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Using the Load Balance Controller, EZ1900, with an LP2951 & StP8 Combination Regulator for a Flexible Motherboard Design

Introduction

The EZ1900 load balance controller is a flexible, low cost device, providing an automatic power supply upgrade from single to split-voltage plane processors, when used with two low dropout regulators. Single plane processors, such as the Intel Pentium® Processor P54C, Cyrix 6x86™, AMD $AMD5_K86$™ and the PowerPC™ require a single supply voltage, normally 3.3 or 3.5V.

New split plane processors, such as the Pentium P55C and versions of the 6x86, $AMD5_K86$ & PowerPC 603/604EV require two supply voltages: $V_{I/O}$ for the I/O circuitry, at 3.3 or 3.5V; and V_{CC2} for the CPU core, at between 2.5 and 2.8V.

The EZ1900 can be used with almost any type of voltage regulator. Application note AN96-4 describes how to use the EZ1900 with a three- or five-terminal low dropout regulator. This application note describes how to use the EZ1900 with Semtech's low cost LP2951 & StP8 discrete regulator combination to provide an automatic upgrade path, avoiding costly production changes or jumpers for different processors.

Principle of Operation

In split plane operation, the EZ1900 switches the output of the slave regulator to the higher voltage required for I/O .

When operating in single plane mode, the EZ1900 controls the output of the slave regulator to provide a lower voltage for V_{CC2}, sharing current with the master for processors whose I/O and core power planes are connected together. In this mode the two regulators' operate as master and slave.

Microprocessors, such as those listed above, have a pin, V_{CC2DET}, or similar, which, indicates to the EZ1900 in which mode to operate. Pin 1 (SEL) of the EZ1900 detects this signal: floating (or open) indicates single-plane (current sharing) and low switches the outputs for split-plane operation.

A typical application circuit is shown in figure 1. The master regulator powers the CPU core and the slave supplies the I/O circuitry.

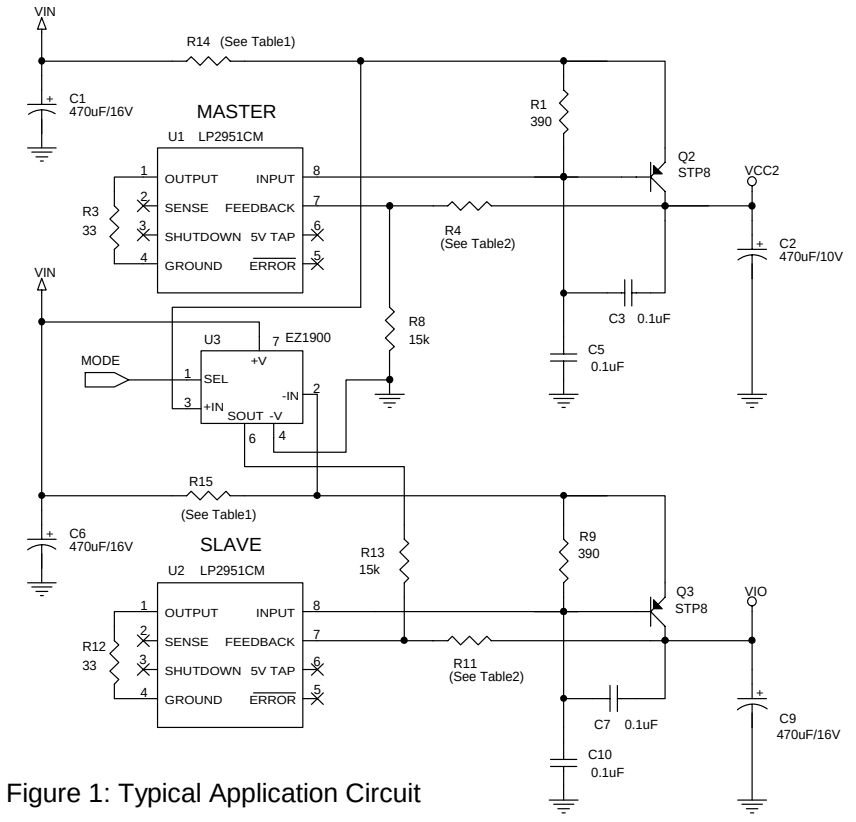

Figure 1: Typical Application Circuit

Current Sharing

The EZ1900 controls current sharing by sensing the input current to the two regulators by means of the two sense resistors, R_{15} & R_{14}. For balanced currents, the voltage drop across each resistor should be of the order of 50 - 100mV [around 10 - 20mΩ for a 5A current].

For most split-plane regulators, the CPU core requires no more than 6A, with 3A or less for the I/O. The two regulators will provide enough power in master-slave mode to power all versions of the Cyrix 6x86 processor at 8A or more.

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Sense Resistor

The values of the sense resistors do not have to be controlled to any great degree of precision — it is the ratio of the two values which is important. As a result, the sense resistors can be constructed inexpensively using copper board traces. Any process related errors in setting the resistors will apply equally to both R_{14} & R_{15}. Suitable resistor sizes are given in Table 1.

How To Design a Circuit using the EZ1900

1. Select the maximum current required for each regulator.
2. From table 1, determine the sense resistor value required.
3. Determine the trace width required, based on the copper weight.
4. Determine the trace length required, based on the copper weight.
5. Design a suitable resistor layout for the board. It is very likely that the resistor will have to be laid out in "serpentine" fashion, as shown in figure 2.

6. Keep the two sense resistors as close to each other and the V_{IN} plane as possible.

Setting the Output Voltages

The output of the two regulators can be set to accommodate different processor voltage requirements, by means of setting the values of resistors R_4 and R_{11}. The values are shown in table 2.

The major difference between the LP2951 based circuit and one using monolithic low dropout regulators such as the EZ1585D, is that the LP2951 has a ground based reference circuit. As such, any adjustment made to the lower resistor in the feedback chain reduces the output voltage, rather than increasing it, as in EZ158x/108x circuits.

This necessitates careful attention to phasing requirements and also means that the slave feedback resistors must be set to give a high output voltage in master/slave mode, to enable the EZ1900 to reduce the actual output voltage and effect a load balance condition.

Conclusion

The EZ1900 can be used with a low cost LP2951/StP8

Table 1: Copper Trace Sizes for EZ1900 Application Circuit

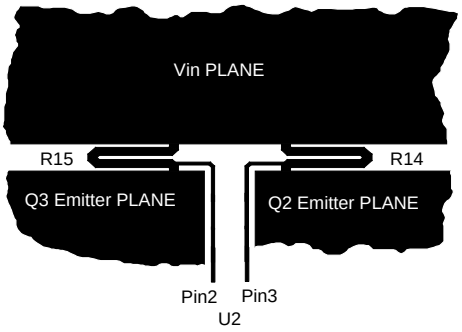
Current	Resistance	Pd	Copper weight (oz)				Copper weight (oz.)			
			0.5	1	2	3	0.5	1	2	3
(Amps)	(mΩ)	(mW)	Trace Width (in.)				Trace Length (in.)			
1	80.0	80	0.010	0.010	0.010	0.010	0.815	1.629	3.259	4.888
2	40.0	160	0.010	0.010	0.010	0.010	0.407	0.815	1.629	2.444
3	26.7	240	0.015	0.010	0.010	0.010	0.407	0.543	1.086	1.629
4	20.0	320	0.027	0.013	0.010	0.010	0.543	0.543	0.815	1.222
5	16.0	400	0.042	0.021	0.010	0.010	0.679	0.679	0.679	0.679
6	13.3	480	0.060	0.030	0.015	0.010	0.815	0.815	0.815	0.815
7	11.4	560	0.082	0.041	0.020	0.014	0.950	0.950	0.950	0.950
8	10.0	640	0.107	0.053	0.027	0.018	1.086	1.086	1.086	1.086
9	8.9	720	0.135	0.068	0.034	0.023	1.222	1.222	1.222	1.222
10	8.0	800	0.167	0.083	0.042	0.028	1.358	1.358	1.358	1.358

Note: 0.5oz/ft^2 copper is 18µm thick; Copper trace widths based on 1200A^2/oz.in, which is a conservative rating for a 40^{o}C rise.
R = (0.491 x L)/(B x W)
where R=Trace Resistance (mΩ);L=Trace Length (in.);B=Copper weight (oz.);W=Trace Width (in.)

combination regulator to construct a flexible circuit which will automatically supply the correct voltages for powering single or split voltage plane processors. The circuit is low cost, eliminating costly production changes and jumpers to set different supply voltage requirements for alternative processor options.

Fig 2: Resistor Layout Example

SHOWN FULL SIZE



1200A^2/oz.in rating per Table 1:
8A per side
1oz copper.
40^{o}C rise in traces

Table 2: Resistor Values

Mode (SEL Pin)	**Processor**	**$V_{I/O}$ (Volts)**	**V_{CC2} (Volts)**	**R_4 (kΩ)**	**R_{11} (kΩ)**
OPEN	VRE	3.6V(1)	3.49V	27.4	28.7
OPEN	STD/VR	3.6V(1)	3.384V	26.1	28.7
LOW	P55C AMD5$_K$86	3.3V	2.8V	19.1	24.9
LOW	6x86 AMD5$_K$86	3.3V	2.5V	15.4	24.9

(1) Although the $V_{I/O}$ setpoint is at 3.6V, the EZ1900 adjusts the slave output downwards to achieve load current balance. V_{CC2} and $V_{I/O}$ must be connected.

R_4 & R_{11} are both 1% tolerance. $R_{13} = R_8 = 15k\Omega$