DATASHEET

Proximity Sensor with I²C Interface PM-16D17-2010-DF6/TR8

Features

- I²C interface (Fast Speed Mode at 400kHz/s)
- Dedicated Interrupt Pin
- Supply Voltage Range from VDD=1.7V to 3.5V
- Operating Temperature Range from-40°C to +85°C
- Program waiting time selection

Proximity Sensor

- Current sink driver for IR LED
- Selectable ADC Output, up to 16-bits
- Programmable integrated time, PGA Gain Selection and Pulse Count Selection
- Individual programmable low and high threshold for interrupt function
- Cross-talk cancellation register
- The product itself will remain within RoHS compliant version
- Compliance with EU REACH
- Compliance Halogen Free(Br < 900ppm, Cl < 900ppm, Br+Cl < 1500ppm)

Description

The PM-16D17-2010-DF6/TR8 is a light to digital converter which combines an advanced proximity sensor and a high efficiency VCSEL infrared. Proximity sensor (PS) built-in an 940nm optical filter for ambient light immunity, so PS can detect reflected IR light intensity for distance information.

Applications

Display and keypad dimming adjustment and proximity sensing for:

- -Mobile Devices: smart phone, PDA, GPS
- -Computing Devices: laptop PC, notebook
- -Consumer Devices: LCD-TV, digital picture frame, digital camera
- -True Wireless Stereo



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Absolute Maximum Ratings (Ta=25°C)

Parameter	Symbol	Min	Max	Unit
Storage Temperature	T _{STG}	-40	100	°C
Supply Voltage	V _{DD}	-0.3	3.6	V
ESD Tolerance (Human Body Model)	VESD	2000	-	V

Recommended Operating Conditions (Ta=25°C)

Parameter	Symbol	Min	Max	Unit
Operating Temperature Range	Topr	-40	85	°C
Operating Supply Voltage Range	V _{DD}	1.7	3.5	V

Block Diagram



Pad Description

Pad	I/O	Function
INT	Output	Interrupt output pin (Open drain output)
VDD	Power	Power supply
GND	Power	Ground
LEDA	Output	IR LED Anode
SDA	I/O	I ² C data input/output terminal
SCL	Input	I ² C derail clock input terminal

Electro-Optical Characteristics (Ta=25°C, VDD=3.0V)

Parameter	Symbol	Min.	Тур.	Max.	Unit	Condition
Shutdown Current	ISTD	-	0.1	0.5	μΑ	Software disable or auto power down
Proximity Sensor						
	IDD2	-	175	240	uA	IR driver off
PS Supply current	Iwait	-	-	30	uA	Wait state
PS output		-	349	-	count	PS gain x 2, Pulse=2, IRDR=12.5mA,A/DC=10bit, Conversion time=0.4ms IC-Gary card distance=1cm
PS A/DC resolution	RES_PS	10	-	16	bit	
PS A/D conversion time	T _{PS}	21.4	25.2	28.9	ms	PS A/DC=16bit
PS wait time setting	Tpswait	10.6	12.5	14.3	ms	12.5ms setting
PS sensitivity peak wavelength	λpps	-	940	-	nm	
IR Driver						
IRDR current setting	I _{LED}			12.5	mA	
IRDR pulse width	T _{IRW}	1		64	Т	
Pulse count	P _{count}	1	-	256	pulse	
I ² C Bus						
I ² C Bus clock frequency	Fı ² c	-	-	400	kHz	
Input voltage L	VIL	-	-	0.25 x VDD	V	
Input voltage H	VIH	0.55 x VDD	-	-	V	
SDA low level output voltage	Vol	-	-	0.4	V	VDD≧2.0V, Io=3.0mA
High level input current	Ін	-10	-	10	uA	
Low level input current	lı∟	-10	-	10	uA	
SDA, SCL rise time	T _R	-	-	300	ns	
SDA, SCL fall time	T _F	-	-	300	ns	

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Fig1. I²C Bus Timing Diagram

I²C Bus Conditions

I₂C bus is inter-I₂C bus system to transfer data by two lines of SDA and SCL. Data transfer is performed by one byte, and acknowledgement is sent when each byte is complete. Data transfer takes place MSB first from a start condition. For more detailed I₂C bus system, please refer to the official I₂C specification.



S: Start condition P: Stop condition A: Acknowledge

Data Format

Read Mode

The data format for read mode is set as below.



Fig3. I²C Bus Timing Diagram for Receive Byte Format

Write Mode

The data format for write mode is set as below.



Fig4. I²C Bus Timing Diagram for Send Byte Format

Register Structure

Slave Address

Slave Address	Command Address	Operation
0x44 (7-bits)	0x88 (8-bits)	Write Command to PM-16D17-00-DF8/TR8
	0x89 (8-bits)	Read Data from PM-16D17-00-DF8/TR8

Pointer register

P7	P6	P5	P4 P3		P2	P1	P0
			Register se	elect			

Address	P7	P6	P5	Ρ4	P 3	P2	P1	P0	R/W	DESCRIPTION	DEFAULT
00h	0	0	0	0	0	0	0	0	R/W	Operation Mode Select Register	00h
01h	0	0	0	0	0	0	0	1	R/W	Interrupt flag register	00h
0Ah	0	0	0	0	1	0	1	0	R/W	PS Setting Resister	00h
0Bh	0	0	0	0	1	0	1	1	R/W	IR Drive Current Select Register	00h
0Ch	0	0	0	0	1	1	0	0	R/W	IR Drive Pulse Setting Register	00h
0Dh	0	0	0	0	1	1	0	1	R/W	PS Interrupt Low threshold (LSB) Register	00h
0Eh	0	0	0	0	1	1	1	0	R/W	PS Interrupt Low threshold (MSB) Register	00h
0Fh	0	0	0	0	1	1	1	1	R/W	PS Interrupt High threshold (LSB) Register	00h
10h	0	0	0	1	0	0	0	0	R/W	PS Interrupt High threshold (MSB) Register	00h
11h	0	0	0	1	0	0	0	1	R	PS Data(LSB) Register	00h
12h	0	0	0	1	0	0	1	0	R	PS Data(MSB) Register	00h
13h	0	0	0	1	0	0	1	1	R/W	PS setting register_2	00h
14h	0	0	0	1	0	1	0	0	R/W	PS offset cancel(LSB) register	00h

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15h	0	0	0	1	0	1	0	1	R/W	PS offset cancel(MSB) register	00h
18h	0	0	0	1	1	0	0	0	R	Device ID register	11h
D5h	1	1	0	1	0	1	0	1	-	Trimming mode register	-

Note : Register D5h specifies the trimming mode to execute the write to the internal NVM (non-volatile memory).

Operation mode select register (00h)

D7	D6	D5	D4	D3	D2	D1	D0
0	0	0	0	PSEN	PINTEN	PPER	RSIST

Default Value: 00h

1. PSEN: PS Enable setting

D3	PS enable
0	Disable PS function
1	Enable PS function

2. PINTEN: PS interrupt enable setting

D2	PS interrupt enable
0	Disable PS interrupt function
1	Enable PS interrupt function

3. PPERSIST: PS persistence count setting

D[1:0]	PS persistence count
00	1 cycles
01	4 cycles
10	8 cycles
11	16 cycles

Interrupt flag register (01h)

D7	D6	D5	D4	D3	D2	D1	D0
-	-	-	-	PLI	PHI	-	-

Default Value: 00h

PLI: PS Low side interrupt Flag

D3	PS Low side interrupt Flag
0	Interrupt is cleared or not triggered yet
1	Interrupt is triggered and will be clearable by write "0"

PLTF: PS High side interrupt Flag

D2	PS High side interrupt Flag
0	Interrupt is cleared or not triggered yet
1	Interrupt is triggered and will be clearable by write "0"

PS operation mode register (0Ah)

D7	D6	D5	D4	D3	D2	D1	D0
PGAIN			PITIME			PWTIME	

Default Value: 00h

PGAIN: PS gain setting

D[7:6]	PS Gain Set
00	x 1
01	x 2
10	x 4
11	x 8

PITIME: PS A/D conversion time

D[5-2]	PS A/D	PS A/DC Output Resolution				
D[5:3]	Conversion time	Without PS offset cancellation	With PS offset cancellation			
000	0.4ms	10bit (Max. 1,023 count)	9bit (Max. 5,11 count)			
001	0.8ms	11bit (Max. 2,047 count)	10bit (Max. 1,023 count)			
010	1.6ms	12bit (Max. 4,095 count)	11bit (Max. 2,047 count)			
011	3.2ms	13bit (Max. 8,191 count)	12bit (Max. 4,095 count)			
100	6.3ms	14bit (Max. 16,383 count)	13bit (Max. 8,191 count)			
101	12.6ms	15bit (Max. 32,767count)	14bit (Max.16,383 count)			
110	25.2ms	16bit (Max, 65,535coupt)	15bit (Max, 32,767count)			
111	25.21115					

PWTIME: PS wait time

D[2:0]	PS Wait time
000	12.5ms
001	25ms
010	50ms
011	100ms
100	200ms
101	400ms
110	800ms
111	1600ms

IR VCSEL drive current register (0Bh)

D7	D6	D5	D4	D3	D2	D1	D0
		IRDRC		-	-	-	-
						Def	ault Value: 00h

IRDRC: IR VCSEL drive current select register

D[6:4]	IR Drive current
000	12.5mA

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D[7:0]	LED Dr	iver pulse cou	nt				
00000000	1						
0000001	2						
00000010	3						
00000011	4						
11111100	253						
11111101	254						
11111110	255						
11111111	256						
PS INTERRUI	PT LOW F	REGISTER <u>-SB) REGIST</u>	rer (0Dh)				
D7	D6	D5	D4	D3	D2	D1	D0
			PL	TLB			
PLTLB: PS low th	nreshold LSE PT LOW(N	B register	TER (0Eh)				
D7	D6	D5	D4	D3	D2	D1	D0
			PL	THB	÷		·
PLTHB: PS low th	hreshold MS PT HIGH(I	B register	TER (0Fh)			De	efault Value: 00h
D7	D6	D5	D4	D3	D2	D1	D0
			PH	TLB			
PHTLB: PS high	threshold LS PT HIGH(I	SB register MSB) REGIS	TER (10h)			De	efault Value: 00h
D7	D6	D5	D4	D3	D2	D1	D0
			PH	ТНВ			
PHTHB: PS high	threshold M	ISB register				De	efault Value: 00h
		TED (11h)					
				D3	D2		D0
	00	00			DZ		
			PDI				
PDATAL: PS data	a LSB regist	er				De	erauit value: 00h

IR LED drive pulse count register (0Ch)



IRD

DRP: IR VCSEL	drive pulse count setting register
D[7:0]	LED Driver pulse count
0000000	1
0000001	2
0000010	3
00000011	4
11111100	253
11111101	254
11111110	255

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PS DATA(MSB) REGISTER (12h)

	/			D4	50	D2	D1	D0
זט		D0	5	D4	D3	DZ	וס	D0
PDATAH								

Default Value: 00h

PDATAH: PS data MSB register

PS SETTING REGISTER_2 (13h)

D7	D6	D5	D4	D3	D2	D1	D0
PSOCEN				(Reserved)*			

Default Value: 00h

D7	PS offset cancel function enable
0	Disable PS offset cancel function-
1	Enable PS offset cancel function

When PSOCEN is 1, the PS offset cancel function is enabled, and the result of subtracting any value specified by the PS offset cancel (LSB) register (14h) and the PS offset cancel (MSB) register (15h) from the internal PS output data is written to the PS output data register.

*make sure to set D6 to D0 to "0"

PS OFFSET CANCEL REGISTER

PS OFFSET CANCEL (LSB) REGISTER (14h)

D7	D6	D5	D4	D3	D2	D1	D0
PSOCL							

PS OFFSET CANCEL (MSB) REGISTER (15h)

D7	D6	D5	D4	D3	D2	D1	D0
0	PSOCH						

Default Value: 00h

Default Value: 00h

DEVICE ID REGISTER (18h)

D7	D6	D5	D4	D3	D2	D1	D0
DEVID							

Default Value: 11h

Functional Description

Shutdown Mode

Shutdown mode becomes effective when the power is turned on and when the shutdown mode is selected with the operation mode select register. Power consumption is typical 0.1uA in the shutdown mode; therefore, the power consumption can be lower standby power consumption. The configuration register is readable and writable even in the shutdown mode.

PS Mode

The proximity sensor drives the IR-LED connected to IRDR pin and detects the intensity of the reflected IR light of an object close to the sensor.

The IR-LED drive and ADC conversion cycle are started by setting the PS enable bit in the operation select register. The output data corresponding to the reflected IR intensity is stored in the data register.

The IR-LED is controlled by an integrated LED driver with sink output. The drive current value (12.5 to 100mA) and the pulse count (1 to 256 pulses) are selectable to adjust the proximity detection distance. Moreover, measurement interval in PS mode can be adjusted with PS wait time (12.5 to 1600ms) which will reduce the overall current consumption.



PS Interrupt Function

The PS interrupt function is interrupting when the count of the PS output data meets the detection condition consecutively persistence count setting. In case of an interrupt event, the interrupt flag according to each condition is set to "1", and the interrupt output pin is set to low level. The detection condition is that the PS output data is lower than the low threshold register value or higher than the high threshold register value. If the output data was out of the detection condition, the count is reset to zero.

Once the interrupt flag has been activated by crossing the high threshold value and is then reset, it can be activated again only when output value drops below the low threshold value. Also when a low interrupt occurred, the next event which can trigger the interrupt is if the PS value exceeds the high threshold value.

Detection Condition

The number of detection is counted with condition below. PS output data < Low Threshold Value "OR" PS output data > High Threshold Value

Flag Set Condition

The interrupt flag is set with condition below and INT pin will be active. Detection count = PS persistence setting count The number of persistence is selectable from 1, 4, 8, and 16 times by an Interrupt Setting Register.









Fig7. Interrupt Operation Diagram



PS Offset Output Data (vs. PS Pulse Counts)



PS offset :

When PS Pulse Counts = 1, PS offset Value set 124. When PS Pulse Counts = 2, PS offset Value set 248. When PS Pulse Counts = 4, PS offset Value set 496.

PS Offset Output data (vs. PS gain)



PS offset :

When PS Gain = x1, PS offset Value set 124. When PS Gain = x2, PS offset Value set 248. When PS Gain = x4, PS offset Value set 496.

Package Dimensions and recommended solder pad layout



Top View

Pad Definition					
1	INT				
2	VDD				
3	GND				
4	LEDA				
5	SCL				
6	SDA				



Bottom View

Recommended Soldering Pad



Unit: mm Tolerances: ± 0.2mm



Label Explanation



- CPN: Customer's Product Number
- P/N: Product Number
- QTY: Packing Quantity
- CAT: Luminous Intensity Rank
- HUE: Dom. Wavelength Rank
- REF: Forward Voltage Rank
- LOT No: Lot Number

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Recommended method of storage

- 1. Do not open moisture proof bag before devices are ready to use.
- 2. Shelf life in sealed bag from the bag seal date: 18 months at 10°C~30°C and < 90% RH.
- After opening the package, the devices must be stored at 10°C~30°C and ≤ 60%RH, and used within 168 hours (floor life).
- 4. If the moisture absorbent material (desiccant material) has faded or unopened bag has exceeded the shelf life or devices (out of bag) have exceeded the floor life, baking treatment is required.
- 5. If baking is required, refer to IPC/JEDEC J-STD-033 for bake procedure or recommend the following conditions:
 192 hours at 40°C +5/–0°C and < 5 % RH (reeled/tubed/loose units) or
 96 hours at 60°C ± 5°C and < 5 % RH (reeled/tubed/loose units) or

24 hours at $125^{\circ}C \pm 5^{\circ}C$, not suitable for reel or tubes.

Recommended Solder Profile



Notice:

- 1. Reflow soldering should not be done more than two times.
- 2. When soldering, do not put stress on the devices during heating.
- 3. After soldering, do not warp the circuit board.
- 4. Reference: IPC/JEDEC J-STD-020D

DISCLAIMER

- 1. EVERLIGHT reserves the right(s) on the adjustment of product material mix for the specification.
- 2. The product meets EVERLIGHT published specification for a period of twelve (12) months from date of shipment.
- 3. The graphs shown in this datasheet are representing typical data only and do not show guaranteed values.
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