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**EKM8003**

**Optical Mouse Controller**

**Product  
Specification**

**DOC. VERSION 1.0**

**ELAN MICROELECTRONICS CORP.**

December 2002




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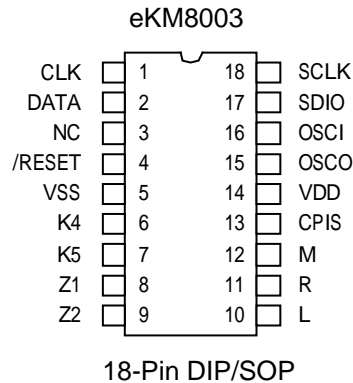


### Specification Revision History

Doc. Version	Revision Description	Date
1.0	Preliminary version	2002/12/17

## 1 General Description

eKM8003 is designed as a 3-D 3-Keys or 5-Keys PS/2 optical mouse controller. It must apply with Agilent sensor ADNS-2051, ADNS-2610, ADNS-2620 or the same compatible series sensor.



## 2 Application and Features

- Application for the PS/2 optical mouse which supports 3-Dimensions with 3-Keys or 5-Keys.
- eKM8003 supports Agilent sensor IC (ADNS-2051, ADNS-2610 and ADNS-2620). It also supports 400/800 CPI via CPIS selection pin for ADNS-2051 only.
- eKM8003 supports 3 types of Z direction input which Z1 and Z2 stable state must be the same voltage level. Where Z1 and Z2 with internal pull down resistors 100KOhm.
  1. Mechanical encoder (Z/2).
  2. Photo couples input for Z/2.
  3. Photo couples input for Z/4.

### 3 Pin Assignment

Symbol	I/O	Pin	Description
CLK	I/O	1	PS/2 CLK I/O pin
DATA	I/O	2	PS/2 Data I/O pin
/RESET	I	4	Reset IC
VSS	-	5	Ground
K4	I	6	The 4th Button Input
K5	I	7	The 5th Button Input
Z1	I	8	Z axis Input 1.
Z2	I	9	Z axis Input 2.
L	I	10	Left Key Input.
R	I	11	Right Key Input.
M	I	12	Middle Key Input.
CPI S	I	13	400/800 CPI Selection pin. Floating: 400 CPI. Ground: 800 CPI (for ADNS-2051 only).
VDD	-	14	+5V Power Input.
OSCO	I/O	15	Return Path for Ceramic Resonator or Crystal Oscillator.
OSCI	I	16	Type A – Ceramic Resonator or Crystal Oscillator Input. Type B – RC Oscillator Input.
SDIO	I/O	17	Serial Data from Agilent sensor IC SDIO.
SCLK	I/O	18	Serial Clock to Agilent sensor IC SCLK.

### 4 Function Description

#### 4.1 Agilent Serial Interface and Control Register

##### 4.1.1 Synchronous Serial Port

The synchronous serial port is used to set and read parameters in Agilent sensor IC, and can be used to read out the motion information. The eKM8003 always initiates communication.

SCLK: The serial port clock. It is always generated by eKM8003.

SDIO: The serial data line.

PD: Power Down line is used to force re-synchronization between the eKM8003 and the ADNS-2051 in case of an error. It also can be used to place the ADNS-2051 in low power mode to meet some special case.



#### 4.1.2 Write Operation

Write operations, where data is going from the eKM8003 to Agilent sensor IC, is always initiated by the micro-controller and consists of two bytes. The first byte contains the address (seven bits) and has a "1" as its MSB to indicate data direction. The second byte contains the data. The transfer is synchronized by SCLK. The eKM8003 changes SDIO on falling edges of SCLK.

#### 4.1.3 Read Operation

A read operation, which means that data is going from Agilent sensor IC to the eKM8003, is always initiated by the eKM8003 and consists of two bytes. The first byte contains the address, is written by the eKM8003, and has a "0" as its MSB to indicate data direction. The second byte contains the data and is driven by Agilent sensor IC. The transfer is synchronized by SCLK. SDIO is changed on falling edges of SCLK and read on every rising edge of SCLK. The eKM8003 will go to a high Z state after the last address data bit.

During a read operation, SCLK will delay after the last address data bit to ensure that Agilent sensor IC has at least 100us to prepare the requested data.

#### 4.1.4 Error Detection and Recovery of ADNS-2051

The eKM8003 will verify the synchronization of the serial port by periodically reading the product ID register of ADNS-2051. Once the eKM8003 and the ADNS-2051 get out of sync, then the eKM8003 will output a valid PD plus to resync.

#### 4.1.5 Error Detection and Recovery of ADNS-2610/2620

1. The ADNS-2610/2620 and the microcontroller might get out of synchronization due to ESD events, power supply droops or microcontroller firmware flaws.
2. The ADNS-2610/2620 has a transaction timer for the serial port. If the sixteenth SCK rising edge is spaced more than approximately 90 milliseconds from the first SCK edge of the current transaction, the serial port will reset.
3. Invalid addresses:
  - Writing to an invalid address will have no effect. Reading from an invalid address will return all zeros.
4. Collision detection on SDIO
  - The only time that the ADNS-2610/2620 drives the SDIO line is during a READ operation. To avoid data collisions, the microcontroller should relinquish SDIO before the falling edge of SCK after the last address bit. Then the ADNS-2610/2620 begins to drive SDIO after the next rising edge of SCK. Next, the ADNS-2610/2620 relinquishes SDIO within 160 ns of the falling SCK edge after the last data bit. The microcontroller can begin driving SDIO any time after that. In order to maintain low power consumption in normal operation or when the PD pin is pulled high, the



microcontroller should not leave SDIO floating until the next transmission (although that will not cause any communication difficulties).

5. In case of synchronization failure, both the ADNS-2610/2620 and the microcontroller may drive SDIO. The ADNS-2610/2620 can withstand 30 mA of short circuit current and will withstand infinite duration short circuit conditions.
6. The microcontroller can verify a successful write operation by issuing a read command to the same address and comparing the written data to the read data.

The microcontroller can verify the synchronization of the serial port by periodically reading the product ID from status register.

## 4.2 Optical Sensor Resolution Selection

Optical Sensor ANDS-2051 resolution can be programmed as 400 or 800 cpi (counts per inch).

The eKM8003 has a selection pin, CPIS, to select the resolution. The default resolution is 400 cpi. If the selection pin is tied to ground, the eKM8003 will program the ANDS-2051 to 800 cpi. To program the resolution, the eKM8003 write data into the ANDS-2051's configuration register address, 0x0a.

## 4.3 Registers of ADNS-2051

### 4.3.1 Product ID

Address: 0x00

Reset Value: 0x02

Usage: The value in this register does not change, it can be used to verify that the serial communications link is OK.

### 4.3.2 Motion

Address: 0x02

Reset Value: 0x00

7	6	5	4	3	2	1	0
MOT	Reserved	FAULT	OVFY	OVFX	Reserved	Reserved	RES

Usage : Register 0x02 allows the user to determine if motion has occurred since the last time it was read. If so, then the eKM8003 should read registers 0x03 and 0x04 to get the accumulated motion. It also tells if the motion buffers have overflowed and whether or not an LED fault occurred since the last reading. The current resolution is also shown.





Field Name	Description
MOT	Motion since last report or PD 0 = No Motion 1 = Motion occurred, data ready for reading in Delta_X and Delta_Y registers.
Reserved	Reserved for future
FAULT	LED fault detected – set when R_BIN is too low or too high, shorts to VDD or Ground. 0 = No fault 1 = Fault detected
OVFY	Motion overflow Y, Delta_Y buffer has overflowed since last report. 0 = No overflow 1 = Overflow has occurred.
OVFX	Motion overflow X, Delta_X buffer has overflowed since last report. 0 = No overflow 1 = Overflow has occurred.
RES	Resolution in counts per inch 0 = 400 1 = 800

**NOTE**  
*Agilent recommends that registers 0x02, 0x03 and 0x04 be read sequentially.*

### 4.3.3 Delta\_X

Address: 0x03

Reset Value: 0x00

Usage : X movement is counts since last report. Absolute value is determined by resolution. Reading clears the register.

### 4.3.4 Delta\_Y

Address: 0x04

Reset Value: 0x00

Usage : Y movement is counts since last report. Absolute value is determined by resolution. Reading clears the register.

### 4.3.5 Configuration\_bits

Address: 0x0a

Reset Value: 0x00

7	6	5	4	3	2	1	0
RESET	LED_MODE	Sys Test	RES	PixDump	Reserved	Reserved	Sleep



Usage : Register 0x0a allows the user to change the configuration of the sensor.  
 Shown below are the bits, their default values, and optional values.

Field Name	Description
RESET	Power up defaults (bit always reads 0) 0 = No effect 1 = Reset registers and bits to power up default settings (bold entries)
LED_MODE	LED shutter Mode 0 = Shutter mode off ( LED always on ) ( even if no motion up to 1sec.) 1 = Shutter mode on (LED only on when the electronic shutter is open)
Sys Test	System tests (bit always reads 0) 0 = No tests 1 = perform all system tests, output 16 bit CRC via Data_Out_Upper and Data_Out_Lower registers.
RES	Resolution in counts per inch 0 = 400 1 = 800
Pix Dump	Dump the pixel array through Data_Out_Upper and Data_Out_Lower, 256 bytes 0 = disable 1 = dump pixel array
Sleep	Sleep Mode 0 = Normal, fall asleep after one second of no movement (1500 frames/s) 1 = always awake

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## 4.4 Registers of ADNS-2610 (ADNS-2620)

### 4.4.1 Configuration

Address:0x00 (0x40)

Reset Value: 0x00

Usage : Status information and type of mouse sensor, current state of the mouse.

7	6	5	4	3	2	1	0
C7	C6	C5	C4	C3	C2	C1	C0

Field Name	Description
C7	Reset 0 = No effect 1 = Reset the part
C6	Power Down 0 = Normal operation 1 = Power down analog circuit
C5 – C1	Reserved
C0	Forced Awake Mode 0 = Normal, fall asleep after one second of no movement (1500 frames/s) 1 = Always awake

#### 4.4.2 Status

Address: 0x01 (0x41)

Reset Value: 0x01 (0x41)

Usage : Status information and type of mouse sensor, current state of the mouse.

7	6	5	4	3	2	1	0
ID2	ID1	ID0	Reserved	Reserved	Reserved	Reserved	Awake

Field Name	Description
ID2 – ID0	Product ID (000 for ADNS-2610; 010 for ADNS-2620)
Reserved	Reserved for future
Awake	Mouse State 0 = Asleep 1 = Awake

#### 4.4.3 Delta\_Y

Address: 0x02 (0x42)

Reset Value: 0x00

Usage : Y movement is counts since last report. Absolute value is determined by resolution. Reading clears the register.

#### 4.4.4 Delta\_X

Address: 0x03 (0x43)

Reset Value: 0x00

Usage : X movement is counts since last report. Absolute value is determined by resolution. Reading clears the register.

## 4.5 PS/2 Mouse Commands Description

Hex Code	Command	eKM8003 echo code
FF	Reset	FA,AA,00
FE	Resend	XX,(XX,XX)
F6	Set Default	FA
F5	Disable	FA
F4	Enable	FA
F3,XX	Set Sampling Rate	FA,FA
F2	Read Device Type	FA,00
F0	Set Remote Mode	FA
EE	Set Wrap Mode	FA
EC	Reset Wrap Mode	FA
EB	Read Data	FA,XX,XX,XX
EA	Set Stream Mode	FA
E9	Status Request	FA,XX,XX,XX
E8	Set Resolution	FA,FA
E7	Set Auto-speed	FA
E6	Reset Auto-speed	FA

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## 4.6 Microsoft PS/2 scrolling mouse

- Entering procedure: Except in WRAP mode, while eKM8003 received the following consecutive command.
  - F3 C8 ---- set sampling rate 200 Hz
  - F3 64 ---- set sampling rate 100 Hz
  - F3 50 ---- set sampling rate 80 Hz
  - F3 3C ---- set sampling rate 60 Hz
  - F3 28 ---- set sampling rate 40 Hz
  - F3 14 ---- set sampling rate 20 Hz
  - F3 0A ---- set sampling rate 10 Hz
- (B) Operating for 3-D 3-Keys:
  - a. All of the commands in legacy mode still be valid.
  - b. The ID code of read device type command (F2) will change from "00" to "03".
  - c. Data report will be four bytes format:

Byte	Bit	Description
1	0	Left button status; 1 = pressed
	1	Right button status; 1 = pressed
	2	Middle button status; 1 = pressed
	3	Reserve
	4	X data sign; 1 = negative
	5	Y data sign; 1 = negative
	6	X data overflow; 1 = overflow
	7	Y data overflow; 1 = overflow
2	0-7	X data (D0-D7)
3	0-7	Y data (D0-D7)
4	0-7	Z data (D0-D7) limit value is +/- 7.

- (C) Operating for 3-D 5-Keys:
  - a. All of the commands in legacy mode still be valid.
  - b. The ID code of read device type command (F2) will change from "00" to "04".
  - c. Data report will be four bytes format:

Byte	Bit	Description
1	0	Left button status; 1 = pressed
	1	Right button status; 1 = pressed
	2	Middle button status; 1 = pressed
	3	Reserve
	4	X data sign; 1 = negative
	5	Y data sign; 1 = negative
	6	X data overflow; 1 = overflow
	7	Y data overflow; 1 = overflow
2	0-7	X data (D0-D7)
3	0-7	Y data (D0-D7)
4	0-3	Z data (D0-D3) limit value is +/- 7.
	4	The 4th button status; 1 = pressed
	5	The 5th button status; 1 = pressed
	6,7	Reserve

- (D) Exiting Microsoft scrolling mode:
  - There are two ways to exit:
    - a. Power off.
    - b. Reset command (FF).

## 5 Absolute Maximum Rating

Symbol	min	max	unit
Temperature under bias	0	70	°C
Storage temperature	-65	150	°C
Input voltage	-0.5	6.0	V
Output voltage	-0.5	6.0	V

## 6 Application Circuit

CPIS pin option (only available for ADNS-2051) :

- CPIS floating: Setting the optical mouse resolution to 400 cpi.
- CPIS tied to ground: Setting the optical mouse resolution to 800 cpi.

### 6.1 For Agilent ADNS-2051

LED BIN	K/L/M/N/P	Q	R	S	T	U
R1 Value (K )	12	12 ~ 15	12 ~ 18	12 ~ 22	12 ~ 27	12 ~ 33

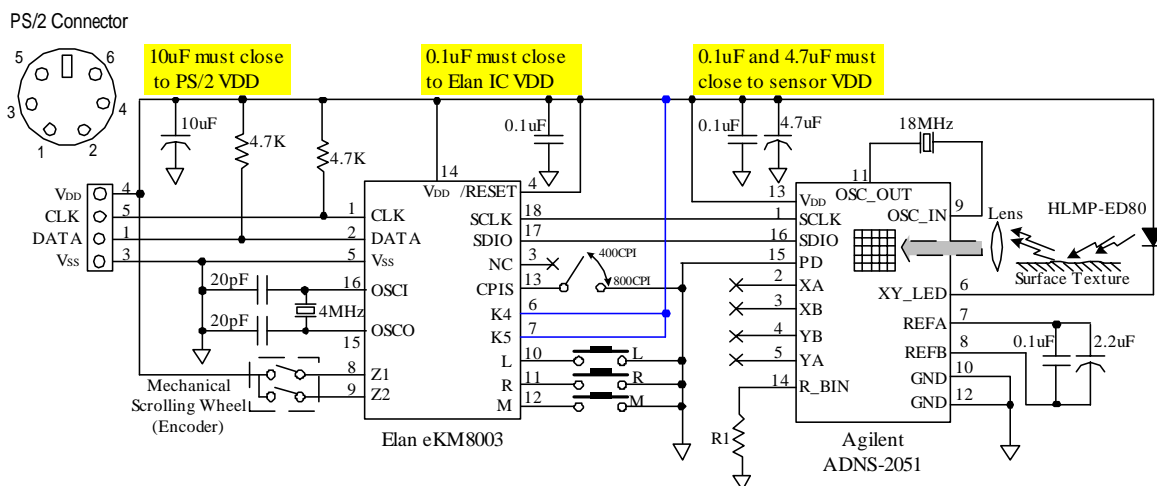
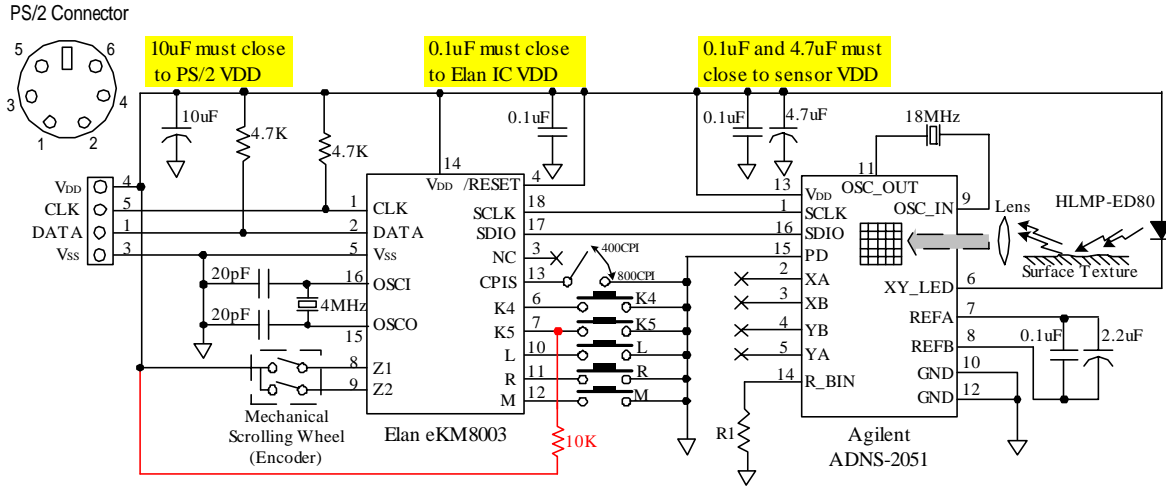
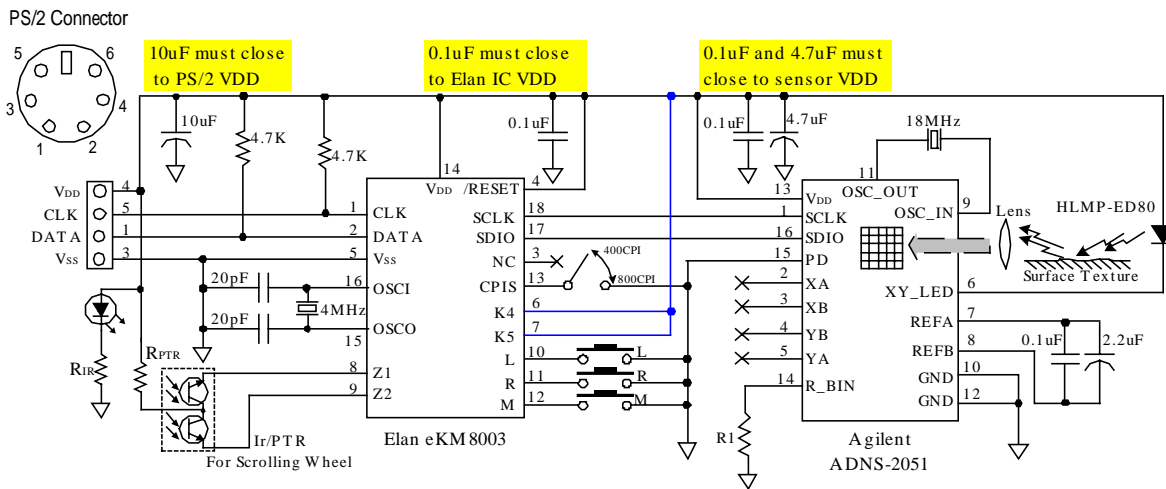


FIG1. 3-D 3-Keys with Mechanical Encoder input for Z/2



**FIG2. 3-D 5-Keys with Mechanical Encoder input for Z/2**



**FIG3. 3-D 3-Keys with Photo Couples input for Z/2**

**Suggestion:** The PTR should cover with a mask to avoid light interference.

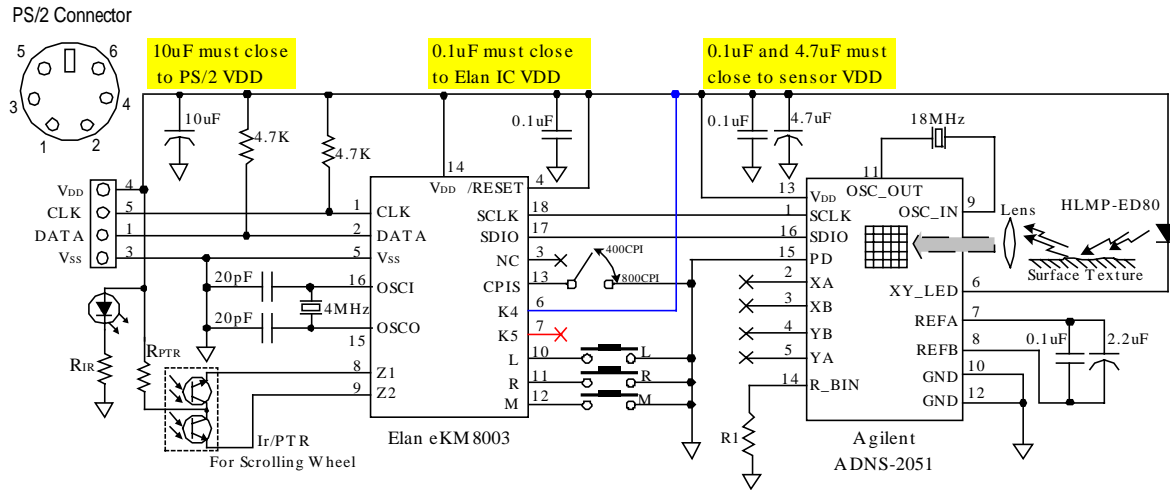


FIG4. 3-D 3-Keys with Photo Couples input for Z/4

**Suggestion:** The PTR should cover with a mask to avoid light interference.

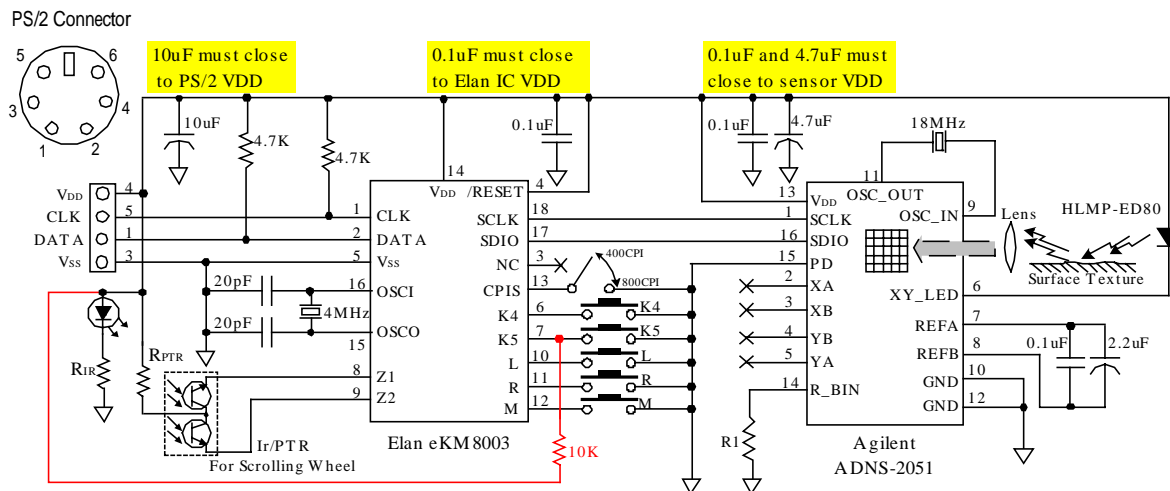


FIG5. 3-D 5-Keys with Photo Couples input for Z/2

**Suggestion:** The PTR should cover with a mask to avoid light interference.



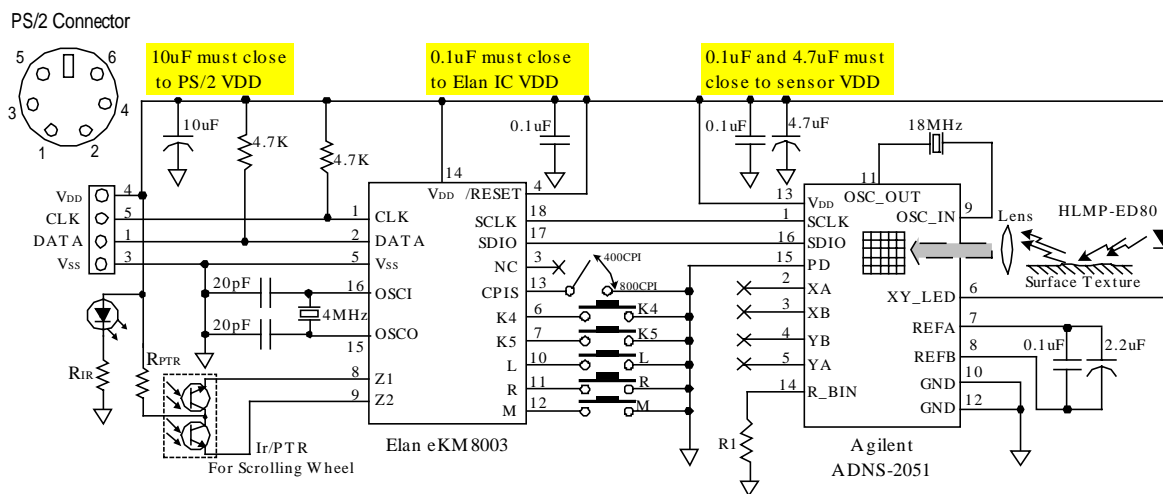


FIG6. 3-D 5-Keys with Photo Couples input for Z/4

**Suggestion:** The PTR should cover with a mask to avoid light interference.

## 6.2 For Agilent ADNS-2610/2620

LED BIN	K/L/M/N	P	Q	R	S	T	U
R1 Value ( )	69.8	78.9	93.1	113	137	169	191

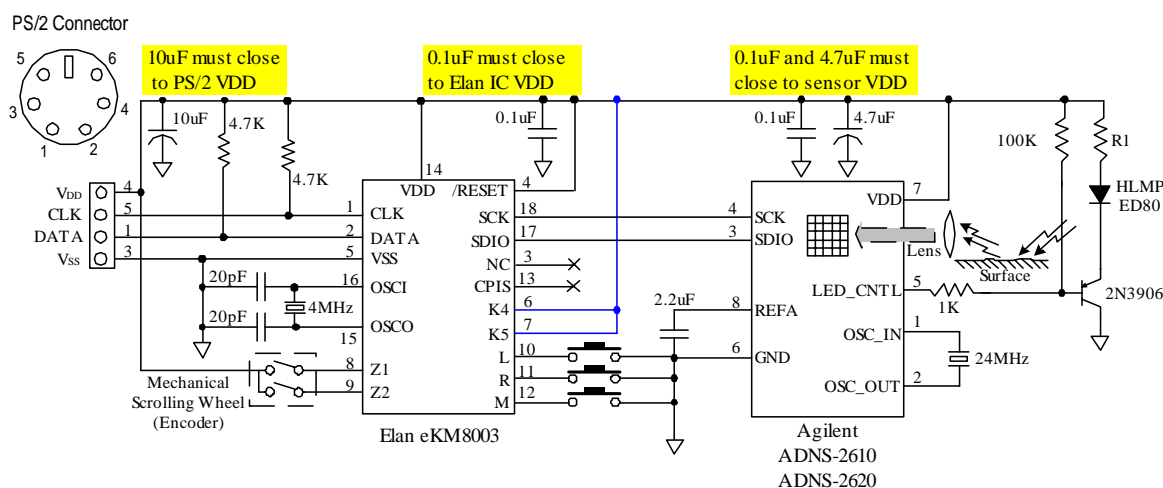
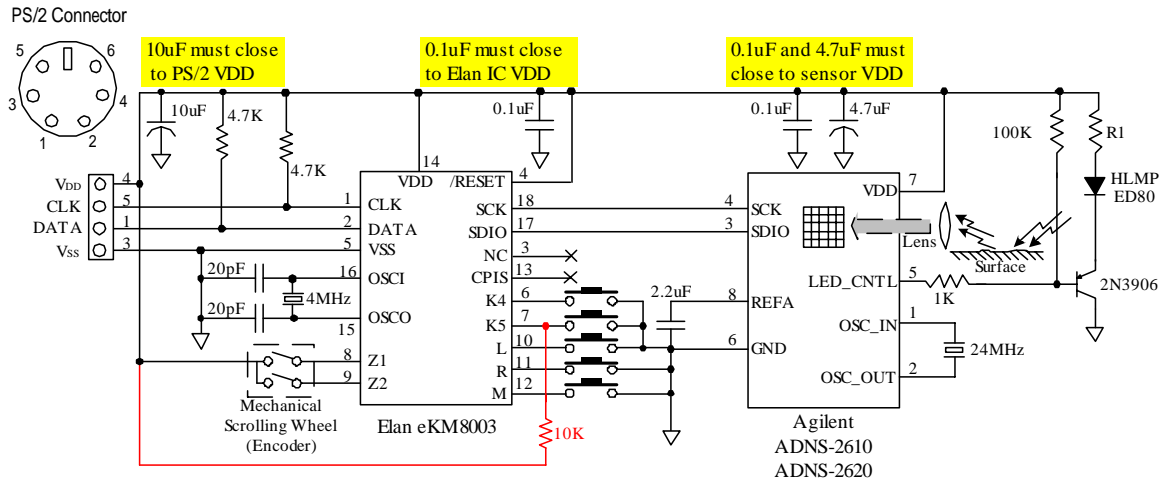
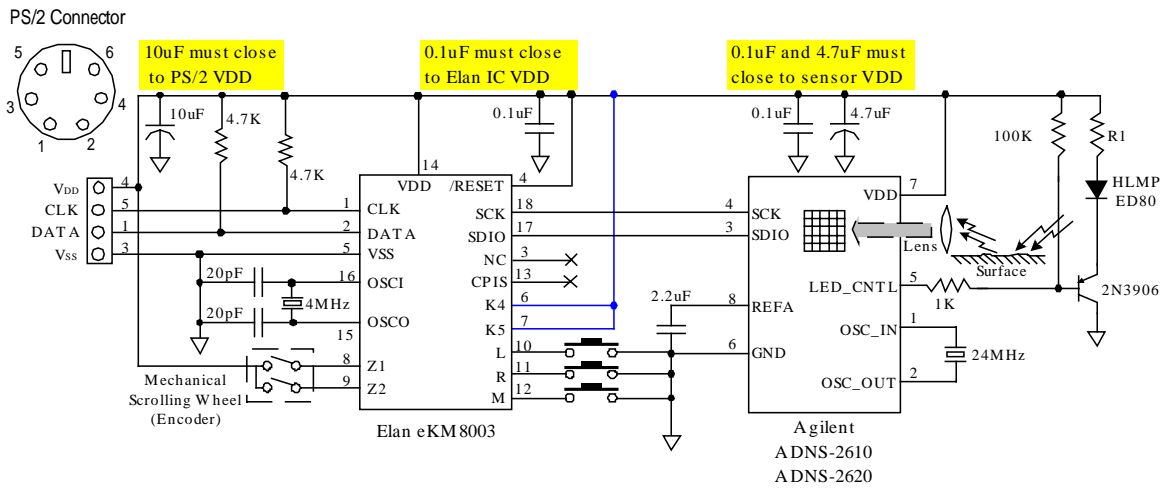


FIG7. 3-D 3-Keys with Mechanical input for Z/2

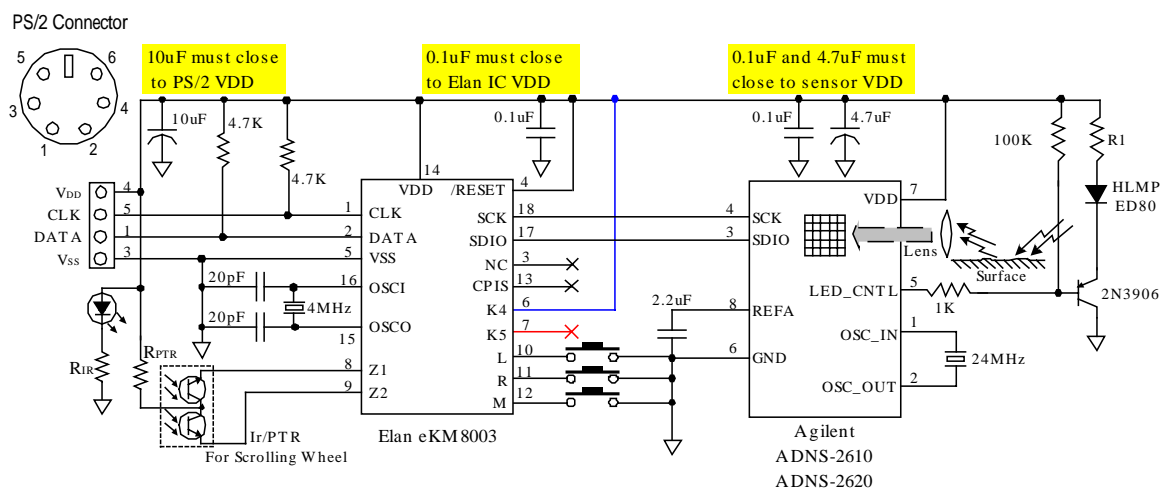


**FIG8. 3-D 5-Keys with Mechanical Encoder input for Z/2**



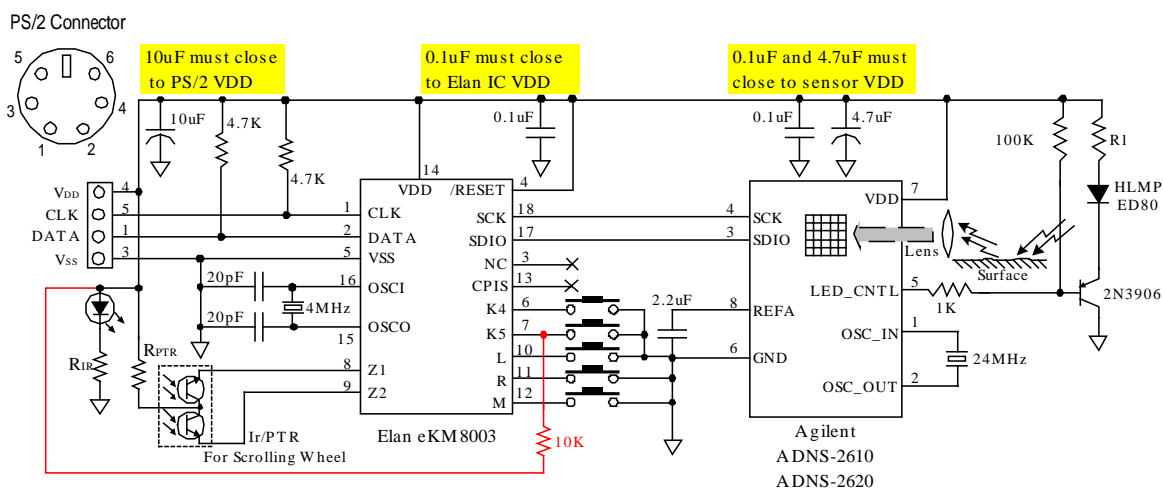
**FIG9. 3-D 3-Keys with Photo Couples input for Z/2**

**Suggestion:** The PTR should cover with a mask to avoid light interference.



**FIG10. 3-D 3-Keys with Photo Couples input for Z1/4**

**Suggestion:** The PTR should cover with a mask to avoid light interference.



**FIG11. 3-D 5-Keys with Photo Couples input for Z1/2**

**Suggestion:** The PTR should cover with a mask to avoid light interference.

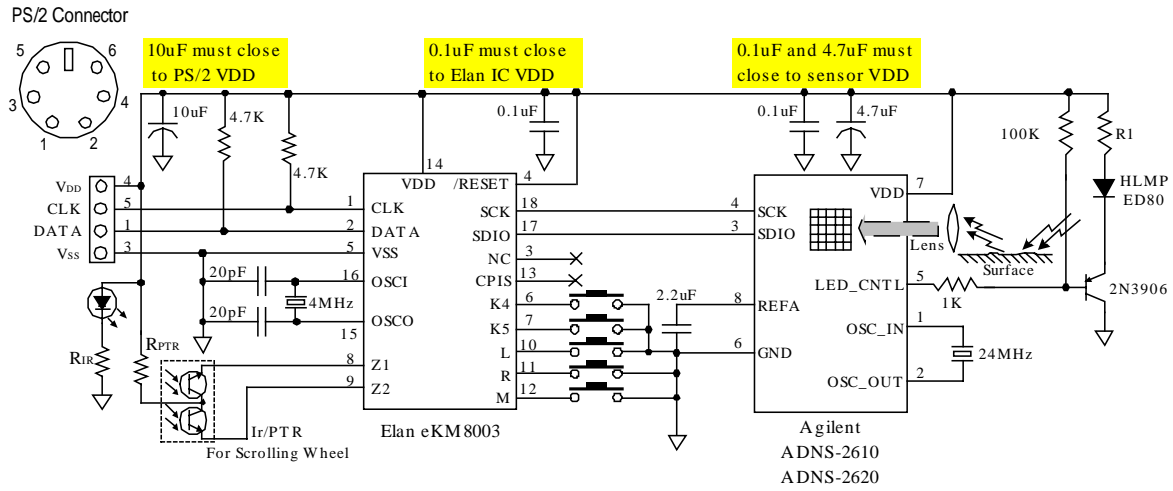
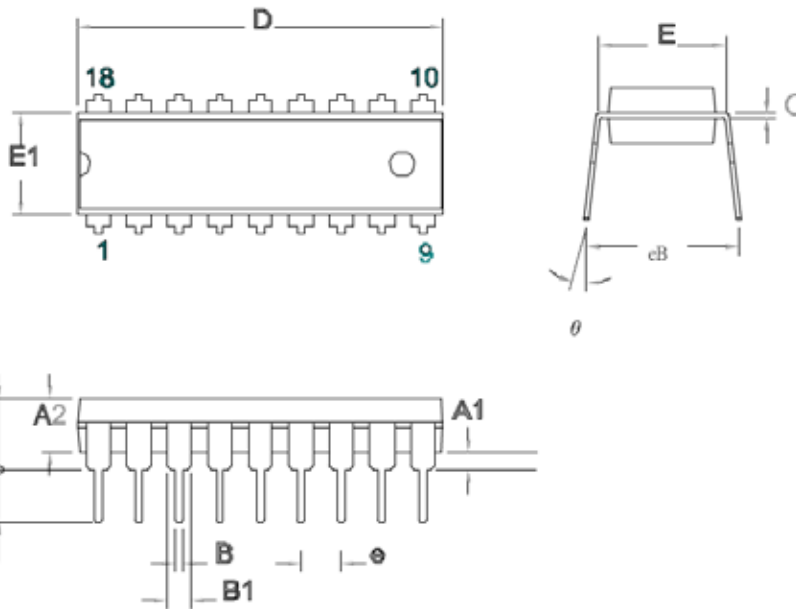


FIG12. 3-D 5-Keys with Photo Couples input for Z/4

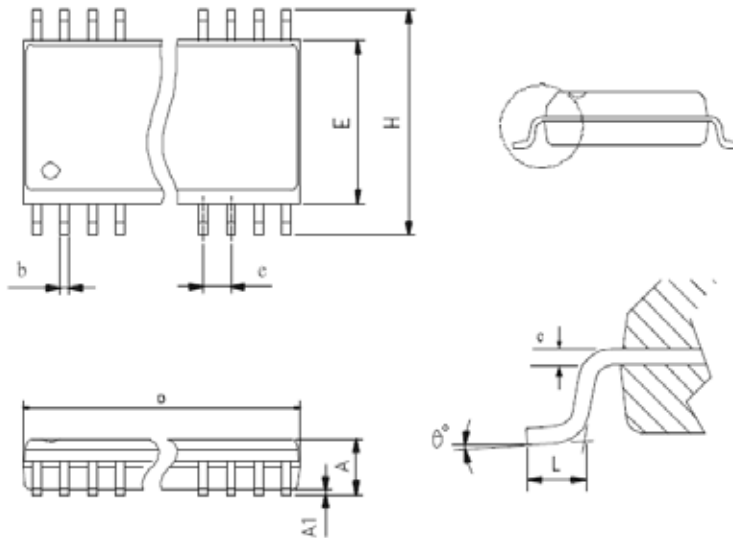
**Suggestion:** The PTR should cover with a mask to avoid light interference.

■ PDIP-18L 300MIL PACKAGE OUTLINE DIMENSION(Unit:mm)



Symbol	Min	Normal	Max
A			4.450
A1	0.381		
A2	3.175	3.302	3.429
c	0.203	0.254	0.356
D	22.610	22.860	23.110
E1	6.220	6.438	6.655
E	7.370	7.620	7.870
eB	8.510	9.020	9.530
B	0.356	0.457	0.559
B1	1.143	1.524	1.778
L	3.048	3.302	3.556
e	2.540(TYP)		
θ	0		15

■ SOP-18L 300MIL PACKAGE OUTLINE DIMENSION(Unit:mm)



Symbol	Min	Normal	Max
A	2.350		2.650
A1	0.102		0.300
b	0.406(TYP)		
c	0.230		0.320
E	7.400		7.600
H	10.000		10.650
D	11.350		11.750
L	0.406	0.838	1.270
e	1.27(TYP)		
$\theta$	0		8

