National Semiconductor

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LMC6953
PCI Local Bus Power Supervisor

General Description

The LMC6953 is a voltage supervisory chip designed to meet PCI (Peripheral Component Interconnect) Specifications Revision 2.1. It monitors 5V and 3.3V power supplies. In cases of power-up, power-down, brown-out, power failure and manual reset interrupt, the LMC6953 provides an active low reset. $\overline{\text{RESET}}$ holds low for 100 ms after both 5V and 3.3V powers recover, or after manual reset signal returns to high state. The external capacitor on pin 8 adjusts the reset delay.

This part is ideal on PCI motherboards or add-in cards to ensure the integrity of the entire system when there is a fault condition. The active low reset sets the microprocessor or local device in a known state.

The LMC6953 has a built-in bandgap reference that accurately determines all the threshold voltages. The internal reset delay circuitry eliminates additional discrete components.

Features

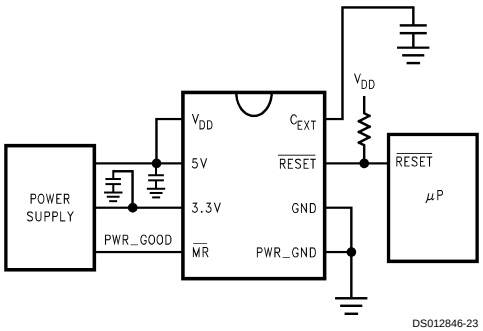
- Compliant to PCI specifications revision 2.1.
- Under and over voltage detectors for 5V and 3.3V
- Power failure detection (5V falling under 3.3V by 300 mV max)
- Manual reset input pin
- Guaranteed $\overline{\text{RESET}}$ assertion at V_{DD} = 1.5V
- Integrated reset delay circuitry
- Open drain output
- Adjustable reset delay
- Response time for over and under voltage detection: 490 ns Max
- Power failure response time: 90 ns Max
- Requires minimal external components

Applications

- Desktop PCs
- PCI-Based Systems
- Network servers

Typical Application Circuits

On Mother Board



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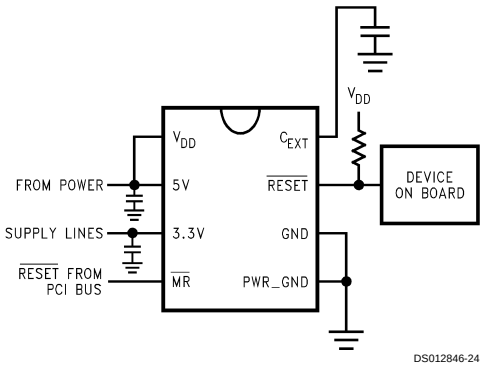
On Add-in Cards



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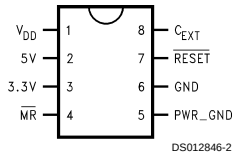
Connection Diagram

8–Pin SO



Top View

Ordering Information

Package	Industrial Temp Range −40˚C to +85˚C	NSC Drawing	Supplied As
8-Pin Small Outline	LMC6953CM	M08A	Rails
	LMC6953CMX		2.5k Tape and Reel

Absolute Maximum Ratings (Note 1)

If Military/Aerospace specified devices are required, please contact the National Semiconductor Sales Office/ Distributors for availability and specifications.

ESD Tolerance (Note 2)	
Human Body Model	2 kV
Machine Model	200V
Voltage at Input Pin	7V
Supply Voltage	7V
Current at Output Pin	15 mA
Current at Power Supply Pin (Note 3)	10 mA
Lead Temp. (Soldering, 10 sec.)	260˚C
Storage Temperature Range	−65˚C to +150˚C
Junction Temperature	150˚C

Operating Ratings (Note 1)

Supply Voltage	1.5V to 6V
Junction Temperature Range	
LMC6953C	−40˚C to +85˚C
Thermal Resistance (θ_{JA})	
M Package	165˚C/W

DC Electrical Characteristics

Unless otherwise specified, all **boldface** limits guaranteed for T_J = −40˚C to +85˚C, V_{DD} = 5V, $R_{PULL-UP}$ = 4.7 kΩ and C_{EXT} = 0.01 µF. Typical numbers are room temperature (25˚C) performance.

Symbol	Parameter	Conditions	Min	Typ	Max	Units
V_{H5}	V_{DD} Over-Voltage Threshold	T_J = 0˚C to 70˚C (Note 4)	**5.45**	5.60	**5.75**	V
		T_J = −40˚C to 85˚C (Note 4)	**5.30**	5.60	**5.90**	V
V_{L5}	V_{DD} Under-Voltage Threshold	T_J = 0˚C to 70˚C (Note 4)	**4.25**	4.40	**4.55**	V
		T_J = −40˚C to 85˚C (Note 4)	**4.10**	4.40	**4.70**	V
$V_{H3.3}$	3.3V Over-Voltage Threshold	T_J = 0˚C to 70˚C (Note 5)	**3.80**	3.95	**4.10**	V
		T_J = −40˚C to 85˚C (Note 5)	**3.60**	3.95	**4.30**	V
$V_{L3.3}$	3.3V Under-Voltage Threshold	T_J = 0˚C to 70˚C (Note 5)	**2.50**	2.65	**2.80**	V
		T_J = −40˚C to 85˚C (Note 5)	**2.30**	2.65	**3.00**	V
V_{MR}	Manual RESET Threshold			2.50	**2.80**	V
V_{PF}	Power Failure Differential Voltage (3.3V Pin–5V Pin)	(Note 6)		150	**300**	mV
R_{IN}	Input Resistance at 5V and 3.3V Pins			35		kΩ
V_{OL}	$\overline{RESET}$ Output Low	T_J = 0˚C to 70˚C V_{DD} = 1.5V to 6V		0.05	**0.10**	V
		T_J = −40˚C to 85˚C V_{DD} = 1.55V to 6V				
I_S	Supply Current	(Note 3)		0.8	**1.50**	mA

AC Electrical Characteristics

Unless otherwise specified, all **boldface** limits guaranteed for T_J = −40˚C to 85˚C, V_{DD} = 5V, $R_{PULL-UP}$ = 4.7 kΩ and C_{EXT} = 0.01 µF. Typical numbers are room temperature (25˚C) performance.

Symbol	Parameter	Conditions	Typ	LMC6953 Limit	Units
t_D	Over or Under Voltage Response Time	(Note 7)	150	**490**	ns max
t_{PF}	Power Failure Response Time	(Note 8)	40	**90**	ns max
t_{RESET}	Reset Delay	C_{EXT} = 0.01 µF	100		ms

Note 1: Absolute Maximum Ratings indicate limits beyond which damage to the device may occur. Operating Ratings indicate conditions for which the device is intended to be functional, but specific performance is not guaranteed. For guaranteed specifications and the test conditions, see the Electrical Characteristics.

Note 2: Human body model, 1.5 kΩ in series with 100 pF. Machine model. 200Ω in series with 100 pF.

AC Electrical Characteristics (Continued)

Note 3: Supply current measured at pins 1, 2, and 3. The 4.7 kΩ pull-up resistor on pin 7 is not tied to V_{DD} in this measurement.

Note 4: PCI Specifications Revision 2.1, Section 4.2.1.1 and Section 4.3.2.

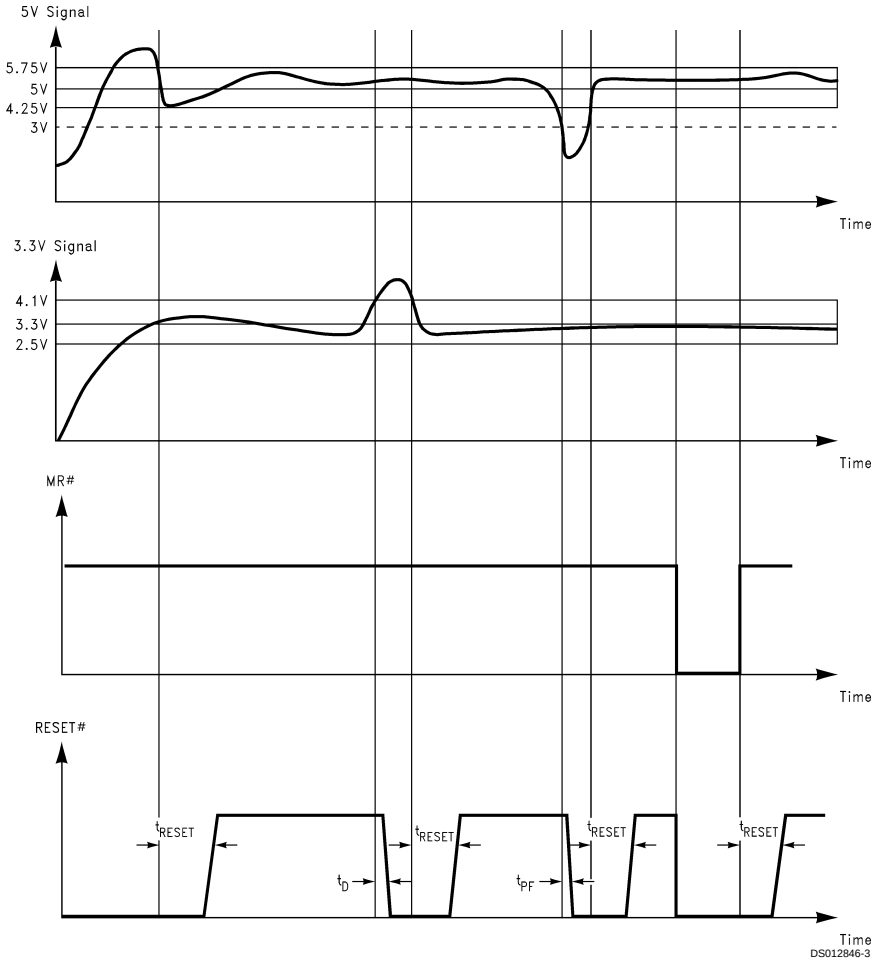
Note 5: PCI Specifications Revision 2.1, Section 4.2.2.1 and Section 4.3.2.

Note 6: PCI Specifications Revision 2.1 and Section 4.3.2.

Note 7: PCI Specifications Revision 2.1, Section 4.3.2. The response time is measured individually with ±750 mV of overdrive applied to pin 2 then ±600 mV of overdrive applied to pin 3 and taking the worst number of the four measurements.

Note 8: PCI Specifications Revision 2.1, Section 4.3.2. The power failure response time is measured with a signal changing from 5V to 3V applied to pin 2 and a 3.3V DC applied to pin 3.

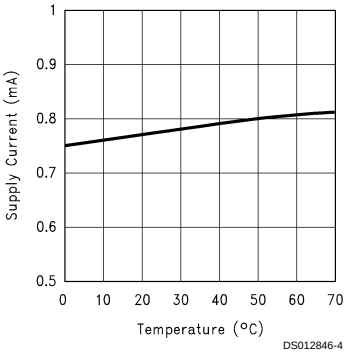
LMC6953 Timing Diagram



Note: t_{RESET}, t_D and t_{PF} are not to scale.

Typical Performance Characteristics Unless otherwise specified, T_A = 25˚C

Supply Current vs Temperature



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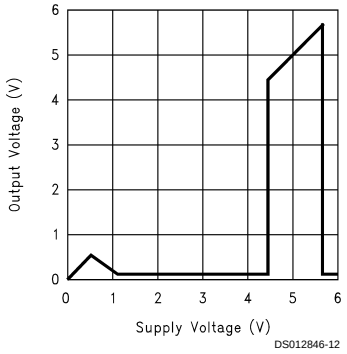
Output Voltage vs Supply Voltage



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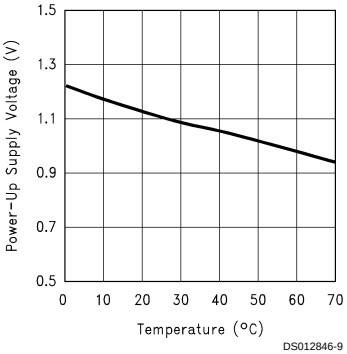
Power-Up Supply Voltage vs Temperature



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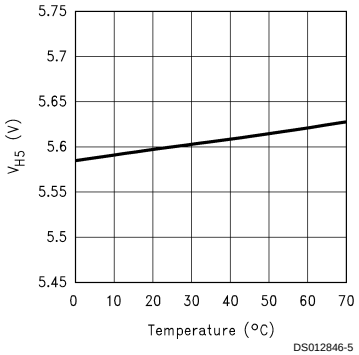
V_{H5} vs Temperature



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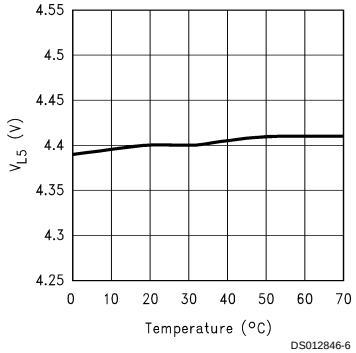
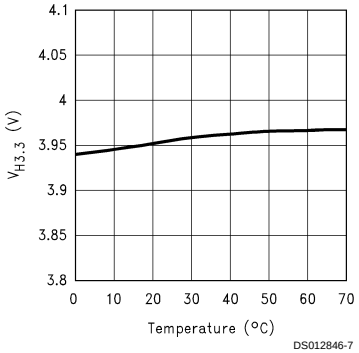
V_{L5} vs Temperature



DS012846-6

$V_{H3.3}$ vs Temperature



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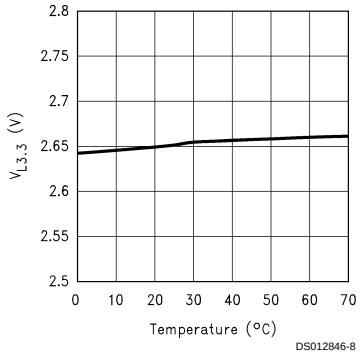
Typical Performance Characteristics Unless otherwise specified, T_A = 25˚C (Continued)

$V_{L3.3}$ vs Temperature



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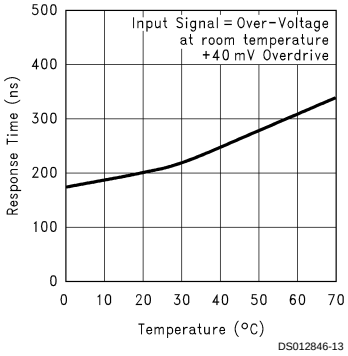
Over-Voltage Response Time vs Temperature



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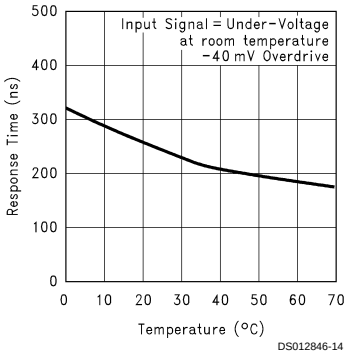
Under-Voltage Response Time vs Temperature



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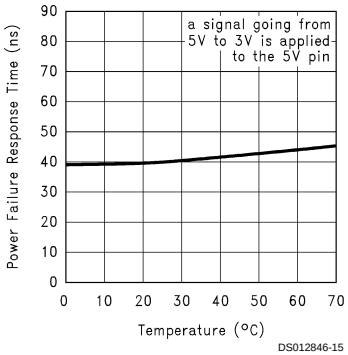
Power Failure Response Time vs Temperature



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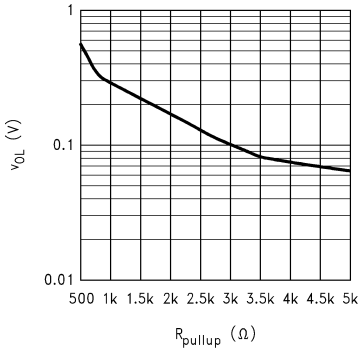
V_{OL} vs $R_{PULL-UP}$



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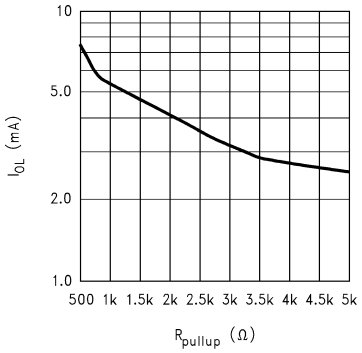
I_{OL} vs $R_{PULL-UP}$



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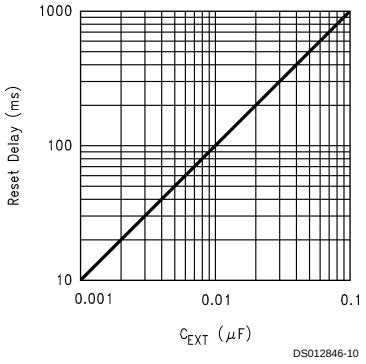
Typical Performance Characteristics Unless otherwise specified, T_A = 25˚C (Continued)

Reset Delay vs C_{EXT}



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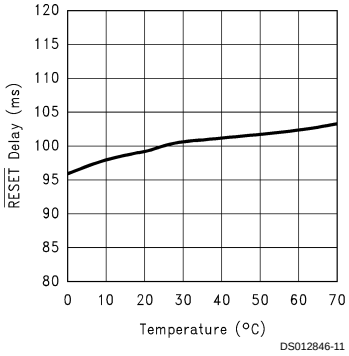
Reset Delay vs Temperature with C_{EXT} = 0.01 µF



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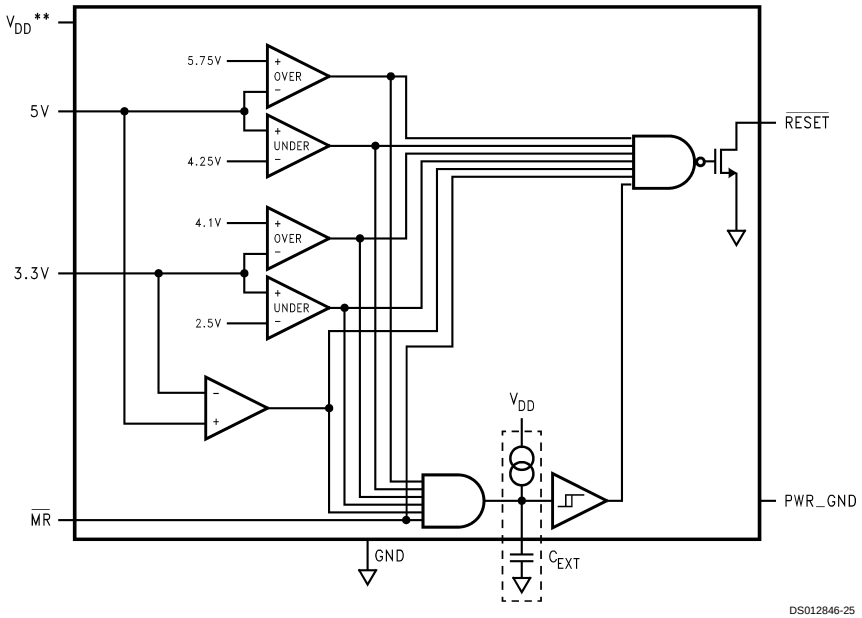
Block Diagram of the LMC6953



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** All five comparators' positive power supplies are connected to V_{DD}

Truth Table

Power Failure	5V Over-Voltage	5V Under-Voltage	3.3V Over-Voltage	3.3V Under-Voltage	$\overline{MR}$	$\overline{RESET}$
Fail	X	X	X	X	High	Low
X	Fail	X	X	X	High	Low
X	X	Fail	X	X	High	Low
X	X	X	Fail	X	High	Low
X	X	X	X	Fail	High	Low
X	X	X	X	X	Low	Low
OK	OK	OK	OK	OK	High	High

X = Don't Care

Pin Description

Pin	Name	Function
1	V_{DD}	5V input supply voltage. This pin supplies power to the internal comparators. It can be connected to a capacitor acting as a back-up battery. Otherwise, it should be shorted to the 5V pin.
2	5V	5V input supply voltage. This pin is not connected to the positive power supply of the internal comparators. It provides input signal to the 5V window comparators as well as the power failure comparator.
3	3.3V	3.3V input supply voltage. This pin provides input signal to the 3.3V window comparators and the power failure comparator.
4	$\overline{MR}$	Manual reset input pin. It takes 5V CMOS logic low and triggers $\overline{RESET}$. If not used, this pin should be connected to V_{DD}.
5	PWR__GND	Ground.
6	GND	This pin should be grounded at all times.
7	$\overline{RESET}$	Active low reset output. $\overline{RESET}$ holds low for 100 ms after both 5V and 3.3V powers recover, or after manual reset signal returns to high state.
8	C_{EXT}	External capacitor pin. The value of C_{EXT} sets the reset delay.

Application Note

HOW THE LMC6953 FUNCTIONS

The LMC6953 is a power supply supervisor with its performance specifications compliant to PCI Specifications Revision 2.1. The chip monitors power-up, power-down, brown-out, power failure and manual reset interrupt situations.

During power-up, the LMC6953 holds $\overline{RESET}$ low for 100 ms after both 5V and 3.3V are within specified windows. It asserts reset in 490 ns when a brown-out is detected. Brown-out occurs when 5V supply is above 5.75V over-voltage or below 4.25V under-voltage or when 3.3V supply is above 4.1V over-voltage or 2.5V under-voltage. In case of power failure where the 5V supply falls under 3.3V supply by 300 mV maximum, reset is asserted in 90 ns. $\overline{RESET}$ also can be asserted by sending a 5V CMOS logic low to the manual reset pin.

Each time $\overline{RESET}$ is asserted, it holds low for 100 ms after a fault condition is recovered. The 100 ms reset delay is generated by the 0.01 µF C_{EXT} capacitor, and can be adjusted by changing the value of C_{EXT}.

It is highly recommended to place lands on printed circuit boards for 120 pF capacitors between pin 2 and ground and also between pin 3 and ground. As power supplies may change abruptly, there can be very high frequency noise present and the capacitors can minimize the noise,

MINIMUM SUPPLY VOLTAGE FOR $\overline{RESET}$ ASSERTION

The LMC6953 guarantees V_{DD} = 1.55V as the minimum supply voltage to achieve consistent $\overline{RESET}$ assertion. This ensures system stability in initialization state.

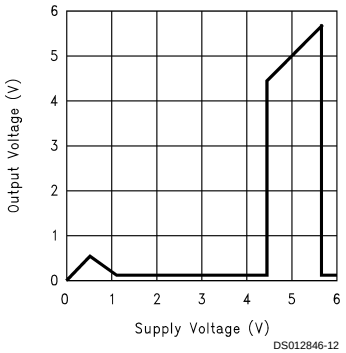

FIGURE 1. Output Voltage vs Supply Voltage

Application Note (Continued)

Figure 1 is measured by shorting pins 1, 2 and 3 together when supply voltage is from 0V to 3.3V. Then pin 3 is connected with a constant 3.3 V_{DC} and pins 1 and 2 are connected to a separate power supply that continues to vary from 3.3V to 6V.

5V AND V_{DD} PINS

By having the 5V and the V_{DD} pins separate, a capacitor can be used as a back-up power supply in event of a sudden power supply failure. This circuit is shown in the application circuit section titled "On Motherboard With Capacitor as a Back-up Power Supply." Under normal condition, the diode is forward-biased and the capacitor is charged up to V_{DD} − 0.7V. If the power supply goes away, the diode becomes reverse-biased, isolating the 5V and the V_{DD} pins. The capacitor provides power to the internal comparators for a short duration for the LMC6953 to operate.

C_{EXT} SETS RESET DELAY IN LINEAR FASHION

The LMC6953 has internal delay circuitry to generate the reset delay. By choosing different values of capacitor C_{EXT}, reset delay can be programmed to the desired length for the system to stabilize after a fault condition occurs.

EVALUATING THE LMC6953

To Measure Over-Voltages and Under-Voltages.

Connect a 3.3V DC to the 3.3V pin and a 5V DC to the V_{DD} and the 5V pins (V_{DD} and 5V pins are shorted). $\overline{\text{RESET}}$ output is high because voltages are within window. These voltages should be monitored. While keeping the 3.3V constant, increase the 5V DC signal until a $\overline{\text{RESET}}$ low is detected. The point on the 5V DC signal at which $\overline{\text{RESET}}$ changes from high to low is the 5V over-voltage. It is typically 5.6V. To detect 5V under-voltage, start the 5V DC signal from 5V and decrease it until a $\overline{\text{RESET}}$ low is detected. The point on the 5V DC signal at which $\overline{\text{RESET}}$ changes from high to low is the 5V under-voltage. It is typically 4.4V.

To find 3.3V over-voltage and under-voltage, keep the 5V DC at 5V and vary the 3.3V DC signal until a $\overline{\text{RESET}}$ low is detected.

To Measure Timing Specifications.

For evaluation purposes only, the V_{DD} and the 5V pins should have separate signals. It is easier to measure response time in this manner. The V_{DD} pin is connected to a steady 5V DC and the 5V pin is connected to a pulse generator. To simulate the power supply voltages going out of window, a pulse generator with disable/enable feature and rise and fall time adjustment is recommended. To measure the $\overline{\text{RESET}}$ signal, a oscilloscope is recommended because of its ability to capture and store a signal.

To measure the 5V under-voltage response time on the LMC6953, set the pulse generator to trigger mode and program the amplitude to have a high value of 5V and a low value of the 5V under-voltage threshold measured previously with 50 mV overdrive. For example, if the measured 5V under-voltage is 4.4V, then a 50 mV overdrive on this signal is 4.35V. The disable feature on the pulse generator should be on. Program the fall time of the pulse to be 30 ns and program the scope to trigger on the falling edge, with trigger level of 4.5V. Set the scope to 200 ns/division. The probes should be connected to the 5V pin and the $\overline{\text{RESET}}$ pin. Now enable the 5V signal from the pulse generator and trigger the signal. Be aware that when the signal is enabled, there is high frequency noise present, and putting a 120 pF capacitor between the 5V pin and ground suppresses some of the noise. Response time is measured by taking the 5V under-voltage threshold on the 5V signal to the point where $\overline{\text{RESET}}$ goes low. *Figure 2* shows a scope photo of 5V under-voltage waveforms. It is taken with a signal going from 5V to 4.25V at the 5V pin.

To measure the 100 ms $\overline{\text{RESET}}$ delay, change the scope to 50 ms/division and trigger the 5V signal again. $\overline{\text{RESET}}$ should stay low for 100 ms after the 5V is recovered and within window.

Other over-voltages and under-voltages can be measured by changing the pulse generator to different voltage steps. Putting a 120 pF capacitor between the 3.3V pin and ground is recommended in evaluating 3.3V signal.

To measure power-failure response time, set the pulse generator from 5V to 3V with fall time of the pulse 3 ns and connect it to the 5V pin. $\overline{\text{RESET}}$ should go low within 90 ns of power failure. *Figure 3* shows a scope photo of power failure waveforms. It is taken with a signal going from 5V to 3V at the 5V pin.

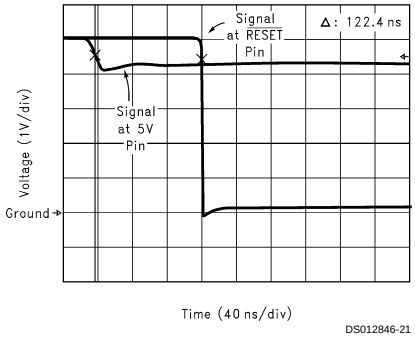

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FIGURE 2. 5V Under-Voltage Waveforms

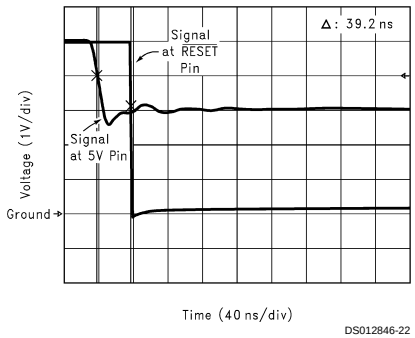

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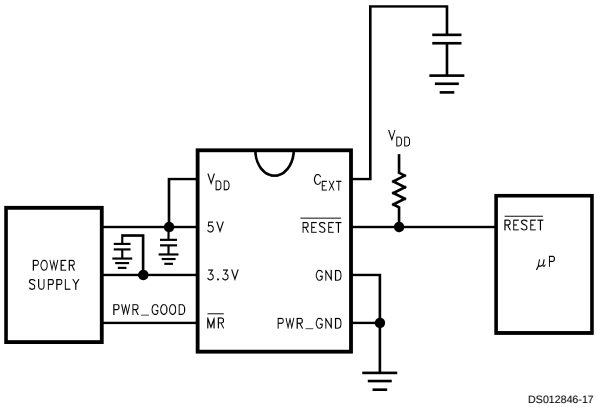
FIGURE 3. Power Failure Waveforms

Typical Application Circuits

On Mother Board



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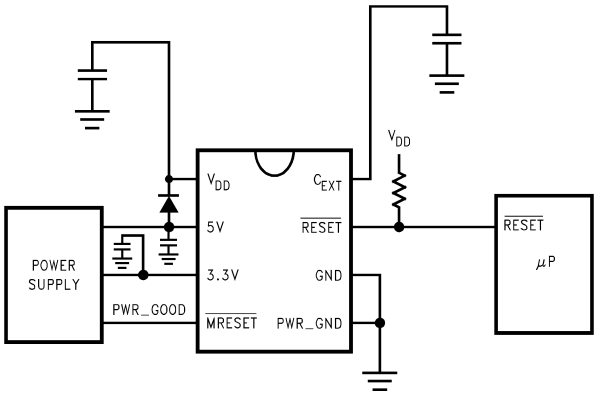
On Mother Board with Capacitor as a Back-up Power Supply



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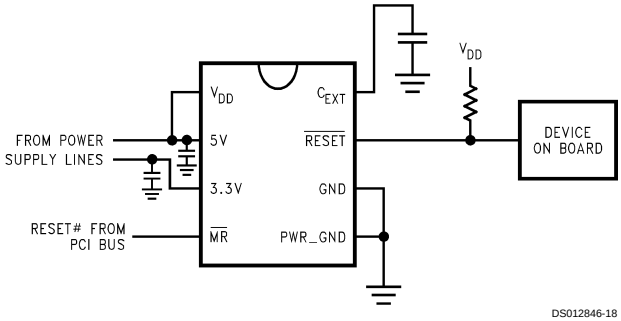
On Add-In Cards



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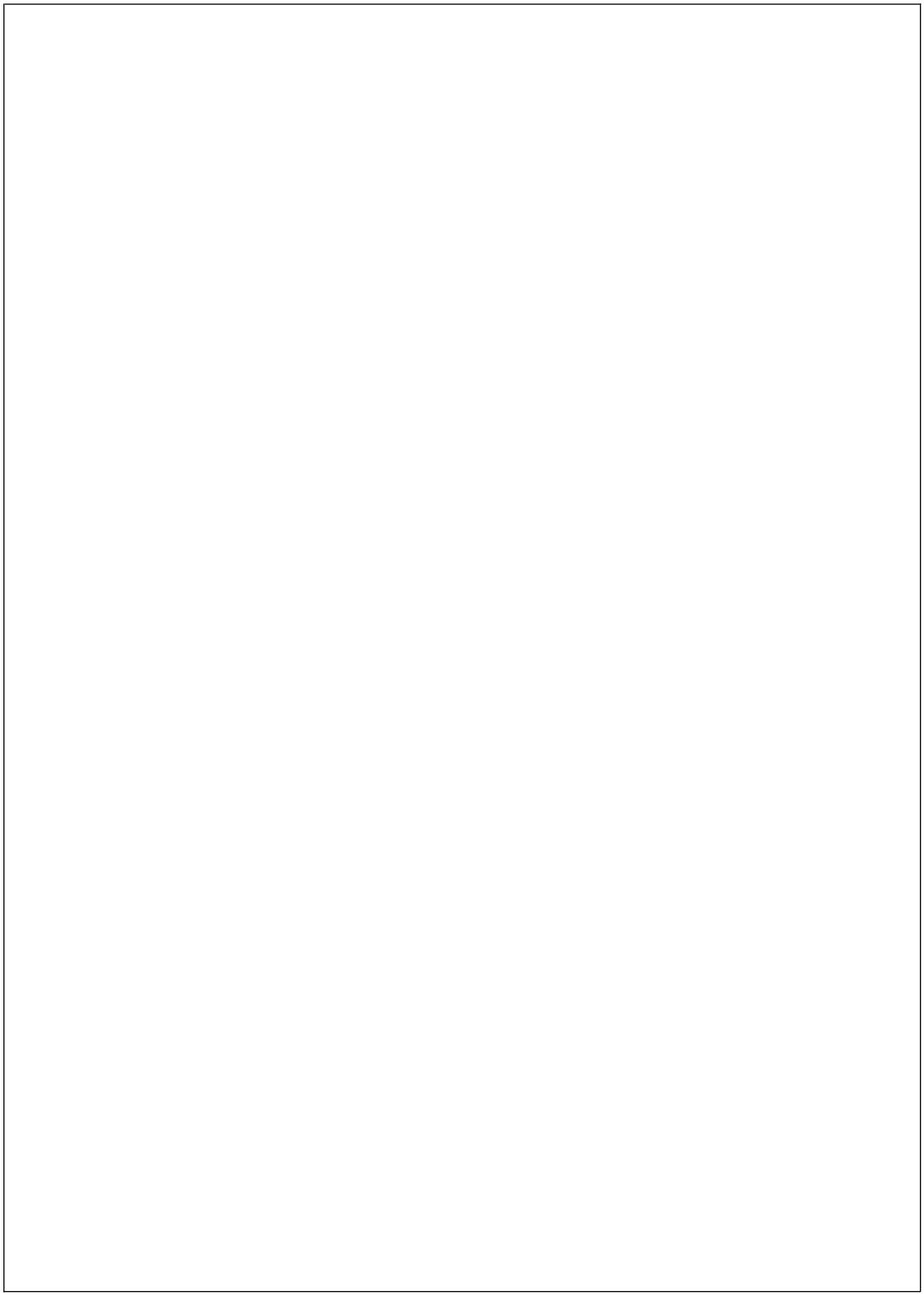
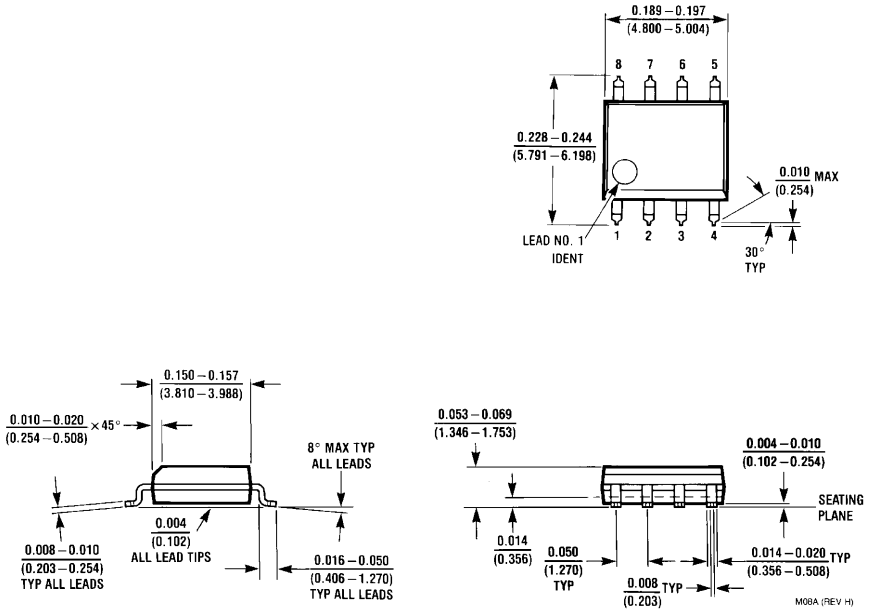


Physical Dimensions inches (millimeters) unless otherwise noted



8-Pin Small Outline Package
Order Number LMC6953CM or LMC6953CMX
NS Package Number M08A

LIFE SUPPORT POLICY

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1. Life support devices or systems are devices or systems which, (a) are intended for surgical implant into the body, or (b) support or sustain life, and whose failure to perform when properly used in accordance with instructions for use provided in the labeling, can be reasonably expected to result in a significant injury to the user.
2. A critical component in any component of a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.

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