NLX Power Supply Recommendations

Version 1.1

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Version 1.1, May 1997

Revision History

1.0	Original reference document
1.1	Updated Figure 1 to metric dimensions and to increase air inlet grill area. Add Figure 2: Chassis Cutout. Add Table 1: Remote On/Of Signal Characteristics. Add Table 2: PW-OK Signal Characteristics. Add Section 4.3 Input Voltage Range. Updated Figure 5: Optional Power Supply Connector Configuration. Changed pin 4 from '1394R' to 'Reserved'. Updated 1394 Section to remove 1394R pin and requirement for isolation. Updated Table 5: Suggested Wire Color Code for Optional NLX Power Supply Connector to solid color wire. Added Section 7.1 Blue Angel. General clean-up and section renumbering.

Contents

List of Figures

List of Tables

1. Scope

This document provides a reference for an NLX power supply. It is provided as a convenience only and is not intended to replace or supplement the user's independent design and validation activity. It includes information about the physical form factor of the power supply, cooling requirements, connector configuration, and pertinent signal timing specifications. Power requirements will vary depending on the specific system configuration. The specific current requirements for an individual power supply will not be discussed here..

2. NLX Power Supply

The location and fan direction for a power supply in an NLX system should accommodate proper cooling for the power supply and integrated chassis components. A standard PS/2 power supply can be modified to support an NLX form-factor system by making a few modifications. These modifications include adding a 3.3V supply rail, PS On, 5 VSB, and possible repositioning of fan venting locations. Consolidating the baseboard connectors into one 20-pin header is also required. Although exhausting warm air from the chassis through the power supply is the preferred airflow solution, other airflow solutions may be implemented to meet the specific cooling requirements.

3. Physical Parameters for an NLX Power Supply

The physical size of an NLX power supply is compatible with the standard PS/2 power supply footprint. Figure 1 is a reference to the physical characteristics of the mounting locations, external dimensions, and venting locations for an NLX power supply.

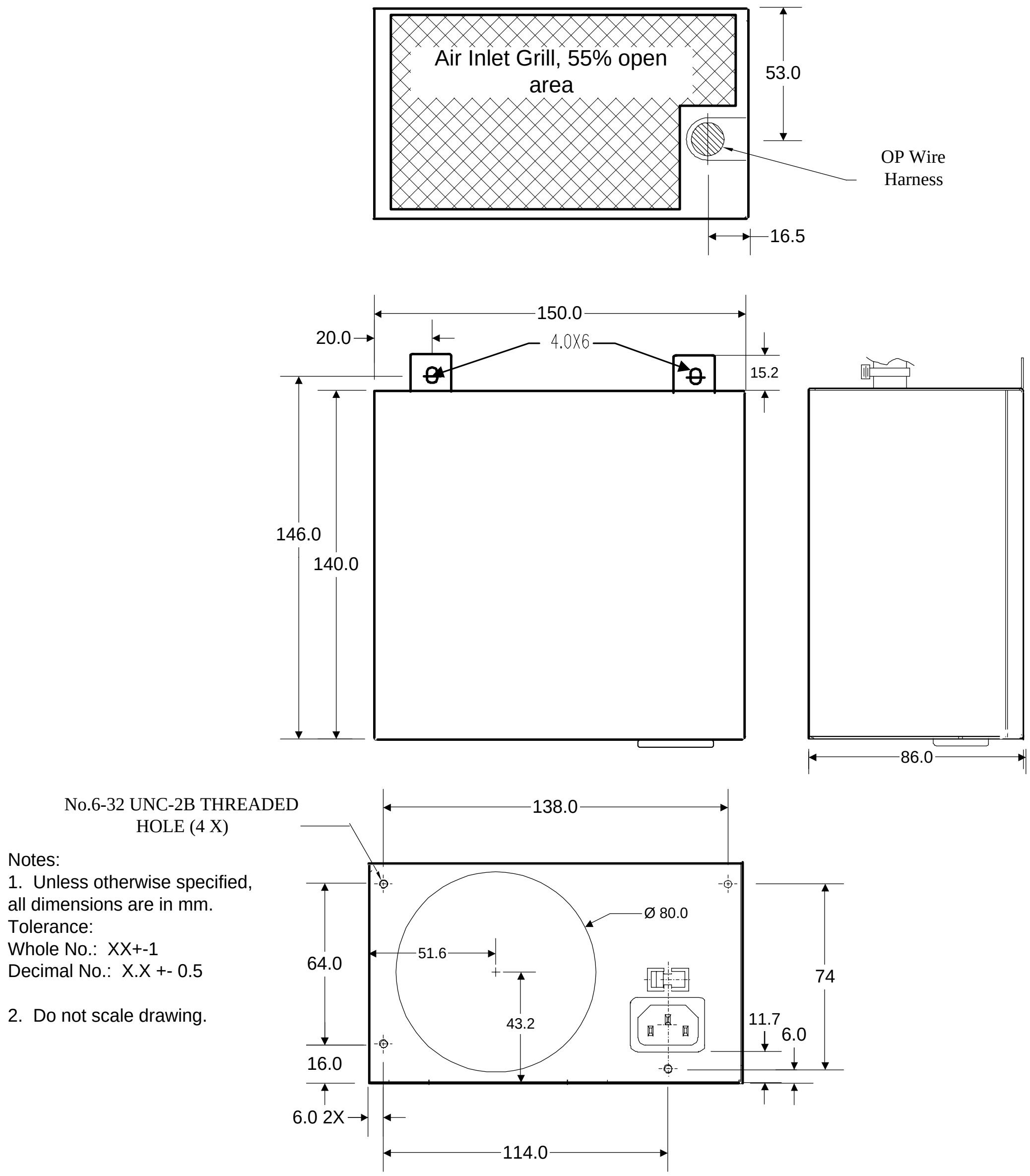


Figure 1: NLX Power Supply Dimensions

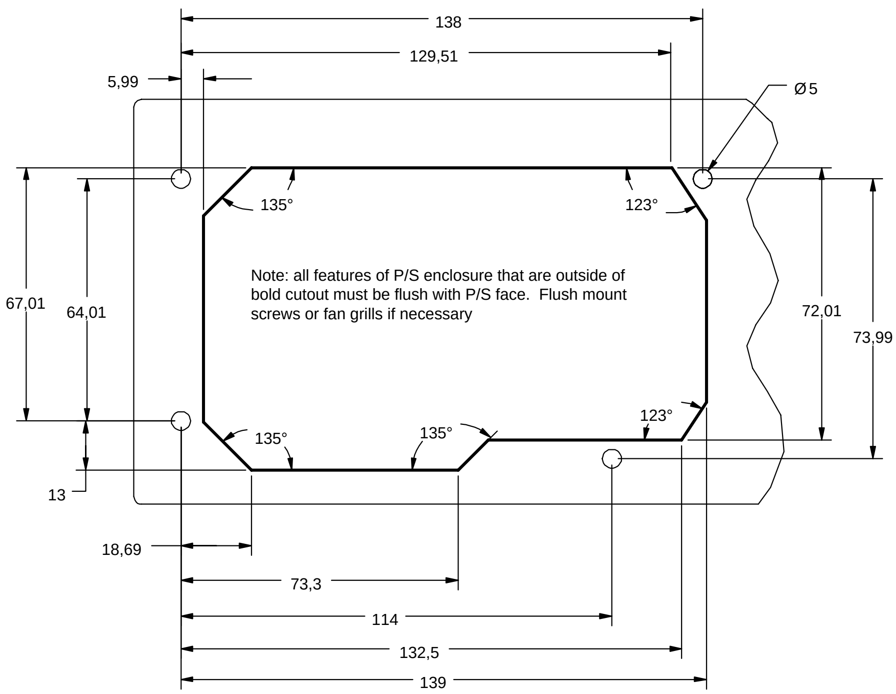


Figure 2: Chassis Cutout

4. Connectors and Cables

Figure 3 shows an example connector pinout. This connector may be implemented with a Molex 39-29-9202 or equivalent. This mates with the power supply connector, Molex 39-01-2200 or equivalent.

The exact location of the power connector is not specified here. Power is routed down through the riser connector to the motherboard. The power connector should be placed as close to the riser connector as possible while still leaving it accessible for easy connection.

ALSO MAIN 3.3V SENSE) 3.3V	11	1	3.3V
-12V	12	2	3.3V
COM	13	3	COM
PS-ON	14	4	5V
COM	15	5	COM
COM	16	6	5V
COM	17	7	COM
-5V	18	8	PW-OK
5V	19	9	5VSB
5V	20	10	12V

Figure 3: Power Supply Main Power Connector Configuration

4.1 Power Signal Control Signals

4.1.1 PS-ON

The PS-ON signal is required if the remote on/off by software, wake-on LAN, or wake-on modem features of the NLX mother board are implemented. Implementation of PS-ON also requires implementation of 5 VSB described in the next section. PS-ON is an active low, TTL compatible signal that turns on the 3.3V, 5V, -5V, 12V, -12V, and 1394 power rails. When this signal is held high by the PC board, or left open circuited, outputs of the power rails should not deliver current and should be held at a zero potential with respect to ground. The power supply should provide potential at the 3.3V, 5V, -5V, 12V, -12V, and 1394 power rails only when this signal is held at ground potential. This signal should be held at +5 VDC by a pull-up resistor internal to the power supply.

Table 1: Remote On/Off Signal Characteristics

PS-ON	MIN	MAX
Vil, Input Low Voltage		0.8V
Iil, Input Low Current, Vin = 0.4V		-1.6mA
Vih, Input High Voltage, Iin = -200uA	2.0V	
Vih open circuit, Iin = 0		5.25

4.1.2 5 VSB

5 VSB is required for the implementation of PS-ON described above. 5 VSB is a standby voltage that may be used to power circuits that require power input during the powered-down state of all power rails. The 5 VSB pin should deliver 5V ± 5% at a minimum of 720mA for PC board circuits to operate. Conversely, PC boards should draw no more than 720mA maximum from this pin. This power may be used to operate circuits such as soft power control, wake-on-LAN, wake-on-MODEM, and tamper detect..

4.1.3 PW-OK

PW-OK (Table 2) is a power good signal and should be asserted high by the power supply to indicate that the +5 VDC and +3.3 VDC outputs are above the under-voltage thresholds of the power supply. When this signal is asserted high, there should be sufficient mains energy stored by the converter to guarantee continuous power operation within specification. Conversely, when either the +5 VDC or the +3.3 VDC output voltage falls below the under-voltage threshold, or when mains power has been removed for a time sufficiently long so that power supply operation is no longer guaranteed, PW-OK should be deasserted to a low state. SeeFigure 4 for a representation of the timing characteristics of the PW-OK, PS-ON, and germane power rail signals.

Table 2: PW-OK Signal Characteristics

Signal Type:	Open collector +5 VDC, TTL compatible
Logic level low:	< 0.4V while sinking 4 mA
Logic level high:	between 2.4 VDC and 5 VDC output while sourcing 200 µA
High state output impedance:	1KΩ from output to common
POK delay:	100 ms < T_3 < 2000 ms
POK rise time	$T_5 \leq$ 10ms
Power down warning:	T_4 > 1 ms

4.2 3.3V Sense

A default 3.3V sense line should be implemented on pin 11 of the connector. This sense line should be overridden by the 3.3V sense line on the optional connector if implemented and connected. See optional connector information for details.

4.3 Input Voltage Range

Table 3 lists reference AC input voltage and frequency ranges.

Table 3: Input Voltage Range

Parameter	Min.	Nom.	Max.	Units
Voltage	90	115	135	Vac_{rms}
	180	230	264	Vac_{rms}
Frequency	47	--	63	Hz

4.4 Voltage Tolerances

Table 4 lists reference tolerances. Note that the tolerance for the 1394 voltage rail is not specified here. The voltage required for 1394 can be from an unregulated source.

Table 4: Voltage Tolerances

Voltage Rail	Tolerance
+5 VDC	**± 5%**
-5 VDC	**± 5%**
+12 VDC	**± 5%**
-12 VDC	**± 5%**
+3.3 VDC	**± 4%**
+5 VSB	**± 5%**

4.5 Signal Timing

Figure 4 is a reference for signal timing for main power connector signals and rails. Suggested timing relationships are:

$$2\text{ms} \leq T_2 \leq 20 \text{ ms}, 100 \text{ ms} < T_3 < 2000 \text{ ms}, T_4 > 1 \text{ ms}, T_5 \leq 10\text{ms}$$

The 3.3 VDC lines should always be held to a lower potential than the +5 VDC lines during power up and power down states. This feature allows for improved reliability of motherboard designs at a reduced cost.

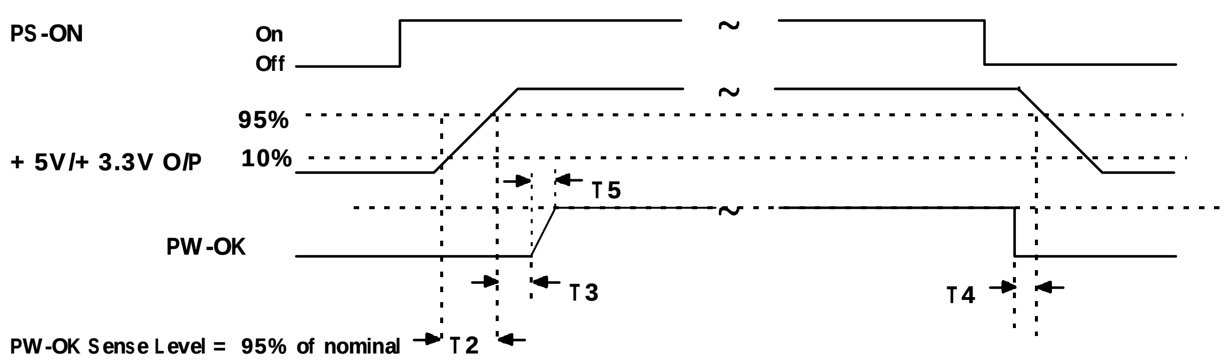


Figure 4: Timing of PS-ON, PW-OK, and Germane Voltage Rails

4.6 Optional Power Connector

In addition to the main power connector, a 2X3 optional connector from the power supply may be used to supply such ancillary functions as fan monitoring, fan control, 1394 power source, and remote 3.3V sense line. This connector may add benefits that are compelling for a full featured system:

- The fan monitor features add the ability to monitor and detect fan failures.
- Implementation of a built-in fan control allows the motherboard to request fan shutdown when the system goes into a sleep or suspend mode.
- Fan speed control is possible to allow for slower fan speeds during low power usage.

Figure 5 shows the pinout for an optional 2X3 connector. The PC board connector should be implemented with a Molex 39-30-1060 or equivalent connector. This mates with the power supply connector, Molex 39-01-2060 or equivalent.

The following sections discuss implementation of the FanM, FanC, Sense, and 1394 signals. Implementation should be done as described here if a standard optional connector is used.

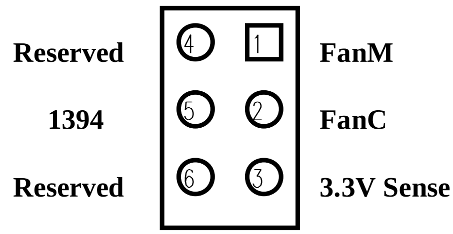


Figure 5: Optional Power Supply Connector Configuration

4.6.1 FanM Signal

The FanM signal is an optional fan monitor signal. It is an open collector, 2 pulse per revolution tachometer signal from the power supply fan. The signal stops cycling during a lock rotor state; the level can be either high or low. This signal allows the system to monitor the power supply for fan speed or failures. Implementation of this signal would allow a system designer to gracefully power down the system in the case of a critical fan failure. The monitoring circuit on the motherboard should use a 1k Ohm to 10k Ohm pull-up resistor for this signal. The output of this signal should be fed into a high impedance gate for the motherboard implementation. See Figure 6 for a simple illustration of the basic circuit requirements. If this signal is not implemented on the motherboard or riser card, it should not impact the power supply function.

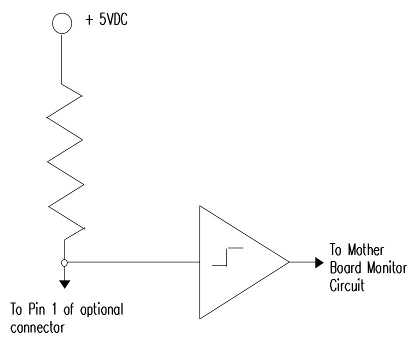


Figure 6: Simple Implementation of a Fan Monitor Circuit

4.6.2 FanC Signal

The FanC signal is an optional fan speed and shutdown control signal. The fan speed and shutdown are controlled by a variable voltage on this pin. This signal allows the system to request control of the power supply fan from full speed to off. Implementation of this signal would allow a system designer to implement a request-fan-speed control or shut-down during low power states such as sleep or suspend. The control circuit on the motherboard should supply voltage to this pin from +12 VDC to 0 VDC for the fan control request.

- If a voltage level of +1 volts or less is sensed by the power supply at pin 2 of the optional connector, the fan is requested by the motherboard to shut down.
- If a voltage level of +10.5 volts or higher is being supplied to pin 2, the fan in the power supply is requested to operate at full speed.

A 10K (minimum) pull-up resistor should be supplied on the riser card of the NLX system to the signal from the riser connector, and this signal should then be routed to pin 2 of the power supply connector. See the *NLX Motherboard Specification* for details of the signal that is supplied at the riser connector. The fan control in the power supply may be implemented so that it allows variable speed operation of the fan, depending on the voltage level supplied. If, for example, a +6 volt signal is sensed at pin 2, the power supply would operate the fan at a medium speed. If this signal is used for on/off control of the power supply fan, and speed control is not implemented in the fan control circuit of the power supply, the power supply fan should operate at full speed for any voltage level over +1 VDC. The power supply should draw no more than 20mA from pin 2 of the optional power supply connector. A pull-up should be used internal to the power supply for this signal so that if the connector is left open, the fan will be requested to operate at full speed.

4.6.3 3.3V Sense Line

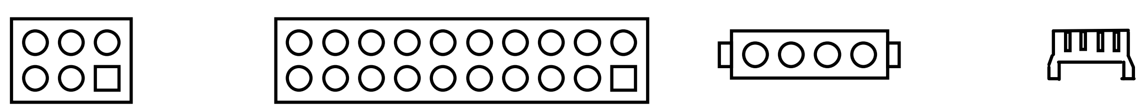
A remote 3.3V sense line can be added to the optional connector to allow for accurate control of the 3.3 VDC line directly at motherboard loads. Because of potential voltage drops across the connector and traces leading to the motherboard components, it may be advantageous to implement a 3.3V sense line that remotely monitors the 3.3 VDC power level at the load on the motherboard. The implementation of this signal should be such that if an NC condition is detected on this line, the default 3.3V sense line on the main connector would be used for sensing the 3.3 VDC voltage level.

4.6.4 1394

1394 is an optional output to support unbiased devices on the IEEE 1394 serial bus. This pin on the optional connector allows for implementation of a segregated voltage supply rail for use with unpowered 1394 solutions. The power derived from this pin should be used to power only 1394 connectors. The output of this power rail is dependent on the 1394 compatibility required. Use of this power rail for motherboard or other power needs may have unpredictable results, because power for 1394 devices is not required to be regulated and may provide voltage levels between 8 and 40 volts. See the 1394 specification for details on the specific power requirements for this voltage rail.

4.7 Power Supply Wiring Recommendations

There is no specific requirement for lengths or coloring of wiring from the power supplyFigure 7 shows suggested wire lengths. Table 5 and Table 6 suggest wire color coding that is followed by many vendors, but this color coding is NOT required.



Optional Connector
Length = 150mm (5.9”)

Main Power Connector
Length = 150mm (5.9”)

Peripheral Connector
Length = 254mm (10.0”)

Floppy Connector
Length = 254mm (10.0”)

Suggested Cable Lengths are from the face of the power supply to the intersection of the cable and connector

Figure 7: Suggested Default Cable Lengths

Table 5: Suggested Wire Color Code for NLX Main Power Supply Connector

18 AWG Wire	Signal	Pin	Pin	Signal	18 AWG Wire
Orange(22AWG) Brown(22AWG)	+3.3 VDC 3.3V sense	11 11	1	+3.3 VDC	Orange
Blue	-12 VDC	12	2	+3.3 VDC	Orange
Black	COM	13	3	COM	Black
Green	PS-ON	14	4	+5 VDC	Red
Black	COM	15	5	COM	Black
Black	COM	16	6	+5 VDC	Red
Black	COM	17	7	COM	Black
White	-5 VDC	18	8	POK	Gray
Red	+5 VDC	19	9	+5 V_{SB}	Purple
Red	+5 VDC	20	10	+12 VDC	Yellow

Table 6: Suggested Wire Color Code for Optional NLX Power Supply Connector

22 AWG Wire	Signal	Pin
White	FanM	1
Blue	FanC	2
Brown	3.3V Sense	3
NC	NC	4
Grey	1394	5
NC	NC	6

5. Typical Power Distribution

Although power requirements and distributions will depend on the specific implementation, this section will identify a typical configuration. For a low profile desktop solution with one ISA slot, one PCI slot, one shared slot, and four peripheral bays, a 145Watt sustained (160 Watt peak) power supply should be sufficient for a typical application. Table 7 lists the power suggestions for this type of application. An expandable desktop or minitower solution may require more power depending on the configuration implemented and the user model specified.

Table 7: Typical Power Distribution for a Low Profile Solution

Output voltage	Min. current (amps)	Max. current (amps)	Peak Current (amps)	Notes:
+12 VDC	0.0	1.4	4	
+5 VDC	1.0	16.0	18	
+3.3 VDC	0.3	9.2	16	
-5 VDC	0.0	0.1		
-12 VDC	0.0	0.2		
+5 VSB*	0.0	0.72		

* +5 VSB is a SELV standby voltage that is always present when AC mains voltage is present.

6. Power Supply Airflow

An NLX power supply should be designed to provide maximum airflow to cool both the power supply and integrated system devices. The exact venting location and geometry as well as fan selection for the power supply will vary, depending on the complete system solution being implemented. The fan should allow sufficient airflow through the chassis to accommodate proper cooling. As a baseline for designing the power supply, it is recommended that 23 CFM minimum be present at the outlet of the power supply. Refer back to Figure 1 for one possible configuration for the power supply vent inside the system. The configuration for the power supply vent on the outside of the system should provide the least possible restriction on the airflow. One recommended solution is to provide a wire fan grill instead of the common stamped sheet metal designs; Figure 8 shows an example. Refer to the *NLX Thermal Design Suggestions*, available at the web site www.teleport.com/~nlx, for a detailed discussion of design considerations relating to fans, venting, and airflow in an NLX system.

It should be noted that tradeoffs exist between the airflow provided, acoustical noise generated by the system, and cost. Structures that attempt to control or restrict airflow will generate acoustical noise and should be designed to provide minimum noise levels achievable. Well vented systems with low flow impedance may allow the use of quieter, lower power fans.

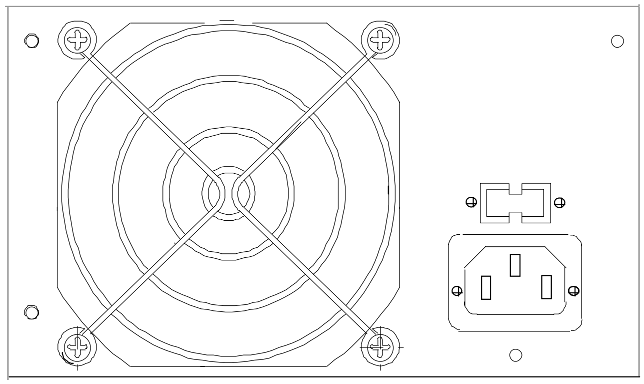


Figure 8: External Fan Grill for Possible Venting Solutions, Example

7. Sleep Mode

The intent of fan control is to allow for a system to operate silently during a sleep state. During this sleep state most computers will consume less than 30 Watts of power. If the power supply comes equipped with fan control capabilities via the optional connector, it should be capable of cooling internal components without the use of the fan during a normal sleep cycle.

7.1 Blue Angel

It is the system designer's responsibility to select components such that the standby load and power supply efficiency shall be of a magnitude that the system shall meet Blue Angel "off but communicating" state of less than 5W AC input, at nominal line (115VAC for 120v mode and 230VAC for 230v mode), the main outputs are in the "DC disabled" state.

7.2 Fanless Operation Characteristics

A baseline for design of a fan control feature is to assume use of 30 Watts for the system during a sleep state. The power supply should be capable of maintaining fanless operation while dissipating internally generated power. The internal power dissipation can be based on the 30 Watt usage model assumption. In a typical power supply with 62% efficiency, the internal power to be dissipated by the power supply would be:

$$(100\% - 62\%) * 30 \text{ Watts} = 11.4 \text{ Watts}$$

In this case the power supply should be capable of dissipating 11.4 Watts of power without the use of a fan.

7.3 Fan Control Override

The power supply fan control is a request signal and should not be used as a direct control for the fan. If the internal sensor in the power supply detects a condition wherein the power supply requires operation of the fan, and a fan shut down or slow down request is received, the power supply should make the determination to continue fan operation. When the power supply has reached an internal ambient that is within normal operating limits, the fan request should be complied to.