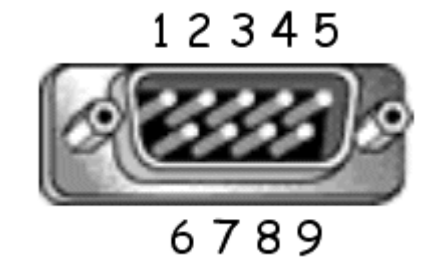
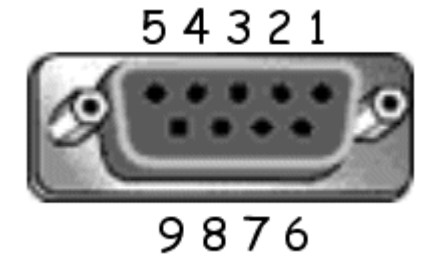


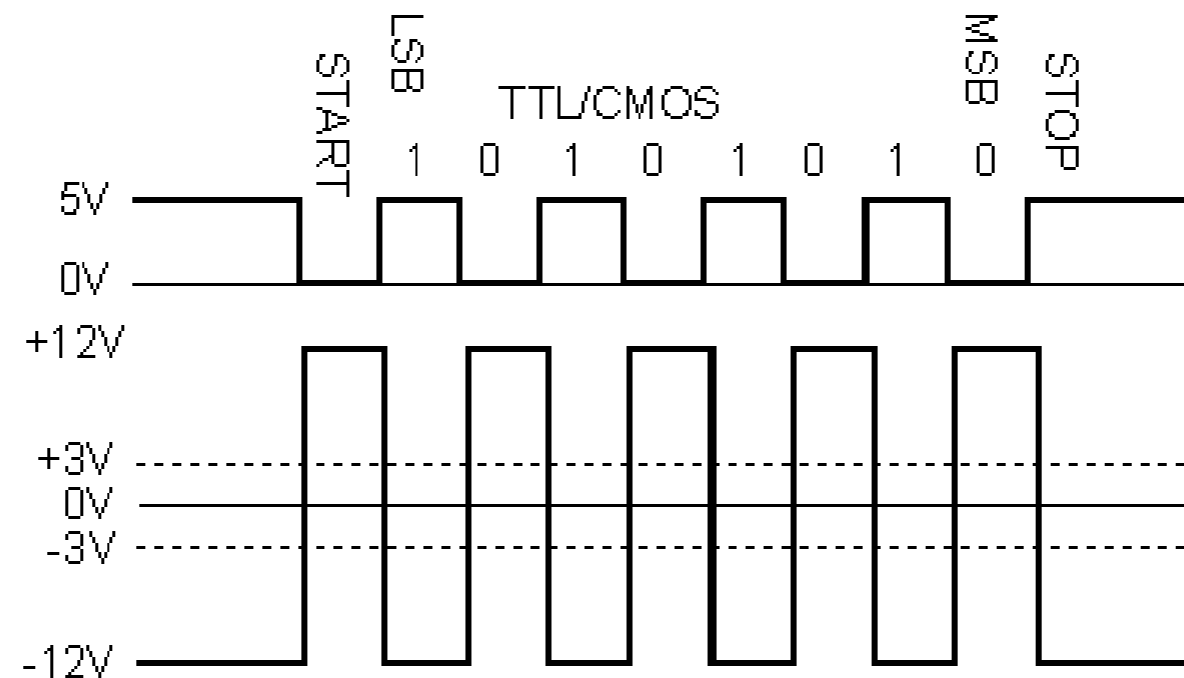
Serielle Datenübertragung

Einführung Teil 1

RS232

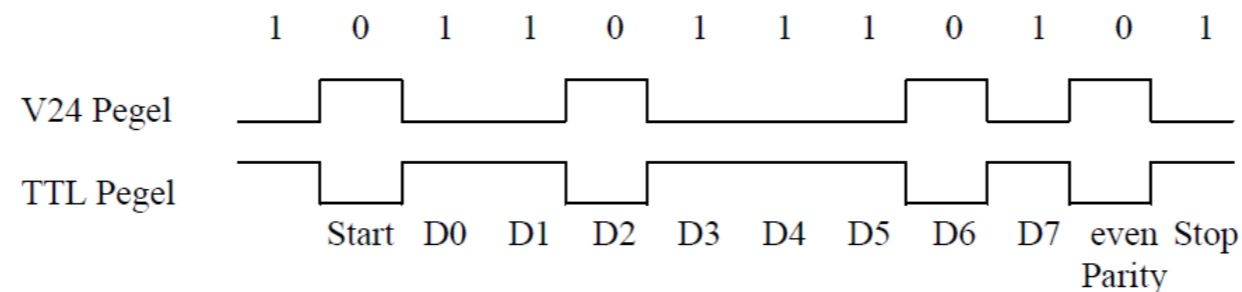


- Pegelspannung
 - -12V bis +12V
 - -12V logisch 1 und +12V logisch 0



RS232

- Hardware Fehlererkennung
 - Even-Parity : Paritätssumme gerade Paritybit = 0
 - Odd-Parity : Paritätssumme gerade Paritybit = 1



- Flusskontrolle
 - Hardware RTS/CTS
 - Software Xon/Xoff 0x11/0x13

RS232

- Leitungslängen
 - Maximal 15 m bei 19200 Baud
- Peer-to-Peer(P2P) Verbindung
 - PC <-> PC (Terminal VT100)
 - PC <-> Modem

RS232

- Belegung
 - DSUB Stecker 9 polig
 - DSUB Buchse 25 polig

Pin 9 polig	PC	Bedeutung	Pin 25 polig
1	DCD	< Data Carrier Detect	8
2	RxD	< Receive Data	3
3	TxD	> Transmit Data	2
4	DTR	> Data Terminal Ready	20
5	GND	Ground	7
6	DSR	< Data Set Ready	6
7	RTS	> Request to Send	4
8	CTS	< Clear to Send	5
9	RI	< Ring Indicator	22

RS232

- Verwendung
 - Datenübertragung
 - PC <-> PC (Terminal VT100)
 - PC <-> Modem
 - Konfiguration
 - PC <-> Mikrokontroller (Arduino, SPS, Servos ..)

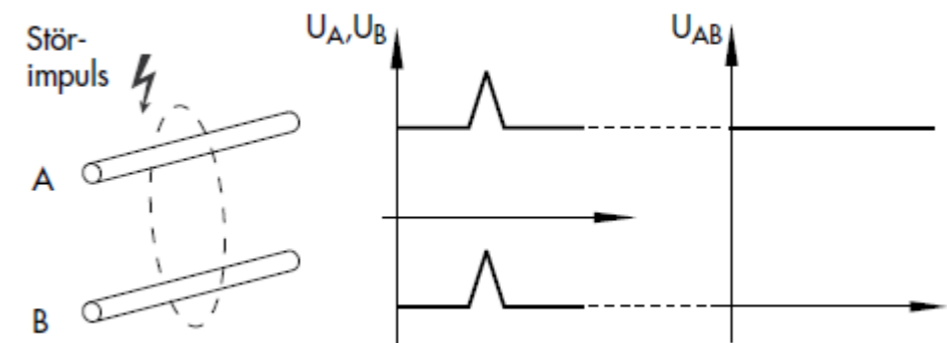
RS232

- Verdrahtung

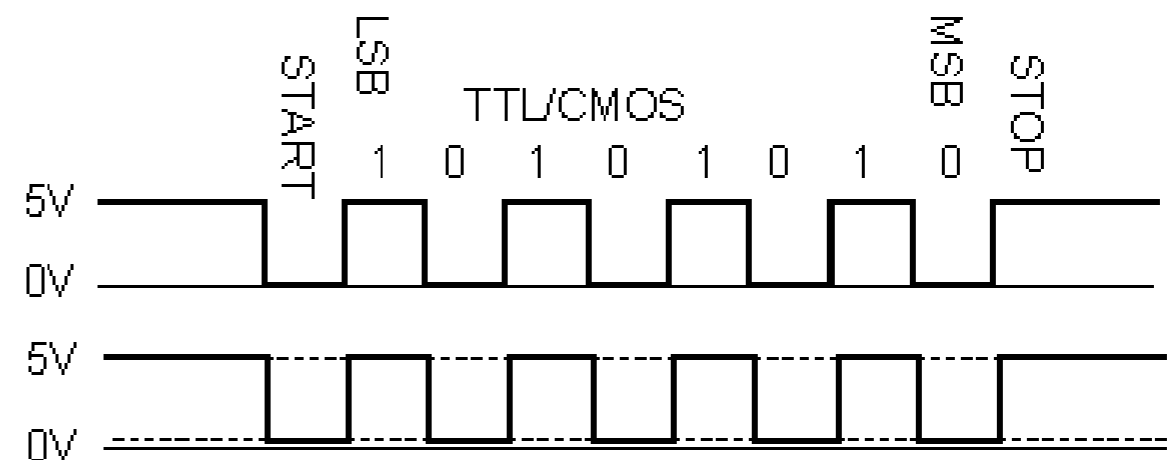


RS485

- Zweidrahtbus
 - Symmetrische Übertragung



- Pegelspannung
 - 0 bis +5V



RS485

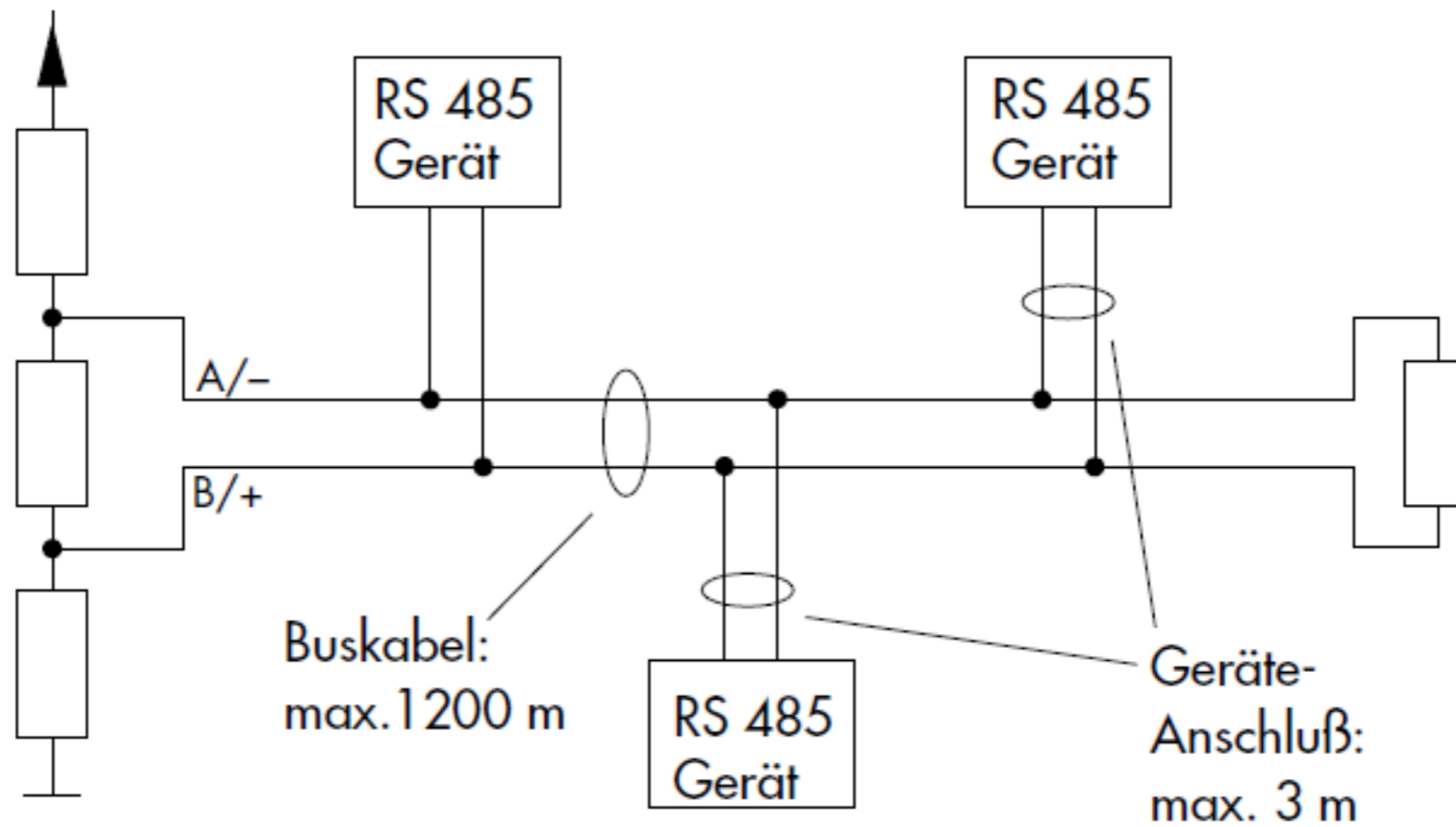
- Leitungslängen

Datenrate [kBit/s]	9,6	187,5	500	1500	12000
Segmentlänge [m]	1200	1000	400	200	100

- 32 (128) Teilnehmer
- Terminierung
 - Anfang und Ende mit 120 Ohm

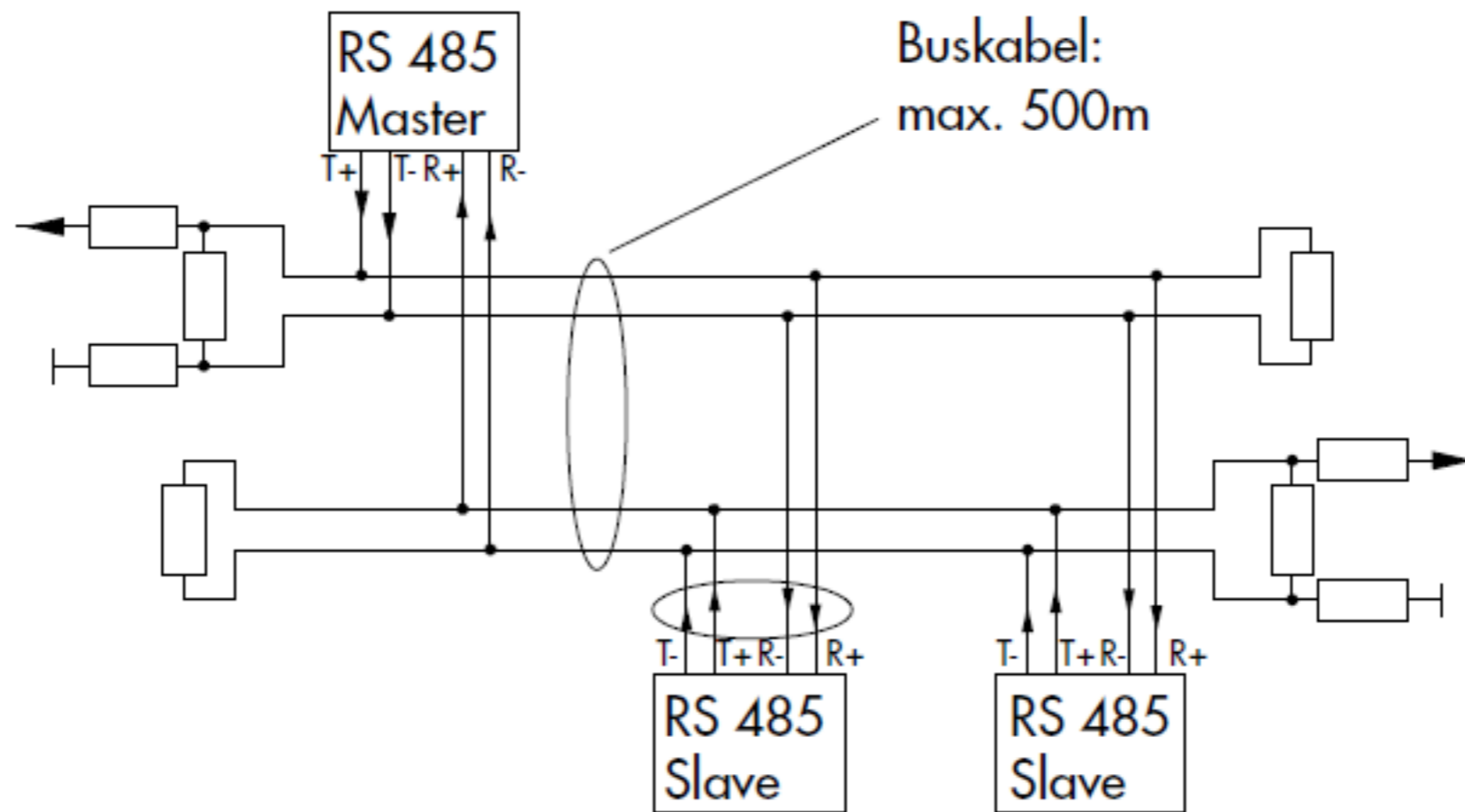
RS485

- Verdrahtung



RS422

- Verdrahtung

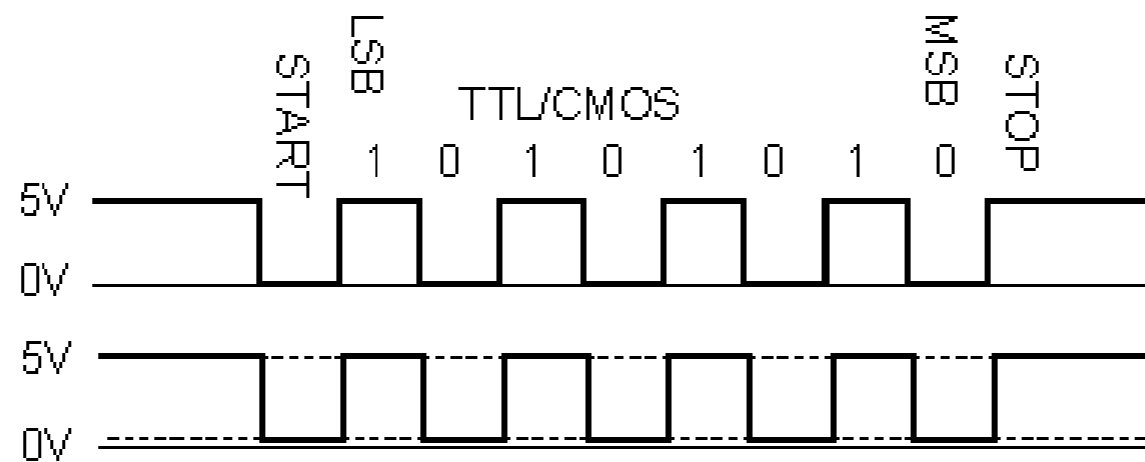


RS485

- Verwendung
 - Bussystem mit mehreren Teilnehmern
 - Hochgeschwindigkeits-Datenübertragung

CAN

- Pegelspannung
 - 0V bis +5V



CAN

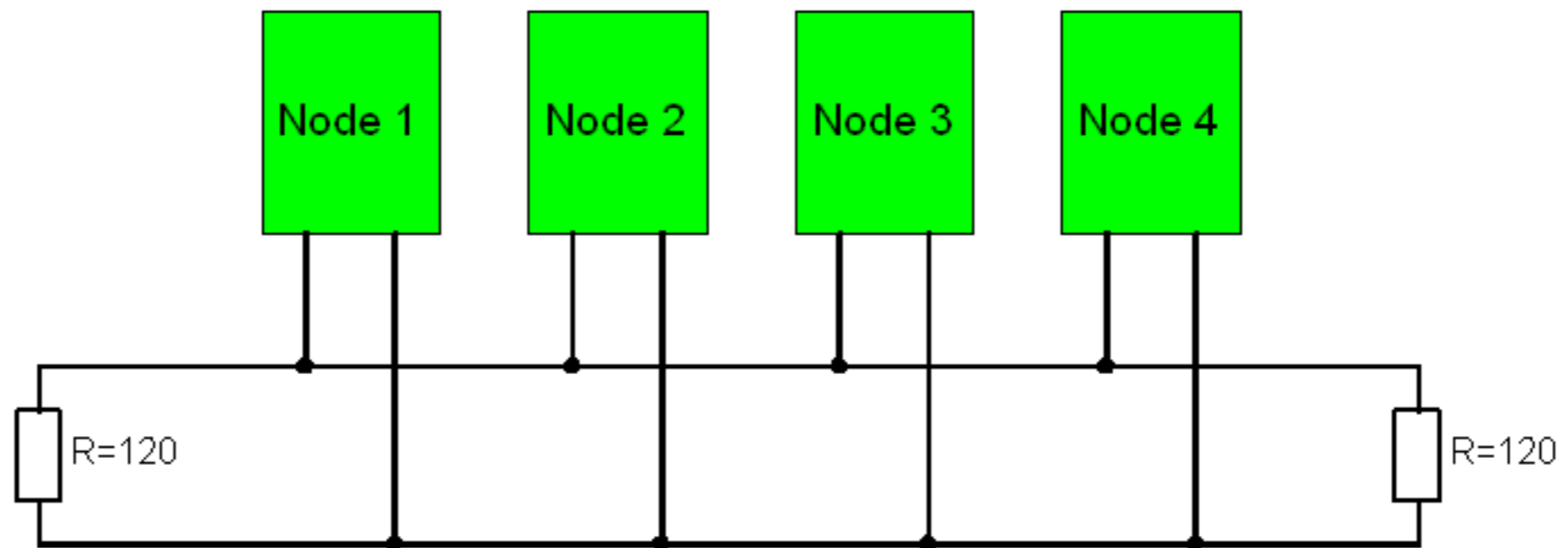
- Leitungslängen

Bitrate	Kabellänge
10 kbits/s	6,7 km
20 kbits/s	3,3 km
50 kbits/s	1,3 km
125 kbits/s	530 m
250 kbits/s	270 m
500 kbits/s	130 m
1 Mbits/s	40 m

- 128 Teilnehmer
- Terminierung
 - Anfang und Ende mit 120 Ohm

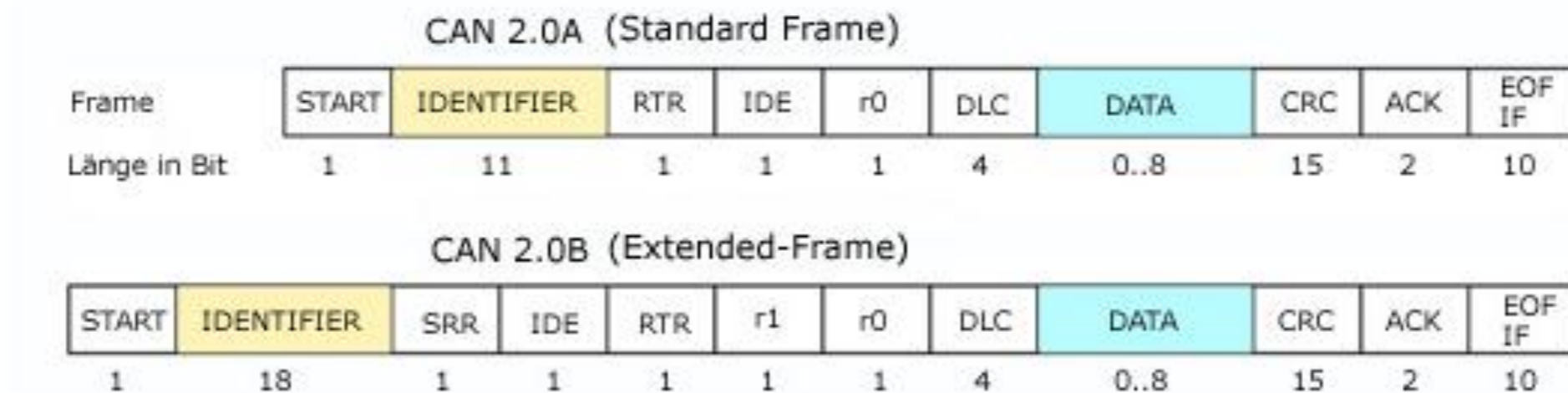
CAN

- Verdrahtung



CAN

- Protokoll
 - CAN Frame



CAN

- SDO Service Data Objects

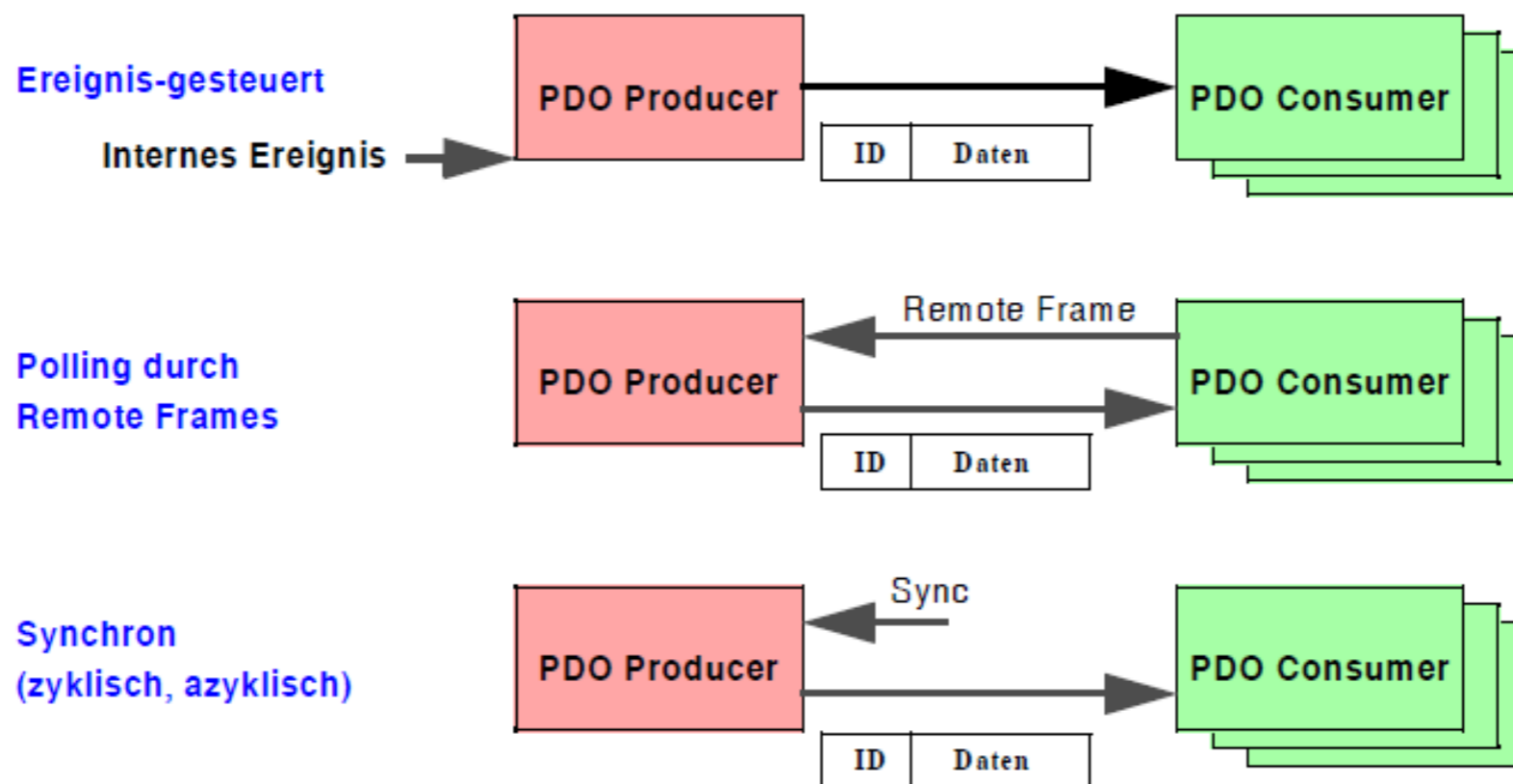
Objekt	Funktion	Function Code	resultierende COB ID	
			hex	dez
Emergency	Status / Fehler	1	0x81 - 0xFF	129 - 255
PDO1 (tx)	dig. Eingänge	11	0x181 - 0x1FF	385 - 511
PDO1 (rx)	digitale Ausgänge	100	0x201 - 0x27F	513 - 639
PDO2 (tx)	analoge Eingänge	101	0x281 - 0x2FF	641 - 767
PDO2 (rx)	analoge Ausgänge	110	0x301 - 0x37F	769 - 895
PDO3 (tx)	analoge Eingänge*	111	0x381 - 0x3FF	897 - 1023
PDO3 (rx)	analoge Ausgänge*	1000	0x401 - 0x47F	1025 - 1151
PDO4 (tx)	analoge Eingänge*	1001	0x481 - 0x4FF	1153 - 1279
PDO4 (rx)	analoge Ausgänge*	1010	0x501 - 0x57F	1281 - 1407
SDO (tx)	Parameter	1011	0x581 - 0x5FF	1409 - 1535
SDO (rx)	Parameter	1100	0x601 - 0x67F	1537 - 1663
Guarding	Life-/Node-guarding, Heartbeat, Boot-Up Nachricht	1110	0x701 - 0x77F	1793 - 1919

- NMT SYNC

Objekt	Funktion	Function Code	resultierende COB ID	
			hex	dez
NMT	Boot-Up	0	0x00	0
SYNC	Synchronisation	1	0x80	128

CAN

- PDO Process Data Objects



CAN

- Verwendung
 - Automobile
 - Industrieanlagen

Modbus

- **Protokolleigenschaften**
 - Master / Slave Kommunikationsprotokoll

- **Anwendung**
 - Industrie
 - Schiffsbau

Modbus

- Protokollaufbau
 - RTU Mode

Start	Adresse	Funktion	Daten	CR-Check	Ende
Wartezeit (min. 3,5 Zeichen)	1 Byte	1 Byte	n Byte	2 Byte	Wartezeit (min 3,5 Zeichen)

- ASCII Mode

Start	Adresse	Funktion	Daten	LR-Check	Ende
1 Zeichen (:)	2 Zeichen	2 Zeichen	n Zeichen	2 Zeichen	2 Zeichen (CRLF)

- TCP/UDP

Transaktionsnummer	Protokollkennzeichen	Zahl der noch folgenden Bytes	Adresse	Funktion	Daten
2 Byte	2 Byte (immer 0x0000)	2 Byte (n+2)	1 Byte	1 Byte	n Byte

NMEA

- Protokolleigenschaften
 - ASCII Kommunikationsprotokoll
- Protokollaufbau

```
$GPRMC,162614,A,5230.5900,N,01322.3900,E,10.0,90.0,131006,1.2,E,A*13  
$GPRMC,HHMMSS,A,BBBB.BBBB,b,LLLLL.LLLL,1,GG.G,RR.R,DDMMYY,M.M,m,F*PP
```

- Anwendung
 - Schiffsbau
 - GPS Navigationsgeräte

Geräte-IDs

NMEA

ID	Bedeutung
AG	Autopilot - General
AP	Autopilot - Magnetic
CC	Computer - Programmed Calculator (outdated)
CD	Communications - Digital Selective Calling (DSC)
CM	Computer - Memory Data (outdated)
CS	Communications - Satellite
CT	Communications - Radio-Telephone (MF/HF)
CV	Communications - Radio-Telephone (VHF)
CX	Communications - Scanning Receiver
DE	DECCA Navigation
DF	Direction Finder
EC	Elektronische Seekarte (ECDIS)
EP	Emergency Position Indicating Beacon (EPIRB)
ER	Engine Room Monitoring Systems
GA	Galileo
GL	GLONASS
GP	Global Positioning System (GPS)
HC	Heading - Magnetic Compass
HE	Heading - North Seeking Gyro
HN	Heading - Non North Seeking Gyro
II	Integrated Instrumentation
IN	Integrated Navigation
LA	Loran A
LC	Loran C
MP	Microwave Positioning System (outdated)
OM	OMEGA Navigation System

ID	Bedeutung
OS	Distress Alarm System (outdated)
P	proprietäre Erweiterungen
PF	FLARM
RA	RADAR and/or ARPA
SD	Sounder, Depth
SN	Electronic Positioning System, other/general
SS	Sounder, Scanning
TI	Turn Rate Indicator
TR	TRANSIT Navigation System
VD	Velocity Sensor, Doppler , other/general
DM	Velocity Sensor, Speed Log, Water, Magnetic
VW	Velocity Sensor, Speed Log, Water, Mechanical
WI	Weather Instruments
YC	Transducer - Temperature (outdated)
YD	Transducer - Displacement, Angular or Linear (outdated)
YF	Transducer - Frequency (outdated)
YL	Transducer - Level (outdated)
YP	Transducer - Pressure (outdated)
YR	Transducer - Flow Rate (outdated)
YT	Transducer - Tachometer (outdated)
YV	Transducer - Volume (outdated)
YX	Transducer
ZA	Timekeeper - Atomic Clock
ZC	Timekeeper - Chronometer
ZQ	Timekeeper - Quartz
ZV	Timekeeper - Radio Update, WWV (Zeitzeichensender) oder WWVH

NMEA

Datensatz-ID RMC Recommended Minimum Sentence C

```
$GPRMC,162614,A,5230.5900,N,01322.3900,E,10.0,90.0,131006,1.2,E,A*13  
$GPRMC,HHMMSS,A,BBBB.BBBB,b,LLLLL.LLLL,1,GG.G,RR.R,DDMMYY,M.M,m,F*PP
```

Symbol	Bedeutung
HHMMSS oder HHMMSS.SSS	Zeit (UTC)
A	Status (A für OK, V bei Warnungen)
BBBB.BBBB	Breitengrad
b	Ausrichtung (N für North, nördlich; S für South, südlich)
LLLLL.LLLL	Längengrad
l	Ausrichtung (E für East, östlich; W für West, westlich)
GG.G	Geschwindigkeit über Grund in Knoten
RR.R	Kurs über Grund in Grad bezogen auf geogr. Nord
DDMMYY	Datum (Tag Monat Jahr)
M.M	magnetische Abweichung (Ortsmissweisung)
m	Vorzeichen der Abweichung (E oder W)
F	Signalintegrität : A = Autonomous mode, D = Differential Mode, E = Estimated (dead-reckoning) mode M = Manual Input Mode S = Simulated Mode N = Data Not Valid
PP	hexadezimale Darstellung der Prüfsumme (Die Prüfsumme ergibt sich durch eine XOR-Verknüpfung aller Daten-Bytes zwischen (jeweils exklusive) dem Dollar-Zeichen '\$' und dem Stern '*'.)

Links

- Serielle Übertragung
 - http://www.samson.de/pdf_de/l153de.pdf
- CAN Einführung
 - http://www.microcontrol.net/download/appnotes/canopen_intro.pdf
- Modbus
 - <https://www.auto.tuwien.ac.at/LVA/HGA/stp/schaller.pdf>
- NMEA
 - <http://www.kowoma.de/gps/zusatzerklaerungen/NMEA.htm>

Serial Quick Reference Guide

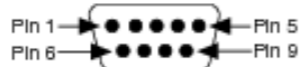
10-Position Modular Jack



Pin	232	422/485
1	No Connect	No Connect
2	RI ¹	TXD-
3	CTS	TXD+
4	RTS	RTS- (HSO-)
5	DSR ¹	CTS- (HSI-)
6	GND	RXD-
7	DTR ¹	RXD+
8	TXD	RTS+ (HSO+)
9	RXD	CTS+ (HSI+)
10	DCD ¹	GND

¹ These signals are "No Connect" on the PCI-232I and PXI-8422 ports.

DB-9 Male

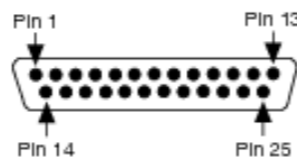


Pin	232 DTE	232 DCE	422/485
1	DCD ²	DCD	GND
2	RXD	TXD	CTS+ (HSI+)
3	TXD	RXD	RTS+ (HSO+)
4	DTR ²	DSR	RXD+
5	GND	GND	RXD-
6	DSR ²	DTR	CTS- (HSI-)
7	RTS	CTS	RTS- (HSO-)
8	CTS	RTS	TXD+
9	RI ²	RI	TXD-

Note: DCE mode supported on USB-232/2 and USB-232/4 only.

² These signals are "No Connect" on the PCI-232I and PXI-8422 ports and ports 9-16 on 16-port boards.

DB-25 Male

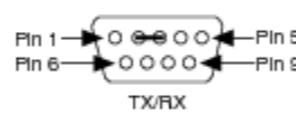


Pin	232	422/485
2	TXD	RTS+ (HSO+)
3	RXD	CTS+ (HSI+)
4	RTS	RTS- (HSO-)
5	CTS	TXD+
6	DSR ³	CTS- (HSI-)
7	GND	RXD-
8	DCD ³	GND
20	DTR ³	RXD+
22	RI ³	TXD-

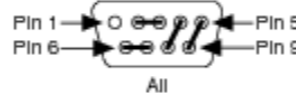
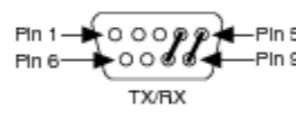
Pins not listed in this table are "No Connect."

³ These signals are "No Connect" on the PCI-232I and PXI-8422 ports.

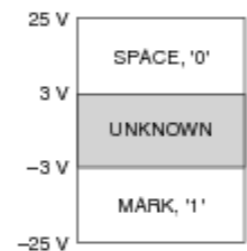
RS-232 Loopback



RS-485/422 Loopback



RS-232 Signals



RS-485/422 Signals

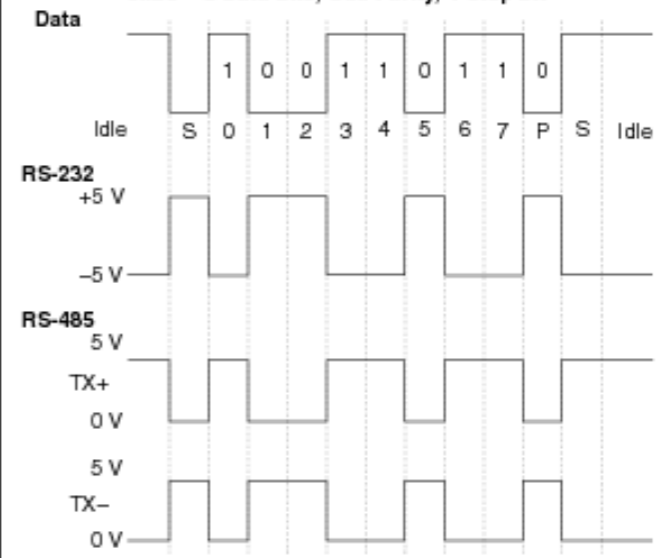
If '-' < '+'
then MARK, '1'

If '-' > '+'
then SPACE, '0'

RS-422 Voltage: ± 7V
RS-485 Voltage: -7V to +12 V

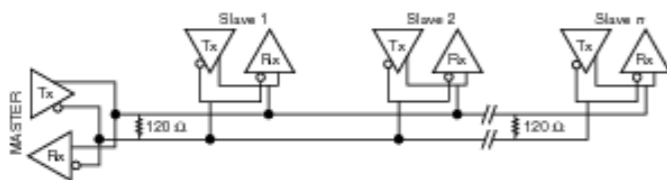
UART Data Frame Example

0x09—8 Data Bits, Odd Parity, 1 Stop Bit

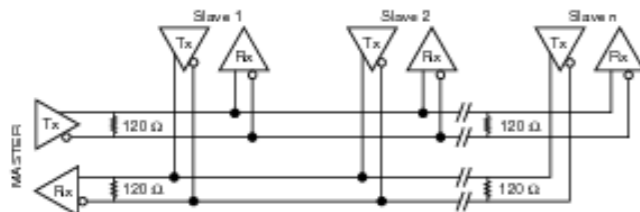


Voltagess are for illustration only. Actual voltage levels may vary.

RS-485 Topologies



2-Wire Multidrop Network Using Terminating Resistors



4-Wire Full-Duplex Multidrop Network Using Terminating Resistors

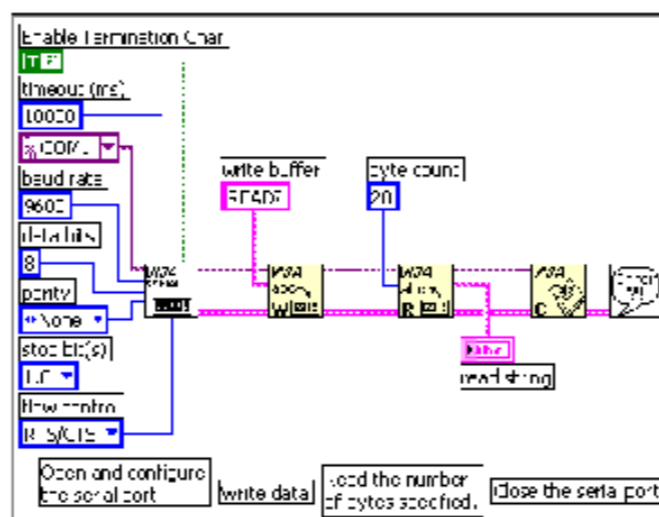
RS-485 terminators are available at ni.com/serial.

RS-485 Transceiver Control

Enable	4-Wire	2-Wire		
		DTR/Echo	DTR/No Echo	Auto
TX	ON	DTR	DTR	TX
RX	ON	ON	DTR	TX

Transceiver control is available on all NI Serial RS-485 interface products.

LabVIEW Programming Example



For more information about LabVIEW, refer to ni.com/labview.

NI-Serial Features

- | | |
|---|---|
| Hardware <ul style="list-style-type: none"> Flexible baud rates up to 3 Mb/s High-performance DMA engine Isolation up to 2000 V RS-485 transceiver control | Software <ul style="list-style-type: none"> Deterministic control with LabVIEW Real-Time Over 3000 instrument drivers online Powerful development tools |
|---|---|

For more information about NI Serial products, refer to ni.com/serial.

ASCII Table

Dec	Hex	Char	Dec	Hex	Char	Dec	Hex	Char	Dec	Hex	Char
0	0x00	(nul)	32	0x20	(sp)	64	0x40	@	96	0x60	`
1	0x01	(soh)	33	0x21	!	65	0x41	A	97	0x61	a
2	0x02	(stx)	34	0x22	"	66	0x42	B	98	0x62	b
3	0x03	(etx)	35	0x23	#	67	0x43	C	99	0x63	c
4	0x04	(eot)	36	0x24	\$	68	0x44	D	100	0x64	d
5	0x05	(enq)	37	0x25	%	69	0x45	E	101	0x65	e
6	0x06	(ack)	38	0x26	&	70	0x46	F	102	0x66	f
7	0x07	(bel)	39	0x27	'	71	0x47	G	103	0x67	g
8	0x08	(bs)	40	0x28	(	72	0x48	H	104	0x68	h
9	0x09	(tab)	41	0x29	)	73	0x49	I	105	0x69	i
10	0x0A	(lf)	42	0x2A	*	74	0x4A	J	106	0x6A	j
11	0x0B	(vt)	43	0x2B	+	75	0x4B	K	107	0x6B	k
12	0x0C	(ff)	44	0x2C	,	76	0x4C	L	108	0x6C	l
13	0x0D	(cr)	45	0x2D	-	77	0x4D	M	109	0x6D	m
14	0x0E	(so)	46	0x2E	.	78	0x4E	N	110	0x6E	n
15	0x0F	(si)	47	0x2F	/	79	0x4F	O	111	0x6F	o
16	0x10	(dle)	48	0x30	0	80	0x50	P	112	0x70	p
17	0x11	(dc1)	49	0x31	1	81	0x51	Q	113	0x71	q
18	0x12	(dc2)	50	0x32	2	82	0x52	R	114	0x72	r
19	0x13	(dc3)	51	0x33	3	83	0x53	S	115	0x73	s
20	0x14	(dc4)	52	0x34	4	84	0x54	T	116	0x74	t
21	0x15	(nak)	53	0x35	5	85	0x55	U	117	0x75	u
22	0x16	(syn)	54	0x36	6	86	0x56	V	118	0x76	v
23	0x17	(etb)	55	0x37	7	87	0x57	W	119	0x77	w
24	0x18	(can)	56	0x38	8	88	0x58	X	120	0x78	x
25	0x19	(em)	57	0x39	9	89	0x59	Y	121	0x79	y
26	0x1A	(sub)	58	0x3A	:	90	0x5A	Z	122	0x7A	z
27	0x1B	(esc)	59	0x3B	;	91	0x5B	[	123	0x7B	{
28	0x1C	(fs)	60	0x3C	<	92	0x5C	\	124	0x7C	|
29	0x1D	(gs)	61	0x3D	=	93	0x5D]	125	0x7D	}
30	0x1E	(rs)	62	0x3E	>	94	0x5E	^	126	0x7E	~
31	0x1F	(us)	63	0x3F	?	95	0x5F	_	127	0x7F	(del)

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July 2005



Sven Neumann
22.01.2013