VCF Southwest

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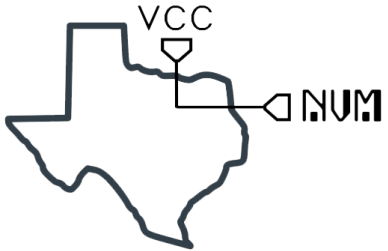
RS-232 Then and Now



From telegraphs, teletypes, to 300 baud DataSet and beyond!

Steve Lewis (YT Xiphod / “voidstar tech”)

June 22nd 2025

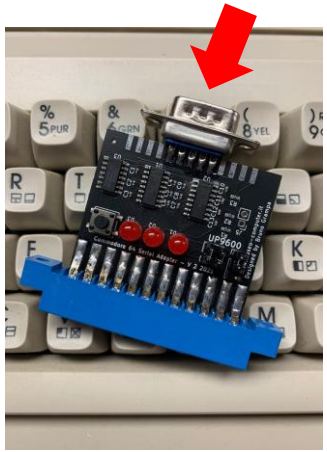
Tandy RS-232 Pak
(1983)

Apple II Super >
Serial Card (1981)

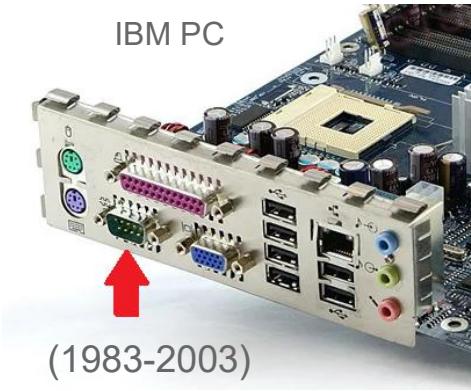
“ the serial port ”

< NEC PC-8001 Mk II
(1979 – 1983)

C64 UserPort to
RS-232 Adapter >
(“device 2”)



IBM PC



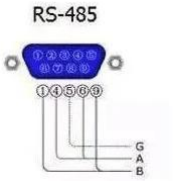
(1983-2003)

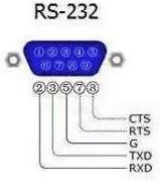
Not talking about…

(parallel)

- GPIB / HP-IB / IEEE-488 (c. 1975)
- IEC (Commodore “cost reduced **serial** version of IEEE-488”)
- I^2C (eye-squared-see) (c. 1982)

- RS-422 / RS-485 (c. 1975, “multi-drop”)





RS = Recommended Standard (<u>not</u> Radio Shack !!!)

Some of the Earliest Games that used RS-232

MAZE (1973)

(DigiBarn Maze War 30 year Reunion – 2003)

COMMBAT (1982)

ATARI
APPLE
TRS-80

TeleChess (1977-1984)

Sopwith II (1985) PC

Modem Wars (1988)

Atari CommLynx (1989)

Doom (1993)

Warcraft 1 (1994)

RS-232 Then and Now

"Domesticating the Computer"

Table of Contents

- Historical Context (18th / 19th century): sending a signal over a wire
- SAGE and the Mo/Dem (1960's): machine-to-machine data exchange
- Uses of RS-232 (1970s – 1990s): beyond MODEMs
- Technical dive into RS-232 (and going past 115.2Kbps)

RS-232 Then and Now

- **1753 to 1809:** various experiments on sending messages across wires, one wire per letter of alphabet.
  - General idea of using wires to send signals (materials study)
  - This establishes the concept of telegraphs (“distant” “writer”)
- **1816:** Francis Ronalds demonstrates “electrostatic telegraph” [UK]
  - Deemed un-necessary [due to conclusion of Napolean wars], Admiralty favored “semaphore telegraph” (15km w/ telescopes)

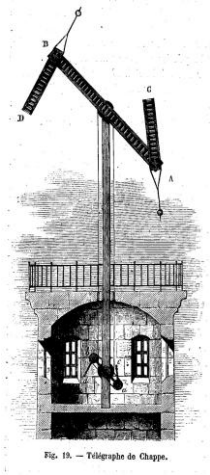
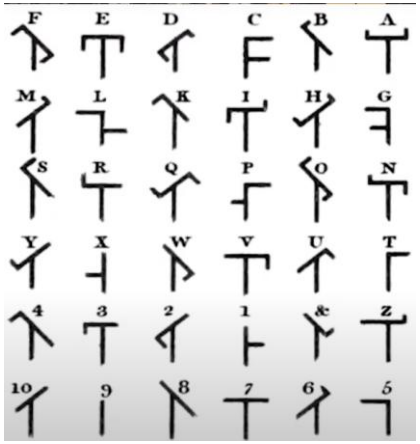
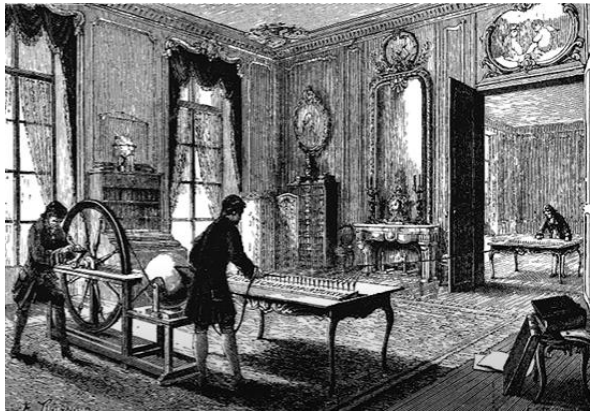


Fig. 19. — Télégraphe de Chappe.



Battery invented in 1800. See Volta and the “voltaic pile”

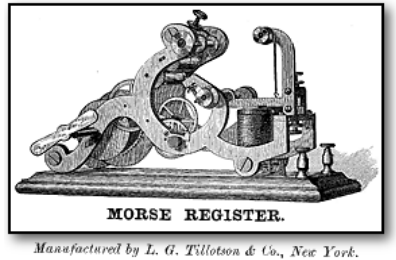


Samual Morse Code

- 1838: Morse Code [dot-dash, “1-3-7” timing] (Joseph Henry research)
- 1844: First Telegraph (US Capital to Baltimore)
- 1861: Transcontinental Telegraph (Sacramento to DC, Pres. Lincoln)

  (pony express disbanded two days later)

  (railroad not until 1869)



Manufactured by L. G. Tillotson & Co., New York.

A ·–	B –···	C –·–·	D –··	E ·	F ··–·	G ––·
H ····	I ··	J ·–––	K –·–	L ·–··	M ––	N –·
O –––	P ·––·	Q ––·–	R ·–·	S ···	T –	U ··–
V ···–	W ·––	X –··–	Y –·––	Z ––··		

varied duration

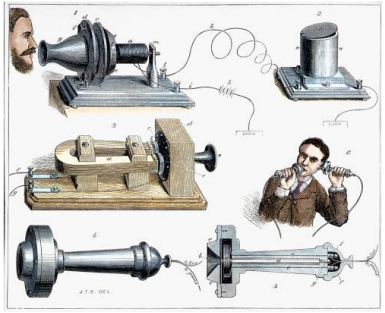
(no standard frequency, but often 600-800Hz)

“American Progress” (1872)

Columbia carries a SCHOOL BOOK and uncoils TELEGRAPH wire into an expanding frontier.

Telegraphs were in use for news bulletins, post office (“telegram”), weather reports, stock exchange updates.

POTS (Plain Old Telephone Service): 1876.



John Gast

(Emile) Baudot vs. (Donald) Murray Code

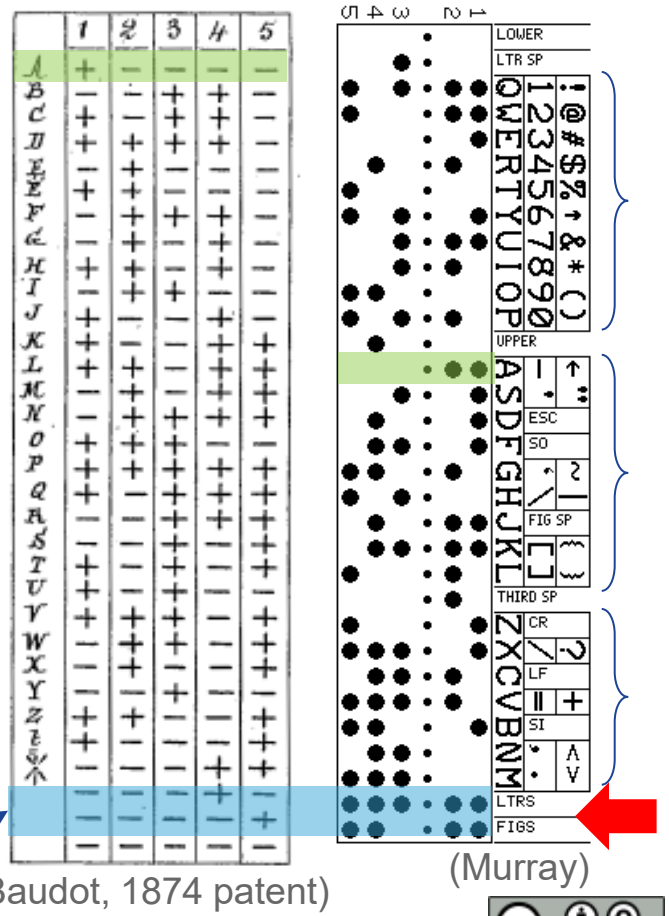
- 1874: Baudot [ITA1] [Baudot Multiplex System]
- 1901: Murray Code [paper tape, “telegraphic typewriter”]
- 1906: Morkrum Company / Krum [Teletype Corporation]
- 1922: Frederick Creed [Commercial Start-Stop system]
- 1932: ITA No. 2 / USTTY [teleprinters]

A ·–	B –···	C –·–·	D –··	E ·	F ··–·	G ––·
H ····	I ··	J ·–––	K –·–	L ·–··	M ––	N –·
O –––	P ·––·	Q ––·–	R ·–·	S ···	T –	U ··–
V ···–	W ·––	X –··–	Y –·––	Z ––··		

varied duration

(no standard frequency, but often 600-800Hz)

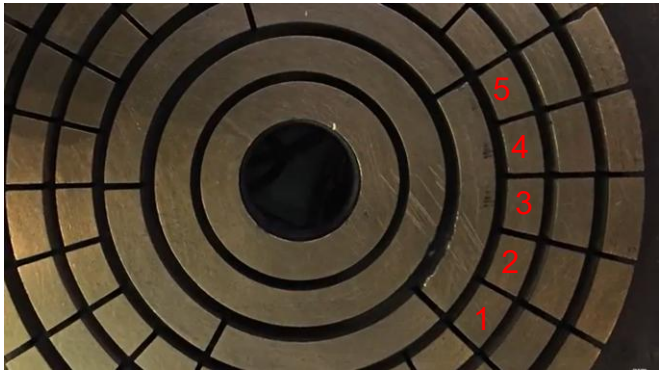
uniform duration

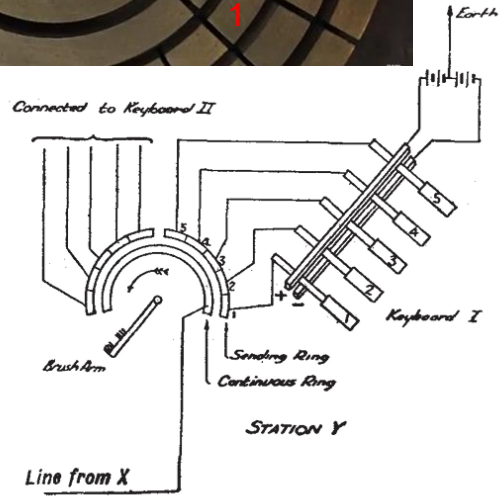


(Baudot, 1874 patent)

(Murray)

Baudot





vowels

Alphabetic Presentation

French	English	Keyboard Layout V IV I II III	Transmission Order I II III IV V
A 1	A 1	●	●
B 8	B 8	● ●	● ●
C 9	C 9	● ●	● ●
D 0	D 0	● ● ●	● ● ●
E 2	E 2	●	●
É &		● ●	● ●
F	F ⅝	● ●	● ●
G 7	G 7	●	●
H	H ¹	● ●	● ●
I	I ¾	● ●	● ●
J 6	J 6	● ●	●
K (	K (	● ●	● ●
L =	L =	● ●	● ●
M)	M)	● ●	● ●
N	N £	● ● ●	● ● ●
O 5	O 5	● ● ●	● ● ●
	/ ½	● ●	● ●
P %	P +	● ● ●	● ● ●
Q /	Q /	● ● ●	● ●
R -	R -	● ●	● ●
S ;	S ⅞	●	●
T !	T ²	● ●	● ●
U 4	U 4	● ●	● ●
V '	V '	● ● ●	● ● ●
W ?	W ?	● ● ●	● ●
X ,	X ⅝	● ●	●
Y 3	Y 3	●	●
Z :	Z :	● ●	● ●
		●	●
✳✳✳✳		● ●	
FIGURE		●	●
LETTER		●	●

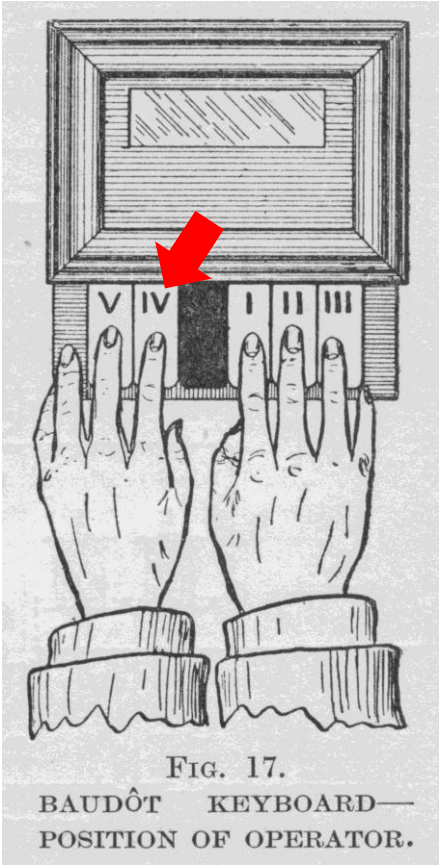


FIG. 17.
BAUDÔT KEYBOARD—
POSITION OF OPERATOR.

(“cadence signal”)

The “start-stop system”

The following is an excerpt from a patent application of Dr. Louis M. Potts (later to become research engineer for the Morkrum-Kleinschmidt Corporation), filed June 17, 1909, giving his idea for achieving a teleprinter intercommunicating system on the synchronous principle. Dr. Potts was a very capable telegraph engineer. His early association was with the telegraph system of the Rowland Telegraphic Company which had limited use in the early 1900s.

> In those synchronous telegraph systems wherein the sending and the receiving commutator brushes constantly rotate, it is necessary to adjust these brushes so that they will approximately simultaneously engage corresponding segments. To effect this adjustment there is usually provided a special device embodying an additional segment on each commutator, and the adjustment consists in causing the brushes to arrive approximately simultaneously on this segment at the two ends of the line. Such adjustment is known as “finding the letter” and has to be made every time synchronism has been interrupted. According to the present invention, the necessity of providing additional means for performing the so-called operation of “finding the letter” is rendered unnecessary, since the transmitting and receiving commutator brushes at the two ends of the line start up afresh as it were for each signal.

“PRINTING TELEGRAPHY ... A NEW ERA BEGINS”
- recollections of *Edward E. Kleinschmidt, 1967*

A mechanical UART?

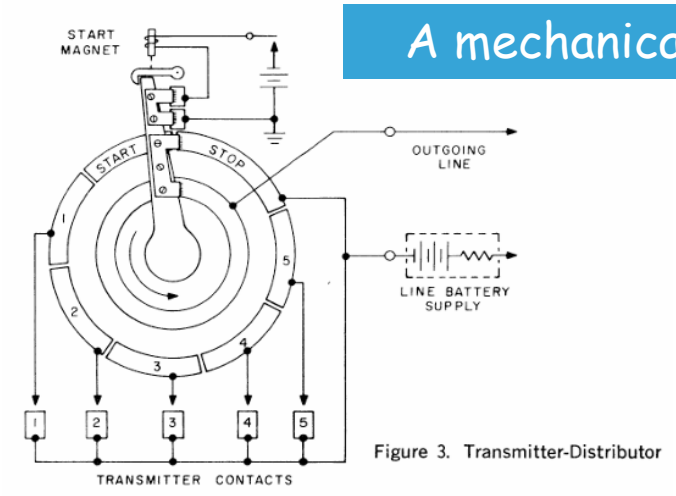


Figure 3. Transmitter-Distributor

~1909

"Teletypewriter Fundamentals" (1965)

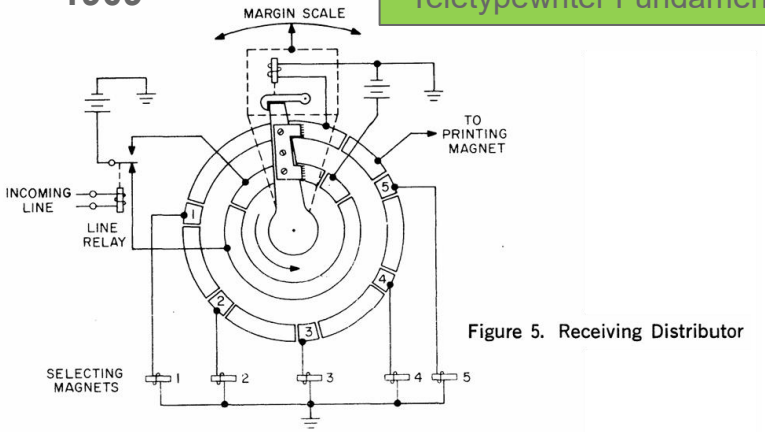


Figure 5. Receiving Distributor

(Murray code)

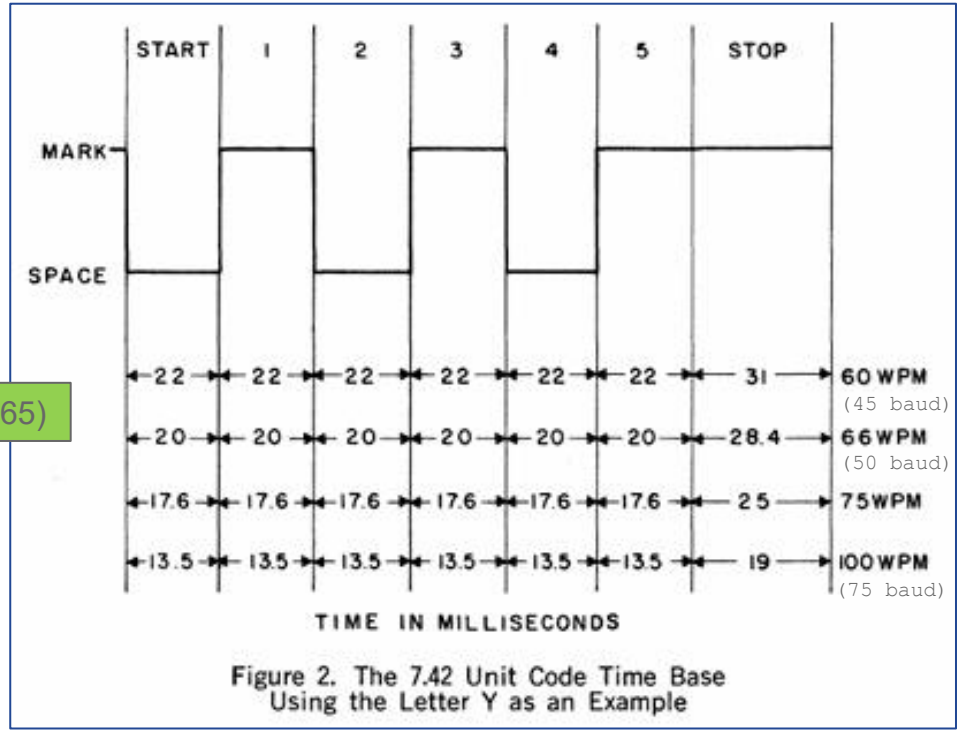
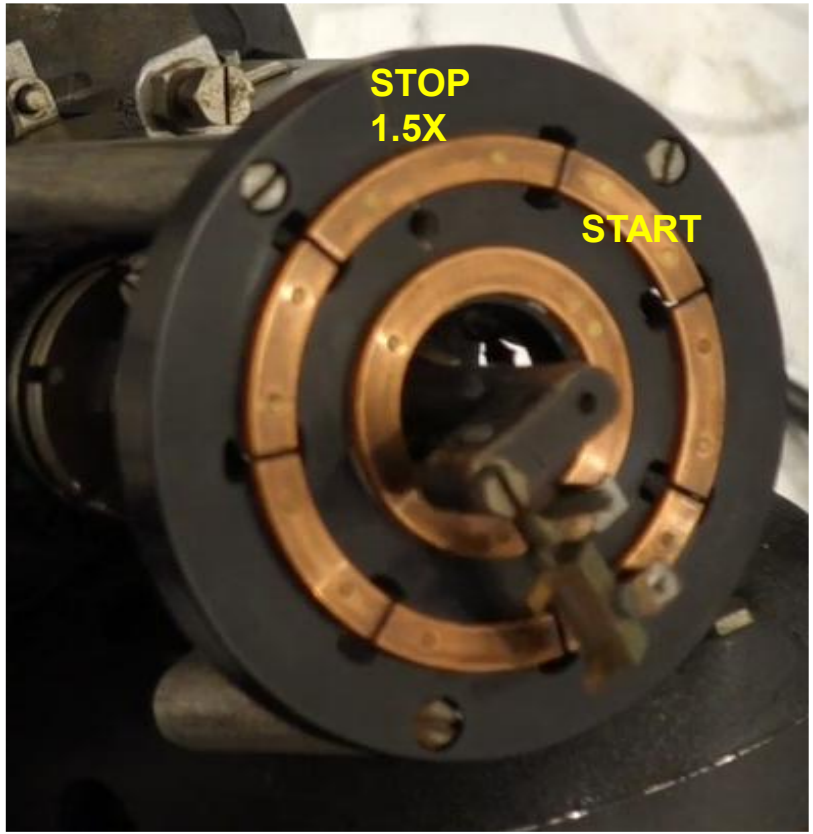
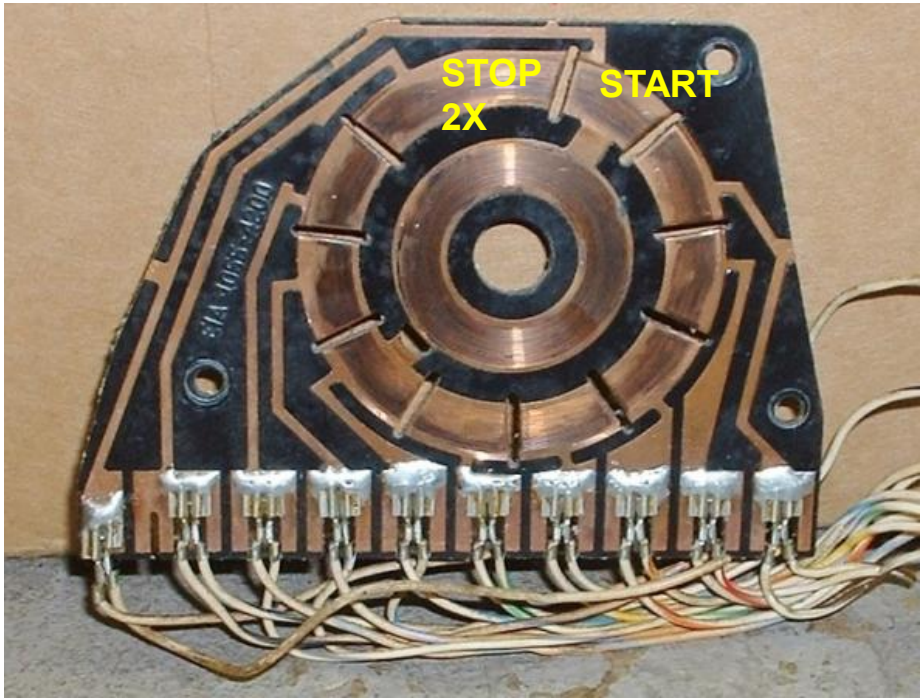


Figure 2. The 7.42 Unit Code Time Base Using the Letter Y as an Example

Stop bit was 1.42x of the others

(U.S. convention, International 1.5x)





(thanks to CuriousMarc)

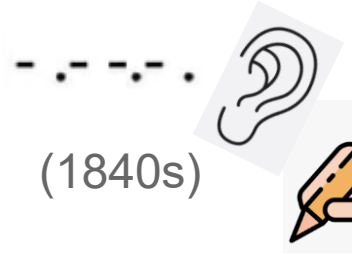
PRINTING TELEGRAPHY ... A NEW ERA BEGINS

Edward E. Kleinschmidt, 1967

"It seems odd that synchronous systems, where both transmitter and receiver were started at the same time (requiring both transmitter and receiver to maintain synchronism), held the field for so long a time, thus limiting telegraph transmission to one-way operation.

It evidently took a mind not bound or hampered by the standard and accepted way of operating synchronous systems to discard such old ideas and to set forth boldly on a new pattern which, in reality, differed but slightly from the then-established synchronous systems, and to sow the seed for starting further developments leading to the present telegraph typewriter, TWX, and TELEX intercommunicating systems. Such a man was Howard L. Krum, who, in further thinking on the subject, came upon the almost simple idea of having the transmitter start the receiver rather than having them both start at the same time. This arrangement required higher speed operation of the receiver and therefore the receiving code pulse positions were spread over a shorter area, which meant progressively decreasing the angular division of the receiving members. Then, to set the received start pulse in the most favorable position with relation to the following code signal reception, an orientation adjustment of the receiver start position was provided."

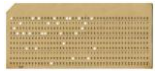
Isn’t this talk about RS-232?



(1840s)

- So far: Discussed serial communication conventions
  - The words “RS-232” hadn’t yet been uttered by anyone (until the 1960s).

(1860s)

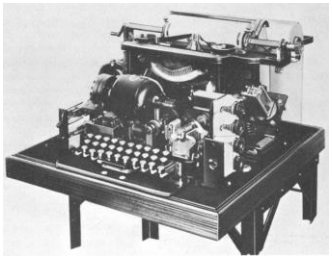


- In 1940, there weren’t too many computers in the world.
  - Standards not an issue - no other system to send your data to anyway
  - (and barely any RAM to store it)

(1920s)

(1940s)

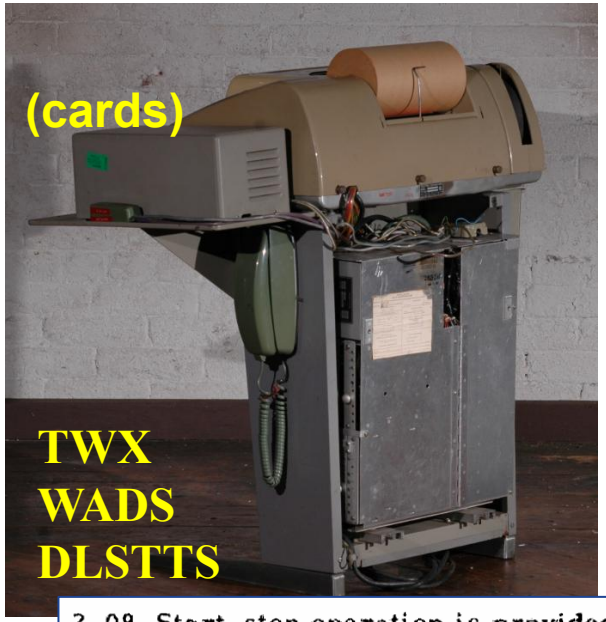
- But people began to realize: “why bother printing everything?”
  - Computers could talk to each other
  - Results of one computer could be passed to another
  - RAM and “data storage” became a thing [magnetic storage]



SAGE: Semi-Automatic Ground Environment

- **Jay Forrester** (who also led development of Whirlwind)
- Involved IBM, RAND, Burroughs, Western Electric in collaboration with MIT Lincoln Labs
- Work began **1952** (urgency increased after Soviet hydrogen bomb demonstration was detonated), SAGE operational c. **1958 - 1982**
- **IBM 704 introduced:** core memory (patent from Wang in 1956), tape storage, the first high-level language (FORTRAN, “formula translator”), keyboard terminals, multi-user / real-time response, PCB construction, and **computer-to-computer communication**

Bell “Data Set 101C” Modem (c. 1959)



2.08 Start-stop operation is provided by the use of a single bit start element and a double bit stop element; thus, 11 bits are transmitted for each character. The equipment operates at 110 bits (ten characters) per second.

Bell “Data Set 103A” Mo/Dem (c. 1963)

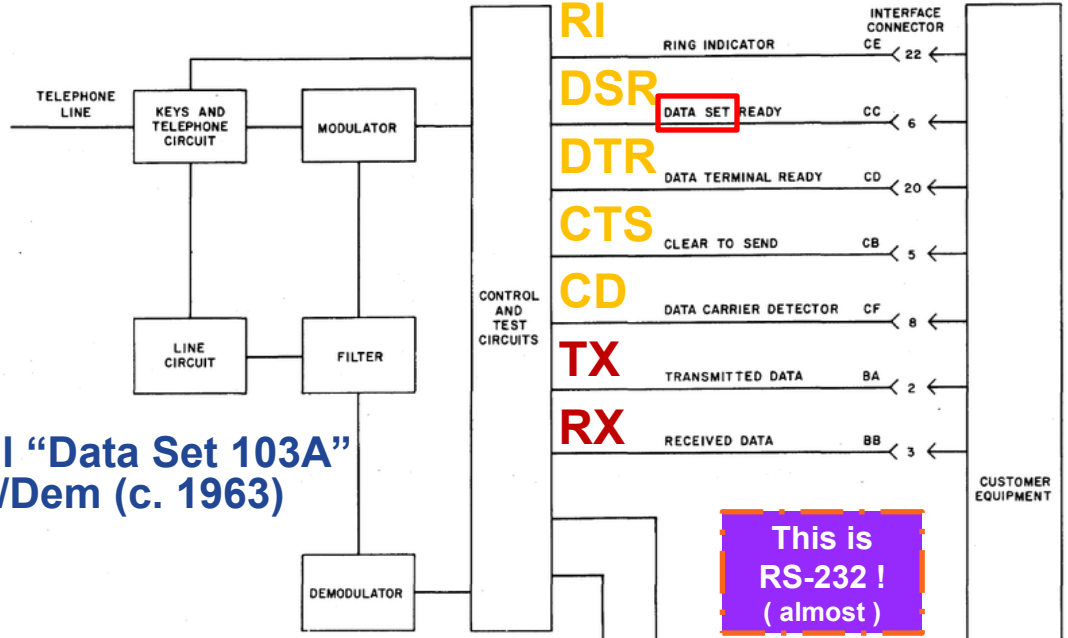
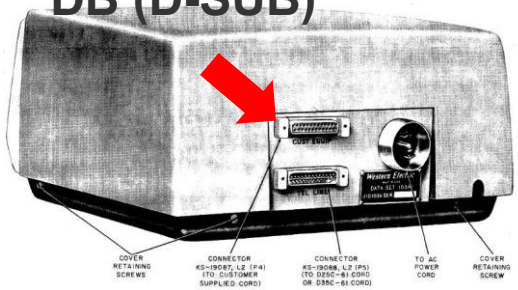


Fig. 5 — Data Set 103A Type, Block Diagram

This is RS-232 ! (almost)

DB (D-SUB)



1963 Modem

Middle “A” @ 440 Hz

Typical modems adapt -V to +V voltage swings over to audible tones.

TABLE A

FREQUENCIES

STATION MODE	SIGNAL TRANSMITTED	FREQUENCY (Hz)	
		DATA SET 103A1	DATA SET 103A2
Originating	f_1 mark (f_{1m})	1070	1270
	f_1 space (f_{1s})	1270	1070
Answering	f_2 mark (f_{2m})	2025	2225
	f_2 space (f_{2s})	2225	2025

The audible frequency chosen allowed up to 300 baud data rate. It was a nice round number and stable on the copper lines of the day, plus suitable for 50Hz and 60Hz power systems.

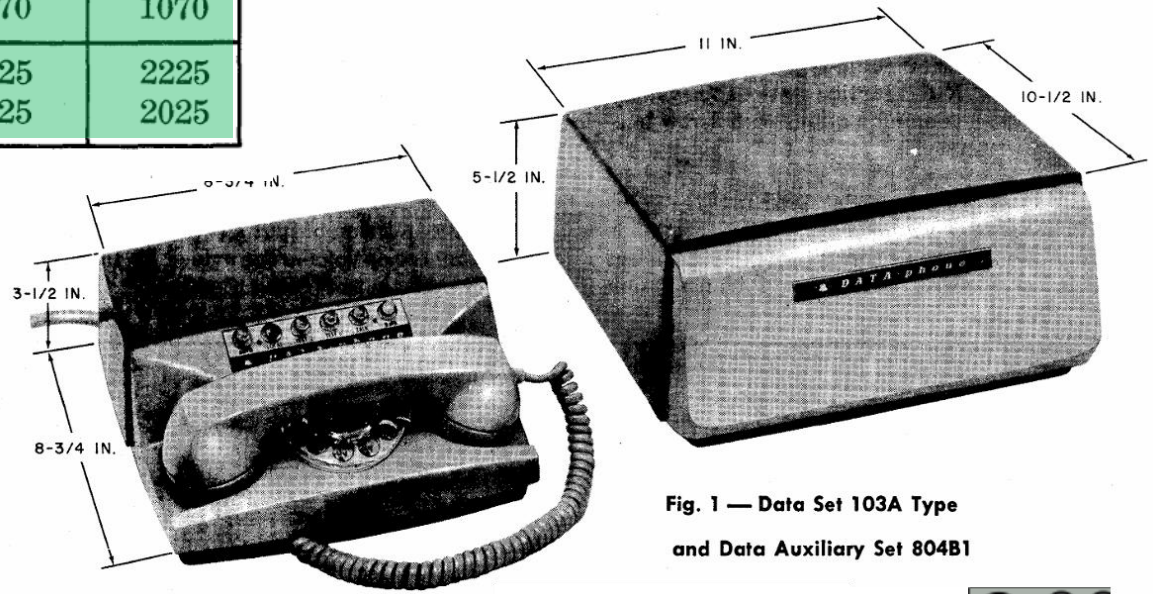


Fig. 1 — Data Set 103A Type and Data Auxiliary Set 804B1

Overview of RS-232 Specifications

- RS-232 (May 1960) [Recommended Standard]
- RS-232-A (October 1963) [per TIA archive, Telecomm. Industry Association]
- RS-232-B (October 1965) [per TIA archive]
- **RS-232-C (Aug. 1969)** 2740_EIA_RS-232-C.pdf
- RS-232-D (Nov. 1986)
- RS-232-E (Jan. 1991) 2741_EIA_RS-232-E.pdf
- TIA/EIA-232-F (Oct. 1997) TIA TIA-232-F | TIA Store

RS-232 does not specify…

- “The standard does not define such elements as the character encoding (i.e. ASCII, EBCDIC, “, etc.
- The standard does not define “the framing of characters (start or stop bits, etc.)”
- The standard does not define “transmission order of bits, or error detection protocols.”

Bell Dataset 103A (Feb. 1967 manual)

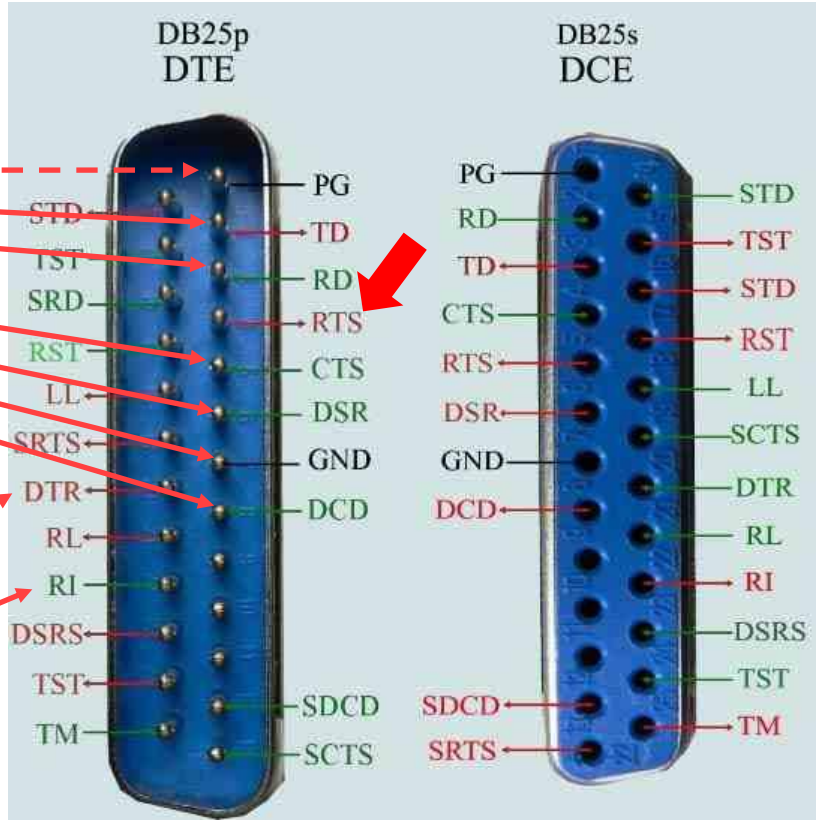
TABLE 1

Interface Connector Pin Assignments

Pin	Circuit	I/O	Function
1	AA	–	Protective Ground
2	BA	I	Transmitted Data
3	BB	O	Received Data
4	–	–	–
5	CB	O	Clear to Send
6	CC	O*	Data Set Ready
7	AB	–	Signal Ground
8	CF	O	Carrier Detector
9	Reserved	(for Telephone Company Use Only)	
10	Reserved	(for Telephone Company Use Only)	
11	–	–	–
12	–	–	–
13	–	–	–
14	–	–	–
15	–	–	–
16	–	–	–
17	–	–	–
18	–	–	–
19	–	–	–
20	CD	I*	Data Terminal Ready
21	–	–	–
22	CE	O	Ringing Indicator
23	–	–	–
24	–	–	–
25	–	–	–

*"Fail Safe" circuit; See Section 4.1

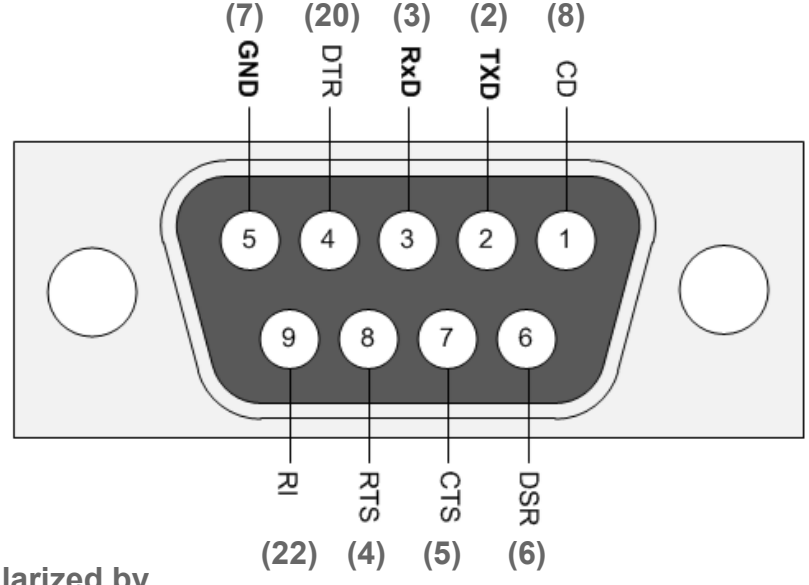
"DB25 Serial Port Spec RS-232C"



Overview of RS-232 Specifications

RS-232-C (1969)

RS-232 Connector Pinout
DCE (Device Side)
DE-9 Female Connector



Popularized by
IBM PC AT in 1984. Standardized by TIA-574 in 1990.

Pin Number	Circuit	Description
1	AA	Protective Ground
2	BA	Transmitted Data
3	BB	Received Data
4	CA	Request to Send
5	CB	Clear to Send
6	CC	Data Set Ready
7	AB	Signal Ground (Common Return)
8	CF	Received Line Signal Detector
9	–	(Reserved for Data Set Testing)
10	–	(Reserved for Data Set Testing)
11		Unassigned (See section 3.2)
12	SCF	Sec. Rec'd. Line Sig. Detector
13	SCB	Sec. Clear to Send
14	SBA	Secondary Transmitted Data
15	DB	Transmission Signal Element Timing (DCE Source)
16	SBB	Secondary Received Data
17	DD	Receiver Signal Element Timing (DCE Source)
18		Unassigned
19	SCA	Secondary Request to Send
20	CD	Data Terminal Ready
21	CG	Signal Quality Detector
22	CE	Ring Indicator
23	CH/CI	Data Signal Rate Selector (DTE/DCE Source)
24	DA	Transmit Signal Element Timing (DTE Source)
25		Unassigned

Figure 3.1
Interface Connector Pin Assignments

Some Particulars of RS-232C (1/2)

- “The physical connection between DTE and DCE is made through plug-in, 25-pin connectors. “
- “The connectors are keyed with 13 pins on the top row and 12 pins on the bottom row to prevent improper connection. “ (but some motherboards use a 26-pin connector…)
- “The male connector is always associated with the DTE, and the female is always associated with the DCE. “
- “The use of short cables, each less than 50 feet or 15 meters, is recommended. Use of longer cables is permissible, ...” (but at slower transmission speed)
- “Pin assignments are explicit and unalterable, unless unassigned. Special functions not specifically defined should be allotted to unassigned pins.”

Table 1. EIA RS-232-C Interface Connector Pin Assignments

Pin Number	Function	Circuit	Data Signal from DCE	Data Signal from DTE	Control Signal from DCE	Control Signal from DTE	Timing Signal from DCE	Timing Signal from DTE	CCITT Equivalent*
1	Protective ground	AA							101
2	Transmitted data	BA		X					103
3	Received data	BB	X						104
4	Request to send	CA				X			105
5	Clear to send	CB			X				106
6	Data set ready	CC			X				107
7	Signal ground/common return	AB							102
8	Received line signal detector	CF			X				109
9	Reserved for data set testing								
10	Reserved for data set testing								
11	Unassigned								
12	Secondary received line signal detector	SCF			X				122
13	Secondary clear to send	SCB			X				121
14	Secondary transmitted data	SBA		X					118
15	Transmission signal element timing (DCE)	DB					X		114
16	Secondary received data	SBB	X						119
17	Receiver signal element timing (DCE)	DD					X		115
18	Unassigned								
19	Secondary request to send	SCA				X			120
20	Data terminal ready	CD				X			108.2
21	Signal quality detector	CG			X				110
22	Ring indicator	CE			X				125
23	Data signal rate selector	CH/CI			X	X			111/112
24	Transmit signal element timing (DTE)	DA						X	113
25	Secondary clear to send	SCB			X				

DCE = Data Communication Equipment

DTE = Data Terminal Equipment

(1991) mistake

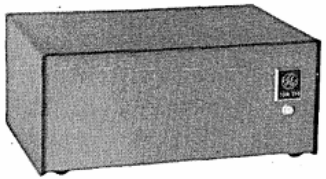
Some Particulars of RS-232C (2/2)

- “Secondary channels are established because in some communications systems, greater channel efficiency can be achieved by using a lower speed subchannel to carry control responses. “
- “A data signal on an interchange circuit is in the **mark** condition when the voltage at the interface point is **more negative than -3 volts..**. When the data signal at the interface point **is more positive than + 3 volts …** the data signal is in the **space** condition. The area between -3 and + 3 volts is the transition region. In the transition region, the signal state is not defined. “
- “A **control function** is considered to be in the ON condition when the voltage is more positive than +3 volts; it is considered to be in the OFF condition when the voltage is more negative than -3 volts. “
- “Open circuit driver voltage (YO), with respect to signal ground, **must not exceed 25** volts with respect to ground. “
- “The potential at the interface point **must not be less than 5 volts nor more than 15 volts in magnitude** when the terminator resistance (RL) is between 3000 and 7000 ohms, and the terminator open voltage (EL) is zero.”
- “The maximum instantaneous rate of voltage must not exceed 30 volts per microsecond .” ←

(slew rate)

Now, use General Electric's new datasets

With this regulation, dataset users have the option to buy . . . keeping economy in mind.



General Electric TDM 210 and TDM 220 datasets deliver that economy plus high reliability. Each handles 1800 and 2400 bits per second respectively. G.E. sells the TDM 210 for $675 and the TDM 220 for $1950. Compare these prices with overall leasing payments, and elementary arithmetic agrees there're greater savings when you buy. You can amortize over 5 years and save 10% a month on a 100-mile leased line.

With G-E TDM 210 datasets you get:

- Complete interchangeability with Bell's 202D-1, using the same RS-232 plugs
- Compactness (9"x13¾"x6")
- Modular construction, solid-state design for easy alignment and test . . . silicon transistors used throughout
- Total of 5 watts power consumption
- One control to minimize operator induced errors

For further information on General Electric's new datasets, write to Communication Products Dept., General Electric Company, Section 131116, Lynchburg, Virginia.

472-02

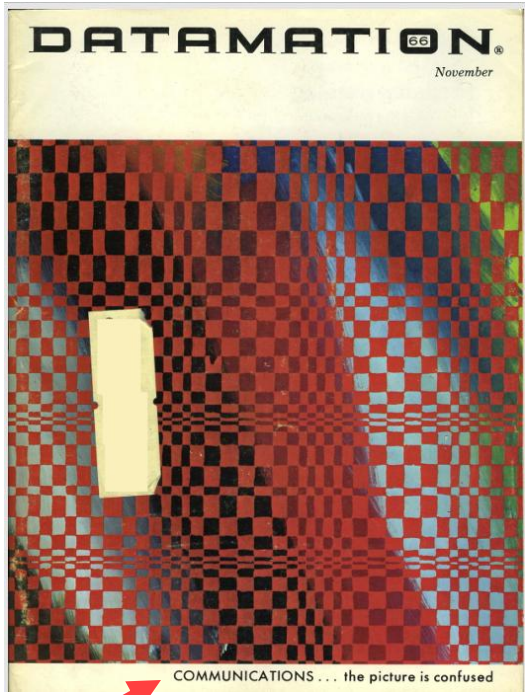
GENERAL ELECTRIC

78

CIRCLE 38 ON READER CARD

DATAMATION

Datamation magazine **earliest** use of the term "RS-232" found in **November 1966** issue.



Datamation

May 1970 (page 18)

You need a DATAMAX MODEM to achieve MAXIMUM DATA THROUGHPUT. DATAMAX has coupled FORWARD ERROR CORRECTION with AUTOMATIC and ADAPTIVE LINE EQUALIZATION to assure accurate data transmission at 4800 and 2400 bits per second. If you missed us at the S.J.C.C. and the Telecommunications Exposition, write or call . . .

DATAMAX CORPORATION

3941 Research Park Drive
Ann Arbor, Michigan 48104
313/769-0900

Where better modems are built

BYTE Magazine - December 1977

80-103A Serial I/O and FSK modem for professional and hobby communications.

D.C. HAYES 80-103A S-100 Modem Board

- Completely compatible with your IMSAI, ALTAIR* SOL** or other S-100 microcomputers. Trademarks of *MITS, **Processor Technology
- Designed for use on the dial telephone or TWX networks, or 2-wire dedicated lines, meets all FCC regulations when used with a CBT coupler.
- All digital modulation and demodulation with on board cyrstal clock and precision filter mean that NO ADJUSTMENTS ARE REQUIRED
  - Bell 103 standard frequencies
  - Automated dial (pulsed) and answer
  - Originate and answer mode
  - 110 or 300 BPS speed select
  - Complete self test capability
  - Character length, stop bit, and parity
  - 90 day warranty and full documentation

PRICES Bare Board and Manual 49.95
Assembled (48 hour burn in) 279.95

DC Hayes Assoc.

P.O. Box 9884, Atlanta, Ga. 30319, 404/231-0574

DATA ... NS ADAPTER

```
"AT"
"ATI"
"ATDT"
"ATH0"
"+++"
```

1981 Hayes Smartmodem

The “ASCII Drama” of 1965-1968

IBM supported the idea of this kind of standard, but…

They had already developed **EBCDIC** and **PL/1** in 1963.
(in PDP-world, they had DEC SIXBIT and RADIX 50)

IBM’s main opposition to ASCII revolved around the VERTICAL-BAR (|). The compromise (1967/1968) was to use a vertical bar with a slit. This was to distinguish it from the OR operator in PL/1. But later ASCII revisions in the 70’s changed it back to a solid vertical bar.

(there were other interesting aspects to the debates, resulting in the 1965 ASCII standard not to be widely adopted at that time)

Things that used RS-232…

These are the “common” things

(pulls power over RS-232)

Hand Scanners, Checkout Scanners & Scales

First grocery scanned item was a pack of gum in Troy, Ohio (1974).

First hand scanner LS1000 around 1979/1980 (used compact laser).

POS = point of sale

1975 VT-52 DECscope

20 mA Adapter Card* – The 20 mA adapter card is supplied with a 4-meter, No. 22 AWG stranded 4-wire cable that terminates in an 8-pin Mate-N-Lok connector. Table 4-4 lists the cable signal names.

Table 4-4 20 mA Interface Signals

Mate-N-Lok Pin No.	Signal Name	Color
7	Transmitted Data (+)	Green
3	Transmitted Data (–)	Red
5	Received Data (+)	White
2	Received Data (–)	Black

EIA Adapter Card – The EIA adapter card is supplied with a 7620 mm cable terminating in a 25-pin, MALE CANNON DB 19604-432 or equivalent connector. Table 4-5 lists the cable signal names.

Table 4-5 EIA Interface Signals

Cannon Pin No.	Signal Name	Comments
1	Protective Ground	Logic 1 = OFF = –10 V
2	Transmitted Data	Logic 0 = ON = +10 V
3	Received Data	Logic 1 = OFF = –5 to –25 V Logic 0 = ON = +5 to +25 V
4	Request to Send	Wired TRUE (+10 V)
7	Signal Ground	
20	Data Terminal Ready	Wired TRUE (+10 V)
All others	No connection	

*Unless otherwise specified, the 20 mA current loop interface is shipped in VT52 terminals.

Table 2-6 Printer Interface Option Baud Rate Selection

Position	Function/Baud Rate
A	Parallel
B	Serial – 150 Baud
C	Serial – 300 Baud
D	Serial – 600 Baud
E	Serial – 1200 Baud
F	Serial – 2400 Baud
G	Serial – 4800 Baud
H	Serial – 9600 Baud

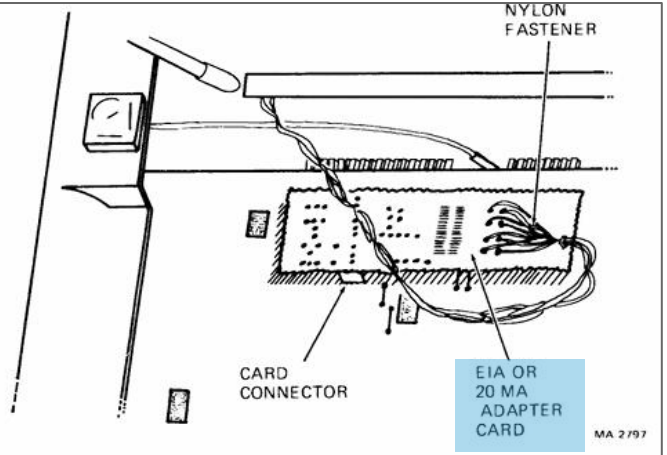
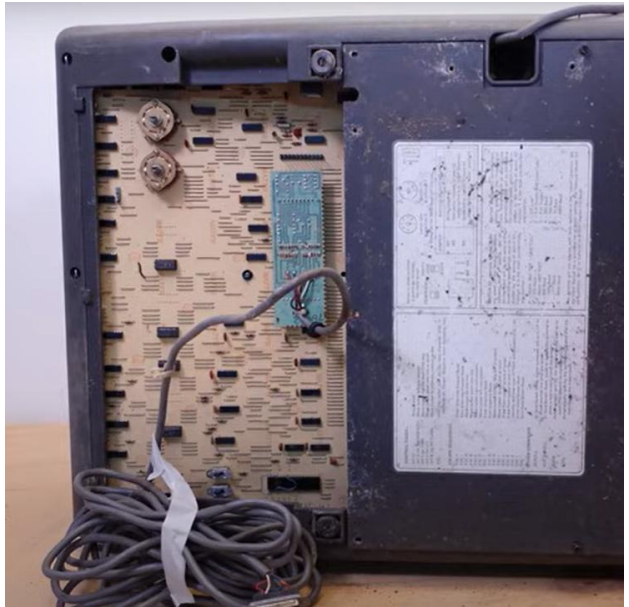


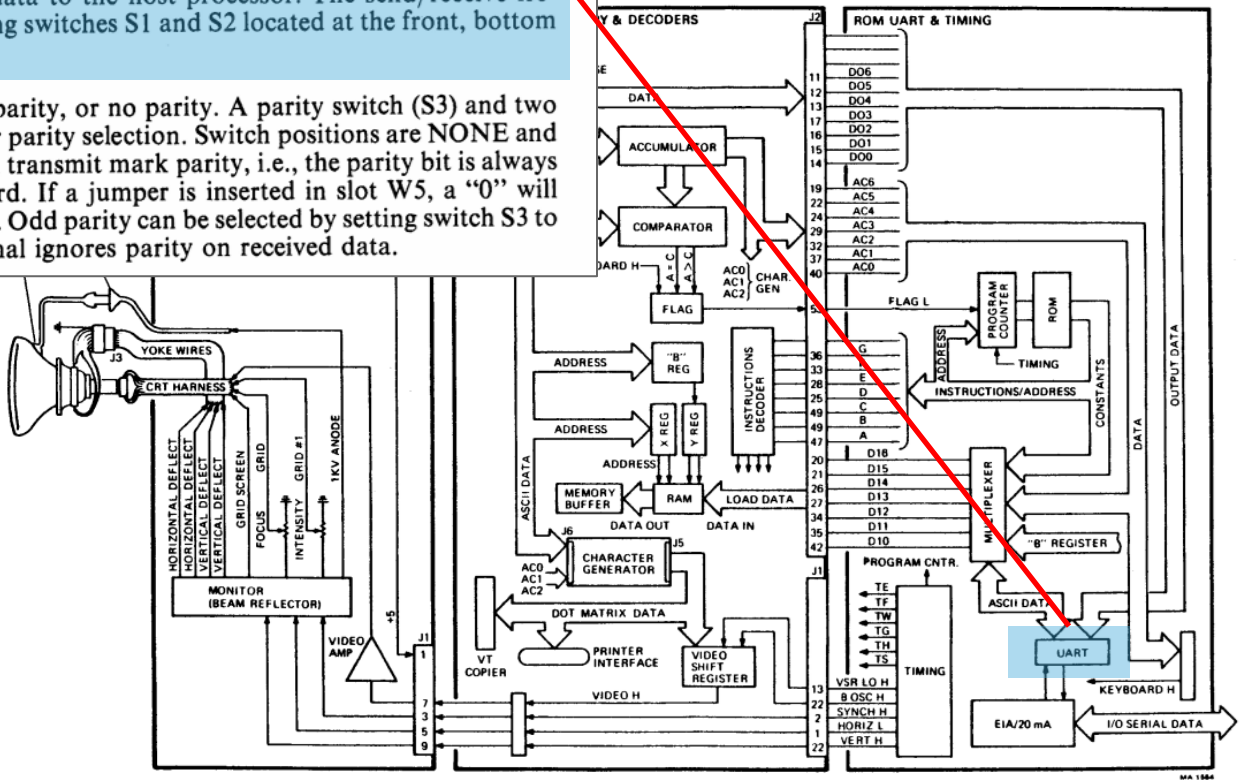
Figure 3-2 Removing and Replacing the EIA or 20 mA Adapter Card

1975 VT-52 DECscope

4.3.2.4 UART – The UART is a full-duplex receiver/transmitter that accepts asynchronous, serial binary characters from the host processor and converts them to parallel format for transfer to the RAM. It also accepts parallel binary characters from the RAM, converts them to serial data with added START and STOP bits and transmits this data to the host processor. The send/receive frequency of the UART (baud rate) is selected by setting switches S1 and S2 located at the front, bottom of the unit, under the keyboard.

The VT52 will transmit data with odd parity, even parity, or no parity. A parity switch (S3) and two jumper slots located under the keyboard are used for parity selection. Switch positions are NONE and EVEN. If the switch is set to NONE, the UART will transmit mark parity, i.e., the parity bit is always a "1" regardless of the number of 1 bits in the word. If a jumper is inserted in slot W5, a "0" will always be transmitted in the parity bit (space parity). Odd parity can be selected by setting switch S3 to EVEN and adding a jumper in slot W6. The terminal ignores parity on received data.





Scientific Lab Equipment (w/ RS232)

Rear panel

The rear panel of the unit contains a serial number plate, receptacle module and an RS232 interface port.

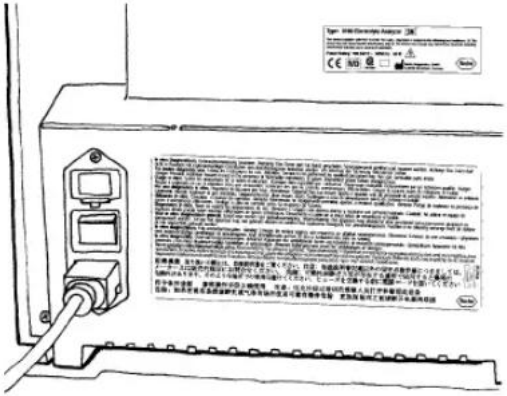


Fig. 1-12

Serial port

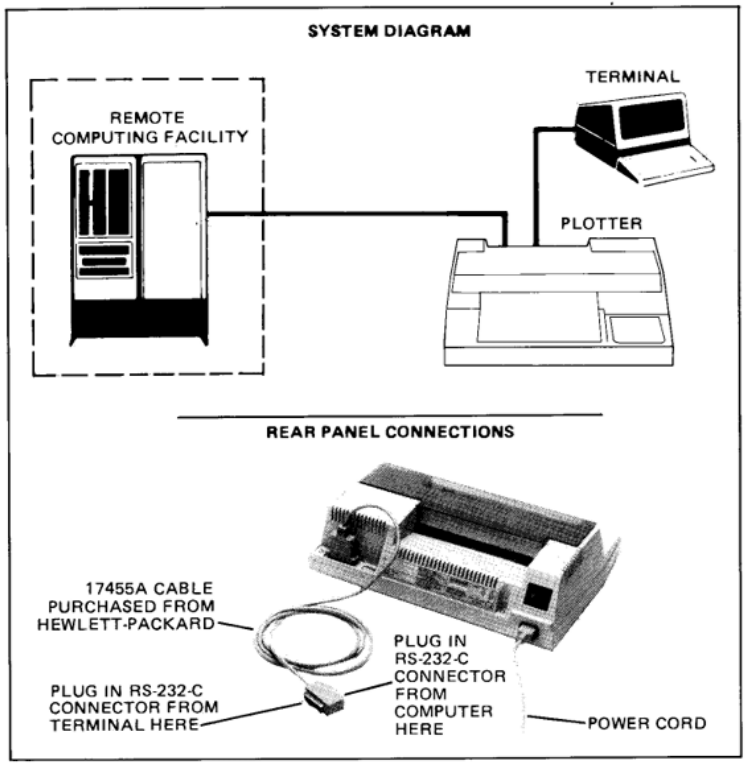
The analyzer is equipped with a serial RS232 interface and allows data to be exchanged with commercially available computer systems. The analyzer can be connected to COMPACT 2/3 systems via the 9-pin DB-9 connector to output a common measurement report.

AVL Electrolyte Analyzer

"Dr. Peter Venkman"

Scientific Lab Equipment

HP 8450A Diode Array Spectrophotometer
Computer w/ 7470A Graphics Plotter



Plotter Interconnection with a Terminal and Remote Facility
Using RS-232-C/CCITT V.24 Cabling

Scientific Lab Equipment

OceanOptics
PART OF OCEAN INSIGHT

High Pressure Gas Analyzer

QMS series ... from $26,500

- 100, 200 or 300 amu systems
- Pressures from 10 mbar to 1 bar
- Better than 1 amu resolution
- Less than 0.5 second response time
- Compact, transportable design
- 6 decades of dynamic range
- RGA Windows software
- RS-232 interface

Serial Protocol over RS-232 on Ocean Spectrometers

RS-232 used for remote monitoring

The Endeco model 1029 SSM water-level recorder can be used as a stand-alone recording device where the data are stored in the memory cartridge or it can be used as a real-time data telemetry device where the data are transmitted through the RS-232C link by way of satellite, radio frequency, or telephone modem to an IBM-compatible personal computer.

The software package to perform real-time data collection (1029PRF) on either the IBM or a Radio Shack TRS-80 model 100 is available also from Endeco. To use a terminal or portable computer in the field, a standard RS-232C cable is needed to connect to the 1029 SSM. This is identical to the cable that is used between the IBM computer and the 1138 cartridge reader. The cable needs a DB25 plug to socket connector. Pins 1, 2, 3, and 7 are used and pin 8 is jumpered to pin 20. These cables are available commercially or through Endeco.

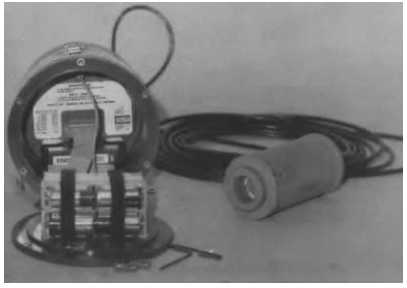
RESULTS OF QUALIFICATION TESTS ON

WATER-LEVEL SENSING INSTRUMENTS, 1987

By Truth E. Olive

U.S. GEOLOGICAL SURVEY

Open-File Report 89-397

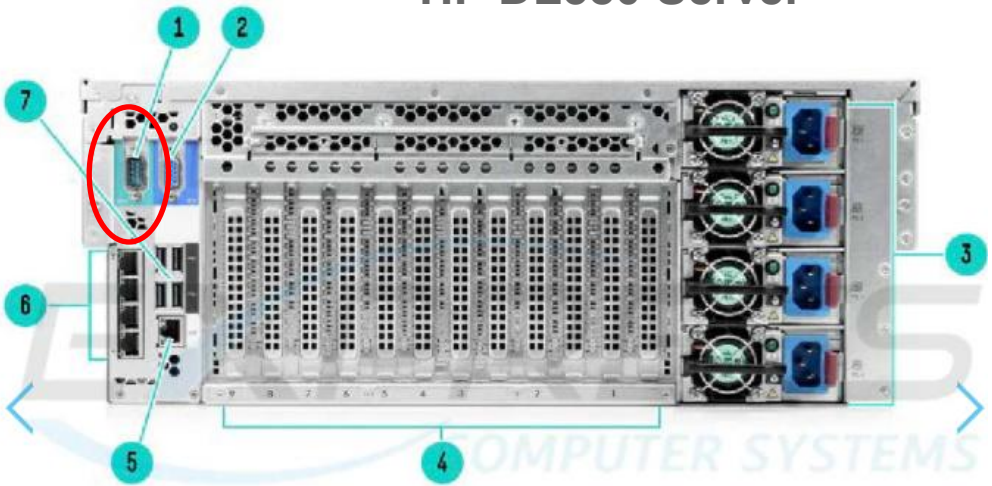


Stennis Space Center, Mississippi

1989

RS-232 used for server login

HP DL580 Server



1. Serial connector
2. Video connector
3. Power Supplies 1-4
4. PCI expansion slots 1-9
5. Dedicated iLO connector
6. FlexibleLOM ports 1-4
7. USB connectors (4)

NOTE: Port configuration is dependent on the

RS-232 used for security scanners, PDAs, “PTZ”

Recognition Systems, Inc. (MODEL HK-2)
Hand IR-based scanner for gate / door security access.

Palm PDA’s, Franklin PDA, etc.

RS-232 used for keyboards and tape punches

KAYPRO 2/83 AND KAYPRO 4/83 KEYBOARD CONNECTOR (J3)

TxD	4	2	RxD
GND	3	1	+5V

Section 16-6 of KAYPRO Technical Manual

(300 baud)

NUMERIDEX LC6000 Paper Tape Reader & Punch

Facit N-4000 is another example of RS-232 based paper tape reader/puncher.

Other Uses for RS-232

RS-232 to DMX Converters:

- For repeatable stage productions
- Light movement, color wheels
- Animatronics (puppets)
- Stunt shows / pyrotechnics

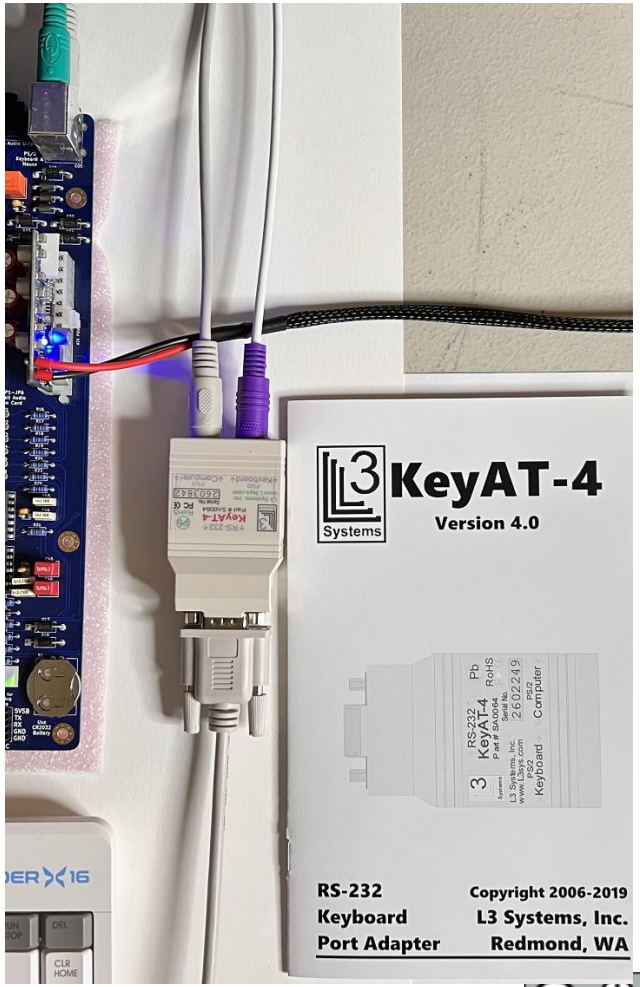
```
Issue commands in regular ASCII.
Examples:

B115200[cr]
G37-126@127:76[cr]
G1@255,3@127,12@10,27@255:24[cr]
WR1,4,7,10,13,16,19[cr]
```

Other Uses for RS-232

The L3 KeyAT-4
RS-232 Keyboard Port Adapter

Send codes across a serial connection in plain-text ASCII, then this device converts those into keyboard scan codes appropriate for PS/2 keyboard connections.

Mainly used to automate testing. I am also using this to conduct automated software demonstrations for the Commander X16.



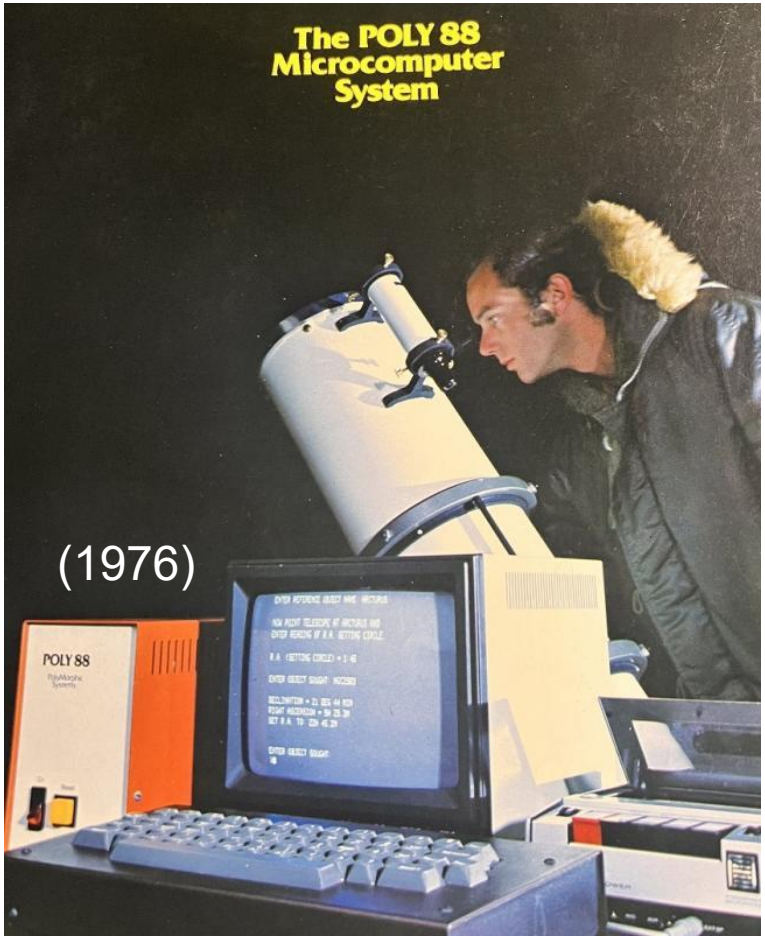
Other Uses for RS-232

- Telescope control (mounts)
  - Meade LX200 commands
  - Celestron NexStar commands

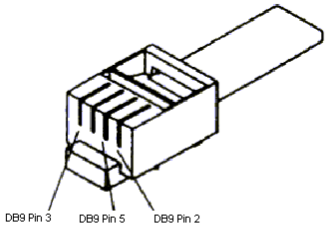
  See Stellarium @ github

- Raw Data exchange
  - X-MODEM (1977, Ward C.)
  - KERMIT (1981)
  - Y-MODEM (1985)
  - Z-MODEM (1986)
  - Bi-Modem (1989) → HS/Link
  - InterLink / LapLink
  - File Maven / DDLINK

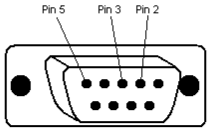
  We'll come back to these…



RS-232 used for telescope tracking control



NexStar End of Control Cable
(connects to bottom of NexStar hand control))



DB-9 End of Control Cable
(connects to serial port on the computer)

The "HC" (hand control) port is 9600 baud and no CTS/RTS.
The AUX port is 19200 baud and uses CTS/RTS pins.

NexStar Communication Protocol

This document describes the serial commands supported by the Celestron NexStar hand control. This information applies to the NexStar GPS, NexStar GPS-SA, NexStar iSeries, NexStar SE Series, NexStar GT, CPC, SLT, Advanced-GT, and CGE mounts.

Communication to the hand control is 9600 bits/sec, no parity and one stop bit via the RS-232 port on the base of the hand control.

Command Function	PC Command	Hand Control Response
Get RA/DEC	"E"	"34AB,12CE#"
Get precise RA/DEC	"e"	"34AB0500,12CE0500#"
Get AZM-ALT	"Z"	"12AB,4000#"
Get precise AZM-ALT	"z"	"12AB0500,40000500#"

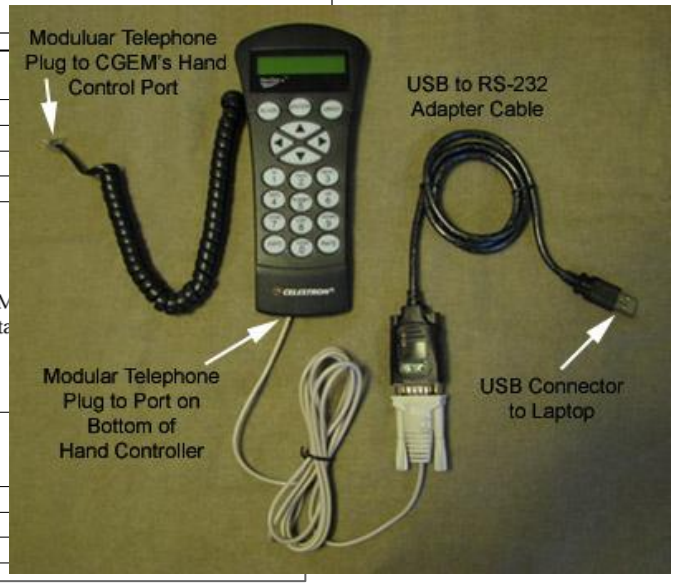
GOTO Commands

The following commands direct the telescope to GOTO a specified RA/DEC or AZM
Position commands, the values are in hexadecimal and represent the fraction of a rota

Note: GOTO RA/DEC commands will not work unless the telescope is aligned.

Command Function	PC Command	Hand Control Response
GOTO RA/DEC	"R34AB,12CE"	"#"
GOTO precise RA/DEC	"r34AB0500,12CE0500"	"#"
GOTO AZM-ALT	"B12AB,4000"	"#"

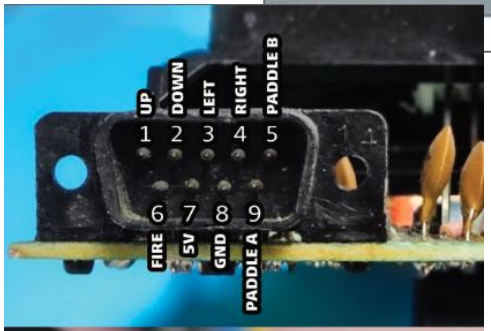
(~1999)

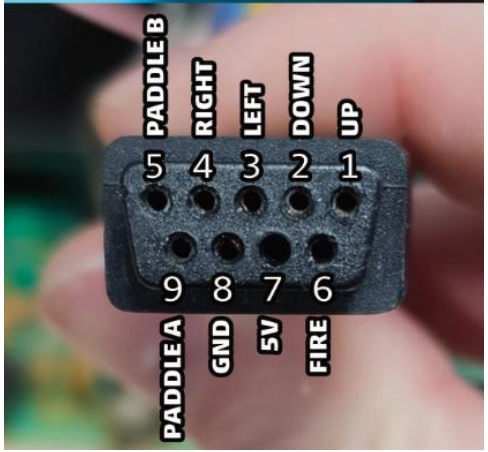


https://www.nexstarsite.com/PCControl/ProgrammingNexStar.htm

Atari

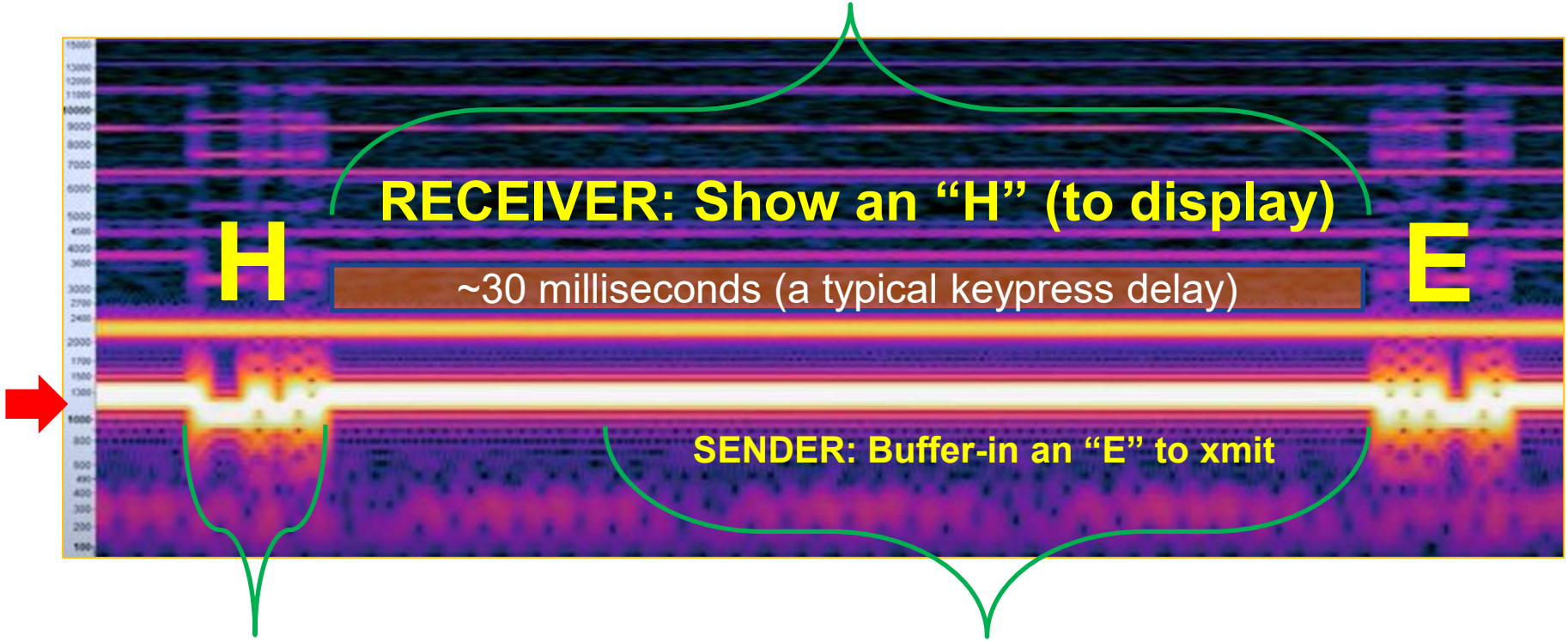
9-pin Joystick Ports are (typically) not RS-232





NOTE: The famous KoalaPad generally used joystick ports, although the KoalaPad manual claims there was an RS-232 version.

The receiver must extract the buffered data from the UART (into RAM), and decide what to do with it (send to display, send to file system, etc.)



300 bits per second
(inc. start, stop, parity)

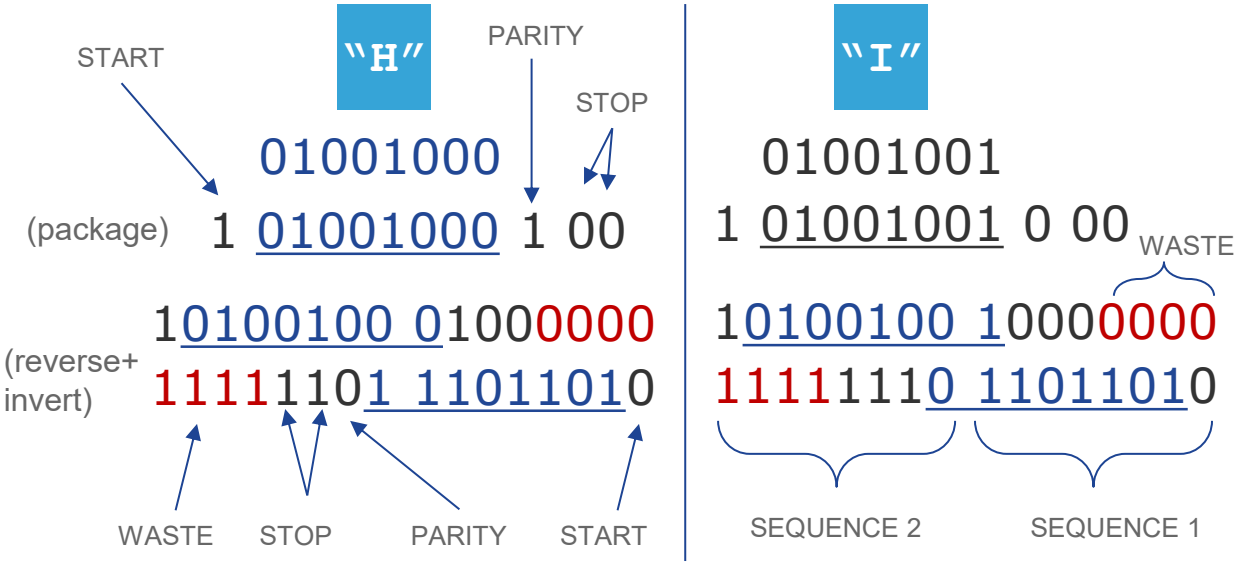
The sender must decide what to send (wait for keyboard, or get the next file from a buffer, transferred from RAM over to the UART)

Why do we need a UART?

- **Handles adding START/STOP bit (or removing them on Rx)** [framing]
- **Handles pacing of the individual bits (so CPU can do other stuff)**
- **Helps data-exchange between fast/slow (old / new) systems**
  - Sometimes a system is relatively “so slow” it can’t even toggle CTS before the FIFO becomes full
  - This is why in some configurations you dial the FIFO down to under 16 bytes (14, 8, etc.)
- **Especially as multi-tasking operating systems become more widely used**
  - Even if a system is normally very fast and responsive, things like ANSI parsing or background tasking eat up data-receive time.
  - The UART buffer is “extra storage” in case some unexpected stall happens, and UART conventions help standardize that behavior
  - The scrolling of the terminal screen in one such pop-up task. When testing “no flow control” scenarios, be sure to also test across screen-scrolling events.

UART vs. (assisted) “Bit Banging”

“Bit Banging” is having the CPU do the work of converting a byte into a transmittable bit stream, by “banging” the bit-sequence onto a pin.



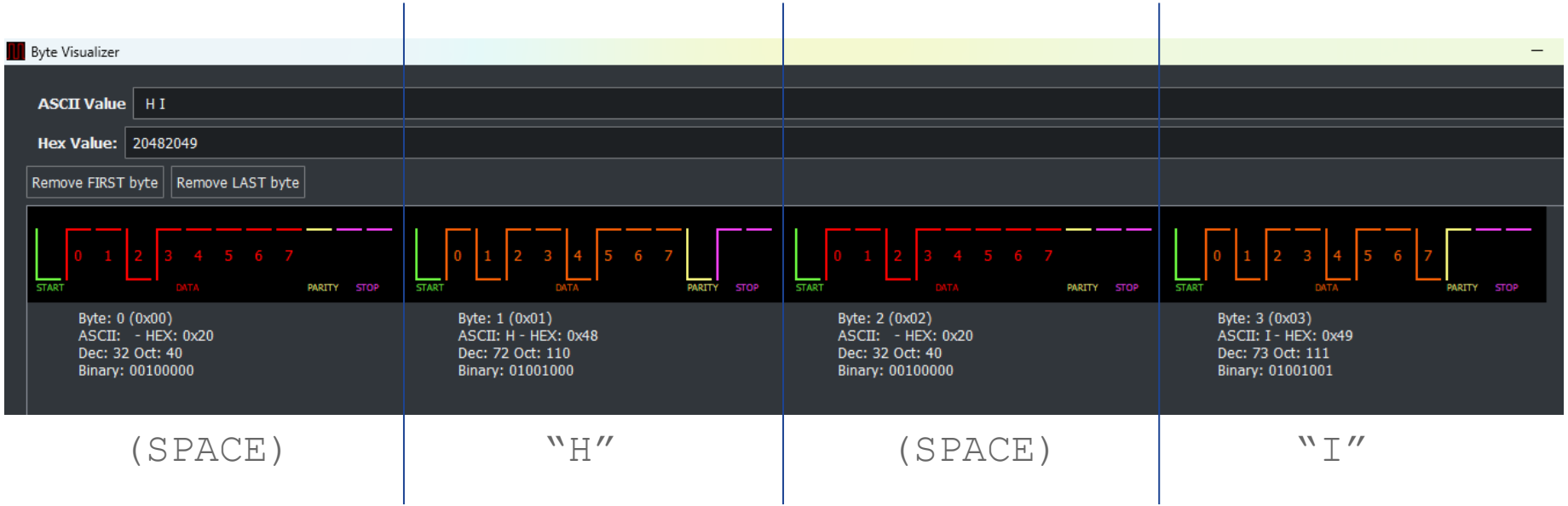
“ flip it and reverse it. ti esrever dna ti pilf ”
– Missy Elliott, 2002

The host CPU needs full attention (no interrupts) and must “bit twiddle” (shift and bit-set/clear operations) the sequence using local RAM.

Dedicated “shift-register” IC’s help some of this work, by sequencing a given byte into bit-sequence. The **VIA / PIA** used in early **Tandy** or **Commodore** systems is like this. [“assisted-bit-banging” ?]

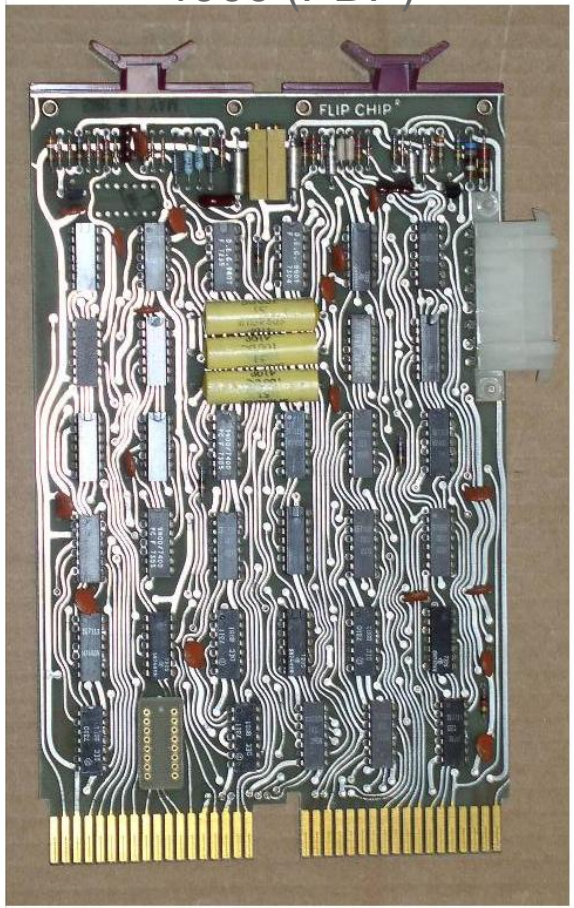
But **UARTS** do all of this, and have features like buffers, flow control, and baud-generators.

Visualizing Serial Signal using the "Byte Visualizer" feature in **SerialTool** software



Neat tool to visualize serial signaling. Remember, START/STOP is a convention inherited from the teleprinter days (and good for BBS's since people type at different speeds).

~1966 (PDP)

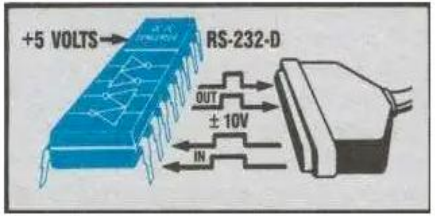


~1971

~1988 (16550, 16x FIFO)

1981 (ISA, 1x FIFO)

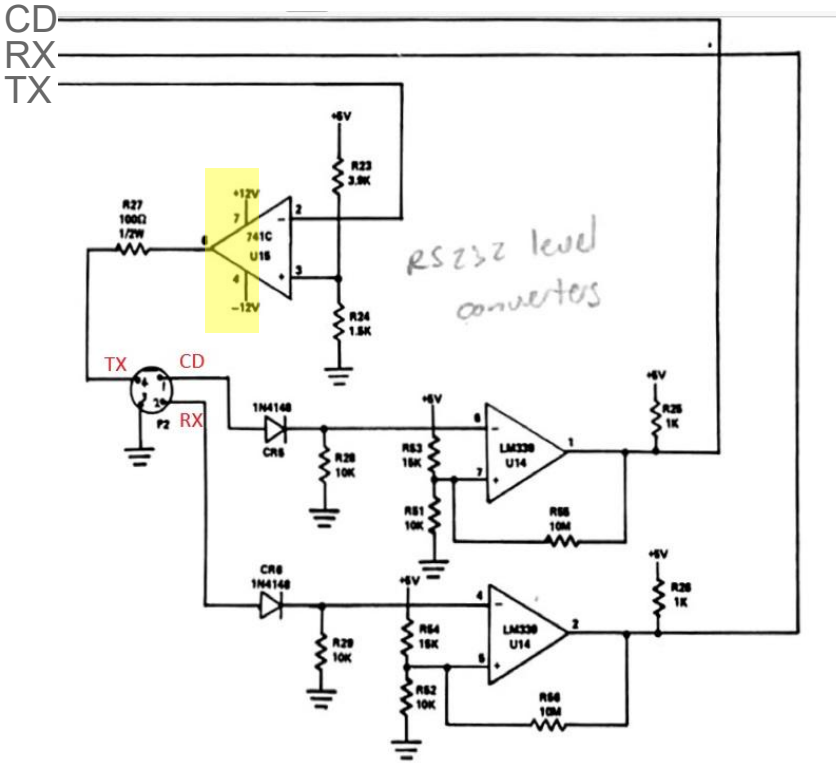
MAX232 IC



The June 23, 1988 issue of *EDN* included a Maxim Design News insert where we asked "Who in their right mind would choose a computer interface standard that uses ±12V supplies, requires expensive connectors, works over a limited distance, is error prone, difficult to network, and has no current loop isolation?" Yet, here we are 28 years later and the classic interface lives on, particularly in industrial applications and applications that need to connect just one peripheral to a host computer.

The SN75188/SN75189 are essentially the Texas Instrument version of the Maxim Integrated Products MAX232.

Tandy Color Computer partial schematic (1980)

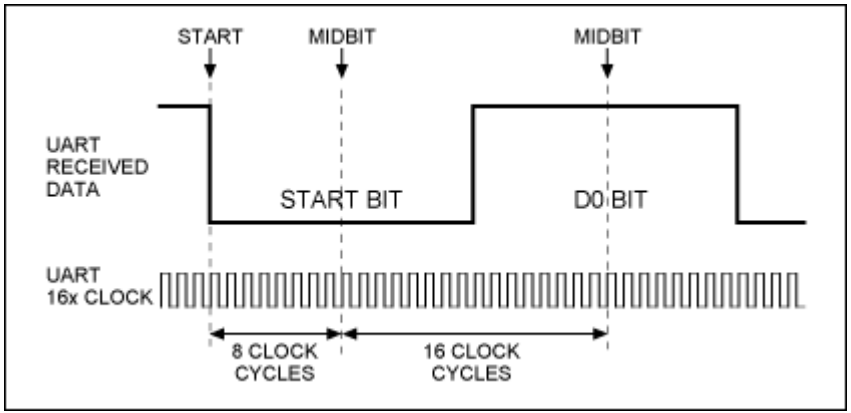


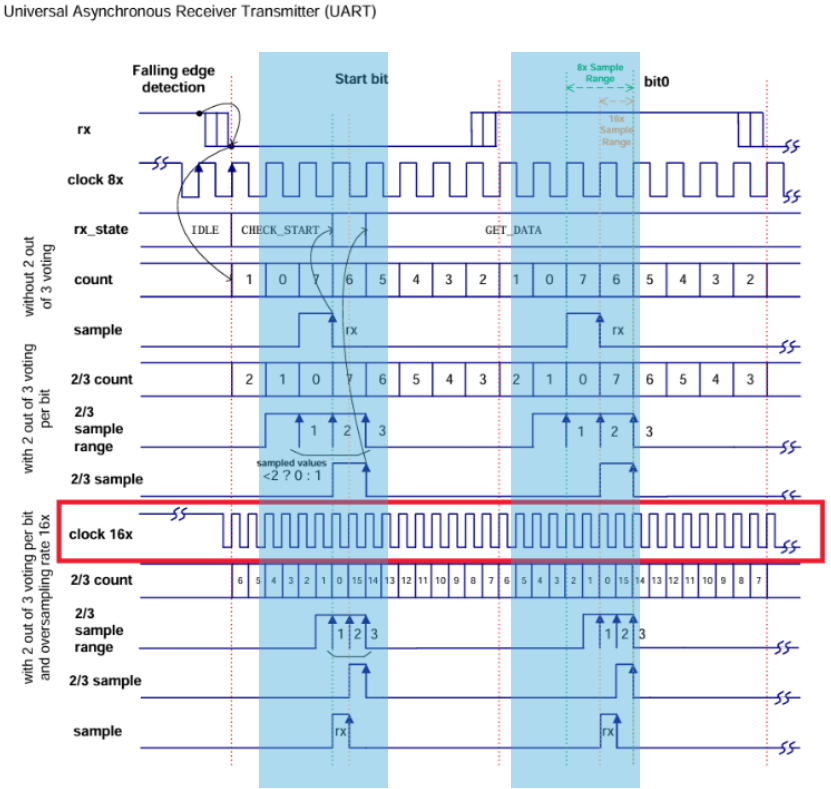
"RS-232 level shifters"

Overview on Parsing Receive Bits

UARTS typically sample 16x faster than their corresponding clock (some 8x / 32x)

Using a general-purpose CPU in this way is typically not practical (due to interrupts).



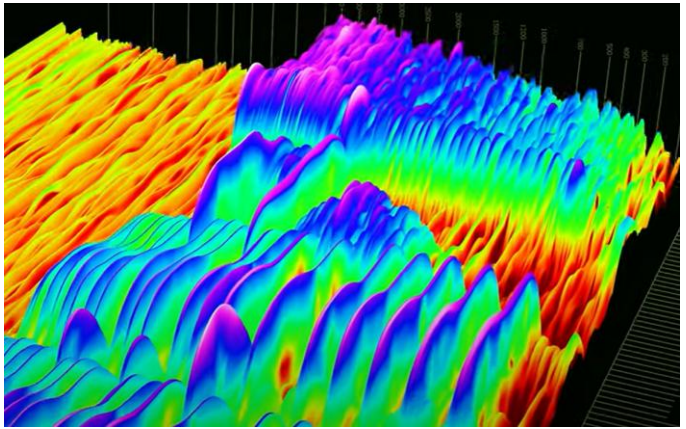


Modems Going Beyond 300 Baud

BAUD	STANDARD	YEAR	NOTES
300	V.21 / V.23	1964	FSK
1200	V.22	1980	DPSK
2400	V.22bis	1984	QAM / DPSK [600 baud]
9600	V.32	1988	TCM [2400 baud]
14,400	V.32bis	1991	(dynamic speed)
28,800	V.34	1994	(v.fast)
33,600	V.34(bis)	1996	(update)
	V.42 (data compression, LAPM)		
56Kbps	V.90	1998	(**v.last**, 33.6K up)
	V.92	2000	(48Kbps up)

- bis **(latin for "twice")**

Pennywhistle Modem 1973



Two Stages of Communication

“bus speed”

“RS-232 speed”

“line speed”

POTS
904-463-5057
817-567-2385

Serial I/O
(hardware assisted parallel byte
to serial assistance, and vice versa)

MODEM
Modulate the signal
(into audible range)

Two Stages of Communication

RS-232 “**null-modem**” cable
RX / TX swapped
CTS / RTS swapped

“bus speed”

“bus speed”

Serial I/O
(hardware assisted parallel byte
to serial assistance, and vice versa)

Going Past 460Kbps w/ RS-232C [maybe, but… $$$]

Thunderlinx™ USB 3 to Serial Adapter

- Model: THX-1000
- **In Stock**

$65.00

Add to Cart: 1

ADD TO CART

Coolgear 2 PORT USB to Serial RS-232 DB-9 Adapter Industrial Metal Housing [$61.77]

Gearmo USB 2 Port Serial RS232 featuring FTDI Chipset with LED Indicators

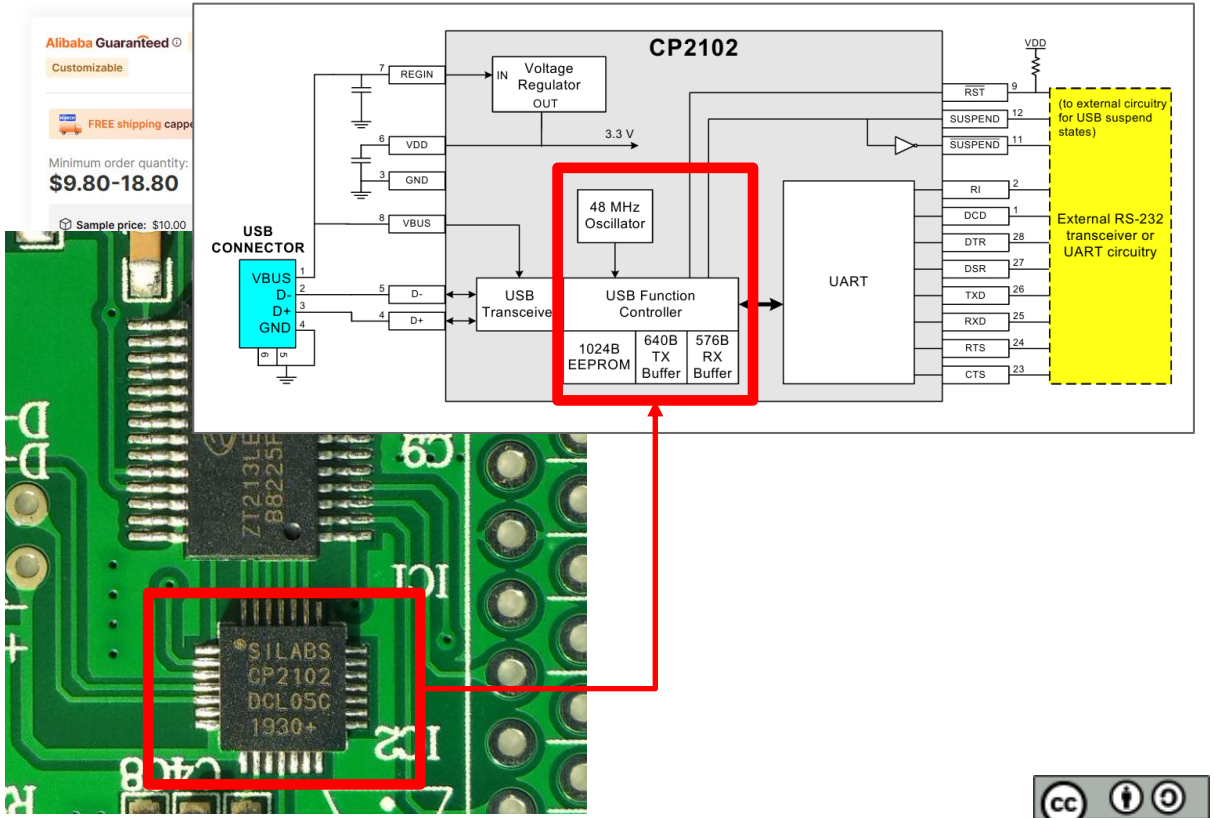
$60.95

Additional Features

- Easy Plug and Play installation
- USB interface: standard Type A female
- Automatic handshake support
- Baud rates up to 921.600bps
- No power supply needed
- Dual 16 Byte hardware data buffer (up/down stream)
- Cable Length: 6 feet
- Windows 11 supported

Going Past 460Kbps w/ RS-232C

This is a null-modem cable!



USB-Serial “bridge” adapters and WiModem232 WiFi-modem

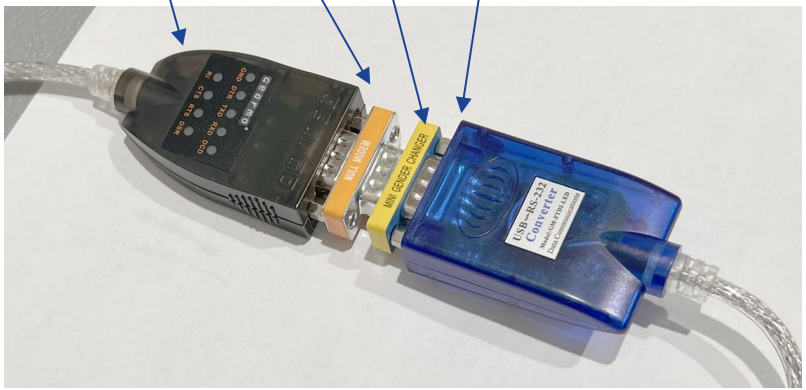
CBMStuff.com
Pro: AT*CABLE 0
else: AT*NULLMODEM 0
“CONNECTED”

USB serial adapter

null-modem adapter

gender changer

USB serial adapter



My RS-232 Experiments

(WiFi Modem's initially available around 2014)

NULL-MODEM SERIAL CABLE	UART (clock/FIFO)	TARGET	throughput KB/s	PROTOCOL
IBM PC 5150 (4.77Mz)	1.8/1	i7 3GHz	0.9	Zmodem/9600
COMPAQ SLT286 (12MHz)	1.8/1	i7 3GHz	2.3	Zmodem/57.6K
PCChips 386DX-33	1.8/16	i7 3GHz	5.6	Zmodem/115.2Kbps
Toshiba T1960CT 486 (50MHz)	1.8/16	i7 3GHz	11.3	Zmodem/115.2Kbps
ThinkPad 385CD (150Mz)	1.8/16	i7 3GHz	11.1	Zmodem/115.2Kbps
PCChips 386DX-33	1.8/16	386DX-20	12.5	FILE MAVEN (7-pin)
PCChips 386DX-33 (w/ SuperIO)	7.3/16	i7 3GHz	15.2	Zmodem/460Kbps
HP EliteBook (i5 3GHz)	*48/128 (USB-bridge)*	i7 3GHz	18.9	Ymodem/460Kbps
DELL Precision M60 (1.7GHz)	855 Chipset	M60 1.7GHz	20.7	FILE MAVEN (7-pin)
ThinkPad 385CD (150Mz) [TX-only]	socket PCMCIA	i7 3GHz	43.6	Zmodem/460Kbps
HP EliteBook (i5 3GHz)	*48/128 (USB-bridge)*	i7 3GHz	44.9	Zmodem/460Kbps
HP EliteBook (i5 3GHz)	*48/576 (USB-bridge)*	i7 3GHz	66.9	Zmodem/921Kbps
ThinkPad 385CD (150Mz) [TX-only]	socket PCMCIA	i7 3GHz	84.7	Zmodem/921Kbps
P3 600MHz [TX-only]	socket PCMCIA	i7 3GHz	89.0	Zmodem/921Kbps
PARALLEL PORT (LPT) SPEEDS				
(SD-card via Parallel Port)		386DX-20	19.5	SDLPT
PCChips 386DX-33		SLT286-12	21.5	LAPLINK5
PCChips 386DX-33		TP-P150	22.2	LAPLINK5 (OS/2)
PCChips 386DX-33		386DX-20	24.6	FILE MAVEN
PCChips 386DX-33		386DX-20	29.0	LAPLINK/INTERLINK
ThinkPad 385CD (P1 150MHz)		P3 600MHz	+64.0	LAPLINK/INTERLINK
Solo P3-500 MHz		P3 600MHz	107.0	FILE MAVEN

TEST FILE USED WAS SINGLE 3MB DATA FILE INCLUDED WITH TYRIAN OR JUNGLE STRIKE

conex 7.5 used as Ymodem/Zmodem terminal, ZOC used on 64-bit Wintel systems

"i7 3GHz" == DELL XPS 9530 laptop "TP-P150" == ThinkPad Pentium 150MHz

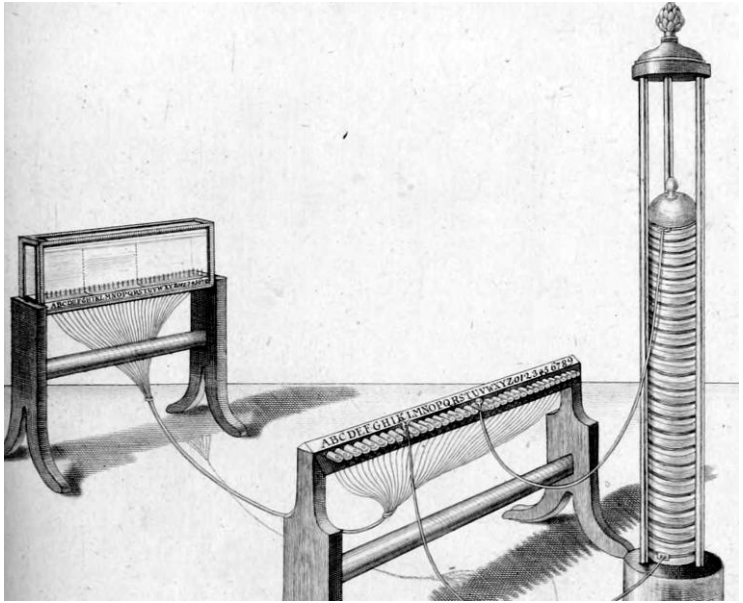
WiModem232 Wireless WiFi		TARGET	throughput KB/s	PROTOCOL
i5 3GHz	WiModem232	i7 3GHz	3.6	Zmodem/38400
i5 3GHz	WiModem232	i7 3GHz	0.4	Zmodem/57600 (errors)
i5 3GHz	WiModem232	i7 3GHz	1.9	Ymodem/57600
i5 3GHz	WiModem232	i7 3GHz	2.8	Ymodem/115200
i5 3GHz	WiModem232	i7 3GHz	3.7	Ymodem/230400
i5 3GHz	WiModem232	i7 3GHz	5.0	Ymodem/460800
WiModem232 Pro Feature				
Wireless ("null-modem mode")				
i5 3GHz	WiModem232	i7 3GHz	6.7	Ymodem/115.2Kbps
i5 3GHz	WiModem232	i7 3GHz	10.6	Ymodem/230Kbps
i5 3GHz	WiModem232	i7 3GHz	13.0	Ymodem/460Kbps
i5 3GHz	WiModem232	i7 3GHz	3.0	Zmodem/460Kbps (errors)

OTHER OPTIONS FOR COMPARISON (approximately KB/s @ ~90%)		
Gigabit Ethernet (1998)	110,000	(1000Mbps)
USB 2.0 (2000)	50,000	(480Mbps)
Wireless-AC (2014)	25000	(200Mbps original)
Wireless-N (2009)	13500	(150Mbps original)
Fast Ethernet (1995)	11000	(100Mbps)
Wireless-G (2003)	6000	(54Mbps)
USB 1.1 Full-Speed (1998)	1500	(12Mbps)
802.11b Wireless (1999)	1000	(11Mbps)
USB 1.1 Low-Speed (1998)	180	(1.5Mbps)

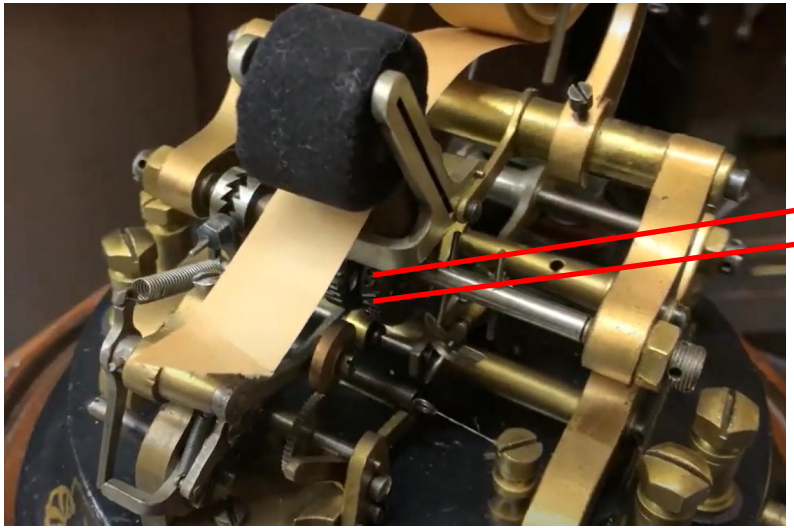
WiModems typically use an ESP8266 or ESP32, These adapt classic RS-232C voltage swing over to a TCP/IP socket. The microcontroller handles the WPA2 encryption.

Thank You !

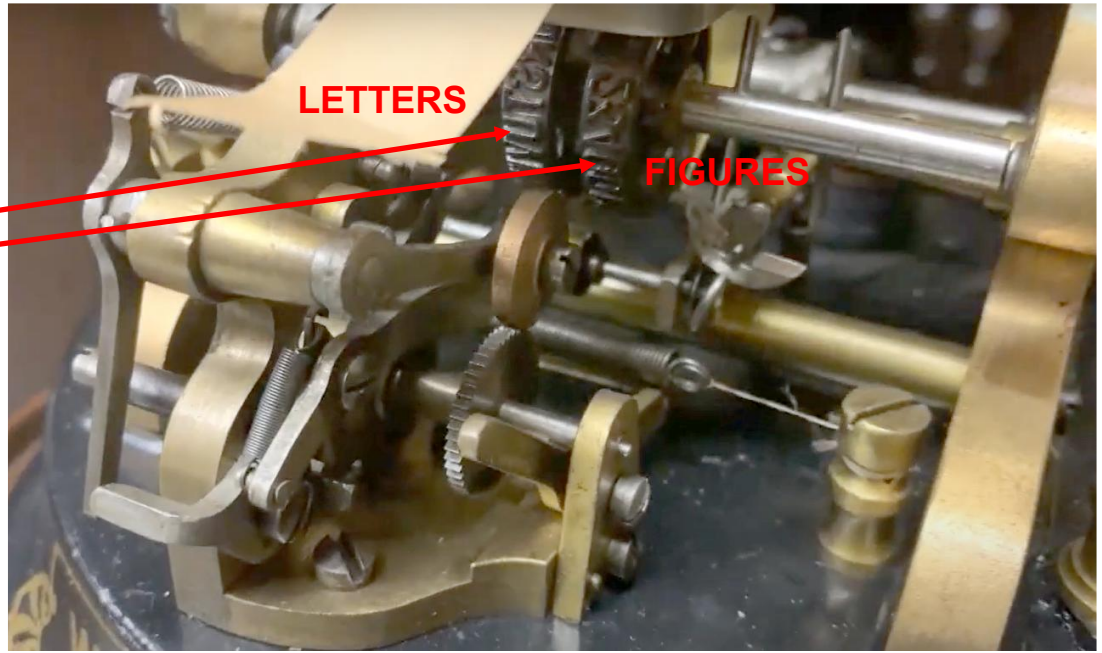
EXTRA



Edison “Universal Stock Printer” c. 1871



Improvement to Edward Calahan original stock ticker from 1867.



Edison’s main contribution was a “Unison Stop” that kept all receivers in sync automatically. He also used “difference encoding.”

Edison Ticker Tape Machine

1 CPS!

LETTERS

RG.I..PR.....A.AJ.....SS.I.....ST.....SF.I.I..PR....
..... 200.8 1/2.....66.92 3/4.....20.99....16 5/8.....76.

FIGURES

GU.....KM.....APR.....U.....SF.....I.I..PR....@.....
...45 3/4.... 35 3/4@6.....97 1/8...100 3/4...64 1/2.....76...4$.14.96 1/8

1883

LETTERS FIGURES

1886: First Ticker Parade, Statue of Liberty

Current Loop vs. Voltage Swing

Telegraphs, Teleprinters and Teletypes used “current loop” to convey signal [60 mA to 20 mA]. Deemed necessary for long distances, and could drive mechanical components (wheels, bell, valves)

After the introduction of the transistor (c. 1947), there began a migration of using “voltage swing” to reliably convey on / off state.

There wasn’t yet any notion of “5V” or “3.3V” standards in electronics. 74’XX series TTL introduced by TI in 1966.

Current-loop 4-20 mA lives on the form of modern-day HART devices (pressure and temperature sensors for hazardous industrial devices; claim to be more “noise resistant” and support >1000m range, but still only 1200 baud!)

Current Loop vs. Voltage Swing

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The IBM PC 8-bit ISA serial card from 1981 has settings to still support for current loop (“shunt module”).

IBM PC Serial Card

Selecting The Interface Format

The Voltage or Current loop interface is selected by plugging the programmed shunt module, with the locator dot up or down. See the figure below for the two configurations.

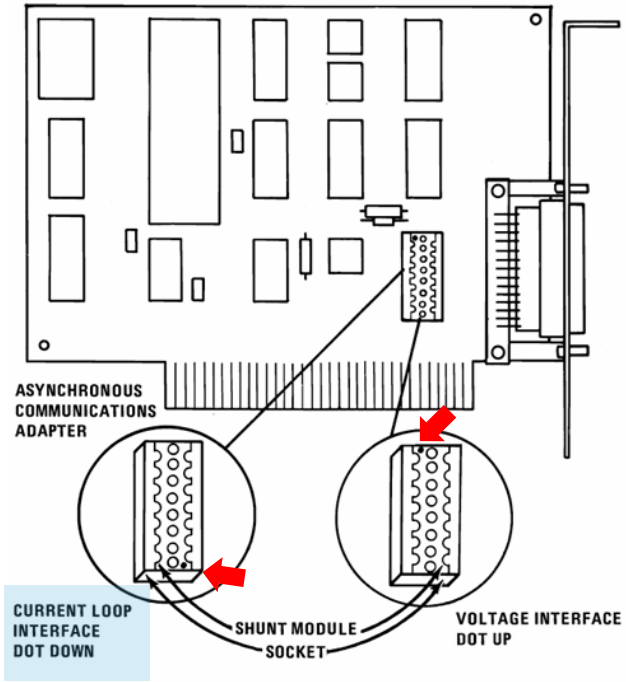

Figure 23. SELECTING THE INTERFACE FORMAT

Current Loop vs. Voltage Swing

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IBM PC Serial Card

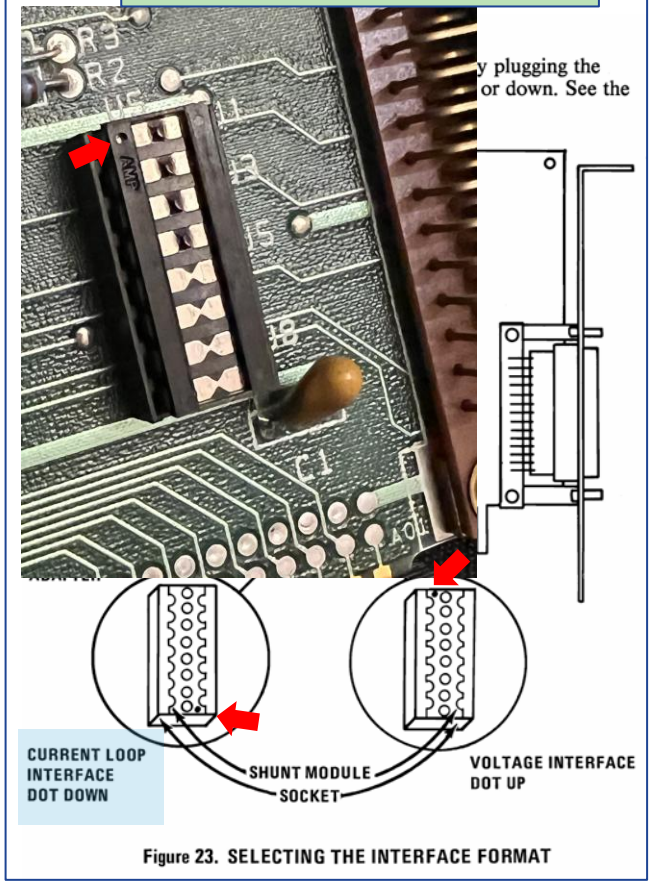
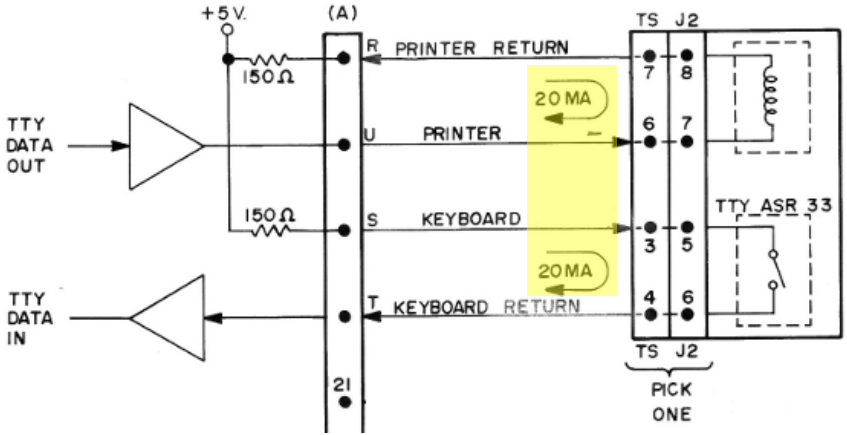


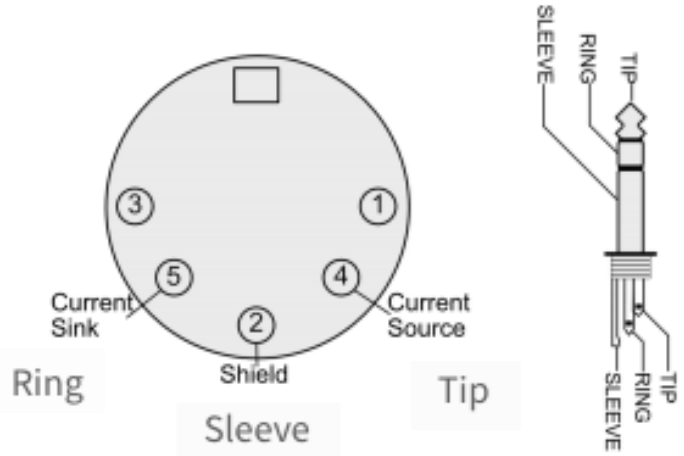
Figure 23. SELECTING THE INTERFACE FORMAT

Other Current Loop Examples

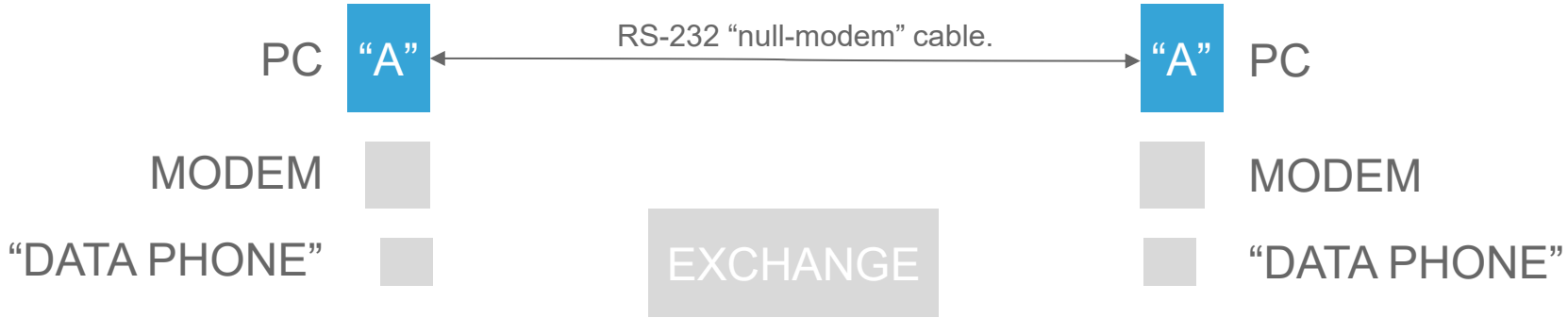
The Commodore **KIM-1** (1976) also had current loop!
(found also on the POLY-88 Bitstream II S-100 card)



Current-loop is also still used in MIDI (c. 1983).
5mA and operates at 31,250 baud
(no flow control)



RS-232 used for direct-data exchange



A UART helps find the start-bit (by being clocked faster)
A device might become “slower” just due to some background “pop-up” task.
One such common pop-up task is **scrolling the screen** when using a CRT.
A slow “dumb terminal” could benefit from a UART when connected to a high-speed server.
Especially if that “dumb terminal” has to **interpret multiple sequences into actions** (VT-52).

Why do we need a UART?

A little math…

Average length of English words.

Operator measured performance

$$\frac{75\ \cancel{words}}{60\ second} x \frac{4.7\ characters}{1\ \cancel{word}} = 5.875\ characters\ per\ second$$

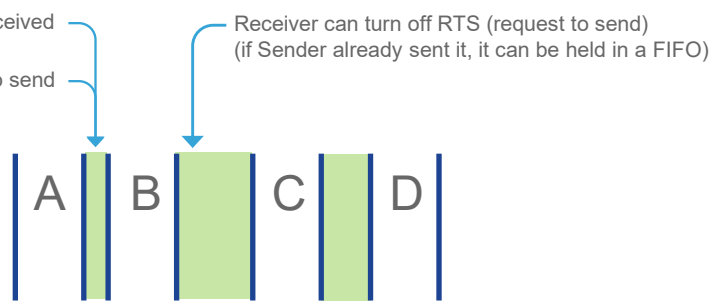
1 start bit + 5 data bits + 2 stop bits = 8 bits per character

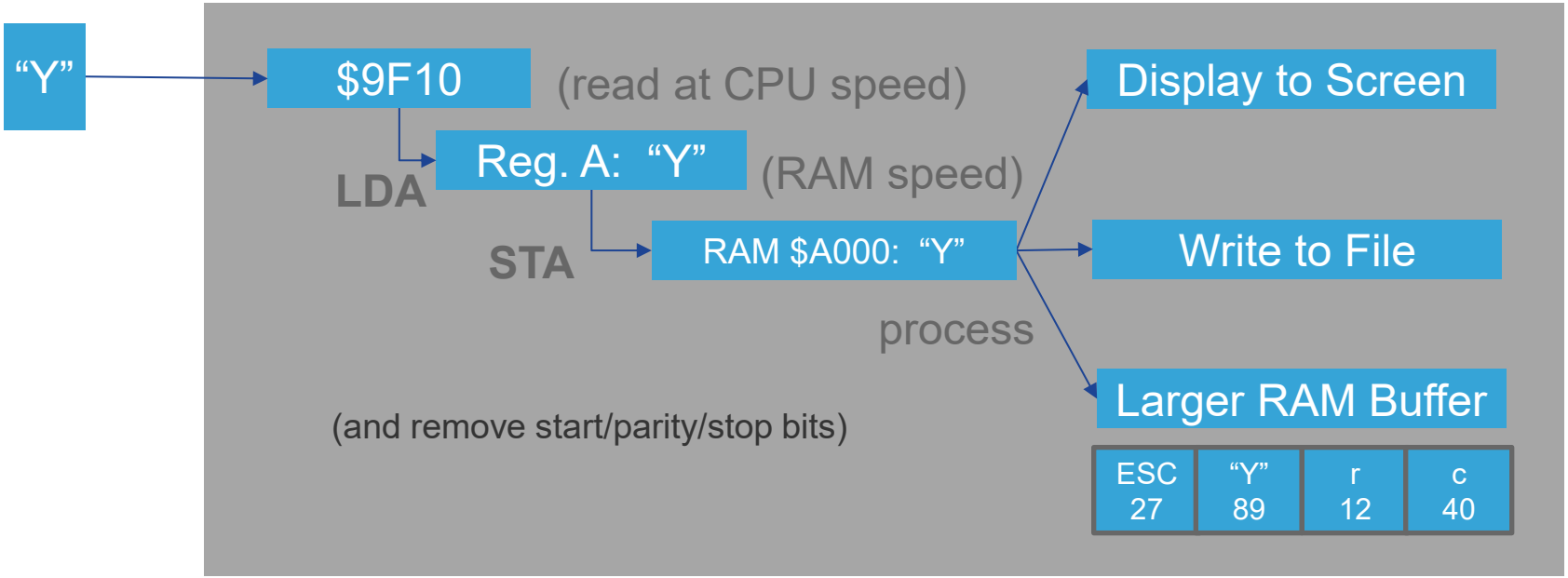
$$\frac{5.875\ \cancel{character}}{1\ second} x \frac{8\ bits}{1\ \cancel{character}} = 47\ bits\ per\ second$$ (baud)

110 baud would be ~175 WPM
300 baud would be ~478 WPM

Human handwriting is between 5 and 20 WPM.
Most people converse (speak) at around 150 WPM.
Most people can read at about 238 WPM.

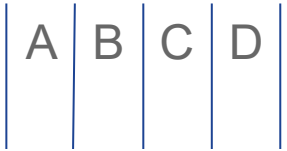
No-UART / No-FIFO Scenario





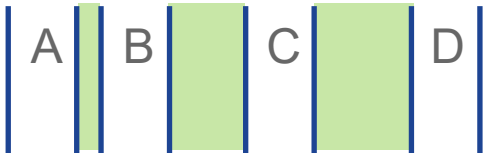
Synchronous, Asynchronous, Isochronous

Synchronous: Fixed time duration between the data, no need for overhead of start/stop bits.



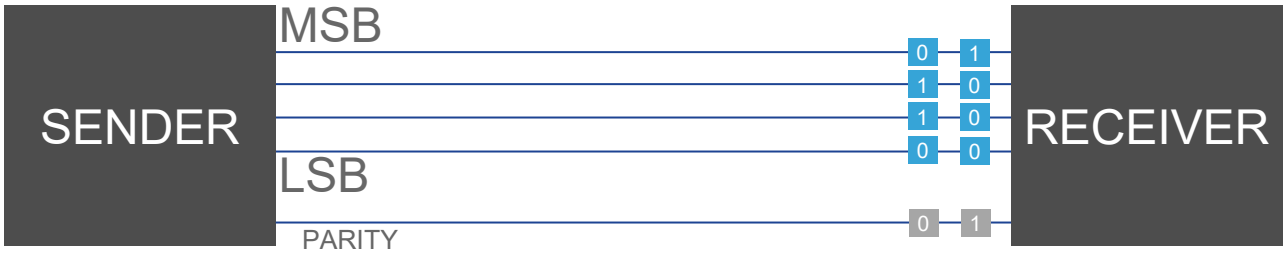
Works well for ‘burst’ data exchange and short distances.

Asynchronous: Actual data sent at an agreed rate, flanked by start/stop indicators. Variable delay between data packets.



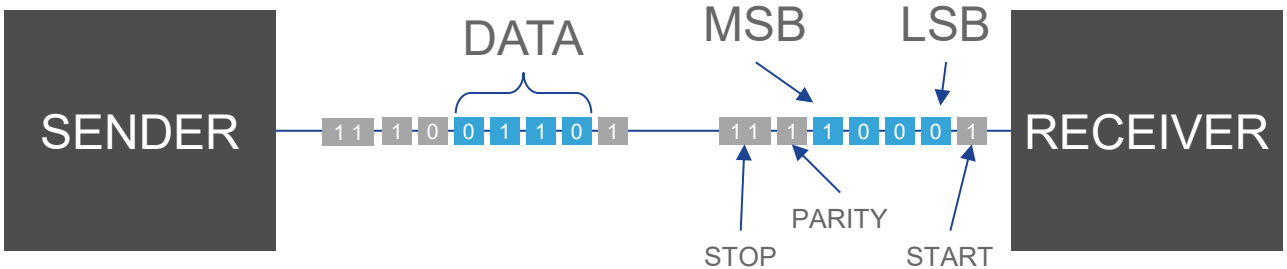
Sender or receiver can slow down as appropriate to changing operating conditions.

Parallel vs. Serial



‘skew’
Crosstalk

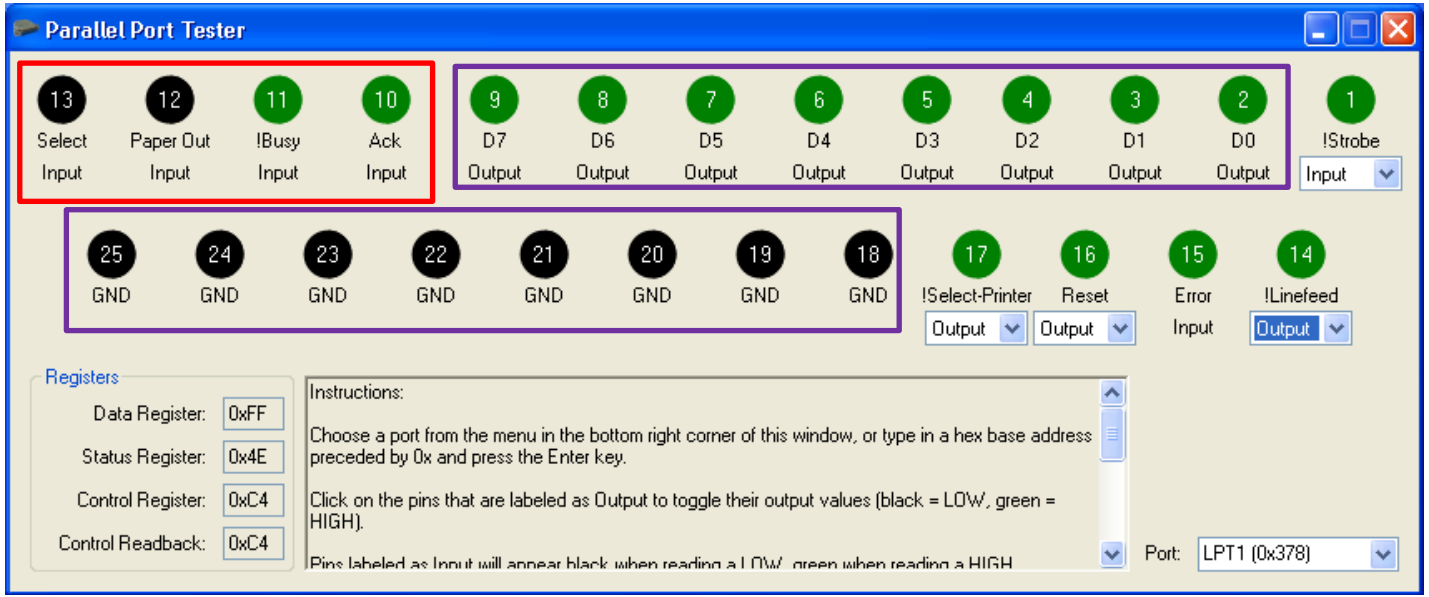
IBM5100 KBD



	PDP	TR1402		IBM PC 8250		XFACTOR	(S-100's?)	8251	XFACTOR	IBM (PS/2?) 16550		XFACTOR	X16	TI TL16C2550	XFACTOR
	MHz	0.9216	0.5	MHz	1.8432	1	MHz	3.6864	2	MHz	7.3728	4	MHz	14.7456	8
IMPROV.															
FACTOR	baud	multiplier	divisor	baud	multiplier	divisor	baud	multiplier	divisor	baud	multiplier	divisor	baud	multiplier	divisor
2.00													921600	16	1
2.00										460800	16	1	460800	32	2
2.00							230400	16	1	230400	32	2	230400	64	4
2.00				115200	16	1	115200	32	2	115200	64	4	115200	128	8
1.50	57600	16	1	57600	32	2	57600	64	4	57600	128	8	57600	256	16
1.33	38400	24	1.5	38400	48	3	38400	96	6	38400	192	12	38400	384	24
1.50	28800	32	2	28800	64	4	28800	128	8	28800	256	16	28800	512	32
1.33	19200	48	3	19200	96	6	19200	192	12	19200	384	24	19200	768	48
1.50	14400	64	4	14400	128	8	14400	256	16	14400	512	32	14400	1024	64
1.33	9600	96	6	9600	192	12	9600	384	24	9600	768	48	9600	1536	96
1.50	7200	128	8	7200	256	16	7200	512	32	7200	1024	64	7200	2048	128
1.33	4800	192	12	4800	384	24	4800	768	48	4800	1536	96	4800	3072	192
1.50	3600	256	16	3600	512	32	3600	1024	64	3600	2048	128	3600	4096	256
1.33	2400	384	24	2400	768	48	2400	1536	96	2400	3072	192	2400	6144	384
1.50	1800	512	32	1800	1024	64	1800	2048	128	1800	4096	256	1800	8192	512
1.33	1200	768	48	1200	1536	96	1200	3072	192	1200	6144	384	1200	12288	768
	50	18432	1152	50	36864	2304	50	73728	4608	50	147456	9216	50	294912	18432

(various S-100 serial boards also use ~5MHz)

Parallel limited to 4-pin input… (receive can only be 4-wire)



ParallelPort Tester for WinXP

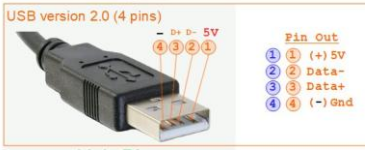
PATA → SATA → M.2 / NVM surface mount

[PATA = 18”, SATA = 40” length limited]

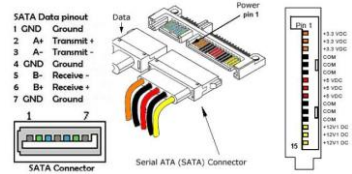
8b/10b encoding patent by IBM in 1983, later used in SATA and USB 3.0

USB 2.0 uses NRZI (non-return to zero inversion)

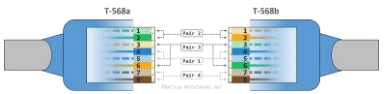
1 PAIR (USB)



2 PAIR (SATA)



4 PAIR (RJ45)



RS-232 set the standard for consumer modems

In early days of computing, the phone line wasn't always near the MODEM or COMPUTER.

Most early computers were "dumb terminals" to connect to a "real computer" (mainframe), using a modem.

Before the term Personal Computer became popular, there was the term "Smart Terminal": a device that could be **programmed** to do more than it was originally set to do. [Datapoint 2200]

COMMBAT

TRS-80
ATARI
APPLE

by Bob Schilling

Requires 2 Complete Computers

COMMBAT is a strategic and tactical battle game that will allow you (interacting through your computer) to pit your skill and dexterity against another player and their computer in a real-time battle to the death!

You and your opponent are located in a 4096-square-kilometer combat reservation with exactly the same resources available to each, the outcome to be governed only by the skills of the players. As soon as you have established serial communication with your enemy (110 to 9600 baud modem or direct connection), the battle begins! You decide which weapons to carry, then load them onto and manuever up to eight remote controlled tanks with the primary goal of finding and destroying your enemy's base before he can do the same to you. Each enemy tank that you can defeat in combat lessens his chances of finding you.

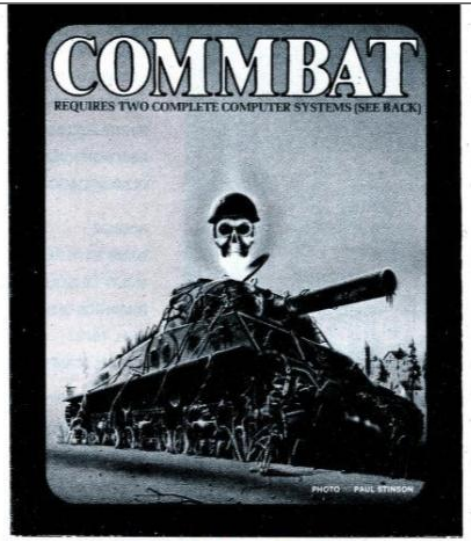
Offensive and defensive weapons available to you include: rockets, lasers, shells, mines, decoys, drone reconnasiance aircraft and one nuclear ICBM. All but the last two items may be loaded onto, carried by and fired or dropped by your tanks, up to their maximum load-carrying capacity.

Your computer displays current resource status, a map of the combat reservation updated by tank, base and decoy sensors, and handles all communication chores, freeing you to make the strategic decisions and handle the tactical battle situations that arise.

COMMBAT requires two computer systems, each with a RS-232 port and a 300 baud full duplex modem. Different types of computers may be used; for example, a TRS-80 user may play an Atari user.

TRS-80 16K TAPE Model 1 & 3	**010-0123**	**$19.95**
TRS-80 32K DISK Model 1 & 3	**012-0123**	**$20.95**
ATARI 24K DISK	**052-0123**	**$24.95**
ATARI 24K TAPE	**050-0123**	**$19.95**
APPLE 48K DISK DOS 3.3	**042-0123**	**$24.95**

Apple version Available July 1, 1982



PROGRAM PARAMETERS

LANGUAGE	Machine
NUMBER OF PLAYERS (min/max)	2/2
AVG. COMPLETION TIME	30 min. - 4 hrs.
SUGGESTED AGE GROUP	14 to Adult
RECOMMENDED FOR NOVICE?	Yes
CLASSIFICATION:	War Game
SOUND?	No
GAME SAVE FEATURE?	Yes
MULTIPLE SKILL LEVELS?	No
GRAPHICS ORIENTED?	Yes
REAL TIME?	Yes

SPECIAL EQUIPMENT: Two computers connected via the RS-232 connection with full duplex modems or LYNX[tm] modem or CONNECTION[tm] modem. Will not work with half-duplex modem. (One modem must be able to originate, the other answer.) If both computers are in same room then the two RS-232 cables may be connected with no modems or phone line required. Note: Atari doesn't support Lynx.

Performance Review…

- Experienced telegraph operators were said to be able to perform about **50 baud** by hand
- Mechanical teletypes were said to operate between **75 / 110 / 150 baud**, depending in model and year. [physical limitations]

- By mid-1960s, electronic serial communication was already reaching 9600 baud. **The Bell "Data Set 103A" manual even identifies 300 baud as "low-speed serial data" by 1967.**

1.03 Data Set 103A type was designed to simultaneously transmit and receive low-speed serial data at rates up to 300 bauds in DATA-PHONE* service over the voice message switched network, or at rates up to 150 bauds in TWX service over teletypewriter exchange type facilities.

Convergence of concepts in c. 1963

- Initial drafts of the **ASCII** standard
  - Prior: 5-bit Baudot / Murray → some 6-bit systems (DEC)
  - ASCII standardized a convention of symbols for 7-bit data
  - A “byte” as 8-bit was not formally standardized until 1993
- Initial drafts of the RS-232 standard [EIA/TIA-232-E]
  - RS-232A published in 1963
- Robert Weitbrecht introduced concept of “acoustic coupler”
  - Weitbrecht Modem (generally limited to 110-150 baud)
  - Later variants handled 300-1200 baud
- Early idea of CRC (Peterson, 1961) [reduces need for parity?]
- Early idea of a UART by Gordon Bell (to connect his PDP-1 to a teletype)

ASCII

RS-232A

ACCOUSTIC COUPLER

CRC

UART

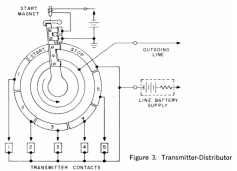


Figure 3. Transmitter-Distributor

Why do we need a UART?

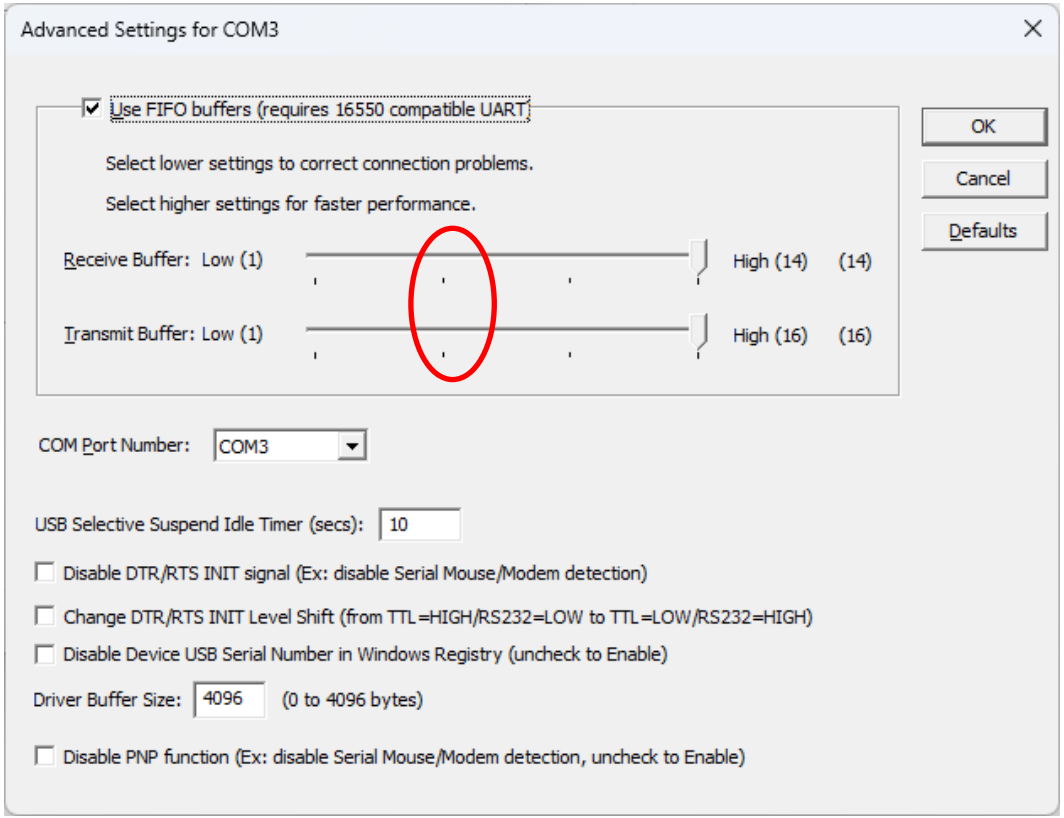
On Analog Modulation of Digital Serial Data

Similar modulation-tech concepts applied to…

- Audio tape data-storage
  - 7-track / 9-track tape storage was around since late 1950's
  - First use of AUDIO CASSETTE for data storage was around 1968 (IBM System/3)
  - Tape-data recording sounds similar to "modem noises"

- Wireless (data) communication
  - Carrier waves and compression techniques
  - AlohaNet (UHF, c. 1971) [407.350 MHz and 413.475 MHz]
  - 9600 bps @ ~60 miles (half-duplex)

COMx (Serial Port) Driver Options



When communicating with much slower or much faster systems, it may help to reduce these FIFO buffers to about half of max. capacity.

This is due to a kind of "**momentum**" where the CTS request isn't detected immediately.

Parallel Port Modem? Mid-1990's.

R

Rynthar
Distinguished

Sep 29, 2002

Oct 13, 2002 #1

Really trying to figure out which is better- Internal or External modems. It wont be a while until I get cable, so I want my final 8-12 months of 56k to be ultra fast =). Right now, I know for certain I want to buy a very good quality USR modem. Currently deciding between there external modem ($94), v90 internal faxmodem ISA ($99), or their v.92 performance pro modem. They say in the "pro" overview it has the ability to switch into gamer mode, but dont understand that. Help =)

multi-link dialup

Parallel Port Modem? Mid-1990's.

Use-case: using a slow computer (e.g. 286 or lower end 386 system) with a fast modem, while trying to run Windows 3.X. The MHz and RAM speed might not have enough "oomph" (under Windows) to reliably sustain a fast modem. A "parallel modem" would make the data exchange more efficient. Makes sense in case of a laptop that can't be upgraded (pre-PCMCIA) or is a company-owned system that can't be modified.

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