RELIABILITY REPORT

FOR

MAX5170xEEE

PLASTIC ENCAPSULATED DEVICES

January 23, 2002

MAXIM INTEGRATED PRODUCTS

120 SAN GABRIEL DR.

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Conclusion

The MAX5170 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.

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I. Device Description

A. General

The MAX5170 low-power, serial, voltage-output, 14-bit digital-to-analog converter (DACs) features a precision output amplifier in a space-saving 16-pin QSOP package. The MAX5170 operates from a +5V single supply and draws only 280µA of supply current, which reduces to 1µA in shutdown. In addition, the programmable power-up reset feature allows for a user-selectable power-up output voltage of either 0 or midscale.

The 3-wire serial interface is compatible with SPI™, QSPI™, and MICROWIRE™ standards. An input register followed by a DAC register provides a double-buffered input, allowing the input and DAC registers to be updated independently or simultaneously with a 16-bit serial word. Additional features include software and hardware shutdown, shutdown lockout, a hardware clear pin, and a reference input capable of accepting DC and offset AC signals. This device provides a programmable digital output pin for added functionality and a serial-data output pin for daisy-chaining. All logic inputs are TTL/CMOS-compatible and are internally buffered with Schmitt triggers to allow direct interfacing to optocouplers.

The MAX5170 incorporates a proprietary on-chip circuit that keeps the output voltage virtually "glitch free," limiting the glitches to a few millivolts during power-up.

The device is available in a 16-pin QSOP package and is specified for the extended (-40°C to +85°C) temperature range.

B. Absolute Maximum Ratings

<table>
<thead>
<tr>
<th>Item</th>
<th>Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>VDD to AGND, DGND</td>
<td>-0.3V to +6V</td>
</tr>
<tr>
<td>AGND to DGND</td>
<td>-0.3V to +0.3V</td>
</tr>
<tr>
<td>Digital Inputs to GND</td>
<td>-0.3V to +6V</td>
</tr>
<tr>
<td>DOUT, UPO to DGND</td>
<td>-0.3V to (VDD + 0.3V)</td>
</tr>
<tr>
<td>OUT, REF to AGND</td>
<td>-0.3V to (VDD + 0.3V)</td>
</tr>
<tr>
<td>OS to DGND</td>
<td>(AGND – 4.0V) to (VDD + 0.3V)</td>
</tr>
<tr>
<td>Maximum Current into Any pin</td>
<td>50mA</td>
</tr>
<tr>
<td>Storage Temp.</td>
<td>-65°C to +150°C</td>
</tr>
<tr>
<td>Lead Temp. (10 sec.)</td>
<td>+300°C</td>
</tr>
<tr>
<td>Power Dissipation</td>
<td></td>
</tr>
<tr>
<td>16-Pin QSOP</td>
<td>667mW</td>
</tr>
<tr>
<td>Derates above +70°C</td>
<td></td>
</tr>
<tr>
<td>16-Pin QSOP</td>
<td>8.0mW/°C</td>
</tr>
</tbody>
</table>
II. Manufacturing Information

A. Description/Function: Low-Power, Serial, 14-Bit DAC with Voltage Output
B. Process: S12 (Standard 1.2 micron silicon gate CMOS)
C. Number of Device Transistors: 3457
D. Fabrication Location: Oregon, USA
E. Assembly Location: Malaysia, Philippines or Thailand
F. Date of Initial Production: July, 2000

III. Packaging Information

A. Package Type: 16-Lead QSOP
B. Lead Frame: Copper
C. Lead Finish: Solder Plate
D. Die Attach: Silver-filled Epoxy
E. Bondwire: Gold (1.0 mil dia.)
F. Mold Material: Epoxy with silica filler
G. Assembly Diagram: Buildsheet # 05-7001-0353
H. Flammability Rating: Class UL94-V0
I. Classification of Moisture Sensitivity per JEDEC standard JESD22-A112: Level 1

IV. Die Information

A. Dimensions: 86 x 120 mils
B. Passivation: Si₃N₄/SiO₂ (Silicon nitride/ Silicon dioxide)
C. Interconnect: Aluminum/Si (Si = 1%)
D. Backside Metallization: None
E. Minimum Metal Width: 1.2 microns (as drawn)
F. Minimum Metal Spacing: 1.2 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 of QA)  
   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 ($\lambda$) is calculated as follows:

   $$\lambda = \frac{1}{\text{MTTF}} = \frac{1.83}{192 \times 4389 \times 80 \times 2}$$

   (Chi square value for MTTF upper limit)

   Temperature Acceleration factor assuming an activation energy of 0.8eV

   $$\lambda = 13.57 \times 10^{-9}$$  $$\lambda = 13.57 \text{ F.I.T. (60\% confidence level @ 25°C)}$$

   This low failure rate represents data collected from Maxim’s reliability qualification and monitor programs. Maxim also performs weekly Burn-In on samples from production to assure reliability of its processes. The reliability required for lots which receive a burn-in qualification 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 rejects from lots exceeding this level. The attached Burn-In Schematic (Spec. # 06-5356) shows the static circuit used for this test. Maxim also performs 1000 hour life test monitors quarterly for each process. This data is published in the Product Reliability Report (RR-1M).

B. Moisture Resistance Tests

   Maxim evaluates pressure pot stress from every assembly process during qualification of each new design. Pressure Pot testing must pass a 20% LTPD for acceptance. Additionally, industry standard 85°C/85%RH or HAST tests are performed quarterly per device/package family.

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

   The PX57-2 die type has been found to have all pins able to withstand a transient pulse of ±1500V, per Mil-Std-883 Method 3015 (reference attached ESD Test Circuit). Latch-Up testing has shown that this device withstands a current of ±250mA and/or ±20V.
# Table 1
Reliability Evaluation Test Results

## MAX5170xEEE

<table>
<thead>
<tr>
<th>TEST ITEM</th>
<th>TEST CONDITION</th>
<th>FAILURE IDENTIFICATION</th>
<th>SAMPLE SIZE</th>
<th>NUMBER OF FAILURES</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Static Life Test</strong> (Note 1)</td>
<td>Ta = 135°C Biased&lt;br&gt;Time = 192 hrs.</td>
<td>DC Parameters &amp; functionality</td>
<td>80</td>
<td>0</td>
</tr>
<tr>
<td><strong>Moisture Testing</strong> (Note 2)</td>
<td>Pressure Pot Ta = 121°C&lt;br&gt;P = 15 psi.&lt;br&gt;RH= 100%&lt;br&gt;Time = 168hrs.</td>
<td>DC Parameters &amp; functionality</td>
<td>700</td>
<td>0</td>
</tr>
<tr>
<td>85/85</td>
<td>Ta = 85°C&lt;br&gt;RH = 85%&lt;br&gt;Biased&lt;br&gt;Time = 1000hrs.</td>
<td>DC Parameters &amp; functionality</td>
<td>77</td>
<td>0</td>
</tr>
<tr>
<td><strong>Mechanical Stress</strong> (Note 2)</td>
<td>Temperature Cycle -65°C/150°C&lt;br&gt;1000 Cycles&lt;br&gt;Method 1010</td>
<td>DC Parameters</td>
<td>77</td>
<td>0</td>
</tr>
</tbody>
</table>

Note 1: Life Test Data may represent plastic D.I.P. qualification lots for the Small Outline package.
Note 2: Generic Package/Process data
TABLE II. Pin combination to be tested. 1/ 2/

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

1/ Table II is restated in narrative form in 3.4 below.
2/ No connects are not to be tested.
3/ Repeat pin combination 1 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.

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**Diagram:***

- **TERMINAL C**
- **TERMINAL A**
- **TERMINAL B**
- **TERMINAL D**

- **REGULATED HIGH VOLTAGE SUPPLY**
- **DUT SOCKET**

- **C1**
- **R1**
- **R2**
- **S1**
- **S2**

- **R = 1.5kΩ**
- **C = 100pf**

**Notice 8**