Technical Delivery Specification

MC01 – Machine Connectivity

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This technical delivery specification, „MC01 – Machine Connectivity“ replaces all previous specifications.

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Department:	IT_SS_SF

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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).

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.

2 Overview Hirschmann Automotive ME-System

2.1 General

HA uses a custom MES solution that handles production operations, provides limited remote machine control through various communication protocols and handshakes, and collects machine data.

It also connects, monitors, and controls complex manufacturing systems and data flows on the factory shopfloor. The main goal of an MES is to ensure effective execution of the manufacturing operations and improve production output.

2.2 Operation modes

Production with MES at HA operates in distinct phases, defined as follows:

01.Enabled

Machine is ready for an order to be placed and loaded, there is nothing physically set up at this moment. Planned maintenance will also happen during this state.

02.Setting Up

We have a planned order that will be processed with this machine. All the physical and system requirements that are needed to check if the machine is ready for production will happen now (loading tools, scanning batches, feeding raw materials etc.)

03.Start Up

We are doing the initial sample parts which will confirm the quality, this is happening every time we produce on a new order or we need to confirm the quality again after a standstill or error and they are counted outside of the order as startup parts.

04.Productive

Normal productive mode where the machine is producing quality released parts

05.Teardown

The time when we need to unload the machine and prepare it for enabled state (take down PRTS, empty materials etc.). This state can be combined with setting up or not exist depending on the machine, number of article and the defined process

06.Unscheduled Down (Setup)

An interruption mode that appears the machine was in productive mode, but it’s stopped because of an error, operator break, MES downtime, network issues etc.

3 Connectivity Standards

3.1 General

HA uses OPC UA as a standard for shopfloor connectivity. This industry standard ensures secure communication between machines and upper-layer systems and specifies the transport of data, security mechanisms, and semantic structures.

To avoid additional workload for both parties involved, if the contractor is already using OPC UA as a standard for machine connectivity, this should be communicated to HA.

The machine should be capable of operating normally with or without MES logic (handshakes) and should allow seamless transition between the two modes based on user permissions available at the HMI.

In the non-fulfillment of this standard, the contractor must inform HA about this fact and declare available communication standards for machine connectivity and data exchange.

3.2 Network Interface

To facilitate the communication, the machine should have at least one free RJ45 port for this purpose. If more than one machine operates as an integrated system, each machine should have its own free RJ45 port.

To accommodate system configuration preferences, the RJ45 port should allow the assignment of a user-defined static IP address, which will be used to connect to the OPC UA server. This ensures alignment with organizational network policies. This implies that a PLC with a single network is insufficient to facilitate the connection to the OPC UA

3.3 OPC UA Server security and connections

The OPC UA server can be operated natively on the controller or by using additional software or hardware. HA does not host the OPC UA server, this should be hosted by the contractor while HA will be a client.

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 permissible. The minimum security requirements for any connection are:

- An authorization with username and password
- Security mode: SignAndEncrypt
- Security policy: Basic256Sha256

3.4 Translation table

The contractor must provide a translation table for all error codes with their description and meaning (ex: 1234 – station 1 error). If OPC UA is already used as a standard, the contractor must provide the documentation for the OPC UA server tags and methods.

3.5 Structure and design

The contractor is responsible for the general structure and the OPC UA server's design. The use of CamelCase is recommended. Spaces and special characters should be avoided. The adjacent parameters should be grouped into structures (folders).

3.6 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:

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

Example:

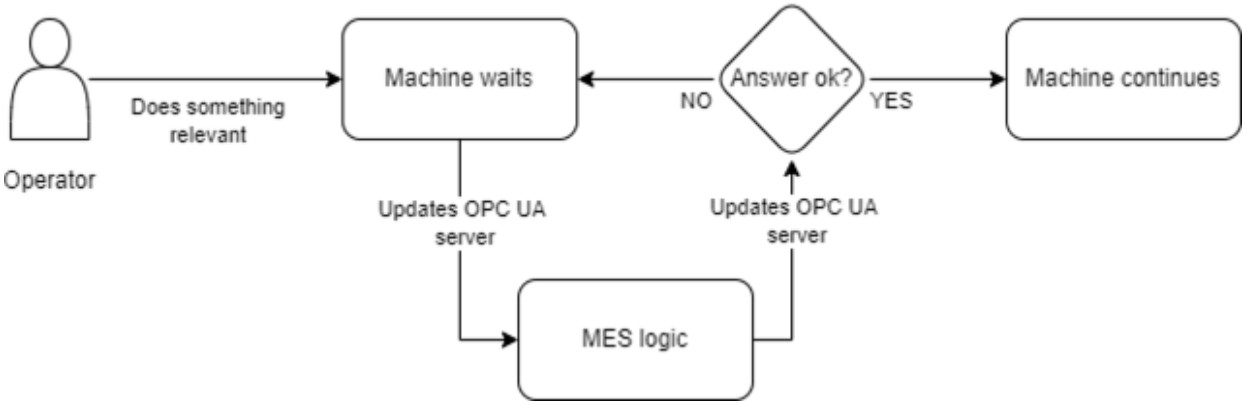
Tag that gives information on the drive speed of a motor	
Namespace	ns=2
Source Folder	MotorControl
Sub-Folder	Drive
Tag Name	Speed
Node ID	ns=2; s=MotorControl.Drive.Speed

4 OPC UA Server requirements

The general machine connectivity standards of HA are defined based on the technology used, the machine type, or the requirements of our customers. Any special or missing requirements form this TDS will be defined during the project review process.

4.1 Release mechanism

HA uses a release mechanism to control machines via the OPC UA communication which helps with controlling and monitoring the machine while ensuring the communication between the technology and the MES system is working properly and within parameters. Depending on the defined workflow of the machine, the trigger points are picked based on client requirements and physical processes with the goal to minimize increased cycle time coming from the additional logic.



4.2 Tags

Tags are defined as data points in an OPC UA server structure, which contains data from the source system and can be identified by a unique ID. Usually, the tags define the lowest level of the complete source system structure hierarchy.

Examples:

Name	Rights	Folder	Description
Timestamp	Read	Machine	Asset time
OperationMode	Read	Machine	Asset operation mode
TotalPartsOK	Read	Machine	Total produced OK parts of lifetime

The tags can change their values over a setup process or display a reaction to the machine's behavior.

4.3 Methods

HA uses methods to trigger certain events or behaviors within a machine (see section 4.1 on the release mechanism). If methods are unavailable, the contractor must communicate this to HA. In this case, an analog using data structures, tags and handshakes must be implemented to approximate the functionality of the methods.

The following methods should be made available:

Name	Input	Description
EnableAutomaticRun	Empty call	UNLOCKS the machine for production Changes the state of AutomaticRunEnable tag from 0 >1 Changes the state of OperationMode
DisableAutomaticRun	Empty call	LOCKS the machine for production Changes the state of AutomaticRunEnable tag from 1 >0 Changes the state of OperationMode
PartStart	boolean string (reason)	This method will say that parts that are ok to be processed If called true, 1. the machine will work further If called false, 1. the machine will do something depending on workflow 2. display reason on HMI
PartAcknowledge	boolean string (reason)	This method will say that parts were processed ok If called true, 1. the machine will work further If called false, 1. the machine will do something depending on workflow 2. display reason on HMI
SendShopOrderData	string (shopOrder number) string (article number) int (order quantity)	This will send the order data to the machine from MES Ideally the machine loads recipe based on the article we send from MES
OperationModeChange	boolean string (reason)	This method will acknowledge changes in the operation mode coming from the machine processes ex: (from dummy to startup parts)

5 Mandatory Machine Data

HA uses the following data points for machine connectivity. All this information is necessary to have a good overview over the machine status, performance, and efficiency, for the purpose of calculating KPI and monitoring shopfloor.

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

In the situation of machines that are situated outside of the normal production behavior (they are not producing parts) the mandatory data will be defined for the special case during the project review (ex. Guidance systems, camera systems, special machinery etc.).

Name	Rights	Folder	Description
Timestamp	Read	Machine	Machine time
OperationMode	Read	Machine	Current operation mode
TotalPartsOK	Read	Machine	Total produced OK parts of lifetime
TotalPartsNOK	Read	Machine	Total produced NOK parts of lifetime
TotalParts	Read	Machine	Total produced parts of lifetime
TotalHours	Read	Machine	Total hours of lifetime
SoftwareVersion	Read	Machine	Actual installed software version on the asset.
ActiveUserLevel	Read	Machine	Logged user at the asset. (Service, Admin, etc.)
ErrorID	Read	Machine	Unique ErrorID
ErrorDescription	Read	Machine	Error Description (when having an error, machine cannot work)
WarningID	Read	Machine	Unique WarningID
WarningDescription	Read	Machine	Warning Description (when having a warning, machine can still work)
MESActive	Read	Machine	Status for the MES logic if it is enabled or not at the machine
AutomaticRun	Read	Machine	Status for the Automatic run if it is enabled or not at the machine
Article	Read	Machine	Current article set on the machine (ex. 908-123-545)
Barcode	Read	NextPart	What was scanned, the unique identifier from the next part
PartPrepared	Read	NextPart	Information if the part is acknowledged or not
StartImpulse	Read	NextPart	When the start button is pressed, or the machine is trying to start
FinishedBarcode	Read	FinishedPart	What was scanned, the unique identifier from the last produced part
Result	Read	FinishedPart	Information whether the last produced part is OK or NOK
ErrorCode	Read	FinishedPart	The error code in case of NOK
Protocol	Read	FinishedPart	The protocol of the part, explanations below
FinishedPartPrepared	Read	FinishedPart	Information if the part is acknowledged or not

The machine protocol can become multiple tags depending on the machine, project, quality or client requirements. This should be discussed during project review regarding what measurements and part data that is required to be provided to HA.

All tags regarding barcode data are not relevant if the machine is not designed to produce or work with barcodes or part identifiers.

5.1 Multiple stations

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

Name	Rights	Folder	Description
Station[x]Protocol	Read	Station	Tied to the product protocol, can be multiple tags
Station[x]TotalPartsOK	Read	Station	Total OK parts of station x
Station[x]TotalPartsNOK	Read	Station	Total NOK parts of station x
Station[x]TotalParts	Read	Station	Total produced parts of station x
Station[x]Active	Read	Station	If the station is active or not
Station[x]Identifier	Read	Station	Identifier of the station, x can also be used
Station[x]Consumption	Read	Station	If there is material consumption at this station
Station[x]Result	Read	Station	The result from the part at station x
Station[x]ErrorCode	Read	Station	The error code in case of NOK

5.2 Dummy tests

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

Name	Rights	Folder	Description
DummyResult	Read	Dummy	The result from the dummy test
DummyRetests	Read	Dummy	How many dummy retests have been done
DummyData[x]	Read	Dummy	The measurements that are required to release the dummy test

5.3 Feeding Stations

In case the machine has feeding stations that can be monitored.

Name	Rights	Folder	Description
AllFeedingStationsReady	Read	FeedingStation	Signal for when all stations are ready
FeedingStation[x]Identifier	Read	FeedingStation	Identifier of the feeding station
FeedingStation[x]Ready	Read	FeedingStation	Signal when feeding station x is ready
FeedingStation[x]Empty	Read	FeedingStation	Signal when feeding station x needs to be refilled

5.4 Blisters

In case the machine uses blisters to store finished parts

Name	Rights	Folder	Description
BlisterFinished	Read	Blister	Signal when the blister is finished
BlisterNumberOfParts	Read	Blister	Numbers of parts in the blister

5.5 Boxes

In case the machine uses boxes to store finished parts

Name	Rights	Folder	Description
BoxFinished	Read	Blister	Signal when the box is finished
BoxNumberOfParts	Read	Blister	Numbers of parts in the box