*Patented

DUAL RS-232 TRANSMITTER/RECEIVER AND POWER SUPPLY

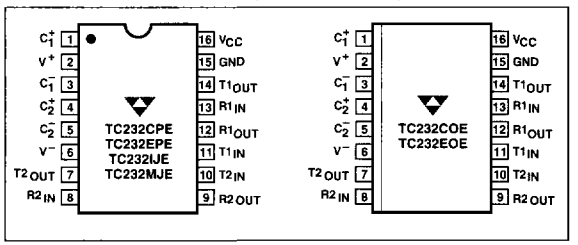
FEATURES

- **Meets All RS-232 Specifications**
- **Operates From Single 5V Power Supply**
- **2 Drivers and 2 Receivers**
- **On-Board Voltage Quadrupler**
- **Input Levels ..... ±30V**
- **Output Swing With +5V Supply ..... ±9V**
- **Low Supply Current ..... 5 mA**
- **Does not require external ±12V supplies**

APPLICATIONS

- **RS-232C Communication Links**
- **Modems, peripherals, computers**
- **Battery-powered systems**

PIN CONFIGURATIONS (DIP and SOIC)



GENERAL DESCRIPTION

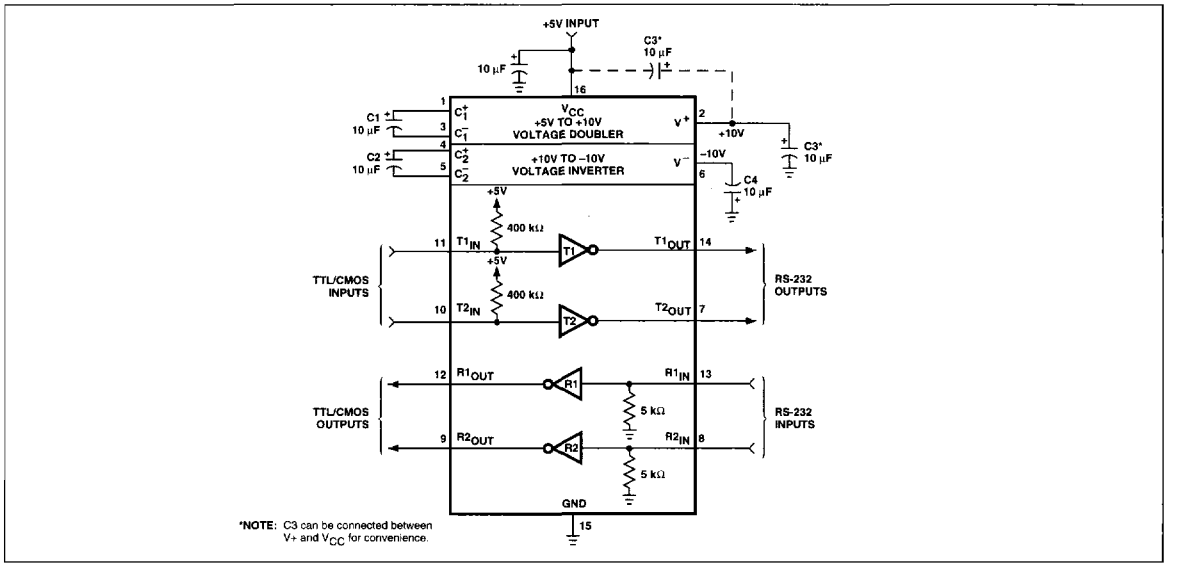
The TC232 is a dual RS-232 transmitter/receiver that complies with EIA /TIA RS-232E guidelines and is ideal for all RS-232 communication links. This device operates from a 5V power supply and contains two charge pump voltage converters that produce ±10V power supplies.

The TC232 has four level translators. Two are RS-232 transmitters that convert TTL/CMOS input levels to 9V RS-232 outputs. The other two translators are RS-232 receivers that convert RS-232 inputs to 5V TTL/CMOS output levels. The receivers have a nominal threshold of 1.3V, a typical hysteresis of 0.5V, and can operate with inputs up to ±30V.

ORDERING INFORMATION

Part No.	Package	Temp. Range
TC232COE	16-Pin SOIC (Wide)	0°C to +70°C
TC232CPE	16-Pin Plastic DIP	0°C to +70°C
TC232EOE	16-Pin SOIC (Wide)	– 40°C to +85°C
TC232EPE	16-Pin Plastic DIP	– 40°C to +85°C
TC232IJE	16-Pin CerDIP	– 25°C to +85°C
TC232MJE	16-Pin CerDIP	– 55°C to +125°C

TYPICAL APPLICATION



TC232-6 10/21/96

TC232

ABSOLUTE MAXIMUM RATINGS*

V_{CC} ..... +6V
V^+ ..... +12V
V^- ..... +12V
Input Voltages
$T1_{IN}$, $T2_{IN}$ ..... –0.3 to (V_{CC} +0.3V)
$R1_{IN}$, $R2_{IN}$ ..... ±30V
Output Voltages
$T1_{OUT}$, $T2_{OUT}$ ..... (V^+ +0.3V) to (V^- –0.3V)
$R1_{OUT}$, $R2_{OUT}$ ..... –0.3 to (V_{CC} +0.3V)
Short Circuit Duration
V^+ 30sec
V^- 30sec
$T1_{OUT}$, $T2_{OUT}$ ..... Continuous
Storage Temperature Range ..... -65°C to +150°C

Package Power Dissipation ($T_A \leq 70°C$)
CerDIP 890mW
Derate 9.5 mW/°C Above +70°C
Plastic DIP 840mW
Derate 7 mW/°C Above +70°C
Small Outline (SOIC) 760mW
Derate 7 mW/°C Above +70°C

*Static-sensitive device. Unused devices must be stored in conductive material. Protect devices from static discharge and static fields. Stresses above those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only and functional operation of the device at these or any other conditions above those indicated in the operation sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

ELECTRICAL CHARACTERISTICS:

V_{CC} = 5V ±10%, T_A = operating temperature range, test circuit unless otherwise noted.

Parameter	Test Conditions	Min	Typ	Max	Unit
Output Voltage Swing	$T1_{OUT}$, $T2_{OUT}$ Loaded With 3 kΩ to Ground	±5	±9	±10	V
Power Supply Current		—	5	10	mA
Input Logic Threshold Low	$T1_{IN}$, $T2_{IN}$	—	—	0.8	V
Input Logic Threshold High	$T1_{IN}$, $T2_{IN}$	2	—	—	V
Logic Pull-Up Current	$T1_{IN}$, $T2_{IN}$ = 0V	—	15	200	µA
RS-232 Input Voltage Operating Range		– 30	—	+30	V
RS-232 Input Threshold Low	V_{CC} = 5V	0.8	1.2	—	V
RS-232 Input Threshold High	V_{CC} = 5V	—	1.7	2.4	V
RS-232 Input Hysteresis		0.2	0.5	1	V
RS-232 Input Resistance	T_A = +25°C, V_{CC} = 5V	3	5	7	kΩ
TTL/CMOS Output Voltage Low	I_{OUT} = 3.2 mA	—	—	0.4	V
TTL/CMOS Output Voltage High	I_{OUT} = – 1 mA	3.5	—	—	V
Propagation Delay	RS-232 to TTL or TTL to RS-232	—	0.5	—	µsec
Instantaneous Slew Rate	C_L = 10 pF, R_L = 3 kΩ to 7 kΩ, T_A = +25°C (Note 1)	—	—	30	V/µsec
Transition Region Slew Rate	R_L = 3 kΩ, C_L = 2500 pF Measured From +3V to – 3V or –3V to +3V	—	3	—	V/µsec
Output Resistance	V_{CC} = V^+ = V^- = 0V, V_{OUT} = ±2V	300	—	—	Ω
RS-232 Output Short-Circuit Current		—	±10	—	mA

NOTE 1. Sample tested.

DETAILED DESCRIPTION

The TC232 contains a +5V to ±10V dual charge pump voltage converter, a dual transmitter and a dual receiver.

+5V to ±10V Dual Charge Pump Voltage Converter

The TC232 power supply consists of two charge pumps. One uses external capacitor C1 to double the +5V input to +10V, with output impedance of about 200Ω. The other uses C2 to invert +10V to – 10V, with overall output impedance of 450Ω (including effects of +5V to +10V doubler impedance).

The clock in the doubler circuit will start at ≈4.2V in the typical part, but external loads may make this point rise to as high as 4.5V with a load of 2 kΩ on each of the two output voltages.

Because of this, use of the doubler and inverter to run additional external circuits should be limited. The maximum current should be no more than 2.5 mA from the +10V and - 10V. in order to guarantee start-up of the doubler clock.

The test circuit employs 22 µF capacitors for C1 to C4, but the value is not critical. These capacitors usually are low-cost aluminum or tantalum electrolytic capacitors.

Increasing C1 and C2 to 47 µF lowers the output impedance of the +10V doubler and the - 10V inverter by the change in the ESR of the capacitors.

Increasing C3 and C4 lowers ripple on the ±10V outputs and 16 kHz ripple on the RS-232 outputs. Where size is critical, the value of C1 to C4 can be lowered to 1 µF. The use of a low ESR capacitor will help lower the output ripple and keep the output impedance of the ±10V as low as possible.

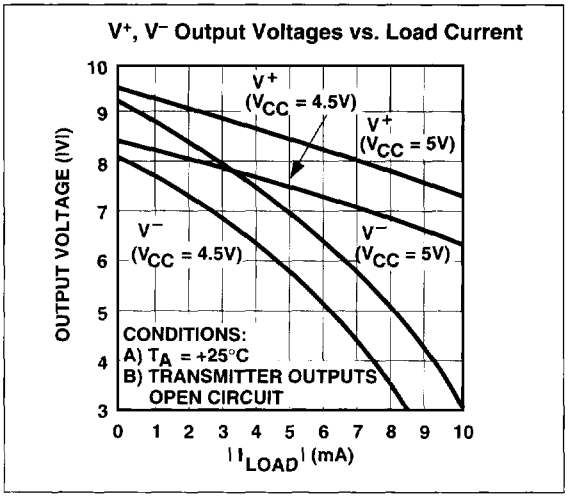
Dual Transmitter

TC232 transmitters are CMOS inverters driven by ±10V internally-generated voltages. The input is TTL/CMOS compatible, with a logic threshold of about 26% of V_{CC} (1.3V for 5V V_{CC}). The input of an unused transmitter can be left unconnected, since an internal 400 kΩ pull-up resistor connected between the transmitter input and V_{CC} pulls the input HIGH and forces the unused transmitter output to the LOW state.

With V_{CC} at 5V, the outputs will go from (V+ – 0.6V) to V^- with no load and will swing ±9V when loaded with 3 kΩ. The minimum output voltage swing, with V_{CC} at 4.5V and at maximum ambient temperature, is ±5V. This conforms to RS-232 specifications for "worst-case" conditions.

EIA/TIA RS-232E specs limit the slew rate at output to less than 30V/µs.

The powered-down output impedance (V_{CC} = 0V) is a minimum of 300Ω with ±2V applied to outputs.



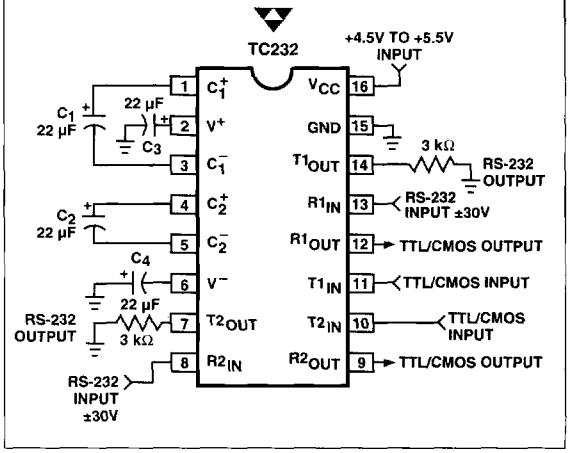
The outputs are protected and can be short-circuited to ground indefinitely.

Dual Receiver

TC232 receivers meet RS-232 input specifications. Input impedance is between 3 kΩ and 7 kΩ. Switching thresholds are within the ±3V limits, and the receivers withstand up to ±30V inputs. RS-232 and TTL/CMOS input compatible, the receivers have 0.8V V_{IL} and 2.4V V_{IH} with 0.5V hysteresis to reject noise.

The TTL/CMOS compatible receiver output is LOW when an RS-232 input is greater than 2.4V. It is HIGH when an input is floating or between +0.8V and – 30V.

TEST CIRCUIT



TC901

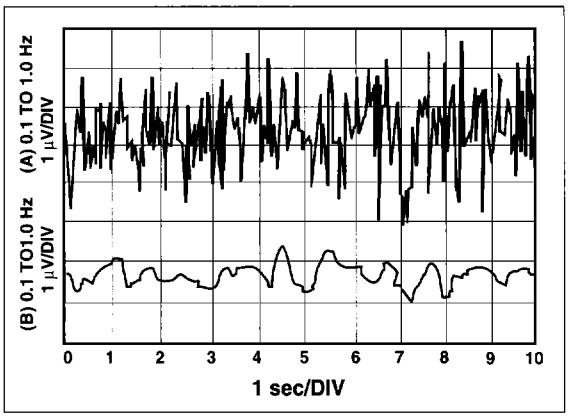


Figure 1. Input Voltage Noise

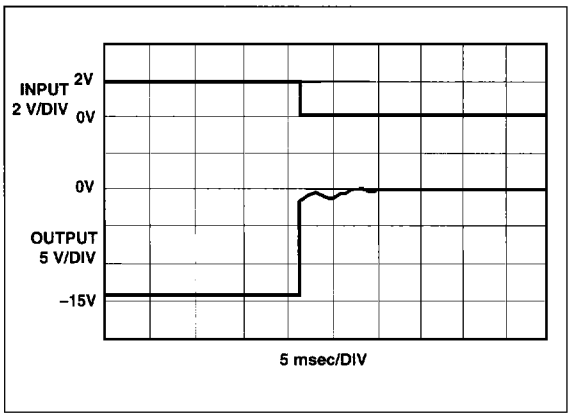


Figure 3. Recovery From Negative Saturation

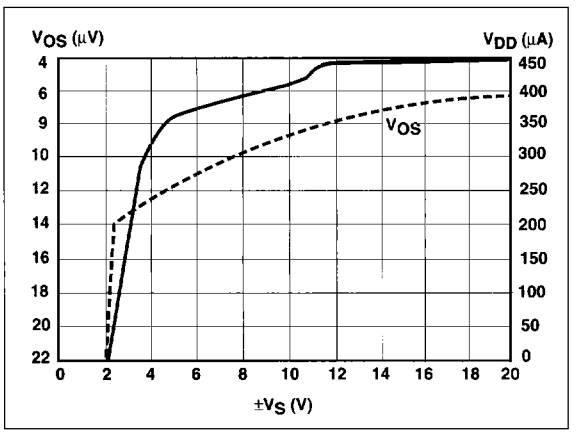


Figure 2. V_{OS} and I_{DD} vs Supply Voltage

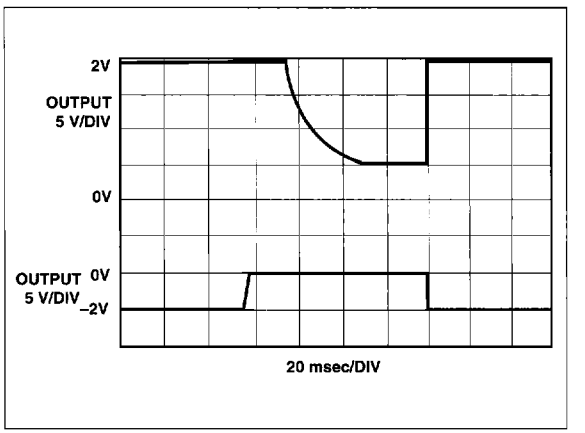


Figure 4. Recovery From Positive Saturation

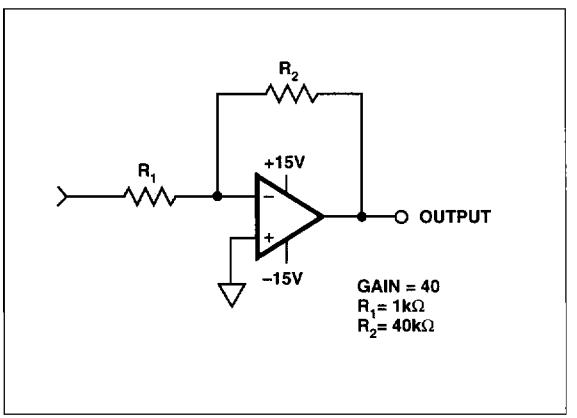


Figure 5. Saturation Test Circuit

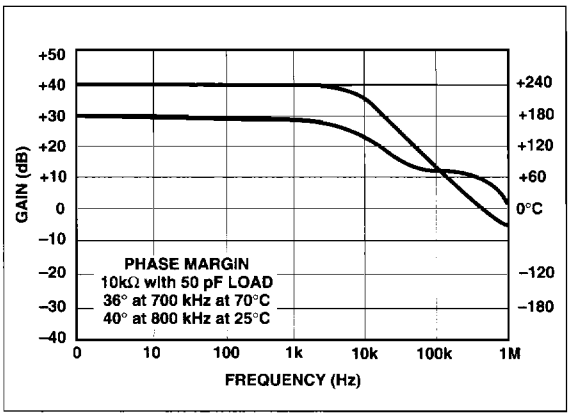


Figure 6. Phase-Gain