FPFR12SR6570NA

Preliminary Datasheet

6-13.2Vdc Input, 70A, 0.65-2.5Vdc Output

The SENPAI Series of non-isolated dc-dc power modules deliver exceptional electrical and thermal performance Point-of-Load power modules. Operating from a 6.0Vdc-14.0Vdc input, these are the power modules of choice for Intermediate Bus Architecture (IBA) and Distributed Power Architecture applications that require high efficiency, tight regulation, and high reliability in elevated temperature environments with low airflow.

非絶縁型DC/DCﾊﾟﾜｰﾓｼﾞｭｰﾙ SENPAIのシリーズは優れた電気的特性、及び温度特性を提供します。
入力電圧6V～14.0Vで動作しますので、このﾊﾟﾜｰﾓｼﾞｭｰﾙは、高効率、高い出力電圧精度、高温、及び風量の少ない環境での高信頼性が要求されるIBA、又はDPAでの使用に最適です。

FPFR12SR6570NA

The **FPFR12SR6570NA** power module of the SENPAI Series delivers 70A of output current at a tightly regulated programmable output voltage of 0.65Vdc to 2.5Vdc. The thermal performance of the **FPFR12SR6570NA** is best-in-class: Little derating is needed up to 85℃, under natural convection.

SENPAIｼﾘｰｽﾞの **FPFR12SR6570NA**は高い電圧精度で065V～2.5Vdcの可変を実現し、70Aの出力が可能です。**FPFR12SR6570NA**の温度特性はｸﾗｽ最高ﾚﾍﾞﾙです。自然対流、85℃の条件で、わずかなﾃﾞｨﾚｰﾃｨﾝｸﾞしか必要としません。

This leading edge thermal performance results from electrical, thermal and packaging design that is optimized for high density circuit card conditions. Extremely high quality and reliability are achieved through advanced circuit and thermal design techniques and FDK's state of the art in-house manufacturing processes and systems.

回路設計、放熱設計、及びﾊﾟｯｹｰｼﾞﾝｸﾞ設計の結果である最先端の温度特性は、高密度実装回路用に最適化されています。非常に優れた品質と信頼性は高度な回路設計、温度設計技術、及びFDKの最先端の自社製造ﾌﾟﾛｾｽによりもたらされます。

Applications

- Intermediate Bus Architecture
  中間ﾊﾞｽ構成ｼｽﾃﾑ
- Telecommunications
  ﾃﾚｺﾑｼｽﾃﾑ
- Data/Voice processing
  ﾃﾞｰﾀ処理ｼｽﾃﾑ
- Distributed Power Architecture
  分散型電源ｼｽﾃﾑ
- Computing (Servers, Workstations)
  ｺﾝﾋﾟｭｰﾀ関係(ｻｰﾊﾞｰ、ﾜｰｸｽﾃｰｼｮﾝ)

Features

- Delivers up to 70A (175W)
  70A (175W)まで供給可能
- High efficiency, no heatsink required
  高効率-放熱器が不要
- Negative ON/OFF logic
  ON/OFFﾛｼﾞｯｸはﾈｶﾞﾃｨﾌﾞ
- RoHS compliance
  RoHS準拠
- Small size and low profile: 1.260" x 1.102" x 0.433" typical (maximum height = 0.453")
  小型、低背 32.0 x 28.0 x 11.0mm (Max高さは11.5mm)
- Coplanarity less than 0.004"
  平面度は0.1mm未満
- Tray packaging
  梱包はﾄﾚｲ仕様
- Programmable output voltage via external resistor
  外部接続の抵抗によりﾌﾟﾛｸﾞﾗﾑ可能な出力電圧
- No minimum load required
  最小負荷は不要
- Start up into pre-biased output
  出力にﾌﾟﾘﾊﾞｲｱｽがあっても起動可能
- Remote ON/OFF
  ﾘﾓｰﾄON/OFF機能
- Auto-reset output over-current protection
  過電流保護機能: 自動復帰
- Auto-reset over-temperature protection
  内部加熱保護機能: 自動復帰
- Comply with UL60950 recognition in U.S. & Canada, and CB Scheme certification per IEC/EN60950 (Pending)
  UL60950、CB Scheme準拠設計
- All materials meet UL94, V-0 flammability rating
  全ての部品は UL94 V-0に適合

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6-13.2Vdc Input, 70A, 0.65-2.5Vdc Output

Electrical Specifications 電気的仕様

All specifications apply over specified input voltage, output load, and temperature range, unless otherwise noted.
注記が無い場合、全ての仕様は指定された入力電圧、負荷、温度範囲で適用されます。

Conditions: Ta=25degC, Airflow=200LFM (1.0m/s), Vin=12Vdc, Vout=0.65-2.5Vdc, unless otherwise specified.

PARAMETER	NOTES	MIN	TYP	MAX	UNITS
ABSOLUTE MAXIMUM RATINGS[1]					
Input Voltage	Continuous	-0.3		14	Vdc
Operating Temperature	Ambient temperature	-40		85	°C
Storage Temperature		-55		125	°C
Output Voltage		0.65		2.5	Vdc
FEATURE CHARACTERISTICS					
Switching Frequency			630		kHz
Output Voltage Programming Range	By external resistor. See trim table-1	0.65		2.5	Vdc
Remote Sense Compensation				0.5	Vdc
Turn-On Delay Time	Full resistive load				
with Vin (module enabled, then Vin applied)	From Vin=Vin(min) to 0.1*Vout(nom)		5.0		ms
with Enable (Vin applied, then enabled)	From enable to 0.1*Vout(nom)		5.0		ms
Rise Time (Full resistive load)	From 0.1*Vout(nom) to 0.9*Vout(nom)		5.0		ms
ON/OFF Control (Negative Logic)					
Module Off		2.4		Vin	Vdc
Module On		-5		0.8	Vdc

[1]Absolute Maximum Ratings 絶対最大定格

Stresses in excess of the absolute maximum ratings may lead to degradation in performance and reliability of the power module and may result in permanent damage.
絶対最大定格を超えたｽﾄﾚｽは、性能の低下、長期信頼性の低下、及びﾓｼﾞｭｰﾙの破損を引き起こすことがあります。

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Preliminary Datasheet

6-13.2Vdc Input, 70A, 0.65-2.5Vdc Output

Electrical Specifications (Continued) 電気的仕様（続き）

Conditions: Ta=25degC, Airflow=200LFM (1.0m/s), Vin=12Vdc, Vout=0.65-2.5Vdc, unless otherwise specified.

PARAMETER	NOTES	MIN	TYP	MAX	UNITS
INPUT CHARACTERISTICS					
Operating Input Voltage Range	Vout≦1.5Vdc	6.0	12.0	14.0	Vdc
	1.5＜Vout≦1.8Vdc	8.0	12.0	14.0	Vdc
	Vout＞1.8Vdc	9.6	12.0	14.0	Vdc
Input Under Voltage Lockout					
Turn-on Threshold			5.3		Vdc
Turn-off Threshold			4.4		Vdc
Maximum Input Current	70Adc out at 6.0Vdc in				
	Vout=2.5Vdc (70Adc at 9.6Vdc in)			19.5	Adc
	Vout=1.8Vdc (70Adc at 8.0Vdc in)			17.1	Adc
	Vout=1.5Vdc			18.9	Adc
	Vout=1.2Vdc			15.5	Adc
	Vout=0.8Vdc			10.7	Adc
	Vout=0.65Vdc			9.0	Adc
Input Stand-by Current (module disabled)			15		mA
Input No Load Current	Vout=2.5Vdc		185		mA
	Vout=1.8Vdc		149		mA
	Vout=1.5Vdc		129		mA
	Vout=1.2Vdc		117		mA
	Vout=0.8Vdc		104		mA
	Vout=0.65Vdc		99		mA
Input Reflected-Ripple Current	See Fig. F for setup (BW=20MHz)				
	Vout=2.5Vdc		13.6		mAp-p
	Vout=1.8Vdc		13.0		mAp-p
	Vout=1.5Vdc		11.8		mAp-p
	Vout=1.2Vdc		8.6		mAp-p
	Vout=0.8Vdc		6.4		mAp-p
	Vout=0.65Vdc		4.7		mAp-p

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Electrical Specifications (Continued) 電気的仕様（続き）

Conditions: Ta=25degC, Airflow=200LFM (1.05m/s), Vin=12Vdc, Vout=0.65-2.5Vdc, unless otherwise specified.

PARAMETER	NOTES	MIN	TYP	MAX	UNITS
OUTPUT CHARACTERISTICS					
Output Voltage Set Point (no load)		-1.5	Vout	+1.5	%Vout
Output Regulation					
Over Line	Full resistive load		+/- 0.1		%Vout
Over Load	From no load to full load		+/- 0.4		%Vout
Output Voltage Range (Over all operating input voltage, resistive load and temperature conditions until end of life)		-3		+3	%Vout
Output Ripple and Noise BW=20MHz	Over line, load and temperature (Fig. E)				
Peak to Peak	Vout=0.65Vdc		15	30	mVp-p
Peak to Peak	Vout=2.5Vdc		30	60	mVp-p
External Load Capacitance	Plus full load (resistive)				
Min ESR > 1mΩ		920		5000	uF
Min ESR > 10mΩ	Must have a 100uF ceramic capacitor	920		10,000	uF
Output Current Range		0		70	A
Output Current Limit Inception (Iout)	Vout=1.2Vdc		92		A
Output Short-Circuit Current	Short=10mΩ, Vout=2.5Vdc set		31.1		Arms
DYNAMIC RESPONSE					
Iout step from 52.5A to 70A with di/dt= 3A/uS	Co=820uF aluminum electrolytic + 100uF ceramic		60		mV
Setting time (Vout < 10% peak deviation)			200		uS
Iout step from 70A to 52.5A with di/dt= 3A/uS	Co=820uF aluminum electrolytic + 100uF ceramic		60		mV
Setting time (Vout < 10% peak deviation)			200		uS
EFFICIENCY	Full load (70A)				
	Vout=2.5Vdc		92.8		%
	Vout=1.8Vdc		91.1		%
	Vout=1.5Vdc		90.3		%
	Vout=1.2Vdc		88.7		%
	Vout=0.8Vdc		84.9		%
	Vout=0.65Vdc		81.2		%

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Operation

Input and Output Impedance

The **FPFR12SR6570NA** power module should be connected to a DC power source using a low impedance input line. In order to counteract the possible effect of input line inductance on the stability of the converter, the use of decoupling capacitors placed in close proximity to the power module input pins is recommended. This will ensure stability of the power module and reduce input ripple voltage. Although low ESR Tantalum or other capacitors should typically be adequate, very low ESR capacitors (ceramic, over 400uF) are recommended to minimize input ripple voltage. The power module itself has on-board internal input capacitance of 60uF with very low ESR (ceramic).

FPFR12SR6570NAと入力電源間は低ｲﾝﾋﾟｰﾀﾞﾝｽで接続してください。ﾊﾟﾜｰﾓｼﾞｭｰﾙの安定性に影響のある入力ｲﾝﾀﾞｸﾀﾝｽを抑えるため、ﾊﾟﾜｰﾓｼﾞｭｰﾙの入力ﾋﾟﾝの近傍にﾃﾞｶｯﾌﾟﾘﾝｸﾞｺﾝﾃﾞﾝｻを付加することをお勧めします。これによりﾊﾟﾜｰﾓｼﾞｭｰﾙの安定動作を確実にし、入力ﾘｯﾌﾟﾙ電圧を抑制します。低ESRﾀﾝﾀﾙ、又はその他のｺﾝﾃﾞﾝｻも一般的には問題ありませんが、入力ﾘｯﾌﾟﾙを最小にするためには、非常に低ESRｺﾝﾃﾞﾝｻ(ｾﾗﾐｯｸで400uF以上)を推奨します。ﾊﾟﾜｰﾓｼﾞｭｰﾙ自身は入力回路に極低ESRの60uFｾﾗﾐｯｸ入力ｺﾝﾃﾞﾝｻを搭載しています。

To minimize output ripple voltage, the use of very low ESR ceramic capacitors is recommended. These capacitors should be placed in close proximity to the load to improve transient performance and to decrease output voltage ripple.

出力ﾘｯﾌﾟﾙを最小にするため、極低ESRのｾﾗﾐｯｸｺﾝﾃﾞﾝｻの接続を推奨します。 過渡時の特性向上と出力ﾘｯﾌﾟﾙ低減のために負荷の近傍にこれらのｺﾝﾃﾞﾝｻを実装することをお勧めします。

Note that the power module has a SENSE pin to counteract voltage drops between the output pins and the load. However, the impedance of the line from the power module output to the load should thus be kept as low as possible to maintain good load regulation.

このﾊﾟﾜｰﾓｼﾞｭｰﾙは出力端子と負荷間の電圧ﾄﾞﾛｯﾌﾟを補正するｾﾝｽ端子を持っています。しかしながら、精度の高い負荷特性を保持するために、ﾊﾟﾜｰﾓｼﾞｭｰﾙの出力から負荷までのﾗｲﾝｲﾝﾋﾟｰﾀﾞﾝｽは可能な限り低くしてください。

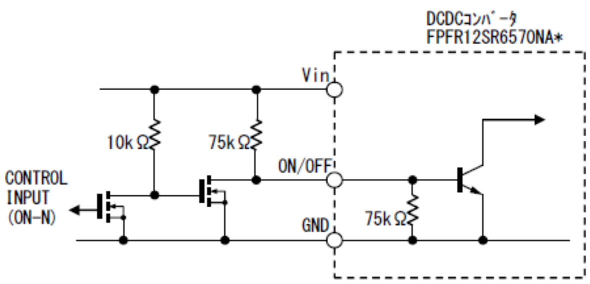

Fig. A: Circuit configuration for remote ON/OFF

ON/OFF

The ON/OFF pin can be used to turn the power module on or off remotely using a signal that is referenced to GND, as shown in Fig. A.

Since this power module is negative logic, to turn the power module on ON/OFF Pin should be at logic low , and to turn the power module off ON/OFF Pin should be at logic high or connected to Vin through a resistor.

ON/OFF端子は図Aのように、ｸﾞﾗﾝﾄﾞを基準としたﾘﾓｰﾄ信号によりﾊﾟﾜｰﾓｼﾞｭｰﾙをON/OFFするのに使われます。
このﾊﾟﾜｰﾓｼﾞｭｰﾙはﾈｶﾞﾃｨﾌﾞﾛｼﾞｯｸですので、ﾊﾟﾜｰﾓｼﾞｭｰﾙをONするにはON/OFF端子をLowﾚﾍﾞﾙとし、ﾊﾟﾜｰﾓｼﾞｭｰﾙをOFFするにはON/OFF端子をHighﾚﾍﾞﾙ、又はVinに抵抗で接続として下さい。

The ON/OFF pin is internally pulled-down. A TTL, CMOS logic gate or an open collector (open-drain) transistor can be used to drive ON/OFF Pin. When using an open collector (open-drain) transistor, a pull-up resistor, R*=75kΩ, should be connected to Vin (See Fig.A).

The device driving ON/OFF Pin must be capable of:

(a) Sinking up to 0.2mA at low logic level (≦0.8V)

(b) Sourcing up to 5.0mA at high logic level (2.3~5V) and limiting source current less than 10mA.

ON/OFFﾋﾟﾝはﾓｼﾞｭｰﾙ内部でﾌﾟﾙﾀﾞｳﾝされています。TTL、CMOSﾛｼﾞｯｸ、又はｵｰﾌﾟﾝｺﾚｸﾀ(ｵｰﾌﾟﾝﾄﾞﾚｲﾝ)のﾄﾗﾝｼﾞｽﾀもON/OFFﾋﾟﾝの操作に使用可能です。ｵｰﾌﾟﾝｺﾚｸﾀ(ｵｰﾌﾟﾝﾄﾞﾚｲﾝ)のﾄﾗﾝｼﾞｽﾀを使用する時は75kΩのﾌﾟﾙｱｯﾌﾟ抵抗をVinに接続してください。(図A参照)
ON/OFFﾋﾟﾝを操作するﾃﾞﾊﾞｲｽには下記能力が必要です。
(a) 0.8V以下のLowﾚﾍﾞﾙで0.2mAまでのｼﾝｸ能力
(b) 2.3V-5VのHighﾛｼﾞｯｸﾚﾍﾞﾙで5.0mAまでの供給能力と10mA以下の供給電流制限

Remote Sense

The **FPFR12SR6570NA** power module incorporates a remote sense function to compensate for voltage drops between Vout and the load. SENSE(-) and SENSE(+) pins should be connected via a separate trace to a point close to the load or to a point where regulation is required; see Fig. B. This trace should be located in proximity to a ground plane to minimize noise pick-up.

In case the remote sense function is not required, SENSE(-) pin must be connected to GND and SENSE(+) pin must be connected to Vout. In the absence of this connection, the power module will provide a slightly higher output voltage than that specified.

FPFR12SR6570NAﾊﾟﾜｰﾓｼﾞｭｰﾙはVoutと負荷の間で起こる電圧低下を補正するためにﾘﾓｰﾄｾﾝｽ機能を有しています。SENSE(－)端子とSENSE(+)端子は負荷端、又は補正が必要な箇所に個別の配線で接続してください。(図B参照) この配線はﾉｲｽﾞの影響を最小にするため、ｸﾞﾗﾝﾄﾞに近接して配線してください。

ﾘﾓｰﾄｾﾝｽ機能が必要無い場合は、SENSE(-)端子はGNDに、SENSE(+)端子はVoutに接続してください。接続が無い場合、ﾊﾟﾜｰﾓｼﾞｭｰﾙは出力電圧規格より若干高い電圧を出力します。

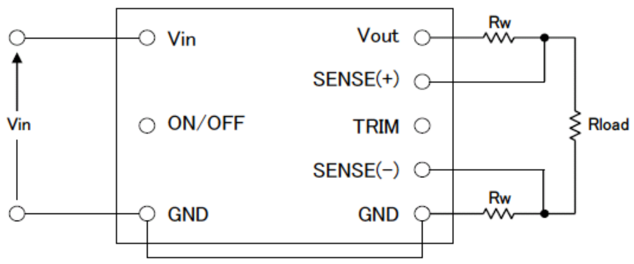

Fig. B: Remote Sense Circuit Configuration

Note that the remote sense function will allow the output voltage at Vout to be up to 0.5V above the nominal rated voltage in order to maintain regulation at the sense point. The system design should take this into account to ensure that the maximum power drawn from the power module under a given set of conditions does not exceed that allowed by the derating curves.

リモートセンス機能は、センス箇所の電圧を規格内にするため、Vout端の電圧を基準出力電圧より最大0.5V高くします。システムをデザインする際、この機能に留意し、ディレーティングカーブで許容される最大電力以下で使用するよう、注意してください。

Output Voltage Programming

The output voltage of the **FPFR12SR6570NA** power module can be programmed from 0.65V to 2.5V by using an external resistor.

FPFR12SR6570NAの出力電圧は外部に抵抗を接続することで0.65V～2.5Vまで可変可能です。

An external trim resistor, R_{TRIM}, should be connected between TRIM Pin and GND; see Fig. C. The value of R_{TRIM}, in kΩ, for a desired output voltage, $V_{O\text{-}REQ}$, in V, is given by:

外部抵抗 R_{TRIM}はTRIM端子とGNDの間に接続してください。図Cを参照。 R_{TRIM} の定数、及び必要な出力電圧は次の式により求めます。

$$R_{TRIM} = \frac{50.2}{(V_{O\text{-}REQ} - 0.6502)} - 10 \ [\Omega]$$

Note that the tolerance of a trim resistor will affect the tolerance of the output voltage. Standard 1% or 0.5% resistors may suffice for most applications; however, a tighter tolerance can be obtained by using two resistors in series instead of one standard value resistor.
Table 1 lists calculated values of R_{TRIM} for common output voltages. For each value of R_{TRIM}, Table 1 also shows the closest available standard resistor value.

R_{TRIM} の公差は出力電圧の公差に影響します。ほとんどの使用状況においては、標準的な1%又は0.5%品の抵抗で十分です。しかしながら、より厳しい出力精度のためには、抵抗1本よりも2本を直列に使用します。Table 1に一般的な出力電圧を設定する際の抵抗値を表示します。またTable 1に標準的な抵抗を使用した場合の近似値も表示しています。

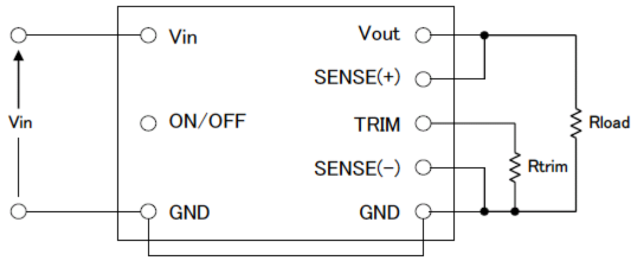

Fig. C: Configuration for programming output voltage

Table 1: Trim Resistor Value

$V_{O\text{-}REG}$ [V]	R_{TRIM} [Ω]	The Closest Standard Value [Ω]
0.65	Open	Open
0.8	325.1	300+24
1.2	81.3	51+30
1.5	49.1	27+22
1.8	33.6	30+3.6
2.5	17.1	12+5.1

External Voltage Source

To program the output voltage using an external voltage source, a voltage, V_{CTRL}, should be applied to the TRIM pin. Use of a series resistor below 300 Ω, R_{EXT}, between the TRIM pin and the programming voltage source is recommended to make trimming less sensitive.

外部電源を使って出力電圧を可変するには、TRIM端子にV_{CTRL}の電圧を印加します。電圧設定が敏感すぎるのを避けるため、TRIM端子と外部電源間に300Ω以下の抵抗を直列に接続することをお勧めします。

The voltage of the control voltage V_{CTRL}, in V, for a given value of R_{EXT}, in Ω, is given by:

V_{CTRL}電圧は下記の式により算出が可能です。

$$V_{CTRL} = 0.6 - \frac{(10 + R_{EXT})(V_{O\text{-}REQ} - 0.6492)}{82} \quad [V]$$

Table 2 lists values of V_{CTRL} for R_{EXT}=0 and R_{EXT}=300Ω.

Table 2はR_{EXT}=0の時とR_{EXT}=300の時のV_{CTRL}電圧を表しています。

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Table 2: Control Voltage [Vdc]		
$V_{O\text{-}REG}$ [V]	V_{CTRL} (R_{EXT}=0)	V_{CTRL} (R_{EXT}=300)
0.6	0.599	0.597
0.8	0.582	0.030
1.0	0.557	-0.726
1.2	0.533	-1.482
1.5	0.496	-2.616
1.8	0.460	-3.751
2.0	0.435	-4.507
2.5	0.374	-6.397

Protection Features

Input Under-Voltage Lockout

From a turned-on state, the power module will turn off automatically when the input voltage drops below typically 4.4V. It will then turn on automatically when the input voltage reaches typically 5.3V.

動作している状態で入力電圧がTYPで4.4V未満になると、このﾊﾟﾜｰﾓｼﾞｭｰﾙは自動的に停止します。また、入力電圧がTYPで5.3V以上になると、このﾊﾟﾜｰﾓｼﾞｭｰﾙは自動的に動作を開始します。

Output Over-Current Protection (OCP)

The power module is self-protected against over-current and short circuit conditions. On the occurrence of an over-current condition, the power module will enter hiccup mode. On the removal of the over-current or short circuit condition, Vout will return to the original value (auto-reset).

このﾊﾟﾜｰﾓｼﾞｭｰﾙは過電流と短絡に対し自己保護します。過電流状態になると、このﾊﾟﾜｰﾓｼﾞｭｰﾙはHiccupﾓｰﾄﾞになり、過電流状態が解除されるとVoutは通常の値に戻ります。(自動ﾘｾｯﾄ)

Over-Temperature Protection (OTP)

The power module is self-protected against over-temperature conditions. In case of overheating due to abnormal operation conditions, the power module will turn off automatically. It will turn back on automatically once it has cooled down to a safe temperature (auto-reset).

このﾊﾟﾜｰﾓｼﾞｭｰﾙは加熱保護機能を有しています。異常な動作条件によって加熱状態になると、このﾊﾟﾜｰﾓｼﾞｭｰﾙは自動的に停止します。安全な温度にまで下がると自動的に復帰します。(自動ﾘｾｯﾄ)

Safety Requirements

The power module meets North American and International safety regulatory requirements per UL60950 and EN60950. (Pending) The power module meets SELV (safety extra-low voltage) requirements under normal operating conditions in that the output voltages are ELV (extra- low voltage) when all the input voltages are ELV. Note that the power module is not internally fused: to meet safety requirements, a fast acting in-line fuse with a maximum rating of 25 A must be used in the positive input line.

このﾊﾟﾜｰﾓｼﾞｭｰﾙはUL60950とEN60950による北米、及び国際的な安全基準を満たしていますが、規格は未取得です。このﾊﾟﾜｰﾓｼﾞｭｰﾙは通常の動作条件下においてSELVの条件を満たしており、入力電圧がELVであれば出力電圧もELVとなります。但し、このﾊﾟﾜｰﾓｼﾞｭｰﾙは内部にﾋｭｰｽﾞを持っていませんので、安全規格に適合させるためには、入力ﾗｲﾝのﾌﾟﾗｽ側に即断型で最大定格25Aのﾋｭｰｽﾞを接続してください。

Characterization

Overview

The power module has been characterized for several operational features, including thermal derating (maximum available load current as a function of ambient temperature and airflow), efficiency, power dissipation, start-up and shutdown characteristics, ripple and noise, and transient response to load step-changes.

このﾊﾟﾜｰﾓｼﾞｭｰﾙは温度ﾃﾞｨﾚｰﾃｨﾝｸﾞ、効率、電力損失、ｽﾀｰﾄｱｯﾌﾟ時、及びｼｬｯﾄﾀﾞｳﾝ時の動作、ﾘｯﾌﾟﾙ･ﾉｲｽﾞ、動的負荷変動などを含む、さまざまな動作状態で特徴付けられます。

Figures showing data plots and waveforms for different output voltages are presented in the following pages. The figures are numbered as Fig.*V-#, where *V indicates the output voltage, and # indicates a particular plot type for that voltage. For example, Fig *V-2 is a plot of efficiency vs. load current for any output voltage *V.

各出力電圧時のﾃﾞｰﾀ、及び波形の図は以後のﾍﾟｰｼﾞに掲載されています。図はFig *V-#のように番号付けされており、*Vは出力電圧を表し、#は特定のﾌﾟﾛｯﾄを表します。例えば Fig *V-2とあれば、*V出力での効率特性を表します。

Test Conditions

To ensure measurement accuracy and reproducibility, all thermal and efficiency data were taken with the power module soldered to a standardized thermal test board. The thermal test board was mounted inside FDK's custom wind tunnel to enable precise control of ambient temperature and airflow conditions.

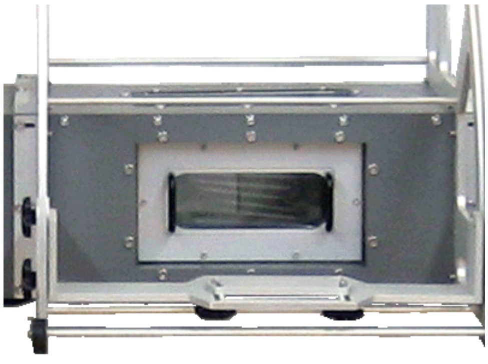
測定精度、及び再現性を確実にするために、全ての温度、及び効率ﾃﾞｰﾀは標準化された温度評価ﾎﾞｰﾄﾞにﾊﾟﾜｰﾓｼﾞｭｰﾙを半田付けして取

得しています。温度評価ﾎﾞｰﾄﾞをFDK特製の風洞実験設備内に設置することで、環境温度、及び風量を精密に管理しています。

The thermal test board comprised a four layer printed circuit board (PCB) with a total thickness of 0.060". Copper metallization on the two outer layers was limited to pads and traces needed for soldering the power module and peripheral components to the board. The two inner layers comprised power and ground planes of 2 oz. copper. This thermal test board, with the paucity of copper on the outer surfaces, limits heat transfer from the power module to the PCB, thereby providing a worst-case but consistent set of conditions for thermal measurements.

温度評価ﾎﾞｰﾄﾞは厚さ0.060"(1.6mm)厚の4層PCBで作成しています。表面2層の銅箔はﾊﾟﾜｰﾓｼﾞｭｰﾙを実装するためのﾊﾟｯﾄﾞと周辺部品へのﾊﾟﾀｰﾝのみに限定しています。内側2層は70μmの銅箔で電力、及びｸﾞﾗﾝﾄﾞﾗｲﾝを形成しています。このように表層の銅箔を限りなく少なくした温度評価ﾎﾞｰﾄﾞは、ﾊﾟﾜｰﾓｼﾞｭｰﾙからPCBへの熱の逃げを制限し、ﾜｰｽﾄｹｰｽでありながら矛盾の無い温度評価条件を実現しています。

FDK Original Wind Tunnel



Test Chamber

FDK's custom wind tunnel was used to provide precise horizontal laminar airflow in the range of 50 LFM (equivalent to natural convection, NC) to 600LFM, at ambient temperatures between 30°C and 85°C. Infrared (IR) thermography and thermocouples were used for temperature measurements.

FDK特製の風洞実験装置は水平方向の層流を50LFM(自然対流と同等、NC)から600LFMまで精密に制御でき、環境温度は30℃から85℃を制御できます。温度測定には赤外線(IR)ｻｰﾓｸﾞﾗﾌｨと熱電対を使用しています。

It is advisable to check the power module temperature in the actual application, particularly if the application calls for loads close to the maximums specified by the derating curves. IR thermography or thermocouples may be used for this purpose. In the latter case, AWG#40 gauge thermocouples are recommended to minimize interference and measurement error. An optimum location for placement of a thermocouple is indicated in Fig. D.

ﾊﾟﾜｰﾓｼﾞｭｰﾙの温度を実際の使用環境で測定することをお勧めします。特に実使用上の負荷が温度ﾃﾞｨﾚｰﾃｨﾝｸﾞの最大値に近い場合は測定が必要です。温度測定には赤外線ｻｰﾓｸﾞﾗﾌｨ、又は熱電対をお使いいただけます。熱電対を使用する場合、風の妨げになることを防ぐためと、測定誤差を少なくするため、AWG40の熱電対を推奨します。熱電対での測定に最適な箇所は図Dに示します。

Thermal Derating

Figs *V-1 show the maximum available load current vs. ambient temperature and airflow rates. Ambient temperature was varied between 30°C and 85°C, with airflow rates from NC(50LFM) to 400LFM (0.25m/s to 2.0m/s). The power module was mounted horizontally, and the airflow was parallel to the long axis of the power module, going from pin 16 to pin 6.

図 *V-1はある環境温度と風量の条件下における最大出力電流を表します。環境温度は風量NC(50LFM)～400LFMの条件で30℃～85℃の間を変動させています。ﾊﾟﾜｰﾓｼﾞｭｰﾙは水平に設置し、風向きはﾊﾟﾜｰﾓｼﾞｭｰﾙの長手方向に平行で16番ﾋﾟﾝから6番ﾋﾟﾝに向けて吹いています。

The maximum available load current, for any given set of conditions, is defined as the lower of:
(i) The output current at which the temperature of any component reaches 120°C, or
(ii) The current rating of the power module (70A)

各々の測定条件で最大出力電流の値は下記のとおり定義します。
(i) いずれかの部品の温度が120℃に到達した時点の出力電流値又は
(ii) ﾊﾟﾜｰﾓｼﾞｭｰﾙの公称定格電流 (70A)

A maximum component temperature of 120°C should not be exceeded in order to operate within the derating curves. Thus, the temperature at the thermocouple location shown in Fig. D should not exceed 120°C in normal operation. (Refer to Notes on page 23)

温度ﾃﾞｨﾚｰﾃｨﾝｸﾞの範囲内で動作させるために、部品温度は120℃を超えないようにご注意ください。従って、通常動作時に図Dに示す位置の熱電対の温度が120℃を超えないようにしてください。(23頁のNotes参照)

Note that continuous operation beyond the derated current as specified by the derating curves may lead to degradation in performance and reliability of the power module and may result in permanent damage.

出力電流ﾃﾞｨﾚｰﾃｨﾝｸﾞｶｰﾌﾞで指定された定格電流を超えた連続した操作は、性能の低下、信頼性の低下、及びﾓｼﾞｭｰﾙの破損を引き起こすことがあります。

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Preliminary Datasheet

6-13.2Vdc Input, 70A, 0.65-2.5Vdc Output

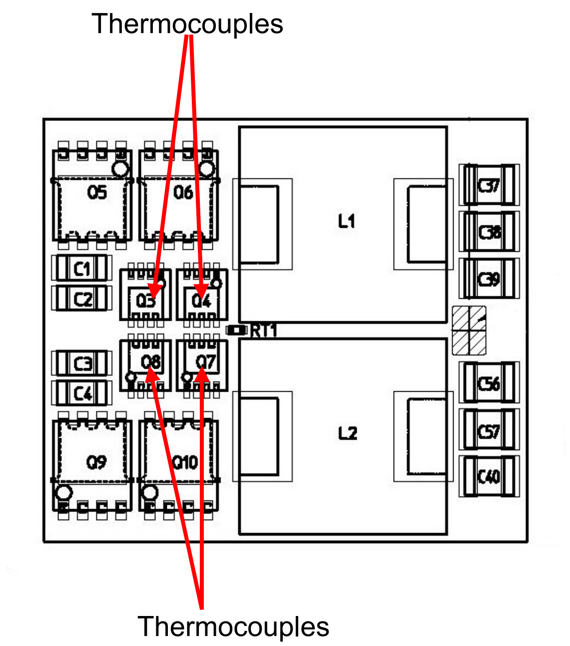

Fig. D: Location of the thermo couples for thermal testing

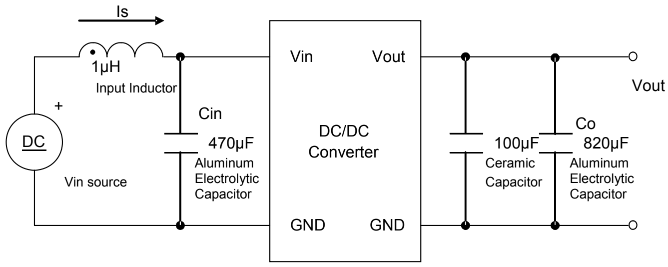

Fig. F: Test setup for measuring input reflected ripple current

Ripple and Noise

The test circuit setup shown in Fig. E was used to obtain the output voltage ripple. And Fig. F was used to obtain the input reflected ripple current waveforms. The output voltage ripple waveform was measured across a 1uF ceramic capacitor at full load current.

図Eに示す試験回路は出力ﾘｯﾌﾟﾙの測定に使用しており、入力ﾘｯﾌﾟﾙの測定には図Fの試験回路を使用しています。全ての出力ﾘｯﾌﾟﾙ波形は1uFのｾﾗﾐｯｸｺﾝﾃﾞﾝｻを通して測定しています。

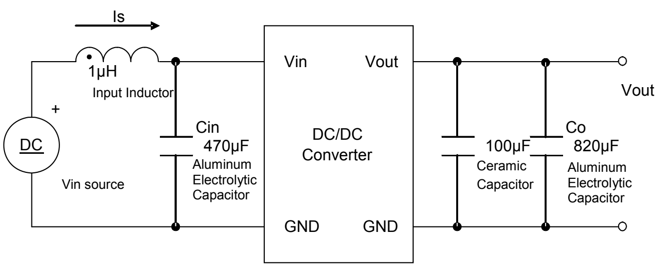

Fig. E: Test setup for measuring output voltage ripple

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6-13.2Vdc Input, 70A, 0.65-2.5Vdc Output

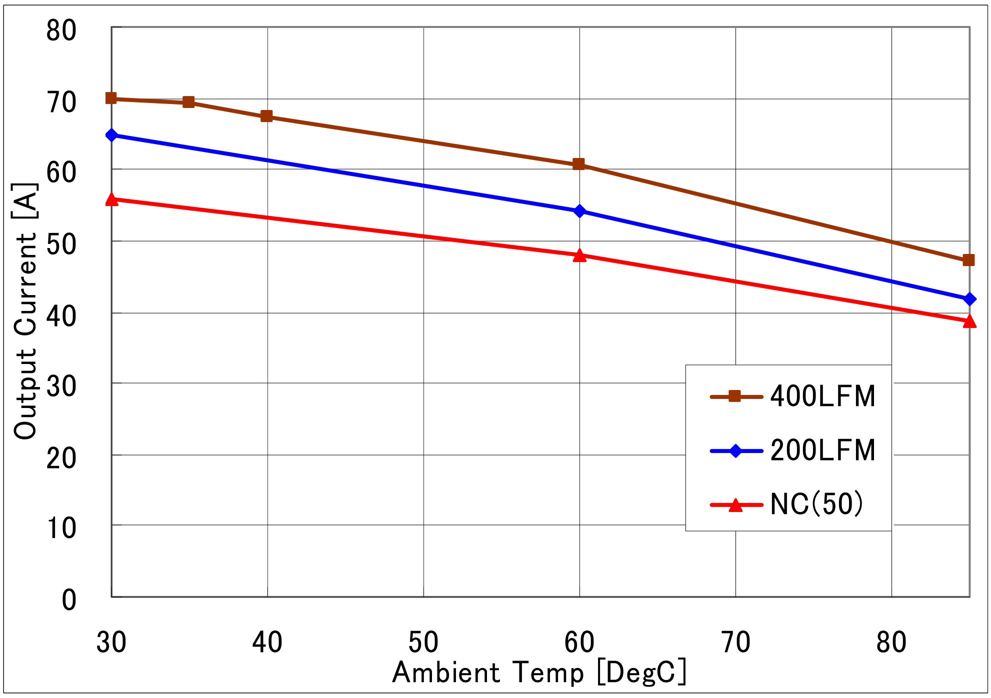

Fig-2.5V-1: Available load current vs. ambient temperature and airflow rates for Vout=2.5V with Vin=12V. Maximum component temperature≦120°C

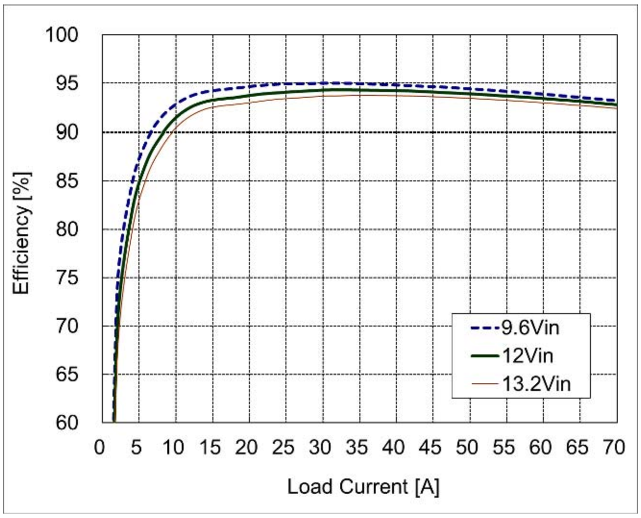

Fig-2.5V-2: Efficiency vs. load current and input voltage for Vout=2.5V.
Airflow rate=200 LFM (1m/s) and Ta=25°C.

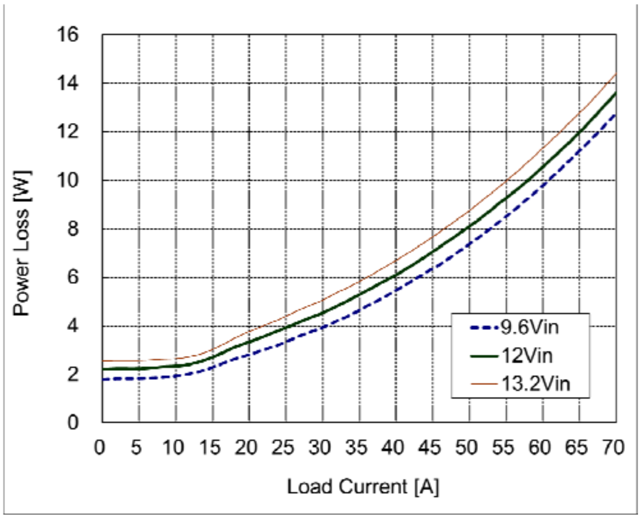

Fig-2.5V-3: Power Loss vs. load current and input voltage for Vout=2.5V.
Airflow rate=200 LFM (1m/s) and Ta=25°C.

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Preliminary Datasheet

6-13.2Vdc Input, 70A, 0.65-2.5Vdc Output

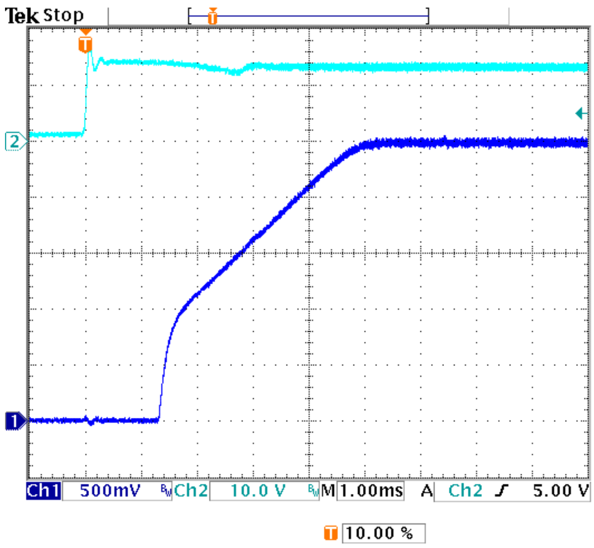

Fig-2.5V-4: Turn-on transient for Vout=2.5V with application of Vin at full rated load current (resistive) and 920uF external capacitance at Vin=12V.
Top trace: Vin (10V/div.)
Bottom trace: output voltage (500mV/div.)
Time scale: 1 ms/div.

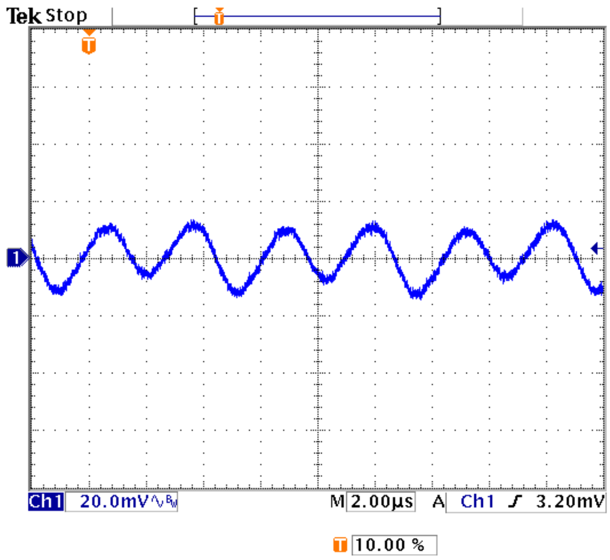

Fig-2.5V-5: Output voltage ripple (20mV/div.) for Vout=2.5V at full rated load current into a resistive load with external capacitance 920uF at Vin=12V.
Time scale: 2 us/div

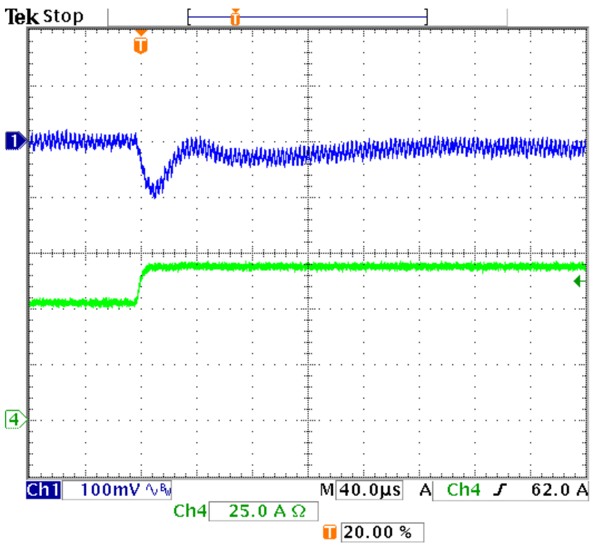

Fig-2.5V-6: Output voltage response for Vout=2.5V to positive load current step change from 52.5A to 70A with slew rate of 3A/us at Vin=12V. Co=920uF.
Top trace: output voltage (100mV/div.)
Bottom trace: load current (25A/div.)
Time scale: 40us/div.

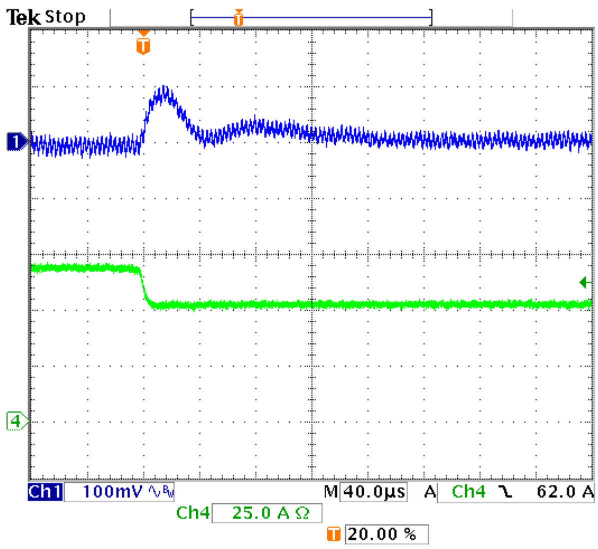

Fig-2.5V-7: Output voltage response for Vout=2.5V to negative load current step change from 70A to 52.5A with slew rate of -3A/us at Vin=12V. Co=920uF.
Top trace: output voltage (100mV/div.)
Bottom trace: load current (25A/div.)
Time scale: 40us/div.

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6-13.2Vdc Input, 70A, 0.65-2.5Vdc Output

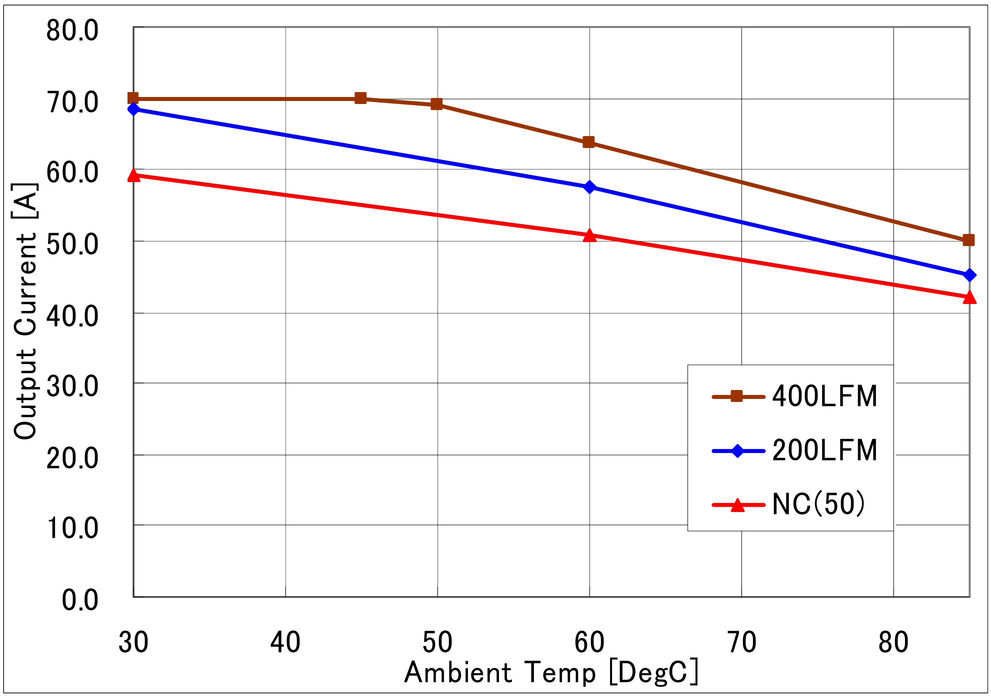

Fig-1.8V-1: Available load current vs. ambient temperature and airflow rates for Vout=1.8V with Vin=12V. Maximum component temperature≦120°C

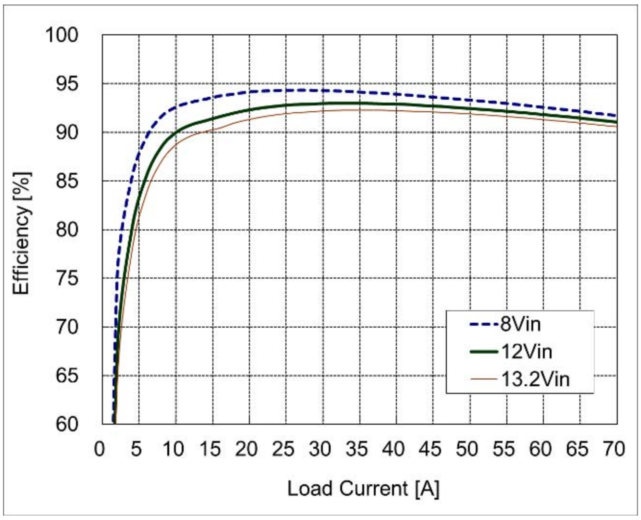

Fig-1.8V-2: Efficiency vs. load current and input voltage for Vout=1.8V.
Airflow rate=200 LFM (1m/s) and Ta=25°C.

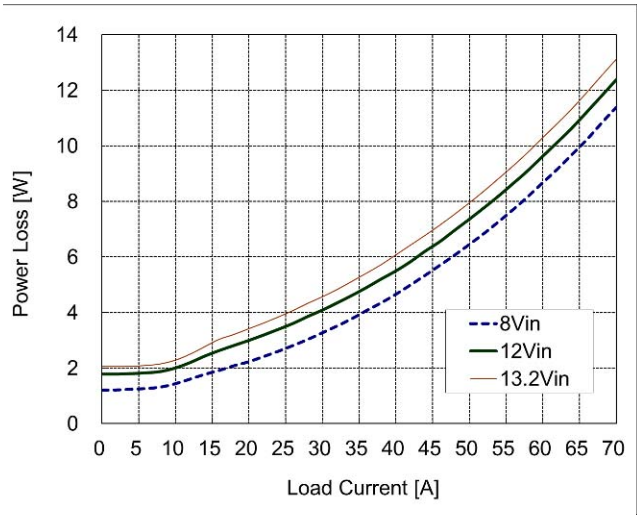

Fig-1.8V-3: Power Loss vs. load current and input voltage for Vout=1.8V.
Airflow rate=200 LFM (1m/s) and Ta=25°C.

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Preliminary Datasheet

6-13.2Vdc Input, 70A, 0.65-2.5Vdc Output

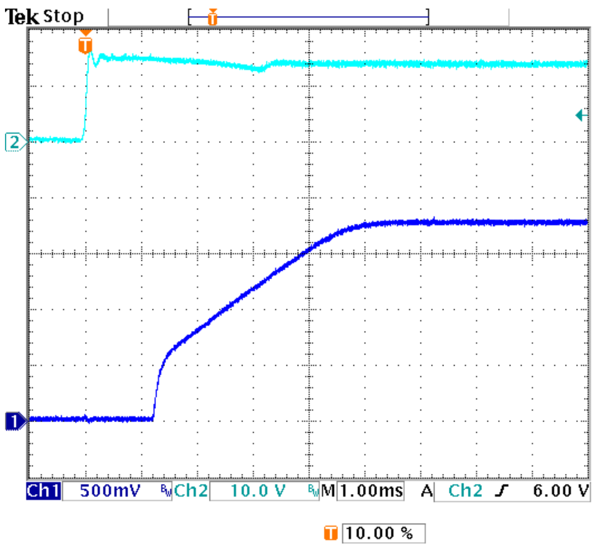

Fig-1.8V-4: Turn-on transient for Vout=1.8V with application of Vin at full rated load current (resistive) and 920uF external capacitance at Vin=12V.
Top trace: Vin (10V/div.)
Bottom trace: output voltage (500mV/div.)
Time scale: 1 ms/div.

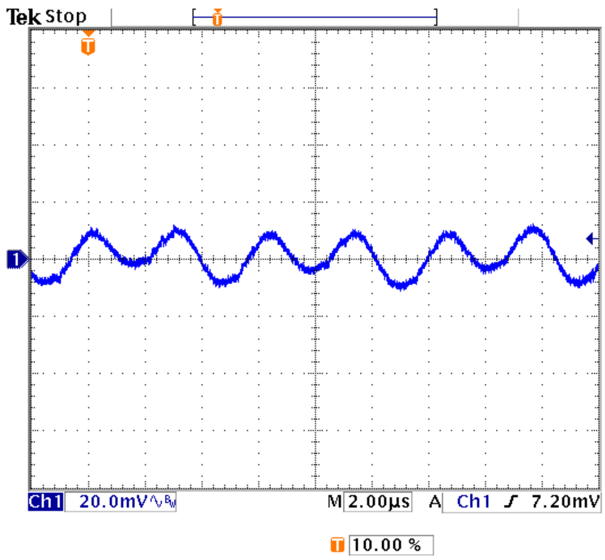

Fig-1.8V-5: Output voltage ripple (20mV/div.) for Vout=1.8V at full rated load current into a resistive load with external capacitance 920uF at Vin=12V.
Time scale: 2 us/div

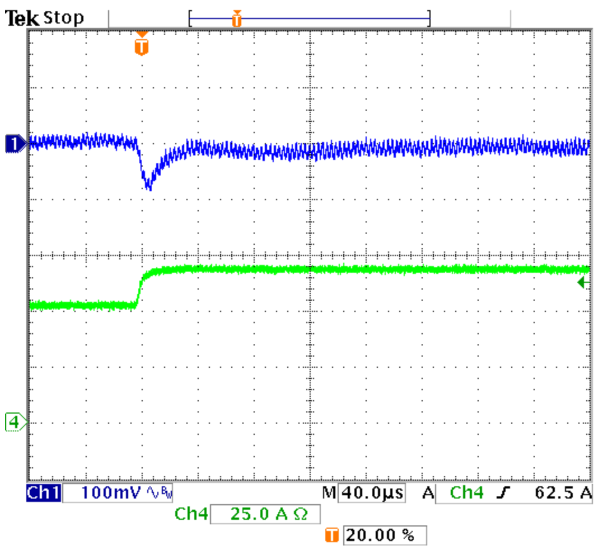

Fig-1.8V-6: Output voltage response for Vout=1.8V to positive load current step change from 52.5A to 70A with slew rate of 3A/us at Vin=12V. Co=920uF.
Top trace: output voltage (100mV/div.)
Bottom trace: load current (25A/div.)
Time scale: 40us/div.

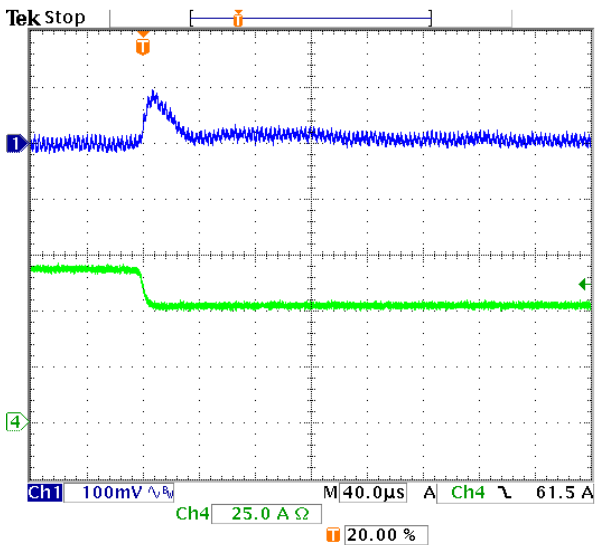

Fig-1.8V-7: Output voltage response for Vout=1.8V to negative load current step change from 70A to 52.5A with slew rate of -3A/us at Vin=12V. Co=920uF.
Top trace: output voltage (100mV/div.)
Bottom trace: load current (25A/div.)
Time scale: 40us/div.

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Preliminary Datasheet

6-13.2Vdc Input, 70A, 0.65-2.5Vdc Output

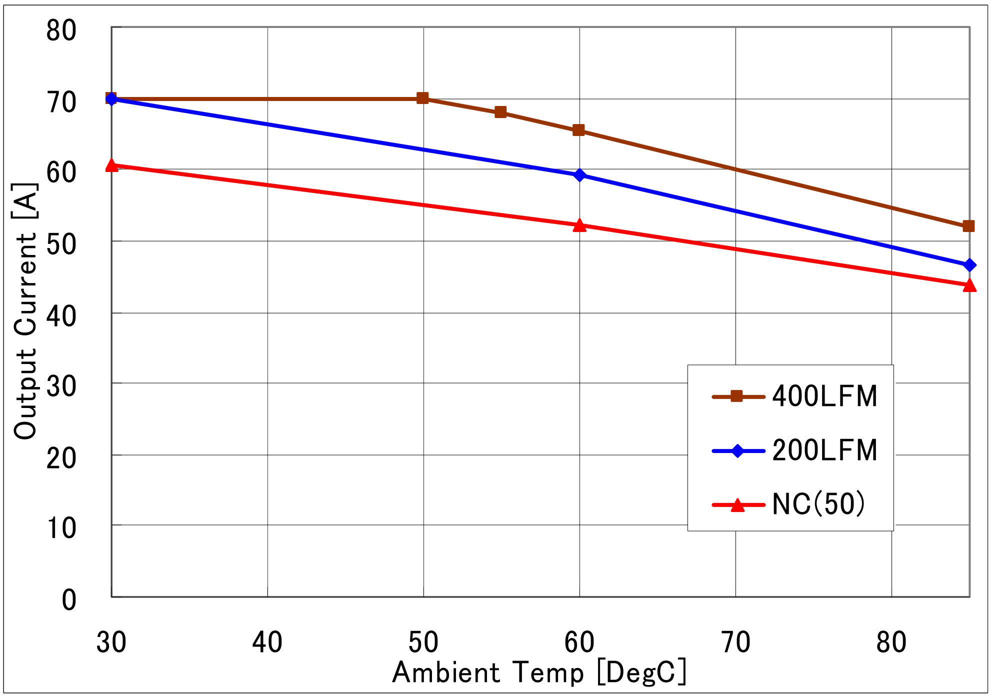

Fig-1.5V-1: Available load current vs. ambient temperature and airflow rates for Vout=1.5V with Vin=12V. Maximum component temperature≦120°C

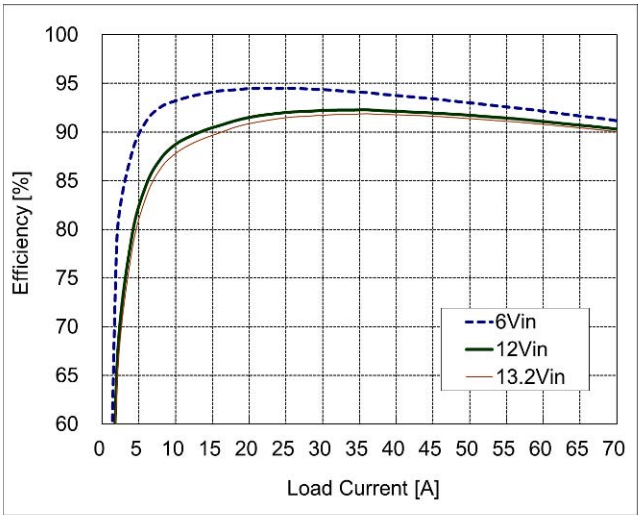

Fig-1.5V-2: Efficiency vs. load current and input voltage for Vout=1.5V.
Airflow rate=200 LFM (1m/s) and Ta=25°C.

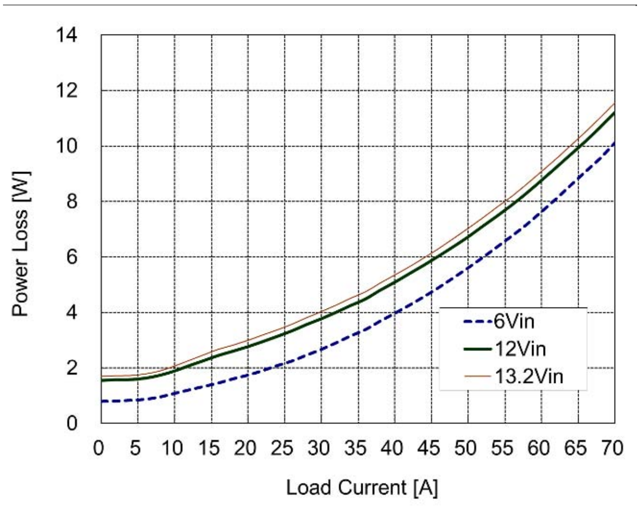

Fig-1.5V-3: Power Loss vs. load current and input voltage for Vout=1.5V.
Airflow rate=200 LFM (1m/s) and Ta=25°C.

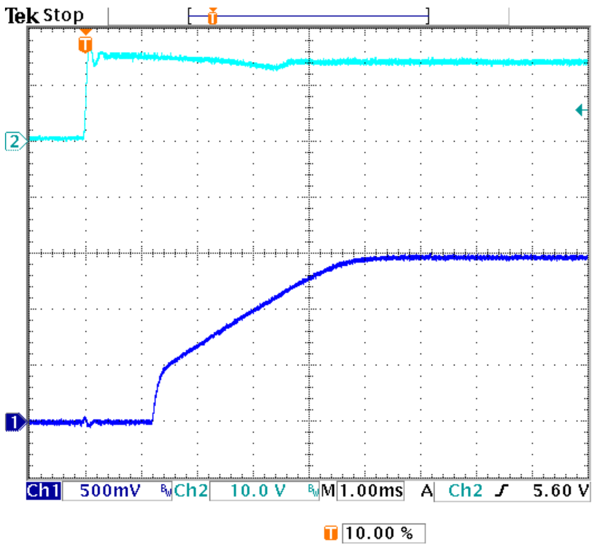

Fig-1.5V-4: Turn-on transient for Vout=1.5V with application of Vin at full rated load current (resistive) and 920uF external capacitance at Vin=12V.
Top trace: Vin (10V/div.)
Bottom trace: output voltage (500mV/div.)
Time scale: 1 ms/div.

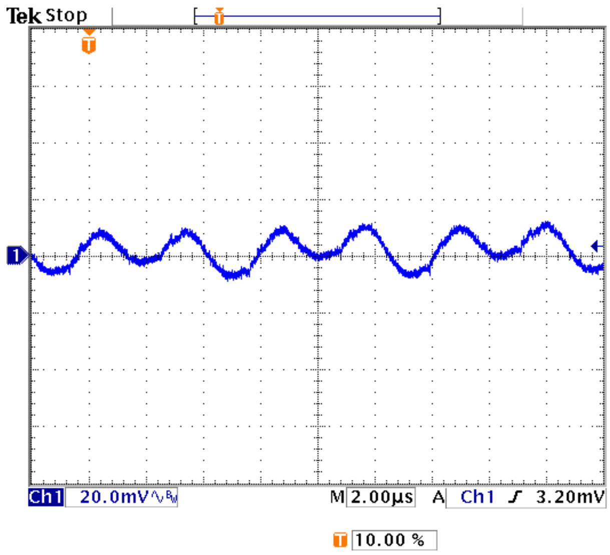

Fig-1.5V-5: Output voltage ripple (20mV/div.) for Vout=1.5V at full rated load current into a resistive load with external capacitance 920uF at Vin=12V.
Time scale: 2 us/div

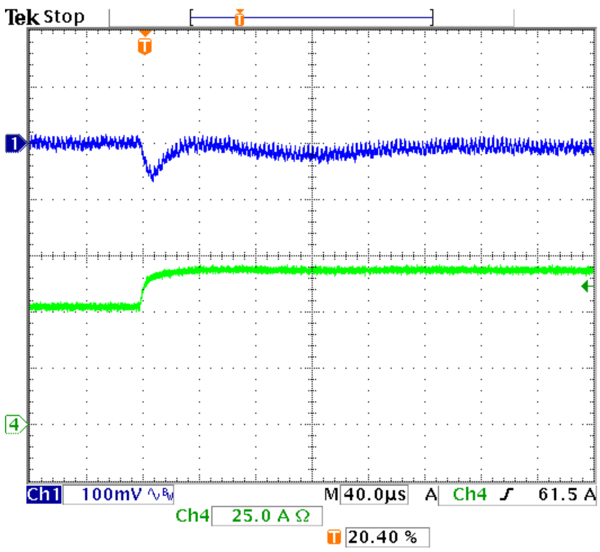

Fig-1.5V-6: Output voltage response for Vout=1.5V to positive load current step change from 52.5A to 70A with slew rate of 3A/us at Vin=12V. Co=920uF.
Top trace: output voltage (100mV/div.)
Bottom trace: load current (25A/div.)
Time scale: 40us/div.

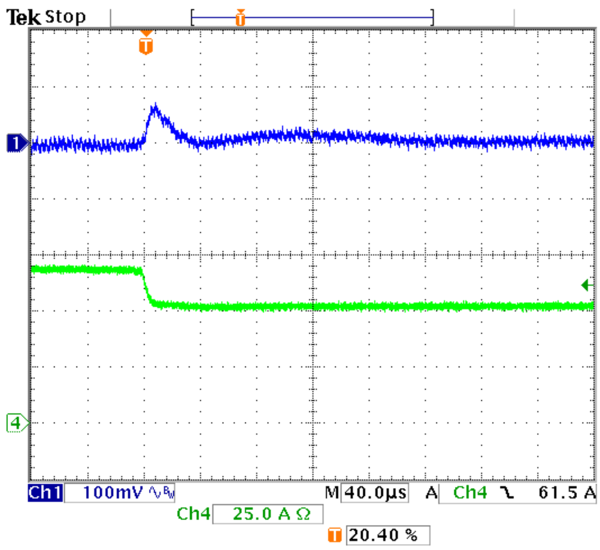

Fig-1.5V-7: Output voltage response for Vout=1.5V to negative load current step change from 70A to 52.5A with slew rate of -3A/us at Vin=12V. Co=920uF.
Top trace: output voltage (100mV/div.)
Bottom trace: load current (25A/div.)
Time scale: 40us/div.

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Preliminary Datasheet

6-13.2Vdc Input, 70A, 0.65-2.5Vdc Output

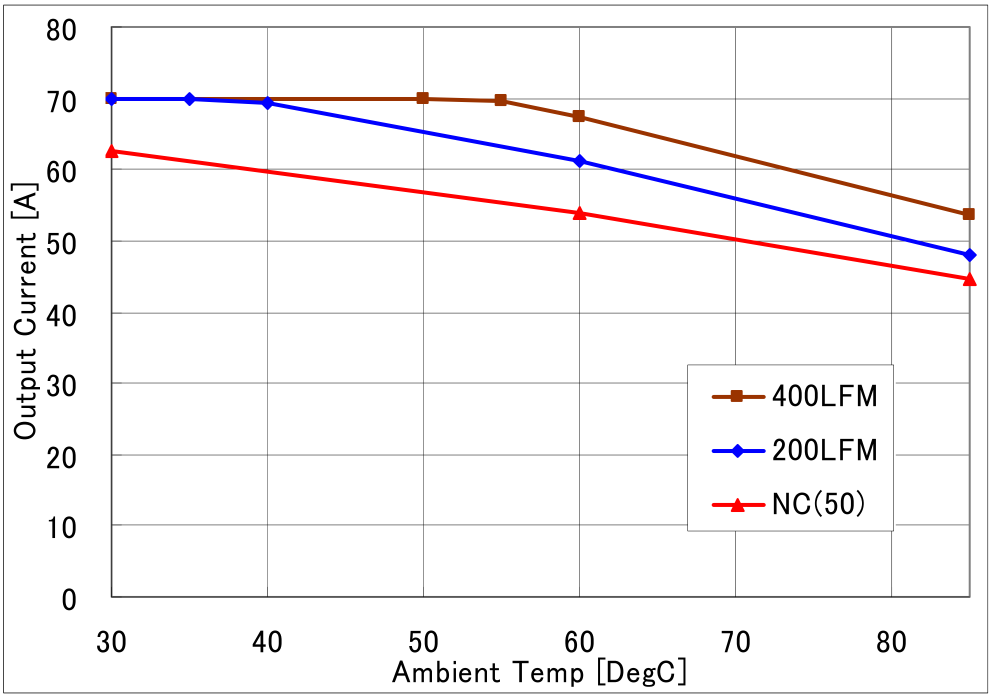

Fig-1.2V-1: Available load current vs. ambient temperature and airflow rates for Vout=1.2V with Vin=12V. Maximum component temperature≦120°C

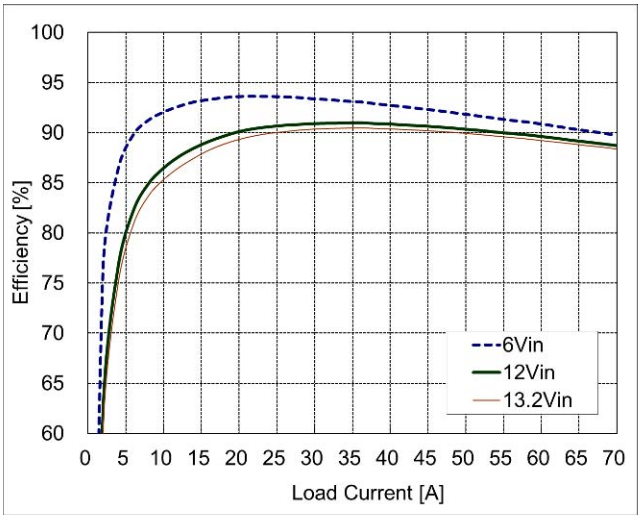

Fig-1.2V-2: Efficiency vs. load current and input voltage for Vout=1.2V.
Airflow rate=200 LFM (1m/s) and Ta=25°C.

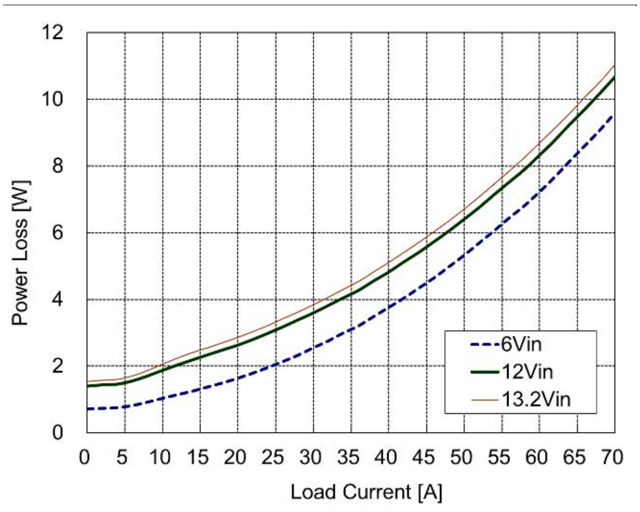

Fig-1.2V-3: Power Loss vs. load current and input voltage for Vout=1.2V.
Airflow rate=200 LFM (1m/s) and Ta=25°C.

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6-13.2Vdc Input, 70A, 0.65-2.5Vdc Output

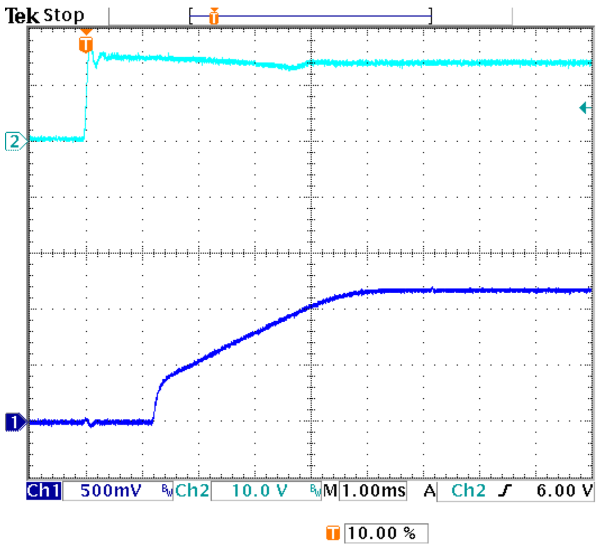

Fig-1.2V-4: Turn-on transient for Vout=1.2V with application of Vin at full rated load current (resistive) and 920uF external capacitance at Vin=12V.
Top trace: Vin (10V/div.)
Bottom trace: output voltage (500mV/div.)
Time scale: 1 ms/div.

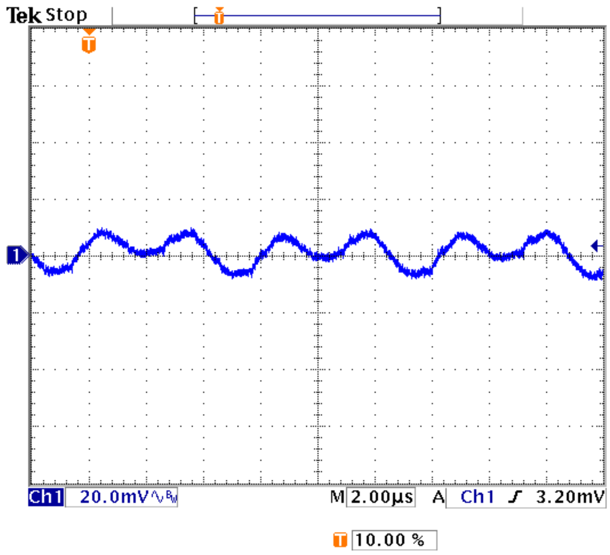

Fig-1.2V-5: Output voltage ripple (20mV/div.) for Vout=1.2V at full rated load current into a resistive load with external capacitance 920uF at Vin=12V.
Time scale: 2 us/div

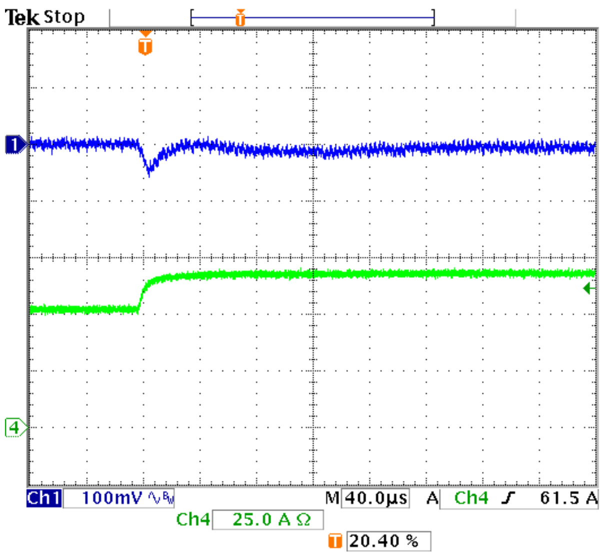

Fig-1.2V-6: Output voltage response for Vout=1.2V to positive load current step change from 52.5A to 70A with slew rate of 3A/us at Vin=12V. Co=920uF.
Top trace: output voltage (100mV/div.)
Bottom trace: load current (25A/div.)
Time scale: 40us/div.

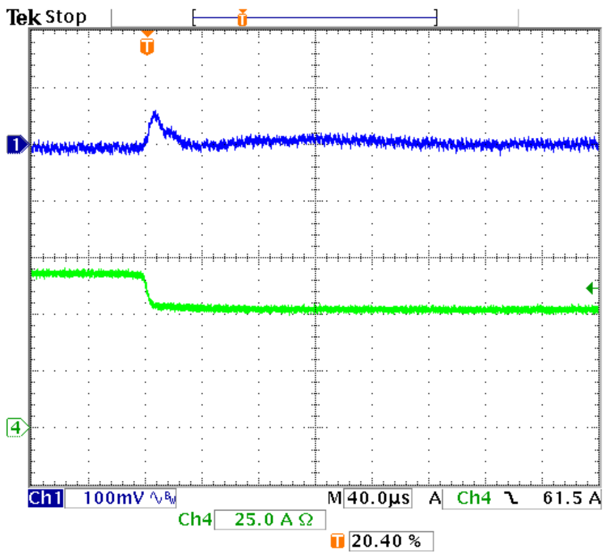

Fig-1.2V-7: Output voltage response for Vout=1.2V to negative load current step change from 70A to 52.5A with slew rate of -3A/us at Vin=12V. Co=920uF.
Top trace: output voltage (100mV/div.)
Bottom trace: load current (25A/div.)
Time scale: 40us/div.

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6-13.2Vdc Input, 70A, 0.65-2.5Vdc Output

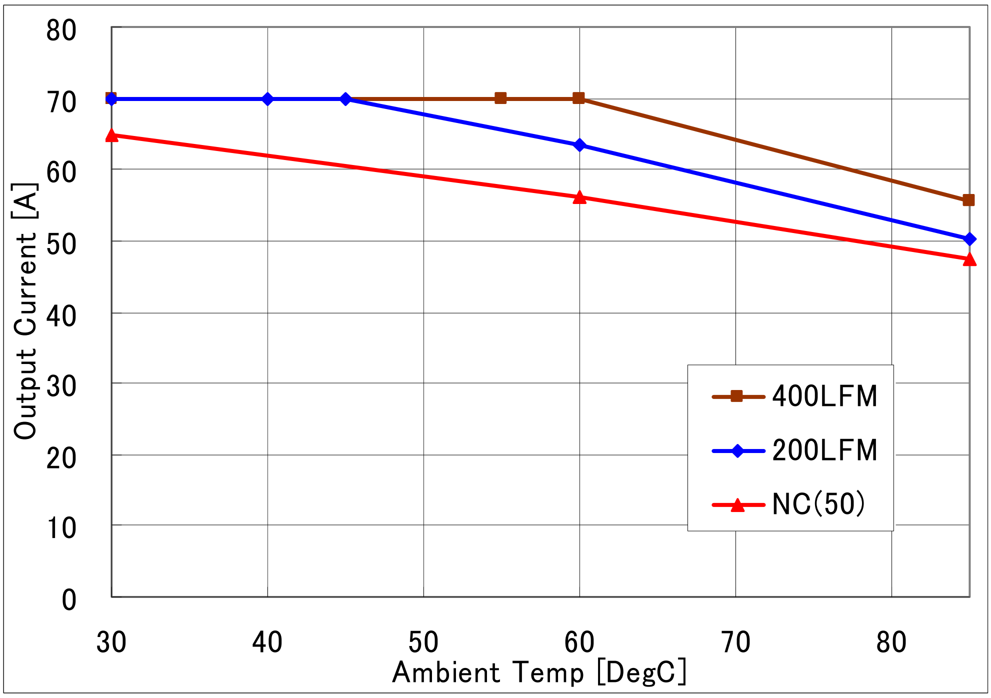

Fig-0.8V-1: Available load current vs. ambient temperature and airflow rates for Vout=0.8V with Vin=12V. Maximum component temperature≦120°C

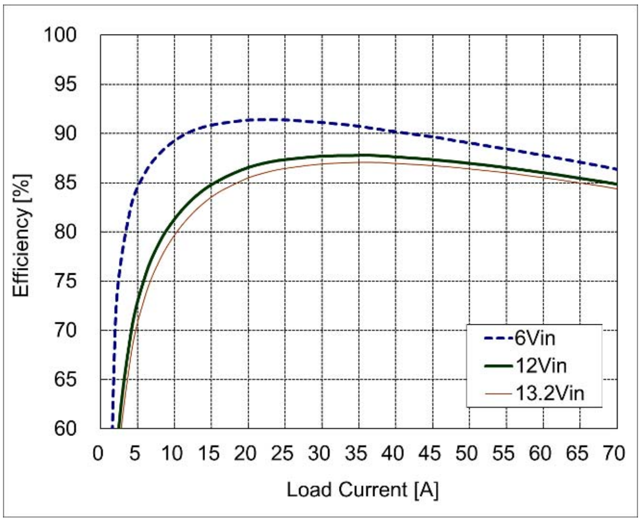

Fig-0.8V-2: Efficiency vs. load current and input voltage for Vout=0.8V.
Airflow rate=200 LFM (1m/s) and Ta=25°C.

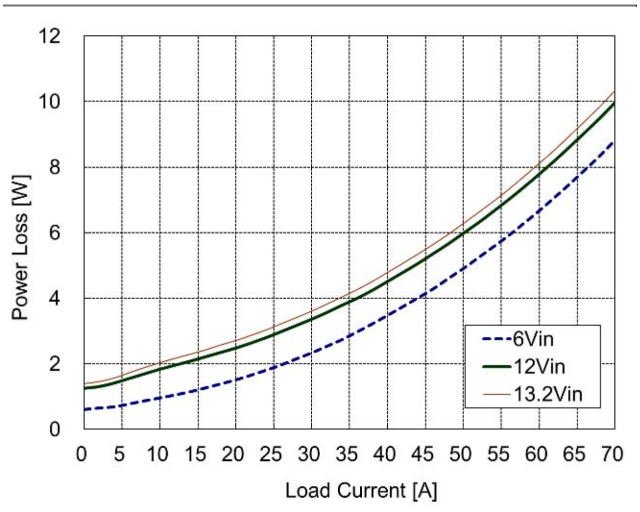

Fig-0.8V-3: Power Loss vs. load current and input voltage for Vout=0.8V.
Airflow rate=200 LFM (1m/s) and Ta=25°C.

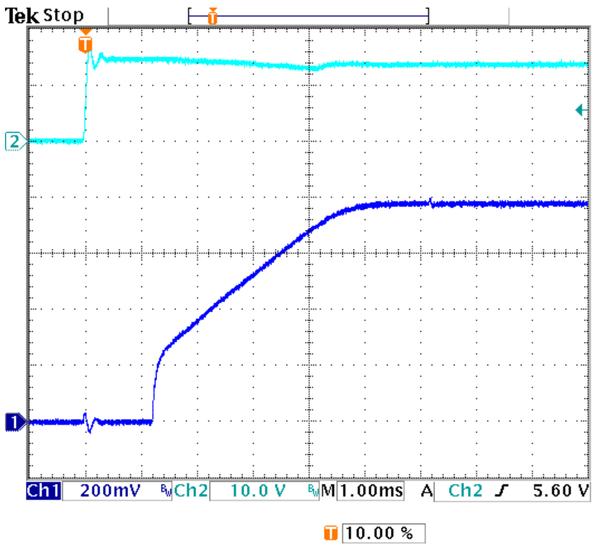

Fig-0.8V-4: Turn-on transient for Vout=0.8V with application of Vin at full rated load current (resistive) and 920uF external capacitance at Vin=12V.
Top trace: Vin (10V/div.)
Bottom trace: output voltage (200mV/div.)
Time scale: 1 ms/div.

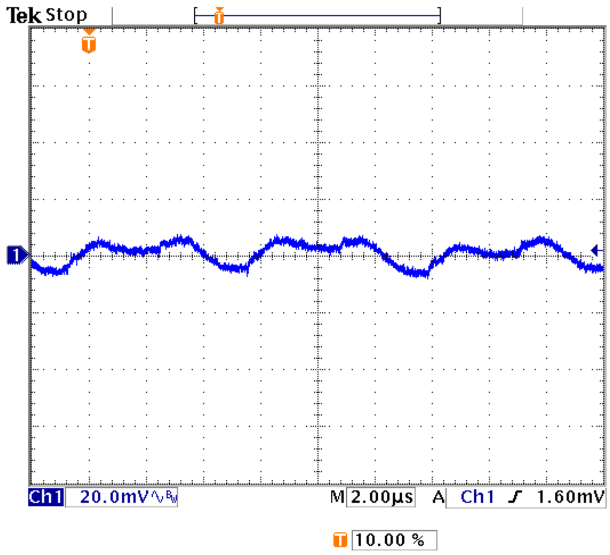

Fig-0.8V-5: Output voltage ripple (20mV/div.) for Vout=0.8V at full rated load current into a resistive load with external capacitance 920uFat Vin=12V.
Time scale: 2 us/div

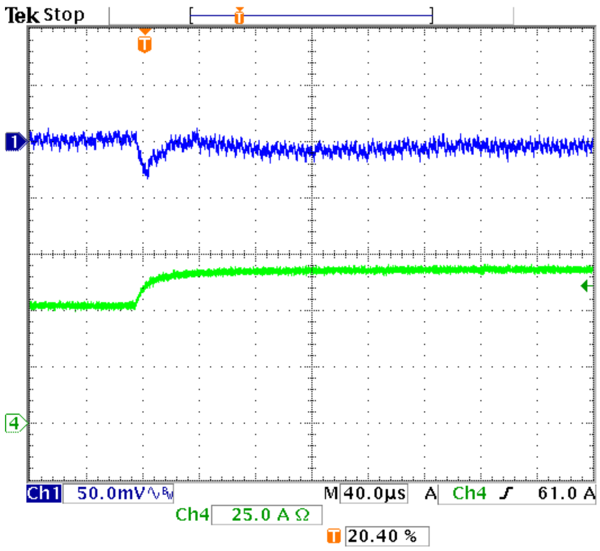

Fig-0.8V-6: Output voltage response for Vout=0.8V to positive load current step change from 52.5A to 70A with slew rate of 3A/us at Vin=12V. Co=920uF.
Top trace: output voltage (50mV/div.)
Bottom trace: load current (25A/div.)
Time scale: 40us/div.

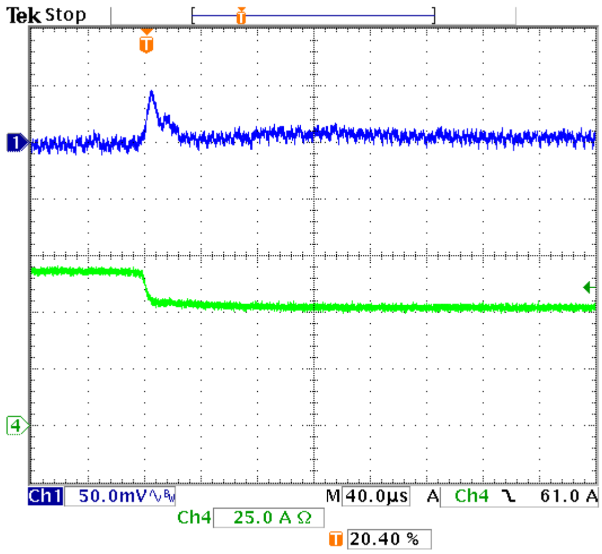

Fig-0.8V-7: Output voltage response for Vout=0.8V to negative load current step change from 70A to 52.5A with slew rate of -3A/us at Vin=12V. Co=920uF.
Top trace: output voltage (50mV/div.)
Bottom trace: load current (25A/div.)
Time scale: 40us/div.

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6-13.2Vdc Input, 70A, 0.65-2.5Vdc Output

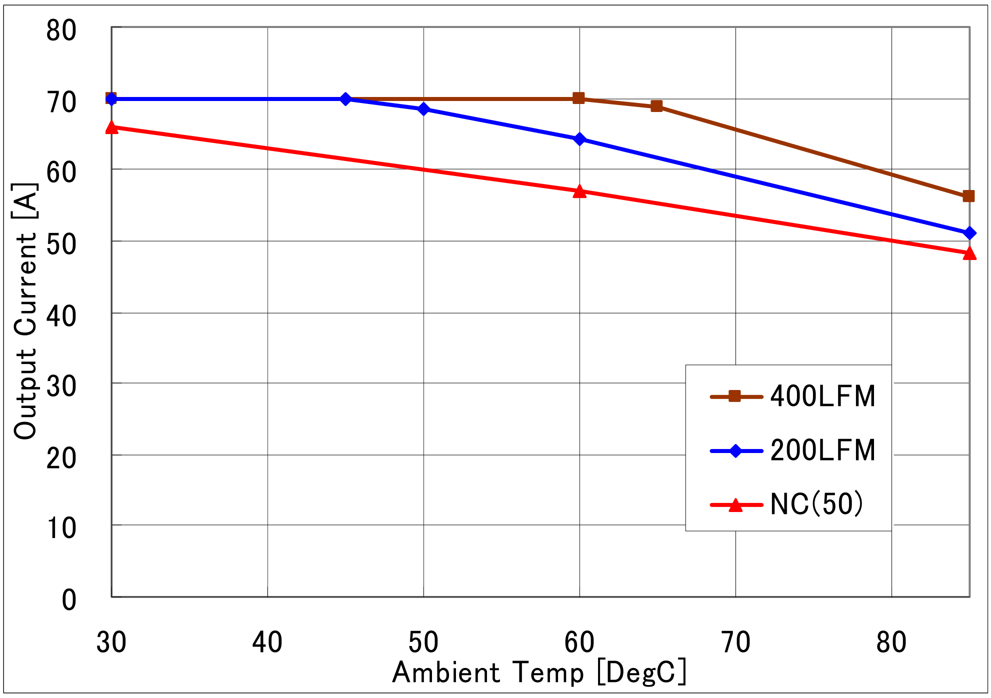

Fig-0.65V-1: Available load current vs. ambient temperature and airflow rates for Vout=0.65V with Vin=12V. Maximum component temperature≦120°C

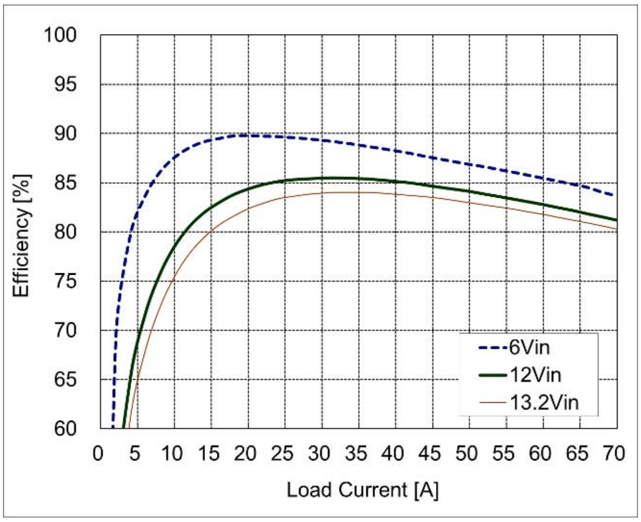

Fig-0.65V-2: Efficiency vs. load current and input voltage for Vout=0.65V.
Airflow rate=200 LFM (1m/s) and Ta=25°C.

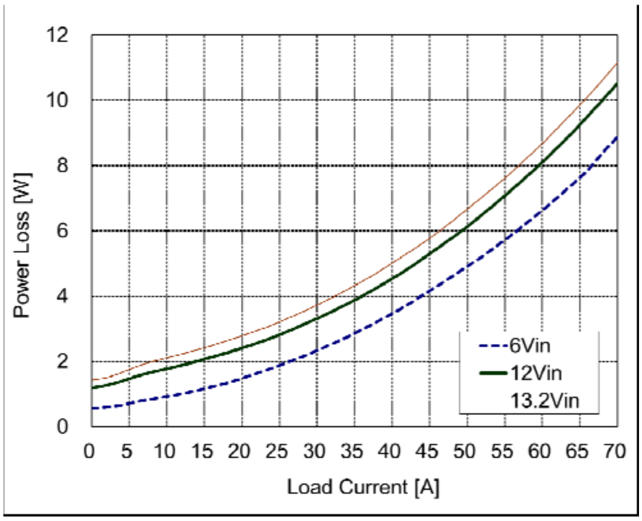

Fig-0.65V-3: Power Loss vs. load current and input voltage for Vout=0.65V.
Airflow rate=200 LFM (1m/s) and Ta=25°C.

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6-13.2Vdc Input, 70A, 0.65-2.5Vdc Output

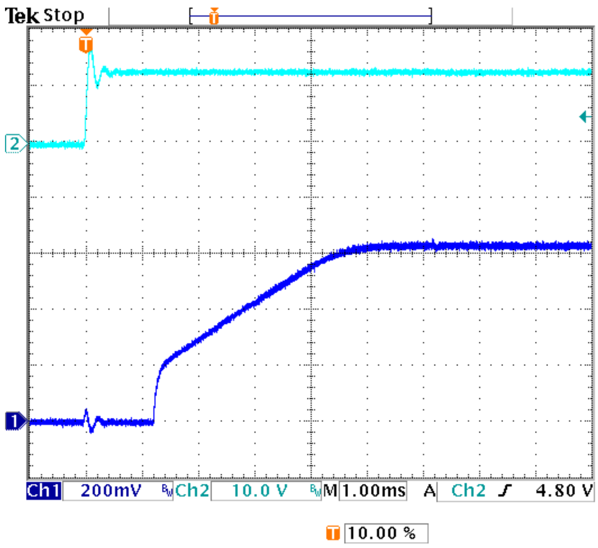

Fig-0.65V-4: Turn-on transient for Vout=0.65V with application of Vin at full rated load current (resistive) and 920uF external capacitance at Vin=12V.
Top trace: Vin (10V/div.)
Bottom trace: output voltage (200mV/div.)
Time scale: 1 ms/div.

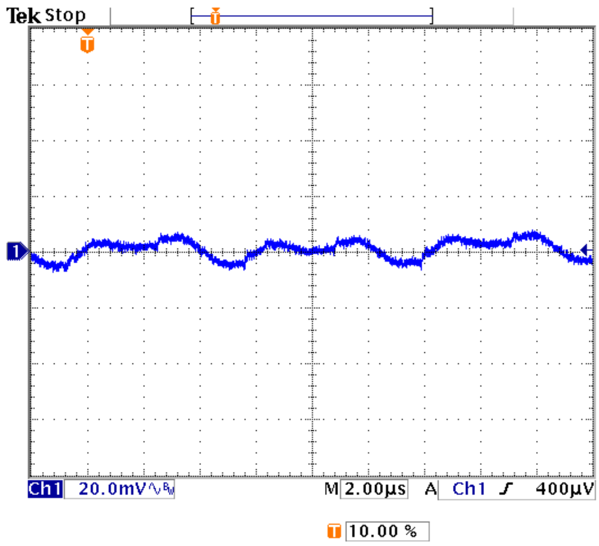

Fig-0.65V-5: Output voltage ripple (20mV/div.) for Vout=0.65V at full rated load current into a resistive load with external capacitance 920uFat Vin=12V.
Time scale: 2 us/div

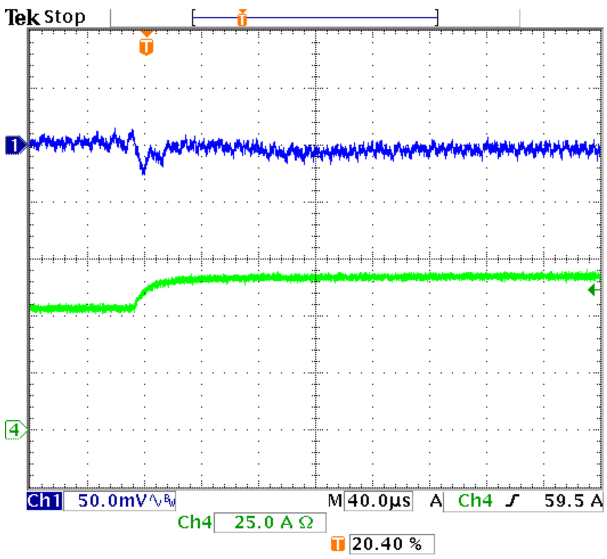

Fig-0.65V-6: Output voltage response for Vout=0.65V to positive load current step change from 52.5A to 70A with slew rate of 3A/us at Vin=12V. Co=920uF.
Top trace: output voltage (50mV/div.)
Bottom trace: load current (25A/div.)
Time scale: 40us/div.

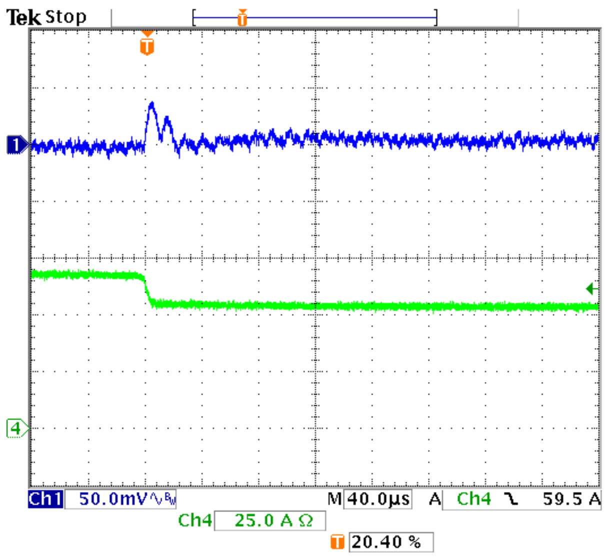

Fig-0.65V-7: Output voltage response for Vout=0.65V to negative load current step change from 70A to 52.5A with slew rate of -3A/us at Vin=12V. Co=920uF.
Top trace: output voltage (50mV/div.)
Bottom trace: load current (25A/div.)
Time scale: 40us/div.

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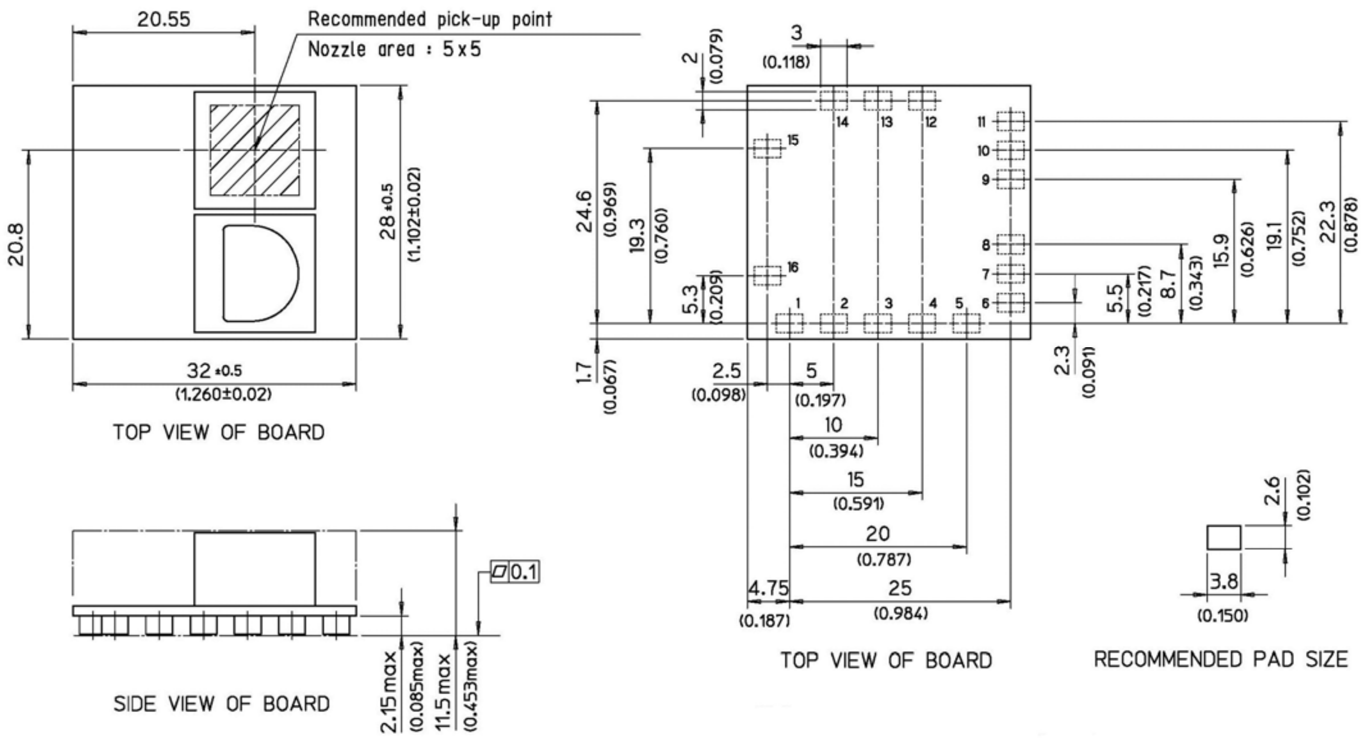
6-13.2Vdc Input, 70A, 0.65-2.5Vdc Output

Mechanical Drawing



Pin Connections			
Pin #	Function	Pin #	Function
1	ON/OFF	9	Vout
2	PGOOD	10	Vout
3	NC *1	11	Vout
4	NC	12	Vsence(+)
5	NC *1	13	Vsence(-)
6	GND	14	Trim
7	GND	15	Vin
8	GND	16	GND

Notes

- All dimensions are in millimeters (inches)
- Unless otherwise specified, tolerances are +/- 0.25mm
- Connector material: Copper
- Connector finish: Gold over Nickel
- Converter weight: 0.614oz (17.4g)
- Converter height: 11.5mm Max
- Recommended surface-mount pads: 2.6 x 3.8mm

*1: Pin 3 and 5 should be no connection to external circuitry.

Part Numbering Scheme

Product Series	Shape	Regulated/ Non	Input Voltage	Mounting Scheme	Output Voltage	Rated Current	ON/OFF Logic	Pin Shape
FP	**F**	**R**	**12**	**S**	**R65**	**70**	**N**	**A**
Series Name	Flat	R: Regulated	Typ=12V	Surface Mount	0.65V (Programmable: See page 6)	70A	N: Negative	Standard

Notes

PATTERN DESIGN: Please prohibit patterns other than 0V shield pattern the pattern drawing under the product considering the interference etc. of the insulation failure and another circuit.

ﾊﾟﾀｰﾝ設計：製品下面へのﾊﾟﾀｰﾝ引き回しは絶縁不良および他回路との干渉等を考慮して0Vｼｰﾙﾄﾞﾊﾟﾀｰﾝ以外のﾊﾟﾀｰﾝは禁止してください。

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Operating Conditions: Do not use power modules under the following conditions because all these factors deteriorate the power module characteristics or cause failures. 1) Wet or humid locations, 2) corrosive or deoxidizing gas (Hydrogen sulfide, Sulfurous acid, Chloride and ammonia, etc), 3) Volatile or flammable gas, 4) Dusty conditions, 5) Under high pressure or low pressure, 6) location with salt water, oils, chemical liquids or organic solvents, or 7) Strong vibrations or mechanical impact.

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HIGH RELIABILITY AND LONG LIFE APPLICATIONS: If FDK Corporation products are used in high reliability or ling life applications, reduce temperature of the power modules and determine the condition on your own responsibility after confirming reliability and life time in your actual application.

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CLEANSING : Cleansing of this power module is not recommended. When cleansing, determine a cleansing condition on your own responsibility after confirming there is no impact on the characteristics/performance of the power module.

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仕様の変更と版数：　仕様は版数によって管理されていますが、予告なしで変更する場合がございます。

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6-13.2Vdc Input, 70A, 0.65-2.5Vdc Output

Storage Condition:

	Sealed bag	Opened *
Storage Temperature	Less than 40 degC	Less than 30 degC
Storage Humidity	Less than 90%RH Non Condensing	Less than 60%RH Non Condensing
Storage Life	12 months	168 hours

* MSL rating of this product is 3 (IPC/JEDEC J-STD-033)

保管条件:

	未開封時	開封後 ＊
保存温度	40℃以下	30℃以下
保存湿度	90%RH以下（結露なきこと）	60%RH以下（結露なきこと）
保存期限	12ヶ月以内（密封後）	168時間以内

＊ 本製品のMSLﾚｰﾃｨﾝｸﾞはﾚﾍﾞﾙ3です（IPC/JEDEC J-STD-033）