



ST3232EB ST3232EC

± 15 kV ESD protection 3 to 5.5 V low power,
up to 250 kbps, RS-232 drivers and receivers

Features

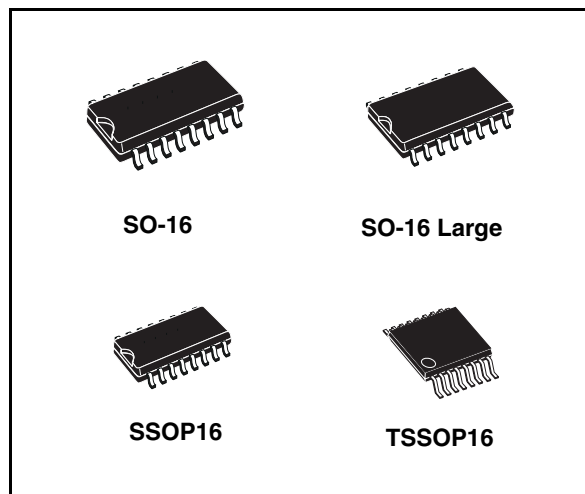
- ESD protection for RS-232 I/O pins
- ±15 kV human body model
- ±8 kV IEC 1000-4-2 contact discharge
- 300 µA supply current
- 250 kbps minimum guaranteed data rate
- 6V/µs minimum guaranteed slew rate
- Meet EIA/TIA-232 specifications down to 3 V
- Available in SO-16, SO-16 large SSOP16 and TSSOP16

Description

The ST3232E is a 3 V powered EIA/TIA-232 and V.28/V.24 communication interfaces with low power requirements, high data-rate capabilities and enhanced electrostatic discharge (ESD) protection to ± 8 kV using IEC1000-4-2 Contact Discharge and ± 15 kV using the Human Body Model. ST3232E has a proprietary low dropout transmitter output stage providing true RS-232 performance from 3 to 5 V supplies with a dual charge pump. The charge pump requires only four small 0.1 µF standard external capacitors for operations from 3 V supply.

The ST3232E has two receivers and two drivers.

The device is guaranteed to run at data rates of 250 kbps while maintaining RS-232 output levels.



Typical applications are Notebook, Subnotebook and Palmtop Computers, Battery Powered Equipment, Hand-Held Equipment, Peripherals and Printers.

Table 1. Device summary

| Order codes | Temp. range | Packages | Packaging |
|-------------|--------------|-------------------------|---------------------|
| ST3232ECDR | 0 to 70 °C | SO-16 (tape and reel) | 2500 parts per reel |
| ST3232EBDR | -40 to 85 °C | SO-16 (tape and reel) | 2500 parts per reel |
| ST3232ECPR | 0 to 70 °C | SSOP16 (tape and reel) | 1350 parts per reel |
| ST3232EBPR | -40 to 85 °C | SSOP16 (tape and reel) | 1350 parts per reel |
| ST3232ECTR | 0 to 70 °C | TSSOP16 (tape and reel) | 2500 parts per reel |
| ST3232EBTR | -40 to 85 °C | TSSOP16 (tape and reel) | 2500 parts per reel |

Contents

| | | |
|---|---|----|
| 1 | Pin configuration | 3 |
| 2 | Absolute maximum ratings | 4 |
| 3 | Electrical characteristics | 5 |
| 4 | Application | 7 |
| 5 | Typical performance characteristics | 8 |
| 6 | Package mechanical data | 9 |
| 7 | Revision history | 18 |

1 Pin configuration

Figure 1. Pin connection

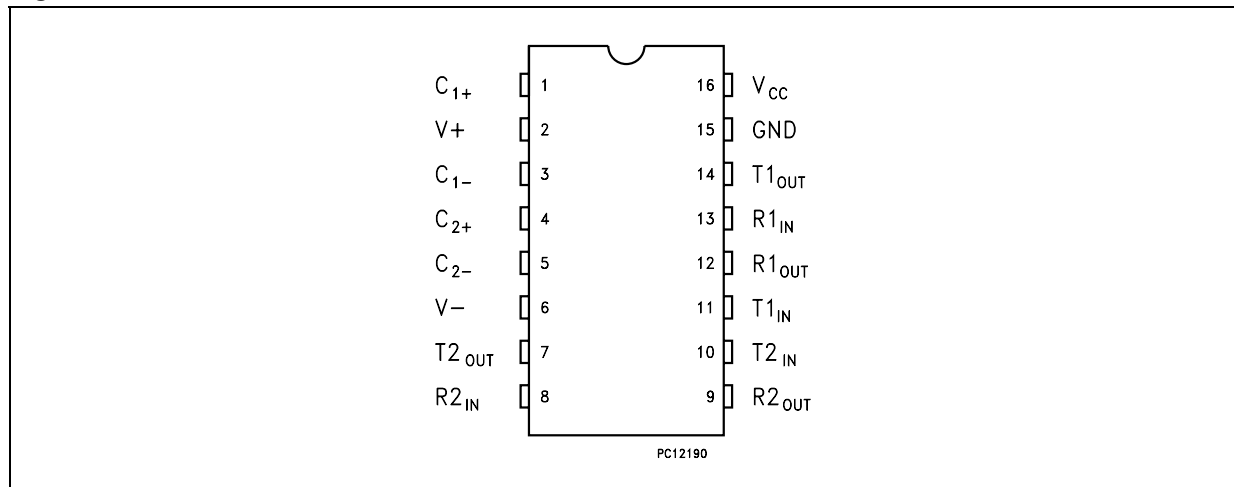


Table 2. Pin description

| Pin n° | Symbol | Name and function |
|--------|--------------------|--|
| 1 | C ₁₊ | Positive terminal for the first charge pump capacitor |
| 2 | V+ | Doubled voltage terminal |
| 3 | C ₁₋ | Negative Terminal for the first charge pump capacitor |
| 4 | C ₂₊ | Positive terminal for the second charge pump capacitor |
| 5 | C ₂₋ | Negative terminal for the second charge pump capacitor |
| 6 | V- | Inverted voltage terminal |
| 7 | T ₂ OUT | Second transmitter output voltage |
| 8 | R ₂ IN | Second receiver input voltage |
| 9 | R ₂ OUT | Second receiver output voltage |
| 10 | T ₂ IN | Second transmitter input voltage |
| 11 | T ₁ IN | First transmitter input voltage |
| 12 | R ₁ OUT | First receiver output voltage |
| 13 | R ₁ IN | First receiver input voltage |
| 14 | T ₁ OUT | First transmitter output voltage |
| 15 | GND | Ground |
| 16 | V _{CC} | Supply voltage |

2 Absolute maximum ratings

Table 3. Absolute maximum ratings

| Symbol | Parameter | Value | Unit |
|-------------|--------------------------------------|--------------------------|------|
| V_{CC} | Supply voltage | -0.3 to 6 | V |
| V+ | Doubled voltage terminal | $(V_{CC} - 0.3)$ to 7 | V |
| V- | Inverted voltage terminal | 0.3 to -7 | V |
| $V+ + V- $ | | 13 | V |
| T_{IN} | Transmitter input voltage range | -0.3 to 6 | V |
| R_{IN} | Receiver input voltage range | ± 25 | V |
| T_{OUT} | Transmitter output voltage range | ± 13.2 | V |
| R_{OUT} | Receiver output voltage range | -0.3 to $(V_{CC} + 0.3)$ | V |
| t_{SHORT} | Transmitter output short to gnd time | Continuous | |

Note: Absolute maximum ratings are those values beyond which damage to the device may occur. Functional operation under these condition is not implied.

Externally applied V+ and V- can have a maximum magnitude of +7 V, but their absolute addition can not exceed 13 V.

Running on internal charge pump, intrinsic self limitation allows exceeding those values without any damage.

Startup voltage sequence (V_{CC} , then V+, then V-) is critical, therefore it is not recommended to use this device using externally applied voltage to V+ and V-.

Figure 2. ESD performance: transmitter outputs, receiver inputs

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|--------|------------------------|------------------|----------|------|------|------|
| ESD | ESD protection voltage | Human body model | ± 15 | | | kV |
| ESD | ESD protection voltage | IEC-1000-4-2 | ± 8 | | | kV |

3 Electrical characteristics

Table 4. Electrical characteristics ($C_1 - C_4 = 0.1 \mu\text{F}$, $V_{\text{CC}} = 3 \text{ V to } 5.5 \text{ V}$, $T_A = -40 \text{ to } 85 \text{ }^\circ\text{C}$, unless otherwise specified. Typical values are referred to $T_A = 25 \text{ }^\circ\text{C}$)

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|---------------------|--------------------------------------|---|------|------|------|------|
| I_{SUPPLY} | V_{CC} Power supply current | No Load, $V_{\text{CC}} = 3\text{V or } 5\text{V}$, $T_A = 25^\circ\text{C}$ | | 0.3 | 1 | mA |

Table 5. Logic input ($C_1 - C_4 = 0.1 \mu\text{F}$, $V_{\text{CC}} = 3 \text{ V to } 5.5 \text{ V}$, $T_A = -40 \text{ to } 85 \text{ }^\circ\text{C}$, unless otherwise specified. Typical values are referred to $T_A = 25 \text{ }^\circ\text{C}$)

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|------------------|------------------------------|-------------------------------|------|------------|---------|---------------|
| V_{TIL} | Input logic threshold low | T-IN | | | 0.8 | V |
| V_{HYS} | Transmitter input hysteresis | | | 0.25 | | V |
| V_{TIH} | Input logic threshold high | $V_{\text{CC}} = 3.3\text{V}$ | 2 | | | V |
| | | $V_{\text{CC}} = 5\text{V}$ | 2.4 | | | |
| I_{IL} | Input leakage current | T-IN | | ± 0.01 | ± 1 | μA |

Table 6. Transmitter ($C_1 - C_4 = 0.1 \mu\text{F}$ tested at $3.3 \text{ V} \pm 10 \%$, $V_{\text{CC}} = 3 \text{ V to } 5.5 \text{ V}$, $T_A = -40 \text{ to } 85 \text{ }^\circ\text{C}$, unless otherwise specified. Typical values are referred to $T_A = 25 \text{ }^\circ\text{C}$)

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|-------------------|-------------------------------|--|---------|-----------|----------|---------------|
| V_{TOUT} | Output voltage swing | All transmitter outputs are loaded with $3\text{k}\Omega$ to GND | ± 5 | ± 5.4 | | V |
| R_{TOUT} | Transmitter output resistance | $V_{\text{CC}} = 0\text{V}$, $V_{\text{OUT}} = \pm 2\text{V}$ | 300 | 10M | | Ω |
| I_{SC} | Output short circuit current | | | ± 60 | | mA |
| I_{TOL} | Output leakage current | $V_{\text{CC}} = 0\text{V or } 3.3\text{V to } 5.5\text{V}$ $V_{\text{OUT}} = \pm 12\text{V}$ Transmitters disable | | | ± 25 | μA |

Table 7. Receiver ($C_1 - C_4 = 0.1 \mu\text{F}$ tested at $3.3 \text{ V} \pm 10 \%$, $V_{\text{CC}} = 3 \text{ V}$ to 5.5 V , $T_A = -40$ to $85 \text{ }^\circ\text{C}$, unless otherwise specified. Typical values are referred to $T_A = 25 \text{ }^\circ\text{C}$)

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|--------------------|--|--|---------------------|---------------------|------|------------------|
| V_{RIN} | Receiver input voltage operating range | | -25 | | 25 | V |
| V_{RIL} | RS-232 Input threshold low | $T_A = 25^\circ\text{C}$, $V_{\text{CC}} = 3.3\text{V}$ | 0.6 | 1.1 | | V |
| | | $T_A = 25^\circ\text{C}$, $V_{\text{CC}} = 5\text{V}$ | 0.8 | 1.5 | | |
| V_{RIH} | RS-232 Input threshold high | $T_A = 25^\circ\text{C}$, $V_{\text{CC}} = 3.3\text{V}$ | | 1.4 | 2.4 | V |
| | | $T_A = 25^\circ\text{C}$, $V_{\text{CC}} = 5\text{V}$ | | 1.8 | 2.4 | |
| V_{RIHYS} | Input hysteresis | | | 0.5 | | V |
| R_{RIN} | Input resistance | $T_A = 25^\circ\text{C}$ | 3 | 5 | 7 | $\text{k}\Omega$ |
| V_{ROL} | TTL/CMOS Output voltage low | $I_{\text{OUT}} = 1.6\text{mA}$ | | | 0.4 | V |
| V_{ROH} | TTL/CMOS Output voltage high | $I_{\text{OUT}} = -1\text{mA}$ | $V_{\text{CC}}-0.6$ | $V_{\text{CC}}-0.1$ | | V |

Table 8. Timing characteristics ($C_1 - C_4 = 0.1 \mu\text{F}$ tested at $3.3 \text{ V} \pm 10 \%$, $V_{\text{CC}} = 3 \text{ V}$ to 5.5 V , $T_A = -40$ to $85 \text{ }^\circ\text{C}$, unless otherwise specified. Typical values are referred to $T_A = 25 \text{ }^\circ\text{C}$)

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|--|--|---|------|------|------|------------------------|
| D_{R} | Data transfer rate | $R_L = 3\text{k}\Omega$, $C_{L2} = 1000\text{pF}$ one transmitter switching | 250 | | | Kbps |
| t_{PHLR} t_{PLHR} | Propagation delay input to output | $R_{\text{XIN}} = R_{\text{XOUT}}$, $C_L = 150\text{pF}$ | | 0.15 | | μs |
| t_{OER} | Receiver output enable time | Normal Operation | | 50 | | ns |
| t_{ODR} | Receiver output disable time | Normal Operation | | 50 | | ns |
| $ t_{\text{PHLT}} - t_{\text{THL}} $ | Transmitter propagation delay difference | (Note 1) | | 200 | | ns |
| $ t_{\text{PHLR}} - t_{\text{THR}} $ | Receiver propagation delay difference | | | 50 | | ns |
| S_{RT} | Transition slew rate | $T_A = 25^\circ\text{C}$ $R_L = 3\text{k}\Omega$ to $7\text{k}\Omega$ $V_{\text{CC}} = 3.3\text{V}$ measured from $+3\text{V}$ to -3V or -3V to $+3\text{V}$ $C_L = 150\text{pF}$ to 1000pF $C_L = 150\text{pF}$ to 2500pF | 6 | | 30 | $\text{V}/\mu\text{s}$ |
| | | | 4 | | 30 | $\text{V}/\mu\text{s}$ |

Note: 1 Transmitter skew is measured at the transmitter zero cross points

4 Application

Figure 3. Application circuits

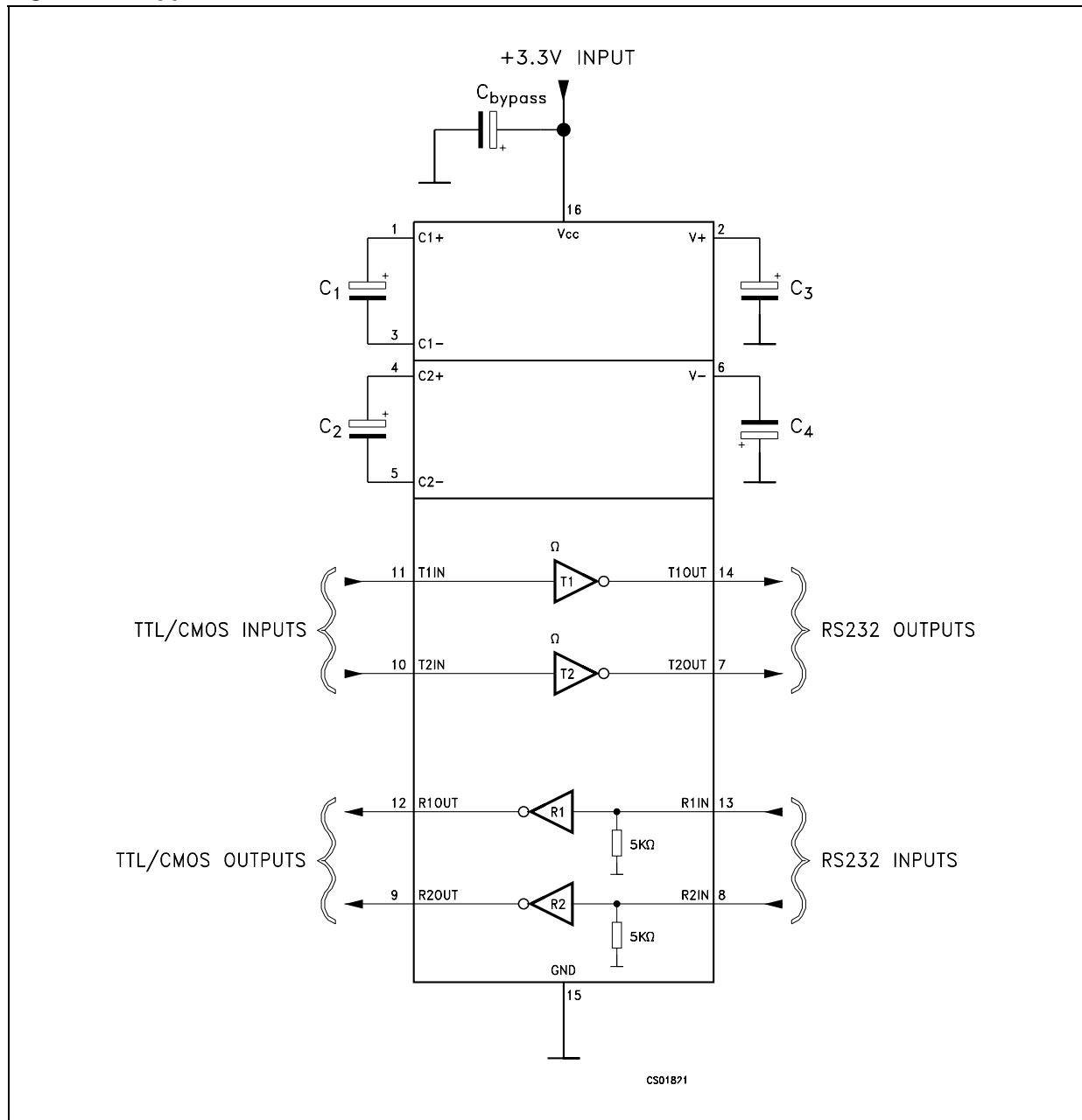


Table 9. Capacitance value (μF)

| V_{CC} | C1 | C2 | C3 | C4 | C_{bypass} |
|------------|-------|------|------|------|--------------|
| 3.0 to 3.6 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| 4.5 to 5.5 | 0.047 | 0.33 | 0.33 | 0.33 | 0.1 |
| 3.0 to 5.5 | 0.1 | 0.47 | 0.47 | 0.47 | 0.1 |

5 Typical performance characteristics

(unless otherwise specified $T_J = 25\text{ }^\circ\text{C}$)

Figure 4. Output current vs output high voltage

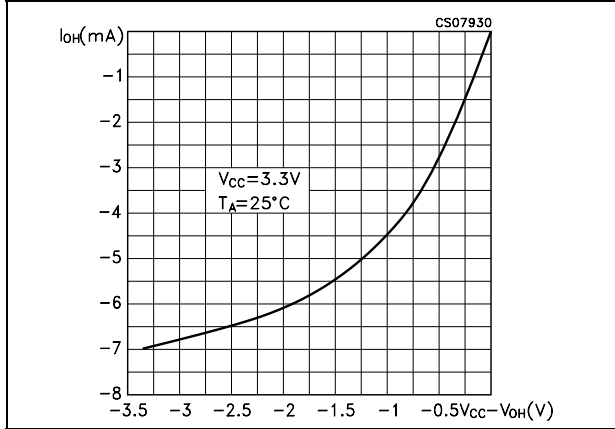


Figure 5. Output current vs output high voltage

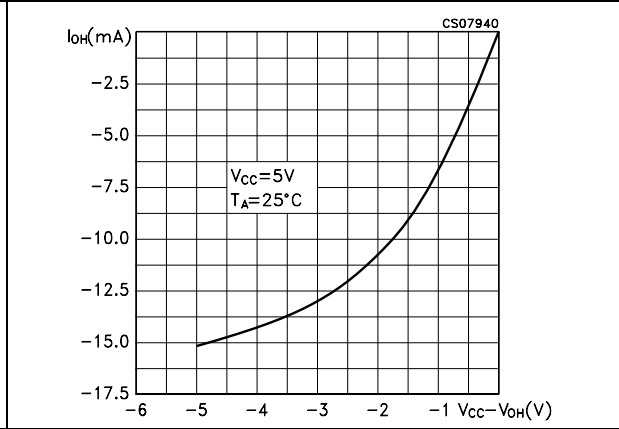


Figure 6. Output current vs output low voltage

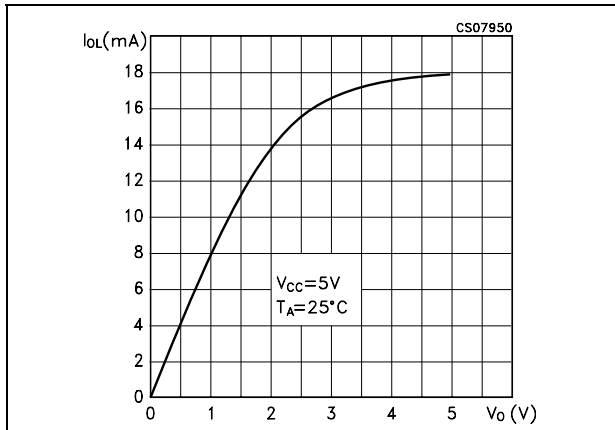


Figure 7. Output current vs output low voltage

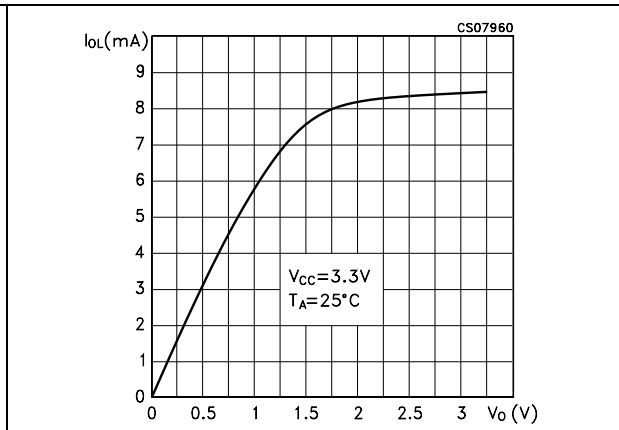


Figure 8. Voltage transfer characteristics for transmitter inputs

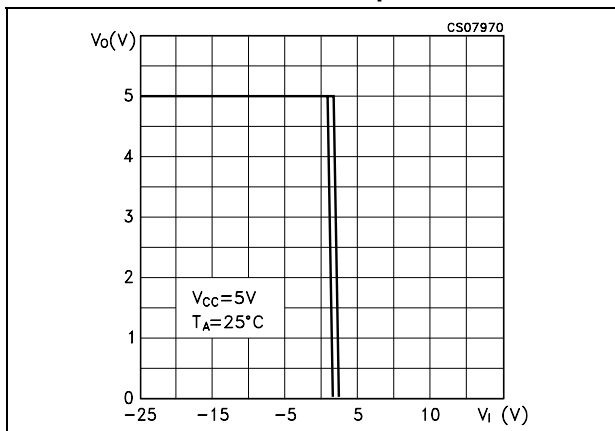
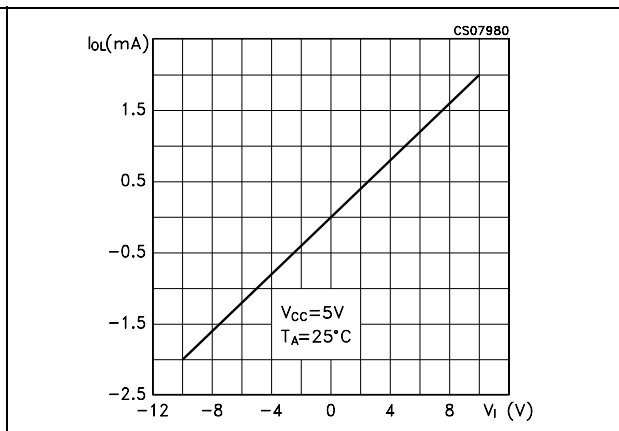


Figure 9. Receiver input resistance

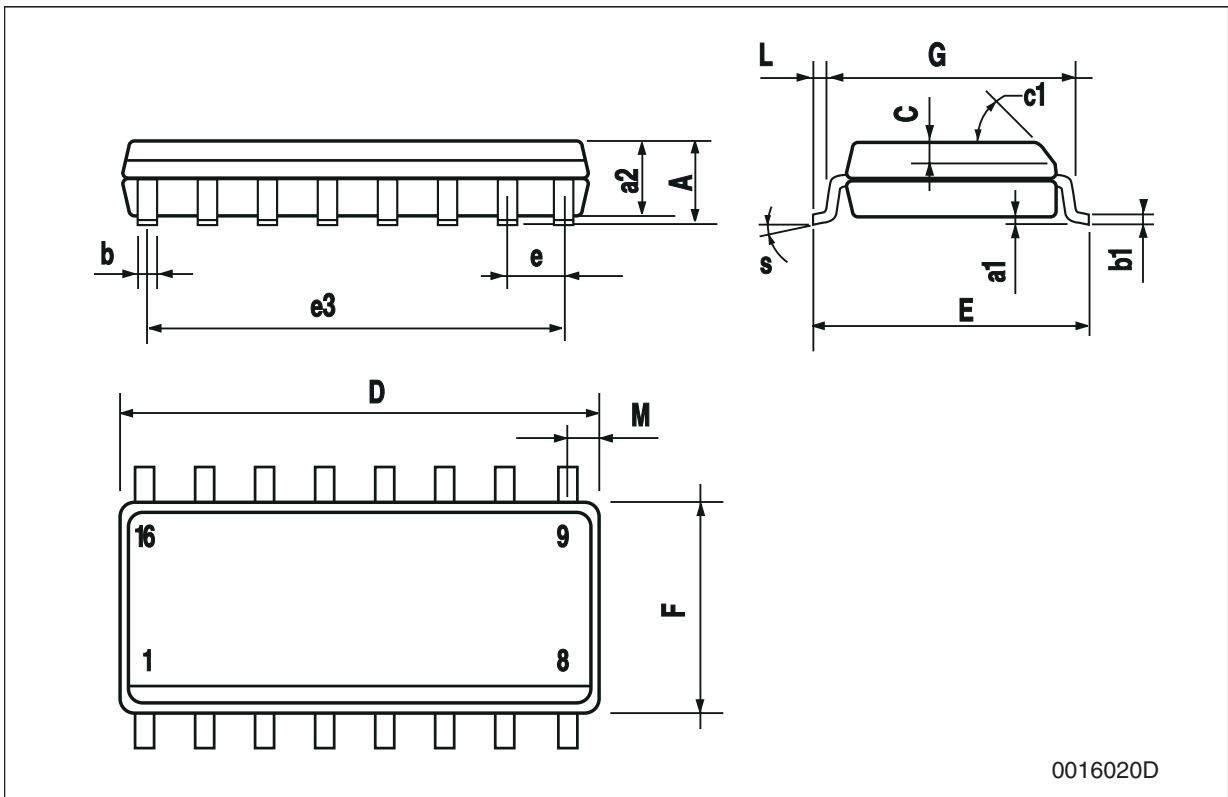


6 Package mechanical data

In order to meet environmental requirements, ST offers these devices in ECOPACK[®] packages. These packages have a lead-free second level interconnect. The category of second Level Interconnect is marked on the package and on the inner box label, in compliance with JEDEC Standard JESD97. The maximum ratings related to soldering conditions are also marked on the inner box label. ECOPACK is an ST trademark. ECOPACK specifications are available at: www.st.com.

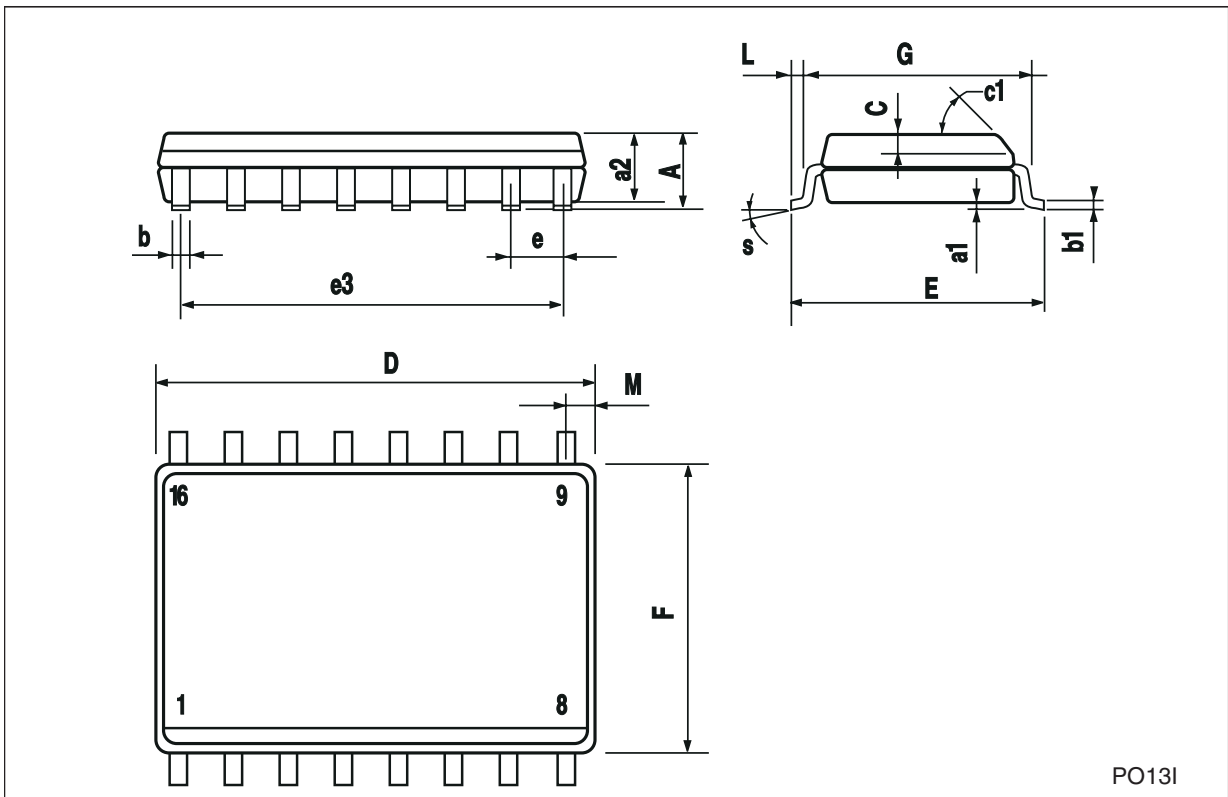
SO-16 mechanical data

| Dim. | mm. | | | inch. | | |
|------|------------|------|------|-------|-------|-------|
| | Min. | Typ. | Max. | Min. | Typ. | Max. |
| A | | | 1.75 | | | 0.068 |
| a1 | 0.1 | | 0.25 | 0.004 | | 0.010 |
| a2 | | | 1.64 | | | 0.063 |
| b | 0.35 | | 0.46 | 0.013 | | 0.018 |
| b1 | 0.19 | | 0.25 | 0.007 | | 0.010 |
| C | | 0.5 | | | 0.019 | |
| c1 | 45° (typ.) | | | | | |
| D | 9.8 | | 10 | 0.385 | | 0.393 |
| E | 5.8 | | 6.2 | 0.228 | | 0.244 |
| e | | 1.27 | | | 0.050 | |
| e3 | | 8.89 | | | 0.350 | |
| F | 3.8 | | 4.0 | 0.149 | | 0.157 |
| G | 4.6 | | 5.3 | 0.181 | | 0.208 |
| L | 0.5 | | 1.27 | 0.019 | | 0.050 |
| M | | | 0.62 | | | 0.024 |
| S | 8° (max.) | | | | | |



SO-16L mechanical data

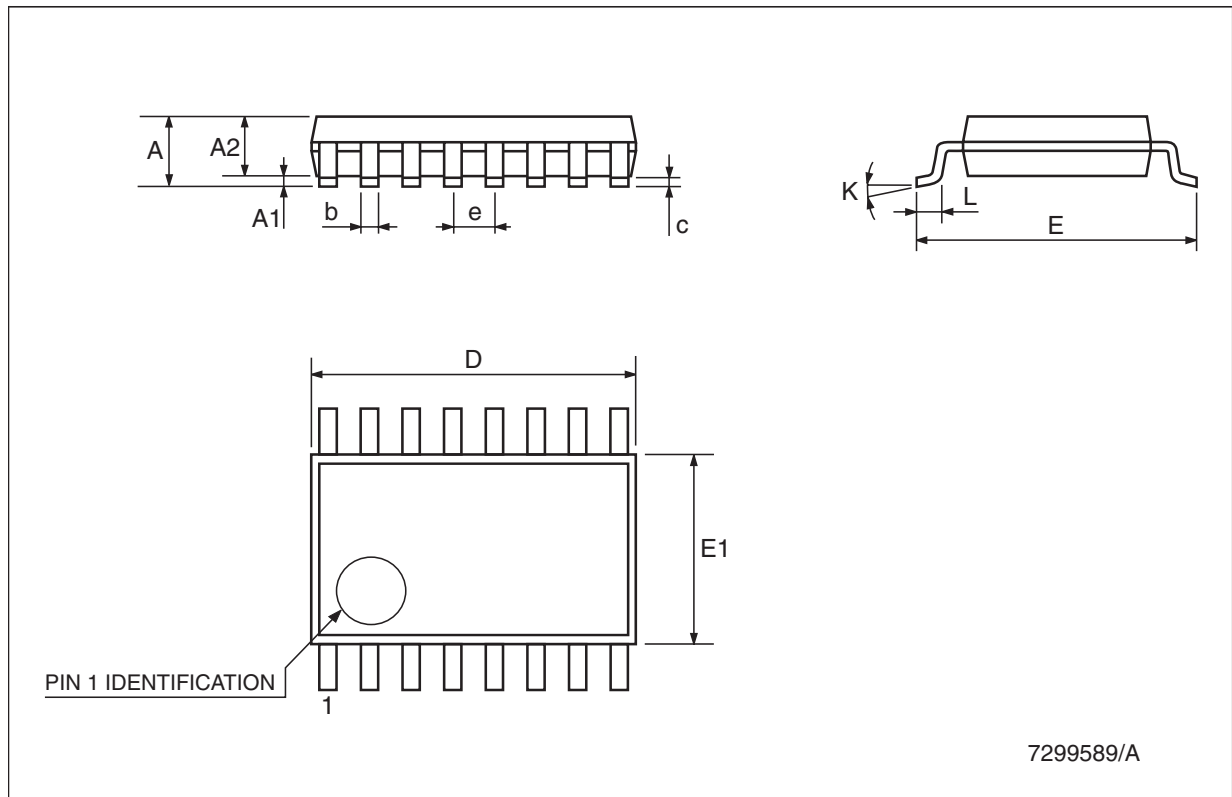
| Dim. | mm. | | | inch. | | |
|------|------------|------|-------|-------|-------|-------|
| | Min. | Typ. | Max. | Min. | Typ. | Max. |
| A | | | 2.65 | | | 0.104 |
| a1 | 0.1 | | 0.2 | 0.004 | | 0.008 |
| a2 | | | 2.45 | | | 0.096 |
| b | 0.35 | | 0.49 | 0.014 | | 0.019 |
| b1 | 0.23 | | 0.32 | 0.009 | | 0.012 |
| C | | 0.5 | | | 0.020 | |
| c1 | 45° (typ.) | | | | | |
| D | 10.1 | | 10.5 | 0.397 | | 0.413 |
| E | 10.0 | | 10.65 | 0.393 | | 0.419 |
| e | | 1.27 | | | 0.050 | |
| e3 | | 8.89 | | | 0.350 | |
| F | 7.4 | | 7.6 | 0.291 | | 0.300 |
| G | | | | | | |
| L | 0.5 | | 1.27 | 0.020 | | 0.050 |
| M | | | 0.75 | | | 0.029 |
| S | 8° (max.) | | | | | |



PO131

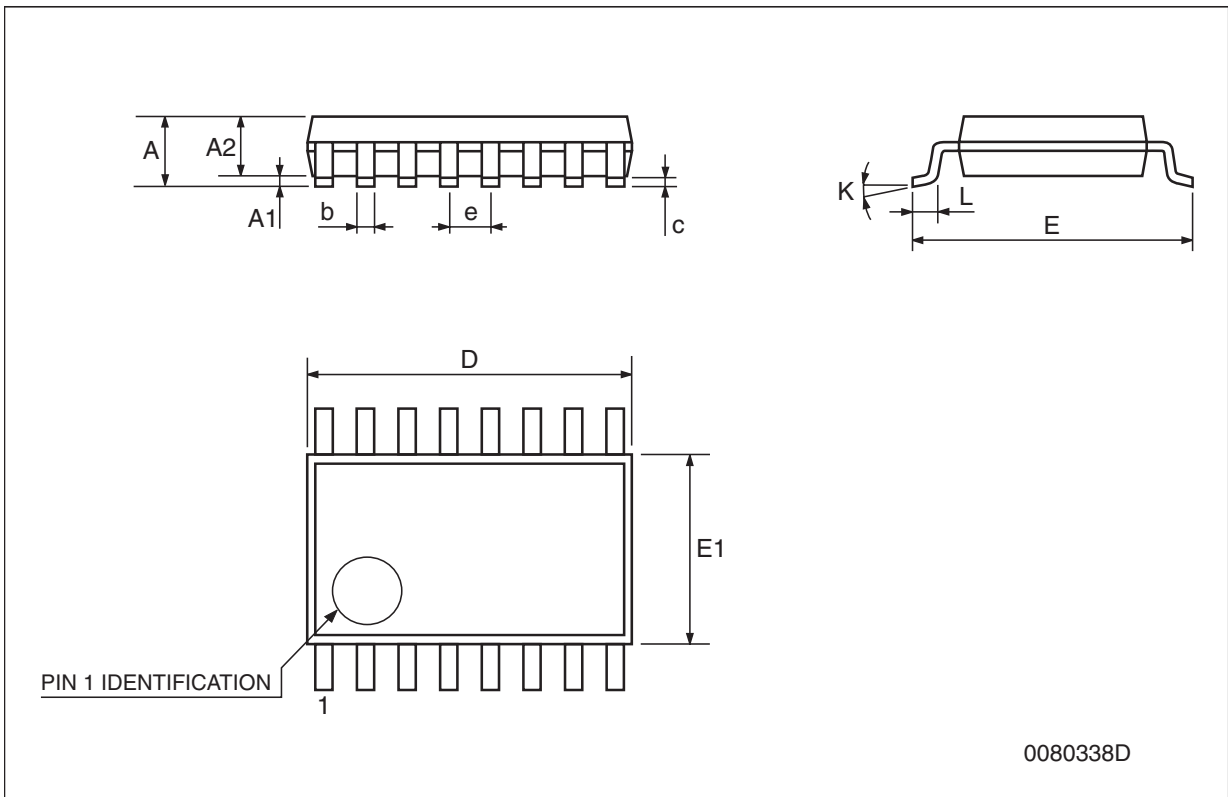
SSOP16 mechanical data

| Dim. | mm. | | | inch. | | |
|------|------|------|------|--------|--------|--------|
| | Min. | Typ. | Max. | Min. | Typ. | Max. |
| A | | | 2 | | | 0.079 |
| A1 | 0.05 | | 0.21 | 0.002 | | 0.008 |
| A2 | 1.65 | | 1.85 | 0.065 | | 0.073 |
| b | 0.22 | | 0.38 | 0.009 | | 0.015 |
| c | 0.09 | | 0.25 | 0.0035 | | 0.0098 |
| D | 5.9 | | 6.5 | 0.232 | | 0.256 |
| E | 7.4 | | 8.2 | 0.291 | | 0.323 |
| E1 | 5.3 | 5 | 5.6 | 0.197 | 0.209 | 0.220 |
| e | | 0.65 | | | 0.0256 | |
| K | 0° | | 8° | 0° | | 8° |
| L | 0.55 | | 0.95 | 0.022 | | 0.037 |



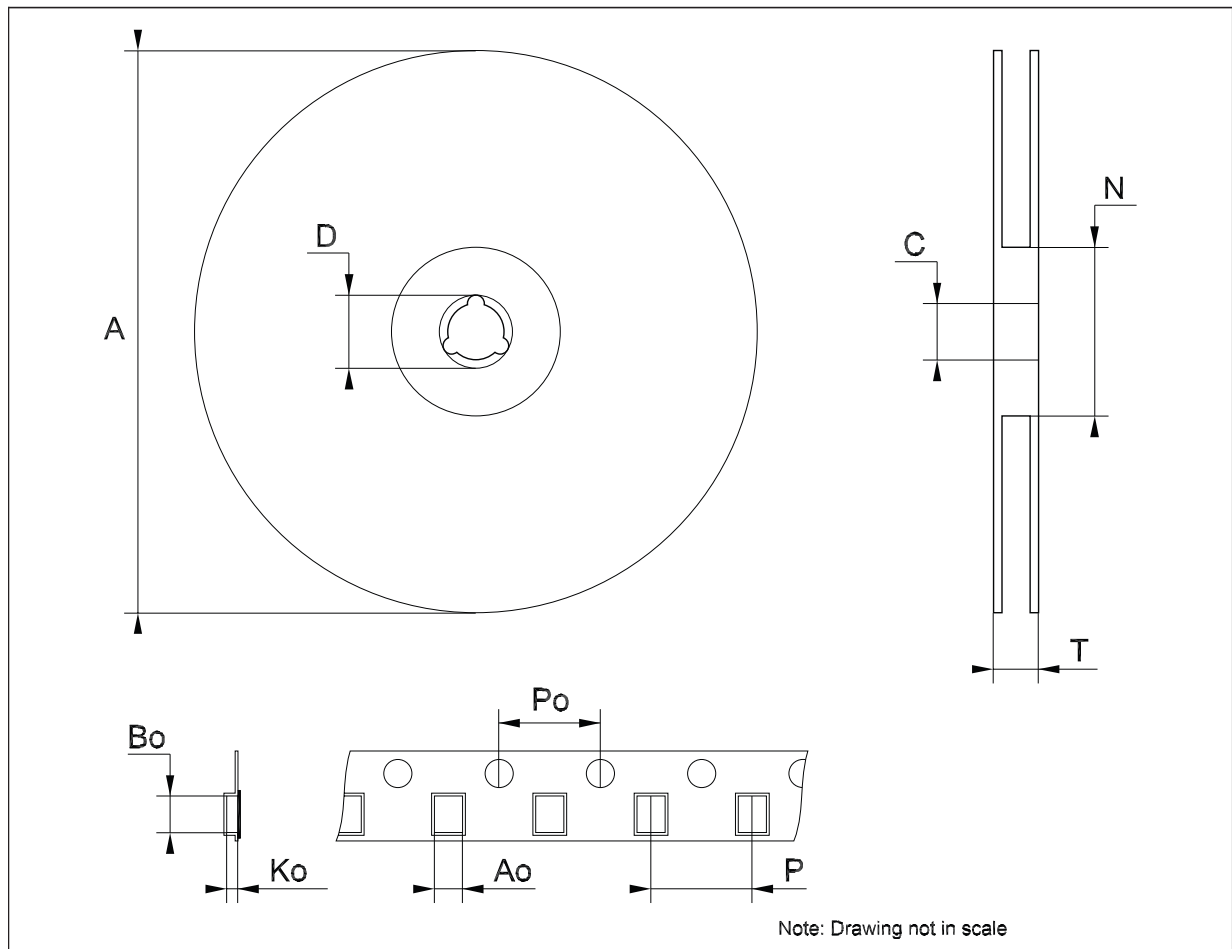
TSSOP16 mechanical data

| Dim. | mm. | | | inch. | | |
|------|------|----------|------|-------|------------|--------|
| | Min. | Typ. | Max. | Min. | Typ. | Max. |
| A | | | 1.2 | | | 0.047 |
| A1 | 0.05 | | 0.15 | 0.002 | 0.004 | 0.006 |
| A2 | 0.8 | 1 | 1.05 | 0.031 | 0.039 | 0.041 |
| b | 0.19 | | 0.30 | 0.007 | | 0.012 |
| c | 0.09 | | 0.20 | 0.004 | | 0.0079 |
| D | 4.9 | 5 | 5.1 | 0.193 | 0.197 | 0.201 |
| E | 6.2 | 6.4 | 6.6 | 0.244 | 0.252 | 0.260 |
| E1 | 4.3 | 4.4 | 4.48 | 0.169 | 0.173 | 0.176 |
| e | | 0.65 BSC | | | 0.0256 BSC | |
| K | 0° | | 8° | 0° | | 8° |
| L | 0.45 | 0.60 | 0.75 | 0.018 | 0.024 | 0.030 |



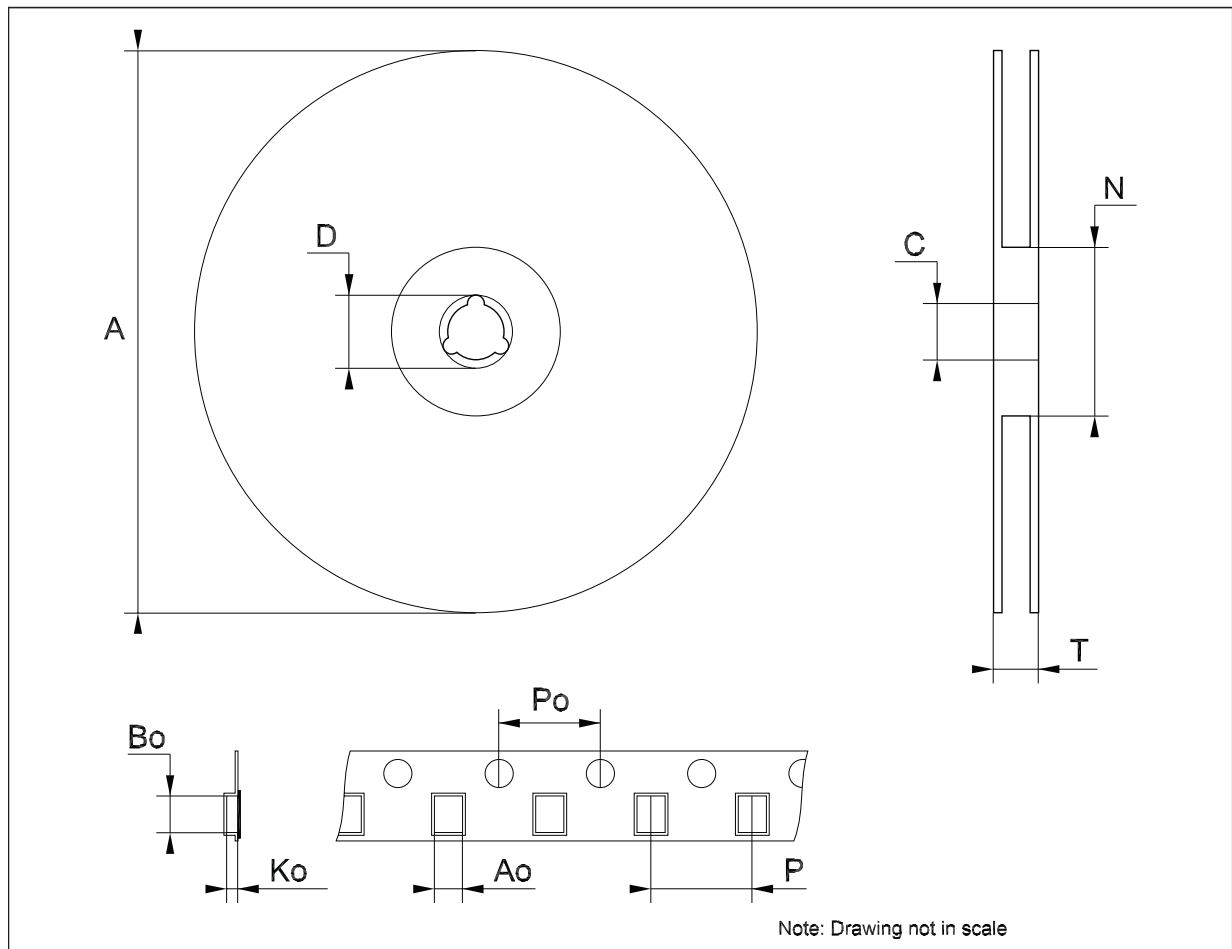
Tape & reel SO-16 mechanical data

| Dim. | mm. | | | inch. | | |
|------|------|------|------|-------|------|--------|
| | Min. | Typ. | Max. | Min. | Typ. | Max. |
| A | | | 330 | | | 12.992 |
| C | 12.8 | | 13.2 | 0.504 | | 0.519 |
| D | 20.2 | | | 0.795 | | |
| N | 60 | | | 2.362 | | |
| T | | | 22.4 | | | 0.882 |
| Ao | 6.45 | | 6.65 | 0.254 | | 0.262 |
| Bo | 10.3 | | 10.5 | 0.406 | | 0.414 |
| Ko | 2.1 | | 2.3 | 0.082 | | 0.090 |
| Po | 3.9 | | 4.1 | 0.153 | | 0.161 |
| P | 7.9 | | 8.1 | 0.311 | | 0.319 |



Tape & reel SO-16L mechanical data

| Dim. | mm. | | | inch. | | |
|------|------|------|------|-------|------|--------|
| | Min. | Typ. | Max. | Min. | Typ. | Max. |
| A | | | 330 | | | 12.992 |
| C | 12.8 | | 13.2 | 0.504 | | 0.519 |
| D | 20.2 | | | 0.795 | | |
| N | 60 | | | 2.362 | | |
| T | | | 22.4 | | | 0.882 |
| Ao | 10.8 | | 11.0 | 0.425 | | 0.433 |
| Bo | 10.7 | | 10.9 | 0.421 | | 0.429 |
| Ko | 2.9 | | 3.1 | 0.114 | | 0.122 |
| Po | 3.9 | | 4.1 | 0.153 | | 0.161 |
| P | 11.9 | | 12.1 | 0.468 | | 0.476 |



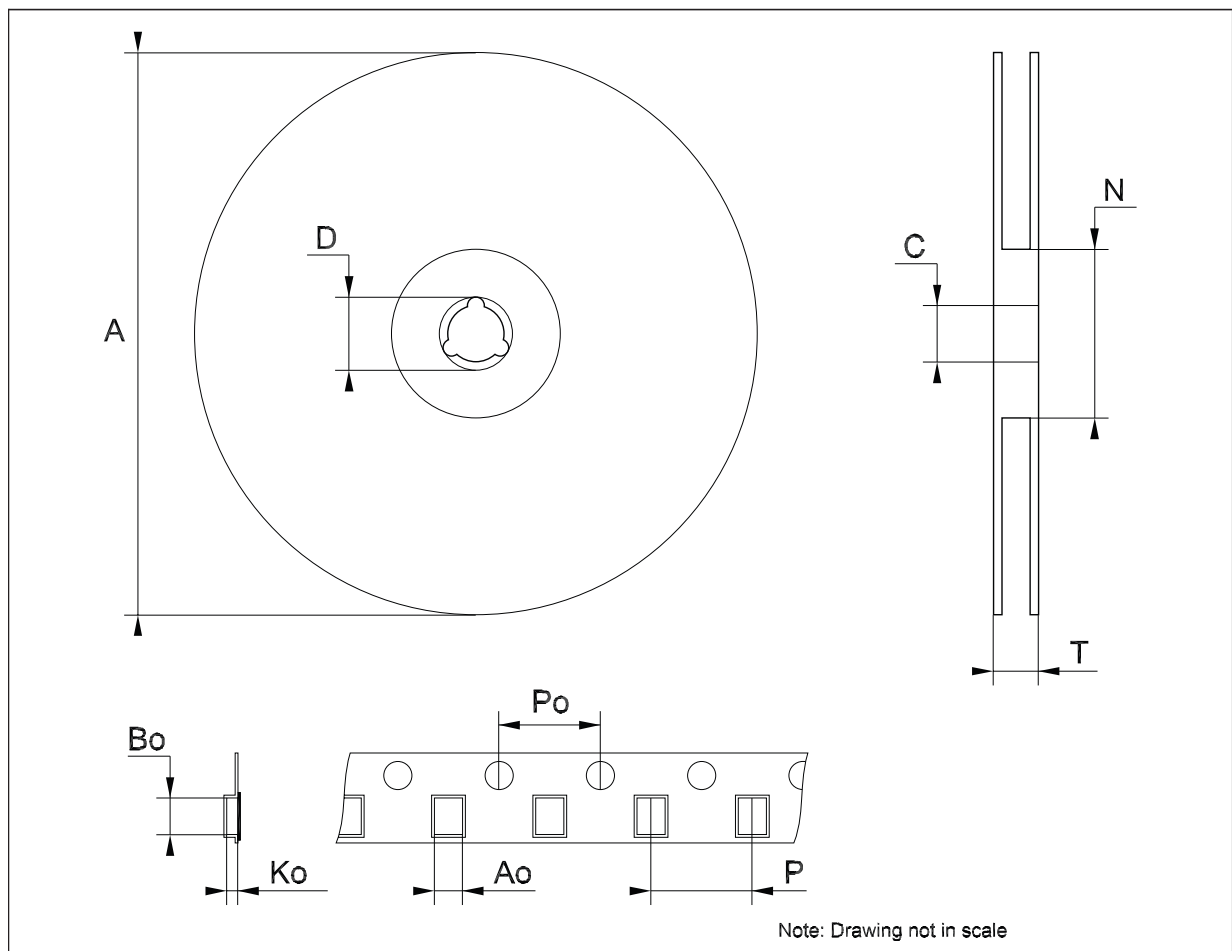
Tape & reel SSOP16 mechanical data

| Dim. | mm. | | | inch. | | |
|------|------|------|------|-------|------|--------|
| | Min. | Typ. | Max. | Min. | Typ. | Max. |
| A | | | 330 | | | 12.992 |
| C | 12.8 | | 13.2 | 0.504 | | 0.519 |
| D | 20.2 | | | 0.795 | | |
| N | 60 | | | 2.362 | | |
| T | | | 22.4 | | | 0.882 |
| Ao | 8.4 | | 8.6 | 0.331 | | 0.339 |
| Bo | 6.7 | | 6.9 | 0.264 | | 0.272 |
| Ko | 2.9 | | 3.1 | 0.114 | | 0.122 |
| Po | 3.9 | | 4.1 | 0.153 | | 0.161 |
| P | 11.9 | | 12.1 | 0.468 | | 0.476 |



Tape & reel TSSOP16 mechanical data

| Dim. | mm. | | | inch. | | |
|------|------|------|------|-------|------|--------|
| | Min. | Typ. | Max. | Min. | Typ. | Max. |
| A | | | 330 | | | 12.992 |
| C | 12.8 | | 13.2 | 0.504 | | 0.519 |
| D | 20.2 | | | 0.795 | | |
| N | 60 | | | 2.362 | | |
| T | | | 22.4 | | | 0.882 |
| Ao | 6.7 | | 6.9 | 0.264 | | 0.272 |
| Bo | 5.3 | | 5.5 | 0.209 | | 0.217 |
| Ko | 1.6 | | 1.8 | 0.063 | | 0.071 |
| Po | 3.9 | | 4.1 | 0.153 | | 0.161 |
| P | 7.9 | | 8.1 | 0.311 | | 0.319 |



7 Revision history

Table 10. Document revision history

| Date | Revision | Changes |
|-------------|----------|--|
| 06-Sep-2006 | 3 | Order codes updated. |
| 21-Jan-2008 | 4 | Added: Table 1 and note on Table 3 . |
| 08-Feb-2008 | 5 | Modified: Table 1 on page 1 . |

Please Read Carefully:

Information in this document is provided solely in connection with ST products. STMicroelectronics NV and its subsidiaries ("ST") reserve the right to make changes, corrections, modifications or improvements, to this document, and the products and services described herein at any time, without notice.

All ST products are sold pursuant to ST's terms and conditions of sale.

Purchasers are solely responsible for the choice, selection and use of the ST products and services described herein, and ST assumes no liability whatsoever relating to the choice, selection or use of the ST products and services described herein.

No license, express or implied, by estoppel or otherwise, to any intellectual property rights is granted under this document. If any part of this document refers to any third party products or services it shall not be deemed a license grant by ST for the use of such third party products or services, or any intellectual property contained therein or considered as a warranty covering the use in any manner whatsoever of such third party products or services or any intellectual property contained therein.

UNLESS OTHERWISE SET FORTH IN ST'S TERMS AND CONDITIONS OF SALE ST DISCLAIMS ANY EXPRESS OR IMPLIED WARRANTY WITH RESPECT TO THE USE AND/OR SALE OF ST PRODUCTS INCLUDING WITHOUT LIMITATION IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE (AND THEIR EQUIVALENTS UNDER THE LAWS OF ANY JURISDICTION), OR INFRINGEMENT OF ANY PATENT, COPYRIGHT OR OTHER INTELLECTUAL PROPERTY RIGHT.

UNLESS EXPRESSLY APPROVED IN WRITING BY AN AUTHORIZED ST REPRESENTATIVE, ST PRODUCTS ARE NOT RECOMMENDED, AUTHORIZED OR WARRANTED FOR USE IN MILITARY, AIR CRAFT, SPACE, LIFE SAVING, OR LIFE SUSTAINING APPLICATIONS, NOR IN PRODUCTS OR SYSTEMS WHERE FAILURE OR MALFUNCTION MAY RESULT IN PERSONAL INJURY, DEATH, OR SEVERE PROPERTY OR ENVIRONMENTAL DAMAGE. ST PRODUCTS WHICH ARE NOT SPECIFIED AS "AUTOMOTIVE GRADE" MAY ONLY BE USED IN AUTOMOTIVE APPLICATIONS AT USER'S OWN RISK.

Resale of ST products with provisions different from the statements and/or technical features set forth in this document shall immediately void any warranty granted by ST for the ST product or service described herein and shall not create or extend in any manner whatsoever, any liability of ST.

ST and the ST logo are trademarks or registered trademarks of ST in various countries.

Information in this document supersedes and replaces all information previously supplied.

The ST logo is a registered trademark of STMicroelectronics. All other names are the property of their respective owners.

© 2008 STMicroelectronics - All rights reserved

STMicroelectronics group of companies

Australia - Belgium - Brazil - Canada - China - Czech Republic - Finland - France - Germany - Hong Kong - India - Israel - Italy - Japan - Malaysia - Malta - Morocco - Singapore - Spain - Sweden - Switzerland - United Kingdom - United States of America

www.st.com