

# Digital Electronics 101

## Binary, Logic and Serial

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# Binary Basics

- We, as humans, count in Base <sup>10</sup> – its natural!
- Systems count with other number bases.
- Binary<sup>2</sup>, Hexadecimal<sup>16</sup> and Octal<sup>8</sup> bases are used to represent data inside of system communication.
- Primarily used for communication but serves to be useful in EVERYTHING that requires processing.

# Decimal – Base<sup>10</sup> (Denary)

- Counting in Decimal seems natural, we learn the basics growing up.
- Decimal increments the carry, every ten iterations.
- I will demonstrate on the whiteboard

# Binary - Base<sup>2</sup>

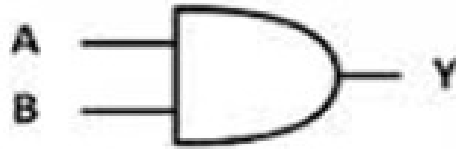
- Binary, or Base<sup>2</sup>, has only two states.
- A ZERO(0) represents the absence of something therefore a zero does not represent nothing as it is something.
- A ONE (1) represents something and is NOT zero
- Allow me to demonstrate.....

# Truth Tables

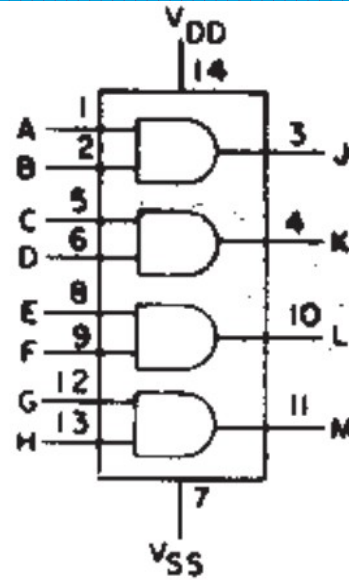
- A truth Table can aid in the design of a circuit.
- A truth Table is a quick memory aid.
- AND OR NOT – Just three of the popular gate types.

# (AND) Any LOW gives a LOW

AND gate



2 Input AND gate		
A	B	A.B
0	0	0
0	1	0
1	0	0
1	1	1



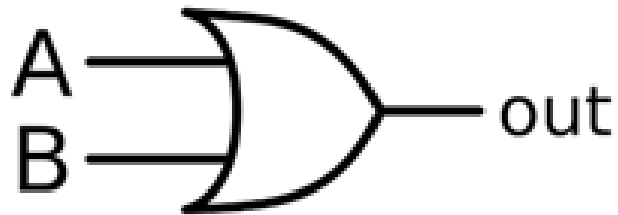
92C5-27503

**CD4081B**

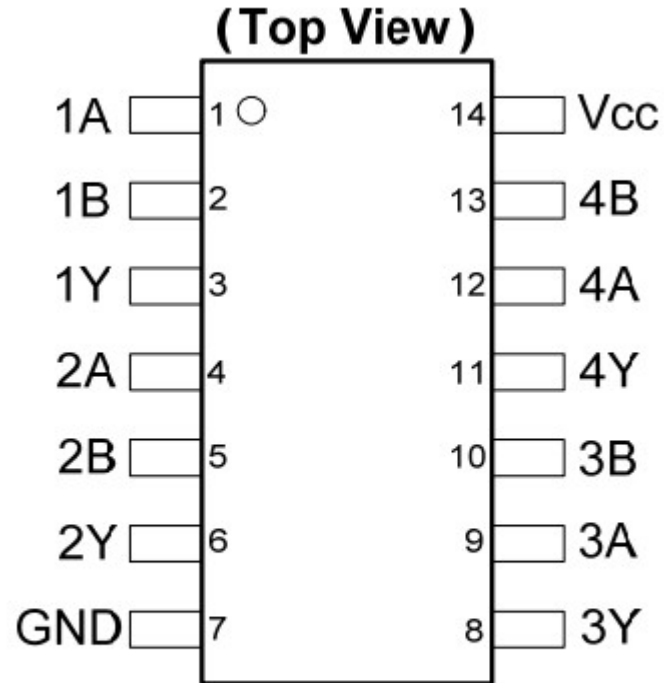
**FUNCTIONAL DIAGRAM**

# (OR) Any HIGH gives a HIGH

OR gate



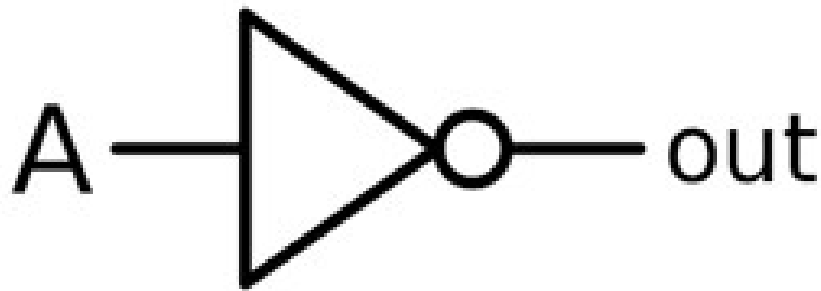
2 Input OR gate		
A	B	A+B
0	0	0
0	1	1
1	0	1
1	1	1



**SO-14 / TSSOP-14**

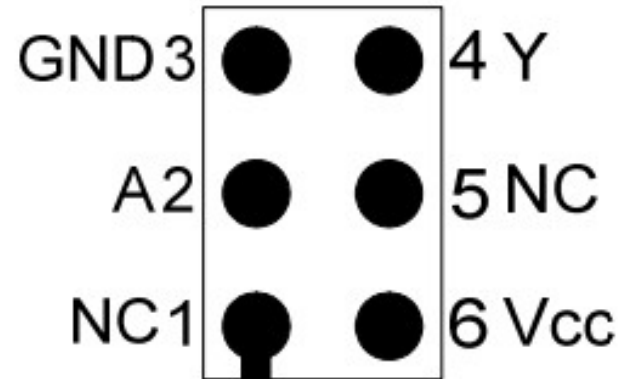
# (NOT) Is an INVERTER

NOT gate



NOT gate	
A	$\bar{A}$
0	1
1	0

(Bottom View)



X2-DFN1409-6

Chip Scale  
Alternative

# Others....

- Octal (Base<sup>8</sup>) is used in TCP/IP and UDP packets.
- Hex (Base<sup>16</sup>) is normally used to represent larger numbers.
- Many others exist but I will not bore you with them.

Offset (h)	00	01	02	03	04	05	06	07	08	09	0A	0B	0C	0D	0E	0F	Decoded text
00000000	FF	D8	FF	FE	00	22	54	68	69	73	49	73	41	53	75	70	ÿÿp."ThisIsASup
00000010	65	72	53	65	63	72	65	74	44	65	63	72	79	70	74	69	erSecretDecrypti
00000020	6F	6E	4B	65	79	21	FF	E0	00	10	4A	46	49	46	00	01	onKey!ÿà..JFIF..
00000030	01	01	00	48	00	48	00	00	FF	DB	00	43	00	06	04	05	...H.H..ÿÛ.C....
00000040	06	05	04	06	06	05	06	07	07	06	08	0A	10	0A	0A	09	.....
00000050	09	0A	14	0E	0F	0C	10	17	14	18	18	17	14	16	16	1A	.....

# Real World Applications

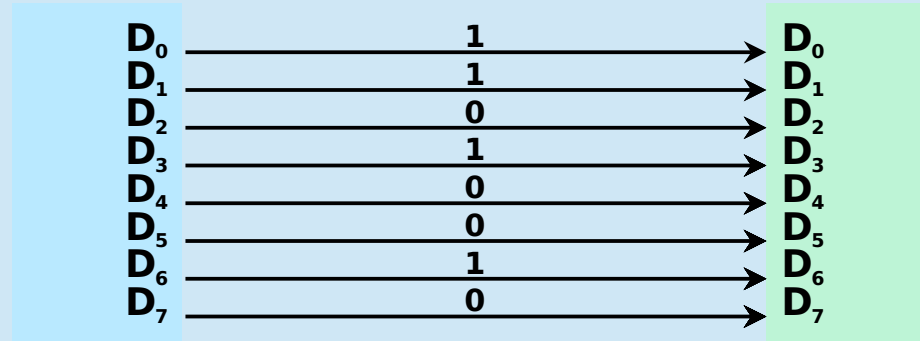
- Logic Gates can be found in a multitude of applications.
- Parallel to Serial data is one application
- You can use Logic Gates to “Level Shift” between states.
- RS232 uses +12v (0) and -12v(1)
- TTL (Transistor to Transistor levels use 5v (3.3 to 13)

# Binary data in practice...

## Parallel interface example

Transmitter (TX)

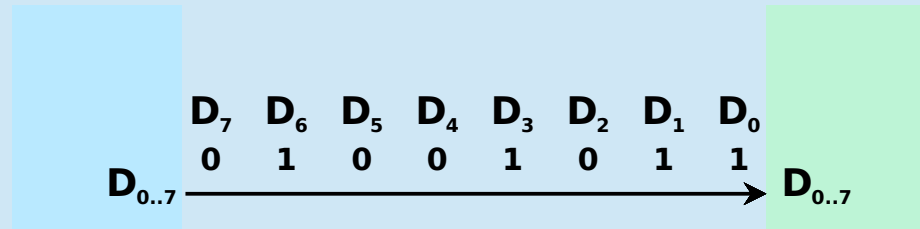
Receiver (RX)



## Serial interface example

Transmitter (TX)

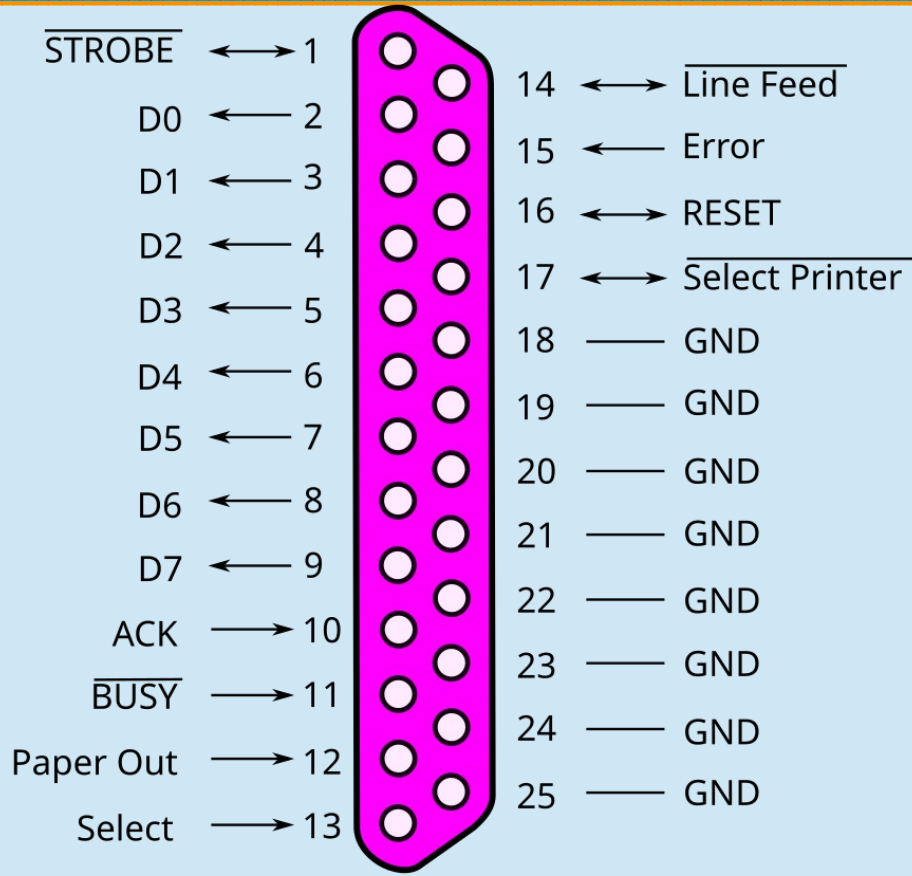
Receiver (RX)



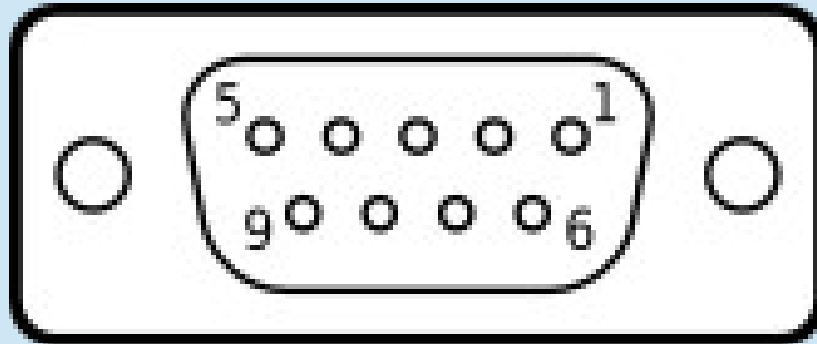
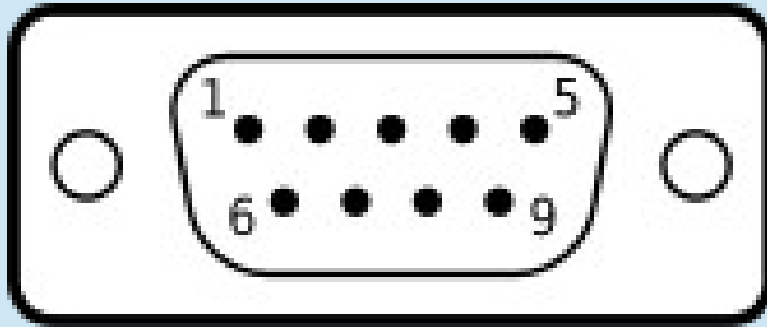
# Pros and Cons

- Parallel data is limited by length, the faster you send the shorter the length you can send it reliably. This is called “Data Skew”
- Timing is more critical with parallel data.
- Serial data requires no conversion
- Serial data supports FULL Duplex (Send and transmit data simultaneously)

# DB25 Data Port (Parallel)

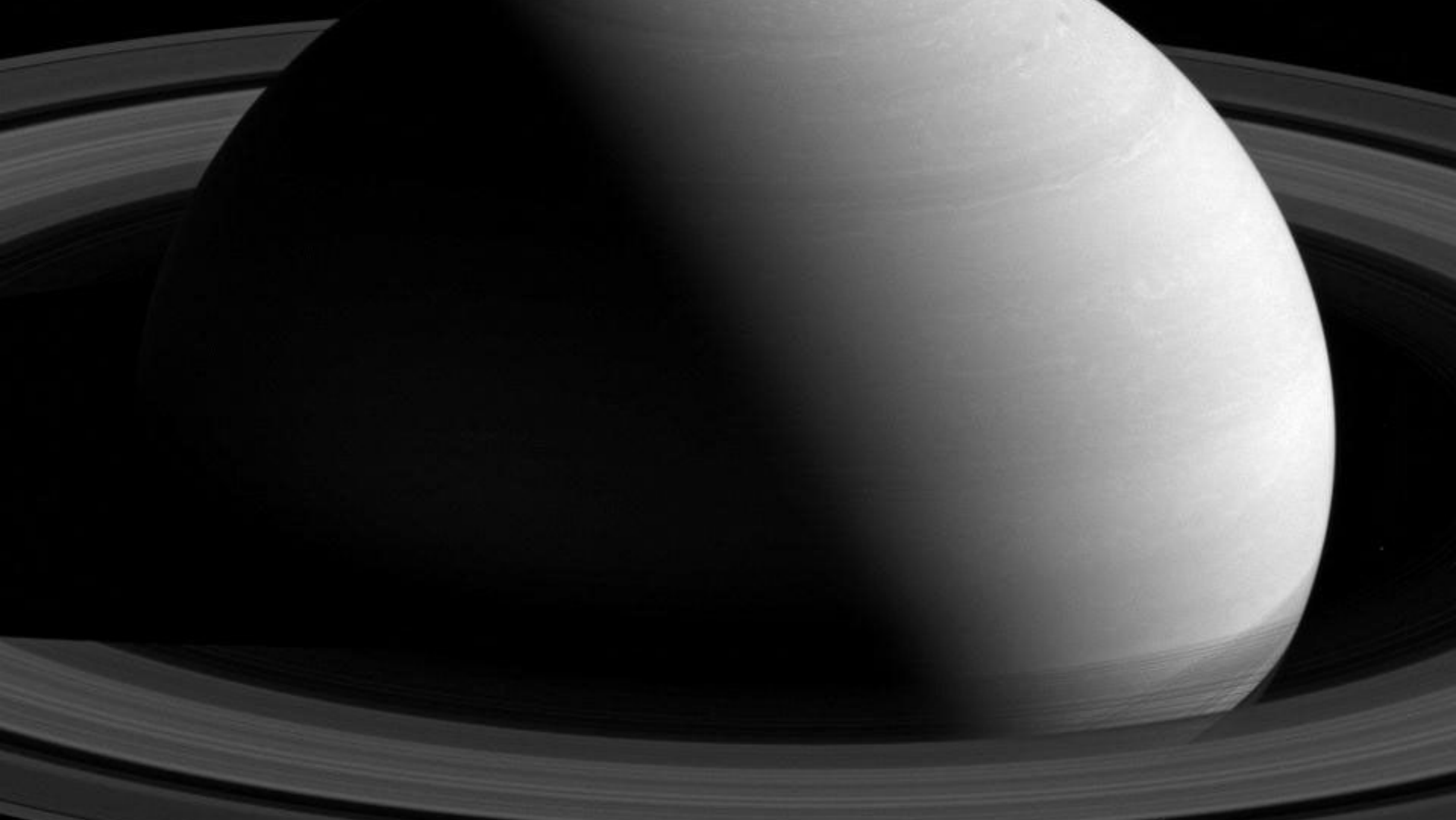


# DB9 (Serial)



# What uses serial data then?

- NASA – Cassini spacecraft launched in 1997 for Jupiter
- The images sent back from the spacecraft were sent using serial data on the on-board radio transceiver.



# Radio Programming

- Radio programming is achieved with serial data.
- USB carries a form of serial data.
- USB can only go as fast as the receive end allows it (RTS CTS)

# What else?

- Transceiver remote mounting kits use serial data to pass the state of the radio main body to the display head
- You can use RS-232 converters to interrogate devices (Routers and consumer electronics)

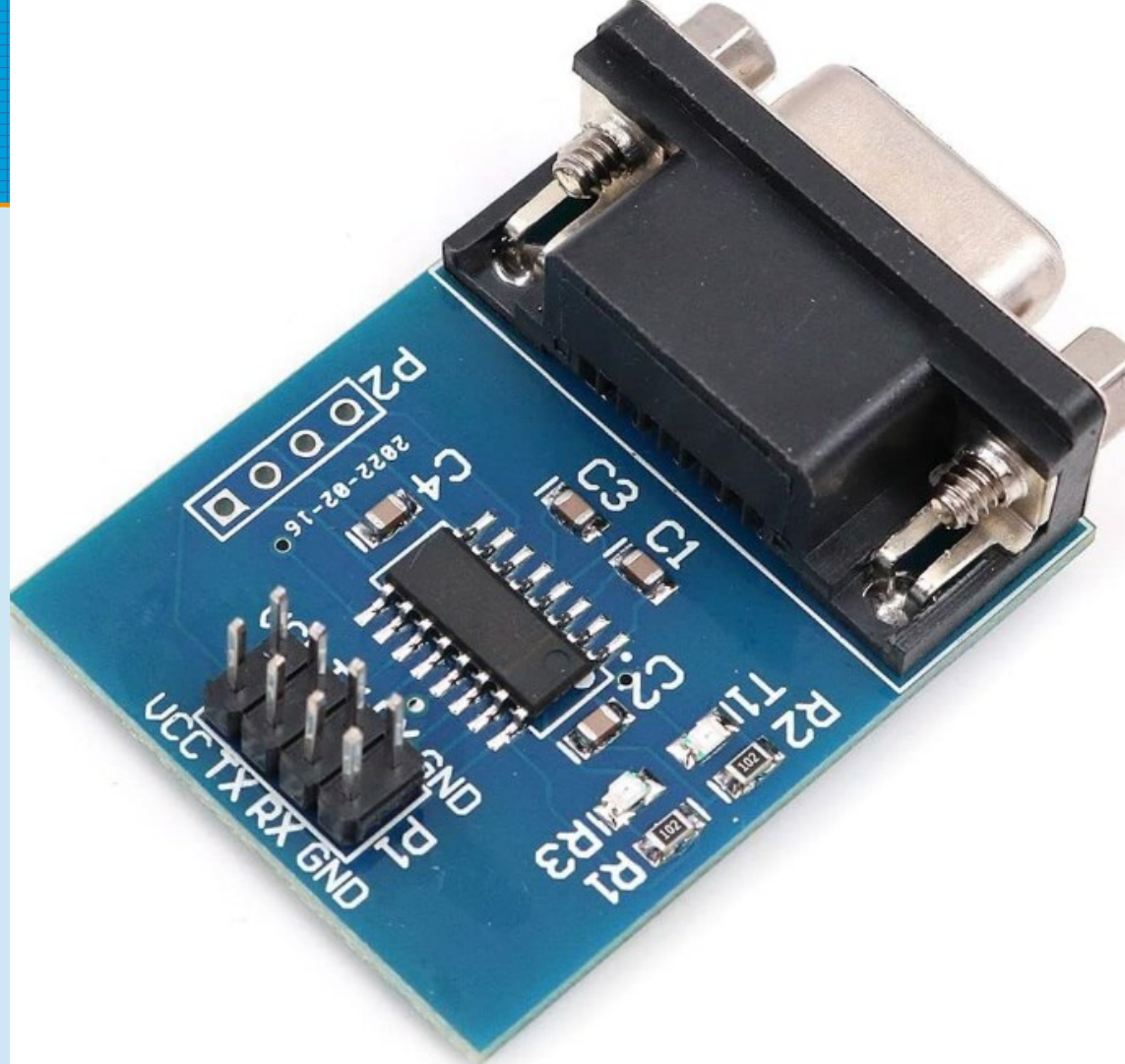
# Analysing..

- Serial data is quite simple to debug.
- Logic analysers and some oscilloscopes can do this.









# Where to go from here?

- Any interest for an online course?
- Any interest in other aspects of data manipulation?
- Next Talk will be reverse engineering and hardware hacking