## General Description

The KY32xx series devices are EIA/TIA-232 and V.28/V.24 communication interfaces achieve 1μA supply current with KEYSEMI's revolutionary POWERSAVE™ feature. A proprietary, high- efficiency, dual charge-pumpregulated voltage converters and a low-dropout transmitter combine to deliver true RS-232 performance from a single +3.0V to +5.5V supply.

These devices can operate from input voltages ranging from +3.0V to +5.5V at the guaranteed data rate of 250k bits/sec with enhanced electrostatic discharge (ESD) protection in all RS232 I/O pins exceeding ±15kV EN61000-4-2 Air Gap Discharge and ±8kV EN61000-4-2 Contact Discharge.

The POWERSAVE proprietary function which automatically powers down the on-chip regulated voltage converters and driver circuits when a RS-232 cable is disconnected from the host interface or when a connected peripheral device is turned off. The system turns on again when a valid level is applied to any RS-232 receiver input.

## Features

- Meets EIA/TIA-232F and CCITT V.28/V.24specifications for $V_{CC}$ at +3.3V ±10% and +5V ±10%
- Low POWERSAVE Current:1μA typical, 10μA max
- Guaranteed Data Rate 250kbps
- Extended ESD Protection for RS-232 I/O Pins ±15kV HBM
- High Data Rate at 1000kbps Available on KY32xxF Series

## Applications

- Battery-Powered And Hand-Held Applications
- Peripherals interface
- Portable Diagnostics Equipment
- Terminal Adapters and POS terminals
- Notebooks, Subnotebooks, and Palmtops
- Industrial and Embedded PCs

## Absolute Maximum Ratings (All voltages referenced to GND.)

Supply Voltage $V_{CC}$ ..... -0.3V to +6V
V+ ..... -0.3V to +7V
V- ..... -0.3V to +7V
|V+| + |V-| .....+13V
Input Voltages
TxIN, $\overline{PWRSAVE}$, $\overline{SD}$, $\overline{EN}$ ..... -0.3V to +6V
R_IN..... ±15V
Output Voltages
TxOUT..... ±13.2V
RxOUT, $\overline{STATE}$ ..... -0.3V to ($V_{CC}$ + 0.3V)
Short-Circuit Duration
TxOUT..... Continuous
Continuous Power Dissipation (TA = +70°C)

**Power Dissipation Per Package**

16-pin SSOP (derate 7.20mW/°C above +70°C) ..... 584mW
16-pin nSOIC (derate 10.00mW/°C above +70°C).....720mW
16-pin TSSOP (derate 6.80mW/°C above +70°C) ..... 556mW
16-pin PDIP (derate 11.20mW/°C above +70°C)..... 896mW
18-pin PDIP (derate 12.60mW/°C above +70°C)..... 962mW
20-pin PDIP (derate 12.80mW/°C above +70°C)..... 976mW
20-pin SSOP (derate 8.10mW/°C above +70°C) ..... 647mW
20-pin TSSOP (derate 7.20mW/°C above +70°C)..... 584mW
28-pin SSOP (derate 9.52mW/°C above +70°C).....762mW
28-pin TSSOP (derate 13.20mW/°C above +70°C) .....1W
32-pin VQFN (derate 29.4mW/°C above +70°C).....2352mW

Operating Temperature Range ..... 0°C to +70°C
Junction Temperature.....+150°C
Storage Temperature Range .....-65°C to +150°C
Lead Temperature (soldering 10s) .....+300°C

*Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.*



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## Product Selection Guide

| PART | Tx | Rx | Data Rate (kbps) | Receiver Enable | SHUTDOWN Enable | POWER SAVE | Number of Pins | Package Type |
|---|---|---|---|---|---|---|---|---|
| KY3220E | 1 | 1 | 250 | Yes | Yes | No | 16 | SSOP, TSSOP |
| KY3221E | 1 | 1 | 250 | Yes | Yes | Yes | 16 | SSOP, TSSOP |
| KY3222E | 2 | 2 | 250 | Yes | Yes | No | 20 | SSOP, TSSOP, |
| KY3223E | 2 | 2 | 250 | Yes | Yes | Yes | 20 | SSOP, TSSOP |
| KY3232E | 2 | 2 | 250 | No | No | No | 16 | NSOIC, SSOP, TSSOP |
| KY1385E | 2 | 2 | 250 | No | Yes | No | 20 | SSOP |
| KY3243E | 3 | 5 | 250 | No | Yes | Yes | 28,32 | 28-SSOP, 28-TSSOP, 32-VQFN |

*High Data Rate at 1000kbps Available on KY32xxF Series

## Electrical Characteristics

($V_{CC}$ = +3.0V to +5.5V, C1–C4 = 0.1µF, TA = TMIN to TMAX, unless otherwise noted, Typical values apply at $V_{CC}$ = +3.3V or +5.0V and $T_A$ = 25°C.)

| Parameters | Conditions | typical $V_{CC}$ | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| ***General InfolTypes*** | | | | | | |
| TTL Logic Input | TxIN, $\overline{PWRSAVE}$, $\overline{SD}$, $\overline{EN}$ | high ZIN | | | | |
| TTL Logic Output | RxOUT, $\overline{STATE}$ | | | | | |
| RS-232 Input | RxIN | | | | | |
| RS-232 Output | TxOUT | | | | | |
| Charge Pump Pin | C1P, C1N, C2P, C2N | | | | | |
| Power Pin | $V_{CC}$, $V_{GND}$, $V_{DD}$, $V_{SS}$ | | | | | |
| Charge Pump Caps | C1P, C1N, C2P, C2N | | | 0.1 | | µF |
| $V_{CC}$ Voltage Range | | 5.0 | 4.5 | 5.0 | 5.5 | V |
| | | 3.3 | 3 | 3.3 | 3.6 | V |
| ***DC Characteristics*** | | | | | | |
| Supply Current, Power_save disabled | $\overline{PWRSAVE}$ = $\overline{SD}$ = $V_{CC}$, TTL I/P= $V_{CC}$ /GND, RS-232 I/P=float | 3.3, 5.0 | | 0.5 | | mA |
| Supply Current, Power_save enabled | $\overline{PWRSAVE}$ =GND, $\overline{SD}$ = $V_{CC}$, TTL I/P= $V_{CC}$ /GND, RS-232 I/P=float | 3.3, 5.0 | | 1 | | µA |
| Supply Current, shutdown enabled | $\overline{PWRSAVE}$ = $V_{CC}$ /GND, $\overline{SD}$ =GND, TTL I/P= $V_{CC}$ /GND, RS-232 I/P=float | 3.3, 5.0 | | 1 | | µA |
| ***LOGIC Input*** | | | | | | |
| Input Threshold Low | | 3.3, 5.0 | | | 0.8 | V |
| Input Threshold High | | 5.0 | 2.4 | | | V |
| | | 3.3 | 2 | | | V |
| Input Hysteresis | | 3.3, 5.0 | | 0.3 | | V |
| Input Leakage Current | $V_{IN}$= $V_{CC}$ and GND | 3.3, 5.0 | | | ±1 | µA |
| ***LOGIC Output*** | | | | | | |
| Output Voltage Low | $I_{OUT}$=1.6mA | 3.3, 5.0 | | | 0.4 | V |
| Output voltage High | $I_{OUT}$ =-1mA | 3.3, 5.0 | Vcc-0.6 | Vcc-0.1 | | V |
| Output Leakage Current | Receiver O/P disabled, $V_{OUT}$= $V_{CC}$ or GND | 3.3, 5.0 | | ±0.05 | | µA |
| Receiver Input | | | | | | |
| Input Voltage Range | | 3.3, 5.0 | -15 | | +15 | V |
| Input Threshold Low | | 5.0 | 0.8 | 1.5 | | V |
| | | 3.3 | 0.6 | 1.2 | | V |
| Input Threshold High | | 3.3, 5.0 | | | 2.4 | V |
| Input Hysteresis | | 3.3, 5.0 | | 0.3 | | V |
| Input Resistance | $V_{IN}$ =±25V | 3.3, 5.0 | 3 | | 7 | kΩ |
| ***Transmitter Output*** | | | | | | |
| Output Voltage Swing | $R_L$ =3-7k, all loaded | 3.3, 5.0 | ±5 | | | V |
| Output Resistance | $V_{CC}$ =$V_{DD}$=$V_{SS}$=GND, $V_{OUT}$=±2V | 0 | 300 | | | Ω |
| Output Short-circuit Current | $V_{OUT}$ =GND | 3.3, 5.0 | | | ±60 | mA |
| Output Leakage Current | Transmitter disabled, $V_{OUT}$=±12V | 0, 3.3, 5.0 | | | ±25 | µA |

| | | | | | | |
|---|---|---|---|---|---|---|
| ***Timing Characteristics*** | | | | | | |
| Maximum Data Rate | | | | | | |
| < standard speed > | $R_L$=3-7k, $C_L$ =50pF-1000pF, 1 DR/RC switching | 3.3, 5.0 | 250 | | | kbps |
| < high speed > | $R_L$ =3-7k, $C_L$ =50pF-1000pF, 1 DR/RC switching | 3.3, 5.0 | 1000 | | | kbps |
| Transition-Region Slew Rate | | | | | | V/μs |
| < standard speed > | $R_L$ =3-7k, $C_L$ =50pF-1000pF, 1 DR/RC switching | 3.3, 5.0 | | 30 | | V/μs |
| < high speed > | $R_L$ =3-7k, $C_L$ =50pF-1000pF, 1 DR/RC switching | 3.3, 5.0 | | 90 | | V/μs |
| Transmitter Propatation $t_{PLH}$ | 3k+1000pF, all loaded | 3.3, 5.0 | | 2 | | μs |
| Transmitter Propatation $t_{PHL}$ | 3k+1000pF, all loaded | 3.3, 5.0 | | 2 | | μs |
| Transmitter Skew | $t_{PHL}$ - $t_{PLH}$ | 3.3, 5.0 | | 100 | | ns |
| Transmitter Output Enable Time | | 3.3, 5.0 | | 400 | | ns |
| Transmitter Output Disable Time | | 3.3, 5.0 | | 250 | | ns |
| Receiver Propagation $t_{PLH}$ | $C_L$=150pF | 3.3, 5.0 | | 0.15 | | μs |
| Receiver Propagation $t_{PHL}$ | $C_L$ =150pF | 3.3, 5.0 | | 0.15 | | μs |
| Receiver Skew | $t_{PHL}$ - $t_{PLH}$ | 3.3, 5.0 | | 50 | | ns |
| Receiver Output Enable Time | | 3.3, 5.0 | | 0.2 | | μs |
| Receiver Output Disable Time | | 3.3, 5.0 | | 0.2 | | μs |
| ***AutoGreen Timing*** | | | | | | |
| Receiver I/P to $\overline{\text{STATE}}$ Output High | | 3.3, 5.0 | | 1 | | μs |
| Receiver I/P to $\overline{\text{STATE}}$ Output Low | | 3.3, 5.0 | | 30 | | μs |
| Power save mode to transmitter enabled | | 3.3, 5.0 | | 100 | | μs |
| ***ESD Tolerance*** | | | | | | |
| ESD HBM | | 3.3, 5.0 | | ±15 | | kV |
| ESD 1000-4-2 Contact | | 3.3, 5.0 | | ±8 | | kV |
| ESD 1000-4-2 Air | | 3.3, 5.0 | | ±15 | | kV |

## Pin Description

| PIN | | | | | | | NAME | FUNCTION |
|---|---|---|---|---|---|---|---|---|
| KY3220 | KY3221 | KY3222 | KY3223 | KY3232 | KY3243 | | | |
| 16Pins | 16Pins | 20Pin | 20Pins | 16Pins | 28Pins | 32Pins | | |
| 1 | 1 | 1 | 1 | — | — | — | $\overline{\text{EN}}$ | Receiver Enable Control. Drive low for normal operation. Drive high to force the receiver outputs into a high-Z state. |
| 5 | 5 | 5 | 5 | 4 | 1 | 29 | C2+ | Positive terminal of inverting charge-pump capacitor |
| 6 | 6 | 6 | 6 | 5 | 2 | 30 | C2- | Negative terminal of inverting charge-pump capacitor |
| 7 | 7 | 7 | 7 | 6 | 3 | 31 | V- | -5.5V generated by the charge pump |
| 8 | 8 | 9, 16 | 9, 16 | 8,13 | 4,5,6,7,8 | 1,2,3,4,5 | R_IN | RS-232 Receiver Inputs |
| 13 | 13 | 8, 17 | 8, 17 | 7,14 | 9,10,11 | 6,7,8 | T_OUT | RS-232 Transmitter Outputs |
| 11 | 11 | 12, 13 | 12, 13 | 10,11 | 12,13,14 | 10,11,12 | T_IN | TTL/CMOS Transmitter Inputs |
| 9 | 9 | 10, 15 | 10, 15 | 9,12 | 15,16,17, 18,19 | 13,14,15, 17,18 | R_OUT | TTL/CMOS Receiver Outputs |
| — | — | — | — | — | 20 | 19 | ROUTB | TTL/CMOS level, noninverting, always enabled receiver outputs. |
| — | 10 | — | 11 | — | 21 | 20 | $\overline{\text{STATE}}$ ( $\overline{\text{INVALID}}$ ) | Output of the valid signal detector. Indicates if a valid RS-232 level is present on receiver inputs logic “1”. |
| 16 | 16 | 20 | 20 | — | 22 | 21 | $\overline{\text{SD}}$ | Drive low to shut down transmitters and on-board power supply. This over- rides all automatic circuitry and $\overline{\text{PWRSAVE}}$ |
| — | 12 | — | 14 | — | 23 | 22 | $\overline{\text{PWRSAVE}}$ | Drive high to override automatic circuitry keeping transmitters on ( $\overline{\text{SD}}$ must be high) |
| 4 | 4 | 4 | 4 | 3 | 24 | 23 | C1- | Negative terminal of the voltage doubler charge-pump capacitor |
| 14 | 14 | 18 | 18 | 15 | 25 | 24 | GND | Ground |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 15 | 15 | 19 | 19 | 16 | 26 | 26 | $V_{CC}$ | +3.0V to +5.5V Supply Voltage |
| 3 | 3 | 3 | 3 | 2 | 27 | 27 | V+ | +5.5V generated by the charge pump |
| 2 | 2 | 2 | 2 | 1 | 28 | 28 | C1+ | Positive terminal of the voltage doubler charge-pump capacitor |

## Truth Table

| Operation Status | $\overline{PWRSAVE}$ | $\overline{SD}$ | $\overline{EN}$ | Signal at RXIN | $\overline{STATE}$ | TxOUT | RxOUT |
|---|---|---|---|---|---|---|---|
| Shutdown | don't care | 0 | 0 | present | 1 | tri-state | active |
| | don't care | 0 | 0 | not present | 0 | tri-state | active |
| | don't' care | 0 | 1 | present | 1 | tri-state | tri-state |
| | don't' care | 0 | 1 | not present | 0 | tri-state | tri-state |
| Normal without $\overline{PWRSAVE}$ | 1 | 1 | 0 | present | 1 | active | active |
| | 1 | 1 | 0 | not present | 0 | active | active |
| | 1 | 1 | 1 | present | 1 | active | tri-state |
| | 1 | 1 | 1 | not present | 0 | active | tri-state |
| Normal with $\overline{PWRSAVE}$ | 0 | 1 | 0 | present | 1 | active | active |
| | 0 | 1 | 0 | not present | 0 | tri-state | active |
| | 0 | 1 | 1 | present | 1 | active | tri-state |
| | 0 | 1 | 1 | not present | 0 | tri-state | tri-state |

## Detailed Description

### Charge-Pump

The KY32xx's family utilizes regulated on-chip dual charge pumps that provides output voltages of +5.5V(doubling charge pump) and -5.5V (inverting charge pump), regardless of the input voltage ($V_{CC}$) over the +3.0V to +5.5V range. The charge pumps operate in a discontinuous mode: if the output voltages are less than 5.5V, the charge pumps are enabled; if the output voltages exceed 5.5V, the charge pumps are disabled. Each charge pump requires a flying capacitor (C1, C2) and a reservoir capacitor (C3, C4) to generate the V+ and V- supplies.

### RS-232 Transmitters

The transmitters are proprietary, low dropout, inverting level translators that convert TTL/CMOS inputs to EIA/TIA-232 output levels. Coupled with the on-chip 5.5V supplies, these transmitters deliver ptrue RS-232 levels over a wide range of single supply system voltages. When $\overline{SD}$ is driven to ground, or the POWERSAVE circuitry senses invalid voltage levels at all receiver inputs, the transmitters are disabled and the outputs are forced into a high- impedance state.

### RS-232 Receive

The KY32xx's receivers convert RS-232 signals to CMOS-logic output levels. They are contain standard inverting receivers that three-state (except for the KY3232, KY3243) via the $\overline{EN}$ or $\overline{SD}$ control lines.

### Controlled Power-Down

The KY3220, KY3221, KY3222, KY3223 and KY3243 have a low-power shutdown mode controlled by the $\overline{SD}$ pin. During shutdown the driver output and the switch-capacitor regulated voltage converter are disabled with the supply current falls to less than 1μA.The KY3221, KY3223 and KY3243 use KEYSEMI's patent pending POWERSAVE circuitry to set/reset latches, which enable the circuit shutdown function when a RS232 cable is disconnected or when the peripheral is turned off and reduce the power supply drain to 1μA supply current. When a RS232 cable is connected or when the peripheral is enabled, the devices will automatically become active again.

### ESD Immunity

The KY32xx series incorporates ruggedized ESD cells on all driver output and receiver input pins.

The ESD structure is improved for more rugged applications and environments sensitive to electro-static discharges and associated transients.

The improved ESD tolerance is at least +15kV without damage nor latch-up.

There are two methods within EN61000-4-2, the Air Discharge method and the Contact Discharge method.

With the Air Discharge Method, an ESD voltage is applied to the equipment under test through air, which simulates an electrically charged person ready to connect a cable onto the rear of the system and the high energy potential on the person discharges through an arcing path to the rear panel of the system before he or she even touches the system.

The Contact Discharge Method applies the ESD current directly to the EUT.

This method was devised to reduce the unpredictability of the ESD arc.

The discharge current rise time is constant since the energy is directly transferred without the air-gap arc inconsistencies.

KEYSEMI's RS232 transceivers meets and exceeds the minimum criteria for EN61000-4-2 with ±15kV for Air Gap Discharge and ±8kV for Contact Discharge.

The circuit models in following Figures represent the typical ESD testing circuit.

The CS is initially charged with the DC power supply when the first switch (SW1) is on.

Now that the capacitor is charged, the second switch (SW2) is on while SW1 switches off.

The voltage stored in the capacitor is then applied through RS, the current limiting resistor, onto the device under test (DUT).

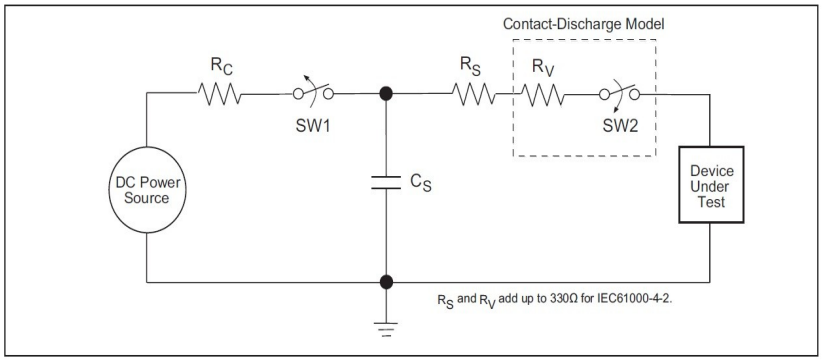
In ESD tests, the SW2 switch is pulsed so that the device under test receives a duration of voltage.

For the Human Body Model, the current limiting resistor (RS) and the source capacitor (CS) are 1.5kΩ and 100pF, respectively. For IEC-61000-4-2, the current limiting resistor (RS) and the source capacitor (CS) are 330Ω and 150pF, respectively.

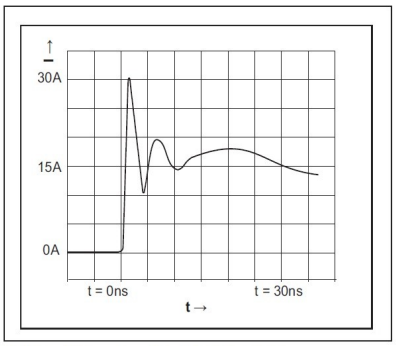
The higher CS value and lower RS value in the IEC61000-4-2 model are more stringent than the Human Body Model.

The larger storage capacitor injects a higher voltage to the test point when SW2 is switched on.

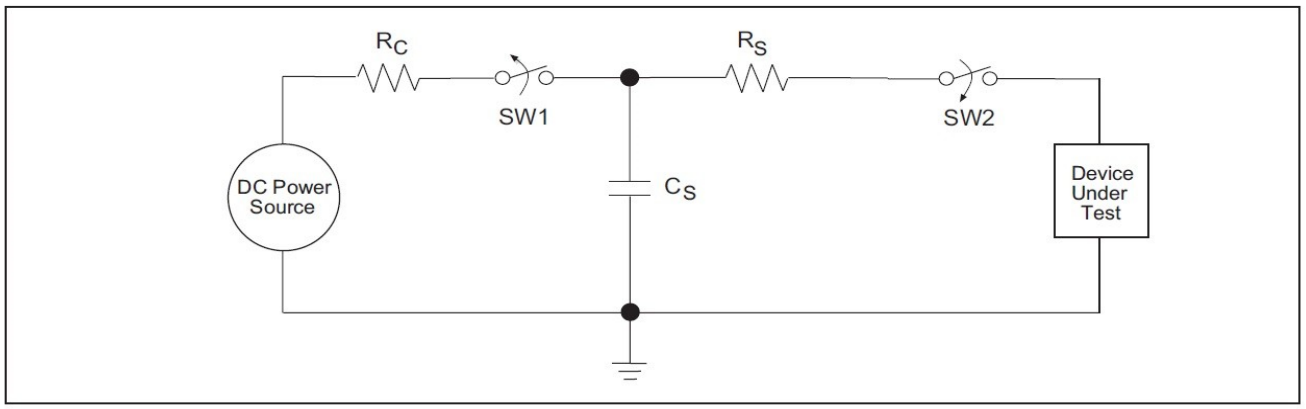
The lower current limiting resistor increases the current charge onto the test point.




ESD Test Circuit for IEC61000-4-2




ESD Test Waveform for IEC61000-4-2



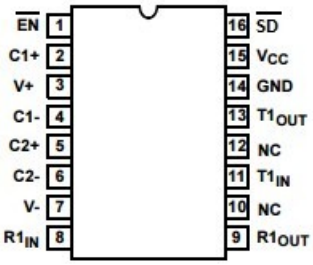

ESD Test Circuit for Human Body Model

| DEVICE PIN TESTED | HUMAN BODY MODEL | IEC61000-4-2 | | |
|---|---|---|---|---|
| | | Air Discharge | Direct Contact | Level |
| Driver Outputs<br>Receiver Inputs | ±15kV<br>±15kV | ±15kV<br>±15kV | ±8kV<br>±8kV | 4<br>4 |

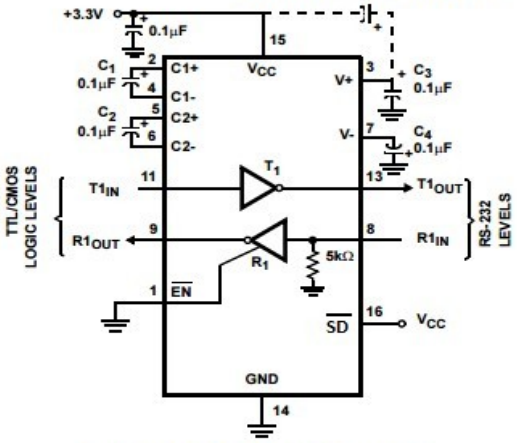
Transceiver ESD Tolerance Levels

## Typical Application Circuits and Pin Configuration

KY3220(SSOP,TSSOP)
TOP VIEW

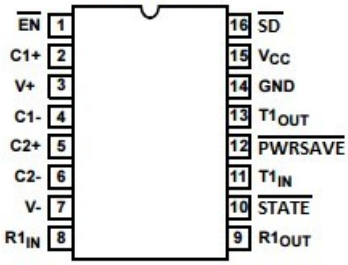



KY3220
$C_3$(OPTIONAL CONNECTION,NOTE)

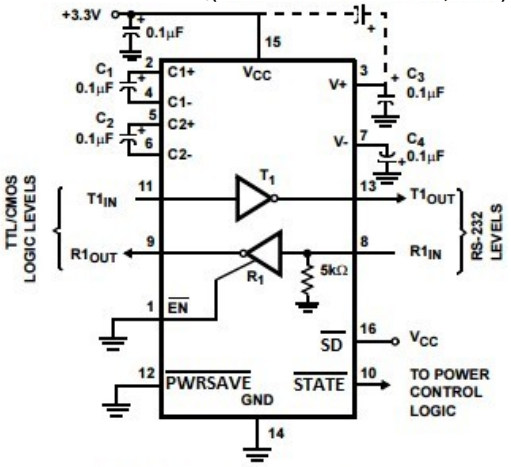



NOTE: The negative terminal of $C_3$ can be connected to either $V_{CC}$ or GND

KY3221(SSOP,TSSOP)
TOP VIEW

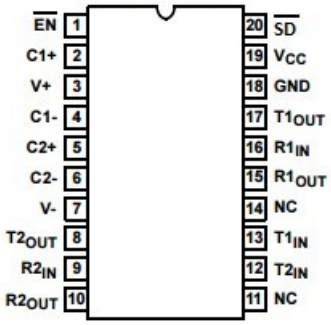



KY3221
$C_3$(OPTIONAL CONNECTION,NOTE)

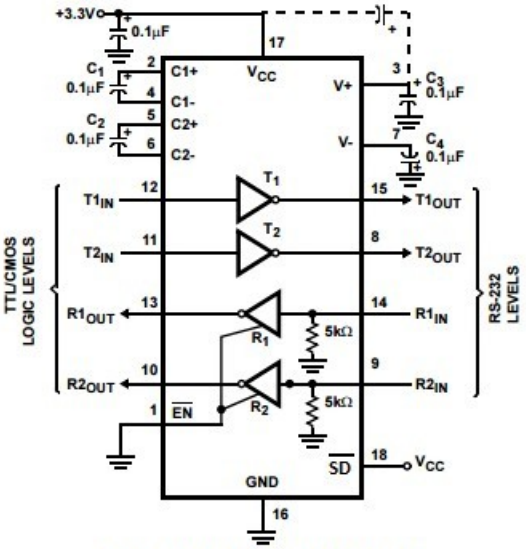



NOTE: The negative terminal of $C_3$ can be connected to either $V_{CC}$ or GND

KY3222(SSOP,TSSOP)
TOP VIEW

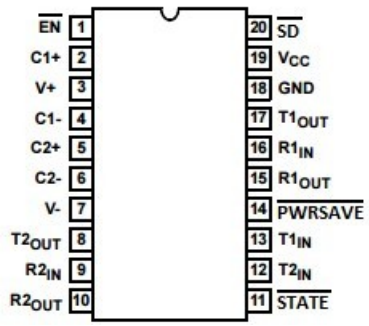



KY3222
C3(OPTIONAL CONNECTION,NOTE)

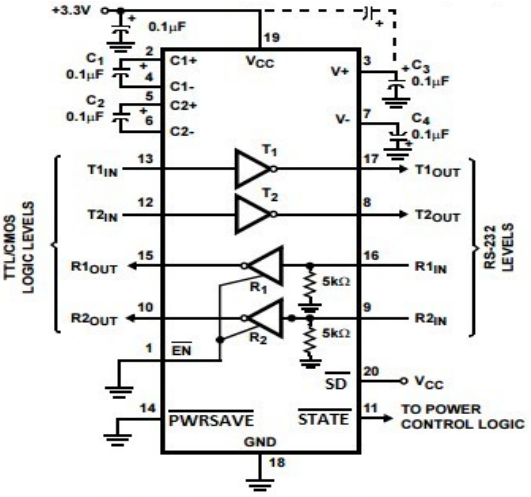



NOTE: The negative terminal of $C_3$ can be connected to either $V_{CC}$ or GND

KY3223(SSOP,TSSOP)
TOP VIEW

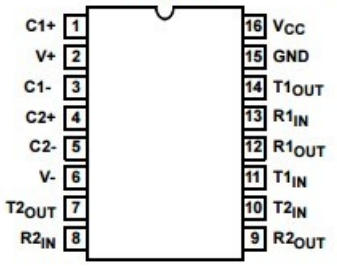



KY3223
C3(OPTIONAL CONNECTION,NOTE)

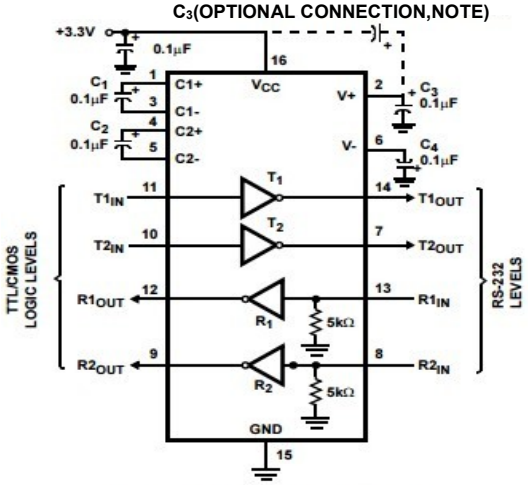



NOTE: The negative terminal of $C_3$ can be connected to either $V_{CC}$ or GND

KY3232(nSOIC,SSOP,TSSOP)
TOP VIEW

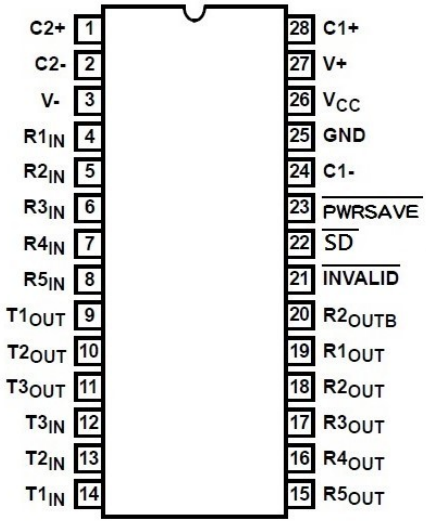



KY3232
C3(OPTIONAL CONNECTION,NOTE)

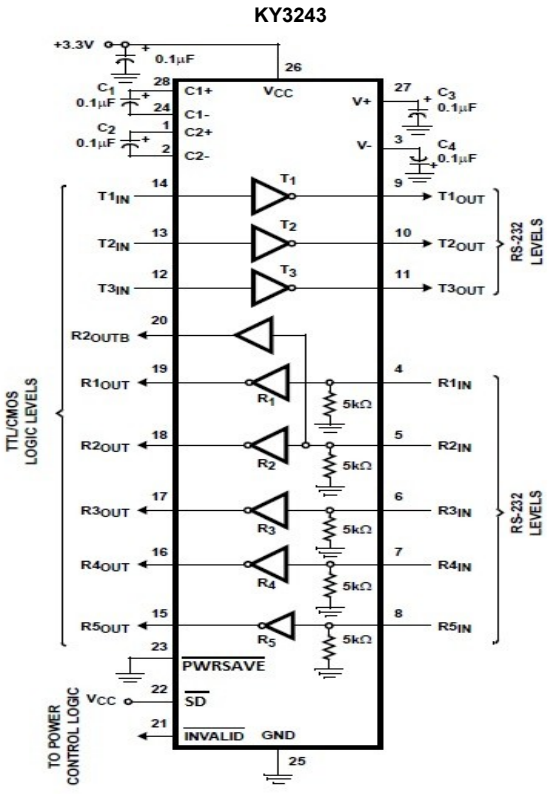



NOTE: The negative terminal of $C_3$ can be connected to either $V_{CC}$ or GND

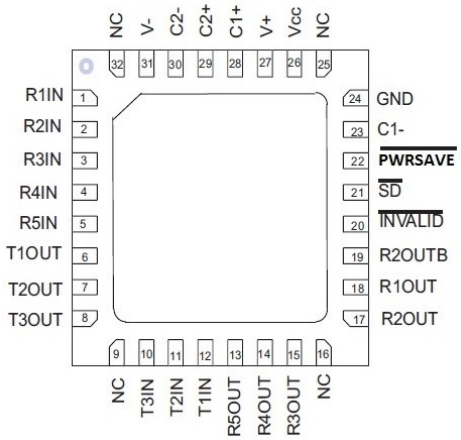
KY3243(SSOP,TSSOP)
TOP VIEW



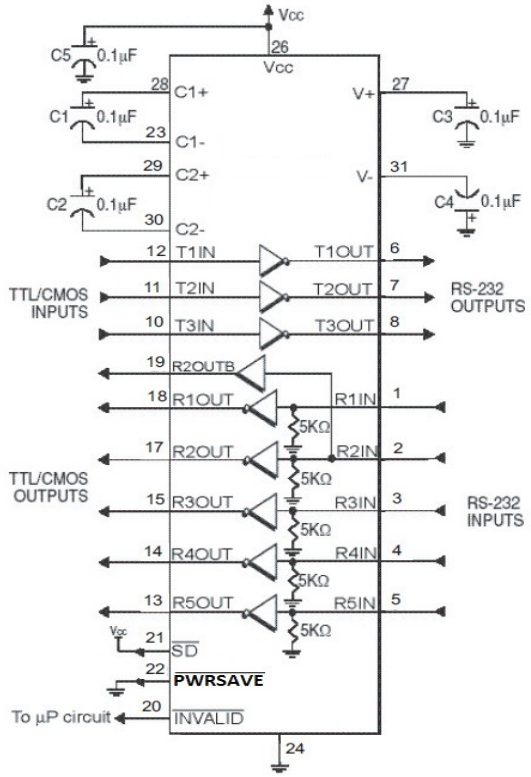

KY3243



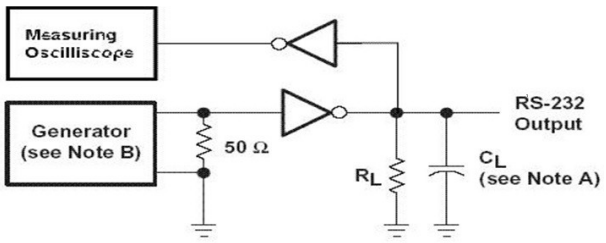
KY3243(32Pin VQFN)




KY3243(VQFN)




## Typical Test Circuits

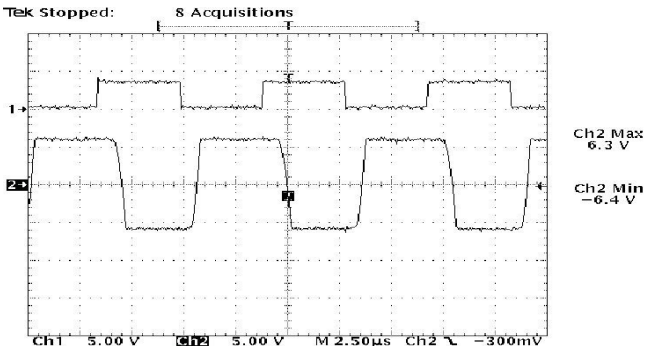



TEST CIRCUIT

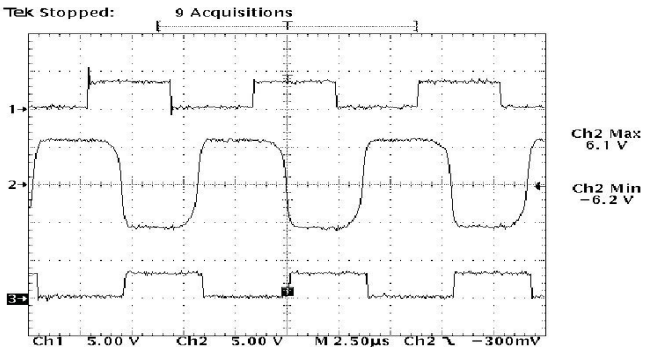
### Maximum Data Rate Test Circuit

Notes:

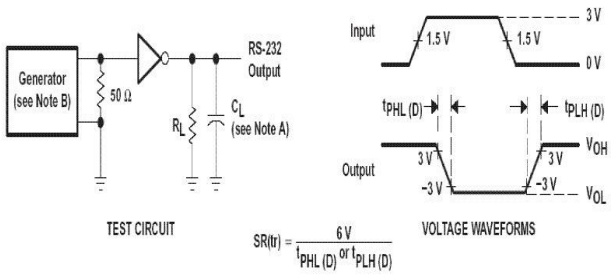
A. $R_L$=3kΩ, $C_L$ = 1000pF, $T_A$ = 25°C, One Driver Switching.
B. The pulse generator had the following characteristics: PRR = 250 kbps, Zo = 50Ω, 50% duty cycle, $T_r$ & $T_f$ ≤ 10ns.
C. $\overline{SD}$ = $V_{CC}$ when applicable.




*KY32xx TxIN to TxOut (no load) at 250kbps waveform*




*KY32xx TxIN to TxOut to RxOut (loopback to Rx with 1000pF load) at 250kbps waveform*



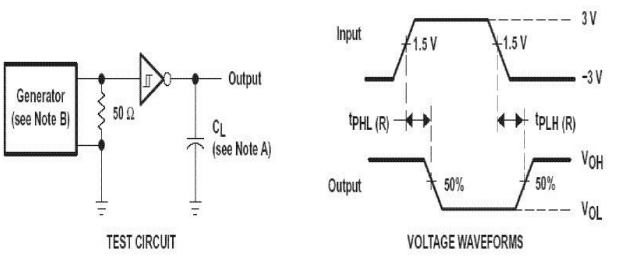

### Driver Transition-Region Slew Rate Test Circuit

Notes:

A. $R_L$=3k~7kΩ,$C_L$= 150~1000pF,$T_A$ = 25°C
One Driver Switching, Measured from +3V to -3V or -3V to +3V.

B. The pulse generator had the following characteristics:
PRR = 250 kbps, Zo = 50Ω, 50% duty cycle, $T_r$ & $T_f$ ≤ 10ns.

C. $\overline{SD}$ = $V_{CC}$ when applicable.



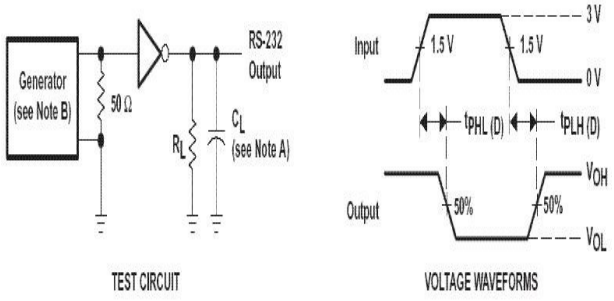

### Driver Propagation ($t_{PHL}$ & $t_{PLH}$) Test Circuit

Notes:

A. All drivers loaded with $R_L$=3kΩ,$C_L$= 1000pF.

B. The pulse generator had the following characteristics:
PRR = 250 kbps, Zo = 50Ω, 50% duty cycle, $T_r$ & $T_f$ ≤ 10ns.

C. $\overline{SD}$ = $V_{CC}$ when applicable.




### Receiver Propagation Delay Times Test Circuit

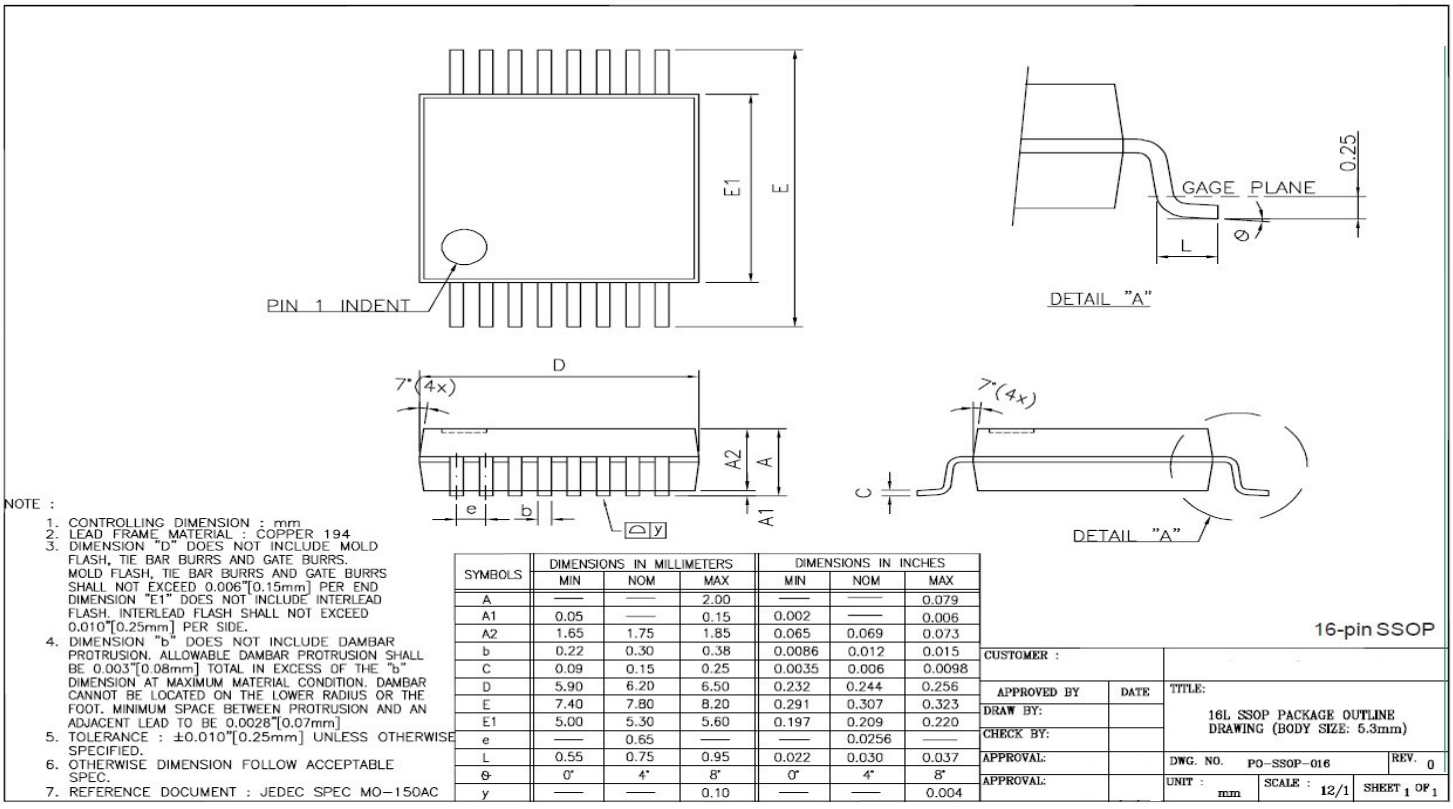
Notes:

A. $C_L$= 150pF, including probe and jig capacitance.

B. The pulse generator had the following characteristics:
PRR = 250 kbps, Zo = 50Ω, 50% duty cycle, $T_r$ & $T_f$ ≤ 10ns.

C. $\overline{SD}$ = $V_{CC}$ when applicable.

## Package Information

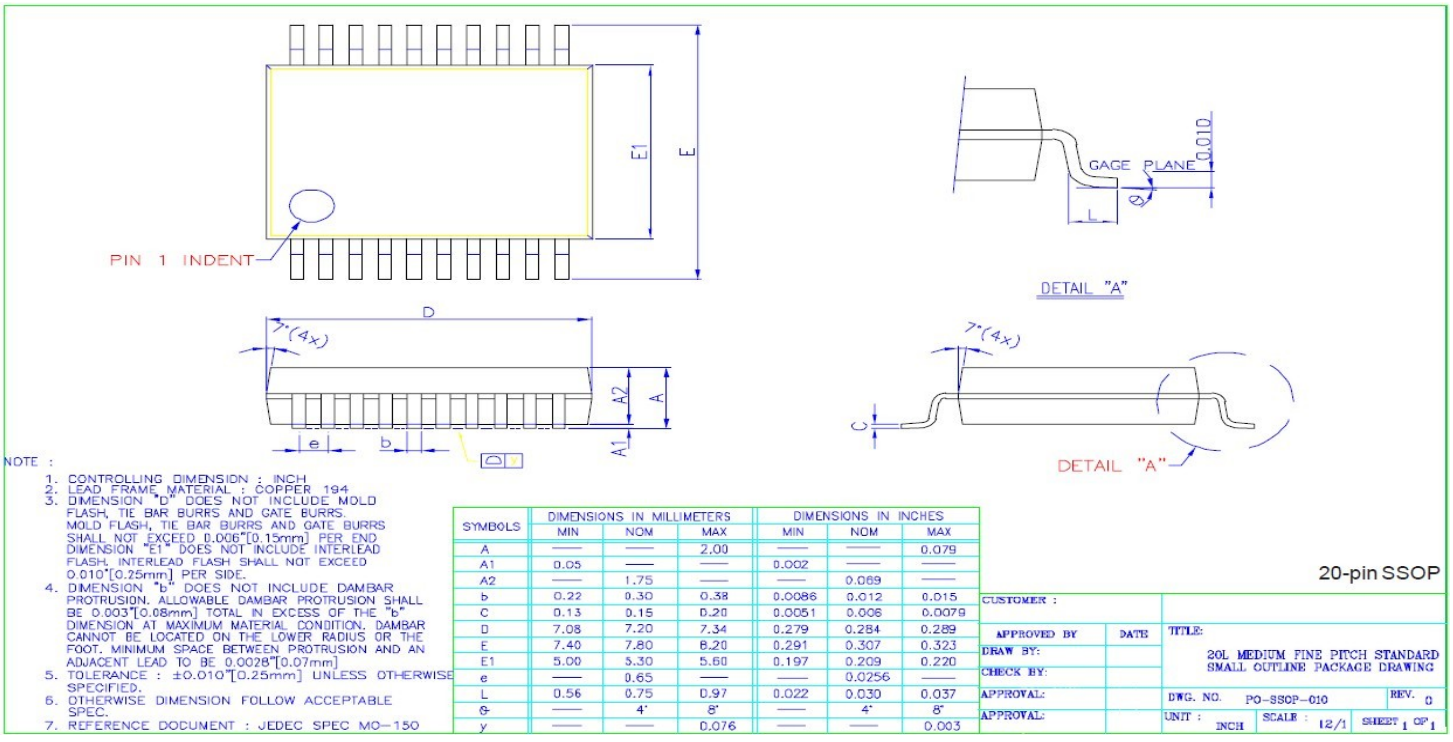



NOTE :
1. CONTROLLING DIMENSION : mm
2. LEAD FRAME MATERIAL : COPPER 194
3. DIMENSION "D" DOES NOT INCLUDE MOLD FLASH, TIE BAR BURRS AND GATE BURRS. MOLD FLASH, TIE BAR BURRS AND GATE BURRS SHALL NOT EXCEED 0.006"[0.15mm] PER END DIMENSION "E1" DOES NOT INCLUDE INTERLEAD FLASH. INTERLEAD FLASH SHALL NOT EXCEED 0.010"[0.25mm] PER SIDE.
4. DIMENSION "b" DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.003"[0.08mm] TOTAL IN EXCESS OF THE "b" DIMENSION AT MAXIMUM MATERIAL CONDITION. DAMBAR CANNOT BE LOCATED ON THE LOWER RADIUS OR THE FOOT. MINIMUM SPACE BETWEEN PROTRUSION AND AN ADJACENT LEAD TO BE 0.0028"[0.07mm]
5. TOLERANCE : ±0.010"[0.25mm] UNLESS OTHERWISE SPECIFIED.
6. OTHERWISE DIMENSION FOLLOW ACCEPTABLE SPEC.
7. REFERENCE DOCUMENT : JEDEC SPEC MO-150AC

| SYMBOLS | DIMENSIONS IN MILLIMETERS | | | DIMENSIONS IN INCHES | | |
|---|---|---|---|---|---|---|
| | MIN | NOM | MAX | MIN | NOM | MAX |
| A | —— | —— | 2.00 | —— | —— | 0.079 |
| A1 | 0.05 | —— | 0.15 | 0.002 | —— | 0.006 |
| A2 | 1.65 | 1.75 | 1.85 | 0.065 | 0.069 | 0.073 |
| b | 0.22 | 0.30 | 0.38 | 0.0086 | 0.012 | 0.015 |
| C | 0.09 | 0.15 | 0.25 | 0.0035 | 0.006 | 0.0098 |
| D | 5.90 | 6.20 | 6.50 | 0.232 | 0.244 | 0.256 |
| E | 7.40 | 7.80 | 8.20 | 0.291 | 0.307 | 0.323 |
| E1 | 5.00 | 5.30 | 5.60 | 0.197 | 0.209 | 0.220 |
| e | —— | 0.65 | —— | —— | 0.0256 | —— |
| L | 0.55 | 0.75 | 0.95 | 0.022 | 0.030 | 0.037 |
| θ | 0° | 4° | 8° | 0° | 4° | 8° |
| y | —— | —— | 0.10 | —— | —— | 0.004 |

16-pin SSOP

| | | |
|---|---|---|
| CUSTOMER : | | |
| APPROVED BY | DATE | TITLE: 16L SSOP PACKAGE OUTLINE DRAWING (BODY SIZE: 5.3mm) |
| DRAW BY: | | |
| CHECK BY: | | |
| APPROVAL: | | DWG. NO. PO-SSOP-016 REV. 0 |
| APPROVAL: | | UNIT : mm SCALE : 12/1 SHEET 1 OF 1 |

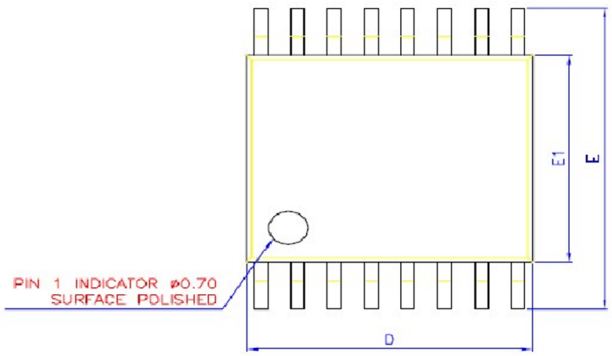


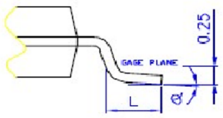

NOTE :
1. CONTROLLING DIMENSION : INCH
2. LEAD FRAME MATERIAL : COPPER 194
3. DIMENSION "D" DOES NOT INCLUDE MOLD FLASH, TIE BAR BURRS AND GATE BURRS. MOLD FLASH, TIE BAR BURRS AND GATE BURRS SHALL NOT EXCEED 0.006"[0.15mm] PER END DIMENSION "E1" DOES NOT INCLUDE INTERLEAD FLASH. INTERLEAD FLASH SHALL NOT EXCEED 0.010"[0.25mm] PER SIDE.
4. DIMENSION "b" DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.003"[0.08mm] TOTAL IN EXCESS OF THE "b" DIMENSION AT MAXIMUM MATERIAL CONDITION. DAMBAR CANNOT BE LOCATED ON THE LOWER RADIUS OR THE FOOT. MINIMUM SPACE BETWEEN PROTRUSION AND AN ADJACENT LEAD TO BE 0.0028"[0.07mm]
5. TOLERANCE : ±0.010"[0.25mm] UNLESS OTHERWISE SPECIFIED.
6. OTHERWISE DIMENSION FOLLOW ACCEPTABLE SPEC.
7. REFERENCE DOCUMENT : JEDEC SPEC MO-150

| SYMBOLS | DIMENSIONS IN MILLIMETERS | | | DIMENSIONS IN INCHES | | |
|---|---|---|---|---|---|---|
| | MIN | NOM | MAX | MIN | NOM | MAX |
| A | —— | —— | 2.00 | —— | —— | 0.079 |
| A1 | 0.05 | —— | —— | 0.002 | —— | —— |
| A2 | —— | 1.75 | —— | —— | 0.069 | —— |
| b | 0.22 | 0.30 | 0.38 | 0.0086 | 0.012 | 0.015 |
| C | 0.13 | 0.15 | 0.20 | 0.0051 | 0.006 | 0.0079 |
| D | 7.08 | 7.20 | 7.34 | 0.279 | 0.284 | 0.289 |
| E | 7.40 | 7.80 | 8.20 | 0.291 | 0.307 | 0.323 |
| E1 | 5.00 | 5.30 | 5.60 | 0.197 | 0.209 | 0.220 |
| e | —— | 0.65 | —— | —— | 0.0256 | —— |
| L | 0.56 | 0.75 | 0.97 | 0.022 | 0.030 | 0.037 |
| θ | —— | 4° | 8° | —— | 4° | 8° |
| y | —— | —— | 0.076 | —— | —— | 0.003 |

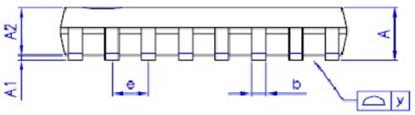
20-pin SSOP

| | | |
|---|---|---|
| CUSTOMER : | | |
| APPROVED BY | DATE | TITLE: 20L MEDIUM FINE PITCH STANDARD SMALL OUTLINE PACKAGE DRAWING |
| DRAW BY: | | |
| CHECK BY: | | |
| APPROVAL: | | DWG. NO. PO-SSOP-010 REV. 0 |
| APPROVAL: | | UNIT : INCH SCALE : 12/1 SHEET 1 OF 1 |




DETAIL A

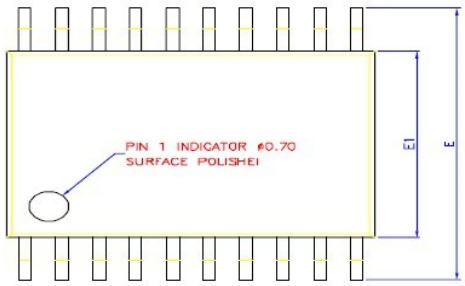


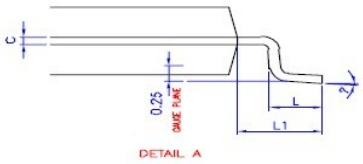
NOTE :
1. CONTROLLING DIMENSION : mm.
2. LEAD FRAME MATERIAL : OLIN C7025/EFTEC 64T
3. DIMENSION "D" DOES NOT INCLUDE MOLD FLASH, TIE BAR BURRS AND GATE BURRS MOLD FLASH, TIE BAR BURRS AND GATE BURRS SHALL NOT EXCEED 0.006"[0.15mm] PER END DIMENSION "E1" DOES NOT INCLUDE INTERLEAD FLASH. INTERLEAD FLASH SHALL NOT EXCEED 0.010"[0.25mm] PER SIDE.
4. DIMENSION "b" DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.003"[0.08mm] TOTAL IN EXCESS OF THE "b" DIMENSION AT MAXIMUM MATERIAL CONDITION. DAMBAR CANNOT BE LOCATED ON THE LOWER RADIUS OR THE FOOT. MININUM SPACE BETWEEN PROTRUSION AND AN ADJACENT LEAD TO BE 0.0028"[0.07mm]
5. TOLERANCE : ±0.010"[0.25mm] UNLESS OTHERWISE SPECIFIED.
6. OTHERWISE DIMENSION FOLLOW ACCEPTABLE SPEC.
7. REFERENCE DOCUMENT : JEDEC SPEC MO-153

| SYMBOLS | DIMENSIONS IN MILLIMETERS | | | DIMENSIONS IN INCHES | | |
|---|---|---|---|---|---|---|
| | MIN | NOM | MAX | MIN | NOM | MAX |
| A | 1.05 | 1.10 | 1.20 | 0.041 | 0.043 | 0.047 |
| A1 | 0.05 | 0.10 | 0.15 | 0.002 | 0.004 | 0.006 |
| A2 | —— | 1.00 | 1.05 | —— | 0.039 | 0.041 |
| b | 0.20 | 0.25 | 0.28 | 0.008 | 0.010 | 0.011 |
| c | —— | 0.127 | —— | —— | 0.005 | —— |
| D | 4.90 | 5.075 | 5.10 | 0.193 | 0.1998 | 0.200△ |
| E | 6.20 | 6.40 | 6.60 | 0.244 | 0.252 | 0.260 |
| E1 | 4.30 | 4.40 | 4.50 | 0.170 | 0.173 | 0.177 |
| e | —— | 0.65 | —— | —— | 0.026 | —— |
| L | 0.50 | 0.60 | 0.70 | 0.020 | 0.024 | 0.028 |
| y | —— | —— | 0.076 | —— | —— | 0.003 |
| θ | 0° | 4° | 8° | 0° | 4° | 8° |

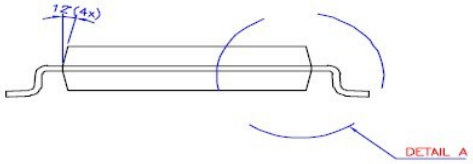
16-pin TSSOP

| | | | |
|---|---|---|---|
| CUSTOMER : | | | |
| APPROVED BY | DATE | TITLE: 16L TSSOP PACKAGE OUTLINE DRAWING | |
| DRAW BY: | | | |
| CHECK BY: | | | |
| APPROVAL: | | DWG. NO. PO-TSSOP-002 | REV. 1 |
| APPROVAL: | | UNIT : mm SCALE : 15/1 | SHEET 1 OF 1 |




DETAIL A

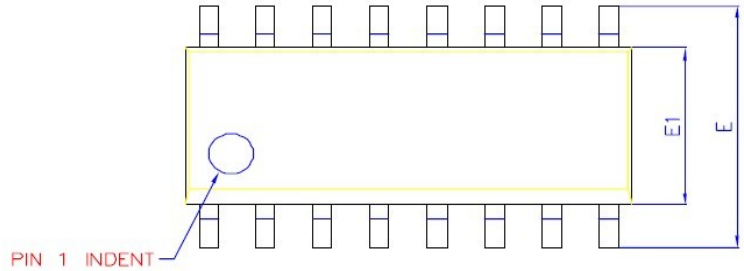


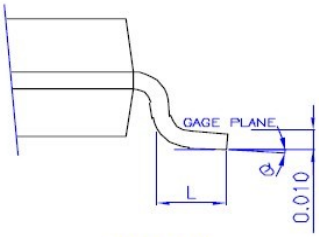

NOTE :
1. CONTROLLING DIMENSION : mm.
2. LEAD FRAME MATERIAL : OLIN C7025/EFTEC 64T
3. DIMENSION "D" DOES NOT INCLUDE MOLD FLASH, TIE BAR BURRS AND GATE BURRS. MOLD FLASH, TIE BAR BURRS AND GATE BURRS SHALL NOT EXCEED 0.006"[0.15mm] PER END DIMENSION "E1" DOES NOT INCLUDE INTERLEAD FLASH. INTERLEAD FLASH SHALL NOT EXCEED 0.010"[0.25mm] PER SIDE.
4. DIMENSION "b" DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.003"[0.08mm] TOTAL IN EXCESS OF THE "b" DIMENSION AT MAXIMUM MATERIAL CONDITION. DAMBAR CANNOT BE LOCATED ON THE LOWER RADIUS OR THE FOOT. MINIMUM SPACE BETWEEN PROTRUSION AND AN ADJACENT LEAD TO BE 0.0028"[0.07mm]
5. TOLERANCE : ±0.010"[0.25mm] UNLESS OTHERWISE SPECIFIED.
6. OTHERWISE DIMENSION FOLLOW ACCEPTABLE SPEC.
7. REFERENCE DOCUMENT : JEDEC SPEC MO-153

| SYMBOLS | DIMENSIONS IN MILLIMETERS | | | DIMENSIONS IN INCHES | | |
|---|---|---|---|---|---|---|
| | MIN | NOM | MAX | MIN | NOM | MAX |
| A | —— | —— | 1.20 | —— | —— | 0.047 |
| A1 | 0.05 | —— | 0.15 | 0.002 | —— | 0.006 |
| A2 | 0.80 | 1.00 | 1.05 | 0.031 | 0.039 | 0.041 |
| b | 0.19 | —— | 0.30 | 0.007 | —— | 0.012 |
| C | 0.09 | —— | 0.20 | 0.0035 | —— | 0.008 |
| D | 6.40 | 6.50 | 6.60 | 0.252 | 0.258 | 0.260 |
| E | —— | 6.40 | —— | —— | 0.252 | —— |
| E1 | 4.30 | 4.40 | 4.50 | 0.170 | 0.173 | 0.177 |
| e | —— | 0.65 | —— | —— | 0.026 | —— |
| L | 0.45 | 0.60 | 0.75 | 0.0177 | 0.024 | 0.0295 |
| L1 | —— | 1.00 | —— | —— | 0.039 | —— |
| y | —— | —— | 0.076 | —— | —— | 0.003 |
| θ | 0° | —— | 8° | 0° | —— | 8° |

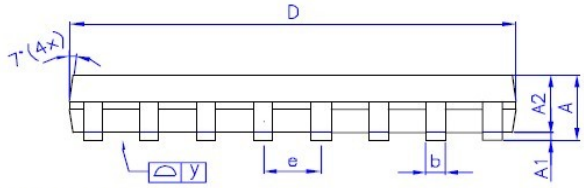
20-pin TSSOP

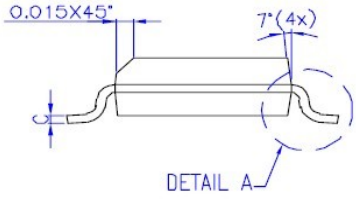
| | | | |
|---|---|---|---|
| CUSTOMER : | | | |
| APPROVED BY | DATE | TITLE: 20L TSSOP PACKAGE OUTLINE DRAWING (4.4mm) | |
| DRAW BY: | | | |
| CHECK BY: | | | |
| APPROVAL: | | DWG. NO. PO-TSSOP-008 | REV. B |
| APPROVAL: | | UNIT : mm SCALE : 15/1 | SHEET 1 OF 1 |




DETAIL A



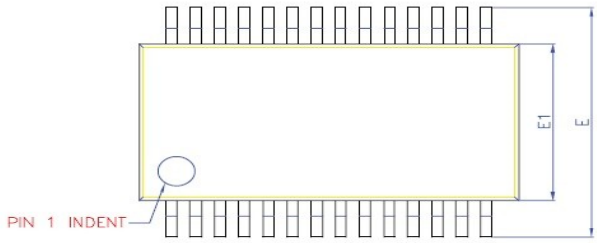

DETAIL A

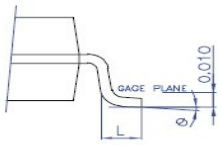
NOTE .
1. CONTROLLING DIMENSION : INCH
2. LEAD FRAME MATERIAL : COPPER 194
3. DIMENSION "D" DOES NOT INCLUDE MOLD FLASH, TIE BAR BURRS AND GATE BURRS. MOLD FLASH, TIE BAR BURRS AND GATE BURRS SHALL NOT EXCEED 0.006"[0.15mm] PER END DIMENSION "E1" DOES NOT INCLUDE INTERLEAD FLASH. INTERLEAD FLASH SHALL NOT EXCEED 0.010"[0.25mm] PER SIDE.
4. DIMENSION "b" DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.003"[0.08mm] TOTAL IN EXCESS OF THE "b" DIMENSION AT MAXIMUM MATERIAL CONDITION. DAMBAR CANNOT BE LOCATED ON THE LOWER RADIUS OR THE FOOT. MINIMUM SPACE BETWEEN PROTRUSION AND AN ADJACENT LEAD TO BE 0.0028"[0.07mm]
5. TOLERANCE : ±0.010"[0.25mm] UNLESS OTHERWISE SPECIFIED
6. OTHERWISE DIMENSION FOLLOW ACCEPTABLE SPEC.
7 REFERENCE DOCUMENT : JEDEC SPEC MS-012

| SYMBOLS | DIMENSIONS IN MILLIMETERS | | | DIMENSIONS IN INCHES | | |
|---|---|---|---|---|---|---|
| | MIN | NOM | MAX | MIN | NOM | MAX |
| A | 1.47 | 1.60 | 1.73 | 0.058 | 0.063 | 0.068 |
| A1 | 0.10 | — | 0.25 | 0.004 | — | 0.010 |
| A2 | — | 1.45 | — | — | 0.057 | — |
| b | 0.33 | 0.41 | 0.51 | 0.013 | 0.016 | 0.020 |
| C | 0.19 | 0.20 | 0.25 | 0.0075 | 0.008 | 0.0098 |
| D | 9.80 | 9.91 | 10.01 | 0.386 | 0.390 | 0.394 |
| E | 5.79 | 5.99 | 6.20 | 0.228 | 0.236 | 0.244 |
| E1 | 3.81 | 3.91 | 3.99 | 0.150 | 0.154 | 0.157 |
| e | — | 1.27 | — | — | 0.050 | — |
| L | 0.38 | 0.71 | 1.27 | 0.015 | 0.028 | 0.050 |
| y | — | — | 0.076 | — | — | 0.003 |
| θ | 0° | — | 8° | 0° | — | 8° |

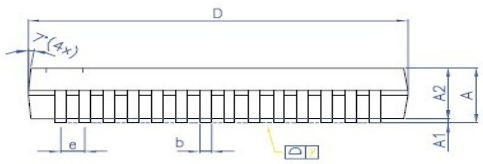
16-pin nSOIC

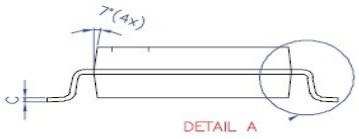
| | | |
|---|---|---|
| CUSTOMER : | | |
| APPROVED BY | DATE | TITLE: 16L SMALL OUTLINE PACKAGE DRAWING(0.150") |
| DRAW BY: | | |
| CHECK BY: | | |
| APPROVAL: | | DWG. NO. PO-SOP-003 REV. 0 |
| APPROVAL: | | UNIT : INCH SCALE : 12/1 SHEET 1 OF 1 |




DETAIL "A"



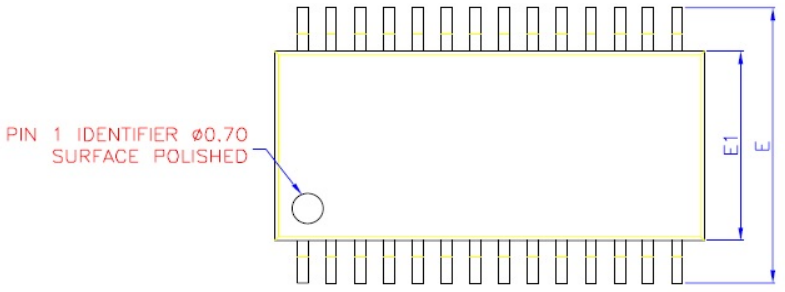

DETAIL A

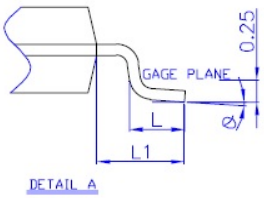
NOTE :
1. CONTROLLING DIMENSION : mm
2. LEAD FRAME MATERIAL : COPPER 194
3. DIMENSION "D" DOES NOT INCLUDE MOLD FLASH, TIE BAR BURRS AND GATE BURRS. MOLD FLASH, TIE BAR BURRS AND GATE BURRS SHALL NOT EXCEED 0.006"[0.15mm] PER END DIMENSION "E1" DOES NOT INCLUDE INTERLEAD FLASH. INTERLEAD FLASH SHALL NOT EXCEED 0.010"[0.25mm] PER SIDE.
4. DIMENSION "b" DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.003"[0.08mm] TOTAL IN EXCESS OF THE "b" DIMENSION AT MAXIMUM MATERIAL CONDITION. DAMBAR CANNOT BE LOCATED ON THE LOWER RADIUS OR THE FOOT. MINIMUM SPACE BETWEEN PROTRUSION AND AN ADJACENT LEAD TO BE 0.0028"[0.07mm]
5. TOLERANCE : ±0.010"[0.25mm] UNLESS OTHERWISE SPECIFIED.
6. OTHERWISE DIMENSION FOLLOW ACCEPTABLE SPEC.
7. REFERENCE DOCUMENT : JEDEC SPEC MO-150

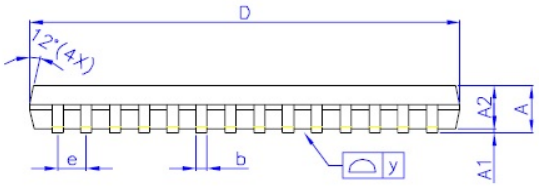
| SYMBOLS | DIMENSIONS IN MILLIMETERS | | | DIMENSIONS IN INCHES | | |
|---|---|---|---|---|---|---|
| | MIN | NOM | MAX | MIN | NOM | MAX |
| A | — | — | 2.00 | — | — | 0.079 |
| A1 | 0.05 | — | — | 0.002 | — | — |
| A2 | — | 1.75 | — | — | 0.069 | — |
| b | 0.22 | 0.30 | 0.38 | 0.0086 | 0.012 | 0.015 |
| C | 0.13 | 0.15 | 0.20 | 0.0051 | 0.006 | 0.0079 |
| D | 10.08 | 10.20 | 10.34 | 0.397 | 0.402 | 0.407 |
| E | 7.40 | 7.80 | 8.20 | 0.291 | 0.307 | 0.323 |
| E1 | 5.00 | 5.30 | 5.60 | 0.197 | 0.209 | 0.220 |
| e | — | 0.65 | — | — | 0.0256 | — |
| L | 0.56 | 0.75 | 0.97 | 0.022 | 0.030 | 0.037 |
| θ | — | 4° | 8° | — | 4° | 8° |
| y | — | — | 0.076 | — | — | 0.003 |

28-pin SSOP

| | | |
|---|---|---|
| CUSTOMER : | | |
| APPROVED BY | DATE | TITLE: 28L (.209") BODY .025" LEAD PITCH SMALL OUTLINE PACKAGE DRAWING |
| DRAW BY: | | |
| CHECK BY: | | |
| APPROVAL: | | DWG. NO. PO-SSOP-011 REV. 0 |
| APPROVAL: | | UNIT : mm SCALE : 10/1 SHEET 1 OF 1 |



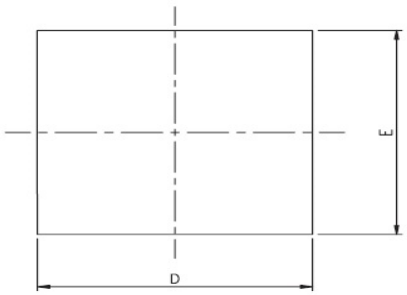



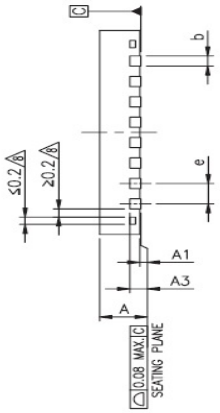
NOTE :
1. CONTROLLING DIMENSION : mm
2. LEAD FRAME MATERIAL : OLIN C7025/EFTEC 64T
3. DIMENSION "D" DOES NOT INCLUDE MOLD FLASH, TIE BAR BURRS AND GATE BURRS. MOLD FLASH, TIE BAR BURRS AND GATE BURRS SHALL NOT EXCEED 0.006"[0.15mm] PER END DIMENSION "E1" DOES NOT INCLUDE INTERLEAD FLASH. INTERLEAD FLASH SHALL NOT EXCEED 0.010"[0.25mm] PER SIDE.
4. DIMENSION "b" DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.003"[0.08mm] TOTAL IN EXCESS OF THE "b" DIMENSION AT MAXIMUM MATERIAL CONDITION. DAMBAR CANNOT BE LOCATED ON THE LOWER RADIUS OR THE FOOT. MINIMUM SPACE BETWEEN PROTRUSION AND AN ADJACENT LEAD TO BE 0.0028"[0.07mm]
5. TOLERANCE : ±0.010"[0.25mm] UNLESS OTHERWISE SPECIFIED.
6. OTHERWISE DIMENSION FOLLOW ACCEPTABLE SPEC.
7. REFERENCE DOCUMENT : JEDEC SPEC MO-153

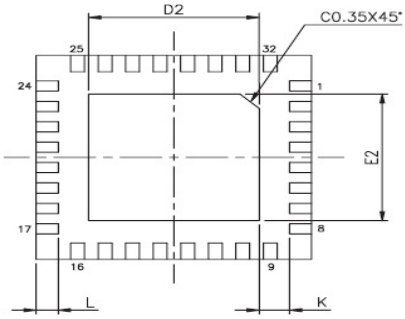
| SYMBOLS | DIMENSIONS IN MILLIMETERS | | | DIMENSIONS IN INCHES | | |
|---|---|---|---|---|---|---|
| | MIN | NOM | MAX | MIN | NOM | MAX |
| A | —— | —— | 1.20 | —— | —— | 0.047 |
| A1 | 0.05 | —— | 0.15 | 0.002 | —— | 0.006 |
| A2 | 0.80 | 1.00 | 1.05 | 0.031 | 0.039 | 0.041 |
| b | 0.19 | —— | 0.30 | 0.007 | —— | 0.012 |
| C | 0.09 | —— | 0.20 | 0.004 | —— | 0.008 |
| D | 9.60 | 9.70 | 9.80 | 0.378 | 0.382 | 0.386 |
| E | —— | 6.40 | —— | —— | 0.252 | —— |
| E1 | 4.30 | 4.40 | 4.50 | 0.169 | 0.173 | 0.177 |
| e | —— | 0.65 | —— | —— | 0.026 | —— |
| L | 0.45 | 0.60 | 0.75 | 0.018 | 0.024 | 0.030 |
| L1 | —— | 1.00 | —— | —— | 0.039 | —— |
| y | —— | —— | 0.076 | —— | —— | 0.003 |
| θ | 0° | —— | 8° | 0° | —— | 8° |

**28-pin TSSOP**

| | | | |
|---|---|---|---|
| CUSTOMER : | | | |
| APPROVED BY | DATE | TITLE: 28L TSSOP PACKAGE OUTLINE DRAWING (4.4mm) | |
| DRAW BY: | | | |
| CHECK BY: | | | |
| APPROVAL: | | DWG. NO. PO-TSSOP-004 | REV. 0 |
| APPROVAL: | | UNIT : mm / SCALE : 12/1 | SHEET 1 OF 1 |




| | PACKAGE TYPE | | |
|---|---|---|---|
| JEDEC OUTLINE | MO-220 | | |
| PKG CODE | VQFN(Y532) | | |
| SYMBOLS | MIN. | NOM. | MAX. |
| A | 0.80 | 0.85 | 0.90 |
| A1 | 0.00 | 0.02 | 0.05 |
| A3 | 0.203 REF. | | |
| b | 0.18 | 0.25 | 0.30 |
| D | 5.00 BSC | | |
| E | 5.00 BSC | | |
| e | 0.50 BSC | | |
| L | 0.35 | 0.40 | 0.45 |
| K | 0.20 | — | — |

| | E2 | | | D2 | | | LEAD FINISH | | JEDEC CODE |
|---|---|---|---|---|---|---|---|---|---|
| PAD SIZE | MIN. | NOM. | MAX. | MIN. | NOM. | MAX. | Pure Tin | PPF | |
| 153X153 MIL | 3.15 | 3.25 | 3.30 | 3.15 | 3.25 | 3.30 | V | V | W(V)HHD-5 |

NOTES :
1. ALL DIMENSIONS ARE IN MILLIMETERS.
2. DIMENSION b APPLIES TO METALLIZED TERMINAL AND IS MEASURED BETWEEN 0.15mm AND 0.30mm FROM THE TERMINAL TIP. IF THE TERMINAL HAS THE OPTIONAL RADIUS ON THE OTHER END OF THE TERMINAL, THE DIMENSION b SHOULD NOT BE MEASURED IN THAT RADIUS AREA.
3. BILATERAL COPLANARITY ZONE APPLIES TO THE EXPOSED HEAT SINK SLUG AS WELL AS THE TERMINALS.

**32-pin VQFN**

## Ordering Information

| Part Number | Temperature Range | Package Type |
|---|---|---|
| KY3220LEEA | -40°C to +85°C | 16-pin SSOP |
| KY3220LEEY | -40°C to +85°C | 16-pin TSSOP |
| KY3221LEEA | -40°C to +85°C | 16-pin SSOP |
| KY3221LEEY | -40°C to +85°C | 16-pin TSSOP |
| KY3222LEEA | -40°C to +85°C | 20-pin SSOP |
| KY3222LEEY | -40°C to +85°C | 20-pin TSSOP |
| KY3223LEEA | -40°C to +85°C | 20-pin SSOP |
| KY3223LEEY | -40°C to +85°C | 20-pin TSSOP |
| KY3232LEEA | -40°C to +85°C | 16-pin SSOP |
| KY3232LEEN | -40°C to +85°C | 16-pin nSOIC |
| KY3232LEEY | -40°C to +85°C | 16-pin TSSOP |
| KY1385LEEA | -40°C to +85°C | 20-pin SSOP |
| KY3243LEEA | -40°C to +85°C | 28-pin SSOP |
| KY3243LEEY | -40°C to +85°C | 28-pin TSSOP |
| KY3243LEEQ | -40°C to +85°C | 32-pin VQFN |

*High Data Rate at 1000kbps Available on KY32xxF Series

Please contact the factory for pricing, availability on Tape-and-Reel, and Green Package options.

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