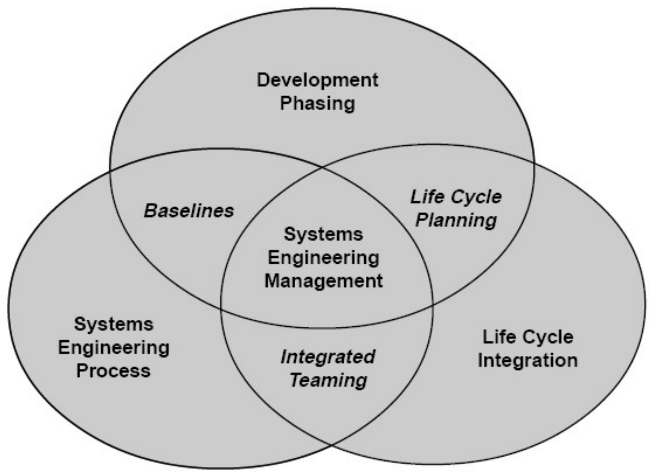
Overview

- **Interfaces**
- **Manufacturing**
- **Power**

Systems Engineering

- Holistic
    - Finance
    - Customer needs
    - Lifecycle
- Interdisciplinary
- Project management
    - Manage complexity
    - Evolution
- Safety
    - Reliability
    - Redundancy

http://en.wikipedia.org/wiki/Systems_engineering



Important issues

- Requirements
- Manufacturability
- Maintainability
- Packaging
- Power
- Interfaces
- Testing

Specifications (what the system must do)

Bandwidth, latency
Accuracy (difference between measured and truth)
Resolution (smallest change that can be detected)
Repeatability (standard deviation of multiple observations)
same operator, conditions, day, machine
Reproducibility (standard deviation of multiple observations)
different operator, conditions, day, machine

Constraints (what the system must not do)

Power, size, weight
Must not stop running for within 24 hours on +9V
Must not be bigger than 5 by 3 by 1 inch
Must not weight more than 1 lbs
software development costs,
Must not cost more than $100,000
memory available,
Must not need more than 2 KiB RAM or 32 KiB ROM
time-table.
Must not take more than 1 month to produce

Requirements Document.

states what the system will do.
serve as an agreement between you and your clients
legally binding contract
easy to read and understand by others
unambiguous, complete, verifiable, and modifiable
It does not state how the system will do it.

Sample Outline

1. Overview

1.1. Objectives: Why are we doing this project? What is the purpose?
1.2. Process: How will the project be developed?
1.3. Roles and Responsibilities: Who will do what? Who are the clients?
1.4. Interactions with Existing Systems: How will it fit in?
1.5. Terminology: Define terms used in the document.
1.6. Security: How will intellectual property be managed?

2. Function Description

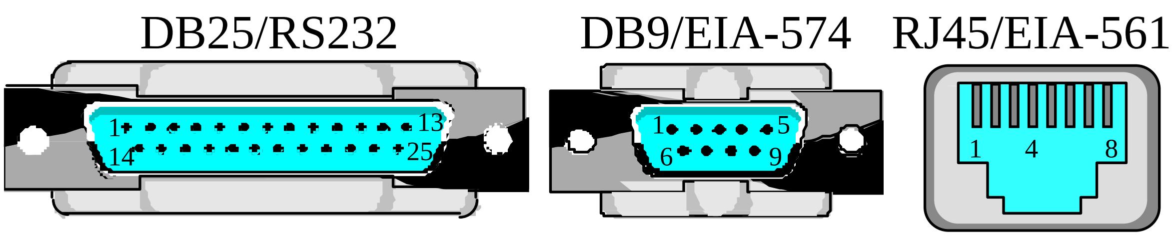
2.1. Functionality: What will the system do precisely?
2.2. Scope: List the phases and what will be delivered in each phase.
2.3. Prototypes: How will intermediate progress be demonstrated?
2.4. Performance: Define the measures and describe how they will be determined.
2.5. Usability: Describe the interfaces. Be quantitative if possible.
2.6. Safety: Explain any safety requirements and how they will be measured.

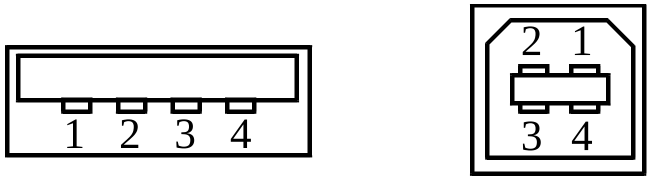
3. Deliverables

3.1. Reports: How will the system be described?
3.2. Audits: How will the clients evaluate progress?
3.3. Outcomes: What are the deliverables? How do we know when the system is done?

Interfaces

- Connector
- Voltage/Current/Capacitance
- Format
- Synchronization



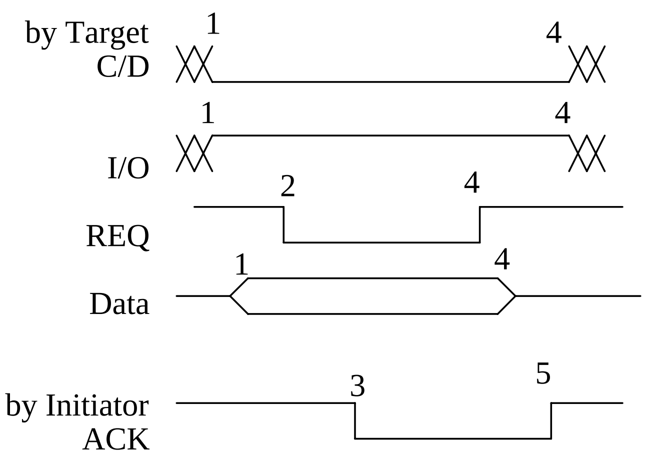


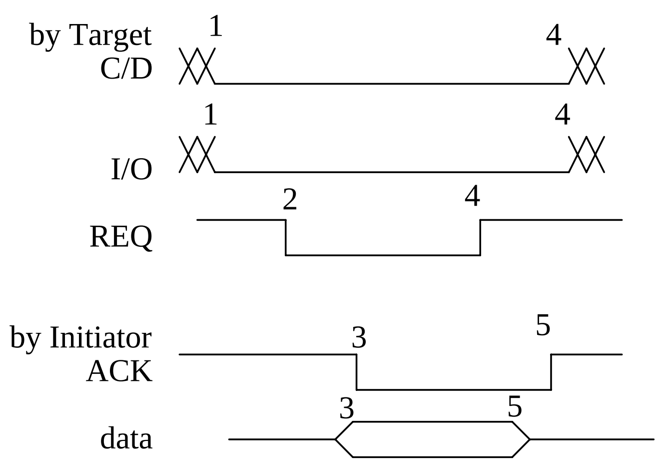
USB Type A USB Type B

Robust systems
- Add timeouts to wait loops
- Add periodic check of proper operation
  - COP
  - Periodic interrupt watch dog

Handshake methods
- Synchronous, tied to clock
- Partially asynchronous
  - Consumer can slow down/stop
- Interlocked

From Target to Initiator





From Initiator to Target

Standard values for 5% resistors range from 10 Ω to 22 MΩ. We can multiply a number in Table A3.2 by powers of 10 to select a standard value 5% resistor.

10	11	12	13	15	16	18	20	22	24	27	30
33	36	39	43	47	51	56	62	68	75	82	91

Table A3.2. Standard resistor values for 5% tolerance

10pF	100pF	1000pF	0.010μF	0.10μF	1.0μF	10μF
12pF	120pF	1200pF	0.012μF	0.12μF	1.2μF	
15pF	150pF	1500pF	0.015μF	0.15μF	1.5μF	
18pF	180pF	1800pF	0.018μF	0.18μF	1.8μF	
22pF	220pF	2200pF	0.022μF	0.22μF	2.2μF	22μF
27pF	270pF	2700pF	0.027μF	0.27μF	2.7μF	
33pF	330pF	3300pF	0.033μF	0.33μF	3.3μF	33μF
39pF	390pF	3900pF	0.039μF	0.39μF	3.9μF	
47pF	470pF	4700pF	0.047μF	0.47μF	4.7μF	47uF
56pF	560pF	5600pF	0.056μF	0.56μF	5.6μF	
68pF	680pF	6800pF	0.068μF	0.68μF	6.8μF	
82pF	820pF	8200pF	0.082μF	0.82μF	8.2μF	

Table A3.3. Standard capacitor values for 10% tolerance

Energy storage for typical AA-sized batteries (50 mm tall by 14 mm diameter).

Battery	Voltage (V)	Energy (mAh)	Type
Alkaline	1.5	2000	Primary
Lithium	1.5	3000	Primary
NiCad	1.2	1200	Secondary
NiMH	1.2	1800	Secondary
Li-ion	3.6	1900	Secondary

Table A3.4. Energy storage for different battery type

Additional feedback
1) How was the mix between simulation and real microcontroller? Want more real 9S12 labs?
2) How was the TRobot competition?
3) How was the in-lab programming quiz? Was it fair?
4) Did the on-line HW help you understand the material?