

INVENSYS PROCESS AUTOMATION

15345 Barranca Parkway Irvine, California 92618 United States of America

Telephone +1 949 885 0700 Facsimile +1 949 753 9101 http://www.triconex.com

August 30, 2001

Document Control Desk United States Nuclear Regulatory Commission Washington, DC 20555

- Nuclear 1E Qualification of the TRICON TMR Programmable Logic Controller Subject: (PLC) - Additional Information related to Component Aging Analysis
- References: 1. EPRI TR-107330, Generic Requirements Specification for Qualifying a Commercially Available PLC for Safety-Related Applications in Nuclear Power Plants.
 - 2. Qualification Summary Report, Triconex Document No. 7286-545, revision 1.
 - 3. Project Number 709

Gentlemen:

In Reference 1, the EPRI specification document governing the Triconex Nuclear 1E Qualification Project, a component aging analysis (per section 4.7.8.2) was required to be performed as part of the qualification effort. Section 8.0 (Documentation) of the specification, did not require submittal of a specific document for this aging analysis; rather, it required that the results of the aging analysis be incorporated into the Final Summary Report/Application Guide. Accordingly, the aging analysis was performed and the results were incorporated into the Qualification Summary Report, 7286-545, Revision 1. This document was transmitted to the NRC on October 2, 2000.

Based on our recent discussions with the Staff, we believe it would be beneficial to provide some supplemental background information on component aging analysis (1) as it relates to our design process and (2) as it pertains to the Triconex Nuclear Qualification Project.

As part of the process of assembling information for the Qualification Summary Report last year, a component aging evaluation was performed. All components in the TRICON were considered. Environmental conditions encompassing those specified in Reference 1, section 4.3.6 were also considered. Since aging considerations have always been an integral part of Triconex design and development activities, the bulk of the analysis work had already been done. Information on

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component failures and projected design life is readily available within Triconex. The conclusions reached after reviewing this information, was that only two components had any significant aging considerations; the back-up batteries and the electrolytic capacitors in the power supplies. These conclusions were reported in section 4.12 of Reference 2.

Also, consistent with TR-107330 section 4.7.8.2, guidance from IEEE 323, section 6.2.1 was followed for providing in-service surveillance and maintenance recommendations. Appendix B, section 6.3 of the Qualification Summary Report provides specific maintenance considerations to account for the potential lifetime limitations of the batteries and electrolytic capacitors. Adherence to these recommendations will assure that no age related component failures present a safety concern with the qualified TRICON systems.

Attached is a Triconex Component Aging Analysis discussion provided by our Engineering Department. If you have any questions or wish further information, please contact me at (281) 360-6401 or Mr. Michael Phillips at (949) 885-0711.

Sincerely,

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J. Troy Martel, P. E. Triconex Nuclear Qualification Project Director

Enclosure cc: L. Raynard Wharton, NRC P. Loeser, NRC

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Attachment to letter, NRC Document Control Desk, August 30, 2001

Attachment 1 – Triconex Component Aging Analysis

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COMPONENT AGING ANALYSIS FOR THE TRICON PRODUCT

When the TRICON was first designed a number of years ago, aging was an important factor in the design, as it was well known that industrial control equipment must live a long life. In February of last year (2000) in connection with the Nuclear Qualification Project, we revisited this issue and reviewed the design of TRICON for potential aging problems. All components in the TRICON were considered. Our conclusions are as follows:

Due to the triple-modular-redundant architecture and comprehensive diagnostics of the TRICON, a failure of any nature including aging is diagnosed and reported to the control system. The system provides error-free uninterrupted control while notifying the system that maintenance is required. The design of all the modules was reviewed to ensure that the components used were within the guidelines of "Military Handbook Reliability Prediction of Electronic Equipment MIL-HDBK-217F". We use the Triconex Engineering Procedure EDM-64.00 to predict the reliability of the components in our product and these were derived from the above military standard (see attached Table 1).

The TRICON chassis backup batteries are the most age-limited component in the system. All TRICON batteries are alarmed, and the replacement is covered in the TRICON P & I Guide. Time specified for replacement is half of the expected lifetime. We reviewed the remaining parts in the system.

Of the remaining parts in the system, the aluminum electrolytic capacitors in the power supply are subject to a wearout mechanism - electrolytic evaporation - which causes the hazard rate to increase with time. This component, although still with a predicted life of greater than 20 years, is, after the battery, the shortest life part in the system. The mean-time-to-failure (MTTF) (see Table 2) is based on many factors including temperature and stress. Since our power supplies are typically running at less than half their rated loads, this component should have long life. Failure of a capacitor and consequent failure of power module still allows the system to maintain operation. If both power supplies fail (a pathological condition) this will result in a fail-safe condition (outputs going to a de-energized state). All the other components in the system have life times that greatly exceed 20 years as shown in the attached short-form failure prediction table. The optoelectronics in the system are also subjected to aging. The LED indicators on the front of the module will dim slightly over time with no impact on system function. The light emitting part of our solid-state relays and opto-isolators also have slight degrading over time, but in the original design, the worst case CTR (current transfer ratio) over a minimum of 20 years was considered, and there was no degradation of the system.

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Paul Groner Date Manager, Engineering (Prepared)

8/3/2

G. Hufton // Date ' Director, Hardware Development (Reviewed/approved)

Capacitors, Aluminum CE			.029				
Capacitors, Ceramic CKR			.004				
Capacitors, Plastic CRH			.002				
Capacitors, Tantalum CSR			.002				
Circuit Breakers			.060				
Connectors, Coaxial			.012				
Connectors, Rack & Panel			.011				
Diodes, Current			.040				
Diodes, General Purpose			.028				
Diodes, Power / Schottky			.022				
Diodes, Varistor			.023				
Diodes, Volt Reg.			.024				
Electronic Filters			.270				
Emitters / LEDs			.001				
Fuses			.010				
IC Sockets			.002				
Inductors			.002				
Opto - Isolators			.070				
PCBs			.053				
Photodetectors			.029				
Quartz Crystals			.032				
Relays			.430				
Resistors, Discrete RL,RN,RC			.003				
Resistors, Film Power RD			.025				
Resistors, Wirewound Power RW,RWR			.031				
Resistors, Wirewound Precision RB,RBR			.018				
Resistors, Network RZ			.007				
Solid State Relays			.500				
Switches, Rotary			.560				
Switches, Toggle			.001				
Thermistor RTH			.320				
Thyristors / SCRs			.020				
Transformers			.023				
Transistors, Bipolar			.001				
Transistors, Bipolar Power			.042				
Transistors, MOS			.099				
gates(digital)/transieters(linear)	100	200	1000	2000	10000	20000	60004

gat	es(digital)/tra	ansistors(linear)	100	300	1000	3000	10000	30000	60000
IC,	CMOS	Digital	.006		.010	.019	.049	.084	.130
IC,	Bipolar	Digital	.004		.006	.011	.033	.052	.075
IC,	CMOS/Bipo	lar Linear	.010	.017	.033	.050			
IC,	CMOS	PLA	.005				.006	.006	.006
IC,	Bipolar	PLA	.006		.011	.022			
IC,	CMOS	Microprocessor	.048(8	bit)	.093(1	6bit)	.190(32	bit)	
IC,	Bipolar	Microprocessor	.028(8	bit)	.052(1	6bit)	.110(32	bit)	
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IC, Memory	MOS/EE/P/ROM	MOS/DRAM	MOS/SRAM	BIPOLAR/P/ROM	BIPOLAR/SRAM
16K	.005	.004	.008	.010	.008
64K	.006	.006	.014	.017	.012
256K	.007	.007	.023	.028	.018
1M	.012	.011	.043	.053	.033

*ASSUMPTIONS:

1. MIL-HDBK-217F APPENDIX A (NOTICE 1 INSERTED)

MID-MDBR-21/F AFFENDIX A (NOTICE TINSERTED)
30C ambient (except resistors @ 40C, discretes @ Tj = 60C).
Parts run typically @ stress of .5 i.e. 1/4W dissipation in 1/2 W resistor.
Quality factor = 8 for IC; 1 other - commercial quality M. This is set in Triconex parts master file.

5. Environmental factor = 1 benign environment.
6. Ref. EDM 64.00

Table 2 - MTBF/MTTF Data

1200xxx-001 Capacitors, Aluminum CE 0.029 3336 1200xxx-001 Capacitors, Ceramic CKR 0.004 28539 1200xx-001 Capacitors, Tantalum CSR 0.002 57078 1830xx-001 Capacitors, Tantalum CSR 0.012 9513 1500xx-001 Connectors, Caxial 0.012 9513 1500xx-001 Donectors, Caxial 0.014 2854 1300xx-001 Diodes, Current 0.04 2854 1300xx-001 Diodes, Power / Schottky 0.022 4963 1300xx-001 Diodes, Varistor 0.023 4963 1300xx-001 Diodes, Varistor 0.024 4756 1300xx-001 Entiters / LEDs 0.001 114155 1410xx-001 Enses 0.01 114156 1300xx-001 Inductors 0.002 57078 1300xx-001 Inductors 0.002 57078 1300xx-001 Inductors 0.032 3567 1300xx-001 Inductors 0.032 3567 1300xx-0	Triconex #	Component	MTBF/million hrs	MTTF in years
1200xxx-001 Capacitors, Ceramic CKR 0.004 28539 1200xxx-001 Capacitors, Tantalum CSR 0.002 57078 1200xxx-001 Circuit Breakers 0.06 1903 1500xx-001 Connectors, Coaxial 0.012 9513 1500xx-001 Connectors, Rack & Panel 0.011 10378 1300xx-001 Diodes, Current 0.04 2854 1300xx-001 Diodes, Carrent 0.022 5189 1300xx-001 Diodes, Varistor 0.023 4963 1300xx-001 Diodes, Varistor 0.024 4756 1320xx-001 Electronic Filters 0.27 423 1300xx-001 Electronic Filters 0.021 57078 1320xx-001 Inductors 0.002 57078 1300xx-001 Inductors 0.002 57078 1300xx-001 Inductors 0.002 57078 1300xx-001 Inductors 0.032 3657 1300xx-001 Resistors, Discrete RL,RN,RC 0.033 38052	1200xxx-001	Capacitors, Aluminum CE	0.029	3936
1200xxx-001 Capacitors, Plastic CRH 0.002 57078 1200xxx-001 Capacitors, Tantalum CSR 0.002 57078 1300xx-001 Cincuit Breakers 0.06 1903 1500xx0-001 Connectors, Caxial 0.012 9513 1500xx0-001 Diodes, Current 0.04 2854 1300xx-001 Diodes, General Purpose 0.028 4077 1300xx0-001 Diodes, Varistor 0.023 4963 1300xx0-001 Diodes, Volt Reg. 0.024 4756 1320xx0-001 Emitters / LEDs 0.001 114165 1300xx0-001 Emitters / LEDs 0.001 114165 1300xx0-001 Fuses 0.01 114165 1300xx0-001 Fuses 0.01 114165 1300xx0-001 Inductors 0.022 57078 1320xx0-001 Inductors 0.002 57078 1320xx0-001 Inductors 0.002 57078 1300xx0-001 Relsitors 0.002 57078 1300xx0-001	1200xxx-001	Capacitors, Ceramic CKR	0.004	28539
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1630xxx-001 Circuit Breakers 0.06 1903 1500xxx-001 Connectors, Coaxial 0.012 9513 1300xxx-001 Diodes, Current 0.04 2854 1300xxx-001 Diodes, General Purpose 0.028 4077 1300xxx-001 Diodes, Varistor 0.023 4963 1300xxx-001 Diodes, Varistor 0.023 4963 1300xxx-001 Diodes, Varistor 0.021 4756 1320xxx-001 Electronic Filters 0.27 423 1330xx-001 Electronic Filters 0.001 114155 1410xx-001 Fuses 0.001 114156 1500xxx-001 Inductors 0.002 57078 1000xx-001 Cpts Isolators 0.001 1631 17300xx-001 PcBs 0.053 2154 1000xx-001 Polsetectors 0.029 3936 1300xx-001 Resistors, Discrete RL,RN,RC 0.003 38652 1100xx-001 Resistors, Wirewound Precision RB,RBR 0.018 6342 1100xx-001 Resistors, Network RZ 0.007 16338<	1200xxx-001	Capacitors, Tantalum CSR	0.002	57078
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7300xxx-001 PCBs 0.053 2154 1000xxx-001 Photodetectors 0.029 3936 1300xxx-001 Quartz Crystals 0.032 3567 1300xxx-001 Relays 0.43 265 1100xxx-001 Resistors, Discrete RL,RN,RC 0.003 38052 1100xxx-001 Resistors, Film Power RD 0.025 4566 1100xxx-001 Resistors, Wirewound Power RW,RWR 0.031 3682 1100xxx-001 Resistors, Network RZ 0.007 16308 100xxx-001 Switches, Rotary 0.56 204 1400xxx-001 Switches, Toggle 0.001 114155 1300xxx-001 Thermistor RTH 0.32 357 1300xxx-001 Thermistor RTH 0.32 3663 1300xxx-001 Transistors, Bipolar 0.001 114155 1300xxx-001 Transistors, NOS 0.099 1153 1000xxx-001 Transistors, MOS 0.091 114155 1300xxx-001 IC, CMOS 0.011 114155 1300xxx-001 IC, CMOS 0.011 114165 <t< td=""><td>1000xxx-001</td><td>Opto – Isolators</td><td>0.07</td><td>1631</td></t<>	1000xxx-001	Opto – Isolators	0.07	1631
1000xxx-001 Photodetectors 0.029 3936 1300xxx-001 Quartz Crystals 0.032 3567 1300xxx-001 Relays 0.43 265 1100xxx-001 Resistors, Discrete RL,RN,RC 0.003 38052 1100xxx-001 Resistors, Wirewound Power RW,RWR 0.031 3682 1100xxx-001 Resistors, Wirewound Power RW,RWR 0.031 3682 1100xxx-001 Resistors, Network RZ 0.007 16308 1000xxx-001 Solid State Relays 0.5 228 1400xxx-001 Switches, Rotary 0.56 204 1400xxx-001 Switches, Toggle 0.001 114155 1300xxx-001 Thermistor RTH 0.32 357 1300xxx-001 Transformers 0.023 4963 1300xxx-001 Transistors, Bipolar Power 0.042 2718 1300xxx-001 Transistors, MOS 0.091 114155 1000xxx-001 IC, VLSI (using worst case numbers) 0.001 114165 1000xxx-001 IC, CMOS 0	7300xxx-001	PCBs	0.053	2154
1300xxx-001 Quartz Crystals 0.032 3567 1300xxx-001 Relays 0.43 265 1100xxx-001 Resistors, Discrete RL,RN,RC 0.003 38052 1100xxx-001 Resistors, Film Power RD 0.025 4566 1100xxx-001 Resistors, Wirewound Power RW,RWR 0.031 3682 1100xxx-001 Resistors, Wirewound Precision RB,RBR 0.018 6342 1100xxx-001 Resistors, Network RZ 0.007 16308 1000xxx-001 Solid State Relays 0.5 228 1400xxx-001 Switches, Rotary 0.56 204 1400xxx-001 Switches, Toggle 0.001 114155 1300xxx-001 Thermistor RTH 0.32 357 1300xxx-001 Transformers 0.023 4963 1300xxx-001 Transistors, Bipolar Power 0.042 2718 1300xxx-001 Transistors, MOS 0.099 1153 1000xxx-001 IC, CMOS 0.01 114165 1000xxx-001 IC, CMOS 0.01 11416 1000xxx-001 IC, CMOS 0.011 1	1000xxx-001	Photodetectors	0.029	3936
1300xxx-001 Relays 0.43 265 1100xxx-001 Resistors, Discrete RL,RN,RC 0.003 38052 1100xxx-001 Resistors, Film Power RD 0.025 4566 1100xxx-001 Resistors, Wirewound Power RW,RWR 0.031 3682 1100xxx-001 Resistors, Wirewound Precision RB,RBR 0.018 6342 1100xxx-001 Resistors, Network RZ 0.007 16308 1000xxx-001 Solid State Relays 0.5 228 1400xxx-001 Switches, Rotary 0.56 204 1400xxx-001 Switches, Toggle 0.001 114155 1300xxx-001 Thermistor RTH 0.32 357 1300xxx-001 Transformers 0.023 4963 1300xx-001 Transistors, Bipolar 0.001 114155 1300xxx-001 Transistors, MOS 0.099 1153 1000xxx-001 Iransistors, MOS 0.099 1153 1000xxx-001 IC, CMOS 0.01 11416 1000xxx-001 IC, CMOS 0.011 10378 1000xxx-001 IC, CMOS 0.11 10378<	1300xxx-001	Quartz Crystals	0.032	3567
1100xxx-001 Resistors, Discrete RL,RN,RC 0.003 38052 1100xxx-001 Resistors, Film Power RD 0.025 4566 1100xxx-001 Resistors, Wirewound Power RW,RWR 0.031 3682 1100xxx-001 Resistors, Wirewound Precision RB,RBR 0.018 6342 1100xxx-001 Resistors, Network RZ 0.007 16308 1000xxx-001 Solid State Relays 0.5 228 1400xxx-001 Switches, Rotary 0.56 204 1400xxx-001 Switches, Toggle 0.001 114155 1300xxx-001 Thermistor RTH 0.32 357 1300xxx-001 Transformers 0.023 4963 1300xxx-001 Transistors, Bipolar 0.001 114155 1300xxx-001 Transistors, MOS 0.099 1153 1000xxx-001 IC, CMOS 0.01 11416 1000xxx-001 IC, CMOS 0.01 11416 1000xxx-001 IC, CMOS 0.01 10378 1000xxx-001 IC, CMOS 0.011 10	1300xxx-001	Relays	0.43	265
1100xxx-001 Resistors, Film Power RD 0.025 4566 1100xxx-001 Resistors, Wirewound Power RW,RWR 0.031 3682 1100xxx-001 Resistors, Wirewound Precision RB,RBR 0.018 6342 1100xxx-001 Resistors, Network RZ 0.007 16308 1000xxx-001 Solid State Relays 0.5 228 1400xxx-001 Switches, Rotary 0.56 204 1400xxx-001 Switches, Toggle 0.001 114155 1300xxx-001 Thermistor RTH 0.32 357 1300xxx-001 Transformers 0.023 4963 1300xxx-001 Transistors, Bipolar 0.001 114155 1300xxx-001 Transistors, Bipolar Power 0.042 2718 1300xxx-001 Transistors, MOS 0.099 1153 1000xxx-001 IC, CMOS 0.01 11416 1000xxx-001 IC, CMOS 0.01 11416 1000xxx-001 IC, CMOS 0.01 11416 1000xxx-001 IC, CMOS 0.011 10378 1000xxx-001 IC, CMOS 0.011 10378	1100xxx-001	Resistors, Discrete RL,RN,RC	0.003	38052
1100xxx-001 Resistors, Wirewound Power RW,RWR 0.031 3682 1100xxx-001 Resistors, Wirewound Precision RB,RBR 0.018 6342 1100xxx-001 Resistors, Network RZ 0.007 16308 1000xxx-001 Solid State Relays 0.5 228 1400xxx-001 Switches, Rotary 0.56 204 1400xxx-001 Switches, Toggle 0.001 114155 1300xxx-001 Thermistor RTH 0.32 357 1300xxx-001 Thermistor RTH 0.32 4963 1300xxx-001 Transformers 0.023 4963 1300xxx-001 Transistors, Bipolar 0.001 114155 1300xxx-001 Transistors, MOS 0.099 1153 1000xxx-001 IC, VLSI (using worst case numbers) 0.001 11416 1000xxx-001 IC, CMOS 0.011 11416 1000xxx-001 IC, CMOS 0.011 10378 1000xxx-001 IC, CMOS 0.011 10378 1000xxx-001 IC, CMOS 0.19 601 1000xxx-001 IC, CMOS 0.19 601	1100xxx-001	Resistors, Film Power RD	0.025	4566
1100xxx-001 Resistors, Wirewound Precision RB,RBR 0.018 6342 1100xxx-001 Resistors, Network RZ 0.007 16308 1000xxx-001 Solid State Relays 0.5 228 1400xxx-001 Switches, Rotary 0.56 204 1400xxx-001 Switches, Toggle 0.001 114155 1300xx-001 Thermistor RTH 0.32 357 1300xx-001 Thyristors / SCRs 0.02 5708 1440xxx-001 Transformers 0.001 114155 1300xx-001 Transistors, Bipolar 0.001 114155 1300xxx-001 Transistors, Bipolar Power 0.042 2718 1300xxx-001 Transistors, MOS 0.099 1153 1000xxx-001 IC, CMOS 0.01 11416 1000xxx-001 IC, CMOS 0.01 11416 1000xxx-001 IC, CMOS 0.011 10378 1000xxx-001 IC, CMOS 0.011 10378 1000xxx-001 IC, CMOS 0.11 10378 1000xxx-001 IC, Bipolar 0.11 10378 10	1100xxx-001	Resistors, Wirewound Power RW,RWR	0.031	3682
1100xxx-001 Resistors, Network RZ 0.007 16308 1000xxx-001 Solid State Relays 0.5 228 1400xxx-001 Switches, Rotary 0.56 204 1400xxx-001 Switches, Toggle 0.001 114155 1300xxx-001 Thermistor RTH 0.32 357 1300xxx-001 Thyristors / SCRs 0.02 5708 1440xxx-001 Transformers 0.023 4963 1300xxx-001 Transistors, Bipolar 0.001 114155 1300xxx-001 Transistors, Bipolar Power 0.042 2718 1300xxx-001 Transistors, MOS 0.099 1153 1000xxx-001 IC, VLSI (using worst case numbers) 0.001 11416 1000xxx-001 IC, CMOS 0.01 11416 1000xx-001 IC, CMOS 0.011 10378 1000xx-001 IC, CMOS 0.011 10378 1000xx-001 IC, CMOS 0.11 10378 1000xx-001 IC, CMOS 0.11 10378 1000xx-001 IC, Bipolar 0.11 10378 1000xxx	1100xxx-001	Resistors, Wirewound Precision RB,RBR	0.018	6342
1000xxx-001 Solid State Relays 0.5 228 1400xxx-001 Switches, Rotary 0.56 204 1400xxx-001 Switches, Toggle 0.001 114155 1300xx-001 Thermistor RTH 0.32 357 1300xxx-001 Thyristors / SCRs 0.02 5708 1440xxx-001 Transformers 0.023 4963 1300xx-001 Transitors, Bipolar 0.001 114155 1300xx-001 Transitors, Bipolar Power 0.042 2718 1300xx-001 Transitors, MOS 0.099 1153 1000xx-001 IC, VLSI (using worst case numbers) 0.011 11416 1000xx-001 IC, CMOS 0.01 11416 1000xx-001 IC, CMOS/Bipolar 0.005 2283 1000xx-001 IC, CMOS 0.011 10378 1000xx-001 IC, Bipolar 0.011 10378 1000xx-001 IC, Bipolar 0.11 10378 1000xx-001 IC, Bipolar 0.11 1038 IC, Memory (using worst case numbers) 0.11 1038 IC, Memory (usin	1100xxx-001	Resistors, Network RZ	0.007	16308
1400xxx-001 Switches, Rotary 0.56 204 1400xxx-001 Switches, Toggle 0.001 114155 1300xx-001 Thermistor RTH 0.32 357 1300xxx-001 Thyristors / SCRs 0.02 5708 1440xxx-001 Transformers 0.023 4963 1300xx-001 Transitors, Bipolar 0.001 114155 1300xx-001 Transistors, Bipolar Power 0.042 2718 1300xx-001 Transistors, MOS 0.099 1153 1000xx-001 IC, VLSI (using worst case numbers) 0.001 11416 1000xx-001 IC, CMOS 0.01 11416 1000xx-001 IC, CMOS/Bipolar 0.005 2283 1000xx-001 IC, CMOS 0.011 10378 1000xx-001 IC, Bipolar 0.011 10378 1000xx-001 IC, MOS 0.11 10378 1000xx-001 IC, Bipolar 0.11 1038 1000xx-001 IC, Bipolar 0.11 1038 1000xx-001 IC, Bipolar 0.11 1038 1000xxx-001 <	1000xxx-001	Solid State Relays	0.5	228
1400xxx-001 Switches, Toggle 0.001 114155 1300xxx-001 Thermistor RTH 0.32 357 1300xxx-001 Thyristors / SCRs 0.02 5708 1440xx-001 Transformers 0.023 4963 1300xxx-001 Transistors, Bipolar 0.001 114155 1300xxx-001 Transistors, Bipolar Power 0.042 2718 1300xxx-001 Transistors, MOS 0.099 1153 1000xxx-001 IC, VLSI (using worst case numbers) 0.006 19026 1000xxx-001 IC, CMOS 0.011 11416 1000xxx-001 IC, CMOS/Bipolar 0.05 2283 1000xxx-001 IC, CMOS 0.011 10378 1000xxx-001 IC, CMOS 0.11 10378 1000xxx-001 IC, Bipolar 0.11 1038 IC, Memory (using worst case numbers) 0.11 1038 IC, Memory (us	1400xxx-001	Switches, Rotary	0.56	204
1300xxx-001 Thermistor RTH 0.32 357 1300xxx-001 Thyristors / SCRs 0.02 5708 1440xxx-001 Transformers 0.023 4963 1300xxx-001 Transistors, Bipolar 0.001 114155 1300xxx-001 Transistors, Bipolar Power 0.042 2718 1300xxx-001 Transistors, MOS 0.099 1153 1000xxx-001 IC, VLSI (using worst case numbers) 0.01 11416 1000xxx-001 IC, CMOS 0.01 11416 1000xxx-001 IC, CMOS/Bipolar 0.006 19026 1000xxx-001 IC, CMOS/Bipolar 0.05 2283 1000xxx-001 IC, CMOS 0.011 10378 1000xxx-001 IC, CMOS 0.011 10378 1000xxx-001 IC, Bipolar 0.11 10378 1000xxx-001 IC, Bipolar 0.11 1038 IC, Memory (using worst case numbers) 0.11 1038 IC, Memory (using worst case numbers) 0.011 11416 1000xxx-001 I6K 0.01 11416 1000xxx-001	1400xxx-001	Switches, Toggle	0.001	114155
1300xxx-001 Thyristors / SCRs 0.02 5708 1440xxx-001 Transformers 0.023 4963 1300xxx-001 Transistors, Bipolar 0.001 114155 1300xxx-001 Transistors, Bipolar Power 0.042 2718 1300xxx-001 Transistors, MOS 0.099 1153 1000xxx-001 IC, VLSI (using worst case numbers) 0.011 11416 1000xxx-001 IC, CMOS 0.01 11416 1000xxx-001 IC, CMOS 0.01 11416 1000xxx-001 IC, Bipolar 0.006 19026 1000xxx-001 IC, CMOS/Bipolar 0.05 2283 1000xxx-001 IC, CMOS 0.011 10378 1000xxx-001 IC, CMOS 0.011 10378 1000xxx-001 IC, Bipolar 0.011 10378 1000xxx-001 IC, Bipolar 0.11 1038 IC, Memory (using worst case numbers) 0.011 10416 1000xxx-001 IC, Memory (using worst case numbers) 0.011 10416 1000xxx-001 IGK 0.011 11416	1300xxx-001	Thermistor RTH	0.32	357
1440xxx-001Transformers0.02349631300xxx-001Transistors, Bipolar0.0011141551300xxx-001Transistors, Bipolar Power0.04227181300xxx-001Transistors, MOS0.09911531000xxx-001IC, VLSI (using worst case numbers)0.011114161000xxx-001IC, CMOS0.01114161000xxx-001IC, CMOS0.006190261000xxx-001IC, CMOS/Bipolar0.0522831000xxx-001IC, CMOS0.011103781000xxx-001IC, CMOS0.11103781000xxx-001IC, CMOS0.196011000xxx-001IC, Bipolar0.1110381000xxx-001IC, Bipolar0.1110381000xxx-001IC, Memory (using worst case numbers)0.01114161000xxx-001IC, Bipolar0.01114161000xxx-001IC, Memory (using worst case numbers)0.01114161000xxx-001IGK0.01114161000xxx-001IGK0.0111416	1300xxx-001	Thyristors / SCRs	0.02	5708
1300xxx-001 Transistors, Bipolar 0.001 114155 1300xxx-001 Transistors, Bipolar Power 0.042 2718 1300xxx-001 Transistors, MOS 0.099 1153 1000xxx-001 IC, VLSI (using worst case numbers) 0.01 11416 1000xxx-001 IC, CMOS 0.01 11416 1000xxx-001 IC, CMOS 0.01 11416 1000xxx-001 IC, CMOS/Bipolar 0.006 19026 1000xxx-001 IC, CMOS/Bipolar 0.05 2283 1000xxx-001 IC, CMOS 0.011 10378 1000xxx-001 IC, CMOS 0.11 10378 1000xxx-001 IC, CMOS 0.19 601 1000xxx-001 IC, Memory (using worst case numbers) 0.11 1038 1000xxx-001 IC, Memory (using worst case numbers) 0.01 11416 1000xxx-001 IGK 0.01 11416 1000xxx-001 IGK 0.01 11416 1000xxx-001 IGK 0.01 11416 1000xxx-001 IGK 0.01 11416	1440xxx-001	Transformers	0.023	4963
1300xxx-001 Transistors, Bipolar Power 0.042 2718 1300xxx-001 Transistors, MOS 0.099 1153 1000xxx-001 IC, VLSI (using worst case numbers) 0.01 11416 1000xxx-001 IC, CMOS 0.01 11416 1000xxx-001 IC, Bipolar 0.006 19026 1000xxx-001 IC, CMOS/Bipolar 0.05 2283 1000xxx-001 IC, CMOS 0.011 10378 1000xxx-001 IC, Bipolar 0.011 10378 1000xxx-001 IC, Bipolar 0.11 10378 1000xxx-001 IC, Bipolar 0.11 10378 1000xxx-001 IC, Bipolar 0.11 1038 1000xxx-001 IC, Bipolar 0.11 1038 1000xxx-001 IC, Bipolar 0.11 1038 1000xxx-001 ICK 0.01 11416 1000xxx-001 16K 0.01 11416 1000xxx-001 64K 0.017 6715	1300xxx-001	Transistors, Bipolar	0.001	114155
1300xxx-001 Transistors, MOS 0.099 1153 1000xxx-001 IC, VLSI (using worst case numbers) 0.01 11416 1000xxx-001 IC, CMOS 0.01 11416 1000xxx-001 IC, Bipolar 0.006 19026 1000xxx-001 IC, CMOS/Bipolar 0.05 2283 1000xxx-001 IC, CMOS 0.011 10378 1000xxx-001 IC, Bipolar 0.011 10378 1000xxx-001 IC, Bipolar 0.11 10378 1000xxx-001 IC, CMOS 0.19 601 1000xxx-001 IC, Bipolar 0.11 1038 1000xxx-001 IC, Bipolar 0.11 1038 10, Memory (using worst case numbers) 0.01 11416 1000xxx-001 16K 0.01 11416 1000xxx-001 64K 0.017 6715	1300xxx-001	Transistors, Bipolar Power	0.042	2718
1000xxx-001 IC, VLSI (using worst case numbers) 1000xxx-001 IC, CMOS 0.01 11416 1000xxx-001 IC, Bipolar 0.006 19026 1000xxx-001 IC, CMOS/Bipolar 0.05 2283 1000xxx-001 IC, CMOS 0.011 10378 1000xxx-001 IC, Bipolar 0.011 10378 1000xxx-001 IC, Bipolar 0.11 10378 1000xxx-001 IC, GMOS 0.11 10378 1000xxx-001 IC, Bipolar 0.11 10378 1000xxx-001 IC, Bipolar 0.11 1038 1000xxx-001 IC, Bipolar 0.11 1038 1000xxx-001 IC, Memory (using worst case numbers) 0.01 11416 1000xxx-001 64K 0.017 6715	1300xxx-001	Transistors, MOS	0.099	1153
1000xxx-001 IC, CMOS 0.01 11416 1000xxx-001 IC, Bipolar 0.006 19026 1000xxx-001 IC, CMOS/Bipolar 0.05 2283 1000xxx-001 IC, CMOS 0.011 10378 1000xxx-001 IC, Bipolar 0.011 10378 1000xxx-001 IC, Bipolar 0.011 10378 1000xxx-001 IC, CMOS 0.19 601 1000xxx-001 IC, Bipolar 0.11 1038 1000xxx-001 IC, Bipolar 0.11 1038 1000xxx-001 IC, Memory (using worst case numbers) 0.01 11416 1000xxx-001 16K 0.017 6715	1000xxx-001	IC, VLSI (using worst case numbers)		
1000xxx-001 IC, Bipolar 0.006 19026 1000xxx-001 IC, CMOS/Bipolar 0.05 2283 1000xxx-001 IC, CMOS 0.011 10378 1000xxx-001 IC, Bipolar 0.011 10378 1000xxx-001 IC, Bipolar 0.011 10378 1000xxx-001 IC, CMOS 0.19 601 1000xxx-001 IC, Bipolar 0.11 1038 IC, Memory (using worst case numbers) 0.01 11416 1000xxx-001 64K 0.017 6715	1000xxx-001	IC, CMOS	0.01	11416
1000xxx-001 IC, CMOS/Bipolar 0.05 2283 1000xxx-001 IC, CMOS 0.011 10378 1000xxx-001 IC, Bipolar 0.011 10378 1000xxx-001 IC, CMOS 0.19 601 1000xxx-001 IC, CMOS 0.11 1038 1000xxx-001 IC, Bipolar 0.11 1038 1000xxx-001 IC, Memory (using worst case numbers) 0.01 11416 1000xxx-001 64K 0.017 6715	1000xxx-001	IC, Bipolar	0.006	19026
1000xxx-001 IC, CMOS 0.011 10378 1000xxx-001 IC, Bipolar 0.011 10378 1000xxx-001 IC, CMOS 0.19 601 1000xxx-001 IC, Bipolar 0.11 1038 1000xxx-001 IC, Bipolar 0.11 1038 1000xxx-001 IC, Memory (using worst case numbers) 0.01 11416 1000xxx-001 64K 0.017 6715	1000xxx-001	IC, CMOS/Bipolar	0.05	2283
1000xxx-001 IC, Bipolar 0.011 10378 1000xxx-001 IC, CMOS 0.19 601 1000xxx-001 IC, Bipolar 0.11 1038 IC, Memory (using worst case numbers) 0.01 11416 1000xxx-001 64K 0.017 6715	1000xxx-001	IC, CMOS	0.011	10378
1000xxx-001 IC, CMOS 0.19 601 1000xxx-001 IC, Bipolar 0.11 1038 IC, Memory (using worst case numbers) 0.01 11416 1000xxx-001 16K 0.017 6715	1000xxx-001	IC, Bipolar	0.011	10378
1000xxx-001 IC, Bipolar 0.11 1038 IC, Memory (using worst case numbers) 0.01 11416 1000xxx-001 16K 0.017 6715	1000xxx-001	IC, CMOS	0.19	601
IC, Memory (using worst case numbers) 1000xxx-001 16K 0.01 11416 1000xxx-001 64K 0.017 6715	1000xxx-001	IC, Bipolar	0.11	1038
1000xxx-001 16K 0.01 11416 1000xxx-001 64K 0.017 6715		IC, Memory (using worst case numbers)		
1000xxx-001 64K 0.017 6715	1000xxx-001	16K	0.01	11416
	1000xxx-001	64K	0.017	6715
1000xxx-001 256K 0.028 4077	1000xxx-001	256K	0.028	4077
1000xxx-001 1M 0.053 2154	1000xxx-001	1M	0.053	2154