

J. A.
SCARLETT

The
Multilayer
Printed
Circuit Board
Handbook

Electrochemical
Publications

6/86

THE MULTILAYER PRINTED CIRCUIT BOARD HANDBOOK

Edited by
J. A. SCARLETT

£110.00

Jack

ELECTROCHEMICAL PUBLICATIONS LIMITED
1985

ELECTROCHEMICAL PUBLICATIONS LIMITED
8 Barns Street, Ayr, Scotland

©
Electrochemical Publications Ltd.
1985

All Rights Reserved
No part of this book may be reproduced in any form
without written authorisation from the publishers

ISBN 0 901150 15 0

Typesetting by Brian Robinson, North Marston, Bucks
Printed and bound in Great Britain by
Anchor Brendon Ltd, Tiptree, Essex

inc
int
au
oft
bo
are
mc
ap
all
wh
mu
ge
pa
wc
of
on
su
as
sp
ex
so
th
nc
ar
th
re
Ev
co
be
to
be
ar
m
ar
na

CONTENTS

PREFACE	v
CHAPTER ONE	
Introduction	
<i>J. A. Scarlett</i>	
1.1 General	1
1.1.1 Printed Circuit Boards	1
1.1.2 History	2
1.1.3 The Electrical Importance of Multilayer Boards	3
1.1.4 Costs and Applications	3
1.1.4.1 Costs of Boards	3
1.1.4.2 Costs of Alternatives to Boards	5
1.1.4.3 Choice of Board Type	6
1.1.4.4 Thermal Problems	7
1.1.4.5 System Architecture and Board Type	8
1.1.4.6 Probable Need for Multilayers	9
1.2 Types of Multilayer Board	11
1.2.1 Access Hole Boards	11
1.2.1.1 Access Hole Boards with Internal Connections	12
1.2.1.2 Disadvantages of Access Hole Boards	14
1.2.1.3 Solder Buttons	14
1.2.2 Plated Pillar Boards	15
1.2.3 Staked Boards	16
1.2.4 Bonded Through-hole Plated Boards	16
1.2.5 Buried Via-hole Boards	17
1.2.6 Sequential Buried Via-hole Boards	18
1.2.6.1 Two-level Buried Via Holes	18
1.2.6.2 Multiple Level Buried Via Holes	18
1.2.7 Double-double Boards	19
1.2.8 Double-multilayer Boards	19
1.2.9 Flexi-rigid Boards	20
1.2.10 Other Forms of Multilayer Interconnects	20
1.2.10.1 Etched and Welded Interconnects	20
1.2.10.2 Three Dimensional Planar Co-axial Interconnects	21
1.2.10.3 Etched and Filled Boards	22
1.2.10.4 Moulded Boards	22
1.2.10.5 Multiwire	23
1.3 Production of Through-hole Plated Multilayers	23
1.3.1 General	23
1.3.2 Preparation of Inner Layers	24
1.3.2.1 Film Work	24
1.3.2.1.1 Incoming Photo Tools	24
1.3.2.1.2 Film Types and Labels	25
1.3.2.1.3 Step and Repeat	27
1.3.2.1.4 Borders	28
1.3.2.1.5 Environmental Control	29

1.3.2.1.6	Film Punching	30
1.3.2.2	Planning	33
1.3.2.3	Tape Making	33
1.3.2.4	Laminate Preparation	34
1.3.2.5	Inner Layer Printing and Etching	34
1.3.2.6	Preparation for Bonding	34
1.3.3	Bonding	38
1.3.4	Drilling	38
1.3.5	Smear Removal	38
1.3.6	Through-hole Plating and Outer Layers	41
1.3.7	Finishing	41
1.4	Production Variants	41
1.4.1	Pillar Plated Boards	41
1.4.2	Buried Via-hole Boards	42
1.4.2.1	Inner Layer Plating	42
1.4.2.2	Lay Up and Bonding	44
1.4.2.3	Pre-filling of Buried Holes	44
1.4.3	Sequential Buried Via Holes	45
1.4.4	Double Boards	45
1.4.5	Flexi-rigids	45
1.4.6	Mass Lamination	46
1.4.7	Semi-additive Multilayers	46
1.4.8	Bonding of Heat Ladders	46
1.5	Build and Thickness	48
1.5.1	Prepreg Layers	48
1.5.2	Board Thickness	49
1.5.3	Practical Builds	50
1.5.3.1	Four Layer Boards	50
1.5.3.2	Higher Build Boards	50
1.5.3.3	Buried Via-hole and Flexi-rigid Builds	52
1.6	Handling Thin Laminates	52
1.6.1	Storage and Transport	53
1.6.2	Cutting	53
1.6.3	Picking Up Thin Laminates	53
1.6.4	Conveyorised Machines	54
1.6.5	Plating Fixtures	54
1.7	Reliability of Multilayer Boards	54
1.7.1	Delamination	55
1.7.2	Outgassing	55
1.7.3	Short Circuits	56
1.7.3.1	Design and Manufacturing Faults	56
1.7.3.2	Growth of Short Circuits	56
1.7.4	Carbonisation	58
1.7.5	Warping	58
1.7.6	Damage to Through-plated Holes	58
1.7.6.1	Mechanical Damage	58
1.7.6.2	Z-Plane Expansion	59

CHAPTER TWO

Laminates and Prepregs

J. S. Sallo

2.1	Introduction	61
2.1.1	Use of Epoxy Materials in Laminate and Prepreg Manufacture	61

Explore Litigation Insights

Docket Alarm provides insights to develop a more informed litigation strategy and the peace of mind of knowing you're on top of things.

Real-Time Litigation Alerts



Keep your litigation team up-to-date with **real-time alerts** and advanced team management tools built for the enterprise, all while greatly reducing PACER spend.

Our comprehensive service means we can handle Federal, State, and Administrative courts across the country.

Advanced Docket Research



With over 230 million records, Docket Alarm's cloud-native docket research platform finds what other services can't. Coverage includes Federal, State, plus PTAB, TTAB, ITC and NLRB decisions, all in one place.

Identify arguments that have been successful in the past with full text, pinpoint searching. Link to case law cited within any court document via Fastcase.

Analytics At Your Fingertips



Learn what happened the last time a particular judge, opposing counsel or company faced cases similar to yours.

Advanced out-of-the-box PTAB and TTAB analytics are always at your fingertips.

API

Docket Alarm offers a powerful API (application programming interface) to developers that want to integrate case filings into their apps.

LAW FIRMS

Build custom dashboards for your attorneys and clients with live data direct from the court.

Automate many repetitive legal tasks like conflict checks, document management, and marketing.

FINANCIAL INSTITUTIONS

Litigation and bankruptcy checks for companies and debtors.

E-DISCOVERY AND LEGAL VENDORS

Sync your system to PACER to automate legal marketing.