

# Parts Selection and Management

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*Edited by*

MICHAEL G. PECHT



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# Preface

Product differentiation often motivates a company to adopt new technologies and insert them into its products. Decisions regarding when, where, and how a technology will be used differentiate the market winners from the losers. Few companies have failed because the right technology was not available; far more have failed when a technology was not effectively selected and managed.

This book provides an “eyes-on, hands-off” approach to parts selection and management, which enables companies to:

- employ risk assessment and mitigation techniques to address technology insertion
- organize and conduct the fact-finding processes necessary to improve part quality, integrity, application-specific reliability, and cost effectiveness
- make an informed companywide decision about parts selection and management based upon company resources, philosophy, and goals and customer demands
- choose parts to fit the functionality of the product, to satisfy system assembly and design level constraints, and to match subsequent manufacturing and handling requirements
- evaluate the part’s actual “micro-environment” within a system and then choose the correct technique to fit the part to its intended environmental requirements
- maximize system supportability by preparing for (in design) and meeting the challenge of part obsolescence during system life
- improve supply chain interactions and communications with customers and regulatory agencies in order to minimize time-to-profit

## Who this guidebook is for

This book presents a process aimed at increasing company profitability and reducing the time-to-profit. It should be used as a guide in the development of a part selection and management team and in the execution of daily business operations related to parts selection and management. Members of product development teams, product designers, supply chain managers, marketing professionals, business development professionals, contract negotiators, and proposal writers will find the guidance provided in this book useful.

## What this guidebook contains

This guidebook presents information and a process guide for parts selection and management. It addresses risk assessment, decision-making steps, and subsequent management activities. The goal is to provide solutions that enable flexibility, innovation, and creativity in product development while ensure that the risks associated with part use are and continue to be acceptable.

**Motivation for a Parts Selection and Management Program:** Chapter 1 provides the reasons that necessitate the presence of a part selection and management process in any industry using electronic parts. The chapter explains how the parts selection and management process should be used and maintained to keep pace with technology advances, electronics marketplace changes, and the dynamics of the electronics industry supply chain.

**Methodology for Parts Selection and Management:** Chapter 2 presents the composition and responsibilities of the parts selection and management team and the infrastructure

needed to support the process. The chapter continues with summaries of each of the processes that comprise parts selection and management, which are explained in detail in following chapters.

**Product Requirements, Constraints, and Specifications:** Chapter 3 addresses the translation of customer and market requirements into product-level requirements and constraints that are necessary to arrive at a preliminary specification. The reader is taught how to synchronize the technology insertion initiatives of a company with the product-specific design process through requirement tracking and technology road mapping.

**Using the Part Datasheet:** Chapter 4 explains how to read electronics part documents and datasheets, including information about the status of a particular datasheet or part, the general format of part numbers, ratings, thermal and electrical characteristics, and reliability information. This information will aid the development of part acceptance and rejection criteria for a product team's decision-making process.

**Candidate Parts Selection: Making the First Cut:** Chapter 5 addresses the candidate part identification process, procurement specifications, product analysis, preliminary design, and availability issues.

**Manufacturer Assessment Procedure and Criteria:** Chapter 6 details the part manufacturer assessment procedure, including criteria that determine if the manufacturer's policies and procedures are consistent with producing quality and reliable parts. The criteria include process control, handling, storage and shipping controls, corrective and preventive action, part traceability, and change notification processes.

**Part Assessment Guidelines and Criteria:** Chapter 7 addresses part assessment. A definition is given for a part group or family, which is used when data are not explicitly available for the candidate part. Criteria are presented by which the quality and integrity of a part group may be assessed. The criteria include average outgoing quality, process capability index, integrity monitoring tests, and assembly guidelines.

**Electronic Part Distribution and Distributor Assessment:** Chapter 8 presents the role of distributors in the electronic supply chain and discusses their relevance to part manufacturers (suppliers) and customers. The criteria by which the distributor may be assessed are outlined, and a discussion is presented on the trends in the electronics industry that affect distributors.

**Tracking Part Changes Through the Part Supply Chain:** Chapter 9 discusses the relevant standards and industry practices for part change notification and control. Examples of commonly made changes and the underlying reasons for them are also provided.

**Parts Selection and Management to Avoid Counterfeit Electronic Parts:** Chapter 10 introduces the counterfeiting problem with respect to electronic parts through examples and financial implications. Initiatives at organizational, industry, and governmental levels against counterfeiting activity are provided, along with specific recommendations for part and equipment manufacturers.

**Equipment Supplier Intervention Techniques:** Chapter 11 provides guidance for equipment supplier intervention in regard to supply chain members. Case studies are provided with example cost information.

**Determination of the Life Cycle Environment:** Chapter 12 marks the beginning of the application-specific tasks of parts selection and management. The focus of this chapter is on

the different parameters that characterize a life cycle environment. Methods and tools used to determine the life cycle environment of an electronic part are provided.

**Performance:** Chapter 13 discusses part performance assessment. Methods of characterizing the thermal profile and making parts compliant to environmental requirements are presented. Three methodologies by which a part may be used beyond the *manufacturer's specified temperature limits* are introduced. Economic aspects of ensuring part conformance to environmental requirements are also presented.

**Reliability Assessment:** Chapter 14 presents the methodology for assessing part reliability. The chapter outlines the information necessary to conduct a reliability assessment, addresses the situations in which part manufacturer testing may be used to assess reliability, and presents guidance for reliability assessment through virtual qualification and accelerated testing.

**Assembly Requirements and Constraints Assessment:** Chapter 15 discusses how to select parts based on assembly requirements and limitations. The focus is on determining the manufacturability associated with including a candidate part within an assembly. Various assembly, routing compatibility, and test and rework acceptability issues are presented, and their impact on the cost and yield of the product is discussed.

**Obsolescence Prediction and Management:** Chapter 16 focuses on minimizing the impact of part obsolescence by providing a methodology to evaluate part and product life cycles, assess their life cycle mismatch, and then select the part based on mismatch assessment. The chapter also identifies obsolescence mitigation strategies, evaluates the pros and cons of the various obsolescence mitigation options, and provides a decision support methodology for selecting the best alternative.

**Part Acceptance and Risk Management:** Chapter 17 guides the reader through the risk management functions associated with parts selection. Risk assessment, mitigation, and management are discussed. Unmanaged risks and their economic impact are presented.

**Environmental and Legislative Issues:** Chapter 18 explains the issues associated with new materials that are used as substitutes for lead and halogenated flame retardants in electronic parts. The legislative framework driving the changes, as well as new materials and their implications for assembly, reliability, and the risks of patent infringement, are discussed. Industry groups working toward "green" electronics and eco-labeling strategies are identified.

**Legal Liabilities:** Chapter 19 explores the legal issues associated with the parts selection and management process. Both international and U.S. laws are discussed. Prudent business and engineering practices that may reduce the implications of a potential legal action are included. Particular attention is devoted to the use of parts beyond the manufacturer's temperature specifications.

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## Acknowledgments

This book was written and reviewed by experts with firsthand knowledge of parts selection and management issues. Additional research for this book was performed at the CALCE Electronics Products and Systems Center of the University of Maryland. The Center provides a knowledge and resource base to support the development of competitive electronic components, products, and systems. The CALCE Center is supported by more than 100 electronic products and systems companies from all sectors including telecommunications, computer, avionics, automotive, and military manufacturers. The following individuals contributed to the development of this guidebook by reviewing material and offering suggestions:

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The CALCE Electronic Products Systems Center has been asked to assess and review a wide variety of documents and standards used by different companies for parts selection and management. Many of these documents are confidential and were not used in preparing this guidebook. Nevertheless, these documents did provide an opportunity for comparing and strengthening our ideas and methodology. A list of the reviewed documents follows.

Advanced Micro Devices, *Specification 00-001: Quality Manual*, Sunnyvale, CA, January 18, 2001.

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# Acronyms

AC	Alternating Current
AC	Autoclave
ADC	Analog to Digital Converter
AEC	Automotive Electronics Council
AEGIS	Advanced Electronic Guidance and Instrumentation System
AME	Advanced Microcircuits Emulation
AMR	Absolute Maximum Ratings
ANSI	American National Standards Institute
AOQ	Average Outgoing Quality
APEX	Acquisition Planning and Execution
ASE Group	Advanced Semiconductor Engineering Inc.
ASICs	Application Specific Integrated Circuits
ASQC	American Society for Quality Control
ASTM	American Society of Testing and Materials
AWACS	Airborne Warning and Control System
AWG	Avionics Working Group
BAT	Brilliant Anti-Armor Submunition
BGA	Ball Grid Arrays
BiCMOS	Bipolar Complementary Metal Oxide Semiconductor
BIT	Binary Digit
BITE	Built-in Test Equipment
BOM	Bill of Materials
BSI	British Standards Institution
CALCE EPSC	Computer-Aided Life Cycle Engineering Electronic Products and Systems Center
CAST	Computer-Aided Software Testing
CCA	Circuit Card Assembly
CDF-AEC	Chrysler-Delco-Ford Automotive Electronics Council
CDR	Critical Design Review
CER	Component Engineering Requirements
CFM	Cubic Feet per Minute
CM	Contract Manufacturers
CMOS	Complementary Metal Oxide Semiconductor
CMP	Chemical Mechanical Polishing
COEX	Core/Executive Interface
COTS	Commercial-off-the-Shelf
CPLD	Complex Programmable Logic Devices
CRT	Cathode Ray Tubes
CSP	Chip Scale Packaging
CTE	Coefficient of Thermal Expansion
DAC	Digital to Analog Converter
DC	Direct Current
DESC	Defense Electronics Supply Center
DFARs	Defense Federal Acquisition Regulations
DFM	Design for Manufacturing

DIP	Dual Inline Package
DISC	Defense Industrial Supply Center
DLA	Defense Logistics Agency
DMEA	Defense Microelectronic Activity
DMS	Diminishing Manufacturing Sources
DMSMS	Diminishing Manufacturing Sources and Material Shortages
DoD	Department of Defense
DoE	Department of Energy
DPA	Defense Production Act
DRAM	Dynamic Random Access Memory
DSCC	Defense Supply Center, Columbus
DSP	Digital Signal Processing
DTAM	Distribution Total Available Market
DTL	Diode Transistor Logic
ECL	Emitter Coupled Logic
ECP	Engineering Change Proposals
EDAC	Error Detection and Correction
EDO	Extended Data Out (RAM)
EE	Electrical Engineering
EEC	European Economic Community
EEPROM	Electrically Erasable Programmable Read-Only Memory
EFSOT	Environmentally Friendly Soldering Technology
EIA	Electronic Industry Association
EIAJ	Electronic Industries Association of Japan
ELFNET	European Lead-Free Network
EMF	Electromotive Force
EMI	Electromagnetic Interference
EMS	Electronic Manufacturing Services
EOL	End-of-Life
ERAI	Electronic Resellers Association International
ESD	Electrostatic Discharge
EU	European Union
FAA	Federal Aviation Administration
FAE	Field Application Engineer
FCC	Federal Communication Commission
FET	Field Effect Transistor
FFF	Form, Fit and Functionality
FFOP	Failure-Free Operating Period
FIFO	First In, First Out
FIT	Failures in Time
FPGA	Field Programmable Gate Arrays
FRU	Field Replacement Units
GATT	General Agreement on Tariffs and Trade
GEIA	Government Electronics and Information Technology Association
GEM	Generalized Emulation of Microcircuits
GIDEP	Government Industry Data Exchange Program
GIFAS/SPER	Groupeement des Industries Francaise Aeronutiques et Spatials (France's aerospace manufacturer's association)/Sybdicat des Industries de Materiels

	Professional d'Electronique et de Radiocommunication
GPC	Government Procurement Committee
GSA	General Services Administration
GSI	General Semiconductor
HALT	Highly Accelerated Life Testing
HAST	Highly Accelerated Stress Test
HCMOS	High-Speed CMOS
HDPUG	High Density Packaging User Group
HP	Hewlett-Packard
HTOL	High-Temperature Operating Life
HTS	High-Temperature Storage
IACC	International Anti-Counterfeiting Coalition
IC	Integrated Circuit
IDEA	Independent Distributors of Electronics Association
IDT	Integrated Device Technology
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineers
IMEC	Interuniversity Micro-Electronics Center
I/O	Input/Output
IP	Intellectual Property
IPC	Institute for Printed Circuits
IRC	International Rectifier Corporation
ISI	International Semiconductor, Inc
ISO	International Standards Organization
IT	Information Technology
ITRI	International Tin Research Institute
JEDEC	Joint Electron Device Engineering Council
JEIDA	Japan Electronic Industry Development Association
JEITA	Japan Electronics and Information Technology Association
JESD	JEDEC Standards Division
JIEP	Japan Institute of Electronics Packaging
JIT	Just in Time
LAR	Lot Acceptance Rate
LCEP	Life Cycle Environment Profile
LOT	Life-of-Type
LRU	Line Replaceable Units
LSI	Large-Scale Integration
LSL	Lower Specification Limit
LTOL	Low Temperature Operating Life
MAIS	Major Automated Information System
MDAP	Major Defense Acquisition Program
MEP	Major Electronics Procurement
MII	China's Ministry of Information
MIL-HDBK	Military Handbook
MIL-SPEC	Military Specification
MIL-STD	Military Standard
MITI	Ministry of International Trade and Industry
MLRS	Multiple Launch Rocket System
MMU	Memory Module Unit
MOSFET	Metal Oxide Semiconductor Field Effect Transistor

MPU	Microprocessor Unit
MTBF	Mean Time Between Failures
MTC	Management to Cost
NAECON	National Aerospace and Electronics Conference
NAVSUP	Naval Supply Systems Command
NCMS	National Center for Manufacturing Sciences
N/C	Not Calculated
NDIA	National Defense Industrial Association
NEC	Nippon Electric Company
NEDA	National Electronic Distributors Association
NEDO	New Energy Development Organization
NEMI	National Electronics Manufacturing Initiative
NMOS	N Channel Metal Oxide Semiconductor
NOVRAM	Non-Volatile Random Access Memory
N/P	Not Provided
NPI	New Product Introductions
NPV	Net Present Value
NRE	Nonrecurring Engineering
OEL	Oki Electronics Limited
OEM	Original Equipment Manufacturers
ONR	Office of Naval Research
PBB	Polybrominated Biphenyls
PBDE	Polybrominated Diphenyl Ether
PBT	Persistent Bioaccumulative and Toxic Substances
PC	Personal Computer
PCB	Printed Circuit Board
PCI	Peripheral Component Interconnect
PCN	Product Change Notification
PCT	Patent Cooperation Treaty
PDN	Product Discontinuance Notice
PDR	Preliminary Design Review
PEM	Plastic Encapsulated Microcircuits
PICMET	Portland International Conference on Management of Engineering and Technology
PLC	Product Life Cycle
PLCC	Plastic Leaded Chip Carriers
PLD	Programmable Logic Devices
PLM	Product Lifecycle Management
PMOS	P Channel Metal Oxide Semiconductor
PoF	Physics-of-Failure
POURS	Point of Use Replenishment System
PPM	Parts Per Million
PQFP	Plastic Quad Flat Pack
PVC	Polyvinyl Chloride
PWB	Printed Wiring Board
PWM	Pulse Width Modulation
PZT	Lead Zirconate Titanate
QML	Qualified Manufacturers List
QPL	Qualified Parts List
QS 9000	Quality System (developed by Big 3 – GM, Ford, Chrysler)

QSA	Qualification Site Approval
RACE	Random Access Computer Equipment
RAM	Random Access Memory
RCA	Radio Corporation of America
RF	Radio Frequency
RH	Relative Humidity
RoHS	Reduction of Hazardous Substances
RTD	Resistive Temperature Detectors
RTL	Resistor Transistor Logic
SAE	Society of Automotive Engineers
SAMPE	Society for Advanced Materials and Process Engineering
SBE	Single Bit Error
SBIR	Small Business Innovation Research
SD	Standard Deviation
SDDV	Stress Driven Diffusion Voiding
SDRAM	Synchronous Dynamic Random Access Memory
SDU	Shop Discardable Units
SGRAM	Static Graphics Random Access Memory
SHARC	System Hardware Availability and Reliability Calculator
SIA	Semiconductor Industry Association
SIMM	Single Inline Memory Module
SIP	Single Inline Package
SMART	Self-Monitoring Analysis Reporting Technology
SMD	Standard Microcircuit Drawings
SMT	Surface Mount
SOA	Safe Operating Area
SOAR	Survivability, Operability, Availability and Recoverability
SOIC	Small Outline Integrated Circuit
SOJ	Small Outline J-Leaded
SOP	Small Outline Package
SPC	Statistical Process Control
SRAM	Static Random Access Memory
TC	Temperature Control
TDDB	Time Dependent Dielectric Breakdown
TH	Through-hole
THB	Temperature Humidity Bias
TI	Texas Instruments
TO	Transistor Outline
TQFP	Thin Quad Flat Pack
TRIPS	Trade-Related Aspects of Intellectual Property Rights
TS	Thermal Shock
TSI	Threshold Single-to-Independence Ratio
TTL	Transistor Transistor Logic
UDR	Urgent Data Requests
UL	Underwriters Laboratories
U.S.C.	United States Code
U.S.C.A.	United States Code Annotated
USL	Upper Specification Limit
UTMC	United Technologies Microelectronics Center
UV	Ultraviolet (radiation)

VHDL	Hardware Description Language
VHSIC	Very-High-Speed Integrated Circuit
VLSI	Very-Large-Scale Integration
VME	Virtual Machine Environment
VRAM	Video Random Access Memory
WEEE	Waste in Electrical and Electronic Equipment
WIPO	World Intellectual Property Organization
WTO	World Trade Organization
XC	Cross-Connect