AN34

Using the TC232

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INTRODUCTION

The TC232 RS232 dual transmitter/receiver IC is specifically designed for computer and telecommunication applications in implementing the RS232 interface protocol. It operates from a single 5V supply and requires a minimum number of external components.

This application note will show how designers using the TC232 can reduce external parts count over similar 232 ICs currently on the market, and that Microchip Technology's improved processing techniques eliminate the worry of CMOS latch-up.

Basic Operation

The heart of the TC232 is the two voltage converters that allow the device to have an output swing of ±10V while being fed from a single 5V supply. 5V is fed into pin 16, then doubled to create 10V by switched capacitor techniques (See TC962 datasheet for further information on switched capacitor charge pumps). This uses the capacitor placed between pins 1 and 3 as the switched capacitor.

The output of pin 2 is fed to a switched capacitor voltage inverter which utilizes the capacitor between pins 4 and 5 of the TC232 as its switched capacitor. The output of the inverter is filtered by a capacitor from pin 6 to ground.

Powering Other External Circuits

The convenience of having a ±10V power supply "for free" is almost too good to pass up, and designers are often tempted to use the TC232's on chip voltage converter to power more than just the 232's drivers and receivers. Succumbing to this temptation can lead to start-up problems if the additional load imposed is too great.

The structure of the TC232's DC-to-DC converter is such that with a sufficiently heavy load on the 10V output it is possible to reduce internal supply voltages to below the point where start up can begin. The graph in Figure 2 shows startup voltage vs. external load current to achieve start up for a typical TC232. For proper operation it is recommended that the combined currents taken from the outputs of the doubler (+10V) and inverter (–10V) be no greater than 6mA. If currents totalling more than 6mA are required, then ICs such as the TC962 or TC4429 should be considered for the job.

Placement of C3

A question often asked is whether C3 should be connected between pin 2 and the 5V supply or between pin 2 and ground, as depicted in Figure 1A. For the TC232 it makes no difference. However, this is not the case for all 232 ICs.

While the best connection for C3 is to ground, users of the first 232 ICs on the market discovered that start-up problems would occur under certain conditions. Investigation showed that if the 5V power supply came "on" abruptly, the voltage converter would stall or latch up. By boot strapping the 10V output to the 5V supply rail this problem could be avoided and subsequent data sheets and application notes showed C3 connected in this manner. The drawback to this configuration is the transference of system noise from the 5V supply to the 10V output through C3.

Microchip Technology has taken special care to avoid this problem, in both the circuit's design and processing used to produce the TC232. The result is a device which is very resistant to latch-up and operates quite well in either configuration.

Deleting the 10V Filtering Capacitor

A unique feature of the TC232's voltage converter is its ability to operate with only three capacitors, instead of the usual four. In those applications where the TC232 power supply outputs (10V) are not required to supply external circuits it is possible to eliminate the 10V filter capacitor, on pin 2, and still obtain satisfactory performance for most 232 interfaces.

Figures 3 through 8 show performance comparisons of the TC232 with and without the filtering capacitor for various load conditions. Notice that while removing the filtering capacitor on pin 2 increases the 10V output's ripple, it does not effect the data outputs enough to cause noise problems for most 232 applications.

In applications where the 10V is used for other external circuits the decoupling capacitor for the circuit can be combined so that it is still not necessary to have a capacitor specifically for the 10V output.

Latch-Up Proof Design

One of the advantages of the TC232 over other CMOS 232 interface ICs is its immunity to CMOS latch-up. This prevents "mysterious" failures of the interface ICs due to transient currents flowing between the two different grounds of the two systems that the ICs are interfacing.

The latch-up ability also allows "hot switching" that is, the ability to change a board in a system without having to shut down the system. Most CMOS ICs will latch-up if this is done resulting in the destruction of the devices and/or the inability of the system to operate.

For further information on latch-up see Application Note 31.

CONCLUSION

It is possible to eliminate one additional capacitor in many designs when using the TC232. This can help save parts cost as well as board space.

Microchip Technology's processing eliminates the designer's worry about latch-up, resulting in improved system operation and reliabiltiy.

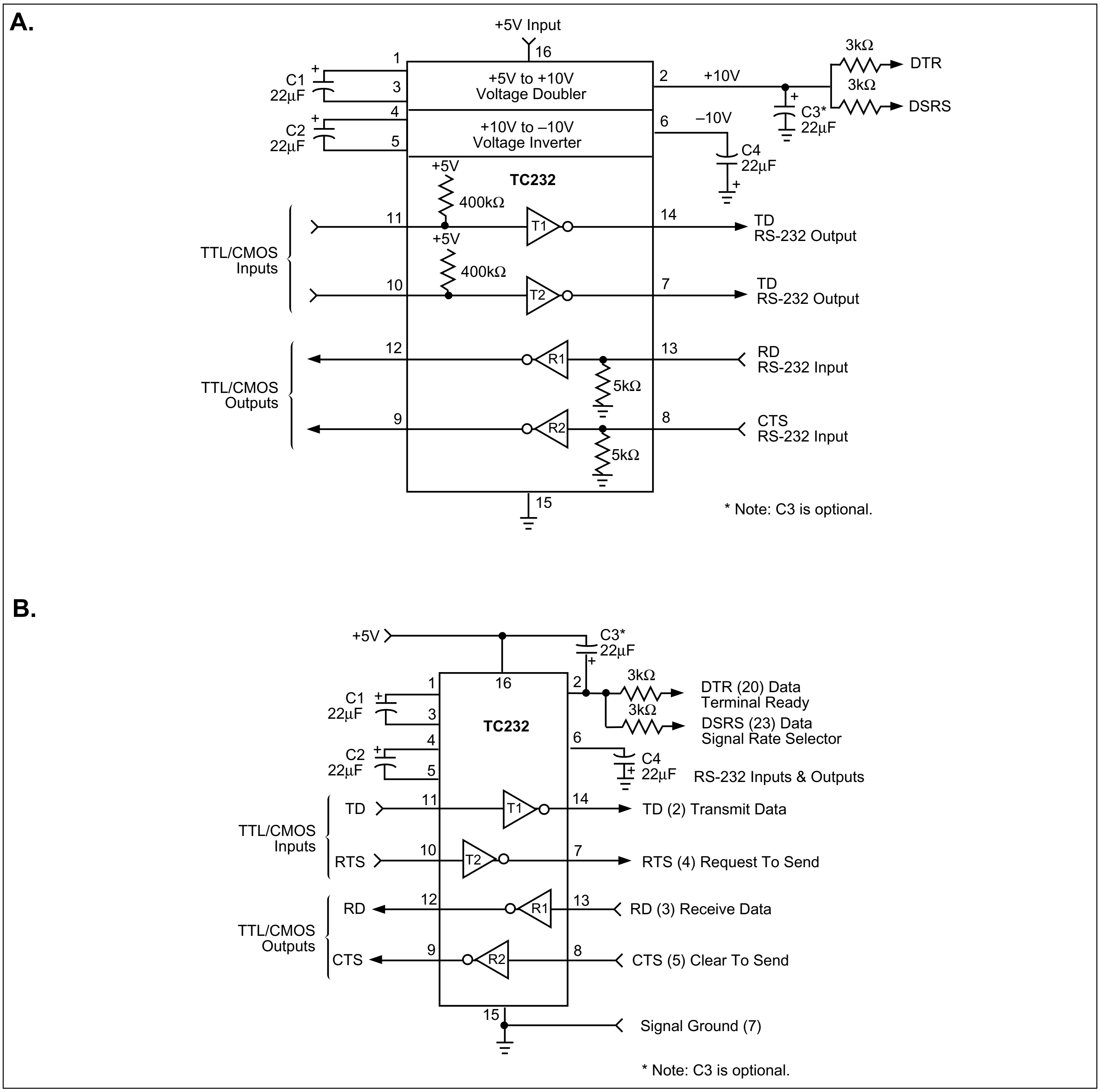

FIGURE 1: *Typical application.*

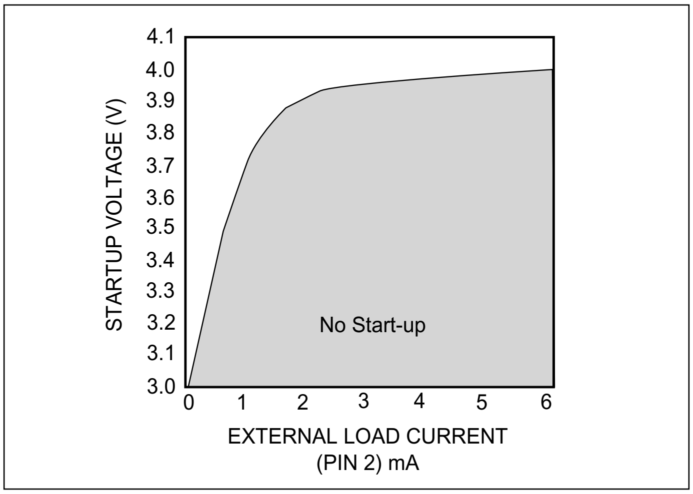

FIGURE 2: *Startup voltage vs. external (pin 2) load.*

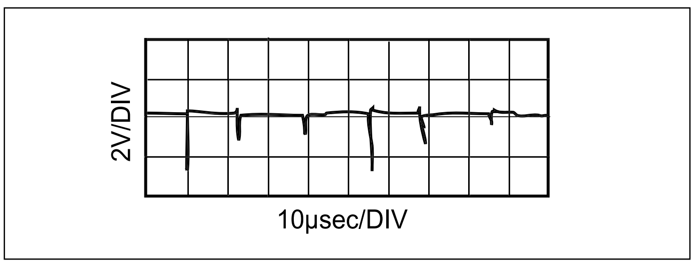

FIGURE 3: *10V output ripple, no C3, no load.*

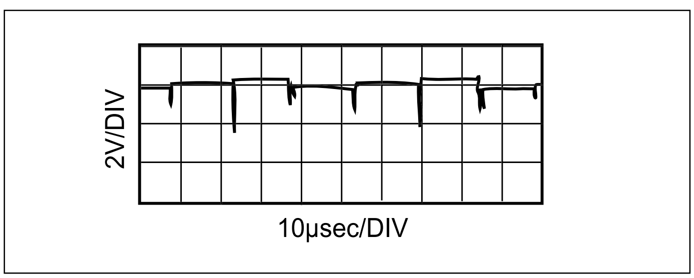

FIGURE 4: *10V output ripple, no C3, I_{LOAD} = 6mA.*

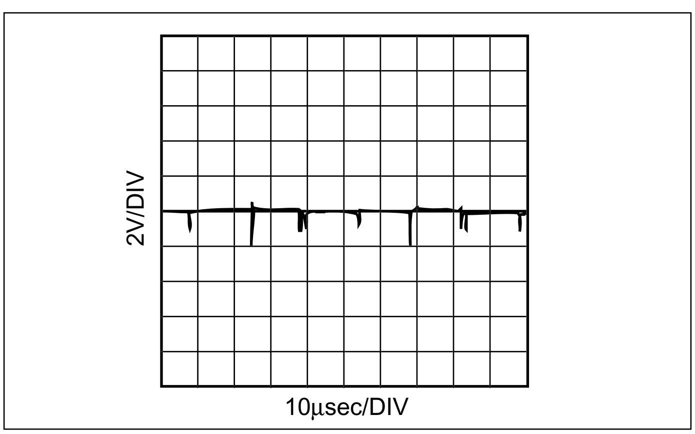

FIGURE 5: *RS232 output high, C3 = 10µF, R_L = 3kΩ.*

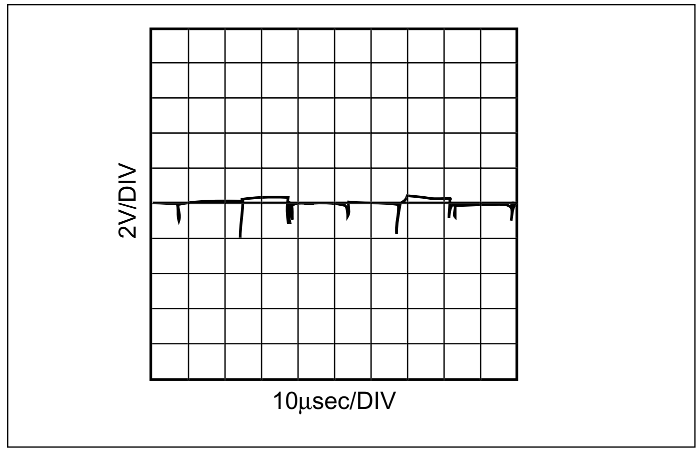

FIGURE 6: *RS232 output high, no C3, R_L = 3kΩ.*

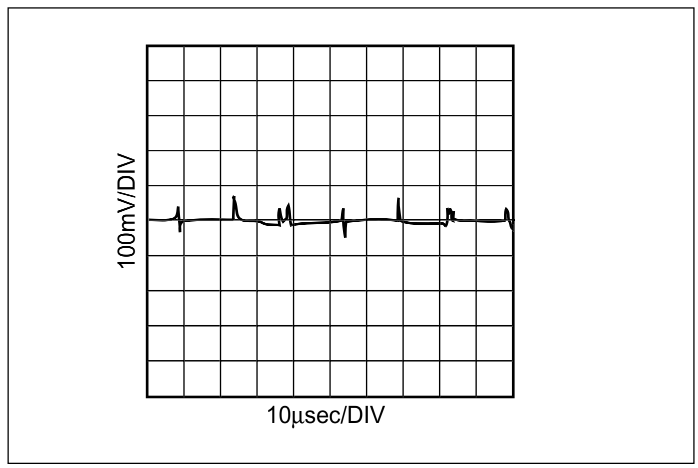

FIGURE 7: *RS232 output low, C3 = 10µF, R_L = 3kΩ.*

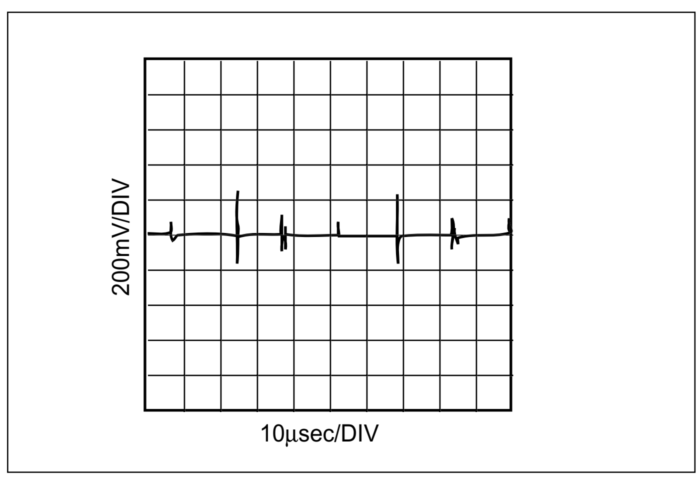

FIGURE 8: *RS232 output low, no C3, R_L = 3kΩ.*

Trademarks

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