**MIDI CONTROLLER SYSTEM – OVERVIEW:**

This system is a sophisticated hybrid analogue/digital MIDI controller, integrated into a **custom electric guitar body**, and designed for **performance control** of external effect units and plugins. Built around an **Adafruit Feather ESP-32 v2**, it combines traditional analogue potentiometers with digital switching, encoder navigation and display feedback for total control in a compact footprint.

The system primarily runs in two modes, one called “**Setup**” that consists of a series of menu items allowing the user to configure the system, and the other called “**Play**” that the user interacts with while playing the guitar. The user switches between these modes with a long press of the ‘mirror’ button.

The font used throughout the system is OpenSans\_Semibold.

The only parts of the display screens that get redrawn must **only ever** be the pixels that actually change in operation. This is **essential** to minimise screen flicker.

RULES THAT MUST BE FOLLOWED BY CHATGPT:

1. **Always refer to this live Google Doc spec (https://docs.google.com/document/d/1SFgdBO\_iSVyG7hlJXhSwEFDKS-ioGw0zzdrPuDCGueo/edit) as the single source of truth for pin mappings, wiring, menu text, and behavior.**
2. **Keep responses concise and focused**, tackling one topic at a time.
3. remember this: ALWAYS always consult, use and check the Adafruit ESP32 Feather V2 API for
4. **After any code change**, insist we test it on the Feather before moving on to the next tweak.
5. Only make the exact change I ask for, and nothing more.
6. Never overwrite or remove existing, working code unless explicitly told to.
7. Preserve all confirmed pin mappings and setup calls—no pin changes or SPI/init tweaks unless asked.
8. Use the minimal diff approach: change only the lines or logic specified, leave everything else intact.
9. Ensure display updates happen exactly where and when requested
10. Ask for clarification if a requested change is ambiguous, rather than guessing.
11. **Always be 100% certain** before asserting—if not absolutely sure, say so rather than guess.
12. **Refer back to elements I’ve already approved** (pin assignments, divider values, function names) rather than re-introducing old defaults
13. Preserve all existing positions, fonts, sizes, and other layout details unless I explicitly request adjustments.
14. Whenever I need tunable values (positions, sizes, colors), expose them as #define constants at the top so I can tweak them easily.
15. For real-time displays, draw static elements once in setup(), then update only the changing regions in loop() to avoid flicker and text artifacts
16. Don’t reorganize or refactor code unless it’s directly called for—keep all code as “lean” as possible around my requested features

**HARDWARE OVERVIEW:**

| **Component** | **Description** |
| --- | --- |
| **Adafruit Feather ESP-32 v2** | Core microcontroller. Sends MIDI over DIN and BLE. |
| **4 Slide Potentiometers w/ LEDs**  Bourns PTL30-15G1-103B1 | Faders send MIDI CC when moved. LEDs are always ON, adjustable brightness via Setup menu. Also bring up relevant status display. |
| **4 Momentary Stomp Switches** RVFM JR5404 | Send MIDI CC (toggle or momentary). Also bring up relevant status display. |
| **1 Momentary ON-OFF-ON Toggle Switch** T8014A-SEBQ-H | Used to increment or decrement preset number, navigate menus and switch input modes |
| **Rotary Encoder w/ Pushbutton**  Bourns PEC11R-4115K-S0018 | Navigates menus and selects presets. Pushbutton confirms actions. |
| **1 Additional Momentary Button (‘mirror’ button)** RVFM JR5404 | Used to send all fader CCs at once on a short press, or to enter/exit Setup or Play modes on a long press. |
| **Adafruit 1.14" 240×135 TFT (ST7789)** | Shows system state, preset selection, fader values, etc. |
| **MIDI Din** | Outputs MIDI data for a wired connection to external hardware |
| **Power slide switch** | Turns the system ON and OFF – connected to the Feather’s ENable pin |

**FEATHER PIN CONNECTIONS:**

| **Function** | **ESP32 GPIO** | **Silkscreen** | **Routing Layer** | **Placement Advice** | **Connection Rules** |
| --- | --- | --- | --- | --- | --- |
| TFT SCK (SPI CLK) | 5 | SCK | Top | Matched impedance; pair with MOSI | Keep short; bypass cap 100nF at display (already on the display board) |
| TFT MOSI (SPI Data) | 19 | MO | Top | Matched impedance; pair with SCK | Keep short; decoupling cap 100nF at display) add 100uf between 3.3v and ground on the shield close to the pins |
| TFT\_CS (Chip Select) | 14 | D14 | Top | Next to TFT\_DC | Digital output; pull high when inactive |
| TFT\_DC (Data/Command) | 15 | D15 | Top | Next to TFT\_CS | Digital output; select data/command |
| MIDI OUT TX | 8 | TX | Top | Keep away from analog | TX pin -to- 220Ω inline resistor -→ - DIN pin 5 -→ - 3.3v. DIN pin 4 = GND DIN pin 2 = not connected DOUBLE CHECK ONLINE! |
| Encoder A (A) | 7 | RX | Top | Close to encoder | Use code for internal pullup – pinmode (7, INPUT\_PULLUP); add series resistor: ENCA -→ - 220Ω resistor -→ - pin 7 optional 0.1µF filter after the resistor to ground for encoder smoothing and emi/rfi rejection. Not fitting it = better edge-speed response |
| Encoder B (B) | 33 | D33 | Top | Close to encoder | As above except pin 33 |
| MUX Control A | 27 ADC2 | D27 | Top | Group with MUX lines | 220Ω series between mux a/b/c and pin; 100nF bypass ceramic cap between mux vcc and 3.3v |
| MUX Control B | 22 | SDA | Top | Group with MUX lines | As above, only one bypass on vcc line as above |
| MUX Control C | 21 MISO | MI | Top | Group with MUX lines | As above, only one bypass on vcc line as above |
| MUX COM | 4 (was 37) | A5 (was D37) | Bottom | Isolate from digital | 1kΩ + 100nF RC filter \* see note below / over |
| TFT Brightness (PWM) | 13 | D13 | Top | Isolate from analog, connect to LIT on TFT | PWM; optional 10kΩ+100nF LPF |
| Fader 1 | 34 | A2 | Bottom | Group analog inputs | 1kΩ + 10nF RC; shielded cable |
| Fader 2 | 39 | A3 | Bottom | Group analog inputs | 1kΩ + 10nF RC; shielded cable |
| Fader 3 | 36 | A4 | Bottom | Group analog inputs | 1kΩ + 10nF RC; shielded cable |
| Fader 4 | 32 | D32 | Bottom | Group analog inputs | 1kΩ + 10nF RC; shielded cable |
| Fader LEDs | - | - | Top | Close to faders | 3.3V → 1kΩ → LED → GND |
| LED Brightness (PWM) | 12 | D12 | Top | Isolate from analog | PWM; optional 100Ω+LPF |
| Battery Voltage (VBAT) | 35 | A7 | - | INTERNAL PIN | Onboard divider; analogReadMilliVolts() |
| Power Switch | - | EN | - | Control enable | Switch between pin and ground |
| 3.3V Power | - | 3V | both layers | Power plane | Traces can be on both layers |
| Ground | - | GND | Both layers | Ground plane | Two ground pours top=digital, bottom-analogue. Use a cluster of small vias to tie the two pours together close to the ESP-32 GND pin, and connect it to that pin. |

**MUX PIN CONNECTIONS:**

| **Function** | **Connected to** | **Mux Pin No** | **Channel** |
| --- | --- | --- | --- |
| Preset Toggle Up | TGUP | MUX2 | CH7 |
| Preset Toggle Down | TGDN | MUX4 | CH6 |
| Stomp Switch 1 | SW1 | MUX15 | CH2 |
| Stomp Switch 2 | SW2 | MUX12 | CH3 |
| Stomp Switch 3 | SW3 | MUX1 | CH4 |
| Stomp Switch 4 | SW4 | MUX5 | CH5 |
| Encoder Switch | ENTER | MUX13 | CH0 |
| MIRROR Button (MUX14 CH1) | EDIT | MUX14 | CH1 |
| 3V (MUX16) | 3V | MUX16 |  |
| Ground (MUX6) | GND | MUX6 |  |
| Ground (MUX7) | GND | MUX7 |  |
| Ground (MUX8) | GND | MUX8 |  |
| MUX Control A (MUX11) | MUXA | MUX11 |  |
| MUX Control B (MUX10) | MUXB | MUX10 |  |
| MUX Control C (MUX9) | MUXC | MUX9 |  |
| MUX Common (MUX3) | MUXCOM | MUX3 |  |

* \* MCU MUXCOM / FADERS
* │
* R1 (1 kΩ)
* │
* ┌────────┴─────────┐
* │ │
* C1 (100 nF) │
* │ │
* GND ──► MUX COM
* For the fader, try 10nF first, increase up to 100uF

**Use This Digital Mux Scan Pattern in All Future Code**

* Use digitalRead(MUXCOM) (37) for the mux common / signal pin.
* Use MUXA =27, MUXB = 22, MUXC = 21 for the select lines.
* Use the selectMuxChannel() function
* Add minimal delay or debounce logic as needed for the real buttons.

**SETUP MODE**

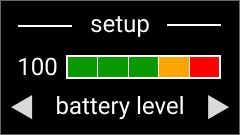
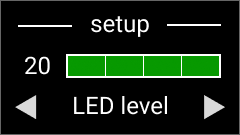
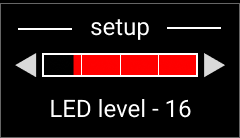
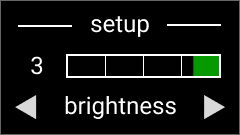
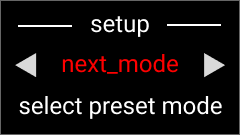
**SETUP MODE GENERAL NOTES:**

* All display screens in Setup mode have the centred header\_text called ‘setup’ in OpenSans\_SemiBold14pt, with horizontal lines either side
* All display screens have either 3 or 4 rows of information.
* All display screens in Setup mode have white filled triangles in fixed positions either side of text on the lower rows, to indicate there are either more menu items to select from on that row, or that that row can be modified by the user.
* Navigate the menus by turning the encoder or using the toggle switch, then press the encoder button to confirm selections
* No MIDI data is sent during ‘SETUP’ mode (unless MIDI channel or fader and stomp CC number selections need to be – confirm this during coding!)

**SETUP MODE - UI FLOW LIST SHOWN IN ORDER OF MENU ITEMS** (menu items are ‘round robin’)**:**

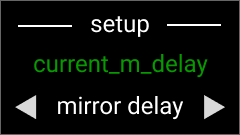
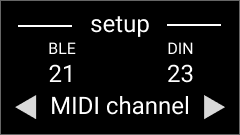
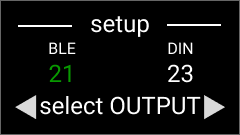
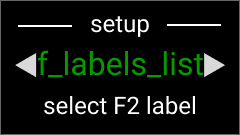
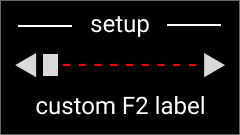
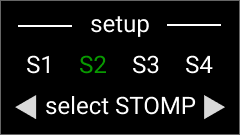
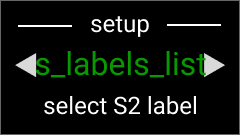
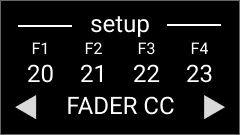
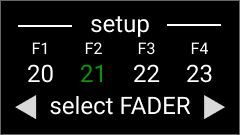
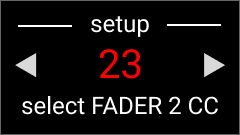
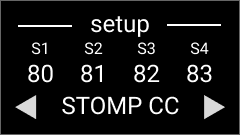
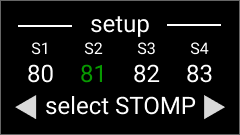
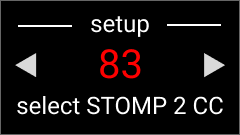
1. setup\_battery
2. setup\_led
   1. setup\_led\_brightness
3. setup\_tft
   1. setup\_tft\_brightness
4. setup\_mode
   1. setup\_mode\_select
5. setup\_mirror
   1. setup\_mirror\_select
6. setup\_midi\_ch
   1. setup\_midi\_ch\_select
7. setup\_fader\_labels
   1. setup\_fader\_labels\_select
   2. setup\_fader\_labels\_confirmation
   3. setup\_fader\_labels\_custom
   4. setup\_fader\_labels\_edit
   5. setup\_fader\_labels\_delete
8. setup\_stomp\_labels
   1. setup\_stomp\_labels\_select
   2. setup\_stomp\_labels\_confirmation
   3. setup\_stomp\_labels\_custom
   4. setup\_stomp\_labels\_edit
   5. setup\_stomp\_labels\_delete
9. setup\_fader\_cc
   1. setup\_fader\_cc\_select
   2. setup\_fader\_cc\_confirmation
10. setup\_stomp\_cc
    1. setup\_stomp\_cc\_select
    2. setup\_stomp\_cc\_confirmation
11. setup\_stomp\_type
    1. setup\_stomp\_type\_select
    2. setup\_stomp\_type\_confirmation

**SETUP MODE - UI FLOW DETAILS:**

1. **setup\_battery**
   * 1. figure 1 - setup\_battery screen
     2. Default display screen shown after a long press of the ‘mirror’ button in ‘Play’ mode
     3. Uses the Use ESP32's built-in milliVolt reading for accuracy – analogReadMilliVolts – to display current battery level
     4. header\_text = ‘setup’ with horizontal lines either side
     5. Next row shows a battery level bar divided into 5 equally spaced sections with a value number (range 0-100) in OpenSans\_SemiBold14pt to the left of the bar. The bar display battery level from 0-100% from right to left, 100% full all the way to the left, 0% empty fill to the right. The far-right section gets filled in red, then moving left the second section gets filled with orange (0xFD20), then the 3 remaining sections to the left get filled with green. The bar outline and dividing lines are all drawn last so they stay on top. Only ever redraw pixels that change. The value number shows the current battery level.
     6. The bottom row shows menu\_item = ‘battery level’ in OpenSans\_SemiBold14pt, centred on the screen, with a white filled triangle either side
     7. Encoder turn or toggle switch moves to the next setup menu item
     8. long press on the mirror button returns into ‘PLAY’ mode from ‘SETUP’ mode:
2. **setup\_led**
   * 1. Figure 2 – setup\_led screen  
        
     2. header\_text = ‘setup’ with horizontal lines either side
     3. Next row shows bar divided into 4 equally spaced sections with a value number (range 0-20) in OpenSans\_SemiBold14pt to the left of the bar. The bar displays current LED brightness from 0-20 from right to left, 100% brightness all the way to the left, 0% (off) to the right. The bar gets filled with green. The bar outline and dividing lines are all drawn last so they stay on top. Only ever redraw pixels that change. The value number shows the current brightness value.
     4. The bottom row shows menu\_item = ‘LED level’ in OpenSans\_SemiBold14pt, centred on the screen, with a white filled triangle either side
     5. Encoder button press displays setup\_led\_brightness screen
     6. Encoder turn or toggle switch moves to the next setup menu item
     7. long press on the mirror button returns into ‘PLAY’ mode from ‘SETUP’ mode:
   1. **setup\_led\_brightness**
      1. Figure 2.2 – setup\_LED brightness screen  
         
      2. header\_text = ‘setup’ with horizontal lines either side
      3. Next row shows a bar divided into 4 equally spaced sections with a white filled triangle either side. The bar displays current LED brightness from 0-20 from right to left, 100% brightness all the way to the left, 0% (off) to the right. The bar gets filled with red. The bar outline and dividing lines are all drawn last so they stay on top. Only ever redraw pixels that change.
      4. The bottom row shows the text ‘LED level’ and a value number (range 0-20) in OpenSans\_SemiBold14pt to the right of the text. The value number shows the current LED brightness value. Only ever redraw pixels that change.
      5. Encoder turn or toggle switch uses PWM on pin D12 to set all 4 fader potentiometer LED brightness level on a logarithmic scale from 0 (off) to 20 (100%), so there is a smooth visual increase in brightness at each step
      6. Encoder button press confirms the brightness selection and saves it to memory (EEPROM) as the ‘LED\_brightness\_value’ then displays setup\_led screen (paragraph 2) again
3. **setup\_tft**
   * 1. Figure 3 – setup\_tft screen  
        
     2. header\_text = ‘setup’ with horizontal lines either side
     3. Next row shows bar divided into 4 equally spaced sections with a value number (range 0-20) in OpenSans\_SemiBold14pt to the left of the bar. The bar displays current TFT brightness from 0-20 from right to left, 100% brightness all the way to the left, 0% (off) to the right. The bar gets filled with green. The bar outline and dividing lines are all drawn last so they stay on top. Only ever redraw pixels that change. The value number shows the current TFT brightness value.
     4. The bottom row shows menu\_item = ‘brightness’ in OpenSans\_SemiBold14pt, centred on the screen, with a white filled triangle either side
     5. Encoder button press displays setup\_tft\_brightness screen (paragraph 3.2)
     6. Encoder turn or toggle switch moves to the next setup menu item
     7. long press on the mirror button returns into ‘PLAY’ mode from ‘SETUP’ mode:
   1. **setup\_tft\_brightness**
      1. Figure 3.2 – setup\_TFT brightness screen  
         
      2. header\_text = ‘setup’ with horizontal lines either side
      3. Next row shows a bar divided into 4 equally spaced sections with a white filled triangle either side. The bar displays current TFT brightness from 0-20 from right to left, 100% brightness all the way to the left, 0% (off) to the right. The bar gets filled with red. The bar outline and dividing lines are all drawn last so they stay on top. Only ever redraw pixels that change.
      4. The bottom row shows menu\_item = ‘brightness’ and a value number (range 0-20) in OpenSans\_SemiBold14pt to the right of the text. The value number shows the current TFT brightness value. Only ever redraw pixels that change.
      5. Encoder turn or toggle switch uses PWM on pin D13 to set the TFT display backlight brightness level on a logarithmic scale from 0 (off) to 20 (100%), so there is a smooth visual increase in brightness at each step
      6. Encoder button press confirms the brightness selection and saves it to memory (EEPROM) as the ‘TFT\_brightness\_value’ then displays setup\_tft screen (paragraph 3) again
4. **setup\_mode**
   * 1. Figure 4 – setup\_mode screen  
        
     2. header\_text = ‘setup’ with horizontal lines either side
     3. Next row shows the current\_mode in use in OpenSans\_SemiBold14pt in green.
     4. The bottom row shows menu\_item = ‘preset mode’ in OpenSans\_SemiBold14pt, centred on the screen, with a white filled triangle either side
     5. Encoder button press displays setup\_mode\_select screen
     6. Encoder turn or toggle switch moves to the next setup menu item
     7. long press on the mirror button returns into ‘PLAY’ mode from ‘SETUP’ mode:
   1. **setup\_mode\_select**
      1. Figure 4.2 – setup\_mode\_select screen  
         
      2. header\_text = ‘setup’ with horizontal lines either side
      3. the next row shows the next\_mode in OpenSans\_SemiBold14pt in red, with a filled white triangle either side.
      4. The bottom row shows the centred text ‘select preset mode’ in OpenSans\_SemiBold14pt.
      5. Encoder turn or toggle switch selects from a list of preset modes called ‘preset\_mode\_list’. These mode functions are listed in table 12 (SYSTEM STATE / EEPROM STORAGE / LOOKUP TABLES) and described in detail in section 13 of this document
      6. Encoder button press confirms the mode selection and saves it to memory (EEPROM) then displays the setup\_mode screen (paragraph 4) again
      7. Upon selection of a preset mode, the system must immediately initialize all Fader and Stomp CC assignments to the values shown below. These defaults apply only on first entry into a mode; users may then adjust any assignment via the Setup → CC Assignment screens. For modes that do not support on‑device MIDI Learn (Kemper, Axe‑FX), the system also provides default labels matching each CC parameter (max 10 characters).

| Mode | Control | CC # | Parameter Controlled | Default Label |
| --- | --- | --- | --- | --- |
| 0–127 | Fader 1 | 20 | User-defined (Full MIDI Learn) | — |
| 0–127 | Fader 2 | 21 | User-defined (Full MIDI Learn) | — |
| 0–127 | Fader 3 | 22 | User-defined (Full MIDI Learn) | — |
| 0–127 | Fader 4 | 23 | User-defined (Full MIDI Learn) | — |
| 0–127 | Stomp 1 | 80 | User-defined (Full MIDI Learn) | — |
| 0–127 | Stomp 2 | 81 | User-defined (Full MIDI Learn) | — |
| 0–127 | Stomp 3 | 82 | User-defined (Full MIDI Learn) | — |
| 0–127 | Stomp 4 | 83 | User-defined (Full MIDI Learn) | — |
|  |  |  |  |  |
| 1–128 | Fader 1 | 20 | User-defined (Full MIDI Learn) | — |
| 1–128 | Fader 2 | 21 | User-defined (Full MIDI Learn) | — |
| 1–128 | Fader 3 | 22 | User-defined (Full MIDI Learn) | — |
| 1–128 | Fader 4 | 23 | User-defined (Full MIDI Learn) | — |
| 1–128 | Stomp 1 | 80 | User-defined (Full MIDI Learn) | — |
| 1–128 | Stomp 2 | 81 | User-defined (Full MIDI Learn) | — |
| 1–128 | Stomp 3 | 82 | User-defined (Full MIDI Learn) | — |
| 1–128 | Stomp 4 | 83 | User-defined (Full MIDI Learn) | — |
|  |  |  |  |  |
| Kemper | Fader 1 | 72 | Amplifier Gain | Amp Gain |
| Kemper | Fader 2 | 4 | Pitch Pedal | Pitch |
| Kemper | Fader 3 | 69 | Delay Feedback | Delay Fdbk |
| Kemper | Fader 4 | 71 | Reverb Time | ReverbTime |
| Kemper | Stomp 1 | 17 | Pre-amp Effect Block A | Effect A |
| Kemper | Stomp 2 | 18 | Pre-amp Effect Block B | Effect B |
| Kemper | Stomp 3 | 22 | Post-amp FX Slot X | FX Slot X |
| Kemper | Stomp 4 | 24 | Post-amp Modulation Slot | Mod Slot |
|  |  |  |  |  |
| Axe-FX | Fader 1 | 20 | Manual – no fixed parameter | CC20 |
| Axe-FX | Fader 2 | 21 | Manual – no fixed parameter | CC21 |
| Axe-FX | Fader 3 | 22 | Manual – no fixed parameter | CC22 |
| Axe-FX | Fader 4 | 23 | Manual – no fixed parameter | CC23 |
| Axe-FX | Stomp 1 | 80 | Manual – no fixed parameter | CC80 |
| Axe-FX | Stomp 2 | 81 | Manual – no fixed parameter | CC81 |
| Axe-FX | Stomp 3 | 82 | Manual – no fixed parameter | CC82 |
| Axe-FX | Stomp 4 | 83 | Manual – no fixed parameter | CC83 |

**Updated Setup UI Flow**

1. **Setup → Mode**
   * User selects a new **Preset Mode**.
2. **On Mode Selection**
   * **Load** the factory CC defaults and, for non-MIDI-Learn modes, populate each label field (ensuring labels do not exceed 10 characters).
3. **Reflect in UI**
   * In **Setup → CC Assignment**, each entry shows its new default value *and* default label where applicable.
4. **Persistence**
   * Save both CC values and labels to EEPROM so defaults persist until the user overrides them.
5. **Edge Cases**
   * Re-selecting the same mode does *not* reload defaults or labels.
6. **setup\_mirror**
   * 1. Figure 5 – setup\_mirror screen  
        
     2. header\_text = ‘setup’ with horizontal lines either side
     3. Next row shows the current\_m\_delay value in OpenSans\_SemiBold14pt (to be confirmed during testing) in green.
     4. The bottom row shows menu\_item = ‘mirror delay’ in OpenSans\_SemiBold14pt, centred on the screen, with a white filled triangle either side
     5. Encoder button press displays setup\_mirror\_select screen
     6. Encoder turn or toggle switch moves to the next setup menu item
     7. long press on the mirror button returns into ‘PLAY’ mode from ‘SETUP’ mode:
   1. **setup\_mirror\_select**
      1. Figure 5.2 – setup\_mirror\_select screen  
         
      2. header\_text = ‘setup’ with horizontal lines either side
      3. the next row shows the next\_m\_delay in seconds using OpenSans\_SemiBold14pt (to be confirmed during testing) in red, with a filled white triangle either side.
      4. The bottom row shows the centred text ‘select mirror delay’ in OpenSans\_SemiBold14pt.
      5. Encoder turn or toggle switch adjusts the delay time value for m\_delay (range 0 (OFF) – 3.0 seconds) and displays it on the screen in seconds to one decimal place, eg ‘1.2 sec’
      6. m\_delay is a value that sets how long the delay time is to the nearest 1/10th of a second between short pressing the mirror button and midi data being sent to update all the current fader potentiometer positions
      7. Encoder button press confirms the mirror delay time and saves it to memory (EEPROM) as the ‘mirror\_delay\_value’ then displays the setup\_mirror screen (paragraph 5) again
7. **setup\_MIDI\_CH**
   * 1. Figure 6 – setup\_MIDI\_CH screen  
        
     2. header\_text = ‘setup’ with horizontal lines either side
     3. the next row shows ‘BLE’ on the left and ‘DIN’ on the right in OpenSans\_SemiBold14pt (to be confirmed during testing) in white
     4. the next row shows the current\_BLE\_MIDI\_CH value for BLE on the left and current\_DIN\_MIDI\_CH value for DIN on the right in OpenSans\_SemiBold14pt (to be confirmed during testing) in white
     5. The bottom row shows the centred text ‘MIDI channel’ in OpenSans\_SemiBold14pt with a filled white triangle either side.
     6. Encoder button press displays setup\_MIDI\_CH\_select screen (paragraph 6.2)
     7. Encoder turn or toggle switch moves to the next setup menu item
     8. long press on the mirror button returns into ‘PLAY’ mode from ‘SETUP’ mode
   1. **setup\_MIDI\_CH\_select**
      1. Figure 6.2 – setup\_MIDI\_CH\_select screen
      2. header\_text = ‘setup’ with horizontal lines either side
      3. the next row shows ‘BLE’ on the left and ‘DIN’ on the right in OpenSans\_SemiBold14pt (to be confirmed during testing) in white
      4. the next row shows the current\_BLE\_MIDI\_CH value for BLE on the left selected and in green and current\_DIN\_MIDI\_CH value for DIN on the right in white in OpenSans\_SemiBold14pt (to be confirmed during testing)
      5. The bottom row shows the centred text ‘select OUTPUT’ in OpenSans\_SemiBold14pt with a filled white triangle either side.
      6. Encoder turn or toggle switch scrolls through the two MIDI channel number values on the display by turning each on green in turn, while the other stays white
      7. Encoder button press confirms which midi output to change the MIDI channel value for and displays the setup\_MIDI\_CH\_confirmation screen (paragraph 6.3)
   2. **setup\_MIDI\_CH\_confirmation**
      1. Figure 6.3 – setup\_MIDI\_CH\_confirmation screen
      2. header\_text = ‘setup’ with horizontal lines either side
      3. Next row shows the current\_BLE/DIN\_CC in use in OpenSans\_SemiBold14pt (to be confirmed during testing) in red, with a white filled triangle either side
      4. The bottom row shows menu\_item = ‘select BLE/DIN MIDI CH’ in OpenSans\_SemiBold14pt, centred on the screen
      5. Encoder turn or toggle switch scrolls through the next\_BLE/DIN\_MIDI\_CH value, a round robin number range between 00 and 127, listed as 00, 01,02...21,22,23...126,127.
      6. Encoder button press confirms the BLE/DIN MIDI channel selection for that output and saves it to memory (EEPROM) as either the ble\_midi\_ch\_value or the din\_midi\_ch\_value, and displays the **setup\_MIDI\_CH screen** (paragraph 6) again
8. **setup\_fader\_labels**
   * 1. Figure 7 – setup\_fader\_labels screen  
        
     2. header\_text = ‘setup’ with horizontal lines either side
     3. the next row shows F1 F2 F3 F4 in a row using OpenSans\_SemiBold14pt (to be confirmed during testing) in white
     4. The bottom row shows menu\_item = ‘FADER labels’ in OpenSans\_SemiBold14pt, centred on the screen, with a white filled triangle either side
     5. Encoder button press displays setup\_fader\_labels\_selectscreen (paragraph 7.2)
     6. Encoder turn or toggle switch moves to the next setup menu item
     7. long press on the mirror button returns into ‘PLAY’ mode from ‘SETUP’ mode
   1. **setup\_fader\_labels\_select**
      1. Figure 7.2 – setup\_fader\_labels\_select screen  
         
      2. header\_text = ‘setup’ with horizontal lines either side
      3. the next row shows F1 F2 F3 F4 in a row using OpenSans\_SemiBold14pt (to be confirmed during testing) in white, apart from the currently selected fader number which is in green text
      4. The bottom row shows menu\_item = ‘FADER labels’ in OpenSans\_SemiBold14pt, centred on the screen, with a white filled triangle either side
      5. Encoder turn or toggle switch scrolls through the four round robin fader number values on the display by turning each on green in turn, while the rest stay white
      6. Encoder button press confirms the fader number to change the label for and displays the Setup\_FADER\_labels\_list screen (paragraph 7.3)
      7. long press on the mirror button returns into ‘PLAY’ mode from ‘SETUP’ mode
   2. **setup\_FADER\_labels\_list**
      1. Figure 7.3 – Setup\_FADER\_labels\_list screen  
         
      2. header\_text = ‘setup’ with horizontal lines either side
      3. Next row shows the current ‘F1/2/3/4\_label\_value’ in OpenSans\_SemiBold14pt (to be confirmed during testing), with a white filled triangle either side, starting with the currently active value in green. All other values in the list are to be displayed in white when called for by the encoder or toggle switch, which turn to green if selected by an encoder switch press
      4. The default ‘F1\_label\_value’ to be active and shown in green for F1 is ‘distortion’
      5. The default ‘F2\_label\_value’ to be active and shown in green for F2 is ‘modulation’
      6. The default ‘F3\_label\_value’ to be active and shown in green for F3 is ‘delay’
      7. The default ‘F4\_label\_value’ to be active and shown in green for F4 is ‘reverb’
      8. See section 15 for details of the ‘fader\_labels\_list’
      9. The bottom row shows menu\_item = ‘select (F1 / F2 / F3 / F4) label’ in OpenSans\_SemiBold14pt, centred on the screen
      10. Encoder turn or toggle switch moves to the next value in the ‘fader\_labels\_list’, displayed in white except the currently selected value which is displayed in green
      11. Encoder button press makes the currently displayed ‘fader\_labels\_list’ item turn green, and makes it active by saving it to the ‘F1/F2/F3/F4\_label\_value’ memory. After a 1500ms delay the display returns to the setup\_fader\_labels screen (paragraph 7) UNLESS the ‘CUSTOM’ value is chosen from the ‘fader\_labels\_list’, in which case display the Setup\_FADER\_labels\_custom screen (paragraph 7.4)
   3. **Setup\_FADER\_labels\_custom**
      1. Figure 7.4 – Setup\_FADER\_labels\_custom screen  
         
      2. header\_text = ‘setup’ with horizontal lines either side
      3. the next row shows a flashing white rectangle the size of the largest capital letter followed by a row of 9 hyphens using OpenSans\_SemiBold14pt (to be confirmed during testing) in red, with a filled white triangle either side.
      4. The flashing rectangle and each hyphen are placeholders for the user to choose a letter in turn to spell out a custom label to add to the ‘custom\_fader\_labels\_list’. The flashing rectangle is a cursor showing which character position is going to be edited.
      5. The bottom row shows the centred text ‘custom (F1 / F2 / F3 / F4) label’ in OpenSans\_SemiBold14pt, centred on the screen
      6. Encoder turn scrolls through a round robin lower case then upper case then number 0-9 list of characters in the position where the flashing cursor rectangle was
      7. Encoder button press confirms the current character selected in the first position, saves it to memory (EEPROM) building a custom label in the ‘custom\_fader\_labels\_list’ and keeps it displayed on the screen, then moves the cursor to the next hyphen position for the user to select a character in the same way.
      8. The toggle switch moves the cursor left or right along the character row at any stage
      9. Every press of the encoder then confirms the current character selected in the next position, saves it to memory (EEPROM) and displays it on the screen, then moves the cursor to the next hyphen position for the user to select a character in the same way.
      10. No more than 10 character positions can be filled
      11. if the mirror button is short pressed, the full name is stored in memory (EEPROM) and added to the ‘custom\_fader\_labels\_list’ as a custom\_label with a suffix number (starting at 01), and the display returns to the setup\_FADER\_labels\_list screen (paragraph 7.3) with the new custom label made active by saving it to the ‘F1/F2/F3/F4\_label\_value’ memory and displaying it in green.
   4. **Setup\_FADER\_labels\_edit**
      1. If an existing user created custom label is selected on the Setup\_FADER\_labels\_list screen, display the Setup\_FADER\_labels\_edit screen:
      2. Figure 7.5 - Setup\_FADER\_labels\_edit screen   
         
      3. header\_text = ‘setup’ with horizontal lines either side
      4. Next row shows the current ‘custom\_fader\_labels\_list’ value in OpenSans\_SemiBold14pt (to be confirmed during testing), in white.
      5. The bottom row shows three options – ‘select’, ‘edit’ and ‘delete’ in OpenSans\_SemiBold14pt. ‘select’ is in green and is the currently selected option, the other two in white.
      6. Encoder turn or toggle switch scrolls through the three round robin options on the display by turning each on green in turn, while the rest stay white
      7. Encoder button press confirms the option selected by displaying the relevant screen:
         1. If encoder button is pressed on ‘select’, make the current ‘custom\_fader\_labels\_list’ value active for the fader being labelled and return to the Setup\_FADER\_labels\_select screen (paragraph 7.2)
         2. If encoder button is pressed on ‘edit’ return to the Setup\_FADER\_labels\_custom screen (paragraph 7.4), with the current label already in the character spaces but editable
         3. If encoder button is pressed on ‘delete’ go to the Setup\_FADER\_labels\_delete (paragraph 7.6) screen
   5. **Setup\_FADER\_labels\_delete**
      1. Figure 7.6 - Setup\_FADER\_labels\_delete screen   
         
      2. header\_text = ‘setup’ with horizontal lines either side
      3. Next row shows ‘confirm delete?’ in OpenSans\_SemiBold14pt (to be confirmed during testing), in white.
      4. The bottom row shows ‘back’ in OpenSans\_SemiBold14pt in green, which is the currently selected option.
      5. Encoder turn or toggle switch scrolls between the two round robin options on the display by turning each on green in turn, while the other stays white
      6. Encoder button press confirms the green option selected by displaying the relevant screen:
         1. If encoder button is pressed on ‘back’ return to the Setup\_FADER\_labels\_edit (paragraph 7.5)
         2. If encoder button is pressed on ‘confirm delete?’, remove that custom label from the custom\_fader\_labels\_list list and return to the Setup\_FADER\_labels\_list screen (paragraph 7.3), with the ‘custom’ label active in green
9. **setup\_stomp\_labels**
   * 1. Figure 8 – setup\_stomp\_labels screen  
        
     2. Exactly the same as setup\_fader\_labels (paragraph 7) except:
        1. F1, F2, F3 and F4 become S1, S2, S3 and S4
        2. ‘FADER labels’ becomes ‘STOMP labels’
   1. **setup\_stomp\_labels\_select**
      1. Figure 8.2 – setup\_stomp\_labels\_select screen  
         
      2. Exactly the same as setup\_fader\_labels\_select (paragraph 7.2) except:
         1. F1, F2, F3 and F4 become S1, S2, S3 and S4
         2. ‘select FADER’ becomes ‘select STOMP’
   2. **setup\_STOMP\_labels\_list**
      1. Figure 8.3 – Setup\_STOMP\_labels\_list screen
      2. Exactly the same as setup\_FADER\_labels\_list (paragraph 7.3) except:
         1. ’f\_labels\_list’ becomes ’s\_labels\_list’ and uses ‘stomp\_labels\_list’ instead of ‘fader\_labels\_list’
         2. ‘select F1, F2, F3, F4 label’ becomes ‘select S1, S2, S3, S4 label’
   3. **Setup\_STOMP\_labels\_custom**
      1. Figure 8.4 – Setup\_STOMP\_labels\_custom screen  
         
      2. Exactly the same as Setup\_FADER\_labels\_custom (paragraph 7.4) except:
         1. ‘custom F1, F2, F3, F4 label’ becomes ‘custom S1, S2, S3, S4 label’ and uses ‘custom\_stomp\_labels\_list’ instead of ‘custom\_fader\_labels\_list’
   4. **Setup\_STOMP\_labels\_edit**
      1. If an existing user created custom label is selected on the Setup\_STOMP\_labels\_list screen, display the Setup\_STOMP\_labels\_edit screen:
      2. Figure 7.5 - Setup\_STOMP\_labels\_edit screen 
      3. Exactly the same as Setup\_FADER\_labels\_edit (paragraph 7.5) except:
         1. the current ‘custom\_fader\_labels\_list’ value becomes the current ‘custom\_stomp\_labels\_list’ value
      4. Encoder button press confirms the option selected by displaying the relevant screen:
         1. If encoder button is pressed on ‘select’, make the current custom\_stomp\_labels\_list value active for the stomp being labelled and return to the Setup\_STOMP\_labels\_select screen (paragraph 8.2)
         2. If encoder button is pressed on ‘edit’ return to the Setup\_STOMP\_labels\_custom screen (paragraph 8.4), with the current label already in the character spaces but editable
         3. If encoder button is pressed on ‘delete’ go to the Setup\_STOMP\_labels\_delete (paragraph 8.6) screen
   5. **Setup\_STOMP\_labels\_delete**
      1. Figure 8.6 - Setup\_STOMP\_labels\_delete screen   
         
      2. Exactly the same as Setup\_FADER\_labels\_delete (paragraph 7.6) except:
         1. If encoder button is pressed on ‘back’ return to the Setup\_STOMP\_labels\_edit (paragraph 8.5)
         2. If encoder button is pressed on ‘confirm delete?’, remove that custom label from the s\_custom label list and return to the Setup\_STOMP\_labels\_list screen (paragraph 8.3), with the ‘custom’ label active in green
10. **setup\_fader\_CC**
    * 1. Figure 9 – setup\_fader\_CC screen
      2. header\_text = ‘setup’ with horizontal lines either side
      3. Next row shows F1 F2 F3 F4 in a row using OpenSans\_SemiBold14pt (to be confirmed during testing) in white.
      4. Next row shows current CC numbers assigned to each fader, values directly below F1 F2 F3 and F4 using OpenSans\_SemiBold14pt (to be confirmed during testing) in white.
      5. The bottom row shows menu\_item = ‘FADER CC in OpenSans\_SemiBold14pt, centred on the screen, with a white filled triangle either side
      6. Encoder button press displays Setup\_FADER\_CC\_select screen (paragraph 9.2)
      7. Encoder turn or toggle switch moves to the next setup menu item
      8. long press on the mirror button returns into ‘PLAY’ mode from ‘SETUP’ mode
    1. **setup\_fader\_CC\_select**
       1. Figure 9.2 – setup\_fader\_CC\_select screen  
          
       2. header\_text = ‘setup’ with horizontal lines either side
       3. the next row shows F1 F2 F3 F4 in a row using OpenSans\_SemiBold14pt (to be confirmed during testing) in white
       4. Next row shows current CC numbers assigned to each fader, with values directly below F1 F2 F3 and F4 using OpenSans\_SemiBold14pt (to be confirmed during testing) in white, apart from the first value below F1 which is currently selected and in green
       5. Default fader CC numbers are:
          1. F1 – 20
          2. F2 – 21
          3. F3 - 22
          4. F4 - 23
       6. The bottom row shows menu\_item = ‘select FADER’ in OpenSans\_SemiBold14pt, centred on the screen, with a white filled triangle either side
       7. Encoder turn or toggle switch scrolls through the four CC number values on the display by turning each on green in turn, while the rest stay white
       8. Encoder button press confirms the fader CC number to change the label for and displays the setup\_FADER\_CC\_confirmation screen (paragraph 9.3)
    2. **Setup\_FADER\_CC\_confirmation**
       1. Figure 9.3 – setup\_FADER\_CC\_confirmation screen  
          
       2. header\_text = ‘setup’ with horizontal lines either side
       3. Next row shows the current\_FADER\_CC in use in OpenSans\_SemiBold14pt (to be confirmed during testing) in red, with a white filled triangle either side
       4. The bottom row shows menu\_item = ‘select FADER 1/2/3/4 CC’ in OpenSans\_SemiBold14pt, centred on the screen
       5. Encoder turn or toggle switch scrolls through the next\_FADER\_CC value, a round robin number range between 00 and 127, listed as 00, 01,02...21,22,23...126,127.
       6. Encoder button press confirms the MIDI CC selection for that fader and saves it to memory (EEPROM), and displays the setup\_fader\_CC screen (paragraph 9) again
11. **setup\_stomp\_cc**
    * 1. Figure 10 – setup\_stomp\_CC screen
      2. header\_text = ‘setup’ with horizontal lines either side
      3. Next row shows S1 S2 S3 S4 in a row using OpenSans\_SemiBold14pt (to be confirmed during testing) in white.
      4. Next row shows current CC numbers assigned to each stomp, values directly below S1 S2 S3 and S4 using OpenSans\_SemiBold14pt (to be confirmed during testing) in white.
      5. The bottom row shows menu\_item = ‘STOMP CC’ in OpenSans\_SemiBold14pt, centred on the screen, with a white filled triangle either side
      6. Encoder button press displays Setup\_STOMP\_CC\_select screen (paragraph 10.2)
      7. Encoder turn or toggle switch moves to the next setup menu item
      8. long press on the mirror button returns into ‘PLAY’ mode from ‘SETUP’ mode
    1. **setup\_stomp\_CC\_select**
       1. Figure 10.2 – setup\_stomp\_CC\_select screen  
          
       2. header\_text = ‘setup’ with horizontal lines either side
       3. the next row shows S1 S2 S3 S4 in a row using OpenSans\_SemiBold14pt (to be confirmed during testing) in white
       4. Next row shows current CC numbers assigned to each stomp, with values directly below S1 S2 S3 and S4 using OpenSans\_SemiBold14pt (to be confirmed during testing) in white, apart from the first value below S1 which is currently selected and in green
       5. Default stomp CC numbers are:
          1. S1 – 80
          2. S2 – 81
          3. S3 - 82
          4. S4 - 83
       6. The bottom row shows menu\_item = ‘select STOMP in OpenSans\_SemiBold14pt, centred on the screen, with a white filled triangle either side
       7. Encoder turn or toggle switch scrolls through the four CC number values on the display by turning each on green in turn, while the rest stay white
       8. Encoder button press confirms the stomp CC number to change the label for and displays the setup\_STOMP\_CC\_confirmation screen (paragraph 10.3)
    2. **Setup\_STOMP\_CC\_confirmation**
       1. Figure 10.3 – setup\_STOMP\_CC\_select screen  
          
       2. header\_text = ‘setup’ with horizontal lines either side
       3. Next row shows the current\_STOMP\_CC in use in OpenSans\_SemiBold14pt (to be confirmed during testing) in red, with a white filled triangle either side
       4. The bottom row shows menu\_item = ‘select STOMP 1/2/3/4 CC’ in OpenSans\_SemiBold14pt, centred on the screen
       5. Encoder turn or toggle switch scrolls through the next\_STOMP\_CC value, a round robin number range between 00 and 127, listed as 00, 01,02...21,22,23...126,127.
       6. Encoder button press confirms the MIDI CC selection for that stomp and saves it to memory (EEPROM), and displays the setup\_stomp\_labels screen (paragraph 10) again
12. **setup\_stomp\_type**
    * 1. Figure 11 – setup\_stomp\_type screen
      2. header\_text = ‘setup’ with horizontal lines either side
      3. Next row shows S1 S2 S3 S4 in a row using OpenSans\_SemiBold14pt (to be confirmed during testing) in white.
      4. Next row shows current stomp switch type assigned to each stomp, values directly below S1 S2 S3 and S4 using OpenSans\_SemiBold14pt (to be confirmed during testing) in white. Options are MO (momentary) and TG (toggle)
      5. The bottom row shows menu\_item = ‘STOMP type’ in OpenSans\_SemiBold14pt, centred on the screen, with a white filled triangle either side
      6. Encoder button press displays setup\_STOMP\_type\_select screen (paragraph 11.2)
      7. Encoder turn or toggle switch moves to the next setup menu item
      8. long press on the mirror button returns into ‘PLAY’ mode from ‘SETUP’ mode
    1. **setup\_stomp\_type\_select**
       1. Figure 11.2 – setup\_stomp\_type\_select screen  
          
       2. header\_text = ‘setup’ with horizontal lines either side
       3. the next row shows S1 S2 S3 S4 in a row using OpenSans\_SemiBold14pt (to be confirmed during testing) in white
       4. Next row shows current stomp switch type assigned to each stomp, with values directly below S1 S2 S3 and S4 using OpenSans\_SemiBold14pt (to be confirmed during testing) in white, apart from the first value below S1 which is currently selected and in green
       5. Default stomp types are:
          1. S1 – TG
          2. S2 – TG
          3. S3 - TG
          4. S4 - TG
       6. The bottom row shows menu\_item = ‘select STOMP in OpenSans\_SemiBold14pt, centred on the screen, with a white filled triangle either side
       7. Encoder turn or toggle switch scrolls through the four switch type values on the display by turning each on green in turn, while the rest stay white
       8. Encoder button press confirms the stomp number to change the type for and displays the setup\_STOMP\_type\_confirmation screen (paragraph 11.3)
    2. **Setup\_STOMP\_type\_confirmation**
       1. Figure 11.3 – setup\_STOMP\_type\_confirmation screen
       2. header\_text = ‘setup’ with horizontal lines either side
       3. Next row shows the current\_STOMP\_type in use in OpenSans\_SemiBold14pt (to be confirmed during testing) in red, with a white filled triangle either side
       4. setup\_stomp\_type\_select OpenSans\_SemiBold14pt, centred on the screen
       5. Encoder turn or toggle switch scrolls through the next\_STOMP\_type value, a round robin choice of either ‘toggle’ (TG) or ‘momentary’ (MO)
       6. Encoder button press confirms the switch type selection for that stomp and saves it to memory (EEPROM), changes the behaviour of that stomp to the selected type, and displays the setup\_stomp\_type screen (paragraph 11) again
13. **SYSTEM STATE / EEPROM STORAGE / LOOKUP TABLES**

| **Type** | **NAME** | **PARAGRAPH** | **RANGE** | **NOTES** |
| --- | --- | --- | --- | --- |
| LED brightness | LED\_brightness\_value | 2.2 | 0 (off) -20 (max) | Logarithmic scale, 0-100% brightness  Default = 100% |
| TFT brightness | TFT\_brightness\_value | 3.2 | 0 (off) -20 (max) | Logarithmic scale, 0-100% brightness  Default = 100% |
| Preset mode | preset\_mode\_list | 4.2.5, 4.2.6 | List – 0-127, 1-128, Axe-FX etc | See section 13 for details.  See section 13.2 for the preset\_mode\_list contents  Default = 001-127 |
| current preset | current\_preset\_value |  | Depends on preset mode selected | See preset handling in ‘PLAY’ mode section  Default = 001 |
| ‘Mirror’ delay | mirror\_delay\_value | 5.25/5.26/5.27 | 0 – 3.0 seconds | Value in seconds to one decimal place  Default = 0.5 seconds |
| BLE MIDI channel | ble\_midi\_ch\_value | 6.3.5 | 00-127 | Default = channel 01 |
| DIN MIDI channel | din\_midi\_ch\_value | 6.3.5 | 00-127 | Default = channel 01 |
| Fader labels | fader\_labels\_list | 7.3.3 | fader 1  fader 2  fader 3  fader 4  distortion  gain  drive  fuzz  modulation  phaser  flanger  rotary  tremolo  wah  ring mod  delay  delay time  delay fbck  reverb  pitch  \*custom\* | Default =  fader 1  fader 2  fader 3  fader 4 |
| Custom fader labels | custom\_fader\_labels\_list | 7.4 | custom\_label\_01  custom\_label\_02  custom\_label\_03  etc | Custom list is created by the user |
| F1 label | F1\_label\_value | 7.3.13 | Selected label for F1 |  |
| F2 label | F2\_label\_value | 7.3.13 | Selected label for F2 |  |
| F3 label | F3\_label\_value | 7.3.13 | Selected label for F3 |  |
| F4 label | F4\_label\_value | 7.3.13 | Selected label for F4 |  |
| stomp labels | stomp\_labels\_list | 8.3.3 | stomp 1  stomp 2  stomp 3  stomp 4  distortion  gain  drive  fuzz  modulation  phaser  flanger  rotary  tremolo  wah  ring mod  delay  reverb  kill  \*custom\* | Default =  stomp 1  stomp 2  stomp 3  stomp 4 |
| Custom stomp labels | custom\_stomp\_labels\_list | 8.4 | custom\_stomp\_label\_01  custom\_stomp\_label\_02  custom\_stomp\_label\_03  etc | Custom list is created by the user |
| S1 label | S1\_label\_value | 8.3 | Selected label for S1 |  |
| S2 label | S2\_label\_value | 8.3 | Selected label for S2 |  |
| S3 label | S3\_label\_value | 8.3 | Selected label for S3 |  |
| S4 label | S4\_label\_value | 8.3 | Selected label for S4 |  |
| Fader 1 CC | F1\_CC\_value | 9.3 | 0-127 |  |
| Fader 2 CC | F2\_CC\_value | 9.3 | 0-127 |  |
| Fader 3 CC | F3\_CC\_value | 9.3 | 0-127 |  |
| Fader 4 CC | F4\_CC\_value | 9.3 | 0-127 |  |
| Stomp 1 CC | S1\_CC\_value | 10.3 | 0-127 |  |
| Stomp 2 CC | S2\_CC\_value | 10.3 | 0-127 |  |
| Stomp 3 CC | S3\_CC\_value | 10.3 | 0-127 |  |
| Stomp 4 CC | S4\_CC\_value | 10.3 | 0-127 |  |
| Stomp 1 type | S1\_type\_value | 11.3 | TG or MO | Toggle or momentary |
| Stomp 2 type | S2\_type\_value | 11.3 | TG or MO | Toggle or momentary |
| Stomp 3 type | S3\_type\_value | 11.3 | TG or MO | Toggle or momentary |
| Stomp 4 type | S4\_type\_value | 11.3 | TG or MO | Toggle or momentary |
| Screen offset (x/y) | screen\_offset |  | Value (pixels) | Distance in pixels from top left corner (x/y) of screen  Default = 5,5 |
| Device name | device\_name |  | Default is ‘deep\_control’ | Use default for now, add ability of user to change later |
|  |  |  |  |  |
|  |  |  |  |  |

1. **EXTERNAL HARDWARE PRESET FORMATS / MODES:**
   1. **General rules:**
   * The controller will work differently depending upon the MODE selected in the SETUP menu
   * All preset numbers are ‘round robin’
   * All fader CC values are 0-127, scaled to 0.0 – 10 on the display
   * All stomps are CC value 0 for OFF and 127 for ON
   1. preset\_mode\_list

* 0-127
* 1-128
* Helix
* Kemper
* Axe-FX
* Bias-FX
* AmpliTube
* JamUp
* ToneStack
* Loopy
  1. **0-127 PRESET HANDLING:**
* Program Change (PC) messages 0-127 change presets 0-127 on the external unit
* The 0-127\_DEFAULT screen [IMAGE OF 0-127\_DEFAULT SCREEN]
  + shows title “- preset -“
  + shows the current PRESET number in large white font
* on encoder turn [IMAGE OF PRESET
  + keeps title “- preset -“ replaces big number with two columns:
  + left column has “NOW” with the current preset number below (0-127)
  + right column has “NEXT” with the next preset number below (0-127), changing with the encoder turn
  + right column is RED colour
  + returns to 0-127\_DEFAULT SCREEN after 5000ms delay if no interaction is detected
* on encoder press
  + returns to the 0-127\_DEFAULT screen with preset number updated
  + sends corresponding MIDI message
* on short toggle switch push
  + keeps title “- preset -“ replaces big number with two columns:
  + left column has “NOW” with the current preset number below (0-127)
  + right column has “NEXT” with the next preset number below (0-127), changing with each toggle press either UP/DOWN (INC/DEC)
  + right column is RED colour
* on long toggle switch push:
  + As short push, except after 1 second the NEXT number scrolls automatically once every 200ms until released
* on toggle release
  + returns to the 0-127\_DEFAULT screen with preset number updated
  + sends corresponding MIDI message
  1. **0-127 CC handling:**
* assume Full MIDI Learn, can send **any CC number** from your controller, and the system will learn it
* **USE THESE DEFAULTS ON FIRST SELECTING THE 0-127 MODE** - user may change them via the SETUP menu:
  + - FADER 1 - **CC 20**
    - FADER 2 - **CC 21**
    - FADER 3 - **CC 22**
    - FADER 4 - **CC 23**
    - STOMP 1 - **CC 80**
    - STOMP 2 - **CC 81**
    - STOMP 3 - **CC 82**
    - STOMP 4 - **CC 83**
  1. **1-128 PRESET HANDLING:**
* EXACTLY THE SAME AS **0-127** mode, except:
  + Program Change (PC) messages 0-127 change presets 1-128 on the external unit
  + The screen shows preset numbers 1-128 instead of 0-127
  1. **1-128 CC handling:**
* assume Full MIDI Learn, can send **any CC number** from your controller, and the system will learn it
* **USE THESE DEFAULTS ON FIRST SELECTING THE 1-128 MODE** - user may change them via the SETUP menu:
  + - FADER 1 - **CC 20**
    - FADER 2 - **CC 21**
    - FADER 3 - **CC 22**
    - FADER 4 - **CC 23**
    - STOMP 1 - **CC 80**
    - STOMP 2 - **CC 81**
    - STOMP 3 - **CC 82**
    - STOMP 4 - **CC 83**
  1. **HELIX PRESET HANDLING:**
* Program Change (PC) messages 0-127 change presets 1-128 on the external unit
* The HELIX\_DEFAULT screen [IMAGE OF HELIX\_DEFAULT SCREEN]
  + shows title “- preset -“
  + shows the current PRESET number in large white font
* on encoder turn [IMAGE OF PRESET
  + keeps title “- preset -“ replaces big number with two columns:
  + left column has “NOW” with the current preset number below (1-128)
  + right column has “NEXT” with the next preset number below (1-128), changing with the encoder turn
  + right column is RED colour
  + returns to HELIX\_DEFAULT SCREEN after 5000ms delay if no interaction is detected
* on encoder press
  + returns to the HELIX\_DEFAULT screen with preset number updated
  + sends corresponding MIDI message
* on short toggle switch push
  + keeps title “- preset -“ replaces big number with two columns:
  + left column has “NOW” with the current preset number below (1-128)
  + right column has “NEXT” with the next preset number below (1-128), changing with each toggle press either UP/DOWN (INC/DEC)
  + right column is RED colour
* on long toggle switch push:
  + As short push, except after 1 second the NEXT number scrolls automatically once every 200ms until released
* on toggle release
  + returns to the HELIX\_DEFAULT screen with preset number updated
  + sends corresponding MIDI message
* There is also **Snapshot Selection**
  + **Controlled via MIDI CC 69:**
    - CC 69 value 0 = Snapshot 1
    - 1 = Snapshot 2
    - 2 = Snapshot 3
    - 3 = Snapshot 4
    - 8 = Next Snapshot
    - 9 = Previous Snapshot
  + This may not work well with my controller because the physical positions of the faders won’t match the snapshots on the external unit
  1. **HELIX CC handling:**
* Helix has Full MIDI Learn, can send **any CC number** from your controller, and the Helix will learn it
* **USE THESE DEFAULTS ON FIRST SELECTING THE HELIX MODE** - user may change them via the SETUP menu:
  + - FADER 1 - **CC 20**
    - FADER 2 - **CC 21**
    - FADER 3 - **CC 22**
    - FADER 4 - **CC 23**
    - STOMP 1 - **CC 80**
    - STOMP 2 - **CC 81**
    - STOMP 3 - **CC 82**
    - STOMP 4 - **CC 83**
  1. **KEMPER PRESET HANDLING:**
* **26 Performances** (banks) contain **5 Slots** (presets) each = 128 presets (PC number 0-127)
* The formula in code to do this is:

uint8\_t pc = (bank - 1) \* 5 + (slot - 1);

sendProgramChange(pc, midiChannel);

* So the display will show and be able to change both performance numbers (1-26) and slot numbers (1-5)
* The KEMPER\_DEFAULT screen [IMAGE OF KEMPER\_DEFAULT SCREEN]
  + shows title “- preset -“
  + with two columns below:
    - left column has “PERF” with the current performance number below (1-26)
    - right column has “SLOT” with the current slot number below (1-5).
* Turning the encoder - [IMAGE OF PERFORMANCE SCREEN]
  + shows title “- performance -“
  + with two columns below:
    - left column has “NOW” with the current performance preset number below (1-26) in white
    - right column has “NEXT” with the next performance number below (1-26), changing with the encoder turn
    - right column is changed to RED colour
  + no MIDI message is sent yet
  + mustn’t bounce, and must change numbers rapidly with a fast turn, and slowly with a slow turn
  + returns to KEMPER\_DEFAULT SCREEN after 5000ms delay if no interaction is detected
* SHORT pressing the encoder button once
  + sends the corresponding MIDI PC message (using formula above)
  + returns to the KEMPER\_DEFAULT SCREEN with preset number updated
* using the toggle switch [IMAGE OF SLOT SCREEN}
  + ON SHORT PUSH:
    - shows title “- slot -“
    - with two columns below:
      * left column has “NOW” with the current slot preset number below (1-5) in white
      * right column has “NEXT” with the next slot number below (1-5), changing with the toggle switch
      * right column is changed to RED colour
      * mustn’t bounce
  + ON LONG PUSH:
    - As short push, except after 1 second the NEXT number scrolls automatically once every 200ms until released
  + ON RELEASE:
    - a corresponding MIDI message is sent after 500ms delay
    - returns to KEMPER\_DEFAULT SCREEN after 500ms delay with preset number updated
  1. **KEMPER CC handling:**
* Kemper has no true MIDI learn facility, You must manually assign CCs to functions (e.g. Wah, Volume, Morph) in **System > MIDI Settings**
  + Create a list in the SETUP / MODE menu under Kemper for the user to select from the **Kemper Profiler — Default MIDI CC Mapping** defaults listed below to assign CC numbers to each fader and stomp button.
  + **Expression Pedals & Wah/Volume – good for POTENTIOMETERS**
    - **CC 1** – Wah Pedal Level
    - **CC 4** – Pitch Pedal
    - **CC 7** – Volume Pedal
  + **Effect Toggles (On/Off) – good for STOMP BUTTONS**
    - **CC 16** – Toggle all stomps A–D, X, MOD
    - **CC 17** – Stomp A – first effect block **before** the amp stack
    - **CC 18** – Stomp B – second effect block **before** the amp stack
    - **CC 19** – Stomp C – third effect block **before** the amp stack
    - **CC 20** – Stomp D– fourth effect block **before** the amp stack
    - **CC 22** – Stomp X - **"X"** is the first effect block **after** the amp stack. Can be any effect type (delay, EQ, chorus, etc.)
    - **CC 24** – Stomp MOD - **"MOD"** is the second post-amp FX slot. Often used for modulation (flanger, phaser, rotary), but can be any effect
  + **Delay & Reverb – good for STOMP BUTTONS**
    - **CC 26** – Delay bypass - *without tails*
    - **CC 27** – Delay bypass - *keep tails*
    - **CC 28** – Reverb bypass - *without tails*
    - **CC 29** – Reverb bypass - *keep tails*
  + **Tap & Tuner - good for STOMP BUTTONS**
    - **CC 30** – Tap Tempo
    - **CC 31** – Tuner on/off
  + **Performance Mode (multi-rig) – handles by encoder and toggle switch so probably not needed. If required use STOMP BUTTONS**
    - **CC 48** – Next Performance index
    - **CC 49** – Previous Performance index
    - **CC 50–54** – Select Slot 1–5 in current Performance
  + **Expression Pedal Assignments for Modulation – good for POTENTIOMETERS**
    - **CC 68** – Delay Mix
    - **CC 69** – Delay Feedback
    - **CC 70** – Reverb Mix
    - **CC 71** – Reverb Time
    - **CC 72** – Amplifier Gain
  + **USE THESE DEFAULTS ON FIRST SELECTING THE KEMPER MODE** - user may change them via the SETUP menu:
    - FADER 1 - **CC 72** – Amplifier Gain
    - FADER 2 - **CC 4** – Pitch Pedal
    - FADER 3 - **CC 69** – Delay Feedback
    - FADER 4 - **CC 71** – Reverb Time
    - STOMP 1 - **CC 17** – Stomp A
    - STOMP 2 - **CC 18** – Stomp B
    - STOMP 3 - **CC 22** – Stomp X
    - STOMP 4 - **CC 24** – Stomp MOD
  1. **AXE-FX PRESET HANDLING:**
* **Use the below information to allow the user to select their Axe-FX model in the SETUP menu after selecting Axe-FX as the MODE. This will then set the preset value range available in the AXE-FX mode.**

Axe-FX Preset Ranges by Model:

| Model | Number of Presets | PC Range | Notes |
| --- | --- | --- | --- |
| Axe-FX II | 384 | 0–383 | Banked via CC0/32 (optional) |
| Axe-FX III | 512 | 0–511 | Default, stored in 2 banks of 256 |
| FM3 / FM9 | 512 | 0–511 | Same as Axe-FX III |

🧠 Important Notes:

* The MIDI PC spec only supports 0–127 per message.
* To access >128 presets, Fractal uses Bank Select:
  + CC 0 (Bank MSB) and/or CC 32 (Bank LSB)
  + Example:
    - Bank Select MSB = 1 → Presets 128–255
    - Bank Select MSB = 2 → Presets 256–383
    - Bank Select MSB = 3 → Presets 384–511

You must send Bank Select first, then Program Change (PC 0–127) to access full range.

✅ Implementation Summary

* Support up to 512 presets
* Auto-calculate Bank MSB + PC from preset number:

cpp

CopyEdit

bankMSB = preset / 128;

pc = preset % 128;

* Send:
  1. CC 0 with bankMSB
  2. PC with value pc
* The AXE-FX\_DEFAULT screen [IMAGE OF AXE-FX\_DEFAULT SCREEN]
  + shows two columns:
    - left column has “PRESET” with the current preset number below (0-383 OR 0-511, depending on Axe-FX model selected)
    - right column has “SCENE” with the current slot number below (1-5).
* Turning the encoder - [IMAGE OF AXE-FX\_PRESET SCREEN]
  + shows title “- preset -“
  + with two columns below:
    - left column has “NOW” with the current preset number below (0-383 OR 0-511, depending on Axe-FX model selected) in white
    - right column has “NEXT” with the next preset number below (0-383 OR 0-511, depending on Axe-FX model selected)
    - right column is changed to RED colour
  + no MIDI message is sent yet
  + mustn’t bounce, and must change numbers rapidly with a fast turn, and slowly with a slow turn
  + returns to AXE-FX\_DEFAULT SCREEN after 5000ms delay if no interaction is detected
* SHORT pressing the encoder button once
  + sends the corresponding MIDI PC message (0-383 OR 0-511, depending on Axe-FX model selected)
  + returns to the AXE-FX\_DEFAULT SCREEN with preset number updated
* using the toggle switch [IMAGE OF AXE-FX\_SCENE SCREEN}
  + ON SHORT PUSH:
    - shows title “- scene -“
    - with two columns below:
      * left column has “NOW” with the current scene number below (1-8) in white
      * right column has “NEXT” with the next scene number below (1-8), changing with the toggle switch
      * right column is changed to RED colour
      * mustn’t bounce
  + ON LONG PUSH:
    - As short push, except after 1 second the NEXT number scrolls automatically once every 200ms until released
  + ON RELEASE:
    - a corresponding MIDI message is sent after 500ms delay
    - returns to AXE-FX\_DEFAULT SCREEN after 500ms delay with preset number updated
  1. **AXE-FX CC handling:**
* Axe-fx has no MIDI Learn
* User has to map CC numbers to effects / toggles manually on the Axe-FX
* My controller SETUP menu to allow user to select CC number 0-127 to map to each fader / stomp button
  + **USE THESE DEFAULTS ON FIRST SELECTING THE AXE-FX MODE** - user may change them via the SETUP menu:
    - FADER 1 - **CC 20**
    - FADER 2 - **CC 21**
    - FADER 3 - **CC 22**
    - FADER 4 - **CC 23**
    - STOMP 1 - **CC 80**
    - STOMP 2 - **CC 81**
    - STOMP 3 - **CC 82**
    - STOMP 4 - **CC 83**
  1. **BIAS-FX PRESET HANDLING:**
* Similar to the Kemper and Axe-fx UI, but uses BANKs (A-D) and PRESETS (1-128) using the following logic:

uint8\_t bank = pcValue / 128;  
uint8\_t preset = (pcValue % 128) + 1;  
  
sendControlChange(0, bank, midiChannel); // Bank Select MSB  
sendProgramChange(preset - 1, midiChannel); // PC is 0–127

* The BIAS-FX\_DEFAULT screen [IMAGE OF BIAS-FX\_DEFAULT SCREEN]
  + shows two columns:
    - left column has “BANK” with the current bank letter number below (A-D)
    - right column has “PRESET” with the current preset number below (1-128).
* Turning the encoder - [IMAGE OF BIAS-FX\_PRESET SCREEN]
  + shows title “- preset -“
  + with two columns below:
    - left column has “NOW” with the current bank letter number below (A-D) in white
    - right column has “NEXT” with the bank letter number below (A-D)
    - right column is changed to RED colour
  + no MIDI message is sent yet
  + mustn’t bounce, and must change numbers rapidly with a fast turn, and slowly with a slow turn
  + returns to BIAS -FX\_DEFAULT SCREEN after 5000ms delay if no interaction is detected
* SHORT pressing the encoder button once
  + sends the corresponding MIDI CC 0 = bank (0–3)
  + returns to the BIAS-FX\_DEFAULT SCREEN with bank letter updated
* using the toggle switch [IMAGE OF BIAS-FX\_PRESET SCREEN}
  + ON SHORT PUSH:
    - shows title “- preset -“
    - with two columns below:
      * left column has “NOW” with the current preset number below (1-128) in white
      * right column has “NEXT” with the next preset number below (1-128), changing with the toggle switch
      * right column is changed to RED colour
      * mustn’t bounce
  + ON LONG PUSH:
    - As short push, except after 1 second the NEXT number scrolls automatically once every 200ms until released
  + ON RELEASE:
    - a corresponding MIDI PC (0-127) message is sent after 500ms delay
    - returns to BIAS-FX\_DEFAULT SCREEN after 500ms delay with preset number updated
  1. **BIAS-FX CC handling:**
* Bias-fx has Full MIDI Learn, can send **any CC number** from your controller, and the system will learn it
* **USE THESE DEFAULTS ON FIRST SELECTING THE BIAS-FX MODE** - user may change them via the SETUP menu:
  + - FADER 1 - **CC 20**
    - FADER 2 - **CC 21**
    - FADER 3 - **CC 22**
    - FADER 4 - **CC 23**
    - STOMP 1 - **CC 80**
    - STOMP 2 - **CC 81**
    - STOMP 3 - **CC 82**
    - STOMP 4 - **CC 83**
  1. **OTHER MODES TO ADD in the near future:**
* AmpliTube
* JamUp / JamUp Pro
* ToneStack Pro
* Loopy

1. **CONTROLLER LOGIC & FUNCTIONALITY**
   1. **SLIDE FADERS**

| **Behavior** | **Description** |
| --- | --- |
| **4 slide pots** | Each mapped to a MIDI CC number (user defined via the setup menu) |
| **Trigger condition** | Only sends MIDI data when **physically moved**, changing at least 3–4 value steps (to prevent jitter). |
| **Display feedback** | Screen display to be confirmed |
| **LEDs** | On at all times, brightness configurable in setup. |
| **MIDI Output** | Sends CC value of position to defined channel (DIN & BLE). |

* 1. **STOMP SWITCHES (1–4)**

| **Feature** | **Description** |
| --- | --- |
| **Type** | Momentary buttons. |
| **Action** | Toggles CC between 0 ↔ 127 on press. |
| **Selectable behavior** | Choose between toggle or momentary per switch in setup. |
| **Screen feedback** | Screen display to be confirmed |
| **MIDI Output** | Sends fixed CC message (value 127 ON, 0 OFF). |
| **CC Assignment** | Global (not per preset), editable via setup. |
| **LEDs** | None associated. |

* 1. **TOGGLE SWITCH (ON–OFF–ON Momentary)**

| **Direction** | **Function** |
| --- | --- |
| **Flick UP** | in ‘SETUP’ mode: used for forward menu navigation in ‘PLAY mode: Increments preset number by 1 May have further functions depending on screen displayed, TBC |
| **Hold UP** | in ‘SETUP’ mode: used for rapid forward menu navigation in ‘PLAY mode: increments preset number rapidly May have further functions depending on screen displayed, TBC |
| **Flick DOWN** | in ‘SETUP’ mode: used for backward menu navigation in ‘PLAY mode: decrements preset number by 1 May have further functions depending on screen displayed, TBC |
| **Hold DOWN** | in ‘SETUP’ mode: used for rapid backward menu navigation in ‘PLAY mode: decrements preset number rapidly May have further functions depending on screen displayed, TBC |
| **Wraparound** | Values loop from 127→0 and 0→127. |
| **Delay** | MIDI PC message sent **after a user-defined ‘mirror’ delay** (set in setup). |

* 1. **ROTARY ENCODER + BUTTON**

| **Use** | **Behavior** |
| --- | --- |
| **‘PLAY’ mode** | Turn scrolls through preset numbers, encoder button press sends MIDI PC message |
| **‘SETUP’ mode** | Menu navigations - rotate to scroll; press to select. |
| **Wraparound** | Enabled for value scrolling (e.g., preset 127 → 0). |
| **Setup integration** | Used for adjusting values and selecting options in setup menus. |

* 1. **‘Mirror’ BUTTON (momentary switch)**

| **Action** | **Function** |
| --- | --- |
| **Short press (outside setup)** | Sends all fader MIDI CCs at once after mirror delay time configured in ‘SETUP’ mode |
| **Long press** | Enters ‘SETUP’ mode from ‘PLAY’ mode, and ‘PLAY’ mode from ‘SETUP’ mode |
| **Short press (in setup)** | Acts as “back” or “cancel” button. |

1. **TFT DISPLAY LOGIC**

**Display Content Rules:**

* **Global margin offset** (to avoid bezel clipping)
* **Configurable safe zone** (via screenOffsetX/Y)
* **Auto-returns** to default screen (TBC) in ‘PLAY’ mode after 20s inactivity (even in setup)
* Displays change instantly in response to hardware input
* The only parts of the display screens that get redrawn must **only ever** be the pixels that actually change in operation. This is **essential** to minimise screen flicker.

**Primary Screens:**

| **Screen Name** | **Trigger** | **Description** |
| --- | --- | --- |
| **Logo Screen** | On boot | Deep Instruments logo + welcome animation |
| **Effect Control Title Sequence** | Boot sequence | “EFFECT CONTROL SYSTEM” screen sequence |
| **‘PLAY’ mode default screen** | After boot sequence and after long mirror button press while in ‘SETUP mode | default\_screen |
| **‘SETUP’ mode default screen** | After long mirror button press while in ‘PLAY’ mode | Setup\_battery screen |

1. **MIDI OUTPUT BEHAVIOR**

| **Action** | **MIDI Message Sent** |
| --- | --- |
| Fader movement | CC message for that fader |
| Stomp press | CC 127 or 0 (toggle or momentary) |
| Toggle or encoder confirm | PC (Program Change) message |
| 5th switch short press | Sends all fader CC messages |
| Setup change | No MIDI output (local only) |

**Roadmap:**

# **SPEC-01-MIDI-Controller-System**

## **Background**

The MIDI Controller System is a hybrid analog/digital performance controller embedded within a custom electric guitar body. Built around the Adafruit Feather ESP-32 V2, it offers real-time control over MIDI-compatible hardware and plugins. It features slide potentiometers, stomp switches, an encoder, and a high-resolution TFT display for feedback and configuration. The system operates in two modes: Setup (for configuration) and Play (for live performance), with persistent user settings stored in EEPROM.

## **Requirements**

### **Must Have**

* Support **Setup Mode** with complete menu navigation and submenus as defined in the spec
* Support **Play Mode** with preset display, mode-dependent CC mappings, and MIDI Program Change messages
* Support **long press mirror button** to switch between Setup/Play modes
* Implement **EEPROM-based persistence** for all configurable parameters
* Support **MIDI OUT via DIN and BLE**, with selectable channel (00–127)
* Interface with all specified **hardware components**: faders, stomp switches, encoder, toggle switch, mirror button, display
* Use Adafruit Feather ESP32 v2 and adhere to **specified pin mappings and electrical requirements**
* Optimize **TFT screen updates** to redraw only changed pixels to minimize flicker
* Implement **preset mode management** for at least 4 external systems: Generic 0–127, 1–128, Kemper, Axe-FX

### **Should Have**

* Implement **label editing and persistence** for faders and stomp switches (including custom labels)
* Use **logarithmic brightness scaling** for LED and TFT brightness adjustments
* Support **real-time CC transmission** from fader and stomp interaction
* Accurate **battery level reading** using analogReadMilliVolts

### **Could Have**

* Ability to rename the device (device\_name)
* Editable **screen offset position** for display alignment
* Snapshot and scene switching support (e.g., for Helix, Axe-FX)

### **Won’t Have (MVP)**

* Wireless firmware update (OTA)
* Web or app-based configuration interface

## **Method**

### **High-Level Architecture**

@startuml

package "MIDI Controller Firmware" {

[Main Loop]

[Setup Mode Manager]

[Play Mode Manager]

[Display Manager]

[Input Manager]

[MIDI Output Manager]

[EEPROM Manager]

}

package "Hardware Interfaces" {

[TFT Display (ST7789)]

[Encoder + Button]

[Toggle Switch]

[Stomp Switches (MUX)]

[Fader Potentiometers]

[Fader LEDs]

[Mirror Button]

[Battery Sensor]

[MUX Controller]

[DIN MIDI OUT]

[BLE MIDI OUT]

}

[Main Loop] --> [Setup Mode Manager]

[Main Loop] --> [Play Mode Manager]

[Main Loop] --> [Display Manager]

[Main Loop] --> [Input Manager]

[Main Loop] --> [MIDI Output Manager]

[Main Loop] --> [EEPROM Manager]

[Display Manager] --> [TFT Display (ST7789)]

[Input Manager] --> [Encoder + Button]

[Input Manager] --> [Toggle Switch]

[Input Manager] --> [Stomp Switches (MUX)]

[Input Manager] --> [Fader Potentiometers]

[Input Manager] --> [Mirror Button]

[Input Manager] --> [MUX Controller]

[Display Manager] --> [Fader LEDs]

[Input Manager] --> [Battery Sensor]

[MIDI Output Manager] --> [DIN MIDI OUT]

[MIDI Output Manager] --> [BLE MIDI OUT]

[Setup Mode Manager] --> [EEPROM Manager]

[Play Mode Manager] --> [EEPROM Manager]

@enduml

### **EEPROM Memory Map (via Preferences)**

| **Key** | **Type** | **Description** | **Default** |
| --- | --- | --- | --- |
| led\_brightness | uint8\_t | 0-20 scale | 20 |
| tft\_brightness | uint8\_t | 0-20 scale | 20 |
| mirror\_delay | float | 0.0-3.0 sec | 0.5 |
| ble\_midi\_channel | uint8\_t | 0-127 | 1 |
| din\_midi\_channel | uint8\_t | 0-127 | 1 |
| preset\_mode | uint8\_t | Mode ID | 0 |
| fader\_label\_fN | string | Label for each fader F1-F4 | As defined |
| stomp\_label\_sN | string | Label for each stomp S1-S4 | As defined |
| fader\_cc\_fN | uint8\_t | MIDI CC for each fader | 20–23 |
| stomp\_cc\_sN | uint8\_t | MIDI CC for each stomp | 80–83 |
| stomp\_type\_sN | string | TG or MO type | TG |
| custom\_fader\_labels | string[] | User-defined fader labels | [] |
| custom\_stomp\_labels | string[] | User-defined stomp labels | [] |
| device\_name | string | BLE name | deep\_control |

**Note:** fN and sN = 1 to 4 for each respective fader and stomp

We'll use the Preferences library under nvs\_flash with namespaces for logical grouping:

cpp

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Preferences eepromSettings; eepromSettings.begin("setup", false); // Open 'setup' namespace eepromSettings.putUInt("led\_brightness", 18);

### **UI State Machine (Setup Mode)**

(See full PlantUML state diagram in chat history)

Includes all flows:

* Menu navigation
* Submenu confirmations
* Custom label editing
* CC and MIDI config confirmations
* Mirror delay configuration

This state machine covers **Setup Mode** navigation, selection, and screen transitions as described in the spec. All transitions occur via:

* **Encoder turn** or **toggle switch** = Navigate
* **Encoder press** = Confirm/select
* **Mirror button long press** = Exit to Play Mode
* **Mirror button short press** = Send all CCs (Play Mode only)

@startuml

skinparam defaultTextAlignment center

[\*] --> Setup\_Battery

' Main Menu Round Robin

Setup\_Battery --> Setup\_LED : Encoder/Toggle

Setup\_LED --> Setup\_TFT : Encoder/Toggle

Setup\_TFT --> Setup\_Mode : Encoder/Toggle

Setup\_Mode --> Setup\_Mirror : Encoder/Toggle

Setup\_Mirror --> Setup\_MIDI\_CH : Encoder/Toggle

Setup\_MIDI\_CH --> Setup\_Fader\_Labels : Encoder/Toggle

Setup\_Fader\_Labels --> Setup\_Stomp\_Labels : Encoder/Toggle

Setup\_Stomp\_Labels --> Setup\_Fader\_CC : Encoder/Toggle

Setup\_Fader\_CC --> Setup\_Stomp\_CC : Encoder/Toggle

Setup\_Stomp\_CC --> Setup\_Stomp\_Type : Encoder/Toggle

Setup\_Stomp\_Type --> Setup\_Battery : Encoder/Toggle

' LED Brightness

Setup\_LED --> Setup\_LED\_Brightness : Encoder Press

Setup\_LED\_Brightness --> Setup\_LED : Confirm

' TFT Brightness

Setup\_TFT --> Setup\_TFT\_Brightness : Encoder Press

Setup\_TFT\_Brightness --> Setup\_TFT : Confirm

' Preset Mode Selection

Setup\_Mode --> Setup\_Mode\_Select : Encoder Press

Setup\_Mode\_Select --> Setup\_Mode : Confirm

' Mirror Delay

Setup\_Mirror --> Setup\_Mirror\_Select : Encoder Press

Setup\_Mirror\_Select --> Setup\_Mirror : Confirm

' MIDI Channel Setup

Setup\_MIDI\_CH --> Setup\_MIDI\_CH\_Select : Encoder Press

Setup\_MIDI\_CH\_Select --> Setup\_MIDI\_CH\_Confirmation : Encoder Press

Setup\_MIDI\_CH\_Confirmation --> Setup\_MIDI\_CH : Confirm

' Fader Labels

Setup\_Fader\_Labels --> Setup\_Fader\_Label\_Select : Encoder Press

Setup\_Fader\_Label\_Select --> Setup\_Fader\_Label\_List : Encoder Press

Setup\_Fader\_Label\_List --> Setup\_Fader\_Labels : Confirm (default)

Setup\_Fader\_Label\_List --> Setup\_Fader\_Label\_Custom : If Custom

Setup\_Fader\_Label\_List --> Setup\_Fader\_Label\_Edit : If Existing Custom

' Custom Fader Label Entry

Setup\_Fader\_Label\_Custom --> Setup\_Fader\_Label\_List : Mirror press to save

' Fader Label Edit Flow

Setup\_Fader\_Label\_Edit --> Setup\_Fader\_Label\_List : Select

Setup\_Fader\_Label\_Edit --> Setup\_Fader\_Label\_Custom : Edit

Setup\_Fader\_Label\_Edit --> Setup\_Fader\_Label\_Delete : Delete

Setup\_Fader\_Label\_Delete --> Setup\_Fader\_Label\_Edit : Back

Setup\_Fader\_Label\_Delete --> Setup\_Fader\_Label\_List : Confirm Delete

' Stomp Labels – mirrors fader label flow

Setup\_Stomp\_Labels --> Setup\_Stomp\_Label\_Select : Encoder Press

Setup\_Stomp\_Label\_Select --> Setup\_Stomp\_Label\_List : Encoder Press

Setup\_Stomp\_Label\_List --> Setup\_Stomp\_Labels : Confirm (default)

Setup\_Stomp\_Label\_List --> Setup\_Stomp\_Label\_Custom : If Custom

Setup\_Stomp\_Label\_List --> Setup\_Stomp\_Label\_Edit : If Existing Custom

Setup\_Stomp\_Label\_Custom --> Setup\_Stomp\_Label\_List : Mirror press to save

Setup\_Stomp\_Label\_Edit --> Setup\_Stomp\_Label\_List : Select

Setup\_Stomp\_Label\_Edit --> Setup\_Stomp\_Label\_Custom : Edit

Setup\_Stomp\_Label\_Edit --> Setup\_Stomp\_Label\_Delete : Delete

Setup\_Stomp\_Label\_Delete --> Setup\_Stomp\_Label\_Edit : Back

Setup\_Stomp\_Label\_Delete --> Setup\_Stomp\_Label\_List : Confirm Delete

' Fader CC Selection

Setup\_Fader\_CC --> Setup\_Fader\_CC\_Select : Encoder Press

Setup\_Fader\_CC\_Select --> Setup\_Fader\_CC\_Confirmation : Encoder Press

Setup\_Fader\_CC\_Confirmation --> Setup\_Fader\_CC : Confirm

' Stomp CC Selection

Setup\_Stomp\_CC --> Setup\_Stomp\_CC\_Select : Encoder Press

Setup\_Stomp\_CC\_Select --> Setup\_Stomp\_CC\_Confirmation : Encoder Press

Setup\_Stomp\_CC\_Confirmation --> Setup\_Stomp\_CC : Confirm

' Stomp Type (Toggle/Momentary)

Setup\_Stomp\_Type --> Setup\_Stomp\_Type\_Select : Encoder Press

Setup\_Stomp\_Type\_Select --> Setup\_Stomp\_Type\_Confirmation : Encoder Press

Setup\_Stomp\_Type\_Confirmation --> Setup\_Stomp\_Type : Confirm

' Exit to Play Mode

Setup\_\* --> PlayMode : Mirror Button (Long Press)

@enduml

This flow maps 1:1 to the document’s detailed UI behavior. Each submenu (e.g., Setup\_LED\_Brightness) is responsible for:

* Accepting encoder/toggle inputs
* Updating value with redraw-on-change
* Storing changes on confirmation via encoder press
* Returning to parent screen

### **Pin Definitions**

We’ll follow the “must-not-change-unless-told” principle. These #define constants go at the **top of your main `` file** or a config.h header.

// --- TFT Display ---

#define TFT\_SCK 5 // SPI Clock

#define TFT\_MOSI 19 // SPI Data

#define TFT\_CS 14 // Chip Select

#define TFT\_DC 15 // Data/Command

#define TFT\_BRIGHTNESS 13 // PWM pin to LIT

// --- MIDI ---

#define MIDI\_TX\_PIN 8 // DIN Out TX

#define MIDI\_TX\_RESISTOR 220 // inline resistor required

// --- Encoder ---

#define ENCODER\_A 7 // Encoder A (RX)

#define ENCODER\_B 33 // Encoder B

#define ENCODER\_SW 0 // MUX CH0 → mapped via MUX (ENTER button)

#define ENCODER\_PULLUP INPUT\_PULLUP

#define ENCODER\_FILTER\_UF 0.1 // optional RC filter (µF)

// --- Toggle Switch ---

#define TOGGLE\_UP 7 // MUX CH7 (TGUP)

#define TOGGLE\_DOWN 6 // MUX CH6 (TGDN)

// --- Mirror Button ---

#define MIRROR\_BTN 1 // MUX CH1 (EDIT)

// --- MUX Control Pins ---

#define MUX\_CONTROL\_A 27 // MUX A → D27 (ADC2)

#define MUX\_CONTROL\_B 22 // MUX B → SDA

#define MUX\_CONTROL\_C 21 // MUX C → MISO

#define MUX\_COM\_PIN 37 // MUX COM → Digital read via RC filter

// --- Faders ---

#define FADER\_1\_PIN 34 // A2

#define FADER\_2\_PIN 39 // A3

#define FADER\_3\_PIN 36 // A4

#define FADER\_4\_PIN 32 // D32

// --- Fader LEDs ---

#define FADER\_LED\_PWM 12 // LED brightness control (PWM)

#define LED\_PWM\_FREQ 5000 // Hz

#define LED\_PWM\_RES 8 // Bit resolution (0-255)

// --- Battery Voltage ---

#define VBAT\_PIN 35 // A7 (internal)

#define VBAT\_READ\_FUNC analogReadMilliVolts

// --- EEPROM ---

#define EEPROM\_NAMESPACE "setup"

// --- Misc ---

#define SCREEN\_OFFSET\_X 5

#define SCREEN\_OFFSET\_Y 5

#define DEVICE\_NAME "deep\_control"

#### **Notes:**

* All **MUX input buttons** (stomps, encoder, toggle, mirror) are read via a selectMuxChannel(channel) function using MUX A/B/C control pins and digitalRead(MUX\_COM\_PIN).
* Each fader should use a **1kΩ + 10nF RC filter**, per analog input protection and smoothing.
* The TFT backlight and LED brightness are both controlled via **PWM** and must be scaled logarithmically from 0–20.

### **Display Redraw Strategy**

#### **General Rules**

| RuleDescription |  |
| --- | --- |
| R1 | **Draw static UI elements once** in setup() (lines, labels, backgrounds) |
| R2 | **Redraw only changed pixels** for values or state changes (e.g., brightness levels, CC numbers) |
| R3 | **All screen updates must respect `` font** and size, using only positions specified in spec |
| R4 | **Use bounding boxes or dirty rectangles** to track and clear only the regions where values change |
| R5 | \*\*Avoid \*\*\*\* or \*\* unless explicitly needed (e.g., during full screen transitions) |

* Draw static layout in setup() only
* Use dirty rectangles to update only changed values
* Never clear or refresh entire screen
* Ensure all values (sliders, numbers) are redrawn over their prior location only
* Triangles and bar outlines are redrawn last to stay on top

#### **UI Regions (Per Spec Layout)**

* **Top row** = header ("setup")
* **Middle rows** = data bars or values
* **Bottom row** = label + left/right triangle

We'll define #define constants like VALUE\_ROW\_Y, BAR\_START\_X, etc., to allow easy tuning.

## **Implementation**

1. **Bootloader + Board Setup**
   * Configure pin modes
   * Load saved values from EEPROM
   * Initialize TFT, MIDI, and Input systems
2. **Core Loop**
   * Poll inputs (encoder, mux)
   * Track current mode (setup/play)
   * Route to appropriate screen renderer
   * Redraw only if state or value changed
3. **Setup Mode**
   * Menu screen renderer
   * Navigation controller
   * EEPROM writes on confirmation
   * Label creation system with character selection
4. **Play Mode**
   * Preset selector screen per mode (0-127, Kemper, etc.)
   * CC/PC message sender
   * Real-time CC from faders + stomps

## **Milestones**

| Milestone | Description |
| --- | --- |
| M1: Base Hardware Test | Confirm all I/O, MUX, display connections |
| M2: EEPROM Read/Write API | Stable parameter persistence layer |
| M3: Setup UI Core | First menu flow with encoder input |
| M4: Play Mode + MIDI TX | Preset + CC handling verified |
| M5: Label Editing Support | UI + storage for custom labels |
| M6: Final Integration | Full device feature test |

## **Gathering Results**

* Test on actual Feather ESP32 v2
* Confirm minimal flicker under all UI screens
* Validate CC and PC values with connected MIDI device
* Check EEPROM values persist after reboot
* Confirm expected behavior for all preset modes