

# USB Current Monitor

20131223

Reference;

USB\_Current\_Monitor\_0.3.2.f

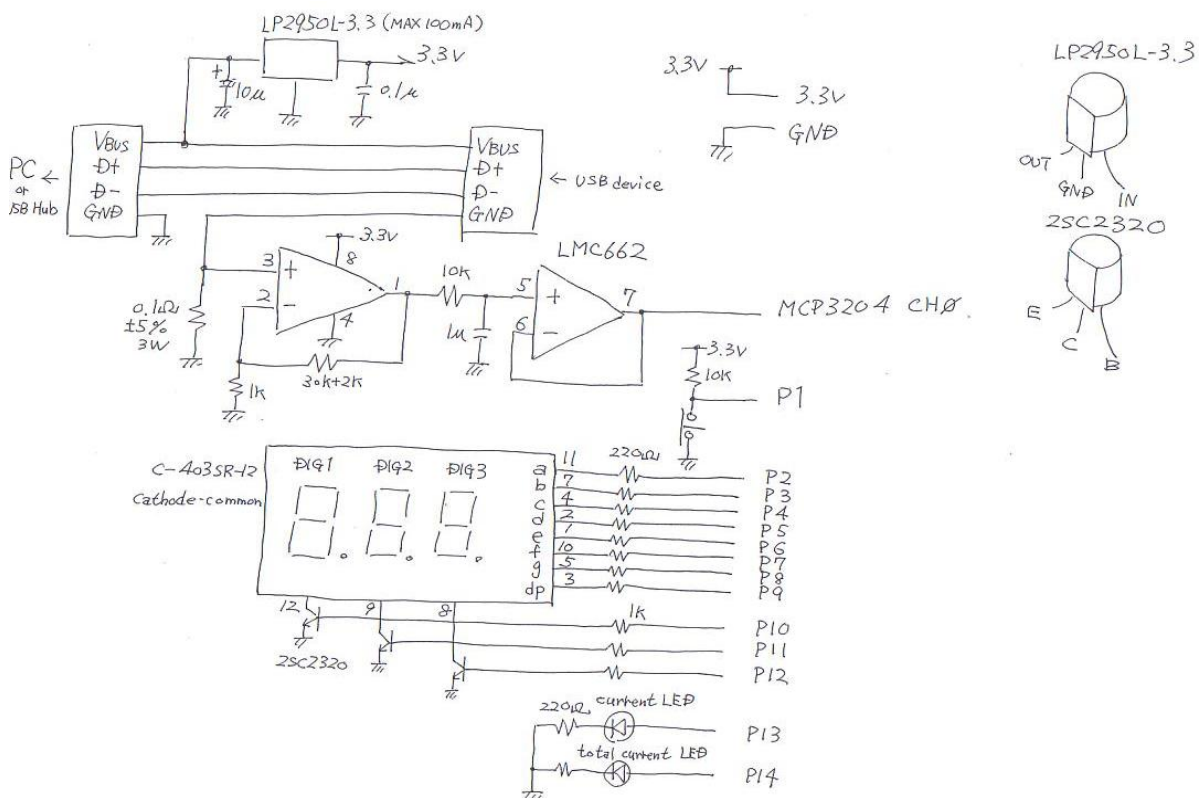
USB Current Monitor display USB-devices-current(mA) and total-current(Ahour).  
Displayment is 1second by 1second.

USB-devices-current(mA): 0mA – 999mA [– – –]at more than 999mA

USB-total-current(Ahour): 0.00Ahour – 999Ahour [– – –]at more than 999Ahour

Current is an approximate value.

## I/F Curcuit



Power(3.3V) is generated by USB-Vbus.

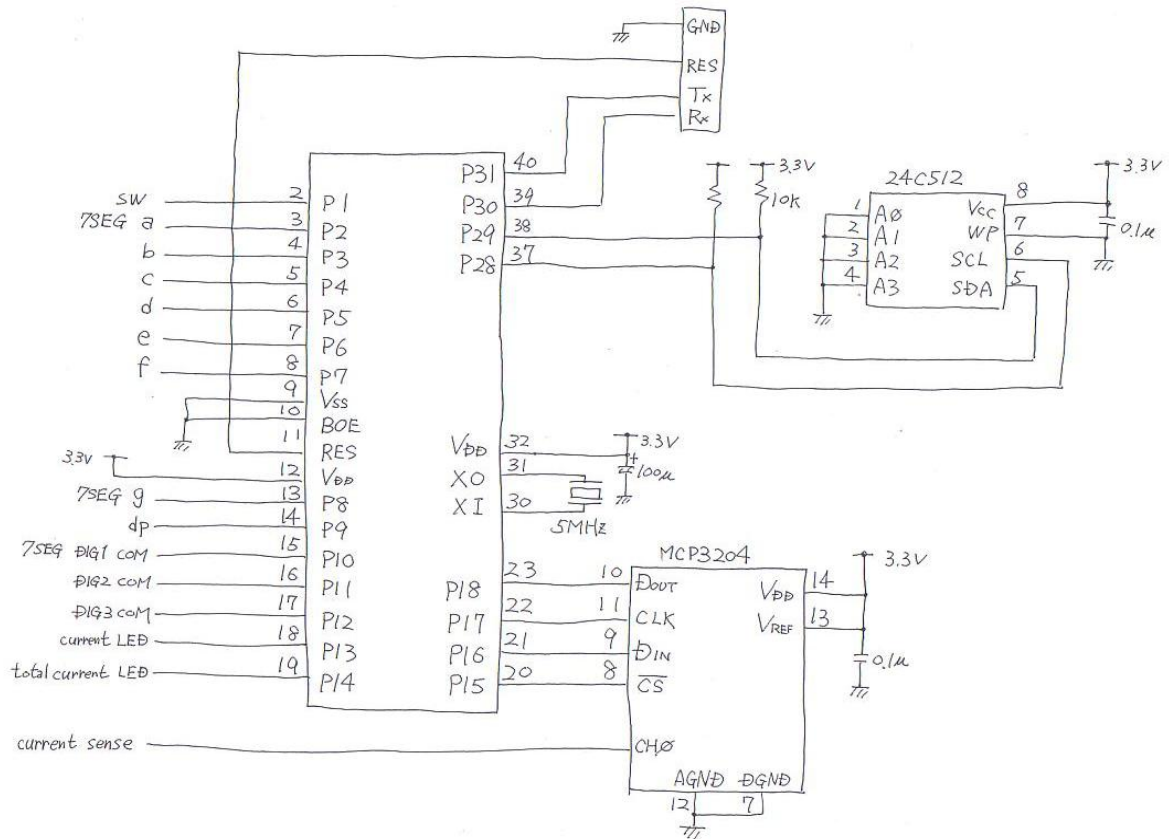
3-digit-7SEG-LED display by Dynamic-drive(400Hz).

USB-device's current is sensed by resistor(0.1ohm).

This resistor has error (max+-5%). Resistor for op-amp is +-5%.

Current-sense-error is max+-5.25%.

## CPU Curcuit



	Parts	Description	Quantity
I/F	LMC662	Op-Amp	1
	LP2950L-3.3	3.3V Regulator(max current 100mA)	1
	2SC2320	NPN Tr	3
	0.1ohm	(+ -5% 3W)	1
	220ohm	(+ -5% 1/4W)	10
	1kohm	(+ -5% 1/4W)	4
	30kohm	(+ -5% 1/4W)	1
	2kohm	(+ -5% 1/4W)	1
	10kohm	(+ -5% 1/4W)	2
	C-403SR-12	3-digit Cathode-common 7SEG	1
	1uF	Ceramic Capacitor	1
	10uF	electrolytic Capacitor	1
	0.1uF	Ceramic Capacitor	1
	Push-Switch	Normal-Close type	1
	LED	3mm yellow	2
	USB connector	Receptacle	1
	USB connector	Plug	1
CPU	P8X32A	40pin DIP	1
	24C512	eeeprom 64kByte	1
	Xtal	5MHz	1
	MCP3204	ADC	1
	100uF	electrolytic Capacitor	1
	0.1uF	Ceramic Capacitor	2
	10kohm	(+ -5% 1/4W)	2
	4-pin	For PropPlug	1
	IC-socket(40pin)	For propeller chip	1
	IC-socket(14pin)	For MCP3204	1
	IC-socket(8pin)	For 24C512	1

There is a mistake about selection for Op-Amp.  
 Power for LMC664 is min 5V.  
 Correct Op-Amp character is "Rail to Rail" and "Single Power 3.3V".  
 I replaced it to NJM2732.

Although using 24C512 as eeprom, using 24C256 is ok.  
 I use Push-Switch for Normal Close-type.  
 So if using it for Normal Open-type, modify word 'read\_sw'.  
 ADC(MCP3204) is used because converting current-sense-voltage.  
 Vref for MCP3204 use 3.3V (generated by LP2950L-3.3).  
 LP2950L-3.3 has error (max  $\pm 2\%$ ).  
 So, digital-value has max  $\pm 2\%$ .

Error for current-sense-resistor and digital-value is  $\pm 5.355\%$ .  
 USB-current's error is max  $\pm 5.355\%$ .  
 But actually display-value is almost correct.

USB-current	Volt for 0.1ohm	Op-Amp Output	ADC-value
1mA	0.1mV	3.3mV	4
10mA	1mV	33mV	40
100mA	10mV	330mV	409
1000mA	100mV	3.3V	4096

#### Using

1. Inserting USB Current Monitor to USB-port for PC or USB-Hub.
2. After "---" on 7SEG-LED, "0" is displayed on it. (zero-adjustment for op-amp)
3. Inserting USB-device to USB Current Monitor
4. When pushig switch, 7SEG-LED display total-current(Ahour).

#### Install

After built-up circuit, insert USB Current monitor to USB-port.  
 Load DevKernel.spin connecting prop-plug to 4-pin-port.  
 Connect to TeraTerm.  
 Loading USB\_Current\_Monitor\_0.3.2.f.

```

Prop0 Cog6 ok
saveforth
.....
Prop0 Cog6 ok
reboot

CON:Prop0 Cog0 RESET - last status: 0 ok

CON:Prop0 Cog1 RESET - last status: 0 ok

CON:Prop0 Cog2 RESET - last status: 0 ok

CON:Prop0 Cog3 RESET - last status: 0 ok

CON:Prop0 Cog4 RESET - last status: 0 ok

CON:Prop0 Cog5 RESET - last status: 0 ok

CON:Prop0 Cog6 RESET - last status: 0 ok

Prop0 Cog6 RESET - last status: 0 ok
Prop0 Cog6 ok

-- USB_Current_Monitor should operate ----

cog?
Cog:0 #io chan:1      RUNNING 7SEG_drive
Cog:1 #io chan:1      RUNNING read_sw
Cog:2 #io chan:1      RUNNING USB-current
Cog:3 #io chan:1 PropForth v5.5 2013Feb20 11:30 3
Cog:4 #io chan:1 PropForth v5.5 2013Feb20 11:30 3
Cog:5 #io chan:1 PropForth v5.5 2013Feb20 11:30 3
Cog:6 #io chan:1 PropForth v5.5 2013Feb20 11:30 3 6(0)->7(0)
Cog:7 #io chan:1      SERIAL 7(0)->6(0)
Prop0 Cog6 ok

-- Connected MP3-player ---
monitor
monitor
A/D   Current[mA]   Total Current[mAsec]   Total Current[d100 X Ahour]
0    0           0           0
0    0           0           0
0    0           0           0
0    0           0           0
0    0           0           0
10   2           2           0
29   7           9           0
81   19          28          0
68   16          44          0
67   16          60          0
95   23          83          0
99   24          107         0
100  24          131         0
94   22          153         0
93   22          175         0
98   23          198         0
98   23          221         0
98   23          244         0
98   23          267         0
93   22          289         0

A/D   Current[mA]   Total Current[mA*sec]
93   22          311          0
114  27          338          0
99   24          362          0
99   24          386          0

```

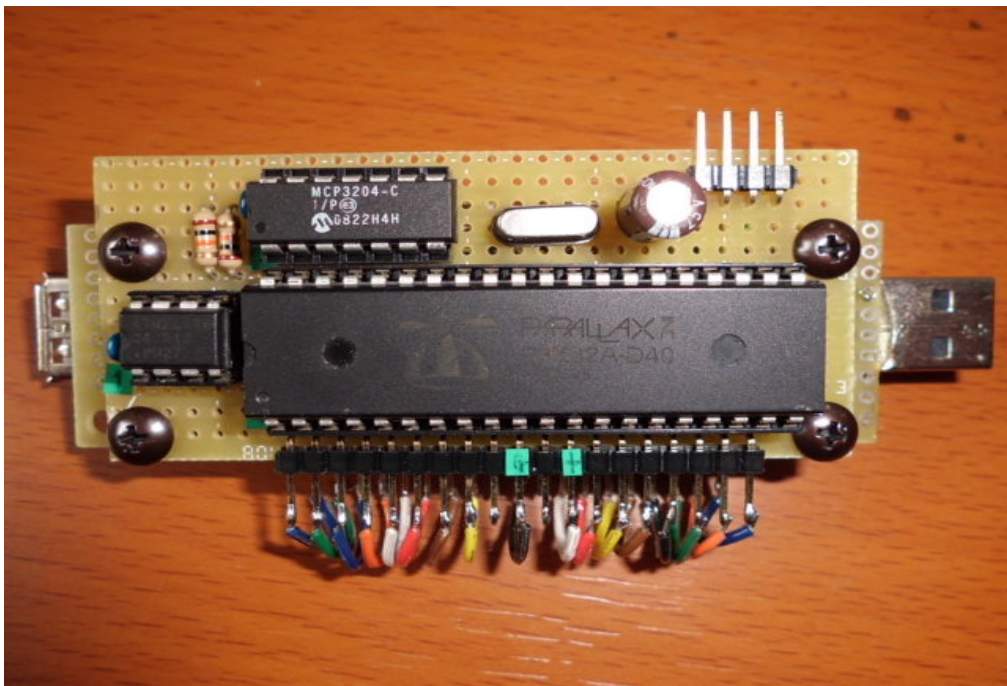
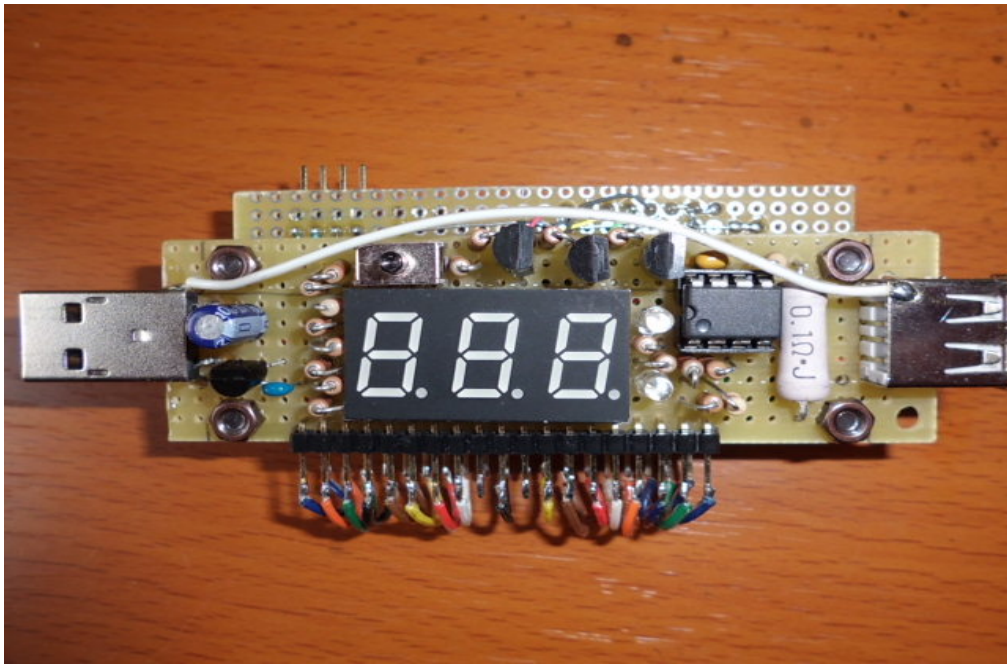
99	24	410	0
99	24	434	0
99	24	458	0
99	24	482	0
99	24	506	0
99	24	530	0
99	24	554	0
99	24	578	0
99	24	602	0
99	24	626	0
99	24	650	0
99	24	674	0
94	22	696	0
93	22	718	0
99	24	742	0
99	24	766	0



Current-measure mode



Total-Current-measure mode



# USB Current Monitor II

20140413

Modified USB\_Current\_Monitor.  
Used OLED-LCD and SMD parts.

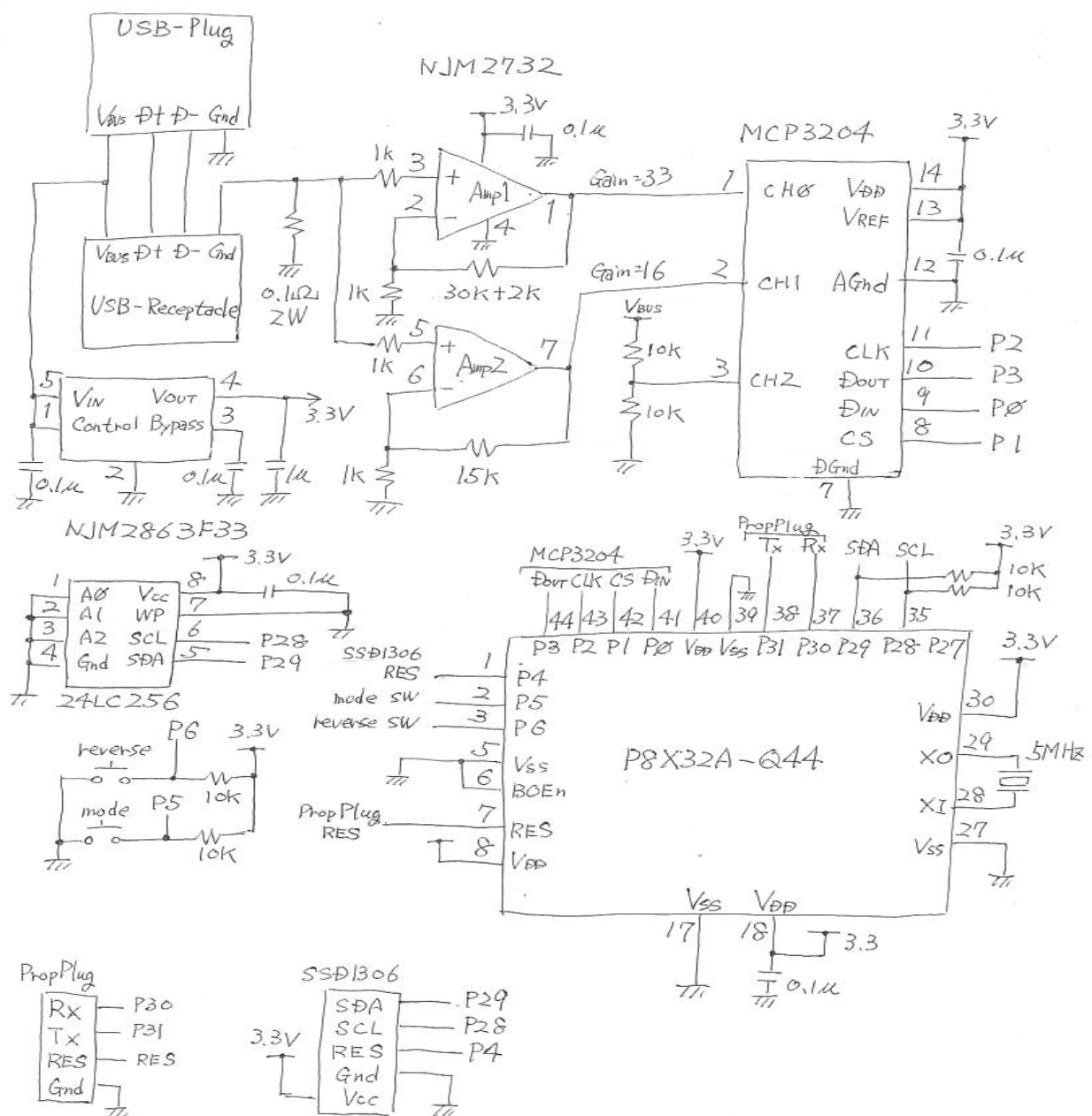
Reference;

USB\_Current\_Monitor\_II\_0.3\_1.f

USB\_Current\_Monitor\_II\_0.3\_2.f

Amp\_offset\_0.1.f

Curcuit:



## Parts:

Parts	Description	Quantity
CPU	P8X32A-Q44	1
Xtal	5MHz	1
OLED-LCD	SSD1306	1
ADC	MCP3204	1
EEPROM	24LC256	1
OpeAmp	NJM2732	1
3.3V Regulator	NJM2863F33	1
Push Switch	Red	1
Push Switch	Green	1
Capacitor	SMD 0.1uF	6
Capacitor	SMD 1uF	1
Resistor	SMD 10k	6
Resistor	SMD 1k	4
Resistor	SMD 15k	1
Resistor	SMD 30k	1
Resistor	SMD 2k	1
USB connector	Plug	1
USB connector	Receptacle	1
PropPlug connect	4pin Angle-pin-connector	1

## Install for Forth code

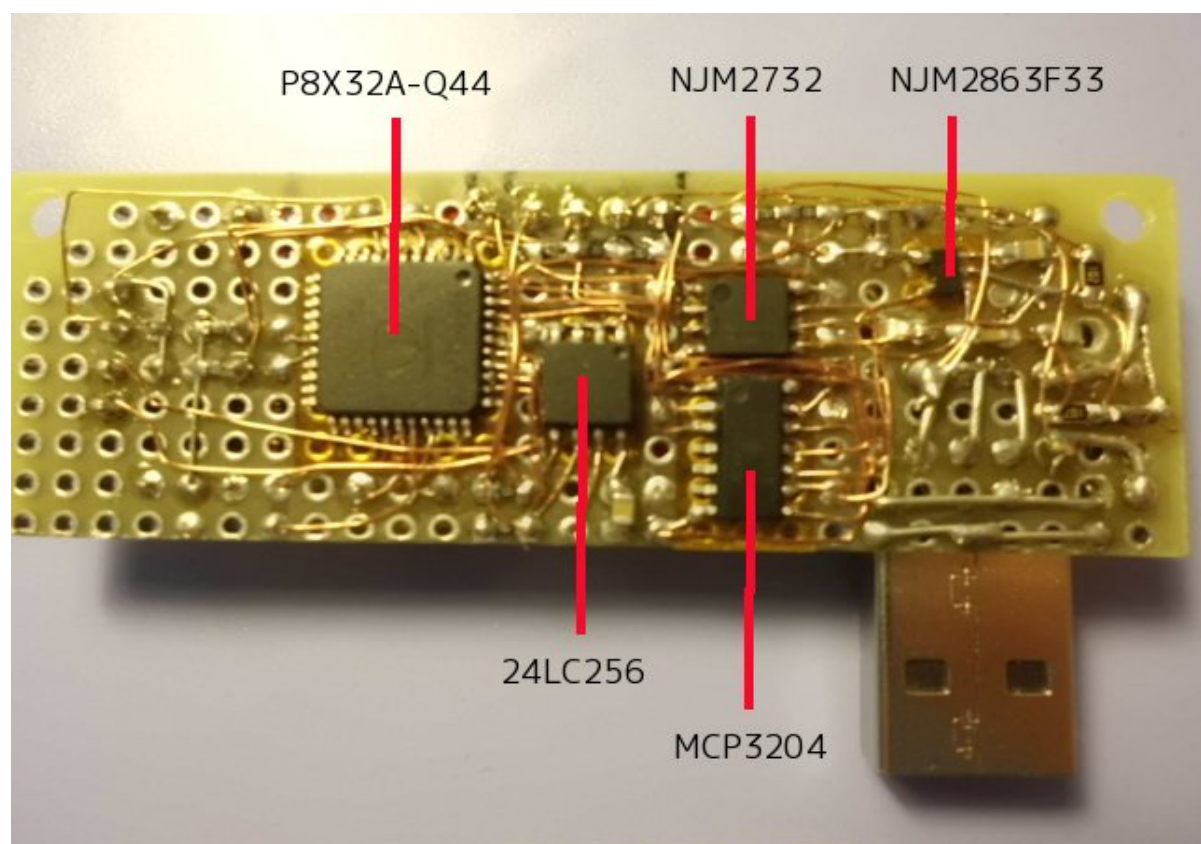
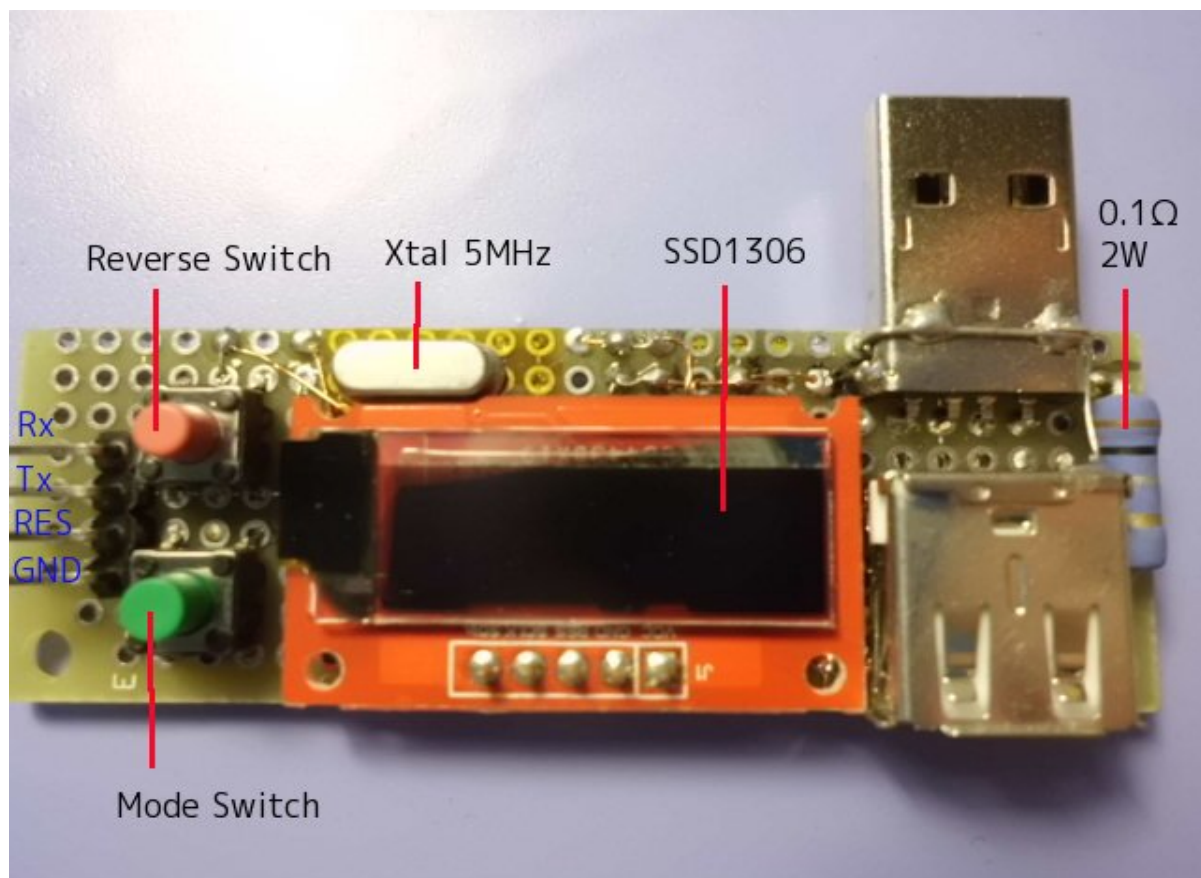
1. Loading Dev-kernel to eeprom
2. Loading Amp\_offset\_0.1.f
3. Add 10mV to input for Amp1 and Amp2
4.
 

```
Prop0 Cog6 ok
get_offset
ch0_offset:59
ch1_offset:67
Prop0 Cog6 ok
```
5. Cop each value of ch0\_offset and ch1\_offset to USB\_Current\_Monitor\_II\_0.1\_1.f
 

```
\ ch*_offset is plus when amp-offset is negative
Line No.355    d59 constant ch0_offset
Line No.356    d67 constant ch1_offset
```
6. Execute “reboot”
7. Loading USB\_Current\_Monitor\_II\_0.2\_1.f and USB\_Current\_Monitor\_II\_0.2\_2.f
8. Execute “saveforth”
9. Execute “reboot”

Resister for current use 0.1ohm 2W.

Really, 1W resister is ok in case of max current 2A.



LCD for USBCurrent Monitor II use 32x16\_font and 8x8\_font.

32x16\_font use vertical mode for SSD1306.

8x8\_font use horizontal mode for SSD1306.

At less than 1A, ADC(MCP3204) select Amp1(Gain=33).

At more than 1A, ADC(MCP3204) select Amp2(Gain=16).

NJM2732 on USBCurrent Monitor has positive offset.

But NJM2732 on USBCurrent Monitor II has negative offset.

So, codes for USBCurrent Monitor can't use on USBCurrent Monitor II.

RC-circuit need at output of Op-amp on USB Current Monitor.

Instead of RC-circuit, USBCurrent Monitor II has ring-buffer for ADC-values.

ADC get ADC-value 50msec by 50msec.

And average value is got from 40 data inside ring-buffer 50msec by 50msec.

Delete USB Current Monitor II

1. forget USB\_Current\_Monitor
2. saveforth

Function:

When connected USB\_Current\_Monitor\_II, it display [0mA] after [-----mA].



USB-decvices-current(mA) : 0mA – 2000mA

(This is added 200mV to op-amp-input for display-test.)



USB-voltage



Total-current and Time after USB-device connected

Time 00:00:00 – 99:59:59

0mAs – 3600mAs

0mAh - 1000mAh

0Ah – 99999Ah



Top line Time and current

2<sup>nd</sup> Line Total-current[mAs]

3<sup>rd</sup> Line Total-current[mAh]

4<sup>th</sup> Line Total-current[Ah]

When reverse-sw is pushed, display' direction is chengeed.



When input for Amp1/Amp2 is 0mv(removed USB-device), LCD is off.



After this, LCD screen is off.

Removal for USB\_Current\_Monitor\_II is ready.

If mode-sw is pushed for a while, back to initial status.(display 0mV)

Connecting to TeraTerm, below;

Prop0 Cog6 ok

cog?

Cog:0 #io chan:1 RUNNING ADC

Cog:1 #io chan:1 RUNNING total-current

Cog:2 #io chan:1 RUNNING Time

Cog:3 #io chan:1 RUNNING USB\_Current\_Monitor\_II

Cog:4 #io chan:1 PropForth v5.5 2013Feb20 11:30 3

Cog:5 #io chan:1 PropForth v5.5 2013Feb20 11:30 3

Cog:6 #io chan:1 PropForth v5.5 2013Feb20 11:30 3 6(0)->7(0)

Cog:7 #io chan:1 SERIAL 7(0)->6(0)

Prop0 Cog6 ok

Cog0 convert data from MCP3204 to current and voltage.

Cog1 calculate total-current(mAs,MAH,Ah)

Cog2 measure elapsed time.

Cog3 is main of USB\_Current\_Monitor\_II.

Searching i2c-devices;

Prop0 Cog6 ok

i2c\_search

0 1 2 3 4 5 6 7 8 9 A B C D E F

00: -- -- -- -- -- -- -- -- -- -- -- -- -- -- -- --

10: -- -- -- -- -- -- -- -- -- -- -- -- -- -- -- --

20: -- -- -- -- -- -- -- -- -- -- -- -- -- -- -- --

30: -- -- -- -- -- -- -- -- -- -- -- 3C -- -- -- h3C is SSD1306

40: -- -- -- -- -- -- -- -- -- -- -- -- -- -- -- --

50: 50 -- -- -- -- -- -- -- -- -- -- -- -- -- -- h50 is eeprom

60: -- -- -- -- -- -- -- -- -- -- -- -- -- -- -- --

70: -- -- -- -- -- -- -- -- -- -- -- -- -- -- -- --

i2c\_device:2

Prop0 Cog6 ok

## Displayment for data

Prop0 Cog6 ok

monitor

Time	Current[mA]	Total Current[mAs]	Total Current[mAh]	Total Current[Ah]
00:01:19	96	3124	1	0
00:01:20	97	3220	1	0
00:01:21	98	3317	1	0
00:01:22	98	3415	1	0
00:01:23	98	3513	1	0
00:01:24	98	11	2	0
00:01:25	98	109	2	0
00:01:26	97	206	2	0
00:01:27	97	303	2	0
00:01:28	97	400	2	0
00:01:29	98	497	2	0
00:01:30	97	595	2	0
00:01:31	98	693	2	0
00:01:32	98	791	2	0
00:01:33	98	889	2	0
00:01:34	98	987	2	0
00:01:35	98	1085	2	0
00:01:36	98	1183	2	0
00:01:37	98	1281	2	0
00:01:38	98	1379	2	0

Time	Current[mA]	Total Current[mAs]	Total Current[mAh]	Total Current[Ah]
00:01:39	98	1477	2	0
00:01:40	98	1575	2	0
00:01:41	98	1673	2	0
00:01:42	98	1771	2	0
00:01:43	98	1869	2	0
00:01:44	98	1967	2	0
00:01:45	98	2065	2	0

## Data inside ring-buffer when mouse is connected.

Prop0 Cog6 ok

disp\_ADC\_buf

101 102 97 99 98 97 98 195 97 244 99 98 98 98 106 98 256 97 101 101 101 101 102 103 101 99 101 99 98 98 98 97 236 98 253 98 99 98 98 99  
101 102 97 99 98 97 98 195 97 244 99 98 98 98 106 98 256 97 101 101 101 101 102 103 101 99 101 99 98 98 98 97 236 98 253 98 99 98 98 99  
96 102 97 99 98 97 98 195 97 244 99 98 98 98 106 98 256 97 101 101 101 101 102 103 101 99 101 99 98 98 98 97 236 98 253 98 99 98 98 99  
96 254 97 99 98 97 98 195 97 244 99 98 98 98 106 98 256 97 101 101 101 101 102 103 101 99 101 99 98 98 98 97 236 98 253 98 99 98 98 99  
96 254 96 99 98 97 98 195 97 244 99 98 98 98 106 98 256 97 101 101 101 101 102 103 101 99 101 99 98 98 98 97 236 98 253 98 99 98 98 99  
96 254 96 96 98 97 98 195 97 244 99 98 98 98 106 98 256 97 101 101 101 101 102 103 101 99 101 99 98 98 98 97 236 98 253 98 99 98 98 99  
96 254 96 96 96 97 98 195 97 244 99 98 98 98 106 98 256 97 101 101 101 101 102 103 101 99 101 99 98 98 98 97 236 98 253 98 99 98 98 99  
96 254 96 96 96 102 98 195 97 244 99 98 98 98 106 98 256 97 101 101 101 101 102 103 101 99 101 99 98 98 98 97 236 98 253 98 99 98 98 99  
96 254 96 96 96 102 102 195 97 244 99 98 98 98 106 98 256 97 101 101 101 101 102 103 101 99 101 99 98 98 98 97 236 98 253 98 99 98 98 99  
96 254 96 96 96 102 102 97 244 99 98 98 98 106 98 256 97 101 101 101 101 102 103 101 99 101 99 98 98 98 97 236 98 253 98 99 98 98 99  
96 254 96 96 96 102 102 102 104 244 99 98 98 98 106 98 256 97 101 101 101 101 102 103 101 99 101 99 98 98 98 97 236 98 253 98 99 98 98 99  
96 254 96 96 96 102 102 102 104 103 99 98 98 98 106 98 256 97 101 101 101 101 102 103 101 99 101 99 98 98 98 97 236 98 253 98 99 98 98 99  
96 254 96 96 96 102 102 102 104 103 103 98 98 98 106 98 256 97 101 101 101 101 102 103 101 99 101 99 98 98 98 97 236 98 253 98 99 98 98 99  
96 254 96 96 96 102 102 102 104 103 103 103 105 98 106 98 256 97 101 101 101 101 102 103 101 99 101 99 98 98 98 97 236 98 253 98 99 98 98 99  
96 254 96 96 96 102 102 102 104 103 103 103 105 99 106 98 256 97 101 101 101 101 102 103 101 99 101 99 98 98 98 97 236 98 253 98 99 98 98 99  
96 254 96 96 96 102 102 102 104 103 103 103 105 99 98 98 256 97 101 101 101 101 102 103 101 99 101 99 98 98 98 97 236 98 253 98 99 98 98 99  
96 254 96 96 96 102 102 102 104 103 103 103 105 99 98 99 97 216 97 101 101 101 101 102 103 101 99 101 99 98 98 98 97 236 98 253 98 99 98 98 99  
96 254 96 96 96 102 102 102 104 103 103 103 105 99 98 99 97 216 97 251 101 101 101 101 102 103 101 99 101 99 98 98 98 97 236 98 253 98 99 98 98 99  
96 254 96 96 96 102 102 102 104 103 103 103 105 99 98 99 97 216 97 251 95 101 102 103 101 99 101 99 98 98 98 97 236 98 253 98 99 98 98 99  
96 254 96 96 96 102 102 102 104 103 103 103 105 99 98 99 97 216 97 251 95 99 102 103 101 99 101 99 98 98 98 97 236 98 253 98 99 98 98 99  
96 254 96 96 96 102 102 102 104 103 103 103 105 99 98 99 97 216 97 251 95 99 97 103 101 99 101 99 98 98 98 97 236 98 253 98 99 98 98 99  
96 254 96 96 96 102 102 102 104 103 103 103 105 99 98 99 97 216 97 251 95 99 97 97 101 99 101 99 98 98 98 97 236 98 253 98 99 98 98 99  
96 254 96 96 96 102 102 102 104 103 103 103 105 99 98 99 97 216 97 251 95 99 97 97 99 99 101 99 98 98 98 97 236 98 253 98 99 98 98 99

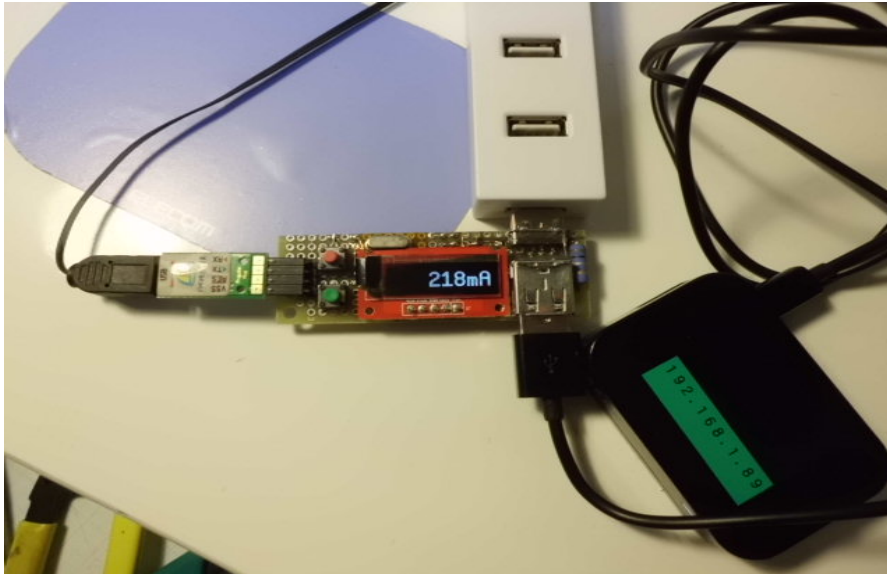
Prop0 Cog6 ok



MP3 Player



## Wireless Router



Generally, LCD value is a littel bigger.

## TroubleShoot

When connecting to USB-Hub, display is [0mA].

But when connecting PropPlug,, display is [16mV].

GND of PropPlug-connector connected to Amp1's 1k-ohm(GND-side).

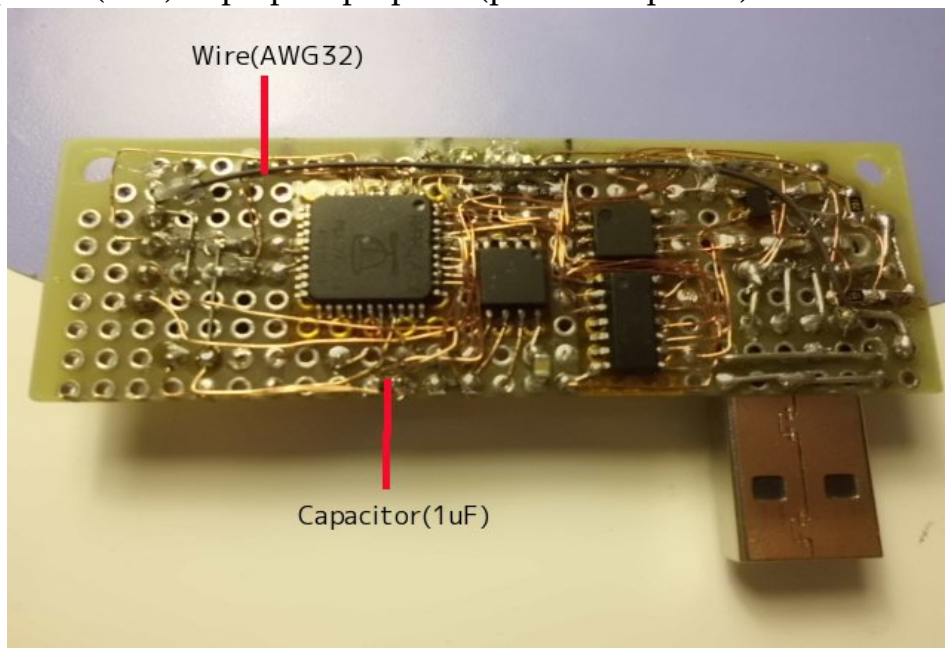
I used wire(UEW polyuretan 0.2mm).

I think maybe GND-line was poor.

So, directly connected PropPlug's GND to USB-plug's GND by black wire(AWG32).

When connecting to PC's USB-port, USB\_Current\_monitor repeat reboot.

I added capacitor(1uF) to prop-chip's power(pin40 and pin 39).

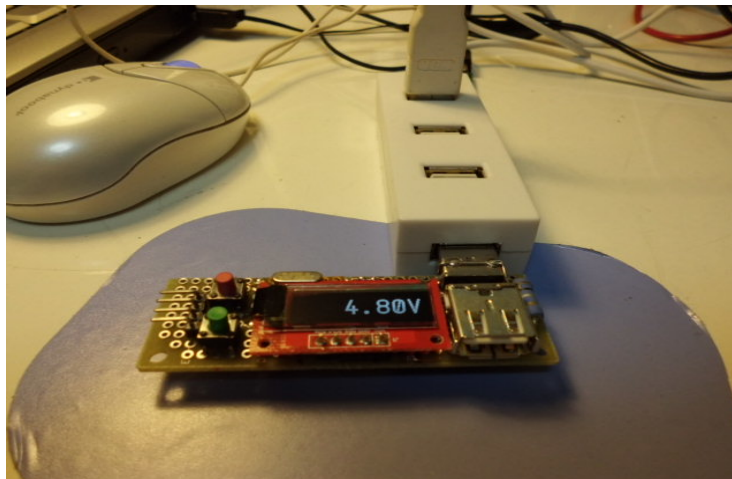


Each USB voltage is different

Camera's USB power supply



USB-Hub



PC's USB port



Input voltage	Output for Amp1	Outpur for Amp2	LCD
4mV	97.0mV	24.5mV	41mA
5mV	128.2mV	38.5mV	51mA
6mV	162.9mV	54.4mV	61mA
7mV	194.3mV	69.0mV	71mA
8mV	227.3mV	84.6mV	81mA
9mV	260.3mV	100.3mV	91mA
10mV	292.3mV	115.6mV	101mA
20mV	0.619V	0.274V	200mA
30mV	0.948V	0.433V	300mA
40mV	1.276V	0.592V	399mA
50mV	1.601V	0.749V	498mA
60mV	1.930V	0.908V	598mA
70mV	2.257V	1.066V	697mA
80mV	2.586V	1.226V	797mA
90mV	2.913V	1.384V	896mA
100mV	3.240V	1.543V	1001mA
110mV	3.283V	1.701V	1101mA
120mV	3.283V	1.860V	1202mA
130mV	3.283V	2.018V	1302mA
140mV	3.283V	2.176V	1401mA
150mV	3.283V	2.335V	1502mA
160mV	3.283V	2.493V	1601mA
170mV	3.283V	2.652V	1701mA
180mV	3.283V	2.810V	1801mA
190mV	3.283V	2.969V	1901mA
200mV	3.283V	3.128V	2002mA