EM84513

Mouse Controller

Product Specification

DOC. VERSION 0.9

ELAN MICROELECTRONICS CORP.

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Contents

1 General Description 1
2 Features 1
3 Application 2
4 Pin Assignment 2
5 Functional Block Diagram 3
6 Pin Descriptions 4
7 Function Description 4
7.1 Legacy PS/2 Mouse Operating 4
7.1.1 Operating Mode 4
7.1.1.1 Reset Mode 4
7.1.1.2 Stream Mode 5
7.1.1.3 Remote Mode 5
7.1.1.4 Wrap Mode 5
7.1.2 PS/2 Mouse Data Report 5
7.1.3 PS/2 Mouse Data Transmission 5
7.1.4 PS/2 Mouse Error Handling 6
7.1.5 PS/2 Mouse Commands Description 7
7.2 Microsoft PS/2 Scrolling Mouse Mode 9
7.2.1 Entering Procedure 9
7.2.2 Operating 9
7.2.3 Exiting Microsoft Scrolling Mode 10
7.3 Z-axis Input Function : The Z0-Z7 Limit Value Is±7 10
7.3.1 Photo Couples Input 10
7.3.2 Mechanical Mode 10
7.4 400CPI / 800CPI Resolution 10
7.4.1 400CPI (EM84513AEP and EM84513AFP) 10
7.4.2 800CPI (EM84513BEP and EM84513BFP) 10
8 Absolute Maximum Rating 10
9 DC Electrical Characteristics 11
10 AC Electrical Characteristics 12
11 Timing Diagrams 12
11.1 Photo-Couples Pulse Width : 12
11.2 PS/2 Mouse : 13
12 Application Circuit 14
12.1 Sensor Type and Mechanical Z/2 14
12.2 Sensor Type and Photo-Couples Z/4 14
12.3 Ball Type and Mechanical Z/2 15
12.4 Ball Type and Mechanical Z/4 15
13 Pad Diagram 16

Specification Revision History

Doc. Version	Revision Description	Date
0.9	Preliminary version	2006/06/16

1 General Description

The EM84513 Scrolling Mouse Controller is specially designed to control 400cpi or 800cpi PS/2 mouse device. This single chip can interface four photo-couples plus z-axis direct to 8042 controller. EM84513 can receive command and echo status or data format which are compatible with IBM PS/2 mode mouse. Key debouncing circuit is provided to prevent false entry and improve the accuracy. In the traditional mouse, a great number of noises are generated when the grid is partially closed or opened. These noises are usually mistaken for movement signals by traditional mouse controller and the cursor of the display screen is thus moved frequently up and down or back and forth. This will consume a great amount of energy. The EM84513 mouse controller provides noise immunity circuits to eliminate these noises in order to reduce energy consumption.

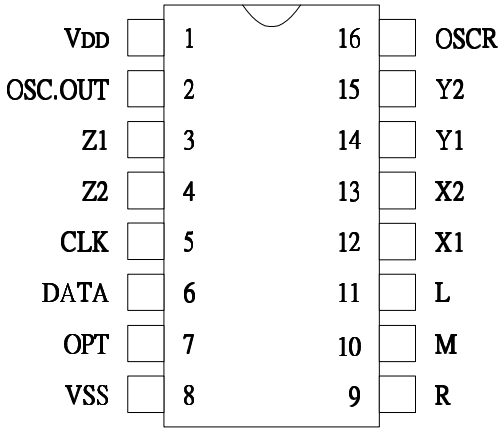
2 Features

- Using 51k 5% resistor for RC oscillation.
- Compatible with legacy PS/2 mouse.
- Compatible with Microsoft scrolling mouse.
- Built-in noise immunity circuit.
- Built-in current comparator for photo-couples input.
- Built-in three step dynamic input impedance.
- Two types Z direction input:
  - Photo couples input. (Z/4)
  - Mechanical input. (Z/2)
- Two types resolution (Selected by package type):
  - 400CPI.
  - 800CPI.
- Both key-press and key-release debounce interval 12 ms.
- The sampilng rate of motion detector is about 65KHz.
- Low power dissipation.
- Package type:
  - EM84513AEP : 16DIP(300mil), 400CPI, Photo couples input. (Z/4)
  - EM84513AFP : 16DIP(300mil), 400CPI, Mechanical input. (Z/2)
  - EM84513BEP : 16DIP(300mil), 800CPI, Photo couples input. (Z/4)
  - EM84513BFP : 16DIP(300mil), 800CPI, Mechanical input. (Z/2)

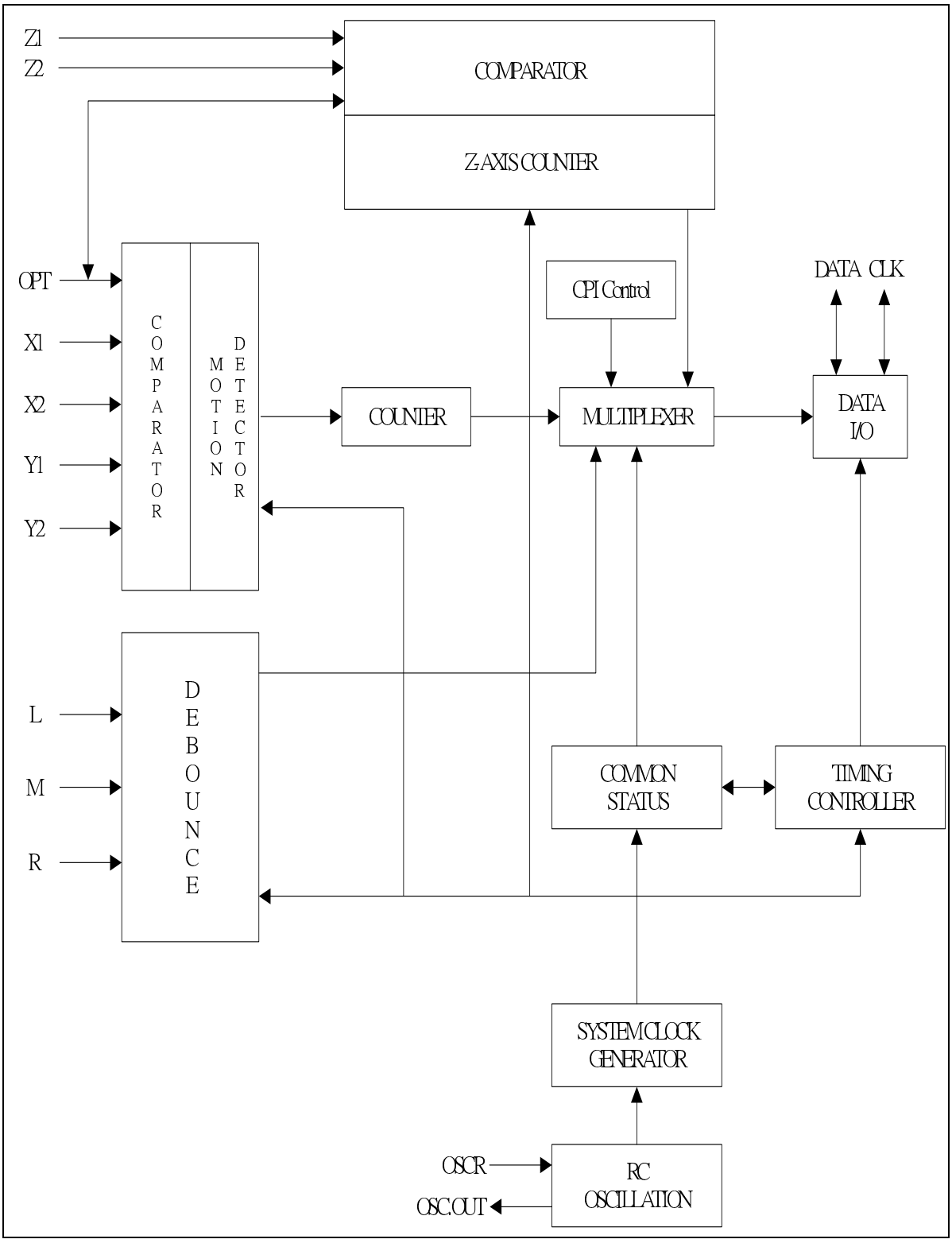
3 Application

PS/2 Ball Mouse or Optical Mouse.

4 Pin Assignment



5 Functional Block Diagram



6 Pin Descriptions

Pin No.	Symbol	I/O	Function
1	VDD	-	Positive power supply.
2	OSC. OUT	O	Oscillation clock output.
3	Z1	I	Z-axis inputs. Photo mode: Three step dynamic input impedance. Mechanical mode : 13.2kohm resistor pull low.
4	Z2	I	
5	CLK	I/O	Connect to 8042 auxiliary port CLK line.
6	DATA	I/O	Connect to 8042 auxiliary port DATA line.
7	OPT	I/O	INPUT: Internal 210Kohm pull low to VSS. When OPT is connected to VDD, EM84513 will enter test mode. In test mode, L will be the output of X1, while M will be the output of X2. Toggling R key can change these output to be Y1, Y2 or Z1, Z2 respectively. OUTPUT: 2KHz Z-axis LED driving source. "1"= VDD, "0"= floating. High duty is about 60us.
8	VSS	-	Ground.
9	R	I	Three key-switches inputs, with internal 150Kohm resistor pull low.
10	M	I	
11	L	I	
12	X1	I	X and Y-axis input. Three step dynamic input impedance. Use current comparator to measure photo-couples "ON", or "OFF".
13	X2	I	
14	Y1	I	
15	Y2	I	
16	OSCR	I	RC mode oscillation with external 51Kohm±5% resistor connected to ground.

7 Function Description

7.1 Legacy PS/2 Mouse Operating

7.1.1 Operating Mode

There are four operating modes in PS/2 mouse:

7.1.1.1 Reset Mode

In this mode a self-test is initiated during power-on or by a Reset command. After reset signal,

PS/2 mouse will send:

- Completion code 0xAA & ID code 0x00.
- Set default :sampling rate: 100 reports/s
  non-autospeed
  stream mode
  2 dot/count
  disable

7.1.1.2 Stream Mode

The maximum rate of transfer is the programmed sample rate.

Data report is transmitted if

- switch is pressed
- movement has been detect

7.1.1.3 Remote Mode

Data is transmitted only in response to a Read Data command.

7.1.1.4 Wrap Mode

Any byte of data sent by the system, except hex 0xEC (Reset wrap mode) or hex 0xFF (Reset), is returned by EM84513.

7.1.2 PS/2 Mouse Data Report

- In stream mode: A data report is sent at the end of a sample interval.
- In remote mode: A data report is sent in response to Read Data command.
- Data report 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 (Always 1)
	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)

7.1.3 PS/2 Mouse Data Transmission

- EM84513 generates the clocking signal when sending data to and receiving data from the system.
- The system requests EM84513 receive system data output by forcing the DATA line to an inactive level and allowing CLK line to go to an active level.
- Data transmission frame:

Bit	Function
1	Start bit (always 0)
2-9	Data bits (D0 – D7)
10	Parity bit (odd parity)
11	Stop bit (always 1)

- Data Output (data from EM84513 to system):

If CLK is low (inhibit status) , data is no transmission.

If CLK is high and DATA is low (request-to-send), data is updated. Data is received from the system and no transmission are started by EM84513 until CLK and DATA both high. If CLK and DATA are both high, the transmission is ready. DATA is valid prior to the falling edge of CLK and beyond the rising edge of CLK. During transmission, EM84513 check for line contention by checking for an inactive level on CLK at intervals not to exceed 100u sec. Contention occurs when the system lowers CLK to inhibit EM84513 output after EM84513 has started a transmission. If this occurs before the rising edge of the tenth clock, EM84513 internal store its data in its buffer and returns DATA and CLK to an active level. If the contention does not occur by the tenth clock, the transmission is complete. Following a transmission, the system inhibits EM84513 by holding CLK low until it can service the input or until the system receives a request to send a response from EM84513.

- Data Input (from system to EM84513):

System first check if EM84513 is transmitting data. If EM84513 is transmitting, the system can override the output forcing CLK to an inactive level prior to the tenth clock. If EM84513 transmission is beyond the tenth clock, the system receives the data. If EM84513 is not transmitting or if the system choose to override the output, the system force CLK to an inactive level for a period of not less than 100 . sec while preparing for output. When the system is ready to output start bit (0), it allows CLK go to active level. If request-to-send is detected, EM84513 clocks 11 bits. Following the tenth clock EM84513 checks for an active level on the DATA line, and if found, force DATA low , and clock once more. If occurs framing error, EM84513 continue to clock until DATA is high, then clocks the line control bit and request a Resend. When the system sends out a command or data transmission that requires a response, the system waits for EM84513 to response before sending its next output.

7.1.4 PS/2 Mouse Error Handling

- A Resend command (FE) following receipt of an invalid input or any input with incorrect parity.
- If two invalid input are received in succession, an error code of hex FC send to the system.
- The counter accumulators are cleared after receiving any command except “Resend”.
- EM84513 receives a Resend command (FE), it transmit its last packet of data.
- In the stream mode “Resend” is received by EM84513 following a 3-byte data packet transmission

- to the system. EM84513 resend the 3-byte data packet prior to clearing the counter.
- A response is sent within 25 ms if
  - The system requires a response
  - An error is detected in the transmission
- When a command requiring a response is issued by the system ,another command should not be issue until either the response is received or 25ms has passed.

7.1.5 PS/2 Mouse Commands Description

There are 16 valid commands that transmits between the system and EM84513. The "FA" code is always the first response to any valid input received from the system other than a Set Wrap Mode or Resend command.

The following table list the commands:

Hex Code	Command	EM84513 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,XX	Set Resolution	FA,FA
E7	Set Autospeed	FA
E6	Reset Autospeed	FA

- The following describes valid commands:
  - Reset (FF)
    EM84513 operation:
    i). Completion the reset.
    ii). Transmitted FA,AA,00 to the system.
    iii). Set default:sampling rate: 100 reports/s
    non-autospeed
    stream mode
    2 dots/count
    disable
  - Resend (FE)
    i). Any time EM84513 receives an invalid command, it returns a Resend command to the system.
    ii). When EM84513 receives a Resend command, it retransmits its last packet of data. If the last packet was a Resend command, it transmits the packet just prior to the Resend command.

iii). In stream mode, if a Resend command is received by EM84513 immediately following a 3-byte data packet transmission to the system.

- Set Default (F6)
  The command reinitializes all conditions to the power-on defaults.
- Disable (F5)
  This command is used in the stream mode to stop transmissions from EM84513.
- Enable (F4)

Begins transmissions, if in stream mode.

- Set Sampling Rate (F3,XX)

  In the stream mode, this command sets the sampling rate to the value indicated by byte hex XX,shown in following:

Second Byte XX	Sample Rate
0A	10/sec
14	20/sec
28	40/sec
3C	60/sec
50	80/sec
64	100/sec
C8	200/sec

- Read Device Type (F2)
  EM84513 always echoes " FA,00 " following this command.
- Set Remote Mode (F0)
  Data value are reported only in response to a Read Data command.
- Set Wrap Mode (EE)
  Wrap mode remains until Reset (FF) or Reset Wrap Mode(EC) is received.
- Reset Wrap Mode (EC)
  EM84513 returns to the previous mode of operation after receiving this command.
- Read Data (EB)
  This command is executed in either remote or stream mode. The data is transmitted even if there has been no movement since the last report or the button status is unchanged. Following a Read Data command, the registers are cleared after a data transmission.
- Set Stream Mode (EA)
  This command sets EM84513 in stream mode.
- Status Request (E9)
  When this command is issued by the system, EM84513 respond with a 3-byte status report as follows:

Byte	Bit	Description
1	0	1 = Right button pressed
	1	1 = Middle button pressed
	2	1= Left button pressed
	3	Reserved
	4	0 = Normal speed, 1 = Autospeed
	5	0 = Disable, 1 = Enabled
	6	0 = Stream mode, 1 = Remote mode
	7	Reserved
2	0-7	Current resolution setting (D0-D7)
3	0-7	Current sampling rate (D0-D7)

- Set Resolution (E8,XX)

  EM84513 provides four resolutions selected by the second byte of this command as follows:

Second Byte XX	Resolution
00	8 dot/count
01	4 dot/count
02	2 dot/count
03	1 dot/count

- Set Autospeed (E7)
  At the end of a sample interval in the stream mode, the current X and Y data values are converted new values. The sign bits are not involved in this conversion. The conversion is only in stream mode.
- Reset Autospeed (E6)
  This command restore normal speed.

7.2 Microsoft PS/2 Scrolling Mouse Mode

7.2.1 Entering Procedure

Except in WRAP mode, while EM84513 received the following consecutive command.

- F3 C8 ---- set sampling rate 200/sec
- F3 64 ---- set sampling rate 100/sec
- F3 50 ---- set sampling rate 80/sec

7.2.2 Operating

- All of the commands in legacy mode still be valid.
- The ID code of read device type command (F2) will changed from "00" to be "03".
- 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 (Always 1)
	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)

7.2.3 Exiting Microsoft Scrolling Mode

There are two ways to exit:

- Power off.
- Reset command (FF).

7.3 Z-axis Input Function : The Z0-Z7 Limit Value Is±7

7.3.1 Photo Couples Input

Z-axis counter accumulates the Z1, Z2 phase changed by movement. This mode includes noise immunity.

Z/4 : 4 dots per count. Counted by Z1=1, Z2=1 phase, the wheel should stay at Z1=0, Z2=0 phase.

7.3.2 Mechanical Mode

The function is the same as photo couples input mode, except there is no noise immunity.

Z/2 : 2 dot per count. Counted by Z2 changing phase.

7.4 400CPI / 800CPI Resolution

7.4.1 400CPI (EM84513AEP and EM84513AFP)

Normal speed.

7.4.2 800CPI (EM84513BEP and EM84513BFP)

Double speed. The relationship between the input and output count follows:

Input	Output
0	0
1	1
N(≧2)	2.0*N

8 Absolute Maximum Rating

Parameter	Sym.	Ratings	Unit
Temperature under bias	T_{OPR}	0~70	℃
Storage temperature range	T_{STR}	-65~150	℃
Input voltage	V_{IN}	-0.3~6.0	V
Output voltage	V_{OUT}	-0.3~6.0	V

9 DC Electrical Characteristics

(TA = 25℃, VDD = 5V)

Parameters		Sym.	Min	Typ.	Max.	Unit
Operating voltage		V_{DD}	4.5	5	5.5	V
Operating Current (no load)		I_{OP}	-	-	1.2	mA
X1,X2,Y1,Y2,Z1,Z2 (photo mode) Low input reference current		I_{PL}	60	-	-	μA
X1,X2,Y1,Y2,Z1,Z2 (photo mode) High input reference current		I_{PH}	-	-	110	μA
X1,X2,Y1,Y2,Z1,Z2 (photo mode) input current (input impedance) (80 μA)		V_{PIL}	0.8	-	1.2	V
X1,X2,Y1,Y2,Z1,Z2 (photo mode) input current (input impedance) (500 μA)		V_{PIH}	1.5	-	2.8	V
CLK, DATA positive-going threshold volage		Vt_+	$0.6V_{DD}$	-	$0.8V_{DD}$	V
CLK, DATA negative-going threshold volage		Vt_-	$0.2V_{DD}$	-	$0.4V_{DD}$	V
L,M,R,OPT input low voltage		Vail	-	-	$0.3V_{DD}$	V
L,M,R,OPT input high voltage		Vaih	$0.7V_{DD}$	-	-	V
L,M,R input resistor (Vin=V_{DD})		Rmi	92	-	310	KΩ
OPT input resistor (Vin=V_{DD})		Rxi	133	-	400	KΩ
Data, CLK input current (pull up resistor) (Vin = 0V)		Idc	0.56	-	1.86	mA
DATA,CLK low output voltage (Iprl = -4mA)		Vprl	-	-	0.4	V
L,M,R,X1,X2,Y1,Y2,Z1,Z2,OPT Input leakage current (Vin = 0V)		Iil	0		-1.0	μA
OPT high output current (Iopt = 10mA)	V_{DD} = 4.5V	Idc	3.2	-	-	V
	V_{DD} = 5V		4.5	-	-	
	V_{DD} = 5.5V		5.5	-	-	

- All voltages in above table are compared with VSS .
- All parameters in above table are tested under VDD =5V.
- CLK & DATA output gates are open drains that connect to pull up resistors.

10 AC Electrical Characteristics

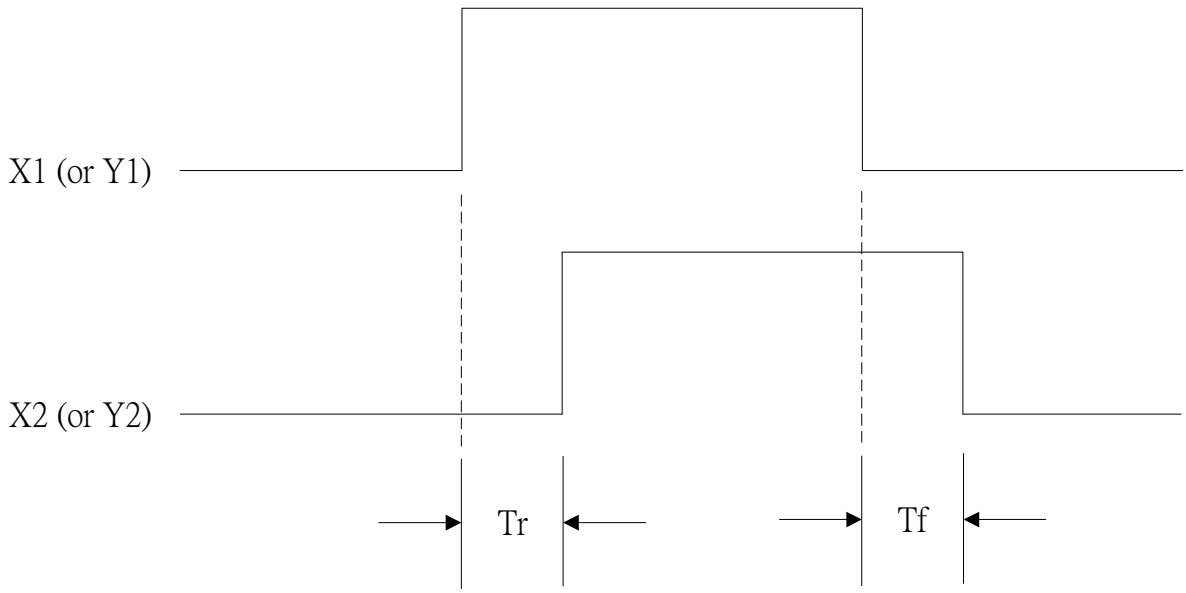
(TA = 25℃, VDD = 5V)

Parameters	Sym.	Min	Typ.	Max.	Unit
Operating Frequency (OSCR = 51K)	F_{OSC}	-10%	37.5	+10%	KHz
Key Debounce	Tkd	-	12	-	ms
Rising Edge Crossed Width Fosc = 35 KHz	Tr	14.6	-	-	us
Falling Edge Crossed Width Fosc = 35 KHz	Tf	14.6	-	-	us
Mouse CLK Inactive Time	T1	-	40	-	us
Mouse CLK Active Time	T2	-	40	-	us
Mouse Sample DATA form CLK rising Edge	T3	-	13.3	-	us
System CLK Inactive Time	T4	-	40	-	us
System CLK Active Time	T5	-	40	-	us
Time from DATA Transition to Falling Edge of CLK	T6	-	13.3	-	us
Time from rising Edge of CLK to DATA Transition	T7	-	26.7	-	us
Time to mouse Inhibit after the 11th CLK to Ensure mouse does not start another Transmission	T8	0	-	50	us

- The AC timings are measured under using 35 KHz system clock signal.

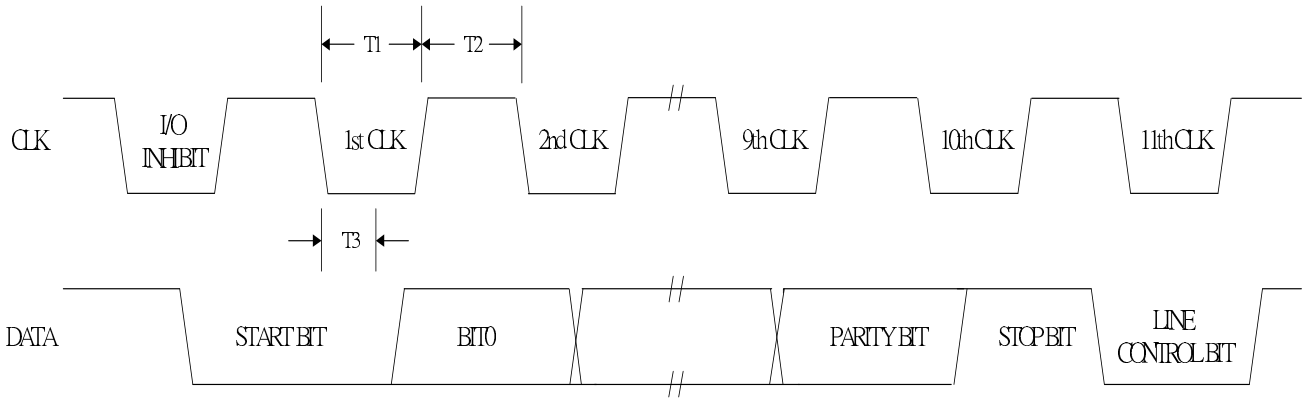
11 Timing Diagrams

11.1 Photo-Couples Pulse Width :

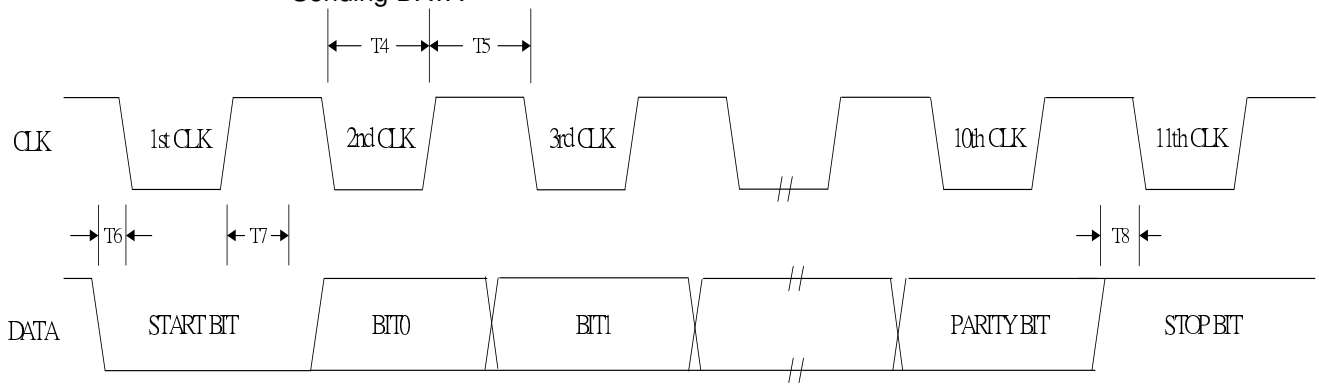


11.2 PS/2 Mouse :

■ Receiving DATA

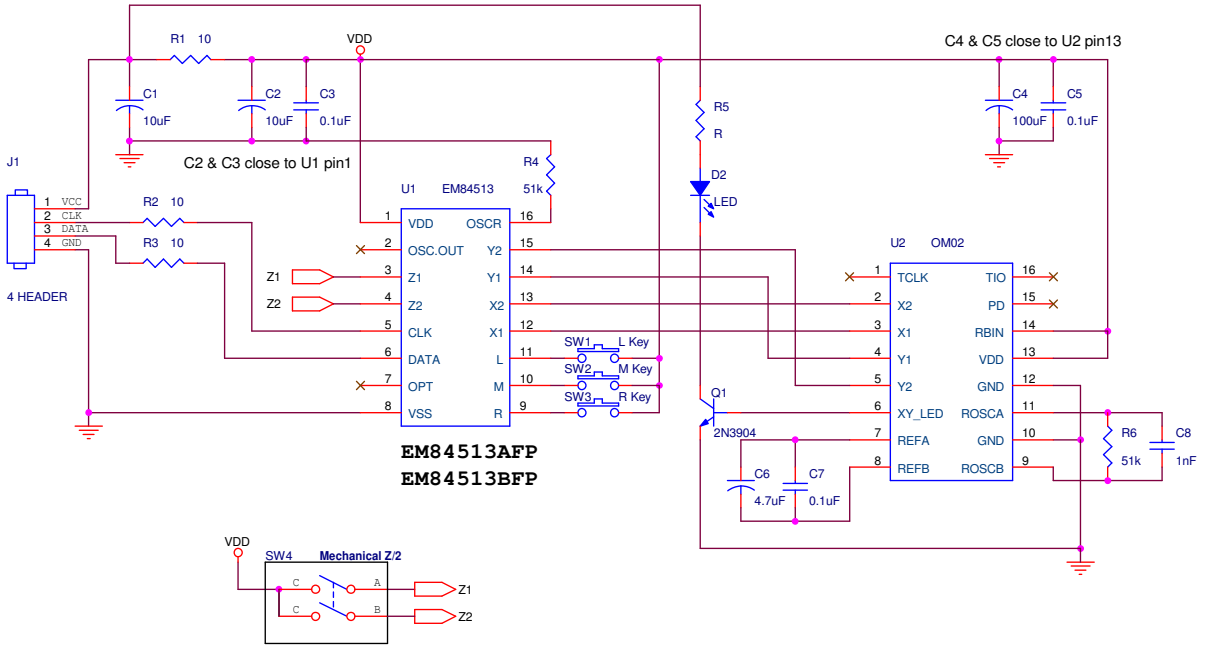


■ Sending DATA

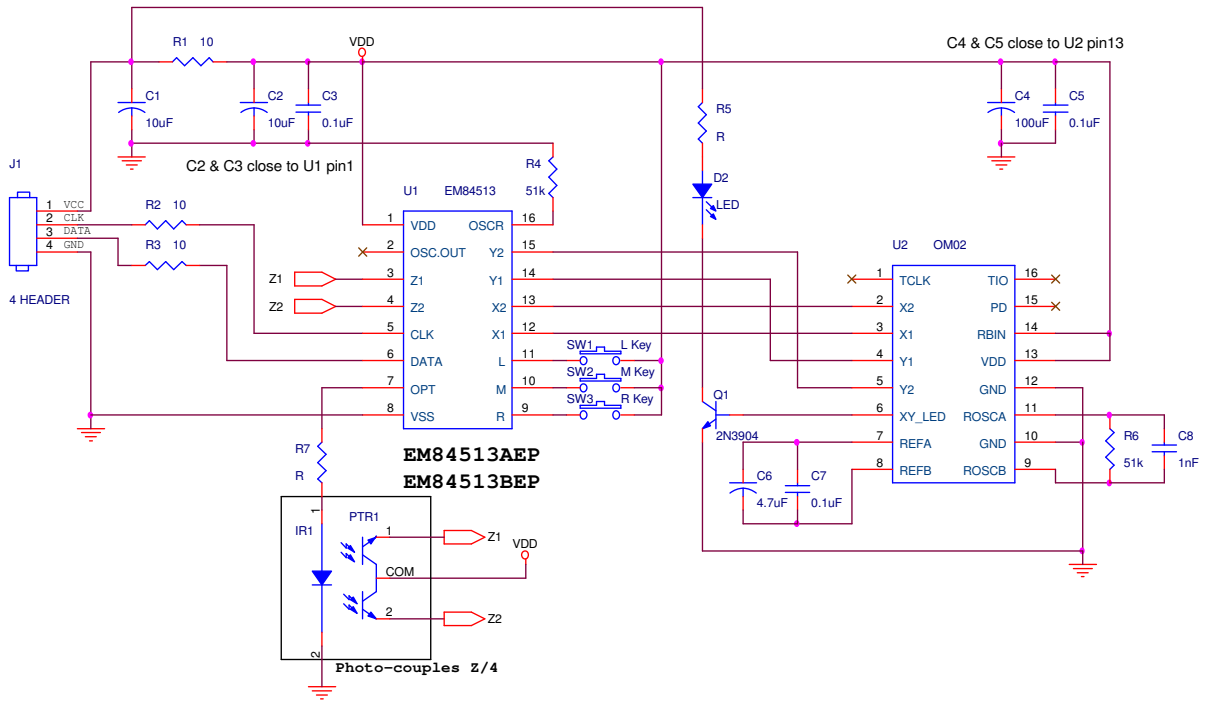


12 Application Circuit

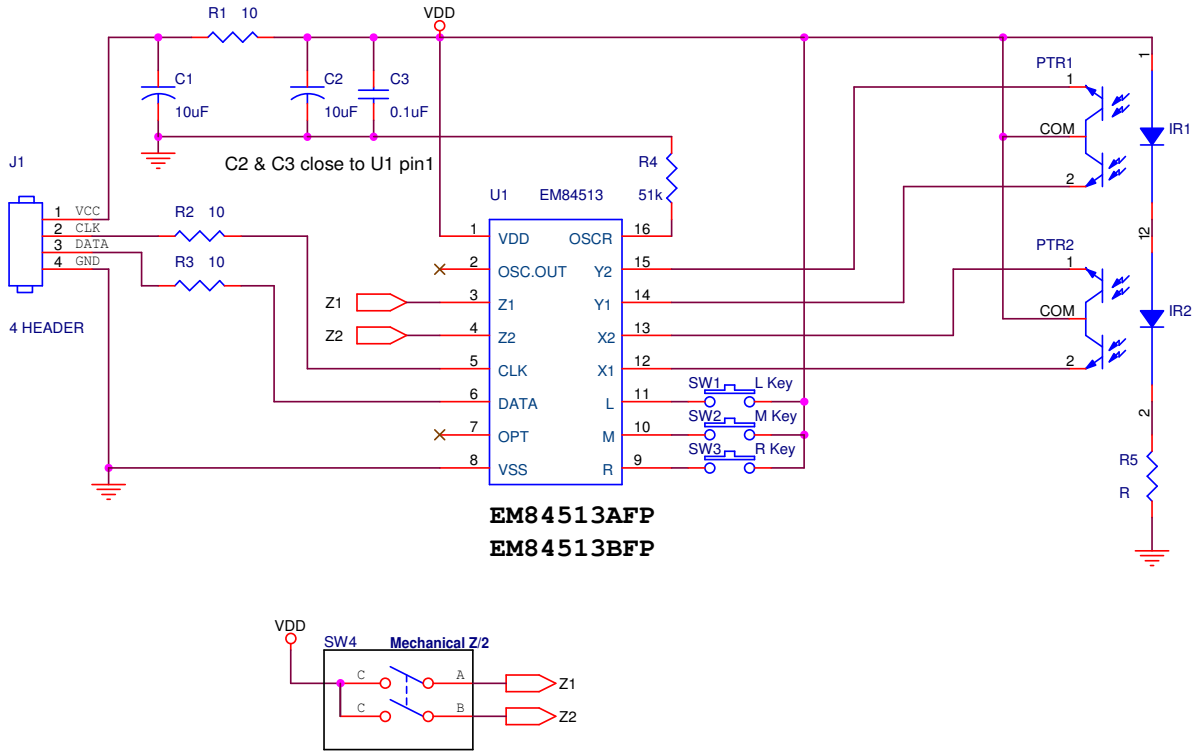
12.1 Sensor Type and Mechanical Z/2



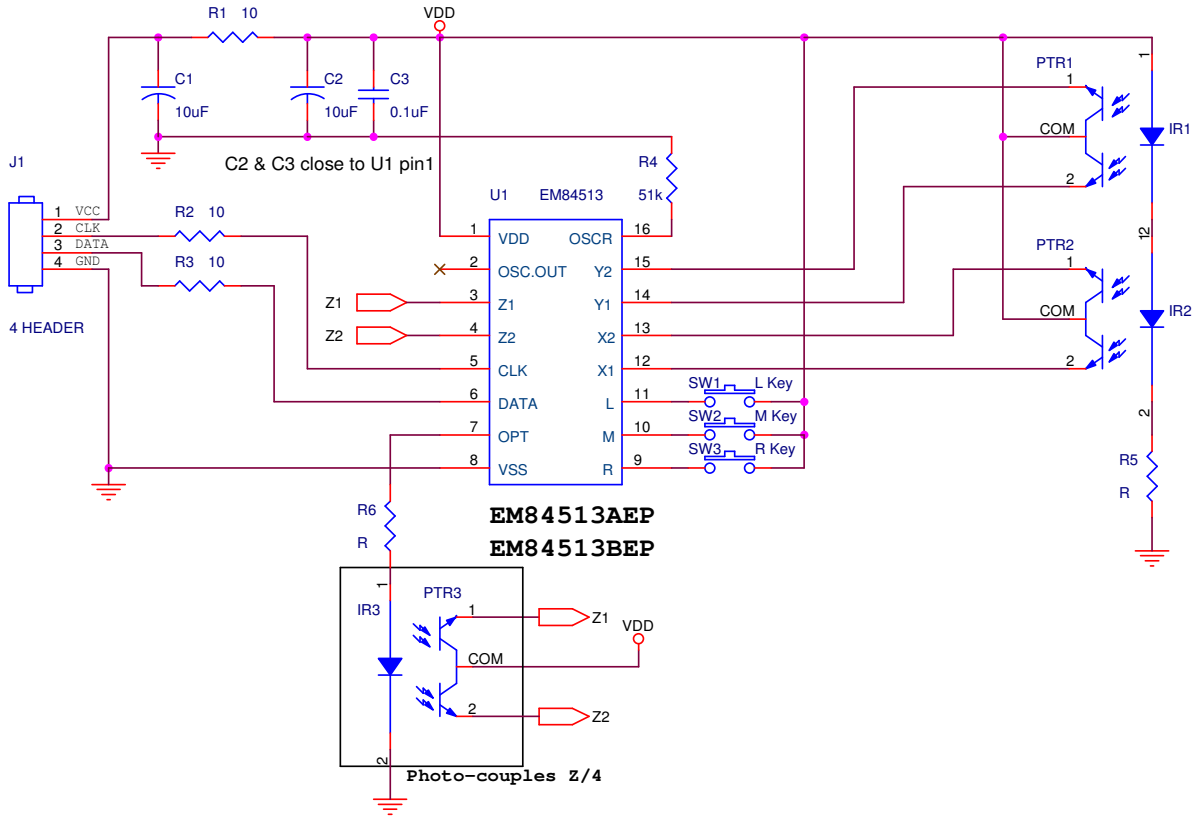
12.2 Sensor Type and Photo-Couples Z/4



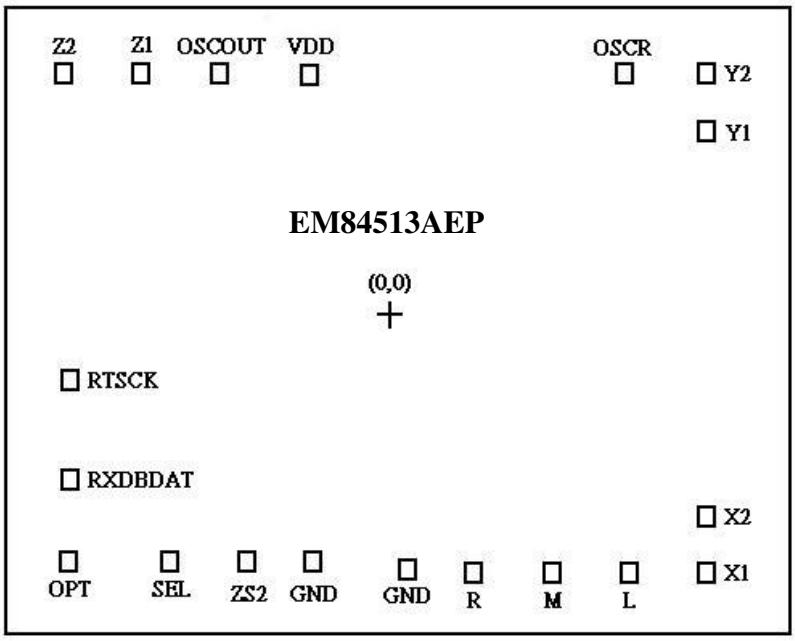
12.3 Ball Type and Mechanical Z/2



12.4 Ball Type and Photo-Couples Z/4

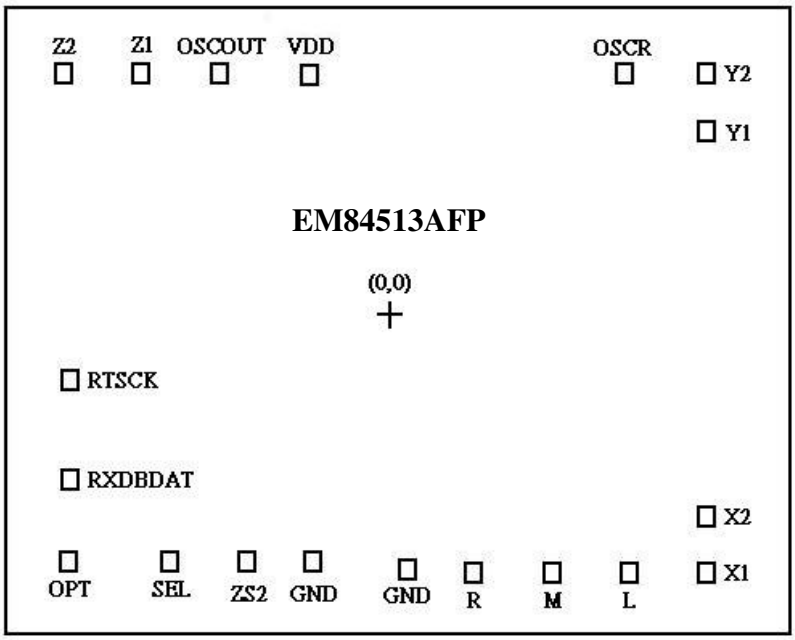


13 Pad Diagram



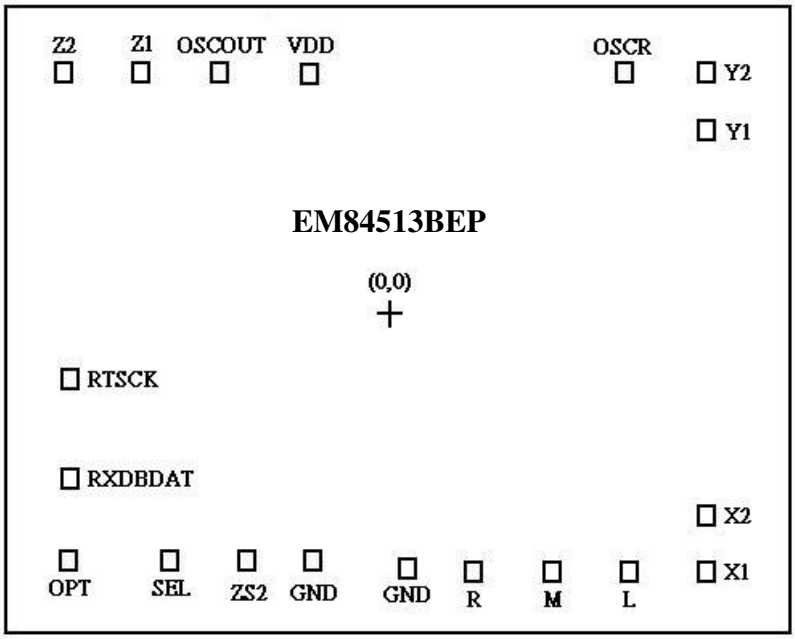
Chip Size : 1750 μm x 1400 μm

Pad No.	Sym.	X	Y
1	VDD	-167.034	557.718
2	OSCOUT	-368.676	557.718
3	Z1	-540.498	557.718
4	Z2	-712.362	557.718
5	RTSCK	-702.450	-125.202
6	RXDBDAT	-702.450	-345.933
7	OPT	-705.852	-530.964
8	SEL	-477.099	-530.985
Null	ZS2	-305.235	-530.985
8	GND	-158.445	-529.872
8	GND	52.311	-546.966
9	R	199.143	-555.471
10	M	370.965	-555.471
11	L	542.829	-555.471
12	X1	715.869	-555.471
13	X2	715.869	-430.731
14	Y1	715.869	428.421
15	Y2	715.869	557.592
16	OSCR	533.001	557.592



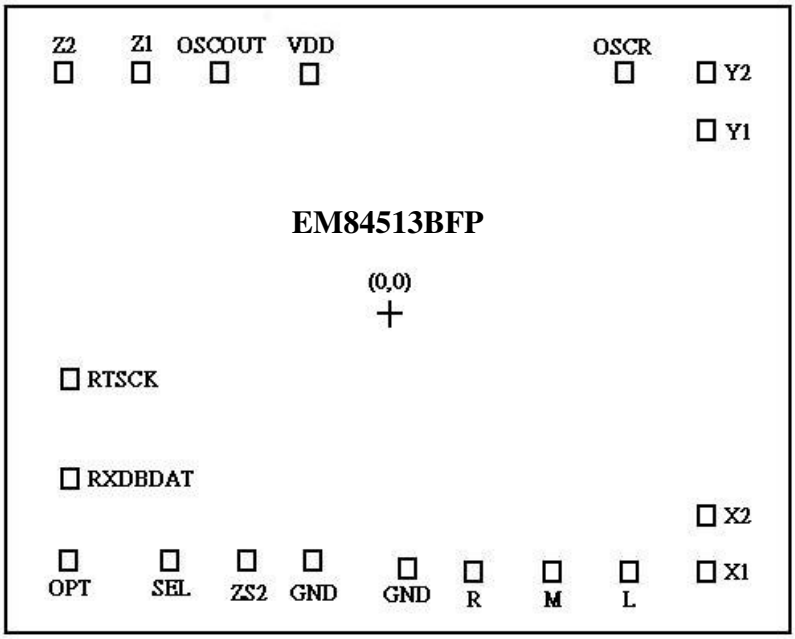
Chip Size : 1750 μm x 1400 μm

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