

## ■ FEATURES

- 110mΩ (5V Input) High-Side MOSFET Switch.
- 500mA Continuous Load Current per Channel.
- 220μA Typical On-State Supply Current.
- 1μA Typical Off-State Supply Current.
- Current-Limit / Short Circuit Protection.
- Thermal Shutdown Protection under Overcurrent Condition.
- Undervoltage Lockout Ensures that Switch is off at Start Up.
- Output can be Forced Higher than Input (Off-State).
- Open-Drain Fault Flag.
- Slow Turn ON and Fast Turn OFF.
- Enable Active-High or Active-Low.

## ■ APPLICATIONS

- USB Power Management.
- Hot Plug-In Power Supplies.
- Battery-Charger Circuit.

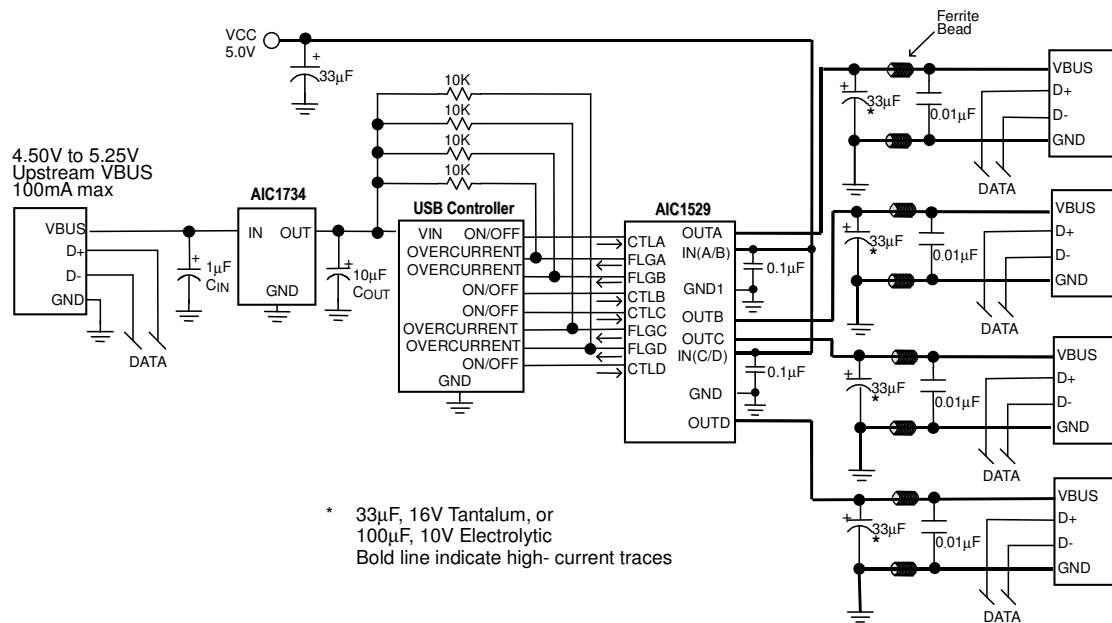
## ■ DESCRIPTION

The AIC1529 is a quad high-side power switch for self-powered and bus-powered Universal Serial Bus (USB) applications. Both high-side switches are MOSFET with 110mΩ  $R_{DS(ON)}$ , which meets USB voltage drop requirements for maximum transmission wire length.

Multi-purpose open-drain fault flag output indicates over-current limiting, thermal shutdown, or undervoltage lockout for each channel. Output current is typically limited to 1.3A, and the thermal shutdown functions of the power switches independently control their channel under overcurrent condition.

Guaranteed minimum output rise time limits inrush current during hot plug-in as well as minimizing EMI and prevents the voltage at upstream port from dropping excessively.

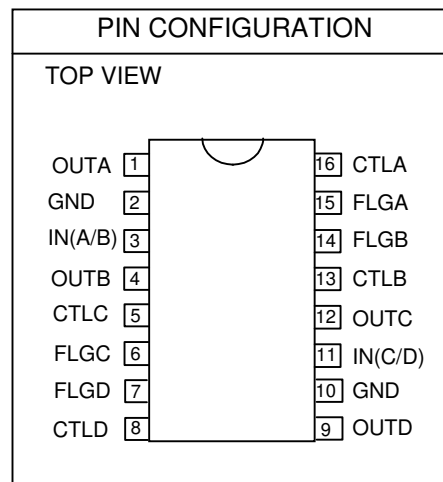
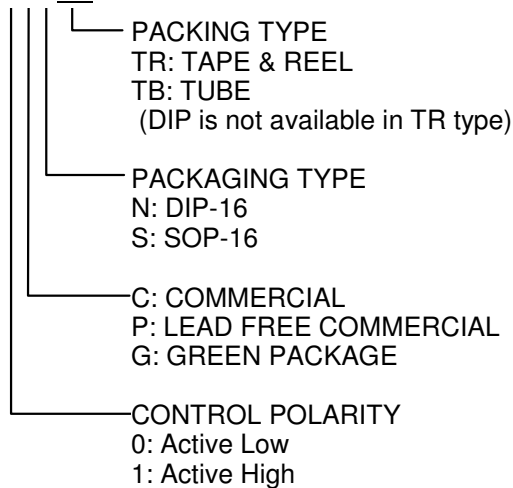
## ■ TYPICAL APPLICATION CIRCUIT



**4-Port Self-Powered Hub**

## ■ ORDERING INFORMATION

AIC1529-XXXXX



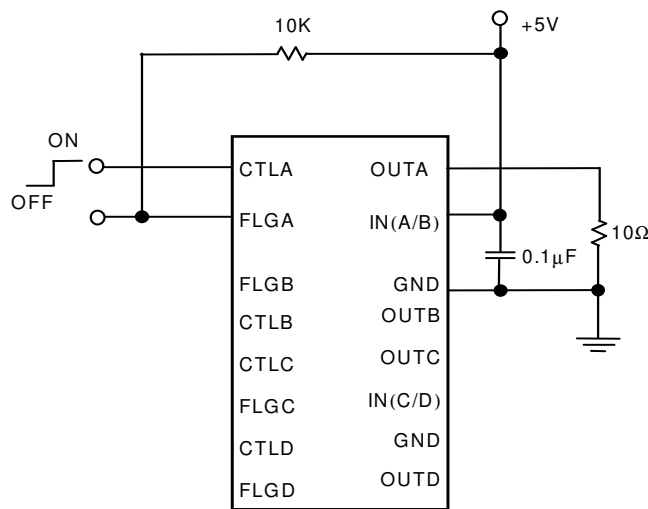
Example: AIC1529-0CSTR  
→ Active Low Version, in SOP-16 Package & Taping & Reel Packing Type

AIC1529-0PSTR  
→ Active Low Version, in Lead Free SOP-16 Package & Taping & Reel Packing Type

**■ ABSOLUTE MAXIMUM RATINGS**

|   |               |
|---|---------------|
| Supply Voltage ( $V_{IN}$ ).....                                      | 7.0V          |
| Fault Flag Voltage ( $V_{FLG}$ ) .....                                | 7.0V          |
| Fault Flag Current ( $I_{FLG}$ ).....                                 | 50mA          |
| Control Input ( $V_{CTL}$ ).....                                      | -0.3V ~7V     |
| Operating Temperature Range.....                                      | -40°C~85°C    |
| Storage Temperature Range.....  | -65°C ~ 150°C |
| Thermal Resistance, $\theta_{JA}$ (Junction to Ambient)   DIP-16..... | 100°C/W       |
| (Assume no Ambient Airflow, no Heatsink)        SOP-16.....           | 160°C/W       |
| Junction Temperature Range.....                                       | 125°C         |
| Lead Temperature (Soldering 10 sec) .....                             | 260°C         |

**Absolute Maximum Ratings are those values beyond which the life of a device may be impaired.**

**■ TEST CIRCUIT**


**AIC1529**  
(For output reference only)

**■ ELECTRICAL CHARACTERISTICS**

 (V<sub>IN</sub>= 5V, T<sub>A</sub>=25°C, unless otherwise specified.) (Note 1)

| PARAMETERS                          | CONDITIONS                                    | MIN. | TYP. | MAX. | UNIT |
|-------------------------------------|---|------|------|------|------|
| Supply Current                      | V <sub>CTL</sub> =Logic "0", OUT=Open         |      | 0.75 | 5    | μA   |
|                                     | V <sub>CTL</sub> =Logic "1", OUT=Open         |      | 110  | 160  |      |
| Control Input Voltage               | V <sub>CTL</sub> =Logic "0"                   |      |      | 0.8  | V    |
|                                     | V <sub>CTL</sub> =Logic "1"                   | 2.4  |      |      |      |
| Control Input Current               | V <sub>CTL</sub> =Logic "0"                   |      | 0.01 | 1    | μA   |
|                                     | V <sub>CTL</sub> =Logic "1"                   |      | 0.01 | 1    |      |
| Control Input Capacitance           |   |      | 1    |      | pF   |
| Output MOSFET Resistance            |   |      | 110  | 150  | mΩ   |
| Output Turn-On Rise Delay           | R <sub>L</sub> = 10Ω each Output              |      | 300  |      | μS   |
| Output Turn-On Rise Time            | R <sub>L</sub> = 10Ω each Output              |      | 1000 | 2500 | μS   |
| Output Turn-Off Delay               | R <sub>L</sub> = 10Ω each Output              |      | 0.8  | 20   | μS   |
| Output Turn-Off Fall Time           | R <sub>L</sub> = 10Ω each Output              |      | 0.7  | 20   | μS   |
| Output Leakage Current              |   |      |      | 10   | μA   |
| Current Limit Threshold             |   | 1    |      | 2    | A    |
| Over Temperature Shutdown Threshold | T <sub>J</sub> Increasing                     |      | 135  |      | °C   |
|                                     | T <sub>J</sub> Decreasing                     |      | 125  |      |      |
| Error Flag Output Resistance        | V <sub>IN</sub> = 5V , I <sub>L</sub> =10 mA  |      | 10   | 25   | Ω    |
|                                     | V <sub>IN</sub> = 3.3V , I <sub>L</sub> =10mA |      | 15   | 40   |      |
| Error Flag Off Current              | V <sub>FLG</sub> = 5V                         |      | 0.01 | 1    | μA   |
| UVLO Threshold                      | V <sub>IN</sub> Increasing                    |      | 2.6  |      | V    |
|                                     | V <sub>IN</sub> Decreasing                    |      | 2.4  |      |      |

Note 1: Specifications are production tested at T<sub>A</sub>=25°C. Specifications over the -40°C to 85°C operating temperature range are assured by design, characterization and correlation with Statistical Quality Controls (SQC).

**TYPICAL PERFORMANCE CHARACTERISTICS**

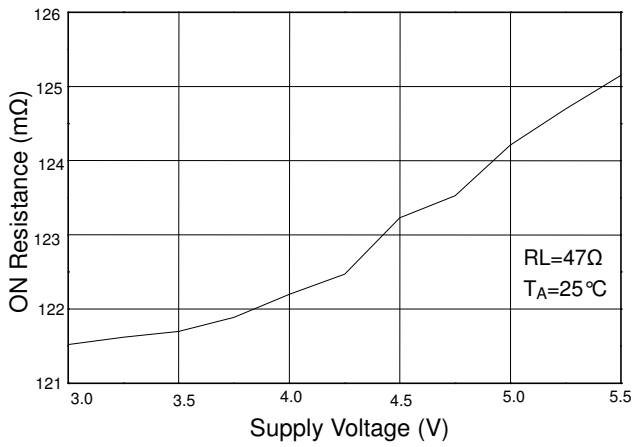


Fig. 1 ON Resistance vs. Supply Voltage

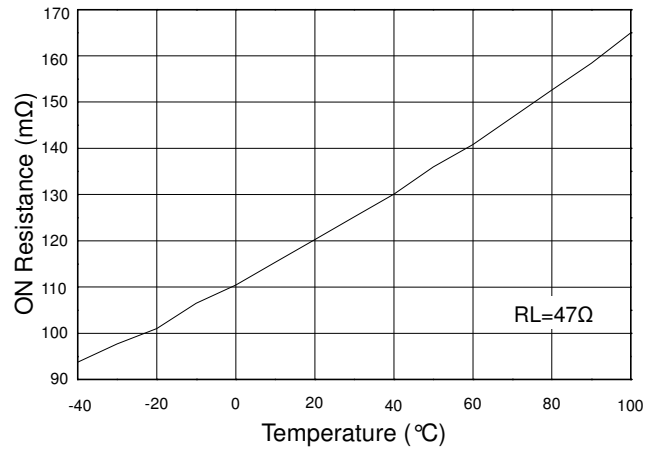


Fig. 2 ON Resistance vs. Temperature

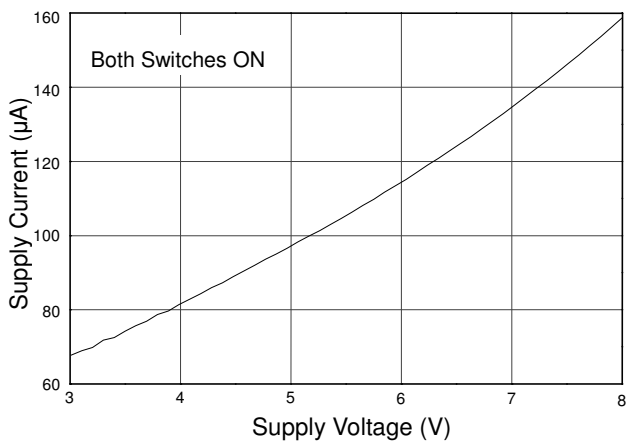


Fig. 3 ON-State Supply Current vs. Supply Voltage

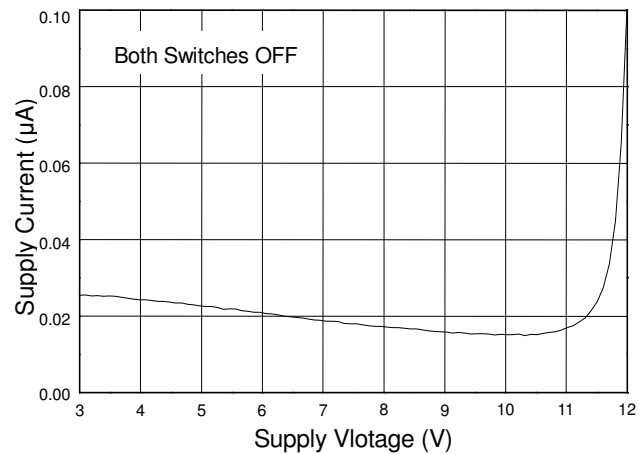


Fig. 4 OFF-State Supply Current vs. Supply Voltage

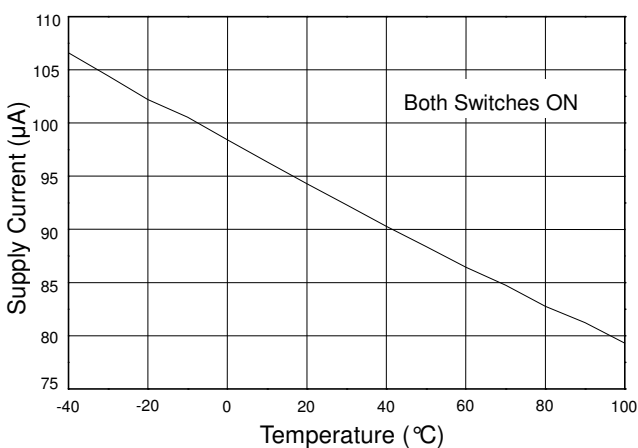


Fig. 5 ON-State Supply Current vs. Temperature

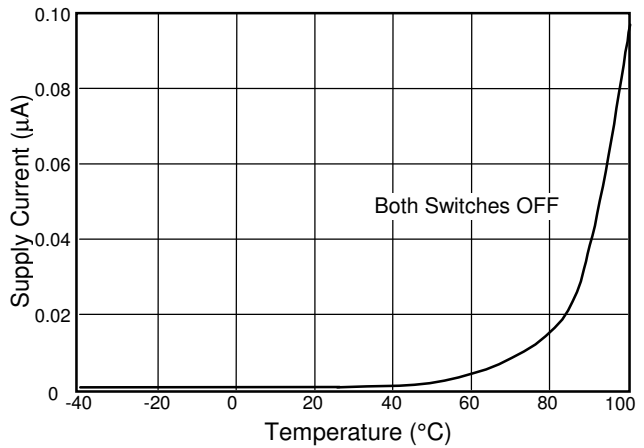


Fig. 6 OFF-State Current vs. Temperature

**TYPICAL PERFORMANCE CHARACTERISTICS (Continued)**

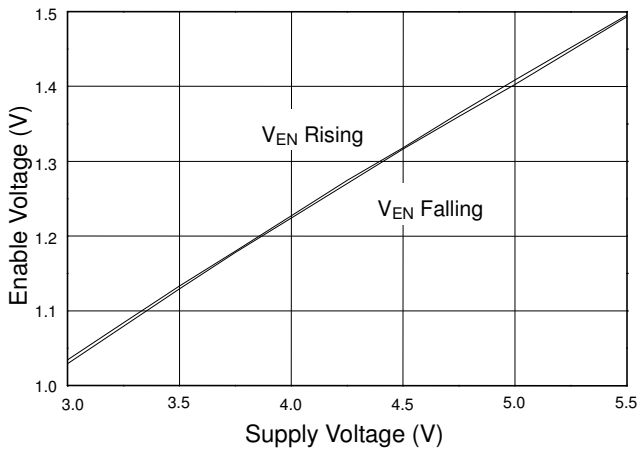


Fig. 7 Control Threshold vs. Supply Voltage

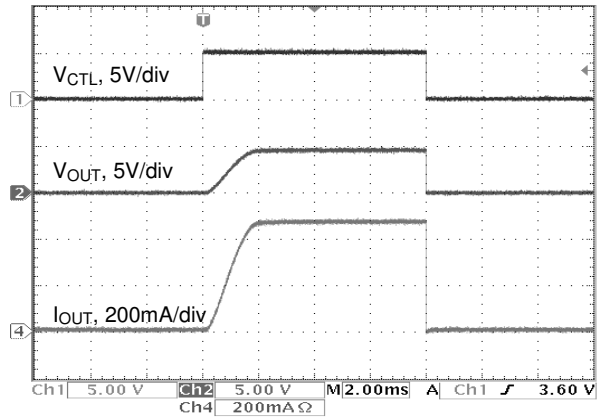


Fig. 8 Turn-On, Turn-Off Characteristics

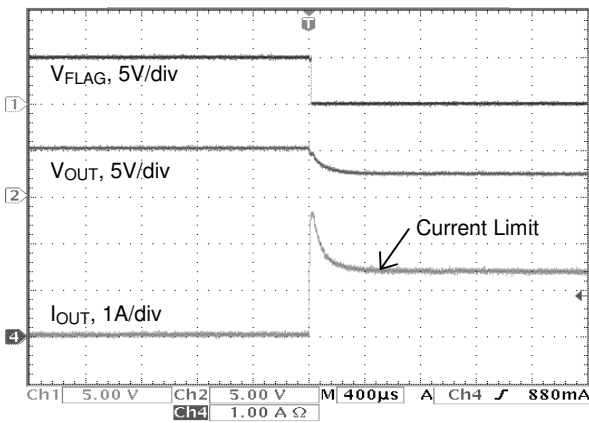
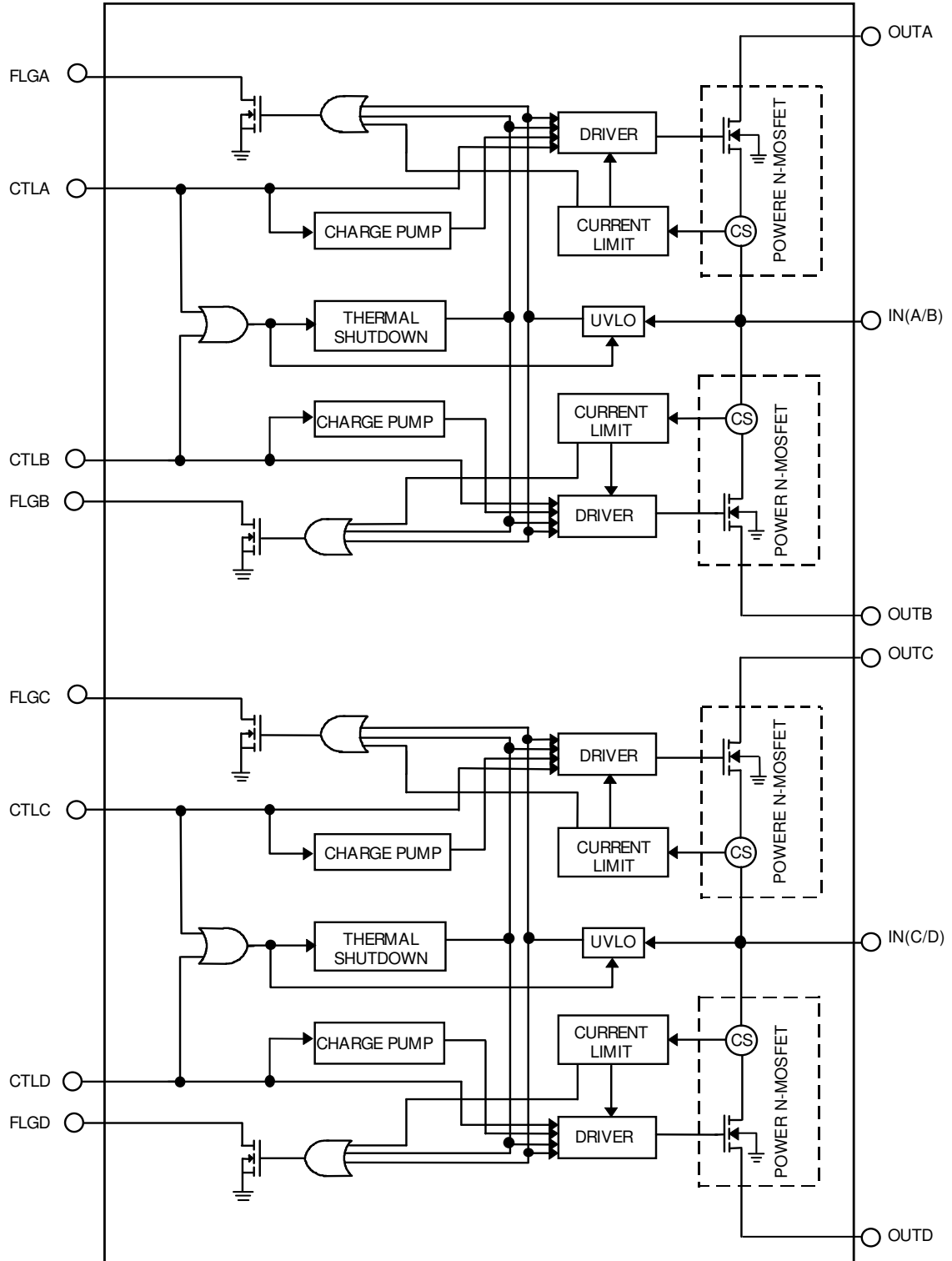


Fig. 9 Current Limit Response

■ BLOCK DIAGRAM



## ■ PIN DESCRIPTIONS

- OUTA (B,C,D) -Channel A (B,C,D) MOSFET switch output.
- GND - Chip power return, Connect both pins to ground.
- IN(A/B, C/D) - Channel A and B (C and D) power supply input.
- CTLA (B,C,D)- Controls the turn-on/turn-off of channel A (B,C,D) MOSFET with TTL as a control input. Active high for AIC1529-1 and active low for AIC1529-0.

FLGA (B,C,D)- An active-low and open-drained fault flag output for channel A (B,C,D). FLGA (B,C,D) is an indicator for current limit when CTLA (B,C,D) is active. In normal mode operation (CTLA(C) or/and CLTB(D) is active), it also can indicate thermal shutdown or undervoltage.

## ■ APPLICATION INFORMATION

### ● Error Flag

An error Flag is an open-drained output of an N-channel MOSFET. FLG output is pulled low to signal the following fault conditions: input undervoltage, output current limit, and thermal shutdown.

### ● Current Limit

The current limit threshold is preset internally. It protects the output MOSFET switches from damage resulting from undesirable short circuit conditions or excess inrush current, which is often encountered during hot plug-in. The low limit of the current limit threshold of the AIC1529 allows a minimum current of 1A through the MOSFET switches. The error flag signals when any current limit conditions occur.

### ● Thermal Shutdown

When temperature of AIC1529 exceeds 135°C for any reasons, the thermal shutdown function turns both MOSFET switches off and signals the error flag. A hysteresis of 10°C prevents the MOSFETs from turning back on until the chip temperature drops below 125°C. However, if thermal shutdown is triggered by chip temperature rise resulting from overcurrent fault

condition of either one of the MOSFET switches, the thermal shutdown function will only turn off the switch that is in overcurrent condition and the other switch can still remain its normal operation. In other words, the thermal shutdown function of the two switches is independent of each other in the case of overcurrent fault.

### ● Supply Filtering

A 0.1μF to 1μF bypass capacitor from IN to GND, located near the device, is strongly recommended to control supply transients. Without a bypass capacitor, an output short may cause sufficient ringing on the input (from supply lead inductance) to damage internal control circuitry.

### ● Transient Requirements

USB supports dynamic attachment (hot plug-in) of peripherals. A current surge is caused by the input capacitance of downstream device. Ferrite beads are recommended in series with all power and ground connector pins. Ferrite beads reduce EMI and limit the inrush current during hot-attachment by filtering high-frequency signals.



- **Short Circuit Transient**

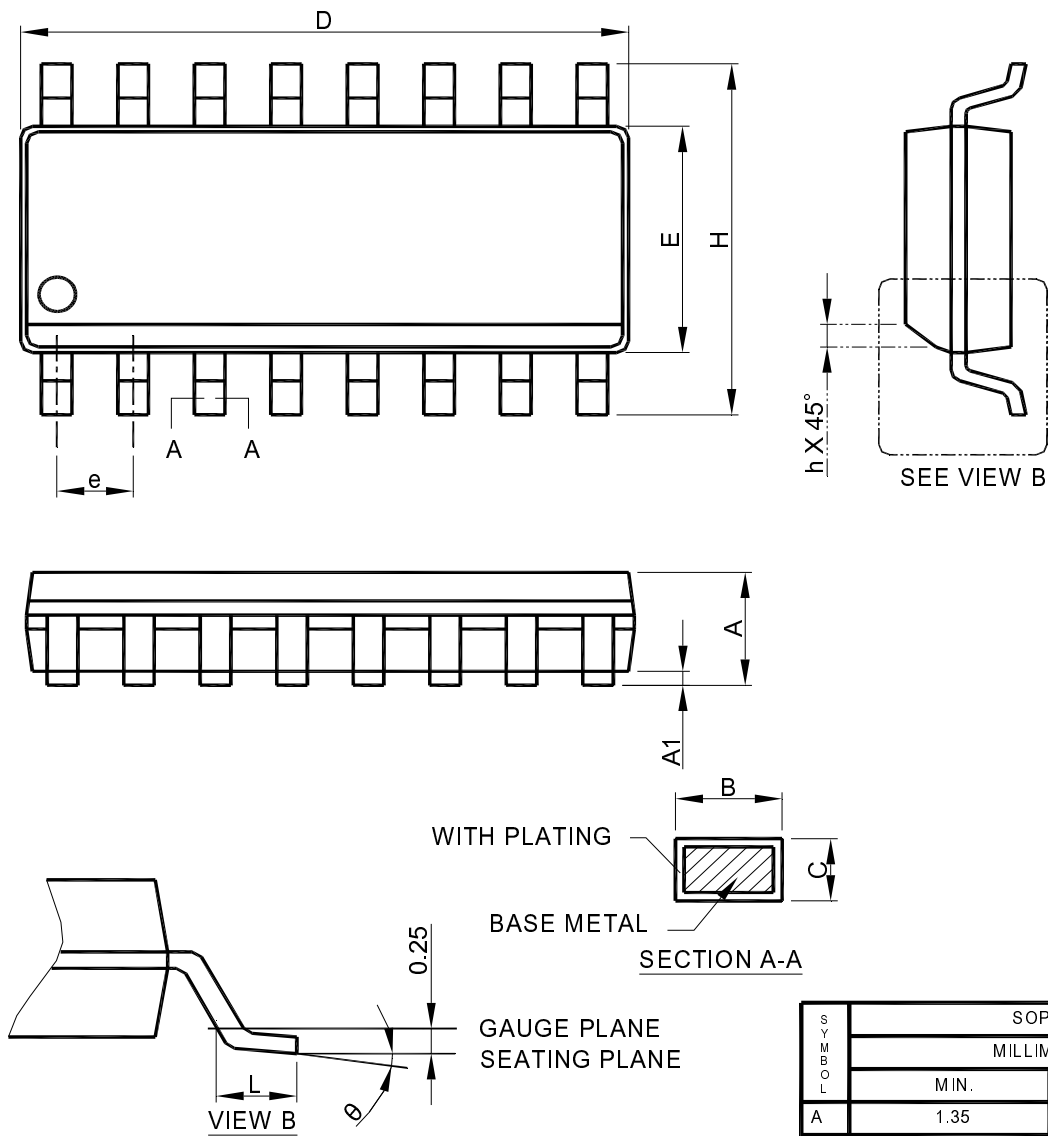
Bulk capacitance provides the short-term transient current needed during a hot-attachment event. A 33 $\mu$ F/16V tantalum or a 100 $\mu$ F/10V electrolytic capacitor mounted close to downstream connector each port should provide transient drop protection.

- **Printed Circuit Layout**

The power circuitry of USB printed circuit boards requires a customized layout to maximize thermal dissipation and to minimize voltage drop and EMI.

■ PHYSICAL DIMENSIONS (unit: mm)

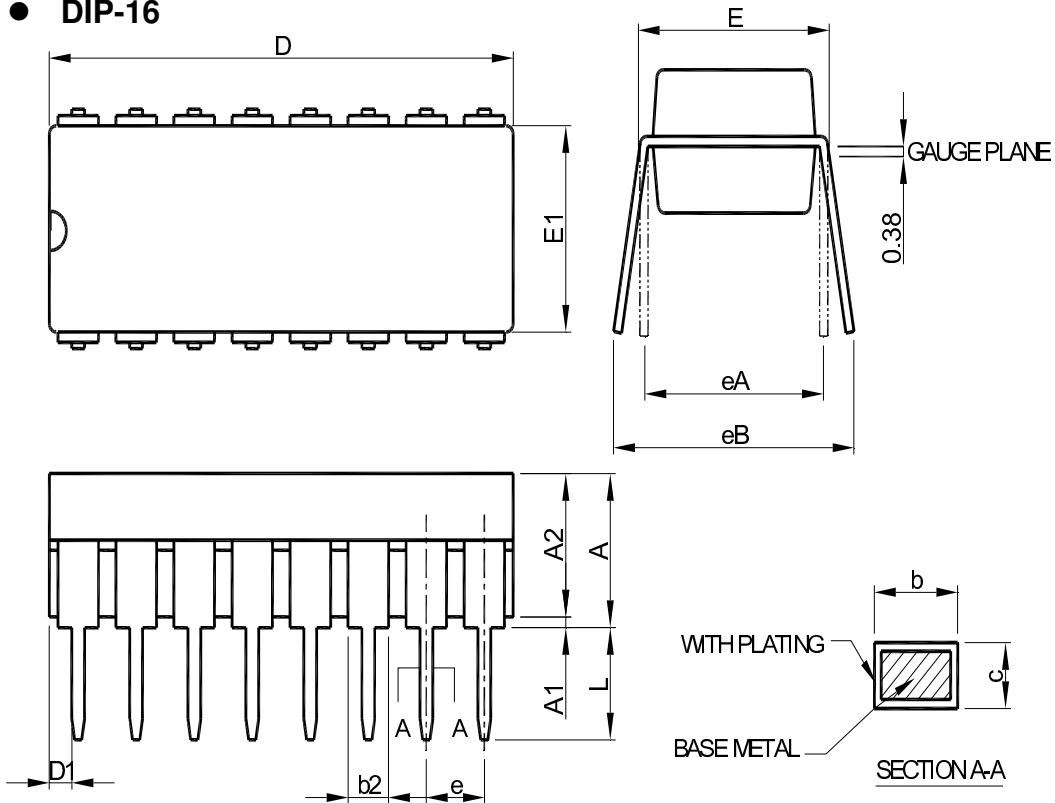
- SOP-16



- Note: 1. Refer to JEDEC MS-012AC.  
 2. Dimension "D" does not include mold flash, protrusions or gate burrs. Mold flash, protrusion or gate burrs shall not exceed 6 mil per side on.  
 3. Dimension "E" does not include inter-lead flash or protrusions.  
 4. Controlling dimension is millimeter, converted inch dimensions are not necessarily exact.

| SYMBOL | SOP-16(150mil) |       |
|--------|----------------|-------|
|        | MILLIMETERS    |       |
|        | MIN.           | MAX.  |
| A      | 1.35           | 1.75  |
| A1     | 0.10           | 0.25  |
| B      | 0.33           | 0.51  |
| C      | 0.19           | 0.25  |
| D      | 9.80           | 10.00 |
| E      | 3.80           | 4.00  |
| e      | 1.27 BSC       |       |
| H      | 5.80           | 6.20  |
| h      | 0.25           | 0.50  |
| L      | 0.40           | 1.27  |
| θ      | 0°             | 8°    |

● DIP-16



- Note: 1. Refer to JEDEC MS-001BB  
 2. Dimension "D" does not include mold flash, protrusions or gate burrs. Mold flash, protrusion or gate burrs shall not exceed 10 mil per side .  
 3. Dimension "D1" and "E1" do not include inter-lead flash or protrusions.  
 4. Controlling dimension is millimeter, converted inch dimensions are not necessarily exact.

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| SYMBOL | DIP-16      |       |
|--------|-------------|-------|
|        | MILLIMETERS |       |
|        | MIN.        | MAX.  |
| A      |             | 5.33  |
| A1     | 0.38        |       |
| A2     | 2.92        | 4.95  |
| b      | 0.36        | 0.56  |
| b2     | 1.14        | 1.78  |
| c      | 0.20        | 0.35  |
| D      | 18.66       | 19.69 |
| D1     | 0.13        |       |
| E      | 7.62        | 8.26  |
| E1     | 6.10        | 7.11  |
| e      | 2.54 BSC    |       |
| eA     | 7.62 BSC    |       |
| eB     |             | 10.92 |
| L      | 2.92        | 3.81  |