TU/TC RANGE
PROFIBUS DP INTERFACE

PROFIBUS PROCESS FIELD BUS ®

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Specifications

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TU/TC Series
PROFIBUS DP Interface

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CONTENTS

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1- INTRODUCTION:

Following documents have been used for these specifications:

-Standard DIN 19245 / Part 1: PROFIBUS.
- Data transmission technique,
- Medium access methods and transmission protocols,
- Service interface to the application layer,
- Management.

- Standard DIN 19245 / Part 3: PROFIBUS DP.
- Process Fieldbus: Decentralised Periphery.

- Standard ISO/IEC 8802-2: Information processing systems.
- Logical Link Control.

- Standard ISO/IEC 8802-4: Information processing systems.
- Token passing bus access method and physical layer specifications.

- Standard CEI 1131-3: programmable controllers
- programming Languages

- Notice HA173535-2: Digital Communication for EUROTHERM thyristor units of the TU Series.

- Notice HA173941 Issue 2: Three Phase Power Thyristor Unit with Digital Communication - User Manual.

- Notice DRIVES: PROFIBUS DP slave communications interface for 584S/590/620COM.

Nota: the last document has been used to keep maximum of compatibility with the interface developed by EUROTHERM DRIVES.

2- GENERAL CHARACTERISTICS OF PROFIBUS:

The goal of this small paragraph is to remember the basic principle of PROFIBUS, issued of 1100^{+} pages of the standard.

PROFIBUS DP (Decentralised Peripherals) is made for the fast control of remote INPUT/OUTPUT.

It is necessary to transmit in the same way:

- **Process values.**
- **Parameters.**
- **Configuration.**
- **Diagnostics and faults.**

This kind of communication require fast reaction times.

Following table give an overview of the main characteristics of PROFIBUS DP.

Requested characteristics	PROFIBUS DP characteristics
Fast reaction time	More than 1000 Input/Output Exchanges with 32 different devices connected on the link in 10ms.(at 12 Mbds)
mono-master or multi-master Operations	Hybrid access to the medium following PROFIBUS part 1.specifications
Simple and cheap Protocol	All of the functionality's of PROFIBUS are integrated in ASICS which can be used alone for simple applications
Diagnostic functions	Diagnostic function shared by masters and slaves.
Simple user Interface	Basic set of parameters and configurations defined on the user level.
Existing Wiring and Tools Used	PROFIBUS FMS and PROFIBUS DP share the same simple RS485 medium. Same technology used for all the applications.
Inter-operability	PNO certification of conformance to the standard.

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3-GENERAL PRODUCT SPECIFICATIONS:

PROFIBUS-DP (DIN 19245-3) .

Certification tests made by: Siemens Schnittstellencenter (Fürth)
Certification given by: PNO Number Z00204
Identification Number given by PNO: 0536 (hex)

Connection using shielded twisted pair (RS485).

Layer 1 and 2 of the OSI model controlled by a specific component: SPC3.

Automatic communication speed search and control
9.6/19.2/93.75/187.5/500/1500/(12000KBauds).

Up to 16 Process Data Parameters, selectable from the master, polled continuously.

Request and response sub-protocol for random access to any parameters within the Data-Base.

Interface status indicated by LEDs.

Address set by jumpers on the control board (Unit address can not be set or changed from the bus).

No redundancy available.

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4- INSTALLATION:

Before to start a DP system, it must be assigned an unmatched address to each station. In the case of the TU Thyristor Unit, this address is set from the jumpers on the control board (same jumpers are used for the MODBUS or EI-BISYNC communication).

Change of address from the communication bus is not supported (no EEPROM storage of the address).

Remember than:

- address 127 reserved for broadcasting (defined in the standard).

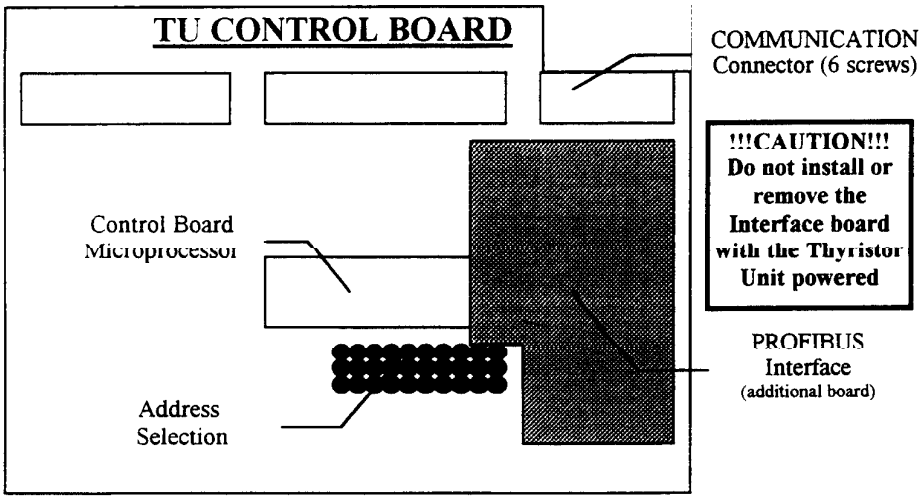
- address 126 reserved for remote configuration by Type 2 master for the first Start-up (not used by this Unit).

Only addresses 0 to 125 can be used in normal operation with a type 1 Master (defined in the standard).

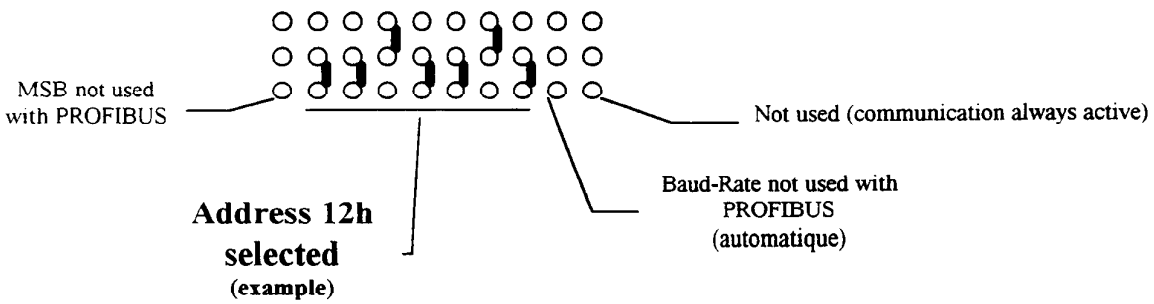
Nota: If possible, do not use address 00 which is, generally, reserved for SIEMENS master.

In the same way, addresses 0,1,2,3 are reserved by Simatic S7 from SIEMENS.

4-1- Installation of the DP board on the TU Series:



Example:



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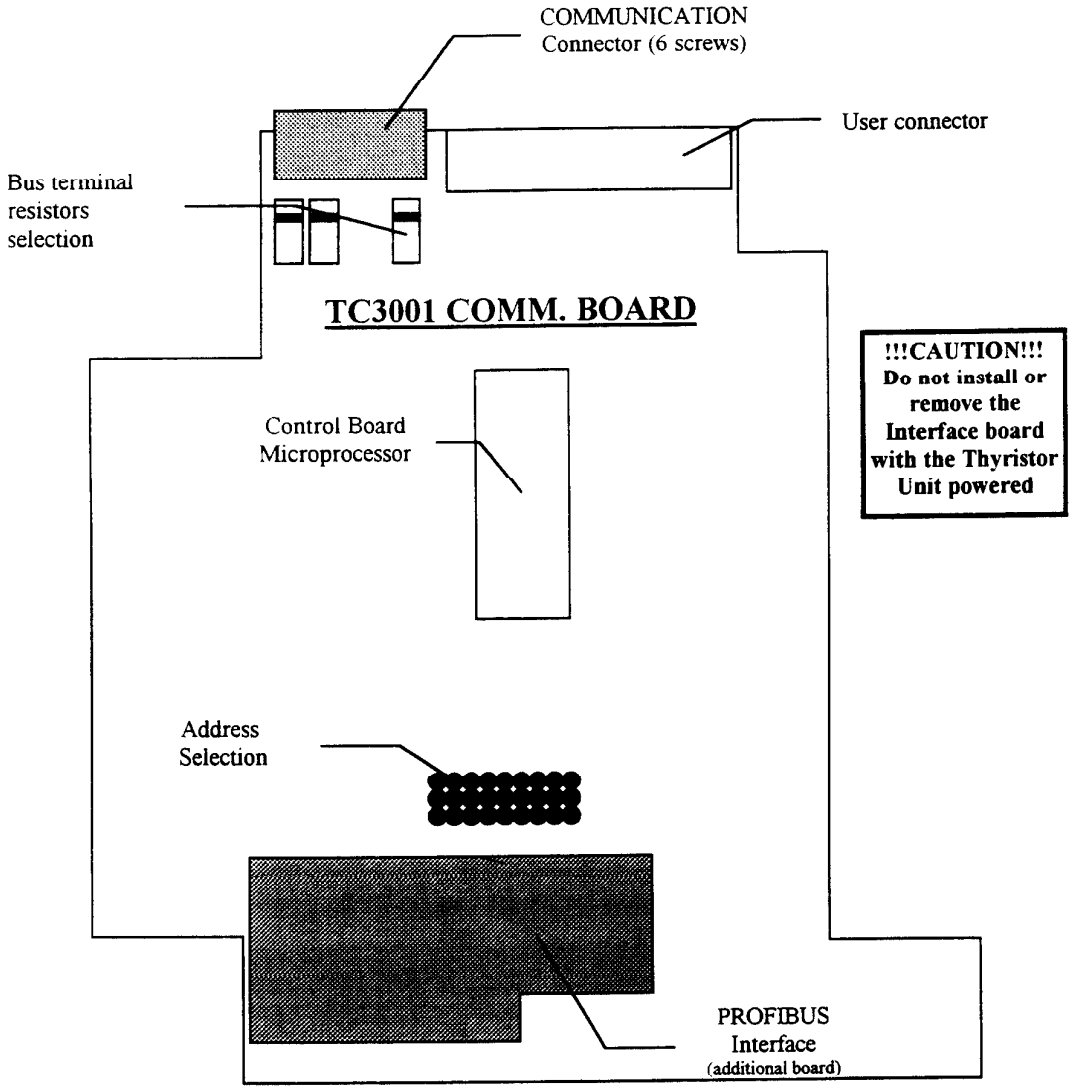
4-2- Installation of the DP board on the TC3001:



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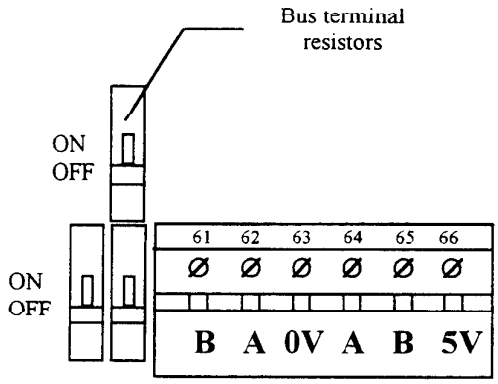
5- CONNECTION:

The 6-pins connector of the control board is used to connect the shielded twisted pair to the Interface. This connector is also used to connect the MODBUS or EI-BYSINC Interface.



The Communication electronics is isolated from the Control electronics.

Wiring and shielding information are given in DIN 19245 (Part 1 Chap.3 and Part 3 Chap. 6). It must be particularly careful to the line impedance, to the impedance adaptation, maximal length, etc.... The Bus terminal resistors can be fitted directly on the board by the 3 switches. Note that only the last Unit on the Bus must have the Impedance adaptor resistors fitted.

More than 32 stations can not be used without any repeater.

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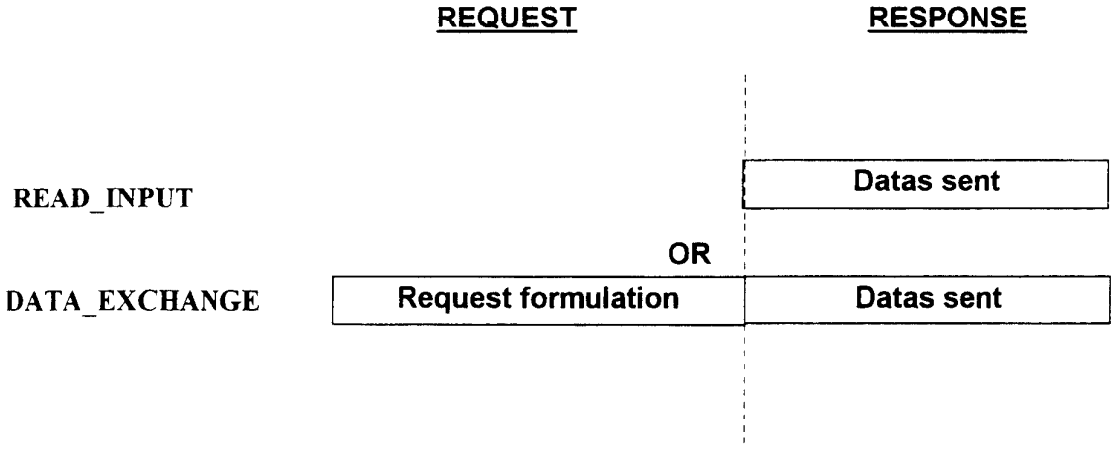
6- CODIFICATION:

See additional documentation.

7- DESCRIPTION OF CYCLIC DATA EXCHANGES:

They are 2 types of cyclic Data Exchange:
- Input Request (Read_Only)
- Datas sent on request (Request/Response).



7-1- DATA TRANSFERS DESCRIPTION / STATE DIAGRAM:

According to the standard DIN 19245-3, the Interface receive Parametrization datas and Configuration datas. These 2 kind of exchange are required during the Start-up phase of the system.

The device can reach the DATA_EXCHANGE STATE only when the 2 sequences: PARAMETRIZATION and CONFIGURATION are finished. At the Start-up, the device start a waiting phase.

The STATE diagram is on the following page (State Machine of the SPC3 described in the standard DIN 19245-3). In this diagram, it will be found following states:

- POWER_ON: The Unit is connected to the mains. An Initialisation phase is started.

Nota: Address Change is not supported on this Unit (SET_SLAVE_ADD not supported ===> An Error message is sent in case of Address change tentative. Error code: RS = Optional service not available ---> code 3 in the FC Byte. see part 1 - chap. 4 - table 4a)

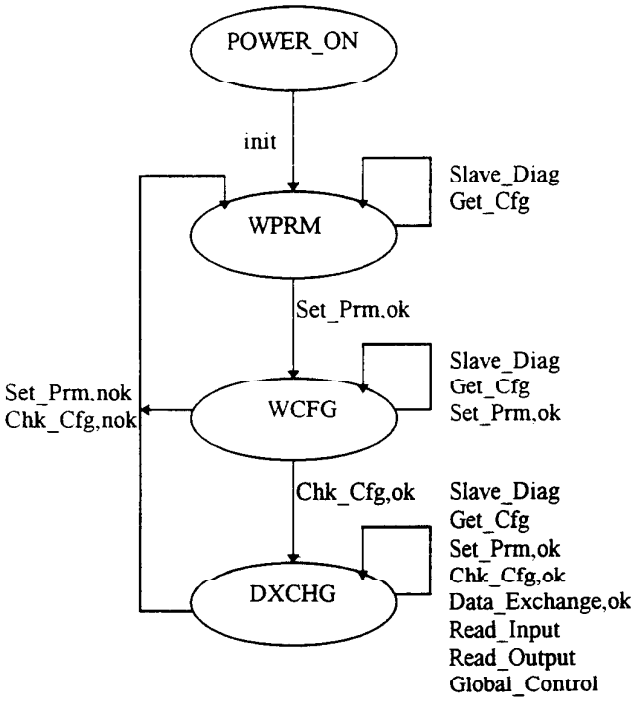
- WPRM = Wait_Parameters. The Device is waiting for System Parametrization Message.(PNO Identification, synchronisation and freeze mode acceptation,...) and for Datas Paramétrisation Message (what datas are effectively available for read access). In this State , a Diagnostic demand is also accepted.

Any other type of message is rejected in this State.

- WCFG =Wait_Configuration. This kind of message specifies the number of datas accessible to the Input and Output Ports and possibilities of Read and Write for different parameters,.... In this State, the Unit is waiting for a Configuration message or Parametrization message or Diagnostic message .

Any other type of message is rejected in this State.

- DXCHG = Data_Exchange. When the Parametrization and the Configuration have been accepted, then the Slave is ready for the Datas exchange with the Master which has Parametrized and configured it, or with another master in the condition stated in the DP standard.



When the system is in the DATA_EXCHANGE_STATE (DXCHG), the process datas can be read and/or written.

A MAXIMUM OF 16 VALUES selected trough the parametrization are accessible by reading, in the same exchange.

Nota: The Parametrization can be changed at any time and consequently, these 16 values, or less, can be redefined (without any change of the Input Buffer.size)

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7-2- DATAS EXCHANGED DURING THE PHASE WPRM: (WAITING FOR PARAMETERS):

7-2-1- PARAMETRIZATION:

According to the Standard (DP chap. 8-3-4), Parameter Frames are constituted of 2 parts:

- A System part.

- A User part.

The 7 first bytes (index 0 to 6) correspond to the standard.

Byte	Bit Position								Designation
	7	6	5	4	3	2	1	0	
0	Lock Req	Unlo Req	Sync Req	Free Req	WD on	Res	Res	Res	Station status
1									WD_Fact_1
2									WD_Fact_2
3									MinTSDR
4									Ident_Number_High
5									Ident_Number_Low
6									Group_Ident
7	0	0	0	0	0	WD_ Base	Dis Stop	Dis Start	Spec_User_Prm_Byte

The 8th Byte (index 7) is specific to the SPC3 and has the following characteristics:

Byte 7	Spec_User_Prm_Byte		
Bit	Name	Significance	Default State
0	Dis_Startbit	The start bit monitoring in the receiver is switched off with this bit.	Dis_Startbit= 1 , that is, start bit monitoring is switched off.
1	Dis_Stopbit	Stop bit monitoring in the receiver is switched off with this bit.	Dis_Stopbit= 0, that is, stop bit monitoring is not switched off.
2	WD_Base	This bit specifies the time base used to clock the watchdog. WD_Base = 0: time base 10 ms WD_Base = 1: time base 1 ms	WD_Base= 0, that is, the time base is 10 ms
3-7	res	to be parameterized with 0	0

Following bytes (User_Prm_Data) indicate to the Unit which values will be accessible from the master by reading it cyclically (READ_INPUT).

Each value is indicated by his address with the following rules:

Index	Data	Parameter
1	High-Byte (= Byte 8)	1rst
	Low-Byte	
2	High-Byte (= Byte 10)	2nd
	Low-Byte	
3	High-Byte (= Byte 12)	3rd
	Low-Byte	
etc...	etc...	etc...
n	High-Byte	nth
	Low-Byte	
n+1	00	End of list
	00	

n parameters will be read in the same cyclic access.

n must be less or equal 16 (16 values maximum accessible through one exchange) .

The End of List is indicated by 00 except if n=16.

parameter addresses are listed in annexe A.

It can be seen than the Most significant Byte is always 00 in the case of a TU or TC Unit (but can be different for other (future) devices).

Attention: It is impossible to Read the Unit_Type (address 00) by this way. For this purpose, the procedure REQUEST/RESPONSE must be used.

Nota: The Address order is of no importance. The same parameter could appear several time in the List. The cyclic read is performed in the same order than the address list of the parametrization.

Example:

Byte	Index	Data(hexadecimal)	Parameter
8		0x00	
9	01	0x04	Tag Number 04
10		0x00	
11	02	0x0E	Tag Number 14
12		0x00	
13	03	0x18	Tag Number 24
14		0x00	
15	04	0x22	Tag Number 34
16		0x00	
17	05	0x00	End of list

With this example, the control value of the 4 ways of a TU 1450 will be read cyclically.

7-2-2- DIAGNOSTICS DEMAND:

During the phase WPRM, a master can also proceed to a Diagnostic Request.

According to the Standard (DP chap. 8-3-1), Diagnostic frames have 2 parts. The first part describes the status of the Interface itself. The second part describes the Unit status.

Byte	Diagnostics Data
0	Station Status_1
1	Station Status_2
2	Station Status_3
3	Diag.Master_Add
4	Ident_Number_High
5	Ident_Number_Low
6	Ext_Diag_Data header
7	SW = UNIT Status Word
8	SW1 = Status Word channel 1
9	SW2 = Status Word channel 2
10	SW3 = Status Word channel 3
11	SW4 = Status Word channel 4

Format and number of these Bytes is related with the Unit Type. Here is a TU 4 channels example.

The first part of the Diag Frame is defined by the DP standard (see below).

The second part is sent with the format Device_Specific_Diagnostics (code 00). That is, the Byte N°6 indicate the total number of bytes specific to the application comprising itself. (Here: Header= 0x06). This number depends on the Unit Type (controlled channel number,...). See annexe B the diags specific to each type of Thyristor Unit.

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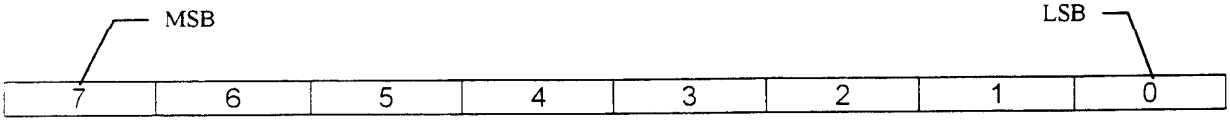
DESCRIPTION OF DIAG BYTES ON FIRST PART OF THE DIAG FIELD:



OCTET 00: STATION STATUS 1
Bit 7: Master Lock (Set by the DP Master).
Bit 6: Prm Fault Last Parameter Frame was faulty.
Bit 5: Invalid Slave Response (Set by the DP Master).
Bit 4: Not Supported Function requested not supported from this DP slave.
Bit 3: Ext Diag A Diag. Entry exists in the Slave specific Diag area (Ext_Diag_Data). This bit is not used with the TU/TC Unit
Bit 2: Cfg Fault The last received configuration data from the DP-Master are different from these which the DP-Slave has determined (see Check_Cfg).
Bit 1: Station Not Ready This Station is not yet ready for data transfer (in this case, the Diag LEDs indicate an Internal communication fault. See chap. 9).
Bit 0: Station Non Existent (Set by the DP Master).

OCTET 01: STATION STATUS 2
Bit 7: Deactivated (Set by the DP Master).
Bit 6: (not used)
Bit 5: Sync Mode This station has received the Sync control command.
Bit 4: Freeze Mode This station has received the Freeze control command.
Bit 3: WD On Set as soon as the WatchDog control has been activated.
Bit 2:always set.
Bit 1: Stat Diag Set as soon as an External communication fault has been detected (in this case, the Diag LEDs. Indicate an External fault. See chap. 9). The DP-Master shall fetch diagnostic informations as long as this bit is reset again.
Bit 0: Prm Req This station shall be reparametrised and reconfigured (This bit has priority on bit 1).

OCTET 02: STATION STATUS 3 Not used here.

OCTET 03: MASTER ADD Address of the master which has parametrized this station.

OCTETS 04/05: IDENT NUMBER PNO Ident number (2 octets).

7-2-3- CONFIGURATION READ:

The Configuration Read(Get_Cfg) is possible in the State WPRM. See following paragraph for details.

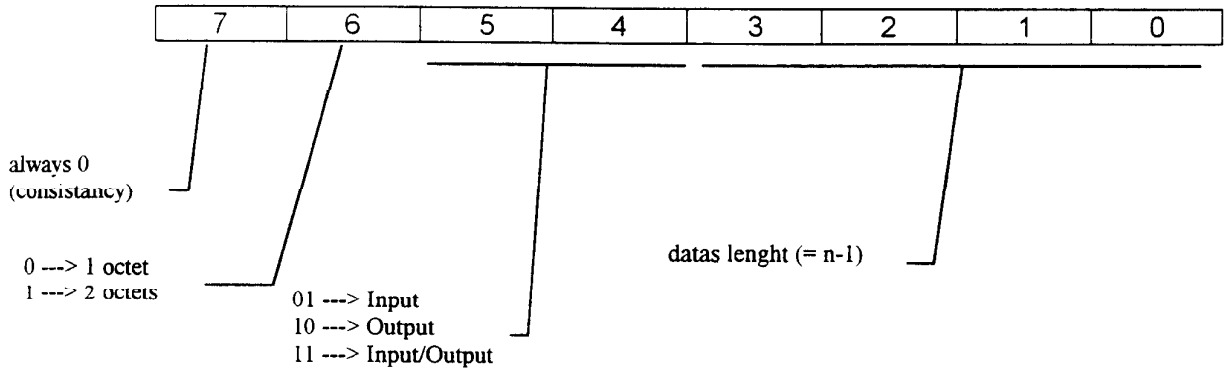
7-3- DATAS EXCHANGED DURING THE PHASE WCFG: (WAITING CONFIGURATION SEQUENCE):

7-3-1- CONFIGURATION:

A Slave Can only receive a config change request (Check_Cfg) from the Master which has paramatrized it. But it can receive a Config Read request (Get_Cfg) from any master.

The Configuration pattern indicate, for each group of values, the type, the number and the access method.

The codification of identifiers is in accordance with the Standard (part 3 chap. 8.3.5).



Examples: 53h ===> 4 datas of 2 octets each on the Input Port.
71h ===> 2 datas of 2 octets each both on the Input Port and on the Output Port.

7-3-1-1- CONFIGURATION READ: (Get_Cfg)

The configuration can be read (Get_Cfg), in any of the 3 States (Waiting Parameters, Waiting Configuration or Data Exchange) by any master.

Before Parametrization, the Configuration is always initialised in the same way: 53h, 63h.That is, the Unit can send 4 words of 2 Bytes each on the Input Port and receive 4 words of 2 bytes each on the Output Port.

After Parametrization, the Configuration is changed in regard of the User Parameter number received. Remember than each User Parameter is the Address of a value which has to be sent cyclically on the Input Port. The first Byte of the Configuration Pattern has to be modified in consequence.

Example: if the total Parameter frame has 18 octets,

The 7 first Bytes are defined by the Standard and are in fact the system parametrization.

The 8th octet is specific to the SPC3.

The 10 following Bytes (non null) indicate than 5 values will be Read cyclically (Read_Data).

The Configuration will then be: 54h, 63h.

Nota:

-The output Port Configuration remains always the same 63h (4 words of 2 octets each).

-The maximal Configuration of the Input Port is 5Fh (Maxi 16 words of 2 octets each).

-The Configuration pattern comprises always 2 Bytes. The first for the Input port and the second for the Output port.

7-3-1-2- CONFIGURATION CHANGE:

The Configuration change is theoretically possible in any State after Parametrization. But the sent Configuration has to be in accordance with the effective Configuration of the Input and Output Ports.

That is, the Input Port will be Configured as defined by the previous Parametrization and the Output Port will always be Configured at 63h.

7-3-2- PARAMETRIZATION AND DIAGNOSTICS:

Parametrization and Diagnostic are accepted in State WCFG.

Remember than only the Master which has parametrized can Write datas.

Attention, The right Configuration corresponds to the last Parametrization received.

7-4- DATAS EXCHANGED DURING THE PHASE DXCHG:

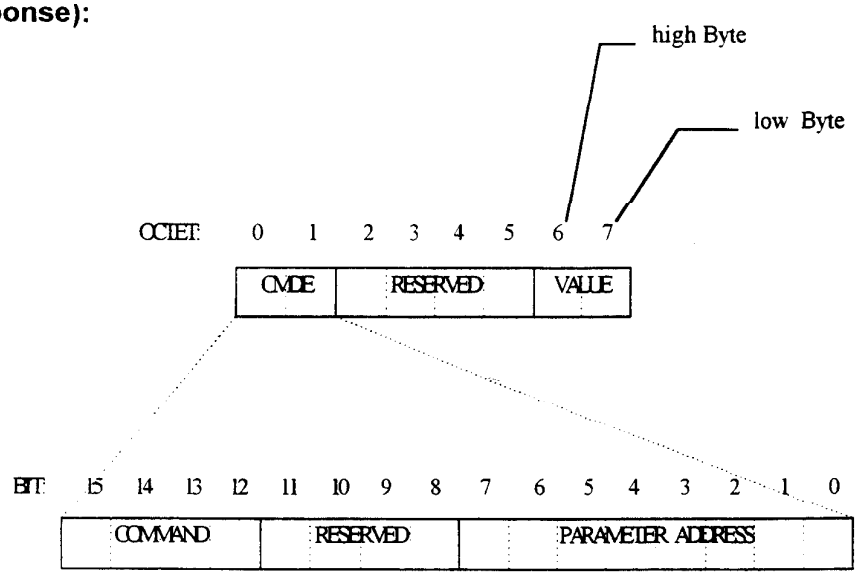
Datas exchanged during the phase Data_Exchange have different types :

Process datas transfer:	
- Request and Response.	(Data_Exchange)
- Multiple datas Read.	(Read_Input)
- Output Read.	(Read_Output)
Transmission modes Control:	(Global_Control)
Parametrization and Configuration	
- Configuration Read	(Get_Cfg)
- Configuration Change	(Chk_Cfg)
- Parametrization	(Set_Prm)
Diagnostic	(Slave_Diag)

7-4-1- REQUEST AND RESPONSE: (Data_Exchange)

This User defined Sub-Protocol give the possibility to reach any process value defined from his address as well reading or writing

The frame is 8 Byte coded as follow (as well for the Request and for the Response):



The « Command » field in the Request message selects the required operation. This is either None, Read or Write.

The Command field in the Response message confirms that operation has been requested, indicates that a Read or Write request has been completed successfully or indicates that a Read or Write request has failed.

Valid values for the Command field are as follows:

Command	Request (Output Buffer)	Response (Input Buffer)
0	No Command	-
1	Read Request	Acknowledge Read
2	Write Request	Acknowledge Write
7	--	Reject Request

The valid REQUEST / RESPONSE Command pairs are as follows:

replaced by the Polling List

Request Command	Response Command
0	-
1	1 or 7
2	2 or 7

Nota: Any Request frame which the length is not 8 Bytes will be rejected (Error code 4).

The Request is put by the Master on the Output Port, The Response is put by the Slave on the Input Port. The Master has to Read the Response after each Demand with another Data_Exchange or with a Read_Input Service.

Nota: the response remains on the Input Port until a new Request or a Null Command is sent by the Master.

The Input buffer Read during the Data_Exchange Service is always the previous response or the previous polling present before the exchange.
In case of Error, the Command Field is filled with the value7 (Reject_Request), and the Value Field indicates the Error Code. Valid Error Codes are as follows:

0 = Invalid Parameter Number.
1 = Read only Parameter (Writing Request).
2 = Data > 0x7FFF (decimal 32767).
3 = Write only Parameter (Reading Request).
4 = Not 8 Bytes in the Output Buffer .
5 = Command not valid with this Unit.

Attention: No Check on the range or on the validity of the value is performed at this level. In case of non validity, the value is not taken into account by the Unit, without any warning. (This due to the very different speed scale between the Profibus Baudrate and the Serial Link with the Unit).

IMPORTANT: Each Set of Request/Response must be terminated by the NULL COMMAND, (code 0), from the Master, else the Read Parameter Service (Read Input) is not re-initialised, excepted if the Slave leave the Data Exchange State.

Nota: Only the first 8 bytes of the Input Buffer are used for the response to a non null command. The rest of the buffer, if configured, is unused for the response.

7-4-2- INPUT READING: (Read Input)

With this Service, the Master can read the total List of values defined by the User Parameter List sent during Parametrization.

This Service is, generally, used cyclically for refreshing pre-defined values. Whenever the Request/Response Service, defined above, is not active, that is when this Service has received the Null Command, the Input Port Buffer is automatically filled with pre-defined datas.

Attention: Whenever the Request/Response Service is activated, the Read Datas Service is de-activated. It is re-activated with the next NULL Request/Response.

Attention: It is impossible to Read the Unit Type (address 00) with the Read Datas Service. For that, the Request/Response Service must be used.

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Example of Data Exchange sequence (after parametrization and configuration).

SERVICE	OUTPUT BUFFER 1 2 3 4 5 6 7 8	INPUT BUFFER max 32 Bytes= 16 values 1 2 3 4 5 6 7 8	COMMENTS
Read_Input	00 xx xx xx xx xx xx xx	polling (max 16 words)	
Read_Input	no change	polling (max 16 words)	
Read_Input	no change	polling (max 16 words)	
Data_Exch	10 nn xx xx xx xx xx xx	polling (max 16 words)	Read value n
Read_Input	no change	10 nn xx xx xx xx vn vn	Response
Read_Input	no change	no change	
Data_Exch	20 01 xx xx xx xx v1 v1	no change	Write 01
Data_Exch	20 02 xx xx xx xx v2 v2	20 01 xx xx xx xx v1 v1	Write 02/Read 01
Data_Exch	20 04 xx xx xx xx v4 v4	20 02 xx xx xx xx v2 v2	Write 04/Read 02 04 is read only!
Read_Input	no change	70 04 xx xx xx xx 00 01	error code 01
Data_Exch	00 xx xx xx xx xx xx xx	no change	return to polling
Read_Input	no change	polling (max 16 words)	
Read_Input	no change	polling (max 16 words)	
etc...	etc...	etc...	etc...

xx = no importance vn vn=value of parameter n(word=2bytes) nn=number n

Nota: This is only an example.

Following file give the frames issued from this example:
DP_TEST from SIEMENS has been used

```
Confirmation data from telegram file for PROFIBUS DP testsoftware
-------------------------------------------------------------------------

 ***DEMO STATION N. 32H

3E 3C 32 00                    ***** DIAG_REQUEST
      > 02 05 00 FF 05 36 06 00 04 04 04 04

 ***PARAMETRIZATION WITH POLLING OF 4 FIRST VALUES

3E 3D 32 10 80 00 00 0B 05 36 00 00 00 01 00 02 00 03 00 04
(nr) - E5 short acknowledge response from norm slave
3E 3E 32 02 53 63              ***** CHECK_CONFIG
(nr) - E5 short acknowledge response from norm slave
3E 3C 32 00                    ***** DIAG_REQUEST
      > 00 04 00 02 05 36 06 00 04 04 04 04
3E 3B 32 00                    ***** READ_CONFIG
      > 53 63

 ***BEGIN OF EXAMPLE

3E 38 32 00                    ***** READ_INPUT
      > 00 00 00 00 01 FE 00 00
3E 38 32 00                    ***** READ_INPUT
      > 00 00 00 00 01 FE 00 00
3E 38 32 00                    ***** READ_INPUT
      > 00 00 00 00 01 FE 00 00
FF FF 32 08 10 04 00 00 00 00 00 00   ***** DATA_EXCHANGE/READ VALUE 04
      > 00 00 00 00 01 FE 00 00
3E 38 32 00                    ***** READ_INPUT
      > 10 04 00 00 00 00 00 00
3E 38 32 00                    ***** READ_INPUT
      > 10 04 00 00 00 00 00 00
FF FF 32 08 20 01 00 00 00 00 00 64   ***** DATA_EXCHANGE/WRITE 0064H AT 01
      > 10 04 00 00 00 00 00 00
FF FF 32 08 20 02 00 00 00 00 00 C8   ***** DATA_EXCHANGE/WRITE 00C8H AT 02
      > 20 01 00 00 00 00 00 64
FF FF 32 08 20 04 00 00 00 00 01 90   ***** DATA_EXCHANGE/WRITE 0064H AT 04
      > 20 02 00 00 00 00 00 C8
3E 38 32 00                    ***** READ_INPUT
      > 70 00 00 00 00 00 00 01
FF FF 32 08 00 00 00 00 00 00 00 00   ***** DATA_EXCHANGE/NULL COMMAND
      > 70 00 00 00 00 00 00 01
3E 38 32 00                    ***** READ_INPUT
      > 00 64 00 C8 01 FE 00 00
3E 38 32 00                    ***** READ_INPUT
      > 00 64 00 C8 01 FE 00 00

 *** END OF EXAMPLE
```

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7-4-3- GLOBAL CONTROL:

The Global Control is automatically managed by the SPC3.

It allows the control of Freeze and Sync modes defined by the standard.

Address RAM Cell	Bit Position								Designation
	7	6	5	4	3	2	1	0	
3CH	Res	Res	Sync	Un sync	Freeze	Un freeze	Clear_ Data	Res	R_GC_Command

Bit	Designation	Significance
0	Reserved	
1	Clear_Data	With this command, the output data is deleted in 'D' and is changed to 'N.'
2	Unfreeze	With „Unfreeze," freezing input data is cancelled.
3	Freeze	The input data is fetched from 'N' to 'D' and „frozen". New input data is not fetched again until the master sends the next 'Freeze' command.
4	Unsync	The „Unsync" command cancels the „Sync" command.
5	Sync	The output data transferred with a WRITE_READ_DATA telegram is changed from 'D' to 'N.' The following transferred output data is kept in 'D' until the next 'Sync' command is given.
6,7	Reserved	The „Reserved" designation specifies that these bits are reserved for future function expansions.

7-4-4- DIAGNOSTICS/CONFIGURATION/PARAMETRISATION:

These operations, already described above, are still permitted in the State DXCHG. But, their use is submitted to the following rules:

A Configuration Change is not permitted in this State. Then if a Parametrisation Change is asked, this one must not change the Configuration, else the SPC3 return automatically in WPRM State (Waiting for Parametrization) until a new Parametrization is sent again and then a new Configuration. That is, the Parameter number must remain the same, else the SPC3 must be re-configured.

Attention: the sequence « Parametrization then Configuration » must always be in this order.

8- PERFORMANCES:

The system reaction time is described by the standard (see part 3 chap. 7 pages 33-34).

Otherwise, datas are transmitted to/from the Unit via a slow Serial Interface. In consequence, an additional delay is introduced for the effective Input/Output Refresh. This time is, of course, independent of the Profibus Communication itself.

At 1.5MBds following performances can be considered:

OPERATION	Max. TIME
Request/Response	
Writing	500 µs
Reading	500 µs
Cyclic Read (Read_Input)	
only 1 value	250 µs
16 values (max.)	500 µs
Effective Refresh	
Writing (TU)	T/ value*
Writing (TC3001)	1 ms / value*
Reading /TU 1 channel	2T**
Reading /TU 2 channel	4T**
Reading /TU 4 channel	8T**
Reading / TC3001	T**

*** This time comprising effective refresh of the value in the Unit.**
**** This time comprising the total refresh of the database**

T=1/f is the mains period:
T=20ms@50Hz.
T=16.7ms@60Hz.

9- TROUBLE SHOOTING:

9-1- STATUS LEDs:

The Interface PC board is equipped with 3 LEDs.

- **GREEN**
- **ORANGE**
- **RED**

The green LED is directly managed by the SPC3 (XDATAEXCH pin). It indicates than the Processor is in the Data Exchange State.

The 2 other LEDs are used in the following way:

- During the INIT phase = TEST, ORANGE LED and RED LED are flashing alternatively for 3 seconds.

- Then, they can be in the following state:

Red LED	Orange LED	Meaning
Off	On	Normal operation -
On	Flashing (0.5Hz)	External Communications Fault*
On	Flashing (1Hz)	Internal Communications Fault*
On	Off	Fatal Error
Off	Off	No power or major hardware failure

* A flag is also set in the Diag Bytes (see diagnostics chap. 7-2-2).

The flashing rate indicates the Default Type:

9-2- INTERNAL COMMUNICATION FAULT:

RED = ON / ORANGE = FLASHING 0.5s ON - 0.5s OFF

The Interface has detected a fault at the Profibus Bus level itself.

It receives erroneous datas, or receives nothing, or more simpler a bad Parametrisation or a bad Configuration has occurred. The Interface is not able to reach the Data_Exchange State. This diag. Appears also when the Watchdog Time-Out has occured.

In this case, following points must be verified:

- **connections**
- **Bus cable**
- **bus length**
- **Impedance adaptation**
- **Address jumpers (Verify that any other Slave or Master has got the same address).**
- **verify that Parametrization and Configuration are correctly assigned in the Master and that the watchdog Time-Out is not too short.**

The Diag.Station_Not_Ready bit is set (see paragraph 7-2-2)

9-3- EXTERNAL COMMUNICATION FAULT:

RED = ON / ORANGE = FLASHING 1s ON - 1s OFF

The Interface has detected a fault which is not directly in relation with the Profibus link.

Verify that :

- The Unit address is comprising between 0 and 125.
- The connection between the Interface and the Unit is correct.
- The Driver Board is operational and the micoprocessor is correctly inserted in its socket.

2 possibilities:

1- The communication between the 2 microprocessors was already established and is stopped. PROFIBUS communication remains established, the Diag.Static_Diag bit is set (see paragraph 7-2-2).
No External Diag Byte sent.

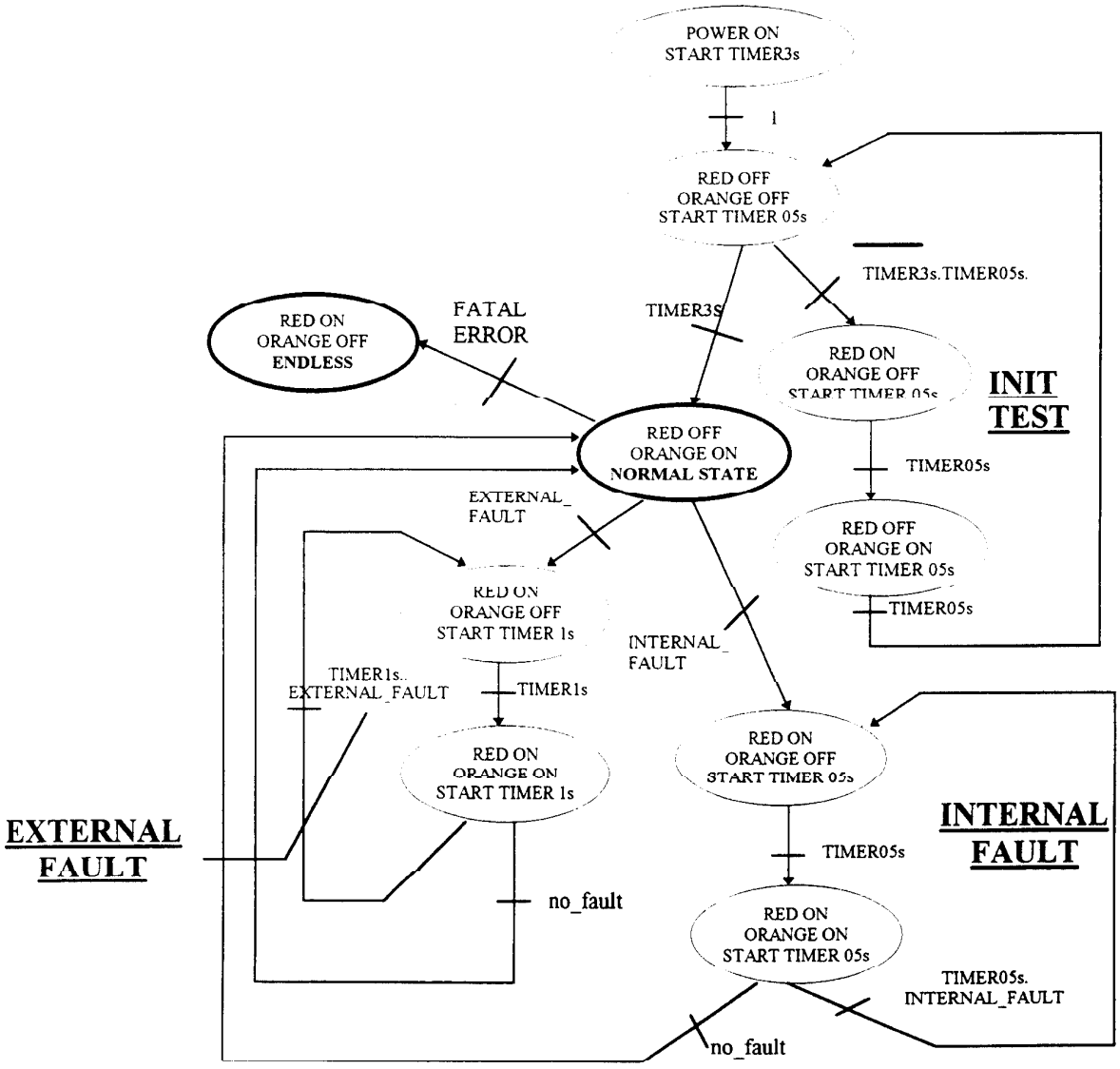
2- No communication between the 2 microprocessors at power up. The PROFIBUS communication processor (SPC3) is not started (No address recognised).

9-4- FATAL ERROR:

ORANGE LED = OFF RED LED = ON definitively.
Any Communication is stopped.

The Interface has detected a GRAVE FAULT at the Hardware level.
The cause is probably a faulty component on the board (Memory for example).The Interface board must then replaced.

9-5- LEDs STATE DIAGRAM:



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10- DEVICE DATA BASE (DDB):

The Data-Base which permits the configuration of the Master is established following the standard (Part 3 - chap. 13).

This DDB is available on floppy disk.

```
; File name: EURO0536.GSD

; General Informations:

#Profibus_DP
Vendor_Name = "EUROTHERM Automation"
Model_Name = "Thyristor Unit"
Revision = "TU/TC series"
Ident_Number = 0x0536
Protocol_Ident = 0                    ; PROFIBUS DP
Station_Type = 0                      ; DP-slave
FMS_supp = 0
Hardware_Release = "V1.0"
Software_Release = "V1.0"
Redundancy = 0
Repeater_Ctrl_Sig =0
24V_Pins = 0

;Supported Communication Speed:

Auto_Baud_supp = 1

9.6_supp = 1                          ; Max lenght = 1200m (line type A or B)
19.2_supp = 1                         ; Max lenght = 1200m (type A or B)
93.75_supp = 1                        ; Max lenght = 1200m (type A or B)
187.5_supp = 1                        ; Max lenght = 1000m (type A)
500_supp = 1                          ; Max lenght = 400m (type A)
1.5M_supp = 1                         ; Max lenght = 200m (type A)
3M_supp = 1                           ; with wiring precaution
6M_supp = 1                           ; with wiring precaution
12M_supp = 1                          ; with wiring precaution
MaxTsdr_9.6 = 60                      ; unit = tbit
MaxTsdr_19.2 = 60                     ; unit = tbit
MaxTsdr_93.75 = 60                    ; unit = tbit
MaxTsdr_187.5 = 60                    ; unit = tbit
MaxTsdr_500 = 100                     ; unit = tbit
MaxTsdr_1.5M = 150                    ; unit = tbit
MaxTsdr_3M = 250                      ; unit = tbit
MaxTsdr_6M = 450                      ; unit = tbit
MaxTsdr_12M = 800                     ; unit = tbit

; DP_Slave Informations:

Freeze_Mode_supp = 1
Sync_Mode_supp = 1
Set_Slave_Add_supp = 0                ; Set by jumpers on the board
Min_Slave_Intervall = 1               ; 100 micro-second
```

```
Modular_Station = 1                    ; for use with several configurators
Max_Module = 1

; Parametrization:

User_Prm_data_Len = 33                 ;max permissible 16 values-->32 bytes
User_Prm_Data = 0x00,\                 ;+1 byte specific to the SPC3
;following table have to be completed for defining the polling list.
0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,\ ;parameters 1-5
0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,\ ;parameters 6-10
0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,\ ;parameters 11-15
0x00,0x00                              ;parameter 16

; Configuration:

Max_Input_Len = 8                      ; must be changed according to the
                                       ; parameter string
Max_Output_Len = 8                     ; never changed
Max_Data_Len =16                       ; must be changed according to the
                                       ; right Data lenght

; Default config string:
; assuming than the number of User Parameter (2 bytes each) is lower
; or equal 4

Module = "TU/TC series" 0x53,0x63
Endmodule


; Unit Type or User depending Informations

; The Unit_Type is always the first value in the Parameter list (address 00)
;
; The User_Prm_Data string give the default list of read parameters with the
; Read_Input Service (automatic polling). These could be changed.
; following example give, for each channel of the unit (see annexe in manual):
;                        - SL = Local Setpoint          (range 0...1000)
;                        - PV = Controlled value   (range 0...1560)
;                        - VV = load voltage            (range 0...1250)
;                        - CV = Load current            (range 0...1250)
; nota: the first byte is SPC3 specific.
; example of User parameter and corresponding config string:
; User_Prm_Data = 0x00,\
; 0x00,0x01,0x00,0x04,0x00,0x06,0x00,0x07,\
; 0x00,0x11,0x00,0x14,0x00,0x16,0x00,0x17,\
; 0x00,0x21,0x00,0x24,0x00,0x26,0x00,0x27,\
; 0x00,0x31,0x00,0x34,0x00,0x36,0x00,0x37,\
; The configuration must then been changed as follows:
; Max_Input_Len = 32
; Max_Output_Len = 8
; Max_Data_Len = 40
; Module = "TU1450" 0x5f,0x63
; Endmodule
; Input cfg (0x5f), Max_Input_Len (32), Max_Data_Len (40)
; could be changed, depending on the User parameter number.
```

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ANNEXE A:TU Series PARAMETER ADDRESSES:

A-1: TU 1 channel: Single Phase Control.

address	mnémon.	parameter	limits	status	format IEEE1131-3
00	TY	Unit Type	01*	R	UBYTE

*** Value 01 indicate a TU 1 channel.**

address	mnemon.	parameter	limits	status	format IEEE1131-3
01	SL	local Setpoint	0-1000	R/W	UWORD
02	FS	waiting Setpoint	0-1000	R/W	UWORD
03	CL	Current Limit Setpoint	0-1000	R/W	UWORD
04	PV	Process Value	0-1560	R	UWORD
05	OP	Power demand	0-1000	R	UWORD
06	VV	Load Voltage	0-1250	R	UWORD
07	CV	Load Current	0-1250	R	UWORD
08	LV	Line Voltage	0-1250	R	UWORD
09	CA	Normalised Current	0-1000	R	UWORD
10	RI	external analogue Setpoint	0-1000	R	UWORD

address	mnemon.	parameter	limits	status	format IEEE1131-3
11	CW	Command Word	0-12	W	UBYTE

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A-2: TU 1 channel: Two Phase Control.

address	mnémon.	parameter	limits	status	format IEEE1131-3
00	TY	Unit Type	05*	R	UBYTE

*** Value 05 indicate a TU 1 channel / 2 phases control (TU21xx).**

address	mnemon.	parameter	limits	status	format IEEE1131-3
01	SL	local Setpoint	0-1000	R/W	UWORD
02	FS	waiting Setpoint	0-1000	R/W	UWORD
03	CL	Current Limit Setpoint	0-1000	R/W	UWORD
04	PV	Process Value	0-1560	R	UWORD
05	OP	Power demand	0-1000	R	UWORD
06	VV	Load Voltage	0-1250	R	UWORD
07	CV	Load Current	0-1250	R	UWORD
08	LV	Line Voltage	0-1250	R	UWORD
09	CA	Normalised Current	0-1000	R	UWORD
10	RI	external analogue Setpoint	0-1000	R	UWORD

address	mnemon.	parameter	limits	status	format IEEE1131-3
11	CW	Command Word	0-12	W	UBYTE

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A-4: TU 4 channels:

Address 0 parameter is always the Unit Type.

COMMON

address	mnemon.	parameter	limits	status	format IEEE1131-3
00	TY	Unit Type	04*	R	UBYTE

*** value 04 indicates a 4 channels TU.**

channel 1

address	mnemon.	parameter	limits	status	format IEEE1131-3
01	SL	local Setpoint	0-1000	R/W	UWORD
02	FS	waiting Setpoint	0-1000	R/W	UWORD
03	CL	Current Limit Setpoint	0-1000	R/W	UWORD
04	PV	Process Value	0-1560	R	UWORD
05	OP	Power demand	0-1000	R	UWORD
06	VV	Load Voltage	0-1250	R	UWORD
07	CV	Load Current	0-1250	R	UWORD
08	LV	Line Voltage	0-1250	R	UWORD
09	CA	Normalised Current	0-1000	R	UWORD
10	RI	external analogue Setpoint	0-1000	R	UWORD

channel 2

address	mnemon.	parameter	limits	status	format IEEE1131-3
11	SL	local Setpoint	0-1000	R/W	UWORD
12	FS	waiting Setpoint	0-1000	R/W	UWORD
13	CL	Current Limit Setpoint	0-1000	R/W	UWORD
14	PV	Process Value	0-1560	R	UWORD
15	OP	Power demand	0-1000	R	UWORD
16	VV	Load Voltage	0-1250	R	UWORD
17	CV	Load Current	0-1250	R	UWORD
18	LV	Line Voltage	0-1250	R	UWORD
19	CA	Normalised Current	0-1000	R	UWORD
20	RI	external analogue Setpoint	0-1000	R	UWORD

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channel 3

address	mnemon.	parameter	limits	status	format IEEE1131-3
21	SL	local Setpoint	0-1000	R/W	UWORD
22	FS	waiting Setpoint	0-1000	R/W	UWORD
23	CL	Current Limit Setpoint	0-1000	R/W	UWORD
24	PV	Process Value	0-1560	R	UWORD
25	OP	Power demand	0-1000	R	UWORD
26	VV	Load Voltage	0-1250	R	UWORD
27	CV	Load Current	0-1250	R	UWORD
28	LV	Line Voltage	0-1250	R	UWORD
29	CA	Normalised Current	0-1000	R	UWORD
30	RI	external analogue Setpoint	0-1000	R	UWORD

channel 4

address	mnemon.	parameter	limits	status	format IEEE1131-3
31	SL	local Setpoint	0-1000	R/W	UWORD
32	FS	waiting Setpoint	0-1000	R/W	UWORD
33	CL	Current Limit Setpoint	0-1000	R/W	UWORD
34	PV	Process Value	0-1560	R	UWORD
35	OP	Power demand	0-1000	R	UWORD
36	VV	Load Voltage	0-1250	R	UWORD
37	CV	Load Current	0-1250	R	UWORD
38	LV	Line Voltage	0-1250	R	UWORD
39	CA	Normalised Current	0-1000	R	UWORD
40	RI	external analogue Setpoint	0-1000	R	UWORD

COMMON

address	mnemon.	parameter	limits	status	format IEEE1131-3
41	CW	Command Word	0-12	W	UBYTE

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ANNEXE B:TU Series Diagnostics:

B-1: TU 1 channel / single phase control:

See B-4 with only SW and SW1.

B-2: TU 1 channel / 2 phases control: (TU21xx)

Status word of the Unit:

SW	name	value	signification
7	FGIR	0 1	RESISTIVE LOAD SHORT I.R. LOAD
6	FGAN	0 1	ANALOGUE SETPOINT COMMUNICATION SETPOINT
5	FGOVV	0 1	LINE OVERVOLTAGE
4	FGUNDV	0 1	LINE UNDERVOLTAGE
3	FGREGU	0 1	U*U CONTROL U*I CONTROL
2			Not Used
1	FGLTO	0 1	SINGLE CYCLE 8 PERIODS BURST
0	FGINH	0 1	Unit running Unit Inhibited

Status Word of the controlled channel:

SW1	name	value	signification
7	FGPLF	0 1	PARTIAL LOAD FAILURE
6	FGNPLF	0 1	PLF HAS NEVER BEEN ADJUSTED
5	FGTLF2	0 1	TOTAL LOAD FAILURE phase 2
4	FGTLF1	0 1	TOTAL LOAD FAILURE phase 1
3	FGLIMI	0 1	CURRENT LIMIT ACTIVE
2	FGSCTH2	0 1	THYRISTOR-SHORT CIRCUIT phase 2
1	FGSCTH1	0 1	THYRISTOR-SHORT CIRCUIT phase 1
0	FGOVL	0 1	OVERLOAD

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B-4: TU 4 channels:

Status word of the Unit:

SW	name	value	signification
7	FGIR	0 1	RESISTIVE LOAD SHORT I.R. LOAD
6	FGAN	0 1	ANALOGUE SETPOINT COMMUNICATION SETPOINT
5	FGOVV	0 1	LINE OVERVOLTAGE
4	FGUNDV	0 1	LINE UNDERVOLTAGE
3	FGREGU	0 1	U*U CONTROL U*I CONTROL
2	FGRAMP	0 1	BURST WITHOUT PROGRESSIVE START 8 PERIODS BURST WITH PROGRESSIVE START
1	FGLTO	0 1	SINGLE CYCLE 8 PERIODS BURST
0	FGAP	0 1	BURST PHASE ANGLE

Status Word per channel:

SW1,2,3,4	name	value	signification
7	FGPLF	0 1	PARTIAL LOAD FAILURE
6	FGNPLF	0 1	PLF HAS NEVER BEEN ADJUSTED
5	FGTLF	0 1	TOTAL LOAD FAILURE
4	FGOVC	0 1	OVERCURRENT
3	FGLIMI	0 1	CURRENT LIMIT ACTIVE
2	FGSCTH	0 1	THYRISTOR-SHORT CIRCUIT
1	FGOVL	0 1	OVERLOAD
0	FGINH	0 1	CHANNEL INHIBITED

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ANNEXE C:TU Series COMMAND CODES (CW):

CODE HEXADECIMAL	CODE DECIMAL	DESCRIPTION
0 / 1	0 / 1	All the channels of the Unit are inhibited
2 / 3	2 / 3	All the channels of the Unit are enabled
4	4	General Aknowledge of active alarms
5	5	P.L.F adjustment of all the channels
6	6	U*I control
7	7	U^2 control
8	8	Phase Angle for all the channels of the Unit*
9	9	Fast-Cycle with Soft-Start for all the channels of the Unit*
A	10	Single Cycle for all the channels of the Unit
B	11	Fast-Cycle for all the channels of the Unit
C	12	Fast-Setpoint transfer

* These commands are available only on the Units with Phase-Angle possibities

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ANNEXE D: TC3001 PARAMETER ADDRESSES:

address	mnémon.	parameter	limits	status	format IEEE1131-3
00	TY	Unit Type	0x10*	R	UBYTE

*** Value 0x10 (hexadecimal) indicate a TC3001 Unit.**

address	mnemon.	parameter	limits	status	format IEEE1131-3
01	SL	Digital Setpoint	0-1000	R/W	UWORD
02	FS	waiting Setpoint	0-1000	R/W	UWORD
03	CW	Command Word	0-99	R/W	UWORD
04	HS	Setpoint Limit	0-1000	R/W	UWORD
05	CL	Current Limit	0-1000	R/W	UWORD
06	AO	Analog Output	0-1000	R/W	UWORD
07	-	RESERVED	0x7FFF	R/W	UWORD
08	II	Instrument Identifier	0x7FFF	R/W	UWORD
09	V0	Driver Software Version	hexa	RO	UWORD
10	-	RESERVED		RO	UWORD
11	-	RESERVED		RO	UWORD
12	-	RESERVED		RO	UWORD
13	-	RESERVED		RO	UWORD
14	V1	Comm. Software version	hexa	RO	UWORD
15	-	RESERVED		RO	UWORD
16	-	RESERVED		RO	UWORD
17	PV	Process Value	0-1000	RO	UWORD
18	SP	Working Setpoint	0-1000	RO	UWORD
19	OP	Thyristor Firing Ratio	0-1000	RO	UWORD
20	PW	Power Output	0-1250	RO	UWORD
21	VV	Load Voltage	0-1250	RO	UWORD
22	CV	Mean Current	0-1000	RO	UWORD
23	C1	Phase 1 Current	0-1000	RO	UWORD
24	C2	Phase 2 Current	0-1000	RO	UWORD
25	C3	Phase 3 Current	0-1000	RO	UWORD
26	LV	Line Voltage	0-1250	RO	UWORD
27	FR	Mains Frequency	40-70	RO	UWORD
28	RI	Remote Input (Analog)	0-1000	RO	UWORD
29	AI	External Measure	0-1000	RO	UWORD
30	CT	Burst firing Lenght	1-255	RO	UWORD
31	ST	Soft Start/End Duration	0-255	RO	UWORD
32	DT	Firing Delay on transformer	0-90	RO	UWORD
33	RR	Ramp Duration / 2	1-32640	RO	UWORD
34	TI	Response Time	13-52	RO	UWORD
35	A1	Analog Input 1	0-1000	RO	UWORD
36	A2	Analog Input 2	0-1000	RO	UWORD

A min time intervalle of 50ms must be keep between 2 values which are to be write into the EEPROM.

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ANNEXE E: TC3001 Diags:

They are 2 kinds of Status Word:
SW (2 bytes) contains the Status of the Unit (stored in the EEPROM).
XS (2 bytes) contains the current state of the Alarms.

These 2 Status words appears 2 time:
In the Diag User Field following the Profibus Diag procedure.
In the parameters Field as other read Only parameters

Structure of SW:

Bit number	Value	Description
1,0	00	ON/OFFF
	01	Burst
	10	Phase Angle
	11	Single Cycle
3,2	00	Without Ramp
	01	Ramp or Soft Start
	10	Without Ramp
	11	Ramp or Soft Start/End
5,4	00	Star without Neutral
	01	Star with Neutral
	10	Closed Triangle
	11	Open Triangle
6	0	Resistive Load
	1	Inductive Load
9,8,7	000	External Measure
	001	V*V
	010	I*I
	011	v*I
	100	Open Loop
	101	Vrms
	110	IRMS
	111	V*V/I*I tranfer
10	0	PLF on Resistive Load
	1	PLF on Infra-Red Load
11	0	PLU not active
	1	PLU active
12	0	Current Limit active
	1	Chop off
13	0	Communication. Command
	1	Analog Command
14	0	Digital Setpoint (SL) active
	1	Analog Setpoint (RI) active
15	0	Communication active
	1	Communication not active

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Structure of XS

1 in a bit signifies "Alarm Active"

If XS=0xFFFF, The Driver microprocessor is Out of Order.

Bit Number	Signification
0	PLF on Phase 1
1	PLF on Phase 2
2	PLF on Phase 3
3	Ramp active
4	Over Current
5	Mains Over Voltage
6	PLU
7	Digital Input Status
8	Phase 1 failure
9	Phase 2 failure
10	Phase 3 failure
11	Mains Under Voltage
12	Frequency Out of Range
13	Thyristor Short-Circuit
14	External Input Error / Neutral wiring break (4 wire only)
15	Unit Inhibited

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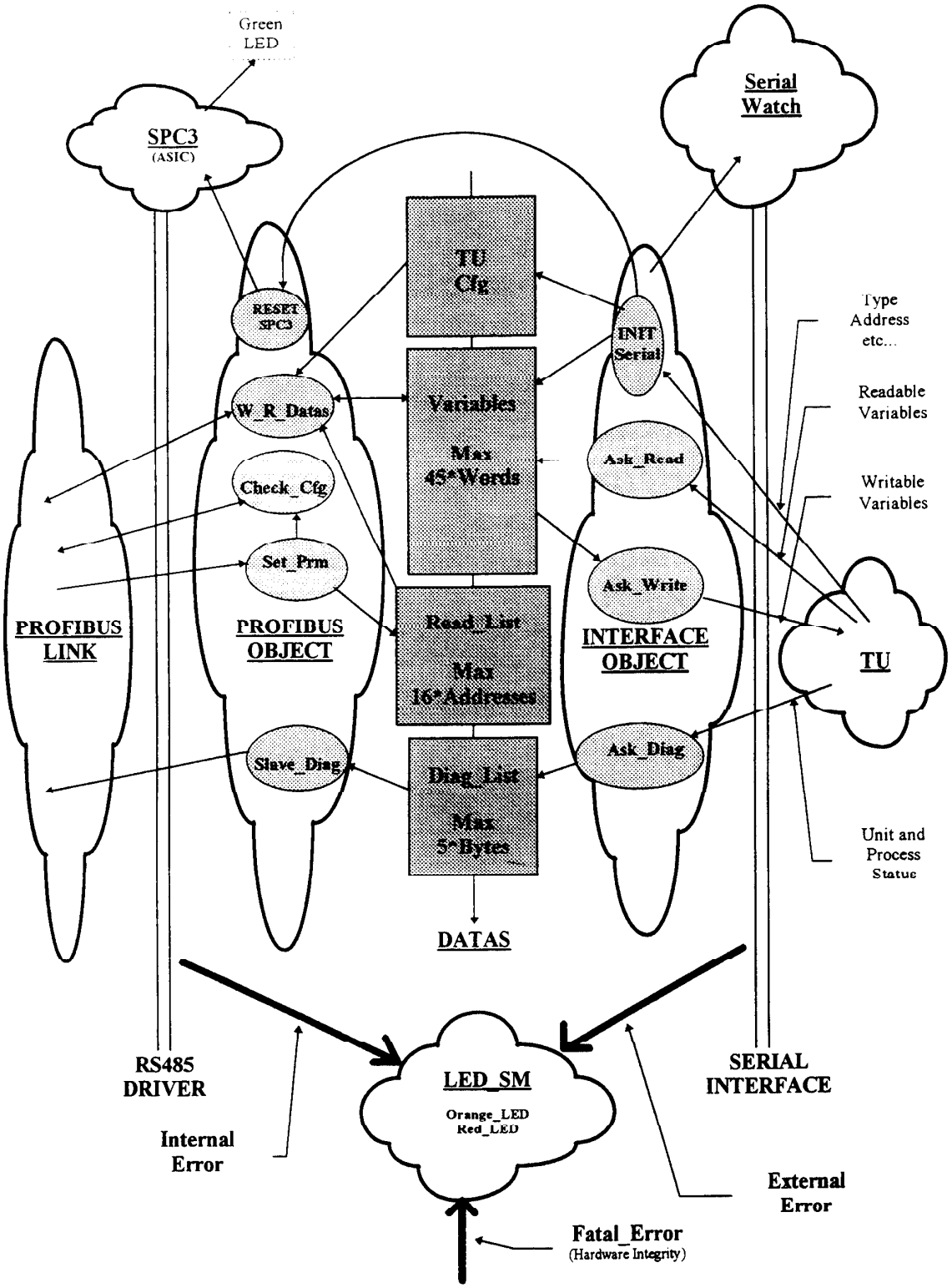
ANNEXE F: Tc3001 Command codes (CW):

Decimal Code	Hexadecimal Code	Operation
0,1	0X00,0X01	Inhibit
2,3	0X02, 0X03	Enable
4	0X04	Alarm Acknowledge
5	0X05	PLF adjustement
6	0X06	V*I Control
7	0X07	V*V Control
8	0X08	Phase Angle Firing
9	0X09	Burst with Soft Start
10	0X0A	Single Cycle
11	0X0B	Burst
12	0X0C	FS--->SL Tranfer
13	0X0D	SL Digital Input
14	0X0E	RI Analog Input
15	0X0F	Phase Angle with positive Ramp
16	0X10	Phase Angle with positive and negative Ramp
17	0X11	RESERVED
18	0X12	Open Loop Control
19	0X13	External Measure Control
20	0X14	I*I Control
21	0X15	Irms Control
22	0X16	Vrms Control
23	0X17	I*I/V*V Transfer Control
24	0X18	Chop off on Over current
25	0X19	Current Limit active
26	0X1A	RESERVED
27	0X1B	Logic Firing
28	0X1C	Logic Firing with Soft Start
29	0X1D	Logic Firing with Soft Start and Soft End
30	0X1E	Burst with Soft Start and Soft End
31-97	0X1F-0X61	RESERVED
98	0X62	Enable Write Command to EEPROM
99	0X63	RESTART the Unit

ANNEXE G: Structure of the multitask Application Layer:



EUROTHERM WORLDWIDE SALES AND SERVICE

AUSTRALIA
Eurotherm Pty. Ltd.
Unit 6, 16-18 Bridge Road
Hornsby New South Wales 2077
Tel (+61 2) 9477 7022
Fax (+61 2) 9477 7756

AUSTRIA
Eurotherm GmbH
Geiereckstrasse 18/1
A 1110 Wienna
Tel (+43 1) 798 7601
Fax (+43 1) 798 7605

BELGIUM
Eurotherm B.V.
Herentalsebaan 71-75
B-2100 Deume Antwerpen
Tel (+32 3) 322 3870
Fax (+32 3) 321 7363

DENEMARK
Eurotherm A/S
Finsensvej 86
DK-2000 Frederiksberg
Tel (+45 31) 871 622
Fax (+45 31) 872 124

FRANCE
Eurotherm Automation SA
6, Chemin des Joncs, B.P. 55
69572 Dardilly Cedex
Tel. (+33) 4 78 66 45 00
Fax (+33) 4 78 35 24 90

GERMANY
Eurotherm Regler GmbH
Ottostrasse 1
65549 Limburg a.d. Lahn
Tel (+49 6431) 2980
Fax (+49 6431) 298119

HONG KONG
Eurotherm Limited
Unit D 18/F Gee Chang Hong Centre
65 Wong Chuk Hang Road Aberdeen
Tel. (+852) 2873 3826
Fax (+852) 2870 0148

INDIA
Eurotherm India Limited
152 Developed Plots Estate
Perungudi Madras 600 096
Tel. (+9144) 4928129
Fax (+9144) 4928131

IRELAND
Eurotherm Ireland Limited
I.D.A. Industrial Estate
Monread Road Naas Co Kildare
Tel. (+353 45) 879937
Fax (+353 45) 875123

ITALY
Eurotherm SpA
Via XXIV Maggio
22070 Guanzate
Tel. (+39 31) 975111
Fax (+39 31) 977512

JAPAN
Eurotherm Japan Ltd.
Matsuo Building 2F
3 1-4-3 Honmachi Shibuya-ku Tokyo 151
Tel (+81 3) 33702951
Fax (+81 3) 33702960

KOREA
Eurotherm Korea Limited
Suite 903, Daejoo Building
132-19 Chungdam-Dong, Kangnam-Ku
Seoul 135-100
Tel (+82 2) 5438507
Fax (+82 2) 545 9758

NETHERLANDS
Eurotherm B.V.
Hoge Rijndijk 48A
2382 AT Zoeterwoude
Tel. (+31 71) 5411841
Fax (+31 71) 5414526

NORWAY
Eurotherm A/S
Postboks 288
1411 Kolbotn
Tel (+47 66) 803330
Fax (+47 66) 803331

SPAIN
Eurotherm España SA
Calle de La Granja 74
28100 Alcobendas Madrid
Tel (+34 1) 6616001
Fax (+34 1) 6619093

SWEDEN
Eurotherm AB
Lundawägen 143
S-21224 Malmo
Tel (+46 40) 384500
Fax (+46 40) 384545

SWITZERLAND
Eurotherm Produkte AG
Schwerzistrasse 20
CH-8807 Freienbach
Tel (+41 055) 4154400
Fax (+41 055) 4154415

UNITED KINGDOM
Eurotherm Controls Ltd.
Faraday Close, Durrengton
Worthing West Sussex,
BN13 3PL
Tel.(+44 1903) 268500
Fax(+44 1903) 265982

U.S.A.
Eurotherm Controls Inc.
1185 Sunset Hills Road
Reston Virginia
22090-5286
Tel. (+1703) 471 4870
Fax (+1703) 787 3436

Manufactured by Eurotherm Automation S.A.