



CENTRO UNIVERSITARIO DE
AUTOMACIÓN Y ROBÓTICA



TECNICAS DIGITALES III



CENTRO UNIVERSITARIO DE
AUTOMACIÓN Y ROBÓTICA



LA INSTRUMENTACIÓN VIRTUAL

Agenda

- ¿De que hablamos cuando hablamos de instrumentación virtual?.
- ¿LabView como software de desarrollo para instrumentos virtuales.
- Librerías PyVisa para desarrollo de instrumentos virtuales.

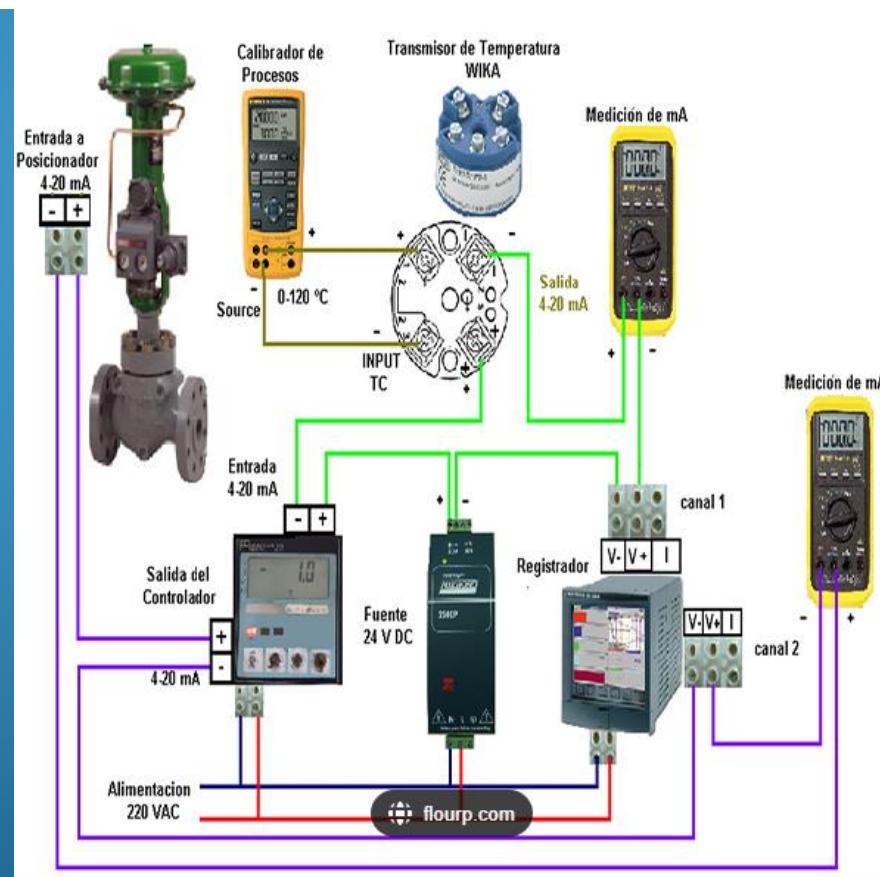
Instrumento

Un instrumento de medición es aquel que permite medir la longitud, volumen, extensión o capacidad por comparación de un elemento estandarizado el cual es tomado como referencia para posteriormente asignarle un valor numérico mediante algún instrumento graduado con dicha unidad.



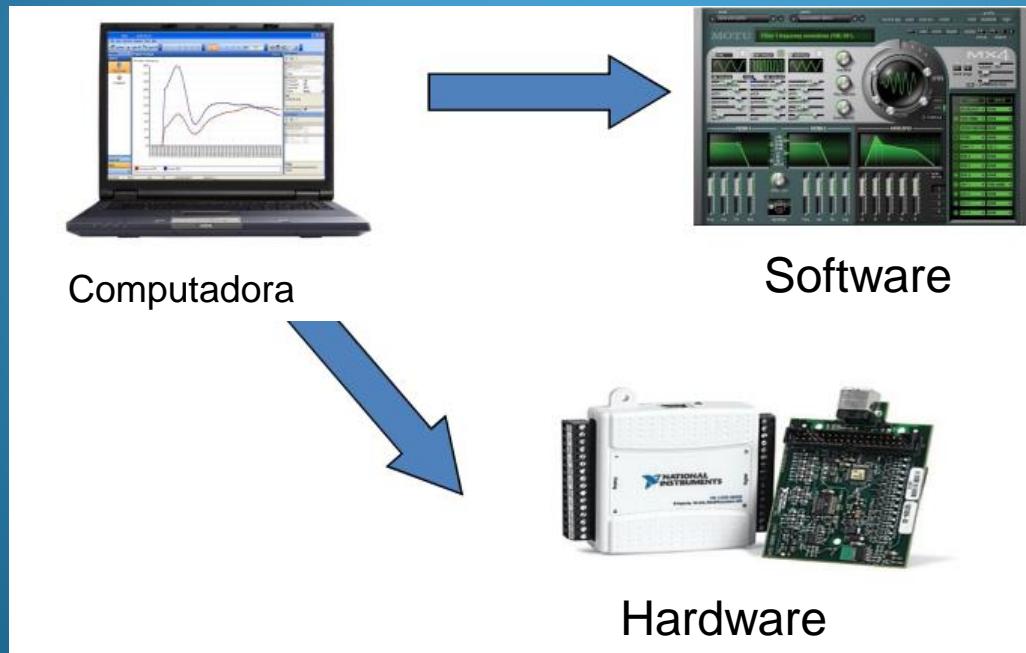
Instrumentación

Instrumentación es el proceso en el que el conjunto de varios instrumentos eléctricos/electrónicos, de medición y control interconectados para medir, analizar y controlar las magnitudes físicas eléctricas y no eléctricas.



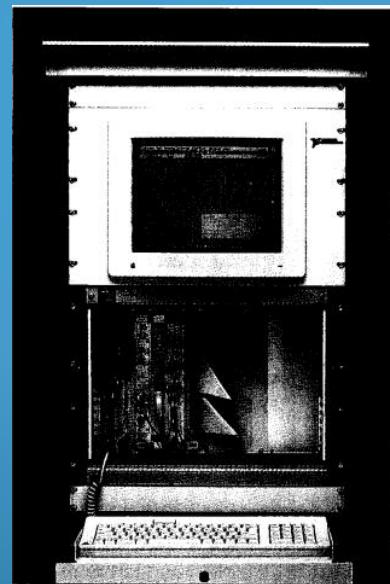
Paradigma de la instrumentación virtual

Un instrumento virtual es aquel cuya funcionalidad es determinada por software.



Historia de los instrumentos virtuales

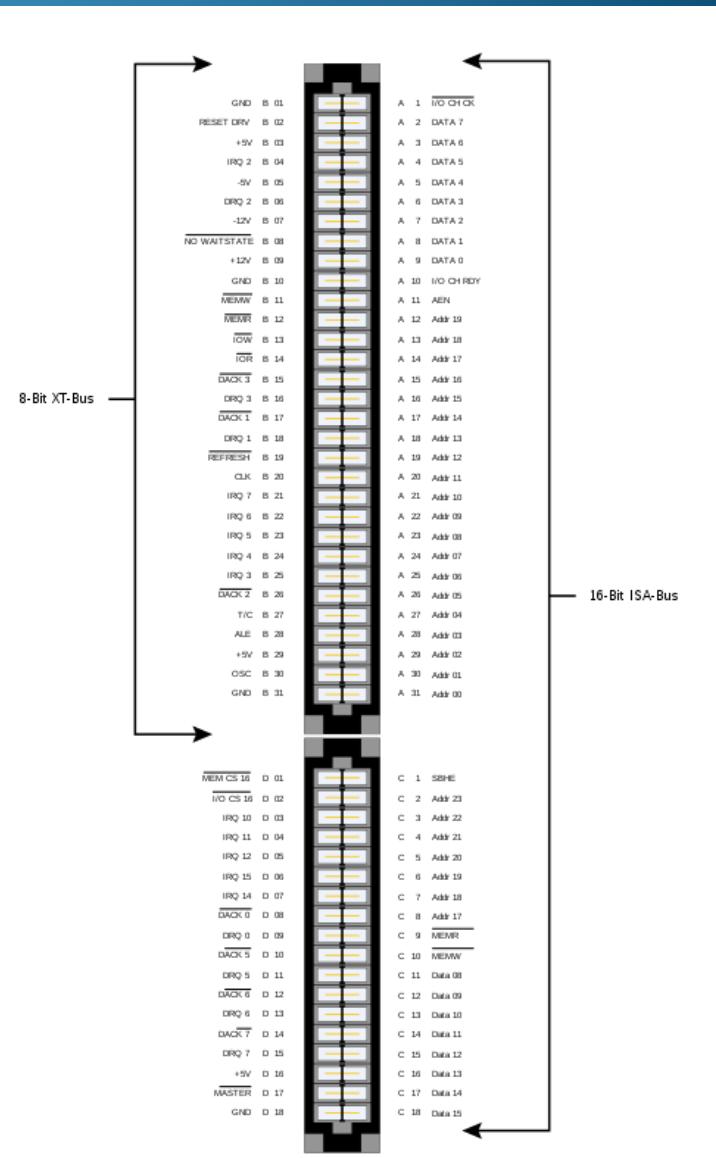
El concepto de instrumentos virtuales nace a fines de 1970, cuando la tecnología de los microprocesadores habilita a que la funcionalidad de una maquina sea fácilmente modificable por software. Hasta principios de los 80 consistían en conectar instrumentos tradicionales a la PC



M. Santori, "An instrument that isn't really", IEEE Spectrum 27(8), 36 - 39 (1990).

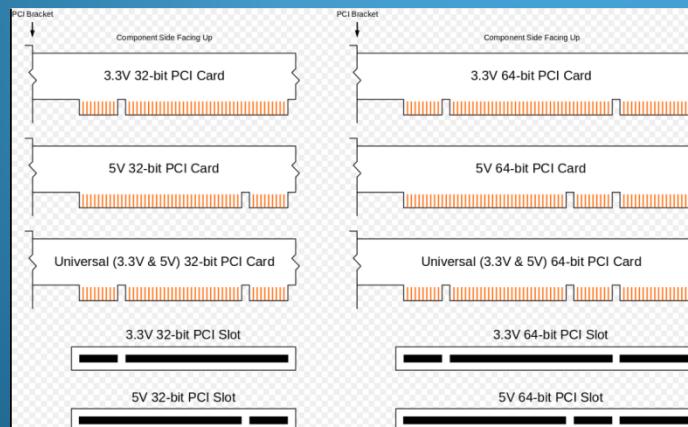
Primeros instrumentos e interfaz paralelo

BUS ISA (Industry Standard Architecture)



Interfaz paralelo

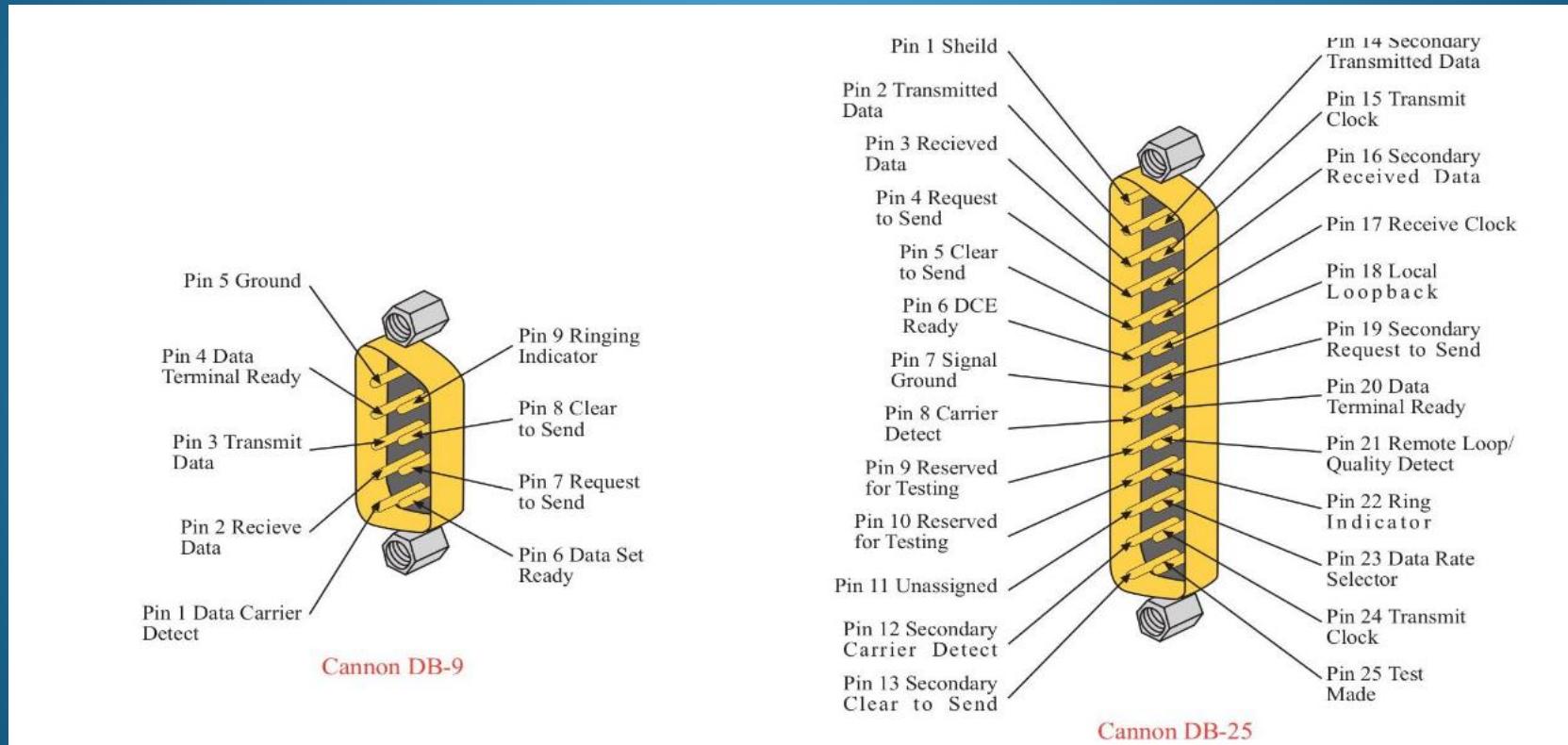
BUS PCI (Peripheral Component Interconnect)



Rear of Computer

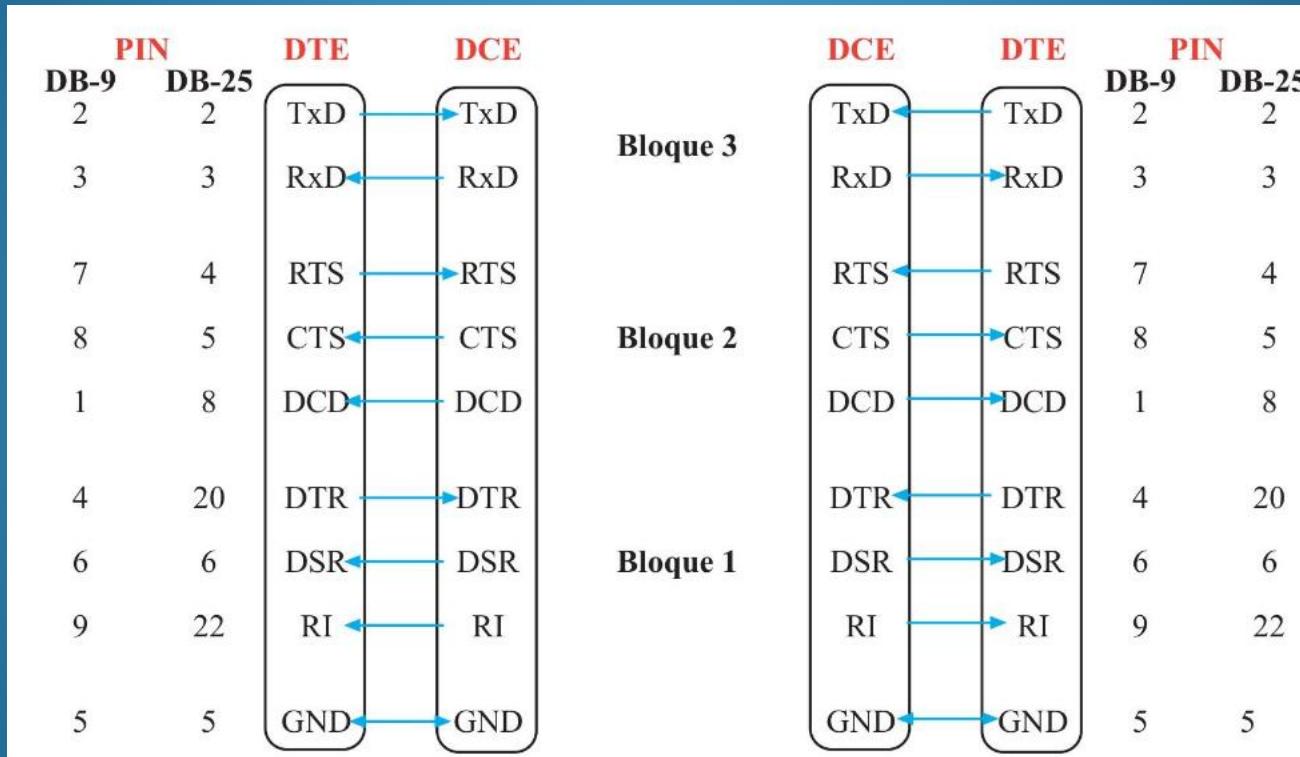
-12V	= B5	A1	= Test Mode Select
Test Data Output	= B6	M	= Test Data Input
Device ID	= B7		
Test Mode Select	= B8		
PCI	= B9		
Interrupt X	= B10	A17	= Interrupt 5
Interrupt D	= B11	A18	= Interrupt 4
Ground	= B12	A19	= Ground
Reserved	= B13	A20	= Ground
PCI/I/O	= B14	A21	= PCI/I/O
PCI/I/O	= B15	A22	= Reserved
PCI/I/O	= B16	A23	= Ground
Class	= B18	A24	= Ground
Ground	= B19	A25	= Ground
PCI/I/O	= B20	A26	= Ground
PCI/I/O	= B21	A27	= Ground
Address 21	= B22	A28	= Address 28
Address 20	= B23	A29	= Address 29
Address 21	= B24	A30	= Address 20
Address 20	= B25	A31	= Address 21
C/IRQ 1	= B26	A32	= Interrupt 1
Address 21	= B27	A33	= Address 22
Address 21	= B28	A34	= Address 26
Address 19	= B29	A35	= Ground
Address 20	= B30	A36	= Address 28
Address 19	= B31	A37	= Address 29
Address 20	= B32	A38	= Address 20
C/IRQ 2	= B33	A39	= +1.8V
Address 21	= B34	A40	= Address 21
Address 21	= B35	A41	= Address 22
Address 21	= B36	A42	= Address 26
Address 19	= B37	A43	= Ground
Address 20	= B38	A44	= Address 28
Address 19	= B39	A45	= Address 29
Address 20	= B40	A46	= Address 20
C/IRQ 3	= B41	A47	= +1.8V
Address 21	= B42	A48	= Address 21
Address 21	= B43	A49	= Address 22
Address 21	= B44	A50	= Address 26
Address 19	= B45	A51	= Ground
Address 20	= B46	A52	= Address 28
Address 19	= B47	A53	= Address 29
Address 20	= B48	A54	= Address 20
Address 19	= B49	A55	= Ground
Address 20	= B50	A56	= Address 21
Address 21	= B51	A57	= Address 22
Address 21	= B52	A58	= Address 26
Address 19	= B53	A59	= Ground
Address 20	= B54	A60	= Address 28
Address 19	= B55	A61	= Address 29
Address 20	= B56	A62	= Address 20
Address 19	= B57	A63	= Ground
Address 20	= B58	A64	= Address 21
Address 21	= B59	A65	= Address 22
Address 21	= B60	A66	= Address 26
Address 19	= B61	A67	= Ground
Address 20	= B62	A68	= Address 28
Address 19	= B63	A69	= Address 29
Address 20	= B64	A70	= Address 20
Address 19	= B65	A71	= Ground
Address 20	= B66	A72	= Address 21
Address 21	= B67	A73	= Address 22
Address 21	= B68	A74	= Address 26
Address 19	= B69	A75	= Ground
Address 20	= B70	A76	= Address 28
Address 19	= B71	A77	= Address 29
Address 20	= B72	A78	= Address 20
Address 19	= B73	A79	= Ground
Address 20	= B74	A80	= Address 21
Address 21	= B75	A81	= Address 22
Address 21	= B76	A82	= Address 26
Address 19	= B77	A83	= Ground
Address 20	= B78	A84	= Address 28
Address 19	= B79	A85	= Address 29
Address 20	= B80	A86	= Address 20
Address 19	= B81	A87	= Ground
Address 20	= B82	A88	= Address 21
Address 21	= B83	A89	= Address 22
Address 21	= B84	A90	= Address 26
Address 19	= B85	A91	= Ground
Address 20	= B86	A92	= Address 28
Address 19	= B87	A93	= Address 29
Address 20	= B88	A94	= Address 20
Address 19	= B89	A95	= Ground
Address 20	= B90	A96	= Address 21
Address 21	= B91	A97	= Address 22
Address 21	= B92	A98	= Address 26
Address 19	= B93	A99	= Ground
Address 20	= B94	A100	= Address 28
Address 19	= B95	A101	= Address 29
Address 20	= B96	A102	= Address 20
Address 19	= B97	A103	= Ground
Address 20	= B98	A104	= Address 21
Address 21	= B99	A105	= Address 22
Address 21	= B100	A106	= Address 26
Address 19	= B101	A107	= Ground
Address 20	= B102	A108	= Address 28
Address 19	= B103	A109	= Address 29
Address 20	= B104	A110	= Address 20
Address 19	= B105	A111	= Ground
Address 20	= B106	A112	= Address 21
Address 21	= B107	A113	= Address 22
Address 21	= B108	A114	= Address 26
Address 19	= B109	A115	= Ground
Address 20	= B110	A116	= Address 28
Address 19	= B111	A117	= Address 29
Address 20	= B112	A118	= Address 20
Address 19	= B113	A119	= Ground
Address 20	= B114	A120	= Address 21
Address 21	= B115	A121	= Address 22
Address 21	= B116	A122	= Address 26
Address 19	= B117	A123	= Ground
Address 20	= B118	A124	= Address 28
Address 19	= B119	A125	= Address 29
Address 20	= B120	A126	= Address 20
Address 19	= B121	A127	= Ground
Address 20	= B122	A128	= Address 21
Address 21	= B123	A129	= Address 22
Address 21	= B124	A130	= Address 26
Address 19	= B125	A131	= Ground
Address 20	= B126	A132	= Address 28
Address 19	= B127	A133	= Address 29
Address 20	= B128	A134	= Address 20
Address 19	= B129	A135	= Ground
Address 20	= B130	A136	= Address 21
Address 21	= B131	A137	= Address 22
Address 21	= B132	A138	= Address 26
Address 19	= B133	A139	= Ground
Address 20	= B134	A140	= Address 28
Address 19	= B135	A141	= Address 29
Address 20	= B136	A142	= Address 20
Address 19	= B137	A143	= Ground
Address 20	= B138	A144	= Address 21
Address 21	= B139	A145	= Address 22
Address 21	= B140	A146	= Address 26
Address 19	= B141	A147	= Ground
Address 20	= B142	A148	= Address 28
Address 19	= B143	A149	= Address 29
Address 20	= B144	A150	= Address 20
Address 19	= B145	A151	= Ground
Address 20	= B146	A152	= Address 21
Address 21	= B147	A153	= Address 22
Address 21	= B148	A154	= Address 26
Address 19	= B149	A155	= Ground
Address 20	= B150	A156	= Address 28
Address 19	= B151	A157	= Address 29
Address 20	= B152	A158	= Address 20
Address 19	= B153	A159	= Ground
Address 20	= B154	A160	= Address 21
Address 21	= B155	A161	= Address 22
Address 21	= B156	A162	= Address 26
Address 19	= B157	A163	= Ground
Address 20	= B158	A164	= Address 28
Address 19	= B159	A165	= Address 29
Address 20	= B160	A166	= Address 20
Address 19	= B161	A167	= Ground
Address 20	= B162	A168	= Address 21
Address 21	= B163	A169	= Address 22
Address 21	= B164	A170	= Address 26
Address 19	= B165	A171	= Ground
Address 20	= B166	A172	= Address 28
Address 19	= B167	A173	= Address 29
Address 20	= B168	A174	= Address 20
Address 19	= B169	A175	= Ground
Address 20	= B170	A176	= Address 21
Address 21	= B171	A177	= Address 22
Address 21	= B172	A178	= Address 26
Address 19	= B173	A179	= Ground
Address 20	= B174	A180	= Address 28
Address 19	= B175	A181	= Address 29
Address 20	= B176	A182	= Address 20
Address 19	= B177	A183	= Ground
Address 20	= B178	A184	= Address 21
Address 21	= B179	A185	= Address 22
Address 21	= B180	A186	= Address 26
Address 19	= B181	A187	= Ground
Address 20	= B182	A188	= Address 28
Address 19	= B183	A189	= Address 29
Address 20	= B184	A190	= Address 20
Address 19	= B185	A191	= Ground
Address 20	= B186	A192	= Address 21
Address 21	= B187	A193	= Address 22
Address 21	= B188	A194	= Address 26
Address 19	= B189	A195	= Ground
Address 20	= B190	A196	= Address 28
Address 19	= B191	A197	= Address 29
Address 20	= B192	A198	= Address 20
Address 19	= B193	A199	= Ground
Address 20	= B194	A200	= Address 21
Address 21	= B195	A201	= Address 22
Address 21	= B196	A202	= Address 26
Address 19	= B197	A203	= Ground
Address 20	= B198	A204	= Address 28
Address 19	= B199	A205	= Address 29
Address 20	= B200	A206	= Address 20
Address 19	= B201	A207	= Ground
Address 20	= B202	A208	= Address 21
Address 21	= B203	A209	= Address 22
Address 21	= B204	A210	= Address 26
Address 19	= B205	A211	= Ground
Address 20	= B206	A212	= Address 28
Address 19	= B207	A213	= Address 29
Address 20	= B208	A214	= Address 20
Address 19	= B209	A215	= Ground
Address 20	= B210	A216	= Address 21
Address 21	= B211	A217	= Address 22
Address 21	= B212	A218	= Address 26
Address 19	= B213	A219	= Ground
Address 20	= B214	A220	= Address 28
Address 19	= B215	A221	= Address 29
Address 20	= B216	A222	= Address 20
Address 19	= B217	A223	= Ground
Address 20	= B218	A224	= Address 21
Address 21	= B219	A225	= Address 22
Address 21	= B220	A226	= Address 26
Address 19	= B221	A227	= Ground
Address 20	= B222	A228	= Address 28
Address 19	= B223	A229	= Address 29
Address 20	= B224	A230	= Address 20
Address 19	= B225	A231	= Ground
Address 20	= B226	A232	= Address 21
Address 21	= B227	A233	= Address 22
Address 21	= B228	A234	= Address 26
Address 19	= B229	A235	= Ground
Address 20	= B230	A236	= Address 28
Address 19	= B231	A237	= Address 29
Address 20	= B232	A238	= Address 20
Address 19	= B233	A239	= Ground
Address 20	= B234	A240	= Address 21
Address 21	= B235	A241	= Address 22
Address 21	= B236	A242	= Address 26
Address 19	= B237	A243	= Ground
Address 20	= B238	A244	= Address 28
Address 19	= B239	A245	= Address 29
Address 20	= B240	A246	= Address 20
Address 19	= B241	A247	= Ground
Address 20	= B242	A248	= Address 21
Address 21	= B243	A249	= Address 22
Address 21	= B244	A250	= Address 26
Address 19	= B245	A251	= Ground
Address 20	= B246	A252	= Address 28
Address 19	= B247	A253	= Address 29
Address 20	= B248	A254	= Address 20
Address 19	= B249	A255	= Ground
Address 20	= B250	A256	= Address 21
Address 21	= B251	A257	= Address 22
Address 21	= B252	A258	= Address 26
Address 19	= B253	A259	= Ground
Address 20	= B254	A260	= Address 28
Address 19	= B255	A261	= Address 29
Address 20	= B256	A262	= Address 20
Address 19	= B257	A263	= Ground
Address 20	= B258	A264	= Address 21
Address 21	= B259	A265	= Address 22
Address 21	= B260	A266	= Address 26
Address 19	= B261	A267	= Ground
Address 20	= B262	A268	= Address 28
Address 19	= B263	A269	= Address 29
Address 20	= B264	A270	= Address 20
Address 19	= B265	A271	= Ground
Address 20	= B266	A272	= Address 21
Address 21	= B267	A273	= Address 22
Address 21	= B268	A274	= Address 26
Address 19	= B269	A275	= Ground
Address 20	= B270	A276	= Address 28
Address 19	= B271	A277	= Address 29
Address 20	= B272	A278	= Address 20
Address 19	= B273	A279	= Ground
Address 20	= B274	A280	= Address 21
Address 21	= B275	A281	= Address 22
Address 21	= B276	A282	= Address 26
Address 19	= B277	A283	= Ground
Address 20	= B278	A284	= Address 28
Address 19	= B279	A285	= Address 29
Address 20	= B280	A286	= Address 20
Address 19	= B281	A287	= Ground
Address 20	= B282	A288	= Address 21
Address 21	= B283	A289	= Address 22
Address 21	= B284	A290	= Address 26
Address 19	= B285	A291	= Ground
Address 20	= B286	A292	= Address 28
Address 19	= B287	A293	= Address 29
Address 20	= B288	A294	= Address 20
Address 19	= B289	A295	= Ground
Address 20	= B290	A296	= Address 21
Address 21	= B291	A297	= Address 22
Address 21	= B292	A298	= Address 26
Address 19	= B293	A299	= Ground
Address 20	= B294	A300	= Address 28
Address 19	= B295	A301	= Address 29
Address 20	= B296	A302	= Address 20
Address 19	= B297	A303	= Ground
Address 20	= B298	A304	= Address 21
Address 21	= B299	A305	= Address 22
Address 21	= B300	A306	= Address 26
Address 19	= B301	A307	= Ground
Address 20	= B302	A308	= Address 28
Address 19	= B303	A309	= Address 29
Address 20	= B304	A310	= Address 20
Address 19	= B305	A311	= Ground
Address 20	= B306	A312	= Address 21
Address 21	= B307	A313	= Address 22
Address 21	= B308	A314	= Address 26
Address 19	= B309	A315	= Ground
Address 20	= B310	A316	= Address 28
Address 19	= B311	A317	= Address 29
Address 20	= B312	A318	= Address 20
Address 19	= B313	A319	= Ground
Address 20	= B314	A320	= Address 21
Address 21	= B315	A321	= Address 22
Address 21	= B316	A322	= Address 26
Address 19	= B317	A323	= Ground
Address 20	= B318	A324	= Address 28
Address 19	= B319	A325	= Address 29
Address 20	= B320	A326	= Address 20
Address 19	= B321	A327	= Ground

Interfaces serie RS232



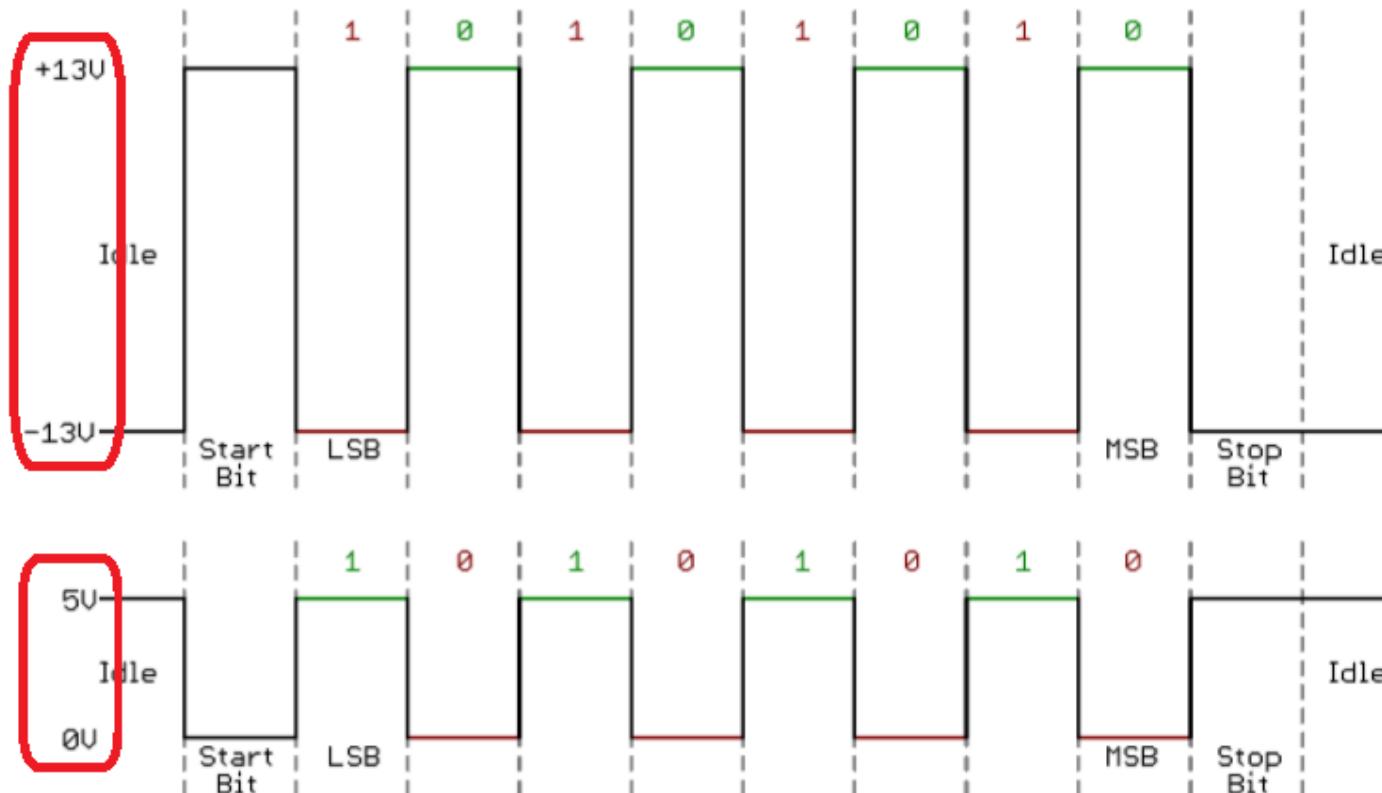
Interfaces série

RS232



Interfaces serie

RS232



This timing diagram shows both a TTL (bottom) and RS-232 signal sending 0b01010101

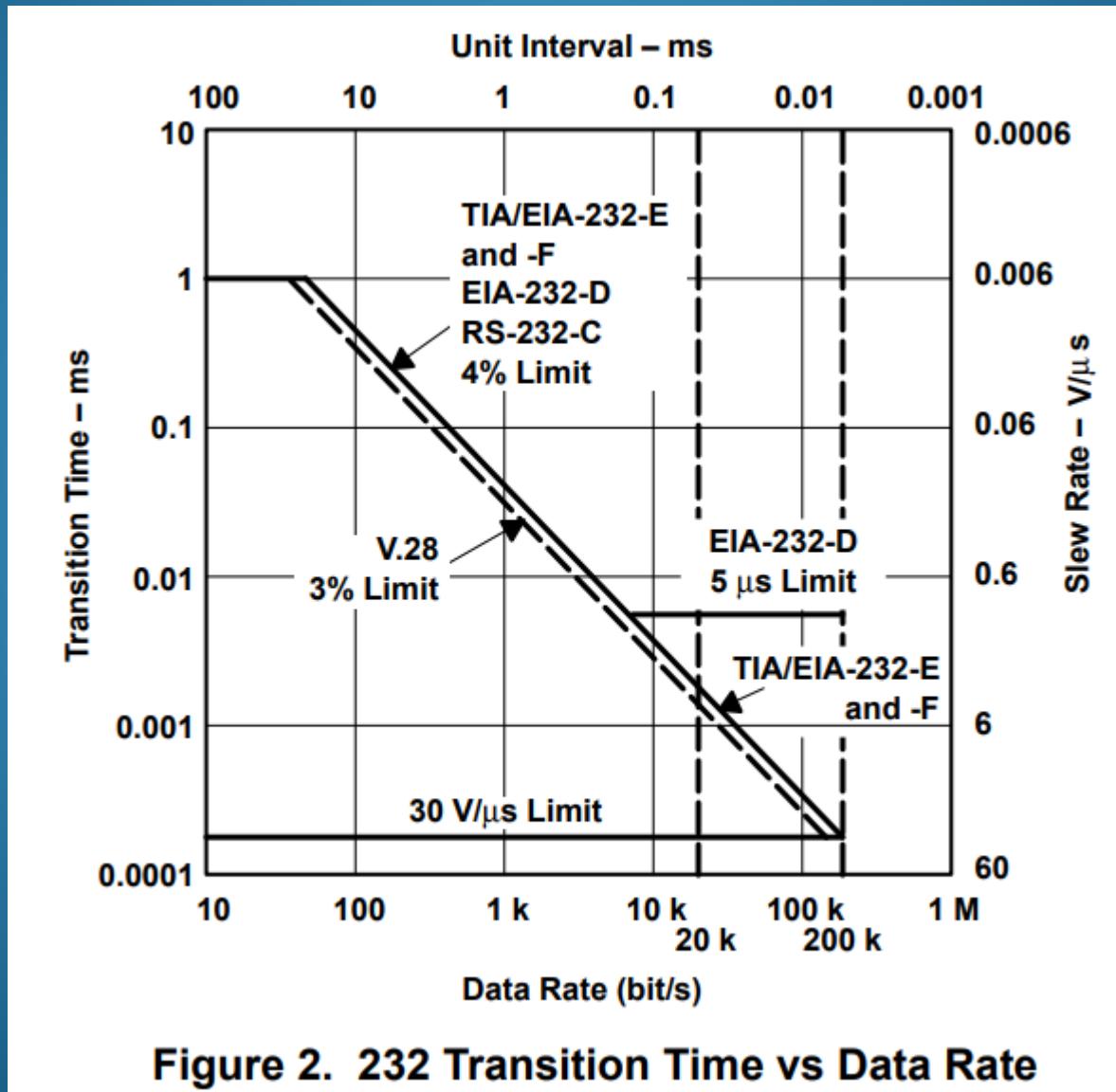
Nota de aplicación RS232



Interface Circuits for TIA/EIA-232-F

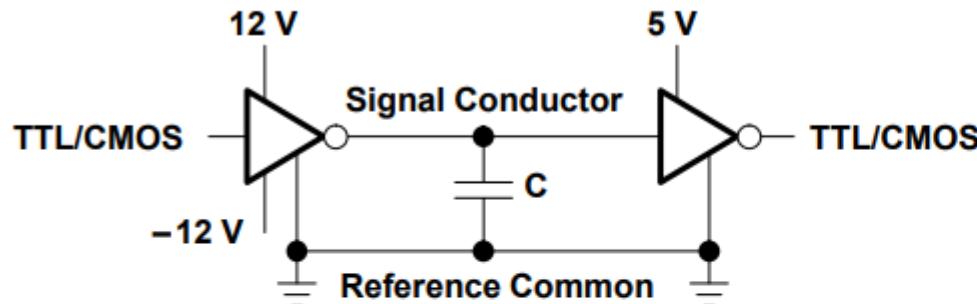
Design Notes

RS232- Detalles de la señal

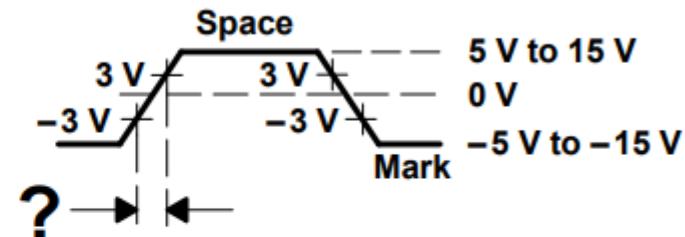


Especificaciones electrica

Single Interface Line (1 of 25 Maximum)



Interchange Signal

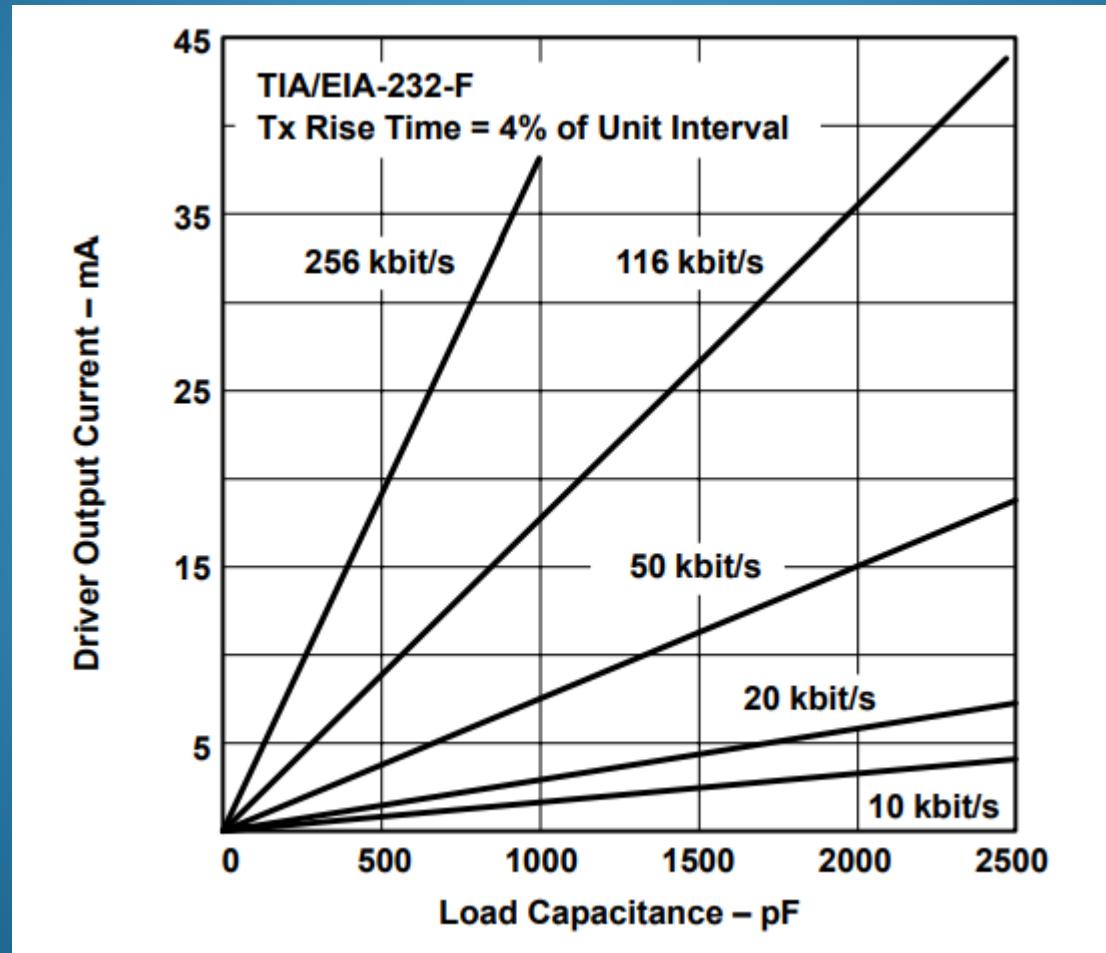


- Receiver Input Impedance, $3 \text{ k}\Omega$ to $7 \text{ k}\Omega$
- Driver Power-Off Impedance, $> 300 \Omega$
- Load Capacitance $< 2500 \text{ pF}$ Includes Receiver Input

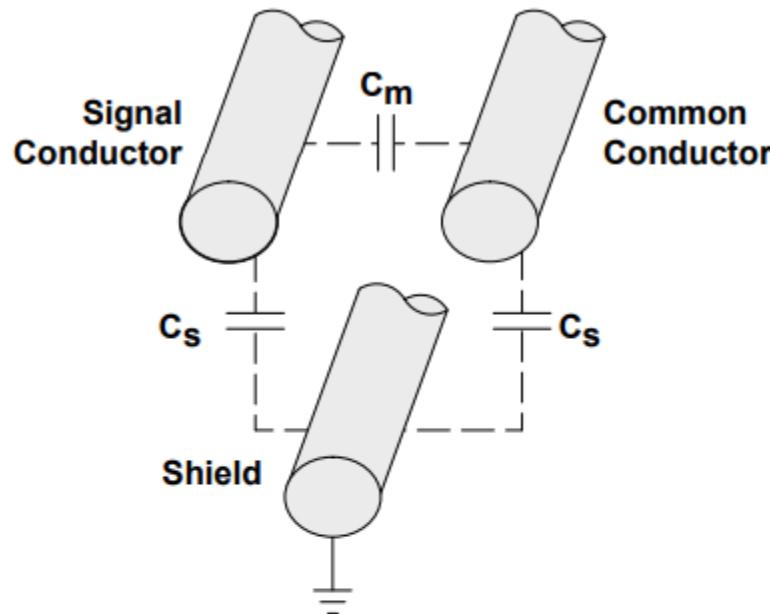
- Tx Rise/Fall Time Within Transition Region
1 ms — Below 40 bit/s
4% of Unit Interval — 30 bit/s to 20 kbit/s
- Slew Rate: $30 \text{ V}/\mu\text{s}$ max

Figure 3. TIA/EIA-232-F Electrical Specification

RS232 – Relación entre la capacidad distribuida del cable y la longitud



RS232 – Calculo de la distancia máxima de comunicaciones



Data-Rate Calculation

$$\text{Unit Interval} = \frac{1}{3} \cdot \frac{0.04}{C_C \ln \left(\frac{I_O + 1}{I_O - 1} \right)}$$

I_O = Short-Circuit Current of Driver

Line-Length Calculation

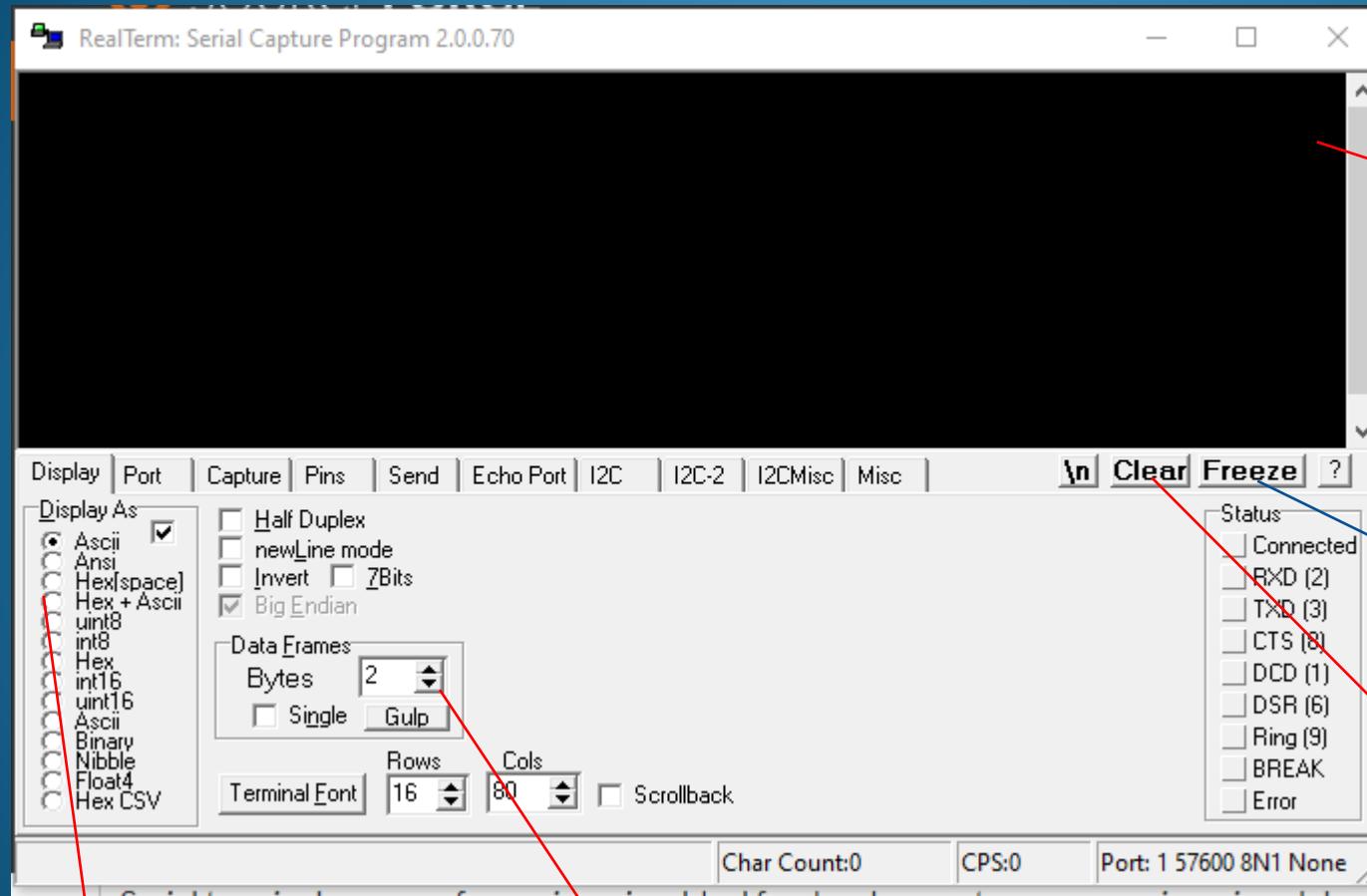
Maximum Capacitance	= 2500 pF
Receiver I/P Capacitance	< 20 pF
Maximum Line Capacitance	= 2480 pF

Total Line Capacitance/m	$C_C = C_M + C_S$
Mutual Capacitance of Cable/m	$C_M \approx 100 \text{ pF}$
Stray Capacitance/m	$C_S \approx 200 \text{ pF}$

Maximum Line Length	$= 2480/C_c$
Standard Cable C_c	$= 24 \text{ pF/m}$
Maximum Line Length Shielded	= 10 Meters

Figure 5. Calculating Line Length and Data Rate

RS232 – RealTerm



Como mostrar el dato

Permite especificar el largo de la trama de datos

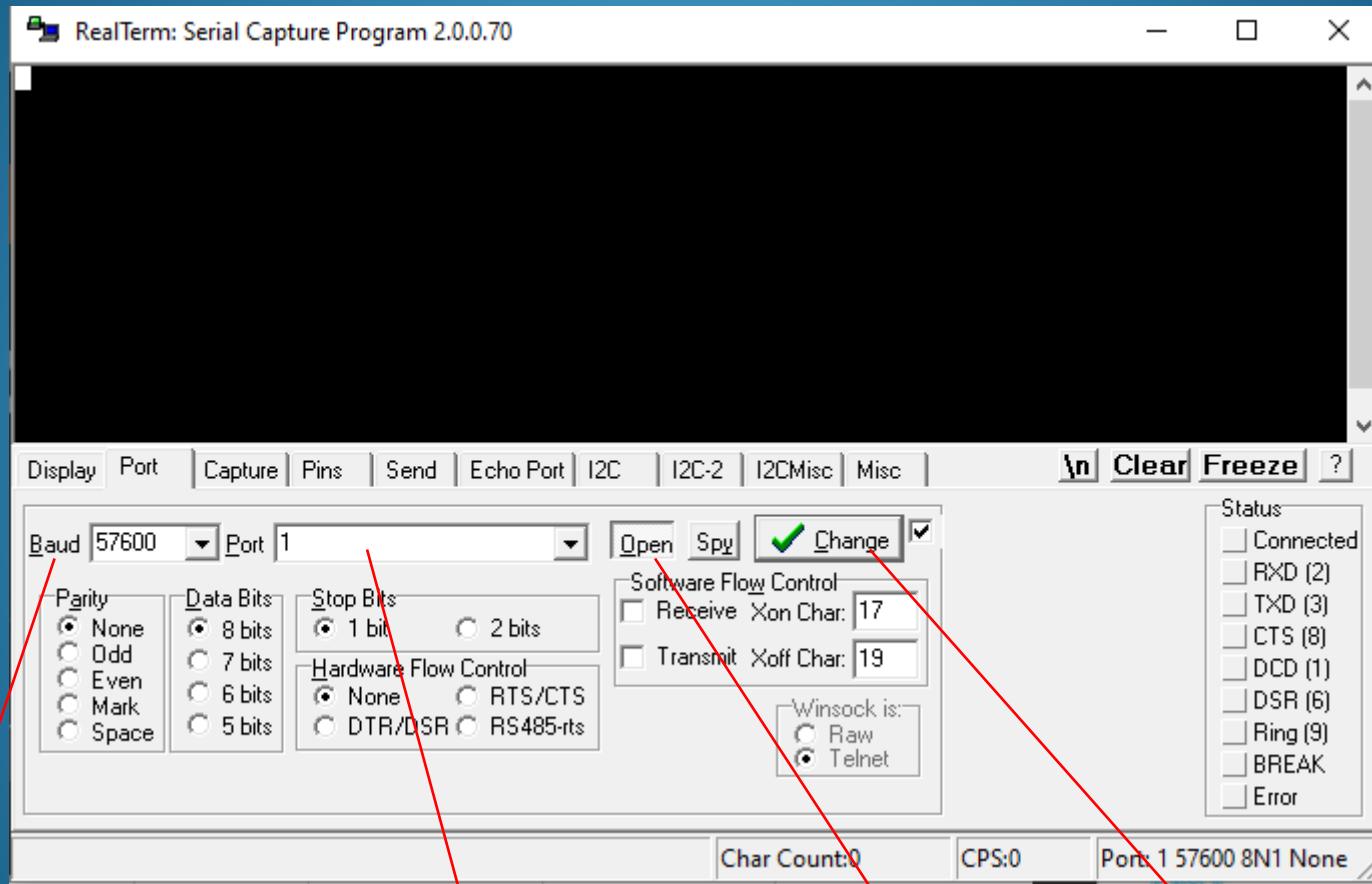
Muestra los datos de entrada y de salida (si esta activo el “echo”)

Congela la pantalla

Limpia pantalla

Datos del puerto

RS232 – RealTerm



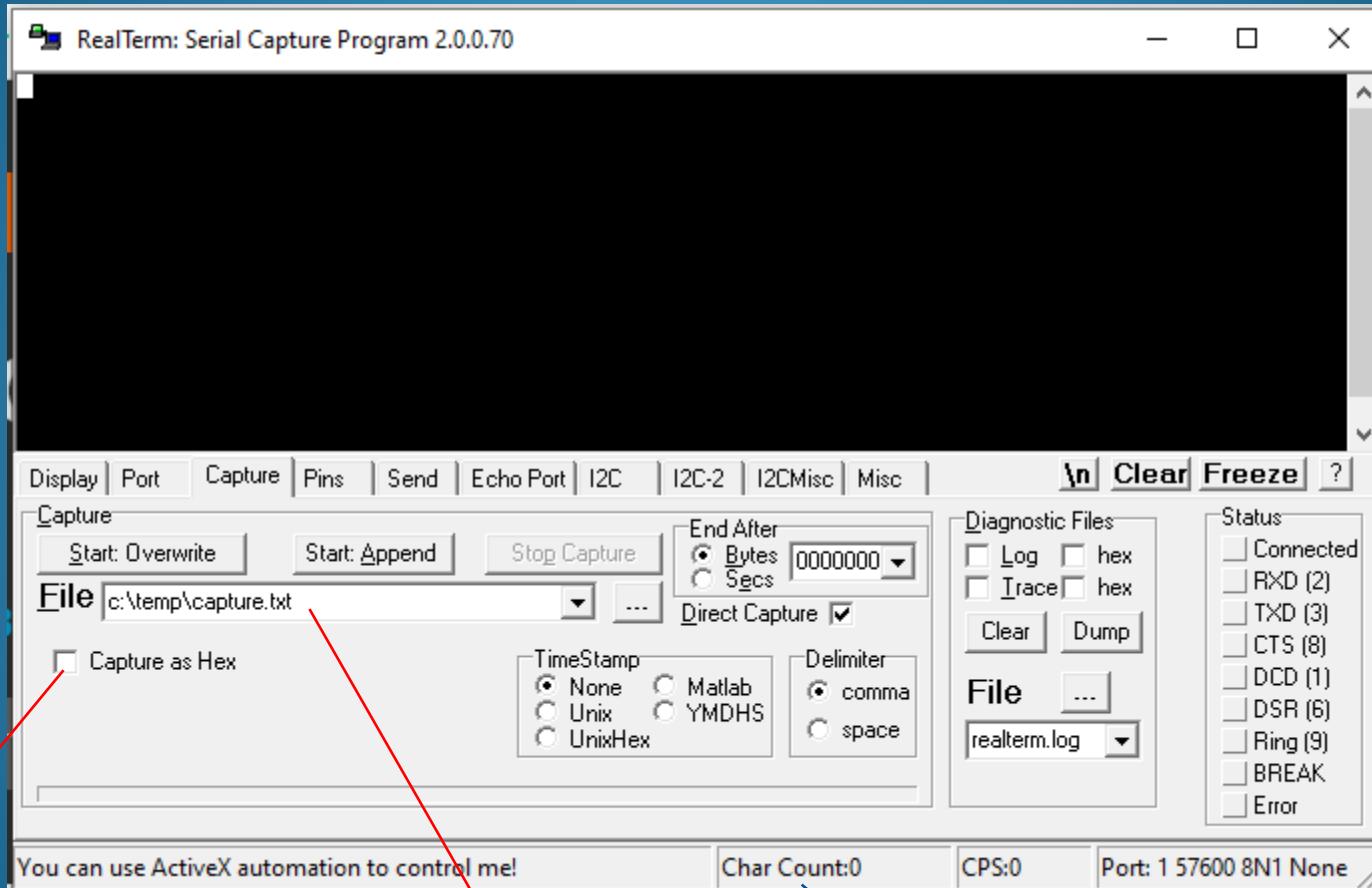
Velocidad de comunicaciones

Puerto de comunicaciones

Abre/cierra el puerto

Aplica cambios

RS232 – RealTerm

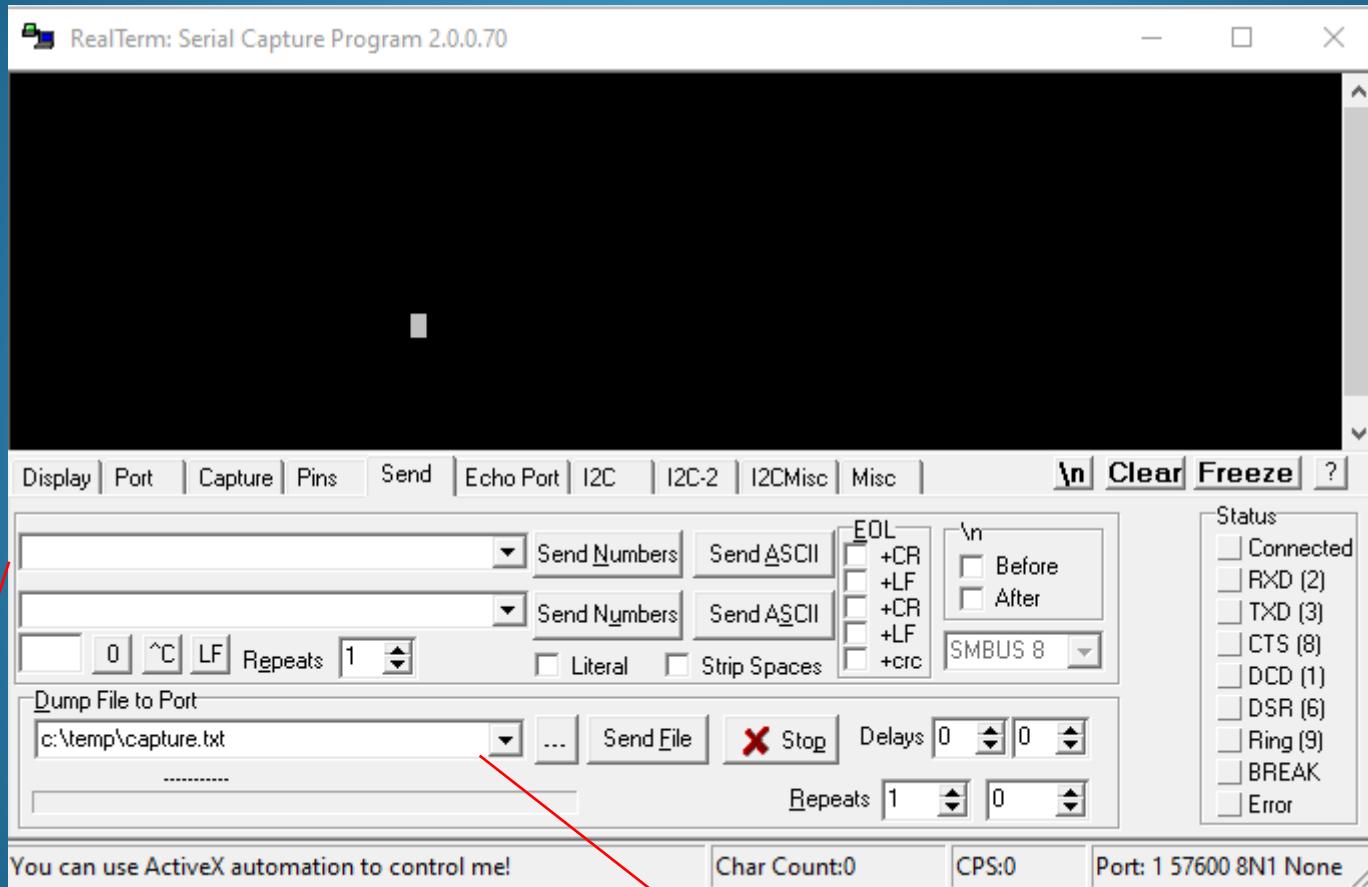


Forma de
almacenamiento,
o, hexadecimal
o binario

Ubicación y nombre de archivo

Caracteres adquiridos

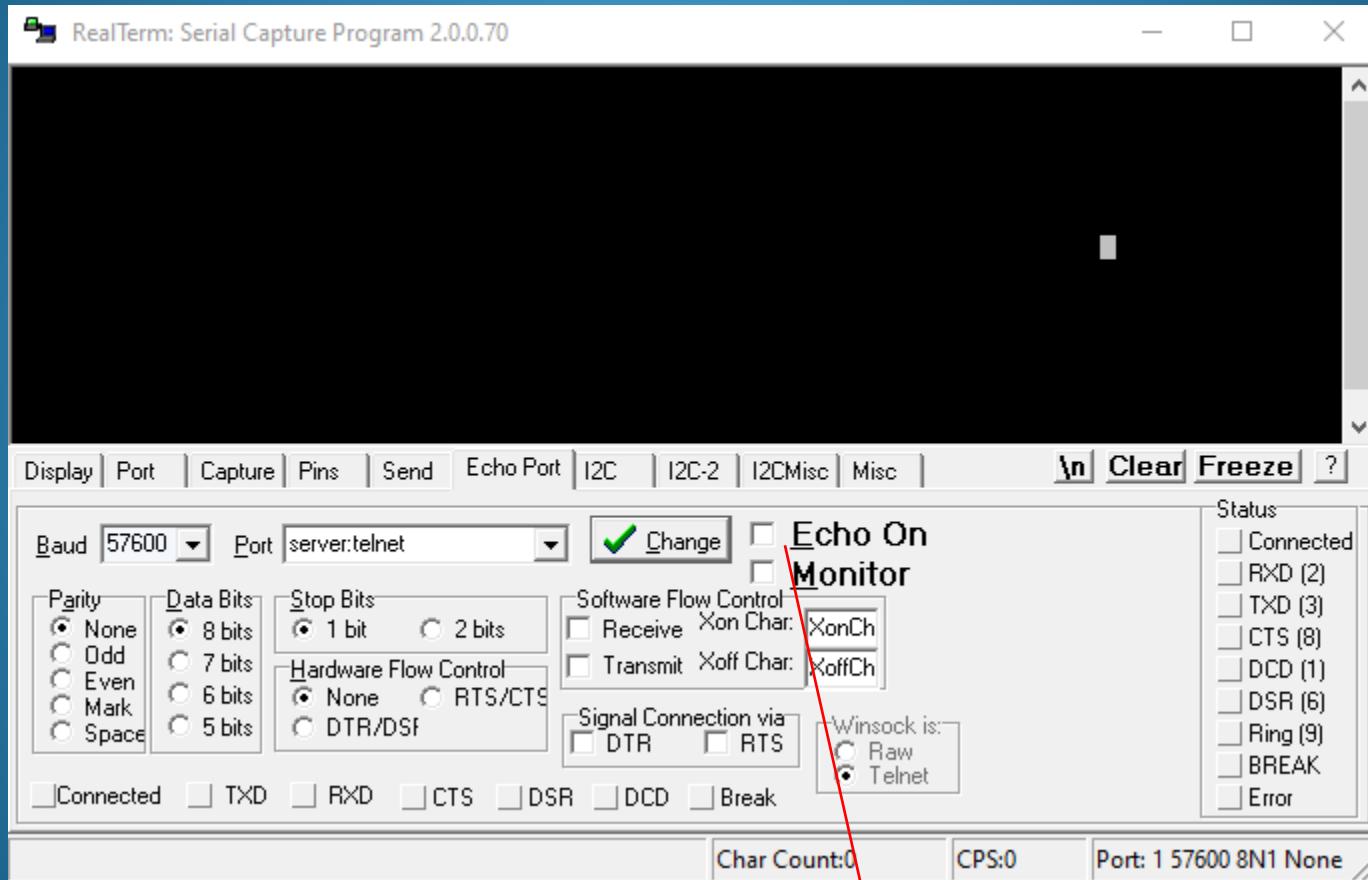
RS232 – RealTerm



Permite enviar una cadena de datos, puede enviarse en ASCII o en hexadecimal

Permite enviar un archivo completo

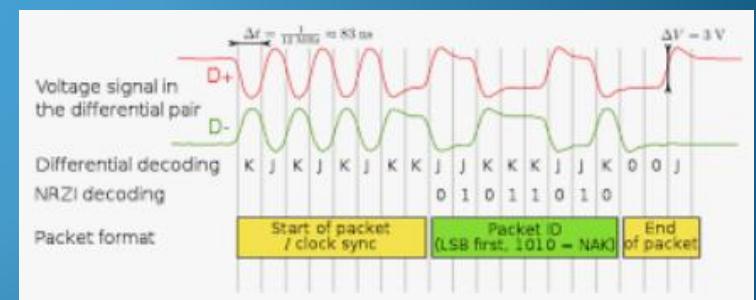
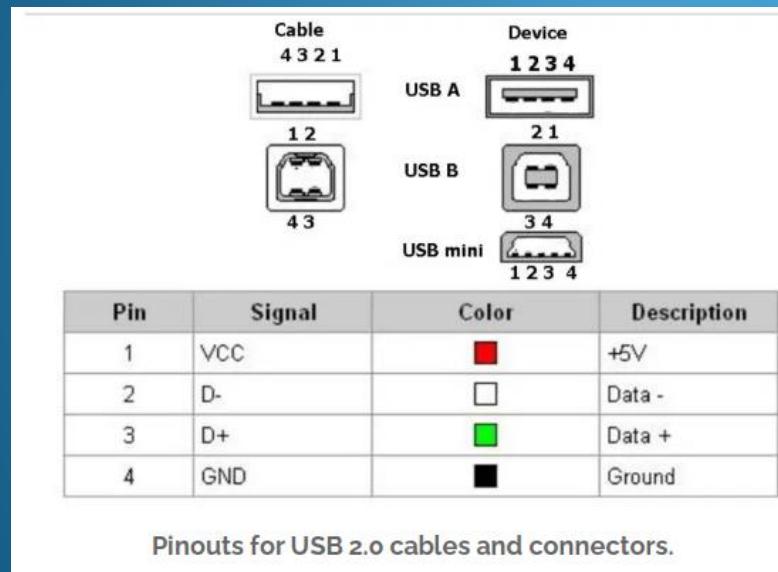
RS232 – RealTerm



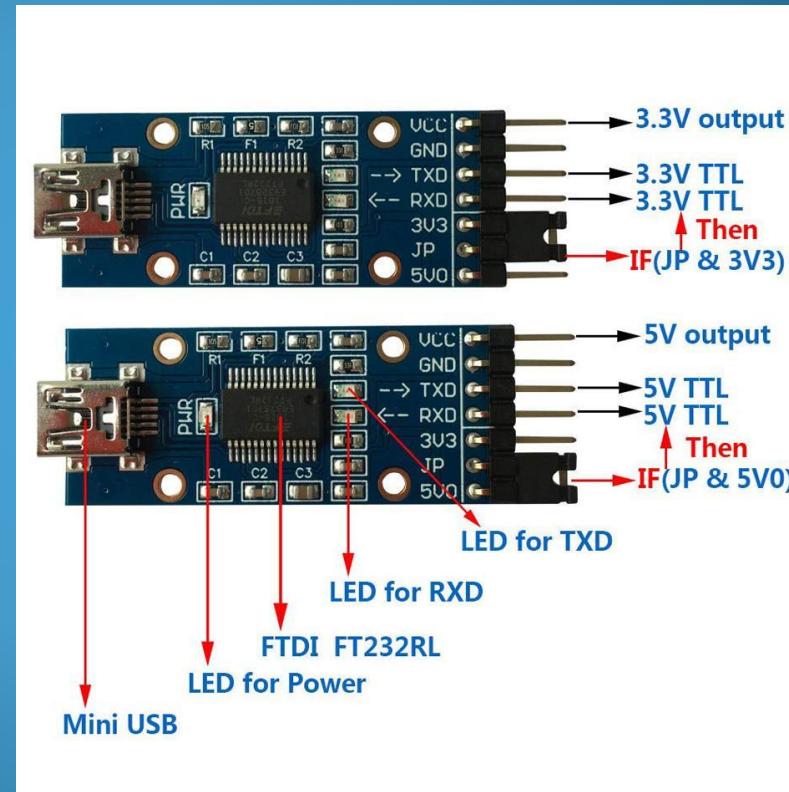
Permite ver lo que se envía por el terminal

Interfaces serie

USB (Universal Serial Bus)



Interfaces serie RS232 -USB



Interfaces serie RS232 -USB



Nuevo | +5 vendidos

**Adaptador Conversor Usb A
Uart Rs232 Arduino Pic Arm** Heart

 (1)

\$ 1.500
en 12x \$ 254⁹⁹

[Ver los medios de pago](#)

 Llega entre el **5 y 12 abr.** por **\$ 1.269⁹⁹**
\$ 1.769⁹⁹
[Beneficio Mercado Puntos](#)
[Ver más formas de entrega](#)

 **Devolución gratis**
Tenés 30 días desde que lo recibís.
[Conocer más](#)

Stock disponible

Cantidad: **1 unidad** ▼ (4 disponibles)

Interfaces serie RS232 -USB



Nuevo | +50 vendidos

Conversor Usb A Rs232
Cp2102 Arduino Nueva
Córdoba

★★★★★ (3)

\$ 2.175³⁷
en 12x \$ 369⁷⁹

[Ver los medios de pago](#)

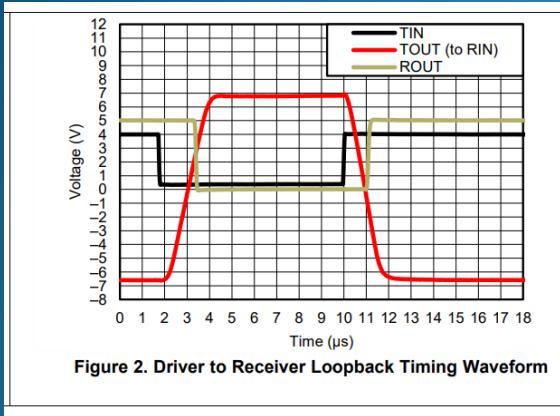
Llega el sábado por \$ 1.084⁹⁹ \$ 1.584⁹⁹
Beneficio Mercado Puntos
[Ver más formas de entrega](#)

↔ Devolución gratis
Tenés 30 días desde que lo recibís.
[Conocer más](#)

Stock disponible

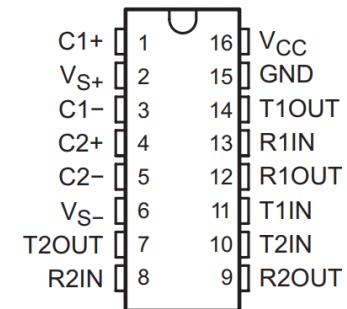
Cantidad: 1 unidad ▾ (67 disponibles)

Interfaces serie RS232



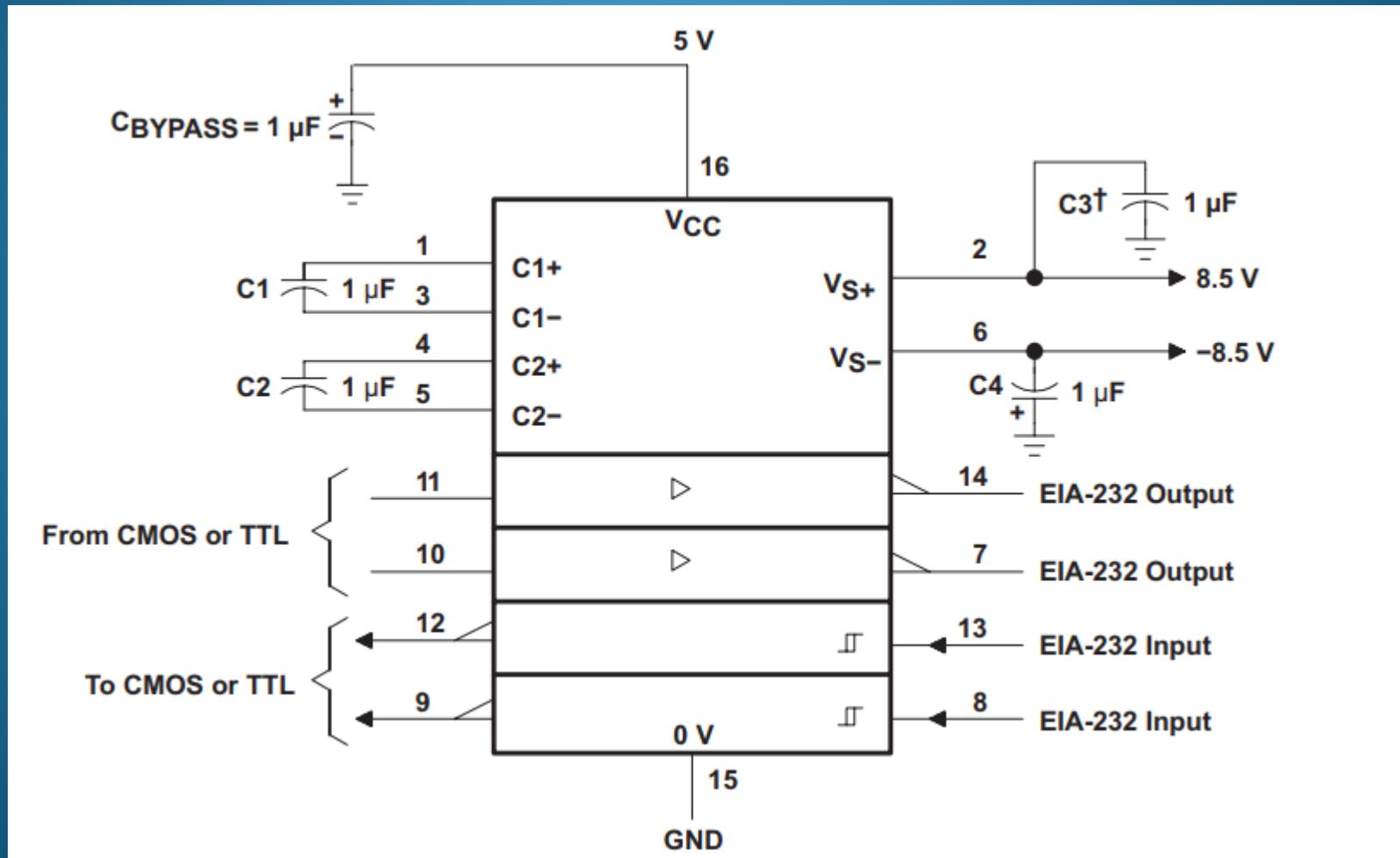
MAX232 . . . D, DW, N, OR NS PACKAGE
MAX232I . . . D, DW, OR N PACKAGE

(TOP VIEW)



PIN		TYPE	DESCRIPTION
NAME	NO.		
C1+	1	—	Positive lead of C1 capacitor
V _{S+}	2	O	Positive charge pump output for storage capacitor only
C1-	3	—	Negative lead of C1 capacitor
C2+	4	—	Positive lead of C2 capacitor
C2-	5	—	Negative lead of C2 capacitor
V _{S-}	6	O	Negative charge pump output for storage capacitor only
T2OUT, T1OUT	7, 14	O	RS232 line data output (to remote RS232 system)
R2IN, R1IN	8, 13	I	RS232 line data input (from remote RS232 system)
R2OUT, R1OUT	9, 12	O	Logic data output (to UART)
T2IN, T1IN	10, 11	I	Logic data input (from UART)
GND	15	—	Ground
V _{CC}	16	—	Supply Voltage, Connect to external 5V power supply

Interfaces serie RS232



Interfaces serie RS232



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Nuevo | 1 vendido

Modulo Adaptador Mini Conversor Rs232 A Ttl 5v Arduino

\$ 828
en 12x \$ 140⁷⁵

[Ver los medios de pago](#)

 Llega entre el viernes y el lunes por \$ 1.584⁹⁹
[Ver más formas de entrega](#)

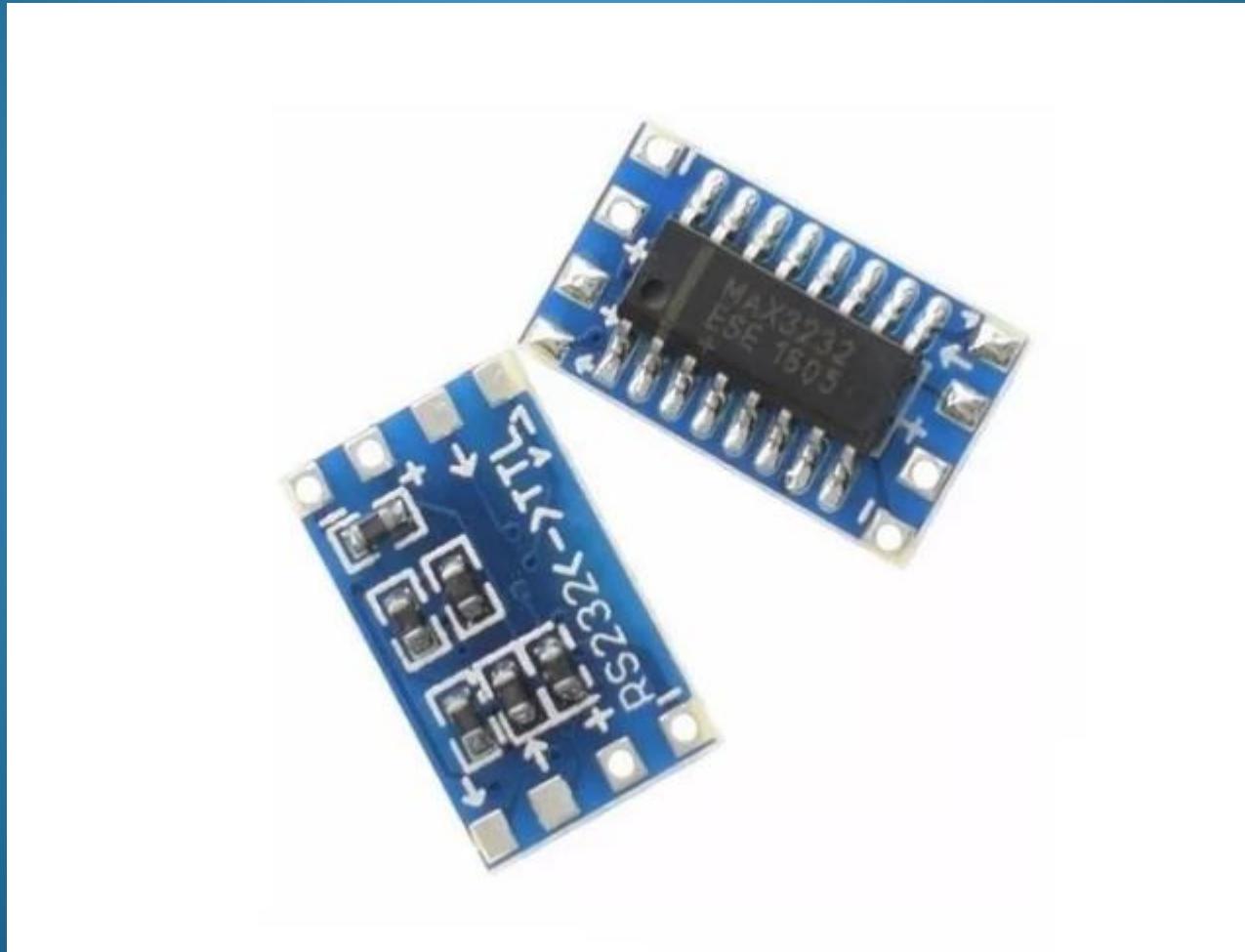
 **Devolución gratis**
Tenés 30 días desde que lo recibís.
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Stock disponible

Cantidad: **1 unidad** (250 disponibles)

Comprar ahora

Interfaces serie RS232



Interfaces serie USB – RS485



- 
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Nuevo | +5 vendidos

Adaptador Usb Rs485 Windows Linux Mac Arduino 

\$ 1.261
en 12x \$ 214³⁶

[Ver los medios de pago](#)

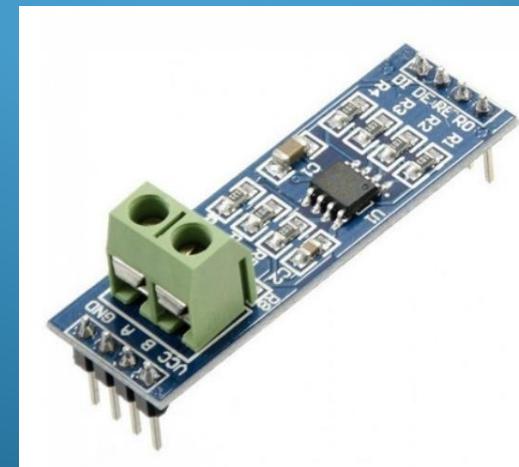
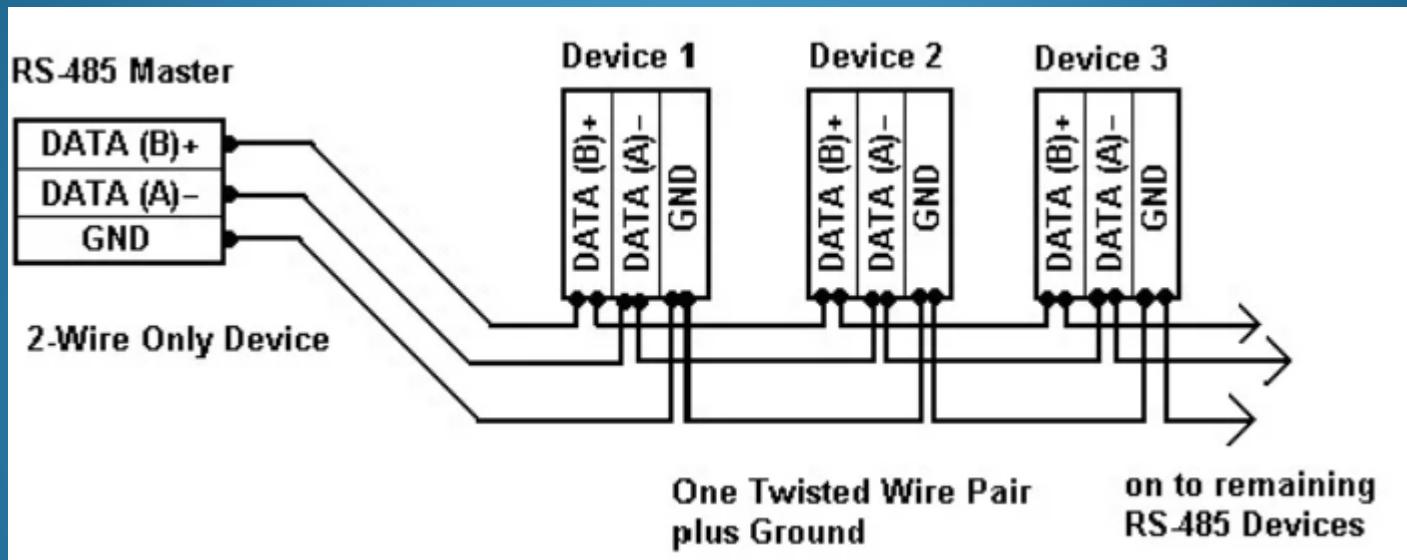
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[Ver más formas de entrega](#)

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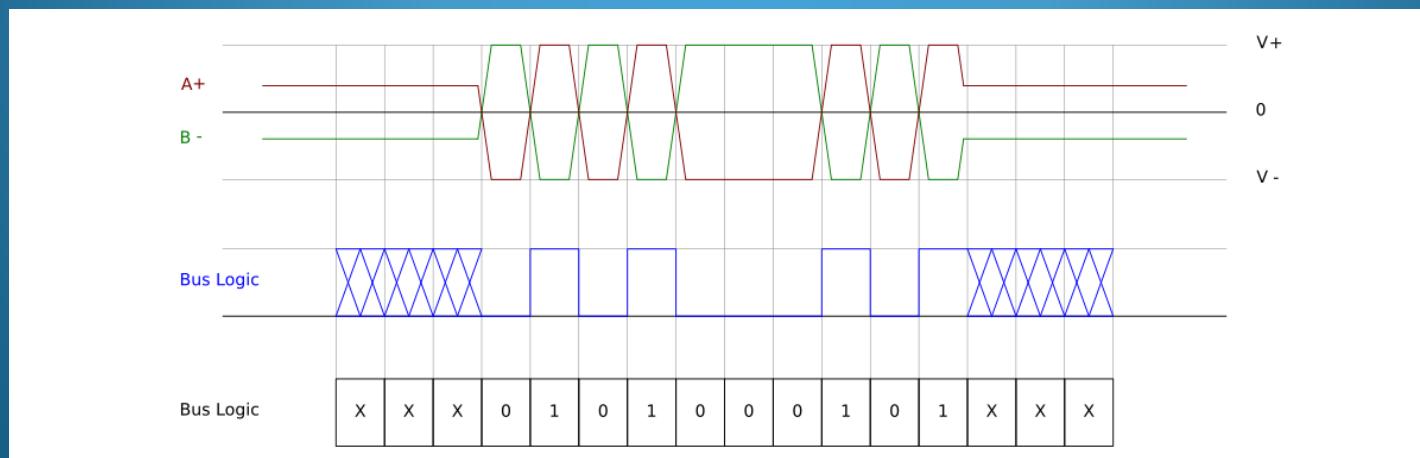
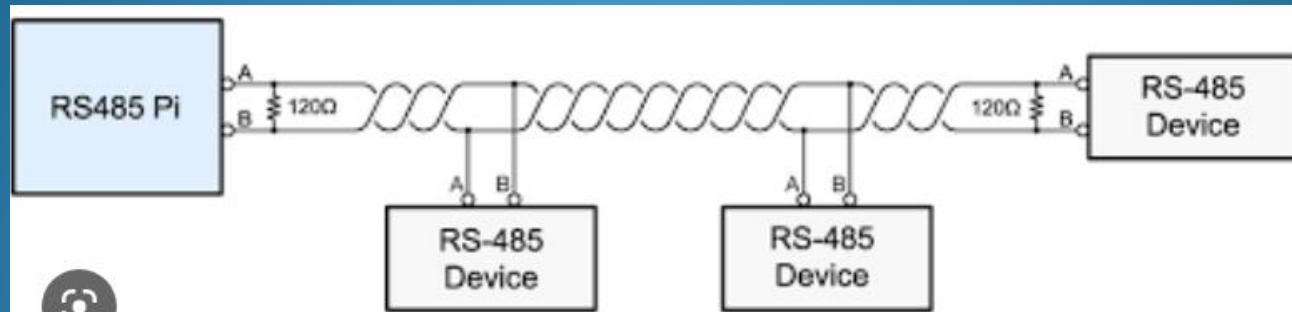
Stock disponible

Cantidad: **1 unidad**  (195 disponibles)

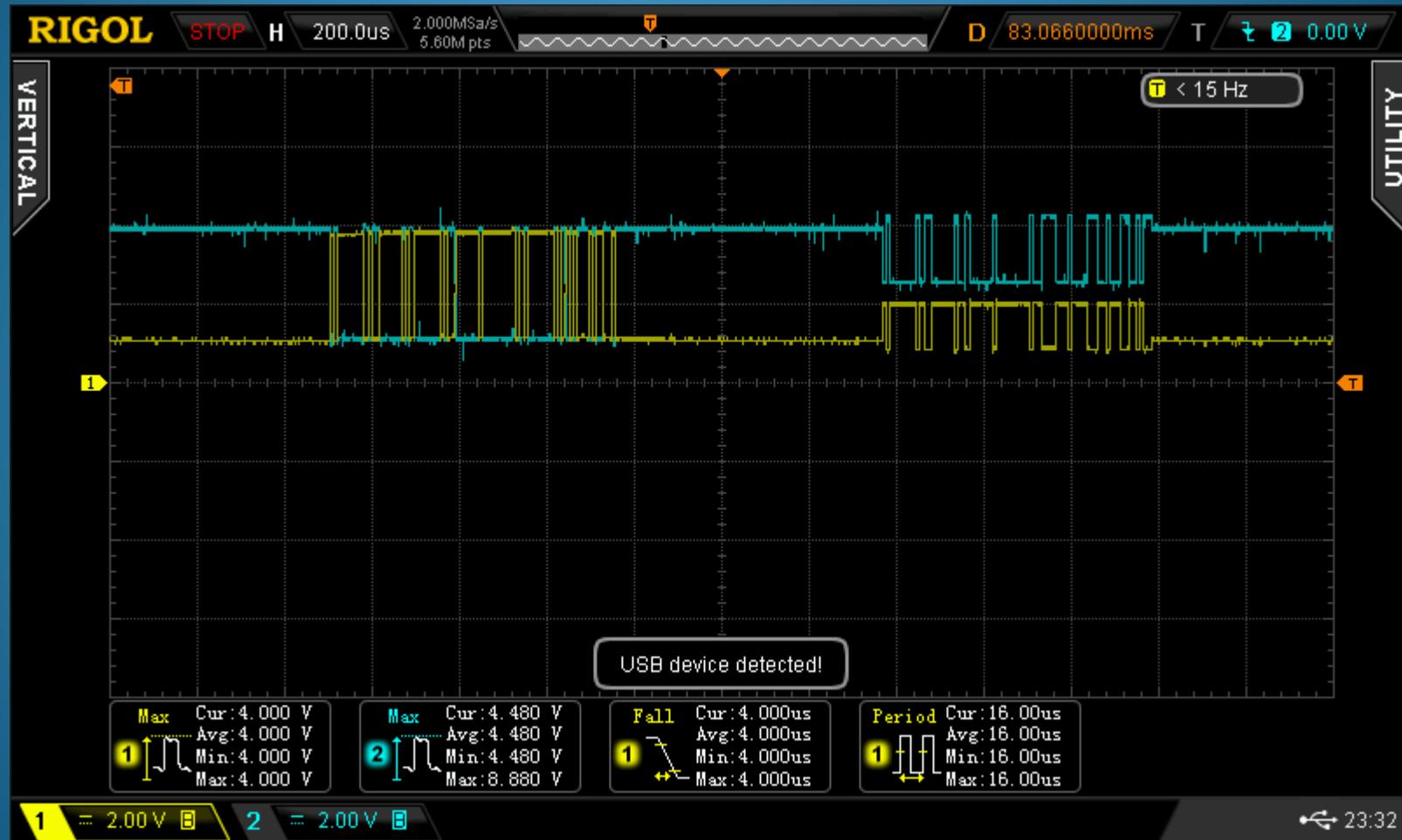
Interfaces serie RS485



Interfaces série RS485

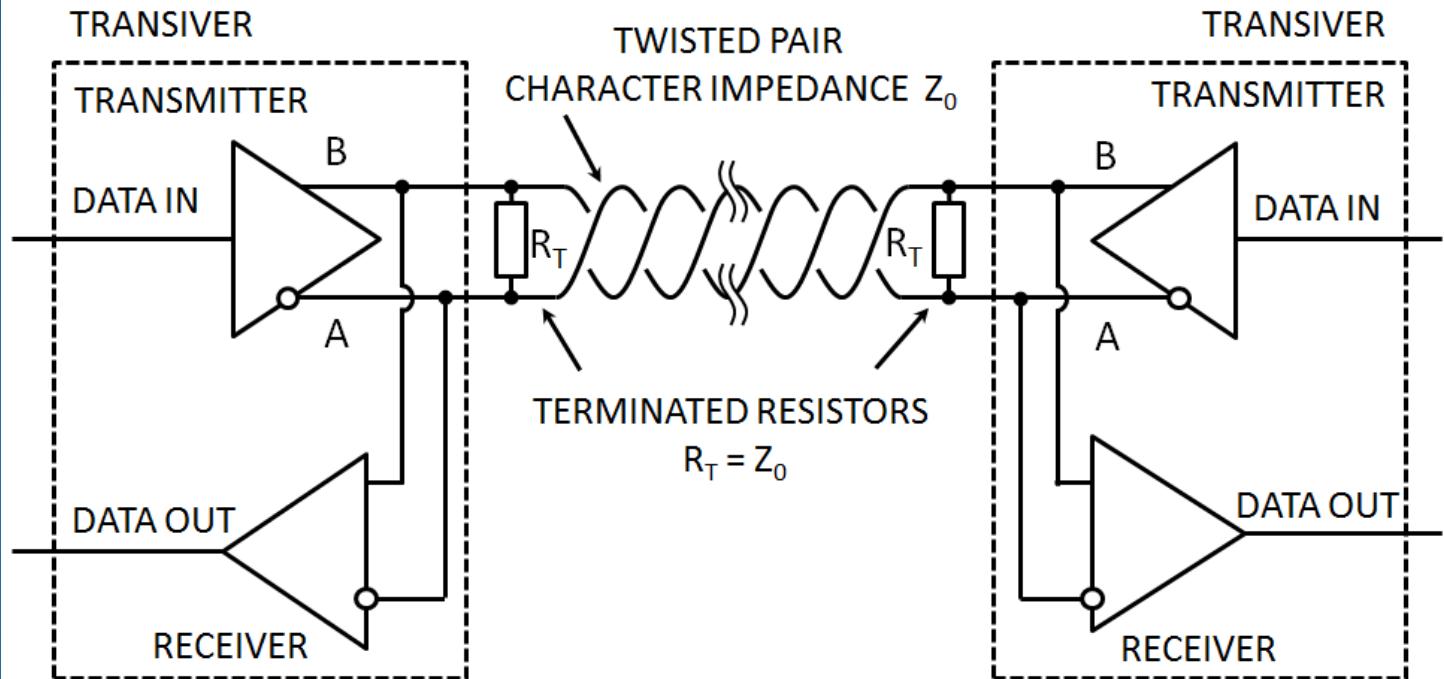


Interfaces serie RS485



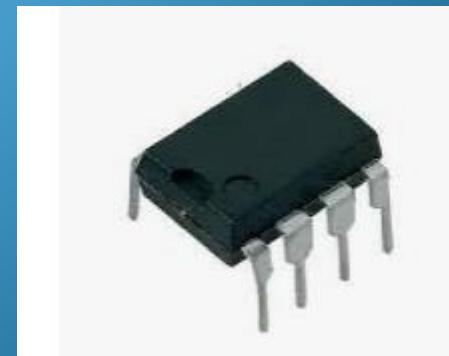
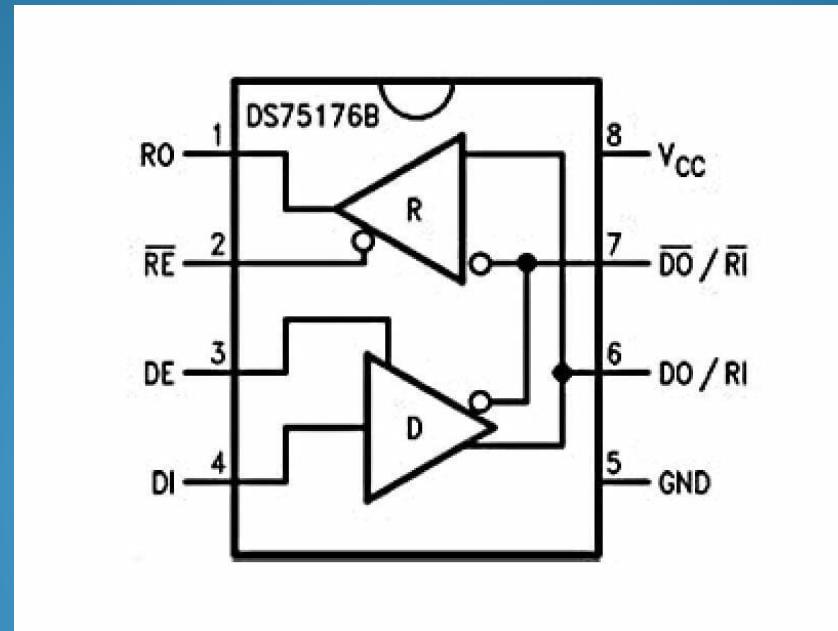
Interfaces serie RS485

Simple RS-485 half-duplex connection

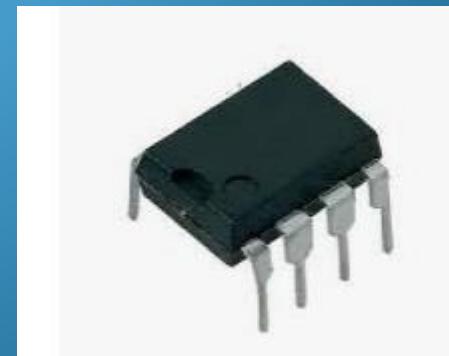
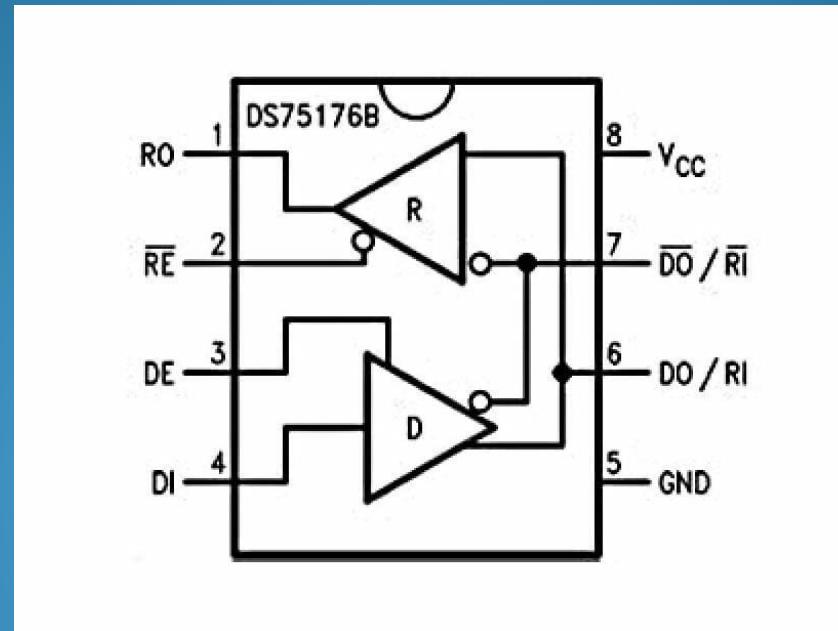


DATA IN	A	B	DATA OUT
0	1	0	0
1	0	1	1

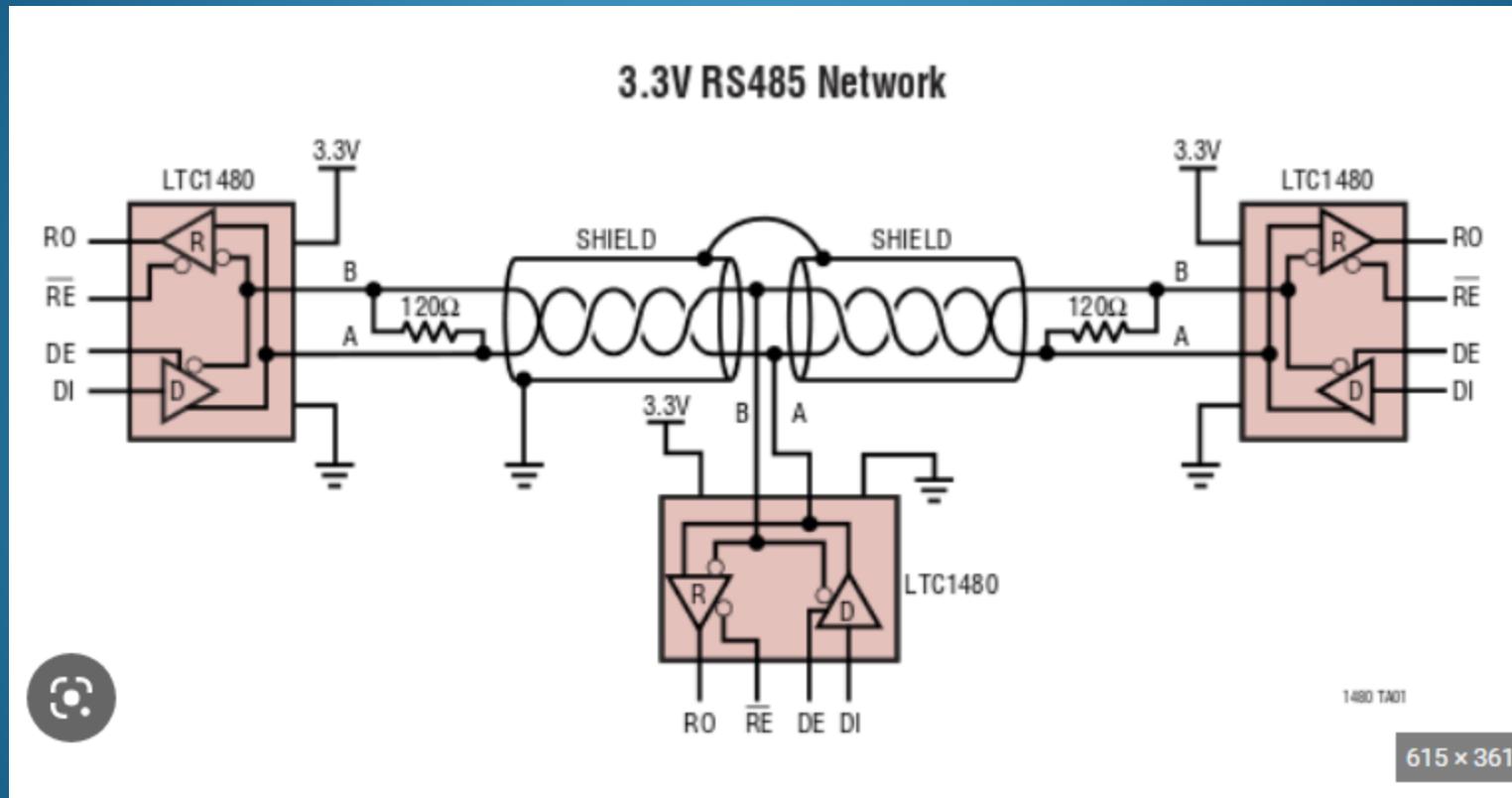
Interfaces serie RS485



Interfaces serie RS485



Interfaces serie RS485



Interfaces serie RS485

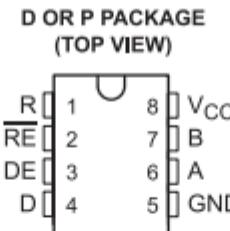
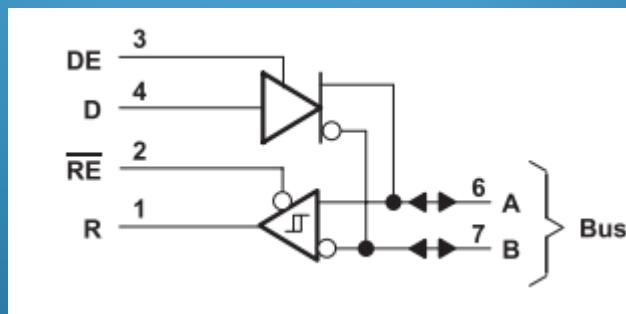


Table 5-1. Pin Functions

PIN		TYPE	DESCRIPTION
NAME	NO.		
R	1	O	Logic Data Output from RS-485 Receiver
RE	2	I	Receive Enable (active low)
DE	3	I	Driver Enable (active high)
D	4	I	Logic Data Input to RS-485 Driver
GND	5	—	Device Ground Pin
A	6	I/O	RS-422 or RS-485 Data Line
B	7	I/O	RS-422 or RS-485 Data Line
V _{CC}	8	—	Power Input. Connect to 5-V Power Source.



Interfaces serie RS485

6.1 Absolute Maximum Ratings

over operating free-air temperature range (unless otherwise noted)⁽¹⁾

		MIN	MAX	UNIT
V _{CC}	Supply Voltage ⁽²⁾		7	V
	Voltage range at any bus terminal	-10	15	V
V _I	Enable input voltage		5.5	V
	Continuous Total power Dissipation	See Dissipation Rating Table		
T _A	Operating free-air temperature range	0	70	°C
T _{stg}	Storage temperature range	65	150	°C

6.2 Recommended Operating Conditions

over operating free-air temperature range (unless otherwise noted)

		MIN	TYP	MAX	UNIT
V _{CC}	Supply Voltage	4.75	5	5.25	V
V _I or V _{IC}	Voltage at any buss terminal (separately or common mode)	-7		12	V
V _{IH}	High-level input voltage	D, DE, and RE	2		V
V _{IL}	Low-level input voltage	D, DE, and RE		0.8	V
V _{ID}	Differential input voltage ⁽¹⁾			±12	V
I _{OH}	High-level output current	Driver		-60	mA
		Receiver		-400	µA
I _{OL}	Low-level output current	Driver		60	mA
		Receiver		8	
T _A	Operating free-air temperature	0		70	°C

Interfaces serie RS485

6.5 Electrical Characteristics – Driver

over recommended ranges of supply voltage and operating free-air temperature (unless otherwise noted)

PARAMETER	TEST CONDITIONS	MIN	TYP ⁽¹⁾	MAX	UNIT
V_{IK}	$I_I = -18 \text{ mA}$			-1.5	V
V_{OH}	$V_{IH} = 2 \text{ V}, V_{IL} = 0.8 \text{ V}, I_{OH} = -33 \text{ mA}$		3.7		V
V_{OL}	$V_{IH} = 2 \text{ V}, V_{IL} = 0.8 \text{ V}, I_{OH} = 33 \text{ mA}$		1.1		V
$ V_{OD1} $	$I_O = 0$			$2V_{DD2}$	V
$ V_{OD2} $	$RL = 100 \Omega$, see Figure 7-1	2	2.7		V
	$RL = 54 \Omega$, see Figure 7-1	1.5	2.4		
$\Delta V_{OOL} $	Change in magnitude of differential output voltage ⁽²⁾			± 0.2	V
V_{OC}	Common-mode output voltage ⁽³⁾	RL = 54 Ω or 100 Ω , see Figure 7-1		3	V
$\Delta V_{OC} $	Change in magnitude of common-mode output voltage ⁽²⁾			± 0.2	V
I_O	Output disabled ⁽⁴⁾	$V_O = 12 \text{ V}$		1	mA
		$V_O = -7 \text{ V}$		-0.8	
I_{IH}	$V_I = 2.4 \text{ V}$			20	μA
I_{IL}	$V_I = 0.4 \text{ V}$			-400	μA
I_{OS}	Short-circuit output current	$V_O = -7 \text{ V}$		-250	mA
		$V_O = V_{CC}$		250	
		$V_O = 12 \text{ V}$		500	
I_{CC}	No load	Outputs enabled	35	50	mA
		Outputs disabled	26	40	

Interfaces serie RS485

6.6 Electrical Characteristics – Receiver

over recommended ranges of supply voltage and operating free-air temperature (unless otherwise noted)

PARAMETER	TEST CONDITIONS	MIN	TYP ⁽¹⁾	MAX	UNIT
V_{IT+}	Positive-going input threshold voltage $V_O = 2.7 \text{ V}$, $I_O = -0.4 \text{ mA}$		0.2		V
V_{IT-}	Negative-going input threshold voltage $V_O = 0.5 \text{ V}$, $I_O = 8 \text{ mA}$	-0.2			V
V_{hys}	Input hysteresis voltage ($V_{IT+} - V_{IT-}$)		50		mV
V_{IK}	Enable clamp voltage $I_I = -18 \text{ mA}$		-1.5		V
V_{OH}	High-level output voltage $V_{ID} = 200 \text{ mV}$, $I_{OH} = -400 \mu\text{A}$ See Figure 7-2	2.7			V
V_{OL}	Low-level output voltage $V_{ID} = 200 \text{ mV}$, $I_{OH} = 8 \text{ mA}$ See Figure 7-2		0.45		V
I_{OZ}	High-impedance-state output current $V_O = 0.4 \text{ V}$ to 2.4 V		± 20		μA
I_I	Line input current Other input = 0 V ⁽²⁾	$V_I = 12 \text{ V}$ $V_I = -7 \text{ V}$	1 -0.8		mA
I_{IH}	High-level enable input current $V_{IH} = 2.7 \text{ V}$		20		μA
I_{IL}	Low-level enable input current $V_{IL} = 0.4 \text{ V}$		-100		μA
r_i	Input resistance	12			$\text{k}\Omega$
I_{os}	Short-circuit output current	-15	-85		mA

Interfaces serie RS485

6.6 Electrical Characteristics – Receiver (continued)

over recommended ranges of supply voltage and operating free-air temperature (unless otherwise noted)

PARAMETER	TEST CONDITIONS	MIN	TYP ⁽¹⁾	MAX	UNIT
I _{CC} Supply current (total package)	No load	Outputs enabled	35	50	mA
		Outputs disabled	26	40	

(1) All typical values are at V_{CC} = 5 V, TA = 25°C.

(2) This applies for both power on and power off. Refer to ANSI Standard EIA/TIA-422-B for exact conditions.

6.7 Switching Characteristics – Driver

V_{CC} = 5 V, T_A = 25°C

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
t _{d(OD)} Differential-output delay time	R _L = 60 Ω, See Figure 7-3	40	60	ns	
t _{t(OD)} Differential-output transition time		65	95	ns	
t _{PZH} Output enable time to high level	R _L = 110 Ω, See Figure 7-4	55	90	ns	
t _{PZL} Output enable time to low level	R _L = 110 Ω, See Figure 7-5	30	50	ns	
t _{PHZ} Output disable time from high level	R _L = 110 Ω, See Figure 7-4	85	130	ns	
t _{PLZ} Output disable time from low level	R _L = 110 Ω, See Figure 7-5	20	40	ns	

6.8 Switching Characteristics – Receiver

V_{CC} = 5 V, C_L = 15 pF, T_A = 25°C

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
t _{PLH} Propagation delay time, low-to-high-level output	V _{ID} = -1.5 V to 1.5 V, See Figure 7-6	21	35	ns	
t _{PHL} Propagation delay time, high-to-low-level output		23	35	ns	
t _{PZH} Output enable time to high level	See Figure 7-7	10	30	ns	
t _{PZL} Output enable time to low level	See Figure 7-7	12	30	ns	
t _{PHZ} Output disable time from high level	See Figure 7-7	20	35	ns	
t _{PLZ} Output disable time from low level	See Figure 7-7	17	25	ns	

Interfaces serie

USB (Universal Serial Bus)

- USB 1.0/Low-Speed: 1,5 Megabits por segundo (Mbps)



- USB 1.1/Full-Speed: 12 Mbps



- USB 2.0/Hi-Speed: 480 Mbps



- USB 3.0/SuperSpeed: 5 Gbps



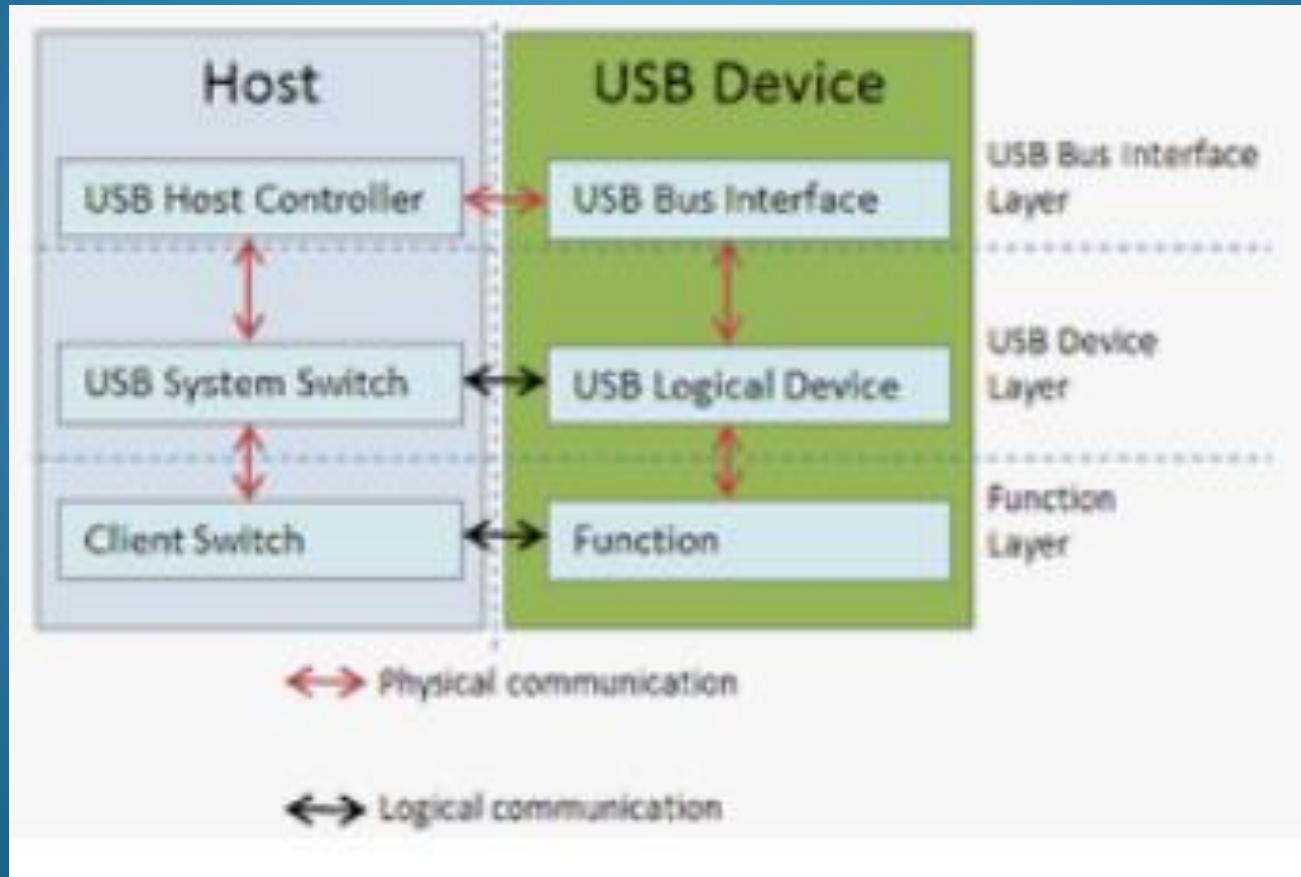
- USB 3.1/SuperSpeed: 10 Gbps



<https://www.usb.org/documents>

Interfaces serie

USB (Universal Serial Bus)



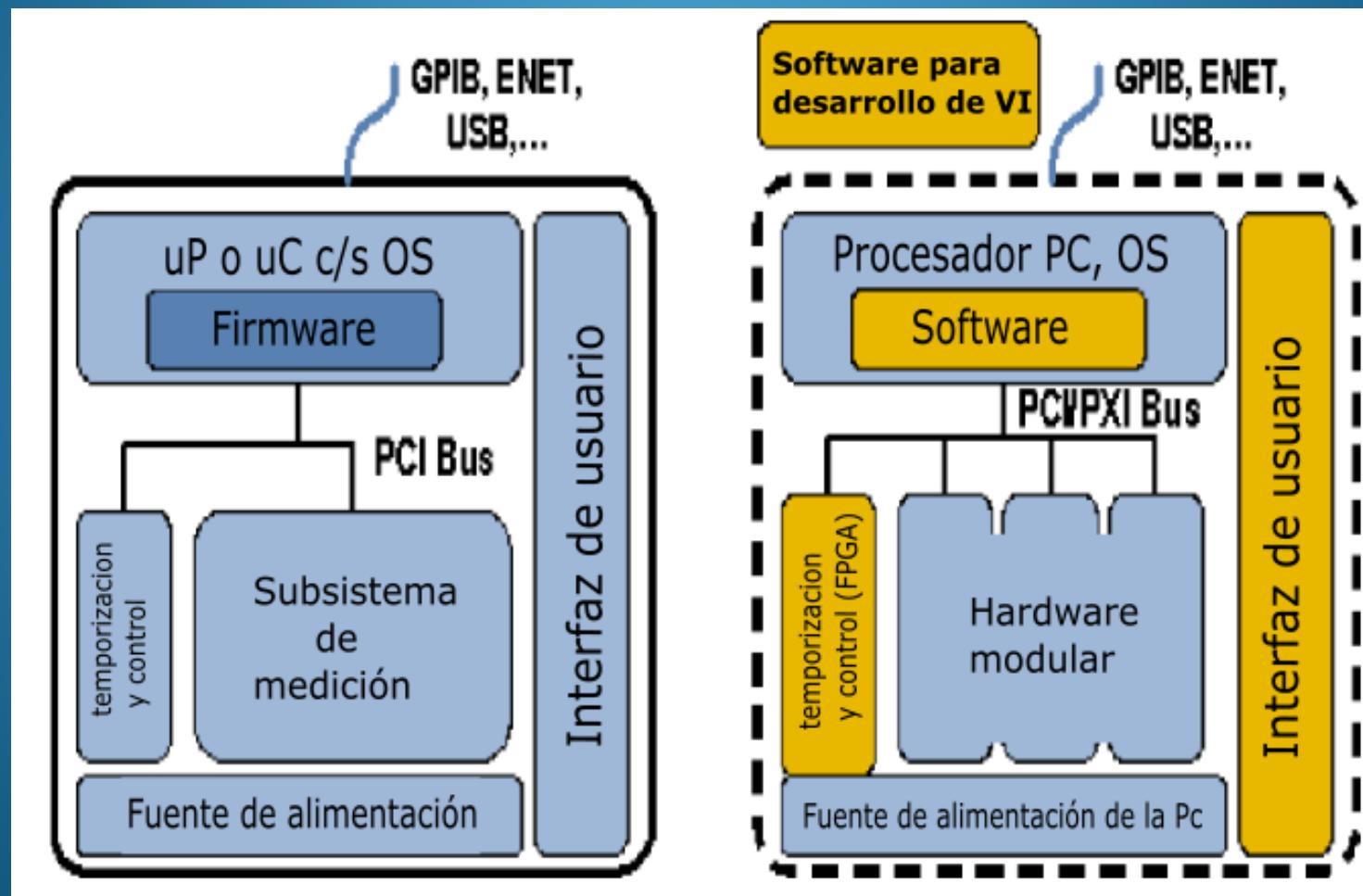
Ventajas de la instrumentación virtual

Flexibilidad: Fácilmente se pueden agregar funciones, como filtros, datos, combinar datos etc. Es posible desarrollar una gran variedad de sistemas definidos por usuario que sean capaces de satisfacer las necesidades específicas de una aplicación, ya sea científica o industrial.

Capacidad de almacenamiento: La instrumentación virtual permite utilizar la capacidad de almacenamiento de las computadoras actuales para almacenar datos, esto habilita la posibilidad de aplicar post procesamiento y algoritmos avanzados de análisis.

Capacidad de visualización: Los monitores de computadora, así como las actuales placas de video presentan mas calidad de imagen que las pantallas clásicas de los instrumentos, además es posible de dotarlas de otras cualidades como acercamientos, marcas de datos etc.

Instrumentación tradicional vs instrumentación virtual.

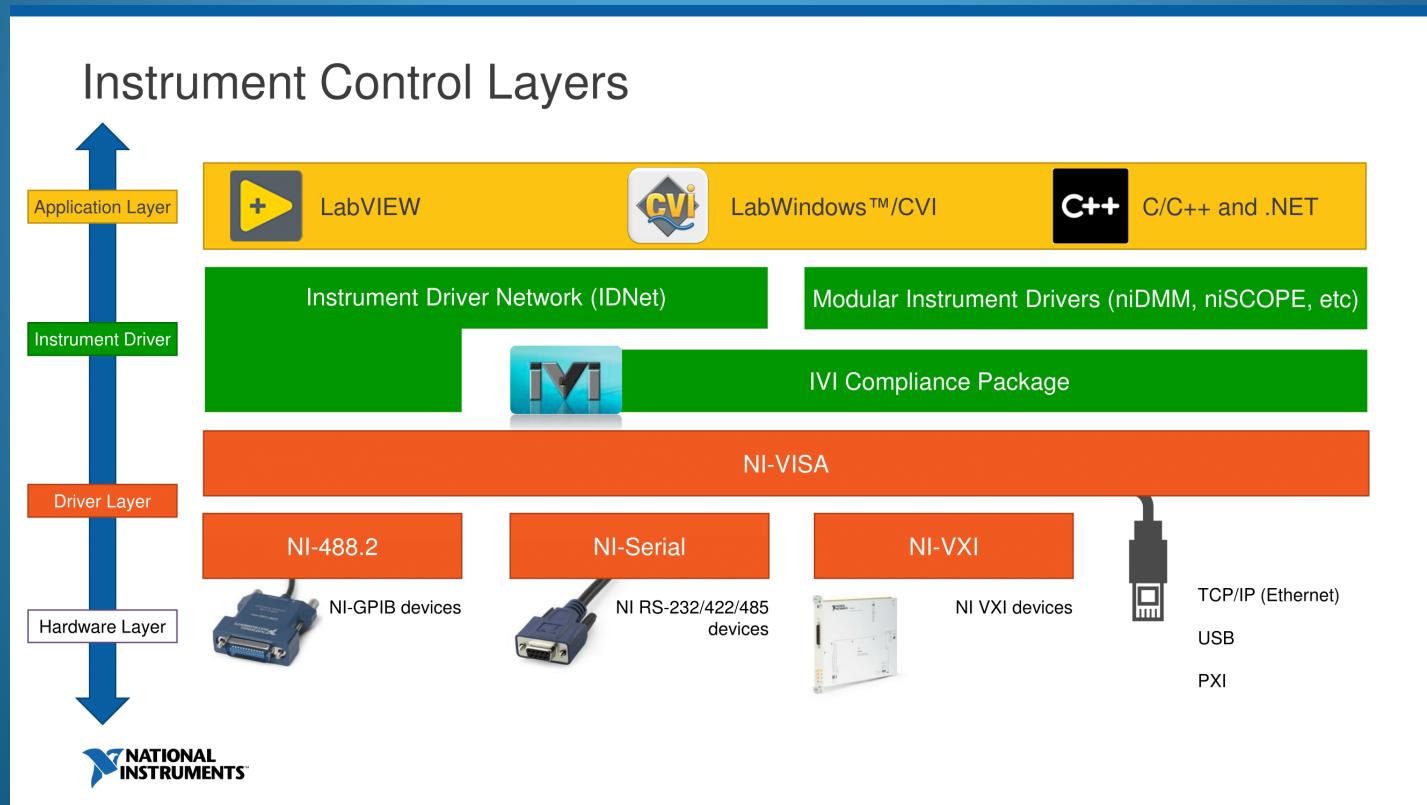


Lenguajes de programación.

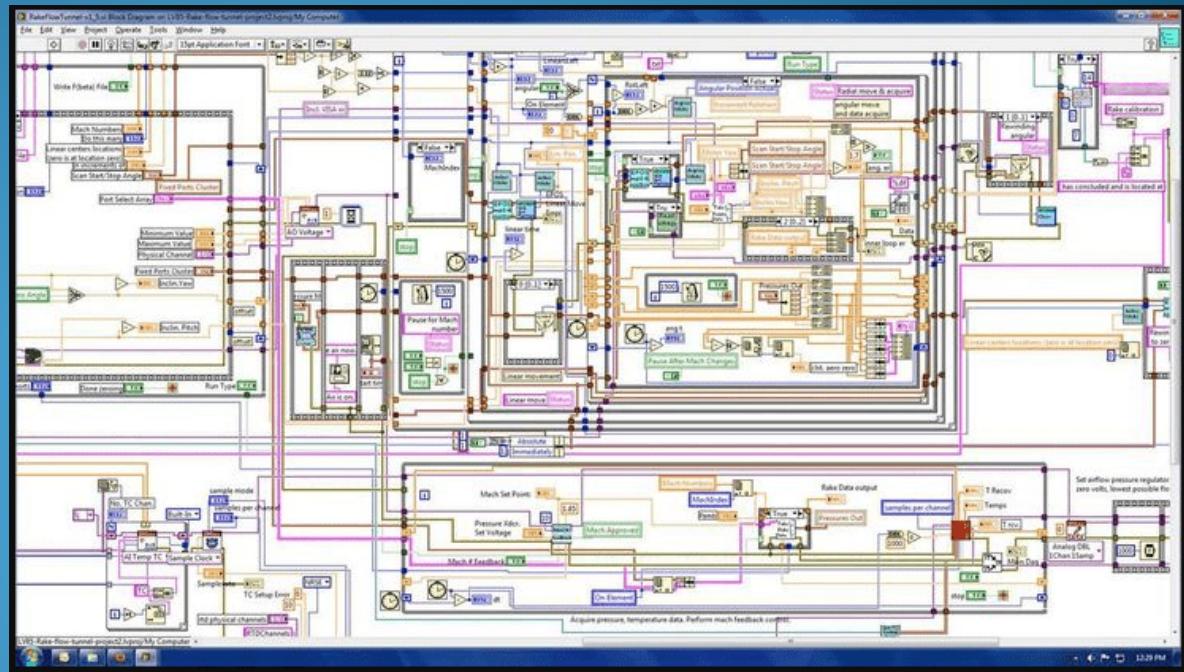
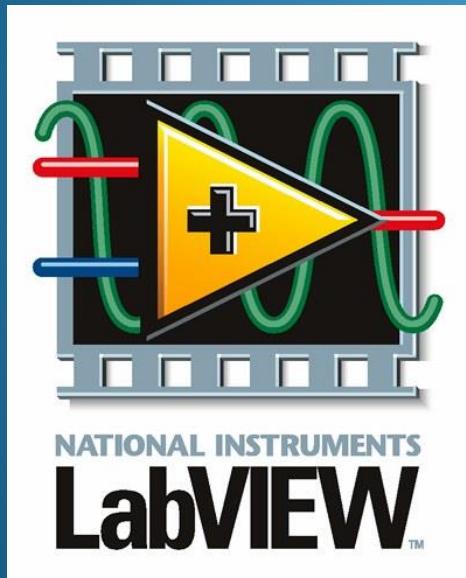
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- ```
graph TD; A[Lenguajes de programación] --> B[Lenguajes de programación convencionales. C, C++, Python, Java, Qt]; A --> C[Herramientas gráficas. LabView]
```
- Lenguajes de programación convencionales. C, C++, Python, Java, Qt
  - Herramientas gráficas.  
LabView

# VISA

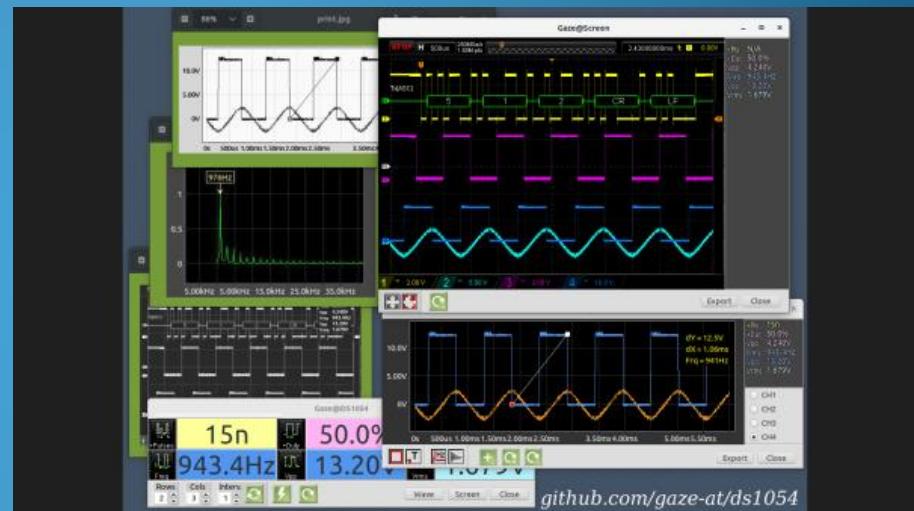
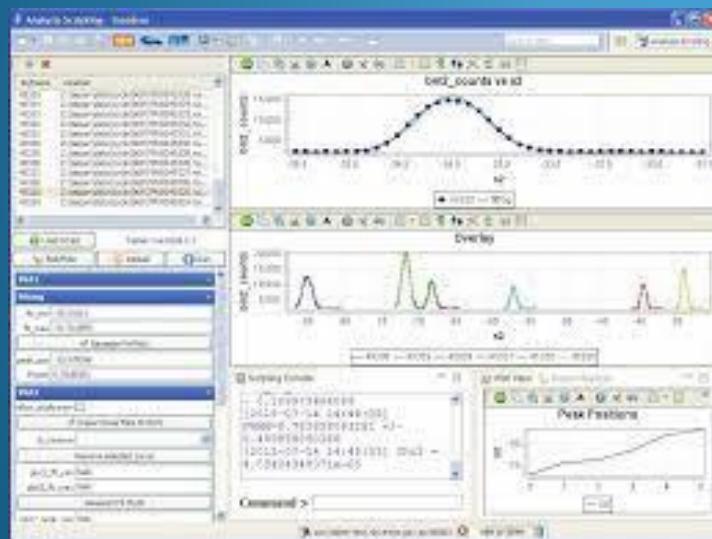
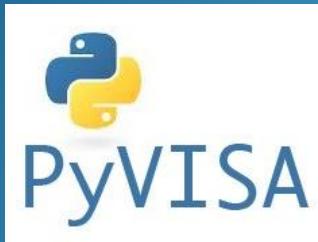
**Virtual instrument software architecture (VISA)** Arquitectura de software para instrumentos virtuales: Es una interfaz de programación (API) ampliamente usada en la industria de medición y verificación para comunicarse con instrumentos desde la computadora.



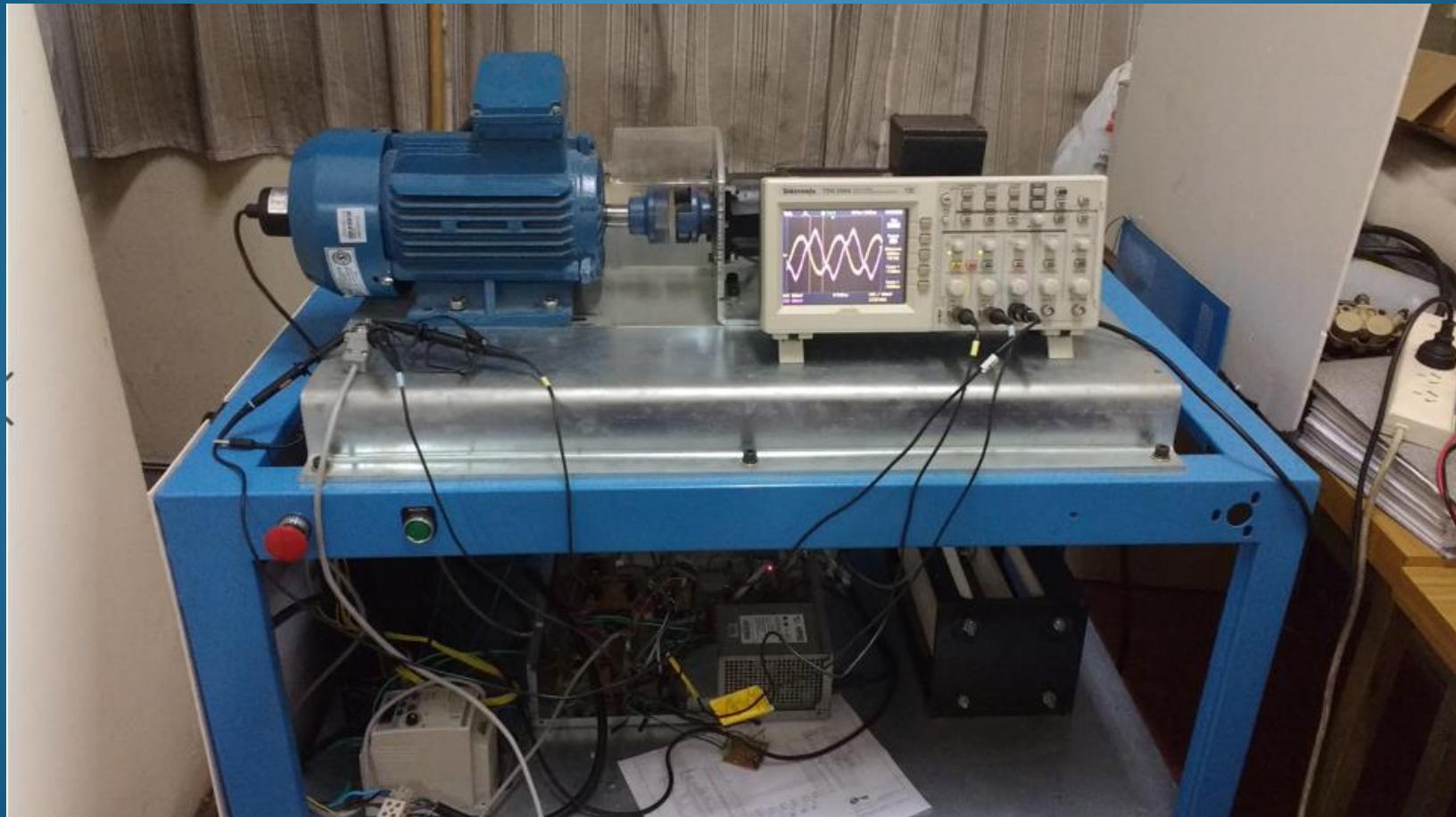
# LabView



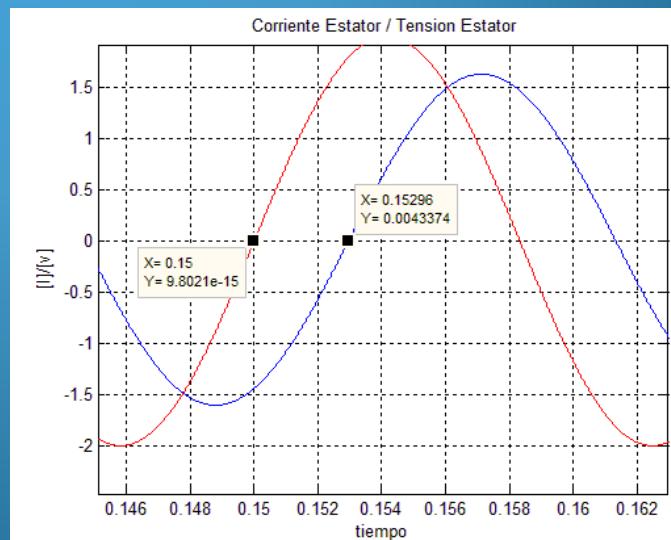
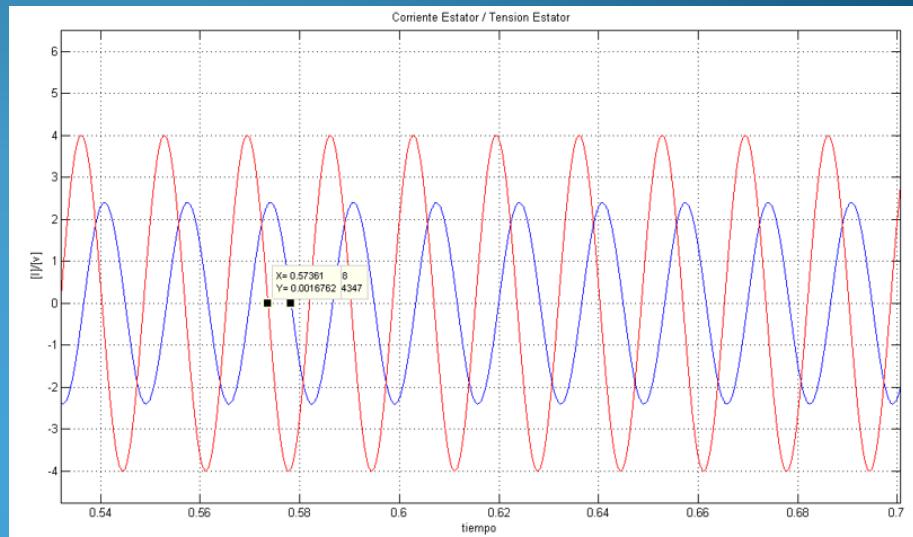
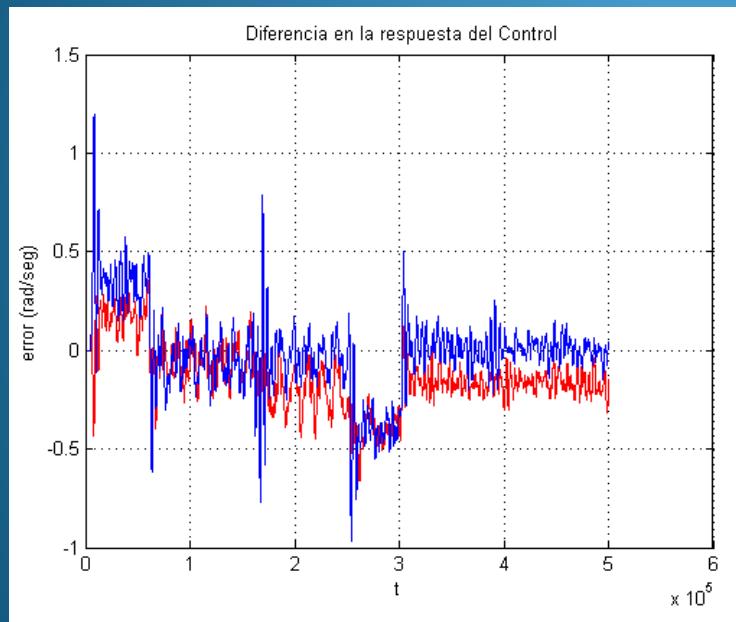
# PyVISA



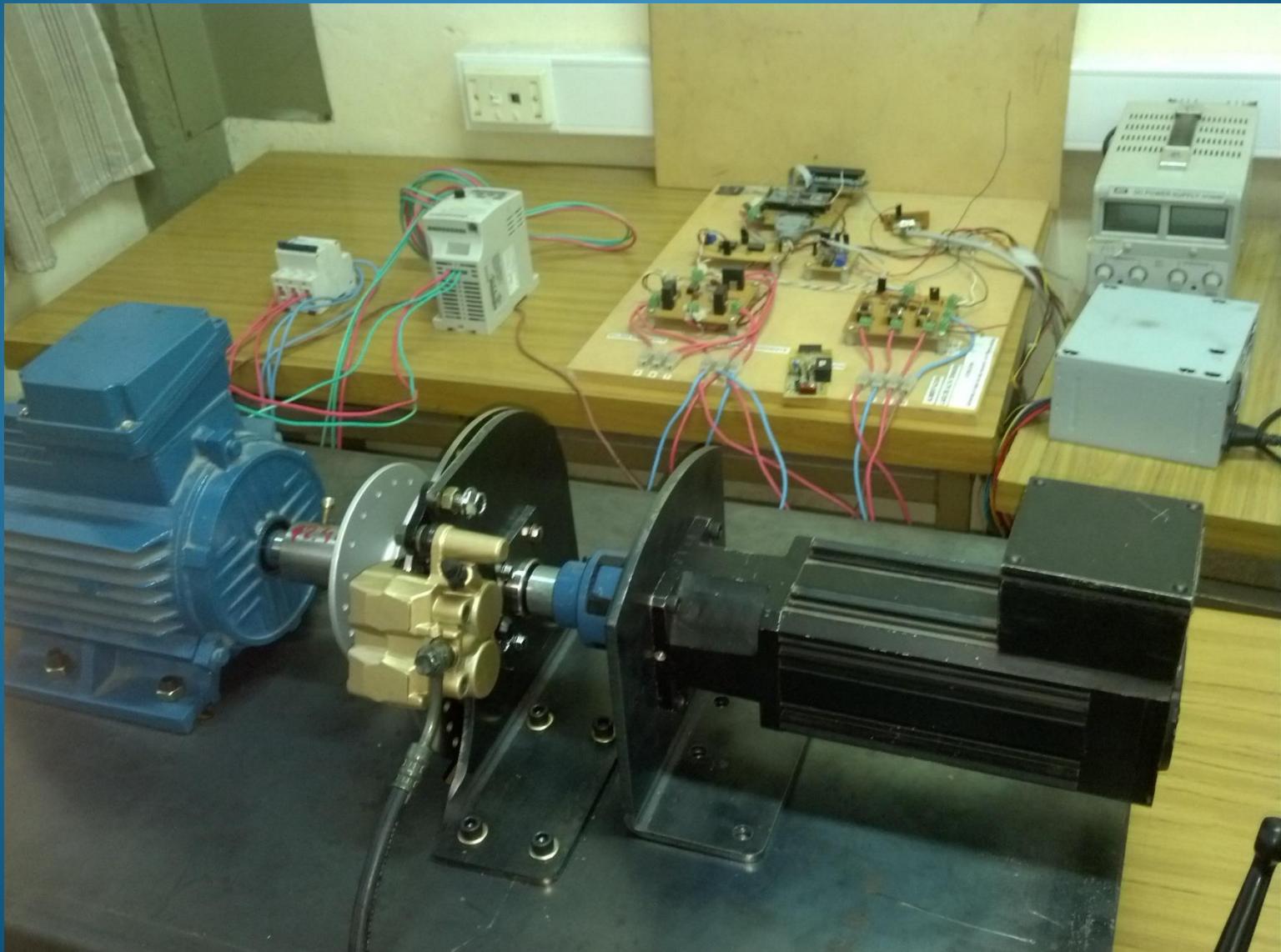
# Ejemplo



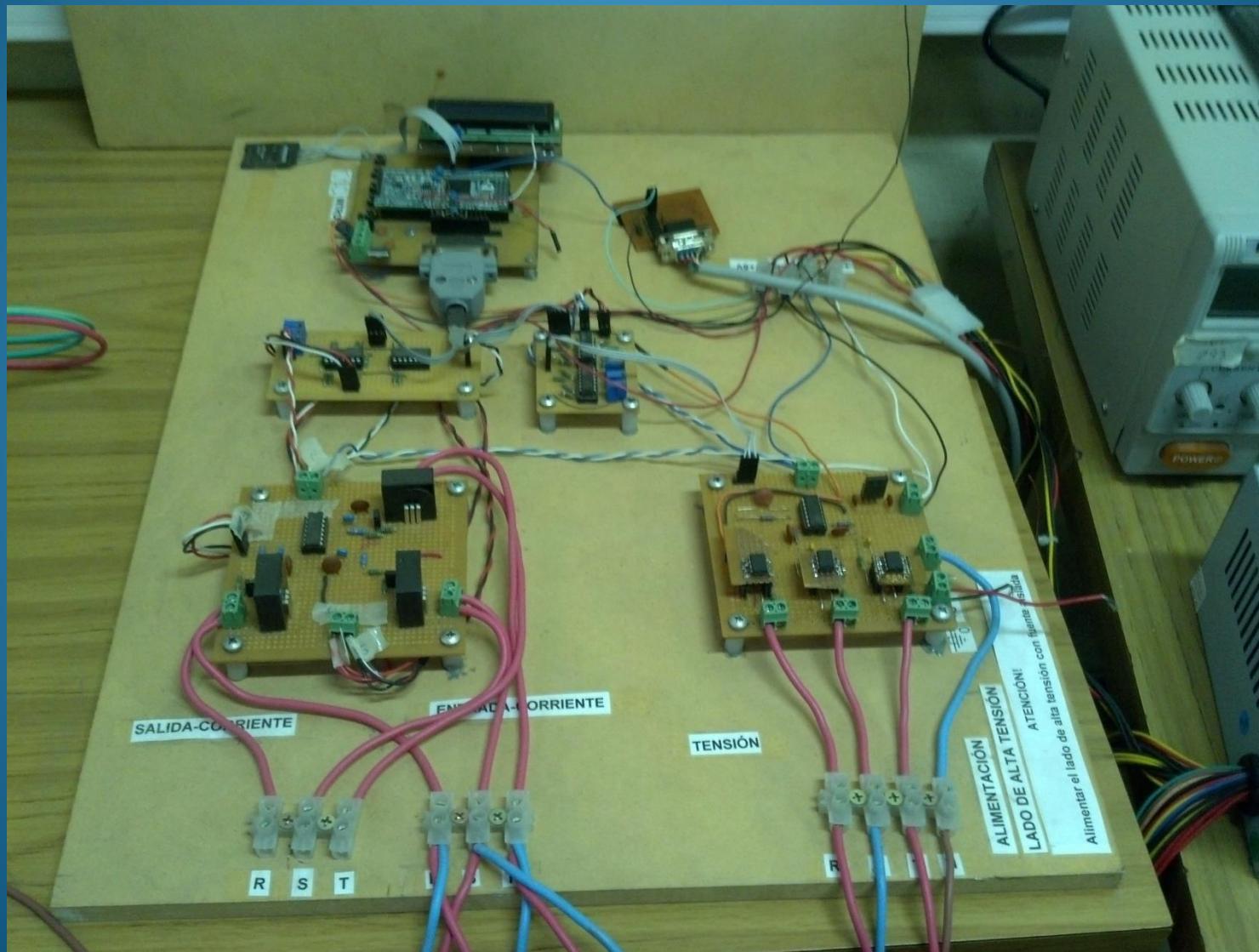
# Ejemplo



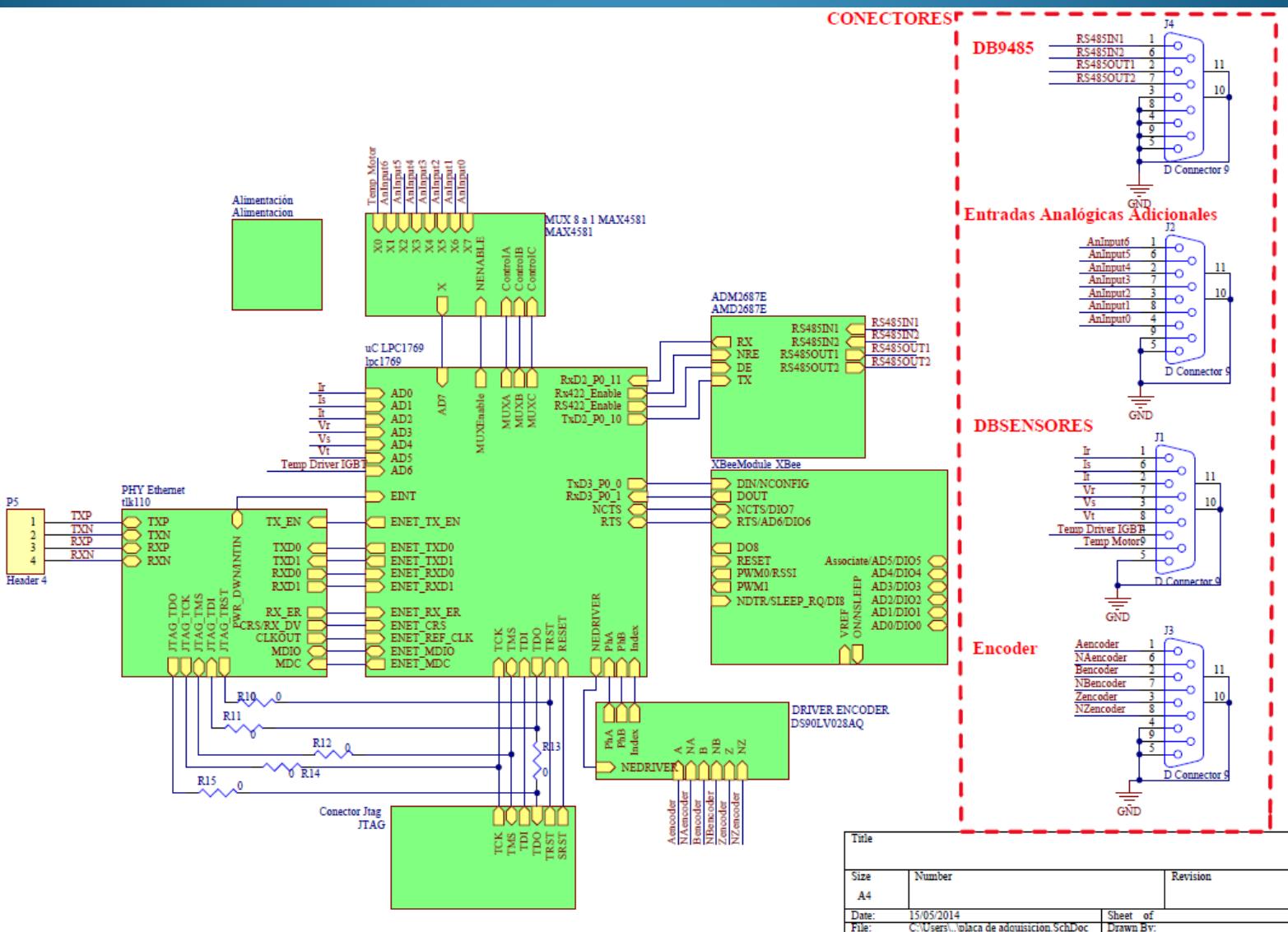
# Ejemplo



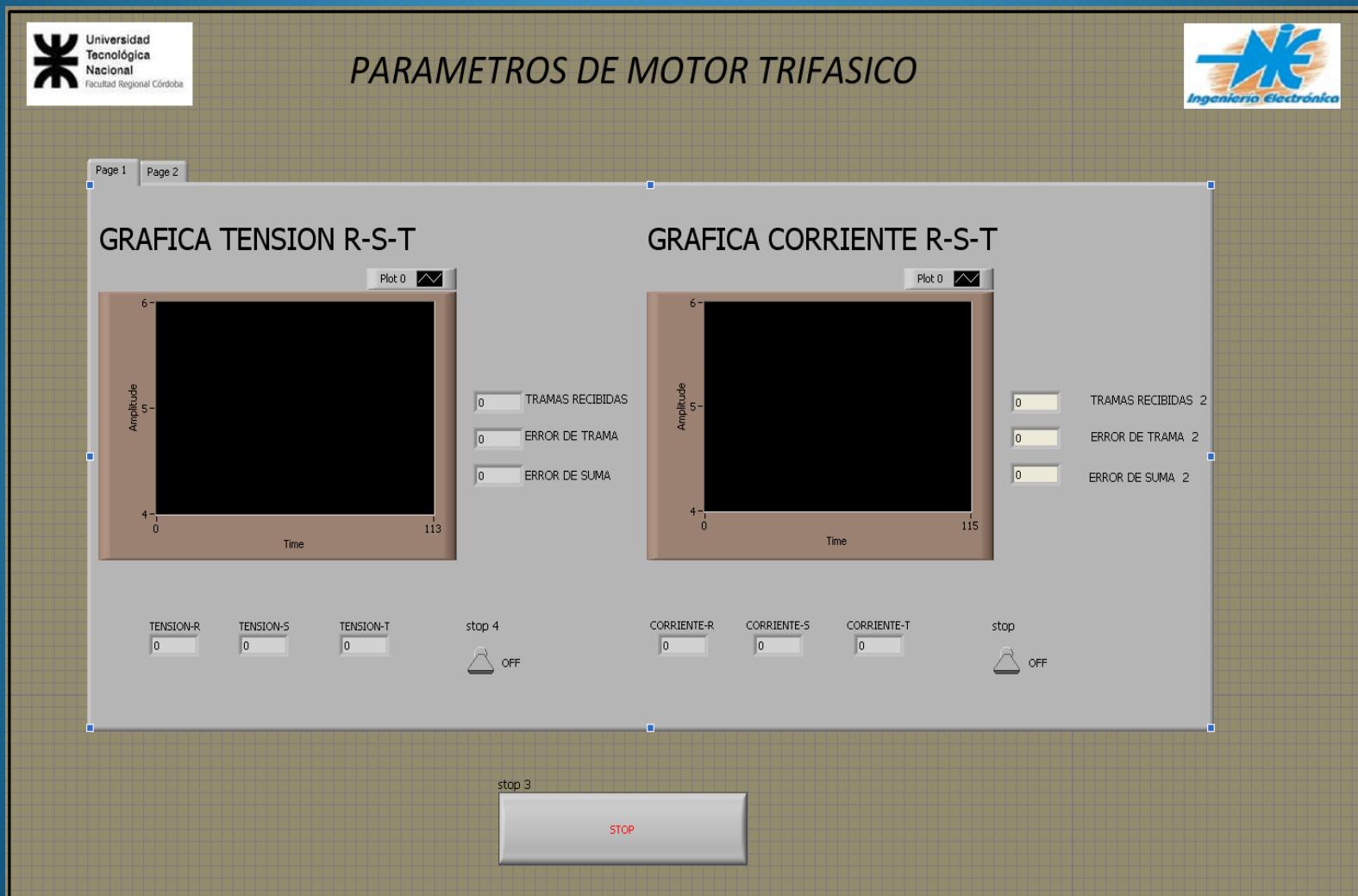
# Ejemplo



# Ejemplo



# Ejemplo



# Implementación Virtual

- Estructura jerárquica y escalable, basada en state machine.
- Código flexible con posibilidad de anexar nuevas etapas.
- Parámetros de comunicaciones configurables.

