1 FEATURES

- Single +5V supply operation
- 4x0.1µF external charge pump capacitors
- Two wake-up receivers
- Four drives and five receivers
- 250Kbps transmission rates
- 1mA typical static supply current
- Pin to pin replacment for MAX213
- ±15KV ESD protection
- Meets all EIA-232 specifications

2 APPLICATIONS

- Battery-Powered Equipment
- Handheld Equipment
- Portable Diagnostics Equipment

3 DESCRIPTION

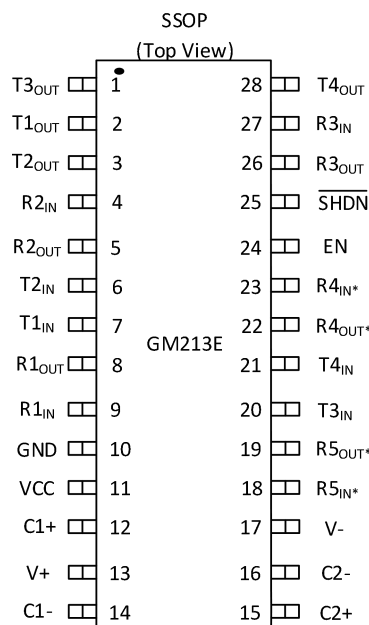GM213E is a family of RS-232 transceivers with integrated charge pump circuitry for single +5V supply operation.

The drivers maintain the ±5V EIA/TIA-232E output signal levels at data rates in excess of 250Kbps when loaded in accordance with the EIA/TIA-232E specification.

The GM213E is available in a 28-pin shrink small outline (SSOP) package.
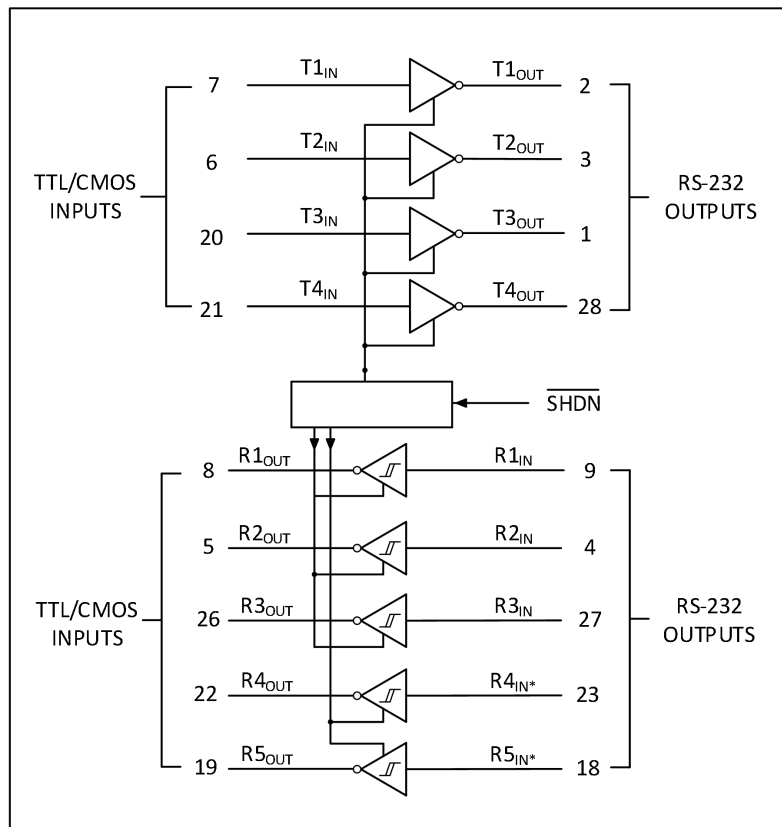
Logic diagram (positive logic)

4 Pin Configuration and Functions

```
                    SSOP
                 (Top View)

    T3OUT  ┌┤├┐  1        28  ┌┤├┐  T4OUT
    T1OUT  ┌┤├┐  2        27  ┌┤├┐  R3IN
    T2OUT  ┌┤├┐  3        26  ┌┤├┐  R3OUT
    R2IN   ┌┤├┐  4        25  ┌┤├┐  SHDN
    R2OUT  ┌┤├┐  5        24  ┌┤├┐  EN
    T2IN   ┌┤├┐  6        23  ┌┤├┐  R4IN*
    T1IN   ┌┤├┐  7  GM213E 22  ┌┤├┐  R4OUT*
    R1OUT  ┌┤├┐  8        21  ┌┤├┐  T4IN
    R1IN   ┌┤├┐  9        20  ┌┤├┐  T3IN
    GND    ┌┤├┐  10       19  ┌┤├┐  R5OUT*
    VCC    ┌┤├┐  11       18  ┌┤├┐  R5IN*
    C1+    ┌┤├┐  12       17  ┌┤├┐  V-
    V+     ┌┤├┐  13       16  ┌┤├┐  C2-
    C1-    ┌┤├┐  14       15  ┌┤├┐  C2+
```

Pin		Type	Description
Name	No.		
$T3_{OUT}$	1	O	RS-232 driver output
$T1_{OUT}$	2	O	RS-232 driver output
$T2_{OUT}$	3	O	RS-232 driver output
$R2_{IN}$	4	I	RS-232 receiver input
$R2_{OUT}$	5	O	Receiver output
$T2_{IN}$	6	I	Driver inputs
$T1_{IN}$	7	I	Driver inputs
$R1_{OUT}$	8	O	Receiver output
$R1_{IN}$	9	I	RS-232 receiver input
GND	10	-	Ground
Vcc	11	-	Supply voltage
C1+	12	-	Positive terminal of the voltage-doubler charge-pump capacitor
V+	13	-	Positive charge pump output voltage
C1-	14	-	Negative terminal of the voltage-doubler charge-pump capacitor
C2+	15	-	Positive terminal of the voltage-doubler charge-pump capacitor
C2-	16	-	Negative terminal of the voltage-doubler charge-pump capacitor
V-	17	-	Negative charge pump output voltage
$R5_{IN}$*	18	I	RS-232 receiver input
R5out*	19	O	Receiver output
$T3_{IN}$	20	I	Driver inputs
$T4_{IN}$	21	I	Driver inputs
$R4_{OUT}$*	22	O	Receiver output
$R4_{IN}$*	23	I	RS-232 receiver input
EN	24	-	Active high enable
$\overline{SHDN}$	25	-	Active low shutdown
$R3_{OUT}$	26	O	Receiver output
$R3_{IN}$	27	I	RS-232 receiver input
$T4_{OUT}$	28	O	RS-232 driver outputs

5 Specifications

5.1 Absolute Maximum Ratings[(1)]

Parameter	Description	Rating	UNIT
Vcc	Supply Voltage	-0.3 to +6	V
V+	Positive charge-pump voltage range	(Vcc-0.3)+12V	V
V-	Negative charge-pump voltage range	+0.3 to -12V	V
T_{IN}	Input voltage range(Drivers)	-0.3 to (Vcc+0.3)	V
R_{IN}	Input voltage range(Receivers)	±25	V
T_{OUT}	Output voltage range(Drivers)	-12.3 to 12.3	V
R_{OUT}	Output voltage range(Receivers)	-0.3 to (Vcc+0.3)	°C
T_J	Operating virtual junction temperature	150	°C
T_{stg}	Storage temperature range	-65 to +160	°C
P	28-Pin Wide SO (derate 12.50mW/°C above +70°C)	1000	mW
P	28-Pin SSOP (derate 9.52mW/°C above +70°C)	762	mW

(1) Stresses beyond 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 beyond those indicated under Recommended Operating Conditions is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

5.2 ESD Ratings

| Parameter	Limit	Unit
HBM (Human Body Model), Driver Outputs and Receiver Inputs	±15	
IEC61000-4-2 Air Discharge, Driver Outputs and Receiver Inputs	±15	KV
IEC61000-4-2 Contact Discharge, Driver Outputs and Receiver Inputs	±8	

5.3 Electrical Characteristics

Vcc = +5V±10%; (unless otherwise noted.)

Parameter		Conditions		MIN	TYP	MAX	UNIT
V_O	Output-Voltage Swing	All transmitter outputs loaded with 3kΩ to ground		±5	±8		V
I_{CC}	Vcc Power-Supply Current	No load, T_A = +25°C			1	2	mA
	Shutdown Supply Current	Figure 1, T_A = +25°C			0.1	2	μA
V_L	Input Logic Threshold Low	TIN, $\overline{EN}$, SHDN, EN, $\overline{SHDN}$				0.8	V
V_H	Input Logic Threshold High	TIN		2.0			V
		$\overline{EN}$, SHDN, EN, $\overline{SHDN}$		2.4			
I_L	Logic Pullup Current	TIN = 0V				0	μA
V_I	RS-232 Input-Voltage Operating Range			-25		+30	V
V_{IL}	Receiver Input Threshold Low	Vcc = +5V, T_A = +25°C	Active mode	0.8	1.2		V
			Shutdown mode,R4, R5	0.6	1.5		
V_{IH}	Receiver Input Threshold High	Vcc = +5V, T_A = +25°C	Active mode		1.7	2.4	V
			Shutdown mode, R4, R5		1.5	2.4	
V_{hys}	RS-232 Input Hysteresis	Vcc = +5V, no hysteresis in shutdown		0.2	0.5	1.0	V
ri	RS-232 Input Resistance	Vcc = +5V, T_A = +25°C		3	6	8	KΩ

Electrical Characteristics(continues)

V_{OL}	TTL/CMOS Output-Voltage Low	I_{OUT} = 1.6mA			0.4	V
V_{OH}	TTL/CMOS Output-Voltage High	I_{OUT} = 1.0mA	3.5			V
I_{OFF}	TTL/CMOS Output Leakage Current	$\overline{EN}$ = Vcc, EN = 0V, $0 \le R_{OUT} \le$ Vcc		0.05	±10	µA
t_{en}	Output Enable Time	Figure 5		150		ns
t_{dis}	Output Disable Time	Figure 5		200		ns
t_p	Receiver Propagation Delay	$\overline{SHDN}$ = 0V, R4, R5		100	200	ns
		$\overline{SHDN}$ = Vcc		100	200	ns
ro	Transmitter Output Resistance	Vcc = V+ = V- = 0V, V_{OUT} = ±2V	300			Ω
$SR_{(tr)}$	Transition Region Slew Rate	C_L = 50pF to 2500pF, R_L = 3kΩ to 7kΩ,Vcc = 5V, T_A = +25°C measured from +3V to-3V or -3V to +3V	3	15	30	V/µs
I_{OS}	RS-232 Output Short Circuit Current			±10	±60	mA
	Maximum Data Rate	R_L = 3kΩ to 7kΩ, C_L = 50pF to 1000pF, one transmitter		250		kbps

6 Typical Operating Characteristics
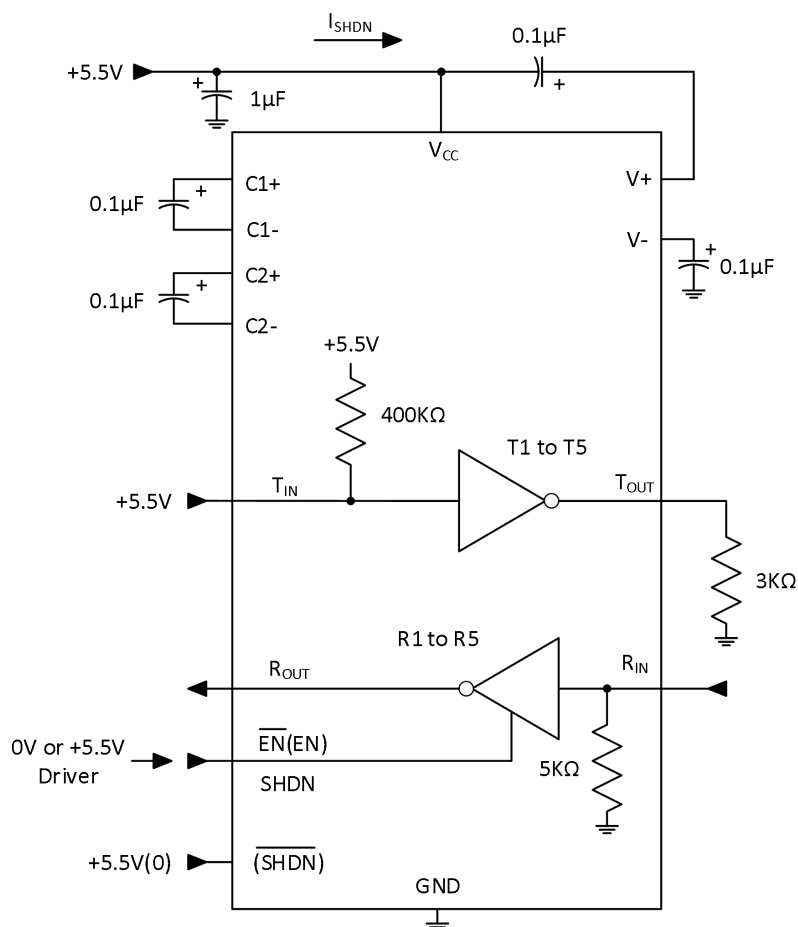
Figure 1. Shutdown Current Test Circuit
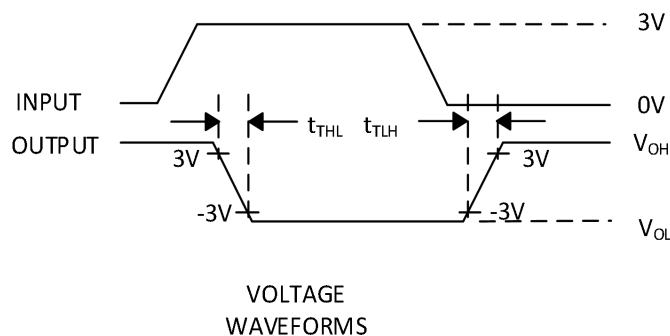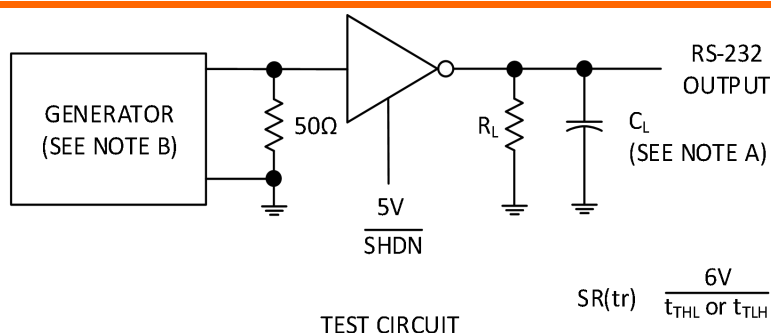
$$SR(tr) \quad \frac{6V}{t_{THL} \text{ or } t_{TLH}}$$

A. CL includes probe and jig capacitance
B. The pulse generator has the following characteristics: PRR = 5kbit/s, Z_O = 50 Ω, 50 % duty cycle, tr ≤ 10ns, tf ≤ 10ns.
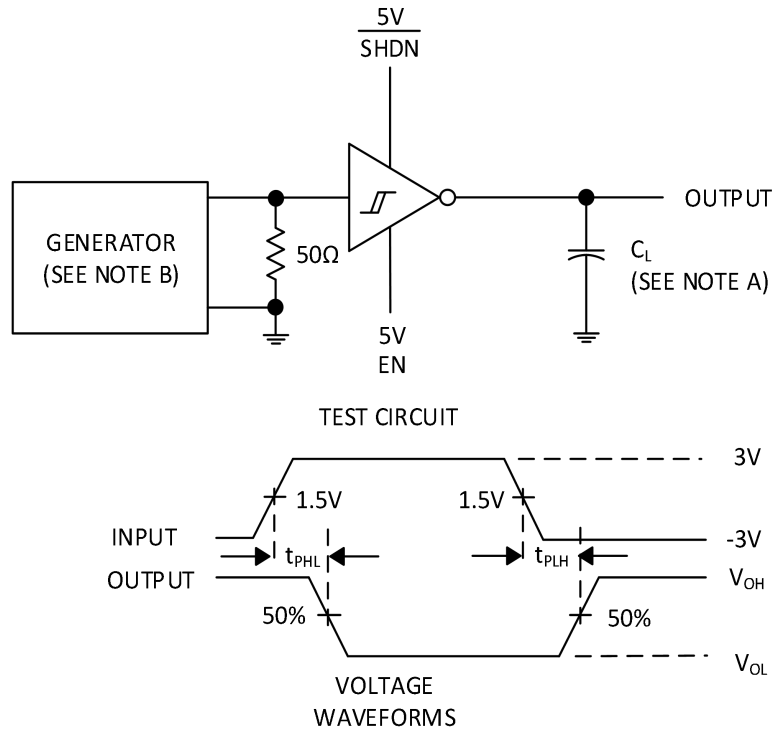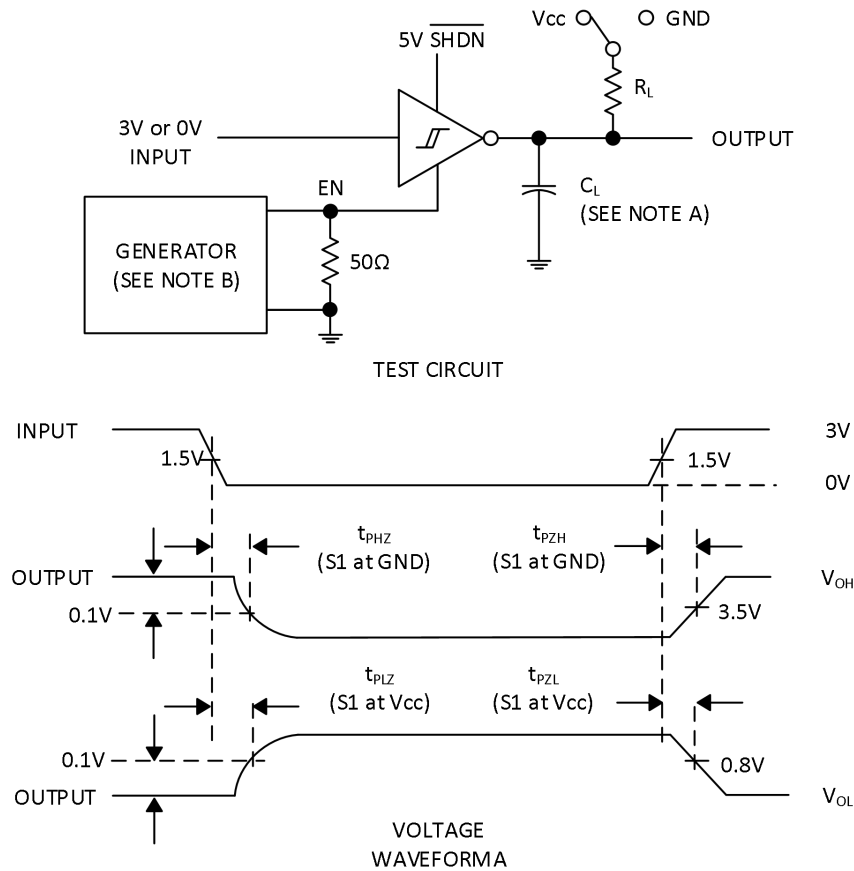
Figure 2. Driver Slew Rate
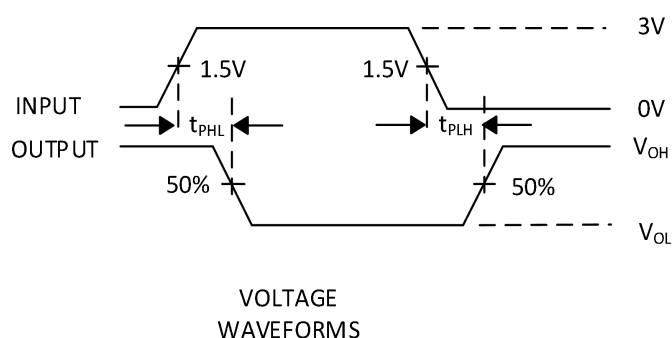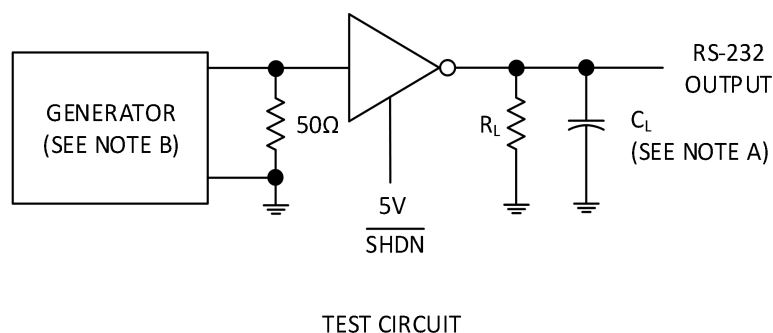
A. CL includes probe and jig capacitance
B. The pulse generator has the following characteristics: PRR = 5kbit/s, Z_O = 50 Ω, 50 % duty cycle, tr ≤ 10ns, tf ≤ 10ns.

Figure 3. Driver Pulse Skew and Progration Delay Times

TEST CIRCUIT

VOLTAGE
WAVEFORMS

A. CL includes probe and jig capacitance
B. The pulse generator has the following characteristics: PRR = 5kbit/s, ZO = 50 Ω, 50 % duty cycle, tr ≤ 10ns, tf ≤ 10ns.

Figure 4. Receiver Propagation Delay Times

TEST CIRCUIT

VOLTAGE
WAVEFORMA

A. CL includes probe and jig capacitance.
B. The pulse generator has the following characteristics: ZO = 50Ω, 50% duty cycle, tr < 10ns, tf < 10ns.
C. t_{PLZ} and t_{PHZ} are the same as tdis.
D. t_{PZL} and t_{PZH} are the same as ten.

Figure 5. Receiver Output Enable and Disable Timing

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7 Detailed Description

The GM213E consist of three sections: charge-pump voltage converters, drivers (transmitters), and receivers. Each section is described in detail.

7.1 +5V to ± 10V Dual Charge-Pump Voltage Converter

The +5V to±10V conversion is performed by two charge pump voltage converters (Figure 7). The first uses capacitor C1 to double +5V to +10V, storing +10V on the V+ output filter capacitor, C3. The second chargepump voltage converter uses capacitor C2 to invert +10V to -10V, storing -10V on the V- output filter capacitor, C4.
In shutdown mode, V+ is internally connected to Vcc by a 1kΩ pulldown resistor and V- is internally connected to ground by a 1kΩ pullup resistor.

7.2 RS-232 Drivers

When Vcc = +5V, the typical driver output-voltage swing is ±8V when loaded with a nominal 5kΩ RS-232 receiver. The output swing is guaranteed to meet the EIA/TIA-232E , which call for ±5V minimum out put levels under worst-case conditions. These include a minimum 3kΩ load, Vcc = +4.5V, and the maximum operating temperature. The open-circuit output-voltage swing ranges from (V+ - 0.6V) to V-.Input thresholds are both CMOS and TTL compatible. The inputs of unused drivers can be left unconnected since 400kΩ pullup resistors to Vcc are included onchip. Since all drivers invert, the pullup resistors force the outputs of unused drivers low. The input pullup resistors typically source 0μA; therefore, the driver inputs should be driven high or open circuited to minimize power-supply current in shutdown mode.
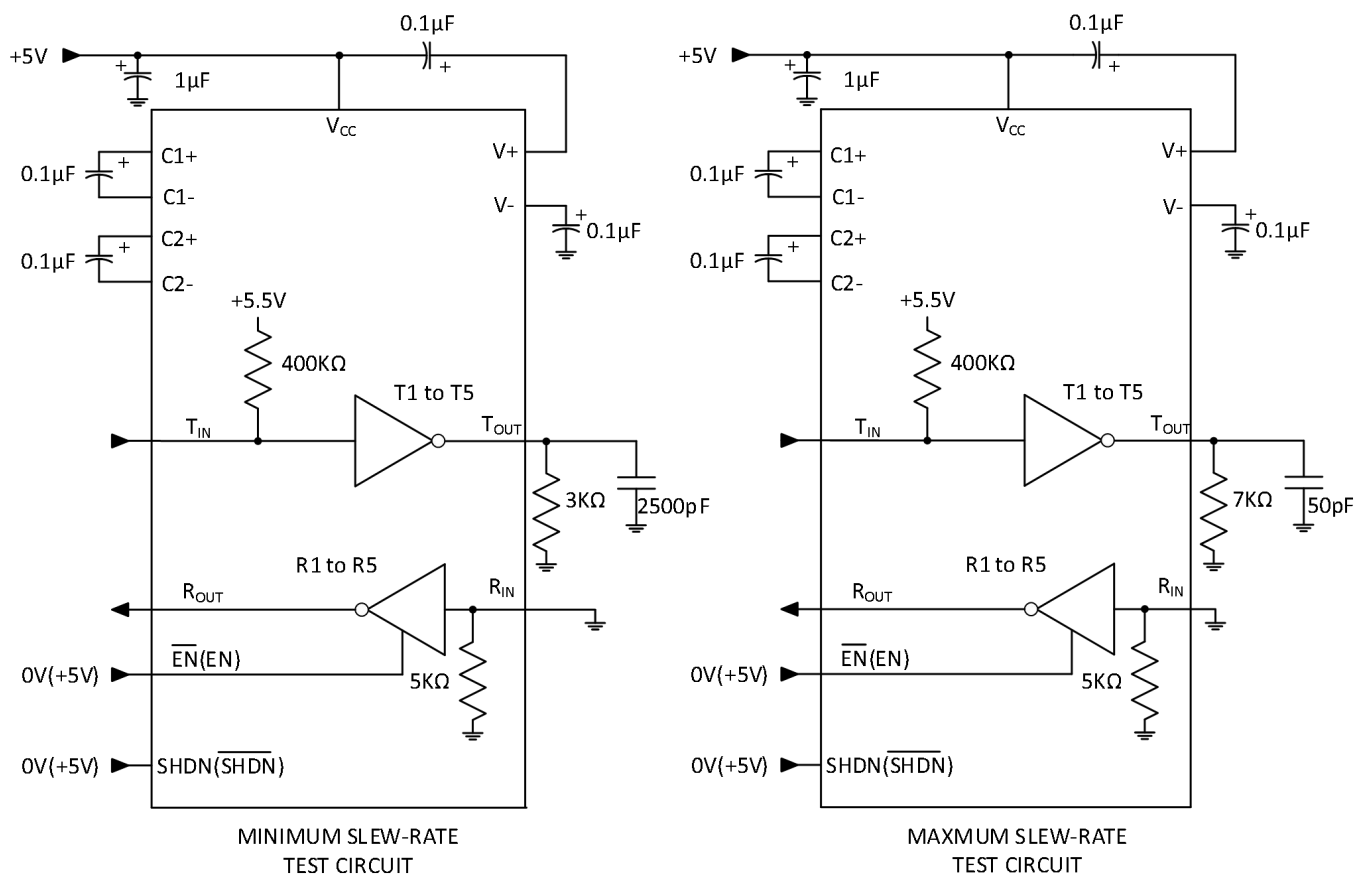

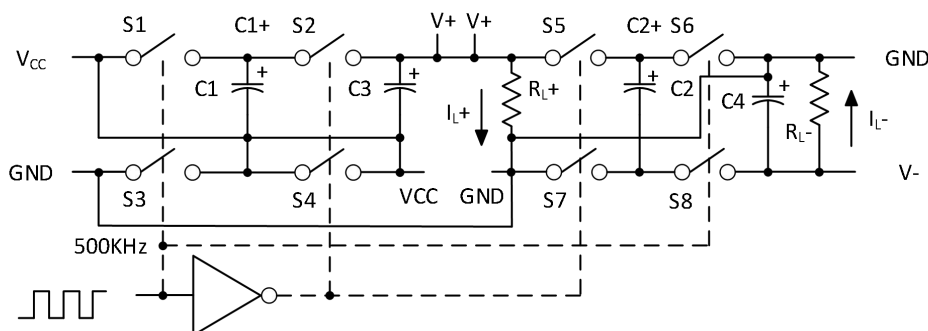**Figure 6. Transition Slew-Rate Test Circuit**

Figure 7. Dual Charge-Pump Diagram

7.3 RS-232 Receivers

The receivers convert RS-232 signals to CMOS logic output levels. Receiver outputs are inverting, maintaining compatibility with driver outputs. The guaranteed receiver input thresholds of +0.8V and +2.4V. This allows receiver inputs to respond to TTL/CMOS logic levels and improves noise margin for RS-232 levels.

The GM213E guaranteed +0.8V threshold (+0.6V in shutdown) ensures that receivers shorted to ground have a logic 1 output. Also, the 5kΩ input resistance to ground ensures that a receiver with its input left open also has a logic 1 output.Receiver inputs have approximately +0.5V hysteresis. This provides clean output transitions, even with slow rise and fall time input signals with moderate amounts of noise and ringing. In shutdown, the GM213E receivers R4 and R5 have no hysteresis.

7.4 Shutdown and Enable Control

In shutdown mode, the GM213E charge pumps are turned off, V+ is pulled down to Vcc, V- is pulled to ground, and the transmitter outputs are disabled. This reduces supply current typically to 1µA. The time required to exit shutdown is 1ms, as shown in Figure 8.All receivers except R4 and R5 on the GM213E are put into a high-impedance state in shutdown mode. The GM213E's R4 and R5 receivers still function in shutdown mode. These two receivers are useful for monitoring external activity while maintaining minimal power consumption.The enable control is used to put the receiver outputs into a high-impedance state, so that the receivers can be connected directly to a three-state bus. It has no effect on the RS-232 drivers or on the charge pumps.
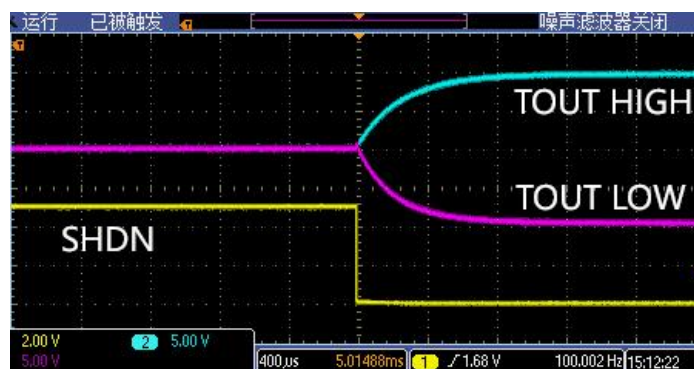

Figure 8. Transmitter Outputs When Exiting Shutdown

7.5 Receiver Operation in Shutdown

During normal operation, the GM213E's receiver propagation delay is typically 100ns. When entering shutdown with receivers active, R4 and R5 are not valid. In shutdown mode, propagation delays increase to 100ns for a high-to-low or a low-to-high transition.When exiting shutdown, all receiver outputs are invalid until the charge pumps reach nominal values (<2ms when using 0.1μF capacitors).

Table 1.GM213E Control Pin Configurations

$\overline{\text{SHDN}}$	EN	OPERATION STATUS	TRANSMITTERS T1-T4	RECEIVERS	
				R1,R2,R3	R4,R5
0	0	Shutdown	All High-Z	High-Z	High-Z
0	1	Shutdown	All High-Z	High-Z	Active*
1	0	Normal Operation	All Active	High-Z	High-Z
1	1	Normal Operation	All Active	Active	Active

*Active = active with reduced performance.

8 Applications Information

8.1 Capacitor Selection

The type of capacitor used is not critical for proper operation. Ceramic capacitors are suggested. To ensure proper RS-232 signal levels over temperature when using 0.1μF capacitors, make sure the capacitance value does not degrade excessively as the temperature varies. If in doubt, use capacitors with a larger nominal value. Also observe the capacitors' ESR value over temperature, since it influences the amount of ripple on V+ and V-. To reduce the output impedance at V+ and V-, use larger capacitors (up to 10μF). If polarized capacitors are used, obey the polarities shown in Figure 1 and the pin configurations.

8.2 Driving Multiple Receivers

Each transmitter is designed to drive a single receiver. Transmitters can be paralleled to drive multiple receivers.

8.3 Driver Outputs When Exiting Shutdown

Figure 5 shows two driver outputs exiting shutdown. As they become active, the two driver outputs go to opposite RS-232 levels (one driver input is high, the other is low). Each driver is loaded with 3kΩ in parallel with 2500pF. The driver outputs display no ringing or undesirable transients as they come out of shutdown.
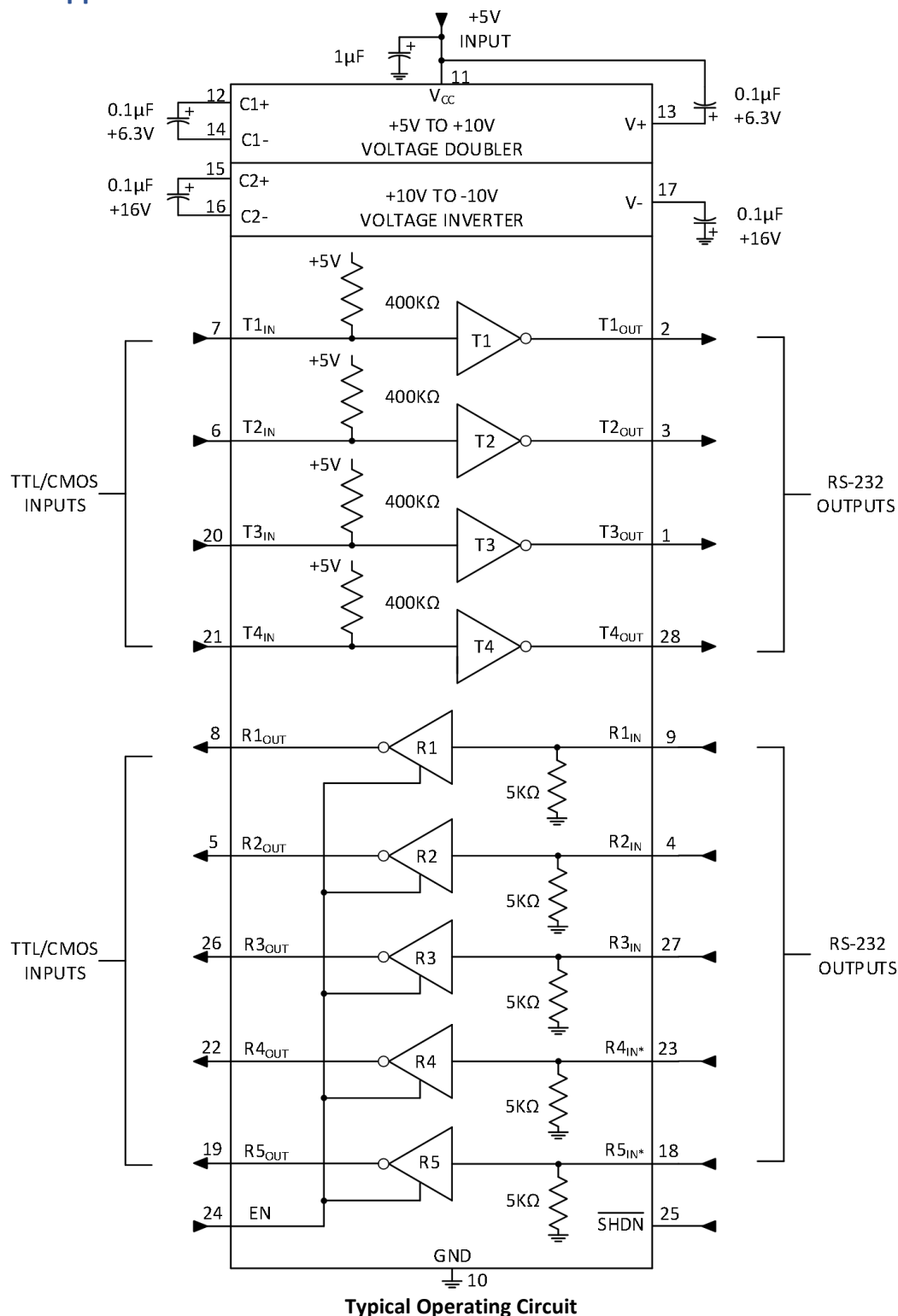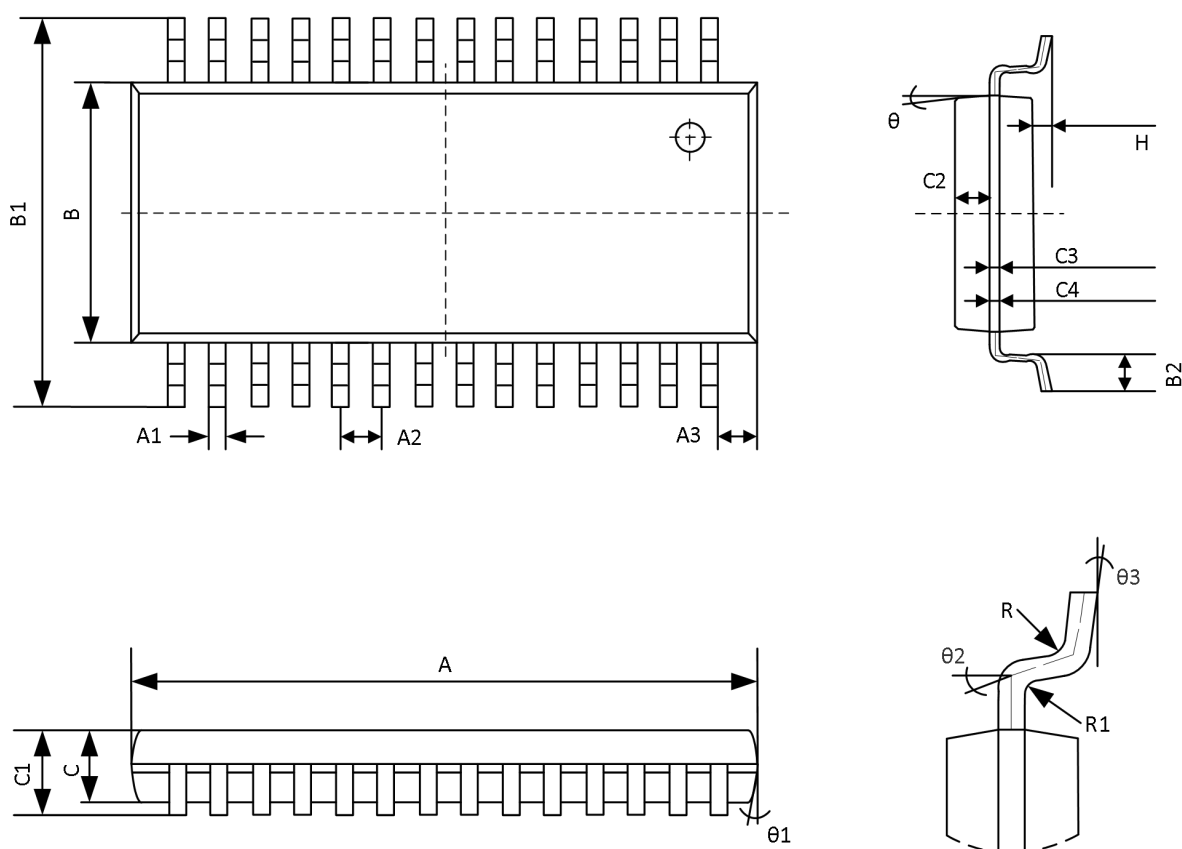
8.4 Power-Supply Decoupling

In applications that are sensitive to power-supply noise, decouple Vcc to ground with a capacitor (1μF at least)

8.5 V+ and V- as Power Supplies

A small amount of power can be drawn from V+ and V-, although this reduces noise margins.

8.6 Typical Application

Typical Operating Circuit

PACKAGE DIMENSION
SSOP28

DIMENSION SYMBOLS	MIN (mm)	MAX (mm)	DIMENSION SYMBOLS	MIN (mm)	MAX (mm)
A	10.15	10.25	C3	0.152	
A1	0.30TYP		C4	0.172	
A2	0.65 TYP		H	0.05	0.15
A3	0.725TYP		θ	12° TYP4	
B	5.25	5.35	θ1	12° TYP4	
B1	7.65	7.95	θ2	10° TYP4	
B2	0.60	0.80	θ3	0° ~ 8°	
C	1.65	1.85	R	0.20 TYP	
C1	1.75	1.95	R1	0.15 TYP	
C2	0.799				

+5V,RS-232 Transceivers
with 0.1μF External Capacitors

Order Information

Order number	Package	Marking information	Operation Temperature Range	MSL Grade	Ship, Quantity	Green
GM213EBA	SSOP28	GM213EBA	-40 to 85°C	3	T&R,2000	Rohs