International
IOR Rectifier

APPLICATION NOTE

Application Note AN- 1181

IPS maximum output current capability consideration

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APPLICATION NOTE

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Introduction

One of the key parameter to choose an IPS is the maximum output current capability. All component suppliers provide this information but each supplier has different conditions:

As an example this is the number given by the datasheet given for the BTS723G:

Parameter and Conditions, each of the two channels at T_j = -40...+150°C, V_{bb} = 24 V unless otherwise specified	Symbol	Values			Unit
		min	typ	Max	
Nominal load current one channel active: two parallel channels active: Device on PCB7), T_a = 85°C, $T_j \leq$ 150°C	$I_{L(NOM)}$	2.5 4.0	2.9 4.2	-- --	A

And as a comparison this is theAUIPS7142G from IR:

Symbol	Parameter	Min.	Max.	Units
Iout	Continuous output current, Tambient=85°C, Tj=125°C Rth=40°C/W, 6cm² footprint	—	1.5	A

As a first result the BTS723G seems have more output current capability than the AUIPS7142G. But a result is nothing without its conditions: need to compare apple with apple.

This is the conditions for the BTS723G

Parameter and Conditions, each of the two channels at T_j = -40...+150°C, V_{bb} = 24 V unless otherwise specified	Symbol	Values			Unit
		min	typ	Max	
Nominal load current one channel active: two parallel channels active: Device on PCB7), T_a = 85°C, $T_j \leq$ 150°C	$I_{L(NOM)}$	2.5 4.0	2.9 4.2	-- --	A

This is the conditions for the AUIPS7142G

Symbol	Parameter	Min.	Max.	Units
Iout	Continuous output current, Tambient=85°C, Tj=125°C Rth=40°C/W, 6cm² footprint	—	1.5	A

How does a quick comparison?

The maximum continous output current capability depends of two types of parameters:

- *Application parameters (ex. Maximum ambiant temperature …).*
- *Component characteristics (ex. Rdson …)*

The application parameters are given for a typical application and identical for the comparison. So the component characteristics are the most relevant for this type of comparison. This is the equation to calculate the maximum output current capability:

Equation 1:

$$Iout_{(\max)} = \sqrt{\frac{(Tj - Ta)}{Rth \times Rdson_{(@Tj)}}}$$

Where:

***Iout**$_{(max)}$ is the maximum output current to be sure that at ambiant temperature equal to **Ta**, the junction temperature will never reach the **Tj**.*

***Ta** is the ambient temperature*

***Tj** is the junction temperature during the regular operation.*

***Rdson**$_{(@Tj)}$ is the ON state resistance of the power MOSFET at **Tj** temperature.*

***Rth** is the static thermal resistance from junction to ambiant.*

***Tj** and **Ta** are the application parameters, so they are define the limit and the condition of use. To do a quick comparison, these parameters are considered as identical for the both component.*

Regarding the equation if we remove these two application parameters, the comparison Rth and Rdson must be enough. Because these values are in the denomitor, lower are these two values, higher is the output current capabilty.

Take a quick look to our example, first the Rdson:

BTS723G:

Load Switching Capabilities and Characteristics

On-state resistance (V_{bb} to OUT); I_L = 2 A, $V_{bb} \geq$ 7V each channel, T_j = 25°C: T_j = 150°C:	R_{ON}	-- --	90 170	105 210	mΩ

AUIPS7142G:

Rds(on)	ON state resistance Tj=25°C	—	75	100	mΩ	Ids=2A
	ON state resistance Tj=150°C(2)	—	135	180		

With the same condition, Iout = 2A for the maximum value, the Rdson of the AUIPS7142G is better than the AUIPS7142G.

Now take a look to the ***Rth*** *parameters:*

The BTS723G:

Parameter and Conditions		Symbol	Values			Unit
			min	typ	Max	
Thermal resistance						
junction - soldering point[5),6)]	each channel:	R_{thjs}	--	--	25	K/W
junction - ambient[5)]	one channel active:	R_{thja}	--	45	--	
	all channels active:		--	41	--	

Always take care to the small note for the conditions:

5) Device on 50mm*50mm*1.5mm epoxy PCB FR4 with 6cm² (one layer, 70µm thick) copper area for V_{bb} connection. PCB is vertical without blown air. See page 15

The AUIPS7142G:

Symbol	Parameter	Typ.	Max.	Units
Rth1	Thermal resistance junction to ambient 6cm² footprint one Mosfet on	45	—	°C/W
Rth2	Thermal resistance junction to ambient 6cm² footprint two Mosfet on	40	—	

note : Tj-Tambient=Power dissipated in the 2 channel x Rth

With the same conditions, the two Rth are equivalent: 45°C/W.

As conclusion, even if at the first look, the output current of the BTS723G seems higher than the AUIPS7142G after a quick analysis it is not true.

Because other parameters are equivalent and the Rdson of the AUIPS7142G is better than the BTS723G so the output current capabality of the AUIPS7142G is higher.

How does the calculation?

The first quick analysis show that the output capability of the IR device is better than the competitor but how much is it better?

For that use the equation 1 and replace parameters name by the numeric values:

$$Iout_{(\max)} = \sqrt{\frac{(Tj - Ta)}{Rth \ \times Rdson_{(@Tj)}}}$$

For the BTS723G:

$$Iout_{(\max)} = 2.62A = \sqrt{\frac{(150 - 85)}{45 \ \times 0.210}}$$

For the AUIPS7142G:

$$Iout_{(\max)} = 2.83A = \sqrt{\frac{(150 - 85)}{45 \ \times 0.180}}$$

As we have determined in previous quick analysis, the AUIPS7142G output current capability is better than the BTS723G. Now, the calculation is done for the two channels in parallel. We will use the same way to calculate but the current in each channel is divided by 2. So the power dissipated by each channel is also divided by 2. Then multiply by two the current for the two channels:

$$Iout_{(Total\ \max)} = 2 \times \sqrt{\frac{1}{2} \times \frac{(Tj - Ta)}{Rth \ \times Rdson_{(@Tj)}}}$$

For the BTS723G:

$$Iout_{(Total\ \max)} = 3.88A = 2 \times \sqrt{\frac{1}{2} \times \frac{(150 - 85)}{41 \ \times 0.210}}$$

For the AUIPS7142G:

$$Iout_{(Total\ \max)} = 4.25A = 2 \times \sqrt{\frac{1}{2} \times \frac{(150 - 85)}{40 \ \times 0.18}}$$

Where:

$Iout_{(total\ max)}$ *is the maximum of the channel1 + channel2*

As shown, the first evaluation, the AUIPS7142G has more output current capability than the BTS723.

Finally, the calculation is done for the two channels not in parallel but activated in same time. We will use the same way to calculate but with the two channels activated the maximum output current is divided by two:

$$Iout_{(\max)} = \sqrt{\frac{1}{2} \times \frac{(Tj - Ta)}{Rth \ \times Rdson_{(@Tj)}}}$$

For the BTS723G:

$$Iout_{(/channel\ \max)} = 1.94A = \sqrt{\frac{1}{2} \times \frac{(150 - 85)}{41 \ \times (0.210)}}$$

For the AUIPS7142G:

$$Iout_{(/channel \max)} = 2.125A = \sqrt{\frac{1}{2} \times \frac{(150 - 85)}{40 \ \times (0.180)}}$$

As shown, the first evaluation, the AUIPS7142G has more output current capability than the BTS723.

Comparison table

Part number	Nb channel	Rth in °C/W	Tj in °C	Tambient in °C	Rdson@150°C in Ohm	Imax in A
BTS723G	*1*	*45*	*150*	*85*	*0,21*	**2,62**
AUIPS7142G		*45*	*150*	*85*	*0,18*	**2,83**
BTS723G	*2*	*41*	*150*	*85*	*0,21*	**3,89**
AUIPS7142G		*40*	*150*	*85*	*0,18*	**4,25**
BTS724G	*4*	*34*	*150*	*85*	*0,18*	**2,30**