International IOR Rectifier

Preliminary Datasheet

AUIRCS3040N

Features

- Integrated Power Stage Module
- Integrated high + low side driver and MOSFET
- 40V, 30A current capability for high efficiency Converters and Inverters
- CMOS Schmitt-triggered inputs
- Matched propagation delay for both channels
- Thermal enhanced package
- Exposed leads for visual inspection
- Under Voltage Lock Out function
- Automotive Qualified
- Leadfree, RoHS compliant

Typical Applications

- 12V to 28V DC-DC single and multi-phase converters for Micro and Mild hybrid vehicles.
- Buck and buck-boost single and multiphase converters.
- Brush and Brushless Motor Drivers at 12V and 24V for Cars and trucks.

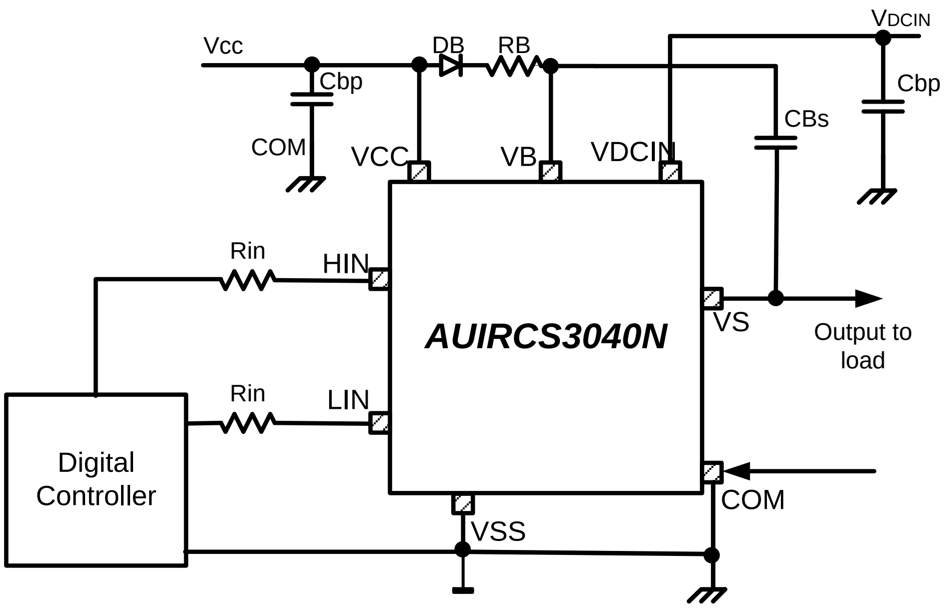
Product Summary

Topology	40V AU-ConvertIR™ Power Stage
V_{DCIN}	40V
I_{OUT} @ Tc=100C	30A
Switching Frequency (max)	400kHz

Package

5x6 Punched PQFN

Typical Connection Diagram



Orderable Part Number	Package Type	Standard Pack		Note
		Form	Quantity	
AUIRCS3040NTR	PQFN 5x6	Tape & Reel	TBD	

Absolute Maximum Ratings

Absolute Maximum Ratings indicate sustained limits beyond which damage to the device may occur. All voltage parameters are absolute voltages referenced to COM lead. Stresses beyond 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 condition beyond those indicated in the “Recommended Operating Conditions” is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability. The thermal resistance and power dissipation ratings are measured under board mounted and still air conditions. Ambient temperature (T_A) is 25°C, unless otherwise specified.

Symbol	Definition	Min.	Max.	Units
V_{DCIN}	Power Input Voltage		40	V
V_{CC}	Bias Supply Voltage	-0.3	20	
V_{IN}	Logic input voltage	-0.3	5.0	
V_B	High side positive floating supply voltage	-0.3	Vs + 20	
V_S	Phase Voltage	V_B - 20	40	
I_D @ TC = -40 to 100 C	Continuous Drain Current on VDCIN, Vs and COM pins.		30	A
Rth_{JC}	Thermal resistance, junction to case	—	3	°C/W
T_J	Junction temperature	—	150	°C
T_S	Storage temperature	-55	150	
T_L	Lead temperature (soldering, 10 seconds)	—	300	

Recommended Operating Conditions

For best operation the device should be used within the recommended conditions. All voltage parameters are absolute voltage referenced to COM=VSS.

Symbol	Definition	Min.	Max.	Units
V_{DCIN}	Power Input Voltage	10	40	V
V_{CC}	Bias Supply Voltage	10	20	
V_{IN}	Logic input voltage	VSS	5	
V_B	High side positive floating supply voltage	Vs	Vs+20	
V_S	Phase Voltage	Note 1	40	
V_{SS}	Logic Ground	-5	5	
Fsw	Switching frequency**	1	400	kHz
Rin	Input resistance*	100	5k	Ω
T_A	Ambient Temperature	-40	125	°C

Note 1: Logic operational for VS of -5V to 40V. Logic state held from -4V to –VBS.
* input resistance value to be calculated based on the desired rise time and switching frequency.
** thermal balance to be verified accordingly

Static Electrical Characteristics

Unless otherwise specified, these specifications apply for an operating ambient temperature range of -40°C≤Ta≤125°C and power supply V_{CC}=15 V. The V_{IN} and I_{IN} parameters are referenced to VSS and are applicable to input leads: LIN and HIN. The V_O and I_O parameters are referenced to COM.

Symbol	Definition	Min	Typ	Max	Units	Test Conditions
	Gate Driver Section					
V_{IL}	PWM logic "0" input voltage			0.7	V	VCC=10V-20V
V_{IH}	PWM logic "1" input voltage	2.5				
I_{IN+}	PWM logic "1" input bias current			13	µA	VIN=3.3V
I_{IN-}	PWM logic "0" input bias current			2		VIN=0V
C_{IN}	Equivalent input capacitance [(1)]		7		pF	
I_{QBS}	Quiescent VBS supply current		120	250	µA	VIN=0V or 3.3V
I_{QCC}	Quiescent VCC supply current		200	350		
I_{LK}	Offset supply leakage current			200		VB=VS=200V
$V_{CCUVHYS}$	Vcc supply undervoltage hysteresis		1		V	
V_{CCUV+}	Vcc supply undervoltage turn on threshold	6	7	8		
V_{CCUV-}	Vcc supply undervoltage turn off threshold	5	6	7		
$V_{BSUVHYS}$	Vcc supply undervoltage hysteresis		1			
V_{BSUV+}	Vcc supply undervoltage turn on threshold	6	7	8		
V_{BSUV-}	Vcc supply undervoltage turn off threshold	5	6	7		
	Power MOSFET Section					
I_{DCS}	VDCIN to VS leakage current			TBD	uA	Vs=0V, VDCIN=40, LIN and HIN=0V.
R_{DSONH}	Drain to Source Resistance High Side MOSFET	-	6	10	mOhm	LIN=0V, HIN=5V, IDC_{IN}=20A, T=25C
R_{DSONL}	Drain to Source Resistance Low Side MOSFET	-	6	10	mOhm	LIN=5V, HIN=0V, IVS_{IN}=20A, T=25C

(1) Guaranteed by design

Dynamic Electrical Characteristics

Unless otherwise noted, these specifications apply for an operating junction temperature range of -40°C≤Ta≤125°C with bias conditions of V_{CC} = VBS = 15 V.

Symbol	Definition	Min	Typ	Max	Units	Test Conditions
Gate Driver Section						
t_{ON}	Turn-on propagation delay (1)	—	60	120	ns	VS=0
t_{OFF}	Turn-off propagation delay (1)	—	60	120		VS=0V and 200V
DM1	Channel to channel turn on delay matching (1)			20		
DM2	Channel to channel turn off delay matching (1)			20		
Module Section						
fsw	Switching Frequency			400	kHz	
D	Maximum Duty Cycle (2)			100	%	VB-VS=15Vdc

(1) Guaranteed by design, Vin 50% to Vs 50%.
(2) When using separated floating supply

Input/Output table

HIN	LIN	VS
L	L	High Z
H	L	H
L	H	L
H	H	ND

Table is valid with values within recommended operating conditions.
There is no minimum deadtime protection embedded in the device.
High Z condition is valid as long as COM < Vs < VDCIN.

Functional Block Diagram:

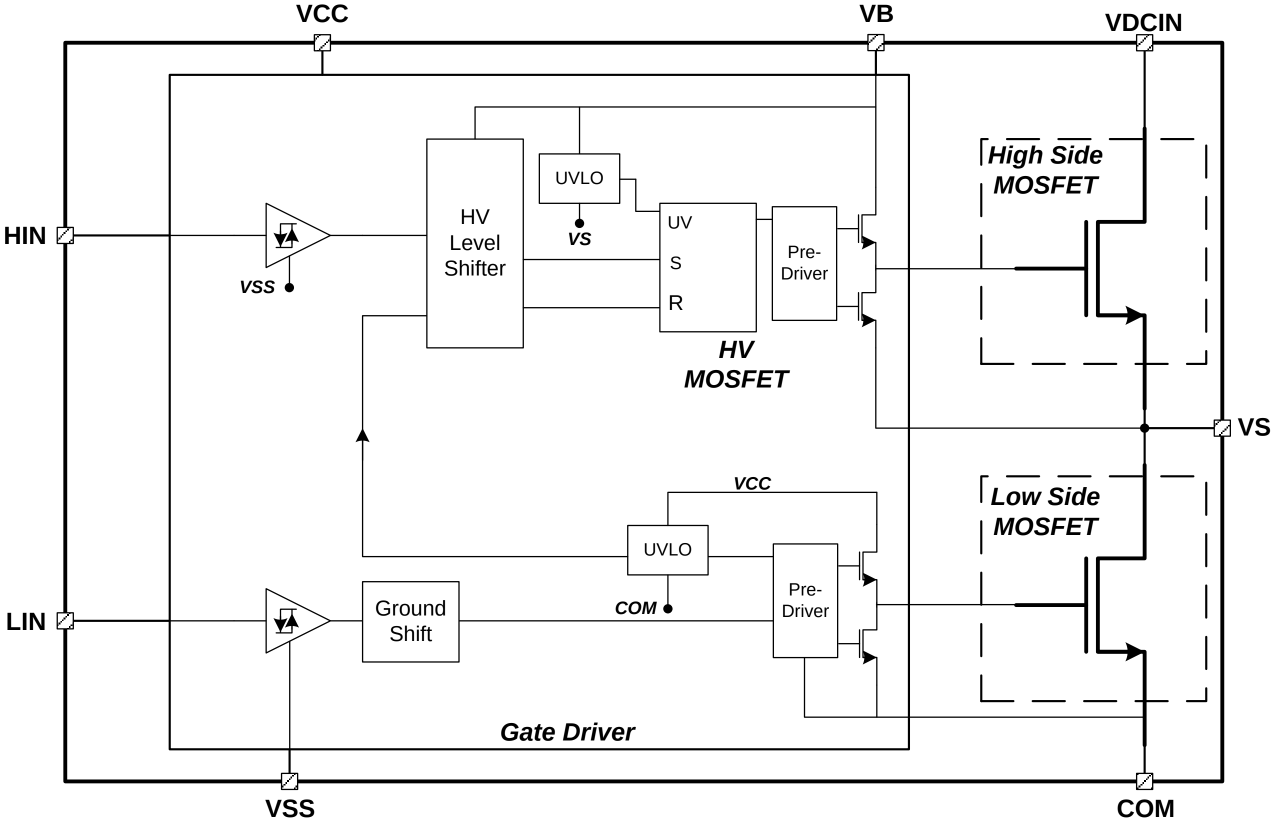


Figure 1

Gate Driver Input/Output Pins Equivalent Circuit Diagrams

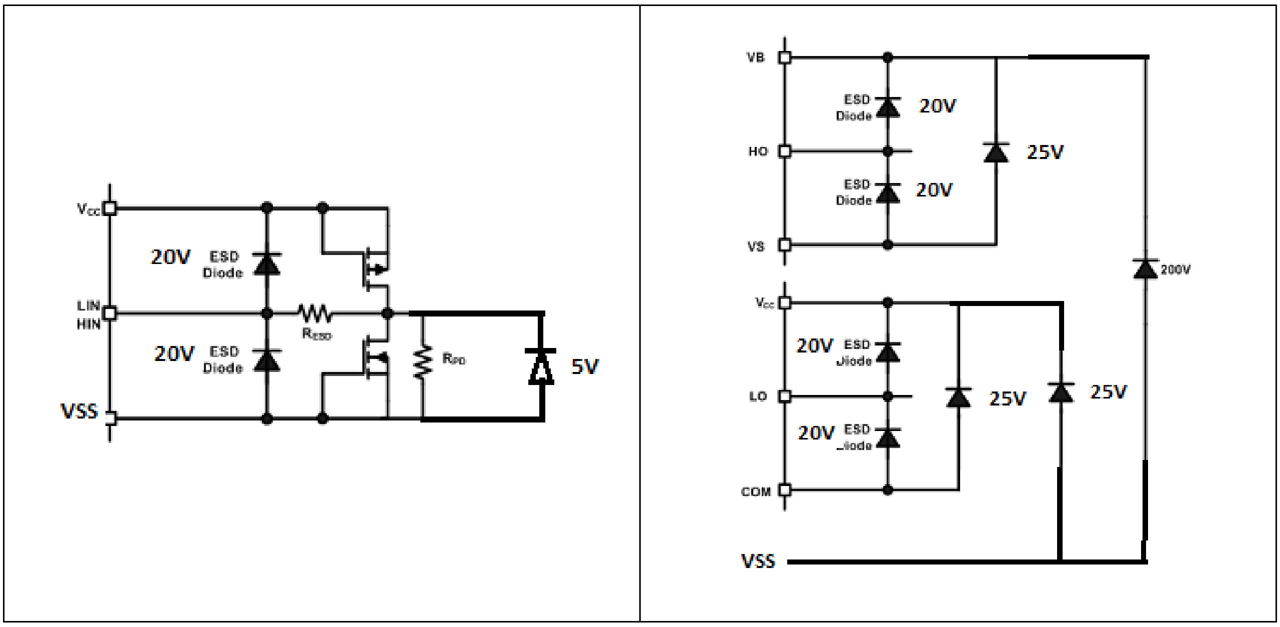


Figure 2

Lead Definitions

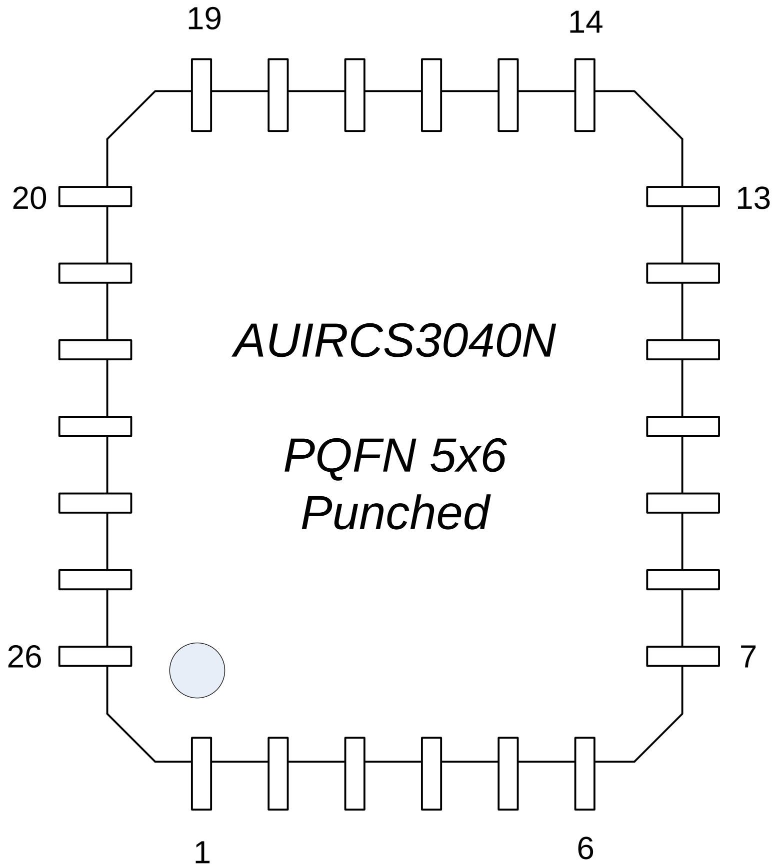
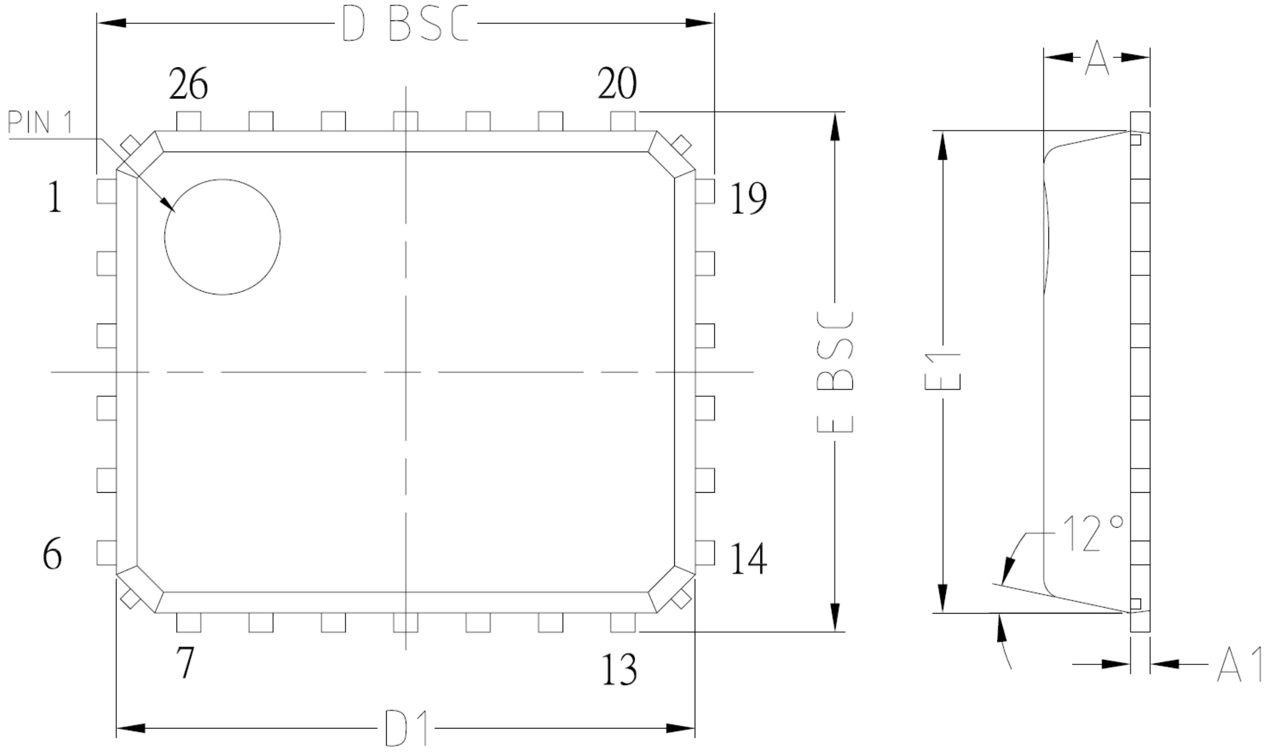
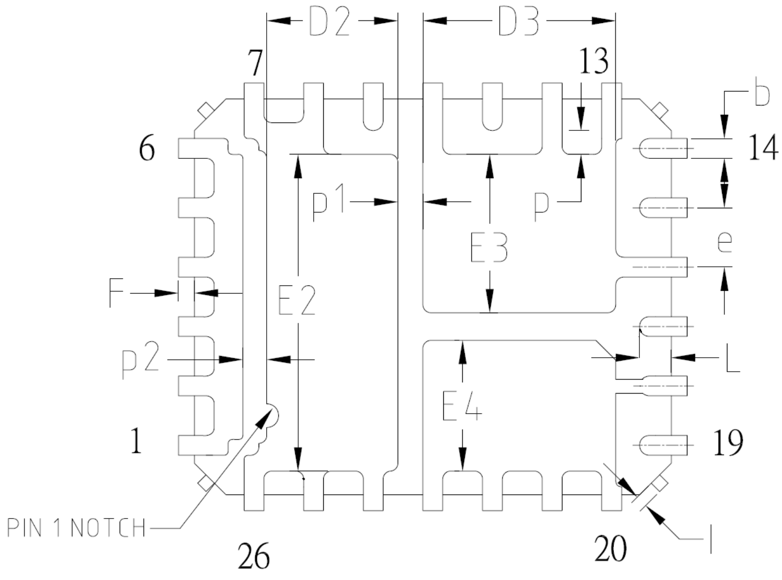


Figure 3

PIN	Symbol	Description
14, 19	NOC	Not Connected
10, 12, 13, 16	VSS	Logic Ground
18, 20-23	VDCIN	INPUT DC Voltage
7-8, 24-26	VS	Phase Voltage – Reference of the floating supply voltage
1-6	COM	Power Ground
9	VCC	Supply voltage
11	LIN	Low Side Input Driver
15	HIN	High Side Input Driver
17	VB	Positive floating supply voltage

Package Information: PQFN 5x6 punched





	COMMON					
	DIMENSIONS MILLIMETER			DIMENSIONS INCH		
	MIN.	NOM.	MAX.	MIN.	NOM.	MAX.
A	1.000	1.100	1.200	0.0393	0.0433	0.0472
A1	0.200 REF.			0.0079 REF.		
b	0.200	0.250	0.300	0.0079	0.0098	0.0118
L	0.350	0.400	0.450	0.0138	0.0157	0.0177
F	0.050	0.200	0.250	0.0019	0.0079	0.0098
e	0.750 BSC.			0.0295 BSC.		
p	0.300 BSC.			0.0118 BSC.		
p1	0.315 BSC.			0.0124 BSC.		
p2	0.300 BSC.			0.0118 BSC.		
D	6.4 BSC.			0.2520 BSC.		
D1	6.0 BSC.			0.2362 BSC.		
D2	1.600	1.650	1.700	0.0630	0.0650	0.0670
D3	2.375	2.425	2.475	0.0935	0.0955	0.0974
E	5.4 BSC.			0.2126 BSC.		
E1	5.0 BSC.			0.1969 BSC.		
E2	3.950	4.000	4.050	0.1555	0.1575	0.1594
E3	1.950	2.000	2.050	0.0768	0.0787	0.0807
E4	1.600	1.650	1.700	0.0630	0.0650	0.0670
I	—	—	0.150	—	—	0.0059

Figure 4

Application Information

A- Typical Applications

1- Single Phase Buck Converter

Figure 5 shows a typical application diagram in which the AUIRCS3040N is used as power stage of a buck converter from a V_{DCIN} supply to a lower Vout power supply. The AU-Convert*IR* allows a dramatically reduced component count implementation of the power stage. The digital controller provides the input signals for both high and low side MOSFETs taking care of the needed dead time; a bootstrap network (i.e. DB, RB and CBs) realizes the power supply for the higher voltage well of the gate driver that is responsible for the High side MOSFET driving.
The VSS and COM pins are the signal and power grounds respectively; those two points have to be connected together in a single point of the pcb to improve the signal integrity and, as a consequence, the module driving.

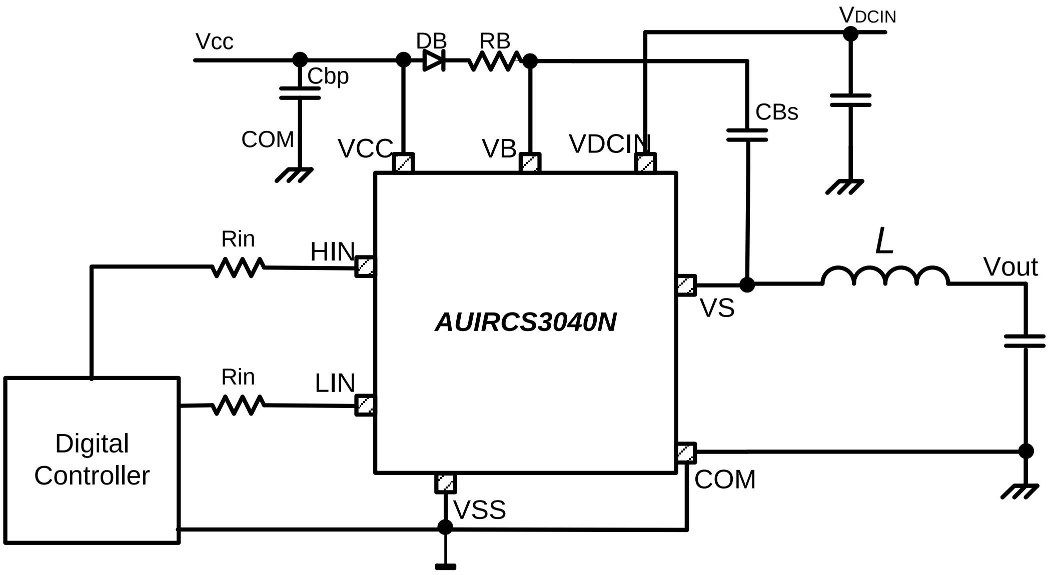


Figure 5

2- Multiphase Buck Converter

Figure 6 shows another typical application diagram in which AUIRCS3040N is used as power stage in a multiphase buck converter. For better understanding the bootstrap connection of AU-Convert*IR* 2, 3 and 4 are not shown. This solution allows a better and more reliable system integration dramatically reducing the component count
It is possible to easily evaluate the power managed by each phase in a specific application considering that each AU-Convert*IR* stage is able to manage up to 30A in a controlled thermal environment. For instance this power is equal about to 400W in a typical 14V battery application. As a consequence, converter in Fig. 6 with 4 phases can ideally manage up to 1.8kW.

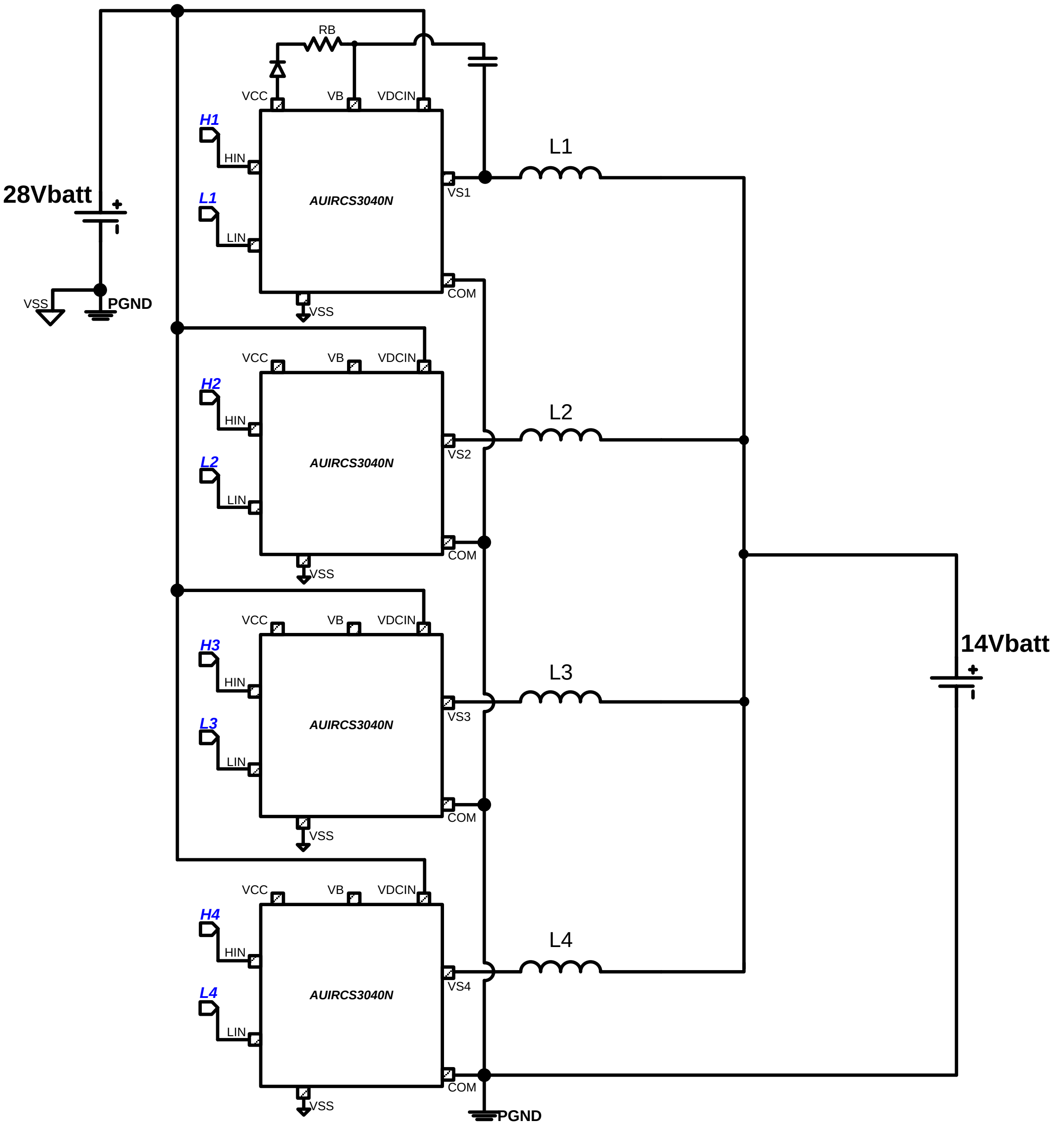

28Vbatt
VSS
PGND
RB
VCC
VB
VDCIN
H1
HIN
L1
LIN
AUIRCS3040N
VS1
COM
VSS
L1
H2
L2
VS2
L2
H3
L3
VS3
L3
H4
L4
VS4
L4
14Vbatt
PGND

Figure 6

3- Single Phase Buck-Boost Converter

Figure 7 shows another possible typical application in which the AUIRCS4030N can be exploited as integrated power stage: it is a buck boost bidirectional DC-DC converter. The 14Vtyp battery is subjected to load cycles that could cause deep battery discharge; an auxiliary 14V battery allows, through the buck boost converter, easy load cycle compensation. Just two AU-Convert*IR* stages realize the whole DC-DC converter in place of the usual six sockets (i.e. two gate drivers and four power switches).

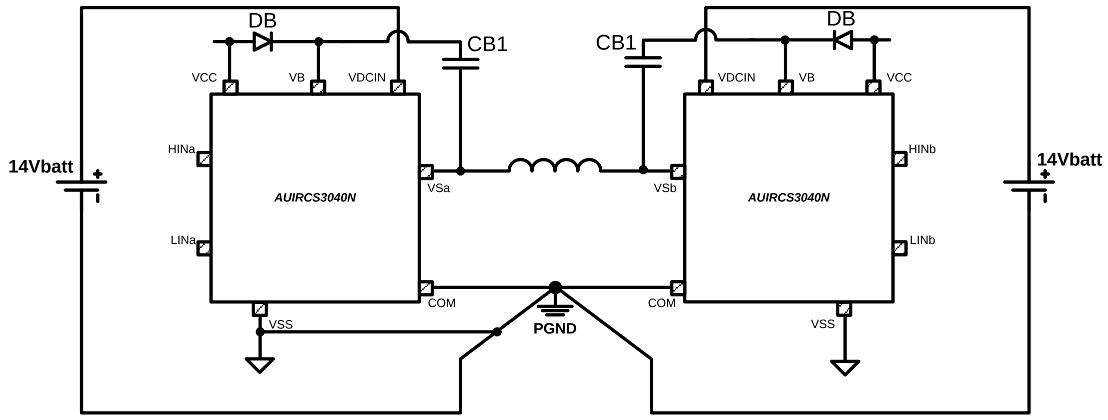


Figure 7

4- Boost Converter

Figure 8 shows a typical application diagram in which the AUIRCS3040N is used as power stage of a boost converter from a V_{DCIN} supply to a higher Vout power supply. The AU-Convert*IR* allows a dramatically reduced component count implementation of the power stage. The digital controller provides the input signals for both high and low side MOSFETs taking care of the needed dead time; a bootstrap network (i.e. DB, RB and CBs) realizes the power supply for the higher voltage well of the gate driver that is responsible for the High side MOSFET driving.

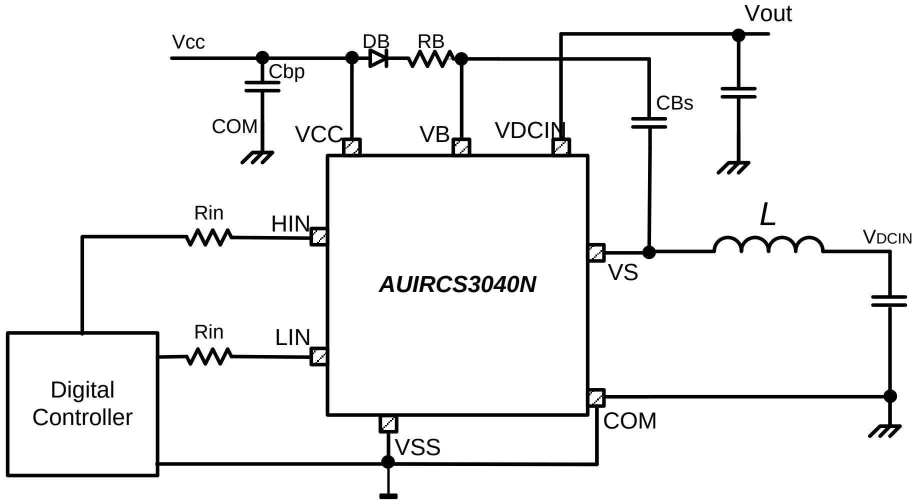


Figure 8

5- Brush Motor driver stage

The following Figure 9 shows the device application as motor driver for an Brush motor in a full bridge configuration. Operation frequency in this case is suggested to be up to 20kHz, however much higher frequency is possible for the device.
The device can be directly driven by any uP or DSP with 3.3V or 5V logic output signals. Short circuit protections are not embedded into the device and they have to be added externally.

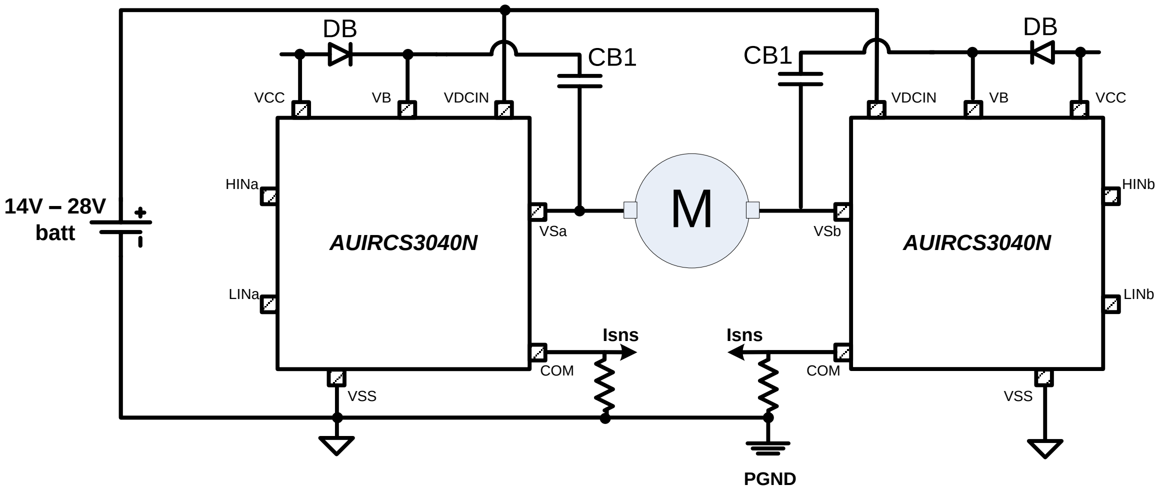


Figure 9

6- Brushless motor driver stage

Figure 10 shows the device application as a Brushless motor driver.
Operation frequency in this case is suggested to be up to 20kHz, however much higher frequency is possible for the device.
The device can be directly driven by any uP or DSP with 3.3V or 5V logic output signals. Short circuit protections are not embedded into the device and they have to be added externally.

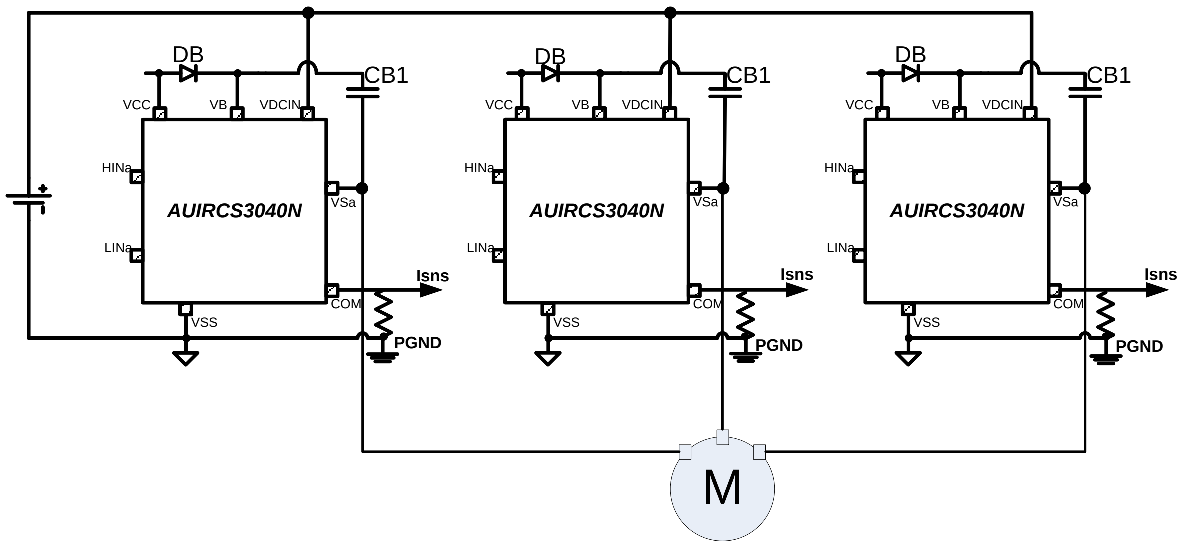


Figure 10

B- AU-Convert*IR*: Estimated Power Losses

Based on the application conditions (i.e. VDCIN, fsw, L) it is possible to estimate the AUIRCS3040N overall power consumption.

Fig. 11 shows typical and maximum power losses of the power stage as a function of the output current Io in a typical application condition.

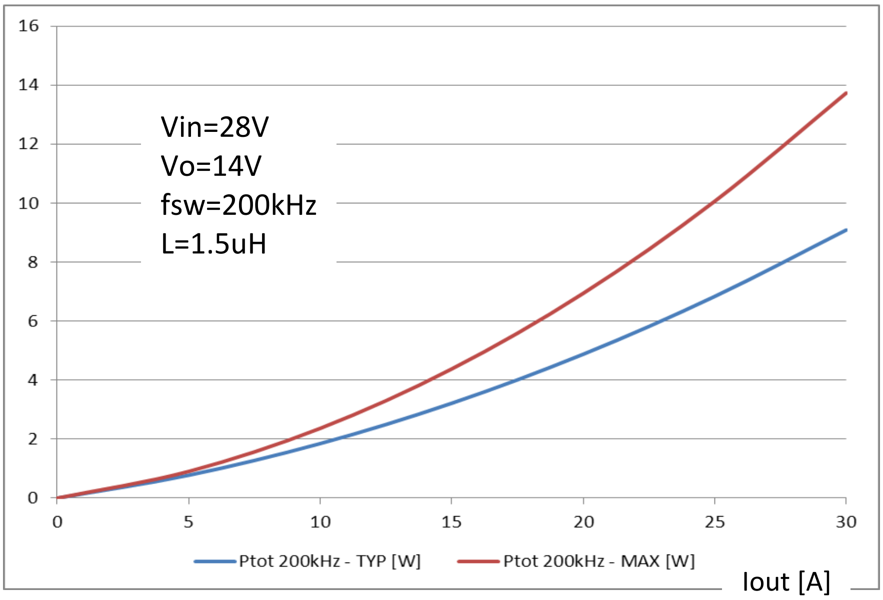


Fig. 11: Typical and Maximum AUIRC3040N power losses as a function of the DC-DC converter output current.

Fig. 12 shows the AUIRCS3040N power losses as a function of the switching frequency in the same application condition.

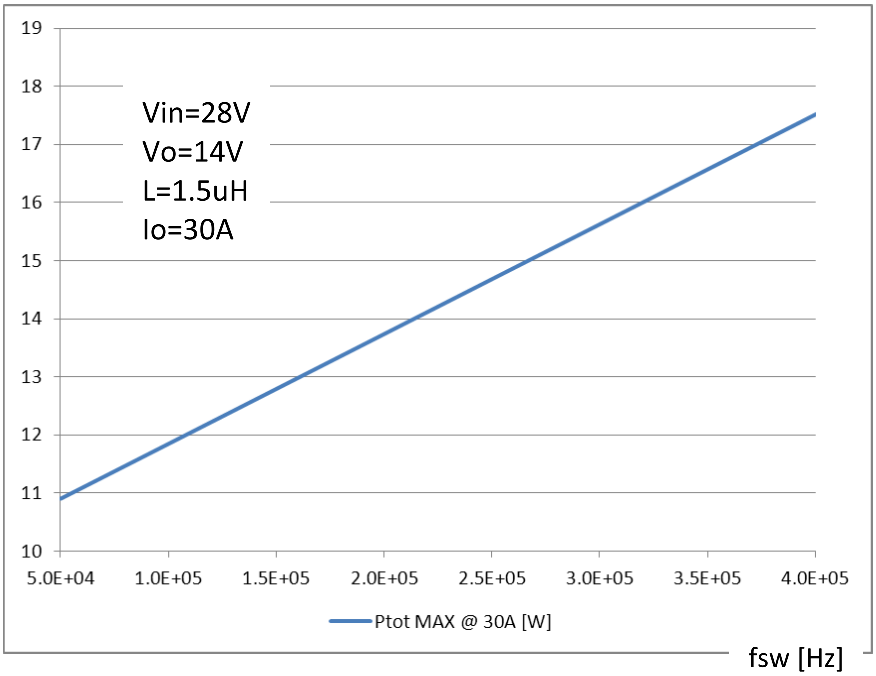


Fig. 12: Maximum power consumption of the power stage as a function of the switching frequency.

The above pictures can be exploited in the design of the case to ambient thermal resistance whose sizing has to be done considering that the maximum junction temperature for the AUIRCS3040N is 150C.

C- AU-ConvertIR: Efficiency, Power Losses and Thermal Measurements

The device performances have been evaluated in a demoboard in buck configuration, the application schematic is the following:

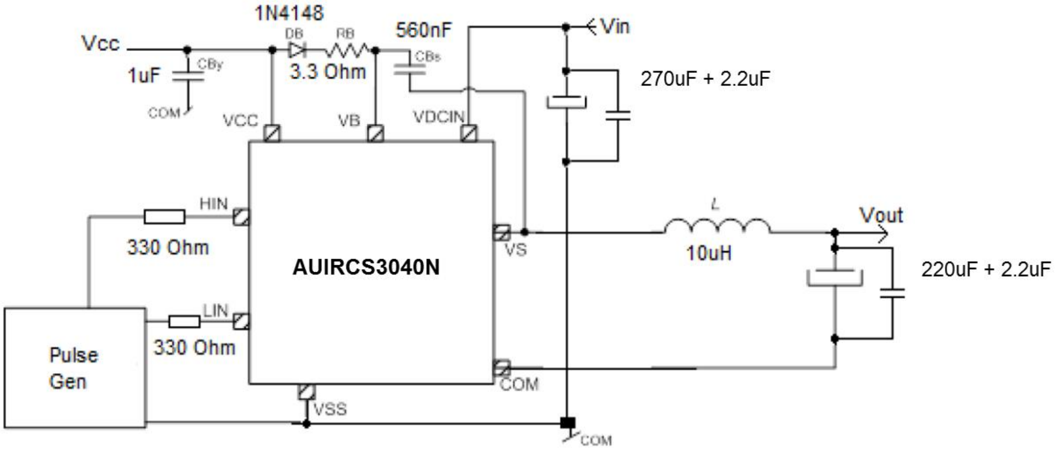


Figure 13

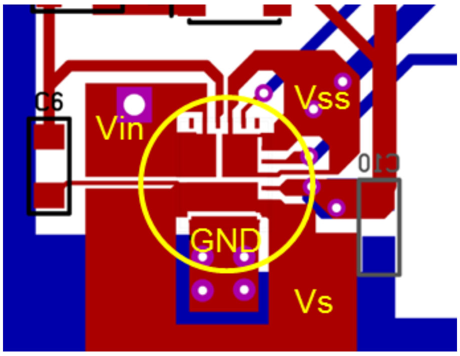


Figure 14

The pcb copper traces under the device are shown in Fig. 14, the board is a standard FR4 – 2 copper layers standard thickness, the related thermal resistance junction – air measured in this condition was of 27.5C/W

The converter operating conditions are the following:

V_{DCIN} = 20 – 24 – 28 V
Vout = 12V
Vcc = 8 – 12 – 16V
Ta = 27C
Fsw = 100 – 200 – 400 kHz

Efficiency, device power losses and temperature increase are reported in the following page.

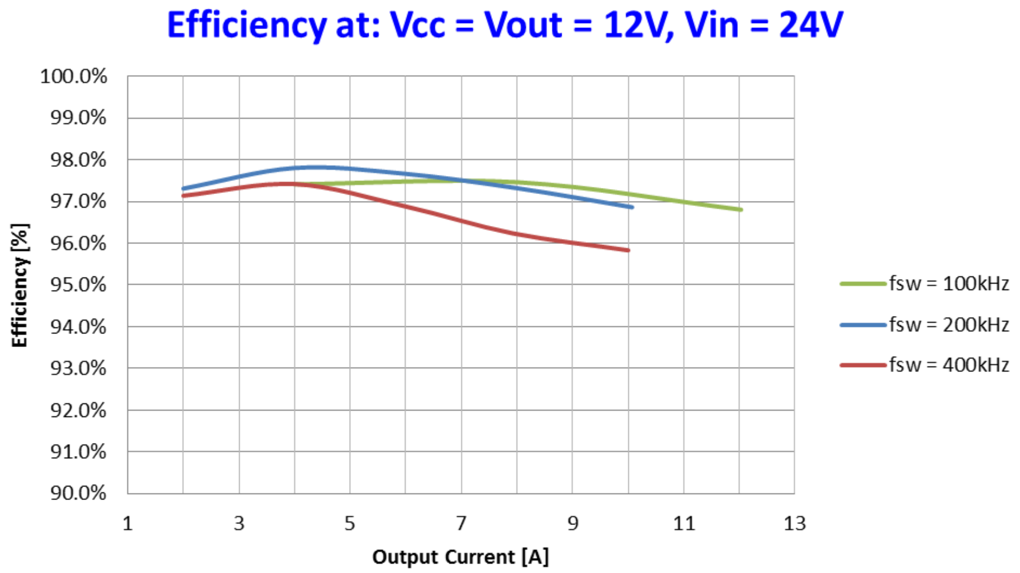


Figure 15

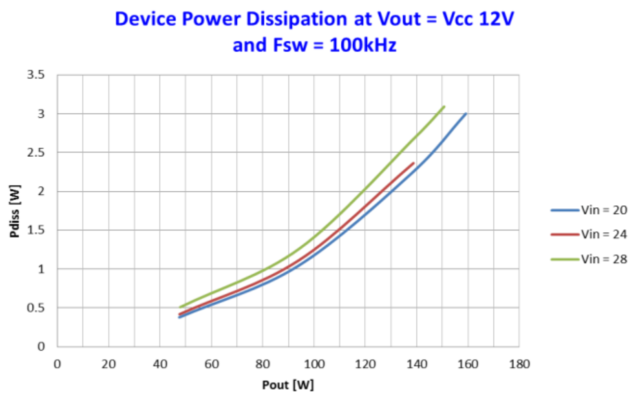


Figure 16

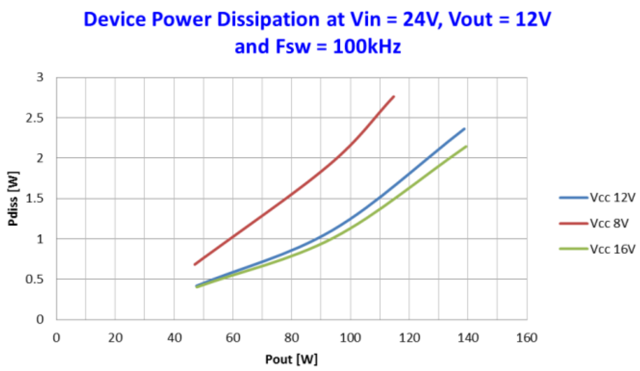


Figure 17

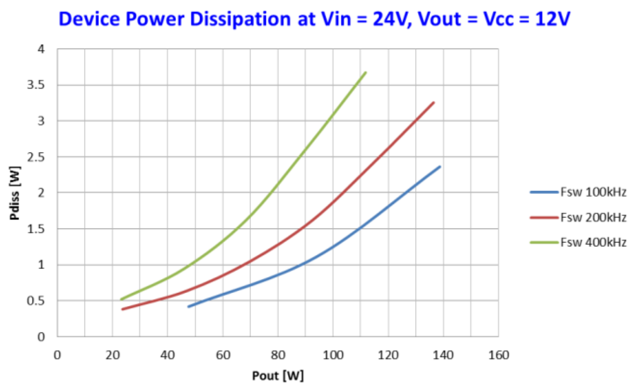


Figure 18

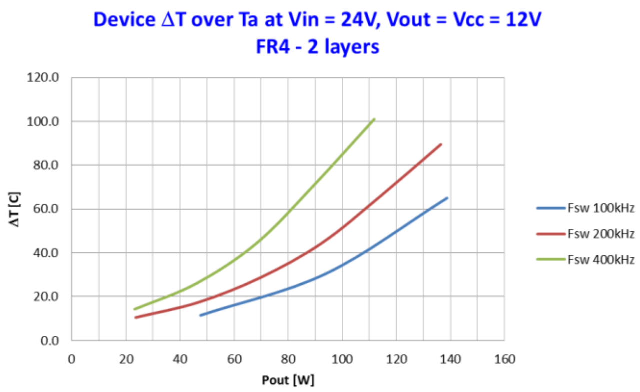


Figure 19

Qualification Information

Qualification Level		Automotive (per AEC-Q100)	
		Comments: This part number passed Automotive qualification. IR's Industrial and Consumer qualification level is granted by extension of the higher Automotive level.	
Moisture Sensitivity Level		PQFN 5x6 Punched	TBD
ESD	Machine Model	TBD (per AEC-Q100-003)	
	Human Body Model	TBD (AEC-Q100-002)	
	Charged Device Model	TBD (per AEC-Q100-011) AEC-Q101-005	
IC Latch-UP Test		TBD (per AEC-Q100-004)	
RoHS Compliant		Yes	

† Qualification standards can be found at International Rectifier web site: http://www.irf.com

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