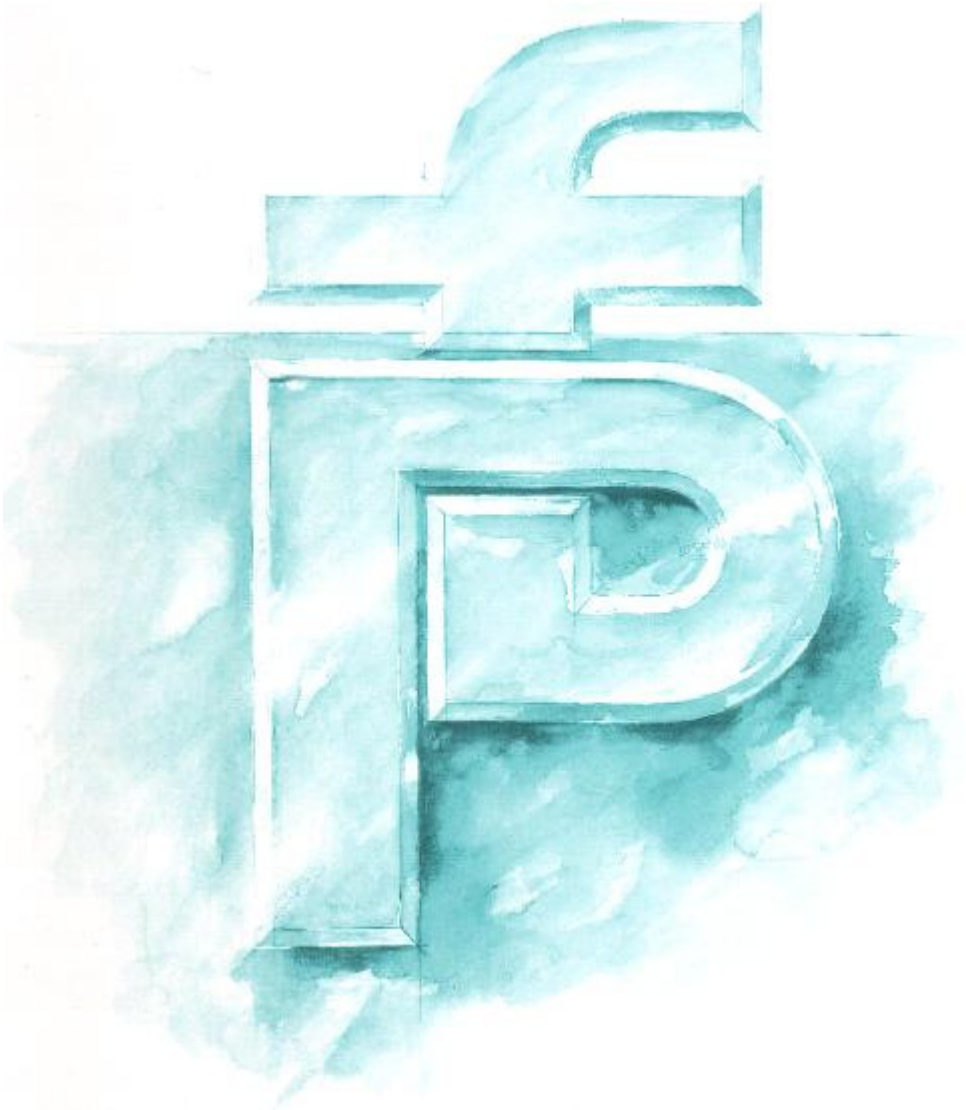
Implementation of the Identification System IVI-KHD2-4HB6 to a SIMATIC S-7 300 PLC



Contents

1 Hardware specification

1.1 Equipment and Devices

NAME	EXPLANATION	PRODUCER
PS 307 4A	Power supply PLC	SIEMENS
CPU 315-2DP	CPU with Profibusinterface	SIEMENS
IVI-KHD2/A6-4HB6	Identification System with Profibusinterface	Pepperl+Fuchs Group
IVH-30GM-V1	Read-/Write head	Pepperl+Fuchs Group

Table 1: Hardware components

1.2 Configuration and Installation

The configuration and the connection of the S-7 PLC components is extracting from the appropriate SIEMENS manuals.

The Identification System IVI-KHD2-4HB6 is appropriate to DC power supply. The voltage has to be a value of U_{DC} = 18V – 32V. The Identification System has to be connected by wire on the terminals 47 (+ brown) and 48 (- blue) to the power supply. By using an alternating current you have to use a supply module. In this situation the usage of the supply module KFA6-STR-1.24.500 is approved.

On the top side of the device there is a 9-pole connector (SUBD). This terminal connects the Profibus system to the Identification System. A bus termination is necessary if the IVI is the last device in the bus thread. There are two different options to realise a bus termination. You can use an inside the IVI integrated bus terminator or an bus terminator inside the male connector. By using the terminator of the IVI you have to turn the rotary switch on the side of the device to the S 1 position.

→ Profibus terminator active: rotary switch to S 1 position

Also on the top side of the device there is a DIP-Switch rail. The rail is used to adjust the Profibus address of the IVI-KHD2-4HB6. By the adjustment of the Profibus address it is necessary to attend that the Profibus address is not occupied by other devices. The following chart shows the necessary settings for the correct parameterisation of the Profibus address.

PROFIBUS ADDRESS	S1	S2	S3	S4	S5	S6	S7	S8
0	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF
1	ON	OFF	OFF	OFF	OFF	OFF	OFF	OFF
2	OFF	ON	OFF	OFF	OFF	OFF	OFF	OFF
……								
126	OFF	ON	ON	ON	ON	ON	ON	OFF

Table 2: Configuration of Profibus address

The Identification System IVI-KHD2-4HB6 is able to mount on a top hat rail or a wall. By mounting on a top hat rail you have to use a 35mm rail. If you mount the IVI on a wall you have to pull out the four brackets on the back side of the unit. The unit can be easily screwed onto the wall through the holes in the brackets. The screw pair spacing is 90mm and you can use screws with a dimension of M5. More information is available in the manual “IVI-KHD2-4HB6”.

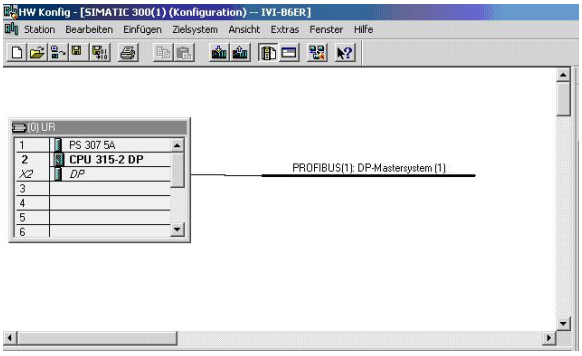
2 Hardware configuration

2.1 Installation GSD file

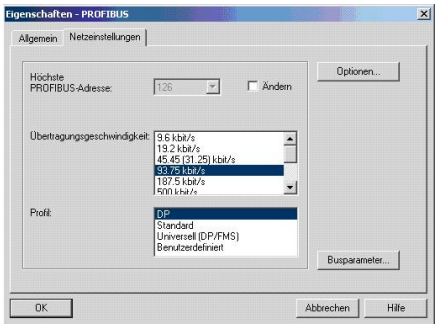
At first the provided GSD file is to installation. For this the Hardware configuration of the PLC is opened. With the menu item “Extra –GSD file installation…” you can integrate the GSD file into the STEP 7 Software. After the installation of the GSD file you have to refresh the Hardware index with the menu item “Extra – refresh index”.

2.2 Profibus configuration

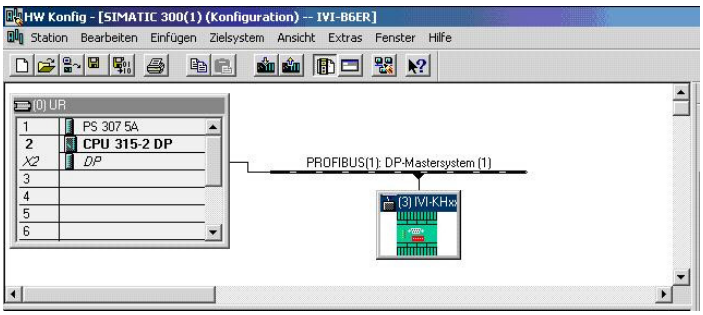
Firstly you have to implement the Hardware equipment. In addition you have to insert the necessary components from the Hardware index by using “drag and drop”.



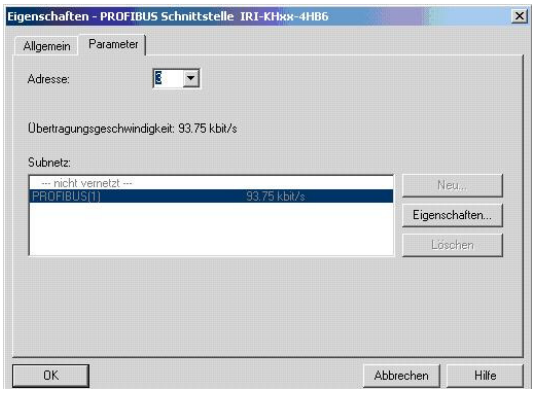
Closing you have to implement a “ProfibusDP-Mastersystem”. The Master system determines the transmission rate of the bus system. The maximum transmission rate of the IVI is 1,5MBit/s. After connecting to the power supply the IVI adjusts its transmission rate to the determined value. By the determination of the transmission rate you have to look that the length of the Profibus wire degrease by increasing transmission rate. You find a chart with the maximal wire length in the manual “IVI-KHD2-4HB6”.



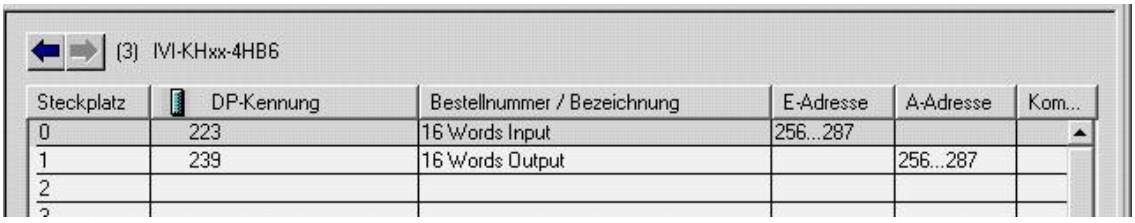
In the next step the Identification System IVI-KHD2-4HB6 have to connect to the ProfibusDP-Mastersystem. For this you must transfer “IVI-KHxx-4HB6” out of the Hardware index into the Master system.



After that you have to determine the Profibus address. After double click on the symbol of the IVI a window will open. In this window you can configure the Profibus address.



This address must be the same as on the top side of the unit adjusted address. After this you must define the addresses of the Input and Output of the IVI. By transfer of the address modules out of the Hardware index into the slots of the chart.



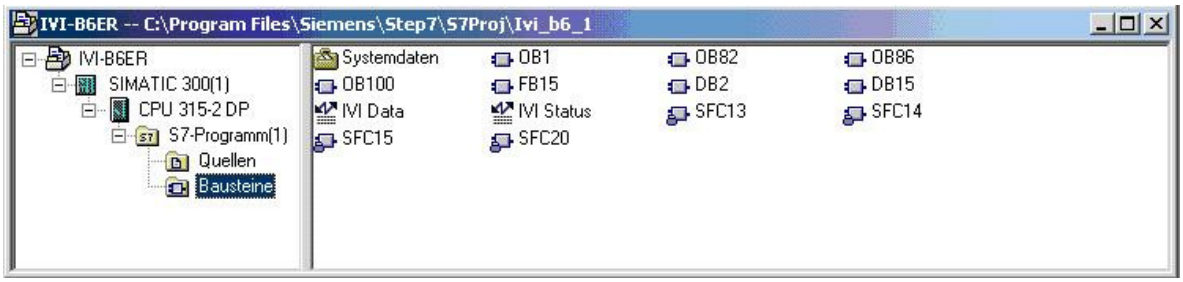
The IVI have got an Input data field with a length of 16 words (32 Bytes). The PLC put the start address of the input data field on the next free address area automatically. But you can change the start address. In the example the input data field starts at address 256(dez). This value must transfer in the IN-Variable #DP_Address by call the FB inside the OB 1. But you have to transform the value into HEX format.
The length of the Out data field is 16 words. The address of the output data field is defined by the PLC automatically. But the user can change the address.

3 Software

The program consists of different blocks. The following chart describes function of the several blocks.

NAME	FUNCTION	EXPLANATION
OB 1	Organisation block	Pass trough cyclical by the operating system of the CPU.
OB 82	Organisation block	Call by diagnostic alert.
OB 86	Organisation block	Call by an equipment alert.
FB 15	Function block	Include the functionality of the IVI-KHD2-4HB6 to the PLC.
DB 15	Data block	Contained all necessary variables.
SFC 14	System function	Import Data of a DP slave.
SFC 15	System function	Send Data to a DP slave.
SFC 20	System function	Copying memory areas.
SFC 13	System function	Import of diagnostic Data.
IVI Data	Variable chart	Observe imported Data.
IVI Status	Variable chart	Observe status Data.
IVI Diagnose	Variable chart	Observe diagnostic Data.

Table 3: Used Software Functions and Explanation



3.1 OB 1

The OB 1 pass trough cyclical by the operating system of the CPU. Inside the OB 1 the Function block FB 15 is called. At the same time the belonging Data block DB 15 is called. By calling the Function block the different parameters are transmitted. In the following chart the parameters are shown.

PARAMETER	PARAMETERTYPE	FUNCTION
HeadsConnected	IN : Byte	Declaration of the number of heads connected to the IVI.
StartupTimer	IN : Timer	Timer to reject the Startup control.
TimeoutTimer	IN : Timer	Timer to repeat a command.
DP_Address	IN : Word	Start address of the Input and Output data field. → Hardware configuration
EnhancedCommand	IN : Word	Command parameters of the executed command.
StatusOK	OUT : Bool	Function block is ready.
DataHead_X	OUT : Bool	Signal of new imported Data of Head X.
StartupFinish	OUT : Bool	Initialisation is finished.
CommandNew	INOUT : Bool	Send a new command to the IVI.

Table 4: Parameters and their Function

After the request of the Function block FB 15 diagnostic data can be imported. The diagnostic data will be import by setting the Bit M 1.0. The diagnostic data filled into Data block DB 2. The import of the diagnostic data is executed by the function SFC 13. By the parameterisation of the System function you must specify the diagnose address. You get the diagnose address out of the Hardware configuration.

3.2 FB 15

The Function block FB 15 is divided into different networks. In the following the functionality of the individual networks is described.

Network 1 "Program Startup":

The task of this network is to initialise a program start. Firstly the System function SFC 14 is called. So the Data of the Source address (LADDR: #DP_Address) imported and transfer to the destination address (RECORD: #InData). After this the parameter #SFC14_Status is checked. This parameter shows the status of the execution of the SFC 14. If the value is 0 the execution was successful and is finished. Else there was an error in the execution and an error notice is set (#Error_SFC14).
In the next step the ending of the Startup phase is controlled (#StartupFinish = 1). Otherwise the Timer #StartupTimer and #TimeoutTimer were enabled.
In the last part the status of the command (#Status_now) and the active heads (#HeadBits) were isolated of the variable #InData.Status. By calling the System function SFC 20 the variable #HeadBits copied into the structure #Head_Active.

Annotation: The Identification System IVI send the command parameter which sent to the IVI after receive back to the PLC.

Network 2 "Analyse of Status":

In the first part the Timer of the Timeout control is checked if the timer is set. Otherwise the Timer is started. The period of the Timer is forced by S5T#2S. Afterwards the Timer of the Startup sequence (rejection of the head control) is started. The period of the Timer is forced by S5T#4S.

In the next step the parameter #InData.Command and #OutData.Command were compared. If the command execution is correct both parameters are identical. But if the parameters are unequal a jump to NW21 is happen.

Furthermore the variable #HeadBits is verifying on the value 0. If the value is 0 and startup delay is active (#StartupTimer = 0) a command abort of the IVI happened. A special failure notice (#Error_ReadHead) is set. Then there is a jump to End2 top the end of this network.

If there is no failure notice the variable #HeadBits and the IN-Variable #HeadsConnected were compared. There is a failure if both are not identical and a failure notice (#Error_ReadHead) is set. After this it jumps to NW24.

In the following part of the network the different values of the status were verified. At first there is a check of the status value 0. If the value of the variable #Status_now is 0 the command is correct executed and finished. Afterwards the variable is checked for the value 5. If the value is 5 there is no data carrier in front of the head (only for the execution of Enhanced commands). If other commands were executed this value is a failure of the command execution. At next the value 4 is checked. If the value is 4 a wrong command parameter was sent to the IVI. An error notice is set (#Error_incorrectCommand). At the last step the value 6 is verify. If the value is 6 there is a Hardware failure. An error notice is set (#Error_Hardwarefailure).

Network 3 "Analyse of New Data":

Inside this network the imported data from the IVI analysed. At the beginning the Bits separated which shows the associated head (K3-K1). Afterwards the isolated Bits transfer into the variable #HeadActive. This variable is compared with the head Bits of the cycle before (#ReadHead_old). Furthermore the actual status (#Status_now) and the status of the cycle before (#Status_old) compared. If both similes are identical there is no change in the answer of the IVI and analyse of status is not necessary. Afterwards jumps to n3en. Otherwise (change in the answer) the actual status

(#Status_now) is transferred to the old status (#Status_old). The same procedure is doing for the head Bits (#HeadActive → #ReadHead_old).
In the next step it analyse from which head the answer is. For analyse the variable #HeadActive is compared with the specific values of the heads (0, 1, 2, 3). Afterwards the program jumps to the associated jump points. On the jump points the System function SFC 20 is called. This function copied the Input Data (#InData) into the specific head Input Data (#InData_Head_X).

Network 4 "Analyse of New Data of Head 1":

Firstly there is a status control in network 4. Besides compare the variable #InData_Head_1.Status with the value 6. If both are identical a Hardware failure existed and a failure notice (#Error_Head_1) is set. In the following there is a control whether the command execution successful finished. A command execution is successful finished if the status has the value 0. If an Enhanced command executed the ERR Bit (MSB) must not set. If the status has the value 0 and the ERR Bit is not set the notice #DataHead_1 is set.
Next is a control whether the status has the value 5. Into this trap or if an error existed (#Error_Head_1 =1) the notice #DataHead_1 is reset. Finally the failure notice #Error_Head_1 is reset, if head 1 is active when an Enhanced command is executed (Bit H1 #Head_Active.Head_1_Active).

Network 5/6/7:

These networks are analogue to the network 4. The task of these networks is to analyse the data of the heads 2, 3 and 4.

Network 8 "Send Command":

The network 8 has the task to set and reset the Togglebit. Firstly there is a control whether a new command is send to the IVI. For this the Bit #CommandNew is checked. If the Bit is not set no command is send to the IVI and the program jump to the point End4 to the end of this network.
If a new command is send to the IVI (#CommandNew = 1) the variable #StartupTime will be set. Doing this the Startup timer is started. Subsequently the IN-Variable #EnhancedCommand is transferred to the variable #CommandSend. Later this variable transferred to the Output data field and transferred to the IVI. First is checked if the

Togglebit of the import data (#InData.Command) is set. If the bit is set, the program jumps to the point End4 to the end of the network. Otherwise the Togglebit is set.

Network 9 “Transmit Data to IVI”:

The network 9 has the task to transmit the command parameter to the IVI. Firstly the variable #CommandSend transferred into the Output data field (#Out-Data.Command). Afterwards the System function SFC 15 is called. This function transmits the Output data field (#OutData) to the configured device address (#DP_Address). In the following the status of the execution of the SFC 15 (#SFC15_Status) is checked to the value 0. If the execution of the function success-ful finished the status value is 0. If the value is not 0 the FB is closing at this point (BEA). Else a failure existed and a specific notice (#Error_SFC15) is set. Afterwards jump to the point clr in network 10.

Network 10 “Clear All”:

The network 10 has the task to reset the data fields of the different heads. In addition the value 0 is transferred in every element of the InData field of head 1. Afterwards the function SFC 20 is called and the InData field of head 1 is copied to all other data fields.

4 Declaration of command parameter

The definition which command is executed on which head is decelerated by the command parameter inside the command telegram. Following chart shows the structure of a command telegram.

WORD 0																
Bit no.	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
name	B4	B3	B2	B1	DS	0	T2	T1	N4	N3	N2	N1	K3	K2	K1	T

WORD 1																
Bit no.	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
name	Word address / Block address															

WORD 2…15																
Bit no.	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
name	Write data															

B4/B3/B2/B1 → Command identification

The Command identification (B4…B1) defines the desired command.

B4	B3	B2	B1	DESICNATION
0	0	0	1	Single Read Fixcode
0	0	1	0	Auto Read Fixcode
0	0	1	1	Buffered Read Fixcode
1	1	0	1	Enhanced Buffered Read Fixcode
0	1	0	0	Single Read Data
0	1	0	1	Auto Read Data
0	1	1	0	Buffered Read Data
1	1	1	0	Enhanced Buffered Read Data
0	1	1	1	Single Write Data
1	0	0	0	Auto Write Data
1	0	0	1	Buffered Write Data
1	1	1	1	Enhanced Buffered Write Data
1	0	1	0	Single Read Block
1	0	1	1	Auto Read Block
1	1	0	0	Buffered Read Block

Table 5: Definition of Command Identification

- Single Read (Write) Fixcode/Data:
  All active parameterised heads will be activated once. If the heads could successfully read (write) the data, then all read (write) data are transmitted.
- Auto Read (Write) Fixcode/Data:
  All active parameterised heads are activated for such a time until one data carrier is read (write).

- Buffered Read (Write) Fixcode/Data:
  All active parameterised heads are activated continuously.
- Enhanced Buffered Read (Write) Fixcode/Data:
  All active parameterised heads are activated continuously. If the code/data carrier leaves the reading area, Status 5 is transmitted.
- Single Read Block:
  Onetime try to read defined memory block.
- Auto Read Block:
  Try to read for such time until memory block could read.
- Buffered Read Block:
  Continuously try to read defined memory block.

DS → Double Side Mode

This function enables double-side reading/writing. If this bit is set (DS = 1), code/data carriers of the types ICC-50, IDC-50 can be read and write from both sides.

T2/T1 → Data carrier type

The data carrier type is defined by the parameters T1 and T2.

T2	T1	DATA CARRIER TYPE
0	0	IDC-1K
0	1	IMC40-64K
1	0	IMC-256K
1	1	Not defined

Table 6: Definition Data Carrier Type

N4/N3/N2/N1 → Number of words

The number of words to be read or written is defined by the parameters N4…N1. It can be maximal transmit 14 words.

N4	N3	N2	N1	WORD NUMBER
0	0	0	0	Not defined
0	0	0	1	1
0	0	1	0	2
0	0	1	1	3
…..				
1	1	1	0	14

Table 7: Definition Word number

K3/K2/K1 → Head number

The parameters K3…K1 define which head shall be activated.

K3	K2	K1	HEAD
0	0	0	1
0	0	1	2
0	1	0	3
0	1	1	4
1	0	0	All
1	0	1	All
1	1	0	All
1	1	1	All

Table 8: Definition of head number of command telegram

T → Togglebit

The Togglebit serves to unambiguously identify a new command which is valid. A new command is only then accepted by the control interface unit and executed provided this flag does not have the same status as the preceding command, i.e. when it is toggled. In the acknowledgment from the IVI to the PLC, the Togglebit does not change and serves to indicate to the user that the command was received by the IVI and has been processed. But be careful if you send the command for the first time: Here is the Togglebit = 0!!!

5 Declaration of answer parameter

After transmission the command telegram to the IVI the IVI send the command parameter back to the PLC. The structure of the answer telegram is shown in the following chart.

WORD 0															
Bit no.	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
name	B4	B3	B2	B1	DS	0	T2	T1	N4	N3	N2	N1	K3	K2	K1	T

WORD 1																
Bit no.	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
name	ERR	K3	K2	K1	A4	A3	A2	A1	H4	H3	H2	H1	S4	S3	S2	S1

WORD 2…15																
Bit no.	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
name	Read data															

The word 0 of the command telegram is unchanged send back to the PLC. The relevance is the same like before.

B4/B3/B2/B1 → Command identification

DS → Double Side Mode

T2/T1 → Data carrier type

N4/N3/N2/N1 → Number of words

K3/K2/K1 → Head number

T → Togglebit

The word 1 of the answer telegram shows the execution status of the command. In the following the relevance of the different bits are shown.

ERR → Read error flag

The read error flag is reset as soon as read data has been received from the IVI (status = 0). The read error flag is set when the data carrier leaves the field of the head. If single/block commands executed the ERR bit is not used (ERR = 0).

K3/K2/K1 → Head number

The parameters defines the head of that the telegram is.

K3	K2	K1	HEAD
0	0	0	1

0	0	1	2
0	1	0	3
0	1	1	4

Table 9: Definition head number response telegram

A4/A3/A2/A1 → Execution counter

The execution counter is reset for command start and incremented each time as soon as new status values or data are available.

H4/H3/H2/H1 → Head activity

The parameter is used only by the execution of an Enhanced command to show the connected heads.

PARAMETER	RELEVANCE
H1 = 1	Kopf 1 active
H2 = 1	Kopf 2 active
H3 = 1	Kopf 3 active
H4 = 1	Kopf 4 active

Table 10: Definition of active heads execute an Enhanced command

S4/S3/S2/S1 → Status indicator

General status and error messages are defined by the parameters S4…S1.

S4	S3	S2	S1	RELEVANCE
0	0	0	0	Error free execution of command
0	0	0	1	Battery weak (only IMC-40)
0	1	0	0	Invalid command parameter
0	1	0	1	Read or write error (no data carrier if Enhanced command)
0	1	1	0	Hardware fault

Table 11: Definition Status value

6 Command examples

1. Enhanced Buffered Read Fixcode (execution on all 4 heads with Double Side Mode)

WORD 0	(D00E)HEX															
value	1	1	1	0	1	0	0	0	0	0	0	0	1	1	1	0
name	B4	B3	B2	B1	DS	0	T2	T1	N4	N3	N2	N1	K3	K2	K1	T

2. Singe Read Fixcode (execution on head 3 without Double Side Mode)

WORD 0	(1004)HEX															
value	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0
name	B4	B3	B2	B1	DS	0	T2	T1	N4	N3	N2	N1	K3	K2	K1	T

3. Singe Read Data (execution on all 4 heads with Double Side Mode; 14 words are read)

WORD 0	(48EE)HEX															
value	0	1	0	0	1	0	0	0	1	1	1	0	1	1	1	0
name	B4	B3	B2	B1	DS	0	T2	T1	N4	N3	N2	N1	K3	K2	K1	T

4. Enhanced Write Data (execution on all 4 heads with Double Side Mode; write 14 words; starting at address 40)

WORD 0	(F8EE)HEX															
value	1	1	1	1	1	0	0	0	1	1	1	0	1	1	1	0
name	B4	B3	B2	B1	DS	0	T2	T1	N4	N3	N2	N1	K3	K2	K1	T

WORD 1																
No.	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
value	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0

WORD 2…15																
No.	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
name	Write data															