Soldering Manual: Input Module

Section 1: Power Supply & Protection Stage

Before populating any sensitive digital logic or isolation components, you must assemble, solder, and verify the local power input and 3.3V voltage regulation stage. This safeguards the downstream integrated circuits against accidental overvoltage.

1.1 Components to Solder in this Step

Solder *only* the following low-profile components onto the Main PCB:

- **U1**: L78L33 Linear Voltage Regulator
- **C1, C3**: 10µF Capacitors
- **C2**: 1µF Capacitor
- **JST 4P Connectors J1,2**: SystemBus input/output headers

1.2 Quality Control & Bench Testing Procedure

Once these initial components are securely soldered, prepare your testing wire harness to safely introduce power to the board and verify the local 3.3V rail.

Step 1: Test Wire & Bench Setup

1. Take your standard 4-pin JST mating cable harness.
2. Connect **Pin 1 (+12V)** of the JST connector directly to the positive terminal of your power supply.
3. Connect **Pin 2 (GND)** of the JST connector to the negative (GND) terminal of your power supply.
4. Set your laboratory bench power supply to **12.0V** and limit the current to **100mA** as an essential safety precaution.

Step 2: Voltage Regulation Test

1. Plug the 4-pin JST test wire into one of the soldered JST bus connectors to power up the rail.
2. Take your multimeter and switch it to **DC Voltage mode**.
3. Place the black probe on a known GND point (such as JST Pin 2) and the red probe on the output pin of the **L78L33 (U1)** or across the pads of **C3**.

📋 **Expected Result**

The multimeter must display a stable **3.3V**.

- **If the voltage is correct:** Disconnect the power supply. You are ready to move on to the next assembly stage.
- **If the voltage reads 0V or U1 gets hot:** Immediately shut off power. Inspect your solder joints for bridges between the input, output, and ground pads.

Section 2: Digital I/O Expander & Address Configuration

In this stage, you will assemble the digital heart of the input module, which communicates the status of your switches back to the Master Unit via the I2C bus.

2.1 Components to Solder in this Step

Solder the following components onto the Main PCB:

- **U3 (PCF8574)**: 8-Bit I2C I/O Expander IC (SOIC-16 package). *Ensure correct Pin 1 orientation by aligning the dot on the chip with the silkscreen indicator.*
- **C5**: 100nF Ceramic Decoupling Capacitor.

2.2 Hardware I2C Address Selection

Directly after soldering the PCF8574, configure the permanent hardware I2C address of the Input Module using the onboard solder jumpers (**A0, A1, A2**).

- Apply solder to bridge the pads according to your system's address map.
- Ensure the solder fully bridges the intended pads cleanly without creating bridges to surrounding ground planes.

Section 3: Hardware Debounce & Optical Isolation Stage

To eliminate electrical noise and safely isolate the vehicle's 12V switch wiring from the 3.3V logic circuit, you will now install the hardware filter arrays and the optocouplers.

3.1 Components to Solder in this Step

Solder the following components onto the Main PCB:

- **Resistor Arrays (2x 4x10kΩ)**: Multi-resistor network networks providing pull-up/pull-down bias for the input lines.
- **Capacitor Arrays (2x ‘x100nF)**: Multi-capacitor networks providing high-frequency hardware noise filtering (Hardware Debounce).
- **U4, U5 (LTV-847S)**: Quad-Channel Optocouplers. These chips isolate the inputs galvanically. *Pay strict attention to the Pin 1 indicator dot on the IC packages.*
- **X1**: Topboard interconnect header/connector.

Section 4: Heavy-Duty Input Terminals & SystemBus Rule

4.1 Components to Solder in this Step

Solder the final high-profile components onto the Main PCB:

- **Screw Terminals**: Heavy-duty terminal blocks where the external physical camper switches and 12V trigger lines will be wired.

System Bus Architecture Rule (R3 & R4 Pull-up Exclusion)

- **DO NOT populate R3 and R4.** These pads are designed for optional I2C bus pull-up resistors.

- Because the central **Master Module** already integrates dedicated, hardware-stabilized pull-up resistors on its core logic rails, adding additional pull-ups on the expansion modules will lower the bus resistance excessively, overloading the data lines and causing communication failures across the SystemBus. Leave these spots completely empty.

Section 5: Topboard User Interface Assembly

The Topboard contains the physical user interface components for local status monitoring and manual interaction.

5.1 Components to Solder in this Step

Solder the components onto the Topboard PCB in the following order:

1. **Status LEDs**: Through-hole LEDs.
2. **Tactile/Slide Switches**: The physical input interaction switches. Ensure they sit 100% flush and square against the PCB surface before soldering.
3. **Interconnect Connector**: Solder the mating connector that links down to the Main PCB's **X1** interface.

Section 6: Final Mechanical Assembly & Enclosure Integration

In this final stage, you will mechanically combine both completed boards and integrate them into the modular housing.