

December 1997

Features

- High Speed ISDN Compatible 230kbits/s
- ESD Protection for RS-232 I/O Pins to $\pm 15kV$ (IEC1000)
- Meets All RS-232E and V.28 Specifications
- HIN203E and HIN205E Require no External Capacitors
- Requires Only 0.1 μF or Greater External Capacitors
- Two Receivers Active in Shutdown Mode (HIN213E)
- Requires Only Single +5V Power Supply
- Onboard Voltage Doubler/Inverter
- Low Power Consumption (202E Typ) 5mA
- Low Power Shutdown Function (Typ) 1 μA
- Three-State TTL/CMOS Receiver Outputs
- Multiple Drivers
 - Output Swing for +5V Input $\pm 10V$
 - Power-Off Source Impedance 300 Ω
 - Output Current Limiting
 - TTL/CMOS Compatible
 - Maximum Slew Rate 30V/ μs
- Multiple Receivers
 - Input Voltage Range $\pm 30V$
 - Input Impedance 3k Ω to 7k Ω
 - Hysteresis to Improve Noise Rejection 0.5V

Description

The HIN202E-HIN213E family of RS-232 transmitters/receivers interface circuits meet all EIA RS-232E and V.28 specifications, and are particularly suited for those applications where $\pm 12V$ is not available. A redesigned transmitter circuit improves data rate and transmitter slew rate, which makes this suitable for ISDN and high speed modems. The transmitter outputs and the receiver inputs are protected to $\pm 15kV$ 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 HIN203E and HIN205E 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 RS-232 transmitter/receiver combinations to accommodate various applications (see Selection Table).

The HIN211E and HIN213E 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 300 Ω power-off source impedance. The receivers can handle up to $\pm 30V$ input, and have a 3k Ω to 7k Ω input impedance. The receivers also feature hysteresis to greatly improve noise rejection.

Applications

- Any System Requiring RS-232 Communications Port
 - Computers - Portables, Mainframes, Laptops
 - Peripherals - Printers and Terminals
 - Portable Instrumentation
 - Modems

Selection Table

PART NUMBER	POWER SUPPLY VOLTAGE	NUMBER OF RS-232 DRIVERS	NUMBER OF RS-232 RECEIVERS	NUMBER OF 0.1 μF EXTERNAL COMPONENTS	LOW POWER SHUTDOWN/TTL THREE-STATE	NUMBER OF RECEIVERS ACTIVE IN SHUTDOWN
HIN202E	+5V	2	2	4 Capacitors	No/No	0
HIN203E	+5V	2	2	None	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

HIN202E thru HIN213E

Ordering Information

PART NO.	TEMP. RANGE (°C)	PACKAGE	PKG. NO.
HIN202ECP	0 to 70	16 Ld PDIP	E16.3
HIN202ECB	0 to 70	16 Ld SOIC	M16.3
HIN202EIP	-40 to 85	16 Ld PDIP	E16.3
HIN202EIB	-40 to 85	16 Ld SOIC	M16.3
HIN202ECBN	0 to 70	16 Ld SOIC	M16.15
HIN202EIBN	-40 to 85	16 Ld SOIC	M16.15
HIN203ECP	0 to 70	20 Ld PDIP	E20.3
HIN203ECB	0 to 70	20 Ld SOIC	M20.3
HIN205ECP	0 to 70	24 Ld PDIP	E24.6
HIN206ECP	0 to 70	24 Ld PDIP	E24.3
HIN206ECB	0 to 70	24 Ld SOIC (W)	M24.3
HIN206ECA	0 to 70	24 Ld SSOP	M24.209
HIN206EIP	-40 to 85	24 Ld PDIP	E24.3
HIN206EIB	-40 to 85	24 Ld SOIC (W)	M24.3
HIN206EIA	-40 to 85	24 Ld SSOP	M24.209
HIN207ECP	0 to 70	24 Ld PDIP	E24.3
HIN207ECB	0 to 70	24 Ld SOIC	M24.3
HIN207ECA	0 to 70	24 Ld SSOP	M24.209

PART NO.	TEMP. RANGE (°C)	PACKAGE	PKG. NO.
HIN207EIP	-40 to 85	24 Ld PDIP	E24.3
HIN207EIB	-40 to 85	24 Ld SOIC	M24.3
HIN207EIA	-40 to 85	24 Ld SSOP	M24.209
HIN208ECP	0 to 70	24 Ld PDIP	E24.3
HIN208ECB	0 to 70	24 Ld SOIC	M24.3
HIN208ECA	0 to 70	24 Ld SSOP	M24.209
HIN208EIP	-40 to 85	24 Ld PDIP	E24.3
HIN208EIB	-40 to 85	24 Ld SOIC	M24.3
HIN208EIA	-40 to 85	24 Ld SSOP	M24.209
HIN211ECB	0 to 70	28 Ld SOIC	M28.3
HIN211ECA	0 to 70	28 Ld SSOP	M28.209
HIN211EIB	-40 to 85	28 Ld SOIC	M28.3
HIN211EIA	-40 to 85	28 Ld SSOP	M28.209
HIN213ECB	0 to 70	28 Ld SOIC	M28.3
HIN213ECA	0 to 70	28 Ld SSOP	M28.209
HIN213EIB	-40 to 85	28 Ld SOIC	M28.3
HIN213EIA	-40 to 85	28 Ld SSOP	M28.209

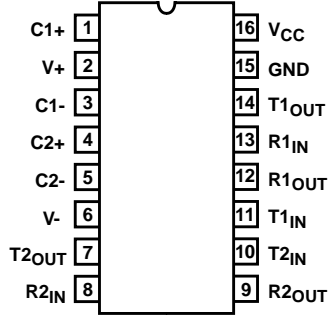
Pin Descriptions

PIN	FUNCTION
V _{CC}	Power Supply Input 5V ±10%.
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.
EN, EN	Enable Input. This is an active low input which enables the receiver outputs. With EN = 5V, (HIN213E EN = 0V), the outputs are placed in a high impedance state.
SD, SD	Shutdown Input. With SD = 5V (HIN213E SD = 0V), the charge pump is disabled, the receiver outputs are in a high impedance state (except R4 and R5 of HIN213E) and the transmitters are shut off.
NC	No Connect. No connections are made to these leads.

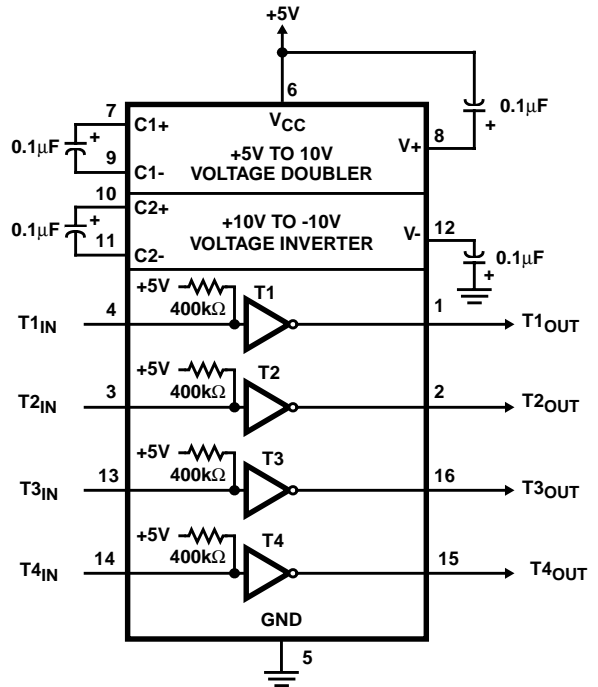
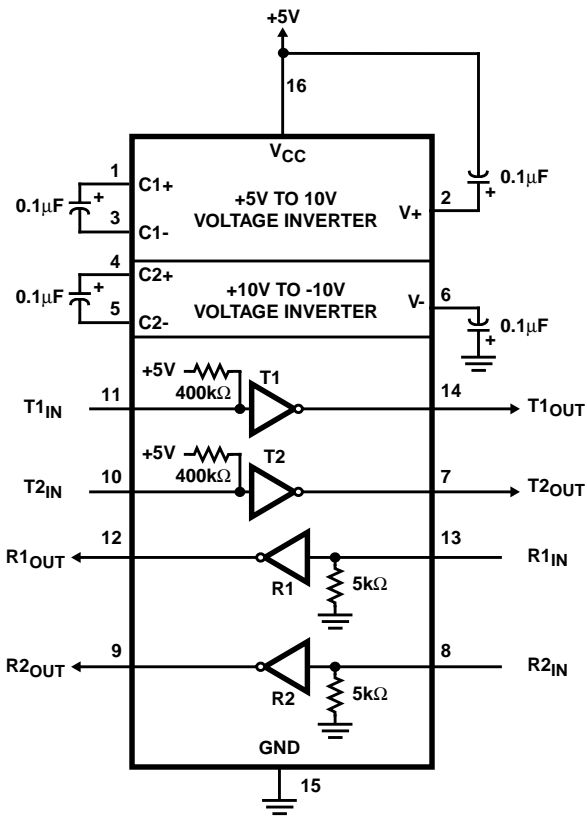
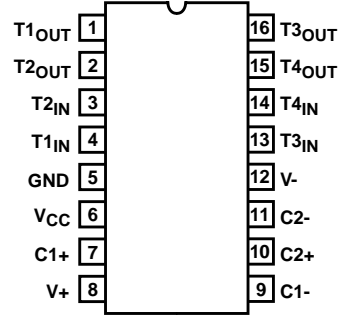
HIN202E thru HIN213E

Pinouts

HIN202E (PDIP, SOIC)
TOP VIEW



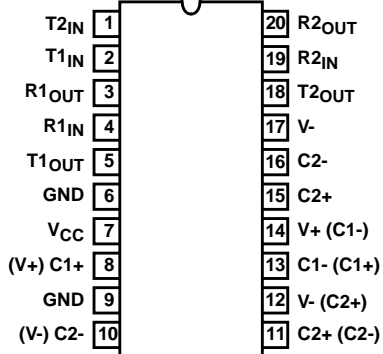
HIN204E (SOIC)
TOP VIEW



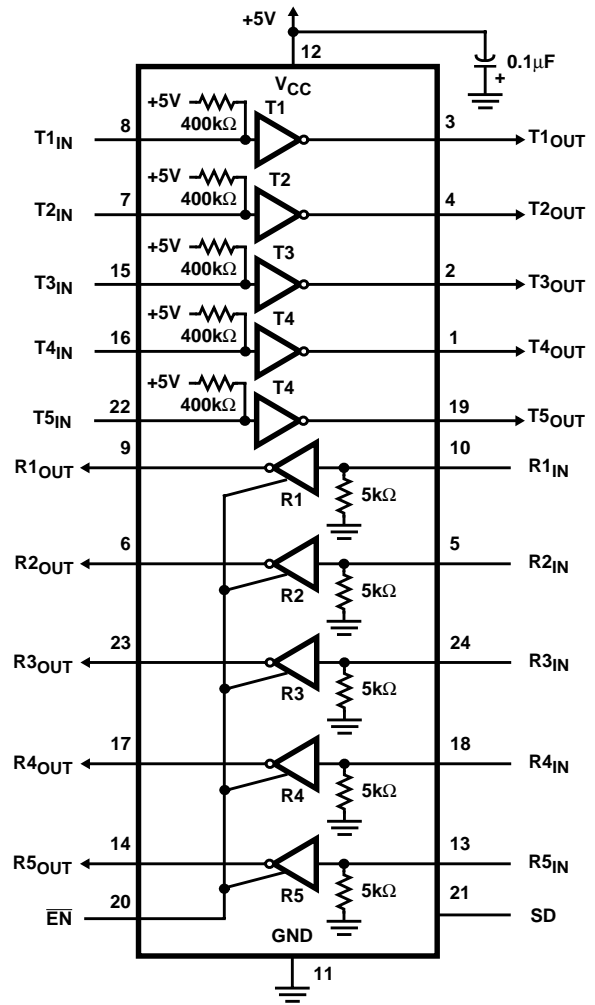
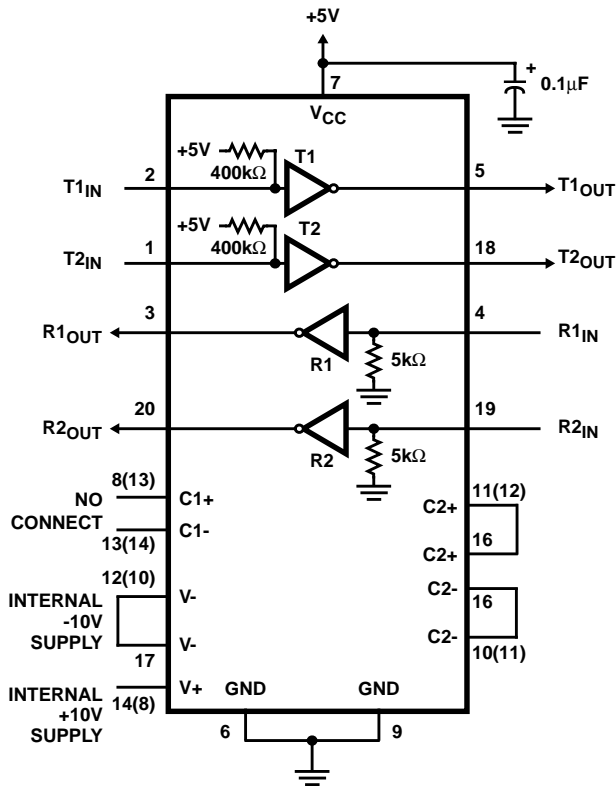
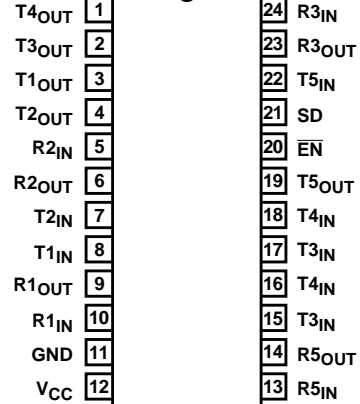
HIN202E thru HIN213E

Pinouts (Continued)

HIN203E (PDIP, SOIC)
TOP VIEW



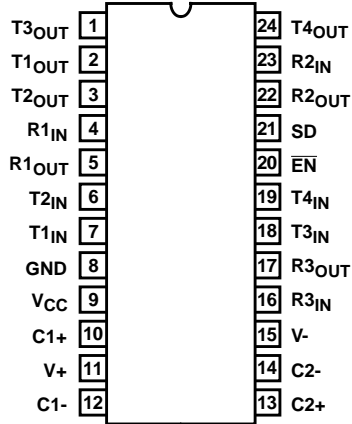
HIN205E (PDIP, SOIC)
TOP VIEW



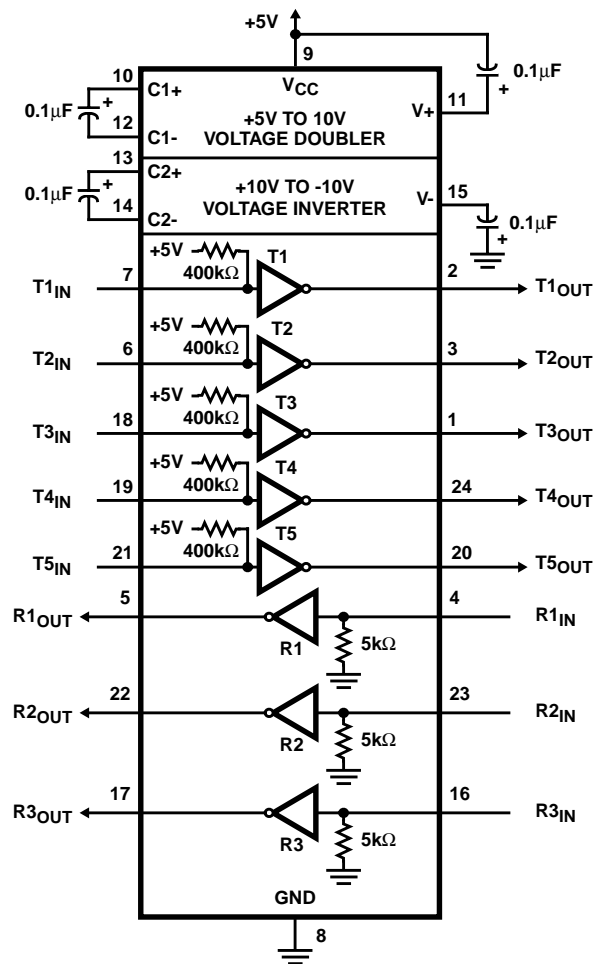
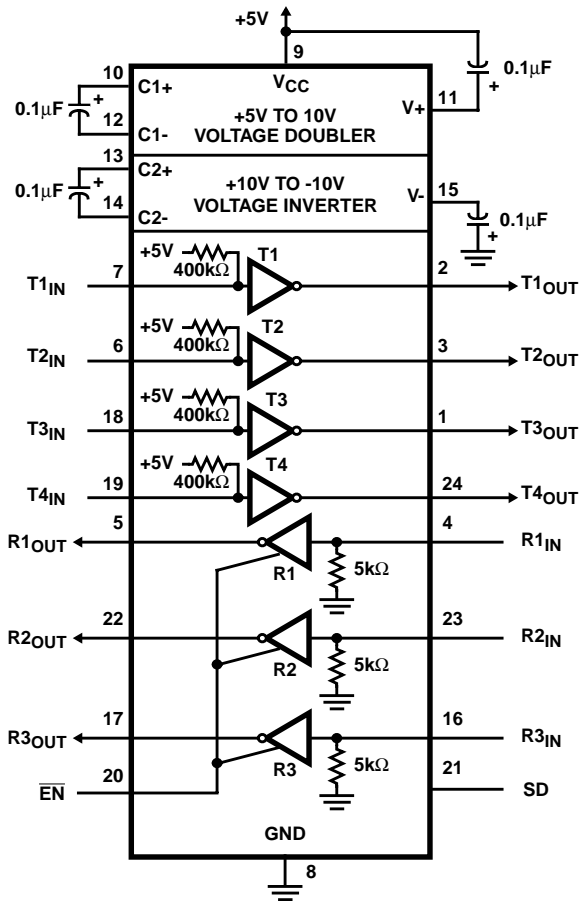
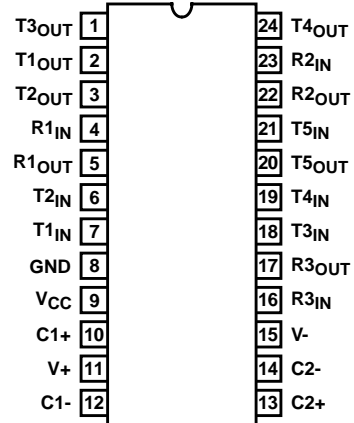
HIN202E thru HIN213E

Pinouts (Continued)

HIN206E (PDIP, SOIC, SSOP)
TOP VIEW



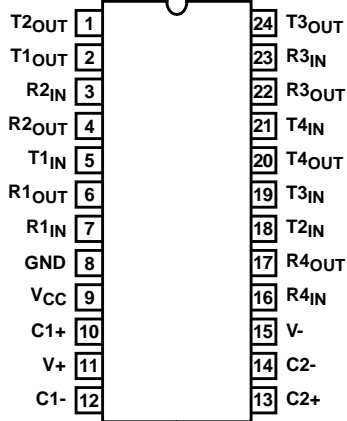
HIN207E (PDIP, SOIC, SSOP)
TOP VIEW



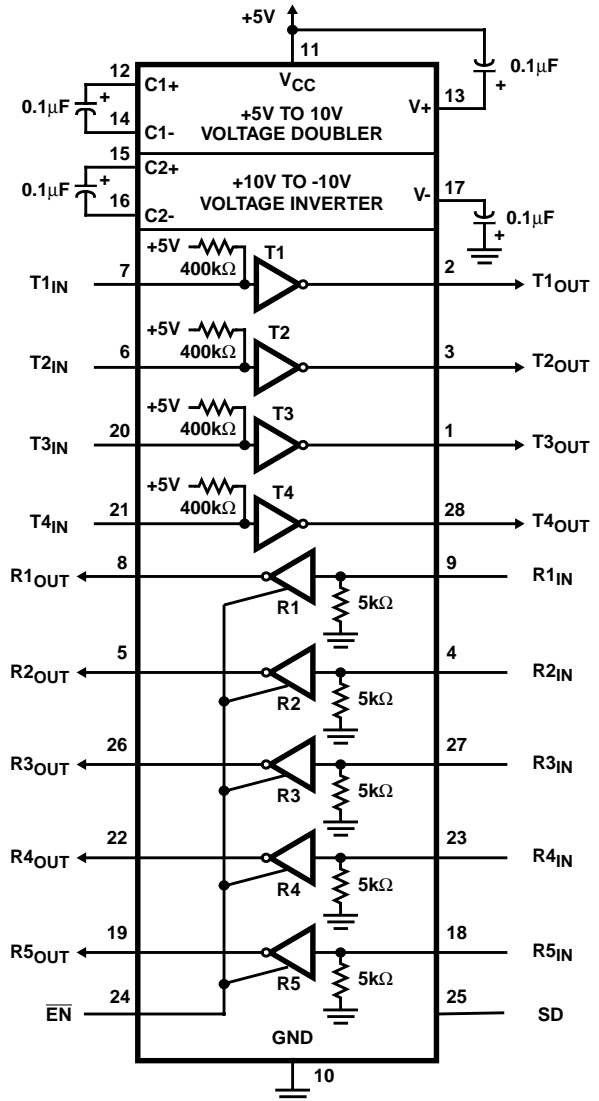
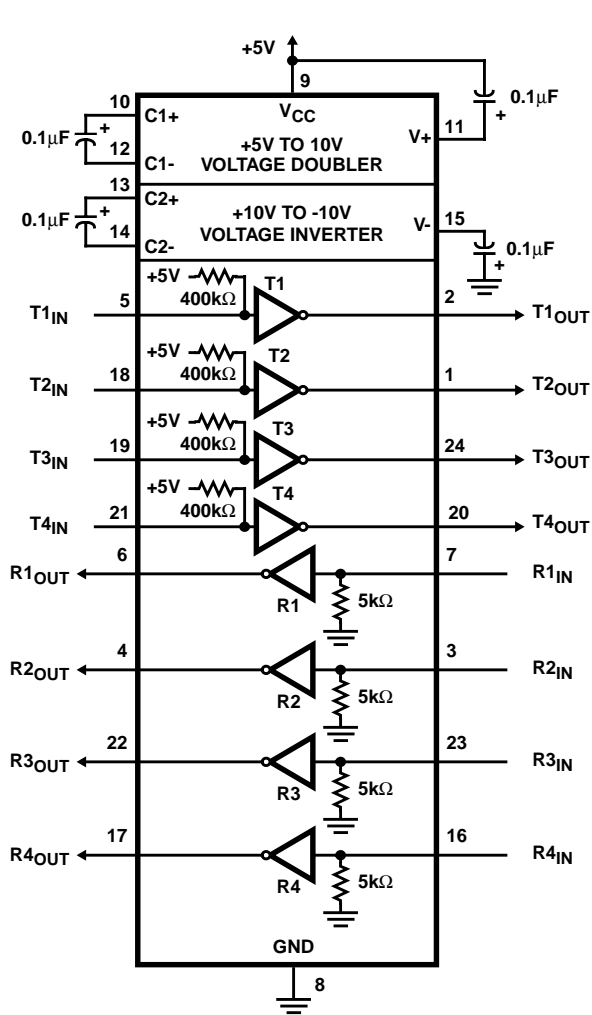
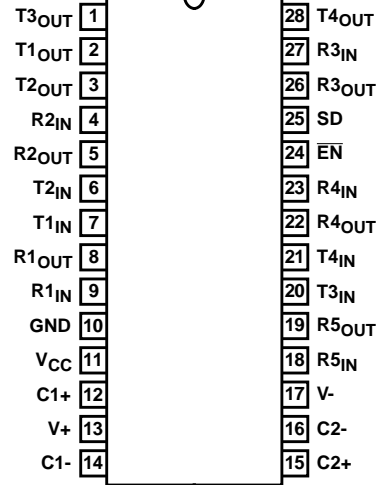
HIN202E thru HIN213E

Pinouts (Continued)

HIN208E (PDIP, SOIC, SSOP)
TOP VIEW



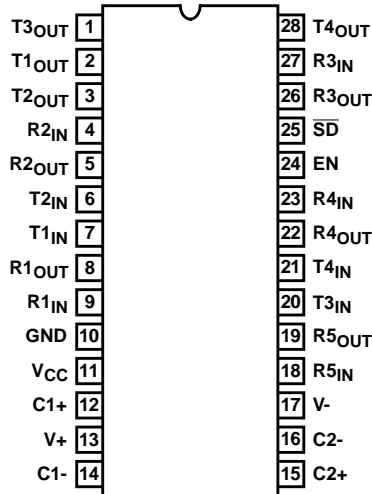
HIN211E (SOIC, SSOP)
TOP VIEW



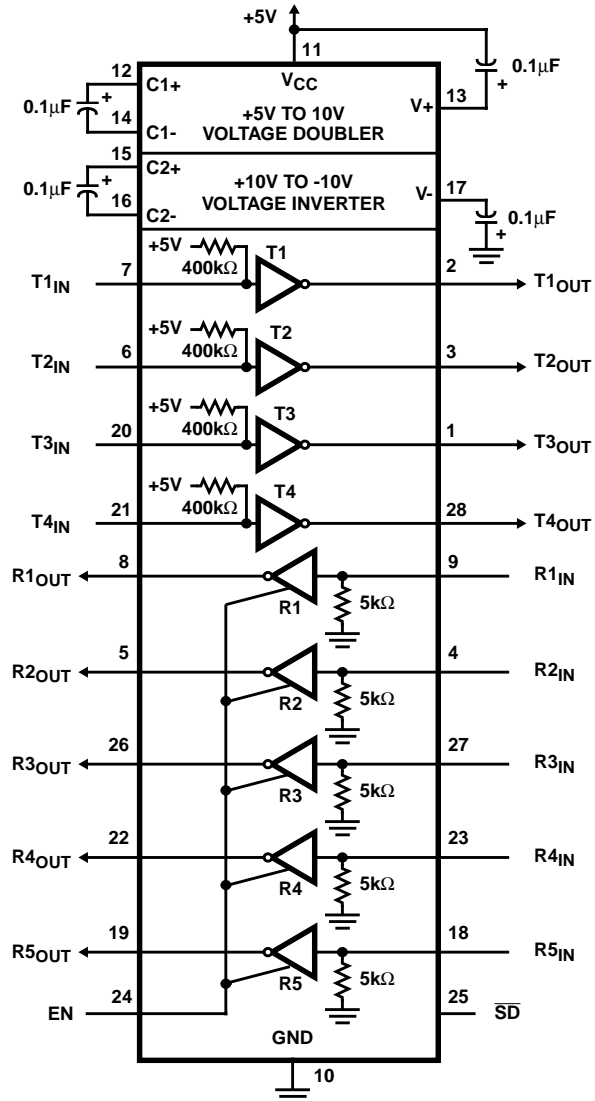
HIN202E thru HIN213E

Pinouts (Continued)

HIN213E (SOIC, SSOP)
TOP VIEW



NOTE: R4 AND R5 ACTIVE IN SHUTDOWN



HIN202E thru HIN213E

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	IEC1000 Compliant

Thermal Information

Thermal Resistance (Typical, Note 1)	θ_{JA} (°C/W)
16 Ld PDIP Package	90
16 Ld SOIC (N) Package	115
16 Ld SOIC (W) Package	100
16 Ld SSOP Package	155
20 Ld PDIP Package	75
20 Ld SOIC Package	100
24 Ld PDIP (N) Package	75
24 Ld PDIP Package	60
24 Ld SOIC Package	75
24 Ld SSOP Package	135
28 Ld SOIC Package	70
28 Ld SSOP Package	100
Maximum Storage Temperature Range	-40°C to 85°C
Maximum Junction Temperature (Plastic Package)	150°C
Maximum Lead Temperature (Soldering 10s) (SOIC and SSOP - Lead Tips Only)	300°C

Operating Conditions

Maximum Operating Temperature Range	
HIN2XXECX	0°C to 70°C
HIN2XXEIX	-40°C to 85°C

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:

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

Electrical Specifications Test Conditions: $V_{CC} = +5V \pm 10\%$, ($V_{CC} = +5V \pm 5\%$ for HIN203E/205E/207E), C1-C4 = 0.1µF (except HIN203E and HIN205E), T_A = Operating Temperature Range

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNITS	
Output Voltage Swing, T_{OUT}	Transmitter Outputs, 3kΩ to Ground	±5	±9	±10	V	
Power Supply Current, I_{CC}	No Load, $T_A = 25^\circ\text{C}$	HIN202E	-	8	15	mA
		HIN202E-208E, HIN211E-213E	-	11	20	mA
Shutdown Supply Current, $I_{CC}(\text{SD})$	$T_A = 25^\circ\text{C}$	HIN205E, HIN206E, HIN211E	-	1	10	µA
		HIN213E	-	15	50	µA
Input Logic Low, T_{IN} , \overline{EN} , 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	
Logic Pullup Current, I_p	$T_{IN} = 0V$	-	15	200	µA	
RS-232 Input Voltage Range, V_{IN}		-30	-	+30	V	
Receiver Input Impedance, R_{IN}	$T_A = 25^\circ\text{C}$, $V_{IN} = \pm 3V$	3.0	5.0	7.0	kΩ	
Receiver Input Low Threshold, V_{IN} (H-L)	$V_{CC} = 5V$, $T_A = 25^\circ\text{C}$	Active Mode	0.8	1.2	-	V
		Shutdown Mode HIN213E R4 and R5	0.6	1.5	-	V
Receiver Input High Threshold, V_{IN} (L-H)	$V_{CC} = 5V$, $T_A = 25^\circ\text{C}$	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	
TTL/CMOS Receiver Output Voltage Low, V_{OL}	$I_{OUT} = 1.6\text{mA}$ (HIN202E-HIN203E, $I_{OUT} = 3.2\text{mA}$)	-	0.1	0.4	V	
TTL/CMOS Receiver Output Voltage High, V_{OH}	$I_{OUT} = -1\text{mA}$	3.5	4.6	-	V	
Output Enable Time, t_{EN}	HIN205E, HIN206E, HIN211E, HIN213E	-	600	-	ns	
Output Disable Time, t_{DIS}	HIN205E, HIN206E, HIN211E, HIN213E	-	200	-	ns	

HIN202E thru HIN213E

Electrical Specifications Test Conditions: $V_{CC} = +5V \pm 10\%$, ($V_{CC} = +5V \pm 5\%$ for HIN203E/205E/207E), $C1-C4 = 0.1\mu F$ (except HIN203E and HIN205E), $T_A =$ Operating Temperature Range **(Continued)**

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNITS	
Propagation Delay, t_{PD}	HIN213E $\overline{SD} = 0V$, R4, R5	-	4.0	40	μs	
	HIN213E $\overline{SD} = V_{CC}$	-	0.5	10	μs	
	HIN202E - HIN211E	-	0.5	10	μs	
Transition Region Slew Rate, SR_T	$R_L = 3k\Omega$, $C_L = 2500pF$ Measured from +3V to -3V or -3V to +3V (Note 1)	HIN202E to HIN213E	3	20	45	$V/\mu s$
Output Resistance, R_{OUT}	$V_{CC} = V_+ = V_- = 0V$, $V_{OUT} = \pm 2V$	300	-	-	Ω	
RS-232 Output Short Circuit Current, I_{SC}	T_{OUT} shorted to GND	-	± 10	-	mA	
TTL/CMOS Receiver Output Leakage	$EN = V_{CC}$, $EN = 0$, $0V < R_{OUT} < V_{CC}$	-	0.5	± 10	μA	
ESD Performance	-	-	-	-	-	
ESD Protection	Human Body Model	+/-15	-	-	kV	
T_{IN} , R_{OUT}	IEC1000-4-2 Contact Discharge	+/-8	-	-	kV	
	IEC1000-4-2 Air Gap	+/-15	-	-	kV	
T_{IN} , R_{OUT}	Human Body Model	+/-2-	-	-	kV	

NOTE:

1. Guaranteed by design.

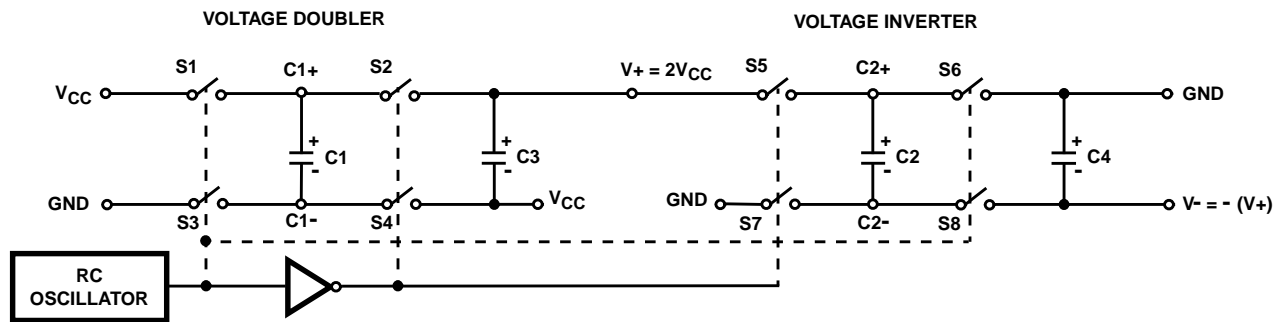


FIGURE 1. CHARGE PUMP

Detailed Description

The HIN202E thru HIN213E family of RS-232 transmitters/receivers are powered by a single +5V power supply and feature low power consumption, and meet all EIA RS-232C 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 1. 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 200 Ω , and the output impedance of the voltage inverter section (V_-) is approximately 450 Ω . A typical application uses 0.1 μF 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, HIN211E and HIN213E, $\overline{SD} = V_{CC}$, HIN213E, $\overline{SD} = 0V$) 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 10 μA . 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 400k Ω 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 3k Ω 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 300 Ω with 2V applied to the outputs and $V_{CC} = 0V$.

Receivers

The receiver inputs accept up to 30V while presenting the required 3k Ω to 7k Ω 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 (EN, on HIN205E and HIN211E, 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).

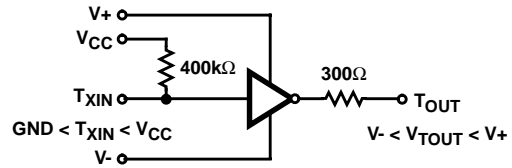


FIGURE 2. TRANSMITTER

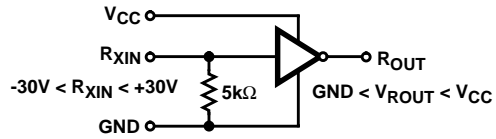
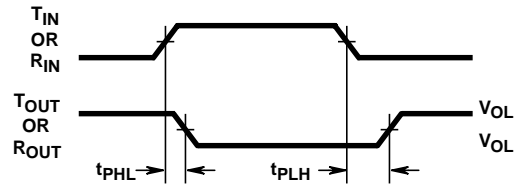


FIGURE 3. RECEIVER



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

FIGURE 4. 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 0.5 μs . This propagation delay increases to 4 μs (typical) during shutdown. When entering shut down mode, receivers R4 and R5 are not valid for 80 μs 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 0.1 μF capacitors.

Test Circuits (HIN202E)

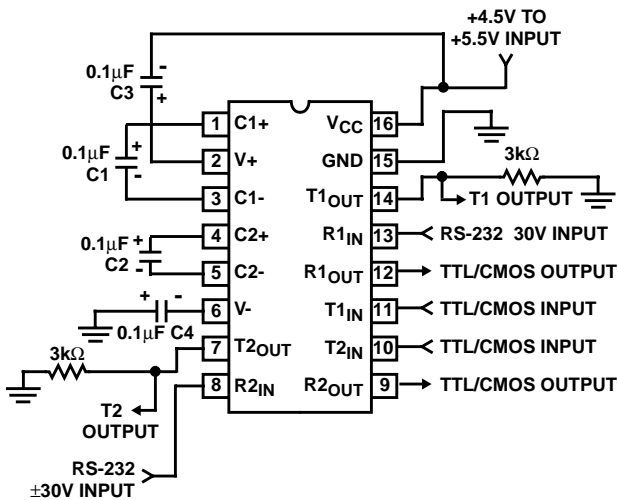


FIGURE 5. GENERAL TEST CIRCUIT

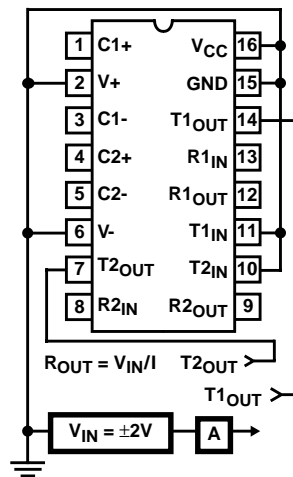


FIGURE 6. POWER-OFF SOURCE RESISTANCE CONFIGURATION

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 9. 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 10), 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.

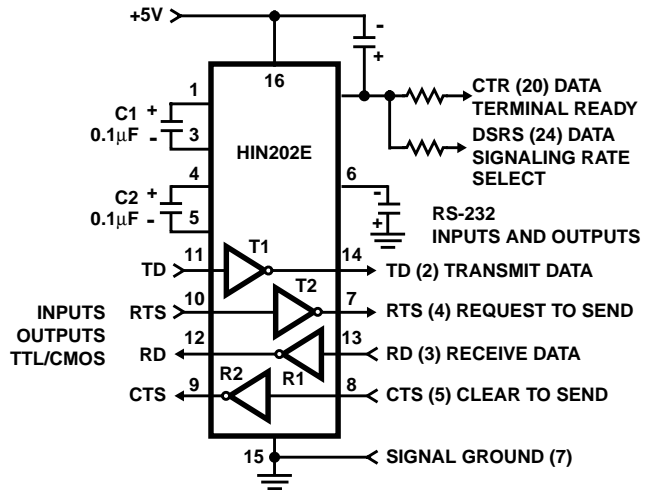


FIGURE 7. SIMPLE DUPLEX RS-232 PORT WITH CTS/RTS HANDSHAKING

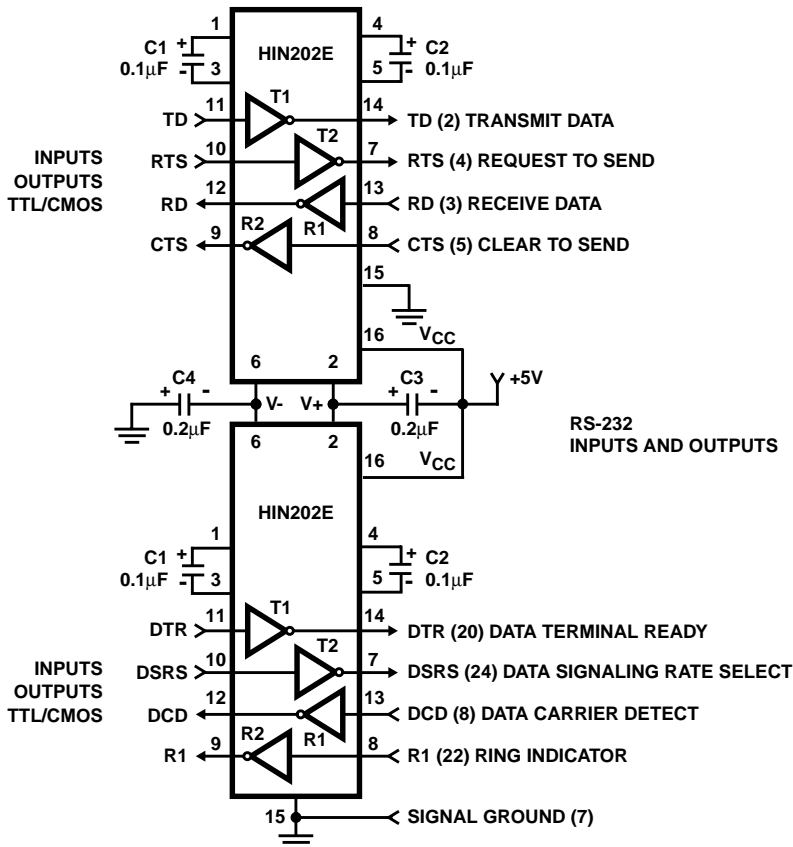


FIGURE 8. COMBINING TWO HIN202Es FOR 4 PAIRS OF RS-232 INPUTS AND OUTPUTS

HIN202E thru HIN213E

Die Characteristics

DIE DIMENSIONS:

139 mils x 134 mils (HIN207E)

METALLIZATION:

Type: Al

Thickness: $10\text{k}\text{\AA} \pm 1\text{k}\text{\AA}$

SUBSTRATE POTENTIAL

GND

PASSIVATION:

Type: Nitride over Silox

Nitride Thickness: $8\text{k}\text{\AA}$

Silox Thickness: $7\text{k}\text{\AA}$

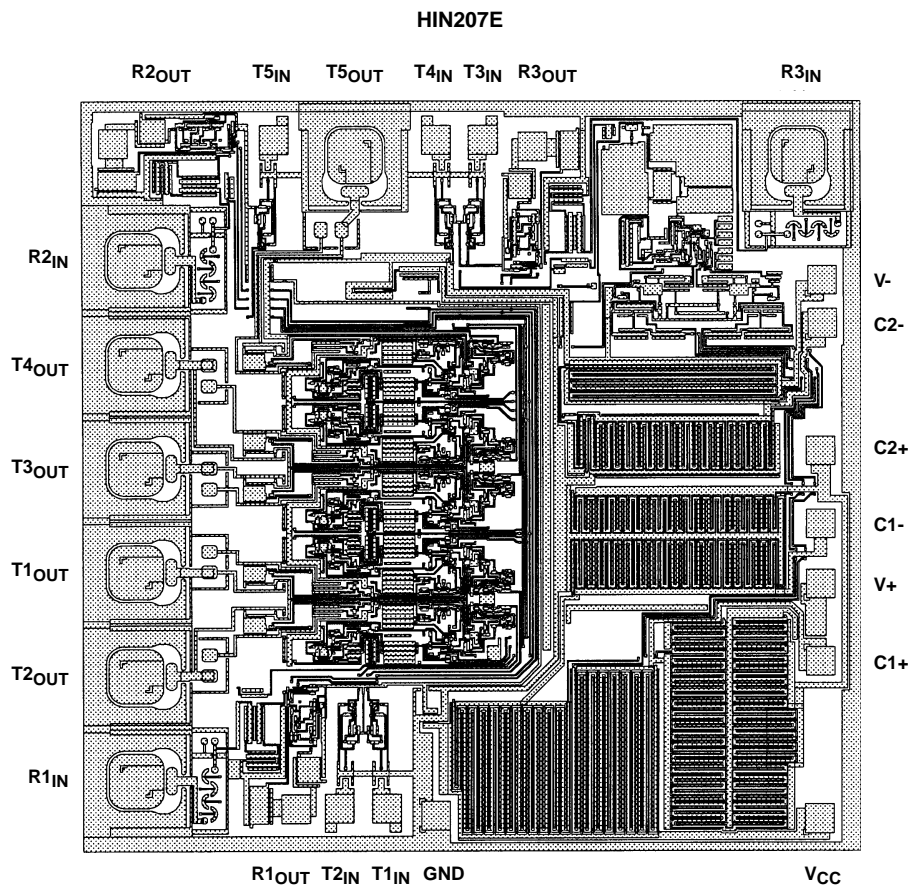
TRANSISTOR COUNT:

332 (HIN207E)

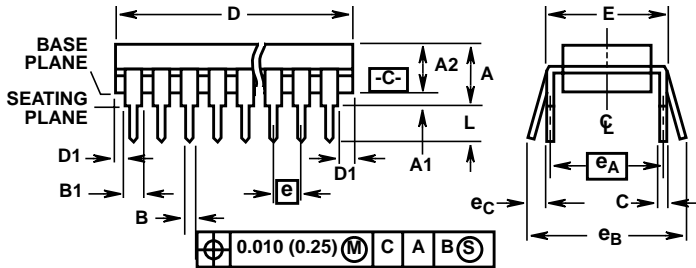
PROCESS:

CMOS Metal Gate

Metallization Mask Layout



Dual-In-Line Plastic Packages (PDIP)



NOTES:

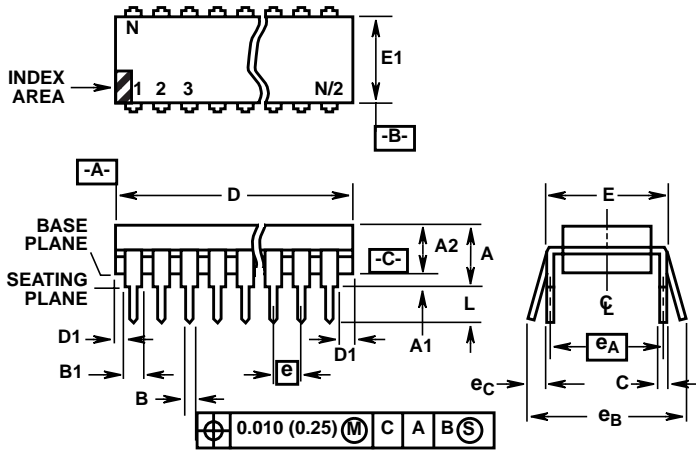
- Controlling Dimensions: INCH. In case of conflict between English and Metric dimensions, the inch dimensions control.
- Dimensioning and tolerancing per ANSI Y14.5M-1982.
- Symbols are defined in the "MO Series Symbol List" in Section 2.2 of Publication No. 95.
- Dimensions A, A1 and L are measured with the package seated in JEDEC seating plane gauge GS-3.
- D, D1, and E1 dimensions do not include mold flash or protrusions. Mold flash or protrusions shall not exceed 0.010 inch (0.25mm).
- E and e_A are measured with the leads constrained to be perpendicular to datum $-C-$.
- e_B and e_C are measured at the lead tips with the leads unconstrained. e_C must be zero or greater.
- B1 maximum dimensions do not include dambar protrusions. Dambar protrusions shall not exceed 0.010 inch (0.25mm).
- N is the maximum number of terminal positions.
- Corner leads (1, N, N/2 and N/2 + 1) for E8.3, E16.3, E18.3, E28.3, E42.6 will have a B1 dimension of 0.030 - 0.045 inch (0.76 - 1.14mm).

**E16.3 (JEDEC MS-001-BB ISSUE D)
16 LEAD DUAL-IN-LINE PLASTIC PACKAGE**

SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN	MAX	MIN	MAX	
A	-	0.210	-	5.33	4
A1	0.015	-	0.39	-	4
A2	0.115	0.195	2.93	4.95	-
B	0.014	0.022	0.356	0.558	-
B1	0.045	0.070	1.15	1.77	8, 10
C	0.008	0.014	0.204	0.355	-
D	0.735	0.775	18.66	19.68	5
D1	0.005	-	0.13	-	5
E	0.300	0.325	7.62	8.25	6
E1	0.240	0.280	6.10	7.11	5
e	0.100 BSC		2.54 BSC		-
e_A	0.300 BSC		7.62 BSC		6
e_B	-	0.430	-	10.92	7
L	0.115	0.150	2.93	3.81	4
N	16		16		9

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Dual-In-Line Plastic Packages (PDIP)



NOTES:

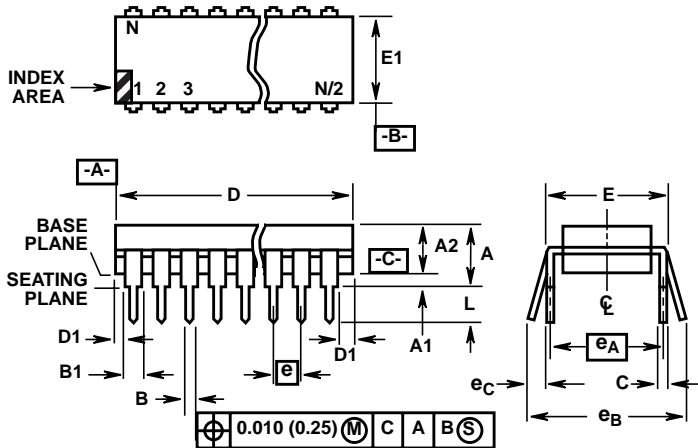
1. Controlling Dimensions: INCH. In case of conflict between English and Metric dimensions, the inch dimensions control.
2. Dimensioning and tolerancing per ANSI Y14.5M-1982.
3. Symbols are defined in the "MO Series Symbol List" in Section 2.2 of Publication No. 95.
4. Dimensions A, A1 and L are measured with the package seated in JEDEC seating plane gauge GS-3.
5. D, D1, and E1 dimensions do not include mold flash or protrusions. Mold flash or protrusions shall not exceed 0.010 inch (0.25mm).
6. E and e_A are measured with the leads constrained to be perpendicular to datum $-C-$.
7. e_B and e_C are measured at the lead tips with the leads unconstrained. e_C must be zero or greater.
8. B1 maximum dimensions do not include dambar protrusions. Dambar protrusions shall not exceed 0.010 inch (0.25mm).
9. N is the maximum number of terminal positions.
10. Corner leads (1, N, N/2 and N/2 + 1) for E8.3, E16.3, E18.3, E28.3, E42.6 will have a B1 dimension of 0.030 - 0.045 inch (0.76 - 1.14mm).

E20.3 (JEDEC MS-001-AD ISSUE D)
20 LEAD DUAL-IN-LINE PLASTIC PACKAGE

SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN	MAX	MIN	MAX	
A	-	0.210	-	5.33	4
A1	0.015	-	0.39	-	4
A2	0.115	0.195	2.93	4.95	-
B	0.014	0.022	0.356	0.558	-
B1	0.045	0.070	1.55	1.77	8
C	0.008	0.014	0.204	0.355	-
D	0.980	1.060	24.89	26.9	5
D1	0.005	-	0.13	-	5
E	0.300	0.325	7.62	8.25	6
E1	0.240	0.280	6.10	7.11	5
e	0.100 BSC		2.54 BSC		-
e_A	0.300 BSC		7.62 BSC		6
e_B	-	0.430	-	10.92	7
L	0.115	0.150	2.93	3.81	4
N	20		20		9

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Dual-In-Line Plastic Packages (PDIP)



NOTES:

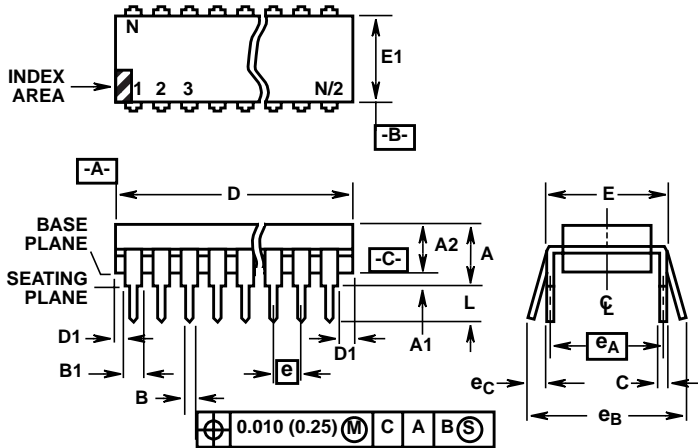
1. Controlling Dimensions: INCH. In case of conflict between English and Metric dimensions, the inch dimensions control.
2. Dimensioning and tolerancing per ANSI Y14.5M-1982.
3. Symbols are defined in the "MO Series Symbol List" in Section 2.2 of Publication No. 95.
4. Dimensions A, A1 and L are measured with the package seated in JEDEC seating plane gauge GS-3.
5. D, D1, and E1 dimensions do not include mold flash or protrusions. Mold flash or protrusions shall not exceed 0.010 inch (0.25mm).
6. E and e_A are measured with the leads constrained to be perpendicular to datum $-C-$.
7. e_B and e_C are measured at the lead tips with the leads unconstrained. e_C must be zero or greater.
8. B1 maximum dimensions do not include dambar protrusions. Dambar protrusions shall not exceed 0.010 inch (0.25mm).
9. N is the maximum number of terminal positions.
10. Corner leads (1, N, N/2 and N/2 + 1) for E8.3, E16.3, E18.3, E28.3, E42.6 will have a B1 dimension of 0.030 - 0.045 inch (0.76 - 1.14mm).

E24.3 (JEDEC MS-001-AF ISSUE D)
24 LEAD NARROW BODY DUAL-IN-LINE PLASTIC PACKAGE

SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN	MAX	MIN	MAX	
A	-	0.210	-	5.33	4
A1	0.015	-	0.39	-	4
A2	0.115	0.195	2.93	4.95	-
B	0.014	0.022	0.356	0.558	-
B1	0.045	0.070	1.15	1.77	8
C	0.008	0.014	0.204	0.355	-
D	1.230	1.280	31.24	32.51	5
D1	0.005	-	0.13	-	5
E	0.300	0.325	7.62	8.25	6
E1	0.240	0.280	6.10	7.11	5
e	0.100 BSC		2.54 BSC		-
e_A	0.300 BSC		7.62 BSC		6
e_B	-	0.430	-	10.92	7
L	0.115	0.150	2.93	3.81	4
N	24		24		9

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Dual-In-Line Plastic Packages (PDIP)



NOTES:

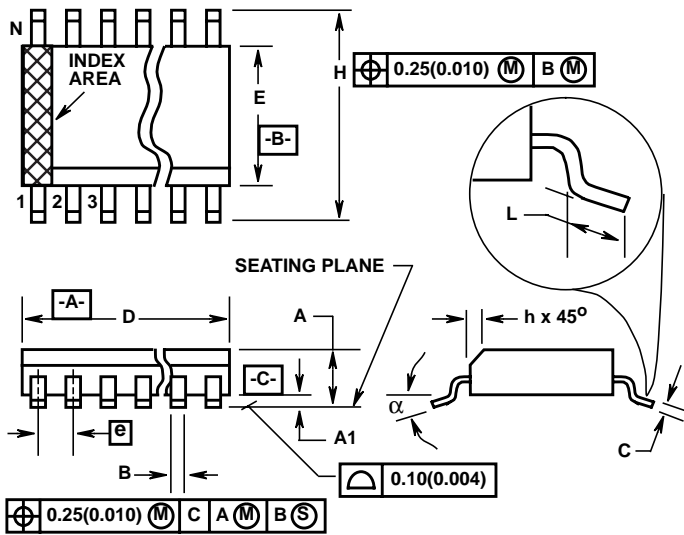
- Controlling Dimensions: INCH. In case of conflict between English and Metric dimensions, the inch dimensions control.
- Dimensioning and tolerancing per ANSI Y14.5M-1982.
- Symbols are defined in the "MO Series Symbol List" in Section 2.2 of Publication No. 95.
- Dimensions A, A1 and L are measured with the package seated in JEDEC seating plane gauge GS-3.
- D, D1, and E1 dimensions do not include mold flash or protrusions. Mold flash or protrusions shall not exceed 0.010 inch (0.25mm).
- E and e_A are measured with the leads constrained to be perpendicular to datum $-C-$.
- e_B and e_C are measured at the lead tips with the leads unconstrained. e_C must be zero or greater.
- B1 maximum dimensions do not include dambar protrusions. Dambar protrusions shall not exceed 0.010 inch (0.25mm).
- N is the maximum number of terminal positions.
- Corner leads (1, N, N/2 and N/2 + 1) for E8.3, E16.3, E18.3, E28.3, E42.6 will have a B1 dimension of 0.030 - 0.045 inch (0.76 - 1.14mm).

E24.6 (JEDEC MS-011-AA ISSUE B)
24 LEAD DUAL-IN-LINE PLASTIC PACKAGE

SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN	MAX	MIN	MAX	
A	-	0.250	-	6.35	4
A1	0.015	-	0.39	-	4
A2	0.125	0.195	3.18	4.95	-
B	0.014	0.022	0.356	0.558	-
B1	0.030	0.070	0.77	1.77	8
C	0.008	0.015	0.204	0.381	-
D	1.150	1.290	29.3	32.7	5
D1	0.005	-	0.13	-	5
E	0.600	0.625	15.24	15.87	6
E1	0.485	0.580	12.32	14.73	5
e	0.100 BSC		2.54 BSC		-
e_A	0.600 BSC		15.24 BSC		6
e_B	-	0.700	-	17.78	7
L	0.115	0.200	2.93	5.08	4
N	24		24		9

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Small Outline Plastic Packages (SOIC)



M16.15 (JEDEC MS-012-AC ISSUE C)
16 LEAD NARROW BODY SMALL OUTLINE PLASTIC PACKAGE

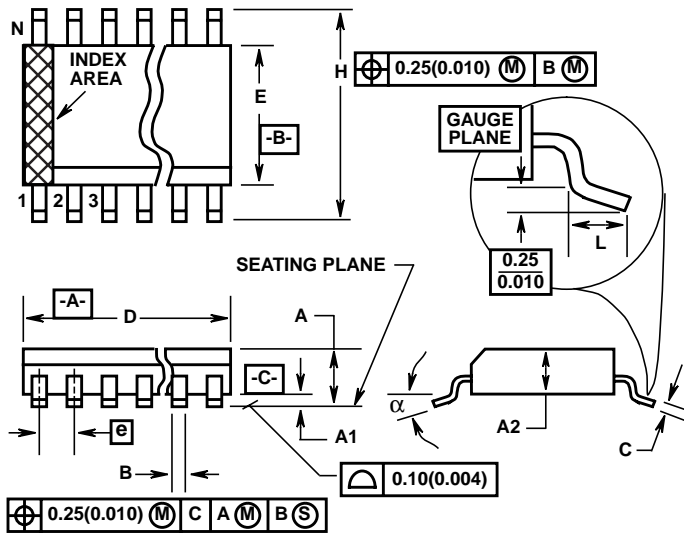
SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN	MAX	MIN	MAX	
A	0.0532	0.0688	1.35	1.75	-
A1	0.0040	0.0098	0.10	0.25	-
B	0.013	0.020	0.33	0.51	9
C	0.0075	0.0098	0.19	0.25	-
D	0.3859	0.3937	9.80	10.00	3
E	0.1497	0.1574	3.80	4.00	4
e	0.050 BSC		1.27 BSC		-
H	0.2284	0.2440	5.80	6.20	-
h	0.0099	0.0196	0.25	0.50	5
L	0.016	0.050	0.40	1.27	6
N	16		16		7
α	0°	8°	0°	8°	-

NOTES:

1. Symbols are defined in the "MO Series Symbol List" in Section 2.2 of Publication Number 95.
2. Dimensioning and tolerancing per ANSI Y14.5M-1982.
3. Dimension "D" does not include mold flash, protrusions or gate burrs. Mold flash, protrusion and gate burrs shall not exceed 0.15mm (0.006 inch) per side.
4. Dimension "E" does not include interlead flash or protrusions. Interlead flash and protrusions shall not exceed 0.25mm (0.010 inch) per side.
5. The chamfer on the body is optional. If it is not present, a visual index feature must be located within the crosshatched area.
6. "L" is the length of terminal for soldering to a substrate.
7. "N" is the number of terminal positions.
8. Terminal numbers are shown for reference only.
9. The lead width "B", as measured 0.36mm (0.014 inch) or greater above the seating plane, shall not exceed a maximum value of 0.61mm (0.024 inch).
10. Controlling dimension: MILLIMETER. Converted inch dimensions are not necessarily exact.

Rev. 0 12/93

Small Outline Plastic Packages (SSOP)



M16.209 (JEDEC MO-150-AC ISSUE B)
16 LEAD SHRINK SMALL OUTLINE PLASTIC PACKAGE

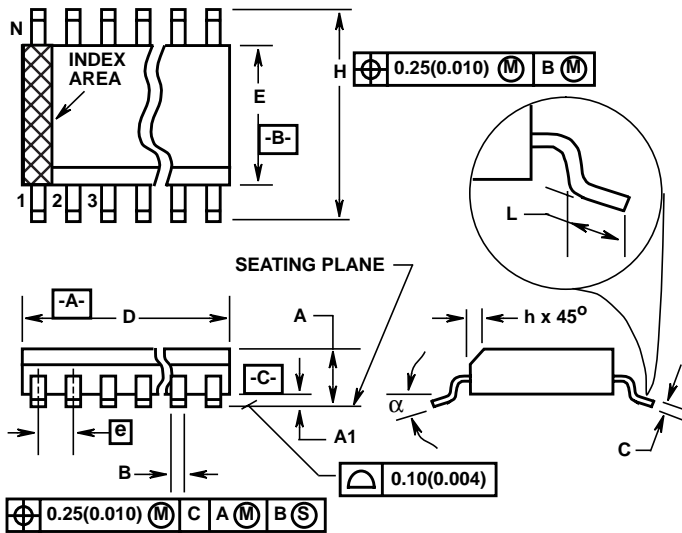
SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN	MAX	MIN	MAX	
A	-	0.078	-	2.00	-
A1	0.002	-	0.05	-	-
A2	0.065	0.072	1.65	1.85	-
B	0.009	0.014	0.22	0.38	9
C	0.004	0.009	0.09	0.25	-
D	0.233	0.255	5.90	6.50	3
E	0.197	0.220	5.00	5.60	4
e	0.026 BSC		0.65 BSC		-
H	0.292	0.322	7.40	8.20	-
L	0.022	0.037	0.55	0.95	6
N	16		16		7
α	0°	8°	0°	8°	-

Rev. 2 3/95

NOTES:

1. Symbols are defined in the "MO Series Symbol List" in Section 2.2 of Publication Number 95.
2. Dimensioning and tolerancing per ANSI Y14.5M-1982.
3. Dimension "D" does not include mold flash, protrusions or gate burrs. Mold flash, protrusion and gate burrs shall not exceed 0.20mm (0.0078 inch) per side.
4. Dimension "E" does not include interlead flash or protrusions. Interlead flash and protrusions shall not exceed 0.20mm (0.0078 inch) per side.
5. The chamfer on the body is optional. If it is not present, a visual index feature must be located within the crosshatched area.
6. "L" is the length of terminal for soldering to a substrate.
7. "N" is the number of terminal positions.
8. Terminal numbers are shown for reference only.
9. Dimension "B" does not include dambar protrusion. Allowable dambar protrusion shall be 0.13mm (0.005 inch) total in excess of "B" dimension at maximum material condition.
10. Controlling dimension: MILLIMETER. Converted inch dimensions are not necessarily exact.

Small Outline Plastic Packages (SOIC)



M16.3 (JEDEC MS-013-AA ISSUE C)
16 LEAD WIDE BODY SMALL OUTLINE PLASTIC PACKAGE

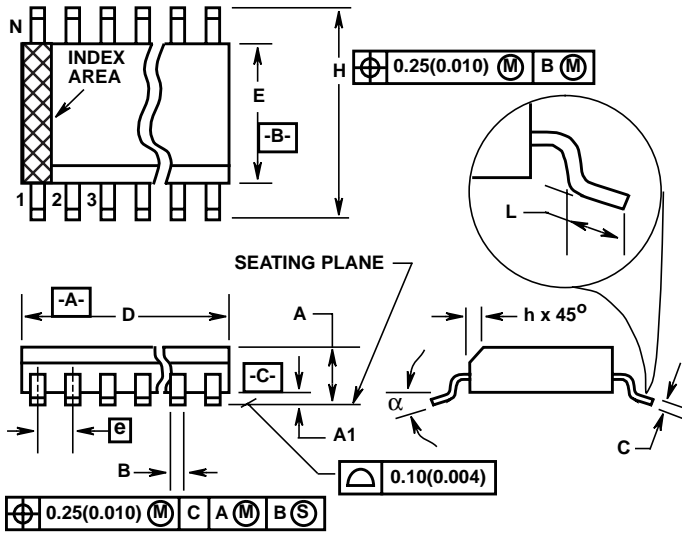
SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN	MAX	MIN	MAX	
A	0.0926	0.1043	2.35	2.65	-
A1	0.0040	0.0118	0.10	0.30	-
B	0.013	0.0200	0.33	0.51	9
C	0.0091	0.0125	0.23	0.32	-
D	0.3977	0.4133	10.10	10.50	3
E	0.2914	0.2992	7.40	7.60	4
e	0.050 BSC		1.27 BSC		-
H	0.394	0.419	10.00	10.65	-
h	0.010	0.029	0.25	0.75	5
L	0.016	0.050	0.40	1.27	6
N	16		16		7
α	0°	8°	0°	8°	-

Rev. 0 12/93

NOTES:

1. Symbols are defined in the "MO Series Symbol List" in Section 2.2 of Publication Number 95.
2. Dimensioning and tolerancing per ANSI Y14.5M-1982.
3. Dimension "D" does not include mold flash, protrusions or gate burrs. Mold flash, protrusion and gate burrs shall not exceed 0.15mm (0.006 inch) per side.
4. Dimension "E" does not include interlead flash or protrusions. Interlead flash and protrusions shall not exceed 0.25mm (0.010 inch) per side.
5. The chamfer on the body is optional. If it is not present, a visual index feature must be located within the crosshatched area.
6. "L" is the length of terminal for soldering to a substrate.
7. "N" is the number of terminal positions.
8. Terminal numbers are shown for reference only.
9. The lead width "B", as measured 0.36mm (0.014 inch) or greater above the seating plane, shall not exceed a maximum value of 0.61mm (0.024 inch)
10. Controlling dimension: MILLIMETER. Converted inch dimensions are not necessarily exact.

Small Outline Plastic Packages (SOIC)



M20.3 (JEDEC MS-013-AC ISSUE C)
20 LEAD WIDE BODY SMALL OUTLINE PLASTIC PACKAGE

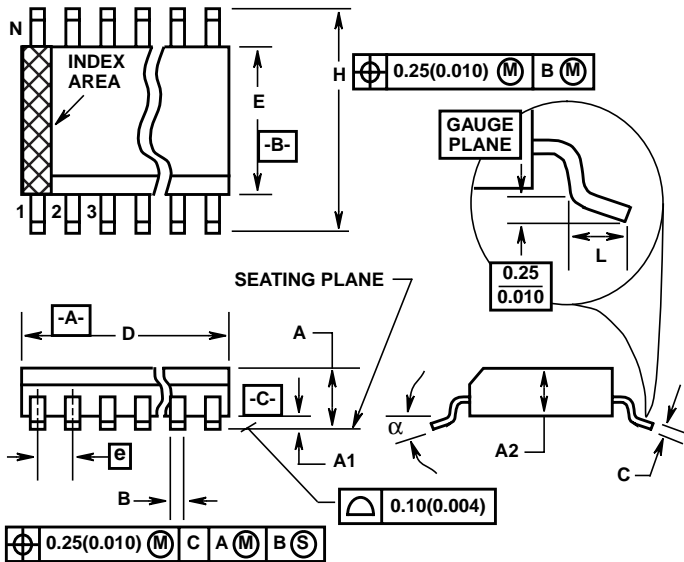
SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN	MAX	MIN	MAX	
A	0.0926	0.1043	2.35	2.65	-
A1	0.0040	0.0118	0.10	0.30	-
B	0.013	0.0200	0.33	0.51	9
C	0.0091	0.0125	0.23	0.32	-
D	0.4961	0.5118	12.60	13.00	3
E	0.2914	0.2992	7.40	7.60	4
e	0.050 BSC		1.27 BSC		-
H	0.394	0.419	10.00	10.65	-
h	0.010	0.029	0.25	0.75	5
L	0.016	0.050	0.40	1.27	6
N	20		20		7
α	0°	8°	0°	8°	-

NOTES:

1. Symbols are defined in the "MO Series Symbol List" in Section 2.2 of Publication Number 95.
2. Dimensioning and tolerancing per ANSI Y14.5M-1982.
3. Dimension "D" does not include mold flash, protrusions or gate burrs. Mold flash, protrusion and gate burrs shall not exceed 0.15mm (0.006 inch) per side.
4. Dimension "E" does not include interlead flash or protrusions. Interlead flash and protrusions shall not exceed 0.25mm (0.010 inch) per side.
5. The chamfer on the body is optional. If it is not present, a visual index feature must be located within the crosshatched area.
6. "L" is the length of terminal for soldering to a substrate.
7. "N" is the number of terminal positions.
8. Terminal numbers are shown for reference only.
9. The lead width "B", as measured 0.36mm (0.014 inch) or greater above the seating plane, shall not exceed a maximum value of 0.61mm (0.024 inch)
10. Controlling dimension: MILLIMETER. Converted inch dimensions are not necessarily exact.

Rev. 0 12/93

Shrink Small Outline Plastic Packages (SSOP)



M24.209 (JEDEC MO-150-AG ISSUE B)
24 LEAD SHRINK SMALL OUTLINE PLASTIC PACKAGE

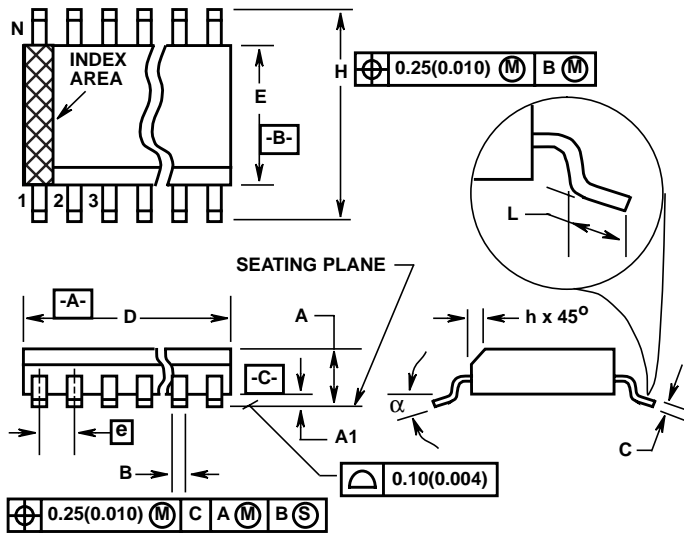
SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN	MAX	MIN	MAX	
A	-	0.078	-	2.00	-
A1	0.002	-	0.05	-	-
A2	0.065	0.072	1.65	1.85	-
B	0.009	0.014	0.22	0.38	9
C	0.004	0.009	0.09	0.25	-
D	0.312	0.334	7.90	8.50	3
E	0.197	0.220	5.00	5.60	4
e	0.026 BSC		0.65 BSC		-
H	0.292	0.322	7.40	8.20	-
L	0.022	0.037	0.55	0.95	6
N	24		24		7
α	0°	8°	0°	8°	-

NOTES:

1. Symbols are defined in the "MO Series Symbol List" in Section 2.2 of Publication Number 95.
2. Dimensioning and tolerancing per ANSI Y14.5M-1982.
3. Dimension "D" does not include mold flash, protrusions or gate burrs. Mold flash, protrusion and gate burrs shall not exceed 0.20mm (0.0078 inch) per side.
4. Dimension "E" does not include interlead flash or protrusions. Interlead flash and protrusions shall not exceed 0.20mm (0.0078 inch) per side.
5. The chamfer on the body is optional. If it is not present, a visual index feature must be located within the crosshatched area.
6. "L" is the length of terminal for soldering to a substrate.
7. "N" is the number of terminal positions.
8. Terminal numbers are shown for reference only.
9. Dimension "B" does not include dambar protrusion. Allowable dambar protrusion shall be 0.13mm (0.005 inch) total in excess of "B" dimension at maximum material condition.
10. Controlling dimension: MILLIMETER. Converted inch dimensions are not necessarily exact.

Rev. 1 3/95

Small Outline Plastic Packages (SOIC)



**M24.3 (JEDEC MS-013-AD ISSUE C)
24 LEAD WIDE BODY SMALL OUTLINE PLASTIC PACKAGE**

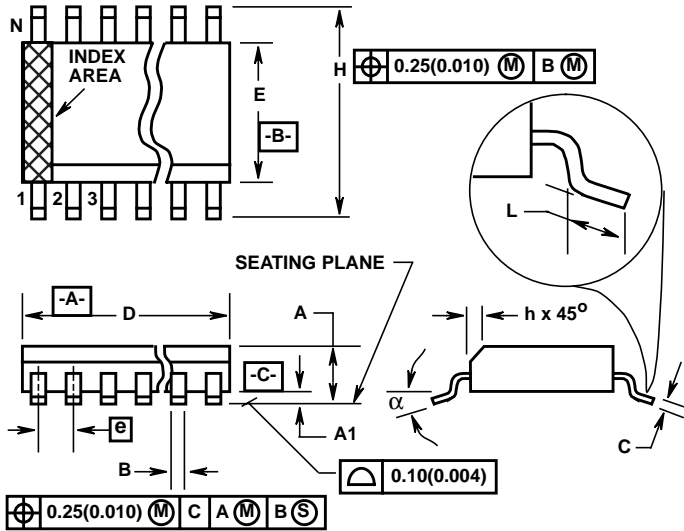
SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN	MAX	MIN	MAX	
A	0.0926	0.1043	2.35	2.65	-
A1	0.0040	0.0118	0.10	0.30	-
B	0.013	0.020	0.33	0.51	9
C	0.0091	0.0125	0.23	0.32	-
D	0.5985	0.6141	15.20	15.60	3
E	0.2914	0.2992	7.40	7.60	4
e	0.05 BSC		1.27 BSC		-
H	0.394	0.419	10.00	10.65	-
h	0.010	0.029	0.25	0.75	5
L	0.016	0.050	0.40	1.27	6
N	24		24		7
α	0°	8°	0°	8°	-

NOTES:

1. Symbols are defined in the "MO Series Symbol List" in Section 2.2 of Publication Number 95.
2. Dimensioning and tolerancing per ANSI Y14.5M-1982.
3. Dimension "D" does not include mold flash, protrusions or gate burrs. Mold flash, protrusion and gate burrs shall not exceed 0.15mm (0.006 inch) per side.
4. Dimension "E" does not include interlead flash or protrusions. Interlead flash and protrusions shall not exceed 0.25mm (0.010 inch) per side.
5. The chamfer on the body is optional. If it is not present, a visual index feature must be located within the crosshatched area.
6. "L" is the length of terminal for soldering to a substrate.
7. "N" is the number of terminal positions.
8. Terminal numbers are shown for reference only.
9. The lead width "B", as measured 0.36mm (0.014 inch) or greater above the seating plane, shall not exceed a maximum value of 0.61mm (0.024 inch)
10. Controlling dimension: MILLIMETER. Converted inch dimensions are not necessarily exact

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Small Outline Plastic Packages (SOIC)



**M28.3 (JEDEC MS-013-AE ISSUE C)
28 LEAD WIDE BODY SMALL OUTLINE PLASTIC PACKAGE**

SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN	MAX	MIN	MAX	
A	0.0926	0.1043	2.35	2.65	-
A1	0.0040	0.0118	0.10	0.30	-
B	0.013	0.0200	0.33	0.51	9
C	0.0091	0.0125	0.23	0.32	-
D	0.6969	0.7125	17.70	18.10	3
E	0.2914	0.2992	7.40	7.60	4
e	0.05 BSC		1.27 BSC		-
H	0.394	0.419	10.00	10.65	-
h	0.01	0.029	0.25	0.75	5
L	0.016	0.050	0.40	1.27	6
N	28		28		7
α	0°	8°	0°	8°	-

Rev. 0 12/93

NOTES:

1. Symbols are defined in the "MO Series Symbol List" in Section 2.2 of Publication Number 95.
2. Dimensioning and tolerancing per ANSI Y14.5M-1982.
3. Dimension "D" does not include mold flash, protrusions or gate burrs. Mold flash, protrusion and gate burrs shall not exceed 0.15mm (0.006 inch) per side.
4. Dimension "E" does not include interlead flash or protrusions. Interlead flash and protrusions shall not exceed 0.25mm (0.010 inch) per side.
5. The chamfer on the body is optional. If it is not present, a visual index feature must be located within the crosshatched area.
6. "L" is the length of terminal for soldering to a substrate.
7. "N" is the number of terminal positions.
8. Terminal numbers are shown for reference only.
9. The lead width "B", as measured 0.36mm (0.014 inch) or greater above the seating plane, shall not exceed a maximum value of 0.61mm (0.024 inch)
10. Controlling dimension: MILLIMETER. Converted inch dimensions are not necessarily exact.

All Harris Semiconductor products are manufactured, assembled and tested under **ISO9000** quality systems certification.

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Sales Office Headquarters

For general information regarding Harris Semiconductor and its products, call **1-800-4-HARRIS**

NORTH AMERICA
Harris Semiconductor
P. O. Box 883, Mail Stop 53-210
Melbourne, FL 32902
TEL: 1-800-442-7747
(407) 729-4984
FAX: (407) 729-5321

EUROPE
Harris Semiconductor
Mercure Center
100, Rue de la Fusee
1130 Brussels, Belgium
TEL: (32) 2.724.2111
FAX: (32) 2.724.22.05

ASIA
Harris Semiconductor PTE Ltd.
No. 1 Tannery Road
Cencon 1, #09-01
Singapore 1334
TEL: (65) 748-4200
FAX: (65) 748-0400

