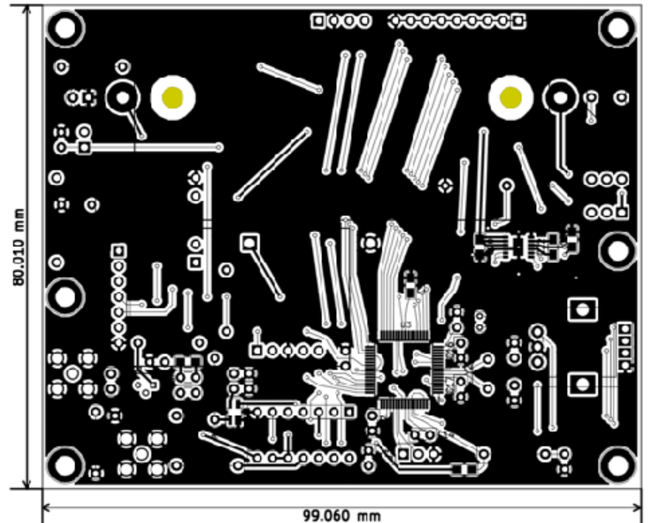
Frequency Counter with Waveform Display

n.k products 202004

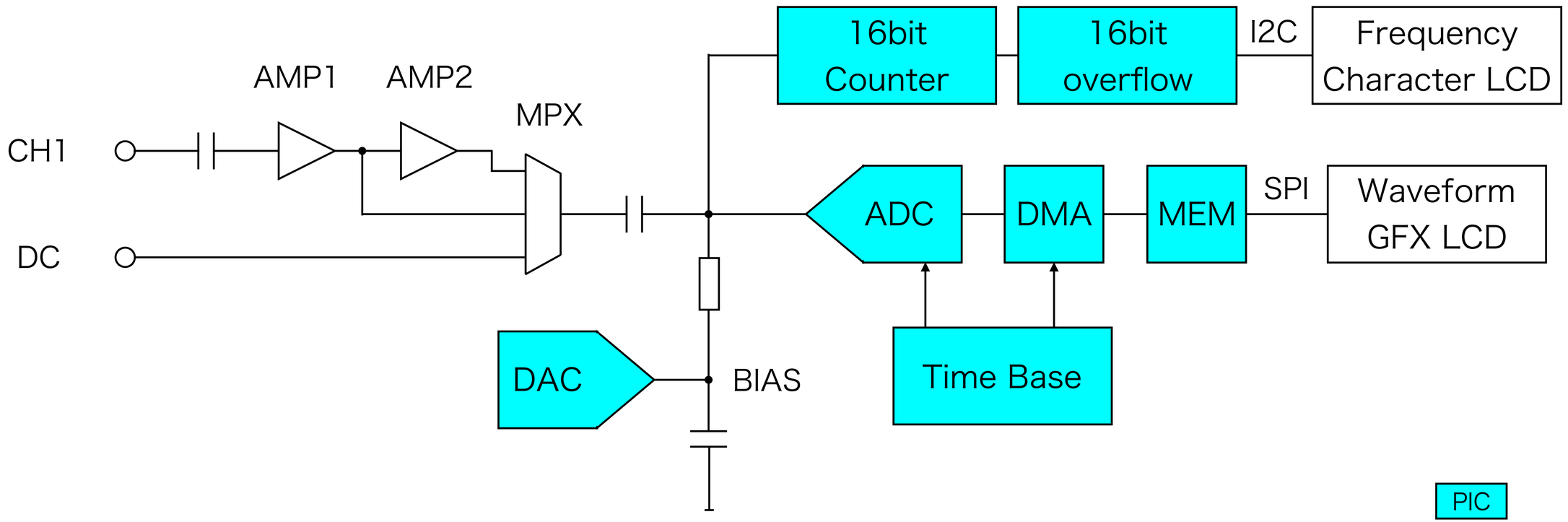
over view

specification

- Measurable frequency: DC to 48MHz (48MHz is actually measured. Performance limit has not been implemented)
- Waveform observable sampling rate: 250ns / sample
  - Measurement range: 250ns, 500ns, 1us, 2.5us, 5us, 10us, 25us, 50us, 100us, 250us
  - Waveform display: Horizontal axis 128 pixels (250ns x 128 = 32us)
  - Logically up to 2MHz, frequencies above this are observed as beat components (aliasing signals)
- Power supply: 18650Li-ion battery x 1
- Charging circuit: If a ready-made Li-ion battery charging board (4056, etc.) is installed, it can be charged via micro B type USB.
- Board size: 99mm x 80mm
- Weight: 113g (actual measurement including battery)



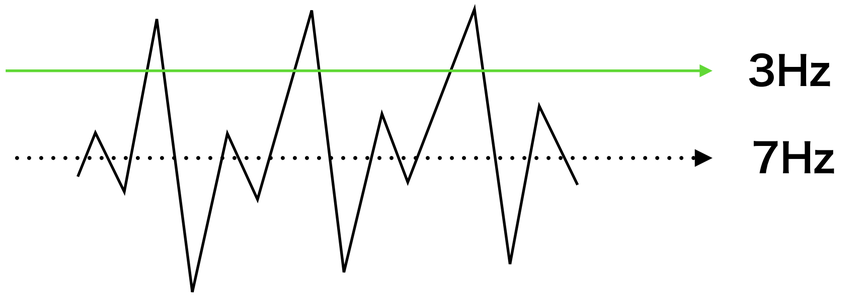
Block Diagram

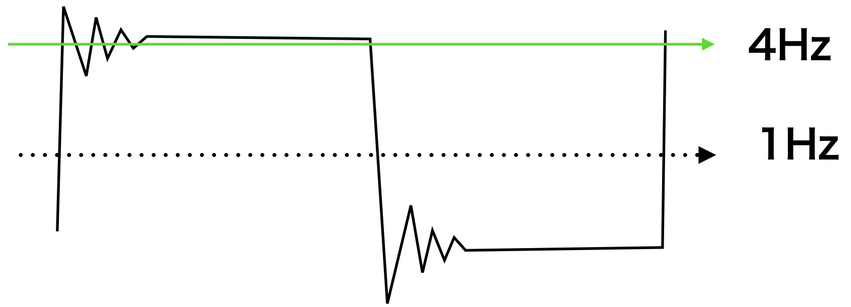


- Signal flow:
  The signal input from the measurement terminal is amplified by the preamplifier, and the amplification factor is selected by the multiplexer. By applying an arbitrary bias voltage to this signal with a DAC, the frequency can be counted (pseudo trigger level change) at any part of the waveform. The frequency counter consists of 16-bit hardware + 16-bit software. The waveform display is A / D converted according to the Time Base, the data is transferred to the memory by DMA, and the data is displayed as a waveform. The light blue part is PIC.

Feature

- By applying an arbitrary bias voltage to the waveform, you can arbitrarily set the threshold value you want to count. It is possible to measure by aiming at the fundamental wave part of the waveform with complicated frequency components or the the ringing part of waveform including ringing such as overshoot and undershoot.





How to use

1. Turn on the power switch Pow (SW3) Test pattern display of character LCD and graphic LCD After a few seconds

2. Frequency count mode The frequency count result and waveform are displayed approximately every second.

3. When the rotary encoder (SW1) is pressed, the frequency counter disappears and the "sampling time change mode" is set. You can select the sampling time for the waveform display by turning it left or right.

4. Press the rotary encoder from 3 to enter the "bias voltage change mode" of the input signal. You can move the waveform up and down by turning it left and right.

5. Press the rotary encoder from 4 to return to 2.

6. From any state, press and hold the rotary encoder to enter the time setting mode. You can set the clock time. By turning it left or right, you can set the year, and each time you press the rotary encoder, you can set the month, day, hour, and minute. Set to minutes or press and hold in the middle to return to 2.

Design overview

- High-speed counter and ADC →PIC24FJ128GC006
- Frequency display is character LCD →I2C
- Waveform display is graphic LCD →SPI
- Analog front end →J-FET & BGA420
- Battery operation →LTC3245

Frequency measurement

- Frequency measurement
  Timer1 is used as an **asynchronous** counter. If it is a synchronous counter, it cannot count above the clock frequency of PIC.

- Timer1 can operate in three modes:
  16-BitTimer
  16-BitSynchronousCounter
  16-BitAsynchronousCounter

- When Timer1 overflows, an interrupt occurs and the software counts the upper 16 bits.

- The clock is input from the external T1CK

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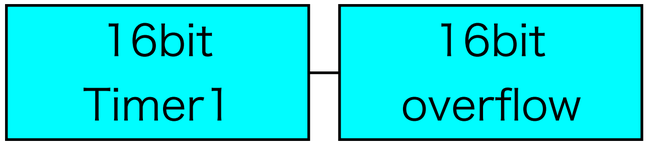
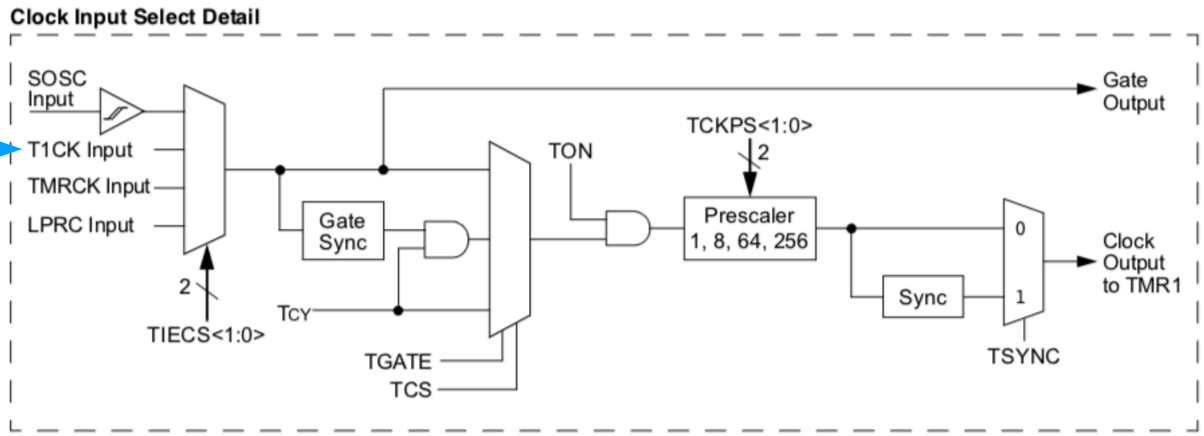


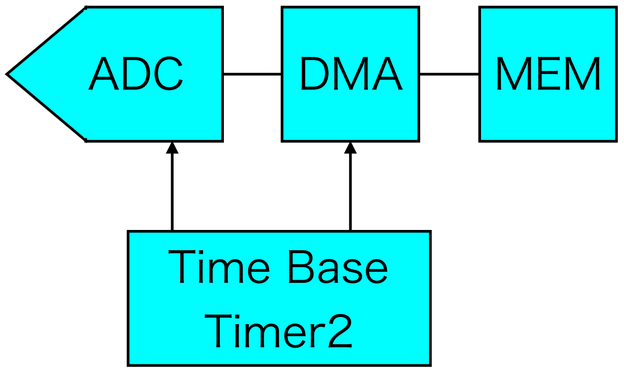


Waveform display

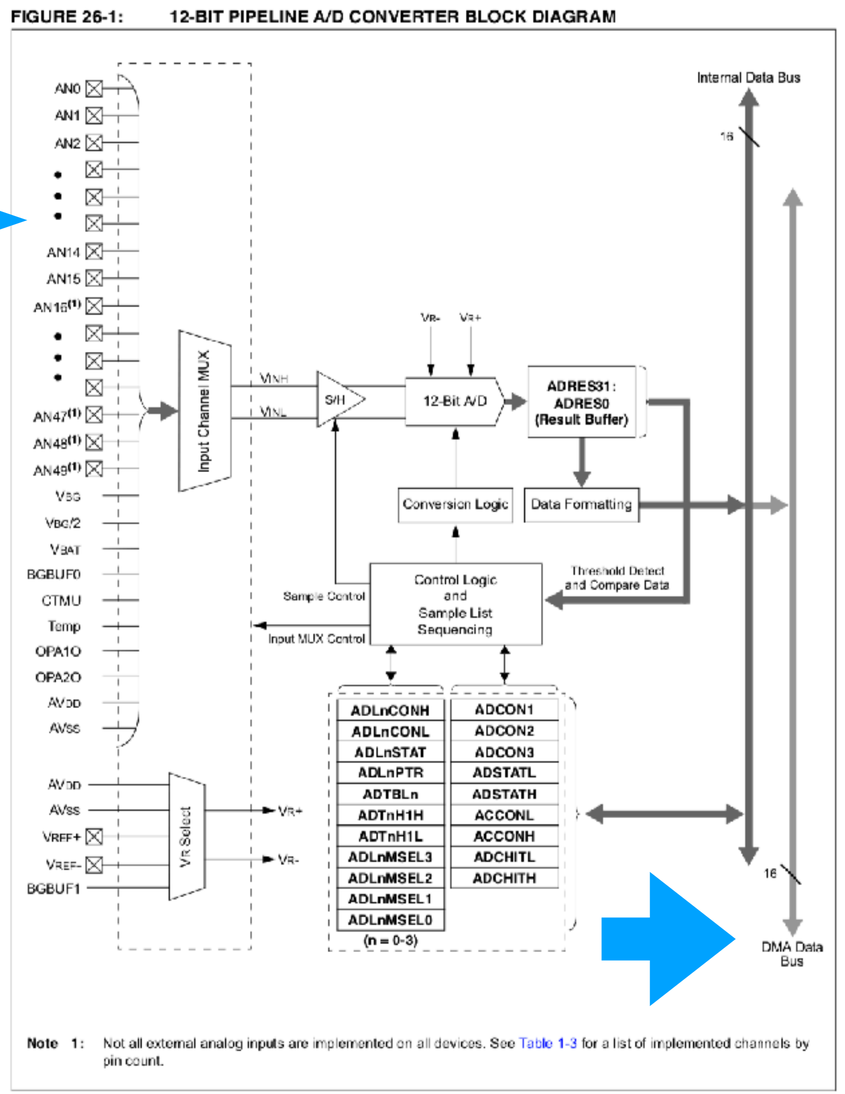
- **12-BIT HIGH-SPEED, PIPELINE A/D CONVERTER**
  Perform high-speed A / D conversion using PADC

- Data transfer using **DMA transfer**
  at the same time as conversion

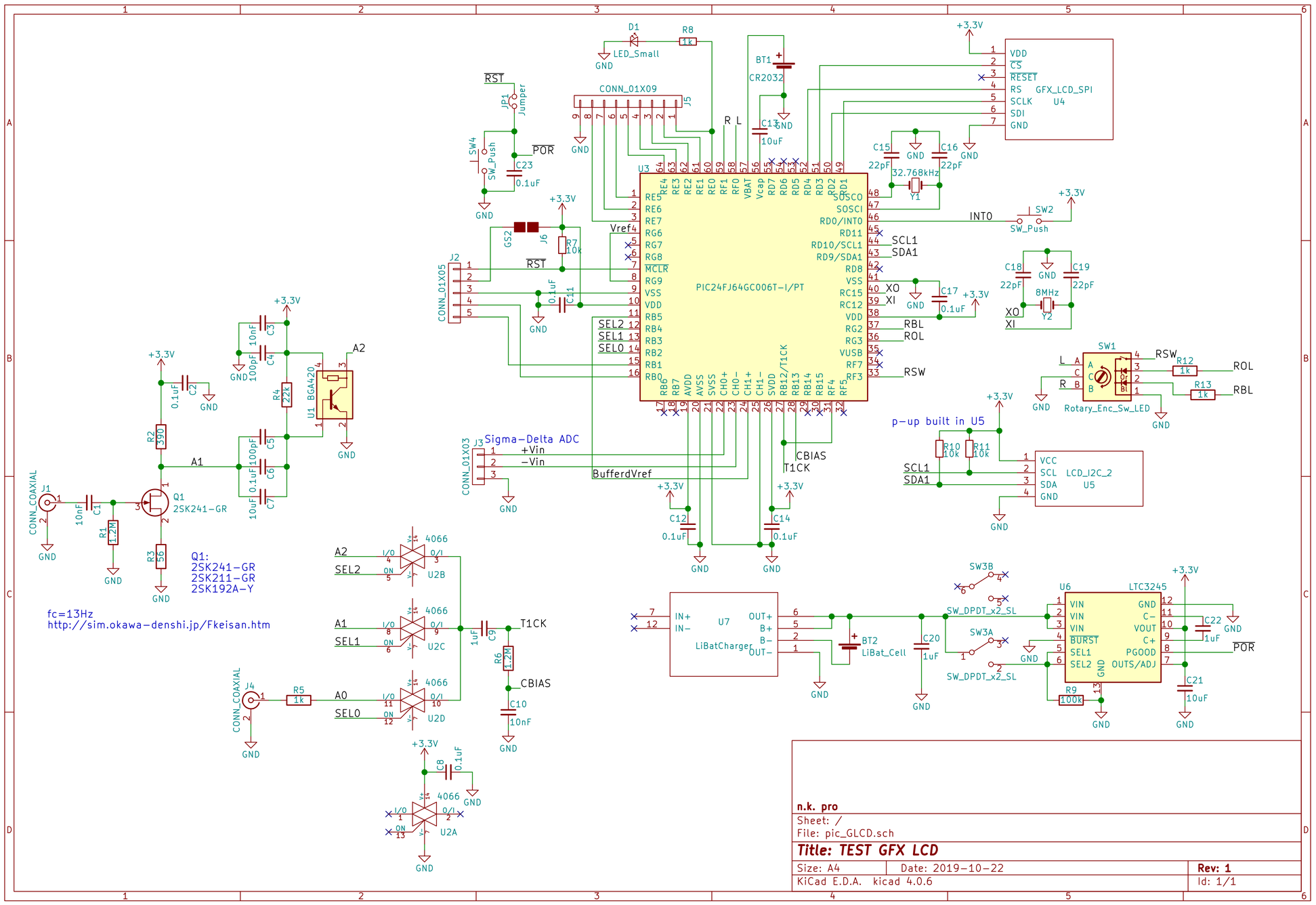
- Display on graphic LCD
  AQM1248A-RN 48x128pixels SPI



AN11



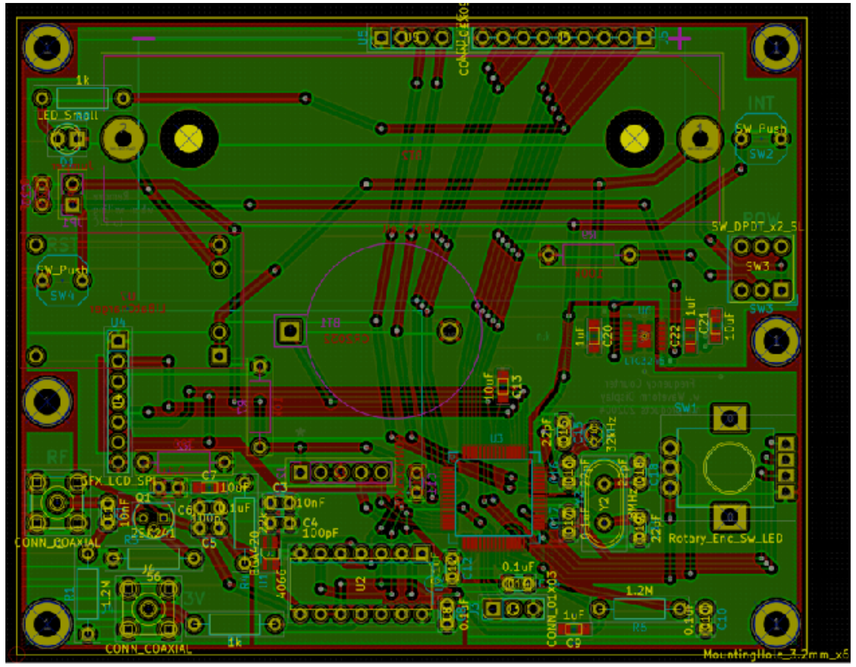
Draw the schematic with “kicad - Eeschema”



BOM

Reference		
BT1	CH25-2032LF	CH25-2032LF
BT2	Batt_Holder_18650	
C1	10nF	RD15W103K1HL2L
C10	10nF	RD15W103K1HL2L
C11	0.1uF	RPEF11H104Z2P1A01B
C12	0.1uF	RPEF11H104Z2P1A01B
C13	10uF_SMD	GRM21BR6YA106KE
C14	0.1uF	RPEF11H104Z2P1A01B
C15	22pF	RD15N220J1HL2L
C16	22pF	RD15N220J1HL2L
C17	0.1uF	RPEF11H104Z2P1A01B
C18	22pF	RD15N220J1HL2L
C19	22pF	RD15N220J1HL2L
C2	0.1uF	RPEF11H104Z2P1A01B
C20	1uF_SMD	GRM21BC72A105KE
C21	10uF_SMD	GRM21BR6YA106KE
C22	1uF_SMD	GRM21BC72A105KE
C23	0.1uF	RPEF11H104Z2P1A
C3	10nF	RD15W103K1HL2L
C4	100pF	RD15N101J1HL2L-
C5	100pF	RD15N101J1HL2L-
C6	0.1uF	RPEF11H104Z2P1A
C7	10uF_SMD	GRM21BR6YA106KE
C8	0.1uF	RPEF11H104Z2P1A
C9	1uF_SMD	GRM21BC72A105KE
D1	LED_Small	
J1	SMA	S-063-49-TGG
J2	Pin_Headers	
J3	Pin_Headers	
J4	SMA	S-063-49-TGG
J5	Pin_Headers	
J6	GS2	
JP1	Pin_Headers	
Q1	2SK241-GR	
R1	1.2M	
R10	10k	
R11	10k	
R12	1k	
R13	1k	
R2	390	
R3	56	
R4	22k	
R5	1k	
R6	1.2M	
R7	10k	
R8	1k	
R9	100k	
SW1	Rotary_Enc_Sw_LED	EC12PLBOSDVF-D-25K-24-24C-31/0
SW2	SW_Push	TVDT18-050CW-T
SW3	SW_DPDT_x2_SL	PS-85S(REDCAP)
SW4	SW_Push	TVDT18-050CW-T
U1	BGA420	BGA420H6327XTSA1
U2	4066	HD74HC4066P
U3	PIC24FJ64GC006T-I/PT	PIC24FJ64GC006-I/PT
U4	GFX_LCD_SPI	AE-AQM1248
U5	LCD_I2C_2	AE-AQM1602A(KIT)
U6	LTC3245	LTC3245EMSE
U7	LiBatCharger	https://www.amazon.co.jp/dp/B010FJTEFC
Y1	32.768kHz	VT-200-F32.768kHz
Y2	8MHz	HUSG-8.000-20

Draw the pattern with “kicad - Pcbnew”

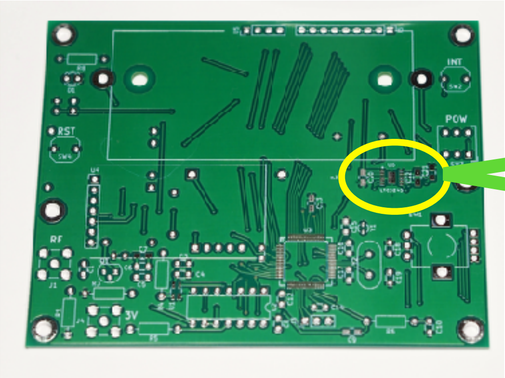


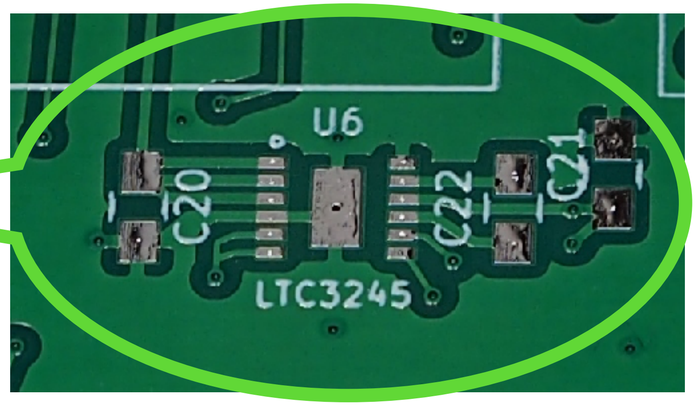
Create a Gerber file and order it to "fusion_pcb"

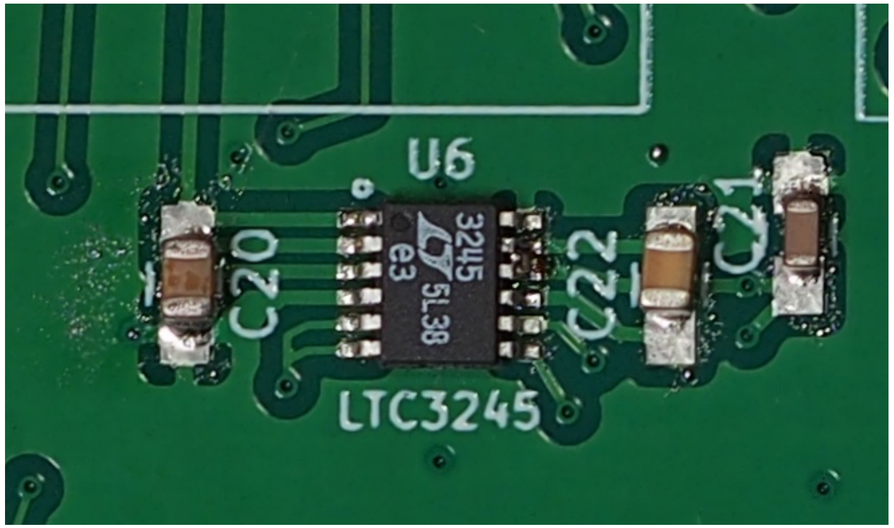
https://www.seeedstudio.com/fusion_pcb.html

Assemble 1

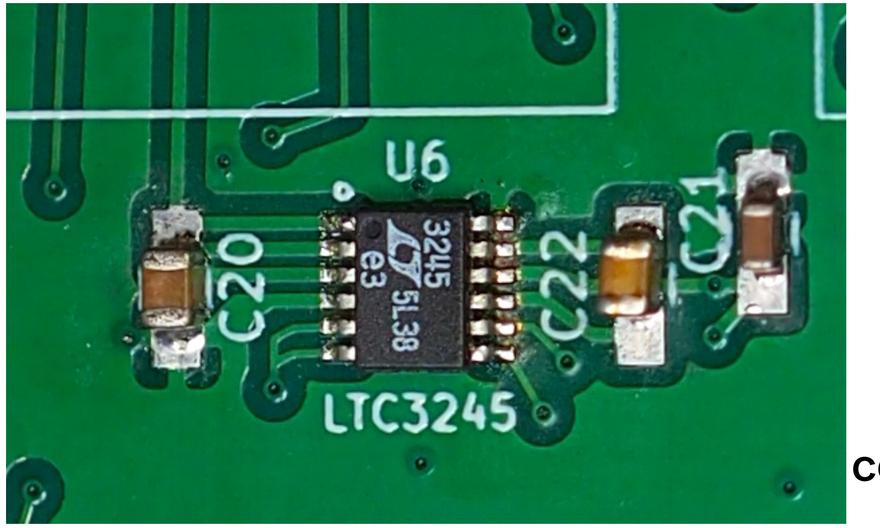
- LTC3245, C20, C21, C22
  Since it is an IC with a heat dissipation pad, solder it with a hot plate.







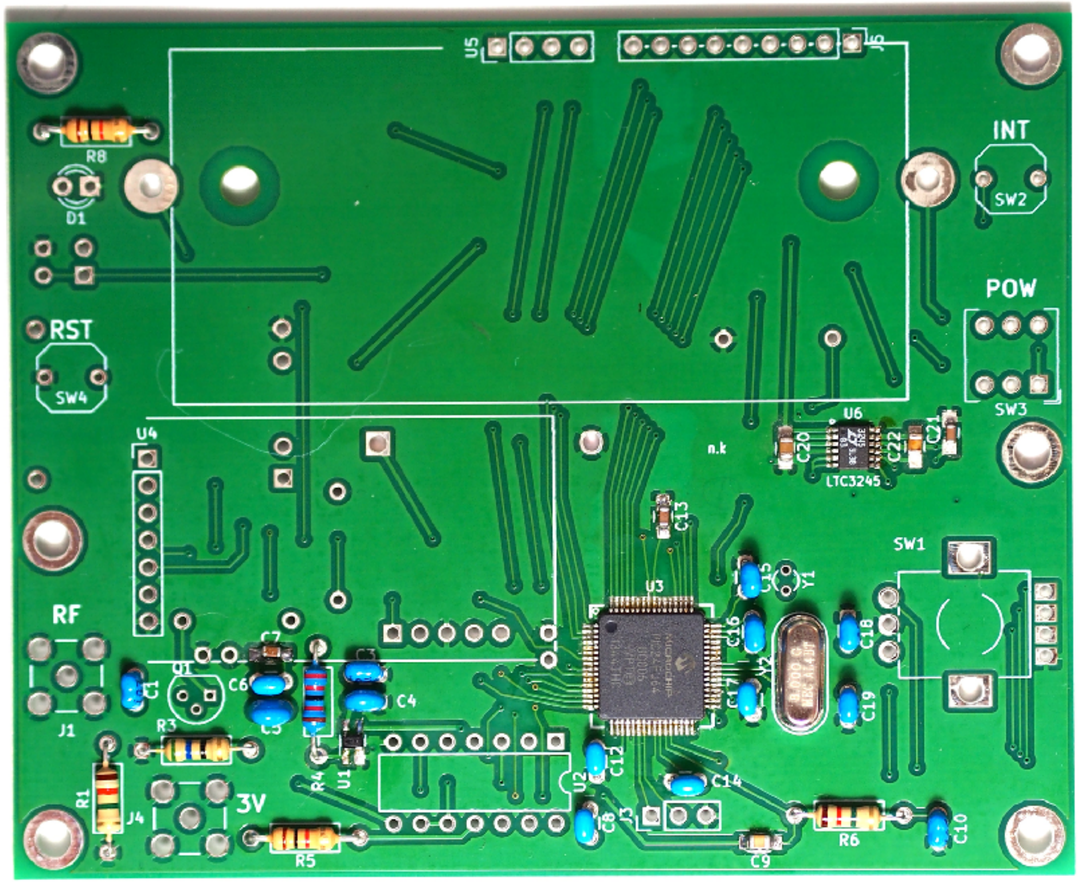
After heating

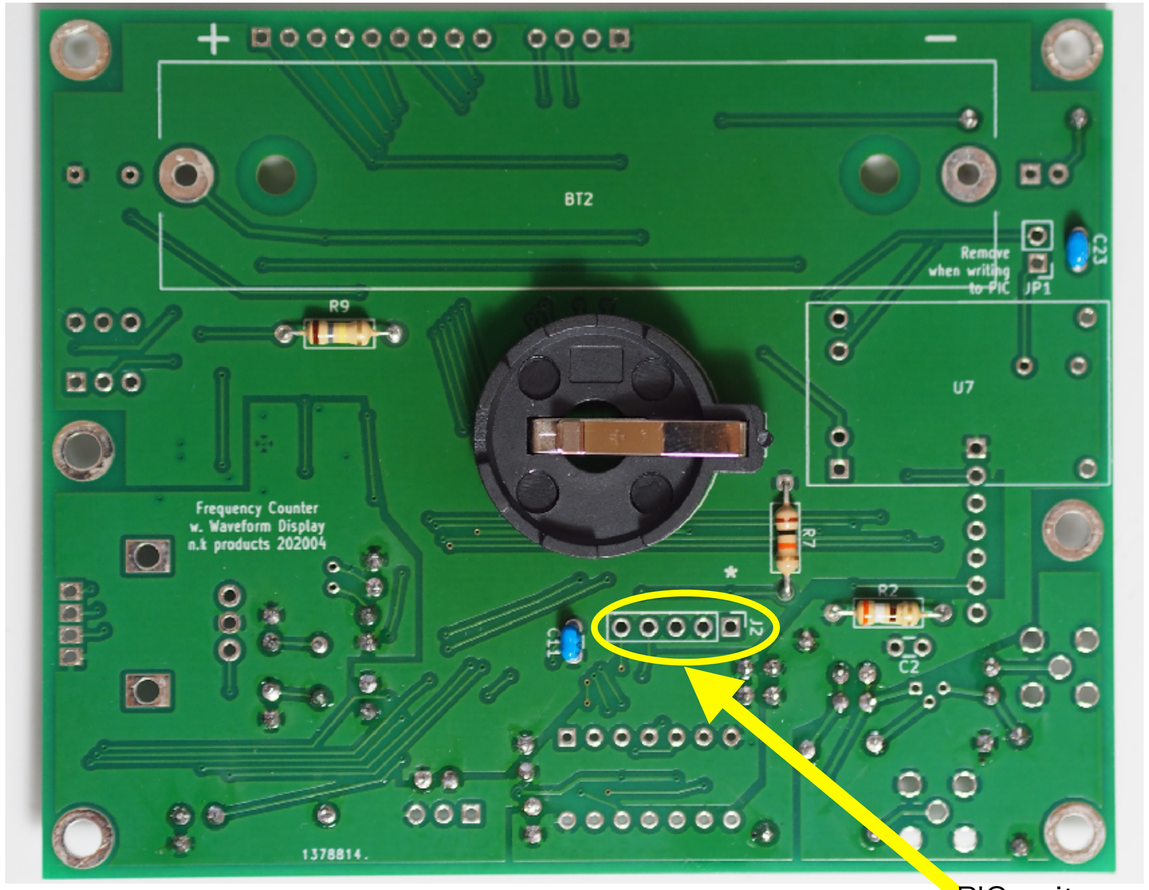


correction

Assemble 2

- parts side: U1 BGA420, U3 PIC, SMD capacitors, R8, R1, R3, R4, R5, R6, C1, C6, C5, C3, C4, C12, C8, C14, C15, C16, C17, Y2, C18, C19, C10
  Back side: R2, R7, R9, C11, C23, D1, BT1, (J2)

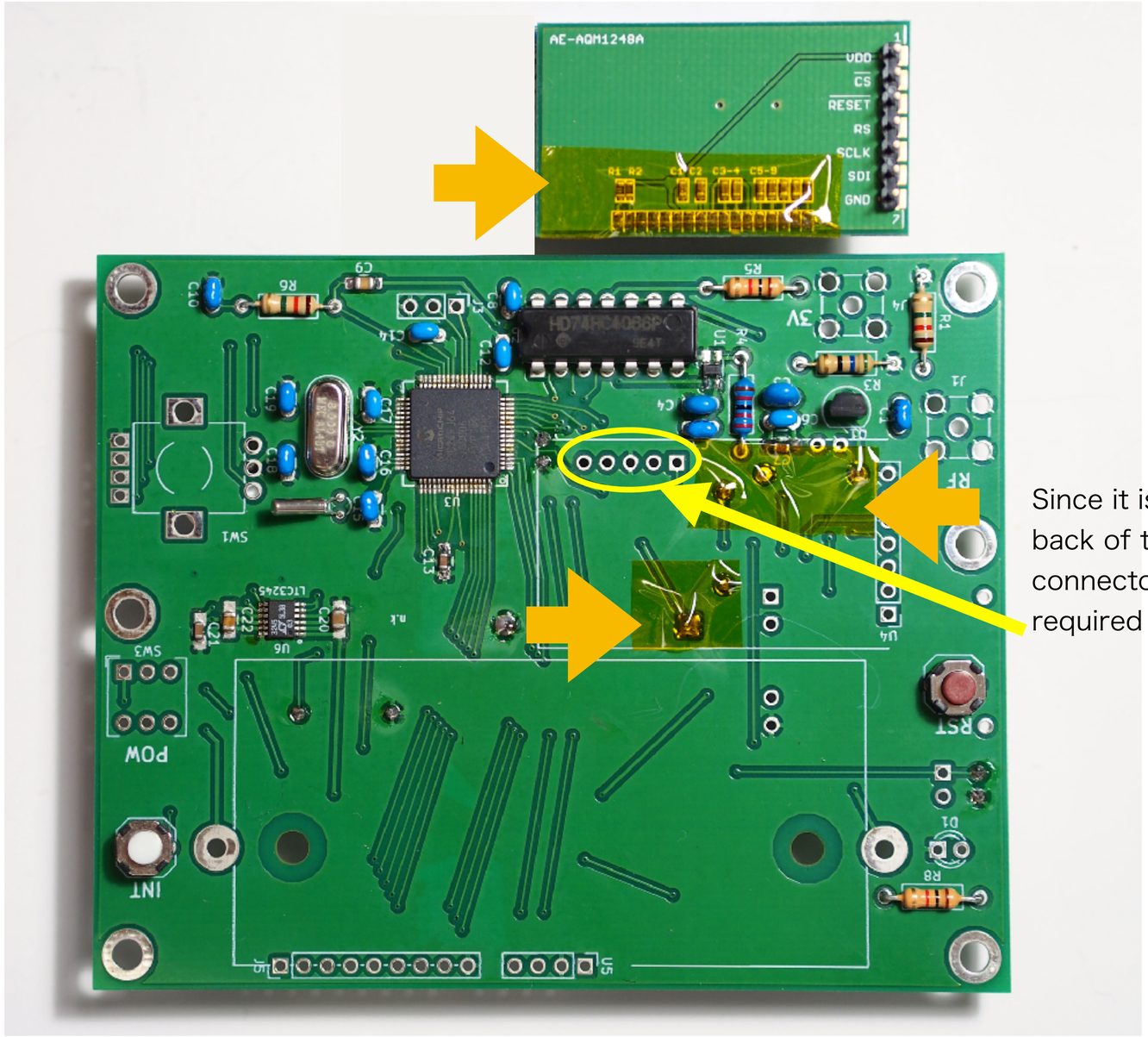




PIC write connector

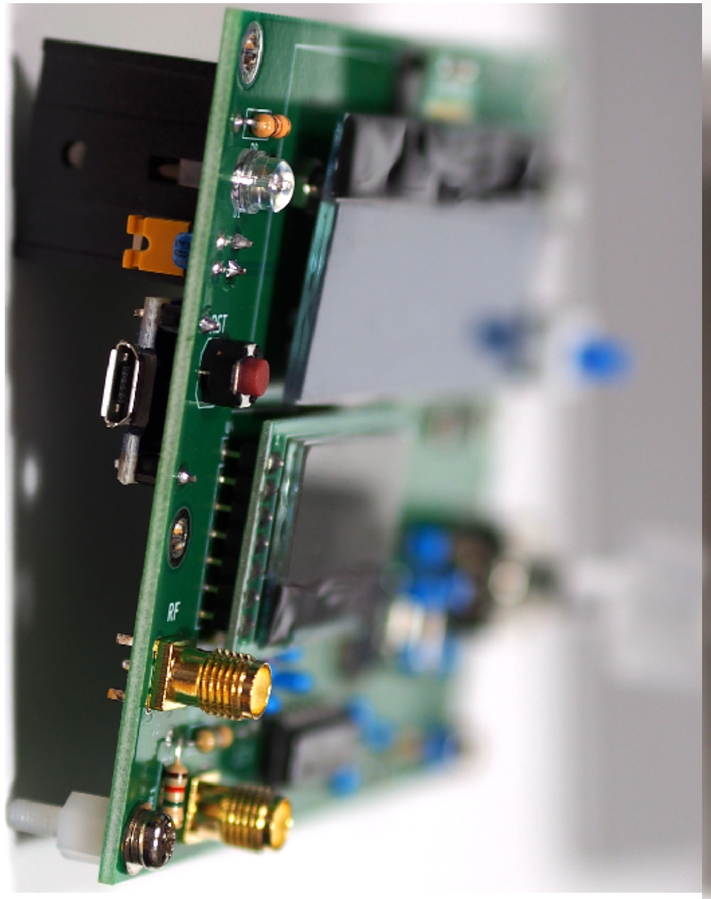
Assemble 3

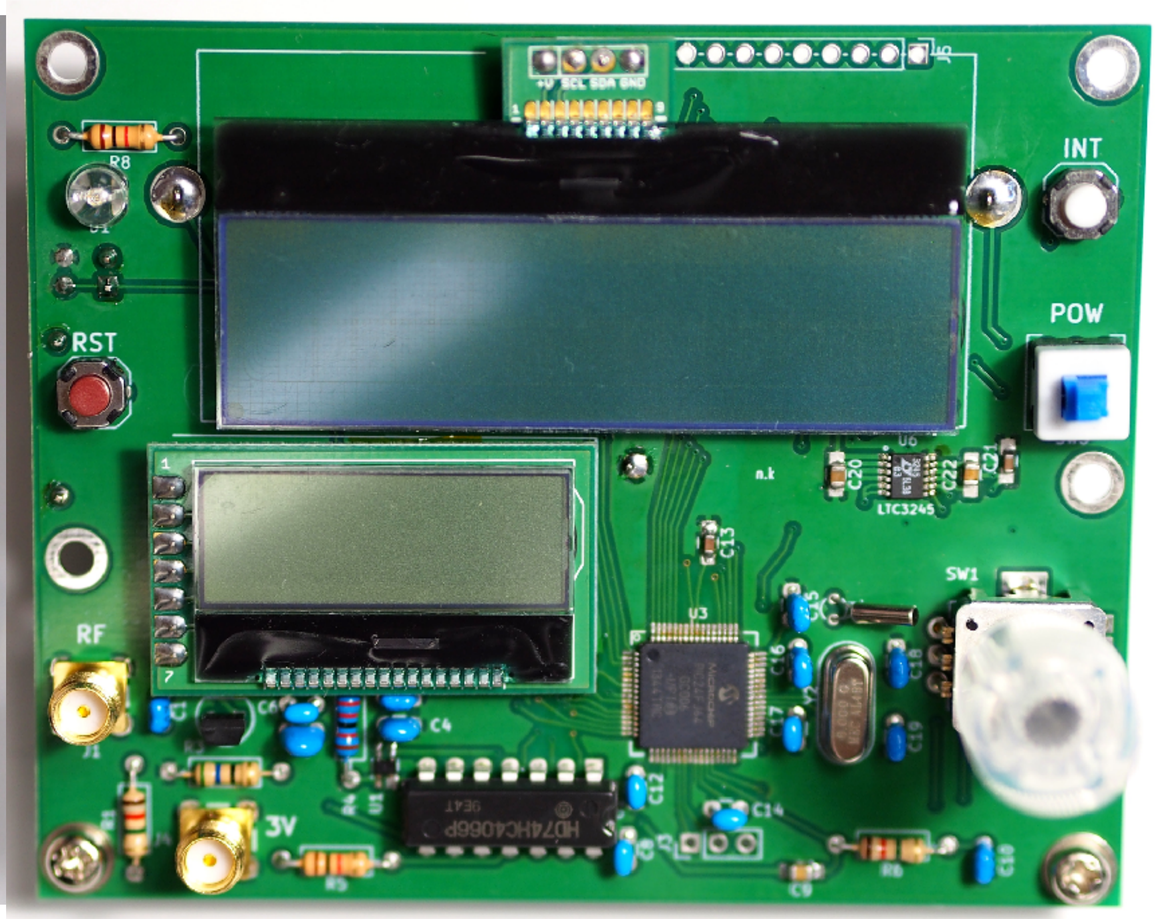
- Tall parts: SW4, Q1, U2, Y1, SW2, U7
- Insulate before installing GFX panel LCD U4
- J1, J4, SW3
  etc: U5, battery holder18650, rotary-encoder U7, JP1, BT2, U5(enabled I2C Pull-UP), SW1

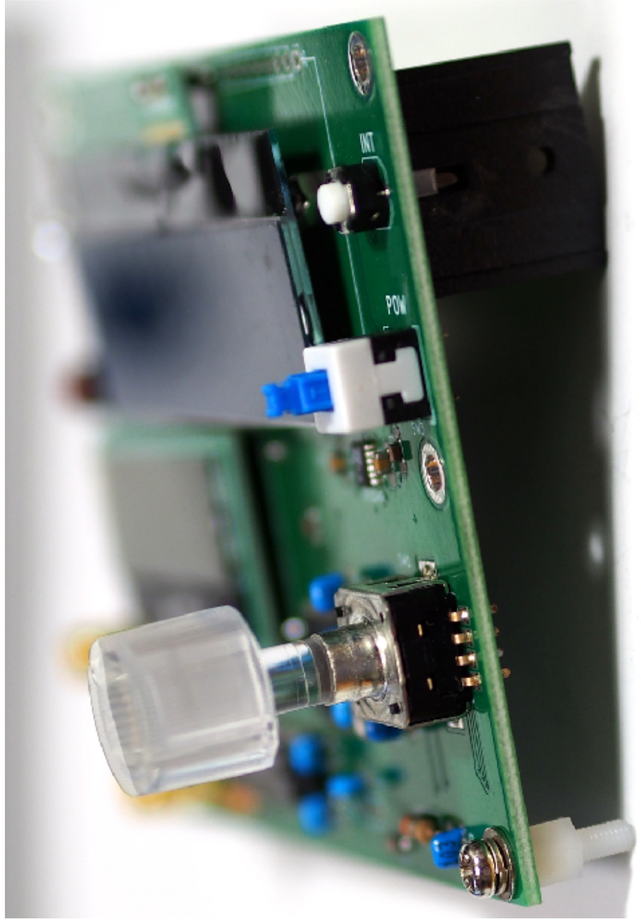


Since it is inserted from the back of the PIC write connector, insulation is required for the GFX LCD.

Assembly completed







program

- https://github.com/agysft/08_FreqCounterWaveform.X
- J2 is the writing connector. Since the power pin is connected, connect it to PICkit3 with the power switch Pow (SW3) turned off.
- When writing, do not short-circuit JP1 (remove the short pin). For normal use, short JP1 before use.