CAT6220

300 mA Adjustable Voltage LDO Regulator

Description

The CAT6220 is a 300 mA CMOS low dropout regulator whose output voltage is user adjustable that provides fast response time during load current and line voltage changes.

With 1 μA of shutdown current, an internal no−load operating current of only 10 μA, and full−load operating current of 40 μA, the CAT6220 is ideal for battery−operated devices with supply voltages from 2.3 V to 6.5 V.

The CAT6220 offers 1% initial accuracy and low dropout voltage, 270 mV typical at 300 mA. Stable operation is provided with a small value ceramic capacitor, reducing required board space and component cost.

Other features include current limit and thermal protection.

The device is available in the low profile (1 mm max height) 5−lead TSOT−23 and 6−pad 2 mm x 2 mm TDFN packages.

Features

- Guaranteed 300 mA Output Current
- Low Dropout Voltage of 270 mV at 300 mA
- Stable with Ceramic Output Capacitor
- No−load Ground Current of 10 μA Typical
- Full−load Ground Current of 40 μA Typical
- ±1.0% Output Voltage Initial Accuracy
- ±2.0% Accuracy over Temperature
- “Zero” Current Shutdown Mode
- Current Limit and Thermal Protection
- 5−lead TSOT−23 and 6−pad TDFN Packages
- These Devices are Pb−Free, Halogen Free/BFR Free and are RoHS Compliant

Applications

- Toys
- Consumer Electronics
- Cellular Phones
- Battery−powered Devices

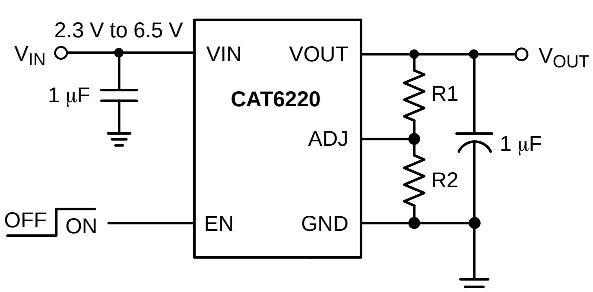
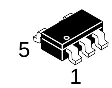


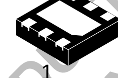
Figure 1. Typical Application Circuit

ON Semiconductor®

http://onsemi.com

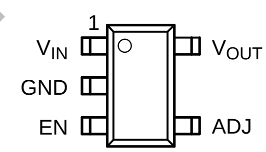


TSOT−23
TD SUFFIX
CASE 419AE

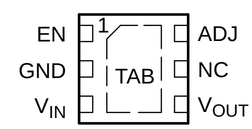


TDFN−6
VP5 SUFFIX
CASE 511AH

PIN CONNECTIONS



TSOT−23



TDFN−6

(Top Views)

ORDERING INFORMATION

See detailed ordering and shipping information in the package dimensions section on page 12 of this data sheet.

Table 1. PIN DESCRIPTIONS

Pin Name	Package Pin #		Function
	TSOT	TDFN	
VIN	1	3	Supply voltage input.
GND	2	2	Ground reference. All GND pins must be grounded.
EN	3	1	Enable input (active high)
ADJ	4	6	Digital programming input
NIC	−−	5	No Internal Connection. A voltage or signal applied to this pin will have no effect upon device operation.
VOUT	5	4	Output Voltage Adjustment.
GND	−−	PAD	Center pad or tab; for heat sinking

Pin Function

VIN is the supply pin for the LDO. A small 1 μF ceramic bypass capacitor is required between the V_{IN} pin and ground near the device. When using longer connections to the power supply, C_{IN} value can be increased without limit. The operating input voltage range is from 2.3 V to 6.5 V.

EN is the enable control logic (active high) for the regulator output. Enable is a high impedance input and must not be left unconnected. Floating EN will result in unpredictable action at VOUT.

VOUT is the LDO regulator's output. Output voltage is set by two external resistors arranged as a voltage divider between VOUT and Ground. The center point of the divider is connected to ADJ as shown in Figure 2. The minimum recommended current through resistors is 5 μA. The ratio of the resistors is set by the formula:

$$V_{OUT} = 1.24\ V \left(1 + \frac{R_1}{R_2}\right)$$

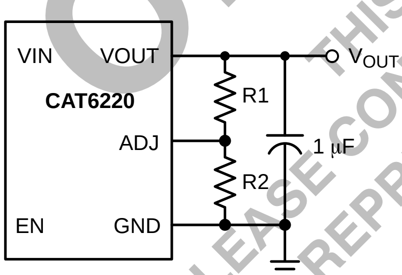


Figure 2. R1 and R2 Set CAT6220's Output Voltage

A small 1 μF ceramic bypass capacitor is required between the VOUT pin and ground. For better transient response, its value can be increased to 2.2 μF. This capacitor should be located near the device.

GND is the ground reference for the LDO. This pin must be connected to the system ground line or the ground plane of the PCB.

The backside center pad of the TDFN package is internally connected to the GND pin. Any PCB connection to this pad must be either floating or at GND potential.

ADJ is the LDO's voltage control input. This pin is connected to the center of the resistor voltage divider R1, R2. A 10 pF capacitor connected in parallel with R1 will improve the transient load regulation for VOUT ≤ 2 V.

Thermal and Short Circuit Protection

CAT6220 is equipped with thermal protection and over−current limiting circuitry.

In the event of a short circuit CAT6220 will limit its output current to approximately 400 mA. If the short circuit persists CAT6220's internal temperature will rise and if the chip's temperature reaches 140°C CAT6220 will shut off all current to the load which protects the system and allows the LDO to cool down. When the LDO's internal temperature drops below 130°C the LDO automatically turns ON again. If the short circuit is still present another thermal cycle will ensue. This will continue until either the short circuit is removed or the Enable pin is taken LOW.

For the TSOT23−5 package, a continuous 300 mA output current may turn−on the thermal protection. If this happens the LDO will respond by shutting off power to the load and thermal cycling will begin.

Table 2. ABSOLUTE MAXIMUM RATINGS

Parameter	Rating	Unit
V_{IN}	0 to 7	V
V_{EN}, V_{OUT}	−0.3 to V_{IN} + 0.3	V
Junction Temperature, T_J	+150	°C
Power Dissipation, P_D	Internally Limited (Note 1)	mW
Storage Temperature Range, T_S	−65 to +150	°C
Lead Temperature (soldering, 5 sec.)	260	°C
ESD Rating (Human Body Model)	2	kV
ESD Rating (Machine Model)	200	V

Stresses exceeding Maximum Ratings may damage the device. Maximum Ratings are stress ratings only. Functional operation above the Recommended Operating Conditions is not implied. Extended exposure to stresses above the Recommended Operating Conditions may affect device reliability.

1. The maximum allowable power dissipation at any T_A (ambient temperature) is $P_{Dmax} = (T_{Jmax} - T_A) / \theta_{JA}$. Exceeding the maximum allowable power dissipation will result in excessive die temperature, and the regulator will go into thermal shutdown.

Table 3. RECOMMENDED OPERATING CONDITIONS (Note 2)

Parameter	Range	Unit
V_{IN}	2.3 to 6.5	V
I_{OUT}	0.005 to 300	mA
V_{EN}	0 to V_{IN}	V
Junction Temperature Range, T_J	−40 to +140	°C
Package Thermal Resistance (TSOT23−5), θ_{JA}	280	°C/W
Package Thermal Resistance (TDFN−6), θ_{JA}	160	°C/W

2. The device is not guaranteed to work outside its operating rating.

Table 4. ELECTRICAL OPERATING CHARACTERISTICS (Note 3) (V_{IN} = V_{OUT} + 1.0 V, V_{EN} = High, I_{OUT} = 100 μA, C_{IN} = 1 μF, C_{OUT} = 1 μF, ambient temperature of 25°C (over recommended operating conditions unless specified otherwise). **Bold numbers** apply for the entire junction temperature range.)

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
V_{ADJ}	Adjustable Voltage	I_{OUT} = 100 μA		1.24		V
V_{ADJ}	Adjustable Voltage Accuracy	Initial accuracy	−1.5		+1.5	%
			−2.5		**+2.5**	
I_{ADJ}	ADJ pin Input Current			1	**50**	nA
TC_{OUT}	Output Voltage Temp. Coefficient			40		ppm/°C
V_{R-LINE}	Line Regulation	V_{IN} = V_{OUT} + 1.0 V to 6.5 V	−0.2	±0.1	+0.2	%/V
			−0.35		**+0.35**	
V_{R-LOAD}	Load Regulation	I_{OUT} = 100 μA to 300 mA		0.9	1.5	%
					2.2	
V_{DROP}	Dropout Voltage (Note 4)	I_{OUT} = 300 mA		270	350	mV
					500	
I_{GND}	Ground Current	I_{OUT} = 5 μA		10	15	μA
					20	
		I_{OUT} = 300 mA		40	**100**	
I_{GND-SD}	Shutdown Ground Current	V_{EN} < 0.4 V			1	μA
					2	
PSRR	Power Supply Rejection Ratio	f = 100 Hz		62		dB
		f = 1 kHz		48		
I_{SC}	Output short circuit current limit	V_{OUT} = 0 V		500	**700**	mA
T_{ON}	Turn−On Time			150		μs
e_N	Output Noise Voltage	BW = 10 Hz to 100 kHz, V_{OUT} = 1.8 V, I_{OUT} = 10 mA		150		μVrms
R_{OUT-SH}	Shutdown Switch Resistance			250		Ω
ESR	C_{OUT} equivalent series resistance		5		500	mΩ
DIGITAL INPUT						
V_{HI}	Logic High Level	V_{IN} = 2.3 to 6.5 V	**1.8**			V
		V_{IN} = 2.3 to 6.5 V, 0°C to +125°C junction temperature	1.6			
V_{LO}	Logic Low Level	V_{IN} = 2.3 to 6.5 V			**0.4**	V
I_{IN}	Input Current	V_{LOGIC} = 0.4 V		0.15	1	μA
		V_{LOGIC} = V_{IN}		1.5	4	
THERMAL PROTECTION						
T_{SD}	Thermal Shutdown			140		°C
T_{HYS}	Thermal Hysteresis			10		°C

3. Specification for 2.5 V output version unless specified otherwise.
4. Dropout voltage is defined as the input−to−output differential at which the output voltage drops 2% below its nominal value measured at 1 V differential. During test, the input voltage stays always above the minimum 2.3 V.

TYPICAL CHARACTERISTICS

(V_{IN} = 3.5 V, R1 = R2 = 250 KΩ, I_{OUT} = 100 μA, C_{IN} = 1 μF, C_{OUT} = 1 μF, T_A = 25°C unless otherwise specified.)

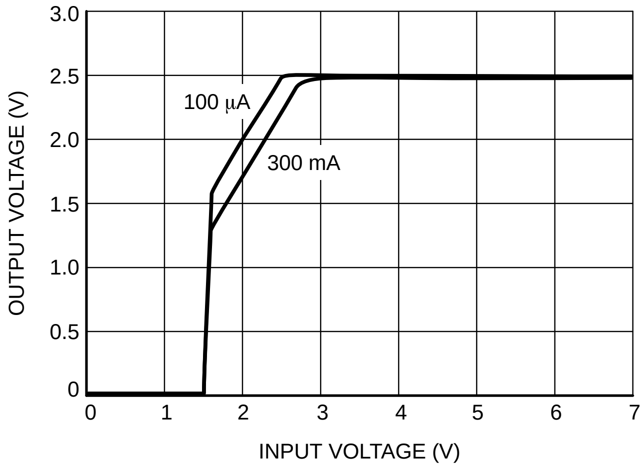


Figure 3. Dropout Characteristics

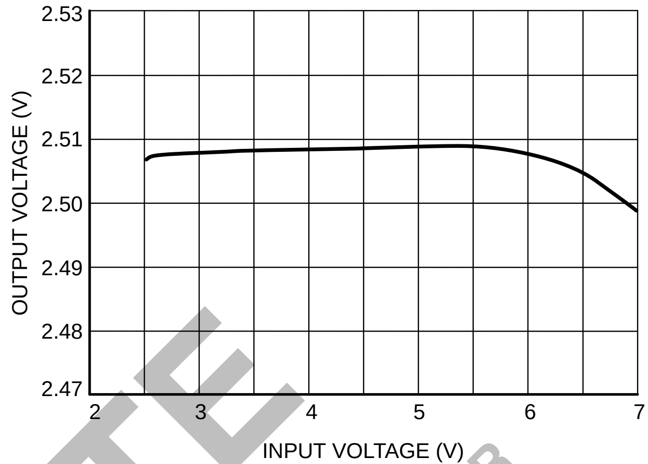


Figure 4. Line Regulation

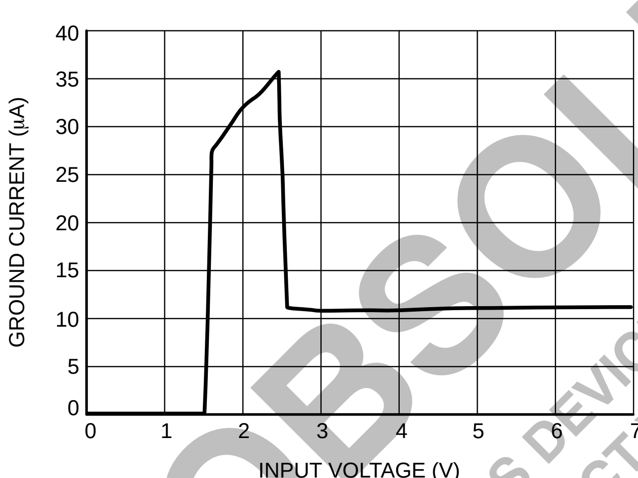


Figure 5. Ground Current vs. Input Voltage

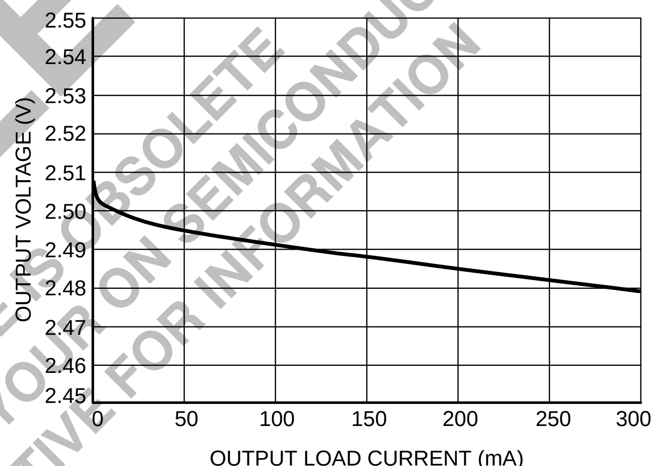


Figure 6. Load Regulation

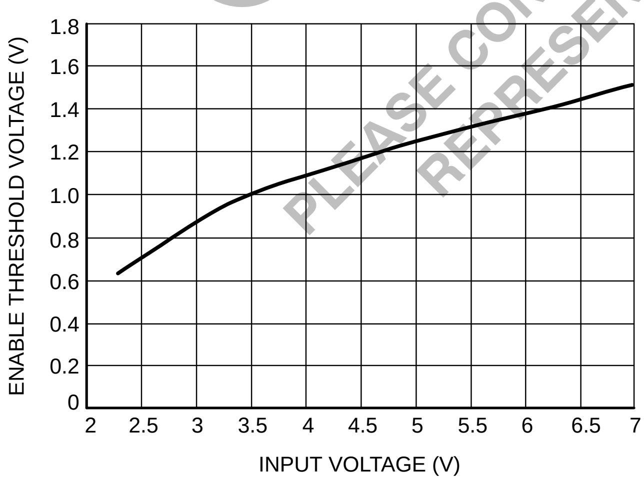


Figure 7. Enable Threshold vs. Input Voltage

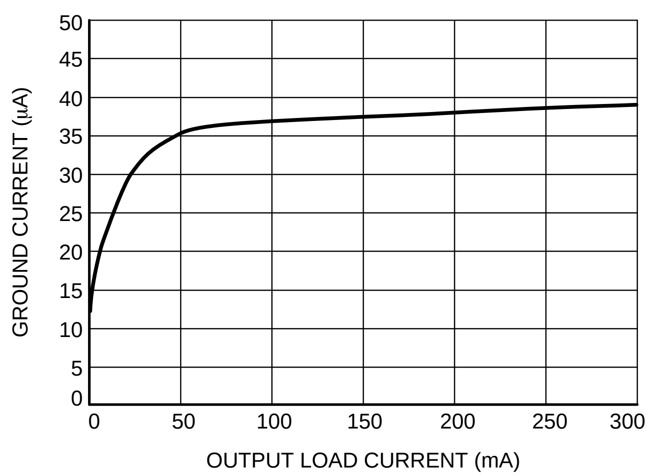


Figure 8. Ground Current vs. Load Current

TYPICAL CHARACTERISTICS

(V_{IN} = 3.5 V, R1 = R2 = 250 KΩ, I_{OUT} = 100 μA, C_{IN} = 1 μF, C_{OUT} = 1 μF, T_A = 25°C unless otherwise specified.)

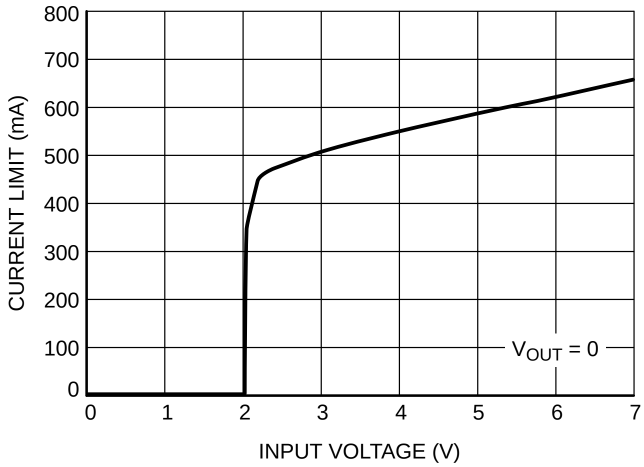


Figure 9. Output Short−circuit Current vs. Input Voltage

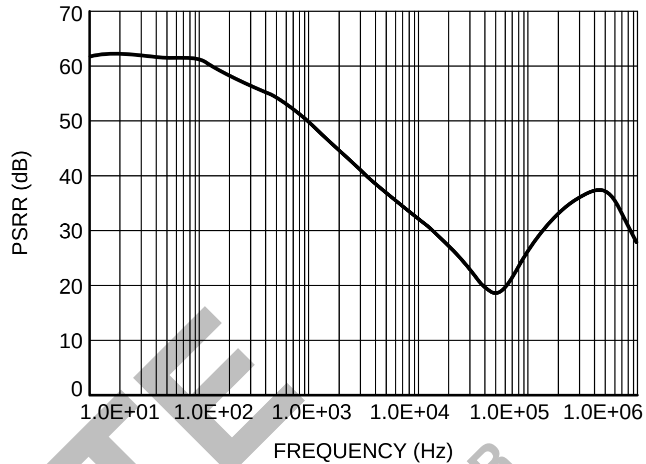


Figure 10. PSRR vs. Frequency (10 mA Load)

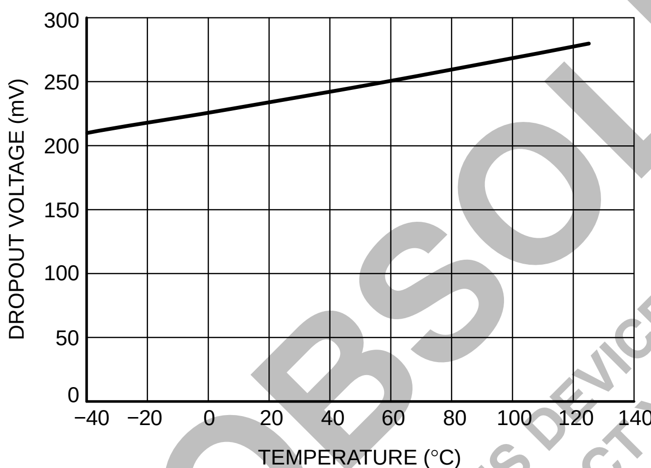


Figure 11. Dropout vs. Temperature (300 mA Load)

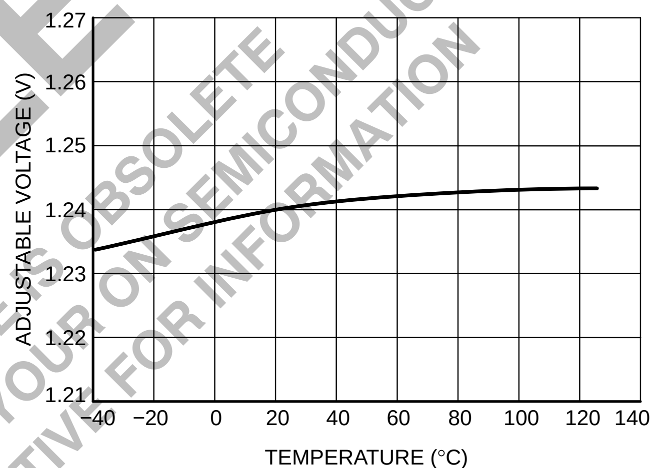


Figure 12. Adjustable Voltage vs. Temperature (100 μA Load)

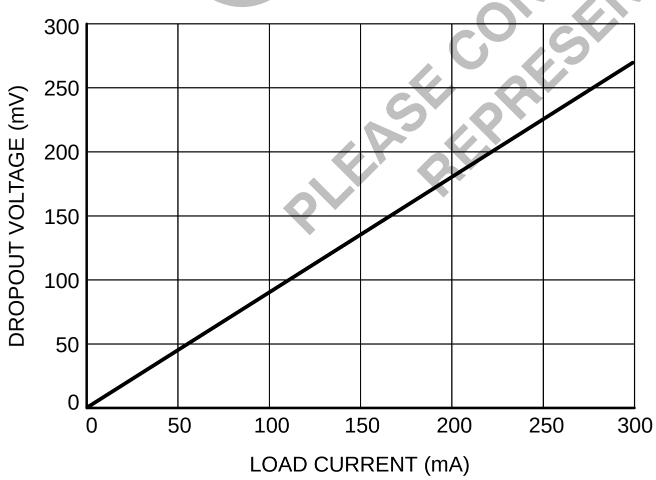


Figure 13. Dropout vs. Load Current

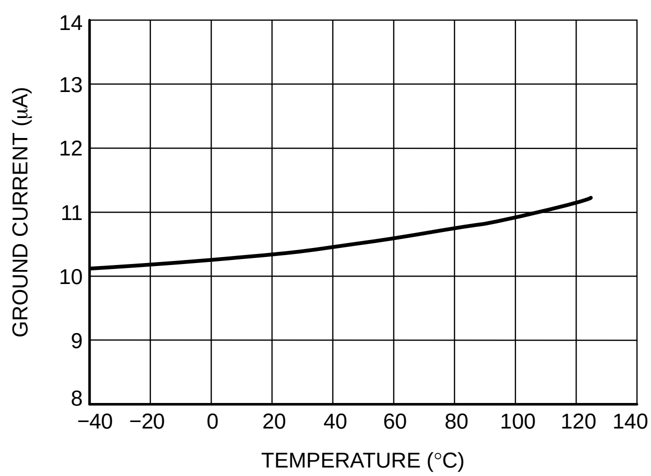


Figure 14. Ground Current vs. Temperature (5 μA Load)

TRANSIENT CHARACTERISTICS

(V_{IN} = 3.5 V, R1 = R2 = 250 KΩ, I_{OUT} = 100 μA, C_{IN} = 1 μF, C_{OUT} = 1 μF, T_A = 25°C unless otherwise specified.)

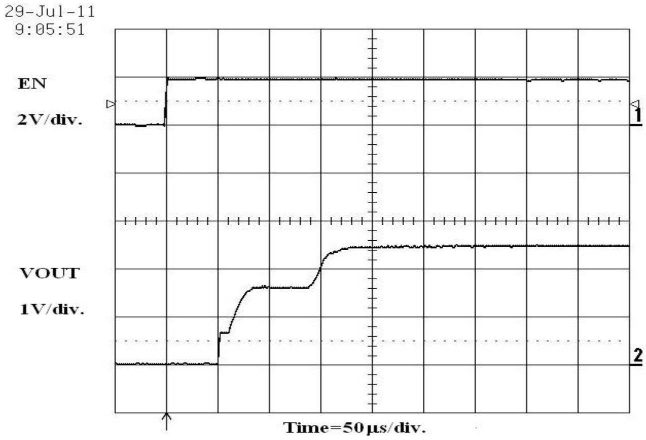


Figure 15. Enable Turn−On (100 μA Load)

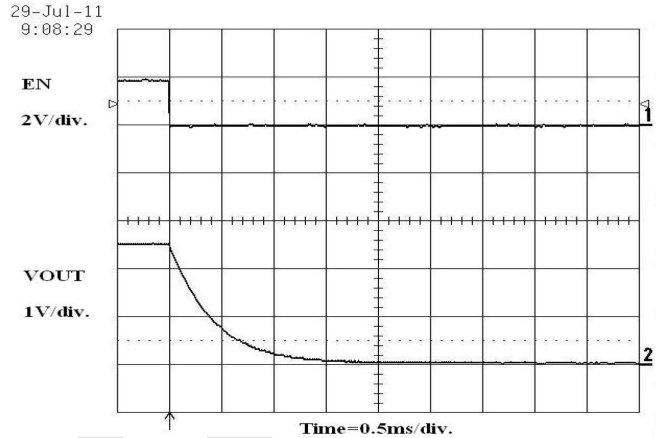


Figure 16. Enable Turn−Off (100 μA Load)

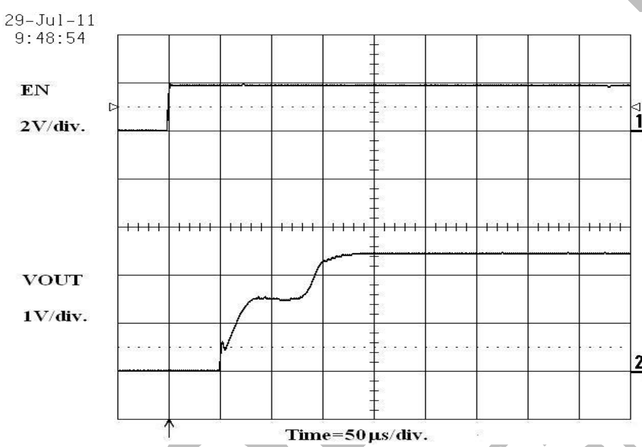


Figure 17. Enable Turn−On (300 mA Load)

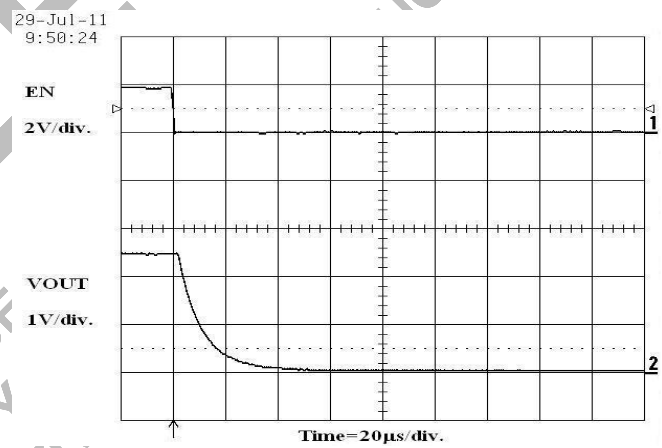


Figure 18. Enable Turn−Off (300 mA Load)

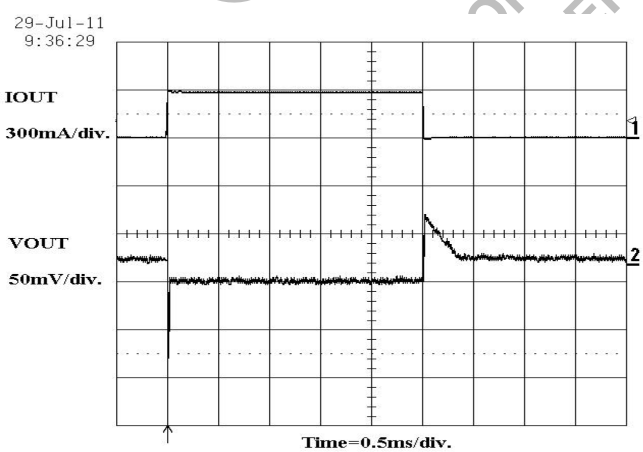


Figure 19. Load Transient Response (0.1 mA to 300 mA)

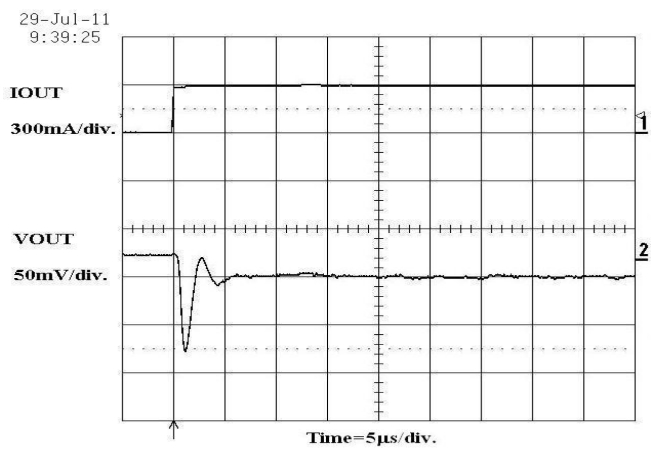


Figure 20. Load Transient Response − Detail

TRANSIENT CHARACTERISTICS

(V_{IN} = 3.5 V, R1 = R2 = 250 KΩ, I_{OUT} = 100 μA, C_{IN} = 1 μF, C_{OUT} = 1 μF, T_A = 25°C unless otherwise specified.)

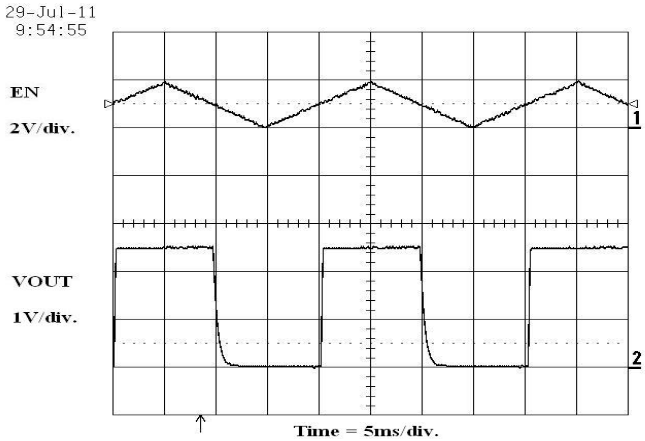


Figure 21. Slow−Enable Operation (100 μA Load)

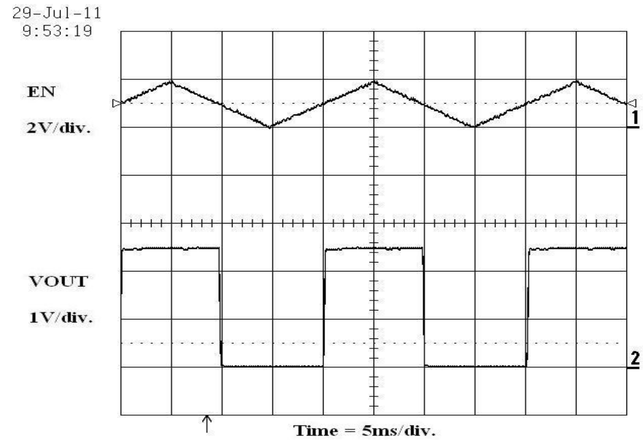


Figure 22. Slow−Enable Operation (300 mA Load)

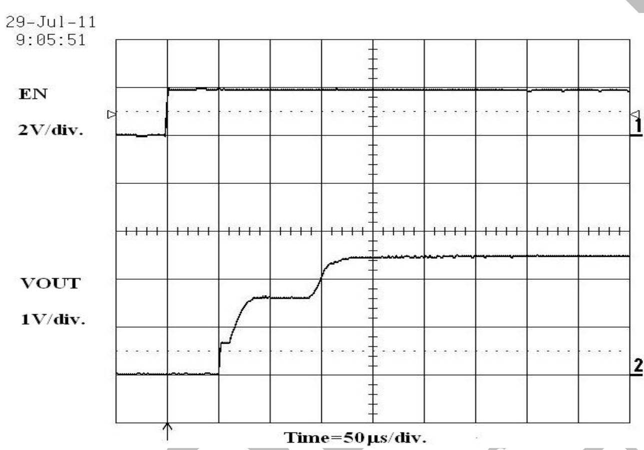


Figure 23. Enable Turn−On at VIN = 4.5 V (100 μA Load)

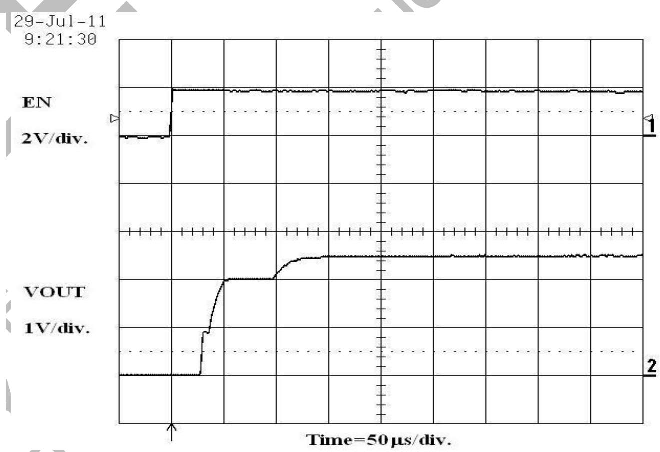


Figure 24. Enable Turn−On at VIN = 5.5 V (100 μA Load)

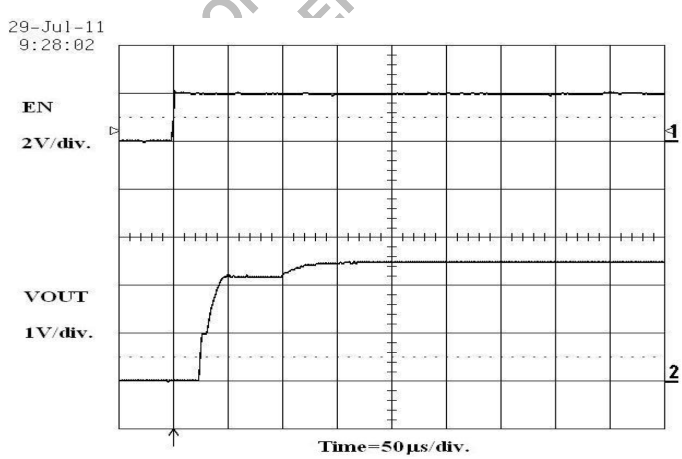


Figure 25. Enable Turn−On at VIN = 6.5 V (100 μA Load)

Table 5. THERMAL PERFORMANCE

Package	Symbol	Test Conditions	Min	Typ	Max	Unit
PACKAGE THERMAL CONDUCTIVITY COMPARISON						
TSOT−23−5	θ_{JA}	1 oz Copper Thickness, 100 mm^2		280		°C/W
	θ_{JC}			68		
TDFN−6	θ_{JA}	1 oz Copper Thickness, 100 mm^2		160		°C/W
	θ_{JC}			35		

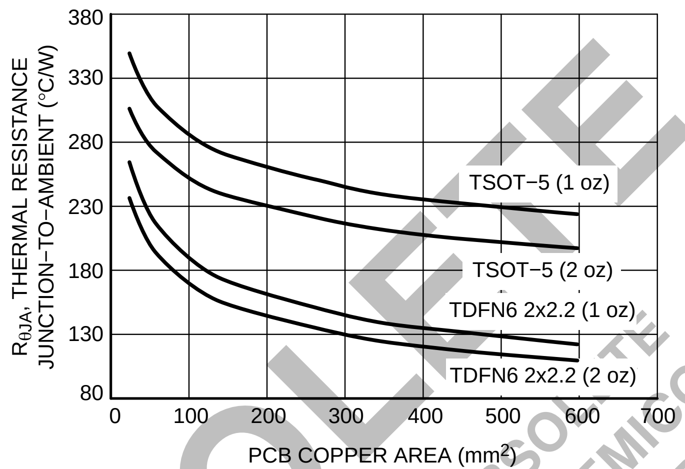


Figure 26. $R_{\theta JA}$ vs. PCB Copper Area

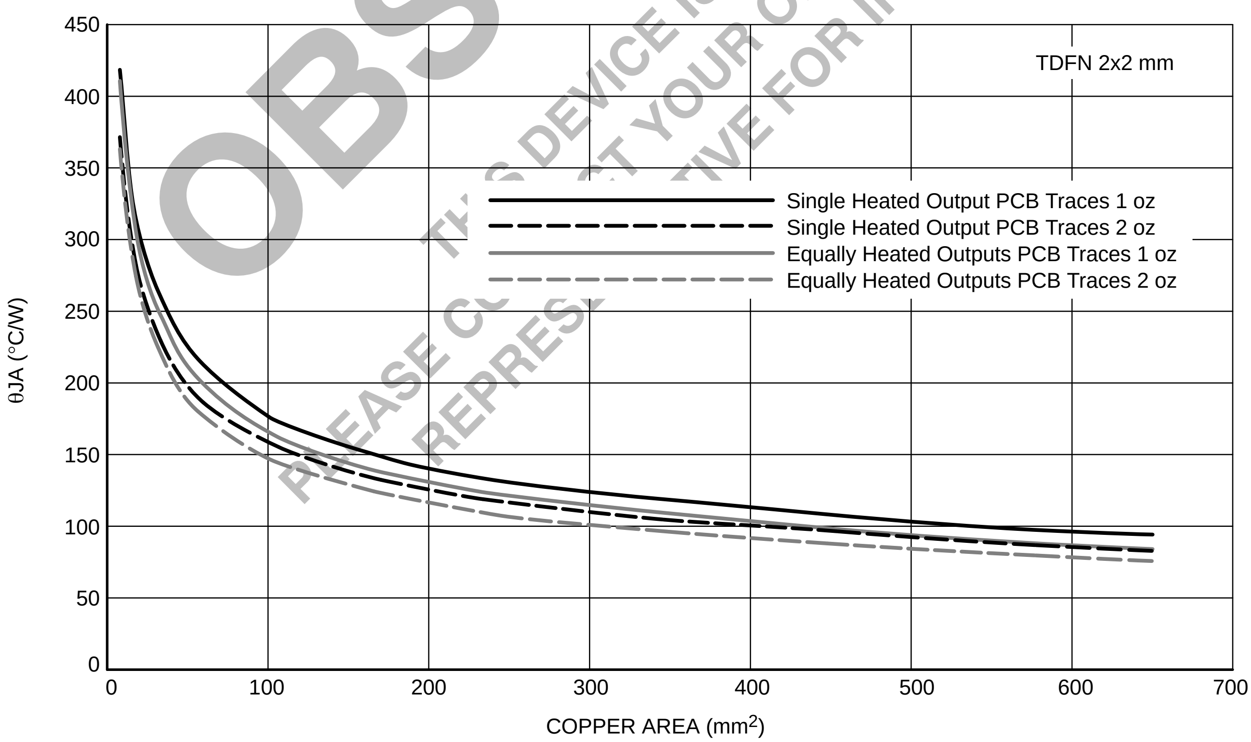
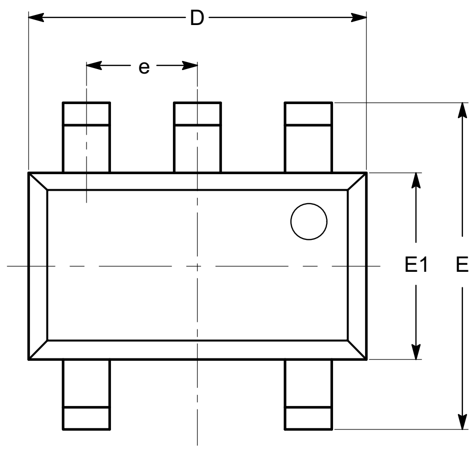


Figure 27. Thermal Characteristic as a Function of Copper Area on the PCB

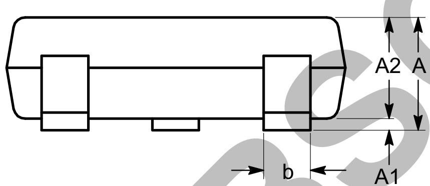
PACKAGE DIMENSIONS

TSOT−23, 5 LEAD
CASE 419AE−01
ISSUE O

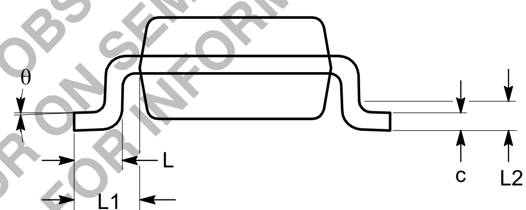


TOP VIEW

SYMBOL	MIN	NOM	MAX
A			1.00
A1	0.01	0.05	0.10
A2	0.80	0.87	0.90
b	0.30		0.45
c	0.12	0.15	0.20
D	2.90 BSC		
E	2.80 BSC		
E1	1.60 BSC		
e	0.95 TYP		
L	0.30	0.40	0.50
L1	0.60 REF		
L2	0.25 BSC		
θ	0º		8º



SIDE VIEW

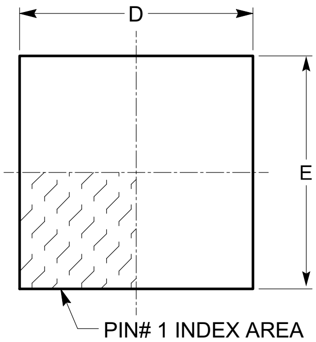


END VIEW

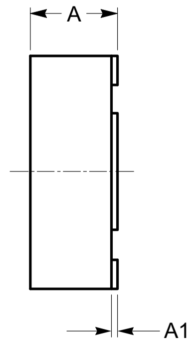
Notes:
(1) All dimensions are in millimeters. Angles in degrees.
(2) Complies with JEDEC MO-193.

PACKAGE DIMENSIONS

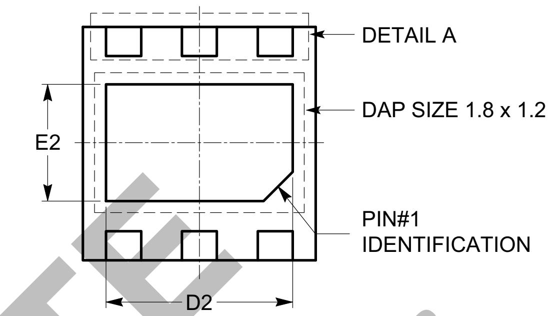
TDFN6, 2x2
CASE 511AH−01
ISSUE A



TOP VIEW

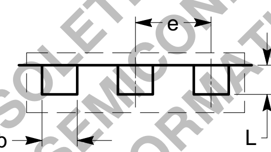


SIDE VIEW

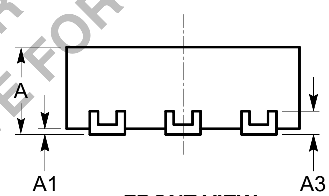


BOTTOM VIEW

SYMBOL	MIN	NOM	MAX
A	0.70	0.75	0.80
A1	0.00	0.02	0.05
A3		0.20 REF	
b	0.25	0.30	0.35
D	1.90	2.00	2.10
D2	1.50	1.60	1.70
E	1.90	2.00	2.10
E2	0.90	1.00	1.10
e		0.65 TYP	
L	0.15	0.25	0.35



DETAIL A



FRONT VIEW

Notes:
(1) All dimensions are in millimeters.
(2) Complies with JEDEC standard MO-229.

ORDERING INFORMATION

Device Order Number	Specific Device Marking	Package Type	Temperature Range	Lead Finish	**Shipping** (Note 7)
CAT6220TDI−GT3	X2	TSOT−23−5	I = Industrial (−40°C to +85°C)	NiPdAu	Tape & Reel, 3,000 Units / Reel
CAT6220VP5I−GT3	AK	TDFN−6	I = Industrial (−40°C to +85°C)	NiPdAu	Tape & Reel, 3,000 Units / Reel

5. All packages are RoHS−compliant (Lead−free, Halogen−free).
6. The standard lead finish is NiPdAu pre−plated (PPF) lead frames.
7. For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D.
8. For detailed information and a breakdown of device nomenclature and numbering systems, please see the ON Semiconductor Device Nomenclature document, TND310/D, available at www.onsemi.com

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