# DIO7708
# 300 mA, Low $I_Q$, Wide Input Voltage Low Dropout Regulator

## Features

- Operating input voltage range: 2.75 V to 24 V
- Fixed voltage options available: 1.2 V to 5 V (upon request)
- Adjustable voltage option from 1.2 V to 5 V
- Ultra−low quiescent current: typ. 4 μA over-temperature
- PSRR: 60 dB at 1 kHz
- Stable with small 1 μF ceramic capacitor
- Soft−start to reduce inrush current and overshoots
- Thermal shutdown and current limit protection
- Active discharge option available (upon request)
- Available in TSOT23-5, SOT23-5 and DFN 2*2-6 packages
- These devices are Pb−free, halogen free/BFR free and are RoHS compliant

## Descriptions

The DIO7708 is a 300 mA LDO linear voltage regulator. It is a very stable and accurate device with an ultra−low quiescent current consumption (typ. 4 μA over the full temperature range) and a wide input voltage range (up to 24 V). The regulator incorporates several protection features such as thermal shutdown and current limiting.

## Applications

- Wireless chargers
- Portable equipment
- Communication systems

## Typical Applications

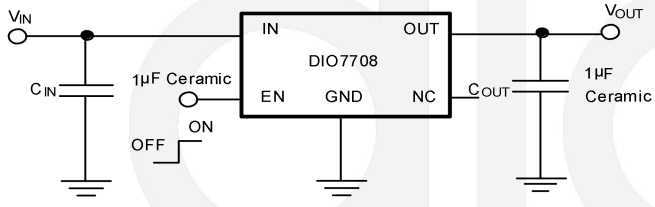



Figure 1. Typical Application Schematic

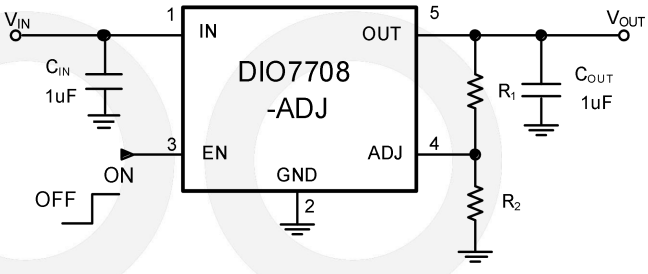



Figure 2. Typical Application Schematic

Note: Choose $R_2$ = 1.2 MΩ to maintain a 1 μA minimum load; If $R_2$ = 120 kΩ, the load is 10 μA. Calculate the value for $R_1$ by using the following equation:

$$R_1 = R_2 \times [\frac{V_{OUT}}{1.2V} - 1] \qquad \text{(eq.1)}$$

## Ordering Information

| Order Part Number | Voltage Option | Top Marking | Option | | $T_A$ | Package | |
|---|---|---|---|---|---|---|---|
| DIO7708AADJTST5 | Adj. | YWAA | With active output discharge | Green | -40 to 105°C | TSOT23-5 | Tape & Reel, 3000 |
| DIO7708A120TST5 | 1.2 V | YWAB | | | | | |
| DIO7708A150TST5 | 1.5 V | YWAC | | | | | |
| DIO7708A180TST5 | 1.8 V | YWAD | | | | | |
| DIO7708A250TST5 | 2.5 V | YWAE | | | | | |
| DIO7708A280TST5 | 2.8 V | YWAJ | | | | | |
| DIO7708A300TST5 | 3.0 V | YWAF | | | | | |
| DIO7708A330TST5 | 3.3 V | YWAG | | | | | |
| DIO7708BADJTST5 | Adj. | YWBA | Without active output discharge | | | | |
| DIO7708B180TST5 | 1.8 V | YWBB | | | | | |
| DIO7708B280TST5 | 2.8 V | YWBJ | | | | | |
| DIO7708AADJST5 | Adj. | YWAA | With active output discharge | Green | -40 to 105°C | SOT23-5 | Tape & Reel, 3000 |
| DIO7708A120ST5 | 1.2 V | YWAB | | | | | |
| DIO7708A150ST5 | 1.5 V | YWAC | | | | | |
| DIO7708A180ST5 | 1.8 V | YWAD | | | | | |
| DIO7708A250ST5 | 2.5 V | YWAE | | | | | |
| DIO7708A280ST5 | 2.8 V | YWAJ | | | | | |
| DIO7708A300ST5 | 3.0 V | YWAF | | | | | |
| DIO7708A330ST5 | 3.3 V | YWAG | | | | | |
| DIO7708BADJST5 | Adj. | YWBA | Without active output discharge | | | | |
| DIO7708B180ST5 | 1.8 V | YWBB | | | | | |
| DIO7708B280ST5 | 2.8 V | YWBJ | | | | | |
| DIO7708AADJCD6 | Adj. | 78AA | With active output discharge | Green | -40 to 105°C | DFN2*2-6 | Tape & Reel, 3000 |
| DIO7708A280CD6 | 2.8 V | 78AJ | | | | | |
| DIO7708A330CD6 | 3.3 V | 78AG | | | | | |
| DIO7708BADJCD6 | Adj. | 78BA | Without active output discharge | | | | |
| DIO7708B280CD6 | 2.8 V | 78BJ | | | | | |

## Pin Assignment

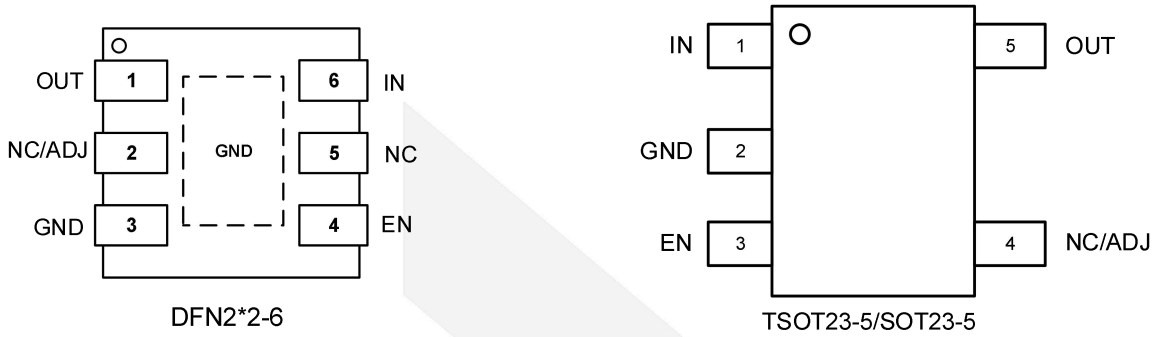



**Figure 3. Top View**

## Pin Descriptions

| Name | Description |
|---|---|
| IN | Input pin. A small capacitor is needed from this pin to ground to assure stability. |
| GND | Power supply ground |
| EN | Enable pin. Driving this pin high turns on the regulator. Driving EN pin low puts the regulator into shutdown mode. |
| NC/ADJ | Fixed Version: No connection. This pin can be tied to ground to improve thermal dissipation or left disconnected.<br>Adjustable Version: Feedback pin for set−up output voltage. Use resistor divider for voltage selection. |
| OUT | Regulated output voltage pin. A small 1 μF ceramic capacitor is needed from this pin to ground to assure stability. |
| NC | No connection. This pin can be tied to ground to improve thermal dissipation or left disconnected. |

## Absolute Maximum Ratings

Stresses beyond those listed under the Absolute Maximum Rating table may cause permanent damage to the device. These are stress ratings only and functional operation of the device at these or any other condition 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.

| Symbol | Parameter | Rating | Unit |
|---|---|---|---|
| $V_{IN}$ | Input voltage (Note 1) | −0.3 to 24 | V |
| $V_{EN}$ | Enable voltage | −0.3 to $V_{IN}$+0.3 | V |
| $V_{OUT}$ | Output voltage | −0.3 to $V_{IN}$+0.3 (max. 6) | V |
| $T_{J(MAX)}$ | Maximum junction temperature | 150 | °C |
| $T_{STG}$ | Storage temperature | −55 to 150 | °C |
| HBM | ESD capability, human body model | 2000 | V |

**Note:**

(1) Refer to ELECTRICAL CHARACTERISTICS and APPLICATION INFORMATION for Safe Operating Area.

## Thermal Information

| Symbol | Thermal Metric | Value | Unit |
|---|---|---|---|
| $R_{\theta JA}$ | Junction-to-ambient thermal resistance (SOT23-5) | 275 | °C/W |
| $R_{\theta JA}$ | Junction-to-ambient thermal resistance (TSOT23-5) | 240 | °C/W |
| $R_{\theta JA}$ | Junction-to-ambient thermal resistance (DFN2*2-6) | 72.8 | °C/W |

## Electrical Characteristics

-40°C ≤ $T_J$ ≤ 125°C; $V_{IN}$ = 2.75 V or ($V_{OUT}$ + 1.0 V), whichever is greater; $I_{OUT}$ = 1 mA, $C_{IN}$ = $C_{OUT}$ = 1 µF, unless otherwise noted. Typical values are at $T_J$ = 25°C. (Note 1)

| Symbol | Parameter | Conditions | | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|---|
| $V_{IN}$ | Operating input voltage | | | 2.75 | | 24 | V |
| $V_{OUT}$ | Output voltage accuracy (fixed versions) | −40°C ≤ $T_J$ ≤ 125°C, $V_{OUT}$ + 1 V < $V_{IN}$ < 24 V, 0.1 mA < $I_{OUT}$ < 300 mA (Note 4) | $V_{OUT}$ < 1.8 V | −3% | | 3% | V |
| | | | $V_{OUT}$ ≥ 1.8 V | −2% | | 2% | |
| $V_{ADJ}$ | Reference voltage | −40°C ≤ $T_J$ ≤ 125°C, $V_{OUT}$ + 1 V < $V_{IN}$ < 24 V | | | 1.2 | | V |
| $V_{OUT}$ | Reference voltage accuracy | −40°C ≤ $T_J$ ≤ 125°C, $V_{OUT}$ + 1 V < $V_{IN}$ < 24 V | | −2% | | 2% | V |
| $Reg_{LINE}$ | Line regulation | $V_{OUT}$ + 1 V ≤ $V_{IN}$ ≤ 24 V, $I_{OUT}$ = 1 mA | | | 10 | | mV |
| $Reg_{LOAD}$ | Load regulation | $I_{OUT}$ = 0.1 mA to 300 mA | | | 10 | | mV |
| $V_{DO}$ | Dropout voltage | $V_{DO}$ = $V_{IN}$ – ($V_{OUT(NOM)}$ – 3%), $I_{OUT}$ = 150 mA (Note 2) | 2.1 V ~ 2.4 V | | 480 | | mV |
| | | | 2.5 V ~ 2.7 V | | 300 | | |
| | | | 2.8 V ~ 3.2 V | | 280 | | |
| | | | 3.3 V ~ 4.9 V | | 260 | | |
| | | | 5 V | | 240 | | |
| | | $V_{DO}$ = $V_{IN}$ – ($V_{OUT(NOM)}$ – 2%), $I_{OUT}$ = 1 mA | | | 5 | | mV |
| $I_{LIM}$ | Output current limit | $V_{IN}$ = $V_{OUT}$ + 1 V | | 300 | | 800 | mA |
| $I_{DIS}$ | Disable current | $V_{EN}$ = 0 V | | | 0.3 | 1.0 | µA |
| $I_Q$ | Quiescent current | $I_{OUT}$ = 0 mA | | | 4.0 | 8.0 | µA |
| $I_{GND}$ | Ground current | $I_{OUT}$ = 10 mA | | | 50 | | µA |
| | | $I_{OUT}$ = 300 mA | | | 300 | | |
| PSRR | Power supply rejection ratio | $V_{IN}$ = 3.5 V + 100 $mV_{pp}$, $V_{OUT}$ = 2.5 V, $I_{OUT}$ = 1 mA, $C_{OUT}$ = 1 µF | f = 1 kHz | | 60 | | dB |
| $V_{EN\_HI}$ | Enable input threshold voltage | Voltage increasing | | 1.2 | | | V |
| $V_{EN\_LO}$ | | Voltage decreasing | | | | 0.4 | |
| $I_{ADJ}$ | ADJ pin current | $V_{IN}$ = $V_{OUT}$ + 1 V | | | 0.1 | 1.0 | µA |
| $I_{EN}$ | EN pin current | $V_{EN}$ = 5.5 V | | | 100 | | nA |

| | | | | | | |
|---|---|---|---|---|---|---|
| $R_{DIS}$ | Active output discharge resistance | $V_{IN}$ = 5.5 V, $V_{EN}$ = 0 V | | 100 | | Ω |
| $T_{SD}$ | Thermal shutdown temperature (Note 3) | Temperature increasing from $T_J$ = 25°C | | 150 | | °C |
| $T_{SDH}$ | Thermal shutdown hysteresis (Note 3) | Temperature falling from $T_{SD}$ | | 25 | | °C |

**Note:**

1. Performance guaranteed over the indicated operating temperature range by design and/or characterization production tested at $T_J$ = $T_A$=25°C. Low duty cycle pulse techniques are used during testing to maintain the junction temperature as close to ambient as possible.
2. Voltage dropout for voltage variants below 2.1 V is given by a minimum input voltage of 2.75 V.
3. Guaranteed by design and characterization.
4. Specifications subject to change without notice.

## Typical Performance Characteristic

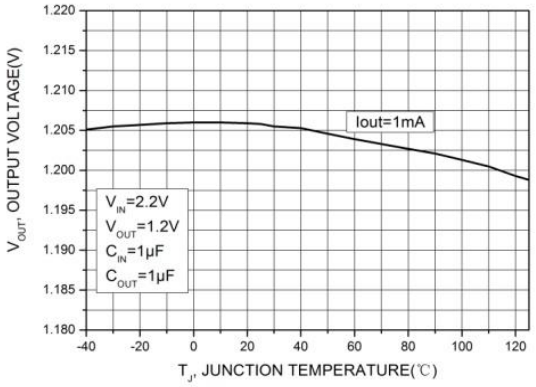



**Figure 4. Output voltage VS. Temperature**
**$V_{OUT}$ = 1.2 V**

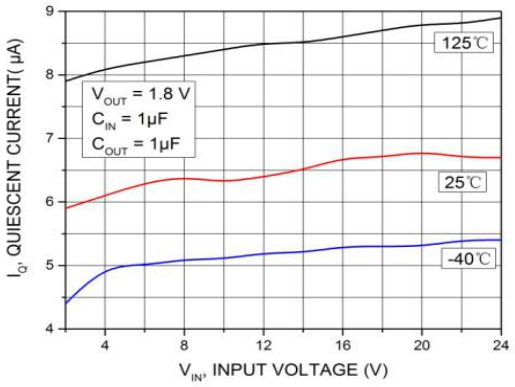



**Figure 5. Quiescent current VS. Input voltage**
**$V_{OUT}$ = 1.8 V**

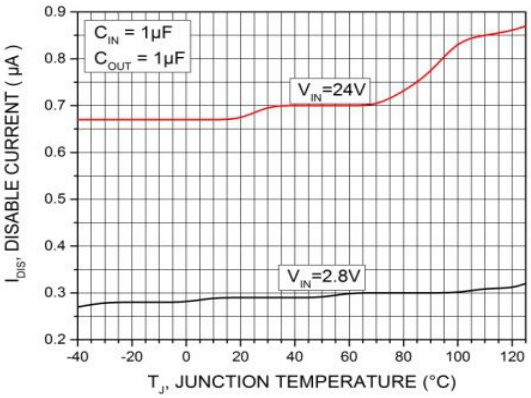



**Figure 6. Disable current VS. Temperature**
**$V_{OUT}$ = 1.8 V**

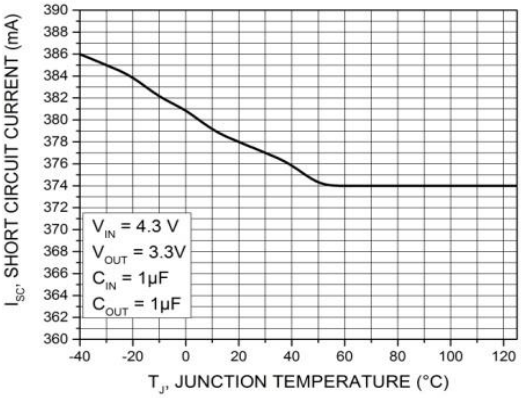



**Figure 7. Short circuit current VS. Temperature**
**$V_{OUT}$ = 3.3 V**

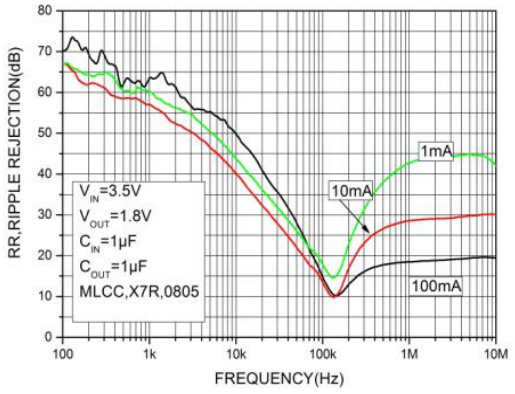



**Figure 8. Power supply rejection ratio VS. Current**
**$V_{IN}$ = 3.5 V, $C_{OUT}$ = 1 μF**

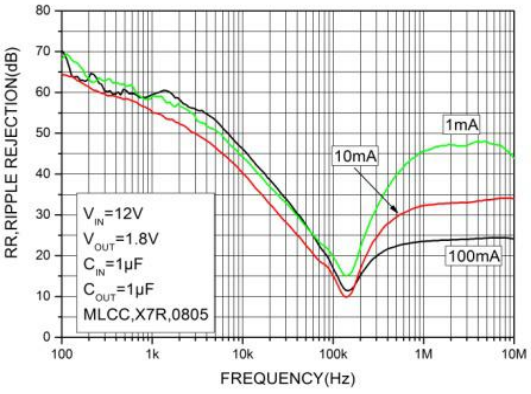



**Figure 9. Power supply rejection ratio VS. Current**
**$V_{IN}$ = 12 V, $C_{OUT}$ = 1 μF**

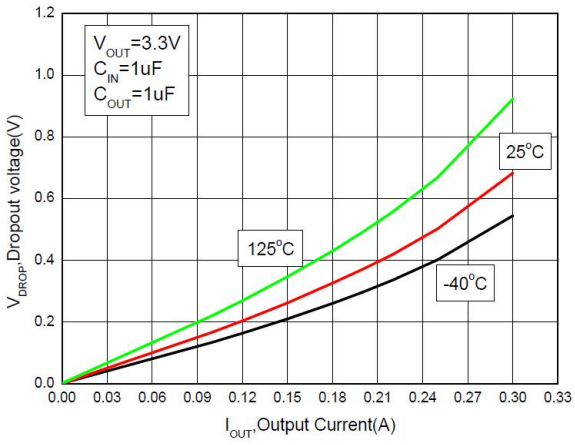



**Figure 10. Dropout voltage VS. Output current**

**$V_{OUT}$ = 3.3 V**

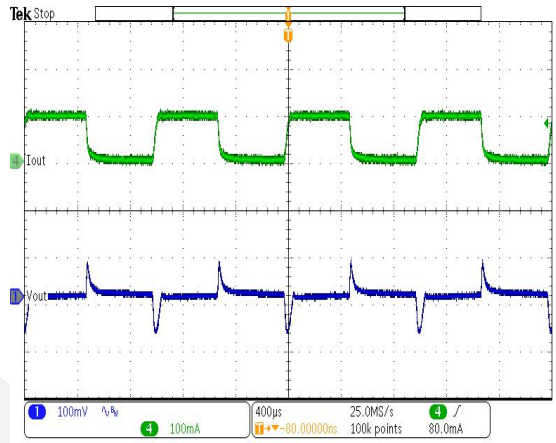



**Figure 11. Load transient response**

**$V_{IN}$ = 2.8 V, $V_{OUT}$ = 1.8 V, $I_{LOAD}$ = 5 mA ~ 100 mA**

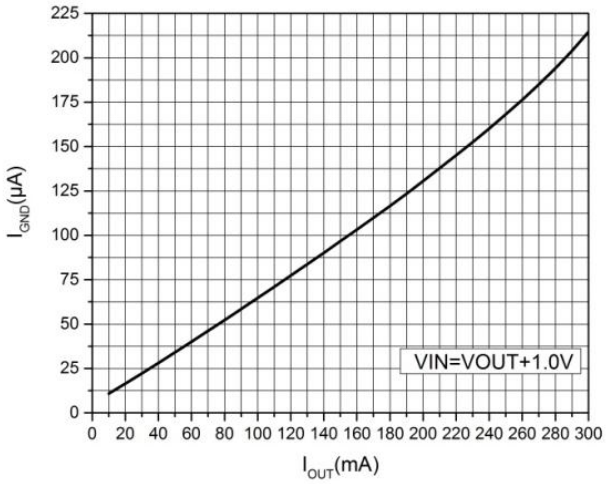



**Figure 12. $I_{GND}$ vs $I_{OUT}$**

## Functional Block Diagram

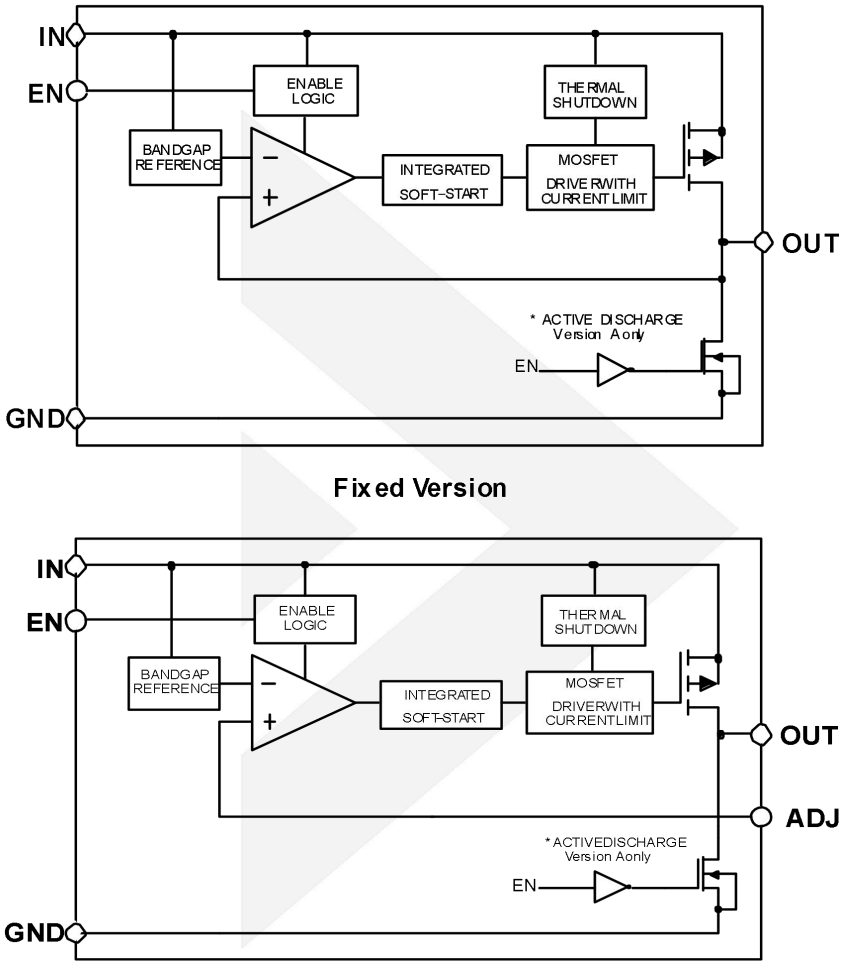



**Figure 13. Functional Block Diagram**

## Application Information

The DIO7708 is a member of the new family of wide input voltage range low dropout regulators that delivers ultra-low ground current consumption, good noise, and power supply rejection ratio performance. The DIO7708 incorporates EN pin and soft−start feature for simple controlling by microprocessor or logic.

### Input Decoupling ($C_{IN}$)

It is recommended to connect at least 1 μF ceramic X5R or X7R capacitor between IN and GND pin of the device. This capacitor will provide a low impedance path for any unwanted AC signals or noise superimposed onto constant input voltage. The good input capacitor will limit the influence of input trace inductances and source resistance during sudden load current changes.

Higher capacitance and lower ESR capacitors will improve the overall line transient response.

**Output Decoupling ($C_{OUT}$)**

The DIO7708 does not require a minimum Equivalent Series Resistance (ESR) for the output capacitor. The device is designed to be stable with standard ceramic capacitors with values of 1 μF or greater. The X5R and X7R types have the lowest capacitance variations over temperature. Thus they are recommendable.

**Power Dissipation and Heat Sinking**

The maximum power dissipation supported by the device is dependent upon board design and layout. Mounting pad configuration on the PCB, the board material, and the ambient temperature affect the rate of junction temperature rise for the part. For reliable operation junction temperature should be limited to 150°C.

The maximum power dissipation the DIO7708 can handle is given by:

$$P_{D(MAX)} = \frac{[T_{J(MAX)} - T_A]}{R_{\theta JA}} \qquad \text{(eq.2)}$$

The power dissipated by the DIO7708 for given application conditions can be calculated from the following equations:

$$P_D \approx V_{IN} \times I_{GND} + I_{OUT} \times (V_{IN} - V_{OUT}) \qquad \text{(eq.3)}$$

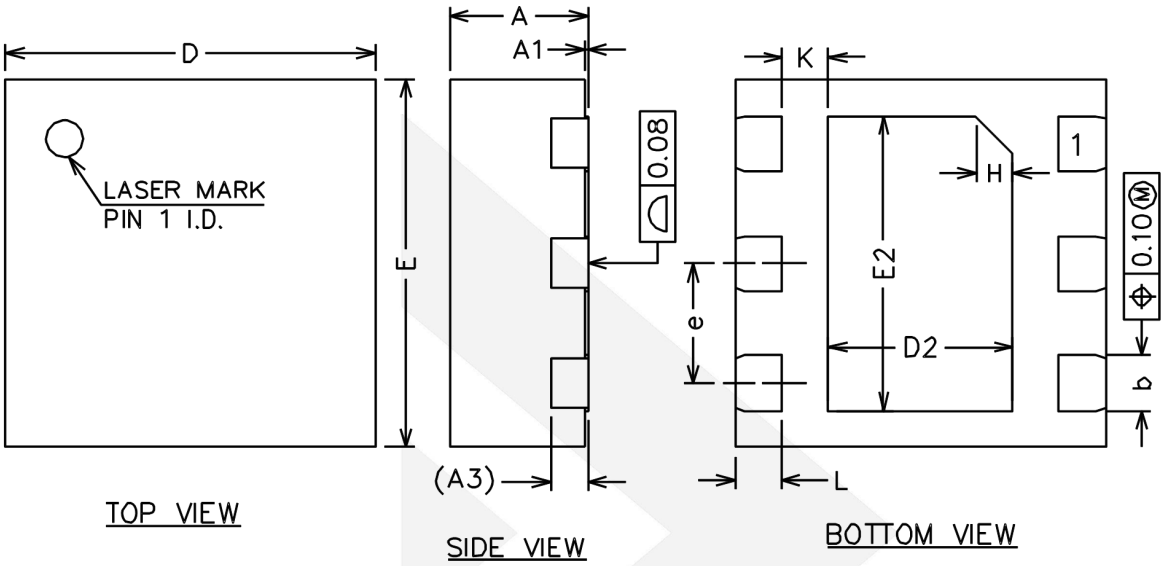
or

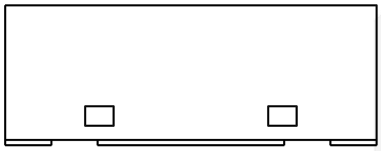
$$V_{IN(MAX)} \approx \frac{P_{D(MAX)} + (V_{OUT} \times I_{OUT})}{I_{OUT} + I_{GND}} \qquad \text{(eq.4)}$$

**Hints**

$V_{IN}$ and GND printed circuit board traces should be as wide as possible. When the impedance of these traces is high, there is a chance to pick up noise or cause the regulator to malfunction. Place external components, especially the output capacitor, as close as possible to the DIO7708, and make traces as short as possible.

## Physical Dimensions: DFN2*2-6

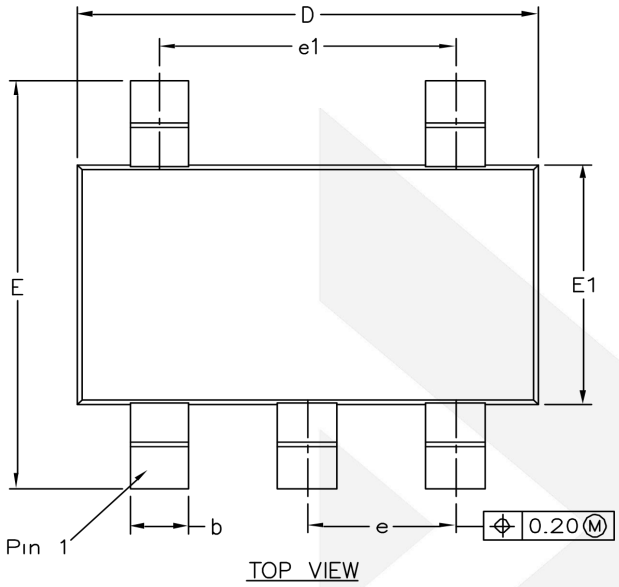


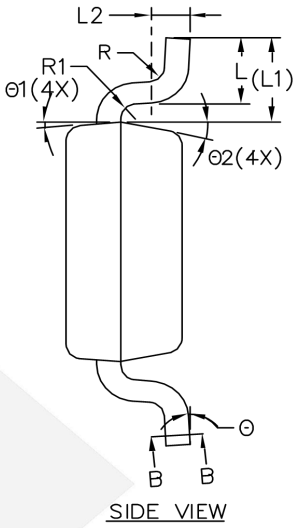



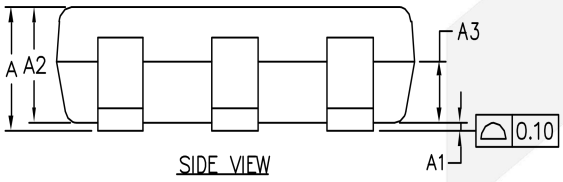
SIDE VIEW

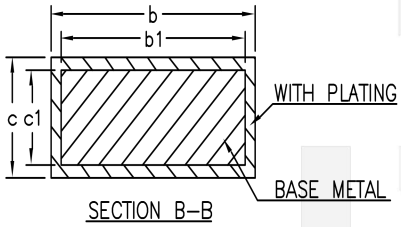
| Common Dimensions (Units of Measure = Millimeter) | | | |
|---|---|---|---|
| **Symbol** | **Min** | **Nom** | **Max** |
| A | 0.70 | 0.75 | 0.80 |
| A1 | 0.00 | 0.02 | 0.05 |
| A3 | | 0.20REF | |
| b | 0.25 | 0.30 | 0.35 |
| D | 1.90 | 2.00 | 2.10 |
| E | 1.90 | 2.00 | 2.10 |
| D2 | 0.90 | 1.00 | 1.10 |
| E2 | 1.50 | 1.60 | 1.70 |
| e | 0.55 | 0.65 | 0.75 |
| K | 0.15 | 0.25 | 0.35 |
| L | 0.20 | 0.25 | 0.30 |
| H | | 0.20 REF | |

# Physical Dimensions: TSOT23-5



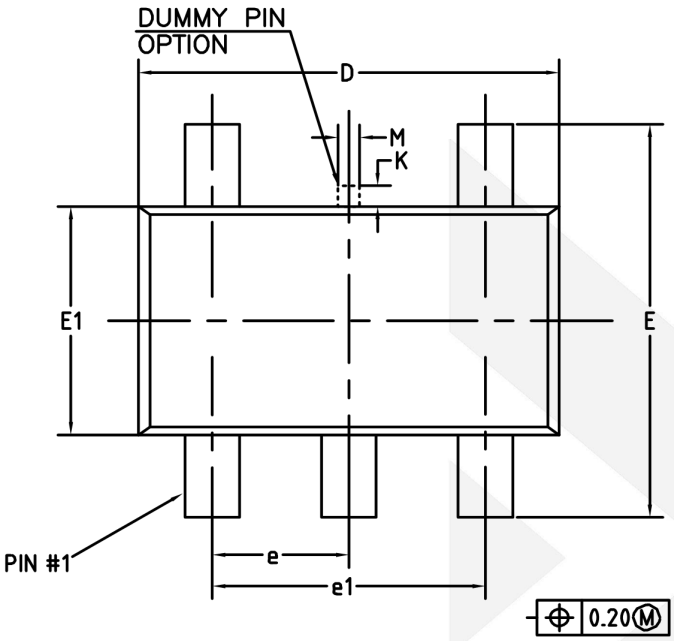



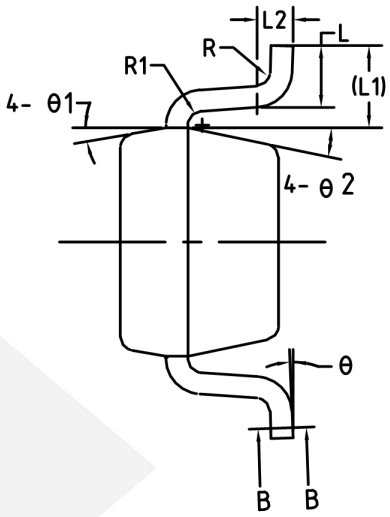



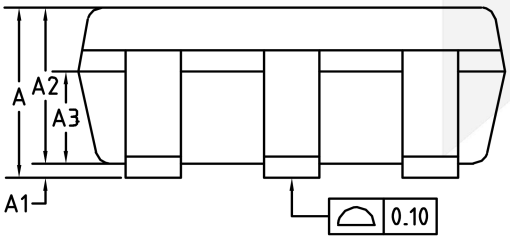



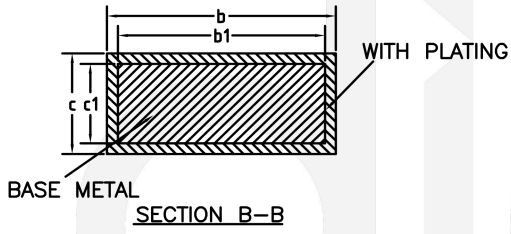

| Common Dimensions (Units of Measure=Millimeter) | | | |
|---|---|---|---|
| **Symbol** | **Min** | **Nom** | **Max** |
| A | - | - | 0.90 |
| A1 | 0 | - | 0.15 |
| A2 | 0.65 | 0.75 | 0.85 |
| A3 | 0.35 | 0.40 | 0.45 |
| b | 0.36 | - | 0.50 |
| b1 | 0.36 | 0.38 | 0.45 |
| c | 0.14 | - | 0.20 |
| c1 | 0.14 | 0.15 | 0.16 |
| D | 2.85 | 2.95 | 3.05 |
| E | 2.65 | 2.80 | 2.95 |
| E1 | 1.60 | 1.65 | 1.70 |
| e | 0.90 | 0.95 | 1.00 |
| e1 | 1.80 | 1.90 | 2.00 |
| L | 0.30 | 0.45 | 0.60 |
| L1 | 0.575REF | | |
| L2 | 0.25BSC | | |
| R | - | - | 0.25 |
| R1 | - | - | 0.25 |
| Θ | 0° | - | 8° |
| Θ1 | 3° | 5° | 7° |
| Θ2 | 10° | 12° | 14° |

# Physical Dimensions: SOT23-5




SECTION B–B

| Common Dimensions (Units of measure = Millimeter) | | | |
|---|---|---|---|
| **Symbol** | **Min** | **Nom** | **Max** |
| A | - | - | 1.25 |
| A1 | 0 | - | 0.15 |
| A2 | 1.00 | 1.10 | 1.20 |
| A3 | 0.60 | 0.65 | 0.70 |
| b | 0.36 | - | 0.45 |
| b1 | 0.35 | 0.38 | 0.41 |
| c | 0.14 | - | 0.20 |
| c1 | 0.14 | 0.15 | 0.16 |
| D | 2.826 | 2.926 | 3.026 |
| E | 2.60 | 2.80 | 3.00 |
| E1 | 1.526 | 1.626 | 1.726 |
| e | 0.90 | 0.95 | 1.00 |
| e1 | 1.80 | 1.90 | 2.00 |
| K | 0 | - | 0.25 |
| L | 0.30 | 0.40 | 0.60 |
| L1 | 0.59 REF | | |
| L2 | 0.25 BSC | | |
| M | 0.10 | 0.15 | 0.25 |
| R | 0.05 | - | 0.20 |
| R1 | 0.05 | - | 0.20 |
| Θ | 0° | - | 8° |
| Θ1 | 8° | 10° | 12° |
| Θ2 | 10° | 12° | 14° |

## CONTACT US

Dioo is a professional design and sales corporation for high-quality and performance analog semiconductors. The company focuses on industry markets, such as cell phones, handheld products, laptops, medical equipment, and so on. Dioo's product families include analog signal processing and amplifying, LED drivers, and charger ICs. Go to http://www.dioo.com for a complete list of Dioo product families.

For additional product information or full datasheet, please contact our sales department or representatives.