



## Rugged 40Mbps, 8 Channel Multi-Protocol Transceiver with Programmable DCE/DTE and Termination Resistors

### FEATURES

- Ultra Fast 40Mbps Differential Transmission Rates Available
  - Improved ESD Tolerance for Analog I/Os with 15kV HBM.
  - Internal Transceiver Termination Resistors for V.11 and V.35
  - Interface Modes:
    - ✓ RS-232 (V.28)                      ✓ EIA-530 (V.10 & V.11)                      *Now Available in Lead Free Packaging*
    - ✓ X.21 (V.11)                        ✓ EIA-530A (V.10 & V.11)
    - ✓ RS-449/V.36                      ✓ V.35
    - (V.10 & V.11)
  - Protocols are Software Selectable with 3-Bit Word
  - Eight (8) Drivers and Eight (8) Receivers
  - V.35 and V.11 Receiver Termination Network Disable Option
  - Internal Line or Digital Loopback for Diagnostic Testing
  - Adheres to NET1/NET2 and TBR-2 Compliancy Requirements
  - Easy Flow-Through Pinout
  - +5V Only Operation
  - Individual Driver and Receiver Enable/Disable Controls
  - Operates in either DTE or DCE Mode
- Refer to page 7 for pinout

### APPLICATIONS

- Router
- Frame Relay
- CSU
- DSU
- PBX
- Secure Communication Terminals

### DESCRIPTION

The SP509 is a monolithic device that supports eight (8) popular serial interface standards for Wide Area Network (WAN) connectivity. The SP509 is fabricated using a low power BiCMOS process technology, and incorporates a Sipex regulated charge pump allowing +5V only operation. Sipex's patented charge pump provides a regulated output of  $\pm 5.8V$ , which will provide enough voltage for compliant operation in all modes. Eight (8) drivers and eight (8) receivers can be configured via software for any of the above interface modes at any time. The SP509 requires no additional external components for compliant operation for all of the eight (8) modes of operation other than four capacitors used for the internal charge pump. All necessary termination is integrated within the SP509 and is switchable when V.35 drivers and V.35 receivers, or when V.11 receivers are used. The SP509 provides the controls and transceiver availability for operating as either a DTE or DCE.

Additional features with the SP509 include internal loopback that can be initiated in any of the operating modes by use of the LOOPBACK pin. While in loopback mode, receiver outputs are internally connected to driver inputs creating an internal signal path bypassing the serial communications controller for diagnostic testing. The SP509 also includes a latch enable pin with the driver and receiver address decoder. The internal V.11 or V.35 receiver termination can be switched off using a control pin (TERM\_OFF) for monitoring applications. All eight (8) drivers and receivers in the SP509 include separate enable pins for added convenience. The SP509 is ideal for WAN serial ports in networking equipment such as routers, concentrators, network muxes, DSU/CSU's, networking test equipment, and other access devices.

Applicable U.S. Patents-5,306,954; and others patents pending

## ABSOLUTE MAXIMUM RATINGS

These are stress ratings only and functional operation of the device at these ratings or any other above those indicated in the operation sections of the specifications below is not implied. Exposure to absolute maximum rating conditions for extended periods of time may affect reliability.

V <sub>CC</sub> .....	+7V
Input Voltages:	
Logic .....	-0.3V to (V <sub>CC</sub> +0.5V)
Drivers .....	-0.3V to (V <sub>CC</sub> +0.5V)
Receivers .....	±15.5V
Output Voltages:	
Logic .....	-0.3V to (V <sub>CC</sub> +0.5V)
Drivers .....	±12V
Receivers .....	-0.3V to (V <sub>CC</sub> +0.5V)
Storage Temperature .....	-65°C to +150°C
Power Dissipation .....	1520mW
(derate 19.0mW/°C above +70°C)	
Package Derating:	
θ <sub>JA</sub> .....	52.7 °C/W
θ <sub>JC</sub> .....	6.5 °C/W

## STORAGE CONSIDERATIONS

Due to the relatively large package size of the 100-pin quad flat-pack, storage in a low humidity environment is preferred. Large high density plastic packages are moisture sensitive and should be stored in Dry Vapor Barrier Bags. Prior to usage, the parts should remain bagged and stored below 40°C and 60%RH. If the parts are removed from the bag, they should be used within 48 hours or stored in an environment at or below 20%RH. If the above conditions cannot be followed, the parts should be baked for four hours at 125°C in order to remove moisture prior to soldering. Sipex ships the 100-pin LQFP in Dry Vapor Barrier Bags with a humidity indicator card and desiccant pack. The humidity indicator should be below 30%RH.

## ELECTRICAL SPECIFICATIONS

T<sub>A</sub> = +25°C and V<sub>CC</sub> = +4.75V to +5.25V unless otherwise noted.

	MIN.	TYP.	MAX.	UNITS	CONDITIONS
<b>LOGIC INPUTS</b>					
V <sub>IL</sub> V <sub>IH</sub>	2.0		0.8	Volts Volts	
<b>LOGIC OUTPUTS</b>					
V <sub>OL</sub> V <sub>OH</sub>	2.4		0.4	Volts Volts	I <sub>OUT</sub> = -3.2mA I <sub>OUT</sub> = 1.0mA
<b>V.28 DRIVER</b>					
<b>DC Parameters</b>					
Outputs					
Open Circuit Voltage			±15	Volts	per <b>Figure 1</b> per <b>Figure 2</b> per <b>Figure 4</b> , V <sub>OUT</sub> =0V per <b>Figure 5</b> V <sub>CC</sub> = +5V for AC parameters
Loaded Voltage	±5.0		±15	Volts	
Short-Circuit Current			±100	mA	
Power-Off Impedance	300			Ω	
<b>AC Parameters</b>					
Outputs					
Transition Time			1.5	μs	per <b>Figure 6</b> ; +3V to -3V per <b>Figure 3</b>
Instantaneous Slew Rate			30	V/μs	
Propagation Delay					
t <sub>PHL</sub>	0.5	1	5	μs	
t <sub>PLH</sub>	0.5	1	5	μs	
Max.Transmission Rate	120	230		kbps	
<b>V.28 RECEIVER</b>					
<b>DC Parameters</b>					
Inputs					
Input Impedance	3		7	kΩ	per <b>Figure 7</b> per <b>Figure 8</b>  V <sub>CC</sub> = +5V for AC parameters
Open-Circuit Bias			+2.0	Volts	
HIGH Threshold		1.7	3.0	Volts	
LOW Threshld	0.8	1.2		Volts	
<b>AC Parameters</b>					
Propagation Delay					
t <sub>PHL</sub>	50	100	500	ns	
t <sub>PLH</sub>	50	100	500	ns	

## ELECTRICAL SPECIFICATIONS

$T_A = +25^\circ\text{C}$  and  $V_{CC} = +4.75\text{V}$  to  $+5.25\text{V}$  unless otherwise noted.

	MIN.	TYP.	MAX.	UNITS	CONDITIONS
<b>V.28 RECEIVER (continued)</b> <b>AC Parameters (cont.)</b> Max. Transmission Rate	120	235		kbps	
<b>V.10 DRIVER</b> <b>DC Parameters</b> Outputs Open Circuit Voltage Test-Terminated Voltage Short-Circuit Current Power-Off Current <b>AC Parameters</b> Outputs Transition Time Propagation Delay $t_{PHL}$ $t_{PLH}$ Max. Transmission Rate	$\pm 4.0$ $0.9V_{OC}$		$\pm 6.0$ $\pm 150$ $\pm 100$ 200 30 30 120	Volts Volts mA $\mu\text{A}$ ns ns kbps	per <b>Figure 9</b> per <b>Figure 10</b> per <b>Figure 11</b> per <b>Figure 12</b> $V_{CC} = +5\text{V}$ for AC parameters  per <b>Figure 13</b> ; 10% to 90%
<b>V.10 RECEIVER</b> <b>DC Parameters</b> Inputs Input Current Input Impedance Sensitivity <b>AC Parameters</b> Propagation Delay $t_{PHL}$ $t_{PLH}$ Max. Transmission Rate	$-3.25$ 4		$+3.25$ $\pm 0.3$ 50 50 120	mA $k\Omega$ Volts ns ns kbps	per <b>Figures 14 and 15</b>  $V_{CC} = +5\text{V}$ for AC parameters
<b>V.11 DRIVER</b> <b>DC Parameters</b> Outputs Open Circuit Voltage Test Terminated Voltage  Balance Offset Short-Circuit Current Power-Off Current <b>AC Parameters</b> Outputs Transition Time Propagation Delay $t_{PHL}$ $t_{PLH}$ Differential Skew $(t_{PHL} - t_{PLH})$ Max. Transmission Rate Channel to Channel Skew	$\pm 2.0$ $0.5V_{OC}$		$\pm 6.0$ $0.67V_{OC}$ $\pm 0.4$ $+3.0$ $\pm 150$ $\pm 100$ 10 30 30 2 40 2	Volts Volts Volts Volts Volts mA $\mu\text{A}$ ns ns ns ns ns ns Mbps ns	per <b>Figure 16</b> per <b>Figure 17</b>  per <b>Figure 17</b> per <b>Figure 17</b> per <b>Figure 18</b> per <b>Figure 19</b> $V_{CC} = +5\text{V}$ for AC parameters  per <b>Figures 21 and 36</b> ; 10% to 90% Using $C_L = 50\text{pF}$ ; per <b>Figures 33 and 36</b> per <b>Figures 33 and 36</b> per <b>Figures 33 and 36</b>
<b>V.11 RECEIVER</b> <b>DC Parameters</b> Inputs Common Mode Range Sensitivity	$-7$		$+7$ $\pm 0.2$	Volts Volts	

# ELECTRICAL SPECIFICATIONS

$T_A = +25^\circ\text{C}$  and  $V_{CC} = +4.75\text{V}$  to  $+5.25\text{V}$  unless otherwise noted.

	MIN.	TYP.	MAX.	UNITS	CONDITIONS
<b>V.11 RECEIVER (continued)</b>					
<b>DC Parameters (cont.)</b>					
Input Current	-3.25		±3.25	mA	per <b>Figure 20</b> and <b>22</b> ; power on or off
Current w/100Ω Termination			±60.75	mA	per <b>Figure 23</b> and <b>24</b>
Input Impedance	4			kΩ	
<b>AC Parameters</b>					
Propagation Delay					<b>V<sub>CC</sub> = +5V for AC parameters</b> Using $C_L = 50\text{pF}$ ;
$t_{PHL}$		30	50	ns	per <b>Figures 33</b> and <b>38</b>
$t_{PLH}$		30	50	ns	per <b>Figures 33</b> and <b>38</b>
Skew ( $ t_{PHL} - t_{PLH} $ )		2	5	ns	per <b>Figure 33</b>
Max. Transmission Rate	40			Mbps	
Channel to Channel Skew		2		ns	
<b>V.35 DRIVER</b>					
<b>DC Parameters</b>					
Outputs					
Test Terminated Voltage	±0.44		±0.66	Volts	per <b>Figure 25</b>
Offset			±0.6	Volts	per <b>Figure 25</b>
Output Overshoot	-0.2V <sub>ST</sub>		+0.2V <sub>ST</sub>	Volts	per <b>Figure 25</b> ; $V_{ST} = \text{Steady state value}$
Source Impedance	50		150	Ω	per <b>Figure 27</b> ; $Z_S = V_2/V_1 \times 50$
Short-Circuit Impedance	135		165	Ω	per <b>Figure 28</b>
<b>AC Parameters</b>					
Outputs					
Transition Time		7	20	ns	per <b>Figure 29</b> ; 10% to 90%
Propagation Delay					
$t_{PHL}$		30	50	ns	per <b>Figures 33</b> and <b>36</b> ; $C_L = 20\text{pF}$
$t_{PLH}$		30	50	ns	per <b>Figures 33</b> and <b>36</b> ; $C_L = 20\text{pF}$
Differential Skew ( $ t_{PHL} - t_{PLH} $ )		2	5	ns	per <b>Figures 33</b> and <b>36</b> ; $C_L = 20\text{pF}$
Max. Transmission Rate	40			Mbps	
Channel to Channel Skew		2		ns	
<b>V.35 RECEIVER</b>					
<b>DC Parameters</b>					
Inputs					
Sensitivity		±50	±100	mV	
Source Impedance	90		110	Ω	per <b>Figure 30</b> ; $Z_S = V_2/V_1 \times 50\Omega$
Short-Circuit Impedance	135		165	Ω	per <b>Figure 31</b>
<b>AC Parameters</b>					
Propagation Delay					<b>V<sub>CC</sub> = +5V for AC parameters</b>
$t_{PHL}$		30	50	ns	per <b>Figures 33</b> and <b>38</b> ; $C_L = 20\text{pF}$
$t_{PLH}$		30	50	ns	per <b>Figures 33</b> and <b>38</b> ; $C_L = 20\text{pF}$
Skew ( $ t_{PHL} - t_{PLH} $ )		2	5	ns	per <b>Figure 33</b> ; $C_L = 20\text{pF}$
Max. Transmission Rate	40			Mbps	
Channel to Channel Skew		2		ns	
<b>TRANSCEIVER LEAKAGE CURRENT</b>					
Driver Output 3-State Current		500		μA	
Rcvr Output 3-State Current		1	10	μA	per <b>Figure 32</b> ; Drivers disabled $T_X$ & $R_X$ disabled, 0.4V - $V_O$ - 2.4V
<b>POWER REQUIREMENTS</b>					
$V_{CC}$	4.75	5.00	5.25	Volts	
$I_{CC}$ (Shutdown Mode)		1		μA	
(V.28/RS-232)		95		mA	
(V.11/RS-422)		230		mA	
(EIA-530 & RS-449)		270		mA	
(V.35)		170		mA	
(EIA-530A)		200		mA	
All $I_{CC}$ values are with $V_{CC} = +5\text{V}$ $f_{IN} = 120\text{kbps}$ ; Drivers active & loaded $f_{IN} = 10\text{Mbps}$ ; Drivers active & loaded $f_{IN} = 10\text{Mbps}$ ; Drivers active & loaded V.35 @ $f_{IN} = 10\text{Mbps}$ , V.28 @ 20kbps $f_{IN} = 10\text{Mbps}$ ; Drivers active & loaded					

## OTHER AC CHARACTERISTICS

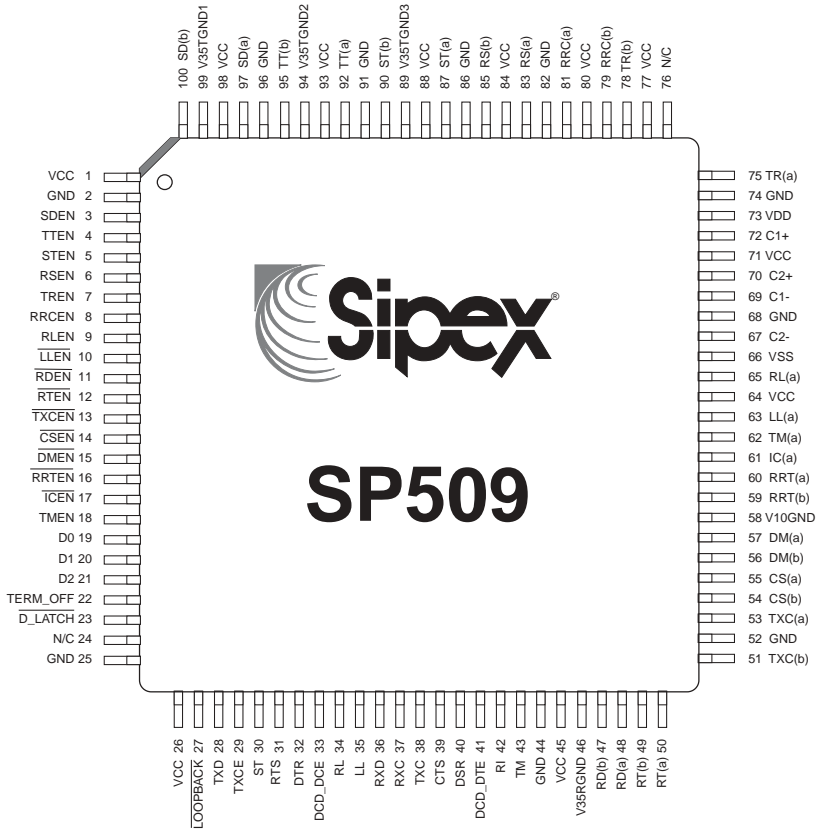
$T_A = +25^\circ\text{C}$  and  $V_{CC} = +5.0\text{V}$  unless otherwise noted.

PARAMETER	MIN.	TYP.	MAX.	UNITS	CONDITIONS
<b>DRIVER DELAY TIME BETWEEN ACTIVE MODE AND TRI-STATE MODE</b>					
<b>RS-232/V.28</b>					
$t_{PZL}$ ; Tri-state to Output LOW		0.11	5.0	$\mu\text{s}$	$C_L = 100\text{pF}$ , Fig. 34 & 40; $S_2$ closed
$t_{PZH}$ ; Tri-state to Output HIGH		0.11	2.0	$\mu\text{s}$	$C_L = 100\text{pF}$ , Fig. 34 & 40; $S_2$ closed
$t_{PLZ}$ ; Output LOW to Tri-state		0.05	2.0	$\mu\text{s}$	$C_L = 100\text{pF}$ , Fig. 34 & 40; $S_2$ closed
$t_{PHZ}$ ; Output HIGH to Tri-state		0.05	2.0	$\mu\text{s}$	$C_L = 100\text{pF}$ , Fig. 34 & 40; $S_2$ closed
<b>RS-423/V.10</b>					
$t_{PZL}$ ; Tri-state to Output LOW		0.07	2.0	$\mu\text{s}$	$C_L = 100\text{pF}$ , Fig. 34 & 40; $S_2$ closed
$t_{PZH}$ ; Tri-state to Output HIGH		0.05	2.0	$\mu\text{s}$	$C_L = 100\text{pF}$ , Fig. 34 & 40; $S_2$ closed
$t_{PLZ}$ ; Output LOW to Tri-state		0.55	2.0	$\mu\text{s}$	$C_L = 100\text{pF}$ , Fig. 34 & 40; $S_2$ closed
$t_{PHZ}$ ; Output HIGH to Tri-state		0.12	2.0	$\mu\text{s}$	$C_L = 100\text{pF}$ , Fig. 34 & 40; $S_2$ closed
<b>RS-422/V.11</b>					
$t_{PZL}$ ; Tri-state to Output LOW		0.04	10.0	$\mu\text{s}$	$C_L = 100\text{pF}$ , Fig. 34 & 37; $S_1$ closed
$t_{PZH}$ ; Tri-state to Output HIGH		0.05	2.0	$\mu\text{s}$	$C_L = 100\text{pF}$ , Fig. 34 & 37; $S_2$ closed
$t_{PLZ}$ ; Output LOW to Tri-state		0.03	2.0	$\mu\text{s}$	$C_L = 15\text{pF}$ , Fig. 34 & 37; $S_1$ closed
$t_{PHZ}$ ; Output HIGH to Tri-state		0.11	2.0	$\mu\text{s}$	$C_L = 15\text{pF}$ , Fig. 34 & 37; $S_2$ closed
<b>V.35</b>					
$t_{PZL}$ ; Tri-state to Output LOW		0.85	10.0	$\mu\text{s}$	$C_L = 100\text{pF}$ , Fig. 34 & 37; $S_1$ closed
$t_{PZH}$ ; Tri-state to Output HIGH		0.36	2.0	$\mu\text{s}$	$C_L = 100\text{pF}$ , Fig. 34 & 37; $S_2$ closed
$t_{PLZ}$ ; Output LOW to Tri-state		0.06	2.0	$\mu\text{s}$	$C_L = 15\text{pF}$ , Fig. 34 & 37; $S_1$ closed
$t_{PHZ}$ ; Output HIGH to Tri-state		0.05	2.0	$\mu\text{s}$	$C_L = 15\text{pF}$ , Fig. 34 & 37; $S_2$ closed
<b>RECEIVER DELAY TIME BETWEEN ACTIVE MODE AND TRI-STATE MODE</b>					
<b>RS-232/V.28</b>					
$t_{PZL}$ ; Tri-state to Output LOW		0.05	2.0	$\mu\text{s}$	$C_L = 100\text{pF}$ , Fig. 35 & 40; $S_1$ closed
$t_{PZH}$ ; Tri-state to Output HIGH		0.05	2.0	$\mu\text{s}$	$C_L = 100\text{pF}$ , Fig. 35 & 40; $S_2$ closed
$t_{PLZ}$ ; Output LOW to Tri-state		0.65	2.0	$\mu\text{s}$	$C_L = 100\text{pF}$ , Fig. 35 & 40; $S_1$ closed
$t_{PHZ}$ ; Output HIGH to Tri-state		0.65	2.0	$\mu\text{s}$	$C_L = 100\text{pF}$ , Fig. 35 & 40; $S_2$ closed
<b>RS-423/V.10</b>					
$t_{PZL}$ ; Tri-state to Output LOW		0.04	2.0	$\mu\text{s}$	$C_L = 100\text{pF}$ , Fig. 35 & 40; $S_1$ closed
$t_{PZH}$ ; Tri-state to Output HIGH		0.03	2.0	$\mu\text{s}$	$C_L = 100\text{pF}$ , Fig. 35 & 40; $S_2$ closed
$t_{PLZ}$ ; Output LOW to Tri-state		0.03	2.0	$\mu\text{s}$	$C_L = 100\text{pF}$ , Fig. 35 & 40; $S_1$ closed
$t_{PHZ}$ ; Output HIGH to Tri-state		0.03	2.0	$\mu\text{s}$	$C_L = 100\text{pF}$ , Fig. 35 & 40; $S_2$ closed

## OTHER AC CHARACTERISTICS (Continued)

T<sub>A</sub> = +25°C and V<sub>CC</sub> = +5.0V unless otherwise noted.

PARAMETER	MIN.	TYP.	MAX.	UNITS	CONDITIONS
<b>RS-422/V.11</b>					
t <sub>PZL</sub> ; Tri-state to Output LOW		0.04	2.0	μs	C <sub>L</sub> = 100pF, <b>Fig. 35 &amp; 39</b> ; S <sub>1</sub> closed
t <sub>PZH</sub> ; Tri-state to Output HIGH		0.03	2.0	μs	C <sub>L</sub> = 100pF, <b>Fig. 35 &amp; 39</b> ; S <sub>2</sub> closed
t <sub>PLZ</sub> ; Output LOW to Tri-state		0.03	2.0	μs	C <sub>L</sub> = 15pF, <b>Fig. 35 &amp; 39</b> ; S <sub>1</sub> closed
t <sub>PHZ</sub> ; Output HIGH to Tri-state		0.03	2.0	μs	C <sub>L</sub> = 15pF, <b>Fig. 35 &amp; 39</b> ; S <sub>2</sub> closed
<b>V.35</b>					
t <sub>PZL</sub> ; Tri-state to Output LOW		0.04	2.0	μs	C <sub>L</sub> = 100pF, <b>Fig. 35 &amp; 39</b> ; S <sub>1</sub> closed
t <sub>PZH</sub> ; Tri-state to Output HIGH		0.03	2.0	μs	C <sub>L</sub> = 100pF, <b>Fig. 35 &amp; 39</b> ; S <sub>2</sub> closed
t <sub>PLZ</sub> ; Output LOW to Tri-state		0.03	2.0	μs	C <sub>L</sub> = 15pF, <b>Fig. 35 &amp; 39</b> ; S <sub>1</sub> closed
t <sub>PHZ</sub> ; Output HIGH to Tri-state		0.03	2.0	μs	C <sub>L</sub> = 15pF, <b>Fig. 35 &amp; 39</b> ; S <sub>2</sub> closed
<b>TRANSCEIVER TO TRANSCEIVER SKEW</b> (per Figures 32, 33, 36, 38)					
RS-232 Driver		100		ns	[ (t <sub>phi</sub> ) <sub>TX1</sub> - (t <sub>phi</sub> ) <sub>TXn</sub> ]
		100		ns	[ (t <sub>phi</sub> ) <sub>TX1</sub> - (t <sub>phi</sub> ) <sub>TXn</sub> ]
RS-232 Receiver		20		ns	[ (t <sub>phi</sub> ) <sub>RX1</sub> - (t <sub>phi</sub> ) <sub>RXn</sub> ]
		20		ns	[ (t <sub>phi</sub> ) <sub>RX1</sub> - (t <sub>phi</sub> ) <sub>RXn</sub> ]
RS-422 Driver		2		ns	[ (t <sub>phi</sub> ) <sub>TX1</sub> - (t <sub>phi</sub> ) <sub>TXn</sub> ]
		2		ns	[ (t <sub>phi</sub> ) <sub>TX1</sub> - (t <sub>phi</sub> ) <sub>TXn</sub> ]
RS-422 Receiver		2		ns	[ (t <sub>phi</sub> ) <sub>RX1</sub> - (t <sub>phi</sub> ) <sub>RXn</sub> ]
		3		ns	[ (t <sub>phi</sub> ) <sub>RX1</sub> - (t <sub>phi</sub> ) <sub>RXn</sub> ]
RS-423 Driver		5		ns	[ (t <sub>phi</sub> ) <sub>TX2</sub> - (t <sub>phi</sub> ) <sub>TXn</sub> ]
		5		ns	[ (t <sub>phi</sub> ) <sub>TX2</sub> - (t <sub>phi</sub> ) <sub>TXn</sub> ]
RS-423 Receiver		5		ns	[ (t <sub>phi</sub> ) <sub>RX2</sub> - (t <sub>phi</sub> ) <sub>RXn</sub> ]
		5		ns	[ (t <sub>phi</sub> ) <sub>RX2</sub> - (t <sub>phi</sub> ) <sub>RXn</sub> ]
V.35 Driver		2		ns	[ (t <sub>phi</sub> ) <sub>TX1</sub> - (t <sub>phi</sub> ) <sub>TXn</sub> ]
		2		ns	[ (t <sub>phi</sub> ) <sub>TX1</sub> - (t <sub>phi</sub> ) <sub>TXn</sub> ]
V.35 Receiver		2		ns	[ (t <sub>phi</sub> ) <sub>RX1</sub> - (t <sub>phi</sub> ) <sub>RXn</sub> ]
		2		ns	[ (t <sub>phi</sub> ) <sub>RX1</sub> - (t <sub>phi</sub> ) <sub>RXn</sub> ]



## PIN DESCRIPTION

Pin Number	Pin Name	Description	Pin Number	Pin Name	Description
1	VCC	5V Power Supply Input	51	TxC(b)	TxC Non-Inverting Input
2	GND	Signal Ground	52	GND	Signal Ground
3	SDEN	TxD Driver Enable Input	53	TxC(a)	TxC Inverting Input
4	TTEN	TxCE Driver Enable Input	54	CS(b)	CTS Non-Inverting Input
5	STEN	ST Driver Enable Input	55	CS(a)	CTS Inverting Input
6	RSEN	RTS Driver Enable Input	56	DM(b)	DSR Non-Inverting Input
7	TREN	DTR Driver Enable Input	57	DM(a)	DSR Inverting Input
8	RRCEN	DCD Driver Enable Input	58	GNDV10	V.10 Rx Reference Node
9	RLEN	RL Driver Enable Input	59	RRT(b)	DCD <sub>DTE</sub> Non-Inverting Input
10	LLEN#	LL Driver Enable Input	60	RRT(a)	DCD <sub>DTE</sub> Inverting Input
11	RDEN#	RxD Receiver Enable Input	61	IC	RI Receiver Input
12	RTEN#	RxC Receiver Enable Input	62	TM(a)	TM Receiver Input
13	TxCEN#	TxC Receiver Enable Input	63	LL(a)	LL Driver Output
14	CSEN#	CTS Receiver Enable Input	64	VCC	Power Supply Input
15	DMEN#	DSR Receiver Enable Input	65	RL(a)	RL Driver Output
16	RRTEN#	DCD <sub>DTE</sub> Receiver Enable Input	66	VSS1	-2xVCC Charge Pump Output
17	ICEN#	RI Receiver Enable Input	67	C2N	Charge Pump Capacitor
18	TMEN	TM Receiver Enable Input	68	GND	Signal Ground
19	D0	Mode Select Input	69	C1N	Charge Pump Capacitor
20	D1	Mode Select Input	70	C2P	Charge Pump Capacitor
21	D2	Mode Select Input	71	VCC	Power Supply Input
22	TERM_OFF	Termination Disable Input	72	C1P	Charge Pump Capacitor
23	D_LATCH#	Decoder Latch Input	73	VDD	2xVCC Charge Pump Output
24	NC	No Connect	74	GND	Signal Ground
25	GND	Signal Ground	75	TR(a)	DTR Inverting Output
26	VCC	5V Power Supply Input	76	NC	No Connect
27	LOOPBACK#	Loopback Mode Enable Input	77	VCC	Power Supply Input
28	TxD	TxD Driver TTL Input	78	TR(b)	DTR Non-Inverting Output
29	TxCE	TxCE Driver TTL Input	79	RRC(b)	DCD Non-Inverting Output
30	ST	ST Driver TTL Input	80	VCC	Power Supply Input
31	RTS	RTS Driver TTL Input	81	RRC(a)	DCD Inverting Output
32	DTR	DTR Driver TTL Input	82	GND	Signal Ground
33	DCD_DCE	DCD <sub>DCE</sub> Driver TTL Input	83	RS(a)	RTS Inverting Output
34	RL	RL Driver TTL Input	84	VCC	Power Supply Input
35	LL	LL Driver TTL Input	85	RS(b)	RTS Non-Inverting Output
36	RxD	RxD Receiver TTL Output	86	GND	Signal Ground
37	RxC	RxC Receiver TTL Output	87	ST(a)	ST Inverting Output
38	TxC	TxC Receiver TTL Output	88	VCC	Power Supply Input
39	CTS	CTS Receiver TTL Output	89	V35TGND3	ST Termination Reference
40	DSR	DSR Receiver TTL Output	90	ST(b)	ST Non-Inverting Output
41	DCD_DTE	DCD <sub>DTE</sub> Receiver TTL Output	91	GND	Signal Ground
42	RI	RI Receiver TTL Output	92	TT(a)	TxCE Inverting Output
43	TM	TM Receiver TTL Output	93	VCC	5V Power Supply Input
44	GND	Signal Ground	94	V35TGND2	ST Termination Reference
45	VCC	Power Supply Input	95	TT(b)	TxCE Non-Inverting Output
46	V35RGND	Receiver Termination Reference	96	GND	Signal Ground
47	RD(b)	RxD Non-Inverting Input	97	SD(a)	TxD Inverting Output
48	RD(a)	RxD Inverting Input	98	VCC	5V Power Supply Input
49	RT(b)	RxC Non-Inverting Input	99	V35TGND1	ST Termination Reference
50	RT(a)	RxC Inverting Input	100	SD(b)	TxD Non-Inverting Output



## SP509 Driver Table

Driver Output Pin	V.35 Mode	EIA-530 Mode	RS-232 Mode (V.28)	EIA-530A Mode	RS-449 Mode (V.36)	X.21 Mode (V.11)	Shutdown	Suggested Signal
MODE (D0, D1, D2)	001	010	011	100	101	110	111	
T <sub>1</sub> OUT(a)	V.35	V.11	V.28	V.11	V.11	V.11	High-Z	TxD(a)
T <sub>1</sub> OUT(b)	V.35	V.11	High-Z	V.11	V.11	V.11	High-Z	TxD(b)
T <sub>2</sub> OUT(a)	V.35	V.11	V.28	V.11	V.11	V.11	High-Z	TxCE(a)
T <sub>2</sub> OUT(b)	V.35	V.11	High-Z	V.11	V.11	V.11	High-Z	TxCE(b)
T <sub>3</sub> OUT(a)	V.35	V.11	V.28	V.11	V.11	V.11	High-Z	TxC_DCE(a)
T <sub>3</sub> OUT(b)	V.35	V.11	High-Z	V.11	V.11	V.11	High-Z	TxC_DCE(b)
T <sub>4</sub> OUT(a)	V.28	V.11	V.28	V.11	V.11	V.11	High-Z	RTS(a)
T <sub>4</sub> OUT(b)	High-Z	V.11	High-Z	V.11	V.11	V.11	High-Z	RTS(b)
T <sub>5</sub> OUT(a)	V.28	V.11	V.28	V.10	V.11	V.11	High-Z	DTR(a)
T <sub>5</sub> OUT(b)	High-Z	V.11	High-Z	High-Z	V.11	V.11	High-Z	DTR(b)
T <sub>6</sub> OUT(a)	V.28	V.11	V.28	V.11	V.11	V.11	High-Z	DCD_DCE(a)
T <sub>6</sub> OUT(b)	High-Z	V.11	High-Z	V.11	V.11	V.11	High-Z	DCD_DCE(b)
T <sub>7</sub> OUT(a)	V.28	V.10	V.28	V.10	V.10	High-Z	High-Z	RL
T <sub>8</sub> OUT(a)	V.28	V.10	V.28	V.10	V.10	High-Z	High-Z	LL

**Table 1. Driver Mode Selection**

## SP509 Receiver Table

Receiver Input Pin	V.35 Mode	EIA-530 Mode	RS-232 Mode (V.28)	EIA-530A Mode	RS-449 Mode (V.36)	X.21 Mode (V.11)	Shutdown	Suggested Signal
MODE (D0, D1, D2)	001	010	011	100	101	110	111	
R <sub>1</sub> IN(a)	V.35	V.11	V.28	V.11	V.11	V.11	High-Z	RxD(a)
R <sub>1</sub> IN(b)	V.35	V.11	High-Z	V.11	V.11	V.11	High-Z	RxD(b)
R <sub>2</sub> IN(a)	V.35	V.11	V.28	V.11	V.11	V.11	High-Z	RxC(a)
R <sub>2</sub> IN(b)	V.35	V.11	High-Z	V.11	V.11	V.11	High-Z	RxC(b)
R <sub>3</sub> IN(a)	V.35	V.11	V.28	V.11	V.11	V.11	High-Z	TxC_DTE(a)
R <sub>3</sub> IN(b)	V.35	V.11	High-Z	V.11	V.11	V.11	High-Z	TxC_DTE(b)
R <sub>4</sub> IN(a)	V.28	V.11	V.28	V.11	V.11	V.11	High-Z	CTS(a)
R <sub>4</sub> IN(b)	High-Z	V.11	High-Z	V.11	V.11	V.11	High-Z	CTS(b)
R <sub>5</sub> IN(a)	V.28	V.11	V.28	V.10	V.11	V.11	High-Z	DSR(a)
R <sub>5</sub> IN(b)	High-Z	V.11	High-Z	High-Z	V.11	V.11	High-Z	DSR(b)
R <sub>6</sub> IN(a)	V.28	V.11	V.28	V.11	V.11	V.11	High-Z	DCD_DTE(a)
R <sub>6</sub> IN(b)	High-Z	V.11	High-Z	V.11	V.11	V.11	High-Z	DCD_DTE(b)
R <sub>7</sub> IN(a)	V.28	V.10	V.28	V.10	V.10	High-Z	High-Z	RI
R <sub>8</sub> IN(a)	V.28	V.10	V.28	V.10	V.10	High-Z	High-Z	TM

**Table 2. Receiver Mode Selection**

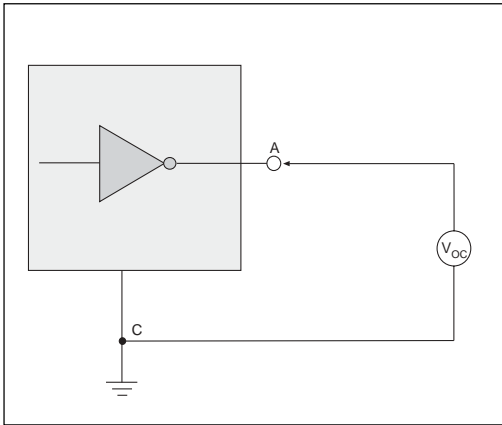


Figure 1. V.28 Driver Output Open Circuit Voltage

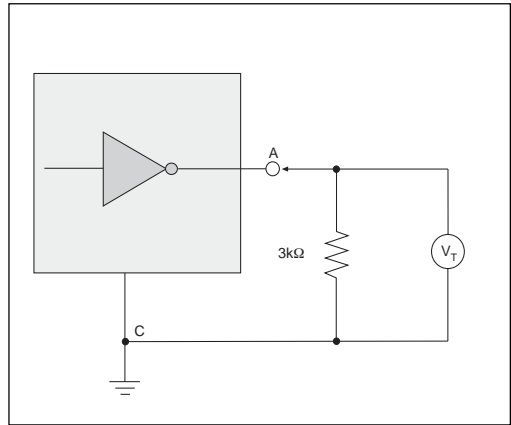


Figure 2. V.28 Driver Output Loaded Voltage

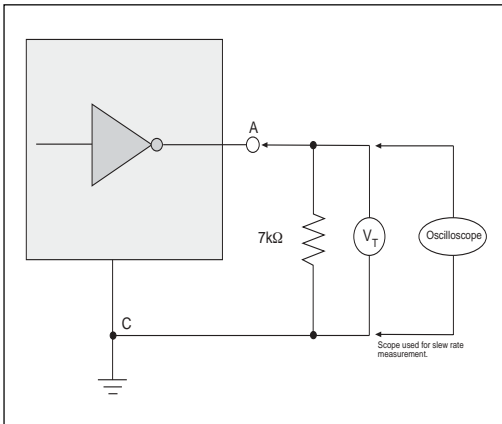


Figure 3. V.28 Driver Output Slew Rate

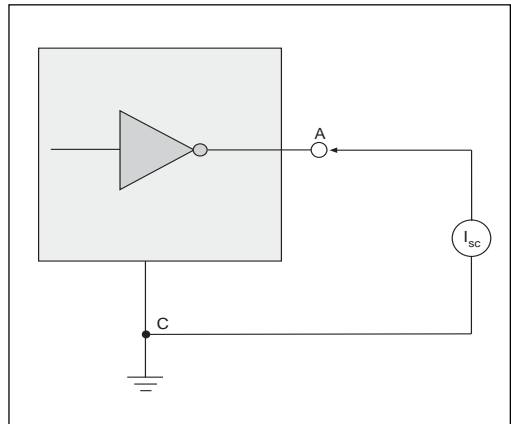


Figure 4. V.28 Driver Output Short-Circuit Current

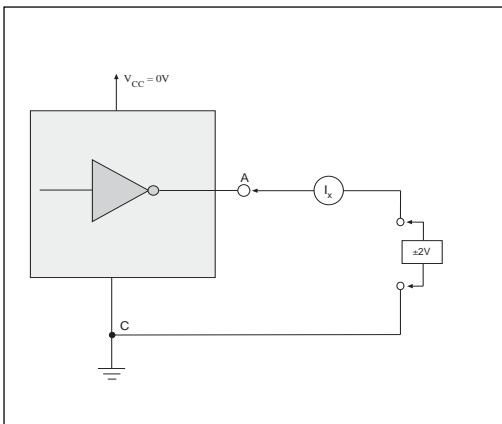


Figure 5. V.28 Driver Output Power-Off Impedance

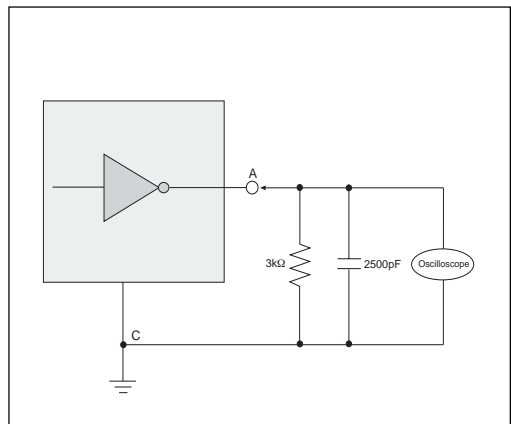


Figure 6. V.28 Driver Output Rise/Fall Times

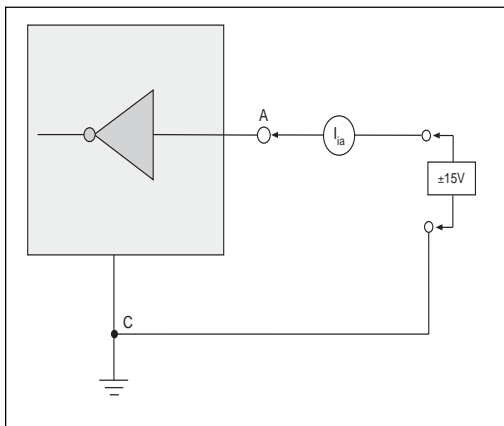


Figure 7. V.28 Receiver Input Impedance

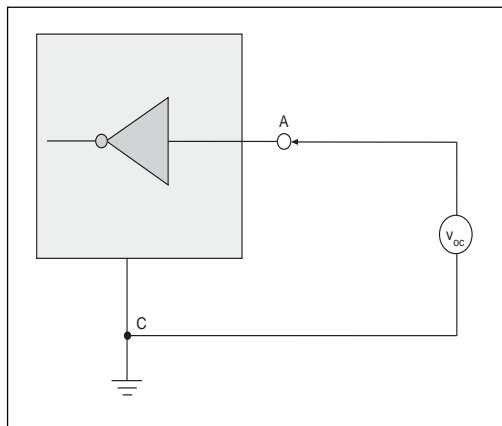


Figure 8. V.28 Receiver Input Open Circuit Bias

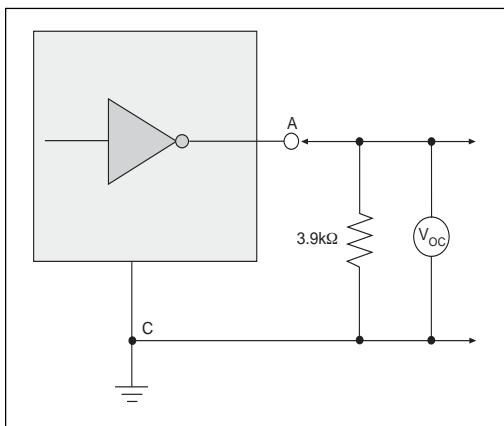


Figure 9. V.10 Driver Output Open-Circuit Voltage

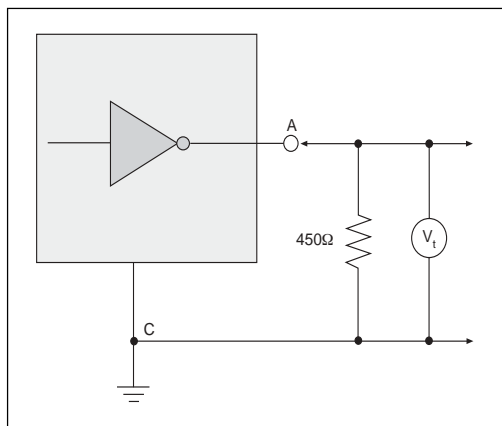


Figure 10. V.10 Driver Output Test Terminated Voltage

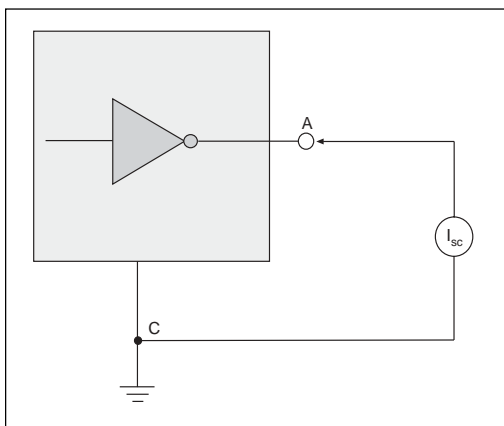


Figure 11. V.10 Driver Output Short-Circuit Current

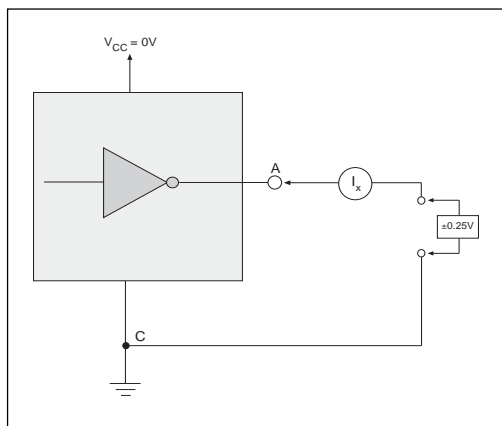


Figure 12. V.10 Driver Output Power-Off Current

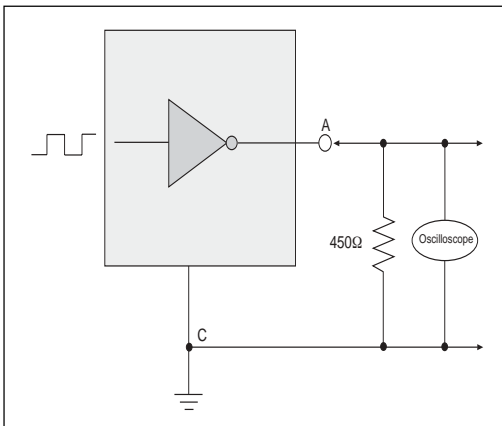


Figure 13. V.10 Driver Output Transition Time

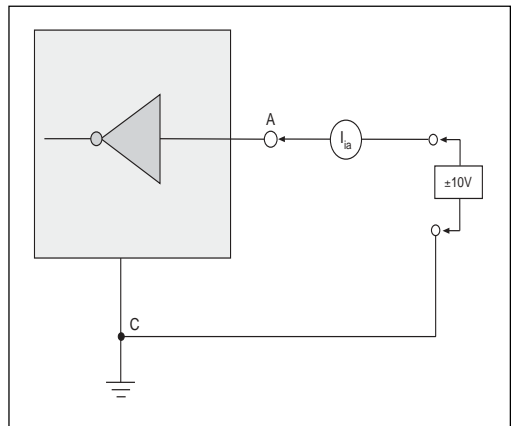


Figure 14. V.10 Receiver Input Current

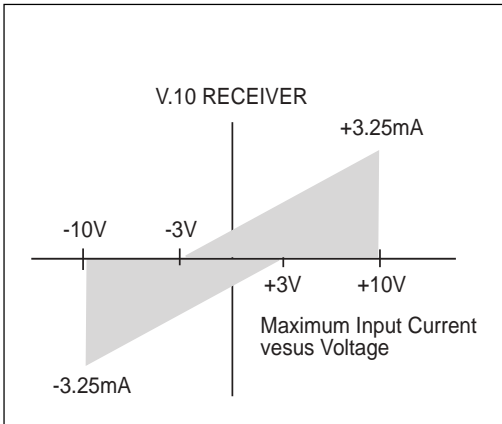


Figure 15. V.10 Receiver Input IV Graph

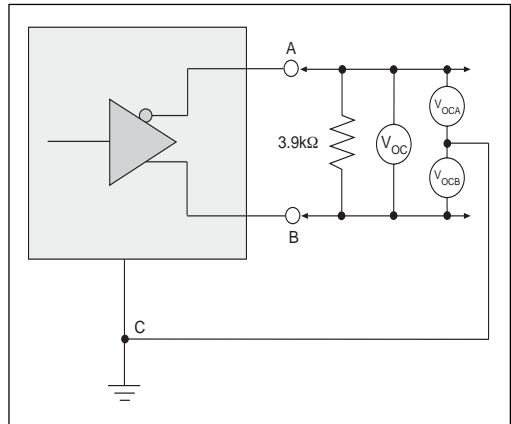


Figure 16. V.11 Driver Output Open-Circuit Voltage

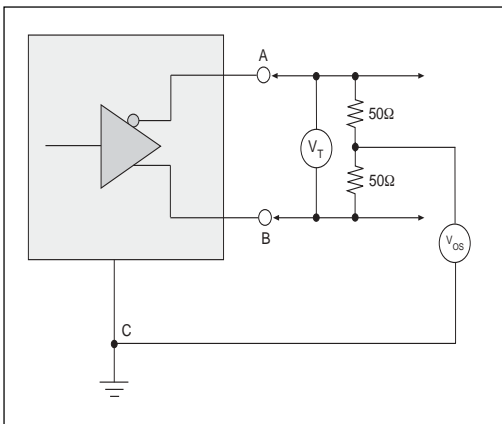


Figure 17. V.11 Driver Output Test Terminated Voltage

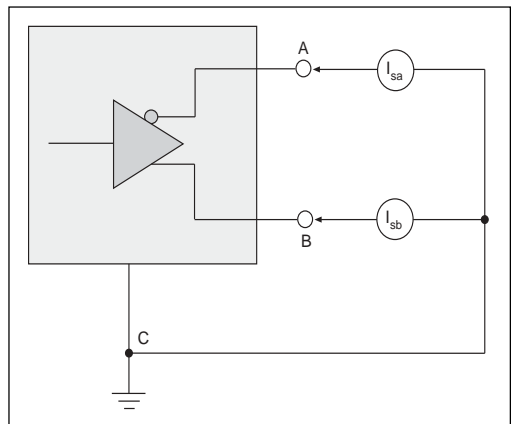


Figure 18. V.11 Driver Output Short-Circuit Current

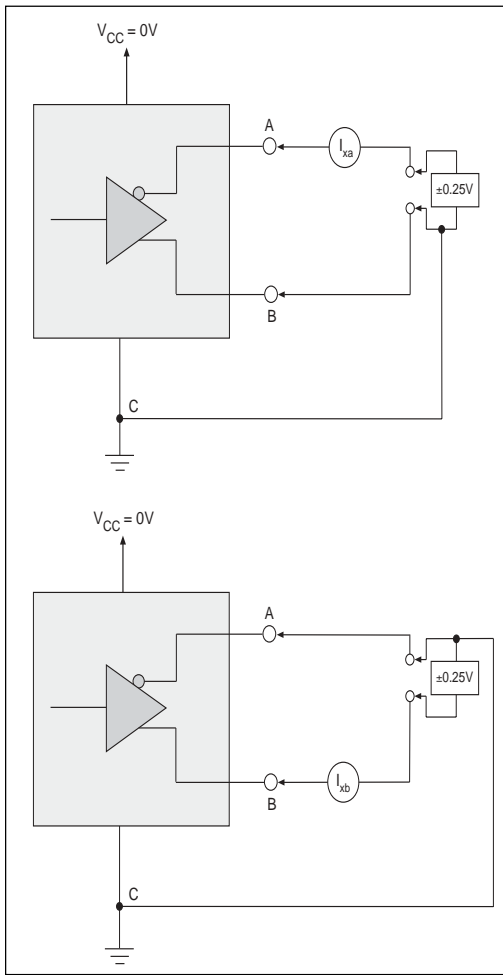


Figure 19. V.11 Driver Output Power-Off Current

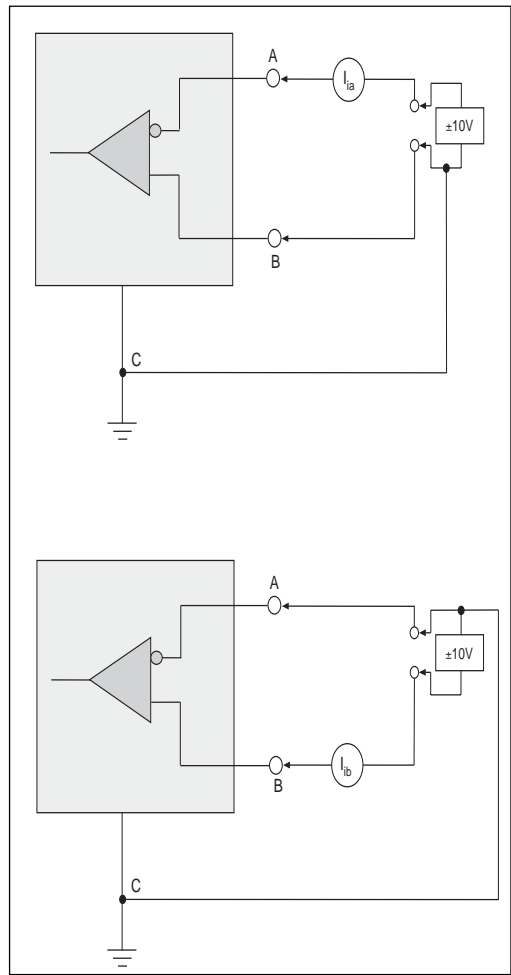


Figure 20. V.11 Receiver Input Current

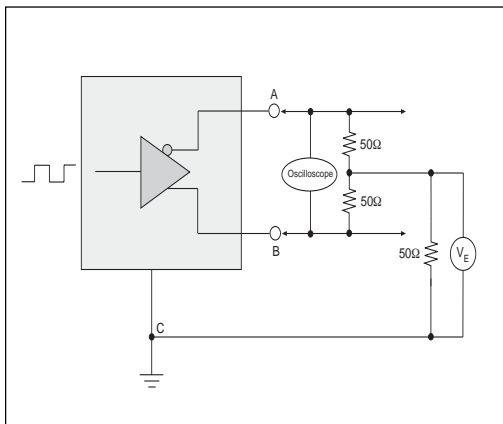


Figure 21. V.11 Driver Output Rise/Fall Time

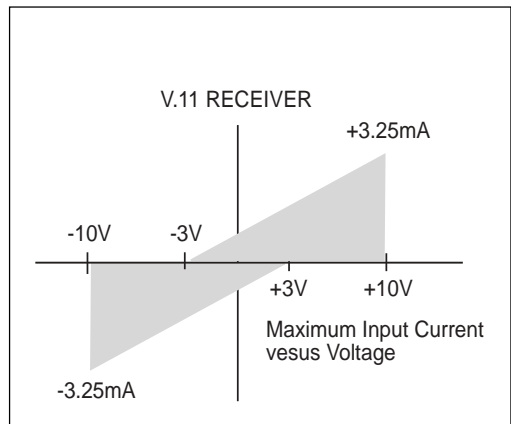


Figure 22. V.11 Receiver Input IV Graph

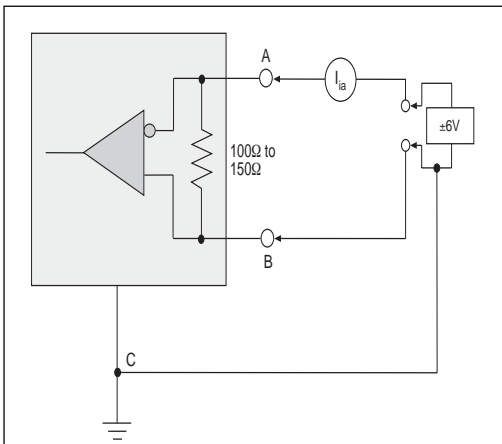


Figure 23. V.11 Receiver Input Current w/ Termination

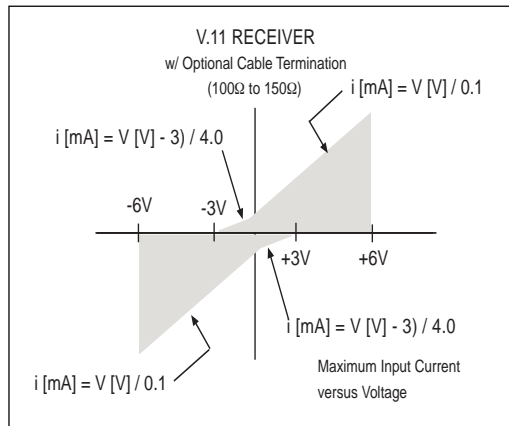


Figure 24. V.11 Receiver Input Graph w/ Termination

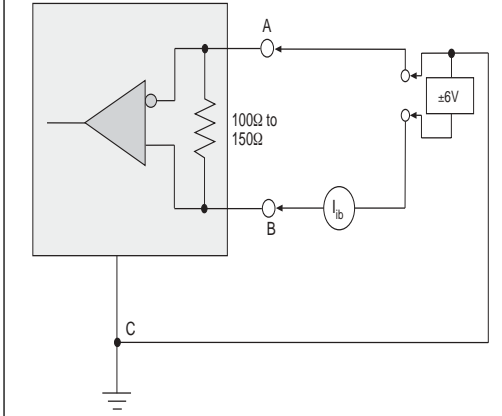


Figure 25. V.35 Driver Output Test Terminated Voltage

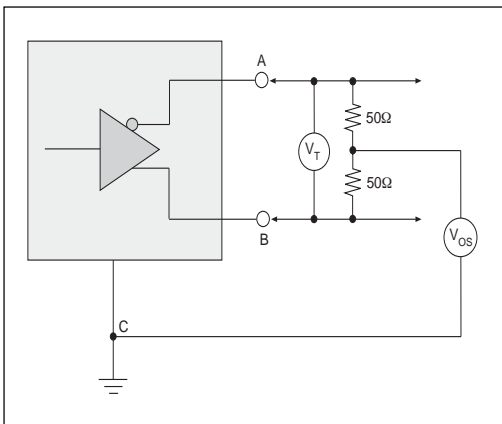


Figure 26. V.35 Driver Output Offset Voltage

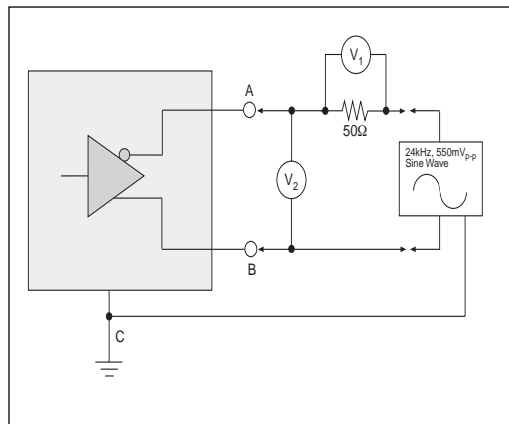


Figure 27. V.35 Driver Output Source Impedance

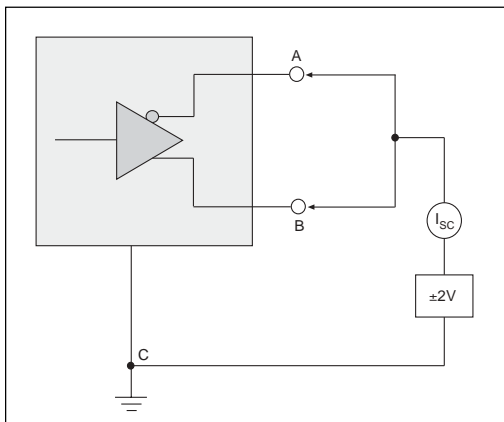


Figure 28. V.35 Driver Output Short-Circuit Impedance

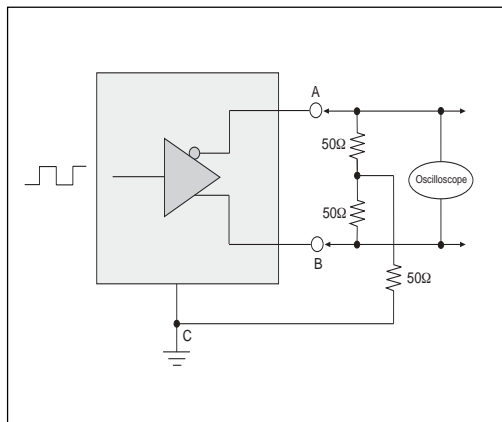


Figure 29. V.35 Driver Output Rise/Fall Time

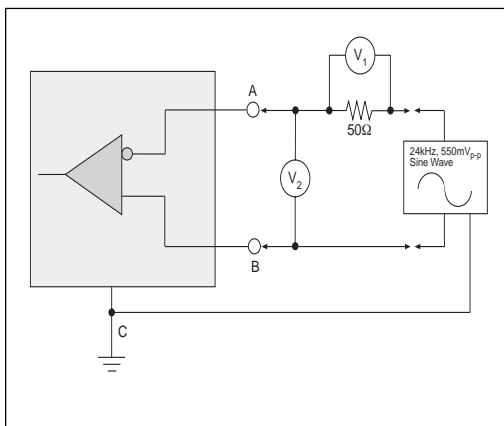


Figure 30. V.35 Receiver Input Source Impedance

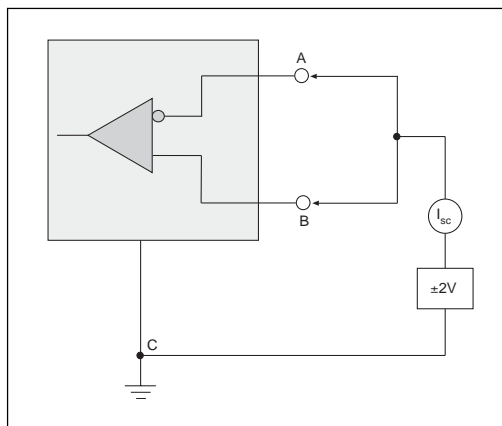


Figure 31. V.35 Receiver Input Short-Circuit Impedance

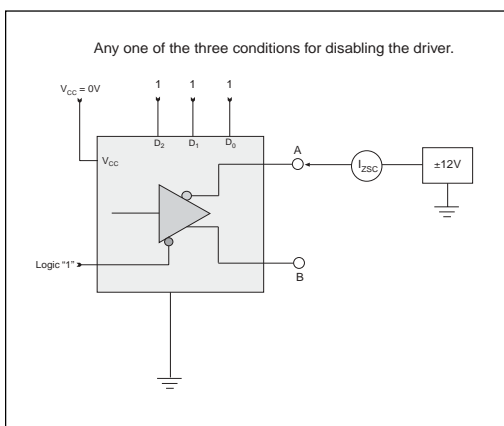


Figure 32. Driver Output Leakage Current Test

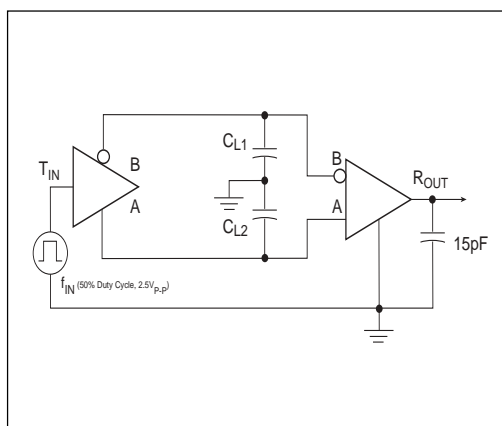


Figure 33. Driver/Receiver Timing Test Circuit

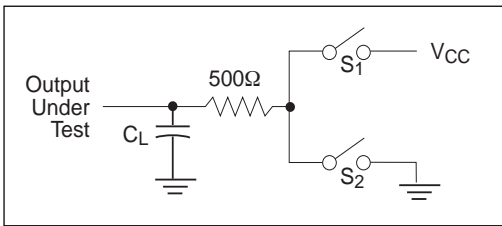


Figure 34. Driver Timing Test Load Circuit

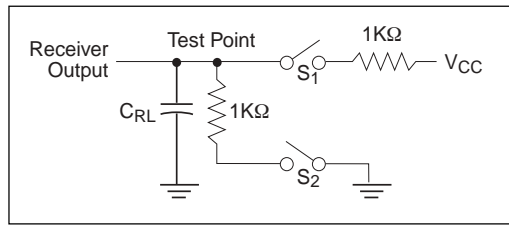


Figure 35. Receiver Timing Test Load Circuit

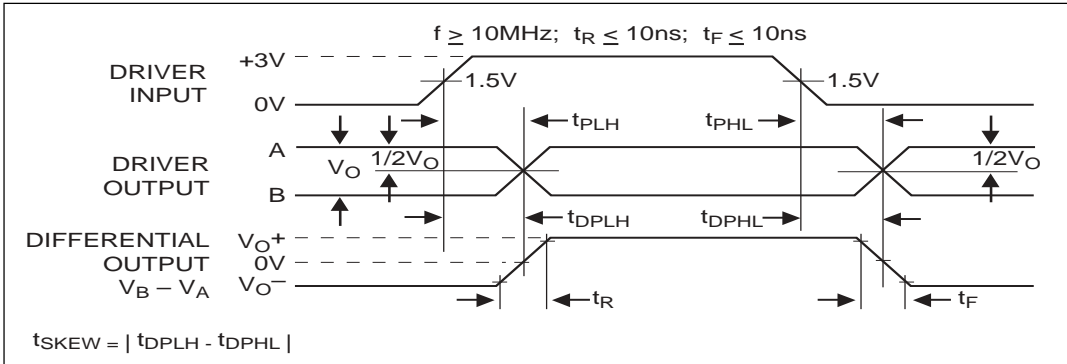


Figure 36. Driver Propagation Delays

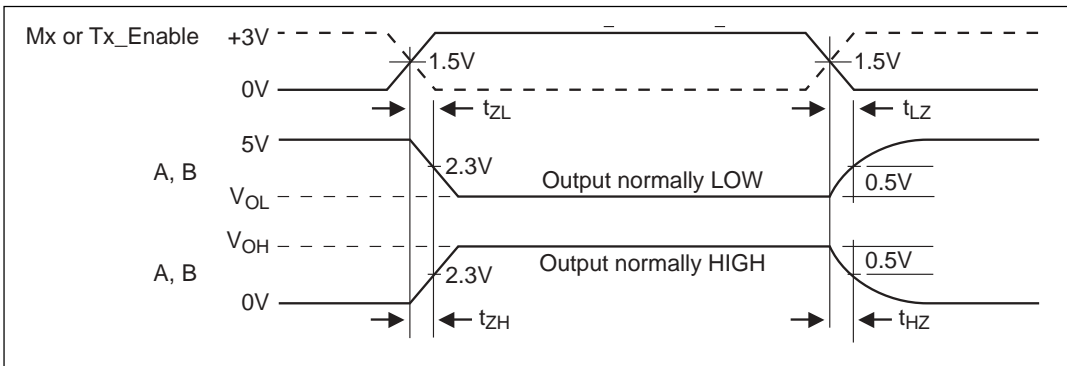


Figure 37. Driver Enable and Disable Times

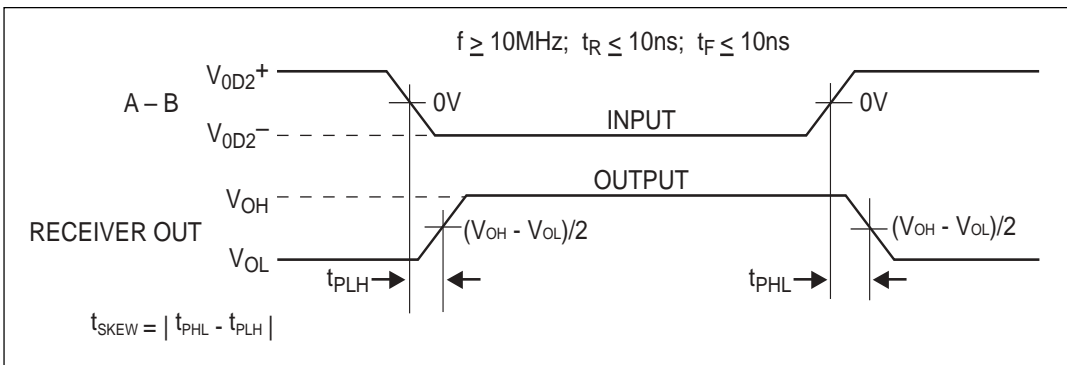


Figure 38. Receiver Propagation Delays



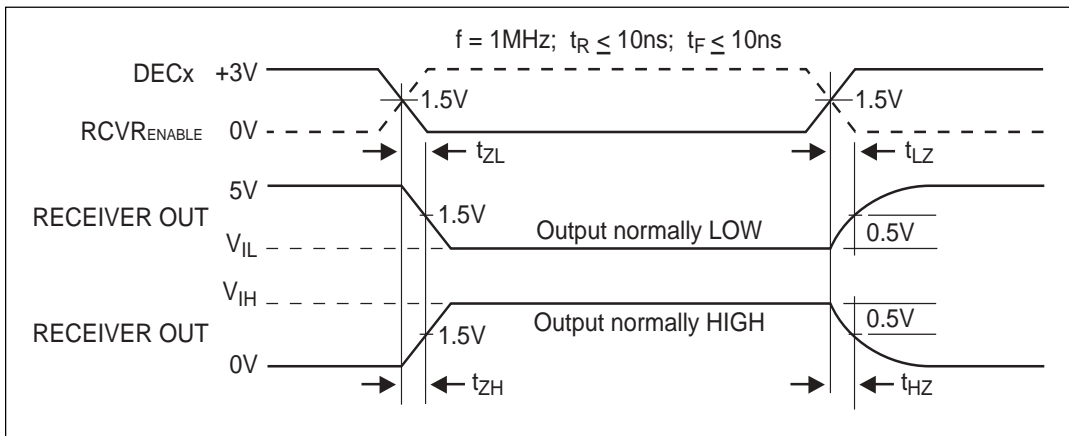


Figure 39. Receiver Enable and Disable Times

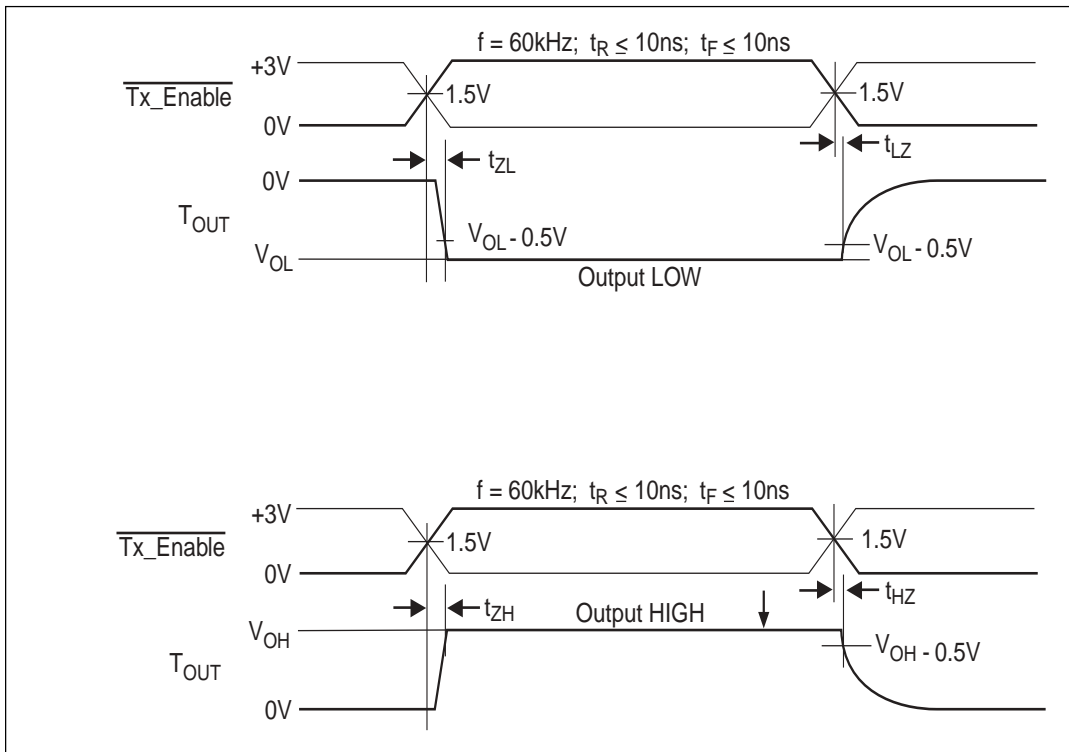


Figure 40. V.28 (RS-232) and V.10 (RS-423) Driver Enable and Disable Times

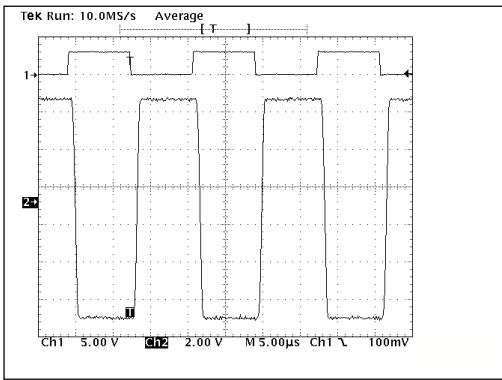


Figure 41. Typical V.28 Driver Output Waveform

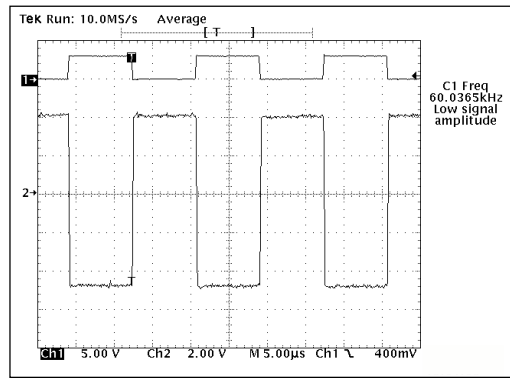


Figure 42. Typical V.10 Driver Output Waveform

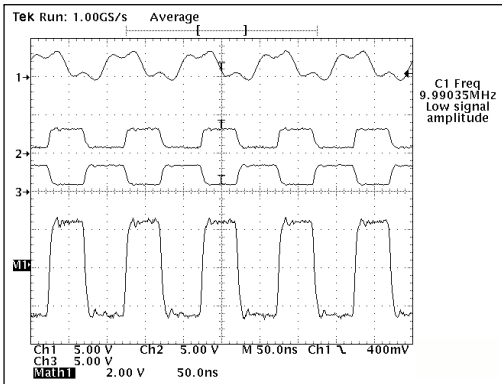


Figure 43. Typical V.11 Driver Output Waveform

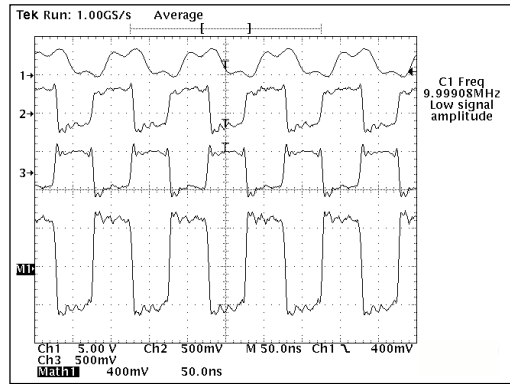


Figure 44. Typical V.35 Driver Output Waveform

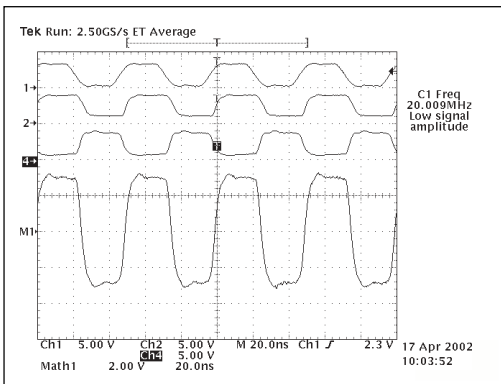


Figure 45. Typical V.11 Driver Output Waveform at 20MHz

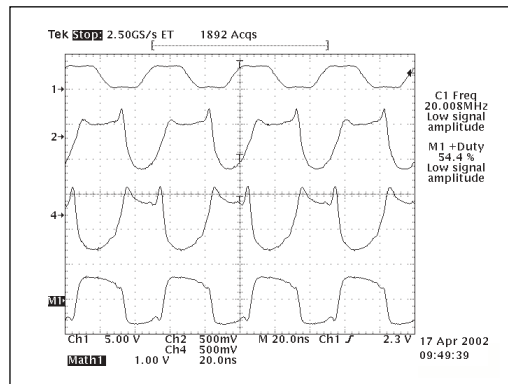


Figure 46. Typical V.35 Driver Output Waveform at 20MHz

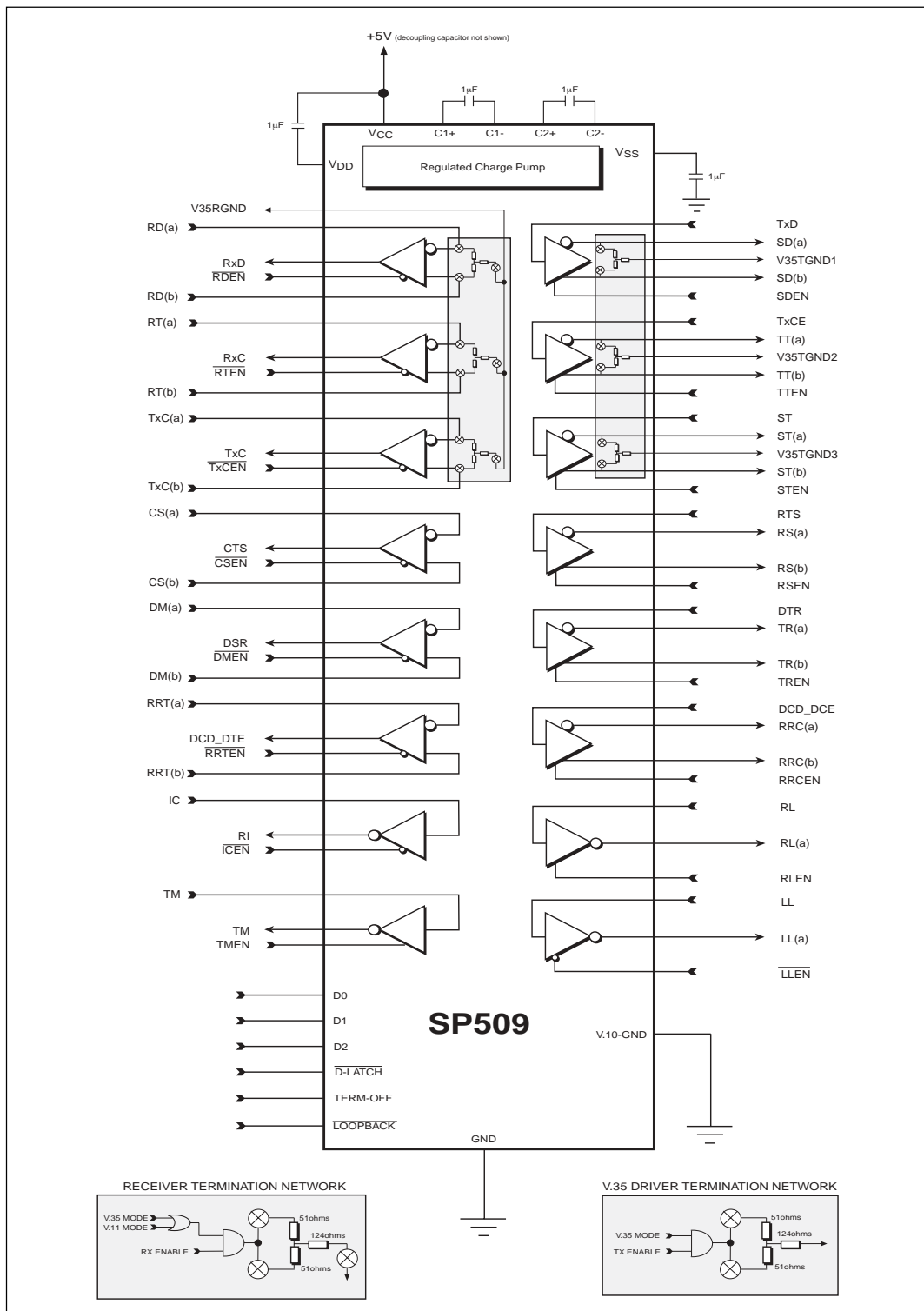


Figure 47. Functional Diagram

The SP509 contains highly integrated serial transceivers that offer programmability between interface modes through software control. The SP509 offers the hardware interface modes for RS-232 (V.28), RS-449/V.36 (V.11 and V.10), EIA-530 (V.11 and V.10), EIA-530A (V.11 and V.10), V.35 (V.35 and V.28) and X.21 (V.11). The interface mode selection is done via three control pins, which can be latched via microprocessor control.

The SP509 has eight drivers, eight receivers, and Sipex's patented on-board charge pump (5,306,954) that is ideally suited for wide area network connectivity and other multi-protocol applications. Other features include digital and line loopback modes, individual enable/disable control lines for each driver and receiver, fail-safe when inputs are either open or shorted, individual termination resistor ground paths, separate driver and receiver ground outputs, enhanced ESD protection on driver outputs and receiver inputs.

## THEORY OF OPERATION

The SP509 device is made up of 1) the drivers, 2) the receivers, 3) a charge pump, 4) DTE/DCE switching algorithm, and 5) control logic.

### Drivers

The SP509 has eight enhanced independent drivers. Control for the mode selection is done via a three-bit control word into D0, D1, and D2. The drivers are prearranged such that for each mode of operation, the relative position and functionality of the drivers are set up to accommodate the selected interface mode. As the mode of the drivers is changed, the electrical characteristics will change to support the required signal levels. The mode of each driver in the different interface modes that can be selected is shown in **Table 1**.

There are four basic types of driver circuits – ITU-T-V.28 (RS-232), ITU-T-V.10 (RS-423), ITU-T-V.11 (RS-422), and CCITT-V.35.

The V.28 (RS-232) drivers output single-ended signals with a minimum of  $\pm 5V$  (with  $3k\Omega$  &  $2500pF$  loading), and can operate over 120kbps. Since the SP509 uses a charge pump to generate the RS-232 output rails, the driver outputs will never exceed  $\pm 10V$ . The V.28 driver architecture is similar to Sipex's standard line of RS-232 transceivers.

The RS-423 (V.10) drivers are also single-ended signals which produce open circuit  $V_{OL}$  and  $V_{OH}$  measurements of  $\pm 4.0V$  to  $\pm 6.0V$ . When terminated with a  $450\Omega$  load to ground, the driver output will not deviate more than 10% of the open circuit value. This is in compliance of the ITU V.10 specification. The V.10 (RS-423) drivers are used in RS-449/V.36, EIA-530, and EIA-530A modes as Category II signals from each of their corresponding specifications. The V.10 drivers are guaranteed to transmit over 120kbps, but can operate at over 1Mbps if necessary.

The third type of drivers are V.11 (RS-422) differential drivers. Due to the nature of differential signaling, the drivers are more immune to noise as opposed to single-ended transmission methods. The advantage is evident over high speeds and long transmission lines. The strength of the driver outputs can produce differential signals that can maintain  $\pm 2V$  differential output levels with a load of  $100\Omega$ . The signal levels and drive capability of these drivers allow the drivers to also support RS-485 requirements of  $\pm 1.5V$  differential output levels with a  $54\Omega$  load. The strength allows the SP509 differential driver to drive over long cable lengths with minimal signal degradation. The V.11 drivers are used in RS-449, EIA-530, EIA-530A and V.36 modes as Category I signals which are used for clock and data. Sipex's new driver design over its predecessors allow the SP509 to operate over 40Mbps for differential transmission.

The fourth type of drivers are V.35 differential drivers. There are only three available on the SP509 for data and clock (TxD, TxCE, and TxC in DCE mode). These drivers are current sources that drive loop current through a differential pair resulting in a 550mV differential voltage at the receiver. These drivers also incorporate fixed termination networks for each driver in order to set the  $V_{OH}$  and  $V_{OL}$  depending on load conditions. This termination network is basically a “Y” configuration consisting of two 51 $\Omega$  resistors connected in series and a 124 $\Omega$  resistor connected between the two 50 $\Omega$  resistors and a V35TGND output. Each of the three drivers and its associated termination will have its own V35TGND output for grounding convenience. Filtering can be done on these pins to reduce common mode noise transmitted over the transmission line by connecting a capacitor to ground.

The drivers also have separate enable pins which simplifies half-duplex configurations for some applications, especially programmable DTE/DCE. The enable pins will either enable or disable the output of the drivers according to the appropriate active logic illustrated on **Figure 47**. The enable pins have internal pull-up and pull-down devices, depending on the active polarity of the receiver, that enable the driver upon power-on if the enable lines are left floating. During disabled conditions, the driver outputs will be at a high impedance 3-state.

The driver inputs are both TTL or CMOS compatible. All driver inputs have an internal pull-up resistor so that the output will be at a defined state at logic LOW (“0”). Unused driver inputs can be left floating. The internal pull-up resistor value is approximately 500k $\Omega$ .

## Receivers

The SP509 has eight enhanced independent receivers. Control for the mode selection is done via a three-bit control word that is the same as the driver control word. Therefore, the modes for the drivers and receivers are identical in the application.

Like the drivers, the receivers are prearranged for the specific requirements of the synchronous serial interface. As the operating mode of the receivers is changed, the electrical characteristics will change to support the required serial interface

protocols of the receivers. **Table 1** shows the mode of each receiver in the different interface modes that can be selected. There are two basic types of receiver circuits—ITU-T-V.28 (RS-232) and ITU-T-V.11, (RS-422).

The RS-232 (V.28) receiver is single-ended and accepts RS-232 signals from the RS-232 driver. The RS-232 receiver has an operating input voltage range of  $\pm 15V$  and can receive signals down to  $\pm 3V$ . The input sensitivity complies with RS-232 and V.28 at  $\pm 3V$ . The input impedance is 3k $\Omega$  to 7k $\Omega$  in accordance to RS-232 and V.28. The receiver output produces a TTL/CMOS signal with a +2.4V minimum for a logic “1” and a +0.4V maximum for a logic “0”. The RS-232 (V.28) protocol uses these receivers for all data, clock and control signals. They are also used in V.35 mode for control line signals: CTS, DSR, LL, and RL. The RS-232 receivers can operate over 120kbps.

The second type of receiver is a differential type that can be configured internally to support ITU-T-V.10 and CCITT-V.35 depending on its input conditions. This receiver has a typical input impedance of 10k $\Omega$  and a differential threshold of less than  $\pm 200mV$ , which complies with the ITU-T-V.11 (RS-422) specifications. V.11 receivers are used in RS-449/V.36, EIA-530, EIA-530A and X.21 as Category I signals for receiving clock, data, and some control line signals not covered by Category II V.10 circuits. The differential V.11 transceiver has improved architecture that allows over 40Mbps transmission rates.

Receivers dedicated for data and clock (RxD, RxC, TxC) incorporate internal termination for V.11. The termination resistor is typically 120 $\Omega$  connected between the A and B inputs. The termination is essential for minimizing crosstalk and signal reflection over the transmission line. The minimum value is guaranteed to exceed 100 $\Omega$ , thus complying with the V.11 and RS-422 specifications. This resistor is invoked when the receiver is operating as a V.11 receiver, in modes EIA-530, EIA-530A, RS-449/V.36, and X.21.

The same receivers also incorporate a termination network internally for V.35 applications. For V.35, the receiver input termination is a “Y” termination consisting of two 51Ω resistors connected in series and a 124Ω resistor connected between the two 50Ω resistors and V35RGND output. The V35RGND is usually grounded. The receiver itself is identical to the V.11 receiver.

The differential receivers can be configured to be ITU-T-V.10 single-ended receivers by internally connecting the non-inverting input to ground. This is internally done by default from the decoder. The non-inverting input is rerouted to V10GND and can be grounded separately. The ITU-T-V.10 receivers can operate over 1Mbps and are used in RS-449/V.36, E1A-530, E1A-530A and X.21 modes as Category II signals as indicated by their corresponding specifications. All receivers include an enable/disable line for disabling the receiver output allowing convenient half-duplex configurations. The enable pins will either enable or disable the output of the receivers according to the appropriate active logic illustrated on *Figure 47*. The receiver’s enable lines include an internal pull-up or pull-down device, depending on the active polarity of the receiver, that enables the receiver upon power up if the enable lines are left floating. During disabled conditions, the receiver outputs will be at a high impedance state. If the receiver is disabled any associated termination is also disconnected from the inputs.

All receivers include a fail-safe feature that outputs a logic high when the receiver inputs are open, terminated but open, or shorted together. For single-ended V.28 and V.10 receivers, there are internal 5kΩ pull-down resistors on the inputs which produces a logic high (“1”) at the receiver outputs. The differential receivers have a proprietary circuit that detect open or shorted inputs and if so, will produce a logic HIGH (“1”) at the receiver output.

## CHARGE PUMP

The charge pump is a **Sipex**-patented design (5,306,954) and uses a unique approach compared to older less-efficient designs. The charge pump still requires four external capacitors, but uses four-phase voltage shifting technique to attain symmetrical power supplies. The charge pump  $V_{DD}$  and  $V_{SS}$  outputs are regulated to +5.8V and -5.8V, respectively. There is a free-running oscillator that controls the four phases of the voltage shifting. A description of each phase follows.

### Phase 1

— $V_{SS}$  charge storage —During this phase of the clock cycle, the positive side of capacitors  $C_1$  and  $C_2$  are initially charged to  $V_{CC}$ .  $C_+$  is then switched to ground and the charge in  $C_1+$  is transferred to  $C_2-$ . Since  $C_2+$  is connected to  $V_{CC}$ , the voltage potential across capacitor  $C_2$  is now  $2_x V_{CC}$ .

### Phase 2

— $V_{SS}$  transfer —Phase two of the clock connects the negative terminal of  $C_2$  to the  $V_{SS}$  storage capacitor and the positive terminal of  $C_2$  to ground, and transfers the negative generated voltage to  $C_3$ . This generated voltage is regulated to -5.8V. Simultaneously, the positive side of the capacitor  $C_1$  is switched to  $V_{CC}$  and the negative side is connected to ground.

### Phase 3

— $V_{DD}$  charge storage —The third phase of the clock is identical to the first phase—the charge transferred in  $C_1$  produces  $-V_{CC}$  in the negative terminal of  $C_1$  which is applied to the negative side of the capacitor  $C_2$ . Since  $C_2+$  is at  $V_{CC}$ , the voltage potential across  $C_2$  is  $2_x V_{CC}$ .

### Phase 4

— $V_{DD}$  transfer —The fourth phase of the clock connects the negative terminal of  $C_2$  to ground, and transfers the generated 5.8V across  $C_2$  to  $C_4$ , the  $V_{DD}$  storage capacitor. This voltage is regulated to +5.8V. At the regulated voltage, the internal oscillator is disabled and simultaneously with this, the positive side of capacitor  $C_1$  is switched to  $V_{CC}$  and the negative side is connected to ground, and the cycle begins again. The charge pump cycle will continue as long as the operational conditions for the internal oscillator are present.

Since both  $V^+$  and  $V^-$  are separately generated from  $V_{CC}$ ; in a no-load condition  $V^+$  and  $V^-$  will be symmetrical. Older charge pump approaches that generate  $V^-$  from  $V^+$  will show a decrease in the magnitude of  $V^-$  compared to  $V^+$  due to the inherent inefficiencies in the design.

The clock rate for the charge pump typically operates at 250kHz. The external capacitors can be as low as 1 $\mu$ F with a 16V breakdown voltage rating.

### **TERM\_OFF FUNCTION**

The SP509 contains a TERM\_OFF pin that disables all three receiver input termination networks regardless of mode. This allows the device to be used in monitor mode applications typically found in networking test equipment. The TERM\_OFF pin internally contains a pull-down device with an impedance of over 500k $\Omega$ , which will default in a "ON" condition during power-up if V.35 receivers are used. The individual receiver enable line and the SHUTDOWN mode from the decoder will disable the termination regardless of TERM\_OFF.

### **LOOPBACK FUNCTION**

The SP509 contains a LOOPBACK pin that invokes a loopback path. This loopback path is illustrated in *Figure 52*. LOOPBACK has an internal pull-up resistor that defaults to normal mode during power up or if the pin is left floating. During loopback, the driver output and receiver input characteristics will still adhere to its appropriate specifications.

### **DECODER AND D\_LATCH FUNCTION**

The SP509 contains a D\_LATCH pin that latches the data into the D0, D1, and D2 decoder inputs. If tied to a logic LOW ("0"), the latch is transparent, allowing the data at the decoder inputs to propagate through and program the SP509 accordingly. If tied to a logic HIGH("1"), the latch locks out the data and prevents the mode from changing until this pin is brought to a logic LOW.

There are internal pull-up devices on D0, D1, and D2, which allow the device to be in SHUTDOWN mode ("111") upon power up. However, if the device is powered-up with the D\_LATCH at a logic HIGH, the decoder state of the SP509 will be undefined.

### **ESD TOLERANCE**

The SP509 device incorporates ruggedized ESD cells on all driver output and receiver input pins. The ESD structure is improved over our previous family for more rugged applications and environments sensitive to electrostatic discharges and associated transients.

### **CTR1/CTR2 EUROPEAN COMPLIANCY**

As with all of Sipex's previous multi-protocol serial transceiver IC's the drivers and receivers have been designed to meet all the requirements to NET1/NET2 and TBR2 in order to meet CTR1/CTR2 compliancy. The SP509 is also tested in-house at Sipex and adheres to all the NET1/2 physical layer testing and the ITU Series V specifications before shipment. Please note that although the SP509, as with its predecessors, adhere to CTR1/CTR2 compliancy testing, any complex or unusual configuration should be double-checked to ensure CTR1/CTR2 compliance. Consult the factory for details.

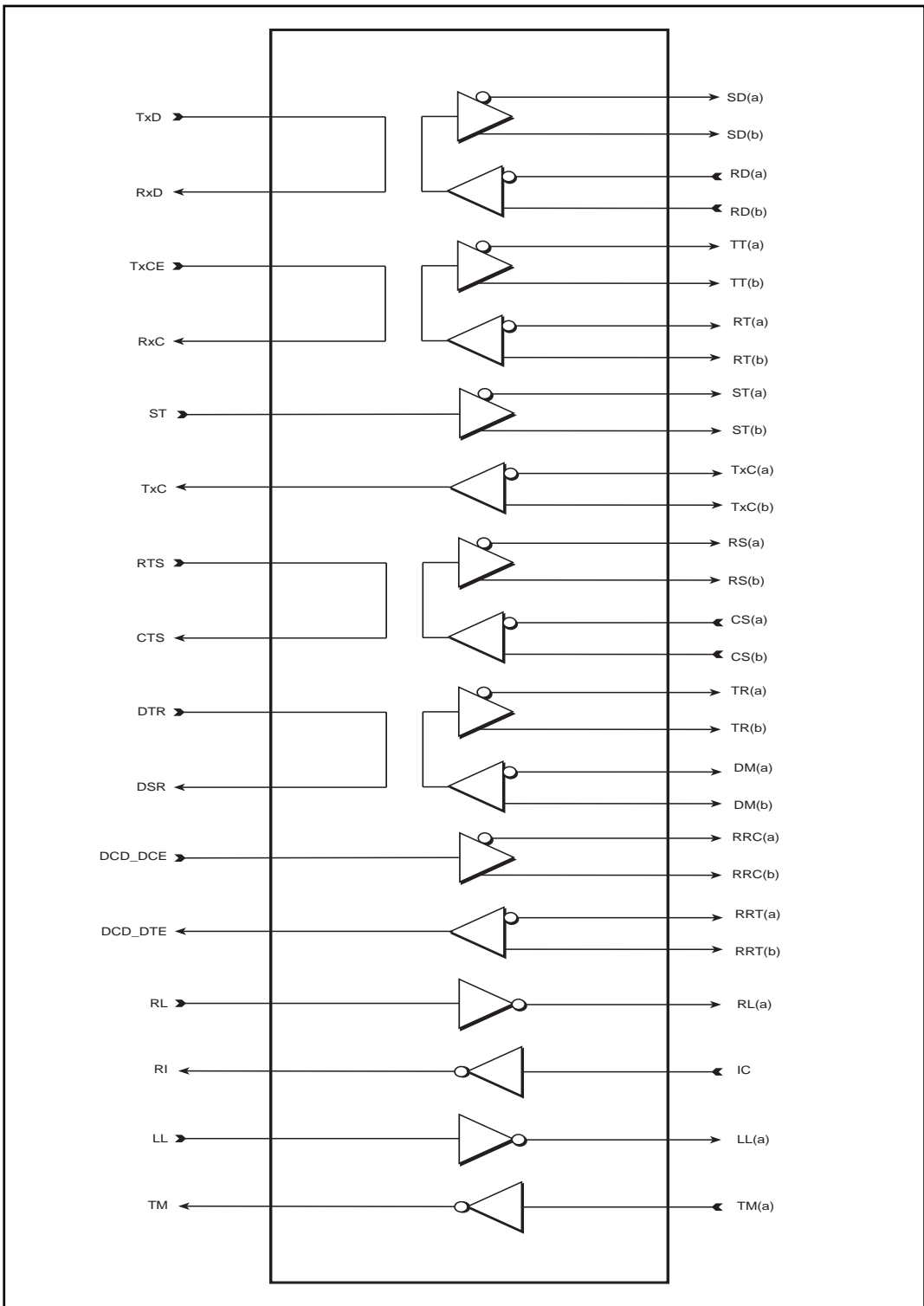


Figure 48. SP509 Loopback Path



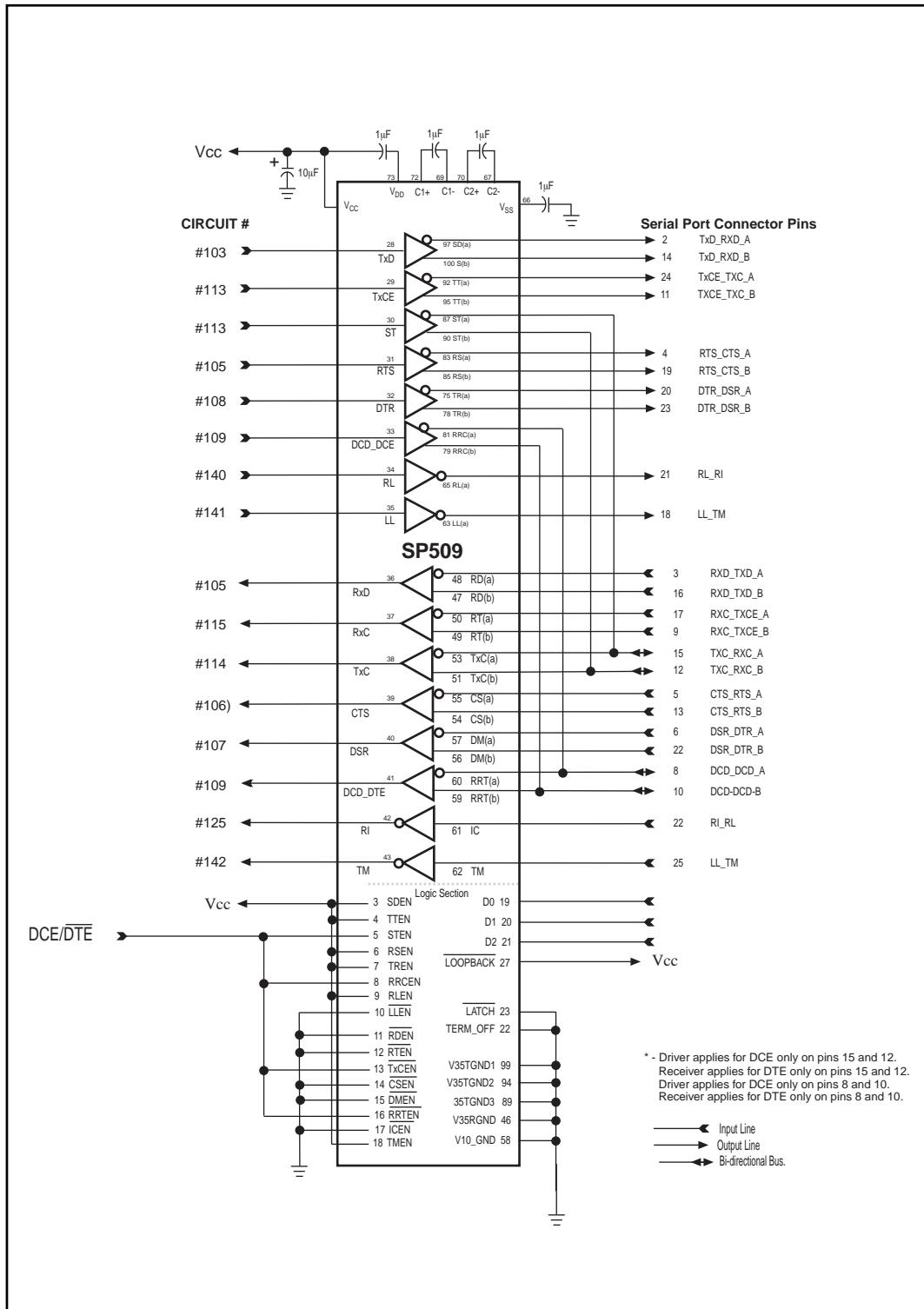
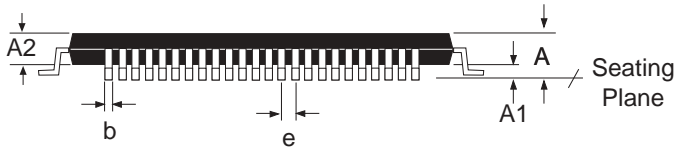
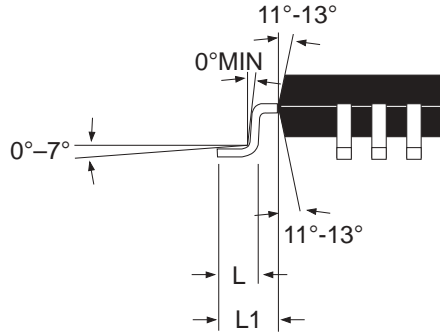
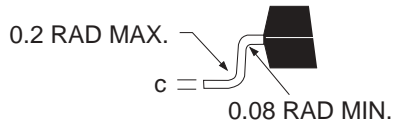
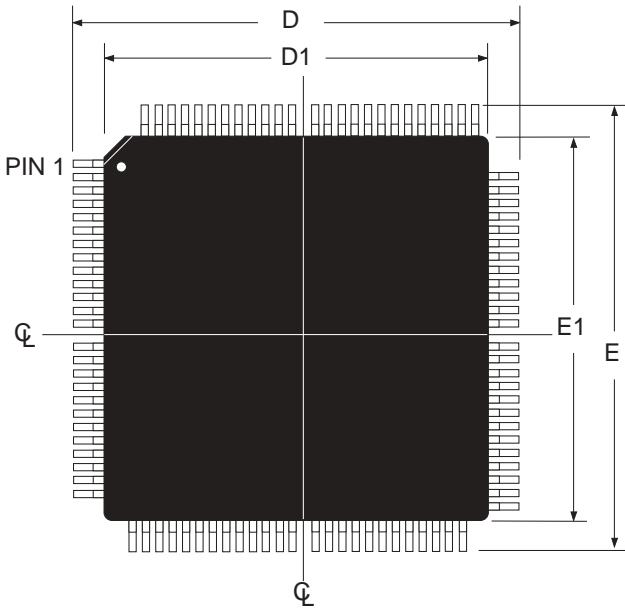


Figure 49. Configuring SP509 to Operate as either DCE or DTE



DIMENSIONS Minimum/Maximum (mm)	100-PIN LQFP JEDEC MS-026 (BED) Variation		
	MIN	NOM	MAX
SYMBOL			
A			1.60
A1	0.05		0.15
A2	1.35	1.40	1.45
b	0.17	0.22	0.27
D	16.00 BSC		
D1	14.00 BSC		
e	0.50 BSC		
E	16.00 BSC		
E1	14.00 BSC		
N	100		

COMMON DIMENSIONS			
SYMBL	MIN	NOM	MAX
c	0.09		0.20
L	0.45	0.60	0.75
L1	1.00 REF		

100 PIN LQFP

SP508 Multiprotocol Configured as DCE

Interface to System Logic			Interface to Port-Connector	
Pin Number	Pin Mnemonic	Circuit	Pin Mnemonic	Pin Number
28	TxD	Driver_1	SD(A)	97
3	SDEN		SD(B)	100
29	TxCE	Driver_2	TT(A)	92
4	TTEN		TT(B)	95
30	ST	Driver_3	ST(A)	87
5	STEN		ST(B)	90
31	RTS	Driver_4	RS(A)	83
6	RSEN		RS(B)	85
32	DTR	Driver_5	TR(A)	75
7	TREN		TR(B)	78
33	DCD_DCE	Driver_6	RRC(A)	81
8	RRCEN		RRC(B)	79
34	RL	Driver_7	RL(A)	65
9	RLEN			
35	LL	Driver_8	LL(A)	63
10	LLEN#			
36	RxD	Receiver_1	RD(A)	48
11	RDEN#		RD(B)	47
37	RxC	Receiver_2	RT(A)	50
12	RTEN#		RT(B)	49
38	TxC	Receiver_3	TxC(A)	53
13	TxCEN#		TxC(B)	51
39	CTS	Receiver_4	CS(A)	55
14	CSEN#		CS(B)	54
40	DSR	Receiver_5	DM(A)	57
15	DMEN#		DM(B)	56
41	DCD_DTE	Receiver_6	RRT(A)	60
16	RRTEN#		RRT(B)	59
42	RI	Receiver_7	IC	61
17	ICEN#			
43	TM	Receiver_8	TM(A)	62
18	TMEN			

Spare drivers and receivers may be used for optional signals (Signal Quality, Rate Detect, Standby) or may be disabled using individual enable pins for each driver and receiver

Recommended Signals and Port Pin Assignments

RS-232 or V.24			EIA-530			RS-449			V.35			X.21		
Signal Type	Mnemonic	DB-25 Pin(F)	Signal Type	Mnemonic	DB-25 Pin(F)	Signal Type	Mnemonic	DB-37 Pin(F)	Signal Type	Mnemonic	M34 Pin(F)	Signal Type	Mnemonic	DB-15 Pin(F)
V.28	BB	3	V.11	BB(A)	3	V.11	RD(A)	6	V.35	104	R	V.11	R(A)	4
			V.11	BB(B)	16	V.11	RD(B)	24	V.35	104	T	V.11	R(B)	11
V.28	DD	17	V.11	DD(A)	17	V.11	RT(A)	8	V.35	115	V	V.11	B(A)	7**
			V.11	DD(B)	9	V.11	RT(B)	26	V.35	115	X	V.11	B(B)	14**
V.28	DB	15	V.11	DB(A)	15	V.11	ST(A)	5	V.35	114	Y	V.11	S(A)	6
			V.11	DB(B)	12	V.11	ST(B)	23	V.35	114	AA	V.11	S(B)	13
V.28	CB	5	V.11	CB(A)	5	V.11	CS(A)	9	V.28	106	D	V.11	I(A)	5
			V.11	CB(B)	13	V.11	CS(B)	27				V.11	I(B)	12
V.28	CC	6	V.11	CC(A)	6	V.11	DM(A)	11	V.28	107	E			
			V.11	CC(B)	22	V.11	DM(B)	29						
V.28	CF	8	V.11	CF(A)	8	V.11	RR(A)	13	V.28	109	F			
			V.11	CF(B)	10	V.11	RR(B)	31						
V.28	CE	22							V.28	125	J			
V.28	TM	25	V.10	TM	25	V.10	TM	18	V.28	142	NN			
V.28	BA	2	V.11	BA(A)	2	V.11	SD(A)	4	V.35	103	P	V.11	T(A)	2
			V.11	BA(B)	12	V.11	SD(B)	22	V.35	103	S	V.11	T(B)	9
V.28	DA	24	V.11	DA(A)	24	V.11	TT(A)	17	V.35	113	U	V.11	X(A)	7**
			V.11	DA(B)	11	V.11	TT(B)	35	V.35	113	W	V.11	X(B)	14**
V.28	CA	4	V.11	CA(A)	4	V.11	RS(A)	7	V.28	105	C	V.11	C(A)	3
			V.11	CA(B)	19	V.11	RS(B)	25				V.11	C(B)	10
V.28	CD	20	V.11	CD(A)	20	V.11	TR(A)	12	V.28	108	H			
			V.11	CD(B)	23	V.11	TR(B)	30						
V.28	RL	21	V.10	RL	21	V.10	RL	14	V.28	140	N			
V.28	LL	18	V.10	LL	18	V.10	LL	10	V.28	141	L			

Pin assignments and signal functions are subject to national or regional variation and proprietary / non-standard implementations

\*\* X.21 use either B() or X(), not both

SP508 Multiprotocol Configured as DTE

Interface to System Logic			Interface to Port-Connector		
Pin Number	Pin Mnemonic	Circuit	Pin Mnemonic	Pin Number	
28	TxD	Driver_1	SD(A)	97	
3	SDEN		SD(B)	100	
29	TxCE	Driver_2	TT(A)	92	
4	TIEN		TT(B)	95	
30	ST	Driver_3	ST(A)	87	
5	STEN		ST(B)	90	
31	RTS	Driver_4	RS(A)	83	
6	RSEN		RS(B)	85	
32	DTR	Driver_5	TR(A)	75	
7	TREN		TR(B)	78	
33	DCD DCE	Driver_6	RRC(A)	81	
8	RRCEN		RRC(B)	79	
34	RL	Driver_7	RL(A)	65	
9	RLEN				
35	LL	Driver_8	LL(A)	63	
10	LLEN#				
36	RxD	Receiver_1	RD(A)	48	
11	RDEN#		RD(B)	47	
37	RxC	Receiver_2	RT(A)	50	
12	RTEN#		RT(B)	49	
38	TxC	Receiver_3	TxC(A)	53	
13	TxCEN#		TxC(B)	51	
39	CTS	Receiver_4	CS(A)	55	
14	CSEN#		CS(B)	54	
40	DSR	Receiver_5	DM(A)	57	
15	DMEN#		DM(B)	56	
41	DCD DTE	Receiver_6	RRT(A)	60	
16	RRTEN#		RRT(B)	59	
42	RI	Receiver_7	IC	61	
17	ICEN#				
43	TM	Receiver_8	TM(A)	62	
18	TMEN				

Spare drivers and receivers may be used for optional signals (Signal Quality, Rate Detect, Standby) or may be disabled using individual enable pins for each driver and receiver

Recommended Signals and Port Pin Assignments

RS-232 or V.24			EIA-530			RS-449			V.35			X.21			AppleTalk™		
Signal Type	Mnemonic	DB-25 Pin(M)	Signal Type	Mnemonic	DB-25 Pin(M)	Signal Type	Mnemonic	DB-37 Pin(M)	Signal Type	Mnemonic	M34 Pin(M)	Signal Type	Mnemonic	DB-15 Pin(M)	Signal Type	Mnemonic	DIN-8 Pin(F)
V.28	BA	2	V.11	BA(A)	2	V.11	SD(A)	4	V.35	103	P	V.11	T(A)	2	V.11	TxD -	3
			V.11	BA(B)	14	V.11	SD(B)	22	V.35	103	S	V.11	T(B)	9	V.11	TxD +	6
V.28	DA	24	V.11	DA(A)	24	V.11	TT(A)	17	V.35	113	U	V.11	X(A)	7**			
			V.11	DA(B)	11	V.11	TT(B)	35	V.35	113	W	V.11	X(B)	14**			
V.28	CA	4	V.11	CA(A)	4	V.11	RS(A)	7	V.28	105	C	V.11	C(A)	3			
			V.11	CA(B)	19	V.11	RS(B)	25				V.11	C(B)	10			
V.28	CD	20	V.11/10	CD(A)	20	V.11	TR(A)	12	V.28	108	H				V.10	HSKo	1
			V.11/Z	CD(B)	23	V.11	TR(B)	30									
V.28	RL	21	V.10	RL	21	V.10	RL	14	V.28	140	N						
V.28	LL	18	V.10	LL	18	V.10	LL	10	V.28	141	L						
V.28	BB	3	V.11	BB(A)	3	V.11	RD(A)	6	V.35	104	R	V.11	R(A)	4	V.11	RxD-	5
			V.11	BB(B)	16	V.11	RD(B)	24	V.35	104	T	V.11	R(B)	11	V.11	RxD+	8
V.28	DD	17	V.11	DD(A)	17	V.11	RT(A)	8	V.35	115	V						
			V.11	DD(B)	9	V.11	RT(B)	26	V.35	115	X						
V.28	DB	15	V.11	DB(A)	15	V.11	ST(A)	5	V.35	114	Y	V.11	S(A)	6			
			V.11	DB(B)	12	V.11	ST(B)	23	V.35	114	AA	V.11	S(B)	13			
V.28	CB	5	V.11	CB(A)	5	V.11	CS(A)	9	V.28	106	D	V.11	I(A)	5			GND
			V.11	CB(B)	13	V.11	CS(B)	27				V.11	I(B)	12	V.10*	HSKi	2
V.28	CC	6	V.11/10	CC(A)	6	V.11	DM(A)	11	V.28	107	E	V.11	B(A)	7**	V.10	GPI	7
			V.11/Z	CC(B)	22 ‡	V.11	DM(B)	29				V.11	B(B)	14**			
V.28	CF	8	V.11	CF(A)	8	V.11	RR(A)	13	V.28	109	F						
			V.11	CF(B)	10	V.11	RR(B)	31									
V.28	CE	22	V.10	RI	22 ‡				V.28	125	J						
V.28	TM	25	V.10	TM	25	V.10	TM	18	V.28	142	NN						

Pin assignments and signal functions are subject to national or regional variation and proprietary / non-standard implementations

‡ EIA-530 uses V.11 (differential) for DSR (CC) and DTR (CD) signals; EIA-530-A uses single-ended V.10 for DSR and DTR and adds RI signal on pin 22

\*\* X.21 use either B() or X(), not both

## ORDERING INFORMATION

<b>Model</b> SP509CF .....	<b>Temperature Range</b> 0°C to +70°C .....	<b>Package Types</b> 100 Lead LQFP
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Available in lead free packaging. To order add "-L" suffix to part number.

Example: SP509CF/TR = standard; SP509CF-L/TR = lead free

## REVISION HISTORY

DATE	REVISION	DESCRIPTION
3/31/04	A	Implemented tracking revision.
6/14/04	B	Added tables to pages 27 and 28.
8/19/04	C	Corrected pin description table and figure 49. Updated DCE/DTE tables.



ANALOG EXCELLENCE

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