

Device for a secure data connection
of at least one manufacturing machine

The invention relates to a device for a secure data connection of at least one manufacturing machine and a manufacturing machine having such a device and a production plant having several such manufacturing machines.

- 5 In production companies, manufacturing machines are regularly integrated into an operational process based on the "automation pyramid" known from the state of the art, which is subdivided into different levels and which permits information to be transferred only in the vertical direction of its levels, wherein any information exchanged
- 10 with external service providers happens via the highest level of the pyramid, i.e. at the enterprise resource planning (ERP) level. As a part of "Industry 4.0", however, a direct connection of manufacturing machines to external data processing devices, such as computers of a cloud (cloud computing) or, with regard to the company operating the machine, to
- 15 computers of other companies, is increasingly desired at the individual levels of the automation pyramid in the horizontal direction, without including further levels of the pyramid. However, in the case of such a direct connection of a manufacturing machine to an external data processing facility, means must be provided to protect the manufacturing
- 20 machine from access by third parties.

From US 2015/0106912 A1 a device for a secure data connection of at least one manufacturing machine to an external (with respect to the manufacturing machine and with respect to the company operating the manufacturing machine) data server is known, having a controller formed

as an integral component of the manufacturing machine, wherein on said controller software for data processing of the machine data of the manufacturing machine, in particular for buffering, forwarding and/or compression, is implemented, and wherein said controller is connected
5 via an external (with respect to the manufacturing machine) firewall to a machine network, in which a plurality of manufacturing machines are provided, wherein said machine network via a further external (with respect to the relevant manufacturing machine) firewall is connected to the external data server, which is connected to the Internet.

10 Access control to the controller of the manufacturing machine, for the remote servicing for troubleshooting by an expert via the Internet, in one exemplary embodiment is implemented by an encryption and in a further exemplary embodiment by an upload of the machine data from the controller, without any data backflow, solely in the direction of the
15 expert's company-external computer, wherein the upload of data denotes the transfer of data from a local computer or storage medium to a computer or storage medium remote from the local computer or storage medium.

An alteration affecting the machine control, such as a write access to the
20 controller of the manufacturing machine, originating from an external (with respect to the manufacturing machine and/or to the company operating the machine) computer, wherein said alteration may have adverse effects on the product manufactured by the machine, cannot be completely ruled out by the known solution, e.g. because of a security
25 gap, a software or hardware error (Spectre and Meltdown) and/or a flawed configuration of the firewalls.

Starting from this prior art, the invention addresses the problem of further improving the known solution such that the operational safety of the manufacturing machine is increased.

This problem is solved by a device for a secure data connection of at least
5 one manufacturing machine, according to the invention, having the features of patent claim 1.

According to claim 1, the device according to the invention has a system that is subdivided into individual zones interconnected by data diodes such that data originating from the machine control of the manufacturing
10 machine in a data flow can be transferred to other zones without the possibility of data backflowing, wherein said zones, ordered hierarchically, each have a lower level of data security than the upstream zone with respect to the data flow, and that every zone is formed as an independent computer in the manner of an isolated application.

15 The design of every zone in the manner of an island solution as an independent computer is defined as every computer being independently functional with regard to its hardware and software and being formed to be separate from the other computers at the hardware and software level, in particular spaced apart.

20 The information processing system is divided into zones, each of which is formed as an independently functioning computer in terms of software and hardware. By separating the zones at the software and hardware levels, an extremely effective access control can be set up in terms of security for read and/or write access of external (with regard to the
25 manufacturing machine) data processing devices to the data originating from the machine control of the manufacturing machine.

In concrete terms, different zones of the information processing system having different levels of data security, i.e. data criticality, can be defined, which can be used to grant access rights in the form of either read and write access or read-only access to an individual external (with respect to the manufacturing machine) data processing device, in accordance with the data security of the individual zone connected to the data processing device. Thus, in the case of access of a data processing device to the zone having the highest level of data security, the data originating from the machine control of the manufacturing machine can be both changed in the sense of a write access and readable, and in the case of access to a zone having lower level of data security in relation to this zone, because of data transmission without any data return flow, i.e. unidirectional data transmission, from the zone having the highest level of data security in the direction of the zone having lower level of data security in relation thereto, the data can be read only and cannot be changed in the sense of a write access, i.e. is immutable by means of a write access.

As a result, a respective zone, subordinate to the zone having the highest level of data security and having a lower level of data security in relation to the latter, can be connected to an external data processing device without the possibility of write access to the data of the zone having the highest level of data security, originating from the machine control of the manufacturing machine. This increases the operational reliability of the manufacturing machine.

In a preferred exemplary embodiment, the first zone downstream of the machine control can, as the production zone, process at least machine data of the manufacturing machine and forward them to a monitoring zone and/or a service zone as the respective downstream zone, wherein

said machine data can be forwarded to an company-internal or external network, such as the Internet. In this case, the respective network is formed as an company-internal or a (company-)external network, with regard to the company operating the manufacturing machine.

- 5 By data transmission can the production zone of the one machine control is connected to machine controls of other manufacturing machines within a production plant.

- The production zone permits at least one of the data processing
10 operations listed below: Data processing of data of the manufacturing execution system (MES) of a manufacturing management system and/or data processing of data collected over a period of time, and/or generation of production logs and/or reports. The MES is a process-related level of a manufacturing management system or production
15 control system that can be represented schematically by the automation pyramid known from the state of the art. Here, the production management system or production control system is based on the product produced by the manufacturing machine.

- 20 The monitoring zone may permit at least one of the data processing operations listed below: Generating a data overview of a manufacturing machine, and/or detecting trends, and/or recording the operating state of the machine.

- 25 The service zone may permit at least one of the data processing operations listed below: Data processing of maintenance data, and/or recording the machine operating state, and/or performing remote diagnostics.

Data transmission between the individual manufacturing machines of a production plant can at least permit the transmission of the data listed below: Data of the Manufacturing Execution System (MES) of the
 5 manufacturing management system, and/or data collected over a period of time.

The company-internal network may at least permit the transmission of the data listed below: Data to generate an overview of multiple
 10 manufacturing machines, and/or data of mobile devices.

The external network can, preferably involving the cloud, at least permits the transmission of data for maintenance scheduling, and/or a creation of directories and/or documentation records and/or a link between real
 15 machine data and documentation in the cloud. This applies in particular to services offered by the machine manufacturer. Further applications are e.g. machine monitoring or predictive maintenance.

The respective data diode used between the individual zones having their
 20 computer units can be formed by a laser diode, which is used for light generation, and a photo diode, which is used for light detection of the generated light.

The zones, at least partially interconnected in parallel, can be connected in series with the first zone with respect to the data flow, and/or can be at
 25 least partially connected in series, starting from the first zone.

Every zone can comprise on the input end at least one protocol converter for protocol conversion and coupling of a data transfer protocol that can

be transmitted by means of the data diodes to a data transfer protocol that can be processed by the zones and/or can comprise on the output end at least one further protocol converter for protocol conversion and coupling of a data transfer protocol that can be processed by the zones
5 to a data transfer protocol that can be transmitted by means of the data diodes.

The computers can be formed identically, in particular with regard to their hardware and/or operating software, and can be configured for their intended use, in particular by means of application software, in
10 accordance with the individual zone.

A data diode may be formed by a transmitting unit, which is part of a respective zone, and a receiver unit, which is part of a zone having a lower level of data security in relation to that zone, wherein a data transmission means is used to interconnect the transmitting unit and the
15 receiver unit.

The transmitting unit may be formed as a transmitting data diode comprising a laser diode and, in particular, a multiplexer and a modulator, wherein the receiver unit may be formed as a receiving data diode comprising a photo diode and, in particular, a demodulator and a
20 demultiplexer, and wherein the transmitting unit and the receiver unit are interconnected via the data transmission means in the form of an optical fiber cable.

According to claim 16, the subject matter of the invention is also a manufacturing machine having, as an integral part thereof, a device
25 according to any one of the preceding claims. The solution according to the invention is particularly suitable for use in blow molding, filling and

sealing machines. These are regularly used in the chemical-pharmaceutical and food industries.

According to claim 17, the subject matter of the invention is also a production plant comprising a plurality of manufacturing machines
5 according to claim 16.

The device according to the invention can be used to particular advantage in companies in which a manufacturing machine must meet above-average safety requirements due to mandatory official regulations.

In such a case, for any change affecting the machine, a producer
10 operating the manufacturing machine has to demonstrate that a particular change affecting the machine will not have any adverse effects on the product produced by the machine. Such a change can be, for instance, a connection of the machine to an external data processing device or an installation of an application software on the controller, i.e.
15 the industrial control system, of the machine.

In addition, on the basis of the regulatory requirements the software services running on the controller of the machine, i.e. the various types of application software, depending on whether they relate to components and processes of the machine that have to be validated or are validated
20 or do not have to be validated, are classified as Good Manufacturing Practice (GMP)-relevant software services subject to regulatory requirements or as non-GMP-relevant software services hardly subject to regulatory requirements, wherein write access by non-GMP-relevant software services to validated components or processes of the machine
25 must be precluded mandatorily.

Therefore, in such "regulated companies", after any such alteration the components and processes of the machine affected by these changes have to be validated based on test procedures and risk assessments, which is time-consuming and costly. However, even such test procedures
5 or risk assessments cannot completely rule out adverse effects on the product manufactured by the machine because of access to the controller of the manufacturing machine from an external (with regard to the manufacturing machine) data processing device or because of newly installed application software.

10 Based on the design of the device according to the invention validation processes in the form of risk assessments and/or test procedures are at least partially eliminated, because the zone subordinate to the zone having the highest level of data security and having a lower level of data security in relation to it, can be connected to an external data processing
15 device, without the possibility of write access to the data, originating from the machine control of the manufacturing machine, of the zone having the highest level of data security, and because the GMP-relevant application software can run in a zone having a higher level of data security and the non-GMP-relevant application software can run in a
20 zone having a lower level of data security.

As a result, when the device according to the invention is used in combination with a manufacturing machine subject to official regulations, modifications affecting the manufacturing machine can be performed simply and inexpensively, in particular with regard to the connection of
25 the manufacturing machine to external data processing equipment and/or the implementation of application software for the manufacturing machine, while complying with the relevant official safety requirements.

Below, the device, according to the invention, for the secure data connection of at least one manufacturing machine is explained in more detail with reference to the drawing. In the figures, in general view, not to scale,

- 5 Fig.1 shows a schematic block diagram of a device for the secure data connection of at least one manufacturing machine, known from the prior art;
- Fig. 2 shows a schematic block diagram of a device for the secure data connection of at least one manufacturing machine, according to the invention; and
- 10 Fig. 3 shows a schematic block diagram of the data flow of the device according to the invention of Fig. 2 from an application software implemented on one zone to an application software implemented on another zone.
- 15 Fig. 1 shows a schematic block diagram of the device, known from the prior art (US 2015/0106912 A1), for connecting at least one manufacturing machine 4 to an external (with regard to the manufacturing machine 4 and with regard to the company 6 operating the manufacturing machine 4) data processing device in the form of a
- 20 data server 8. The device comprises a controller 10, i.e., the controller of the machine, which is formed as an integral part of the manufacturing machine 4 and on which software 14 for data processing of the machine data of the manufacturing machine 4, in particular for buffering, forwarding and/or compressing, is implemented and which is connected
- 25 to an company-internal machine network 18 via a firewall 16, which is external with respect to the manufacturing machine 4 and company-

internal with respect to the company operating the manufacturing machine. In the company-internal machine network 18 a plurality of manufacturing machines 4 are provided and the company-internal machine network 18 is connected to the company-external data server 8 via a further company-internal firewall 20 and via a company-external network 22. The network 22 can be connected to a remote service not shown in the figures by means of the Internet 24, wherein in the context of a remote service an expert working remotely from the company operating the manufacturing machine troubleshoots the manufacturing machine by means of a computer via the Internet 24.

Access control to the controller 10 of the manufacturing machine 4 for performing the remote service is implemented by encrypting or uploading the machine data from the controller 10 solely towards the company-external computer of the expert, without any data backflow.

Fig. 2 shows a schematic block diagram of a device according to the invention, which can be designated as a multi-zone computing platform, for connecting at least one manufacturing machine 104 to external (with respect to the manufacturing machine 104) data processing devices not shown in the figures. The manufacturing machine 104 may be manufactured and delivered in conjunction with the device as an integral part of the manufacturing machine 104, or it may be subsequently equipped with the device after the manufacturing machine 104 has been delivered.

The device according to the invention has an information-processing system 114 divided into three individual zones 108, 110, 112 (Fig. 2) in the form of computers, wherein every computer is independently

- functional in terms of its hardware and software and is formed to be separate at the hardware and software level, and, in particular spatially, separated from the computers of the other zones 108, 110, 112. In addition, the computers correspond to each other in terms of their
- 5 hardware and their operating software and can each be configured for use as intended in accordance with the individual zones 108, 110, 112 by means of application software 122, 124 (Fig. 3) (Application Software, App). The application software 122, 124 may be used, for instance, for data conversion, data processing, or data forwarding.
- 10 A first zone 108 (Fig. 2) is connected to the machine control 118 of the manufacturing machine 104 via a data link 116, in particular a bidirectional data link 116, and is used to process data transmitted by the machine control 118 via the data link 116. In addition, the first zone 108 may be connected, in particular bidirectionally, to the machine control of
- 15 at least one other manufacturing machine via a network, wherein all manufacturing machines connected to the first zone 108 via the network are provided within a production plant. In addition, in the sense of a series connection, the first zone 108 is connected to a second zone 110 and the second zone 110 is connected to a third zone 112 by one
- 20 unidirectional data link each, in the form of a data diode 120, whereby the direction of the data flow of the machine control data 118 located in the first zone 108 from the first zone 108 to the second zone 110 and from the second zone 110 to the third zone 112 is predetermined, wherein a backflow of data from the third zone 112 into the second zone
- 25 110 and/or from the second zone 110 into the first zone 108 is completely precluded. In the direction of the data flow, the zones 108, 110, 112, starting from the first zone 108 having the highest level of data security, i.e. data criticality, arranged in a hierarchically descending

manner, each have a lower level of data security than the at least one upstream zone 108, 110 with respect to the data flow, such that the last zone of the hierarchically descending series circuit, i.e., the third zone 112 in Fig. 2, has the lowest level of data security.

- 5 Every zone 108, 110, in particular a transmitting unit 128 (Fig. 3) of the respective zone 108, 110, comprises at least one configurable filter module on the output end, which provides at least one predefinable, unfiltered subset of a data quantity of the respective zones 108, 110 for transmission by means of the respective data diode 120 to a zone 110, 112 having a low level of data security. The filter module can be used to select which data may leave a respective zone 108, 110 and be made available to the downstream zone having the lower level of data security.

- Fig. 3 shows schematically in a principal block diagram the data flow from a respective zone 108, 110 to another zone 110, 112 of the device
- 15 according to the invention, on each of which different types of application software 122, 124 are implemented. The data processed by respective application software 122, 124 implemented in the zone 108, 110 having the higher level of data security is first transmitted to one of a plurality of protocol converters 126 provided in this zone 108, 110,
 - 20 wherein said protocol converters 126 serves for protocol conversion and coupling of a data transfer protocol that can be processed by the zone 108, 110 having the higher level of data security to a data transfer protocol that can be transmitted by means of the data diode 120. The protocol-converted data are transferred from the protocol converter to a
 - 25 transmitting unit 128, provided in the zone 108, 110 having the higher level of data security, of the data diode 120, which has a multiplexer 130, the output end of which is connected to a modulator 132 of the

transmitting unit 128, wherein said modulator 132 transfers the modulated data to a laser diode 134 included in the transmitting unit 128 to generate a light signal.

The multiplexer 130 is provided by the layer 2a in the form of the MAC (Media Access Control) layer according to the OSI model (Open System Interconnection Model) known from the prior art, wherein said layer may additionally comprise a data flow control system and is part of the layer 2 in the form of the data link layer according to the OSI model. The multiplexer 130 can be used to transmit the data, provided by the protocol converters 126, in the form of corresponding different data streams via a single channel in the form of the data diode 120. The modulator 132 is provided by the layer 1 in the form of the physical layer according to the OSI model and is used to encode the data present digitally in the zones 108, 110 having the higher level of data security, into modulated analog data that can be transmitted using the data diode 120. The laser diode is part of an Ethernet transceiver, e.g. SFP (Small Form-Factor Pluggable) or SFP+, which is used as an optical fiber network interface and whose data receiving port Rx is blocked.

The zone 110, 112 having the lower level of data security (Fig. 3) has a receiver unit 136 of the data diode 120, which is connected to the transmitting unit 128 of the zone 108, 110 having the higher level of data security by a data transmission means 138 in the form of an optical fiber cable 140, which transmits the light signal comprising data and emitted from the laser diode 134 of the transmitting unit 128 to the receiver unit 136 of the data diode 120, which comprises a photo diode 142 for detecting the light signal. In addition, the receiver unit 136 has a demodulator 144, into which the data stream received from the photo

diode 142 is input at the input end and which passes the demodulated data at the output end to a demultiplexer 146 of the receiver unit 136, which on the output end transmits the data processed thereby to at least one protocol converter 126, in each case for protocol conversion and
 5 coupling of the data transfer protocol that can be transmitted by means of the data diode 120 to the data transfer protocol that can be processed by the zone 110, 112 having the lower level of data security. Every protocol converter 126 provides the converted data to various types of application software 122, 124 for further processing.

10 The photo diode 142 is part of an Ethernet transceiver (e.g. SFP or SFP+) that serves as an optical fiber network interface and whose data transmitting port Tx is blocked. The demodulator 144 is provided by the physical layer according to the OSI model and is used to decode the modulated analog data that can be transmitted by the data diode 120
 15 into digital data that can be processed by the zone 110, 112 having the lower level of data security. The demultiplexer 146 is provided by the MAC layer according to the OSI model and is used to separate the data streams combined by the multiplexer 130 of the transmitting unit 128.

In Fig. 2, the first zone 108 is a production zone, the second zone 110 is a
 20 monitoring zone, and the third zone 112 is a service zone.

The MES interface 148 of the production zone 108 (Fig. 2) can be connected via an company-internal (with respect to the company operating the manufacturing machine 104) manufacturing network 150, e.g. via a local area network (LAN), to a computer of the manufacturing
 25 execution system (MES) 152 of the manufacturing management system for managing the production of the product manufactured by means of

the manufacturing machine 104 and/or the database interface 154 of the production zone can be connected via the manufacturing network 150 to a computer of a data storage device 156, on which machine data collected over a period of time, in particular a long period of time, are stored or buffered and from which they can be retrieved. The MES 152 can be used to automatically control several manufacturing machines 104 of a production plant at the same time, permitting the production process to be streamlined and human errors, such as typing errors, to be minimized. Setpoints, process values, alarms, and/or events can be stored on the data storage device 156 for long-term storage, or data can be buffered, in particular using OPC Historical Data Access (HDA), for a short time. In addition to processing data from the machine control, the production zone 108 is used to forward such data to the computer of the MES 152 and/or to the computer of the data storage device 156, and to process data transmitted from the computer of the MES 152 and/or from the computer of the data processing device 156. Data processing includes the generation of production logs 174 and reports 174.

The monitoring zone 110 (Fig. 2) can be connected via a company-internal (with respect to the company operating the manufacturing machine 104) office network 158, for instance via a further local area network (LAN) to a computer, on which a data overview 164 of data of all manufacturing machines 104 of the production plant can be generated, and/or to mobile terminals 162, for instance a tablet, a laptop and/or a smartphone. The monitoring zone 110 (Fig. 2) is used to generate a data summary 160 of the data of a manufacturing machine 104 to detect trends 178, and to record the operating state 176 of the manufacturing machine 104, each computed from data transmitted from the machine control 118 of the manufacturing machine 104 to the monitoring zone

110. Using the data summary 160, the efficiency of the manufacturing machine 104 can be monitored and less efficient components can be identified. In addition, a particularly good overview of the manufacturing machine 104 can be obtained by means of the data overview 160 when
 5 the key performance indicators are displayed. The browser of the terminal devices 162 can be used to access the data overview 160.

The service zone 112 (Fig. 2) can be connected via an external network 166, for instance via a wide area network (WAN), preferably via the Internet, particularly preferably using cloud computing, to a computer for
 10 creating a directory 168 and/or a documentation 168, and/or via the external network 166 by means of a maintenance interface 170 to a computer of the manufacturer 172 of the manufacturing machine. The directories 168 and/or documentation 168 can be located in the cloud (cloud computing) and can include lists of spare parts of the
 15 manufacturing machine 104. The documentation 168 includes technical information about the manufacturing machine 104 and its associated components, in particular the device according to the invention. The service zone 112 is used to record the operating state 176 of the manufacturing machine and/or to perform remote diagnostics 180. The
 20 machine manufacturer can provide the producer with troubleshooting assistance within the framework of remote diagnostics 180.

Example applications of the device according to the invention and its advantages are discussed in more detail below:

Remote diagnosis: By introducing a service zone 112, the machine
 25 manufacturer 172 can provide remote diagnostics 180, which does not impose any additional risk or validation burden on the producer. In this

case, access by the manufacturer 172 is limited to a subset of the data from the service zone 112 by means of the data filter.

Machine optimization: By introducing a service zone 112 in the manufacturing machine 104, usage data of the machine 104 can be
 5 recorded and transmitted to the machine manufacturer 172. These data can be used as a basis for further developments and improvements of the machine manufacturer 172. It can be used to better adapt future machine generations to the actual usage behavior of customers.

Efficiency Data Record: The formation of different zones 108, 110, 112
 10 permits the efficiency data to be made available on the office network 158 or a cloud service. The recording of efficiency data of production lines and machines 104, e.g. Overall Equipment Effectiveness (OEE), permits the producer to evaluate process changes and identify improvement potentials. In particular, the recording of key figures is not
 15 necessarily GMP-relevant. Thus, the key figure recording does not require write access to the production zone 108, but only to the relevant information. In this respect, the key figures can be acquired and evaluated in a separate zone 110, 112.

Scheduling maintenance: Setting up of different zones 108, 110, 112
 20 permits runtime information to be provided, improving the scheduling of maintenance work. For instance, the scheduling of maintenance activities on a manufacturing machine 104 ideally requires data on the operating time or cycles of operation of individual components or assemblies, e.g. a valve has to be replaced after a certain number of switching cycles or a
 25 seal after a certain number of operating hours. On the one hand, the machine manufacturer 172 can use runtime information to prepare

deliveries of spare parts even before the producer orders them or to inform the producer about upcoming maintenance work; on the other hand, the producer can use such information to arrange a more efficient maintenance schedule.

- 5 Predictive Maintenance: The data-supported analysis of machine data, e.g. the switching time of valves, based on different zones 108, 110, 112 can be used to estimate when a component has to be replaced. For this purpose, the device permits local processing in a non-production zone, i.e., the monitoring zone 110 or the service zone 112. Additionally, the
10 corresponding application software 122, 124 (Fig. 3) can be coupled to external services.

- Pre-validation of application software: Because of the different zones 108, 110, 112 newly installed application software 122, 124 (Fig. 3) can be run in a non-production zone, e.g. in the monitoring zone 110 or in the
15 service zone 112, in parallel with the application software 122, 124 used, wherein the software 122, 124 is supplied with identical production data in both zones 108, 110, 112, which can be used to check whether the newly installed application software 122, 124 provides the same results as the application software 122, 124 already implemented. In this way, tests
20 whether the newly installed application software 122, 124 is a hazard to the integrity, safety and/or productivity of the production plant can be conducted during operation.

- Production logs: The different zones 108, 110, 112 can be used to generate logs 174 (Fig. 2) and reports 174 in the monitoring zone 110 or
25 in the service zone 112, because processing production information, e.g.

the generation of production logs 174, does not require access to the production zone 108, only to machine data.

GMP Documentation: By separating the GMP-relevant and the non-GMP-relevant software 122, 124 into different zones 108, 110, 112, the scope
5 of the required GMP documentation can be reduced to the GMP-relevant software 122, 124 in the production zone 108.

Secure connection of alarms via insecure networks 166: The device permits alarms, status messages and other information to be sent directly to end devices 162, such as tablets, laptops and/or smartphones, via, in
10 particular, insecure networks 166, such as the Internet and/or mobile networks, without any security risk to the producer.

Claims

1. A device for a secure data connection of at least one manufacturing machine (104), having an information-processing system (114), which is subdivided into individual zones (108, 110, 112)
5 interconnected by data diodes (120) such that data originating from the machine control (118) of the manufacturing machine (104) in a data flow can be transferred to other zones (108, 110, 112) without the possibility of a data return flow, wherein said zones (110, 112), ordered hierarchically, each have a lower level of data security than
10 the upstream zone (108, 110) in relation to the data flow, and in that every zone (108, 110, 112) is formed as an independent computer in the manner of an isolated application.
2. The device according to claim 1, characterized in that the first zone (108) downstream of the machine control (118), as a production
15 zone, processes at least machine data of the manufacturing machine (104) and forwards them to a monitoring zone (110) and/or a service zone (112) as the respective downstream zone, wherein said machine data can be forwarded to an company-internal (150, 158) or external network (166), such as the Internet.
- 20 3. The device according to claim 1 or 2, characterized in that by data transmission (116) the production zone (108) of the one machine control (118) is connected to machine controls of other manufacturing machines within a production plant.

4. The device according to any one of the preceding claims,
characterized in that the production zone (108) permits at least one
of the data processing operations listed below:
- data processing of data (152) of the manufacturing execution
5 system of a manufacturing management system,
 - data processing of data (156) collected over a period of time,
 - generation of production logs (174) and/or reports (174).
5. The device according to any one of the preceding claims,
10 characterized in that the monitoring zone (110) permits at least one
of the data processing operations listed below:
- generating a data overview (160) of a manufacturing machine
(104),
 - detecting trends (178),
 - 15 - recording of the operating state (176) of the machine.
6. The device according to any one of the preceding claims,
characterized in that the service zone (112) permits at least one of
the data processing operations listed below:
- 20 - data processing of maintenance data,
 - recording the machine operating state (176),
 - performing remote diagnostics (180).
7. The device according to any one of the preceding claims,
25 characterized in that the data transmission between the individual
manufacturing machines of a production plant permits at least the
transmission of the data listed below:
- data of the manufacturing execution system (152) of a
manufacturing management system,

- data (156) collected over a period of time.
8. The device according to any one of the preceding claims,
characterized in that the company-internal network (158) permits at
5 least the transmission of the data listed below:
- data to generate a data summary (164) of multiple
manufacturing machines (104),
 - mobile device data (162).
- 10 9. The device according to any one of the preceding claims,
characterized in that the external network (166), preferably including
the cloud, permits at least the transmission of data for
- maintenance scheduling and/or
 - a creation of directories (168) and/or documentation documents
15 (168) and/or
 - a link between real machine data and documentation in the
cloud.
- 20 10. The device according to any one of the preceding claims,
characterized in that the respective data diode (120) used between
the individual zones (108, 110, 112) having their computer units is
formed by a laser diode (134), which is used for light generation,
and a photo diode (142), which is used for light detection of the
generated light.
- 25 11. The device according to any one of the preceding claims,
characterized in that the zones (110, 112) at least partially
interconnected in parallel, are connected in series with the first zone

(108) with respect to the data flow, and/or are at least partially connected in series, starting from the first zone (108).

12. The device according to any one of the preceding claims,
characterized in that every zone (108, 110, 112) comprises on the
5 input end at least one protocol converter (126) for protocol
conversion and coupling of a data transfer protocol that can be
transmitted by means of the data diodes (120) to a data transfer
protocol that can be processed by the zones (108, 110, 112) and/or
on the output end comprises at least one further protocol converter
10 (126) for protocol conversion and coupling of a data transfer
protocol that can be processed by the zones (108, 110, 112) to a
data transfer protocol that can be transmitted by means of the data
diodes (120).
13. The device according to any one of the preceding claims,
15 characterized in that the computers are formed identically, in
particular with regard to their hardware and/or operating software,
and can be configured for the intended use, in particular by means
of application software (122, 124), in accordance with the individual
zone (108, 110, 112).
- 20 14. The device according to any one of the preceding claims,
characterized in that a data diode (120) is formed by a transmitting
unit (128), which is part of a respective zone (108, 110, 112), and a
receiver unit (136), which is part of a zone (110, 112) having a lower
level of data security, wherein a data transmission means (138) is
25 used to interconnect the transmitting unit (128) and the receiver
unit (136).

15. The device according to any one of the preceding claims,
characterized in that the transmitting unit (128) is formed as a
transmitting data diode comprising a laser diode (134), and, in
particular, a multiplexer (130) and a modulator (132), in that the
5 receiver unit (136) is formed as a receiving data diode comprising a
photo diode (142) and in particular a demodulator (144) and a
demultiplexer (146), and in that the transmitting unit (128) and the
receiver unit (136) are interconnected via the data transmission
means (138) in the form of an optical fiber cable (140).
- 10 16. A manufacturing machine having a device according to any one of
the preceding claims as an integral part thereof.
17. A production plant comprising a plurality of manufacturing
machines according to claim 16.