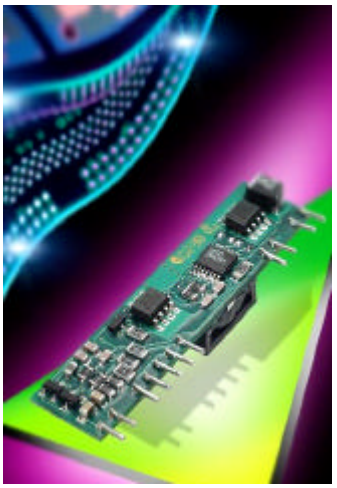
PL10S-05 Non Isolated DC/DC Converters
Long Form Datasheet

Features



- Synchronous Rectification
- Non-Isolated
- Fixed Frequency
- Nominal Input Voltage Range from (3-5V)
- Output Voltage Adjustable with the Trim Function (0.9 to 3.3V)
- Current Limit and Short-Circuit Protection using Hiccup Mode and Auto-Restart
- Over Temperature Protection
- Up to 95% efficiency at 3.3V output
- Input Logic Shutdown
- Positive and Negative Remote Sense Pins (optional)
- Wide Operation Temperature Range –40°C to 85°C
- UL/BSI EN60950 approved

Description

Lambda's 5V SIP power modules are non-isolated dc-dc converters that can deliver up to 10A of output current with full load efficiency of 95% at 3.3V output.
Lambda's PL10 Series offers designers the choice of models with either customer selectable output voltages or factory set output voltage.
With the customer selectable model the output is set by a fixed value resistance (see section 1.51, 1.52, 1.53) This model is identified with a suffix C on the part number description, as donated in the nomenclature and its output voltage is set to 0.9V (see page 26).
The factory set voltage model requires identification on the part number description, eg. PL10S-05-3V3-K (see page 26).
For the purpose of this Application Note, values of 0.9V, 1.5V, 2.5V and 3.3V have been used to illustrate the parameters and the characteristics at these voltages.
For details of other output voltage parameters please contact Lambda UK.

Applications

- Distributed power architectures
- Communication equipment
- Computer equipment
- Workstations and Servers
- Latest generation IC'S (DSP, FPGA, ASIC) and Microprocessor powered applications

Input / Output Selection table

Input Voltage	Output Voltage	Max. Output current	Max. Output Power	Min Efficiency 3.3V I/P@10A O/P	Min Efficiency 5V I/P@10A O/P	Typical Efficiency 5V I/P@10A
3-5.5Vdc	0.9V	10A	9W	78%	81%	83%
3-5.5Vdc	1.2V	10A	12W	82%	44%	86%
3-5.5Vdc	1.5V	10A	15W	85.5%	87%	89%
3-5.5Vdc	1.8V	10A	18W	87%	88%	90%
3.3-5.5Vdc	2.5V	10A	25W	90%	91%	93%
4.5-5.5Vdc	3.3V	10A	33W		93%	95%

Note: All the measurements are taken at +25°C ambient temperature

Absolute Maximum Ratings

Parameter	Symbol	Min	Typical	Max	Unit
Input Voltage (Continuous)	Vin	3	5	5.5	V
ON/OFF Terminal Voltage	Von/off	0		5.5	V
Operating Ambient Temperature	Tamb	-40		85	°C
Storage Temperature	Tstor	-65		150	°C

Note: Use beyond the maximum ratings may cause a reliability degradation of the DC/DC converter or may permanently damage the device.

General Specifications

Parameter	Symbol	Min	Typical	Max	Units
Efficiency at full output power			See the table above		%
Switching Frequency	Fosc		300		KHZ
Output Voltage Trim Range (See section 1.5)		0.9		3.3	V
Calculated MTBF Calculated using Bellcore (V3.1-BELL4 or V3.1-BELL3) ,Ta= 25°C, full power.			6		Mhours
Remote Sense Compensation				200	mV
Turn On Voltage Threshold		2.63	2.8	2.95	V
Turn Off voltage Threshold		2.47	2.7	2.9	V
Duty Cycle Ratio	D			75	%
Weight			7		g

Note: All the measurements are taken at +25°C ambient temperature

1.1) Vo=0.9V

Input Specifications
Vo= 0.9V

Parameter	Symbol	Min	Typical	Max	Units
Operating Input Voltage	Vin	3	5	5.5	V
Input Current			3.7		A
No Load Input Current			51		mA
Remote Off Input Current			5.5		mA
Input Reflected Ripple Current			0.26		m A_{rms}
Input Reflected Ripple Current (P-P)			0.92		mApk
Inrush Current Transient			0.0375		A^2 s

Note: All the measurements are taken at +25°C ambient temperature

Output Specifications
Vo=0.9V

Parameter	Module	Symbol	Min	Typical	Max	Units
Output Voltage Adjustments		Vout	0.9		3.3	V
Load Regulation				10		mV
Line Regulation				1.7		mV
Output Ripple and Noise (20MHZ BW)				20	45	mVp-p
Output Current Range		Iout	0		10	A
Output DC Current Limit		Ilim	11		20	A
Rise up time				2.52		ms
Overshoot at Turn On				0		%
Output Capacitance					3300	uF

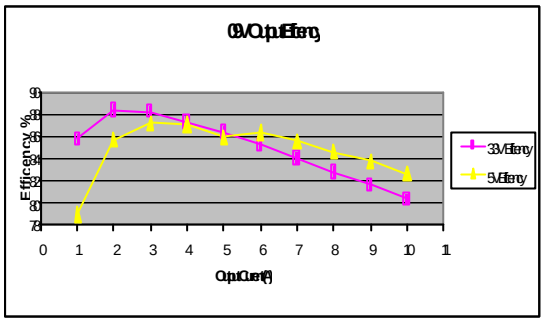
Note: All the measurements are taken at +25°C ambient temperature

Transient Response
Vo= 0.9V

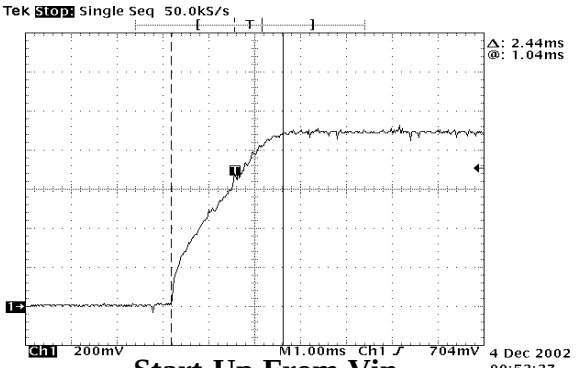
Parameter	Symbol	Min	Typical	Max	Units
Peak deviation for 50% to 100% step load, di/dt = 100mA/us					
Vin = 5V	Vdynamic		65		mV
Vin= 3.3V	Vdynamic		86		mV
Settling Time to within 1% of output set point					
Vin = 5V	Ts		40		us
Vin= 3.3V	Ts		44		us
Peak deviation for 100% to 50% step load, di/dt = 100mA/us					
Vin = 5V	Vdynamic		90		mV
Vin= 3.3V	Vdynamic		76		mV
Settling Time to within 1% of output set point					
Vin = 5V	Ts		80		us
Vin= 3.3V	Ts		44		us

Note: All the measurements are taken at +25°C ambient temperature

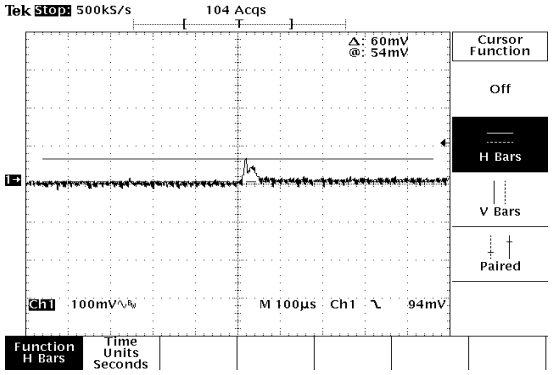
CHARACTERISTIC CURVES-0.9V Model



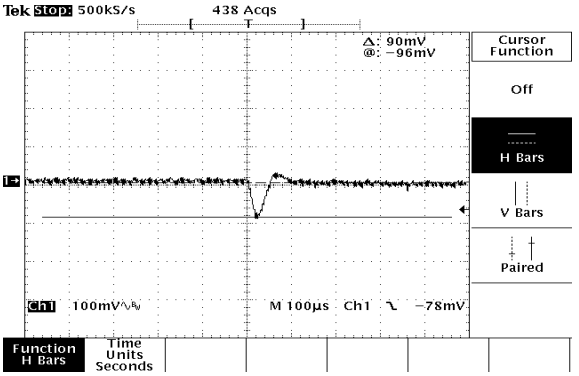
Efficiency Curve



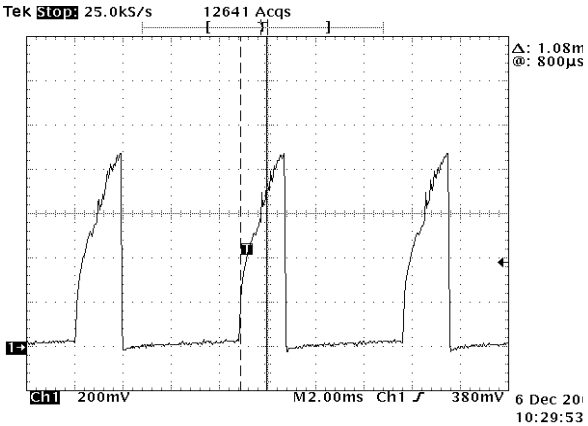
Start-Up From Vin
(Vin=5V, Vo=0.9V, Io=10A)



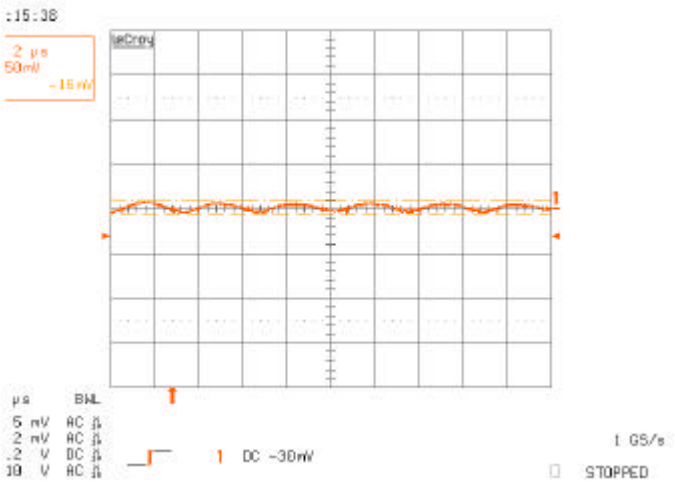
Transient Response
(Vin = 5V, Vo=0.9V 50% to 100% Load Step)



Transient Response
(Vin = 5V, Vo=0.9V 100% to 50% Load Step)



Short Circuit
(Vin = 5V, Vo Short)



Output ripple
(Vin=5v, Io=10A)

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Fax: +44 (0) 1271 864894

1.2) Vo=1.5V

Input Specifications
Vo= 1.5V

Parameter	Symbol	Min	Typical	Max	Units
Operating Input Voltage	Vin	3	5	5.5	V
Input Current			5.8		A
No Load Input Current			67		mA
Remote Off Input Current			5.5		mA
Input Reflected Ripple Current			2.04		m A_{rms}
Input Reflected Ripple Current (P-P)			7		mApk
Inrush Current Transient			0.0375		A^2 s

Note: All the measurements are taken at +25°C ambient temperature

Output Specifications
Vo=1.5V

Parameter	Module	Symbol	Min	Typical	Max	Units
Output Voltage adjustment		Vout	0.9		3.3	V
Load Regulation				5		mV
Line Regulation				4		mV
Output Ripple and Noise (20MHZ BW)				30	45	mVp-p
Output Current Range		Iout	0		10	A
Output DC Current Limit		Ilim	11		20	A
Turn on Time				2.28		ms
Overshoot at Turn On				0		%
Output Capacitance					3300	uF

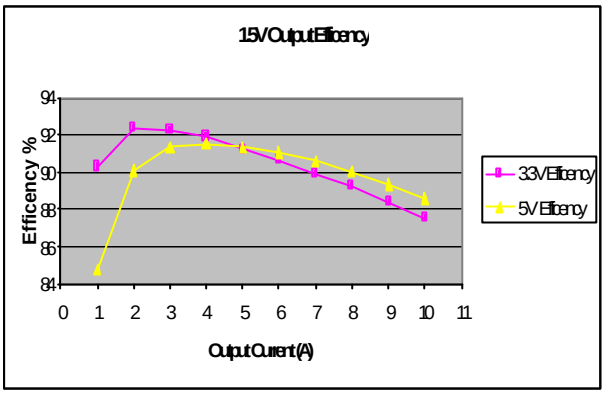
Note: All the measurements are taken at +25°C ambient temperature

Transient Response
Vo=1.5V

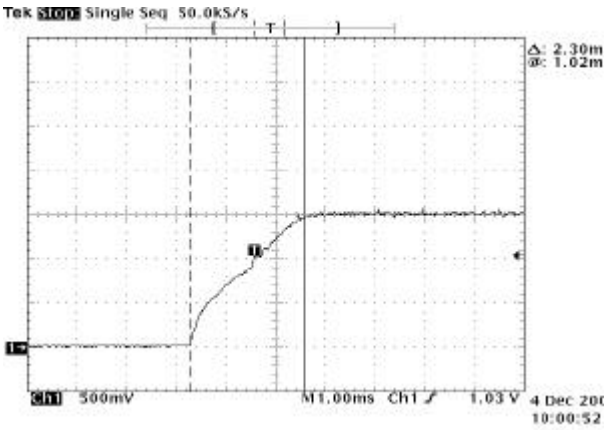
Parameter	Symbol	Min	Typical	Max	Units
Peak deviation for 50% to 100% step load, di/dt = 100mA/us					
Vin = 5V	Vdynamic		45		mV
Vin= 3.3V	Vdynamic		98		mV
Settling Time to within 1% of output set point					
Vin = 5V	Ts		35		us
Vin= 3.3V	Ts		85		us
Peak deviation for 100% to 50% step load, di/dt = 100mA/us					
Vin = 5V	Vdynamic		72		mV
Vin= 3.3V	Vdynamic		88		mV
Settling Time to within 1% of output set point					
Vin = 5V	Ts		45		us
Vin= 3.3V	Ts		50		us

Note: All the measurements are taken at +25°C ambient temperature

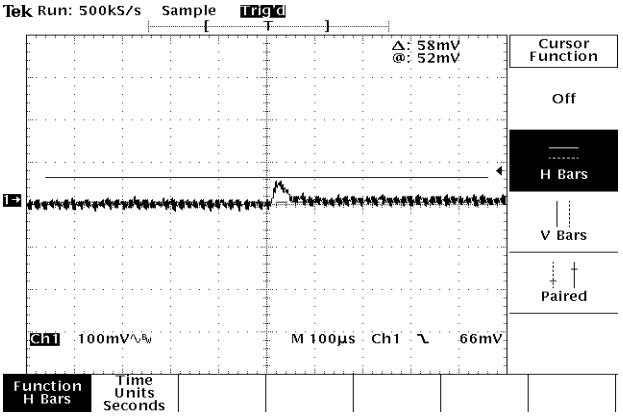
CHARACTERISTIC CURVES-1.5V Model



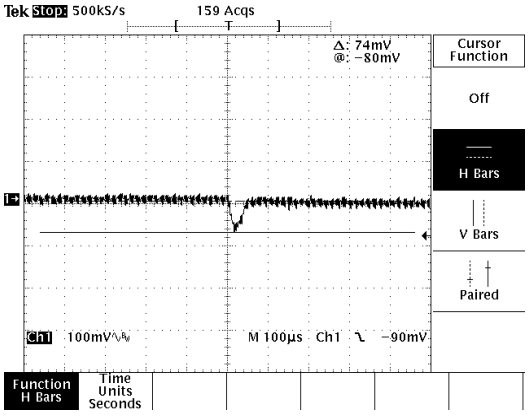
Efficiency Curve



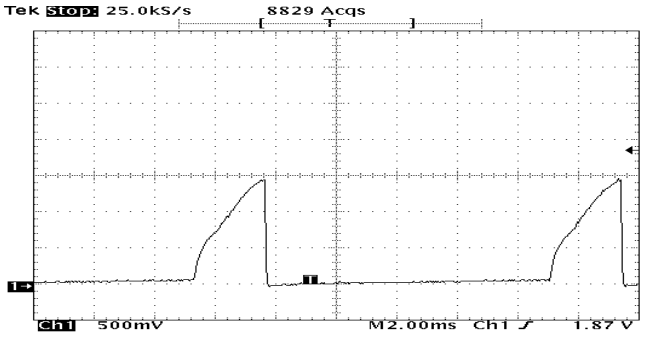
Start Up-From Vin
(Vin=5V, Io = 10A)



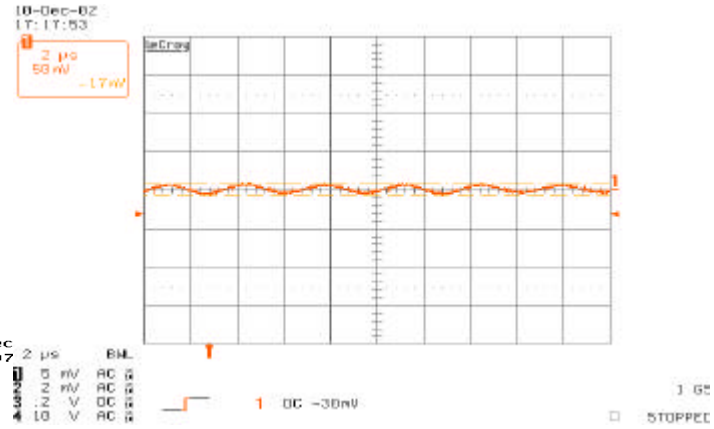
Transient Response
(Vin = 5V, Vo=1.5V 50% to 100% Load Step)



Transient Response
(Vin = 5V, Vo=1.5V 100% to 50% Load Step)



Short Circuit
(Vin = 5V, Vo Short)



Output Ripple
(Vin=5V, Io=10A)

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Fax: +44 (0) 1271 864894

1.3) Vo=2.5V

Input Specifications
Vo= 2.5V

Parameter	Symbol	Min	Typical	Max	Units
Operating Input Voltage	Vin	3.3	5	5.5	V
Input Current			9.1		A
No Load Input Current			79		mA
Remote Off Input Current			5.5		mA
Input Reflected Ripple Current			2.53		m A_{rms}
Input Reflected Ripple Current (P-P)			8		mApk
Inrush Current Transient			0.0375		A^2 s

Note: All the measurements are taken at +25°C ambient temperature

Output Specifications
Vo=2.5V

Parameter	Module	Symbol	Min	Typical	Max	Units
Output Voltage adjustment		Vout	0.9		3.3	V
Load Regulation				10		mV
Line Regulation				5.7		mV
Output Ripple and Noise (20MHZ BW)				32	45	mVp-p
Output Current Range		Iout	0		10	A
Output DC Current Limit		Ilim	11		20	A
Rise up Time				2.56		ms
Overshoot at Turn On				0		%
Output Capacitance				3300		uF

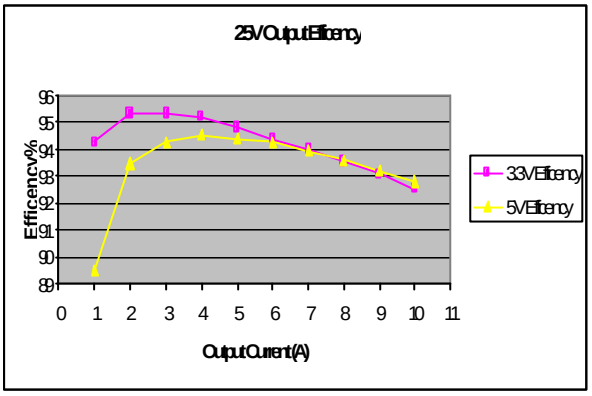
Note: All the measurements are taken at +25°C ambient temperature

Transient response
Vo= 2.5

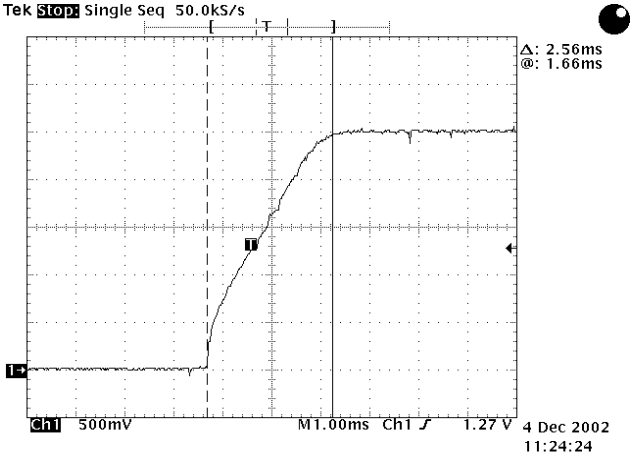
Parameter	Symbol	Min	Typical	Max	Units
Peak deviation for 50% to 100% step load, di/dt = 100mA/us					
Vin = 5V	Vdynamic		75		mV
Vin= 3.3V	Vdynamic		130		mV
Settling Time to within 1% of output set point					
Vin = 5V	Ts		60		us
Vin= 3.3V	Ts		105		us
Peak deviation for 100% to 50% step load, di/dt = 100mA/us					
Vin = 5V	Vdynamic		66		mV
Vin= 3.3V	Vdynamic		104		mV
Settling Time to within 1% of output set point					
Vin = 5V	Ts		60		us
Vin= 3.3V	Ts		72		us

Note: All the measurements are taken at +25°C ambient temperature

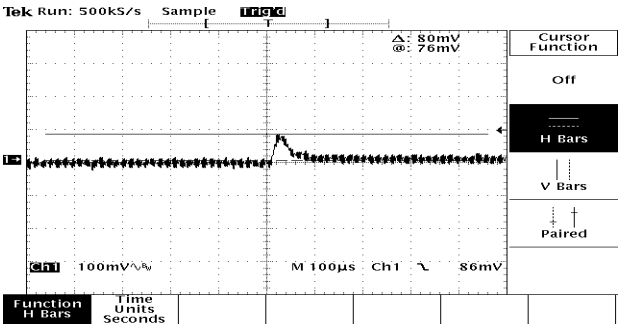
CHARACTERISTIC CURVES-2.5V Model



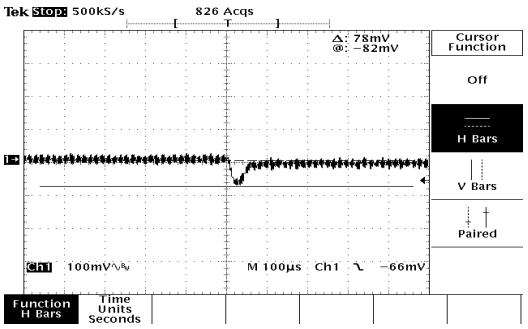
Efficiency Curve



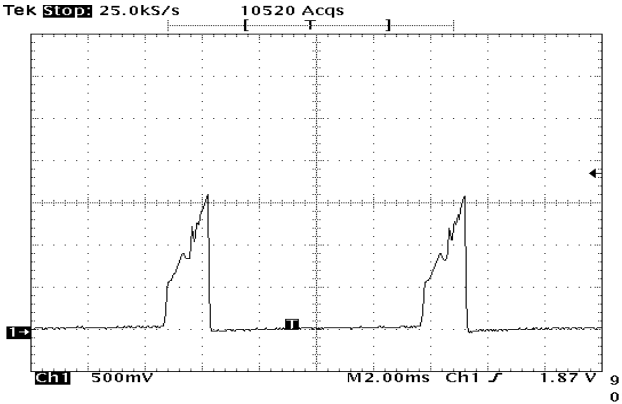
Start up from Vin
(Vin = 5V , Io = 10A)



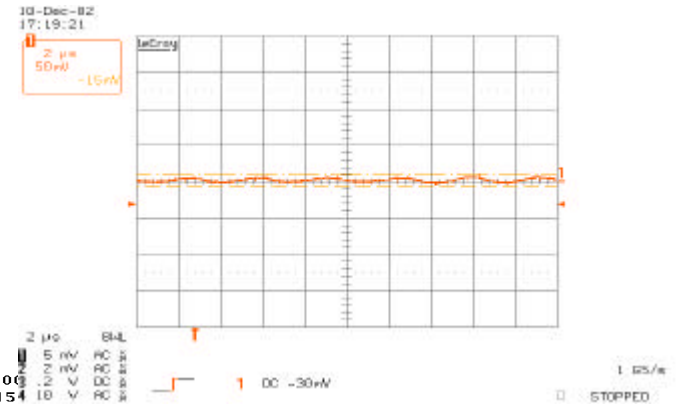
Transient Response
(Vin = 5V, Vo=2.5V 50% to 100% Load Step)



Transient Response
(Vin = 5V, Vo=2.5V 100% to50% Load Step)



Short Circuit
(Vin = 5V, Vo Short)



Output ripple
(Vin=5V, Io=10A)

1.4) Vo=3.3V

Input Specifications
Vo= 3.3V

Parameter	Symbol	Min	Typical	Max	Units
Operating Input Voltage	Vin	4.5	5	5.5	V
Input Current			7.7		A
No Load Input Current			73		mA
Remote Off Input Current			5.5		mA
Input Reflected Ripple Current			0.227		m A_{rms}
Input Reflected Ripple Current (P-P)			1		mApk
Inrush Current Transient			0.0375		A^2 s

Note: All the measurements are taken at +25°C ambient temperature

Output Specifications
Vo=3.3

Parameter	Module	Symbol	Min	Typical	Max	Units
Output Voltage Set Point		Vout	0.9		3.3	V
Load Regulation				10		mV
Line Regulation				10		mV
Output Ripple and Noise (20MHZ BW)				35	45	mVp-p
Output Current Range		Iout	0		10	A
Output DC Current Limit		Ilim	11		20	A
Rise up Time				2.66		ms
Overshoot at Turn On				0		%
Output Capacitance					3300	uF

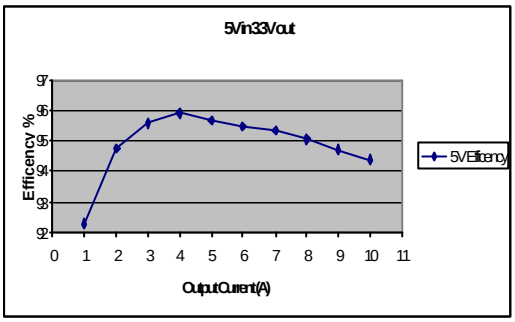
Note: All the measurements are taken at +25°C ambient temperature

Transient response
Vo= 3.3V

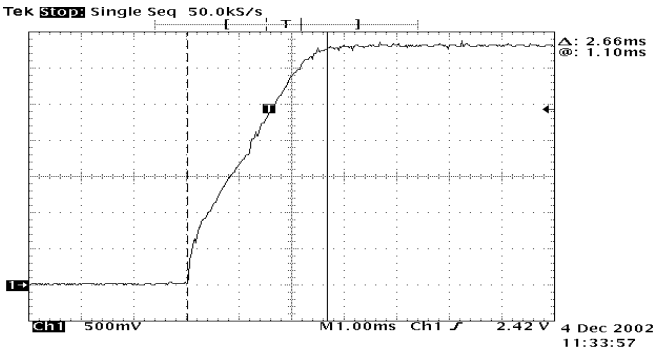
Parameter	Symbol	Min	Typical	Max	Units
Peak deviation for 50% to 100% step load, di/dt = 100mA/us. Vin = 5V	Vdynamic		100		mV
Settling Time to within 1% of output set point Vin = 5V	Ts		75		us
Peak deviation for 100% to 50% step load, di/dt = 100mA/us. Vin = 5V	Vdynamic		92		mV
Settling Time to within 1% of output set point Vin = 5V	Ts		60		us

Note: All the measurements are taken at +25°C ambient temperature

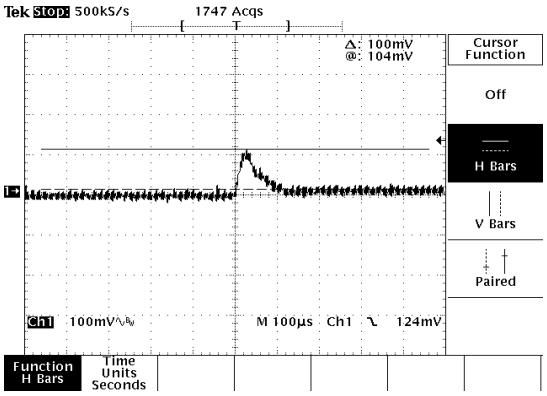
CHARACTERISTIC CURVES-3.3V Model



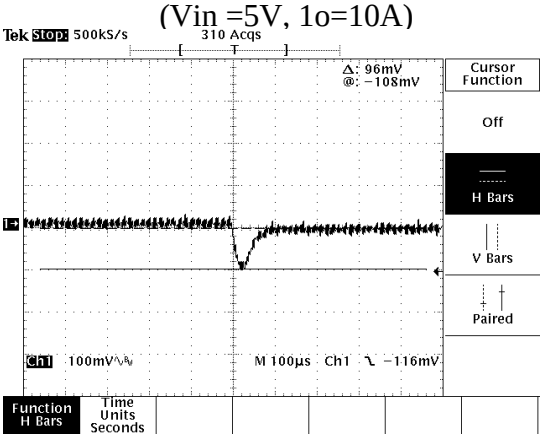
Efficiency Curve



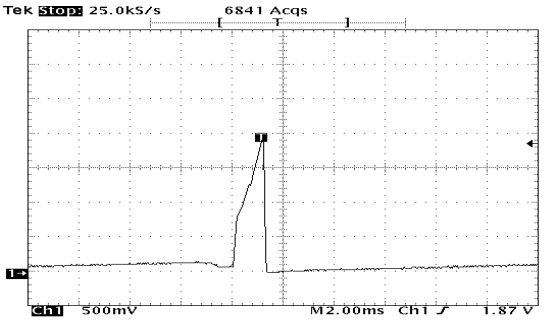
Start up from Vin
(Vin =5V, 1o=10A)



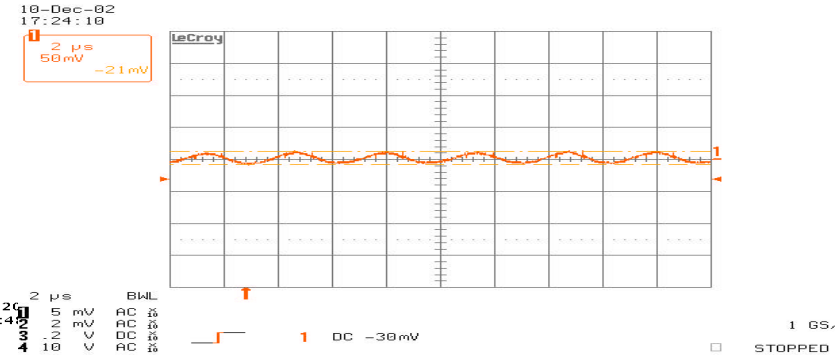
Transient Response
(Vin = 5V, Vo=3.3V 50% to 100% Load Step)



Transient Response
(Vin = 5V, Vo=3.3V 50% to 100% Load Step)



Short circut
(Vin 5V, Vo Short)



Output ripple
(Vin=5v, Io=10A)

1.5) Output voltage trim function

1.51) PL10S-05V-*-T (For 9 Pin Model)

To set up the output voltage, connect an external resistor Rtrim between the trim pin (8) and the Ground pin (4), as shown in the diagram below.

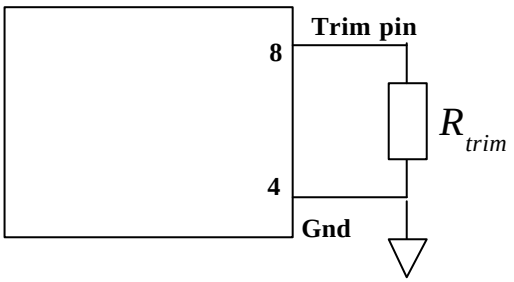


Diagram: shows the trim resistor Rtrim connected between trim pin and the ground pin.

The value of R_{trim} could be calculated by using equation 1.51.

$$R_{trim} = \frac{64x10^4}{(80xV_O) - 72} \qquad (1.51)$$

Eg: V_O=1.5V

$$R_{trim} = \frac{64x10^4}{(80x1.5\ ) - 72} = 13.3K\Omega$$

In the table below the value of R_{trim} is calculated for some output voltages.

Vo (V)	1	1.2	1.5	2.5	3.3
Rt (KΩ)	80KΩ	26.6KΩ	13.3KΩ	5KΩ	3.3K

1.52) Output voltage trim (PL10S-05-*-TR) For 11 Pin Model

To set the output voltage, connect an external resistor Rtrim between the trim pin (10) and the –ve sense pin (pin 6), as shown in the diagram below.

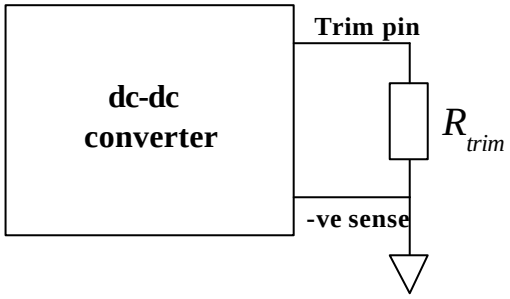


Diagram: shows the trim resistor connected between trim pin and the –ve sense pin.

The value of R_{trim} could be calculated by using equation 1.52.

$$R_{trim} = \frac{64x10^4}{(80xV_O) - 72.008} \qquad (1.52)$$

Eg: V_O=1.5V

$$R_{trim} = \frac{64x10^4}{(80x1.5\ ) - 72.008} = 13.336K\Omega$$

In the table below the value of R_{trim} is calculated for some output voltages.

Vo (V)	1	1.2	1.5	2.5	3.3
Rt (KΩ)	80KΩ	26.6KΩ	13.3KΩ	5KΩ	3.3K

Note: Don't leave the negative remote sense pin floating. If not used, connect it to the ground at the load.

1.53) Output voltage Trim (PL10S-05V-*-TP) For 10 Pin Model

To set up the output voltage, connect an external Resistor Rtrim between the trim pin (pin 9) and the Ground pin (pin 5), as shown in the diagram.

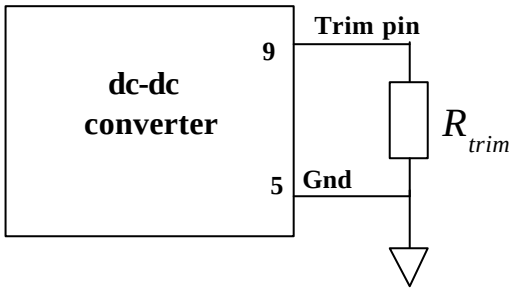


Diagram: shows the trim resistor Rtrim connected between trim pin and the ground pin.

The value of R_{trim} could be calculated by using equation 1.53

.

$$R_{trim} = \frac{64x10^4}{(80xV_O) - 72.008} \qquad (1.53)$$

Eg: V_O=1.5V

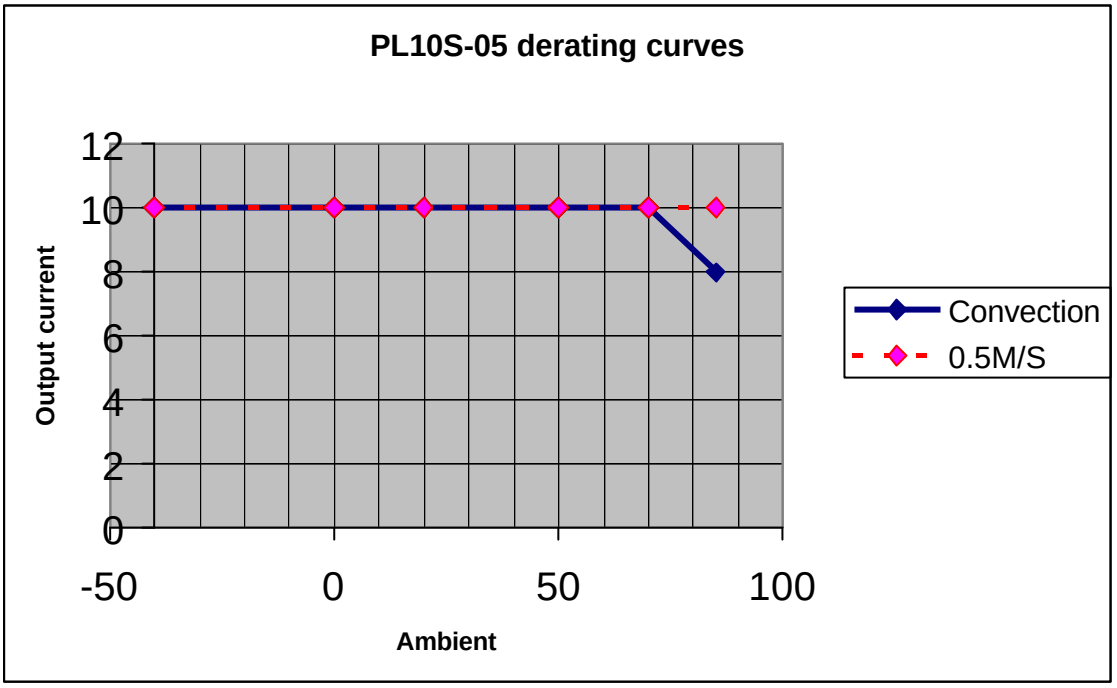
$$R_{trim} = \frac{64x10^4}{(80x1.5\ ) - 72.008} = 13.336K\Omega$$

In the table below the value of R_{trim} is calculated for some output voltages.

Vo (V)	1	1.2	1.5	2.5	3.3
Rt (KΩ)	80KΩ	26.6KΩ	13.3KΩ	5KΩ	3.3K

1.6) Derating Curve

The graph below represents the derating curve for PL10S-05-*-* at all the input and output combinations.



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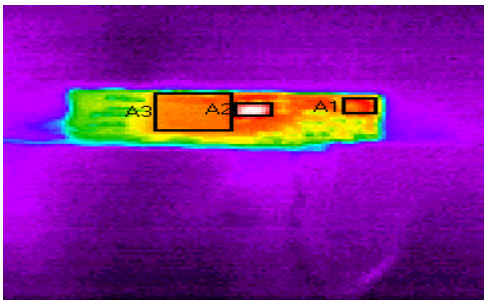
1.61) Thermal Images

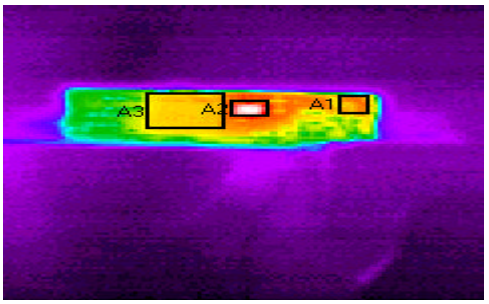
The thermal images below show the PL10S-05 when it is delivering 10A at different input and output voltages. The purpose of such images is to highlight the hottest components on the board.
A1 represents the top side Switch area, **A2** represents the low side Switch area and **A3** Represents the Inductor area.
A1 temperature should not exceed 120°C.
A2 temperature should not exceed 120°C.
A3 temperature should not exceed 115°C.

5V input 0.9V output 10A Load
Ambient = 23.2° C



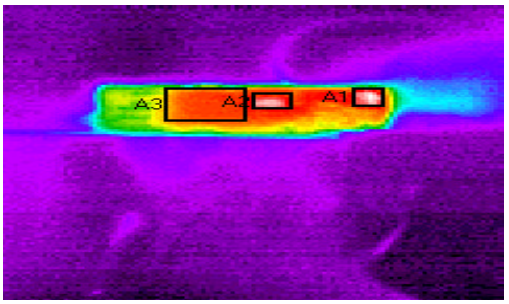
	Min	Max	Average
A1=	44.2	52.6	49.7
A2=	50.6	57.4	54.7
A3=	47	51.8	49.1

3V input 0.9V output 10A load
Ambient =24.3° C



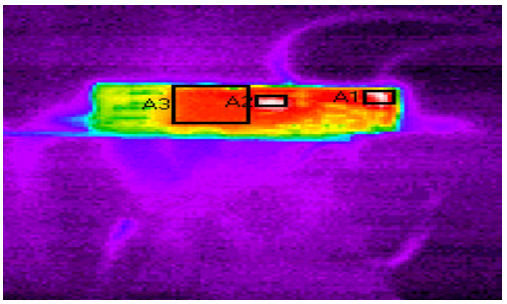
	Min	Max	Average
A1=	52.6	60.6	57.6
A2=	60.9	71.5	66.3
A3=	52.7	59.1	55.8

4.5V input 3.3V output 10A load
Ambient = 24.7° C



	Min	Max	Average
A1=	38.6	45.8	42.6
A2=	39.5	44.9	42.4
A3=	34.3	41.4	39.1

5.5V input 3.3V output 10A load
Ambient = 24.5° C



	Min	Max	Average
A1=	37.4	45.9	42.6
A2=	42	45.5	44.2
A3=	30.6	41.7	39.7

1.62) Thermal Considerations

The power module operates in a variety of thermal environments; however, sufficient cooling should be provided to help ensure reliable operation of the unit. Heat is removed by conduction, convention and radiation to the surrounding environment. Proper cooling can be verified by monitoring XQ3 and XQ4 and maintaining a maximum temperature of 120°C on these devices.
The output power of the module should not exceed the rated power for the module as listed in the electrical specifications. The thermal derating charts represent the unit in vertical or horizontal orientation.

1.7) Fusing Considerations

CAUTION: This power module is not internally fused. An input line fuse must always be used. Type: Time-delay, high breaking capacity (HBC), ceramic, 250V minimum, 20A maximum rating. (20A is the maximum current rating, the same type of fuse with a lower current rating may be used but testing in application is recommended to ensure no nuisance blowing results)

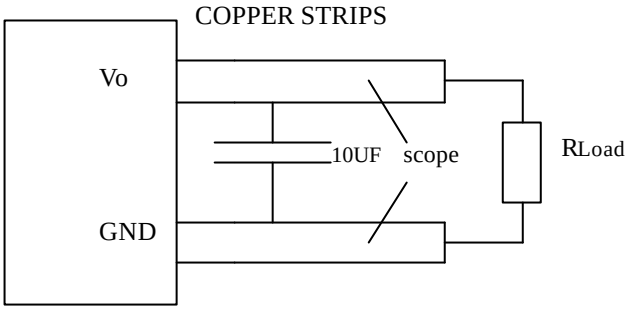
1.8) Design Considerations

1.81) Input Source Impedance

The power module should be connected to a low ac-impedance input source. Highly inductive source impedance's can affect the stability of the power module. It is recommended to fit 100µF capacitor mounted close to the power module input. Its also recommended to use short and thick input and output leads or tracks to eliminate the occurrence of triggering the under voltage lockout at turn on and turn off, when switching from Vin. Otherwise its recommended to switch the unit on and off from the ON/OFF pin.

1.82) Output Filtering

The PL10 meets the output voltage ripple and transient response specifications without the need for additional output capacitance. However additional output capacitance may be required to reduce the output ripple or to improve the transient response performance. Low ESR (3300UF max, 20mΩ ESR minimum) polymer capacitor is recommended to improve both the ripple and the transient response performance.



Output Ripple and noise Test Setup

1.9) Feature Descriptions

1.91) Current Limit

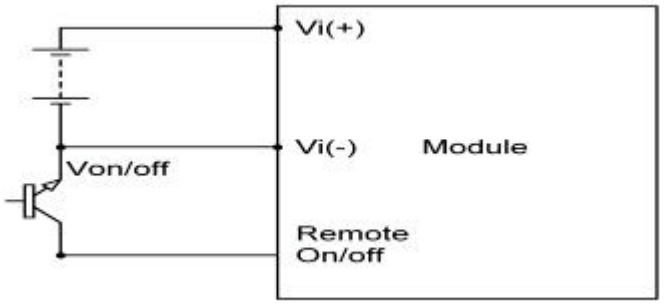
To provide protection in a fault (output overload) condition, the unit is equipped with internal current-limiting circuitry. At the point of current-limit inception, the unit goes into hiccup mode. The unit operates normally once the output current is brought back into its specified range.

1.92) Over Temperature Protection

If the temperature of the high side Fet exceeds 125°C the unit will go into Hiccup mode and the output voltage will fall. Reducing the output power until the Fet temperature drops below 125°C.

1.93) Remote On/Off

To turn the power module on and off, the user must supply a switch to control the voltage between the on/off terminal and the Vo(-) terminal. The switch may be an open collector or equivalent. A logic low is Von/off = 0 V to +0.4 V. The maximum Ion/off during logic low is 5.5mA. The switch should maintain a logic-low voltage while sinking 5.5mA.



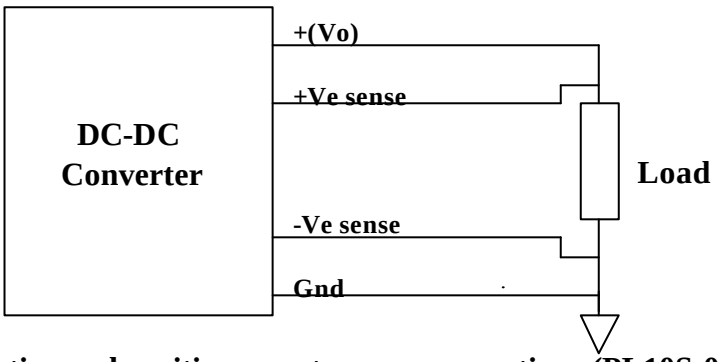
Remote on/off pin	Unit condition
Logic low	Unit off
Logic high or open circuit	Unit on

Function	PL10S-05-*-T	PL10S-05-*-TP	PL10S-05-*-TR
Vo(-)	Pin 4	Pin 5	Pin 4
ON/OFF	Pin 9	Pin 10	Pin 11

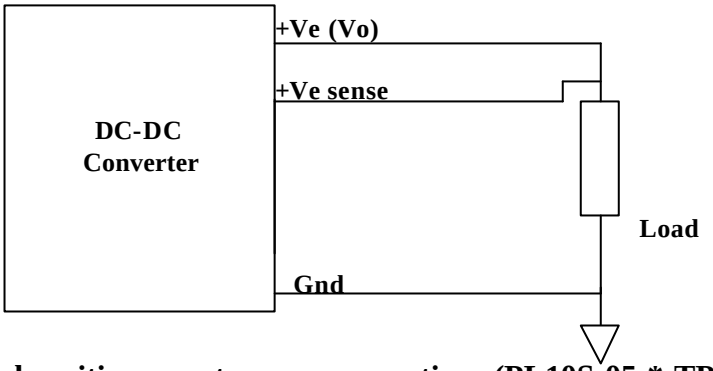
Remote On/Off Implementation

1.94) Remote Sense

The PL10S-05-*-TR series has a positive and negative remote sense pins option and the PL10S-05-*-TP has a positive sense pin only. The purpose of the remote sense option is to compensate for any IR drop in conductors and cabling. The remote sense connections don't require heavy cabling because of the little current they carry. Therefore, a minimal cross-sectional area conductor could be used. The remote sense pins are capable of compensating for voltage drops between the output and the sense pins that do not exceed 200mV. When using remote sense, attention should be paid to the duty cycle ratio. E.g. If the input voltage is 3.3V and the output voltage is set at 2.5V and the remote sense is set to compensate for 200mV, as a result the output voltage at the unit terminals will rise to 2.7V. Therefore, the minimum input voltage should be raised by 300mv (3.6V) to give a duty cycle ratio less than 75%.



Typical negative and positive remote sense connections (PL10S-05-*-TR)



Typical positive remote sense connections (PL10S-05-*-TP)

Therefore,

$$D = \frac{V_O}{V_{IN}}$$

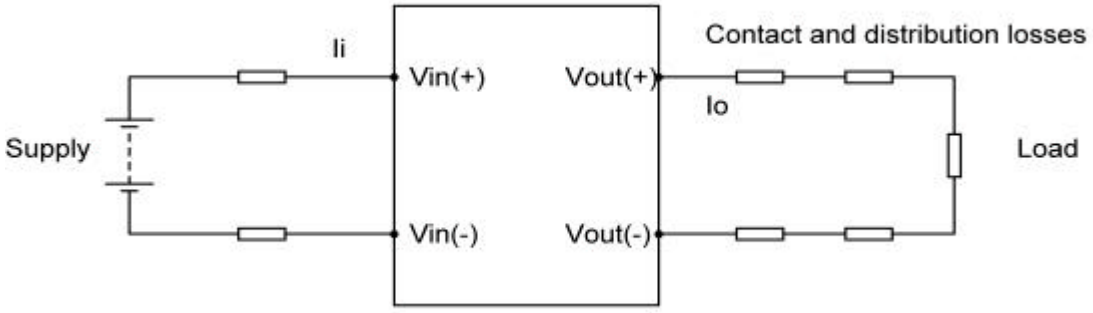
$$\frac{V_O\, pins}{V_{IN}} \leq 75\%$$

The output power of the unit should not exceed the specified power rating of the unit.
E.g. If the output voltage is set to provide 3.3V at the load and the load is drawing 10A and there is 0.2V drop in the connections between the unit terminals and the load. The output voltage at the unit terminals would rise to 3.5V. This would cause the output power to exceed the power rating of the unit. Therefore,

Vout at terminals x Iout ≤ Power Rating.

Note: Do not leave the negative remote sense pin floating. If not used, connect it to the ground at the load.

1.95) Efficiency Measurement



Output Voltage and Efficiency Measurement Test Setup

$$h = \left(\frac{[Vo(+) - Vo(-)]Io}{Vi(+) - (Vi(-)Ii} \right) \times 100$$

Note: All measurements are taken at the module terminals. When socketing, place Kelvin connections at module terminals to avoid measurement errors due to socket contact resistance.
The table below summaries the functionality of each pin on the PL series.

Function	PL10S-05-*-TR Pin	PL10S-05-*-TP Pin	PL10S-05-*-T Pin
Vin(+)	9,8	7,8	6,7
Vin(-)	7	6	5
Vout(+)	1,2,3	1,2,4	1,2,3
Vout(-)	4	5	4

2) EMI Radiated Emissions

All PL105-05 models meet the requirements of EN55022 Radiated Emissions to Class B. The minimum measured margin to Class B is 2.63dBµV, which equates to a minimum margin of 12.63dBµV to
Class A. Full EMC test data is available on request.

3) Paralleling PL10 with the ST L6615 Current Share Controller

The PL10 range of non-isolated DC-DC converters is capable of parallel operation for current share. Paralleling two or more PL10s requires a small circuit including a load share controller and a small amount of external components. Whilst there are a number of load share controllers on the market Lambda recommend the ST L6615 current share IC for accurate and stable load sharing.

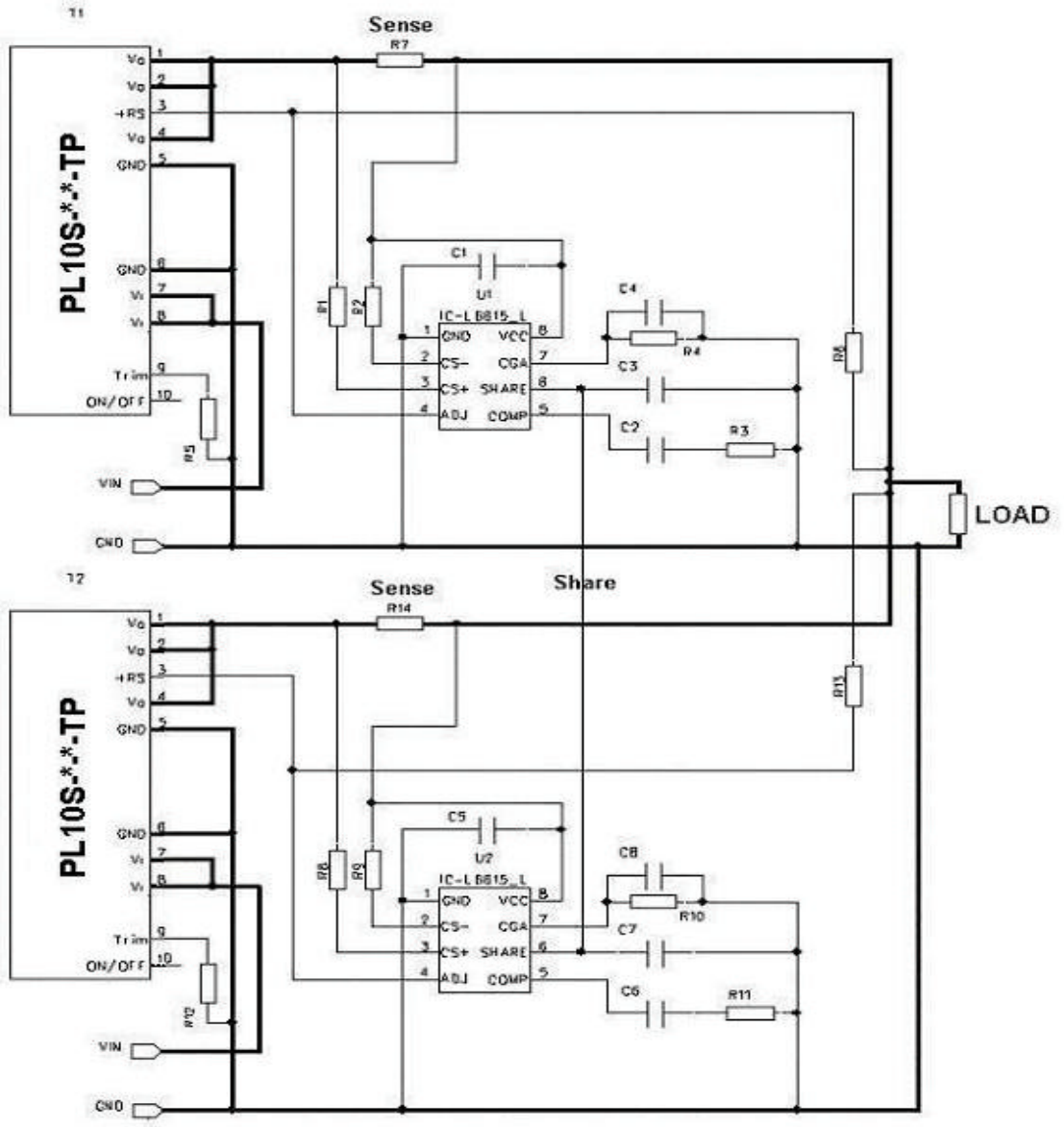


Figure 3.1: The PL10 Current Share Circuit

Table 1. Component List

Resistors

Circ. Ref.	Value/Ohms
R7,R14	0.0015
R1,R2,R8,R9	200
R5,R12	Trim Value
R10,R4	7K5
R3,R11	100
R6,R13	82

Capacitors

Circ. Ref.	Value/F
C1,C5	100n
C3,C7,C4,C8	10n
C2,C6	1u

Integrated Circuits

U1,U2	L6615

Figure 3.1 shows the circuit used to parallel two PL10S-*-*TP units and Table 1 lists the components used. Figure 3.2 shows the connections for the PL10-*-* TR model. The circuit itself remains the same as figure 3.1.

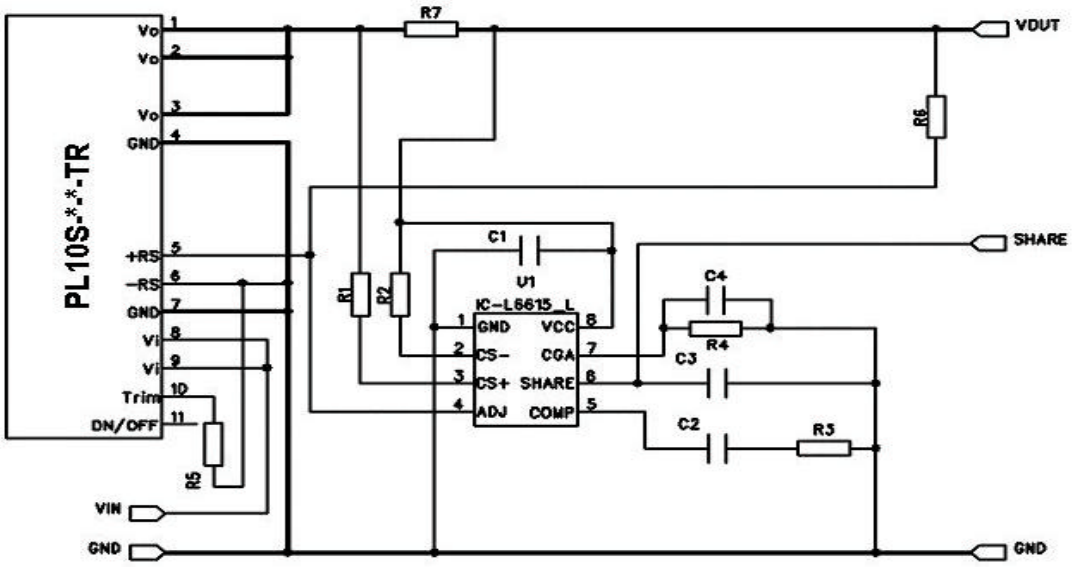
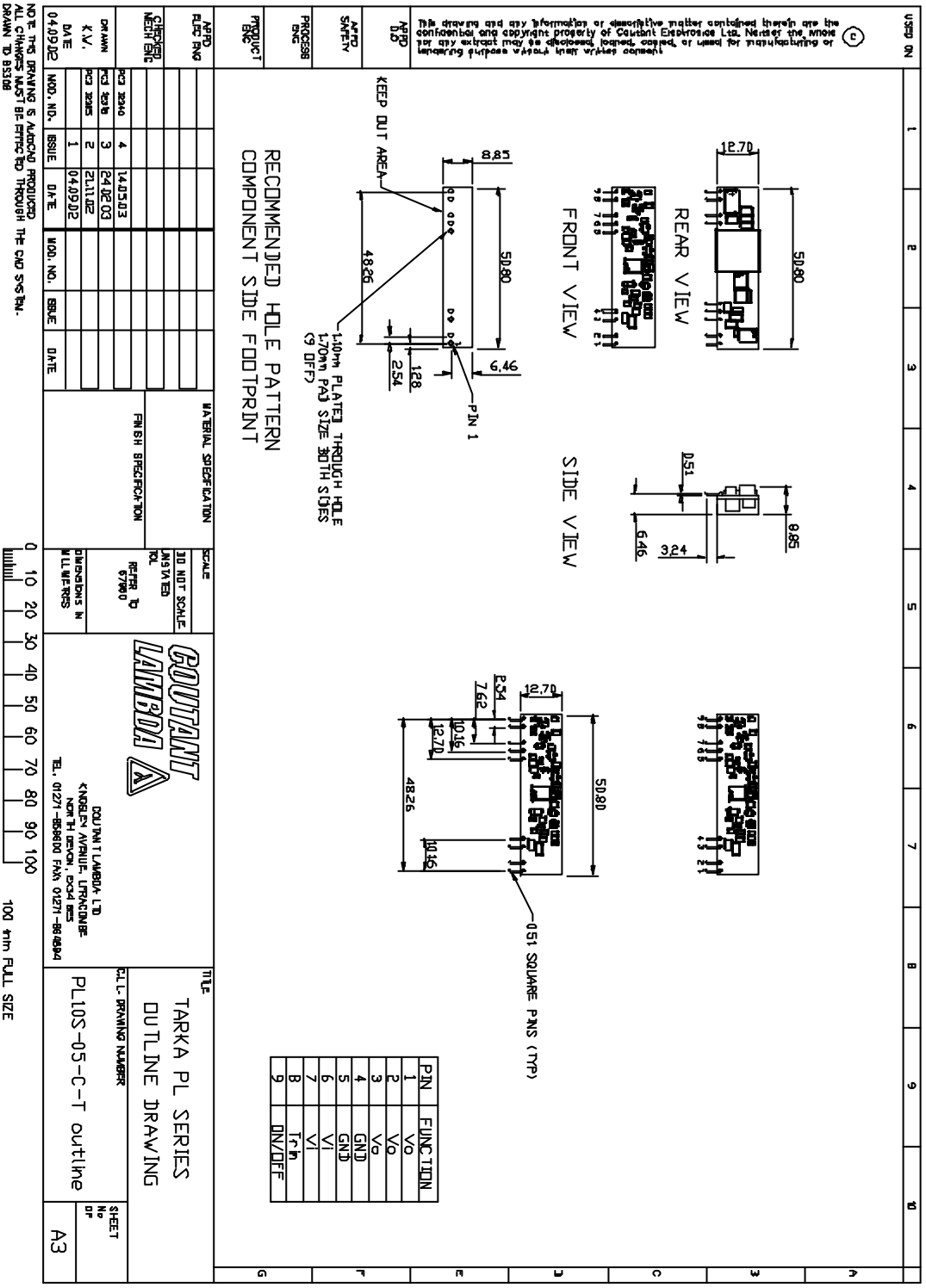


Figure 3.2: The PL10S-05-*-TR Model Connections

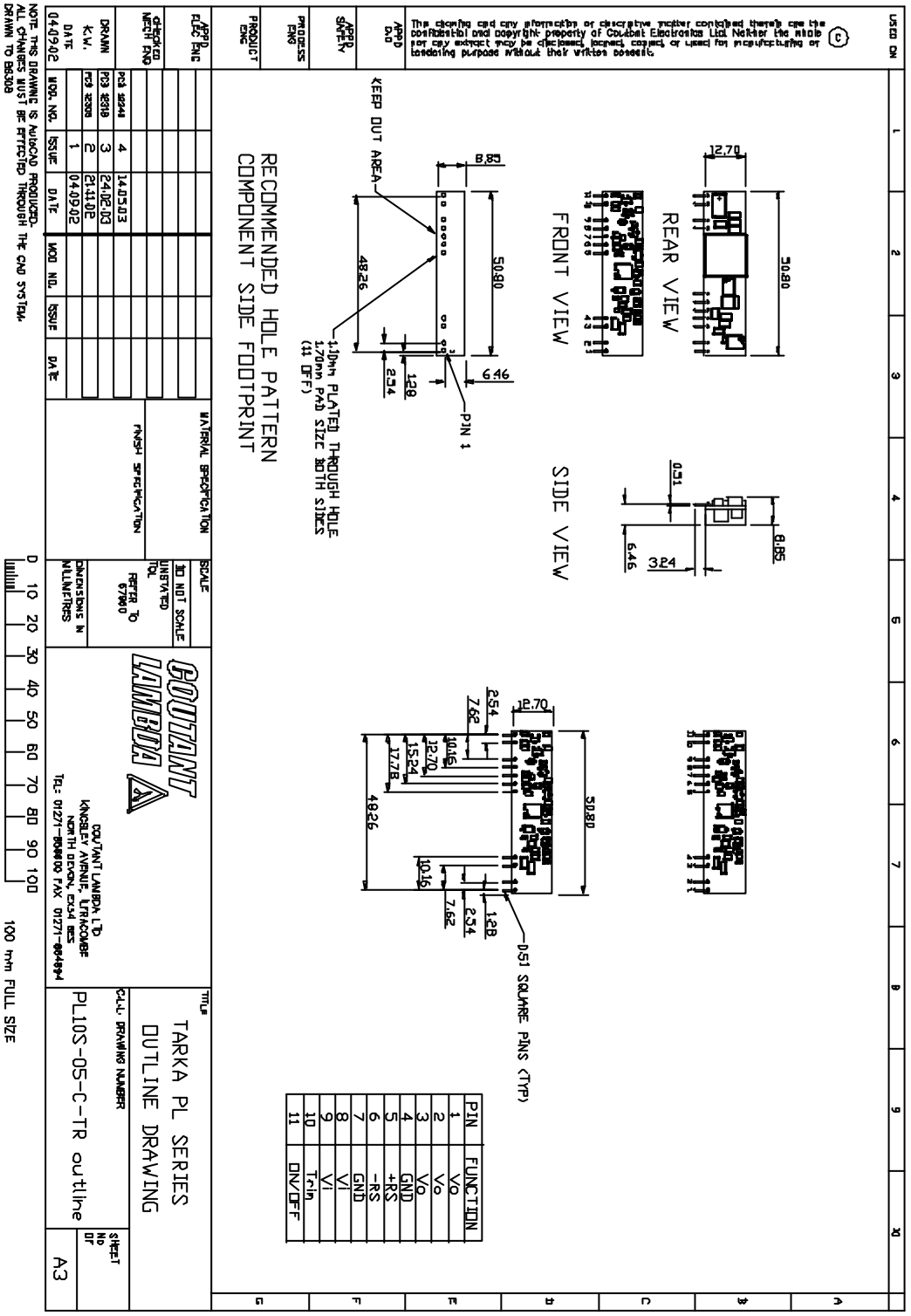
The trim resistors R5, R12 used to set the output voltage of the PL10S should be selected according to the PL10 Series Datasheet. The power dissipated in the sense resistors R7 and R14 is 1.5W under normal operation and the resistors should be chosen accordingly.

$$\begin{aligned} P_{Sense} &= I^2 R_{Sense} \\ &= 10^2 \times 0.015 \\ &= 1.5W \end{aligned}$$

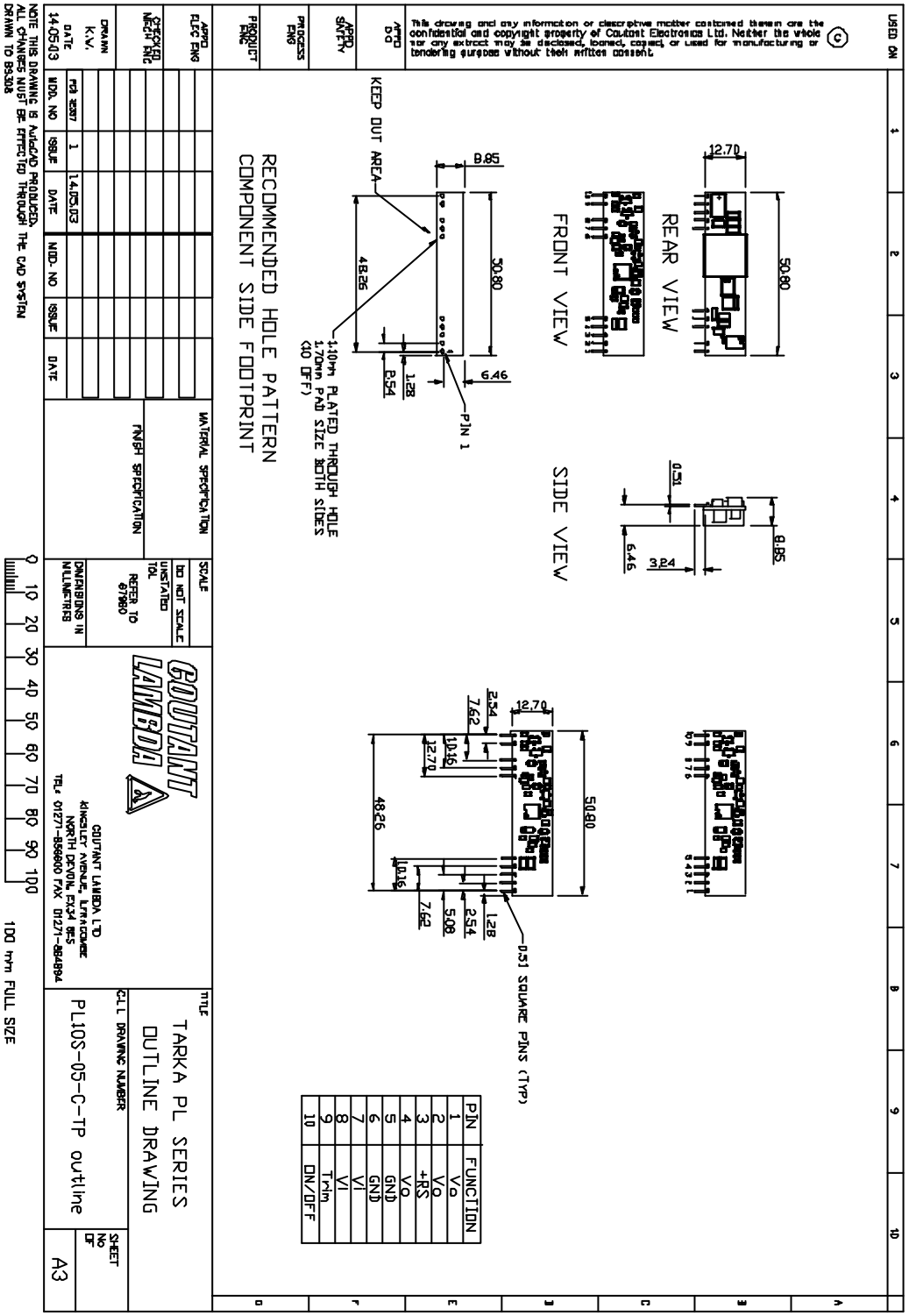
Outline Mechanical Drawing
PL10S-05-*-T



Outline Mechanical Drawing
PL10S-05-*-TR



Out line Mechanical Drawing
PL10S-05-*-TP



TARKA SERIES
NON Isolated DC-DC
CONVERTERS

Nomenclature

PL	**10**	**S**	**- 05**	**- C**	**- ***	**- ***

Prefix PL = Point of Load	maximum output current		input voltage e.g. **05** or **12**		Either	Package option
		S = Single output		**C** = Customer selectable output or e.g. 1v2 or 2v5 or 3 or 3v3 whereby customer has requested factory set output	**T** "Thru Hole" **TP** "Positive sense only" or **TR** "Thru hole with positive and negative Remote sense pins"	**K -** Box Tray

e.g

PL10S-05-C-TR-K
PL10S-12-3v3-T-K
PL10S-05-C-TP-K

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