

Build a digital clock

The TJ-56-428 kit: how it's wired, the two chips inside, and how to solder it well



PLAN

Today's 15 minutes

01

What it does

A 5 V clock that shows time, time, date and temperature

2 min

02

How it's wired

The two chips, the sensors and how they connect

5 min

03

How to solder

Safety, the five-second joint, good vs. bad joints

5 min

04

Build and test

Assembly order, power-up, troubleshooting

3 min

By the end you can read the board, name every part, and make a reliable solder joint.

What you're building

A pre-programmed microcontroller, a clock chip and two sensors become a desk clock you soldered yourself.

Power: 5 V DC (USB cable)

Size built: 77 × 33 × 25 mm

Case: stacked acrylic plates



Time and date

Hours, minutes, date, weekday, year



Temperature

Measured with an NTC thermistor



Alarm

Four tunes, adjustable volume



Auto brightness

A photoresistor senses room light



Memory

A coin cell keeps time when unplugged

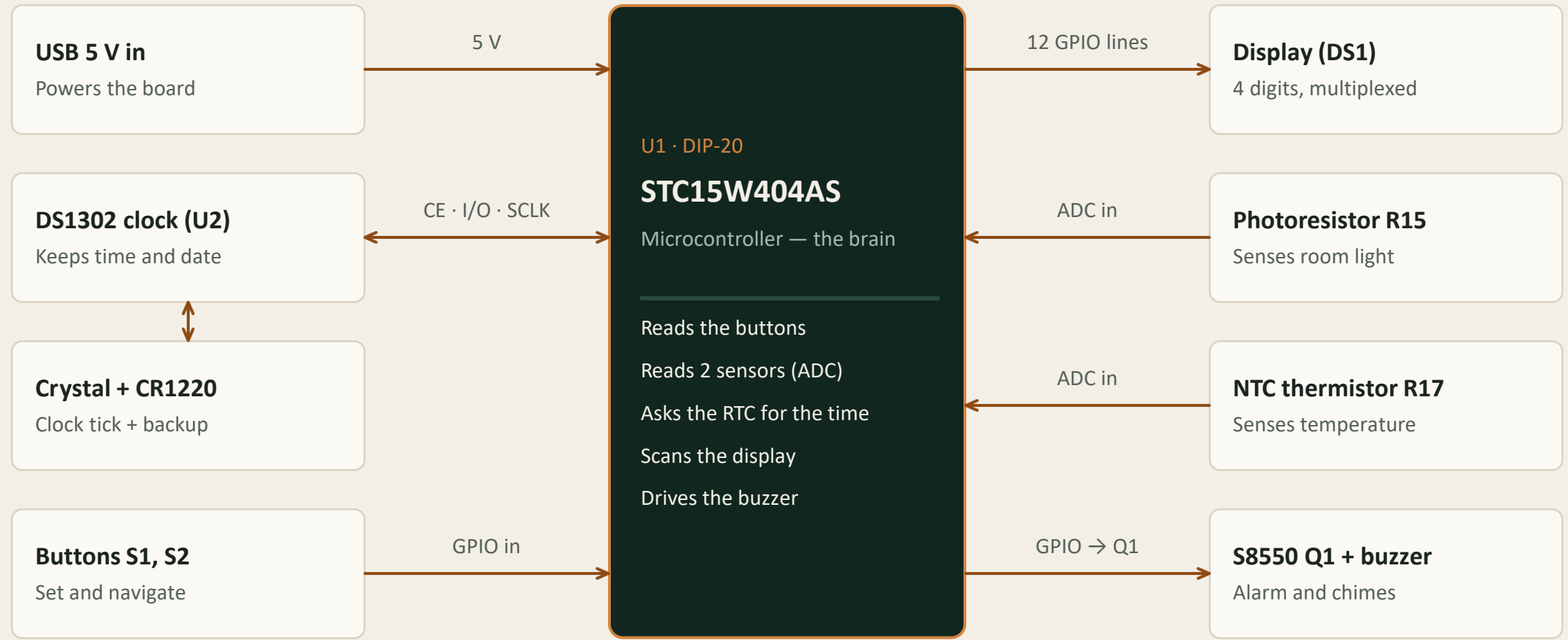


Two buttons

S1 and S2 set everything

PART 2 · CONNECTIONS

How it's wired: everything talks to U1



STC15W404AS: the microcontroller

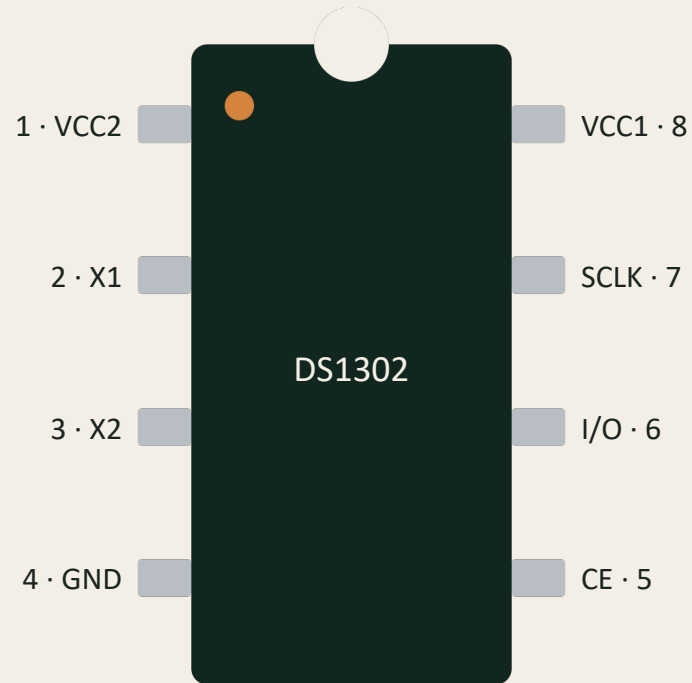


Feature	What it means here
Core	8051-compatible, 1T (fast) version
Program memory	4 KB flash — clock firmware preloaded
RAM	512 bytes
Analog input	10-bit ADC (reads the two sensors)
Clock source	Built-in RC oscillator
Supply	About 2.4–5.5 V; runs at 5 V here

Orientation rule

Notch on the chip → notch on the socket → notch on the silkscreen. The dot marks pin 1. Backwards = it won't work, and it may be damaged.

DS1302: the real-time clock



Counts time

Seconds through years, with leap years handled through 2100.

Three-wire serial link

CE, I/O and SCLK go to U1, which reads and sets the time.

Crystal on X1 and X2

The 32.768 kHz crystal Y2 is its heartbeat.

Two power pins

VCC2 = main 5 V. VCC1 = CR1220 coin cell, so time survives unplugging.

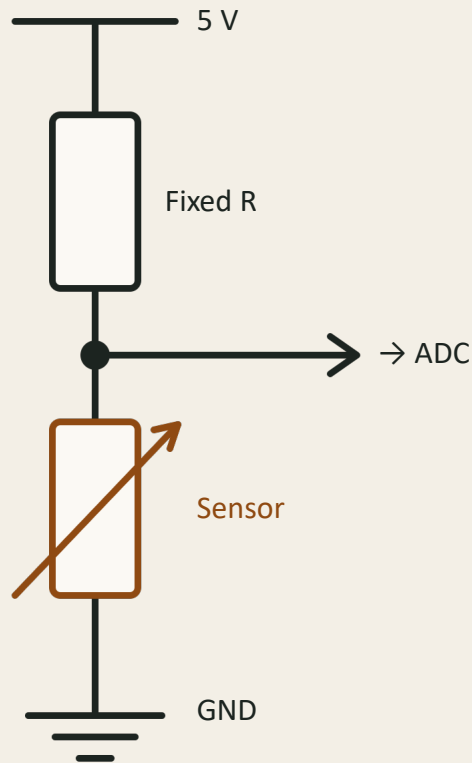
WHY THAT STRANGE CRYSTAL FREQUENCY?

$$32,768 \text{ Hz} = 2^{15}$$

Divide by two, fifteen times, and the crystal's vibration becomes exactly one tick per second. A chain of simple flip-flops does the dividing.

32,768 → 16,384 → 8,192 → ... → 4 → 2 → 1 Hz

Both sensors are voltage dividers



$$V_{out} = 5\text{ V} \times R_{sensor} \div (R_{fixed} + R_{sensor})$$

Change the sensor's resistance and V_{out} moves. The 10-bit ADC turns 0–5 V into a number from 0 to number from 0 to 1023.

NTC thermistor · R17 · 10 k Ω

Negative Temperature Coefficient: warmer → warmer → lower resistance. U1 converts the the voltage to °C. Calibratable in settings. settings.

Photoresistor · GL5516 · R15

Brighter light → lower resistance. U1 dims the display in a dark room (brightness (brightness setting "A" = auto).

Neither part has polarity — but they look alike. Check the silkscreen: R15 vs. R17.

Four digits, one at a time

32

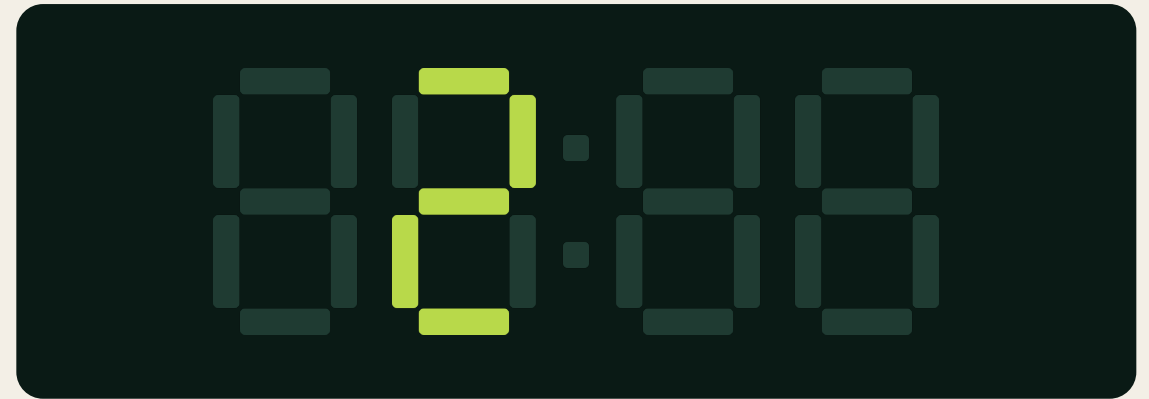
LEDs: 4 digits × (7 segments + dot)

12

pins: 8 shared segment lines + 4 digit selects

U1 turns on one digit, sets its segments, then moves to the next — hundreds of times per second. Your eye blends it into a steady display (persistence of vision).

Shortening each digit's on-time dims the display: that's brightness control works.



A snapshot: only digit 2 is on. A few milliseconds later, digit 3.

Know your parts before you heat anything

Part	Board mark	Watch for
Resistors: 10 k Ω $\times$ 5, 20 k Ω , 510 Ω	R13,16,18,19,21 · R14 · R20	No polarity; confirm value with a meter
Ceramic caps 104 $\times$ 2, 5 pF $\times$ 2	C1 C2 · C4 C5	No polarity; tiny, don't lose them
Electrolytic cap 100 μ F	C3	Stripe = negative; long leg = +
1N4148 diode	D1	Band = cathode; match the silkscreen
S8550 PNP transistor	Q1	Flat face matches the outline
Passive buzzer	LS1	Match the + marking
Photoresistor · 10 k Ω NTC	R15 · R17	No polarity; don't swap them
32.768 kHz crystal	Y2	No polarity; heat briefly
IC sockets DIP-20, DIP-8	U1 · U2	Socket notch $\rightarrow$ silkscreen notch
Buttons, DC jack	S1 S2 · DC	Press flat against the board
4-digit display	DS1	Match silkscreen; decimal points at bottom
CR1220 holder (surface mount)	BT1	Solder it first; mind the + side

Soldering is a metal bond, not glue

1 • Heat

The iron heats the copper pad and the component lead together.

2 • Flux

Flux in the solder's core strips oxide so metal can touch metal.

3 • Wet

Molten tin flows onto both, forming a thin intermetallic bond with the copper.

183 °C

63/37 tin-lead solder melts

~217 °C

Common lead-free (SAC) solder melts

Typical iron temperature setting: 626 - 698 fahrenheit

The tip is ~350 °C. Respect it.



Iron in the stand

Always — never resting on the bench or cable.



Eye protection on

Clipped leads and flicked solder can fly.



Ventilate

Don't breathe flux smoke; use the fume extractor.



Wash your hands

After soldering. No food or drink at the bench.



Hands off hot parts

Hold parts with tape or tweezers, not fingers.



If you get burned

Cool running water 10+ minutes; tell the instructor.

The five-second joint

1

Prep

Wipe the tip on damp sponge or brass wool, then add a dab of solder: a shiny tip transfers heat.

2

Heat

Touch the tip to BOTH pad and lead at the same time. About 1 second.

3

Feed

Feed solder into the tip — not onto the iron.

4

Remove

Pull the solder away first, first, then the iron. Don't move the part while it cools.

5

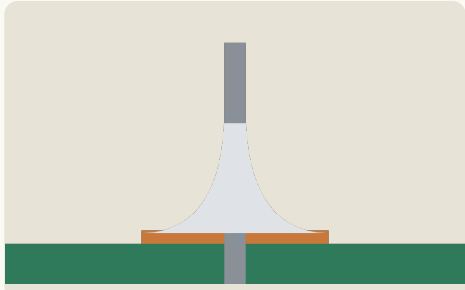
Trim

Clip the lead just above above the joint.



Keep it short. The kit manual warns that holding the iron on a part too long damages it. If a joint isn't working, stop, let it cool, and retry.

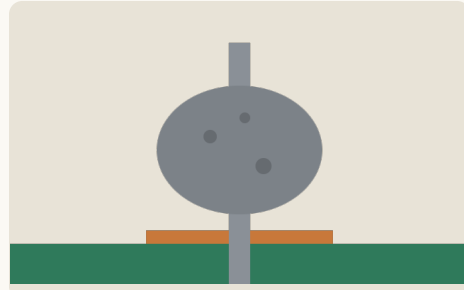
Good joint vs. bad joint



✓ PASS

Good joint

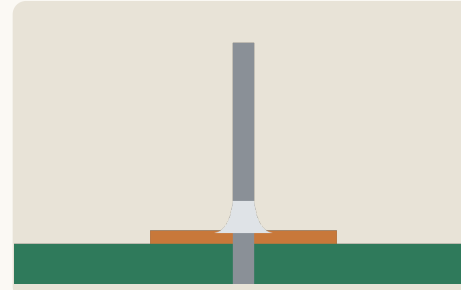
Shiny, smooth, concave that wets pad and lead.



✗ FIX

Cold or blobby

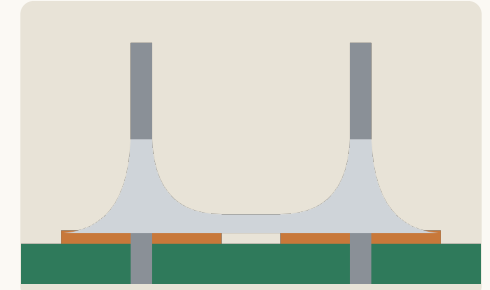
Dull, grainy ball that never wetted the pad. Reheat the joint.



✗ FIX

Too little

Pad not covered. Reheat and add a little more solder.



✗ FIX

Bridge

Solder joins two pads: a short. Remove with wick or a clean tip.

Build order: flat parts to tall parts

1

Surface mount first

CR1220 holder BT1: tack one pad, align, then solder the other.



2

Lowest parts

Resistors, 1N4148 diode, ceramic caps, crystal Y2.



3

Medium parts

IC sockets (not the chips!), S8550, buttons, sensors, buzzer, 100 μ F cap.



4

Tallest parts

DC jack and the 4-digit display. Then, power off, insert U1 and U2 by the notch and add the coin cell.

Why this order? The board lies flat on the bench while you work, so each part sits snug against it. Solder the sockets, not the chips — the chips never see the iron.

Power up and set the clock

Before you plug in

- ✔ Inspect every joint under good light or a magnifier.
- ✔ Look for bridges, especially on the socket pins.
- ✔ Meter on continuity: 5 V to GND must NOT beep.
- ✔ Chips seated, notches matching the silkscreen.

Then plug in USB 5 V

Garbled digits on the very first power-up are normal — set the set the time and date.

Hold S1 + S2 for 3 seconds → setup

Mode	Sets
Fu-1	Time (hour, minute)
Fu-2	Date: month, day, year (2000–2099)
Fu-3	Alarm time; hour 24 = alarm off
Fu-4	Hourly chime, display mode, brightness (A = auto)
Fu-5	Alarm tune (1 of 4), volume 4–40

S1 changes the value or picks the mode. **S2** selects, moves to the next field, and saves.

If it doesn't work, think like an engineer

Symptom	Check first
Nothing lights up	USB power, DC jack joints, U1 orientation
One segment dark on every digit	That segment's display pin: cold joint
One whole digit dark	That digit's select pin on the display
Time lost when unplugged	CR1220 cell present, + side, BT1 joints
Clock runs fast or slow	Crystal Y2 and C4/C5 joints
Temperature reads off	Calibrate: Fu-4 display mode 3
No alarm sound	Q1 orientation, buzzer joints; Fu-3 hour ≠ 24

Reason from the block diagram: which block would cause exactly this symptom? Then inspect that block's joints first.

WRAP-UP

Three habits to take to every build

01

Check orientation twice.

Notch, band, stripe, flat face, + mark.

02

Heat the joint, not the solder.

Let the hot metal melt the solder.

03

Inspect before power.

Look, then meter, then plug in.

Questions? Then sort your parts, heat up your iron, and start with BT1.