2 T807/808 Circuit Operation

This section provides a basic description of the circuit operation of the T807 / 808 Switch Mode Power Supply.

The following topics are covered in this section.

2.1 Introduction

The Tait T807/808 switched mode power supply uses the well proven conventional half-bridge, push-pull topology.

Regulation of the output voltage with varying mains input voltage and load conditions is provided by pulse width modulation of power MOSFET transistors at the primary of the main isolating transformer.

2.2 Mains Input Circuitry

When the mains supply is first connected to the unit, R3 will limit the maximum inrush current to an acceptable level. The large filter capacitors (C9 to C12) at first show a very low impedance, which would result in excessive inrush current without R3. Once the supply has begun to function, RLY1 will switch, shorting out R3 and avoiding excessive power dissipation in R3.

The incoming mains is filtered to remove noise and spikes, R2 and R49 providing protection against high voltage spikes that may be on the mains supply. In 230V mode, D1 to D4 act as a conventional bridge rectifier and C9 to C12 are the smoothing capacitors. In 115V mode, D1 and D2 together with C9 to C12 form a conventional voltage doubler circuit to provide the same overall DC voltage as in 230V mode. R4 and R7 serve to equalise the voltage appearing across the series connected capacitors. C9 to C12 are high temperature, high ripple current capacitors. C14 and C13 are low loss, high frequency capacitors and together with T1, Q1 and Q2 form a conventional half-bridge, push-pull circuit, operating at 166kHz. D14, D15, D18 and D19 provide reverse voltage protection for Q1 and Q2.

2.3 Undervoltage Lockout & Fan Control

R50 and D31 provide a 5.6V reference to the 2 comparators formed by IC3. IC3 (pins 1, 2 & 3) is a comparator that is configured with R5, R6, R8, R53 and R54 to detect low AC input conditions. The values are such that for an AC input of 185V [95V] or less, the comparator shuts down the main control circuitry via IC4 pin 10. R52 provides approximately 5V hysteresis to prevent on/off oscillations due to mains fluctuations caused by loading when the supply turns on.

The purpose of the comparator formed by IC3 (pins 5, 6, & 7) and R55 is to prevent the fan from being activated when the ambient temperature drops below -10C, as the bearings inside the fan become prone to excessive wear. R59 provides a few degrees of hysteresis.

2.4 Main Isolation Transformer T1, Snubbing Network & Output Rectifier

T1 provides the required isolation between input and output and its small size is due to the high operating frequency and low loss ferrite core. This transformer is hi-pot tested to 3750V to ensure compliance with the most stringent VDE safety regulations.

The main secondary winding is centre tapped, thus requiring only 2 diodes (D43) to provide full-wave rectification, resulting in reduced power loss. R11, C15, R79, C66 and C67 provide some high frequency snubbing. The effect of this snubbing is twofold: firstly, it reduces high frequency spikes due to leakage inductance, and, secondly, it shapes the load line, resulting in reduced switching losses within Q1 and Q2.

2.5 Output Filter & Minimum Load

T5, C68 to C73, C76 and C78 reduce the 166kHz ripple to an acceptable level, while C74, C75, L6, C79, C80 and C81 reduce the level of higher frequency noise components.

Q9 switches in R81, R82 and RLY1 which serve as a minimum load to enhance stability. Q9 is activated via D41 only when the supply is active. This ensures that R81, R82 and RLY1 will not drain any back-up batteries that might be present on the supply output, while the supply is switched off or the mains supply is interrupted.

2.6 Output Voltage Regulation & Switching Transistor Drive

The output voltage is sampled via R84 and R83 (or SKT 7 if remote sense is used), fed to IC8 (a programmable high stability zener diode), and the error voltage transmitted by IC7 to the pulse width modulator IC (IC4). R91 to R96 and C86 to C89 form the stabilisation network which ensures good transient response and loop stability. IC4 contains an oscillator whose frequency is determined by R71 and C59. R72 sets the dead time between pulses to approximately 1s. IC4 modulates the width of the output pulses and is buffered by the high current CMOS drivers, IC5 and IC6. The output from the buffers feeds into T3 which provides the isolated and correctly phased drive to Q1 and Q2. R18 and R20 provide low resistance to the FET gates which, in their normal high impedance states, are prone to spurious turn-on. R17 and R19 lower the Q of the gate drive circuitry in order to prevent excessive ringing which can otherwise cause the FETs to turn on at the wrong time.

2.7 Current Limit Circuitry

T2 is a current transformer and the current sampled is converted to voltage by R12. D5 to D8 rectify the sampled waveform which is then sent to a current limit comparator IC1 (pins 1, 2 & 3). This current limit is set at 10% above the normal load capability of the supply. Comparator IC1 (pins 5, 6 & 7) is responsible for protecting the supply against short circuit conditions and limits the short circuit current to a level that is safe for extended periods (approximately 90% of output capability).

Note: ***Issue 05 & 07.*** An indication of overcurrent and approaching overcurrent is had by LED D23. This LED starts to glow approximately ½ Amp lower than the current limit set point.

2.8 Output Overvoltage & Reverse Polarity Protection

2.8.1 Issue 05 & 07

Protection against reverse polarity situations is provided by D43, the main rectifier diode. The supply has an overvoltage protection circuit based on sampling the AC voltage from T1. D38 detects this voltage and R40, 43, 45, C18 and 19 filter the waveform to extract a voltage which is very nearly proportional to the output voltage of the power supply. The voltage is compared to a presettable reference by IC1 (pins 1, 2 & 3). If the sampled voltage is higher than the reference, IC1 outputs a high to trigger the shutdown circuitry. Overvoltage is indicated by both “On” and “Overload” LEDs flashing on and off. Overvoltage can be caused by a failure in the remote sense circuitry outside of the power supply.

2.8.2 Issue 03

Protection against reverse polarity situations is provided by D46, a special high energy diode that reacts instantly to overvoltage DC or spikes. If an overvoltage condition persists which may cause excessive power dissipation, D46 will become short circuit and will need to be replaced before proper operation of the power supply can resume. D46 also provides some level of protection against reverse polarity connection, as it also acts as a normal diode. The level of protection afforded by D46 is only a "first level" approach, in that it protects mainly the supply itself. As protection is very dependent on system configurations, further protection should be determined and implemented by the system engineer (refer also to Section 7).

2.9 Overtemperature Protection

Protection against overheating is provided by thermal cut-out TC1. Should the temperature of the main transformer (T1) rise to an unsafe level, TC1 will interrupt the supply voltage to the control circuitry and the supply will shut down. There is some hysteresis in TC1 and only after the temperature has dropped by approximately 5°C will it restore power to the control circuitry, thus restoring normal operation.

2.10 Mains And/or Power Supply Fail Alarm

In the case of a mains and/or power supply failure, a "logic 0" (0V) is available at the "Mains/PS Fail Alarm" output, even with a battery connected across the main DC output.

If there is no fault with the mains or power supply, the main DC output voltage (typ. +13.8V) is supplied to this alarm output via Q8 and R99.

2.11 Noise Modulator

2.11.1 Issue 05 & 07

Q11 and Q12 form the white noise circuit and are further amplified/buffered by Q13. The noise modulates the frequency of oscillation of IC4, the switched mode control IC. The purpose of the noise modulator is to spread the discrete harmonic frequencies energy of the switching circuits over a wide bandwidth so that possible interference is minimised. This results in an overall reduction in noise of approximately 10dB.

2.11.2 Issue 03

A noise modulator PCB is available as an add-on for Issue 03 PCBs, under IPN 220-01268-00. This solders on to TP4 and works as described above.