# 1A LOW NOISE CMOS LDO REGULATOR WITH ENABLE AP2115

## General Description

The AP2115 is CMOS process low dropout linear regulator with enable function, the regulator delivers a guaranteed 1A (min.) continuous load current.

The AP2115 features low power consumption.

The AP2115 is available in 1.2V, 1.8V, 2.5V and 3.3V regulator output, and available in excellent output accuracy ±1.5%, it is also available in an excellent load regulation and line regulation performance.

The AP2115 is available in standard packages of SOIC-8 and SOT-89-5.

## Features

- Output Voltage Accuracy: ±1.5%
- Output Current: 1A (Min.)
- Fold-back Short Current Protection: 50mA
- Low Dropout Voltage (3.3V): 450mV (Typ.) @ $I_{OUT}$=1A
- Stable with 4.7μF Flexible Cap: Ceramic, Tantalum and Aluminum Electrolytic
- Excellent Line Regulation: 0.02%/V (Typ.), 0.1%/V (Max.) @ $I_{OUT}$=30mA
- Excellent Load Regulation: 0.2%/A @ $I_{OUT}$=1mA to 1A
- Low Quiescent Current: 60μA (1.2V/1.8V/ 2.5V)
- Low Output Noise: 30$\mu V_{RMS}$
- PSRR: 68dB @ Freq=1kHz (1.2V/1.8V)
- OTSD Protection
- Operation Temperature Range: -40°C to 85°C
- ESD: MM 400V, HBM 4000V

## Applications

- LCD Monitor
- LCD TV
- STB

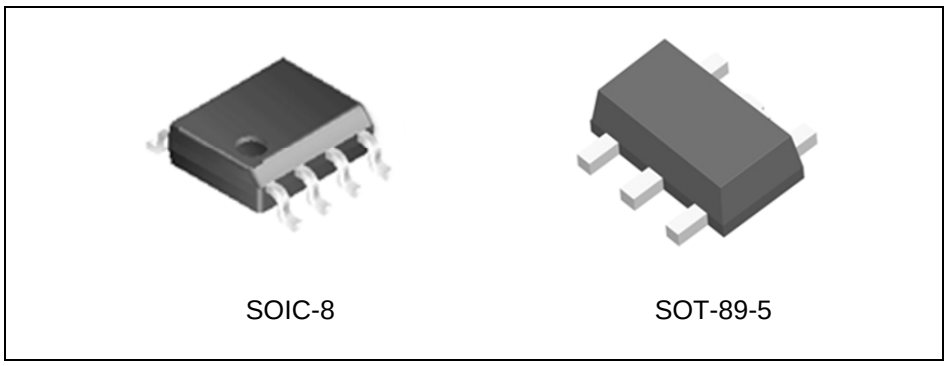


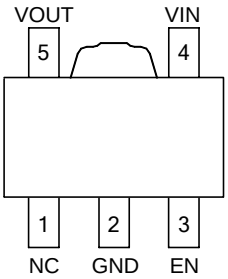

Figure 1. Package Types of AP2115

# 1A LOW NOISE CMOS LDO REGULATOR WITH ENABLE AP2115

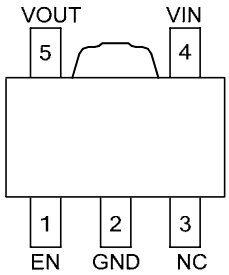
## Pin Configuration

R5 Package
（SOT-89-5）

R5




R5A




M Package
（SOIC-8）

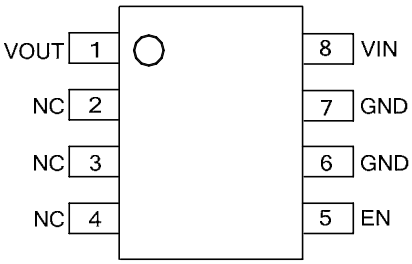



Figure 2. Pin Configuration of AP2115 (Top View)

## Pin Descriptions

| Pin No. | | Name | Function |
|---|---|---|---|
| SOT-89-5 | SOIC-8 | | |
| 1 | 2, 3, 4 | NC/EN | No connection/Chip Enable |
| 2 | 6, 7 | GND | GND |
| 3 | 5 | EN/NC | Chip Enable, H – normal work, L – shutdown output/ No Connection |
| 4 | 8 | VIN | Input Voltage |
| 5 | 1 | VOUT | Output Voltage |

## Functional Block Diagram

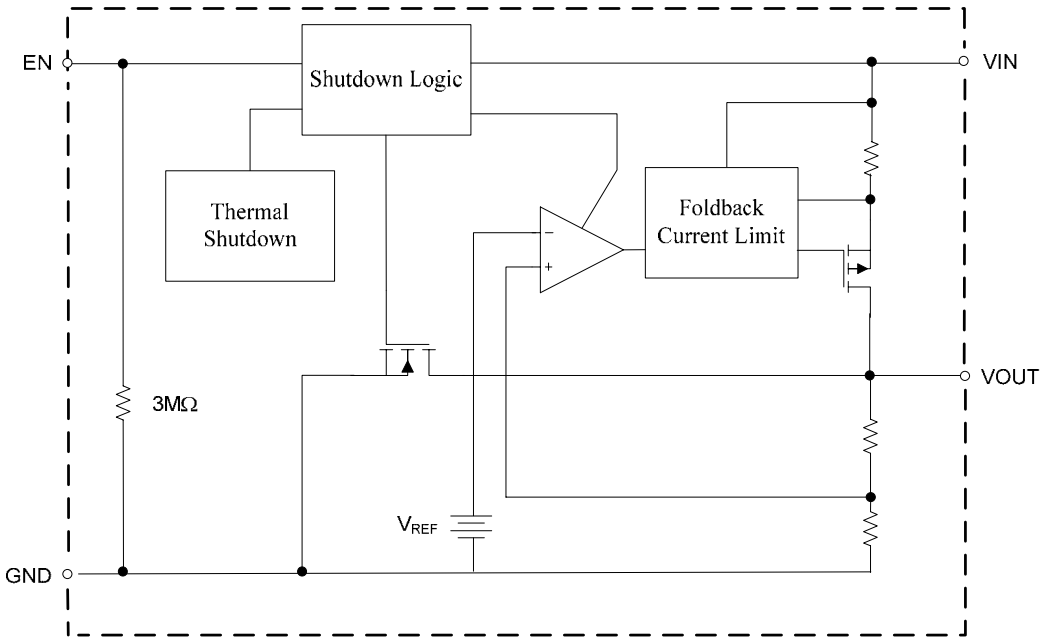
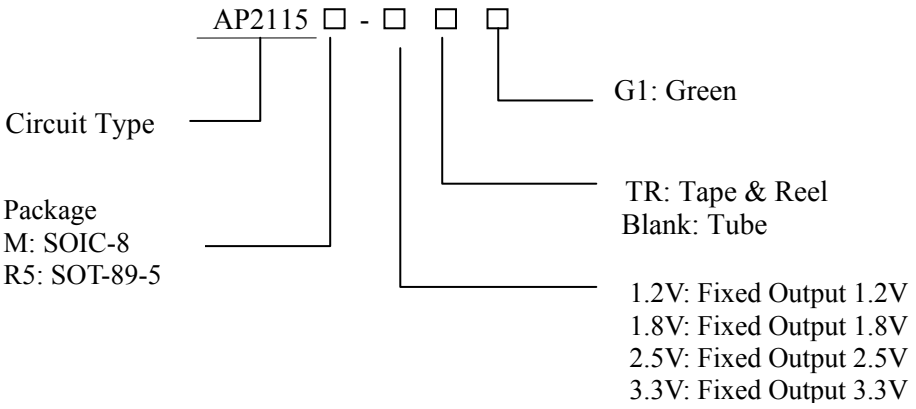



Figure 3. Functional Block Diagram of AP2115

# 1A LOW NOISE CMOS LDO REGULATOR WITH ENABLE AP2115

## Ordering Information




| Package | Temperature Range | Condition | Part Number | Marking ID | Packing Type |
|---|---|---|---|---|---|
| SOIC-8 | -40 to 85°C | 1.2V | AP2115M-1.2G1 | 2115M-1.2G1 | Tube |
| | | | AP2115M-1.2TRG1 | 2115M-1.2G1 | Tape & Reel |
| | | 1.8V | AP2115M-1.8G1 | 2115M-1.8G1 | Tube |
| | | | AP2115M-1.8TRG1 | 2115M-1.8G1 | Tape & Reel |
| | | 2.5V | AP2115M-2.5G1 | 2115M-2.5G1 | Tube |
| | | | AP2115M-2.5TRG1 | 2115M-2.5G1 | Tape & Reel |
| | | 3.3V | AP2115M-3.3G1 | 2115M-3.3G1 | Tube |
| | | | AP2115M-3.3TRG1 | 2115M-3.3G1 | Tape & Reel |
| SOT-89-5 | -40 to 85°C | 1.2V (R5) | AP2115R5-1.2TRG1 | G22G | Tape & Reel |
| | | 1.8V (R5) | AP2115R5-1.8TRG1 | G22H | Tape & Reel |
| | | 2.5V (R5) | AP2115R5-2.5TRG1 | G37H | Tape & Reel |
| | | 3.3V (R5) | AP2115R5-3.3TRG1 | G41H | Tape & Reel |
| SOT-89-5 | -40 to 85°C | 1.2V (R5A) | AP2115R5A-1.2TRG1 | G27D | Tape & Reel |
| | | 1.8V (R5A) | AP2115R5A-1.8TRG1 | G27G | Tape & Reel |
| | | 2.5V (R5A) | AP2115R5A-2.5TRG1 | G41F | Tape & Reel |
| | | 3.3V (R5A) | AP2115R5A-3.3TRG1 | G41G | Tape & Reel |

BCD Semiconductor's Pb-free products, as designated with "G1" suffix in the part number, are RoHS compliant and green.

## Absolute Maximum Ratings (Note 1)

| Parameter | Symbol | Value | Unit |
|---|---|---|---|
| Power Supply Voltage | $V_{CC}$ | 6.5 | V |
| Operating Junction Temperature Range | $T_J$ | 150 | ºC |
| Storage temperature Range | $T_{STG}$ | -65 to 150 | ºC |
| Lead Temperature (Soldering,10 Seconds) | $T_{LEAD}$ | 260 | ºC |
| ESD (Machine Model) | | 400 | V |
| ESD (Human Body Model) | | 4000 | V |

Note 1: Stresses greater than 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 under "Recommended Operating Conditions" is not implied. Exposure to "Absolute Maximum Ratings" for extended periods may affect device reliability.

## Recommended Operating Conditions

| Parameter | Symbol | Min | Max | Unit |
|---|---|---|---|---|
| Supply Voltage | $V_{IN}$ | 2.5 | 6.0 | V |
| Ambient Operation Temperature Range | $T_A$ | -40 | 85 | °C |

# Electrical Characteristics

## AP2115-1.2 Electrical Characteristics (Note 2)

$V_{IN}$=2.5V, $C_{IN}$=4.7μF (Ceramic), $C_{OUT}$=4.7μF (Ceramic), Typical $T_A$=25°C, **Bold** typeface applies over -40°C≤$T_J$≤85°C ranges, unless otherwise specified (Note 3).

| Parameter | Symbol | Test Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| Output Voltage | $V_{OUT}$ | $V_{IN}$=2.5V, 1mA ≤ $I_{OUT}$ ≤ 30mA | $V_{OUT}$ ×98.5% | 1.2 | $V_{OUT}$ ×101.5% | V |
| Input Voltage | $V_{IN}$ | | | | 6 | V |
| Maximum Output Current | $I_{OUT(MAX)}$ | $V_{IN}$=2.5V, $V_{OUT}$=1.182V to 1.218V | 1 | | | A |
| Load Regulation | $\frac{\triangle V_{OUT}/V_{OUT}}{\triangle I_{OUT}}$ | $V_{IN}$=2.5V, 1mA ≤ $I_{OUT}$ ≤1A | | 0.2 | 1 | %/A |
| Line Regulation | $\frac{\triangle V_{OUT}/V_{OUT}}{\triangle V_{IN}}$ | 2.5V≤$V_{IN}$≤6V, $I_{OUT}$=30mA | -0.1 | 0.02 | 0.1 | %/V |
| Dropout Voltage | $V_{DROP}$ | $I_{OUT}$=1.0A | | 1200 | 1300 | mV |
| Quiescent Current | $I_Q$ | $V_{IN}$=2.5V, $I_{OUT}$=0mA | | 60 | 75 | μA |
| Power Supply Rejection Ratio | PSRR | Ripple 1Vp-p, $V_{IN}$=2.5V, $I_{OUT}$=100mA, f=100Hz | | 68 | | dB |
| | | Ripple 1Vp-p, $V_{IN}$=2.5V, $I_{OUT}$=100mA, f=1KHz | | 68 | | |
| Output Voltage Temperature Coefficient | $\frac{\triangle V_{OUT}/V_{OUT}}{\triangle T}$ | $I_{OUT}$=30mA, $T_A$ =-40°C to 85°C | | ±30 | | ppm/°C |
| Short Current Limit | $I_{SHORT}$ | $V_{OUT}$=0V | | 50 | | mA |
| RMS Output Noise | $V_{NOISE}$ | 10Hz ≤ f ≤100kHz (No Load) | | 30 | | $\mu V_{RMS}$ |
| $V_{EN}$ High Voltage | $V_{IH}$ | Enable logic high, regulator on | 1.5 | | | V |
| $V_{EN}$ Low Voltage | $V_{IL}$ | Enable logic low, regulator off | | | 0.4 | |
| Standby Current | $I_{STD}$ | $V_{IN}$=3.5V, $V_{EN}$ in OFF mode | | 0.01 | 1.0 | μA |
| Start-up Time | $t_S$ | No Load | | 20 | | μs |
| EN Pull Down Resistor | $R_{PD}$ | | | 3.0 | | MΩ |
| $V_{OUT}$ Discharge Resistor | $R_{DCHG}$ | Set EN pin at Low | | 60 | | Ω |
| Thermal Shutdown Temperature | $T_{OTSD}$ | | | 160 | | °C |
| Thermal Shutdown Hysteresis | $T_{HYOTSD}$ | | | 25 | | |
| Thermal Resistance | $\theta_{JC}$ | SOIC-8 | | 74.6 | | °C/W |
| | | SOT-89-5 | | 47 | | |

Note 2: To prevent the Short Circuit Current protection feature from being prematurely activated, the input voltage must be applied before a current source load is applied.
Note 3: Production testing at $T_A$=25°C. Over temperature specifications guaranteed by design only.

## Electrical Characteristics (Continued)

### AP2115-1.8 Electrical Characteristics (Note 2)

$V_{IN}$=2.8V, $C_{IN}$=4.7μF (Ceramic), $C_{OUT}$=4.7μF (Ceramic), Typical $T_A$=25°C, **Bold** typeface applies over -40°C≤$T_J$≤85°C ranges, unless otherwise specified (Note 3).

| Parameter | Symbol | Test Conditions | | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|---|
| Output Voltage | $V_{OUT}$ | $V_{IN}$ =2.8V, 1mA ≤ $I_{OUT}$ ≤ 30mA | | 98.5% ×$V_{OUT}$ | 1.8 | 101.5% × $V_{OUT}$ | V |
| Maximum Output Current | $I_{OUT(MAX)}$ | $V_{IN}$=2.8V, $V_{OUT}$=1.773V to 1.827V | | 1 | | | A |
| Load Regulation | $\frac{\triangle V_{OUT}/V_{OUT}}{\triangle I_{OUT}}$ | $V_{IN}$=2.8V, 1mA ≤ $I_{OUT}$ ≤1A | | | 0.2 | 1 | %/A |
| Line Regulation | $\frac{\triangle V_{OUT}/V_{OUT}}{\triangle V_{IN}}$ | 2.8V≤$V_{IN}$≤6V, $I_{OUT}$=30mA | | -0.1 | 0.02 | 0.1 | %/V |
| Dropout Voltage | $V_{DROP}$ | $I_{OUT}$=1.0A | | | 500 | 750 | mV |
| Quiescent Current | $I_Q$ | $V_{IN}$=2.8V, $I_{OUT}$=0mA | | | 60 | 75 | μA |
| Power Supply Rejection Ratio | PSRR | Ripple 1Vp-p $V_{IN}$=2.8V, $I_{OUT}$=100mA | f=100Hz | | 68 | | dB |
| | | | f=1KHz | | 68 | | |
| Output Voltage Temperature Coefficient | $\frac{\triangle V_{OUT}/V_{OUT}}{\triangle T}$ | $I_{OUT}$=30mA, $T_A$ =-40°C to 85°C | | | ±30 | | ppm/°C |
| Short Current Limit | $I_{SHORT}$ | $V_{OUT}$=0V | | | 50 | | mA |
| RMS Output Noise | $V_{NOISE}$ | 10Hz ≤ f ≤100kHz (No load) | | | 30 | | $\mu V_{RMS}$ |
| $V_{EN}$ High Voltage | $V_{IH}$ | Enable logic high, regulator on | | 1.5 | | | V |
| $V_{EN}$ Low Voltage | $V_{IL}$ | Enable logic low, regulator off | | | | 0.4 | |
| Standby Current | $I_{STD}$ | $V_{IN}$=3.5V, $V_{EN}$ in OFF mode | | | 0.01 | 1.0 | μA |
| Start-up Time | $t_S$ | No Load | | | 20 | | μs |
| EN Pull Down Resistor | $R_{PD}$ | | | | 3.0 | | MΩ |
| $V_{OUT}$ Discharge Resistor | $R_{DCHG}$ | Set EN pin at Low | | | 60 | | Ω |
| Thermal Shutdown Temperature | $T_{OTSD}$ | | | | 160 | | °C |
| Thermal Shutdown Hysteresis | $T_{HYOTSD}$ | | | | 25 | | |
| Thermal Resistance | $\theta_{JC}$ | SOIC-8 | | | 74.6 | | °C/W |
| | | SOT-89-5 | | | 47 | | |

Note 2: To prevent the Short Circuit Current protection feature from being prematurely activated, the input voltage must be applied before a current source load is applied.
Note 3: Production testing at $T_A$=25°C. Over temperature specifications guaranteed by design only.

## Electrical Characteristics (Continued)

### AP2115-2.5 Electrical Characteristics (Note 2)

$V_{IN}$=3.5V, $C_{IN}$=4.7μF (Ceramic), $C_{OUT}$=4.7μF (Ceramic), Typical $T_A$=25°C, **Bold** typeface applies over -40°C≤$T_J$≤85°C ranges, unless otherwise specified (Note 3).

| Parameter | Symbol | Test Conditions | | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|---|
| Output Voltage | $V_{OUT}$ | $V_{IN}$=3.5V, 1mA ≤ $I_{OUT}$ ≤ 30mA | | 98.5% ×$V_{OUT}$ | 2.5 | 101.5% ×$V_{OUT}$ | V |
| Maximum Output Current | $I_{OUT(MAX)}$ | $V_{IN}$=3.5V, $V_{OUT}$=2.463V to 2.537V | | 1 | | | A |
| Load Regulation | $\frac{\triangle V_{OUT}/V_{OUT}}{\triangle I_{OUT}}$ | $V_{OUT}$=2.5V, $V_{IN}$=$V_{OUT}$+1V<br>1mA ≤ $I_{OUT}$ ≤1A | | | 0.2 | 1 | %/A |
| Line Regulation | $\frac{\triangle V_{OUT}/V_{OUT}}{\triangle V_{IN}}$ | 3.5V≤$V_{IN}$≤6V, $I_{OUT}$=30mA | | -0.1 | 0.02 | 0.1 | %/V |
| Dropout Voltage | $V_{DROP}$ | $I_{OUT}$ =1A | | | 450 | 750 | mV |
| Quiescent Current | $I_Q$ | $V_{IN}$=3.5V, $I_{OUT}$=0mA | | | 60 | 80 | μA |
| Standby Current | $I_{STD}$ | $V_{IN}$=3.5V, $V_{EN}$ in OFF mode | | | 0.01 | 1.0 | μA |
| Power Supply Rejection Ratio | PSRR | Ripple 1Vp-p<br>$V_{IN}$=3.5V,<br>$I_{OUT}$=100mA | f=100Hz | | 65 | | dB |
| | | | f=1KHz | | 65 | | |
| Output Voltage Temperature Coefficient | $\frac{\triangle V_{OUT}/V_{OUT}}{\triangle T}$ | $I_{OUT}$=30mA | | | ±30 | | ppm/°C |
| Short Current Limit | $I_{SHORT}$ | $V_{OUT}$=0V | | | 50 | | mA |
| RMS Output Noise | $V_{NOISE}$ | 10Hz ≤ f ≤100kHz | | | 30 | | $\mu V_{RMS}$ |
| $V_{EN}$ High Voltage | $V_{IH}$ | Enable logic high, regulator on | | 1.5 | | | V |
| $V_{EN}$ Low Voltage | $V_{IL}$ | Enable logic low, regulator off | | | | 0.4 | |
| Start-up Time | $t_S$ | No Load | | | 20 | | μs |
| EN Pull Down Resistor | $R_{PD}$ | | | | 3.0 | | MΩ |
| $V_{OUT}$ Discharge Resistor | $R_{DCHG}$ | Set EN pin at Low | | | 60 | | Ω |
| Thermal Shutdown Temperature | $T_{OTSD}$ | | | | 160 | | °C |
| Thermal Shutdown Hysteresis | $T_{HYOTSD}$ | | | | 25 | | |
| Thermal Resistance | $\theta_{JC}$ | SOIC-8 | | | 74.6 | | °C/W |
| | | SOT-89-5 | | | 47 | | |

Note 2: To prevent the Short Circuit Current protection feature from being prematurely activated, the input voltage must be applied before a current source load is applied.
Note 3: Production testing at $T_A$=25°C. Over temperature specifications guaranteed by design only.

## Electrical Characteristics (Continued)

### AP2115-3.3 Electrical Characteristics (Note 2)

$V_{IN}$=4.3V, $C_{IN}$=4.7μF (Ceramic), $C_{OUT}$=4.7μF (Ceramic), Typical $T_A$=25°C, **Bold** typeface applies over -40°C≤$T_J$≤85°C ranges, unless otherwise specified (Note 3).

| Parameter | Symbol | Test Conditions | | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|---|
| Output Voltage | $V_{OUT}$ | $V_{IN}$=4.3V, 1mA ≤ $I_{OUT}$ ≤ 30mA | | 98.5% ×$V_{OUT}$ | 3.3 | 101.5% ×$V_{OUT}$ | V |
| Maximum Output Current | $I_{OUT(MAX)}$ | $V_{IN}$ =4.3V, $V_{OUT}$=3.25V to 3.35V | | 1 | | | A |
| Load Regulation | $\frac{\triangle V_{OUT}/V_{OUT}}{\triangle I_{OUT}}$ | $V_{IN}$=4.3V, 1mA ≤ $I_{OUT}$ ≤1A | | | 0.2 | 1 | %/A |
| Line Regulation | $\frac{\triangle V_{OUT}/V_{OUT}}{\triangle V_{IN}}$ | 4.3V≤$V_{IN}$≤6V, $I_{OUT}$=30mA | | -0.1 | 0.02 | 0.1 | %/V |
| Dropout Voltage | $V_{DROP}$ | $I_{OUT}$=1A | | | 450 | 750 | mV |
| Quiescent Current | $I_Q$ | $V_{IN}$=4.3V, $I_{OUT}$=0mA | | | 65 | 90 | μA |
| Power Supply Rejection Ratio | PSRR | Ripple 1Vp-p $V_{IN}$=4.3V, $I_{OUT}$=100mA | f=100Hz | | 65 | | dB |
| | | | f=1KHz | | 65 | | |
| Output Voltage Temperature Coefficient | $\frac{\triangle V_{OUT}/V_{OUT}}{\triangle T}$ | $I_{OUT}$=30mA | | | ±30 | | ppm/°C |
| Short Current Limit | $I_{SHORT}$ | $V_{OUT}$=0V | | | 50 | | mA |
| RMS Output Noise | $V_{NOISE}$ | 10Hz ≤ f ≤100kHz (No load) | | | 30 | | μ$V_{RMS}$ |
| $V_{EN}$ High Voltage | $V_{IH}$ | Enable logic high, regulator on | | 1.5 | | | V |
| $V_{EN}$ Low Voltage | $V_{IL}$ | Enable logic low, regulator off | | | | 0.4 | |
| Standby Current | $I_{STD}$ | $V_{IN}$=3.5V, $V_{EN}$ in OFF mode | | | 0.01 | 1.0 | μA |
| Start-up Time | $t_S$ | No Load | | | 20 | | μs |
| EN Pull Down Resistor | $R_{PD}$ | | | | 3.0 | | MΩ |
| $V_{OUT}$ Discharge Resistor | $R_{DCHG}$ | Set EN pin at Low | | | 60 | | Ω |
| Thermal Shutdown Temperature | $T_{OTSD}$ | | | | 160 | | °C |
| Thermal Shutdown Hysteresis | $T_{HYOTSD}$ | | | | 25 | | |
| Thermal Resistance | $\theta_{JC}$ | SOIC-8 | | | 74.6 | | °C/W |
| | | SOT-89-5 | | | 47 | | |

Note 2: To prevent the Short Circuit Current protection feature from being prematurely activated, the input voltage must be applied before a current source load is applied.
Note 3: Production testing at $T_A$=25°C. Over temperature specifications guaranteed by design only.

## Typical Performance Characteristics

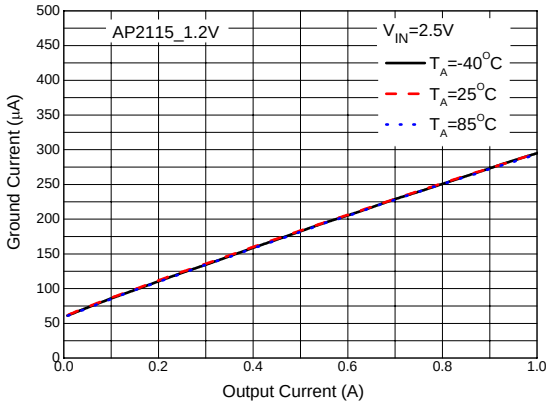



Figure 4. Ground Current vs. Output Current

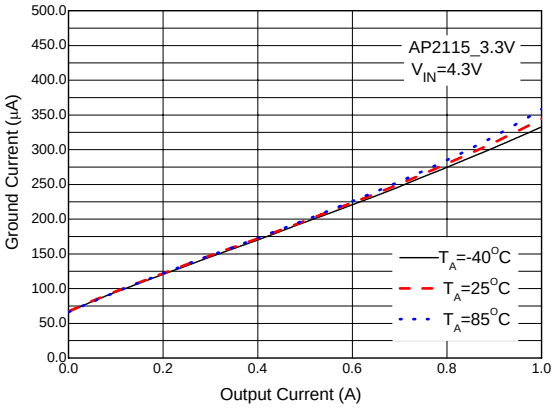



Figure 5. Ground Current vs. Output Current

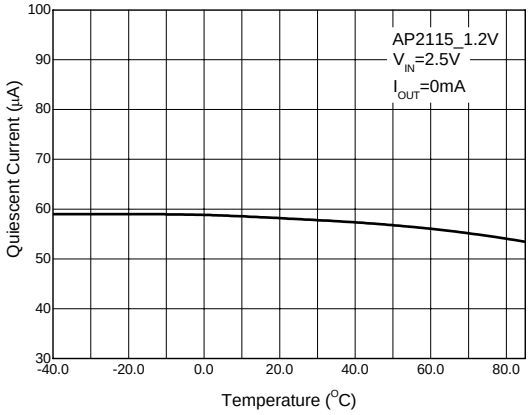



Figure 6. Quiescent Current vs. Temperature

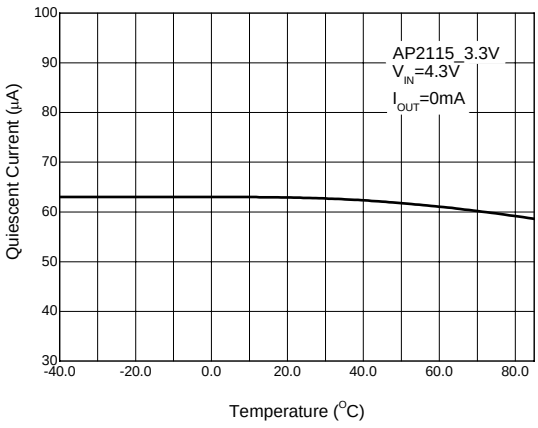



Figure 7. Quiescent Current vs. Temperature

## Typical Performance Characteristics (Continued)

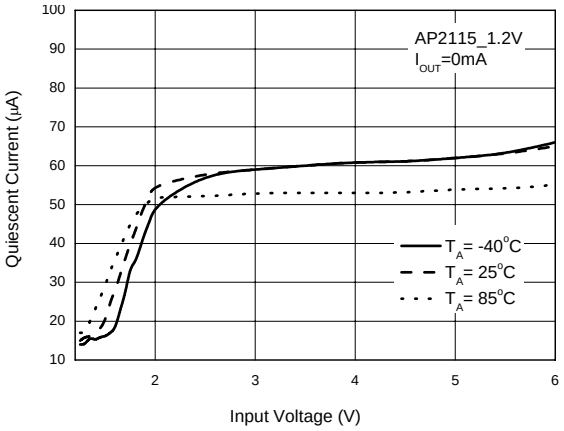



Figure 8. Quiescent Current vs. Input Voltage

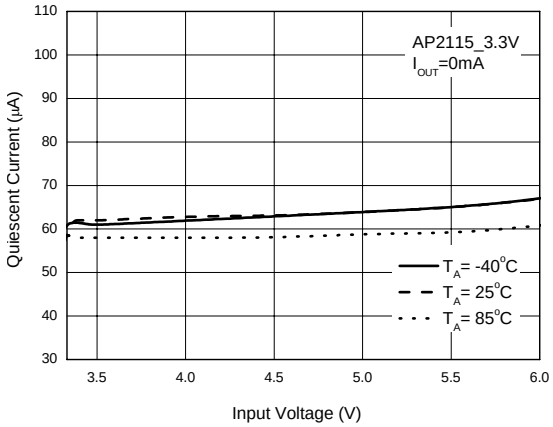



Figure 9. Quiescent Current vs. Input Voltage

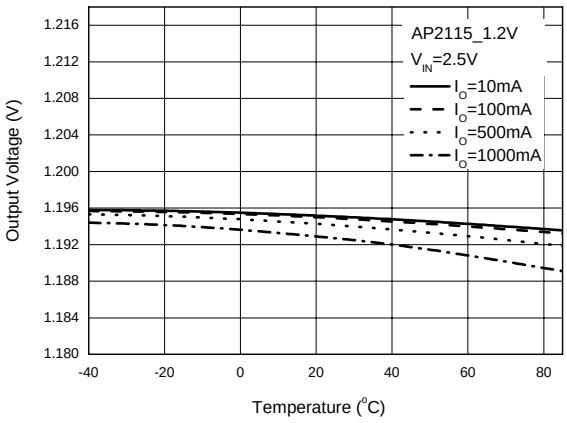



Figure 10. Output Voltage vs. Temperature

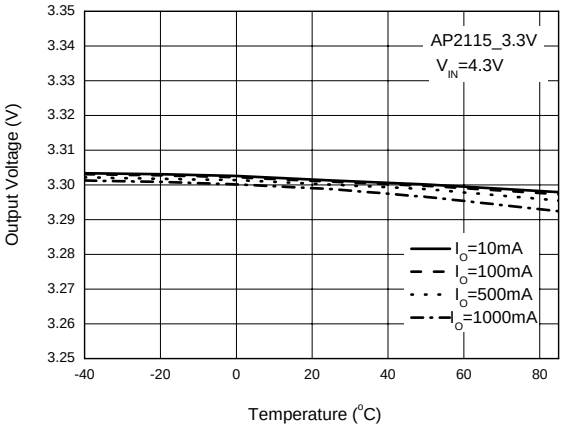



Figure 11. Output Voltage vs. Temperature

## Typical Performance Characteristics (Continued)

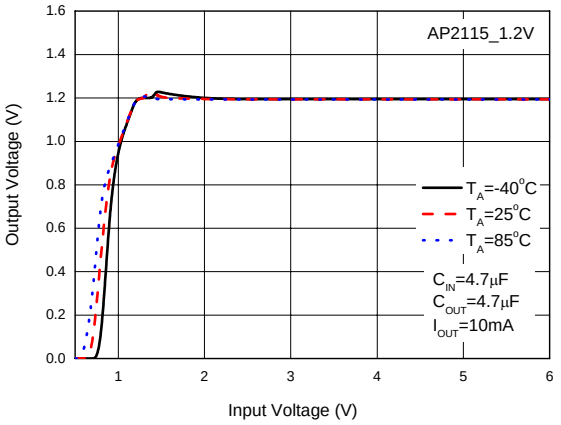



Figure 12. Output Voltage vs. Input Voltage

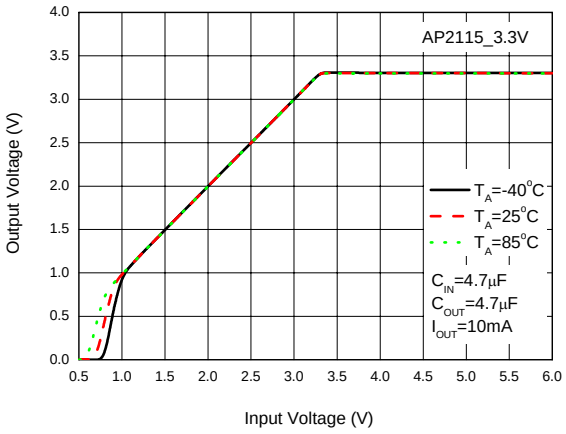



Figure 13. Output Voltage vs. Input Voltage

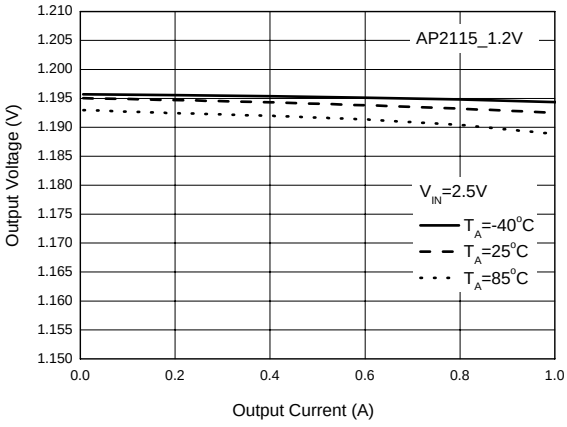



Figure 14. Output Voltage vs. Output Current

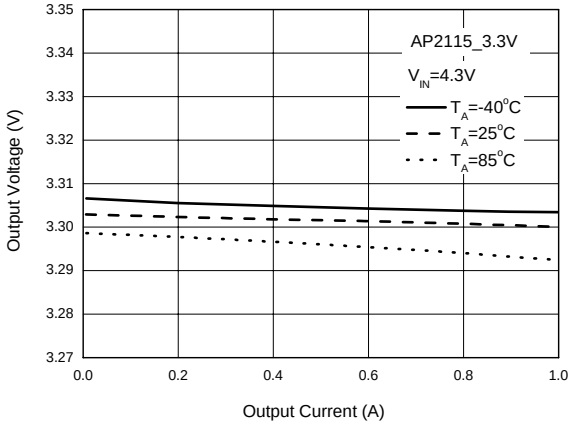



Figure 15. Output Voltage vs. Output Current

## Typical Performance Characteristics (Continued)

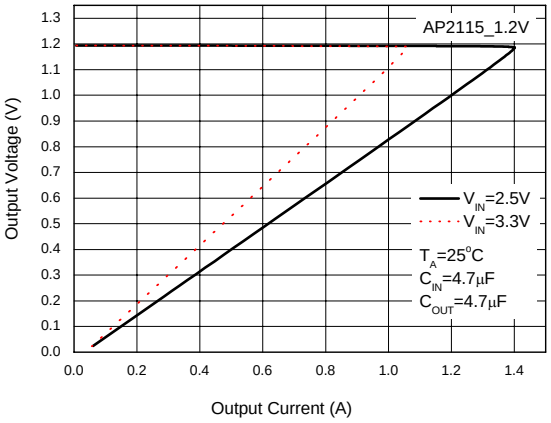



Figure 16. Output Voltage vs. Output Current

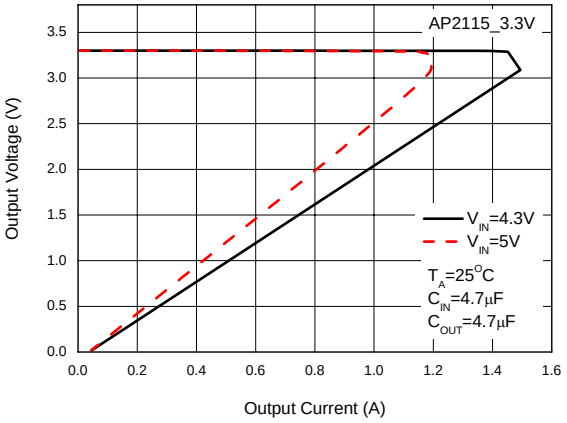



Figure 17. Output Voltage vs. Output Current

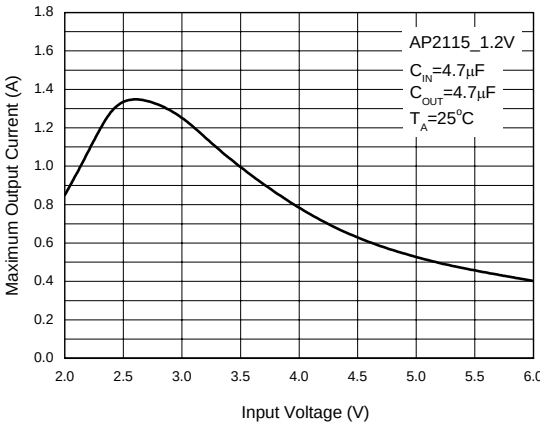



Figure 18. Maximum Output Current vs. Input Voltage

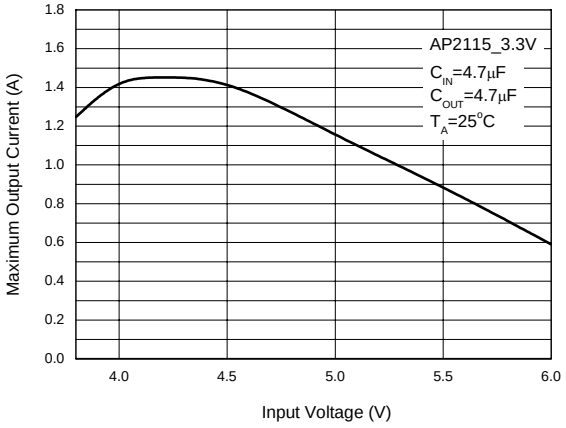



Figure 19. Maximum Output Current vs. Input Voltage

## Typical Performance Characteristics (Continued)

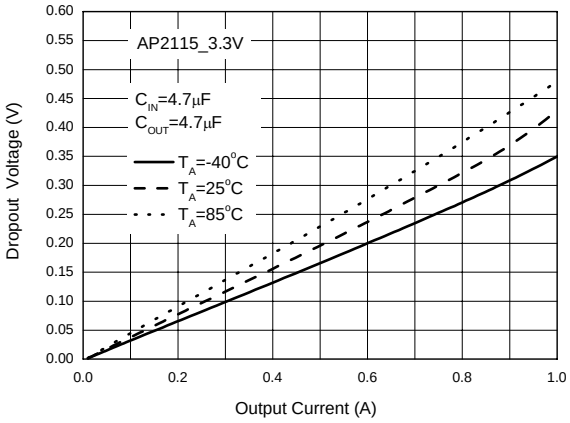



Figure 20. Dropout Voltage vs. Output Current

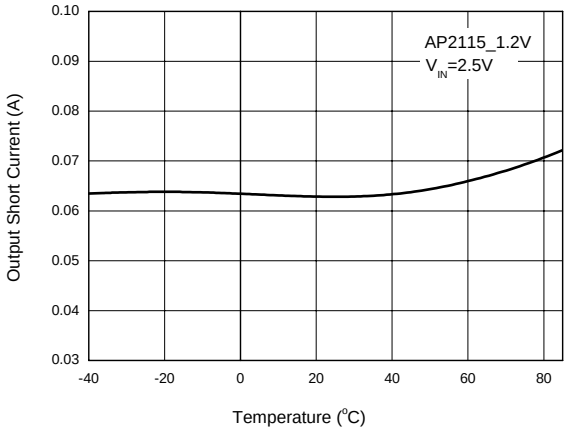



Figure 21. Output Short Current vs. Temperature

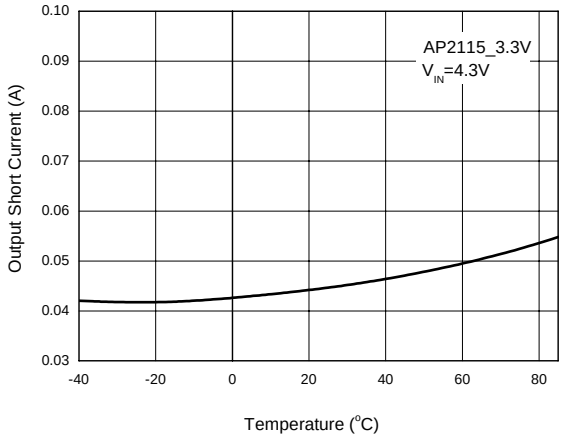



Figure 22. Output Short Current vs. Temperature

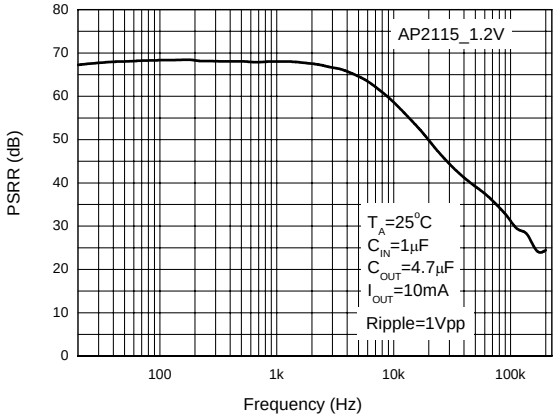



Figure 23. PSRR vs. Frequency

## Typical Performance Characteristics (Continued)

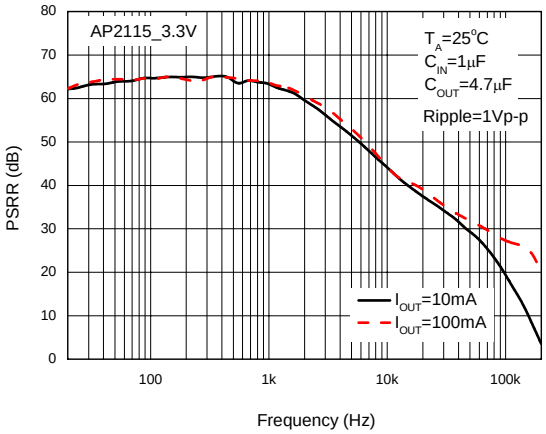



Figure 24. PSRR vs. Frequency

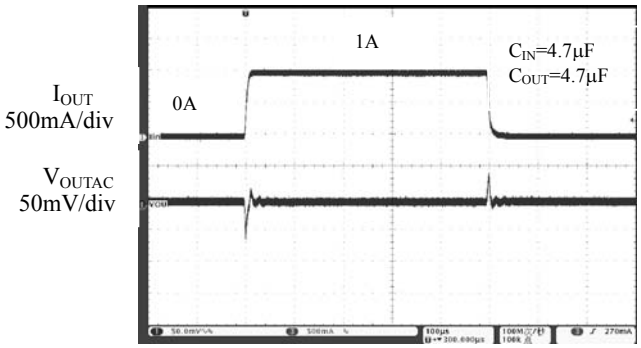



Figure 25. Load Transient

## Typical Application

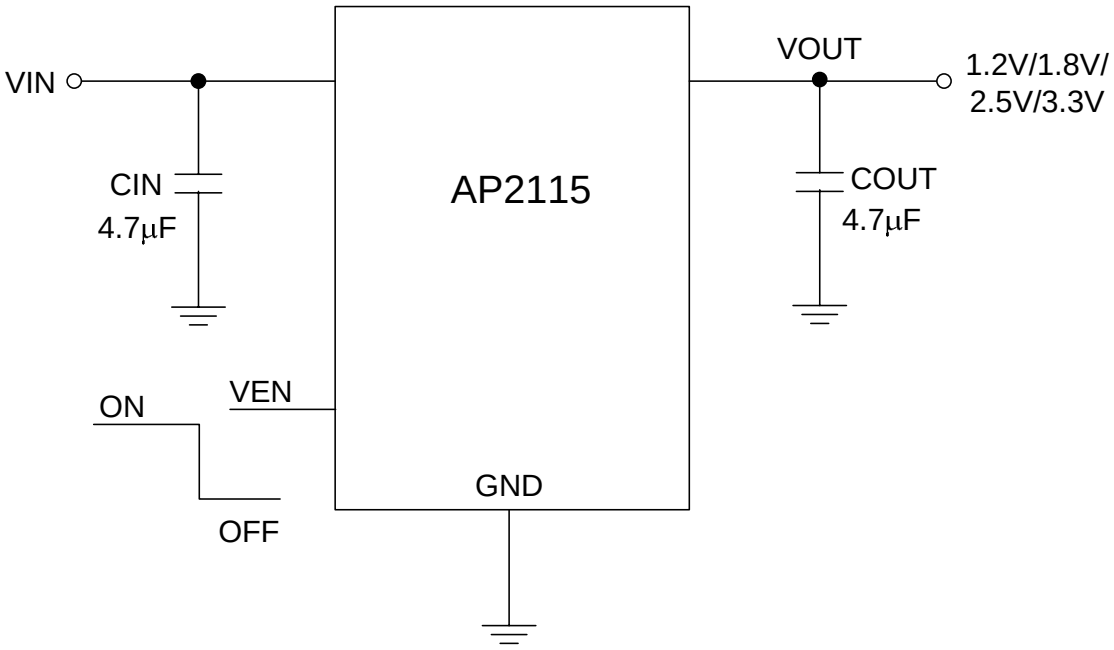
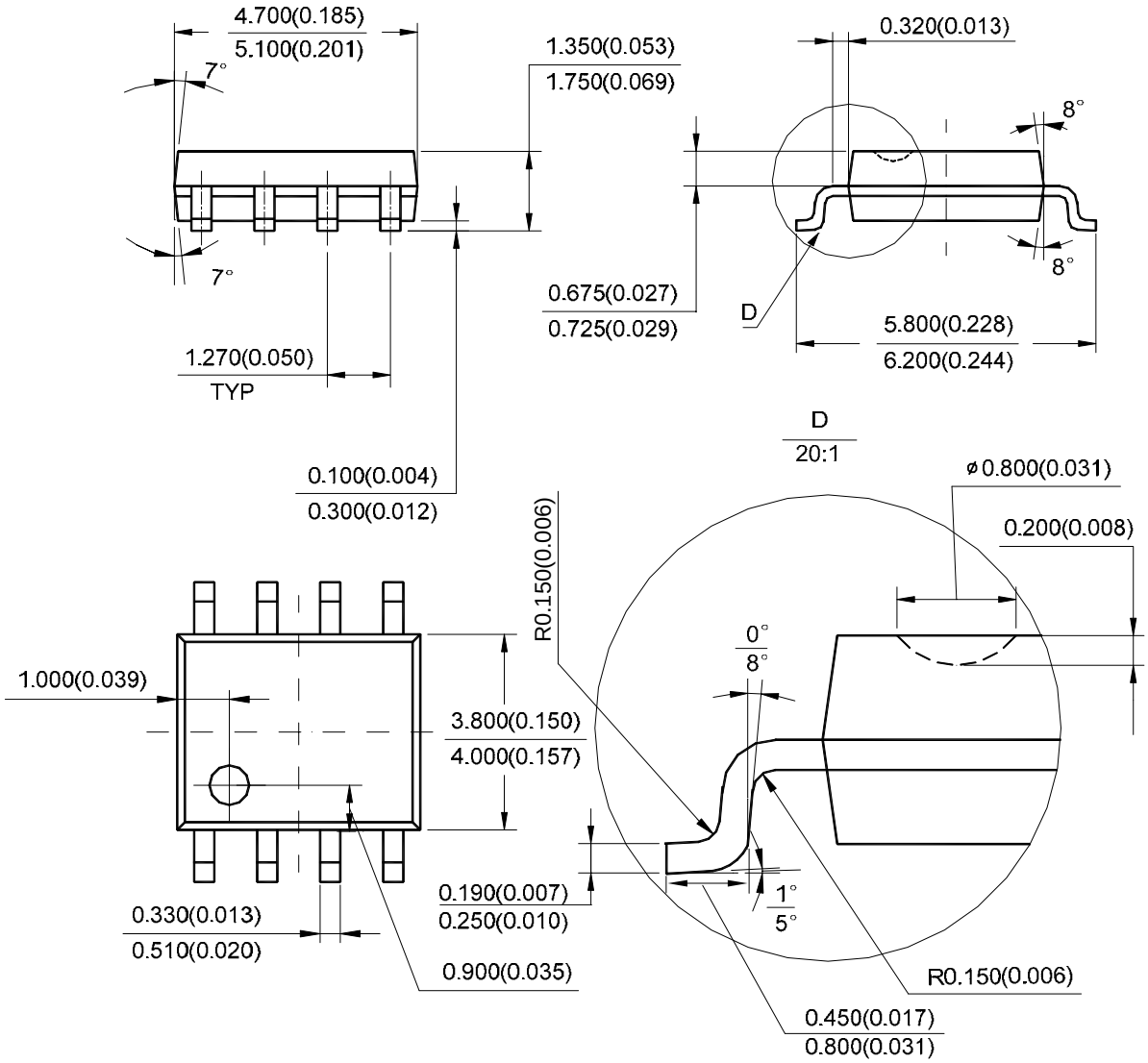



Figure 26. AP2115 Typical Application

## Mechanical Dimensions

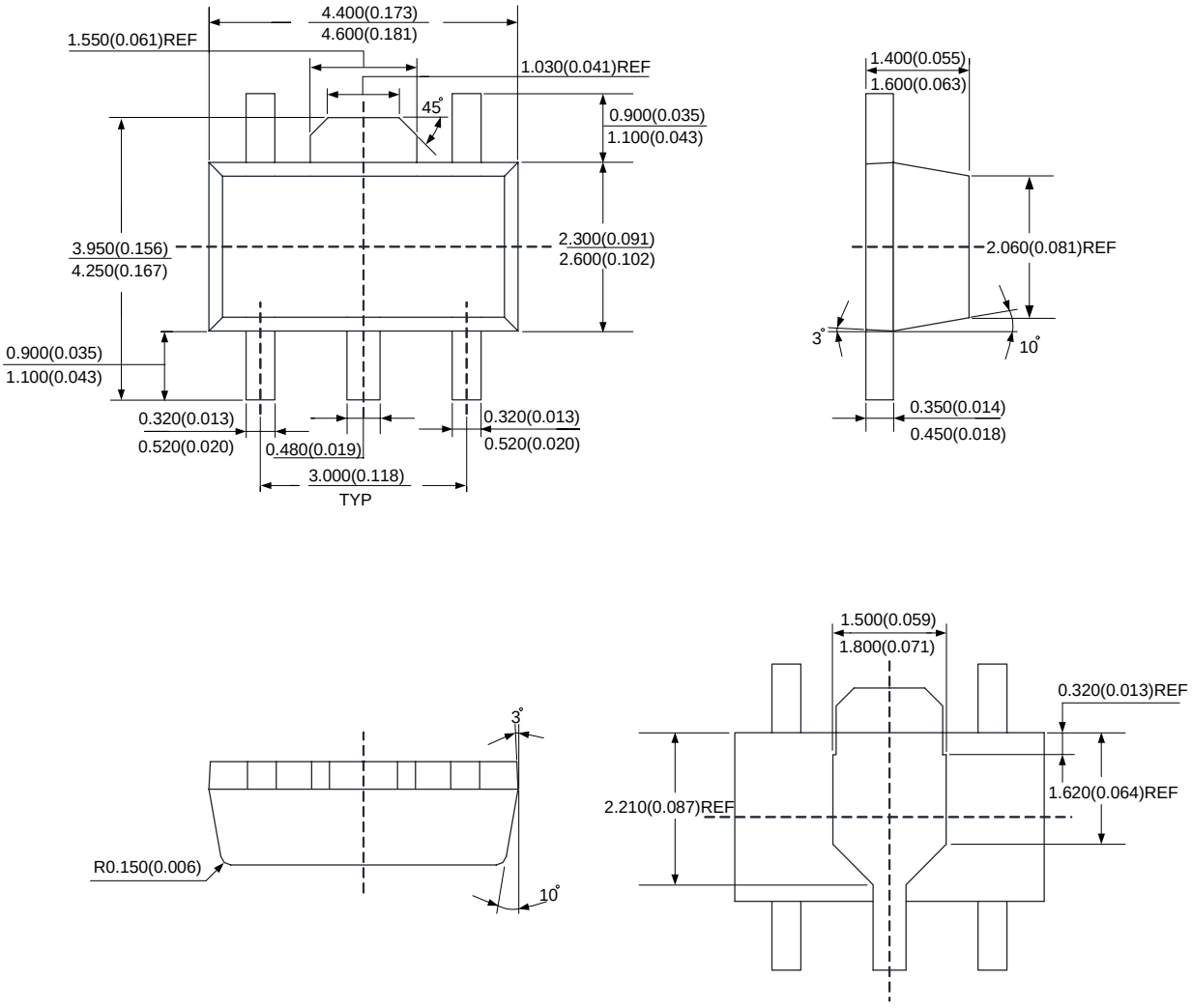
**SOIC-8** **Unit: mm(inch)**




Note: Eject hole, oriented hole and mold mark is optional.

## Mechanical Dimensions (Continued)

**SOT-89-5** **Unit: mm(inch)**





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