Constant Voltage and Constant Current Controller

Features

- Constant Voltage and Constant Current Control
- Supply Voltage: 3 V to 36 V
- Low Supply Current: Maximum 200 μA
- Precision Internal Reference
  - Voltage Control Loop: 1.21 V
  - Current Control Loop: 50/70/100/150/200 mV
- Operating Temperature Range: −40°C to 125°C

Applications

- Power Module
- Adapter
- Led Lighting

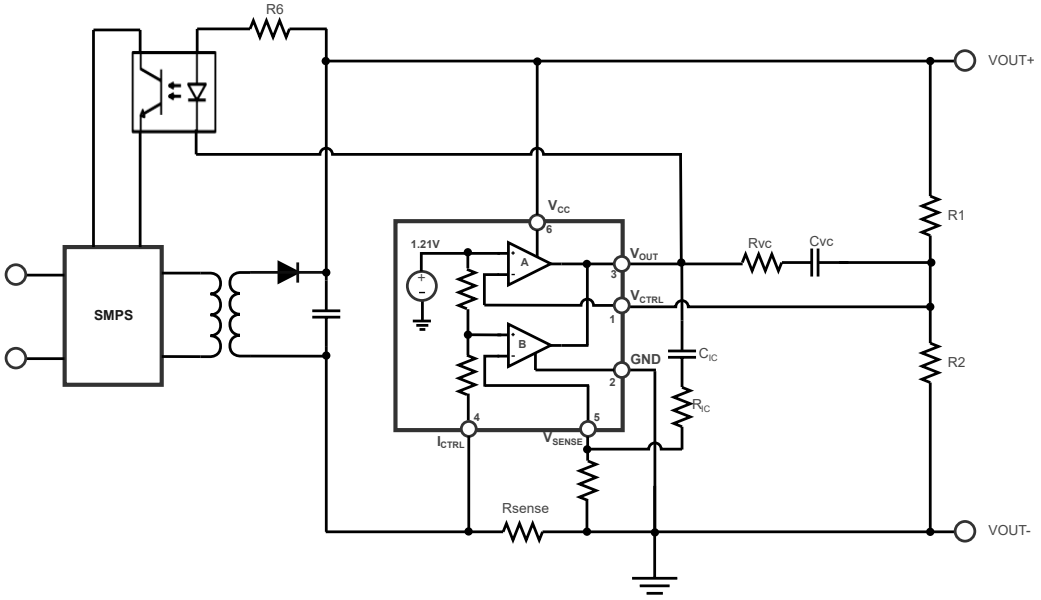
Description

The TPA725x is a highly integrated solution for SMPS (Switching Mode Power Supply) applications requiring voltage and current control loop.

The TPA725x series integrates two op amps with an open-drain output, a 1.21-V voltage reference, and a lower voltage reference for low-side current-sensing circuits.

The TPA725x series has a 200-μA supply current, which can be used in low-power applications.

Typical Application Circuit



TPA725x in a Constant-Current and Constant-Voltage Battery Charger

Table of Contents

Revision History

Date	Revision	Notes
2023-08-20	Rev.A.0	Initial version.
2024-12-18	Rev.A.1	The following updates are all about the new datasheet formats or typos, and the actual product remains unchanged. • Updated the Tape and Reel Information.

Pin Configuration and Functions

TPA725x
SOT23-6 Package
Top View

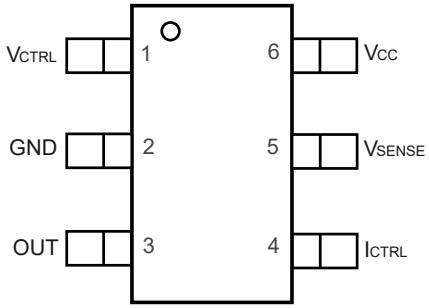


Table 1. Pin Functions: TPA725x

Pin		I/O	Description
No.	Name		
1	V_{CTRL}	I	Inverting input of the voltage loop op amp.
2	GND		Ground.
3	V_{OUT}	O	Common open-drain output of the two internal op amps.
4	I_{CTRL}	I	Non-inverting input of the current loop op amp.
5	V_{SENSE}	I	Inverting input of the current loop op amp.
6	V_{CC}		Power supply.

Specifications

Absolute Maximum Ratings (1)

Parameter		Min	Max	Unit
	Supply Voltage, V_{CC}		40	V
	Voltage on Input and Output Pins	– 0.3	V_{CC} + 0.3	V
	Input Current: V_{CTRL}, I_{CTRL}, V_{SENSE} (2)	−10	10	mA
	Output Short-Circuit Duration (3)		Infinite	
T_J	Maximum Junction Temperature		150	°C
T_A	Operating Temperature Range	−40	125	°C
T_{STG}	Storage Temperature Range	−65	150	°C
T_L	Lead Temperature (Soldering, 10 sec)		260	°C

(1) Stresses beyond those listed under Absolute Maximum Ratings may cause permanent damage to the device. Exposure to any Absolute Maximum Rating condition for extended periods may affect device reliability and lifetime.
(2) The inputs are protected by ESD protection diodes to each power supply. If the input extends more than 300 mV beyond the power supply, the input current should be limited to less than 10 mA.
(3) A heat sink may be required to keep the junction temperature below the absolute maximum. This depends on the power supply voltage and how many amplifiers are shorted. Thermal resistance varies with the amount of PC board metal connected to the package. The specified values are for short traces connected to the leads.

ESD, Electrostatic Discharge Protection

Symbol	Parameter	Condition	Minimum Level	Unit
HBM	Human Body Model ESD	ANSI/ESDA/JEDEC JS-001 (1)	2	kV
CDM	Charged Device Model ESD	ANSI/ESDA/JEDEC JS-002 (2)	1	kV

(1) JEDEC document JEP155 states that 500-V HBM allows safe manufacturing with a standard ESD control process.
(2) JEDEC document JEP157 states that 250-V CDM allows safe manufacturing with a standard ESD control process.

Recommended Operating Conditions

Parameter		Min	Typ	Max	Unit
V_S	Supply Voltage, V_{CC}	3		36	V
T_A	Operating Temperature Range	−40		125	°C

Thermal Information

Package Type	θ_{JA}	θ_{JC}	Unit
SOT23-6	250	81	°C/W

Electrical Characteristics

All test conditions: T_A = 25°C, V_{CC} = 5 V, unless otherwise noted.

Symbol	Parameter	Conditions	T_A	Min	Typ	Max	Unit
Power Supply							
V_{CC}	Supply Voltage Range			3		36	V
I_Q	Quiescent Current, No Load	V_{CC} = 36 V			150	185	μA
			−40 to 125°C			200	μA
		V_{CC} = 5 V			125	170	μA
			−40 to 125°C			200	μA
Voltage Control Loop							
GM_V	Transconduction Gain	Sink current only			8		mA/mV
V_{REF_V}	Voltage Reference for Voltage Control Loop			1.198	1.21	1.222	V
			−40 to 125°C	1.17		1.25	V
I_B	Input Bias Current		−40 to 125°C		200		pA
Current Control Loop							
GM_I	Transconduction Gain	Sink current only			6		mA/mV
V_{REF_I}	Voltage Reference for Current Control Loop; Connect V_{SENSE} to GND, V_{REF_I} = Voltage on V_{SENSE} – Voltage on I_{CTRL}	TPA7255			50		mV
			−40 to 125°C				mV
		TPA7256		66	70	74	mV
			−40 to 125°C	63		77	mV
		TPA7257			100		mV
			−40 to 125°C				mV
		TPA7258			150		mV
			−40 to 125°C				mV
		TPA7259			200		mV
			−40 to 125°C				mV
	Current Out of Pin I_{CTRL}			10	20	30	μA
			−40 to 125°C		25		μA
V_{OL}	Low-Level Output Voltage	I_{SINK} = 2 mA			100	200	mV
			−40 to 125°C			300	mV
I_{OS}	Output Short-Circuit Current	Sink current only		15	25		mA
			−40 to 125°C	10			mA

Typical Performance Characteristics

All test conditions: test chip is TPA7256, V_{CC} = 5 V, T_A = 25°C, unless otherwise noted.

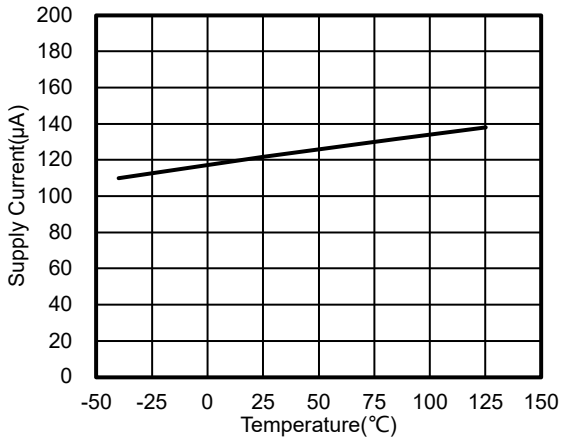


Figure 1. Supply Current vs. Temperature

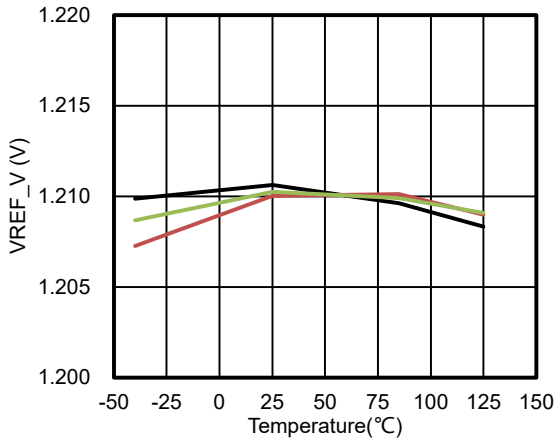


Figure 2. Reference for Voltage Loop vs. Temperature

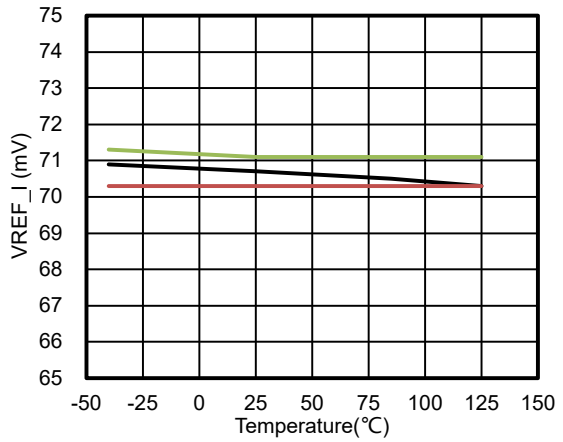


Figure 3. Reference for Current Loop vs. Temperature

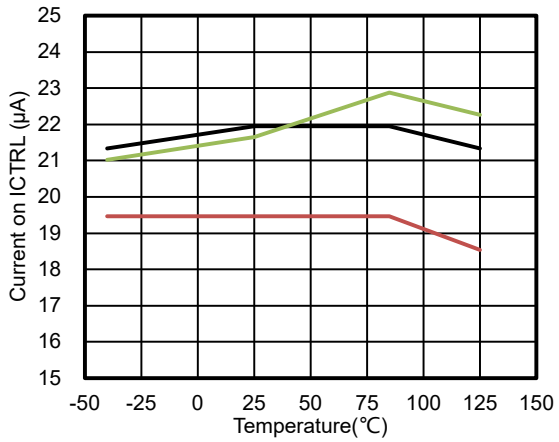


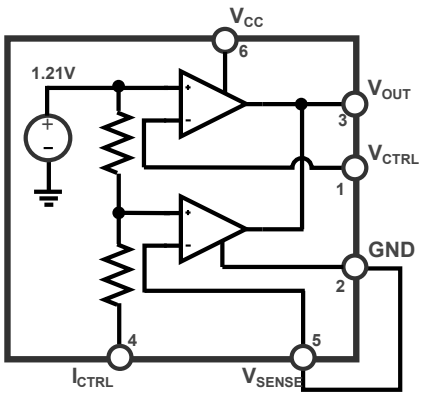
Figure 4. Current on I_{CTRL} vs. Temperature

Detailed Description

Overview

The TPA725x series integrates two op amps with an open-drain output, a 1.21-V voltage reference, and a lower-voltage reference for low-side current-sensing circuits.

Functional Block Diagram



V_{REF_V} = 1.21V

Connect Pin 5 to Pin 2.
V_{REF_I} = Voltage on V_{SENSE} Pin(Pin 5)
– Voltage on I_{CTRL} Pin(Pin 4)

V_{REF_I} voltage:
TPA7255: 50mV
TPA7256: 70mV
TPA7257: 100mV
TPA7258: 150mV
TPA7259: 200mV

Figure 5. Functional Block Diagram

Feature Description

Operating Voltage

The TPA725x series is designed for single-supply operation from 3 V to 36 V. The high-power supply voltage helps the TPA725x survive on the noisy power supply.

Low-Power Operation

The TPA725x series has a 200-μA power supply, which is very useful in low-power applications.

Application and Implementation

> Note
>
> Information in the following application sections is not part of the 3PEAK's component specification and 3PEAK does not warrant its accuracy or completeness. 3PEAK's customers are responsible for determining suitability of components for their purposes. Customers should validate and test their design implementation to confirm system functionality.

Application Information

Power Supply Recommendations

Place 0.1-μF bypass capacitors close to the power-supply pins to reduce coupling errors from the noise or high-impedance power supplies.

Typical Application

Figure 6 shows the typical application schematic.

Constant-Current and Constant-Voltage Battery Charger

Figure 6 shows the device configured in a constant-current and constant-voltage battery charger.

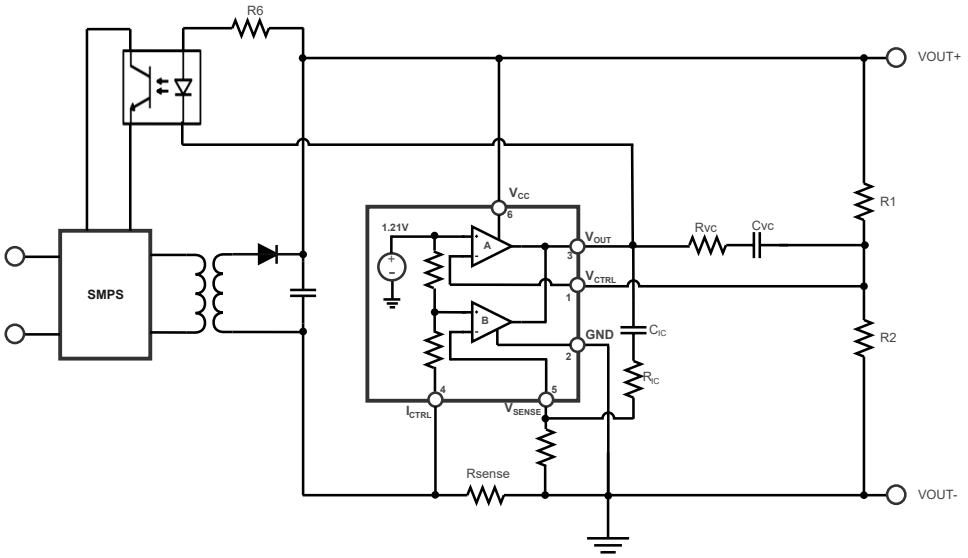


Figure 6. TPA725x in a Constant-Current and Constant-Voltage Battery Charger

The voltage control loop is controlled by the operational amplifier A and the resistor divider (R1, R2), and the output voltage is given in Equation 1.

$$V_{OUT} = V_{REF\_V} \times \frac{R1 + R2}{R2} \quad (1)$$

Where: V_{OUT} is the desired maximum output voltage, and V_{REF_V} is the voltage reference for the voltage control loop.

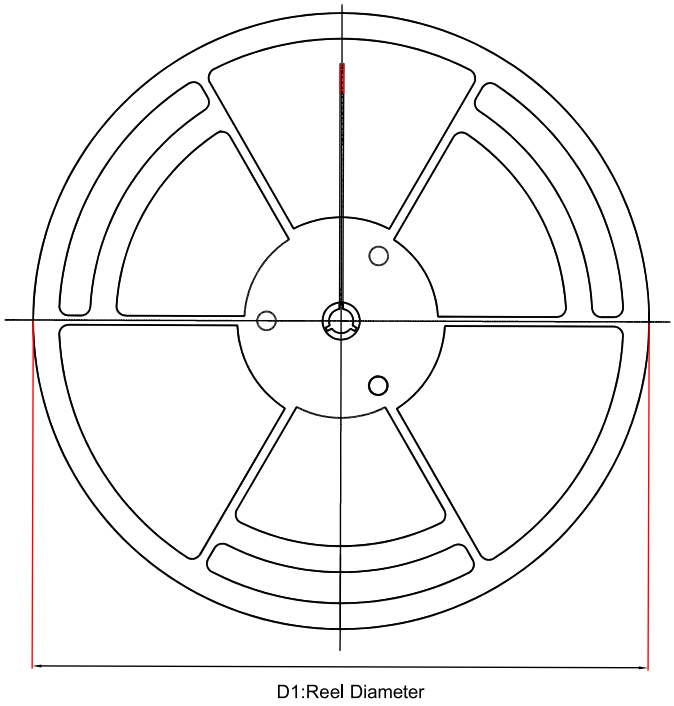
The current control loop is controlled by the operational amplifier B, and the maximum output current is given in Equation 2.

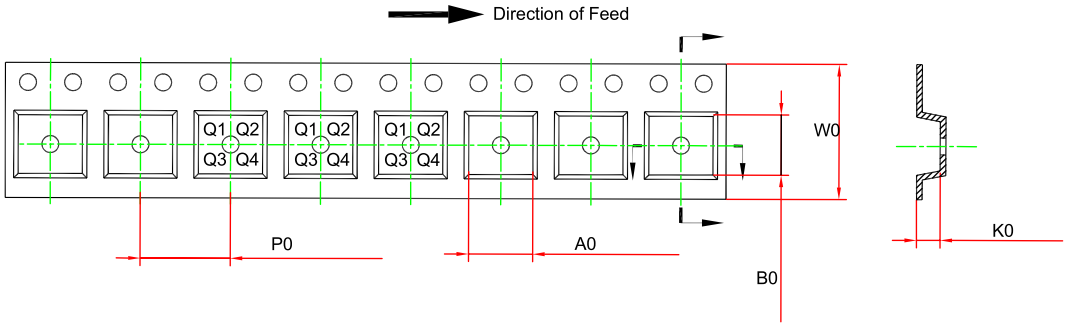
$$I_{OUT} = \frac{V_{REF\_I}}{R_{SENSE}} \quad (2)$$

Where: I_{OUT} is the desired maximum output current, and V_{REF_I} is the voltage reference for the current control loop.

The open-drain outputs of the two operational amplifiers are connected to the opto-coupler, enabling an ORing function that activates the opto-coupler whenever the values of the current or voltage are too high.

Tape and Reel Information





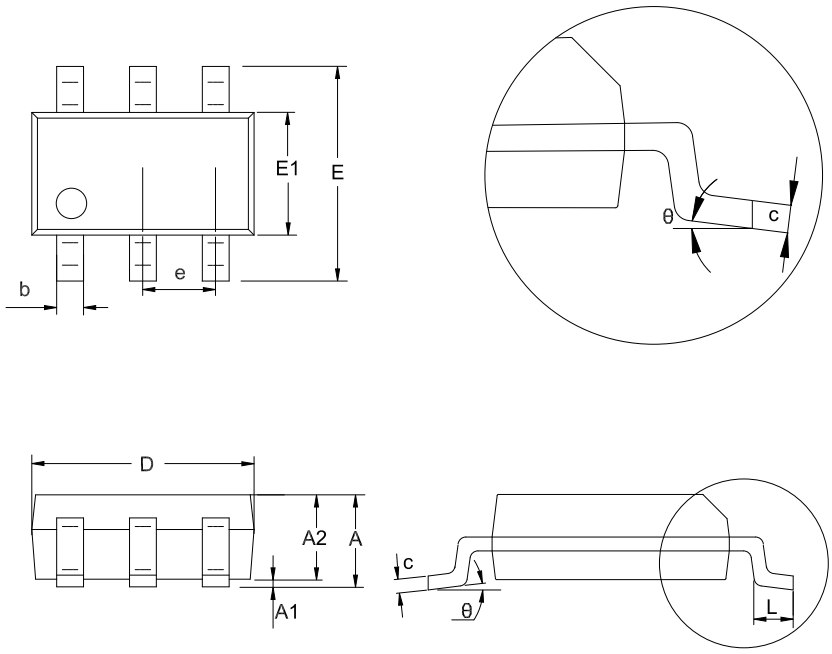
Order Number	Package	D1 (mm)	W1 (mm)	A0 (mm) (1)	B0 (mm) (1)	K0 (mm) (1)	P0 (mm)	W0 (mm)	Pin1 Quadrant
TPA725x-S6TR	SOT23-6	180.0	12.0	3.3	3.2	1.4	4.0	8.0	Q3

(1) The value is for reference only. Contact the 3PEAK factory for more information.

Package Outline Dimensions

SOT23-6

Package Outline Dimensions S6T(SOT23-6-A)



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	1.050	1.250	0.041	0.049
A1	0.000	0.150	0.000	0.006
A2	1.000	1.200	0.039	0.047
b	0.280	0.500	0.011	0.020
c	0.100	0.230	0.004	0.009
D	2.820	3.020	0.111	0.119
E	2.600	3.000	0.102	0.118
E1	1.500	1.720	0.059	0.068
e	0.950 BSC		0.037 BSC	
L	0.300	0.600	0.012	0.024
θ	0	8°	0	8°

NOTES

1. Do not include mold flash or protrusion.
2. This drawing is subject to change without notice.

Order Information

Order Number	Operating Temperature Range	Package	Marking Information	MSL	Transport Media, Quantity	Eco Plan
TPA7255-S6TR (1)	−40 to 125°C	SOT23-6	755	3	Tape and Reel, 3000	Green
TPA7256-S6TR	−40 to 125°C	SOT23-6	756	3	Tape and Reel, 3000	Green
TPA7257-S6TR (1)	−40 to 125°C	SOT23-6	757	3	Tape and Reel, 3000	Green
TPA7258-S6TR (1)	−40 to 125°C	SOT23-6	758	3	Tape and Reel, 3000	Green
TPA7259-S6TR (1)	−40 to 125°C	SOT23-6	759	3	Tape and Reel, 3000	Green

(1) For future products, contact the 3PEAK factory for more information and samples.

Green: 3PEAK defines "Green" to mean RoHS compatible and free of halogen substances.

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