Dual Channel Fixed Voltage ULDO Linear Regulator — TJ5641
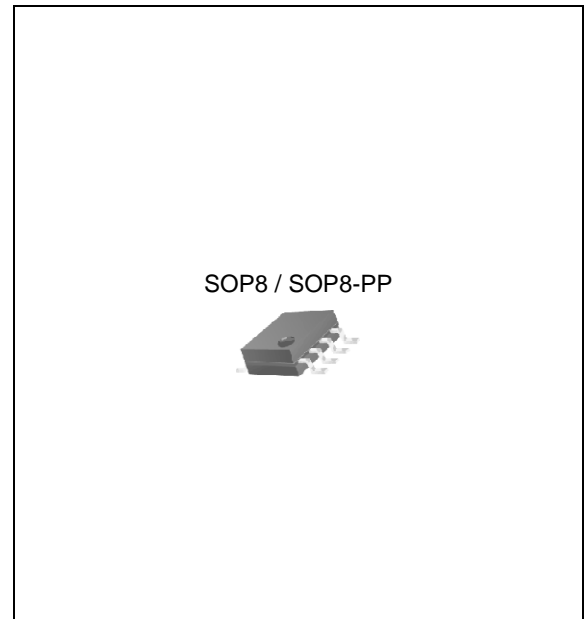
FEATURES

• Dual Channel Ultra Low Dropout Voltage
• Compatible with low ESR MLCC as Input / Output Capacitor
• Good Line and Load Regulation
• Guaranteed Output Current of 600/600mA
• Available in SOP8, SOP8-PP
• Fixed Output Voltage: 1.0V ~ 3.3V
• Over-Temperature Protection
• Over-Current Protection

APPLICATION

• LCD TVs and SETTOP Boxes
• Battery Powered Equipments
• Motherboards and Graphic Cards
• Microprocessor Power Supplies
• Peripheral Cards
• High Efficiency Linear Regulators
• Battery Chargers

SOP8 / SOP8-PP

ORDERING INFORMATION

Device	Package
TJ5641GD-XXYY	SOP8
TJ5641HGD-XXYY	SOP8
TJ5641GDP-XXYY	SOP8-PP
TJ5641HGDP-XXYY	SOP8-PP

XX : Output Voltage code of channel 1 (VOUT1)
YY : Output Voltage code of channel 2 (VOUT2)

DESCRIPTION

The TJ5641 of two channels high performance ultra-low dropout linear regulators operates from 2.5V to 5.5V input supply and provides ultra-low dropout voltage with low ground current. These ultra-low dropout linear regulators respond fast to step changes in load which makes them suitable for low voltage micro-processor applications. The TJ5641 is developed on a CMOS process technology which allows low quiescent current operation independent of output load current. This CMOS process also allows the TJ5641 to operate under extremely low dropout conditions.

ABSOLUTE MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	MIN.	MAX.	UNIT
Input Supply Voltage (Survival)	V_{IN1}, V_{IN2}	-	6.5	V
Enable Input Voltage (Survival)	V_{EN1}, V_{EN2}	-	6.5	V
Maximum Continuous Output Current	I_{MAX}	-	600/600	mA
Lead Temperature	T_{SOL}		260	ºC
Storage Temperature Range	T_{STG}	-65	150	ºC
Operating Junction Temperature Range	T_{JOPR}	-40	150	ºC

OPERATING RATINGS (Note 2)

CHARACTERISTIC	SYMBOL	MIN.	MAX.	UNIT
Operating Input Voltage	$V_{IN1,\,2}$	2.5	5.5	V
Package Thermal Resistance *	$\Theta_{JA\text{-}SOP\text{-}8PP}$	68		ºC/W
	$\Theta_{JC\text{-}SOP\text{-}8PP}$	15		ºC/W
Maximum Power Dissipation	$PD_{(max\text{-}SOP\text{-}8PP)}$	1.47		W

* Calculated from package in still air, mounted to 2.6mm X 3.5mm(minimum foot print) 2 layer PCB without thermal vias per JESD51 standards.

ORDERING INFORMATION

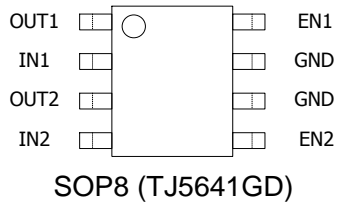| Package	Order No.	Channel 1 Output Voltage [V]	Channel 2 Output Voltage [V]	Description	Package Marking	Status
SOP8	TJ5641GD – XXYY	X.X	Y.Y	Fixed, Enable	XXYY TJ5641G	Contact Us
	TJ5641HGD – XXYY	X.X	Y.Y	Fixed	XXYY TJ5641HG	Contact Us
SOP8-PP	TJ5641GDP – XXYY	X.X	Y.Y	Fixed, Enable	XXYY TJ5641G	Contact Us
	TJ5641HGDP – XXYY	X.X	Y.Y	Fixed	XXYY TJ5641HG	Contact Us

X.X = 1.0, 1.2, 1.5, 1.8, 2.5, 2.8, and 3.3
Y.Y = 1.0, 1.2, 1.5, 1.8, 2.5, 2.8, and 3.3
* Customer can choose one of the above output voltages on each channel.

TJ 5641 ☐ ☐ ☐ — ☐☐ ☐☐

Channel 2 Output Voltage Code

Channel 1 Output Voltage Code

Package Type { D : SOP-8
DP : SOP-8PP

Green Mode   G   : Halogen Free

Enable Mode { Blank : Normal Enable
H   : Enable is internally connected to Input

Root Name

Product Code

PIN CONFIGURATION

```
OUT1 ┌──○──┐ EN1
IN1  │     │ GND
OUT2 │     │ GND
IN2  └─────┘ EN2
```
SOP8 (TJ5641GD)

```
OUT1 ┌──○──────┐ EN1
IN1  │ Exposed │ GND
OUT2 │  PAD    │ GND
IN2  └─────────┘ EN2
```
SOP8-PP (TJ5641GDP)

```
OUT1 ┌──○──┐ NC
IN1  │     │ GND
OUT2 │     │ GND
IN2  └─────┘ NC
```
SOP8 (TJ5641HGD)

```
OUT1 ┌──○──────┐ NC
IN1  │ Exposed │ GND
OUT2 │  PAD    │ GND
IN2  └─────────┘ NC
```
SOP8-PP (TJ5641HGDP)

PIN DESCRIPTION

Pin No.	Name		Function
	TJ5641 (SOP8/SOP-8PP)	TJ5641H (SOP8/SOP-8PP)	
1	OUT1	OUT1	Channel 1 Output Voltage
2	IN1	IN1	Channel 1 Input Voltage
3	OUT2	OUT2	Channel 2 Output Voltage
4	IN2	IN2	Channel 2 Input Voltage
5	EN2	NC	Channel 2 Chip Enable or No Connection (TJ5641H:Enable Version)
6	GND	GND	Ground
7	GND	GND	Ground
8	EN1	NC	Channel 1 Chip Enable or No Connection (TJ5641H:Enable Version)

- Exposed Pad of SOP8-PP package should be connected to GND.

## TYPICAL APPLICATION
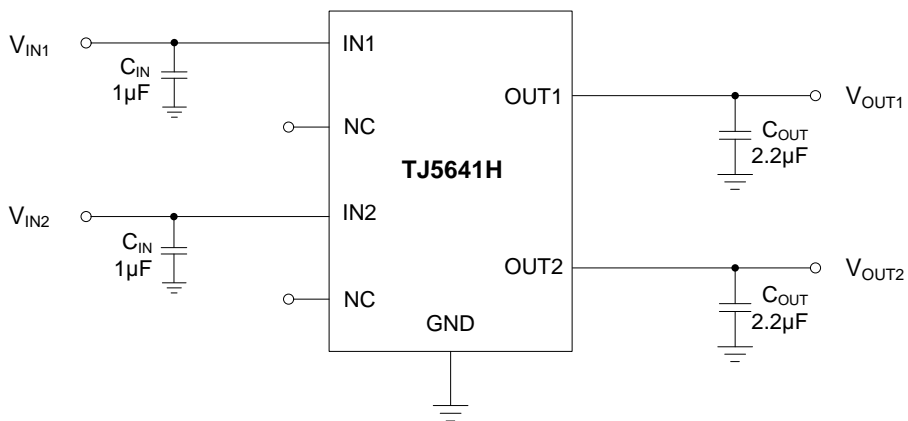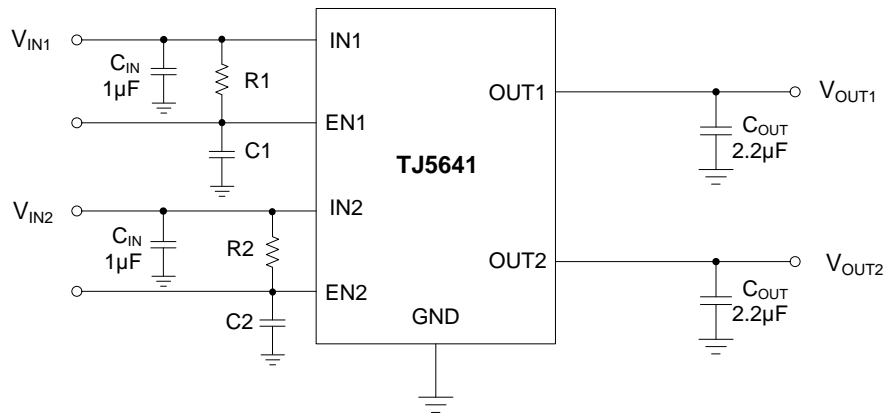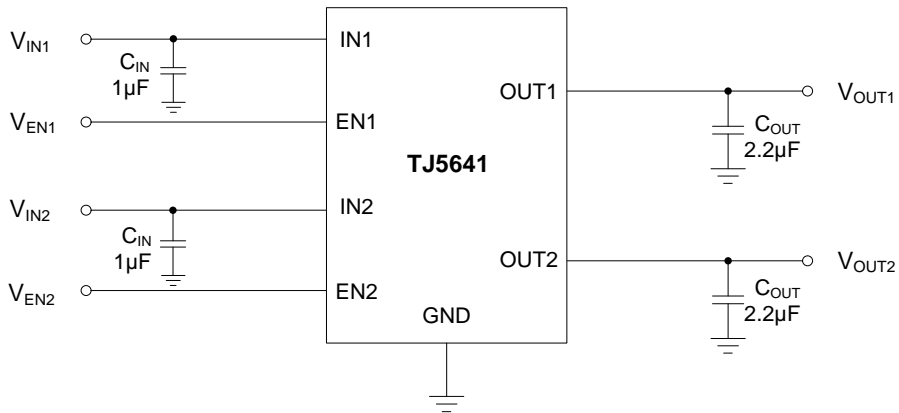
* The output current is limited by the restriction of power dissipation which differs from packages. A heat sink may be required depending on the maximum power dissipation and maximum ambient temperature of application. With respect to the applied package, the maximum continuous output current of each channel may be still undeliverable.
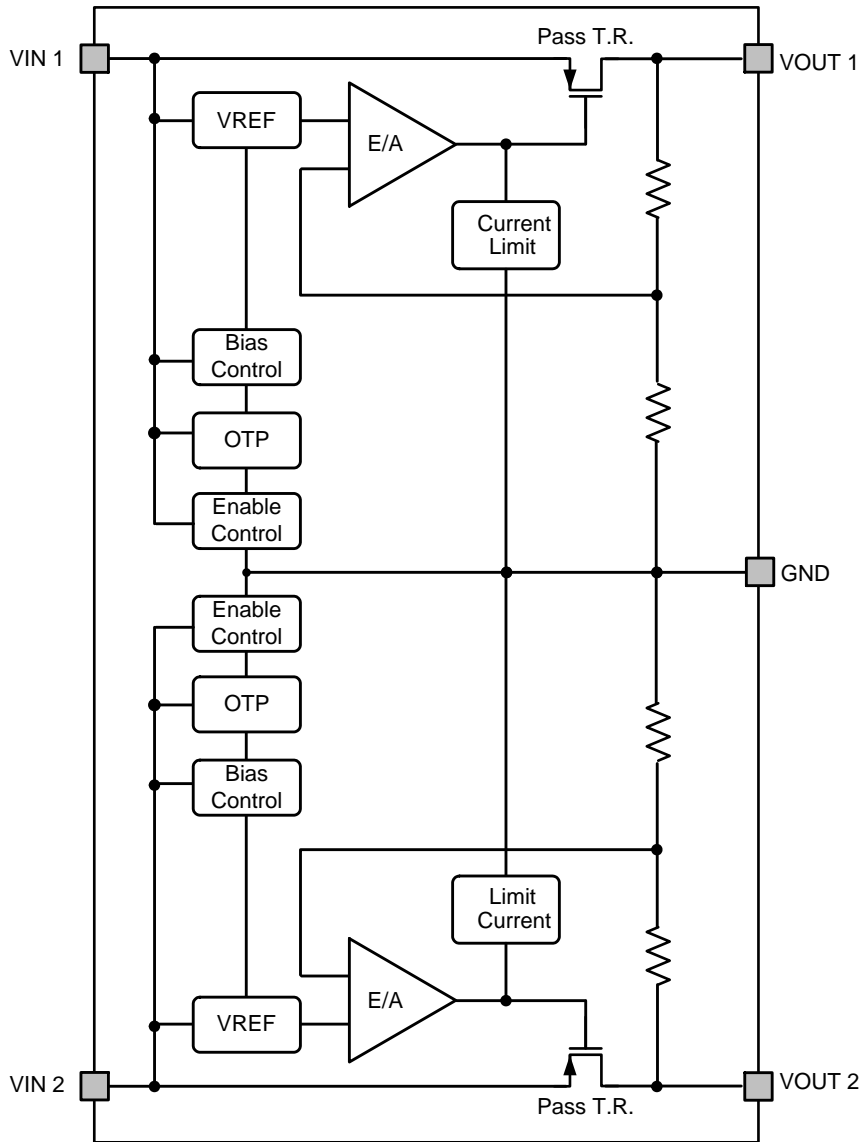
* See Application Information.

BLOCK DIAGRAM

TJ5641 Version

TJ5641H Version

Dual Channel Fixed Voltage ULDO Linear Regulator   TJ5641
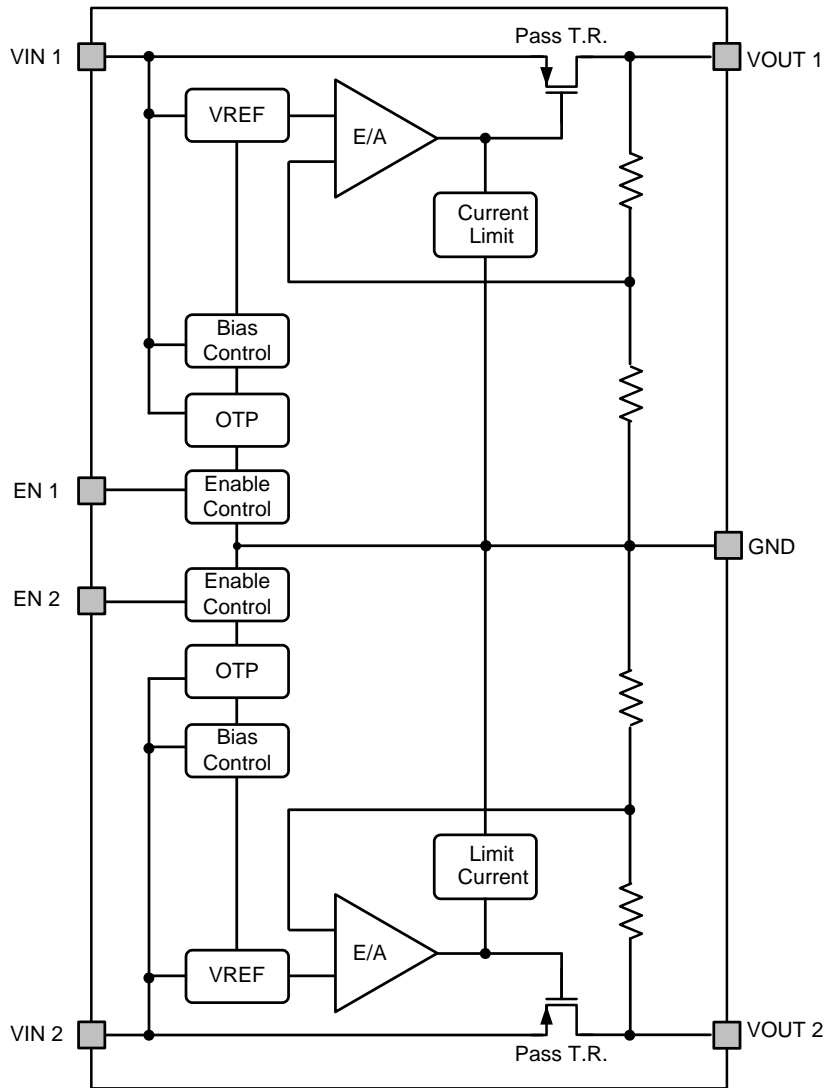
ELECTRICAL CHARACTERISTICS[Note 1]

Limits in standard typeface are for T_J=25⁰C, and limits in **boldface type** apply over the **full operating temperature range**.
Unless otherwise specified: V_{IN}[Note 2] = $V_{O(NOM)}$ + 1V, I_L = 10 mA, C_{IN} = 1 μF, C_{OUT} = 2.2 μF, V_{EN} = V_{IN} - 0.3 V

PARAMETER		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Input Voltage Range		$V_{IN1, 2}$		2.5		5.5	V
Output Voltage Tolerance		$V_{OUT1, 2}$		-2 **-3**	-	+2 **+3**	%
VIN Shutdown Current[Note 7]		$I_{GND.OFF}$	V_{EN1} = V_{EN2} = 0V	-	0.1	2	μA
VIN Supply Current[Note 6,7]		$I_{GND.ON}$	V_{EN1} = V_{EN2} = 5V, I_{OUT} = 0A	-	140	220	μA
Line Regulation[Note 3]		ΔV_{LINE}	V_{IN} = V_{OUT}+1V to 5V	-	0.25	-	%/V
Load Regulation[Note 3, 4]		ΔV_{LOAD}	10mA $\leq$ I_{OUT} $\leq$ 300mA	-	15	30	mV
			10mA $\leq$ I_{OUT} $\leq$ 600mA	-	30	50	mV
Dropout Voltage[Note 5]		V_{DROP}	V_{OUT} = 3.3V, I_{OUT} = 600mA	-	240	360	mV
Ripple Rejection		PSRR	V_{IN} = V_{OUT}+2V, f = 1kHz	-	55	-	dB
Output Current Limit		I_{LIM}		700	-	-	mA
Thermal Shutdown Temperature		T_{SD}		-	150	-	℃
Enable Threshold[Note 7]	Logic High	V_{IH}	Output = High	1.6	-	-	V
	Logic Low	V_{IL}	Output = Low	-	-	0.4	V

Note 1. Stresses listed as the absolute maximum ratings may cause permanent damage to the device. These are for stress ratings. Functional operating of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may remain possibly to affect device reliability.

Note 2. The minimum operating value for input voltage is equal to either ($V_{OUT,NOM}$ + V_{DROP}) or 2.5V, whichever is greater.

Note 3. Output voltage line regulation is defined as the change in output voltage from the nominal value due to change in the input line voltage. Output voltage load regulation is defined as the change in output voltage from the nominal value due to change in load current.

Note 4. Regulation is measured at constant junction temperature by using a 10ms current pulse. Devices are tested for load regulation in the load range from 10mA to 600mA.

Note 5. Dropout voltage is defined as the minimum input to output differential voltage at which the output drops 2% below the nominal value. Dropout voltage specification applies only to output voltages of 2.5V and above. For output voltages below 2.5V, the dropout voltage is nothing but the input to output differential, since the minimum input voltage is 2.5V.

Note 6. Ground current, or quiescent current, is the difference between input and output currents. It's defined by I_{GND1} = $I_{IN\,1}$- I_{OUT1} under the given loading condition. The total current drawn from the supply is the sum of the load current plus the ground pin current.
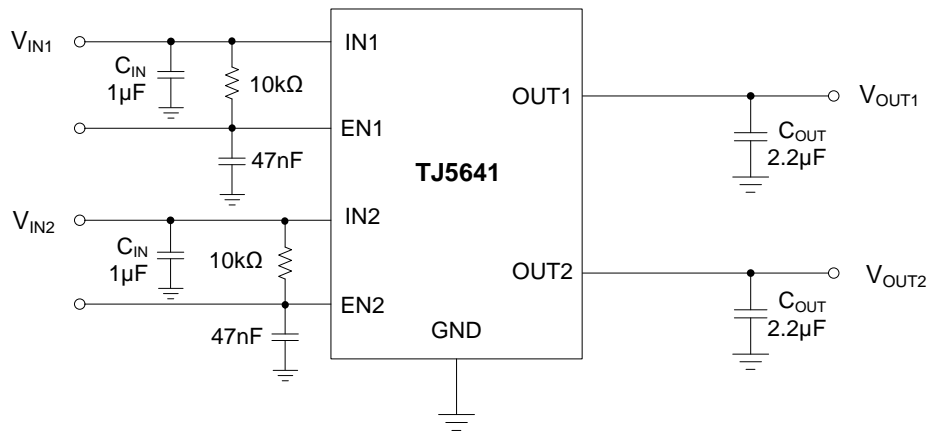
Note 7. Enable Mode Normal Version only. Enable Mode H version is not applied.
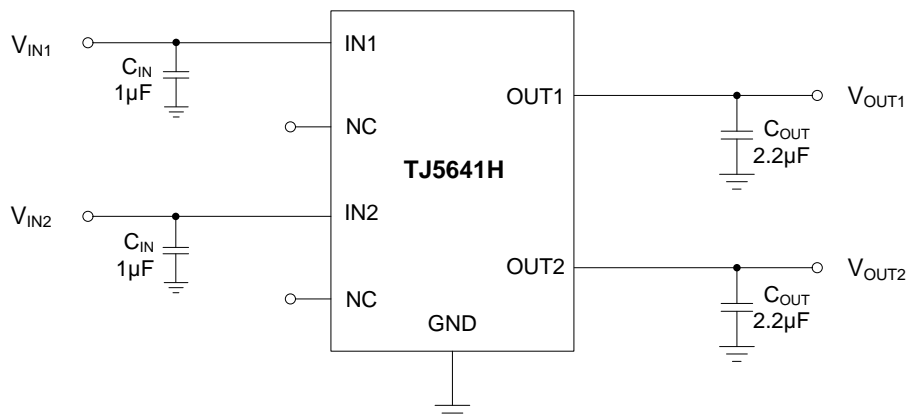
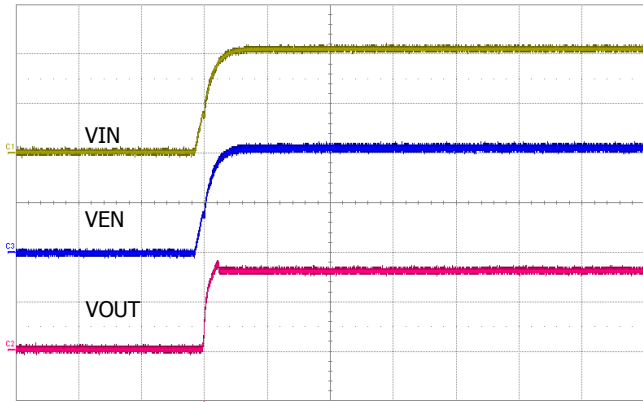## TYPICAL OPERATING CHARACTERISTICS

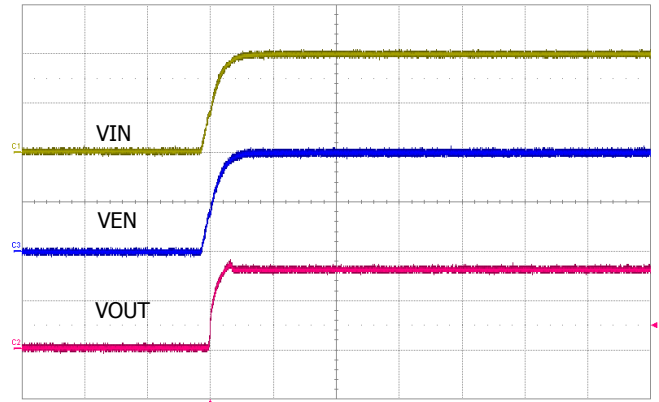### TEST CIRCUIT
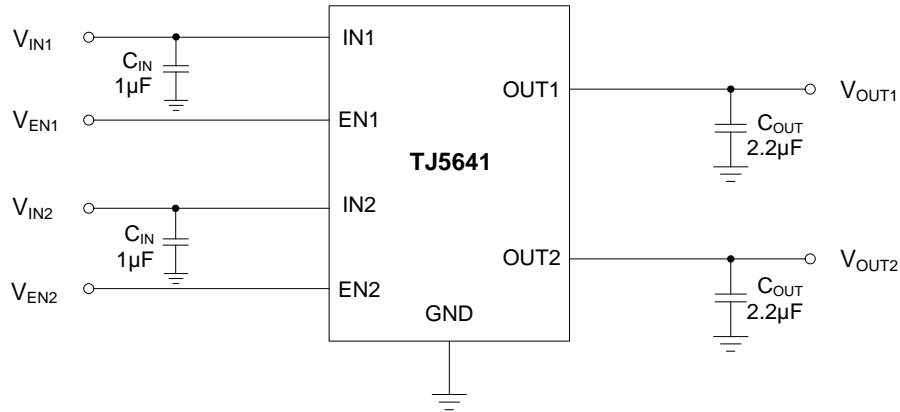
Circuit 1

Circuit 2

Circuit 3

Channel 1 (VOUT=3.3V)

Circuit 1

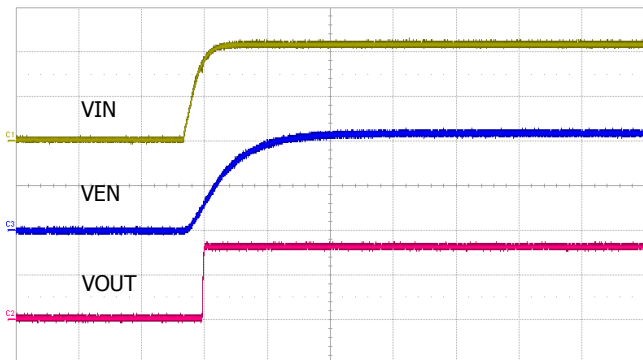VIN

VEN

VOUT

VIN: 2.0V/div,   VEN: 2.0V/div,   VOUT: 2.0V/div,   Time: 1ms/div

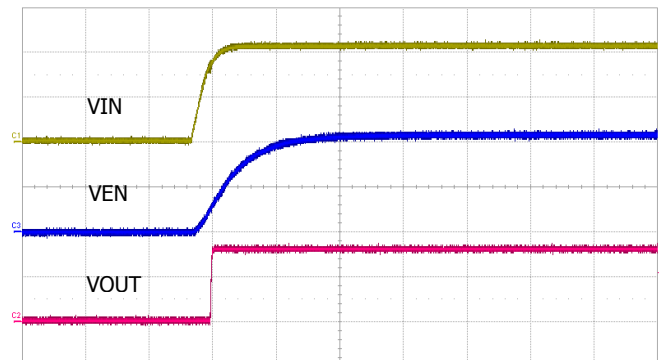Start Up @ IOUT=10mA

Circuit 1

VIN

VEN

VOUT

VIN: 2.0V/div,   VEN: 2.0V/div,   VOUT: 2.0V/div,   Time: 1ms/div
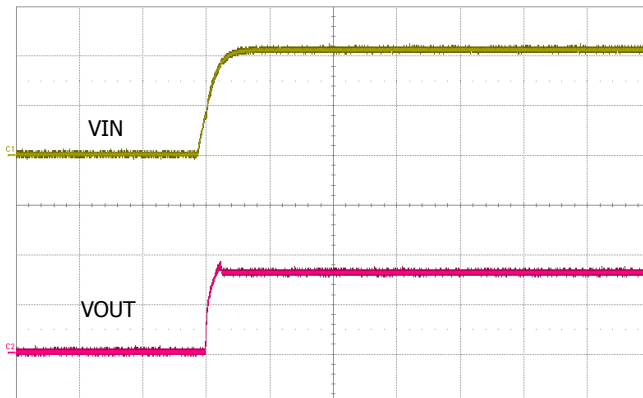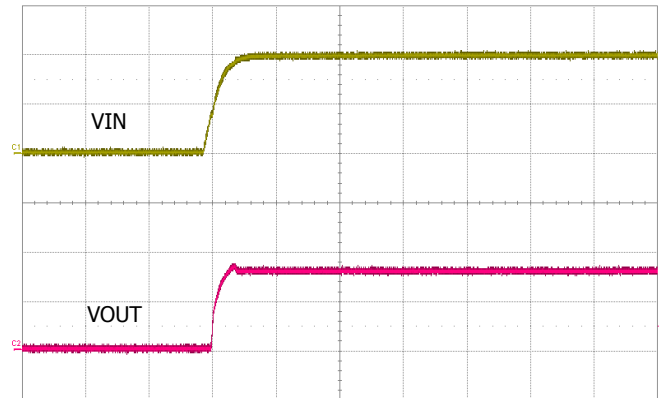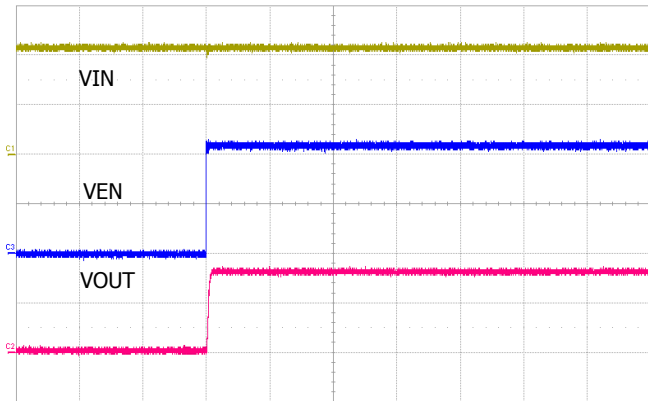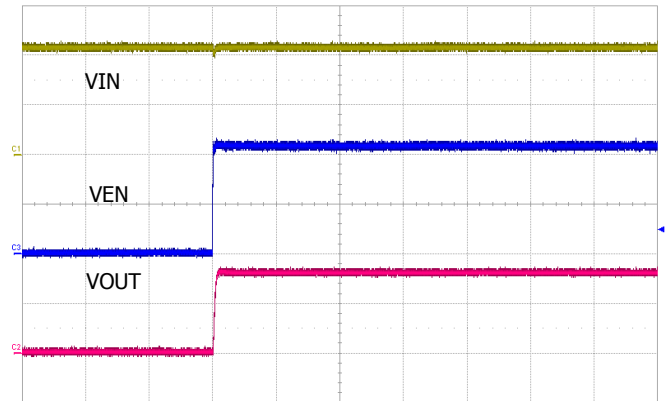
Start Up @ IOUT=600mA

Circuit 2

VIN

VEN

VOUT

VIN: 2.0V/div,   VEN: 2.0V/div,   VOUT: 2.0V/div,   Time: 1ms/div

Start Up @ IOUT=10mA

Circuit 2

VIN

VEN

VOUT

VIN: 2.0V/div,   VEN: 2.0V/div,   VOUT: 2.0V/div,   Time: 1ms/div

Start Up @ IOUT=600mA

Circuit 3

VIN

VOUT

VIN: 2.0V/div,   VOUT: 2.0V/div,   Time: 1ms/div

Start Up @ IOUT=10mA

Circuit 3

VIN

VOUT

VIN: 2.0V/div,   VOUT: 2.0V/div,   Time: 1ms/div
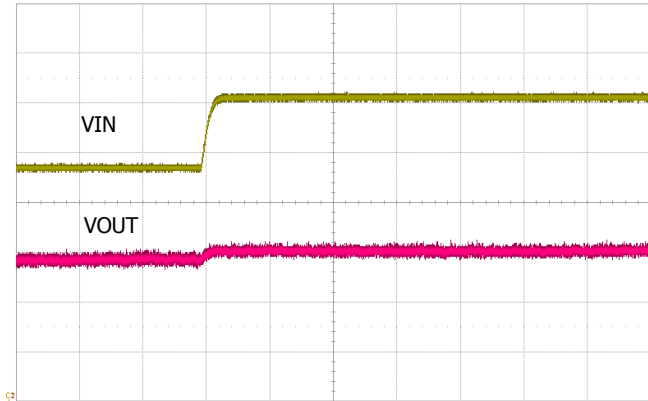
Start Up @ IOUT=600mA

Circuit 1

VIN: 2.0V/div,   VEN: 2.0V/div,   VOUT: 2.0V/div,   Time: 500μs/div

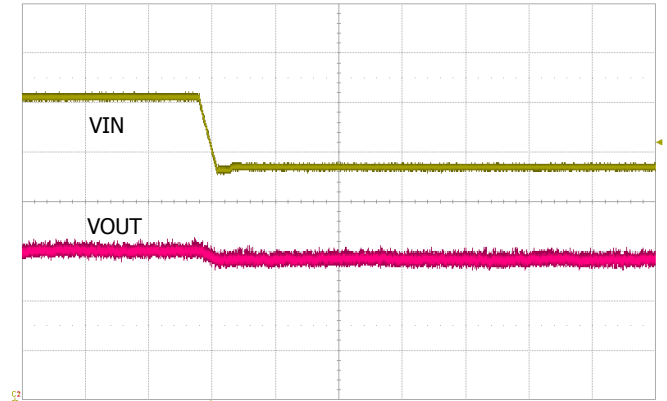Start Up by External EN @ IOUT=10mA

Circuit 1

VIN: 2.0V/div,   VEN: 2.0V/div,   VOUT: 2.0V/div,   Time: 500μs/div

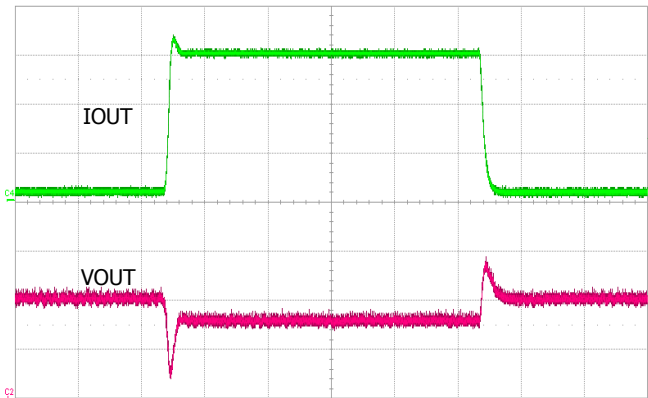Start Up by External EN @ IOUT=600mA

Circuit 1, 2, 3

VIN: 0.5V/div,   VOUT: 50mV/div,   Time: 2ms/div
VIN:4.3 to 5.0V   @ IOUT=10mA

Line Transient Response

Circuit 1, 2, 3

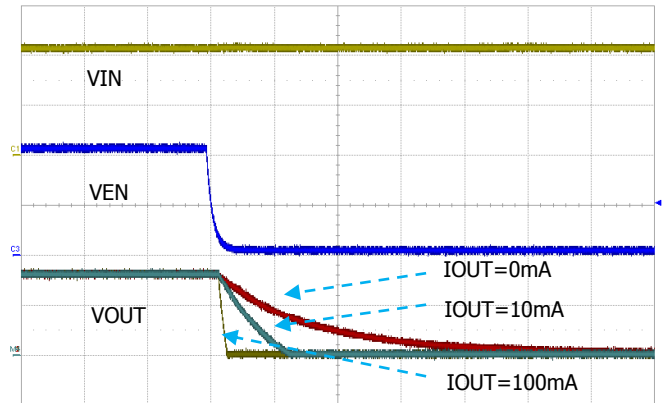
VIN: 0.5V/div,   VOUT: 50mV/div,   Time: 2ms/div
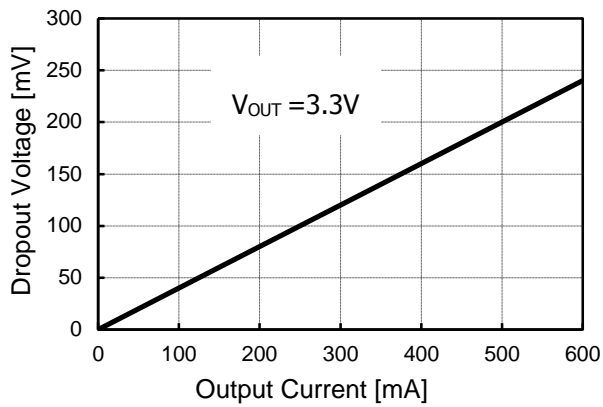VIN:5.0 to 4.3V   @ IOUT=10mA

Line Transient Response

Circuit 1, 2, 3

IOUT: 200mA/div,   VOUT: 50mV/div,   Time: 200μs/div
VIN=VEN=4.3V @ IOUT=10mA to 600mA
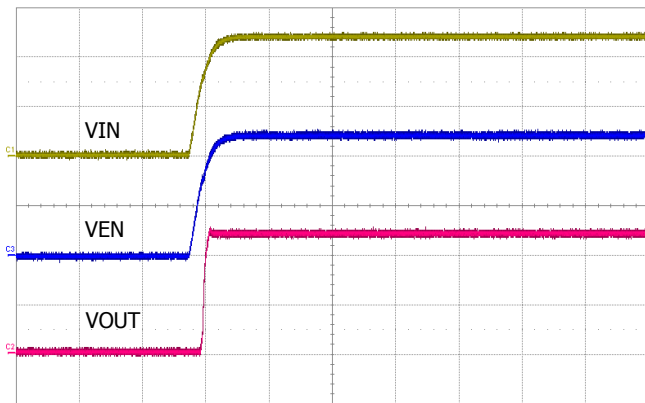
Load Transient Response

Circuit 1

VIN: 2.0V/div,   VEN: 2.0V/div,   VOUT: 2.0V/div,   Time : 1ms/div
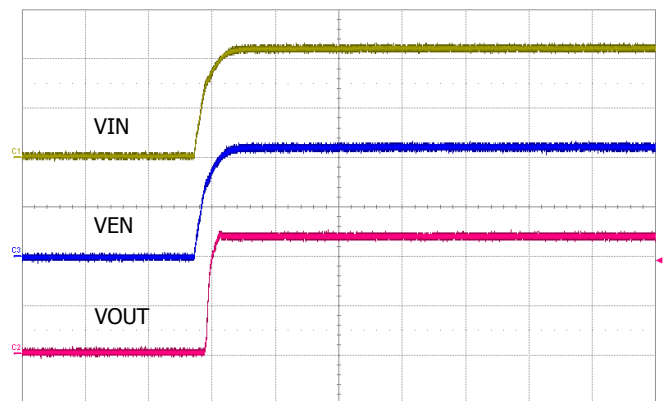
EN off

Dropout Voltage

Channel 2 (VOUT=1.2V)

Circuit 1

VIN: 1.0V/div,   VEN: 1.0V/div,   VOUT: 0.5V/div,   Time: 1ms/div

Start Up @ IOUT=10mA

Circuit 1

VIN: 1.0V/div,   VEN: 1.0V/div,   VOUT: 0.5V/div,   Time: 1ms/div

Start Up @ IOUT=600mA

Circuit 2

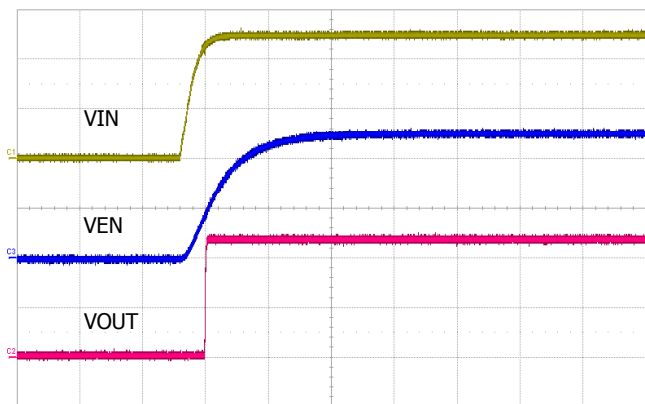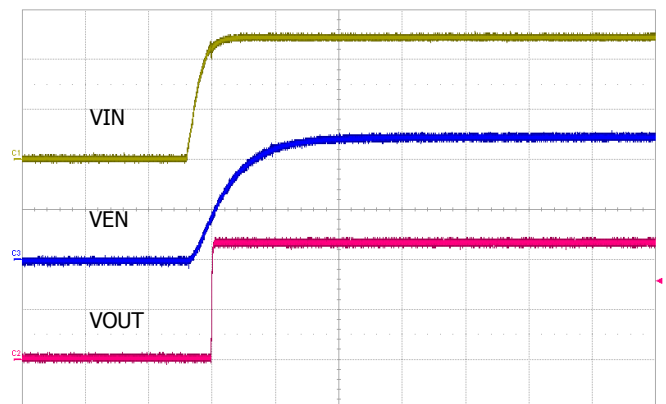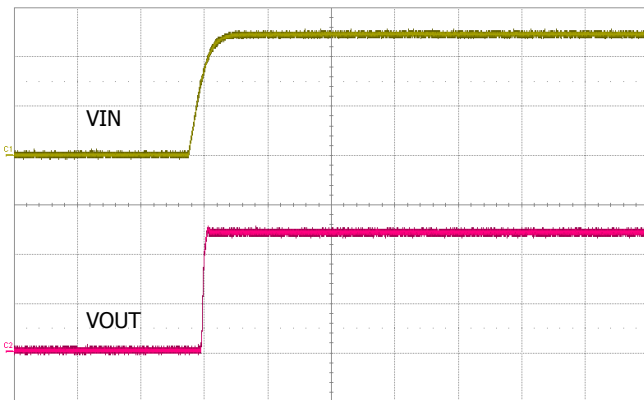VIN: 1.0V/div,   VEN: 1.0V/div,   VOUT: 0.5V/div,   Time: 1ms/div

Start Up @ IOUT=10mA

Circuit 2

VIN: 1.0V/div,   VEN: 1.0V/div,   VOUT: 0.5V/div,   Time: 1ms/div

Start Up @ IOUT=600mA
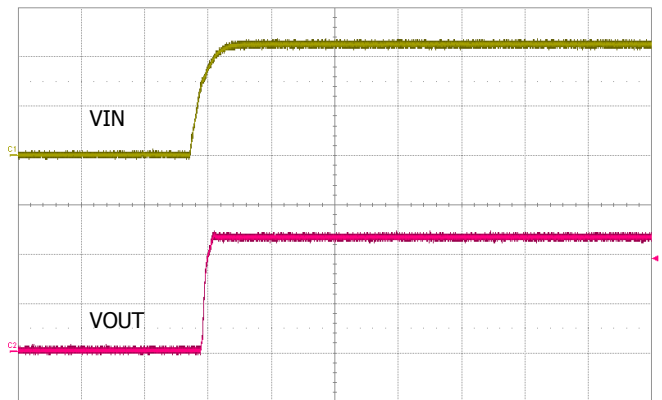
Circuit 3

VIN

VOUT

VIN: 1.0V/div,   VOUT: 0.5V/div,   Time: 1ms/div
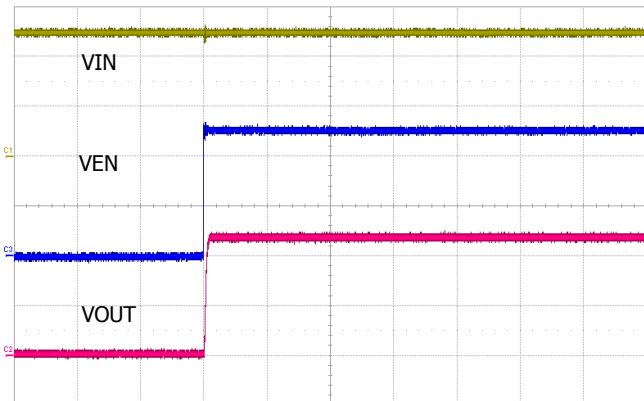
Start Up @ IOUT=10mA

Circuit 3

VIN

VOUT

VIN: 1.0V/div,   VOUT: 0.5V/div,   Time: 1ms/div

Start Up @ IOUT=600mA

Circuit 1

VIN

VEN

VOUT

VIN: 1.0V/div,   VEN: 1.0V/div,   VOUT: 0.5V/div,   Time: 0.5ms/div

Start Up By External EN @ IOUT=10mA

Circuit 1

VIN

VEN

VOUT
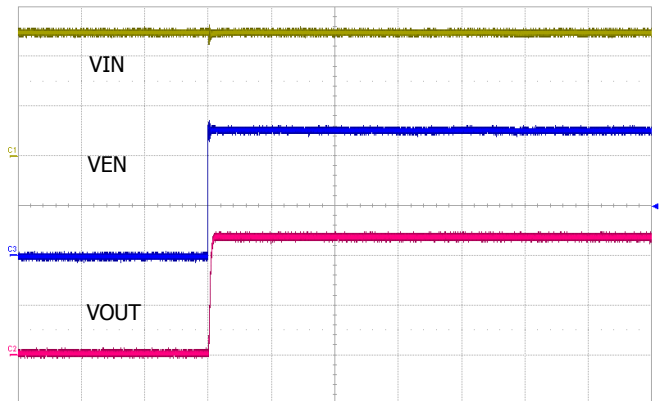
VIN: 1.0V/div,   VEN: 1.0V/div,   VOUT: 0.5V/div,   Time: 0.5ms/div

Start Up By External EN @ IOUT=600mA

Circuit 1, 2, 3

VIN

VOUT

VIN: 0.5V/div,   VOUT: 50mV/div,   Time: 2ms/div
VIN:2.5 to 5.0V   @ IOUT=10mA

Line Transient Response

Circuit 1, 2, 3

VIN

VOUT

VIN: 0.5V/div,   VOUT: 50mV/div,   Time: 2ms/div
VIN:5.0 to 2.5V   @ IOUT=10mA

Line Transient Response

Circuit 1, 2, 3

IOUT

VOUT

IOUT: 200mA/div,   VOUT: 50mV/div,   Time: 200μs/div

VIN=VEN=2.5V   @ IOUT=10mA to 600mA

Load Transient Response

Circuit 1

VIN

VEN

VOUT

IOUT=0mA

IOUT=10mA

IOUT=100mA

VIN: 1.0V/div,   VEN: 1.0V/div,   VOUT: 0.5V/div,   Time : 1ms/div
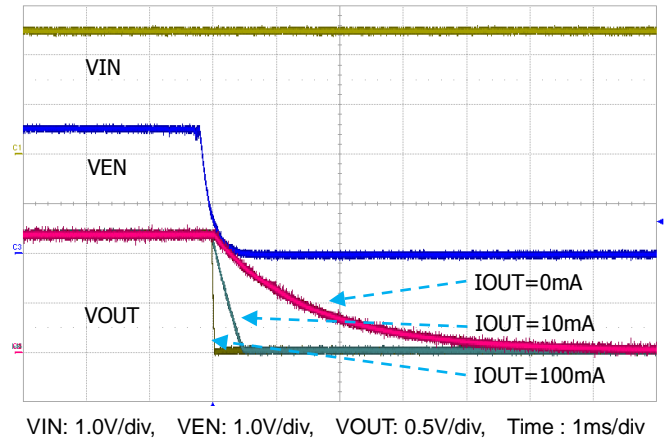
EN off

APPLICATION INFORMATION

Introduction

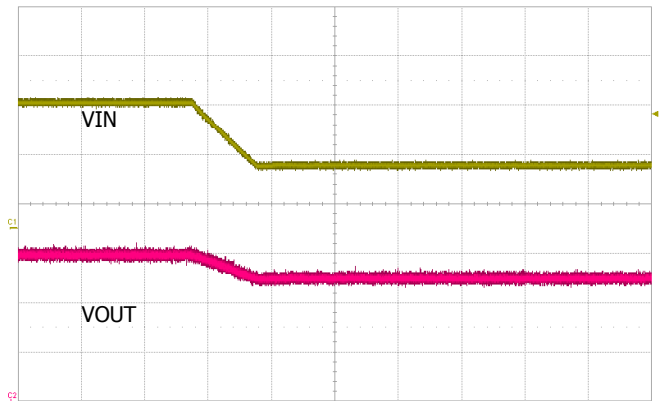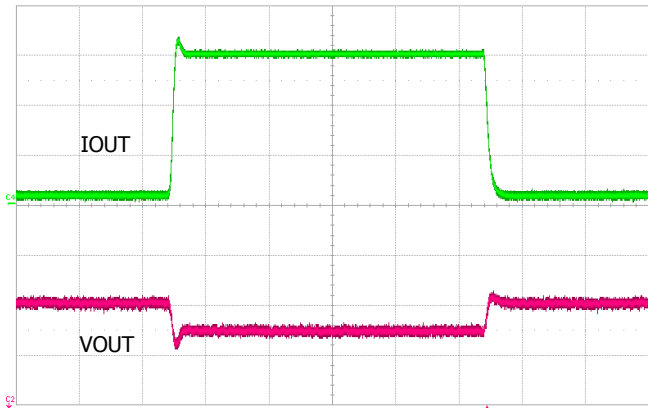TJ5641 is intended for applications where very low dropout voltage and current capability are required. It provides a simple, low cost solution that occupies very little PCB estate. Additional features include an enable pin to allow for a very low power consumption standby mode.

Component Selection

Input Capacitor

A ceramic capacitance over than 1µF should be closely placed to the input supply pin of the TJ5641 to ensure that the input supply voltage does not sag. Also a minimum of 1µF ceramic capacitor is recommended to be placed directly next to the V_{IN1} and V_{IN2} Pin. It allows for the device being some distance from any bulk capacitor on the rail. Additionally, input droop due to load transients is reduced, improving load transient response.   Additional capacitance may be added if required by the application.

Output Capacitor

A minimum ceramic capacitor over than 2.2µF should be very closely placed to the output voltage pin of the TJ5641. Increasing capacitance will improve the overall transient response and stability.

Decoupling (Bypass) Capacitor

In very electrically noisy environments, it is recommended that additional ceramic capacitors be placed from VIN to GND. The use of multiple lower value ceramic capacitors in parallel with output capacitor also allows to achieve better transient performance and stability if required by the application.

Start-Up

To turn on TJ5641, Input Voltage should be supplied prior to Enable Voltage. So, it is recommended to apply delayed start-up by using C1 as shown in Fig. 1. It can adjust proper delay by R1-C1 time constant. It is recommended that R1 and R2 value are greater than 10kΩ. Also, it is suggested that C1 and C2 value are greater than 47nF.
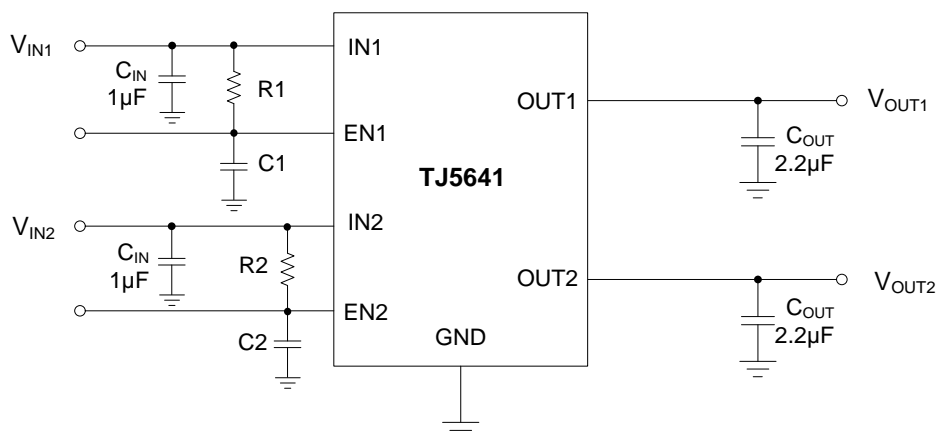

Fig. 1

Maximum Continuous Output Current Capability

The TJ5641 can deliver a continuous current of 600mA/600mA over the full operating junction temperature range. However, the output current is limited by the restriction of power dissipation which differs from packages.   A heat sink may be required depending on the maximum power dissipation and

maximum ambient temperature of application.   With respect to the applied package, the maximum continuous output current of 600mA may be still undeliverable due to the restriction of the power dissipation of TJ5641.   Under all possible conditions, the junction temperature must be within the range specified under operating conditions.

The temperatures over the device are given by:

$$T_C = T_A + P_D \times \theta_{CA}$$
$$T_J = T_C + P_D \times \theta_{JC}$$
$$T_J = T_A + P_D \times \theta_{JA}$$

where T_J is the junction temperature, T_C is the case temperature, T_A is the ambient temperature, P_D is the total power dissipation of the device, θ_{CA} is the thermal resistance of case-to-ambient, θ_{JC} is the thermal

resistance of junction-to-case, and θ_{JA} is the thermal resistance of junction to ambient.

The total power dissipation of the device is given by:

$$P_D = P_{IN} - P_{OUT} = (V_{IN} \times I_{IN}) - (V_{OUT} \times I_{OUT})$$
$$= (V_{IN} \times (I_{OUT} + I_{GND})) - (V_{OUT} \times I_{OUT}) = (V_{IN} - V_{OUT}) \times I_{OUT} + V_{IN} \times I_{GND}$$

where I_{GND} is the operating ground current of the device which is specified at the Electrical Characteristics.

The maximum allowable temperature rise (T_{Rmax}) depends on the maximum ambient temperature (T_{Amax}) of the application, and the maximum allowable junction temperature (T_{Jmax}):

$$T_{Rmax} = T_{Jmax} - T_{Amax}$$

The maximum allowable value for junction-to-ambient thermal resistance, θ_{JA}, can be calculated using the formula:

$$\theta_{JA} = T_{Rmax} / P_D$$

TJ5641 is available in SOP8 and SOP8-PP packages.   The thermal resistance depends on amount of copper area or heat sink, and on air flow.

If proper cooling solution such as heat sink, copper plane area, or air flow is applied, the maximum allowable power dissipation could be increased.   However, if the ambient temperature is increased, the allowable power dissipation would be decreased.
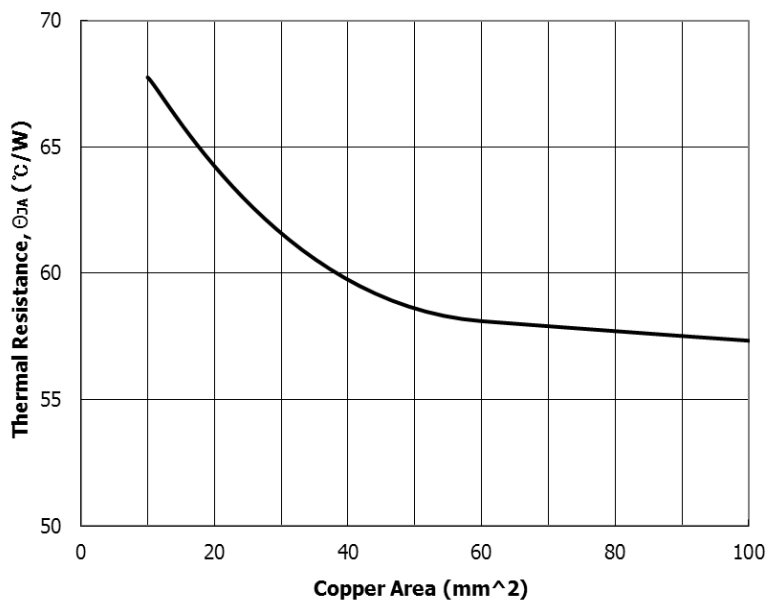
Power Disspation(P_D) vs. Ambient Temperature(T_A)
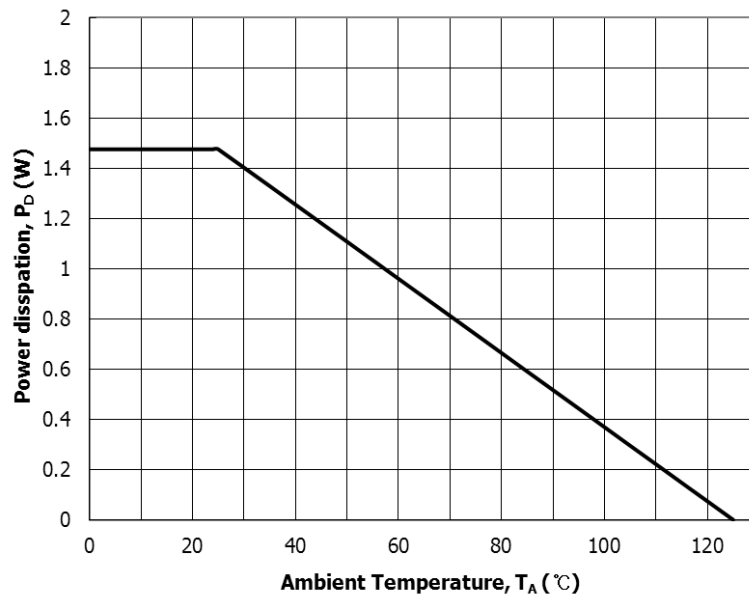
The graph above is valid for the thermal impedance specified in the Absolute Maximum Ratings section on page 1.

The θ_{JA} could be decreased with respect to the copper plane area.   So, the specification of maximum power dissipation for an application is fixed, the proper plane area could be estimated by following graphs. Wider copper plane area leads lower θ_{JA}.

Thermal Resistance(Θ_{JA}) vs. Copper Area

The maximum allowable power dissipation is also influenced by the ambient temperature. With the θ_{JA}-Copper plane area relationship, the maximum allowable power dissipation could be evaluated with respect to the ambient temperature. As shown in graph, the higher copper plane area leads θ_{JA}. And the higher ambient temperature leads lower maximum allowable power dissipation.

REVISION NOTICE

The description in this datasheet can be revised without any notice to describe its electrical characteristics properly.