# MIC5295

## Low Quiescent Current, 150mA LDO Regulator

## General Description

The MIC5295 is a 150mA highly accurate, low dropout regulator with high input voltage and low ground current. This combination of high voltage and low ground current makes the MIC5295 ideal for USB and portable electronics applications, using 1-cell, 2-cell or 3-cell Li-Ion battery inputs.

A µCap LDO design, the MIC5295 is stable with either a ceramic or tantalum output capacitor. It only requires a 2.2µF capacitor for stability.

Features of the MIC5295 includes enable input, thermal shutdown, current limit, reverse battery protection, and reverse leakage protection.

Available in fixed and adjustable output voltage versions, the MIC5295 is offered in the TO-252-5 (D-Pak) package with a junction temperature range of –40°C to +125°C.

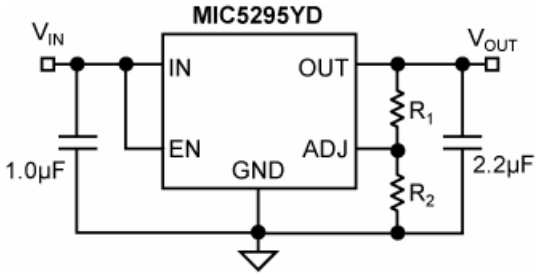
## Features

- Wide input voltage range: 2.3V to 24V
- Ultra low ground current: 18µA
- Low dropout voltage: 300mV at 150mA
- High initial output accuracy: ±1.0%
- Stable with ceramic or tantalum capacitors
- Excellent line and load regulation specifications
- Reverse battery protection
- Reverse leakage protection
- Thermal shutdown and current limit protection
- PowerTO-252-5 (D-Pak)package
- Adjustable output from 1.24V-20V

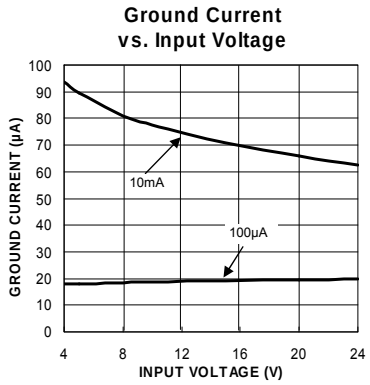
## Applications

- USB power supply
- Cellular phones
- Keep-alive supply in notebook and portable computers
- Logic supply for high-voltage batteries
- Automotive electronics
- Battery powered systems

## Typical Application




**Low Current Adjustable Regulator Application**




**Ground Current vs. Input Voltage**

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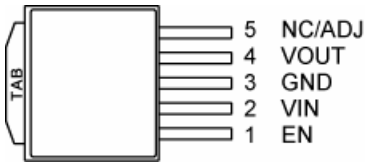
## Ordering Information

| Part Number | Marking Code | Voltage | Junction Temp. Range | Package |
|---|---|---|---|---|
| MIC5295-3.0YD | 5295-30Y | 3.0V | –40° to +125°C | 5-Pin TO-252 |
| MIC5295-3.3YD | 5295-33Y | 3.3V | –40° to +125°C | 5-Pin TO-252 |
| MIC5295-5.0YD | 5295-50Y | 5.0V | –40° to +125°C | 5-Pin TO-252 |
| MIC5295YD | 5295YD | Adj | –40° to +125°C | 5-Pin TO-252 |

## Pin Configuration




**5-Pin TO-252**

## Pin Description

| Pin Number | Pin Name | Pin Function |
|---|---|---|
| 1 | EN | Enable (Input): Logic low = shutdown; logic high = enable. Do not leave floating. |
| 2 | VIN | Supply Input. |
| 3 | GND | Ground. |
| 4 | VOUT | Regulator Output. |
| 5 | NC(fixed) | No Connect. |
| | ADJ(adj) | Adjust (Input): Feedback input. Connect to resistive Voltage-divider network. |

## Absolute Maximum Ratings[1]

Input Supply Voltage ..... –20V to 38V
Enable Input Voltage..... –0.3V to 38V
Power Dissipation ..... Internally Limited
Junction Temperature ..... –40°C to +125°C
Storage Temperature..... –65°C to +150°C
ESD Rating[3]..... ESD Sensitive

## Operating Ratings[2]

Input Supply Voltage ..... 2.3V to 24V
Enable Input Voltage..... 0V to 24V
Junction Thermal..... –40°C to +125°C
Package Thermal Resistance
TO-252-5 ($\theta_{JA}$) ..... 50°C/W

## Electrical Characteristics[4]

$V_{IN} = V_{OUT} + 1V$; $I_{OUT}$ = 100µA; $C_{IN}$ =1.0µF, $C_{OUT}$ = 2.2µA; $T_J$ = 25°C, **bold** values indicate –40°C<$T_J$<+125°C; unless otherwise specified.

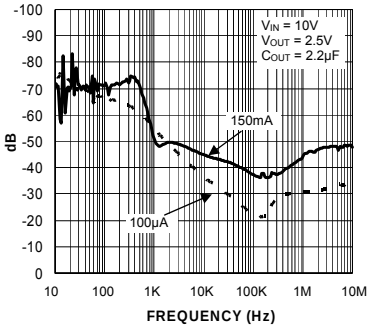
| Parameter | Condition | Min | Typ | Max | Units |
|---|---|---|---|---|---|
| Output Voltage Accuracy | Variation from nominal $V_{OUT}$ | –1.0<br>**–2.0** | | +1.0<br>**+2.0** | %<br>% |
| Line Regulation | $V_{IN} = V_{OUT}$ + 1V to 24V | | 0.04 | | % |
| Load Regulation | Load = 100µA to 150mA | | 0.25 | 1 | % |
| Dropout Voltage | $I_{OUT}$ = 100µA | | 45 | | mV |
| | $I_{OUT}$ = 50mA | | 220 | **400** | mV |
| | $I_{OUT}$ = 100mA | | 260 | **450** | mV |
| | $I_{OUT}$ = 150mA | | 300 | **500** | mV |
| Reference Voltage | | | 1.24 | | V |
| | | -1.0 | | +1.0 | % |
| Ground Current | $I_{OUT}$ = 100µA | | 18 | 30<br>**35** | µA<br>µA |
| | $I_{OUT}$ = 50mA | | 0.35 | 0.7 | mA |
| | $I_{OUT}$ = 100mA | | 1 | 2 | mA |
| | $I_{OUT}$ = 150mA | | 2 | 4 | mA |
| Ground Current in Shutdown | $V_{EN}$ = 0V; $V_{IN}$ = 24V | | 0.1 | 1 | µA |
| Current Limit | $V_{OUT}$ = 0V | | 350 | 500 | mA |
| Ripple Rejection | f =1kHz | | 50 | | dB |
| Output Voltage Noise | 10Hz to 100kHz | | 47 | | $\mu V_{RMS}$ |
| Output Leakage, Reverse Polarity Input | Load = 500Ω; $V_{IN}$ = –15V; $V_{EN}$ =0.4V | | –0.1 | | µA |
| **Enable Input** | | | | | |
| Enable turn on time | | | 1.2 | 10 | ms |
| Input Low Voltage | Regulator OFF | | | **0.4** | V |
| Input High Voltage | Regulator ON | **2.0** | | | V |
| Enable Input Current | $V_{EN}$ = 0.6V; Regulator OFF<br>$V_{EN}$ = 2.0V; Regulator ON<br>$V_{EN}$ = 24V; Regulator ON | –1.0 | 0.01<br>0.1<br>0.5 | 1.0<br>1.0<br>2.5 | µA<br>µA<br>µA |

**Notes:**

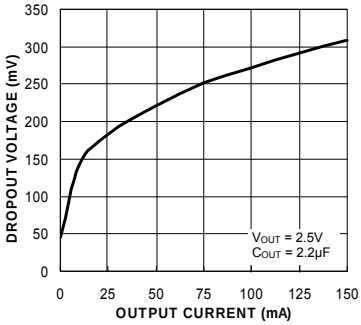
1. Exceeding the absolute maximum rating may damage the device.
2. The device is not guaranteed to function outside its operating rating.
3. Devices are ESD sensitive. Handling precautions recommended. Human body model, 1.5kΩ in series with 100pF.
4. Specification for packaged product only.

## Typical Characteristics

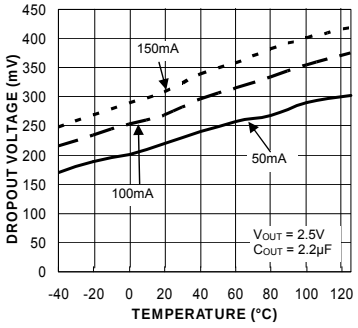
**PSRR**



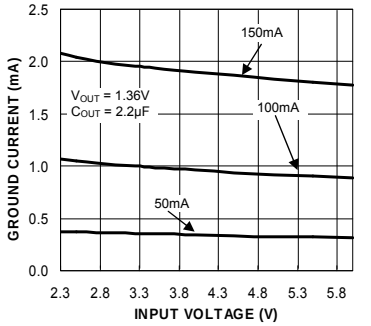

**Dropout Voltage vs. Output Current**



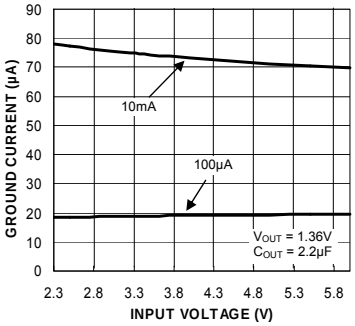

**Dropout Voltage vs. Temperature**



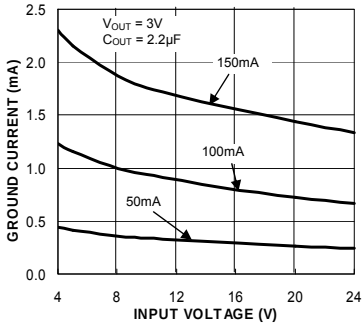

**Ground Current vs. Input Voltage**



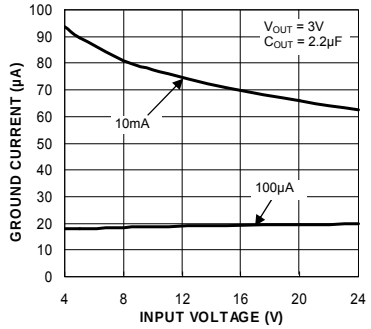

**Ground Current vs. Input Voltage**



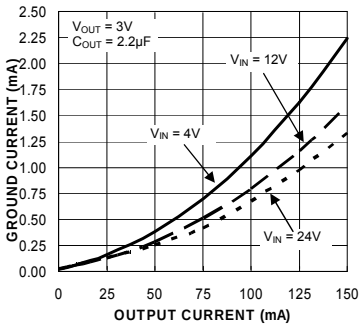

**Ground Current vs. Input Voltage**



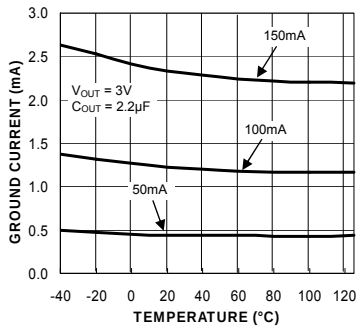

**Ground Current vs. Input Voltage**



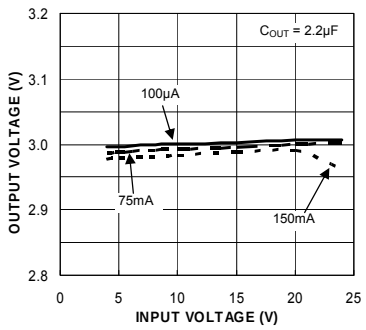

**Ground Current vs. Output Current**



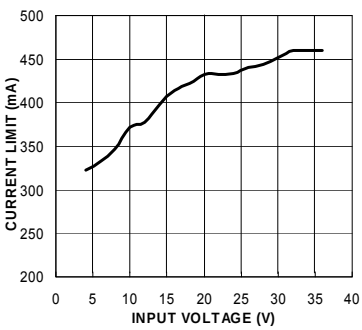

**Ground Current vs. Temperature**



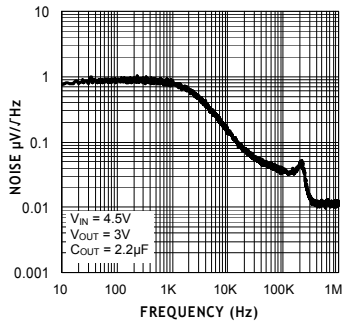

**Output Voltage vs. Input Voltage**




**Current limit vs. Input Voltage**

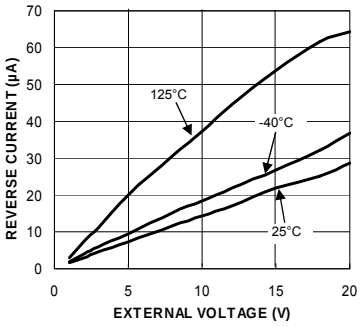



**MIC5295 - Output Noise Spectral Density**

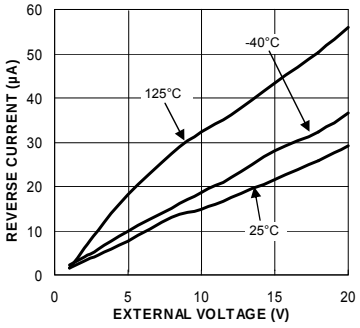


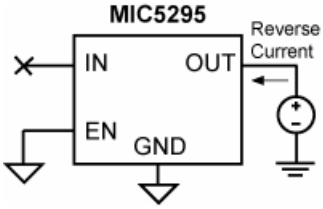
## Typical Characteristics (continued)

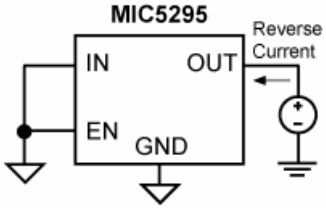
**Reverse Current (Open Input)**




**Reverse Current (VIN Grounded)**

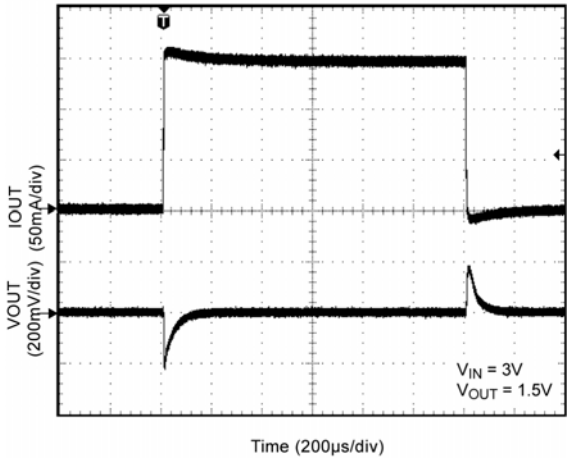


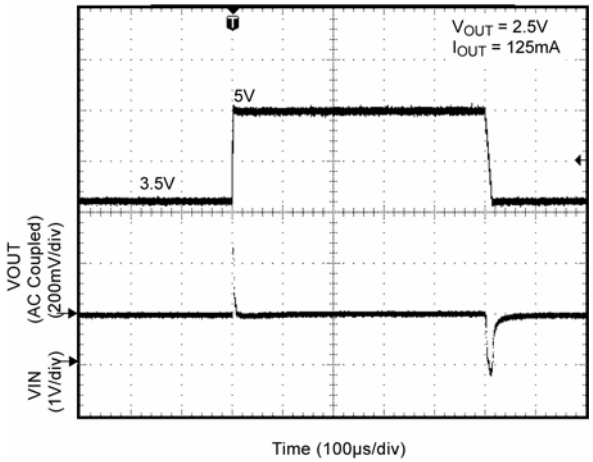



## Functional Characteristics

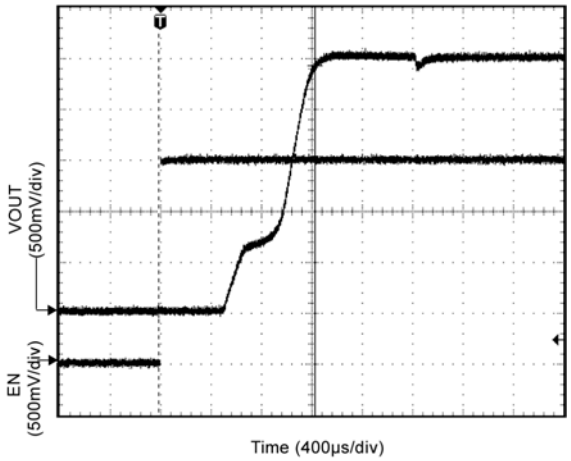
**Load Transient**



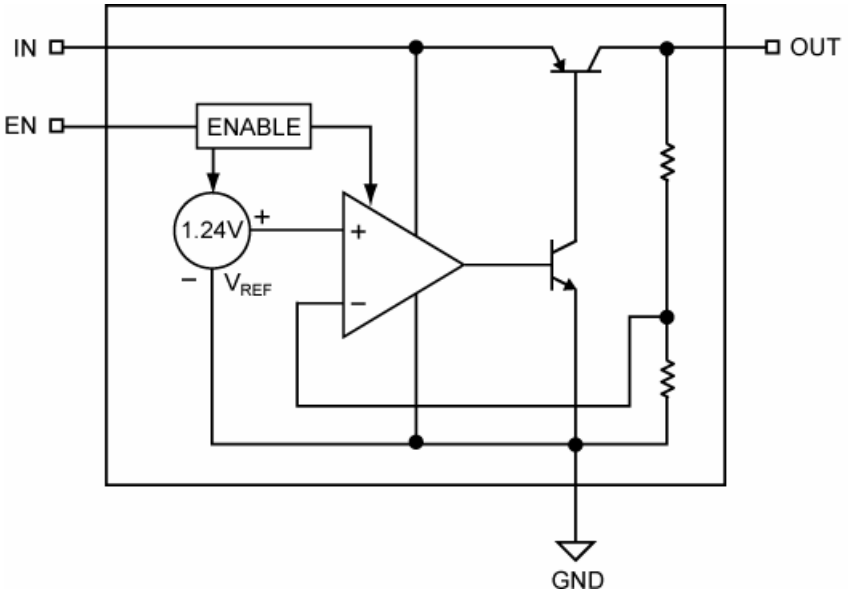

**Line Transient**



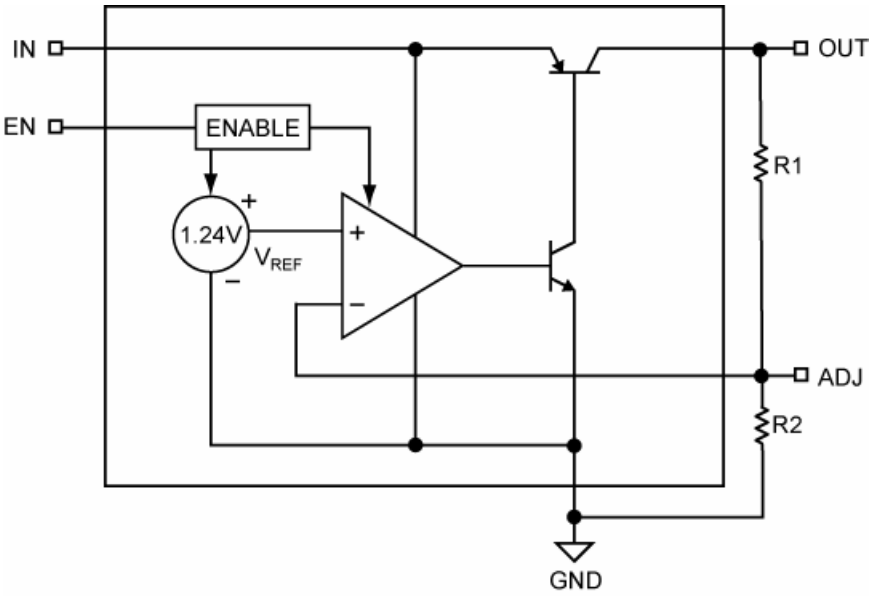

**Turn-On Time**



## Functional Diagram




**Block Diagram – Fixed Output Voltage**




**Block Diagram – Adjustable Output Voltage**

## Application Information

### Enable/Shutdown

The MIC5295 comes with an active-high enable pin that allows the regulator to be disabled. Forcing the enable pin low disables the regulator and sends it into a "zero" off-mode-current state. In this state, current consumed by the regulator goes nearly to zero. Forcing the enable pin high enables the output voltage. Do not leave this pin floating as the output will be in indeterminate state.

### Input Capacitor

The MIC5295 has high input voltage capability up to 24V. The input capacitor must be rated to sustain voltages that may be used on the input. An input capacitor may be required when the device is not near the source power supply or when supplied by a battery. Small, surface mount, ceramic capacitors can be used for bypassing. Larger values may be required if the source supply has high ripple.

### Output Capacitor

The MIC5295 requires an output capacitor for stability. The design requires 2.2µF or greater on the output to maintain stability. The design is optimized for use with low-ESR ceramic chip capacitors. High ESR capacitors may cause high frequency oscillation. The maximum recommended ESR is 3Ω. The output capacitor can be increased without limit. Larger valued capacitors help to improve transient response.

X7R/X5R dielectric-type ceramic capacitors are recommended because of their temperature performance. X7R-type capacitors change capacitance by 15% over their operating temperature range and are the most stable type of ceramic capacitors. Z5U and Y5V dielectric capacitors change value by as much as 50% and 60% respectively over their operating temperature ranges. To use a ceramic chip capacitor with Y5V dielectric, the value must be much higher than a X7R ceramic capacitor to ensure the same minimum capacitance over the equivalent operating temperature range.

### No-Load Stability

The MIC5295 will remain stable with no load unlike many other voltage regulators. This is especially important in CMOS RAM keep-alive applications.

### Thermal Considerations

The MIC5295 is designed to provide 150mA of continuous current in a small package. Maximum ambient operating temperature can be calculated based on the output current and the voltage drop across the part. For example, given that the input voltage of 3.3V the output voltage is 2.3V and the output current = 150mA. The actual power dissipation of the regulator circuit can be determined using the equation:

$$P_D = (V_{IN} – V_{OUT})I_{OUT} + V_{IN} \times I_{GND}$$

Due to the potential for input voltages up to 24V, ground current must be taken into consideration.

$$P_{D(MAX)} = (3.3 – 2.3V)150mA + 3.3x\ 1.2mA$$

$$P_{D(MAX)} = 0.154W$$

The junction-to-ambient thermal resistance for the MIC5295, D-Pak is 50°C/W.To determine the maximum ambient operating temperature of the package, use the junction-to-ambient thermal resistance of the device and the following basic equation:

$$P_{D(MAX)} = \left( \frac{T_{J(MAX)} - T_A}{\theta_{JA}} \right)$$

$T_{J(MAX)}$ is the maximum junction temperature of the die, 125°C, the maximum ambient temperature can be calculated to be 117.3°C as shown below:

$$0.154W = \left( \frac{125°C - T_A}{50°C/W} \right)$$

$$T_A = 117.3°C$$

### Adjustable Regulator Application

The MIC5295YD can be adjusted from 1.24V to 20V by using two external resistors (Figure 1). The resistors set the output voltage based on the following equation:

$$V_{OUT} = V_{REF}\left(1 + \left(\frac{R_1}{R_2}\right)\right)$$

Where $V_{REF}$ = 1.24V.

Feedback resistor R2 should be no larger than 300kΩ.

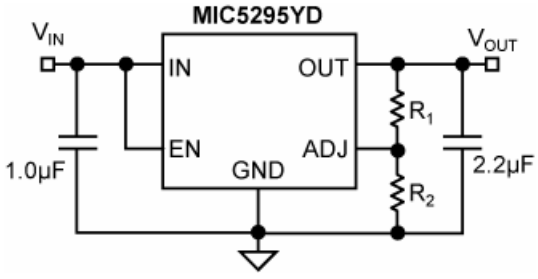
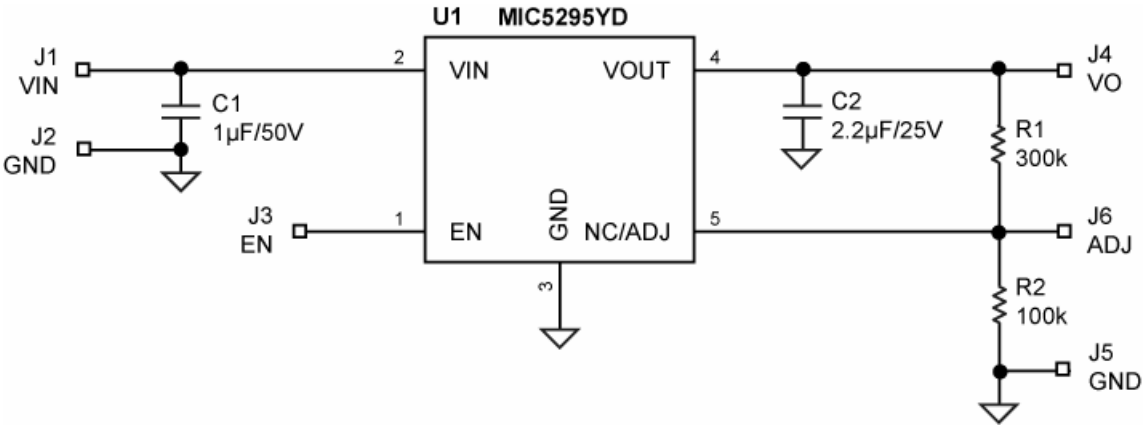



**Figure 1. Adjustable Voltage Application**

## Evaluation Board Schematic



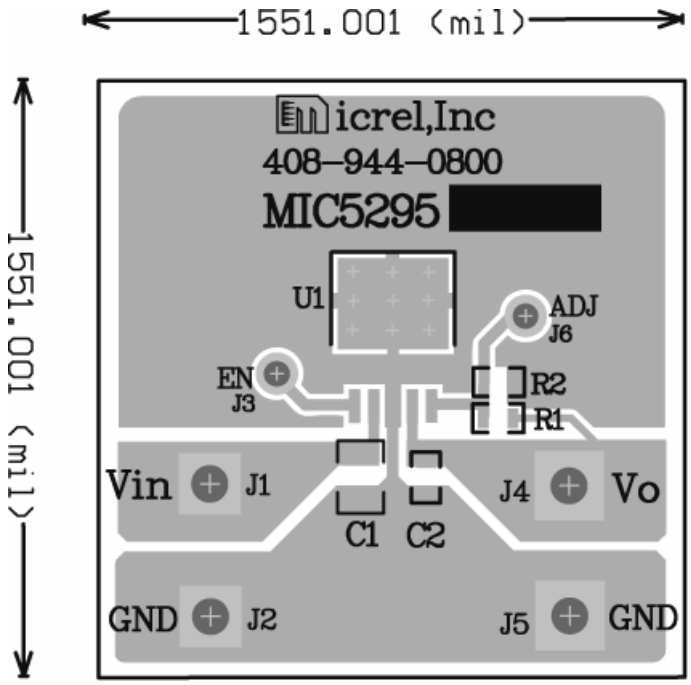

## Bill of Materials

| Item | Part Number | Manufacturer | Description | Qty. |
|---|---|---|---|---|
| C1 | UMK325BJ105KM-T | Taiyo Yuden[1] | Capacitor, 1µF, 50V, X5R, Size 1210 | 1 |
| C2 | TMK212BJ225KG-T | Taiyo Yuden | Capacitor, 2.2µF, 25V, X5R, Size 0805 | 1 |
| R1 | CRCW06033003FKEYE3 | Vishay Dale[2] | Resistor, 300k, 1%. 1/16W, Size 0603 | 1 |
| R2 | CRCW06031003FKEYE2 | Vishay Dale | Resistor, 100k, 1%. 1/16W, Size 0603 | 1 |
| **U1** | **MIC5295YD** | **Micrel, Inc.[3]** | **Low Quiescent Current, 150mA LDO Regulator** | **1** |

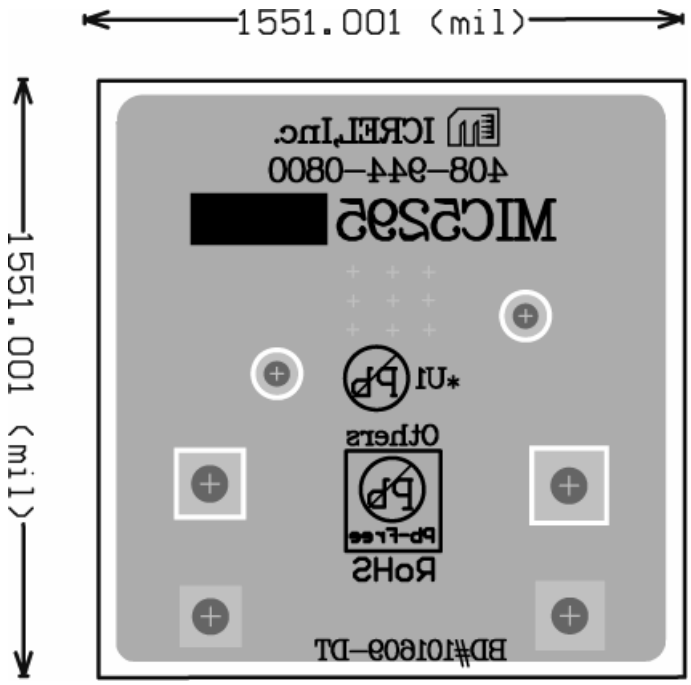
**Notes:**

1. Murata: www.t-yuden.com
2. Vishay: www.vishay.com.
3. **Micrel, Inc.: www.micrel.com.**

## PCB Layout Recommendations

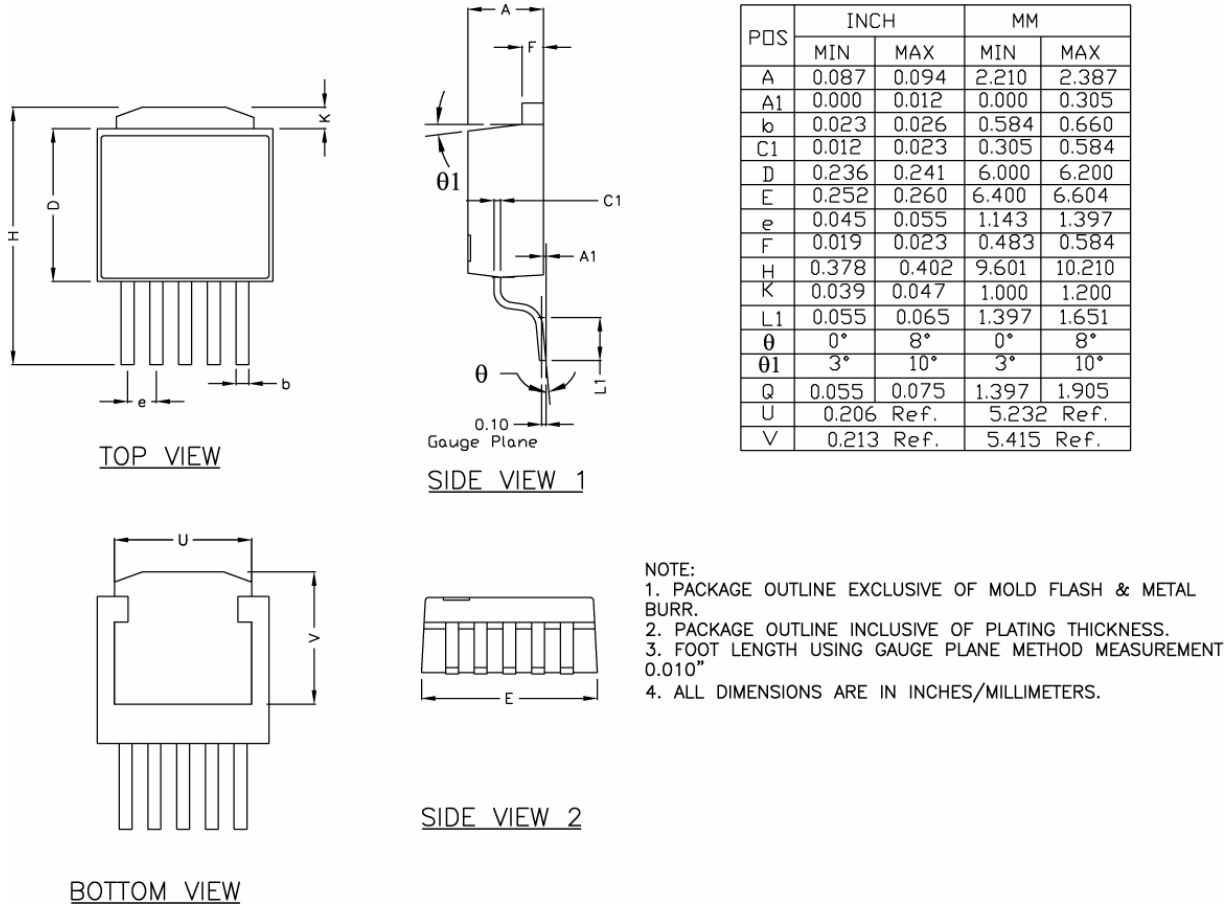



**Top Layer**




**Bottom Layer**

## Package Information




| POS | INCH | | MM | |
|---|---|---|---|---|
| | MIN | MAX | MIN | MAX |
| A | 0.087 | 0.094 | 2.210 | 2.387 |
| A1 | 0.000 | 0.012 | 0.000 | 0.305 |
| b | 0.023 | 0.026 | 0.584 | 0.660 |
| C1 | 0.012 | 0.023 | 0.305 | 0.584 |
| D | 0.236 | 0.241 | 6.000 | 6.200 |
| E | 0.252 | 0.260 | 6.400 | 6.604 |
| e | 0.045 | 0.055 | 1.143 | 1.397 |
| F | 0.019 | 0.023 | 0.483 | 0.584 |
| H | 0.378 | 0.402 | 9.601 | 10.210 |
| K | 0.039 | 0.047 | 1.000 | 1.200 |
| L1 | 0.055 | 0.065 | 1.397 | 1.651 |
| θ | 0° | 8° | 0° | 8° |
| θ1 | 3° | 10° | 3° | 10° |
| Q | 0.055 | 0.075 | 1.397 | 1.905 |
| U | 0.206 Ref. | | 5.232 Ref. | |
| V | 0.213 Ref. | | 5.415 Ref. | |

NOTE:
1. PACKAGE OUTLINE EXCLUSIVE OF MOLD FLASH & METAL BURR.
2. PACKAGE OUTLINE INCLUSIVE OF PLATING THICKNESS.
3. FOOT LENGTH USING GAUGE PLANE METHOD MEASUREMENT 0.010"
4. ALL DIMENSIONS ARE IN INCHES/MILLIMETERS.

**5-Pin TO-252**

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# Elektronik komponent tedarikinde Entegreci

Entegreci, Eskişehir merkezli, Türkiye geneline satış yapan bir elektronik komponent mağazasıdır. Entegreler (IC), mikrodenetleyiciler, transistörler, diyotlar, pasif elemanlar, konnektörler, modüller ve geliştirme kartları tek adetten seri üretim adetlerine kadar satılır. Ürün sayfalarında güncel stok durumunu, fiyatı ve datasheet bağlantısını bulabilirsiniz.

### Parça koduyla arama

Üretici parça numarasını yazın; stok ve fiyatı hemen görün.

**www.entegreci.com**

### Ürün kategorileri

Entegreden kapasitöre tüm elektronik komponent kategorileri.

**Kategorilere göz atın**

### Üreticiler

Aradığınız üreticinin ürünlerini tek sayfada inceleyin.

**Üreticileri görün**

### Toplu alım ve teklif

Listede olmayan ya da yüksek adetli parçalar için teklif isteyin.

**Teklif isteyin**

**www.entegreci.com** | **destek@entegreci.com** | **0850 305 90 34**

Entegreci is an online electronic components store based in Türkiye. Search by manufacturer part number to see stock, prices and datasheets for integrated circuits, microcontrollers, transistors, passive components and connectors, or request a quote for parts that are not listed.

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