RELIABILITY REPORT

FOR

MAX78000EXG+

September 25, 2020

MAXIM INTEGRATED

160 RIO ROBLES

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Conclusion

The MAX78000 successfully meets the quality and reliability standards required of all Maxim Integrated products. In addition, Maxim Integrated's continuous reliability monitoring program ensures that all outgoing product will continue to meet Maxim Integrated's quality and reliability standards.

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I. Device Description

A. General

Artificial intelligence (AI) requires extreme computational horsepower, but Maxim is cutting the power cord from AI insights. The MAX78000 is a new breed of AI microcontroller built to enable neural networks to execute at ultra-low power and live at the edge of the IoT. This product combines the most energy-efficient AI processing with Maxim's proven ultra-low power microcontrollers. Our hardware-based convolutional neural network (CNN) accelerator enables battery-powered applications to execute AI inferences while spending only microjoules of energy.

The MAX78000 is an advanced system-on-chip featuring an Arm® Cortex®-M4 with FPU CPU for efficient system control with an ultra-low-power deep neural network accelerator. The CNN engine has a weight storage memory of 442KB, and can support 1-, 2-, 4-, and 8-bit weights (supporting networks of up to 3.5 million weights). The CNN weight memory is SRAM-based, so AI network updates can be made on the fly. The CNN engine also has 512KB of data memory. The CNN architecture is highly flexible, allowing networks to be trained in conventional toolsets like PyTorch and TensorFlow®, then converted for execution on the MAX78000 using tools provided by Maxim.

In addition to the memory in the CNN engine, the MAX78000 has large on-chip system memory for the microcontroller core, with 512KB flash and up to 128KB SRAM. Multiple high-speed and low-power communications interfaces are supported, including I2S and a parallel camera interface (PCIF).

The device is available in 81-pin CTBGA (8mm x 8mm, 0.8mm pitch) and 130-pin WLP (4.6mm x 3.7mm, 0.35mm pitch) packages.

II. Manufacturing Information

A. Description/Function:	Ultra-Low-Power Arm Cortex-M4 Processor with FPU-Based Microcontroller with Convolutional Neural Network Accelerator
B. Process:	TS40EF
C. Device Count:	10788658
D. Fabrication Location:	Taiwan
E. Assembly Location:	Taiwan
F. Date of Initial Production:	July 2, 2020

III. Packaging Information

A. Package Type:	CTBGA-CU
B. Lead Frame:	N/A
C. Lead Finish:	BT Green
D. Die Attach:	AB2025D
E. Bondwire:	0.8 mil CUPd
F. Mold Material:	KE-G1250
G. Assembly Diagram:	05-101655
H. Flammability Rating:	N/A
I. Classification of Moisture Sensitivity per JEDEC standard J-STD-020-C	Level 3
J. Single Layer Theta Ja:	N/A
K. Single Layer Theta Jc:	N/A
L. Multi Layer Theta Ja:	33.55 °C/W
M. Multi Layer Theta Jc:	6.73 °C/W

IV. Die Information

A. Dimensions:	147.4173X188.7 mils
B. Passivation:	SiO/SiN

V. Quality Assurance Information

A. Quality Assurance Contacts:	Ryan Wall (Manager, Reliability) Michael Cairnes (Executive Director, Reliability) Bryan Preeshl (SVP of QA)
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 125C biased (static) life test are shown in Table 1. Using these results, the Failure Rate λ is calculated as follows:

$$\lambda = \frac{1}{MTTF} = \frac{1.83}{192\ x\ 2454\ x\ 80\ x\ 2}$$ (Chi square value for MTTF upper limit)

(where 2454 = Temperature Acceleration factor assuming an activation energy of 0.8eV)

$$\lambda = 24.3\ x\ 10^{-9}$$

$$\lambda = 24.3\ FITs\ (60\%\ confidence\ level\ @25°C)$$

Maxim Integrated performs quarterly life test monitors on its processes. This data is published in the Reliability Report found at https://www.maximintegrated.com/en/support/qa-reliability/reliability/reliability-monitor-program.html.

TS40 cumulative process Fit

$$\lambda = 1.50\ FITs\ (60\%\ confidence\ level\ @25°C)$$

$$\lambda = 18.03\ FITs\ (60\%\ confidence\ level\ @55°C)$$

B. ESD and Latch-Up Testing

The MAX78000EXG+ has been found to have all pins able to withstand an HBM transient pulse of ±1500 V per JEDEC / ESDA JS-001. Latch-Up testing has shown that this device withstands ±250 mA current injection and supply overvoltage per JEDEC JESD78.

Table 1

Reliability Evaluation Test Results

MAX78000EXG+

TEST ITEM	TEST CONDITION	FAILURE IDENTIFICATION	SAMPLE SIZE	NUMBER OF FAILURES	COMMENTS
Static Life Test (Note 1)	Ta = 125°C Biased Time = 192 hrs.	DC parameters & functionality	80	0	

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