CM36781

High Sensitivity Long Distance Proximity Sensor

Rev: 1.7 Revised 18th-May-2017

Description

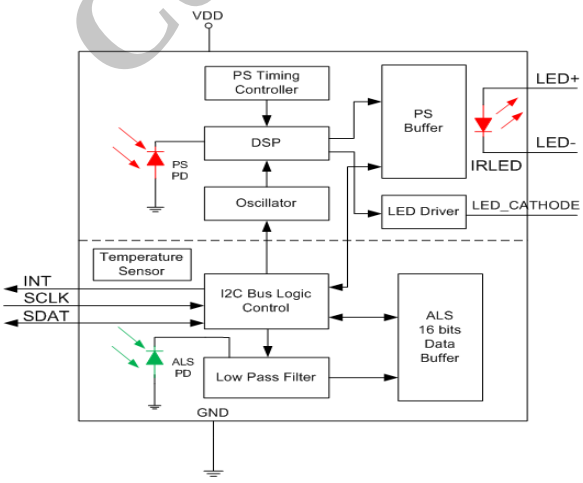
CM36781 integrates a high sensitivity long distance proximity sensor (PS), ambient light sensor (ALS), and 940 nm IR LED into one small package. It incorporates photodiodes, amplifiers and analog to digital converting circuits into a single chip using a CMOS process. The 16-bit high resolution ALS offers excellent sensing capabilities with sufficient selections to fulfill most applications whether a dark or high transparency lens design. CM36781 offers individual programmable high and low threshold interrupt features for the best utilization of resources and power saving on the microcontroller. For the 12-bit proximity sensing function, CM36781 has a built in intelligent cancellation scheme that eliminates cross talk issues. The persistence feature prevents false judgment of proximity sensing due to ambient light noise.

The adoption of Capella's patented Filtron™ technology achieves the closest ambient light spectral sensitivity to real human eye responses. CM36781 provides excellent temperature compensation capability for keeping the output stable under changing temperature. . ALS and PS functions are easily operated via the simple command format of I ² C (SMBus compatible) interface protocol. Operating voltage ranges from 2.5 V to 3.6 V.

Applications

- LCD Monitor
- Notebook
- All-In-One PC
- Industrial and medical application

Block Diagram



Features

- Operates ALS and PS in parallel structure
- Filtron™ technology adoption for robust background light cancellation
- Supports low transmittance (dark) lens design

Ambient Light Sensor

- High accuracy ALS of ±10%
- Spectrum close to human eye response
- Selectable maximum detection range (164\328\655\1311) lux with highest sensitivity 0.003lux/step

Proximity Sensor

- Immunity to red glow (940 nm IR LED)
- Intelligent cancellation to reduce cross talk phenomenon
- Smart persistence scheme to reduce PS response time
- Selectable for 12-bit PS output data

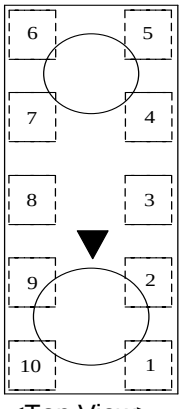
Interrupt

- Programmable interrupt function for ALS and PS with upper and lower thresholds
- Adjustable persistence to prevent false triggers for ALS and PS

Additional Features

- Temperature compensation
- Low power consumption I²C (SMBus Compatible) Interface
- Output type: I²C Bus (ALS/PS)
- Operation voltage of 2.5 V to 3.6 V
- Package : Molding package 8.0 x 3.0 x 1.8 mm
- Lead-free package (RoHS compliant)

Pin Definition



<Top View>

1	GND	6	LED+
2	LED_Cathode	7	NC
3	VDD	8	INT
4	NC	9	SDAT
5	LED-	10	SCLK

Ordering Information

PART NUMBER	PACKING	PACKAGE	PIN NO.	QUANTITY	LEAD FREE
CM36781M3OI	Tape and Reel	8.0 x 3.0 x 1.8 mm	10	2500	Compliant

Absolute Maximum Ratings

PARAMETER	SYMBOL	MIN.	MAX.	UNIT	CONDITION
Storage temperature	T_S	-40	+100	°C	
Operating temperature	T_A	-40	+85	°C	
Supply voltage	V_{DD}		5	V	

Recommended Operating Conditions

PARAMETER	SYMBOL	MIN.	MAX.	UNIT	CONDITION
Operating temperature	T_A	-40	+85	°C	
Supply voltage	V_{DD}	2.5	3.6	V	
I²C Bus operating frequency	$f_{(I^2CCLK)}$	10	400	kHz	

Pin Descriptions

PIN ASSIGNMENT	SYMBOL	TYPE	FUNCTION
1	GND	I	Ground
2	LED_CATHODE	I	IR LED cathode connection
3	V_{DD}	I	Power supply input
4	NC		No Connection
5	LED-	O	CATHODE of IR LED
6	LED+	I	Anode of IR LED
7	NC		No Connection
8	INT	O	Interrupt pin
9	SDAT	I/O (Open Drain)	I²C data bus data in/output
10	SCLK	I	I²C digital bus clock input

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Electrical & Optical Specifications

PARAMETER		SYMBOL	MIN.	TYP.	MAX.	UNIT	CONDITION
Supply voltage		V_{DD}	2.5		3.6	V	
Supply voltage for VIRLED		VIRLED	3.8		5.5	V	
Supply current		I_{DD}		350		uA	Excluded LED driving
Shutdown current		I_{DD} (SD)		0.2		uA	Light Condition = Dark; V_{DD}= 3.3 V, Ta= 25°C
ALS shut down		IALSSD		300		uA	PS Enabled
PS shut down		IPSSD		213		uA	ALS Enable
I^2C signal input	Logic High	VIH	1.5			V	Note1, V_{DD} = 3.3 V
	Logic Low	VIL			0.8		Note1, V_{DD} = 3.3 V
I^2C signal input	Logic High	VIH	1.4			V	Note1, V_{DD} = 2.6V
	Logic Low	VIL			0.6		Note1, V_{DD} = 2.6V
Peak sensitivity wavelength of ALS		λ_P		550		nm	
Peak sensitivity wavelength of PS		λ_{PPS}		940		nm	
Full ALS counts					65535	steps	16-bit resolution
Full PS counts					4095	steps	12-bit resolution
Detectable intensity	Minimum			0.003		Lux	IT = 640ms, 1 step, Note1, 2
	Maximum			1311			IT = 80ms, 65535 steps, Note1, 2
ALS dark offset			0		3	STEP	IT = 80ms, normal sensitivity, Note 1
Operating temperature		T_A	-40		+85	°C	
LED driving current					800	mA	Note 3

Note:

1. Test condition: V_{DD} = 3.3 V, Temperature: 25°C.
2. Light source: White LED. Maximum detection range to ambient light can be determined by ALS refresh time adjustment. Refer to Table 15, page 15.
3. Based on IR LED on/off duty ratio=1/160, 1/320, 1/640 and 1/1280.

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I²C Bus Timing Characteristics

PARAMETER	SYMBOL	STANDARD MODE		FAST MODE		UNIT
		MIN.	MAX.	MIN.	MAX.	
Clock frequency	$f_{(SMBCLK)}$	10	100	10	400	kHz
Bus free time between start and stop condition	$t_{(BUF)}$	4.7		1.3		us
Hold time after (repeated) start condition. After this period, the first clock is generated	$t_{(HDSTA)}$	4.0		0.6		us
Repeated start condition setup time	$t_{(SUSTA)}$	4.7		0.6		us
Stop condition setup time	$t_{(SUSTO)}$	4.0		0.6		us
Data hold time	$t_{(HDDAT)}$		3450		900	ns
Data setup time	$t_{(SUDAT)}$	250		100		ns
I²C clock (SCK) low period	$t_{(LOW)}$	4.7		1.3		us
I²C clock (SCK) high period	$t_{(HIGH)}$	4.0		0.6		us
Clock / Data fall time	$t_{(F)}$		300		300	ns
Clock / Data rise time	$t_{(R)}$		1000		300	ns

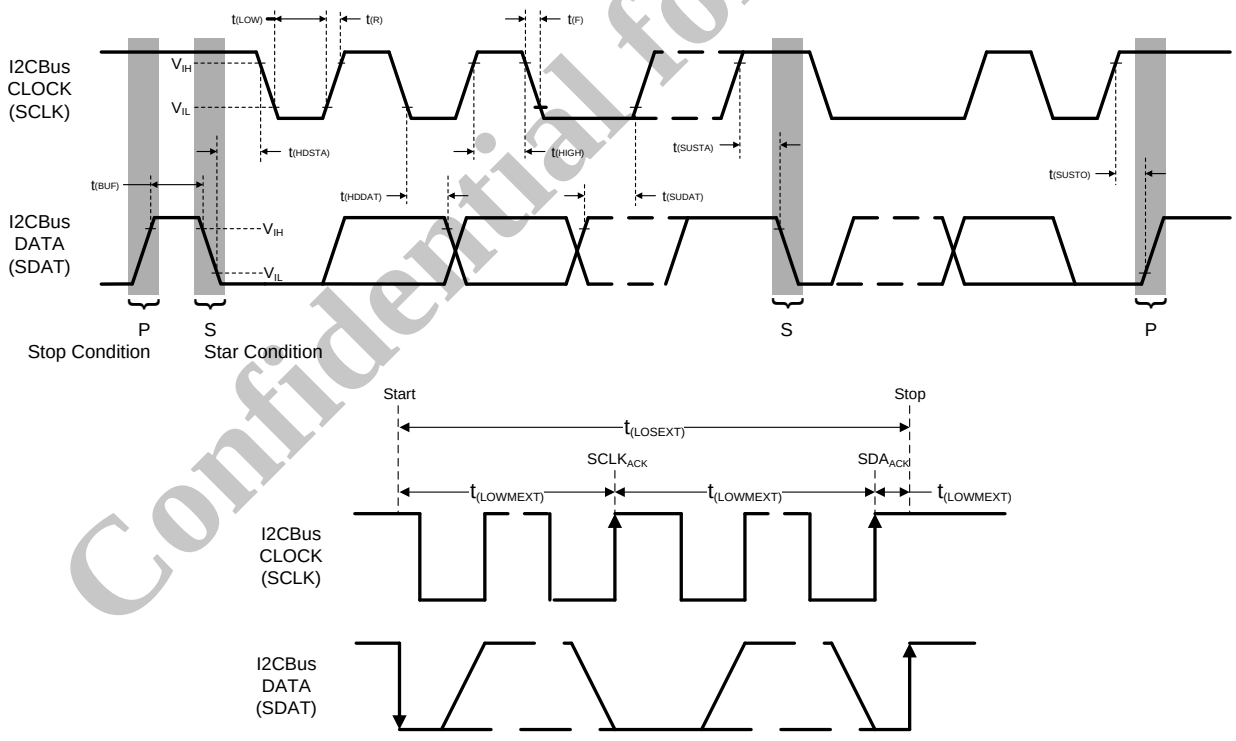

Figure 1. I²C Bus Timing Diagram

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Parameter Timing Information

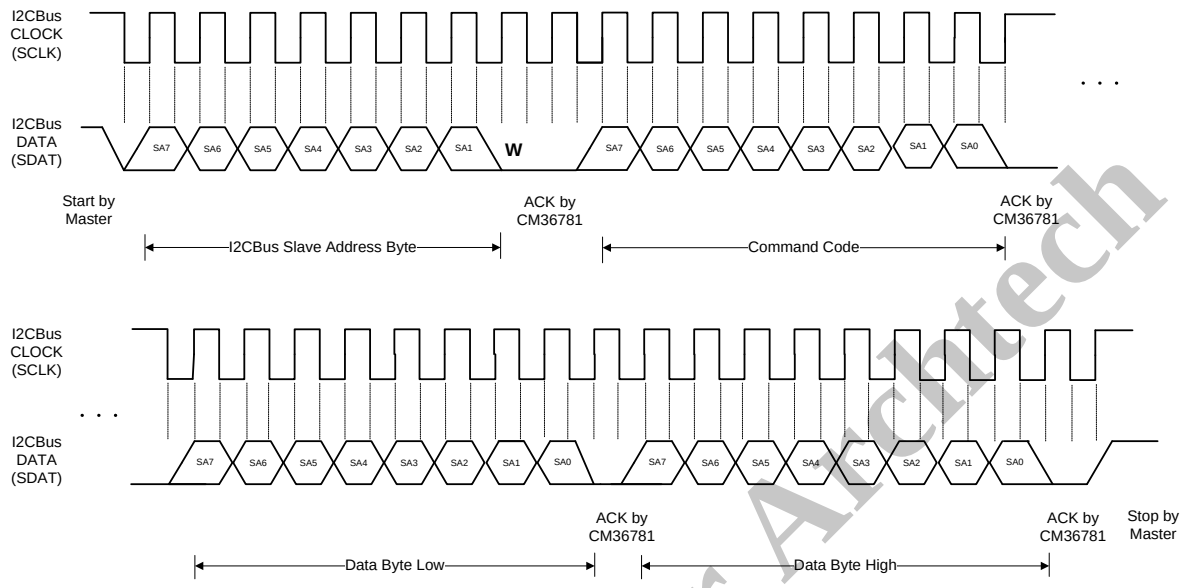


Figure 2. I²C Bus Timing for Sending Word Command Format

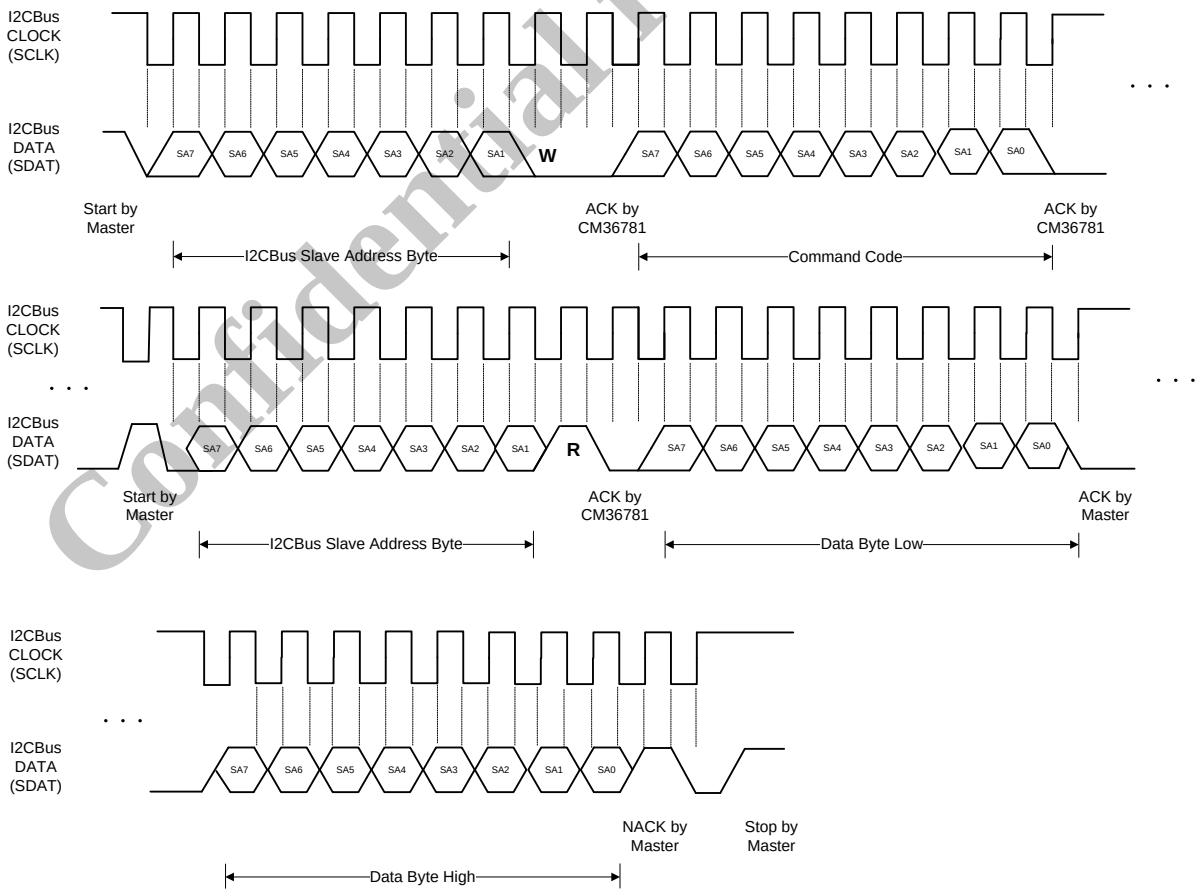


Figure 3. I²C Bus Timing for Receiving Word Command Format

Typical Performance Characteristics

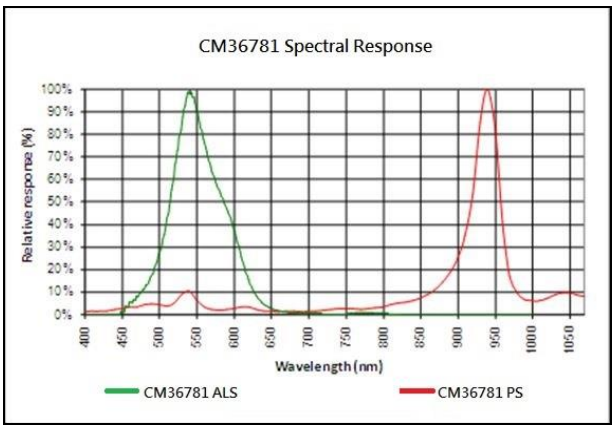


Figure 4. Normalized Spectral Response

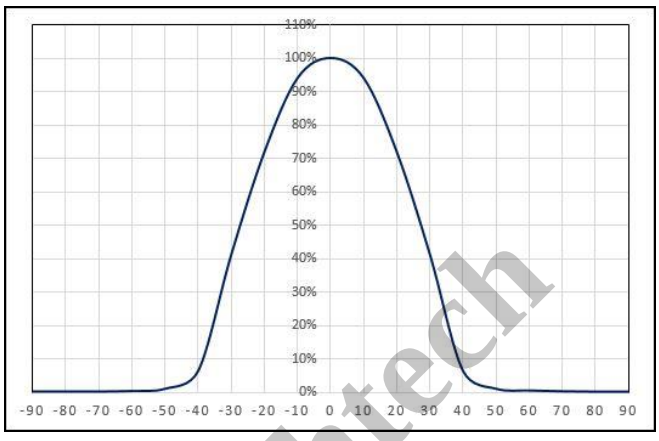


Figure 5. ALS Normalized Output vs. View Angle

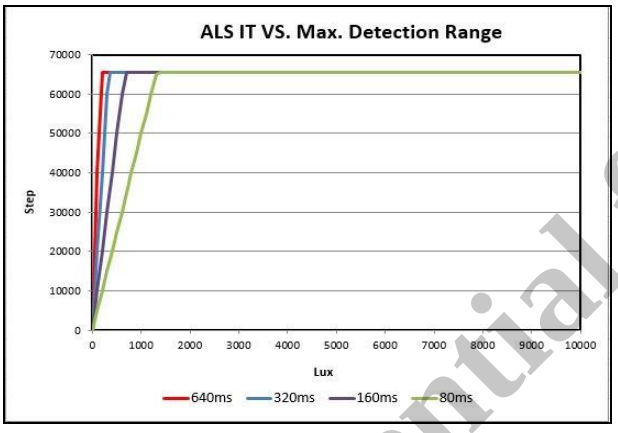


Figure 6. ALS Refresh Time vs. Maximum Detection Range

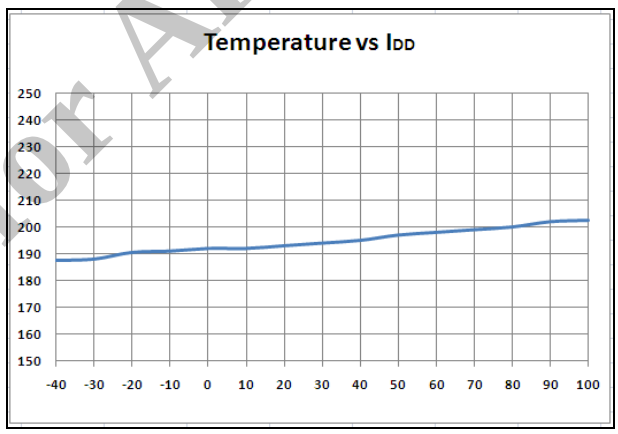
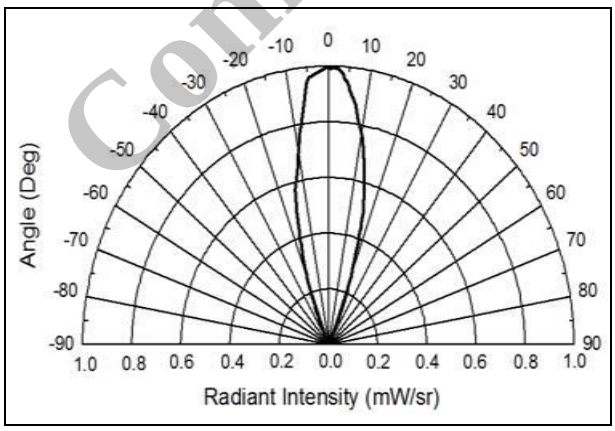


Figure 7. IDD vs. Temperature



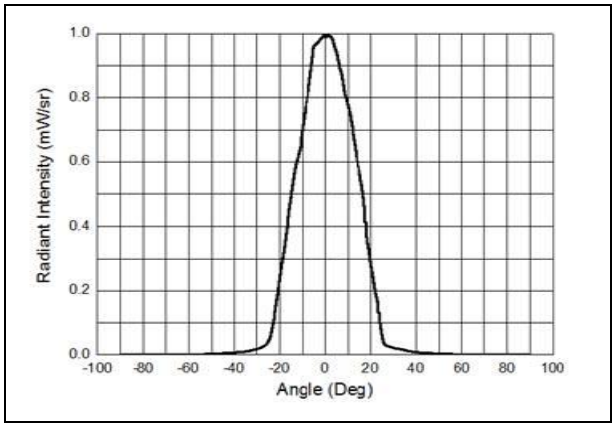


Figure 8. Relative Radiant Intensity vs. Angular Displacement

Application Information

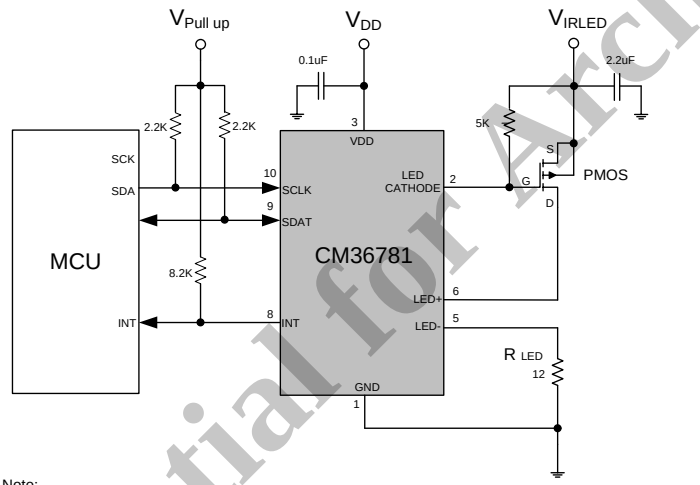
Pin Connection with the Host

CM36781 is a cost effective solution as a long distance proximity sensor with I²C interface. The standard serial digital interface easily accesses “light intensity” by using simple calculations.

Two additional capacitors in the circuit can be used for the following purposes: (1) the 0.1uF capacitor near the V_{DD} pin is used for power supply noise rejection and (2) the 2.2μF capacitor, which connects to the V_{IRLED}, is used to provide sufficient energy for the IRLED when the IRLED is turned on.

The R_{LED} tunes the forward current for the emitting power of the IRLED. The smaller the R_{LED} value, the larger the IRLED emitting power.

For the I²C bus design, the pull-up voltage refers to the I/O specification of the baseband due to its “open drain” design. The pull-high resistors for the I²C bus design are recommended to be 2.2KΩ. The circuit diagram is shown as an example in Figure 9.



Note:
1. VDD range: 2.6 ~ 3.6V and V_{IRLED} is recommended 5.0V
2. Power path of Vdd and V_{IRLED} should be independent layout
3. The RLED resister value is reference for test stage, it should be adjusted again for the product usage basing on the power and the lens final design.

Figure 9. Hardware Pin Connection Diagram

Digital Interface

CM36781 applies single 7-bit slave address 0x51 (HEX) following I²C protocol. All operations can be controlled by the command register. The simple command structure helps users easily program the operation setting and latch the light data from CM36781. As Figure 10 shows, CM36781’s I²C command format is simple for Read and Write operations between CM36781 and the host. The white sections indicate host activity and the gray sections indicate CM36781’s acknowledgement of the host access activity. Write Word and Read Word protocols are suitable for accessing registers particularly for 16-bit ALS data and 12-bit PS data. Interrupt can be cleared by reading data out from Register: INT_Flag.

Send Byte → Write Command to CM36781

1	7	1	1	8	1	8	1	8	1	1
S	Slave Address	Wr	A	Command Code	A	Data Byte Low	A	Data Byte High	A	P

Receive Byte → Read Data from CM36781

1	7	1	1	8	1	1	7	1	1	8	1	8	1	1
S	Slave Address	Wr	A	Command Code	A	S	Slave Address	Rd	A	Data Byte Low	A	Data Byte High	A	P

S = Start Condition
P = Stop Condition
A = Acknowledge
Shaded area = CM36781 acknowledge

Figure 10. Command Protocol Format

Function Description

CM36781 applies a 16-bit high resolution ALS that provides the best ambient light sensing capability up to 0.01 lux/step which works well under a low transmittance lens design (dark lens). A flexible interrupt function of ALS (Register: ALS_CONF) is also supported.The INT signal will not be asserted by CM36781 if the ALS value is not over high INT threshold window level, or lower than low INT threshold window level of ALS. As long as the ALS INT is asserted, the host can read the data from CM36781. CM36781 detects different light sources such as fluorescent light, incandescent light, sunlight and white LED with high accuracy ALS data output after detection algorithm is implemented.

For proximity sensor function, CM36781 supports different mechanical designs to achieve the best proximity detection performance for any color of object for design flexibility. The basic PS function settings, such as duty ratio, integration time, interrupt PS enable/disable and persistence, are handled by the Register: PS_CONF1. Duty ratio controls the PS response time. Integration time represents the duration of the energy being received. The Interrupt is asserted when the PS detection levels are over the high threshold level setting (Register: PS_THDH) or lower than low threshold (Register: PS_THDL). If the Interrupt function is enabled, the host reads the PS output data from CM36781 which saves host loading from periodically reading PS data. Additionally, the INT flag(Register: INT_Flag) indicates the behavior of INT triggered under different conditions. PS persistence (PS_PERS) sets up the PS INT asserted conditions as long as the PS output value continually exceeds the threshold level. The intelligent cancellation level can be set on Register: PS_CANC to reduce cross talk .

CM36781 also supports an easy use of proximity detection logic output mode that outputs just High/Low levels saving loading from the host. Normal operation mode or Proximity Detection Logic Output Mode can be selected on the Register: PS_MS. A Smart Persistence is provided to get faster PS response time and prevent false trigger for PS. Descriptions of each slave address operation are shown in Table 1.

COMMAND CODE	Date Byte Low/High	REGISTER NAME	R/W	DEFAULT VALUE	FUNCTION DESCRIPTION
0x00	L	ALS_CONF	R/W	0x01	ALS integration time, persistence, interrupt and function enable and disable
	H	Reserved	R/W	0x00	Reserved
0x01	L	ALS_THDH_L	R/W	0x00	ALS high interrupt threshold LSB byte
	H	ALS_THDH_M	R/W	0x00	ALS high interrupt threshold MSB byte
0x02	L	ALS_THDL_L	R/W	0x00	ALS low interrupt threshold LSB byte
	H	ALS_THDL_M	R/W	0x00	ALS low interrupt threshold MSB byte
0x03	L	PS_CONF1	R/W	0x01	PS duty ratio, integration time, persistence, and PS enable/disable
	H	PS_CONF2	R/W	0x00	PS gain, PS output resolution selection, PS interrupt trigger method ,
0x04	L	PS_CONF3	R/W	0x00	PS multi pulse, Active Force mode, sunlight immunity setting
	H	PS_MS	R/W	0x00	PS mode selection, PS protection setting
0x05	L	PS_CANC_L	R/W	0x00	PS cancellation level setting
	H	PS_CANC_M	R/W	0x00	PS cancellation level setting
0x06	L	PS_THDL_L	R/W	0x00	PS low interrupt threshold setting LSB byte
	H	PS_THDL_M	R/W	0x00	PS low interrupt threshold setting MSB byte
0x07	L	PS_THDH_L	R/W	0x00	PS high interrupt threshold setting LSB byte
	H	PS_THDH_M	R/W	0x00	PS high interrupt threshold setting MSB byte
0x08	L	PS_Data_L	R	0x00	PS LSB output data
	H	PS_Data_M	R	0x00	PS MSB output data
0x09	L	ALS_Data_L	R	0x00	ALS LSB output data
	H	ALS_Data_M	R	0x00	ALS MSB output data

COMMAND CODE	Date Byte Low/High	REGISTER NAME	R/W	DEFAULT VALUE	FUNCTION DESCRIPTION
0x0D	L	Reserved	R	0x00	Reserved
	H	INT_Flag	R	0x00	ALS, PS interrupt flags
0x0E	L	ID_L	R	0x58	Device ID LSB
	H	ID_M	R	0x01	Device ID MSB

Note: All of reserved register are used for internal test. Please keep as default setting.

Table 1. Command Code and Register Description

Command Register Format

CM36781 provides an 8-bit command register for ALS and PS controlling independently. The description of each command format is shown in following tables.

REGISTER NAME		Command Code: 0x00_L (0x00 Data Byte Low) or 0x00_H (0x00 Data Byte High)							
COMMAND	BIT	7	6	5	4	3	2	1	0

REGISTER: ALS_CONF		Command Code: 0x00_L (0x00 Data Byte Low)
COMMAND	BIT	Description
ALS_IT	7:6	ALS sensor integration time (0 : 0) = 50 ms ; (0 : 1) = 100 ms ; (1 : 0) = 200 ms ; (1 : 1) = 400 ms ALS integration time setting, longer integration time has higher sensitivity
ALS_INT_SW	5	Default = 0
Reserved	4	Default = 0
ALS_PERS	3:2	ALS sensor interrupt presistence setting (0 : 0) = 1, (0 : 1) = 2, (1 : 0)= 4, (1 : 1)= 8 (times)
ALS_INT_EN	1	ALS interrupt Control 0 = ALS INT disable, 1 = ALS INT enable
ALS_SD	0	ALS sensor shutdown 0 = ALS power on, 1 = ALS shut down, Default = 1

Table 2. Register: ALS_CONF Description

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Command Code: 0x00_H (0x00 Data Byte High)		
COMMAND	BIT	Description
Reserved	7:0	(0 : 0 : 0 : 0 : 0 : 0 : 0 : 0), reserved

Table 3. Register Description

Command Code: 0x01_L (0x01 Data Byte Low) and 0x01_H(0x01 Data Byte High)		
REGISTER	BIT	Description
ALS_THDH_L	7:0	0x00 ~ 0xFF, ALS high interrupt threshold LSB byte
ALS_THDH_M	7:0	0x00 ~ 0xFF, ALS high interrupt threshold MSB byte

Table 4. Register ALS_THDH_L and ALS_THDH_M Description

Command Code: 0x02_L (0x02 Data Byte Low) and 0x02_H(0x02 Data Byte High)		
REGISTER	BIT	Description
ALS_THDL_L	7:0	0x00 ~ 0xFF, ALS low interrupt threshold LSB byte
ALS_THDL_M	7:0	0x00 ~ 0xFF, ALS low interrupt threshold MSB byte

Table 5. Register ALS_THDL_L and ALS_THDL_M Description

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REGISTER: PS_CONF1		Command Code: 0x03_L (0x03 Data Byte Low)
COMMAND	BIT	Description
PS_Duty	7:6	PS Emitter LED duty ration configure (0 : 0) = 1/160, (0 : 1) = 1/320, (1 : 0) = 1/640, (1 : 1) = 1/1280
PS_PERS	5:4	PS interrurpt presistence setting (0 : 0) = 1, (0 : 1) = 2, (1 : 0) = 3, (1 : 1) = 4 (times)
PS_ IT	3:1	PS integration time setting (0 : 0 : 0) = 1T, (0 : 0 : 1) = 1.5T, (0 : 1 : 0) = 2T, (0 : 1 : 1) = 4T, (1 : 0 : 0) = 8T, (1 : 0 : 1) = 9T, (1 : 1 : 0) =reserved, (1 : 1 : 1) = reserved, PS integration time setting PS_IT[0 : 0 :0]= 1T x PS_MPS x 1/PS_Duty Example PS_IT = (0 : 0 : 0), PS_MPS = 4 times, PS_Duty = 1/160, PS_IT = 1T x 4 x 160 = 640T
PS_SD	0	Proximity sensor shutdow 0 = PS power on, 1= PS shut down, Default = 1

Table 6. Register PS_CONF1 Description

REGISTER: PS_CONF2		Command Code: 0x03_H (0x03 Data Byte High)
COMMAND	BIT	Description
Reserved	7:2	(0 :0 :0 : 0 : 0 : 0), reserved
PS_INT	1:0	Proximity Interrupt Configure Registor (0 : 0) = interrupt disable, (0 : 1) = trigger by closing, (1 : 0)= trigger by away, (1 : 1)= trigger by closing and away

Table 7. Register HB and PS_CONF2 Description

REGISTER: PS_CONF3		Command Code: 0x04_L (0x04 Data Byte Low)
COMMAND	BIT	Description
Reserved	7	Reserved (0)
PS_MPS	6:5	Proximity multi pulse numbers (0 : 0) = 1 (0 : 1) = 2 (1 : 0) = 4 (1 : 1) = 8 multi pulses
PS_SMART_PERS	4	Proximity sensor smart persistence 0 = Disable ; 1 = Enable
PS_FOR	3	Proximity Acvtive force mode 0 = Active Force Mode disable(normal mode), 1 = Active Force Mode enable
PS_FOR_Trig	2	Proximity Interrupt mode 0 = no PS Active Force mode trigger, 1 = trigger one time cycle CM36781 output one cycle data every time host writes in ‘ 1 ‘ to sensor. The state returns to ‘ 0’ automatically.
Reserved	1:0	Default = (0 : 0)

Table 8. Register PS_CONF3 Description

REGISTER: PS_MS		Command Code: 0x04_H (0x04 Data Byte High)
COMMAND	BIT	Description
Reserved	7:6	(0 : 0)
PS_MS	5	Proximity operation mode 0 = Proximity normal operation with interrupt function 1 = Proximity detection logic output mode enable
Reserved	4:0	Reserved, (0 : 0 : 0 : 0 : 0)

Table 9. Register PS_MS Description

Command Code: 0x05_L (0x05 Data Byte Low) and 0x05_H(0x05 Data Byte High)		
REGISTER	BIT	Description
PS_CANC_L	7:0	0x00 ~ 0xFF, PS cancellation level setting_LSB byte
PS_CANC_M	7:0	0x00 ~ 0xFF, PS MSB cancellation level setting_MSB byte

Note: The maximum calibration code of PS_CAL is 10 bit.

Table 10. Register PS_CANC_L and PS_CANC_M Description

Command Code: 0x06_L (0x06 Data Byte Low) and 0x06_H(0x06 Data Byte High)		
REGISTER	BIT	Description
PS_THDL_L	7:0	0x00 ~ 0xFF, PS interrupt low threshold setting_LSB byte
PS_THDL_M	7:0	0x00 ~ 0xFF, PS interrupt low threshold setting_MSB byte

Table 11. Register PS_THDL_L and PS_THDL_M Description

Command Code: 0x07_L (0x07 Data Byte Low) and 0x07_H(0x07 Data Byte High)		
REGISTER	BIT	Description
PS_THDH_L	7:0	0x00 ~ 0xFF, PS interrupt high threshold setting_LSB byte
PS_THDH_M	7:0	0x00 ~ 0xFF, PS interrupt high threshold setting_MSB byte

Table 12. Register PS_THDH_L and PS_THDH_M Description

REGISTER	Command Code	BIT	Description
PS_Data_L	0x08_L (0x08 Data Byte Low)	7:0	0x00 ~ 0xFF, PS LSB output data
PS_Data_M	0x08_H (0x08 Data Byte High)	7:0	0x00 ~ 0xFF, PS MSB output data
ALS_Data_L	0x09_L (0x09 Data Byte Low)	7:0	0x00 ~ 0xFF, ALS LSB output data
ALS_Data_M	0x09_H (0x09 Data Byte High)	7:0	0x00 ~ 0xFF, ALS MSB output data
Reserved	0x0B_L (0x0B Data Byte Low)	7:0	Reserved, (0 : 0 : 0 : 0 : 0 : 0 : 0 : 0)
Reserved	0x0B_H(0x0B Data Byte High)	7:0	Reserved, (0 : 0 : 0 : 0 : 0 : 0 : 0 : 0)
Reserved	0x0C_L (0x0C Data Byte Low)	7:0	Reserved, (0 : 0 : 0 : 0 : 0 : 0 : 0 : 0)
Reserved	0x0C_H(0x0C Data Byte High)	7:0	Reserved, (0 : 0 : 0 : 0 : 0 : 0 : 0 : 0)
Reserved	0x0D_L(0x0D Data Byte Low)	7:0	Reserved, (0 : 0 : 0 : 0 : 0 : 0 : 0 : 0)
INT_Flag	0x0D_H(0x0D Data Byte High)	7 6 5 4 3 2 1 0	PS_SAFLAG, PS code saturation flag PS_SPFLAG, PS entering protection mode ALS_IF_L, ALS crossing low THD INT trigger event ALS_IF_H, ALS crossing high THD INT trigger event Reserved Reserved PS_IF_CLOSE, PS rises above PS_THDH INT trigger event PS_IF_AWAY, PS drops below PS_THDL INT trigger event
ID_L	0x0EH_L (0x0EH Data Byte Low)	7:0	58H for MP version sample Device ID LSB byte
ID_M	0x0EH_H (0x0EH Data Byte High)	7:6 5:4 3:0	(0 : 0) (0 : 0) Slave address = 0x51 (7-bit) Version code (0 : 0 : 0 : 0) = ES1 Device ID MSB byte

Table 13. Read Out Register Description

Adjustable Sampling Time

CM36781's embedded LED driver drives the external IR LED with the "LED CATHODE" pin by a pulsed duty cycle. The IR LED On/off duty ratio can be programmable by I²C command at Register: PS_Duty is related to the current consumption and PS response time. The higher the duty ratio selected, the faster response time achieved with higher power consumption.

Initialization

CM36781 includes default values for each register. As long as power is on, it is ready to be controlled by host via I² C bus.

Threshold Window Setting

ALS Threshold Window Setting (Applying ALS INT)

Register: ALS_THDH_L and ALS_THDH_M defines 16-bit ALS high threshold data for LSB byte and MSB byte. Register: ALS_THDL_L and ALS_THDL_M defines 16-bit ALS low threshold data for LSB byte and MSB byte. As long as ALS INT function is enabled, INT will be asserted once the ALS data exceeds ALS_THDH or goes below ALS_THDL. To easily define the threshold range, multiply the value of the resolution (Lux/Step) by the threshold level.

ALS_IT		Sensitivity	Maximum Detection Range
ALS_IT[7:6]	Integration time(typ)	Unit: Lux/Step	Unit: Lux
(0,0)	50ms	0.02	1311
(0,1)	100ms	0.01	655
(1,0)	200ms	0.005	328
(1,1)	400ms	0.003	164

Table 14. ALS Resolution and Maximum Detection Range

ALS Persistence

The ALS INT is asserted as long as the ALS value is higher or lower than the threshold window when ALS_PERS(1\2\4\8 times) is set to one time. If ALS_PERS is set to four times, then the ALS INT will not be asserted if the ALS value is not over (or lower) than the threshold window for four continued refresh times (integration time).

Programmable PS Threshold

CM36781 provides both high and low thresholds 16-bit data setting for PS.(Register: PS_THDL, PS_THDH).

PS Persistence

The PS persistence function (PS_PERS, 1\2\3\4) helps to avoid false trigger of the PS INT. For example, if PS_PERS=3 times, the PS INT will not be asserted unless the PS value is greater than the PS threshold(PS_THDH) value for three periods of time continuously.

PS Active Force mode

An extreme power saving for PS is to apply PS Active Force(Register:PS_CONF3 Command : PS_FOR =1) mode. Anytime host would like to read out just one PS data, write in '1' at Register: PS_CONF3 Command: PS_FOR_Trig. Without commands placed, there is no PS data output. CM36781 stays in standby mode constantly.

PS detection object

Any color of object is detectable by CM36781.

Data Access

All CM36781 command registers are readable. To access 16-bit high resolution ALS output data, it is suitable to use Read Word protocol to read out data by just one command at Register: ALS_DataL and ALS_DataM. To represent the 16-bit data of ALS, it has to apply two bytes. One byte is for LSB, and the other byte is for MSB as shown in Table 16. In terms of reading out 12-bit PS data, it is also very convenient to read PS at Register: PS_Data.

	CM36781 16-BIT ALS DATA FORMAT															
Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Register	ALS_DataM								ALS_DataL							

Table 15. 16-BIT ALS DATA FORMAT

Intelligent Cancellation

CM36781 provides an Intelligent Cancellation method to reduce cross talk for the proximity sensor. The output data will be subtracted by the input value on Register: PS_CANC.

Interruption (INT)

CM36781 has ALS and PS interrupt feature operated by a single pin “INT”. The purpose of the interrupt feature is to actively inform the host once INT has been asserted. With the interrupt function applied, the host doesn’t need to be constantly pulling data from the sensor, but to read data from the sensor while receiving interrupt request from the sensor. As long as the host enables ALS interrupt (Register: ALS_INT_EN) or PS interrupt (Register: PS_INT) function, the level of INT pin (pin 6) is pulled low once INT asserted. All registers are accessible even if INT is asserted.

ALS INT asserted when ALS value cross over the value set by Register: ALS_THDH or lower than the value set by Register: ALS_THDL. To effectively adopt PS INT function, it is recommended to use Capella PS detection mechanism at Register: PS_INT =1 for the best PS detection performance which can be adjusted by high/low THD level of PS. PS INT trigger way is defined by Register: PS_INT.

Interruption Flag

Register: INT_Flag represents all of interrupt trigger status for ALS and PS. Any flag value changes from ‘0’ to ‘1’ state, the level of INT pin will be pulled low. As long as Host reads INT_Flag data, the bit will change from ‘1’ state to ‘0’ state after reading out, the INT level will be returned to high afterwards.

Proximity Detection Logic Output Mode

CM36781 provides a Proximity Detection Logic Output Mode that uses INT pin as a proximity detection logic high/low output(Register: PS_MS). When this mode is selected, the PS output (INT/Pout) is pulled low when an object is close to being detected and returned to level high when the object moves away. Register: PS_THDH\L defines how sensitive PS detection is.

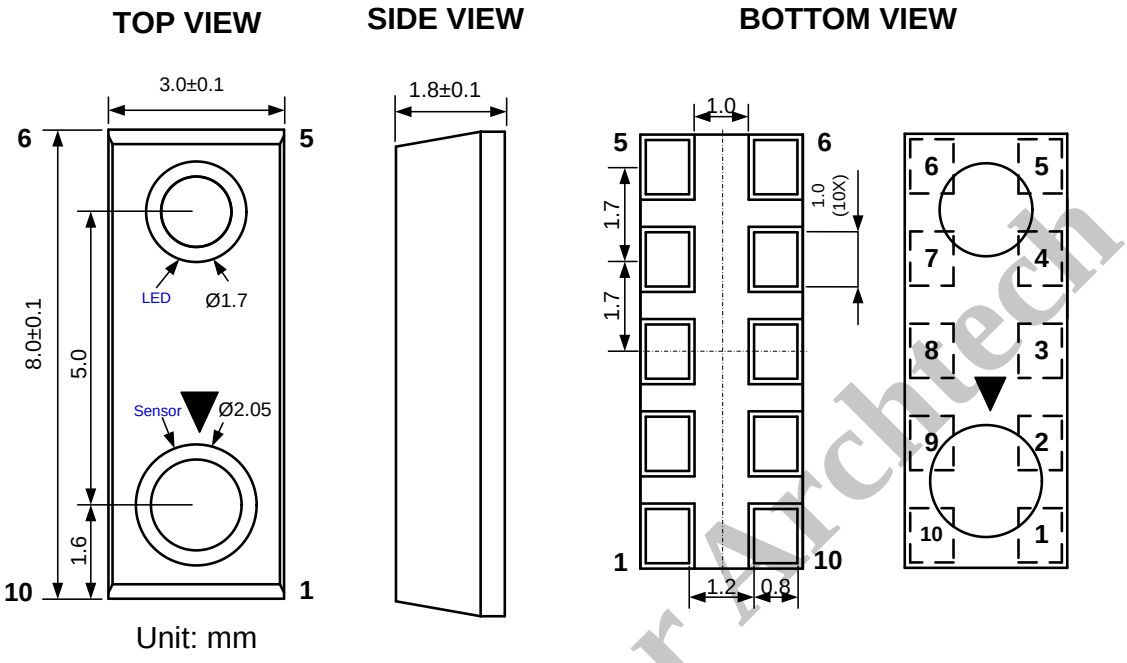
One thing to be noted is that whenever Proximity detection logic mode applied, INT pin is only used as a logic high/low output. If host would like to use ALS with INT function, Register: PS_MS has to be selected to normal operation mode (PS_MS = 0). Meanwhile, Host has to simulate the GPIO pin as an INT pin function. If not, Host needs to periodically read the state of INT at this GPIO pin.

Proximity Detection Hysteresis

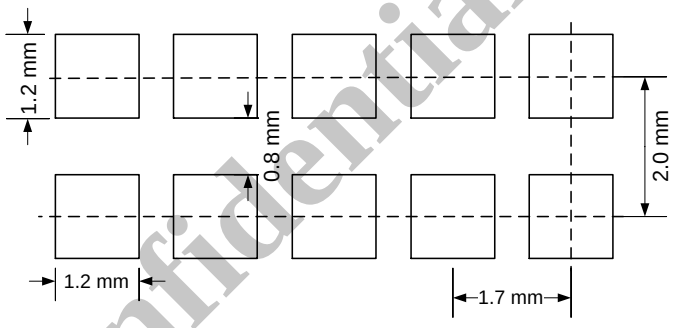
A PS detection hysteresis is important that keeps PS state in a certain range of detection distance. For example, PS INT asserts when PS value over PS_THDH. Host switches off panel backlight and then clears INT. When PS value is less than PS_THDL, Host switches on panel backlight. Any PS value lower than PS_THDH or higher than PS_THDL, PS INT will not be asserted. Host does keep the same state.

Serial No. 201707050003

Package Information (CM36781M3OI)



For Reflow Soldering (PCB Footprint)



1	GND	6	LED+
2	LED_Cathode	7	NC
3	VDD	8	INT
4	NC	9	SDAT
5	LED-	10	SCLK

Figure 11. CM36781 Package Dimensions

Layout Notice and Reference Circuit (CM36781M3OI)

Circuit Layout Reference

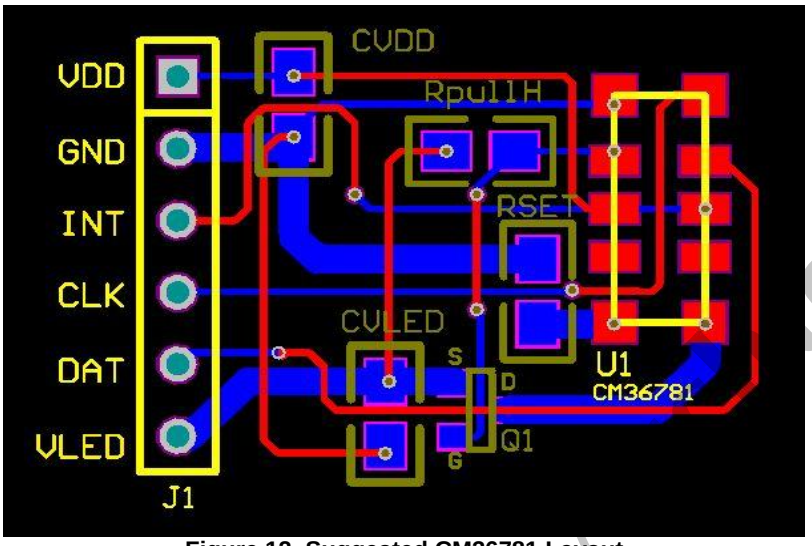
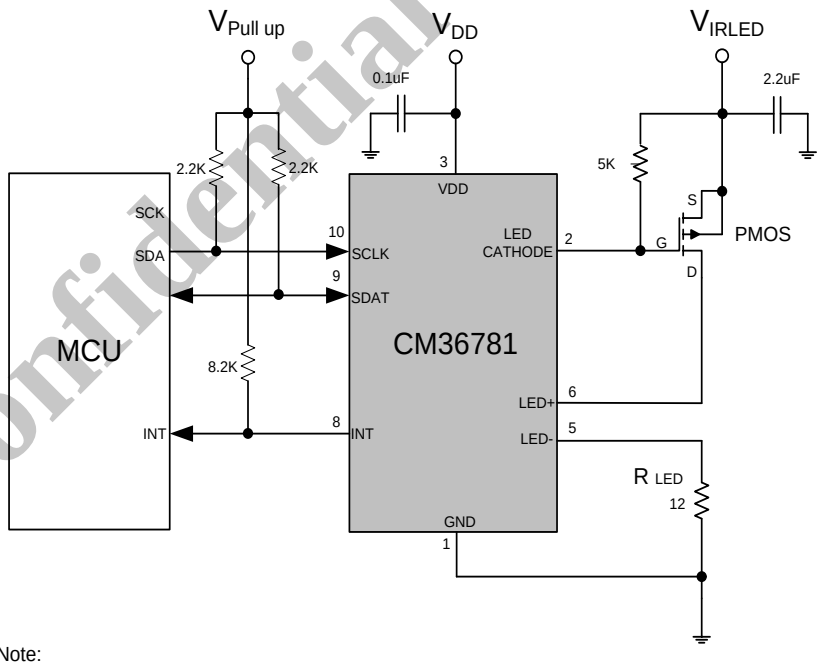


Figure 12. Suggested CM36781 Layout

Application Circuit Block Reference



Note:
1. VDD range: 2.6 ~ 3.6V and VIRLED is recommended 5.0V
2. Power path of Vdd and VIRLED should be independent layout
3. The RLED resister value is reference for test stage, it should be adjusted again for the product usage basing on the power and the lens final design.

Figure 13. CM36781 Application Circuit

Recommended Storage and Re-baking Conditions

PARAMETER	MIN.	MAX.	UNITS	CONDITION
Storage temperature	5	50	°C	
Relative humidity		60	%	
Open time		168	hrs	
Total time	12 months from the date code on the aluminized envelope (unopened)			
Rebaking	1. Tape and Reel: 60ºC, 22 hours 2. Tube: 60ºC, 22 hours			

Recommended Infrared Reflow

Soldering conditions which are based on J-STD-020 C

1. IR reflow profile condition

PARAMETER	TEMPERATURE	TIME	CONDITION
Peak temperature	260+5/-5 ºC (max.: 265ºC)	10 seconds	
Preheat temperature range and timing	150 ~ 200ºC	60 ~ 180 seconds	
Timing within 5ºC to peak temperature		10 ~ 30 seconds	
Timing maintained above temperature / time	217ºC	60 ~ 150 seconds	
Timing from 25ºC to peak temperature		8 minutes (max.)	
Ramp-up rate	3ºC/seconds (max.)		
Ramp-down rate	6ºC/seconds (max.)		

2. Recommend normal solder reflow is: 235 ~ 265℃.

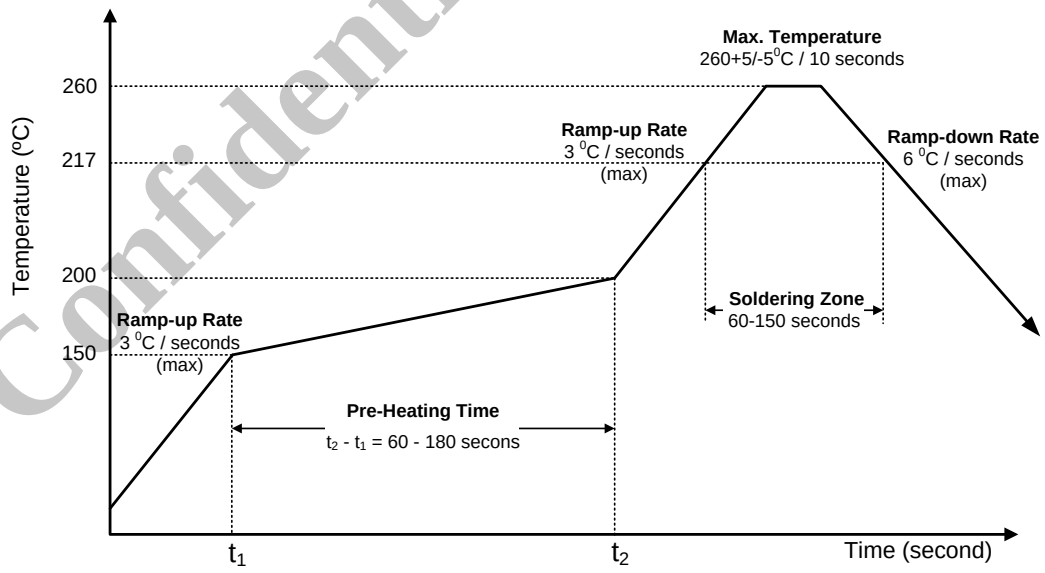


Figure 14. CM36781 Solder Reflow Profile Chart

Serial No. 201707050003

Recommended Iron Tip Soldering Condition and Warning Handling

1 Solder the device with the following conditions:
  1.1 Soldering temperature: 400℃ (max.)
  1.2 Soldering time: 3 seconds (max.)
2 If the temperature of the method portion rises in addition to the residual stress between the leads, the possibility that an open or short circuit occurs due to the deformation or destruction of the resin increases.
3 The following methods: VPS and wave soldering, have not been suggested for the component assembly.
4 Cleaning method conditions:
  4.1 Solvent: Methyl Alcohol, Ethyl Alcohol, Isopropyl Alcohol
  4.2 Solvent temperature < 45℃ (max.)
  4.3 Time: 3 minutes (min.)

Tape Packagin Information (CM36781M3OI)

DIMENSION OF CARRIER TAPE

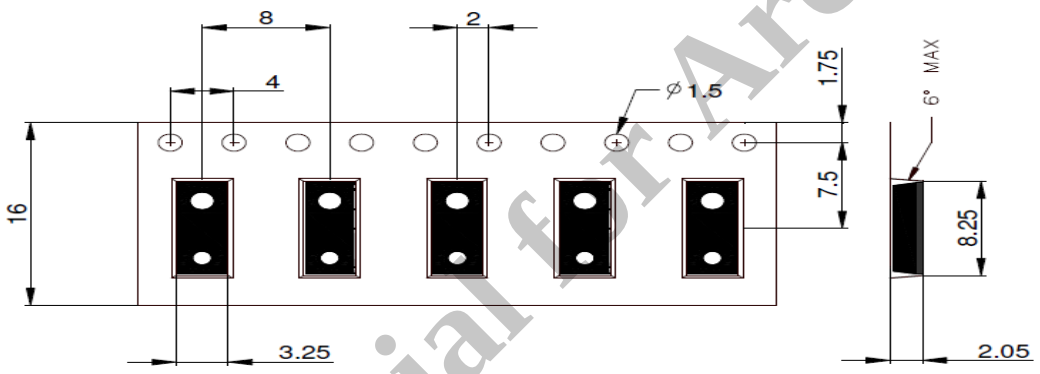


Figure 15. CM36781 Package Carrier Tape

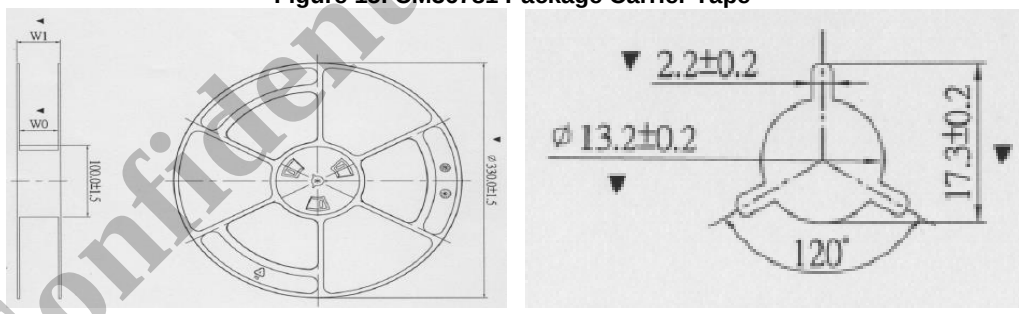


Figure 16. Reel Dimension

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