Advanced Power Electronics Corp.

APE1085-HF-3

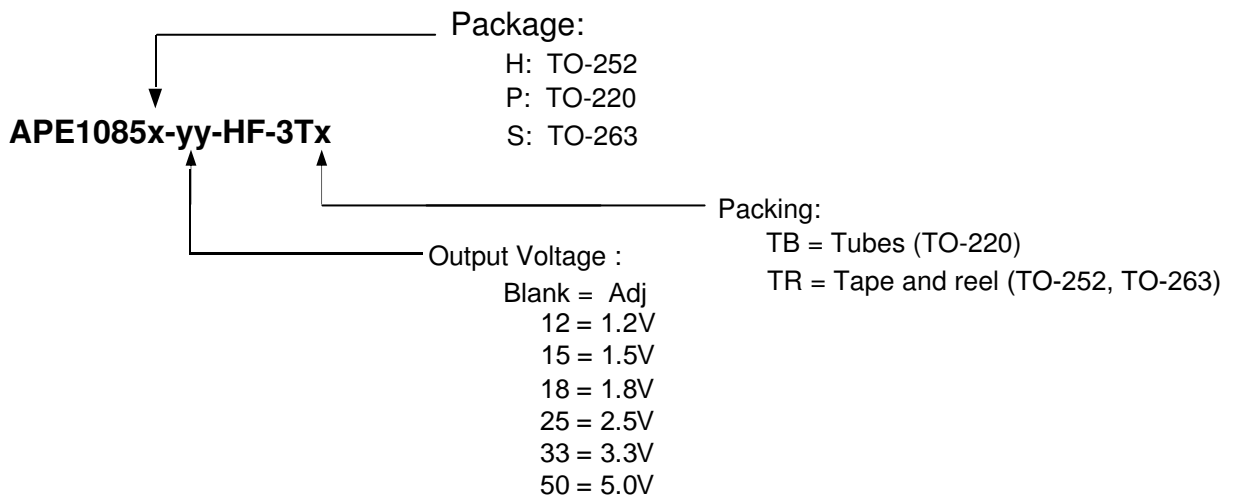## 3A Low Dropout Regulator

Features

- 3-Terminal Adjustable or Fixed 1.2V, 1.5V, 1.8V, 2.5V, 3.3V or 5.0V Output
- Maximum Dropout 1.4V at Full Load Current
- Fast Transient Response
- Built-in Thermal Shutdown
- Output Current Limiting
- Good Noise Rejection
- Packages: TO-220, TO-252, TO-263
- RoHS-compliant halogen-free packages

Description

The APE1085 is a low dropout positive adjustable or fixed-mode regulator with minimum output current capability of 3.0A. The product is specifically designed to provide a well-regulated supply for low-voltage IC applications such as high-speed bus termination and low current 3.3V logic supplies.
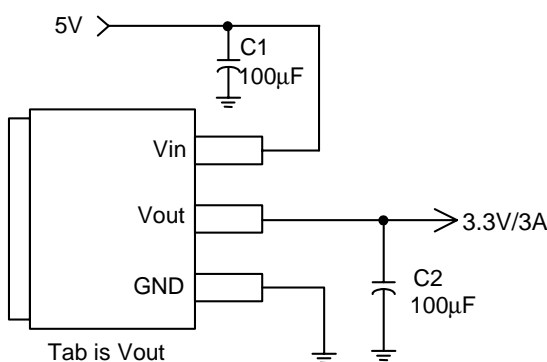
The APE1085 is also well suited for other applications such as VGA cards, and is guaranteed to have less than 1.4V dropout at full load current, making it ideal for providing well-regulated outputs of 1.2V to 5.0V from inputs up to 12V inputs.
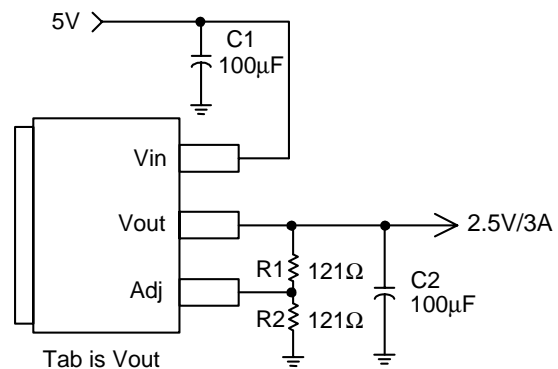
Ordering Information

APE1085x-yy-HF-3Tx

Package:
- H: TO-252
- P: TO-220
- S: TO-263

Output Voltage :
- Blank = Adj
- 12 = 1.2V
- 15 = 1.5V
- 18 = 1.8V
- 25 = 2.5V
- 33 = 3.3V
- 50 = 5.0V

Packing:
- TB = Tubes (TO-220)
- TR = Tape and reel (TO-252, TO-263)

Typical Applications

5.0V to 3.3V Fixed Mode Regulator

Adjustable Regulator

Note: $V_O = V_{REF} * (1 + \dfrac{R_2}{R_1})$

Absolute Maximum Ratings

Symbol	Parameter	Rating	Unit
Vin	DC Supply Voltage	-0.3 to 12	V
P_D	Power Dissipation	Internally Limited	
T_{ST}	Storage Temperature	-65 to +150	℃
T_{OP}	Operating Junction Temperature Range	0 to +150	℃

Electrical Specifications

Sym.	Parameter	Conditions (Notes)	Min.	Typ.	Max.	Unit
V_{REF}	Reference Voltage	Io=10mA, Tj=25°C, (Vin-Vout)=1.5V	1.225	1.250	1.275	V
Line Regulation	APE1085-XX	I_O=10mA, V_{OUT}+1.5V<V_{IN}<12V, T_J=25°C		0.2	0.5	%
	APE1085-12	I_{OUT} = 10mA, T_J = 25°C, 3V<V_{IN}<12V	1.176	1.200	1.224	V
	APE1085-15	I_{OUT} = 10mA, T_J = 25°C, 3V<V_{IN}<12V	1.470	1.500	1.530	V
	APE1085-18	I_{OUT} = 10mA, T_J = 25°C, 3.3V<V_{IN}<12V	1.764	1.800	1.836	V
	APE1085-25	I_{OUT} = 10mA, T_J = 25°C, 4V<V_{IN}<12V	2.450	2.500	2.550	V
	APE1085-33	I_{OUT} = 10mA, T_J = 25°C, 4.8V<V_{IN}<12V	3.235	3.300	3.365	V
	APE1085-50	I_{OUT} = 10mA, T_J = 25°C, 6.5V<V_{IN}<12V	4.900	5.000	5.100	V
Load Regulation	APE1085-Adj	V_N=3.3V, 0mA<Io<3A, T_J=25°C (Note 1,2)			1	%
	APE1085-12	V_N=3V, 0mA<Io<3A, T_J=25°C (Note 1,2)		10	12	mV
	APE1085-15	V_N=3V, 0mA<Io<3A, T_J=25°C (Note 1,2)		12	15	mV
	APE1085-18	V_N=3.3V, 0mA<Io<3A T_J=25°C (Note 1,2)		15	18	mV
	APE1085-25	V_N=4V, 0mA<Io<3A T_J=25°C (Note 1,2)		20	25	mV
	APE1085-33	V_N = 5V, 0mA<Io<3A , T_J=25°C (Note 1,2)		26	33	mV
	APE1085-50	V_N = 8V, 0mA<Io<3A, T_J=25°C (Note 1,2)		40	50	mV
ΔVo	Dropout Voltage	Io=3.0A (ΔVout = 1% Vout)		1.3	1.4	V
	Current Limit	Vin-Vout=5V	5.1			A
	Minimum Load Current			5	10	mA
	Temperature Stability	Io=10mA		0.5		%
$θ_{JA}$	Thermal Resistance Junction-to-Ambient (No heat sink ;No air flow)	TO-252 TO-263 TO-220		98 83 83		°C/W
$θ_{JC}$	Thermal Resistance Junction-to-Case	TO-252: Control Circuitry/Power Transistor TO-263: Control Circuitry/Power Transistor TO-220: Control Circuitry/Power Transistor		10 0.65/2.7 0.65/2.7		°C/W

Note 1: See thermal regulation specifications for changes in output voltage due to heating effects. Line and load regulation are measured at a constant junction temperature by low duty cycle pulse testing. Load regulation is measured at the output lead = 1/18" from he package.

Note 2:Line and load regulation are guaranteed up to the maximum power dissipation of 15W. Power dissipation is determined by the difference in input and output and the output current. Guaranteed maximum power dissipation will not be available over the full input/output range.

Pin Configuration

TO263
FRONT VIEW

3 — Vin
2 — Vout
1 — Adj (GND)

Tab is Vout

TO252
FRONT VIEW

3 — Vin
2 — Vout
1 — Adj (GND)

Tab is Vout

TO220
FRONT VIEW

3 — Vin
2 — Vout
1 — Adj (GND)

Tab is Vout
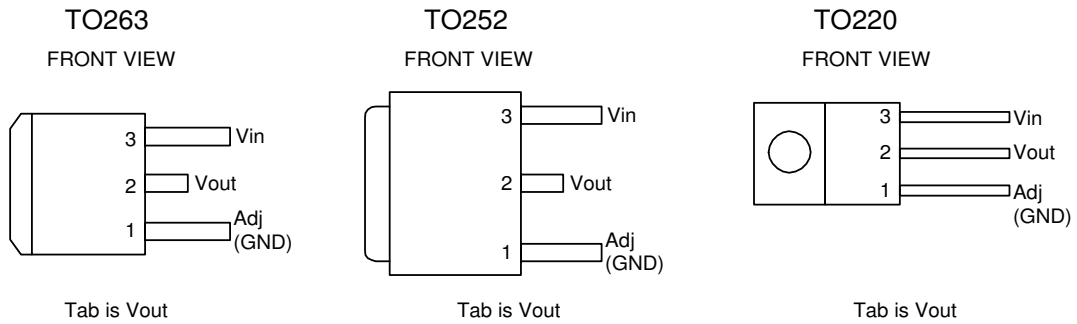
Pin Descriptions

Name	I/O	Pin No.	Function
Adj (GND)	I	1	Adjustable (Ground only for fixed mode) A resistor divider from this pin to the Vout pin and ground sets the output voltage.
Vout	O	2	The output of the regulator. A capacitor of at least 10uF with $(0.15\Omega < ESR < 20\Omega)$ must be connected from this pin to ground to ensure stability.
Vin	I	3	The input pin of regulator. Typically a large storage capacitor with $(0.15\Omega < ESR < 20\Omega)$ is connected from this pin to ground to ensure that the input voltage does not sag below the minimum dropout voltage during the load transient response. This pin must always be 1.4V (1.3V) higher than Vout in order for the device to regulate properly.

Block Diagram
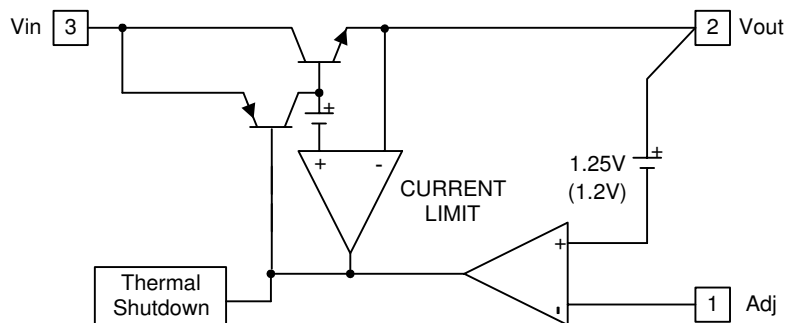
Vin [3]   [2] Vout

CURRENT LIMIT

1.25V (1.2V)

Thermal Shutdown

[1] Adj
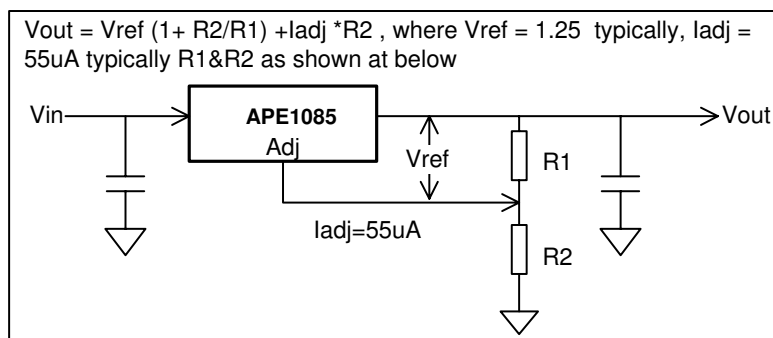
Application Information

Introduction
The APE1085 adjustable Low Dropout (LDO) regulator is a 3-terminal device that can easily be programmed with the addition of two external resistors to any voltage within the range of 1.20V to Vin-1.4V. The APE1085 only needs 1.4V differential between Vin and Vout to maintain output regulation. In addition, the output voltage tolerances are also extremely tight and they include the transient response as part of the specification. For example, Intel VRE specification calls for a total of +/- 100mV including initial tolerance, load regulation and 0 to 3.0A load step.

The APE1085 is specifically designed to meet the fast current transient needs as well as providing an accurate initial voltage, reducing the overall system cost with the need for fewer output capacitors.

Output Voltage Setting
The APE1085 can be programmed to any voltages in the range of 1.20V to Vin-1.4V with the addition of R1 and R2 external resistors according to the following formula:

$$V_{out} = V_{ref}(1 + R2/R1) + I_{adj} * R2, \text{ where } V_{ref} = 1.25 \text{ typically, } I_{adj} = 55uA \text{ typically } R1\&R2 \text{ as shown at below}$$

The APE1085 keeps a constant 1.25V between the output pin and the adjust pin. By placing a resistor R1 across these two pins a constant current flows through R1, adding to the **Iadj** current and into the R2 resistor producing a voltage equal to the (1.25/R1)*R2+Iadj*R2 which will be added to the 1.25V to set the output voltage. This is summarized in the above equation. Since the minimum load current requirement of the APE1085 is 10mA, R1 is typically selected to be 121Ω resistor so that it automatically satisfies the minimum current requirement. Notice that since Iadj is typically in the range of 55uA it only adds a small error to the output voltage and should only be considered when a very precise output voltage setting is required. For example, in a typical 3.3V application where R1=121Ω and R2=200Ω the error due to **Iadj** is only 0.3% of the nominal set point.

Load Regulation
Since the APE1085 is only a 3-terminal device, it is not possible to provide true remote sensing of the output voltage at the load. The best load regulation is achieved when the bottom side of R2 is connected to the load and the top-side of R1 resistor is connected directly to the case or the Vout pin of the regulator and not to the load. It is important to note that for high current applications, this can represent a significant percentage of the overall load regulation and one must

keep the path from the regulator to the load as short as possible to minimize this effect.

Stability
The APE1085 requires the use of an output capacitor as part of the frequency compensation in order to make the regulator stable. For most applications an aluminum electrolytic capacitor of at least 10μF ensures both stability and good transient response.
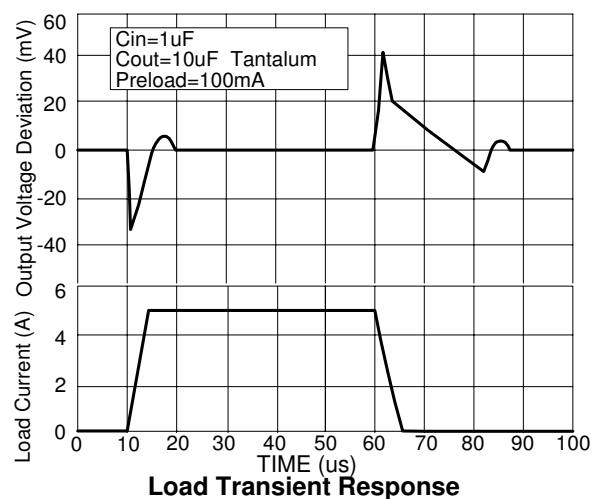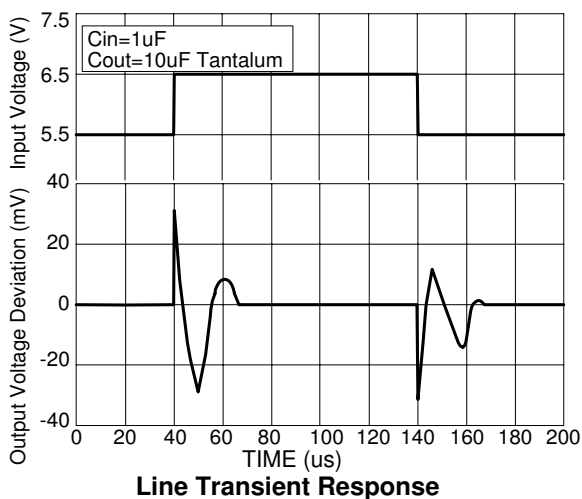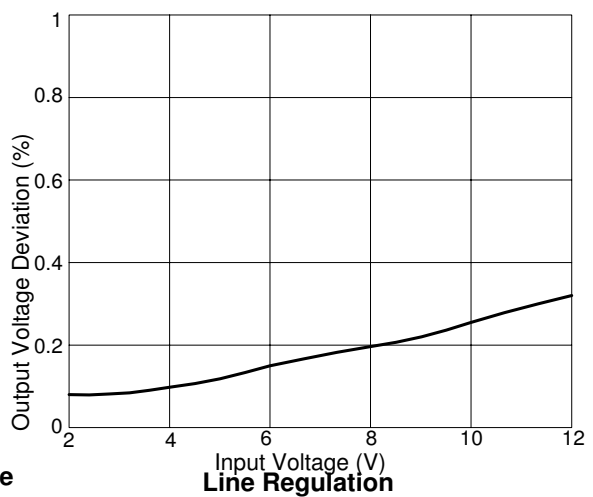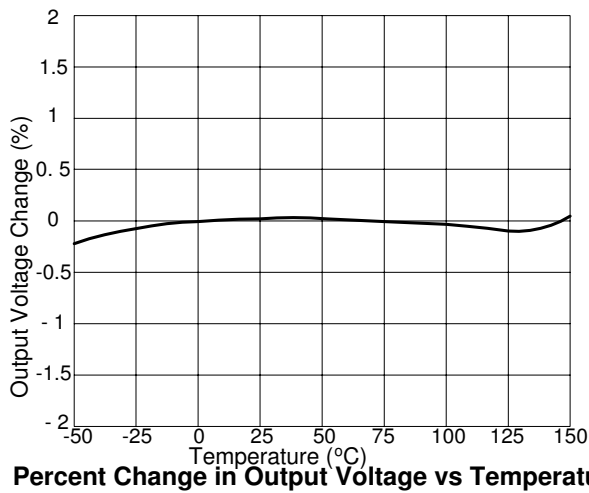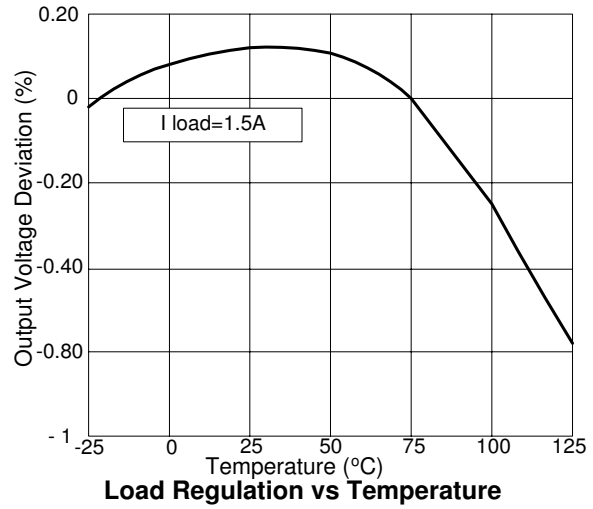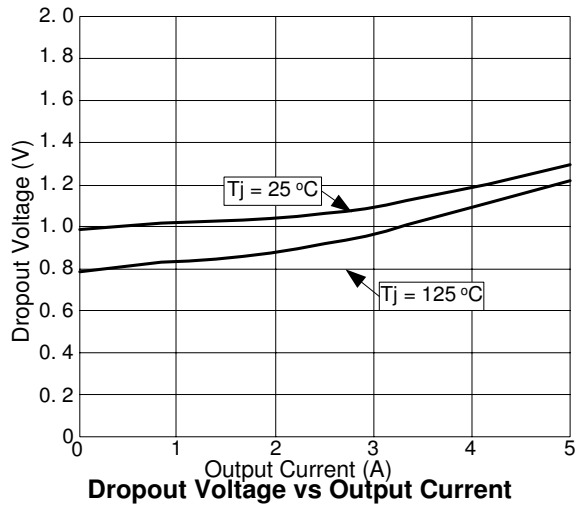
Thermal Design
The APE1085 incorporates an internal thermal shutdown that protects the device when the junction temperature exceeds the maximum allowable junction temperature. Although this device can operate with junction temperatures in the range of **150°C**, it is recommended that the selected heat sink be chosen such that during maximum continuous load operation the junction temperature is kept below this temperature.

Layout Consideration
The output capacitors must be located as close to the Vout terminal of the device as possible. It is recommended to use a section of a layer of the PC board as a plane to connect the Vout pin to the output capacitors to prevent any high frequency oscillation that may result due to excessive trace inductance.
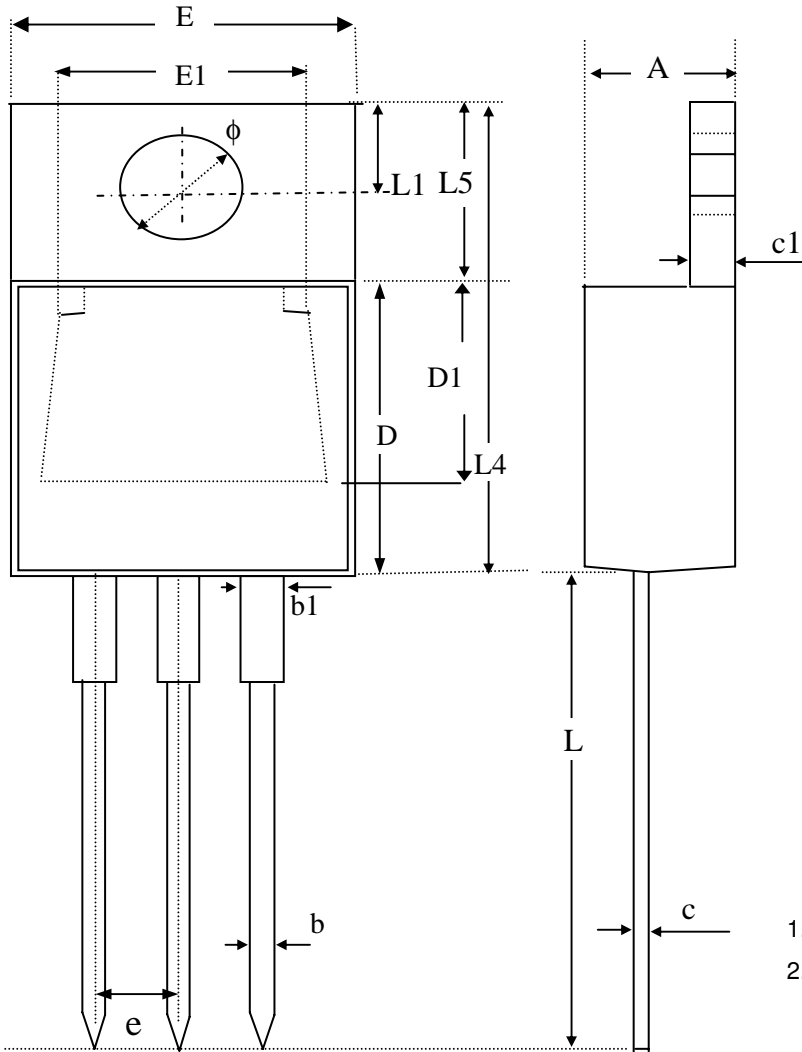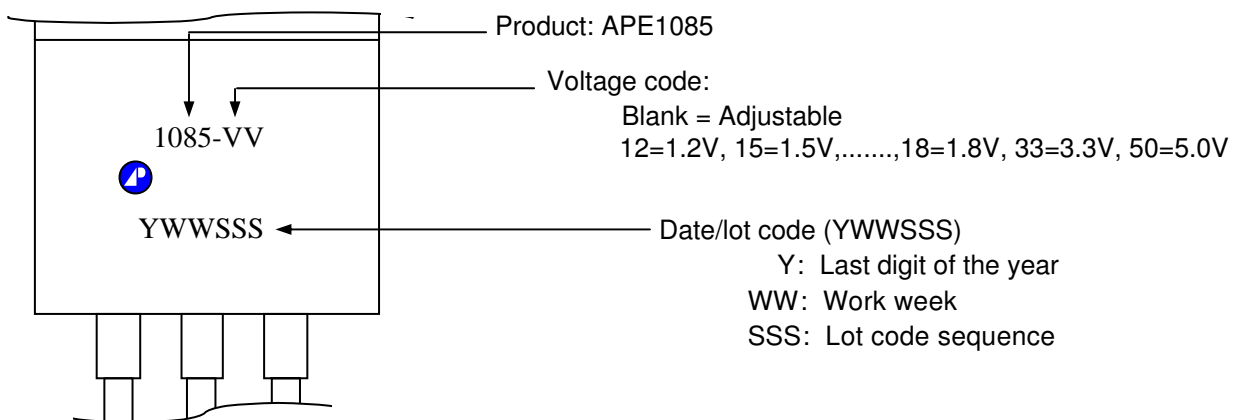
Typical Performance Characteristics

Dropout Voltage vs Output Current

Load Regulation vs Temperature

Percent Change in Output Voltage vs Temperature

Line Regulation

Line Transient Response

Load Transient Response

Package Dimensions: TO-220

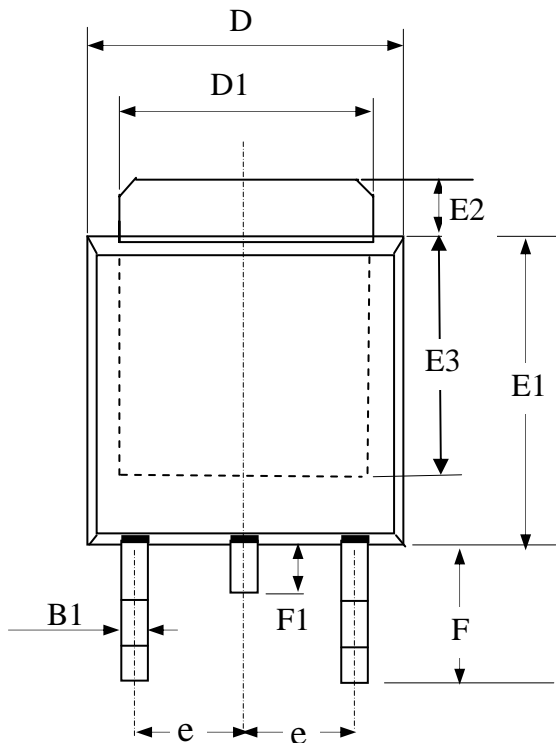| SYMBOLS	Millimeters		
	MIN	NOM	MAX
A	4.40	4.60	4.80
b	0.76	0.88	1.00
D	8.60	8.80	9.00
c	0.36	0.43	0.50
E	9.80	10.10	10.40
L4	14.70	15.00	15.30
L5	6.20	6.40	6.60
D1	5.10 REF.		
c1	1.25	1.35	1.45
b1	1.17	1.32	1.47
L	13.25	13.75	14.25
e	2.54 REF.		
L1	2.60	2.75	2.89
φ	3.71	3.84	3.96
E1	7.4 REF,		

1. All dimensions are in millimeters.

2. Dimensions do not include mold protrusions.
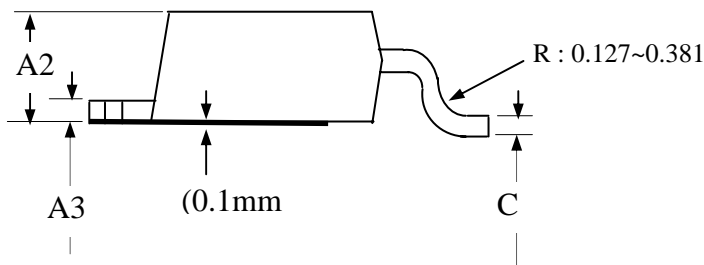
Marking Information: TO-220

Product: APE1085

Voltage code:
Blank = Adjustable
12=1.2V, 15=1.5V,.......,18=1.8V, 33=3.3V, 50=5.0V

Date/lot code (YWWSSS)
 Y: Last digit of the year
 WW: Work week
 SSS: Lot code sequence

1085-VV

YWWSSS

Package Dimensions: TO-252

SYMBOLS	Millimeters		
	MIN	NOM	MAX
A2	1.80	2.30	2.80
A3	0.40	0.50	0.60
B1	0.40	0.70	1.00
D	6.00	6.50	7.00
D1	4.80	5.35	5.90
E3	3.50	4.00	4.50
F	2.20	2.63	3.05
F1	0.50	0.85	1.20
E1	5.10	5.70	6.30
E2	0.50	1.10	1.80
e	--	2.30	--
C	0.35	0.50	0.65

1. All dimensions are in millimeters.

2. Dimensions do not include mold protrusions.
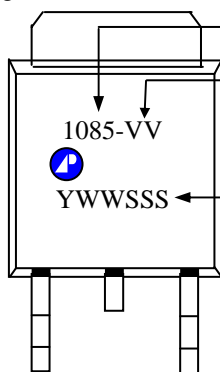
Marking Information: TO-252

Laser Marking

Product: APE1085

Voltage code
Blank = Adjustable
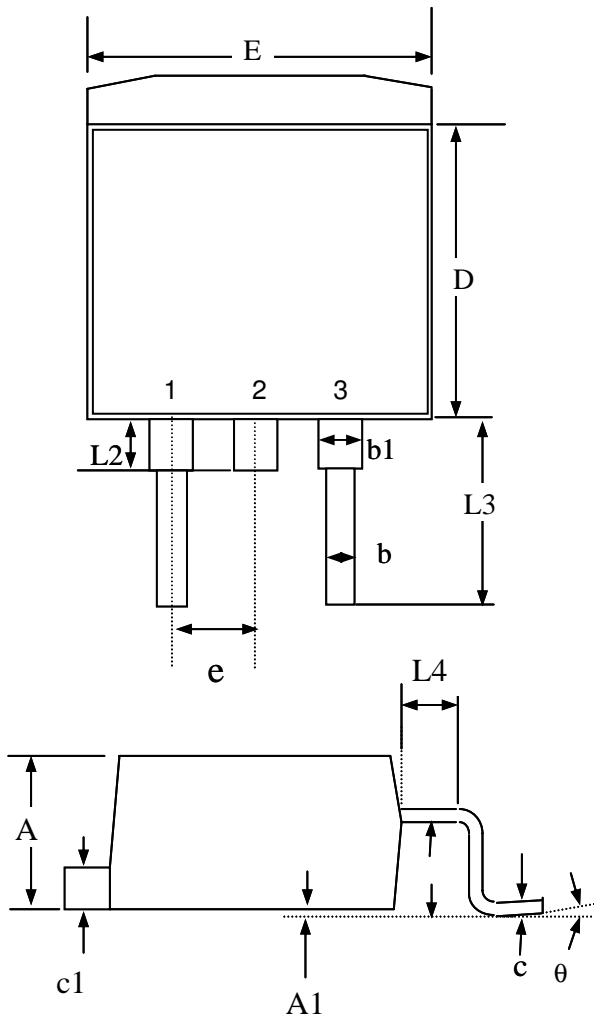12=1.2V, 15=1.5V,......,18=1.8V, 33=3.3V, 50=5.0V

1085-VV

YWWSSS

Date/lot code (YWWSSS)
Y: Last digit of the year
WW: Work week
SSS: Lot code sequence

Package Dimensions: TO-263

SYMBOLS	Millimeters		
	MIN	NOM	MAX
A	4.25	4.75	5.20
A1	0.00	0.15	0.30
A2	2.20	2.45	2.70
b	0.70	0.90	1.10
b1	1.07	1.27	1.47
c	0.30	0.45	0.60
c1	1.15	1.30	1.45
D	8.30	8.90	9.40
E	9.70	10.10	10.50
e	2.04	2.54	3.04
L2	-----	1.50	-----
L3	4.50	4.90	5.30
L4	-----	1.50	----

1. All dimensions are in millimeters.

2. Dimensions do not include mold protrusions.

Marking Information: TO-263

Product: APE1085

1085-VV

Voltage code:
   Blank = Adjustable
   12=1.2V, 15=1.5V,......,18=1.8V, 33=3.3V, 50=5.0V

YWWSSS

Date Code (YWWSSS)
   Y : Last digit of the year
   WW : Work week
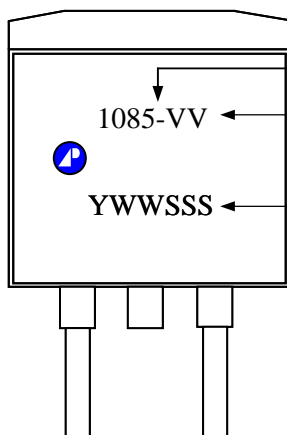   SSS : Lot code sequence