

QUALIFICATION TESTING OF SOLDERERS, CLASS G.

DEFINITION

Soft soldering shall be taken to mean soldering using filler with a melting point below 450 °C.

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The following modification has been made, as compared to issue 7 of 2006:

Estimated time in test 5, appendix 7, increased from 160 to 220 minutes.
Chapter 12 material and materiel has been updated.

1 GENERAL

This standard is applicable for basic qualification testing of solderers to perform soldering work on defence materiel.

Each of the training units that is to train and qualification test as per this standard must be a training unit approved by FMV as per FSD 5115. Requirements for training units as per FSD 5138 and FSD 5139 are to be met.

Auditing will be carried out by FMV at least every three years, which presupposes a valid agreement between FMV and the training unit.

Only training units approved by FMV may issue authorization certificates as per FSD 5115.

Data on approved training units are available by applying to FMV, product manager technical standards.

Qualification test of instructor/examiner is carried out as per FSD 5116.

References to standards always refer to the latest edition of the applicable standard.

2 QUALIFICATION CLASSES

Qualification class G: New manufacture and repairs on cables, solder tags and circuit boards with hole-mounted components. Basic qualification as per FSD 5115 is for soldering with both leaded and lead-free solder.

Qualification class YR: New manufacture, repairs and modification on circuit boards with surface-mounted components. Additional qualification as per FSD 5117 is for soldering with both leaded and lead-free solder.

3 VISION CONTROL

The solderer must have passed a vision control within 3 months before the qualification testing. A vision certificate shall be issued by optician, industrial health service or medical doctor. The following requirements apply for approved vision control:

Distance vision: A Visus value of 0.7 or equivalent, for at least one eye, with or without correction.

Near vision: Normal near vision as per Jaeger No 1 (5 p), Swedish style scales as per Anders Hedin 5 p, the T scale 5 p, or equivalent, at a distance of 30-45 cm for at least one eye, with or without correction.

Colour vision: Normal colour vision.

Deviations from the requirements with regard to distance vision and normal colour vision are allowed provided security and functioning are not affected with regard to the sweaters work. Deviations shall be stated on the authorization certificate.

Before a renewal of authorization as per section 7 of this standard the solderer must have passed a vision control.

Passed vision control shall be noted in the column in the qualification testing log for the solderer. See the example in Appendix 2.

4 QUALIFICATION TEST

Qualification testing shall be preceded by theoretical training with regard to applicable standards as per FSD 5207, primarily IPC J-STD-001 and IPC-A-610. The testing shall also be preceded by practical training. The execution shall be carried out under satisfactory control.

Solderers must be familiar with the contents of applicable regulations with regard to soft soldering.

A solderer who does not meet the requirements at the qualification test is entitled to carry out a new qualification test, after the necessary education and training, provided that the solderer is not considered to be unsuitable for soldering work.

5 QUALIFICATION AND QUALIFICATION VALIDITY

A solderer who, after required education, has been approved in a qualification testing, is qualified to carry out soldering work in defence materiel. Please see section 10 with regard to authorization certificates.

The qualification is valid for four years. If more than four years have passed since the latest test new training and new qualification testing is required. The maintenance of the solderer's skill shall be checked in connection with the routine follow-up of the solderer's work.

It is the supervisor's and verification authority's duty to inform the instructor/examiner of badly or erroneously performed soldering work. If there are serious, or frequent, errors, that are attributable to the solderer, the authorization shall be recalled.

Qualification renewal for the solderer shall be carried out as per the stipulations in section 7.

6 SCOPE AND EXECUTION OF QUALIFICATION TEST

Training premises and tools used must be adapted for soldering operations, and the materiel must be in a satisfactory and reliable condition, see FSD 5138.

The training and qualification testing shall be carried out under the guidance of instructor/examiner with appropriate qualification as per FSD 5116. Minutes shall be kept, including the names of the participants, with columns for filling in used time for the different sub-tests. A code number shall be used for each participant in the minutes.

When a solderer has completed a sub-test this is to be handed over to instructor/examiner immediately. He/she notes the time used in the minutes and marks the test with the solderer's code number.

The qualification testing as per this standard shall consist of soldering, cleaning and inspection of the tests specified below, as well as of written tests.

The theoretical tests are to comprise at least 20 questions, where the course member is to reply to the questions without access to standards or other literature, and where at least 20 questions with specified reference literature as per section 13 in this standard may be utilised. The requirements for an approved theoretical test is 70% correct answers per sub-test

For each soldering test the stripped part of multi-wire conductors must be tin coated before installation, which is a deviation from the requirements in the IPC standard.

Test 1 Appendix 3

Soldering of conductor for 2 x 10 pole card connector.

- Soldered with lead-free solder.
- Ten wires are installed using a z-shaped bend – 5 Raychem 55T and 5 PVC.
- When z-shaped bend is used the hole shall be filled with solder.
- Ten wires are installed using open loop – 5 Raychem 55T and 5 PVC.
- For open loops the hole shall not be filled with solder.
- For open loops the wire shall end at the edge of the soldering tag ± 0.5 mm.
- The gap width of the soldered seam shall as a maximum equal the thickness of the soldering tag for both types of connections.

Estimated time 110 minutes.

Test 2 Appendix 4

Soldering of wires to 15 pole connection device.

- Soldered using leaded solder.
- After soldering of all wires, and control, three wires are to be soldered loose (13-15) and be replaced with new wires.
- Heat effects on the plastic material are acceptable unless two sequential connection numbers have thermal damage (maximum grading of 4). The holes in the plastic material must not have been enlarged significantly due to thermal effects. It shall be possible to connect the component.
- A thin layer of solder on the external surface of the housing is acceptable.

Estimated time 120 minutes.

Test 3 Appendix 5

Installation and soldering of components on board with soldering tower.

- Soldered using leaded solder.
- Installation sequence: copper wires, resistors and conductors.
- Shear marks on the towers entail a non-approved grade.
- Minor scratching on the towers does not lead to non-approved grade.
- The expansion bow must be visible.

Estimated time 130 minutes.

Test 4 Appendix 6

Soldering of two coaxial pins on a coaxial cable.

- Soldered using leaded solder.
- The distance between the insulation and pin must not exceed 0.5 mm.
- The wires must be pushed to the bottom of the coaxial pin. The inspection hole is not in the bottom of the coaxial pin, and the only methods for inspecting it are therefore cutting or x-raying.
- Wires must not stick out through the inspection hole (leads to a grading of 4 at the most).
- The inspection hole should not be filled with solder (leads to a lower grade).
- It shall be possible to install the coaxial pin on the conductor in the appropriate component housing. As an alternative a gauge can be used.

Estimated time 45 minutes.

Test 5 Appendix 7

Soldering of four diodes, six capacitors, two transistors, two resistors and two 16 pole IC-capsules of type "Dual in line" for wire pattern on pattern card with metallized holes. The board has soldering surfaces with a minimum width of 0.5 mm.

- Soldered with lead-free solder.
- Solder in 90 degree angle on axial components is only acceptable on one side. If this is found on both sides it renders a grading of 4 or lower.
- With regard to space bending of resistors drawing is to be followed. Deviations lead to lower grades – not failed however, provided the insulation distance is not falling short (5 V => 0.13 mm from table).
- Two resistors shall be space bent. When IC-capsule of type "Dual in line" is used the air gap between the component and the pattern board is regulated by the design of the connection legs.
- The component connectors must be installed straight in the holes.
- After soldering of specified components, and control, the IC-capsule – see appendix 7, pos. 10:1 – shall be replaced by a resistor net, pos. 11.
- After soldering and control one of the resistors should be replaced – see appendix 7, pos. 9.
- Two repairs are carried out on the interrupted conductor pattern. These are carried out as per appendix 7, pos. 12 and 13. The contact length shall be at least twice the foil width and the plated holes shall not be used or filled with solder when the connection is established.

- Two conductors shall be connected by soldering, see appendix 7. One of the conductors shall be connected as a modification – see pos. 13 and 15 – and one as a connection with unloading – see pos. 14.

Estimated time 220 minutes.

Test 6 Appendix 8

Soldering of three shielding connection lines to six shielded double conductors of the flat shielding type with tear thread.

- Soldered using leaded solder.
- The shielded conductors shall be bundled with two straps before the work is commenced.
- The stripping of the conductors shall be carried out as per appendix 8.
- The connection is accomplished in three different combinations – one single, one double (two shielded conductors in one soldering sleeve), one triple (three shielded conductors in one soldering sleeve) and two jumpers plus shield connection.
- The soldering is to be carried out using soldering sleeve which should be installed so that the melting rings are centred over the exposed shielding. Both soldering sleeve and shrinking tubing are heated using either hot-air equipment or IR lamp (IR irradiation).
- The solder ring contours must have disappeared completely.
- Large, bright red indication colour accumulations should have disappeared as a result of heating.
- Solder pearls that have floated up on the insulation under the soldering sleeve inside the melting ring is acceptable and does not lower the grade.

Estimated time 90 minutes.

7 QUALIFICATION RENEWAL

Renewal of FSD 5115 requires valid qualification as per FSD 5115. The solderer must be given an opportunity to renew his/her qualification in good time before the expiration of the validity. It must be possible to prove the qualification.

The applicable regulations shall be reviewed before the testing. If the solderer so wishes he/she shall be given an opportunity to train before the testing.

The qualification test shall comprise test 2, 5 and 6 plus written tests – see section 6.

For renewal of authorization both the practical and the theoretic test must be approved.

8 EVALUATION OF QUALIFICATION TEST

The tests shall be evaluated by instructor/examiner with a valid authorisation as per FSD 5116. The solderer's identity must not be known to the evaluator at the evaluation.

8.1 Requirements

The applicable requirement specification for the tests must be met – see FSD 5207. The training unit requirements as per FSD 5138 and FSD 5139 are applicable. The IPC process indicators as per IPC-A-610 are to be used for the evaluation, and are rated 0–4 for the soldering tests.

There is an exception for cleaning, where some component markings might disappear, which does not entail any lowered ratings. The motive is that solderers shall be familiar with what is required for satisfactory soldering.

8.2 Evaluation points

The following evaluation points are to be considered when evaluating the tests:

- stripping has been performed in accordance with the applicable requirements,
- components, wires etc. are correctly installed and undamaged,
- there are no free strands on conductors,
- the correct solder temperature has been used,
- the amount of solder has been correctly balanced,
- the solder has floated out well and formed an even surface,
- the solder has not floated out too far outside of the soldering area as such,
- there are no unsoldered connections,
- there is no dry jointing,
- the specified air and creepage distances have not been reduced as a result of the soldering,
- there are no heat damages in insulation, board, components etc,
- the soldering has been sufficiently cleaned to remove flux, solder pearls, solder flakes etc,
- the soldering has not been mechanically processed,
- there are no cracks in the soldered joint,
- the estimated time for the qualification test is not exceeded materially (when this evaluation is made the identity of the solderer may be known to the evaluator)

8.3 Grading

Each test is evaluated and graded using the following scale of marks: Due regard should however be taken to deviations with regard to the appearance of lead-free solder:

- Grade 9-10 afforded when the performance is without remarks with regard to all evaluation points,
- when the soldering is without remarks with regard to all evaluation points,
 - when the overall performance is excellent.
- Grade 7-8 is afforded in case of any of the following remarks:
- minor irregularities or blisters,
 - minor remarks with regard to stripping or contact length,
 - minor remarks with regard to cleaning,
 - when the overall performance is good.
- Grade 5-6 is afforded in case of any of the following remarks:
- irregularities or blisters (e.g. high soldering temperature),
 - remarks with regard to stripping or contact length,
 - minor flux residues or other contaminations,
 - minor remarks with regard to the flattening-out of the solder,
 - minor excess or deficit of solder,
 - if the solder has floated out outside of the soldering area as such,
 - unsuitably installed wires, components etc,
 - minor damage on wires or soldering surfaces,
 - minor heat or mechanical damage on board or component,
 - repaired point of connection,
 - if the time has been exceeded,
 - when the overall performance is acceptable.
- Grade 3-4 is afforded in case of any of the following remarks:
- major irregularities or blisters,
 - incorrect stripping or contact length,
 - flux residues (prevent inspection),
 - if the solder has not floated out well over the soldering area,
 - excess or deficit of solder,
 - if the solder has floated out far outside of the soldering area as such,
 - incorrectly installed wires, components etc,
 - damage on wires or soldering surfaces (e.g. foil coming off),
 - heat or mechanical damage on board or component,
 - mechanical post-processing of the soldering area,
 - overheating of the soldering area (dull solder surface),
 - remaining solder pearls, solder flakes etc,
 - if the calculated time has been exceeded considerably (by more than 20%),
 - when the overall performance is unsatisfactory.

- Grade 1-2 is afforded in case of any of the following remarks:
- if the solder has not floated out over the soldering area,
 - considerable solder excess,
 - considerable heat or mechanical damage on board or component, considerable overheating of the soldering area (grey and grainy solder),
 - cracks in the soldered joint, dislodged soldering,
 - wire pattern missing,
 - when the overall performance is bad.
- Rate 0 is afforded in case of any of the following remarks:
- unsoldered connection,
 - dry jointing,
 - solder bridge,
 - (direction sensitive) component placed the wrong way round,
 - mis-connection,
 - when the overall performance is very bad.

9 REQUIREMENTS

The requirement for approved qualification testing is that all the tests are approved with a grade of 5 or more, immediately or after retesting. If only one test is failed a maximum of two re-tests are permitted that test. It is not possible to get a rating above 5 at a repeated test.

In case of a failed second test all of the practical qualification tests are to be carried out once again – i.e. tests 2, 5 and 6, for renewal, and tests 1-6, for new certification.

If more than one of the tests in the practical soldering test is not approved, with a rating below 5, the full practical qualification test including all tests are to be carried out once again, i.e. three for renewal and six for new certification.

Exceptions in connection with new certifications: Retesting of failed test is not to be carried out if just one test has failed and the average rating for the completed stages 1—6 exceeds 5. Please note that this is only applicable for new certifications – not for renewal of authorization.

In case of failures with regard to sub-stages, for reasons which are not attributable to the carrying out of the sub-operation, this sub-stage may be carried out again.

In case of failed theoretical tests new theoretical education must be carried out before a new test is allowed. The new test shall not consist of the same questions as the previously carried out test.

10 CERTIFICATE OF QUALIFICATION

The training unit approved by FMV issues authorization certificates and the certificates shall be signed by instructor/examiner. The number of the training unit and the registration number of the course participant shall be stated on the authorization certificate. Sample form – see appendix 1.

11 LOGGING

The results of the qualification tests shall be logged on a form as per the example in appendix 2. The instructor/examiner must log and file the logs for a minimum of 5 years.

12 MATERIAL AND MATERIEL

All soldering as per this standard shall be carried out using spelter solder approved as per IPC J-STD-006 "Requirements for Electronic Grade Solder Alloys and Fluxed and Non-Fluxed Solid Solders for Electronic Soldering Applications", alloy Sn60Pb40 and Sn95.5Ag3.8Cu0.7 respectively. Suitable dimensions: 0.25-0.70 mm.

The flux used shall be approved as per IPC J-STD-004 "Requirements for Soldering Fluxes". The flux shall be of type ROL0 or ROL1.

Ethanol with a strength of 95 percent, denatured with 3 percent ethyl acetate, or some other cleaning liquid giving an equivalent result, shall be used for the cleaning of soldering areas.

Soldering kits for tests 1-6 as per section 6 are stored in the form of separate test kits, packed in plastic bags.

The specified material and materiel are stored at FMLOG RESMAT, Kundtjänst, Box 1002, SE-732 26 ARBOGA, Sweden.

<u>Store designation</u>	<u>Stores denomination</u>	<u>Designation of origin</u>
M0726-204703	Spelter solder 0.32 mm	Multicore 60362D032A 60/40 solder
M0726-204706	Spelter solder 0,56 mm	Multicore 60362D056A 60/40 solder
M0726-201707	Spelter solder 0,70 mm	Multicore 60362D070B 60/40 solder
M0726-204802	Lead-free spelter solder 0.25 mm	Multicore 96362D025A 96SC
M0726-204805	Lead-free spelter solder 0,50 mm	Multicore 96362D050A 96SC
M0726-204807	Lead-free spelter solder 0,70 mm	Multicore 96362D070B 96SC
M0734-802105	Flux, floating	Multicore 5381
M0736-218001	Cleaning liquid 218	
M8600-803330	Soldering test 1G/S	
M8600-803430	Soldering test 2G/S	
M8600-803520	Soldering test 3E/S	
M8600-803620	Soldering test 4E/S	
M8600-803730	Soldering test 5G/S	
M8600-803830	Soldering test 6G/S	

13 REFERENCES

FSD 5116	Qualification test of instructor/examiner for FSD 5115
FSD 5138	Training premises and tools for soft soldering.
FSD 5139	Requirements for training units for soft soldering personnel. Auditing and approval as per defence standard.
FSD 5207	Electric installations including electronics.
IPC J-STD-001	Requirements for Soldered Electrical and Electronic Assemblies.
IPC J-STD-004	Requirements for Soldering Fluxes.
IPC J-STD-006	Requirements for Electronic Grade Solder Alloys and Fluxed and Non-Fluxed Solid Solders for Electronic Soldering Applications.
IPC-A-610	Acceptability of Electronic Assemblies.
IPC-7711/21	Rework and Repair Guide.

Example

CERTIFICATE OF QUALIFICATION

for

approved solderer as per defence standard FSD 5115

New manufacture and repairs of harnesses, soldering towers and circuit boards with hole-mounted components.

Name: _____

Civic registration number: _____

Test no.	1	2	3	4	5	6	Points in all	Theo. test
Grade								%

Note: _____

City and date

Instructor/examiner

The qualification is valid for four years from the date specified.

Issued by training unit

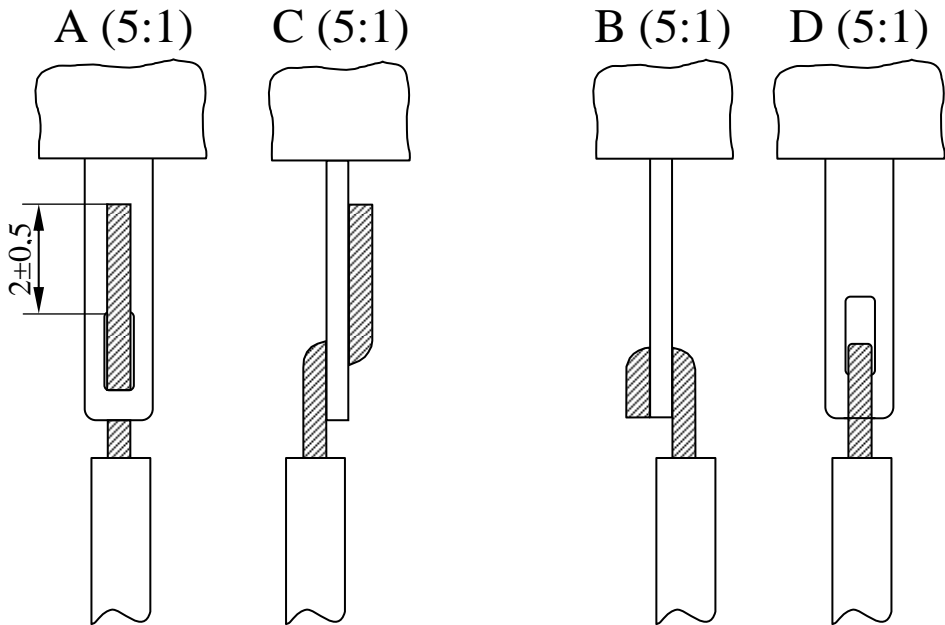
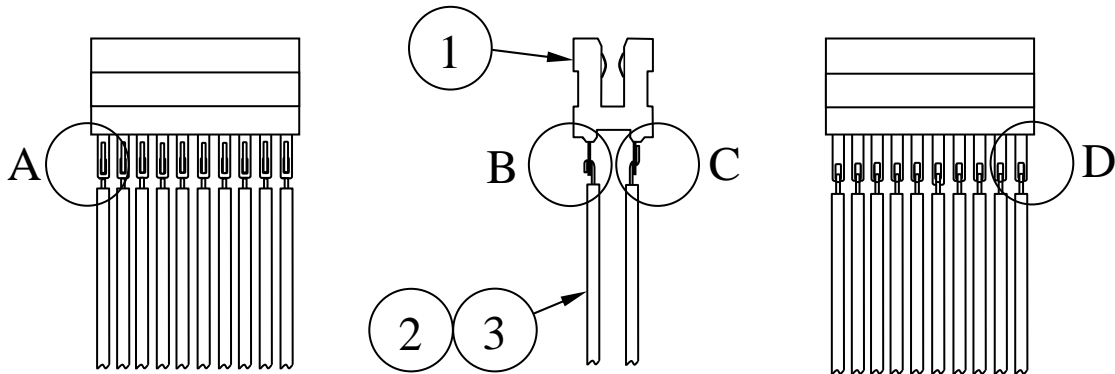
Number of approved training unit

TEST 1

M8600-803330

Soldering test 1 G/S

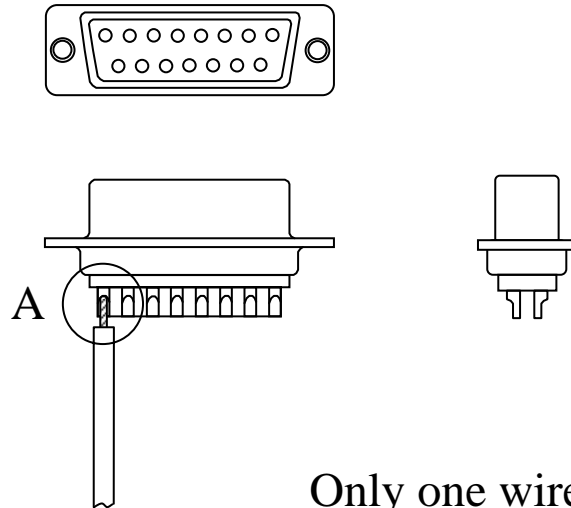
Soldered with lead-free solder.



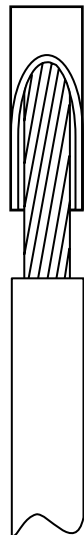
3	10	Conductor	M1062-747029	Raychem 55T8015-24-9	AWG 24, L = 100
2	10	Conductor	ÖLFLEX DEF 1522	PVC	AWG 24, L = 100
1	1	Card connector	ELCO 206072020002001	Lead-free	LL 10-10
Pos.	No.	Denomination	Designation	Material	Note

TEST 2**M8600-803430****Soldering test 2 G/S**

Soldered using leaded solder.



A (5:1)



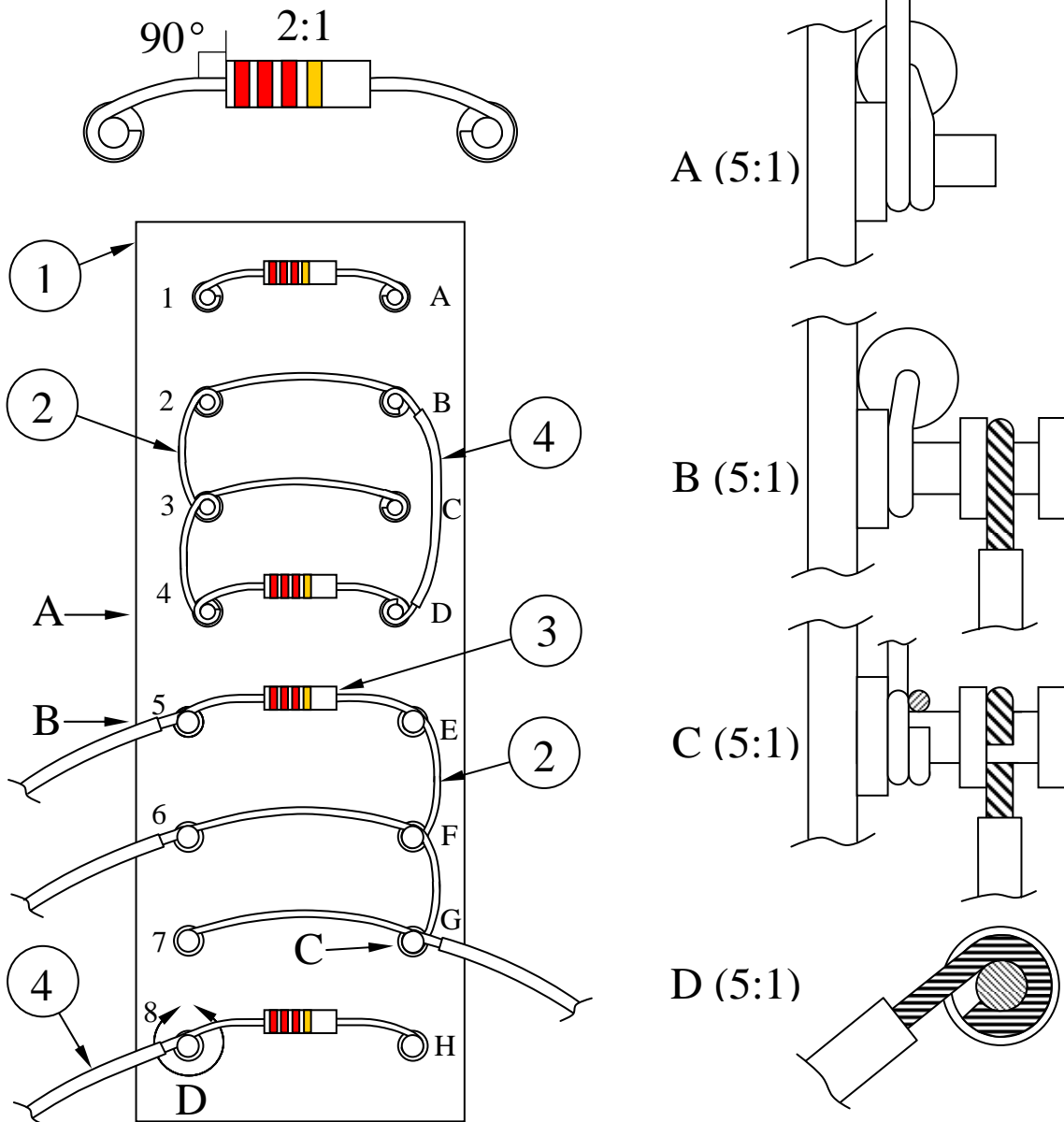
2	18	Conductor	ÖLFLEX DEF 185	PVC	AWG 20, L = 100
1	1	Plug	Assmann A-DS15LL/G		
Pos.	No.	Denomination	Designation	Material	Note

TEST 3

M8600-803520

Soldering test 3 E/S

Soldered using leaded solder.



Pos. 2 should be uninterrupted between B-2-3-4 and between E-F-G.

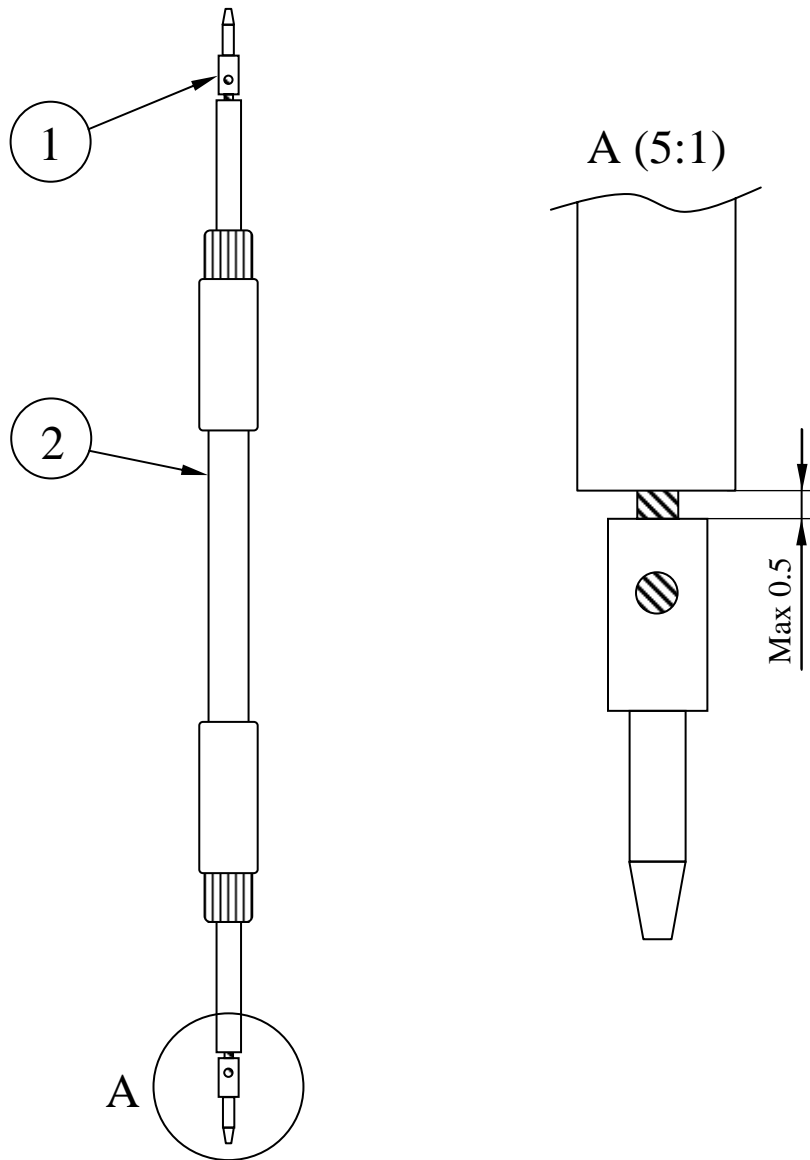
4	5	Conductor	M1062-740129	Raychem 44A0111-24-9	AWG 24
3	4	Resistor			½ W
2	5	Copper wire			∅ 0.5
1	1	Board			45 x 120 x 1.5
Pos.	No.	Denomination	Designation	Material	Note

TEST 4

M8600-803620

Soldering test 4 E/S

Soldered using leaded solder.



2	1	Coaxial cable	RG 58		
1	2	Coaxial pin	F1230-900938		
Pos.	no.	Denomination	Designation	Material	Note

TEST 5

M8600-803730
Soldering test 5 G/S

Soldered with lead-free solder.

The pattern card shall be provided with the components shown in figure 1. Both the resistors are to be space bent as per section A-A

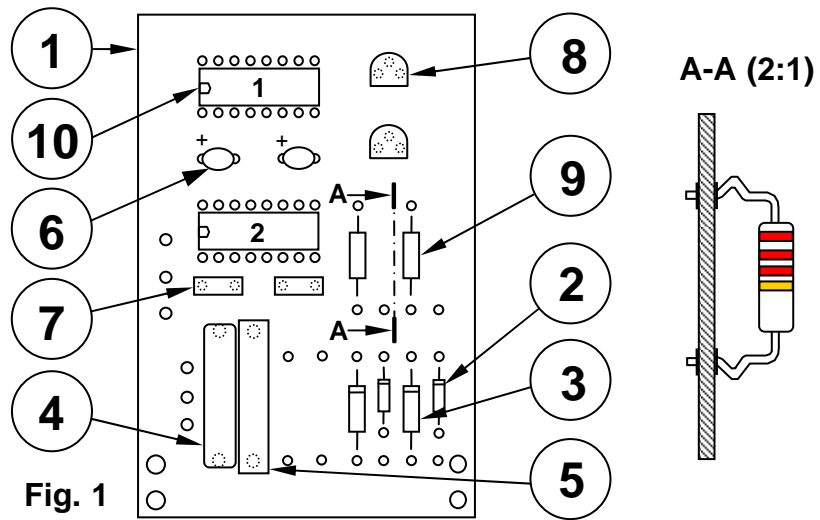


Fig. 1

One of the resistors 9 is replaced and installed as per section B-B. IC-capsule 10:1 is replaced by resistor net 11. Three wires 12, 13 and 13 + 15 and conductor 14 is soldered as per figure 2.

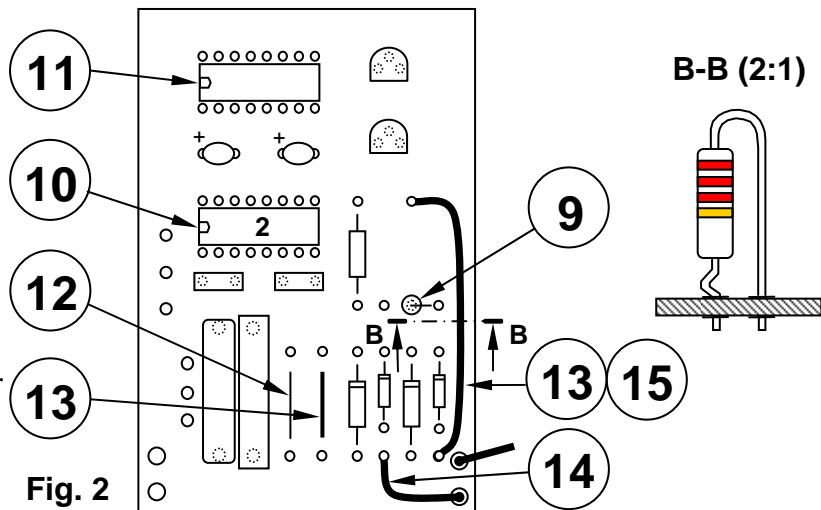


Fig. 2

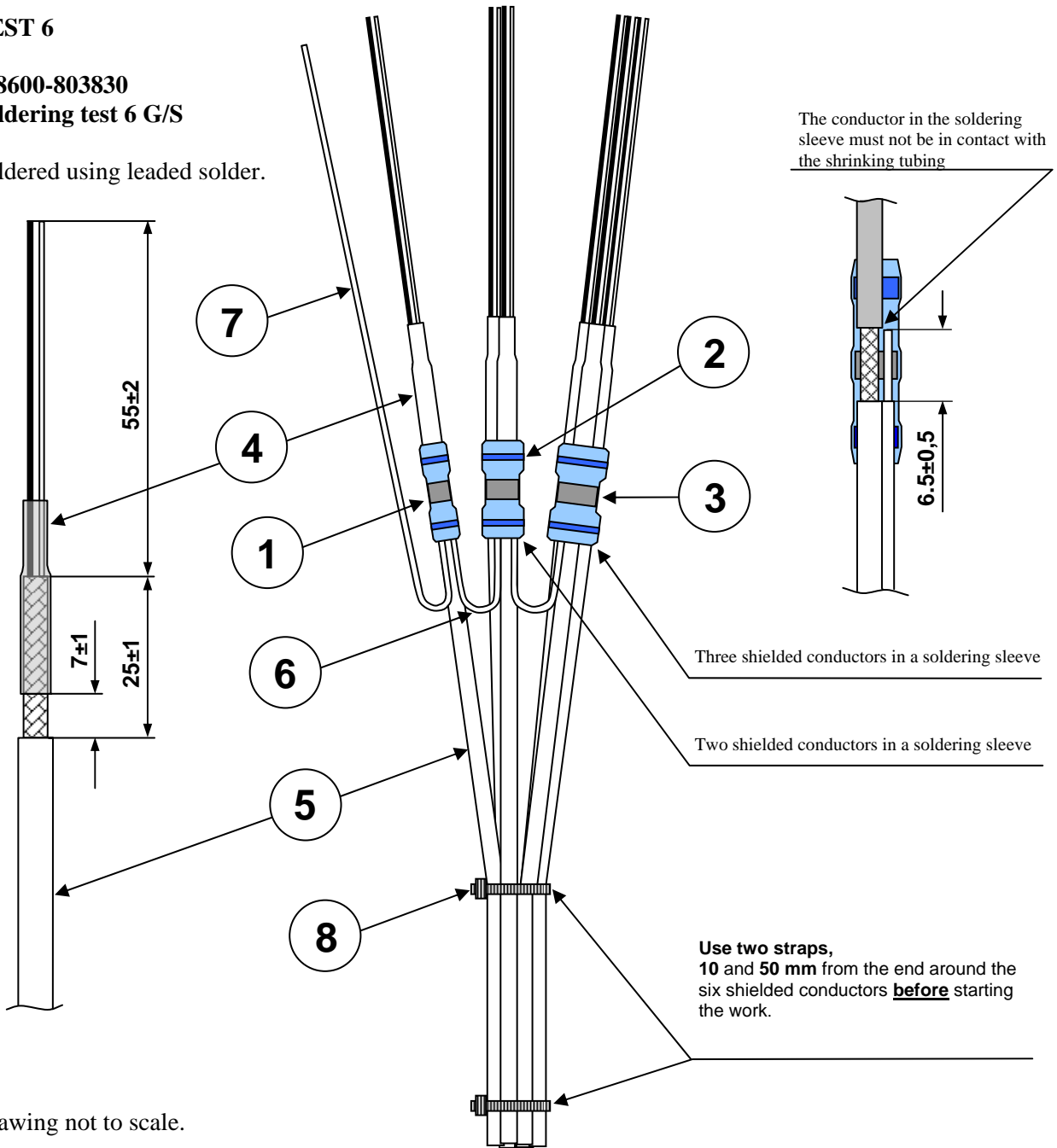
15	1	Isolation tube		PTFE	AWG 24; L = 50
14	1	Conductor	M1062-740129	Raychem 44A0111-24-9	AWG 24; L = 100
13	2	Copper wire			Ø 0.5; L = 100
12	1	Wrapping wire			Ø 0.25; L = 100
11	1	Resistor net			DIL 16p
10	2	IC-capsule			DIL 16p
9	3	Resistor			¼ W
8	2	Transistor			TO92
7	2	Capacitor			S=2, MKT
6	2	Capacitor			S=2, SH
5	1	Capacitor			S=6, MKT
4	1	Capacitor			S=6, type 368
3	2	Diode			DO-41
2	2	Diode			DO-35
1	1	Pattern card	5 G/S	FR4, lead-free	44 x 58
Pos.	No.	Denomination	Designation	Material	Note

TEST 6

M8600-803830

Soldering test 6 G/S

Soldered using leaded solder.



Drawing not to scale.

8	2	Strap	CV-140		
7	1	Conductor	M1062-747029	Raychem 55T8015-24-9	AWG 24; L = 120
6	2	Conductor	M1062-747029	Raychem 55T8015-24-9	AWG 24; L = 70
5	6	Conductor 2X AWG	M1063-817302	Raychem 55T9239-24-0/9-9	AWG 24; L = 200
4	6	Shrinking tubing	RNF-100-3/32-9-SP	Raychem	L = 30
3	1	Soldering sleeve	Raychem D-107-00		
2	1	Soldering sleeve	Raychem D-101-00		
1	1	Soldering sleeve	Raychem D-100-00		
Pos.	No.	Denomination	Designation	Material	Note