

Rules and Standards for Implementation

MEDIBUS.X

WARNING

For a full understanding of this software protocol, the user should carefully read this document as well as the instructions for use of the basic device.

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Safety information definition

NOTE

A NOTE provides additional information intended to avoid inconvenience during operation.

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Introduction

Document history

Edition	Changes
Edition 4	Definitions have been added that allow to derive the device type from a device identification number. All existing MEDIBUS.X responders comply with these definitions.
Edition 3	Besides editorial changes the following clarifications of existing requirements have been added: dealing with measurements during device standby, dealing with unit conversion, dealing with nomenclature, dealing with data precision. References to legacy MEDIBUS data have been removed where possible to avoid misinterpretation. Note: This edition is backward compatible to edition 2, i.e. devices complying to the requirements defined within edition 2 still comply to the requirements in edition 3.
Edition 2	Editorial changes.
Edition 1	Initial version.

Overview

This document specifies the Common MEDIBUS Device Profile MEDIBUS.X.

In the past, different MEDIBUS Device Profiles for different devices or device families have been maintained.

Over time, this has led to slight differences between the different device profiles when it comes to the meaning of some of the MEDIBUS codes used.

A receiver capable of processing MEDIBUS responses from different devices has to deal with those differences to prevent misinterpretation of the data.

One approach is to keep a positive list of those devices the receiver is aware of.

Consequently, introducing new devices into the market is often accompanied by broken or limited connectivity in the established network infrastructure of a hospital.

To avoid these types of limitations in the future, this document specifies a common MEDIBUS Device Profile that can be used by any device to express its state via MEDIBUS.

This common MEDIBUS device profile is called MEDIBUS.X.

Intended use

The specification applies to all devices that want to comply with MEDIBUS.X.

This document specifies rules to which a device has to comply, if it implements MEDIBUS.X.

References

"Dräger RS 232 MEDIBUS Protocol Definition" (order no. 9028258, 11th edition - September 2010 or later)

"MEDIBUS.X, Profile Definition for Data Communication" (order no. 9052608, 11th edition - March 2015 or later)

Definitions, acronyms, and abbreviations

Abbreviation	Explanation, Definition
Device Profile	Defines the MEDIBUS commands that a device is able to process, the MEDIBUS codes that a device sends and the meaning of these codes.
Regulated command	MEDIBUS command for which MEDIBUS.X specifies rules and requirements.
Commander	A device sending MEDIBUS commands.
Responder	A device sending MEDIBUS responses.
Compliant commander	A commander that complies with MEDIBUS.X
Compliant responder	A responder that complies with MEDIBUS.X

NOTE

MEDIBUS is a symmetrical protocol. A device may (and for some elementary commands like ICC (order to initialize) has to) act both as responder and as commander.

The typical use case for MEDIBUS usually involves a therapy device that is (except for communication establishment and upholding of the connection) waiting for a MEDIBUS command before sending an appropriate response.

On the other side is a device, usually a monitor or an IT tool, which collects and aggregates data from one or more sources.

This device repetitively sends the MEDIBUS commands, which request status and data information from the other device, and processes the responses.

Due to this standard use case, the assumption would be that the monitor represents the commander whereas the therapy device represents the responder.

This assumption needs not to be true. As a matter of fact, the monitor and the therapy device can play both roles, but usually with a different emphasis.

Nevertheless, it is important to respect that a therapy device may send MEDIBUS commands. This requires the other device to act as a compliant responder.

This document uses the same style as the "Dräger RS 232 MEDIBUS Protocol Definition" for documenting the structure of MEDIBUS commands and responses.

In this document, the auxiliary verb:

- "shall" means that compliance with a requirement is mandatory for compliance with this document
- "should" means that compliance with a requirement is recommended, but is not mandatory for compliance with this document
- "may" means a permissible way to achieve compliance with a requirement

Process of MEDIBUS.X development

MEDIBUS.X shall grow with the needs of those devices intended to comply with MEDIBUS.X.

Increasing the set of response codes will hence be a natural change of MEDIBUS.X.

The process of managing MEDIBUS.X is designed such that the extension of the MEDIBUS.X codelist will be maintained and published in parallel to the development of new therapy devices.

Backward compatibility

As stated before, MEDIBUS.X will evolve over time.

The following rules apply for each new version of MEDIBUS.X.

The syntax and meaning of any single MEDIBUS response code that is already part of the MEDIBUS.X definition will not be redefined.

Any definition once made will stay valid and new versions of MEDIBUS.X will not overwrite the definitions in an older version.

Text that is transmitted together with a response code, e.g., in a Request Current Alarm Response, will not be changed.

To allow the profile to evolve over time the following changes are allowed:

- MEDIBUS response codes may be added to the profile.
- MEDIBUS commands may be added to the profile for defining the arguments and the corresponding response data.
- MEDIBUS response codes may be marked as deprecated, which signals to compliant responders not to use such a code in the future. (The deprecated code will nevertheless continue to be part of the profile.)

New response codes will not be added in such a way that the combination of these new codes with already existing codes will change the meaning of the latter.

With these requirements each version of MEDIBUS.X is designed to be backward compatible to older versions.

Together with the rules for response processing given in the chapter "General Requirements", any compliant commander that complies with MEDIBUS.X in a certain version (e.g., 1.0) is able to process MEDIBUS responses from a compliant responder even though it uses MEDIBUS.X in a higher version (e.g., 2.x).

Furthermore, any compliant responder is able to react in a precisely defined way to any command a compliant commander may send.

Therefore, the major.minor scheme used in the MEDIBUS.X version does not imply compatibility or non-compatibility between different versions of MEDIBUS.X.

All versions of MEDIBUS.X will hence be compatible to each other (for compliant commanders and responders).

General requirements

This document defines different general rules regarding command processing that a compliant device shall obey to ensure the connectivity between devices implementing MEDIBUS.X.

This document covers commands that have been introduced with MEDIBUS 6.x or lower.

The covered commands are called *regulated* commands.

A responder is said to be compliant with MEDIBUS.X if and only if it follows the rules, regulations and requirements stated in this document and if it uses only the response codes defined in the "MEDIBUS.X Profile Definition for Data Communication" for regulated command responses.

A commander is said to be compliant with MEDIBUS.X, if and only if it follows the rules and requirements as stated in this document.

To be compliant it is not required that a device uses the MEDIBUS protocol stack in the previously mentioned version. However, it has to implement the general requirements given in this document as well as the requirements for regulated commands that it uses or replies to.

NOTE

This implies that such a device is able to respond to arbitrary MEDIBUS commands, e.g., those that have been introduced in a later version of the "Dräger RS 232 MEDIBUS Protocol Definition" than the one it is using. See chapter "Dealing with unknown response codes" on page 13 for details on this issue.

A MEDIBUS.X-compliant device may act as commander and as responder.

In both roles it has to follow the rules defined in this document.

Commands that are mandatory according to the "Dräger RS 232 MEDIBUS Protocol Definition" in order to initialize (ICC), keep alive (NOP) and stop (STOP) communication shall be implemented by any compliant commander and compliant responder.

Both commander and receiver shall obey the general rules for command processing as described in the "Dräger RS 232 MEDIBUS Protocol Definition", especially for connection establishment as stated above.

The same applies for the parts of the MEDIBUS protocol where a specific command-response sequence is required or recommended, e.g., for the transmission of real-time data.

See the "Dräger RS 232 MEDIBUS Protocol Definition" for further details.

All texts transmitted with MEDIBUS command responses are written in English.

The set of MEDIBUS codes defined in MEDIBUS.X is the entire set of MEDIBUS codes sent by compliant responders. This means that not all codes are likely to appear in responses of a compliant responder.

"MEDIBUS.X Profile Definition for Data Communication" contains information on the subset a specific device is actually using in its responses.

In addition to the commands listed in the chapter "MEDIBUS command responses regulated by MEDIBUS.X", in the table "List of MEDIBUS commands with MEDIBUS.X regulated responses" and those defined as mandatory in the "Dräger RS 232 MEDIBUS Protocol Definition", a compliant commander may send out other MEDIBUS commands, if and only if the following conditions are fulfilled:

- The command string does not contain any arguments nor does the response to the command contain any data, or

- the data used within such command and its response is explicitly defined by "Dräger RS 232 MEDIBUS Protocol Definition", or
- the data used within such a command is implicitly defined by MEDIBUS.X.

An example for a command fulfilling the first condition is the command "Time Changed" (49H).

An example for a command with explicitly defined data is the command "Configure Realtime Transmission" (54H).

An example for a command with implicitly defined data is the "Request Trend Data" command (6DH).

NOTE

Since MEDIBUS.X was designed to support legacy devices and new devices, this document contains also "should" requirements and individual device types may differ in behavior or do not implement these requirements.

A compliant commander should be able to deal with this variance that is in conformance with the basic MEDIBUS protocol specification

Dealing with unknown or unaccepted command codes

MEDIBUS.X defines the possible responses to MEDIBUS commands which are listed in the chapter "MEDIBUS command responses regulated by MEDIBUS.X" on page 14.

The list of existing MEDIBUS codes is bigger, but there was no need to regulate the responses to other commands when this MEDIBUS.X version was defined.

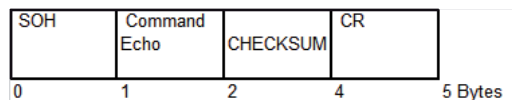
MEDIBUS.X does not impose what commands (except for the mandatory commands according to the "Dräger RS 232 MEDIBUS Protocol Definition") a compliant commander shall implement.

MEDIBUS.X only recommends what commands a compliant responder shall process.

MEDIBUS.X does not prohibit that a compliant commander sends out other commands than those listed in the chapter "MEDIBUS Command Responses Regulated by MEDIBUS.X" as long as the commander complies with the appropriate requirements mentioned earlier.

A compliant device shall respond as specified in the "Dräger RS 232 MEDIBUS Protocol Definition" when it receives an unknown command by another device.

This means that when a compliant device receives a MEDIBUS command that it is not able or willing to process, it has to respond by sending a response to such a command that acknowledges the receipt of the command but contains no data:



NOTE

This must also be implemented in devices which primarily issue MEDIBUS commands and process responses but which look at the other device rather as a data source and not as an active device.

The reason behind this requirement in MEDIBUS.X is to ensure connectivity especially between a monitor and a therapy device if such a therapy device uses more features available with MEDIBUS than currently used in existing devices.

Example:

In a connected system it is reasonable to distribute the time and the date from a central server.

Currently this is implemented within existing monitoring networks and any monitor connected to this network.

The MEDIBUS protocol already contains a command that enables a device to request the time and the date from the other device.

A therapy device could use this command to get the current time and date from the monitor it is connected to.

Connectivity shall not be lost if such a device is connected to a (compliant) monitor that is not prepared to send the Request Time And Date Response.

Sending data during special device states

While a device is in mode standby, a compliant responder should reduce the set of measurement data sent with a response to a "Request current measured Data" command to those that still make sense while the device is not connected to a patient.

An example would be a measurement of some ambient condition, e.g. ambient pressure.

While a device is in a test mode, e.g., device check or service, a compliant responder should reduce the set of measurement data sent with a response to a "Request current measured Data" command to those that still make sense during the test.

Same applies to the responses for the commands "Request current Device Settings", "Request current high/low Alarm Limits" and "Request current Text Messages".

NOTE

Since these requirements are "should" requirements, devices may deviate from them in their implementation. This may especially be true for device types that have been released prior to the release of the MEDIBUS.X profile specifications.

Response processing

Processing of known response codes

If not stated otherwise below, it is in the responsibility of a compliant commander to decide how received codes shall be handled.

A compliant commander has to present data to a user in a way that is compliant to the meaning defined in this document and in the "MEDIBUS.X Profile Definition for Data Communication".

Nomenclature and text display

A compliant commander is allowed to replace a received text string with another string having the same meaning, e.g., when the text shall be localized before presenting it to the user.

Another example would be the need for abbreviating the text before display.

Unit conversion

A compliant commander is allowed to present values in a different physical unit, if and only if this transformation is possible with the data available for the commander.

The transformation must not lead to an inconsistent display of information neither on the commander's user interface nor the responder's user interface.

NOTE

The definition of the physical unit to be used for interpreting physical values transmitted via MEDIBUS is part of the MEDIBUS.X definition (as it is for any other device profile that was defined in the past for specific therapy devices).

NOTE

Simple examples for a possible transformation would be: mL -> L or °C -> °F. Other, more difficult transformations like partial pressure, e.g., mmHg -> Vol%, require additional information that is not always available to the commander.

NOTE

The conversion constant to be used to convert mbar into cmH₂O is 1.00. This conversion factor is used by all Dräger devices that support the selection of different pressure units.

If a commander intends to present data in a different unit than the one defined for MEDIBUS.X, care must be taken that the transformed value matches the value that will be displayed for the user at the user interface of the responder.

Since minor imprecisions may still occur due to rounding and fixed integer arithmetic the general recommendation is to not perform such a transformation at the commander's site.

A compliant responder may transmit a measured value with different units, i.e. may use more than one respond code for a parameter like, e.g., etCO₂.

It is recommended to send only one such representation at a time. The representation chosen should be the one that matches the unit settings of the responding device.

If more than one representation is sent at a time, then a compliant responder should transmit a text message response value that allows to derive the unit that is currently used by the responding device.

A compliant commander may freely choose which data to display, if it receives multiple representations. It is recommended to choose the value that matches the mentioned text message, if present.

Data precision

A compliant commander is allowed to present values with a reduced digital precision.

The compliant commander has to mathematically round the value to the reduced digital precision before presenting it.

A compliant responder may round the transmitted values in comparison to the value it displays on its own user interface.

But a compliant responder should use rounding of data only, if this is required to cope with the limitations of value representation given with the MEDIBUS protocol.

To cope with the limitation of the value representation in MEDIBUS a compliant responder may send the same physical value with different units like mL and L. It is recommended that a responder sends only one representation at a time, not multiple.

If more than one representation is sent at a time, then a compliant responder should transmit a text message response value that allows to derive the unit that is currently used by the responding device.

A compliant commander may freely choose which data to display, if it receives multiple representations. It is recommended to choose the value that matches the mentioned text message, if present else the one with the highest precision.

A compliant commander should not increase the level of precision by adding trailing zeros since this may lead to differences in displaying the same value at the commander's display and the responder's display, if the responder had to round the value before sending it.

If possible, the commander should use and present the data with the received precision.

Skipping response values

A compliant commander may discard the processing of some of the received (and known) response codes.

It may also issue a Configure Data Response Command as described in the "Dräger RS 232 MEDIBUS Protocol Definition". For exceptions to this rule, see chapter "Presenting and processing MEDIBUS text message responses for ventilation modes" on page 25.

Note that MEDIBUS.X does not enforce that a compliant responder has to be able to process this command.

In both cases it is in the responsibility of the commander to ensure that the resulting data (sub-)set is still meaningful to the user and will not lead to a potential misinterpretation by the user.

Dealing with unknown response codes

In a situation in which a more recent version of MEDIBUS.X is installed on a compliant responder, the commander might receive response codes which have not been defined in the version of MEDIBUS.X used by the commander.

In that case, if not stated otherwise below, a compliant commander shall discard processing of codes that have not been defined in the version used by the commander.

The commander should discard these data without setting off alarms in order to not disturb the user with annoyance alarms.

See chapter "Dealing with unknown alarm codes" on page 21 for specific requirements for processing unknown Alarm Message Response codes.

See chapter "Presenting and processing MEDIBUS text message responses for ventilation modes" on page 25 for specific requirements for processing unknown Text Message Response codes used to transmit information about ventilation modes.

NOTE

The process of extending MEDIBUS.X over time will ensure that discarding the processing of received unknown codes will not lead to a potential misinterpretation by the user.

MEDIBUS command responses regulated by MEDIBUS.X

For the following commands, MEDIBUS.X gives detailed guidelines with respect to allowed responses.

List of MEDIBUS commands with MEDIBUS.X-regulated responses

Code	Command
52H	Request Device Identification
24H	Request current measured Data (Codepage 1)
2BH	Request current measured Data (Codepage 2)
25H	Request current low Alarm Limits (Codepage 1)
2CH	Request current low Alarm Limits (Codepage 2)
26H	Request current high Alarm Limits (Codepage 1)
2DH	Request current high Alarm Limits (Codepage 2)
27H	Request current Alarms (Codepage 1)
2EH	Request current Alarms (Codepage 2)
23H	Request current Alarms (Codepage 3)
29H	Request current Device Settings
2AH	Request current Text Messages
28H	Request current Date and Time
53H	Request Realtime Configuration
59H	Device Extension Command for Infusion Pumps

A compliant responder should support these commands if the responding device supports the underlying functionality (e.g., a therapy device with integrated alarm monitoring should support the "Request current Alarms" commands).

A compliant responder may also support other MEDIBUS commands, see chapter "Dealing with unknown response codes" on page 13.

With the regulation of responses for the MEDIBUS commands "Request current measured Data (Codepage 1)" (24H) and "Request current measured Data (Codepage 2)" (2BH), MEDIBUS.X implicitly defines the allowed responses to the "Request Trend Data" command (6DH).

See the "Dräger RS 232 MEDIBUS Protocol Definition" for specific requirements about dealing with trend data.

NOTE

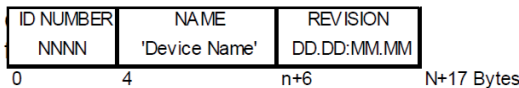
The support for transmission of trend data is optional for a compliant responder.

Device identification response

This response must be sent in reply to the "Request Device Identification" command (52H).

See the "Dräger RS 232 MEDIBUS Protocol Definition" for the syntax of this response.

Compliant responders use the following response field:



ID NUMBER

The ID NUMBER is a four-byte field containing the ASCII identification number NNNN.

The range for the ID NUMBER for MEDIBUS.X-compliant devices is defined to be 5000 to 6999:

- The range [5000 to 6499] is reserved for Dräger devices.
- The range [6500 to 6999] may be used by compliant third-party devices.

The allocation of numbers is managed by Dräger.

By sending an ID NUMBER within this range, a responder declares compliance with MEDIBUS.X.

As in former profiles, the ID NUMBER identifies a specific device.

A compliant commander shall establish communication with and accept and process responses from all devices that answer with an ID NUMBER in the above given range.

The specified range is divided into subranges that allow the identification of the device type:

- The range [5000 to 5199] is reserved for ventilators.
- The range [5500 to 5699] is reserved for anesthesia machines.
- The range [5700 to 5749] is reserved for warming therapy devices.

- The range [6300 to 6309] is reserved for phototherapy devices.

Additional device types might be added in the future.

NAME

The NAME is an ASCII character string [20H to 7FH] that is delimited by apostrophes (ASCII Code 27H).

Therefore, the device name itself must not contain apostrophes.

The length of the device name may range from 1 to 32 characters.

The value of this field is not predefined in MEDIBUS.X.

A compliant responder shall send a valid ASCII string that identifies the sending device by name.

REVISION

The REVISION is an eleven-byte field that contains ASCII characters representing the device revision level (DD.DD) and the MEDIBUS revision level (MM.MM) used by the device.

A compliant commander must not assume that the ID NUMBER infers the concrete set of data that can be expected from the responder which is represented by that ID NUMBER.

This means that the concrete set of data sent by a specific compliant device may change (within the rules of the MEDIBUS.X definition), even if the Device Identification Response stays unchanged.

Therefore, no compliant responder must assume that a commander will react to the information provided in the Device Identification Response in a specific way, i.e., will change its behavior upon receiving a specific ID NUMBER.

Current measured data and alarm limit response

This response must be sent in reply to the following commands:

- "Request current measured Data (codepage 1)" command (24H)
- "Request current low Alarm Limits (codepage 1)" command (25H)
- "Request current high Alarm Limits (codepage 1)" command (26H)

- "Request current measured Data (codepage 2)" command (2BH)
- "Request current low Alarm Limits (codepage 2)" command (2CH)
- "Request current high Alarm Limits (codepage 2)" command (2DH)

See the "Dräger RS 232 MEDIBUS Protocol Definition" for the syntax of this response.

General requirements

MEDIBUS.X does not prescribe if measured data is accompanied by either a high limit or a low limit or both.

The availability of a limit setting is device-specific and cannot be part of the MEDIBUS.X definition.

Therefore, a compliant commander must be able to deal with a situation where any DATA CODE within the Current Measured Data Response may or may not be matched by the appearance of the same DATA CODE inside either the Current Low Alarm Limit or the Current High Alarm Limit response or both.

A compliant responder shall only include those values in the response that correspond to valid measurements.

A compliant responder should cease transmission of patient-related measured data values during standby.

A compliant responder should include only those alarm limit codes together with their current value in the (High/Low) Alarm Limit Response that are applicable for the current mode of operation and state of the device.

NOTE

In this context, mode of operation means what therapy is set on the device, e.g., which ventilation mode is selected. In terms of sending alarm limit values, MEDIBUS.X does not prescribe how a responder shall react when it is in standby.

Interpreting numerical data responses

MEDIBUS.X defines the unit that has to be used to transform the transmitted data into a physical value.

In general, MEDIBUS.X does not prescribe the format in which measured data values and the limit value(s) are encoded. (This is different from other MEDIBUS device profiles that defined the exact format, e.g., '_X.X'.)

A compliant responder should transmit a value as displayed, i.e. with the same precision. If displayed precision is greater than transmitted precision, then a compliant responder shall round the parameter value to the transmitted precision.

Hence, a compliant commander has to parse the response to calculate the transmitted number under the general assumption that the number is transmitted with a valid format.

A compliant commander must be able to deal with changing formats during an established connection.

As defined in the "Dräger RS 232 MEDIBUS Protocol Definition", values of measured data and alarm limits are transmitted as a 4-byte ASCII field.

The characters '-' (2DH), '0' (30H) – '9' (39H), '.' (2EH) and SPC (20H) are allowed values inside this field.

SPC shall be ignored during parsing.

SPC characters may appear before the first digit (if no '-' character is present), between the '-' character and the first digit, and at the end of the field.

By parsing the field in the order the characters have been received, the rest of the field shall be interpreted to be a signed, rational number in decimal notation with digits representing higher powers of 10 appearing first.

The character '-' (if the number to be represented is negative) must appear as the first character sent.

The character '.' indicates the position of the decimal separator, i.e., digits received before the '.' define the integer part of the number, digits received after the '.' define the fractional part of the number.

The response will always contain an explicit integer part for the number, even if it is 0.

To sum up, interpret the characters in the "natural" way: If you have stored them in a string, interpret the characters in the order they were received after removing white space (first char received = s[0] = highest order digit, second = s[1] a.s.o.).

It is recommended that the responder uses the same format when sending a certain parameter.

For instance, a value that is usually represented as 'X.XX' should always use all four characters in the same way, regardless of whether the value is 1.23 or 1.00, although the value 1.00 could also be sent in several other formats.

MEDIBUS.X usually does not prescribe the value range of a measured data value and the limit value(s).

In that case a compliant commander must be able to deal with the complete range of values.

For measured data and the respective limits the potential value range is [-999; 9999].

A limitation of this range may be given for certain response codes, see "MEDIBUS.X Profile Definition for Data Communication".

If a limitation is given, this limited range becomes part of the semantics of the response code and will never be changed by more recent versions of MEDIBUS.X.

If no limitation is given, this also is part of the semantics of the response code and will never be changed by more recent versions of MEDIBUS.X.

This means that if there is a need for a different range for a measurement value than specified by a defined MEDIBUS.X response code, then a new code with a new range definition has to be introduced.

The same rules that apply to range also apply to maximum precision.

Without limitation, a compliant commander shall assume that the maximum precision for measurement data is 2 decimal digits.

If a valid value exceeds the possible or defined range, a compliant responder shall transmit the maximum value of the range (e.g., 12000 mL fresh-gas flow shall be transmitted as 9999 mL).

If a valid value falls below the possible or defined range, then a compliant responder shall transmit the minimum value of the range (e.g., -5000 mbar shall be transmitted as -999 mbar).

Such values shall not be suppressed.

NOTE

If the maximum range has been explicitly reduced, e.g., to [-99; 99], then these limit values shall be used instead of the potentially possible values (-99 mbar instead of -999 mbar).

Interpreting non-numerical data responses

MEDIBUS.X does not exclude the possibility of defining codes, whose response is not to be interpreted as a number.

Such codes have been used in legacy implementations of MEDIBUS and they may be defined within MEDIBUS.X in the future.

Once MEDIBUS.X has defined such an exception, it will stay valid for all more recent versions of MEDIBUS.X.

MEDIBUS.X does not exclude the possibility of defining codes that are used to transmit non-numeric status information.

For these codes MEDIBUS.X will define the general meaning of the status information, the meaning of possible states, and the exact representation of the states.

It is recommended that a compliant responder avoids using the Current Measured Data data type for transmitting status information whenever possible.

In the past this kind of information was often used in order to qualify other measured values.

In such a case MEDIBUS.X also will define the relations between the defined status information and all affected data codes.

Once MEDIBUS.X has defined such status information, it will stay valid for all more recent versions of MEDIBUS.X.

See "MEDIBUS.X Profile Definition for Data Communication" for any definition of such values.

Multiple parameter values for physiological data

For some measurements some devices supply more than one parameter.

Those parameters are discriminated by using indices.

The indices (and the description) of the parameter qualify the parameter with respect to the place of measurement or time of measurement.

E.g. the index "e" stands for "expiratory" and indicates that a measurement has been taken during patient expiration.

If the responder sends both parameters with indices and without, then the one without the index is less qualified with respect to measurement time and place, but not with respect to accuracy.

E.g., the parameter MV (minute volume) can be either expiratory measured or inspiratory measured or a combination of both.

It is beyond the scope of the MEDIBUS.X profile definition to detail the specifics of such an unqualified parameter.

A compliant responder may send multiple parameter values in parallel that relate to a physiological parameter.

In general a processing commander should keep this redundancy and should not try to map the parameters on each other.

For the following parameters the MEDIBUS.X specification gives the following recommendation to process the parameters.

Minute volume

Applies to the parameters
MVe (code page 1, 03H),
MV (code page 1, B9H),
MVi (code page 1, 06H)

A compliant commander may decide to automatically display only one of these parameters at a time.

In that case, the displayed label shall match the name of the parameter chosen.

In that case, if the responder sends more than one of these parameters at a time, then the compliant commander shall display the first parameter according to the sequence given above.

Tidal volume

Applies to the parameters
VT_e (code page 2, 21H),
VT (code page 1, 88H),
VT_i (code page 2 22H)

A compliant commander may decide to automatically display only one of these parameters at a time.

In that case, the displayed label shall match the name of the parameter chosen.

In that case, if the responder sends more than one of these parameters at a time, then the compliant commander shall display the first parameter according to the sequence given above.

Respiratory Rate

Applies to the parameters
RR (code page 1 D6H),
RR_f (code page 1, D7H),
RR_c (code page 1, D5H),
RR_p (code page 1, B4H)

A compliant commander may decide to automatically display only one of these parameters at a time.

In that case, the displayed label shall match the name of the parameter chosen.

In that case, if the responder sends more than one of these parameters at a time, then the compliant commander shall display the first parameter according to the sequence given above.

MEDIBUS.X measured data and alarm limit code list

See "MEDIBUS.X Profile Definition for Data Communication".

NOTE

Checkmarks in columns LL and HL indicate, that the respective code may appear in the Alarm Limit Response of a compliant responder.

Alarm status response

This response must be sent in reply to the following commands:

- "Request current Alarms (codepage 1)" command (27H)
- "Request current Alarms (codepage 2)" command (2EH)
- "Request current Alarms (codepage 3)" command (23H).

See the "Dräger RS 232 MEDIBUS Protocol Definition" for the syntax of this response.

Text abbreviations

Alarm text responses may contain the following abbreviations:

\$&	(24H 26H)	= 'LOW'
"#	(22H 23H)	= 'HIGH'
'@	(27H 40H)	= 'ALARM'

NOTE

In the transmitted alarm phrase the abbreviation may be directly preceded or followed by further characters without an SPC (20H) or any other separator in between.

Dealing with priority value

The ALARM Priority value sent with the Alarm Status Response is not defined within MEDIBUS.X.

Accordingly, each compliant responder may associate a different priority to an Alarm Code.

A compliant responder shall choose the priority sent with an Alarm Status Response such that the following assertions hold:

- If the alarm is displayed with HIGH PRIORITY at the responder's user interface, then $24 < \text{ALARM Priority} \leq 31$
- If the alarm is displayed with MEDIUM PRIORITY at the responder's user interface, then $10 < \text{ALARM Priority} \leq 24$

- If the alarm is displayed with LOW PRIORITY at the responder's user interface, then $0 < \text{ALARM Priority} \leq 10$

For the definition of the three-valued alarm urgency classification scheme (LOW PRIORITY, MEDIUM PRIORITY, HIGH PRIORITY), see IEC-60601-1-8 2003.

Dealing with unknown alarm codes

If the Alarm Status Response contains a code whose meaning is unknown to the commander, a compliant commander that is able to express alarm conditions by using textual representation has to process this code in one of the following two ways:

It may display the alarm condition together with the text sent in the Alarm Status Response (ALARM PHRASE).

If the phrase contains the afore mentioned abbreviations, the responder shall replace them as defined above.

If the abbreviation is not separated by spaces from other text, it is recommended that an SPC is inserted before or after the abbreviation in order to separate the words LOW, HIGH, or ALARM from the preceding or following text.

It may display the alarm condition together with a self-chosen text that expresses the source of the alarm and its urgency according to the afore mentioned classification scheme defined in IEC-60601-1-8 2003.

E. g. "HIGH PRIORITY ALARM @ MEDIBUS DEVICE".

Instead of a generic identification of the alarm source, the commander may also use the name of the device that has been received with the Device Identification Response.

NOTE

The commander may also use the information about the Device Identification Number to choose an appropriate text.

A compliant responder guarantees that the ALARM Priority sent with an Alarm Status Response complies to the aforementioned rules, i.e., even if the meaning of an ALARM CODE is not known to a commander, it may infer the urgency classification (HIGH, MEDIUM, LOW) according to IEC-60601-1-8 2003.

MEDIBUS.X alarm code list

See "MEDIBUS.X Profile Definition for Data Communication".

Device setting responses

This response must be sent in reply to the "Request Current Device Settings" command (29H).

See the "Dräger RS 232 MEDIBUS Protocol Definition" for the syntax of this response.

MEDIBUS.X defines the unit that has to be used to transform the transmitted data into a physical value.

In general, MEDIBUS.X does not prescribe the format in which setting data values are encoded. (This is different from other MEDIBUS device profiles that defined the exact format, e.g., 'X.X').

A compliant responder should transmit a value as displayed, i.e. with the same precision.

If displayed precision is greater than transmitted precision then a compliant responder shall round the parameter value to the transmitted precision.

Hence, a compliant commander has to parse the response to calculate the transmitted number under the general assumption that the number is transmitted with a valid format.

A compliant commander must be able to deal with changing formats during an established connection.

As defined in the "Dräger RS 232 MEDIBUS Protocol Definition", data values are transmitted as a 5-byte ASCII field.

For the syntax of this field, see chapter "Current measured data and alarm limit response".

It is recommended that the responder uses the same format when sending a certain parameter.

For instance, a value that is usually represented as 'X.XX' should always use all five characters in the same way, regardless of from whether the data value is 1.23 or 1.00, although the value 1.00 could also be sent in several other formats.

MEDIBUS.X usually does not prescribe the value range of setting data.

In that case a compliant commander must be able to deal with the complete range of values.

For setting data this is [-9999;99999].

A limitation of this range may be given for certain response codes, see "MEDIBUS.X Profile Definition for Data Communication".

If that is the case, this limited range becomes part of the semantics of the response code and will never be changed by more recent versions of MEDIBUS.X.

If a limitation is given, this limited range becomes part of the semantics of the response code and will never be changed by more recent versions of MEDIBUS.X.

This means that if there is a need for a different range for a setting value than specified by a defined MEDIBUS.X response code, then a new code with a new range definition has to be introduced.

The same rules that apply to range also apply to maximum precision.

Without limitation, a compliant commander shall assume that the maximum precision for measurement data is 3 decimal digits.

A compliant responder should include only those setting codes together with their current values in the Device Setting Response that are relevant for the current mode of operation.

NOTE

In this context, mode of operation means what therapy is set on the device, e.g., which ventilation mode is selected.

NOTE

MEDIBUS.X version 1.0 does not contain values for setting response codes, that need to be interpreted non-numerically.

MEDIBUS.X device setting code list

See "MEDIBUS.X Profile Definition for Data Communication".

Text message response

This response must be sent in reply to the "Request current Text Messages" command (2AH).

See the "Dräger RS 232 MEDIBUS Protocol Definition" for the syntax of this response.

Ventilation mode messages

Text messages are used to identify the applied ventilation mode of a therapy device (for those devices that are able to ventilate).

In MEDIBUS.X, the information about the applied ventilation mode of a ventilator is split up into information about the basic ventilation pattern and an optional list of ventilation adjuncts.

Example:

On the therapy device, a ventilation mode is labeled PC-SIMVPS.

This mode consists of the basic ventilation pattern named PC-SIMV and the adjunct pressure support with the corresponding label PS.

There may be no or more than one adjunct to the basic pattern.

In the example, the user may activate Volume Guarantee (VG) which results in the display of two adjunct labels: PS and VG.

All text strings that are used to represent a basic ventilation mode start with a space character (20H).

In MEDIBUS.X, no other text strings will start with this character.

All text strings that are used to represent a ventilation adjunct start with a *'* character (ASCII code 2FH).

In MEDIBUS.X, no other text strings will start with this character.

A compliant responder shall send at most one code in a text message response that is used to represent a basic ventilation pattern.

A compliant responder may send an arbitrary number (including zero) of (different) codes in a text message response that are used to represent a ventilation adjunct.

A compliant responder shall transmit only those codes that represent the currently selected ventilation mode.

For text messages containing text that is defined by the user of the device, e.g., first name or family name of the patient, a compliant responder has to ensure that those text messages do not start with a *'* or space.

Therefore user-defined text requires a compliant responder to eliminate a leading *'* or space from the text before transmission.

See "MEDIBUS.X Profile Definition for Data Communication" for the defined responses.

Presenting and processing MEDIBUS text message responses for ventilation modes

A compliant commander should extract and use the strings from the text message response that stand for the basic ventilation pattern and the applied adjuncts.

A compliant commander should use these strings for presenting the information to an end user.

If necessary, the text should be localized.

The following algorithm (or an equivalent variation) should be used to yield one single string representing the ventilation mode:

- 1 Let **s** be an empty string.
- 2 Set **s** to the (localized) string value of the received basic ventilation mode text message code, with the leading space removed.
- Repeat the following steps 3 and 4 for all string values in the message response, that represent ventilation adjuncts.
- 3 Set **t** to the localized value of the received text string.
- 4 Append the value of **t** to the end of **s**.

If the commander is built using MEDIBUS.X with a lower version than the one used by the responder, the responder might use codes for the basic ventilation pattern and/or the adjuncts that the commander does not know.

The following requirements describe how a compliant commander shall react in such a situation.

To simplify the specification of these requirements, the following terminology is used: When the requirement uses the phrase “does not contain”, this means:

the commander does not find a code in the response that represents a basic ventilation pattern although the commander knows the definitions of the older MEDIBUS.X version and the codes for basic ventilation patterns defined therein.

If the text message response does not contain a code for a basic ventilation pattern, the commander has three choices to process the information about the ventilation mode:

- It may scan for a string in the response that starts with a space character and if it finds such a string, it may assume that this string represents a basic ventilation pattern.
- It discards the space character and proceeds with processing of codes that represent ventilation adjuncts as described above.
- It may inform the user or other information processing systems about the fact that the commander was unable to generate this information in a proper way.
- It may provide no information at all about the ventilation mode to the user or other information processing systems (IT applications a.s.o).

(An example for a situation when this might be the only option would be the need to map the received information to another numerical encoding system for ventilation modes.)

To process all adjuncts and to be aware that the response may contain (unknown) codes representing an adjunct, a compliant commander must parse all strings sent with unknown codes for the appearance of the ‘/’ character as the first character in the string field.

If at least one such string exists, the commander has again three choices to process this information about the ventilation adjunct:

- 1 It may use the string as is to provide the information about the adjunct to the user or other information processing systems.

If the commander processes the strings as described above, it shall append the strings of the unknown adjuncts in the order they were received.

In this case, none of the strings (basic pattern and adjuncts) shall be localized.

- 2 It may stop to process the information about the unknown adjunct.

In that case, it shall inform the user and other information processing systems that the representation of the ventilation mode is incomplete.

- 3 It may provide no information at all about the ventilation mode to the user or other information processing systems (IT applications a.s.o).

If a compliant commander processes ventilation mode information, it shall not use the Configure Data Response command for text messages.

Otherwise, the commander might miss unknown and therefore unforeseen ventilation mode information.

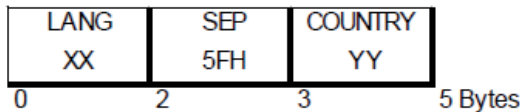
Localization considerations

As stated above, all text strings transmitted with the Text Message Response and the Request Alarm Message Response remain in English language.

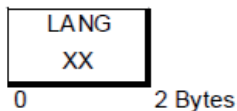
A compliant responder should transmit code 2CH (Selected Display Language) in its Text Message Response.

The text transmitted with this code is variable.

Allowed values are:



or



LANG

Identifies the language using two lower-case ASCII characters [61H - 7AH] as defined in ISO 639.

COUNTRY

Optional identification of the country using two upper-case ASCII characters [41H - 5AH] as defined in ISO 3166-1.

It is also allowed to use one of the following strings to express the language:

String	Alternative for
English	en
US English	enUS
German	de
Italian	it
Swedish	sv
Spanish	es
French	fr
Dutch	nl
Bulgarian	bg
Czech	cs
Danish	da
Greek	el
Finnish	fi
Hungarian	hu
Japanese	ja
Korean	ko
Lithuanian	lt
Norwegian	no
Polish	pl
Portuguese	pt
Romanian	ro
Russian	ru
Slovak	sk
Turkish	tr
Chinese (Simplified)	zh

This enables the commander to use this information to perform a proper localization, if wanted.

MEDIBUS.X text message code list

See "MEDIBUS.X Profile Definition for Data Communication".

Other special text messages

"MEDIBUS.X Profile Definition for Data Communication" contains a couple of text messages that inform about the unit which is currently selected (by the user) for a certain measurement.

A Text Message Response will contain such a message if the responder is able to send a measurement or setting value (e.g., etCO₂) in different units.

A compliant commander may process only those measurement / setting values that correspond to the selected unit for the measurement/setting.

Request time and date response

This response must be sent in reply to the "Request Time and Date" command (28H).

This response shall be given as specified in the "Dräger RS 232 MEDIBUS Protocol Definition".

Time changed command (49H)

In order to allow synchronization between linked devices, it is recommended that a compliant device sends the Time Changed command whenever the time or date setting of the device has either been changed manually by the user or by another remote controlling device (which may exclude frequent and regular synchronization with a central clock device).

In addition to responding to the command, the responder of the Time Changed command may issue the Request Current Date And Time command (28H) to synchronize itself with the commander of the Time Changed command.

After synchronization with the commander, the responder may turn into a commander by sending the Time Changed command to further MEDIBUS devices.

However, care has to be taken not to initiate an endless synchronization loop.

Real-time data

General requirements

Responders shall fulfill the "Dräger RS 232 MEDIBUS Protocol Definition" with respect to real-time data.

The commander has to strictly follow the following order of commands to initiate the transmission of real-time data:

- Request real-time configuration
- Configure real-time transmission
- Enable data streams

If the order above is not followed, then the responder shall ignore the commands and not send any real-time streams at all.

The responder again has to follow the same order and has to process the commands accordingly.

It is recommended that the real-time data receiver requests as few data as possible and only as many as necessary.

The real-time data source shall be able to process the 'enable/disable data stream' sync commands.

The data source shall not send real-time data before the 'enable' sync command has been received.

The real-time data source must correctly support the sync commands used to identify which real-time data are contained in a real-time telegram (first sync byte and the 'transmitted data stream' sync commands).

The real-time data source shall not unnecessarily repeat the 'enable data stream' sync command.

The receiver of data streams shall ignore unknown sync commands.

In order to protect itself against processor or RS232 line overload, the real-time data source is allowed to limit without notice the maximum amount of data sent.

The limitation shall consider the bandwidth of the RS232 line at the given baud rate and that there must be enough bandwidth left to run the basic MEDIBUS protocol in order to avoid communication timeouts and thus communication errors.

The real-time data receiver is also recommended to consider the constraints regarding performance as well as bandwidth and not to request more data than the RS232 line can carry at the set baud rate.

The real-time data source shall send the real-time telegrams equidistantly. For instance, if data are offered and requested to be sent every 10 ms, then a single telegram shall be sent every 10 ms instead of sending bulk telegrams, i.e., 10 telegrams every 100 ms.

MEDIBUS.X does not define the INTERVAL, MIN, MAX, and MAXBIN values of the Realtime Configuration Response. Thus a compliant commander has to scan and process the received response, making the implementation more flexible and independent of changes.

When possible, a compliant responder should send the appropriate sync command bytes for the start of an inspiratory cycle and/or the expiratory cycle as part of the real-time data.

MEDIBUS.X does not define the correlation between multiple real-time data streams. This depends on sample rate and processing delays that differ from device to device and from value to value.

Real-time data during standby

During standby the responder should cease transmission of real-time data.

It is recommended that the responder sends the "Real-time configuration changed" (56H) command after having stopped transmission during standby.

The responder should reply to a following "Request real-time configuration" (53H) command, with an empty response.

If the responder has used the "Real-time configuration changed" (56H) upon entering standby, it shall also use this command when leaving standby to announce the availability of real-time data.

NOTE

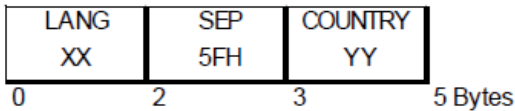
Since these requirements are "should" requirements, devices may deviate from them in their implementation. This may especially be true for device types that have been released prior to the release of the MEDIBUS.X profile specifications.

MEDIBUS.X real-time data code list

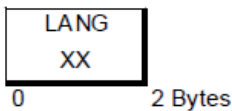
See "MEDIBUS.X Profile Definition for Data Communication".

Set language command

A compliant commander may send this command (4BH) with the following command argument syntax:



or



LANG

Identifies the language using two lower-case ASCII characters [61H - 7AH] as defined in ISO 639.

COUNTRY

Optional identification of the country using two upper-case ASCII characters [41H - 5AH] as defined in ISO 3166-1.

If the responder accepts the requests, it has to respond by copying the command argument into its response.

If the responder does not accept the request, it has to respond as specified in the chapter "Dealing with unknown or unaccepted command codes".

Infusion pump command response

This response must be sent in reply to the “Device Extension Command for Infusion Pumps” command (59H).

This response shall be given as specified in the "Dräger RS 232 MEDIBUS Protocol Definition".

Variable text responses

The text responses to the following text message response codes are variable.

Code	Meaning	Format
0DH	Drug short name	any valid MEDIBUS.X text response
0EH	Drug long name	any valid MEDIBUS.X text response
0FH	Dosing unit	any valid MEDIBUS.X text response
11H	Concentration unit	any valid MEDIBUS.X text response

The response text for the dosing unit and the concentration unit will represent the units as set at the pump as best as possible when using characters from the ASCII character set.

The Greek character μ that is usually used as an abbreviation of 'micro', e.g., as in μm for micrometer, is replaced by the character 'u' (75H).

Powers of a base unit, e.g., as in m^2 for square meter, are expressed using the Caret character '^' (5EH), e.g., 'm^2' for square meter.

Examples of dosing unit responses are: mg/h, mg/min, mL/h, mL/min, ug/h, ug/min, mg/kg/h, mg/kg/min, mL/kg/h, mL/kg/min, ug/kg/h, ug/kg/min.

Examples of concentration units are: mg/mL, ug/mL.

MEDIBUS.X infusion pump code list

Responses to the command have been added to the MEDIBUS.X profile with version 1.01.

See "MEDIBUS.X Profile Definition for Data Communication".

Device Specific Command

Neither a compliant commander nor a compliant responder has to support the “Device Specific” command (6A).

The use of this command is deprecated.

As the name suggests, this command is device-specific and it will never be regulated by MEDIBUS.X.

Appendix


This appendix is for information purposes only.

Differences to Legacy Device Profiles


Most of the following has already been mentioned, but this chapter summarizes the differences between MEDIBUS.X and former device profiles:


- With one exception, no support for different languages
- Rules for processing unknown commands and responses clearly defined
- Rules for processing numbers by a commander
- Connectivity to be assured for a predefined range of device identification numbers (see chapter "Device identification response")
- No a priori definition of what data is sent by a responder
- Value range for numbers not necessarily predefined by MEDIBUS.X
- Precision of numbers not necessarily predefined by MEDIBUS.X
- Number response format not predefined by MEDIBUS.X
- Recommendation which measurements and settings to be sent
- No predefined alarm priority, instead, a definition of a rule which allows calculation of the alarm grade from the alarm priority
- Separate text message codes for basic ventilation patterns and enabled ventilation adjuncts
- Rules for dealing with ventilation mode information
- Leading SPC to discriminate ventilation mode information from other text messages
- / instead of '+' for ventilation mode adjuncts
- Sending information about the user interface language


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