Data Sheet May 2000 File Number 4315.4

+/-15kV, ESD-Protected, +5V Powered, RS-232 Transmitters/Receivers

The HIN202E-HIN241E family of RS-232 transmitters/receivers interface circuits meet all EIA high-speed RS-232E and V.28 specifications, and are particularly suited for those applications where ±12V is not available. A redesigned transmitter circuit improves data rate and slew rate, which makes this suitable for ISDN and high speed modems. The transmitter outputs and receiver inputs are protected to ±15kV ESD (Electrostatic Discharge). They require a single +5V power supply and feature onboard charge pump voltage converters which generate +10V and -10V supplies from the 5V supply. The HIN205E and HIN235E require no external capacitors and are ideally suited for applications where circuit board space is critical. The family of devices offers a wide variety of high-speed RS-232 transmitter/receiver combinations to accommodate various applications (see Selection Table).

The HIN205E, HIN206E, HIN211E, HIN213E, HIN235E, HIN236E, and HIN241E feature a low power shutdown mode to conserve energy in battery powered applications. In addition, the HIN213E provides two active receivers in shutdown mode allowing for easy “wakeup” capability.

The drivers feature true TTL/CMOS input compatibility, slew rate-limited output, and 300Ω power-off source impedance. The receivers can handle up to ±30V input, and have a 3kΩ to 7kΩ input impedance. The receivers also feature hysteresis to greatly improve noise rejection.

Applications

- Any System Requiring High-Speed RS-232 Communications Port
  - Computer - Portable, Mainframe, Laptop
  - Peripheral - Printers and Terminals
  - Instrumentation, UPS
  - Modems, ISDN Terminal Adaptors

Features

- High Speed ISDN Compatible 230kbits/s
- ESD Protection for RS-232 I/O Pins to ±15kV (IEC1000)
- Meets All RS-232E and V.28 Specifications
- Requires Only 0.1μF or Greater External Capacitors HIN205E and HIN235E Require No External Capacitors)
- Two Receivers Active in Shutdown Mode (HIN213E)
- Requires Only Single +5V Power Supply
- Onboard Voltage Doubler/Inverter
- Low Power Consumption (Typ). 5mA
- Low Power Shutdown Function (Typ) 1μA
- Three-State TTL/CMOS Receiver Outputs
- Multiple Drivers
  - ±10V Output Swing for +5V Input
  - 300Ω Power-Off Source Impedance
  - Output Current Limiting
  - TTL/CMOS Compatible
- Multiple Receivers
  - ±30V Input Voltage Range
  - 3kΩ to 7kΩ Input Impedance
  - 0.5V Hysteresis to Improve Noise Rejection

Selection Table

PART NUMBER	POWER SUPPLY VOLTAGE	NUMBER OF RS-232 DRIVERS	NUMBER OF RS-232 RECEIVERS	NUMBER OF 0.1μF EXTERNAL CAPACITORS	LOW POWER SHUTDOWN/TTL THREE-STATE	NUMBER OF RECEIVERS ACTIVE IN SHUTDOWN
HIN202E	+5V	2	2	4 Capacitors	No/No	0
HIN205E	+5V	5	5	None	Yes/Yes	0
HIN206E	+5V	4	3	4 Capacitors	Yes/Yes	0
HIN207E	+5V	5	3	4 Capacitors	No/No	0
HIN208E	+5V	4	4	4 Capacitors	No/No	0
HIN211E	+5V	4	5	4 Capacitors	Yes/Yes	0
HIN213E	+5V	4	5	4 Capacitors	Yes/Yes	2
HIN232E	+5V	2	2	4 Capacitors	No/No	0
HIN235E	+5V	5	5	None	Yes/Yes	0
HIN236E	+5V	4	3	4 Capacitors	Yes/Yes	0
HIN237E	+5V	5	3	4 Capacitors	No/No	0
HIN238E	+5V	4	4	4 Capacitors	No/No	0
HIN241E	+5V	4	5	4 Capacitors	Yes/Yes	0

CAUTION: These devices are sensitive to electrostatic discharge; follow proper IC Handling Procedures.
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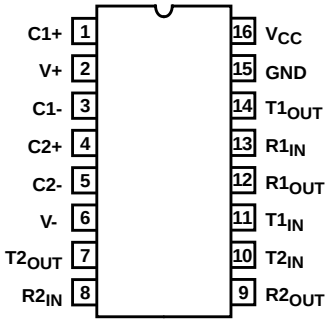
Ordering Information

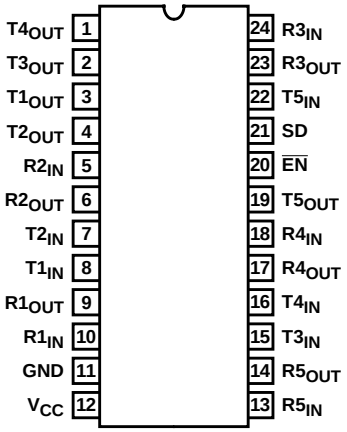
PART NO.	TEMP. RANGE (^{O}C)	PACKAGE	PKG. NO.
HIN202ECA	0 to 70	16 Ld SSOP	M16.209
HIN202ECB	0 to 70	16 Ld SOIC	M16.3
HIN202ECBN	0 to 70	16 Ld SOIC (N)	M16.15
HIN202ECP	0 to 70	16 Ld PDIP	E16.3
HIN202EIB	-40 to 85	16 Ld SOIC	M16.3
HIN202EIB-T	-40 to 85	Tape and Reel	
HIN202EIBN	-40 to 85	16 Ld SOIC (N)	M16.15
HIN202EIP	-40 to 85	16 Ld PDIP	E16.3
HIN205ECP	0 to 70	24 Ld PDIP	E24.6
HIN206ECA	0 to 70	24 Ld SSOP	M24.209
HIN206ECB	0 to 70	24 Ld SOIC (W)	M24.3
HIN206ECB-T	0 to 70	Tape and Reel	
HIN206ECP	0 to 70	24 Ld PDIP	E24.3
HIN206EIA	-40 to 85	24 Ld SSOP	M24.209
HIN206EIB	-40 to 85	24 Ld SOIC (W)	M24.3
HIN206EIP	-40 to 85	24 Ld PDIP	E24.3
HIN207ECA	0 to 70	24 Ld SSOP	M24.209
HIN207ECA-T	0 to 70	Tape and Reel	
HIN207ECB	0 to 70	24 Ld SOIC	M24.3
HIN207ECB-T	0 to 70	Tape and Reel	
HIN207ECP	0 to 70	24 Ld PDIP	E24.3
HIN207EIA	-40 to 85	24 Ld SSOP	M24.209
HIN207EIB	-40 to 85	24 Ld SOIC (W)	M24.3
HIN207EIP	-40 to 85	24 Ld PDIP	E24.3
HIN208ECA	0 to 70	24 Ld SSOP	M24.209
HIN208ECA-T	0 to 70	Tape and Reel	
HIN208ECB	0 to 70	24 Ld SOIC	M24.3
HIN208ECB-T	0 to 70	Tape and Reel	
HIN208ECP	0 to 70	24 Ld PDIP	E24.3
HIN208EIA	-40 to 85	24 Ld SSOP	M24.209
HIN208EIB	-40 to 85	24 Ld SOIC	M24.3
HIN208EIB-T	-40 to 85	Tape and Reel	
HIN208EIP	-40 to 85	24 Ld PDIP	E24.3
HIN211ECA	0 to 70	28 Ld SSOP	M28.209
HIN211ECA-T	0 to 70	Tape and Reel	
HIN211ECB	0 to 70	28 Ld SOIC	M28.3
HIN211EIA	-40 to 85	28 Ld SSOP	M28.209
HIN211EIB	-40 to 85	28 Ld SOIC	M28.3
HIN213ECA	0 to 70	24 Ld SSOP	M28.209
HIN213ECA-T	0 to 70	Tape and Reel	
HIN213ECB	0 to 70	28 Ld SOIC	M28.3
HIN213EIA	-40 to 85	28 Ld SSOP	M28.209
HIN213EIB	-40 to 85	28 Ld SOIC	M28.3
HIN232ECA	0 to 70	16 Ld SSOP	M16.209
HIN232ECB	0 to 70	16 Ld SOIC	M16.3
HIN232ECBN	0 to 70	16 Ld SOIC (N)	M16.15
HIN232ECP	0 to 70	16 Ld PDIP	E16.3
HIN235ECP	0 to 70	24 Ld PDIP	E24.6
HIN236ECA	0 to 70	24 Ld SSOP	M24.209
HIN236ECB	0 to 70	24 Ld SOIC (W)	M24.3
HIN236ECB-T	0 to 70	Tape and Reel	
HIN236ECP	0 to 70	24 Ld PDIP	E24.3
HIN237ECA	0 to 70	24 Ld SSOP	M24.209
HIN237ECA-T	0 to 70	Tape and Reel	
HIN237ECB	0 to 70	24 Ld SOIC	M24.3
HIN237ECB-T	0 to 70	Tape and Reel	
HIN237ECP	0 to 70	24 Ld PDIP	E24.3
HIN238ECA	0 to 70	24 Ld SSOP	M24.209
HIN238ECA-T	0 to 70	Tape and Reel	
HIN238ECB	0 to 70	24 Ld SOIC	M24.3
HIN238ECB-T	0 to 70	Tape and Reel	
HIN238ECP	0 to 70	24 Ld PDIP	E24.3
HIN241ECA	0 to 70	28 Ld SSOP	M28.209
HIN241ECB	0 to 70	28 Ld SOIC	M28.3

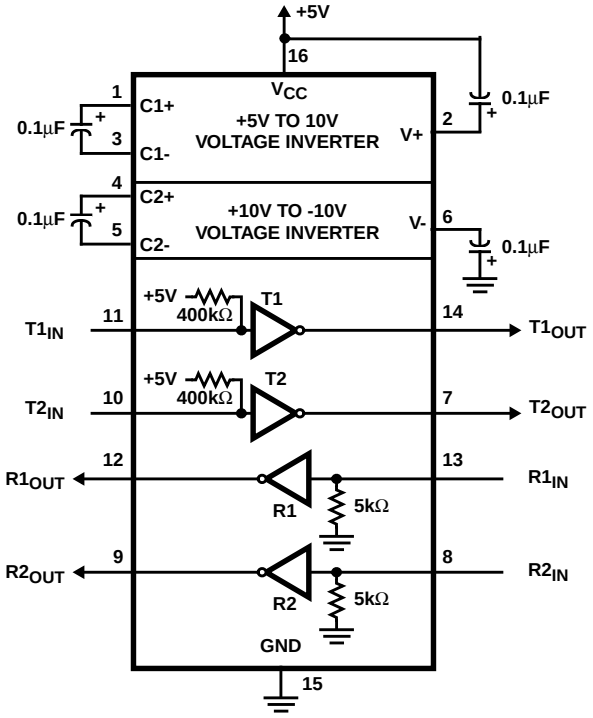
Pinouts

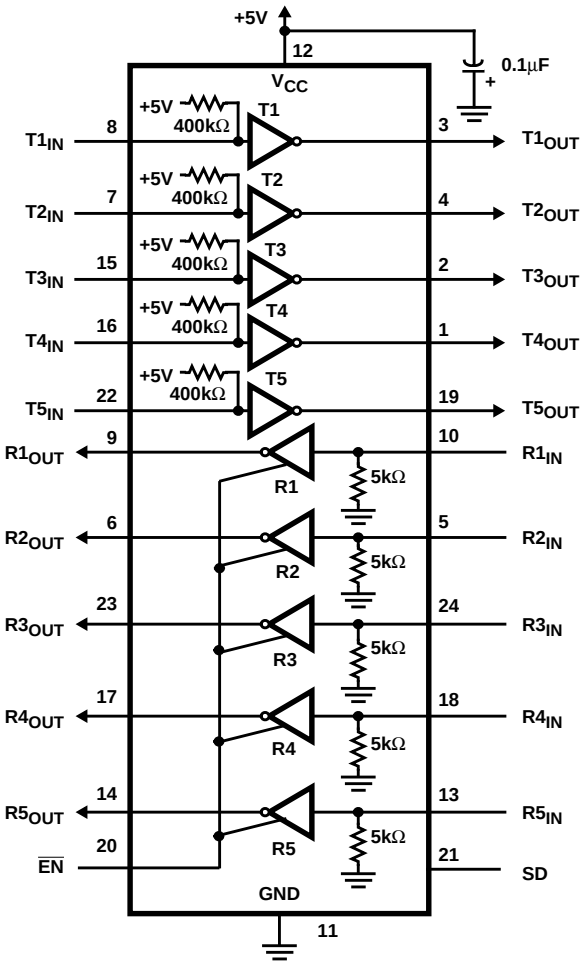
HIN202E (PDIP, SOIC)
TOP VIEW



HIN205E (PDIP)
TOP VIEW

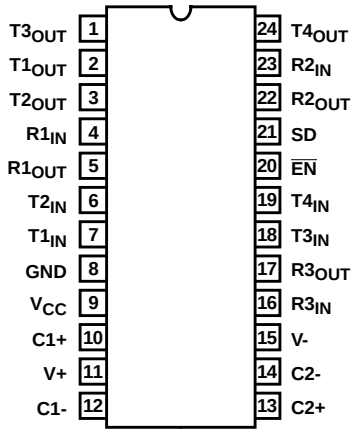




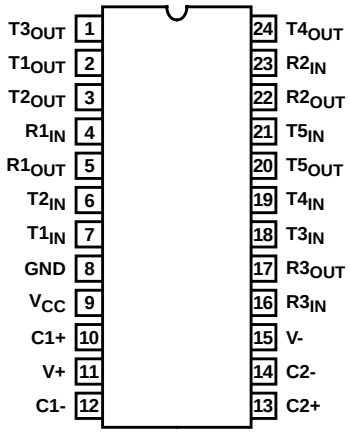


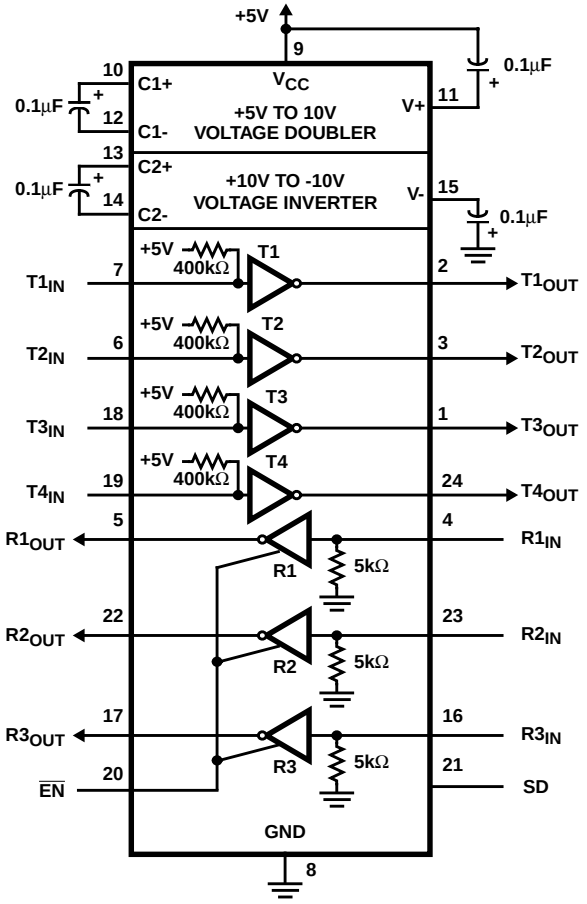
Pinouts (Continued)

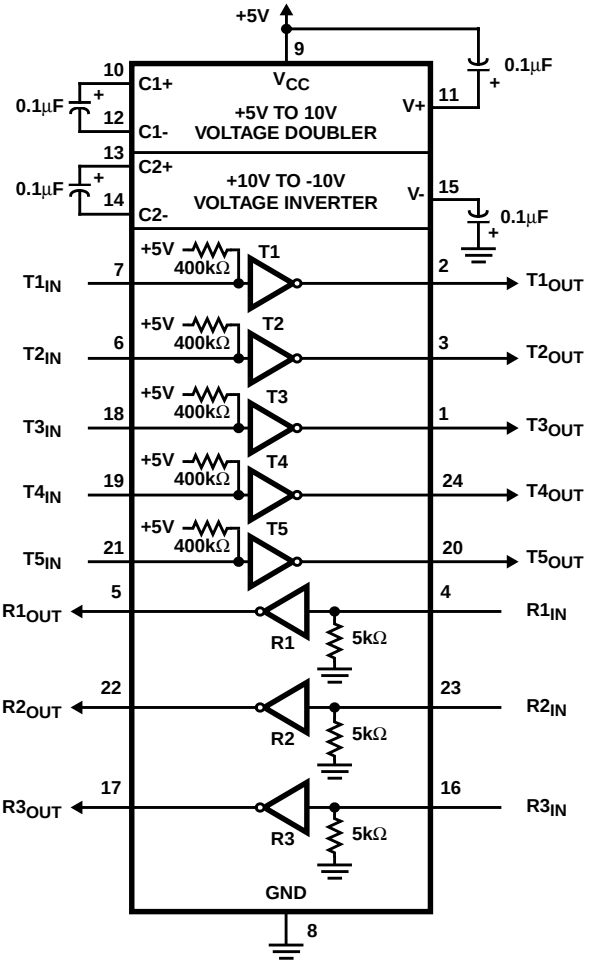
HIN206E (PDIP, SOIC, SSOP)
TOP VIEW



HIN207E (PDIP, SOIC, SSOP)
TOP VIEW

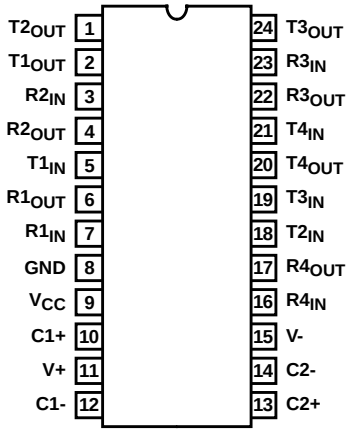




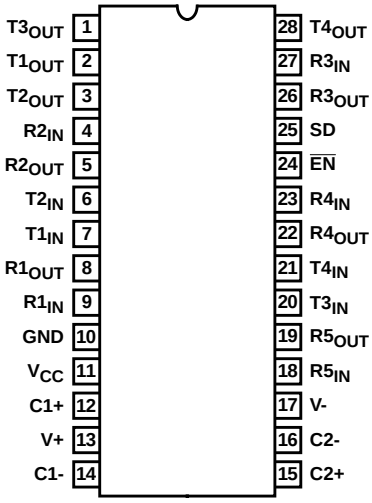


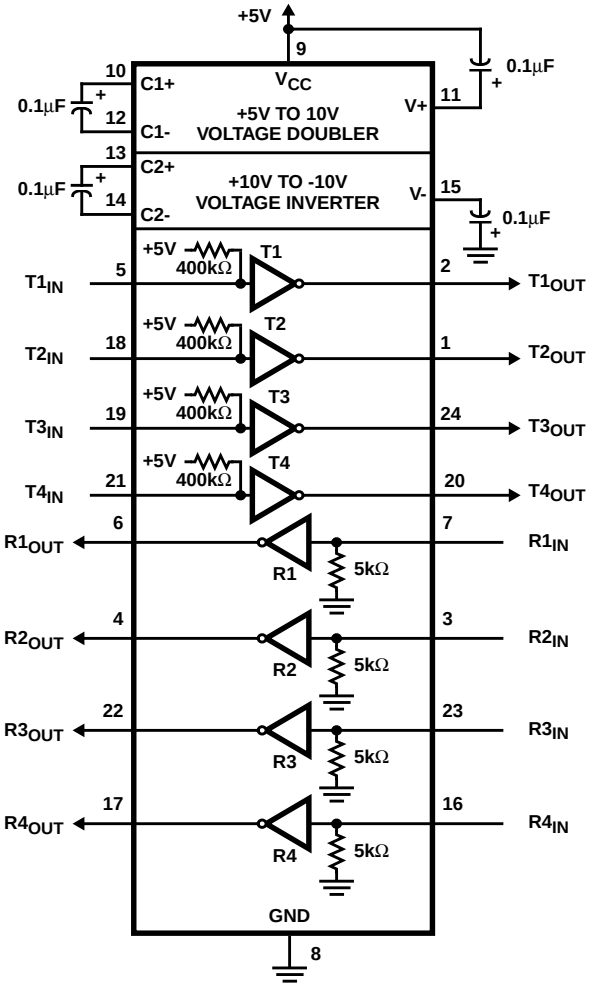
Pinouts (Continued)

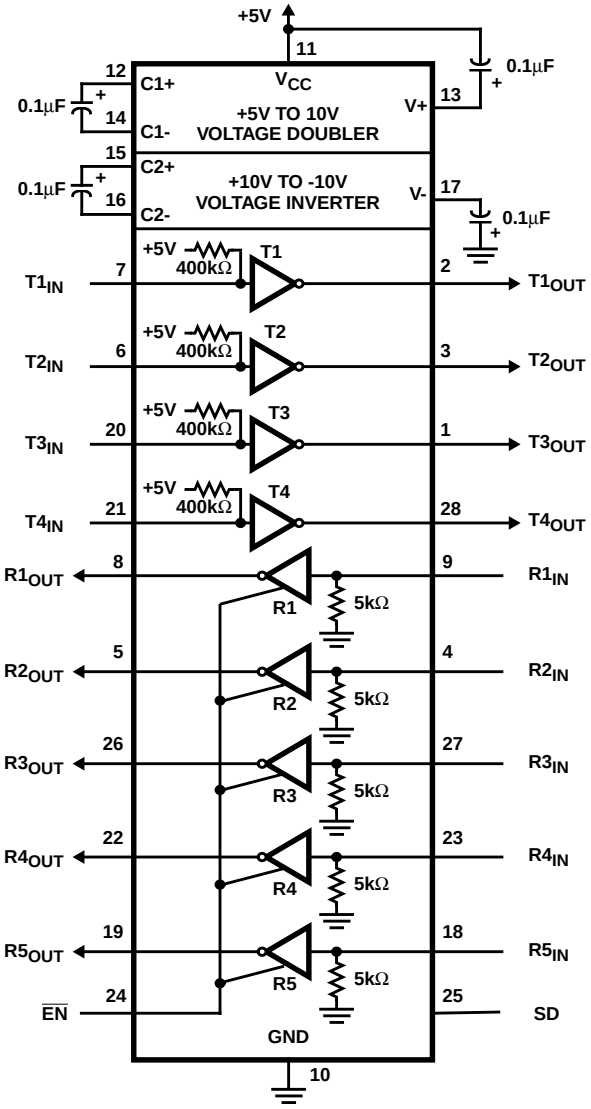
HIN208E (PDIP, SOIC, SSOP)
TOP VIEW



HIN211E (SOIC, SSOP)
TOP VIEW

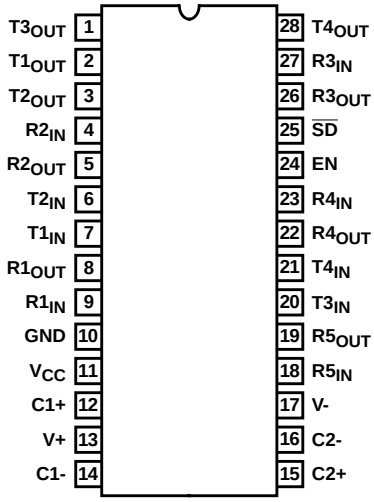




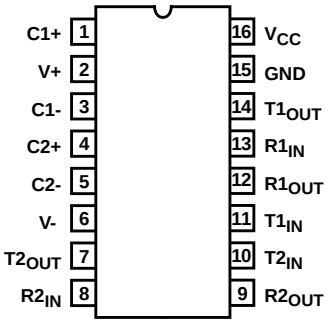


Pinouts (Continued)

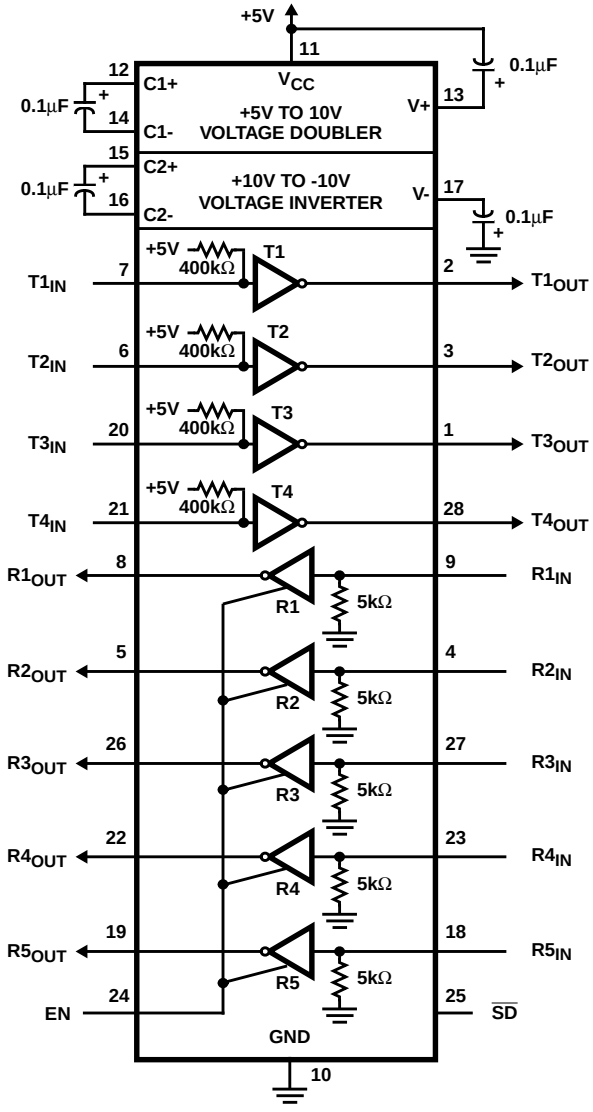
HIN213E (SOIC, SSOP)
TOP VIEW

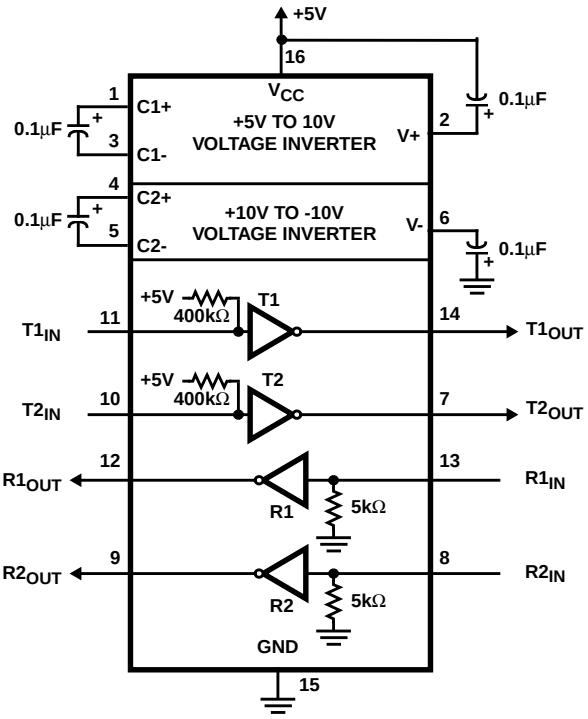


HIN232E (PDIP, SOIC)
TOP VIEW



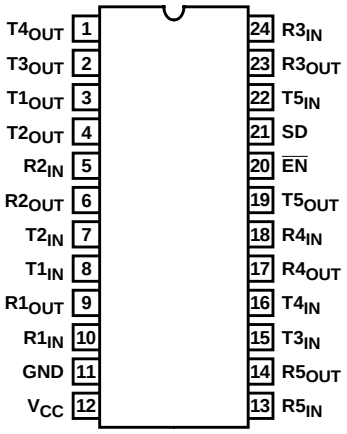
NOTE: R4 and R5 active in shutdown.



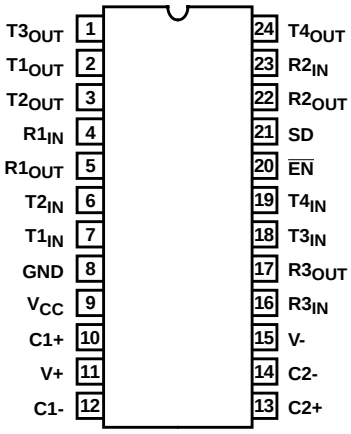


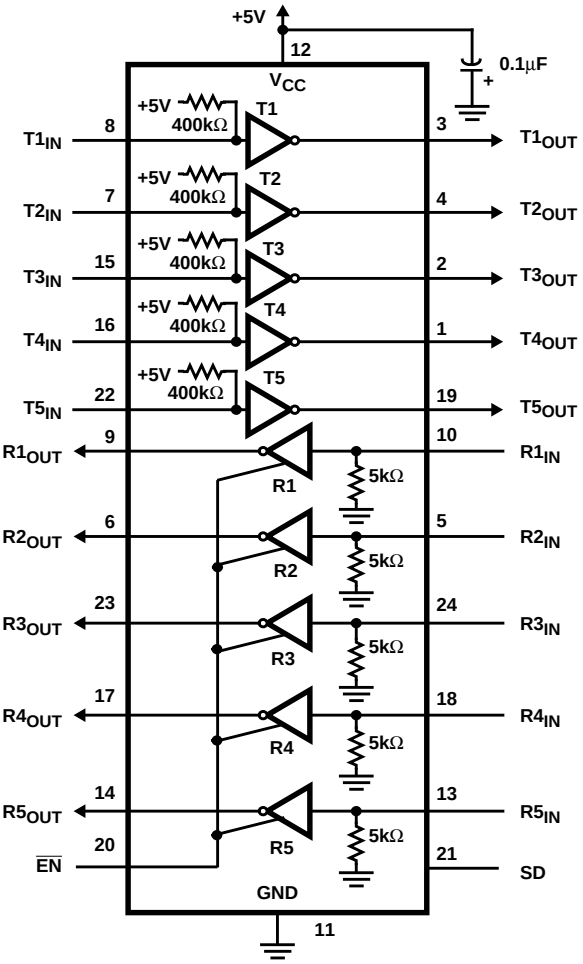
Pinouts (Continued)

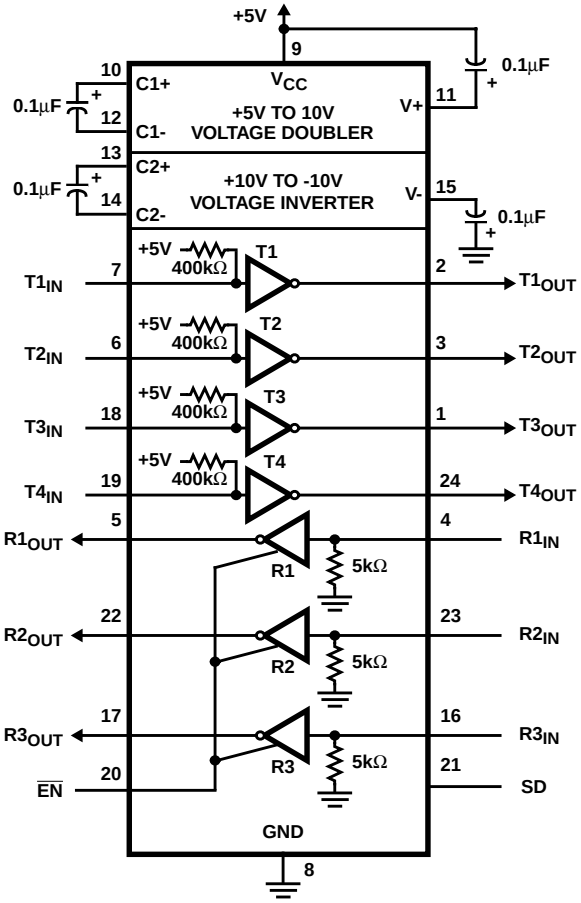
HIN235E (PDIP)
TOP VIEW



HIN236E (PDIP, SOIC, SSOP)
TOP VIEW

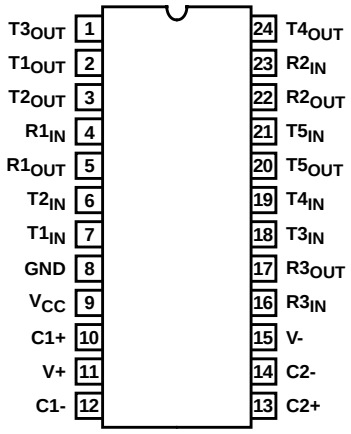




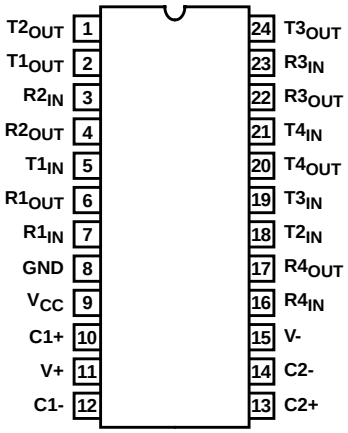


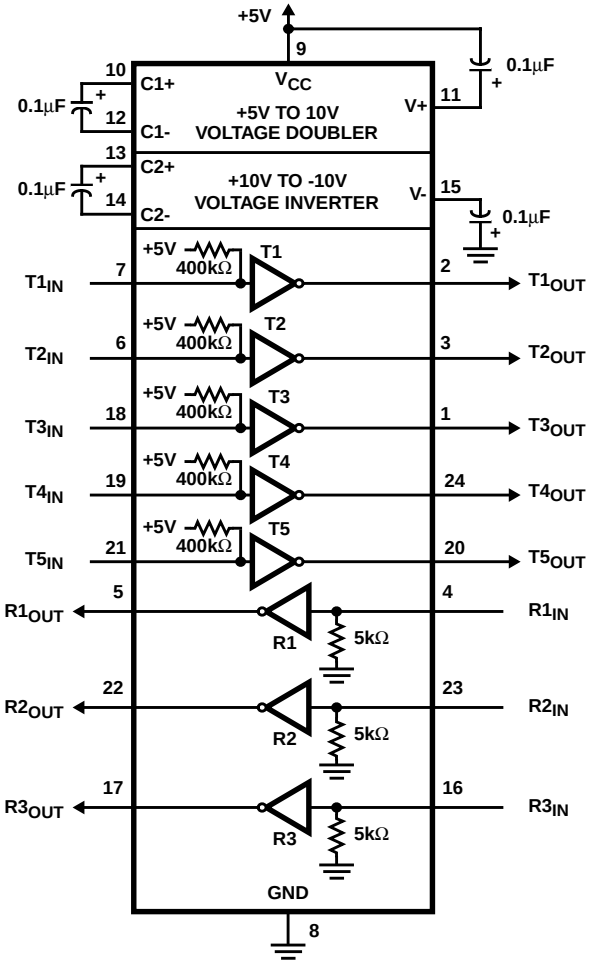
Pinouts (Continued)

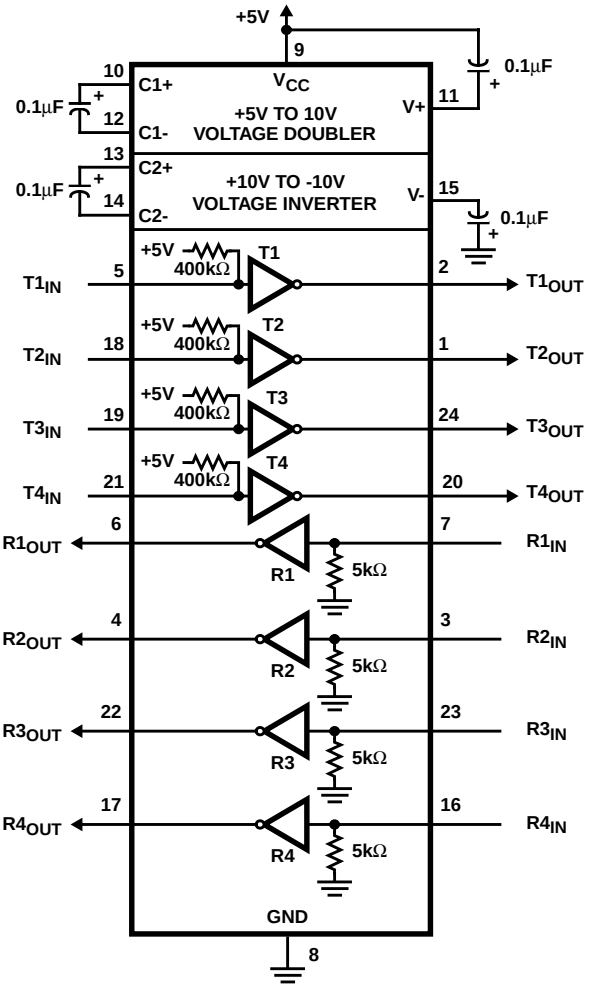
HIN237E (PDIP, SOIC, SSOP)
TOP VIEW



HIN238E (PDIP, SOIC, SSOP)
TOP VIEW

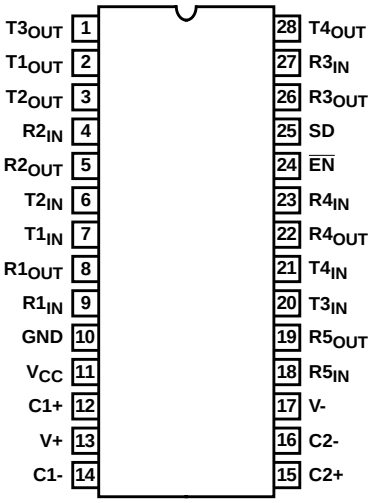


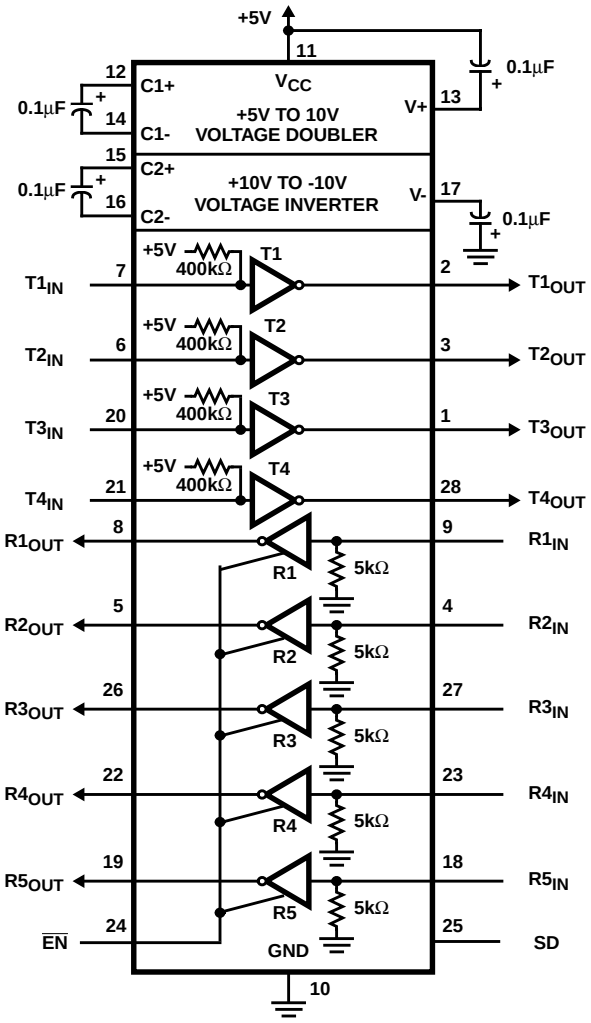




Pinouts (Continued)

HIN241E (SOIC, SSOP)
TOP VIEW





Pin Descriptions

PIN	FUNCTION
V_{CC}	Power Supply Input 5V ±10%, (5V ±5% HIN207E).
V+	Internally generated positive supply (+10V nominal).
V-	Internally generated negative supply (-10V nominal).
GND	Ground Lead. Connect to 0V.
C1+	External capacitor (+ terminal) is connected to this lead.
C1-	External capacitor (- terminal) is connected to this lead.
C2+	External capacitor (+ terminal) is connected to this lead.
C2-	External capacitor (- terminal) is connected to this lead.
T_{IN}	Transmitter Inputs. These leads accept TTL/CMOS levels. An internal 400kΩ pull-up resistor to V_{CC} is connected to each lead.
T_{OUT}	Transmitter Outputs. These are RS-232 levels (nominally ±10V).
R_{IN}	Receiver Inputs. These inputs accept RS-232 input levels. An internal 5kΩ pull-down resistor to GND is connected to each input.
R_{OUT}	Receiver Outputs. These are TTL/CMOS levels.
$\overline{EN}$	Enable Input. This is an active low input which enables the receiver outputs. With $\overline{EN}$ = 5V, the outputs are placed in a high impedance state.
SD, $\overline{SD}$	Shutdown Input. With SD = 5V (HIN213E $\overline{SD}$ = 0V), the charge pump is disabled, the receiver outputs are in a high impedance state (except R4 and R5 of HIN241E) and the transmitters are shut off.
NC	No Connect. No connections are made to these leads.

Absolute Maximum Ratings

V_{CC} to Ground . . . . . (GND -0.3V) < V_{CC} < 6V
V+ to Ground . . . . . (V_{CC} -0.3V) < V+ < 12V
V- to Ground . . . . . -12V < V- < (GND +0.3V)
Input Voltages
  T_{IN} . . . . . (V- -0.3V) < V_{IN} < (V+ +0.3V)
  R_{IN} . . . . . ±30V
Output Voltages
  T_{OUT} . . . . . (V- -0.3V) < V_{TXOUT} < (V+ +0.3V)
  R_{OUT} . . . . . (GND -0.3V) < V_{RXOUT} < (V+ +0.3V)
Short Circuit Duration
  T_{OUT} . . . . . Continuous
  R_{OUT} . . . . . Continuous
ESD Classification . . . . . See Specification Table

Operating Conditions

Temperature Range
  HIN2XXCX . . . . . 0^oC to 70^oC
  HIN2XXIX . . . . . -40^oC to 85^oC

Thermal Information

Thermal Resistance (Typical, Note 1)	θ_{JA} ($^oC/W$)
16 Ld SOIC (N) Package	110
16 Ld SOIC (W) Package	100
16 Ld SSOP Package	155
16 Ld PDIP Package	90
24 Ld SOIC Package	75
24 Ld SSOP Package	135
24 Ld PDIP (N) Package	75
24 Ld PDIP (W) Package	55
28 Ld SOIC Package	70
28 Ld SSOP Package	100

Maximum Junction Temperature (Plastic Package) . . . . . 150^oC
Maximum Storage Temperature Range . . . . . -65^oC to 150^oC
Maximum Lead Temperature (Soldering 10s) . . . . . 300^oC
(SOIC and SSOP - Lead Tips Only)

CAUTION: Stresses above those listed in "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress only rating and operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied.

NOTE:

1. θ_{JA} is measured with the component mounted on an evaluation PC board in free air.

Electrical Specifications

Test Conditions: V_{CC} = +5V ±10%, (V_{CC} = +5V ±5% HIN207E); C1-C4 = 0.1µF; T_A = Operating Temperature Range

PARAMETER	TEST CONDITIONS		MIN	TYP	MAX	UNITS
SUPPLY CURRENTS						
Power Supply Current, I_{CC}	No Load, $T_A = 25^oC$	HIN202E	-	8	15	mA
		HIN205E - HIN208E, HIN211E, HIN213E, HIN235E - HIN241E	-	11	20	mA
		HIN232E	-	5	10	mA
Shutdown Supply Current, I_{CC}(SD)	$T_A = 25^oC$	HIN205E, HIN206E, HIN211E, HIN235E, HIN236E, HIN241E	-	1	10	µA
		HIN213E	-	15	50	µA
LOGIC AND TRANSMITTER INPUTS, RECEIVER OUTPUTS						
Input Logic Low, V_{IL}	T_{IN}, $\overline{EN}$, SD, EN, $\overline{SD}$		-	-	0.8	V
Input Logic High, V_{IH}	T_{IN}		2.0	-	-	V
	$\overline{EN}$, SD, EN, $\overline{SD}$		2.4	-	-	V
Transmitter Input Pullup Current, I_P	T_{IN} = 0V		-	15	200	µA
TTL/CMOS Receiver Output Voltage Low, V_{OL}	I_{OUT} = 1.6mA (HIN202E, HIN232E, I_{OUT} = 3.2mA)		-	0.1	0.4	V
TTL/CMOS Receiver Output Voltage High, V_{OH}	I_{OUT} = -1mA		3.5	4.6	-	V
TTL/CMOS Receiver Output Leakage	$\overline{EN}$ = V_{CC}, EN = 0, 0V < R_{OUT} < V_{CC}		-	0.5	±10	µA
RECEIVER INPUTS						
RS-232 Input Voltage Range, V_{IN}			-30	-	+30	V
Receiver Input Impedance, R_{IN}	$T_A = 25^oC$, V_{IN} = ±3V		3.0	5.0	7.0	kΩ
Receiver Input Low Threshold, V_{IN} (H-L)	V_{CC} = 5V, $T_A = 25^oC$	Active Mode	-	1.2	-	V
		Shutdown Mode HIN213E R4 and R5	-	1.5	-	V
Receiver Input High Threshold, V_{IN} (L-H)	V_{CC} = 5V, $T_A = 25^oC$	Active Mode	-	1.7	2.4	V
		Shutdown Mode HIN213E R4 and R5	-	1.5	2.4	V
Receiver Input Hysteresis, V_{HYST}	V_{CC} = 5V, No Hysteresis in Shutdown Mode		0.2	0.5	1.0	V

Electrical Specifications Test Conditions: V_{CC} = +5V ±10%, (V_{CC} = +5V ±5% HIN207E); C1-C4 = 0.1µF; T_A = Operating Temperature Range **(Continued)**

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNITS
TIMING CHARACTERISTICS					
Output Enable Time, t_{EN}	HIN205E, HIN206E, HIN211E, HIN213E, HIN235E, HIN236E, HIN241E	-	600	-	ns
Output Disable Time, t_{DIS}	HIN205E, HIN206E, HIN211E, HIN213E, HIN235E, HIN236E, HIN241E	-	200	-	ns
Transmitter, Receiver Propagation Delay, t_{PD}	HIN213E $\overline{SD}$ = 0V, R4, R5	-	4.0	40	µs
	HIN213E $\overline{SD}$ = V_{CC}, R1 - R5	-	0.5	10	µs
	All except HIN213E	-	0.5	10	µs
Transition Region Slew Rate, SR_T	R_L = 3kΩ, C_L = 1000pF Measured from +3V to -3V or -3V to +3V, 1 Transmitter Switching (Note 2)	3	20	45	V/µs
TRANSMITTER OUTPUTS					
Output Voltage Swing, T_{OUT}	Transmitter Outputs, 3kΩ to Ground	±5	±9	±10	V
Output Resistance, R_{OUT}	V_{CC} = V+ = V- = 0V, V_{OUT} = ±2V	300	-	-	Ω
RS-232 Output Short Circuit Current, I_{SC}	T_{OUT} Shorted to GND	-	±10	-	mA
ESD PERFORMANCE					
RS-232 Pins (T_{OUT}, R_{IN})	Human Body Model	-	±15	-	kV
	IEC1000-4-2 Contact Discharge	-	±8	-	kV
	IEC1000-4-2 Air Gap (Note 3)	-	±15	-	kV
All Other Pins	Human Body Model	-	±2	-	kV

NOTES:

2. Guaranteed by design.
3. Meets Level 4 with the exception of HIN205E $T5_{OUT}$ = ±12kV.

Test Circuits (HIN232E)

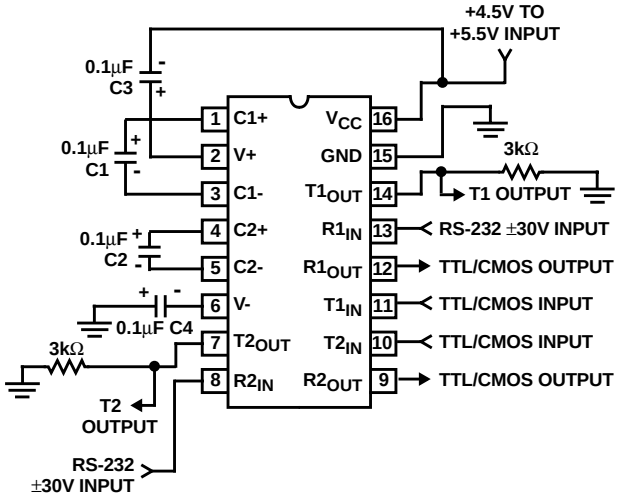


FIGURE 1. GENERAL TEST CIRCUIT

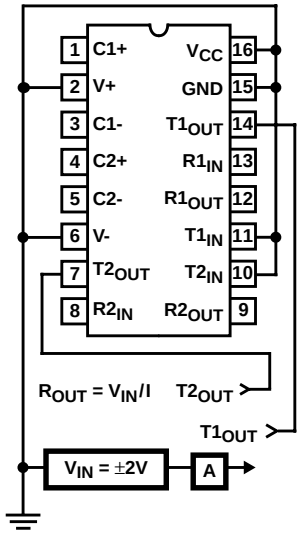


FIGURE 2. POWER-OFF SOURCE RESISTANCE CONFIGURATION

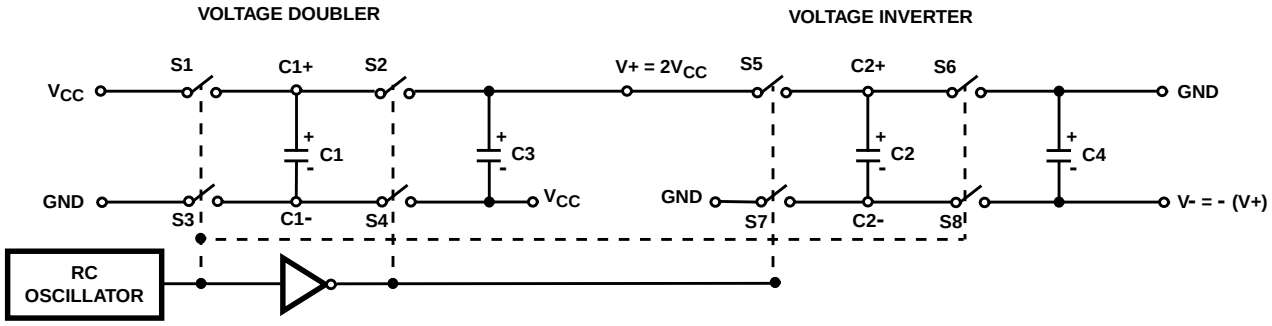


FIGURE 3. CHARGE PUMP

Detailed Description

The HIN2XXE family of high-speed RS-232 transmitters/receivers are powered by a single +5V power supply, feature low power consumption, and meet all EIA RS232C and V.28 specifications. The circuit is divided into three sections: the charge pump, transmitter, and receiver.

Charge Pump

An equivalent circuit of the charge pump is illustrated in Figure 3. The charge pump contains two sections: the voltage doubler and the voltage inverter. Each section is driven by a two phase, internally generated clock to generate +10V and -10V. The nominal clock frequency is 125kHz. During phase one of the clock, capacitor C1 is charged to V_{CC}. During phase two, the voltage on C1 is added to V_{CC}, producing a signal across C3 equal to twice V_{CC}. During phase two, C2 is also charged to $2V_{CC}$, and then during phase one, it is inverted with respect to ground to produce a signal across C4 equal to $-2V_{CC}$. The charge pump accepts input voltages up to 5.5V. The output impedance of the voltage doubler section (V+) is approximately 200Ω, and the output impedance of the voltage inverter section (V-) is approximately 450Ω. A typical application uses 0.1µF capacitors for C1-C4, however, the value is not critical. Increasing the values of C1 and C2 will lower the output impedance of the voltage doubler and inverter, increasing the values of the reservoir capacitors, C3 and C4, lowers the ripple on the V+ and V- supplies.

During shutdown mode (HIN205E, HIN206E, HIN211E, HIN213E, HIN235E, HIN236E and HIN241E) the charge pump is turned off, V+ is pulled down to V_{CC}, V- is pulled up to GND, and the supply current is reduced to less than 10µA. The transmitter outputs are disabled and the receiver outputs (except for HIN213E, R4 and R5) are placed in the high impedance state.

Transmitters

The transmitters are TTL/CMOS compatible inverters which translate the inputs to RS-232 outputs. The input logic threshold is about 26% of V_{CC}, or 1.3V for V_{CC} = 5V. A logic

1 at the input results in a voltage of between -5V and V- at the output, and a logic 0 results in a voltage between +5V and (V+ -0.6V). Each transmitter input has an internal 400kΩ pullup resistor so any unused input can be left unconnected and its output remains in its low state. The output voltage swing meets the RS-232C specifications of ±5V minimum with the worst case conditions of: all transmitters driving 3kΩ minimum load impedance, V_{CC} = 4.5V, and maximum allowable operating temperature. The transmitters have an internally limited output slew rate which is less than 30V/µs. The outputs are short circuit protected and can be shorted to ground indefinitely. The powered down output impedance is a minimum of 300Ω with ±2V applied to the outputs and V_{CC} = 0V.

Receivers

The receiver inputs accept up to ±30V while presenting the required 3kΩ to 7kΩ input impedance even if the power is off (V_{CC} = 0V). The receivers have a typical input threshold of 1.3V which is within the ±3V limits, known as the transition region, of the RS-232 specifications. The receiver output is 0V to V_{CC}. The output will be low whenever the input is greater than 2.4V and high whenever the input is floating or driven between +0.8V and -30V. The receivers feature 0.5V hysteresis (except during shutdown) to improve noise rejection. The receiver Enable line $\overline{EN}$, (EN on HIN213E) when unasserted, disables the receiver outputs, placing them in the high impedance mode. The receiver outputs are also placed in the high impedance state when in shutdown mode (except HIN213E R4 and R5).

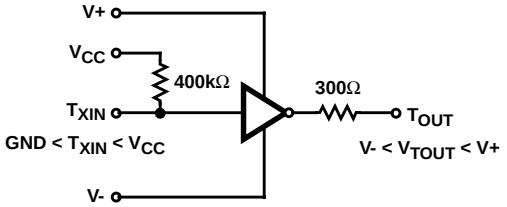


FIGURE 4. TRANSMITTER

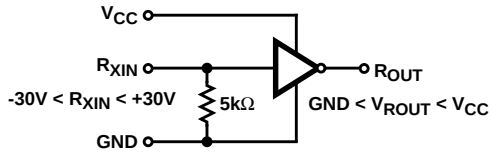
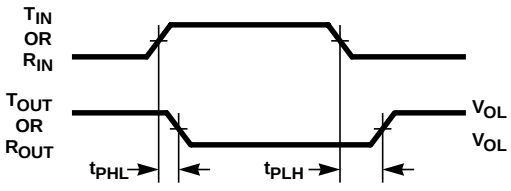


FIGURE 5. RECEIVER



$$\text{AVERAGE PROPAGATION DELAY} = \frac{t_{PHL} + t_{PLH}}{2}$$

FIGURE 6. PROPAGATION DELAY DEFINITION

HIN213E Operation in Shutdown

The HIN213E features two receivers, R4 and R5, which remain active in shutdown mode. During normal operation the receivers propagation delay is typically 0.5µs. This propagation delay may increase slightly during shutdown. When entering shut down mode, receivers R4 and R5 are not valid for 80µs after $\overline{SD} = V_{IL}$. When exiting shutdown mode, all receiver outputs will be invalid until the charge pump circuitry reaches normal operating voltage. This is typically less than 2ms when using 0.1µF capacitors.

Application Information

The HIN2XXE may be used for all RS-232 data terminal and communication links. It is particularly useful in applications where ±12V power supplies are not available for conventional RS-232 interface circuits. The applications presented represent typical interface configurations.

A simple duplex RS-232 port with CTS/RTS handshaking is illustrated in Figure 7. Fixed output signals such as DTR (data terminal ready) and DSRS (data signaling rate select) is generated by driving them through a 5kΩ resistor connected to V+.

In applications requiring four RS-232 inputs and outputs (Figure 8), note that each circuit requires two charge pump capacitors (C1 and C2) but can share common reservoir capacitors (C3 and C4). The benefit of sharing common reservoir capacitors is the elimination of two capacitors and the reduction of the charge pump source impedance which effectively increases the output swing of the transmitters.

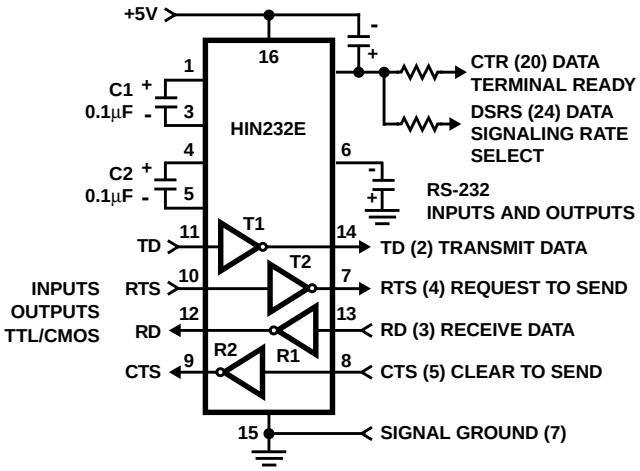


FIGURE 7. SIMPLE DUPLEX RS-232 PORT WITH CTS/RTS HANDSHAKING

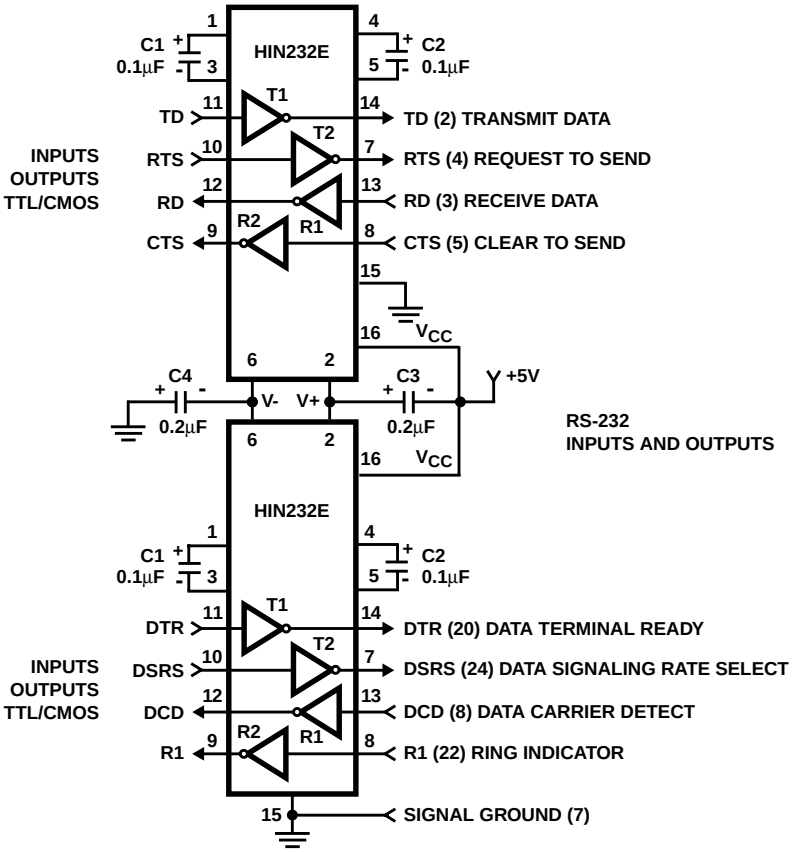


FIGURE 8. COMBINING TWO HIN232Es FOR 4 PAIRS OF RS-232 INPUTS AND OUTPUTS

Typical Performance Curves

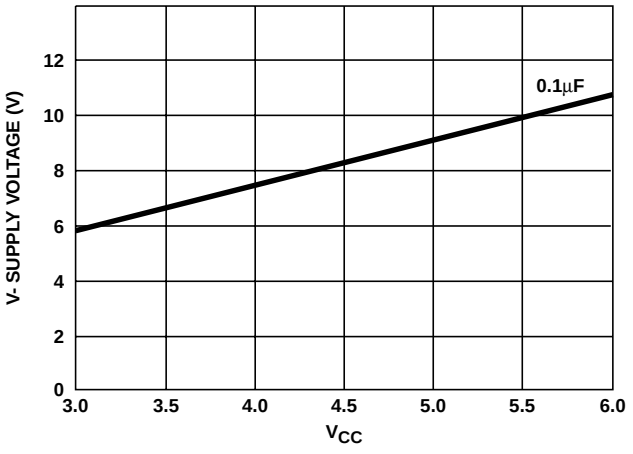


FIGURE 9. V- SUPPLY VOLTAGE vs V_{CC}

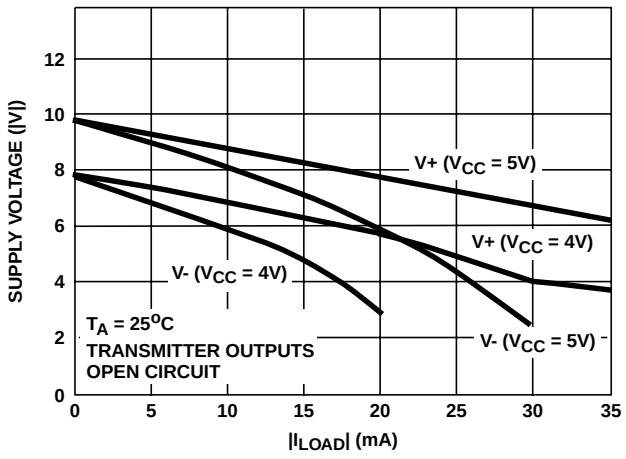


FIGURE 10. V+, V- OUTPUT VOLTAGE vs LOAD

Die Characteristics

DIE DIMENSIONS:

128 mils x 77 mils

METALLIZATION:

Type: Al
Thickness: 10kÅ ±1kÅ

SUBSTRATE POTENTIAL

GND

PASSIVATION:

Type: Nitride over Silox
Nitride Thickness: 8kÅ
Silox Thickness: 7kÅ

TRANSISTOR COUNT:

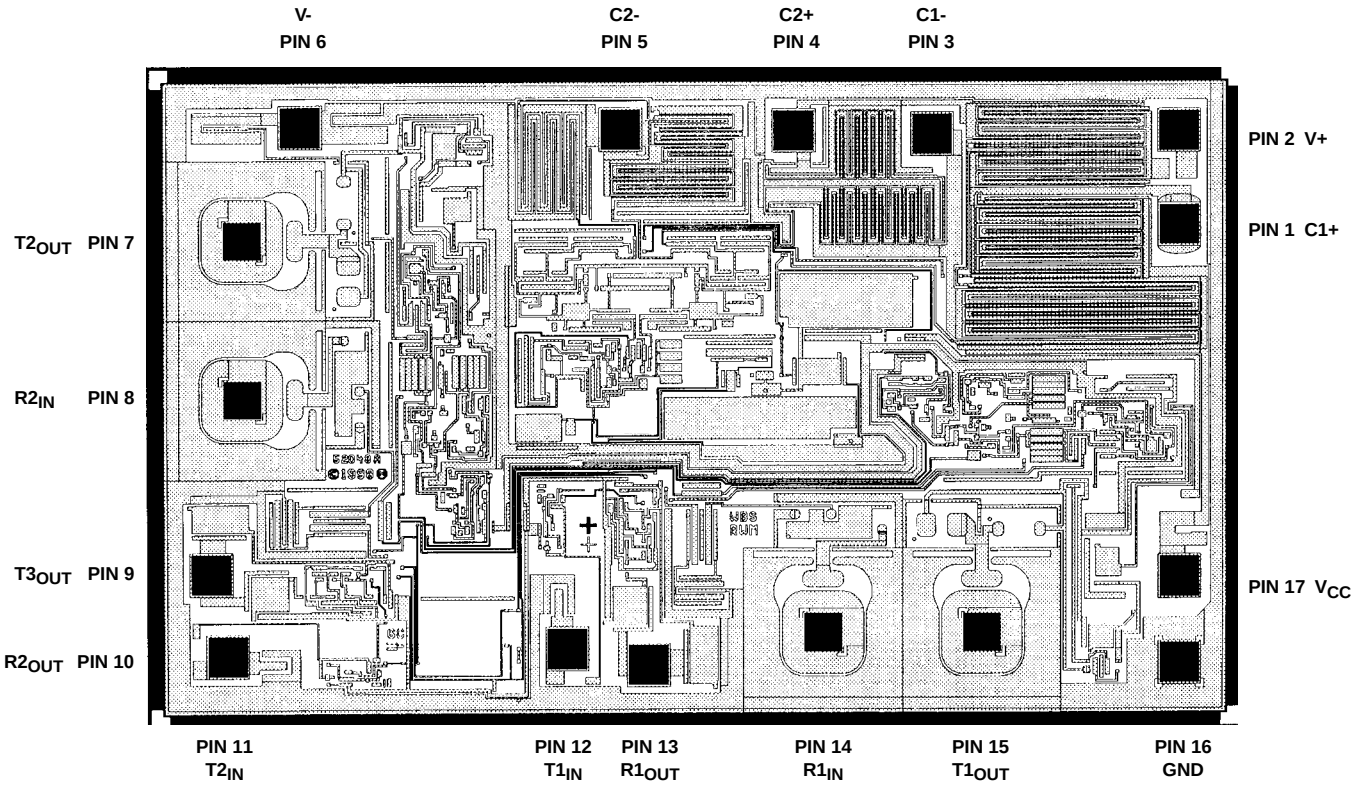
185

PROCESS:

CMOS Metal Gate

Metallization Mask Layout

HIN232E



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