

DS8935 LocalTalk™ Dual Driver/Triple Receiver

General Description

The DS8935 is a dual driver/triple receiver device optimized to provide a single chip solution for a LocalTalk Interface. The device provides one differential TIA/EIA-422 driver, one TIA/EIA-423 single ended driver, one TIA/EIA-422 receiver and two TIA/EIA-423 receivers, all in a surface mount 16-pin package. This device is electrically similar to the 26LS30 and 26LS32 devices.

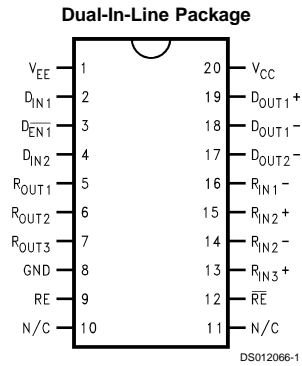
The drivers feature $\pm 10V$ common mode range, and the differential driver provides TRI-STATEable outputs. The receivers offer ± 200 mV thresholds over the $\pm 10V$ common mode range.

The device offers enable circuitry for the differential driver and selectable enabling for the three receivers.

Features

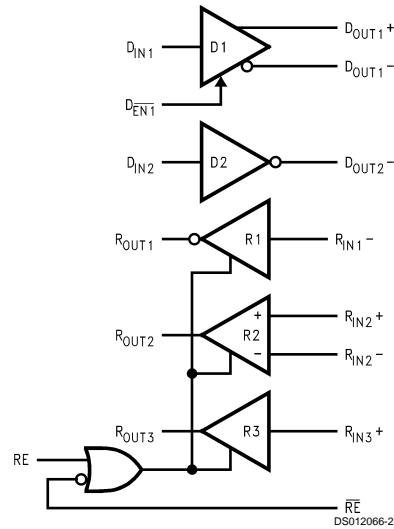
- Single chip solution for LocalTalk port
- Two driver/three receivers per package
- Wide common mode range: $\pm 10V$
- ± 200 mV receiver sensitivity
- 70 mV typical receiver input hysteresis
- Available in SOIC packaging
- Failsafe receiver for open inputs

Connection Diagram



Order Number **DS8935WM**
See NS Package Number **M20B**

Functional Diagram



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LocalTalk™ is a trademark of Apple Computer, Inc.

Absolute Maximum Ratings (Note 1)

If Military/Aerospace specified devices are required, please contact the National Semiconductor Sales Office/Distributors for availability and specifications.

| | |
|---|-------|
| Supply Voltage (V_{CC}) | +7V |
| Supply Voltage (V_{EE}) | -7V |
| Enable Input Voltage ($\overline{D_{EN1}}$, RE, \overline{RE}) | +7V |
| Driver Input Voltage (D_{IN}) | +7V |
| Driver Output Voltage (Power Off: D_{OUT}) | ±15V |
| Receiver Input Voltage (V_{ID} : R_{IN+} - R_{IN-}) | ±25V |
| Receiver Input Voltage (V_{CM} : $(R_{IN+} + R_{IN-})/2$) | ±25V |
| Receiver Input Voltage (Input to GND: R_{IN}) | ±25V |
| Receiver Output Voltage (R_{OUT}) | +5.5V |
| Maximum Package Power Dissipation @+25°C | |
| M Package | 1.34W |

Derate M Package 10.7 mW/°C above +25°C
 Storage Temperature Range -65°C to +150°C
 Lead Temperature Range (Soldering, 4 Sec.) +260°C
 This device does not meet 2000V ESD Rating (Note 8)

Recommended Operating Conditions

| | Min | Typ | Max | Units |
|--|-------|------|-------|-------|
| Supply Voltage (V_{CC}) | +4.75 | +5.0 | +5.25 | V |
| Supply Voltage (V_{EE}) | -4.75 | -5.0 | -5.25 | V |
| Operating Free Air Temperature (T_A) | 0 | 25 | 70 | °C |

Electrical Characteristics (Notes 2, 3)

Over Supply Voltage and Operating Temperature ranges, unless otherwise specified

| Symbol | Parameter | Conditions | Pin | Min | Typ | Max | Units | |
|--|---|---|--|--------------|-------|------|-------|----|
| DIFFERENTIAL DRIVER CHARACTERISTICS | | | | | | | | |
| V_{OD} | Output Differential Voltage | $R_L = \infty$ or $R_L = 3.9\text{ k}\Omega$ | D _{OUT+} , D _{OUT-} | ±7 | ±9.0 | ±10 | V | |
| V_O | Output Voltage | $R_L = \infty$ or $R_L = 3.9\text{ k}\Omega$ | | ±4.5 | ±5.25 | | V | |
| V_{OD1} | Output Differential Voltage | $R_L = 100\Omega$, Figure 1 | | 4.0 | 6.4 | | V | |
| V_{SS} | $ V_{OD1} - \overline{V_{OD1}} $ | | | 8.0 | 12.8 | | V | |
| ΔV_{OD1} | Output Unbalance | | | | 0.02 | 0.4 | V | |
| V_{OS} | Offset Voltage | | | | 0 | 3 | V | |
| ΔV_{OS} | Offset Unbalance | | | | 0.05 | 0.4 | V | |
| V_{OD2} | Output Differential Voltage | $R_L = 140\Omega$, Figure 1 | | 6.0 | 7.0 | | V | |
| I_{OZD} | TRI-STATE® Leakage Current | $V_{CC} = 5.25V$ $V_{EE} = -5.25V$ | | $V_O = +10V$ | | 2 | 150 | µA |
| | | | | $V_O = +6V$ | | 1 | 100 | µA |
| | | | $V_O = -6V$ | | -1 | -100 | µA | |
| | | | $V_O = -10V$ | | -2 | -150 | µA | |
| SINGLE ENDED DRIVER CHARACTERISTICS | | | | | | | | |
| V_O | Output Voltage (No Load) | $R_L = \infty$ or $R_L = 3.9\text{ k}\Omega$, Figure 2 | D _{OUT-} | 4 | 4.4 | 6 | V | |
| V_T | Output Voltage | $R_L = 3\text{ k}\Omega$, Figure 2 | | 3.7 | 4.3 | | V | |
| | | $R_L = 450\Omega$, Figure 2 | | 3.6 | 4.1 | | V | |
| ΔV_T | Output Unbalance | | | 0.02 | 0.4 | V | | |
| DRIVER CHARACTERISTICS | | | | | | | | |
| V_{CM} | Common Mode Range | Power Off, or D1 Disabled | D _{OUT+} , D _{OUT-} | ±10 | | | V | |
| I_{OSD} | Short Circuit Current | $V_O = 0V$, Sourcing Current | | | -80 | -150 | mA | |
| | | $V_O = 0V$, Sinking Current | | | 80 | 150 | mA | |
| I_{OXD} | Power-Off Leakage Current ($V_{CC} = V_{EE} = 0V$) | $V_O = +10V$ | | | 2 | 150 | µA | |
| | | $V_O = +6V$ | | | 1 | 100 | µA | |
| | | $V_O = -6V$ | | | -1 | -100 | µA | |
| | | $V_O = -10V$ | | | -2 | -150 | µA | |

Electrical Characteristics (Notes 2, 3) (Continued)

Over Supply Voltage and Operating Temperature ranges, unless otherwise specified

| Symbol | Parameter | Conditions | Pin | Min | Typ | Max | Units | |
|---------------------------------|--|---|---|--------------|-----|-------|-------|----|
| RECEIVER CHARACTERISTICS | | | | | | | | |
| V_{TH} | Input Threshold | $-7V \leq V_{CM} \leq +7V$ | R_{IN+} , R_{IN-} | -200 | ±35 | +200 | mV | |
| V_{HY} | Hysteresis | $V_{CM} = 0V$ | | | 70 | | mV | |
| R_{IN} | Input Resistance | $-10V \leq V_{CM} \leq +10V$ | | | 6.0 | 8.5 | kΩ | |
| I_{IN} | Input Current (Other Input = 0V, Power On, or $V_{CC} = V_{EE} = 0V$) | $V_{IN} = +10V$ | | | | | 3.25 | mA |
| | | $V_{IN} = +3V$ | | | 0 | | 1.50 | mA |
| | | $V_{IN} = -3V$ | | 0 | | -1.50 | mA | |
| | | $V_{IN} = -10V$ | | | | -3.25 | mA | |
| V_{IB} | Input Balance Test | $R_S = 500\Omega$ (R2 only) | | | | ±400 | mV | |
| V_{OH} | High Level Output Voltage | $I_{OH} = -400 \mu A$, $V_{IN} = +200 mV$ | R_{OUT} | 2.7 | 4.2 | | V | |
| | | $I_{OH} = -400 \mu A$, $V_{IN} = OPEN$ | | 2.7 | 4.2 | | V | |
| V_{OL} | Low Level Output Voltage | $I_{OL} = 8.0 mA$, $V_{IN} = -200 mV$ | | | 0.3 | 0.5 | V | |
| I_{OSR} | Short Circuit Current | $V_O = 0V$ | | | -15 | -34 | -85 | mA |
| I_{OZR} | TRI-STATE Output Current | $V_{CC} = Max$ | | $V_O = 2.4V$ | | 0 | +20 | μA |
| | | | $V_O = 0.4V$ | | 0 | -20 | μA | |
| DEVICE CHARACTERISTICS | | | | | | | | |
| V_{IH} | High Level Input Voltage | | D_{IN+} , D_{EN1+} , RE , RE | 2.0 | | | V | |
| V_{IL} | Low Level Input Voltage | | | | | 0.8 | V | |
| I_{IH} | High Level Input Current | $V_{IN} = 2.4V$ | | | | 1 | 40 | μA |
| I_{IL} | Low Level Input Current | $V_{IN} = 0.4V$ | | | | -10 | -200 | μA |
| V_{CL} | Input Clamp Voltage | $I_{IN} = -12 mA$ | | | | | -1.5 | V |
| I_{CC} | Power Supply Current | No Load D1 Enabled or Disabled | V_{CC} | | 40 | 65 | mA | |
| I_{EE} | | | V_{EE} | | -5 | -15 | mA | |

Switching Characteristics (Notes 4, 5)

Over Supply Voltage and Operating Temperature Ranges, unless otherwise specified

| Symbol | Parameter | Conditions | Min | Typ | Max | Units | |
|--|--|---|-----|-----|-----|-------|----|
| DIFFERENTIAL DRIVER CHARACTERISTICS | | | | | | | |
| t_{PHLD} | Differential Propagation Delay High to Low | $R_L = 100\Omega$, $C_L = 500 pF$, (Figures 3, 4) $C_1 = C_2 = 50 pF$ | 70 | 134 | 350 | ns | |
| t_{PLHD} | Differential Propagation Delay Low to High | | 70 | 141 | 350 | ns | |
| t_{SKD} | Differential Skew $ t_{PHLD} - t_{PLHD} $ | | | | 7 | 50 | ns |
| t_r | Rise Time | | | 50 | 140 | 300 | ns |
| t_f | Fall Time | | | 50 | 140 | 300 | ns |
| t_{PHZ} | Disable Time High to Z | $R_L = 100\Omega$, $C_L = 500 pF$ (Figures 7, 8) | | 300 | 600 | ns | |
| t_{PLZ} | Disable Time Low to Z | | | | 300 | 600 | ns |
| t_{PZH} | Enable Time Z to High | | | | 160 | 350 | ns |
| t_{PZL} | Enable Time Z to Low | | | | 160 | 350 | ns |
| SINGLE ENDED DRIVER CHARACTERISTICS | | | | | | | |
| t_{PHL} | Propagation Delay High to Low | $R_L = 450\Omega$, $C_L = 500 pF$ (Figures 5, 6) | 70 | 120 | 350 | ns | |
| t_{PLH} | Propagation Delay Low to High | | 70 | 150 | 350 | ns | |
| t_{SK} | Skew, $ t_{PHL} - t_{PLH} $ | | | | 30 | 70 | ns |
| t_r | Rise Time | | | 50 | 100 | 300 | ns |
| t_f | Fall Time | | | 20 | 50 | 300 | ns |
| RECEIVER CHARACTERISTICS | | | | | | | |
| t_{PHL} | Propagation Delay High to Low | $C_L = 15 pF$ (Figures 9, 10) | 10 | 33 | 75 | ns | |
| t_{PLH} | Propagation Delay Low to High | | 10 | 30 | 75 | ns | |
| t_{SK} | Skew, $ t_{PHL} - t_{PLH} $ | | | | 3 | 20 | ns |

Switching Characteristics (Notes 4, 5) (Continued)

Over Supply Voltage and Operating Temperature Ranges, unless otherwise specified

| Symbol | Parameter | Conditions | Min | Typ | Max | Units |
|---------------------------------|------------------------|--|-----|-----|-----|-------|
| RECEIVER CHARACTERISTICS | | | | | | |
| t_{HZ} | Disable Time High to Z | $C_L = 15 \text{ pF}$ (Figures 9, 11) | | 20 | 75 | ns |
| t_{LZ} | Disable Time Low to Z | | | 20 | 75 | ns |
| t_{ZH} | Enable Time Z to High | | | 20 | 75 | ns |
| t_{ZL} | Enable Time Z to Low | | | 20 | 75 | ns |

Note 1: Absolute Maximum Ratings are those values beyond which the safety of the device cannot be guaranteed. They are not meant to imply that the devices should be operated at these limits. The table of Electrical Characteristics specifies conditions of device operation.

Note 2: Current into device pins is defined as positive. Current out of device pins is defined as negative. All voltages are referenced to ground except V_{OD} , V_{OD1} , V_{OD2} , and V_{SS} .

Note 3: All typicals are given for: $V_{CC} = +5.0\text{V}$, $V_{EE} = -5.0\text{V}$, $T_A = +25^\circ\text{C}$ unless otherwise specified.

Truth Tables

Driver (D1)

| Inputs | | Outputs | |
|----------------------|-----------|-------------|-------------|
| $\overline{D_{EN1}}$ | D_{IN1} | D_{OUT1+} | D_{OUT1-} |
| H | X | Z | Z |
| L | L | L | H |
| L | H | H | L |

Driver (D2)

| Input | Output |
|-----------|-------------|
| D_{IN2} | D_{OUT2-} |
| L | H |
| H | L |

Receiver (1)

| RE | \overline{RE} | Input | Output |
|-----------------------|-----------------|------------------------|------------|
| | | R_{IN1-} | R_{OUT1} |
| 0 | 1 | X | Z |
| Any Other Combination | | $\leq -200 \text{ mV}$ | H |
| | | $\geq +200 \text{ mV}$ | L |
| | | Open [†] | H |

Receiver (2)

| RE | \overline{RE} | Inputs | Output |
|-----------------------|-----------------|------------------------|------------|
| | | $R_{IN2+}-R_{IN2-}$ | R_{OUT2} |
| 0 | 1 | X | Z |
| Any Other Combination | | $\leq -200 \text{ mV}$ | L |
| | | $\geq +200 \text{ mV}$ | H |
| | | Open [†] | H |

Receiver (3)

| RE | \overline{RE} | Input | Output |
|-----------------------|-----------------|------------------------|------------|
| | | R_{IN3+} | R_{OUT3} |
| 0 | 1 | X | Z |
| Any Other Combination | | $\leq -200 \text{ mV}$ | L |
| | | $\geq +200 \text{ mV}$ | H |
| | | Open [†] | H |

H = Logic High Level (Steady State)

L = Logic Low Level (Steady State)

X = Irrelevant (Any Input)

Z = Off State (TRI-STATE, High Impedance)

[†]OPEN = Non-Terminated

Parameter Measurement Information

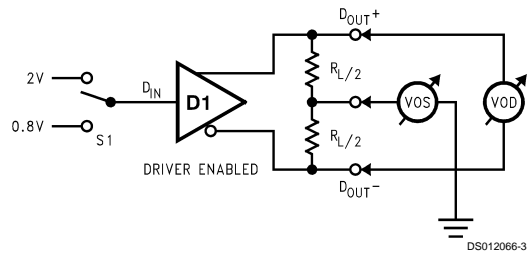


FIGURE 1. Differential Driver DC Test Circuit

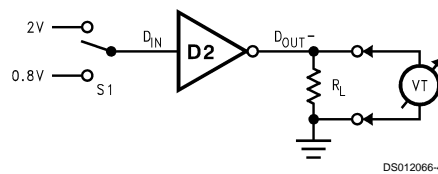


FIGURE 2. Single Ended Driver DC Test Circuit

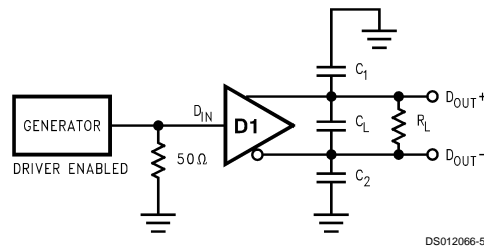


FIGURE 3. Differential Driver Propagation Delay and Transition Time Test Circuit

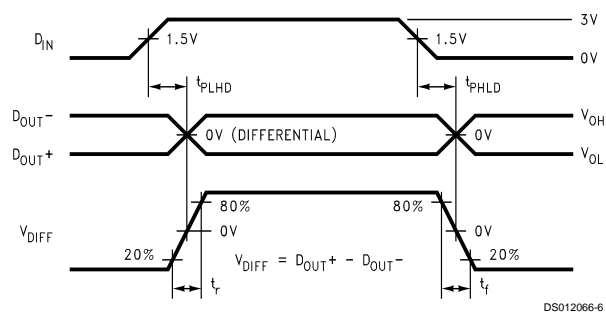


FIGURE 4. Differential Driver Propagation Delay and Transition Time Waveforms

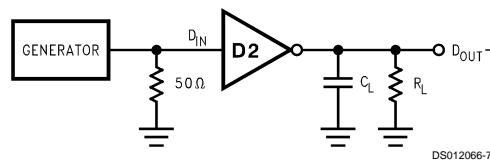


FIGURE 5. Single Ended Driver Propagation Delay and Transition Time Test Circuit

Parameter Measurement Information (Continued)

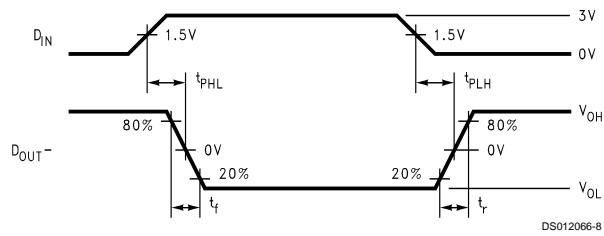


FIGURE 6. Single Ended Driver Propagation Delay and Transition Time Waveform

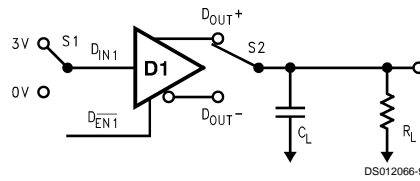


FIGURE 7. Differential Driver TRI-STATE Test Circuit

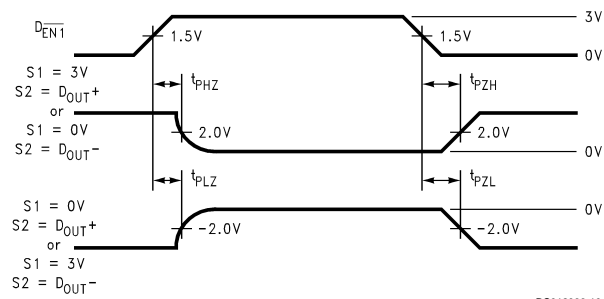


FIGURE 8. Differential Driver TRI-STATE Waveforms

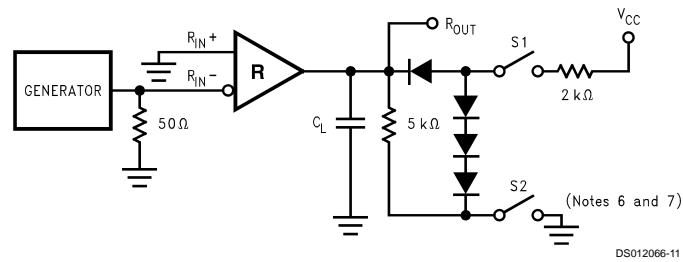


FIGURE 9. Receiver Propagation Delay Test Circuit

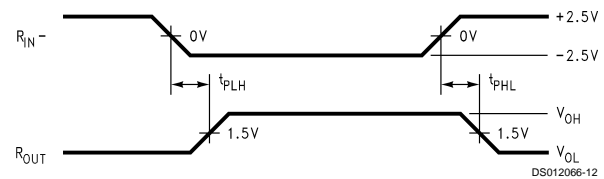


FIGURE 10. Receiver Propagation Delay Waveform

Parameter Measurement Information (Continued)

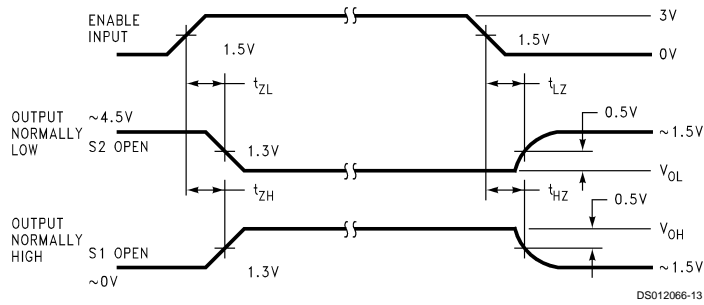


FIGURE 11. Receiver TRI-STATE Delay Waveform

Note 4: Generator waveform for all tests unless otherwise specified: $f = 500 \text{ kHz}$, $Z_O = 50\Omega$, $t_r \leq 10 \text{ ns}$, $t_f \leq 10 \text{ ns}$.

Note 5: C_L includes probe and jig capacitance.

Note 6: All diodes are 1N916 or equivalent.

Note 7: S1 and S2 closed except where shown.

Note 8: ESD Rating HBM (1.5 k Ω , 100 pF) pins 14, 16 $\geq 1500\text{V}$, all other pins $\geq 2000\text{V}$.

Typical Application Information

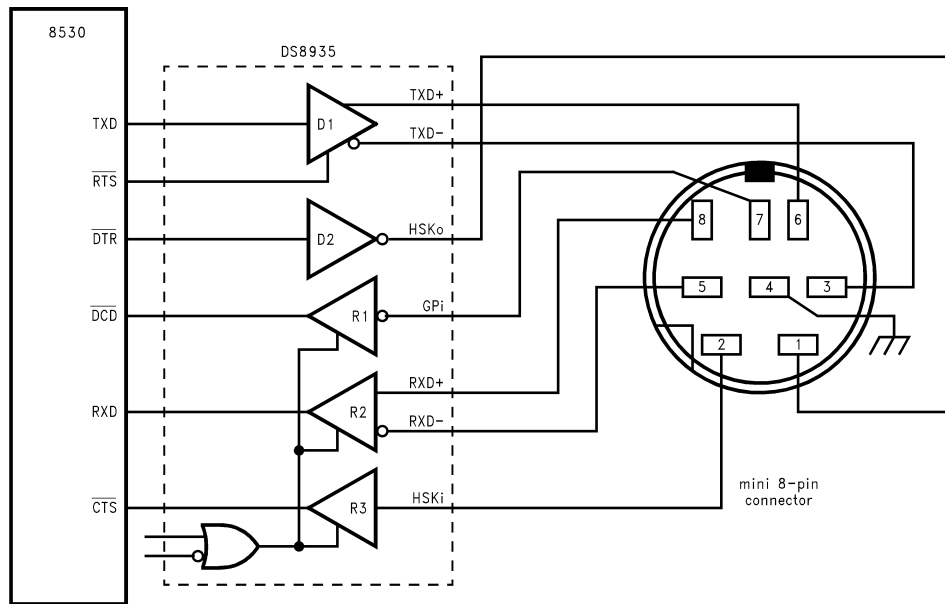


FIGURE 12. Typical LocalTalk Application

Typical Application Information (Continued)

TABLE 1. Device Pin Descriptions

| Pin# | Name | Description |
|---------|------------|--|
| 2, 4 | D_{IN} | TTL Driver Input Pins |
| 3 | D_{EN1} | Active Low Driver Enable Pin. A High on this Pin TRI-STATES the Driver Outputs (D1 Only) |
| 19 | D_{OUT+} | Non-Inverting Driver Output Pin |
| 17, 18 | D_{OUT-} | Inverting Driver Output Pin |
| 13, 15 | R_{IN+} | Non-Inverting Receiver Input Pin |
| 16, 14 | R_{IN-} | Inverting Receiver Input Pin |
| 5, 6, 7 | R_{OUT} | Receiver Output Pin |
| 9 | R_{EN} | Active Low Receiver Enable |
| 12 | R_{EN} | Active High Receiver Enable |
| 10, 11 | N/C | Not Connected |
| 8 | GND | Ground Pin |
| 1 | V_{EE} | Negative Power Supply Pin, $-5V \pm 5\%$ |
| 20 | V_{CC} | Positive Power Supply Pin, $+5V \pm 5\%$ |

DRIVER OUTPUT WAVEFORMS

The driver configuration on the DS8935 is unique among TIA/EIA-422 devices in that it utilizes $-5V V_{EE}$ supply. A typical TIA/EIA-422 driver uses $+5V$ only and generates signal swings of approximately $0V-5V$.

By utilizing V_{EE} , the differential driver is able to generate a much larger differential signal. The typical output voltage is about $|4| V$, which gives $|8| V$ differentially, thus providing a

much greater noise margin than $+5V$ drivers. See Figure 13. The receiver therefore has a range of $+8V$ to $-8V$ or V_{SS} of $16V$ ($V_{SS} = V_{OD} - V_{OD}$).

Each side of the differential driver operates similar to a TIA/EIA-423 driver. The output voltages are slightly different due to the loading: the differential driver has differential termination, the single-ended driver is terminated with a resistor to ground.

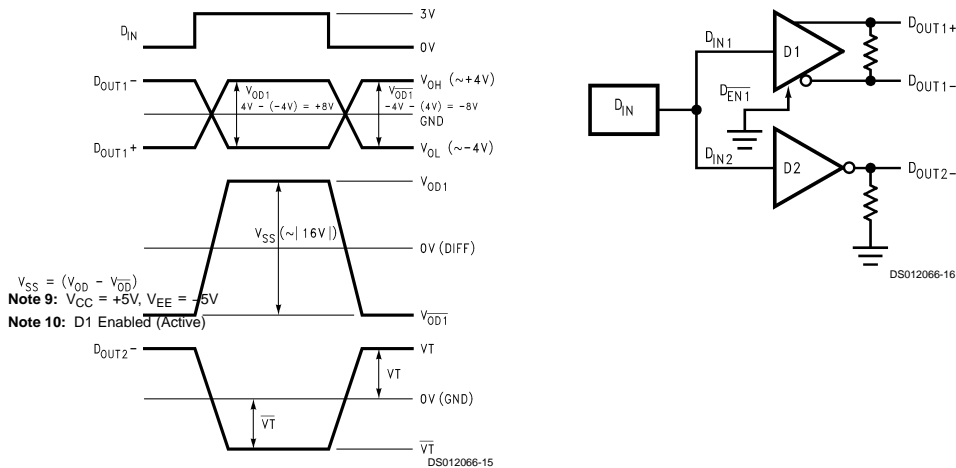


FIGURE 13. Typical Driver Output Waveforms

Typical Application Information

(Continued)

UNUSED PINS

Unused driver outputs should be left open. If tied to either ground or supply, the driver may enter an I_{OS} state and consume excessive power. Unused driver inputs should not be left floating as this may lead to unwanted switching which may affect I_{CC} , particularly the frequency component. Unused driver inputs should be tied to ground.

Receiver outputs will be in a HIGH state when inputs are open; therefore, outputs should not be tied to ground. It is best to leave unused receiver outputs floating.

RECEIVER FAILSAFE

All three receivers on this device incorporate open input fail-safe protection. The differential receiver output will be in a HIGH state when inputs are open, but will be indetermined if inputs are shorted together. Unused differential inputs should be left floating.

Both single-ended receivers (inverting and non-inverting) are biased internally so that an open input will result in a HIGH output. Therefore, these inputs should not be shorted to ground when unused.

BYPASS CAPACITORS

Bypass capacitors are recommended for both V_{CC} and V_{EE} . Noise induced on the supply lines can affect the signal quality of the output; V_{CC} affects the V_{OH} and V_{EE} affects the V_{OL} . Capacitors help reduce the effect on signal quality. A value of 0.1 μF is typically used.

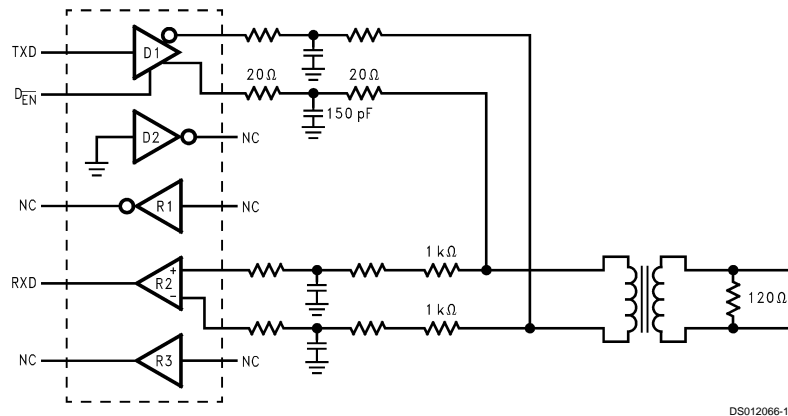


FIGURE 14. Differential Communication, Transformer-Coupled to a Twisted-Pair Line

SINGLE +5V SUPPLY

The DS8935 is derived from the DS3691/92 which could be configured using a single +5V supply ($V_{EE} = 0\text{V}$). This device is not specified for this type of operation. However, the device will not be damaged if operated using a single +5V supply.

Both drivers require the -5V supply in order to meet the output voltage levels specified. When the device switches from a positive voltage to the complimentary state, it is pulled toward the V_{EE} level. If that level is 0V , then the complimentary

state will be near 0V instead of V_{EE} . Thus, the output would switch from about 4V to 0V , instead of 4V to -4V . The differential driver will meet TIA/EIA-422, but with a reduced noise margin. The single-ended driver will not meet TIA/EIA-423 without the -5V supply.

TERMINATION

On a multi-point transmission line which is electrically long, it is advisable to terminate the line at both ends with its characteristic impedance to prevent signal reflection and its associated noise/crosstalk.

A 100Ω termination resistor is commonly specified by TIA/EIA-422 for differential signals. The DS8935 is also specified using 140Ω termination which will result in less power associated with the driver output. The additional resistance is typical of applications requiring EMI filtering on the driver outputs.

TWO-WIRE LocalTalk

The DS8935 is a single chip solution for a LocalTalk interface. A typical application is shown in Figure 12.

An alternative implementation of LocalTalk is to only use two wires to communicate. The differential data lines can be transformer-coupled on to a twisted pair medium. See Figure 14. The handshake function must then be accomplished in software.

Typical Application Information (Continued)

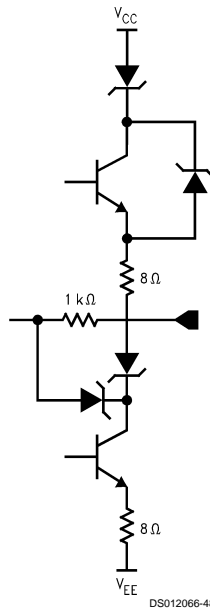


FIGURE 15. Driver Output Structure

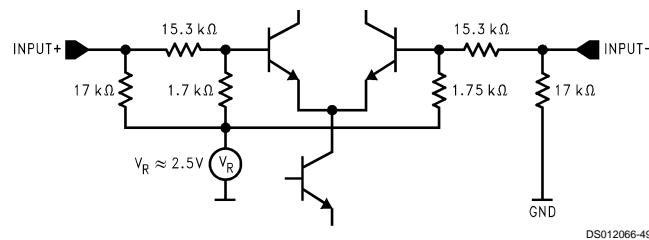
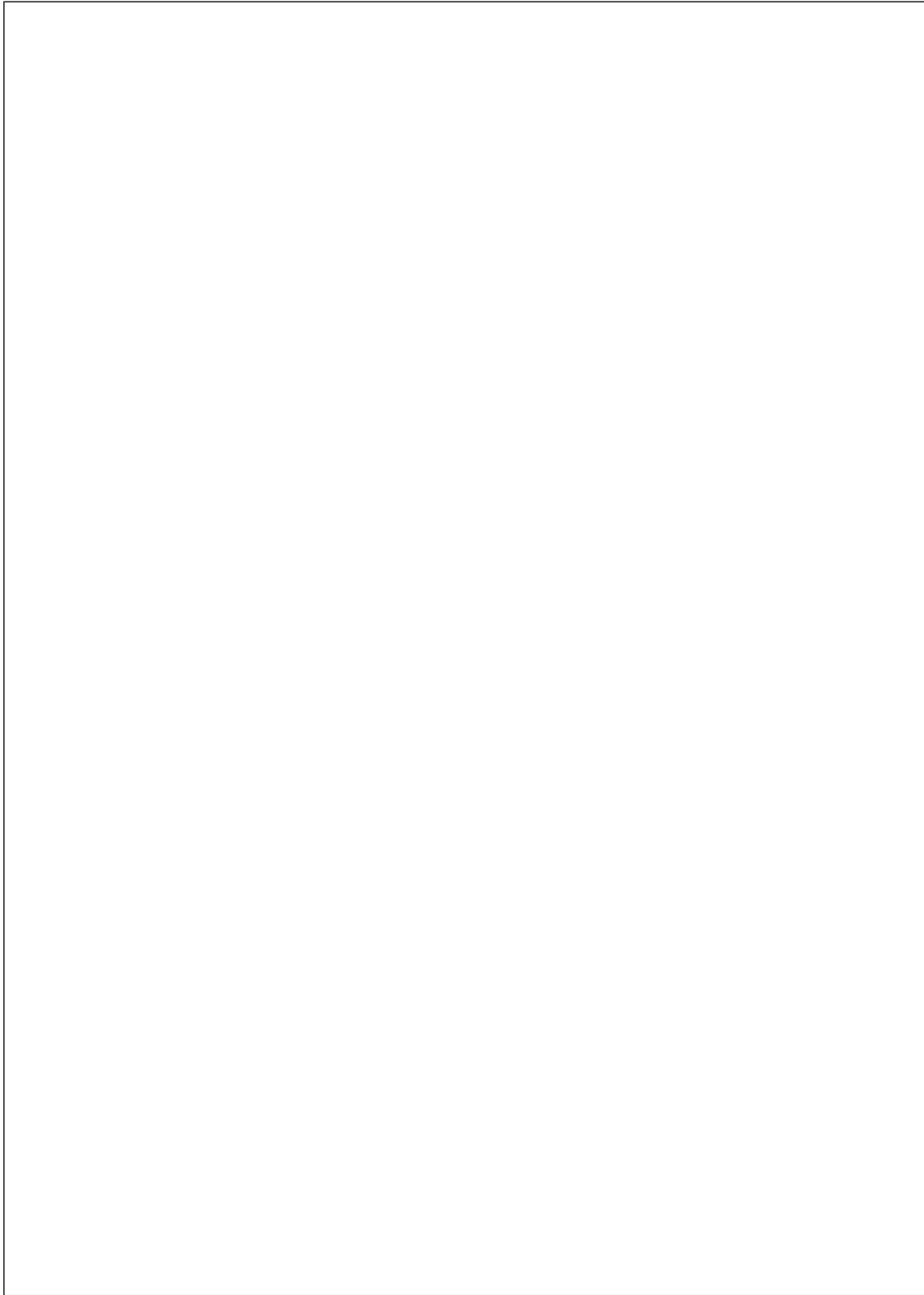


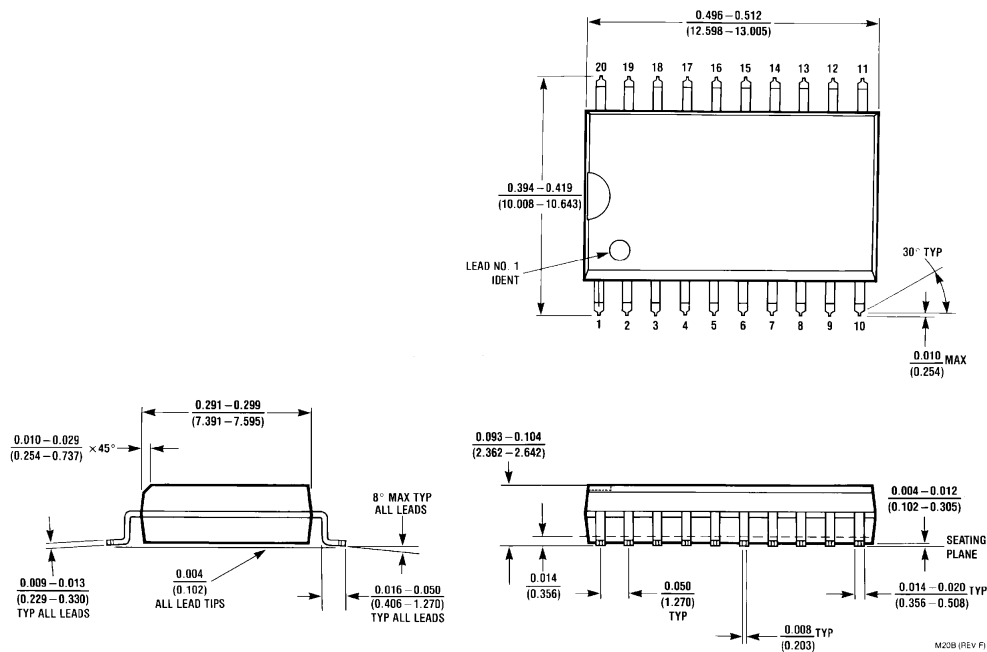
FIGURE 16. Receiver Input Structure

Typical Performance Characteristics

The DS8935 is very closely related to the DS8925. Please refer to the DS8925 datasheet for the typical performance characteristics.



Physical Dimensions inches (millimeters) unless otherwise noted



**20-Lead (0.300" Wide) Molded Small Outline Package, JEDEC
Order Number DS8935WM
NS Package Number M20B**

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