Technical Delivery Specification

MC01 – Machine Connectivity

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1 General

1.1 Area of application

This Technical Delivery Specification (TDS) defines the standards for the connectivity of machines, systems, and production facilities of Hirschmann Automotive (HA).

The purpose of this document is for the supplier to fully understand what hardware and software they need to prepare for HA to be able to monitor and control their machine. Since the machines are built project specific, some minor deviations are possible, but this document should be enough for an official offer to be done without additional costs for machine connectivity later during the project.

1.2 Deviations

Any deviations from this TDS require written approval from HA. If there is any ambiguity or unclear specifications, please contact HA.

1.3 Regulations, norms, and industry standards

The contractor is fully responsible for adhering to and fulfilling any requirements resulting from applicable regulations, norms, and industry standards, even if not explicitly stated in this TDS.

Any specifications referenced in this TDS should be checked by the contractor against the most current regulations, norms, and industry standards.

Suppose the contractor identifies any problems arising from the specifications in this TDS that would render the services provided by the contractor partially or completely unsuitable for the intended purpose, in that case, the contractor must inform HA about this immediately.

1.4 Pre-acceptance

The pre-acceptance is carried out remotely. The supplier should present the implemented structure and demonstrate the functions before the delivery of the machine.

Ideally, the pre-acceptance will take place in a Microsoft Teams meeting in which the control technicians who programmed the machine present the interface and the functions. Questions and ambiguities can be clarified quickly here.

2 Machine connectivity

2.1 General

HA uses different communication protocols to communicate and control the production machines. The standards are in the following order, 1. MQTT, 2. OPCUA, any of them can be used, with MQTT being preferred.

2.2 Important Notes

Since communication with the machine involves triggers to ensure the delivery of the data in a safe storage space, the machine **must** provide a trigger-free option where the machine is not dependent on external systems. **This switch must be available in the HMI under higher administrative permissions**. When MQTT protocol is used, a broker-free option where the machine is not waiting for QoS, (see section 4.2) must also be provided.

If neither MQTT nor OPCUA is available, the contractor should inform HA to establish the minimum requirements for the machine.

2.3 General workflow

Idle: No recipe/order loaded on the machine, the machine can be used in this state for other purposes (planned maintenance, validation, tests, etc.). **Any other state can go to idle by canceling the order.**

Setting Up: Order was received from HA + **any process that doesn't consume raw materials**

Start Up: Finished parts or semi-finished parts that are **not** part of the order**, will be destroyed by HA** following quality processes

Productive: Normal productive mode**, only these parts will be counted towards the order quantity**

Unscheduled Down: Error mode, when machine is stopped for any reason

The current state should be found in the **OperationMode** data point. The actual triggers should be established together with HA after the design of the machine is finished. Going back to a state is not possible. Start Up can be omitted if it's not done.

3 Network interface

3.1 Interface for smart connection (single PLC)

When a single PLC is used for controlling the machine, the PLC should have multiple networks available (at least two RJ45 ports) one for the machine local network, the other for the OPC UA / MQTT access.

Note: These must be independently configurable networks, not just two switched ports within the same network.

3.2 Interface for smart connection (multiple devices)

The machine should have an RJ45 port as an interface. This port must be connected to a router that provides externally accessible services via port forwarding. The router firewall must be configured to allow connections from inside the machine to the outside while blocking connections from the outside to the machine's internal devices (except for the forwarded ports).

HA must have access to configure this router as well as change the port forwarding rules.

3.3 Interface for Remote access

It's mandatory that suppliers have remote access to their machines. For this purpose, a deactivatable RJ45 port must be provided, separate from the one used for the smart connection.

The standard for this access is the eWon router from HMS Networks. If it is not possible to use this device or if there are any questions regarding its use, HA must be contacted to clarify the questions and available options.

3.4 Network configuration

Static IP addresses are assigned to the router and the connection for remote access. HA provides the configurations to the supplier. The supplier shall provide a list of the ports forwarded by the router on request.

The machine should also be correlated with a time server. The IP addresses for the time servers will be provided by HA.

4 MQTT

4.1 MQTT security and connections

HA operates MQTT brokers at each location, minimum version 3.1 to ensure (publish, subscribe and QoS). The respective connection data to the broker (IP and port) is provided on request. The communication with the broker should use the MQTT protocol.

The machine is authenticated via username and password. It must be possible to change any connection data in the machine settings. These settings should be available in the HMI under higher administrative permissions.

4.2 Quality of service level (QoS)

MQTT provides three levels of QoS:

QoS 0(At most once): Can be used for less relevant data that is retransmitted with each machine cycle. These are, for example, (error / good) counters of individual stations.

QoS 1(At least once): Must be used for all data relating to parts and the system status. This includes, for example, measurement data, data on parts placement, operating mode of the machine, machine faults, etc. Furthermore, all information that triggers a reaction from the MES system (Triggers) must be published with QoS 1.

QoS 2(Exactly once): Not currently used, if this is necessary, it must be clarified with HA.

4.3 Topic naming structure

The topic names consist of minimum 4 layers which are:

1. **Prefix:** namespace for the MQTT broker
2. **Cluster(optional):** Used for interconnected machines that are part of one system
3. **Machine Identifier:** HA machine identification
4. **Internal Identifier:** Path to the topic
5. **Topic name:** name of the topic

The Prefix and the Machine Identifier should be available for modifications in the HMI under higher administrative permissions. For Internal identifier and topic name check Section 6.

Example of a topic that provides information about the cycle time of a station:

Prefix	rw
MachineIdentifier	H743
InternalIdentifier	station01
TopicName	cycleTime
Full Topic structure	rw/H743/station01/cycleTime

4.4 Last will message

When the connection is established, a **Last Will Message** is to be transmitted from the machine to the broker in which the machine status is displayed as “disconnected”.

The topic used should be **TriggerActive,** and here we should also see **the other states of the machine** which are mentioned under **section 2.2** in the following priority:

1. **connected:** Machine waiting for Trigger
2. **disabledTrigger:** Machine sends signals to MQTT with QoS but ignores Triggers
3. **disabledCommunication:** Machine works without MQTT broker
4. **disconnected:** Last will message

4.5 Topic data

The data content of the published topics should be in **JSON format**. The top object level should contain a **UTC timestamp** with the key “ts”. The timestamp is **generated when the object is created** and should correspond to the **ISO 8601** format (e.g. “2025-04-24T09:31:03.885Z”). The other two object levels should be the **data type of the value and the value itself**.

Examples:

{"ts":"2025-04-24T09:31:03.885Z","type":"number","unit": "s","value": 1.586}
{"ts":"2025-04-24T09:45:53.799Z","type":"object","value":{"active":true,"code":300501}}
{"ts":"2025-04-24T09:23:00.424Z","type":"string","value":"Automatic"}
{"ts":"2025-04-24T10:02:45.852Z","type":"string","value":true}

5 OPC UA

5.1 Network interface

HA does not host the OPC UA server, this should be hosted by the contractor locally on the machine while **HA will be a client**.

5.2 OPC UA server security and connections

The OPC UA server should be set up to make multi-client sessions possible. There will be a maximum of 5 connections at the same time. However, there should be some leeway in case additional connections need to be made later.

Unsecured connections are not allowed. The **minimum-security** requirement for any connection to the OPC UA server is an **authorization with username and password**.

5.3 OPC UA Node ID naming methodology

The node ID should consist of several components that together form a unique and descriptive identifier. The use of a TagName is mandatory. The structure can be defined as:

1. **Namespace:** A prefix that denotes the application or system namespace.
2. **SourceFolder:** The primary folder or module from which the tag originates.
3. **SubFolder:** Any sub-categories or sub-modules within the primary folder.
4. **TagName:** The specific tag or variable name.

Example of a tag that provides information on the cycletime of a station:

Namespace	ns=2
Source Folder	MES
SubFolder	Machine
Tag Name	CycleTime
Node ID	ns=2; s=MES.station01.CycleTime

6 Triggers

HA uses **triggers** to start certain events or behaviors within a machine.

1. **For MQTT:** this will be handled by using defined topics where the supplier must subscribe and make decisions based on the value that HA publishes in the topic

2. **For OPC UA:** this will be handled by using defined methods where the supplier must make decisions based on the value the methods are called with by HA

6.1 Standard triggers for all machines

Name	Input	Description
AutomaticRun	1.true/false (string)	**AutomaticRun** is controlling the machine, any **OperationMode besides Idle** must be completed with **AutomaticRun = true**. If **AutomaticRun = false**, the machine is **not allowed to start** its processes, if the machine is already in the middle of a cycle and AutomaticRun is set to false by HA, the machine **must do a soft stop** (complete the current cycle and stop)
OrderData	1.Article (string) 2.Quantity (number) 3.Order (string)	When the machine has multiple recipes, the correct recipe must be selected **automatically** based on Article value. **The quantity is a dynamic** value that can be **changed** during the current order, the supplier **must prepare all the necessary calculations** to **stop the feed in of the raw material based on the order quantity** and the number of stations on the machine at the beginning of every machine cycle. The order is just visual data.

6.2 Traceability level 3 triggers

As a standard, the first trigger (PartStart) is used to **acknowledge the scanned barcode**, the second one (PartFinish) is used to **acknowledge the safe storage of data from HA**. The exact behavior of the traceability level 3 triggers **needs to be discussed with HA to avoid cycle time increases** as this is heavily dependent on how the machine is being built up.

Name	Input	Description
PartStart	Barcode Response	The machine **must wait** for a response. If no response happens, a **timeout must trigger** after 10 seconds. If the **barcode input is not the expected barcode, an error must be shown.** **1.** If called true, the machine is allowed to work further **2.** If called false the part must be removed and the scanning process restarted on a different part
PartAcknowledge	Barcode Response	The machine **must wait** for a response. If no response happens, a **timeout must trigger** after 10 seconds. If the **barcode input is not the expected barcode, an error must be shown.** **1.** If called true, the machine is allowed to work further **2.** If called false, the part must be scrapped

7 Mandatory machine data

Depending on the project requirements, additional data points can be requested during the project review.

The contractor must provide a translation table for all error codes with their description and meaning (ex: 1234 = station 1 error 234).

MQTT -Topic name OPCUA – Tag name	MQTT – Internal Identifier OPCUA – SubFolder	Description
MachineMode	Machine	Automatic/Manual (defined by supplier)
OperationMode	Machine	Idle/SettingUp/StartUp/Productive/UnscheduledDown
TotalPartsOK	Machine	Total produced OK parts of lifetime
TotalPartsNOK	Machine	Total produced NOK parts of lifetime
TotalParts	Machine	Total produced parts of lifetime
TotalHours	Machine	Total hours of lifetime
SoftwareVersion	Machine	Actual installed software version on the machine, should be created automatically CRC
ActiveUserLevel	Machine	User currently logged in at the asset. (Operator, Maintenance, etc.)
ErrorID	Machine	Machine ErrorID (breakdown reason)
TriggerActive	Machine	Check section 4.4
TriggerAutomaticRun	Machine	Control bit for AutomaticRun Trigger (true/false)
TriggerWait	Machine	Should be true while machine is waiting for a trigger, false otherwise
Article	Machine	Current article set on the machine (ex. 908-123-545)
OrderNumber	Machine	Current order set on machine
Quantity	Machine	The quantity be produced for the current order, may be adjusted during the order by HA
CycleTime	Machine	The time between two parts (every time a part leaves the machine)
Recipe	Machine	Ex: measurement limits, additional explanations below

Recipe: Any value that can be changed by HA on the machine which is related to the article/recipe/machine setting must be visible in the data points. Since this is heavily dependent on the design of the machine, the supplier must define the structure of the data.

7.1 Traceability level 3

MQTT -Topic name OPCUA – Tag name	MQTT – Internal Identifier OPCUA – SubFolder	Description
Barcode	Parts	The scanned barcode
PartPrepared	Parts	Trigger for HA to read the Barcode data, if timeout is reached the value must be reset
FinishedBarcode	Parts	the part from the station where PartAcknowledge trigger is happening
Result	Parts	Information whether the FinishedBarcode part is OK or NOK
ErrorCode	Parts	The error code in case of NOK, If error code is not possible every station must send the quality bits from that station.
Protocol	Parts	Any measurement that is requested by the client (project specific)
FinishedPartPrepared	Parts	Trigger for HA to read the FinishedBarcode data, if timeout is reached the value must be reset

7.2 Multiple stations

In case the machine has multiple stations, we need the following information from each station.

MQTT -Topic name OPCUA – Tag name	MQTT – Internal Identifier OPCUA – SubFolder	Description
Protocol	Station[X]	Measurements performed by the station, can be multiple tags/topics
TotalPartsOK	Station[X]	Total OK parts of station X
TotalPartsNOK	Station[X]	Total NOK parts of station X
TotalParts	Station[X]	Total produced parts of station X
Active	Station[X]	Whether the station is active or not
Identifier	Station[X]	Identifier of the station, X can also be used
CycleTime	Station[X]	Should only account for the station's processing time
Result	Station[X]	The result from the part at station X
ErrorCode	Station[X]	The error code in case of NOK (scrap reason), If error code is not possible, all the quality bits of the station must be shown in the interface!
SerialNumber	Station[X]	Number of the current part at the station[X], ex: ordernumber+index Must be unique. Can also be defined by the supplier.
FeedingStation	Station[X]	Signal when the feeding station is running out of material, should also mention which one when multiple feeding stations are used

7.3 Dummy tests

In case the machine needs to make a dummy test for production release.

MQTT -Topic name OPCUA – Tag name	MQTT – Internal Identifier OPCUA – SubFolder	Description
DummyResult	Station[X]	The result from the dummy test
DummyData[x]	Station[X]	The measurements that are required to release the dummy test

7.4 Blisters

In case the machine uses blisters to store or deliver finished parts

MQTT -Topic name OPCUA – Tag name	MQTT – Internal Identifier OPCUA – SubFolder	Description
BlisterFinished	Station[X]	Signal when the blister is finished
BlisterNumberOfParts	Station[X]	Number of parts in the blister

7.5 Boxes

In case the machine uses boxes to store or deliver finished parts

MQTT -Topic name OPCUA – Tag name	MQTT – Internal Identifier OPCUA – SubFolder	Description
BoxFinished	Station[X]	Signal when the box is finished
BoxNumberOfParts	Station[X]	Number of parts in the box