

## Description

The AP1686 is a high performance AC/DC power supply controller for LED lighting application. The device uses Pulse Frequency Modulation (PFM) method to build discontinuous conduction mode (DCM) flyback power supplies.

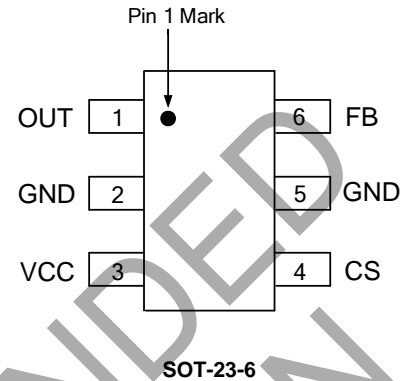
The AP1686 provides accurate constant voltage, constant current (CV/CC) regulation without requiring an opto-coupler and the secondary control circuitry. It also eliminates the need of loop compensation circuitry while maintaining good stability. The AP1686 can achieve excellent regulation and high average efficiency, yet meets no-load consumption less than 30mW.

It also has an adjustable built-in line compensation function to achieve tight CC.

The AP1686 is available in SOT-23-6 package.

## Pin Assignments

(Top View)



## Features

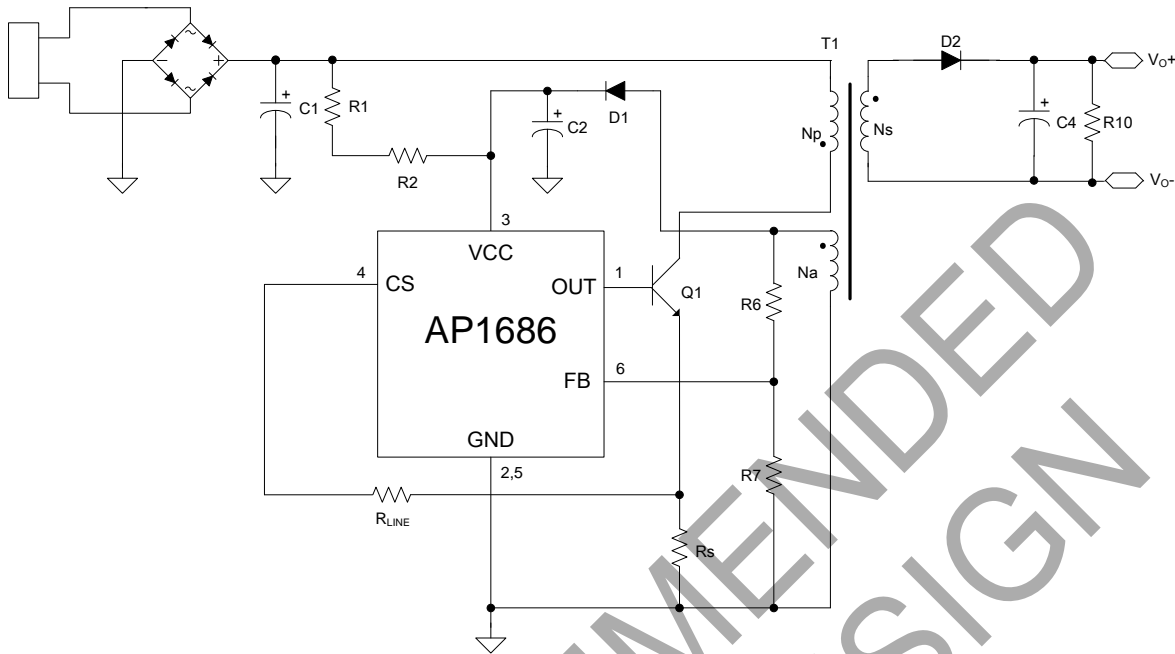
- Primary Side Control for Tight Constant Current and Constant Voltage
- 30mW No-load Input Power
- Bipolar Junction Transistor (BJT) Driving
- Open Circuit Protection
- Over Voltage Protection
- Short Circuit Protection
- SOT-23-6 Package

## Applications

- LED Driver

NOT RECOMMENDED FOR NEW DESIGN

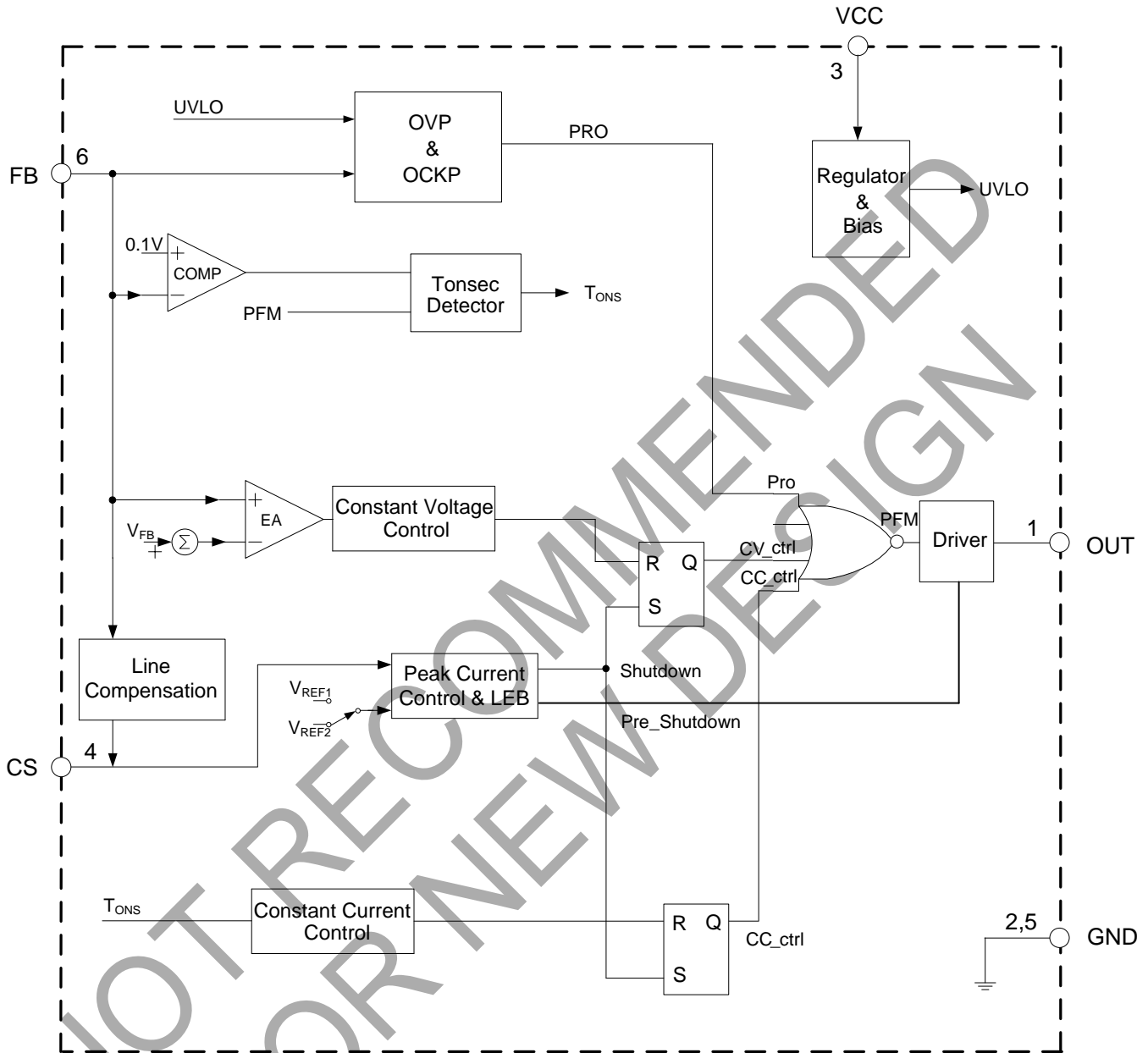
## Typical Applications Circuit



## Pin Descriptions

Pin Number	Pin Name	Function
1	OUT	The OUT pin is used to turn on and turn off the power switch. When turning on the power switch, the OUT pin will output 30mA source current to support the base current of the power BJT. When turning off the power switch, the resistance between the OUT and GND will become to 5Ω
2, 5	GND	The GND pin is the ground of the IC. When the power BJT is turned off, a fast reverse sinking current to the gate of BJT will flow out from this pin. Attention should be paid to in the PCB layout
3	VCC	The VCC pin supplies the power for the IC. In order to get the correct operation of the IC, a capacitor with low ESR should be placed as close as possible to the VCC pin
4	CS	The CS is the current sense pin of the IC. The IC will turn off the power BJT according to the voltage on the CS pin. When the power BJT is on, a current is output from the CS pin which is proportional to the line voltage to realize the function of line compensation
6	FB	The CV and CC regulation are realized based on the voltage sampling of this pin

**Functional Block Diagram**



### Absolute Maximum Ratings (Note 1)

Symbol	Parameter	Value	Unit
$V_{CC}$	Supply Voltage	-0.3 to 30	V
–	CS to GND Voltage	-0.3 to 7	V
$V_{FB}$	FB Input Voltage	-40 to 7.5	V
$I_{SOURCE}$	Source Current at OUT Pin	Internally Limited	A
$T_J$	Operating Junction Temperature	+150	°C
$T_{STG}$	Storage Temperature	-65 to +150	°C
$T_{LEAD}$	Lead Temperature (Soldering, 10 sec)	+300	°C
$\theta_{JA}$	Thermal Resistance (Junction to Ambient)	200	°C/W
–	ESD (Human Body Model)	2000	V

Note 1: Stresses greater than those listed under “Absolute Maximum Ratings” may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under “Recommended Operating Conditions” is not implied. Exposure to “Absolute Maximum Ratings” for extended periods may affect device reliability.

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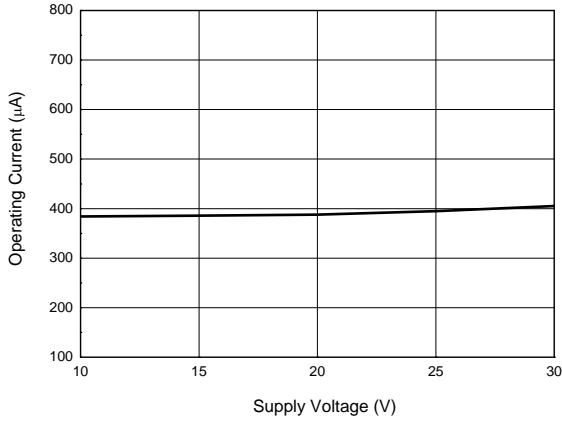
**Electrical Characteristics** ( $V_{CC} = 15V$ ,  $T_A = +25^\circ C$ , unless otherwise specified.)

Symbol	Parameter	Conditions	Min	Typ	Max	Unit		
<b>UVLO SECTION</b>								
$V_{TH}(ST)$	Startup Threshold	–	13	15.5	18	V		
$V_{OPR}(MIN)$	Minimal Operating Voltage	–	3	3.5	4.5	V		
<b>STANDBY CURRENT SECTION</b>								
$I_{ST}$	Startup Current	$V_{CC} = V_{TH}(ST) - 1V$ , Before startup	0	0.2	0.6	μA		
$I_{CC}(OPR)$	Operating Current	Static current	250	400	600			
<b>DRIVE OUTPUT SECTION</b>								
$I_{SINK}$	Output Current	Sink	Apply 1V @OUT pin		200	300	500	mA
$I_{SOURCE}$		Source	–	24	30	45	mA	
<b>CURRENT SENSE SECTION</b>								
$V_{CS}$	Current Sense Threshold Voltage	–	440	500	550	mV		
$\frac{\Delta V_{cs,eq}}{V_{cs,eq}}$	Equivalent Current Sense Voltage Accuracy (Note 2)	–	–	–	4	%		
$t_{LEB}$	Leading Edge Blanking	The minimum power switch turn on time	300	475	720	ns		
<b>FEEDBACK INPUT SECTION</b>								
$R_{FB}$	Input Resistance of FB Pin	$V_{FB} = 4V$	1	1.6	2	MΩ		
$V_{FB}$	Feedback Threshold	–	3.7	3.974	4.21	V		
<b>LINE COMPENSATION SECTION</b>								
$g_m$	Line Compensation Transconductance (Note 2)	–	1.14	1.43	1.72	μs		
<b>PROTECTION SECTION</b>								
$V_{FB}(OVP)$	Over Voltage Protection	–	6.5	7.5	8.5	V		
$tonp(MAX)$	Maximum On Time of Primary Side	–	11	18	50	μs		

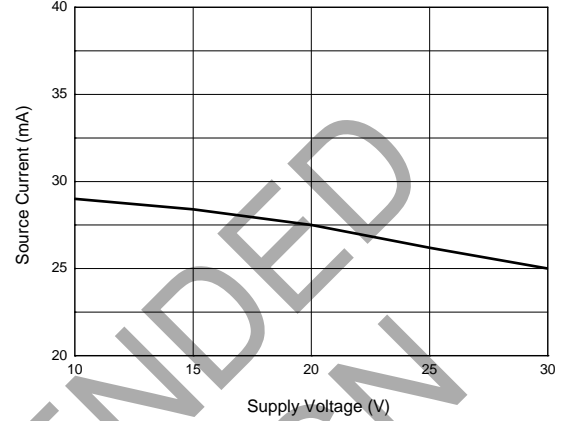
Note 2: The output current is given by  $I_{OUT} = \frac{V_{cs,eq}}{R_{cs}} \times \frac{N_p}{N_s}$

**Performance Characteristics**

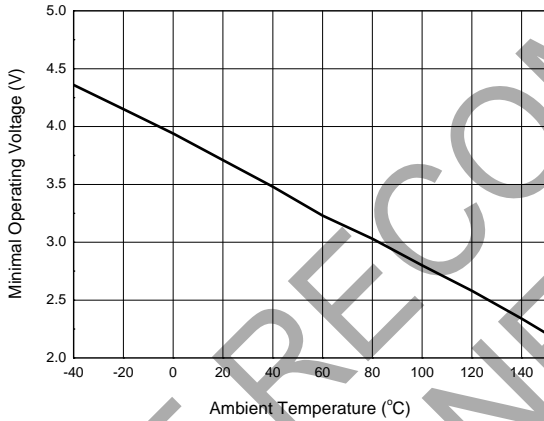
**Operating Current vs. Supply Voltage**



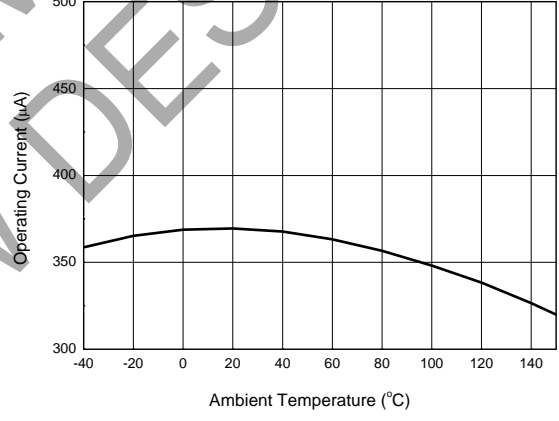
**Source Current vs. Supply Voltage**



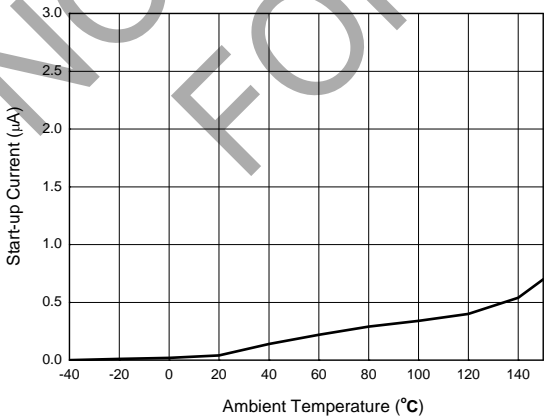
**Minimal Operating Voltage vs. Ambient Temperature**



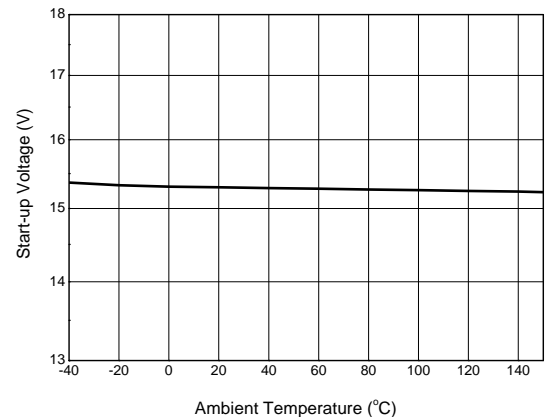
**Operating Current vs. Ambient Temperature**



**Start-up Voltage vs. Ambient Temperature**

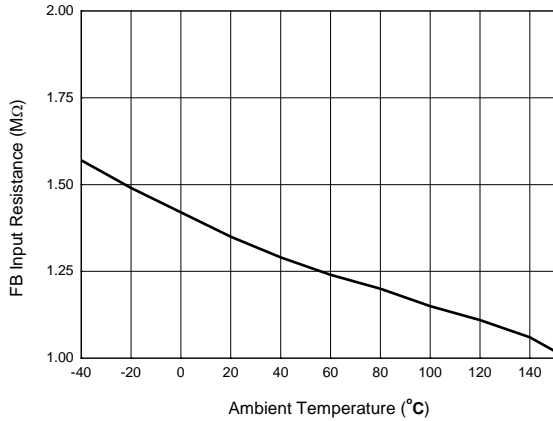


**Start-up Voltage vs. Ambient Temperature**

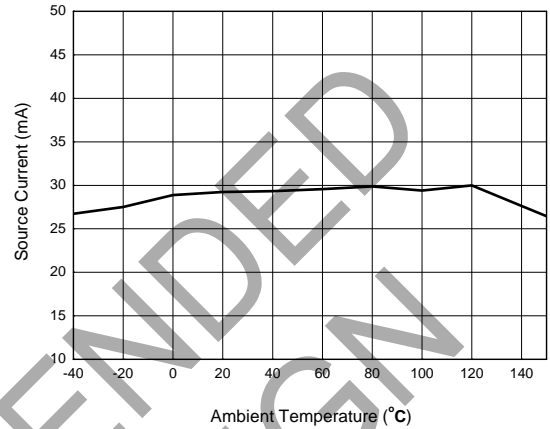


**Performance Characteristics (Cont.)**

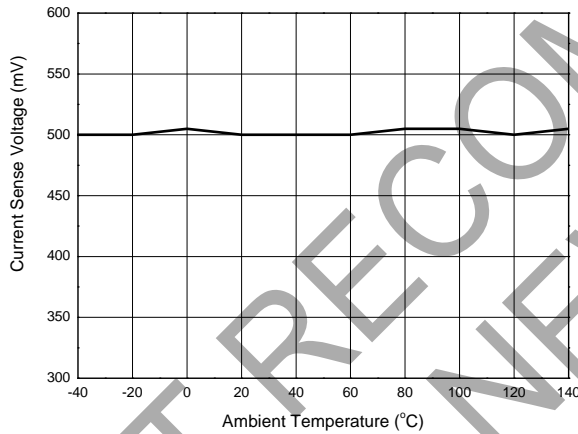
**FB Input Resistance vs. Ambient Temperature**



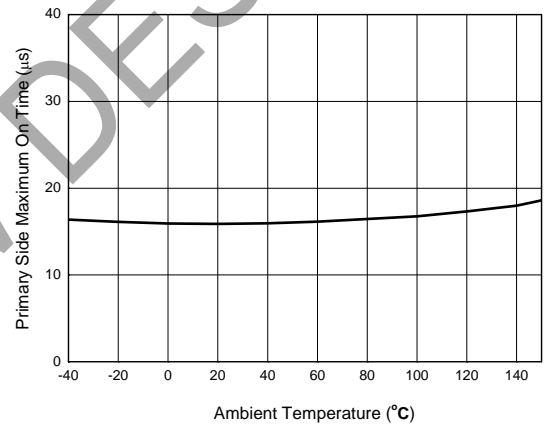
**Source Current vs. Ambient Temperature**



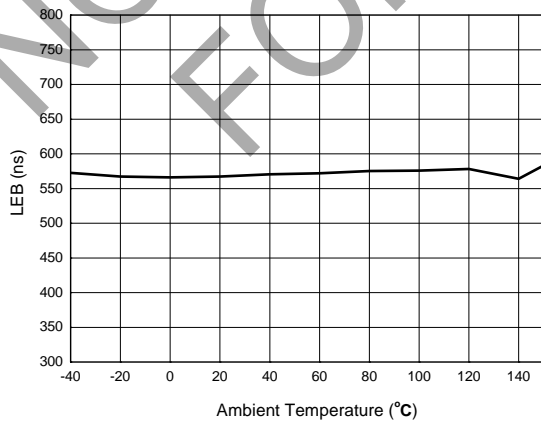
**Current Sense Voltage vs. Ambient Temperature**



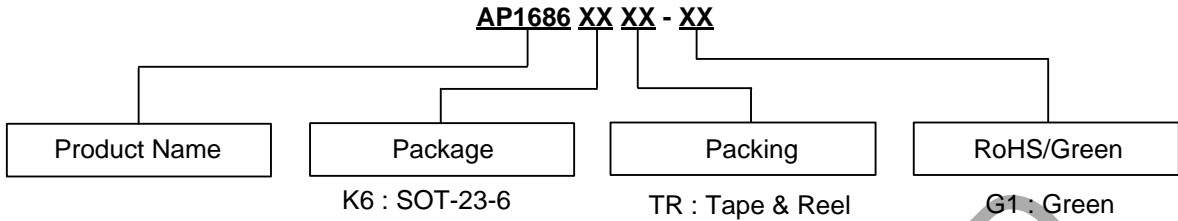
**Primary Side Maximum On Time vs. Ambient Temperature**



**LEB vs. Ambient Temperature**



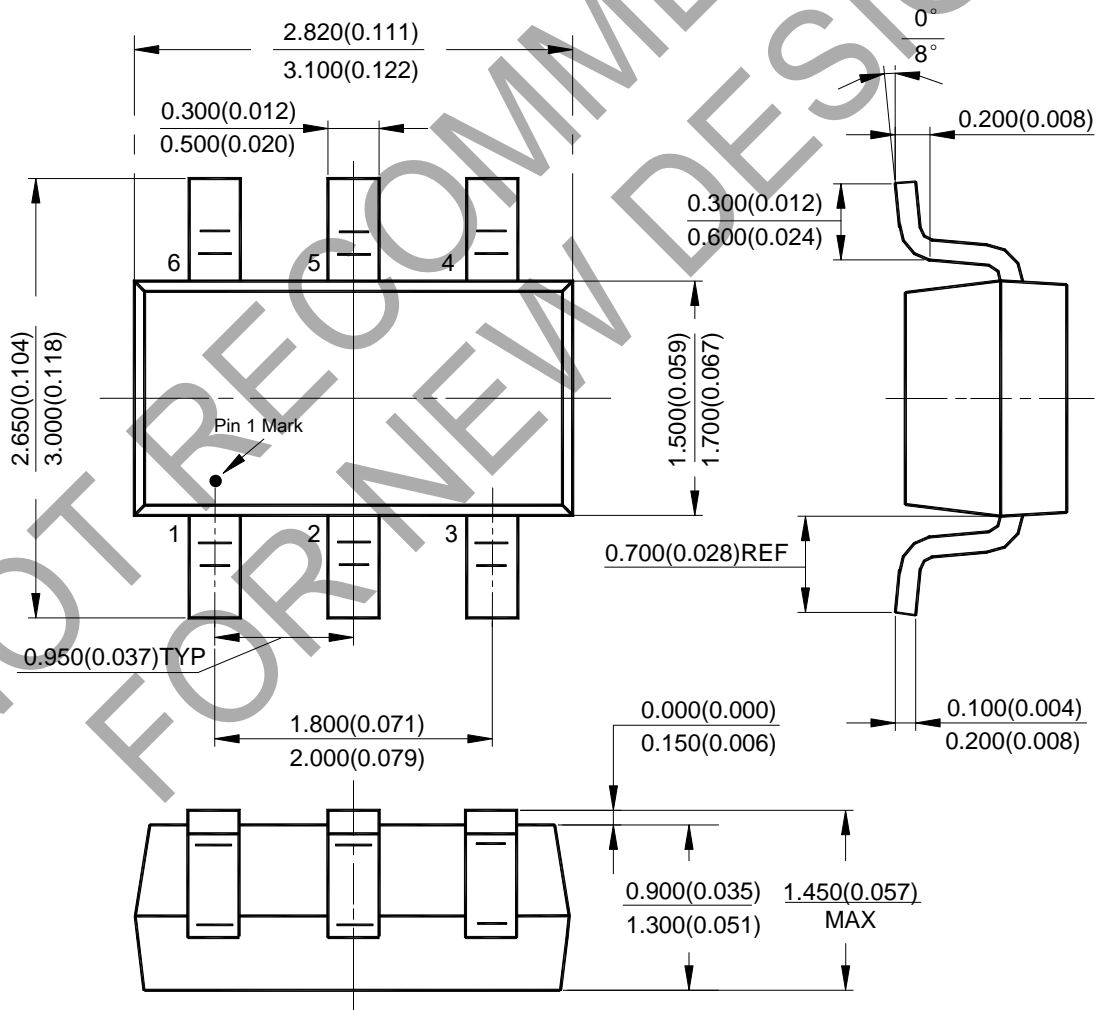
**Ordering Information**



Package	Temperature Range	Part Number	Marking ID	Packing
SOT-23-6	-40 to +85°C	AP1686K6TR-G1	GBQ	Tape & Reel

**Package Outline Dimensions** (All dimensions in mm(inch).)

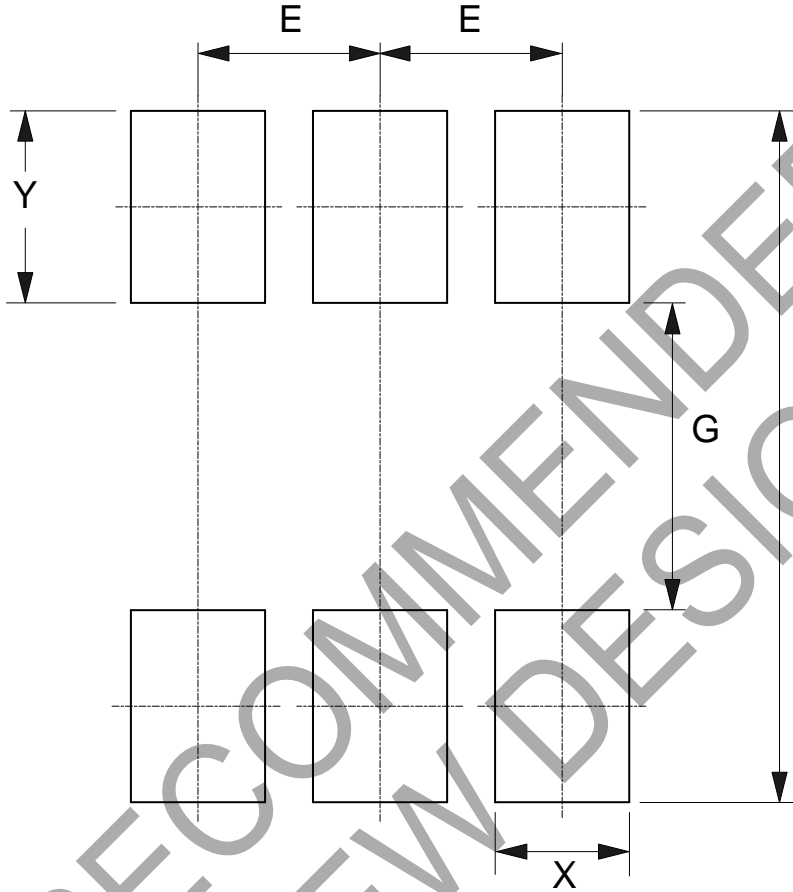
(1) Package Type: SOT-23-6





**Suggested Pad Layout**

(1) Package Type: SOT-23-6



Dimensions	Z (mm)/(inch)	G (mm)/(inch)	X (mm)/(inch)	Y (mm)/(inch)	E (mm)/(inch)
Value	3.600/0.142	1.600/0.063	0.700/0.028	1.000/0.039	0.950/0.037

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