

14.7. Universal Serial Bus (USB)

General References

<http://www.usb.org>.

<http://www.beyondlogic.org/usbnutshell/>

Lab 4 References

<http://www.ftdichip.com/Documents/ProgramGuides/D2XXPG34.pdf>

<http://www.ftdichip.com/Drivers/D2XX.htm>

http://www.ftdichip.com/Documents/InstallGuides/Windows_XP_Installation_Guide.pdf

<http://www.dlpdesign.com/test.shtml>

<http://www.ftdichip.com/Projects/CodeExamples.htm>

<http://www.dlpdesign.com/drivers/D2XXPG21.pdf>

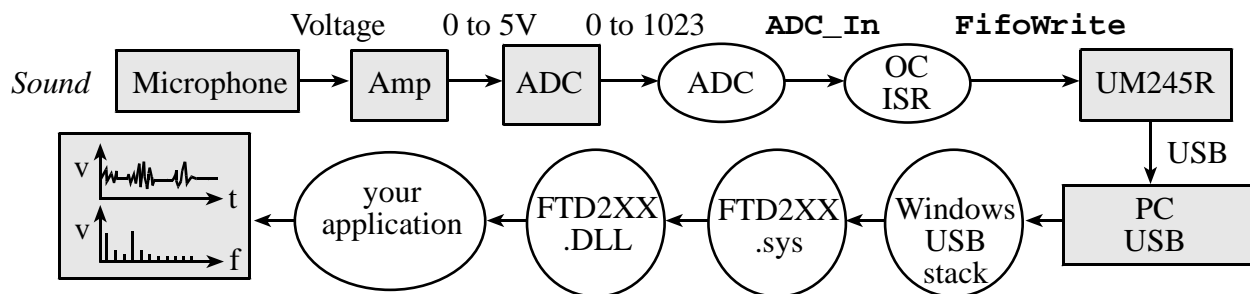


Figure 4.1. Data-flow graph of the digital scope and spectrum analyzer.

Specifications

Short distance (typically less than 4 meters)

USB 2.0 supports three speeds.

High Speed - 480Mbits/s

Full Speed - 12Mbits/s

Low Speed - 1.5Mbits/s

One host per bus (at a time)

all transactions and scheduling bandwidth

Token-based protocol

Tiered star topology (Host-centered)

Hub provides power

Monitors power

Switching off a device drawing too much current

Filter out high speed and full speed transactions

7-bit address, up to 127 devices can be connected

Host loads and unloads drives automatically

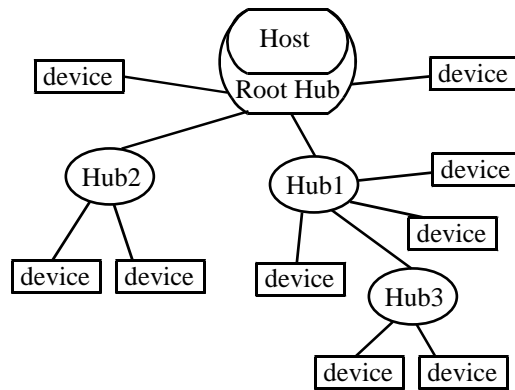


Figure 14.31. USB network topology.

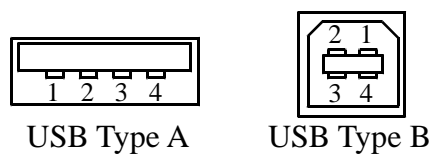
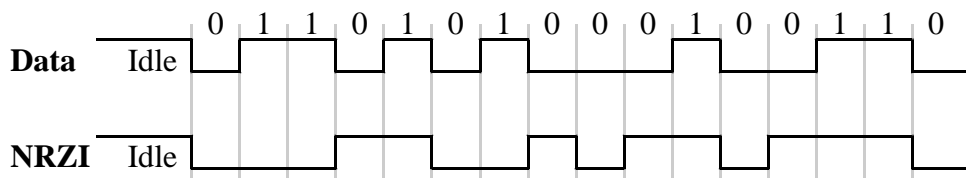


Figure 7.18. USB connectors.

Pin Number	Color	Function
1	Red	VBUS (5 V)
2	White	D-
3	Green	D+
4	Black	Ground

Table 7.5. USB signals.

The D+ and D- are twisted pair differential data
Non Return to Zero Invert (NRZI) encoding
 1 is represented by no change in level
 0 is represented by a change in level
 String of zeros causes the NRZI data to toggle each bit time
 String of ones causes long periods with no transitions in the data
 Bit stuffing ensures transitions for the receiver to synchronize to
 0 inserted after 6 consecutive 1's
 1 inserted after 6 consecutive 0's



The USB architecture comprehends four basic types of data transfers:

- **Control Transfers:** Used to configure a device
- **Bulk Data Transfers:** Large quantities and wide latitude in constraints.
- **Interrupt Data Transfers:** Used for timely but reliable delivery of data.
- **Isochronous Data Transfers:** Prenegotiated bandwidth
 Prenegotiated latency.
 Streaming real time transfers
 Audio or video applications.
 Stream pipe
 Unidirectional.

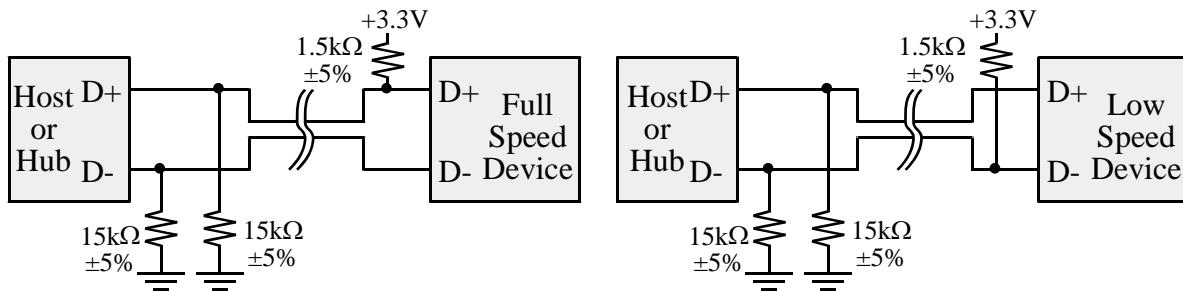


Figure 14.32. Pull-up resistors on USB devices signal specify the speed.

Each USB transaction consists of three packets

- **Token Packet** (header),
- **Optional Data Packet**, (information) and
- **Status Packet** (acknowledge)

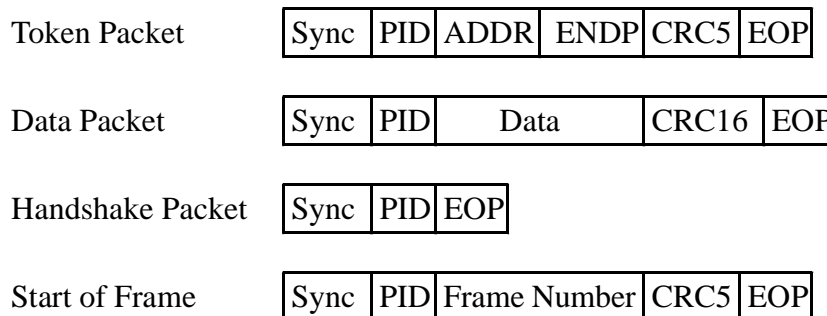


Figure 14.33. USB packet types.

USB **functions** provide a capability

Printer, Thumb Drive, Scanner, Modem or your 9S12.

Endpoints are sources or sinks of data (buffers within the device)

Host can send data to an endpoint

Device puts data in endpoint, but it is not transferred until host requests it

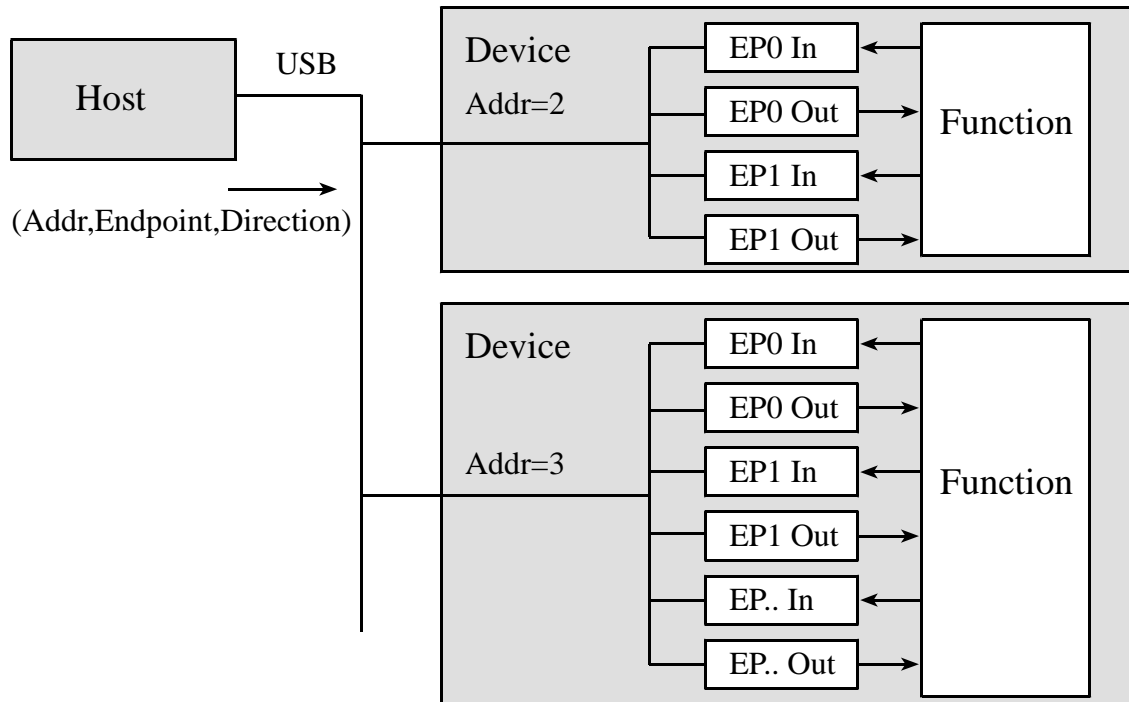


Figure 14.34. USB data flow model.

pipe is a logical connection between the host and endpoint(s).

how much bandwidth

what transfer type (Control, Bulk, Iso or Interrupt)

direction of data flow

maximum packet/buffer sizes

Stream Pipes can be used send unformatted data.

Data flows sequentially

pre-defined direction, either in or out.

bulk, isochronous and interrupt transfer types

controlled by the host or device

Message Pipes have a

defined USB format

host-controlled

Data is then transferred in the desired direction

support control transfers.

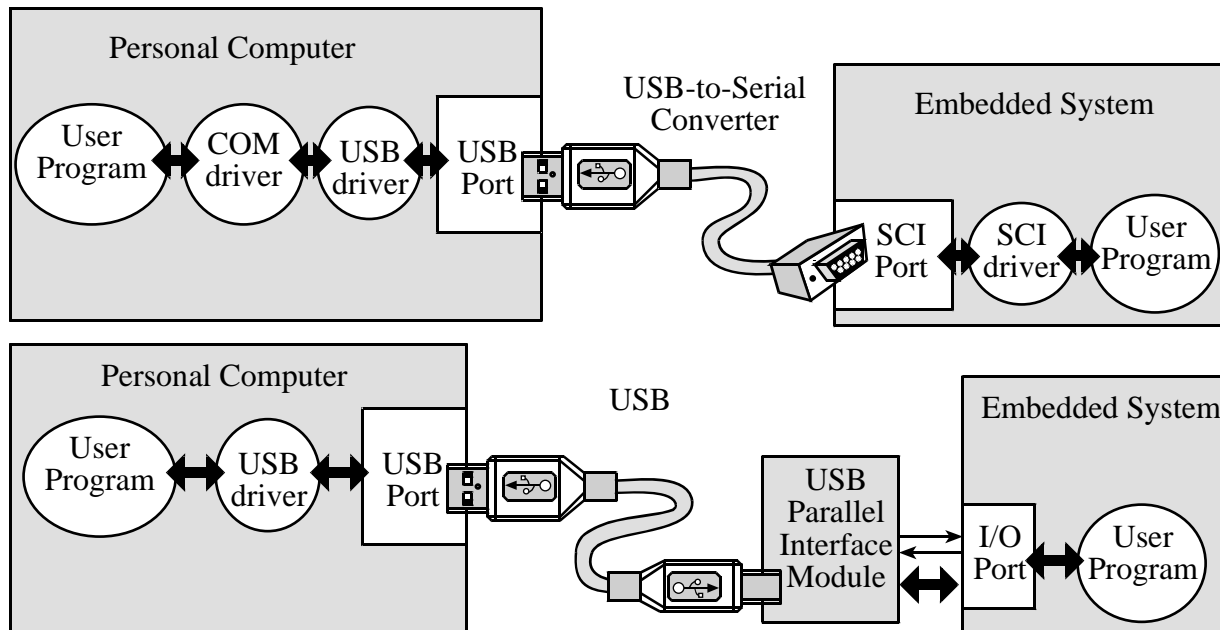


Figure 14.35. Modular approach to USB interfacing.

14.7.2. Modular USB interface

USB-to-serial converters

IOGear Inc.	http://www.iogear.com
Wyse Technology	http://www.wyse.com
D-Link Corporation	http://www.dlink.com
Computer Peripheral Sys, Inc.	http://www.cpscom.com
Jo-Dan International, Inc.	http://www.jditech.com

USB parallel interface module.

- send and receive data using parallel handshake protocols
- Include a USB-enabled interface and receiver/transmit FIFO buffers
- more flexible than the serial cable method,
 - the microcontroller module can be tailored
 - USB drivers can be tailored
- burn PID and VID numbers into EEPROM.
- data is unformatted
- does not implement high bandwidth bulk transfers
- does not negotiate for real-time bandwidth with isochronous data transfers.

Companies that make these modules include

Future Tech. Devices Inter. Ltd.	http://www.ftdichip.com/
ActiveWire, Inc.	http://www.activewireinc.com
DLP Design, Inc.	http://www.dlpdesign.com
Elexol Pty Ltd.	http://www.elexol.com

14.7.3. Integrated USB interface

- Microchip PIC18F2455
- FTDI FT245BM
- Freescale 9S12UF32

Freescale web site as Reference Design “RDHCS12UF32TD”.

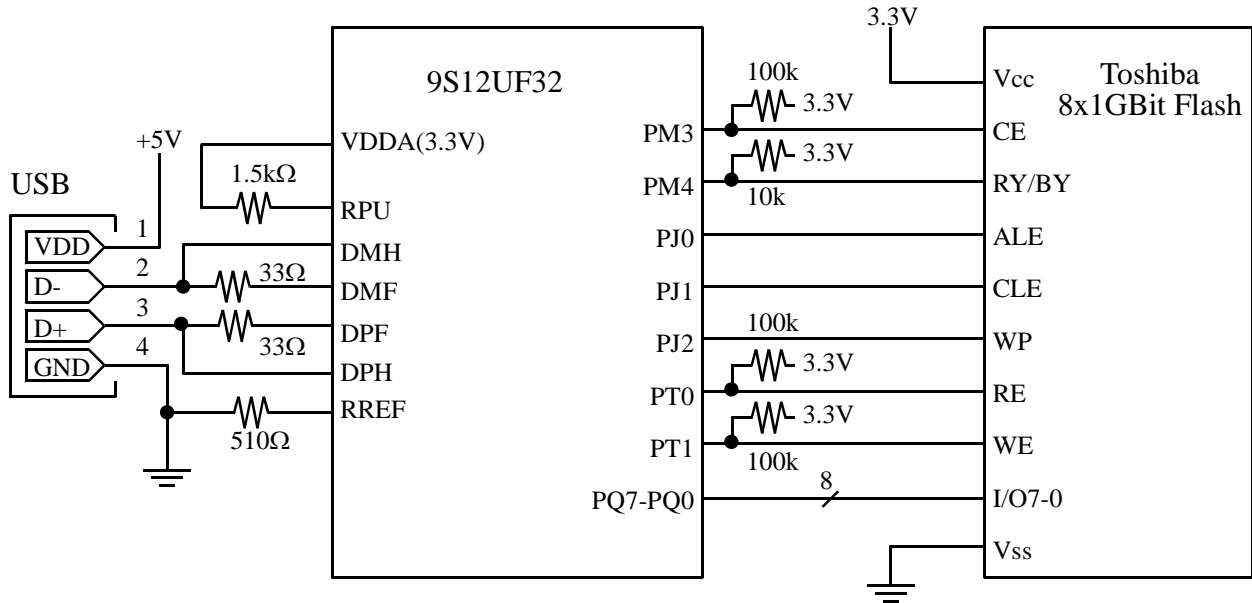


Figure 14.36. Thumbdrive system with USB interface built with a 9S12UF32 microcontroller.