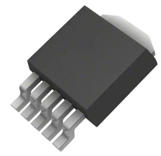
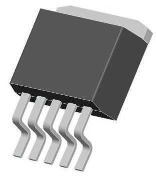
D29152

1.5A Low-Dropout Adjustable Regulator



TO252-5



TO263-5

TO220-5

General Description

The D29152 is high current, high accuracy, low dropout voltage regulators. This regulators feature 350mV to 425mV (full load) typical dropout voltages and very low ground current. Designed for high current loads, these devices also find applications in lower current, extremely low dropout-critical systems,where their tiny dropout voltage and ground current values are important attributes.

The D29152 is fully protected against over current faults, reversed input polarity,reversed lead insertion, over temperature operation, and positive and negative transient voltage spikes.

On the D29152, the ENABLE pin may be tied to VIN if it is not required for ON/OFF control.

The D29152 is available in TO263-5 ,TO252-5 and TO220-5 packages.

Features

- High Current Capability of 1.5A
- Low Dropout Voltage
- Low Ground Current
- Accurate 1% Guaranteed Tolerance
- Extremely Fast Transient Response
- Reverse-Battery and “Load Dump” Protection
- Zero-Current Shutdown Mode
- Also Characterized for Smaller Loads with Industry-Leading Performance Specifications
- Adjustable Versions

Package Information

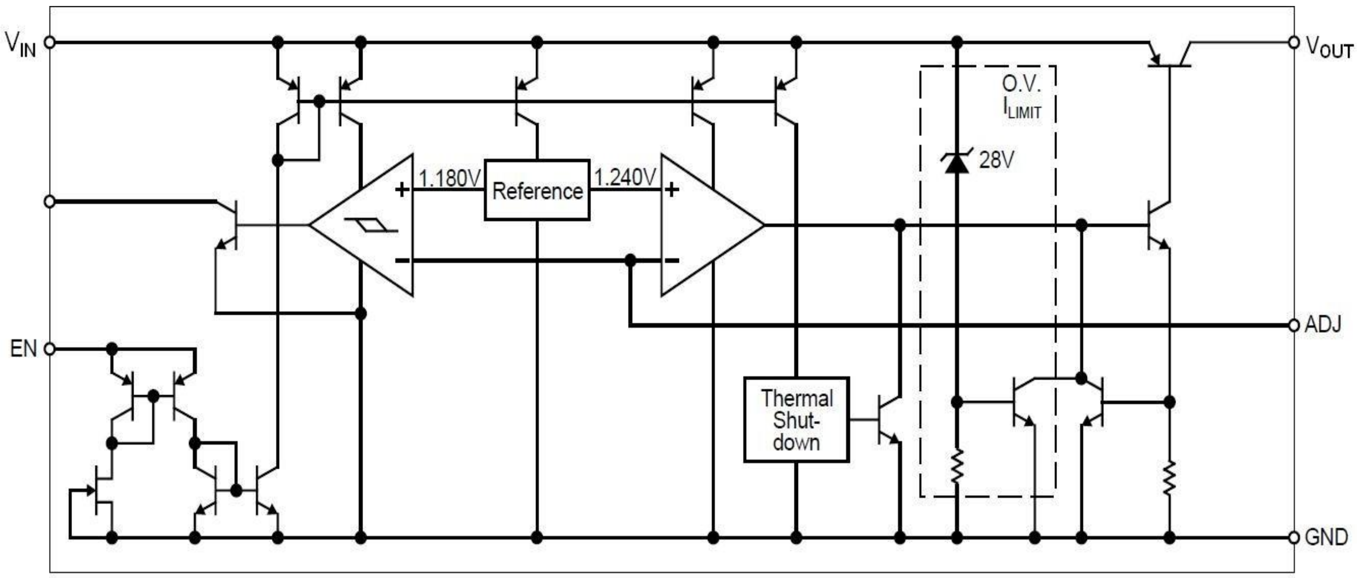
Part NO.	Package Description	Package Marking	Package Option
D29152(D)	TO252-5	CHMC D29152 SXXXX	70/Tube 2500/Reel
D29152(S)	TO263-5	CHMC D29152 SXXXX	50/Tube 800/Reel
D29152(T)	TO220-5	CHMC D29152 SXXXX	50/Tube

CHMC:Trademark D29152:Part NO. SXXXX:Lot NO.

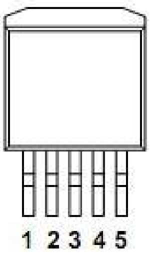
Applications

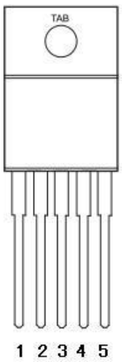
- Battery-Powered Equipment
- High-Efficiency Green Computer Systems
- Automotive Electronics
- High-Efficiency Linear Power Supplies
- High-Efficiency Post-Regulator for Switching Supply

Functional Diagram



Pin Configuration





D29152(TO252-5/TO263-5) D29152(TO220-5)

Pin Description

Pin Number	Pin Name	Function Description
1	EN	Enable pin.CMOS compatible control input. Logic-high =enable, logic-low = shutdown.
2	V_{IN}	Input Power Supply.
3	GND	Ground. TAB is also connected internally to the IC's ground.
4	V_{OUT}	Output
5	ADJ	Adjustable pin.Adjustable regulator feedback input that connects to the resistor voltage divider that is placed from V_{OUT} to GND in order to set the output voltage.

Absolute Maximum Ratings

Parameter Name	Symbol	Value	Unit
Power Dissipation	P_D	Internally Limited	
Input Supply Voltage （*1）	V_{IN}	-20～+50	V
Enable Input Voltage	V_{EN}	–0.3V ~V $_{IN}$	V
Lead Temperature (soldering, 5 seconds)	T_{LEAD}	260	℃
Operating Junction Temperature	T_{OPR}	-40～+125	℃
Storage Temperature Range	T_{STG}	-65～+150	℃
Thermal Resistance(JC)	θ_{JC}	2	℃/W
Thermal Resistance(JA)	θ_{JA}	28	℃/W

Note 1: The maximum allowable power dissipation is a function of ambient temperature, the maximum allowable junction temperature and the thermal resistance from junction to air (i.e., T_A, T_J, θ_{JA}). Exceeding the maximum allowable power dissipation will cause the device operating junction temperature to exceed the maximum +125°C rating. Sustained junction temperatures above +125°C can impact the device reliability.

Recommended Operating Conditions

Parameter Name	Symbol	Value	Unit
Maximum Operating Input Voltage	V_{IN}	26	V

Notice: Stresses above those listed under "Absolute Maximum Ratings" may cause permanent damage to the device.This is a stress rating only and functional operation of the device at those or any other conditions above those indicated in the operational sections of this specification is not intended. Exposure to maximum rating conditions for extended periods may affect device reliability.

Notice: The device is not guaranteed to function outside its operating ratings.

Note 1: Maximum positive supply voltage of 60V must be of limited duration (<100 ms) and duty cycle (≤1%). The maximum continuous supply voltage is 26V. Exceeding the absolute maximum rating may damage the device.

2: Devices are ESD sensitive. Handling precautions recommended.

Electrical Characteristics (Note 1, Note 2)

$V_{IN} = V_{OUT} + 1V$; $I_{OUT} = 10mA$; $T_J = +25°C$. Bold values indicate $-40°C \le T_J \le +125°C$, unless noted.

Parameter	Symbol	Min.	Typ.	Max.	Units	Conditions
Output Voltage	V_{OUT}	–1	—	+1	%	$I_{OUT} = 10mA$
		–2	—	+2		$10mA \le I_{OUT} \le I_{FL}$, $(V_{OUT} + 1V) \le V_{IN} \le 26V$ (Note 3)
Line Regulation	LNR	—	0.06	0.5	%	$I_{OUT} = 10mA$, $(V_{OUT} + 1V) \le V_{IN} \le 26V$
Load Regulation	LDR	—	0.2	1	%	$V_{IN} = V_{OUT} + 1V$, $10mA \le I_{OUT} \le 1.5A$(Note 3, Note 4)
$\Delta V_{OUT} / \Delta T$		—	**20**	**100**	ppm/°C	Output Voltage (Note 4) Temperature Coefficient
Dropout Voltage $\Delta V_{OUT} = -1\%$ (Note 5)	V_{DROP}	—	80	**200**	mV	$I_{OUT} = 100mA$
		—	250	—		$I_{OUT} = 750mA$
		—	370	**600**		$I_{OUT} = 1.5A$
Ground Current (Note 6)	I_{GND}	—	8	**20**	mA	$I_{OUT} = 750mA$, $V_{IN} = V_{OUT} + 1V$
		—	22	—		$I_{OUT} = 1.5A$
Ground Pin Current at Dropout	I_{GRNDDO}	—	0.9	—	mA	V_{IN} = 0.5V less than specified $V_{OUT} \times I_{OUT} = 10mA$
Current Limit	I_{LIM}	—	2.1	**3.5**	A	$V_{OUT} = 0V$, (Note 7)
Output Noise Voltage (10Hz to 100kHz) I_L=100mA	V_{NO}	—	400	—	μV_{RMS}	$C_L = 10\ \mu F$
		—	260	—		$C_L = 33\ \mu F$
Reference						
Reference Voltage	V_{REF}	1.228	1.240	1.252	V	
		1.215	—	**1.265**	V_{MAX}	
Reference Voltage		**1.203**	—	**1.277**	V	Note 8
Adjust Pin Bias Current	I_{ADJ}	—	40	80	nA	
		—	—	**120**		
Reference Voltage Temperature Coefficient		—	20	—	ppm/°C	Note 9
Adjust Pin Bias Current Temperature Coefficient		—	0.1	—	nA/°C	

Parameter	Symbol	Min.	Typ.	Max.	Units	Conditions
Enable Input						
Input Logic Voltage Low (OFF)	EN_L	—	—	0.8	V	
Input Logic Voltage High (ON)	EN_H	2.4	—	—	V	
Enable Pin Input Current	I_{EN}	—	100	600	µA	V_{EN} = 26V
		—	—	**750**		
		0.7	—	2		V_{EN} = 0.8V
		—	—	**4**		
Regulator Output Current in Shutdown	I_{SHUT}	—	10	500	µA	$V_{EN} \leq 0.8V$ and $V_{IN} \leq 26V$, $V_{OUT} = 0$.

Note 1: Specification for packaged product only.

2: When used in dual supply systems where the regulator load is returned to a negative supply, the output voltage must be diode clamped to ground.

3: Full load current (I_{FL}) is defined as 1.5A for the D29152

4: Output voltage temperature coefficient is defined as the worst case voltage change divided by the total temperature range.

5: Dropout voltage is defined as the input-to-output differential when the output voltage drops to 99% of its normal value with V_{OUT} + 1V applied to V_{IN} .

6: Ground pin current is the regulator quiescent current. The total current drawn from the source is the sum of the load current plus the ground pin current.

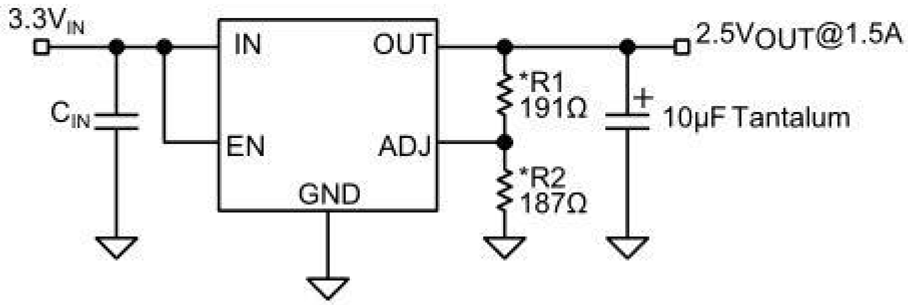
7: $V_{IN} = V_{OUT}$ (nominal) + 1V. For example, use V_{IN} = 4.3V for a 3.3V regulator or use 6V for a 5V regulator.Employ pulse-testing procedures to pin current.

8: $V_{REF} \leq V_{OUT} \leq (V_{IN} - 1V)$, $2.3V \leq V_{IN} \leq 26V$, $10mA < I_L \leq I_{FL}$, $T_J \leq T_{JMAX}$.

9: Thermal regulation is defined as the change in output voltage at a time T after a change in power dissipation is applied, excluding load or line regulation effects. Specifications are for a 200 mA load pulse at V_{IN} =20V (a 4W pulse) for T = 10 ms.

10: Comparator thresholds are expressed in terms of a voltage differential at the adjust terminal below the nominal reference voltage measured at 6V input. To express these thresholds in terms of output voltage change, multiply by the error amplifier gain = V_{OUT}/V_{REF} = (R1 + R2)/R2. For example, at a programmed output voltage of 5V, the error output is guaranteed to go low when the output drops by 95mV×5V/1.240V = 384mV. Thresholds remain constant as a percent of V_{OUT} as V_{OUT} is varied, with the drop-out warning occurring at typically 5% below nominal, 7.7% guaranteed.

Typical Application Circuits



Note: See minimum load current section

Application Information

The D29152 is high-performance low-dropout voltage regulators suitable for all moderate to high-current voltage egulator applications. Their 350mV to 425mV typical dropout voltage at full load make them especially valuable in battery powered systems and as high efficiency noise filters in post-regulator applications.Unlike older NPN-pass transistor designs, where the minimum dropout voltage is limited by the base-emitter voltage drop and collector-emitter saturation voltage,dropout performance of the PNP output of these devices is limited merely by the low VCE saturation voltage.

A trade-off for the low-dropout voltage is a varying base driver requirement. this drive requirement to merely 1% of the load current.

The D29152 family of regulators are fully protected from damage due to fault conditions. Current limiting is provided. This limiting is linear;output current under overload conditions is constant.Thermal shutdown disables the device when the die temperature exceeds the +125°C maximum safe operating temperature. Line transient protection allows device and load survival even when the input voltage spikes between –20V and

+50V. When the input voltage exceeds approximately 32V, the over voltage sensor disables the regulator. The output structure of these regulators allows voltages in excess of the desired output voltage to be applied without reverse current flow. D29152 versions offer a logic-level ON/OFF control. When disabled, the devices draw nearly zero current.

An additional feature of this regulator family is a common pin out. A design's current requirement may change up or down, but use the same board layout because all of these regulators have identical pin outs.

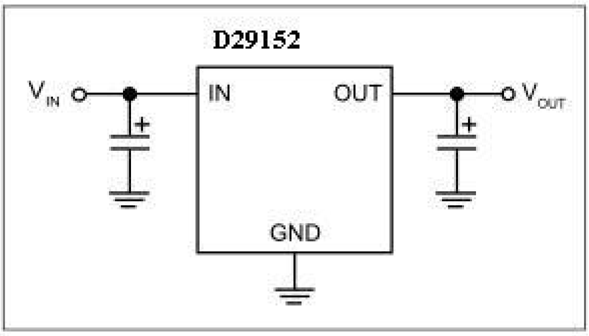


Fig 4-1: Linear Regulators Require Only Two Capacitors for Operation.

Thermal Design

Linear regulators are simple to use. The most complicated design parameters to consider are thermal characteristics. Thermal design requires the following application-specific parameters:

- Maximum Ambient Temperature, T_A
- Output Current, I_{OUT}
- Output Voltage, V_{OUT}
- Input Voltage, V_{IN}

First, calculate the power dissipation of the regulator from these numbers and the device parameters from this data sheet.

$$P_D = I_{OUT}(1.01 \times (V_{IN} - V_{OUT}))$$

The ground current is approximated by 1% of I_{OUT} .Then the heat sink thermal resistance is determined with this formula:

$$\theta_{SA} = \frac{T_{JMAX} - T_A}{P_D} - (\theta_{JC} + \theta_{CS})$$

Where $T_{J\ MAX} \leq 125°C$ and θ_{CS} is between 0 and 2°C/W.

The heat sink may be significantly reduced in applications where the minimum input voltage is known and is large compared with the dropout voltage. Use a series input resistor to drop excessive voltage and distribute the heat between this resistor and the regulator. The low-dropout properties regulators allow very significant reductions in regulator power dissipation and the associated heat sink without compromising performance. When this technique is employed, a capacitor of at least 0.1 µF is needed directly between the input and regulator ground.

Please refer to Application Note 9 and Application Hint 17 for further details and examples on thermal design and heat sink specification.

With no heat sink in the application, calculate the junction temperature to determine the maximum power dissipation that will be allowed before exceeding the maximum junction temperature of the D29152. The maximum power allowed can be calculated using the thermal resistance (θ_{JA}) of the D-Pak adhering to the following criteria for the PCB design: 2 oz. copper and 100 mm 2 copper area for the D29152.

For example, given an expected maximum ambient temperature (T_A) of +75°C with V_{IN} =3.3V, V_{OUT} =2.5V, and I_{OUT} = 1.5A, first calculate the expected PD using Equation 3-3:

Equation 3-3:

$$P_D = (3.3V - 2.5V) \times 1.5A - (3.3V \times 0.016A) = 1.1472W$$

Next, calculate the junction temperature for the expected power dissipation.

Equation 3-4:

$$\begin{aligned} T_J &= (\theta_{JA} \times P_D) + T_A \\ &= (56^oC/\mathrm{W} \times 1.1472W) + 75^oC = 139.24^oC \end{aligned}$$

Now determine the maximum power dissipation allowed that would not exceed the IC's maximum junction temperature (+125°C) without the use of a heat sink.

Equation 3-5:

$$\begin{aligned} P_{D(MAX)} &= (T_{J(MAX)} - T_A) \div \theta_{JA} \\ &= (125^oC - 75^oC) \div 56^oC/\mathrm{W} = 0.893W \end{aligned}$$

Capacitor Requirements

For stability and minimum output noise, a capacitor on the regulator output is necessary. The value of this capacitor is dependent upon the output current; lower currents allow smaller capacitors. The D29152 regulators is stable with the following minimum capacitor values at full load 10uF.

This capacitor need not be an expensive low ESR type: aluminum electrolytics are adequate. In fact, extremely low ESR capacitors may contribute to instability.Tantalum capacitors are recommended for systems where fast load transient response is important.Where the regulator is powered from a source with high AC impedance, a 0.1μF capacitor connected between Input and GND is recommended. This capacitor should have good characteristics to above 250 kHz.

Minimum Load Current

The D29152 regulators is specified between finite loads. If the output current is too small,leakage currents dominate and the output voltage rises. The following minimum load current swamps any expected leakage current across the operating temperature range: 5mA.

Adjustable Regulator Design

The adjustable regulator versions, D29152, allow programming the output voltage anywhere between 1.25V and the 25V. Two resistors are used. The resistor values are calculated by $R_1 = R_2\left(\frac{V_{OUT}}{1.240} - 1\right)$.

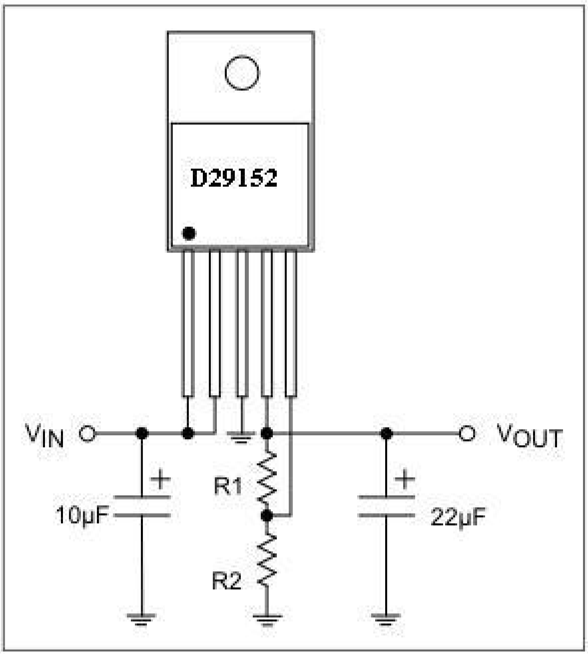


Fig 4-2: Adjustable Regulator with Resistors

In the equation above, V_{OUT} is the desired output voltage. Figure shows component definition.Applications with widely varying load currents may scale the resistors to draw the minimum load current required for proper operation (see the Minimum Load Current sub-section).

Enable Input

D29152 versions feature an enable (EN) input that allows ON/OFF control of the device.Special design allows "zero" current drain when the device is disabled; only micro-amperes of leakage current flows. The EN input has TTL/CMOS compatible thresholds for simple interfacing with logic, or may be directly tied to ≤30V. Enabling the regulator requires approximately 20 μA of current.

Characteristic Curves

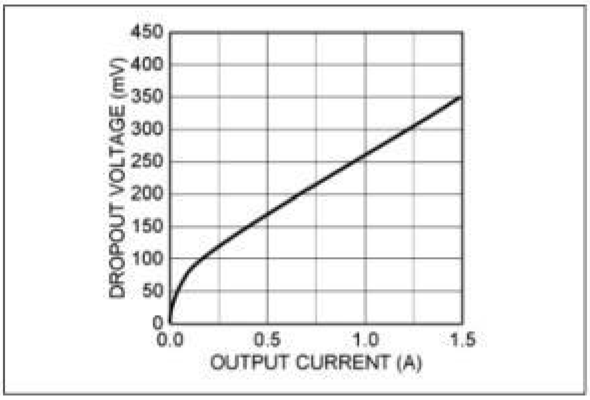


FIGURE 2-1: D29152 Dropout Voltage

Output Current.

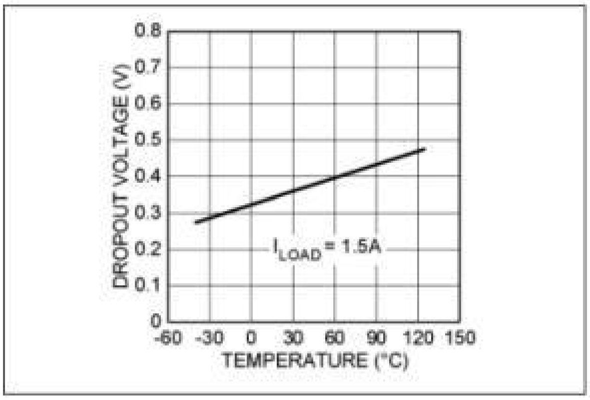


FIGURE 2-2: D29152 Dropout Voltage

vs. Supply Voltage.

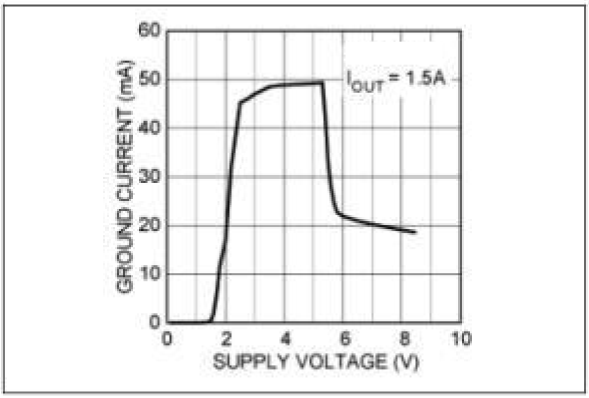


FIGURE 2-3: D29152 Ground Current

vs. Supply Voltage.

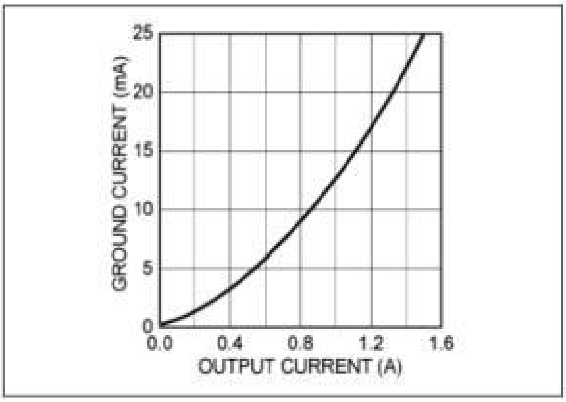


FIGURE 2-4: D29152 Ground Current vs.

vs. Output Current.

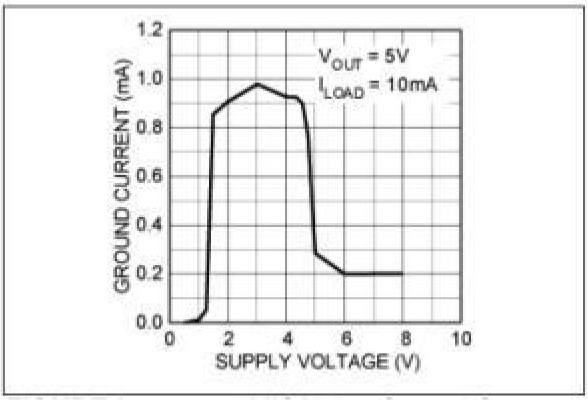


FIGURE 2-5: D29152 Ground Current

vs. Temperature.

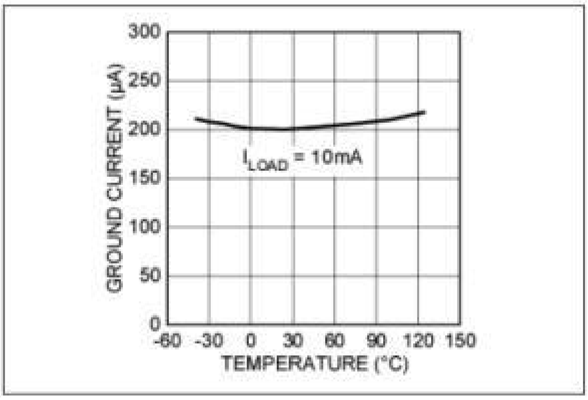


FIGURE 2-6: D29152 Ground Current

vs. Temperature.

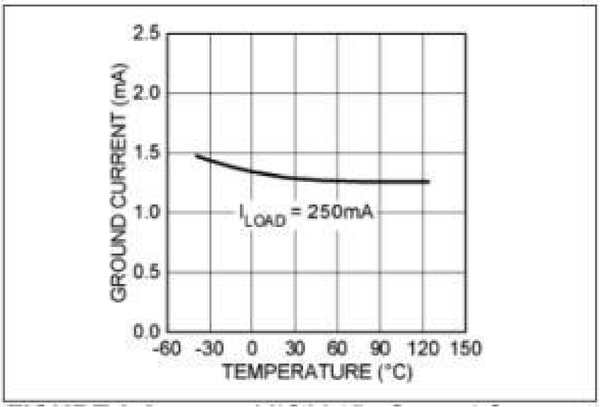


FIGURE 2-7: D29152 Ground Current

Temperature.

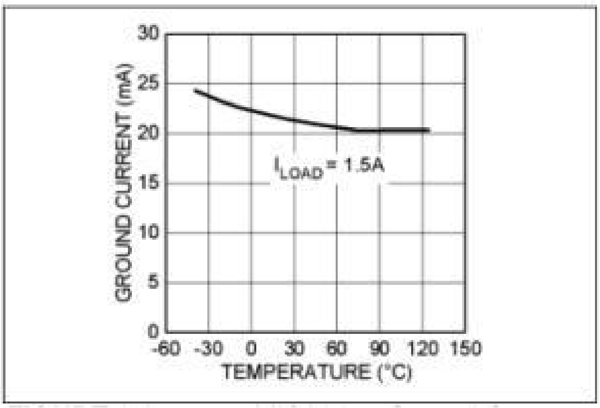


FIGURE 2-10: D29152 Ground Current vs.

vs. Temperature.

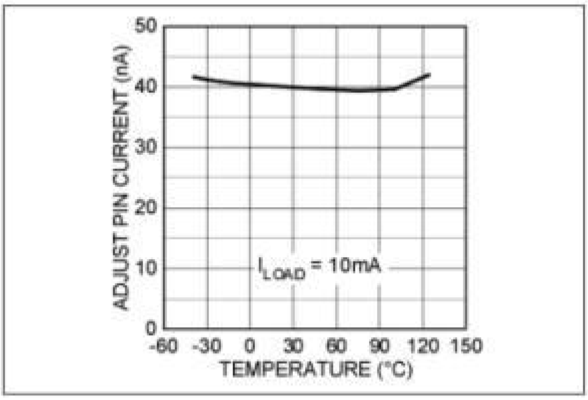


FIGURE 2-8: D29152 Adjust Pin

Current vs. Temperature.

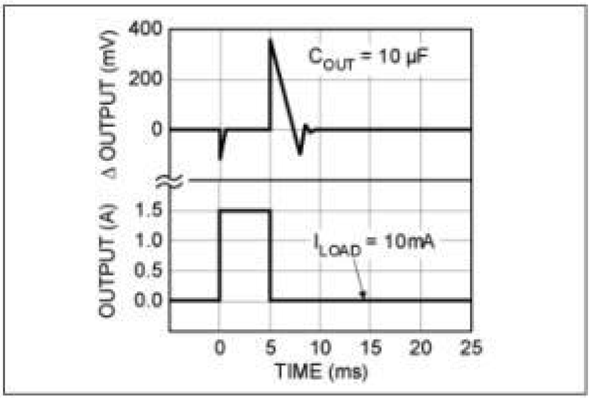


FIGURE 2-11: D29152 Load Transient.

.

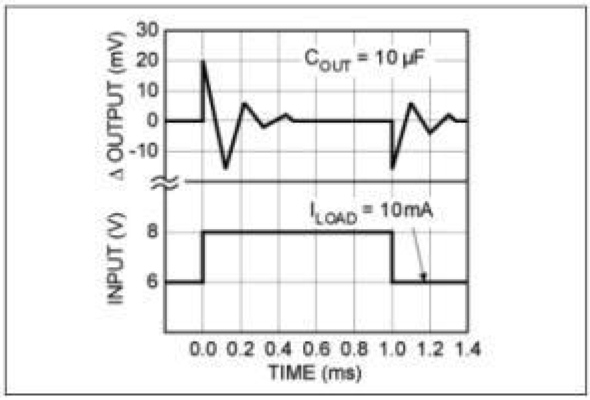


FIGURE 2-9: D29152 Line Transient.

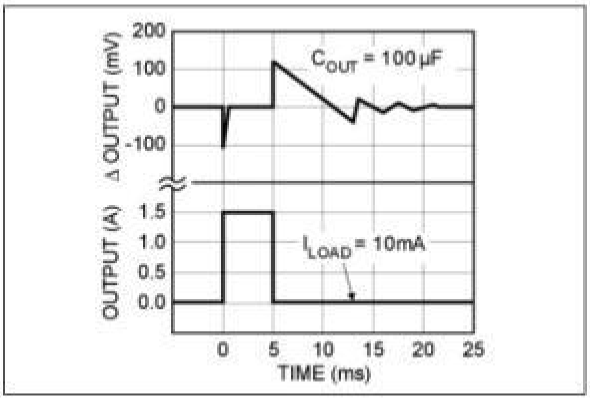


FIGURE 2-12: D29152 Load Transient.

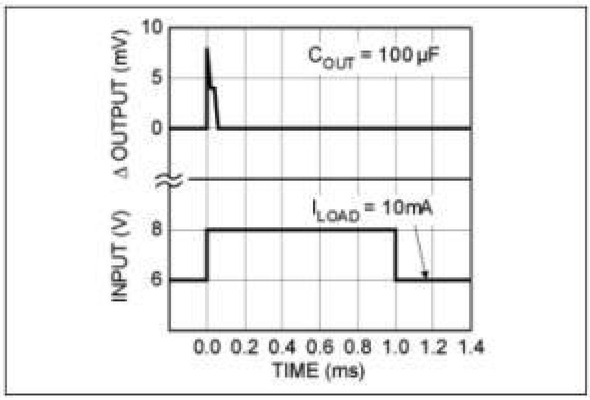


FIGURE 2-13: D29152 Line Transient.

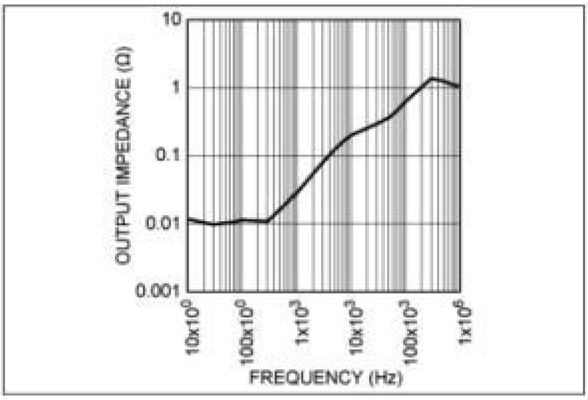


FIGURE 2-15: D29152 Output Impedance vs. Frequency.

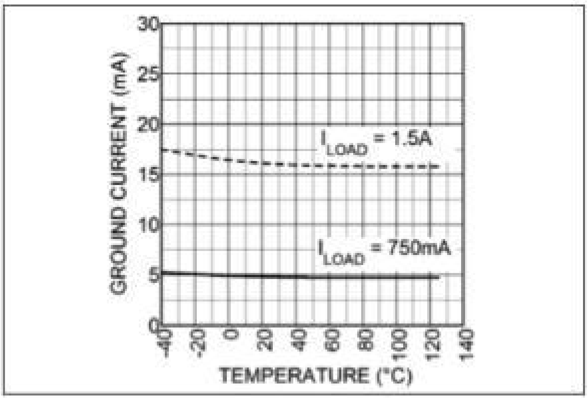


FIGURE 2-14: D29152 Ground Current Temperature.

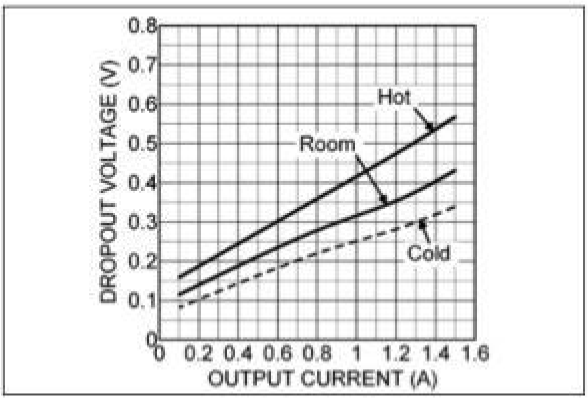
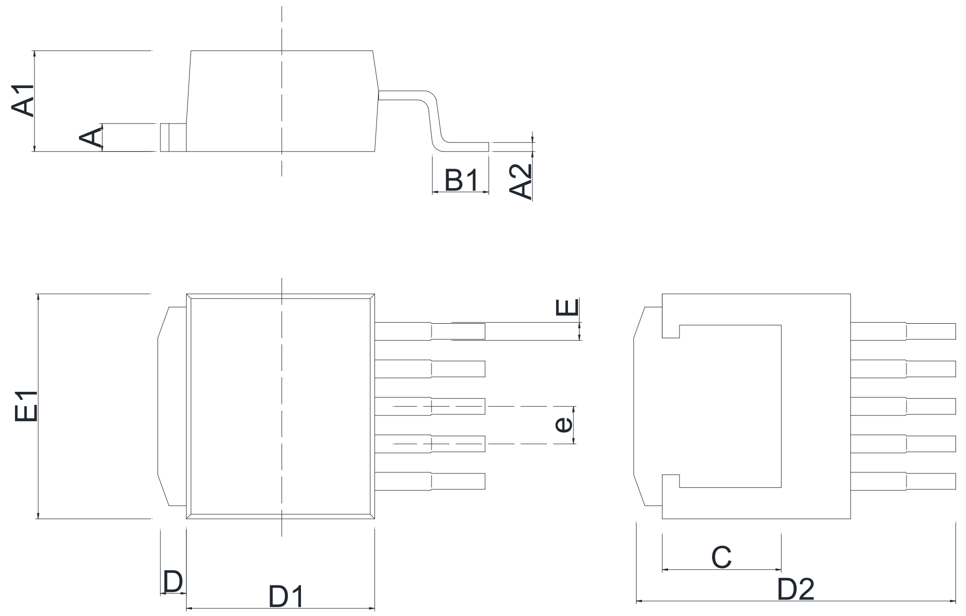


FIGURE 2-16: D29152 Dropout Voltage vs. vs. Output Current.

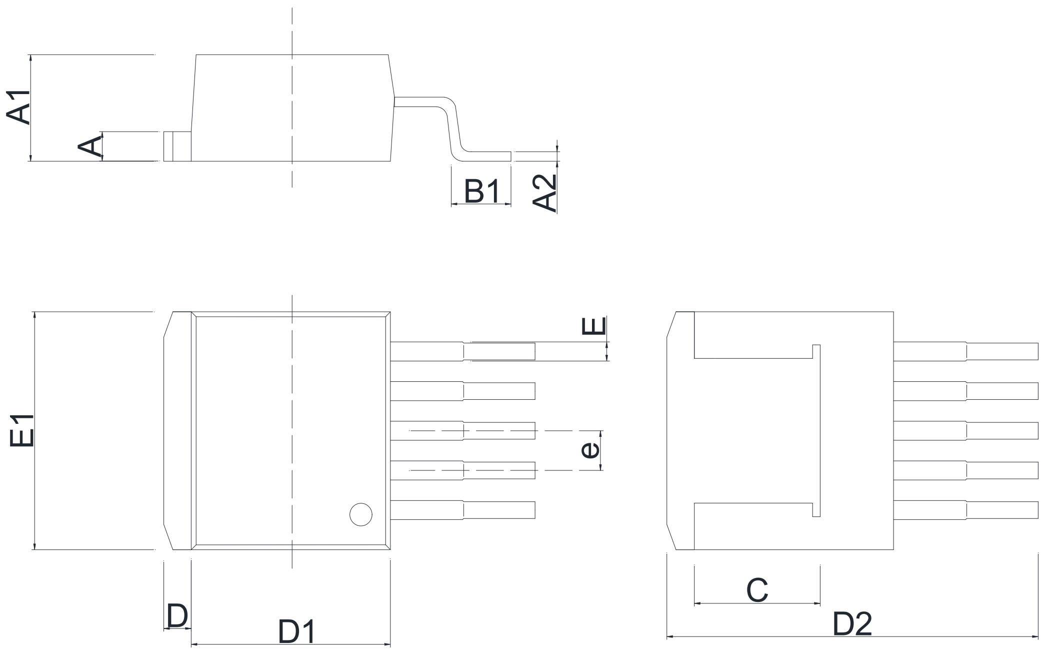
Outline Dimensions

TO252-5	Unit: mm



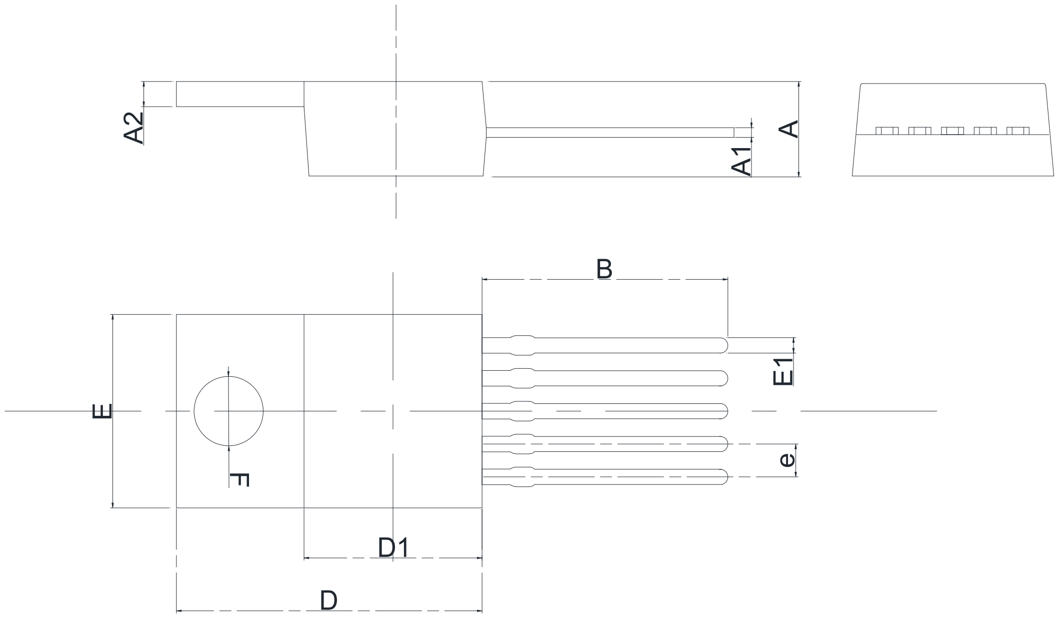
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	0.470	0.530	0.018	0.021
A1	2.180	2.400	0.085	0.094
A2	0.250	0.350	0.009	0.013
B1	1.100	1.300	0.043	0.051
C	5.200	5.600	0.204	0.220
D	1.000	1.200	0.039	0.047
D1	6.000	6.200	0.236	0.245
D2	9.800	10.100	0.385	0.397
E	0.630	0.770	0.024	0.031
E1	6.450	6.750	0.253	0.266
e	1.270（BSC）		0.050（BSC）	

TO263-5 Unit: mm



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	1.170	1.370	0.046	0.054
A1	4.350	4.750	0.171	0.187
A2	0.310	0.530	0.012	0.021
B1	2.340	2.740	0.092	0.108
C	5.080 REF		0.200 REF	
D	1.170	1.370	0.046	0.054
D1	8.100	8.900	0.318	0.350
D2	14.550	15.550	0.572	0.612
E	0.660	0.860	0.025	0.034
E1	9.800	10.310	0.385	0.406
e	1.700（BSC）		0.067（BSC）	

TO220-5 Unit：mm



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	4.300	4.700	0.169	0.185
A1	0.450	0.600	0.017	0.023
A2	1.250	1.400	0.049	0.055
B	12.880	13.380	0.507	0.527
D	15.500	15.900	0.610	0.626
D1	9.000	9.400	0.354	0.370
E	9.700	10.100	0.381	0.398
E1	0.660	0.914	0.025	0.036
e	1.702（BSC）		0.670（BSC）	
F	Φ3.500	Φ3.700	Φ0.137	Φ0.146

Statements

- Silicore Technology reserves the right to make changes without further notice to any products or specifications herein. Before customers place an order, customers need to confirm whether datasheet obtained is the latest version, and to verify the integrity of the relevant information.

- Failure or malfunction of any semiconductor products may occur under particular conditions, customers shall have obligation to comply with safety standards when customers use Silicore Technology products to do their system design and machine manufacturing, and take corresponding safety measures in order to avoid potential risk of failure that may cause personal injury or property damage.

- The product upgrades without end, Silicore Technology will wholeheartedly provide customers integrated circuits that have better performance and better quality.