G.L.Electronic
Czech Company for Aerospace Technologies

Microsection inspection

Tensile strength test

Test scope

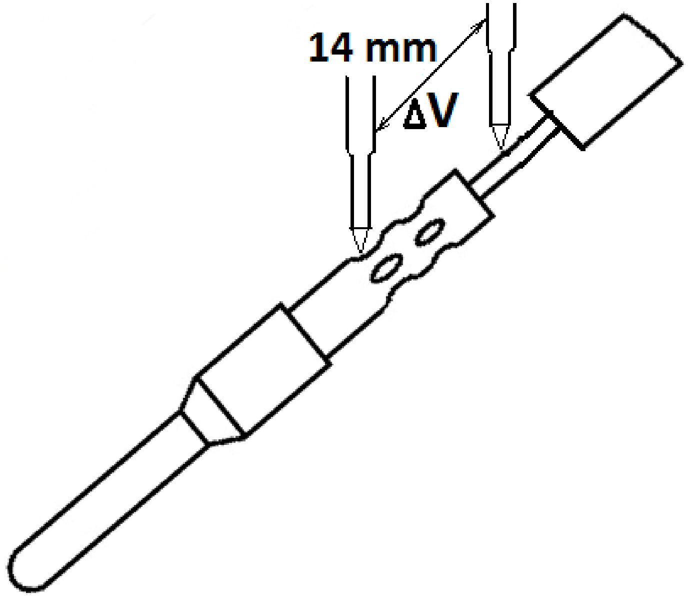
- Qualification tests for bunched cables according to ESA – ECSS specification that covers :
  - Wires tensile test,
  - Voltage drop test,
  - Microsection,
  - Definition of crimped joint quality based on measured results
- Furthermore by means of microsection there is a possibility to test electronic components from PCBs

Tensile strength test

- Tensile strength measurement which is needed for crimped joint disconnection/pulling away while axial tension is being applied.
- Continuously increasing axial load is being applied on crimped joint until limit of failure is reached.
- Tensile speed (i.e. speed by which is a wire and contact pulled away from each other) is the relevant factor influencing the final tensile strength that is stated in specifications.

Voltage drop test

- Correct workmanship verification of a crimped or soldered joint by measuring its crossing resistence.
- ECSS-Q-ST-70-26C specification defines maximal allowable voltage drop for each combination of a wire and pin. By volt drop measurement can be verified if this parameter complies or does not comply with required resistance.

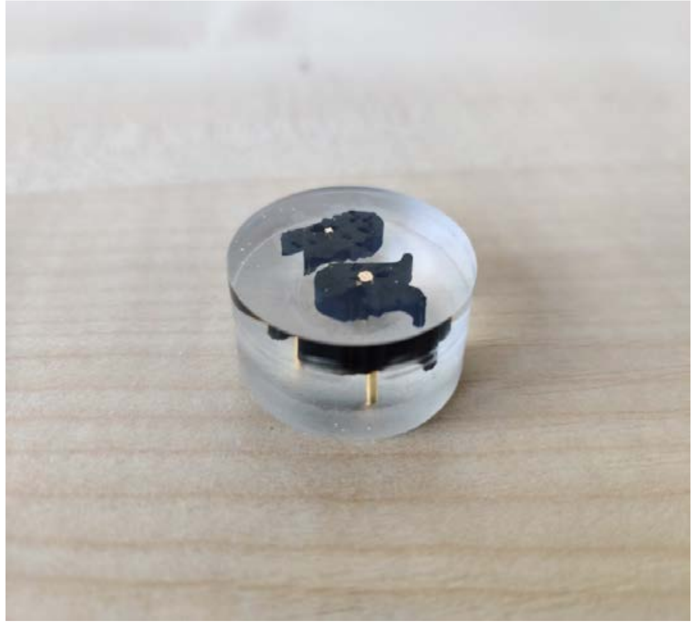


Note:

Verification procedure in this step is executed according to original ECSS specification, as more and more projects are required to be performed per old version because of lower cost.

Microsection inspection

- Cross section of an evaluated sample in order to get access to internal structure of the crimped joint.
- It serves for a proper assessment of the real crimping quality by means of critical factors analysis:
  - percentage of cavities,
  - wires and contacts deformation,
  - braided shields distribution,
  - contacts and wires compactness (cracks creation and coating delamination).

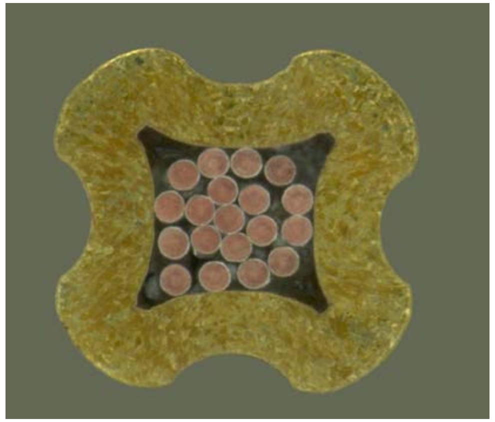


Space Level

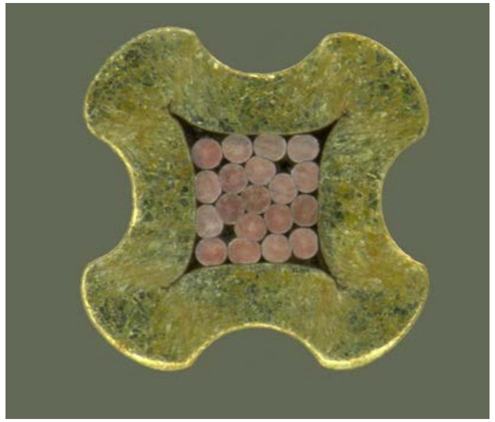
- Microsection is required by ECSS specifications for European Space Agency (ESA) projects as input and output quality assessment of a crimped joint for a specific wire in given project (validation process).
- ECSS-Q-ST-70-26C specification, applied in ESA projects, states that cavities among individual wire cores within crimped joint area must occupy less than 10% of a wire cross-section. This specification also requires for a contact not to have any cracks or other damages caused by crimping process.
- Tensile strength test is an essential need in space sector. Too low tensile strength causes a bad gas tightness of separated areas which can result in failure due to oxidation or corrosion.

Examples

- Examples of rejected and accepted crimped joints according to ECSS-Q-ST-70-26C specification:

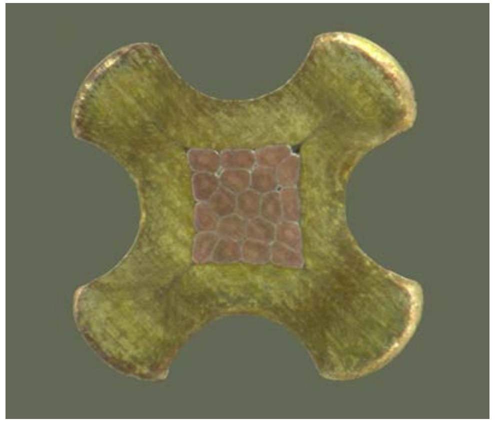


Non-accepted joint

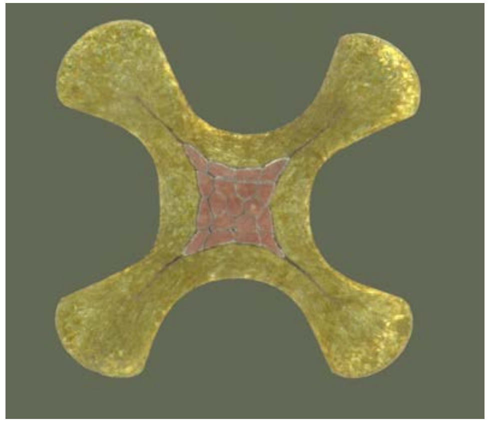


Accepted joint:

tolerance 10%



Preferred joint



Non-accepted joint

Used equipment

- **Secotom 50** – Portable unit for microsection cut and grinding cutter
- **CitoVac** – Vacuum chamber for filling-in samples after microsection cut execution
- **Tegramin 30** – Automatic metallographic grinder and polisher for samples
- **Stemi 508** – Stereomicroskope for visual samples analysis
- **AFG Mk4** – Manual digital dynamometer, 2500N
- **MULTITEST 2.5-dV** – Motor controlled stand

Tensile Strength Test

Equipment Survey

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AFG Mk4

- Manual digital dynamometer
- Measured force 2500N both in push and pull
- Accuracy +/-0.1 % of a range, resolution 1:5000
- Memory maximum: for 500 values

MULTITEST 2.5-dV

- Motor controlled stand
- Max. load 2500N
- Transverse bar regulated movement 0,1-1 200 mm/min
- Length, speed and force monitoring on display

Voltage Drop Test

Equipment survey

Switched mode lab supply

- Output voltage 1 – 18 V
- Output current 0 – 20 A
- Current value is set per ECSS-Q-ST-70-26C specification

Multimeter (V): UNI-T UT805A

- AC and DC voltage measurement – ESA specification gives allowed voltage drop (mV) between crimped joint and insulation-free wire in mutual distance of 14 mm

Microsection Inspection

Equipment survey

Secotom 50

- Microsection is a multistep process and begins with separation of an examined sample from remaining assembly – a gentle cut in crimped area
- For this purpose a portable modular grinding saw is used. It has a movable splitting table with adjustable speed of circular saw aimed at splitting both small and big samples (electronic components from PCB assembly).
- Automatic splitting procedure with cutting process electronic control and with cutting speed correction.

CitoVac

- Vacuum impregnating equipment with vacuum pump for filling-in and impregnation of sensitive, porous and complicated

Tegramin 30

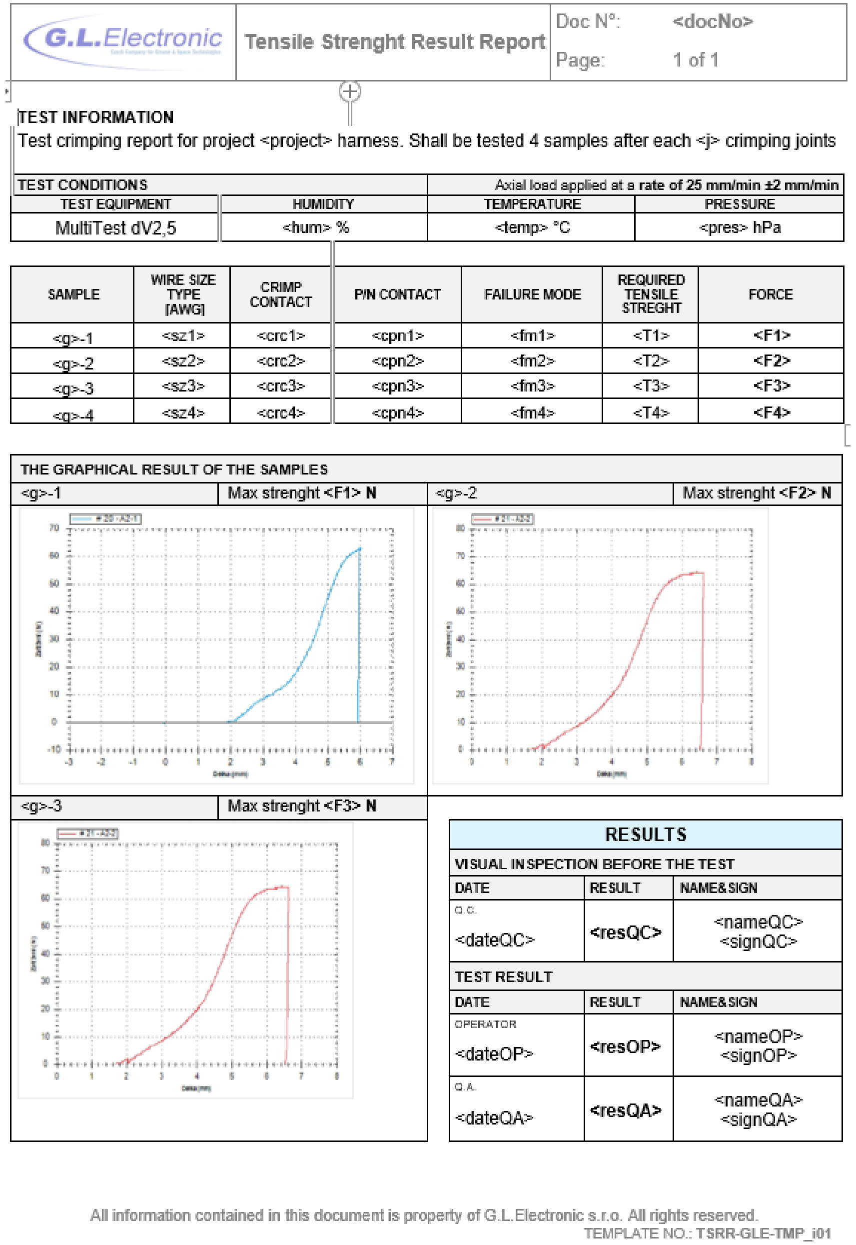
- Automatic microprocessor controlled system for grinding and polishing of metallographic grindings.
- Operating disk diameter: 300 mm
- Central and individual press grip
- Equipped with cut-off material amount measurement, databank and circular saw cooling

Stemi 508

- Stereo microscope - Zoom 8:1 with apochromatic correction, magnification 6.3x…50x, camera Axiocam ERc 5s + SW ZEN 2 starter

Tensile Strength Reporting

- For each test we attach a complete reporting per Aerospace standard



G.L.Electronic	Tensile Strenght Result Report	Doc N°: <docNo> Page: 1 of 1

TEST INFORMATION

Test crimping report for project <project> harness. Shall be tested 4 samples after each <j> crimping joints

TEST CONDITIONS		Axial load applied at a rate of 25 mm/min ±2 mm/min	
TEST EQUIPMENT	HUMIDITY	TEMPERATURE	PRESSURE
MultiTest dV2,5	<hum> %	<temp> °C	<pres> hPa

SAMPLE	WIRE SIZE TYPE [AWG]	CRIMP CONTACT	P/N CONTACT	FAILURE MODE	REQUIRED TENSILE STREGHT	FORCE
<g>-1	<sz1>	<crc1>	<cpn1>	<fm1>	<T1>	**<F1>**
<g>-2	<sz2>	<crc2>	<cpn2>	<fm2>	<T2>	**<F2>**
<g>-3	<sz3>	<crc3>	<cpn3>	<fm3>	<T3>	**<F3>**
<g>-4	<sz4>	<crc4>	<cpn4>	<fm4>	<T4>	**<F4>**

THE GRAPHICAL RESULT OF THE SAMPLES

<g>-1 Max strenght **<F1> N**

<g>-2 Max strenght **<F2> N**

<g>-3 Max strenght **<F3> N**

RESULTS

VISUAL INSPECTION BEFORE THE TEST

DATE	RESULT	NAME&SIGN
Q.C. <dateQC>	**<resQC>**	<nameQC> <signQC>

TEST RESULT

DATE	RESULT	NAME&SIGN
OPERATOR <dateOP>	**<resOP>**	<nameOP> <signOP>
Q.A. <dateQA>	**<resQA>**	<nameQA> <signQA>

TEMPLATE NO.: **TSRR-GLE-TMP_i01**

Validation Test Reporting

- Validation test report consists following: visual inspection, voltage drop test, tensile strength test, microsection inspection of final metallographic grinding of crimped joint and overall photo documentation.
- On the right side, there is one of examples of metallographic output and evaluation procedure

G.L.Electronic	Crimping Tools Validation Report for Harness Manufacturing	Doc. N°: **SAMPLE-GLE-CTVR-001** Date: 16.08.2021 Page: 5 of 6

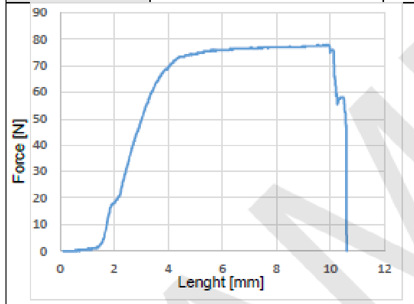
VISUAL INSPECTION	*acc. to ECSS-ST-Q-70-26C §5.5.4.2*	**SAMPLE GRP.**	**N1**
N1-1	**PASS**	WIRE SIZE [AWG]	22
N1-2	**PASS**	BARREL [AWG]	20/20
N1-3	**PASS**	P/N WIRE	E2219916878/4BFE9
N1-4	**PASS**	P/N CONTACT	ESCC340100501B

VOLTAGE DROP TEST *acc. to ECSS-ST-Q-70-26C §5.4.2 and Table 5-2*

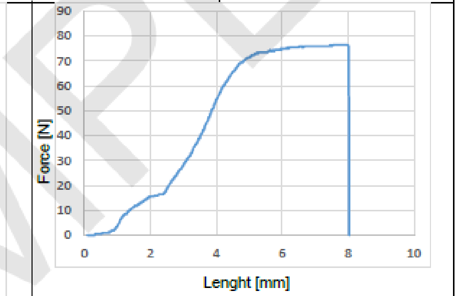
SAMPLE	REQUIRED CURRENT [A]	REQUIRED V-D MAX [mV]	MEASURE [mV]
N1-2	5	4	3,59
N1-3	5	4	3,14

TENSILE STRENGTH TEST *acc. to ECSS-ST-Q-70-26C §5.4.3 and Table 5-3*

SAMPLE	FAILURE MODE	REQUIRED TENSILE STRENGTH [N]	FORCE [N]
N1-2	Break in Crimp	60	78
N1-3	Break in Wire	60	76,5

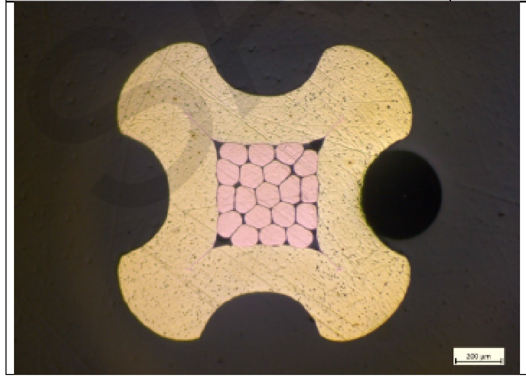


N1-2 Tensile Strength



N1-3 Tensile Strength

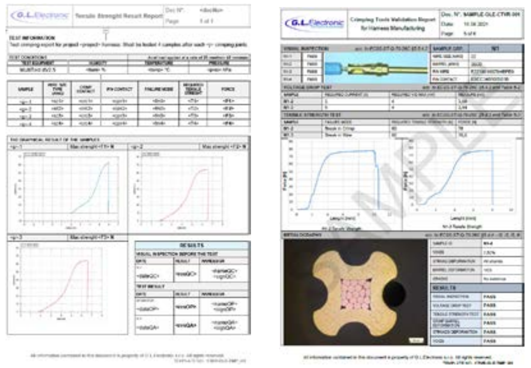
METALOGRAPHY *acc. to ECSS-ST-Q-70-26C §5.4.4 – i2, i3, i5, i6*



SAMPLE ID.	**N1-4**
VOIDS	7,52%
STRAND DEFORMATION	All strands
BARREL DEFORMATION	YES
CRACKS	No evidence
RESULTS	
VISUAL INSPECTION	**PASS**
VOLTAGE DROP TEST	**PASS**
TENSILE STRENGTH TEST	**PASS**
CRIMP BARREL DEFORMATION	**PASS**
STRANDS DEFORMATION	**PASS**
VOIDS	**PASS**

TEMPLATE NO.: **CTVR-GLE-TMP i01**

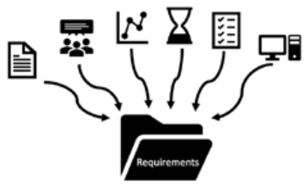
Flowchart of Proposed Process



Evaluation in form of reporting according to Aerospace standard

Documentation archiving

Requirements Specification by customer

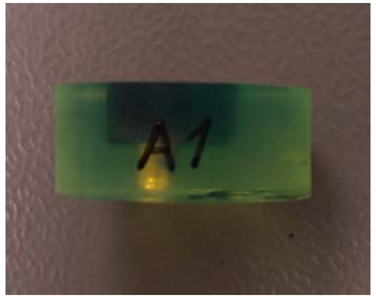


Internal procedure per CTVP-01-GLE, VDTP-01-GLE and MICOP-01-GLE in order to assure reproducibility of the whole process created in compliance with requirements ECSS-Q-ST-70-26C specification

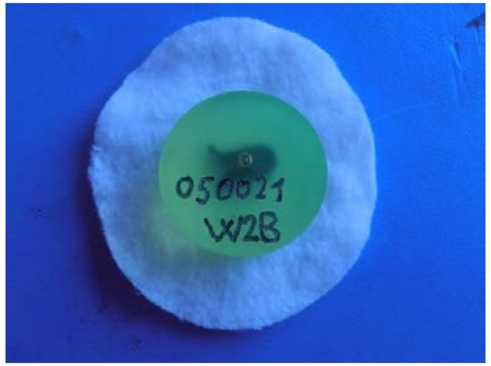
Equipment for tests execution and evaluation with relevant parameters

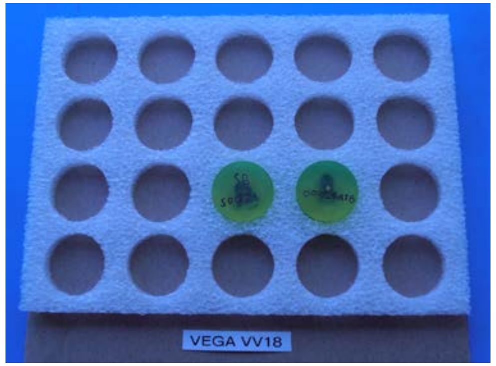
Samples Marking and Archiving

- Microsection samples – pucks are marked for identification and archiving in a repository
- Temporary marking – sideways, after taking out of mold



- Final marking – on the bottom, after grinding and cleaning



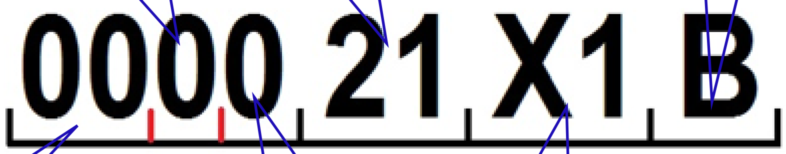


Storing in depository

0 – 9:
Model order
EM - FM

year

Part:
B – begin
E - end



00-99:
Project order

0 – 9:
Sample issue (repair, modification)

Group:
per LCT

Utilization Areas

We can offer these kind of tests for following fields where the highest quality requirements are:

- **Space industry**
- **Aircraft industry**
- **Earth support equipment**
- **Military industry**
- **Automotive industry**
- **Transport industry**
- **Navy industry**

Test by means of microsection can be also used for mechanical materials and metal parts analysis in case there is no access for visual control.

Motivation for gaining authorization enabling certified laboratory operation and accreditation

- Lack of specialized departments they can carry out tensile strength and microsection tests (Italy, Germany, France, Spain)
- Long waiting times needed for evaluation – project delay (must be done before project start and on its outcome as validation)
- New vacancies in Czech republic creation
- Influence of Czech companies reinforcement in field of space industry
- Monetary gain from foreign companies, benefit for Czech economy
- Planned goals fulfilling in area of development and service within National Space Plan 2020 - 2025

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