Advance Data Sheet: iJA Series – Non-isolated SMT Power Module

iJA Series DC/DC Power Modules
12V Input, 35A Output
Surface Mount Power Module

iJA power modules perform local voltage conversion from a bus voltage in the 12V range. The iJA12035A007V offers an extremely high power density and high operating efficiency from full to light load conditions. It provides a highly integrated design that results in a reliable module with a high level of performance. iJA modules are PMBus™ compliant and digitally controlled, allowing for a great deal of flexibility and customization to the end application's needs. iJA modules support easy paralleling with interleaving for implementation in higher power, higher performance systems. The compact, surface mountable design features a low profile and weight for extremely flexible and robust manufacturing processes.

Features

- Size: 22.9 mm x 12.7 mm x 9.7 mm (0.9 in. x 0.5 in. x 0.382 in.)
- Weight 6.5g (0.23oz)
- Surface mountable
- Ultra High Power density, 580W/in^3
- PMBus™ read and write compliant
- Minimal derating of output power even in high ambient temperature, low airflow environments
- Negative logic on/off
- Multi-phase / parallel operation with current sharing
- Starts with pre-biased output
- Wide range output voltage adjustment by resistor or PMBus
- Optimized dynamic transient performance over a wide capacitive loading range without the need for control loop tuning
- Constant switching frequency
- Precision current / temperature monitoring
- Remote Sense
- Full, auto-recovery protection:
  - o Input under voltage
  - o Short circuit
  - o Thermal limit

Options

- Positive logic on/off
- Fault pin for parallel operation

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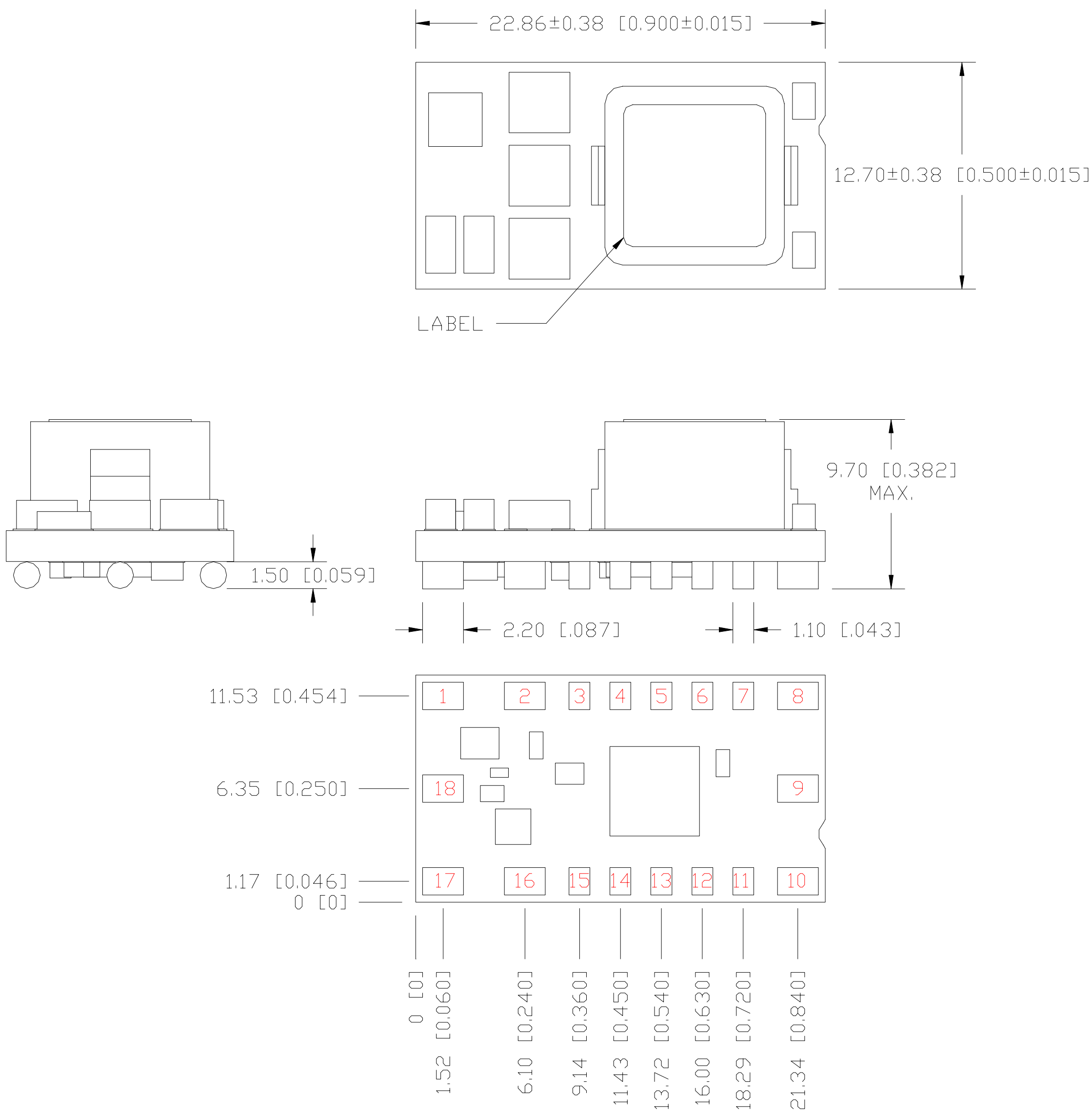
Mechanical Specification:

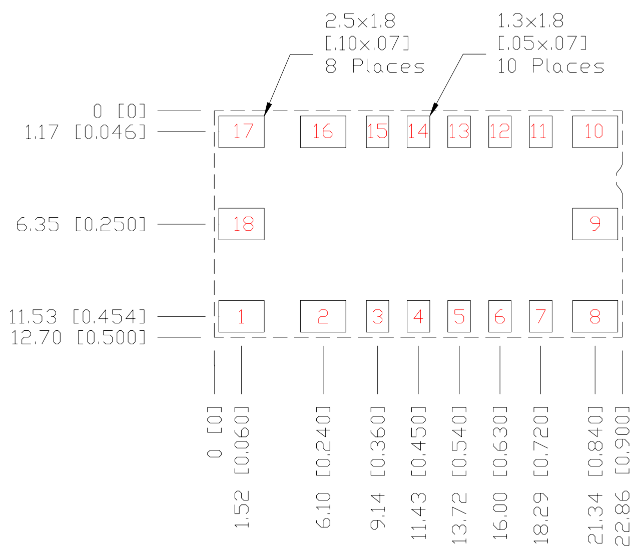
Dimensions are in mm [in]. Unless otherwise specified tolerances are: x.x ± 0.5 [0.02], x.xx ± 0.25 [0.010]



Pin Assignment:

PIN	NAME	FUNCTION
1	GND	Power module ground pin
2	GND	Power module ground pin
3	ENABLE	Enable, remote on/off feature pin
4	SCLK	SMBus compatible clock serial input
5	SDAT	SMBus compatible data serial input/output
6	SALERT (00x)	Alert line, to communicate faults and/ or warnings to the host system
	FAULT (0Px)	Fault communication bus, suggested for parallel operation
7	ADDR	Pin for resistor strap to set SMBus address
8	VOUT	Power module output voltage
9	VOUT	Power module output voltage
10	VOUT	Power module output voltage
11	SENSE +	Positive Remote Sense feature pin
12	SENSE -	Negative Remote Sense feature pin
13	TRIM	Pin for resistor strap to set output voltage
14	SHARE	Pin used for current communication between modules in multi-phase configurations
15	SYNC	Pin used for timing communication between modules in multi-phase configurations
16	GND	Power module ground pin
17	GND	Power module ground pin
18	VIN	Power module input voltage

Recommended Footprint: (top view)



Absolute Maximum Ratings:

Stress in excess of Absolute Maximum Ratings may cause permanent damage to the device.

Characteristic	Min	Max	Unit	Notes & Conditions
Continuous Input Voltage	-0.3	16	V	
Control Pin Voltage, Output Voltage	-0.3	3.6	V	
Storage Temperature	-55	125	˚C	
Operating Temperature Range (Tc)	-40	125*	˚C	Maximum temperature as measured at the location specified in the thermal measurement figure varies with output current – see curve in the thermal performance section of the data sheet.

* Engineering estimate

Input Characteristics:

Unless otherwise specified, specifications apply over all rated Input Voltage, Resistive Load, and Temperature conditions.

Characteristic	Min	Typ	Max	Unit	Notes & Conditions
Operating Input Voltage	8	---	14	Vdc	
Maximum Input Current	---	---	16	A	Vin= 8 to Vin,max; Io=Io,max
Startup Delay Time from application of input voltage	---	10	---	mS	Vo=0 to 0.1*Vo,set; on/off=on, Io=Io,max, Tc=25˚C
Startup Delay Time from on/off	---	2	---	mS	Vo=0 to 0.1*Vo,set; Vin=Vi,nom, Io=Io,max,Tc=25˚C
Output Voltage Rise Time	---	3.5	---	mS	Io=Io,max,Tc=25˚C, Vo=0.1 to 0.9*Vo,set
Input Reflected Ripple	---	30	---	mApp	See input/output ripple measurement figure; BW=20 MHz
Turn on input voltage	---	7.6	---	V	
Turn off input voltage	---	7.0	---	V	
Input Over-voltage Protection	-	15	-	V	
Input Over-voltage Fault Hysteresis	-	1	-	V	

*Engineering Estimate

Caution: The power modules are not internally fused. An external input line normal blow fuse with a maximum value of 20A is required, see the Safety Considerations section of the data sheet.

Electrical Data:

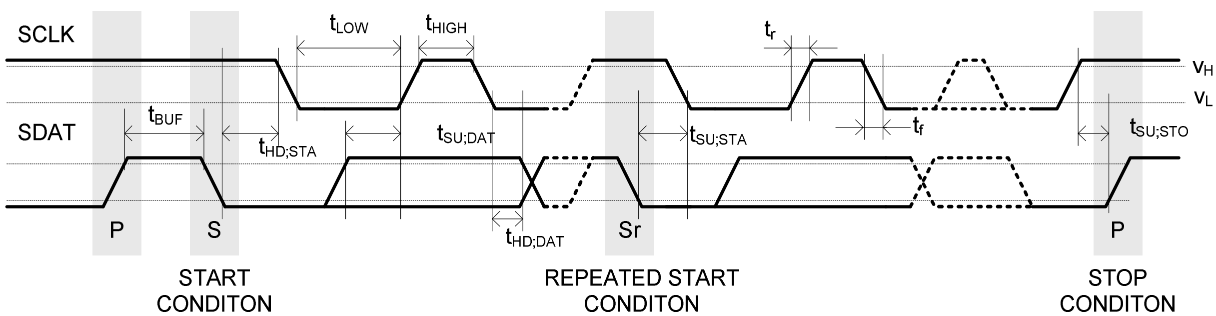
Characteristic	Min	Typ	Max	Unit	Notes & Conditions
Output Voltage Initial Setpoint	-1	---	+1	%	Vo=1.2 V setting, Vin=Vin,nom; Io=0.5*Io,max; Tc = 25˚C
Output Voltage Tolerance	-2	---	+2	%	Over all rated input voltage, load, and temperature conditions to end of life
Efficiency Vo = 1.2V Vo = 1.8V Vo = 3.3V	--- --- ---	85 86 94	--- --- ---	% % %	Vin=12V; Io=0.8*Io,max; Tc=25˚C
Line Regulation	---	4	---	mV	Vin=Vin,min to Vin,max
Load Regulation	---	8	---	mV	Io=Io,min to Io,max
Output Current	0	---	35	A	
Output Current Limiting Threshold	---	40	---	A	Vo = 0.9*Vo,nom, Tc<Tc,max
Short Circuit Current	---	1.5	---	A	Vo = 0.25V, Tc = 25˚C
Output Ripple and Noise Voltage	---	10	---	mVpp	Measured across 344uF ceramic capacitor – see input/output ripple measurement figure; BW = 20MHz.
Output Voltage Adjustment Range	0.6	---	3.3	V	
Output Voltage Sense Range	---	---	5	%	
Dynamic Response: Recovery Time Transient Voltage	______	25 120	______	uS mV	di/dt =1A/uS, Vin=Vin,nom; Vo=1.8V, load step from 25% to 75% of Io,max, Cout = 344uF ceramic capacitor near the module and 500uF ceramic capacitor near load
Switching Frequency	---	500	---	kHz	Fixed
External Load Capacitance	400	---	2400*	uF	344uF ceramic output capacitors near unit w/ recommended layout

*Please contact TDK-Lambda Americas for technical support if higher capacitance is required

Electrical Data:

Power Management / Telemetry Features	Min	Typ	Max	Unit	Notes & Conditions
Load Current Monitoring Accuracy	-	2	-	%	Vin=12V; Vo=1.2V Io=Io,max; Tc=25˚C; average of 100 readings; See curves for typical performance
Output Voltage Monitoring Accuracy	-1.5	-	1.5	%	Vo=1.2 V setting, Vin=Vin,nom; Io=0.5*Io,max; Tc = 25˚C
Module Temperature Monitoring Accuracy	-5	-	5	˚C	Not production tested parameter, guaranteed by design based on supplier's datasheet
Output Overcurrent Fault	-	40	-	A	
Output Overvoltage Protection	-	15	-	%	
Over Temperature Fault	-	120	-	˚C	
Over Temperature Fault Hysteresis	-	15	-	˚C	
Over Temperature Warning	-	110	-	˚C	
Under Temperature Warning	-	-30	-	˚C	

PMBus Timing characteristics



PMBus DC and Timing Characteristics

Characteristic	Symbol	Min.	Typ.	Max.	Unit	Note & Condition
Operating Frequency	f_{PMB}	10	100	400	kHz	
Input High Voltage	V_H	2.1			V	SCLK,SDAT
Input Low Voltage	V_L			0.8	V	SCLK,SDAT
Sink current	$I_{S,PMB}$	4			mA	SDAT,SALT current sinking capability
Pin Capacitance	C_{PMB}			10	pF	
Bus Free Time	t_{BUF}	1.3			us	Between Stop and Start Condition
Hold Time	$t_{HD;STA}$	0.6			us	Wait time after Start Condition
Repeated Start Condition Setup Time	$t_{SU;STA}$	0.6			us	Wait time after Repeated Start Condition
Stop Condition Setup Time	$t_{SU;STO}$	0.6			us	
Data Setup Time	$t_{SU;DAT}$	100			ns	
Data Hold Time	$t_{HD;DAT}$	300			ns	
Clock Low Period	t_{LOW}	1.3			us	
Clock High Period	t_{HIGH}	0.6			us	
Clock/Data Rise Time	t_R	20		300	ns	
Clock/Data Fall Time	t_F	20		300	ns	

Guaranteed by design, not production tested

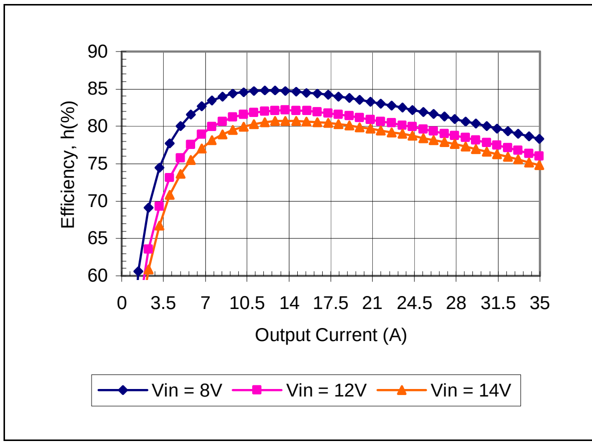
Supported PMBus Commands:

Functionality	Command	Code (Hex)	Read/ Write	Number of Byte	Coefficient (Decimal)
Control	OPERATION	01	R/W	1	N/A
	ON_OFF_CONFIG	02	R/W	1	N/A
Memory	STORE_DEFAULT_ALL*1	11	W	0	N/A
	RESTORE_DEFAULT_ALL	12	W	0	N/A
Output Voltage	VOUT_MODE	20	R	1	N/A
	VOUT_COMMAND	21	R/W	2	m=5120,R=b=0
	VOUT_TRIM	22	R/W	2	m=5120,R=b=0
	VOUT_MAX	24	R/W	2	m=5120,R=b=0
	VOUT_MARGIN_HIGH	25	R/W	2	m=5120,R=b=0
	VOUT_MARGIN_LOW	26	R/W	2	m=5120,R=b=0
	VOUT_TRANSITION_RATE	27	R/W	2	m=256,R=b=0
	VOUT_SCALE_LOOP	29	R/W	2	m=16384,R=b=0
	VOUT_SCALE_MONITOR	2A	R	2	m=16384,R=b=0
Fault Management	CLEAR_FAULT	03	W	0	N/A
	VIN_ON	35	R/W	2	m=1862,R=b=0
	VIN_OFF	36	R/W	2	m=1862,R=b=0
	VOUT_OV_FAULT_LIMIT	40	R/W	2	m=5120,R=b=0
	VOUT_UV_FAULT_LIMIT	44	R/W	2	m=5120,R=b=0
	IOUT_OC_FAULT_LIMIT	46	R/W	2	m=10.24,R=b=0
	OT_FAULT_LIMIT	4F	R/W	2	m=1,R=b=0
	OT_WARN_LIMIT	51	R/W	2	m=1,R=b=0
	UT_WARN_LIMIT	52	R/W	2	m=1,R=b=0
	UT_FAULT_LIMIT	53	R/W	2	m=1,R=b=0
	VIN_OV_FAULT_LIMIT	55	R/W	2	m=1862,R=b=0
Vout Sequencing	TON_DELAY	60	R/W	2	m=62.56,R=b=0
	TON_RISE	61	R/W	2	m=32,R=b=0
	TOFF_DELAY	64	R/W	2	m=62.56,R=b=0
Status	STATUS_BYTE	78	R	1	N/A
	STATUS_WORD	79	R	2	N/A
	STATUS_VOUT	7A	R	1	N/A
	STATUS_IOUT	7B	R	1	N/A
	STATUS_INPUT	7C	R	1	N/A
	STATUS_TEMPERATURE	7D	R	1	N/A
	STATUS_CML	7E	R	1	N/A
Telemetry	READ_VIN	88	R	2	m=1862,R=b=0
	READ_VOUT	8B	R	2	m=640,R=b=0
	READ_IOUT	8C	R	2	m=10.24,R=b=0
	READ_TEMPERATURE	8D	R	2	m=1,R=b=0
Security	PASSWORD	EA	W	2	N/A
	SECURITY_LEVEL	EB	R/W	1	N/A

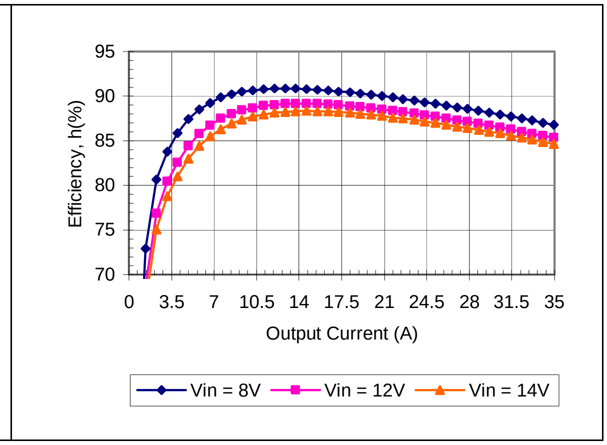
- **Note that the power modules undergo a permanent structural change when parameters are written to the memory. The Store_default_all command can be used 2 times to write to NVM before the memory is used up. When using the store_default_all command, please allow 3 seconds before powering down or the memory could be corrupted.**
- **For more detailed information about use of the supported PMBus commands please contact your TDK-Lambda Americas' sales or technical support person**

Electrical Characteristics:

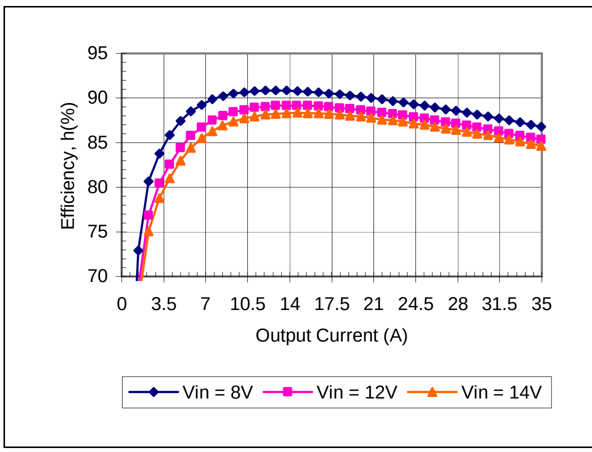
Typical Efficiency vs. Input Voltage



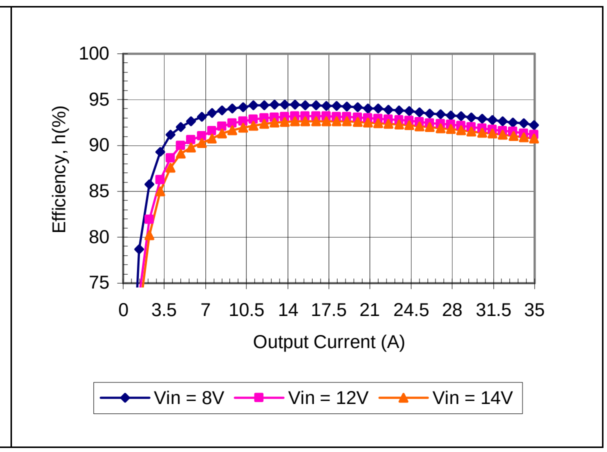
Vout = 0.6V , Ta = 25degC



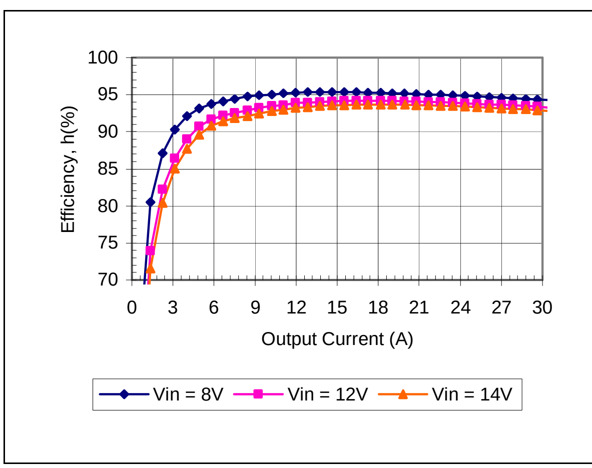
Vout = 1.2V , Ta = 25degC



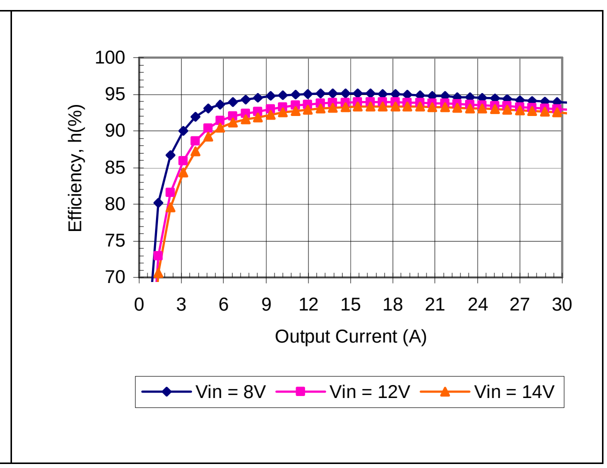
Vout = 1.8V , Ta = 25degC



Vout = 2.5V , Ta = 25degC



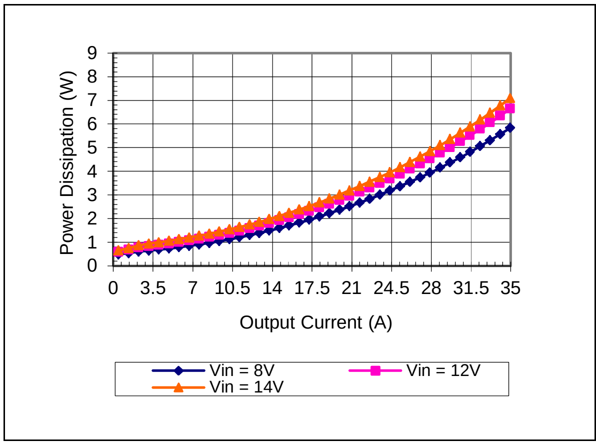
Vout = 3.3V , Ta = 25degC



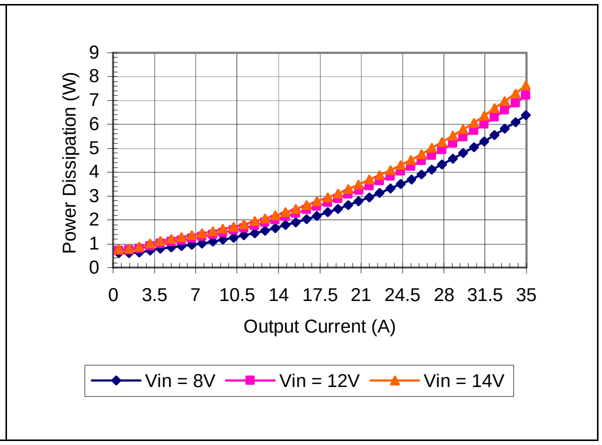
Vout = 3.3V , Ta = 85degC

Electrical Characteristics:

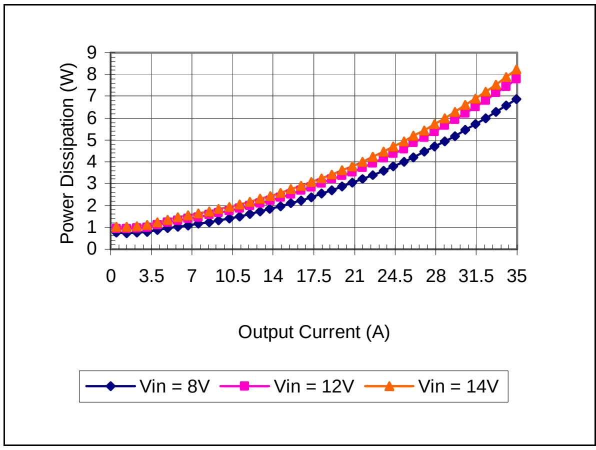
Typical Power Dissipation vs. Input Voltage



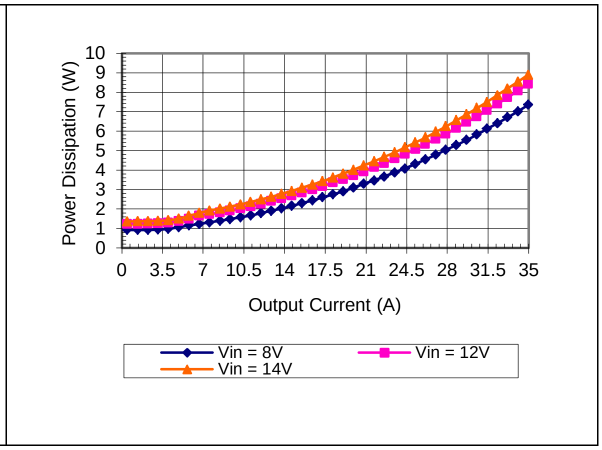
Vout = 0.6V , Ta = 25degC



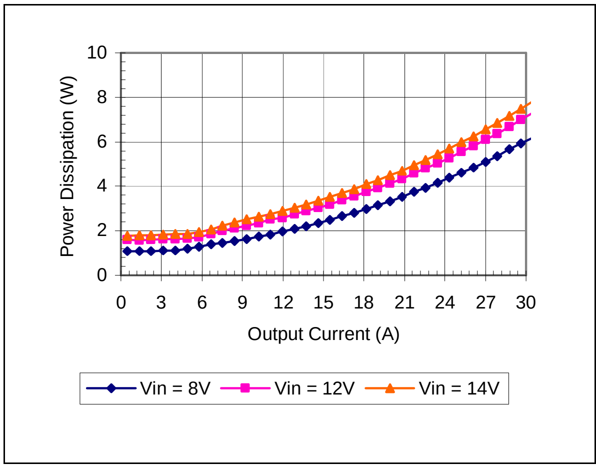
Vout = 1.2V , Ta = 25degC



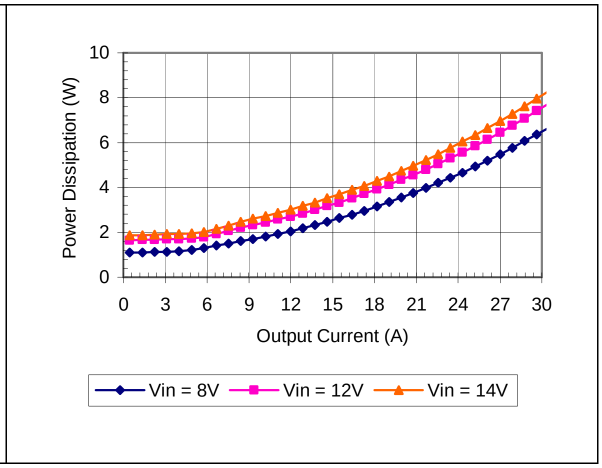
Vout = 1.8V , Ta = 25degC



Vout = 2.5V , Ta = 25degC



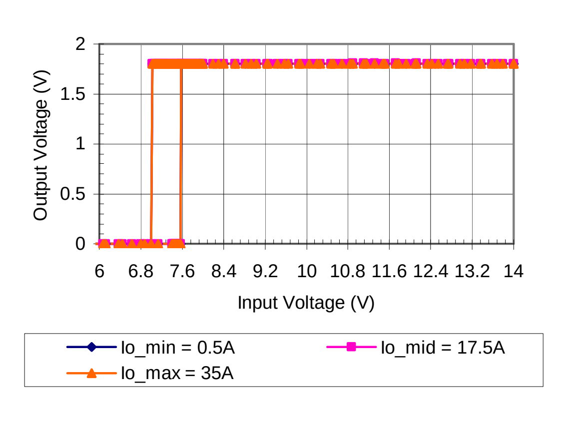
Vout = 3.3V , Ta = 25degC



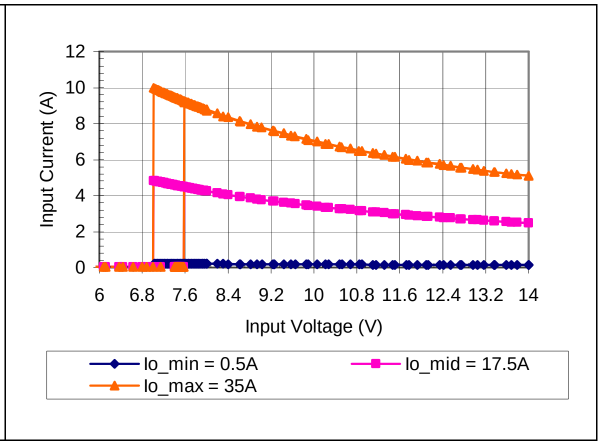
Vout = 3.3V , Ta = 85degC

Electrical Characteristics:

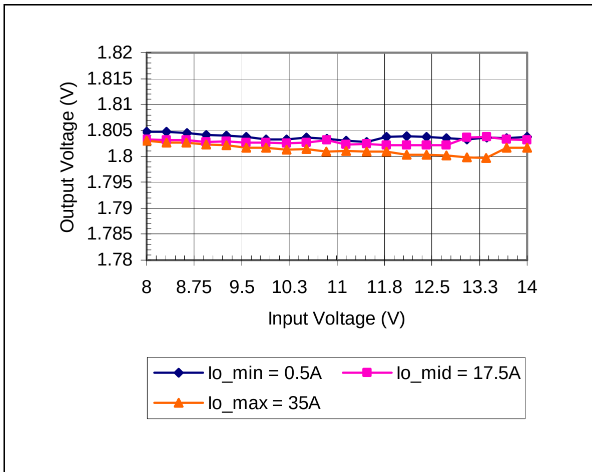
Static characteristics



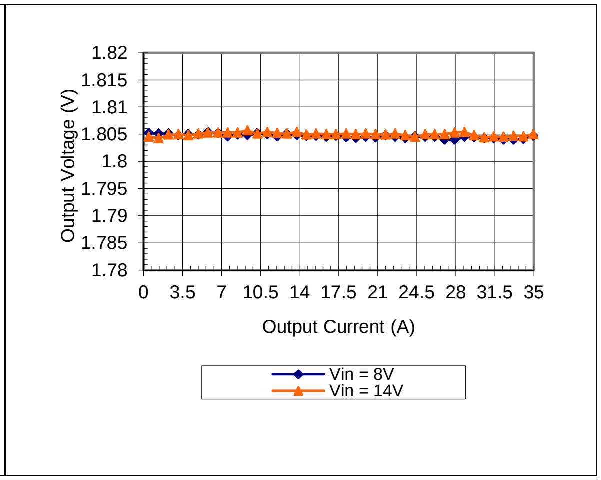
Typical Output Voltage vs. Input Voltage Characteristic
Vout = 1.8V , Ta = 25degC



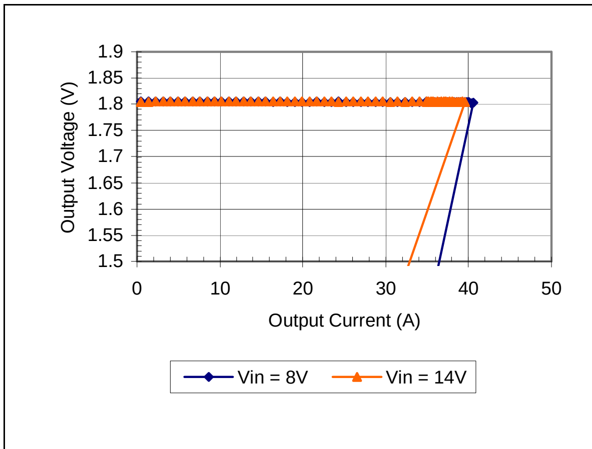
Typical Input Current vs. Input Voltage Characteristic
Vout = 1.8V , Ta = 25degC



Typical Line Regulation
Vout = 1.8V , Ta = 25degC



Typical Load Regulation
Vout = 1.8V , Ta = 25degC



Typical Current Limit Characteristics
Vout = 1.8V , Ta = 25degC

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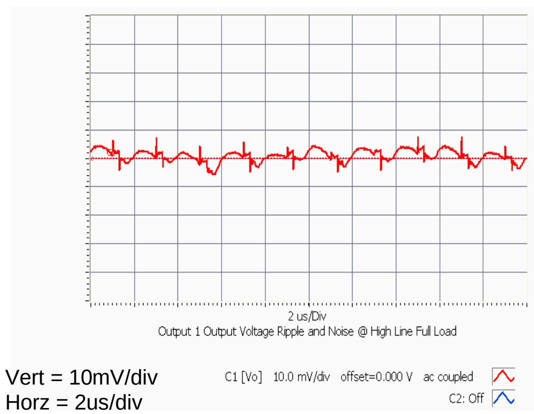
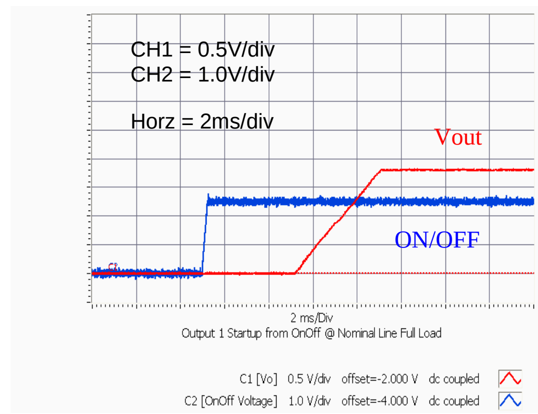
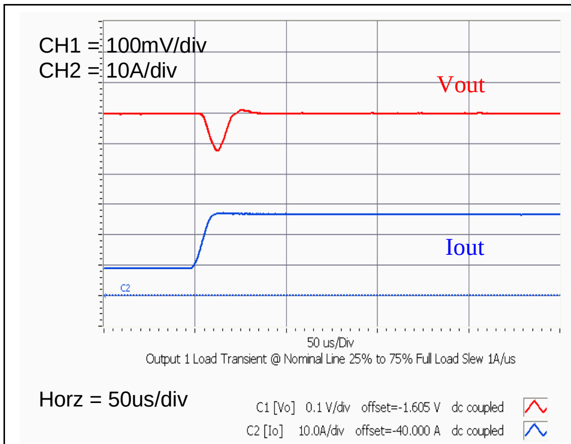
Electrical Characteristics:



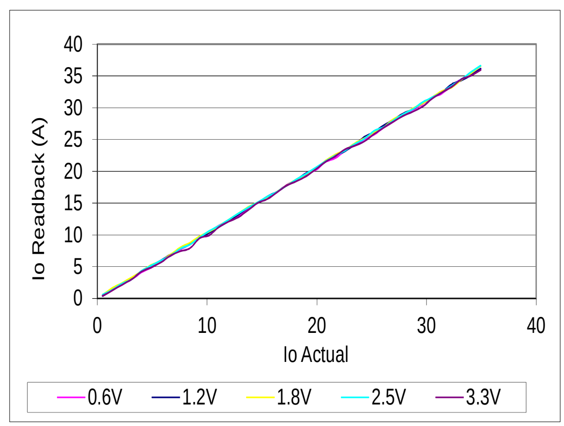
Typical Output ripple at Full Load
Vin = 14V , Vout = 1.8V , Ta = 25degC



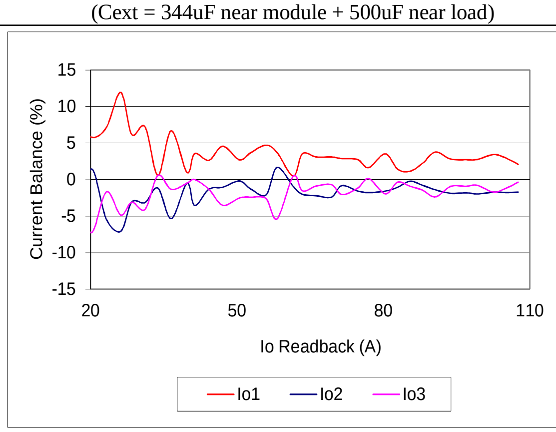
Typical Start-up wave form by on/off at Full Load
Vin = 12V , Vout = 1.8V , Ta = 25degC



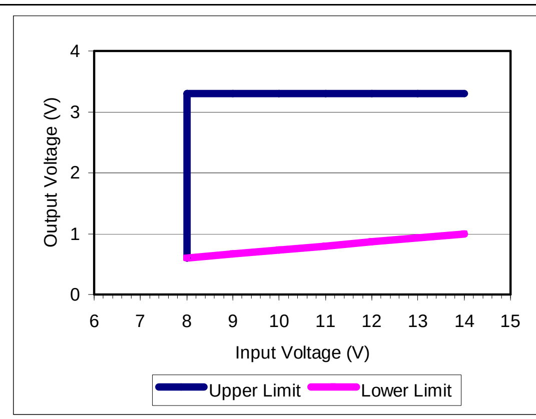
Typical output voltage transient response at Vo=1.8V
load step from 25% to 75% of full load
output current slew rate of 1.0A/uS.
(Cext = 344uF near module + 500uF near load)



Typical Measured Output Current vs. Output Current Read back
Vin = 10V , Ta = 25degC

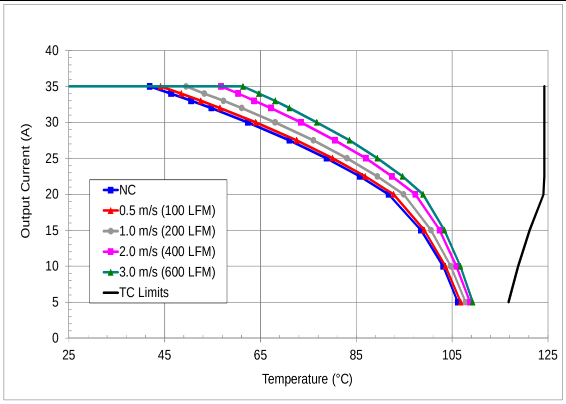


Typical current sharing between three units
Vin = 10V , Vout = 1.8V , Ta = 25degC

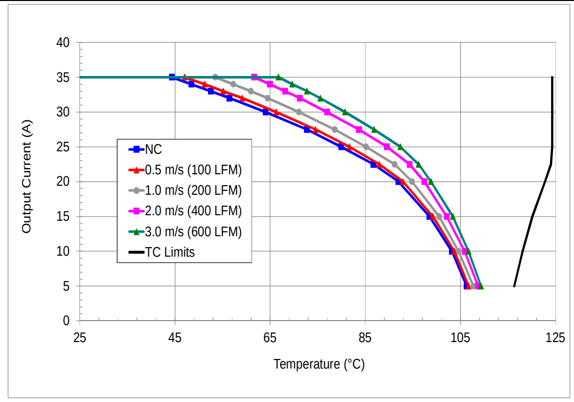


Output Voltage vs. Input Voltage Operating Range
** if operating below pink line , the module will regulate output voltage but ripple may increase

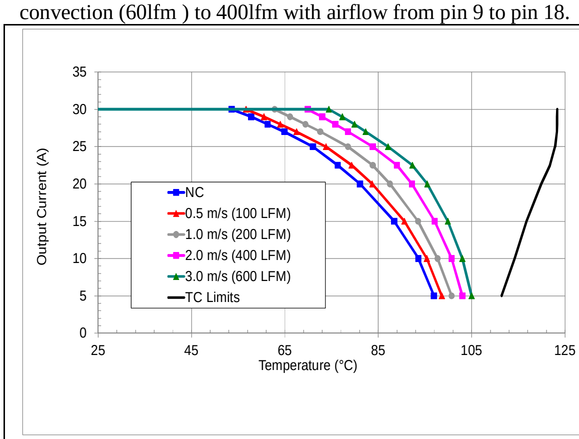
Thermal Performance:



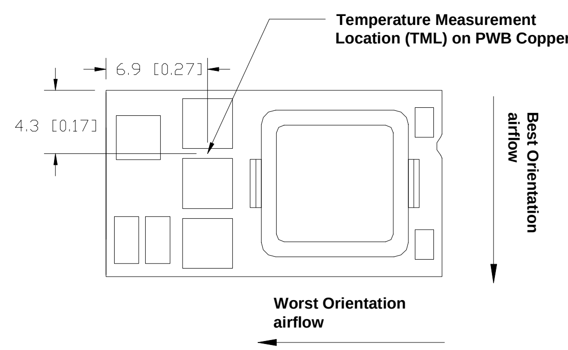
Vo=1.8V, Vin=12V preliminary maximum output current vs. ambient temperature at nominal input voltage for natural convection (60lfm) to 400lfm with airflow from pin 9 to pin 18.



Vo=1.8V, Vin=12V preliminary maximum output current vs. ambient temperature at nominal input voltage for natural convection (60 lfm) to 400lfm with airflow from pin 18 to pin 9.



Vo=3.3V, Vin=12V preliminary maximum output current vs. ambient temperature at nominal input voltage for natural convection (60lfm) to 400lfm with airflow from pin 18 to pin 9.

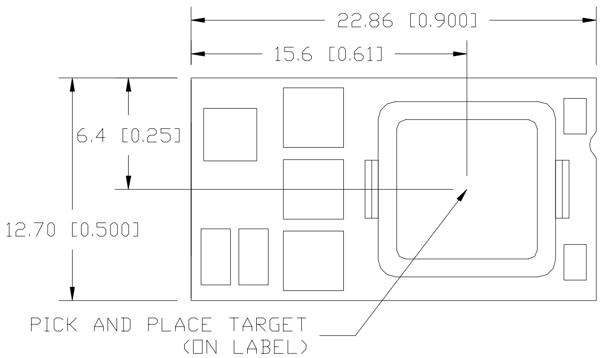


iJA12035A007V thermal measurement location – top view

The thermal curves provided are based upon measurements made in TDK-Lambda Americas' experimental test setup that is described in the Thermal Management section. Due to the large number of variables in system design, TDK-Lambda Americas recommends that the user verify the module's thermal performance in the end application. The critical component should be thermo coupled and monitored, and should not exceed the temperature limit specified in the derating curve. It is critical that the thermocouple be mounted in a manner that gives direct thermal contact or significant measurement errors may result. TDK-Lambda Americas can provide modules with a thermocouple pre-mounted to the critical component for system verification tests

Soldering Information:

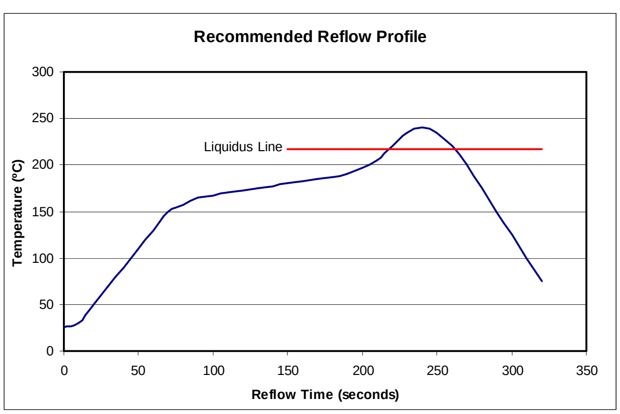
iJA surface mountable power modules are intended to be compatible with standard surface mount component soldering processes and either hand placed or automatically picked and placed. The figure below shows the position for vacuum pick up. The maximum weight of the power module is 6.5g (0.23 oz.). Improper handling or cleaning processes can adversely affect the appearance, testability, and reliability of the power modules. The iJA product is a moisture sensitivity level 2 device. Contact TDK-Lambda Americas' technical support for guidance regarding proper handling, cleaning, and soldering of TDK-Lambda Americas' power modules.



Reflow Soldering

The iJA platform is an open frame power module manufactured with SMT (surface mount technology). Due to the high thermal mass of the power module and sensitivity to heat of some SMT components, extra caution should be taken when reflow soldering. Failure to follow the reflow soldering guidelines described below may result in permanent damage and/or affect performance of the power modules.

The iJA power modules can be soldered using natural convection, forced convection, IR (radiant infrared), and convection/IR reflow technologies. The module should be thermally characterized in its application to develop a temperature profile. Thermal couples should be mounted to terminal 1 and terminal 13 and be monitored. The temperatures should be maintained below 260 degrees. Oven temperature and conveyer belt speeds should be controlled to ensure these limits are not exceeded. In most manufacturing processes, the solder paste required to form a reliable connection can be applied with a standard 6 mil stencil.



iJA Power Module suggested reflow-soldering profile

Thermal Management:

An important part of the overall system design process is thermal management; thermal design must be considered at all levels to ensure good reliability and lifetime of the final system. Superior thermal design and the ability to operate in severe application environments are key elements of a robust, reliable power module.

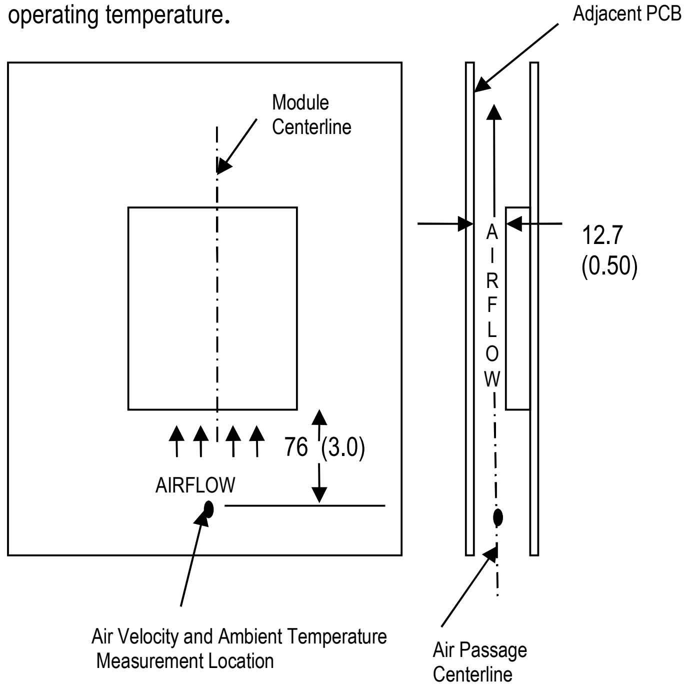
A finite amount of heat must be dissipated from the power module to the surrounding environment. This heat is transferred by the three modes of heat transfer: convection, conduction and radiation. While all three modes of heat transfer are present in every application, convection is the dominant mode of heat transfer in most applications. However, to ensure adequate cooling and proper operation, all three modes should be considered in a final system configuration.

The open frame design of the power module provides an air path to individual components. This air path improves convection cooling to the surrounding environment, which reduces areas of heat concentration and resulting hot spots.

Test Setup: The thermal performance data of the power module is based upon measurements obtained from a wind tunnel test with the setup shown in the wind tunnel figure. This thermal test setup replicates the typical thermal environments encountered in most modern electronic systems with distributed power architectures. The electronic equipment in networking, telecom, wireless, and advanced computer systems operates in similar environments and utilizes vertically mounted PCBs or circuit cards in cabinet racks.

The power module, as shown in the figure, is mounted on a printed circuit board (PCB) and is vertically oriented within the wind tunnel. The cross section of the airflow passage is rectangular. The spacing between the top of the module and a parallel facing PCB is kept at a constant (0.5 in). The power module's orientation with respect to the airflow direction can have a significant impact on the module's thermal performance.

Thermal Derating: For proper application of the power module in a given thermal environment, output current derating curves are provided as a design guideline on the Thermal Performance section for the power module of interest. The module temperature should be measured in the final system configuration to ensure proper thermal management of the power module. For thermal performance verification, the module temperature should be measured at the component indicated in the thermal measurement location figure on the thermal performance page for the power module of interest. In all conditions, the power module should be operated below the maximum operating temperature shown on the derating curve. For improved design margins and enhanced system reliability, the power module may be operated at temperatures below the maximum rated operating temperature.



Wind Tunnel Test Setup Figure Dimensions are in millimeters and (inches).

Heat transfer by convection can be enhanced by increasing the airflow rate that the power module experiences. The maximum output current of the power module is a function of ambient temperature (T_{AMB}) and airflow rate as shown in the thermal performance figures on the thermal performance page for the power module of interest. The curves in the figures are shown for natural convection through 2 m/s (400 ft/min). The data for the natural convection condition has been collected at 0.3 m/s (60 ft/min) of airflow, which is the typical airflow generated by other heat dissipating components in many of the systems that these types of modules are used in. In the final system configurations, the airflow rate for the natural convection condition can vary due to temperature gradients from other heat dissipating components.

Operating Information:

Address Configuration:

The power modules feature one pin, ADDR, for setting the SMBus address. When multiple devices are connected to the serial interface data lines, SCLK and SDAT then a 1% or better tolerance resistor should be connected between pin 7 and GND to avoid conflicts on the bus. The resistor should be selected according to the following table:

RADDR (Kohm)	PMBus Address
0 – 6.81	10h
10	11h
13.3	12h
17.8	13h
21.5	14h
26.1	15h
31.6	16h
34.8	17h
38.3	18h
42.2	19h
46.4	1Ah
51.1	1Bh
56.2	1Ch
61.9	1Dh
68.1	1Eh
75	1Fh
82.5	20h
90.9	21h
100	22h
110	23h
121	24h
133	25h
147	26h
158	27h

Output Enable: - The power modules feature an active low enable function. The power module will be active when terminal 3 EN, is low and will be off if terminal 3, EN is high. A logic low is defined as 0.8V max and a logic high is defined as 2.4V minimum. The power module features an internal 100Kohm, pull down resistor, so if terminal 3 is open, the power module will be on.

Output Voltage Setting: The output voltage of the power module may be set by using an external resistor connected between the TRIM terminal, pin 13, and GND terminal. The resistor should be selected according to the following table:

Vout (V)	Rtrim (Kohm)
0.6	0-6.8
0.7	11.5
0.75	18.2
0.8	24.9
0.85	31.6
0.9	38.3
0.95	45.3
1.0	52.3
1.05	59
1.1	66.5
1.2	73.2
1.5	80.6
1.8	86.6
2.5	93.1
3.3	100
0.6*	> 115

* unit off until PMBus commands operation

Please note that the when the power module reads the value of the trim resistor, the following parameters are automatically set based upon the resistor value:

VOUT_MARGIN_HIGH = 105% of VOUT_COMMAND
VOUT_MARGIN_LOW = 95% of VOUT_COMMAND
VOUT_OV_FAULT_LIMIT = 120% of VOUT_COMMAND
VOUT_UV_FAULT_LIMIT = 80% of VOUT_COMMAND

In addition, the power modules feature an internal voltage divider which can be disabled to enhance voltage setpoint accuracy when no attenuation is required (output voltage 1.5V or lower). During startup the module will turn the divider on or off depending on the VOUT_OV_FAULT_LIMIT that was determined based on trim resistor's value. With voltage attenuation off VOUT_MAX = 1.6V. With voltage attenuation on VOUT_MAX=3.5V.

The total tolerance of the resistor tied to the Rset terminal should be 0.5% or better to ensure accurate voltage setting.

Remote Sense:
The power modules feature differential remote sense to compensate for the effect of output distribution drops. The output voltage sense range defines the maximum voltage allowed between the output power terminals and output sense terminals, and it is found on the electrical data page for the power module of interest. If the remote sense feature is not being used, the Sense + terminal should be connected to the Vo + terminal and the Sense – terminal should be connected to the GND terminal. Care should be taken when routing the remote sense leads to avoid noise pickup.

The output voltage at the Vo terminal can be increased by both the remote sense and by setting the output voltage's dc level. The maximum voltage increase allowed is the larger of the remote sense range or the allowed output voltage adjustment range; it is not the sum of both. As the output voltage increases due to the use of the remote sense, the maximum output current may need to be decreased for the power module to remain below its maximum power rating. Care should be taken to avoid hitting the over-voltage protection threshold when using the remote sense feature.

Excessive inductance between the output power terminal and output sense terminal can destabilize point of load power modules. Please follow good layout techniques and minimize the distance between the load and power module.

Over-Current Protection:
The power modules have a dual threshold over load protection scheme to protect the module during overload conditions. During overload conditions, the power modules may protect themselves by entering a hiccup current limit mode. In hiccup mode, the modules will attempt to restart every 500mS and operate normally once the output current returns to the specified operating range. In severe overload or short circuit conditions a faster second level over current protection (SCP) circuit may engage. If the over current thresholds are adjusted by the PMBus, the SCP current limit trip point should be maintained at 2x the over current protection threshold. Long term operation outside the rated conditions and prior to the over current protection engaging is not recommended unless measures are taken to ensure the module's thermal limits are being observed.

Over-Temperature Protection:
The power modules feature over temperature protection to reduce the risk of damage due to over heating. When the power supply detects an over temperature event, the module shuts off. The module will attempt to restart and operate normally after the temperature drops below the over temperature shut down point minus the over temperature fault hysteresis.

Over-Voltage Protection:
The power modules feature output over voltage protection to reduce the risk of damage due to over heating. When the power supply detects an over voltage event, the module shuts off. The module will remain off until input power to the module is cycled. The over voltage protection is set to a nominal threshold based on Trim resistor value, which is 120% of Vout_Command.

Input Voltage cycling:
If input voltage supply is removed and the power module turns off, it is recommended to have a 1500mS minimum delay time before input power is reapplied. The input power delay will help to ensure module resets and turns on properly.

SHARE:
The share pin is used to facilitate current sharing between parallel modules. If only one iJA module is being used, then the Share pin should be connected to GND.

SYNC:
The Sync provides timing information for a multi-phase, interleave scheme. It can be an output or input in multi-phase configuration depending on whether the module is configured as a master or slave. The Sync pin should be left floating if it is not being used.

PMBus signal (SDAT/SCLK/SALT):

The module implements PMBus with a 3-wire bus, SDAT, SCLK and SALT. The module works only as slave device. The SALT function is not available on the -0Px parallel option modules.

PMBus signal pins need external pull up resistor. The recommend value for pull up resistor is 10kΩ for typical application.

Multiphase Parallel Operation:
For higher power loads, up to five iJA modules can be operated in a parallel. -xPx option code modules featuring the FAULT pin are recommended for use in multi-phase applications.

In order to operate in parallel mode, the following connections need to be made.

1) SCLK, SDAT pins should be connected together with pull-up resistor of 10Kohm to 3.3V.
2) Each module should be assigned a unique address using the ADDR terminal.
3) The module Enable pins should be connected together
4) The module Share pins should be tied together
5) The module SYNC pins should be tied together
6) The module FAULT pins should be tied together

Once the physical connections are made, the power modules can be configured by the host system controller.

In parallel mode the startup should be done using the Enable feature or PMBus command.

Grouped PMBus commands guarantee that each device will execute the command at the same time providing accurate timing between modules for power on/off, voltage margining, etc. The following group commands may be needed when operating in multi-phase configuration.

Supported PMBus Group Commands:

CODE	COMMAND NAME
01h	OPERATION
21h	VOUT_COMMAND
25h	VOUT_MARGIN_HIGH
26h	VOUT_MARGIN_LOW
27h	VOUT_TRANSITION_RATE
60h	TON_DELAY
61h	TON_RISE
64h	TOFF_DELAY

Multiphase Fault Management:

The –xPx option code modules feature a FAULT pin on terminal . The pin is an open-drain input/output fault signal, that will indicate if the module gets fault condition (OVP, OVLO, UVLO, OCP, OTP or SCP). The FAULT pin is pulled low if the module recognizes a fault condition and the module will terminate power conversion as soon as the FAULT pin becomes de-asserted.

In parallel operation, the FAULT pin of each module should be tied together to coordinate the fault management. If one of the modules used to generate a voltage rail recognizes a fault condition, all other joined modules will thus terminate power conversion. Once the fault condition clears all modules, then all modules will restart and resume normal operation.

The FAULT terminal is weakly pulled up to 2.0V inside of the module. If the fault management feature is not used then the FAULT pin should be left open.

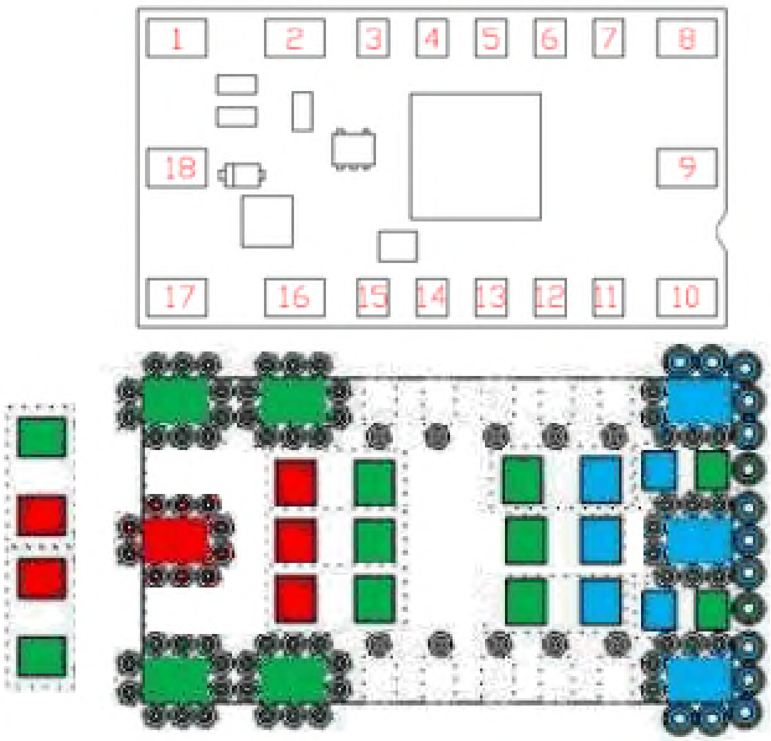
EMC Considerations: TDK-Lambda Americas' power modules are designed for use in a wide variety of systems and applications. For assistance with designing for EMC compliance, please contact TDK-Lambda Americas' technical support.

Input Impedance:
The source impedance of the power feeding the DC/DC converter module will interact with the DC/DC converter. To minimize the interaction, low-esr capacitors should be located at the input to the module. It is recommended that 100uF of ceramic input capacitor be placed as close as possible to the module. .

Output Impedance:
The power module is designed to be stable and function properly over a wide range of output capacitors, including low esr ceramic capacitors. It is recommended that 344uF of ceramic output capacitors be placed as close as possible to the module. Additional capacitors near the load can be added to further improve dynamic response and noise level. Data is provided on the electrical characteristics page, showing the typical output ripple voltage and transient response with three 100uF 1206 size and two 22uF 0805 size ceramic capacitors.

Suggested Layout and External Components:

The power module footprint has been designed to allow a significant quantity of input and output capacitors and required power and signal vias to be positioned within the keep out area of the power module's footprint. It is recommended to use the basic component placement and capacitor values shown in the following figure in order to minimize design to design performance variation and to help ensure proper operation.



Green = GND
Red = Vin
Blue = Vout

Shown in Figure:
Cout = 3 x 1206 and 2 x 0805 Ceramic Capacitors, TDK C3216X5R0J107MT and TDK C2012X5R0J226MT
Cinput = 5 x 1206 Ceramic Capacitor , TDK C3216X5R1C226MT

Security and Password Provisions:

The digital content of the power module allows for a broad range of supported PMBus commands which offers great flexibility as well as the ability to store configuration changes in the power module memory. In order to help avoid risk of unexpected or unauthorized parameter changes a security system with password protection is implemented in iJA power modules.

There are two levels of password protection, “Field mode” and “Engineering mode”. Only “Engineering mode” allows users to to implement “STORE_DEFAULT_ALL” command. The default setting of the security mode is “Field mode”.

If an incorrect password is entered, the module will latch off and input power will need to be recycled to restart the module operation. Also, please note that use of the STORE_DEFAULT_ALL command will store the current security state to NVM and could unlock the device. To use STORE_DEFAULT_ALL without storing the valid password / security state in memory, please send an invalid password to the device before storing all data to the non-volatile memory. For more detailed information about use of the security feature, including the valid password list please contact your TDK-Lambda Americas’ sales or technical support person.

Security Mode	Ability to change NVM by “STORE_DEFAULT_ALL”?
Engineering Mode	YES
Field Mode	NO

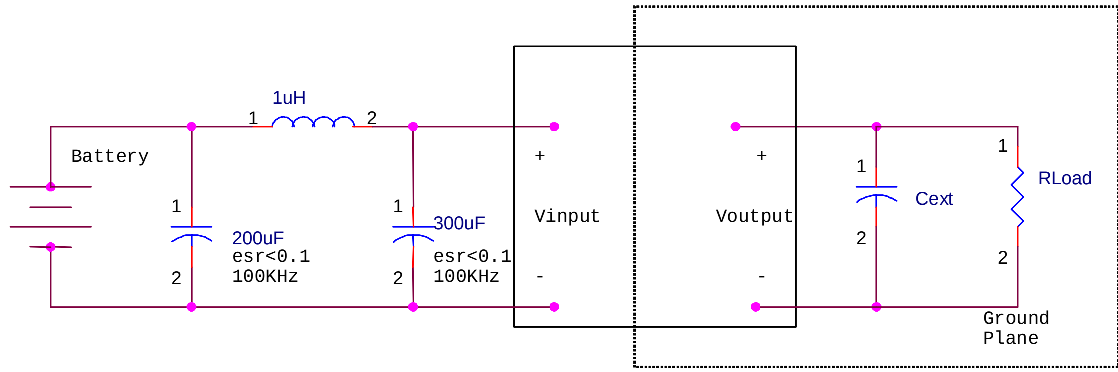
Reliability:

The power modules are designed using TDK-Lambda Americas’ stringent design guidelines for component derating, product qualification, and design reviews. The MTBF is calculated to be greater than 12M hours at full output power and Ta = 40˚C using the Telcordia SR-332 calculation method.

Quality:

TDK-Lambda Americas’ product development process incorporates advanced quality planning tools such as FMEA and Cpk analysis to ensure designs are robust and reliable. All products are assembled at ISO certified assembly plants.

Input/Output Ripple and Noise Measurements:



The input reflected ripple is measured with a current probe and oscilloscope. The ripple current is the current through the 1uH inductor. The output ripple measurement is made approximately 9 cm (3.5 in.) from the power module using an oscilloscope and BNC socket. The capacitor Cext is located about 5 cm (2 in.) from the power module; its value varies from code to code and is found on the electrical data page for the power module of interest under the ripple & noise voltage specification in the Notes & Conditions column.

Safety Considerations:

As of the publishing date, certain safety agency approvals may have been received on the iJA series and others may still be pending. Check with TDK-Lambda Americas for the latest status of safety approvals on the iJA product line.

For safety agency approval of the system in which the DC-DC power module is installed, the power must be installed in compliance with the creepage and clearance requirements of the safety agency.
To preserve maximum flexibility, the power modules are not internally fused.

An external input line normal blow fuse with a maximum value of 20A is required by safety agencies. A lower value fuse can be selected based upon the maximum dc input current and maximum inrush energy of the power module.

Warranty:

TDK-Lambda Americas' comprehensive line of power solutions includes efficient, high-density DC-DC converters. TDK-Lambda Americas offers a three-year limited warranty. Complete warranty information is listed on our web site or is available upon request from TDK-Lambda Americas.

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