address counter. When the master device sends Acknowledge, the AK9757W sends 8-bit data in the next address and increments the address counter. The master device sends Stop condition, Read operation is finished.

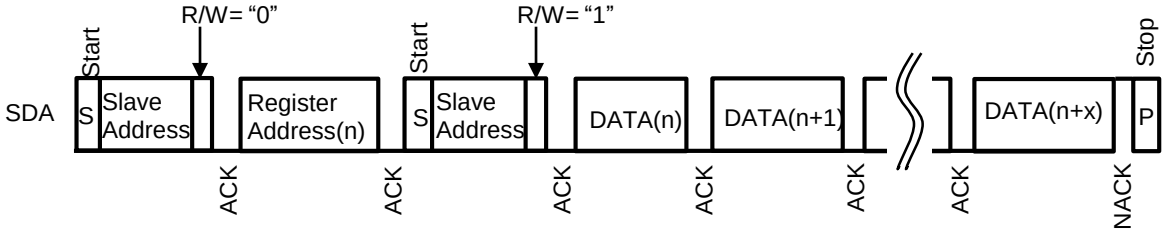

Figure 11.9. Random Read

12. Register Definitions

12.1. Register Map

Table 12.1 Register Map

Address	Name	D7	D6	D5	D4	D3	D2	D1	D0
00H	WIA1	0	1	0	0	1	0	0	0
01H	WIA2	0	0	0	1	0	1	1	1
02H	INFO1	0	0	0	0	0	0	0	0
03H	INFO2	0	0	0	0	0	0	0	0
04H	ST	1	1	1	OVF	THU	THL	BFULL	DRDY
05H	TOUTL	TOUT[7:0]							
06H	TOUTH	TOUT[15:8]							
07H	TS	TS[7:0]							
08H	TS	TS[15:8]							
09H	IR	IR[7:0]							
0AH	IR	IR[15:8]							
0BH	ST2	1	1	1	1	1	1	1	1
0CH	SBUF0	SB0[7:0]							
0DH	SBUF0	SB0[15:8]							
0EH	SBUF1	SB1[7:0]							
0FH	SBUF1	SB1[15:8]							
10H	SBUF2	SB2[7:0]							
11H	SBUF2	SB2[15:8]							
12H	SBUF3	SB3[7:0]							
13H	SBUF3	SB3[15:8]							
14H	SBUF4	SB4[7:0]							
15H	SBUF4	SB4[15:8]							
16H	SBUF5	SB5[7:0]							
17H	SBUF5	SB5[15:8]							
18H	SBUF6	SB6[7:0]							
19H	SBUF6	SB6[15:8]							
1AH	SBUF7	SB7[7:0]							
1BH	SBUF7	SB7[15:8]							
1CH	SBUF8	SB8[7:0]							
1DH	SBUF8	SB8[15:8]							
1EH	SBUF9	SB9[7:0]							
1FH	SBUF9	SB9[15:8]							
20H	CNTL1	1	1	1	1	1	1	1	SRST
21H	CNTL2	1	1	1	1	1	1	1	BUFON
22H	CNTL3	IROFF	GAIN[2:0]			CALC	dummy	ODR[1:0]	
23H	CNTL4	ANG	dummy[1:0]		IOVF	ITHU	ITHL	IBFULL	IDRDY
24H	CNTL5	LPFON	TOUTLPF	THSEL	DIFFON	DNUM[3:0]			
25H	CNTL6	TOTH[7:0]							
26H	CNTL7	TOTH[15:8]							
27H	CNTL8	1	1	AVN[5:0]					
28H	CNTL9	1	1	1	IRINV	Reserved			MODE

Address	Name	D7	D6	D5	D4	D3	D2	D1	D0
29H	FCOEF4	FC4[7:0]							
2AH	FCOEF4	FC4[15:8]							
2BH	FCOEF4EX	FC4EX[7:0]							
2CH	FCOEF3	FC3[7:0]							
2DH	FCOEF3	FC3[15:8]							
2EH	FCOEF3EX	FC3EX[7:0]							
2FH	FCOEF2	FC2[7:0]							
30H	FCOEF2	FC2[15:8]							
31H	FCOEF2EX	1	1	FC2EX[5:0]					
32H	FCOEF1	FC1[7:0]							
33H	FCOEF1	FC1[15:8]							
34H	FCOEF1EX	1	1	1	FC1EX[4:0]				
35H	FCOEF0	FC0[7:0]							
36H	FCOEF0	FC0[15:8]							
37H	GCOEF4	GC4[7:0]							
38H	GCOEF4	GC4[15:8]							
39H	GCOEF4EX	GC4EX[7:0]							
3AH	GCOEF3	GC3[7:0]							
3BH	GCOEF3	GC3[15:8]							
3CH	GCOEF3EX	GC3EX[7:0]							
3DH	GCOEF2	GC2[7:0]							
3EH	GCOEF2	GC2[15:8]							
3FH	GCOEF2EX	1	1	GC2EX[5:0]					
40H	GCOEF1	GC1[7:0]							
41H	GCOEF1	GC1[15:8]							
42H	GCOEF1EX	1	1	1	GC1EX[4:0]				
43H	GCOEF0	GC0[7:0]							
44H	GCOEF0	GC0[15:8]							
45H	XCOEF4	XC4[7:0]							
46H	XCOEF4	XC4[15:8]							
47H	XCOEF4EX	XC4EX[7:0]							
48H	XCOEF3	XC3[7:0]							
49H	XCOEF3	XC3[15:8]							
4AH	XCOEF3EX	XC3EX[7:0]							
4BH	XCOEF2	XC2[7:0]							
4CH	XCOEF2	XC2[15:8]							
4DH	XCOEF2EX	1	1	XC2EX[5:0]					
4EH	XCOEF1	XC1[7:0]							
4FH	XCOEF1	XC1[15:8]							
50H	XCOEF1EX	1	1	-1	XC1EX[4:0]				
51H	XCOEF0	XC0[7:0]							
52H	XCOEF0	XC0[15:8]							

Address	Name	D7	D6	D5	D4	D3	D2	D1	D0
53H	reserved	1	1	1	Reserved				
54H	GIR	GIR[7:0]							
55H	GIR	GIR[15:8]							
56H	OIR	OIR[7:0]							
57H	OIR	0	0	0	0	OIR[11:8]			
58H	GTS	GTS[7:0]							
59H	OTS	OTS[7:0]							
5AH	OTS	0	0	OTS[13:8]					
5BH	GIT	GIT[7:0]							
5CH	reserved	Reserved							
5DH	reserved	Reserved							
5EH	reserved	Reserved							
5FH	reserved	Reserved							

Table 12.2 Address Increment

Address	Name	Read/ Write	Address Increment	Remark
00H	WIA1	R		
01H	WIA2	R		
02H	INFO1	R		
03H	INFO2	R		
04H	ST	R		
05H	TOUTL	R		
06H	TOUTH	R		
07H	TS	R		
08H	TS	R		
09H	IR	R		
0AH	IR	R		
0BH	ST2	R		Returns to address 04H after reading address 0BH
0CH	SBUF0	R		
0DH	SBUF0	R		
0EH	SBUF1	R		
0FH	SBUF1	R		
10H	SBUF2	R		
11H	SBUF2	R		
. .	. .	. .	. .	. .
1BH	SBUF7	R		
1CH	SBUF8	R		
1DH	SBUF8	R		
1EH	SBUF9	R		
1FH	SBUF9	R		Returns to address 0CH after reading address 1FH
20H	CNTL1	R/W		
21H	CNTL2	R/W		
22H	CNTL3	R/W		
23H	CNTL4	R/W		
24H	CNTL5	R/W		
25H	CNTL6	R/W		
26H	CNTL7	R/W		
27H	CNTL8	R/W		
28H	CNTL9	R/W		Returns to address 20H after reading address 28H
29H	FCOEF4	R/W		
2AH	FCOEF4	R/W		
2BH	FCOEF4EX	R/W		
2CH	FCOEF3	R/W		
2DH	FCOEF3	R/W		
2EH	FCOEF3EX	R/W		
. .	. .	. .	. .	. .
5BH	GIT	R/W		
5CH	reserved	R		
5DH	reserved	R		
5EH	reserved	R		
5FH	reserved	R		Returns to address 29H after reading address 5FH

12.2. Function Descriptions

12.2.1. WIA1: Company Code (Read Only Register)

Address	Name	D7	D6	D5	D4	D3	D2	D1	D0
00H	WIA1	0	1	0	0	1	0	0	0

One Byte fixed code as Company code of AKM.

12.2.2. WIA2: Device ID (Read Only Register)

Address	Name	D7	D6	D5	D4	D3	D2	D1	D0
01H	WIA2	0	0	0	1	0	1	1	1

One Byte fixed code as the AK9757 device ID.

12.2.3. INFO1: Information1 (Read Only Register)

Address	Name	D7	D6	D5	D4	D3	D2	D1	D0
02H	INFO1	0	0	0	0	0	0	0	0

INFO1[7:0]: Information for AKM use only.

12.2.4. INFO2: Information2 (Read Only Register)

Address	Name	D7	D6	D5	D4	D3	D2	D1	D0
03H	INFO2	0	0	0	0	0	0	0	0

INFO2[7:0]: Information for AKM use only.

12.2.5. ST: Status (Read Only Register)

Address	Name	D7	D6	D5	D4	D3	D2	D1	D0
04H	ST	1	1	1	OVF	THU	THL	BFULL	DRDY
Reset		1	1	1	0	0	0	0	0

Bit	Field	Description
7:5	N.A.	
4	OVF	Indicates Overflow status. "0" : Normal State (default) "1" : Overflow occurred during a calculation.
3	THU	Indicate whether TO exceeds the preset threshold or not. "0" : Normal State (default) "1" : TO is changed from below TOTH to equal to or above TOTH.
2	THL	Indicate whether TO below the preset threshold or not. "0" : Normal State (default) "1" : TO is changed from above TOTH to equal to or below TOTH.
1	BFULL	Indicates Streaming buffer is full. "0" : Normal State (default) "1" : Streaming buffer is full.
0	DRDY	Indicates Data Ready status. "0" : Normal State (default) "1" : Data Ready

The value of these bits are protected and not updated during data read. Data protection is released after reading the ST2 register or when NACK is returned from the master IC after reading any of the TOUTH, TSH, IRH or SB0H registers.

12.2.6. TOUT, TS, IR: data register (Read Only Register)

12.2.7. Address	Name	D7	D6	D5	D4	D3	D2	D1	D0
05H	TOUT	TOUT[7;0]							
06H		TOUT[15:8]							
Reset		0000H							

Address	Name	D7	D6	D5	D4	D3	D2	D1	D0
07H	TS	TS[7:0]							
08H		TS[15:8]							
09H	IR	IR[7:0]							
0AH		IR[15:8]							
Reset		8000H							

Name	Description
TOUT	Temperature calculation result data register Unsigned 16bit Upper 6bit :integer ,Lower 10bit : decimal When CALC="0", IR(THSEL="0") or TS(THSEL="1")
TS	Built-in Temperature sensor data register Signed 16bit
IR	IR sensor data register Signed 16bit

12.2.8. ST2: Status2 (Read Only Register)

Address	Name	D7	D6	D5	D4	D3	D2	D1	D0
0BH	ST2	1	1	1	1	1	1	1	1
Reset		1	1	1	1	1	1	1	1

This register is used to release data protection.

12.2.9. SBUFx: Streaming Buffer data (Read Only Register)

Address	Name	D7	D6	D5	D4	D3	D2	D1	D0
0CH	SBUF0	SB0[7;0]							
0DH		SB0[15:8]							
0EH	SBUF1	SB1[7:0]							
0FH		SB1[15:8]							
10H	SBUF2	SB2[7:0]							
11H		SB2[15:8]							
12H	SBUF3	SB3[7:0]							
13H		SB3[15:8]							
14H	SBUF4	SB4[7:0]							
15H		SB4[15:8]							
16H	SBUF5	SB5[7:0]							
17H		SB5[15:8]							
18H	SBUF6	SB6[7:0]							
19H		SB6[15:8]							
1AH	SBUF7	SB7[7:0]							
1BH		SB7[15:8]							
1CH	SBUF8	SB8[7:0]							
1DH		SB8[15:8]							
1EH	SBUF9	SB9[7:0]							
1FH		SB9[15:8]							
Reset		0000H (8000H when CALC=”0”)							

Name	Description
SBUFx	AK9757W has a streaming buffer that can store10 samples of TO. The latest value will be stored in SBUF0. When reading out, set BUFON="0".

12.2.10. CNTL1: Soft Reset (Read/Write Register)

Address	Name	D7	D6	D5	D4	D3	D2	D1	D0
20H	CNTL1	1	1	1	1	1	1	1	SRST
Reset		1	1	1	1	1	1	1	0

Bit	Field	Description
7:1	N.A.	
0	SRST	Soft Reset "0" : Normal State (default) "1" : Reset Logic circuit and all registers are reset. SRST automatically returns to "0" after reset.

12.2.11. CNTL2: Streaming buffer control (Read/Write Register)

Address	Name	D7	D6	D5	D4	D3	D2	D1	D0
21H	CNTL2	1	1	1	1	1	1	1	BUFON
Reset		1	1	1	1	1	1	1	0

Bit	Field	Description
7:1	N.A.	
0	BUFON	Streaming Buffer setting "0" : Streaming buffer OFF "1" : Streaming buffer ON

When ITHU, ITHL, or IBFULL is set to "1" and an interrupt occurs, BUFON will automatically return to "0".

12.2.12. CNTL3: I/V AMP, Temp. calc., ODR setting (Read/Write Register)

Address	Name	D7	D6	D5	D4	D3	D2	D1	D0
22H	CNTL3	IROFF	GAIN[2:0]			CALC	dummy	ODR[1:0]	
Reset		0	1H			0	0	0H	

Bit	Field	Description
7	IROFF	Short-circuit IRINA and IRINC inside the AK9757W. "0" : Normal State (default) "1" : Shorting IRINA and IRINC
6:4	GAIN	I/V AMP Gain setting "000" : x2 "001" : x1 (default) "010" : x1/2 "011" : x1/4 "100" : x1/6 "101"-"111" : Do not use
3	CALC	Enable Temperature calculation "0" : Disabled(default) "1" : Enabled
2	dummy	-
1:0	ODR	Output Data Rate(frequency) setting "00" : 1Hz (default) "01" : 2Hz "10" : 10Hz "11" : 50Hz

12.2.13. CNTL4: Interrupt setting (Read/Write Register)

Address	Name	D7	D6	D5	D4	D3	D2	D1	D0
23H	CNTL4	ANG	dummy[1:0]		IOVF	ITHU	ITHL	IBFULL	IDRDY
Reset		0	0H		0	0	0	0	0

Bit	Field	Description
7	ANG	INTN auto negate setting "0" : Disabled(default) "1" : Enabled
6:5	dummy	-
4	IOVF	Interrupt enable when overflow occurs. "0" : Disabled(default) "1" : Enabled Interrupt is asserted when overflow is occurred in calculation.
3	ITHU	Interrupt enable when TO exceeds TOTH "0" : Disabled (default) "1" : Enabled Interrupt is asserted when TO is changed from below TOTH to equal or above TOTH.
2	ITHL	Interrupt enable when TO is below TOTH "0" : Disabled (default) "1" : Enabled Interrupt is asserted when TO is changed from above TOTH to equal or below TOTH.
1	IBFULL	Interrupt enable when Streaming buffer is full "0" : Disabled (default) "1" : Enabled Interrupt is asserted when streaming buffer is full.
0	IDRDY	Interrupt enable on Data Ready "0" : Disabled (default) "1" : Enabled Interrupt is asserted when a measurement is finished and the AK9757W is ready to read out.

12.2.14. CNTL5: Threshold judgment setting (Read/Write Register)

Address	Name	D7	D6	D5	D4	D3	D2	D1	D0
24H	CNTL5	LPFON	TOUTLPF	THSEL	DIFFON	DNUM[3:0]			
Reset		0	0	0	0	0H			

Bit	Field	Description
7	LPFON	Indicates whether LPF should be applied to the calculation result. "0" : Disabled (default) "1" : Enabled
6	TOUTLPF	Select the signal to be stored in the TOUT register. "0" : Calculation result signal(TO) (default) "1" : LPF output (TOLPF)
5	THSEL	Selects the output signal when Temperature calculation is disabled(CALC ="0"). "0" : IR (default) "1" : TS
4	DIFFON	Setting the input signal for threshold judgment "0" : use TOLPF (default) "1" : use TOLPF - SBx
3:0	DNUM	Select the Streaming Buffer data(SBx) when DIFFON = "1" "0000" : SB0 (latest data) (default) "0001" : SB1 "0010" : SB2 "0011" : SB3 "0100" : SB4 "0101" : SB5 "0110" : SB6 "0111" : SB7 "1000" : SB8 "1001" : SB9 "1010"-"1111" : Do not use

12.2.15. CNTL6, CNTL7: Threshold Level setting (Read/Write Register)

Address	Name	D7	D6	D5	D4	D3	D2	D1	D0
25H	CNTL6	TOTH[7:0]							
26H	CNTL7	TOTH[15:8]							
Reset		0000H							

Name	Description
TOTH	Threshold Level CALC="0" : unsigned, CALC="1" : signed

12.2.16. CNTL8: ADC average number setting (Read/Write Register)

Address	Name	D7	D6	D5	D4	D3	D2	D1	D0
27H	CNTL8	1	1	AVN[5:0]					
Reset		1	1	00H					

Bit	Field	Description
7:6	NA	
5:0	AVN	ADC average number setting

ODR[1:0] / AVN[5:0]	0x00		0x01		0x10		0x11	
	1Hz		2Hz		10Hz		50Hz	
	IR path	TS path	IR path	TS path	IR path	TS path	IR path	TS path
0x00	1	1	1	1	1	1	1	1
0x01	2	1	2	1	2	1	2	1
0x02	3	1	3	1	3	1	3	1
0x03	4	1	4	1	4	1	4	1
0x04	5	1	5	1	5	1	5	1
0x05	6	1	6	1	6	1	6	1
0x06	7	1	7	1	7	1	Do not use	
0x07	8	1	8	1	8	1		
0x08	9	2	9	2	9	2		
0x09	10	2	10	2	10	2		
:	:	:	:	:	:	:		
0x1E	31	4	31	4	31	4		
0x1F	32	4	32	4	32	4		
0x20	64	8	64	8	Do not use			
0x21	96	12	96	12				
0x22	128	16	128	16				
0x23	160	20	160	20				
0x24	192	24	Do not use					
0x25	224	28						
0x26	256	32						
0x27	288	36						
0x28	320	40						
0x29	Do not use							
:								
0x3F								

12.2.17. CNTL9: Mode setting (Read/Write Register)

Address	Name	D7	D6	D5	D4	D3	D2	D1	D0
28H	CNTL9	1	1	1	IRINV	Reserved			MODE
Reset		1	1	1	0	0	0	0	0

Bit	Field	Description
7:5	NA	
4	IRINV	Invert setting for IR signal after AD conversion. “0” : Normal(default) “1” : Invert
3:1	Reserved	When writing these registers, you must set these bits to “0”
0	MODE	Operation Mode setting “0” : Stand-By Mode(default) “1” : Continuous Measurement Mode

12.2.18. FCOEF4,FCOEF4EX: Calculation coefficient setting (Read/Write Register)

Address	Name	D7	D6	D5	D4	D3	D2	D1	D0
29H	FCOEF4	FC4[7:0]							
2AH	FCOEF4	FC4[15:8]							
Reset		0000H							
2BH	FCOEF4EX	FC4EX[7:0]							
Reset		00H							

Set the coefficient fc4 of the calculation by the following formula. The type of this coefficient is singed.

fc4 = FC4 × $2^{-(15+FC4EX)}$

12.2.19. FCOEF3,FCOEF3EX: Calculation coefficient setting (Read/Write Register)

Address	Name	D7	D6	D5	D4	D3	D2	D1	D0
2CH	FCOEF3	FC3[7:0]							
2DH	FCOEF3	FC3[15:8]							
Reset		0000H							
2EH	FCOEF3EX	FC3EX[7:0]							
Reset		00H							

Set the coefficient fc3 of the calculation by the following formula. The type of this coefficient is singed.

fc3 = FC3 × $2^{-(15+FC3EX)}$

12.2.20. FCOEF2,FCOEF2EX: Calculation coefficient setting (Read/Write Register)

Address	Name	D7	D6	D5	D4	D3	D2	D1	D0
2FH	FCOEF2	FC2[7:0]							
30H	FCOEF2	FC2[15:8]							
Reset		0000H							
31H	FCOEF2EX	1	1	FC2EX[5:0]					
Reset		C0H							

Set the coefficient fc2 of the calculation by the following formula. The type of this coefficient is singed.

fc2 = FC2 × $2^{-(15+FC2EX)}$

12.2.21. FCOEF1,FCOEF1EX: Calculation coefficient setting (Read/Write Register)

Address	Name	D7	D6	D5	D4	D3	D2	D1	D0
32H	FCOEF1	FC1[7:0]							
33H	FCOEF1	FC1[15:8]							
Reset		0000H							
34H	FCOEF1EX	1	1	1	FC1EX[4:0]				
Reset		E0H							

Set the coefficient fc1 of the calculation by the following formula. The type of this coefficient is singed.

fc1 = FC1 × $2^{-(14+FC1EX)}$

12.2.22. FCOEF0,FCOEF0EX: Calculation coefficient setting (Read/Write Register)

Address	Name	D7	D6	D5	D4	D3	D2	D1	D0
35H	FCOEF0	FC0[7:0]							
36H	FCOEF0	FC0[15:8]							
Reset		0000H							

Set the coefficient fc0(**fc0** = FC0). The type of this coefficient is singed.

12.2.23. GCOEF4,GCOEF4EX: Calculation coefficient setting (Read/Write Register)

Address	Name	D7	D6	D5	D4	D3	D2	D1	D0
37H	GCOEF4	GC4[7:0]							
38H	GCOEF4	GC4[15:8]							
Reset		0000H							
39H	GCOEF4EX	GC4EX[7:0]							
Reset		00H							

Set the coefficient gc4 of the calculation by the following formula. The type of this coefficient is singed.

gc4 = GC4 × $2^{-(15+GC4EX)}$

12.2.24. GCOEF3,GCOEF3EX: Calculation coefficient setting (Read/Write Register)

Address	Name	D7	D6	D5	D4	D3	D2	D1	D0
3AH	GCOEF3	GC3[7:0]							
3BH	GCOEF3	GC3[15:8]							
Reset		0000H							
3CH	GCOEF3EX	GC3EX[7:0]							
Reset		00H							

Set the coefficient gc3 of the calculation by the following formula. The type of this coefficient is singed.

gc3 = GC3 × $2^{-(15+GC3EX)}$

12.2.25. GCOEF2,GCOEF2EX: Calculation coefficient setting (Read/Write Register)

Address	Name	D7	D6	D5	D4	D3	D2	D1	D0
3DH	GCOEF2	GC2[7:0]							
3EH	GCOEF2	GC2[15:8]							
Reset		0000H							
3FH	GCOEF2EX	1	1	GC2EX[5:0]					
Reset		C0H							

Set the coefficient gc2 of the calculation by the following formula. The type of this coefficient is singed.

gc2 = GC2 × $2^{-(15+GC2EX)}$

12.2.26. GCOEF1,GCOEF1EX: Calculation coefficient setting (Read/Write Register)

Address	Name	D7	D6	D5	D4	D3	D2	D1	D0
40H	GCOEF1	GC1[7:0]							
41H	GCOEF1	GC1[15:8]							
Reset		0000H							
42H	GCOEF1EX	1	1	1	GC1EX[4:0]				
Reset		E0H							

Set the coefficient gc1 of the calculation by the following formula. The type of this coefficient is singed.

gc1 = GC1 × $2^{-(14+GC1EX)}$

12.2.27. GCOEF0,GCOEF0EX: Calculation coefficient setting (Read/Write Register)

Address	Name	D7	D6	D5	D4	D3	D2	D1	D0
43H	GCOEF0	GC0[7:0]							
44H	GCOEF0	GC0[15:8]							
Reset		0000H							

Set the coefficient gc0(**gc0** = GC0 × 2^{-14}). The type of this coefficient is singed.

12.2.28. XCOEF4,XCOEF4EX: Calculation coefficient setting (Read/Write Register)

Address	Name	D7	D6	D5	D4	D3	D2	D1	D0
45H	XCOEF4	XC4[7:0]							
46H	XCOEF4	XC4[15:8]							
Reset		0000H							
47H	XCOEF4EX	XC4EX[7:0]							
Reset		00H							

Set the coefficient xc4 of the calculation by the following formula. The type of this coefficient is singed.

xc4 = XC4 × $2^{-(15+XC4EX)}$

12.2.29. XCOEF3,XCOEF3EX: Calculation coefficient setting (Read/Write Register)

Address	Name	D7	D6	D5	D4	D3	D2	D1	D0
48H	XCOEF3	XC3[7:0]							
49H	XCOEF3	XC3[15:8]							
Reset		0000H							
4AH	XCOEF3EX	XC3EX[7:0]							
Reset		00H							

Set the coefficient xc3 of the calculation by the following formula. The type of this coefficient is singed.

xc3 = XC3 × $2^{-(15+XC3EX)}$

12.2.30. XCOEF2,XCOEF2EX: Calculation coefficient setting (Read/Write Register)

Address	Name	D7	D6	D5	D4	D3	D2	D1	D0
4BH	XCOEF2	XC2[7:0]							
4CH	XCOEF2	XC2[15:8]							
Reset		0000H							
4DH	XCOEF2EX	1	1	XC2EX[5:0]					
Reset		C0H							

Set the coefficient xc2 of the calculation by the following formula. The type of this coefficient is singed.

xc2 = XC2 × $2^{-(15+XC2EX)}$

12.2.31. XCOEF1,XCOEF1EX: Calculation coefficient setting (Read/Write Register)

Address	Name	D7	D6	D5	D4	D3	D2	D1	D0
4EH	XCOEF1	XC1[7:0]							
4FH	XCOEF1	XC1[15:8]							
Reset		0000H							
50H	XCOEF1EX	1	1	1	XC1EX[4:0]				
Reset		E0H							

Set the coefficient xc1 of the calculation by the following formula. The type of this coefficient is singed.

xc1 = XC1 × $2^{-(14+XC1EX)}$

12.2.32. XCOEF0,XCOEF0EX: Calculation coefficient setting (Read/Write Register)

Address	Name	D7	D6	D5	D4	D3	D2	D1	D0
51H	XCOEF0	XC0[7:0]							
52H	XCOEF0	XC0[15:8]							
Reset		0000H							

unsigned

Set the coefficient xc0 of the calculation by the following formula. The type of xc0 is unsinged.

xc0 = XC0 × 2^{-10}

12.2.33. reserved (Read/Write Register)

Address	Name	D7	D6	D5	D4	D3	D2	D1	D0
53H	reserved	1	1	1	Reserved				
Reset		1	1	1	0	0	0	0	0

Bit	Field	Description
7:5	NA	
4:0	Reserved	When writing these registers, you must set these bits to “0”

12.2.34. GIR: IR gain Correction parameter setting (Read/Write Register)

Address	Name	D7	D6	D5	D4	D3	D2	D1	D0
54H	GIR	GIR[7:0]							
55H	GIR	GIR[15:8]							
Reset		4000H							

Set the correction parameter gir by the following formula. The type of this coefficient is unsinged.

gir = GIR × 2^{-14}

12.2.35. OIR: IR offset Correction parameter setting (Read/Write Register)

Address	Name	D7	D6	D5	D4	D3	D2	D1	D0
56H	OIR	OIR[7:0]							
57H	OIR	0	0	0	0	OIR[11:8]			
Reset		0000H							

Set the correction parameter oir(**oir** = OIR). The type of this coefficient is singed.

12.2.36. GTS: TS Gain Correction parameter setting (Read/Write Register)

Address	Name	D7	D6	D5	D4	D3	D2	D1	D0
58H	GTS	GTS[7:0]							
Reset		00H							

Set the correction parameter gts by the following formula. The type of this coefficient is singed.

gts = GTS × 2^{-10}

12.2.37. OTS: TS offset Correction parameter setting (Read/Write Register)

Address	Name	D7	D6	D5	D4	D3	D2	D1	D0
59H	OTS	OTS[7:0]							
5AH	OTS	0	0	OTS[13:8]					
Reset		0000H							

Set the correction parameter ots(**ots** = OTS). The type of this coefficient is singed.

12.2.38. GIT: Temperature dependent ingredient of IR gain setting (Read/Write Register)

Address	Name	D7	D6	D5	D4	D3	D2	D1	D0
5BH	GIT	GIT[7:0]							
Reset		00H							

Set the correction parameter git by the following formula. The type of this coefficient is singed.

git = GIT × 2^{-23}

12.2.39. reserved (Read Only Register)

Address	Name	D7	D6	D5	D4	D3	D2	D1	D0
5CH	reserved	Reserved							
5DH									
5EH									
5FH									
Reset		00H							

13. Recommended External Circuits

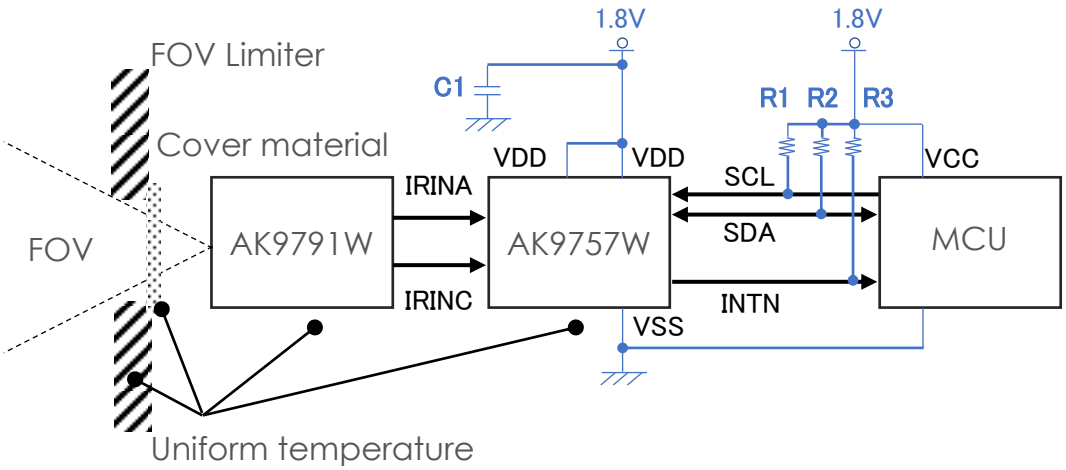

Figure 13.1 recommend External Circuits

Table 13.1 parts

Parts No.	Value	Comment
C1	0.1μF	Ceramic Capacitor
R1	10kΩ	Pull-up Resister
R2	10kΩ	Pull-up Resister
R3	10kΩ	Pull-up Resister

14. Ordering Guide

AK9757W	-30 to 85ºC	wafer

15. Revision History

Date (Y/M/D)	Revision	Reason	Page	Contents
2023/02	00	First edition	-	-
2023/05/19	01	Correction	30	IC name typo corrected (AK9756→AK9757).
2023/06/22	02	Correction	17	Corrected ITHU description (same notation as p.34).
			14	Coefficient font corrected to bold.
			38,39	Unified table formatting.

IMPORTANT NOTICE

0. Asahi Kasei Microdevices Corporation (“AKM”) reserves the right to make changes to the information contained in this document without notice. When you consider any use or application of AKM product stipulated in this document (“Product”), please make inquiries the sales office of AKM or authorized distributors as to current status of the Products.
1. All information included in this document are provided only to illustrate the operation and application examples of AKM Products. AKM neither makes warranties or representations with respect to the accuracy or completeness of the information contained in this document nor grants any license to any intellectual property rights or any other rights of AKM or any third party with respect to the information in this document. You are fully responsible for use of such information contained in this document in your product design or applications. AKM ASSUMES NO LIABILITY FOR ANY LOSSES INCURRED BY YOU OR THIRD PARTIES ARISING FROM THE USE OF SUCH INFORMATION IN YOUR PRODUCT DESIGN OR APPLICATIONS.
2. The Product is neither intended nor warranted for use in equipment or systems that require extraordinarily high levels of quality and/or reliability and/or a malfunction or failure of which may cause loss of human life, bodily injury, serious property damage or serious public impact, including but not limited to, equipment used in nuclear facilities, equipment used in the aerospace industry, medical equipment, equipment used for automobiles, trains, ships and other transportation, traffic signaling equipment, equipment used to control combustions or explosions, safety devices, elevators and escalators, devices related to electric power, and equipment used in finance-related fields. Do not use Product for the above use unless specifically agreed by AKM in writing.
3. Though AKM works continually to improve the Product’s quality and reliability, you are responsible for complying with safety standards and for providing adequate designs and safeguards for your hardware, software and systems which minimize risk and avoid situations in which a malfunction or failure of the Product could cause loss of human life, bodily injury or damage to property, including data loss or corruption.
4. Do not use or otherwise make available the Product or related technology or any information contained in this document for any military purposes, including without limitation, for the design, development, use, stockpiling or manufacturing of nuclear, chemical, or biological weapons or missile technology products (mass destruction weapons). When exporting the Products or related technology or any information contained in this document, you should comply with the applicable export control laws and regulations and follow the procedures required by such laws and regulations. The Products and related technology may not be used for or incorporated into any products or systems whose manufacture, use, or sale is prohibited under any applicable domestic or foreign laws or regulations.
5. Please contact AKM sales representative for details as to environmental matters such as the RoHS compatibility of the Product. Please use the Product in compliance with all applicable laws and regulations that regulate the inclusion or use of controlled substances, including without limitation, the EU RoHS Directive. AKM assumes no liability for damages or losses occurring as a result of noncompliance with applicable laws and regulations.
6. Resale of the Product with provisions different from the statement and/or technical features set forth in this document shall immediately void any warranty granted by AKM for the Product and shall not create or extend in any manner whatsoever, any liability of AKM.
7. This document may not be reproduced or duplicated, in any form, in whole or in part, without prior written consent of AKM.