A Comparison of Telecom Hot Swap Power Managers TPS2398/99 vs. TPS2390/91

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ABSTRACT

This application note compares and contrasts the TPS2398/99 hot swap power managers to the TPS2390/91.

1 Comparison of TPS2390/91 and TPS2398/99

The TPS2398/99 and the TPS2390/91 hot swap power managers are 8-pin, controlled current, hot swap protection devices for −48-V telecommunication systems. All four devices provide programmable current limiting, programmable current ramp, an enable input, ability to withstand −100-V transients, and a programmable fault time during which transients are ignored to avoid nuisance trips of the overcurrent circuit. The TPS2390 and TPS2398 latch off in the case of an over current fault while the TPS2391 and TPS2399 will turn off and attempt to repower the load after a fault-clearing delay time. The four devices have much in common. However, the TPS2398/99 differ from the TPS2390/91 devices in two subtle but significant functions which are described below.

The common aspects of these four devices are covered in detail in TI's application report (SLUA283) – *Universal Telecommunications Hot Swap Family*. Some useful definitions are;

1. Minor overcurrent event/minor overcurrent condition – Current through R_{SENSE} is causing a voltage drop across R_{SENSE} such that 40 mV < V_{RSENSE} < 100 mV.
2. Major overcurrent event/major overcurrent condition – Current through R_{SENSE} is causing a voltage drop across R_{SENSE} such that V_{RSENSE} > 100 mV. Datasheet calls this an overload.
3. Fault time – A period of user set length which starts immediately upon detection of any overcurrent condition (major or minor). Fault time is set by the capacitor from the FLTTIME pin to $–V_{IN}$. Device response is different for the four devices. However, during fault time the GATE output of all four devices will regulate current to the programmed current limit level for minor overcurrent events.
4. Fault clearing time – A period ~ 100 times the programmed fault time. It is the time between restart attempts performed by the TPS2391 and TPS2399. Restart attempts are made after an overcurrent condition of sufficient duration and/or magnitude has caused the power FET to turn off.

Figure 2 shows a −48-V controlled-current hot swap circuit built around a functional block diagram of the TPS2398/99. Figure 3 shows a TPS2390/91 similarly configured. Note that almost all the differences are in the control circuitry.

2 What is Different?

2.1 $\overline{\text{Power Good}}$ Output vs. $\overline{\text{FAULT}}$ Output

The most obvious difference between the TPS2398/99 and the TPS2390/91 is the $\overline{\text{PG}}$ ($\overline{\text{Power Good}}$) output of the TPS2398/99 which replaces the $\overline{\text{FAULT}}$ output of the TPS2390/91. Both $\overline{\text{PG}}$ and $\overline{\text{FAULT}}$ are open-drain, active-low signals. Unlike $\overline{\text{FAULT}}$, the $\overline{\text{PG}}$ output can be used to sequence downstream supplies or provide power ready feedback to a controller. $\overline{\text{FAULT}}$ can be used as an error signal to a status monitor system. Table 1 is a detailed functional comparison of $\overline{\text{FAULT}}$ on the TPS2390/91 to $\overline{\text{PG}}$ on the TPS2398/99.

Table 1. TPS2390/91 $\overline{\text{FAULT}}$ Output vs. TPS2398/99 $\overline{\text{PG}}$ Output

	TPS2390/91 ($\overline{\text{FAULT}}$ Output)	TPS2398/99 ($\overline{\text{PG}}$ Output)
Event(s) required to cause assertion	1) Still in current regulation mode at end of $\overline{\text{FAULT}}$ timer period or 2) Overload causes greater than 100-mV drop across R_{SENSE}.	1) The TPS2398/99 output has been enabled by a high signal on the EN pin and 2) The TPS2398/99 GATE pin is over 7 V and 3) The voltage on the TPS2398/99 IRAMP pin is over 5 V.
Event(s) required to cause deassertion	1) Cycle EN input or V_{IN} off then on or 2) **TPS2391 ONLY** − device attempts to reapply power to the load at intervals which are ~100 times the fault time set by the capacitor on the FLTTIME pin. If device is not in current limit at end of fault time then $\overline{\text{FAULT}}$ will deassert.	1) EN pin deasserts or 2) An overcurrent condition exists for the duration of the set fault time. NOTE**:** An overcurrent causing V_{RSENSE} to exceed 100 mV causes GATE to go low immediately but $\overline{\text{PG}}$ does not deassert until fault time has expired.

As noted in Table 1 an over current condition of any magnitude will not cause $\overline{\text{PG}}$ to deassert until the fault time period has timed out. This makes proper sizing of bulk capacitors on the output important in order to prevent excessive voltage droop while the TPS2398/99 is running out fault time.

In contrast, the $\overline{\text{FAULT}}$ output of the TPS2390/91 goes active (low) if the voltage across the sense resistor exceeds 100 mV for any length of time or exceeds 40 mV for the duration of the programmed fault time. $\overline{\text{FAULT}}$ will deassert if the EN pin goes low.

2.2 Short Overload Timeout vs. Long Overload Timeout

The second difference between the TPS2390/91 and the TPS2398/99 is the overload timeout function. During a major overcurrent event the TPS2398/99 gate output will be pulled low approximately 4 μs after the sense resistor voltage exceeds 100 mV. However, the $\overline{\text{PG}}$ output will remain asserted until the fault time has been exceeded. If the fault condition still exists at the expiration of fault time then $\overline{\text{PG}}$ will deassert.

Unlike the TPS2391 (which will not attempt to turn on until after the fault clearing time has expired) the TPS2398/99 will immediately start to ramp up the current as soon as the GATE pin has been pulled to $-V_{IN}$. If the overload condition still exists the current will ramp up until the current limit level is reached. The current will be limited at that level until fault time expires at which point GATE will be pulled to $-V_{IN}$ to shut off the output and $\overline{\text{PG}}$ will deassert. The TPS2398 will latch off in a fault condition while a TPS2399 will repeatedly attempt to reapply power to the load at the fault clearing time interval.

A momentary high current event is often the result of switching from one power source to a second source which is greater in voltage magnitude. Since the pass FET on the powered module is fully enhanced the current can spike as the bus attempts to charge the bulk capacitors to the new, greater, voltage. In this scenario $\overline{PG}$ will not deassert, even though the pass FET may have been momentarily shutoff in response to a major overcurrent event. Typically, it would not be desirable to signal downstream functions that power was not *good* since the current will have settled to a non-limiting level before fault time has expired. Figure1 illustrates the difference in overcurrent response between the TPS2390 and TPS2398.

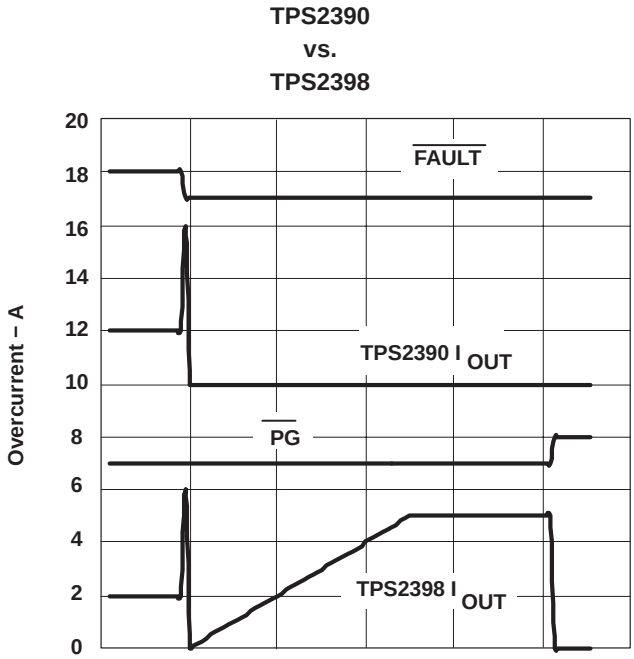

Figure 1. Overcurrent Response

3 Summary

For systems requiring immediate response to a sharp increase in load current or requiring a logic output indicating a fault condition, the TPS2390/91 is preferred. This part has an open drain fault output and instant shutdown in the event of an over-current fault. For systems that may experience a step in input supply or that require a power-good output to enable a down-stream dc-to-dc converter, the TPS2398/99 will attempt restart immediately after an over-current fault, allowing the quickest recovery from an instantaneous input supply voltage step. Such steps in supply voltage can be expected in dual supply systems.

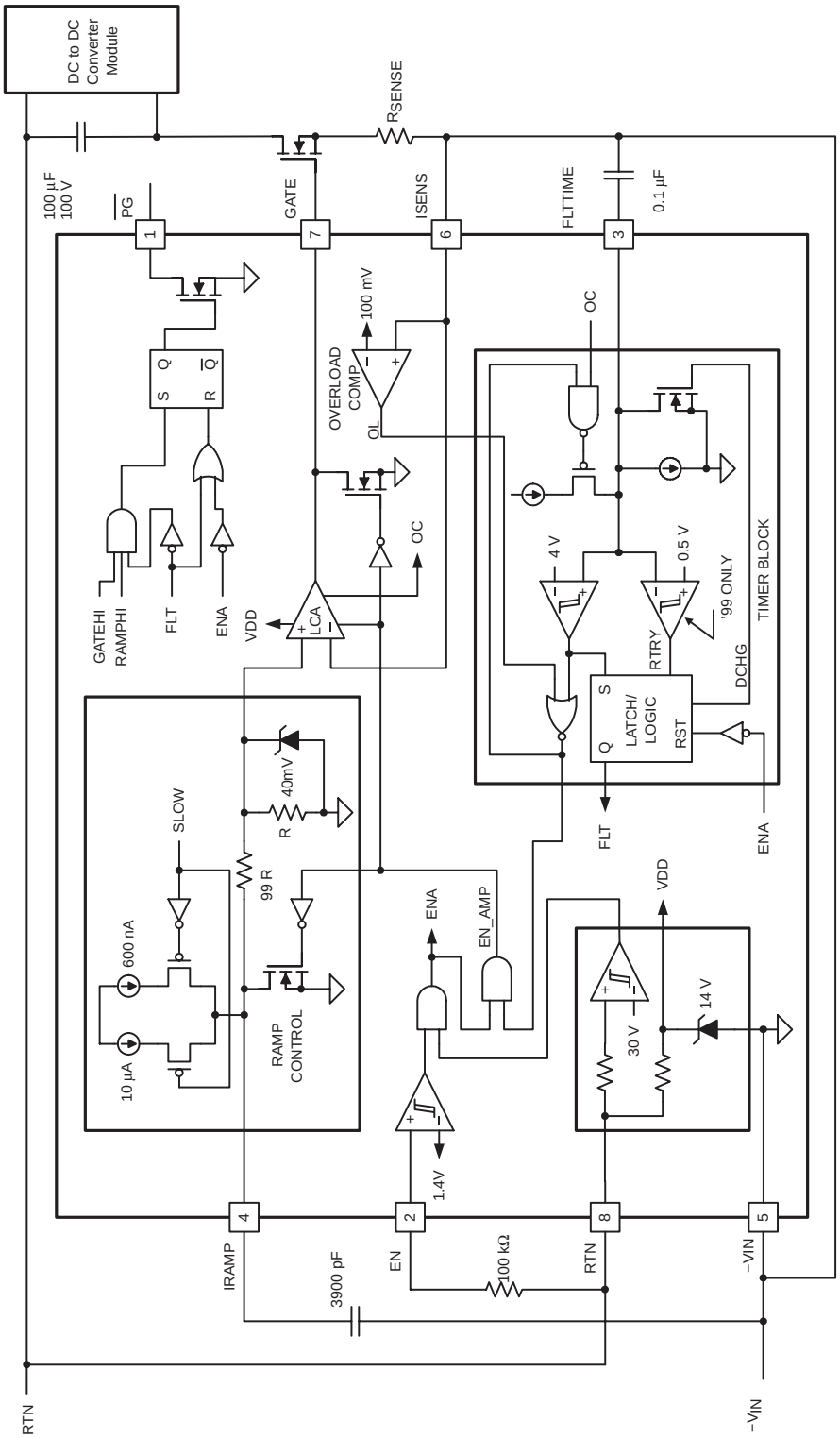

Figure 2. TPS2398/99 Controlled-Current Hot Swap Circuit

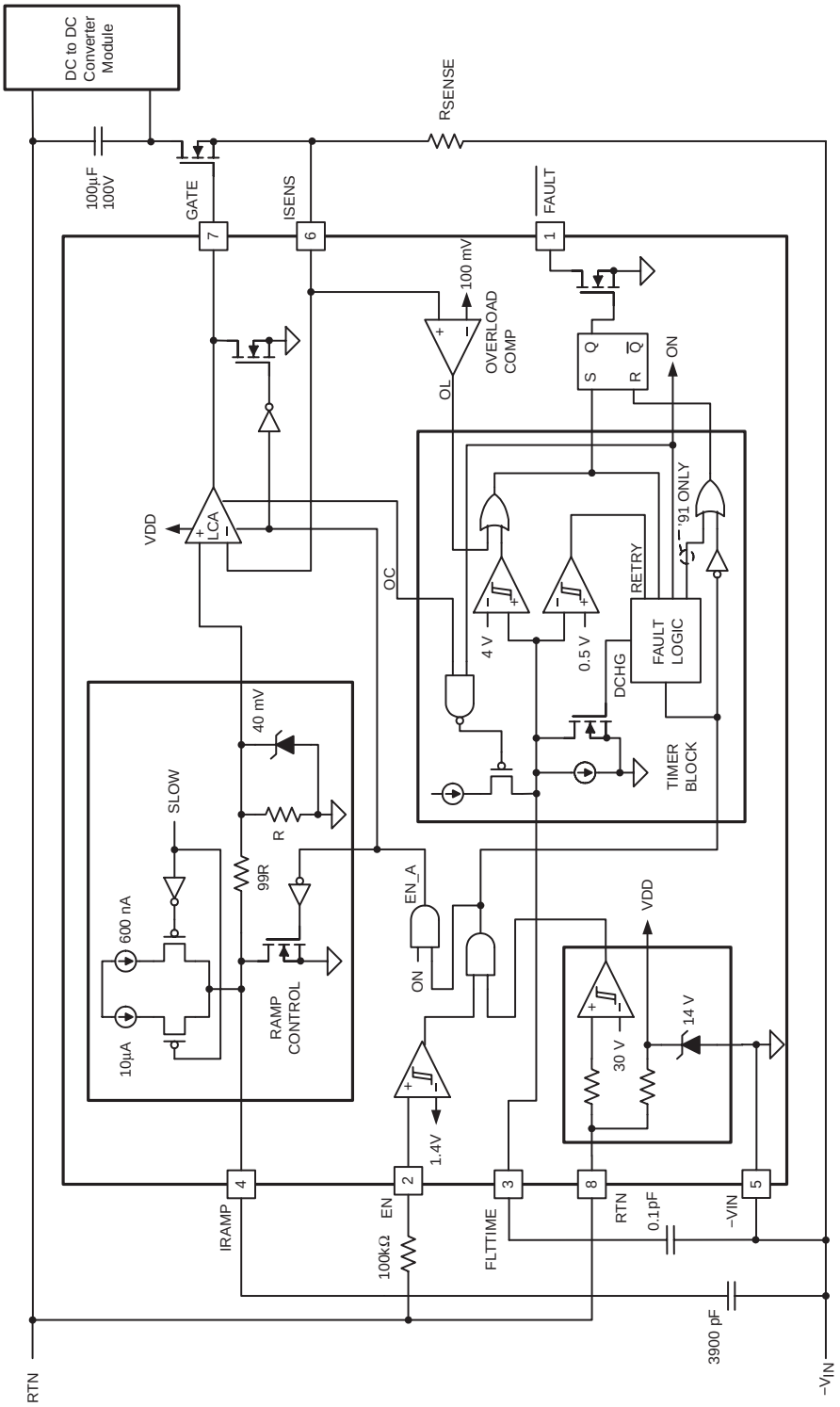

Figure 3. TPS2390/91 Controlled-Current Hot Swap Circuit

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