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mannesmann
Rexroth

INTERBUS-S - Assembly DBS 2.1
DRIVECOM Profile 21
Velocity Control

Technical Documentation

DOK-SUPPL*-DBS2.1*DIAX-ANW1-AE-P

278544

Indramat

Title Interbus - S Assembly DBS 2.1

Type of documentation Technical Information

Document code DOK-SUPPL*-DBS2.1*DIAX-ANW1-AE-P

Internal file reference

- 109-0919-4117-00

The purpose of this documentation: This document contains technical data on the Interbus - S Assembly DBS 2.1.

Editing sequence

Status	Release	Comment
Technical data	01.98	First release

Published by INDRAMAT GmbH • Bgm.-Dr.-Nebel-Str. 2 • D-97816 Lohr a. Main

Telefon 09352/40-0 • Tx 689421 • Fax 09352/40-4885

Contents

1 Interbus - S Module DBS 2.1

Plug-In Module Construction

The DBS 2.1 module has been designed as a plug-in module for digital intelligent drive controllers DDS 2.1/ 3.1, DKS 1.1 and DDC.

The module is inserted into the drive controller as a command communications module equipped with an interface to the drive controller via which both card identification and data exchange to the drive controller can take place.

The control voltage required to operate the module is directly tapped off the controller. The user must make available the control voltage of 24 volts for the external signals on the DBS 2.1.

Field Bus Participant

The DBS 2.1 is a field bus participant as defined by the Interbus-S. Within such a field bus installation, this module can be combined with any other Interbus-S interface module manufactured by someone other than Indramat if this other module meets Interbus-S certificate specifications.

Maximum Participant Number

Up to 256 field bus participants can be interconnected within one field bus installation.

Galvanic Isolation

The Interbus-S interfacing module DBS 2.1 is outfitted with galvanically-isolated field bus inputs and outputs. This achieves the greatest resistance to interference.

Diagnostic LEDs

There are (8) LEDs for diagnostics on the front with which it can be quickly checked if the DBS is functioning properly or not. These LEDs enable diagnostics of the function of the Interbus-S ring as per Interbus-S standards.

2 The Operating Modes of the DBS 2.1 Module

Two different modes

The DBS 2.1 assembly controls modes

speed settings as per DRIVECOM Profile 21

and

homing as per DRIVECOM Profile 22

when used with digital drive controllers of the DIAX02 series.

Object 6060 set via PCP channel

The mode is selected with the use of a control word triggered by the PCP channel.

The main operating mode, i.e., the default setting, is the speed setting as per DRIVECOM Profile 21. It is effective immediately after powering up if the user has not made any other changes.

The operating modes are coded as follows in object "Operating Modes - Selection Code" 6060:

Operating mode	Value in object 6060
velocity feedback setting as per Profile 21	2 D (0002H)
referencing as per Profile 21	6 D (0006H)

Homing is also a subfunction implemented with control word 6040.

2.1 Operating Mode Descriptions

2.1.1 Speed Settings as per DRIVECOM Profile 21

The master interconnection access to PCP channel

The following EPROM types are to be used with SERCANS assemblies.

In the main operating mode of the Interbus-S interface, speed setting, can be set directly via the Interbus-S.

The master interface can be any PLC or PC with Interbus-S interface module.

The master interface should support the PCP channel. If it does **not**, then the drive controller can still be used with Interbus-S DBS 2.1 module, but parametrization must implement an external PC with PC AT-T module.

Operating mode "Speed setting as per Profile 21" needs at least two words in the process data channel. These are also prescribed as mandatory objects in Profile 21.

Word 1: status or control word

Word 2: velocity feedback or command value

The status word (object 6041) and the control word (6040) are needed to control the status machine. The speed command value is set via object 6042, the speed back value via object 6044.

Any additional settings can be read out of the position feedback value of the motor encoder via object 6064.

2.1.2 Homing Mode (Profile 22)

Relative axes must be set!

If the user needs the position feedback value information taken from a singleturn motor encoder or an external relative linear scale, then it is necessary to first establish a dimensoinal reference. "Homing" is used in this case. It establishes the zero point depending on the approach to zero point selected.

The "homing" procedure uses three objects:

object 6099 homing speed
object 607C homing selection code
and **object 6098** homing offset.

Start is initiated by a signal change in control word 6040. Homing completion is signalled with status signals in status word 6041.

Note: If an absolute linear scale (e.g., DSF - GDM) is used, then there is an absolute dimension right from the start and homing is no longer necessary.

2.2 The Process Data Channel of the Interbus-S DBS 2.1

Field bus participants with 6 word max. process data without PCP channel

The DBS 2.1 module designed as a field bus - slave module has a process data channel that is six words wide. This maximum number of words does not always have to be used. Any data width from one to six words (without PCP) can be set. As a change in the number of words within the Interbus S ring leads to errors, a CRC error is always sent to the master with each accessing. This forces the master to reconfigure thus restarting the entire bus and entering the current number of words.

User-specific object allocation possible

The assignment of the process data channel itself can be performed by reading objects 6000 (process input data description) and 6001 (process output data description). Within these objects, accessible only via the PCP channel, can not only the object identifier itself by determined but also the length of the object, i.e., byte, word, longword, etc.

PCP channel used

Those applications without PCP support require that the process channel assignment is manually entered into the master and may not be changed during the course of operations.

Regardless of whether the master uses the PCP channel or not, the first word is reserved in the slave (DBS 2.1) for the PCP channel and is always included. Only the execution of the PCP services can be terminated, not, however, the PCP channel itself.

The master automatically recognizes whether a slave has PCP channel capabilities or not (E3). The process data channel of the DBS 2.1 module therefore has seven data words at its disposal with six for the "process".

The number of words set is the same for both data directions. Thus the maximum for the DBS 2.1 is:

6	data words	master ---> DBS 2.1	(output data)
6	data words	DBS2.2 --> master	(input data)
1	data word	master ---> DBS 2.1	(PCP output)
1	data word	DBS2.2 --> master	(PCP input)

Attention! Maintain profile regulations!

The process data channel of the DBS 2.1 can always be configured, i.e., the objects to be placed on the relevant data word can be placed by the user via the PCP into both objects 6000 and 6001, i.e., the objects for describing the process data channel. The descriptive algorithm is fixed by the Interbus-S standards and described in profile 12. The mandatory objects ascribed to profile 21 in the process data channel **may not** be changed.

Note DRIVECOM profile data in user configurations

However, only those objects may be used that have also been released for the process data channel (see object directory DBS 2.1). Also note that as per DRIVECOM profile 21, the assignments of the process data channel have already been made and **the user may in not violate these**.

Thus only the optional process data words in module DBS 2.1 may be used for the user's configurations. The mandatory objects defined by the profile cannot be changed.

Process word (OUT)

Process output data word

PCP-out	**1**	**2**	**3**	**4**	**5**	**6**
word 1	**word 2**	**word 3**	**word 4**	**word 5**	**word 6**	**word 7**

Mandatory area

Process word (IN)

word 1	**word 2**	**word 3**	**word 4**	**word 5**	**word 6**	**word 7**

Process input data word

PCP-IN	**1**	**2**	**3**	**4**	**5**	**6**

A setting configuration takes effect as soon as and at once with the initial powering up. This corresponds to the minimum mandatory configuraiton prescribed in profile 21.

	PCP out	**1**	**2**
	Object:	**6040**	**6042**
Process word (OUT)	**word 1**	**word 2**	**word 3**

Mandatory area

Process word (OUT)	**word 1**	**word 2**	**word 3**
	Object:	**6041**	**6044**
	PCP in	**1**	**2**

2.2.1 DBS 2.1 Process Data Channel Configuration

Take DRIVECOM profile 22 data into account

If it becomes necessary to assign the process data channel for user-specific applications, then the settings for the DRIVECOM 21 affecting mandatory objects and their allocation within the process data channel must always be taken into account. The rest allocation of the process data channel is freely open and available to the user.

Objects for write-accessing PD channel

User-specific configurations are only possible if nibbles 1 to 3 in parameter B024 have been set to zero. In this case, with the user of the PCP channel, user-specific allocations of the process data channel can be made via objects:

object 6000 write process input data

and

object 6001 write process output data

Note profile 12!

The structure of the objects is described in the Interbus-S document, profile 12.

3 The I/O Level Configuration

In BA2 (speed settings), there is the option of an additonal local I/O level with DEA modules. These modules can be used for user-specific applications and have no effect on actual drive functions. They can only be used, however, if the drive is either in state BB, AB or AF. It is possible to determine the state via diagnosis word object 5FF6.

3.1 The I/O level in speed setting mode BA2

Additional I/O levels with DEA4.1 and 5.1 possible!

Depending on the digital drive-controller, additional I/O modules (DEA 4.1 and 5.1) can be used in the free slots which can then, in turn, be used as additional I/O levels locally. The possible configurations are outlined in the system configurations list.

If the DEA modules are operated together with an Interbus-S module in BA2 mode, then the DEA cards can be set via the Interbus-S outputs, and the inputs queried via the Interbus-S.

The use hereof depends not only on the hardware configuration (system configuration) but also on the assignment of the process data channel. The following objects must be applied to the process data channel if the DEA modules are to be used.

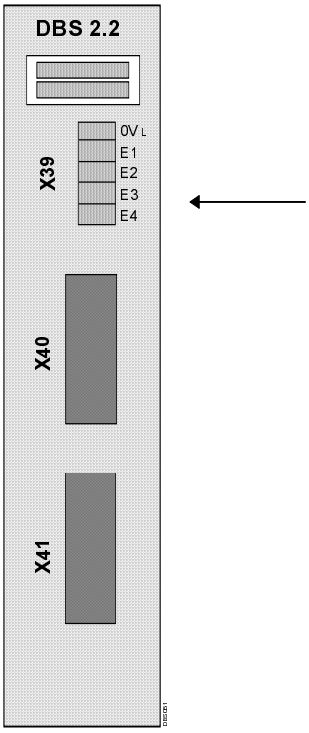
Objects for additional I/O levels

Object:	**5FE8**	**DEA4.1**	**15 inputs**	**(PD-IN)**
	5FEE	**DEA4.1**	**16 outputs**	**(PD-OUT)**
	5FE9	**DEA5.1**	**16 inputs**	**(PD-IN)**
	5FEF	**DEA5.1**	**16 outputs**	**(PD-OUT)**

The process or PCP channel can be used. Note real-time capabilities!

If these objects are **not** used in the process data channel, then there exists the possibility that data will be handled via the PCP channel. In this case, however, real-time will be lost. Data output via the PCP channel is only then possible if the object is not applied to the process data channel (PD). Data input is always possible either via the PCP or the process data channel (with applied object).

3.2 DBS 2.2 Hardware Inputs



The Interbus-S interface module has four potential-free hardware inputs to be used for the following functions:

Input	Function	Active
E1	**not used**	**high**
E2	**reference cams**	**high**
E3	**ventilate brakes, ext.**	**high**
E4	**emergency stop**	**low**

The four inputs have 24 volts. The precise data are outlined in the Tecnical Data Sheet.

The inputs cannot be queried via the process data channel. There is the option, however, of reading the inputs via the PCP channel.

The following objects are available for this purpose:

Object 5FF4 DBS 2.2 inputs

The object is assigned as follows:

Object 5FF4 (R) Inputs:

X X X X X X X X X X X X X X X X DBSD 2.1

E4
E3
E2
E1
not used

4 The DRIVECOM Status Machine in Target Position Setting Mode

In the main mode of the DBS 2.1 module, the digital drive controller is placed under the control of a status machine as per profile 21.

The status machine controls NC and drive controller

This **status machine** describes the internal unit states of the drive controller and displays this state in the **status word**. The **control word** can be used to set a specific drive state. The commands to do so are called the **unit control commands.**

An extensive description of the status machine is specified in DRIVECOM profiles 21 and 22 dated August 1994.

As the behavior of Indramat's AC servo drive is different from that of a frequency converter, for which the command and status messages in profile 21 were actually defined, it is necessary to adjust the status machine to correspond to the relevant commands and status messages.

Indramat's status machine is illustrated in Figure 4.1.

Explanations about the status machine, Figure 4.1:

Unit status shown in status word 6041

The status of the unit as shown in the status word of object 604 is shown within the status field. Only bits 0 to 7 of the status word are relevant to the status of the status machine. Bit 0 is shown on the right.

Commands generated via control word 6040

Transitions are highlighted. In addition to the transitions, results are also shown (commands) that are generated by the master via control word object 6040. In the control word as well, only bits 0 to 7 are of importance which is why only these are shown. Both control word and status word have 16 bits each.

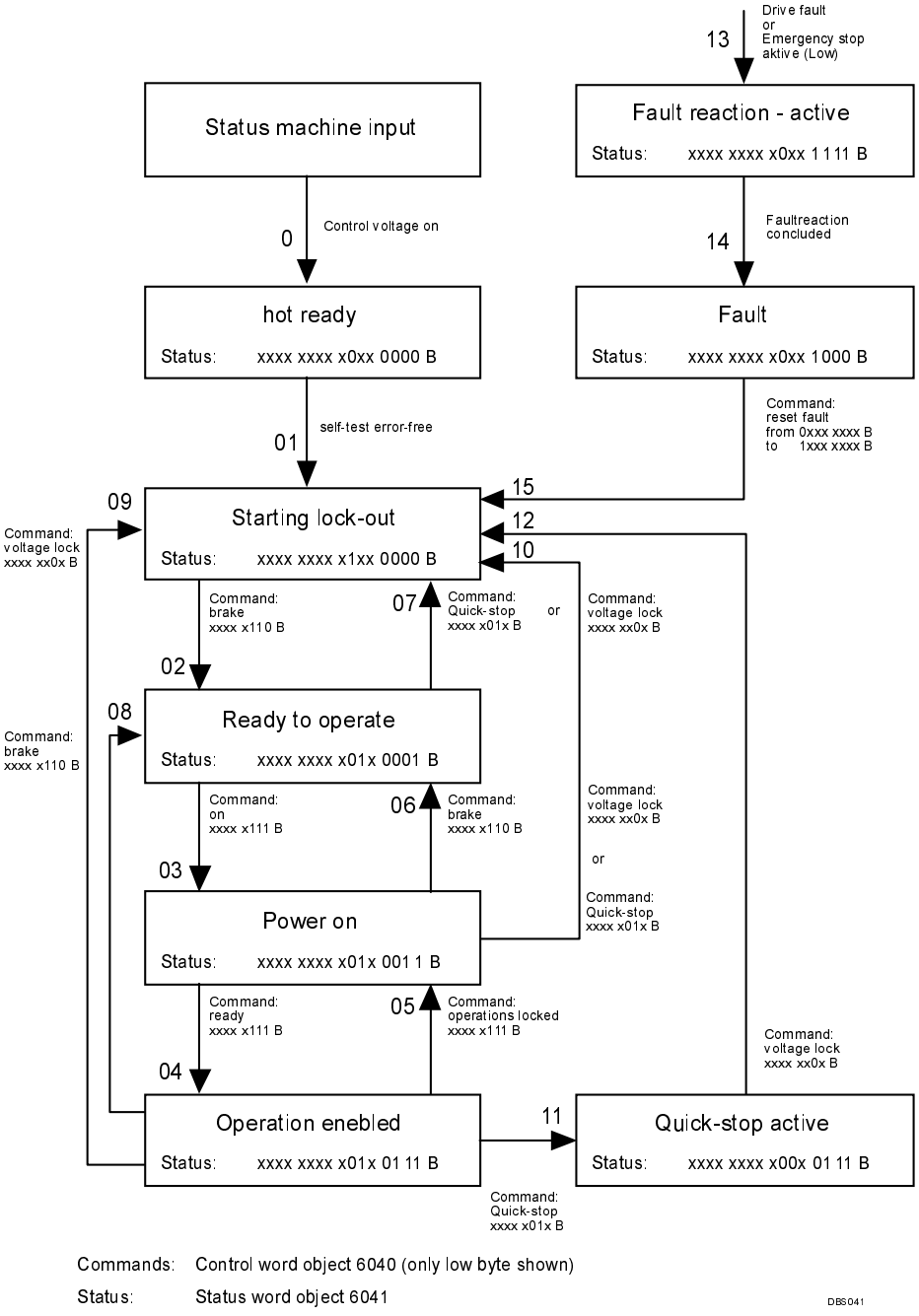


Fig. 4-1: Status machine as per DRIVECOM profile 21

4.1 The Status and Control Words

Control word: 6040

Status word: 6041

If a digital, intelligent drive controller is being operated in either speed set mode or in one of the auxiliary operating modes, e.g., homing, then all control processes and commands are initiated with the use of a control word, i.e., object 6040. This control word contains the commands for the status machine and the control bits for handshaking when setting the target position. User-specific auxiliary signals are also transmitted in this control word.

The current status of the digital drive controller can be queried with the use of the status word, object 6041. The status word contains both the state of the status machine (section 4 and Figure 4.1) and the status of the user-specific status information.

Both the status and control words are mandatory objects in DRIVECOM applications as specified by profiles 21 and 22. They are always the first word in the process data channel (PD) (after PCP channel).

Error status in separate objects! Only sum message in status word 6041!

Within the status word, bits 3, 7 and 8 are also used. These point to either an error status or a warning or message. The information can be read in the relevant object:

Object 5FF6 status of the drives (bits 0 to 7)

Object 603F DRIVECOM fault code

These objects can be applied in the process data channel but also read out of the PCP.

Figures 4.2 and 4.3 illustrate the assignment of both the control and status words.

Control Word 6040

Signal assignment in various modes:

Operating modes						
Bit	Mandatory	Velocity BA 2H				Homing BA6H
0	yes	Switch on				
1	yes	Lock voltage				
2	yes	Quick stop				
3	yes	Release enable				
4						start home
5						
6						
7	yes	Reset fault				
8						
9						
10						
11		start home				
12		torque limit active				
13		spindle positioning on				
14						
15						imm. stop

Status Word 6041

Signal assignment in various modes:

Operating modes					
Bit	Mandatory	Velocity BA 2H			Homing BA6H
0	yes	Ready to switch on			
1	yes	Switched on			
2	yes	Enabled			
3	yes	Fault Fault = high			
4	yes	Voltage locked			
5	yes	Quick stop			
6	yes	Starting lockout			
7		Warning			
8		Message			
9	yes	Remote			
10	yes	Command value reached			
11	yes	Limited value reached			
12					home found
13					homing error
14					
15		Spindle position reached			

4.1.1 Control Signal Descriptions

Control signals of the status machine are set via control word 6040

The signals depicted in control word 6040 have the following definition:

Control word 6040

Signal Switch on Bit: 0 (high)

Upon completion of a successful initialization of the Interbus-S DBS 2.1 module and the self-test which follows this, this signal is used to prepare the drive for the drive enable signal. After a correct start up sequence that derives from the status diagram, status "XX23" is signalled upon completion of the command and if **power is present**. If power had **not** been previously switched on, then the status remains in state "XX21".

Signal Lock voltage Bit: 1 (low)

This signal brings the drive back into the "switch-on inhibit" state. Drive function is locked. If power is still being applied (separate power section), then the status machine can still be run up via the command "standstill". Upon completion of the command, status "XX40" is signalled. The quick stop signal releases, given a drive enable, an immediate stop by setting the "drive stop" signal (internal signal). A drive in motion is brought to a stop with the greatet possible deceleration delay. Status "XXX7" is signalled out of this state. Any renewed start ups of the status machine is now only possible via the command "lock voltage". If the "quick stop" signal is activated in "ready", status "XX21", or "ON" status "XX23", then the status machine is brought into "Switch-on inhibit", status "XX40".

Signal Operation enable Bit: 3 (high)

This signal brings the status machine, after it has reached the "ON" state, into status "XX23", into state "ready for operation", status "XX27". This sets the drive enable and the drive goes into drive status 2AF" once power is switched on.

Note! The drive is now in control mode!

Signal Homing (BA6H) Bit: 4 (high)

If this signal is set too high while in operating mode BA 6, homing, then a homing procedure is initiated. The homing velocity specified in **object 6099** is used for this purpose. Which homing cycle (mode) may be used, can be specified by the user in **object 6098**.

Signal Reset fault Bit: 7 (high)

If either a fault, message or warning is set in the status word, then a reset is possible once the problem has been eliminated or once the message has been read. This can be done by setting the bit to "high".

4.1.2 Status Signal Description

The signals shown in status word object 6041 are defined as follows:

Status word 6041

Signal Ready for power **Bit: 0** **(high)**

This signal identifies the state "ready to operate" of the status machine which has reached the command "standstill", for example.

Signal Switched on **Bit: 1** **(high)**

This signal is reached after the command "power up", if the ready to power up state was previously reached. The signal "ready to power up" is signalled additionally.

Signal Operation enable **Bit: 2** **(high)**

After power has been switched on, the drive can be brought into "operation enabled" with the command "operation enabled". The status machine will, in this case, accept status "XX27". Once this bit is set, then the drive enable is also set and the drie is in control mode which is also identified with the drive status "AF" and which can be read in object 5FF6.

Signal Fault **Bit: 3** **(high)**

A problem in the status machine, a drive error or a problem in the DLC 2.1 sets this signal. The precise cause of the fault can only be determined by reading the diagnosis object 5FF6 (drive and DLC diagnoses) and 603F (DRIVECOM status).

Signal Voltage locked **Bit: 4** **(high)**

This signal is not presently in use.

Signal Quick-stop active **Bit: 5** **(low)**

This signal is set to low if the command "quick stop" is issued. After a "quick stop", it is necessary to run the status machine up again, as described. If the quick stop signal is set, then the drive stastus "AH" is simultaneously set (103D; 67H).

Note: The drive remains in control mode!

Signal On lockout **Bit: 6** **(high)**

This signal is reached after every "lock voltage" command. A "reset problem" can also set this signal after a problem. The only way out of this

state is by means of a "standstill" command of the drive, followed by a renewed start-up sequence of the status machine.

Signal Warning **Bit: 7** **(high)**

Warnings are set if the drive generates "warnings". At present, all diagnostic messages "5X2" of the drive diagnostics generate this signal. Warnings must be reset or acknowledged. Once the cause is cleared, the DBS 2.1 module resets this status bit.

Note: Warnings, especially those from the drive, often generate error messages causing the controller to be shut down.

Signal Message **Bit: 8** **(high)**

If the message bit is set then object 603F must be read in order to specify the message. In module DBS 2.1, all use of the brakes (external controls via DBS 2.1 input E3) cause the setting of the message bits. Messages do not cause the status machines to shut down, but they must be akcnowledged with command "reset error".

Note: Messages are only specified in the DRIVECOM status object 603F. The messages are also cleared after "reset error" is reset.

Signal Remote **Bit: 9** **(high)**

The "remote" signal is set if module DBS 2.2 can be parametrized via the PCP channel. DBS 2.2 module parametrization necessitates the support of the PCP by the master.

Signal Command value reached **Bit: 10** **(high)**

The signal "command value reached" informs the master that the set command value has been reached. This bit depends on the mode and is specified with a speed setting if the command velocity is reached and lies within the tolerance window.

Also note object tolerance window 5FFD !

Signal Limit value reached **Bit: 11** **(high)**

Presently not implemented!

In preparation! **Signal Limit value reached** **Bit: 11** **(high)**

This signal is set if the homing procedure has been successfully completed in "homing" mode (BA6). After the DBS 2.1 module has homed and set this signal, then a servo motor equipped with a singleturn encoder can output the positioin data in "speed setting" mode (BA2).

Note: Axes that have not been homed have no absolute reference!

4.2 Speed Setting per DRIVECOM Profile 21

Command value setting in object 6042

In operating mode "speed setting" as per DRIVECOM Profile 21, it is possible to set a speed command value directly via the Interbus-S using object 6042.

Once the status machine is run up (section 4.9), then the speed can be digitally specified via

Speed command value Object 6042

Tthe speed command value is set in object 6042 without any dimensions and is not converted into revolutions per mm until it has been computed with the

Dimension factor determines input unit!

Dimension factor Object 604C.

The dimension factor is outfitted with a multiplier and a divisor meaning that this object can determined every user-specific speed unit.

Object 604C

Multiplier (32 bit, integer 32)

Divisor (32 bit, integer 32)

Calculate as follows:

User unit x dimension factor = rpm

E x DF = A

User-specific determinations of user unit possible

E = value in object 6042
A = speed vaue in 1 / min. at motor shaft
DF = dimension factor in object 604C

$$= \frac{1}{\text{user unit}} \times \frac{1}{\text{min}}$$

The default setting, which takes effect immediately after the initial powering up, is 1 in both the multiplier and divisor, i.e., the unit 1 / min. results.

Also see securing parameters via object 5FE4!

Current speed

The message about the current speed is specified using the above calculation method in object

speed feedback vaue object 6044

The velocity, converted to speed at the motor shaft, is further restricted to its limit value by the object

velocity minimum / maximum amount object 6046

The minimum velocity value must be entered with zero. The maximum amount relates to the limits of the relevant application, but may not exceed the limit specified in the drive controller.

Module DBS 2.1 is also equipped with an internal ramp generator which applies a linear ramp to a jerky velocity change in the shape of an input variable.

This ramp can be specified separately via two objects for acceleration and deceleration:

Separate ramps are settable

Speed acceleration **object 6048**

Speed deceleration **object 6049**

The setting is made for both objects as follows:

$$\text{speed change} = \frac{\text{delta velocity}}{\text{delta time (seconds)}}$$

Objects 6048 and 6049 thus each have two subparameters, i.e., the value for velocity change delta V (unsigned 32) in the counter and the value for decel time (unsigned 16) in the nominator.

Setting

The setting is as follows:

Object 6048: **1000 : 1 (1000 user units / seconds)**

Object 6049: **3000 : 1**

Attention

The setting "zero" is not permitted in either counter or nominator of either object.

4.2.1 Torque Limit

In "velocity setting" mode as per profile 21, the user can set a dynamic torque limit. the torque limit is held available in object

Maximum torque amount **object 6072**

and specifies the limit in tenths of one per cent of the nominal torque.

Note

It must be noted that this is purely a nominal torque limit and not a torque setting in terms of torque control.

Torque control is onlyx active if bit 12 has been set in

Object 6040 torque limit active bit 12 (high).

Torque feedback value via PD or PCP

The current torque feedback value can be read out of

torque feedback value object 6072.

This object is available in both the process data channel and via the PCP:

4.2.2 Position feedback vaue in velocity setting mode

Module DBS 2.1 makes available, in addition to the mandatory objects in profile 21, the position feedback value as a 32 value bit via object

Position feedback value object 6064 (32 bits)

This option is presently only available in objects:

Multiturn DSF and
Multiturn resolver.

Objects
multiplication factor position feedback value object 5FFE
and
division factor position feedback value object 5FFF

can be used to adapt the position feedback value to the application-specific dimensions. Both objects have a word length of 32 bits.

Scaling position information

Note that the position feedback value is made available to the encoder with a scaling of 2 *** -20. Bits 0 through 19 specify the position with a revolution. Bits 20 to 31 specify the number of revolutions the encoder has completed. A maximum of 4,096 revolutions (0 to 4096; 0 to FFFH) are possible.

A singleturn encoder also makes a total range of 4096 revolutions available after honing. If at any time the control voltage is shut off, however, then the encoder returns to position "zero" after power is returned (bits 20 to 31 = 000H). The value "within" the revolution remains absolute.

4.2.3 Homing

This function is presently not in use.

4.3 Object Directory of Module DBS 2.1

Manufacturer-independent data structures using object descriptions

To make data exchange between master and Interbus-S equipment at the bus possible between different manufacturers, the Interbus-S uses socalled objects are are compiled in an object directory (index). Objects are described more closely in terms of attributes (names, data types and

so on) so that the master has a very precise knowledge of the structure of the object.

The master, in turn, must administer all objects used by means of the structure allocated to the objects.

Interbus-S supports static objects, in other words, those that are already projected which can neither be deleted (dynamic) nor redefined.

Readable object directory

The Interbus-S DBS 2.1 module supports a number of static objects are are compiled in an object directory. They can be read using the PCP service **Get OV**.

There are two groups of Interbus-S objects used in the DBS 2.1:

DRIVECOM objects (index no. 6000 ...)

USER objects (Index no. 5000 ...)

The DRIVECOM objects are largely recruited from the objects described in profiles 21 and 22.

User specific objects: 5XXX .. 5FFF

The USER objects are used in Indramat DBS 2.1 modules to define the I/O level. Also, object descriptions have been fixed so that they can be used in addition to profile definitions.

The objects used in module DBS 2.1 are described in Table 4.3.1. Note that all objects listed there an be read via the PCP channel, but not every object has write-access capabilities.

An additional limits applies to the allocation to the process data channel:

Objects via the process data channel

Objects applied to the process data channel are especially identified. It thereby applies that R/W (read/write) objects process output data and R(read) objects are process input data.

Note: Objects applied out of the process data channel can only be read via the PCP channel!

User-specific configuration of the process data channel as of DBS 2.1 SN 1025

The user can determine which object can be applied via the process data channel be describing the

process output data object 6001

for those objects that the master transmits to the drive controller and

process input data object 6000

for objects that are transmitted from the drive controller to the master.

Note: If a configuration is selected for DRIVECOM profile 21 then the mandatory configuration must be taken into consideration. It is possible to apply additional objects but these cannot be subdstituted for the mandatory objects. The maximum number of words is six (without PCP).

DRIVECOM Communications Objects for DBS 2.1 Module

Index	Type	Object code	Access rights	Mandatory (M) Optional (O) BA spec. (B)	PD	Setting	Description
6000	PDB	rec.	R/W	M	no	table	pro. input data des.
6001	PDB	rec.	R/W	M	no	table	pro. output data des.
6002	Bool	var.	R/W	M	no	FFH	pro. output data rel.
6003	u16	var.	R/W	O	no	2000 (ms)	pro. data mon. time
600F	Oct.	array	R	M	no	1210;2210 2220;2240	funktion group des.
603F	Oct.2	var.	R	M	yes	0	DRIVECOM fault
6040	Oct.2	var.	R/W	M	yes	0	DRIVECOM control
6041	Oct.2	var.	R	M	yes	0	DRIVECOM status
6042	i16	var.	R/W	M	yes	0	speed com. val. 21
6044	i16	var.	R	M	yes	0	speed fdbck. val. 21
6046	u32	array	R/W	M	no	0/3000	speed min/max
6048	Ra	record	R/W	M	no	1000/1	speed accel
6049	Ra	record	R/W	M	no	2000/1	speed decel
604A	Ra	record	R/W	O	no	? (open)	speed quick stop
605A	i16	var.	R/W	O	no	0	quick stop/E-stop
6060	i16	var.	R/W	M	no	1 *)	DRIVECOM op. mod.
6061	i16	var.	R	M	no	1 *)	DRIVEC. mode dis.
6064	i32	var.	R	B	yes	position	pos.fdbck.value
6072	u16	var.	R/W	O	yes	? (open)	torque max.
6077	u16	var.	R	O	yes	0	torque fdbck. value

User-Specific Communications Objects for DBS 2.1 Module

Index	Type	Object code	Access rights	Mandatory (M) Optional (O) BA spec. (B)	PD	Setting	Description
5FDE	i16	var.	R/W	0	yes	0	AK1 analog val.
5FDF	i16	var.	R/W	0	yes	0	AK2 analog val.
5FE1	u16	var.	R/W	0	no	0	select criteria
5FE3		array	R/W	0	no	0	drive para. (DBS2.1)
5FE4	u16	var.	R/W	0	no	0	sec. para. com.
5FE7	u16	var.	R	0 locked	no	0	int. DBS diagnosis
5FE8	u16	var.	R	0	yes	0	DEA 4.1 inputs
5FE9	u16	var.	R	0	yes	0	DEA 5.1 inputs
5FEA	u16	var.	R	0	yes	0	DEA 6.1 inputs
5FEEE	u16	var.	R/W	0	yes	0	DEA 4.1 outputs
5FEF	u16	var.	R/W	0	yes	0	DEA 5.1 inputs
5FFO	u16	var.	R/W	0	yes	0	DEA 6.1 inputs
5FF4	u16	var.	R/W	0	no	0	DBS 2.2 inputs E1-4
5FF6	u16	var.	R	0	yes	0	DLC2.1/drive
5FFD	u16	var.	R/W	0	no	10D	tolerance window
5FFE	u32	var.	R/W	0	no	1	pos.fdbck.val. mult.
5FFF	u32	var.	R/W	0	no	1	pos.fdbck.val. divisor

4.3.1 DRIVECOM Object Description

This description assumes a basic knowledge of object structure. This is extensively described in the documents "**Interbus-S, DIN 19258**" and "**Interbus-S, Profile 21, Sensor / Actor**".

Additional profile-specific objects are outlined in **"DRIVECOM Profiles 21 and 22, General documentation**".

Process input data illustrated

Object 6000 process input data description

This object specifies which object is to be illustrated in the process data channel and in what order in direction of the master.

Example: mandatory object for profile 21 illustrated

status word	6041	(1 word)
velocity feedback value	6044	(2 words)

Process data lengths ------->	06	PD length (bytes)	
	6041	first byte	
	00		1 word
	0000	second byte	
	00		
	6044	third byte	2 word
	00		
	0000	fourth byte	
	00		

Process data channel:

Word 1		Word 2	
1st byte	**2nd byte**	**3rd byte**	**4th byte**
Status word 6041		**Actual velocity value 6044**	

Object 6001 process output data description

This object specifies which objects are to be applied in the process data channels that are to be transmittd by the master in the direction of the DBS 2.2.

The structure corresponds to object 6000.

Object 6002 process output data release

Release process output data

Each **bit** in this object is allocated to **one byte** of the "process output data description". If this bit is "1", then the relevant object is released by the master to the slave. During a dynamic reparametrization, these bits are changed and must be set again.

Example:

Process output data description

6001

06	
6040	bit 0
00	
0000	bit 1
00	
6042	bit 2
00	
0000	bit 3
00	
0000	bit 4
00	
0000	bit 5
00	

6002

Process output data description

If an object occupies several bytes, then the **first byte is relevant** for the release of the object.

Object 6003 process data monitoring time

Process monitoring with watchdog

The user uses this object to specify the maximum amount of time between two Interbus-S cycles on the process data channel so that new data can be made available before the watchdog is actuated.

Monitoring time must suit the entire system. If the watchdog detects that time has been exceeded, then the status machine is switched off and all output words (DEA) that may still be present will be deleted.

Object 600F function group description

This object describes which function group in which profile i the module is to be used.

Object 603F DRIVECOM fault code

Drivecom fault code

The Drivecom fault code (even messages and warnings) are illustrated in this object.

Object 6040 DRIVECOM control word

The master writes the control commands and signal for equipment control in this object.

Object 6041 operating mode selection codes

The operating mode of the Interbus-S module is fixed in this object. The user can dynamically change the operating mode as long as the objects in the process data channel do not have to be redefined.

The valid operating modes are listed in Section 2.1. Upon completion of the switch, such is reported in object 6061.

Object 6060 operating mode select code

Drive controller operating modes

The operating mode of the Interbus-S is set in this object. The user can dynamically alter the mode as long as no redefinition of the objects in the process data channel is necessary.

The valid modes are described in section 2.1. Upon completion of the switch, such is signalled to object 6061.

Object 6061 operating mode display

Confirmation of set mode in controller

The user is informed of both the set and active modes in this object. This is generally the mode that has been set in object 6060. Additionally, the status of object 603F can be queried here.

Object 6064 position feedback value (32 bits)

Position feedback value

The position feedback value is illustrated in object 6064 in the same manner as it is made available by the drive. The position feedback value can, however, also be calculated with either a multiplier or a divisor to accomodate user-specific calculations.

It is computed in the Interbus-S module, not in objects 6089 and 608A.

Object 6042 speed command value profile 21

Speed command value

The speed command value is made available through object 6042 (16 bits) and has a qualifying sign (integer 16).

Object 6044 speed command value profile 21

The speed command value is illustrated through object 60442 (16 bits) and has a qualifying sign (integer 16).

Object 60464 speed minimum / maximum value

The minimum and maximum speed limit values are entered in object 6046. The limits are symmetrical.

Example:	minimum value:	0
	maximum value:	2000

The speed range includes

0 to -2000 and 0 to +2000

Object 6048 speed acceleration

Decel and accel ramps separate!

The linear acceleration ramp is set in object 6048. This object is made up of two subobjects, i.e., 6048.1 for delta speed and 6048.2 for delta time (seconds). Also see section 4.2 for details!

Object 6049 speed deceleration

As with object 6048, but interpreted as a decel (braking ramp).

Object 604C speed dimension factor

User-specific speed setting possible

This object can be used to adapt the command and feedback values to the user-specific dimensional unit. The object is made up of two subobjects, i.e., 604C.1 for 32 bit unsigned multiplier and 604C.2 as 32 bit unsigned divisor.

This is added to the command value of object 6042 and handed over to the drive controller. The velocity feedback value supplied by the drive controller is also added to object 604 and the results stored in object 6044 velocity feedback value.

In preparation **Object 604A speed quick stop**

The decel ramp for a quick stop and an emergency stop can be fixed with this object via E4 of the DBS 2.1.

In preparation **Object 605A quick stop select code**

The mode is selected with this object which applies to both the quick stop and the emergency stop. Especially the behavior of the status machine is fixed herewith.

Object 6072 maximum amount of torque

This object objects determine maximum motor torque (nominal torque). This object can only be reached via the PCP.

Object 6077 torque feedback value

The current torque value is illustrated via this object. The content can be transmitted either via the PCP or the process data channel.

4.3.2 A Description of User-Specific Objects

User-specific objects are not fixed in the profiles!

The user-specific objects of the DBS 2.1 module start with object number:

5XXX user-specific objects

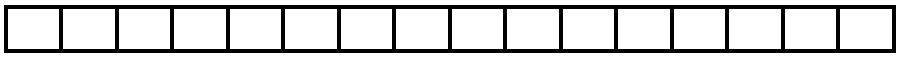
The DBS 2.1 module uses the user-specific objects primarily to integrate the I/O level in the drive controller equipment.

The diagnosis of the drive controller is also generated via the user-specific objects. This diagnosis is available in addition to the DRIVECOM diagnosis in the same code which is also described in the technical documentation of the drive controller (Fault Clearance Guidelines, doc. no. 209-0069-4357-00).

In preparation **Object 5FE1 Selection criteria for special function**

This parameter contains the selection and release conditions for the emergency stop function and analog signal outputs AKS1 and AK2 of the drive controller.

Parameter 5FE1



analog channel AK1
analog channel AK2
E-stop select
encoder select

Enable analog channels AK1 / AK2:

0 = output locked
1 = output analog value of +/- 10 V over AK1/AK2 if drive ready
2 = output as above but only if DRIVECOM status machine booted up
3 - 9 = not used

Emergency stop select

0 = effects servo axis
1 = effects analog channels, putting them to zero
2 = only effects analog channels, servo axis remains functional

In preparation **Object 5FE3 drive parameter (array)**
(data interchange object)

This object is used for data exchange between drive and master for parametrization. All parameters and data blocks of the drive are exchanged via this object in the relevant format (see section xx.x). This means that the Interbus-S module is independent of format and syntax of the transmitter parameter and block structure and is open for expansion.

This object can only be used via the PCP channel!

Object 5FE4 data save commands in EEPROM

Attention! Only available for modules starting from SN 01025!

All dawta save commands affecting all object contents in the EEPROM of module DBS 2.1 are issued via this object. Three commands are available. These are described in detail in section 7.2.

Commands:

Read EEPROM	**0001H**
Write EEPROM	**0002H**
Delete EEPROM	**0004H**

Once the command is issued, it must be checked whether the command has been properly executed or not. This is done by reading back the object (return code).

Object 5FE8 DEA 4.1 inputs

Section 3.1 describes the I/O level in connection with the Interbus-S circuit. If this object is illustrated on the process bus (PD.IN), then the master can query the 15 inputs of the DEA 4.1. The DEA 4.1 inputs can be assigned as needed.

The inputs are illustrated in the object as follows:

Input 1	**(x17.1)**	**object 5FE8**	**bit 0**
Input 15	**(x17.15)**	**object 5FE8**	**bit 14**

Bit 15 in object 5FE8 remains unused and is constantly held at low once a DEA 4.1 module has been inserted. **A non-inserted DEA 4.1 module** generates the value **FFFFH** in object 5FE8.

Object 5FE9 DEA 5.1 inputs

This object is used to illustrate the inputs of the DEA 5.1 module on the BUS. If the inputs of the DEA 5.1 module are not used simultaneously, then the user can assign these inputs as needed. BUS behavior is describe din object 5FE8 and applies here.

Object 5FEA DEA 6.1 inputs

If a DEA 6.1 module is installed, then the inputs of the DEA 6.1 module can be illustrated via this object. The description of the behavior of objects 5FE8 and 5FE9 apply here as well.

Hinweis

The digital controllers DDS2.1 asnd DKS as well as the DDC are only equipped with four module slots. This means that no more than three DEA modules can be used. Which module can be used is fixed in the configuration list with the relevant configuration designations.

Object 5FEE DEA 4.1 Outputs

Direct signal output of Interbus-S to DEA 4.1, 5.1 and 6.1 outputs

The 16 outputs of DEA 4.1 are controlled directly by the Interbus-S. The user can assign these as needed. It must be noted that the output sttus is not valid if the drive controller is signalled "ready to operate".

Object 5FEF DEA 5.1 Outputs

The output for DEA 5.1 is analog to object 5FEE.

Object 5FFO DEA 6.1 Outputs

The output for DEA 6.1 is analog to object 5FEF.

Object 5FF4 Inputs E1 .. E4 of the DBS 2.2 Module

The inputs E1 to E4 on the DBS 2.1 module can be queried by the mater via object 5FF4. **The query can only take place via the PCP channel.**

The definition of the signals and their allocations to the BUS is described in section 3.2.

Note:

The inputs of module DBS 2.1 are permanently allocated to the functions described in section 3.2 and are no user signals.

Object 5FE6 Drive diagnostics

Diagnostics messages of the drive controller are in this object:

The following allocations apply:

Bit 15	Bit 18	**Bit 7**	**Bit0**
Reserved for DLC		Drive diagnostics	

The codes correspond to the data as specified in the documentation on the relevant drive controllers. Also see "Fault Clearance Guidelines", doc. no. 209-0069-4357.

5 DRIVECOM Fault Codes

DRIVECOM fault codes are generated out of the drive diagnostics

The DRIVECOM fault code, generated as specified in profiles 21 and 22, can be illustrated in object 603F.

As a rsult of the technical differences between frequency converters and digital AC servo drive systems there can be no complete conversion. User-specific fault codes or messages were assigned to those areas released for user-specific determinations.

The diagnostic messages in object 5FF6 (low byte) completely correspond to those of drive diagnostics and as displayed via the two-place LEDs of the controller.

In addition to the diagnoses in object 603F, the following signals are also set in status word 6041:

Messages	**bit 8**	**is set with**:	
		brakes ventillated	9018

Messages do not stop the drive

Messages can be reset with signal "fault reset" in control word 6040. They do not generate a shut down of the status machine, the drive remains functional:

Warnings	**bit 7**	**is set with**:	
		attempted brake ventillation with power ON	9012
		attempted brake ventilation with speed > 10 rpm	9014
		all drive diagnoses between 50H and 5FH	

Warnings can lead to faults

Brake warnings do not have to be reset with signal "reset fault". They are automatically cleared upon removal of signal "ventillate brakes" (E3). All other warnings can only be reset with a "reset fault" in control word 6040. Not all warnings lead to a reset of the status machine so that the drive remains functional.

Faults	Bit 3	is set with:
		all other diagnostic messages that do not generate messages or warnings

Faults effect shutdown of status machine

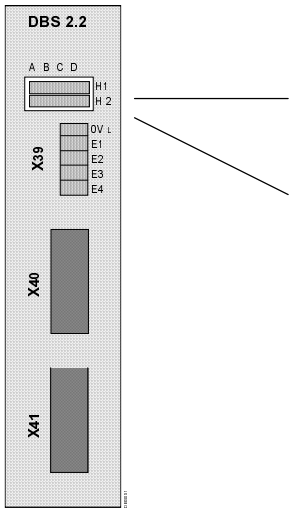
Faults bring about an immediate standstill of the drive and the shutdown of the status machine.

After a fault and its clearance, it is necessary to reset the fault with a "reset fault". The drive must be returned to operation by rebooting the status machine.

DRIVECOM Diagnostics Messages in Object 603F

Drive diagnostics	Designation	DRIVECOM error code
18	Amplifier overtemperature shutdown	4210
19	Motor overtemperature shutdown	4310
20	Bleeder overtemperature shutdown	4315
21	Control voltage error (cummulative message)	5110
22	Motor encoder error	7300
24	Overcurrent (Iu, Iv, Iw > 1.5 * unit nominal current)	2310
25	Overvoltage error (U DC bus > 475 volts)	3210
26	Overvoltage error (U DC bu < 150 to 200 volts)	3220
33	Error external voltage supply (nominal 24 volts)	9100
50	Amplifier overtemperature (Warning)	4211
51	Motor overtemperature (Warning)	4311
52	Bleeder overtemperature (Warning)	4316
60	Bridge fuse	5454
61	Ground connection fuse (Iu + Iv + Iw > 0.5 * unit nominal current)	2320
67	Hardware synchronization (internal PLL)	8101
68	Error brake (braking current > 2.5A or < 0.2 A)	7110
69	+ / - 15 volt error	5111
70	+ 24 volt error	5112
71	+ 10 volt error, current measuring module	5114
72	+ 8 volt error, motor encoder voltage	5115
73	driver voltage (U driver) error	5116
76	Position feedback value exceeds monitoring window range	8600
78	error in velocity control loop	8400
83	error when reading amplifier data	6301
84	amplifier data invalid	6302
87	parameter memory data invalid	5520
88	error while reading motor data	6303
91	configuration error	5520
92	read error of absolute encoder reference position	7320
93	watchdog error (no communications with DBS 2.1)	8510
94		
---	emergency stop of DBS 2.1 active (E4)	9400
---	not available	9022
---	not available	9024
---	external brake control on; power on	9012
---	external brake control on; speed > 10 rpm	9014
---	external brake control on; brake ventillated	9018
---	parameter loss of the DBS 2.1 module	6310

5.1 The Diagnostic LEDs of the DBS 2.1 Module



The DBS 2.1 module has a total of eight (8) diagnostic LEDs arranged in two rows on the upper part of the module.

LED H1 (H1A to H1D)

LED H2 (H2A to H2D)

The LEDs are primarily intended for use for interbus diagnostics. As a result, the Interbus-S standard defines them.

There are, however, DBS 2.1 module diagnostics in the bottom LED row.

The LEDs H2A and H2C to be used for DBS 2.2 diagnostics

Diagnostic LEDs	Color	Symbol	Definition
H1A	green	UL	voltage supply of Interbus-S working
H1B	green	BA	process data transmission Interbus-S active (bus active)
H1C	green	TR	Interbus S PCP transmission active (transmit receive)
H1D	green	RC	Remote BUS check to previous Interbus-S unit working
H2A	red	SW run	DBS 2.1 software running (pulse of about 1 second)
H2B	red	reserve	
H2C	red	Sync	synchronization to drive working
H2D	red	RD	remove BUS disable (conductive BUS)

6 Special Functions

6.1 External Brake Control

Some applications require that is is possible to release the holding brake built into the drive, such as, for example, when making adjustments within the installation.

This necessitates especial care as particularly hanging axes represent that danger of damaging the machine or injuring personnel.

There is an input on plug-in connector X39 in the Interbus-S DBS 2.1 module especially intended for handling the function "ventillate brakes".

Function "ventillate brakes" DBS 2.1 X39/ E3

As this function entails the hazards and dangers described above, ventillating the brakes is affected not just by setting input E3 to +24 volts, but rather the user must generate a series of prerequisites before this function can be activated. The functions conducted in the drive controller for ventilating the holding brake with strnasition to "set drive enable" (AF status) is not affected.

If the user wants to ventilate the holding brake via E3, then the following prerequisites must first be met:

Prerequisites for ventilating brakes

The power to the drive controller must be off.

Speed prior to opening msut be less than 10 rpm.

The external brake control in the drive controller must be enabled.

Default: external brake ventilation must be locked!

If these conditions are not met then by applying *24 volts to input E3 of the DBS 2.1 module, then the brake can be ventilated. Both in the event of a fault or with the execution of the function, the stastus in object 603F is diagnosed and then displayed with the relevant signals in the status word (see section 5.1) The following messages or warnings are generated in object 603F:

Brake ventillated	9018
Brake control on, power still on	9012
Brake control on, speed < 10 rpm	9014

User fully responsible for "ventillate brake" function

Attention:

Indramat would like to in particular point out that the user assumes complete responsible for the use of the function "ventilate external brakes". The user must take especial care in the case of hanging axes.

6.2 Emergency Stop Function

The DBS 2.1 module has an input on plug-in connector X39 for the emergency stop function:

Emergency stop input DBS 2.2 X 39 / E4

The drive can **bring** the Interbus-S to a **stop** with this input. If + 24 voltzs are applied to this input, then the emergency stop function is inactive. Removing the signal activates the emergency stop function which has the following effect, depending upon the parametrization:

Mode 1 Default setting

Status machine set to XX08H

The servo axis is brought to a quick stop (AH). Once standing still, the drive enable is removed. The status machine is brought into the "quick halt" and "fault" state.

This can only be reached through "reset fault" in control word 6040 followed by running up the status machine back into a ready state if +24 volt were previously applied to input E4.

Mode 2 Presently not implemented

Drive is stopped, status machine remains on

Only "quick halt" (AH) is applied to the servo axis. The removal of the "emergency stop" (+24 volts applied to E4), will start the drive back up.

The user must organize the correct command value setting himself.

The setting is made in object 605A (quick halt - selection code).

Quick halt selection code	**object 605A**
Mode 1	**code: 0000**
Mode 2	**code: 0002**

In both cases, fault code 9400 is generted in object 603F as described in section 5.0:

Emergency stop active object 603F 9400

The fault bit is also set in status word 6041 in mode 1. In mode 2, the warning bit is set instead of the fault bit. The warning bit, in contrast to the fault bit, does not have to be cleared with "reset fault".

In preparation

The emergency stop siganl can affect, depending on the setting in object 5FE1, either the servo axis or the analog channels used. The user makes the selection. If a "main spindle drive" is operated via an analog channel, then a general shutdown is not always the intention when stopping the servo axis.

Object 5FE1 selection criteria default: 0000H

X X X X

Analog channel AK1

analog channel AK2

emergency stop selection

not assigned

Emergency stop selection:

0	emergency stop only effects servo axis **(default)**
1	emergency stop only effects servo axis and sets the channels and sets it to 0 volt output
2	emergency stop only effects servo axis and sets the channels and sets it to 0 volt output

Note: Analog channels are presently not in use!

7 Securing Parameters (In Preparation!)

7.1 Securing DBS 2.1 Module Parameters

All DBS 2.1 parameters stored in Interbus objects

All parameters (objects) with **R/W access** can be changed via the PCP channel by the master. This means that the basic setting (default), fixed by Indramat at delivery, and which applies to the object initialization after powering up, can be overwritten by the user at any time. The user can change these objects **dynamically** during operation and **secure them permanently, if necessary**.

Store parameters dynamically or permanently

The data are permanently backed up on the EEPROM so that data content are always maintained even with a power failure and no battery backed up system.

Note:

Write-access EEPROMs up to 100,000 times

EEPROMs have an upper limit for R/W cycles so that a dynamic change in parameters does not mean that they are automatically stored in the EEPROM.

Only if the application requires it, or if permanent changes (user-specific settings) are made should the command for permanent data storage be given.

7.2 Command to Secure Data in EEPROM

For permanent back up of parameters (objects) only:

Data backup via EEPROM possible with hardware as of SN 1025

object 5FE4 command to secure data

is available for objects which can be reached via the PCP. The following commands can be applied to the object:

DBS software

EEPROM	**read**	**0001H**
EEPROM	**write**	**0002H**
EEPROM	**delete**	**0004H**

After a command is output it is necessary to read object 5FE4 to obtain the return code:

Query return codes

returncode	**0 =**	**faulty command execution**
returncode	**1 =**	**command could not be executed**

Read EEPROM command:

After a dynamic change in the object, it is possible to reset the previous state using this command (stored state). If the EEPROM contains no

data, then the default values as described in object list in seciton 4.2 will be used.

Command write EEPROM:

Conduct permanent parameter backup

If this command is issued after a dynamic change in the objects, then the changed object contents must be stored permanently in the EEPROM.

After the DBS 2.1 module is swtiched back on, these object contents and not the default values are loaded. The user should use this command in those cases where user-specific parametrizations are to be loaded in place of default settings.

Command clear EEPROM:

Default settings effective at restart

This command writes "FFH" into the EEPROM so that when the DBS 2.1 module is switched back on the default values, as ddescribed in section 4.3, are again valid. The user can change the parameters dynamically at any time and re-write the EEPROM again.

Note:

If a new parameter setting is to be stored, then it is not necessary to clear the EEPROM before hand.

Structure of object 5FE4:

Object 5FE4			**bit 0**
not in use			

Note:

Function available as of serial no. 01025 and DBS software

The function "permanent data back up" via EEPROM is only asvailable for those modules delivered after June 1995 with serial numbers 01025. These modules are functionally downard compatible, i.e., older modules can be replaced by new modules without compatibility restritions.

Modules with SN < 1025 cannot be equipped to this function.

The new function additionally needs hardware expansion with relelvant software that supports such functions. This will be available after calendar week 45 / 1995.

7.3 Parametrizing the Drive via Interbus-S

The DBS 2.1 module makes it possible to completely parametrize the drive controller via the Interbus-S.

This function is only available for Interbus-S modules DBS 2.1 starting from serial numbers 01025 (delivery date after June 1995).

A data exchange object is defined in the DBS 2.1 module to parametrize the drive. This can handle all the parameters of the drive.

Object 5FE3 DBS 2.1 / drive parametr - array

This object has R/W access and can only be reached via the PCP.

7.3.1 Reading Drive Parameters

8 Terminal Diagrams

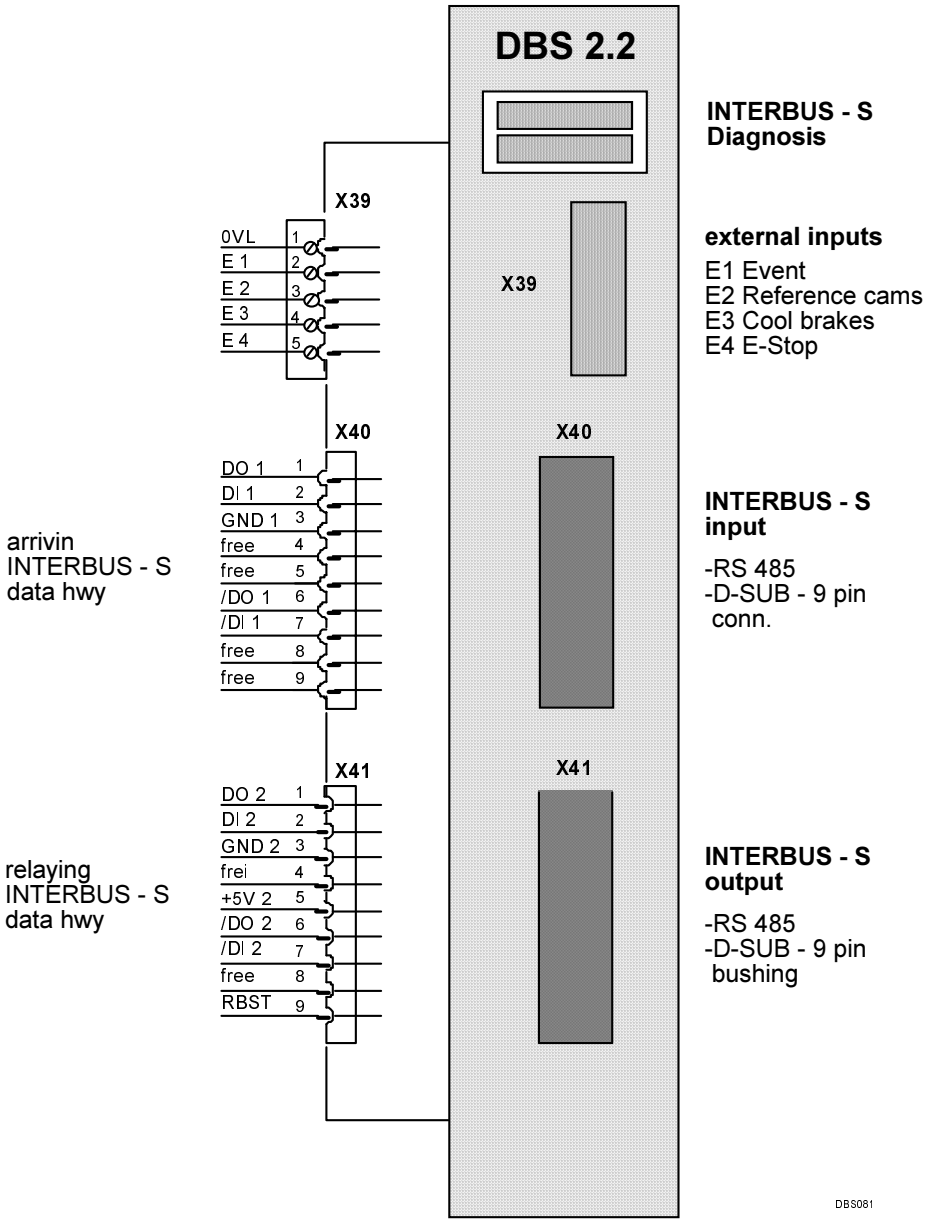


Fig. 8-2: Terminal diagram of the DBS 2.2

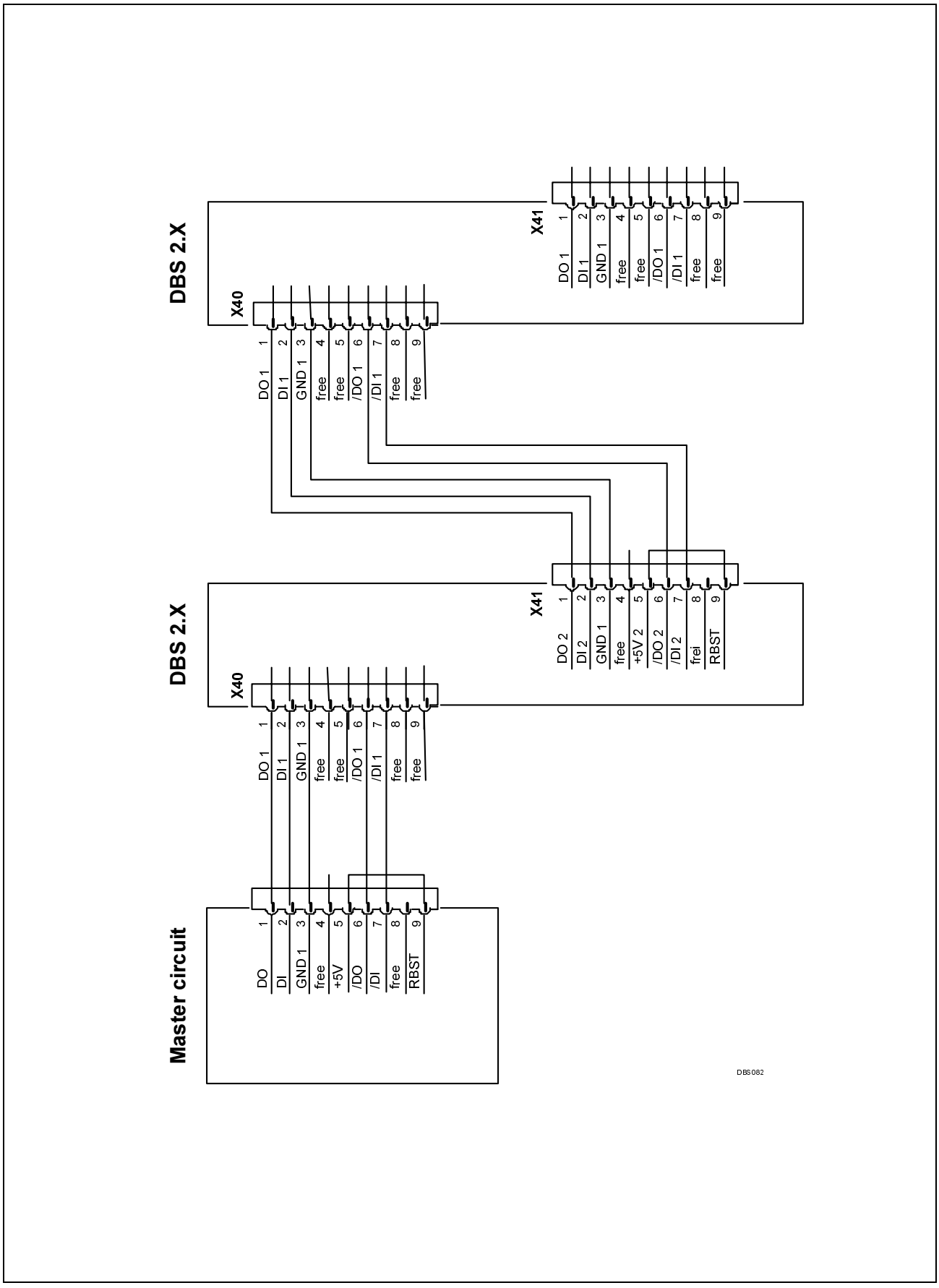


Fig. 8-3: Master circuit with two data highway subscribers

9 Connector Accessories

9.1 Sets

Depending on the configuration, the following connectors are needed:

Configuration	Pcs.	Connector	Part no.:
Connector accessories kit for the following configurations:			
DC01-01FW	1	IN456;D-SUB, 9 pin Male	257046
	1	IN457;D-SUB, 9 pin Female	257045
RC01-01FW	1	IN439;D-SUB, 15 pin Male	252884
Connector accessories kit for the following configurations:			
DC02-01FW	1	IN523;D-SUB, 37 pin Female	263369
	1	IN456;D-SUB, 9 pin Male	257046
RC02-01FW	1	IN457;D-SUB, 9 pin Female	257045
	1	IN439;D-SUB, 15 pin Male	252884
Connector accessories kit for the following configurations:			
DC03-01FW	2	IN523;D-SUB, 37 pin Female	263369
	1	IN456;D-SUB, 9 pin Male	257046
RC03-01FW	1	IN457;D-SUB, 9 pin Female	257045
	1	IN439;D-SUB, 15 pin Male	252884

Fig. 9-4: Connector sets

Part number for DBS2.1 : 261306

Note: The 5 pin female strip for plug-in connector X39 is always included and does not have to be ordered separately.


Indramat