An Optimized DCE Interface for V.34 Modems Using the DS8933 and DS8934 Line Drivers and Receivers

INTRODUCTION

This application note describes the V.34 Modem Interface and the benefits obtained when the DS8933 and DS8934 Line Drivers and Receivers are employed. The following sections are covered.

- V.34 Standard
- DS8934 and DS8933
- Async Application
- Sync Application
- Driver Characteristics
- Receiver Characteristics
- RS-232 and RS-423
- Summary
- References

V.34 THE STANDARD

V.34 is the latest dial-up modem standard providing support at 28,800 bits per second. This standard, officially known as a recommendation was developed by the ITU (International Telecommunications Union). 28.8 kbps is only the basic rate, as this class of advanced modems uses sophisticated compression/decompression techniques along with error-correction to provide throughputs above 100,000 bits per second (115.2 kbps typical!) depending upon data patterns and compression scheme used. The impressive 115 kbps presses the de facto RS-232 interface standard to the limit, as it is officially only specified to 20 kbps maximum. For this reason, the ITU selected V.10 (RS-423) instead of V.28 (RS-232) drivers and receivers.

DS8934 AND DS8933

The DS8934 provides five V.10/RS-423 drivers and three receivers in a single 24 lead surface mount package. This configuration provides the correct number of drivers and receivers for an asynchronous interface. The DS8933 is a companion device that provides an additional two drivers and one receiver. Using the two devices together provides the correct configuration for basic synchronous communication. Prior to these devices, multiple packages were required since drivers and receivers were commonly only available in separate packages and were either quad or dual devices. For asynchronous applications, two DS1488 quad RS-232 drivers and one DS1489A quad RS-232 receiver are required, but this solution requires the placement of three devices on the PCB, is RS-232, and is not optimized (3 extra drivers and one extra receiver). Another approach is to mix RS-423 and RS-232 components to establish a hybrid interface. This would employ RS-423 drivers on the high speed lines (data, and clock if synchronous), and RS-232 on the others. This configuration has multiple packages and is not optimized for the application. The DS8934 and DS8933 are optimized parts which save precious PCB real estate, simplify assembly and procurement, and provide multiple operational (electrical) benefits over RS-232 components. The DS8934 offers a substantial cost reduction over a multi package RS-423 interface, and a comparable price against the low end RS-232 multi package solution.

ASYNCHRONOUS - APPLICATION

The DS8934 provides all the necessary drivers and receivers to implement a basic asynchronous interface and is illustrated in *Figure 1*. The five driven lines are: RI, CTS, RXD, DSR, and DCD. The three received lines are: DTR, TXD, and RTS. Driver outputs and Receiver inputs are located on one side of the device to simplify the PCB layout. Additionally the ordering of the drivers and receiver in the package allows for a non-cross over interconnect between the device and the common 9 pin D shell connector. The other side of the device provides the logic interface.
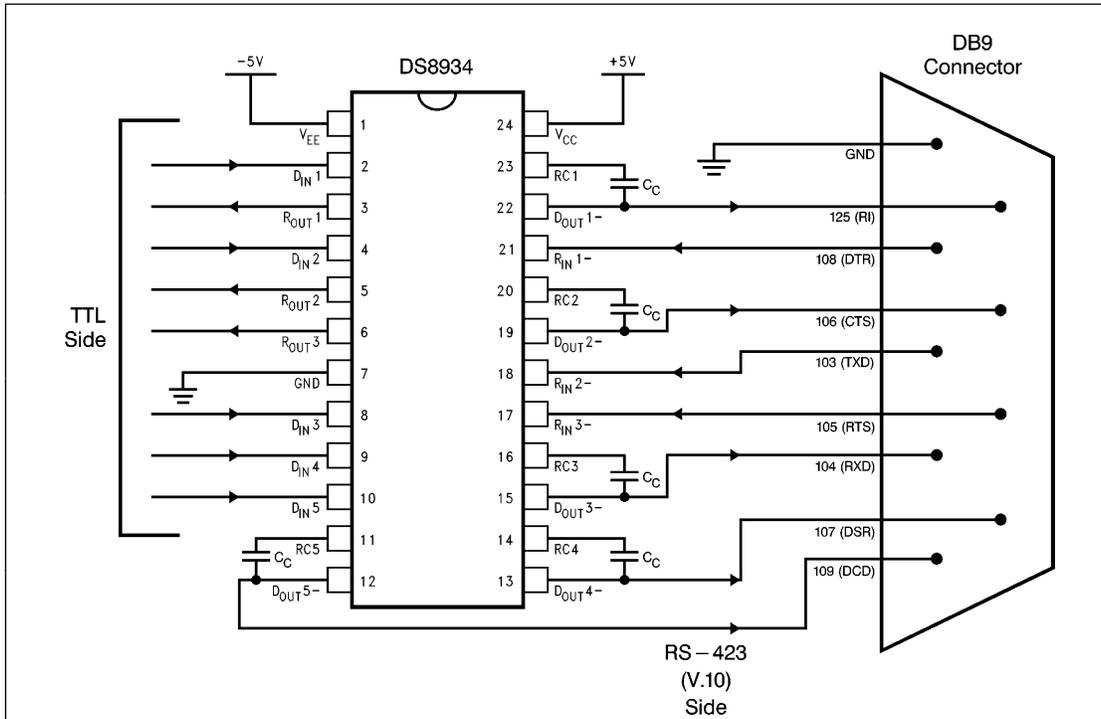
FIGURE 1. Asynchronous Application

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SYNCHRONOUS - APPLICATION

When used together, the DS8934 and the DS8933 provides all the necessary drivers and receivers to implement a basic synchronous interface. This is illustrated in *Figure 2*. The five driven lines in the DS8934 are once again: RI, CTS, RXD, DSR, and DCD. The three received lines in the DS8934 are: DTR, TXD, and RTS. The DS8933 supports the clocking lines required in a synchronous application. The lines TXC and RXC are driven, and ETXC is received. The clock lines are isolated in the DS8933 package.
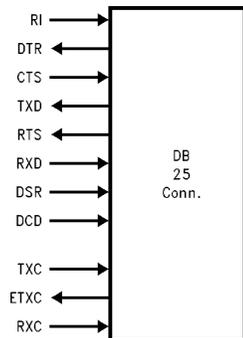
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FIGURE 2. Synchronous Application

THE V.10/RS-423 DRIVER

The drivers conform to the V.10 and TIA/EIA-423-B standards. They provide an inverting logic function that translates between TTL and RS-423 levels. The driver has a typical input to output delay of 175 ns with a typical output skew of 65 ns. With an IOS of 100 mA, the driver has high drive capability (especially compared to RS-232 drivers at 5 mA IOS). The driver circuit is a low impedance single-ended voltage source producing an output from 4V to 6V in magnitude. Independent driver slew rate control is achieved by using an external capacitor on the driver response control pin. This allows for optimized control for higher speed clock and data lines, while the control lines can be slowed to minimize noise generation. Slew rates can be adjusted up to 60 V/μs. Slew rate is virtually independent of RL and CL (see Table I). In contrast an RS-232 driver's slew rate is dependent upon CL (cable length). The DS8933/34 driver rise time (tr) can be calculated by the following equation: tr = Cc x (54 ns/pF). The slew rate (sr+) can then be calculated by: sr+ = 6V/tr. When laying out the PC board, the response control capacitor should be located as close to the device (driver output) to minimize parasitic. Surface mount capacitors are advised. The driver output waveform is shown in *Figure 3*. Note that a response control capacitor of 10 pF has been used, and the driver is loaded with

2,500 pF and a 3 kΩ resistor (both to ground). Input frequency is 115 kHz (230 kbps), supplies (±5V) and operating temperature is nominal. The driver's output features a ±4V swing with smooth controlled transitions.

TABLE I. Driver Output Characteristics

Response Cap.	Load Resistor	Load Cap.	Rise Time	Slew Rate
15 pF	3 kΩ	2,500 pF	750 ns	8V/μs
15 pF	7 kΩ	50 pF	750 ns	8V/μs

X̄Rise	X̄Fall
614.2 ns	621.3 ns
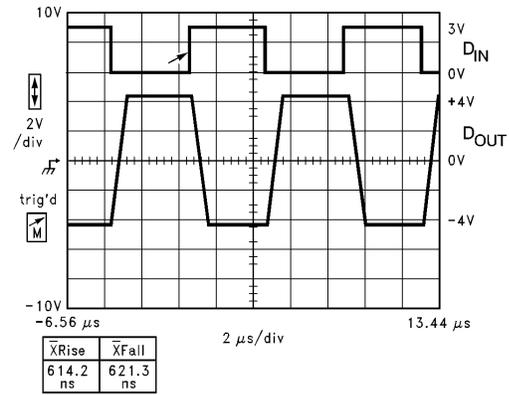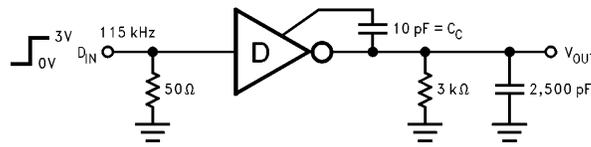
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FIGURE 3. Driver Output Waveform

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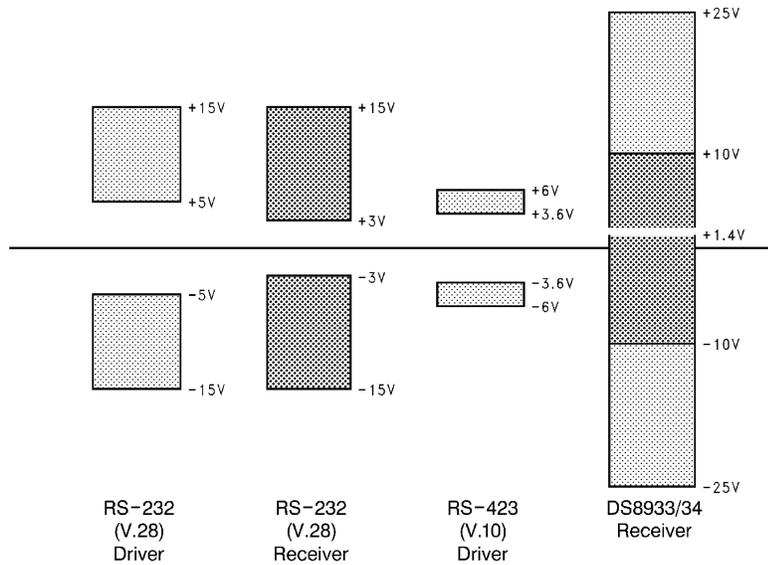
FIGURE 4. Signaling Levels

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THE RECEIVER

The receivers conform to the V.10 and TIA/IEIA-423-B standards. They provide an inverting logic function that translates between RS-423 and TTL levels. The receiver has a typical input to output delay of 30 ns with a typical output skew of 3 ns. The receiver input circuitry accommodates ±25V input signals and 3 kΩ to 8 kΩ input impedance, which assures compatibility with RS-232 drivers. The receiver threshold of +1.4V guarantees a failsafe HIGH output state for an open input state (pulled low by the internal bias resistor) when the cable is unplugged. The offset threshold provides 1V of noise rejection around ground, and also a minimum 2V of noise margin between a V_{IH} of ±3.6V and the threshold at +1.36V (see *Figures 4* and *5*). 40 mV of hysteresis is incorporated to prevent oscillations.

V.28/RS-232 vs V.10/RS-423

The V.28/RS-232 Interface is without contest the most popular interface standard in the world today. The original specification was developed in the early 1960s, and even in its current revision (EIA/TIA-232-E-1991) the maximum specified data rate is still 20,000 bits per second. Unofficially some RS-232 drivers and receivers are capable of operating at higher data rates, however that maximum data rate is cable length (capacitance load) and device (slew rate) specific. With careful component selection, and limitations on capacitance load, it is possible to select a RS-232 driver that is capable of operating at 115 kbps. However, operation at the other end of the cable is not guaranteed, as the DCE manufacturer is in control over the components it selects, but is not in control over the selection of devices inside the DTE (PC). For this reason and others, the ITU recommends the use of V.10 drivers instead of the popular RS-232 components. V.10/RS-423 drivers can easily operate above 500,000 bits per second, are *not* limited by cable length (as RS-232 drivers are), and offer superior wave shaping control. Higher data rate capability is very important as the compression techniques used today double (MNP5) or quadruple (V.42bis) the basic rate of 28.8 kbps, higher ratios are being discussed and 230.4 kbps may not be too far off in the future (some high-end V.34 modems support 230 kbps today!). RS-423 drivers and receivers are however fully compatible with RS-232 drivers and receivers, as backwards compatibility was built into the RS-423 standard.

SUMMARY

The DS8934 provides an economical single chip interface optimized for a V.34 DCE modem interface. When used with the companion device, the DS8933, a basic sync interface is provided with only two small surface mount packages. Additionally, both devices offer the following performance advantages:

Less Noise—RS-423 with its typical output swing of 8V (±4V) compared to RS-232's 16V (±8V) generates less noise, and the receivers provide tight thresholds, thereby maximizing noise margins.

>230 kbps—The drivers easily operate at 115 kbps and are capable of operating above 500 kbps independent of load. This provides an easy upgrade path to high data rates that are already being discussed.

Slew Rate Control—RS-423 drivers provide independent slew rate control, allowing higher speed clock and data lines to be optimally controlled, and control lines slowed to minimize noise generation.

Single Chip—The DS8934 provides a one chip solution for an asynchronous interface saving PCB space, and costs.

Dual Chip—Together the DS8933 and DS8934 support a basic synchronous interface, again saving PCB space over multi-package solutions.

V.10 Drivers—The DS8933 and DS8934 drivers conform to the V.10/RS-423 standards as required by the V.34 standard.

REFERENCES

ITU-T Recommendations: V.10, V.24, V.28, and V.34

TIA/EIA Standards: EIA/TIA-232-E, and TIA/EIA-423-B

National Datasheets: DS8933, and DS8934
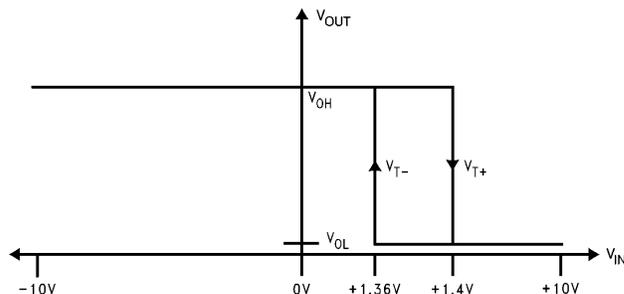
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FIGURE 5. Receiver Voltage Transfer Curve (VTC)
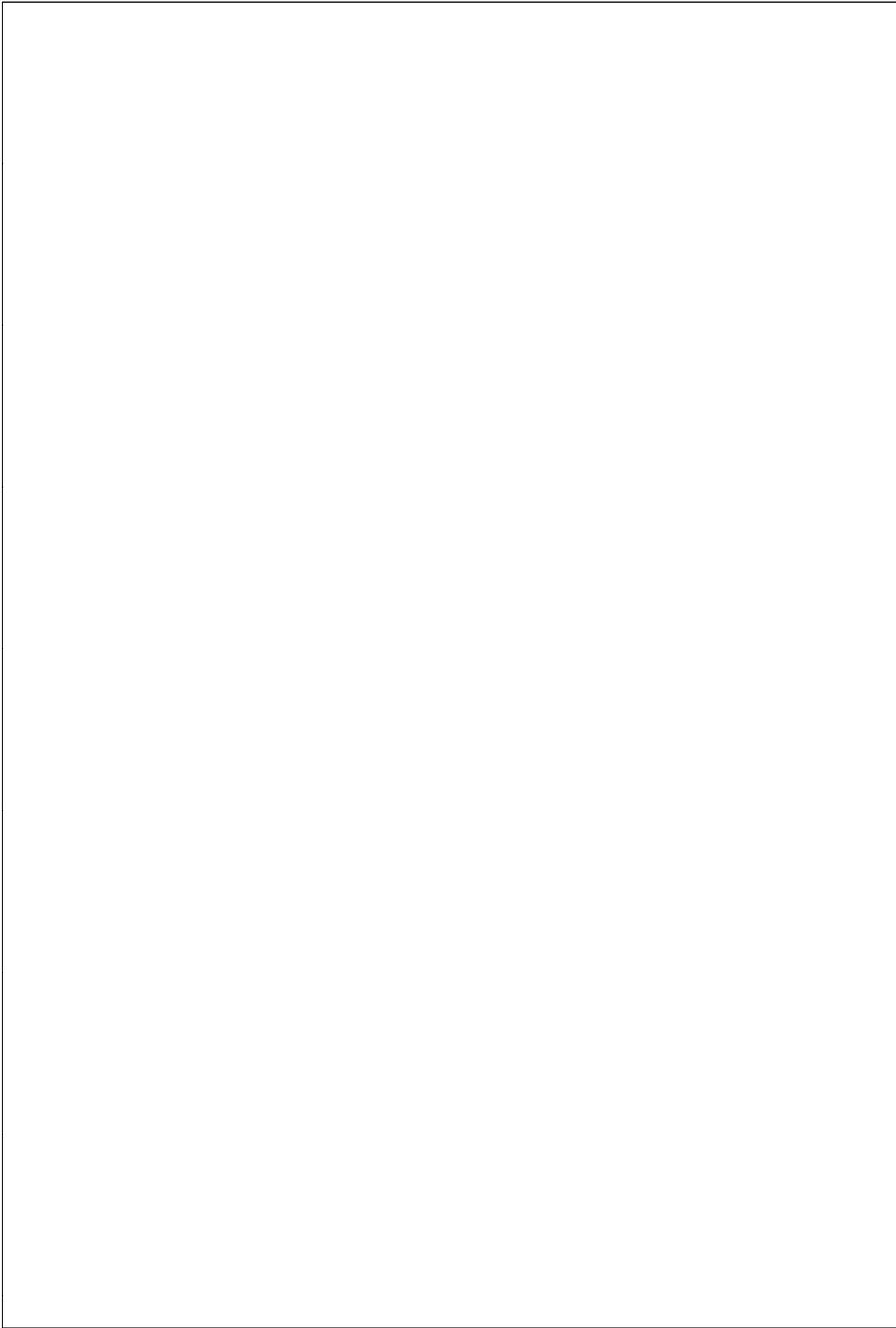
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