Advanced Low Power 5V RS232 Drivers/Receivers with Small Capacitors

FEATURES

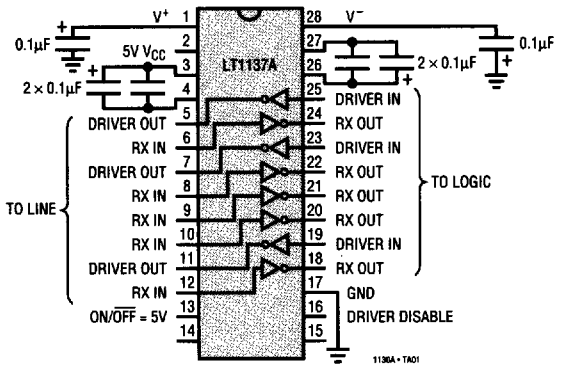
- ESD Protection over ±**10kV**
- Uses Small Capacitors: 0.1µF, 0.2µF
- 1µA Supply Current in SHUTDOWN
- Operates to 120k Baud
- CMOS Comparable Low Power
- Operates from a Single 5V Supply
- Easy PC Layout: Flowthrough Architecture
- Rugged Bipolar Design: Absolutely No Latch-Up
- Outputs Assume a High Impedance State When Off or Powered Down
- Improved Protection: RS232 I/O Lines Can be Forced to ±30V Without Damage
- Output Overvoltage Does Not Force Current Back Into Supplies
- Available in SO and SSOP Packages

DESCRIPTION

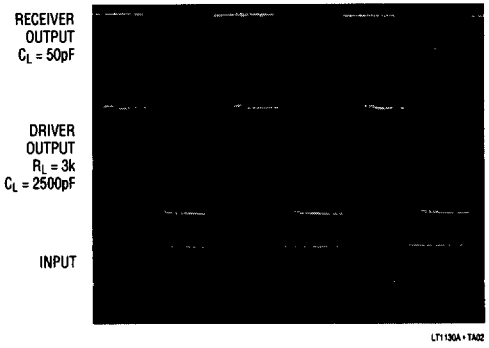
The LT1130A/LT1140A series of RS232 drivers/receivers features special bipolar construction techniques which protect the drivers and receivers beyond the fault conditions stipulated for RS232. Driver outputs and receiver inputs can be shorted to ±30V without damaging the device or the power supply generator. In addition, the RS232 I/O pins are resilient to multiple ±10kV ESD strikes. An advanced driver output stage operates up to 120kBaud while driving heavy capacitive loads. Supply current is typically 12mA, competitive with CMOS devices.

Several members of the series include flexible operating mode controls. The Driver Disable pin disables the drivers and the charge pump, the ON/$\overline{\text{OFF}}$ pin shuts down all circuitry. While shut down, the drivers and receivers assume high impedance output states.

Basic Operation



Output Waveforms



LT1130A 5-Driver/5-Receiver RS232 Transceiver
LT1131A 5-Driver/4-Receiver RS232 Transceiver w/Shutdown
LT1132A 5-Driver/3-Receiver RS232 Transceiver
LT1133A 3-Driver/5-Receiver RS232 Transceiver
LT1134A 4-Driver/4-Receiver RS232 Transceiver
LT1135A 5-Driver/3-Receiver RS232 Transceiver w/o Charge Pump
LT1136A 4-Driver/5-Receiver RS232 Transceiver w/Shutdown
LT1137A 3-Driver/5-Receiver RS232 Transceiver w/Shutdown
LT1138A 5-Driver/3-Receiver RS232 Transceiver w/Shutdown
LT1139A 4-Driver/4-Receiver RS232 Transceiver w/Shutdown
LT1140A 5-Driver/3-Receiver RS232 Transceiver w/o Charge Pump
LT1141A 3-Driver/5-Receiver RS232 Transceiver w/o Charge Pump

ABSOLUTE MAXIMUM RATINGS (Note 1)

Supply Voltage (V_{CC}) 6V
V^+ 13.2V
V^- ..... −13.2V
Input Voltage
Driver ..... V^- to V^+
Receiver ..... −30V to 30V
On/Off Pin ..... −0.3V to 12V
Driver Disable Pin ..... −0.3V to V_{CC} + 0.3V
Output Voltage
Driver ..... −30V to 30V
Receiver ..... −0.3V to V_{CC} + 0.3V

Short-Circuit Duration
V^+ ..... 30 sec
V^- ..... 30 sec
Driver Output ..... Indefinite
Receiver Output ..... Indefinite
Operating Temperature Range
LT113XAC/LT114XAC ..... 0°C to 70°C
LT113XAIN/LT114XAIS ..... −40° to 85°C
Storage Temperature Range ..... −65°C to 150°C
Lead Temperature (Soldering, 10 sec) ..... 300°C

PRODUCT SELECTION TABLE

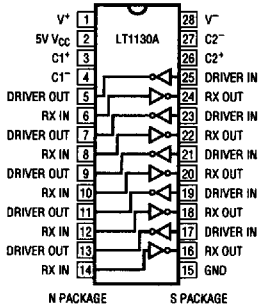
Part Number	Power Supply Voltages*	Shutdown	Driver Disable	Drivers	Receivers	External Components
LT1130A	5	No	No	5	5	4 Capacitors
LT1131A	5	Yes	Yes	5	4	4 Capacitors
LT1132A	5	No	No	5	3	4 Capacitors
LT1133A	5	No	No	3	5	4 Capacitors
LT1134A	5	No	No	4	4	4 Capacitors
LT1135A	5, 12, −12	No	No	5	3	None
LT1136A	5	Yes	Yes	4	5	4 Capacitors
LT1137A	5	Yes	Yes	3	5	4 Capacitors
LT1138A	5	Yes	Yes	5	3	4 Capacitors
LT1139A	5, 12	Yes	No	4	4	2 Capacitors
LT1140A	5, 12, −12	Yes	Yes	5	3	None
LT1141A	5, 12, −12	Yes	Yes	3	5	None

*The LT1130A, LT1131A, LT1132A, LT1134A, LT1136A, LT1137A and LT1138A can operate with 5V and 12V supplies and two external capacitors.

PACKAGE/ORDER INFORMATION

5-DRIVER/5-RECEIVER

TOP VIEW



N PACKAGE 28-LEAD PLASTIC DIP (.600" WIDE)
S PACKAGE 28-LEAD PLASTIC SOL (.300" WIDE)

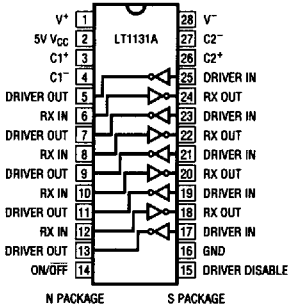
T_{JMAX} = 150°C, θ_{JA} = 56°C/W (N)
T_{JMAX} = 150°C, θ_{JA} = 68°C/W (S)

ORDER PART NUMBER

LT1130ACN
LT1130ACS

5-DRIVER/4-RECEIVER WITH SHUTDOWN

TOP VIEW



N PACKAGE 28-LEAD PLASTIC DIP (.600" WIDE)
S PACKAGE 28-LEAD PLASTIC SOL (.300" WIDE)

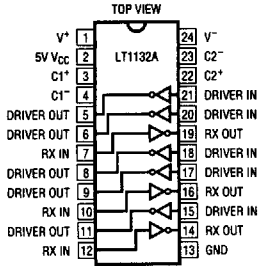
T_{JMAX} = 150°C, θ_{JA} = 56°C/W (N)
T_{JMAX} = 150°C, θ_{JA} = 68°C/W (S)

ORDER PART NUMBER

LT1131ACN
LT1131ACS

PACKAGE/ORDER INFORMATION

5-DRIVER/3-RECEIVER



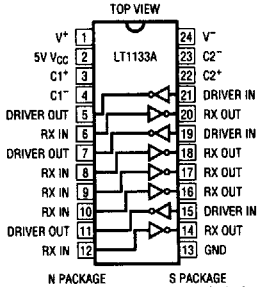
N PACKAGE 24-LEAD PLASTIC DIP (.300" WIDE)
S PACKAGE 24-LEAD PLASTIC SOL (.300" WIDE)

T_{JMAX} = 150°C, θ_{JA} = 58°C/W (N)
T_{JMAX} = 150°C, θ_{JA} = 80°C/W (S)

ORDER PART NUMBER

LT1132ACN
LT1132ACS

3-DRIVER/5-RECEIVER



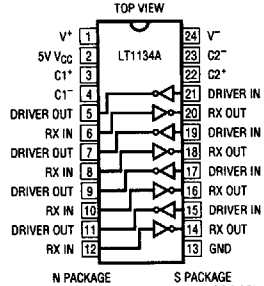
N PACKAGE 24-LEAD PLASTIC DIP (.300" WIDE)
S PACKAGE 24-LEAD PLASTIC SOL (.300" WIDE)

T_{JMAX} = 150°C, θ_{JA} = 58°C/W (N)
T_{JMAX} = 150°C, θ_{JA} = 80°C/W (S)

ORDER PART NUMBER

LT1133ACN
LT1133ACS

4-DRIVER/4-RECEIVER



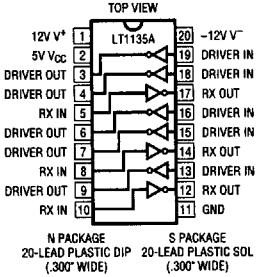
N PACKAGE 24-LEAD PLASTIC DIP (.300" WIDE)
S PACKAGE 24-LEAD PLASTIC SOL (.300" WIDE)

T_{JMAX} = 150°C, θ_{JA} = 58°C/W (N)
T_{JMAX} = 150°C, θ_{JA} = 80°C/W (S)

ORDER PART NUMBER

LT1134ACN
LT1134ACS
LT1134AIN
LT1134AIS

5-DRIVER/3-RECEIVER WITHOUT CHARGE PUMP



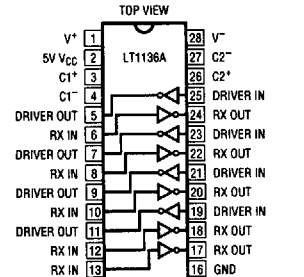
N PACKAGE 20-LEAD PLASTIC DIP (.300" WIDE)
S PACKAGE 20-LEAD PLASTIC SOL (.300" WIDE)

T_{JMAX} = 150°C, θ_{JA} = 79°C/W (N)
T_{JMAX} = 150°C, θ_{JA} = 85°C/W (S)

ORDER PART NUMBER

LT1135ACN
LT1135ACS

4-DRIVER/5-RECEIVER WITH SHUTDOWN



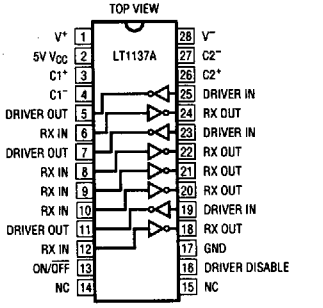
N PACKAGE 28-LEAD PLASTIC DIP (.600" WIDE)
S PACKAGE 28-LEAD PLASTIC SOL (.300" WIDE)

T_{JMAX} = 150°C, θ_{JA} = 56°C/W (N)
T_{JMAX} = 150°C, θ_{JA} = 68°C/W (S)

ORDER PART NUMBER

LT1136ACN
LT1136ACS

3-DRIVER/5-RECEIVER WITH SHUTDOWN



G PACKAGE 28-LEAD PLASTIC SSOP (.300" WIDE)
N PACKAGE 28-LEAD PLASTIC DIP (.600" WIDE)
S PACKAGE 28-LEAD PLASTIC SOL (.300" WIDE)

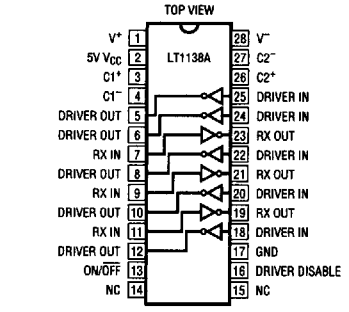
T_{JMAX} = 150°C, θ_{JA} = 96°C/W (G)
T_{JMAX} = 150°C, θ_{JA} = 56°C/W (N)
T_{JMAX} = 150°C, θ_{JA} = 68°C/W (S)

ORDER PART NUMBER

LT1137ACG
LT1137ACN
LT1137ACS
LT1137AIN
LT1137AIS

PACKAGE/ORDER INFORMATION

5-DRIVER/3-RECEIVER WITH SHUTDOWN



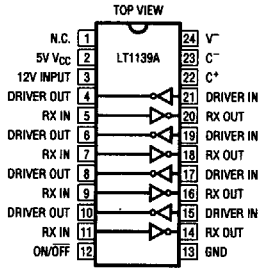
G PACKAGE 28-LEAD PLASTIC SSOP (.300" WIDE)
N PACKAGE 28-LEAD PLASTIC DIP (.600" WIDE)
S PACKAGE 28-LEAD PLASTIC SOL (.300" WIDE)

T_{JMAX} = 150°C, θ_{JA} = 96°C/W (G)
T_{JMAX} = 150°C, θ_{JA} = 56°C/W (N)
T_{JMAX} = 150°C, θ_{JA} = 68°C/W (S)

ORDER PART NUMBER

LT1138ACG
LT1138ACN
LT1138ACS

4-DRIVER/4-RECEIVER WITH SHUTDOWN WITH 12V AND 5V SUPPLIES



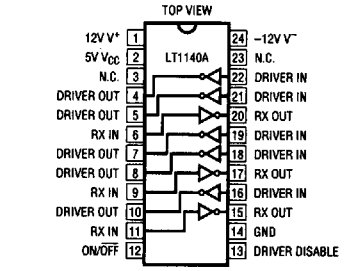
N PACKAGE 24-LEAD PLASTIC DIP (.300" WIDE)
S PACKAGE 24-LEAD PLASTIC SOL (.300" WIDE)

T_{JMAX} = 150°C, θ_{JA} = 58°C/W (N)
T_{JMAX} = 150°C, θ_{JA} = 80°C/W (S)

ORDER PART NUMBER

LT1139ACN
LT1139ACS

5-DRIVER/3-RECEIVER WITH SHUTDOWN WITHOUT CHARGE PUMP



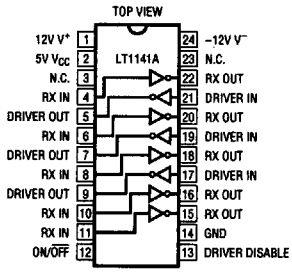
N PACKAGE 24-LEAD PLASTIC DIP (.300" WIDE)
S PACKAGE 24-LEAD PLASTIC SOL (.300" WIDE)

T_{JMAX} = 150°C, θ_{JA} = 58°C/W (N)
T_{JMAX} = 150°C, θ_{JA} = 80°C/W (S)

ORDER PART NUMBER

LT1140ACN
LT1140ACS

3-DRIVER/5-RECEIVER WITH SHUTDOWN WITHOUT CHARGE PUMP



N PACKAGE 24-LEAD PLASTIC DIP (.300" WIDE)
S PACKAGE 24-LEAD PLASTIC SOL (.300" WIDE)

T_{JMAX} = 150°C, θ_{JA} = 58°C/W (N)
T_{JMAX} = 150°C, θ_{JA} = 80°C/W (S)

ORDER PART NUMBER

LT1141ACN
LT1141ACS

Consult the factory for Industrial and Military parts

ELECTRICAL CHARACTERISTICS (Note 2)

PARAMETER	CONDITIONS		MIN	TYP	MAX	UNITS
Power Supply Generator						
V^+ Output				8.6		V
V^- Output				–7.8		V
5V V_{CC} Supply Current: LT1130A, LT1131A, LT1132A, LT1133A, LT1134A, LT1136A, LT1138A	(Note 3)	●		15	25	mA
5V V_{CC} Supply Current: LT1135A, LT1140A, LT1141A	(Note 3), V^+ = 12V, V^- = –12V	●		8	15	mA
5V V_{CC} Supply Current: LT1137A	(Note 3)	●		12	17	mA
5V V_{CC} Supply Current: LT1139A	(Note 3), V^+ = 12V	●		8	15	mA

ELECTRICAL CHARACTERISTICS (Note 2)

PARAMETER	CONDITIONS		MIN	TYP	MAX	UNITS
12V V^+ Supply Current: LT1139A	(Note 3)	●		6	10	mA
−12V V^- Supply Current: LT1135A, LT1140A, LT1141A	(Note 3) V^+ = 12V	●		2	6	mA
Supply Current when OFF (V_{CC})	SHUTDOWN (Note 4) DRIVER DISABLE	●		1 4	10	µA mA
Supply Rise Time SHUTDOWN to Turn-On	C1, C2, C^+, C^- = 1.0µF C^+, C^- = 0.1µF, C1, C2 = 0.2µF			2.0 0.2		ms ms
ON/$\overline{OFF}$ Pin Thresholds	Input Low Level (Device SHUTDOWN) Input High Level (Device Enabled)	● ●	 2.4	1.4 1.4	0.8	V V
ON/$\overline{OFF}$ Pin Current	0V ≤ $V_{ON/OFF}$ ≤ 5V	●	−15		80	µA
DRIVER DISABLE Pin Thresholds	Input Low Level (Drivers Enabled) Input High Level (Drivers Disabled)	● ●	 2.4	1.4 1.4	0.8	V V
DRIVER DISABLE Pin Current	0V ≤ $V_{DRIVER\ DISABLE}$ ≤ 5V	●	−10		500	µA
Oscillator Frequency				130		kHz
Any Driver						
Output Voltage Swing	Load = 3k to GND Positive Negative	● ●	5	7.3 −6.5	 −5	V V
Logic Input Voltage Level	Input Low Level (V_{OUT} = High) Input High Level (V_{OUT} = Low)	● ●	 2	1.4 1.4	0.8	V V
Logic Input Current	0.8V ≤ V_{IN} ≤ 2V	●		5	20	µA
Output Short-Circuit Current	V_{OUT} = 0V		±9	±17		mA
Output Leakage Current	SHUTDOWN V_{OUT} = ±30V (Note 4)	●		10	100	µA
Slew Rate	R_L = 3k, C_L = 51pF R_L = 3k, C_L = 2500pF			15 6	30	V/µs V/µs
Propagation Delay	Output Transition t_{HL} High-to-Low (Note 5) Output Transition t_{LH} Low-to-High			0.6 0.5	1.3 1.3	µs µs
Any Receiver						
Input Voltage Thresholds	Input Low Threshold (V_{OUT} = High) Input High Threshold (V_{OUT} = Low)	● ●	0.8 	1.3 1.7	 2.4	V V
Hysteresis		●	0.1	0.4	1	V
Input Resistance	V_{IN} = ±10V		3	5	7	kΩ
Output Voltage	Output Low, I_{OUT} = −1.6mA Output High, I_{OUT} = 160µA (V_{CC} = 5V)	● ●	 3.5	0.2 4.2	0.4	V V
Output Leakage Current	SHUTDOWN (Note 4) 0 ≤ V_{OUT} ≤ V_{CC}	●		1	10	µA
Output Short-Circuit Current	Sinking Current, V_{OUT} = V_{CC} Sourcing Current, V_{OUT} = 0V		 10	−20 20	−10	mA mA
Propagation Delay	Output Transition t_{HL} High-to-Low (Note 6) Output Transition t_{LH} Low-to-High			250 350	600 600	ns ns

The ● denotes specifications which apply over the operating temperature range (0°C ≤ T_A ≤ 70°C for commercial grade and −40°C ≤ T_A ≤ 85°C for industrial grade).

Note 1: Absolute Maximum Ratings are those values beyond which the life of the device may be impaired.

Note 2: Testing done at V_{CC} = 5V and $V_{ON/OFF}$ = 3V.

Note 3: Supply current is measured with driver and receiver outputs unloaded and the driver inputs tied high.

Note 4: Supply current and driver leakage current measurements in SHUTDOWN are performed with $V_{ON/OFF}$ = 0.1V. Supply current measurements using DRIVER DISABLE are performed with $V_{DRIVER\ DISABLE}$ = 3V.

For LT1135A, LT1139A, LT1140A and LT1141A with 12V supplies, V_{OUT} leakage is 200µA for V_{OUT} forced to ±25V.

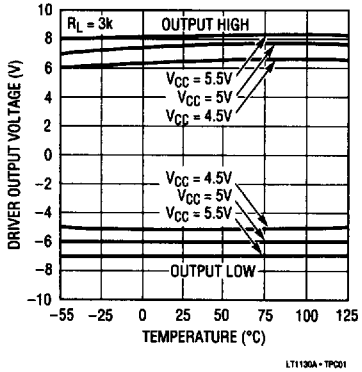
Note 5: For driver delay measurements, R_L = 3k and C_L = 51pF. Trigger points are set between the driver's input logic threshold and the output transition to the zero crossing (t_{HL} = 1.4V to 0V and t_{LH} = 1.4V to 0V).

Note 6: For receiver delay measurements, C_L = 51pF. Trigger points are set between the receiver's input logic threshold and the output transition to standard TTL/CMOS logic threshold (t_{HL} = 1.3V to 2.4V and t_{LH} = 1.7V to 0.8V).

Note 7: For the LT1133A and LT1137A absolute maximum externally applied V^- = 6.5V. Internal charge pump will drive this pin to a higher negative voltage.

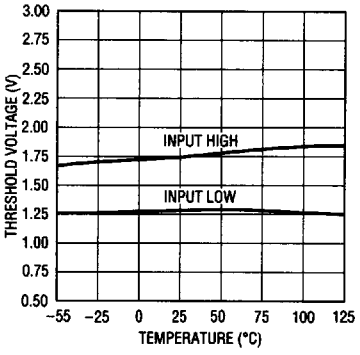
TYPICAL PERFORMANCE CHARACTERISTICS

Driver Output Voltage



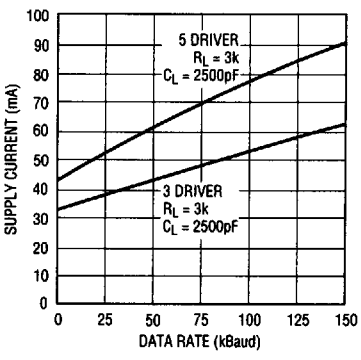
LT1130A • TPC01

Receiver Input Thresholds



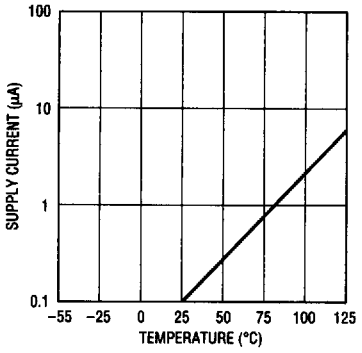
LT1137A • TPC02

Supply Current vs Data Rate



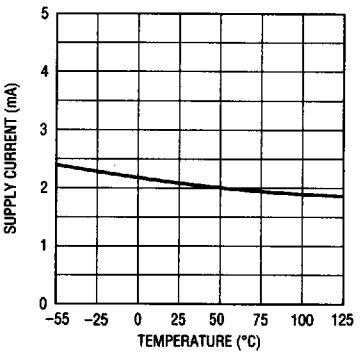
LT1130A • TPC03

Supply Current in SHUTDOWN



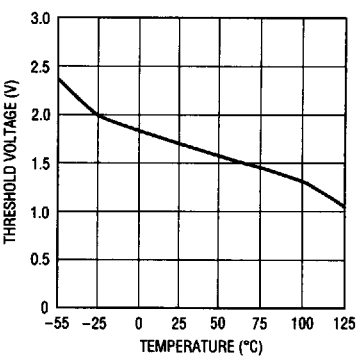
LT1137A • TPC04

Supply Current in DRIVER DISABLE



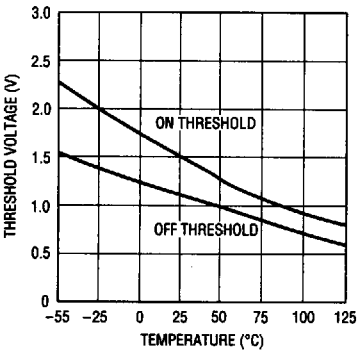
LT1137A • TPC05

DRIVER DISABLE Threshold



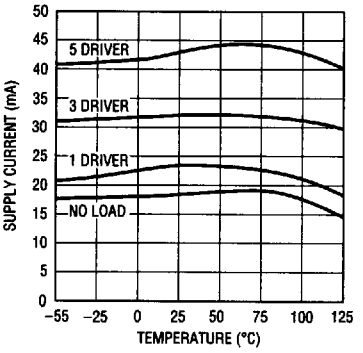
LT1137A • TPC06

ON/$\overline{\text{OFF}}$ Thresholds



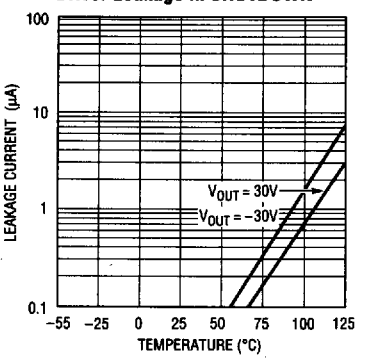
LT1137A • TPC07

Supply Current



LT1130A • TPC08

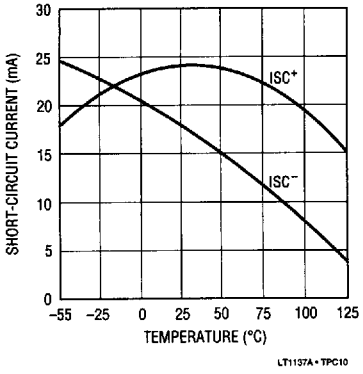
Driver Leakage in SHUTDOWN



LT1137A • TPC09

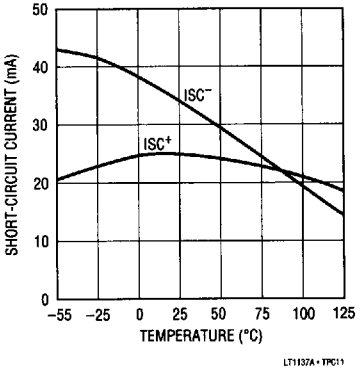
TYPICAL PERFORMANCE CHARACTERISTICS

Driver Short-Circuit Current



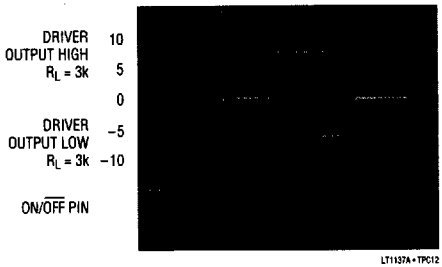
LT1137A • TPC10

Receiver Short-Circuit Current



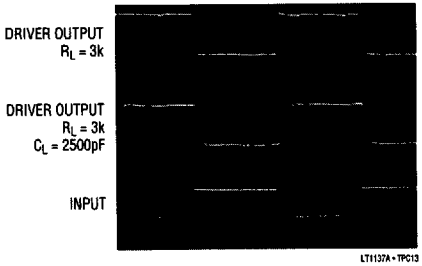
LT1137A • TPC11

SHUTDOWN to Driver Output



LT1137A • TPC12

Driver Output Waveforms



LT1137A • TPC13

PIN FUNCTIONS

V_{CC}: 5V Input Supply Pin. Supply current drops to zero in the SHUTDOWN mode. This pin should be decoupled with a 0.1µF ceramic capacitor close to the package pin. Insufficient supply bypassing can result in low output drive levels and erratic charge pump operation.

GND: Ground Pin.

ON/$\overline{OFF}$: Control the operation mode of the device and is TTL/CMOS compatible. A logic low puts the device in the SHUTDOWN mode which reduces input supply curent to zero and places all of the drivers and receivers in high impedance state. A logic high fully enables the transceiver.

DRIVER DISABLE: This pin provides an alternate control for the charge pump and RS232 drivers. A logic high on this pin shuts down the charge pump and places all drivers in a high impedance state. Receivers remain active under these conditions. Floating the driver disable pin or driving it to a logic low level fully enables the transceiver. A logic low on the ON/$\overline{OFF}$ pin supersedes the state of the Driver Disable pin. Supply current drops to 4mA when in DRIVER DISABLE mode.

V^+: Positive Supply Output (RS232 Drivers). This pin requires an external charge storage capacitor C ≥ 1.0µF, tied to ground or V_{CC}. Larger value capacitors may be used to reduce supply ripple. With multiple transceivers, the V^+ and V^- pins may be paralleled into common capacitors. For large numbers of transceivers, increasing the size of the shared common storage capacitors is recommended to reduce ripple.

PIN FUNCTIONS

V^-: Negative Supply Output (RS232 Drivers). This pin requires an external charge storage capacitor $C \geq 0.1\mu F$. V^- is short-circuit proof for 30 seconds.

$C1^+$, $C1^-$, $C2^+$, $C2^-$: Commutating Capacitor Inputs. These pins require two external capacitors $C \geq 0.2\mu F$: one from $C1^+$ to $C1^-$, and another from $C2^+$ to $C2^-$. To maintain charge pump efficiency, the capacitor's effective series resistance should be less than 2Ω. For $C \geq 1\mu F$, low ESR tantalum capacitors work well in this application, although small value ceramic capacitors may be used with a minimal reduction in charge pump compliance. In applications where larger positive voltages are available, such as 12V, C1 may be omitted and the positive voltage may be connected directly to the $C1^+$ pin. In this mode of operation, the V^+ pin should be decoupled with a $0.1\mu F$ ceramic capacitor.

DRIVER IN: RS232 Driver Input Pins. These inputs are TTL/CMOS compatible. Inputs should not be allowed to float. Tie unused inputs to V_{CC}.

DRIVER OUT: Driver Outputs at RS232 Voltage Levels. Driver output swing meets RS232 levels for loads up to 3k. Slew rates are controlled for lightly loaded lines. Output current capability is sufficient for load conditions up to 2500pF. Outputs are in a high impedance state when in SHUTDOWN mode, V_{CC} = 0V, or when the driver disable pin is active. Outputs are fully short-circuit protected from V^- + 30V to V^+ – 30V. Applying higher voltages will not damage the device if the overdrive is moderately current limited. Short circuits on one output can load the power supply generator and may disrupt the signal levels of the other outputs. The driver outputs are protected against ESD to ±10kV for human body model discharges.

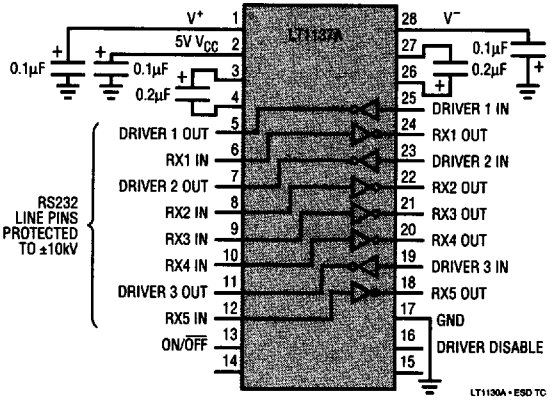
RX IN: Receiver Inputs. These pins accept RS232 level signals (±30V) into a protected 5k terminating resistor. The receiver inputs are protected against ESD to ±10kV for human body model discharges. Each receiver provides 0.4V of hysteresis for noise immunity. Open receiver inputs assume a logic low state.

RX OUT: Receiver Outputs with TTL/CMOS Voltage Levels. Outputs are in a high impedance state when in SHUTDOWN mode to allow data line sharing. Outputs are fully short-circuit protected to ground or V_{CC} with the power on, off, or in SHUTDOWN mode.

ESD PROTECTION

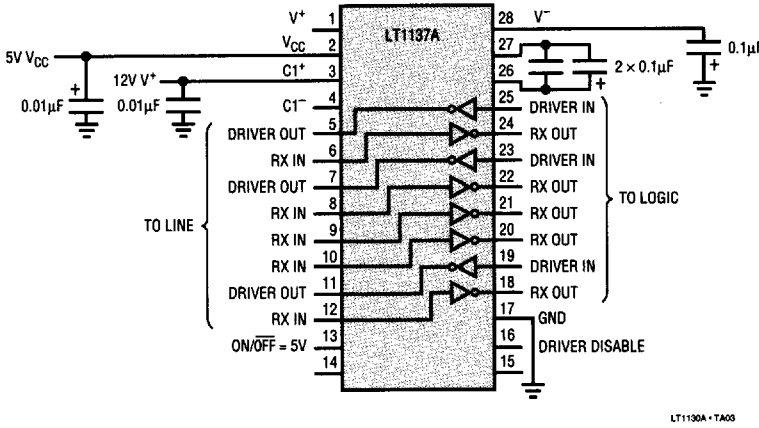
The RS232 line inputs of the LT1130A/LT1140A series of RS232 Driver/Receivers have on-chip protection from ESD transients up to ±10kV. The protection structures act to divert the static discharge safely to system ground. In order for the ESD protection to function effectively, the power supply and ground pins of the LT1130A/LT1140A must be connected to ground through low impedances. The power supply decoupling capacitors and charge pump storage capacitors provide this low impedance in normal application of the circuit. The only constraint is that low ESR capacitors must be used for bypassing and charge storage. ESD testing must be done with pins V_{CC}, V^+, V^- and GND shorted to ground or connected with low ESR capacitors.

ESD Test Circuit

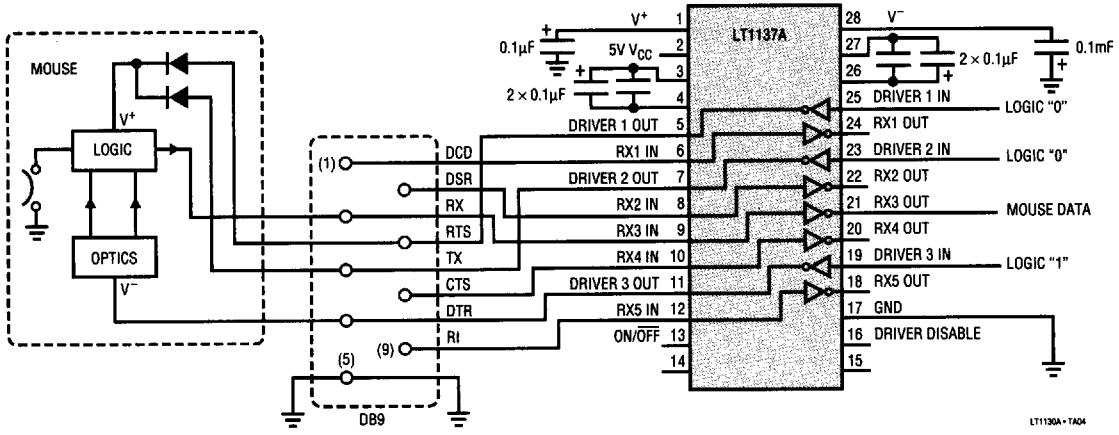


TYPICAL APPLICATIONS

Operation Using 5V and 12V Power Supplies



Typical Mouse Driving Application



TYPICAL APPLICATIONS

Sharing Power Supply Generator with a Second Transceiver