

Frequency Counter with Waveform Display

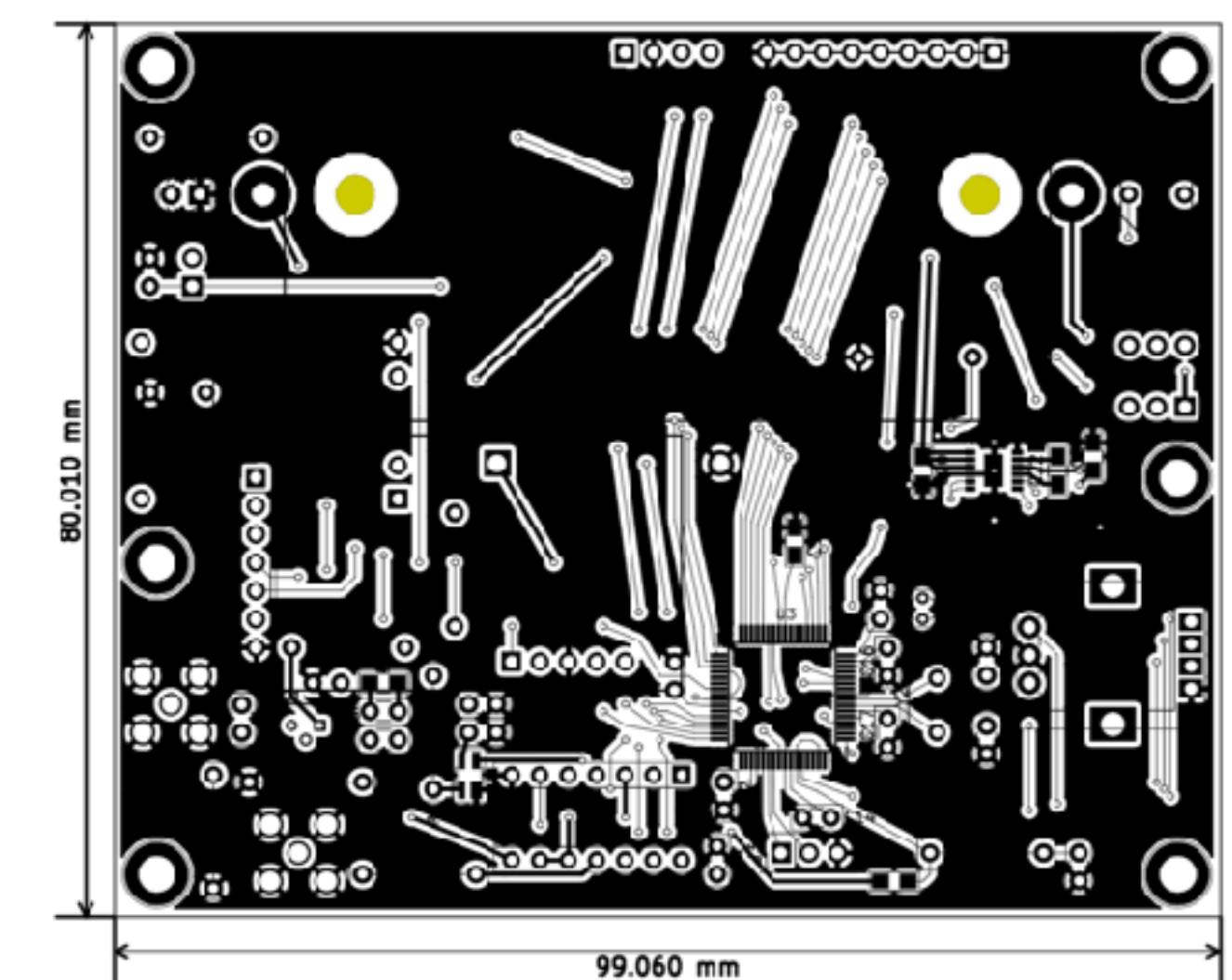
n.k products 202004 agysft

over view

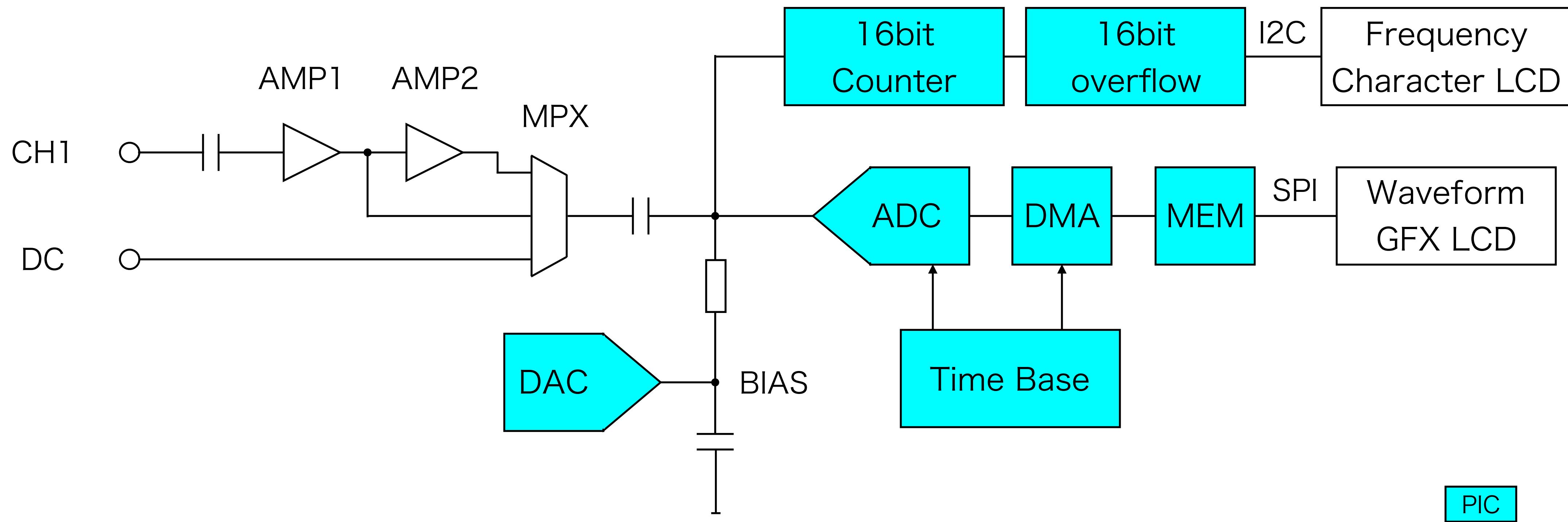


specification

- 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 ($250\text{ns} \times 128 = 32\text{us}$)
 - 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

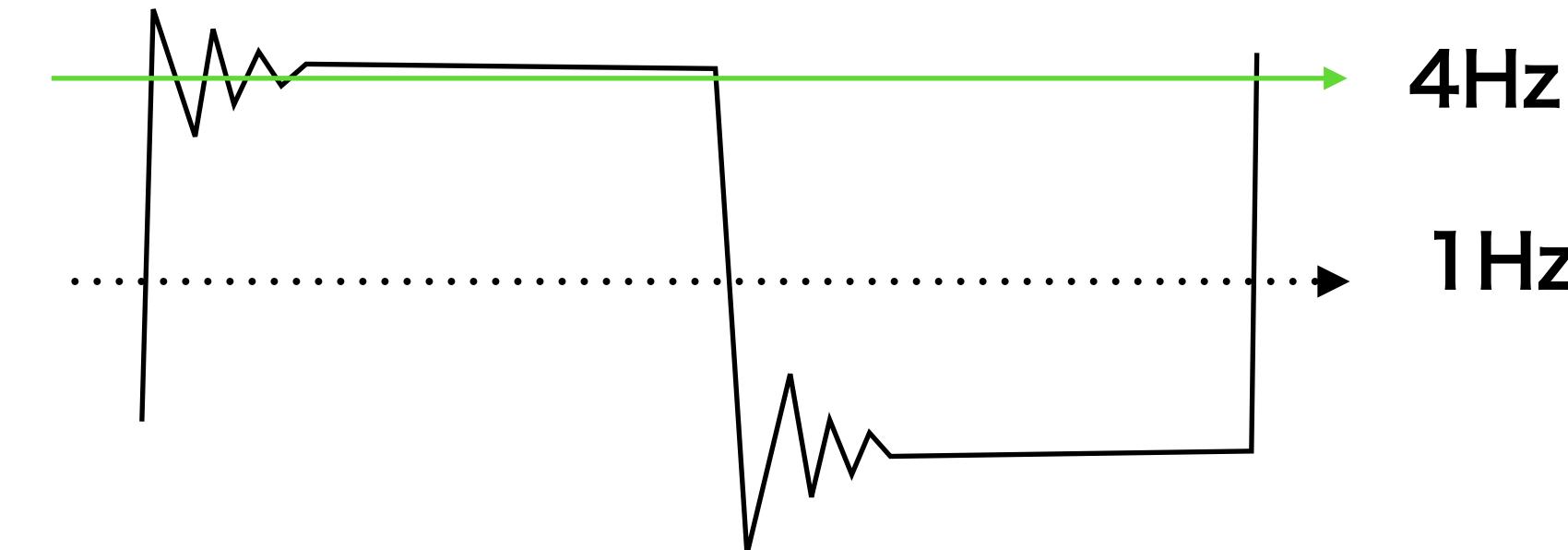
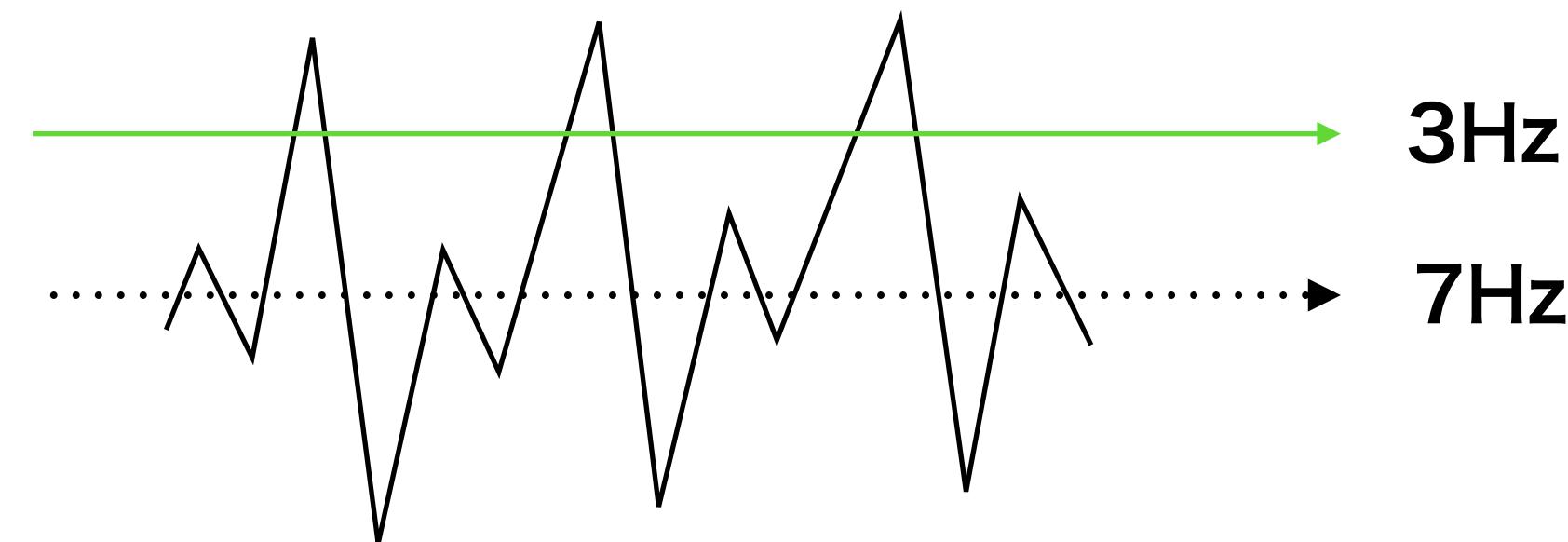


- Signal flow:

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

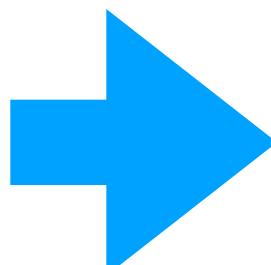
- Frequency measurement
Timer1 is used as an **asynchronous** counter. If it is a synchronous counter, it cannot count above the clock frequency of PIC.

- Timer1 can operate in three modes:

16-BitTimer

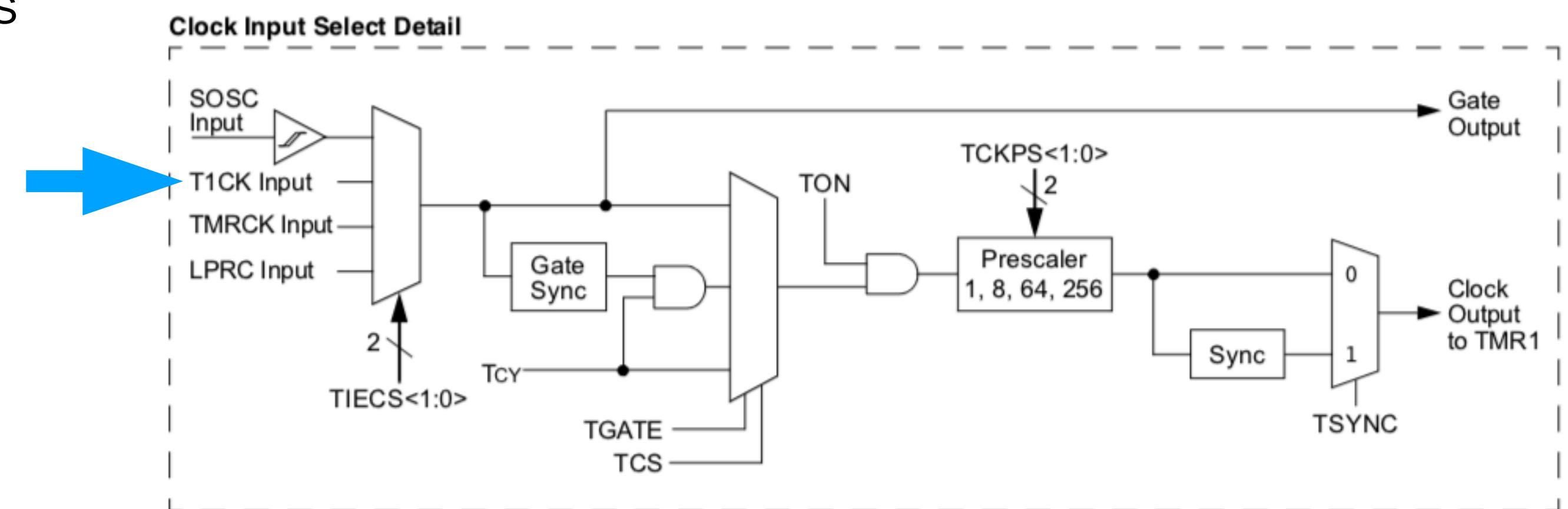
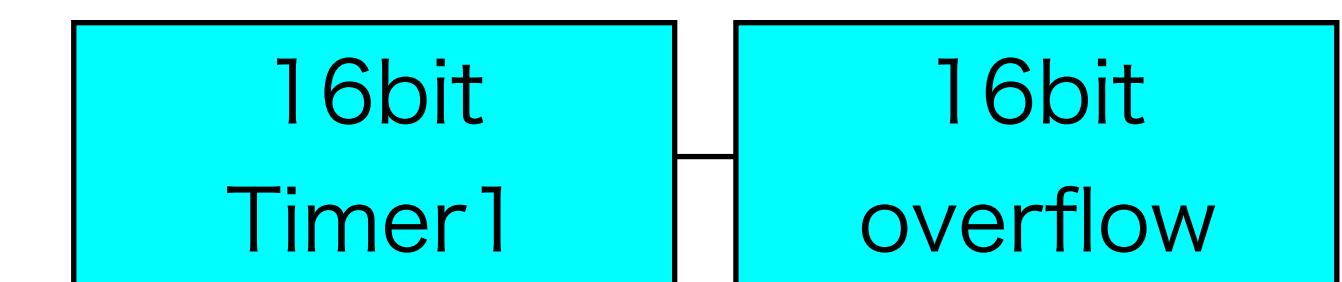
16-BitSynchronousCounter

16-BitAsynchronousCounter



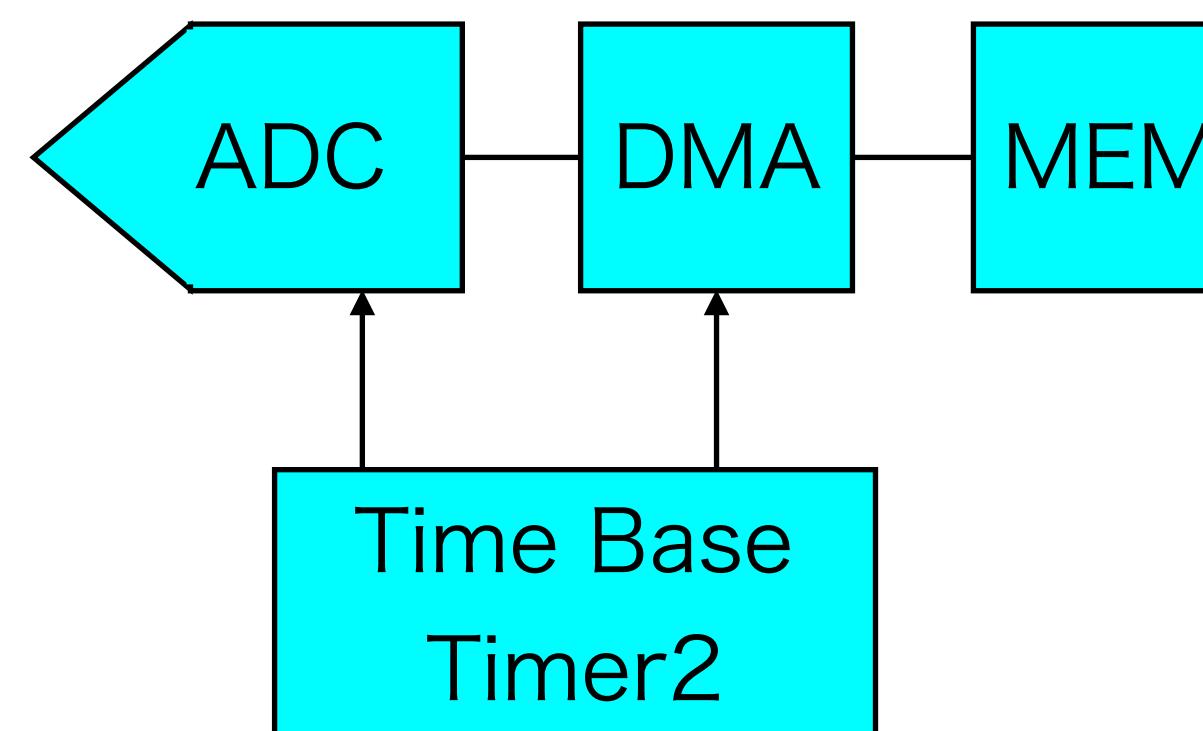
- When Timer1 overflows, an interrupt occurs and the software counts the upper 16 bits.

- The clock is input from the external T1CK

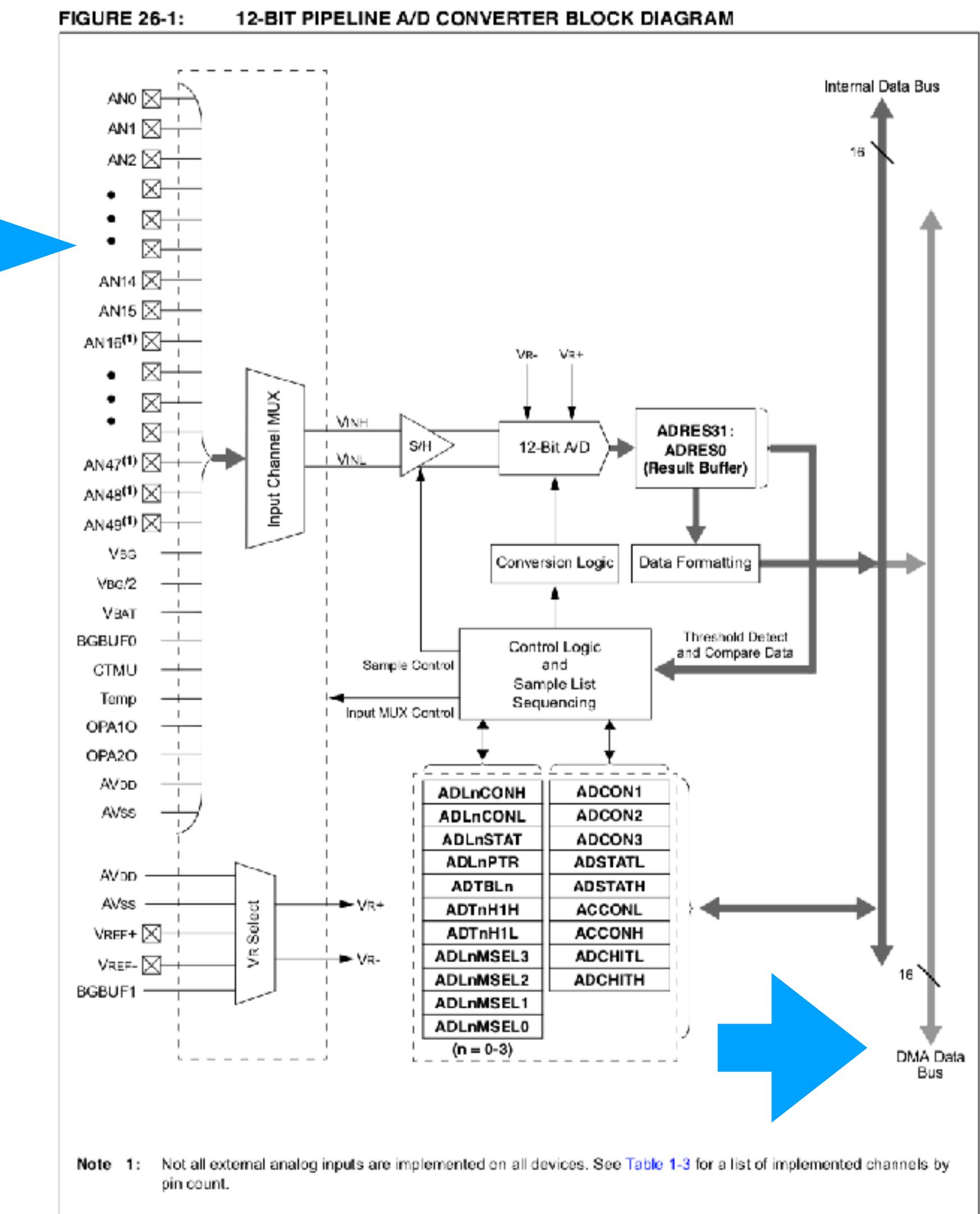


Waveform display

- **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

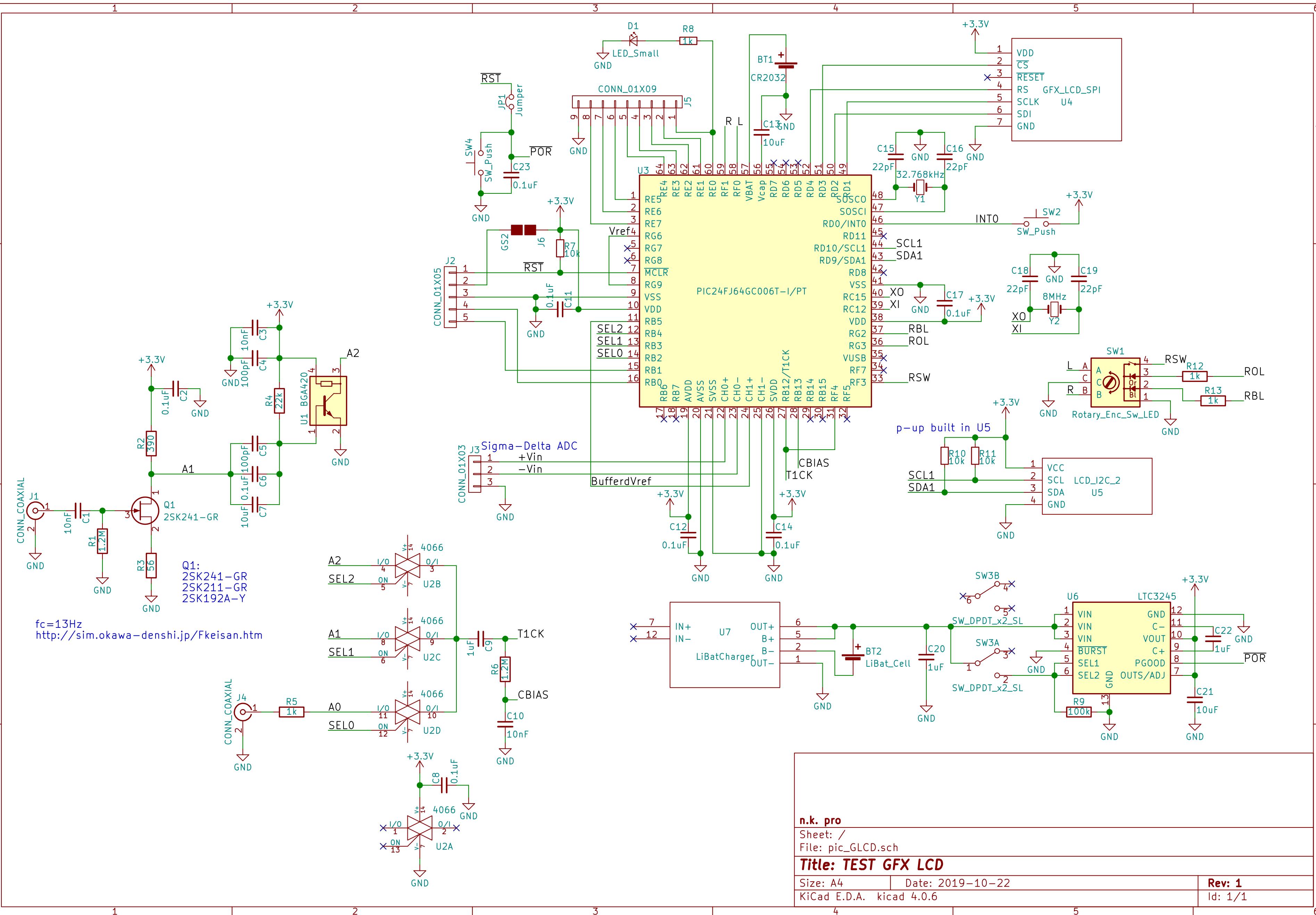


AN11 →



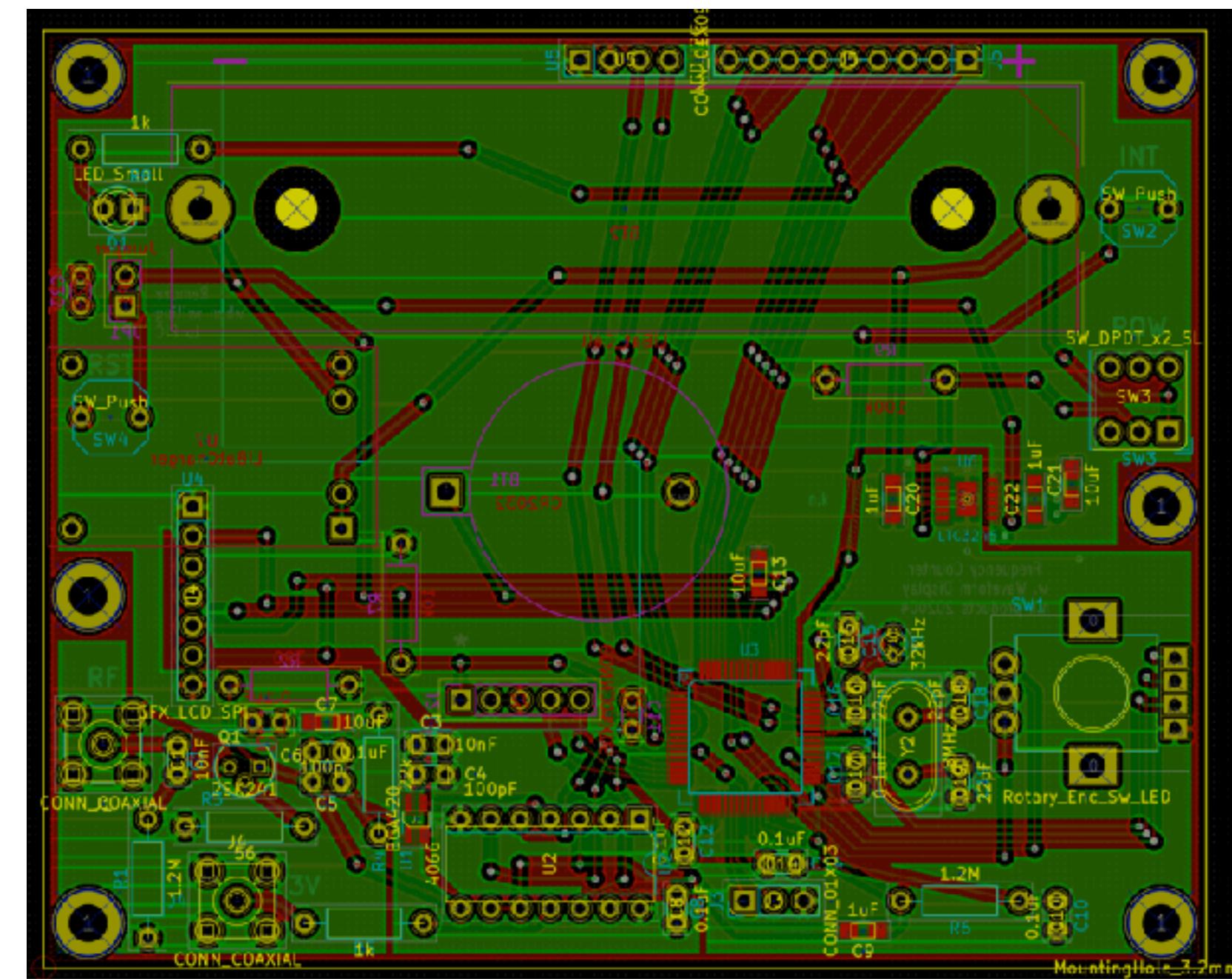
Draw the schematic with “kicad - Eeschema”

BOM



Reference	BOM	
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	SMA	S-063-49-TGG
J4	Pin-Headers	
J5	Pin-Headers	
J6	GS2	
JP1	Pin-Headers	
Q1	2SK241-GR	
R1	1.2M	
R10	10k	
R11	10k	
R12	1k	
R13	1k	
R14	390	
R15	56	
R16	22k	
R17	1k	
R18	1.2M	
R19	10k	
R20	1k	
R21	100k	
R22	100k	
R23	100k	
R24	100k	
R25	100k	
R26	100k	
R27	100k	
R28	100k	
R29	100k	
R30	100k	
R31	100k	
R32	100k	
R33	100k	
R34	100k	
R35	100k	
R36	100k	
R37	100k	
R38	100k	
R39	100k	
R40	100k	
R41	100k	
R42	100k	
R43	100k	
R44	100k	
R45	100k	
R46	100k	
R47	100k	
R48	100k	
R49	100k	
R50	100k	
R51	100k	
R52	100k	
R53	100k	
R54	100k	
R55	100k	
R56	100k	
R57	100k	
R58	100k	
R59	100k	
R60	100k	
R61	100k	
R62	100k	
R63	100k	
R64	100k	
R65	100k	
R66	100k	
R67	100k	
R68	100k	
R69	100k	
R70	100k	
R71	100k	
R72	100k	
R73	100k	
R74	100k	
R75	100k	
R76	100k	
R77	100k	
R78	100k	
R79	100k	
R80	100k	
R81	100k	
R82	100k	
R83	100k	
R84	100k	
R85	100k	
R86	100k	
R87	100k	
R88	100k	
R89	100k	
R90	100k	
R91	100k	
R92	100k	
R93	100k	
R94	100k	
R95	100k	
R96	100k	
R97	100k	
R98	100k	
R99	100k	
R100	100k	
R101	100k	
R102	100k	
R103	100k	
R104	100k	
R105	100k	
R106	100k	
R107	100k	
R108	100k	
R109	100k	
R110	100k	
R111	100k	
R112	100k	
R113	100k	
R114	100k	
R115	100k	
R116	100k	
R117	100k	
R118	100k	
R119	100k	
R120	100k	
R121	100k	
R122	100k	
R123	100k	
R124	100k	
R125	100k	
R126	100k	
R127	100k	
R128	100k	
R129	100k	
R130	100k	
R131	100k	
R132	100k	
R133	100k	
R134	100k	
R135	100k	
R136	100k	
R137	100k	
R138	100k	
R139	100k	
R140	100k	
R141	100k	
R142	100k	
R143	100k	
R144	100k	
R145	100k	
R146	100k	
R147	100k	
R148	100k	
R149	100k	
R150	100k	
R151	100k	
R152	100k	
R153	100k	
R154	100k	
R155	100k	
R156	100k	
R157	100k	
R158	100k	
R159	100k	
R160	100k	
R161	100k	
R162	100k	
R163	100k	
R164	100k	
R165	100k	
R166	100k	
R167	100k	
R168	100k	
R169	100k	
R170	100k	
R171	100k	
R172	100k	
R173	100k	
R174	100k	
R175	100k	
R176	100k	
R177	100k	
R178	100k	
R179	100k	
R180	100k	
R181	100k	
R182	100k	
R183	100k	
R184	100k	
R185	100k	
R186	100k	
R187	100k	
R188	100k	
R189	100k	
R190	100k	
R191	100k	
R192	100k	
R193	100k	
R194	100k	
R195	100k	
R196	100k	
R197	100k	
R198	100k	
R199	100k	
R200	100k	
R201	100k	
R202	100k	
R203	100k	
R204	100k	
R205	100k	
R206	100k	
R207	100k	
R208	100k	
R209	100k	
R210	100k	
R211	100k	
R212	100k	
R213	100k	
R214	100k	
R215	100k	
R216	100k	
R217	100k	
R218	100k	
R219	100k	
R220	100k	
R221	100k	
R222	100k	
R223	100k	
R224	100k	
R225	100k	
R226	100k	
R227	100k	
R228	100k	
R229	100k	
R230	100k	
R231	100k	
R232	100k	
R233	100k	
R234	100k	
R235	100k	
R236	100k	
R237	100k	
R238	100k	
R239	100k	
R240	100k	
R241	100k	
R242	100k	
R243	100k	
R244	100k	
R245	100k	
R246	100k	
R247	100k	
R248	100k	
R249	100k	
R250	100k	
R251	100k	

Draw the pattern with “kicad - Pcbnew”



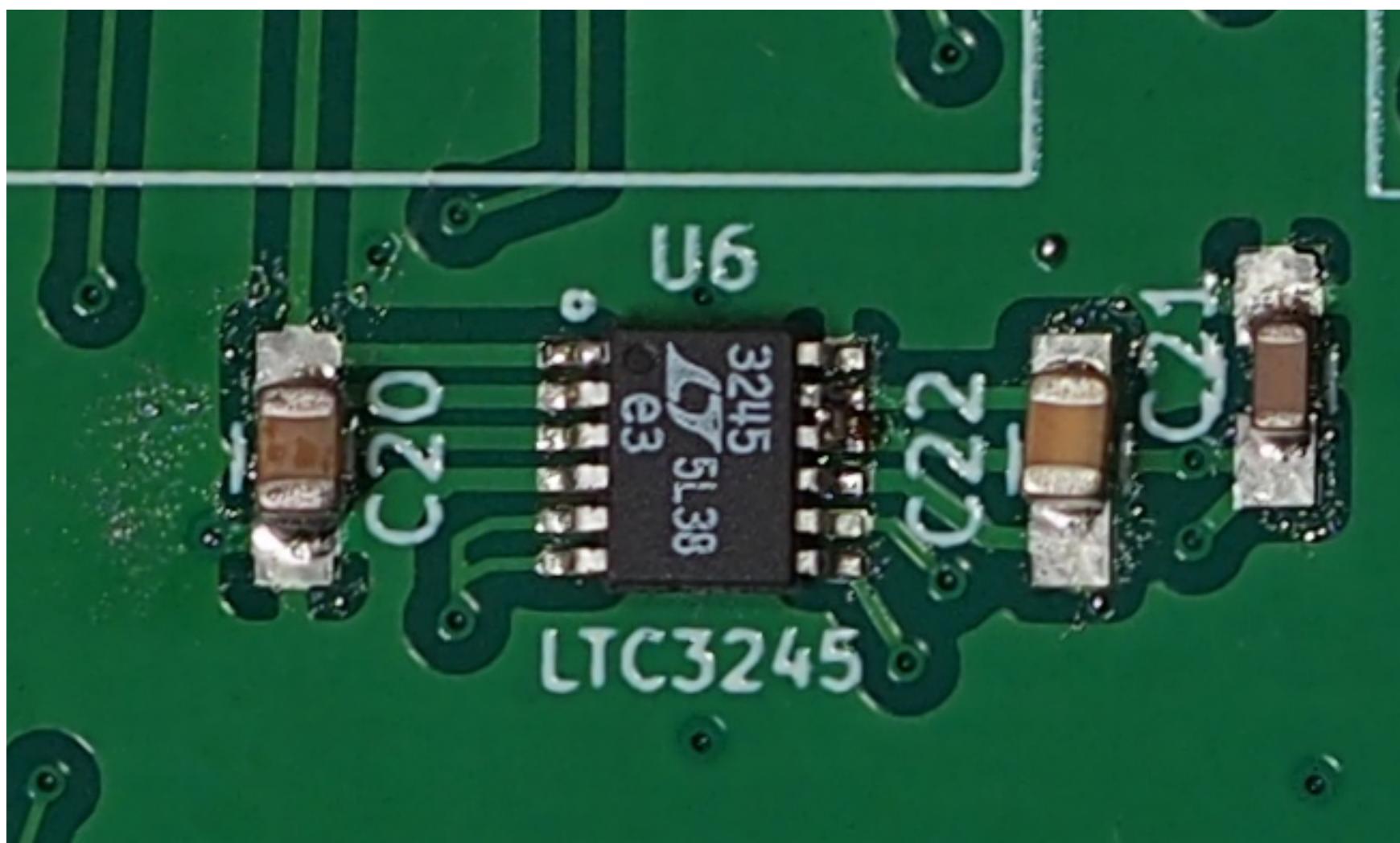
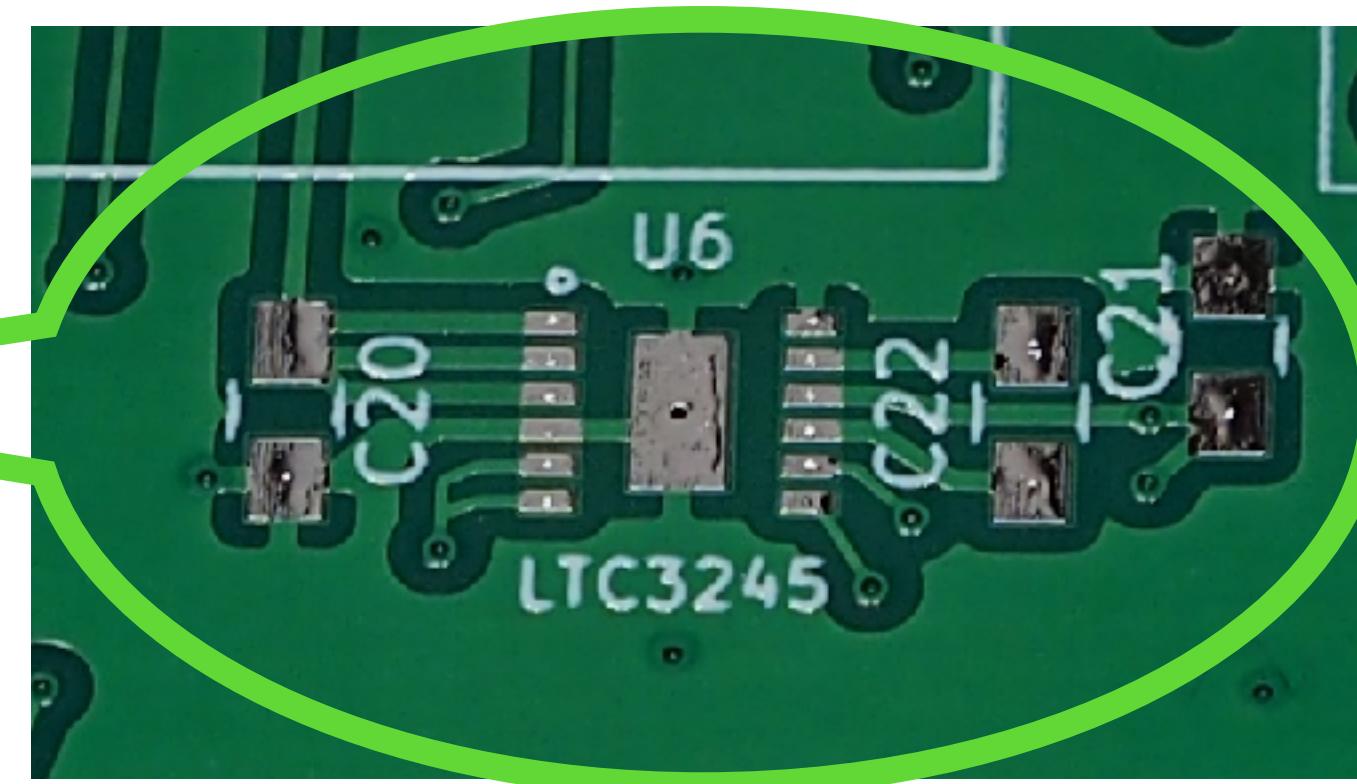
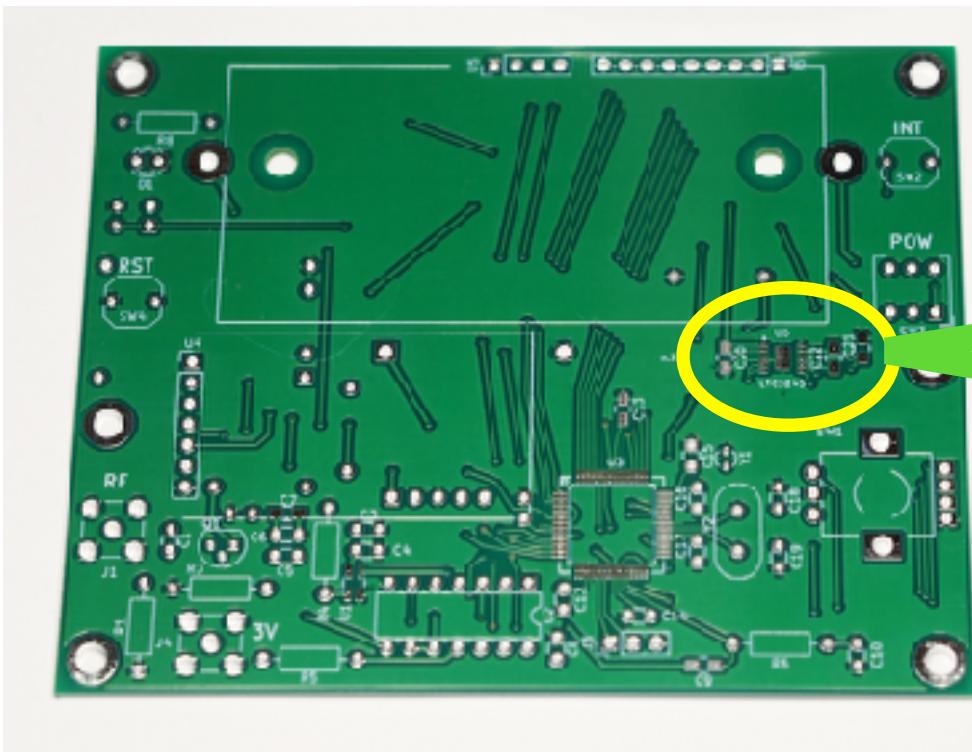
Create a Gerber file and order it to "fusion_pcb"

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

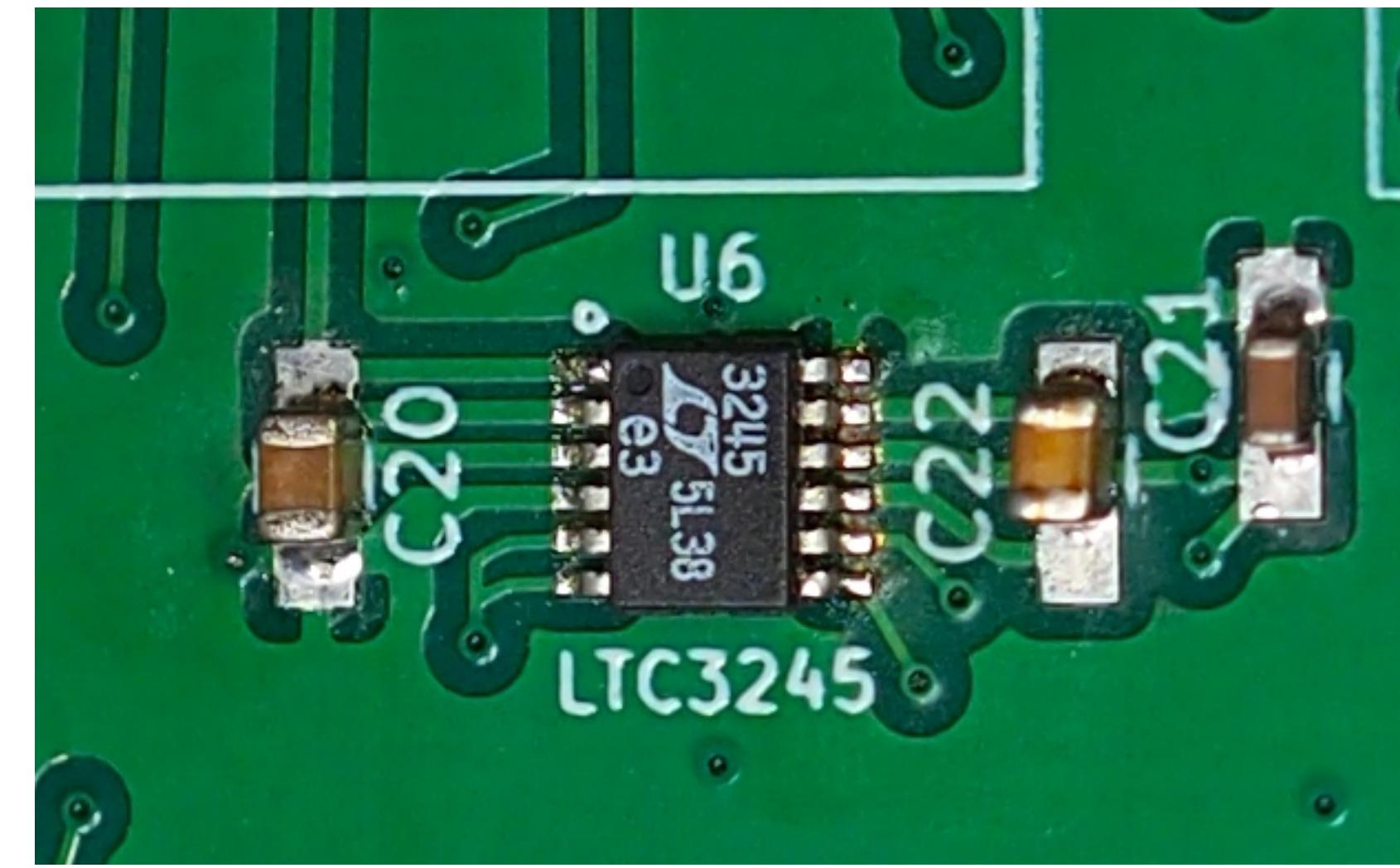
Assemble 1

- LTC3245, C20, C21, C22

Since it is an IC with a heat dissipation pad, solder it with a hot plate.



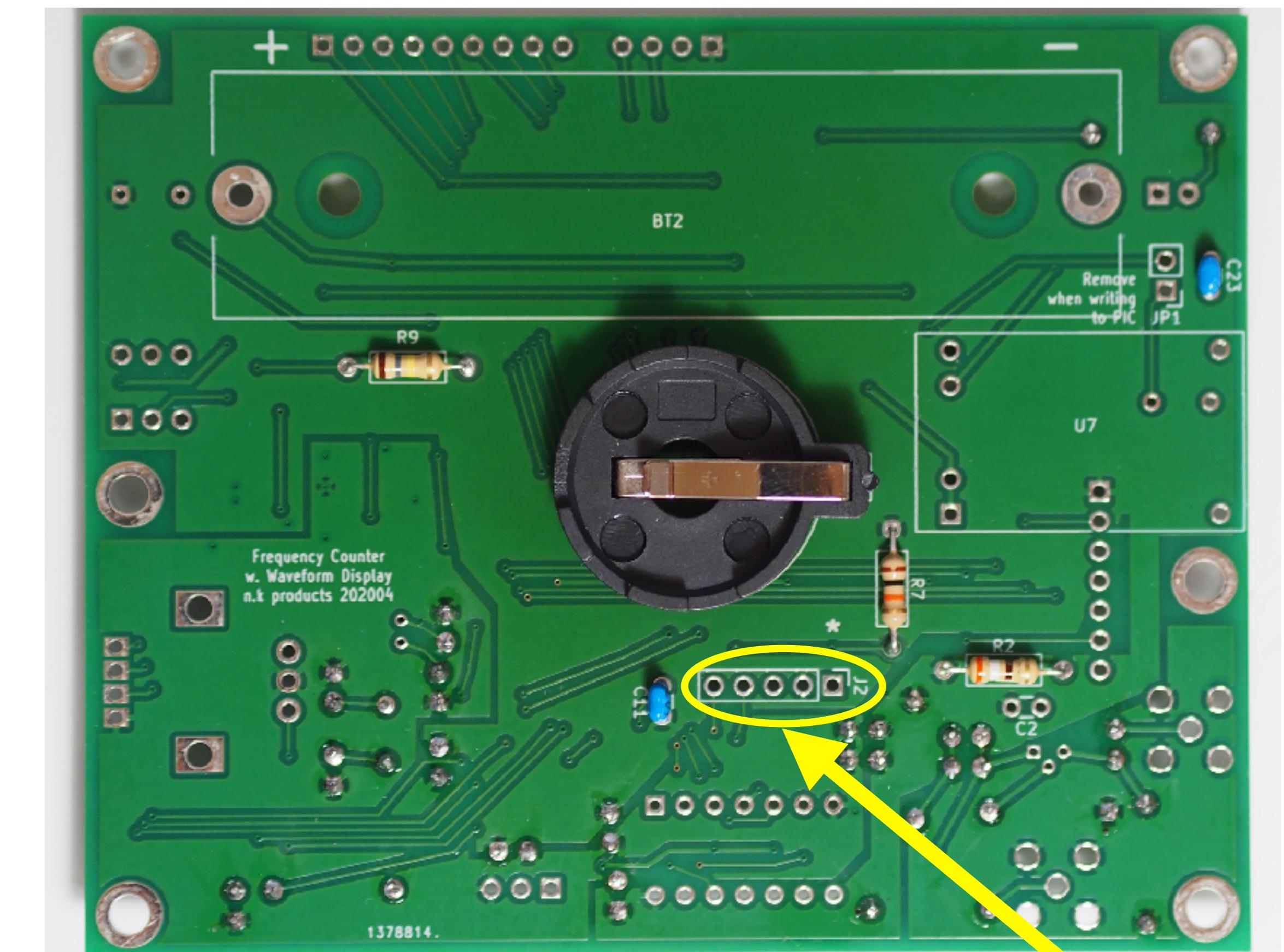
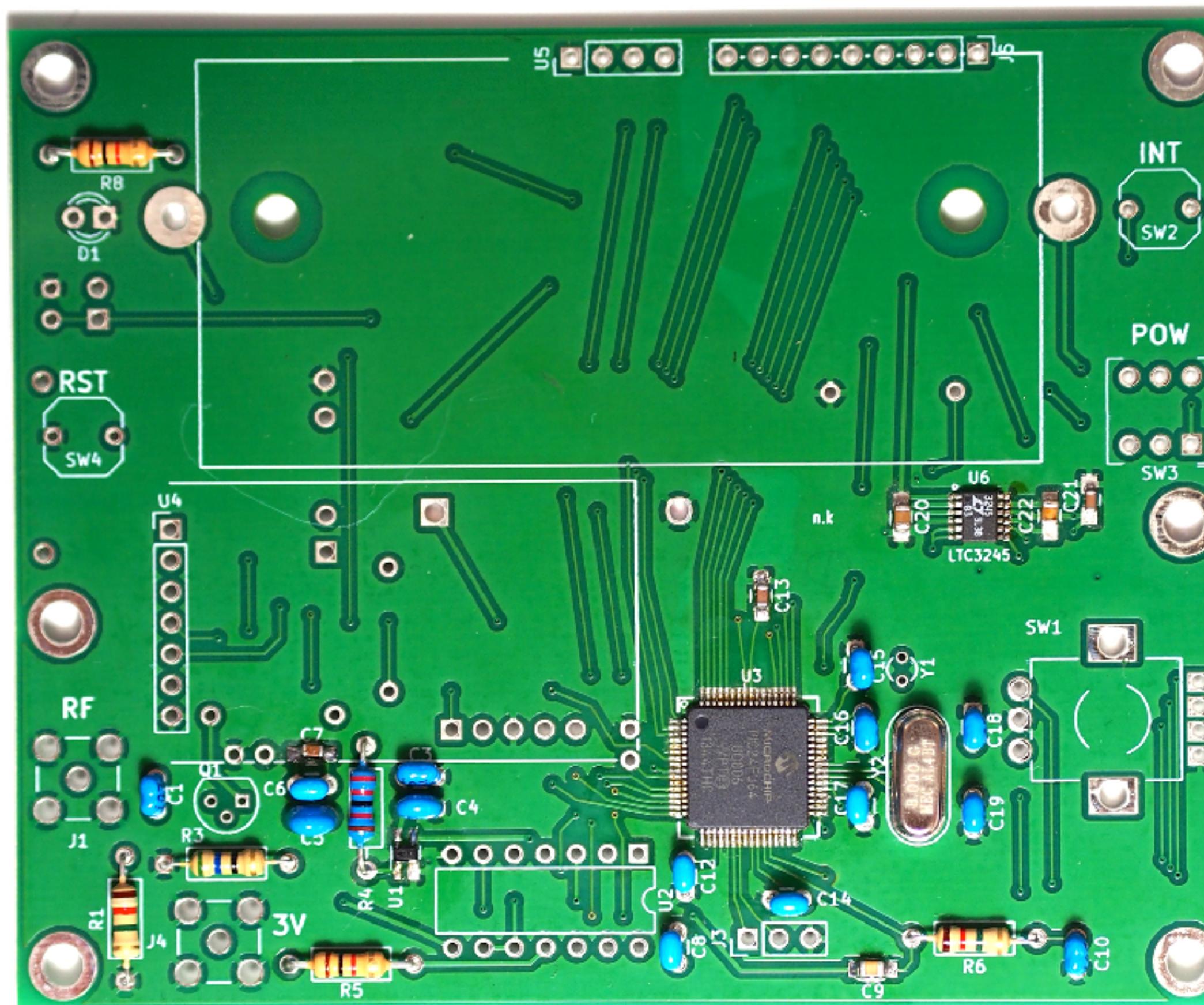
After
heating



correction

Assemble 2

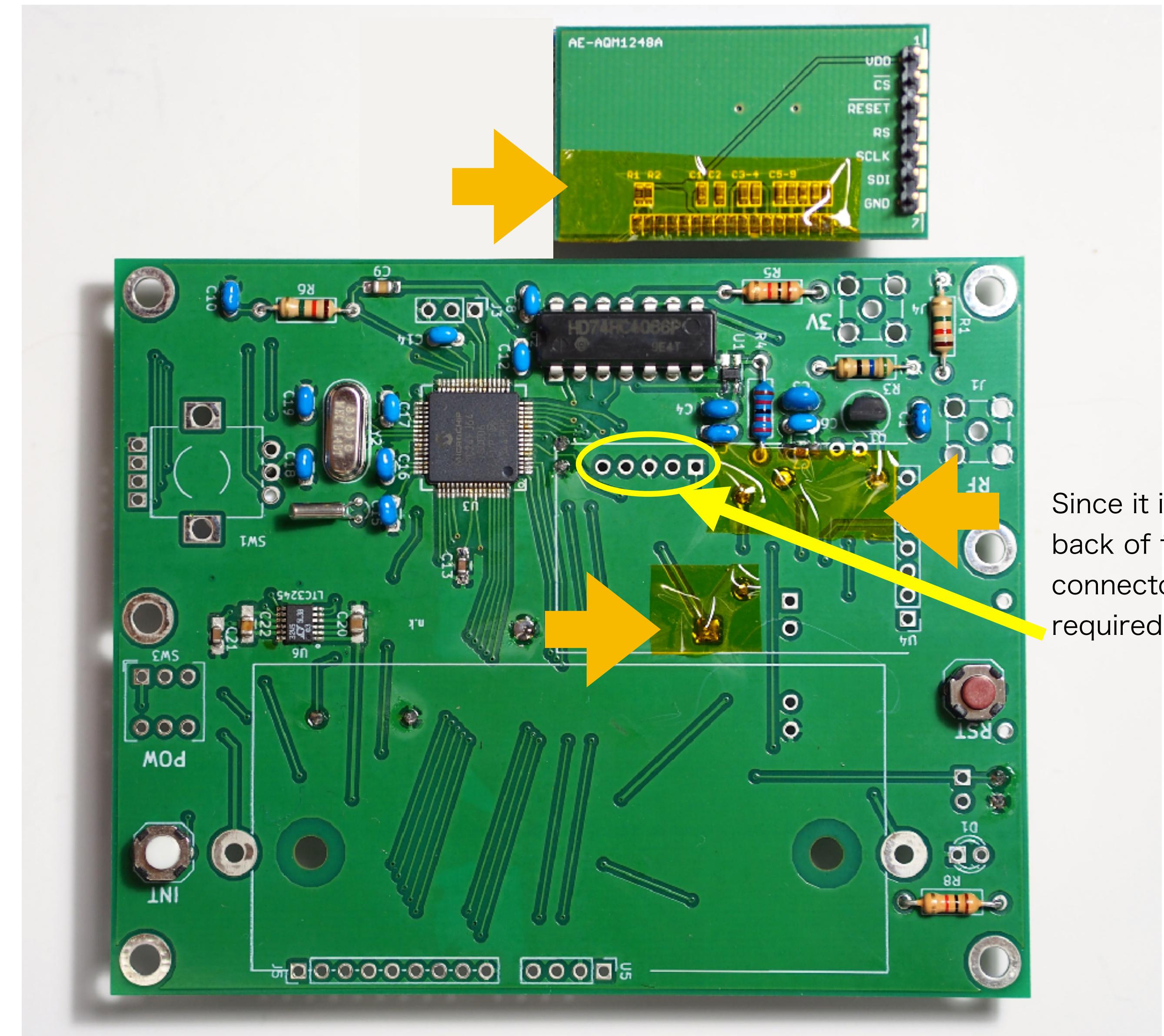
- parts side: U1 BGA420, U3 PIC, SMD capacitors, R8, R1, R3, R4, R5, R6, C1, C6, C5, C3, C4, C12, C8, C14, C15, C16, C17, Y2, C18, C19, C10
Back side: R2, R7, R9, C11, C23, D1, BT1, (J2)



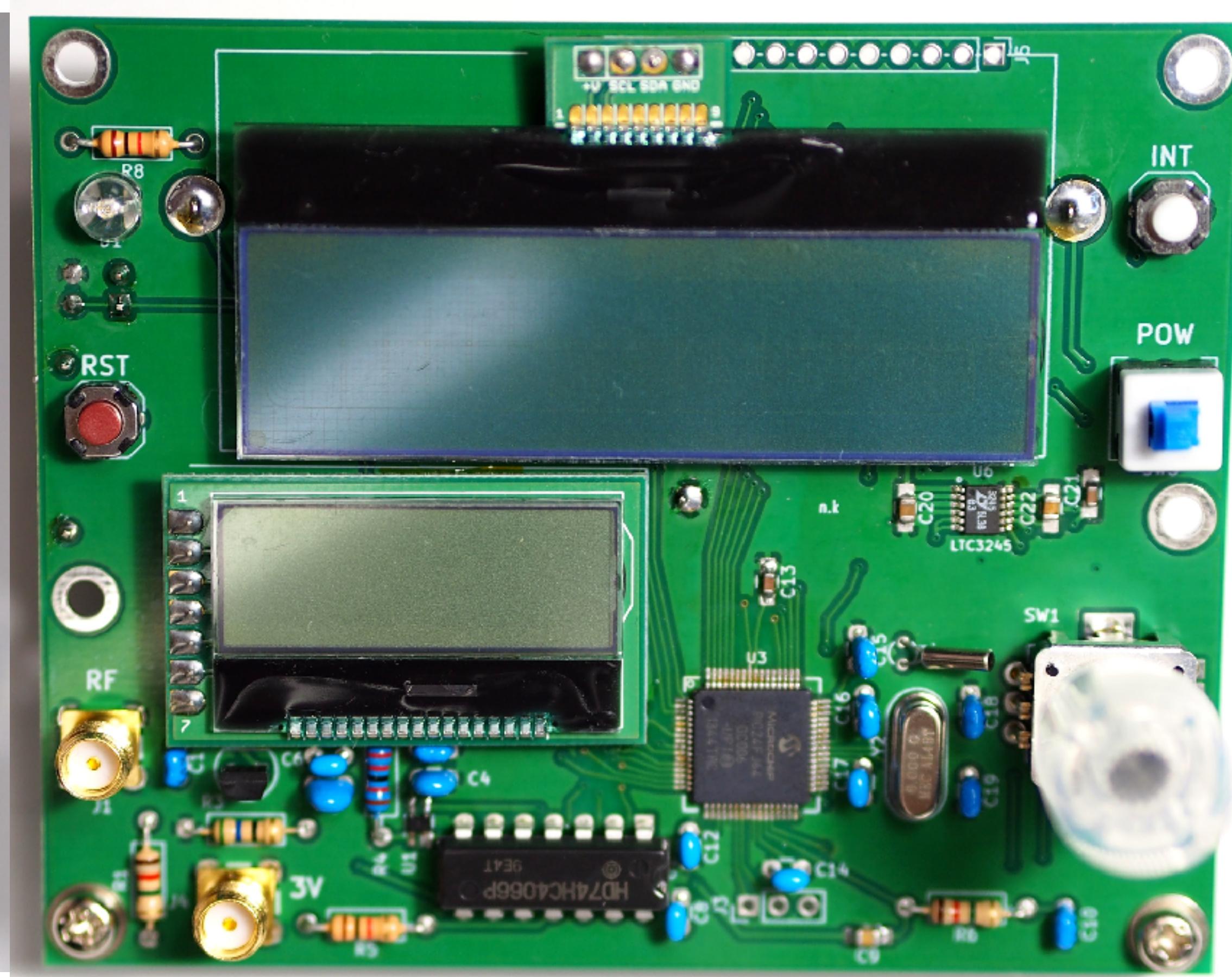
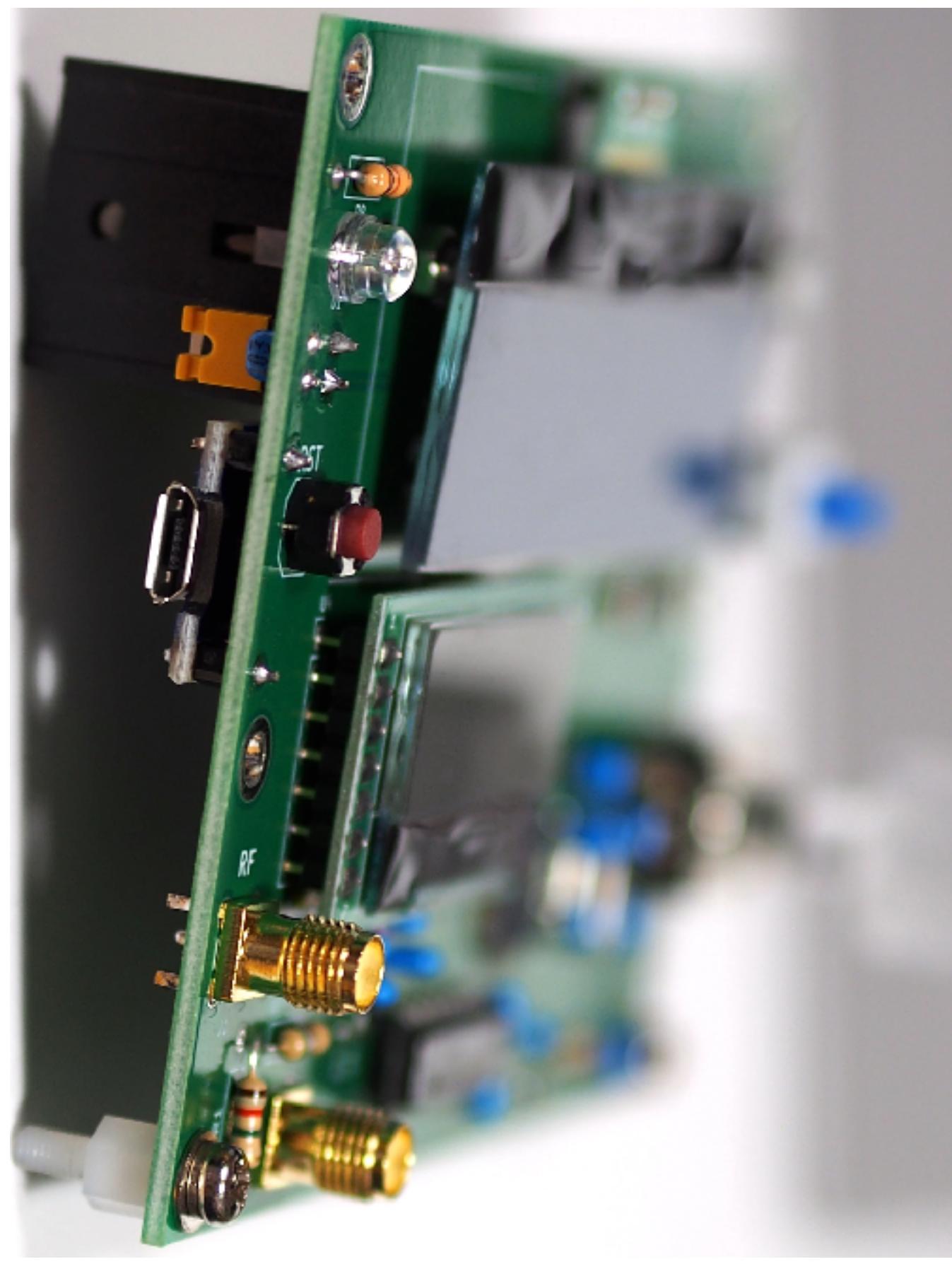
PIC write connector

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



Assembly completed !



program

- https://github.com/agysft/08_FreqCounterWaveform.X
- J2 is the writing connector.
If J6 is close, connect it to PICkit3 with the power switch Pow (SW3) turned OFF.
If J6 is open, connect it to PICkit3 with the power switch Pow (SW3) turned ON.
- When writing, do not short-circuit JP1 (remove the short pin). For normal use, short JP1 before use.