worldskills

*Standards and Assessment Guide*

# Autonomous Mobile Robotics

v1.1

# Introduction

Welcome to the Standards and Assessment Guide (SAG), a comprehensive resource designed to support excellence in assessment practices for all skills competitions hosted at the WorldSkills Competition. A key component of the SAG is the commitment to continuous improvement through ongoing review, ensuring that these guides consistently reflect the latest industry innovations and high standards of assessment in an open and transparent manner.

# Purpose

The primary purpose of this guide is to provide a structured framework for the consistent and fair assessment of each skill competition. It aims to ensure that all assessments are conducted with a high degree of accuracy, reliability, validity, and reflect global industry standards. By adhering to these guidelines, assessors can maintain the integrity of the competition and uphold the high standards associated with WorldSkills.

**Note**: this guide is not a replacement for the Marking Scheme and should only be used as a reference when required during the assessment process. Competitors are not allowed to have a copy of this SAG in the workshop in either digital or paper form.

# Scope

This document covers general assessment practices applicable to a diverse range of industry sectors including:

- Manufacturing and Engineering Technology
- Information and Communication Technology
- Construction and Building Technology
- Transportation and Logistics
- Social and Personal Services
- Creative Arts and Fashion

Each skill competition has its unique requirements and benchmarks, which are detailed within sections of this guide. The consistency of assessment across each skill is the overarching principle, ensuring a unified approach to evaluating Competitor performance to the highest standards.

# Key Components

The guide is structured into several key components, each addressing critical aspects of the assessment process:

## Assessment Principles and Objectives

- Emphasis on fairness, transparency, and objectivity in assessments.
- Alignment with global industry standards and best practices.

## Assessment Methods and Tools

- Description of various assessment methods in Measurement and Judgement.
- Guidance on the application of appropriate assessment tools and equipment (if applicable).

## Criteria and Benchmarks

- Examples of assessment criteria and aspects for each skill, outlining the expected competencies and performance standards.
- Benchmarks for different levels of proficiency i.e. Judgement award range 0, 1, 2, 3 or Yes/No criteria alongside clear measurable descriptors.

## Expert assessment requirements

- Completion of the Access Programme.
- Approved Curriculum Vitae (CV).
- Reaching **100%** Expert preparedness.
- Full participation of online and in-person Mandatory Assessment Training (MAT).
- Completion of practical assessment testing at the Competition.

## Quality Assurance and Improvement

- Monitoring and evaluation: Ensuring assessments are carried out correctly and produce reliable results.
- Continuous improvement: Using feedback from Experts and Skill Competition Managers to enhance future assessments.
- Periodic review: Regularly updating processes to reflect current industry and WorldSkills standards.

# Implementation

For effective implementation, this guide should be used for guidance purposes only and in parallel with the Technical Description for each skill. Experts are encouraged to familiarize themselves thoroughly with both the general guidelines and the particular requirements of their respective skill areas. Collaborative efforts between the Skill Management Team, Experts, and Competitors are vital for achieving the ultimate goal of global skills development.

# Conclusion

The Standards and Assessment Guide embodies the commitment of the WorldSkills movement to nurturing talent and promoting the highest standards of vocational education and training worldwide. By providing clear and comprehensive guidance, we aim to empower Experts to conduct marking and assessment practices that are not only rigorous and equitable but also inspiring and transformative for all participants.

Thank you for your dedication to upholding these standards and contributing to the success of the WorldSkills Competition. Together, we can continue to champion skills excellence and celebrate the achievements of talented individuals from around the globe.

## How to Use This SAG

Assessment within this skill is divided into Measurement and Judgement.

The selection of assessment method is predefined in the Marking Scheme and implemented through the marking system (official marking system). This ensures consistency, reduces subjectivity, and aligns assessment with the intended design of the Test Project.

Experts will be clearly guided for each aspect whether:

- Measurement or
- Judgement is required.

Experts must:

- Apply the assigned assessment method exactly as indicated
- Not substitute one method for another
- Not reinterpret a Measurement aspect as Judgement or vice versa

## Use of Measurement

Measurement is used where performance can be objectively verified.

Experts are required to:

- Record outcomes as presented (e.g. YES/NO, count, time)
- Follow the Descriptor exactly
- Avoid interpretation beyond observable results

## Use of Judgement

Judgement is used only where quality of execution cannot be measured objectively.

Experts are required to:

- Select the score (0–3) that best matches observed performance
- Use descriptors and supporting resources for calibration
- Ensure scoring differences between Experts do not exceed the allowed range

## Key Principle

*Experts do not determine the assessment method. The assessment method is defined by the Marking Scheme and must be applied as instructed.*

## Relationship to the Test Project

The SAG defines standards, benchmarks, and examples of evidence that may be used when assessing occupational competence. It does not define the specific tasks, layouts, sequences, objects, conditions, or solutions that may appear in the Test Project. The detailed assessment requirements for each competition module are defined by the Test Project and Marking Scheme.

# Skill 23 – Autonomous Mobile Robotics

## Measurement

Measurement is used to assess accuracy, precision, and other performance that can be measured objectively. It is applied where ambiguity must be avoided.

The total marks allocated to measurement marking may vary from competition to competition depending on the Test Project.

Assessment may be recorded using objective measures such as YES/NO, count, time, distance, dimensions, mass, or other defined measurable values, as applicable.

| Aspect | WSOS section as per TD | Descriptor |
|---|---|---|
| | 1 & 2 | **Work Organization, Management, and Communication:**<br>• Competitors demonstrate professional working practices appropriate to autonomous mobile robotics. Measurement may verify compliance with defined requirements relating to safe working practices, organization of the work area, appropriate use of tools and resources, completion of required records or documentation, adherence to competition requirements, and effective team coordination and communication. Evidence must be objectively observable or verifiable.<br>**Examples of measurable evidence may include:**<br>• Compliance with defined safety requirements<br>• Compliance with competition and workplace requirements<br>• Required documentation completed correctly<br>• Tools, equipment, and resources used appropriately<br>• Work area maintained according to defined requirements<br>• Required team planning or communication records completed |

| Aspect | WSOS section as per TD | Descriptor |
|---|---|---|
| A | 3 | **Design:**<br>• Competitors demonstrate the ability to develop, interpret, implement, and verify mechanical, electrical and control-system designs appropriate to autonomous mobile robotics. Measurement may verify compliance with defined specifications, dimensions, interfaces, component requirements, engineering documentation, system constraints, safety requirements, and functional design criteria. Evidence must be objectively observable or verifiable.<br>• **Examples of measurable evidence may include:**<br>  • Compliance with defined design specifications<br>  • Compliance with specified dimensions or tolerances<br>  • Correct interpretation and implementation of engineering documentation<br>  • Correct selection or application of components according to defined requirements<br>  • Compliance with specified mechanical, electrical, or system interfaces<br>  • Required engineering documentation completed correctly<br>  • Compliance with defined safety and operational constraints |
| B | 4 & 7 | **Prototyping and Robot Environment Interaction:**<br>• Competitors demonstrate the ability to develop, implement, integrate and verify functional robotic solutions and their interaction with the operating environment. Measurement may verify compliance with defined functional requirements, correct subsystem integration, interface requirements, operational accuracy, reliability, repeatability, system response and applicable safety or operating constraints. Evidence must be objectively observable or verifiable.<br>• **Examples of measurable evidence may include:**<br>  • Compliance with defined functional requirements<br>  • Correct integration of required system elements<br>  • Compliance with defined mechanical, electrical, sensor or control interfaces<br>  • Correct system response to defined operating conditions<br>  • Accuracy against specified requirements or tolerances<br>  • Repeatability and Reliability of integrated system operation<br>  • Compliance with defined safety and operational constraints |

| Aspect | WSOS section as per TD | Descriptor |
|---|---|---|
| C | 5 | **Navigation and Localization:**<br>• Competitors demonstrate the ability to implement, configure, and verify autonomous navigation and localization appropriate to mobile robotic systems. Measurement may verify positional and navigational accuracy, system response, path execution, localization performance, reliability, repeatability, and compliance with defined environmental, safety, and operational requirements. Evidence must be objectively observable or verifiable.<br>• **Examples of measurable evidence may include:**<br>  • Accuracy of localization against defined requirements or tolerances<br>  • Accuracy of autonomous navigation against defined requirements<br>  • Correct execution of defined navigational requirements<br>  • Correct system response to changes in operating conditions<br>  • Reliability and repeatability of navigation and localization<br>  • Compliance with defined environmental or operational constraints<br>  • Compliance with defined safety requirements |
| D | 6 | **Vision:**<br>• Competitors demonstrate the ability to implement, configure, integrate, and verify vision systems appropriate to autonomous mobile robotics. Measurement may verify the acquisition, detection, recognition, interpretation, and use of visual information, together with accuracy, system response, reliability, repeatability, and compliance with defined operational requirements. Evidence must be objectively observable or verifiable.<br>• Examples of measurable evidence may include:<br>  • Correct acquisition of visual information according to defined requirements<br>  • Accuracy of detection or recognition against defined criteria<br>  • Correct interpretation of visual information<br>  • Correct system response based on processed visual information<br>  • Reliability and repeatability of vision-system operation<br>  • Integration of vision information with the robotic system<br>  • Compliance with defined operational requirements or tolerances |

| Aspect | WSOS section as per TD | Descriptor |
|---|---|---|
| E | 8 | **Testing and Fault Finding:**<br>• Competitors demonstrate the ability to systematically test, diagnose, correct, and verify autonomous mobile robotic systems. Measurement may verify the correct application of testing procedures, identification and diagnosis of system conditions, implementation of appropriate corrective actions, restoration of required functionality, and verification of system performance against defined requirements. Evidence must be objectively observable or verifiable.<br>• **Examples of measurable evidence may include:**<br>  • Correct application of defined testing procedures<br>  • Accurate interpretation of test results or system information<br>  • Correct identification of system conditions requiring attention<br>  • Correct diagnosis of the cause of identified system conditions<br>  • Appropriate implementation of corrective actions<br>  • Successful restoration and verification of required system functionality<br>  • Compliance with defined testing, safety, and operational requirements |
| F | 9 | **Performance Review and Commissioning**<br>• Competitors demonstrate the ability to commission, verify, and evaluate the performance of an integrated autonomous mobile robotic system against defined requirements. Measurement may verify system functionality, operational accuracy, consistency, reliability, repeatability, system response, and compliance with defined performance, safety, and operational criteria. Evidence must be objectively observable or verifiable.<br>• **Examples of measurable evidence may include:**<br>  • Successful verification of required system functionality<br>  • Accuracy of system performance against defined requirements or tolerances<br>  • Correct system response under defined operating conditions<br>  • Reliability and repeatability of integrated system operation<br>  • Verification of required interfaces and subsystem operation<br>  • Compliance with defined performance and operational criteria<br>  • Compliance with defined safety and commissioning requirements |

## Judgement

Judgement is used to assess the quality of performance about which there may be small differences of view when applying the external benchmarks.

The Resources column in the table below may include all kinds/formats of resources such as a link to a YouTube video, a website link, an illustration, a photo, a reference to a book, and so on. It needs to be as detailed as possible to show the differentiation between 0, 1, 2, 3.

## Generic rules

The assessment group comprises three Experts plus one Expert who acts as the supervisor. The supervising Expert will replace an Expert in the marking group to prevent compatriot marking.

The difference of the three Experts' scores may not exceed 1. If this is the situation the Experts must re-score until there is a maximum difference of 1. As long as the three Experts judge within 1, the result can be entered into the CIS.

The total marks allocated to judgement marking may vary from competition to competition depending on the Test Project.

## Robot Mechanical Assembly – Fastening Quality

| WSOS section as per TD | Score | Descriptor | Resource | |
|---|---|---|---|---|
| | | | What the reference photograph should show | What Experts should observe |
| 3 | 0 | Fastening does not provide mechanical integrity for normal operation. Fasteners are visibly unsecured or incorrectly seated, allowing movement between components or preventing the assembly from being securely retained. | Fasteners visibly unsecured, incorrectly seated, or not clamping the assembled components. | Fasteners do not securely retain the assembly. Movement between fastened components is possible, or the fastening arrangement cannot maintain mechanical integrity during normal operation. |
| | 1 | Fastening provides basic mechanical integrity, but the assembly contains clearly identifiable deficiencies in fastening application or consistency that may reduce mechanical reliability during normal operation. | An assembly that remains mechanically retained but shows identifiable fastening deficiencies, such as missing required fasteners, incomplete fastening, inconsistent fastener application, or fasteners not correctly seated. | The assembly remains mechanically retained, but one or more fastening deficiencies are evident that may reduce mechanical reliability during normal operation. |
| | 2 | Fastening provides secure mechanical integrity for normal operation. Required connections are correctly seated and secure, with no visible fastening deficiencies that affect functionality or reliability. | A securely retained assembly with required fasteners present, correctly positioned and seated, providing effective clamping of the connected components. | Fasteners securely retain the components with no visible movement, incorrect seating, missing required fastening, or other fastening condition affecting normal operation or mechanical reliability. |
| | 3 | Fastening provides secure mechanical integrity and fully complies with the defined fastening requirements. Connections are correctly seated, secure, and consistently applied throughout the assessed assembly. | An assembly with all required fasteners present and correctly applied, positioned and seated in accordance with the defined fastening requirements. | Fastening is complete and consistent, with required fasteners correctly positioned, seated, and applied according to defined requirements. |

# ROBOT MECHANICAL ASSEMBLY – FASTENING QUALITY – REFERENCE PHOTOS

## SCORE 0

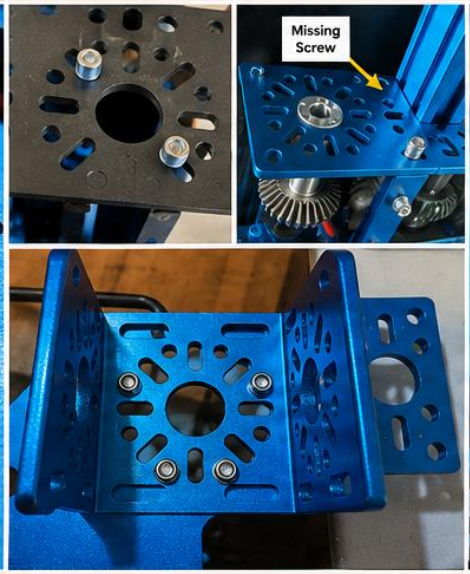
**Does Not Provide Mechanical Integrity for Normal Operation**

**Fastening does not provide mechanical integrity for normal operation.**
**Fasteners are visibly unsecured or incorrectly seated, allowing movement between components or preventing the assembly from being securely retained.**

- Fasteners not tightened or not seated.
- Components can move or separate.
- Fasteners installed incorrectly.
- Assembly cannot maintain mechanical integrity.
- Not suitable for normal operation.

## SCORE 1

**Provides Basic Mechanical Integrity, but Identifiable Deficiencies Exist**




**Fastening provides basic mechanical integrity, but the assembly contains clearly identifiable deficiencies that may reduce mechanical reliability during normal operation.**

- Missing required fastener(s).
- Incomplete or inconsistent fastening.
- Fasteners not fully seated or tightened.
- Washers/lock components missing or incorrectly used.
- Deficiencies may affect reliability.

## SCORE 2

**Provides Secure Mechanical Integrity for Normal Operation**

**Fastening provides secure mechanical integrity for normal operation.**
**Required connections are correctly seated and secure, with no visible fastening deficiencies that affect functionality or reliability.**

- All required fasteners present.
- Fasteners correctly positioned and seated.
- Components securely clamped.
- No visible deficiencies affecting functionality or reliability.
- Suitable for normal operation.

## SCORE 3

**Provides Secure Mechanical Integrity and Fully Complies with Requirements**

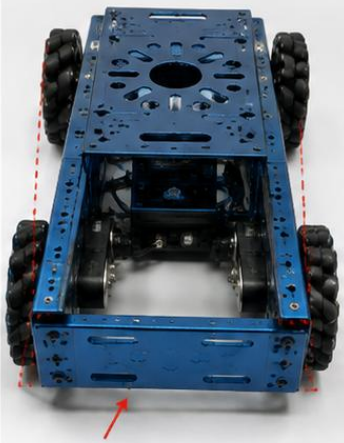

**Fastening provides secure mechanical integrity and fully complies with the defined fastening requirements.**
**Connections are correctly seated, secure, and consistently applied throughout the assessed assembly.**

- All required fasteners present and correct.
- Fasteners correctly positioned and seated.
- Fastening complete and consistent throughout.
- Complies with defined fastening requirements.
- Exceeds expectations for normal operation.

**Note for Experts:** Assess fastening quality only. Do not consider wire routing, crimping, identification, or electrical correctness of connections.

## Robot Mechanical Assembly - Chassis

| WSOS section | Score | Descriptor | Resource<br>What the reference photograph should show | <br>What Experts should observe |
|---|---|---|---|---|
| 3 | 0 | Chassis assembly does not provide the structural integrity required for normal operation. Components are incorrectly fitted or positioned in a manner that prevents secure assembly or causes unintended movement or interference. | A chassis with a structural member clearly incorrectly positioned, improperly seated, or visibly unsecured, resulting in obvious distortion or unintended movement. | Structural integrity is not achieved. |
| | 1 | Chassis provides basic structural integrity, but observable fitment or alignment deficiencies cause unintended movement, interference, or inconsistent positioning that may affect reliable operation. | A complete and functional chassis, but with a clearly visible fitment/alignment problem, for example, a structural member visibly skewed or components not seating correctly against mating surfaces. | Basic integrity exists, but assembly quality could affect reliability. |
| | 2 | Chassis provides secure structural integrity for normal operation. Components are securely fitted and positioned, with no observable fitment or alignment condition that affects functionality or reliability. | A correctly assembled, secure chassis. Members are properly seated and there is no visible condition affecting normal operation, but the assembly is not being presented as the benchmark for full conformity. | Competent, secure and functional assembly. |
| | 3 | Chassis provides secure structural integrity and demonstrates consistent assembly throughout. Components are securely fitted, correctly positioned and aligned in accordance with the defined assembly or engineering requirements. | A correctly assembled chassis that demonstrably conforms to the applicable assembly/drawing requirements, with structural members correctly positioned, seated and consistently aligned. | Fully compliant and consistently assembled. |

| SCORE 0 | SCORE 1 | SCORE 2 | SCORE 3 |
|---|---|---|---|
| **Unacceptable** | **Basic** | **Competent** | **Exemplary / Fully Compliant** |
|  |  |  |  |
| • Structural members are incorrectly positioned.<br>• Front panel is not seated or fastened correctly.<br>• Chassis is visibly distorted and not square.<br>• Gaps and misalignment are obvious.<br>• Structural integrity is NOT achieved. | • Chassis is complete and stands together.<br>• Visible fitment or alignment issues.<br>• Front panel or side members are not square/parallel.<br>• Components are seated but not consistently aligned.<br>• May affect reliable operation or cause interference. | • Chassis is correctly assembled and square.<br>• All structural members are properly seated and secured.<br>• No visible gaps, distortion or interference.<br>• Provides secure structural integrity for normal operation.<br>• Meets functional requirements of the assembly. | **REFERENCE REQUIREMENTS**<br>✓ Structural members correctly positioned<br>✓ Mating surfaces fully seated<br>✓ Required orientation maintained<br>✓ No unintended interference<br>✓ Assembly conforms to specified configuration / drawing requirements<br><br>• All reference requirements are fully met with consistent assembly quality throughout the chassis. |

**Note for Experts**: Evaluate the overall chassis assembly quality using visible evidence only.
Use the reference requirements (Score 3) as the benchmark for full compliance.

## Robot Mechanical Assembly – Structural Integration

| WSOS section as per TD | Score | Descriptor | Resource | |
|---|---|---|---|---|
| | | | What the reference photograph should show | What Experts should observe |
| 3 | 0 | Mechanical components or structural elements are incorrectly integrated, resulting in inadequate support, incorrect positioning, interference, or loss of required clearance. | Mechanical components or structural elements incorrectly positioned or integrated, resulting in interference, inadequate support, loss of required clearance, or restricted movement. | Required support, positioning or clearance is not achieved, preventing reliable mechanical integration. |
| | 1 | Mechanical components and structural elements are integrated sufficiently for basic operation, but observable interface conditions affect alignment, spacing, clearance, or support and may reduce reliable operation. | A functional mechanical assembly with an observable interface deficiency affecting spacing, clearance, alignment, positioning, or support. | Basic operation is possible, but the mechanical interface may reduce reliability, cause unintended movement, interference, or premature wear. |
| | 2 | Mechanical components and structural elements are securely integrated, with appropriate alignment, spacing, clearance, and support for reliable normal operation. | Mechanical components securely integrated with appropriate positioning, alignment, spacing, clearance, and support for normal operation. | Components are securely supported and can operate as intended without interference. The integration provides reliable functional operation. |
| | 3 | Mechanical components and structural elements are correctly positioned, supported, and integrated in accordance with the defined engineering requirements. Appropriate mechanical interfaces are used to maintain required alignment, spacing, clearance, and support. | Mechanical components correctly integrated using appropriate engineering interfaces and fully conforming to the defined structural or assembly requirements. | Required alignment, spacing, clearance, positioning, and support are consistently achieved using appropriate engineering practice. |

## ROBOT MECHANICAL ASSEMBLY – STRUCTURAL INTEGRATION (REFERENCE PHOTOS)

| SCORE 0 | SCORE 1 | SCORE 2 | SCORE 3 |
|---|---|---|---|
| **Incorrect / Unacceptable** | **Basic – Interface Deficiency** | **Correct – Functional Integration** | **Exemplary – Full Compliance** |
|   |   |   |   |
| **Mechanical components are incorrectly integrated.**<br>• Structural element is bent or incorrectly positioned.<br>• No clearance provided between components.<br>• Components interfere and/or cannot move freely.<br>• Will affect normal operation or cause damage. | **Mechanical components are integrated with interface deficiencies.**<br>• No appropriate spacing or support is used where required.<br>• Observable interface conditions affect alignment, spacing, clearance or support.<br>• May reduce reliability or cause premature wear.<br>• Acceptable for basic operation but not optimal. | **Mechanical components are securely integrated.**<br>• Appropriate clearance and support are achieved.<br>• Components are correctly positioned and aligned.<br>• No interference; parts operate as intended.<br>• Provides reliable performance for normal operation. | **Mechanical components are correctly integrated in accordance with the defined requirements.**<br>• Appropriate mechanical interfaces (e.g. spacers, standoffs) are used to maintain required alignment, spacing, clearance and support.<br>• Components are consistently positioned and supported.<br>• Fully meets the engineering requirements for the assembly. |

**Note for Experts:** Evaluate the structural integration of mechanical components using visible evidence only.
Use Score 3 as the benchmark for full compliance with the defined engineering requirements.

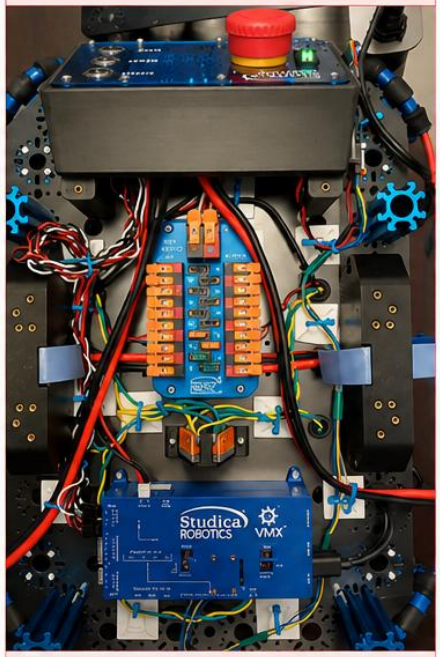
## Robot wire labelling

| WSOS section | Score | Descriptor | Resource | |
|---|---|---|---|---|
| | | | What the reference photograph should show | What Experts should observe |
| 3 | 0 | Wire identification cannot be reliably determined from the applied labelling. Labels are absent, incorrect, illegible, or positioned so that identification requires tracing or additional verification. | Wiring with absent, illegible, incorrect, detached, or unusably positioned identification, making connections impossible to identify reliably from the labels. | Wire identification cannot be established from the labelling without tracing or additional verification. |
| | 1 | Wire identification is possible, but labelling contains observable deficiencies in correctness, legibility, attachment, positioning, or consistency that require additional effort to identify connections reliably. | Wiring that can be identified, but labels show observable problems with placement, attachment, legibility, orientation, or consistency. | Identification is possible, but the Expert must reposition wiring, interpret inconsistent labels, or perform additional verification. |
| | 2 | Wires can be reliably identified from the applied labelling. Labels are legible, securely attached, and positioned for identification, with no labelling condition that prevents correct interpretation. | Clearly labelled wiring with labels legible, securely attached, and positioned so connections can be reliably identified. | Wires can be identified without tracing the circuit or disconnecting connections. Labelling supports reliable maintenance and fault finding. |
| | 3 | Wire labelling fully conforms to defined requirements and documentation; labels are correct, legible, secure, and unambiguous. | Consistently labelled wiring that conforms to the defined wiring documentation and labelling requirements, with labels clearly positioned at the required identification points. | Identification is immediate and unambiguous, with labels correctly and consistently corresponding to the documentation. |

# ROBOT WIRE LABELLING – REFERENCE PHOTOS

## SCORE 0

**Not Identifiable**

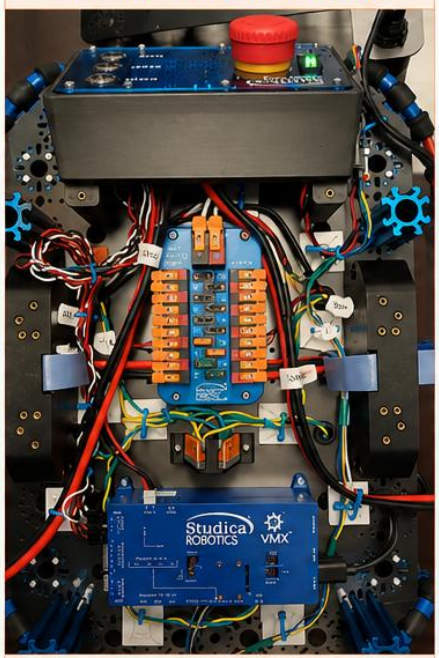



**Wire identification cannot be established from the labelling.**

- No labels on wires.
- Connections cannot be identified without tracing or testing.
- Additional verification is required to determine connections.
- Does not support safe operation, maintenance or fault finding.

## SCORE 1

**Limited / Difficult to Identify**

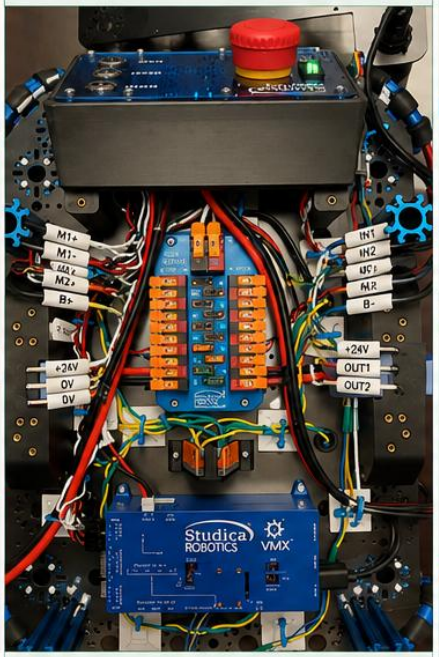



**Wire identification is possible but requires additional effort.**

- Some labels present but missing in places or not on all conductors.
- Labels are inconsistent, poorly positioned or difficult to read.
- Wires can be identified, but verification or interpretation is needed.
- Not reliable for maintenance or fault finding.

## SCORE 2

**Identifiable / Reliable**

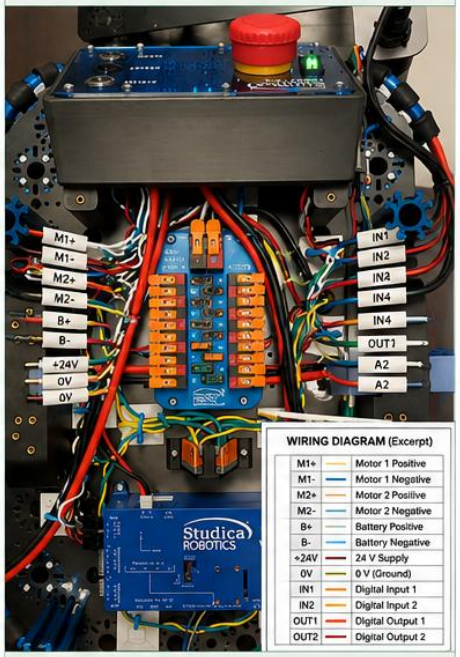



**Wire identification is reliable.**

- Labels are legible, correctly applied and securely attached.
- Wires can be identified without tracing or additional verification.
- Supports reliable operation, maintenance and fault finding.
- No labelling issues affect identification.

## SCORE 3

**Fully Conforming / Professional**




**Wire labelling fully conforms to the defined requirements and documentation.**

- All labels are correct, legible, securely attached and consistently applied.
- Identification is immediate and unambiguous.
- Labels are positioned at required identification points.
- Supports safe operation, maintenance and fault finding at the highest level.

## Robot wire neatness

| WSOS section as per TD | Score | Descriptor | Resource<br><br>What the reference photograph should show | <br><br>What Experts should observe |
|---|---|---|---|---|
| 3 | 0 | Wiring is unorganised and uncontrolled, with routing that obstructs access to components or creates risk of interference during normal operation or maintenance. | Uncontrolled wiring with conductors crossing extensively, unsupported routing, and wiring occupying component or working areas. | Wiring is not organised into identifiable routes and obstructs access or creates potential for interference during operation or maintenance. |
| | 1 | Wiring follows a general route, but unsupported loops, crossings, or inconsistent grouping reduce accessibility and may interfere with normal operation or maintenance. | Wiring generally follows a defined area or route but contains unsupported loops, unnecessary crossings, or inconsistent grouping. | Basic routing is established, but wiring occupies unnecessary space or reduces accessibility and may interfere with operation or maintenance. |
| | 2 | Wiring follows defined routes and is adequately supported and grouped, maintaining access to components without interfering with normal operation or maintenance. | Wiring routed and grouped within defined areas, with conductor lengths controlled and access to components maintained. | Wiring is organised and supported sufficiently for reliable operation, inspection, and maintenance without interference. |
| | 3 | Wiring is consistently routed, grouped and supported, providing clear access and reliable installation throughout. | Consistently organized wiring using appropriate routing, grouping, support and protection at mechanical interfaces or pass-through points. | Wiring follows controlled routes throughout, unnecessary slack is avoided, access is maintained, and wiring is protected from interference or damage. |

# ROBOT WIRE NEATNESS – REFERENCE PHOTOS

## SCORE 0

**Uncontrolled / Obstructive**

**Wiring is unorganised and uncontrolled, obstructing access and creating risk of interference.**

- No defined routing or organisation.
- Wires cross excessively and form loose loops.
- Wiring occupies working areas and obstructs components.
- Creates risk of interference with moving parts or other components.
- Makes inspection and maintenance difficult and unsafe.

## SCORE 1

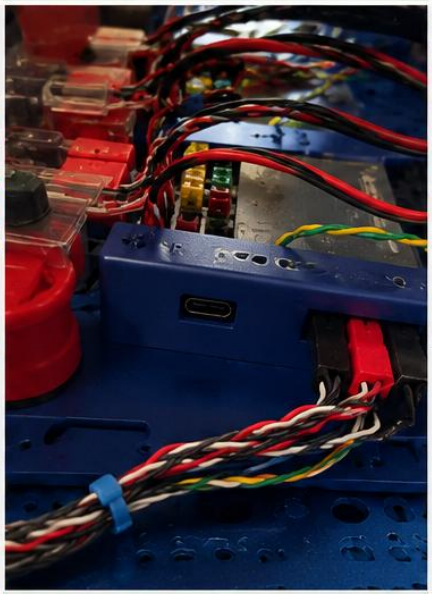
**Basic Route / Inconsistent**

**Wiring follows a general route but contains unsupported loops, crossings or inconsistent grouping.**

- General routing is established but not controlled.
- Unsupported loops and unnecessary crossings are present.
- Grouping and separation are inconsistent.
- Reduces accessibility and may interfere with normal operation or maintenance.
- Improvement required for reliable installation.

## SCORE 2

**Organised / Functional**



**Wiring follows defined routes and is adequately supported and grouped.**

- Wiring routed within defined areas.
- Conductors grouped and secured at intervals.
- Wire lengths controlled with minimal slack.
- Access to components is maintained.
- Does not interfere with operation or maintenance.
- Suitable for reliable operation.

## SCORE 3

**Consistent / Professional**

**Wiring is consistently neat, well-supported and professionally installed.**

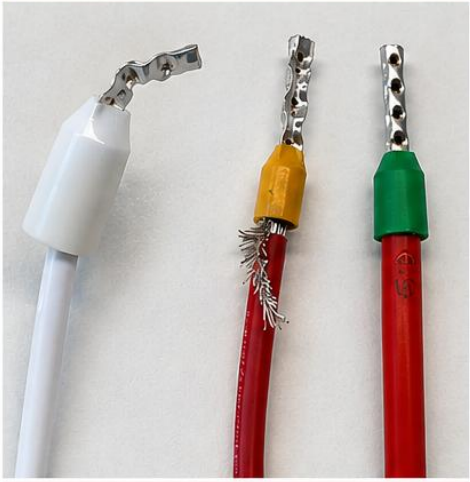
- All wiring follows defined routes with consistent organisation.
- Conductors are neatly grouped, supported and secured at regular intervals.
- Wire lengths are controlled with no unnecessary slack.
- Access to all components is clear.
- No risk of interference with movement or other components.
- Professional standard suitable for long-term, reliable operation and maintenance.

**Note for Experts:** Assess wire neatness only. Do not consider wire identification (labelling) or electrical correctness of connections.

## Robot wire crimping

| WSOS section as per TD | Score | Descriptor | Resource | |
|---|---|---|---|---|
| 3 | 0 | Termination is incorrectly formed, assembled, or sized, resulting in inadequate conductor retention or an unreliable connection. | Incorrectly formed or sized termination, exposed strands, incomplete conductor insertion, or inappropriate terminal-to-conductor fit. | The conductor is not correctly contained or retained, or the termination cannot provide a reliable connection. |
| | 1 | Termination retains the conductor, but observable deficiencies in conductor positioning, crimp formation, or terminal fit may reduce reliability. | Conductor is retained, but crimp formation, conductor position, or terminal fit contains an identifiable deficiency. | The termination is functional, but an observable condition may reduce its mechanical or electrical reliability. |
| | 2 | Termination securely retains the conductor and provides a reliable connection but does not fully conform to the defined crimping requirements. | Secure and functional termination, but with an incorrect or inconsistent crimp profile or other deviation from the defined crimping requirement. | Conductor retention and connection are reliable, but the required crimp profile or termination standard is not fully achieved. |
| | 3 | Termination is correctly formed, securely retains the conductor, and fully conforms to the defined crimping requirements. | Correctly sized ferrule with conductor correctly inserted and a defined, uniform crimp profile produced using the appropriate crimping method. | Correct terminal-to-conductor fit, conductor containment, insulation position and required crimp profile are demonstrated. |

# ROBOT WIRE CRIMPING – REFERENCE PHOTOS

| SCORE 0 | SCORE 1 | SCORE 2 | SCORE 3 |
|---|---|---|---|
| **Incorrectly Formed / Assembled / Sized** | **Retained but Deficient** | **Secure and Functional (Not Fully Conforming)** | **Correct and Fully Conforming** |
|  |  |  | **Correct Crimp Profiles (Examples)**<br>**Hexagonal Profile**<br>  <br>**Square Profile**<br>  |
| **Termination is incorrectly formed, assembled, or sized, resulting in inadequate conductor retention or an unreliable connection.**<br>• Conductor not fully inserted or retained.<br>• Exposed strands outside the ferrule.<br>• Deformed, incomplete or incorrect crimp.<br>• Ferrule/terminal size not suitable for conductor.<br>• Connection unreliable and unacceptable. | **Termination retains the conductor, but observable deficiencies in conductor positioning, crimp formation, or terminal fit may reduce reliability.**<br>• Conductor is retained within the ferrule.<br>• Crimp formation or conductor position is inconsistent.<br>• Ferrule fit or insulation support may be insufficient.<br>• Reliability may be compromised. | **Termination securely retains the conductor and provides a reliable connection, but does not fully conform to the defined crimpihping requirements.**<br>• Conductor is securely contained and retained.<br>• Connection is mechanically and electrically reliable.<br>• Crimp profile or termination standard is not fully achieved.<br>• Minor visible deviations from the required crimping requirement. | **Termination is correctly formed, securely retains the conductor, and fully conforms to the defined crimping requirements.**<br>• Correct terminal-to-conductor size and fit.<br>• Conductor fully inserted and strands completely contained.<br>• Insulation positioned correctly within the ferrule.<br>• Correct crimp profile achieved using the appropriate crimping method.<br>• Consistent, uniform and professional crimp. |

**Note for Experts:** Assess crimp quality only. Do not consider wire identification (labelling), routing, or electrical correctness of connections.