NEW Product

TLP150 Series

Application Note 201

RoHS
2002/95/EC

ARTESYN® TECHNOLOGIES

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1. Introduction

This Application Note describes the features and functions of Artesyn Technologies' TLP150 series of high power density, ac-dc power supplies. These open-frame modules are targeted at the communications, distributed power, industrial and medical markets. The TLP150 series power supplies have a footprint of 3 x 5 inches with a component height of 1.25 inches for use in 1U applications.

These ac-dc supplies complement Artesyn's dc-dc products enabling the implementation of distributed and point-of-load power archiectures.

This series of power supplies are high-frequency, low-cost, high-density, high-performance ac-dc power supplies designed to operate with universal line inputs (85 Vac to 264 Vac) at a rated continuous output power of up to 100 W with natural convection cooling and 150 W with forced air cooling. The power supplies meet all major safety standards (UL, CSA and VDE) and are CE marked to LVD/RoHS directives. They comply with the EMC directives (EN61000-4-2,3,4,5), meet input harmonic current limits standards EN61000-3-2, as well as FCC/CISPR 22 (EN55022) Class B Conducted EMI limits and Class A Radiated EMI limits.

The modules are fully protected against overcurrent, overvoltage and overtemperature conditions. Standard features include remote sense. Optional features include remote ON/OFF and 5 V Standby.

In addition, a high level of reliability has been designed into all models through extensive use of conservative derating criteria. Automated manufacturing methods, together with an extensive qualification program, ensure that all TLP150 converters are extremely reliable.

The series complies with standard environmental expectations including shock, vibration, humidity and thermal performance.

2. Models

The TLP150 power supply family comprises of 2 series.
- The -9**6**SxxJ series are designed for Information Technology Equipment (ITE) and Industrial applications and meet all the requirements of IEC60950-1 safety expectations.
- The -9**9**SxxJ series are designed for medical applications and meet all the requirements of IEC60601-1 safety expectations.

The TLP150 IT series comprises of 3 models as listed in Table 1.

Model	Input Voltage	Output Voltage	Output Current
TLP150R-96S12J	85-264 Vac	12 Vdc	12.5 A
TLP150R-96S24J	85-264 Vac	24 Vdc	6.3 A
TLP150R-96S48J	85-264 Vac	48 Vdc	3.2 A

Table 1 - TLP150 IT Models

The TLP150 Medical series comprises of 2 models as listed in Table 2.

Model	Input Voltage	Output Voltage	Output Current
TLP150N-99S12J	85-264 Vac	12 Vdc	12.5 A
TLP150N-99S24J	85-264 Vac	24 Vdc	6.3 A

Table 2 - TLP150 Medical Models

Nomenclature reference:
- 'R' refers to models designed for redundant and parallel applications.
- 'N' refers to models designed for single unit applications.

Note: Replace the 'J' at the end of the model number with 'FJ' when the optional standby output and/or remote ON/OFF control is required e.g. TLP150R-96S12FJ.

RoHS Compliance Ordering Information

RoHS 2002/95/EC

The 'J' at the end of the part number indicates that the part is Pb-free (RoHS 6/6 compliant). TSE RoHS 5/6 (non Pb-free) compliant versions may be available on special request, please contact your local sales representative for details.

2.1 Features
- Universal input range (85 Vac to 264 Vac) with EMI Filter and PFC
- 150 W with forced air
- 12 Vdc @ 0.5 A fan output
- Standby output of 5 V @ 1 A (optional)
- Integrated Or-ing diode and active current sharing ('R' versions)
- Integrated control and monitoring features
- Overcurrent, overvoltage and overtemperature protection
- Compliance to EN55022-B conducted noise standard
- Compact size: 3 x 5 x 1.25 inches
- RoHS compliant

3. General Description

3.1 Electrical Description
A block diagram of the TLP150 series is shown in Figure 1. High efficiency power conversion is achieved by fixed frequency half bridge topology.

The power conversion is implemented using a voltage-mode controlled half bridge topology. Power is transferred magnetically across the isolation barrier, via isolating power transformers. The regulated voltage on the output pins is governed by closed loop voltage feedback techniques.

A front end EMI filter is provided, so that conducted EMI levels will comply with FCC Part 15, Class B and EN55022 (CISPR 22 test method) Class B limits. There is a harmonic current correction (HCC) stage to ensure the product meets EN61000-3-2 harmonic content requirements. The main output voltage channel is controlled by variable pulse width in the dc-dc converter. Output filtering on the secondary side ensures that the unit meets stated regulation and transient response.

The output is adjustable over a range ±10% of the nominal output voltage, using the on board TRIM potentiometer. Remote sense for automatic line drop compensation is also provided, allowing a maximum 0.2 Vdc drop compensation from no load to full load on customer output connection cables/wire runs. The converter can be shut down via a remote ON/OFF input that is referenced to the secondary ('F' version only). This input is compatible with popular logic devices. A 'positive' logic input is supplied as standard.

The output is monitored for overvoltage conditions. The unit will shutdown at the overvoltage set-point and is latched until power cycling or reset is performed. The power supply is also protected against overtemperature conditions. If the converter is overloaded or the ambient temperature gets too high, the converter will shut down until the temperature falls below a minimum threshold, after which restart is automatic. The unit incorporates continuous short circuit protection, employing a current fold back operation to reduce continuous short-circuit current. Recovery is automatic upon removal of the short.

Additional signaling includes an input power good and dc output voltage good and a load share signal (on the parallel TLP150R versions only) that can be used to indicate % loading. Active current sharing allows for Paralleling and for true fault tolerant applications the optional Or-ring version can be provided under appropriate model nomenclature.

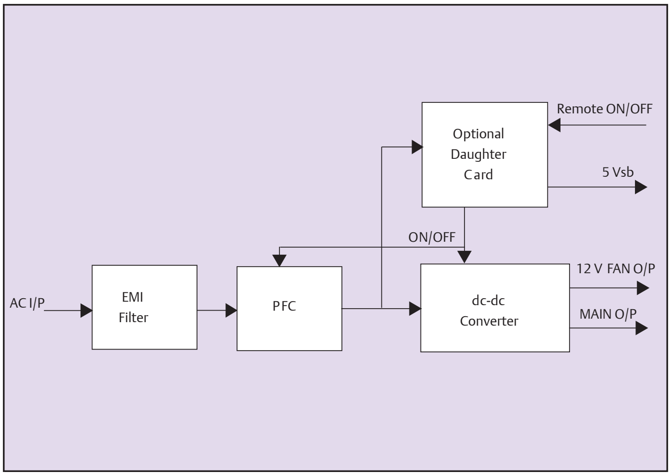

Figure 1 - Electrical Block Diagram

3.2 Mechanical Description

The TLP150 is constructed using a two-layer FR4 PCB. Both SMT and power components are placed on either side of the PCB. Heat dissipation of the power components is optimized, ensuring that control components are not thermally stressed. The standard supply is an open-frame product measuring 3.00 in (W) x 5.00 in (L) x 1.25 in (H) (76.20 x 127.00 x 3.75 mm).

Figure 2 shows the mounting hole locations for horizontal (bottom/flat) assembly within applications.

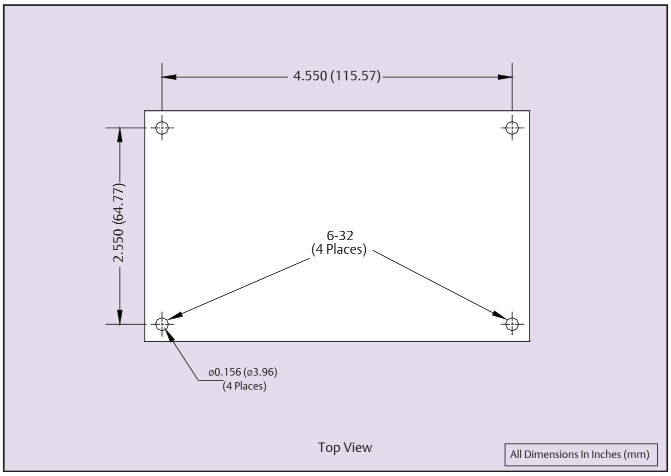

Figure 2 - Horizontal Mounting Hole Location Top View

3.3 Connector Pin Assignment

A large diversity of connector housing and crimp terminals are available from many manufacturers (e.g. housing with/without locking ramps, anti-vibrate crimps etc.). The molex suggestions below are therefore for reference purposes only, but should meet the requirements of most standard applications. It is advisory to consult with appropriate manufactures in order to best fit specific application needs.

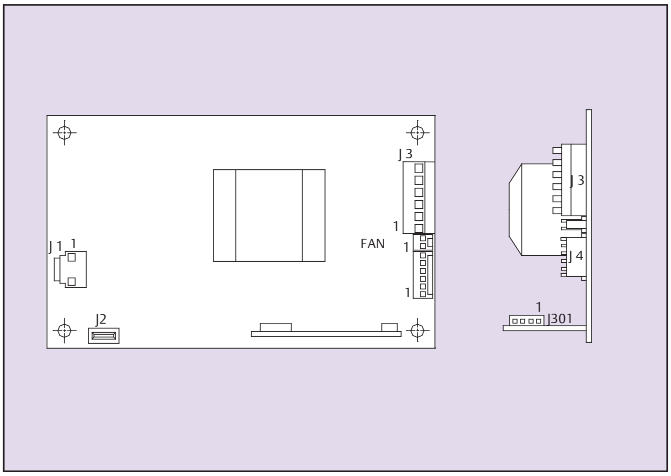

Figure 3 – Connector Location

CONNECTOR AND MATING CONNECTOR TYPES		
CONNECTOR	TYPE	MATING CONNECTOR
J1	Molex 09-65-2038 (5273 series) void pin 2 or equivalent	Molex 09-52-4034 (5239 series or equivalent with Molex 0 8-52-0072 (2478 series) crimps or equivalent
J2	AMP 63849-1 or equivalent (6.35 mm straight)	AMP 2-520263-4 or equivalent (straight spade for 22-18 AWG wire)
J3	Molex 09-65-2068 (5273 series) void pin 2 or equivalent	Molex 09-52-4064 (5239 series or equivalent with Molex 0 8-52-0072 (2478 series) crimps or equivalent
J4	Molex 22-23-2061 (6373 series) void pin 2 or equivalent	Molex 22-01-3067 (2695 series or equivalent with Molex 08-50-0113 (2759 series) crimps or equivalent
J301 (optional)	Leoco 2421P04H000 (2421 series) or equivalent	Leoco 2420S04000 (2420 series) or equivalent with Leoco 2453TPB00V1 (2453T series) or equivalent crimp terminals or JST EHR-4 (EH series) or equivalent with JST SEH-001T-P0.6 (EH series) or equivalent crimp terminals
Fan	Molex 22-23-2021 (6373 series) void pin 2 or equivalent	Molex 22-01-3027 (2695 series or equivalent with Molex 08-50-0113 (2759 series) crimps or equivalent

Table 3 - Connector Type and Mating Recommendations

- **J1** is the input connection

J1Pin Connections	
Pin 1	Neutral
Pin 3	Live

Table 4 - J1 Pin Connections

- **J2** is the protective earthing terminal

J2 Tab Connection	
Tab	Ground/Earth

Table 5 - J2 Pin Connections
Tab (faston) size is 0.25 in (6.35 mm) straight spade

- **J3** provides the main output voltage. The terminal assignment is summarized in Table 6 and is assigned left to right as you face the connector. Maximum output current allowed on each individual pin is 5.0 A.

J3 Pin Connections		
Pin 1	RTN	Main Return
Pin 2	RTN	Main Return
Pin 3	RTN	Main Return
Pin 4	Vo	+Main Output
Pin 5	Vo	+Main Output
Pin 6	Vo	+Main Output

Table 6 - J3 Pin Connections

- **J4** provides control signals. The connector type and recommended mating connector and crimp terminals are listed in Table 3. The pin assignment is summarized in Table 7 and is assigned left to right as you face the connector. See Section 5 for detailed description.

J4 Pin Connections		
Pin 1	-S	-Vo Remote Sense
Pin 2	DC OK	DC Power Good Signal
Pin 3	PW OK	Power Good
Pin 4	LS	Load Share Signal
Pin 5	+S	+Vo Remote Sense
Pin 6	SGND	Signal Common

Table 7 - J4 Pin Connections

- **FAN** provides a 12 Vdc @ 500 mA external voltage. This may be used to run an external 12 Vdc fan in applications requiring additional cooling or airflow. The connector type and recommended mating connector and crimp terminals are listed in Table 3. The pin assignment is summarized in Table 8.

  Note - The unloaded voltage may be higher than the 12 Vdc advised.

Fan Pin Connections		
Pin 1	+12 V	Fan Voltage
Pin 2	+SGND	Return

Table 8 - Fan Pin Connections

- **J301 (optional)** provides stand-by output and remote ON/OFF control signals. The connector type and recommended mating connector and crimp terminals are listed in Table 3. The pin assignment is summarized in Table 9. See Section 5 for detailed description.

J301 Pin Connections (Optional)		
Pin 1	5 Vsb	Standby Voltage
Pin 2	SGND	Signal Common
Pin 3	Reserved	Reserved
Pin 4	PS OFF	Remote ON/OFF signal

Table 9 - J301 Pin Connections

4. Performance Features and Functions

4.1 Electrical Input Characteristics

4.1.1 Input Voltage Range and EMC Expectation

All outputs will regulate within the specification detailed in the datasheet over an input voltage range of 85 V rms to 264 V rms and input frequency range of 47 Hz to 63 Hz. In addition, dc input from 120 Vdc to 300 Vdc is also possible, although specifications may vary slightly.

Notes

- Mains input voltage dropouts or sags of any duration below the minimum specified above will not damage the supply. The supply will recover to normal operation when the ac line returns to within the specified range.
- The units will withstand input fast transients specified in EN61000-4-4 Level 3 severity and input surges specified in EN61000-4-5 Level 3 severity. Transient or surges beyond these limits may damage the supply.
- The input harmonic currents comply with EN61000-3-2:1995 with Amendment A14:2000. The input power factor will be greater than 0.9 (90%) at rated load and is typically in the order of 0.95 or better.
- An internal EMI filter is provided, so that conducted EMI levels will comply with FCC Part 15, Class B and EN55022 (CISPR 22 test method) Class B limits.

4.1.2 Input Current

At 115 V, 60 Hz, the RMS input current shall be 2 A or less. Typical input currents at various line voltages are listed in Table 10.

Vin rms	Iin rms 250 W Series
85 V	2.35 A
120 V	1.73 A
230 V	0.86 A
264 V	0.72 A

Table 10 - Input RMS Current

Note - Model label marking is governed by appropriate safety approval certification and guidelines and thus may not reflect maximum operating conditions as advised on the technical datasheets.

4.1.3 Startup Surge (Inrush) Current

Inrush current is limited by means of a NTC (negative temperature coefficient) resistor. The peak cold start-up surge current at various line voltages at 25 °C ambient are less than the values specified in Table 11. Note the lower the ambient the lower the inrush current.

Vin ac (rms)	Iin (peak, cold start)	Line Impedance (Ω)
85 V	14 A	0
120 V	18 A	0
230 V	35 A	0
264 V	40 A	0

Table 11 - Inrush Current (Worst Case)

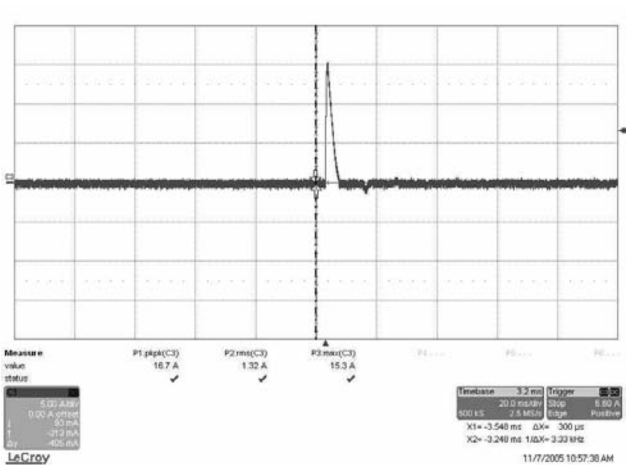

Figure 4 - Typical Surge Current @ 264 Vac for 12 V Model

4.1.4 Input Fusing

- ITE Models (-96SxxJ)
  The unit is equipped with internal non-user-serviceable 3.15 A 250 Vac fuse to IEC127 for fault protection in the 'live' input line.
- Medical Models (-99SxxJ)
  The unit is equipped with internal non-user-serviceable 3.15 A 250 Vac fuses to IEC127 for fault protection in both the 'live' and 'neutral' input lines.

4.2 Electrical Output Characteristics

Model number listing and output voltage and current ratings are specified on the relevant datasheet.

Notes

- Voltages are factory settings, and the main output is adjustable ±10%. (See Section 8.2).
- Maximum currents and power must not be exceeded.
- There is no minimum load requirement for any output.

4.2.1 Output Voltage Initial Accuracy and Trimming

All outputs have an initial setting accuracy better than ±2% at 75% of maximum rated load.

4.2.2 Regulation

The total output regulation for both line and load variations is better than ±3% of nominal voltage for all outputs.

4.2.3 Temperature Stability and Coefficient

The temperature coefficient of any output voltage is less than ±0.02%/C, for the full operating temperature range of 0 °C to 70 °C.

4.2.4 Minimum Output Current

There are no minimum load requirements to maintain stated datasheet regulation. The TLP150 family is designed to cater for no load operation.

4.2.5 Ripple and Noise

The peak-to-peak ripple and noise for all outputs is less than 1% of the nominal output voltage, over and ambient range of 0 °C to 50 °C. (see Section 8.12 for more details).

4.2.6 Transient Response

For the main output on all models, the maximum transient deviation for a step load change from 25% to 75% of maximum rated current is less than 5%. The maximum slew rate of load current is 0.5 A/µs. A minimum capacitance equal to 100 µF/A of rated load current should be connected to the load point for appropriate measurement.

The output will recover to within the regulation band within 1 ms.

4.2.7 Hold-up Time

All outputs will remain within the specified regulation band for a period of at least 20 ms following a sudden loss of ac input voltage. The supply can be operated at full load, and the ac line power should be programmed to vanish at the zero crossing point.

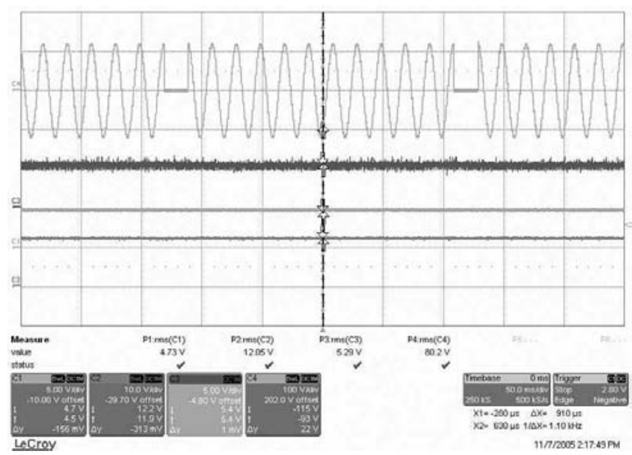

Figure 5 - Typical Hold-up Plot 12 V Model Full Load @ 85 Vac (Channel 1: PWOK; Channel 2: 12 V; Channel 3: DCOK; Channel 4: Mains)

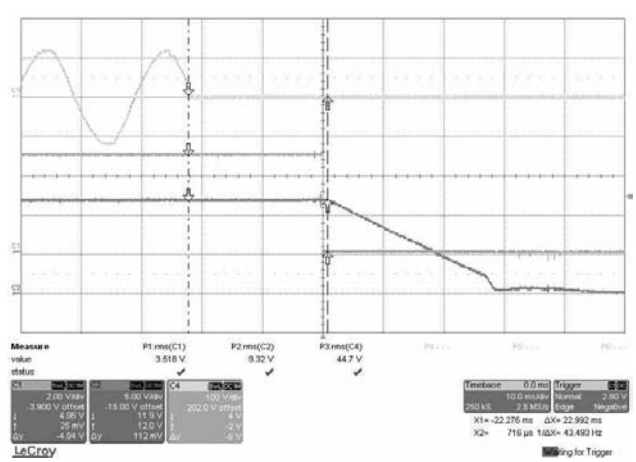

Figure 6 - Typical Hold-up to Decay Plot 12 V Model Full Load @ 85 Vac (Channel 1: PWOK; Channel 2: 12 V; Channel 4: Mains)

Notes

- Hold-up time is mainly influenced by amount of loading and is shortest on full load.
- Testing indicates that the units will handle 50% input voltage dips for 500 ms at full load without interruption on output voltage supply.

4.2.8 Efficiency
The efficiency of the TLP150 series at worst case operating conditions at full rated load is greater than 75% and typically in the order of 80% for normal operating conditions. Efficiency maybe as high as 87% depending on model and test configuration.

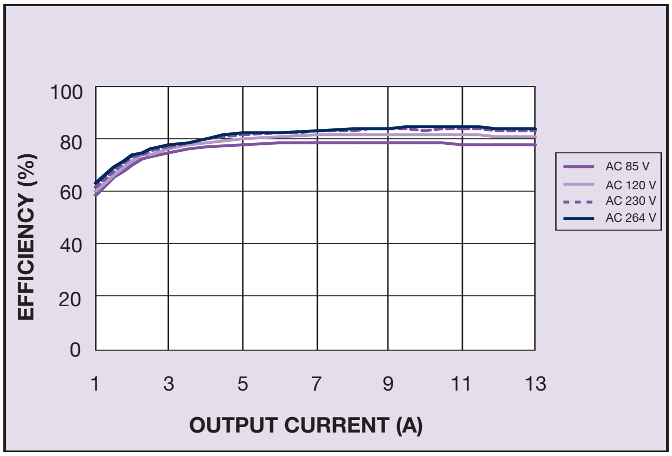

Figure 7 - Efficiency for TLP150R-96S12J

4.2.9 Output Voltage Rise Time
The output voltage rise time (10% to 90% of Vout) will depend on model type, mains input voltage and amount of loading. Specification is for min. 5 ms ≤ 100 ms for all possible variations and is typically 40 ms for 230 Vac.

Output voltage rise time is not influenced by method of turn-on (i.e. via mains only or via PS OFF control signals).

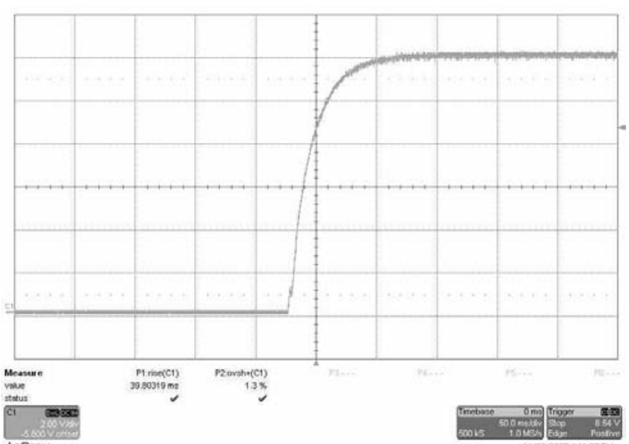

Figure 8 - Output Voltage Rise Time (12 V Model)

4.2.10 PSU Turn-on Time
The maximum delay from application of mains input voltage until the unit produces a valid output is less than 2 seconds worse case. Turn-on time is influenced by model type, main input voltage and method of turn-on (see Section 8.3 for more details).

4.2.11 Standby Mode Power Consumption
The full featured TLP150 (i.e. Suffix 'FJ' versions) can operate in a standby mode. The main converter and PFC section are shut down in standby mode to reduce power consumption.

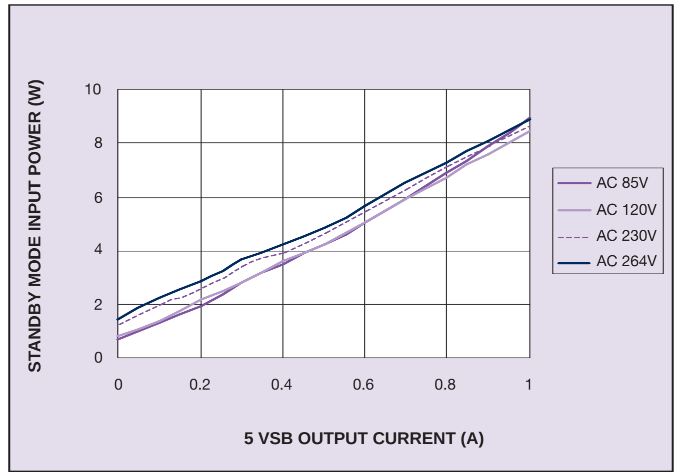

Figure 9 - Standby Mode Power Consumption

4.3 Protection Features
4.3.1 Overload Protection
The TLP150 family includes internal current limit circuitry to prevent damage in the event of overload or short circuit. In the event of overloads, the output voltage may deviate from the regulation band but recovery is automatic when the load is reduced to within specified limits.

The current sensing circuit is set to 115% (±5%) of full load current at 90% of nominal output voltage. If an overload occurs this circuit takes control of the feedback loop and forces the unit into constant current mode. The unit delivers 115% of rated current, but its output voltage is reduced to maintain safe power dissipation. If the overload is removed the power supply will immediately revert to constant voltage control and resume regulation at voltage setpoint.

The constant current mode operates for output voltage greater than 4 V. Below 4 V, the output current fold backs to 50% rated current when output shorts circuit.

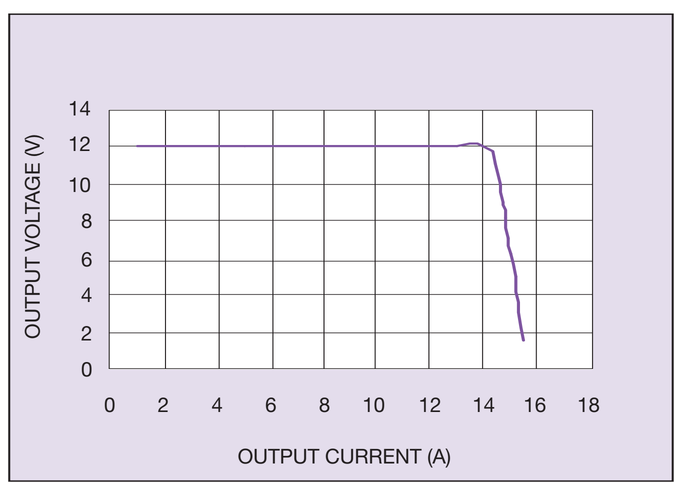

Figure 10 - Output Characteristics of TLP150R-96S12J

4.3.2 Short-circuit Protection
All outputs are protected against continuous short-circuit. The outputs protect themselves against short-circuit failure (defined as output impedance less than or equal to 0.1 Ω) for an indefinite period of time. Outputs will automatically resume normal operation when the fault is removed.

Note: The 5 Vsb will remain active during overload or short circuit on the main output.

4.3.3 Output Overvoltage Protection
All TLP150 models include OVP protection for the output. The power supply OVP shutdown circuit shall be activated when main output voltage exceeds 125% ± 5% of nominal value. When the OVP is activated, the output is shutdown and the power supply will lock out until the ac power is cycled or the remote ON/OFF is asserted for 1 second (i.e. PS OFF signal is pulled low). During lockout, the 5 Vsb output will remain active.

Note: Output under voltage protection is not provided.

4.3.4 Overtemperature Protection (OTP)
The TLP150 main converter is equipped with non-latching overtemperature protection. A temperature sensor monitors the temperature of the PFC power MosFet. If the temperature exceeds a threshold of 125 °C (typical) the power supply will shut down, disabling the output. When the FET substrate temperature has decreased to between 90 °C and 100 °C the converter will automatically restart.

The TLP150 might experience overtemperature conditions during a persistent overload on the output. Overload conditions can be caused by external faults. OTP might also be entered due to a loss of control of the environmental conditions e.g. an increase in the converter's ambient temperature due to a failing fan or external cooling system etc.

During thermal shutdown, the 5 Vsb output will remain active.The standby converter 5 Vsb equipped with a latching overtemperature protection. When 5 Vsb is thermal protected, the main output will be shut down. AC power cycling is required to reset the protection.

4.4 Environmental Features
4.4.1 Operating Temperature
The power supplies will start and operate within stated specifications at an ambient temperature from 0 °C to 50 °C under all load conditions. Derate output current and power by 2.5% per °C above 50 °C. Maximum operating ambient temperature is 70 °C (which implies a 50% derating at max 70 °C ambient). Under convection cooling condition, the maximum output power derates linearly from 100 Watts to 90 Watts from 90 Vac to 85 Vac.

4.4.2 Storage and Shipping Temperature/Humidity
The power supplies can be stored or shipped at temperatures between –40 °C to +85 °C and relative humidity from 5% to 95% non-condensing.

4.4.3 Altitude
The power supplies will operate within specifications at altitudes up to 10,000 feet. The power supply will not be damaged when stored in altitudes up to 30,000 feet. Operation in some environments may require derating (See Section 8.8 for optimum thermal performance guidelines)

4.4.4 Humidity
The power supplies will operate within specifications when subjected to a relative humidity from 5% to 95% non-condensing.

4.4.5 Shock
The power supplies will pass shock test of 30 G rms, half sine, 11 ms, allowing for one drop on each of the six faces.

4.4.6 Vibration
The power supplies, while not operating, will withstand random vibrations in 3 orthogonal axes, 2.4 G rms, 5 Hz to 500 Hz for 10 minutes each axis.

4.4.7 Electrostatic Discharge (ESD)
The power supplies will pass ESD tests of EN61000-4-2 standards, level 3 severity with normal performance (NR).

4.4.8 Electromagnetic Susceptibility
The power supplies shall perform satisfactorily when subjected to radiated electromagnetic interference per EN61000-4-3 standards, level 3 severity with normal performance (NR).

5. Monitoring and Signal Interfacing

5.1 Remote Shutdown and ON/OFF (PS OFF)
Full featured TLP150 supply includes normally open (NO) remote shutdown (inhibit) PS OFF as standard. If the PS OFF signal is asserted low, the supply will shut down within 200 ms. When PS OFF is high or open, the power supply will start and run normally.

Note: When not using PS OFF the pin should be left open circuit. Activating the remote shutdown inhibits the output voltage and 12 Vdc fan supply. The 5 Vsb remains active. (see Section 8.4 for more details)

5.2 Remote Sensing (+S, -S)
Remote sensing (+S, -S) is provided for all output ratings. The remote sense circuitry will overcome a total voltage drop of 0.2 V between the output terminals and the remote sense point (See Section 8.7 for more details).

5.3 Output Good (DC OK)
The TLP150 series includes a DC OK signal. When the output voltage is within 12% of nominal (i.e. Vo > -12% of the nominal), the DC OK signal will switch to a logic high (5 V), and can source 5 mA or less. If the ac input voltage is below limits to maintain regulation of the outputs, or if a protective shutdown circuit operates, DC OK will switch to a logic low. DC OK is an TTL compatible output signal (see Section 8.6 for more details).

5.4 Power Good (PW OK)
The TLP150 series includes a PW OK signal. When the power supply starts, this signal will switch to a logic high within 500 ms. When the ac input is interrupted, the PW OK signal will switch to a logic low at least 1 ms before loss of output regulation. PW OK is an TTL compatible output signal (see Section 8.5 for more details).

Note: When the unit is inhibited by PS OFF, PW OK will switch to a logic low.

5.5 Standby Voltage (5 Vsb)
In addition to the main outputs, all TLP150 models may be equipped with an optional 5 V stand-by output (5 Vsb). The 5 Vsb output remains active when the power supply is limited or shut down by control or protective circuitry. Maximum current for the 5 Vsb output is 1.0 A and regulation is ±5%.

5.6 Load Share (LS) - 'R' versions only
When operating the TLP150 'R' versions alone within single module applications, the J4 pin # 4 LS signal may be used to measure output current where 3 V ±10% equals 100% load and is linear in design. Thus 50% load will equal 1.5 V ±10%. Otherwise the signal is used to parallel multiple module systems (see Section 8.9 for more details).

5.7 Signal Common (SGND)
0 Vdc pin for return connection of control signals. This is the secondary ground of the PSU and is internally connected to the main output ground (0 Vdc).

5.8 Fan Voltage (12 V Fan)
The fan voltage output is designed to drive an external dc fan. The signal is rated for 0.5 A continuous rated operation. The fan output is not available when the main output is overloaded/current limited or shutdown by control or protective circuitry. Additionally the 12 V Fan is independently short-circuit protected at approximately 0.9 A so that the main output will remain unaffected if fan failure/short occurs.

Notes
- The Fan voltage output is tracking with the main output. When the main output is trimmed, the fan voltage will change proportionally.
- The PSU is independently protected for loss of system airflow.
- During Artesyn thermal evaluation a 40 x 40 mm 12 Vdc fan (ref.: Delta P/N FFB0412VHN-F00) was used to check cooling effectiveness of the PSU at full loading.

6. Safety

6.1 Certification
The TLP150 power supply is intended for inclusion in other equipment and the installer must ensure that it is in compliance with all the requirements of the end application. This product is only for inclusion by professional installers within other equipment and must not be operated as a stand alone product.

The TLP150 ITE models have been designed in accordance with EN60950-1 and UL/cUL 60950-1 'Safety of Information Technology Equipment'. The series also conforms with the provisions of the European Council Low Voltage Directive 73/23/EEC (as amended by 93/68/EEC) to bear the CE Mark.

The TLP150 Medical models have been designed in accordance with EN 60601-1 and UL/cUL 60601-1 'Safety of Medical Equipment'.

Note: Appropriate safety certificates and approvals are available to download from our website **www.artesyn.com**

6.2 Isolation
The galvanic isolation is verified in an electric strength test during production. For TLP150 ITE models the test voltage between input and output is 3.0 kVac and 1.5 kVac between input to chassis. For TLP150 Medical models the test voltage between input and output is 4.0 kVac and 1.5 kVac between input to chassis. Also, note that the flammability ratings of the PCB and terminal support header blocks and all internal plastic constructions meet UL94V-0.

6.3 Input Fusing
For fault protection, units with ITE approvals are equipped with fuse in the 'live' line while units with medical approvals are equipped with fuses in both 'live' and 'neutral' lines. All fuses are internal non-user serviceable 3.15 A 250 Vac fuse to IEC 127 fault protection.

WARNING: FOR CONTINUED PROTECTION AGAINST RISK OF FIRE, REPLACE ONLY WITH SAME TYPE AND RATING OF FUSE.

Notes
- CAUTION: Allow a minimum of 1 minute after disconnection line power when making measurements or handling the Unit.
- The TLP150 family is NOT evaluated for use as critical components in life support equipment or use in hazardous of nuclear environments. If uncertain consult Artesyn Technologies.
- HIGH VOLTAGE WARNING: during operation dangerous voltages maybe present. These products maybe supplied open frame or with covers, and professional installers should take appropriate provision to avoid service/user inadvertent contact within end applications.
- The TLP150 family has IPX0 rating and thus are not protected for ingress of water, cleaning agents and other liquids etc.

6.4 Leakage Current
The ITE models (-96SxxJ) are designed for worst case leakage current of below 1.0 mA. The Medical models (-99SxxJ) are designed for worst case leakage current of below 0.15 mA.

7. EMC

The TLP150 series has been designed to comply with the EMC requirements of EN 55022 (FCC Part 15) for emissions and relevant sections of EN 61000 (IEC 61000) for immunity.

7.1 Conducted Emissions
The applicable standard for conducted emissions is EN55022 (FCC Part 15). Conducted noise can appear as both differential mode and common mode noise currents. Differential mode noise is measured between the two input lines, with the major components occurring at the supply fundamental switching frequency and its harmonics. Common mode noise, a contributor to both radiated emissions and input conducted emissions, is measured between the input lines and system ground and can be broadband in nature.

The TLP150 power supplies have internal EMI filters to ensure the converters' conducted EMI levels comply with EN55022 (FCC Part 15) Class B and EN55022 (CISPR 22) Class B limits.

The EMI measurements are performed with resistive loads under forced air convection at maximum rated loading.

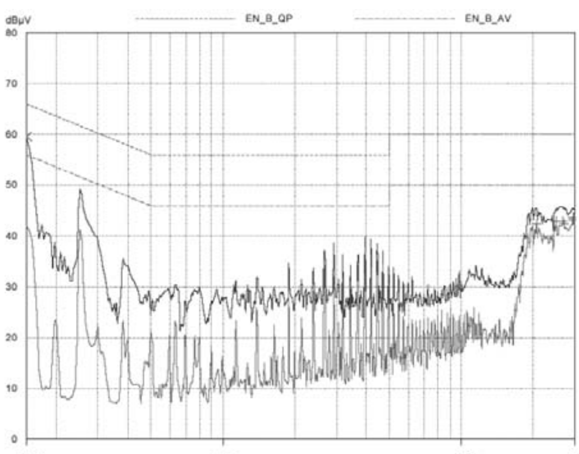

Figure 11 - Sample EN55022 Conducted EMI Measurement

7.2 Radiated Emissions
Unlike conducted EMI, radiated EMI performance in a system environment may differ drastically from that in a stand-alone power supply. The shielding effect provided by the system enclosure may bring the EMI level from Class A to Class B. It is thus recommended that radiated EMI be evaluated in a system environment.
The applicable standard is EN55022 Class A (FCC Part 15). Testing ac-dc converters as a stand-alone component to the exact requirements of EN55022 can be difficult, because the standard calls

for 1 m leads to be attached to the input and outputs and aligned such as to maximize the disturbance. In such a set-up, it is possible to form a perfect dipole antenna that very few ac-dc converters could pass. However, the standard also states that 'an attempt should be made to maximize the disturbance consistent with the typical application by varying the configuration of the test sample'.

8. Applications

8.1 Mounting Considerations

Figure 2 on page 3 shows the mounting hole locations for horizontal (bottom/flat) assembly within applications. Four mounting positions are provided and hole dimensions are designed to accept fitting fixtures to maximum diameter of 0.156 in (3.96 mm). The power supplies may also require appropriate mounting standoff heights as per system level safety requirements (creepage and clearance). A minimum of 0.25 in (6.35 mm) is suggested.

Notes

- For three wire systems Earth Tab J2 is provided and accepts 6.35 mm spade connectors.
- Fixing holes marked ⏚ in Figure 12 are bonded to the J2 Earth Tab point and allow for earthing to system chasis in two wire systems (if required).

8.2 Output Voltage Adjustment

The main output voltage on all models can be trimmed by ±10% of the nominal voltage setpoint via on board Single Turn Clock Potentiometer.

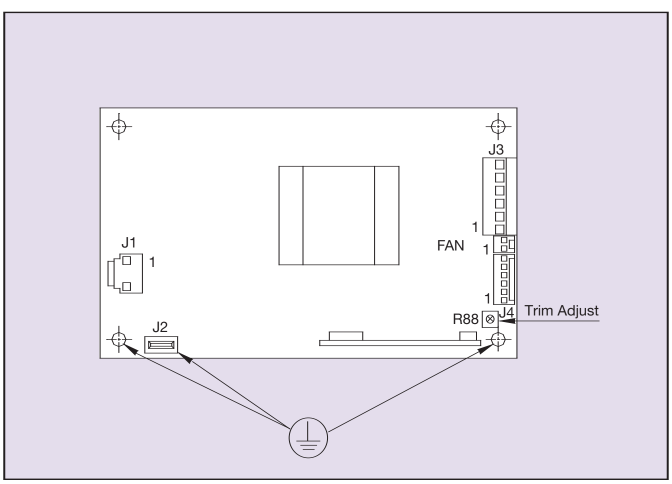

Figure 12 - Trim Potentiometer Location

Turning the potentiometer clockwise increases the output voltage. Turning anti-clockwise decreases the output voltage. The overvoltage setting/trip point are not automatically adjusted when the unit is trimmed and remain at fixed settings which are well above the +10% trim up range.

Note: When the main output is trimmed, the fan voltage will change proportionally.

8.3 Turn on Delay

Maximum turn on delay from application of input ac voltage until the output is within regulation is less than 2.0 seconds.

8.3.1 Remote ON/OFF Inactive: Mains AC Input applied

Here the TLP150 is allowed to startup under the influence of mains ac input voltage only and there is no external ON/OFF control logic. Turn-on delay is typically 320 ms.

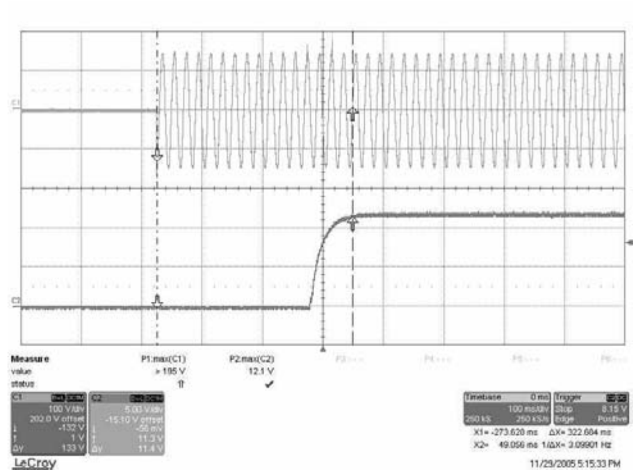

Figure 13 - Turn-on via AC Input Applied (Channel 1: ac Mains Input; Channel 2: Output Voltage (12 Vdc)

8.3.2 Remote ON/OFF active: Mains ac Input Present

Here the TLP150 is allowed to startup under the control of external ON/OFF control logic. The mains ac input voltage is already applied and the TLP150 is held OFF externally. Upon activation of the external ON/OFF the TLP150 will startup. Turn-on delay is typically 270 ms.

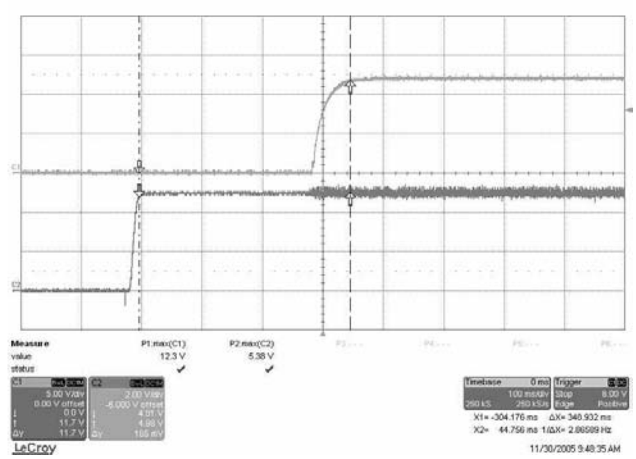

Figure 14 - Turn-on via Remote ON/OFF (Channel 1: Output Voltage (12 Vdc); Channel 2: Remote ON/OFF Signal)

8.4 Remote Shutdown and Remote ON/OFF

The remote ON/OFF input allows external circuitry to put the TLP150 supply into a low dissipation sleep mode (i.e. inhibits the main output). Active-high remote ON/OFF (PS OFF) is available as an option at J301 pin 4.

The TLP150 series is factory supplied with the PS OFF signal open and thus the unit will start-up when a valid input is present.

PS OFF Usage:
- PS OFF = Open (High) implies that the TLP150 unit is ON.
  PS OFF = Closed (Low) implies that the TLP150 unit is OFF.

The maximum external voltage that can be applied to the PS OFF pin is 15 Vdc. The maximum acceptable drive current is 10 mA and the minimum holding current is 1 mA. The remote ON/OFF input can be driven in a variety of ways. Internally to the TLP150 series the remote ON/OFF control logic is on the secondary control electronics. The external remote ON/OFF input can be driven through a discrete device (e.g. a bipolar signal transistor) or directly from a logic gate output. The output of the logic gate may be an open-collector (or open-drain) device. If the external drive signal originates on the primary side, the remote ON/OFF input can be isolated or driven through an optocoupler (in order to maintain the safety isolation barrier).

8.5 Power Good Signal (PW OK)

The PW OK is an active HIGH signal that indicate the readiness of the power supply main output. It will be asserted HIGH (+5 V) 300 ms after the output is within regulation during the start up. It also act as the 1 ms pre-warning signal to the system when the ac input is removed.

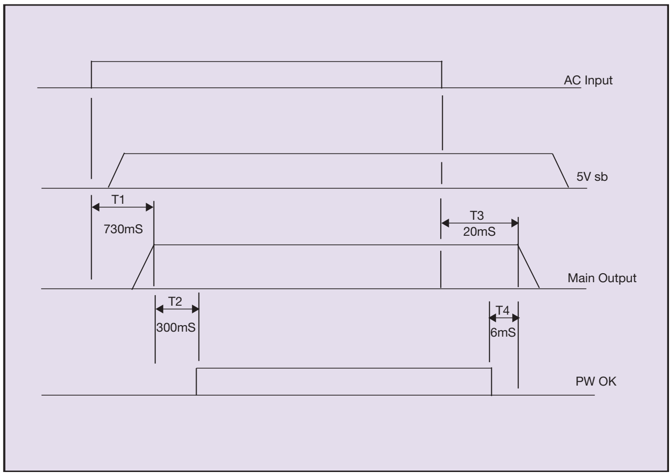

Figure 15 - Typical Values for PW OK Timing @ 85 Vac Input

Ref	Min.	Typ.	Max.	Description
T1	400 ms	730 ms	2000 ms	Main output turn-on upon ac input application
T2	100 ms	300 ms	500 ms	PW OK upon main output turn-on
T3	20 ms	25 ms	32 ms	Main output hold-up
T4	1 ms	2 ms	7 ms	PW OK upon main output turn-off (pre warning)

Table 12 - PW OK Timing

8.6 DC Power Good Signal (DC OK)

The DC OK is an active HIGH (+5 Vdc) signal that indicates the main output voltage of the power supply to be within –12% of the nominal regulation point.

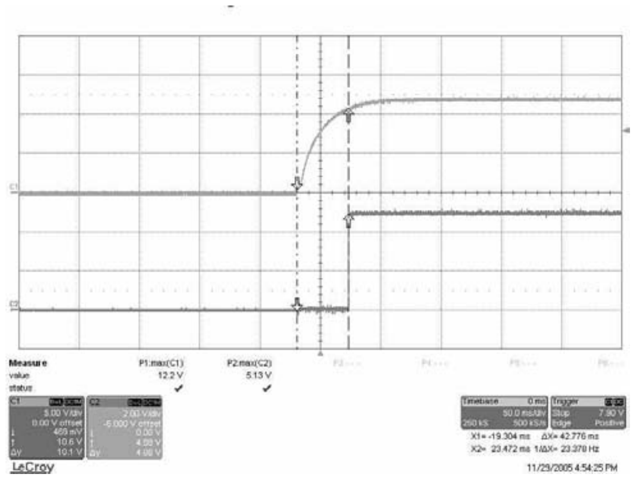

Figure 16 - Typical Turn-on Timing of DC OK with Respect to Main Output. (Channel 1: Output Voltage (12 Vdc); Channel 2: DC OK Signal Upon Output Rise)

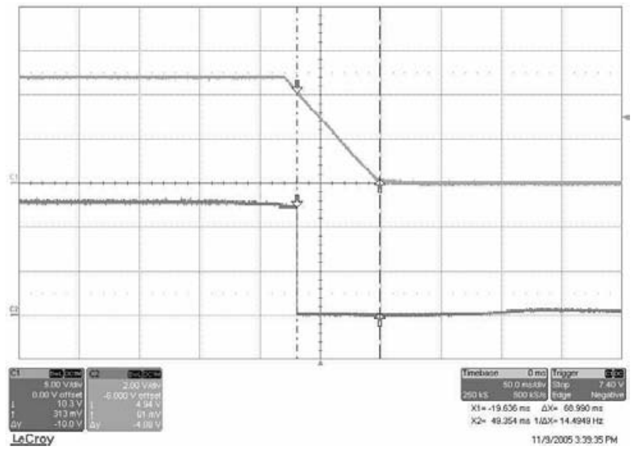

Figure 17 - Typical Turn-off Timing of DC OK with Respect to Main Output. (Channel 1: Output Voltage (12 Vdc); Channel 2: DC OK Signal Upon Fall)

8.7 Remote Sense Compensation

The remote sense compensation feature minimizes the effect of resistance in the distribution system and facilitates accurate voltage regulation at the load terminals or another selected point. A remote sense improves system performance by allowing the power supply to compensate for any 'IR' voltage drop between itself and the load. The remote sense lines will carry very little current and hence do not require a large cross-sectional area. However, if the sense lines are routed on a PCB, they should be located close to a ground plane in order to minimize any noise coupled onto the lines that might impair control loop stability. A small 100 nF ceramic capacitor can be connected at the point of load to decouple any noise on the sense wires. The module will compensate for a maximum drop of 0.2 Vdc of the nominal output voltage. However, if the unit is already trimmed up, the available remote sense compensation range will be correspondingly reduced. Remember that when using remote sense compensation all the resistance, parasitic inductance and capacitance of the distribution system are incorporated into the feedback loop of the power module. This can have an effect on the module's compensation capabilities, affecting its stability and dynamic response.

Notes

- Disconnection of the main output to the load should not occur while the unit is operating, otherwise the full load current may flow on the actual sense wires which may not be appropriately rated to carry such current.
- The remote sense is protected against reverse connection, and if +S and/or –S is connected to the wrong polarity, the power supply may shut down and lock out due to operation of the protection circuits.
- Use of the remote sense is optional, it not used the sense pins can be left open.

8.8 Optimum Thermal Performance

The electrical operating conditions of the TLP150 namely:

- Input voltage, Vin
- Output voltage, Vo
- Output current, Io

determine how much power is dissipated within the power supply. The following parameters further influence the thermal stresses experienced by the converter:

- Ambient temperature
- Air velocity
- Thermal efficiency of the end system application
- Parts mounted on system application that may block airflow
- Real airflow characteristics at the PSU location

8.8.1 Thermal Derating Expectations

The maximum operating ambient temperature is 70 °C. However, the power supplies will have different ratings under natural and forced convection. Under forced air convection, the maximum output power is raised up to 150 W with 200 LFM for all models. Under natural convection, the maximum continuous output power is limited to 100 W for all models and the standby output 5 Vsb shall be derated to 0.5 A.

- For all models at forced air cooling operation above 50 °C (up to 70 °C), a 2.5% per °C power derating should be applied.
- For all models at convection cooling operation below 90 Vac (down to 85 Vac), the output power derates linearly from 100 W to 90 W.

Assuming the converter is operated within its thermal limits it can deliver rated output current Irated. Note, however, that when the unit is trimmed up, the output current may need to be derated so that the output power does not exceed 150 W. The module will still deliver Irated when trimmed down.

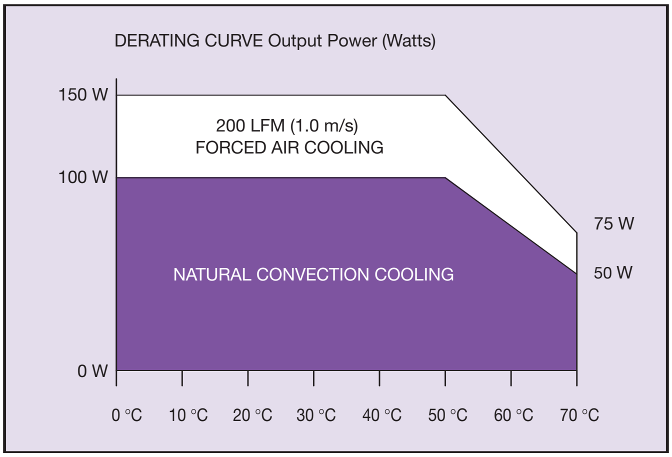

Figure 18 - Derating Curve

The direction of the airflow has different cooling effects. As shown in Figure 19, the recommended airflow direction is blowing from the output side of the power supply. The best airflow direction is from the two short sides. Airflow from the long sides is not recommended.

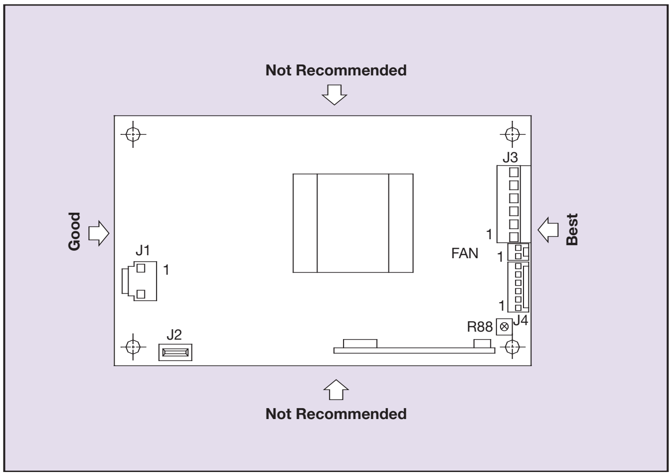

Figure 19 - Airflow Direction

The setup used for characterizing thermal performance and the effective airflow path are illustrated in Figure 20.

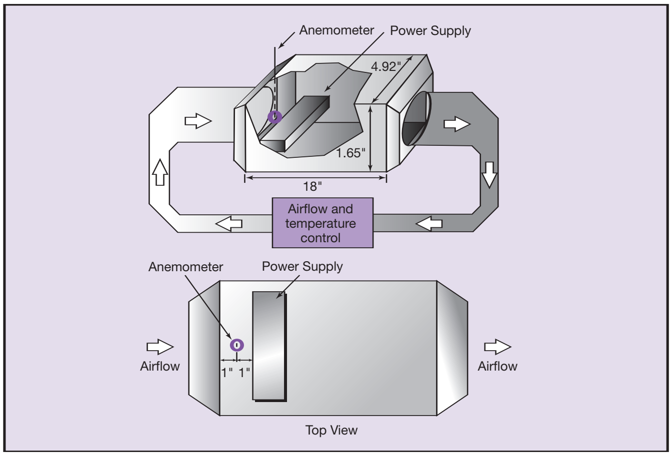

Figure 20 - Illustration of the Setup for Thermal Characterization

The power supply is tested in a wind tunnel of size 125 mm (4.92 inches) x 42 mm (1.65 inches).

8.8.2 Hot Spot Temperature Points

The maximum acceptable temperature measured at the thermal reference points is 120 °C. These thermal reference points are shown in Figure 21.

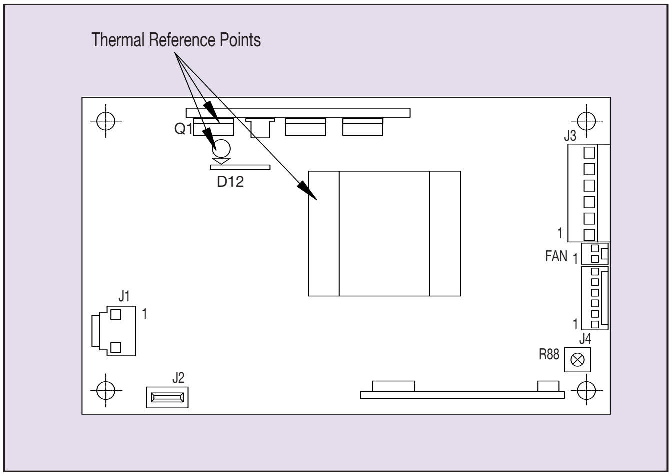

Figure 21 - Thermal Reference Point

Since the thermal performance is heavily dependent upon the final system application, the user needs to ensure the thermal reference point temperatures are kept within the recommended temperature rating. It is recommended that the thermal reference point temperatures are measured using a thermocouple or an IR camera. In order to comply with stringent Artesyn derating criteria the ambient temperature should never exceed 70 °C. Please contact Artesyn Technologies for further support.

8.9 Parallelling and Load Sharing Operation

8.9.1 Passive and Active Parallelling

The outputs of the TLP150 series can be connected in parallel with identical outputs of another similar TLP150 supply. However, under such passive current sharing conditions the output of one supply may reach maximum current before the paralleled supply begins to provide current.

Thus the TLP150R series are designed with active current share on the main output, in order to balance output currents between paralleled supplies. One wire common bus, active (democratic) current sharing scheme is employed to achieve current sharing between units. Here output current imbalance of the paralleled units is used to correct output voltage so that the load current will be shared within ±10% of the full load rating of the output. To implement load sharing, the output voltages of paralleled outputs must be individually set to within 2% of each other.

Connector J4 Pin 4 (LS = load share) on the secondary side control connector is provide to connect the current sharing bus between paralleled 'R' units.

Simply direct connect the two LS pins from the paralleled units with the shortest wire possible in daisy chain fashion. Care should be taken in order not to pass the LS bus through electrically 'noisy' parts of the system to prevent noise pick up, which will affect the accuracy of the current sharing and output regulation. If not in use, the LS pins maybe left open.

Note: Remote sense pins (+S and -S) on both paralleled units should be connect to the point of load.

8.9.2 Redundancy and Fault Tolerance

For true redundant and fault tolerant applications, an Or-ing element (diode or similar device) may be placed in each output of each paralleled supply to prevent interaction in the event of failure. Here the Or-ing element blocks fault current from affecting the remaining good units within the chain.

The Or-ring element may be factory supplied located within the power supply, on the main and auxiliary outputs (refer to 'R' options within the model nomenclature on page 2).

Notes

- The remote sensing included in the TLP150 series is capable of sensing the common bus after the Or-ing elements, thereby maintaining regulation limits at the regulation limits at the remote sense point. When Or-ing elements are used, load sharing may be used to balance currents.
- When operating alone, the LS signal may be used to measure output current where 3 V ±10% equals 100% load.
- The maximum number of same rated TLP150 units that can be connected in parallel is unlimited, provided that there is a monitoring mechanism in the user system to make sure that the system will draw n X rated full load only after there are n X number of PW OK signals asserted HIGH.

8.10 Load Types and Output Capacitance
The TLP150 series is designed for both resistive and constant current load. The maximum rated value of output capacitance for each model will differ, due to equivalent series resistance (ESR) load capacitance types.

Sample DVT testing results:
12 V model = 10,800 µF electrolytic
24 V model = 2,850 µF electrolytic
48 V model = 1,000 µF electrolytic

Contact your local Artesyn Technologies representative for further information if larger output capacitance values are required in the application.

8.11 Reflected Ripple Current and Output Ripple and Noise Measurement
The measurement set-up outlined in Figure 22 has been used for output voltage ripple and noise measurements on the TLP150 series. When measuring output ripple and noise, a 50 Ω termination should be used to prevent impedance mismatch reflections disturbing the noise readings at higher frequencies. Measurements were taken directly at the output terminals via a 6 in output cable (wiring = twisted pair) with a 20 MHz bandwidth. A 10 µF tantalum capacitor and a 0.1 µF ceramic capacitor are used across the test points during the measurement. The ripple and noises are measured at 60 Hz input with North American line (90 Vac to 132 Vac) or 50 Hz input with European line (180 Vac to 264 Vac). Please refer to datasheets for the specification and Figure 22 for the test setup and measurement recommendations.

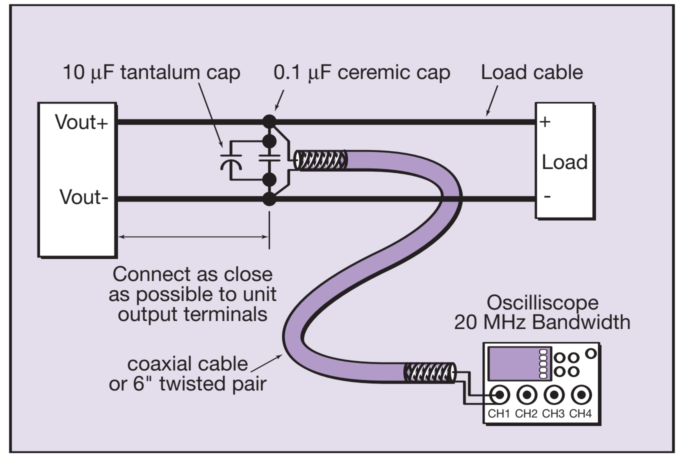

Figure 22 - Illustration of Setup for Ripple and Noise Measurement

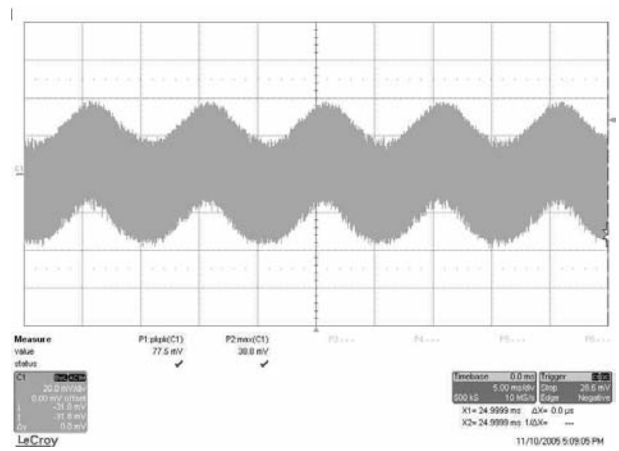

Figure 23 - Sample Ripple and Noise Measurement (12 Vdc Model)

	OUTPUT	LOADING	RIPPLE & NOISE		SPEC (12 V)
Vin (Vac)	5 Vsb	12 V	(mVp-p, 5 Vsb)	(mVp-p, 12 V)	(mVp-p)
85	0 A	0 A	13.1	19.2	<120
85	0 A	12.5 A	18.8	84.6	<120
85	1 A	0 A	26.3	19.4	<120
85	1 A	12 A	31.6	80.8	<120
264	0 A	0 A	19.4	19.4	<120
264	0 A	12.5 A	23.8	81.2	<120
264	1 A	0 A	46.3	19.6	<120
264	1 A	12 A	42.8	80.3	<120

Table 13 - Sample Ripple and Noise For 12 V Model
Tested with ripple filter 10 µF Tantalum-Capacitor in parallel with 0.1 µF Ceramic Capacitor