March 11, 1998

TEL:805-498-2111 FAX:805-498-3804 WEB:http://www.semtech.com

Using the Load Balance Controller, EZ1900, with Low Dropout Regulators 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 three- or five-terminal voltage regulators. This application note describes how to use the EZ1900 to provide an automatic upgrade path, avoiding costly production changes or jumpers for different processors.

Principle of Operation

In single plane operation, the EZ1900 controls the output of two regulators so that they provide the same output voltage, sharing current for processors whose I/O and core power planes are connected together. In this mode, the two regulators operate as master and slave.

When operating in split-plane mode, the EZ1900 switches the output of the slave regulator to provide a lower voltage V_{CC2}. The two regulators' outputs are independent of each other.

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 slave regulator powers the CPU core and the master supplies the I/O circuitry. The EZ1900 can be used with almost any three- or five-terminal voltage regulator, even with devices of different rated current.

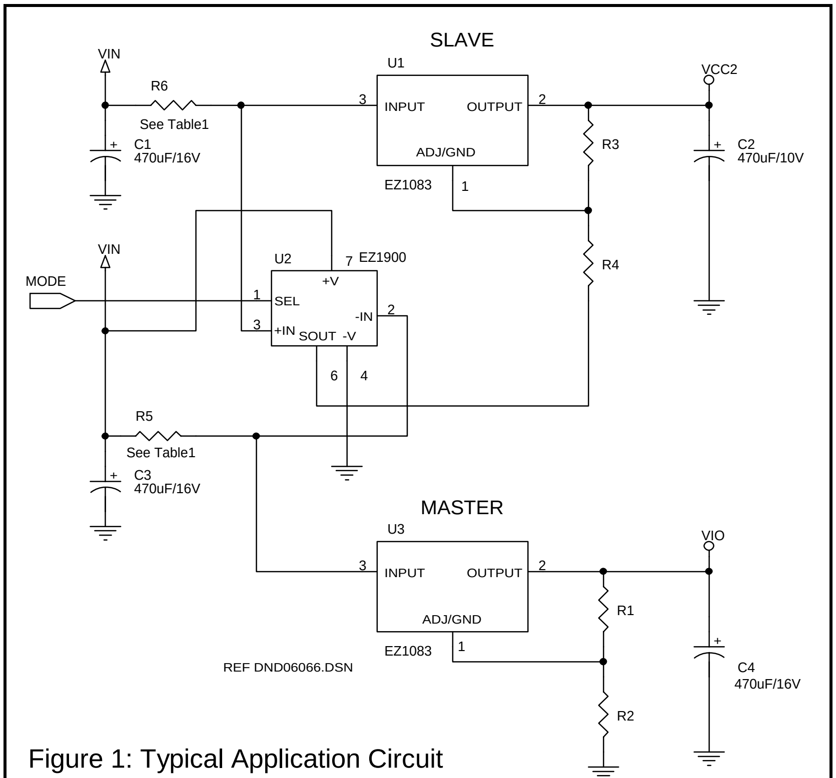


Figure 1: Typical Application Circuit

Pentium is a registered trademark of Intel Corporation; 6x86 is a trademark of Cyrix Corporation; $AMD5_K86$ is a trademark of AMD; PowerPC is a trademark of IBM.

Current Sharing

The EZ1900 controls current sharing by sensing the input current to the two regulators by means of the two sense resistors, R_5 & R_6. 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 most economical solution is to use a 6A regulator, such as the EZ1585DCT for the core (slave), and a 3A regulator, such as the EZ1085 for the I/O (master). This would give a maximum total current in single-plane mode of 9A; enough to power all versions of the Cyrix 6x86.

When two different regulators are installed, the currents must be shared proportionally, so that neither regulator enters current limit. This is done by ad-

652 MITCHELL ROAD NEWBURY PARK CA 91320

March 11, 1998

justing the values of R_5 & R_6 so that the voltage drops across each at rated current are the same. In this case, R_5 should be set to twice the value of R_6 [3A x 2R = 6A x R].

Please see Semtech's datasheet for the EZ1900 for application examples using the EZ1580 and EZ1087 five-terminal low dropout regulators.

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_5 & R_6. 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.Suitable regulators are Semtech's EZ1585DCT (6A) for CPU core and EZ1085CT (3A) for the I/O.
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} 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_1 through R_4. The values are shown in table 2.

Conclusion

The EZ1900 can be used with any three or five terminal 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.

Table 1: Copper Trace Sizes for EZ1900 Application Circuit

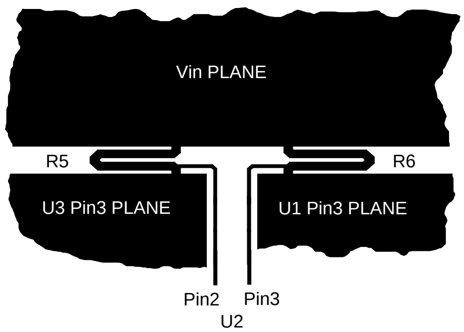
Current (Amps)	Resistance (mΩ)	Pd (mW)	Copper weight (oz) 0.5	1	2	3	Copper weight (oz.) 0.5	1	2	3
			Trace Width (in.)				Trace Length (in.)			
1	80.0	80	0.010	0.010	0.010	0.010	0.815	1.629	3.259	4.888
2	40.0	160	0.010	0.010	0.010	0.010	0.407	0.815	1.629	2.444
3	26.7	240	0.015	0.010	0.010	0.010	0.407	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^oC 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.)

March 11, 1998

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_1 (Ω)**	**R_2 (Ω)**	**R_3 (Ω)**	**R_4 (Ω)**
OPEN	VRE	3.49	3.49(1)	133	237	133	165(2)
OPEN	STD/VR	3.384	3.384(1)	133	226	133	165(2)
LOW	P55C AMD5$_K$86	3.3	2.8	133	215	133	165
LOW	6x86 AMD5$_K$86	3.3	2.5	133	215	133	133

(1) Although the V_{CC2} setpoint is at 2.8V, the EZ1900 adjusts the slave output upwards to achieve load current balance at the $V_{I/O}$ setpoint. V_{CC2} and $V_{I/O}$ must be connected.

(2) As required for split plane V_{CC2}, e.g. 165Ω for 2.8V, 133Ω for 2.5V

R_1 to R_4 are 1% tolerance resistors.