HC500 heater controller

function description -
S7/HC500-2DPmaster (version 2.x)

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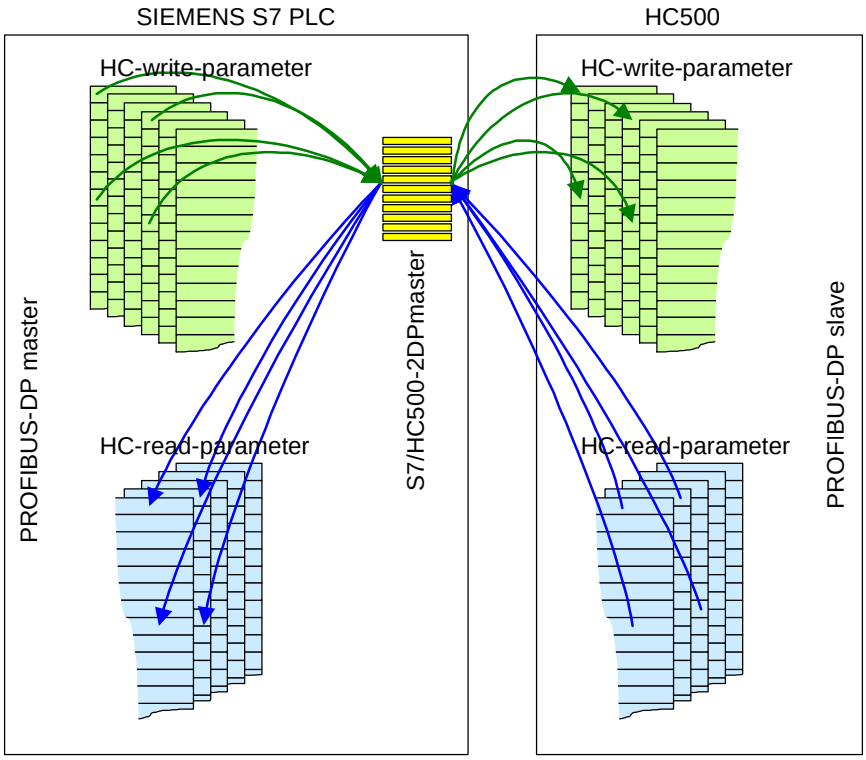
1 Table of contents

2 Introduction

In order to understand this manual knowledge of the
- „HC500 function description - basics" and the
- „HC500 hardware description"

is essential.

A fully equipped HC500 system has over 12'000 HC-parameter.
Via PROFIBUS (v0) only 20 words or respectively 40 bytes with one single PROFIBUS service are sent and received.



For this reason a "master" is needed to handle data exchange between the SIEMENS S7 SPS PLC and one ore more HC500 via PROFIBUS-DP.

This document describes the S7/HC500-2DPmaster.
2 strand for the second version of PROFIBUS-DP for HC500.

~~For detailed information about PROFIBUS-DP for HC500, please refer to the document "PROFIBUS-2DP for HC500". This document is not necessary to understand and use S7/HC500-2DPmaster.~~

3 Compatibility

For development of S7/HC500-2DPmaster
1) S7-300 CPU315-2DP (6ES7 315-2AG10-0AB0 V2.6) and
2) STEP 7 version 5 + SP 5 (Revision Level K5.4.5.0)
was used.

Regarding 1)
S7/HC500-2DPmaster support all S7-300 and S7-400 CPUs with PROFIBUS-DP interface directly on the S7 CPU.
The PROFIBUS-DP communication processor CP 342-5 is not supported.
Reason: The S7 system bus is not fast enough to handle the data exchange of many thousand HC-parameters between the S7 CPU and the CP.

Regarding 2)
When STEP-7 version 5.3 was released, the CPU above was not already available.
S7/HC500-2DPmaster function also with STEP 7 version 5.3 if a "STEP 7 hardware support packages" is installed, containing the S7 CPU mentioned above.

4 Deliverable

S7/HC500-2DPmaster is not delivered in this card board box

,

but exclusively via e-mail.

S7/HC500-2DPmaster is delivered as a file archived with STEP 7.
For example:
Version 2.0 for one HC500 system = S7_HC500-2DPmaster_1slave_2v0.zip
Version 2.0 for two HC500 systems = S7_HC500-2DPmaster_2slaves_2v0.zip

Info

In case you need to interface more then two (2) HC500 systems with you PLC, please contact us. We will delivery a ready to use configured project.

Hinweis

Please do not unzip the .zip file. It is not a WINZIP File, but a file "achieved" with STEP 7 that must be "retrieved" with STEP 7.

STEP 7 project name:
HC52DP20
HC5 = HC500
2DP = second version of PROFIBUS-DP v0 for HC500
20 = version (for this example version 2.0)

4.1 License

With the purchase of S7/HC500-2DPmaster, the license owner is allowed to use S7/HC500-2DPmaster with a non limited quantity of S7 or STEP 7 compatible PLCs.
The license certificate is our delivery note.

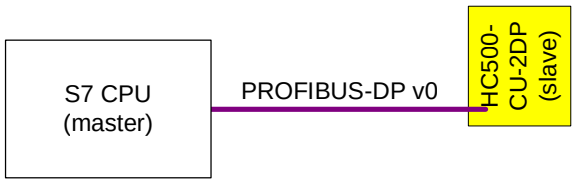
Only the FB100, containing the "master", is protected to be prevented from unintentional modifications.

5 Hardware

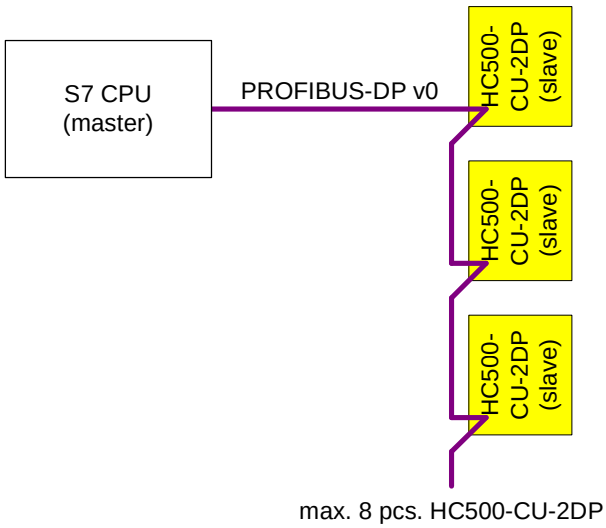
Each HC500 system consist of

- one HC500-CPU-2DP CPU-unit (CU) and
- one or more output-cards (OC) and
  (output-modules (OM) and output-units (OU) are not mentioned since they behave like OCs)
- optional one voltage-unit (VU) and
- optional one ore more temperature-units (TU)

The S7 PLC (PROFIBUS-DP Master) is communicating with the PROFIBUS-DP interface on the HC500 CPU-unit (CU) = the PROFIBUS-DP Slave



Depending on the performance of the S7 CPU, S7/HC500-2DPmaster support max. eight (8) HC500 systems.



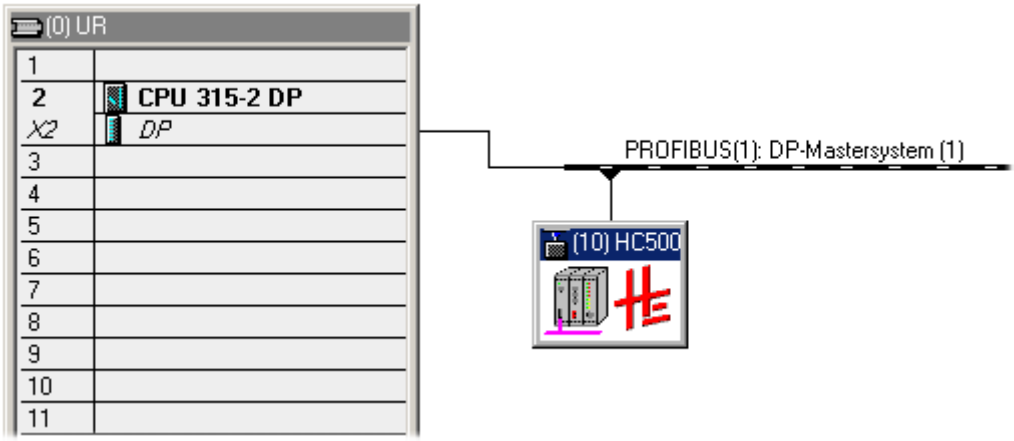
max. 8 pcs. HC500-CU-2DP

The PROFIBUS-DP slave network address is setup with 2 HEX switches 

on the CPU-unit (CU)
Refer to "HC500 hardware description" please.

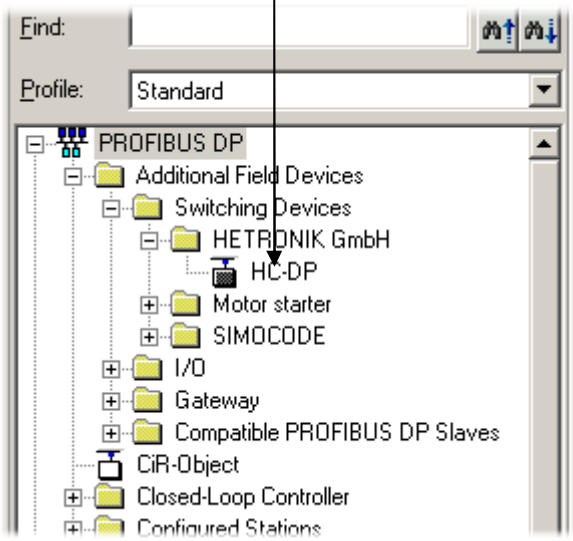
5.1 STEP 7 Hardware configuration

S7/HC500-2DPmaster contains in the STEP 7 HW Config a CPU315-2DP (6ES7 315-2AG10-0AB0 V2.6).

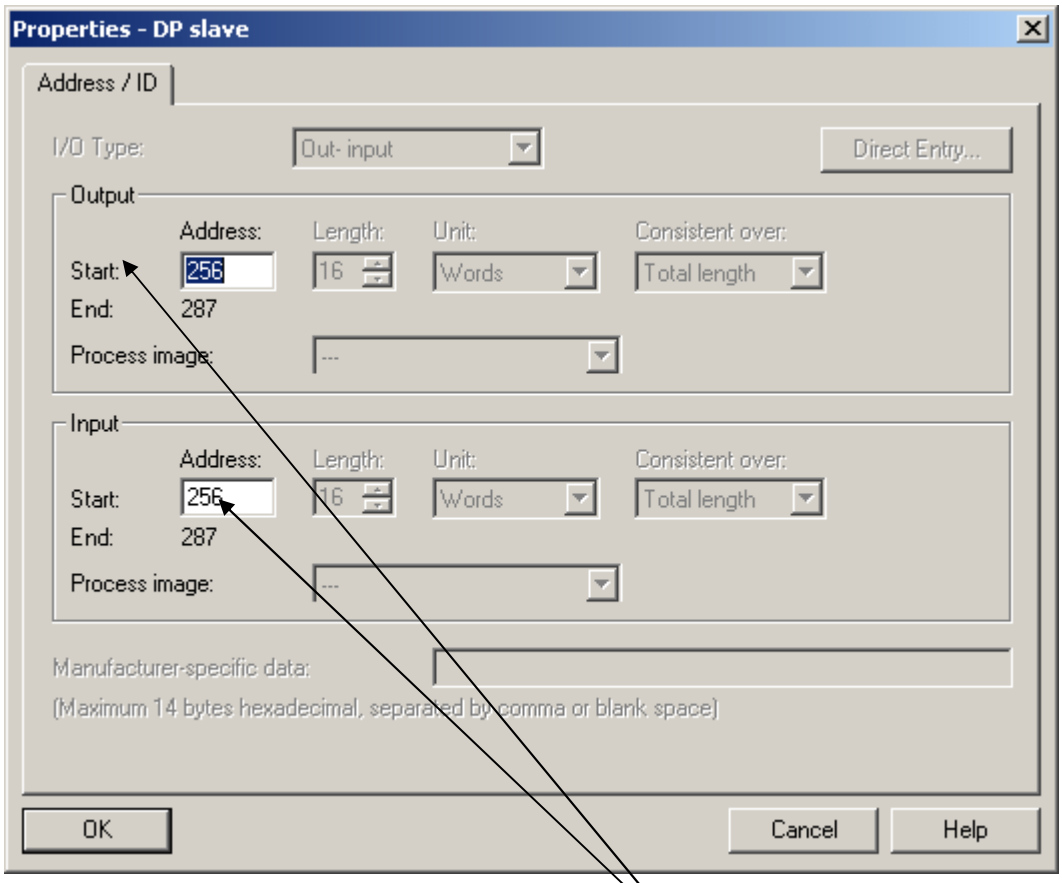


In case you a different S7 CPU is used, the following information if of importance:

1). The CPU-unit (CU) HC500-CPU-2DP is located here in the STEP 7 HW Config:

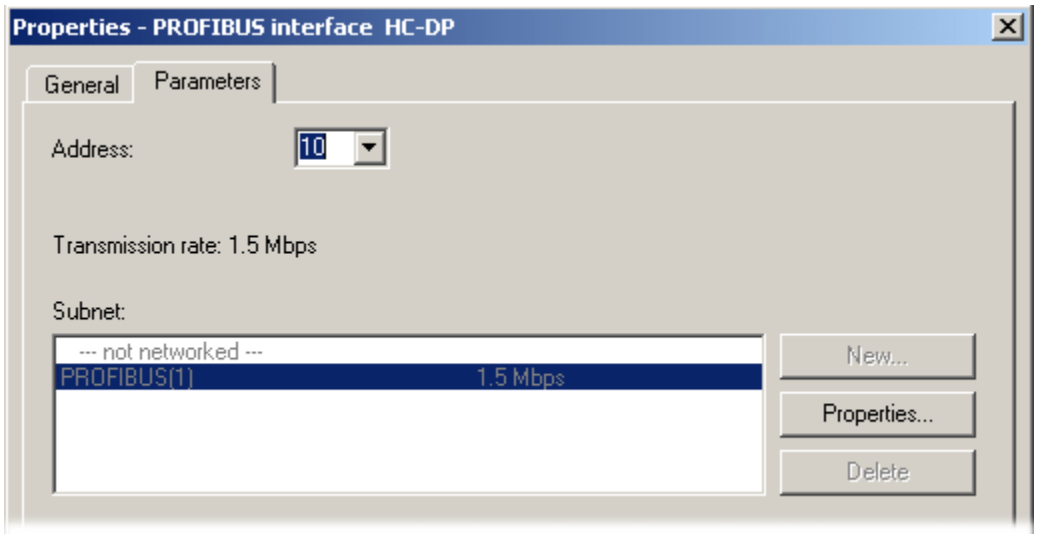


2) The Output und Input Address for the HC500-CU-2DP CPU-unit (CU)



must be identical with the IN_HC_adress in OB 1.
In OB1, the first slave (= the first CU) is setup to "256".

3.)
This address



must correspond with the PROFIBUS-DP address, setup with HEX switches S5 and S6 on the CU.

6 Function description

S7/HC500-2DPmaster is configured ready to use (upload & use), so that in most application cases no changes are necessary.
In DB101, 1-config for one HC500 System, and
in DB201, 2-config for a second HC500 system.

- After PROFIBUS-DP communication between the S7 CPU and the CU is established all HC-write-parameters are send automatically and as fast as possible = initialization. Initialization is executed also automatically after communication interrupts.
- After initialization, all HC-write-parameters and all HC-read-parameters are send/received periodically according to its priorities. Important HC-parameters, like for example channel-values [CH%] with higher priority then channel-field-index [CFI].
- It is guaranteed that all HC-parameters are refreshed within 10 seconds for one HC500 system.
- The HC-parameters TALP, automatically found with auto-tuning from the temperature-units (TU), are automatically read from S7/HC500-2DPmaster.

In case you need or want to
- change the priorities of the HC-parameter exchange or
- disable sending/reading of not needed HC-parameters in order to increase the communication speed or
- delete DBs of not used HC-parameters

please get in contact with us.

7 First Steps

Before any other action, please follow the steps below.

You need
- a S7 CPU with PROFIBUS-DP interface,
- STEP 7 version 5.3 or newer,
- a CPU-unit (CU) HC500-CU-2DP and
- one output-card (OC), output-module (OM) or output-unit (OU) with three (3) SSRs. For simplification following only named OC.

Step 1
Wire and setup the HC500 system like described in the HC500 hardware description.

Setup the CU with the PROFIBUS-DP address 10: Hex switch S5 = "0" and S6 = "A"; ($A_{hex} = 10_{dec}$).

Network the S7 CPU with the CU via a PROFIBUS-DP cable.

Wire to each of the first three OC channels a heater.

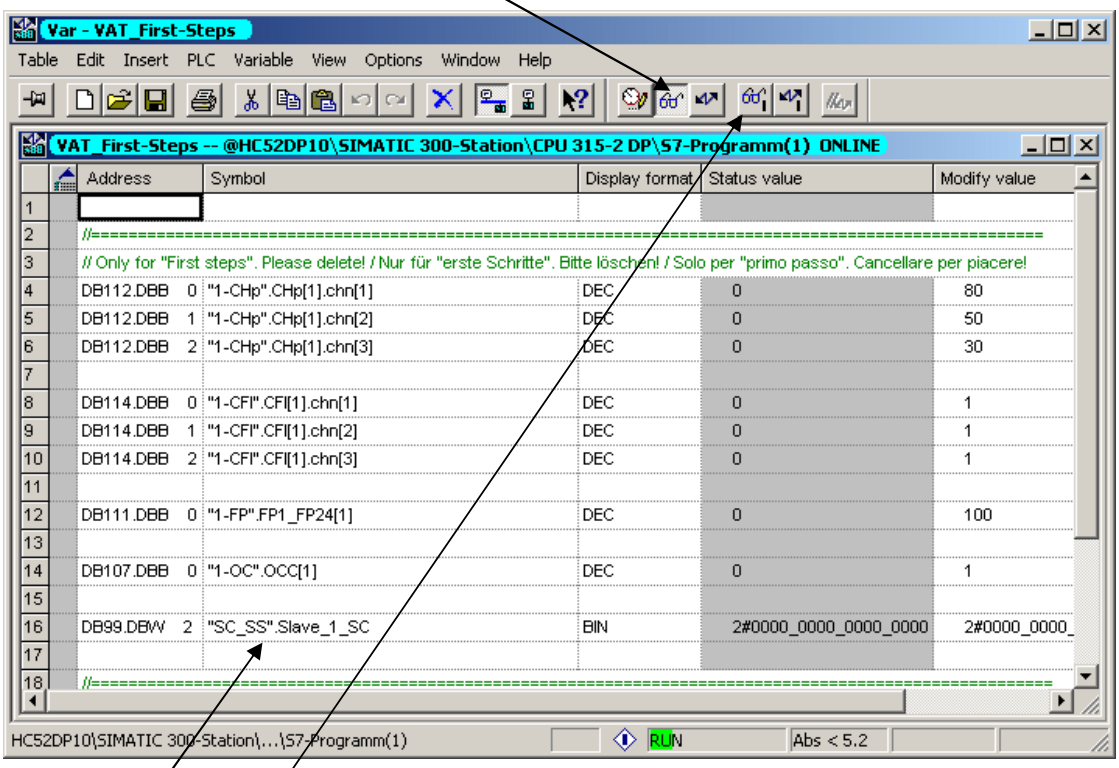
Step 2
Retrieve with STEP 7 S7_HC500-2DPmaster_1slave-#V#.zip and open it.
This means the project that is setup for one HC500 system (_1slave), not the project for two HC500 systems (_2slaves).

Step 3
Remove all S7 hardware modules physically from the S7 CPU.
If there is a project in the program memory already, delete it in order to avoid any conflict with S7/HC500-2DPmaster.
Eventually change and download the STEP 7 Hardware configuration (HW config) in the PLC CPU.

Step 4
Supply all HC500 components with voltage.

Step 5
Download HC52DP## in the PLC and run the project in the PLC.

Step 6
Open VAT_First-Steps and activate {Monitor variable}



Input for system-control (SC)

- bit 0 (NormaSTART) respectively
- bit 3 (softSTART / softSTARTlight for output-cards (OC) with -S or SL for shot wave heaters) "1" and press {Modify variable}.

LED H5 (heating-ON with NormalStart) respectively LED 6 (heating-ON with softSTART or softSTARTlight) goes ON and the heaters at the first 3 channels are ON with 80, 50 und 30%.

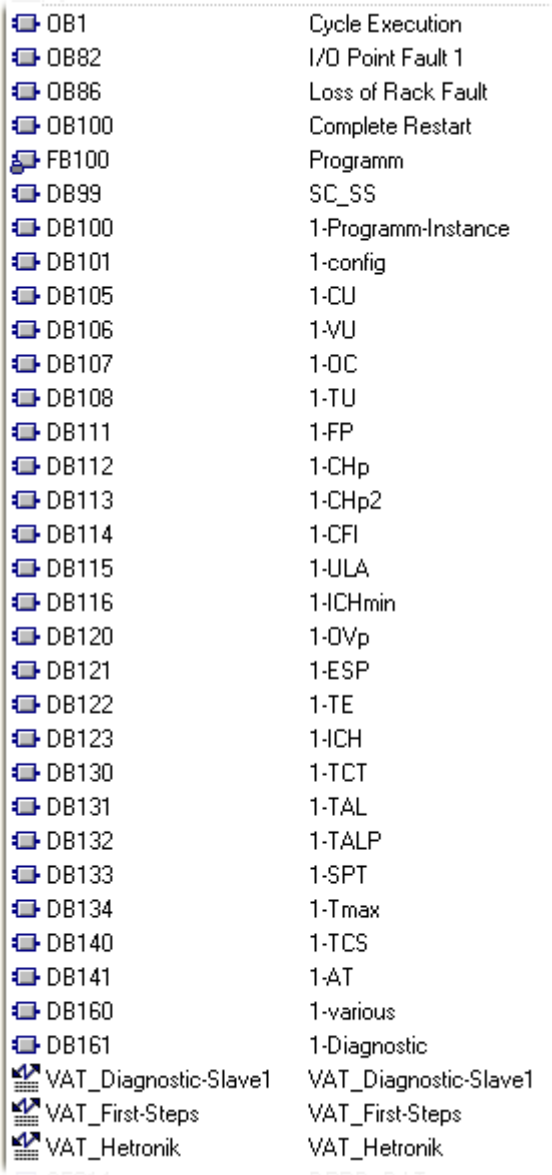
Congratulations for a successful startup of the HC500 with S7/HC500-2DPmaster.

Step 7

Please delete VAT_First-Steps from the final version of your STEP 7 project.

8 STEP 7 objects (FB's, OB's and DB's)

For one (1) slave =1 HC500 system:



OB1	Cycle Execution
OB82	I/O Point Fault 1
OB86	Loss of Rack Fault
OB100	Complete Restart
FB100	Programm
DB99	SC_SS
DB100	1-Programm-Instance
DB101	1-config
DB105	1-CU
DB106	1-VU
DB107	1-OC
DB108	1-TU
DB111	1-FP
DB112	1-CHp
DB113	1-CHp2
DB114	1-CFI
DB115	1-ULA
DB116	1-ICHmin
DB120	1-OVp
DB121	1-ESP
DB122	1-TE
DB123	1-ICH
DB130	1-TCT
DB131	1-TAL
DB132	1-TALP
DB133	1-SPT
DB134	1-Tmax
DB140	1-TCS
DB141	1-AT
DB160	1-various
DB161	1-Diagnostic
VAT_Diagnostic-Slave1	VAT_Diagnostic-Slave1
VAT_First-Steps	VAT_First-Steps
VAT_Hetronik	VAT_Hetronik

info

If the DBs conflict with already used DBs in your existing STEP 7 project, please get in contact with us. We will change the DBs to numbers of your choice.

8.1 OB1

OB1 call the S7/HC500-2DPmaster program in FB100.
For each DP-slave (= for each HC500 system) there is a network in OB1.

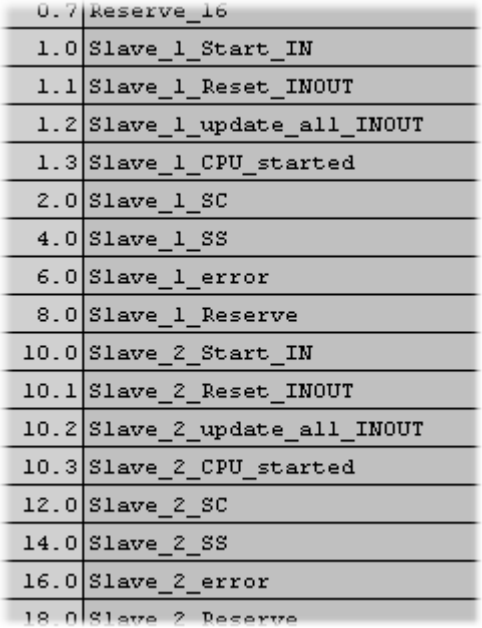
8.2 OB82 and OB86

OB82 for diagnostic interrupt.
OB86 für rack failure.
Please refer to STEP 7 online help.

8.3 FB100 and DB100

FB100 contain the S7/HC500-2DPmaster program. DB100 is the instance DB for the FB100.
FB100 is protected against unintentional modifications.
Also DB100 must not be modified in any case.

8.4 DB99



0.7	Reserve_16
1.0	Slave_1_Start_IN
1.1	Slave_1_Reset_INOUT
1.2	Slave_1_update_all_INOUT
1.3	Slave_1_CPU_started
2.0	Slave_1_SC
4.0	Slave_1_SS
6.0	Slave_1_error
8.0	Slave_1_Reserve
10.0	Slave_2_Start_IN
10.1	Slave_2_Reset_INOUT
10.2	Slave_2_update_all_INOUT
10.3	Slave_2_CPU_started
12.0	Slave_2_SC
14.0	Slave_2_SS
16.0	Slave_2_error
18.0	Slave_2_Reserve

and so on

DB99 contain
- the system-control (SC) = _SC
- the system-status (SS) = _SS and
- a PROFIBUS-DP communication status = _error

for all eight (8) HC500 systems.

- _Start_IN,
- _Reset_INOUT,
- _update_all_INOUT and
- _CPU-started

are for internal use of the master only (are without any meaning to a user of S7/HC500-2DPmaster)

short	SC	
name	system-control	
concern	CPU-unit (CU)	
direction	S7/HC500-2DPmaster write to HC500	
no of values	1; one CPU-unit (CU)	
data type	word	
description	bit-control for the most important HC500 functions	
importance	E.G. to turn ON/OFF all outputs (alternative = via digital input E1)	
address	**symbolic name**	**comment**
DB99.DBW 2	"SC_SS".Slave_1_SS	HC500 system no. 1
DB99.DBW 12	"SC_SS".Slave_2_SC	HC500 system no. 2

and so on

short	SS	
name	system-status	
concern	CPU-unit (CU)	
direction	S7/HC500-2DPmaster read from HC500	
no of values	1; one CPU-unit (CU)	
data type	word	
description	bit-information about the HC500 system	
importance	With these bits alarms should be programmed in the HMI.	
	For example if an OC is missing or PROFIBUS-DP communication has failures.	
address	**symbolic name**	**comment**
DB99.DBW 4	"SC_SS".Slave_1_SC	HC500 system no. 1
DB99.DBW 14	"SC_SS".Slave_2_SC	HC500 system no. 2

and so on

short name		
concern	S7/HC500-2DPmaster	
direction		
no of values	1; one CPU-unit (CU)	
data type	word	
description	bit-information about the PROFIBUS-DP communication	
importance	If the value is not "0" there are communcation problems. Because a defective triac can not be reported to the PLC, the power voltage should be turned OFF.	
address	**symbolic name**	**comment**
DB99.DBW 6	"SC_SS".Slave_1_error	HC500 system no. 1
DB99.DBW 16	"SC_SS".Slave_2_error	HC500 system no. 2

and so on

If _error is different then "0", then PROFIBUS-DP communication malfunctions.

If PROFIBUS-DP communication malfunction, then the PLC eventually is not informed about a short triac.
A short triac continue to fire the heater despite the heating is turned OFF (either automatically from the HC500 because of no communication with the PLC or manually via digital input E1 on the CPU-unit (CU)).

DANGER OF FIRE !!!
Disable power supply to all output-cards (OC), output-modules (OM) and SSRs controlled with output-units (OU) if _error is different then "0".

8.5 From DB#01 to DB#60

In DB**1**01 to DB**1**60 are located the HC-write/read-parameters for HC500 system no. **1**.
In DB**2**01 to DB**2**60 are located the HC-write/read-parameters for HC500 system no. **2**.
…
In DB**8**01 to DB**8**60 are located the HC- HC-write/read-parameters for HC500 system no. **8**.

Please download this EXCEL file here:
http://www.heatcontrol.com\downloads\S7_HC500-2DPmaster_1slave_v2_en.xls
and/or this .pdf document here:
http://www.heatcontrol.com\downloads\S7_HC500-2DPmaster_1slave_v2_en.pdf

Both contain all S7 HC-write-parameters and HC-read-paramters with addresses and symbolic names in their DBs.

E. g. for channel-values [CH%]:

short	CH%
name	channel-values
concern	output-cards (OC)
direction	S7/HC500-2DPmaster write to HC500
no of values	1024; 64 output-cards (OC) with 16 channels each
data type	byte
description	Maximum output (0...100%) of each channel. The output value [OV%] also depend on the field-value [FP%] of the field, each channel must be assigned to with the channel-field-index [CFI].
importance	Essential for the functionality.

address	**symbolic name**	**comment**
DB112.DBB 0	"1-CHp".CHp[0].chn[0]	HC500 system no. 1; output-card (OC) no. 1; channel no. 1
DB112.DBB 1	"1-CHp".CHp[0].chn[1]	HC500 system no. 1; output-card (OC) no. 1; channel no. 2
DB112.DBB 2	"1-CHp".CHp[0].chn[2]	HC500 system no. 1; output-card (OC) no. 1; channel no. 3
…		
DB112.DBB 1022	"1-CHp".CHp[63].chn[14]	HC500 system no. 1; output-card (OC) no. 64; channel no. 15
DB112.DBB 1023	"1-CHp".CHp[63].chn[15]	HC500 system no. 1; output-card (OC) no. 64; channel no. 16

8.6 VAT-Diagnostic-Slave#

Address	Name	Type	Initial value	Actual value	C
0.0	Para_Check[0].Call_act	DINT	L#0	L#0	
4.0	Para_Check[0].Call_60sec	DINT	L#0	L#0	
8.0	Para_Check[0].HM_Call_60sec	DINT	L#0	L#0	
12.0	Para_Check[1].Call_act	DINT	L#0	L#12	
16.0	Para_Check[1].Call_60sec	DINT	L#0	L#11	
20.0	Para_Check[1].HM_Call_60sec	DINT	L#0	L#1	
24.0	Para_Check[2].Call_act	DINT	L#0	L#16	
28.0	Para_Check[2].Call_60sec	DINT	L#0	L#14	
32.0	Para_Check[2].HM_Call_60sec	DINT	L#0	L#2	
36.0	Para_Check[3].Call_act	DINT	L#0	L#3	
40.0	Para_Check[3].Call_60sec	DINT	L#0	L#3	
44.0	Para_Check[3].HM_Call_60sec	DINT	L#0	L#0	
48.0	Para_Check[4].Call_act	DINT	L#0	L#788	
52.0	Para_Check[4].Call_60sec	DINT	L#0	L#724	
56.0	Para_Check[4].HM_Call_60sec	DINT	L#0	L#64	
60.0	Para_Check[5].Call_act	DINT	L#0	L#788	
64.0	Para_Check[5].Call_60sec	DINT	L#0	L#724	
68.0	Para_Check[5].HM_Call_60sec	DINT	L#0	L#64	
72.0	Para_Check[6].Call_act	DINT	L#0	L#788	

Name	ParaCheck[0..67].Call_act
description	HC-parameters write/read communications totally

Name	ParaCheck[0..67].call_60sec
description	HC-parameters write/read per minute (refresh speed) Example: Value = 14. Meaning: 60s / 14 = ever 4.29 seconds one execution.

Controller Tag name	ParaCheck[0..67].HM_call_60sec
description	--- no meaning ---

Reset of counters with setting S7 CPU from RUN to PROG mode, CPU supply voltage OFF and overflow of counter.

HC-parameter	short	[0..67] = HC-parameter no.
temperature-unit quantity	TUQ	1
lowest excepted supply voltage	Umin	2
rated voltage of heaters	Urc	3
field-values 1 … 24	FP1…FP24	4
field-values 25 … 48	FP25…FP48	5
field-values 49 … 64	FP49…FP64	6
field-values-temperature 1 … 24	FT1…FT24	7
field-values-temperature 25 … 48	FT25…FT48	8
field-values-temperature 49 … 64	FT49…FT64	9
~~CU-model~~	~~CUmod~~	~~10~~
~~CU-firmware~~	~~CUfw~~	~~11~~
~~CU-switch3~~	~~CUswitch3~~	~~12~~
output-card quantity	OCQ	13
~~COM1 baudrate~~	~~COM1baud~~	~~14~~
~~COM2 baudrate~~	~~COM2baud~~	~~15~~

continue

HC-parameter	short	[0..67] = HC-parameter no.
~~COM3 baudrate~~	~~COM3baud~~	~~16~~
~~operation hours total~~		~~17~~
~~operation hours heatON~~		~~18~~
~~VU-model~~	~~VUmod~~	~~19~~
~~VU-firmware~~	~~VUfw~~	~~20~~
phase-rotation	Urot	21
frequency	FREQ	22
voltage-unit-status	VUS	23
phase-voltages	UL1_UL3 (= UL)	24
lowest expected channel-amps 1…8	Ichmin	35
lowest expected channel-amps 9…16	Ichmin	36
output-card-control	OCC	30
phase-association	ULA	31
channel-field-index	CFI	32
channel-values	CHp (= CH%)	33
channel-values2	CHp2 (= HC%2)	34
output-card-status	OCS	37
electronic-temperature	TE	38
error-status-power-circle	ESP	39
output-values	OVp (= OV%)	40
~~OC-model~~	~~OCmod~~	~~41~~
~~OC-firmware~~	~~OCfw~~	~~42~~
channel-amps 1…8	Ich	43
channel-amps 9…16	Ich	44
thermocouple-type	TCT	50
temperature algorithm	TAL	51
temperature-channel-control	TCC	52
set point temperature	SPT	53
alarm temperature	Tmax	54
~~TU-model~~	~~TUmod~~	~~55~~
~~TU-firmware~~	~~TUfw~~	~~56~~
temperature-unit-status	TUS	57
temperature-channel-status	TCS	58
actual temperature	TA	59
temperature algorithm parameter - proportional	TALP-kp	60
temperature algorithm parameter - integral	TALP-ki	61
temperature algorithm parameter - differential	TALP-kd	62
temperature algorithm parameter - delay time	TALP-dt	63
temperature algorithm parameter - inclination	TALP-inc	64
temperature algorithm parameter - execution repeat	TALP-EXR	65
temperature algorithm parameter - controlled temperature max	TALP-CTmax	66
temperature algorithm parameter - controlled temperature min	TALP-CTmin	67

~~xxx~~ = not documented. You have access to all this information with HC500-DIAG.