Features

- Good Transient Response
- Output voltage accuracy: tolerance ±2%
- TO252 package
- PSRR:60dB@10KHz
- High input voltage (up to 40V)
- Low Power Consumption: 3μA (Typ)
- Maximum Output Current: 350mA
- Voltage drop:400mV@100mA(12V)

Applications

- Portable, Battery Powered Equipmpm
- Microcontroller Applications
- Smoke detector and sensor
- Audio/Video equipment
- Weighting Scales
- Home Automation

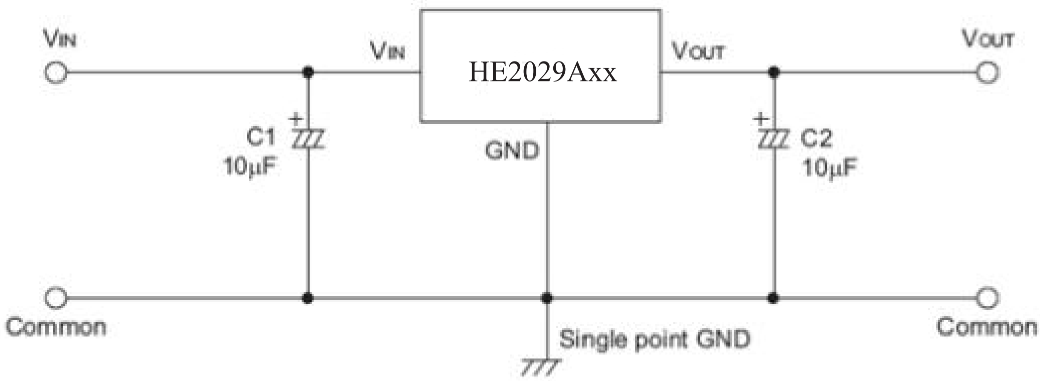
General Description

The HE2028 series is a high voltage, ultralow-power, low dropout voltage regulator. The device can deliver 350mA output current with a dropout voltage of 400mV and allows an input voltage as high as 40V. The typical quiescent current is only 3.0μA. The device is available in fixed output voltages of 6.0 9.0 and 12V.The device features integrated short-circuit and thermal shutdown protection.Although designed primarily as fixed voltage regulators, the device can be used with external components to obtain variable voltages.

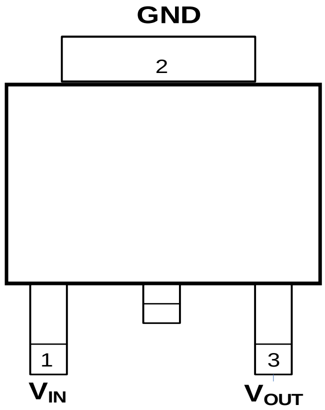
Selection Table

Part No.	Output Voltage	Package	Marking
HE2028A60GR	6.0V	TO252	
HE2028A90GR	9.0V	TO252	
HE2028AC0GR	12V	TO252	

Application Circuits

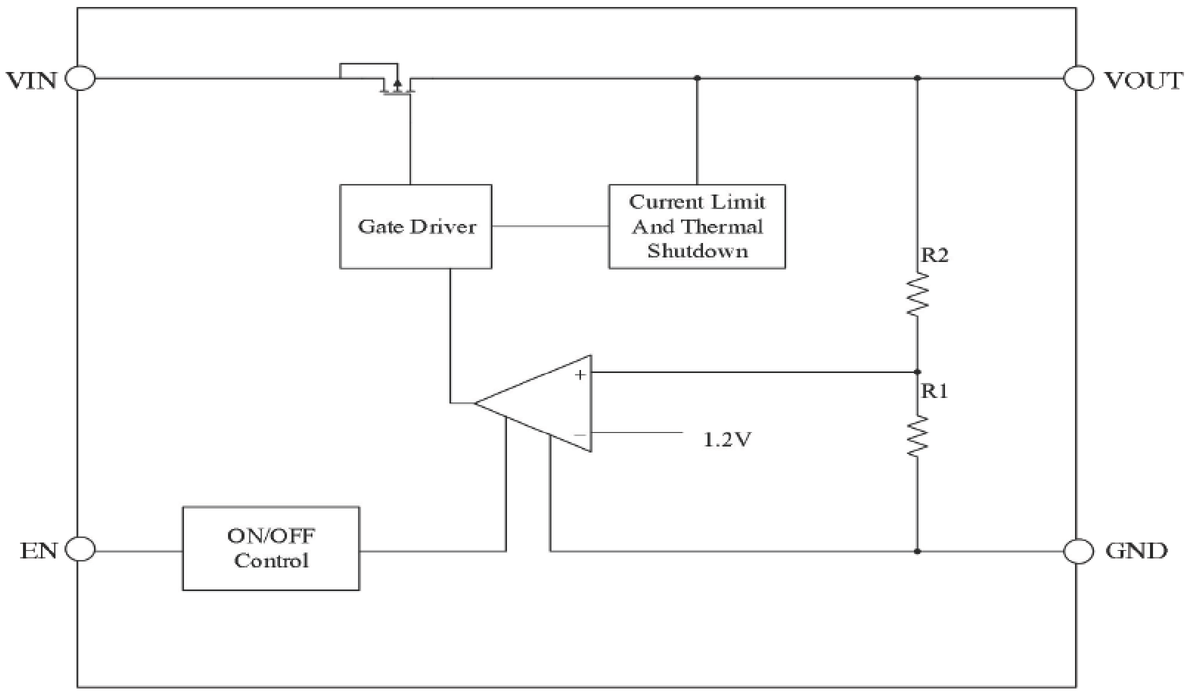


Pin Assignment



TO252 (Top View)

Functional Block Diagrara



Absolute Maximum Ratings [1] [2]

Parameter		Symbol	Maximum Rating	Unit
Input Voltage		V_{IN}	V_{SS} -0.3~V_{SS}+45.0	V
		V_{OUT}	V_{SS} -0.3~V_{SS}+12	V
Output Current		I_{OUT}	350	mA
Power Dissipation	TO252-3L	Pd	1800	mW
Thermal Resistance	TO252-3L	$R_{\theta JA}$ [3]	150	℃/W ℃/W
Operating Temperature		Topr	-40~85	℃
Storage Temperature		Tstg	-40~125	℃
Soldering Temperature & Time		Tsolder	260℃, 10s	

Note (1): Exceeding these ratings may damage the device.

Note (2): The device is not guaranteed to function outside of its operating conditions

Note (3): The package thermal impedance is calculated in accordance to JESD 51-7.

ESD Ratings

Item	Description	Value	Unit
$V_{(ESD-HBM)}$	Human Body Model (HBM) ANSI/ESDA/JEDEC JS-001-2014 Classification, Class: 2	±4000	V
$V_{(ESD-CDM)}$	Charged Device Mode (CDM) ANSI/ESDA/JEDEC JS-002-2014 Classification, Class: C0b	±200	V
$I_{LATCH-UP}$	JEDEC STANDARD NO.78E APRIL 2016 Temperature Classification, Class: I	±150	mA

ESD testing is performed according to the respective JESD22 JEDEC standard.The human body model is a 100 pF capacitor discharged through a 1.5kΩ resistor into each pin. The machine model is a 200pF capacitor discharged directly into each pin.

Recommended Operating Conditions

Parameter	MIN.	MAX.	Units
Supply voltage at V_{IN}	---	30	V
Operating junction temperature range, Tj	-40	125	°C
Operating free air temperature range, TA	-40	85	°C

Note : All limits specified at room temperature (TA = 25°C) unless otherwise specified. All room temperature limits are 100% production tested. All limits at temperature extremes are ensured through correlation using standard Statistical Quality Control (SQC) methods. All limits are used to calculate Average Outgoing Quality Level (AOQL).

Electrical characteristics

（At T_A=25°C, C_{IN}=1uF, V_{IN}=V_{OUTNOM}+1.0V, C_{OUT}=10µF, unless otherwise noted）

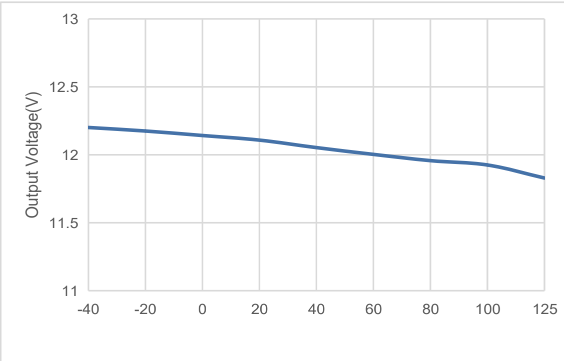
Symbol	Parameter	Test Conditions	Min	Typ.	Max	Units
V_{IN}	Input Voltage		3.0	—	40	V
I_Q	Quiescent Current	V_{IN}=12V No load	—	3.0	6.0	µA
V_{OUT}	Output Voltage	V_{IN}=12V I_{OUT} =10mA	-2.0		+2.0	%
I_{SD}	Shutdown Ground Current	V_{IN}=0V	—	—	0.1	µA
I_{LEAK}	V_{OUT} Shutdown Leakage Current	V_{OUT} = 0V	—	—	0.1	µA
I_{OUT_MAX}	Output Current		—	350	—	mA
V_{DROP}	Dropout Voltage(1)	I_{OUT} =10mA V_{IN} = V_{OUTNOM}-0.1V	—	40	—	mV
		I_{OUT} =100mA V_{IN} = V_{OUTNOM}-0.1V	—	400	—	mV
ΔLOAD	Load Regulation	V_{IN}= V_{OUT} +1V 1mA≤I_{OUT}≤100mA	—	40	—	mV
ΔLINE	Line Regulation	I_{OUT}=1mA, V_{OUTNOM} +0.5V≤V_{IN}≤40V	—	0.01	—	%/V
PSRR	Power Supply Rejection Ratio	V_{IN}=14V , I_{OUT} =10mA f=10KHz, V_{OUT} =12V	—	60	—	dB
I_{LIMIT}	Current Limit	V_{IN}= V_{OUT} +1V	300	350	400	mA
I_{SHORT}	Short /Start Load Current	RL=1Ω		100		mA
e_{NO}	Output Noise Voltage	10Hz to 100kHz C_{OUT}=1µF	—	100	—	µVRMS
T_{SD}	Thermal Shutdown Temperature		—	150	—	℃
$ΔT_{SD}$	Thermal Shutdown Hysteresis		—	20	—	℃

Note：*1 Dropout Voltage is the voltage difference between the input and the output at which the output voltage drops 2% below its nominal value.

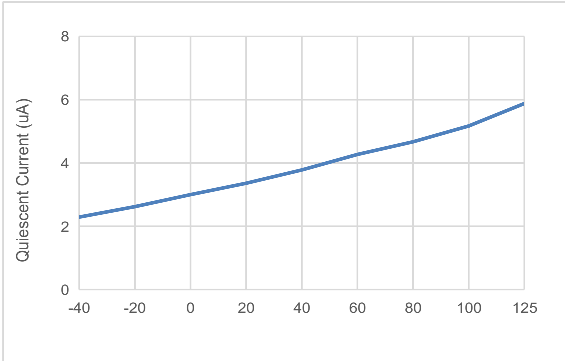
Typical Characteristics(Continued)

VOLTAGE VERSION 12V

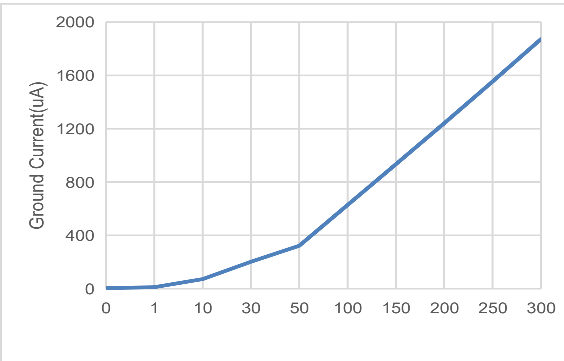
(V_{OUT} =12V, V_{IN} =14V, C_{IN} = C_{OUT} = 1.0μF, unless otherwise noted.Typical values are at T_A = +25°C.)



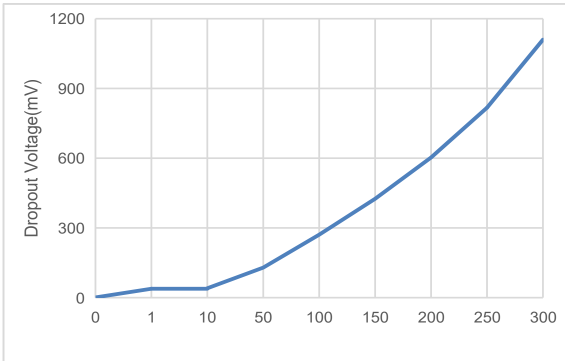
Output Voltage VS Temperature



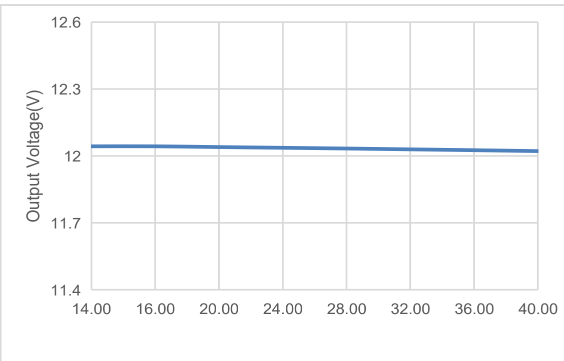
Quiescent Current VS Temperature



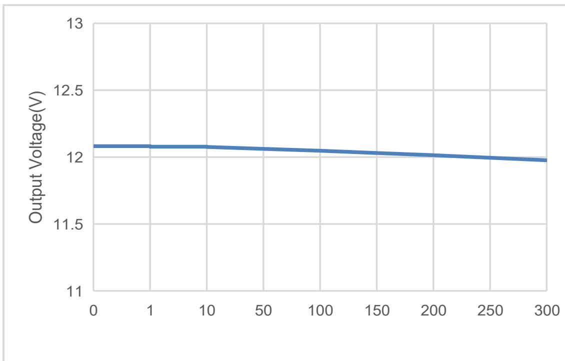
Ground Current VS Output Current



Dropout Voltage VS Output Current



Output Voltage VS Input Voltage

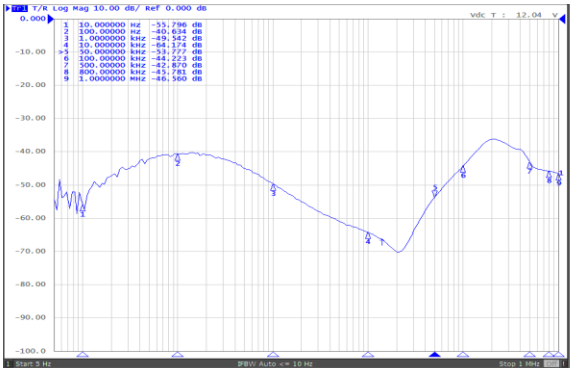


Output Voltage VS Output Current

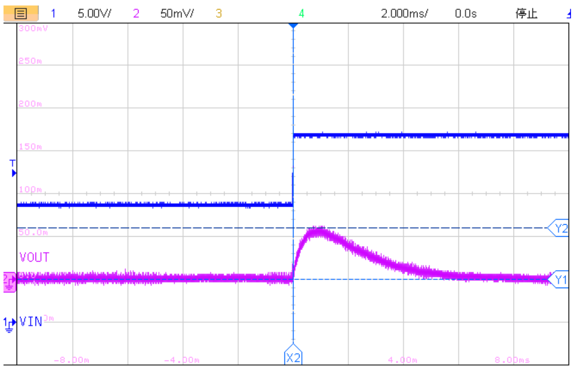
Typical Characteristics(Continued)

VOLTAGE VERSION 12V

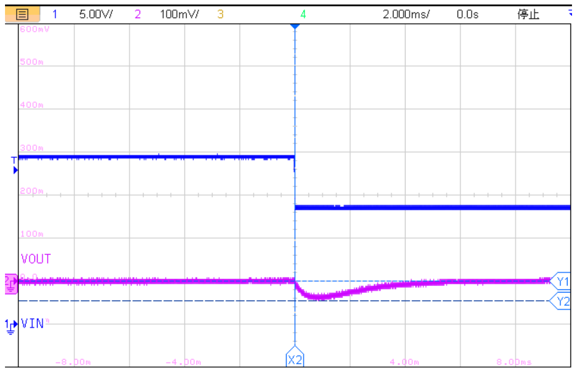
(V_{OUT} =12V, V_{IN} =14V, C_{IN} = C_{OUT} = 1.0μF, unless otherwise noted.Typical values are at T_A = +25°C.)



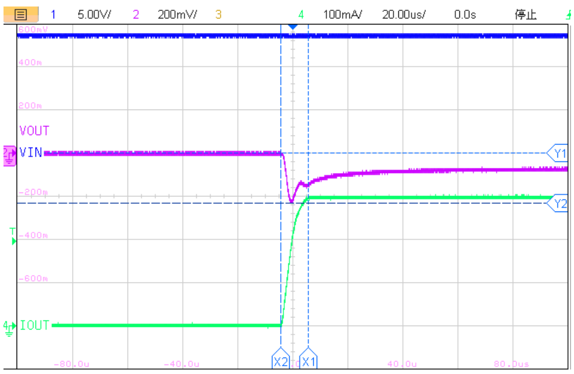
PSRR VS Output Current



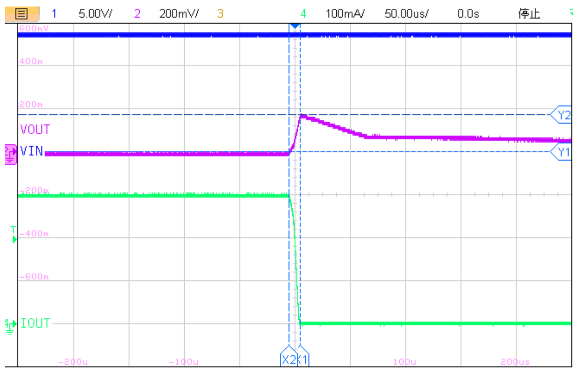
Input Transient(14~22V t=10μs 10mA)



Input Transient(22~14V t=10μs 10mA)



Load Transient(1mA~300mA t=10μs)



Load Transient(300mA~1mA t=10μs)

Application Guideline

Input Capacitor

A 10μF ceramic capacitor is recommended to connect between V_{DD} and GND pins to decouple input power supply glitch and noise. The amount of the capacitance may be increased without limit. This input capacitor must be located as close as possible to the device to assure input stability and less noise. For PCB layout, a wide copper trace is required for both VIN and GND.

Output Capacitor

An output capacitor is required for the stability of the LDO. The recommended output capacitance is 10μF, ceramic capacitor is recommended, and temperature characteristics are X7R or X5R. Higher capacitance values help to improve load/line transient response. The output capacitance may be increased to keep low undershoot/overshoot. Place output capacitor as close as possible to VOUT and GND pins.

Dropout Voltage

The dropout voltage refers to the voltage difference between the VIN and VOUT pins while operating at specific output current. The dropout voltage VDROP also can be expressed as the voltage drop on the pass-FET at specific output current (IRATED) while the pass-FET is fully operating at ohmic region and the pass-FET can be characterized asan resistance RDS(ON). Thus the dropout voltage can bedefined as (VDROP = VIN − VOUT = RDS(ON) x IRATED). Fornormal operation, the suggested LDO operating range is (VIN > VOUT + VDROP) for good transient response and PSRR ability. Vice versa, while operating at the ohmic region will degrade the performance severely.

Thermal Application

For continuous operation, do not exceed the 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 as below: TA=25°C, PCB,

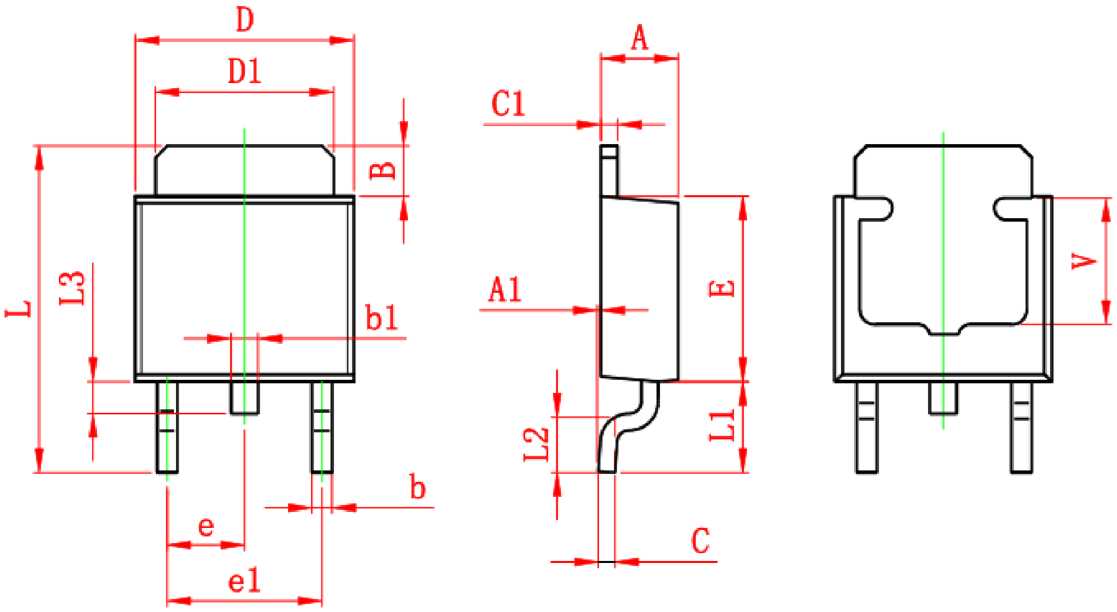
The max PD= (125°C − 25°C) / (Thermal Resistance °C/W)

Power dissipation (PD) is equal to the product of the output current and the voltage drop across the output pass element, as shown in the equation below:

PD = (VIN – VOUT) × IOUT

■ PACKAGING INFORMATION

TO-252-2L PACKAGE OUTLINE DIMENSIONS



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min.	Max.	Min.	Max.
A	2.200	2.400	0.087	0.094
A1	0.000	0.127	0.000	0.005
B	1.350	1.650	0.053	0.065
b	0.500	0.700	0.020	0.028
b1	0.700	0.900	0.028	0.035
c	0.430	0.580	0.017	0.023
c1	0.430	0.580	0.017	0.023
D	6.350	6.650	0.250	0.262
D1	5.200	5.400	0.205	0.213
E	5.400	5.700	0.213	0.224
e	2.300 TYP.		0.091 TYP.	
e1	4.500	4.700	0.177	0.185
L	9.500	9.900	0.374	0.390
L1	2.550	2.900	0.100	0.114
L2	1.400	1.780	0.055	0.070
L3	0.600	0.900	0.024	0.035
V	3.800 REF.		0.150 REF.	