

RELIABILITY REPORT
FOR
MAX6651EEE
PLASTIC ENCAPSULATED DEVICES

November 11, 2002

MAXIM INTEGRATED PRODUCTS

120 SAN GABRIEL DR.

SUNNYVALE, CA 94086

Written by



Jim Pedicord
Quality Assurance
Reliability Lab Manager

Reviewed by



Bryan J. Preeshl
Quality Assurance
Executive Director

Conclusion

The MAX6651 successfully meets the quality and reliability standards required of all Maxim products. In addition, Maxim's continuous reliability monitoring program ensures that all outgoing product will continue to meet Maxim's quality and reliability standards.

Table of Contents

I.Device Description	V.Quality Assurance Information
II.Manufacturing Information	VI.Reliability Evaluation
III.Packaging Information	IV.Die Information
Attachments

I. Device Description

A. General

The MAX6651 fan controller uses an SMBus™/I²C™-compatible interface to regulate and monitor the speed of 5VDC/12VDC brushless fans with built-in tachometers. It automatically forces the fan's tachometer frequency (fan speed) to match a preprogrammed value in the Fan-Speed Register by using an external MOSFET or bipolar transistor to linearly regulate the voltage across the fan. The MAX6651 regulates the speed of a single fan, but it contains additional tachometer inputs to monitor up to four fans and control them as a single unit when they are used in parallel.

The MAX6651 provides general-purpose input/output (GPIO) pins that serve as digital inputs, digital outputs, or various hardware interfaces. Capable of sinking 10mA, these open-drain inputs/outputs can drive an LED. To add additional hardware control, configure GPIO1 to fully turn on the fan in case of software failure. To generate an interrupt when a fault condition is detected, configure GPIO0 to behave as an active-low alert output. Synchronize multiple devices by setting GPIO2 as an internal clock output or an external clock input.

The MAX6651 is available in a small 16-pin QSOP package.

B. Absolute Maximum Ratings

<u>Item</u>	<u>Rating</u>
V _{CC} to GND	-0.3V to +6V
FB, TACH_	-0.3V to +13.2V
All Other Pins	-0.3V to (V _{CC} + 0.3V)
Output Voltages	-0.3V to (V _{CC} + 0.3V)
Maximum Current	
Into V _{CC} , GND, V _{OUT}	100mA
Into All Other Pins	50mA
Continuous Power Dissipation (TA = +70°C)	
16-Pin QSOP	667mW
Derates above +70°C	
16-Pin QSOP	8.3mW/°C
Operating Temperature Range	-40°C to +85°C
Junction Temperature	+150°C
Storage Temperature Range	-65°C to +150°C
Lead Temperature (soldering, 10s)	+300°C

II. Manufacturing Information

- A. Description/Function: Fan-Speed Regulators and Monitors with SMBus/I²C-Compatible Interface
- B. Process: TC06
- C. Number of Device Transistors: 11,158
- D. Fabrication Location: Taiwan
- E. Assembly Location: Korea, Thailand, Philippines or Malaysia
- F. Date of Initial Production: July, 2000

III. Packaging Information

- A. Package Type: **16-Pin QSOP**
- B. Lead Frame: Copper
- C. Lead Finish: Solder Plate
- D. Die Attach: Silver-filled Epoxy
- E. Bondwire: Gold (1 mil dia.)
- F. Mold Material: Epoxy with silica filler
- G. Assembly Diagram: # 05-1601-0098
- H. Flammability Rating: Class UL94-V0
- I. Classification of Moisture Sensitivity per JEDEC standard JESD22-112: Level 1

IV. Die Information

- A. Dimensions: 60 x 86 mils
- B. Passivation: Si₃N₄/SiO₂ (Silicon nitride/ Silicon dioxide)
- C. Interconnect: Aluminum/Si (Si = 1%)
- D. Backside Metallization: None
- E. Minimum Metal Width: Metal 1 - 0.9 microns / Metal 2 - 0.9 microns (as drawn)
- F. Minimum Metal Spacing: Metal 1 - 0.9 microns / Metal 2 - 0.9 microns (as drawn)
- G. Bondpad Dimensions: 5 mil. Sq.
- H. Isolation Dielectric: SiO₂
- I. Die Separation Method: Wafer Saw

V. Quality Assurance Information

- A. Quality Assurance Contacts: Jim Pedicord (Reliability Lab Manager)
Bryan Preeshl (Executive Director)
Kenneth Huening (Vice President)
- B. Outgoing Inspection Level: 0.1% for all electrical parameters guaranteed by the Datasheet.
0.1% For all Visual Defects.
- C. Observed Outgoing Defect Rate: < 50 ppm
- D. Sampling Plan: Mil-Std-105D

VI. Reliability Evaluation

A. Accelerated Life Test

The results of the 135°C biased (static) life test are shown in **Table 1**. Using these results, the Failure Rate (λ) is calculated as follows:

$$\lambda = \frac{1}{\text{MTTF}} = \frac{1.83}{192 \times 4389 \times 160 \times 2} \quad (\text{Chi square value for MTTF upper limit})$$

▲
Temperature Acceleration factor assuming an activation energy of 0.8eV

$$\lambda = 6.79 \times 10^{-9}$$

$$\lambda = 6.79 \text{ F.I.T. (60\% confidence level @ 25°C)}$$

This low failure rate represents data collected from Maxim's reliability monitor program. In addition to routine production Burn-In, Maxim pulls a sample from every fabrication process three times per week and subjects it to an extended Burn-In prior to shipment to ensure its reliability. The reliability control level for each lot to be shipped as standard product is 59 F.I.T. at a 60% confidence level, which equates to 3 failures in an 80 piece sample. Maxim performs failure analysis on any lot that exceeds this reliability control level. Attached Burn-In Schematic (Spec. # 06-5530) shows the static Burn-In circuit. Maxim also performs quarterly 1000 hour life test monitors. This data is published in the Product Reliability Report (**RR-1M**).

B. Moisture Resistance Tests

Maxim pulls pressure pot samples from every assembly process three times per week. Each lot sample must meet an LTPD = 20 or less before shipment as standard product. Additionally, the industry standard 85°C/85%RH testing is done per generic device/package family once a quarter.

C. E.S.D. and Latch-Up Testing

The MS34-1 die type has been found to have all pins able to withstand a transient pulse of $\pm 800\text{V}$ Mil-Std-883 Method 3015 (reference attached ESD Test Circuit). Latch-Up testing has shown that this device withstands a current of $\pm 100\text{mA}$ and/or $\pm 20\text{V}$.

Table 1
Reliability Evaluation Test Results

MAX6651EEE

TEST ITEM	TEST CONDITION	FAILURE IDENTIFICATION	PACKAGE	SAMPLE SIZE	NUMBER OF FAILURES
Static Life Test (Note 1)					
	Ta = 135°C Biased Time = 192 hrs.	DC Parameters & functionality		160	0
Moisture Testing (Note 2)					
Pressure Pot	Ta = 121°C P = 15 psi. RH= 100% Time = 168hrs.	DC Parameters & functionality	QSOP	77	0
85/85	Ta = 85°C RH = 85% Biased Time = 1000hrs.	DC Parameters & functionality		77	0
Mechanical Stress (Note 2)					
Temperature Cycle	-65°C/150°C 1000 Cycles Method 1010	DC Parameters		77	0

Note 1: Life Test Data may represent plastic DIP qualification lots.

Note 2: Generic Package/Process data

Attachment #1

TABLE II. Pin combination to be tested. 1/ 2/

	Terminal A (Each pin individually connected to terminal A with the other floating)	Terminal B (The common combination of all like-named pins connected to terminal B)
1.	All pins except V_{PS1} <u>3/</u>	All V_{PS1} pins
2.	All input and output pins	All other input-output pins

1/ Table II is restated in narrative form in 3.4 below.

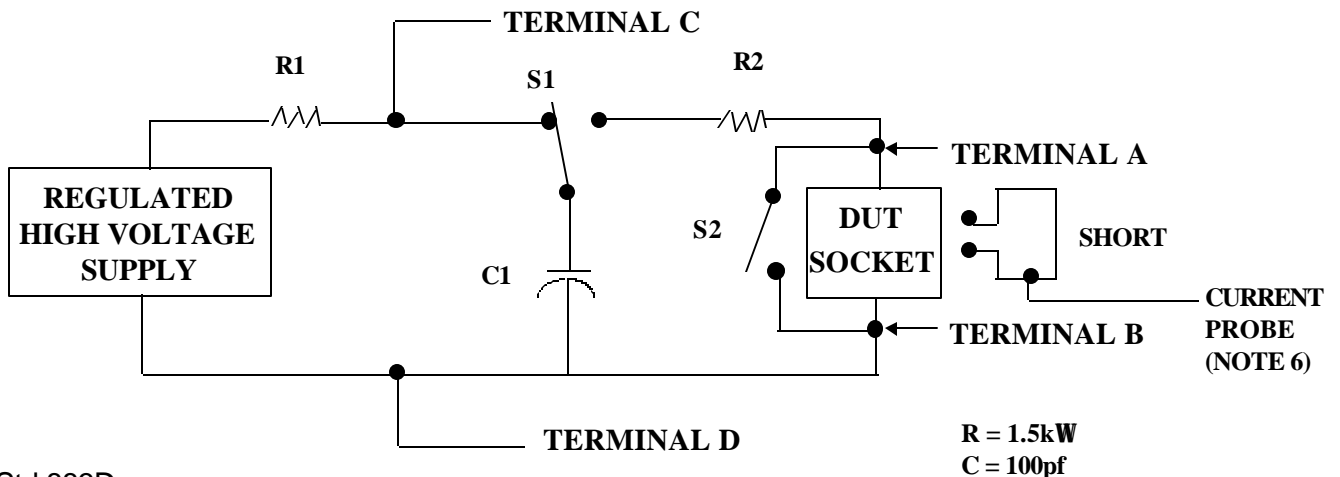
2/ No connects are not to be tested.

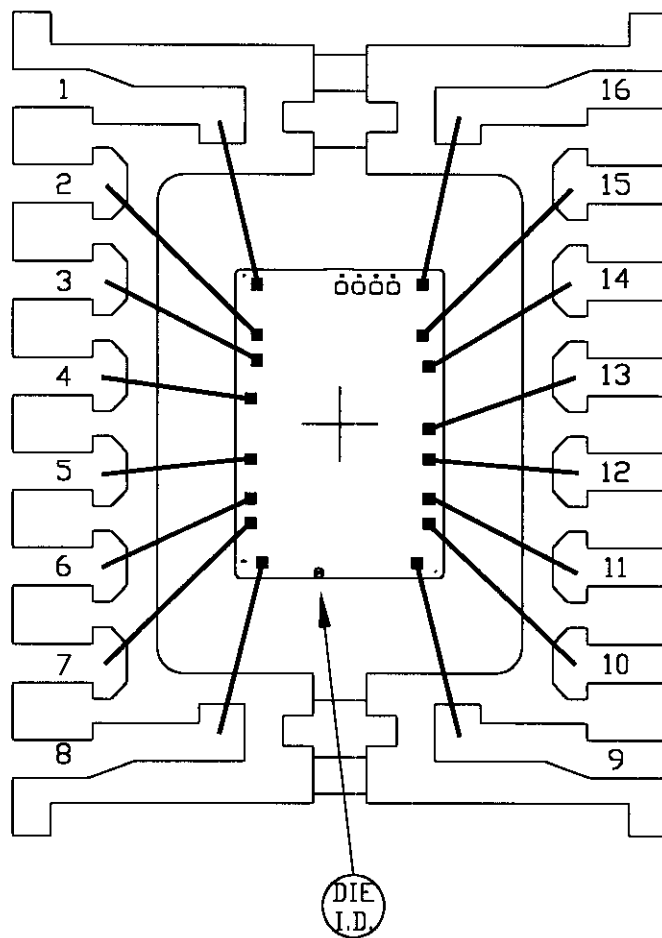
3/ Repeat pin combination I for each named Power supply and for ground

(e.g., where V_{PS1} is V_{DD} , V_{CC} , V_{SS} , V_{BB} , GND, $+V_S$, $-V_S$, V_{REF} , etc).

3.4 Pin combinations to be tested.

- a. Each pin individually connected to terminal A with respect to the device ground pin(s) connected to terminal B. All pins except the one being tested and the ground pin(s) shall be open.
- b. Each pin individually connected to terminal A with respect to each different set of a combination of all named power supply pins (e.g., V_{SS1} , or V_{SS2} or V_{SS3} or V_{CC1} , or V_{CC2}) connected to terminal B. All pins except the one being tested and the power supply pin or set of pins shall be open.
- c. Each input and each output individually connected to terminal A with respect to a combination of all the other input and output pins connected to terminal B. All pins except the input or output pin being tested and the combination of all the other input and output pins shall be open.





PKG.CODE: E16-1

APPROVALS

DATE



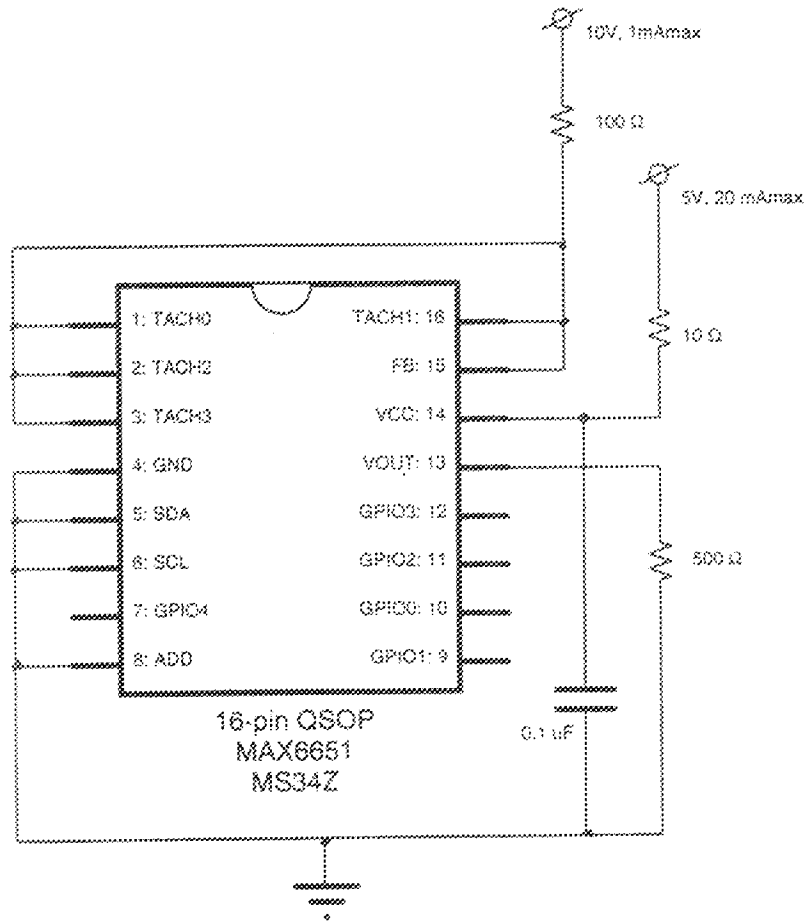
CAV./PAD SIZE:
96X130

PKG.
DESIGN

BUILDSHEET NUMBER:
05-1601-0098

REV.:
A

Burn-in Schematic MS34



06-5530