

CHAPTER 3

DEVELOPMENT METHODOLOGY

3.1.1 Design Specification

This project is mainly about using IR transmission to transmit signal derived from the computer peripheral. There are a few considerations that is to be made in this project, to determine the viability of the transmission. The length of the transmission is approximate around 0.194 -0.235 m for the IR transmission from the mouse or the keyboard. Any length beyond the limits requires source link alignment to maximize energy received It is much less than the projected length of 100cm-150cm.

The infrared printer ideally is to be designed to operate within the length of 200cm-300cm. Due unavailability of the photodiode TD6061 needed to build the infrared link to the printer. Whereas the printer needs a decoder to decode the received signal. The project shall be made to be a success by solving both the problems.

3.2.1 Infrared Wireless Mouse (Internal Structure)

The internal structure of the infrared mouse is divided into 2 sections. The first section is govern by the MA6221-Q17K IC manufactured by Agilent, which control the infrared transmission of the device and link the communication of the mouse to the center processing unit. The Section is governed by the ADNS-2000 IC which controls the optical sensor of the mouse. Both of these devices have a supporting oscillator input which is synchronized using a crystal input.

3.2.2 The MA6221-Q17K IC

The MA6221-Q17K IC is an encoder IC that can encode data from the mouse optical sensor and send it via RF, Blue Tooth, Infrared etc. The IC is equipped with a complete set of FSK modulator which is possible for any wireless transmission. There are 2 kinds of output from the optical mouse sensor; they are the quadrature and SPI (serial peripheral interface) which is being supported

3.2.3 The Serial Peripheral Interface (SPI)

Is a kind of device which communicate in master and slave mode, device when the master device initiate the data stream while the multiple slave device are allowed with multiple slave select line



Figure 3.23 : SPI block diagram me

The SPI specifies four logics signal:

- SCLK — Serial Clock (output from master)
- MOSI/SIMO — Master Output, Slave Input (output from master)
- MISO/SOMI — Master Input, Slave Output (output from slave)
- SS — [Slave Select](#) ([active low](#); output from master)

Operation functions of the SPI:

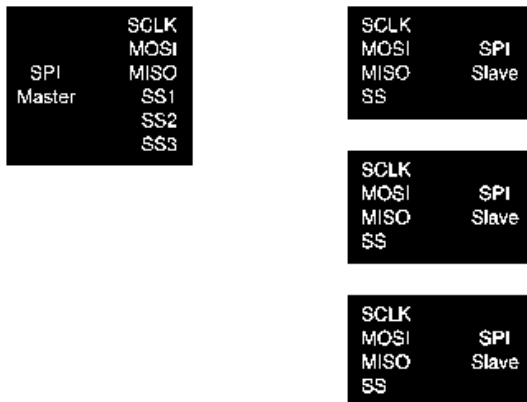


Figure 3.2.4 :Master and Slave SPI

1. Slave select low for the desired chip.
2. The master then generates a clock frequency, which the slave device can support.
3. The master sends data on the MOSI line. The slave reads the data from MOSI line
4. The Slave send data from the MISO line .The master reads the data from the MISO line.

3.2.4 Features of the MA6221-Q17K IC

- 76.8KHz clock rate
- Hi speed & 32.76 KHz OSC supported.
- Build in data scrambler and error detection encoder.
- Build in single dual signal generator ,modulator and amplifier
- 3V/5V DC embedded.
- X/Y axis supported for both quadrate and SPI input.
- Z axis supports for optical mouse and mechanical inputs.

3.2.5 Device Connection for the Infrared Mouse:

The connection of the MA6221_Q17K IC to the mouse operation controller is based on the IC ADNS-2000 .These IC will decode all the instruction executed by the mouse and transmit these instruction in binary. Pin such as Y2IN, Y1IN, XIN, X2IN,Z2IN,Z1IN are all the function control by the IC ADNS-2000.All these pin represent the three dimensional area x,y,z which is determined by the sensor of the mouse ,when it sense an object. Whereas the infrared wireless transmission part is totally control by the MA6221_Q17K IC

3.2.6 Infrared Mouse Transmitter Schematic:

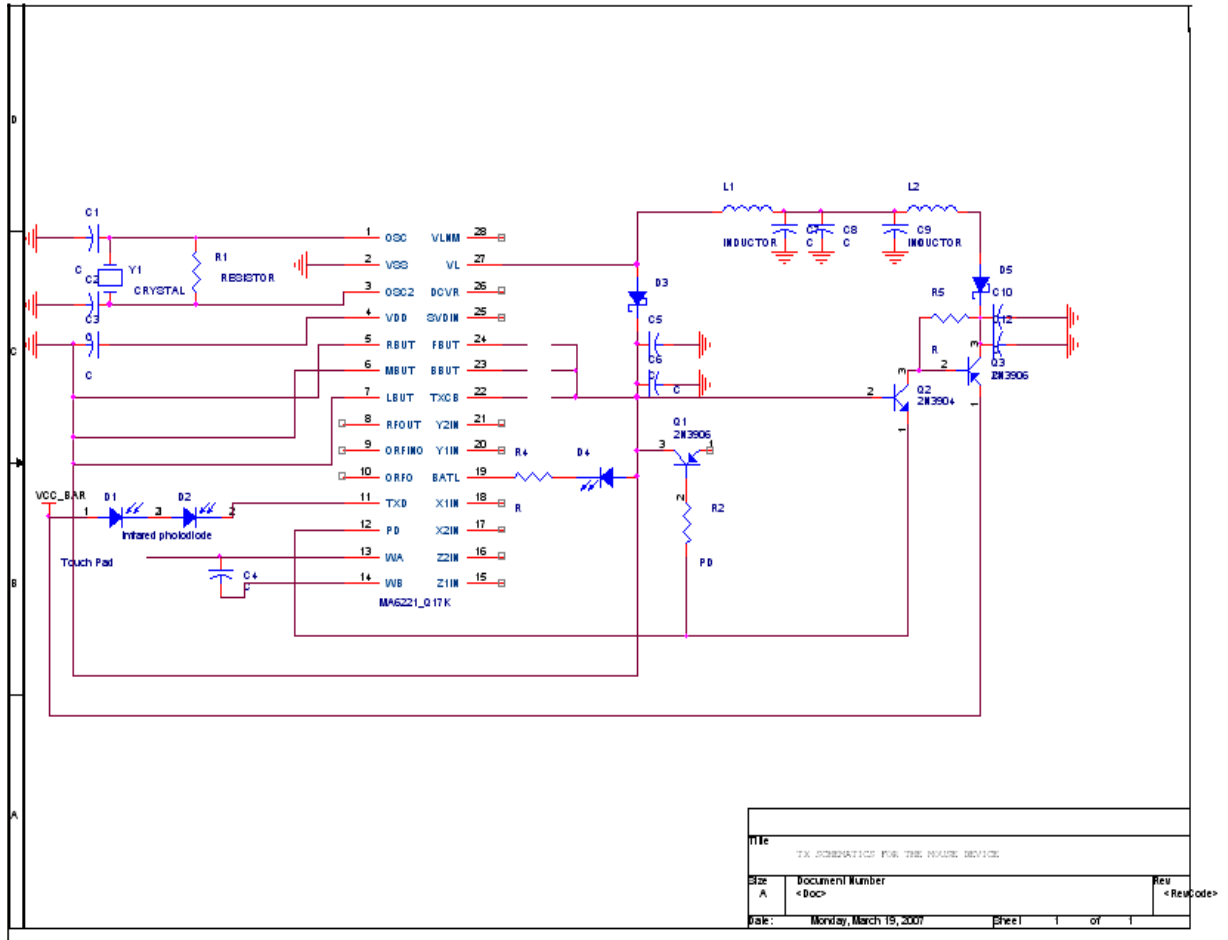


Figure 3.2.6 Infrared Mouse Transmitter Schematic

Listing of component for the schematic above:

- Capacitor (22p X 2,104u X 5,10n ,220u X 2)
- Crystal (76.8k)
- Microcontroller (MA6221_Q17K)
- Transistor (2N3906 X 2, 2N3904)
- Zener Diode (RB421 X 2)
- Infrared photodiode (PT 491 X 2)
- Inductor (82uH X 2)

3.2.7 Circuit Function :

- The function of the crystal which is connected to the OSC1 and OSC2 is to create an electrical signal with precise frequency. The function of the frequency is to keep track with time, in order to provide stable clock signal to the integrated circuit for wireless transmission.
- RBUT, MBUT, LBUT are the three button of the mouse which include the right click, left click and the scroll. WA and WB are reserved for the touch pad function which can be found in laptop keyboards.
- DCVR is a voltage reference between the both controller MA6221_Q17K and ADNS 2000. While SVDIN is a port which detect the supply input voltage generated from the ADNS 2000 IC .VL is the switch output which multiplex the signal which are generated by the MA6221_Q17K IC.FBUT is the forward switch, BBUT is the backward switch and TXCB is the ID change detector.
- BATL represent the Battery low display which is accompanied by a LED connected to indicate the battery status.

- X1IN, X2IN, Z2IN, Z1IN, Y1IN, Y2IN, all these represent the x, y, z polarity of the 3D sensor of the mouse.
- Function of the Zener diode which is connected to the VL is to regulate the voltage. The capacitor will accumulate charge in one cycle and discharges it through the network. The voltage being discharge by the capacitor has to be small enough that the current through the Zener diode will keep it at a reverse breakdown mode. The reverse break down current for the Zener diode is this prototype is 3mA. If the capacitor does not discharge efficiently or there are uneven current flow through the Zener Diode , the status will be unregulated. The value of the capacitor should be sufficient in supply the breakdown current through the Zener diode. Proper designing provides voltage stability to the microcontroller too.
- The series resonance circuit which consist of 2 inductor and 3 capacitors which support the second Zener diode which is constructed in a Darlington mode. Their function is basically the same as mentioned above .It acts like a filter by determining the selectivity. The higher inductance and the lower capacitance will narrow the band width of the filter.
The transistor 2N3906 ,2N 3904 which are NPN and PNP CASCADED in Sziklai form provide high gains ,There is simply a residue saturation voltage that will cause further power dissipation and effect the switching speed of the VL and FBUT, BBUT under control by the microcontroller

3.2.8 Block Diagram me for the operation function of the mouse.

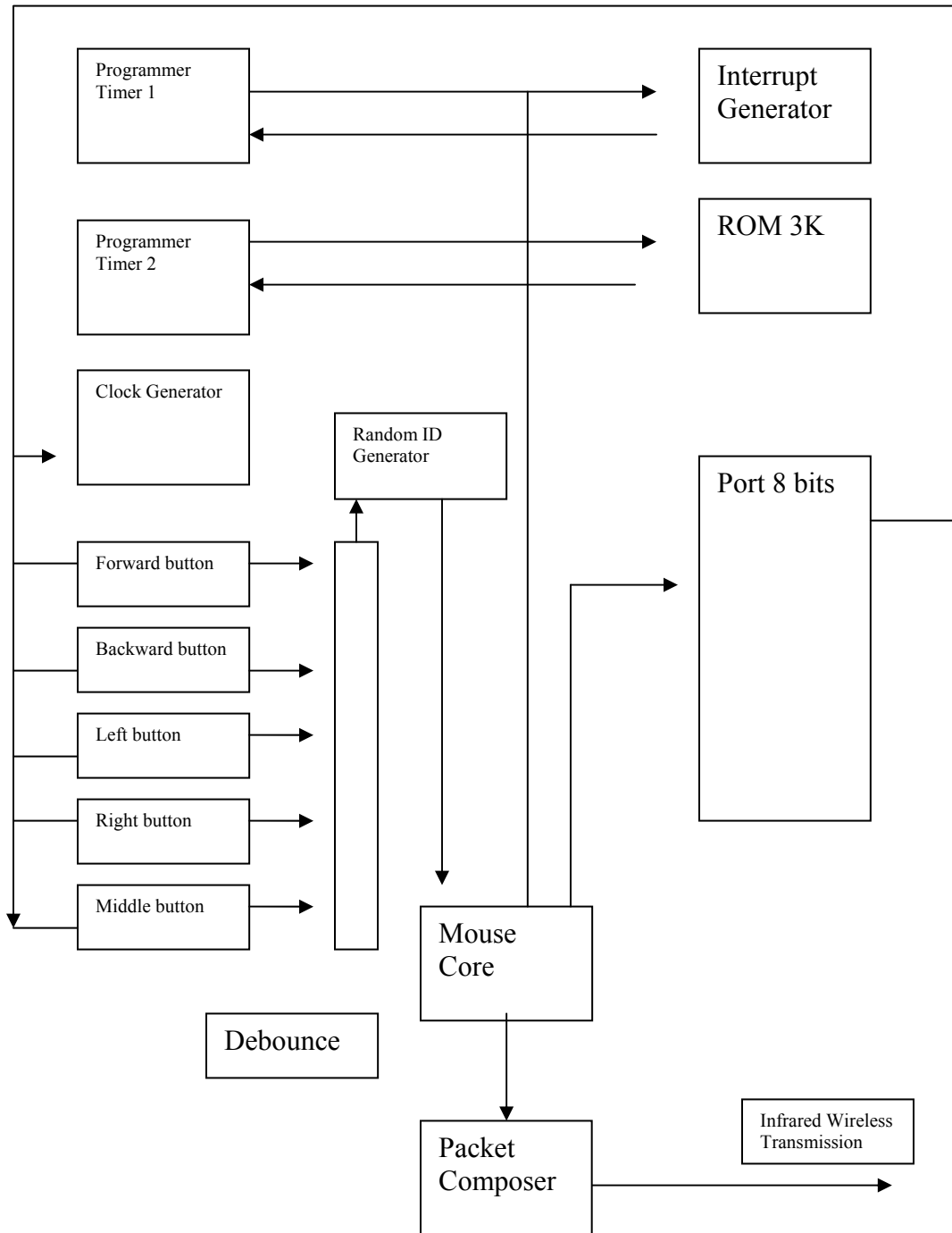
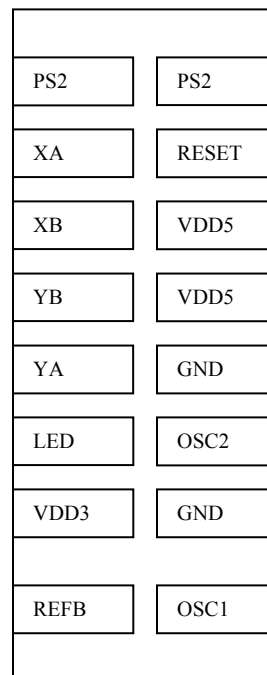


Figure 3.28 : Operation function of the mouse

3.2.9 Quadrature Dimension

The ADNS -2000 is an IC which governs the operation of the mouse. The most important function of this IC is to Coordinate the quadrature function of the sensor. The sensor consist of three axis x, y ,z. Where x,y,z is divided into XA, XB, YA, YB, ZA ,ZB .The purpose of these divided functions is to coordinate the degree movement of axis x,y,z. As three axis will rotate accordingly in line with the movement of the mouse sensor.

Below is the IC diagram me for the ADNS-2000:



Quadrature Table:

Degree	0	90	180	270	
X1	XB	YB	XA	YA	
X2	XA	YA	XB	YB	
Y1	YB	XA	YA	WB	
Y2	YA	XB	YB	XA	

Table 3.3 :Quadrature table

These data represent the movement of degree which is equivalent to binary understandable by the mouse controller IC. Every single degree is a representation of matrix which determines the angle which is detected by the mouse sensor.

3.3.1 Infrared wireless keyboard: (Internal Structure)

The MA 6121 is a keyboard encoder for various kind of wireless support. It has various integrated wireless component especially optimized for various wireless transmission. The IC also has a 32.768 kHz main clock which lowers the amount of power consumption

3.3.2 Features

- Build in keyboard controller
- Seamless sleep mode
- Phantom key detection.
- 32.768 KHz clock rate.
- Internal pull up resistor
- 4k bps baud rate in air
- Internal OSC
- Internal power amplifier
- 20*8 scan lines for all possible key matrices

3.3.3 The keyboard Function:

The function of each key pressed in process is determined by the rows and columns which is controlled by the IC MA6121. The microcontroller that is used in this project comprises 18 column and 8 row. Each combination of row and column represent a button in the keyboard. When a key is pressed, one of row is made high by making one bit of the output port IC MA6121 high which is equivalent to "1". Then the Controller of the input port will detect the suitable column by referring to the counter. The counter will rotate the information until the next instruction appear or set.

3.3.4 The Programming of the Controller

Start of main program:

to check that whether any key is pressed

```
start:  mov a,#00h
        mov p1,a      ;making all rows of port p1 zero
        mov a,#0fh
        mov p1,a      ;making all rows of port p1 high
press:  mov a,p2
        jz press      ;check until any key is pressed
```

after making sure that any key is pressed

```
        mov a,#01h    ;make one row high at a time
        mov r4,a
        mov r3,#00h   ;initiating counter
next:   mov a,r4
        mov p1,a      ;making one row high at a time
        mov a,p2      ;taking input from port A
        jnz colscan   ;after getting the row jump to check
                    column
        mov a,r4
        rl a          ;rotate left to check next row
        mov r4,a
        mov a,r3
        add a,#08h    ;increment counter by 08 count
        mov r3,a
        sjmp next     ;jump to check next row
```

after identifying the row to check the column following steps are followed

```
colscan: mov r5,#00h
in:      rrc a        ;rotate right with carry until get the carry
        jc out       ;jump on getting carry
        inc r3       ;increment one count
        jmp in
out:     mov a,r3
        da a         ;decimal adjust the contents of counter
                    before display
        mov p2,a
        jmp start    ;repeat for check next key.
```

3.3.5 Table for the Column and Row which represent the key inside the keyboard.

	0000	0001	0010	0011	0100	0101	0110	1001
	R0	R1	R2	R3	R4	R5	R6	R7
0000	PAUSE	POWER	E#	SLEEP	CTRL	WAKEUP	CTRL-L	F5
0001	Q	TAB	A	ESC	Z	N-CHG	(-)	1(!)
0010	W	CAP	S	K45	X	CHG	F1	2@
0011	E	F3	D	F4	C	ROMA	F2	3(#)
0100	R	T	F	G	V	B	5(%)	4(\$)
0101	U	Y	J	H	M	N	6(^)	7(&)
0110	1	1]({)	K	F6	;(<)	K56	+{=}	8(*)
0111	0	F7	L		.(>)	APP	F8	9())
1000	P	D({)	⊗;)	‘(‘)	K42	/(?)	_(-)	0(0)
1001	SCROLL		F0	ALT-L	M/MODE	ALT-T		PRINT
1010	K14	BACK	\()	F11	ENTER	F12	F9	F10
1011	7	4	1	SPAC E	NUM	DOWN	DEL	POWER
1100	8	5	2	0	/	RIGHT	INS	SLEEP
1101	9	6	3	`	*	~	PAGEUP	PAGEDOWN
1110	+	K107	ENTER	UP	PLAY/PAUSE	LEFT	HOME	END
1111	WAKEUP	SHIFT L	SHIFT R					

Table 3.3.5 :Key board key representation

3.3.6 Key board priority execute procedure:

Normally the keyboard will prioritize from low to high. For instant a key 'R' can produce CTRL-A ALT- A etc. Under this circumstances the actual state yield of the controller depends on the modifier key (SHIFT, ALT, CTRL, CAPSLOCK, NUMLOCK).The controller will prioritize the Alt, following by Ctrl, Shift, Numlock then finally with the one which is pressed by not accompany by a modifier key. When the user is pressing one or more modifier key the controller only identifies the key which have the most priority. For instance the Numlock and cap lock represent the case status of the key .If this case is pressed and then the shift key is pressed then the shift key will be inactive.

3.3.7 Special case for modifier key:

There is an exception, not every combination of the modifier key is valid. When the combination of the modifier key with origin key does match what it is contain inside the ASCII Codec library the function of the modifier key will be inactive. For instance CTRL -DOWN. The ISR (information system research) will generate most of the ASCII for the modifier key, The Legal combination of the key modifier combination will be determined by the programmed.

3.3.8 The Key Board controller block diagrammed

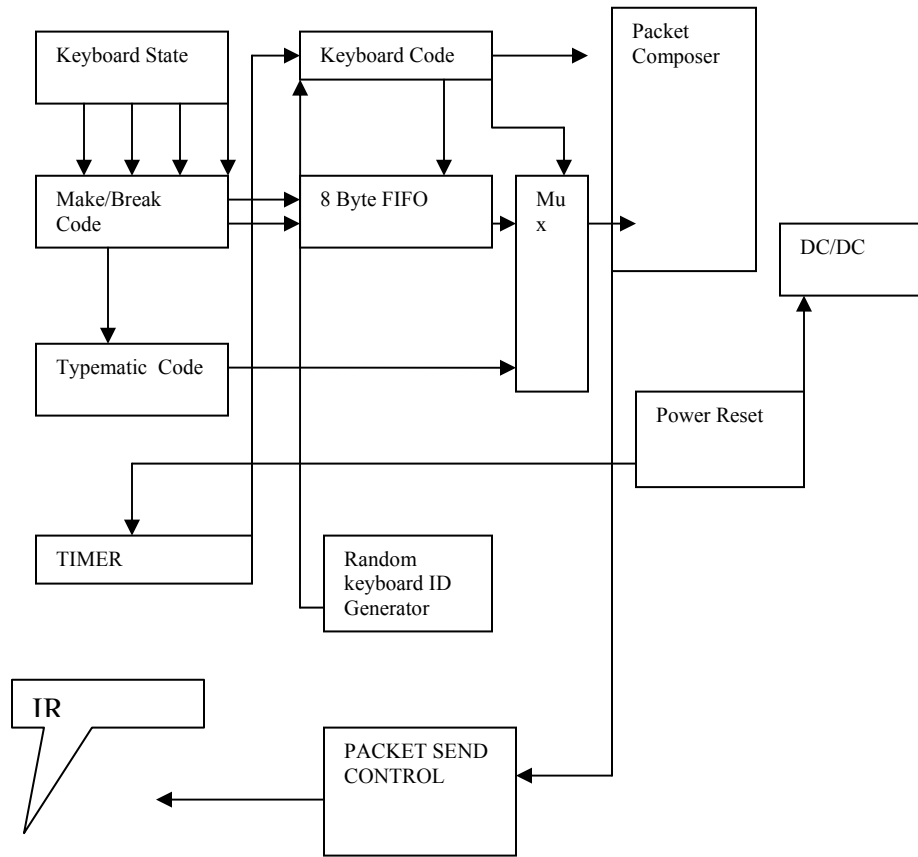


Figure 3.38: Keyboard controller block diagram me

3.3.9 Pin Out & Description

Pin No.	Symbol	I/O	Description
1,2	COL[1:0]	0	Keyboard Output Scan Line (Internal pull-up)
3	VDD	D	Power
4	FBUT	I	Mouse Forward Button (4 th key)
5	BBUT	I	Mouse Backward Button (5 th key)
⁶ J	OSC1	I	32.768Khz Crystal Input
7	OSC2	O	32.768Khz Crystal Output
8	RBUT	I	Mouse Right Button
9	MBUT	I	Mouse Middle Button
10	LBUT	I	Mouse Left Button
11	TXCB	I	ID Change Button
12	ORF1	I	27Mhz Channel Crystal Input
13	ORF2	O	27Mhz Channel Crystal Output
14	RFOUT	O	Internal Modulated RF Output
15 j	RFCTRL	O	RF enable
16	TXD	0	Digital Encoded Data
17	TEST	I	Test Mode
18,19	X1IN, X2IN	I	X Axis Photo Input
20,21	Y 1IN, Y2IN	I	Y Axis Photo Input
22,23	Z1IN, Z2IN	I	Z Axis Photo Input
24	XRESET	I	Reset
25,26	W1IN, W2IN	I	4D Axis Photo Input
27	XIR	O	IR control
28	SVDIN	I	Supply Voltage Detect Pin
29	VSS	D	Ground
30-37	ROW[7:0]	I	Keyboard Input Scan Line (Internal pull-up)
38	P2[6]	O	GPIO for Battery Low Indicator
39-43	N.C.		
44	VSSS	D	DC/DC' Ground
45	VL	I	DC/DC' I.x Switch
46 47-64	DCVR COLH 9~2] ~	I 0	DC/DC Voltage Reference Keyboard Output Scan Line (Internal pull-up)

Table 3.3.9 : IC PIN in & Out description

3.3.10 Infrared wireless keyboard circuit function

Basically the keyboard circuit consists of several parts. The first parts is the oscillation 1 and oscillation 2 (OSC1 and OSC2) .Both of these pins are interconnected, both devices are accompanied and connected by a crystal X1 which has an oscillation frequency of 32768KHz, with a 10 M ohm resistor interconnected with the 30 piko Farad capacitance in order to generate the upper and lower critical frequency for the circuit. This set of device will provide stability timing for the MA6121 to operate in a well manner,

The second part is the TXD pin, the infrared photodiode is attached to this .Two photodiode is used, the function of the IC MA6121 is designed to operate any kind of wireless transmission including blue tooth, infrared, RF control.

The third part of the Circuit is the voltage reference pin VL ,the supporting circuit in the schematic below which consist of several capacitor ,resistor and zener diode produce and generate a reference voltage in the range of 3-5V in order for the IC to operate normally. The first row consist of 2 capacitor connected in parallel which made up a total capacitance of $470\text{U} + 100\text{U} = 570\text{U}$ produce a LC circuit combine with the inductor 100 micro H. Both parts of this will regulate the voltage and ensure that the voltage supplied are always matched with the reference voltage as it was set at VL for the IC MA 6121.

3.3.11 Infrared wireless keyboard Circuit Diagram me.

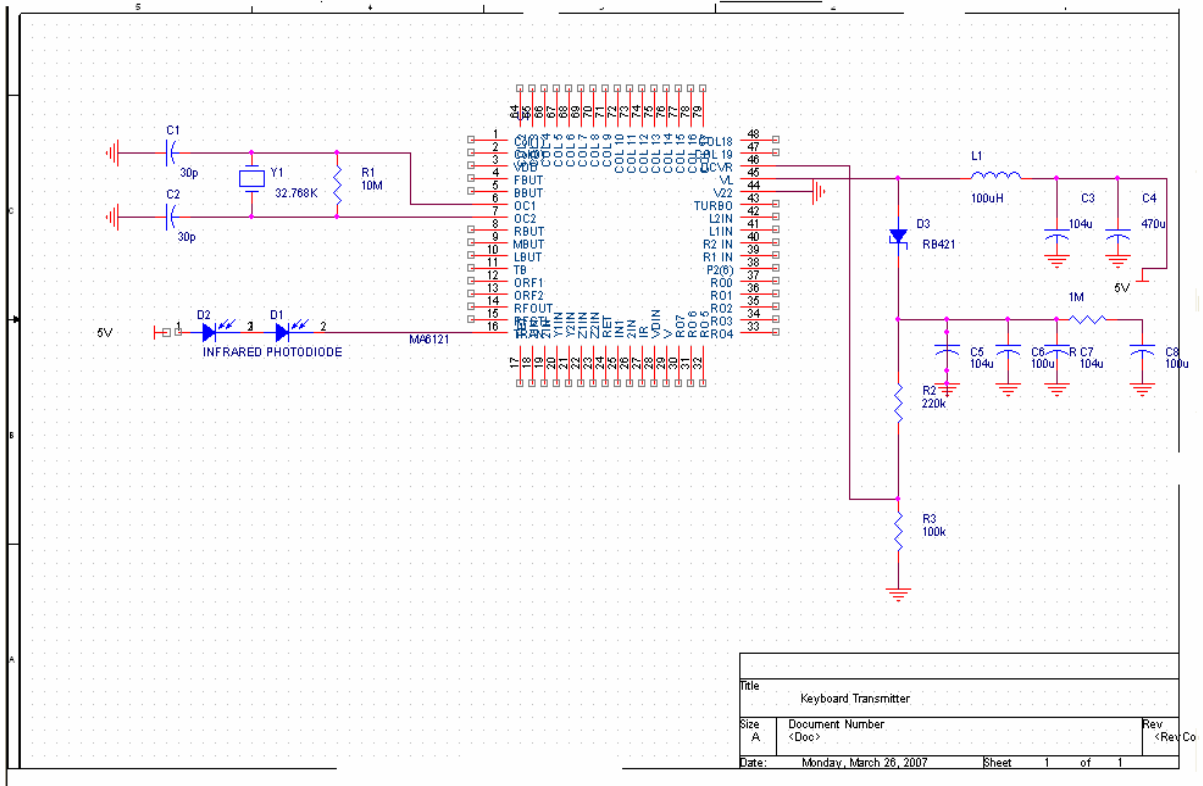


Figure 3.3.11 Infrared wireless keyboard Circuit Diagram me.

3.4.1 Infrared Receiver for mouse and keyboard

The RF keyboard and mouse controller .In this project we used the MA 6131 IC which is developed by IBM as a supporting IC for PS2 interface to decode signal which is send wireless (RF ,Blue Tooth ,Infrared etc). It is a 27MHz receiver for any kind of wireless transmission. It has a 32.768 KHz main clock to reach quite low power consumption for the IC

Features of the module:

- Single chip keyboard & mouse controller.
- CPU embedded for keyboard code mapping
- 8K ROM & 128 bytes SRAM
- 32.768KHz clock rate
- 256 ID codes randomly generated to resist interference.

The IC I programmed o decode matrix function received form the keyboard and the data derived from the mouse. Inside the structure it is divide into two kind of clock ,the first one is the interrupt generator, and the second one is the clock Generator. Both clock signal generated should correlate and match each other in order to produce the right frequency to operate the device.

The Keyboard and the mouse is separately controlled by different clock .Both device need it on buffer and indicator. After the signal I decoded it I transmitted and received separately through NRZ moue and NRZ keyboard .The re is a watch dog timer which reads into the ROM of the IC to check if the programmed timing executed matches the instruction timer.

3.4.2 Functional Block Diagramme

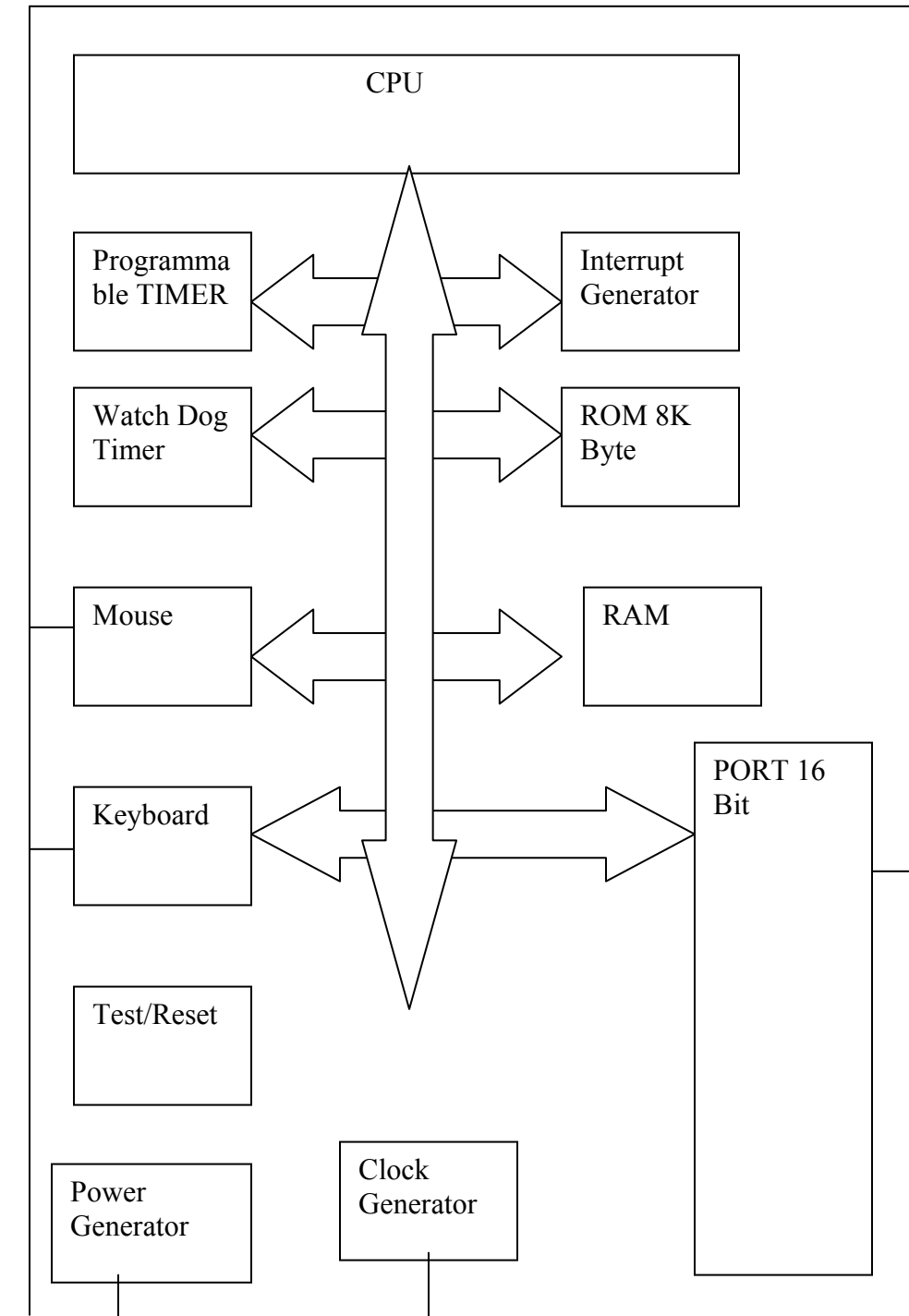


Figure 3.4.2: Receiver functional block Diagram me

3.4.4 Keyboard and Mouse Controller RX Circuit Function

1. The 93C46B is a controller for the MA6131. It functions as an EEPROM device which stands for electrical erasable read only memory. This function is to store new data derived from the device without erasing the prior contents. Only the bytes and the addresses of the information are updated. The write operation will take time of the order of several hundred μ /byte. Data derived from the mouse and keyboard is initially stored before processing and transmitting via infrared.

2. Supporting circuit for the infrared photodiode detector. The circuit consists of two BC54742 NPN transistors, one 1k resistor, two 10k resistors, and one 1M feedback resistor. Both transistors act as a multistage amplifier arranged in a direct coupling form. Direct coupling is chosen because the data frequency derived from the keyboard and mouse can be very low, if a high frequency device is used, frequency sensitive components like capacitors and transformers will be needed.

The DC output will appear in the input of the next stage. When the signal is applied to the input of the first transistor, the amplified output appears at the collector of the second transistor. The amplified output becomes the base signal for the second transistor; the further amplification is the multiplication of the first stage current gain and the second stage current gain. The 1M Ω resistor acts as a compensation circuit to reduce the drift of the operating point, and provides excellent bias and good stabilization. The 10k Ω resistor connected next to the infrared photodetector serves as a load resistance to switch the device on and off in nanosecond range for both rise time and fall time.

3. The CN1A is the frequency regulator that generates the signal for each instruction being executed by the mouse and keyboard govern by a clock frequency implanted inside the device. There are three indicator diodes which indicate the scroll status of the mouse and cap lock ,Numlock for the mouse.
4. An oscillator is used to generate the right clock frequency from the crystal ,to ensure that the IC will work properly.
5. A DC 9V battery is used in this device as the active component .

3.5.1 Infrared Printer

The transfer rate of a normal printer usually is about 1.5mbps..Whereas the infrared transmission is between 30-40KHz..Initially I have tried to convert the ATMEL IC wireless module into infrared wireless. But the Amtel did not support the instruction send by the printer.

Then the communication port which connect the printer to the transmitter is connected to the parallel port .8 bits of the transmitter is used from pin 32 toward pin39.Each output port from pin 32-39 is accompanied by a pull up resistor of 1k Ω to pull up its voltage before it is being transmitted to the parallel port

There is an indicator which is connected to pin 22 and 21 to indicate the status of the printer. The indicator is determine is determine by binary 0 and 1.If 1 occur in pin 22 it means that the printer is in stable mode, if bone occur in pin 21 it means the printer is in the busy mode Only when 10 occur for both pin 22 ,21 the printer can start transmitting signal

Then a crystal is connected to the pin 18 and 19 to ensure that the IC is working on the right mode.

The ISP port is connected to load low level programming form the computer to control the printer transmission. Then the pin 10 is connected with a direct coupling transistor to invert signal The coupling circuit that is used as a supporting circuit to the photodiode is exactly the same as what is used for the keyboard and mouse

3.5.2 Infrared Printer Circuit diagram me

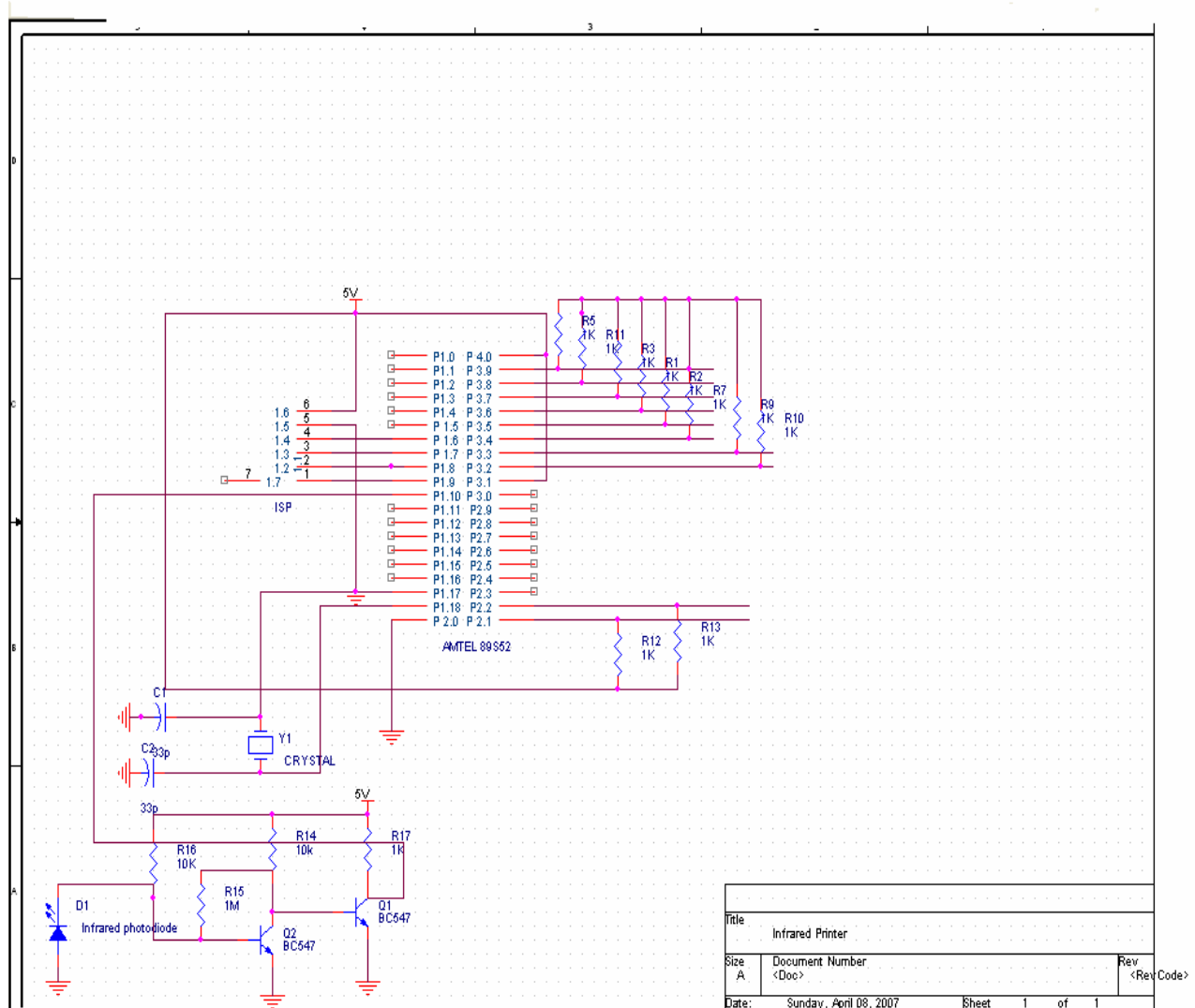


Figure 3.5.2 : infrared printer circuit diagram me

3.5.3 Infrared Printer programme

After the hard ware is assemble, program me need to be loaded into the AMTEL 895S2, initial the file from the note pad was being saved as (.asm).After that the parallel port will be plugged into the personal computer. Then the manually open the ISP programme and load the file into the IC

The following programme is showmn below:

```

CPU "8051.TBL"
INCL "8051.INC"

org 0000h

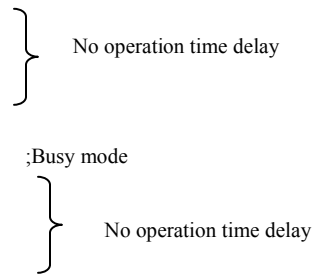
mov p0,#0h                ;AS output address
mov p2,#0f2h             ;As input address
mov p1,#0h                ;buffer
mov p3,#0ffh             ;temporary input

mov tmod,#20h
mov th1,#0fah             ;4800Baud
mov scon,#50h
setb tr1                  ;Start time

main:  call recv
       call print
start: mov r0,#1
       call recv1
       call print
       jmp start

print:
mov p0,a                   ;receive data from port p0 and move into a
nop
nop
nop
nop
clr p2.1                   ;Busy mode
nop
nop
nop
nop
setb p2.1

```



```

ack:    jb p2.0,ack           ;jump if bit high
        ret

finish:
        mov a,#12            ;Command paper out count
        call print
        jmp main

recv1:  inc r0
        call delay1
        cjne r0,#255,con1
        jmp finish

con1:   jnb ri,recv1
        mov a,sbuf
        clr ri
        ret

recv:   jnb ri,recv
        mov a,sbuf
        clr ri
        ret

delay1:
        mov r7,#10
again2: mov r6,#50
again3: djnz r6,again3
        djnz r7,again2
        ret

        end

```

3.5.4 Infrared Printer

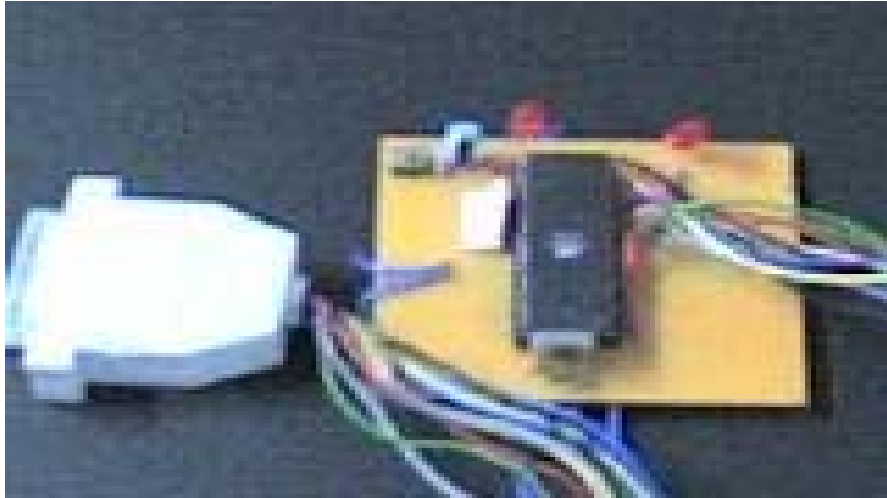


Figure 3.5.4 : Infrared Printer

3.5.5 Factors which contribute to the transmission problem of the infrared printer

There are no supporting IC module that are available to support the transmission of the IR signal. Transmission rate of the printer is far beyond the ability of the infrared photodiode to cope with. Image transmission from the printer which is determined by its alignment cannot be decoded by the IC ATMEL 89s52.

3.5.6 Recommendation

A suitable IC which supports IRDA or PWM format should be used. The photodiode which has stronger intensity will contribute and decrease the probability of redundancy during transmission.