# Connectors

Lecture 18

Josh Brake Harvey Mudd College

# Learning Objectives

By the end of this lecture you will be able to:

- List the most commonly used connectors in embedded systems.
- Select an appropriate connector for a particular application.
- Design a plan for wiring up your final project.

# How to Select a Connector

### **Selection Criteria**

- Environmental Factors
- Current/Voltage Requirements
- Size and Weight
- Ease of Assembly
- Cost

# **Types of Connectors**

- Wire to Wire
- Board to Board
- Wire to Board
- Power
- Modular
- Terminal Blocks

## **Searching for connectors**

- Often can use an (overwhelming!) parametric search on an electronics distributor website (e.g., Digikey, Mouser).
- Helpful to go in with an idea of what the basic types and parameters are.

Connectors, Interconnects 4,871,686 results												
Filters	Connectors, Interconnects Categories											
Search Within Q In Stock RoHS Complant + More Filters Categories	AC Power Connectors 1.738 Items	Backplane Connectors 51,965 Items	Banana and Tip Connectors 2,058 items	Barrel Connectors 3,612 Items	Between Series Adapters 750 Rems							
AC Power Connectors Backplane Connectors Barnel Connectors Barrel Connectors Between Geries Adapters Blade Type Power Connectors Card Edge Connectors Circular Connectors	Blade Type Power Connectors 3767 Items	Card Edge Connectors 619,994 Jtems	Circular Connectors 2.752.402 Items	Coaxial Connectors (RF) 41,213 Hems	Connector Adapter Kits S1 nems							
Oaxial Connectors (RF) Connector Adapter Kits Connector Kits D-Sub, D-Shaped Connectors FFC, FPC (Filst Flexible) Connectors Filser Optic Connectors Heavy Duty Connectors	Connector Kits 819 Hems	Contacts 3.258 Rems	D-Sub, D- Shaped Connectors 132,570 Items	FFC, FPC (Flat Floxible) Connectors 17/011 Hems	Fiber Optic Connectors 6,354 fitms							
Keystone Connectors LGH Connectors Modular Connectors Photovolitale (Solar Panel) Connectors Phugable Connectors Restangular Connectors Shunts, Jumpers	Heavy Duty Connectors 20.756 Items	Keystone Connectors 3,307 Rems	LGH Connectors 332 Items	Memory Connectors 4,100 Rems	Modular Connectors 18.538 Hems							
Sockets for ICa, Transistors Solid State Lighting Connectors Terminal Junction Systems Terminal Supps and Turret Boards Terminals USB, DVI, HDMI Connectors	Photovoltaic (Solar Panel) Connectors 541 Itens	Pluggable Connectors \$890 Items	Rectangular Connectors 892,770 Items	Shunts, Jumpers 1.338 Items	Sockets for ICs, Transistors 19,507 Items							
	Solid State Lighting Connectors 1,665 Items	Terminal Blocks 270,192 Hems	Terminal Junction Systems 1,944 Items	Terminal Strips and Turret Boards 470 Items	Terminals 38,135 Hems							
	USB, DVI, HDMI Connectors 5.409 Rems											

Digikey Connector Library

### **Pin Headers**

- Very common connector
- Typically come in 0.100" (2.54 mm) pitch
- Good for simple board-to-board or wireto-board connections, but no locking mechanism which makes it mechanically unstable.



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Male header By oomlout - Flickr: 6 Pin Header - HEAD-06, CC
BY-SA 2.0
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Female header By oomlout - Flickr: 6 Pin Female Header - FHEA-06, CC BY-SA 2.0

## Insulation-Displacement Contact (IDC) Connectors

- Connector pierces cable to make connections
- Often keyed to ensure alignment
- Used to route large numbers of wires with ribbon cables



By Heron 21:16, 22 Nov 2004 (UTC) - Self-photographed, CC BY-SA 3.0



By Hans Haase - Own work, CC BY-SA 4.0

## Japan Solderless Terminal (JST) Connectors

- Design standard created by Japan Solderless Terminal (J.S.T.) Manufacturing Company
- Wire-to-board and wire-to-wire
- A variety of different families with different parameters
  - Pin-to-pin pitch
  - Number of rows
  - Current/Voltage ratings and wire size
  - Shroud
  - Lock

See more on the Wikipedia page.

Wire-to-board connectors												
JST series	Pin-to-pin pitch	Pin rows	Current (Amp)	Voltage (Volt)	Wire size (AWG)	Shroud	Loc	ck	Notes	Datasheet		
VH <sup>[5]</sup>	3.96 mm (0.156 in)		10	250	22 to 16	Yes/No	Ye	es	Unshrouded seems to be more popular than shrouded.	JST VH 🔤		
RE <sup>[6]</sup>	2.54 mm (0.100 in)		2	250	30 to 24	No	No	o	Similar to female "DuPont" connectors and male pin headers. RF series is double row. <sup>[7]</sup>	JST RE 脑		
EH <sup>[8]</sup>	2.50 mm (0.098 in)		3	250	32 to 22	Yes	No	o	Not 0.1-inch pitch.	JST EH 🔤		
XA <sup>[9]</sup>	2.50 mm (0.098 in)		3	250	30 to 20	Yes	Ye	s	Not 0.1-inch pitch.	JST XA 💩		
XH <sup>[10]</sup>	2.50 mm (0.098 in)		3	250	30 to 22	Yes	No		Not 0.1-inch pitch. Used by many radio control (R/C) batteries.	JST XH 🔤		
PA [11]	2.00 mm (0.079 in)		3	250	28 to 22	Yes	Ye	es	Used by FMA Cellpro R/C battery chargers.	JST PA 💩		
PH <sup>[12]</sup>	2.00 mm (0.079 in)		2	100	32 to 24	Yes	No		Many stepper motors. Compatible with KR (IDC), KRD (IDC), CR (IDC) series. <sup>[13][14][15]</sup>	JST PH 🔤		
ZH <sup>[16]</sup>	1.50 mm (0.059 in)			50	32 to 26	Yes	N	o	Compatible with ZR (IDC) and ZM (crimp) series. <sup>[17][18]</sup>	JST ZH 📷		
GH <sup>[19]</sup>	1.25 mm (0.049 in)			50	30 to 26	Yes	Ye	es	Not 0.05-inch pitch. Sometimes confused with Molex PicoBlade. <sup>[20]</sup>	JST GH 🚵		
SH <sup>[21]</sup>	1.00 mm (0.039 in)			50	32 to 28	Yes	N	o	Compatible with SR (IDC) and SZ (IDC) series. $\ensuremath{^{[22]}}$	JST SH 💩		
Wire-to-wire connectors												
JST series	Pin-to-pin pitch	Pin rows	Current (Amp)	Voltage (Volt)	Wire size (AWG)	Feature	s	i Notes		Datasheet		
RCY [23]	2.50 mm (0.098 in)		3	250	28 to 22	Locking		Used in radio control (R/C), also known as BEC or P connector. Commonly found on small models, toys, and small LiPo packs.		JST RCY 🔤		
SM <sup>[24]</sup>	2.50 mm (0.098 in)		3	250	28 to 22	Locking, High force	•	Used in some RGB LED decorative light strips.		JST SM 🔤		

Table of connectors from the Wikipedia page.

# **Example JST Connectors**

#### JST-XH vertical wire-to-board



By Laurenz Wagner - Own work, CC BY 3.0

#### JST-SM Connector wire-to-wire



JST-SM Connector from Datasheet

### **DIN Connectors**

- Standardized by Deutsches Institut für Normung (DIN), the German Institute for Standards.
- Some common examples include the DIN 41524 circular connector for audio (e.g., MIDI)
- Includes not just the most common circular connectors, but some others as well under the DIN umbrella.



By MarcoTangerino - Own work, Public Domain

### **D-Sub Connectors**

- "D" because of physical shape (ensures orientation)
- More durable and mechanically stable than IDC connectors. (e.g., often come in sturdy housings, include screws to secure)
- Available with shielding to protect signals when traveling longer distances.
- Used in a variety of applications like video (VGA) or serial communication (RS-232, RS-485)



D-Sub connectors from Molex Catalog

### **Board-to-Board Connectors**

- Edge connectors (e.g., PCIe cards, m2 SSDs)
- Sockets/interconnects to stack boards on top of each other





PCIe Card - Own Work by Lam Tung Lee

Molex SlimStack Connectors

### "DuPont" Connectors

- Not an actual connector term but colloquially used to refer to these
- Likely seen these before in servos
- 0.100" (2.54 mm) pitch



DuPont Connector Shroud



**DuPont Connectors** 

### "Molex" Connectors

- Another example of a colloquial term. Molex is a manufacturer and "Molex Connector" doesn't refer to one specific connector or connector type.
- Often people are referring to Micro/Mini Fit line, commonly used in desktop PC power supplies.



Molex Micro-Fit Connectors

# **Connectors in Practice**

### How to make a connector

- 1. Select the appropriate connector
- 2. Select the appropriate wire (correct gauge)
- 3. Use crimping tool to attach the connector
- 4. Insert connectors into the plastic shroud

### What we have in the lab

- JST-XH wire-to-board, locking
- JST-SM wire-to-wire, locking
- JST-SYP wire-to-wire
- Dupont (DP)



Crimp tool



**Connector Kit Contents** 

# Activity

In your team, identify the various physical components in your system that will need to be electrically connected with cables. For each connection identify:

- 1. The number of circuits/wires
- 2. The type of connection (e.g., wire to wire, wire to board, board to board)
- 3. The top candidates for connector type
- 4. A bill of materials for connectors and cabling