Application Note: Optional Serial Interfaces

SUMMARY

This document describes the optional serial interfaces that are supported on the freETarget board. The interfaces include:

- Accessory connector to drive
  - RS-422 line driver for long distances
  - WiFi interface
- Alternate USB drivers for long distances
- Spare USB port to drive a spectator display

INTRODUCTION

freETarget was originally designed with a single connection between the target and the firing point. With that, the native USB connector on the Arduino MEGA was sufficient for the task. As time moved on, new applications for freETarget evolved, such as

- Transmitting the information beyond the original 10 meter distance
- Reducing the cable runs for multiple installations
- Spectator displays to aggregate shooters on a common display

To accommodate these needs, the onboard circuitry was expanded to support additional interfaces. This document outlines the interfaces that are available and how to use them. It should be pointed out that the interfaces are by no-means exclusive, for example a long distance driver could be used for driving a spectator display. It is suggested that the reader review all of the options before choosing a particular implementation.

INTERFACES

freETarget supports three interfaces that can be used to connect to various remote programs. The interfaces and their use are presented in Table 1.

Table 1: freETarget Interfaces

Interface	Firmware Download	Report Score	JSON Control	Program Trace
Arduino USB	Yes	Yes	Yes	Yes
Accessory Connector		Yes	Yes	
Duplicate USB		Yes	Yes	

USB Interfaces

Simple USB Interfaces – Up to 10 Meters

The default interface to freETarget is a 15-meter USB cable between the PC and the Arduino. Communications takes place at 115,200 baud, N – 8 – 1. This is the connection that is used to download new firmware into the freETarget when needed.

These cables work by inserting a small USB repeater every two meters or so to remain in compliance with the USB specifications for line driving. See Figure 2.

Figure 2: Simple USB Extension

Examples of a typical interface include

https://www.amazon.com/Pasow-Female-Extension-Cable-Speed/dp/B018LYWWKM/ref=sr_1_6?dchild=1&keywords=15+meter+usb+cable&qid=1623362832&sr=8-6

https://www.amazon.com/StarTech-com-15m-Active-USB-Cable/dp/B00DDXOFL6/ref=sr_1_9?dchild=1&keywords=15+meter+usb+cable&qid=1623362832&sr=8-9

Extended USB Interfaces – Up to 200 Meters

The simple USB extension cable is fine but is limited to a single connection over a relatively short distance.

An alternative is to choose a USB extender that uses a CAT5 or CAT6 Ethernet cable to extend the distance. In this case the PC – USB is connected to a transmitter box, connects over an Ethernet cable to a receiver and then to a USB cable. Figure 3 illustrates an example.

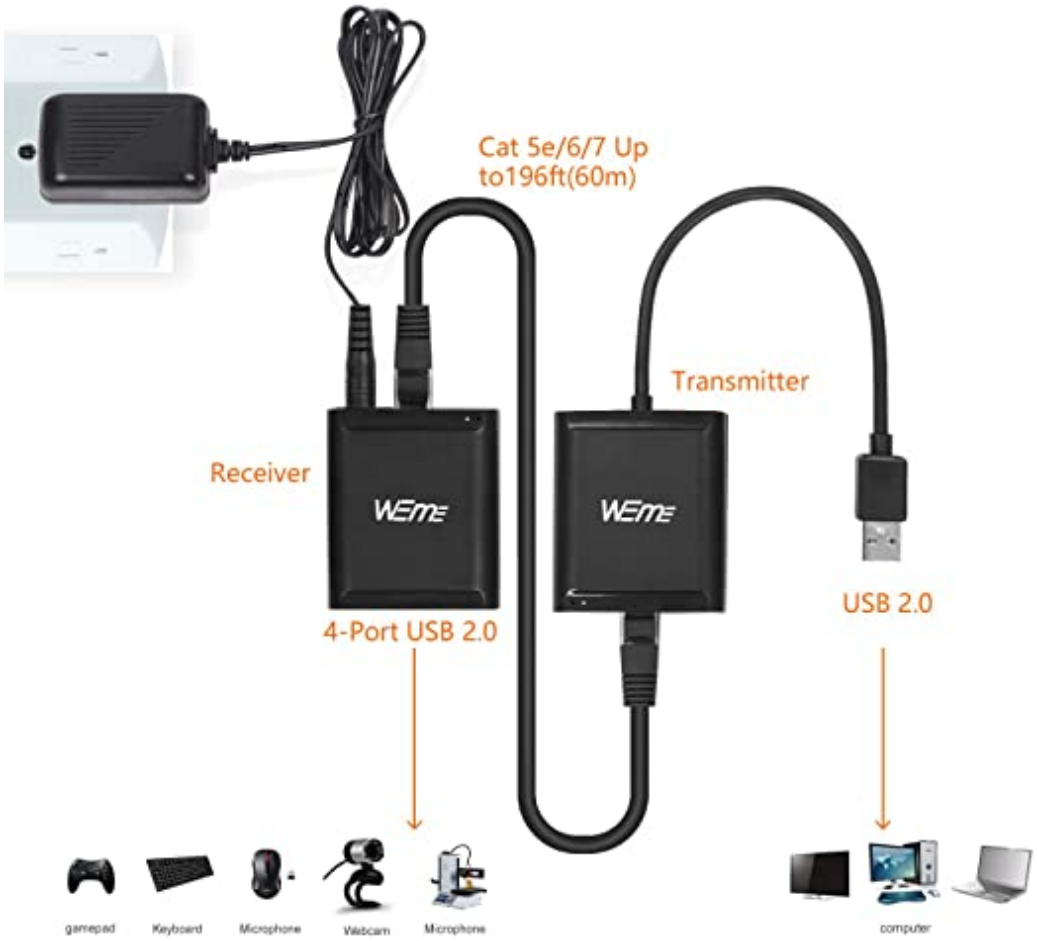

Figure 3: USB Extender

This approach has the advantage of supporting up to four remote USB devices, but all four 'belong' to the same PC. Another advantage is that cabling over a long distance is much easier than the simple USB cable.

Examples of suitable interfaces include

https://www.amazon.com/gp/product/B01MRL2SK1/ref=ppx_yo_dt_b_asin_title_o07_s00?ie=UTF8&psc=1

https://www.amazon.com/USB-2-0-Extender-DriverGenius-Driver-Free/dp/B0744DX8JP/ref=sr_1_2_sspa?dchild=1&keywords=USB+extender+197&qid=1623363818&s=electronics&sr=1-2-spons&psc=1&spLa=ZW5jcnlwdGVkUXVhbGlmaWVyPUEzVVQ5RlNLS1RJSVY1JmVuY3J5cHRlZElkPUEwMDI5NzUyMkkxUjJHSzM4S0JLTSZlbmNyeXB0ZWRBZElkPUEwNjQ4MjUxMVIyTDRJSEwzNFdVNCZ3aWRnZXROYW1lPXNwX2F0ZiZhY3Rpb249Y2xpY2tSZWRpcmVjdCZkb05vdExvZ0NsaWNrPXRydWU=

Network USB Interfaces – Arbitrary Distances and Configuration

The USB extender described above is a simple solution to installing a single freETarget in a large range. Since there is only one USB connection to the PC, that means that more than one target shows up on the same PC. This would be fine for a spectator display which aggregates four targets onto a single display.

An alternative is to use an Ethernet USB server as shown in Figure 4.

Figure 4: Ethernet USB Server

In this case, each PC has a USB driver that uses the LAN to make remote USB devices appear on the PC. The advantage is that potentially many PCs can share the USB ports. In other words, four targets connect to the server, and four PCs extract the USB ports from the server.

While easy in concept, the implementation is sometimes difficult, and device drivers may not be available for the particular PC in use. For example MAC drivers are not always available.

An example of a USB server would be

https://www.amazon.com/Silex-DS-510-Device-Server-Ports/dp/B00U9UDSH8/ref=sr_1_4?dchild=1&keywords=USB+server&qid=1623364111&s=electronics&sr=1-4

ACCESSORY SERIAL PORT

The accessory serial port was created with the intention of providing a back door connection to more sophisticated interfaces such as RS-422 or WiFi.

The output from the accessory serial port is a logic level UART. The user can then interface this to the hardware needed for their application.

Long Distance Up to 1.5 Km

For long ranges, USB or Ethernet is impractical, and RS-422 becomes the connection of choice. On the PC side, the RS-422 appears as a regular serial port, and on the freETarget side, a level convertor changes from differential to logic serial.

The components needed to do this is in three parts:

- PC USB interface
- Twisted pair cable
- Level converter.

PC USB Interface

The typical RS-422 interface resembles a USB serial dongle with an additional terminal block to connect the twisted pair wires. Figure 6 shows an example

Figure 6: Example RS-422 USB Dongle

The Amazon part is:

https://www.amazon.com/Jeirdus-Converter-Adapter-Protection-0-5Meter/dp/B07QN6JVG1/ref=sr_1_4?dchild=1&keywords=usb+rs-422&qid=1623366182&s=electronics&sr=1-4

freETarget Level Convertor

The RS-422 is a differential pair that needs to be converted to a single sided logic signal. This is done using a level convertor shown in Figure 7. It installs between the twisted pair cable and the Accessory Connector.

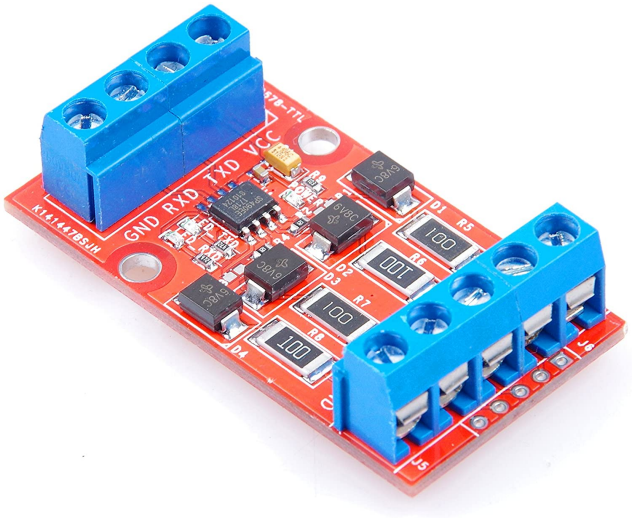

Figure 7: RS-422 Level Convertor

A convertor can be obtained from

https://www.amazon.com/Serial-Conversion-Over-voltage-Over-current-Protection-5V/dp/B078MYJH45/ref=asc_df_B078MYJH45/?tag=hyprod-20&linkCode=df0&hvadid=241973970700&hvpos=&hvnetw=g&hvrand=2281326882776496844&hvpone=&hvptwo=&hvqmt=&hvdev=c&hvdvcmdl=&hvlocint=&hvlocphy=9023226&hvtargid=pla-406394896246&psc=1

WiFi Interface

The accessory port can also be used to drive a WiFi interface such as ESP-01. The ESP-01 turns the freETarget into a WiFI server that the PC program connects to to obtain shot information. The ESP-01 operates at 3.3 Volts requiring the addition of a level translator. Both the ESP-01 and level translator are shown in Figure 8A and 8B

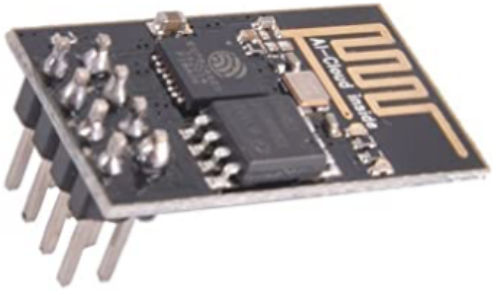

Figure 8A: ESP-01 WiFi Interface

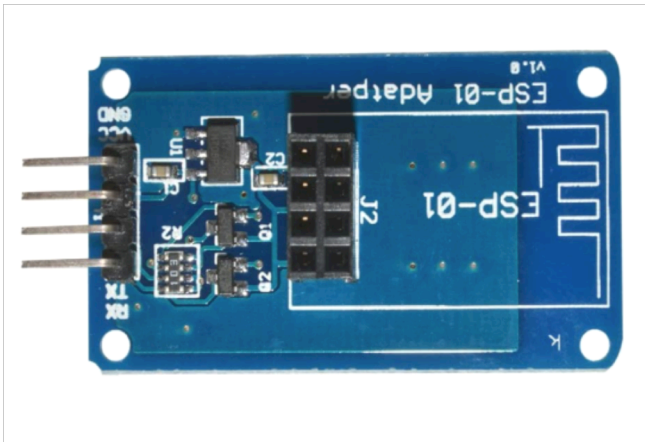

Figure 8b: Level Translator

The ESP-01 can be obtained from a number of suppliers including Amazon

https://www.amazon.com/MakerFocus-Wireless-Transceiver-DC3-0-3-6V-Compatible/dp/B01EA3UJJ4/ref=asc_df_B01EA3UJJ4/?tag=hyprod-20&linkCode=df0&hvadid=309773039951&hvpos=&hvnetw=g&hvrand=2051183349447808769&hvpone=&hvptwo=&hvqmt=&hvdev=c&hvdvcmdl=&hvlocint=&hvlocphy=9023226&hvtargid=pla-599566692924&psc=1

The companion level translator is also available from Amazon

https://www.amazon.com/Aideepen-ESP8266-Wireless-Adapter-Compatible/dp/B01M09B43H/ref=sr_1_3?crid=2I5RIKN375XUI&dchild=1&keywords=esp-01+5v&qid=1623368341&s=electronics&sprefix=esp-01%2Celectronics%2C263&sr=1-3