Teensy4.1 MIDI and Audio interface User Manual 2.0

Deftaudio Teensy 1U Interface – a powerful, feature-rich solution designed for musicians, audio engineers, and developers seeking a compact yet highly capable MIDI and Audio interface. This advanced unit delivers an impressive combination of functionality in a sleek 1U form factor, including:

- **MIDI Interface:** 8x14 MIDI routing capabilities for complex configurations and flexible connectivity.
- **Audio Outputs:** 4 audio output channels, ideal for professional sound applications.
- **Trigger & Sync:** 6 configurable trigger and sync outputs for seamless integration with modular gear, drum machines, or analog synthesizers.
- **USB Connectivity:** Full USB MIDI and Audio Class Compliant support for easy interfacing with computers and standalone operation without the need for a host system.
- **(new in 2.x) Luma-mu integration:** Able to control polyphonically Luma-mu modules.

At its core is the robust **Teensy 4.1 microcontroller**, powered by a 600 MHz ARM Cortex-M7 processor. Renowned for its speed and reliability, the Teensy platform utilizes the Arduino programming environment, making development accessible and flexible for both beginners and advanced users.

The Teensy 4.1 offers a comprehensive suite of features, including:

- **Eight hardware serial I/O ports** for extensive device communication.

- **Programmable Flex I/O ports** to tailor your setup for specific workflows or hardware integrations.

- Access to a vast **open-source audio design library**, including modules for synthesis, effects, and real-time audio processing.

Best of all, the **Deftaudio Teensy 1U Interface is fully open-source**. All hardware schematics and software source code are freely available. The unit comes with a fully featured firmware which requires no extra development for the basic operation. However, can be easily customized, inviting users to expand, or adapt the system for their own creative or technical needs.

Technical Specifications

- **Core Platform:** Teensy 4.1 (600MHz ARM Cortex-M7)

- **MIDI Routing:** 8 input x 14 output matrix (8x8 DIN5 ports + 6 TRS configurable ports)

- **Audio Outputs:** 4 independent channels (2 high-quality Burr-Brown DAC channels + 2 MSQ Teensy channels)

- **TRS MIDI/Trigger/Sync Outputs:** 6 configurable ports between MIDI, 5V Trigger out or Sync out (resolution can be adjusted)

- **Integration with Luma-mu:** Able to drive Luma-mu Clock, Trigger, Pause and Reset inputs to build a fully playable synth module with up to 3 voices.

- **USB Connectivity:** USB MIDI and Audio class compliant client port. Shows as 16x16 MIDI + 2x2 USB Audio device. Additional USB Host port for routing USB MIDI Class Compliant devices. Standalone operation capable.

- **Controls:** OLED Screen, two rotary encoders, activity and power LEDs. Allows TRS port configuration from the panel without re-programming. Displays real-time information on the screen.

- **Power Source:** Over USB or with external 9-12V PSU for driving high loads on trigger outs

- **Hardware:** Options include 1U aluminum front panel, full PCB enclosure.\

- **Programming Environment:** Arduino IDE compatible

- **Software:** Includes the basic firmware that implements all functions. Extensive audio design libraries are available from Teensy/PJRC to implement extra functionalities (synth, FX, processing).

- **Open Source:** Full access to hardware schematics and source code for customization and development

Basic Operation

Following features come with the basic firmware and can be modified if desired for extra functionality. They cover the broad spectrum of use cases and let you use the device right away.

USB MIDI assignment

By default Teensy 1U interface shows as 16x16 MIDI and 2x2 Audio interface under the OS. This has following port assignment:

USB MIDI Ports	Teensy Ports
1 - 8	DIN5 #1 - #8 (in/out)
9 - 14	TRS 9-14 MIDI out (MIDI configuration) or TRS 9-14 MIDI Clock (Sync configuration)
15	USB HOST device #1
16	TRS 9-14 Trigger out (Trigger configuration), Luma-mu control and MSQ audio out "kick" pulse output

TRS OUT 9-14 support three modes of operation which can be selected per port:

- **MIDI mode.** Maps USB MIDI Ports 9-14 to TRS-A MIDI OUT 9-14
- **TRIGGER mode**. For triggering external gear from 5V TRS out (trigger on tip), TS cable can be used. Can drive up to 200mA per port. Can be used together with Eurorack gear, sequencers, drum machines, arpeggiator input on synths. Suitable for external load such as relays, LEDs, etc. To enable trigger send Note ON command on USB MIDI Port 16 MIDI, to disable send Note OFF. Here is the mapping:

Note C3	OUT 9
Note D3	OUT 10
Note E3	OUT 11
Note F3	OUT 12
Note G3	OUT 13
Note A3	OUT 14

- **SYNC mode.** For syncing external gear from TRS OUT 9-14. Signal is on tip, TS cable is supported. Supports individual tempo/speed per port. Can be driven by different software per port, DAW, etc.

CLOCK OUT 9	USB MIDI Port 9 (MIDI Clock)
CLOCK OUT 10	USB MIDI Port 10 (MIDI Clock)
CLOCK OUT 11	USB MIDI Port 11 (MIDI Clock)
CLOCK OUT 12	USB MIDI Port 12 (MIDI Clock)
CLOCK OUT 13	USB MIDI Port 13 (MIDI Clock)
CLOCK OUT 14	USB MIDI Port 14 (MIDI Clock)

- **Luma-mu modes (since FW 2.0):**
  - **MU-CLOCK:** Pitch Clock output to Luma-mu Clock Input. This drives how quickly it plays the rom and always in tune (if source waveforms properly looped).
    - Clock output only supported on TRS OUT 9, 10 and 14. This limits max polyphony to three.
  - **MU-GATE:** Output to Luma-mu TRIGGER input. Set to High on Note On evens, and Low on Note Off.
  - **MU-PAUSE:** Output to Luma-mu PAUSE input. Set to High on Note Off event and Low on Note-On.
  - **MU-RESET:** Output to Luma-mu RESET input. Set to High on Note Off event and Low on Note-On.

  See more details about Luma-mu integration in the Tutorial video:
  https://youtu.be/bmPMPr6Gudg

USB HOST supports USB MIDI Class Compliant devices and routes them to USB MIDI Ports 15 and 16.

USB Audio assignment

- **HQ audio output.** Uses high quality Burr Brown codec. Receives data from USB Audio. Also sends 440Hz sine pulse at power on. "Assign" encoder controls USB Audio volume out (if not in the configuration mode).
- **MSQ audio output.** Medium Quality direct Teensy 4.1 out. Could be used for triggering drum sounds on analog drum machines trigger input (such as Simmons, Dynacord, Pearl, etc). Plays a kick sound on the Note On C2 event at USB MIDI Port 16 or if the Assign button is pushed.

All settings are preserved in configuration and reloaded at power on. This includes Audio output level on HQ out.

Configuration Mode

To enter Configuration Mode press on the "Menu" encoder. Every screen controls one parameter. To move between screens rotate the "Menu" encoder. The value of a parameter is selected by the "Assign" encoder.

- The first 6 screens are to set the TRS out mode for ports 9-14 per port.

- The following 6 are for Sync resolution. Use the "Assign" encoder to select between 24ppqn, sixteen, eight, quarter, half, bar, two bars and four bars.

- Trigger MIDI Channel Number. Sets the channel on USB port 16 for standard trigger outputs TRS 9-14.

- Luma-mu MIDI Channel. Sets the channel on USB port 16 for Luma-mu integration.

- Luma-mu Tuning and Fine Tuning. Adjusts the clock rate to tune the pitch of Luma-mu. Typically not needed if waveforms are created with samples in power of two.

- Luma-mu Base Octave Multiplier. Adjusts the clock rate in octaves. It's independent from Tuning option, to go up or down in octaves.

- Luma-mu PitchBend Range. Sets in semitones how the clock output tracks the pitchbend wheel.

- Luma-mu Note Off Mode. Defines what interface sends on Note Off message for Luma-mu. Options are - only Stop Clock, only send Pause, only send Reset or Stop All.

- The last screen is to save settings. Press Assign encoder to save settings (reboot is needed when mode is changing from TRIGGER to MIDI). Press "Menu" encoder to exit without saving persistent changes (on the next reboot they will revert to the last saved configuration).

Advanced Features

Teensy 1U interface can be used to generate static square waves on ports TRS 9, 10 and 14 and control them by SysEx messages. Set to MU-CLOCK mode for desired output. Construct SysEx Command, by the rule below and send with SendMIDI utility (https://github.com/gbevin/SendMIDI):

Structure:
sendmidi dev "Teensy 1U Port 16" hex syx 7d [TRSPort# (9=0, 10=1, etc)] [MSB value] [LSB value] 7f
Example, set TRS OUT 9 to 1F00 (7936 Hz):
sendmidi dev "Teensy 1U Port 16" hex syx 7d 00 1F 00 7f

Additional information

- Github repository
  https://github.com/Deftaudio/Midi-boards

- Assembly Manual
  https://docs.google.com/document/d/1ITEHbHSMusflXBKHPS3dOLayXbjl5RHZaCQrSSs7MuU/edit?usp=sharing

- Video Overview:
  https://youtu.be/H7egfIanS1A

- Luma-mu Tutorial:
  https://youtu.be/bmPMPr6Gudg