

## ±20kV ESD Protection, 3V-5.5V Power Supply, True RS-232 Transceivers

### FEATURES

- Meet or Exceed TIA/EIA-232-F Standard
- For the RS232 Bus Pin,  
ESD Protection: ±20kV (HBM)
- 3V-5.5V Single Power Supply
- 250kbps Data Transmission Rate
- Including Two Receivers and Two Transmitters
- 1mA Low Quiescent Current
- Adopt Small-sized SOP16 and TSSOP16 Packages
- Fail Safety for Output Open-circuit

### PRODUCT DESCRIPTION

The MS2232/MS2232T is integrated with a charge pump. And it is a RS-232 transceiver with ±20kV ESD protection, which includes two receivers and two transmitters. The chip meets TIA/EIA-232 standard, which provides the communication interface for asynchronous communication controller and the serial port connector.

The chip operates on 3V-5.5V power supply and employs a charge pump with only four 0.1-0.47μF capacitors, which guarantees the RS-232 output level can maintain at 250kbps data rate.

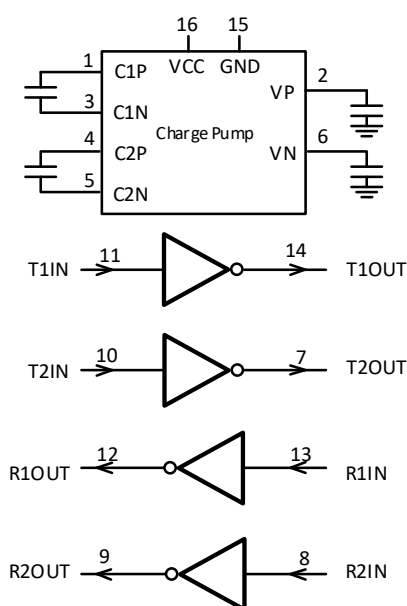
### APPLICATIONS

- Battery-powered Equipment
- Laptops
- Printer
- xDSL Modem

### PRODUCT SPECIFICATION

Part Number	Package	Marking
MS2232	SOP16	MS2232
MS2232T	TSSOP16	MS2232T

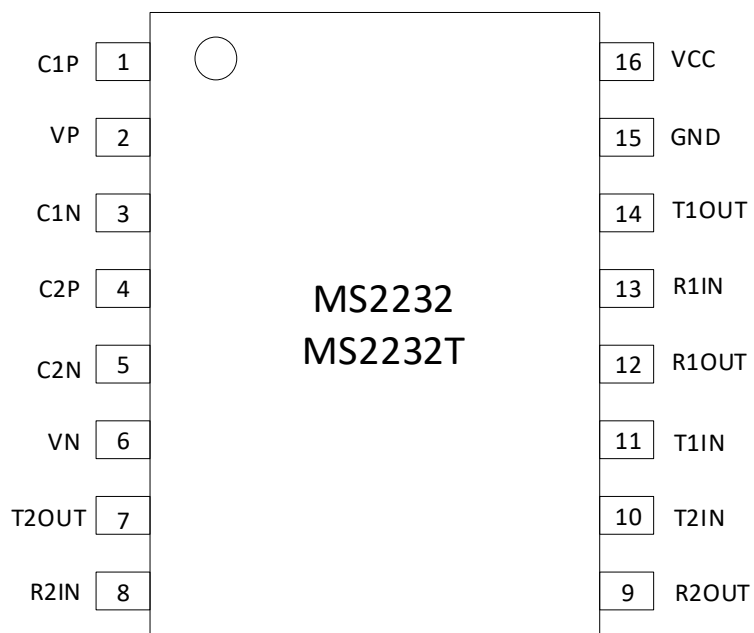
### BLOCK DIAGRAM



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## PIN CONFIGURATION



## PIN DESCRIPTION

Pin	Name	Type	Description
1	C1P	-	Positive Terminal of Voltage Doubler Charge Pump Capacitor
2	VP	-	+5.5V Charge Pump Output Voltage
3	C1N	-	Negative Terminal of Voltage Doubler Charge Pump Capacitor
4	C2P	-	Positive Terminal of Inverting Charge Pump Capacitor
5	C2N	-	Negative Terminal of Inverting Charge Pump Capacitor
6	VN	-	-5.5V Charge Pump Output Voltage
7	T2OUT	O	Output of RS-232 Transmitter 2
8	R2IN	I	Input of RS-232 Receiver 2
9	R2OUT	O	Output of TTL/CMOS Receiver 2
10	T2IN	I	Input of TTL/CMOS Transmitter 2
11	T1IN	I	Input of TTL/CMOS Transmitter 1
12	R1OUT	O	Output of TTL/CMOS Receiver 1
13	R1IN	I	Input of RS-232 Receiver 1
14	T1OUT	O	Output of RS-232 Transmitter 1
15	GND	-	Ground
16	VCC	-	3V-5.5V Power Supply Input

## ABSOLUTE MAXIMUM RATINGS

Any exceeding absolute maximum rating application causes permanent damage to device. Because long-time absolute operation state affects device reliability. Absolute ratings just conclude from a series of extreme tests. It doesn't represent chip can operate normally in these extreme conditions.

Parameter	Symbol	Range	Unit
Power Supply	$V_{CC}$	-0.3 ~ +6	V
Positive Output Voltage of Charge Pump	$V_P$	-0.3 ~ +7	V
Negative Output Voltage of Charge Pump	$V_N$	+0.3 ~ -7	V
Voltage Difference between Positive and Negative Outputs	$V_P - V_N$	0 ~ +13	V
Input Voltage on the RS232 Bus	$V_{R1IN}, V_{R2IN}$	-25 ~ +25	V
Output Voltage on the RS232 Bus	$V_{T1OUT}, V_{T2OUT}$	-13 ~ +13	V
Maximum Communication Rate	$f_{MAX}$	1000	kbps
Soldering Temperature(10s)	$T_{SOLDERING}$	260	°C
Storage Temperature	$T_{STG}$	-65 ~ +150	°C
ESD HBM (R1IN,R2IN,T1OUT,T2OUT) (TLP Test Passed)	$V_{ESD}$	±20	kV
ESD (HBM)(Other Pins)		±5	kV

In addition to differential input voltage, reference potential for all voltages is respect to GND.

## RECOMMENDED OPERATING CONGITIONS

Parameter	Symbol	Min	Typ	Max	Unit
Power Supply	$V_{CC}$	3		5.5	V
Operating Temperature	$T_A$	-40		125	°C

## ELECTRICAL CHARACTERISTICS

Unless otherwise noted, all operating conditions are at  $V_{CC}=3-5.5V$ ,  $T_A=25^{\circ}C$ .

### DC CHARACTERISTICS

Parameter	Symbol	Condition	Min	Typ	Max	Unit
<b>Receiver Input</b>						
Input Voltage	$V_I$		-25		+25	V
Low-level Input Voltage	$V_{IL}$	$V_{CC}=3.3V$	0.6	0.9		V
		$V_{CC}=5V$	0.9	1.4		
High-level Input Voltage	$V_{IH}$	$V_{CC}=3.3V$		1.9	2.4	V
		$V_{CC}=5V$		2.4	2.8	
Input Hysteresis Voltage	$V_{IHYS}$			1		V
Input Resistance	$V_{IR}$		3	5	7	k $\Omega$
<b>Receiver Output</b>						
Low-level Output Voltage	$V_{OL}$	$I_{OUT}=1.6mA$			0.4	V
High-level Output Voltage	$V_{OH}$	$I_{OUT}=-1mA$	$V_{CC}-0.6$	$V_{CC}-0.1$		V
<b>Transmitter Input</b>						
Low-level Input Voltage	$V_{IL}$	$V_{CC}=3.3V$			0.8	V
		$V_{CC}=5V$			0.8	
High-level Input Voltage	$V_{IH}$	$V_{CC}=3.3V$	2.0			V
		$V_{CC}=5V$	2.4			
Input Hysteresis Voltage	$V_{IHYS}$			0.5		V
Input Leakage Current	$I_{ILEAK}$			$\pm 0.01$	$\pm 1$	$\mu A$
<b>Transmitter Output</b>						
Output Voltage Swing <sup>1</sup>	$V_O$	All transmitter output terminals connect 3k $\Omega$ load resistor to ground.	$\pm 5.0$	$\pm 5.5$		V
Output Open-circuit Current <sup>1</sup>	$I_{OUTSC}$			$\pm 30$		mA
Output Leakage Current <sup>1</sup>	$I_{OLEAK}$	$V_{CC}=0V$ , $V_{OUT}=\pm 12V$			$\pm 25$	$\mu A$
<b>Power Supply Characteristics</b>						
Supply Current <sup>1</sup>	$I_{CC}$	No Load, $V_{CC}=3.3V$ or $5V$		1.1	1.4	mA

**SWITCH CHARACTERISTICS**

Parameter	Symbol	Condition	Min	Typ	Max	Unit
Maximum Data Rate <sup>1</sup>	$f_{MAX}$	$R_L=3k\Omega$ , $C_L=1000pF$ , One Transmitter Operates Only		250	400	kbps
Receiver Propagation Delay	$t_{RPLH}$	Receiver Input to Output, $C_L=150pF$		80		ns
	$t_{RPHL}$			140		
Receiver Skew Time	$t_{RSKEW}$	$ t_{RPLH} - t_{RPHL} $		60		ns
Transmitter Propagation Delay <sup>1</sup>	$t_{TPLH}$	Receiver Input to Output, $C_L=150pF$		370		ns
	$t_{TPHL}$			330		
Transmitter Skew Time <sup>1,2</sup>	$t_{DSKEW}$	$ t_{DPLH} - t_{DPHL} $		40		ns
Transmitter Output Slew Rate <sup>1</sup>	$SR_D$	$V_{CC}=3.3V$ , $R_L=3k\Omega$ , $C_L=1nF$ , Measured from -3V to +3V or Vice Versa, One Transmitter Operates Only		30		V/ $\mu s$

1. When  $V_{CC}=3.3V$ ,  $C_1=C_2=C_3=C_4=0.1\mu F-0.47\mu F$ ; When  $V_{CC}=5V$ ,  $C_1=0.047\mu F$ ,  $C_2=C_3=C_4=0.33\mu F$ .

2. The transmitter output skew time is respect to zero-crossing point.

## TYPICAL CHARACTERISTICS

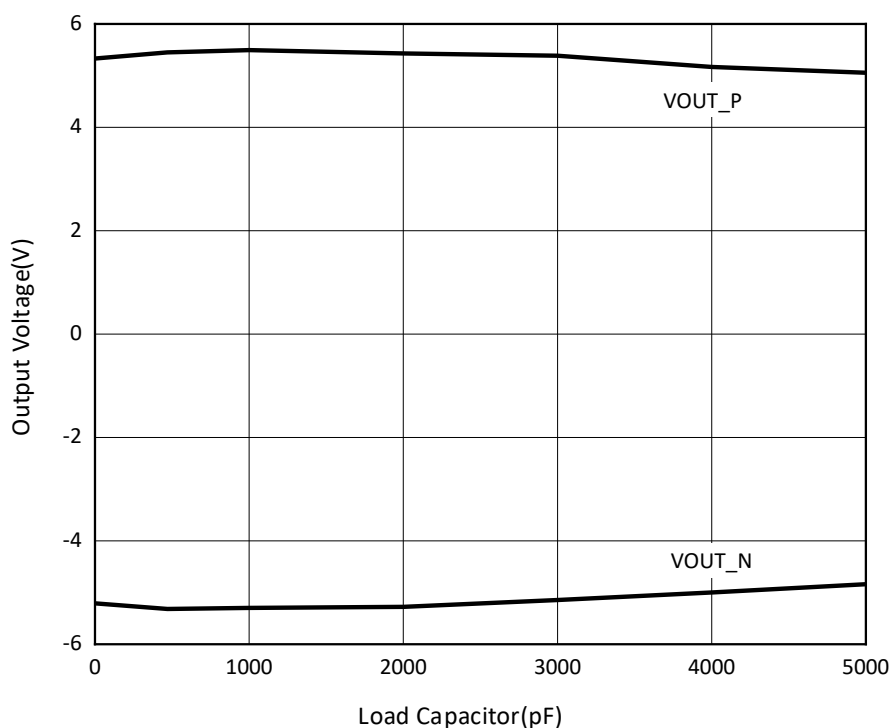


Figure 1. Output Voltage of Transmitter VS. Load Capacitor

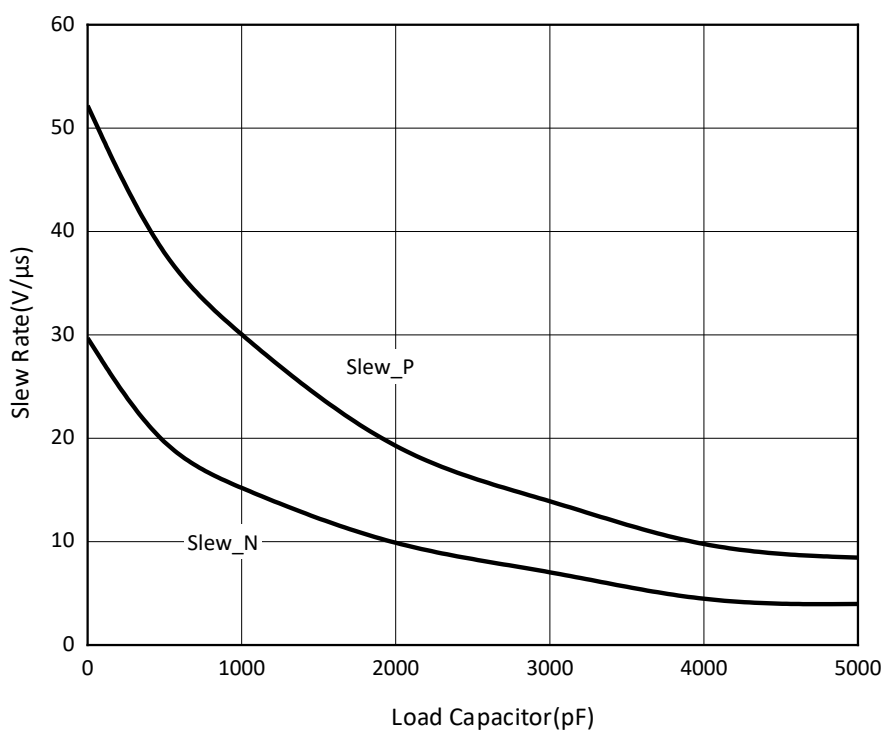


Figure 2. Transmitter Slew Rate VS. Load Capacitor



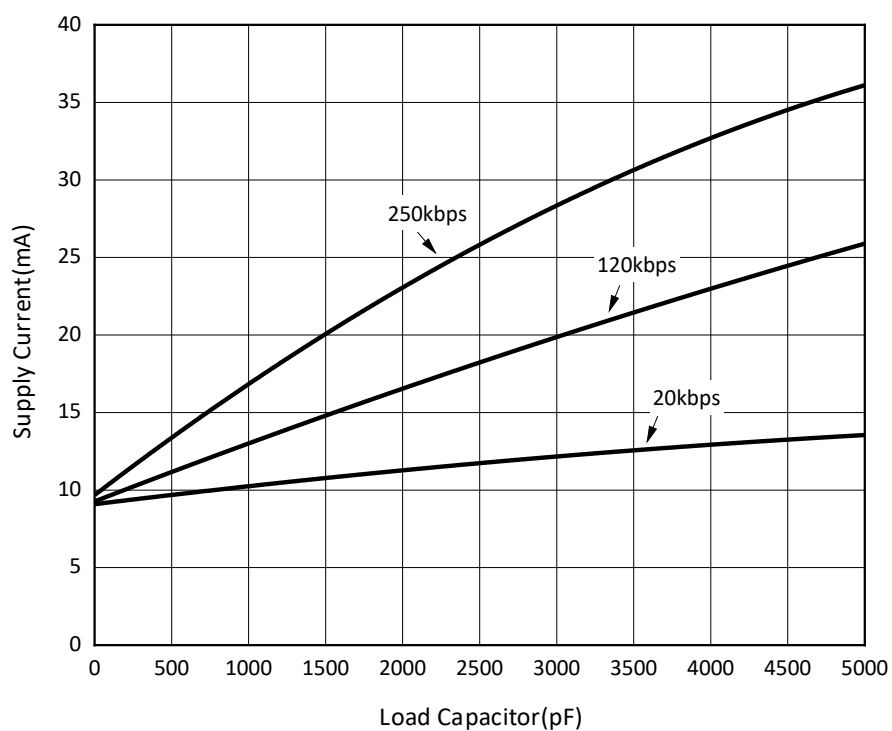


Figure 3. Supply Current VS. Load Capacitor

## APPLICATION INFORMATION

### Overview

The MS2232/MS2232T is integrated with a charge pump, and it is a RS-232 transceiver with  $\pm 20\text{kV}$  ESD protection, which includes two receivers and two transmitters. It can provide +5.5V and -5.5V output voltages throughout the VCC power supply ranging from +3V to +5.5V. Two flying capacitors C1, C2 and two energy storage capacitors C3, C4 are needed to generate VP(+5.5V) and VN(-5.5V).

All pins in the MS2232/MS2232T adopt ESD protection structure. In the process of operation and assembling, when an electrostatic discharge occurs, the device can be provided. For the transmitter output pins and receiver input pins on the RS-232 bus, the enhanced circuit structure and device structure are designed to make these pins to withstand  $\pm 20\text{kV}$  ESD impacts. In all states, including standard operating mode, high-impedance state and power-off mode, after the pins are impacted, the MS2232/MS2232T can continue to operate instead of being in latch-up state. But the 232 interface chips which cannot adopt ESD protection structure are in lock state and must be powered off to release this state.

### RS-232 Receiver and Transmitter

The MS2232/MS2232T includes two RS-232 transmitters and two RS-232 receivers.

The transmitters are inverting level converters, which converts the TTL/CMOS logic level to EIA/TIA-232 compatible level greater than  $\pm 5\text{V}$ . In the worst case (load of  $3\text{k}\Omega$  resistor in parallel with  $1000\text{pF}$  capacitor), the 250kbps data rate can be guaranteed, providing PC to PC communication software.

The transmitters can drive many receivers in parallel, when the transmitters are in the off-high impedance state, the output is allowed to be driven up to  $\pm 12\text{V}$ . Because the transmitter input does not have pull up resistors, the unused input terminal should be connected to GND or VCC to avoid floating and logic errors.

The receivers invert the RS-232 signal to the CMOS/TTL logic output level. The maximum input range is from -25V to +25V, each receiver input is built in  $5\text{k}\Omega$  pull-down resistor.

The MS2232/MS2232T can directly communicate with all kinds of 5V logic levels, including ACT and HCTCMOS. The logic level compatibility under different power supplies is shown in the table below.

System Power Supply(V)	VCC Voltage (V)	Compatibility
3.3	3.3	Compatible with CMOS Series
5	5	Compatible with TTL and CMOS Series
5	3.3	Compatible with ACT, HCT, AC, HC and CD4000 CMOS Series

### Charge Pump Capacitor Selection and Power Supply Decoupling

The type of capacitors used for C1 to C4 have little effect on normal operation, polarized or non-polarized capacitors can be used. When in 3.3V power supply, the external C1, C2, C3 and C4 values are 0.1 $\mu$ F. Capacitor selections under other power supply are shown in the table below. Please do not use capacitors below the values in the table. Increasing capacitor values (e.g. doubling all capacitors) is helpful to reduce the ripple of transmitter output, slightly decreasing power dissipation of the chip. C1 can remain unchanged, only increasing C2, C3 and C4. Conversely, if C1 is increased, while C2, C3, C4 and C<sub>BYPASS</sub> are not increased, the charge pump will operate abnormally. Please maintain the appropriate ratio of these capacitors.

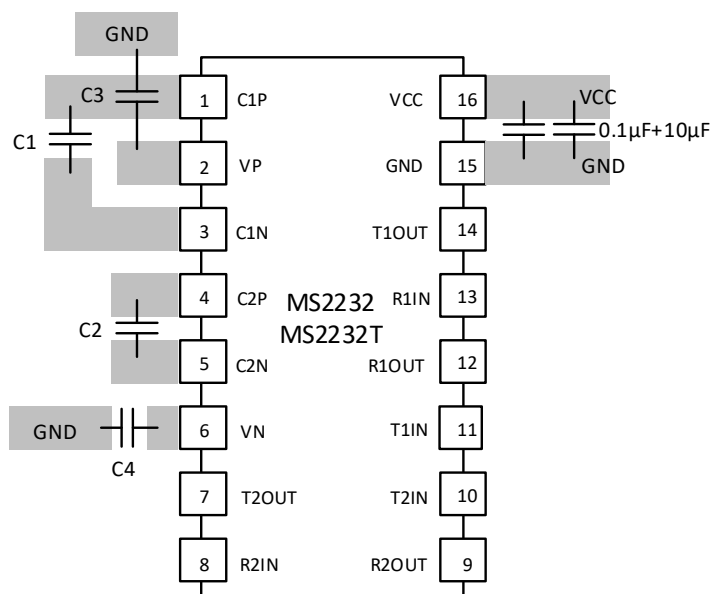
VCC(V)	C1( $\mu$ F)	C2, C3, C4( $\mu$ F)
3~3.6	0.1~0.47	0.1~0.47
4.5~5.5	0.047	0.33
3~5.5	0.1	0.47

If the minimum capacitor in the table is used, please make sure that capacitor values cannot change with temperature significantly. The capacitor equivalent series resistance (ESR) usually increases at low temperature, which will seriously affect the ripple of VP and VN.

In most case, using a 0.1 $\mu$ F VCC bypass capacitor can meet the needs. In applications sensitive to power supply noise, 0.1 $\mu$ F+10 $\mu$ F capacitors can be used. Bypass capacitor should be placed as close to the chip as possible.

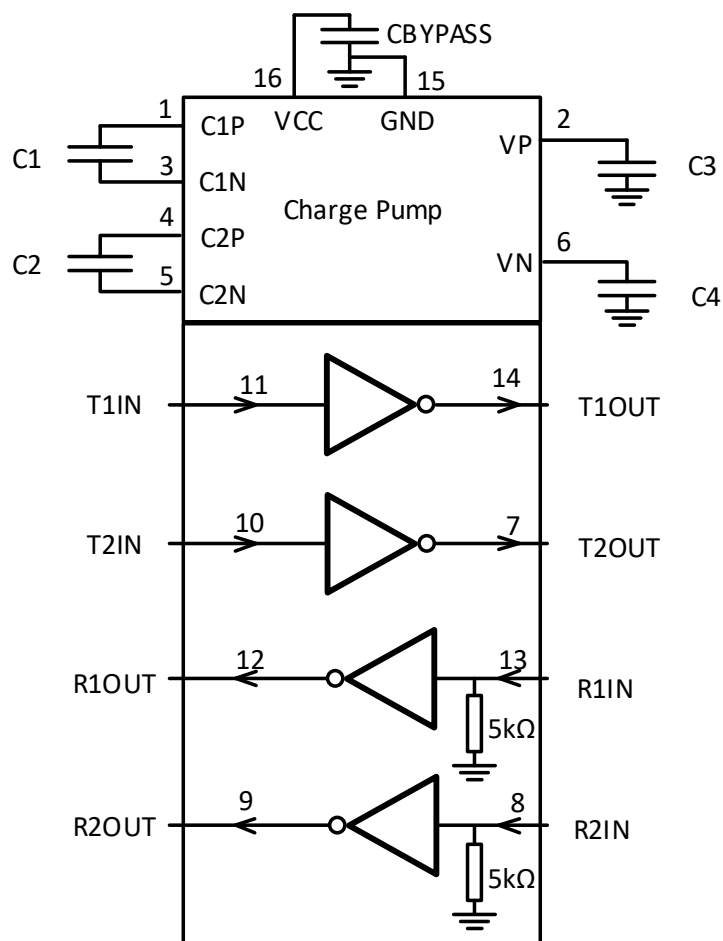
### PCB Layout Instruction

The connection from external capacitor to pins should be short and wide as possible. A recommended PCB layout is provided in the following figure.



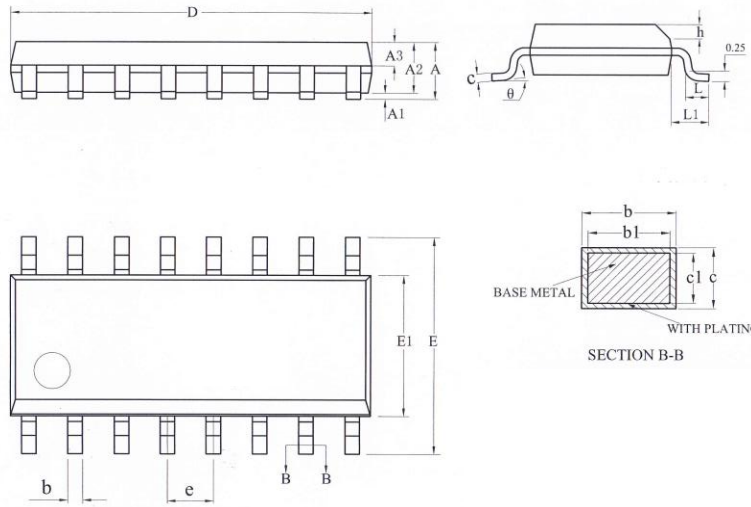
## TYPICAL APPLICATION

Please refer to the capacitor selection table for the capacitance of 4 charge pumps connecting capacitors externally.



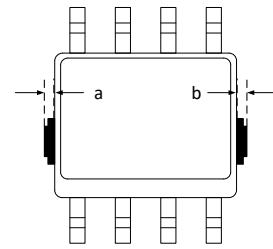
# PACKAGE OUTLINE DIMENSIONS

## SOP16



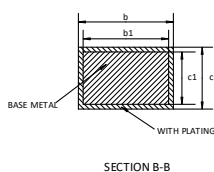
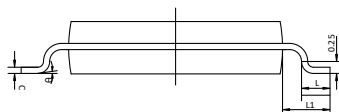
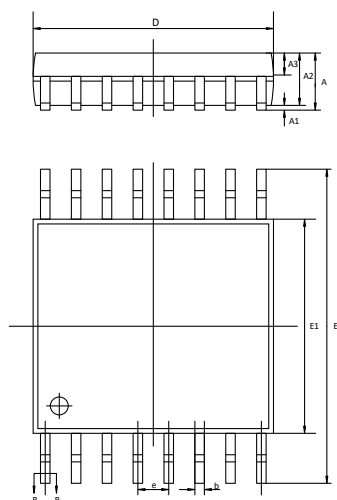
Note: In addition to the package size, a and b are allowed to have the maximum size of 0.15mm for waste glue simultaneously.

The diagram is as follows: taking SOP8 package as an example.



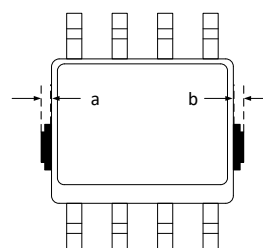
Symbol	Dimensions in Millimeters		
	Min	Typ	Max
A	-	-	1.75
A1	0.10	-	0.225
A2	1.30	1.40	1.50
A3	0.60	0.65	0.70
b	0.39	-	0.47
b1	0.38	0.41	0.44
c	0.20	-	0.24
c1	0.19	0.20	0.21
D	9.80	9.90	10.00
E	5.80	6.00	6.20
E1	3.80	3.90	4.00
e	1.27 BSC		
h	0.25	-	0.50
L	0.50	-	0.80
L1	1.05 REF		
θ	0	-	8°

## TSSOP16



Note: In addition to the package size, a and b are allowed to have the maximum size of 0.15mm for waste glue simultaneously.

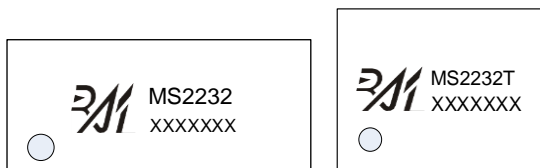
The diagram is as follows: taking SOP8 package as an example.



Symbol	Dimensions in Millimeters		
	Min	Typ	Max
A	-	-	1.20
A1	0.05	-	0.15
A2	0.90	1.00	1.05
A3	0.39	0.44	0.49
b	0.20	-	0.28
b1	0.19	0.22	0.25
c	0.13	-	0.17
c1	0.12	0.13	0.14
D	4.90	5.00	5.10
E	6.20	6.40	6.60
E1	4.30	4.40	4.50
e	0.65(BSC)		
L	0.45	0.60	0.75
L1	1.00(BSC)		
θ	0	-	8°

## MARKING and PACKAGING SPECIFICATION

### 1. Marking Drawing Description



Product Name: MS2232, MS2232T

Product Code: XXXXXXX

### 2. Marking Drawing Demand

Laser printing, contents in the middle, font type Arial.

### 3. Packaging Specification

Device	Package	Piece/Reel	Reel/Box	Piece /Box	Box/Carton	Piece/Carton
MS2232	SOP16	2500	1	2500	8	20000
MS2232T	TSSOP16	3000	1	3000	8	24000

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- The process of improving product is endless. And our company would sincerely provide more excellent product for customer.



**MOS CIRCUIT OPERATION PRECAUTIONS**

Static electricity can be generated in many places. The following precautions can be taken to effectively prevent the damage of MOS circuit caused by electrostatic discharge:

1. The operator shall ground through the anti-static wristband.
2. The equipment shell must be grounded.
3. The tools used in the assembly process must be grounded.
4. Must use conductor packaging or anti-static materials packaging or transportation.



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