

DIN EN 16602-70-38:2019-11 (E)

Space product assurance - High-reliability soldering for surface-mount and mixed technology; English version EN 16602-70-38:2019

Table of contents

- European Foreword..... 11**
- Introduction..... 12**
- 1 Scope..... 15**
- 2 Normative references 16**
- 3 Terms, definitions and abbreviated terms..... 18**
 - 3.1 Terms from other standards..... 18
 - 3.2 Terms specific to the present standard 18
 - 3.3 Abbreviated terms..... 20
 - 3.4 Nomenclature 21
 - 3.4.1 Formal verbs..... 21
- 4 Principles of reliable soldered connections..... 22**
- 5 Process identification document (PID)..... 23**
 - 5.1 General..... 23
 - 5.1.1 Purpose 23
 - 5.1.2 Document preparation..... 23
 - 5.1.3 <<deleted>>..... 23
 - 5.1.4 Approval..... 23
 - 5.1.5 SMT contact person 24
 - 5.2 <<deleted>> 24
 - 5.3 Process identification document updating 24
- 6 Preparatory conditions 25**
 - 6.1 Calibration 25
 - 6.2 Facility cleanliness..... 25
 - 6.3 Environmental conditions..... 25
 - 6.4 Precautions against static charges 25
 - 6.5 Lighting requirements 25
 - 6.6 Equipment and tools..... 25
 - 6.6.1 Brushes..... 25

6.6.2	Cutters and Pliers	26
6.6.3	Bending tools	26
6.6.4	Clinching tools.....	26
6.6.5	Insulation strippers	26
6.6.6	Soldering tools	26
6.6.7	Soldering irons and resistance soldering equipment	26
6.6.8	<<deleted>>.....	26
6.6.9	Solder baths for degolding and pretinning	26
6.7	Soldering machines and equipment.....	27
6.7.1	General	27
6.7.2	Dynamic wave-solder machines.....	27
6.7.3	Condensation (vapour phase) reflow machines.....	28
6.7.4	Hot gas reflow machines.....	28
6.7.5	<<deleted>>.....	28
6.7.6	Convection and radiation reflow systems	28
6.7.7	Other equipment for reflow soldering	29
6.8	Ancillary equipment	29
6.8.1	General	29
6.8.2	Solder deposition equipment.....	29
6.8.3	Automatic device placement equipment	29
6.8.4	<<deleted>>.....	29
6.8.5	Cleanliness testing equipment	30
6.8.6	Magnification aids	30
6.8.7	X-ray inspection equipment.....	30
6.8.8	Metallographic equipment	30
7	Material selection	31
7.1	General.....	31
7.2	Solder.....	31
7.2.1	Form	31
7.2.2	Composition	31
7.2.3	Solder paste.....	31
7.2.4	Maintenance of paste purity	33
7.3	Flux	33
7.3.1	Rosin based flux	33
7.3.2	Corrosive acid flux.....	33
7.3.3	Flux controls for wave-soldering equipment	33
7.4	Solvents.....	33

7.5	Flexible insulation materials	34
7.6	Terminals.....	34
7.7	Wires	34
7.8	Printed circuit substrates.....	34
7.8.1	<<deleted>>	34
7.8.2	<<deleted>>	34
7.8.3	<<deleted>>	34
7.8.4	<<deleted>>	34
7.8.5	<<deleted>>	35
7.8.6	<<deleted>>	35
7.9	Devices.....	35
7.9.1	General	35
7.9.2	<<deleted>>	36
7.9.3	Moisture sensitive devices	36
7.9.4	<<deleted>>	36
7.10	Adhesives, encapsulants and conformal coatings.....	36
8	Preparation for soldering	38
8.1	Preparation of devices and terminals	38
8.1.1	Preparation of wires and terminals	38
8.1.2	Preparation of surfaces to be soldered.....	38
8.1.3	Degolding and pretinning of conductors	38
8.1.4	Alloying of pure tin finish	38
8.2	Preparation of solder bit.....	39
8.3	Handling	39
8.4	Storage.....	39
8.5	Baking of PCBs and moisture sensitive devices	39
9	Mounting of devices prior to soldering	40
9.1	General requirements	40
9.2	Lead bending and cutting requirements	40
9.3	Mounting of terminals to PCBs.....	40
9.4	Lead attachment to through holes.....	40
9.5	Mounting of devices to terminals.....	40
9.6	Mounting of through hole connectors to PCBs	40
9.7	Surface mount requirements.....	41
9.7.1	General	41
9.7.2	Stress relief.....	41
9.7.3	Registration of devices and footprints	42

9.7.4	Lead forming	42
9.7.5	Mounting devices in solder paste	42
9.7.6	Leadless devices	43
9.7.7	Leaded devices	43
9.7.8	<<deleted>>	43
9.7.9	Stacking and bonding of heavy devices	43
10	Attachment of conductors to terminals, solder cups and cables	45
11	Soldering to printed circuit boards	46
11.1	General.....	46
11.2	<<deleted>>	46
11.3	Solder applications to PCBs	46
11.4	Wicking.....	46
11.5	Soldering of SMDs.....	46
11.5.1	General requirements	46
11.5.2	End-capped and end-metallized devices	47
11.5.3	Bottom terminated chip devices	49
11.5.4	Cylindrical and square end-capped devices	50
11.5.5	Castellated chip carrier devices.....	52
11.5.6	Flat pack and Gull-wing leaded devices with round, rectangular, ribbon leads	53
11.5.7	Devices with “J” leads	54
11.5.8	Area array devices	54
11.5.9	Devices with ribbon terminals without stress relief	56
11.5.10	L-Shape inwards devices	57
11.5.11	Stacked modules devices with leads protruding vertically from bottom.....	58
11.5.12	Leaded device with plane termination	59
11.5.13	Moulded magnetics	59
11.6	<<deleted>>	60
11.7	<<deleted>>	60
11.8	<<deleted>>	60
12	Cleaning of PCB assemblies	61
12.1	General.....	61
12.2	Ultrasonic cleaning	61
12.3	Monitoring for cleanliness	61
13	Final inspection	62
13.1	General.....	62

13.2	Acceptance criteria	62
13.3	Visual rejection criteria.....	63
13.4	X-ray rejection criterion.....	65
13.5	Warp and twist of populated boards.....	65
13.6	Inspection records	65
14	Verification procedure.....	66
14.1	General.....	66
14.2	Verification by similarity	68
14.2.1	General	68
14.2.2	Conditions for similarity	69
14.3	Verification programme.....	71
14.4	Electrical testing of devices.....	75
14.4.1	General	75
14.5	Vibration and shock	78
14.6	Temperature cycling test.....	78
14.7	Microsection	79
14.7.1	Microsection facilities	79
14.7.2	Microsectioning	79
14.8	<<deleted>>	95
14.9	Special verification testing for hermetic ceramic area array packages	95
14.9.1	<<deleted>>	95
14.9.2	<<deleted>>	95
14.9.3	General	95
14.9.4	Evaluation of capability samples	98
14.9.5	Verification	98
14.10	Verification acceptance and rejection criteria	99
14.11	Approval of verification	108
14.12	Withdrawal of approval status	108
14.13	Conditions for delta verification	108
14.14	Verification of cleanliness	111
14.15	Verification approval procedure	111
14.15.1	Request for verification	111
14.15.2	Technology sample	111
14.15.3	Audit of assembly processing.....	111
14.15.4	Verification programme	112
14.15.5	Final verification review.....	112
14.15.6	Certification approval of assembly line	112

15 Quality assurance	113
15.1 General.....	113
15.2 Data.....	113
15.3 Nonconformance	113
15.4 Calibration	113
15.5 Traceability	113
15.6 Workmanship standards	113
15.7 Inspection	114
15.8 Operator and inspector training and certification.....	114
15.9 Quality records	114
16 <<deleted and moved into clause 14.7.2 and Annex I>>	115
Annex A (informative) <<deleted>>	116
Annex B (informative) <<deleted, SMT summary table DRD created in Annex H>>	117
Annex C (informative) <<deleted>>	118
Annex D (informative) Example of an SMT audit report	119
Annex E (informative) Additional information	128
E.1 <<deleted>>	128
E.2 Melting temperatures and choice.....	128
Annex F (normative) Process Identification Document (PID) - DRD	129
F.1 DRD identification.....	129
F.1.1 Requirement identification and source document.....	129
F.1.2 Purpose and objective.....	129
F.2 Expected response	129
F.2.1 Scope and content	129
F.2.2 Special remarks	131
Annex G (normative) Verification programme report - DRD	132
G.1 DRD identification.....	132
G.1.1 Requirement identification and source document.....	132
G.1.2 Purpose and objective.....	132
G.2 Expected response	132
G.2.1 Scope and content	132
G.2.2 Special remarks	133
Annex H (normative) SMT summary table - DRD	134

H.1	DRD identification	134
H.1.1	Requirement identification and source document	134
H.1.2	Purpose and objective	134
H.2	Expected response	134
H.2.1	Scope and content	134
H.2.2	Special remarks	134

Annex I (informative) Visual and X-ray workmanship standards 136

I.1	Workmanship illustrations for standard SMDs	136
I.1.1	Chip components	136
I.1.2	MELF components	139
I.1.3	Gull-wing leaded devices with round, rectangular, ribbon shape	140
I.1.4	“J” leaded devices	142
I.1.5	L-shape Inward leaded component	144
I.1.6	LCC devices	144
I.1.7	Miscellaneous soldering defects	145
I.2	Workmanship illustrations for ball grid array devices	146
I.3	Workmanship illustrations for column grid array devices	148

Bibliography..... 151

Figures

Figure 9-1:	Exposed element.....	43
Figure 11-1:	Mounting of rectangular and square end-capped and end-metallized devices.....	48
Figure 11-2:	Mounting of bottom terminated chip devices.....	49
Figure 11-3:	Mounting of cylindrical end-capped devices	50
Figure 11-4:	Mounting of square end-capped devices	51
Figure 11-5:	Mounting of castellated chip carrier devices	52
Figure 11-6:	Mounting of gull-wing leaded devices with round, rectangular, ribbon leads	53
Figure 11-7:	Mounting of devices with “J” leads.....	54
Figure 11-8:	<<deleted>>	55
Figure 11-9:	Typical ceramic area array showing ball grid array configuration on left and column grid array on right (CBGA & CCGA)	55
Figure 11-10:	Typical assembled CCGA device	55
Figure 11-11:	Mounting of devices without stress relief	56
Figure 11-12:	Mounting of devices with “L-shape inwards” leads (1 = Toe, 2 = Heel)	57
Figure 11-13:	Mounting of stacked modules devices with leads protruding vertically from bottom	58

Figure 11-14: Mounting of leaded devices with leads with plane termination	59
Figure 11-15: <<deleted>>	60
Figure 14-1: Verification programme flow chart (standard flow)	74
Figure 14-2: Verification programme flow chart (electrical testing).....	77
Figure 14-3: Verification programme flow chart (AAD).....	97
Figure 14-4: <<deleted>>	100
Figure I-1 : Preferred solder (see also Table 11-1)	136
Figure I-2 : Acceptable, maximum solder (see also Table 11-1)	136
Figure I-3 : Acceptable, minimum Solder (see also Table 11-1).....	137
Figure I-4 : Unacceptable, excessive solder (see also Table 11-1).....	137
Figure I-5 : Unacceptable, poor wetting (see also Table 11-1).....	137
Figure I-6 : Unacceptable, excessive tilt (see also Table 11-1).....	138
Figure I-7 : Unacceptable, tombstone effect	138
Figure I-8 : Examples of Unacceptable solder joints - (see also Table 11-1).....	138
Figure I-9 : Acceptable, terminal wetted along end, face and sides (see also Table 11-1).....	139
Figure I-10 : Acceptable, maximum solder joint (see also Table 11-3).....	139
Figure I-11 : Not Acceptable, insufficient solder joint (see also Table 11-3).....	139
Figure I-12 : Unacceptable overhang.....	139
Figure I-13 : Examples of Gullwing leads: Acceptable	140
Figure I-14 : Examples of gull-wing device with rectangular lead: Acceptable	140
Figure I-15 : Acceptable, minimum solder joint	140
Figure I-16 : Unacceptable, insufficient heel fillet.....	141
Figure I-17 : Unacceptable, excessive solder	141
Figure I-18 : Unacceptable, excessive solder	141
Figure I-19 : Preferred solder joint	142
Figure I-20 : Acceptable solder joint	142
Figure I-21 : Unacceptable, excessive solder joint.....	143
Figure I-22 : Unacceptable, excessive degolding.....	143
Figure I-23 : Acceptable, preferred solder joint	144
Figure I-24 : LCC General view, acceptable solder joints	144
Figure I-25 : Examples of unacceptable soldering	145
Figure I-26 : Angled-transmission X-radiograph showing solder paste shadow due to partial reflow: Reject.....	146
Figure I-27 : Micrograph showing	146
Figure I-28 : Perpendicular transmission X-radiograph showing unacceptable defects.....	147
Figure I-29 : Perpendicular transmission X-radiograph showing non-wetted footprint.....	147
Figure I-30 : Underside view showing missing column.....	148

Figure I-31 : CGA mounted on PCB showing columns tilted < 10°: Accept.....	148
Figure I-32 : X-radiograph of CGA mounted on PCB showing solder bridge: Reject.....	149
Figure I-33 : X-radiograph of CGA showing solder fillets at base of columns: acceptable ...	149
Figure I-34 : Micrograph of CGA mounted on PCB, bent column: reject	150
Figure I-35 : Micrograph of CGA mounted on PCB.....	150

Tables

Table 7-1: Chemical composition of spacecraft solders	32
Table 7-2: <<deleted>>	34
Table 11-1: Dimensional and solder fillet for rectangular and square end capped devices.....	48
Table 11-2: Dimensional and solder fillet for bottom terminated chip devices	49
Table 11-3: Dimensional and solder fillet for cylindrical end-capped devices.....	50
Table 11-4: Dimensional and solder fillet for square end-capped devices	51
Table 11-5: Dimensional and solder fillet for castellated chip carrier devices.....	52
Table 11-6: Dimensional and solder fillet for gull-wing leaded devices with round, rectangular, ribbon leads.....	53
Table 11-7: Dimensional and solder fillet for devices with “J” leads	54
Table 11-8: Dimensional and solder fillet for area array devices	55
Table 11-9: Dimensional and solder fillet for devices without stress relief.....	56
Table 11-10: Dimensional and solder fillet for “L-shape inwards” devices.....	57
Table 11-11: Dimensional and solder fillet for stacked modules devices with leads protruding vertically from bottom	58
Table 11-12: Dimensional and solder fillet for leaded devices with plane termination	59
Table 14-1: Device type classification.....	68
Table 14-2: Device microsection location	81
Table 14-3: Critical zone definition per device type and acceptance criteria	101
Table 14-4: Conditions invoking verification.....	110
Table E-1 : Guide for choice of solder type.....	128
Table H-1 : Device type preparation and mounting configuration.....	135