

FPFR12SR6570NA

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

Preliminary Datasheet

The **SENDA3** 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パワーモジュール **SENDA3** 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、このパワーモジュールは、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。

The **FPFR12SR6570NA** power module of the **SENDA3** 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°C, under natural convection.

SENDA3 シリーズの **FPFR12SR6570NA** は高い電圧精度で0.65V~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ベルです。自然対流、85°Cの条件で、わずかなデレギュレーション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、及びパッケージング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プロセスによりもたらされます。

Applications

- Intermediate Bus Architecture
中間バス構成システム
- Telecommunications
テレコムシステム
- Data/Voice processing
データ処理システム
- Distributed Power Architecture
分散型電源システム
- Computing (Servers, Workstations)
コンピュータ関係(サーバー、ワークステーション)

**FPFR12SR6570NA**

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ロジックはネガティブ
- 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プログ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
出力にプリバ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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Electrical Specifications 電氣的仕様

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: $T_a=25\text{degC}$, $\text{Airflow}=200\text{LFM}$ (1.0m/s), $V_{in}=12\text{Vdc}$, $V_{out}=0.65\text{-}2.5\text{Vdc}$, unless otherwise specified.

PARAMETER	NOTES	MIN	TYP	MAX	UNITS
ABSOLUTE MAXIMUM RATINGS¹					
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 V_{in} (module enabled, then V_{in} applied)	From $V_{in}=V_{in}(\text{min})$ to $0.1*V_{out}(\text{nom})$		5.0		ms
with Enable (V_{in} applied, then enabled)	From enable to $0.1*V_{out}(\text{nom})$		5.0		ms
Rise Time (Full resistive load)	From $0.1*V_{out}(\text{nom})$ to $0.9*V_{out}(\text{nom})$		5.0		ms
ON/OFF Control (Negative Logic)					
Module Off		2.4		V_{in}	Vdc
Module On		-5		0.8	Vdc

¹Absolute 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、及びモジュールの破損を引き起こすことがあります。

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Electrical Specifications (Continued) 電氣的仕様 (続き)

Conditions: $T_a=25\text{degC}$, Airflow=200LFM (1.0m/s), $V_{in}=12\text{Vdc}$, $V_{out}=0.65\text{-}2.5\text{Vdc}$, unless otherwise specified.

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

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Electrical Specifications (Continued) 電氣的仕様 (続き)

Conditions: $T_a=25\text{degC}$, Airflow=200LFM (1.05m/s), $V_{in}=12\text{Vdc}$, $V_{out}=0.65\text{-}2.5\text{Vdc}$, 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ピーダンスで接続してください。パワーモジュールの安定性に影響のある入力インダクタンスを抑えるため、パワーモジュールの入力ピンの近傍にデカップリングコンデンサを付加することをお勧めします。これによりパワーモジュールの安定動作を確実にし、入力リップル電圧を抑制します。低ESRタンタル、又はその他のコンデンサも一般的には問題ありませんが、入力リップルを最小にするためには、非常に低ESRコンデンサ(セラミックで400uF以上)を推奨します。パワーモジ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デ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.

出力リップルを最小にするため、極低ESRのセラミックコンデンサの接続を推奨します。過渡時の特性向上と出力リップル低減のために負荷の近傍にこれらのコンデ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.

このパワーモジュールは出力端子と負荷間の電圧ドロップ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、パワーモジュールの出力から負荷までのラインインピーダンスは可能な限り低くしてください。

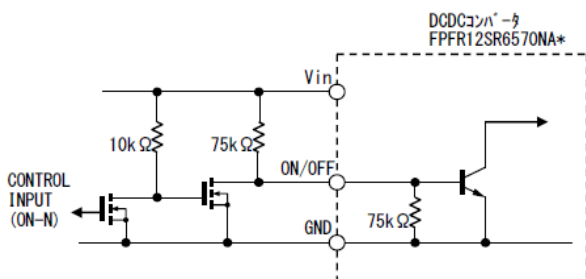


Fig. A: Circuit configuration for remote ON/OFF

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、グラウンドを基準としたリモート信号によりパワーモジュールをON/OFFするのに使われます。このパワーモジュールはネガティブロジックですので、パワーモジュールをONするにはON/OFF端子をLowレベルとし、パワーモジュールをOFFするにはON/OFF端子をHighレベル、又はVinに抵抗で接続して下さい。

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, $R^*=75k\Omega$, 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 ($\leq 0.8V$)
- (b) Sourcing up to 5.0mA at high logic level (2.3~5V) and limiting source current less than 10mA.

ON/OFFピンはモジュール内部でプルダウンされています。TTL、CMOSロジック、又はオープンコレクタ(オープンドレイン)のトランジスタもON/OFFピンの操作に使用可能です。オープンコレクタ(オープンドレイン)のトランジスタを使用する時は75kΩのプルアップ抵抗をVinに接続してください。(図A参照)

- ON/OFFピンを操作するデバイスには下記能力が必要です。
- (a) 0.8V以下のLowレベルで0.2mAまでのシンク能力
- (b) 2.3V~5VのHighロジックレベルで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パワーモジュールは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) この配線はノイズの影響を最小にするため、グラウンドに近接して配線してください。

リモートセンス機能が不要な場合は、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、パワーモジュールは出力電圧規格より若干高い電圧を出力します。

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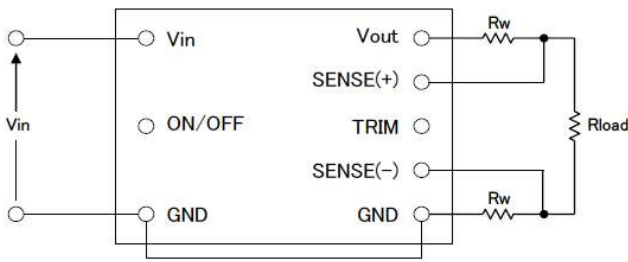


Fig. B: Remote Sense Circuit Configuration

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、テールテイングカーブで許容される最大電力以下で使用するように、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 k Ω , for a desired output voltage, V_{O-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。

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

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。

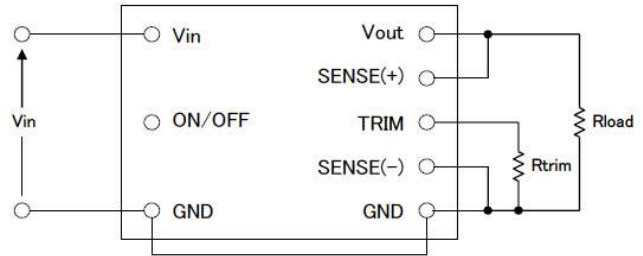


Fig. C: Configuration for programming output voltage

Table 1: Trim Resistor Value		
V_{O-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変化するには、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300 Ω 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。

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

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

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-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、このパワーモジ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、このパワーモジ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, V_{out} will return to the original value (auto-reset).

このパワーモジ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、このパワーモジュールはHiccupモードになり、過電流状態が解除されるとV_{out}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).

このパワーモジ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、このパワーモジ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.

このパワーモジュールは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。このパワーモジ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、このパワーモジュールは内部にヒューズを持っていませんので、安全規格に適合させるためには、入力ラインのプラス側に即断型で最大定格25Aのヒューズ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.

このパワーモジュールは温度デレーティング、効率、電力損失、スタートアップ時、及びシャットダウン時の動作、リップル・ノイズ、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.

各出力電圧時のデータ、及び波形の図は以後のページに掲載されていません。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、#は特定のプロットを表します。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、及び効率データは標準化された温度評価ボードにパワーモジュールを半田付けして取

FPFR12SR6570NA

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

Preliminary Datasheet

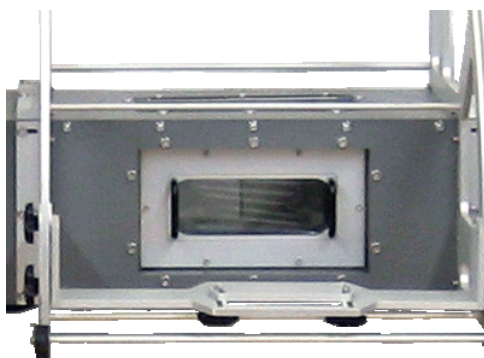
得しています。温度評価ボードをFDK特製の風洞実験設備内に設置することで、環境温度、及び風量を精密に管理しています。

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.

温度評価ボードは厚さ0.060"(1.6mm)厚の4層PCBで作成しています。表面2層の銅箔はパワーモジュールを実装するためのパッドと周辺部品へのパターンだけに限定しています。内側2層は70μmの銅箔で電力、及びグラウンド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ボードは、パワーモジュールから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°Cから85°Cを制御できます。温度測定には赤外線(IR)サーモグ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.

パワーモジ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。特に実用上の負荷が温度デレーティング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グラフィ、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、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°C~85°Cの間を変動させています。パワーモジュールは水平に設置し、風向きはパワーモジュールの長手方向に平行で16番ピンから6番ピ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°Cに到達した時点の出力電流値又は
- (ii) パワーモジ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)

温度デレーティングの範囲内で動作させるために、部品温度は120°Cを超えないようご注意ください。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°C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. 出力電流デレーティングカーブ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、及びモジュールの破損を引き起こすことがあります。

FPFR12SR6570NA

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

Preliminary Datasheet

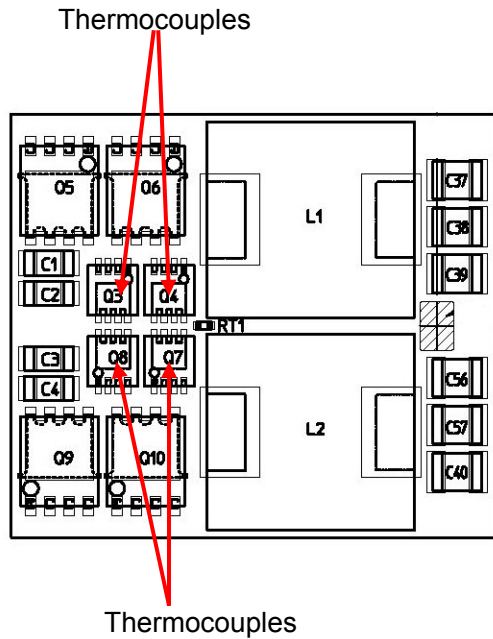


Fig. D: Location of the thermo couples for thermal testing

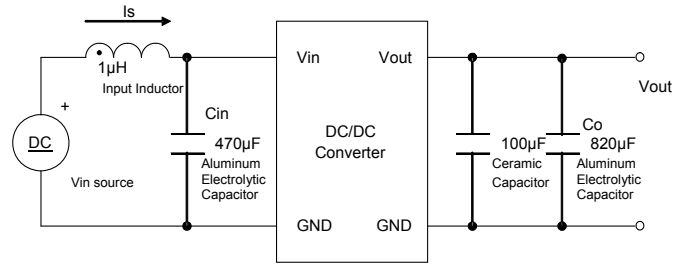


Fig. F: Test setup for measuring input reflected ripple current

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 1µF ceramic capacitor at full load current.

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

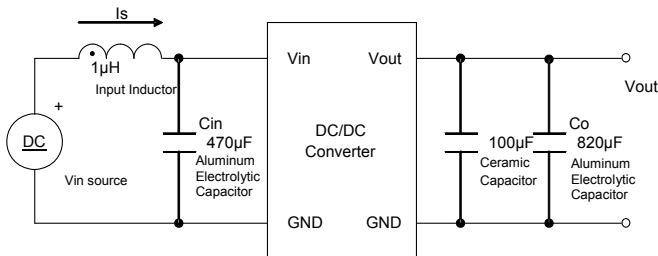


Fig. E: Test setup for measuring output voltage ripple

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Preliminary Datasheet

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

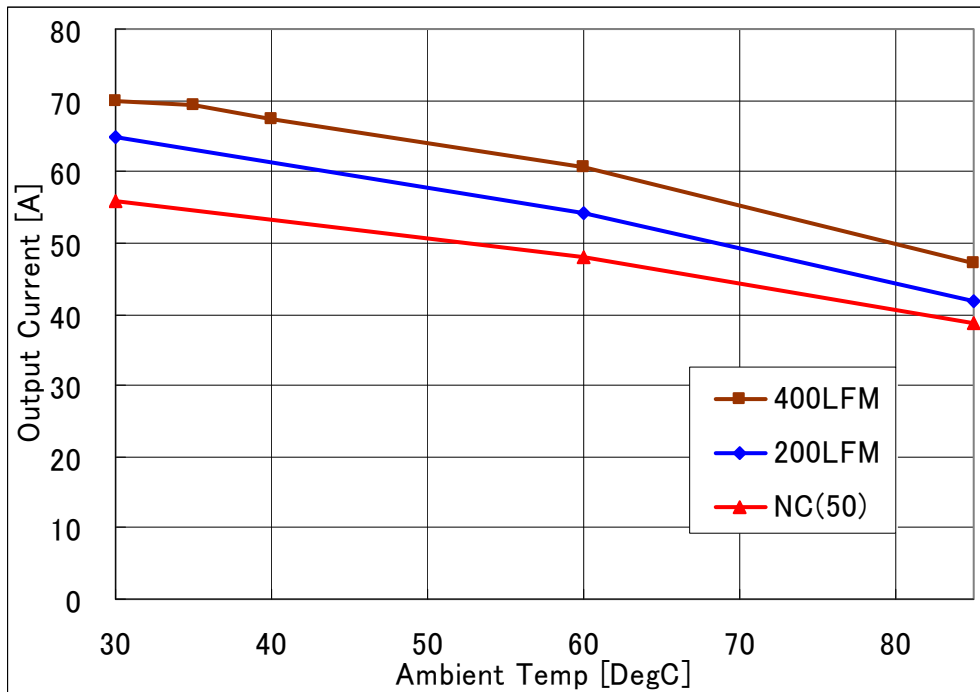


Fig-2.5V-1: Available load current vs. ambient temperature and airflow rates for Vout=2.5V with Vin=12V. Maximum component temperature $\leq 120^{\circ}\text{C}$

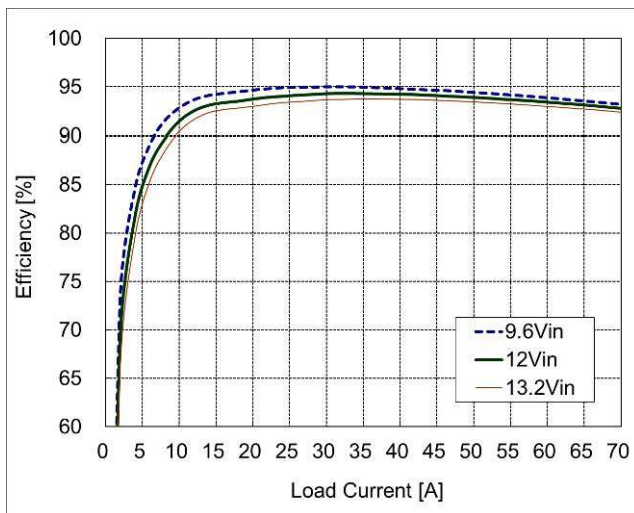


Fig-2.5V-2: Efficiency vs. load current and input voltage for Vout=2.5V. Airflow rate=200 LFM (1m/s) and Ta=25°C.

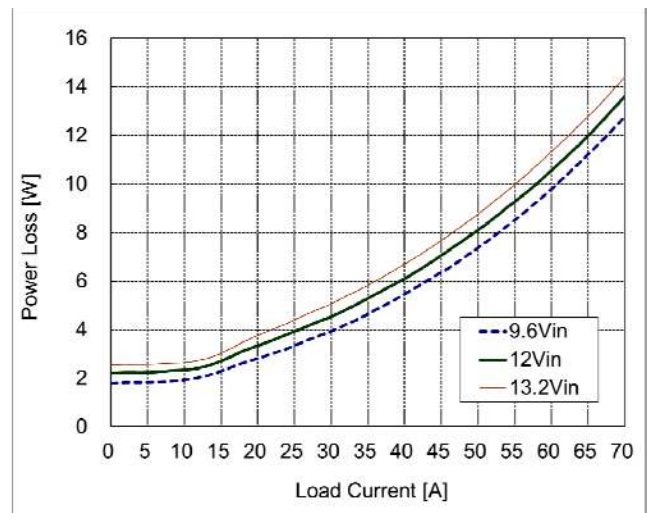


Fig-2.5V-3: Power Loss vs. load current and input voltage for Vout=2.5V. Airflow rate=200 LFM (1m/s) and Ta=25°C.

FPFR12SR6570NA

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

Preliminary Datasheet

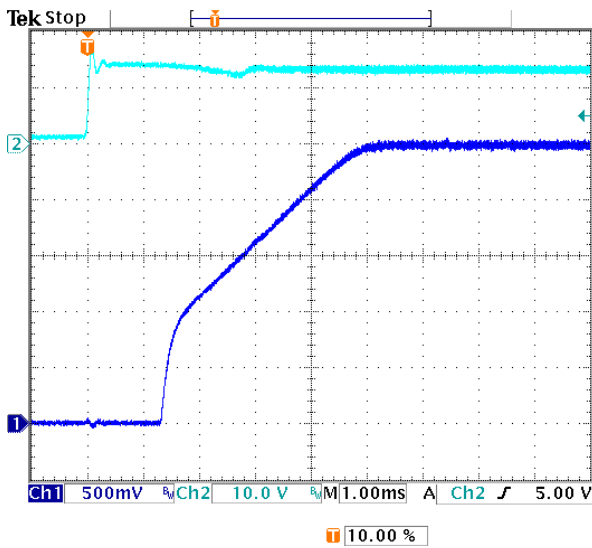


Fig-2.5V-4: Turn-on transient for $V_{out}=2.5V$ with application of V_{in} at full rated load current (resistive) and 920uF external capacitance at $V_{in}=12V$.
 Top trace: V_{in} (10V/div.)
 Bottom trace: output voltage (500mV/div.)
 Time scale: 1 ms/div.

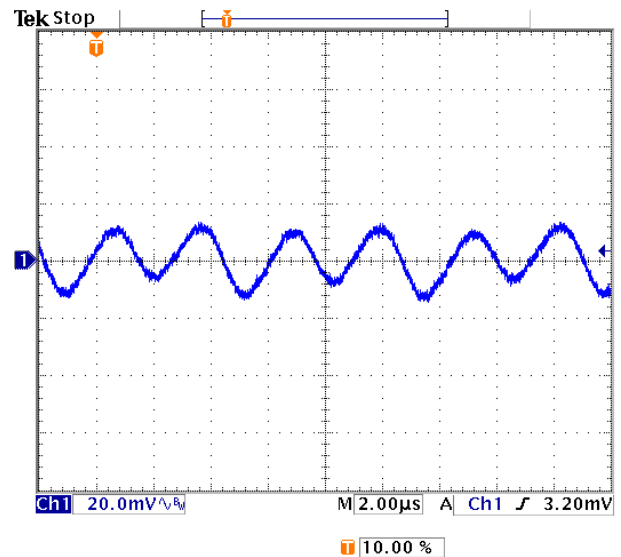


Fig-2.5V-5: Output voltage ripple (20mV/div.) for $V_{out}=2.5V$ at full rated load current into a resistive load with external capacitance 920uF at $V_{in}=12V$.
 Time scale: 2 us/div

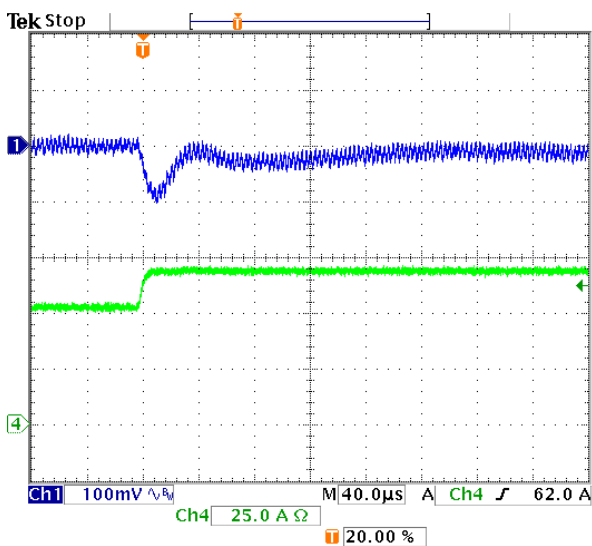


Fig-2.5V-6: Output voltage response for $V_{out}=2.5V$ to positive load current step change from 52.5A to 70A with slew rate of 3A/us at $V_{in}=12V$. $C_o=920uF$.
 Top trace: output voltage (100mV/div.)
 Bottom trace: load current (25A/div.)
 Time scale: 40us/div.

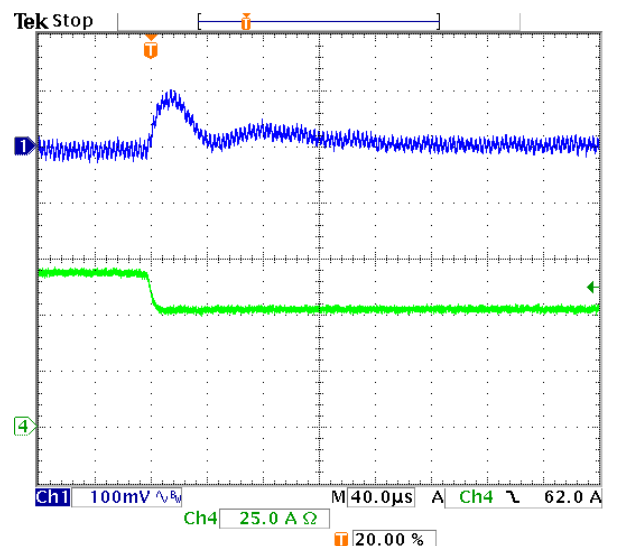


Fig-2.5V-7: Output voltage response for $V_{out}=2.5V$ to negative load current step change from 70A to 52.5A with slew rate of -3A/us at $V_{in}=12V$. $C_o=920uF$.
 Top trace: output voltage (100mV/div.)
 Bottom trace: load current (25A/div.)
 Time scale: 40us/div.

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Preliminary Datasheet

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

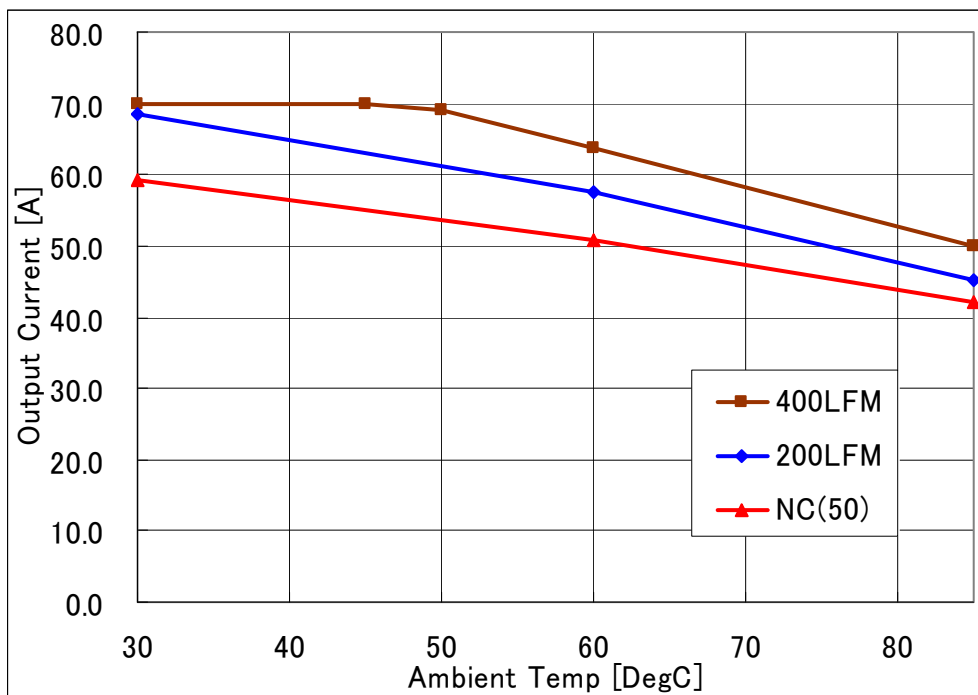


Fig-1.8V-1: Available load current vs. ambient temperature and airflow rates for Vout=1.8V with Vin=12V. Maximum component temperature $\leq 120^{\circ}\text{C}$

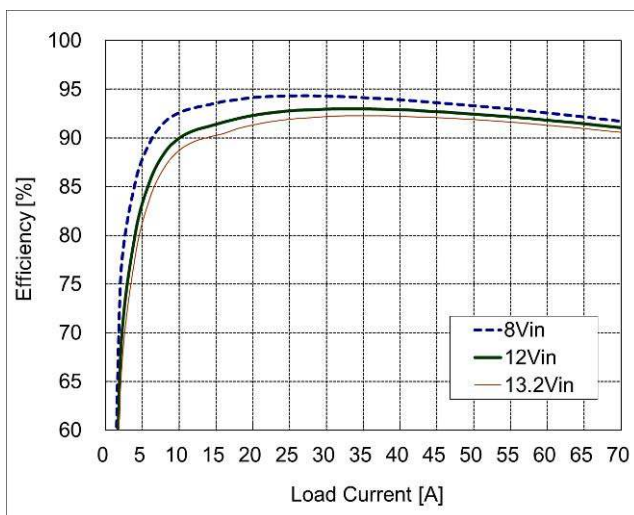


Fig-1.8V-2: Efficiency vs. load current and input voltage for Vout=1.8V. Airflow rate=200 LFM (1m/s) and Ta=25°C.

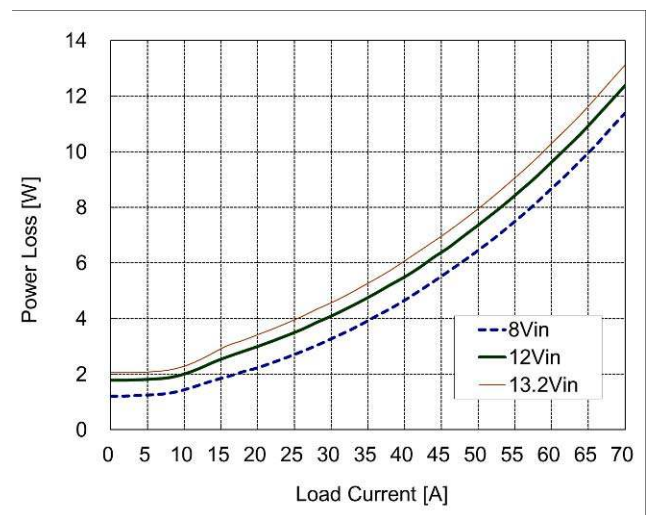


Fig-1.8V-3: Power Loss vs. load current and input voltage for Vout=1.8V. Airflow rate=200 LFM (1m/s) and Ta=25°C.

FPFR12SR6570NA

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

Preliminary Datasheet

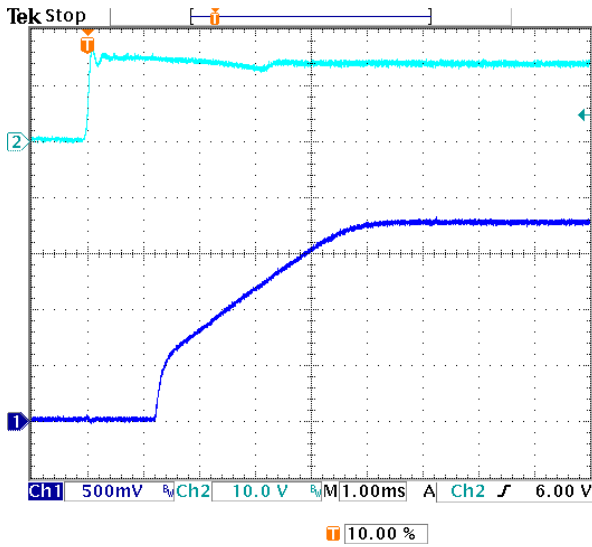


Fig-1.8V-4: Turn-on transient for $V_{out}=1.8V$ with application of V_{in} at full rated load current (resistive) and $920\mu F$ external capacitance at $V_{in}=12V$.
 Top trace: V_{in} (10V/div.)
 Bottom trace: output voltage (500mV/div.)
 Time scale: 1 ms/div.

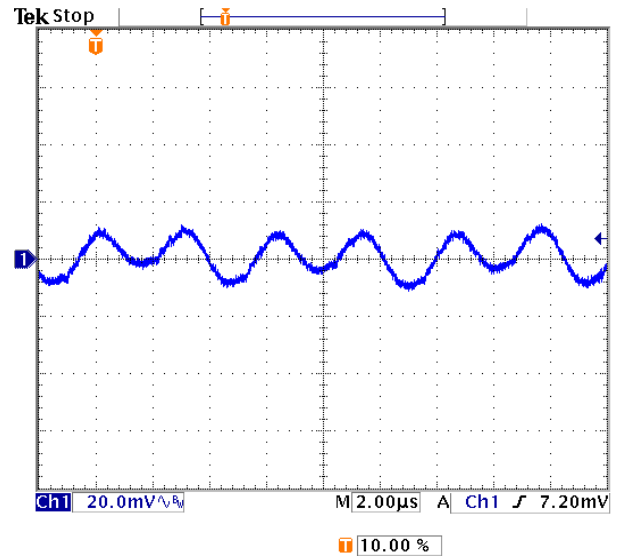


Fig-1.8V-5: Output voltage ripple (20mV/div.) for $V_{out}=1.8V$ at full rated load current into a resistive load with external capacitance $920\mu F$ at $V_{in}=12V$.
 Time scale: 2 us/div

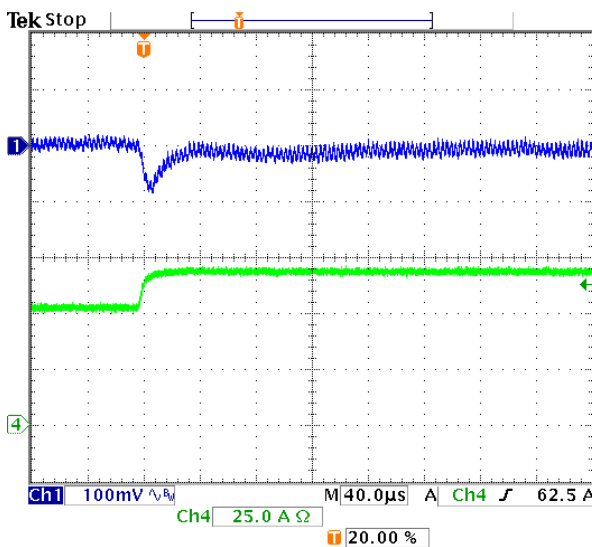


Fig-1.8V-6: Output voltage response for $V_{out}=1.8V$ to positive load current step change from 52.5A to 70A with slew rate of $3A/\mu s$ at $V_{in}=12V$. $C_o=920\mu F$.
 Top trace: output voltage (100mV/div.)
 Bottom trace: load current (25A/div.)
 Time scale: 40us/div.

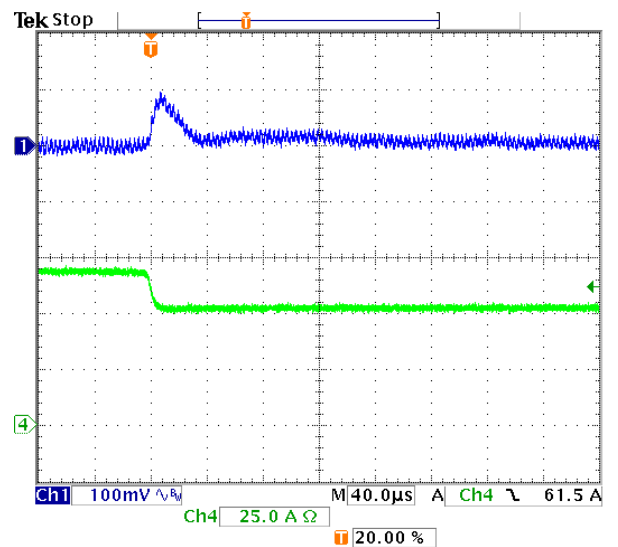


Fig-1.8V-7: Output voltage response for $V_{out}=1.8V$ to negative load current step change from 70A to 52.5A with slew rate of $-3A/\mu s$ at $V_{in}=12V$. $C_o=920\mu F$.
 Top trace: output voltage (100mV/div.)
 Bottom trace: load current (25A/div.)
 Time scale: 40us/div.

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Preliminary Datasheet

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

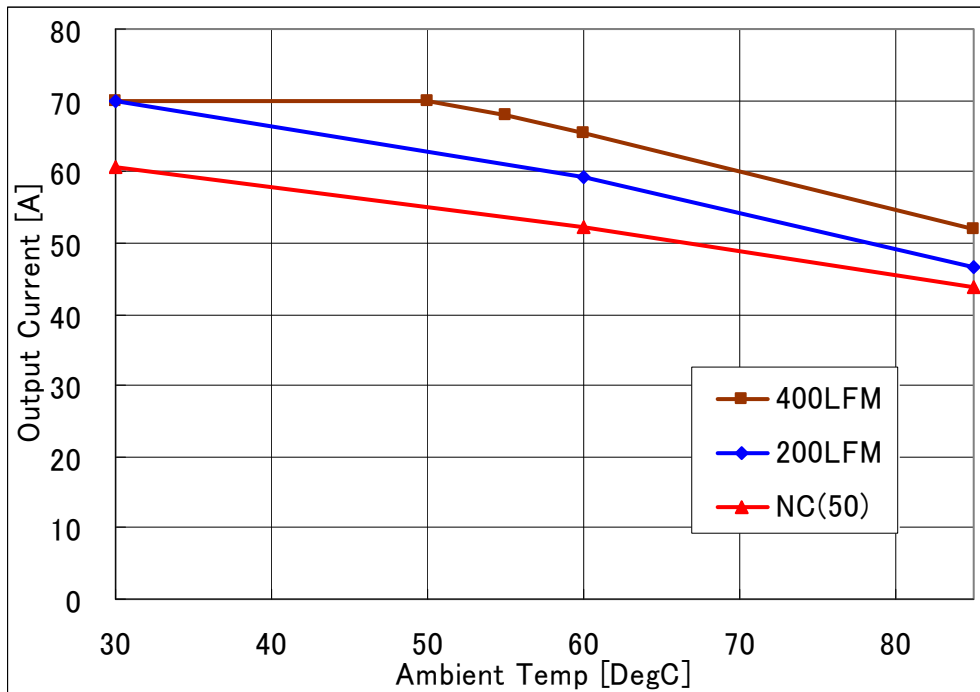


Fig-1.5V-1: Available load current vs. ambient temperature and airflow rates for Vout=1.5V with Vin=12V. Maximum component temperature $\leq 120^{\circ}\text{C}$

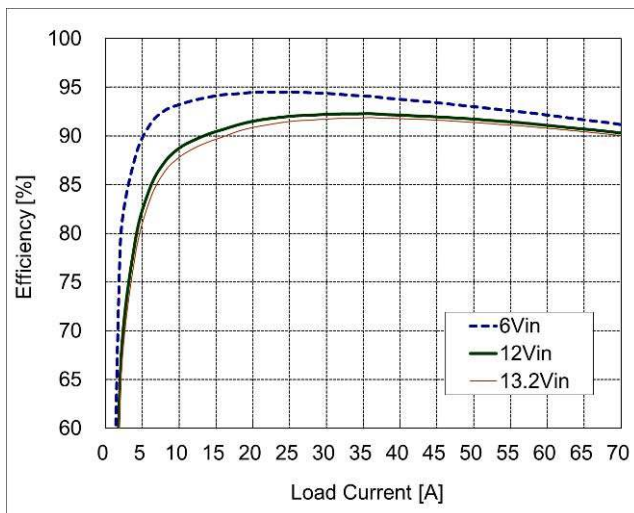


Fig-1.5V-2: Efficiency vs. load current and input voltage for Vout=1.5V. Airflow rate=200 LFM (1m/s) and Ta=25°C.

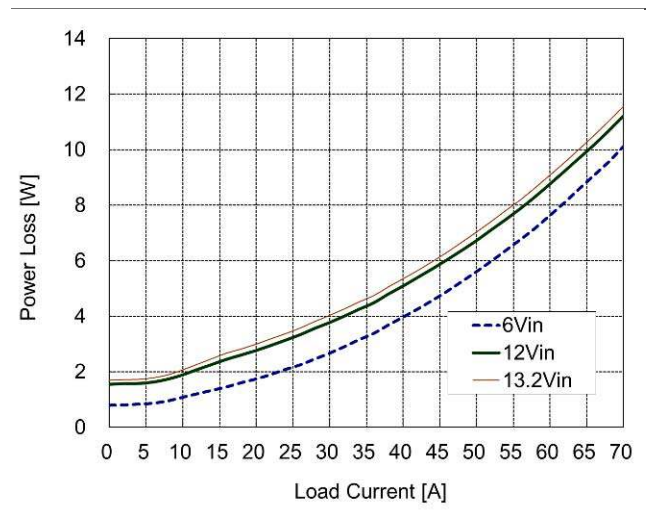


Fig-1.5V-3: Power Loss vs. load current and input voltage for Vout=1.5V. Airflow rate=200 LFM (1m/s) and Ta=25°C.

FPFR12SR6570NA

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

Preliminary Datasheet

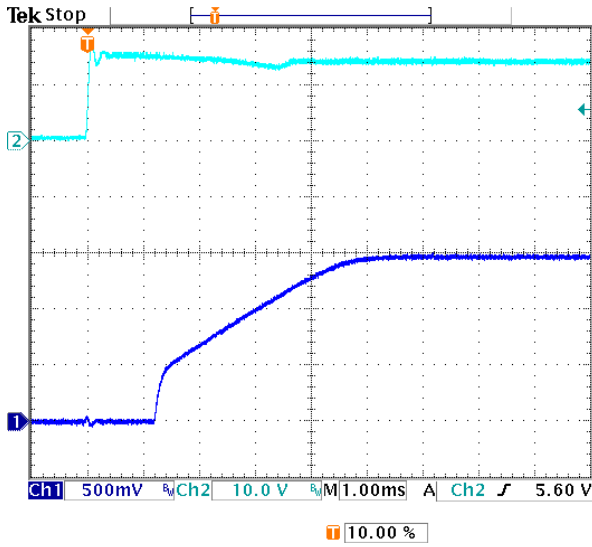


Fig-1.5V-4: Turn-on transient for $V_{out}=1.5V$ with application of V_{in} at full rated load current (resistive) and 920uF external capacitance at $V_{in}=12V$.
 Top trace: V_{in} (10V/div.)
 Bottom trace: output voltage (500mV/div.)
 Time scale: 1 ms/div.

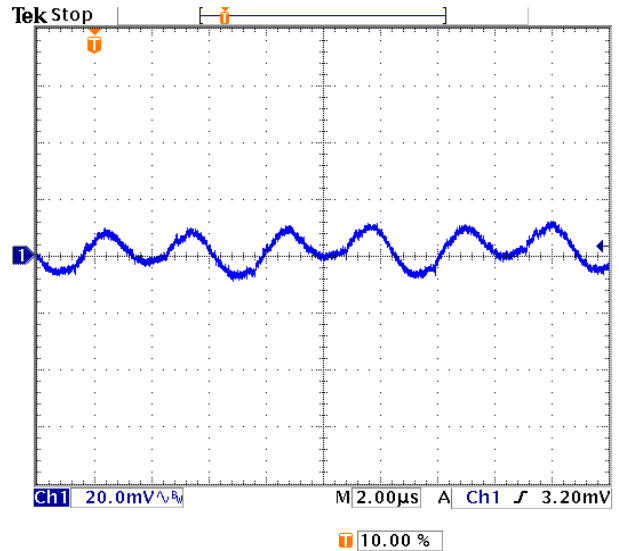


Fig-1.5V-5: Output voltage ripple (20mV/div.) for $V_{out}=1.5V$ at full rated load current into a resistive load with external capacitance 920uF at $V_{in}=12V$.
 Time scale: 2 us/div

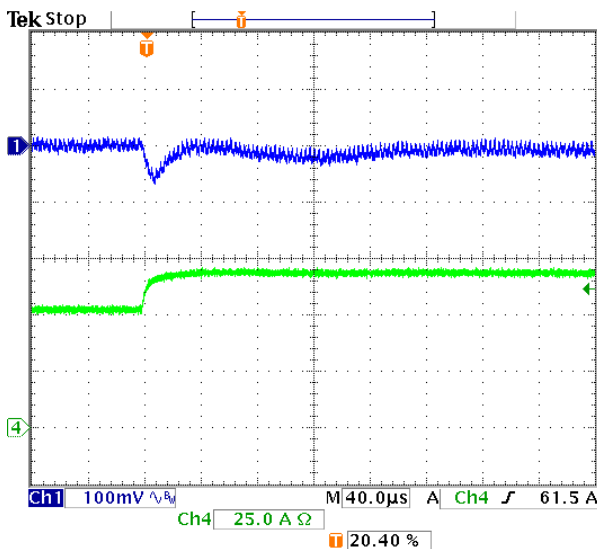


Fig-1.5V-6: Output voltage response for $V_{out}=1.5V$ to positive load current step change from 52.5A to 70A with slew rate of 3A/us at $V_{in}=12V$. $C_o=920uF$.
 Top trace: output voltage (100mV/div.)
 Bottom trace: load current (25A/div.)
 Time scale: 40us/div.

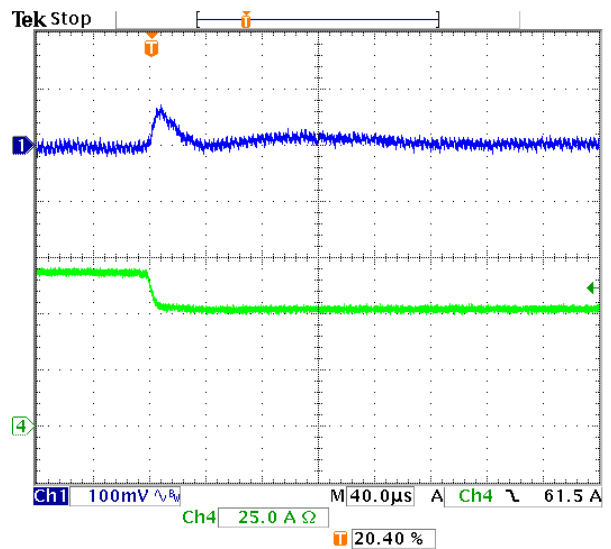


Fig-1.5V-7: Output voltage response for $V_{out}=1.5V$ to negative load current step change from 70A to 52.5A with slew rate of -3A/us at $V_{in}=12V$. $C_o=920uF$.
 Top trace: output voltage (100mV/div.)
 Bottom trace: load current (25A/div.)
 Time scale: 40us/div.

FPFR12SR6570NA

Preliminary Datasheet

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

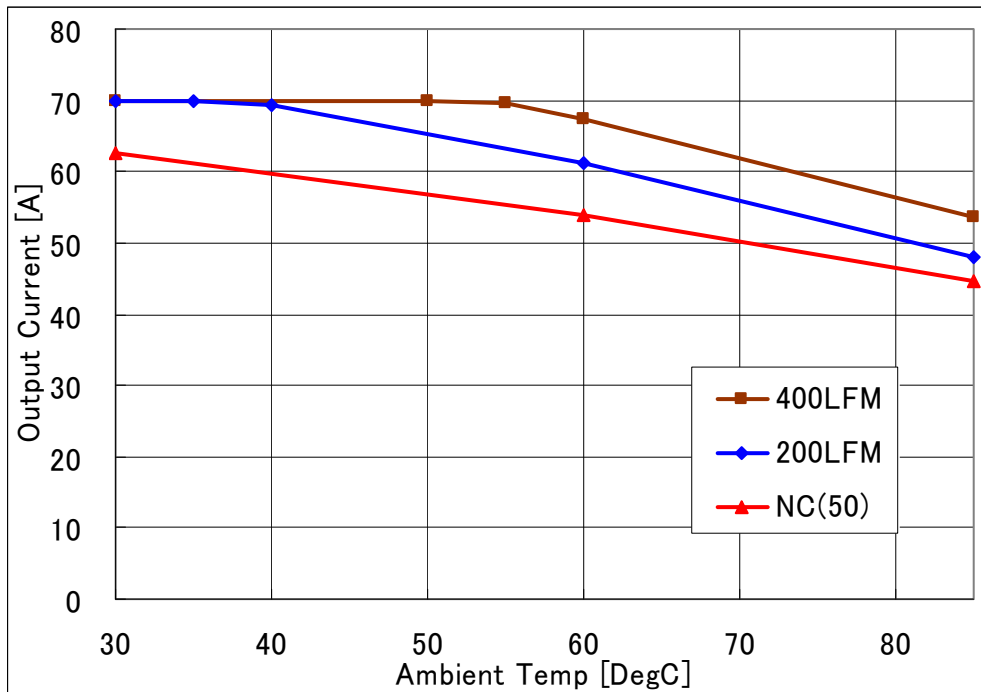


Fig-1.2V-1: Available load current vs. ambient temperature and airflow rates for Vout=1.2V with Vin=12V. Maximum component temperature $\leq 120^{\circ}\text{C}$

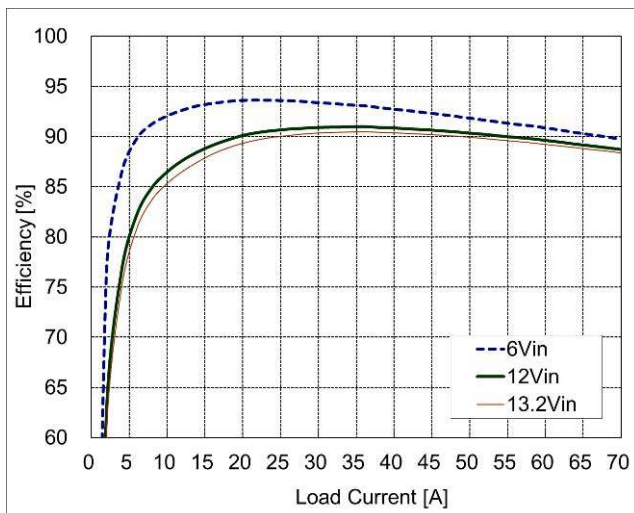


Fig-1.2V-2: Efficiency vs. load current and input voltage for Vout=1.2V. Airflow rate=200 LFM (1m/s) and Ta=25°C.

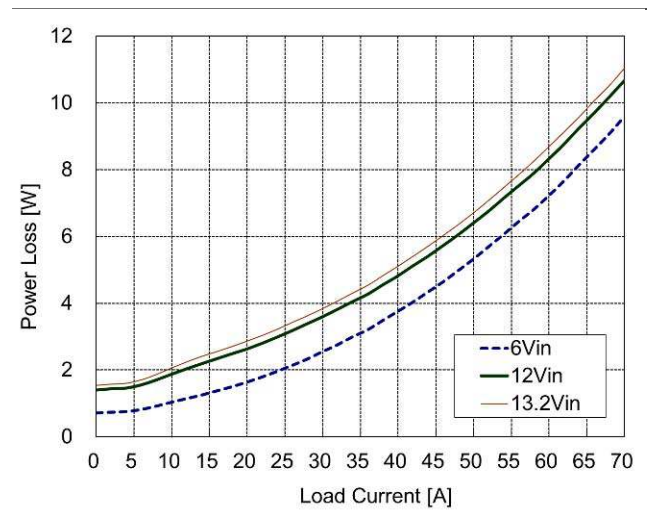


Fig-1.2V-3: Power Loss vs. load current and input voltage for Vout=1.2V. Airflow rate=200 LFM (1m/s) and Ta=25°C.

FPFR12SR6570NA

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

Preliminary Datasheet

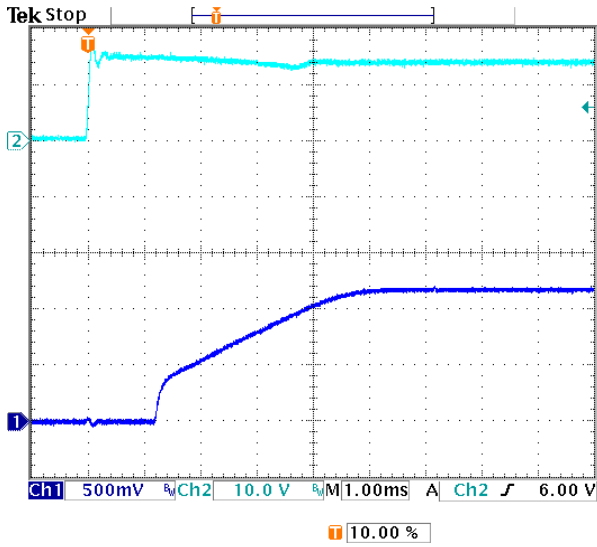


Fig-1.2V-4: Turn-on transient for $V_{out}=1.2V$ with application of V_{in} at full rated load current (resistive) and 920uF external capacitance at $V_{in}=12V$.
 Top trace: V_{in} (10V/div.)
 Bottom trace: output voltage (500mV/div.)
 Time scale: 1 ms/div.

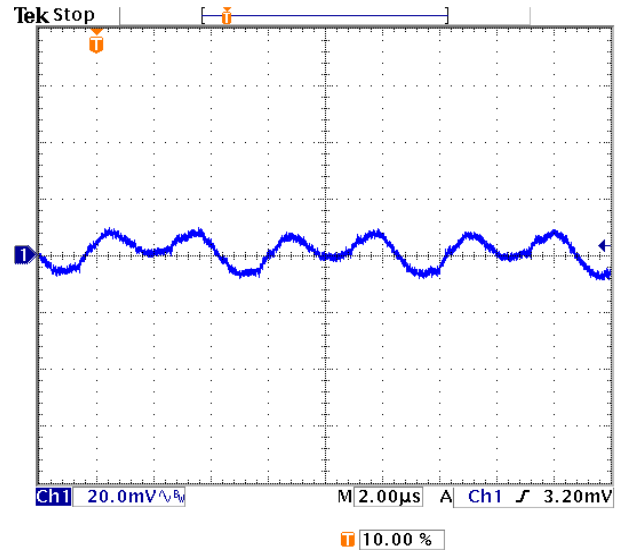


Fig-1.2V-5: Output voltage ripple (20mV/div.) for $V_{out}=1.2V$ at full rated load current into a resistive load with external capacitance 920uF at $V_{in}=12V$.
 Time scale: 2 us/div

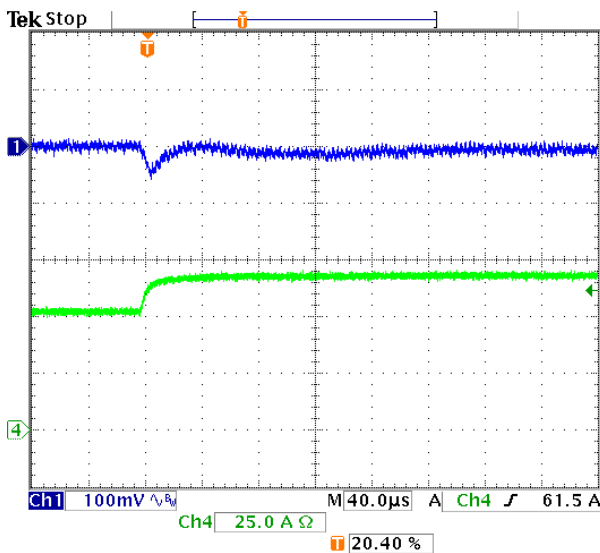


Fig-1.2V-6: Output voltage response for $V_{out}=1.2V$ to positive load current step change from 52.5A to 70A with slew rate of 3A/us at $V_{in}=12V$. $C_o=920uF$.
 Top trace: output voltage (100mV/div.)
 Bottom trace: load current (25A/div.)
 Time scale: 40us/div.

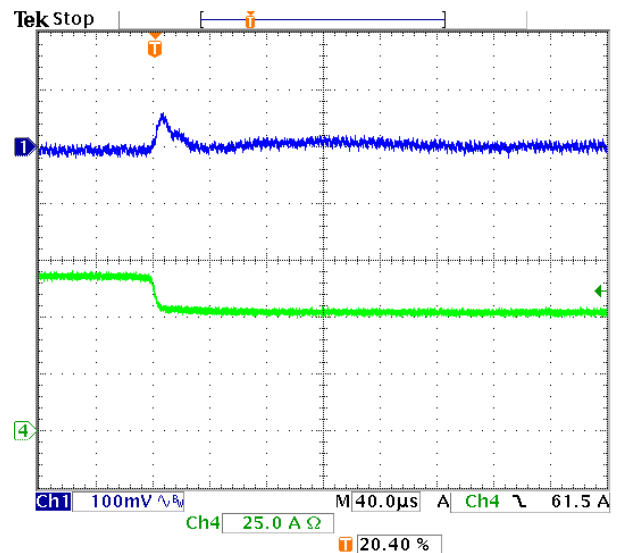


Fig-1.2V-7: Output voltage response for $V_{out}=1.2V$ to negative load current step change from 70A to 52.5A with slew rate of -3A/us at $V_{in}=12V$. $C_o=920uF$.
 Top trace: output voltage (100mV/div.)
 Bottom trace: load current (25A/div.)
 Time scale: 40us/div.

FPFR12SR6570NA

Preliminary Datasheet

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

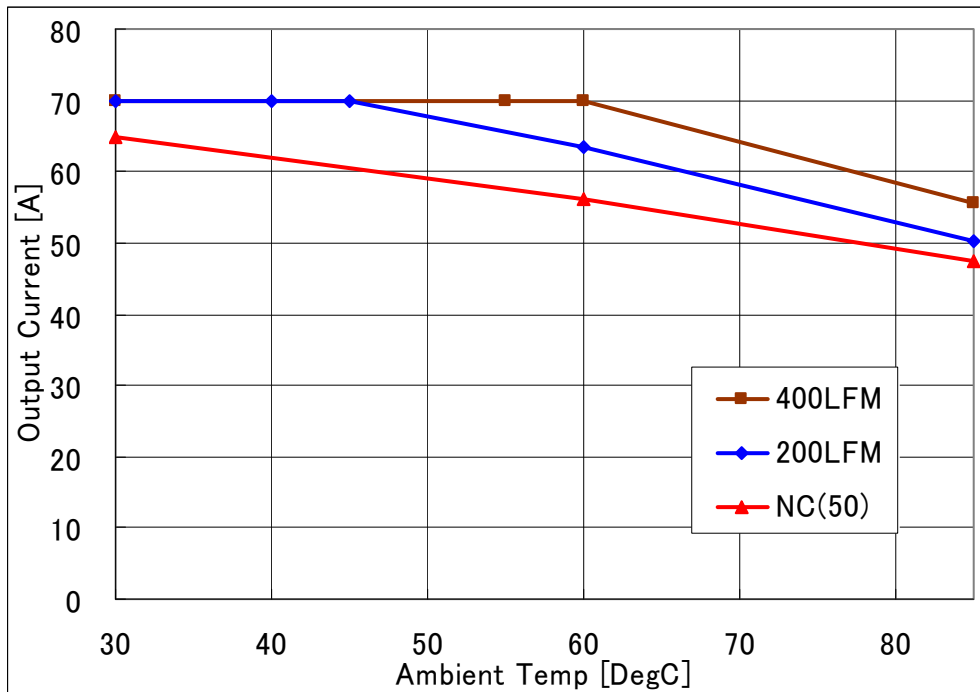


Fig-0.8V-1: Available load current vs. ambient temperature and airflow rates for Vout=0.8V with Vin=12V. Maximum component temperature $\leq 120^{\circ}\text{C}$

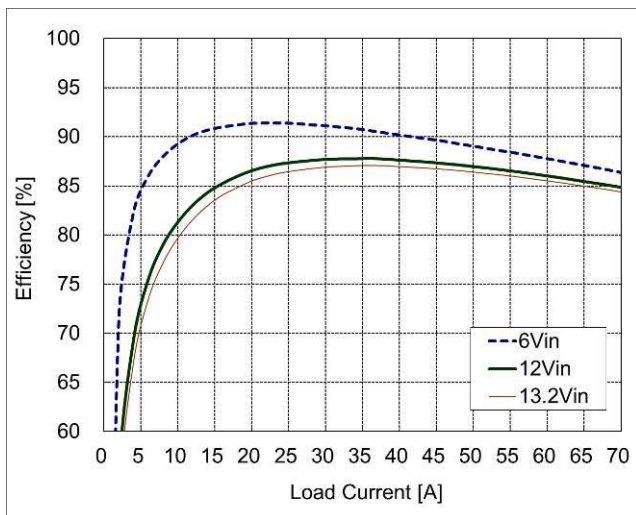


Fig-0.8V-2: Efficiency vs. load current and input voltage for Vout=0.8V. Airflow rate=200 LFM (1m/s) and Ta=25°C.

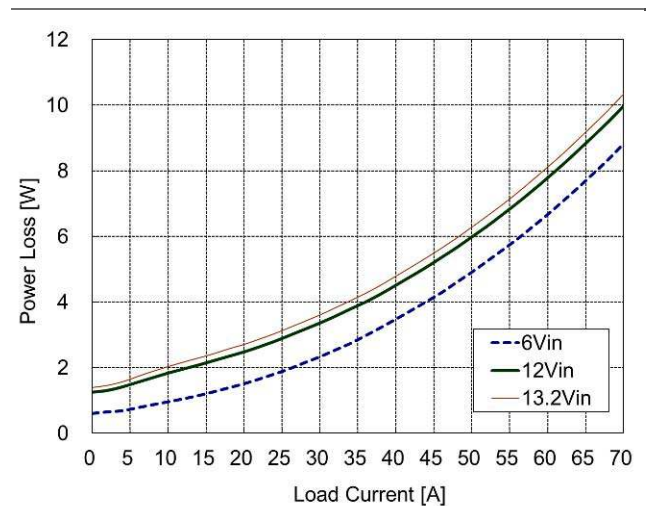


Fig-0.8V-3: Power Loss vs. load current and input voltage for Vout=0.8V. Airflow rate=200 LFM (1m/s) and Ta=25°C.

FPFR12SR6570NA

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

Preliminary Datasheet

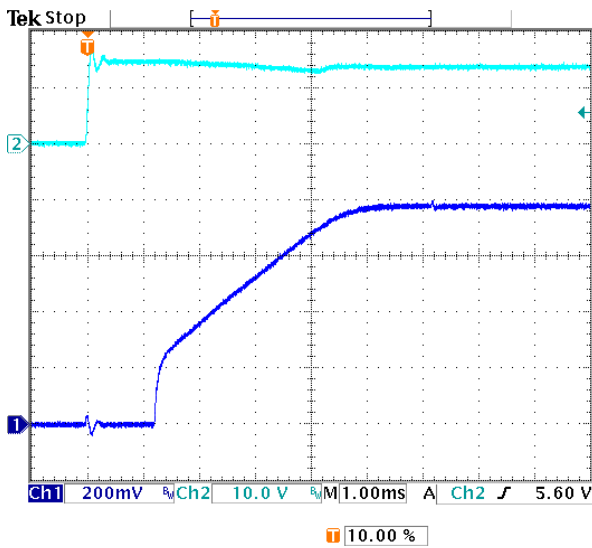


Fig-0.8V-4: Turn-on transient for $V_{out}=0.8V$ with application of V_{in} at full rated load current (resistive) and $920\mu F$ external capacitance at $V_{in}=12V$.
 Top trace: V_{in} (10V/div.)
 Bottom trace: output voltage (200mV/div.)
 Time scale: 1 ms/div.

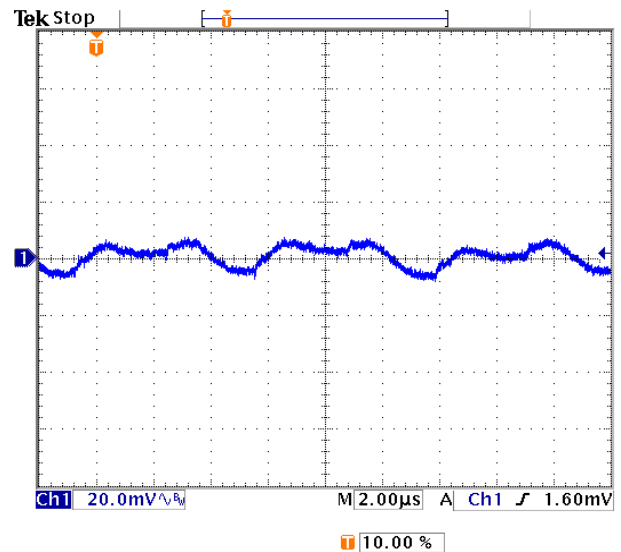


Fig-0.8V-5: Output voltage ripple (20mV/div.) for $V_{out}=0.8V$ at full rated load current into a resistive load with external capacitance $920\mu F$ at $V_{in}=12V$.
 Time scale: 2 us/div

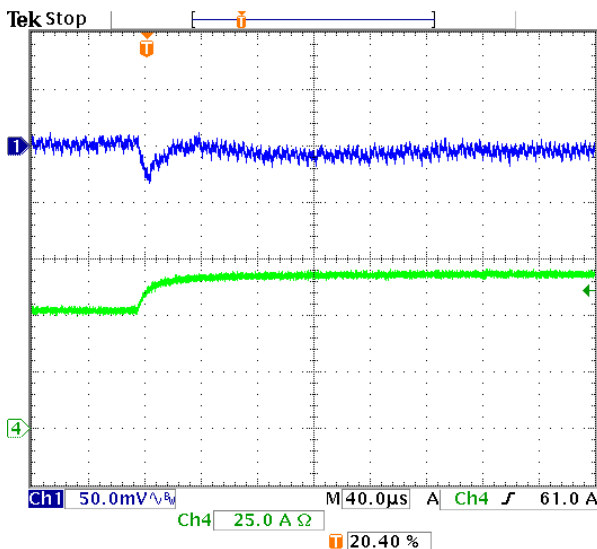


Fig-0.8V-6: Output voltage response for $V_{out}=0.8V$ to positive load current step change from 52.5A to 70A with slew rate of $3A/\mu s$ at $V_{in}=12V$. $C_o=920\mu F$.
 Top trace: output voltage (50mV/div.)
 Bottom trace: load current (25A/div.)
 Time scale: 40us/div.

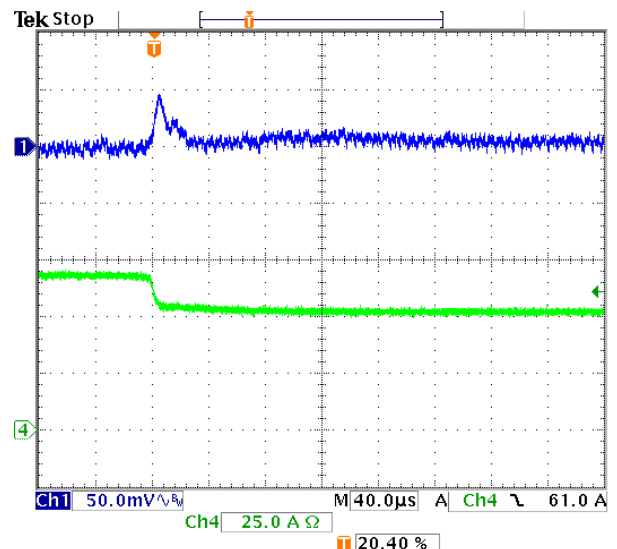


Fig-0.8V-7: Output voltage response for $V_{out}=0.8V$ to negative load current step change from 70A to 52.5A with slew rate of $-3A/\mu s$ at $V_{in}=12V$. $C_o=920\mu F$.
 Top trace: output voltage (50mV/div.)
 Bottom trace: load current (25A/div.)
 Time scale: 40us/div.

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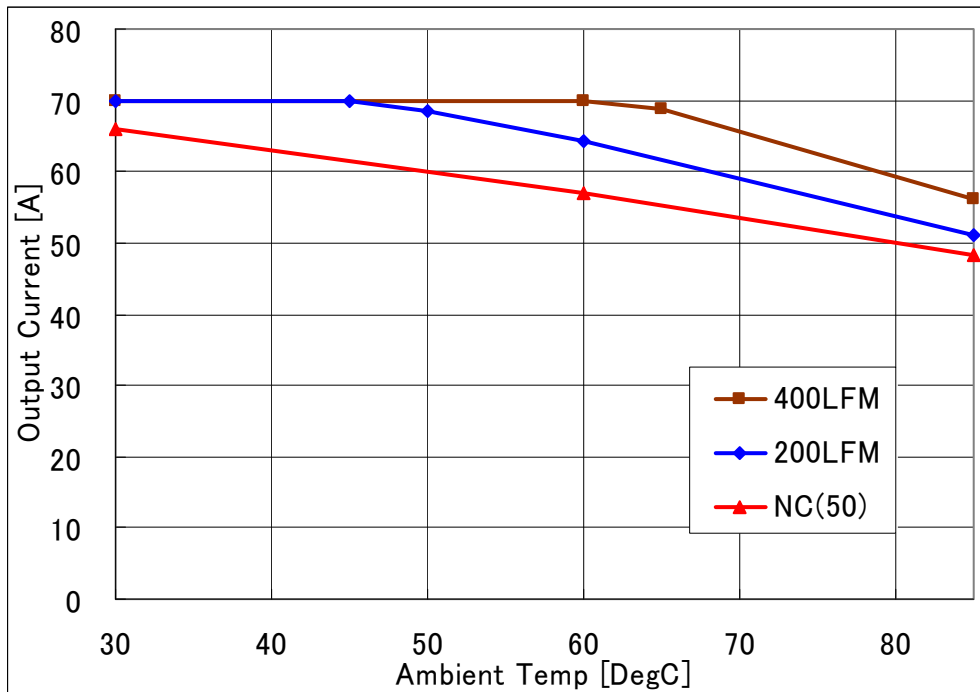


Fig-0.65V-1: Available load current vs. ambient temperature and airflow rates for Vout=0.65V with Vin=12V. Maximum component temperature ≤ 120°C

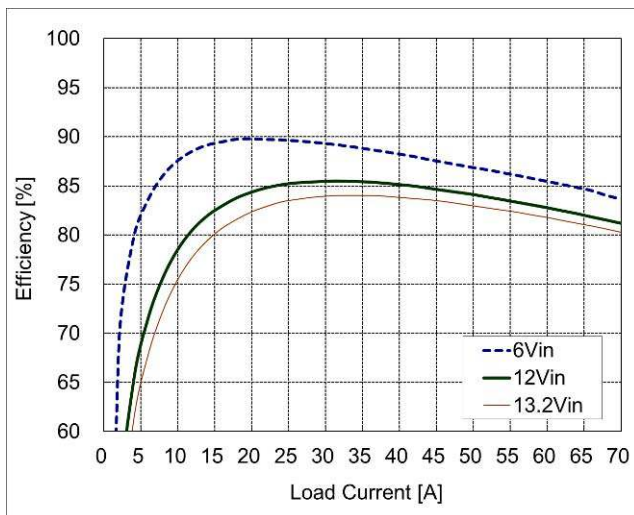


Fig-0.65V-2: Efficiency vs. load current and input voltage for Vout=0.65V. Airflow rate=200 LFM (1m/s) and Ta=25°C.

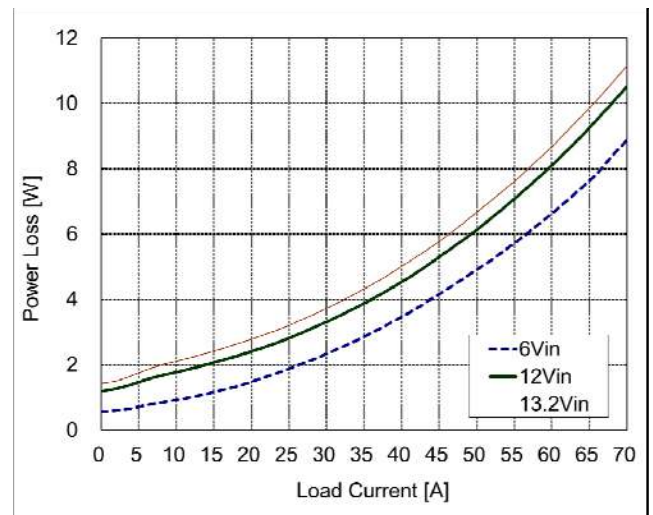


Fig-0.65V-3: Power Loss vs. load current and input voltage for Vout=0.65V. Airflow rate=200 LFM (1m/s) and Ta=25°C.

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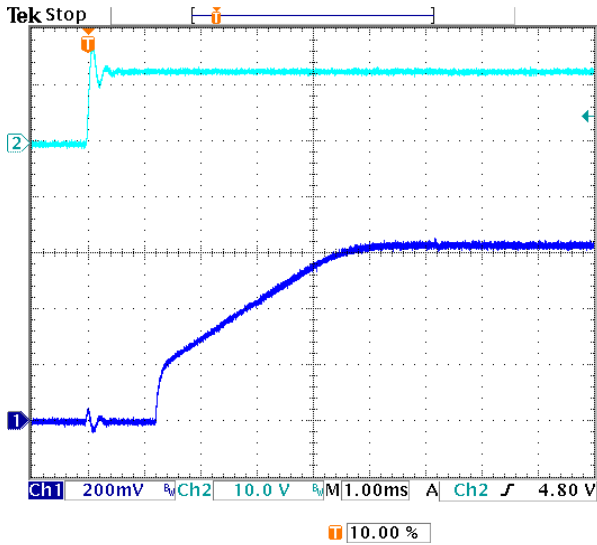


Fig-0.65V-4: Turn-on transient for $V_{out}=0.65V$ with application of V_{in} at full rated load current (resistive) and 920uF external capacitance at $V_{in}=12V$.
 Top trace: V_{in} (10V/div.)
 Bottom trace: output voltage (200mV/div.)
 Time scale: 1 ms/div.

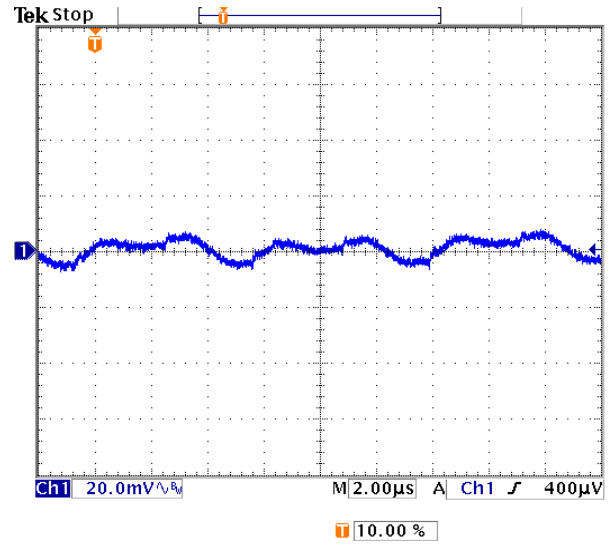


Fig-0.65V-5: Output voltage ripple (20mV/div.) for $V_{out}=0.65V$ at full rated load current into a resistive load with external capacitance 920uF at $V_{in}=12V$.
 Time scale: 2 us/div

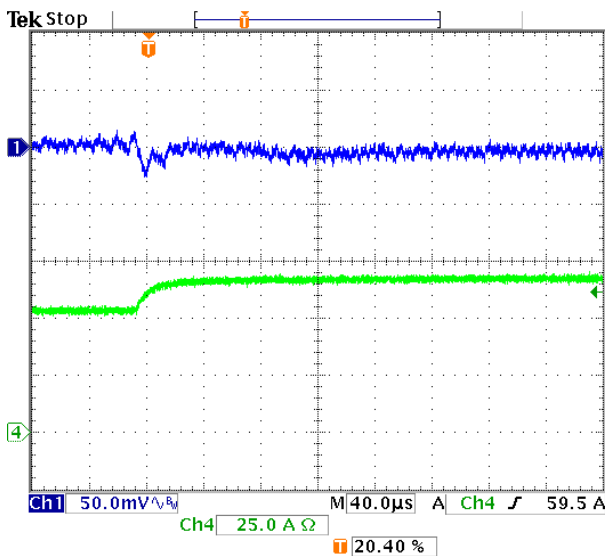


Fig-0.65V-6: Output voltage response for $V_{out}=0.65V$ to positive load current step change from 52.5A to 70A with slew rate of 3A/us at $V_{in}=12V$. $C_o=920uF$.
 Top trace: output voltage (50mV/div.)
 Bottom trace: load current (25A/div.)
 Time scale: 40us/div.

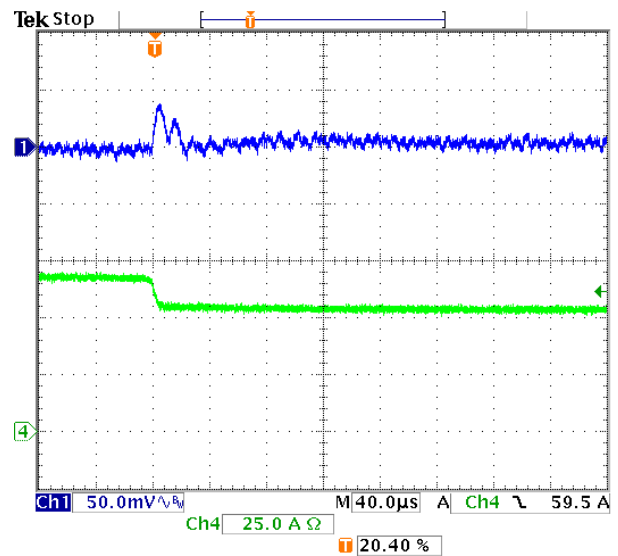


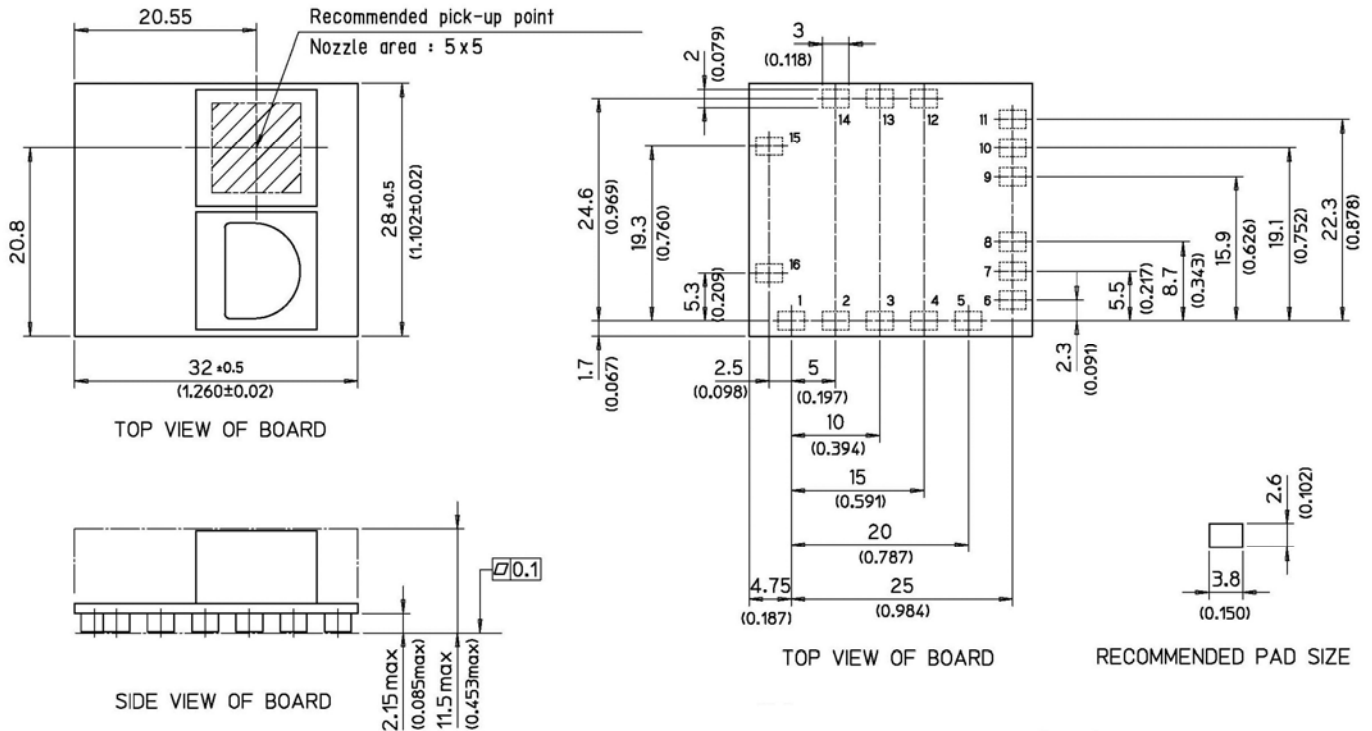
Fig-0.65V-7: Output voltage response for $V_{out}=0.65V$ to negative load current step change from 70A to 52.5A with slew rate of -3A/us at $V_{in}=12V$. $C_o=920uF$.
 Top trace: output voltage (50mV/div.)
 Bottom trace: load current (25A/div.)
 Time scale: 40us/div.

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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	Vsense(+)
5	NC *1	13	Vsense(-)
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

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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.

パターン設計: 製品下面へのパ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シールドパターン以外のパターンは禁止してください。

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HIGH RELIABILITY AND LONG LIFE APPLICATIONS: If FDK Corporation products are used in high reliability or long 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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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°C以下	30°C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レーティングはレベル3です (IPC/JEDEC J-STD-033)