

HM6118B 20V, 1A High Speed LDO

General Description

The HM6118B series are the low noise LDO with enable function, the output operates from 0.8V to 5.0V by 0.1V/step. The characteristics are low noise and good PSRR and low dropout voltage, make this device ideal for portable consumer applications.

The HM6118B series can operate with up to 20V input.

The Devices are available in SOT223 ,SOT89-3,ESOP8, TO252-2L, DFN6 packages

Features

- Operating Input Voltage Range:2.7V~20V
- Max Output Current: 1A
- Output Voltage Accuracy: $\pm 2\%$
- Adjustable Output Voltage Option $V_{FB}=0.6V$
- Fixed Output Voltage Version : 0.8V~5.5V
- Standby Current: 100uA (Typ.)
- High Ripple Rejection: 80dB at 1kHz
- Low Dropout: 0.6V (Typ.) at 1A @ $V_{OUT} \geq 2V$

Applications

- Consumer and Industrial Equipment Point of Regulation.
- Switching Power Supply Post Regulation
- Battery Chargers
- Hard Drive Controllers

Device Information

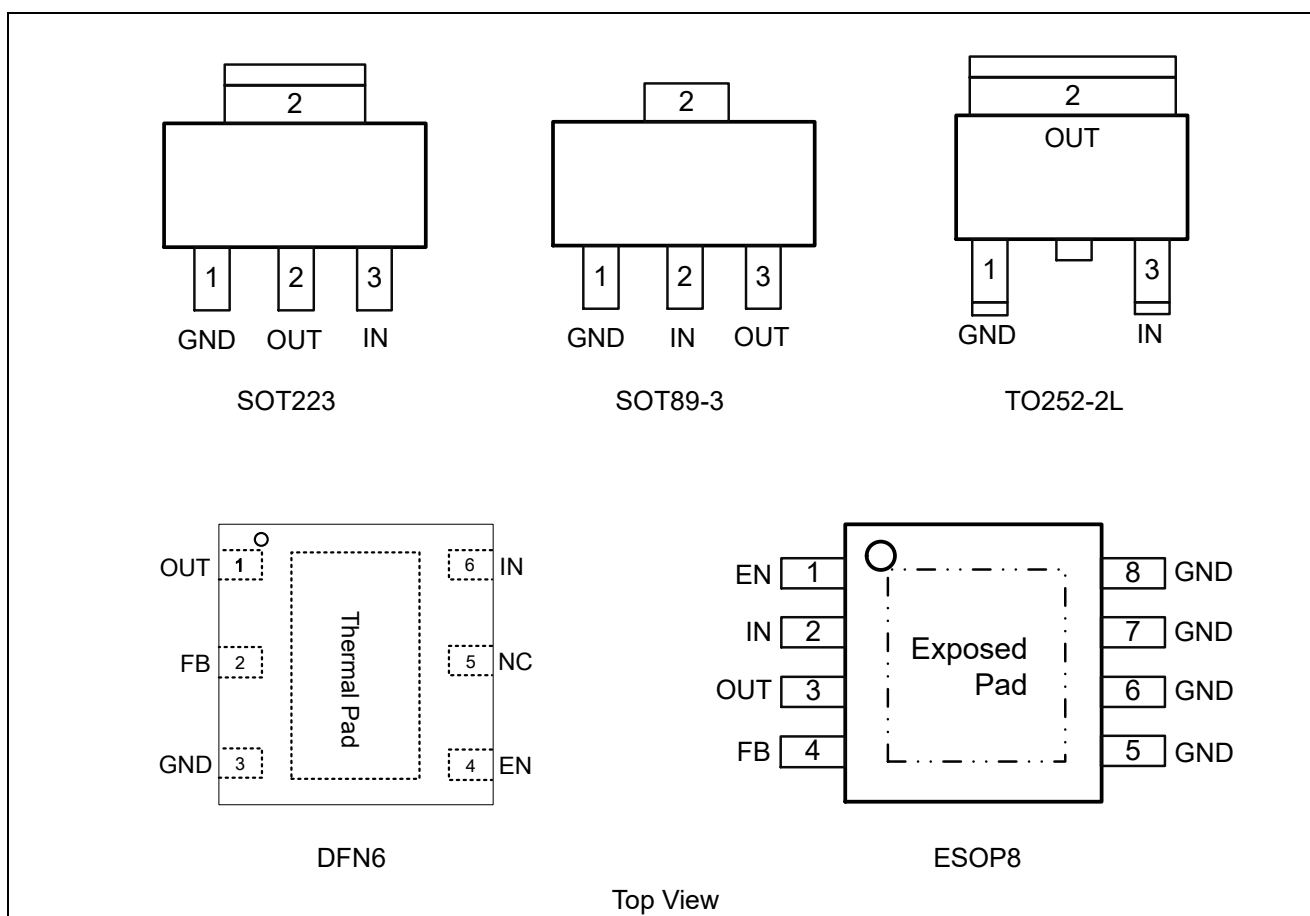
HM6118 B - ADJ / XX X

| <u>ADJ</u> / <u>XX</u> Output Voltage | <u>X</u> Package | | <u>B</u> Auto-Discharging Func |
|---|------------------|----------|---------------------------------------|
| ADJ - Output Adjustable XX - Output X.XV | P | SOT89-3 | B - Available / - Not equipped |
| | T | TO252-2L | |
| | R | SOT223 | |
| | E | ESOP8 | |
| | D | DFN6 | |

Ordering Information

| V _{OUT} | Package | Part No. | Description |
|------------------|----------|--------------|------------------------|
| ADJ | DFN6 | HM6118B-ADJD | 1A, Adjustable, Enable |
| ADJ | ESOP8 | HM6118B-ADJE | 1A, Adjustable, Enable |
| 1.8V | SOT223 | HM6118B-18R | 1A |
| | SOT89-3 | HM6118B-18P | 1A |
| | TO252-2L | HM6118B-18T | 1A |
| 2.5V | SOT223 | HM6118B-25R | 1A |
| | SOT89-3 | HM6118B-25P | 1A |
| | TO252-2L | HM6118B-25T | 1A |
| 3.3V | SOT223 | HM6118B-33R | 1A |
| | SOT89-3 | HM6118B-33P | 1A |
| | TO252-2L | HM6118B-33T | 1A |
| 5.0V | SOT223 | HM6118B-50R | 1A |
| | SOT89-3 | HM6118B-50P | 1A |
| | TO252-2L | HM6118B-50T | 1A |

Pin Configuration



Pin Function

ET5HAXX

| Pin Number | | | Pin Name | Functions |
|------------|---------|----------|----------|--------------------|
| SOT223 | SOT89-3 | TO252-2L | | |
| 1 | 1 | 1 | GND | Ground |
| 2 | 3 | 2 | OUT | Output |
| 3 | 2 | 3 | IN | Power Supply Input |

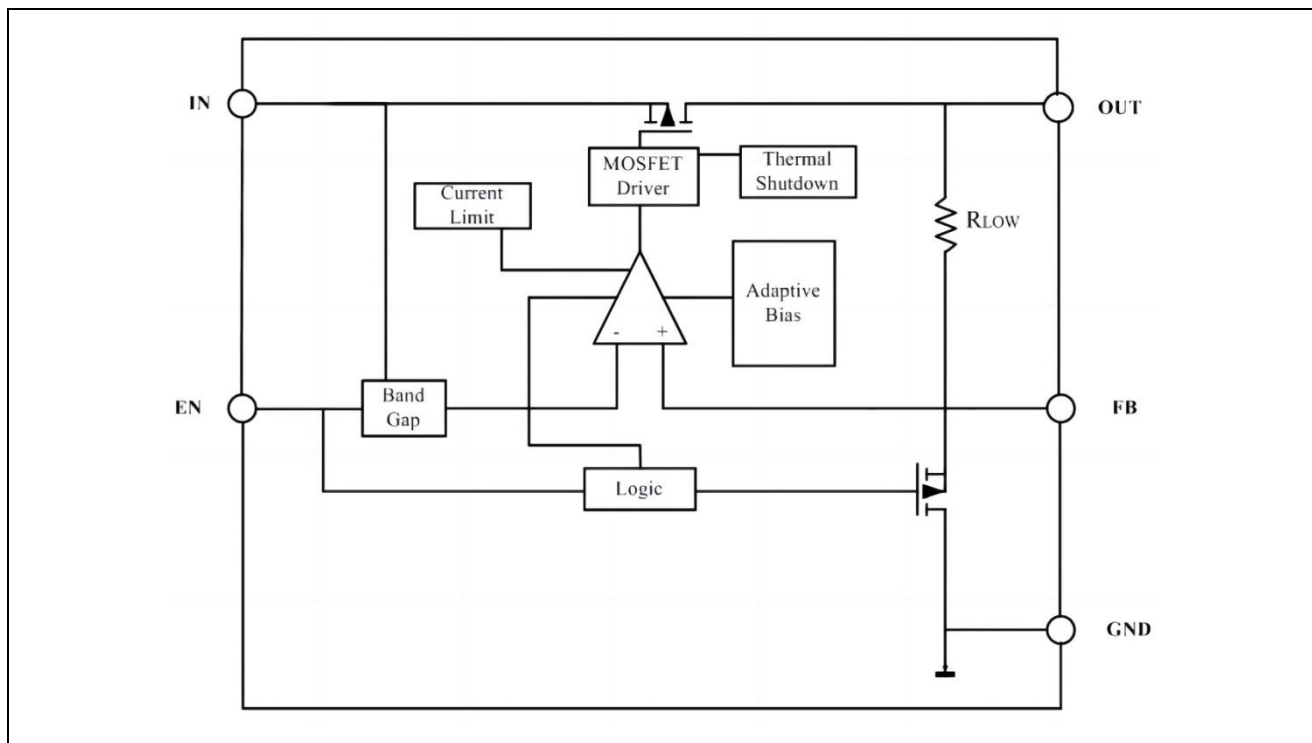
DFN6

| Pin Number | Pin Name | Functions |
|------------|----------|------------------------------------|
| 1 | OUT | Output |
| 2 | FB | Set the output voltage of the LDO. |
| 3 | GND | Ground |
| 4 | EN | Enable Pin |
| 5 | NC | Not Connect |
| 6 | IN | Power Supply Input |

ESOP8

| Pin Number | Pin Name | Functions |
|------------|----------|------------------------------------|
| 1 | EN | Enable Pin. |
| 2 | VIN | Power Supply Input. |
| 3 | OUT | Output. |
| 4 | FB | Set the output voltage of the LDO. |
| 5 | GND | Ground. |
| 6 | GND | Ground. |
| 7 | GND | Ground. |
| 8 | GND | Ground. |

Block Diagram



Functional Description

Enable

The HM6118B delivers the output power when it is set to enable state. When it works in disable state, there is no output power and the operation quiescent current is almost zero. The enable pin (EN) is active high.

Shutdown

Turn off the device by forcing the EN pin to drop below $V_{EN(LO)}$. If shutdown capability is not required, connect EN to IN. The HM6118B has an internal pull down MOSFET that connects an $R_{PULLDOWN}$ resistor to ground when the device is disabled. The discharge time after disabling depends on the output capacitance (C_{OUT}) and the load resistance (R_L) in parallel with the pull-down resistor (R_{PD}).

Formula 1 calculates the time constant:

$$\tau = (R_{PD} \times R_L) / (R_{PD} + R_L) \quad (1)$$

Over-Temperature Protection

The over-temperature protection function will turn off the P-MOSFET when the junction temperature exceeds 150°C (typ.). Once the junction temperature cools down by approximately 20°C, the regulator will automatically resume operation.

Current-Limit Protection

The HM6118B provides current limit function to prevent the device from damages during over-load or shorted-circuit condition. This current is detected by an internal sensing transistor.

Absolute Maximum Ratings

| Symbol | Parameter | Value | Unit |
|---------------------|---------------------------------------|---------|------|
| V _{IN} | Input Voltage ⁽¹⁾ | 0~24 | V |
| V _{OUT} | Output Voltage | 0.8~6 | V |
| V _{CE} | Chip Enable Input | -0.3~22 | V |
| T _{J(MAX)} | Maximum Junction Temperature | 150 | °C |
| T _{STG} | Storage Temperature | -55~150 | °C |
| ESD _{HBM} | Human Body Model ⁽²⁾ | 2000 | V |
| ESD _{CDM} | ESD Capability ⁽²⁾ | 1500 | V |
| Latch up | Current Maximum Rating ⁽²⁾ | 200 | mA |

Stresses exceeding those listed in this table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

Note1. Refer to **ELECTRICAL CHARACTERISTICS** and **APPLICATION INFORMATION** for Safe Operating Area.

Note2. This device series incorporates ESD protection and is tested by the following methods:

ESD Human Body Model tested per EIA/JESD22-A114.

CDM tested per JESD22-C101 ; Latch up Current Maximum Rating tested per JEDEC78.

Thermal Characteristics

| Symbol | Package | Ratings | Value | Unit |
|------------------|----------|--|-------|------|
| R _{θJA} | MSOP8 | Thermal Characteristics, Thermal Resistance, Junction-to-Air | 150 | °C/W |
| | DFN6 | | 100 | °C/W |
| | SOT223 | | 110 | °C/W |
| | SOT89-3 | | 125 | °C/W |
| | TO252-2L | | 60 | °C/W |

Recommended Operating Conditions

| Symbol | Parameter | Min | Unit |
|------------------|---|-----------|------|
| V _{IN} | Input Voltage | 2.7 to 22 | V |
| I _{OUT} | Output Current | 0 to 1 | A |
| T _a | Operating Ambient Temperature | -40 to 85 | °C |
| C _{IN} | Effective Input Ceramic Capacitor Value ⁽³⁾ | 1 to 10 | uF |
| C _{OUT} | Effective Output Ceramic Capacitor Value ⁽³⁾ | 1 to 10 | uF |
| ESR | Input and Output Capacitor Equivalent Series Resistance (ESR) | 5 to 100 | mΩ |

Note3. The capacitor refers to a chip capacitor, and larger capacitance value is required if electrolytic capacitor is used.

Electrical Characteristics

$V_{IN} = V_{OUT} + 1V$; $I_{OUT} = 10mA$, $C_{IN} = C_{OUT} = 10\mu F$, unless otherwise noted. Typical values are at $T_A = +25^\circ C$.

| Symbol | Parameter | Test Conditions | Min | Typ. | Max | Unit |
|------------------|---|--|-------|------------------|-------|---------------|
| $V_{IN}^{(4)}$ | Operating Input Voltage | | 2.7 | | 20 | V |
| V_{OUT} | Output Voltage | $T_A = +25^\circ C$ | -2% | | +2% | V |
| | | $-40^\circ C \leq T_A \leq 85^\circ C$ | -3% | | +3% | |
| V_{REF} | Reference Voltage | $T_A = +25^\circ C$ | 0.588 | 0.60 | 0.612 | V |
| $Line_{Reg}$ | Line Regulation | $2.8V \leq V_{IN} \leq 20V$, $I_{OUT} = 10mA$ | | 0.05 | 0.20 | %/V |
| $V_{DROP}^{(5)}$ | Dropout Voltage $I_{OUT}=1A, V_{IN} \geq 2.7V$ $-40^\circ C \leq T_A \leq 125^\circ C$ | $V_{OUT}=1.8V$ | | 750 | 800 | mV |
| | | $V_{OUT}=3.3V$ | | 480 | 600 | |
| | | $V_{OUT}=5.0V$ | | 450 | 550 | |
| | Dropout Voltage $I_{OUT}=500mA, V_{IN} \geq 2.7V$ $-40^\circ C \leq T_A \leq 125^\circ C$ | $V_{OUT}=1.8V$ | | 650 | 900 | mV |
| | | $V_{OUT}=3.3V$ | | 210 | 450 | |
| | | $V_{OUT}=5.0V$ | | 200 | 400 | |
| $Load_{Reg}$ | Load Regulation | $1mA \leq I_{OUT} \leq 800mA$, $V_{IN} = V_{OUT} + 1V$ | | | 40 | mV |
| I_{LMT} | Current Limit | $V_{IN} = V_{OUT} + 1V$ | 1.04 | 1.3 | | A |
| I_{SHORT} | Short Circuit Current Limit | $V_{OUT} = 0V$ | | 330 | | mA |
| I_Q | Quiescent Current | $I_{OUT} = 0mA$ | | 160 | 190 | μA |
| I_{Q_OFF} | Standby Current | $V_{EN} = 0V, T_A = 25^\circ C$ | | 0.1 | 1 | μA |
| V_{ENH} | EN Pin Threshold Voltage | EN Input Voltage "H" | 1.4 | | | V |
| V_{ENL} | EN Pin Threshold Voltage | EN Input Voltage "L" | | | 0.4 | V |
| I_{EN} | EN Pin Current | $V_{EN} \leq V_{IN} \leq 20V$ | | 1 | | μA |
| PSRR | Power Supply Rejection Ratio $V_{IN} = V_{OUT} + 2V$ $I_{OUT} = 50mA$ | $f = 1kHz$ | | 80 | | dB |
| | | $f = 100kHz$ | | 70 | | |
| | | $f = 1MHz$ | | 65 | | |
| e_N | Output Noise Voltage | $V_{IN} = V_{OUT} + 1V, I_{OUT} = 1mA$, $f = 10Hz \text{ to } 100KHz$, $V_{OUT}=3V, C_{OUT} = 1\mu F^{(4)(5)}$ | | 30* V_{OUT} | | μV_{rms} |
| R_{LOW} | Active Output Discharge Resistance | $V_{IN} = 4V, V_{EN} = 0V$ | | 300 | | Ω |
| T_{SD} | Thermal Shut down Temperature | Temperature Increasing from $T_A = +25^\circ C^{(6)}$ | | 150 | | $^\circ C$ |
| T_{SDH} | Thermal Shutdown Hysteresis | Temperature Falling from T_{SD} $^{(6)}$ | | 25 | | $^\circ C$ |

Note4. V_{IN} range guarantees internal circuit can work normal.

If $V_{IN} < V_{OUTSET}$, V_{OUT} follows $V_{IN}(I_{OUT}=1mA)$, circuit is safe still.

Note5. The minimum operating voltage is 2.7V. $V_{DROP} = V_{IN(min)} - V_{OUT}$.

V_{DROP} FT test method: Test the V_{OUT} voltage at $V_{OUTSET} + V_{DROP-MAX}$ with 1A output current.

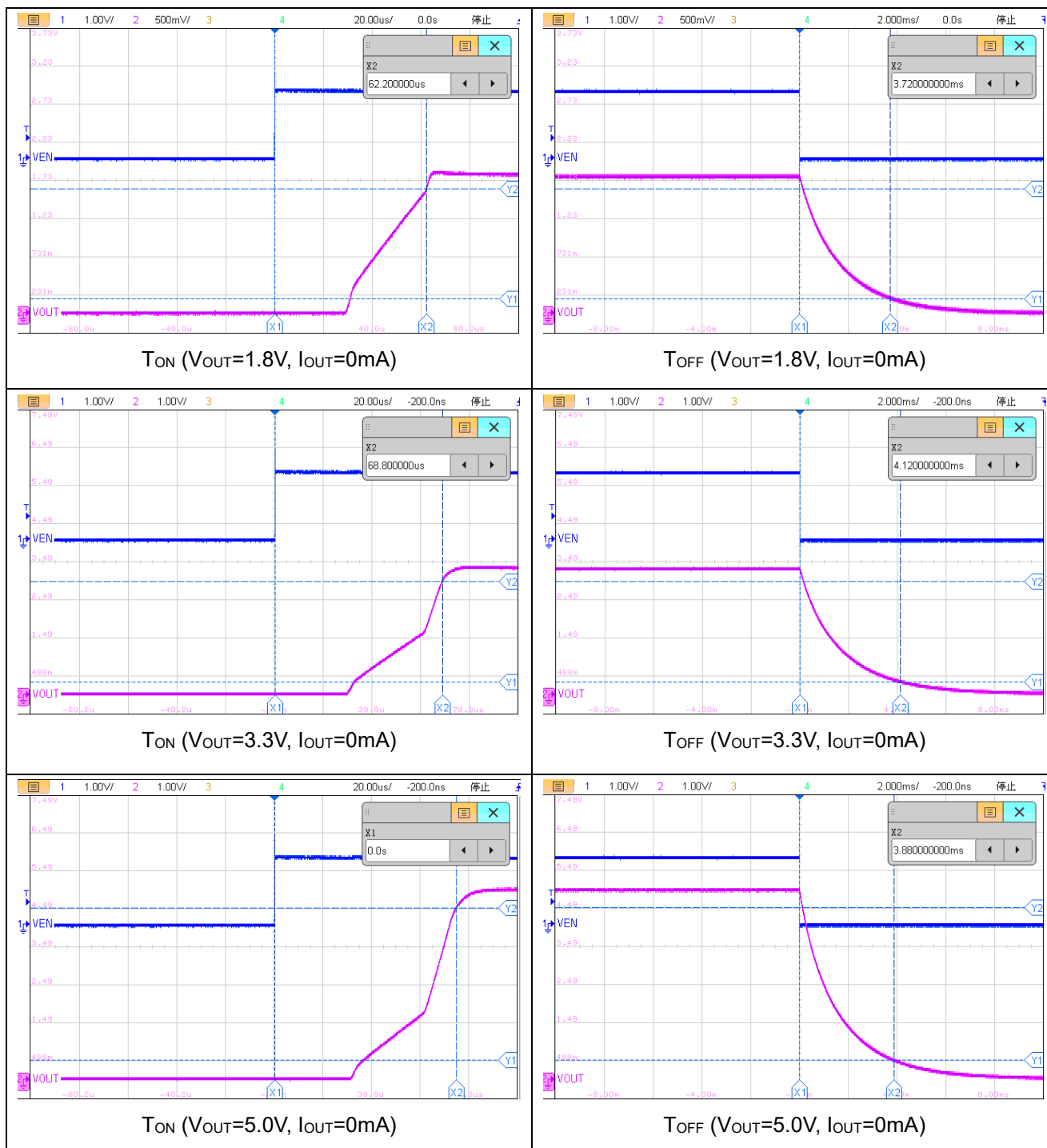
Note6. Guaranteed by design, not an FT item.

Typical Characteristics

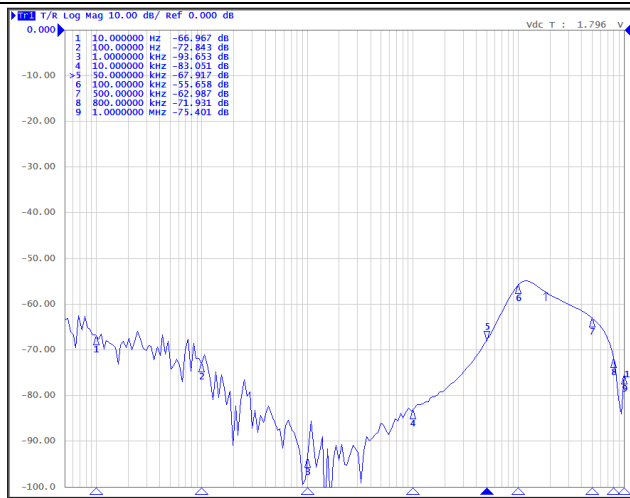
Typical Characteristics are ONLY for reference, thus they are not guaranteed in practical use.

$V_{IN} = V_{OUT} + 1V$, $I_{OUT} = 1mA$, $C_{IN} = C_{OUT} = 10\mu F$ (Ceramic Cap), unless otherwise noted.

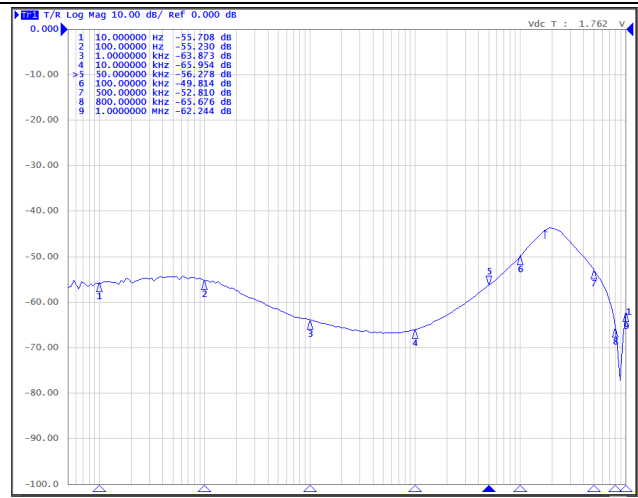
T_{ON} and T_{OFF}



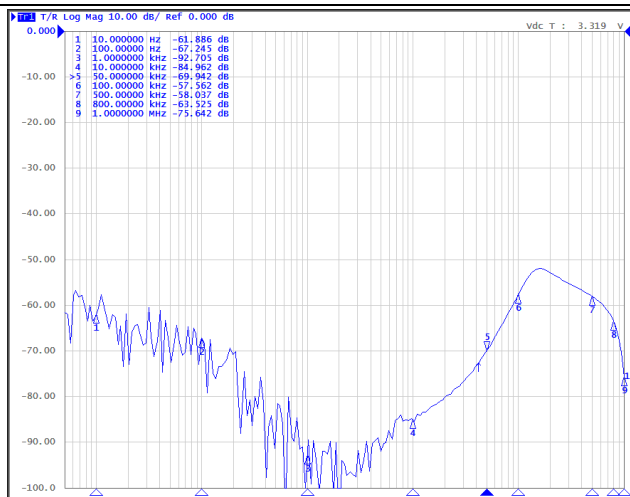
PSRR



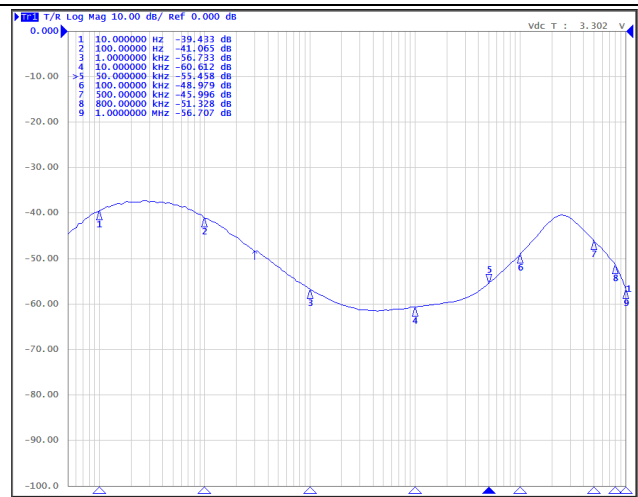
PSRR ($V_{OUT}=1.8V$, $I_{OUT}=50mA$)



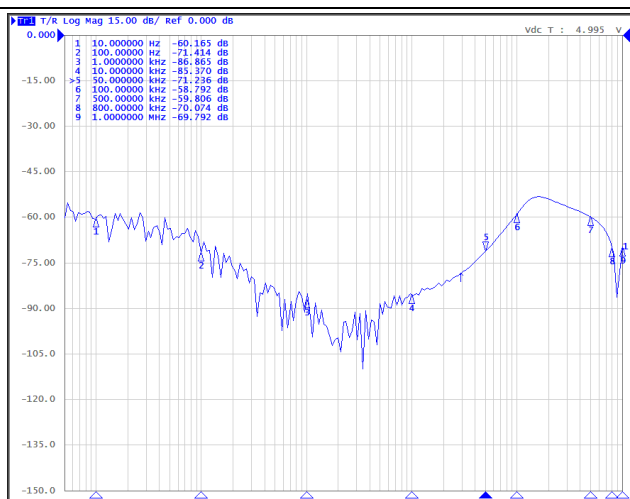
PSRR ($V_{OUT}=1.8V$, $I_{OUT}=500mA$)



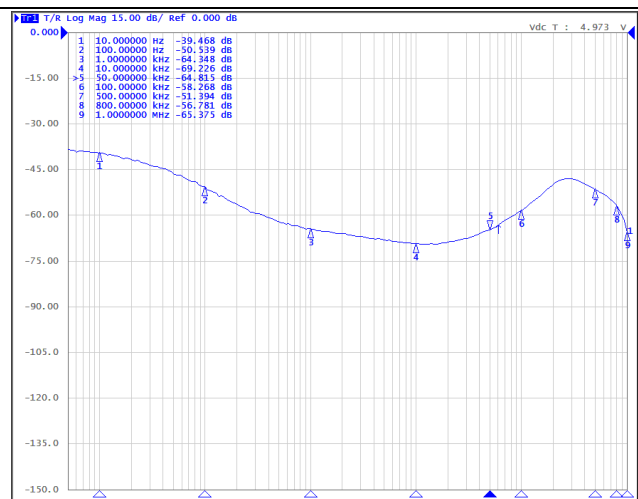
PSRR ($V_{OUT}=3.3V$, $I_{OUT}=50mA$)



PSRR ($V_{OUT}=3.3V$, $I_{OUT}=500mA$)



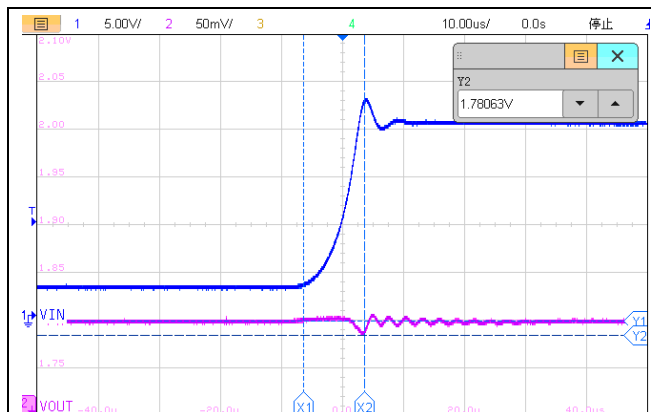
PSRR ($V_{OUT}=5.0V$, $I_{OUT}=50mA$)



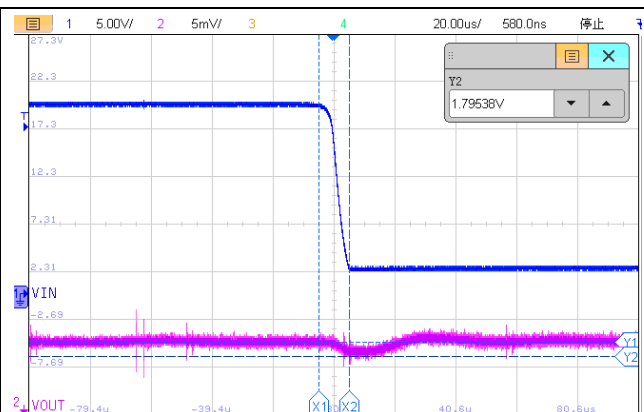
PSRR ($V_{OUT}=5.0V$, $I_{OUT}=500mA$)

Line Transient Response

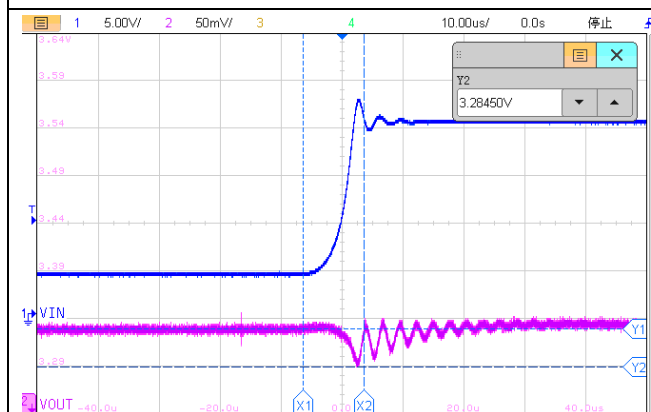
Test Condition: $V_{IN}=V_{OUT}+1V$, $C_{OUT}=10\mu F$, $t_R=t_F=10\mu s$, $I_{OUT}=10mA$, V_{IN} step between 6V ~ 18V.



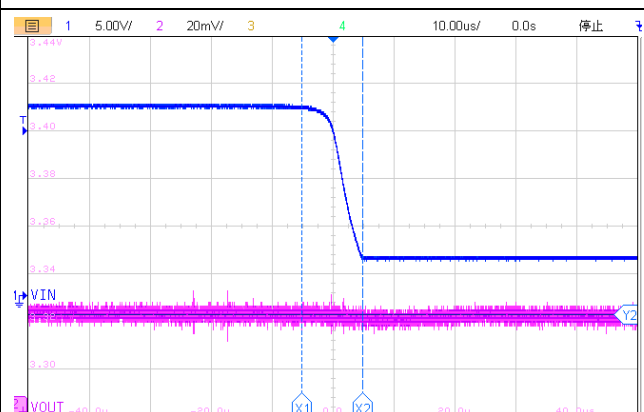
Line Transient Response
($V_{OUT}=1.8V$, $I_{OUT}=1mA$)



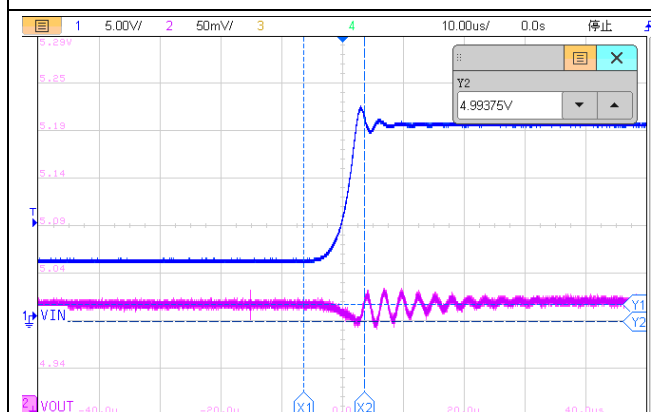
Line Transient Response
($V_{OUT}=1.8V$, $I_{OUT}=1mA$)



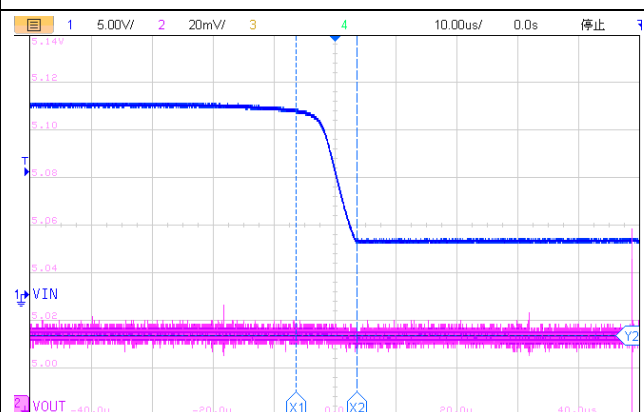
Line Transient Response
($V_{OUT}=3.3V$, $I_{OUT}=1mA$)



Line Transient Response
($V_{OUT}=3.3V$, $I_{OUT}=1mA$)



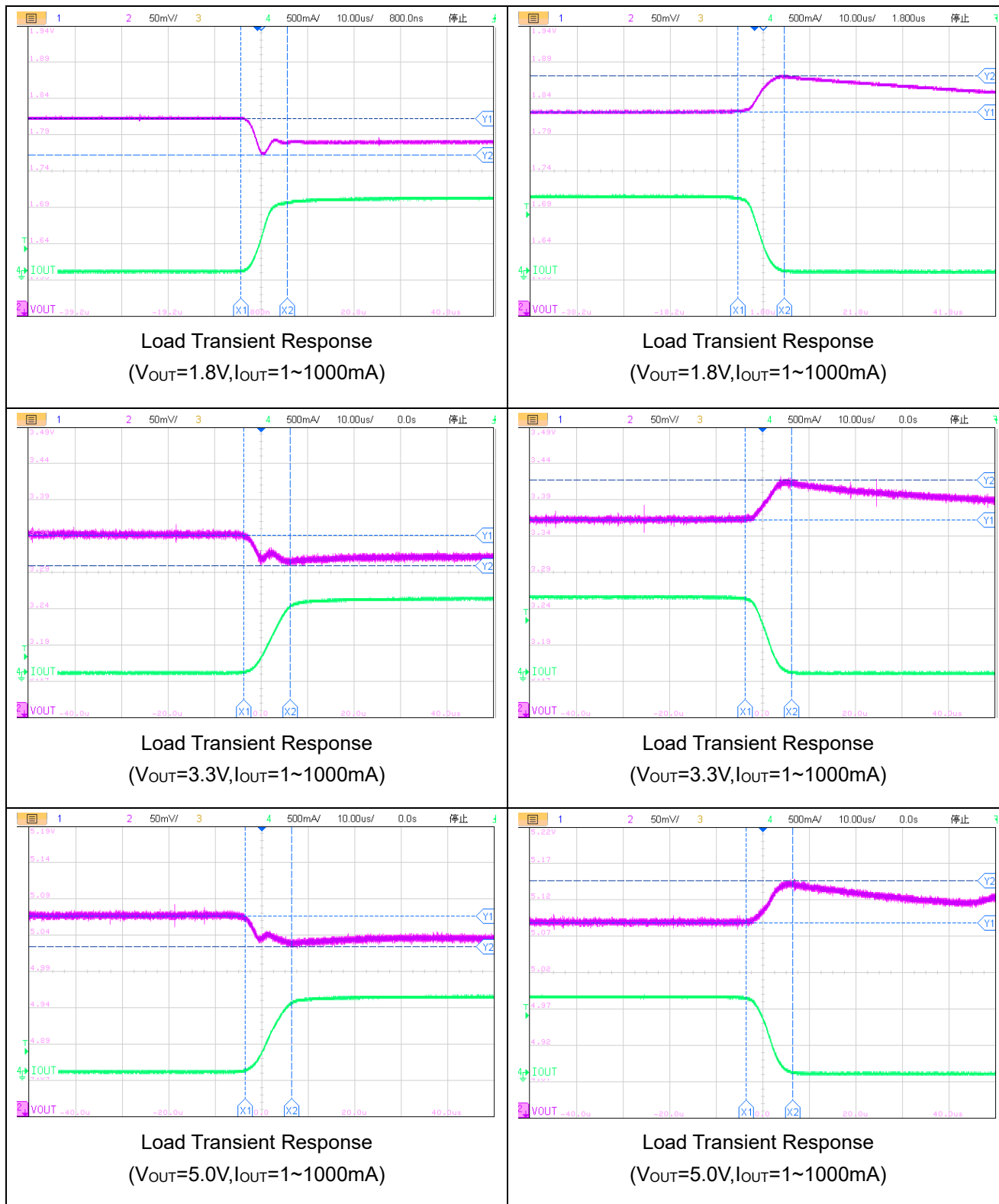
Line Transient Response
($V_{OUT}=5.0V$, $I_{OUT}=1mA$)



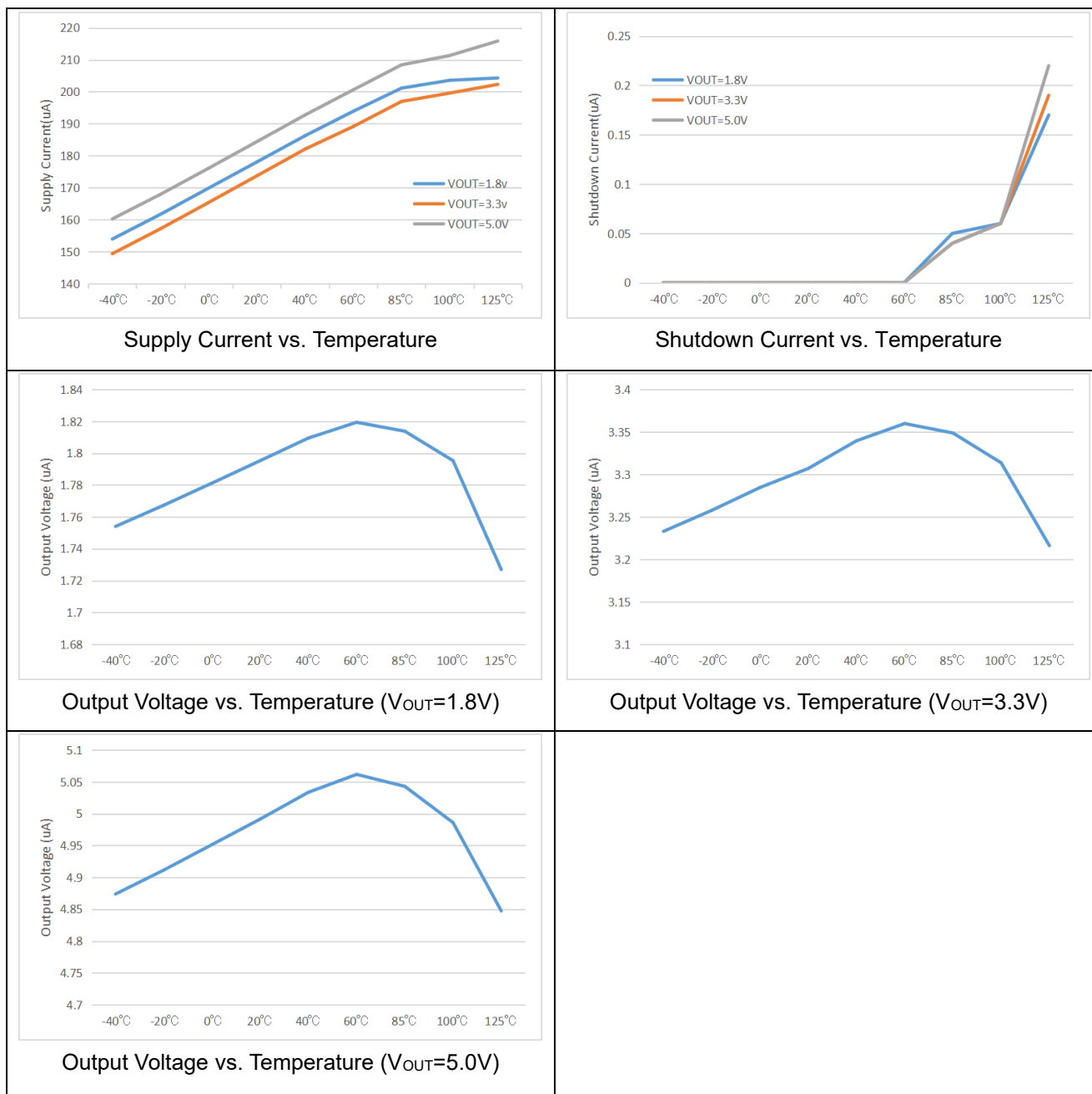
Line Transient Response
($V_{OUT}=5.0V$, $I_{OUT}=1mA$)

Load Transient Response

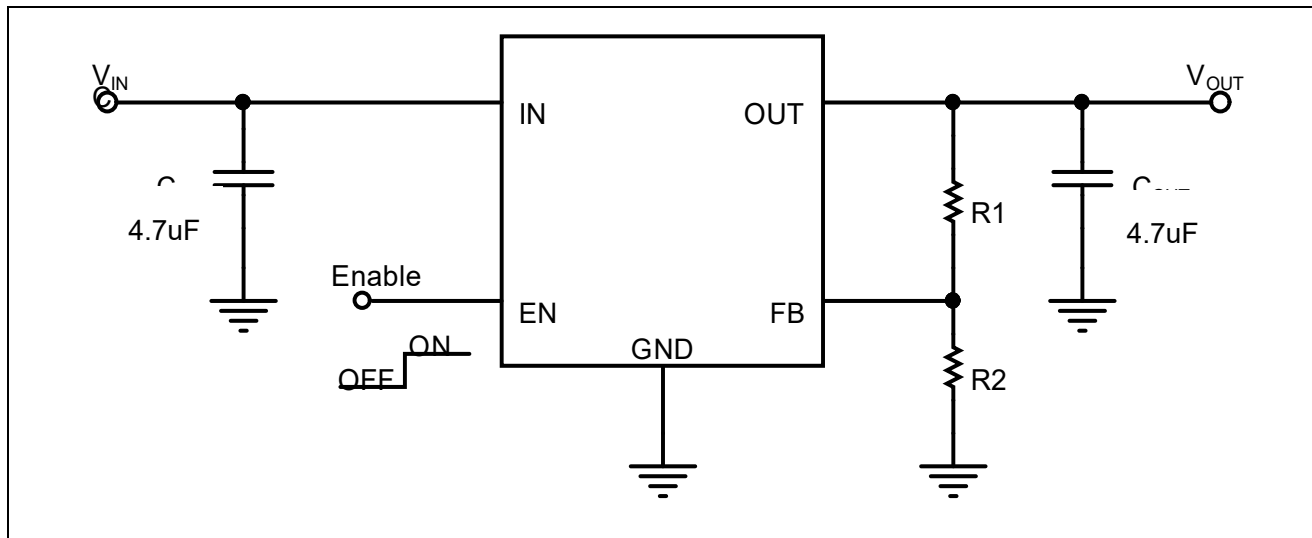
Test Condition: $V_{IN}=V_{OUT}+1V$, $t_R=T_F=10\mu s$, I_{OUT} step between 1mA ~ 1000mA.



Temperature Characteristics



Application Circuits



Application Information

Input and Output Capacitor Selection

The HM6118B requires an output capacitance of $4.7\mu\text{F}$ or larger for stability. Use X5R and X7R type ceramic capacitors because these capacitors have minimal variation in value and equivalent series resistance (ESR) over temperature. When choosing a capacitor for a specific application, pay attention to the dc bias characteristics for the capacitor. Higher output voltages cause a significant derating of the capacitor.

Although an input capacitor is not required for stability, good analog design practice is to connect a capacitor from IN to GND. Some input supplies have a high impedance, thus placing the input capacitor on the input supply helps reduce the input impedance. This capacitor counteracts reactive input sources and improve transient response, input ripple, and PSRR. If the input supply has a high impedance over a large range of frequencies, several input capacitors can be used in parallel to lower the impedance over frequency. Use a higher-value capacitor if large, fast, rise-time load transients are anticipated, or if the device is located several inches from the input power source.

Application of Electrolytic Capacitor

If the electrolytic capacitor should be used as input and output capacitor, the capacitance of the capacitor must be greater. The capacity value must be greater than $22\mu\text{F}$.

Enable

The HM6118B has an EN pin to turn on or turn off the regulator. When the EN pin is in logic high, the regulator will be turned on. The shutdown current is almost $0\mu\text{A}$ typical. The EN pin may be directly tied to V_{IN} to keep the part on. The Enable input is CMOS logic and cannot be left floating.

Setting the Output Voltage

The HM6118B develops a 0.6V reference voltage, V_{REF} , between the output and the adjust terminal. This voltage is applied across resistor R1 to generate a constant current. The current I_{ADJ} from the ADJ terminal could introduce DC offset to the output. Because, this offset is very small (about $0.1\mu\text{A}$), it can be ignored.

The constant current then flows through the output set resistor R2 and sets the output voltage to the desired

level. Formula 2 is used for calculating V_{OUT} :

$$V_{OUT} = 0.6V \times (1 + R1 / R2) \quad (2)$$

Although I_{ADJ} is very small, $R1+R2$ should be limited to less than 100 K Ω for optimum performance.

Dropout Voltage

The HM6118B uses a PMOS pass transistor to achieve low dropout. When $(V_{IN} - V_{OUT})$ is less than the dropout voltage (V_{DO}), the PMOS pass device is in the linear region of operation and the input-to-output resistance is the $R_{DS(ON)}$ of the PMOS pass element. V_{DO} scales approximately with output current because the PMOS device behaves like a resistor in dropout mode. As with any linear regulator, PSRR and transient response degrade as $(V_{IN} - V_{OUT})$ approaches dropout operation.

Thermal Shutdown

Thermal shutdown protection disables the output when the junction temperature rises to approximately 150°C. Disabling the device eliminates the power dissipated by the device, allowing the device to cool. When the junction temperature cools to approximately 125°C, the output circuitry is again enabled. Depending on power dissipation, thermal resistance, and ambient temperature, the thermal protection circuit may cycle on and off. This cycling limits regulator dissipation, protecting the LDO from damage as a result of overheating. Activating the thermal shutdown feature usually indicates excessive power dissipation as a result of the product of the $(V_{IN} - V_{OUT})$ voltage and the load current. For reliable operation, limit junction temperature to 150°C maximum.

Thermal Considerations

For continuous operation, do not exceed absolute maximum junction temperature. The maximum power dissipation depends on the thermal resistance of the IC package, PCB layout, rate of surrounding airflow, and difference between junction and ambient temperature. The maximum power dissipation can be calculated by Formula 3:

$$PD_{(MAX)} = (T_{J(MAX)} - T_A) / \theta_{JA} \quad (3)$$

where $T_{J(MAX)}$ is the maximum junction temperature, T_A is the ambient temperature, and θ_{JA} is the junction to ambient thermal resistance.

For recommended operating condition specifications the maximum junction temperature is 150°C and T_A is the ambient temperature. The junction to ambient thermal resistance, θ_{JA} , is layout dependent. For DFN6 package, the thermal resistance, θ_{JA} , is 100°C/W on the test board. The maximum power dissipation at $T_A = 25^\circ\text{C}$ can be calculated by Formula 4:

$$PD_{(MAX)} = (150^\circ\text{C} - 25^\circ\text{C}) / (100^\circ\text{C/W}) = 1.25W \quad (4)$$

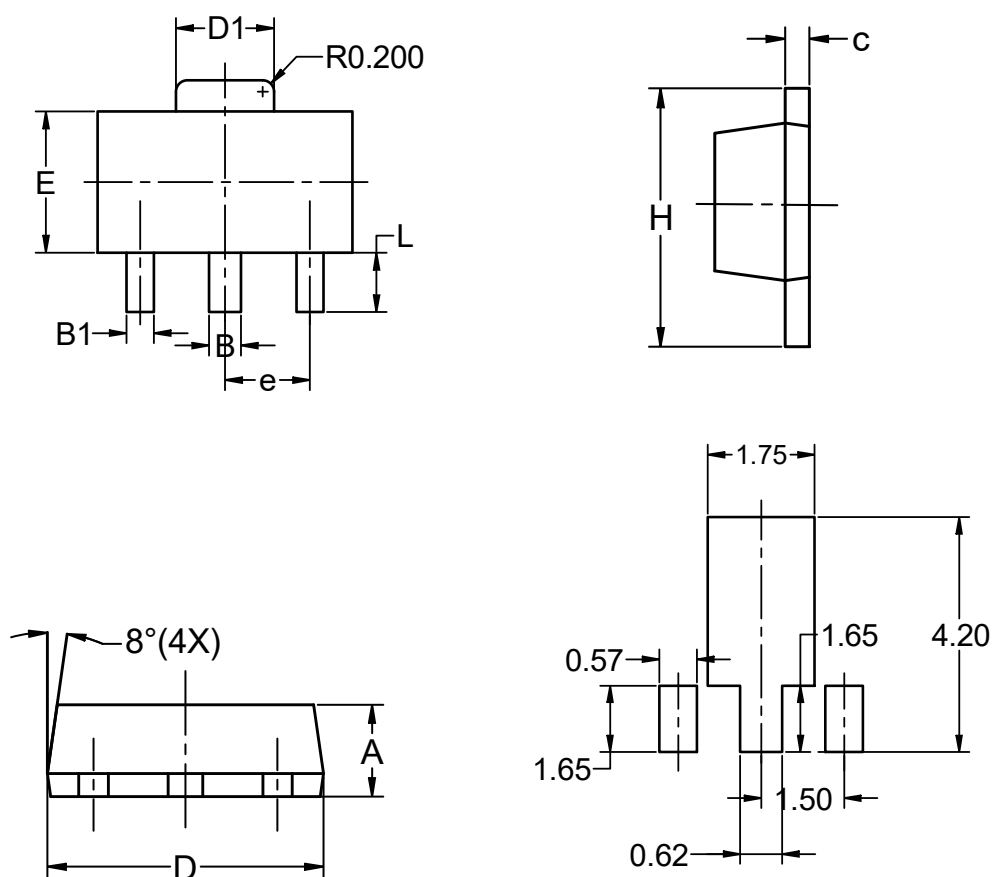
Layout

Layout Guidelines

- Place input and output capacitors as close to the device as possible.
- Use copper planes for device connections in order to optimize thermal performance.
- Place thermal vias around the device to distribute heat.
- Do not place a thermal via directly beneath the thermal pad of the DRV package. A via can wick solder or solder paste away from the thermal pad joint during the soldering process, leading to a compromised solder joint on the thermal pad.

Package Dimension

SOT89-3

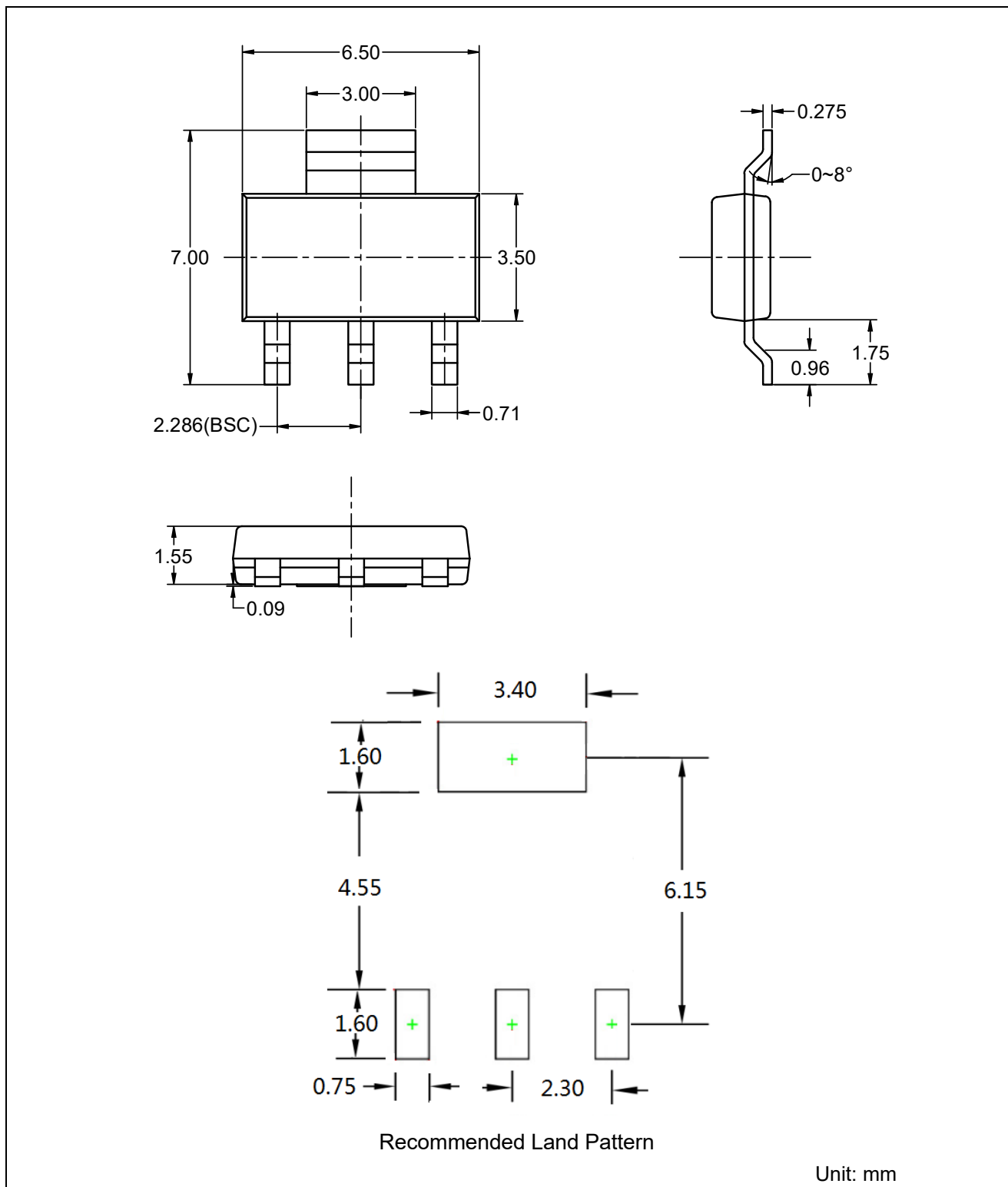


Recommended Land Pattern

Unit: mm

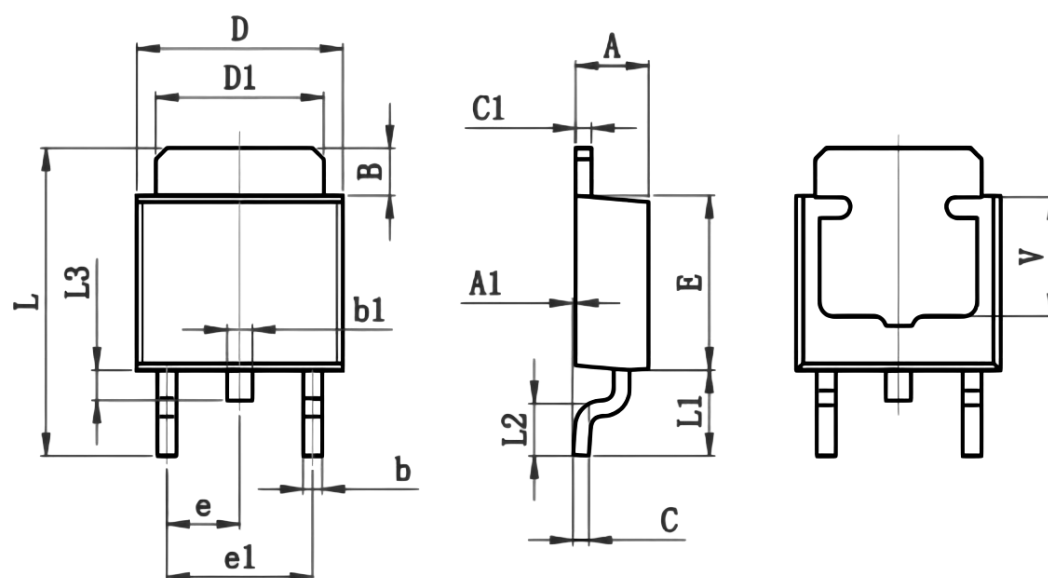
Package Dimension (Continued)

SOT-223



Package Dimension (Continued)

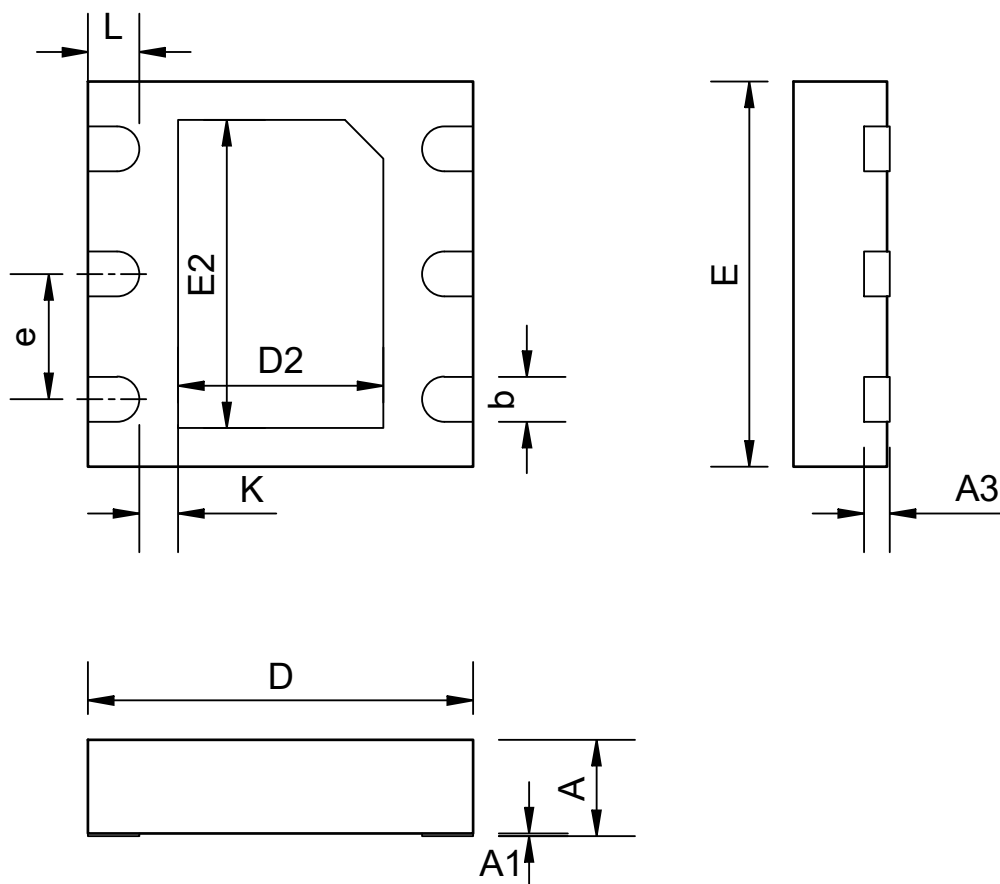
TO252-2



| SYMBOL | MIN | MAX |
|--------|-----------|-------|
| A | 2.200 | 2.400 |
| A1 | 0.000 | 0.127 |
| B | 1.350 | 1.650 |
| b | 0.500 | 0.700 |
| b1 | 0.700 | 0.900 |
| C | 0.430 | 0.580 |
| c1 | 0.430 | 0.580 |
| D | 6.350 | 6.650 |
| D1 | 5.200 | 5.400 |
| E | 5.400 | 5.700 |
| e | 2.300 TYP | |
| e1 | 4.500 | 4.700 |
| L | 9.500 | 9.900 |
| L1 | 2.550 | 2.900 |
| L2 | 1.400 | 1.780 |
| L3 | 0.600 | 0.900 |
| V | 3.800 REF | |

Package Dimension (Continued)

DFN6 (2×2)

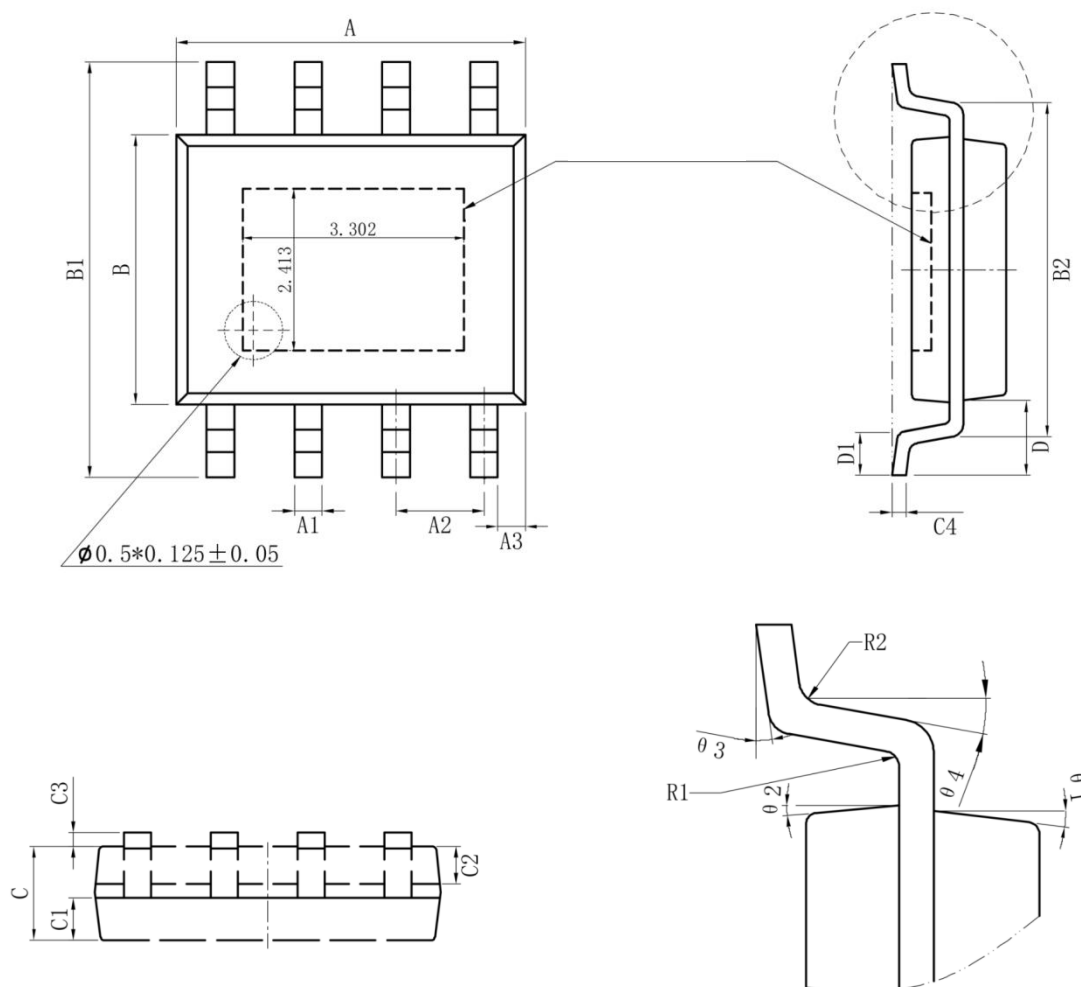


COMMON DIMENSIONS
(UNITS OF MEASURE=MILLIMETER)

| SYMBOL | MIN | NOM | MAX |
|--------|---------|------|------|
| A | 0.70 | 0.75 | 0.80 |
| A1 | 0.00 | 0.02 | 0.05 |
| A3 | 0.20REF | | |
| b | 0.25 | 0.35 | 0.45 |
| D | 1.90 | 2.00 | 2.10 |
| E | 1.90 | 2.00 | 2.10 |
| D2 | 0.65 | 0.80 | 0.90 |
| E2 | 1.35 | 1.50 | 1.60 |
| e | 0.65BSC | | |
| L | 0.30 | 0.35 | 0.40 |
| k | 0.20 | -- | -- |

Package Dimension (Continued)

ESOP-8



| Symbol | Min (mm) | Max (mm) | Symbol | Min (mm) | Max (mm) |
|--------|----------|----------|--------|----------|----------|
| A | 4.80 | 5.00 | C3 | 0.00 | 0.09 |
| A1 | 0.356 | 0.456 | C4 | 0.203 | 0.233 |
| A2 | | 1.27TYP | D | | 1.05TYP |
| A3 | | 0.345TYP | D1 | 0.40 | 0.80 |
| B | 3.80 | 4.00 | R1 | | 0.20TYP |
| B1 | 5.80 | 6.20 | R2 | | 0.20TYP |
| B2 | | 5.00TYP | θ1 | | 17°TYP4 |
| C | 1.30 | 1.60 | θ2 | | 13°TYP4 |
| C1 | 0.55 | 0.65 | θ3 | | 0°~ 8° |
| C2 | 0.55 | 0.65 | θ4 | | 4°~ 12° |