Smart Thermostat Build Guide

Complete Documentation Package

Generated: November 26, 2025
Version: 2.0
Compatibility: Web Serial API, CH340 Relay, DS18B20 Sensor, Android Tablets

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🚀 Quick Start Guide {#quick-start}

What You're Building

A professional smart thermostat system using:

- **7" Android tablet** as the display/controller

- **CH340 USB relay module** to control HVAC equipment

- **DS18B20 USB temperature sensor** for accurate readings

- **24VAC power from furnace** (no batteries needed!)

- **Your custom React app** for complete control

Timeline

- **Component Testing:** 1-2 hours

- **Integration:** 1-2 hours

- **Initial Testing:** 24-48 hours

- **Optimization:** Ongoing

✅ Parts Compatibility Check {#compatibility}

Component	Status	Notes
ONN Surf 7" Tablet	✅ Perfect	Android tablet with USB OTG
CH340 8CH USB Relay	✅ Perfect	AT command support built-in
DS18B20 USB Thermometer	✅ Perfect	Works with Web Serial API

Component	Status	Notes
Wall Mounted AC L-2008	✅ Perfect	Your HVAC unit to control
24VAC to 12VDC Converter	⚠️ Required	Powers relay module
24VAC to 5VDC USB Converter	⚠️ Required	Powers tablet continuously
USB Cables/Adapters	⚠️ Required	For connections
Tablet Wall Mount	✨ Recommended	Professional installation

All your existing parts are compatible! You just need the power converters and cables.

🛒 Shopping List {#shopping-list}

Priority 1: Core Installation (Required)

Item	Price	Notes
ONN Surf 7" Tablet (32GB, 3GB RAM)	$45.00	✅ In Cart
8CH USB Serial Port Relay Module (CH340)	$16.41	✅ In Cart
AC 24V to DC 5V 3A USB Converter	$22.00	✅ In Cart
24VAC to 12VDC Converter	$18.99	✅ In Cart
USB A to B Cable (1.5m)	$3.69	✅ In Cart
USB-C to USB-A OTG Adapter	$5.49	✅ In Cart
360° Rotation Tablet Wall Mount	$11.98	✅ In Cart

Subtotal: $123.56

Priority 2: Temperature Sensor & USB Hub (Required)

Item	Price	Notes
DS18B20 USB ASCII Thermometer	$35.00	⚠️ **ADD THIS**
Anker 4-Port Powered USB Hub	$20-25	⚠️ **ADD THIS**

Subtotal: $55-60

Priority 3: Testing & Safety (Recommended)

Item	Price	Notes
Extension Cord (12-16 AWG)	$8-15	For testing
Wire Nuts (Assorted, #22-18 AWG)	$5-8	Secure connections
Electrical Tape	$3-5	Safety

Subtotal: $16-28

Total Cost Summary

Configuration	Cost
Minimum Setup	~$178-183
Recommended Setup	~$199-216
Complete Setup (with all options)	~$235-291

⚠️ Safety Overview {#safety-overview}

Critical Safety Rules

1. **Always turn off power** before wiring

2. **Use proper wire gauge:**
   - 18-22 AWG for 24VAC (low voltage)
   - 14-16 AWG for 120VAC (line voltage)

3. **Use wire nuts** for all connections (never just twist wires)

4. **Test with multimeter** before applying power

5. **Check relay ratings** (10A max on CH340 module)

6. **Keep water away** from all electrical connections

Electrical Ratings

Component	Rating	Max Load
CH340 Relay Module	10A @ 250VAC	Check your AC unit!
Typical Small AC (5,000 BTU)	~5A	✅ Safe
Medium AC (8,000 BTU)	~7A	✅ Safe
Large AC (12,000 BTU)	~10A	⚠️ At limit
Very Large AC (18,000+ BTU)	12-15A	❌ Need contactor

🔌 USB Relay Module Setup {#relay-setup}

CH340 8-Channel USB Relay Module

Specifications:

- **Model:** DC 5V/12V/24V 8CH USB Serial Port Relay Module

- **Chip:** CH340 USB-to-Serial

- **Connector:** USB-B (female)

- **Relays:** 8 channels (plenty for W, Y, G + future expansion)

- **Rating:** 10A @ 250VAC

- **Command Format:** AT commands or 8-byte binary

- **Cost:** ~$15-25

Why This Module Is Perfect

✅ **CH340 chip** - Well-supported on Android, Windows, Linux, Mac
✅ **Very affordable** - Cheaper than SainSmart alternatives
✅ **8 relays** - More than you need (W, Y, G), but future-proof
✅ **AT commands** - Simple text commands, easy to debug
✅ **Auto-recognition** - Supports both AT and binary commands

Hardware Setup

1. USB Connection

For Android Tablet:

- USB-B to USB-C adapter (or USB-B to USB-A, then USB-A to USB-C OTG)

- Connect USB-B end to relay module

- Connect USB-C end to tablet via OTG adapter

For Computer (testing):

- Standard USB-A to USB-B cable

2. Power Supply

The module needs **external power** (even when connected via USB):

Option A: Use Furnace Transformer (Recommended!)

```
Furnace 24VAC Transformer
    ↓
24VAC to 12VDC Converter
    ↓
Relay Module Power Terminals
```

Option B: Separate Power Supply

- Use wall adapter (5V/12V/24V depending on module jumper)

- Connect to module's power terminals

3. Wiring to HVAC

```
Relay Module        →  Furnace
_____

Relay 1 (NO)        →  W (Heat)
Relay 2 (NO)        →  Y (Cool)
Relay 3 (NO)        →  G (Fan)
Common (C)          →  C (24VAC return)
```

AT Command Format

Turn Relay ON:

```
AT+ON1\r\n   (Relay 1)
AT+ON2\r\n   (Relay 2)
AT+ON3\r\n   (Relay 3)
```

Turn Relay OFF:

```
AT+OFF1\r\n  (Relay 1)
AT+OFF2\r\n  (Relay 2)
AT+OFF3\r\n  (Relay 3)
```

⚠️ **Note:** Relay numbers are 1-based (1-8), not 0-based!

Testing the Relay

Using Web Serial API (in browser):

```javascript
```

```javascript
const port = await navigator.serial.requestPort();
await port.open({ baudRate: 9600 });
const writer = port.writable.getWriter();
const encoder = new TextEncoder();

// Turn on relay 1
await writer.write(encoder.encode("AT+ON1\r\n"));

// Turn off relay 1
await writer.write(encoder.encode("AT+OFF1\r\n"));
```

🌡️ Temperature Sensors {#temperature-sensors}

DS18B20 USB ASCII Thermometer (Recommended)

Specifications:

- **Interface:** USB Serial (PL-2303TA chip)

- **Output Format:** ASCII text (e.g., "+25.3C")

- **Update Rate:** Every 10 seconds

- **Temperature Range:** -55°C to +125°C

- **Accuracy:** ±0.5°C (-10°C to +85°C)

- **Resolution:** 0.1°C

- **Cable Length:** 5m (extendable to 100m)

- **Water Resistant:** Yes

- **Cost:** ~$10-20

Why This Sensor Is Perfect

✅ **Web Serial API** - Same interface as your relay!
✅ **ASCII format** - Super easy to parse
✅ **PL-2303TA chip** - Well-supported on Android
✅ **Same USB hub** - Can use same hub as relay
✅ **No drivers needed** - Standard serial device
✅ **Good accuracy** - ±0.5°C is excellent
✅ **Water resistant** - Can measure liquid temperatures

Integration Code

```javascript
javascript
// Connect to sensor
const port = await navigator.serial.requestPort();
await port.open({ baudRate: 9600 });

const reader = port.readable.getReader();
const decoder = new TextDecoder();

// Read temperature data (sent every 10 seconds)
const { value } = await reader.read();
const data = decoder.decode(value).trim(); // e.g., "+25.3C"
const tempC = parseFloat(data.replace("C", ""));
const tempF = (tempC * 9) / 5 + 32;

console.log(`Temperature: ${tempF.toFixed(1)}°F`);
```

Sensor Placement

Optimal Location:

- ✅ Away from direct sunlight

- ✅ Away from AC vents

- ✅ At average room height (4-5 feet)

- ✅ Not near heat sources (lamps, computers, stoves)

- ✅ Good air circulation

⚡ Power Supply Configuration {#power-supply}

Using Furnace Transformer (Best Option!)
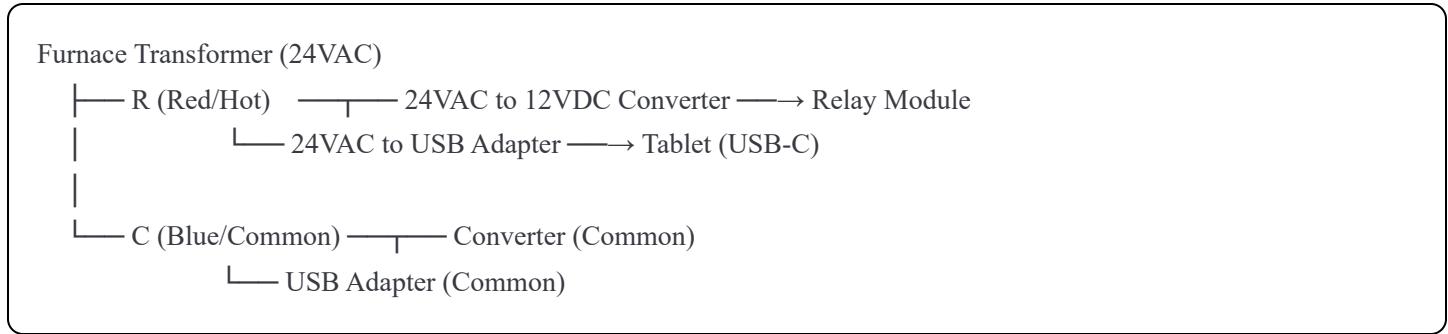
Your furnace already has a 24VAC transformer. Use it to power everything!

What You Need

1. **24VAC to 5V USB Adapter** (~$10-20)
   - Powers tablet continuously
   - Search: "24VAC to USB adapter" or "thermostat USB power"

2. **24VAC to 12VDC Converter** (~$10-20)

- Powers relay module

- Regulated output, screw terminals

Wiring Diagram

```
Furnace Transformer (24VAC)
 ├──── R (Red/Hot) ─────┬──── 24VAC to 12VDC Converter ───→ Relay Module
 │                      └──── 24VAC to USB Adapter ───→ Tablet (USB-C)
 │
 └──── C (Blue/Common) ─────┬──── Converter (Common)
                            └──── USB Adapter (Common)
```

Power Calculations

Furnace Transformer Capacity:

- Typical: 20-40VA (watts)

- At 24VAC: ~0.8-1.7A

Your Requirements:

- Tablet charging: ~5-10W (1-2A @ 5V)

- Relay module: ~1-3W (0.1-0.25A @ 12V)

- **Total: ~6-13W**

Verdict: ✅ Furnace transformer has plenty of capacity!

Installation Steps

1. **Turn off furnace power** at breaker

2. **Remove old thermostat** from wall

3. **Identify wires:**
   - R (Red) - 24VAC hot

   - C (Blue/Black) - 24VAC common

   - W, Y, G - Control wires (for relay module)

4. **Connect 24VAC to USB adapter:**
   - R and C to adapter input

   - USB cable to tablet

5. **Connect 24VAC to 12VDC converter:**
   - R and C to converter input

   - DC output to relay module

   - Set relay module voltage jumper to 12V

6. **Wire relay to HVAC:**
   - Relay 1 → W (Heat)

   - Relay 2 → Y (Cool)

   - Relay 3 → G (Fan)

   - Common → C

7. **Test with multimeter** before powering on

8. **Restore power** and test

🎛️ Android Tablet Configuration {#tablet-setup}

ONN Surf 7" Tablet (2024)

Perfect for this project!

Specifications:

- 7" touchscreen (ideal thermostat size)

- USB-C port (modern OTG support)

- Android OS (likely 11-13)

- 3GB RAM (sufficient for React app)

- Very affordable (~$30-50)

Setup Steps

1. Enable USB OTG

```
Settings → Developer Options → Enable USB Debugging
```

Some tablets have "USB OTG" toggle - enable it if present.

2. Install Chrome or Edge

3. Test Web Serial API Support

1. Open Chrome on tablet

2. Go to: `https://web-serial-test.glitch.me/`

3. If it can detect serial ports, you're good! ✅

4. Set Up Kiosk Mode (Optional)

Option A: Kiosk Browser App

- Install "Kiosk Browser Lockdown"

- Set your React app URL as home page

- Lock to that app only

Option B: Auto-Launch

- Use "Auto Start" or "Tasker" app

- Auto-open browser to app URL on boot
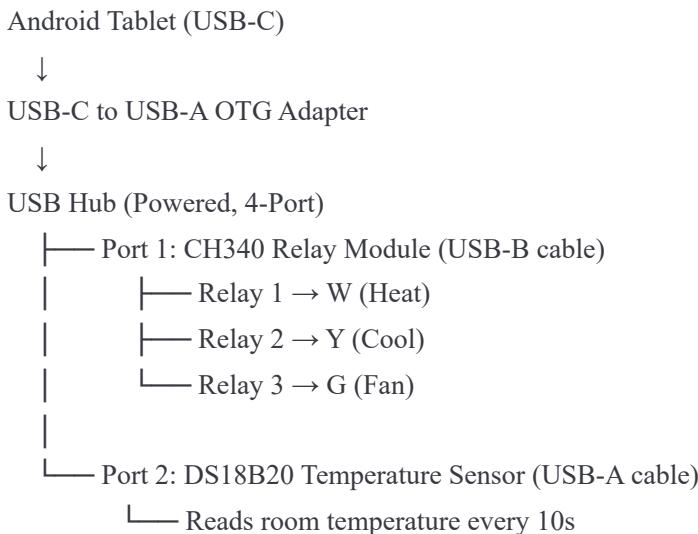
5. Keep Screen On

```
Settings → Display → Keep screen on
Settings → Display → Sleep → Never
```
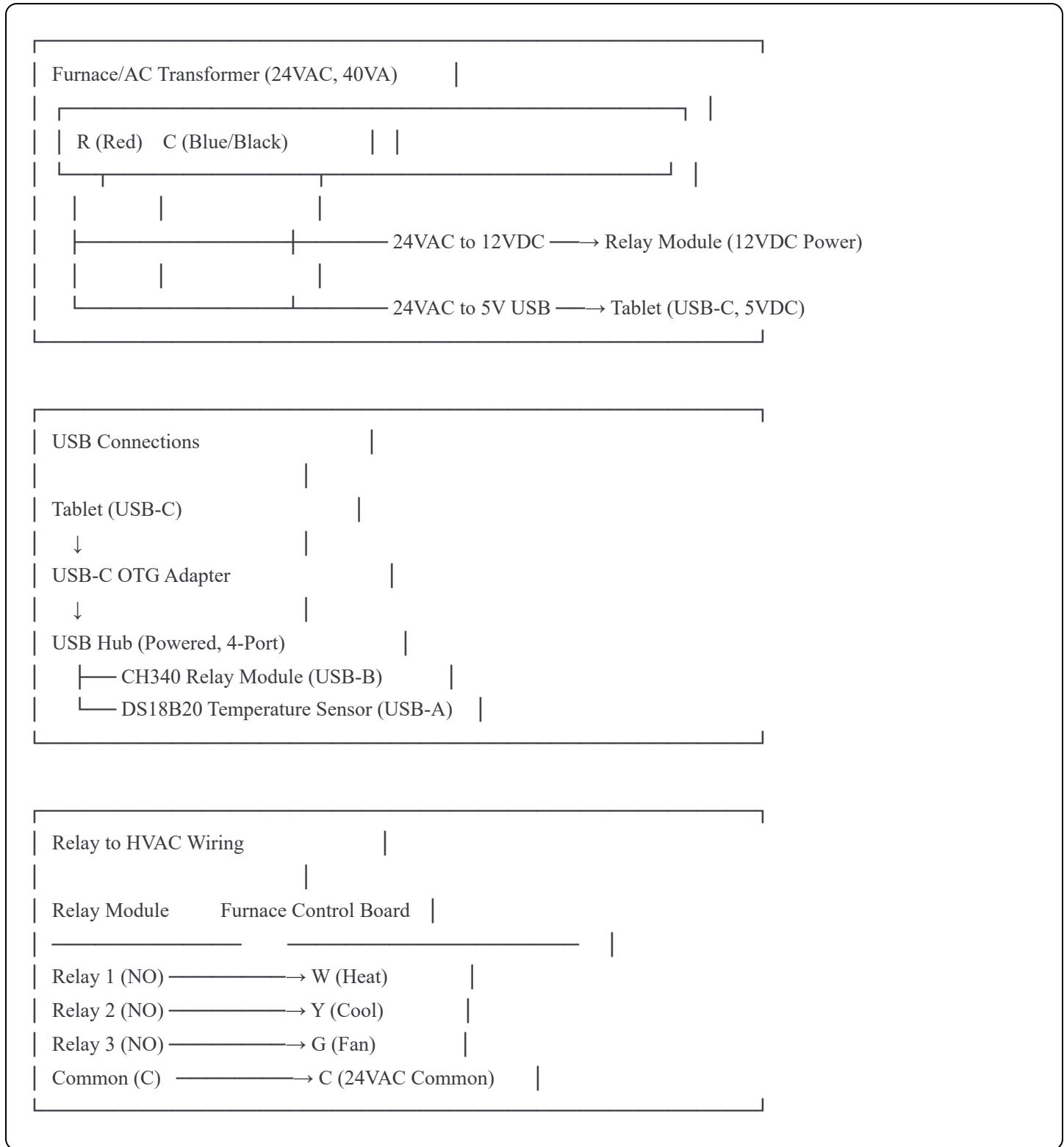
Or use "Stay Awake" in Developer Options.

USB Connection Tree

```
Android Tablet (USB-C)
  ↓
USB-C to USB-A OTG Adapter
  ↓
USB Hub (Powered, 4-Port)
  ├── Port 1: CH340 Relay Module (USB-B cable)
  │     ├── Relay 1 → W (Heat)
  │     ├── Relay 2 → Y (Cool)
  │     └── Relay 3 → G (Fan)
  │
  └── Port 2: DS18B20 Temperature Sensor (USB-A cable)
        └── Reads room temperature every 10s
```

🏠 Main HVAC Installation {#hvac-installation}

Complete Wiring Diagram

```
┌─────────────────────────────────────────────────────────────────┐
│ Furnace/AC Transformer (24VAC, 40VA)        │                    │
│   ┌──────────────────────────────────────────┐          │        │
│   │  R (Red)    C (Blue/Black)          │   │                    │
│   └──────┬────────┬──────────────┬──────────┘          │         │
│          │        │              │                                │
│          ├────────────────────────┼───── 24VAC to 12VDC ──→ Relay Module (12VDC Power)
│          │        │              │                                │
│          └────────────────────────┴───── 24VAC to 5V USB ──→ Tablet (USB-C, 5VDC)
│                                                                   │
└───────────────────────────────────────────────────────────────────┘


┌─────────────────────────────────────────────────────────────────┐
│ USB Connections                    │                              │
│                                    │                              │
│ Tablet (USB-C)                     │                              │
│    ↓                               │                              │
│ USB-C OTG Adapter                  │                              │
│    ↓                               │                              │
│ USB Hub (Powered, 4-Port)          │                              │
│    ├──── CH340 Relay Module (USB-B)        │                      │
│    └──── DS18B20 Temperature Sensor (USB-A)    │                  │
│                                                                   │
└───────────────────────────────────────────────────────────────────┘


┌─────────────────────────────────────────────────────────────────┐
│ Relay to HVAC Wiring                    │                         │
│                                    │                              │
│ Relay Module       Furnace Control Board   │                     │
│ ──────────────────      ────────────────────────      │          │
│ Relay 1 (NO) ─────────────→ W (Heat)        │                     │
│ Relay 2 (NO) ─────────────→ Y (Cool)          │                   │
│ Relay 3 (NO) ─────────────→ G (Fan)           │                   │
│ Common (C)  ─────────────→ C (24VAC Common)     │                 │
│                                                                   │
└───────────────────────────────────────────────────────────────────┘
```

Safety Critical Checks

Before Powering On:

☐ All wiring connections secure and tight

☐ Wire nuts properly installed on all splices

☐ Electrical tape on all connections

☐ Relay module has external power (12VDC)

☐ Tablet has power (5VDC USB)

☐ USB connections secure

☐ AC unit unplugged during wiring

☐ Multimeter tested all connections

☐ Relay rating checked vs AC amperage

☐ Temperature sensor mounted properly

☐ Software configured for AT commands

☐ Browser permissions granted

☐ No exposed bare wires

☐ Strain relief on all cables

🪟 Window AC Testing Setup {#window-ac-testing}

Why Test on Window AC First?

✅ **Safer** - Won't affect main HVAC

✅ **Portable** - Move it around, test in different rooms

✅ **Simple** - Just power on/off, no complex wiring

✅ **Visible** - You can see/hear when it's working

✅ **Low risk** - If something goes wrong, just unplug it

Control Options

Option 1: Control Entire Unit Power (Easiest)

How it works:

- Relay controls AC's power cord

- When relay closes → AC gets power → runs

- When relay opens → AC loses power → stops

Wiring:

```
Wall Outlet (120VAC)
    ↓
Hot Wire (Black) → Relay 1 (NO terminal)
    ↓
Hot Wire → AC Unit Power Cord


Neutral Wire (White) ─────────────→ AC Unit (direct)
Ground Wire (Green) ─────────────→ AC Unit (direct)
```

⚠️ **Important:** Your CH340 relay is rated for 10A @ 250VAC. Check your AC unit's amperage!

Option 2: Control Compressor Only (Advanced)

Requires opening AC unit (voids warranty). Not recommended for testing phase.

Complete Testing Setup

```
Android Tablet (USB-C)
    ↓
USB-C OTG Adapter
    ↓
USB Hub (Powered)
    ├──── Port 1: CH340 Relay Module
    │         └──── Relay 1 (controls AC power via extension cord)
    │
    └──── Port 2: DS18B20 USB Thermometer
              └──── Monitors room temperature

Extension Cord (Modified):
    Wall Outlet → Hot wire → Relay 1 → Hot wire → AC Unit
            Neutral ─────────────────────→ AC Unit
            Ground ─────────────────────→ AC Unit
```

Testing Procedure

Test 1: USB Connections ✅

1. Connect relay module to tablet

2. Open Chrome/Edge

3. Navigate to your app

4. Go to "Contactor Demo" page

5. Click "Connect Relay"

6. Grant permission

7. Verify "Connected" status

Test 2: Relay Control ✅

1. Toggle relay on/off via app

2. Listen for audible click

3. Check LED indicators

4. Use multimeter to verify contacts close

Test 3: Temperature Sensor ✅

1. Connect DS18B20 to tablet

2. Wait 10 seconds for first reading

3. Verify temperature data appears

4. Compare with known good thermometer

5. Expected: within ±1°C of reference

Test 4: AC Unit Control ✅

1. Wire relay to AC power (see Option 1 above)

2. Set AC's thermostat to coldest

3. Connect relay to tablet

4. Turn on relay via app

5. Verify AC starts (compressor + fan)

6. Turn off relay

7. Verify AC stops

Test 5: Full Thermostat Control ✅

1. Connect both relay and sensor (via hub)

2. Set target temperature (e.g., 72°F)

3. Set differential (e.g., 2°F)

4. Let system run automatically:

- When room temp > target + differential → AC turns on

- When room temp < target - differential → AC turns off

5. Monitor for 30 minutes

6. Verify proper cycling

💧 Dehumidifier Integration {#dehumidifier-wiring}

Why Include Dehumidifier Testing?

✅ **Lower power draw** (300-500W vs 1000-1500W for AC)
✅ **Safer for relay testing** (lower amperage)
✅ **Provides humidity data** (useful for HVAC control)
✅ **Can be hacked** as spot cooler (vent condenser outside)
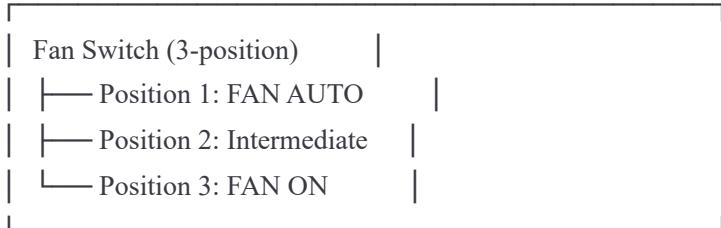✅ **Useful for humidity control** testing

Dehumidifier Internal Components
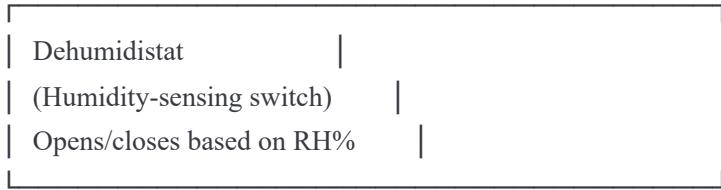
Standard Dehumidifier Circuit:

```
Power Source (115VAC, 60Hz, Single Phase)
    ├── Hot (Black)
    ├── Neutral (White)
    └── Ground (Green)

     ↓

    ┌─────────────────────────────────┐
    │ Fan Switch (3-position)      │  │
    │  ├── Position 1: FAN AUTO       │ │
    │  ├── Position 2: Intermediate   │ │
    │  └── Position 3: FAN ON         │ │
    └─────────────────────────────────┘

     ↓

    ┌─────────────────────────────────┐
    │ Dehumidistat          │         │
    │ (Humidity-sensing switch)   │   │
    │ Opens/closes based on RH%   │   │
    └─────────────────────────────────┘

     ↓

    ┌─────────────────────────────────┐
    │ Defrost Thermostat       │      │
    │ (Prevents ice buildup on coil)  │ │
    │ Opens when coil temp too low   │ │
    └─────────────────────────────────┘

     ↓

    ┌─────────────────────────────────┐
    │ Compressor Motor         │      │
    │  ├── C (Common) → White      │  │
    │  ├── S (Start) → Yellow     │   │
    │  ├── R (Run) → Red          │   │
    │  └── Ground → Green          │  │
    └─────────────────────────────────┘

     ↓

    ┌─────────────────────────────────┐
    │ Run Capacitor           │       │
    │ (Provides phase shift for motor) │ │
    │ Typical: 15-30 μF         │     │
    └─────────────────────────────────┘
```
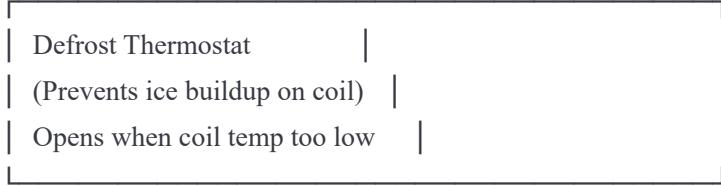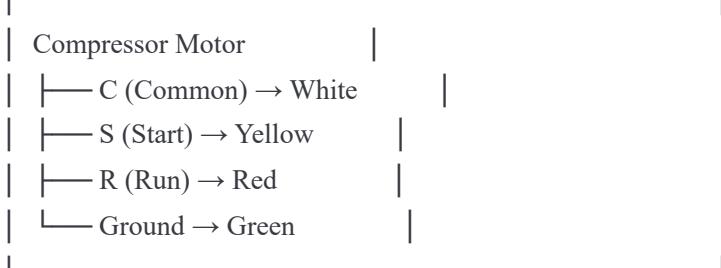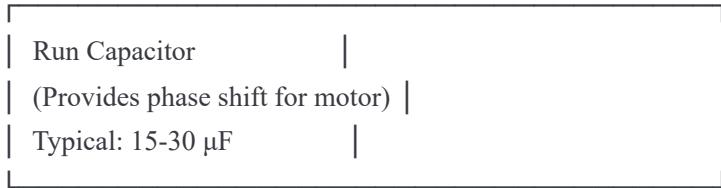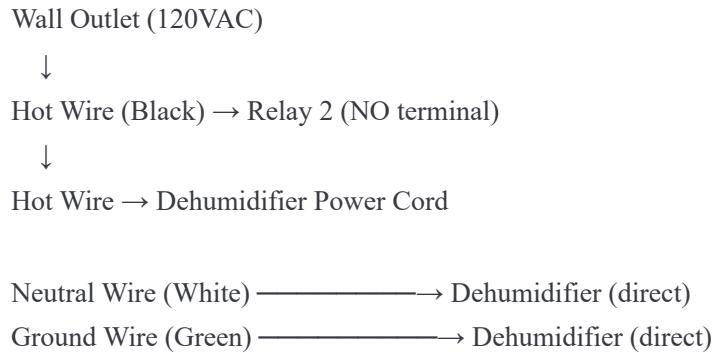
Relay Control Wiring

Control Entire Dehumidifier Power:

```
Wall Outlet (120VAC)

    ↓

Hot Wire (Black) → Relay 2 (NO terminal)

    ↓

Hot Wire → Dehumidifier Power Cord


Neutral Wire (White) ——————→ Dehumidifier (direct)
Ground Wire (Green) ——————→ Dehumidifier (direct)
```

Venting Condenser Heat (Optional Cooling Hack)

Materials:

- Window exhaust kit OR DIY foam board

- Flexible ducting (4-6" diameter, 3-5 feet)

- Duct tape

- Weatherstripping

Setup:

1. Locate condenser exhaust on dehumidifier

2. Measure exhaust opening (typically 4-6")

3. Cut foam board to fit window

4. Cut hole for ducting

5. Connect ducting from dehumidifier to window

6. Seal all connections

Performance:

- Cooling capacity: ~3,000-5,000 BTU equivalent

- Efficiency: Moderate (not as good as real AC)

- Bonus: Full dehumidification capacity still works!

📦 Wall Mounting & Enclosure {#enclosure-specs}
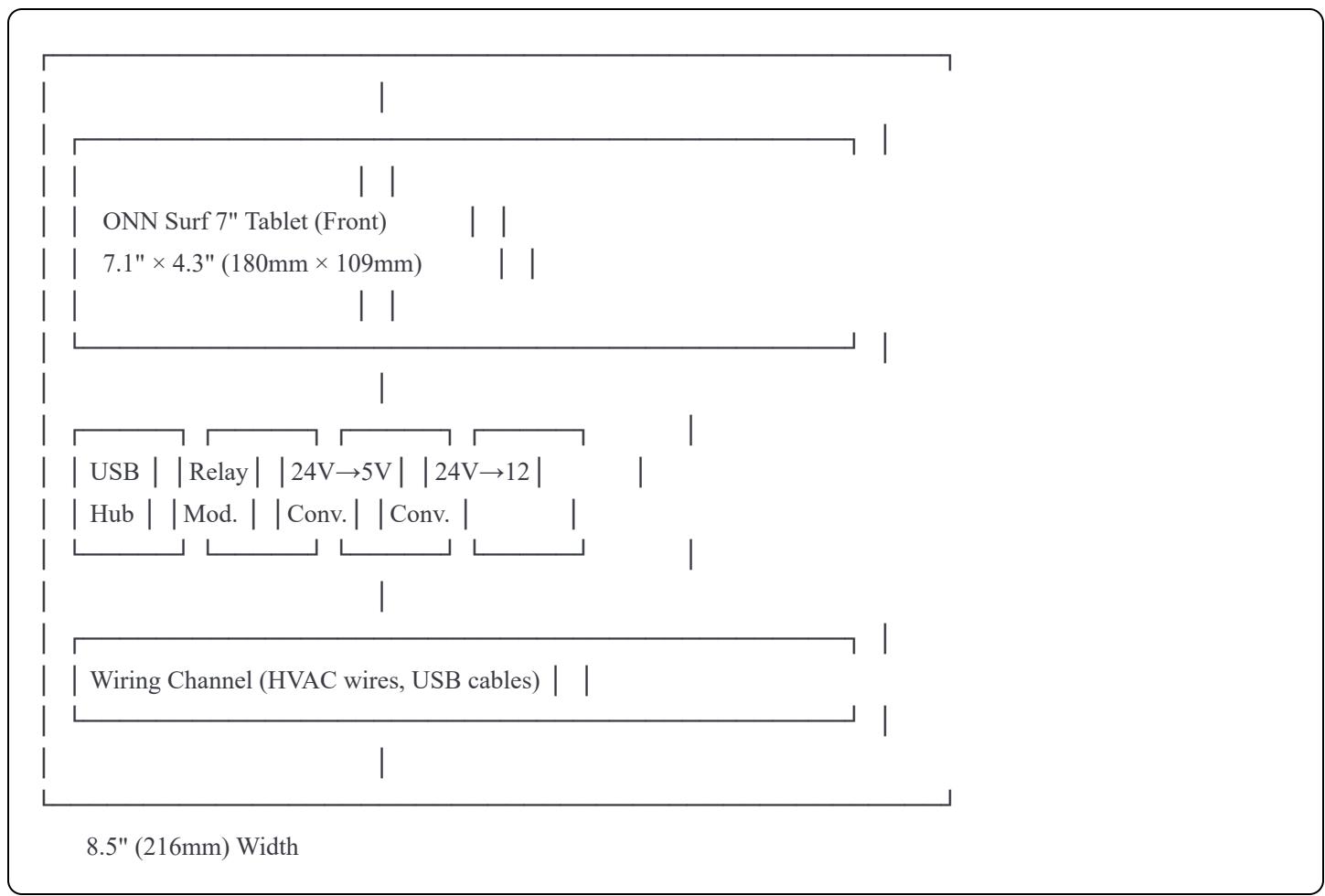
Recommended Enclosure Dimensions

Overall Size:

- Width: 8.5" (216mm)
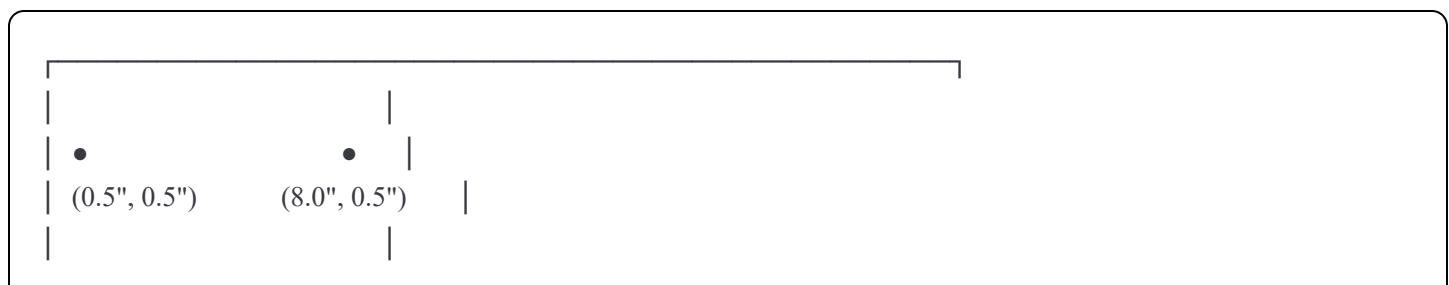
- Height: 6.5" (165mm)

- Depth: 2.5" (64mm)

Rationale:

- Fits ONN Surf 7" tablet (7.1" × 4.3" × 0.4")

- Accommodates USB hub, relay module, power converters

- Standard electrical box depth

- Professional appearance

Component Layout (Top View)

```
┌─────────────────────────────────────────────────────────────┐
│  ┌─────────────────────────────────────────────┐             │
│  │              │ │                             │             │
│  │ │            │ │                          │ ││             │
│  │ │  ONN Surf 7" Tablet (Front)           │ ││             │
│  │ │  7.1" × 4.3" (180mm × 109mm)          │ ││             │
│  │ │            │ │                          │ ││             │
│  │ └────────────────────────────────────────┘ ││             │
│  │              │                              │             │
│  │ ┌──────┐ ┌──────┐ ┌──────┐ ┌──────┐        ││            │
│  │ │ USB  │ │Relay │ │24V→5V│ │24V→12│         ││            │
│  │ │ Hub  │ │Mod.  │ │Conv. │ │Conv. │         ││            │
│  │ └──────┘ └──────┘ └──────┘ └──────┘         ││            │
│  │              │                              ││            │
│  │ ┌─────────────────────────────────────────┐ ││           │
│  │ │ Wiring Channel (HVAC wires, USB cables) │ ││           │
│  │ └─────────────────────────────────────────┘ ││           │
│  │              │                              │             │
│  └─────────────────────────────────────────────┘             │
│        8.5" (216mm) Width                                    │
└─────────────────────────────────────────────────────────────┘
```

Mounting Holes Pattern

```
┌──────────────────────────────────────────┐
│  │                │                       │
│  │ ●              ●    │                  │
│  │ (0.5", 0.5")   (8.0", 0.5")    │      │
│  │                │                       │
```

```
|              |
|              |
|              |
| •        •   |
| (0.5", 6.0")   (8.0", 6.0")   |
|              |
|_____|
```

Screw Specifications:

- Hole Diameter: 0.25" (6mm)

- Screw Size: #8 or #10 wood screws

- Screw Length: 1.5" (38mm) minimum

Installation Steps

1. **Mark mounting holes** using drilling template

2. **Check for studs** with stud finder

3. **Drill holes** (0.25" diameter)

4. **Install anchors** if not mounting to stud

5. **Mount plate** and secure with screws

6. **Route HVAC wires** through bottom cutout

7. **Mount enclosure** to plate

8. **Connect power** converters

9. **Test system** before final assembly

💻 Web Serial API Setup {#web-serial}

Browser Requirements

Supported Browsers:

- ✅ Chrome (Desktop & Android)

- ✅ Edge (Desktop & Android)

- ❌ Firefox (Not yet supported)

- ❌ Safari (Not yet supported)

Basic Connection Code

```javascript
// Request access to serial port
const port = await navigator.serial.requestPort();

// Open with standard settings
await port.open({ baudRate: 9600 });

// Get writer for sending commands
const writer = port.writable.getWriter();
const encoder = new TextEncoder();

// Send AT command to relay
await writer.write(encoder.encode("AT+ON1\r\n"));

// Get reader for receiving data
const reader = port.readable.getReader();
const decoder = new TextDecoder();

// Read temperature data
while (true) {
  const { value, done } = await reader.read();
  if (done) break;

  const data = decoder.decode(value);
  console.log("Received:", data);
}
```

Error Handling

```javascript
```

```javascript
try {
  const port = await navigator.serial.requestPort();
  await port.open({ baudRate: 9600 });

  // ... use port ...

} catch (error) {
  if (error.name === 'NotFoundError') {
    console.error('No device selected');
  } else if (error.name === 'SecurityError') {
    console.error('Permission denied');
  } else {
    console.error('Serial error:', error);
  }
}
```

⚙️ React App Configuration {#react-config}

Relay Control Integration

```javascript
import { getWebSerialRelay } from "../lib/webSerialRelay";

function ThermostatControl() {
  const [relayConnected, setRelayConnected] = useState(false);
  const relay = getWebSerialRelay();

  const connectRelay = async () => {
    try {
      await relay.connect();
      setRelayConnected(true);
    } catch (error) {
```