

## WAN Multi-Mode Serial Transceiver

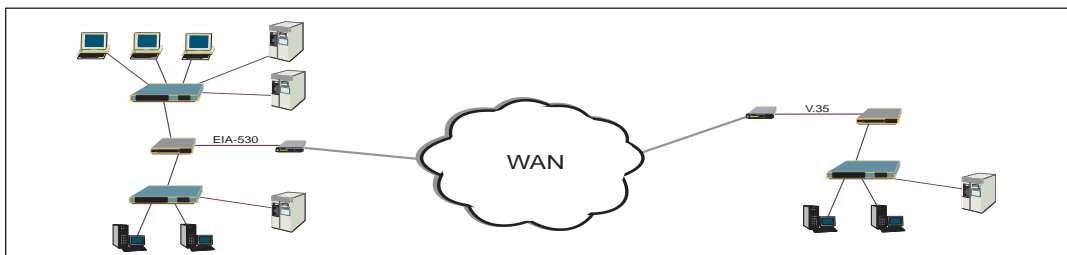
- +5V Only Operation
- Seven (7) Drivers and Seven (7) Receivers
- Driver and Receiver Tri-state Control
- Internal Transceiver Termination Resistors for V.11 and V.35 Protocols
- Loopback Self-Test Mode
- Software Selectable Protocol Selection
- Interface Modes Supported:
  - ✓ RS-232 (v.28)                    ✓ X.21/RS-422 (v.11)
  - ✓ EIA-530 (v.10 & v.11)       ✓ EIA-530A (v.10 & v.11)
  - ✓ RS-449 (v.10 & v.11)       ✓ V.35 (v.35 & v.28)
  - ✓ V.36 (v.10 & v.11)       ✓ RS-485 (un-terminated V.11)
- Improved ESD Tolerance for Analog I/Os
- High Differential Transmission Rates
  - ➔ SP505A - 10Mbps
  - ➔ SP505B - over 16Mbps
- Compliant to NET1/2 and TBR2 Physical Layer Requirements  
(TUV Test Report NET2/052101/98)  
(TUV Test Report CTR2/052101/98)



### DESCRIPTION...

The **SP505** is a monolithic device that supports eight (8) popular serial interface standards for DTE to DCE connectivity. The **SP505** is fabricated using a low power BiCMOS process technology, and incorporates a Sipex patented (5,306,954) charge pump allowing +5V only operation. Seven (7) drivers and seven (7) receivers can be configured via software for any of the above interface modes at any time. The **SP505** requires no additional external components for compliant operation for all of the eight (8) modes of operation. All necessary termination is integrated within the **SP505** and is switchable when V.35 drivers, V.35 receivers, and V.11 receivers are used. The **SP505** can operate as either a DTE or DCE.

Additional features with the **SP505** include internal loopback that can be initiated in either single-ended or differential modes. While in loopback mode, driver outputs are internally connected to receiver inputs creating an internal signal path convenient for diagnostic testing. This eliminates the need for an external loopback plug. The **SP505** also includes a latch enable pin with the driver and receiver address decoder. Tri-state ability for the driver and receiver outputs is controlled by supplying a 4-bit word into the address decoder. Seven (7) drivers and one (1) receiver in the **SP505** include separate enable pins for added convenience. The **SP505** is ideal for WAN serial ports in networking equipment such as routers, switches, DSU/CSU's, and other access devices.



## 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.

$V_{CC}$ .....+7V

Input Voltages:

Logic.....-0.3V to ( $V_{CC} + 0.5V$ )

Drivers.....-0.3V to ( $V_{CC} + 0.5V$ )

Receivers..... $\pm 15.5V$

Output Voltages:

Logic.....-0.3V to ( $V_{CC} + 0.5V$ )

Drivers..... $\pm 15V$

Receivers.....-0.3V to ( $V_{CC} + 0.5V$ )

Storage Temperature.....-65°C to +150°C

Power Dissipation.....2000mW

Package Derating:

$\theta_{JA}$ .....46°C/W

$\theta_{JC}$ .....16°C/W

## STORAGE CONSIDERATIONS

Due to the relatively large package size of the 80-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 80-pin QFP in Dry Vapor Barrier Bags with a humidity indicator card and desiccant pack. The humidity indicator should be below 30%RH.

## SPECIFICATIONS

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

|                         | MIN.      | TYP. | MAX.      | UNITS            | CONDITIONS   |
|-------------------------|-----------|------|-----------|------------------|--|
| <b>LOGIC INPUTS</b>     |           |      |           |                  |  |
| $V_{IL}$                | 2.0       |      | 0.8       | Volts            |  |
| $V_{IH}$                |           |      |           | Volts            |  |
| <b>LOGIC OUTPUTS</b>    |           |      |           |                  |  |
| $V_{OL}$                | 2.4       |      | 0.4       | Volts            | $I_{OUT} = -3.2\text{mA}$<br>$I_{OUT} = 1.0\text{mA}$  |
| $V_{OH}$                |           |      |           | Volts            |  |
| <b>V.28 DRIVER</b>      |           |      |           |                  |  |
| <b>DC Parameters</b>    |           |      |           |                  |  |
| Outputs                 |           |      |           |                  |  |
| Open Circuit Voltage    | $\pm 5.0$ |      | $\pm 15$  | Volts            | per Figure 1<br>per Figure 2<br>per Figure 4<br>per Figure 5<br><b><math>V_{CC} = +5V</math> for AC parameters</b> |
| Loaded Voltage          |           |      | $\pm 15$  | Volts            |  |
| Short-Circuit Current   |           |      | $\pm 100$ | mA               |  |
| Power-Off Impedance     | 300       |      |           | $\Omega$         |  |
| <b>AC Parameters</b>    |           |      |           |                  |  |
| Outputs                 |           |      |           |                  |  |
| Transition Time         |           |      | 1.5       | $\mu\text{s}$    | per Figure 6; +3V to -3V<br>per Figure 3   |
| Instantaneous Slew Rate |           |      | 30        | V/ $\mu\text{s}$ |  |
| Propagation Delay       |           |      |           |                  |  |
| $t_{PHL}$               | 0.5       | 1    | 5         | $\mu\text{s}$    |  |
| $t_{PLH}$               | 0.5       | 1    | 5         | $\mu\text{s}$    |  |
| Max. Transmission Rate  | 120       | 230  |           | kbps             |  |
| <b>V.28 RECEIVER</b>    |           |      |           |                  |  |
| <b>DC Parameters</b>    |           |      |           |                  |  |
| Inputs                  |           |      |           |                  |  |
| Input Impedance         | 3         |      | 7         | k $\Omega$       | per Figure 7<br>per Figure 8   |
| Open-Circuit Bias       |           |      | +2.0      | Volts            |  |
| HIGH Threshold          |           | 1.7  | 3.0       | Volts            | <b><math>V_{CC} = +5V</math> for AC parameters</b>   |
| LOW Threshold           | 0.8       | 1.2  |           | Volts            |  |
| <b>AC Parameters</b>    |           |      |           |                  |  |
| Propagation Delay       |           |      |           |                  |  |
| $t_{PHL}$               | 50        | 100  | 500       | ns               |  |
| $t_{PLH}$               | 50        | 100  | 500       | ns               |  |

## 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>V.28 RECEIVER (continued)</b><br><b>AC Parameters (cont.)</b><br>Max. Transmission Rate  | 120                        | 230  |   | kbps   |  |
| <b>V.10 DRIVER</b><br><b>DC Parameters</b><br>Outputs<br>Open Circuit Voltage<br>Test-Terminated Voltage<br>Short-Circuit Current<br>Power-Off Current<br><b>AC Parameters</b><br>Outputs<br>Transition Time<br>Propagation Delay<br>t <sub>PHL</sub><br>t <sub>PLH</sub><br>Max. Transmission Rate   | ±4.0<br>0.9V <sub>OC</sub> |      | ±6.0<br>±150<br>±100<br>200<br>50<br>50<br>120  | Volts<br>Volts<br>mA<br>μA<br>ns<br>ns<br>kbps                                       | per Figure 9<br>per Figure 10<br>per Figure 11<br>per Figure 12<br><b>V<sub>CC</sub> = +5V for AC parameters</b><br>per Figure 13; 10% to 90%  |
| <b>V.10 RECEIVER</b><br><b>DC Parameters</b><br>Inputs<br>Input Current<br>Input Impedance<br>Sensitivity<br><b>AC Parameters</b><br>Propagation Delay<br>t <sub>PHL</sub><br>t <sub>PLH</sub><br>Max. Transmission Rate  | -3.25<br>4                 |      | +3.25<br>±0.3<br>50<br>50<br>120  | mA<br>kΩ<br>Volts<br>ns<br>ns<br>kbps  | per Figures 14 and 15<br><br><b>V<sub>CC</sub> = +5V for AC parameters</b>   |
| <b>V.11 DRIVER</b><br><b>DC Parameters</b><br>Outputs<br>Open Circuit Voltage<br>Test Terminated Voltage<br><br>Balance<br>Offset<br>Short-Circuit Current<br>Power-Off Current<br><b>AC Parameters</b><br>Outputs<br>Transition Time<br>Propagation Delay<br>t <sub>PHL</sub><br>t <sub>PLH</sub><br>Differential Skew<br>Max. Transmission Rate<br>SP505ACF<br>SP505BCF | ±2.0<br>0.5V <sub>OC</sub> |      | ±5.0<br>0.67V <sub>OC</sub><br>±0.4<br>+3.0<br>±150<br>±100<br>20<br>50<br>50<br>10<br>16.4 | Volts<br>Volts<br>Volts<br>Volts<br>mA<br>μA<br>ns<br>ns<br>ns<br>ns<br>Mbps<br>Mbps | per Figure 16<br>per Figure 17<br><br>per Figure 17<br>per Figure 17<br>per Figure 18<br>per Figure 19<br><b>V<sub>CC</sub> = +5V for AC parameters</b><br>per Figures 21 and 36; 10% to 90%<br>per Figures 33 and 36, C <sub>L</sub> = 50pF<br>per Figures 33 and 36, C <sub>L</sub> = 50pF<br>per Figures 33 and 36, C <sub>L</sub> = 50pF<br>per Figure 33, C <sub>L</sub> = 50pF<br>f <sub>IN</sub> = 5MHz<br>f <sub>IN</sub> = 8.2MHz |
| <b>V.11 RECEIVER</b><br><b>DC Parameters</b><br>Inputs<br>Common Mode Range<br>Sensitivity  | -7                         |      | +7<br>±0.3  | Volts<br>Volts   |  |

# 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>V.11 RECEIVER (continued)</b>    |       |      |        |       |   |
| <b>DC Parameters (cont.)</b>        |       |      |        |       |   |
| Input Current                       | -3.25 |      | ±3.25  | mA    | per Figure 20 and 22  |
| Current w/ 100 Termination          |       |      | ±60.75 | mA    | per Figure 23 and 24  |
| Input Impedance                     | 4     |      |        | kΩ    |   |
| <b>AC Parameters</b>                |       |      |        |       |   |
| Propagation Delay                   |       |      |        |       | <b>V<sub>CC</sub> = +5V for AC parameters</b>                       |
| t <sub>PHL</sub>                    | 80    | 110  | 130    | ns    | per Figures 33 and 38; C <sub>L</sub> = 50pF                        |
| t <sub>PLH</sub>                    | 80    | 110  | 130    | ns    | per Figures 33 and 38; C <sub>L</sub> = 50pF                        |
| Differential Skew                   |       | 20   |        | ns    | per Figure 33; C <sub>L</sub> = 50pF                                |
| Max.Transmission Rate               |       |      |        |       | per Figure 33; C <sub>L</sub> = 50pF                                |
| SP505ACF                            | 10    | 12   |        | Mbps  | f <sub>IN</sub> = 5MHz  |
| SP505BCF                            | 16.4  | 18   |        | Mbps  | f <sub>IN</sub> = 8.2MHz  |
| <b>V.35 DRIVER</b>                  |       |      |        |       |   |
| <b>DC Parameters</b>                |       |      |        |       |   |
| Outputs                             |       |      |        |       |   |
| Open Circuit Voltage                |       |      | ±1.20  | Volts | per Figure 16   |
| Test Terminated Voltage             | ±0.44 |      | ±0.66  | Volts | per Figure 25   |
| Offset                              |       |      | ±0.6   | Volts | per Figure 25   |
| Source Impedance                    | 50    |      | 150    | Ω     | per Figure 27; Z <sub>S</sub> = V <sub>2</sub> /V <sub>1</sub> x 50 |
| Short-Circuit Impedance             | 135   |      | 165    | Ω     | per Figure 28   |
| <b>AC Parameters</b>                |       |      |        |       |   |
| Outputs                             |       |      |        |       |   |
| Transition Time                     |       | 30   | 40     | ns    | per Figure 29; 10% to 90%   |
| Propagation Delay                   |       |      |        |       |   |
| t <sub>PHL</sub>                    | 50    | 90   | 110    | ns    | per Figures 33 and 36; C <sub>L</sub> = 20pF                        |
| t <sub>PLH</sub>                    | 50    | 90   | 110    | ns    | per Figures 33 and 36; C <sub>L</sub> = 20pF                        |
| Differential Skew                   |       | 20   | 30     | ns    | per Figures 33 and 36; C <sub>L</sub> = 20pF                        |
| Max.Transmission Rate               |       |      |        |       | per Figure 33; C <sub>L</sub> = 20pF                                |
| SP505ACF                            | 10    | 12   |        | Mbps  | f <sub>IN</sub> = 5MHz  |
| SP505BCF                            | 16.4  | 18   |        | Mbps  | f <sub>IN</sub> = 8.2MHz  |
| <b>V.35 RECEIVER</b>                |       |      |        |       |   |
| <b>DC Parameters</b>                |       |      |        |       |   |
| Inputs                              |       |      |        |       |   |
| Sensitivity                         |       | ±80  |        | mV    |   |
| Source Impedance                    | 90    |      | 110    | Ω     | per Figure 30; Z <sub>S</sub> = V <sub>2</sub> /V <sub>1</sub> x 50 |
| Short-Circuit Impedance             | 135   |      | 165    | Ω     | per Figure 31   |
| <b>AC Parameters</b>                |       |      |        |       |   |
| Propagation Delay                   |       |      |        |       | <b>V<sub>CC</sub> = +5V for AC parameters</b>                       |
| t <sub>PHL</sub>                    | 80    | 110  | 130    | ns    | per Figures 33 and 38; C <sub>L</sub> = 20pF                        |
| t <sub>PLH</sub>                    | 80    | 110  | 130    | ns    | per Figures 33 and 38; C <sub>L</sub> = 20pF                        |
| Differential Skew                   |       | 20   |        | ns    | per Figure 33; C <sub>L</sub> = 20pF                                |
| Max.Transmission Rate               |       |      |        |       | per Figure 33; C <sub>L</sub> = 20pF                                |
| SP505ACF                            | 10    | 12   |        | Mbps  | f <sub>IN</sub> = 5MHz  |
| SP505BCF                            | 16.4  | 18   |        | Mbps  | f <sub>IN</sub> = 8.2MHz  |
| <b>TRANSCEIVER LEAKAGE CURRENTS</b> |       |      |        |       |   |
| Driver Output 3-State Current       |       | 100  | 500    | μA    | per Figure 32; Drivers disabled                                     |
| Rcvr Output 3-State Current         |       | 1    | 10     | μA    | DEC <sub>X</sub> = 0000, 0.4V V <sub>O</sub> 2.4V                   |

## 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                               |      | 0.70 | 5.0  | $\mu\text{s}$ | $C_L = 100\text{pF}$ , Fig. 34 & 40; $S_1$ closed |
| $t_{PZH}$ ; Tri-state to Output HIGH                              |      | 0.40 | 2.0  | $\mu\text{s}$ | $C_L = 100\text{pF}$ , Fig. 34 & 40; $S_2$ closed |
| $t_{PLZ}$ ; Output LOW to Tri-state                               |      | 0.20 | 2.0  | $\mu\text{s}$ | $C_L = 100\text{pF}$ , Fig. 34 & 40; $S_1$ closed |
| $t_{PHZ}$ ; Output HIGH to Tri-state                              |      | 0.40 | 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                               |      | 0.15 | 2.0  | $\mu\text{s}$ | $C_L = 100\text{pF}$ , Fig. 34 & 40; $S_1$ closed |
| $t_{PZH}$ ; Tri-state to Output HIGH                              |      | 0.20 | 2.0  | $\mu\text{s}$ | $C_L = 100\text{pF}$ , Fig. 34 & 40; $S_2$ closed |
| $t_{PLZ}$ ; Output LOW to Tri-state                               |      | 0.20 | 2.0  | $\mu\text{s}$ | $C_L = 100\text{pF}$ , Fig. 34 & 40; $S_1$ closed |
| $t_{PHZ}$ ; Output HIGH to Tri-state                              |      | 0.15 | 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                               |      | 2.80 | 10.0 | $\mu\text{s}$ | $C_L = 100\text{pF}$ , Fig. 34 & 37; $S_1$ closed |
| $t_{PZH}$ ; Tri-state to Output HIGH                              |      | 0.10 | 2.0  | $\mu\text{s}$ | $C_L = 100\text{pF}$ , Fig. 34 & 37; $S_2$ closed |
| $t_{PLZ}$ ; Output LOW to Tri-state                               |      | 0.10 | 2.0  | $\mu\text{s}$ | $C_L = 15\text{pF}$ , Fig. 34 & 37; $S_1$ closed  |
| $t_{PHZ}$ ; Output HIGH to Tri-state                              |      | 0.10 | 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                               |      | 2.60 | 10.0 | $\mu\text{s}$ | $C_L = 100\text{pF}$ , Fig. 34 & 37; $S_1$ closed |
| $t_{PZH}$ ; Tri-state to Output HIGH                              |      | 0.10 | 2.0  | $\mu\text{s}$ | $C_L = 100\text{pF}$ , Fig. 34 & 37; $S_2$ closed |
| $t_{PLZ}$ ; Output LOW to Tri-state                               |      | 0.10 | 2.0  | $\mu\text{s}$ | $C_L = 15\text{pF}$ , Fig. 34 & 37; $S_1$ closed  |
| $t_{PHZ}$ ; Output HIGH to Tri-state                              |      | 0.15 | 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                               |      | 0.12 | 2.0  | $\mu\text{s}$ | $C_L = 100\text{pF}$ , Fig. 35 & 38; $S_1$ closed |
| $t_{PZH}$ ; Tri-state to Output HIGH                              |      | 0.10 | 2.0  | $\mu\text{s}$ | $C_L = 100\text{pF}$ , Fig. 35 & 38; $S_2$ closed |
| $t_{PLZ}$ ; Output LOW to Tri-state                               |      | 0.10 | 2.0  | $\mu\text{s}$ | $C_L = 100\text{pF}$ , Fig. 35 & 38; $S_1$ closed |
| $t_{PHZ}$ ; Output HIGH to Tri-state                              |      | 0.10 | 2.0  | $\mu\text{s}$ | $C_L = 100\text{pF}$ , Fig. 35 & 38; $S_2$ closed |
| <b>RS-423/V.10</b>  |      |      |      |               |   |
| $t_{PZL}$ ; Tri-state to Output LOW                               |      | 0.10 | 2.0  | $\mu\text{s}$ | $C_L = 100\text{pF}$ , Fig. 35 & 38; $S_1$ closed |
| $t_{PZH}$ ; Tri-state to Output HIGH                              |      | 0.10 | 2.0  | $\mu\text{s}$ | $C_L = 100\text{pF}$ , Fig. 35 & 38; $S_2$ closed |
| $t_{PLZ}$ ; Output LOW to Tri-state                               |      | 0.10 | 2.0  | $\mu\text{s}$ | $C_L = 100\text{pF}$ , Fig. 35 & 38; $S_1$ closed |
| $t_{PHZ}$ ; Output HIGH to Tri-state                              |      | 0.10 | 2.0  | $\mu\text{s}$ | $C_L = 100\text{pF}$ , Fig. 35 & 38; $S_2$ 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                      |      | 0.10 | 2.0  | μs    | C <sub>L</sub> = 100pF, Fig. 35 & 39; S <sub>1</sub> closed                 |
| t <sub>PZH</sub> ; Tri-state to Output HIGH                     |      | 0.10 | 2.0  | μs    | C <sub>L</sub> = 100pF, Fig. 35 & 39; S <sub>2</sub> closed                 |
| t <sub>PLZ</sub> ; Output LOW to Tri-state                      |      | 0.10 | 2.0  | μs    | C <sub>L</sub> = 15pF, Fig. 35 & 39; S <sub>1</sub> closed                  |
| t <sub>PHZ</sub> ; Output HIGH to Tri-state                     |      | 0.10 | 2.0  | μs    | C <sub>L</sub> = 15pF, Fig. 35 & 39; S <sub>2</sub> closed                  |
| <b>V.35</b>   |      |      |      |       |   |
| t <sub>PZL</sub> ; Tri-state to Output LOW                      |      | 0.10 | 2.0  | μs    | C <sub>L</sub> = 100pF, Fig. 35 & 39; S <sub>1</sub> closed                 |
| t <sub>PZH</sub> ; Tri-state to Output HIGH                     |      | 0.10 | 2.0  | μs    | C <sub>L</sub> = 100pF, Fig. 35 & 39; S <sub>2</sub> closed                 |
| t <sub>PLZ</sub> ; Output LOW to Tri-state                      |      | 0.10 | 2.0  | μs    | C <sub>L</sub> = 15pF, Fig. 35 & 39; S <sub>1</sub> closed                  |
| t <sub>PHZ</sub> ; Output HIGH to Tri-state                     |      | 0.10 | 2.0  | μs    | C <sub>L</sub> = 15pF, Fig. 35 & 39; S <sub>2</sub> closed                  |
| <b>TRANSCEIVER TO TRANSCEIVER SKEW</b> (per Figures 33, 36, 38) |      |      |      |       |   |
| V.28 Driver   |      | 100  |      | ns    | (t <sub>phi</sub> ) <sub>TX1</sub> - (t <sub>phi</sub> ) <sub>TX6,7</sub>   |
|   |      | 100  |      | ns    | (t <sub>phi</sub> ) <sub>TX1</sub> - (t <sub>phi</sub> ) <sub>TX6,7</sub>   |
| V.28 Receiver   |      | 20   |      | ns    | (t <sub>phi</sub> ) <sub>RX1</sub> - (t <sub>phi</sub> ) <sub>RX2,7</sub>   |
|   |      | 20   |      | ns    | (t <sub>phi</sub> ) <sub>RX1</sub> - (t <sub>phi</sub> ) <sub>RX2,7</sub>   |
| V.11 Driver   |      | 2    |      | ns    | (t <sub>phi</sub> ) <sub>TX1</sub> - (t <sub>phi</sub> ) <sub>TX6,7</sub>   |
|   |      | 2    |      | ns    | (t <sub>phi</sub> ) <sub>TX1</sub> - (t <sub>phi</sub> ) <sub>TX6,7</sub>   |
| V.11 Receiver   |      | 3    |      | ns    | (t <sub>phi</sub> ) <sub>RX1</sub> - (t <sub>phi</sub> ) <sub>RX2,7</sub>   |
|   |      | 3    |      | ns    | (t <sub>phi</sub> ) <sub>RX1</sub> - (t <sub>phi</sub> ) <sub>RX2,7</sub>   |
| V.10 Driver   |      | 5    |      | ns    | (t <sub>phi</sub> ) <sub>TX2</sub> - (t <sub>phi</sub> ) <sub>TX3,4,5</sub> |
|   |      | 5    |      | ns    | (t <sub>phi</sub> ) <sub>TX2</sub> - (t <sub>phi</sub> ) <sub>TX3,4,5</sub> |
| V.10 Receiver   |      | 5    |      | ns    | (t <sub>phi</sub> ) <sub>RX2</sub> - (t <sub>phi</sub> ) <sub>RX3,4,5</sub> |
|   |      | 5    |      | ns    | (t <sub>phi</sub> ) <sub>RX2</sub> - (t <sub>phi</sub> ) <sub>RX3,4,5</sub> |
| V.35 Driver   |      | 4    |      | ns    | (t <sub>phi</sub> ) <sub>TX1</sub> - (t <sub>phi</sub> ) <sub>TX6,7</sub>   |
|   |      | 4    |      | ns    | (t <sub>phi</sub> ) <sub>TX1</sub> - (t <sub>phi</sub> ) <sub>TX6,7</sub>   |
| V.35 Receiver   |      | 6    |      | ns    | (t <sub>phi</sub> ) <sub>RX1</sub> - (t <sub>phi</sub> ) <sub>RX2,7</sub>   |
|   |      | 6    |      | ns    | (t <sub>phi</sub> ) <sub>RX1</sub> - (t <sub>phi</sub> ) <sub>RX2,7</sub>   |

## POWER REQUIREMENTS

| PARAMETER                          | MIN. | TYP. | MAX. | UNITS | CONDITIONS  |
|------------------------------------|------|------|------|-------|---|
| V <sub>CC</sub>                    | 4.75 | 5.00 | 5.25 | Volts |   |
| I <sub>CC</sub> (No Mode Selected) |      | 30   |      | mA    | All I <sub>CC</sub> values are with V <sub>CC</sub> = +5V, T = +25°C, all drivers are loaded to their specified maximum load and all drivers are active at their maximum specified data transmission rates. |
| (V.28/RS-232)                      |      | 60   |      | mA    |   |
| (V.11/RS-422)                      |      | 300  |      | mA    |   |
| (RS-449)                           |      | 250  |      | mA    |   |
| (V.35)                             |      | 105  |      | mA    |   |
| EIA-530                            |      | 260  |      | mA    |   |
| EIA-530A                           |      | 250  |      | mA    |   |
| V.36                               |      | 65   |      | mA    |   |

## TEST CIRCUITS...

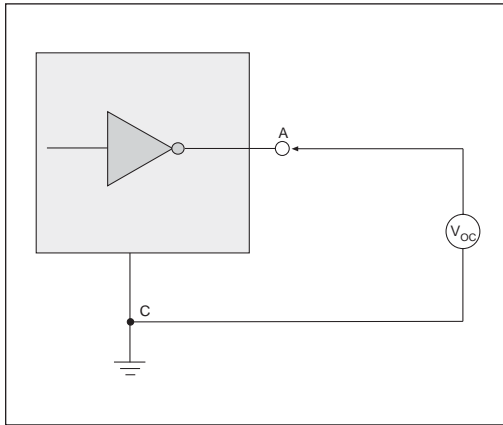


Figure 1. V.28 Driver Output Open Circuit Voltage

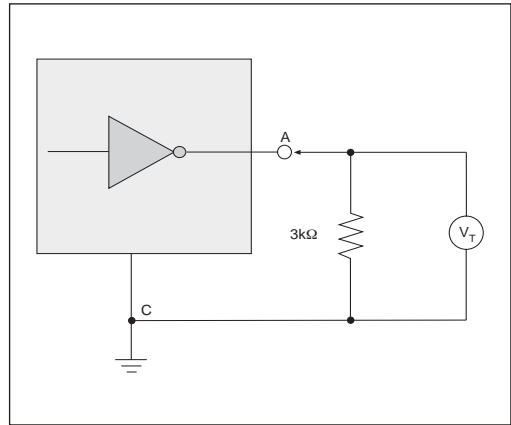


Figure 2. V.28 Driver Output Loaded Voltage

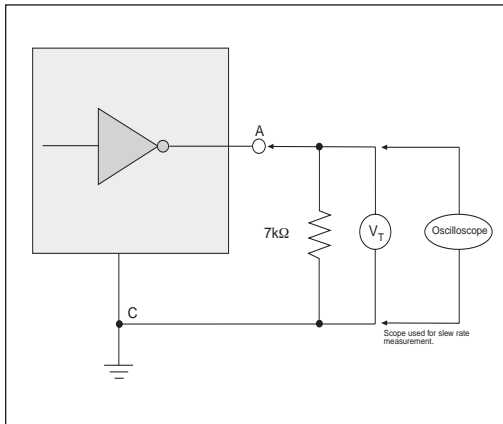


Figure 3. V.28 Driver Output Slew Rate

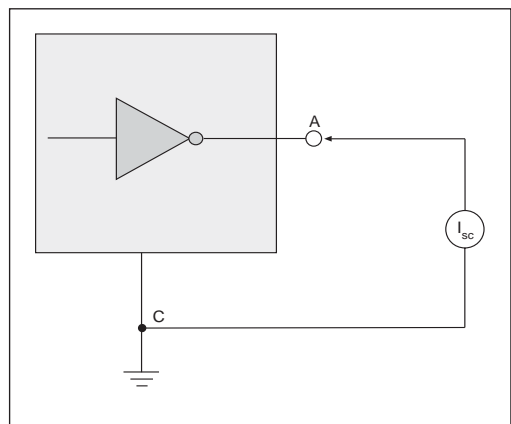


Figure 4. V.28 Driver Output Short-Circuit Current

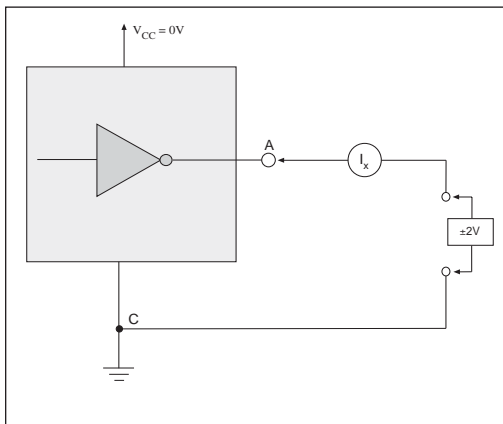


Figure 5. V.28 Driver Output Power-Off Impedance

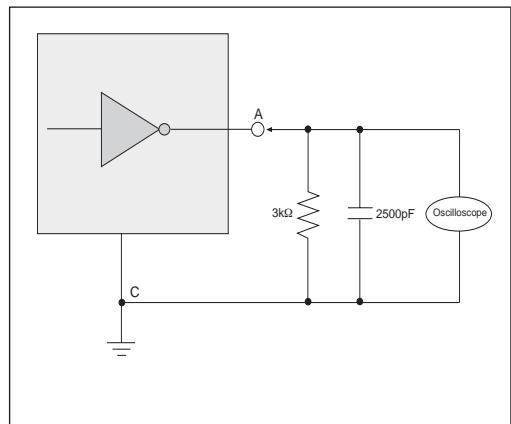


Figure 6. V.28 Driver Output Rise/Fall Times

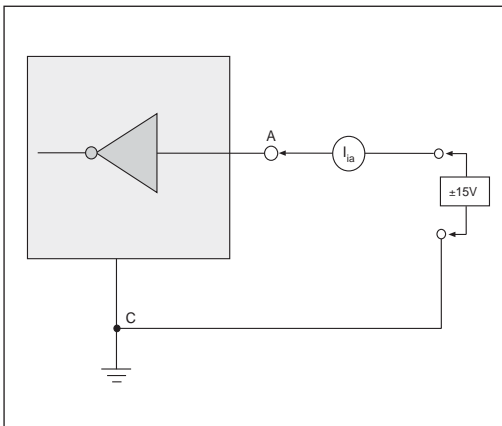


Figure 7. V.28 Receiver Input Impedance

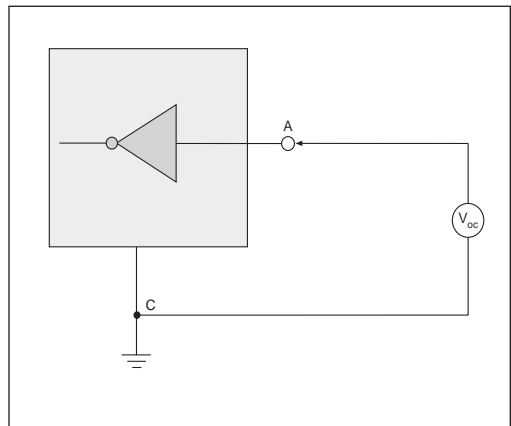


Figure 8. V.28 Receiver Input Open Circuit Bias

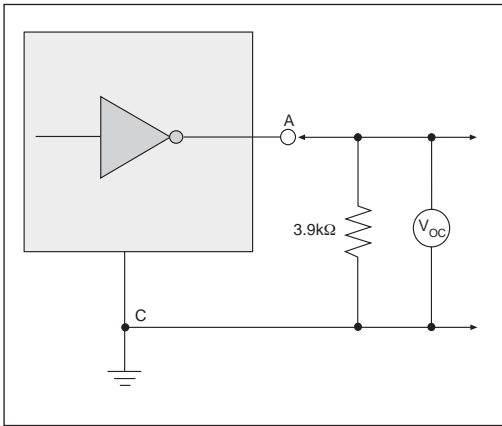


Figure 9. V.10 Driver Output Open-Circuit Voltage

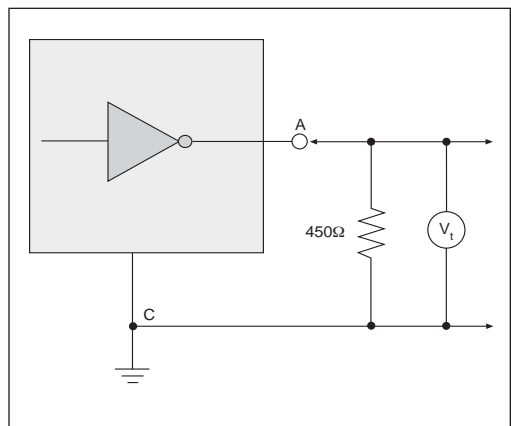


Figure 10. V.10 Driver Output Test Terminated Voltage

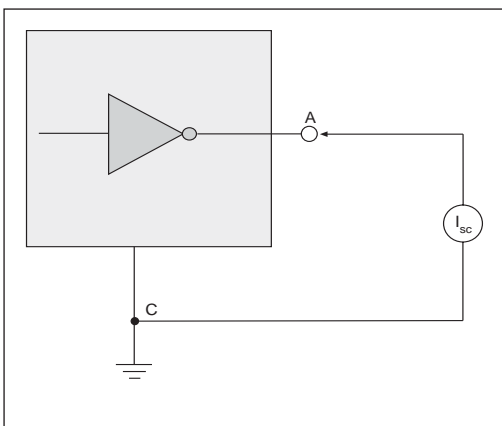


Figure 11. V.10 Driver Output Short-Circuit Current

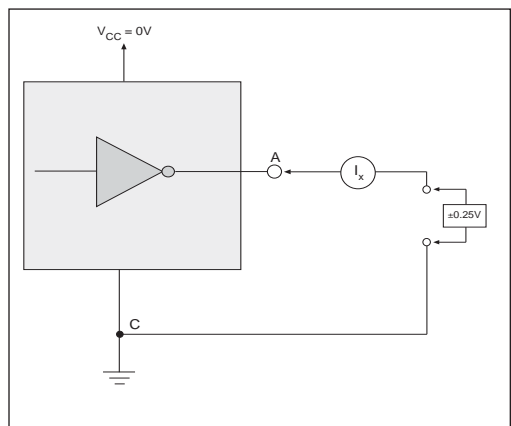


Figure 12. V.10 Driver Output Power-Off Current



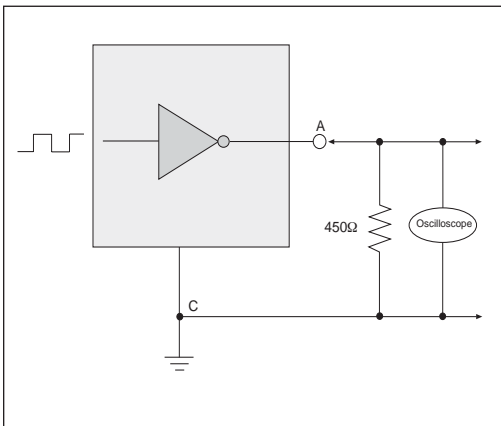


Figure 13. V.10 Driver Output Transition Time

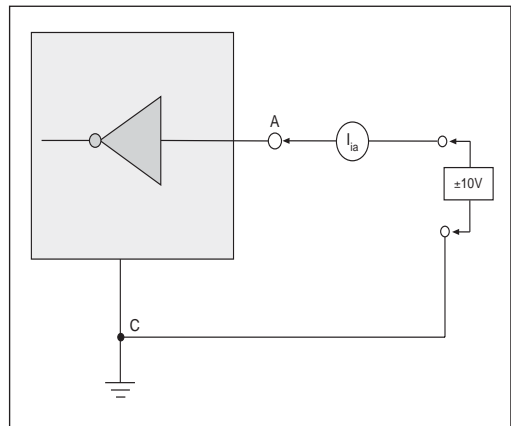


Figure 14. V.10 Receiver Input Current

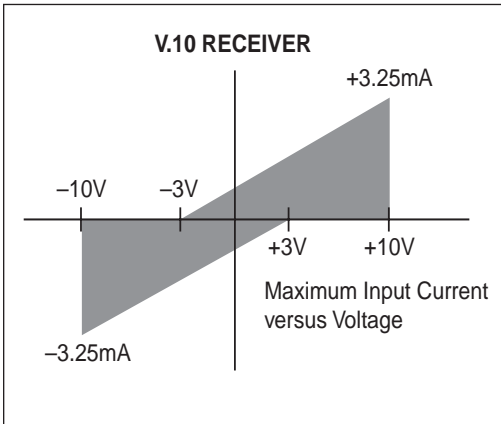


Figure 15. V.10 Receiver Input IV Graph

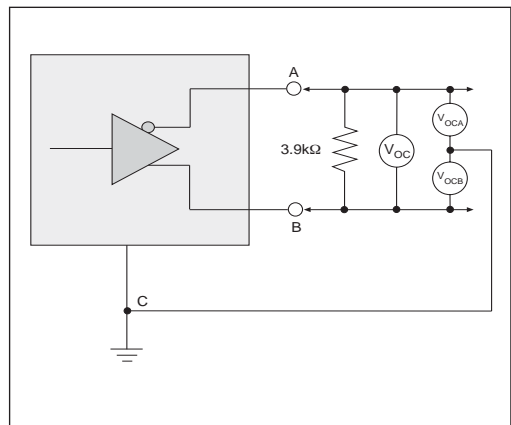


Figure 16. V.11 and V.35 Driver Output Open-Circuit Voltage

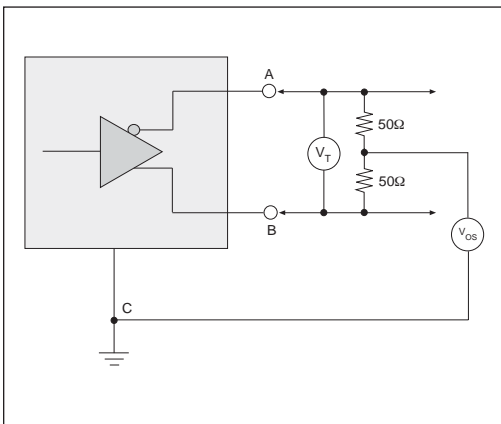


Figure 17. V.11 Driver Output Test Terminated Voltage

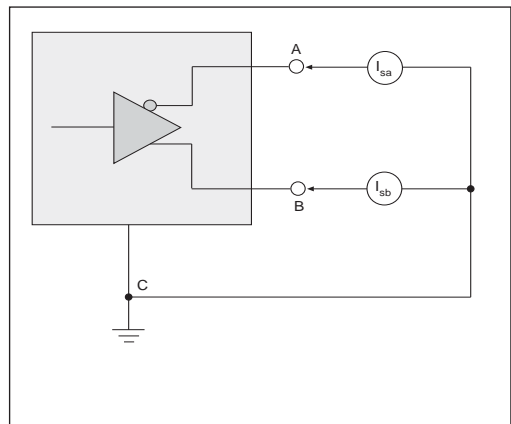


Figure 18. V.11 Driver Output Short-Circuit Current

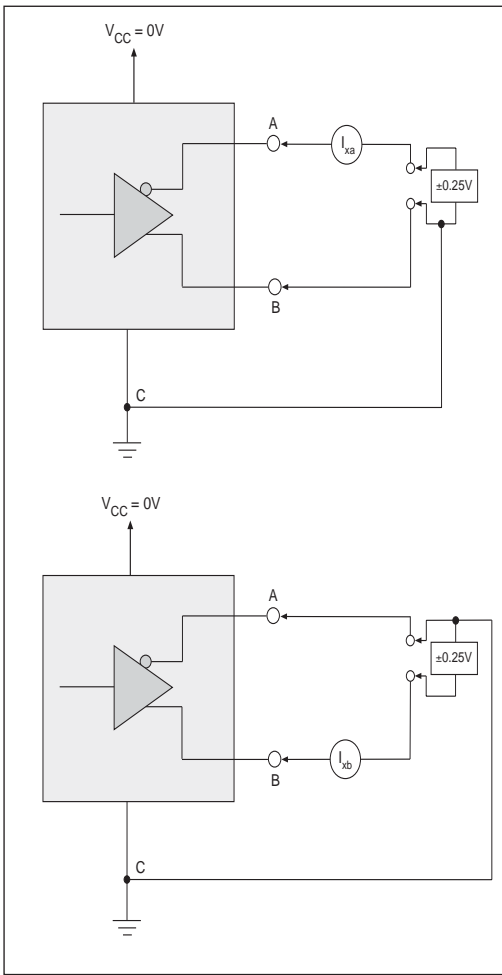


Figure 19. V.11 Driver Output Power-Off Current

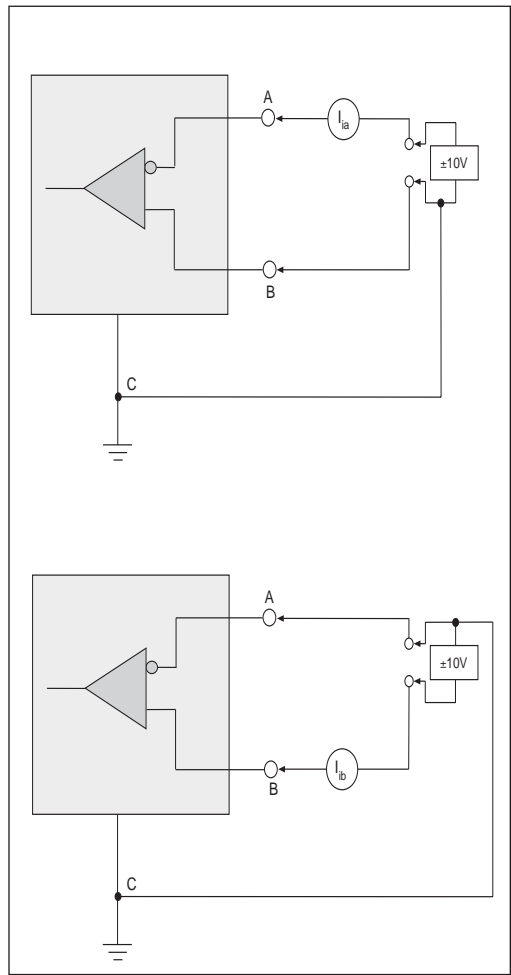


Figure 20. V.11 Receiver Input Current

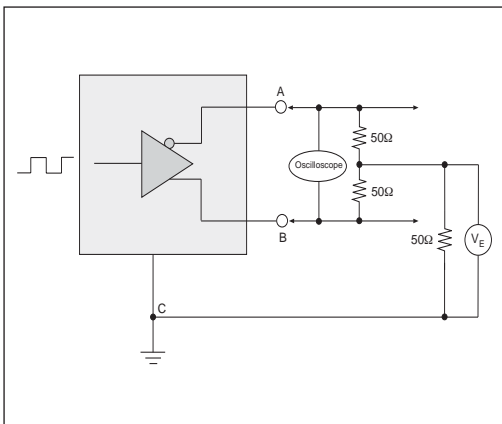


Figure 21. V.11 Driver Output Rise/Fall Time

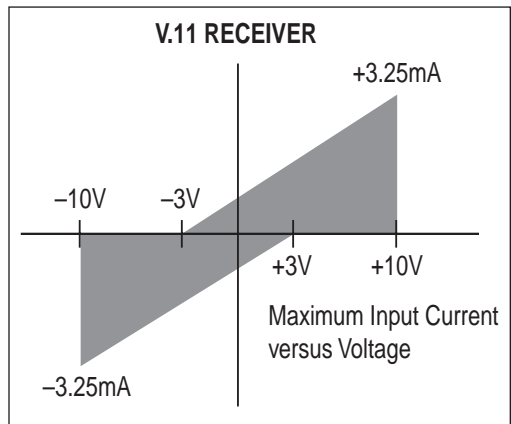


Figure 22. V.11 Receiver Input IV Graph

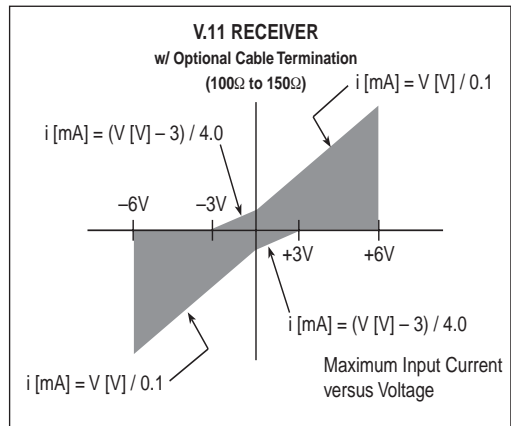
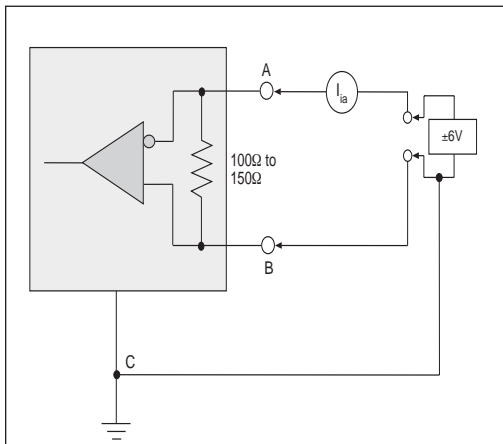


Figure 24. V.11 Receiver Input Graph w/ Termination

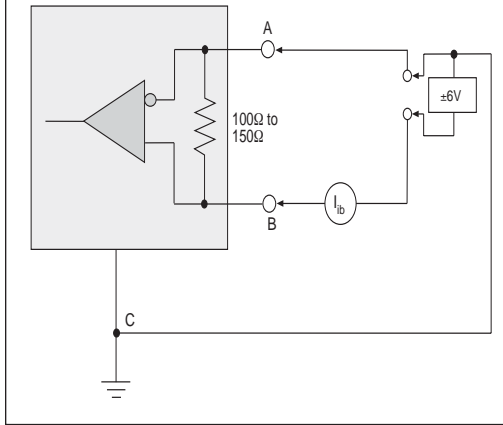


Figure 23. V.11 Receiver Input Current w/ Termination

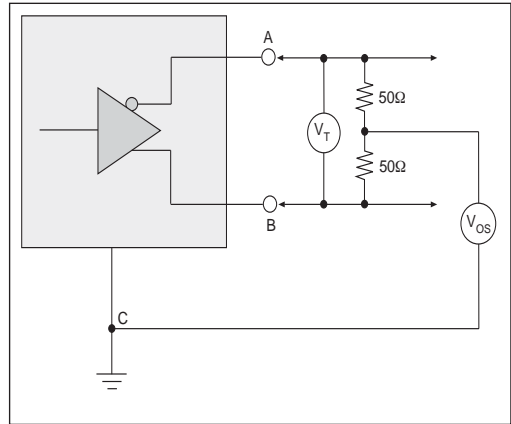


Figure 25. V.35 Driver Output Test Terminated Voltage

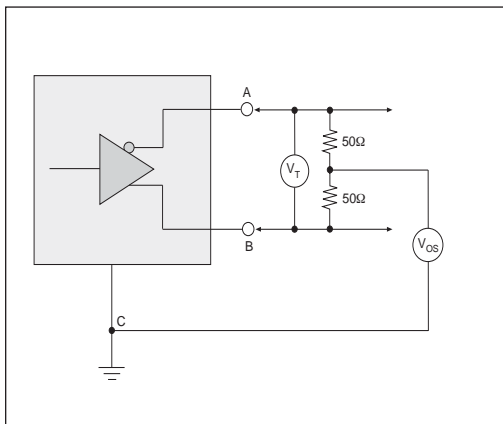


Figure 26. V.35 Driver Output Offset Voltage

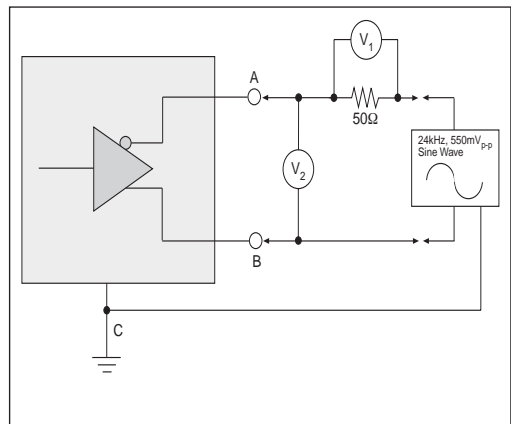


Figure 27. V.35 Driver Output Source Impedance

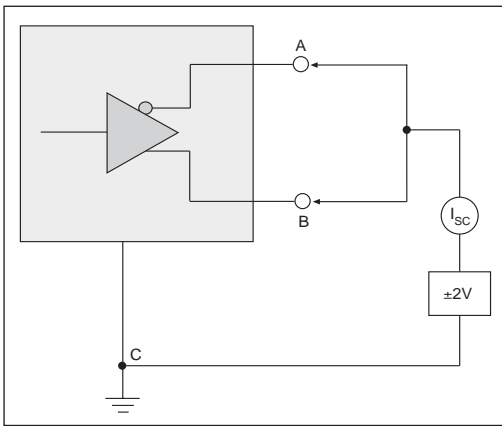


Figure 28. V.35 Driver Output Short-Circuit Impedance

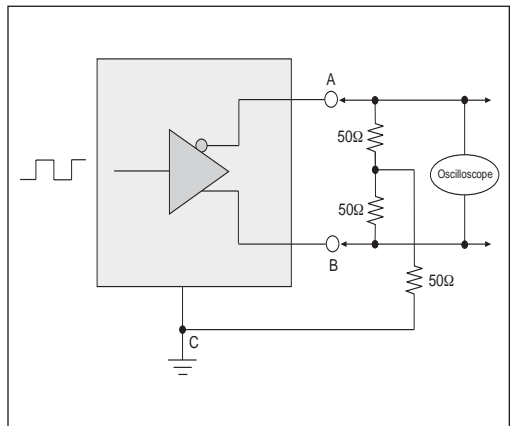


Figure 29. V.35 Driver Output Rise/Fall Time

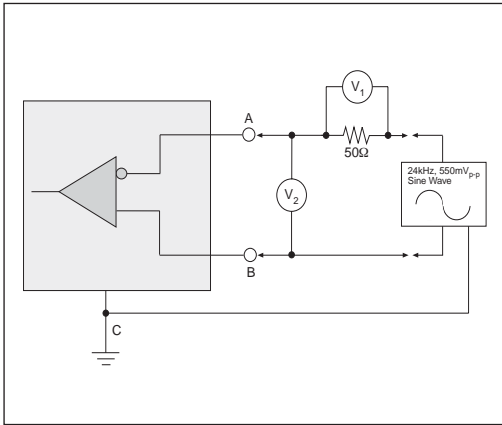


Figure 30. V.35 Receiver Input Source Impedance

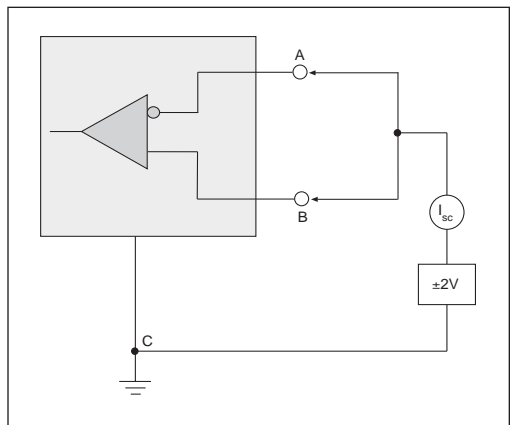


Figure 31. V.35 Receiver Input Short-Circuit Impedance

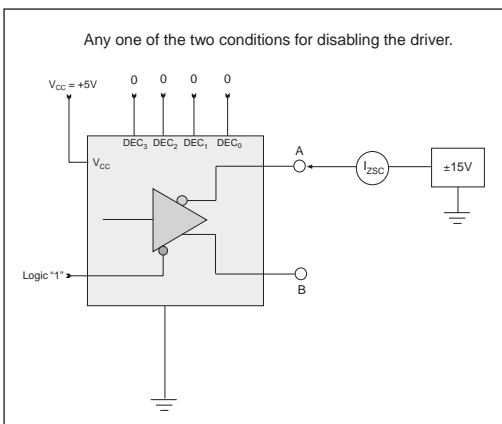


Figure 32. Driver Output Leakage Current Test

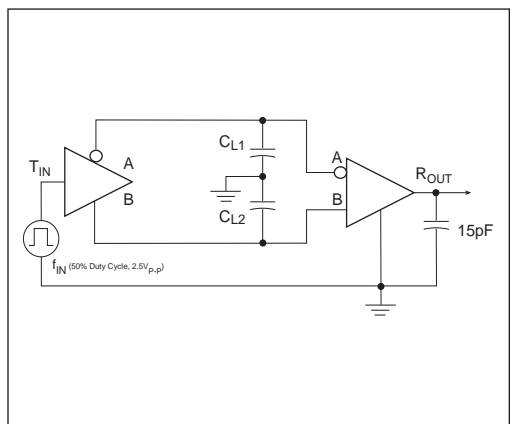


Figure 33. Driver/Receiver Timing Test Circuit

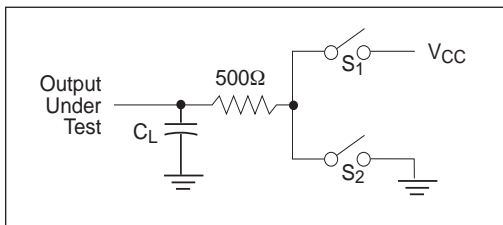


Figure 34. Driver Timing Test Load Circuit

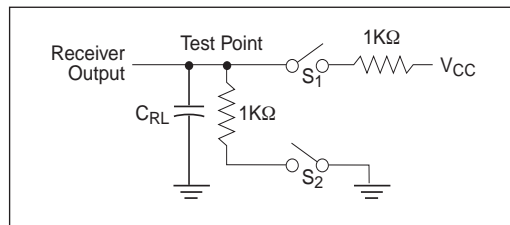


Figure 35. Receiver Timing Test Load Circuit

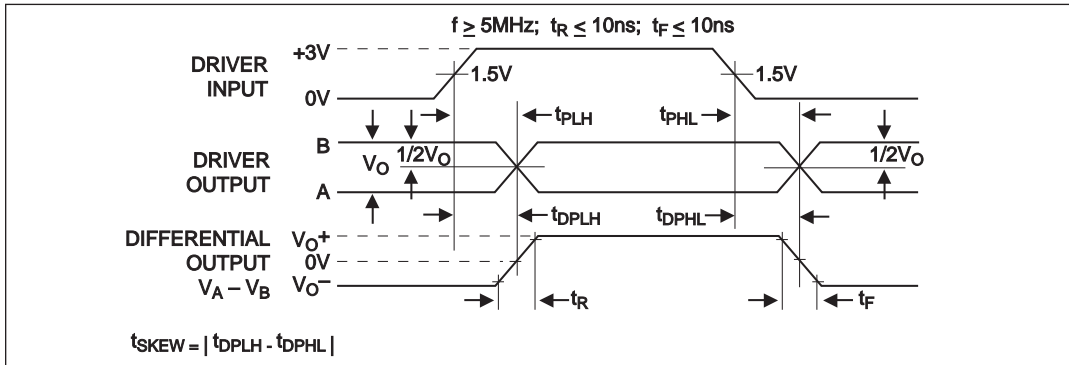


Figure 36. Driver Propagation Delays

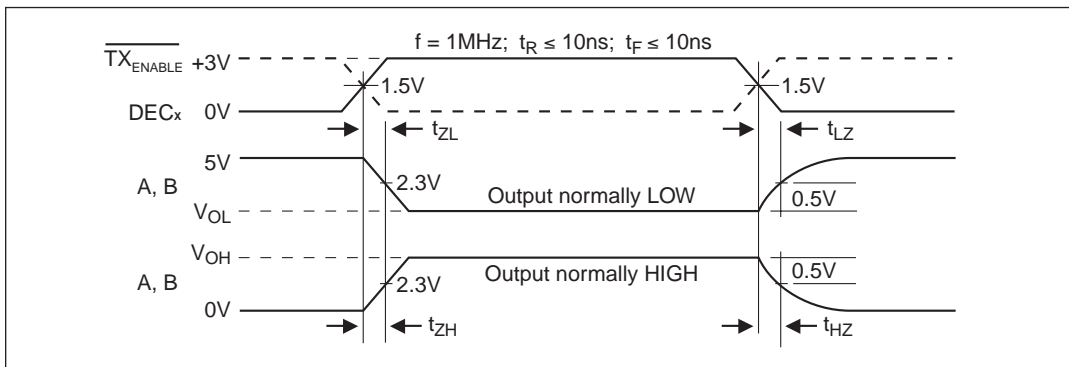


Figure 37. Driver Enable and Disable Times

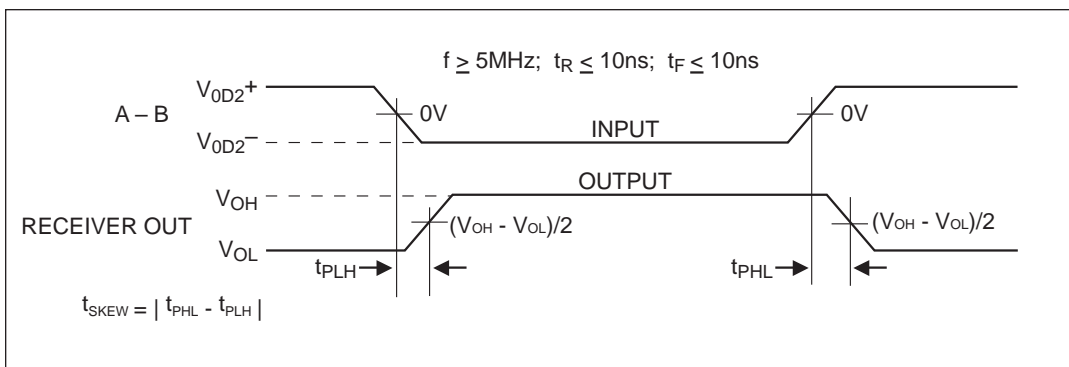


Figure 38. Receiver Propagation Delays

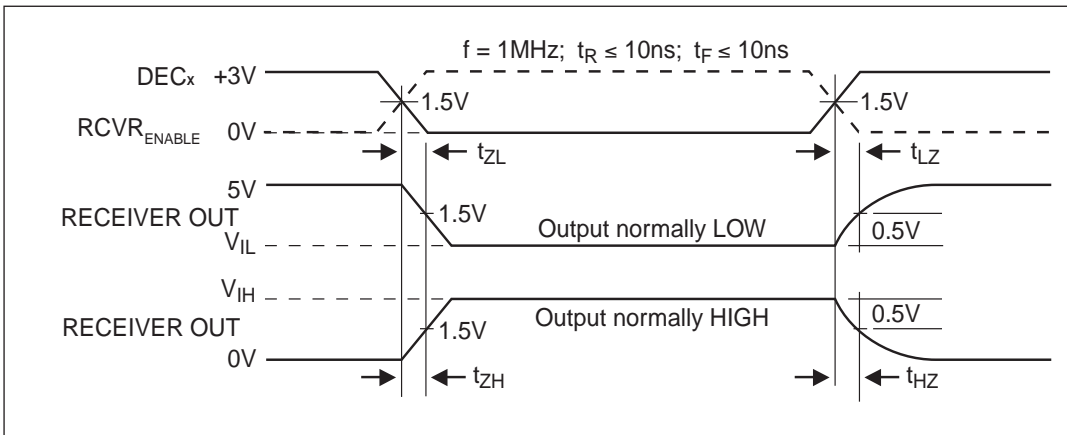


Figure 39. Receiver Enable and Disable Times

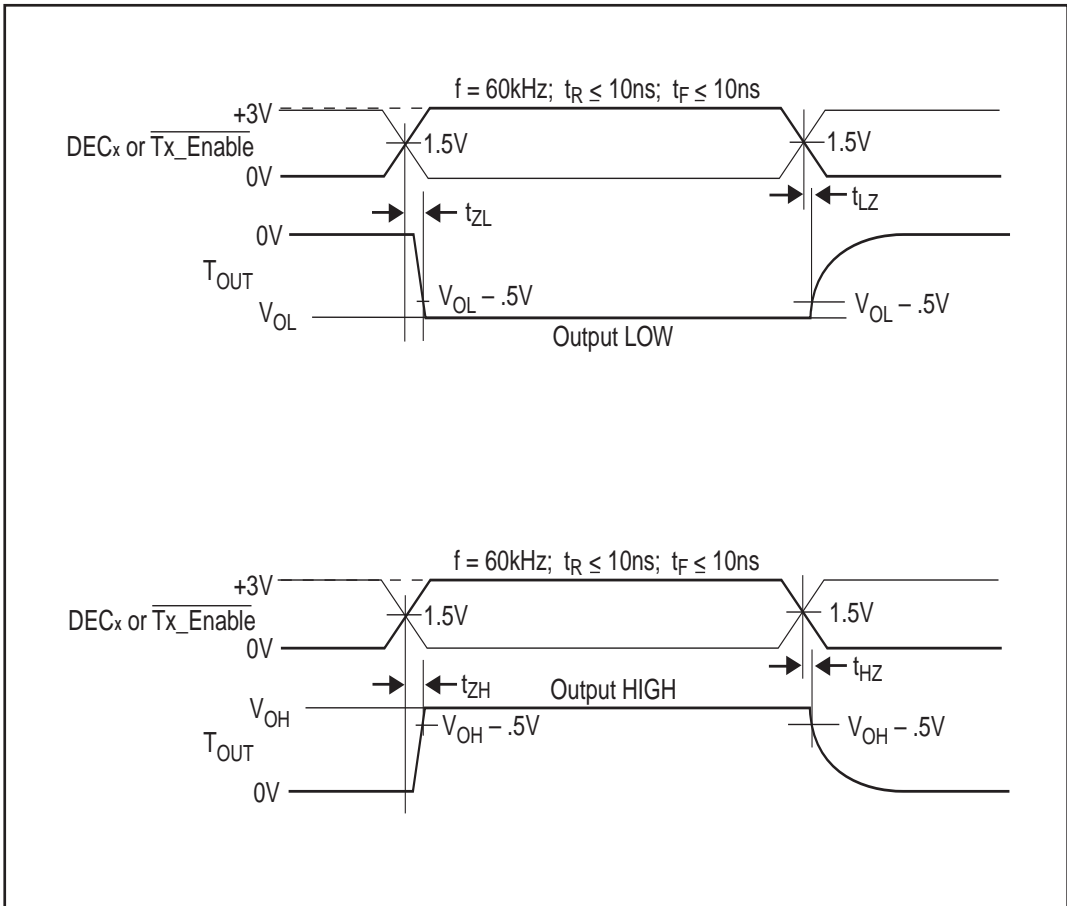


Figure 40. V.28 (RS-232) and V.10 (RS-423) Driver Enable and Disable Times

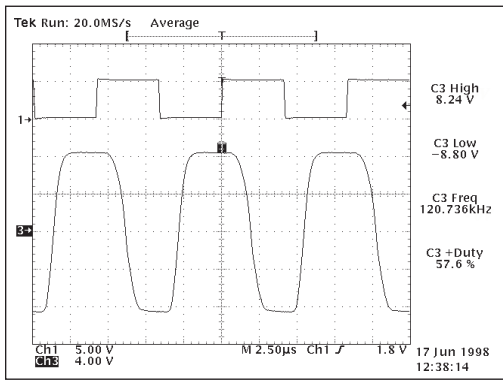


Figure 41. Typical V.28 Driver Output Waveform

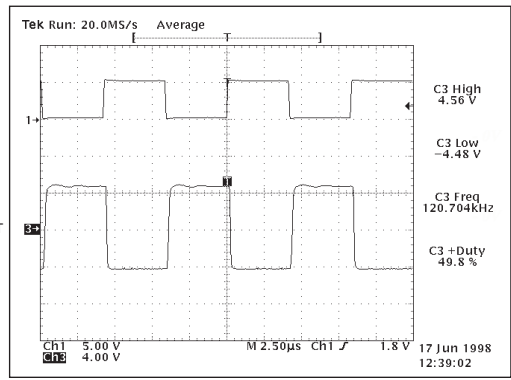


Figure 42. Typical V.10 Driver Output Waveform

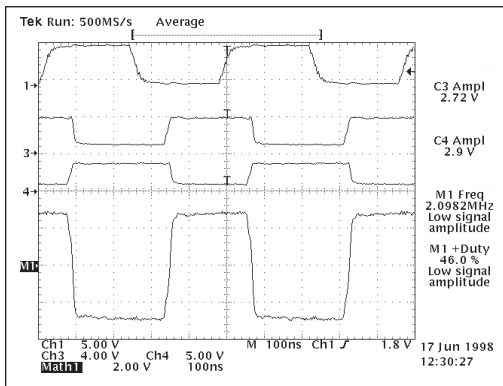


Figure 43. Typical V.11 Driver Output Waveform

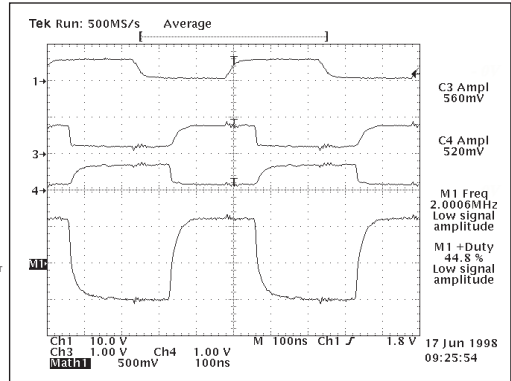
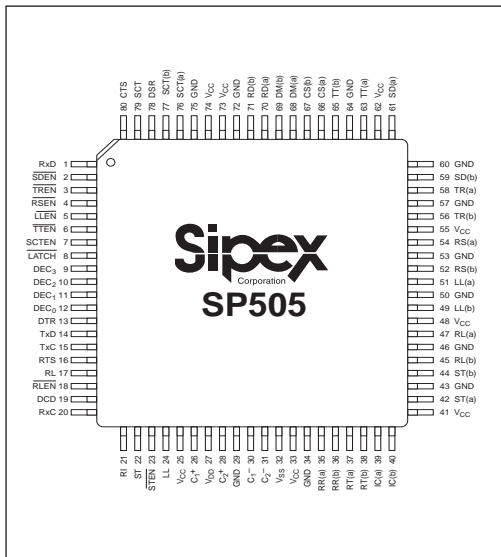


Figure 44. Typical V.35 Driver Output Waveform

## PINOUT...



## PIN ASSIGNMENTS...

### CLOCK AND DATA GROUP

Pin 1 — RxD — Receive Data; TTL output, sourced from RD(a) and RD(b) inputs.

Pin 14 — TxD — TTL input ; transmit data source for SD(a) and SD(b) outputs.

Pin 15 — TxC — Transmit Clock; TTL input for TT driver outputs.

Pin 20 — RxC — Receive Clock; TTL output sourced from RT(a) and RT(b) inputs.

Pin 22 — ST — Send Timing; TTL input; source for ST(a) and ST(b) outputs.

Pin 37 — RT(a) — Receive Timing; analog input, inverted; source for RxC.

Pin 38 — RT(b) — Receive Timing; analog input, non-inverted; source for RxC.

Pin 42 — ST(a) — Send Timing; analog output, inverted; sourced from ST.

Pin 44 — ST(b) — Send Timing; analog output, non-inverted; sourced from ST.

Pin 59 — SD(b) — Analog Out — Send data, non-inverted; sourced from TxD.

Pin 61 — SD(a) — Analog Out — Send data, inverted; sourced from TxD.

Pin 63 — TT(a) — Analog Out — Terminal Timing, inverted; sourced from TxC

Pin 65 — TT(b) — Analog Out — Terminal Timing, non-inverted; sourced from TxC.

Pin 70 — RD(a) — Receive Data, analog input; inverted; source for RxD.

Pin 71 — RD(b) — Receive Data; analog input; non-inverted; source for RxD.

Pin 76 — SCT(a) — Serial Clock Transmit; analog input, inverted; source for SCT.

Pin 77 — SCT(b) — Serial Clock Transmit; analog input, non-inverted; source for SCT

Pin 79 — SCT — Serial Clock Transmit; TTL output; sources from SCT(a) and SCT(b) inputs.

### CONTROL LINE GROUP

Pin 13 — DTR — Data Terminal Ready; TTL input; source for TR(a) and TR(b) outputs.

Pin 16 — RTS — Ready To Send; TTL input; source for RS(a) and RS(b) outputs.

Pin 17 — RL — Remote Loopback; TTL input; source for RL(a) and RL(b) outputs.

Pin 19 — DCD — Data Carrier Detect; TTL output; sourced from RR(a) and RR(b) inputs.

Pin 21 — RI — Ring In; TTL output; sourced from IC(a) and IC(b) inputs.

Pin 24 — LL — Local Loopback; TTL input; source for LL(a) and LL(b) outputs.

Pin 35 — RR(a) — Receiver Ready; analog input, inverted; source for DCD.

Pin 36 — RR(b) — Receiver Ready; analog input, non-inverted; source for DCD.

Pin 39 — IC(a) — Incoming Call; analog input, inverted; source for RI.

Pin 40 — IC(b) — Incoming Call; analog input, non-inverted; source for RI.



Pin 45 — RL(b) — Remote Loopback; analog output, non-inverted; sourced from RL.

Pin 47 — RL(a) — Remote Loopback; analog output inverted; sourced from RL.

Pin 49 — LL(b) — Local Loopback; analog output, non-inverted; sourced from LL.

Pin 51 — LL(a) — Local Loopback; analog output, inverted; sourced from LL.

Pin 52 — RS(b) — Ready To Send; analog output, non-inverted; sourced from RTS.

Pin 54 — RS(a) — Ready To Send; analog output, inverted; sourced from RTS.

Pin 56 — TR(b) — Terminal Ready; analog output, non-inverted; sourced from DTR.

Pin 58 — TR(a) — Terminal Ready; analog output, inverted; sourced from DTR.

Pin 66 — CS(a) — Clear To Send; analog input, inverted; source for CTS.

Pin 67 — CS(b) — Clear To Send; analog input, non-inverted; source for CTS.

Pin 68 — DM(a) — Data Mode; analog input, inverted; source for DSR.

Pin 69 — DM(b) — Data Mode; analog input, non-inverted; source for DSR.

Pin 78 — DSR — Data Set Ready; TTL output; sourced from DM(a), DM(b) inputs.

Pin 80 — CTS — Clear To Send; TTL output; sourced from CS(a) and CS(b) inputs.

## CONTROL REGISTERS

Pins 2 —  $\overline{\text{SDEN}}$  — Enables TxD driver, active low; TTL input.

Pins 3 —  $\overline{\text{TREN}}$  — Enables DTR driver, active low; TTL input.

Pins 4 —  $\overline{\text{RSEN}}$  — Enables RTS driver, active low; TTL input.

Pins 5 —  $\overline{\text{LLEN}}$  — Enables LL driver, active low; TTL input.

Pin 6 —  $\overline{\text{TTEN}}$  — Enables TT driver, active low; TTL input.

Pin 7 — SCTEN — Enables SCT receiver; active high; TTL input.

Pin 8 —  $\overline{\text{LATCH}}$  — Latch control for decoder bits (pins 9-12), active low. Logic high input will make decoder transparent.

Pins 12-9 —  $\text{DEC}_0 - \text{DEC}_3$  — Transmitter and receiver decode register; configures transmitter and receiver modes; TTL inputs.

Pin 18 —  $\overline{\text{RLEN}}$  — Enables RL driver; active low; TTL input.

Pin 23 —  $\overline{\text{STEN}}$  — Enables ST driver; active low; TTL input.

## POWER SUPPLIES

Pins 25, 33, 41, 48, 55, 62, 73, 74 —  $V_{\text{CC}}$  — +5V input.

Pins 29, 34, 43, 46, 50, 53, 57, 60, 64, 72, 75 — GND — Ground.

Pin 27 —  $V_{\text{DD}} + 10\text{V}$  Charge Pump Capacitor — Connects from  $V_{\text{DD}}$  to  $V_{\text{CC}}$ . Suggested capacitor size is 22 $\mu\text{F}$ , 16V.

Pin 32 —  $V_{\text{SS}} - 10\text{V}$  Charge Pump Capacitor — Connects from ground to  $V_{\text{SS}}$ . Suggested capacitor size is 22 $\mu\text{F}$ , 16V.

Pins 26 and 30 —  $C_1^+$  and  $C_1^-$  — Charge Pump Capacitor — Connects from  $C_1^+$  to  $C_1^-$ . Suggested capacitor size is 22 $\mu\text{F}$ , 16V.

Pins 28 and 31 —  $C_2^+$  and  $C_2^-$  — Charge Pump Capacitor — Connects from  $C_2^+$  to  $C_2^-$ . Suggested capacitor size is 22 $\mu\text{F}$ , 16V.

## FEATURES...

The **SP505** is a highly integrated serial transceiver that allows software control of its interface modes. Similar to the SP504, the **SP505** offers the same hardware interface modes for RS-232 (V.28), RS-422A (V.11), RS-449, RS-485, V.35, EIA-530 and includes V.36 and EIA-530A. The interface mode selection is done via a 4-bit switch for the drivers and receivers. The **SP505** is fabricated using low-power BiCMOS process technology, and incorporates a **Sipex**-patented (5,306,954) charge pump allowing +5V only operation. Each device is packaged in an 80-pin JEDEC Quad FlatPack package.

The **SP505** is ideally suited for wide area network connectivity based on the interface modes offered and the driver and receiver configurations. The **SP505** has seven (7) independent drivers and seven (7) independent receivers. In V.35 mode, the **SP505** includes the necessary components and termination resistors internal within the device for compliant V.35 operation.

## THEORY OF OPERATION

The **SP505** is made up of five separate circuit blocks — the charge pump, drivers, receivers, decoder and switching array. Each of these circuit blocks is described in more detail below.

### Charge-Pump

The **SP505** charge pump is based on the SP504 design where **Sipex's** patented charge pump design (5,306,954) uses a four-phase voltage shifting technique to attain symmetrical 10V power supplies. The charge pump still requires external capacitors to store the charge. In addition the SP504 charge pump supplies  $\pm 10V$  or  $\pm 5V$  on  $V_{SS}$  and  $V_{DD}$  depending on the mode of operation. There is a free-running oscillator that controls the four phases of the voltage shifting. A description of each phase follows.

The **SP505** charge pump is used for RS-232 where the output voltage swing is typically  $\pm 10V$  and also used for RS-423. However, RS-423 requires the voltage swing on the driver output be between  $\pm 4V$  to  $\pm 6V$  during an open-circuit (no load). The charge pump would need to be regulated down from  $\pm 10V$  to  $\pm 5V$ .

A typical  $\pm 10V$  charge pump would require external clamping such as 5V zener diodes on  $V_{DD}$  and  $V_{SS}$  to ground. The  $\pm 5V$  output has symmetrical levels as in the  $\pm 10V$  output. The  $\pm 5V$  is used in the following modes where RS-423 (V.10) are used: RS-449, EIA-530, EIA-530A and V.36.

### Phase 1 ( $\pm 10V$ )

—  $V_{SS}$  charge storage — During this phase of the clock cycle, the positive side of capacitors  $C_1$  and  $C_2$  are initially charged to +5V.  $C_1^+$  is then switched to ground and the charge on  $C_1^-$  is transferred to  $C_2^-$ . Since  $C_2^+$  is connected to +5V, the voltage potential across capacitor  $C_2$  is now 10V.

### Phase 1 ( $\pm 5V$ )

—  $V_{SS}$  &  $V_{DD}$  charge storage and transfer — With the  $C_1$  and  $C_2$  capacitors initially charged to +5V,  $C_1^+$  is then switched to ground and the charge on  $C_1^-$  is transferred to the  $V_{SS}$  storage capacitor. Simultaneously the  $C_2^-$  is switched to ground and 5V charge on  $C_2^+$  is transferred to the  $V_{DD}$  storage capacitor.

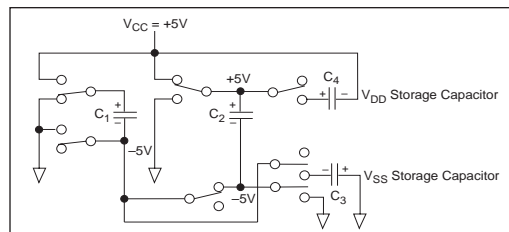


Figure 45. Charge Pump Phase 1 for  $\pm 10V$ .

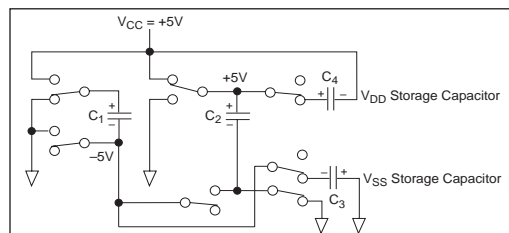


Figure 46. Charge Pump Phase 1 for  $\pm 5V$ .

## Phase 2 ( $\pm 10V$ )

—  $V_{SS}$  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 generated  $-10V$  or the generated  $-5V$  to  $C_3$ . Simultaneously, the positive side of capacitor  $C_1$  is switched to  $+5V$  and the negative side is connected to ground.

## Phase 2 ( $\pm 5V$ )

—  $V_{SS}$  &  $V_{DD}$  charge storage —  $C_1^+$  is reconnected to  $V_{CC}$  to recharge the  $C_1$  capacitor.  $C_2^+$  is switched to ground and  $C_2^-$  is connected to  $C_3$ . The  $5V$  charge from Phase 1 is now transferred to the  $V_{SS}$  storage capacitor.  $V_{SS}$  receives a continuous charge from either  $C_1$  or  $C_2$ . With the  $C_1$  capacitor charged to  $5V$ , the cycle begins again.

## 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  $-5V$  in the negative terminal of  $C_1$ , which is applied to the negative side of capacitor  $C_2$ . Since  $C_2^+$  is at  $+5V$ , the voltage potential across  $C_2$  is  $10V$ . For the  $5V$  output,  $C_2^+$  is connected to ground so that the potential on  $C_2$  is only  $+5V$ .

## Phase 4

—  $V_{DD}$  transfer — The fourth phase of the clock connects the negative terminal of  $C_2$  to ground and transfers the generated  $10V$  or the generated  $5V$  across  $C_2$  to  $C_4$ , the  $V_{DD}$  storage capacitor. Again, simultaneously with this, the positive side of capacitor  $C_1$  is switched to  $+5V$  and the negative side is connected to ground, and the cycle begins again.

Since both  $V_{DD}$  and  $V_{SS}$  are separately generated from  $V_{CC}$  in a no-load condition,  $V_{DD}$  and  $V_{SS}$  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  $15kHz$ . The external capacitors must be a minimum of  $22\mu F$  with a  $16V$  breakdown rating.

## External Power Supplies

For applications that do not require  $+5V$  only, external supplies can be applied at the  $V^+$  and  $V^-$  pins. The value of the external supply voltages must be no greater than  $\pm 10.5V$ . The tolerance should be  $\pm 5\%$  from  $\pm 10V$ . The current drain for the supplies is used for RS-232 and RS-423 drivers. For the RS-232 driver, the current requirement will be  $3.5mA$  per driver. The RS-423 driver worst case current drain will be  $11mA$  per driver. Power sequencing is required for the SP505. The supplies must be sequenced accordingly:  $+10V$ ,  $+5V$  and  $-10V$ . It is important to prevent  $V_{SS}$  from starting up before  $V_{CC}$  or  $V_{DD}$ .

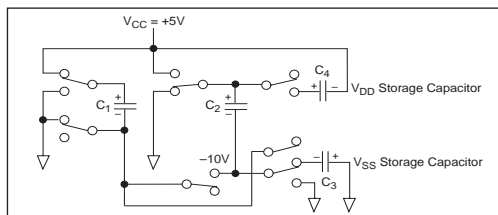


Figure 47. Charge Pump Phase 2 for  $\pm 10V$ .

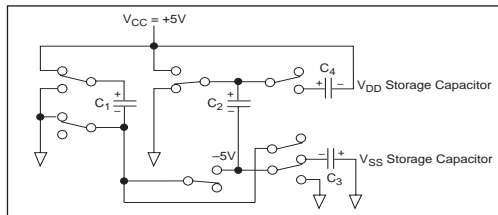


Figure 48. Charge Pump Phase 2 for  $\pm 5V$ .

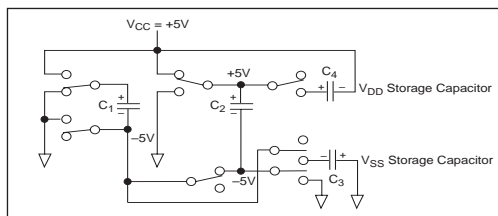


Figure 49. Charge Pump Phase 3.

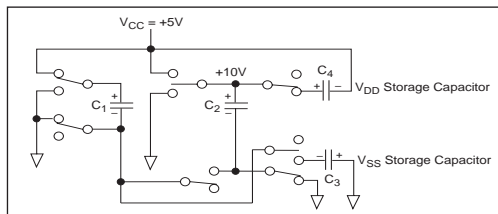


Figure 50. Charge Pump Phase 4.

## Drivers

The **SP505** has seven (7) enhanced independent drivers. Control for the mode selection is done via a four-bit control word. 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 requirements of clock, data, and control line signal levels. *Table 1* shows the mode of each driver in the different interface modes that can be selected.

There are four basic types of driver circuits — V.28, V.11, V.10 and V.35.

### V.28 Drivers

The V.28 drivers output single-ended signals with a minimum of  $\pm 5V$  (with  $3k\Omega$  &  $2500pF$  loading), and can operate to at least 120kbps under full load. Since the **SP505** uses a charge pump to generate the RS-232 output rails, the driver outputs will never exceed  $\pm 10V$ . The V.28 drivers are used in RS-232 mode for all signals, and also in V.35 mode where four (4) drivers are used as the control line signals (DTR, RTS, LL, and RL).

### V.10 Drivers

The V.10 (RS-423) 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 drivers are used in RS-449, EIA-530, EIA-530A and V.36 modes as Category II signals from each of their corresponding specifications.

### V.11 Drivers

The third type of driver is a V.11 (RS-422) type differential driver. 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 typically  $\pm 2.2V$  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  $\pm 1.5V$  minimum differential output levels with a  $54\Omega$  load. The driver is designed to operate over a common mode range of  $+12V$  to  $-7V$ , which follows the RS-485 specification. This also covers the  $+7V$  to  $-7V$  common mode range for V.11 (RS-422) requirements. 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 signals.

### V.35 Drivers

The fourth type of driver is the V.35 driver. These drivers were specifically designed to comply with the requirements of V.35. Unique to the industry, the **Sipex's** V.35 driver architecture used in the **SP505** does not need external termination resistors to operate and comply with V.35. This simplifies existing V.35 implementations that use external termination schemes. The V.35 drivers can produce  $\pm 0.55V$  driver output signals with minimum deviation (maximum 20%) given an equivalent load of  $100\Omega$ . With the help of internal resistor networks, the drivers achieve the  $50\Omega$  to  $150\Omega$  source impedance and the  $135\Omega$  to  $165\Omega$  short-circuit impedance for V.35. The V.35 driver is disabled and transparent when the decoder is in all other modes. All of the differential drivers; V.11 (RS-422) and V.35, can operate over 10Mbps.

### Driver Enable and Input

All the drivers in the **SP505** contain individual enable lines which can tri-state the driver outputs when a logic "1" is applied. This simplifies half-duplex configurations for some applications and also provides simpler DTE/DCE flexibility with one integrated circuit.

The driver inputs are both TTL or CMOS compatible. Each driver input should have a pull-down or pull-up resistor so that the output will be at a defined state. Unused driver inputs should not be left floating.

## Receivers

The **SP505** has seven (7) independent receivers which can be programmed for the different interface modes. Control for the mode selection is done via a 4-bit control word, which is the same as the driver's 4-bit control word. 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 requirements of clock, data, and control line receivers. *Table 2* shows the mode of each receiver in the different interface modes that can be selected.

There are three basic types of receiver circuits — V.28, V.10, and V.11.

### **V.28 Receivers**

The V.28 receiver is single-ended and accepts V.28 signals from the V.28 driver. The V.28 receiver has an operating voltage range of  $\pm 15\text{V}$  and can receive signals down to  $\pm 3\text{V}$ . The input sensitivity complies with RS-232 and V.28 specifications at  $\pm 3\text{V}$ . The input impedance is  $3\text{k}\Omega$  to  $7\text{k}\Omega$  in accordance to RS-232 and V.28 over a  $\pm 15\text{V}$  input range. The receiver output produces a TTL/CMOS signal with a  $+2.4\text{V}$  minimum for a logic "1" and a  $+0.8\text{V}$  maximum for a logic "0". V.28 receivers are used in RS-232 mode 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 V.28 receivers can operate to at least 120kbps.

### **V.10 Receivers**

The V.10 receivers are also single-ended as with the V.28 receivers but have an input threshold as low as  $\pm 200\text{mV}$ . The input impedance is guaranteed to be greater than  $4\text{k}\Omega$ , with an operating voltage range of  $\pm 7\text{V}$ . The V.10 receivers can operate to at least 120kbps. V.10 receivers are used in RS-449, EIA-530, EIA-530A and V.36 modes as Category II signals as indicated by their corresponding specifications.

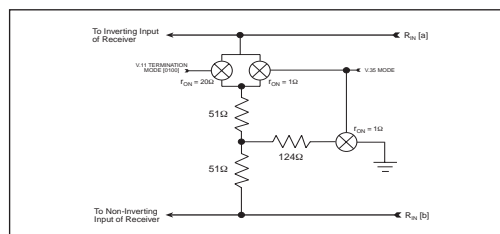
### **V.11 Receivers**

The third type of receiver is a differential which supports V.11 and RS-485 signals. This receiver has a typical input impedance of  $10\text{k}\Omega$  and a typical differential threshold of  $\pm 200\text{mV}$ , which complies with the V.11 specification. Since the characteristics of the V.11 receivers are actually subsets of RS-485, the V.11 receivers can accept RS-485 signals. However, these receivers cannot support 32-transceivers on the signal bus due to the lower input impedance as specified in the RS-485 specification. Three receivers (RxD, Rx C, and SCT) include a typical  $120\Omega$  cable termination resistor across the A and B inputs. The resistor for the three receivers

is switched on when the **SP505** is configured in a mode which uses V.11 receivers. The V.11 cable termination resistor is switched off when the receiver is disabled or in another operating mode not using V.11 receivers. The V.11 receivers are used in X.21, RS-449, EIA-530, EIA-530A and V.36 as Category I signals for receiving clock, data, and some control line signals not covered by Category II V.10 circuits. The differential receivers can receive signals over 10Mbps.

### **V.35 Receiver**

The V.11 receivers are also used for the V.35 mode. Unlike the older implementations of differential receivers used for V.35, the **SP505** contains an internal resistor termination network that ensures a V.35 input impedance of  $100\Omega$  ( $\pm 10\Omega$ ) and a short-circuit impedance of  $150\Omega$  ( $\pm 15\Omega$ ). The traditional V.35 implementations required external termination resistors to achieve the proper V.35 impedances. The internal network is connected via low on-resistance FET switches when the decoder is changed to V.35 mode. These FET switches can accept input signals of up to  $\pm 15\text{V}$  without any forward biasing and other parasitic affects. The V.35 termination resistor network is switched off when the receiver is disabled either by the decoder or receiver enable pin. The termination network is transparent when all other modes are selected. The V.35 receivers can operate over 10Mbps.



**Figure 51. Simplified  $R_{IN}$  Termination Circuit**

### **Receiver Enable and Output**

Only one receiver includes an enable line. The SCTEN input for the SCT receiver can enable or tri-state the output of the receiver. When the pin is at a logic "0", the receiver output is high impedance and any input termination internal connected is switched off. The inputs will be at approximately  $10\text{k}\Omega$  during tri-state.

All receivers include a fail-safe feature that outputs a logic "1" when the receiver inputs are open. The differential receivers allocated for data and clock signals (RxD, RxC, and SCT) have advanced fail-safe that outputs a logic "1" when the inputs are either open, shorted, or terminated. Other discrete or integrated implementations require external pull-up and pull-down resistors to define the receiver output state. For single-ended V.28 receivers, there are internal 5k $\Omega$  pull-down resistors on the inputs which produces a logic high ("1") at the receiver outputs. The single-ended V.10 receivers produce a logic LOW ("0") on the output when the inputs are open. This is due to an internal pull-up device connected to the input. The differential receivers have the same internal pull-up device on the non-inverting input which produces a logic HIGH ("1") at the receiver output, representing an "OFF" state to the HDLC controller. The three differential receivers when configured in V.35 mode (RxD, RxC & SCT) will also include fail-safe even when the internal termination resistor network is connected and the inputs are either shorted or floating.

### Decoder

The **SP505** has the ability to change the interface mode of the drivers or receivers via a 4-bit switch. The decoder for the drivers and receivers can be latched through a control pin.

The control word can be latched either high or low to write the appropriate code into the **SP505**. The codes shown in *Tables 1 and 2* are the only specified, valid modes for the **SP505**. Undefined codes may represent other interface modes not specified (consult the factory for more information). The drivers and receivers are controlled with the data bits labeled DEC<sub>3</sub>–DEC<sub>0</sub>. All of the drivers outputs and receiver outputs can be put into tri-state mode by writing 0000 to the driver decode switch. All internal termination networks are switched off during this mode. Individual tri-state capability is possible for all drivers through each driver's own enable control input. The SCT receiver also contains an individual enable input. When this control pin is disabled (logic "0"), the V.11 and V.35 input termination is deactivated. The 0000 decoder word will override the enable control line for the one receiver (SCT).

The **SP505** contains internal loopback capabilities for self-diagnostic tests. Loopback is enabled through the decoder. To initiate single-ended mode loopback, the decoder word is 1010. To initiate differential mode loopback, the decoder word is 1011. The minimum transmission rates into the **SP505** under loopback conditions are 120kbps for single-ended mode and 5Mbps for differential mode. The driver outputs are tri-stated and the receiver inputs are disabled during loopback. The receiver input impedance during loopback is approximately 10k $\Omega$ .

The **SP505** is equipped with a latch control for the four (4) decoder bits. The latch control pin is pin 8 of the **SP505**. The latch control is active low, a logic low on pin 8 will latch the decoder signals. A logic "1" on pin 8 will force the latch to be transparent to the user. A pulse width of at least 30ns is required to latch the decoder for the next mode. The resultant output is typically 600ns after the latch control pin is toggled assuming that the decoder word is set.

### NET1/2 & TBR2 European Compliancy

As with all of **Sipex's** previous multi-protocol serial transceiver ICs, the drivers and receivers have been designed to meet all the requirements to NET1/2. The **SP505** is internally tested to all the NET1/2 physical layer testing parameters and the ITU Series V specifications.

With the emergence of ETSI TBR2 (Technical Basis for Regulation) document now in place as an alternative for European compliancy, **Sipex** has tested the **SP505** to TBR2 specifications to ensure "CE" approval for either testing method.

The **SP505** was externally tested by TUV Telecom Services, Division of TUV Rheinland, and passed both NET1/2 and TBR2 requirements. Test reports (NET2/052101/98 for NET1/2 and CTR2/05101/98 for TBR2) can be furnished upon request.

Please note that although the **SP505** adheres to NET1/2 testing; any complex or unusual configuration should be double-checked to ensure NET compliance. Consult factory for details.

## SP505 Driver Mode Selection

| Pin Label                           | Mode:     | RS232     | V.35      | RS422 w/Term. | RS422 | RS449     | EIA530    | EIA-530A  | V.36      |
|-------------------------------------|-----------|-----------|-----------|---------------|-------|-----------|-----------|-----------|-----------|
| DEC <sub>3</sub> - DEC <sub>0</sub> | 0000      | 0010      | 1110      | 0100          | 0101  | 1100      | 1101      | 1111      | 0110      |
| SD(a)                               | tri-state | V.28      | V.35-     | V.11-         | V.11- | V.11-     | V.11-     | V.11-     | V.11-     |
| SD(b)                               | tri-state | tri-state | V.35+     | V.11+         | V.11+ | V.11+     | V.11+     | V.11+     | V.11+     |
| TR(a)                               | tri-state | V.28      | V.28      | V.11-         | V.11- | V.11-     | V.11-     | V.10      | V.10      |
| TR(b)                               | tri-state | tri-state | tri-state | V.11+         | V.11+ | V.11+     | V.11+     | tri-state | tri-state |
| RS(a)                               | tri-state | V.28      | V.28      | V.11-         | V.11- | V.11-     | V.11-     | V.11-     | V.10      |
| RS(b)                               | tri-state | tri-state | tri-state | V.11+         | V.11+ | V.11+     | V.11+     | V.11+     | tri-state |
| RL(a)                               | tri-state | V.28      | V.28      | V.11-         | V.11- | V.10      | V.11-     | V.11-     | V.10      |
| RL(b)                               | tri-state | tri-state | tri-state | V.11+         | V.11+ | tri-state | V.11+     | V.11+     | tri-state |
| LL(a)                               | tri-state | V.28      | V.28      | V.11-         | V.11- | V.10      | V.10      | V.10      | V.10      |
| LL(b)                               | tri-state | tri-state | tri-state | V.11+         | V.11+ | tri-state | tri-state | tri-state | tri-state |
| ST(a)                               | tri-state | V.28      | V.35-     | V.11-         | V.11- | V.11-     | V.11-     | V.11-     | V.11-     |
| ST(b)                               | tri-state | tri-state | V.35+     | V.11+         | V.11+ | V.11+     | V.11+     | V.11+     | V.11+     |
| TT(a)                               | tri-state | V.28      | V.35-     | V.11-         | V.11- | V.11-     | V.11-     | V.11-     | V.11-     |
| TT(b)                               | tri-state | tri-state | V.35+     | V.11+         | V.11+ | V.11+     | V.11+     | V.11+     | V.11+     |

Table 1. SP505 Driver Decoder Table

## SP505 Receiver Mode Selection

| Pin Label                           | Mode:        | RS232        | V.35         | RS422 w/Term. | RS422 | RS449         | EIA530        | EIA-530A      | V.36          |
|-------------------------------------|--------------|--------------|--------------|---------------|-------|---------------|---------------|---------------|---------------|
| DEC <sub>3</sub> - DEC <sub>0</sub> | 0000         | 0010         | 1110         | 0100          | 0101  | 1100          | 1101          | 1111          | 0110          |
| RD(a)                               | >10kΩ to GND | V.28         | V.35-        | V.11- ← [20k] | V.11- | V.11- ← [20k] | V.11- ← [20k] | V.11- ← [20k] | V.11- ← [20k] |
| RD(b)                               | >10kΩ to GND | >10kΩ to GND | V.35+        | V.11+ ← [20k] | V.11+ | V.11+ ← [20k] | V.11+ ← [20k] | V.11+ ← [20k] | V.11+ ← [20k] |
| RT(a)                               | >10kΩ to GND | V.28         | V.35-        | V.11- ← [20k] | V.11- | V.11- ← [20k] | V.11- ← [20k] | V.11- ← [20k] | V.11- ← [20k] |
| RT(b)                               | >10kΩ to GND | >10kΩ to GND | V.35+        | V.11+ ← [20k] | V.11+ | V.11+ ← [20k] | V.11+ ← [20k] | V.11+ ← [20k] | V.11+ ← [20k] |
| CS(a)                               | >10kΩ to GND | V.28         | V.28         | V.11-         | V.11- | V.11-         | V.11-         | V.11-         | V.10          |
| CS(b)                               | >10kΩ to GND | >10kΩ to GND | >10kΩ to GND | V.11+         | V.11+ | V.11+         | V.11+         | V.11+         | >10kΩ to GND  |
| DM(a)                               | >10kΩ to GND | V.28         | V.28         | V.11-         | V.11- | V.11-         | V.11-         | V.10          | V.10          |
| DM(b)                               | >10kΩ to GND | >10kΩ to GND | >10kΩ to GND | V.11+         | V.11+ | V.11+         | V.11+         | >10kΩ to GND  | >10kΩ to GND  |
| RR(a)                               | >10kΩ to GND | V.28         | V.28         | V.11-         | V.11- | V.11-         | V.11-         | V.11-         | V.10          |
| RR(b)                               | >10kΩ to GND | >10kΩ to GND | >10kΩ to GND | V.11+         | V.11+ | V.11+         | V.11+         | V.11+         | >10kΩ to GND  |
| IC(a)                               | >10kΩ to GND | V.28         | V.28         | V.11-         | V.11- | V.10          | V.10          | V.10          | V.10          |
| IC(b)                               | >10kΩ to GND | >10kΩ to GND | >10kΩ to GND | V.11+         | V.11+ | >10kΩ to GND  | >10kΩ to GND  | >10kΩ to GND  | >10kΩ to GND  |
| SCT(a)                              | >10kΩ to GND | V.28         | V.35-        | V.11- ← [20k] | V.11- | V.11- ← [20k] | V.11- ← [20k] | V.11- ← [20k] | V.11- ← [20k] |
| SCT(b)                              | >10kΩ to GND | >12kΩ to GND | V.35+        | V.11+ ← [20k] | V.11+ | V.11+ ← [20k] | V.11+ ← [20k] | V.11+ ← [20k] | V.11+ ← [20k] |

Table 2. SP505 Receiver Decoder Table

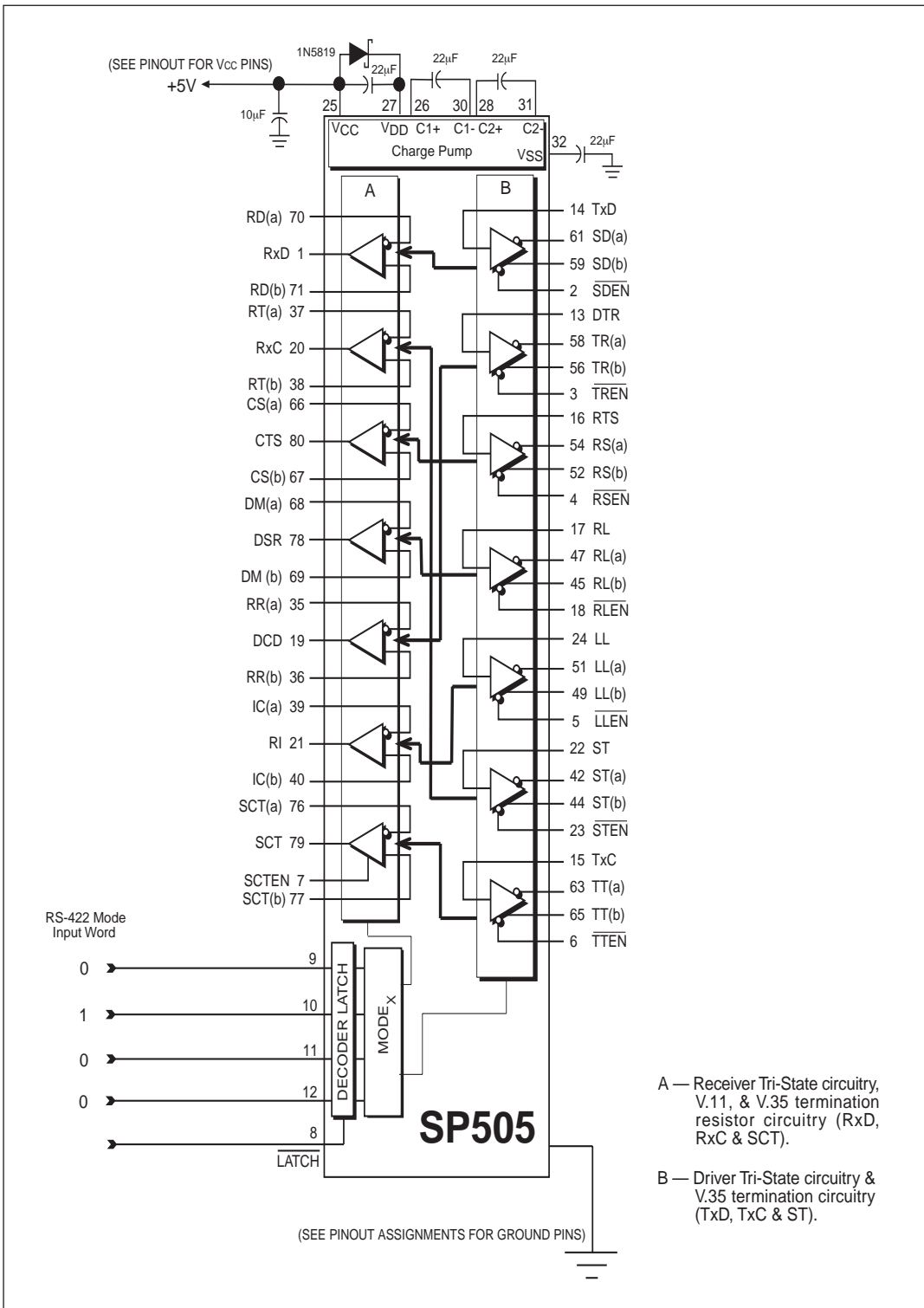


Figure 52. SP505 Typical Operating Circuit



| MODE: RS-232 (V.28) |                  |                  |                  |
|---------------------|------------------|------------------|------------------|
| DRIVER/RECEIVER     |                  |                  |                  |
| DEC <sub>3</sub>    | DEC <sub>2</sub> | DEC <sub>1</sub> | DEC <sub>0</sub> |
| 0                   | 0                | 1                | 0                |

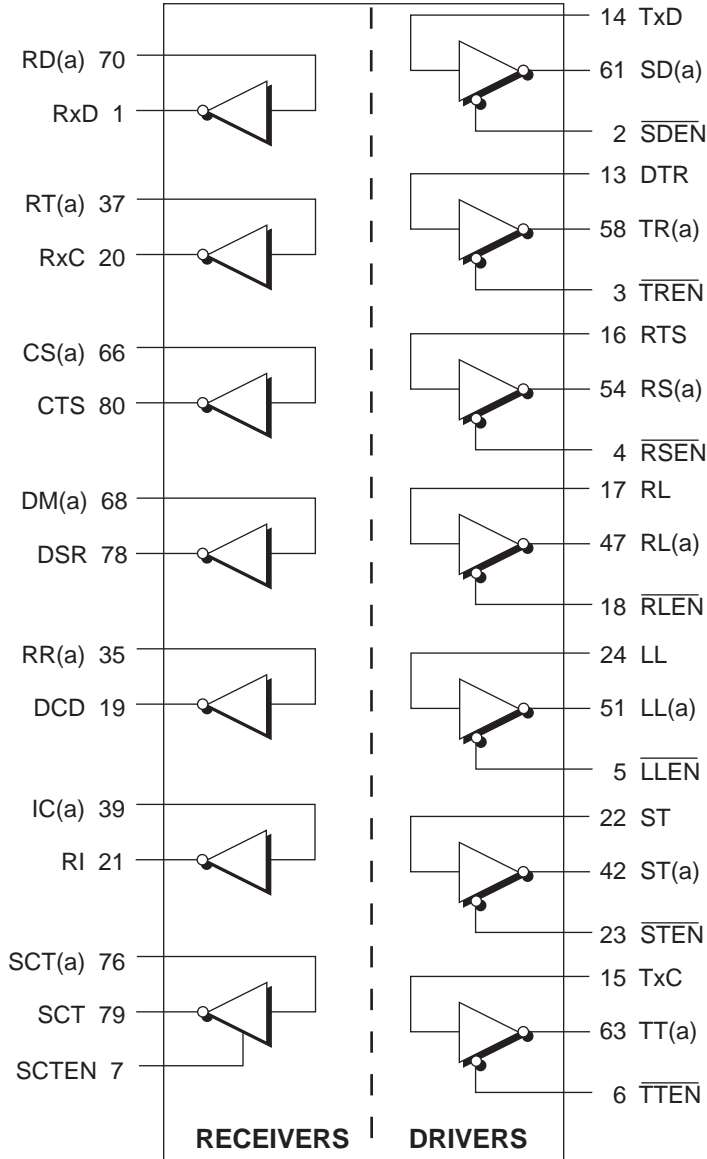


Figure 53. Mode Diagram — RS-232

| MODE: V.35       |                  |                  |                  |
|------------------|------------------|------------------|------------------|
| DRIVER/RECEIVER  |                  |                  |                  |
| DEC <sub>3</sub> | DEC <sub>2</sub> | DEC <sub>1</sub> | DEC <sub>0</sub> |
| 1                | 1                | 1                | 0                |

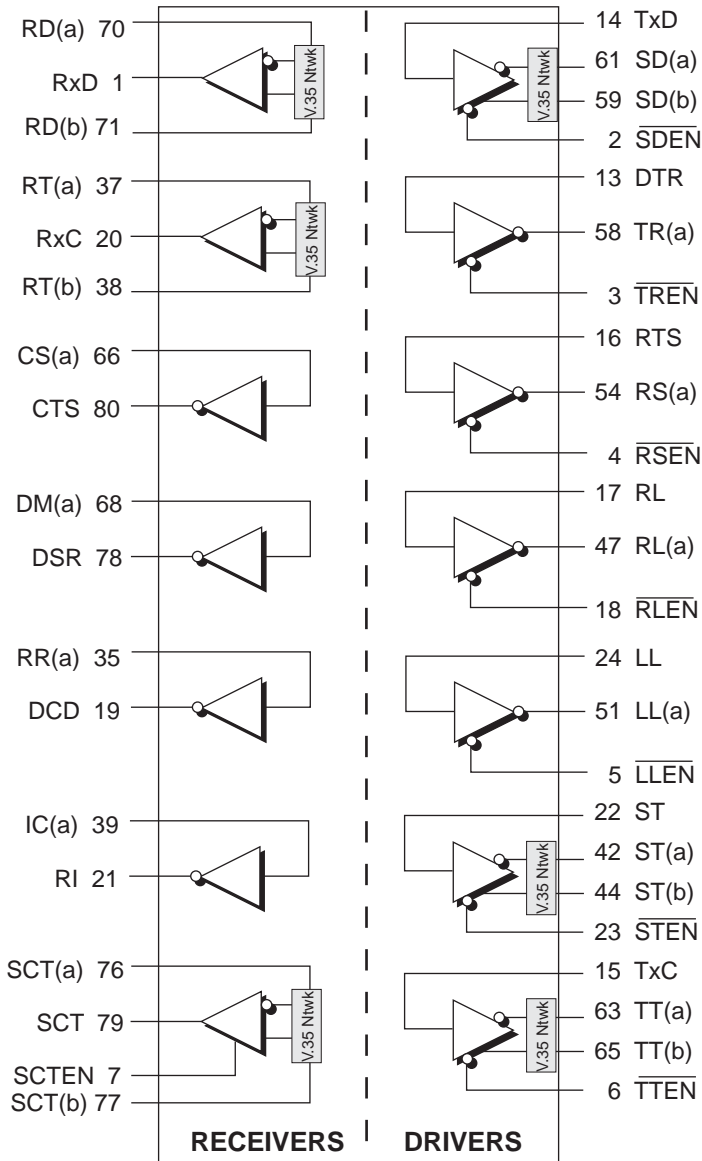


Figure 54. Mode Diagram — V.35

| MODE: RS-422 [w/ termination] |                  |                  |                  |
|-------------------------------|------------------|------------------|------------------|
| DRIVER/RECEIVER               |                  |                  |                  |
| DEC <sub>3</sub>              | DEC <sub>2</sub> | DEC <sub>1</sub> | DEC <sub>0</sub> |
| 0                             | 1                | 0                | 0                |

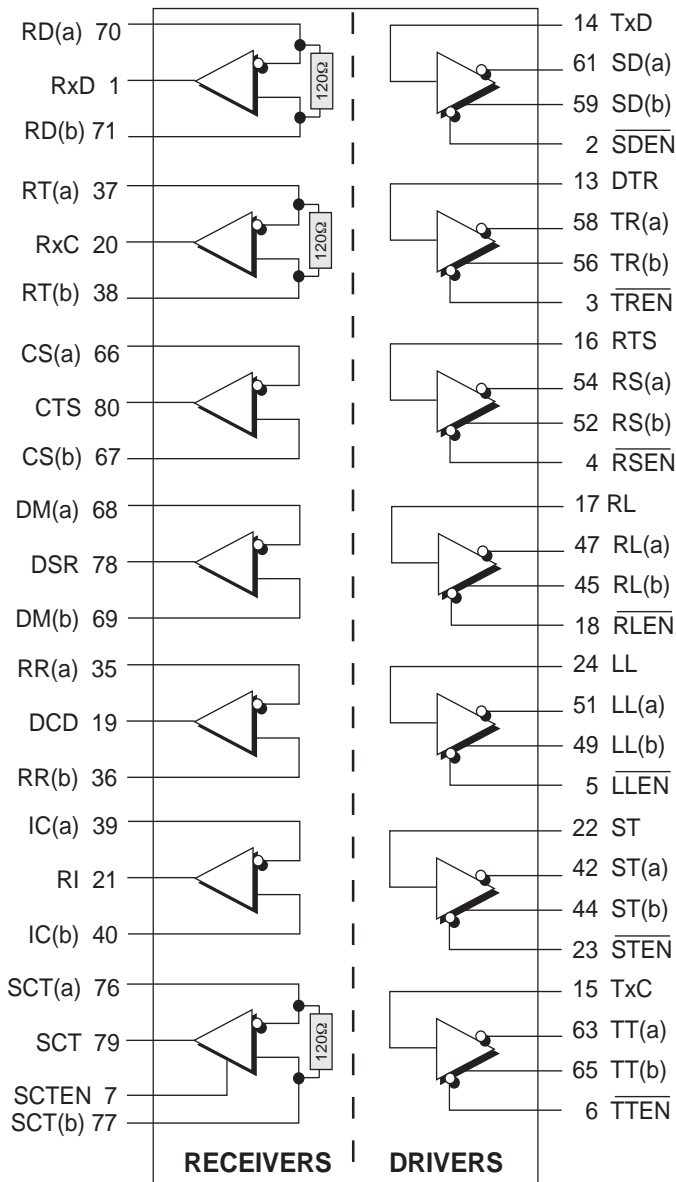


Figure 55. Mode Diagram — RS-422

| MODE: RS-449     |                  |                  |                  |
|------------------|------------------|------------------|------------------|
| DRIVER/RECEIVER  |                  |                  |                  |
| DEC <sub>3</sub> | DEC <sub>2</sub> | DEC <sub>1</sub> | DEC <sub>0</sub> |
| 1                | 1                | 0                | 0                |

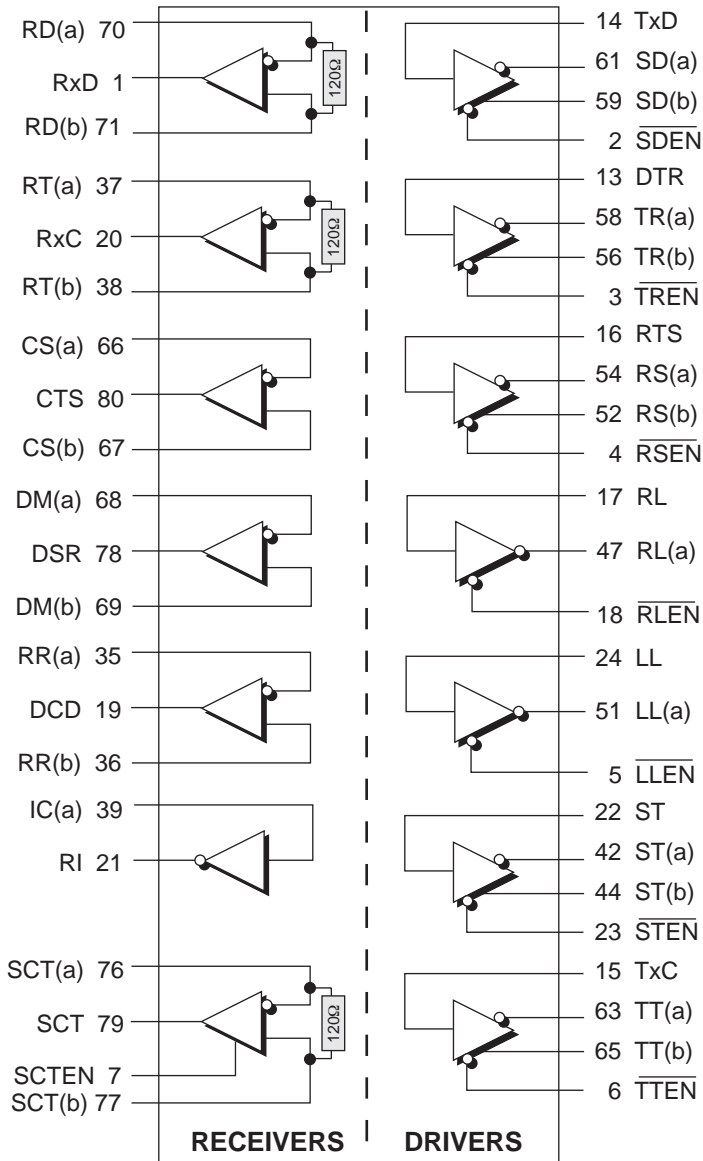


Figure 56. Mode Diagram — RS-449

| MODE: RS-422 [no termination] |                  |                  |                  |
|-------------------------------|------------------|------------------|------------------|
| DRIVER/RECEIVER               |                  |                  |                  |
| DEC <sub>3</sub>              | DEC <sub>2</sub> | DEC <sub>1</sub> | DEC <sub>0</sub> |
| 0                             | 1                | 0                | 1                |

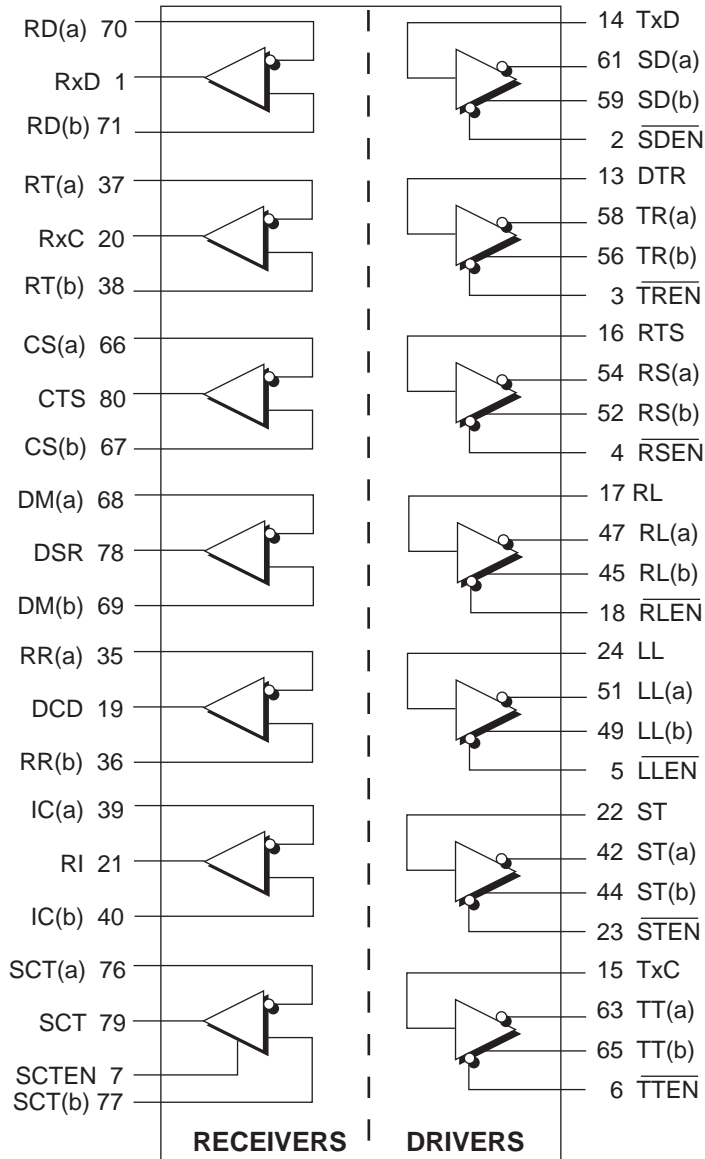


Figure 57. Mode Diagram — RS-422 w/o termination

| MODE: EIA-530    |                  |                  |                  |
|------------------|------------------|------------------|------------------|
| DRIVER/RECEIVER  |                  |                  |                  |
| DEC <sub>3</sub> | DEC <sub>2</sub> | DEC <sub>1</sub> | DEC <sub>0</sub> |
| 1                | 1                | 0                | 1                |

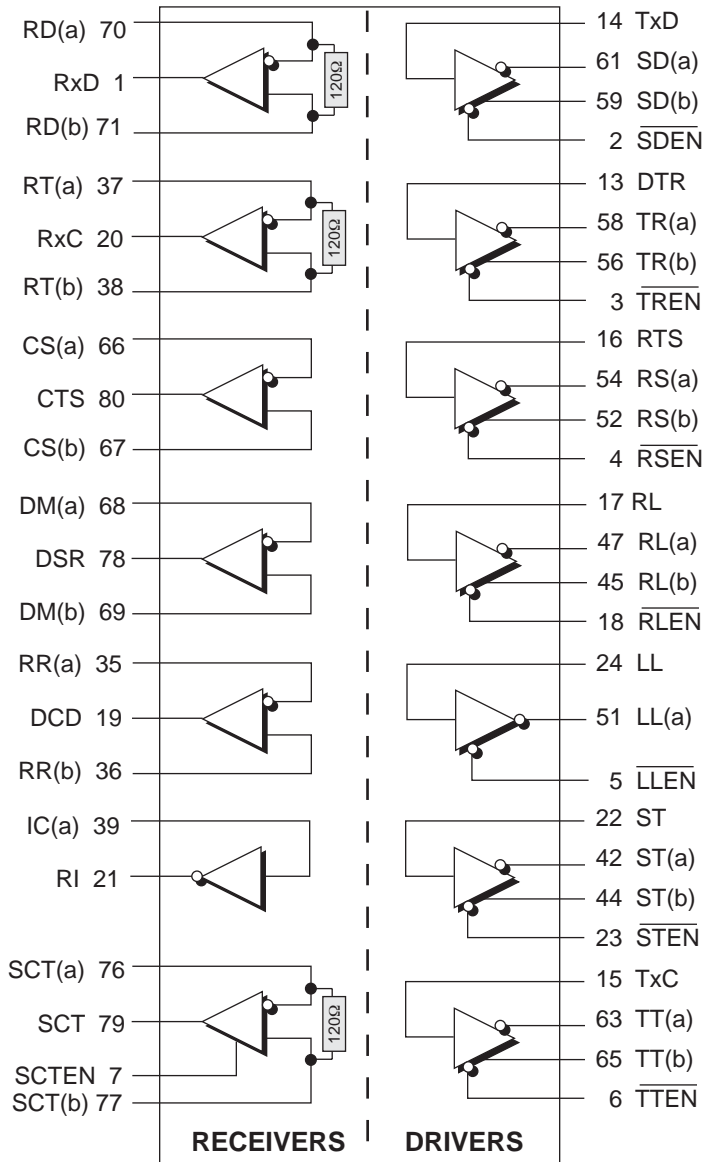


Figure 58. Mode Diagram — EIA-530

| MODE: EIA-530A   |                  |                  |                  |
|------------------|------------------|------------------|------------------|
| DRIVER/RECEIVER  |                  |                  |                  |
| DEC <sub>3</sub> | DEC <sub>2</sub> | DEC <sub>1</sub> | DEC <sub>0</sub> |
| 1                | 1                | 1                | 1                |

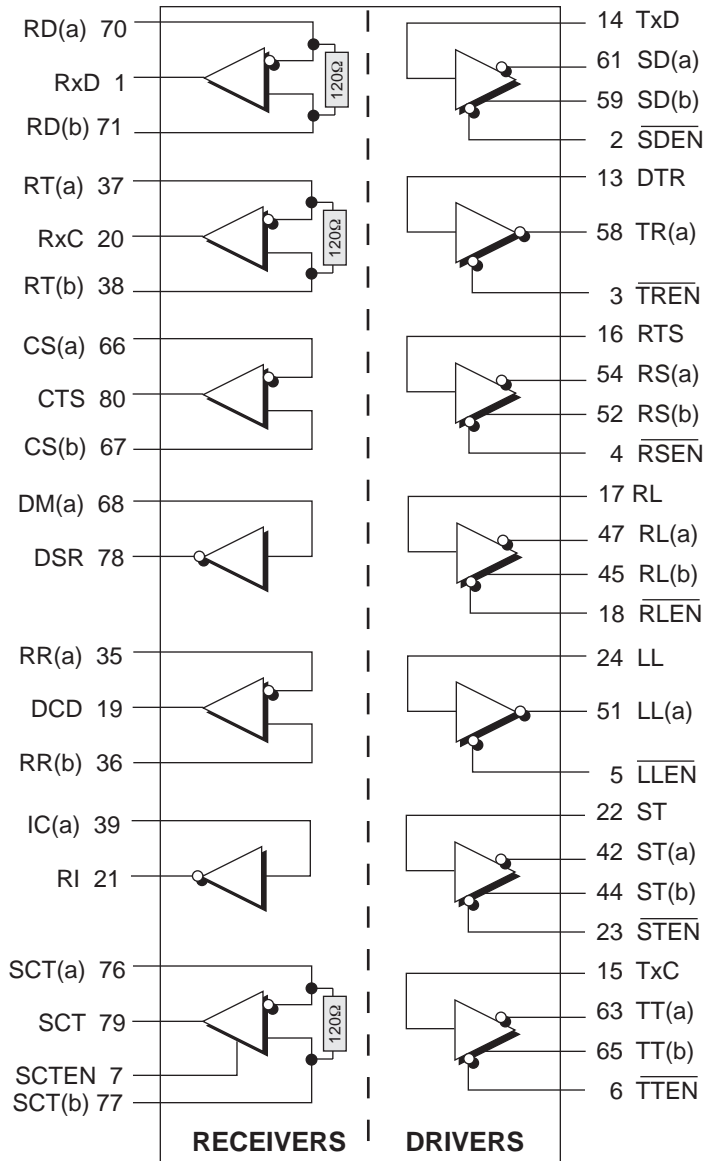


Figure 59. Mode Diagram — EIA-530A

| MODE: V.36       |                  |                  |                  |
|------------------|------------------|------------------|------------------|
| DRIVER/RECEIVER  |                  |                  |                  |
| DEC <sub>3</sub> | DEC <sub>2</sub> | DEC <sub>1</sub> | DEC <sub>0</sub> |
| 0                | 1                | 1                | 0                |

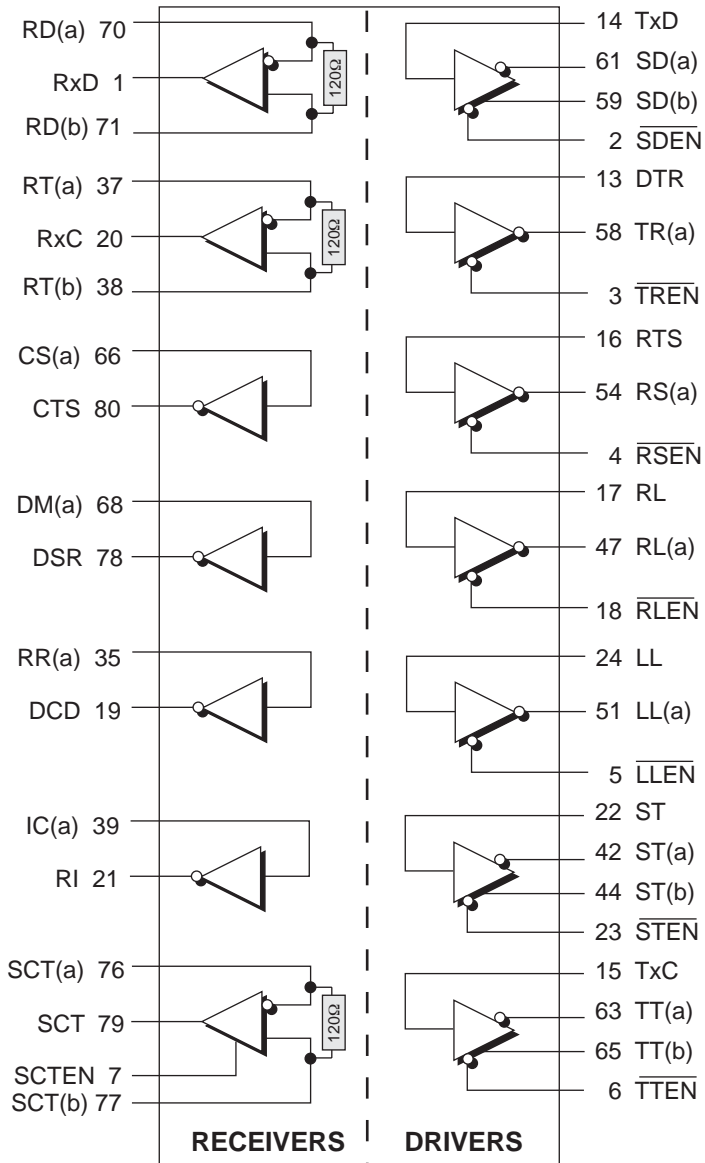


Figure 60. Mode Diagram — V.36

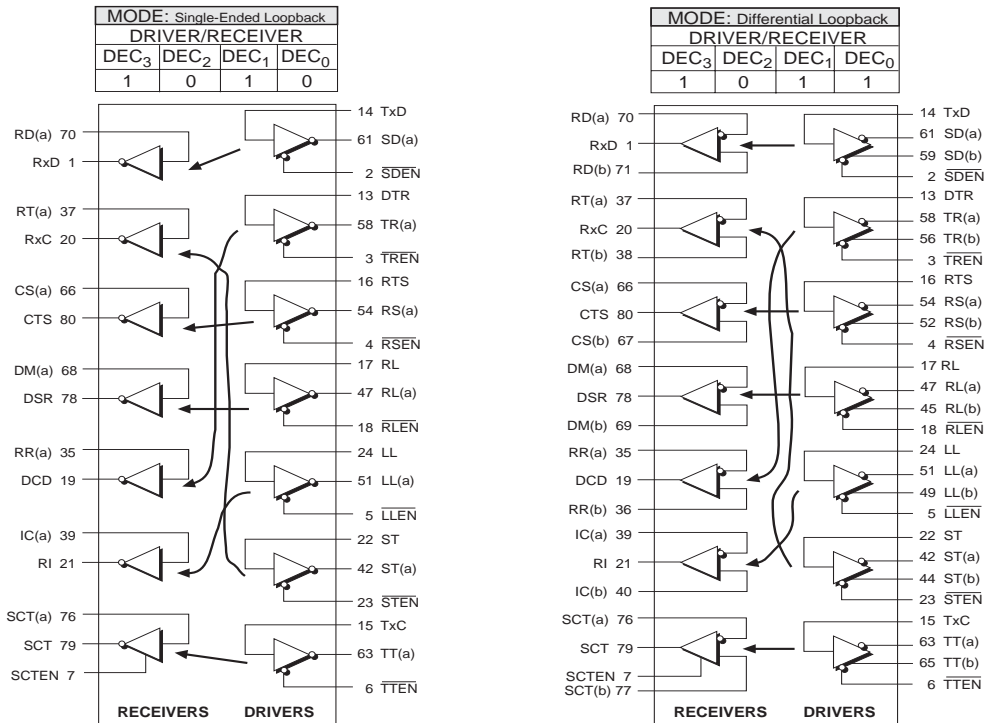


## LOOPBACK MODE...

The **SP505** is equipped with two loopback modes. Single-ended loopback internally connects V.28 driver outputs to V.28 receiver inputs. The signal path is non-inverting and will support data rates up to 120kbps. The propagation delay times are as specified in the electrical specifications. To initiate a single-ended loopback, the code "1010" should be written to the driver decoder. Differential loopback is implemented by applying "1011" to the driver decoder. This internally connects V.11 driver

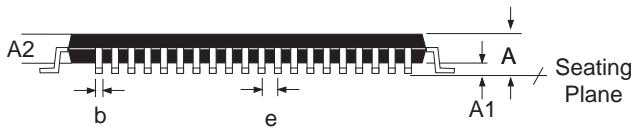
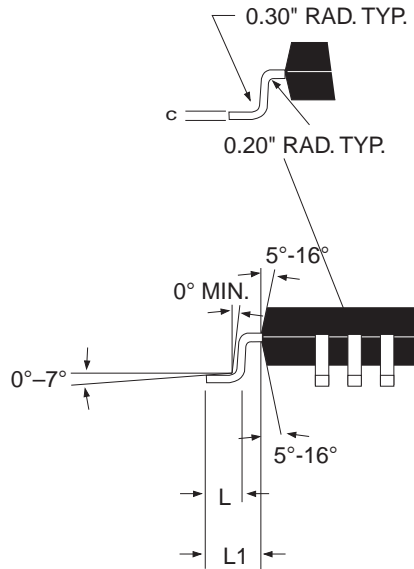
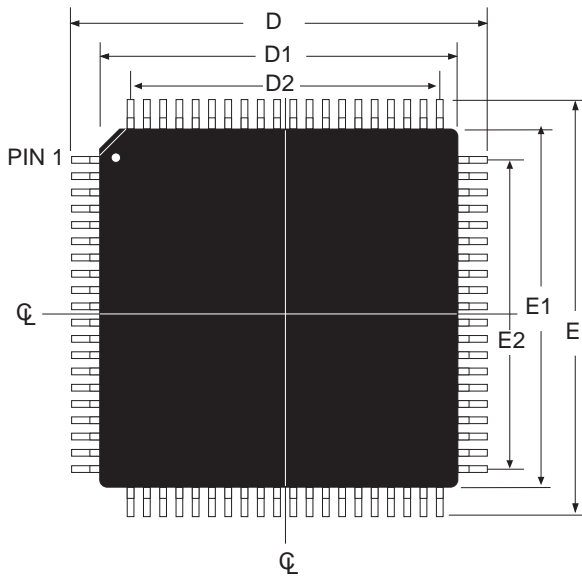
outputs to V.11 receiver inputs. The signal path again is non-inverting; the differential loopback data rate can be at least 5Mbps.

Under loopback conditions the receiver decoder is disabled. While the **SP505** is in either single-ended or differential loopback mode, the driver outputs are tri-stated and the receiver inputs are disabled.



| Mode   | Driver Output |           | Receiver Input |             | Driver Input | Receiver Output  |
|--|---------------|-----------|----------------|-------------|--------------|------------------|
|  | non-inverting | inverting | non-inverting  | inverting   |              |                  |
| <b>Loopback</b><br>DEC=1010  | tri-state     | tri-state | >10K to GND    | >10K to GND | active       | active           |
| DEC=1011   | tri-state     | tri-state | >10K to GND    | >10K to GND | active       | active           |
| <b>Power down</b><br>V <sub>CC</sub> =V <sub>DD</sub> =V <sub>SS</sub> =0V | tri-state     | tri-state | >10K to GND    | >10K to GND | inactive     | clamped at ±0.6V |
| <b>Tri-state</b><br>DEC=0000   | tri-state     | tri-state | >10K to GND    | >10K to GND | inactive     | tri-state        |

# PACKAGE: 80 PIN MQFP



| DIMENSIONS<br>Minimum/Maximum<br>(mm) | 80-PIN MQFP<br>JEDEC MS-22<br>(BEC) Variation |      |      |
|---------------------------------------|---|------|------|
|                                       | MIN   | NOM  | MAX  |
| A                                     |   |      | 2.45 |
| A1                                    | 0.00  |      | 0.25 |
| A2                                    | 1.80  | 2.00 | 2.20 |
| b                                     | 0.22  |      | 0.40 |
| D                                     | 17.20 BSC                                     |      |      |
| D1                                    | 14.00 BSC                                     |      |      |
| D2                                    | 12.35 REF                                     |      |      |
| E                                     | 17.20 BSC                                     |      |      |
| E1                                    | 14.00 BSC                                     |      |      |
| E2                                    | 12.35 REF                                     |      |      |
| e                                     | 0.65 BSC                                      |      |      |
| N                                     | 80  |      |      |

| COMMON DIMENSIONS |            |      |       |
|-------------------|------------|------|-------|
| SYMBL             | MIN        | NOM  | MAX   |
| c                 | 0.11       |      | 23.00 |
| L                 | 0.73       | 0.88 | 1.03  |
| L1                | 1.60 BASIC |      |       |

## 80 PIN MQFP (MS-022 BC)

## ORDERING INFORMATION

| Model          | Temperature Range  | Package Types                    |
|----------------|--------------------|----------------------------------|
| SP505ACF ..... | 0°C to +70°C ..... | 80-pin JEDEC (BE-2 Outline) MQFP |
| SP505BCF ..... | 0°C to +70°C ..... | 80-pin JEDEC (BE-2 Outline) MQFP |

Please consult the factory for pricing and availability on a Tape-On-Reel option.

## REVISION HISTORY

| DATE    | REVISION | DESCRIPTION                    |
|---------|----------|--------------------------------|
| 1/27/04 | A        | Implemented tracking revision. |
|         |          |                                |
|         |          |                                |



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