

One Microamp Supply-Current, +3V to +5.5V, 250kbps, RS-232 Transmitters/Receivers

The Intersil ICL32XX devices are 3.0V to 5.5V powered RS-232 transmitters/receivers which meet EIA/TIA-232 and V.28/V.24 specifications, even at $V_{CC} = 3.0V$. Targeted applications are PDAs, Palmtops, and notebook and laptop computers where the low operational, and even lower standby, power consumption is critical. Efficient on-chip charge pumps, coupled with manual and automatic powerdown functions (except for the ICL3232), reduce the standby supply current to a $1\mu A$ trickle. Small footprint packaging, and the use of small, low value capacitors ensure board space savings as well. Data rates greater than 250kbps are guaranteed at worst case load conditions. This family is fully compatible with 3.3V only systems, mixed 3.3V and 5.0V systems, and 5.0V only systems.

The ICL324X are 3-driver, 5-receiver devices that provide a complete serial port suitable for laptop or notebook computers. Both devices also include noninverting always-active receivers for "wake-up" capability.

The **ICL3221, ICL3223 and ICL3243**, feature an **automatic powerdown** function which powers down the on-chip power-supply and driver circuits. This occurs when an attached peripheral device is shut off or the RS-232 cable is removed, conserving system power automatically without changes to the hardware or operating system. These devices power up again when a valid RS-232 voltage is applied to any receiver input.

Table 1 summarizes the features of the devices represented by this data sheet, while Application Note AN9863 summarizes the features of each device comprising the ICL32XX 3V family.

Features

- Pb-Free Available as an Option (See Ordering Info)
- 15kV ESD Protected (Human Body Model)
- Drop in Replacements for MAX3221, MAX3222, MAX3223, MAX3232, MAX3241, MAX3243, SP3243
- ICL3221 is Low Power, Pin Compatible Upgrade for 5V MAX221
- ICL3222 is Low Power, Pin Compatible Upgrade for 5V MAX242, and SP312A
- ICL3232 is Low Power Upgrade for HIN232/ICL232 and Pin Compatible Competitor Devices
- RS-232 Compatible with $V_{CC} = 2.7V$
- Meets EIA/TIA-232 and V.28/V.24 Specifications at 3V
- Latch-Up Free
- On-Chip Voltage Converters Require Only Four External $0.1\mu F$ Capacitors
- Manual and Automatic Powerdown Features (Except ICL3232)
- Guaranteed Mouse Driveability (ICL324X Only)
- Receiver Hysteresis For Improved Noise Immunity
- Guaranteed Minimum Data Rate 250kbps
- Guaranteed Minimum Slew Rate $6V/\mu s$
- Wide Power Supply Range Single +3V to +5.5V
- Low Supply Current in Powerdown State $1\mu A$

Applications

- Any System Requiring RS-232 Communication Ports
 - Battery Powered, Hand-Held, and Portable Equipment
 - Laptop Computers, Notebooks, Palmtops
 - Modems, Printers and other Peripherals
 - Digital Cameras
 - Cellular/Mobile Phones

TABLE 1. SUMMARY OF FEATURES

PART NUMBER	NO. OF Tx.	NO. OF Rx.	NO. OF MONITOR Rx. (ROUTB)	DATA RATE (kbps)	Rx. ENABLE FUNCTION?	READY OUTPUT?	MANUAL POWER-DOWN?	AUTOMATIC POWERDOWN FUNCTION?
ICL3221	1	1	0	250	Yes	No	Yes	Yes
ICL3222	2	2	0	250	Yes	No	Yes	No
ICL3223	2	2	0	250	Yes	No	Yes	Yes
ICL3232	2	2	0	250	No	No	No	No
ICL3241	3	5	2	250	Yes	No	Yes	No
ICL3243	3	5	1	250	No	No	Yes	Yes

Ordering Information

(NOTE 1) PART NO.	TEMP. RANGE (°C)	PACKAGE	PKG. DWG. #
ICL3221CA	0 to 70	16 Ld SSOP	M16.209
ICL3221CAZ (Note 2)	0 to 70	16 Ld SSOP (Pb-free)	M16.209
ICL3221CV	0 to 70	16 Ld TSSOP	M16.173
ICL3221CVZ (Note 2)	0 to 70	16 Ld TSSOP (Pb-free)	M16.173
ICL3221IA	-40 to 85	16 Ld SSOP	M16.209
ICL3221IAZ (Note 2)	-40 to 85	16 Ld SSOP (Pb-free)	M16.209
ICL3222CA	0 to 70	20 Ld SSOP	M20.209
ICL3222CAZ (Note 2)	0 to 70	20 Ld SSOP (Pb-free)	M20.209
ICL3222CB	0 to 70	18 Ld SOIC	M18.3
ICL3222CBZ (Note 2)	0 to 70	18 Ld SOIC (Pb-free)	M18.3
ICL3222CP	0 to 70	18 Ld PDIP	E18.3
ICL3222CV	0 to 70	20 Ld TSSOP	M20.173
ICL3222CVZ (Note 2)	0 to 70	20 Ld TSSOP (Pb-free)	M20.173
ICL3222IA	-40 to 85	20 Ld SSOP	M20.209
ICL3222IB	-40 to 85	18 Ld SOIC	M18.3
ICL3222IV	-40 to 85	20 Ld TSSOP	M20.173
ICL3223CA	0 to 70	20 Ld SSOP	M20.209
ICL3223CAZ (Note 2)	0 to 70	20 Ld SSOP (Pb-free)	M20.209
ICL3223CP	0 to 70	20 Ld PDIP	E20.3
ICL3223CV	0 to 70	20 Ld TSSOP	M20.173
ICL3223IA	-40 to 85	20 Ld SSOP	M20.209
ICL3223IAZ (Note 2)	-40 to 85	20 Ld SSOP (Pb-free)	M20.209
ICL3223IV	-40 to 85	20 Ld TSSOP	M20.173
ICL3223IVZ (Note 2)	-40 to 85	20 Ld TSSOP (Pb-free)	M20.173
ICL3232CA	0 to 70	16 Ld SSOP	M16.209
ICL3232CAZ (Note 2)	0 to 70	16 Ld SSOP (Pb-free)	M16.209
ICL3232CB	0 to 70	16 Ld SOIC	M16.3
ICL3232CBZ (Note 2)	0 to 70	16 Ld SOIC (Pb-free)	M16.3

Ordering Information (Continued)

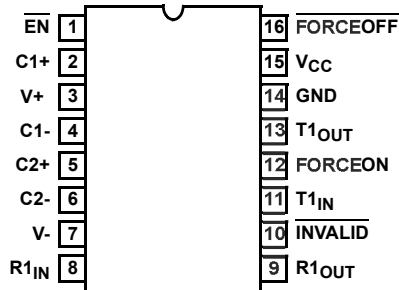
(NOTE 1) PART NO.	TEMP. RANGE (°C)	PACKAGE	PKG. DWG. #
ICL3232CBN	0 to 70	16 Ld SOIC (N)	M16.15
ICL3232CBNZ (Note 2)	0 to 70	16 Ld SOIC (N) (Pb-free)	M16.15
ICL3232CP	0 to 70	16 Ld PDIP	E16.3
ICL3232CV	0 to 70	16 Ld TSSOP	M16.173
ICL3232CVZ (Note 2)	0 to 70	16 Ld TSSOP (Pb-free)	M16.173
ICL3232IA	-40 to 85	16 Ld SSOP	M16.209
ICL3232IAZ (Note 2)	-40 to 85	16 Ld SSOP (Pb-free)	M16.209
ICL3232IB	-40 to 85	16 Ld SOIC	M16.3
ICL3232IBZ (Note 2)	-40 to 85	16 Ld SOIC (Pb-free)	M16.3
ICL3232IBN	-40 to 85	16 Ld SOIC (N)	M16.15
ICL3232IBNZ (Note 2)	-40 to 85	16 Ld SOIC (N) (Pb-free)	M16.15
ICL3232IV	-40 to 85	16 Ld TSSOP	M16.173
ICL3232IVZ (Note 2)	-40 to 85	16 Ld TSSOP (Pb-free)	M16.173
ICL3241CA	0 to 70	28 Ld SSOP	M28.209
ICL3241CB	0 to 70	28 Ld SOIC	M28.3
ICL3241CV	0 to 70	28 Ld TSSOP	M28.173
ICL3241IA	-40 to 85	28 Ld SSOP	M28.209
ICL3241IB	-40 to 85	28 Ld SOIC	M28.3
ICL3241IV	-40 to 85	28 Ld TSSOP	M28.173
ICL3243CA	0 to 70	28 Ld SSOP	M28.209
ICL3243CB	0 to 70	28 Ld SOIC	M28.3
ICL3243CV	0 to 70	28 Ld TSSOP	M28.173
ICL3243IA	-40 to 85	28 Ld SSOP	M28.209

NOTES:

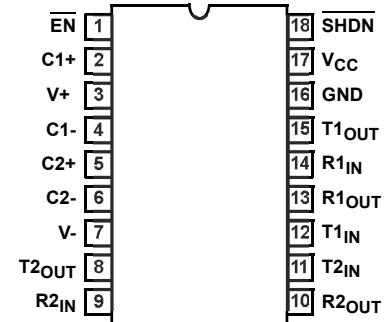
1. Most surface mount devices are available on tape and reel; add "-T" to suffix.
2. Intersil Pb-free products employ special Pb-free material sets; molding compounds/die attach materials and 100% matte tin plate termination finish, which is compatible with both SnPb and Pb-free soldering operations. Intersil Pb-free products are MSL classified at Pb-free peak reflow temperatures that meet or exceed the Pb-free requirements of IPC/JEDEC J Std-020B.

Pinouts

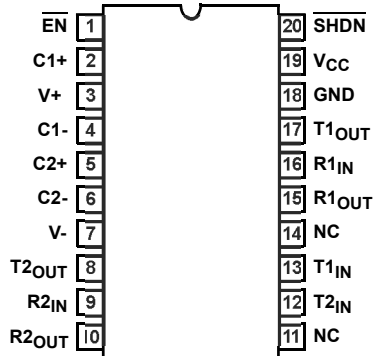
ICL3221 (SSOP, TSSOP)
TOP VIEW



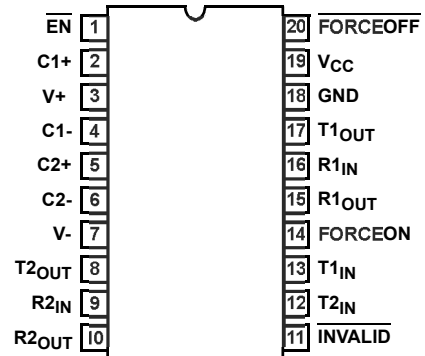
ICL3222 (PDIP, SOIC)
TOP VIEW



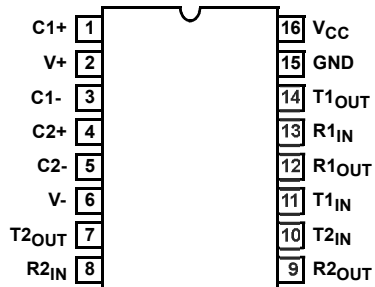
ICL3222 (SSOP, TSSOP)
TOP VIEW



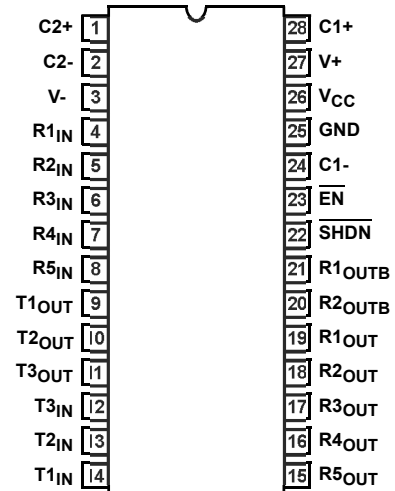
ICL3223 (PDIP, SSOP, TSSOP)
TOP VIEW



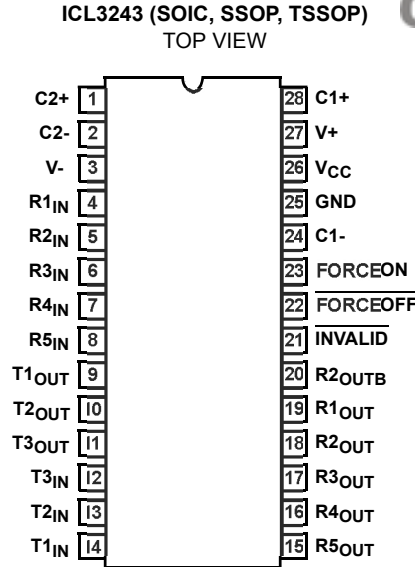
ICL3232 (PDIP, SOIC, SSOP, TSSOP)
TOP VIEW



ICL3241 (SOIC, SSOP, TSSOP)
TOP VIEW



Pinouts (Continued)



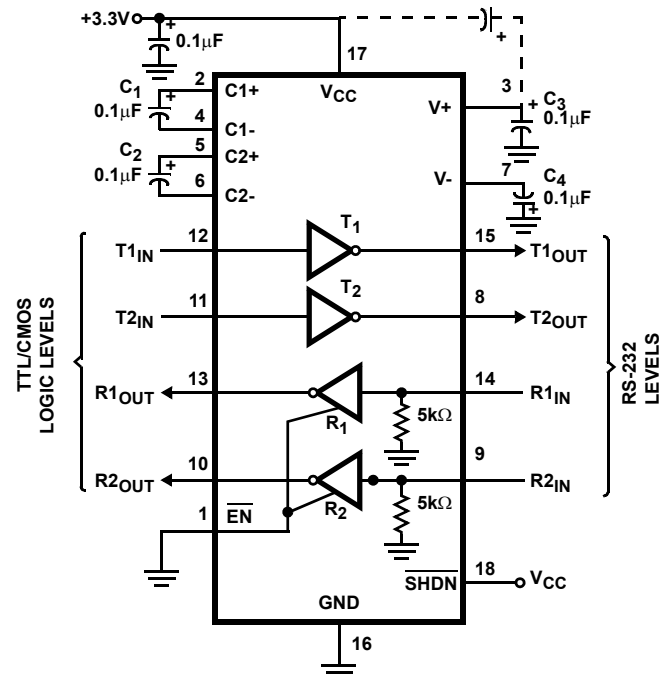
Pin Descriptions

PIN	FUNCTION
V _{CC}	System power supply input (3.0V to 5.5V).
V+	Internally generated positive transmitter supply (+5.5V).
V-	Internally generated negative transmitter supply (-5.5V).
GND	Ground connection.
C1+	External capacitor (voltage doubler) is connected to this lead.
C1-	External capacitor (voltage doubler) is connected to this lead.
C2+	External capacitor (voltage inverter) is connected to this lead.
C2-	External capacitor (voltage inverter) is connected to this lead.
T _{IN}	TTL/CMOS compatible transmitter Inputs.
T _{OUT}	RS-232 level (nominally ±5.5V) transmitter outputs.
R _{IN}	RS-232 compatible receiver inputs.
R _{OUT}	TTL/CMOS level receiver outputs.
R _{OUTB}	TTL/CMOS level, noninverting, always enabled receiver outputs.
INVALID	Active low output that indicates if no valid RS-232 levels are present on any receiver input.
$\overline{\text{EN}}$	Active low receiver enable control; doesn't disable R _{OUTB} outputs.
$\overline{\text{SHDN}}$	Active low input to shut down transmitters and on-board power supply, to place device in low power mode.
$\overline{\text{FORCEOFF}}$	Active low to shut down transmitters and on-chip power supply. This overrides any automatic circuitry and FORCEON (see Table 2).
FORCEON	Active high input to override automatic powerdown circuitry thereby keeping transmitters active. ($\overline{\text{FORCEOFF}}$ must be high).

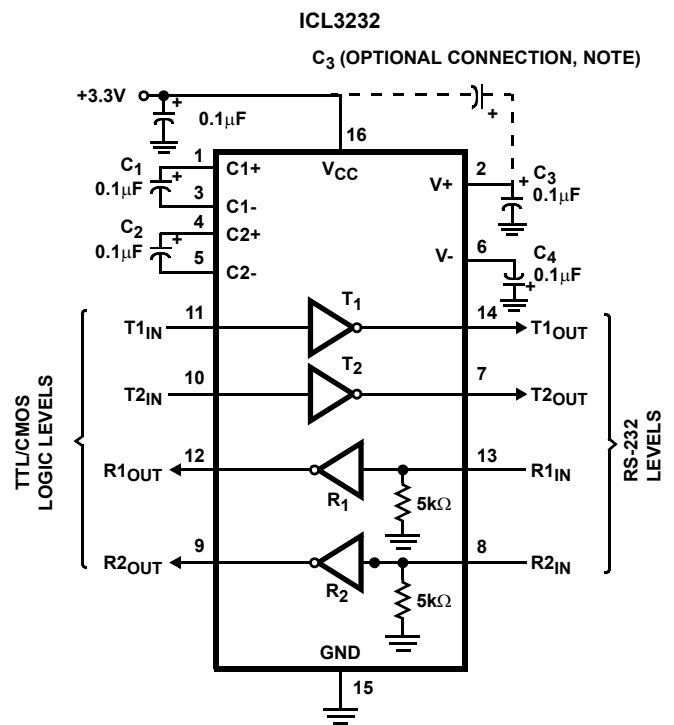
ICL3222

ICL3222

C₃ (OPTIONAL CONNECTION, NOTE)



NOTE: The negative terminal of C_3 can be connected to either V_{CC} or GND

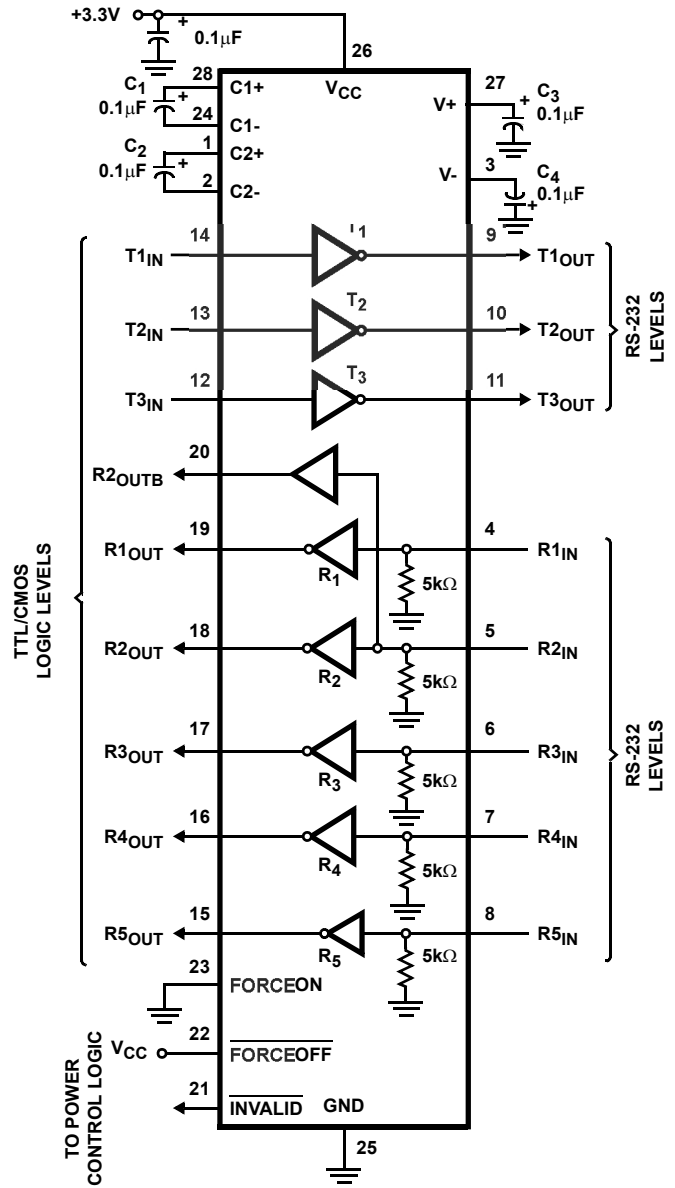
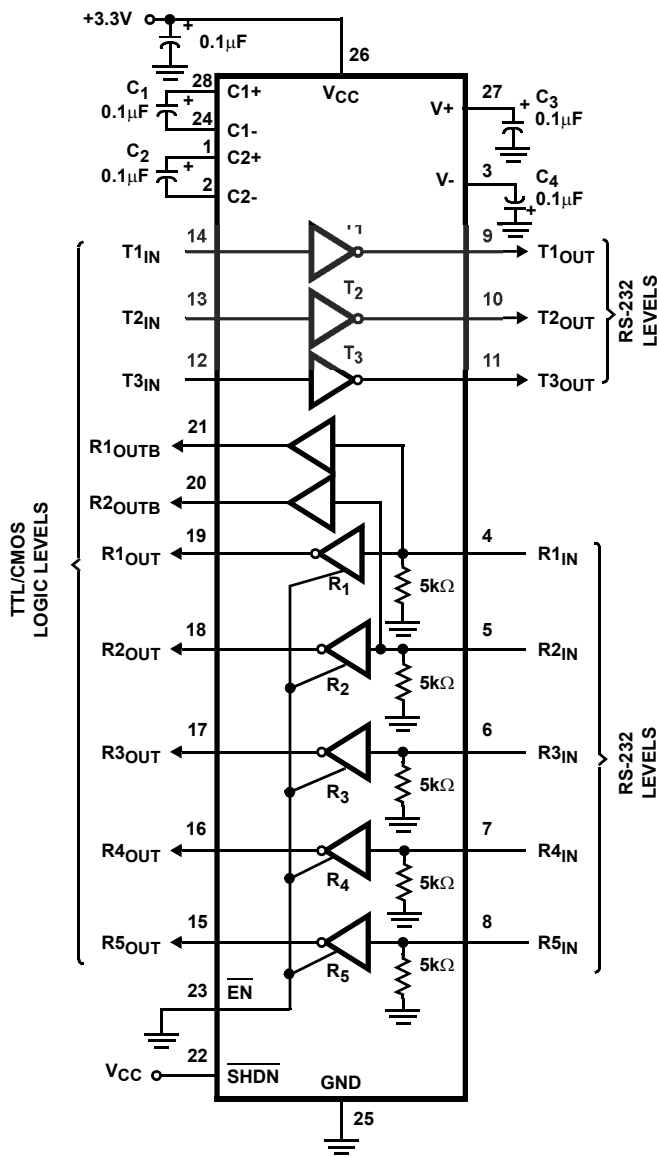


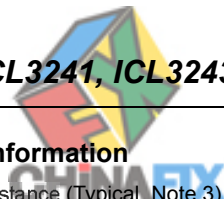
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Typical Operating Circuits (Continued)

ICL3241

ICL3243





Absolute Maximum Ratings

V _{CC} to Ground	-0.3V to 6V
V ₊ to Ground	-0.3V to 7V
V ₋ to Ground	+0.3V to -7V
V ₊ to V ₋	14V
Input Voltages	
T _{IN} , FORCEOFF, FORCEON, $\overline{\text{EN}}$, $\overline{\text{SHDN}}$	-0.3V to 6V
R _{IN}	±25V
Output Voltages	
T _{OUT}	±13.2V
R _{OUT} , INVALID	-0.3V to V _{CC} +0.3V
Short Circuit Duration	
T _{OUT}	Continuous
ESD Rating	See Specification Table

Operating Conditions

Temperature Range	
ICL32XXCX	0°C to 70°C
ICL32XXIX	-40°C to 85°C

Thermal Information

Thermal Resistance (Typical, Note 3)	θ _{JA} (°C/W)
16 Ld PDIP Package	90
18 Ld PDIP Package	80
20 Ld PDIP Package	77
16 Ld Wide SOIC Package	100
16 Ld Narrow SOIC Package	115
18 Ld SOIC Package	75
28 Ld SOIC Package	75
16 Ld SSOP Package	135
20 Ld SSOP Package	122
16 Ld TSSOP Package	145
20 Ld TSSOP Package	140
28 Ld SSOP and TSSOP Packages	100
Maximum Junction Temperature (Plastic Package)	150°C
Maximum Storage Temperature Range	-65°C to 150°C
Maximum Lead Temperature (Soldering 10s)	300°C (SOIC, SSOP, TSSOP - 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:

- θ_{JA} is measured with the component mounted on a low effective thermal conductivity test board in free air. See Tech Brief TB379 for details.

Electrical Specifications

Test Conditions: V_{CC} = 3V to 5.5V, C1 - C4 = 0.1μF; Unless Otherwise Specified.
Typicals are at TA = 25°C

PARAMETER	TEST CONDITIONS	TEMP (°C)	MIN	TYP	MAX	UNITS	
DC CHARACTERISTICS							
Supply Current, Automatic Powerdown	All R _{IN} Open, FORCEON = GND, $\overline{\text{FORCEOFF}} = \text{V}_{\text{CC}}$ (ICL3221, ICL3223, ICL3243 Only)	25	-	1.0	10	μA	
Supply Current, Powerdown	$\overline{\text{FORCEOFF}} = \overline{\text{SHDN}} = \text{GND}$ (Except ICL3232)	25	-	1.0	10	μA	
Supply Current, Automatic Powerdown Disabled	All Outputs Unloaded, $\overline{\text{FORCEON}} = \overline{\text{FORCEOFF}} = \overline{\text{SHDN}} = \text{V}_{\text{CC}}$	V _{CC} = 3.15V, ICL3221-32	25	-	0.3	1.0	mA
		V _{CC} = 3.0V, ICL3241-43	25	-	0.3	1.0	mA
LOGIC AND TRANSMITTER INPUTS AND RECEIVER OUTPUTS							
Input Logic Threshold Low	T _{IN} , FORCEON, $\overline{\text{FORCEOFF}}$, $\overline{\text{EN}}$, $\overline{\text{SHDN}}$	Full	-	-	0.8	V	
Input Logic Threshold High	$\overline{\text{T}_{\text{IN}}}$, FORCEON, $\overline{\text{FORCEOFF}}$, $\overline{\text{EN}}$, $\overline{\text{SHDN}}$	V _{CC} = 3.3V	Full	2.0	-	-	V
		V _{CC} = 5.0V	Full	2.4	-	-	V
Input Leakage Current	T _{IN} , FORCEON, $\overline{\text{FORCEOFF}}$, $\overline{\text{EN}}$, $\overline{\text{SHDN}}$	Full	-	±0.01	±1.0	μA	
Output Leakage Current (Except ICL3232)	$\overline{\text{FORCEOFF}} = \text{GND}$ or $\overline{\text{EN}} = \text{V}_{\text{CC}}$	Full	-	±0.05	±10	μA	
Output Voltage Low	I _{OUT} = 1.6mA	Full	-	-	0.4	V	
Output Voltage High	I _{OUT} = -1.0mA	Full	V _{CC} -0.6	V _{CC} -0.1	-	V	
AUTOMATIC POWERDOWN (ICL3221, ICL3223, ICL3243 Only, FORCEON = GND, $\overline{\text{FORCEOFF}} = \text{V}_{\text{CC}}$)							
Receiver Input Thresholds to Enable Transmitters	ICL32XX Powers Up (See Figure 6)	Full	-2.7	-	2.7	V	
Receiver Input Thresholds to Disable Transmitters	ICL32XX Powers Down (See Figure 6)	Full	-0.3	-	0.3	V	
$\overline{\text{INVALID}}$ Output Voltage Low	I _{OUT} = 1.6mA	Full	-	-	0.4	V	
$\overline{\text{INVALID}}$ Output Voltage High	I _{OUT} = -1.0mA	Full	V _{CC} -0.6	-	-	V	
Receiver Threshold to Transmitters Enabled Delay (t _{WU})		25	-	100	-	μs	

Electrical Specifications Test Conditions: VCC = 3V to 5.5V, C1 - C4 = 0.1μF; Unless Otherwise Specified.
Typicals are at TA = 25°C (Continued)

PARAMETER	TEST CONDITIONS	TEMP (°C)	MIN	TYP	MAX	UNITS	
Receiver Positive or Negative Threshold to <u>INVALID</u> High Delay (t _{INVH})		25	-	1	-	μs	
Receiver Positive or Negative Threshold to <u>INVALID</u> Low Delay (t _{INVL})		25	-	30	-	μs	
RECEIVER INPUTS							
Input Voltage Range		Full	-25	-	25	V	
Input Threshold Low	V _{CC} = 3.3V	25	0.6	1.2	-	V	
	V _{CC} = 5.0V	25	0.8	1.5	-	V	
Input Threshold High	V _{CC} = 3.3V	25	-	1.5	2.4	V	
	V _{CC} = 5.0V	25	-	1.8	2.4	V	
Input Hysteresis		25	-	0.3	-	V	
Input Resistance		25	3	5	7	kΩ	
TRANSMITTER OUTPUTS							
Output Voltage Swing	All Transmitter Outputs Loaded with 3kΩ to Ground	Full	±5.0	±5.4	-	V	
Output Resistance	V _{CC} = V+ = V- = 0V, Transmitter Output = ±2V	Full	300	10M	-	Ω	
Output Short-Circuit Current		Full	-	±35	±60	mA	
Output Leakage Current	V _{OUT} = ±12V, V _{CC} = 0V or 3V to 5.5V Automatic Powerdown or FORCEOFF = <u>SHDN</u> = GND	Full	-	-	±25	μA	
MOUSE DRIVEABILITY (ICL324X Only)							
Transmitter Output Voltage (See Figure 9)	T1 _{IN} = T2 _{IN} = GND, T3 _{IN} = V _{CC} , T3 _{OUT} Loaded with 3kΩ to GND, T1 _{OUT} and T2 _{OUT} Loaded with 2.5mA Each	Full	±5	-	-	V	
TIMING CHARACTERISTICS							
Maximum Data Rate	R _L = 3kΩ, C _L = 1000pF, One Transmitter Switching	Full	250	500	-	kbps	
Receiver Propagation Delay	Receiver Input to Receiver Output, C _L = 150pF	t _{PHL}	25	-	0.3	-	μs
		t _{PLH}	25	-	0.3	-	μs
Receiver Output Enable Time	Normal Operation (Except ICL3232)	25	-	200	-	ns	
Receiver Output Disable Time	Normal Operation (Except ICL3232)	25	-	200	-	ns	
Transmitter Skew	t _{PHL} - t _{PLH}	Full	-	200	1000	ns	
Receiver Skew	t _{PHL} - t _{PLH}	Full	-	100	500	ns	
Transition Region Slew Rate	V _{CC} = 3.3V, R _L = 3kΩ to 7kΩ, Measured From 3V to -3V or -3V to 3V	C _L = 200pF to 2500pF	25	4	8.0	30	V/μs
		C _L = 200pF to 1000pF	25	6	-	30	V/μs
ESD PERFORMANCE							
RS-232 Pins (T _{OUT} , R _{IN})	Human Body Model	ICL3221 - ICL3243	25	-	±15	-	kV
	IEC1000-4-2 Contact Discharge	ICL3221 - ICL3243	25	-	±8	-	kV
	IEC1000-4-2 Air Gap Discharge	ICL3221 - ICL3232	25	-	±8	-	kV
		ICL3241 - ICL3243	25	-	±6	-	kV
All Other Pins	Human Body Model	ICL3221 - ICL3243	25	-	±2	-	kV

Detailed Description

ICL32XX interface ICs operate from a single +3V to +5.5V supply, guarantee a 250kbps minimum data rate, require only four small external 0.1μF capacitors, feature low power consumption, and meet all EIA RS-232C and V.28 specifications. The circuit is divided into three sections: charge pump, transmitters and receivers.

Charge-Pump

Intersil's new ICL32XX family utilizes regulated on-chip dual charge pumps as voltage doublers, and voltage inverters to generate ±5.5V transmitter supplies from a V_{CC} supply as low as 3.0V. This allows these devices to maintain RS-232 compliant output levels over the ±10% tolerance range of 3.3V powered systems. The efficient on-chip power supplies require only four small, external 0.1μF capacitors for the voltage doubler and inverter functions at $V_{CC} = 3.3V$. See the *Capacitor Selection* section, and Table 3 for capacitor recommendations for other operating conditions. The charge pumps operate discontinuously (i.e., they turn off as soon as the V+ and V- supplies are pumped up to the nominal values), resulting in significant power savings.

Transmitters

The transmitters are proprietary, low dropout, inverting drivers that translate TTL/CMOS inputs to EIA/TIA-232 output levels. Coupled with the on-chip ±5.5V supplies, these transmitters deliver true RS-232 levels over a wide range of single supply system voltages.

Except for the ICL3232, all transmitter outputs disable and assume a high impedance state when the device enters the powerdown mode (see Table 2). These outputs may be driven to ±12V when disabled.

All devices guarantee a 250kbps data rate for full load conditions (3kΩ and 1000pF), $V_{CC} \geq 3.0V$, with one transmitter operating at full speed. Under more typical conditions of $V_{CC} \geq 3.3V$, $R_L = 3k\Omega$, and $C_L = 250pF$, one transmitter easily operates at 900kbps.

Transmitter inputs float if left unconnected, and may cause I_{CC} increases. Connect unused inputs to GND for the best performance.

Receivers

All the ICL32XX devices contain standard inverting receivers that three-state (except for the ICL3232) via the EN or FORCEOFF control lines. Additionally, the two ICL324X products include noninverting (monitor) receivers (denoted by the R_{OUTB} label) that are always active, regardless of the state of any control lines. All the receivers convert RS-232 signals to CMOS output levels and accept inputs up to ±25V while presenting the required 3kΩ to 7kΩ input impedance (see Figure 1) even if the power is off ($V_{CC} = 0V$). The receivers' Schmitt trigger input stage uses hysteresis to increase noise immunity and decrease errors due to slow input signal transitions.

The ICL3221/22/23/41 inverting receivers disable only when EN is driven high. ICL3243 receivers disable during forced (manual) powerdown, but not during automatic powerdown (see Table 2).

ICL324X monitor receivers remain active even during manual powerdown and forced receiver disable, making them extremely useful for Ring Indicator monitoring. Standard receivers driving powered down peripherals must be disabled to prevent current flow through the peripheral's protection diodes (see Figures 2 and 3). This renders them useless for wake up functions, but the corresponding monitor receiver can be dedicated to this task as shown in Figure 3.

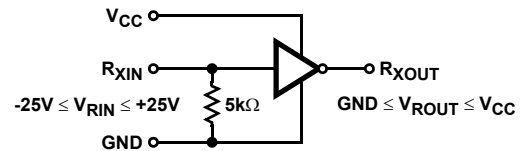


FIGURE 1. INVERTING RECEIVER CONNECTIONS

Low Power Operation

These 3V devices require a nominal supply current of 0.3mA, even at $V_{CC} = 5.5V$, during normal operation (not in powerdown mode). This is considerably less than the 5mA to 11mA current required by comparable 5V RS-232 devices, allowing users to reduce system power simply by switching to this new family.

Pin Compatible Replacements For 5V Devices

The ICL3221/22/32 are pin compatible with existing 5V RS-232 transceivers - see the *Features* section on the front page for details.

This pin compatibility coupled with the low I_{CC} and wide operating supply range, make the ICL32XX potential lower power, higher performance drop-in replacements for existing 5V applications. As long as the ±5V RS-232 output swings are acceptable, and transmitter input pull-up resistors aren't required, the ICL32XX should work in most 5V applications.

When replacing a device in an existing 5V application, it is acceptable to terminate C_3 to V_{CC} as shown on the *Typical Operating Circuit*. Nevertheless, terminate C_3 to GND if possible, as slightly better performance results from this configuration.

Powerdown Functionality (Except ICL3232)

The already low current requirement drops significantly when the device enters powerdown mode. In powerdown, supply current drops to 1μA, because the on-chip charge pump turns off (V_+ collapses to V_{CC} , V_- collapses to GND), and the transmitter outputs three-state. Inverting receiver outputs may or may not disable in powerdown; refer to Table 2 for details. This micro-power mode makes these devices ideal for battery powered and portable applications.

Software Controlled (Manual) Powerdown

Most devices in the ICL32XX family provide pins that allow the user to force the IC into the low power, standby state.

On the ICL3222 and ICL3241, the powerdown control is via a simple shutdown (SHDN) pin. Driving this pin high enables normal operation, while driving it low forces the IC into its powerdown state. Connect SHDN to V_{CC} if the powerdown function isn't needed. Note that all the receiver outputs remain enabled during shutdown (see Table 2). For the lowest power consumption during powerdown, the receivers should also be disabled by driving the $\overline{EN}$ input high (see next section, and Figures 2 and 3).

The ICL3221, ICL3223, and ICL3243 utilize a two pin approach where the $\overline{FORCEON}$ and $\overline{FORCEOFF}$ inputs determine the IC's mode. For always enabled operation, $\overline{FORCEON}$ and $\overline{FORCEOFF}$ are both strapped high. To switch between active and powerdown modes, under logic or software control, only the $\overline{FORCEOFF}$ input need be driven. The $\overline{FORCEON}$ state isn't critical, as $\overline{FORCEOFF}$ dominates over $\overline{FORCEON}$. Nevertheless, if strictly manual control over powerdown is desired, the user must strap $\overline{FORCEON}$ high to disable the automatic powerdown circuitry. ICL3243 inverting (standard) receiver outputs also disable when the device is in manual powerdown, thereby eliminating the possible current path through a shutdown peripheral's input protection diode (see Figures 2 and 3).

TABLE 2. POWERDOWN AND ENABLE LOGIC TRUTH TABLE

RS-232 SIGNAL PRESENT AT RECEIVER INPUT?	$\overline{FORCEOFF}$ OR SHDN INPUT	$\overline{FORCEON}$ INPUT	$\overline{EN}$ INPUT	TRANSMITTER OUTPUTS	RECEIVER OUTPUTS	(NOTE 4) $\overline{ROUTB}$ OUTPUTS	$\overline{INVALID}$ OUTPUT	MODE OF OPERATION
ICL3222, ICL3241								
N.A.	L	N.A.	L	High-Z	Active	Active	N.A.	Manual Powerdown
N.A.	L	N.A.	H	High-Z	High-Z	Active	N.A.	Manual Powerdown w/Rcvr. Disabled
N.A.	H	N.A.	L	Active	Active	Active	N.A.	Normal Operation
N.A.	H	N.A.	H	Active	High-Z	Active	N.A.	Normal Operation w/Rcvr. Disabled
ICL3221, ICL3223								
No	H	H	L	Active	Active	N.A.	L	Normal Operation (Auto Powerdown Disabled)
No	H	H	H	Active	High-Z	N.A.	L	
Yes	H	L	L	Active	Active	N.A.	H	Normal Operation (Auto Powerdown Enabled)
Yes	H	L	H	Active	High-Z	N.A.	H	
No	H	L	L	High-Z	Active	N.A.	L	Powerdown Due to Auto Powerdown Logic
No	H	L	H	High-Z	High-Z	N.A.	L	
Yes	L	X	L	High-Z	Active	N.A.	H	Manual Powerdown
Yes	L	X	H	High-Z	High-Z	N.A.	H	Manual Powerdown w/Rcvr. Disabled
No	L	X	L	High-Z	Active	N.A.	L	Manual Powerdown
No	L	X	H	High-Z	High-Z	N.A.	L	Manual Powerdown w/Rcvr. Disabled
ICL3243								
No	H	H	N.A.	Active	Active	Active	L	Normal Operation (Auto Powerdown Disabled)
Yes	H	L	N.A.	Active	Active	Active	H	Normal Operation (Auto Powerdown Enabled)
No	H	L	N.A.	High-Z	Active	Active	L	Powerdown Due to Auto Powerdown Logic
Yes	L	X	N.A.	High-Z	High-Z	Active	H	Manual Powerdown
No	L	X	N.A.	High-Z	High-Z	Active	L	Manual Powerdown

NOTE:

- Applies only to the ICL3241 and ICL3243.

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