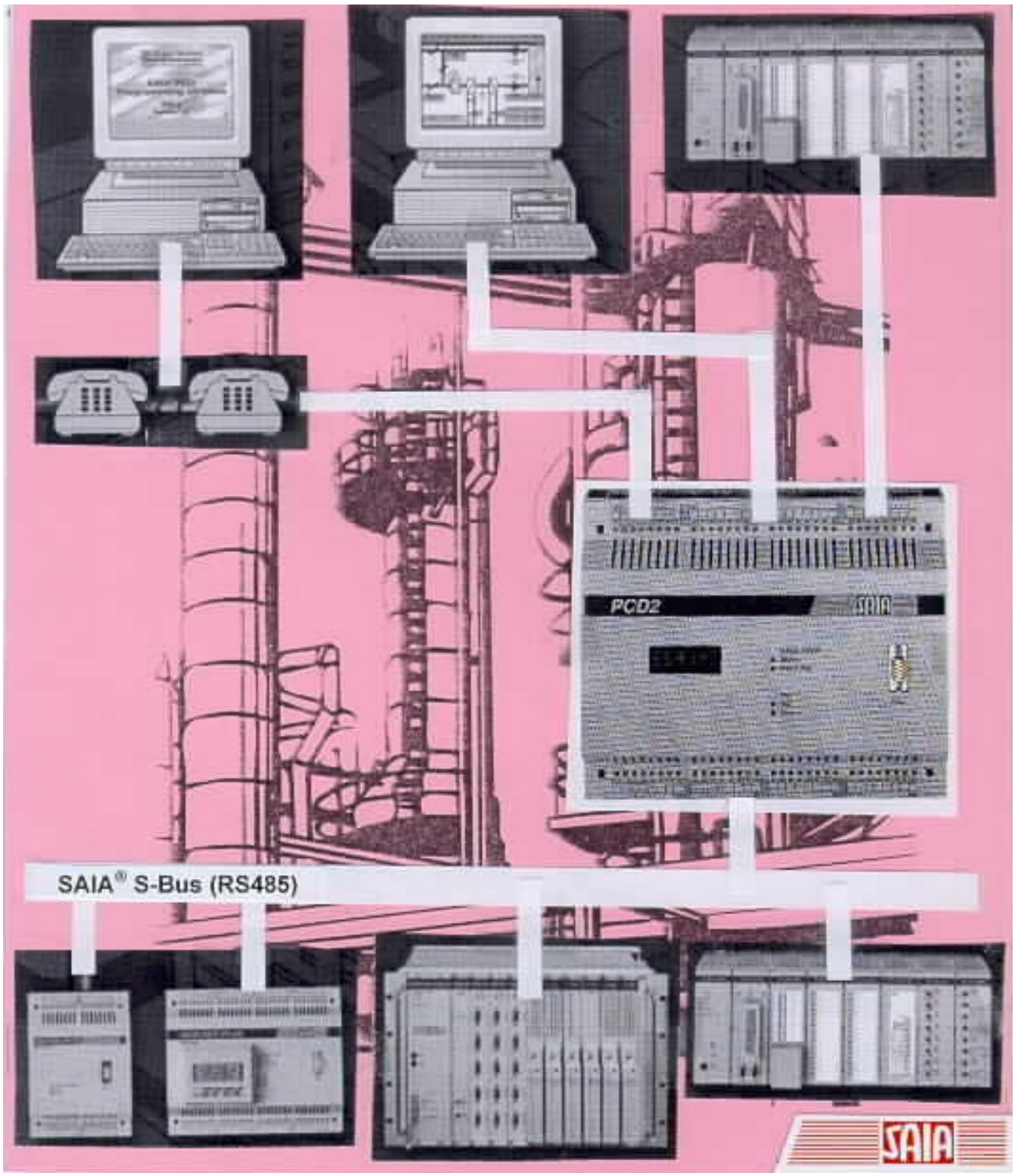
SAIA-Burgess Electronics

SWITCHES • MOTORS • CONTROLLERS

SAIA® PCD

Process Control Devices

Manual
SAIA® S-Bus



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SAIA® Process Control Devices

Manual

SAIA® S-BUS

for the PCD family

Edition 26/739 E4 - 04.2000

Subject to technical changes

Updates

Manual : SAIA S-Bus for the PCD family - Edition E4

Date	Chapter	Page	Description
11.05.2000	6.6	6-8 / 6-9	Gateway master, enlarged table
06.10.2000	3.12	3-53	SYSWR : Code 6000 (write EEPROM)

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7. Using S-Bus with the PG3

8. Appendixes

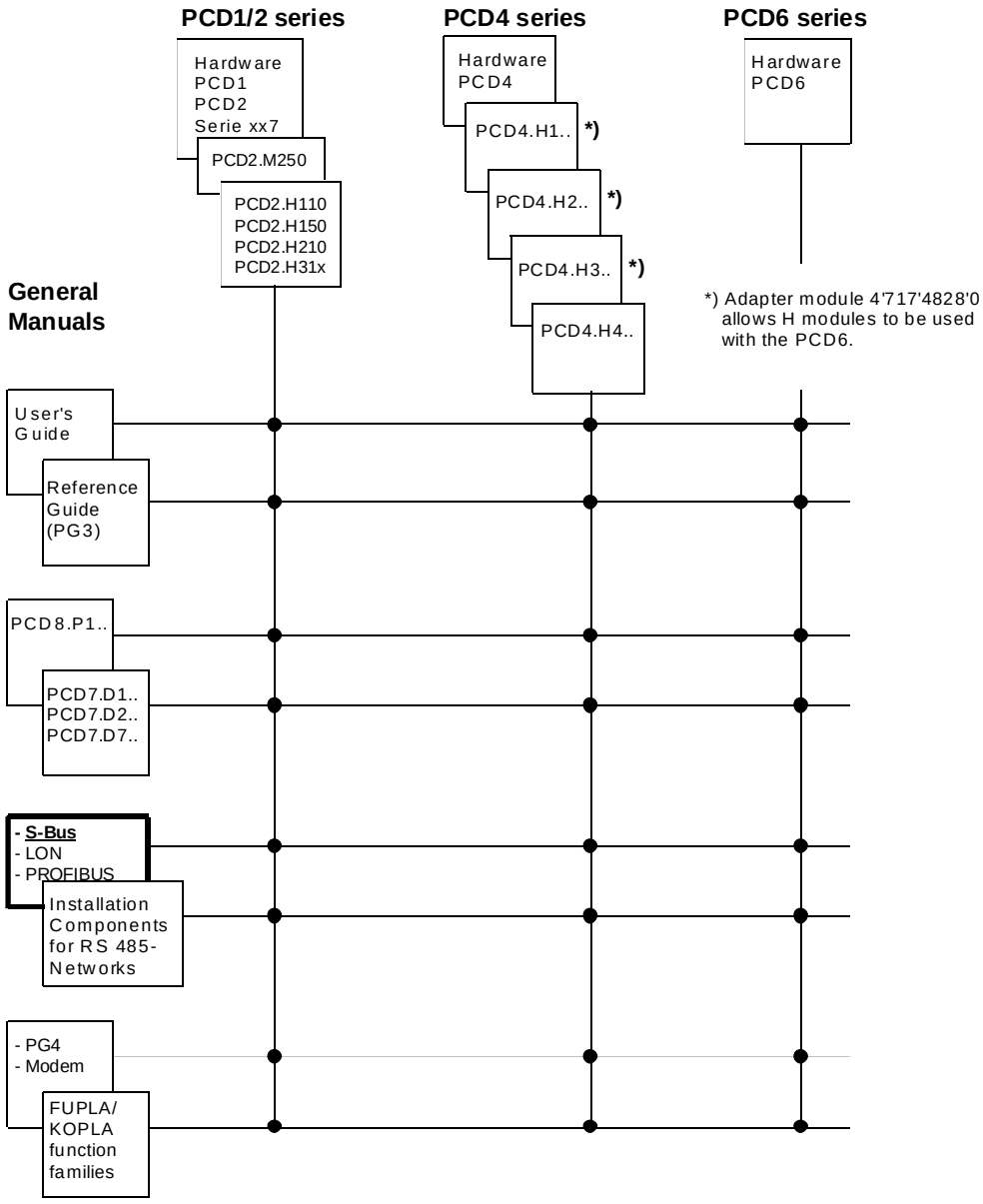
Please note :

A number of detailed manuals are available to aid installation and operation of the SAIA PCD. These are for use by technically qualified staff, who may also have successfully completed one of our "workshops".

To obtain the best performance from your SAIA PCD, closely follow the guidelines for assembly, wiring, programming and commissioning given in these manuals. In this way, you will also become one of the many enthusiastic SAIA PCD users.

If you have any technical suggestions or recommendations for improvements to the manuals, please let us know. A form is provided on the last page of this manual for your comments.

Summary



Reliability and safety of electronic controllers

SAIA-Burgess Electronics Ltd. is a company which devotes the greatest care to the design, development and manufacture of its products:

- state-of-the-art technology
- compliance with standards
- ISO 9001 certification
- international approvals: e.g. Germanischer Lloyd,
  United Laboratories (UL), Det Norske Veritas, CE mark ...
- choice of high-quality componentry
- quality control checks at various stages of production
- in-circuit tests
- run-in (burn-in at 85°C for 48h)

Despite every care, the excellent quality which results from this does have its limits. It is therefore necessary, for example, to reckon with the natural failure of components. For this reason SAIA-Burgess Electronics Ltd. provides a guarantee according to the "General terms and conditions of supply".

The plant engineer must in turn also contribute his share to the reliable operation of an installation. He is therefore responsible for ensuring that controller use conforms to the technical data and that no excessive stresses are placed on it, e.g. with regard to temperature ranges, overvoltages and noise fields or mechanical stresses.

In addition, the plant engineer is also responsible for ensuring that a faulty product in no case leads to personal injury or even death, nor to the damage or destruction of property. The relevant safety regulations should always be observed. Dangerous faults must be recognized by additional measures and any consequences prevented. For example, outputs which are important for safety should lead back to inputs and be monitored from software. Consistent use should be made of the diagnostic elements of the PCD, such as the watchdog, exception organization blocks (XOB) and test or diagnostic instructions.

If all these points are taken into consideration, the SAIA PCD will provide you with a modern, safe programmable controller to control, regulate and monitor your installation with reliability for many years.

1. Introduction

1.1 What is the SAIA S-Bus ?

S-Bus is the name of an efficient communication protocol for the SAIA® PCD generation of controllers. It can be used for both point-to-point communications and within a local master/slave network.

For point-to-point communications, any of the PCD's serial interfaces can be used.

At the physical level, an S-Bus network uses the RS 485 standard, via two-core twisted and shielded cable. S-Bus can be used as a simple, economic means of networking up to 255 PCD systems, connected to up to 8 segments, each containing up to 32 stations.

S-Bus has the following major characteristics :

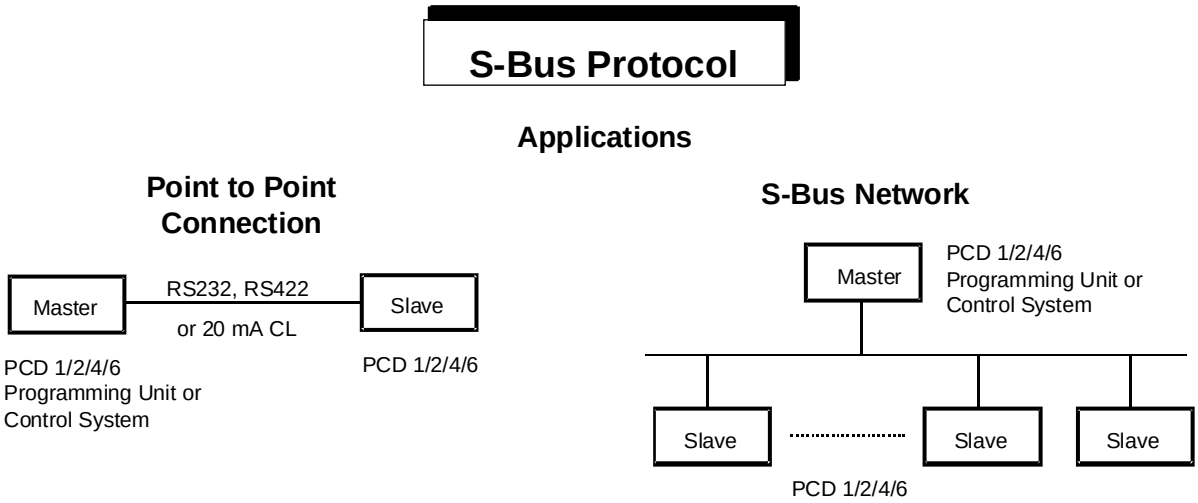
- Ease of handling (installation, commissioning and user programming)
- Cost effective, since the S-Bus protocol is already built into every PCD processor. This means that no additional dedicated communications processor is required.
- Fail-safe data transfer, using CRC-16 error detection.
- High data transfer rate, due to the efficient binary protocol with transmission speed up to 38.4 kbps.
- Support for remote data access and diagnostics via a modem on leased or dial-up lines.
- Drivers are available for supervisory control systems such as Wizcon, InTouch, FactoryLink, Fix D-Macs and Genesis.
- With application level 2 (commissioning service) the programming unit has access to all slave stations on the network. This means that any slave station connected to the network can be controlled by the programming unit from a central point (e.g. by the debugger).
- Multi-master possibility by using the S-Bus Gateway
- Access possible to all media in slave.

Glossary

P8 or P800	also called D mode : original protocol used for the programming unit.
PGU	ProGramming Unit. This term designates the programming console, but also by extension the port where the console must be connected. The PGU designates also the protocol used by the programming console.
PLM	Public Line Modem.
PSTN	Public Switched Telephone Network.
SCADA	Supervisory Control and Data Acquisition
SCS	Supervisory Control Systems
GSM	Global System for Mobile communication
ISDN	Integrated Services Digital Network

1.2 Typical Applications

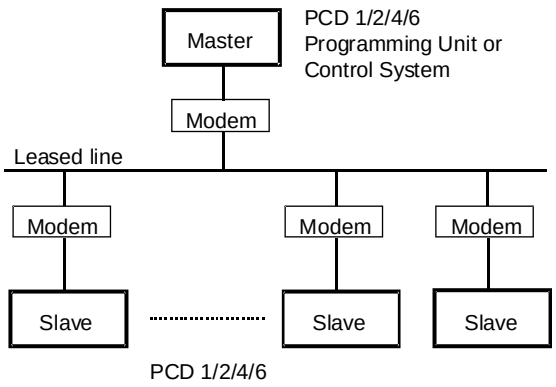
The S-Bus protocol was developed specifically for the RS 485 S-Bus network. However, it can also be used with the other serial interfaces for point-to-point connections.



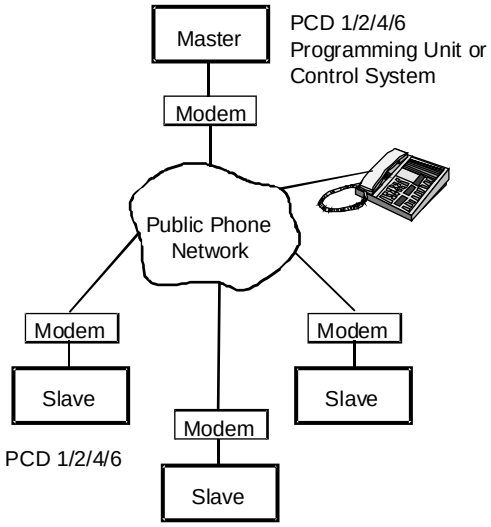
The master station can be a PCD2, PCD4, PCD6 (also PCD1 from FW version V005), the programming unit or any non-SAIA system. Several supervisory control systems (e.g. Wizcon, FactoryLink, In Touch, Fix DMACS, …) provide driver for the S-Bus protocol.

Without repeaters it is possible to connect up to 32 stations over a maximum distance of 1200m in this way.

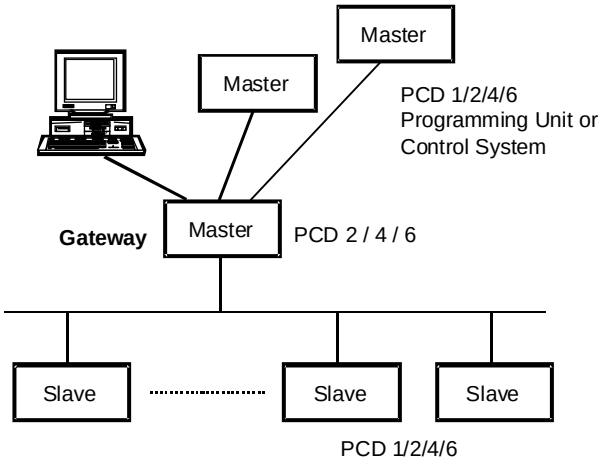
Network with "Multipoint" modem to bridge large distances using leased or private telephone lines. The RS 232 interface is used in S-Bus mode to connect between the modem and the PCD.



The S-Bus protocol can also be used with modems; allowing the SAIA PCDs to communicate through the Public Telephone Network.
This type of connection can be used for remote supervision and/or remote programming and commissioning. Possible telephone networks are: analogue, digital (ISDN), radio (GSM), etc.



Even if the S-Bus network is a single master / multiple slaves; a feature called the “Gateway” allows other masters connected to the first one to communicate with all the slaves present on the network.



1.3 Characteristics

Network

Master/slave	bus with single master and several slaves (Single Client / Multiple Servers)
Physical interface	RS 485
Bus line	twisted two-core, shielded, line section min. 2 ∗ 0.5 mm2 length max. 1200 m per segment
Number of stations	max. 32 per segment, total max. 255
Number of segments	max. 8, connected together via repeater PCD7.T100

Point-to-point connection

Interfaces	RS 232, RS 422, 20mA CL

Electrical characteristics of interfaces

See hardware manuals	PCD1 - PCD2, PCD4 and PCD6.

S-Bus protocol

Baud rate	from 110 to 38'400 bit/s	
Start bit	1	
Character length	8 bits	
Parity bit	mode SM2/SS2 : mode SM1/SS1 : mode SM0/SS0 :	no parity parity 1 / 0 no parity
Stop bit	1	
Data transfer rate	standard : maximum :	167 registers/s (at 9600 bps) 265 registers/s (at 19200 bps)
Reaction times for transmission at 9600 bps of	1 to 8 in-/outputs or flags : 128 in-/outputs or flags : 1 register : 32 registers	18 ms 35 ms 20 ms 125 ms
Error detection	CRC-16	

Programming

The following PCD instructions are provided :

- Initialise serial interfaces instructions
- Instructions for data exchange
- Control line handling instructions
- System parameters read & write instructions

Supervisory control systems

S-Bus drivers are available for the following systems :

- Wizcon
- Genesis
- FactoryLink
- InTouch
- Fix D-Macs
- Windows DDE

For implementation of the S-Bus protocol in a non-SAIA system, SAIA-Burgess Electronics Ltd. provides software libraries for Windows DLL as well as in the C programming language.

1.4 The S-Bus protocol

OSI model applied to SAIA S-Bus:
The following diagram shows the implementation of the layers in the SAIA-Bus protocol

Application Layer	SAIA S-Bus Reduced & Full Protocol
Presentation Layer	Telegrams 0 .. 255
Session Layer	not used
Transport Layer	not used
Network Layer	Forced parity mechanism
Data Link Layer	ACK/NAK mechanism Byte synchronisation + CRC 16 Error check
Physical Layer	RS485, RS 232, 20mA CL, etc.

1.4.1 Application Layer

Data transfer service (level 1)

A subset of the S-Bus protocol (also called Reduced protocol). The master station can only read and write PCD data in a slave station, and the slave station's status can be read.

PCD data : Inputs, Outputs, Flags, Registers, Timers, Counters, Data Blocks and the hardware clock.

Commissioning service (level 2)

This level supports the entire S-Bus protocol (Full S-Bus), the programming unit (PGU) can be used to control each slave station on the network. The commissioning service is also called S-Bus PGU. Access via the public telephone system is also supported: slave station programming and commissioning can therefore be done from a central point.

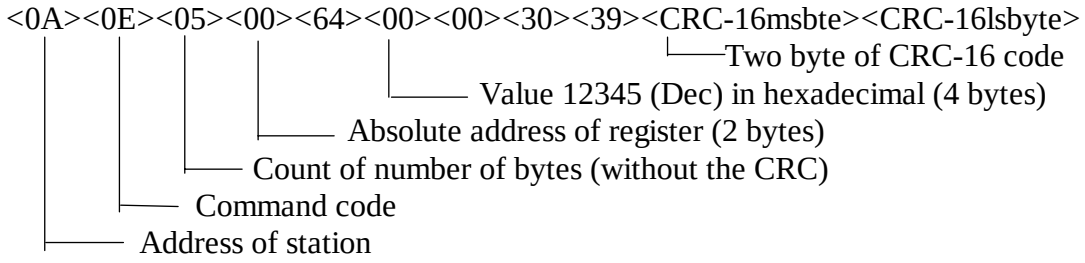
1.4.2 Presentation Layer

Most of the telegram are of a fixed length and so there is no requirement for a special end of telegram character. Those telegrams that are not of fixed length have a count byte immediately following the command code to indicate the length of the telegram. There is no need of a count byte in the response telegram as the Client will already know the length of the telegram that he is expecting.

A telegram can have an absolute maximum length of 32 registers/ timers/counters or 128 flags/inputs/outputs when in run. Some special telegrams can have more bytes than this but these telegrams cannot be used when the CPU is in run. For instance, to optimise the downloading of a program up to 64 program lines can be transferred at a time which gives a maximum telegram length of 263 bytes.

Example of an S-Bus telegram

Write Register 100 with the value 12345 (Dec) to station 10 in the SAIA-Bus network. The telegram will look like so :



1.4.3 Network Layer

The network layer service is very simple and takes advantage of the multidrop feature of the DUART used in the PCD family. This multidrop mode eliminates the need for special start characters in each telegram.

This mode supports two different types of character, an address character and a data character. The difference between the two is that for an address character the parity bit is forced to 1 and for a data character the parity bit is forced to 0.

A telegram consists of an address character followed by a number of data characters targeted for a particular slave station. When any address character is detected in the data stream the slave station compares its address to the address character received before deciding whether to receive the data characters in the telegram. Slave stations which are not addressed continue monitoring the data stream for the next address character.

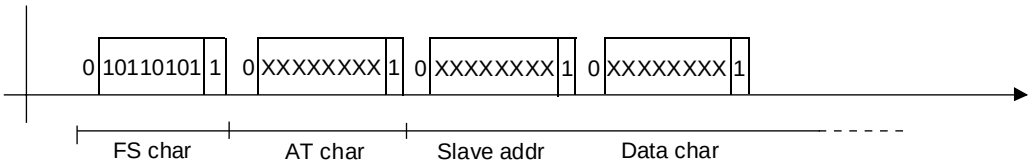
The address 255 (dec) is to be reserved for broadcast messages. No response is expected after transmission of a broadcast message. This mode of operation is called the parity mechanism.

Because that most of the public line modems do not support 9 bit characters as used for the parity mechanism and also the Break character used to indicate the beginning of every telegram; another mode called “Data Mode” is then used.

1.4.3.1 Data Mode (SM2/SS2)

In data mode each telegram begins with a special FS character. (FS = frame synchronisation). This FS character always has the value B5 and does not appear in the telegram, except in the telegram header. The second character transmitted in data mode is telegram information. This telegram information is called the AT character and may contain, for example, the following information: The current telegram is a request telegram, a reply telegram, etc.

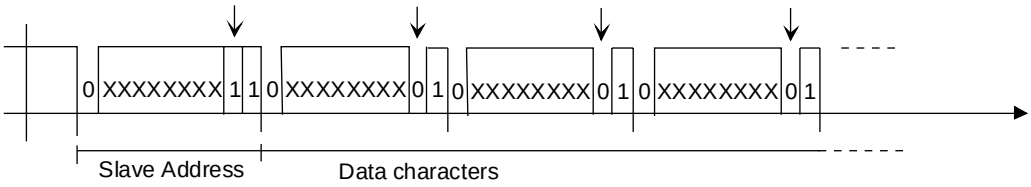
S-Bus Telegram (principle) :



1.4.3.2 Parity Mode (SM1/SS1)

The parity bit used in so called multidrop mode to indicate the type of current character as follows : 1 Address character
0 Data character

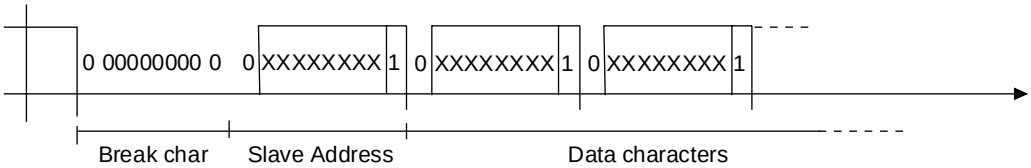
S-Bus Telegram (principle) :



1.4.3.3 Break Mode (SM0/SS0)

The BREAK character is a special character: the serial data is low for the entire character including the stop bit.

S-Bus Telegram (principle) :



The Break character can be detected by the remote PCD; it indicates the start of an S-Bus telegram. The S-Bus driver on the remote PCD will always read the character following the Break character as the address character and the appended character as data characters of current telegram.

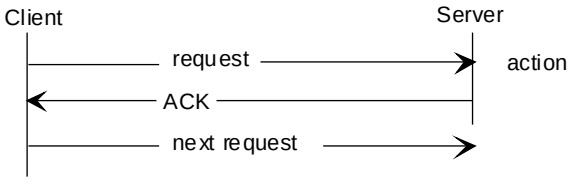
1.4.4 Data Link Layer

The Upper Sub-layer manages the point to point communication between stations on the network. If a telegram is lost or corrupted then this layer will manage the retransmission of this telegram. The functionality of this level can be seen in the following diagrams.

If a corrupted telegram is detected then there is no response and the client will time-out up to three times before informing the upper layers that there has been a transmission failure. The time-out will be a function of the Baud rate.

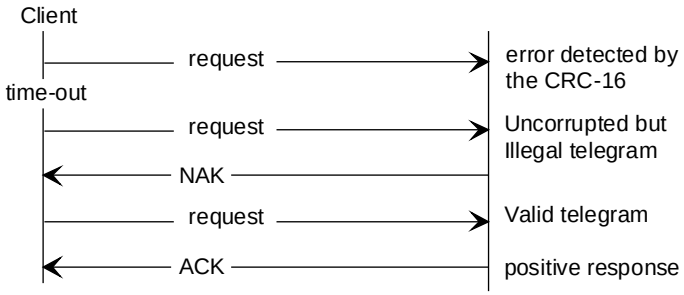
Transmission of a command telegram

This shows the successful transmission of a telegram.



If a corrupted telegram is received at the server and the client receives no response. The telegram will then be retransmitted after the client has timed out.

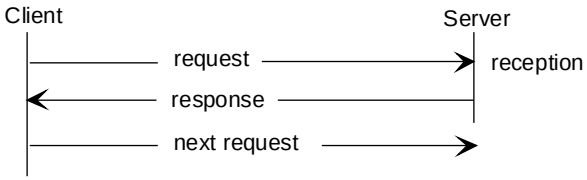
A message is transmitted a total of three times, i.e. there will be two retries.



Invocation of response messages

Upon reception of the read telegram the server will transmit the response directly. Any response which appears on the network must be for the client, so there is no need for a special start of telegram character or address character for the response.

This example shows the successful execution of a read response telegram.



Half-Duplex Protocol

Only one station can be master in a network and so only a half duplex protocol is supported. This means that there is never any danger of deadlock of contending clients.

Lower Sub-layer

The main task of this layer is to manage the CRC-16 error checking code. This type of error checking is used since this protocol uses no form of parity checking on individual bytes.

The CRC-16 error checking algorithm uses the polynomial:

X^16 + X^12 + X^5 + 1 = 1021 Hex

This is the standard CCITT CRC (Reference CCITT V-41).

1.4.5 Physical Layer

SAIA-Bus will run on all the types of communications ports of the PCD family.

The SAIA S-Bus is designed principally to run over an RS485 Multidrop network of one client and a maximum of 255 servers using an S-Bus repeater.

The SAIA S-Bus can also run over an RS-232 serial interface and via modems.

2. Installation

2.1 Point to point connection

In principle, any type of interface can be assigned in S-Bus mode. Since, as a rule, the creation of a point-point connection causes no installation problems, further details are not given here.

A comprehensive description of pin allocation and data on the various interface types can be found in the PCD1 - PCD2, PCD4 and PCD6 hardware manuals.

For using S-Bus in RS232 on port 0 on a PCD2, a special handling must be done after the serial line has been assigned (see the SOCL instruction on chapter 3.10).

2.2 S-Bus network

For installation of the S-Bus network, modules are required with the RS485 interface.

Modules with RS485 interface :

- PCD1.M110 with interface n° 1 (RS485)
- PCD1.M120/M130 with PCD7.F110/F150 interface n° 1 (RS422/485)
- PCD2.M110/M120 or M150 with interface n° 0 (RS485) or with F-modules PCD7.F110/F150 interface n° 1 (RS422/485) or with PCD2.F5xx interface n° 3 (RS422/485)
- PCD2.M250 (resp. M220) with interface n° 0 (RS485) or with F-modules PCD7.F110/F150 interface n° 1 (RS422/485) or with PCD2.F5xx interface n° 3 (RS422/485)
- PCD4.C130 bus module (interface n° 1) with processor modules PCD4.M12x, M14x, M240, M340 or M44x
- PCD4.C340 bus module with PCD7.F110/F150 with processor modules PCD4.M12x, M14x, M240, M340 or M44x
- PCD6.M540 single processor module (interface n° 1)
- PCD6.M220 communications processor module (interface n° 0)
- PCD6.M260 communications processor module (interfaces n° 0, 1, 2, 3)
- PCD6.M300 communications processor module with F-modules PCD7.F110/F150 (interfaces n° 0, 1, 2, 3)

Consult the appropriate PCD hardware manual to obtain all information about these modules and how to connect them.

To guarantee in a rough and noisy industrial environment an error free operation of the RS485 network it is recommended to use the special installation components for RS485 networks.

The following components are available :

Termination box PCD7.T160

This very simple module is used to terminate the network correctly and to apply bias voltage to the signal lines with an electrically isolated supply and the correct off-load potential.

Converter PCD7.T120 (RS232/485) and PCD7.T140 (RS422/485)

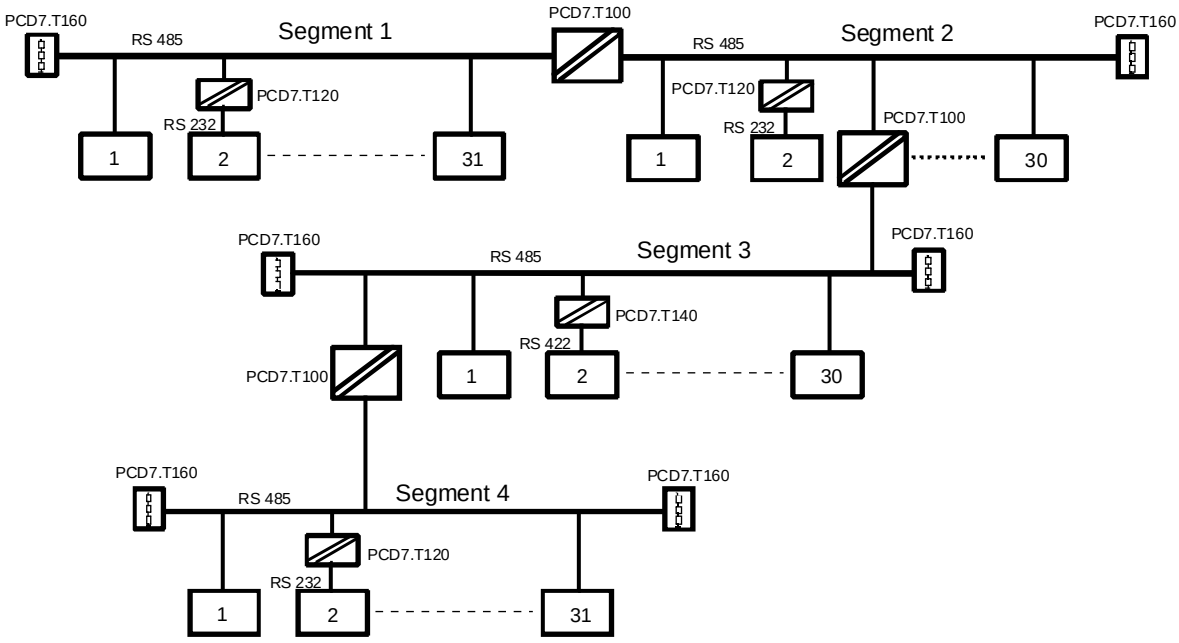
The converters enable electrically isolated conversion from the RS232 or RS422 of a remote station to the RS485 2-wire bus and vice versa.

Repeater PCD7.T100

The repeater is used not only for the electrical isolation of individual line sections from each other, but also to reprocess signals travelling longer distances.

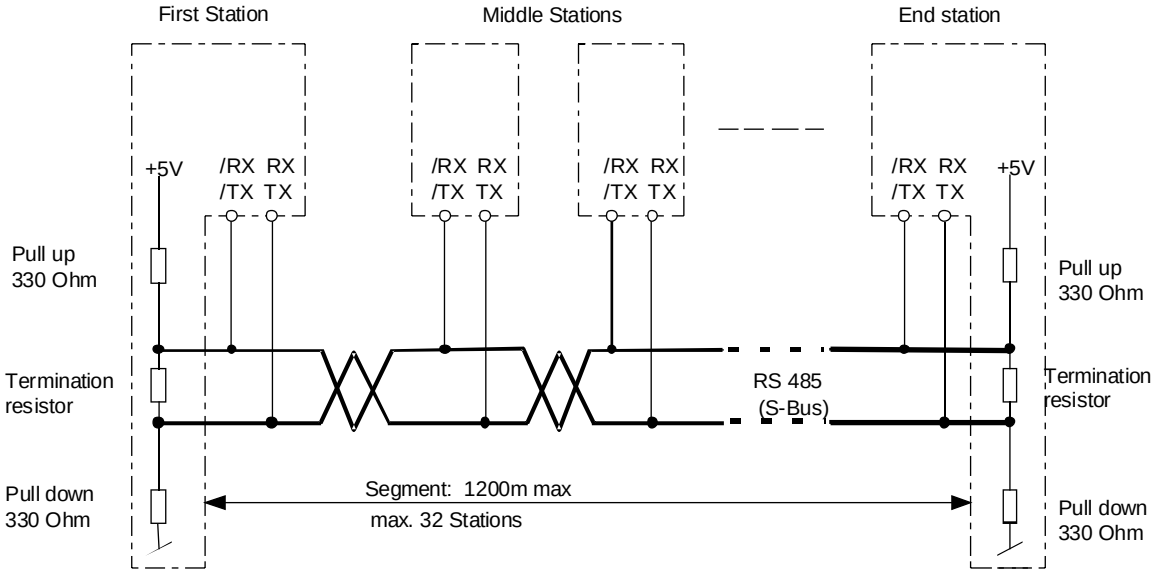
A detailed description of these components and general information for the installation and commissioning of an RS485 network can be found in the manual "Installation components for RS 485 networks".

In this manual the installation of an S-Bus network is described without the use of the special installation components.



Connection and placement of RS485 bus line

To suppress interference and avoid reflections, pull-up/down line termination resistors must be provided both at the **start and end** of the bus line. These resistors are incorporated in all processor and bus modules and they can be switched on or connected according to choice.



When using the internal resistors of the processor or bus modules to terminate the lines, these stations can not be powered down otherwise the communication over the network is no more possible.

If the network must still continue to work when the first and end stations are not powered, you must use PCD7.T160 termination boxes.

The following points demand special attention :

- When making the bus cable, strict attention is necessary not to mix up the data lines - "RX-TX" must therefore always run to "RX-TX" and "/RX-/TX" to "/RX-/TX".

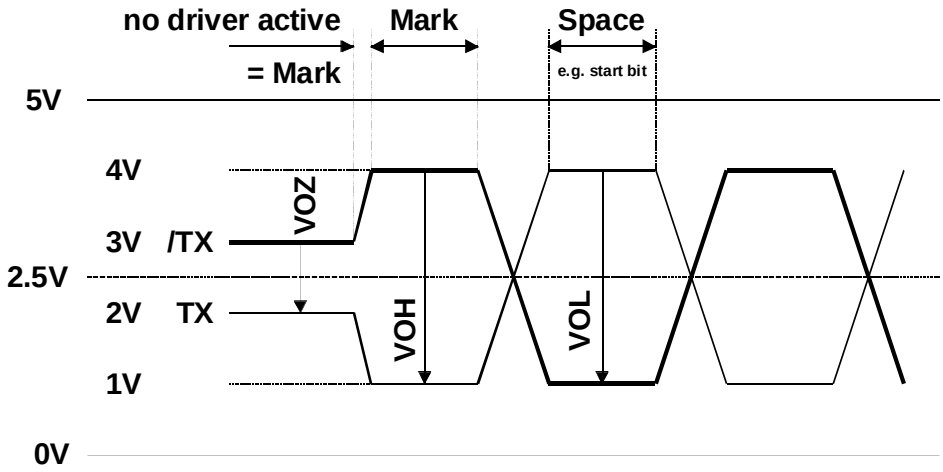
  The denominations “RX-TX” and “/RX-/TX”are not always used :

RX	D	–RX
/RX	/D	+RX
TX	D	–TX
/TX	/D	+TX

- Care should also be taken that the bus line remains continuously connected, even when one or more plugs are pulled out.
- Spur cables (stubs) should not exceed 0.5 m.
- Use stranded cable of at least 0.5 mm^2, with 2 cores, twisted and shielded.

Signal levels of the RS485 interface

Signal type	Logical state	Polarity
Data signal	0 (space)	RX-TX positive to /RX-/TX
	1 (mark)	/RX-/TX positive to RX-TX

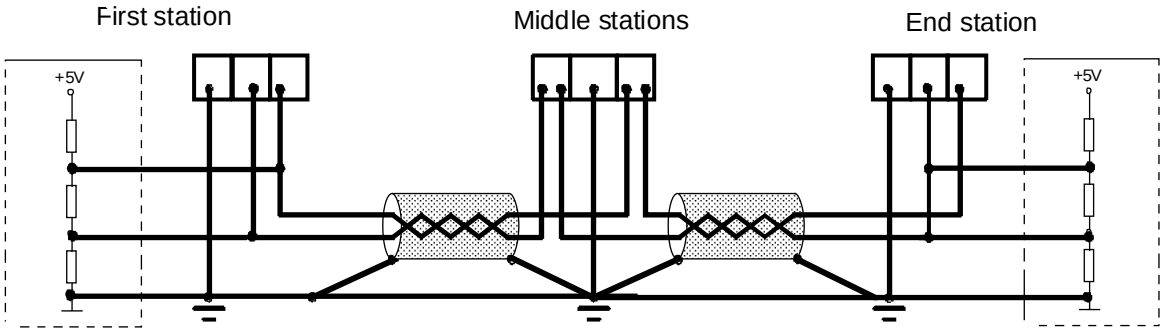


VOZ = 0.9V min... 1.7V max (no driver active) *)
VOH = 2V min (with load) ... 5V max (without load)
VOZ = -2V ... -5V

*) dependent of the Pull up, Termination and Pull down resistors.

Grounding of an RS485 bus line

The cable's screening must always be connected at both ends, to produce a continuous, solid earth line, and so reduces potential differences to a minimum.



It is recommended that the RS485 cable is not laid in direct proximity to motor cables which may be produce interference, unless these cables are also well screened.

3. Data Transfer Service

3.1 Operating principle and application

Application level 1 (Reduced Protocol) enables PCD data to be exchanged via the S-Bus network or a point to point connection.

The master station can be a PCD2, PCD4, PCD6 or any other non-SAIA system (e.g. a supervisory control system such as Wizcon, Factory Link, etc.) which has a driver for the S-Bus protocol.

All communication is controlled from the master station. The user program in the master station defines which data from a connected slave station are to be read or written. From the user's point of view, the behaviour of the slave station in this is passive. Communication is run automatically in the background by the CPU firmware. For the slave station, the user program only initialises the interface.

PCD interfaces are assigned for the master station in SM2, SM1 or SM0 mode (S-Bus master) and for the slave station in SS2, SS1 or SS0 mode (S-Bus slave).

Station number definition

Each slave station is allocated a number, so that it can be addressed from the master station. This number is stored in the user program's "header" in the memory module of a slave station

The station number is stored differently, depending on the memory modules used.

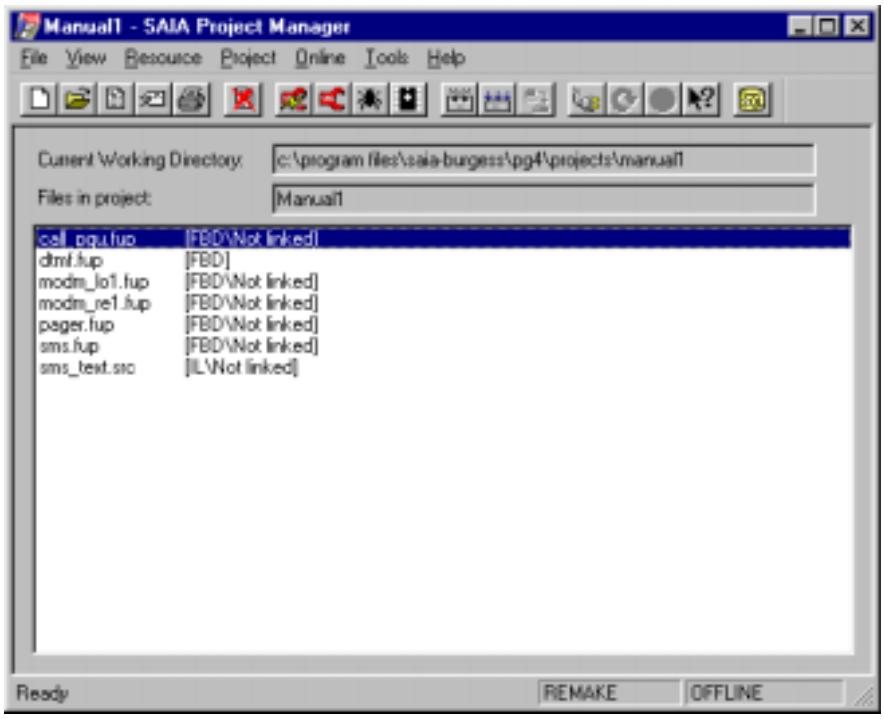
The main difference is that, when RAM memory modules are used, the number of the slave station is stored online in the PCD.

However, if an EPROM memory module is used, slave number definition occurs offline, i.e. an EPROM is programmed with the slave number and the user program and is put in the PCD later.

Station number definition when using memory modules with RAM

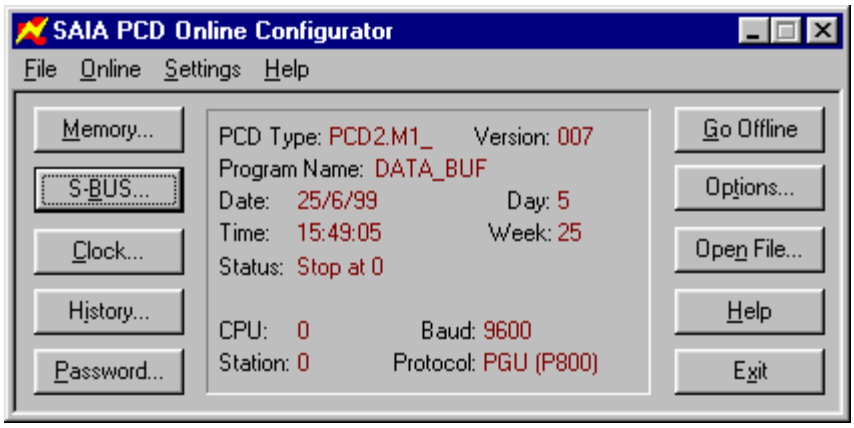
1. Connect the programming unit to the "PGU" programming interface on the PCD.

2. Start PG4 Project Manager.

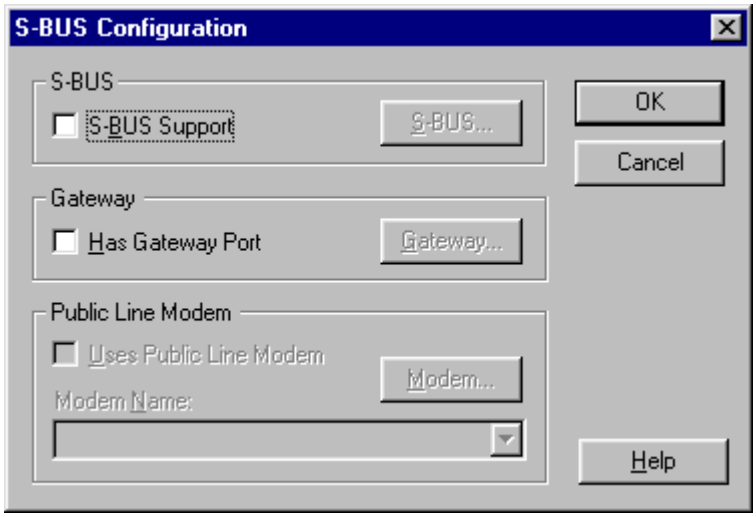


3. Press the "Online Configurator" button on the toolbar.

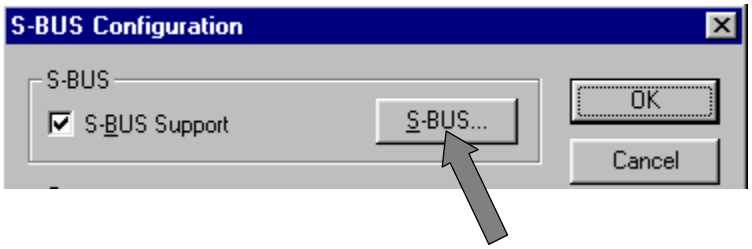
The online configurator can then be seen:



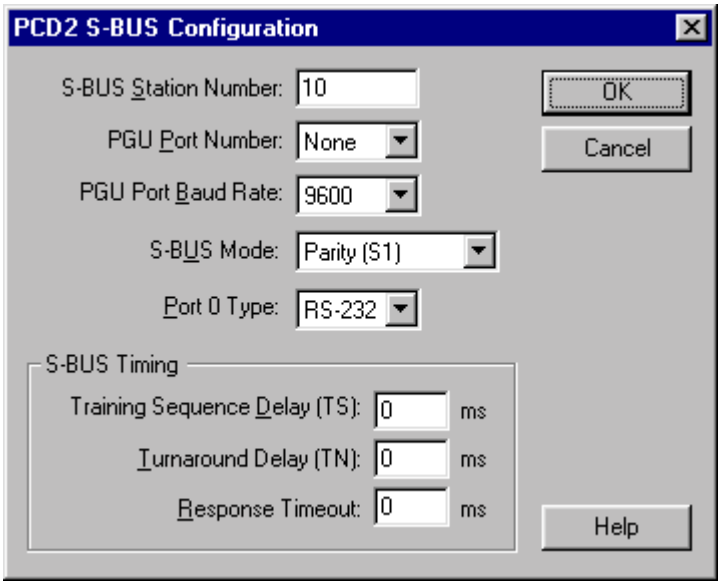
4. Press the 'S-Bus' button:



5. Select S-Bus Support and press the 'S-Bus' button:

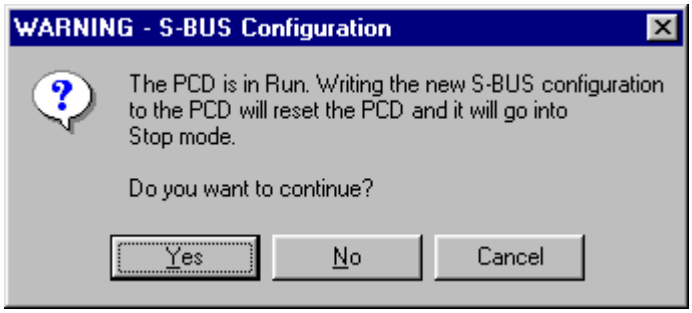


6. Enter the required station number



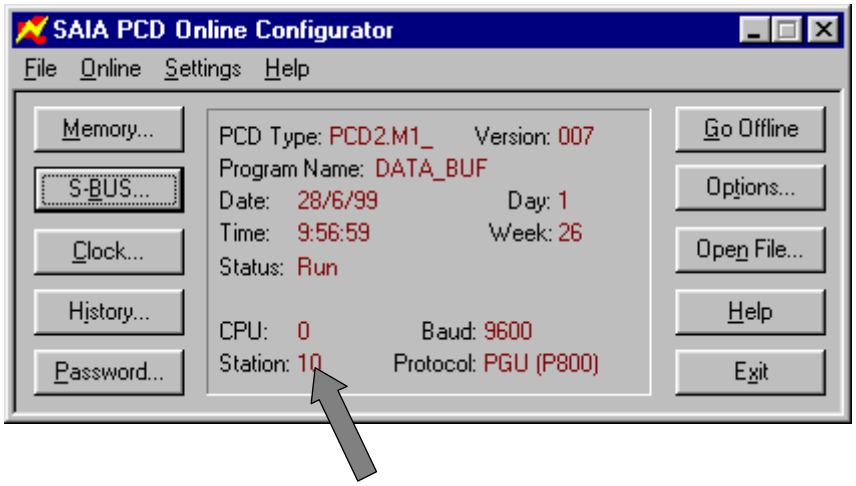
All other parameters are not relevant at S-Bus Level 1, when neither a modem nor a repeater is being used.
Exit the entry window by pressing the OK button.
The following window must also be exited by pressing the OK button.

The following warning can be confirmed with the YES button



This will download the configuration that has been set to the controller.

The number assigned can be viewed in the "Online Configurator" window.

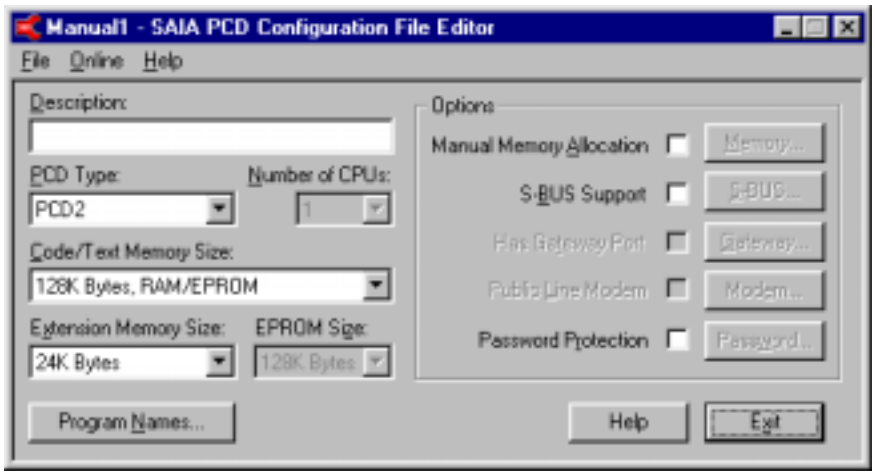


Station number definition when EPROM memory modules are used

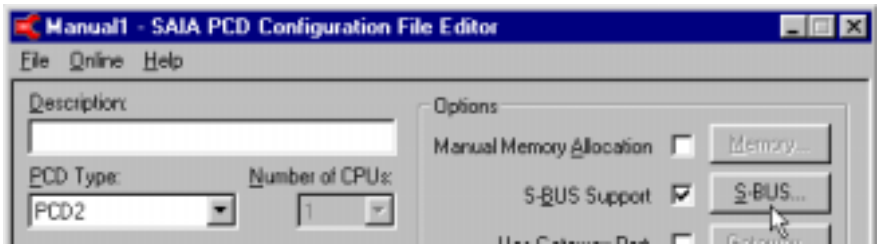
1. Start the PG4 Project Manager.

2. Press the "Offline Configurator" button on the toolbar

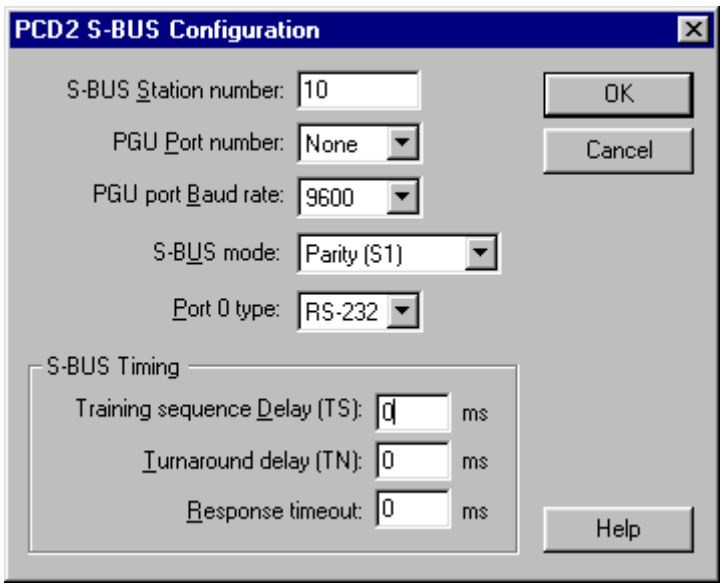
The offline configurator can then be seen:



3. Select S-Bus Support and press the 'S-Bus' button:



4. Enter the S-Bus station number:



Exit the entry window by pressing the OK button.
The entry window of the "SAIA PCD Configurator File Editor" can then also be exited.
This saves the previously entered parameters to a specific file.
The information stored in this file is saved onto the EPROM when it is programmed.

The station number always applies for the whole PCD station, even if several ports have been assigned to the same station in S-Bus mode.

3.2 PCD instructions for S-Bus

The following instructions are supported in S-bus mode :

SASI **SASII**	Assign serial interface	Master and Slave
SRXM **SRXMI**	Serial receive media Receive data or status from a slave station	Master only
STXM **STXMI**	Serial transmit media Transmit data to a slave station	Master only
SICL	Serial input control line Read status of a control line	Master and Slave
SOCL	Serial output control line Set control line signal	Master and Slave
SYSRD	System Read	Master and Slave
SYSWR	System Write	Master and Slave

Before communication can take place via the serial interface in S-Bus protocol, application level 1, master and slave PCD interfaces must be assigned using the SASI instruction to SM2, SM1 or SM0 mode and SS2, SS1 or SS0 mode respectively.

3.3 SASI Assign serial interface

Description :

Initialisation of a serial interface.

The instruction consists of two lines :

The first line indicates the channel number.
The second line indicates the number of a text, in which the interface parameters are defined.

Every interface used must be initialised once (mostly in XOB 16).

Format :

SASI	**Channel**	; Serial channel number 0..3
	Text_number	; Definition text-number 0..3999, 4000..7999

Text_number :	0..3999	in standard memory
	4000..7999	in extension memory

Example :

SASI	1	; Initialise channel 1
	999	; Interface definitions in text 999

Flags :

The error (E) flag is set if the definition text is missing or invalid, or if the station number has not been defined or the interface is configured as S-Bus PGU port.

SASI Definition text

The SASI instruction uses a special definition text to initialise the serial interface.

Format :

TEXT xxxx	**"<UART_DEF>;"** **"<MODE_DEF>;"** **"<DIAG_DEF>;"**

where xxxx valid text number 0000..3999 in the standard memory
4000..7999 in the extension memory.

The entire text can also be written on one line.

Significance of the different text parameters :

<UART_DEF> Defines Baud rate, Timeout, TS-Delay, TN-Delay and Break-Length.

<MODE_DEF> Defines communications mode (SM2/SS2, SM1/SS1 resp. SM0/SS0) and the register containing the number of the slave station to be accessed.

<DIAG_DEF> Addresses of the diagnostic flag and the diagnostic register.

Example :

Definition text to initialise the interface of a slave station with :

9600 Baud
diagnostic flags at address 2000 to 2007
diagnostic register at address 1500.

```
$SASI
TEXT     100          "UART:9600;"
                      "MODE:SS1;"
                      "DIAG:F2000,R1500;"
$ENDSASI
```

Important :

If the SASI texts are not located between the assembler directives $SASI and $ENDSASI, capital letters only should be used.

<UART_DEF>

Defines Baud rate, Timeout, TS-Delay and TN-Delay.

The definitions of character length, parity and stop bits are not required, as the S-Bus protocol includes the following definitions as fixed settings :

Character length	8 bits	
Stop bit	1 bit	
Parity bit	mode SM2/SS2	data mode
	mode SM1/SS1	parity bit "1" for address character "0" for data character
	mode SM0/SS0	with Break character

Format :

"UART:<Baudrate>[,<Timeout>][,TS-Delay>][,TN-Delay][,Break-Length];"

Baud rate	[Timeout] adjustable or default value			[TS-Delay]	[TN-Delay] adjustable or	default value	[Break-Length] adjustable
		Parity+Break	Data-Mode				
110		15000 ms	15000 ms			27 ms	
150		9000 ms	15000 ms			20 ms	
300		5000 ms	7500 ms			20 ms	
600		3000 ms	4500 ms			5 ms	
1200	1...15000	2000 ms	3000 ms	1...15000	1...15000	3 ms	4…25
2400	ms	1000 ms	1500 ms	ms	ms	2 ms	characters
4800		500 ms	750 ms			2 ms	
9600		250 ms	375 ms			1 ms	
19200		200 ms	300 ms			1 ms	
38400		200 ms	300 ms			1 ms	

TimeOut, TS-Delay and TN-Delay are optional and normally only needed to be defined when a modem is used.

Definitions must then be made both in the master station as well as in the slave stations.

If no parameter is specified the default values on the above table are used.

Default value for TS-Delay = 0ms.
Default value for Break Length = 4 characters (only in mode SM0).

For the precise meaning and purpose of Ts-Delay and TN-Delay values, see "Multipoint modems and converters" on chapter 3.13.1.

Baud rate :

Baud rates up to 19.2 Kbps are supported by all PCD modules, regardless of hardware version, firmware version, or interface type.
(exception : 20mA current loop - only up to 9600 bps).

The baud rate 38.4 Kbps is not supported on the old PCD hardware (see Appendix A).

When assigning an interface as 38.4 Kbps it should also be noted that, for physical reasons, some baud rates are no longer possible for assigning the second DUART interface.

For interfaces 0 + 1 (DUART 1) and 2 + 3 (DUART 2) respectively, the following combinations of baud rates are not possible :

	38.4 Kbps	+	38.4 Kbps
or	38.4 Kbps	+	19.2 Kbps
or	38.4 Kbps	+	150 bps
or	38.4 Kbps	+	110 bps

If an attempt is still made to assign a prohibited combination, the error flag is set and XOB 13 is called.

CPU load for communications at 38.4 Kbps :

Since S-Bus communication does not use a separate communications processor, data transmission at 38.4 Kbps makes corresponding demands on CPU capacity.

If the communications throughput is large, it can demand up to 40 % of CPU capacity. This in turn means that processing of the user program is slowed down by the same factor.

Timeout :

This value defines the maximum time after sending a read telegram (instruction SRXM), during which the reply telegram must be received from the station addressed.

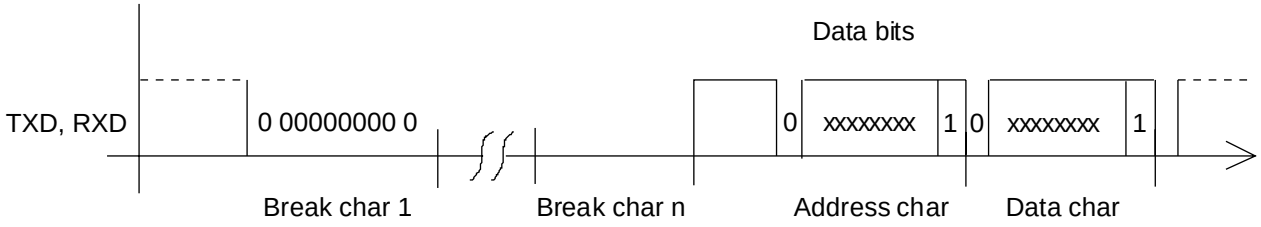
If no valid reply is received within this time, the last telegram transmitted is repeated and the corresponding diagnostic elements are set. Two repeat transmissions are the maximum for any telegram.

Break-Length :

This parameter allows the length of the break signal to be adjusted in SM0 mode. This is used to differentiate between data and address characters. An address character is identified by a preceding break signal. A break signal is only sent by the master station in SM0 mode and can therefore also only be adjusted from that station. It is not normally necessary to change the break length.

Break signal : Data line = low for duration of n characters including stop bit.

Structure of an S-Bus telegram with break signal :



If the break length is defined in SM2/SS2, SM1/SS1 or SS0 mode, the error flag is set and XOB 13 is called when the interface is assigned.

Example :

for a UART definition text : "UART:4800;"

The interface is initialised with 4800 bps.

For a standard application, no Timeout, TS-Delay, TN-Delay or Break-Length is defined.

<MODE_DEF>

Defines communications mode and a register for the station number.

Format : "MODE: <sbus_mode>[,<dest_reg>];"

<sbus_mode>	Description
SM2	S-Bus master, Data Mode
SM1	S-Bus master, with parity bit control
SM0	S-Bus master, with break character
SS2	S-Bus slave, Data Mode
SS1	S-Bus slave, with parity bit control
SS0	S-Bus slave, with break character
GS2	S-Bus Gateway slave, Data Mode
GS1	S-Bus Gateway slave, with parity bit control
GS0	S-Bus Gateway slave, with break character
GM	S-Bus Gateway master
OFF	De-initialize the serial line

SM2/SS2 mode :

A telegram always begins with a definite character (FS character).

Advantage : Easy recognition of the start of a telegram. Does not need a break or parity character. It means that any modem can be used for modem communication.

Disadvantage : Since the FS character cannot occur in the middle of a telegram, if it is present it must be replaced. This can make the telegram longer.

SM1/SS1 mode :

The parity bit is used to distinguish between address and data character.

Advantage : very quick and efficient addressing of the slave stations thanks to the parity bit.

Disadvantage : for modem communications the modem must support 9 data bits (8 data and 1 parity bit).

SM0/SS0 mode :

An address character is indicated with a preceding "break" character (data line = low for the duration of one character including start and stop bit).

Advantage : for modem communications any standard modem can be used which supports only 8 data bits and transmits the break character.

Disadvantage : time intensive addressing of the slave stations because of the preceding break signal.

GS2/GS1/GS0/GM mode :

See Chapter 6 : S-Bus Gateway.

Mode OFF :

The mode OFF is used when you want to re-initialise an interface which has already be initialised (to change from mode as example).

Example : “MODE:OFF”

For more informations when using S-Bus level 2, see **UNDO/REDO a S-Bus PGU port** (SASI OFF), chapter 5.4.3.

<dest_reg>	**Description**
R xxxx	Register containing the partner station number

Station number : 0..254
255 reserved for broadcast

A register is defined for partner station number only in the case of the master station.

Examples :

Definition text for master station.

"MODE:SM1,R350;"

Register 350 is used for the station number :

Definition text for a slave station :

"MODE:SS1;"

Broadcast telegrams :

Broadcast telegrams can be sent using station address 255. Broadcast telegrams are received and processed by all slave stations on the bus.

The slave station does not reply to or acknowledge a broadcast telegram. This in turn means that, in broadcast mode, it is only possible to sent write telegrams (STXM instructions).

The error flag is set when processing an SRXM instruction with broadcast address.

Example : All slave station clocks are synchronised by the master station via the S-Bus.

```
LD      R   350     ; Register with station address
            255     ; for broadcast
STXM        1       ; interface 1
            0       ; Special code to write the clock
        R   150     ; of a slave station with the contents
        K   1000    ; of registers 150 and 151.
```


<DIAG_DEF>

Defines diagnostic elements for S-Bus communication.

Format :

"DIAG: <diag_elem>,<diag_reg>;"

	Type	Description
<diag_elem>	F xxxx O xxxx	Base address of 8 consecutive flags or outputs
<diag_reg>	R xxxx	Address of diagnostic register

Example :

"DIAG:F3900,R120;"

Diagnostic flags

Address	Name	Description
xxxx	**RBSY**	Receiver busy
xxxx + 1	**RFUL**	Receive buffer full
xxxx + 2	**RDIA**	Receiver diagnostic
xxxx + 3	**TBSY**	Transmitter busy
xxxx + 4		Not used
xxxx + 5	**TDIA**	Transmitter diagnostic
xxxx + 6	**XBSY**	SASI permission
xxxx + 7	**NEXE**	Not executed

Receiver Busy (RBSY) is set high when a slave station receives a telegram. The flag is reset as soon as the reply telegram has been sent. This flag has no significance in the case of the master station.

Receive Buffer Full (RFUL) is set high when elements in the slave station have been changed by the master station.

Receiver Diagnostic (RDIA) is set high when an error is noticed during receipt of a telegram. A detailed description of the error can be obtained from the diagnostic register (bits 0..15). The flag is reset as soon as all receiver diagnostic bits (0..15) have been reset in the diagnostic register.

Transmitter Busy (TBSY) is set high while transmission is taking place.

Significance for

Master station :	It is set high during execution of an STXM or SRXM instruction. The flag is reset as soon as a valid reply is received.
Slave station :	It is set high while the reply is transmitted.

Transmitter Diagnostic (TDIA) is set high if an error is noticed during transmission of a telegram. A detailed description of the error can be obtained from the diagnostic register (bits 16..31). The flag is reset as soon as all transmitter diagnostic bits (16..31) have been reset in the diagnostic register.

Interface busy (XBSY) is low when the user has the permission to perform a SASI OFF to undo the S-Bus PGU for Public Line modem. For a complete explanation see **UNDO/REDO a S-Bus PGU port** (SASI OFF), chapter 5.4.3.

Not Executed (NEXE) is set high if an instruction (STXM or SRXM) has not been completed after three attempts. The flag is reset by the next S-Bus instruction.

DIAGNOSTIC REGISTER

	Bit	Designation	Description
	0	Overrun error	Overrun of the internal receiver buffer
	1		
	2	Framing error	Usually caused by an incorrect baud rate
	3	Break error	Break in data line *)
R	4	BCC error	Bad Block Check Code or CRC-16
E	5	S-Bus PGU status	S-Bus PGU with Public Line modems
C	6	SASI OFF permission	SASI OFF permission
E	7		
I	8	Length error	The telegram length is invalid
V	9		
E	10	Address error	Address of ACK is invalid
R	11	Status error	PCD in false status, cannot execute command
	12	Range error	Invalid element address
	13	Value error	Error in the received value
	14	Missing media error	Address of media not defined or invalid
	15	Program error	Station number not allocated (or invalid)
	16	Retry count	Indicates the number of retries (in binary)
	17		(telegram repeats in binary representation)
T	18		
R	19		
A	20	NAK response	Negative response (NAK) was received
N	21	Missing response	No response was received after timeout
S	22	Multiple NAK	NAK received after retries
M	23	CTS-Timeout	No CTS set after TS delay
I	24		
T	25		
T	26		
E	27		
R	28	Range error	Invalid element address
	29		
	30		
	31	Program error	Attempt to transmit when unauthorised

Any bit which has been set high in the diagnostic register remains so, until manually reset by the user program or the debugger.

*) No signification in mode SM0/SS0

Overrun Error (Bit 0) is set high when there is an overrun of the internal buffer of the DUART.

Cause : Baud rate assigned is too high

→ the CPU can no longer process all characters received.

This can happen if one CPU is involved in communications requiring a high rate of data transmission via several interfaces simultaneously. It is theoretically possible for all interfaces of a CPU (excluding the 20mA current loop) to be assigned the maximum Baud rate of 19.200 bps at the same time. In practice, however, this error can arise when there is a very high level of communication over several interfaces. The system program handles the interfaces with differing priorities. The highest priority is allocated to interface 0, declining to interface 3.

Remedy :
- Reduce Baud rate.
- For fast communication, use an interface with high priority, if possible.

Framing Error (Bit 2) is set high when a character is received with a framing error (missing stopbit). This is usually caused by setting the Baud rate wrongly.

Break Error (Bit 3) is set high when an interruption is noticed during receipt of a character.

Cause : Data line broken or wrongly set Baud rate.

BCC or CRC-16 Error (Bit 4) is set high if a CRC-16 error is identified on the incoming telegram. The incoming telegram is rejected.

Reaction of Slave : The received telegram will be ignored

Master : The received telegram will be ignored and the last telegram will be retransmitted.

Cause : Interference on the data line.

Remedy : Check electrical installation.

S-Bus PGU Status (Bit 5) shows the current S-Bus PGU with Public Line Modem (PLM)

"1" S-Bus port is in STANDBY status , waiting for modem connection.

"0" No S-Bus PGU PLM port configured or in FINAL status (PCD ready in mode S-Bus level 2 for modem or S-Bus PGU PLM undone yet.

SASI OFF Permission (Bit 6) indicates that somebody has disabled an UNDO/REDO process of the S-Bus PGU PLM in performing a RUN or STOP via S-Bus or PG4/PG3 Utilities during the SASI OFF execution delay period.

Length Error (Bit 8) is set high when a telegram is received with invalid length. This error cannot arise in a network made up exclusively of PCD stations. The error indicates that an invalid telegram has been received from an external system. This results in a NAK response.

Address Error (Bit 10) is set high if an invalid telegram is received (incorrect command code).

Cause : Same as for Length Error (there is no NAK response).

Status Error (Bit 11) is set high when the PCD can not execute a command request because the slave PCD is not in the correct status (Run/ Halt/Stop/Diconnected/…). Only used for S-Bus level 2

Range Error (Bit 12) is set high if an incoming telegram contains an invalid PCD element address. This error cannot arise in a network made up exclusively of PCD stations, as the master PCD monitors the element address range of telegrams as they are transmitted. The slave station responds to this error with NAK.

Value Error (Bit 13) is set high when an invalid data value is received.

Example : The STXM instruction is used in an attempt to load the clock. The value received for the hour is 30. However, the maximum range for the hour is only 0..23.

The slave station responds to this error with NAK.

Missing Media Error (Bit 14) is set high when the addressed media is not defined or invalid media code for current request. Only used for S-Bus level 2

Program Error (Bit 15) is set high during execution of a SASI instruction with the definition SS1 mode, if the user program header has not been configured for the S-Bus slave station, or if the configuration is invalid.

See also "Station number definition" on chapter 3.1.1.

Retry Count (Bits 16 and 17) shows the number of repeat telegrams sent during execution of a SRXM or STXM instruction, represented in binary. Bit 16 is the LS bit. The quality of an S-Bus network can be judged by monitoring these two bits.

Negative Response (Bit 20) is set high if a NAK response is received from a slave. This means that the master has previously sent an invalid telegram. Check for the following errors: Value Error, Range Error and Length Error.

Missing Response (Bit 21) is set high if no response has been received from the slave station after the time-out has elapsed.
In this case, the telegram is retransmitted (maximum two times).

Possible causes :

- The slave station addressed does not exist.
- Installation error in network (wiring).
- The slave station has received a confused telegram with a CRC-16 error.

Remedies :

- Check slave station (connections, station number)
- Have the correct line termination and pull-up/down resistors been connected on the bus line at the first and last stations ?

Multiple NAK (Bit 22) is set high if, instead of the expected ACK or NAK, a different response is received from a slave station.

Possible causes :

- More than one slave with the same station number.
- More than one master in the network.
- Interference on the bus line.

Remedies :

- As for Missing Response error

CTS Timeout (Bit 23) is set high if the time between setting the control line RTS (by the PCD) and receiving the CTS (from the modem) exceeds the "TS Delay". See also "Communication via modem" on chapter 3.13.

Range Error (Bit 28) is set high if the SRXM or STXM instructions indicate an element address (source or destination address) lying outside the permitted range.

Cause : Error in user program

Ranges monitored :

Inputs/outputs	0..8191
Flags	0..8191
Timers/counters	0..1599
Registers	0..4095

Example : During execution of the following STXM instruction, the Range Error bit is set high.

```
STXM    1       ; channel 1
        25      ; 25 registers
      R 1000    ; base address source
      R 4072    ; base address destination
```

An attempt is made to transmit the contents of registers 1000 to 1024 in the master station to registers 4072 to 4096 in the slave station.

Program Error (Bit 31) is set high during execution of an STXM or SRXM instruction if the interface has been assigned in SS1 mode, or if a similar instruction is already executing (TBSY flag was not polled before executing the instruction).

Notes :

3.4 SRXM Receive data from a slave station

Description :

This instruction reads data or the status of a slave station. The slave's station number must be loaded into the register defined by the SASI instruction before execution of this instruction.

This instruction can only be used in the master PCD.

While it is being processed, the TBSY flag is set high. The flag is reset once transfer of data is complete. Before executing any SRXM instruction, therefore, the TBSY flag must be polled to ensure that its state is "low".

The instruction consists of four lines :

- The first operand is the channel number.
- The second operand defines the number of incoming elements.
- The third operand defines the base address (lowest) of the source elements in the slave PCD.
- The fourth operand defines the base address (lowest) of the destination elements in the master PCD.

Format :

SRXM[X]	**Channel**	**; channel number**
	Number	**; number of elements to receive**
	Source (i)	**; base address of source elements (slave)**
	Dest (i)	**; base addr. of destination elements (master)**

Channel :	0..3	number of the interface used	
Number :	1..32	number of R/T/C to read *)	
	1..128	number of I/O/F to read	
	0	Special function code	
	R nnnn	Used for Data Block transfer	
Source :	I/O/F	0..8191	
	R	0..4095	Base address of elements
	T/C	0..1599	in the slave PCD
	DB	0..7999	
	K	0..6000	Special function code
Destination :	I/O/F	0..8191	
	R	0..4095	Base address of elements
	T/C	0..1599	in the master PCD
	DB	0..7999	

*) for old PCD firmware the number of R/T/C can be limited to 31

The following table shows which elements can be copied from the source station to the appropriate elements in the destination station.

		Master PCD (destination)					
		O	**F**	**R**	**C**	**T**	**DB**
Slave PCD (source)	**I**	•	•				
	O	•	•				
	F	•	•				
	R			•	•	•	•
	C			•	•	•	•
	T			•	•	•	•
	K			•			
	DB			•	•	•	

Flags :

The Error (E) flag is set when :

The interface has not been assigned or has been assigned incorrectly an SRXM instruction is already being executed (TBSY high).

Examples :

```
SRXM      1       ; Registers 1500-1513 are read from
          14      ; a slave station and copied
      R   1500    ; into registers 100-113
      R   100     ; of the master station.
```

```
SRXM      1       ; The clock is read from a
          0       ; slave station and copied
      K   1000    ; into registers 20 and 21
      R   20      ; of the master station.
```

3.4.1 Special functions

Code	Function description	Result
K 0 ..7	**Read CPU status** 0..6 : CPU number of slave PCD 7 : own CPU status	R Run C Conditional Run H Halt S Stop D Disconnected
K 1000	**Read Clock**	The content of the clock is written in two Registers (same format as RTIME inst.)
K 2000	**Read Display Register**	
K 5000 K 5010	**Read Device type** in ASCII in decimal	ASCII / Dec / Type " D1" / 1 / PCD1 " D2" / 2 / PCD2 " D4" / 4 / PCD4 " D6" / 6 / PCD6
K 5100 K 5110	**Read Module type** in ASCII in decimal	ASCII / Dec / Type " M1_" / 10 / PCD1.M1 " M1_" / 10 / PCD2.M12 " M15" / 15 / PCD2.M15 " M11" / 11 / PCD4.M11 " M12" / 12 / PCD4.M12 " M14" / 14 / PCD4.M14 " M24" / 24 / PCD4.M24 " M34" / 34 / PCD4.M34 " M44" / 44 / PCD4.M44 " M1_" / 10 / PCD6.M1 " M2_" / 20 / PCD6.M2 " M3_" / 30 / PCD6.M3 " M54" / 54 / PCD6.M5
K 5200 K 5210	**Read Firmware version** in ASCII in decimal	Examples of valid responses : " $4C", " 004", " X41" Ex : 5 dec for Version 005 -1 dec for any '$', 'X', 'β'
K 5300 K 5310	**Read CPU number** in ASCII in decimal	ASCII / dec / Type " 0" / 0 / PCD1 " 0" / 0 / PCD2 " 0" or " 1" / 0 or 1 / PCD4 " 0" to " 6" / 0 to 6 / PCD6
K 6000	**Read S-Bus station number** in BROADCAST This telegram is always transmitted in broadcast mode (address = 255). This will only work in point-to-point communication.	

3.4.2 Transfer of Data Blocks (Read)

The format of the SRXM instruction, when working with Data-Block, differs slightly from the conventional format. To address an element of a Data-Block, it is always necessary to specify the number of the Data-Block and then the position of the element in the Data-Block.

Format : **SRXM** **Channel**
Count + Position
Source
Destination

Channel : This parameter is used to specify the channel number (range : 0...3).

Count + Position :

This parameter is a register number. This register contains the "Count" or number of elements to transfer (range 1...32) and the "Position" in the Data-Block where to put or get the data. "Count" is given in the MS Word of the register and "Position" in the LS Word of the register. The initialisation of this register can be done easily with the LDL and LDH instructions. The initialisation of "Position" with the LDL instructions must be done **before** the initialisation of "Count" with the LDH, because the LDL instruction over-write the MS Word with zero.

Source / Destination :

These parameters specify the Source and Destination of the transfer. The source and the destination must respect the source-destination validity described previously.

SRXM in indexed mode :

The instruction can work in indexed mode (SRXMX).
When working in indexed mode, source and destination are both indexed with standard media (I/O/F/R/T/C), but **Data-Blocks are never indexed**.

SRXM in parametrised mode :

When working with Data-Block, it is always possible to use a Function Block and SRXM in parametrised mode.

Example :

Registers 2000...2031 (32 elements) of the slave station will be transferred in Data-Block #7999 from position 10000 of the master station via channel #3.

```
LDL     R   100     ; Initialisation of Position in the DB
            10000
LDH     R   100     ; Initialisation of Count
            32

SRXM        3       ; Transfer
        R   100     ;
        R   2000    ;
        DB  7999    ;
```

Error report :

List of errors which can occurs and how they are signalled in the diagnostic register of SBus.

SRXM DB → R or T/C.

"range error" of diagnostic register is set when :

- Count = 0 or ≥33
- try to access beyond the limit of a type of media (i.e. Reg. 4096 and above)

"no response" of diagnostic register is set when :

- Data-Block in the slave station doesn't exist
- Data-Block in the slave station is defined as text
- Tried to get element beyond the end of the Data-Block
- Tried to get a Data-Block in the memory extension (DB 4000....7999) when there is no memory extension in the slave station

SRXM R or T/C → DB.

"range error" of diagnostic register is set when :

- Count = 0 or ≥33
- try to access beyond the limit of a type of media (i.e. Reg. 4096 and above)
- Data-Block in the master station doesn't exist
- Data-Block in the master station is defined as text
- Tried to get element beyond the end of the Data-Block
- Tried to access a Data-Block in the memory extension (DB 4000....7999) when there is no memory extension in the master station

Size of a Data-Block :

```
Format : SRXM      Channel    ; 1st parameter
         K         3000       ; 2nd parameter
         DB        x          ; 3rd parameter
         R         y          ; 4th parameter
```

'Channel'
This parameter is used to specify the channel number (range: 0...3).

'2nd parameter'
K 3000 indicates that a "Read Size of Data-Block" is performed.

'3rd parameter'
This parameters specifies the Data-Block number.

'4th parameter'
This parameter specifies the register number where the return value (size of Data-Block) will be written.

Error report.
A "range error" occurs when the 3rd parameter is not a Data-Block and or the 4th operand is not a Register.

Return value of the "Read Data-Block Size".
If the return value which is in the register specified by the 4th parameter is :

```
0     :  The Data-Block of the slave station doesn't exist
1...n :  Size of a Data-Block in the slave station (n max. = 16384)
65535 :  (or FFFF hex) means that the Data-Block specified is
         defined as a Text in the slave
```

Example :
The size of the Data-Block #3999 of the slave station will be reported in the register #100 of the master station.

```
SRXM      2
          K     3000
          DB    3999
          R     100
```

Size of a Data-Block in indexed mode.
Reading the size of a Data-Block can be done in indexed mode.
Format :

```
SRXMX  <channel>      ; 1st parameter
       K     3000     ; 2nd parameter
       DB    x        ; 3rd parameter
       R     y        ; 4th parameter (indexed)
```

The first until the third parameters remain the same as in normal mode.
Only the destination Register is indexed.

3.4.3 Practical application

Inputs 0..31 are to be copied from slave station number 5 into flags 500..531 of the master station.

Master station program :

```
        XOB     16

        SASI    1       ; Interface no. 1
                100     ; Definition text 100

TEXT    100             "UART:9600;"
                        "MODE:SM1,R500;"
                        "DIAG:F1000,R1000"
        .
        EXOB

        COB             0
                        0

        STH     F       1002        ; If RDIA
        ORH     F       1005        ;    or TDIA flag  =  high
        CPB     H       ERROR       ;    Then handle error
        STH     F       1003        ; If TBSY flag  =  low
        CPB     L       RECEIVE     ;    Then read data

        ECOB


        PB              RECEIVE
        LD      R       500         ; Load station number
                        5           ;    (no. 5)
        SRXM            1           ; Interface no. 1
                        32          ; Read 32 elements
                I       0           ; inputs 0..31 and copy
                F       500         ; them to flags 500..531
        EPB


        PB              ERROR       ; Error handler
        …
        …
        EPB
```

Error handling :

Polling the RDIA and TDIA diagnostic flags is optional and does not have to be programmed. However, it is recommended that these flags are be monitored during commissioning in particular, and also during operation, so that problems can be identified early and the appropriate remedial action taken.

Depending on the type of error, there may be a serious problem demanding a direct remedy, or it may only be a temporary malfunction, without any threat to the operation of the machine or the installation.

Examples :

- Programming errors (Range Error, Program Error etc.) are usually recognised at the commissioning stage and can be removed immediately.
- If the NEXE flag is set, this means that the last instruction was not executed (SRXM or STXM).

Slave station program :

```
        XOB     16
        …
        SASI    1
                100
TEXT    100     "UART:9600;
                "MODE:SS1;"
                "DIAG:F1000,R1000"
        …
        EXOB
```

In the case of the slave station, it is only necessary to assign the interface with the user program. All communication in S-Bus mode is then processed as a background operation by the CPU working autonomously. It is not necessary to monitor diagnostic flags, as practically all communications errors are recognised by the master station and therefore do not need to be monitored here.

3.5 STXM Transmit data to a slave station

Description :

This instruction copies data from the master station to a slave station. Before the instruction can be executed, the slave station number must have been loaded into the register defined by the SASI instruction.

This instruction can only be used by the master PCD.

While the instruction is executing, the TBSY flag is set high. It is reset when the transfer of data is complete. The TBSY flag must therefore be polled as low before execution of another STXM instruction.

The instruction has four lines :

- The first operand is the channel number.
- The second operand defines the number of elements to be sent.
- The third operand defines the base address (lowest) of the source elements in the master PCD.
- The fourth operand defines the base address (lowest) of the destination elements in the slave PCD.

Format :

```
STXM[X]Channel      ; Channel number
       Number       ; Number of elements to be transmit
       Source (i)   ; Base address of source elements (Master)
       Dest (i)     ; Base addr. of destination elements (Slave)
```

Channel :	0..3	Interface to be used	
Number :	1..32	number of R/T/C to read *)	
	1..128	number of I/O/F to read	
	0	Special function code	
Source :	I/O/F	0..8191	Base address of elements in the master PCD
	R	0..4095	
	T/C	0..1599	
	DB	0..7999	
	K	4000	Special function
Destination :	I/O/F	0..8191	Base address of elements in the slave PCD
	R	0..4095	
	T/C	0..1599	
	DB	0..7999	
	K	1000	Write clock in the slave PCD
	K	17, 18, 19	Special function

*) for old PCD firmware the number of R/T/C can be limited to 31

The following table shows which elements can be copied from the source station to the appropriate elements in the destination station.

		Slave PCD (destination)						
		O	**F**	**R**	**C**	**T**	**DB**	**Clock**
Master PCD (source)	**I**	•	•					
	O	•	•					
	F	•	•					
	R			•	•	•	•	•
	C			•	•	•	•	
	T			•	•	•	•	
	DB			•	•	•		

When writing to the clock, two registers are sent. For the data format of registers, see the WTIME instruction.

3.5.1 Special functions

It is possible to provoke the execution of an XOB in a slave station using the STXM instruction with the following arguments :

```
STXM      0..3          ; Serial channel number
          0             ; (must be 0)
      K   4000          ; Used to indicate XOB interrupt
      K   17|18|19      ; number of the XOB to execute
```

It is also possible to use this instruction in broadcast mode; this allows the synchronisation of events.

Flags :

The Error (E) flag is set when the interface has not been assigned, has been assigned incorrectly, or when an STXM instruction is already executing (in spite of a high TBSY flag).

Examples :

```
STXM      1             ; Registers 300-324 are copied
          25            ; from the master station to
      R   300           ; a slave station into
      R   2400          ; registers 2400-2424.
```

```
STXM      1             ; The clock of a slave station
          0             ; is loaded with the contents
      R   20            ; of registers 20 and 21
      K   1000
```


3.5.2 Transfer of Data Blocks (Write)

The format of the STXM instruction, when working with Data-Block, differs slightly from the conventional format. To address an element of a Data-Block, it is always necessary to specify the number of the Data-Block and then the position of the element in the Data-Block.

Format : **STXM** **Channel**
Count + Position
Source
Destination

Channel : This parameter is used to specify the channel number (range : 0...3).

Count + Position :

This parameter is a register number. This register contains the "Count" or number of elements to transfer (range 1...32) and the "Position" in the Data-Block where to put or get the data. "Count" is given in the MS Word of the register and "Position" in the LS Word of the register. The initialisation of this register can be done easily with the LDL and LDH instructions. The initialisation of "Position" with the LDL instructions must be done **before** the initialisation of "Count" with the LDH, because the LDL instruction over-write the MS Word with zero.

Source / Destination :

These parameters specify the Source and Destination of the transfer. The source and the destination must respect the source-destination validity described previously.

STXM in indexed mode :

The instruction can work in indexed mode (STXMX).
When working in indexed mode, source and destination are both indexed with standard media (I/O/F/R/T/C), but **Data-Blocks are never indexed**.

STXM in parametrised mode :

When working with Data-Block, it is always possible to use a Function Block and STXM in parametrised mode.

Example :

20 elements of Data-Block #4000 from position 50 of the master station will be transferred to Register 1000...1019 of the slave station via the channel #1.

```
LDL     R   100     ; Initialisation of  Position in the DB
            50
LDH     R   100     ; Initialisation of Count
            20

STXM        1       ; Transfer
        R   100     ;
        DB  4000    ;
        R   1000    ;
```

Error report :

STXM DB → R or T/C.

"range error" of diagnostic register is set when :

- Count = 0 or ≥33
- tried to access beyond the limit of a type of media (i.e. Reg. 4096 and above)
- Data-Block in the master station doesn't exist
- Data-Block in the master station is defined as text
- Tried to get element beyond the end of the Data-Block
- Tried to access a Data-Block in the memory extension (DB 4000...7999) when there is no memory extension in the master station

STXM R or T/C → DB.

"range error" of diagnostic register is set when :

- Count = 0 or ≥33
- tried to access beyond the limit of a type of media (i.e. Reg. 4096 and above)

"nak response" of diagnostic register is set when :

- Data-Block in the slave station doesn't exist
- Data-Block in the slave station is defined as text
- Tried to access element beyond the end of the Data-Block
- Tried to get a Data-Block in the memory extension (DB 4000...7999) when there is no memory extension in the slave station

3.5.3 Practical application

Registers 150..165 are to be copied from the master station to counters 500..515 of slave station 12.

Master station program :

```
        XOB     16
        …
        SASI    1           ; Interface no. 1
                900         ; Definition text 900

TEXT    900                 "UART:9600;"
                            "MODE:SM1,R500;"
                            "DIAG:F2500,R4095"

        EXOB

        COB     0
                0
        …
        STH     F   2502    ; If RDIA
        ORH     F   2505    ;    or TDIA flag  =  high
        CPB     H   ERROR   ;    Then handle error
        STH     F   2503    ; If TBSY flag  =  low
        CPB     L   TRANSMIT ;   Then transmit data
        …
        ECOB


        PB          TRANSMIT
        LD      R   500     ; load
                    12      ; Station number 12
        STXM        1       ; Interface no. 1
                    16      ; Transmit 16 elements
                R   150     ; Register 150..165
                C   500     ; to counters 500..515
        EPB

        PB          ERROR   ; Error handler
        …
        EPB
```

Error handling :

Polling the RDIA and TDIA diagnostic flags is optional and does not have to be programmed. However, it is recommended that these flags are monitored during commissioning in particular, and also during operation, so that problems can be identified early and the appropriate remedial action taken. Depending on the type of error, there may be a serious problem demanding a direct remedy, or it may only be a temporary malfunction, without any threat to the operation of the machine or the installation.

Examples :

- Programming errors (Range Error, Program Error etc.) are usually recognised at the commissioning stage and can be removed immediately.
- If the NEXE flag is set, this means that the last instruction was not executed (SRXM or STXM).

Slave station program :

```
        XOB     16
        …
        SASI    1
                100
TEXT    100     "UART:9600;
                "MODE:SS1;"
                "DIAG:F1000,R1000"
        …
        EXOB
```

In the case of the slave station, it is only necessary to assign the interface with the user program. All communication in S-Bus mode is then processed as a background operation by the CPU working autonomously. It is not necessary to monitor diagnostic flags, as practically all communications errors are recognised by the master station and therefore do not need to be monitored here.

3.6 SASII Assign serial interface indirect

Description :

This instruction works in the same way as the SASI instruction.
The difference is that it works in indirect mode. Indirect mode means that the number of the channel and the definition text number can be given by the content of registers.

Format :

SASII	**Channel**
	Text_definition

Channel : Channel number to be initialised
This parameter can be given directly or indirectly :

0..3	Serial channel number
R 0..4095	Register containing the channel number (0..3)

Text_definition :

This parameter is a register number (R 0..4095)
This register contents the address of a text containing where the interface parameters are defined
Valid addresses for text :

0..3999	in standard memory
4000..7999	in extension memory

Examples :

```
SASII       1       ; Initialise channel 1
        R   1       ; Interface parameters text address
                    ;   is in R 1

SASII   R   0       ; Initialise channel number
                    ;   contained in R 0
        R   1       ; Interface parameters text address
                    ;   is in R 1
```

Flags :

The error (E) flag is set if the definition text is missing or invalid, or if the station number has not been defined or the interface is configured as S-Bus PGU port.

The definition text are the same as for the SASI instruction

SASII does not work in indexed and parametrised mode.

3.7 SRXMI Read data in indirect mode

Description :

This instruction works in the same way as the existing SRXM instructions. The difference is that it works in indirect mode. Indirect mode means that the number of the media for source and destination is given by the content of a register. SRXMI are only available for transfer of media. Transfer options like the Real Time clock, Display-Register,... are not allowed.

Format :

SRXMI	**Channel**
	Count or Count + Position
	Source-type and Reg-number
	Destination-type and Reg-number

Channel : This parameter is used to specify the channel number (range : 0...3).

Count or Count + Position :

This parameter is a register number. This register contains the "Count" for standard medias or "Count" and "Position" for Data-Block. For Data-Block, "Count" is given in the MS Word of the register and "Position" in the LS Word of the register and in that case, the initialisation of this register can be easily done with LDL and LDH instructions.

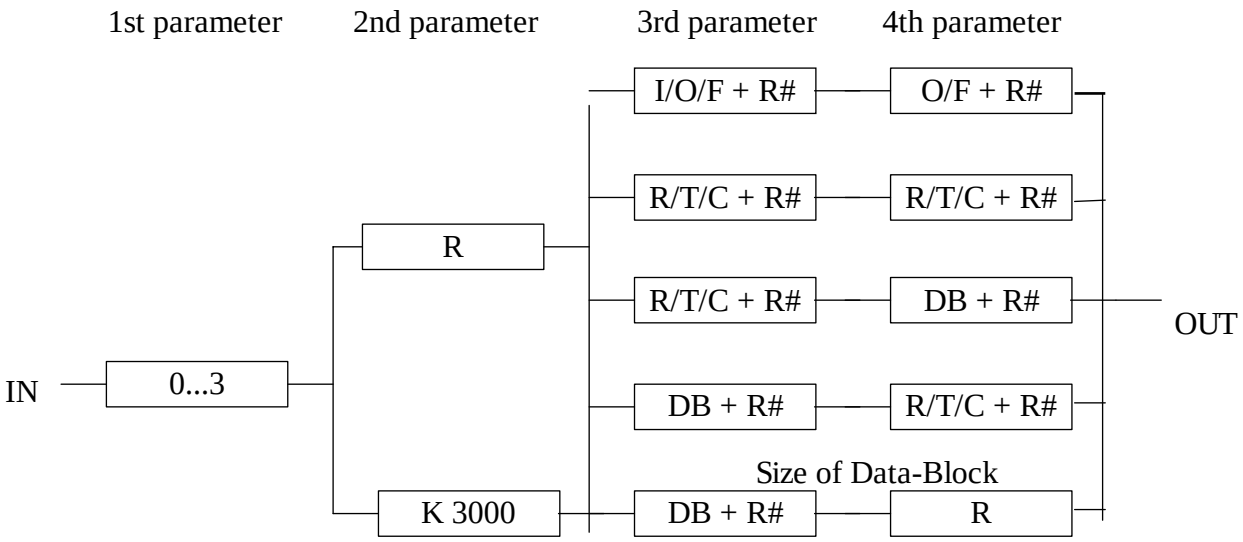
Source-type and Register number :

Destination-type and Register number :

These parameters specify the "Source" and "Destination" of the transfer. Each of these parameter is composed of a character giving the type of media (I/O/F/R/T/C/DB) and a register number (0...4095). The source and the destination must respect the source-destination validity described in the table for the SRXM/STXM instructions.

SRXMI does not work in indexed and parametrised mode.

SRXMI syntax flowchart



Example :

Output #200...231 (32 elements) of the slave station will be transferred on Flags #1000...1031 of the master station via channel #3.

```
LD      R   100     ; Initialisation of Count
                32
LD      R   101     ; Output 200
                200
LD      R   102     ; Flag 1000
                1000

SRXMI       3       ; channel #3
        R   100     ; R 100  =  32
        O   101     ; R 101  =  200
        F   102     ; R 102  =  1000
```

Error report :

For standard media, the error reports are the same as the existing SRXM instruction. A "range error" occurs now when Count = 0. When Data-Block are engaged, the same error report as SRXM can be used.

Size of Data-Block indirect.

Asking the size of a Data-Block of a slave station indirectly is possible with the SRXMI instruction. The format is approximately the same as the direct format, but the Data-Block number is supplied in a register.

Format :

```
SRXMI     Channel     ; 1st parameter
          K    3000   ; 2nd parameter
          DB   x      ; 3rd parameter (indirect mode)
          R    y      ; 4th parameter
```

'Channel'
This parameter is used to specify the channel number (range: 0...3).

'2nd parameter'
K 3000 indicates that a "Read Size of Data-Block" is required.

'3rd parameter'
This parameter specifies the Data-Block and the register number which contains the number of the Data-Block to read the size (only this parameter is in indirect mode).

'4th parameter'
This parameter specifies the register number where the return value (size of Data-Block) will be written.

Return value of the "Read Data-Block Size" indirect.
If the return value which is in the register specified by the 4th parameter is :

0 : The Data-Block of the slave station doesn't exist
1...n : Size of a Data-Block in the slave station (n max. = 16384)
65535 : (or FFFF hex) means that the Data-Block specified is defined as a Text in the slave

Example :

```
          LD     R    99          ; Init. Data-Block number
                      3999

          SRXMI       2
                 K    3000
                 DB   99
                 R    100
```

In this example, the size of the Data-Block #3999 of the slave station will be reported in the register #100 of the master station via channel #2

3.8 STXMI Transmit data in indirect mode

Description :

This instruction works in the same way as the existing STXM instructions. The difference is that it works in indirect mode. Indirect mode means that the number of the media for source and destination is given by the content of a register. STXMI are only available for transfer of media. Transfer options like the Real Time clock, Display-Register,... are not allowed.

Format :

STXMI	**Channel**
	Count or Count + Position
	Source-type and Reg-number
	Destination-type and Reg-number

Channel : This parameter is used to specify the channel number (range : 0...3).

Count or Count + Position :

This parameter is a register number. This register contents the "Count" for standard medias or "Count" and "Position" for Data-Block. For Data-Block, "Count" is given in the MS Word of the register and "Position" in the LS Word of the register and in that case, the initialisation of this register can be easily done with LDL and LDH instructions.

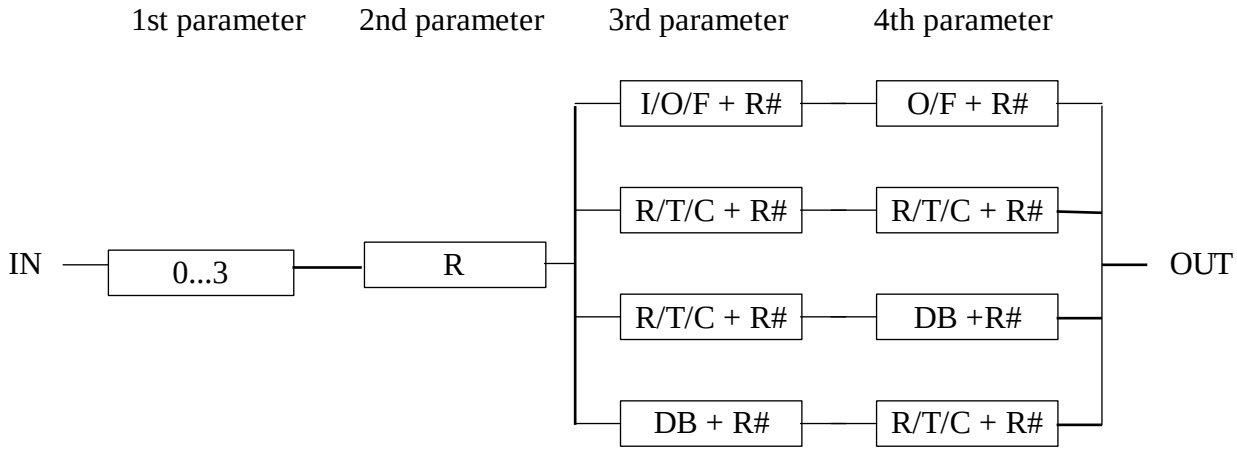
Source-type and Reg-number :

Destination-type and Reg-number :

These parameters specify the "Source" and "Destination" of the transfer. Each of these parameter is composed of a character giving the type of media (I/O/F/R/T/C/DB) and a register number (0...4095). The source and the destination must respect the source-destination validity described in the table for the STXM instruction.

STXMI does not work in indexed and parametrised mode.

STXMI syntax flowchart



Example :

20 elements of Data-Block #4000 from position 50 to 69 of the master station will be transferred to Register #1000...1019 of the slave station via the channel #1.

```
LDL     R   100     ; Initialisation of Position in the Data-Block
            50      ;
LDH     R   100     ; Initialisation of Count
            20          ;
LD      R   101     ; Initialisation of the DB number (source)
            4000    ;
LD      R   102     ; Initialisation of Register nb. (destination)
            1000    ;

STXMI       1       ; channel #1
        R   100     ; MSW of R 100 = 20; LSW of R 100 = 50
        DB  101     ; R 101  =  4000
        R   102     ; R 102  =  1000
```

Error report :

For standard media, the error reports are the same as the existing STXM instruction. A “range error” occurs now when Count = 0. When Data-Block are engaged, the same error report as STXM can be used.

3.9 SICL Input Control Line

Description :

The SICL instruction reads a control signal from the serial channel given in the 1st operand, and stores its state in the ACCU. The 2nd operand is the signal to be read :

0	=	CTS	Clear To Send
1	=	DSR	Data Set Ready
2	=	DCD	Data Carrier Detect

For the Port 0 (PGU) of the PCD1, PCD2, PCD4 and PCD6.M540 as well as for the port 4 (PGU) of the PCD6.M300, the instruction SICL is always allowed (independently, whether the port is assigned or configured). For any other port of PCD1, PCD2, PCD4, PCD6.M540 or PCD6.M300, the instruction SICL is only allowed on a port configured for S-Bus PGU. Otherwise, the instruction SICL is only allowed after execution of a SASI.

Format :

SICL	**Channel**	**; Serial channel number 0-3**
	Signal	**; Signal number 0-2**

Channel : This parameter is used to specify the channel number (range : 0...3).

Signal number :

0	CTS	Clear To Send
1	DSR	Data Set Ready
2	DCD	Data Carrier Detect

Flags :

The ACCU is set to the state of the addressed control line. The Error flag is set if the channel does not exist or has not been correctly initialised.

Tips :

- For a port configured for S-Bus Level 2 for public line modem, the user can for example read the DCD signal to detect whether the PCD is on-line with a remote modem or not. According to current DCD status he can then execute different code in the user program.
- The programming unit can be detected by reading the DSR signal (DSR = 1).
- It is not possible to detect whether the PCD is on-line with S-Bus Level 2 or not since the DSR signal on the PGU port (PCD1/PCD2/ PCD4/PCD6M5/M3) is LOW for S-Bus Level 2 as well as if the port is free for any user assignation (SASI).

3.10 SOCL Output Control Line

Description :

The SOCL instruction sets a selected control signal of the serial channel given in the first operand to the state of the ACCU (H or L)
The second operand is the signal to be set:

0	=	RTS	Request To Send
1	=	DTR	Data Terminal Ready
2	=		Special Functions

For the Port 0 (PGU) of the PCD1, PCD2, PCD4 and PCD6.M540 as well as for the Port 4 (PGU) of the PCD6.M300, the instruction SOCL is always allowed (independently, whether the port is assigned or configured). For any other port of PCD1, PCD2, PCD4, PCD6.M540 or PCD6.M300, the instruction SOCL is only allowed on a port configured for S-Bus PGU. Otherwise, the instruction SOCL is only allowed after execution of a SASI.

Format :

```
SOCL    Channel     ; Serial channel number 0-3
        Signal      ; Signal number  0-2
```

Channel : This parameter is used to specify the channel number (range : 0...3).

Signal number :

0	RTS	Request To Send
1	DTR	Data Terminal Ready
2		Special Functions

Flags :

The Error flag is set if the channel does not exist or has not been correctly initialised.

Special functions :

Port 0 on PCD2

A SASI for SM1/SS1 in the user program will configure the port 0 to RS-485. If the user wishes to use RS-232 on the port 0 then he must perform the following instructions after the SASI instruction:

```
ACC     L
SOCL        0
            2
```


Switch from RS 485 to RS 422

The serial interface RS 422/RS 485 on the interface modules (F-Modules) PCD7.F110/F150 and PCD2.F520/F30 as well as on the bus modules PCD4.C130 switches automatically to RS 485 when certain modes are assigned.

Mode	**Type**
MC0 .. MC3, MD0 / SD0	RS 422
MC4, S-Bus	RS 485

It is sometimes needed to force the PCD to use S-Bus with RS 422; in this case, the following instructions must be performed after the SASI instruction :

```
ACC     L
SOCL        Port_nb
            2
```

It is also possible to force the RS 485 mode with MC0..MC3 or MD0/SD0 with :

```
ACC     H
SOCL        Port_nb
            2
```

Switch from receive to transmit mode in RS 485

The following instructions must be executed after the SASI :

- Switch RS 485 in transmit mode

```
ACC     H
SOCL        Port_nb
            0
```

- Switch RS 485 in receive mode

```
ACC     L
SOCL        Port_nb
            0
```

3.11 SYSRD System Read

Description :

This instruction read the PCD system parameters like :
PCD Device type, CPU type, Firmware version, User program name, S-Bus parameters, …

Format :

SYSRD	**Function**	**; Function code**
	Result	**; Result of the read**

Function :

K x or **R x** : constant or register containing a function code
This instruction can either be direct, by using a constant for the function code or indirect by using a register. It permits the user to have access to useful system information via the user program.

Result : **R 0 ..4095** Register containing the result

Example :

```
SYSRD   K   5000    ; Read the PCD type in ASCII
        R   20      ;    and put the result in R 20
```

Flags :

If the function code does not exist, the Error flag is set.

Function codes

Code	Function description		Result		
2000 2001 2002 2003 2004 2005 ¦ 2049	**Read User EEPROM**	Register 0 Register 1 Register 2 Register 3 Register 4 Register 5 Register nn register 49	Value contained in the EEPROM Remark : PCD1: max. 5 registers (0 .. 5) Other PCD: max. 49 registers (0 .. 49)		
5000 5010	**Read Device type**	in ASCII in decimal	ASCII " D1" " D2" " D4" " D6"	Dec 1 2 4 6	Type PCD1 PCD2 PCD4 PCD6
5100 5110	**Read own CPU type**	in ASCII in decimal	ASCII " M1_" " M1_" " M15" " M11" " M12" " M14" " M24" " M34" " M44" " M1_" " M2_" " M3_" " M54"	Dec 10 10 15 11 12 14 24 34 44 10 20 30 54	Type PCD1.M1 PCD2.M12 PCD2.M15 PCD4.M11 PCD4.M12 PCD4.M14 PCD4.M24 PCD4.M34 PCD4.M44 PCD6.M1 PCD6.M2 PCD6.M3 PCD6.M5
5200 5210	**Read own Firmware version** in ASCII in decimal		Examples of valid responses : " $4C", " 004", " X41" Ex : 5 dec for Version 005 -1 dec for any '$', 'X', 'β'		
5400	**Read User program name** in ASCII The user program name always contains 8 ASCII characters		**R x** contains the upper 4 bytes of the program name in ASCII **R x+1** contains the lower 4 bytes of the program name in ASCII		
6000	**Read S-Bus station number**		Example of result : 2 station number = 2 -1 station number not configured		
6010	**Read S-Bus PGU TN delay**				
6020	**Read S-Bus PGU TS delay**		Example of result : 10 delay in ms -1 S-Bus not configured		
6030	**Read S-Bus PGU timeout**				

Code	Function description	Result	
6040	**Read S-Bus PGU baudrate**	Example of result : 9600 bps -1 S-Bus not configured	
6050	**Read S-Bus PGU mode**	Status	Dec
		BREAK without modem PARITY without modem DATA without modem BREAK with modems PARITY with modems DATA with modems S-Bus not configured	0 1 2 10 11 12 -1
6060	**Read S-Bus PGU port number**	Example of result : 1 S-Bus PGU port configured on port 1 -1 S-Bus not configured	
6070	**Read S-Bus level**	Status	Dec
		S-Bus Level 1 (reduced) S-Bus Level 2 (full) S-Bus not configured	1 2 -1
6080	**Read current PGU owner** (S-Bus or P8 protocol)	CPU 0 CPU 1	0 1
6100	**Read modem status byte** Reads the current status of the modem connection. This information tells the user at what stage the modem is at in the initialisation procedure. Example of result : 2 PCD waiting for modem connection. 6 .. 39 PCD initialising the modem. 40 Reassign serial port for mode SS2/SS1/SS0. 45..49 Connection to modem has been lost. This is an intermediate status before the modem in reinitialised. 50 Everything is OK and PCD is online in mode SS2/SS1/SS0		
6500 6510 6520	**Read modem type string** **Read modem reset string** **Read modem initialisation string**	Read the specified modem string from the user program extended header into the block of registers starting with base address **R x**.	
7000	**Read system counter** An internal System Counter is incremented every millisecond. This system Counter is reset to 0 at power up, so a "Restart Cold" , for instance, doesn't affect it. The period of the System counter is exactly : **24 days 20 hours 31 minutes 23 seconds 647 ms** For an example see the SYSCMP instruction in the reference guide manual	0.. 2.147.483.647	

3.12 SYSWR System Write

Description :

This is the complement to SYSRD and it allows modification of system information or initialisation of system functions via the user program.

Only the usage of the SYSWR with S-bus is explained here.
For more explanations about the other possibilities of this instruction, consult the PCD Reference Guide.

Format :

```
SYSWR   Function    ; Function code
        Value       ; Value to be written
```

Function :

K x or **R x** : constant or register containing a function code
This instruction can either be direct, by using a constant for the function code or indirect by using a register. It permits the user to have access to useful system information via the user program.

Value : **K y** Value to be written
R 0 ..4095 Register containing the value to be written

Flags :

If the function code does not exist, the Error flag is set.

Function codes

Code	Function description
4017 4018 4019	**Execute XOB 17 / 18 / 19** Execute the XOB specified in **R x** or **K x** on the CPU specified in **K y** or **R y**. The XOBs 17/18/19 are user XOBs which can be provoked via S-Bus or the user program. The XOBs are only executed if the CPU is in RUN or in CONDITIONAL RUN. Function code : 4017 Execute XOB 17 4018 Execute XOB 18 4019 Execute XOB 19 Permitted values of **R y** or **K y** : 0 .. 6 CPU on which XOB will be provoked 7 Provoke XOB on own CPU 8 Provoke XOB on all CPUs
6000	**Write S-Bus station number** Change the S-Bus station number to the value held in **K y** or **R y** (in the system RAM and in the EEPROM). This instruction will work for user program in RAM (write protected), in EPROM and in Flash EPROM. Permitted values of **K y** or **R y**: 0 .. 254 **Write EEPROM** (not on all PCD, depending of the hardware) Warning: A maximum of 100,000 user writes is permitted on the EEPROM so do not execute this instruction frequently in your user program. The SYSWR instruction takes 20mS to execute so it is should not be used in XOB 0.

Notes :

3.13 Communication via modem

The use of a modem is necessary when communication has to cover large distances.

Distances for S-Bus with the RS 485 interface :

- without repeater, max. 1.2 km
- with three repeaters connected in series, max. 4.8 km

The use of a modem therefore makes sense for distances above 1.2 km. The maximum distance depends on modem type, Baud rate and line quality.

Basically, there are two different types of modem :

- **Modems for private lines or leased telephone line**

  This type of modem is fully supported by S-Bus mode, application level 1. Using these modems, all PCD data can be exchanged not only via a simple point to point connection, but also within a network.

- **Modems for the public telephone network *)**

  These modems can be used to exchange all PCD data via a dial up point to point connection. Although dialling a telephone number is not supported by S-Bus mode application level 1, modem communication via the public telephone network (automatic) is still possible. The user has to switch from S-Bus mode to C mode (character) to dial the phone number and then switch back to S-Bus mode when the connection is established.

  The connection can be analogue, digital (ISDN) or radio (GSM).

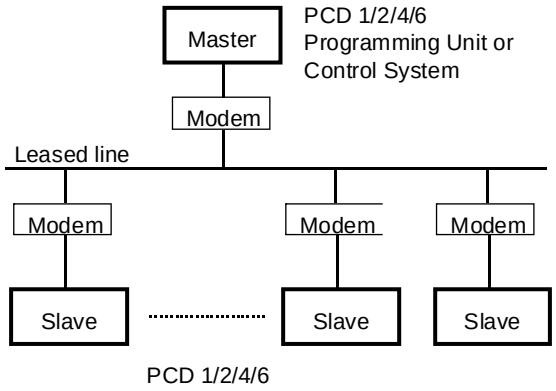
***)** Telecom, Cablecom etc…

3.13.1 Multipoint modems and converters

Modems for private lines or leased telephone lines as well the converters PCD7.T120 and ..T140 are fully supported by the S-Bus protocol. Both the modems and the converters are working according the same operation principle.

"Multipoint" modems can be used to construct a master/slave network over large distances.

S-Bus Network with "Multipoint" modem :



The RS 232 interface forms the connection between PCD and modem. Communication between modems is via a 2-wire line in half-duplex operation.

Requirements for the modems :

For SM2/SS2 mode :

Any standard modem which supports 8 data bits, 1 start bit and 1 stop bit can be used.

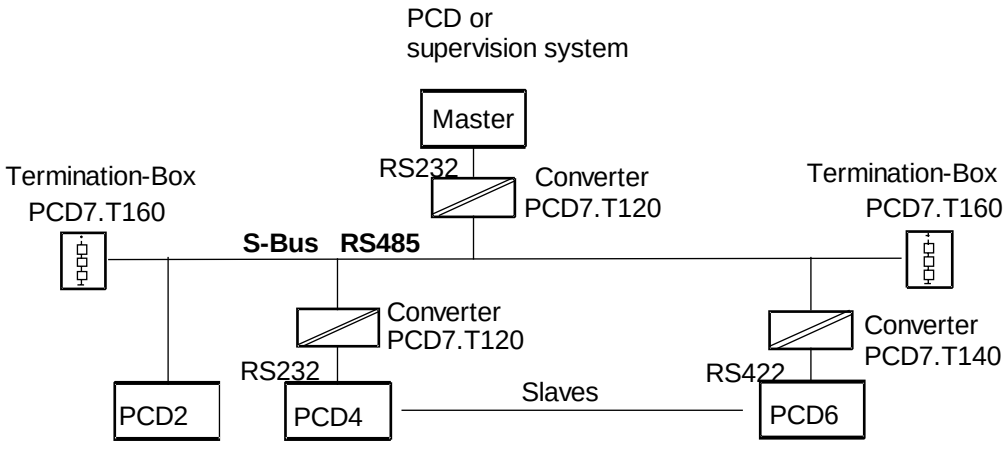
For SM1/SS1 mode :

The parity bit has a special use, therefore the modem must support 9 data bits (8 data + 1 parity), 1 start bit and 1 stop bit.

For SM0/SS0 mode :

The parity bit is not used, therefore any standard modem which supports 8 data bits, 1 start bit and 1 stop bit and transmits the break character can be used.

S-Bus Network with converters PCD7.T120 and ..T140 :



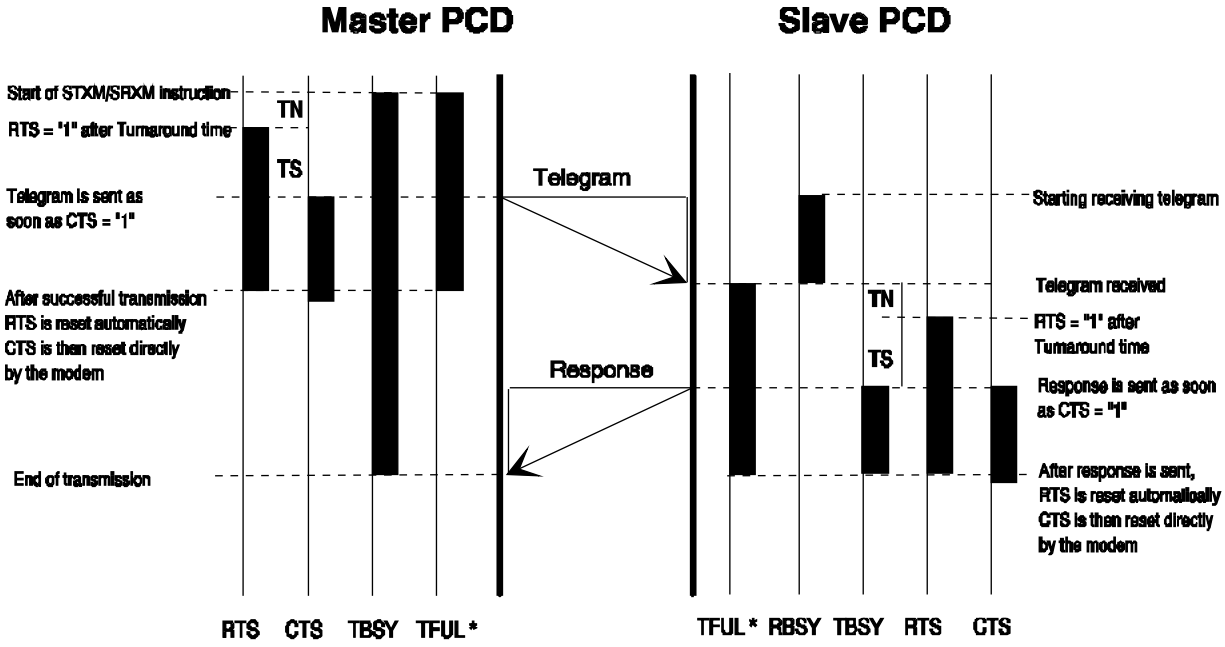
Operating principle :

At the interface to the PCD, the previously mentioned modems and converters function similarly:

On any RS 485 bus, only one station's transmitter can be switched on at any one time. In order to produce half-duplex communication on a two-wire line, the transmitter and receiver must therefore be controlled by each station on the bus.

In its idle state, a modem or converter is always set to receive. Before a telegram can be sent, the transmitter of the participating station must be switched on and, at the end of transmission, switched off again. In order to switch the transmitter of a connected modem or converter on or off via the RS 232 or RS 422 interface, S-Bus mode provides automatic control of the interface's RTS (Request To Send) control line whenever an STXM or SRXM instruction is being executed. The RTS signal is switched on for as long as a telegram is being transmitted. After transmission the signal is reset within 1 ms.

The following diagram shows the functioning principle for an SRXM or STXM instruction :



*) The TFUL flag is only controlled for baud rates up to 4800 bps.

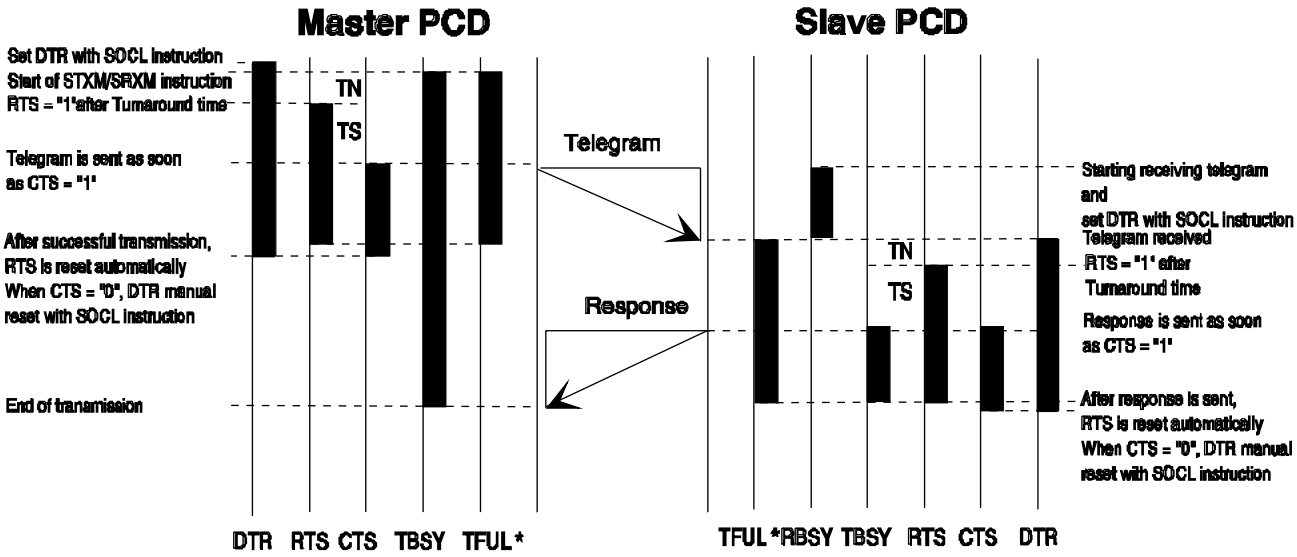
TN-Delay (Delay time on turnaround)
This parameter defines the delay time before the RTS signal is switched on at the RS 232 and RS 422 interfaces, or before the transmitter is switched on at the RS 485 interface. A telegram is sent at the earliest after this delay time has elapsed.

TS-Delay (Training Sequence Delay time)
This parameter defines a monitoring time for the CTS (Clear To Send) signal of a connected device. The PCD sends a telegram as soon as the connected device (modem) has shown its readiness to receive by setting the CTS signal, or at the end of the TS-Delay time. If the CTS signal has not been set by the end of the TS-Delay time, bit 23 (CTS-Timeout) is set in the diagnostic register. Monitoring and handling of the CTS signal is only active if the parameter has been defined in the SASI text. Otherwise the CTS signal is ignored. The standard value for the TS-Delay time is 0 ms.

If, within the timeout defined by the SASI instruction, the master station receives an incomplete or invalid reply telegram, the telegram sent before is transmitted again.

Radio data modem

These types of modem allow radio data transmission in S-Bus mode. The following diagram shows the operating principle for SRXM or STXM instructions using a radio data modem :



*) The TFUL Flag is controlled up to 4800 Baud only.

To run a radio data modem, the DTR (data terminal ready) control line is also used, so that the UHF carrier frequency can be stabilized by the modem before transmission of data. In contrast to the RTS and CTS signals, the DTR signal is not controlled automatically by the PCD and must therefore be set or reset by the user program with the SOCL instruction.

SASI Definition text

For modem or repeater operation, the UART definition can be expanded to include the Timeout, TS-Delay, TN-Delay and Break-Length parameters.

Format:

"UART:<Baudrate>[,<Timeout>][,TS-Delay>][,TN-Delay]
[,Break Length];"

For more details on the different parameters, see page 3-7.

Indicating Timeout, TS-Delay, TN-Delay and Break Length is optional. If nothing is specified, default values are used :

TimeOut :	calculated in function of the Baudrate
TS-Delay :	0ms.
Break-Length :	4 characters (valid for mode SM0 only)

The parameters can be defined or leave out individually.
TimeOut, TS-Delay and TN-Delay can be set individually from 1 to 15.000 ms

Examples :

"UART:9600,500,50,30,7;"	→	Timeout = 500ms, TS-Delay = 50ms, TN-Delay = 30ms, Break-Length = 7 characters.
"UART:9600,500,50;"	→	Timeout = 500ms, TS-Delay = 50ms, TN-Delay = TS-Del/2 + default-TN-Del = 25ms + 1ms = 26ms, Default Break-Length = 4 char.
"UART:9600, ,100,50;"	→	default Timeout and Break-Length, TS-Delay = 100ms, TN-Delay = 50ms Default Break-Length = 4 char.
"UART:9600, , ,30;"	→	default Timeout, TS-Delay and Break-Length, TN-Delay = 30ms Default Break-Length = 4 char.

Determining values for TS-Delay, TN-Delay and Timeout :

The duration of the TS-Delay and TN-Delay should be taken from the description for the modem used. When using the repeater PCD7.T100, the turnaround time TN-Delay must be adapted. The suitable values can be found in the manual "Installation components for RS 485 networks" (ref 26/740).

The following rule applies for the Timeout :

Timeout = 3 * (TS-Delay+TN-Delay+Break-Length) + default Timeout

3.13.2 Modems for the Public Telephone Network

A connection is made via the public telephone network by the modem dialling the telephone number of the desired partner station. As soon as the point to point connection has been established between the two stations, both modems are transparent and PCD data can be exchanged in SM2/SS2 mode.

Before a modem can dial a telephone number it must first be told its operating mode and the number of the partner station by the PCD. This function is not supported by S-Bus mode. However, transmission of initialization parameters and the telephone number can also take place in C mode.

As soon as a connection is made, the interface is reassigned to S-Bus mode for the exchange of data.

Procedure for addressing a partner station and exchanging data via the public telephone network :

1. Assign interface in C mode.
2. Initialize modem.
3. Dial partner station telephone number.
4. When the connection is made (DCD = high), reassign the interface in S-Bus mode.
5. Exchange data.
6. Break connection and reassign interface in C mode.

Procedure for receiving a call :

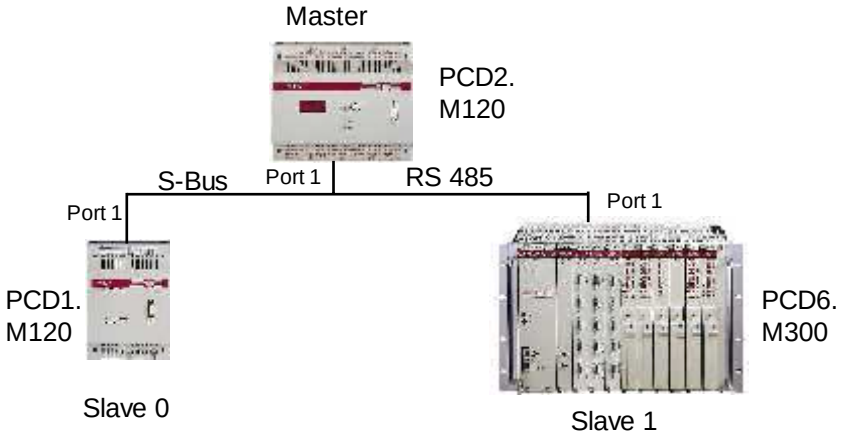
1. Assign interface in C mode.
2. Initialize modem.
3. In case of a call (DCD = high), reassign interface in S-Bus mode.
4. As soon as the connection is broken off, reassign the interface again in C mode.

3.14 Examples of user programs in IL

3.14.1 Example 1

This example concerns a very simple test program for commissioning an S-Bus network.

The following hardware installation is used :



The master station is to read the status of slave stations 0 and 1 and copy them into registers 1000 and 1001.

Commissioning :

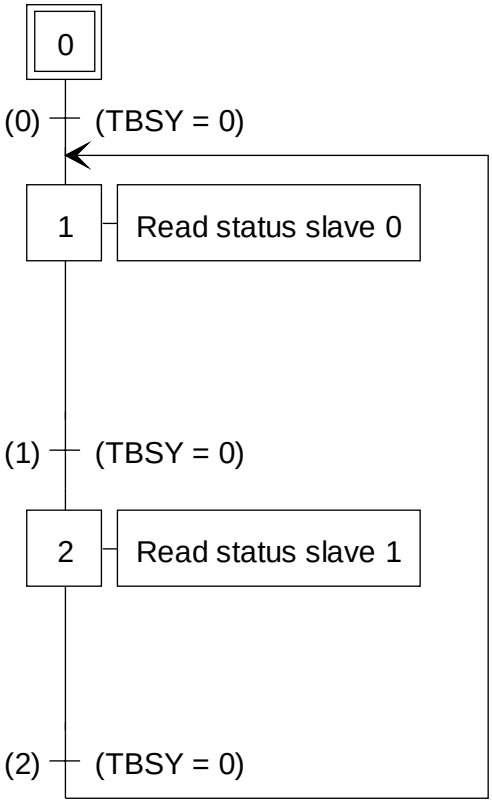
1. First check hardware installation according to the installation requirements(consult the appropriate hardware manual)
2. The slave stations are then allocated their station numbers by the programming unit, as described in "Station number definition" on page 3-1.
3. Load user programs into the slave stations with the programming unit and switch the CPUs to RUN.
4. Load user program into the master station (do not switch CPU to RUN).
5. Use the debugger to display serial interface diagnostic flags and registers, and registers 1000+1, in the refresh window.
6. Run program in single step mode (TRACE) and observe diagnostic elements and the two registers 1000+1.

If the installation is correct, the diagnostic elements show no errors and, after processing the SRXM instruction, registers 1000+1 contain the ASCII character "R" (Run) in memory, which corresponds to the status of the two slave stations.

The following pages reproduce test programs for master station (TEST_M.SRC) and slave stations (TEST_S0.SRC and TEST_S1.SRC).

```
; Test program for the S-Bus master station  (PCD1.M120)
; ------------------------------------------------------------------------
; This program reads the status of slaves 0 and 1 and stores it into
; the registers 1000 and 1001
; File:          TEST_M.SRC
; Création:      22.06.99              C. Alfonsi
```

```
$sasi
        TEXT        100         "UART:9600;"
                                "MODE:SM2,R4;"
                                "DIAG:F100,R998;"
$endsasi
        XOB         16          ; Cold start routine
                                ;    Assignation S-Bus
        SASI        1           ; Assignation RS 485 interface
                    100         ;    with parameters in Text 100
        LD        R 1000        ; Reset status register of server 0
                    0
        LD        R 1001        ; Reset status register of server 1
                    0
        EXOB
        ; ------------------------------------------------------------------------
        COB         0           ; Main Program
                    0
        CSB         0
        ECOB
```



SB 0

```
stl     F 103

ld      R 4
        0           ; slave n° 0
srxm    1           ; channel 1
        0           ; read status
        k 0         ; cpu 0
        R 1000      ; copy to R 1000
- - - - - - - - - - - - - - - -
stl     F 103

ld      R 4
        1           ; slave n° 1
srxm    1           ; channel 1
        0           ; read status
        k 0         ; cpu 0
        R 1001      ; copy to R 1001
- - - - - - - - - - - - - - - -
stl     F 103
```

```
; Test program for the S-Bus slave station  0
; ---------------------------------------------------
; Only the RS 485 interface must be initialised
; File:     TEST_S0.SRC
; Création:       22.06.99        C. Alfonsi
```

```
$sasi
        TEXT        100         "UART:9600;"
                                "MODE:SS2"
                                "DIAG:F100,R998;"
$endsasi

        XOB         16          ; Cold start routine
                                ;    Assignation S-Bus
        SASI        1           ; Assignation RS 485 interface
                    100         ;   with parameters in Text 100
        EXOB

        COB         0           ; Main Program
                    0
        ECOB
```

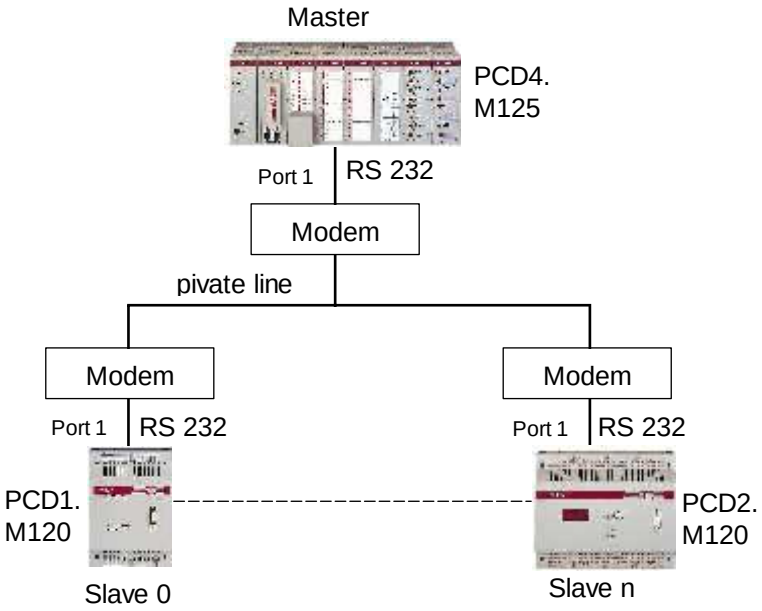
```
; Test program for the S-Bus slave station  1
; ---------------------------------------------------
; Only the RS 485 interface must be initialised
; File:           TEST_S1.SRC
; Création:       22.06.99            C. Alfonsi
```

```
$sasi
        TEXT        100         "UART:9600;"
                                "MODE:SS2"
                                "DIAG:F100,R998;"
$endsasi

        XOB         16          ; Cold start routine
                                ;   Assignation S-Bus
        SASI        1           ; Assignation RS 485 interface
                    100         ;   with parameters in Text 100
        EXOB

        COB         0           ; Main Program
                    0
        ECOB
```


3.14.2 Example 2

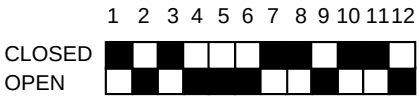
This example can be used when commissioning an S-Bus installation with modem for private lines or leased public telephone lines.

Hardware installation :



Modem type : ALCATEL LBM 19200

DIL switch setting in modem



Program function :

The master station copies 8 source elements (I8..15) to destination elements (O40..47) of a slave station. The slave station address can be preselected by a BCD switch (connected to inputs 16..31) on the PCD6.

Diagnostic flags are allocated to outputs 32..39.

The debugger can be used to display diagnostic registers in the refresh window.

The following pages reproduce the test program for master station (TEST_M1.SRC) and slave stations (TEST_SN.SRC).

The test program is identical for all slave stations.

```
; Test program for the S-Bus master station  (PCD4.M125)
; ------------------------------------------------------------------------
; This program copies the inputs 0..15 of the master station to the
; outputs 40..47 of a selected slave station
; File:          TEST_M1.SRC
; Création:      22.06.99              C. Alfonsi
```

```
$sasi
        TEXT        100         "UART:9600,100,30;"
                                "MODE:SM1,R4;"
                                "DIAG:O32,R0;"
$endsasi

        XOB         16          ; Cold start routine
                                ;    Assignation S-Bus
        SASI        1           ; Assignation RS 232 interface
                    100         ;   with parameters in Text 100

        EXOB
        ; ---------------------------------------------------

        COB          0          ; Main Program
                     0
        STH     I    0          ; If Input 0 goes High
        DYN     F    0
        ANL     O   35          ;    and TBSY = 0
        CPB     H    1          ; Then Write elements

        ECOB
        ; ---------------------------------------------------

        PB           1          ; Write elements
        LD      R    0          ; Clear diag register
                     0
        DIGI         2          ; Read destination station number
                I   16          ;    on BCD switches on I 16
                R   10
        STXM         1          ; Transmit
                     8          ;    Number of elements
                I    8          ;    Source address
                O   40          ;   Destination address
        EPB
```



```
; Test program for the S-Bus slave station  (PCD1)
; ------------------------------------------------------------
; Only the RS 232 interface must be initialised
; For all slaves the same program is used
; File:          TEST_SN.SRC
; Création:      22.06.99              C. Alfonsi
```

```
$sasi
        TEXT        100         "UART:9600,100,30;"
                                "MODE:SS1;"
                                "DIAG:O32,R0;"
$endsasi

        XOB         16          ; Cold start routine
                                ;    Assignation S-Bus
        SASI        1           ; Assignation RS 232 interface
                    100         ;    with parameters in Text 100

        EXOB
        ; ---------------------------------------------------------------------

        COB         0           ; Main Program
                    0

        ECOB
```

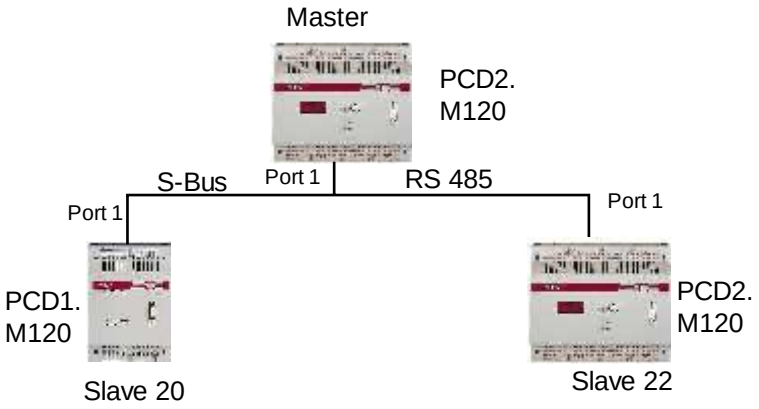

3.15 Example of user programs in FUPLA

Example

The example concerns an application in which a master reads and writes the following data from two slaves:

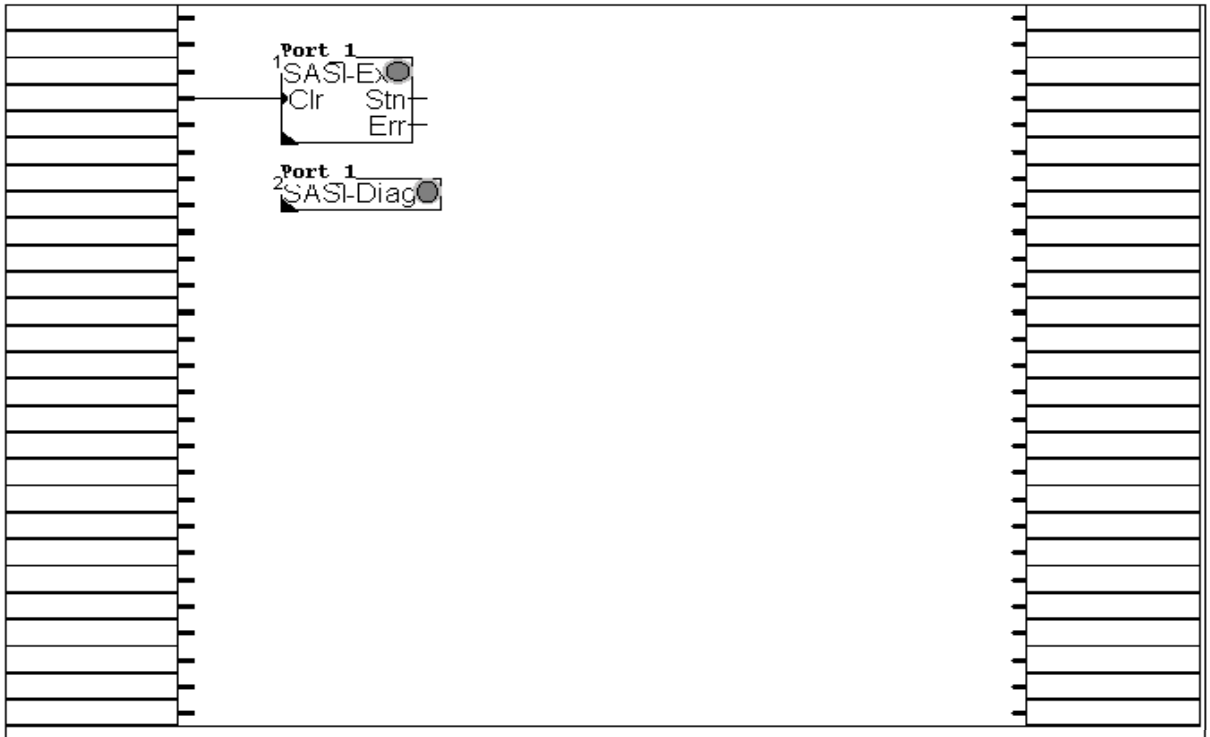
- slave 20:
  - slave registers 100..107 are copied to master registers 200..207.
  - Master inputs 16..23 are copied to slave outputs 32..39.
- slave 22:
  - slave inputs 0..7 are copied to master flags 1000..1007.
  - Master flags 2000..2007 are copied to slave outputs 16..23.

The following hardware installation is used:



Program for the master controller

Initialization of interface:



PAGE DESCRIPTION
Sasi Intruction for the port1 for the Master PCD

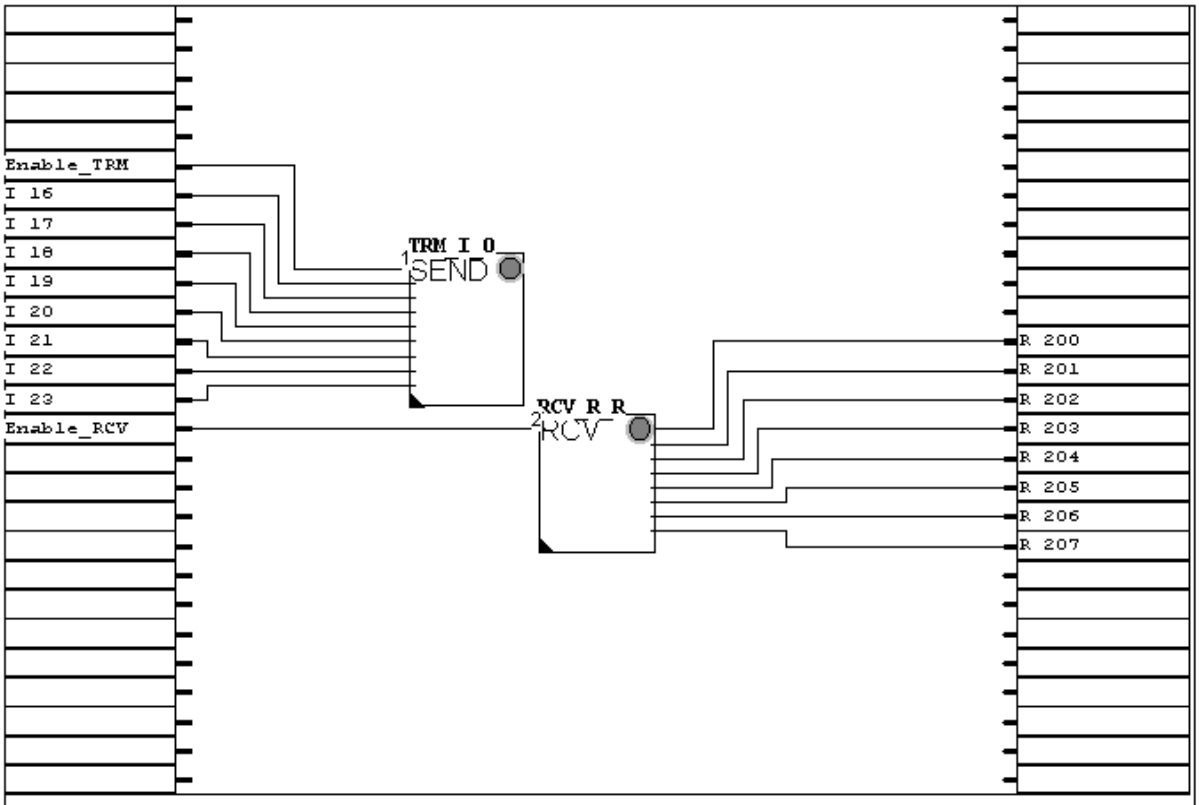
FBOX EXTRA INFORMATION WITH ADJUST VARIABLES

1	FBox: SASI S-BUS Extended (SASI-Ex), Family: Communication	
	User Name:	Port_1
	Channel	Channel 1
	S-Bus Mode	Data
	Communications mode	Master
	Gateway	No
	RS Type	Default
	Transmission speed	9600 bps
	S-BUS Timeout [msec]	0
	S-BUS TS-Delay [msec]	0
	S-BUS TN-Delay [msec]	0
	S-BUS Break length [car]	0
2	FBox: SASI Diagnostic (SASI-Diag), Family: Communication	
	User Name:	Port_1
	Channel	Channel 1

	Date	Name	File: g:\ec teilnehmer\s467\s-bus manual\master\main.fup
Creation	15:51:24, July 02, 1999		Block: COB 0
Last Modified	10:46:02, July 29, 1999		Page: FUP-1 [SASI S_Bus]

FOR SAIA'S INTERNAL USE ONLY Page 1/3

Communication with slave 20:



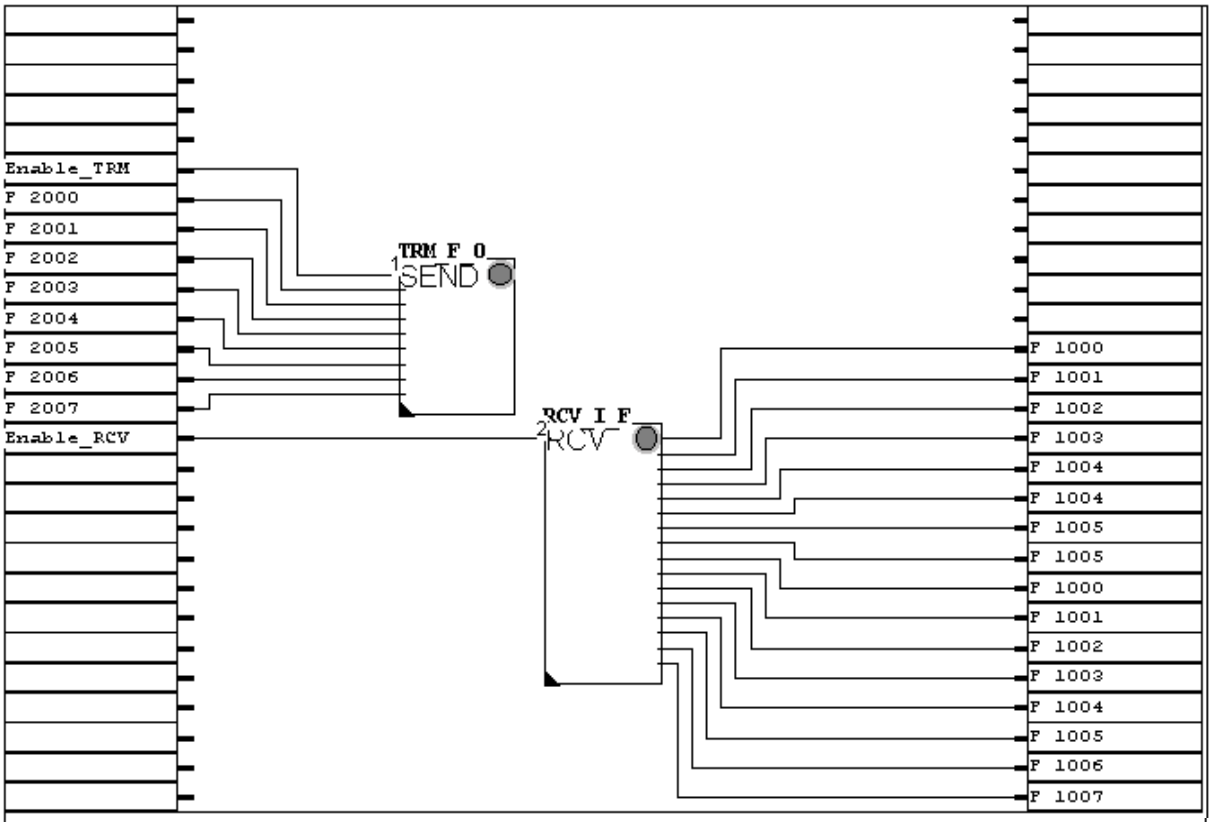
FBOX EXTRA INFORMATION WITH ADJUST VARIABLES

1	FBox: Transmit 1-20 I/O/F (SEND), Family: Communication	
	User Name:	TRM_I_O
	Initialization	No
	Channel	Channel 1
	Destination station	20
	Destination element	Output
	Destination address	32
2	FBox: Receive 1-20 R/T/C/Clock (RCV), Family: Communication	
	User Name:	RCV_R_R
	Initialization	No
	Channel	Channel 1
	Source station	20
	Source element	Register
	Source address	100

	Date	Name	File: g:\ec teilnehmer\s467\s-bus manual\master\main.fup
Creation	15:51:24, July 02, 1999		Block: COB 0
Last Modified	10:46:02, July 29, 1999		Page: FUP-2 [Com Slave 20]

FOR SAIA'S INTERNAL USE ONLY Page 2/3

Communication with slave 22:



PAGE DESCRIPTION
Communication with the slave 22

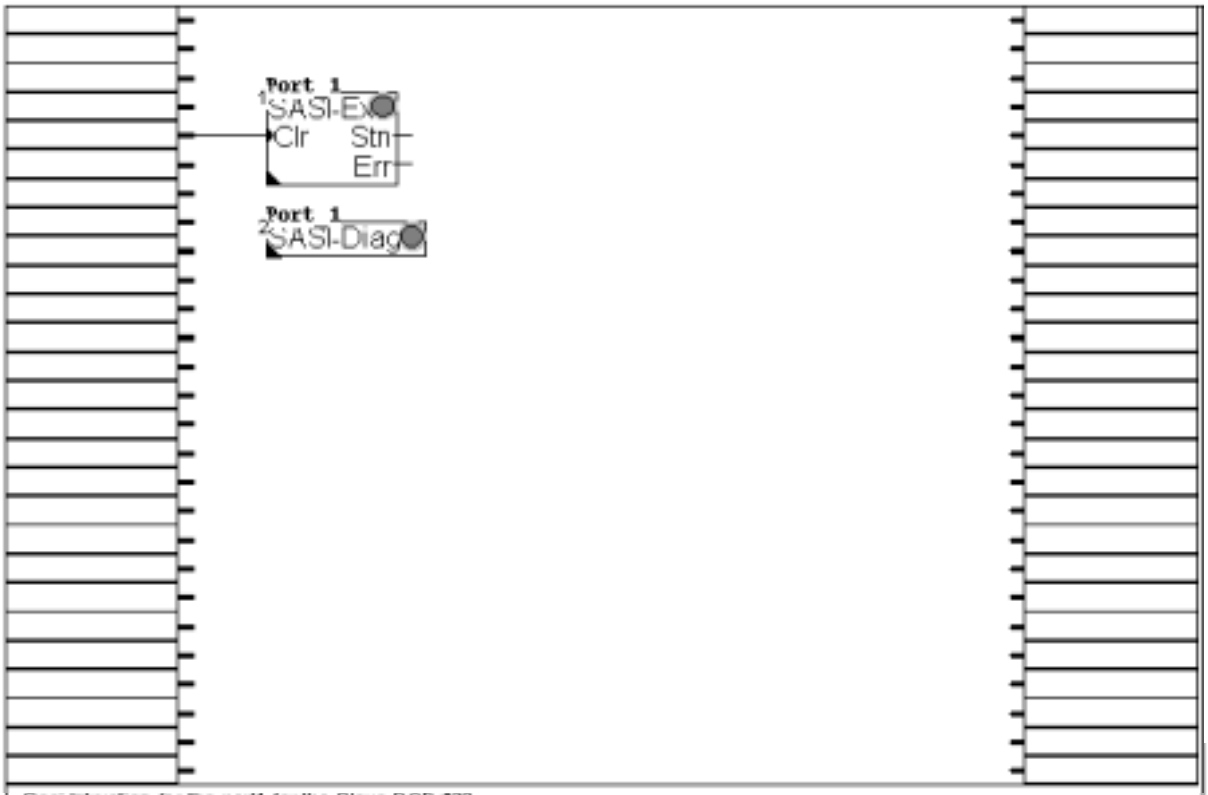
FBOX EXTRA INFORMATION WITH ADJUST VARIABLES

1	FBox: Transmit 1-20 I/O/F (SEND), Family: Communication	
	User Name:	TRM_F_O
	Initialization	No
	Channel	Channel 1
	Destination station	22
	Destination element	Output
	Destination address	16
2	FBox: Receive 1-20 I/O/F (RCV), Family: Communication	
	User Name:	RCV_I_F
	Initialization	No
	Channel	Channel 1
	Source station	22
	Source element	Input
	Source address	0

	Date	Name	File: g:\ec teilnehmer\s467\s-bus manual\master\main.fup
Creation	15:51:24, July 02, 1999		Block: COB 0
Last Modified	10:46:02, July 29, 1999		Page: FUP-3 [Com Slave 22]

FOR SAIA'S INTERNAL USE ONLY Page 3/3

Program for the slave controller 20



Sasi Intruction for the port1 for the Slave PCD #20

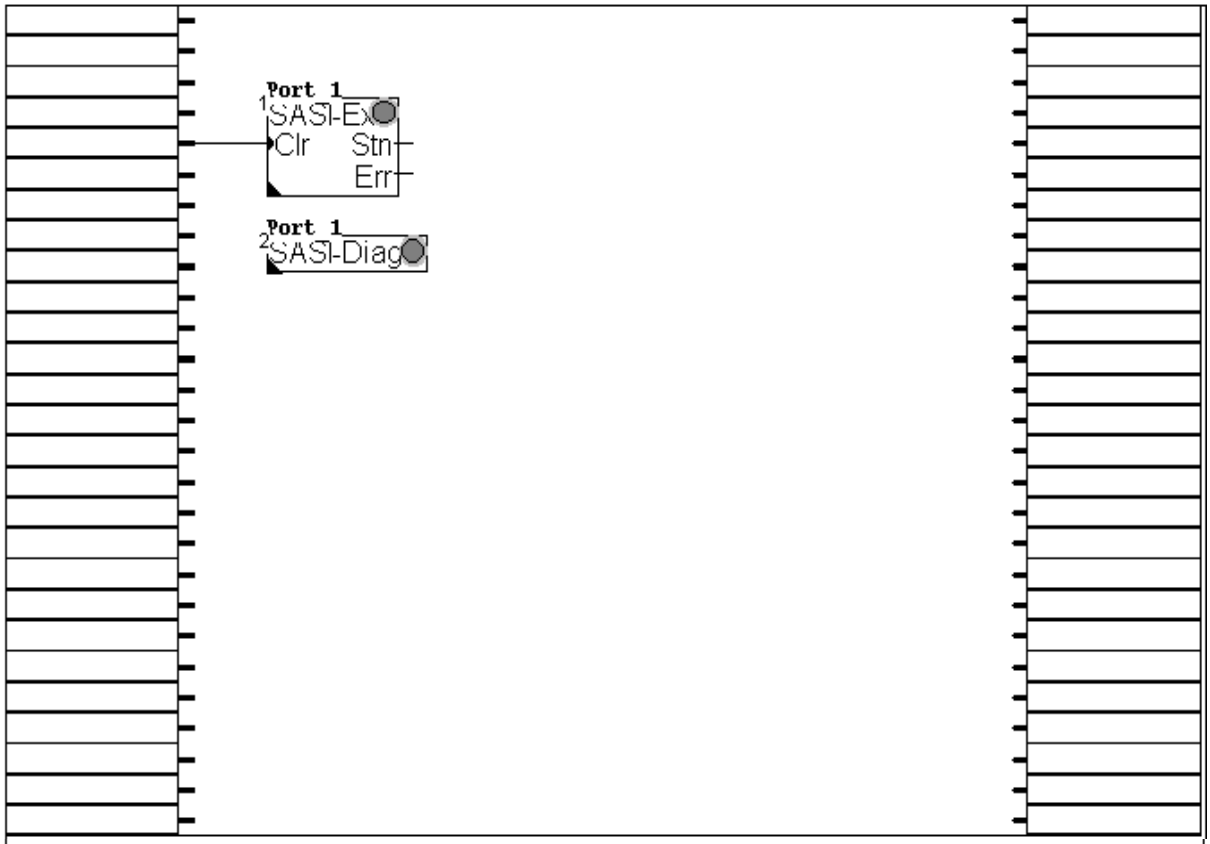
FBOX EXTRA INFORMATION WITH ADJUST VARIABLES

1	FBox: SASI S-BUS Extended (SASI-Ex), Family: Communication	
	User Name:	Port_1
	Channel	Channel 1
	S-Bus Mode	Data
	Communications mode	Slave
	Gateway	No
	RS Type	Default
	Transmission speed	9600 bps
	S-BUS Timeout [msec]	0
	S-BUS TS-Delay [msec]	0
	S-BUS TN-Delay [msec]	0
	S-BUS Break length [car]	0
2	FBox: SASI Diagnostic (SASI-Diag), Family: Communication	
	User Name:	Port_1
	Channel	Channel 1

	Date	Name	File: g:\ec teilnehmer\s467\s-bus manual\slave 20\main_20.fup
Creation	15:51:24, July 02, 1999		Block: COB 0
Last Modified	15:45:22, July 02, 1999		Page: FUP-1 [Sasi_20]

FOR SAIA'S INTERNAL USE ONLY Page 1/1

Program for the slave controller 22



PAGE DESCRIPTION
Sasi Intruction for the port1 for the Slave PCD #22

FBOX EXTRA INFORMATION WITH ADJUST VARIABLES

1	FBox: SASI S-BUS Extended (SASI-Ex), Family: Communication	
	User Name:	Port_1
	Channel	Channel 1
	S-Bus Mode	Data
	Communications mode	Slave
	Gateway	No
	RS Type	Default
	Transmission speed	9600 bps
	S-BUS Timeout [msec]	0
	S-BUS TS-Delay [msec]	0
	S-BUS TN-Delay [msec]	0
	S-BUS Break length [car]	0
2	FBox: SASI Diagnostic (SASI-Diag), Family: Communication	
	User Name:	Port_1
	Channel	Channel 1

	Date	Name	File: g:\ec teilnehmer\s467\s-bus manual\slave 22\main_22.fup
Creation	15:51:26, July 02, 1999		Block: COB 0
Last Modified	15:47:04, July 02, 1999		Page: FUP-1 [Sasi_22]

FOR SAIA'S INTERNAL USE ONLY Page 1/1

4. Commissioning service

4.1 Essential characteristics and applications

With Level 2, the entire S-Bus protocol is supported.

Level 2's additional telegrams support the programming, commissioning and diagnosis of any PCD by the programming unit (PG). Level 2 can only be used with the programming unit.

The PG is always master in any S-Bus network. Access to a slave station may be in point-to-point connection, via the RS485 network, or via modem, including the telephone dialling network.

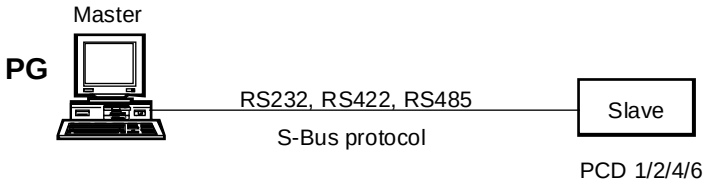
Essential characteristics of level 2 :

- The simple efficiency of the S-Bus protocol results in fast downloading (up to 38.4 Kbps) of user programs.
- Programming and commissioning of all slave stations connected to the network from a central point.
- Remote diagnosis and programming by modem via the public telephone dialling network.

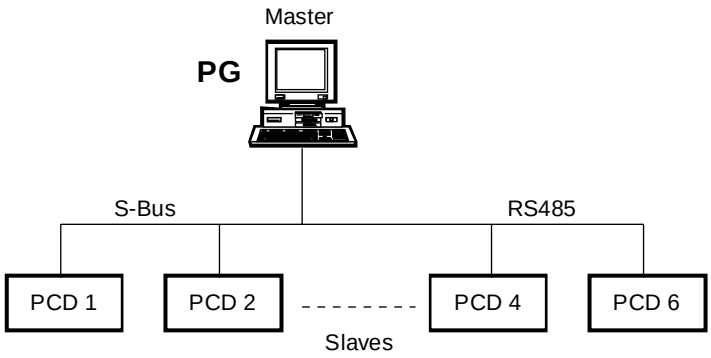
Applications

Programming, commissioning and diagnosis

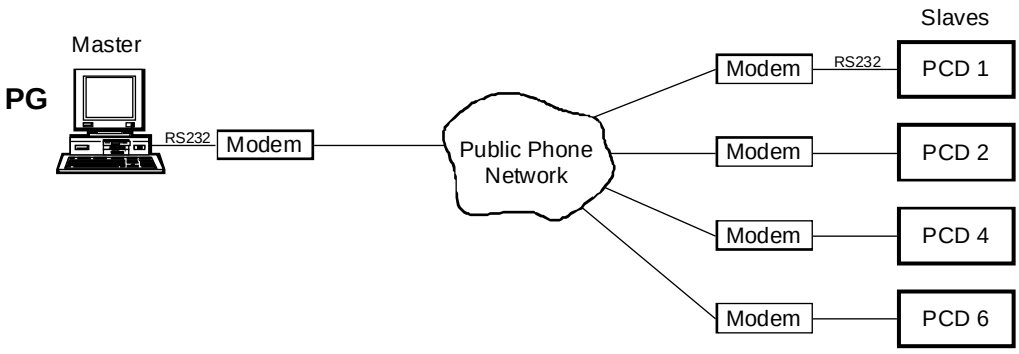
Local point-to-point



In an RS 485 network



By modem via the telephone dialling network



4.2 Local programming and commissioning

The programming interface (PGU) is defined as whichever interface provides the programming unit with access to a CPU.

Standard PGU interface :

PCD type	Port number	Standard Protocol
PCD1	Port 0	S-Bus
PCD2.M110/M120	Port 0	P8
PCD2.M150	Port 0	S-Bus
PCD4	Port 0	P8
PCD6.M540	Port 0	P8
PCD6.M1/M2..	with PCD8.P800	P8
PCD6.M300	Port 4	S-Bus

The P8 protocol is only supported from this original PGU interface. With S-Bus protocol level 2, the programming unit can access a CPU via another interface. (see Appendix B).

In the case of PCD2.M110/M120, PCD4 and PCD6.M540 CPUs, interface no. 0 supports the P8 and S-Bus protocols simultaneously, if previously configured to do so by the utilities. However, the P8 protocol always has priority.

This means :

- On delivery from the factory, the PGU interface is set for the P8 protocol. The PGU interface of the PCD1, PCD2.M150 and PCD6.M300 is set for the S-Bus protocol only (see table above).
- If it is necessary to configure a PGU interface for the S-Bus protocol, this configuration can only be carried out while using the P8 protocol.
- It is always possible to produce an "online" connection to a PCD CPU using the programming unit and corresponding programming cable via the PGU interface. This applies even when the PGU interface has already been assigned for another purpose (e.g. communication with a terminal in C mode) or has been configured for the S-Bus protocol.

In their original state (ex factory) all CPUs have their PGU interface configured for the P8 protocol. From this starting point it is possible, with the aid of the programming unit, to configure the PGU interfaces of the PCD2.M110/M120, PCD4 and PCD6.M540 for the S-Bus protocol in addition to the P8 protocol. In this way, the CPU at the PGU interface supports both protocols. The PCD8.K111 programming cable enables the CPU to recognize which protocol has been set and assign the interface accordingly.

The PCD1, PCD2.M150 and the PCD6.M300 support ex factory only the S-Bus PGU protocol on the PGU interface.

In the case of the PCD6.M1/2.. the PCD8.P800 interface processor is connected to the PGU interface. This processor only supports the P8 protocol and cannot be configured as an S-Bus PGU. A standard interface can also be configured as an S-Bus PGU (see Appendix D).

The following rules apply :

- A maximum of two PGU interfaces per CPU is possible. However, only one of these can be configured for S-Bus.

  Examples for the PCD4 :

Port 0	P8-PGU
Port 1	S-Bus-PGU
or	
Port 0	P8 and S-Bus-PGU

- If an interface is configured as S-Bus-PGU, it can only be employed by the user program for general communications after doing a SASI MODE OFF. If a SASI instruction is executed by the user program without a de-assignation, the error flag is set.

- If two programming units are connected simultaneously to one CPU, the programming unit at the standard PGU interface (in P8 protocol) has priority. This means that the second programming unit has reduced CPU access, only being able to execute the read commands from level 2. From level 1 (data transfer service) all write and read commands are allowed.

Important :

The assignation of an S-Bus PGU interface can not be done with a SASI instruction, but must be configured with the PCD Utilities.

4.3 Configuration and assignment of an S-Bus PGU interface

The procedure which applies here is different depending on whether memory modules are used with RAM or EPROM components.

If RAM memory modules are used on the PCD, configuration of the S-Bus PGU interface takes place directly online on the PCD.

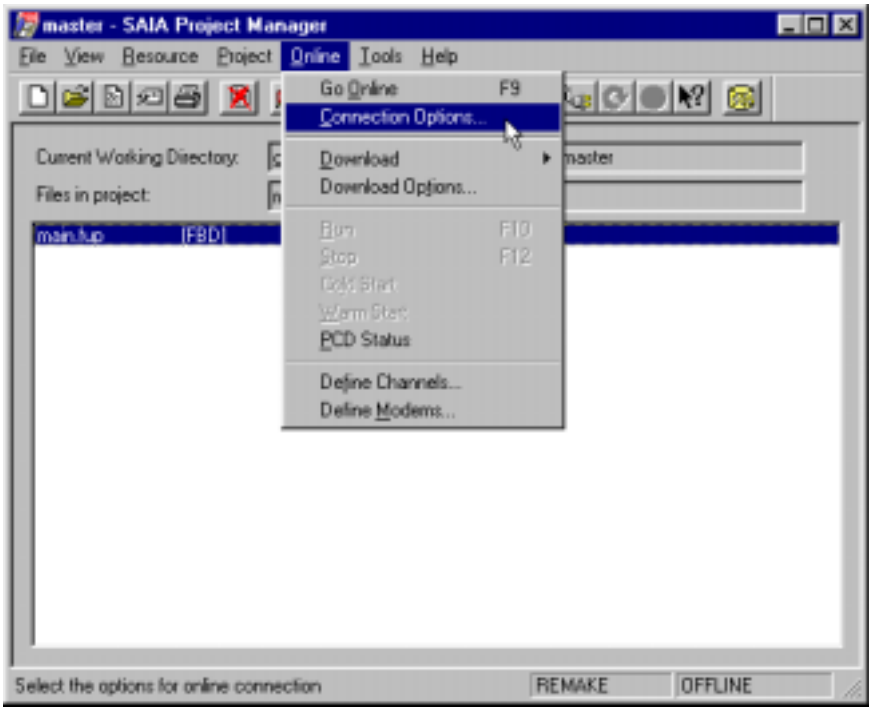
If EPROM memory modules are used on the PCD, configuration of the S-Bus PGU interface is defined in the offline configurator. This definition is then saved to the EPROM during EPROM programming.

4.3.1 Memory modules with RAM components

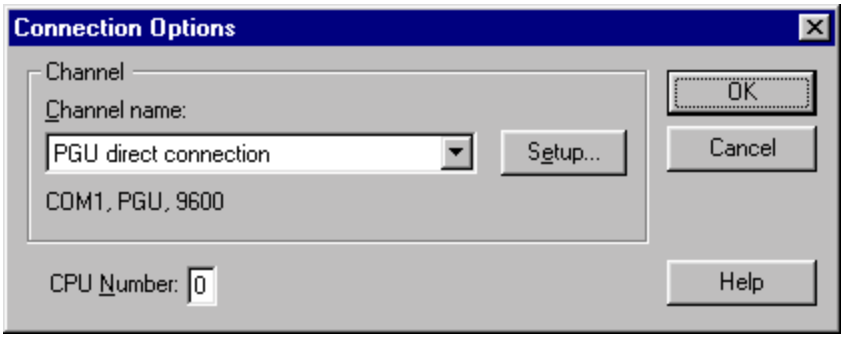
The following generally applies :

An S-Bus PGU interface can only be configured via the original interface using the P8 protocol.

1. Adjust interfaces, baud rates and transmission mode at the PC. Call "Connection Options" from the "Online" menu in the "Project Manager".



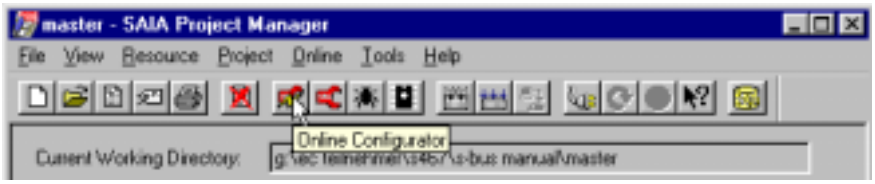
Select "PGU direct connection" and the correct CPU number:



Confirm with OK.

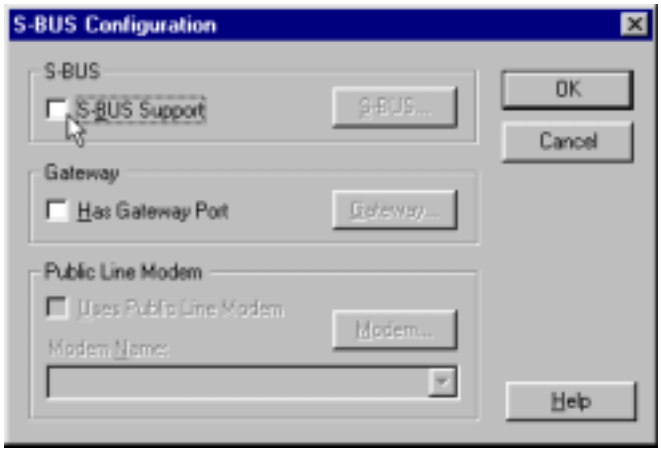
2. Join PCD8.K111 connecting cable between PC and PCD.

3. In the Project Manager, press the "Online Configurator" button:

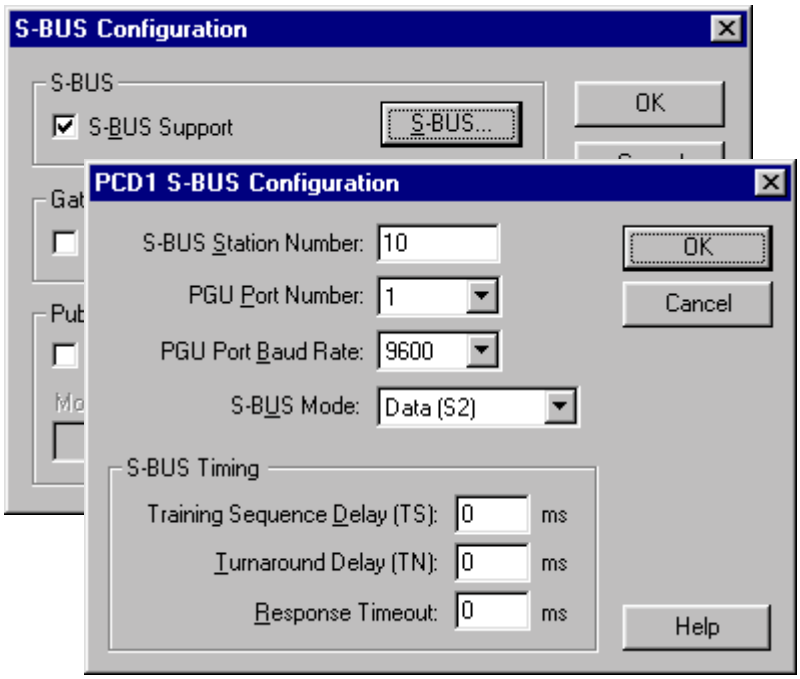


The online connection with the PCD has thereby been produced.

4. Press the 'S-Bus' button



5. Select of "S-Bus Support" and press the 'S-Bus' button

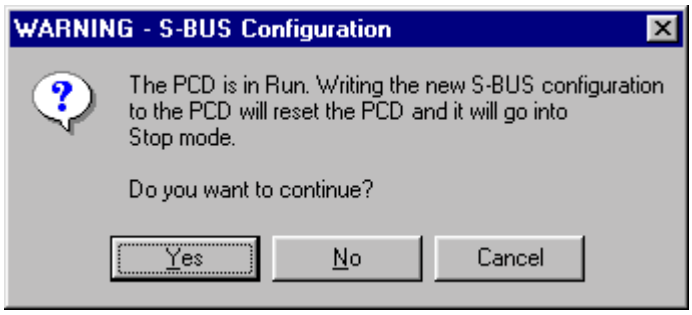


6. Definition of S-Bus parameters:
This menu defines the S-Bus station number, the interface number for the S-Bus PGU, the baud rate and the S-Bus mode (normally "Data", if no modems are being used).

Normally "S-Bus timing" must be left at 0 (= standard value).

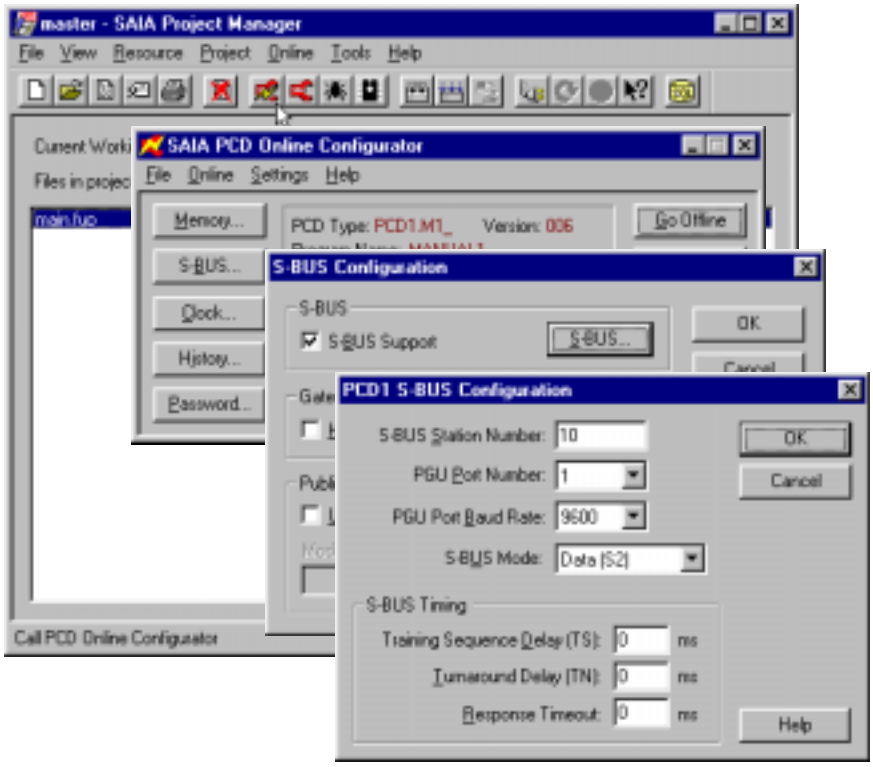
After pressing the OK button, this window is exited and one then returns to the "S-Bus Configuration" window.
Exit this window also with the 'OK' button.

With this, the following warning appears on the screen:



After this warning has been confirmed with the YES button, the current S-Bus configuration is transferred to the PCD and activated in it.

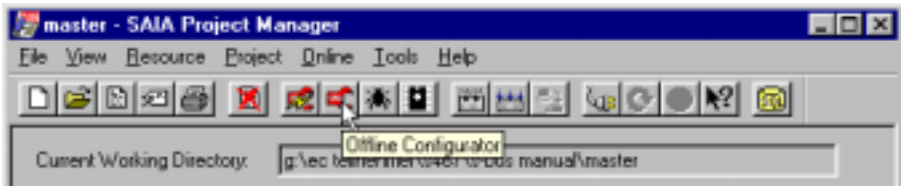
7. Check configured S-Bus parameters.
When the "S-Bus Configuration" window is called from the "Online Configurator" the configured S-Bus parameters are read from the PCD and displayed on the screen.



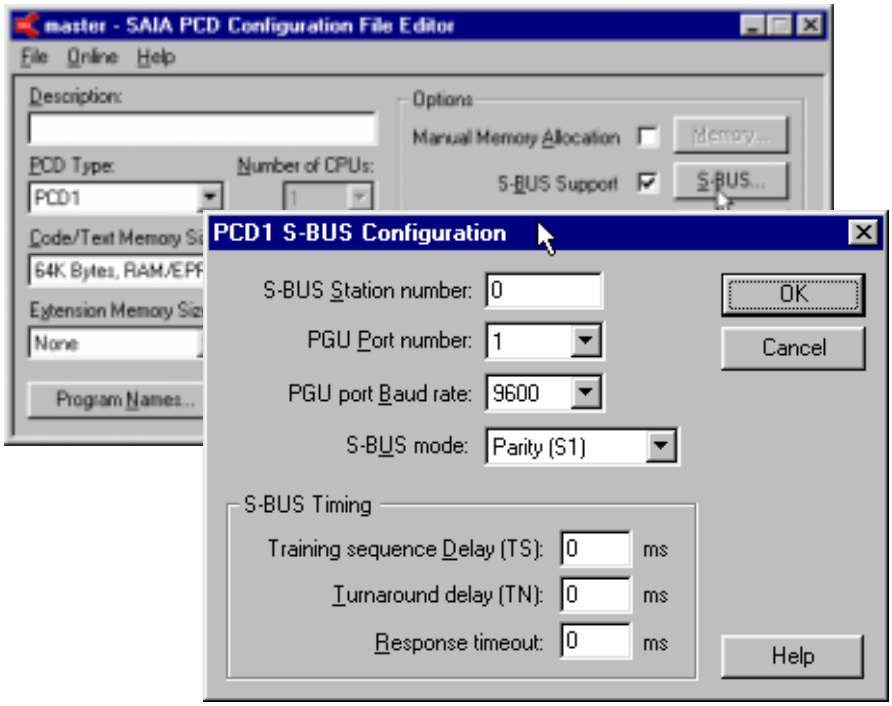
The S-Bus PGU interface has now been configured with the S-Bus protocol and is ready to use. This configuration can only be changed with the "Online Configurator", by means of the "S-Bus Configuration" submenu.

4.3.2 Memory modules with EPROM components

1. Run the "Offline Configurator" from "Project Manager".

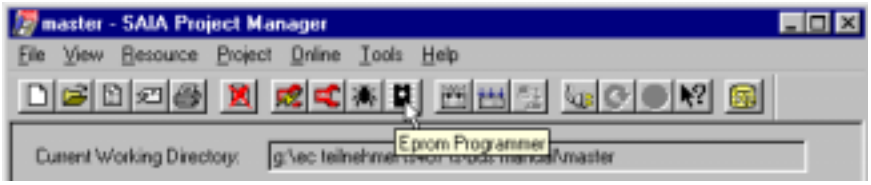


2. In the "Configuration File Editor" select the "S-Bus Support" field and press the "S-Bus" button.



3. Definition of S-Bus parameters: This menu defines the S-Bus station number, the number of the interface to be used for the S-Bus PGU, the baud rate and the S-Bus mode (normally "Data", if no modems are being used). Normally the "S-Bus timing" must be left at 0 (= standard value)
Exit this menu item.

4. With the "Eprom Programmer" menu in the "Project Manager“ an EPROM can then be programmed or a HEX file can be created. The S-Bus configuration is written automatically to the EPROM.



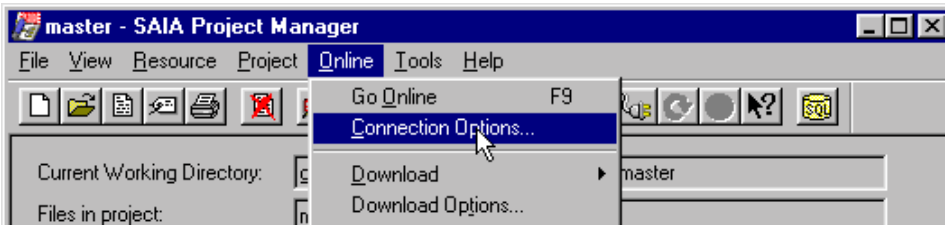
5. Insert the EPROM in the PCD and establish a connection with the programming unit. Select the PGU (P8) protocol with the "Connection Options" submenu from the "Online" menu.

6. Check the settings using the "Online Configurator".

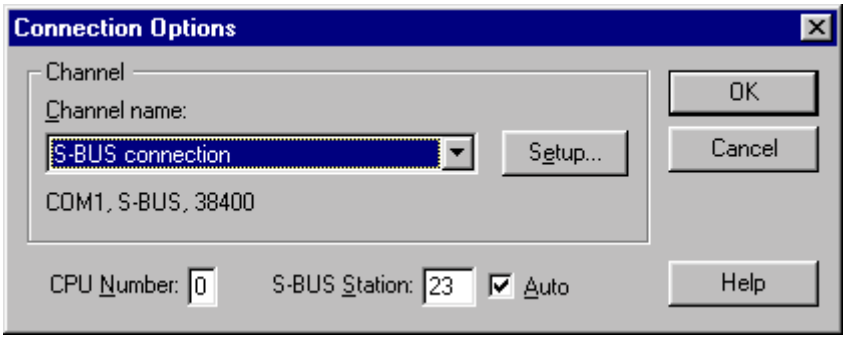
7. The configured S-Bus PGU interface has now been assigned with the S-Bus protocol and is ready to use. Since the configuration is stored in the EPROM, data can only be changed by reprogramming the EPROM.

4.4 Connection of the PG Unit via S-Bus

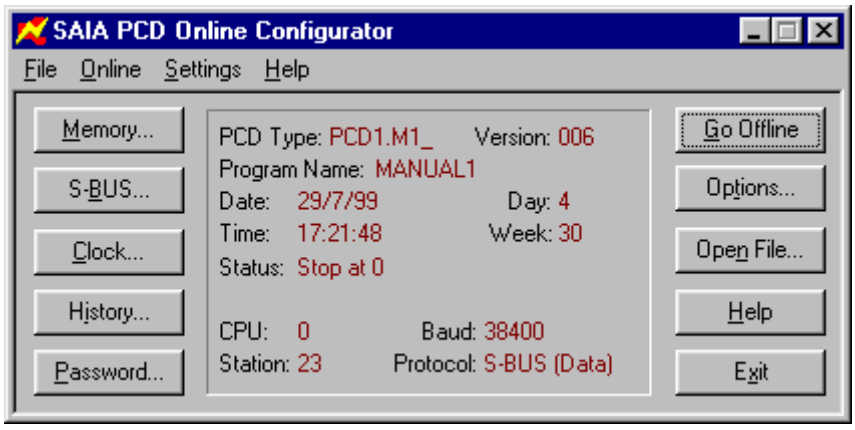
The programming unit should be connected to the S-Bus PGU interface (as a point-to-point connection or via RS485 network) and the S-Bus protocol, CPU and station numbers must be selected from the "Online" menu, sub-menu "Connection Options".



An 'S-Bus connection' must be selected:

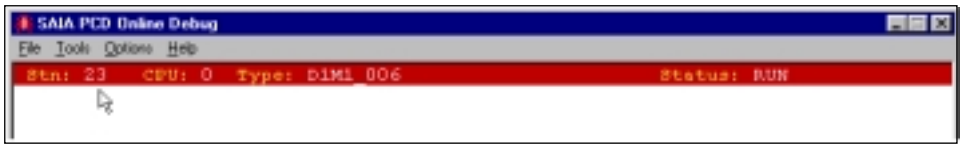


The connection test is done using the "Online Configurator".
The station number and S-Bus protocol are displayed throughout at the foot of the window.



After a successful connection with the station defined in the "Connection Options" menu, all functions of the PG4 Utilities can be used via the S-Bus PGU interface.

If the S-Bus protocol has been selected, the PCD Debugger displays the station number of each connected slave station on the top line (status line) of the screen.



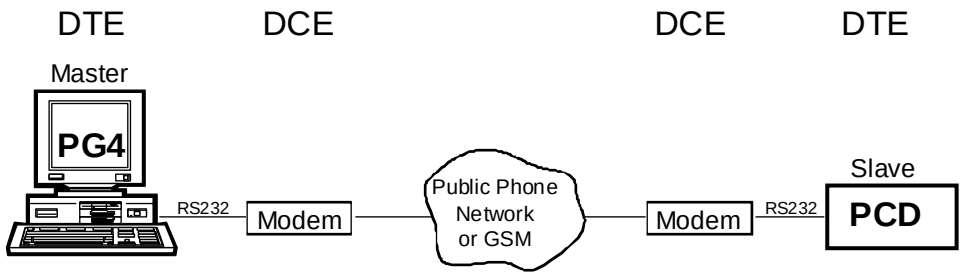
Debug "cOnnect"

This submenu enables a CPU of the connected slave to be selected (PCD4.M445).

In an S-Bus network it is possible to switch between the individual stations (but only if an S-Bus gateway has previously been defined on the master).

5. Modems

This part concerns modems used on the Public Telephone Network (PSTN), these modems are called Public Line Modems (PLM)



DTE : **D**ata **T**erminal **E**quipment

DCE : **D**ata **C**ommunication **E**quipment

5.1 Transmission speeds

Data speeds are defined in ITU-T standards (**I**nternational **T**elecommunication **U**nion - **T**elecommunication Standardization Sector).
Former the ITU-T was called CCITT standards (**C**omité **C**onsultatif **I**nternational **T**éléphonique et **T**élégraphique)

Main defined modem communications standards :

ITU-T V.21	300 bps
ITU-T V.22	1 200 bps
ITU-T V.23	1 200/75 bps
ITU-T V.22bis	2 400 bps
ITU-T V.32	4 800 and 9 600 bps
ITU-T V.32bis	4 800, 7 200, 9 600, 12 000 and 14 400 bps
ITU-T V.34	33 600 bps
ITU-T V.42	Error control MNP (Microcom Networking Protocol) MNP 2-4 for V.22, V.22bis, V.32 and V32bis modems
ITU-T V.42bis	Data compression for V.42 modems
ITU-T V.90	56 000 bps
ITU-T V.110	Synchronous bit rate adaptation for ISDN without error correction. 600, 1 200, 2 400, 4 800, 7 200, 9 600, 12 000, 14 400, 19 200, 48 000 and 56 000 bps
ITU-T V.120	Synchronous and asynchronous bit rate adaptation for ISDN with error correction. Baud rates same as V.110

V.32terbo	19 200 bps, only supported by few modem manufacturers
V.Fast	28 800 bps
MNP 5	Data compression not compatible with V.42bis

There also exist manufacturer specific communications protocol like for example CODEX V.Fast for 24 000 bps of Motorola which are not standardised.

Fax Standards :

ITU-T V.27ter	4 800 bps
ITU-T V.29	9 600 bps (also supported by many fax-modems)
ITU-T V.17	14 400 bps

The usable speed in practice is dependent on :

- the used modem types
- the telephone line quality

In principle any combination of modem types is possible for the communication between PG3 and PCD. This means a fast V.32bis modem can also communicate with slow V.22bis modem. The fast modem will automatically adapt the speed to the slower modem.

To allow this, the following parameter must be set in the fast modem :

- speed buffering and normal mode must be enabled.

PG4 - Modem or PCD - Modem (DTE - DCE) data speed

The PG4 and PCD support DTE baud rates up to 38 400 bps.
The baud rates between PG4 - modem and between PCD - modem can be different.

To allow this, the following parameters must be set in the modems :

- Automatic speed adaptation for the DTE interface must be disabled.
- Speed buffering must be enabled.

Notes :

- When the PG4 uses a higher baudrate than the PCD then the S-Bus time-out in the PG4 must be adapted for the slower baudrate.

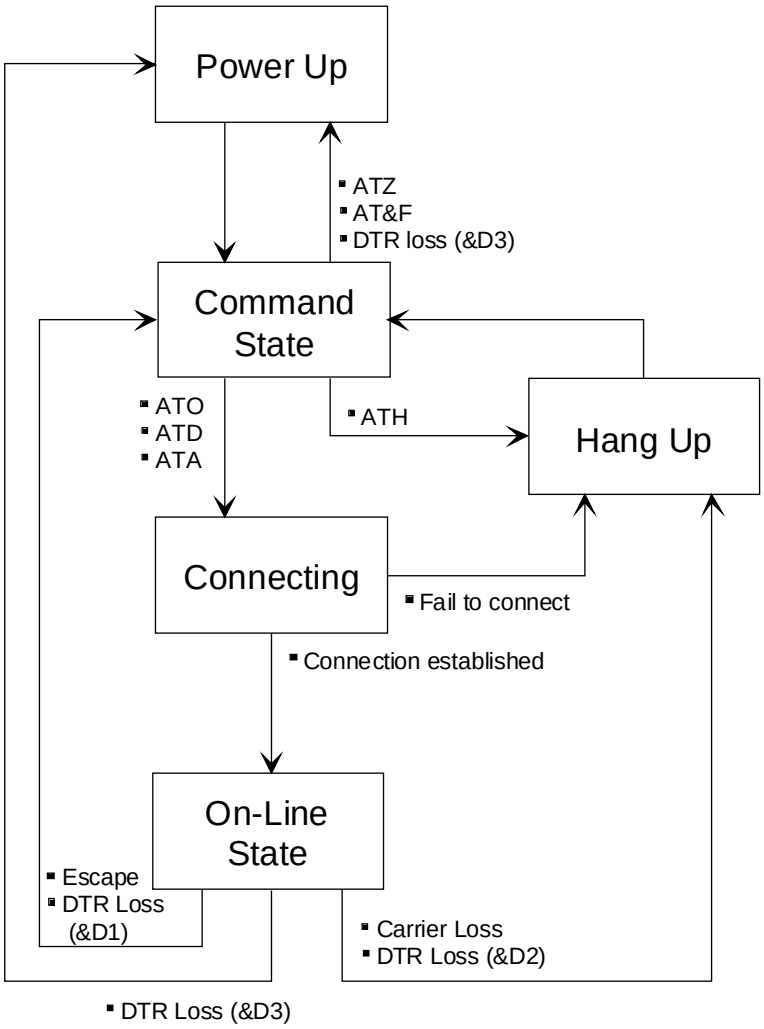
- Fast modems require buffered UARTs in the computer. An old AT (286) or XT may not work at 38 400 bps.

5.2 Operating your modem

Your modem has two operating modes : the Command mode and the Data mode.

- The Command mode lets you send instructions (in the form of commands) to your modem to perform a variety of functions.

- The Data mode lets you exchange data across the telephone line with a remote device. In this mode, your modem assumes everything it receives from your computer is data and sends it across the telephone line. Therefore, you can not issue a modem command while your modem is in the Data mode.



5.2.1 The AT command set

AT commands are used to set or modify the modem parameters.

Original AT command set
This standard has been implemented for the Hayes-Smart modem 1200 and describes the so called "one character commands" like for example ATD for dialling or ATH for hang up. This standard is used by all Hayes compatible modems.

Extended AT command set
This is a command standard for V22bis modems. The reference is again the Hayes-Smart modem 2400. The original commands have been extended by so called "& commands".

Superset AT command set
This command set is based on the extended command set and supports new functions for high speed modems (V.32 and V.32bis). For example data compression (AT%C) or error control (AT\N).
Unfortunately for this superset there is no common standard.
The meaning for the commands can be different depending on the modem supplier.

Hayes compatibility is only valid for commands used in the V.22bis standard.

Configuration parameter profiles

- User specific profiles
  The modems are equipped with a non volatile memory to store one or several user specific configuration profiles and telephone numbers.
  The active profile can be stored using the command AT&W.
  The stored user profile can be activated with the command ATZ.

- Factory default profiles
  Each modem has one or several factory default profiles which are permanently stored in the ROM. This profiles can not be modified by the user.
  The factory profiles can be activated with the command AT&F.

Viewing and modifying modem parameters

Modem parameters can be modified only when the modem is in the command state. By means of a terminal emulation program the modem parameters can be displayed or modified.

Command input format :

AT command1 [command2] [...commandn] <CR>
(max. 40 characters)

The modem echoes all received characters unless the echo is disabled by issuing :

ATE0 <CR>

This command is executed when the PCD initialises the modem.

The modem sends a response code (if defined so) after an executed command line :

OK	when the command was processed
ERROR	in case of invalid command

The active and the user profiles can be displayed with the command :

AT&V
(For the Us-Robotics modem use the ATI4 command)

5.2.2 Important configuration parameters for the PG4 and PCD modem

The following list is an example of a working modem set-up. The list is the result of executed tests with a V.32bis modem type 'US Robotics Courier'. The same modem type was used for both the PG4 and the PCD.

If you use another type of modem, it can be that the extended HAYES command set is not 100 % the same as this one below. So before you try these commands, consult your modem's manual to be sure that they have the same effect on your modem.

If you can not find the same commands, try to find an equivalent by comparing the description.

AT commands for the US Robotics Courier V.32bis modem :
The following applies :

- Commands written in bold are important for a correct function.
- Commands between ( ) have no influence on the functionality.
- Commands in normal writing were not especially analysed and should be set as indicated in the list.

PG4 modem	PCD modem	Description
B0	B0	Handshake options ITU-T standard V.32
E1	E0	Local Echo : PG4 --> enabled, PCD --> disabled
F1	F1	Local Echo OFF once a connection has been made
(L2)	(L2)	No function for this modem, for other modems : speaker volume setting
(M1)	(M0)	M0 : speaker off M1 : speaker on until carrier detected
Q0	Q0	Return result codes
V1	V1	Display result codes as words (e.g. "OK", "CONNECT", ...)
X4	X4	Provides basic call progress result codes, connection speed, Busy signal detection and dial tone detection
&A3	&A3	Display protocol result codes
&B1	&B1	DTE - DCE speed independent of DCE - DCE speed (fixed DTE speed)
&C1	&C1	Track status of carrier detect signal (DCD)

PG4 modem	PCD modem	Description
&D0 or D2	&D0 or D2	&D0 : ignore DTR signal (requires proper hang up string in the file 'modem.dat') &D2 : Monitor DTR signal. For an On-to-off transition of DTR the modem hangs up and enters the command state.
&G0	&G0	Use no guard tone
&H0	**&H0**	**Disable transmit data flow control (CTS)**
&I0	**&I0**	**Disable receive data software flow control**
&K0	**&K0**	**Data compression disabled**
&L0	**&L0**	Normal phone line operation
&M0	**&M0**	**Normal mode, no error control**
&N0	**&N0**	**Auto mode for DCE - DCE speed** (normal link operation) When originating, permit negotiation of a common communication standard at highest line speed supported by both modems.
&P0	&P0	Pulse dial make/break ratio : North America
&R1	&R1	Ignore RTS
&S0	**&S0**	DSR always on
&T5	&T5	Modem testing : deny remote digital loop back
&X0	&X0	Synchronous timing source
&Y3	**&Y3**	**Transmit BREAK sequentially with received data stream** (non-destructive, unexpected)
&N6	&N6	Synchronous clock speed : 9 600 bps

Summary of main important modem functions which must be set for S-Bus PGU :

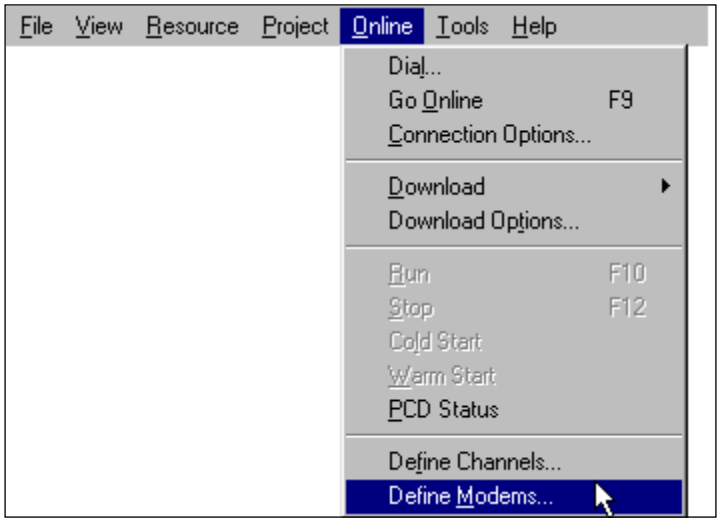
- Data compression must be disabled (for Break and parity modes)
- Error control must be disabled (for Break and Parity modes)
- RTS/CTS flow control must be disabled
- DSR must always be on
- BREAK characters must be transmitted in sequence with received data (only for Break mode)

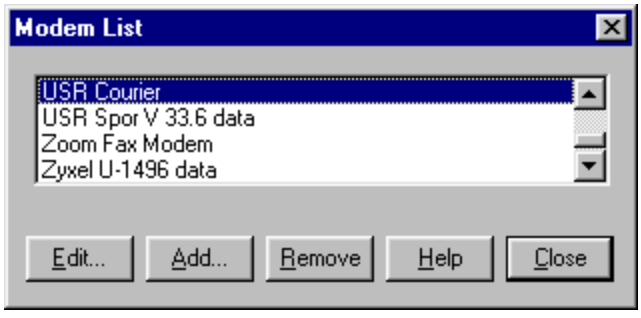
5.2.3 Configuring the PCD Utilities for your modem

The PCD Utilities contains some standard modems configuration :

- Hayes compatible
- Hayes compatible High Speed
- US Robotics Courier
- Zyxel U-1496 Series
- Miracom WS 3000
- User-defined modems

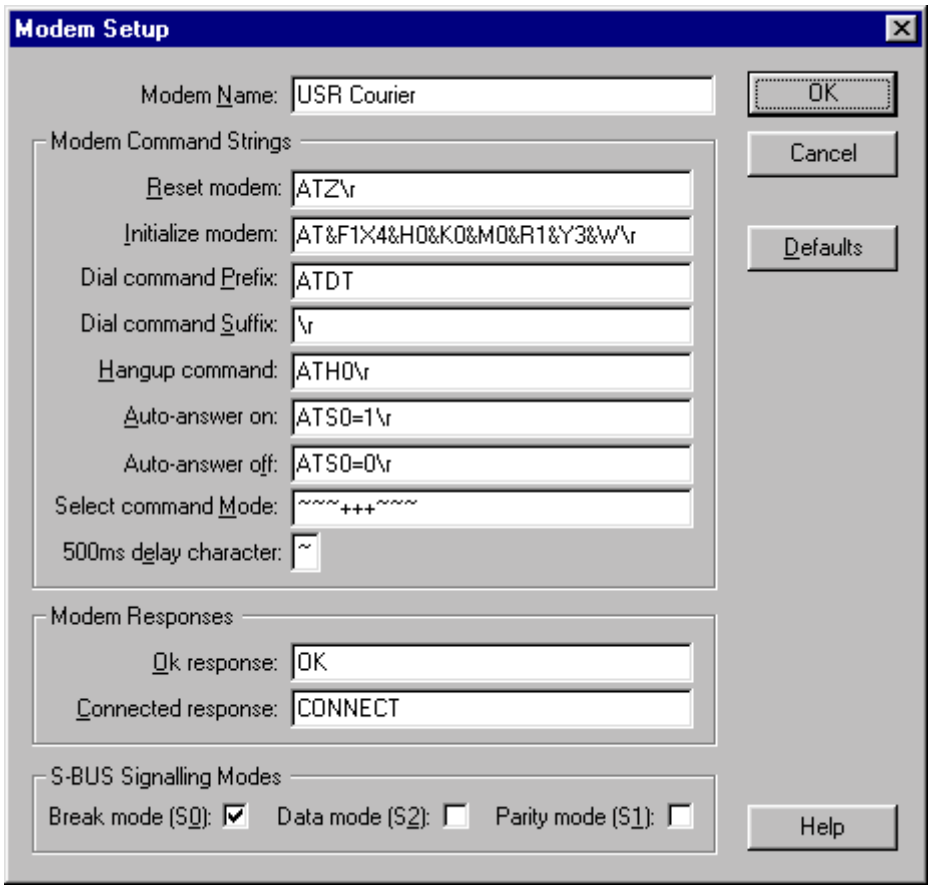
The different modems and commands they use can be seen with the "Define Modems" submenu from the "Online" main menu of the "Project Manager". Modem parameter entries under this menu item always relate to the modem that is connected to the PC. All entries are stored in the "Windows" directory, file "spgmodm.ini".





In 'Modem List' all known modems are listed. Existing modems are indicated with the "Edit" button. New modems are added with the "Add" button. Existing modems are deleted with the "Remove" button.

After pressing the 'Edit' button, the following window can be seen:



Reset Modem	Resets the modem to its factory default state
Initialize Modem	Initialises the modem : Set time-outs, disable error control data compression, enable call progress detection etc…
Dial command Prefix	Sent before the telephone number when dialling
Dial command Suffix	Sent after the number when dialling, this is usually "\r" (CR).
Hangup command	The command to disconnect and hang up the line. If empty, it is assumed that dropping DTR (Data Terminal Ready) for seconds will hang up the line, as for Hayes compatible modems.

Auto-answer on	This string must put the modem into auto-answer mode so that it will automatically answer an incoming call and connect to the remote modem. This is used to enable "auto-answer mode". This string usually loads a register in the modem (S0) with a ring count. When the ring count is non-zero, the modem answers an incoming call on the defined number of rings.
Auto-answer off	This must disable auto-answer mode, so that the modem will not automatically answer an incoming call. This string usually sets the modem's ring count register (S0) to 0.
Select command Mode	The sequence which switches the modem from data transfer to command mode. The "+++" string is preceded and followed by a 1.5 second delay, defined by three 0.5 second Delay characters : "~~~".
500ms delay character	A special dummy character. Whenever this character appears a modem command string the system waits for 500ms instead of transmitting the character to the modem. Traditionally this is the tilde character (~), which can be seen in the example "Command" string.
Ok response	The string returned by the modem when a command is accepted. This is the string returned when the "Reset", "Init" or "Hangup" commands are sent.
Connected response	The string returned by the modem after the dial command, when the remote modem has answered, connection has been established, and the carrier detect signal (DCD) is being returned.

S-BUS Signalling Modes - Break mode - Data mode - Parity mode	The S-Bus protocols that the modem supports can be defined with these parameters. More than one S-Bus protocol can be selected. When there is an S-Bus connection via modem, the PG4 will try to make a connection with the PCD using all the selected S-Bus protocols. As soon as the right S-Bus protocol has been found, the S-Bus connection will be made. In order to accelerate S-Bus connection, or to avoid undesirable side effects in the modem, only the required S-Bus protocol should be switched on. The last S-Bus protocol to have been selected will be used first when a new S-Bus connection is made.

Modem strings can contain escape sequences for common ASCII control characters or hex values in strings. These are preceded by a backslash '\' :

\r	0x0D	CR	carriage return
\n	0x0A	LF	line feed
\a	0x07	BEL	bell
\b	0x08	BS	backspace
\f	0x0C	FF	form feed
\t	0x09	HT	tab
\v	0x0B	VT	vertical tab
\xhh	0xhh		hex value \x00..\xFF
\\	0x5C	\	backslash
\"	0x22	"	quotation mark

Modem response strings (Ok response and Connected response)

The "Ok response" and "Connected response" strings are delimited by CR/LF characters. CR and LF must NOT be entered in the string definitions, do not enter '\n' or '\r'. Only the characters entered in the "Ok response" or "Connected response" string, excluding the delimiting CR/LF, are compared. If the response is longer, the additional characters are ignored.

For example, "CONNECT" matches "<CR><LF>CONNECT 2400 <CR><LF>", the "<CR><LF>" and " 2400" are ignored.

Do not initialise the modem to return single digit result codes (e.g. "0"), these will not work. String values, enclosed by CR/LF characters must be returned (see Hayes command "V1"). Do not initialise the modem so that it does not return response strings, these are required by the dialler to monitor connection progress (see Hayes command "Q0").

High speed modems with data compression and error correction

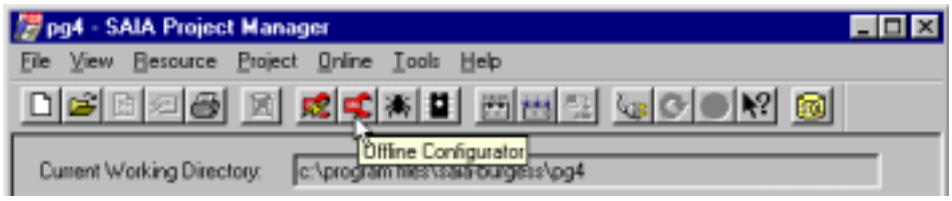
Data compression and error correction protocols are **not compatible** with S-Bus break and parity modes, and must be disabled.
Usually the Hayes command "&Q0" will do this, use Init="AT&Q0\r" (or use pre-defined modem type [Hayes Compatible High-Speed]).

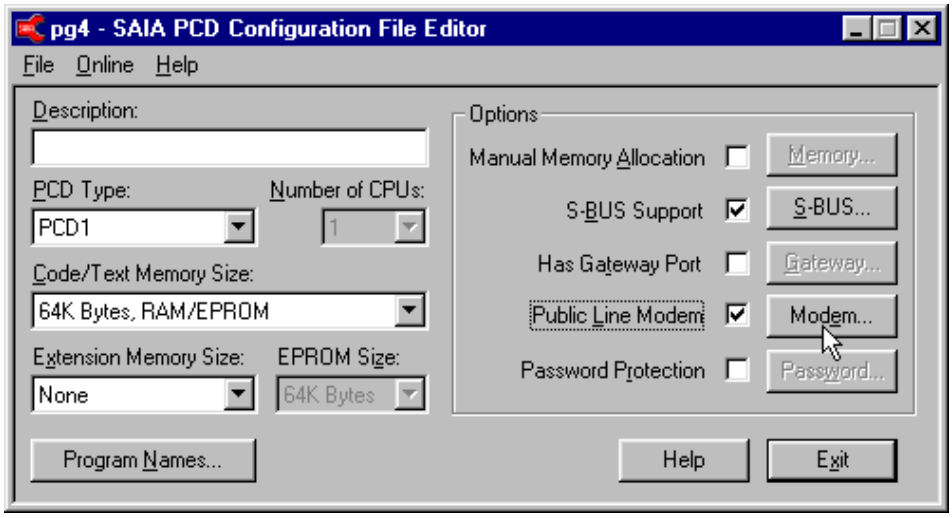
Call progress detection

Some modems have the ability to detect if the line is busy (engaged) or there is no dial tone. If the modem has this capability, it is useful to enable it with the "Init" string. This speeds up the dial retries, because the dialler will be able to detect these conditions instead of waiting for the dial time-out period to elapse.

5.2.4 PCD and modem

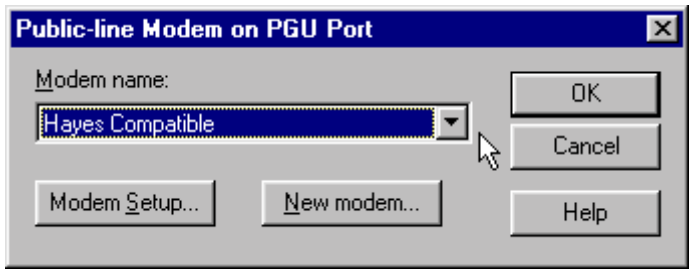
Initialization settings for the modem connected to the PCD are defined in the Project Manager's "Tools/Configuration File Editor" menu item.



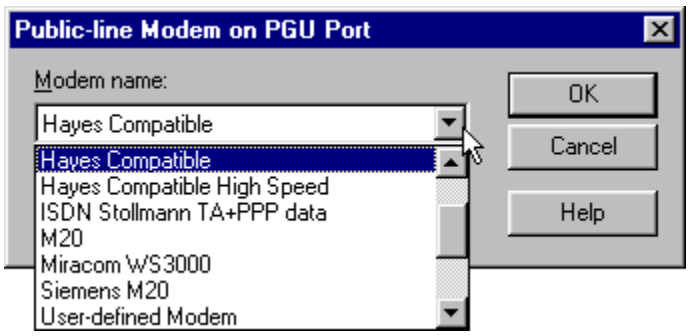


To do this, the "S-Bus Support" and "Public Line Modem" options must have been selected.

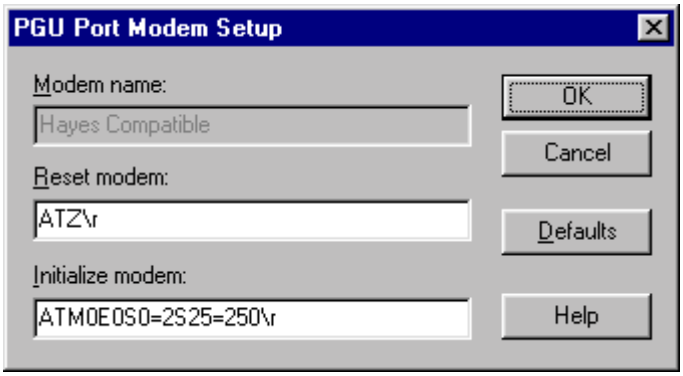
After pressing the "Modem" button, the following selection window appears:



An existing modem can be selected with the "down arrow" key:



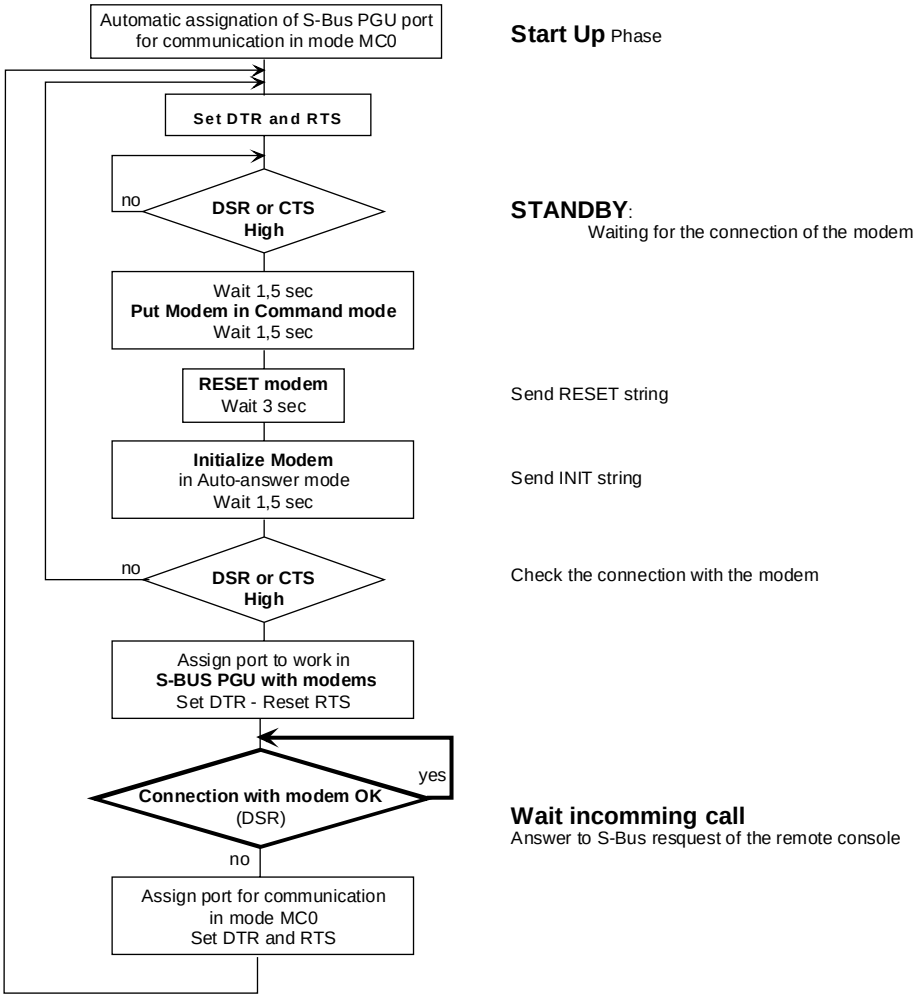
Window that appears after the "Modem Setup" button has been pressed:



Modem name	Indicates the name of the selected modem.
Reset modem	Reset String for the Modem.
Initialize modem	Places the modem into "auto-answer" mode, so that it automatically answers an incoming call. This string should also set the "DTR detect time" to greater than 250 mS, to stop the modem hanging up the line when a "restart" is done.

5.2.5 Run sequence of modem in the PCD

The following steps are executed by the PCD when the modem is connected to the RS 232 interface (using the utilities the interface was previously configured for S-Bus PGU with public line modem) :



1. The modem is set into command state by sending the escape sequence "+++"

2. The modem is reset and the stored user profile 0 is recalled by sending the reset command string (usually "ATZ").

3. The "initialise modem" string is sent.
   Usually :

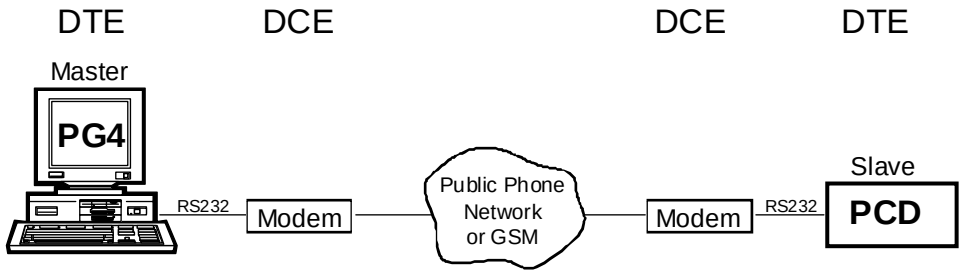
E0 :	Local echo disabled.
M0 :	Speaker is turned off.
S0=002 :	Put modem into auto answer mode. After 2 rings the modem goes off-hook and automatically answers the call.
S25=250 :	DTR change detect time.

Make sure that your modem accepts register S25 and the meaning is the same as described above. If this is not the case, you can try to work with your modem by disabling the DTR signal (ignore DTR signal "&D0").

Notes :

5.3 Connection via the Public Telephone Network

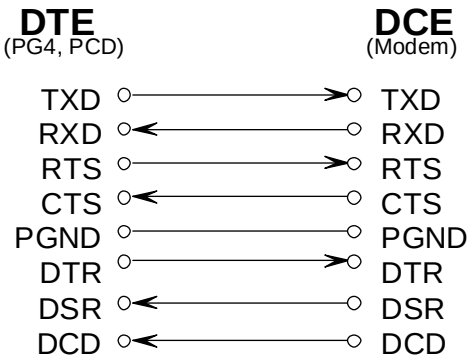
5.3.1 Application diagram



DTE : **D**ata **T**erminal **E**quipment

DCE : **D**ata **C**ommunication **E**quipment

Cable



PCD ports supporting S-Bus PGU with modems

The PGU port on the PCD lacks some important signals which make it impossible to use Public Line Modems on this port. The PCD requires 5 control signals (RTS, CTS, DTR, DSR, DCD) to manage the modem.

RTS	REQUEST TO SEND
CTS	CLEAR TO SEND
DTR	DATA TERMINAL READY
DSR	DATA SET READY
DCD	DATA CARRIER DETECT

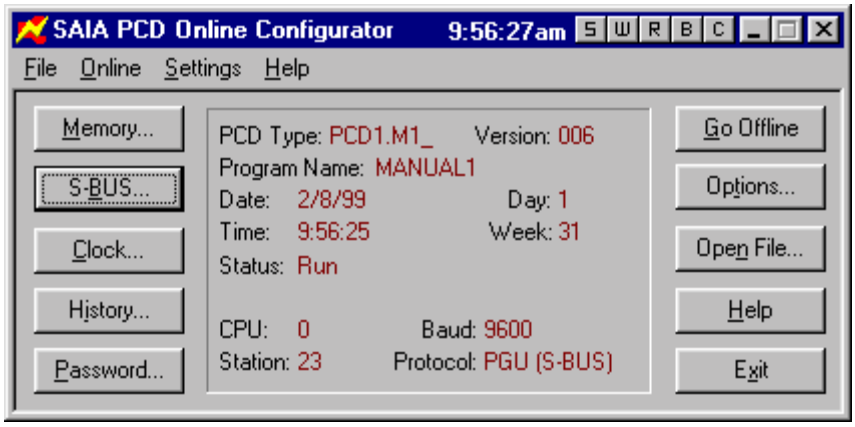
The following ports support S-Bus PGU with modems :

PCD1.M120/M130 :	port 1 (RS 232)	
PCD2 :	port 1 (RS 232)	
PCD4:	port 1 (RS 232)	with bus module PCD4.C120 or C340
PCD6.M540 :	port 2 (RS 232)	
PCD6.M1/2 :	all RS 232 ports (0..3)	
PCD6.M300 :	all RS 232 ports (0..3)	

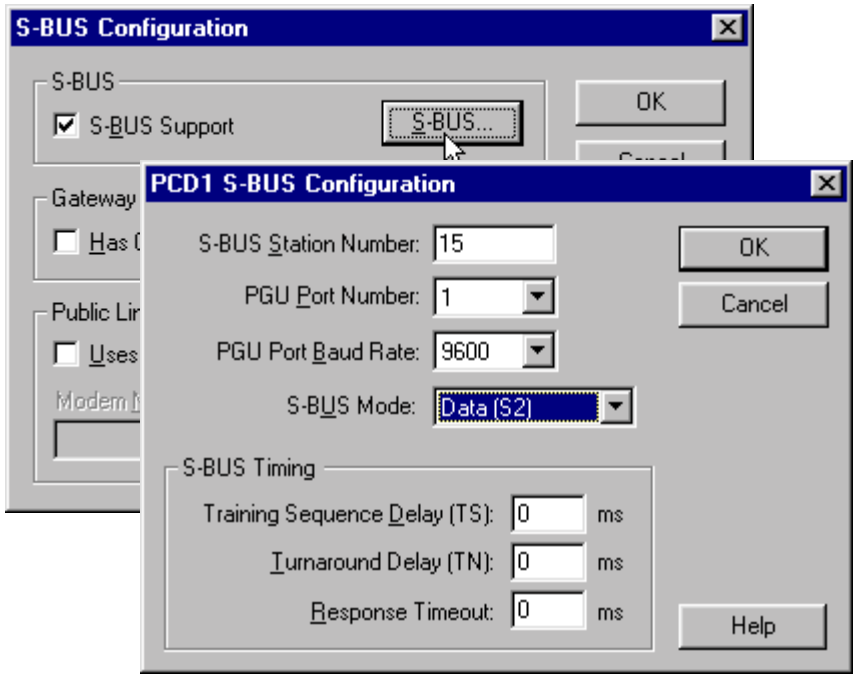
5.3.2 Configuring the PCD

1. Connect the PC's RS232 port with the PCD's PGU interface.

2. From "Project Manager", start the "Online Configurator".



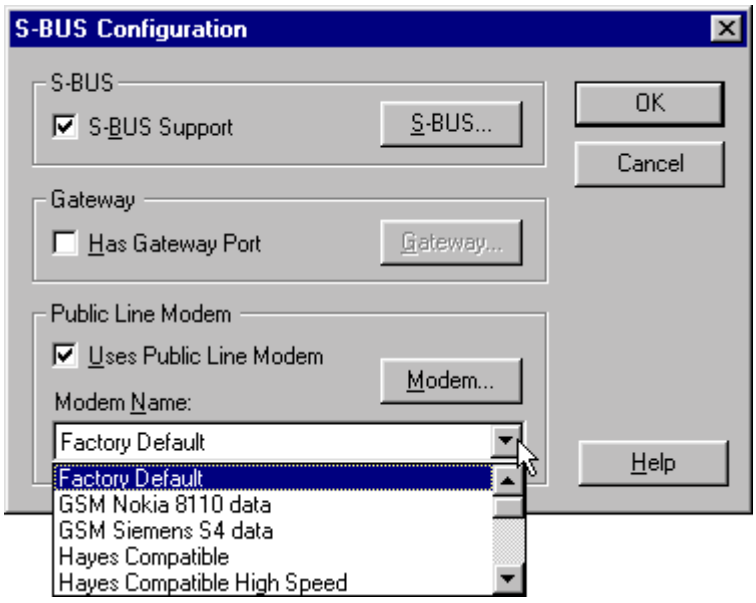
3. Press "S-Bus".



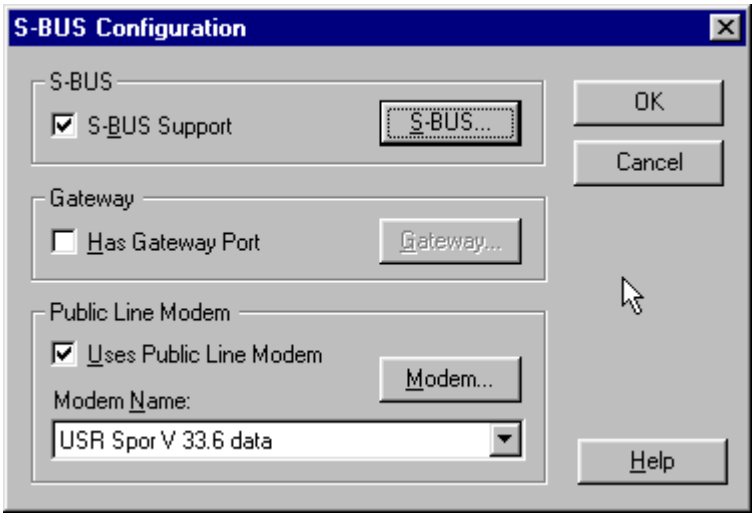
- Give to the PCD a Station number (from 0 to 254)

- Select the PGU port you want to use with the modem
  Remember : that port 0 **cannot** be used with a modem
- Select the Baud rate for your modem
- Select the S-Bus mode : BREAK or DATA
- Confirm with the OK button.

4. Select which modem is to be connected to the PCD.



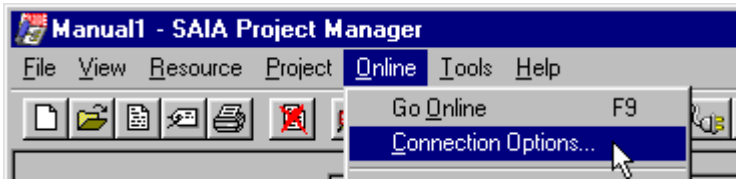
- With the "Modem" button it is possible to verify the reset and initialization strings of the selected modem.
- Confirm with the OK button.



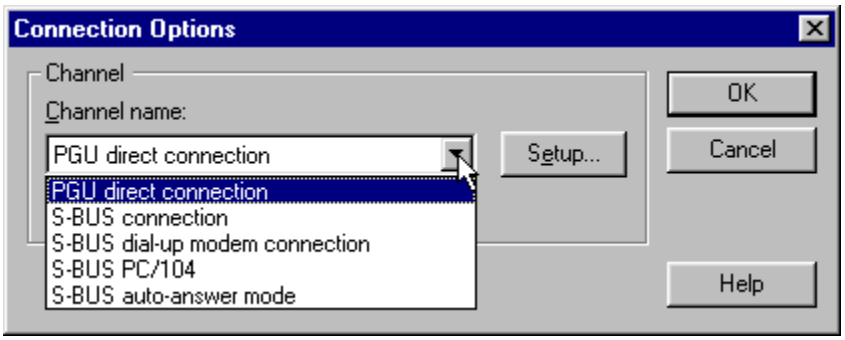
5. Download the configuration to the PCD by pressing the 'OK' button.

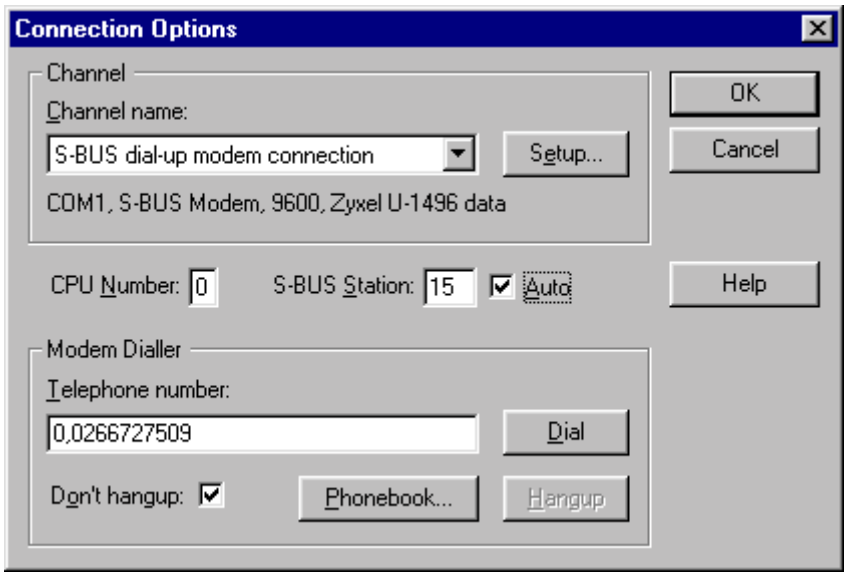
5.3.3 Configuring the PC (PG4)

1. From "Project Manager", select the "Online/Connection Options" menu:

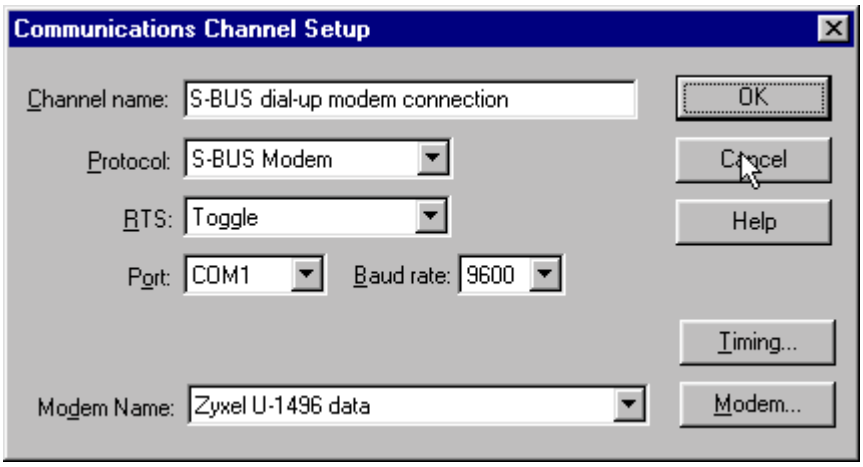


2. Select "S-Bus dial-up modem connection" for the "Channel name":

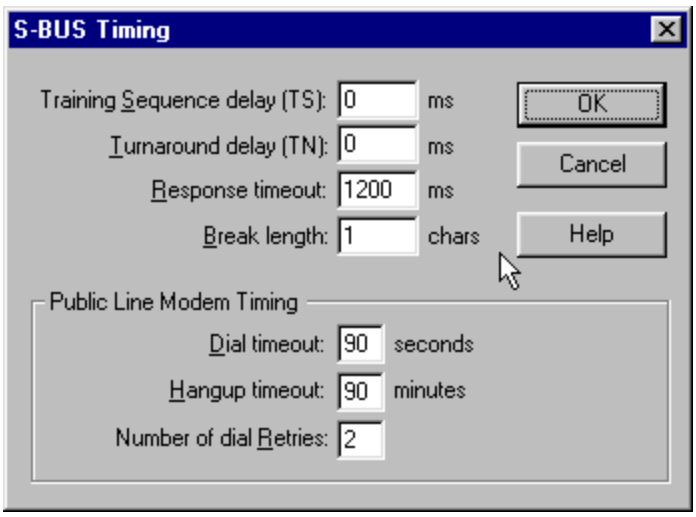




3. The port, baud rate, modem and timing parameters can be modified with the "Setup" button:



4. When necessary, adjustment of timing parameters is possible with the "Timing" button:
As long as no connection problems arise, it is not advisable to change the standard parameters of S-Bus time settings.



Training Sequence delay (TS)	Training sequence delay, in milliseconds. This is the delay between setting RTS (Request To Send) and the transmission of the message.
Turnaround delay (TN)	Turnaround time in milliseconds. The minimum time between the end of a response and transmission of the next telegram. It gives the remote station time to switch back to receive mode. The TN delay is particularly important if using the PCD7.T100 repeater or private line modems.

Response timeout	Response time-out in milliseconds. This is the time-out until the end of the response message is received.
Break length	The "Break length" is the duration of the break signal, in character times. The break signal tells the remote station that a new telegram is about to be transmitted. The default is 4 character times, but some modems may need longer to register the break signal. Normally this should never be greater than 10, otherwise communications throughput will be affected.
Remarks :	The TS delay, time-out and TN delay should be set to the minimum possible values required by the hardware. If (TS delay + TN delay) is greater than about 500 mS the "Debug" program will not work. It polls the PCD every 500 mS, and all the processing time would be taken up by these delays. The Timeout should also be set as low as possible because this affects the processing of key depressions if the PCD is off line. The TN delay is the most critical, Timeout and TS delay are both usually 0 so that default values are used. The response time-out is the time the PC will wait until the start of the response message. It is rounded up to the nearest 55 mS, since the PC's internal clock ticks at 55 mS intervals. After the 1st character of a response has been received, the PC uses and inter-character time-out of 55 mS.

Dial timeout	The time to wait after dialling for the detection of the carrier signal (DCD) from the remote modem. Note : The modem itself often has an internal time-out value (usually 30-45 seconds). "Timeout" is never used if the modem's internal value is less. To use a longer time-out, change the modem's internal time-out value by adding the command to the "Init" sequence. For Hayes compatible modems this is "S7=n", where "n" is the time-out in seconds, e.g. for a 45 second time-out on a Hayes compatible modem, use : Init="ATS7=45\r" ; set 45 seconds time-out Timeout=45
Hangup timeout	Waiting time in minutes. If no telegrams are transmit ted, after this time the modem connection will be broken off. This avoids high telephone charges if the user forgets to discontinue modem connection. Monitoring time is not active if a 0 value is entered.
Number of dial Retries	The number of additional dialling attempts made on failure to connect to the remote modem. Max. is 3.

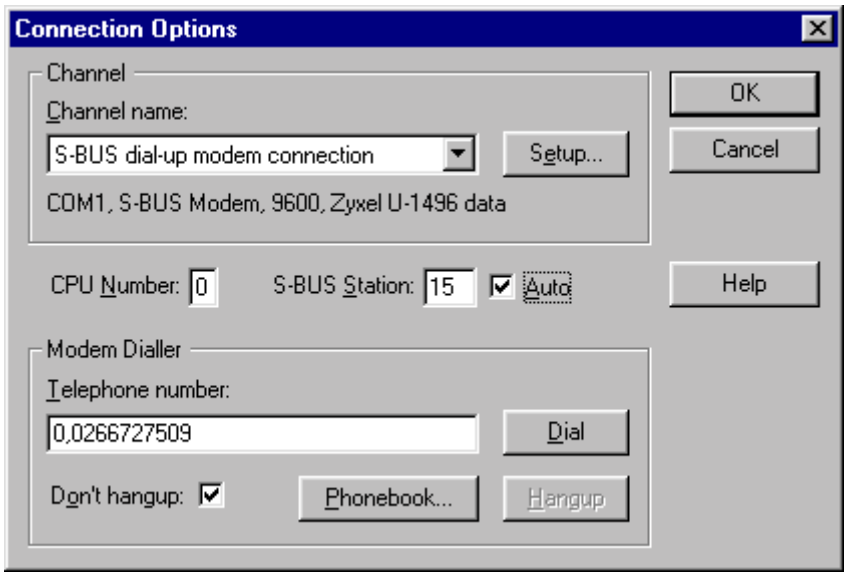
5.3.4 Making the connection

1. Connect the PCD and the modem together. It is not necessary that the PCD contains a program.

2. Connect the modem to the public telephone line

3. Issue a power down/power up sequence to be sure that the PCD initialises your modem correctly.

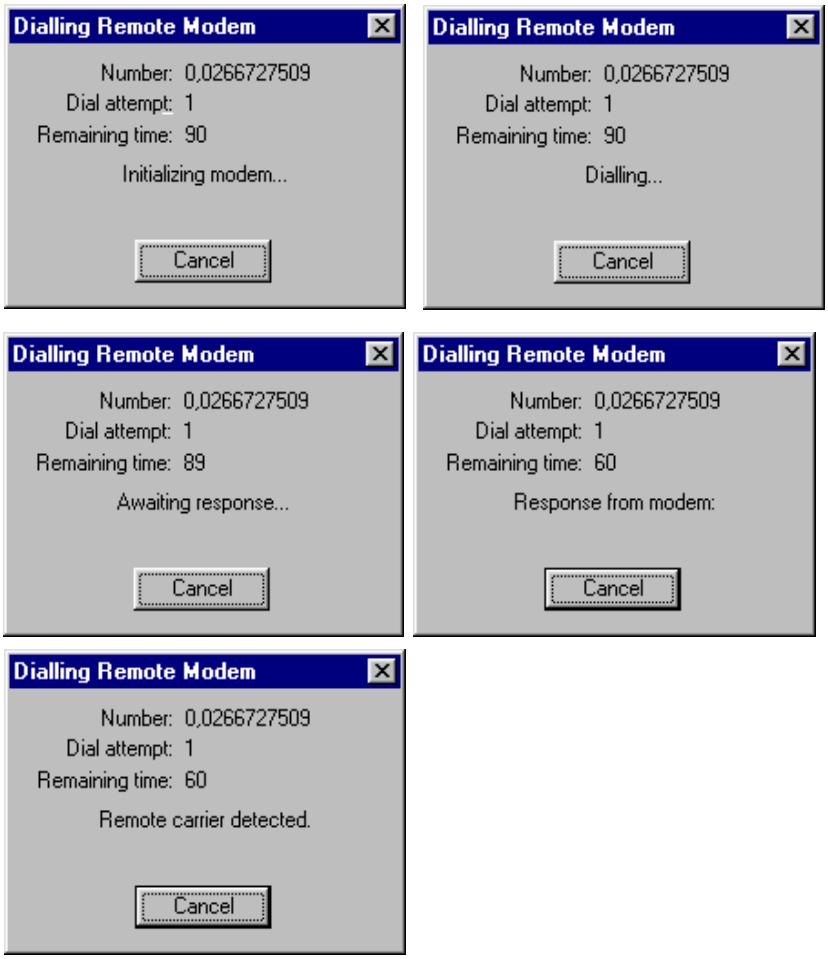
4. From the Online Configurator's, "Online" menu, "Connection Options", select: "S-Bus dial-up modem connection":



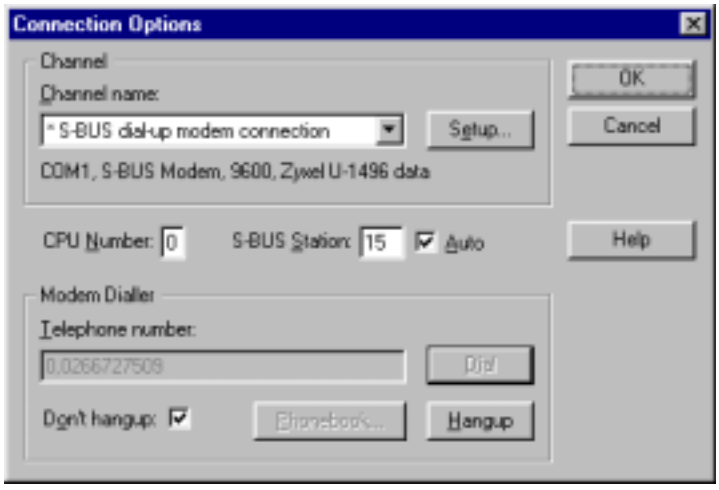
- Put the CPU and station number
- Type the telephone number to dial
  The telephone number can contain digits and any characters supported by the modem. On HAYES modems ',' generates a 1 second delay for pausing when dialling.
  The telephone number can be chosen from a user-editable Phonebook file by selecting the key "Phonebook". You can edit this phonebook with a text editor.
- Select "Don't hang up".
  This stops the connection from being discontinued when there is a change of editor.
- Press the "Dial" button to make a connection.

The PC begins to initialise the modem and after a few seconds, you must hear the telephone tone and the dialling progress.

Dialling can be aborted by pressing "Cancel". On the last line, messages are displayed showing the progress of the connection.

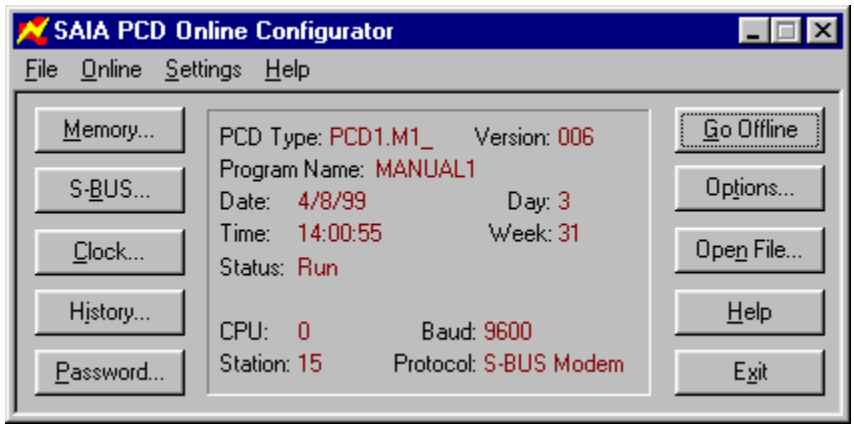


If the connection is successful, the Utilities returns to the main menu. The character " * " in front of the "Channel name" shows you that you are connected.

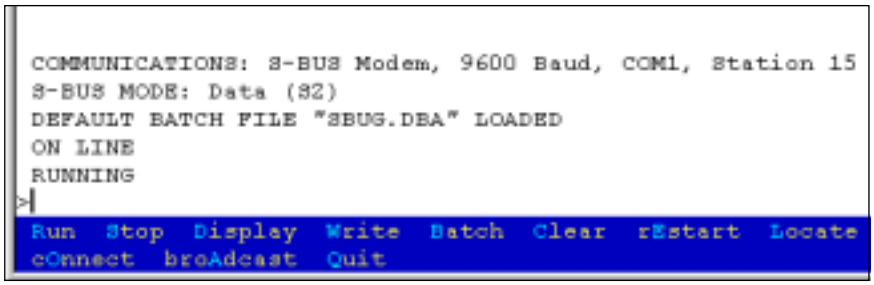


Any editor can now be switched online.
At the same time it is apparent in any editor that this is an S-Bus modem connection:

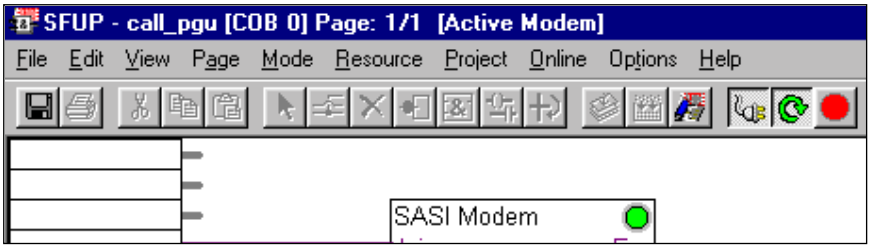
- "Online Configurator"



- "Debugger"



- "Fupla"



5.3.5 Trouble shooting

Problem 1 : The PCD modem does not answer to an incoming call.

Verify that the modem is in auto answer mode :

- LED on the modem front panel on ?
- Is the cable correct wired ?
- Make a power down/power up and observe the receive LED of the PCD modem to see if it receives the initialisation sequence from the PCD.

Problem 2 : After dialling the phone number the message "connected to remote modem" is displayed but immediately a dial retry is made.

Verify the response string of the modem :

- Check specified response strings in modem.dat file
- Check modem parameters V1, W0, X4

Problem 3 : After an established connection to the remote modem it is not possible to come online with the S-Bus protocol. Error message in connect menu: "No response from PCD"

- Check the S-Bus station number
- If DTE speed of the PCD modem is lower than DTE speed of PG4 modem then PG4 time-out value must be adapted for the lower speed.
- Check modem parameters set-up according to the parameter list in this document.

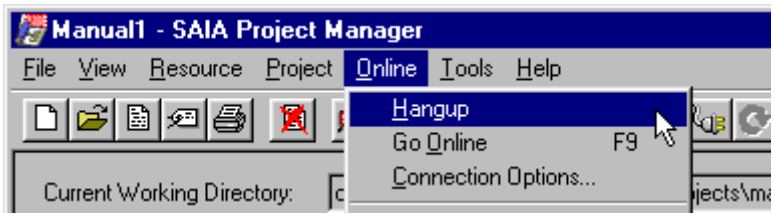
Problem 4 : By means of the utilities downloader the configuration of an S-Bus PGU port on the PCD has been changed (for instance the baud rate has been modified) while the modem was connected to this port but this new baud rate has not been taken in account.

To activate a modified configuration the modem must be disconnect and reconnect again. This means while the modem is connected to an S-Bus PGU port the new configuration will not be taken in account.

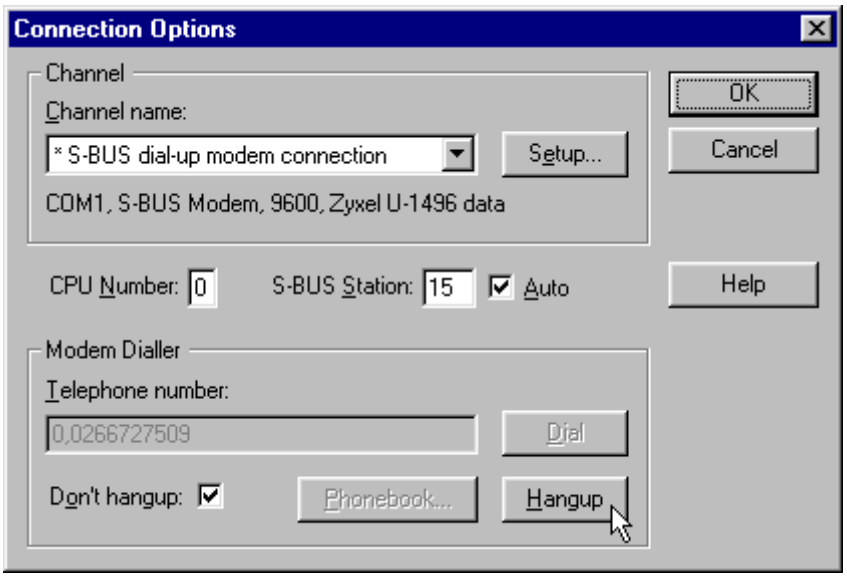
However sometimes it is not possible to get a modem working because of any reason. In this situation it is recommended to connect a serial interface communications analyser (for example SANALYS or RSO) between PG4 and modem or between PCD and modem to analyse the transmitted and received telegrams.

5.3.6 Ending the connection

Either select "Hangup" from the "Online" menu:

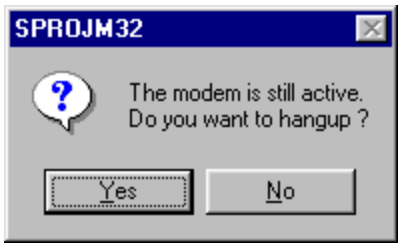


or press the "Hangup" button in the "Online/Connection Options" menu:



Both will result in the following message being displayed on the screen:

Failure to discontinue the connection before exiting the PCD Utilities will produce the following notice:



The "Yes" button breaks off the modem connection.
The "No" button closes the PG4 without breaking off the modem connection.

5.4 Modem +

With S-Bus level 2 (S-Bus PGU), no SASI instruction has to be performed; all the handling is made by the firmware of the PCD without intervention of the user program.

However, in certain circumstances, it is necessary that the user program interacts with the firmware :

- the user wants to detect when the PCD is online with a remote modem or console
- the slave PCD wants to contact the master (in an alarm situation for example)
- the user wants to re-assign the serial line.

5.4.1 Diagnostics (SASI DIAG)

The DIAG SASI allows to link the S-Bus-Level 2 background job to the user program.

With this feature, the user has the possibility to indicate the S-Bus Level 2 activities in his user program.

Format :

TEXT xxxx "DIAG:<diag_elem>,<diag_reg>"

where :

diag_elem = F xxxx or O xxxx (base address of 8 flags or outputs)
diag_reg = R xxxx (address of diagnostic register)

Example :

```
        SASI    1               ; SASI text 100 for channel number 1
                100             ; configure for S-Bus Level 2.

TEXT 100        "DIAG:F0,R0;" ; F0 to F7 and R0 contain the normal
                              ;    standard S-Bus diagnostic
                              ;    informations.
```

The DIAG SASI is cleared when :

- a RESTART COLD/WARM is performed
- a File Load command

5.4.2 SICL instruction

For a port configured for S-Bus Level 2 for public line modem, the user can read the DCD signal to detect whether the PCD is on-line with a remote modem or not. According to current DCD status he can then execute different code in the user program. See the SICL instruction on chapter 3.9.

5.4.3 UNDO/REDO a S-Bus PGU port (SASI OFF)

The S-Bus PGU port can be deassigned (UNDO), new assigned for any other standard communication mode and afterwards reassigned (REDO) to S-Bus Level 2 mode with or without modem initialisation.

With the UNDO/REDO procedures as mentioned above, it is possible for the slave stations to call the master station via modem and to go back to S-Bus Level 2 mode afterwards.

To avoid a SASI error and to be able to work properly on an S-Bus PGU-PLM port, the user first has to perform a DIAG SASI to link S-Bus PGU activity to his user program. Now he is able to work with the user Diagnostic Flag 'XBSY'.

To undo an assignation of a port configured as S-Bus PGU PLM, the user has simply to execute a SASI OFF instruction if permitted.

Format :

TEXT xxxx "MODE:OFF,x,y,z;"

where :

x execution delay of an UNDO/REDO of S-Bus-PGU via PLM.

Unit : [Seconds]
Range : 0...300 s
Default : 0 s

During this time the UNDO/REDO request is not yet executed and can be cancelled by stopping the CPU or a "Restart Cold/Warm" of the CPU

y time out to perform another assignation for any standard communication mode following the SASI OFF.

Unit : [Milliseconds]
Range : 0...5000 ms, rounded up modulo 250 ms
Default : 1000 ms

If this timeout is elapsed, the port is automatically re-assigned for S-Bus PGU PLM. It means that, for the UNDO procedure, the user has to perform an assignation before this time elapses.

z option to perform a REDO to S-Bus-Level 2 mode with or without modem re-initialisation.

Value : 0 (with modem re-initialisation)
1 (without modem re-initialisation)
Default : 0 (with modem re-initialisation).

5.4.3.1 Overview of all possible SASI OFF options for 'MODEMS+' :

The character ';' at the end of the text is always optional and does not need to be defined.

"MODE:OFF;"	all default
"MODE:OFF,xxx;"	yyyy and z = default
"MODE:OFF,xxx,yyyy;"	z = default
"MODE:OFF,xxx,yyyy,z;"	no default
"MODE:OFF,,yyyy,z;"	xxx = default
"MODE:OFF,,,z;"	xxx and yyyy = default
"MODE:OFF,,yyyy;"	xxx and z = default
"MODE:OFF,xxx,,z;"	yyyy = default

Examples :

"MODE:OFF;" No option (x,y,z) is used.

Use this format to immediately perform an UNDO of S-Bus PGU for public line modems.

The XBSY-Flag goes immediately to LOW to indicate 'Permission for any standard assignation (except for another SASI OFF)'. The user has then to perform an assignation within one second. If that time-out elapses, the XBSY-Flag is set HIGH immediately and the port will automatically be re-assigned for S-Bus-PGU-PLM. This possibility can be used to restart the init/reset procedure of the connected modem. The main reason why it works like so is to come on-line again.

"MODE:OFF,xxx;" Option 'xxx' : 0..300 seconds
(default : 0 sec, no delay).

Use this format to perform an UNDO of S-Bus PGU-PLM after a certain delay of xxx seconds.

While such a delay is active, the XBSY-Flag stays HIGH to indicate 'NO SASI' permission for the moment to the user. During this period the S-Bus PGU-PLM mechanism is working as usual. That means that it stays in current status. But the response upon a 'Read Own PCD Status'-request is toggling as shown below during the delay time : (S-Bus and P8)

e.g. PG4 (PG3) polling 'Read Status'-request (each second) :

PCD S-Bus Slave response :
Real Status ('R/C/S/H') or 'X'
('X' means Exceptional Intermediate Status)

This feature can especially be interesting for a PCD which is on-line with a remote modem and our PG4 (PG3)-Utilities :

The user can detect visually that the PCD is in an exceptional intermediate status: as long as the described SASI OFF delay is active the user has the possibility to cancel current UNDO request which is still in process but not yet executed. That he can do in simply putting the PCD into 'STOP (own)' or 'RUN (own)' using the PG4 (PG3) Utilities with the S-Bus- or the P8-protocol.

A 'RESTART COLD/WARM' causes the same. The advantage of this feature is, that the user can actively and immediately take action on the exceptional situation. He can also avoid that the PCD performs a HANG UP after the delay period. In other words, it is possible to stay on-line with S-Bus Level 2 for modems. The S-Bus debugger of the Utilities displays during described 'X'-Status the HANG UP time-out as well as the actual real PCD status (Toggling).

The display in the right corner of the top bar will then look as follows: 'HANG UP xxx SECS'. The P8 debugger of the Utilities displays during described 'X'-Status a special message as well as the actual real PCD status (Toggling). The display in the right corner of the top bar will then look as follows: 'HANGING UP MODEM'. After the delay has elapsed, the SASI OFF works in exactly the same way as described above.

"MODE:OFF,[xxx],[yyyy],[z];"

Additional and optional parameters 'yyyy' and 'z'.

The main functionality of the SASI OFF to UNDO respectively REDO S-Bus with PLM is already described detailed enough in the formats (1) and (2) above. At this place there is only an additional description for the options 'yyyy' and 'z' :

Option 'yyyy' :	Unit :	[Milliseconds]
	Range :	0..5000 milliseconds
	Default :	1000 milliseconds

The XBSY-Flag goes immediately to LOW to indicate 'Permission for any standard assignation (except for another SASI OFF)'. The user has then to perform an assignation within yyyy milliseconds (rounded up modulo 250 ms). During the time-out the DTR control signal stays high to not force a connected modem to hang up. If that time-out elapses, the XBSY-Flag is set HIGH immediately and the port will automatically be re-assigned for S-Bus PGU-PLM in function of the next option :

Option 'z' :	Unit :	(REDO mode)
	Range :	0 or 1
	Default :	0 (Redo mode with modem initialisation)

This option can be used to define the REDO mode as follows :

'z' : = 0 : REDO mode with modem initialisation.

The firmware restarts the init/reset procedure of the connected modem and then assigns the corresponding port for S-Bus Level 2 for modems.

That means that the modem hangs up -if online- because of reprogramming for 'autoanswer'-mode.

That could be a big disadvantage for a PC supervision system who has to stay online with the modem and later on with S-Bus Level 2.
Therefore the parameter 'z' can be defined to 1:

'z' : = 1 : Assign S-Bus-PGU-PLM directly for S-Bus Level 2 without re-initialisation of the connected modem.

Remember that the PCD stays only in S-Bus Level 2 mode as long as the DSR signal (PCD side) stays HIGH. If this signal goes low, the PCD automatically re-initialises the modem and assigns the S-Bus PGU-PLM port for S-Bus Level 2 afterwards.

5.4.3.2 'REDO' assignation of a serial port defined for S-Bus-PGU PLM

The firmware will automatically reassign the S-Bus-PGU port for S-Bus-PGU with PLM :

- after a restart request.
- on a power ON.
- after the user has performed a “SASI OFF” on the S-Bus-PGU port.
- immediately after the cpu goes in HALT.

Remarks :

- It is the user's responsibility to perform a 'MODE:OFF,xxx,yyyy,z;' to come back on-line with S-Bus.

- This can only ever work on a FULL RS 232 port.

- Special care has to be taken in using the UNDO/REDO mechanism for S-Bus PGU-PLM for a PCD4.M240 and PCD4.M44x. :

Do not mix the different assignations such as SASI OFF, DIAG SASI and DIAG OFF in the user programs of the CPU 0 and/or the CPU 1.
The permissions are a function of the current PG-owner-CPU.

Do not forget that the PG-owner-CPU can be changed in performing a 'Connect CPU0/1' via PG4 (PG3)-Utilities. This can cause problems with the co-ordination of a user program e.g. for CPU 1 and the actual PG owner which could be either CPU 0 or CPU1.

If the PG owner changes and an UNDO request is currently in process, the PCD immediately clears this job and remains in the actual S-Bus PGU- PLM status. Afterwards the user has again the permission for a SASI OFF (only).

Assume that the user program of the CPU 0 has executed a SASI OFF to undo the S-Bus PGU-PLM assignation. Just afterwards the user may change the PG owner to CPU 1 via the PG4 (PG3)-Utilities. As long as the CPU 1 is the PG owner, a second SASI OFF to redo the S-Bus PGU-PLM assignation, programmed in the user program of the CPU 0, gives an instruction error and will n o t be executed since CPU 0 is not the owner of the PGU and therefore CPU 0 has not the permission to work on this port. In other words, the PCD does not automatically initialise and reprogram the modem for auto-answer mode.

5.5 Example of PCD program

This is an example of program which handles S-Bus communications to or from a supervision system and from the Programming console.

The communication can be initiated by :

- the PCD (Outgoing call)
- Supervision system (Incomming Call)
- PG4

The program is written in Fupla.

Outgoing call :

To initiate an outgoing call, the flag "CALL" must be set to 1. The PCD will then try to make a connection with a remote central computer; if this connection succeed, the PCD is switched to S-Bus slave mode and it can then be interrogated by a Supervision system.

After successfully establishing a connection, the central computer must set the flag high that was defined under FBox "Call PGU", "Cnf".

This enables communication without a time limit.

If this flag is not set high, the modem connection will be broken off at the end of the time defined with “Confirm Timeout” in the "Call PGU" FBox.

Shutting down the modem connection always takes place from the side of the central computer.

If the connection fails or is interrupted, after a certain "recall time" the central computer is called again in the "Call PGU" FBox. This is repeated until the number defined under "recall count" in the "Call PGU” FBox is reached.

If there is an error, the "Err" output of the "Call PGU" FBox is set high.

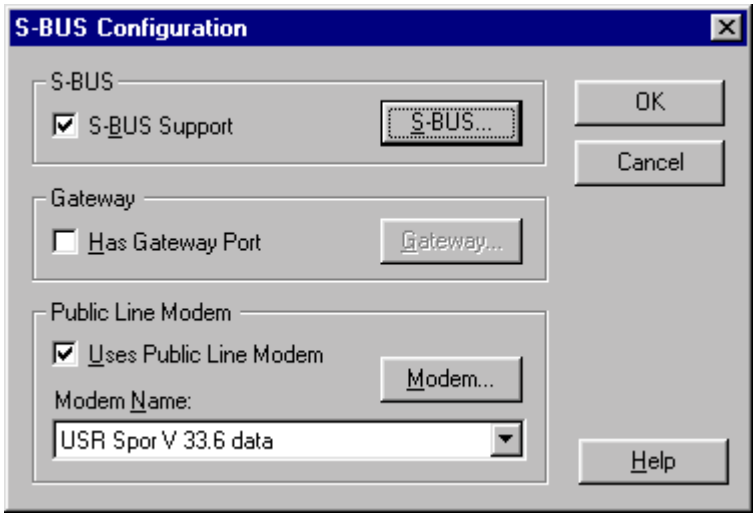
If there is a valid connection, the "Con" output of the "Call PGU" FBox is set high.

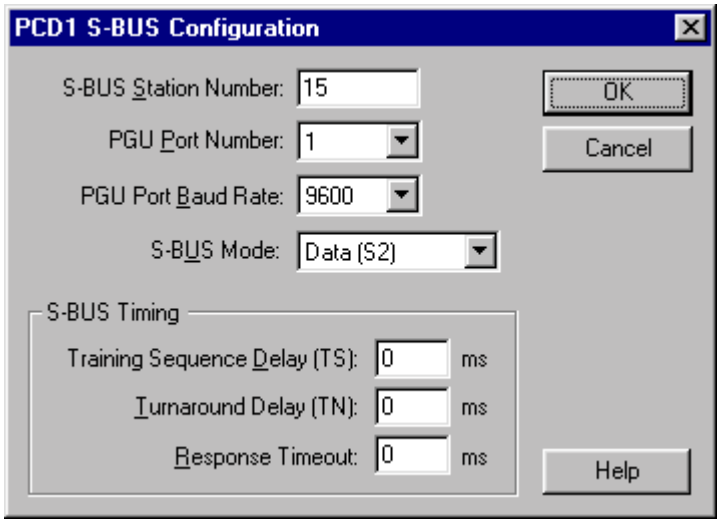
Incomming call :

The PCD answer any incomming call comming from a central computer or the SAIA Programming Tools. When a connection is made, the flags "Inc_Call" is set to 1 until disconnection.

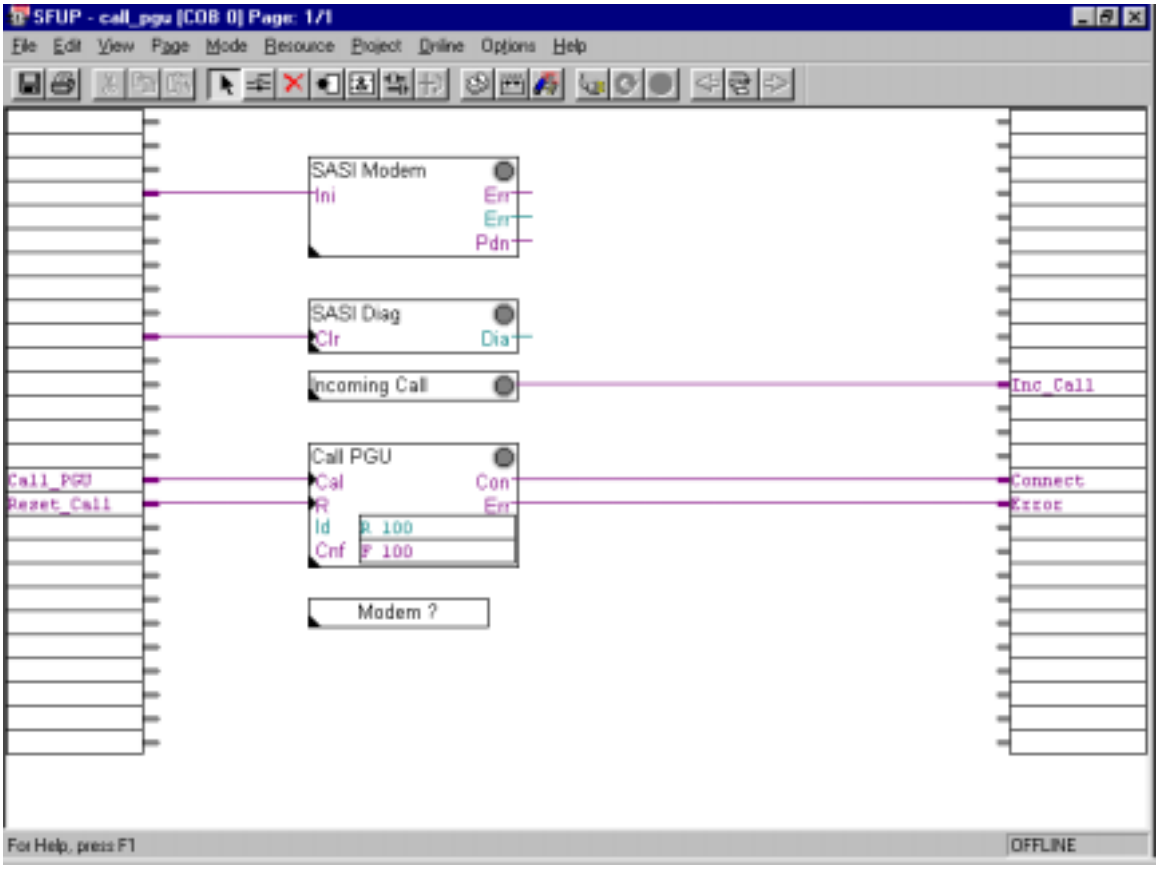
If communication has ceased, the modem connection is discontinued by the PC at the end of the waiting time defined under "Hangup timeout" in the "Online/Connection Options" menu, "Setup", "Timing".

S-Bus PGU definition of PCD:





Fupla program of PCD:



PAGE DESCRIPTION
Programm to call a PG4.

If the flag Call_PGU is set to high then a call is relased to a PC with PG4 programming unit. Before the PG4 has to be set in S-Bus auto-answer mode to be able to detect the incomming call. After that the connection between the Call PGU and the PC is established, the PC switches in the S-Bus master mode and send level 2 S-Bus telegrams.

FBOX EXTRA INFORMATION WITH ADJUST VARIABLES

1	FBox: SASI Modem (SASI Modem), Family: Modem SP 2.0.82	
	Channel	Channel 1
	Standby mode	S-Bus PGU
	Default S-Bus mode	Data
	Default transmission speed	9600 bps
	Default Bits-Parity-Stop ...	8-N-1
	S-Bus Timeout [msec]	0
	S-Bus TS-Delay [msec]	0
	S-Bus TN-Delay [msec]	0
	S-Bus Break length [car]	0
	Station identification	0
	Modem type	User 1
	X-Command	None
	Dial signal	Tone
	Output prefix ...	
	Recall count ...	0
	Connect timeout [sec] ...	45.0
	Pause time [sec] ...	2.0
	Power down hangup	No
	Auto initialization	Yes
2	FBox: SASI Diagnostic (SASI Diag), Family: Modem SP 2.0.82	
	Channel	Channel 1

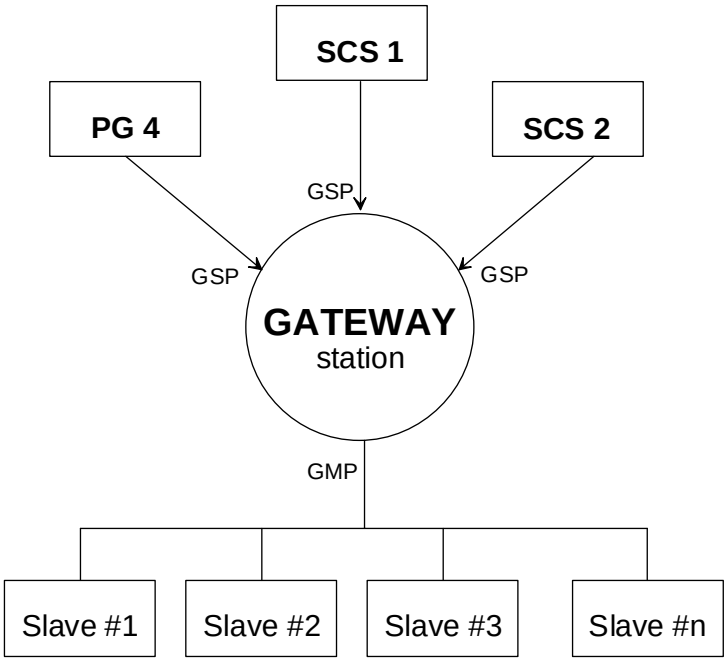
3	FBox: Incoming Call (Incoming Call), Family: Modem SP 2.0.82	
	Channel	Channel 1
	On delay time	2.0
4	FBox: Call PGU (Call PGU), Family: Modem SP 2.0.82	
	Channel	Channel 1
	S-Bus Mode	PGU-Config
	Tf number 1 ...	0,026672
	Tf number 2 ...	7508
	Tf number 3 ...	
	Recall count ...	0
	Recall time [sec] ...	0.0
	Confirm timeout [sec]	60.0
5	FBox: Version Modem ? (Modem ?), Family: Modem SP 2.0.82	

6. S-Bus Gateway

6.1 Introduction

The main limitation of S-Bus was that it is not possible to put more than one master on a network. This had drawbacks for networks which required, for instance, a supervision system and a PCD as masters. This limitation also made commissioning of S-Bus networks more difficult. With the S-Bus GATEWAY, it is possible to have up to 3 external masters which are all capable of communicating with any slave on an S-Bus network as well as the normal PCD master.

The following diagram shows a typical network configuration which is now possible with S-Bus. It can be seen that there is one Full protocol connection for the PG4 and two reduced protocol connections for supervisory control systems (SCS). The Gateway station itself can also act as a master giving four S-Bus masters.



Gateway Station

The Gateway Station is a dedicated PCD station which manages the transparent connection of up to 3 external masters to the S-Bus network. It can also act as a normal S-Bus master.

Gateway Slave Port (GSP)

The Gateway Slave port is used to connect the gateway station to the external master. This can either be the S-Bus-PGU port or a port defined using a SASI instruction.

Gateway Master Port (GMP)

The Gateway Master Port connects the Gateway station to the network of S-Bus slaves

6.2 Features of the Gateway

The Gateway Station can have up to 3 Gateway Slave Ports connected to external masters. The Gateway Station itself can also serve as an S-Bus master making a total of 4 S-Bus masters per network. All 4 masters can work in parallel, with the Gateway Station monitoring reception of telegrams from the external masters and the communications instructions in the user program, and re-transmitting them onto the S-Bus network.

The baud rates and the S-Bus mode (break/parity) can be independently selected on all 3 Gateway Slave Ports and the Gateway Master Port.

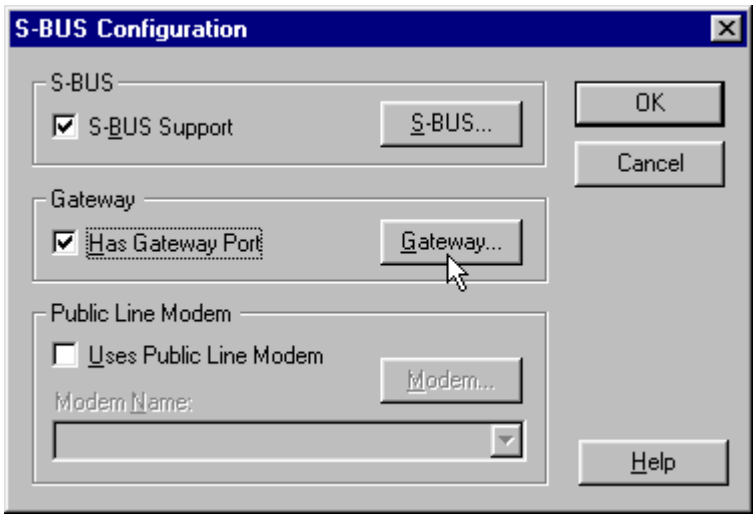
Only **one** of the Gateway Slave Ports can be assigned for FULL S-Bus-PGU, the others are defined by a SASI instruction and are therefore reduced protocol.

The Gateway can be a single CPU system , for example PCD2, or a multiple CPU system such as the PCD6. In a PCD6 the gateway task can be distributed over multiple processors, for instance, the Gateway Slave Ports could be defined on CPU1, CPU2 and CPU3 and the Gateway Master Port on CPU 0.

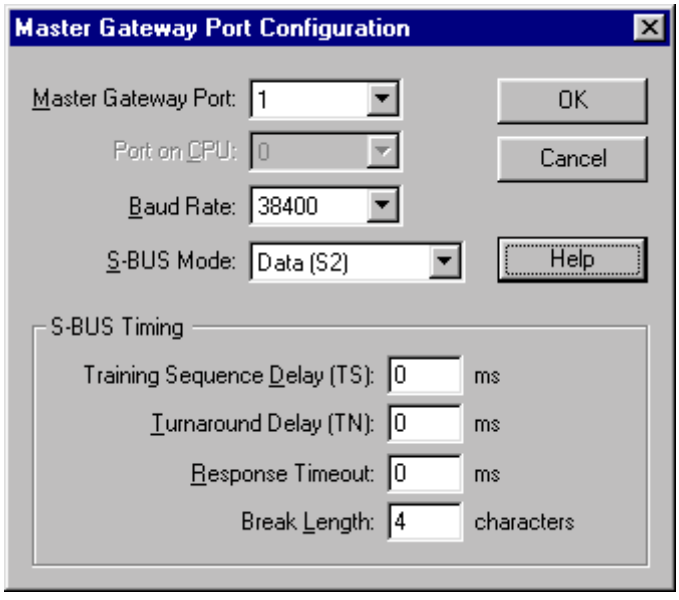
Only **one** Gateway Station per network is allowed, do not cascade or put in parallel Gateway Stations as this will give undefined results.

6.3 Configuration of a Gateway Master Port (GMP)

The master gateway port is configured using the "Online Configurator" or with the "Offline Configurator" under S-Bus in the "Project Manager" of the PG4 utilities.



When "Has Gateway Port" is selected and the "Gateway" button has been pressed, the following window appears:



It is necessary to define the following eight essential parameters necessary for the initialisation of the Gateway.

Master Gateway Port (GMP)

This field specifies the port to be used for the Gateway Master Port. At the same time, all possible ports on the PCD concerned are displayed.

Port on CPU (PCD6 only)

This field specifies the port to be used for the Gateway Master Port. At the same time, all possible ports on the PCD concerned are displayed.

Baud Rate

The transmission speed of the Gateway Master Port, this is selectable between 110 - 38400 bps as with any standard S-Bus communications protocol.

S-BUS Mode

This defines whether the Gateway Master Port will use the break mode (mode 0), the parity mode (mode 1) or the data mode (mode 2).

Training Sequence Delay (TS)

Training sequence delay in milliseconds. This is the delay between setting RTS (Request To Send) and the transmission of the message and is principally for modems. If zero is entered for the TS delay then the default value will be used which can be found in the configure help index (key Help) and in the table next page.

Turnaround Delay (TN)

Turnaround time in milliseconds. This is the minimum time between the end of a response and transmission of the next telegram. It gives the remote station time to switch back to receive mode. The TN delay is particularly important if using the PCD7.T100 repeater or private line modems. If a zero is entered for the TN delay then the default value will be used. which can be found in the configure help index (key Help) and in the table next page.

Response Timeout

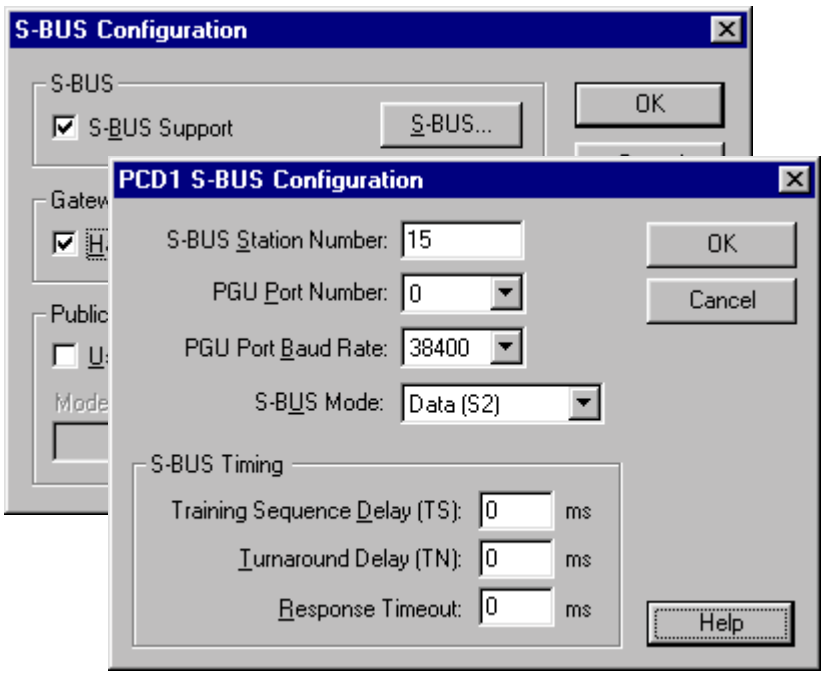
This time-out delay in milliseconds concerns the transmission between the Master Gateway Port and its connected slave(s). This defines the maximum time that the master will wait before transmitting a retry in the case of error. The table below lists the default time-out values in milliseconds to set in function of the baud-rate of the Master Gateway port. It may be necessary to adjust these values if the TS and TN delays differ from their default values. If zero is entered here then the default value will be used.

Baud rate	**110**	**150**	**300**	**600**	**1200**	**2400**	**4800**	**9600**	**19200**	**38400**
TS delay [ms]	0	0	0	0	0	0	0	0	0	0
TN delay [ms]	27	20	20	5	3	2	2	1	1	1
Timeout [ms] Br/Par	15000	9000	5000	3000	2000	1000	500	250	200	200
Timeout [ms] Data	15000	15000	7500	4500	3000	1500	750	375	300	300

Break Length

This parameter specifies the number of break characters in break mode (mode 0). The default is 4.

The S-Bus number and and the S-Bus PGU port can be set in the menu "S-Bus" from the "S-Bus Configuration".



6.4 Configuration of the Gateway Slave Port

A Gateway Slave Port can be defined for reduced protocol using a SASI instruction or for full protocol as the S-Bus PGU port.

6.4.1 S-Bus-PGU

By definition, the S-Bus-PGU port will **always** be linked to the Gateway Master Port. This means that if the S-Bus-PGU port receives an S-Bus telegram which is not for the Gateway Station itself (address does not match), it will be automatically re-transmitted on the Gateway Master Port. This applies to the full S-Bus protocol.

6.4.2 User SASI instruction

A Gateway Slave Port can be defined via the user-program using the standard SASI assignation instruction. The SASI text must contain a new mode definition for GS-mode (for Gateway Slave). When the instruction is executed an automatic link between the Gateway Slave Port and the Gateway Master Port is established for all telegrams which are not for the Gateway Station itself.

A port configured in GS-mode can be considered as working in the same way as a port defined in SS-mode (i.e. reduced S-Bus protocol), but with the link to the Gateway Master Port. The diagnostic flags and register work in the same way for both modes.

Format of the SASI text

"UART: <uart_def>, <timeout>, <TS-delay>, <TN-delay> ;"
"MODE:GS <mode_option>;"
"DIAG:<diag_def>"

where :

<uart_def>	Specifies the baud rate for the GSP for communication with the external master.
<timeout>	This has no significance for the Gateway Slave Port.
<TS-delay>	The training sequence delay to be initialised for communication with the external master.
<TN-delay>	The turnaround time to be initialised for communication with the external master.
<mode_option>	Break (0), parity (1) or data (2).
<diag_def>“	Specifies the diagnostics flags and register , it works in the same way as the SS mode .

Example :

TEXT 1000 "UART: 9600,,0,1;MODE:GS1;DIAG:F500,R500"

6.5 Using STXM / SRXM in the Gateway station

For the Gateway Station to be able to execute STXM/SRXM instructions as a normal master station, it is necessary to execute a user SASI instruction on the GMP. The user program will then be linked to the Gateway Master Port using a new GM mode definition (for Gateway Master). The STXM/SRXM instructions can then be used in exactly the same way as with SM mode, the diagnostic flags and register will have the same functionality.

Format of the SASI text

"MODE:GM,<dest_reg>;DIAG:<diag_def>"

where :

<dest_reg> Register number to specify the S-Bus destination address.

<diag_def> Specify the diag Flag and Diag register of the transmission. It works in the same way as the SMx mode (compatibility).

All the values for the S-Bus mode, TN-delay, TS-delay, time-out are taken directly from the Gateway Master Port configuration menu..

Example :

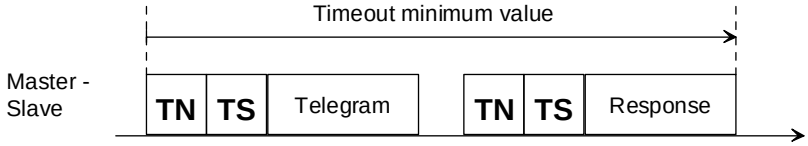
TEXT 1000 "MODE:GM,R300;DIAG:F500,R500"

The SASI GM can only be performed on the CPU of the Master Gateway port.

If a SASI GM is performed, this must be taken in account when setting the access time-out.

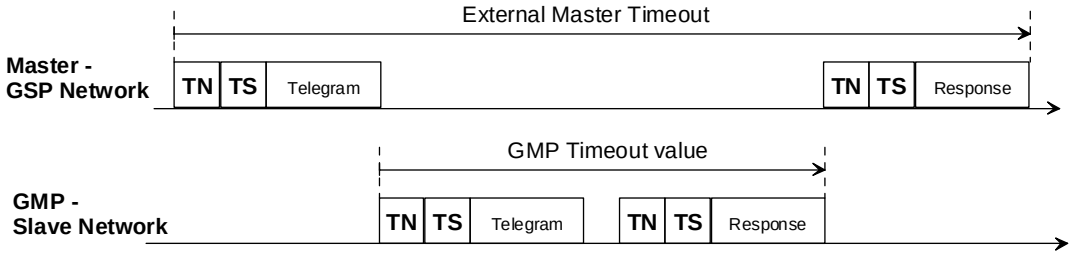
6.6 Setting Timeout in an S-Bus network

Consider the following diagram for a simple Master-Slave network :



The diagram shows that the minimum time-out of the master must be greater than the combined time for the transmission of the telegrams plus the TN/TS delays. The default values which are initialised when using S-Bus respect this rule. If the TN/TS delays are increased then the time-out must be increased proportionally.

By adding an extra layer of external masters then the calculation for the time-out becomes more complex.



It can be seen from this diagram that the external master time-out must be increased to at least twice the GMP time-out. Any retry from the external master during the retransmission operation of the Gateway Station will be ignored.

The calculation for the external master time-out value is further complicated when adding more masters because the Gateway Station may already be retransmitting another telegram from another external master. To simplify the calculation of the external master time-out value the following general rule should be respected.

External Master Timeout = (1,5 GMP Timeout) x Number of Masters

Where "Number of Masters" refers to the number of external masters and the Gateway as a master itself.

The gateway is only taken as master, when STXM/SRXM commands from the gateway PCD are executed to the master port. In this case, the gateway PCD will be worth 3 masters. (Due to the condition that a gateway telegram gets repeated 3 times if an error occurs).

Example for the amount of masters:

2 external masters + gateway, which executes STXM/SRXM commands to the GWA master port.

Amount of masters = 2 + 3 = 5

The following table shows the external master time-out (in ms) in function of the number of masters and the baud rate of the Gateway Master Port. All external masters, i.e. PG4 and supervision systems should be initialised with these values.

For break and parity modes :

	Number of masters					
GMP baud drate	**1**	**2**	**3**	**4**	**5**	**6**
110	22'500	-	-	-	-	-
150	13'500	27'000	-	-	-	-
300	7'500	15'000	22'500	-	-	-
600	4'500	9'000	13'500	18'000	22'500	27'000
1'200	3'000	6'000	9'000	12'000	15'000	18'000
2'400	1'500	3'000	4'500	6'000	7'500	9'000
4'800	750	1'500	2'250	3'000	3'750	4'500
9'600	375	750	1'125	1'500	1'875	2'250
19'200	300	600	900	1'200	1'500	1'800
38'400	300	600	900	1'200	1'500	1'800

For data mode:

	Number of masters					
GMP baud rate	**1**	**2**	**3**	**4**	**5**	**6**
110	33'750	-	-	-	-	-
150	20'250	40'500	-	-	-	-
300	11'250	22'500	33'750	-	-	-
600	6'750	13'500	20'250	27'000	33'750	40'500
1'200	4'500	9'000	13'500	18'000	22'500	27'000
2'400	2'250	4'500	6'750	9'000	11'250	13'500
4'800	1'125	2'250	3'375	4'500	5'625	6'750
9'600	563	1'125	1'688	2'250	2'812	3'375
19'200	450	900	1'350	1'800	2'250	2'700
38'400	450	900	1'350	1'800	2'250	2'700

6.7 Possible sources of errors

If an error occurs during configuration of the Master Gateway Port during start-up, then the PCD goes directly in “HALT” and the following message is displayed in the debugger :

"MGWY INIT FAIL"

Possible reasons :

- An assignation of a Master Gateway port on a non existent CPU, this message will be only be displayed on CPU0.
- An assignation of a Master Gateway port on a CPU which has no communication ports (wrong type of CPU) will also display this message.

If the communication is non-existent or perturbed between an external master and the Gateway station or a slave station, it could come from a bad setting of the different timing values in the Gateway station and in the external master. The time-out in all the external masters must be adapted in function of the number of masters and the selected baud rates.

7. Using S-Bus with the PG3

The method for configuring and using S-Bus with the PG3 Programming Utilities is the same as with the PG4 under Windows. The main difference is that the PG3 uses DOS and that the configuration of the PCD is not done online.

To get an extensive description consult the following :

- **Station number definition** on chapter 3.1
- **Configuration and assignment of an S-Bus PGU interface** on chapter 4.3
- **Connection of the PG Unit via S-Bus** on chapter 4.4
- **Configuring the PCD Utilities for your modem** on chapter 5.2.3
- **Connection via the Public Telephone Network** on chapter 5.3
- **Example of PCD program (with modem)** on chapter 5.5
- **Configuration of a Gateway Master Port (GMP)** on chapter 6.3

7.1 Station number definition

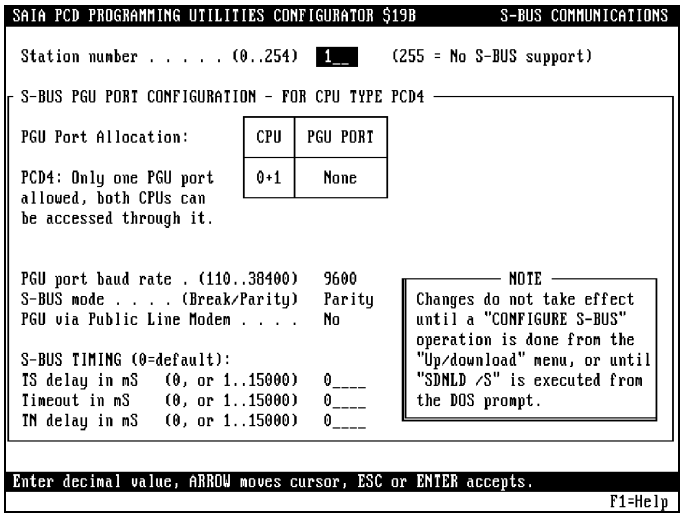
Each slave station is allocated a number, so that it can be addressed from the master station. This number is stored in the user program's "header" in the memory module of a slave station

Station number definition when using memory modules with RAM (PCD7.R2.. , PCD7.R3.., PCD6.R51. or PCD6.R610.) :

1. Connect the programming unit to the "PGU" programming interface on the PCD.

2. From the main menu, select first the "Configure" option.

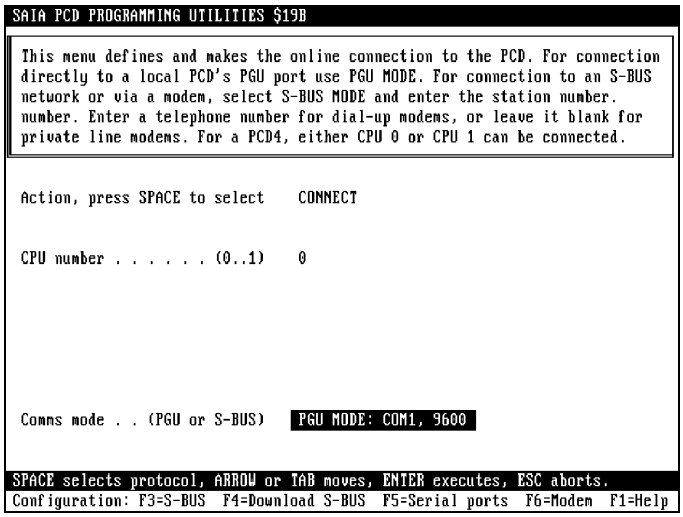
3. Select the "S-Bus Communication" submenu (SAIA PCD Configuration) and enter the desired station number.



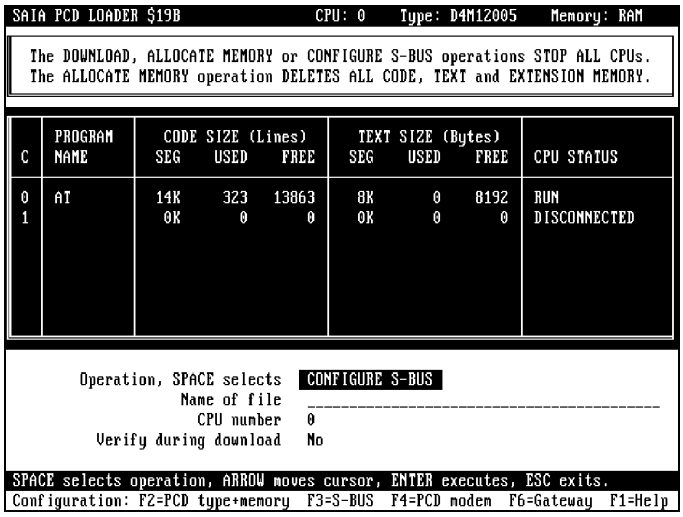
The other parameters are not relevant for S-Bus level 1 without modems or repeaters.

4. Save your changes and go back to the main menu

5. From the "coNnect" menu, on the "Comms mode" line select PGU MODE.



6. From the "Up/Download" menu, transfer defined configuration to PCD with "Configure S-Bus" option. This writes the S-Bus station number into the header of the memory module.



The number allocated can be checked using the debugger's "Display S-Bus" command.

Station number definition when using EPROMs

1. Run the PCD Programming Utilities and enter the station number on the "Configure S-Bus communications" menu.

2. From the "Program Eproms" menu, program the User-Eprom. The defined number is automatically stored in the user program's header.

   The station number is always valid for the entire PCD station, even if several interfaces are assigned to the same station in S-Bus mode.

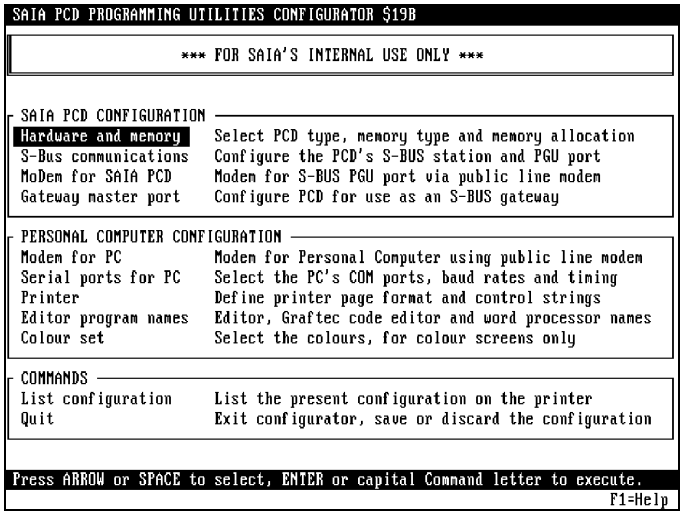
7.2 Configuration and assignment of an S-Bus PGU interface

The procedure which applies here is different depending on whether memory modules are used with RAM or EPROM components.

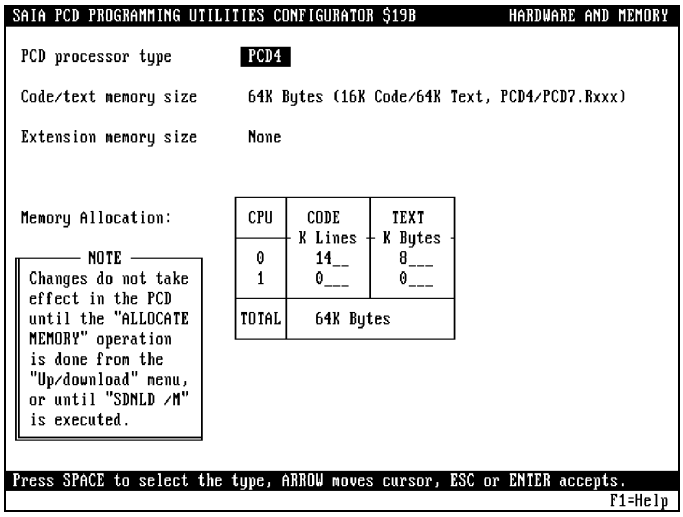
7.2.1 Memory modules with RAM components

The following generally applies :

An S-Bus PGU interface can only be configured via the original interface using the P8 protocol.

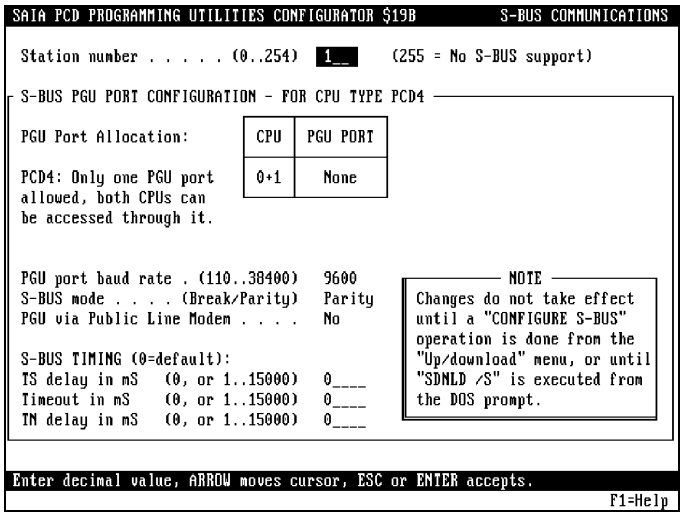


1. Definitions in the **"Configure"** menu :
   SAIA PCD Configuration "Hardware and memory": PCD type



This menu defines PCD type, memory size and memory allocation. Once defined, the memory allocation must be transferred to the PCD using the "Reallocate memory" command on the "Up/downloader" menu. Depending on the type of PCD defined here, other menus and programs offer a selection of different settings.

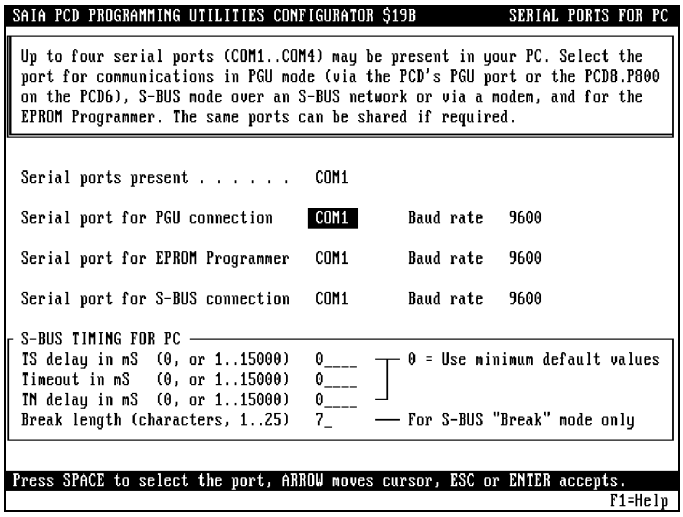
"S-Bus communications" : Station number, PGU port, baud rate, modem



You must define the S-Bus station number, the number of the interface you want to use for S-Bus PGU, the baud rate and the S-Bus mode (usually Parity when you do not use modems).

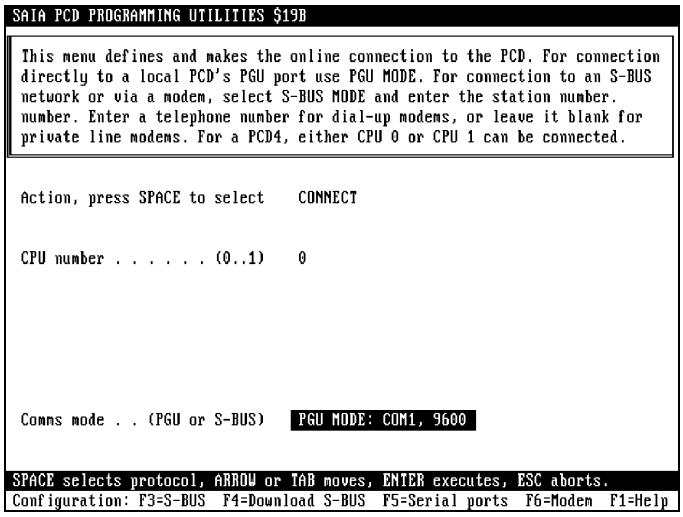
In normal cases, the S-Bus timing must be left at 0 (= default values).

Personal Computer Configuration :
"Serial ports for PC": Interfaces and baud rates of programming unit.



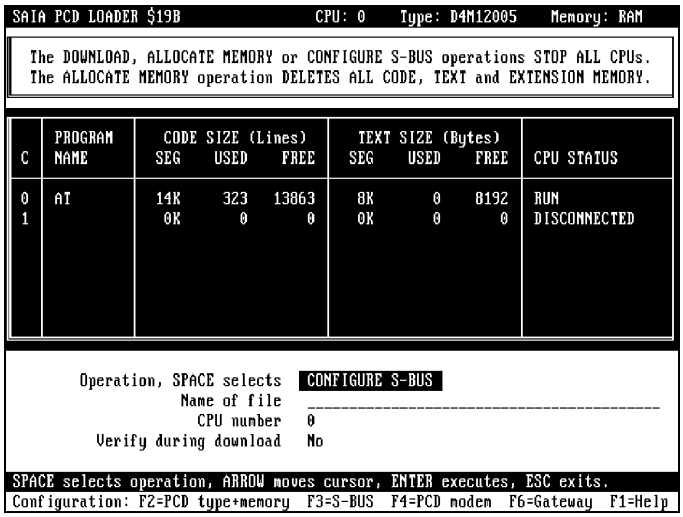
The programming unit's serial interfaces are defined in this menu.
Baud rate settings must agree with those in the PCD ("S-Bus communications" menu).

2. From "**coNnect**" menu: for the COMMS mode select PGU.



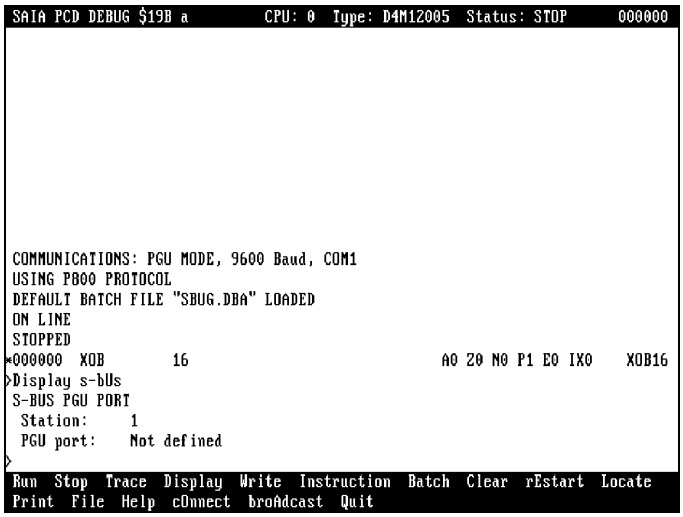
This menu is used to set the communications protocol (S-Bus or P8 PGU) for the programming unit, and any connected PCD's station and CPU numbers. Before connection to a PCD via an online program (e.g. the debugger), it is necessary to define the communications protocol in this menu.

3. From "**Up/download**" menu, transfer the defined configuration to PCD with "Configure S-Bus".



The "Configure S-Bus" function transfers to the PCD definitions made in the "Configure / S-Bus communications" menu and activates them. This function is only applicable if a memory module with RAM components is used. For memory modules with EPROM components, the S-Bus configuration must be written into the EPROM using the program "Program eproms" utility. You can also access the S-Bus parameters without going in the "Configure" menu by using the function keys : F2 (PCD type + memory), F3 (S-Bus), F4 (PCD modem) and F6 (Gateway)

4. From "**Debug**", check correctness of definitions with "Display s-bUs". This command lists the current S-Bus configuration of any connected CPU.



The configured S-Bus PGU interface has now been assigned with the S-Bus protocol and is ready for use. This configuration will remain in force until it is changed from the "Up/downloader" by "Configure S-Bus".

7.2.2 Memory modules with EPROM components

1. As for RAM components.

2. Program the EPROMs or Create HEX files from the "Program eproms" menu. The S-Bus configuration is written automatically into the EPROMs.

3. Insert EPROM into PCD and connect the PG3. Set PGU (P8) protocol from the "coNnect" menu.

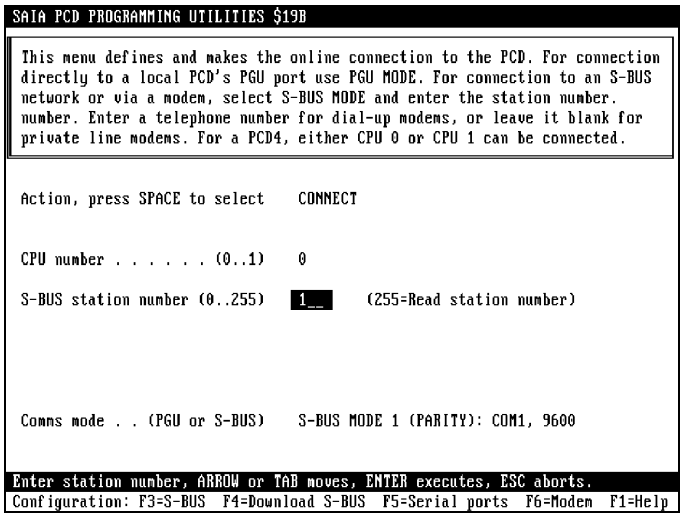
4. In the "Debugger", use "Display s-bUs" to check that settings are correct.

5. The configured S-Bus PGU interface is now assigned with the S-Bus protocol and ready to use. Since this configuration is stored in EPROMs, it can only be changed by programming new EPROMs.

6. As for RAM components.

7.3 Connection of the PG Unit via S-Bus

Connect the programming unit to the S-Bus PGU interface (in point-to-point or via the RS 485 network) and select S-Bus protocol, CPU and station numbers from the "coNnect" menu.



If there has been a successful connection with the station defined in the "Connect" menu, it is now possible to use all functions of the PG3 utilities via the S-Bus PGU interface.

If the S-Bus protocol is set, all PCD Programming Utilities online programs will display the station number of any slave station connected on the screen's status line (top line).

Debug cOnnect

With this command it is possible to select a CPU of the connected station. In an S-Bus network switching between stations is possible. The command "Analyse-sbus-network" can be used to check the whole network during operation for baud rate and station numbers of all stations present. In this way it is possible to display the network on the programming unit.

7.4 Configuring the PCD Utilities for your modem

The PCD Utilities contains some standard modems configuration :

- Hayes compatible
- Hayes compatible High Speed
- US Robotics Courier
- Zyxel U-1496 Series
- Miracom WS 3000
- User-defined modems

You can see the different modems and the commands they used from the "Configure" menu and the following sub-menus :

- Modem for SAIA PCD menu
- Modem for PC

If you can not find your modem or a modem with the same command strings : you can add your modem in the list by editing the file "modem.dat" (located in the directory where you have installed the PCD Utilities, generally \PCD)

The file "modem.dat" must be edited with a text editor (such as EDIT from Dos), at the end of this file you will find a "User-defined modem" that you can adapt for your modem. If you use more than one modem, you can add these at the end of the file.

```
;SAIA MODEM CONFIGURATION FILE - MODEM.DAT
;SEE CONFIGURATOR'S HELP TEXTS FOR DETAILS

;DO NOT EDIT THESE

[Hayes Compatible]
……

;CAN BE EDITED FOR CUSTOM MODEM CONFIGURATION

[User-defined modem]          ;Modem type
BreakMode=Yes                 ;No=Break mode not supported, default=Yes
ParityMode=No                 ;Yes=parity mode supported, default=No

;*** PC Modem
Reset="ATZ\r"                 ;Reset modem
Init="AT&Q0\r"                ;Initialise modem ("AT&Q0\r" for high-speed modem)
DialPrefix="ATDT"             ;Sent before number ("ATDP"=pulse dialling)
DialSuffix="\r"               ;Sent after number
Hangup="ATH0\r"               ;If blank, dropping DTR for 2 sec is used
Command="~~~+++~~~"           ;Switch modem to command mode
Delay="~"                     ;Character to provide 0.5 second delay
AnswerOn="ATS0=1\r"           ;Turn on auto-answer mode (S0=1 answer on 1st
ring)
AnswerOff="ATS0=0\r"          ;Turn off auto-answer mode
Timeout=45                    ;Connect time-out in seconds
Retries=2                     ;Number of dialler retries if Timeout occurs
CmdOk="OK"                    ;Response string, command executed OK
Connect="CONNECT"             ;Response string, connected OK after dial

;*** PCD Modem
PCDReset="ATZ\r"              ;Reset PCD modem
PCDInit="ATM0E0S0=2S25=250\r" ;Init PCD modem, must include 'S0=x'
                              ;  (with x ;not 0) to put the modem into
                              ;   auto answer mode

;OTHER MODEM CONFIGURATIONS CAN BE ADDED HERE
```

Break mode
Parity mode

These parameters can be used to define which S-Bus protocols the modem supports. More than one S-Bus protocol can be selected. When there is an S-Bus connection via modem, the PG3 will try to make a connection with the PCD using all the selected S-Bus protocols. As soon as the right S-Bus protocol has been found, the S-Bus connection will be made. In order to accelerate S-Bus connection, or to avoid undesirable side effects in the modem, only the required S-Bus protocol should be switched on. The last S-Bus protocol to have been selected will be used first when a new S-Bus connection is made. S-Bus data mode is always switched on.

Reset

Resets the modem to its factory default state

Init

Initialises the modem: Set time-outs, disable error control data compression, enable call progress detection etc.

DialPrefix	Sent before the telephone number when dialling
DialSuffix	Sent after the number when dialling, this is usually "\r" (CR).
Hangup	The command to disconnect and hang up the line. If empty, it is assumed that dropping DTR (Data Terminal Ready) for seconds will hang up the line, as for Hayes compatible modems.
Command	The sequence which switches the modem from data transfer to command mode. The "+++" string is preceded and followed by a 1.5 second delay, defined by three 0.5 second Delay characters: "~~~".
Delay	A special dummy character. Whenever this character appears a modem command string the system waits for 500 mS instead of transmitting the character to the modem. Traditionally this is the tilde character (~), which can be seen in the example "Command" string.
Auto-answer on	This string must put the modem into auto-answer mode so that it will automatically answer an incoming call and connect to the remote modem. This is used to enable "auto-answer mode". This string usually loads a register in the modem (S0) with a ring count. When the ring count is non-zero, the modem answers an incoming call on the defined number of rings.
Auto-answer off	This must disable auto-answer mode, so that the modem will not automatically answer an incoming call. This string usually sets the modem's ring count register (S0) to 0.
Timeout	The time to wait after dialling for the detection of the carrier signal (DCD) from the remote modem. NOTE : The modem itself often has an internal time-out value (usually 30-45 seconds). "Timeout" is never used if the modem's internal value is less. To use a longer time-out, change the modem's internal time-out value by adding the command to the "Init" sequence. For Hayes compatible modems this is "S7=n", where "n" is the time-out in seconds, e.g. for a 45 second time-out on a Hayes compatible modem, use : Init="ATS7=45\r" ; set 45 seconds time-out Timeout=45

Retries	The number of additional dialling attempts made on failure to connect to the remote modem. Max. is 3.
CmdOk	The string returned by the modem when a command is accepted. This is the string returned when the "Reset", "Init" or "Hangup" commands are sent.
Connect	The string returned by the modem after the dial command, when the remote modem has answered, connection has been established, and the carrier detect signal (DCD) is being returned.

PCD MODEM :

PCDReset	For the modem connected to a PCD only. Resets the modem.
PCDInit	For the modem connected to a PCD only. Places the modem into "auto-answer" mode, so that it automatically answers an incoming call. This string should also set the "DTR detect time" to greater than 250 mS, to stop the modem hanging up the line when a "restart" is done.

Modem strings can contain escape sequences for common ASCII control characters or hex values in strings. These are preceded by a backslash '\' :

\r	0x0D	CR	carriage return
\n	0x0A	LF	line feed
\a	0x07	BEL	bell
\b	0x08	BS	backspace
\f	0x0C	FF	form feed
\t	0x09	HT	tab
\v	0x0B	VT	vertical tab
\xhh	0xhh		hex value \x00..\xFF
\\	0x5C	\	backslash
\"	0x22	"	quotation mark

Modem response strings (CmdOk and Connect)

The "CmdOk" and "Connect" response strings are delimited by CR/LF characters. CR and LF must NOT be entered in the string definitions, do not enter '\n' or '\r'. Only the characters entered in the "CmdOk" or "Connect" string, excluding the delimiting CR/LF, are compared. If the response is longer, the additional characters are ignored.

For example, "CONNECT" matches "<CR><LF>CONNECT 2400 <CR><LF>", the "<CR><LF>" and " 2400" are ignored.

Do not initialise the modem to return single digit result codes (e.g. "0"), these will not work. String values, enclosed by CR/LF characters must be returned (see Hayes command "V1"). Do not initialise the modem so that it does not return response strings, these are required by the dialler to monitor connection progress (see Hayes command "Q0").

High speed modems with data compression and error correction

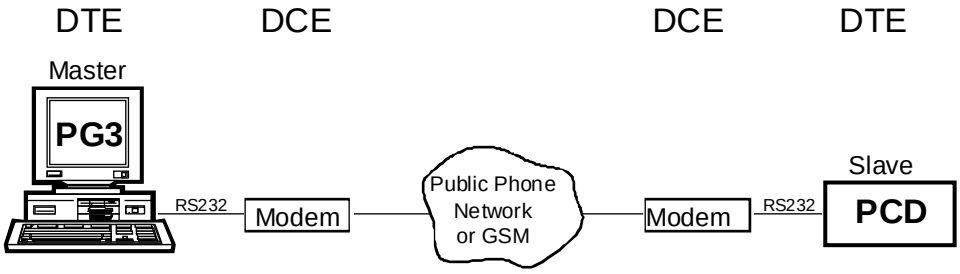
Data compression and error correction protocols are **not compatible** with S-Bus break and parity modes, and must be disabled.
Usually the Hayes command "&Q0" will do this, use Init="AT&Q0\r" (or use pre-defined modem type [Hayes Compatible High-Speed]).

Call progress detection

Some modems have the ability to detect if the line is busy (engaged) or there is no dial tone. If the modem has this capability, it is useful to enable it with the "Init" string. This speeds up the dial retries, because the dialler will be able to detect these conditions instead of waiting for the dial time-out period to elapse.

7.5 Connection via the Public Telephone Network

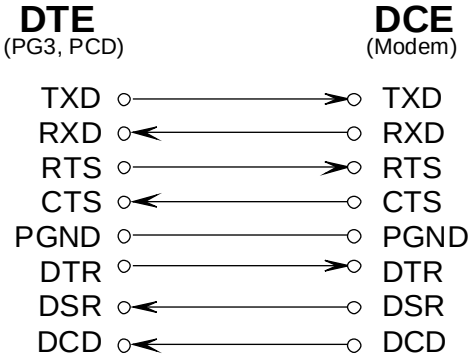
7.5.1 Application diagram



DTE : **D**ata **T**erminal **E**quipment

DCE : **D**ata **C**ommunication **E**quipment

Cable



PCD ports supporting S-Bus PGU with modems

The PGU port on the PCD lacks some important signals which make it impossible to use Public Line Modems on this port. The PCD requires 5 control signals (RTS, CTS, DTR, DSR, DCD) to manage the modem.

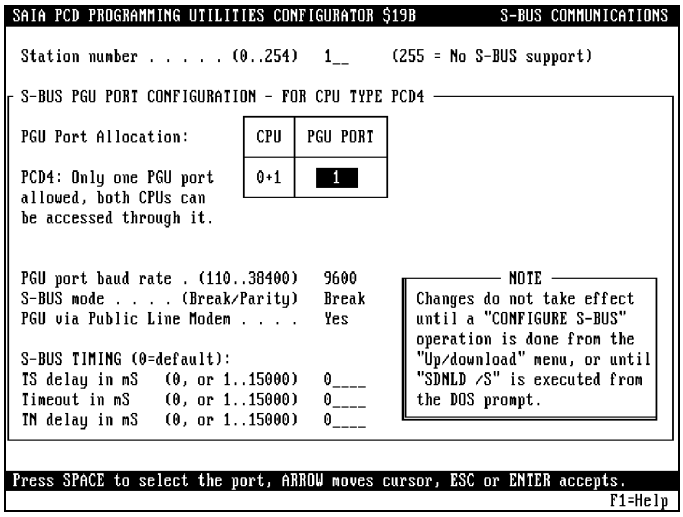
The following ports support S-Bus PGU with modems :

PCD1.M120/M130 :	port 1 (RS 232)	
PCD2 :	port 1 (RS 232)	
PCD4:	port 1 (RS 232)	with bus module PCD4.C120 or C340
PCD6.M540 :	port 2 (RS 232)	
PCD6.M1/2 :	all RS 232 ports (0..3)	
PCD6.M300 :	all RS 232 ports (0..3)	

7.5.2 Configuring the PCD

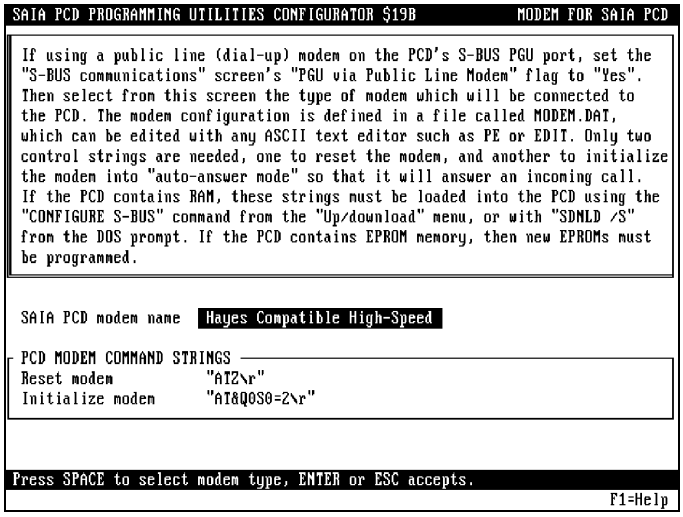
1. Select the appropriate hardware in the menu "Hardware and memory"

2. Enter the sub-menu "S-Bus communication"



- Give to the PCD a Station number (from 0 to 254)
- Select the PGU port you want to use with the modem
  Remember : that port 0 **cannot** be used with a modem
- Select the Baud rate for your modem
- Select the S-Bus mode : BREAK
- Select YES for PGU via Public Line Modem

3. In the menu "Modem for SAIA PCD", select the modem you are using :

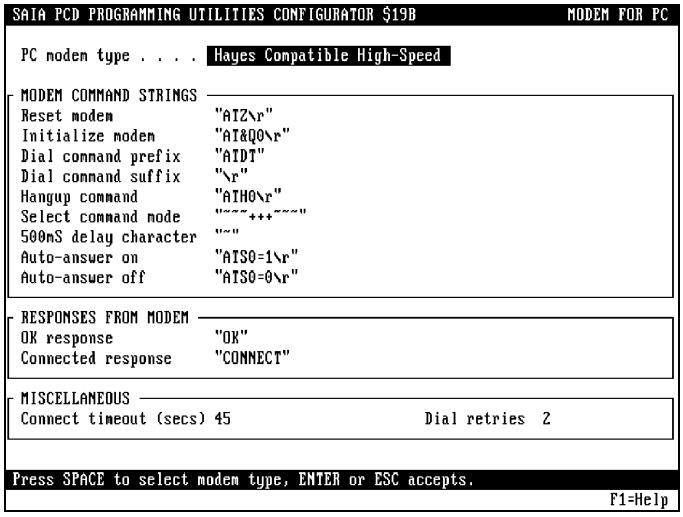


If you can not find your modem or one with the same command strings as yours : you can add your own modem by editing the file "modem.dat" (see Configuring the PCD Utilities for your modem on chapter 7.4)

4. The changes and selection you have made must now be down-loaded in the PCD; select first the PGU protocol in the "Connect" menu and then with the "Up/Download" program do a "Configure S-Bus".

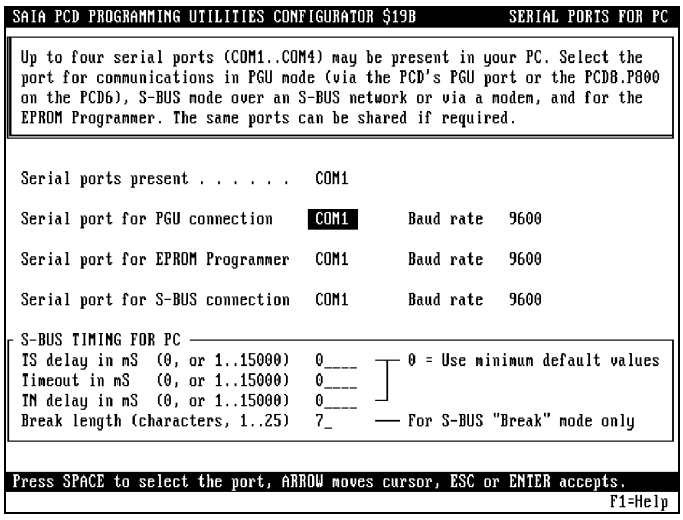
7.5.3 Configuring the PC (PG3)

1. In the menu "Modem for PC" choose your modem :



If you can not find your modem or a modem with the same command strings. (see Configuring the PCD Utilities for your modem on chapter 7.4)

2. In the "Serial Port for PC", checks that the S-Bus speed and timings are compatible with your modem:



Unless you have connection problems, you must not change the 'defaults' parameters for the S-Bus timings.

TS delay : Training sequence delay, in milliseconds. This is the delay between setting RTS (Request To Send) and the transmission of the message.

Timeout : Response time-out in milliseconds. This is the time-out until the end of the response message is received.

TN delay : Turnaround time in milliseconds. The minimum time between the end of a response and transmission of the next telegram. It gives the remote station time to switch back to receive mode. The TN delay is particularly important if using the PCD7.T100 repeater or private line modems.

The TS delay, time-out and TN delay should be set to the minimum possible values required by the hardware.
If (TS delay + TN delay) is greater than about 500 mS the "Debug" program will not work. It polls the PCD every 500 mS, and all the processing time would be taken up by these delays. The Timeout should also be set as low as possible because this affects the processing of key depressions if the PCD is off line.

The TN delay is the most critical, Timeout and TS delay are both usually 0 so that default values are used. The response time-out is the time the PC will wait until the start of the response message. It is rounded up to the nearest 55 mS, since the PC's internal clock ticks at 55 mS intervals. After the 1st character of a response has been received, the PC uses and inter-character time-out of 55 mS.

The "Break length" is the duration of the break signal, in character times. The break signal tells the remote station that a new telegram is about to be transmitted. The default is 4 character times, but some modems may need longer to register the break signal. Normally this should never be greater than 10, otherwise communications throughput will be affected.

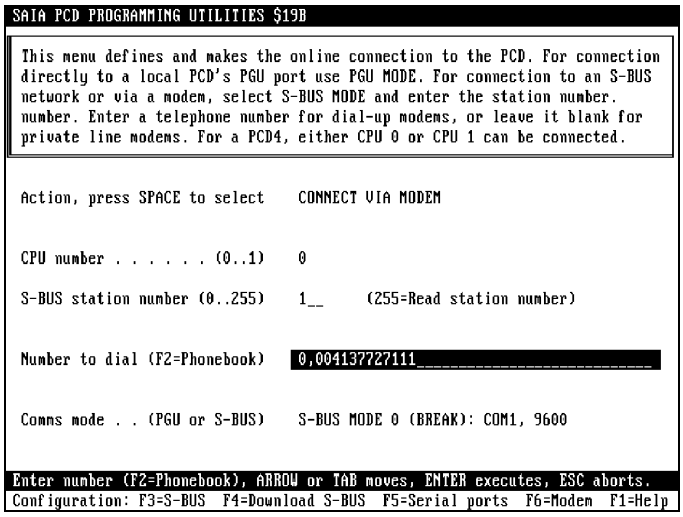
7.5.4 Making the connection

1. Connect the PCD and the modem together. It is not necessary that the PCD contains a program.

2. Connect the modem to the public telephone line

3. Issue a power down/power up sequence to be sure that the PCD initialises your modem correctly.

4. From the "Connect" menu :



   - Select for COMMS mode the S-Bus Mode 0 (BREAK) protocol
   - Select CONNECT VIA MODEM
   - Put the station number you have given to your PCD
   - Type the telephone number to dial
     The telephone number can contain digits and any characters supported by the modem. On HAYES modems ',' generates a 1 second delay for pausing when dialling.
     The telephone number can be chosen from a user-editable Phonebook file by pressing function key F2 when the cursor is in the "Number to dial" field. You can edit this phonebook with a text editor; it is named "phones.dat".
   - Press <return> to make the connection

The PC begins to initialise the modem and after a few seconds, you must hear the telephone tone and the dialling progress. Dialling can be aborted by pressing ESCape. On the last line, messages are displayed showing the progress of the connection.

If the connection is successful, the Utilities returns to the main menu; the first line shows you that you are connected.

7.5.5 Trouble shooting

Problem 1 : The PCD modem does not answer to an incoming call.

Verify that the modem is in auto answer mode :

- LED on the modem front panel on ?
- Is the cable correct wired ?
- Make a power down/power up and observe the receive LED of the PCD modem to see if it receives the initialisation sequence from the PCD.

Problem 2 : After dialling the phone number the message "connected to remote modem" is displayed but immediately a dial retry is made.

Verify the response string of the modem :

- Check specified response strings in modem.dat file
- Check modem parameters V1, W0, X4

Problem 3 : After an established connection to the remote modem it is not possible to come online with the S-Bus protocol. Error message in connect menu: "No response from PCD"

- Check the S-Bus station number
- If DTE speed of the PCD modem is lower than DTE speed of PG3 modem then PG3 time-out value must be adapted for the lower speed.
- Check modem parameters set-up according to the parameter list in this document.

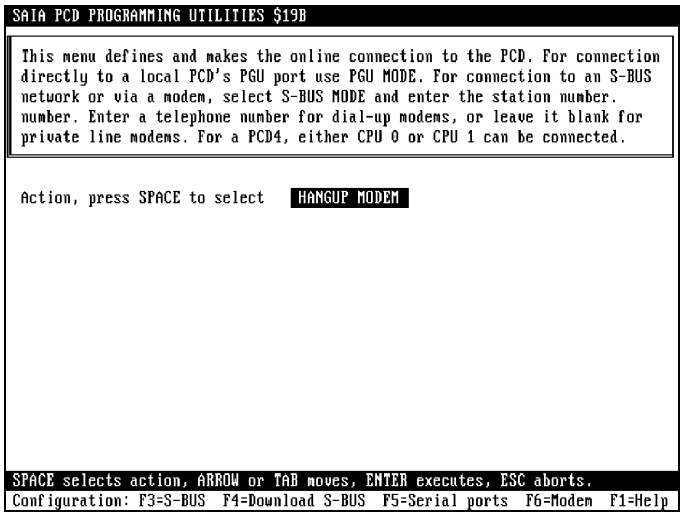
Problem 4 : By means of the utilities downloader the configuration of an S-Bus PGU port on the PCD has been changed (for instance the baud rate has been modified) while the modem was connected to this port but this new baud rate has not been taken in account.

To activate a modified configuration the modem must be disconnect and reconnect again. This means while the modem is connected to an S-Bus PGU port the new configuration will not be taken in account.

However sometimes it is not possible to get a modem working because of any reason. In this situation it is recommended to connect a serial interface communications analyser (for example SANALYS or RSO) between PG3 and modem or between PCD and modem to analyse the transmitted and received telegrams.

7.5.6 Ending the connection

From the "Connect" menu, select the HANG UP modem option :



If you forget to disconnect before exiting the PCD Utilities, an automatic hang up will be done.

7.6 Example of PCD program (with modem)

This is an example of program which handles S-Bus communications to or from a supervision system and from the Programming console.

The communication can be initiated by :

- the PCD (Outgoing call)
- Supervision system (Incomming Call)
- PG3

The program is made in the form of a sequential block.

Usage :

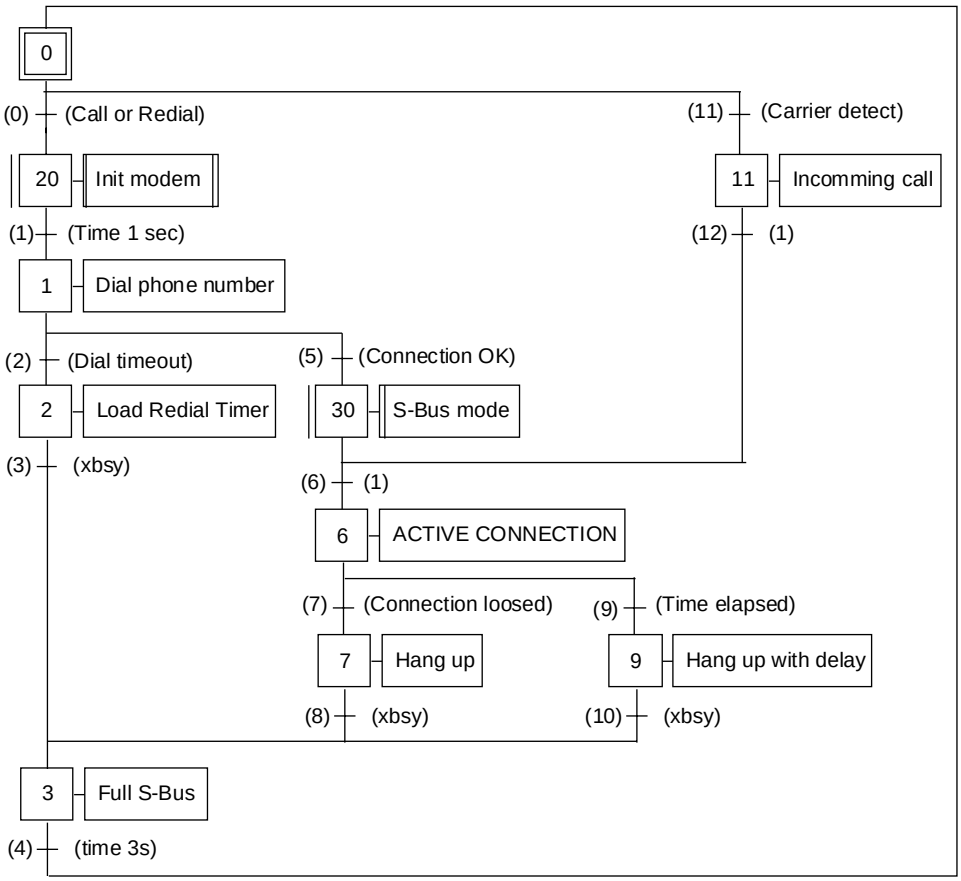
```
COB         x
            0
...
CSB         MODEM
...
ECOB
```

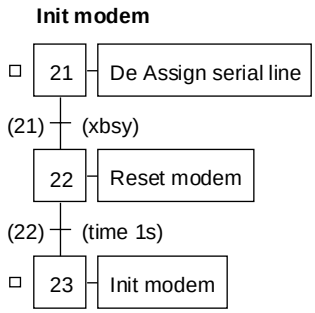
Outgoing call :

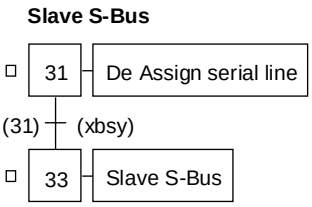
To initiate an outgoing call, the flag "CALL" must be set to 1. The PCD will then try to make a connection with a remote central computer; if this connection succeed, the PCD is switched to S-Bus slave mode and it can then be interrogated by a Supervision system. When all the datas have been read, the central computer must reset the CALL flag. If the connection does not succeed (or is interrupted), the central computer is called again after a delay ("redial_tim"); this will happen until the flag "CALL" is reset (by the PCD application program or the remote computer). The flag "CONNECT" is set to 1 when there is a valid connection. If the connection is longer than "commtime" the PCD will hang up automatically.

Incomming call :

The PCD answer any incomming call comming from a central computer or the SAIA Programming Tools. When a connection is made, the flags "CONNECT" and "INC_CALL" are set to 1 until disconnection. If the connection is longer than "commtime" the PCD will hang up automatically. When using the remote Programming Tools, the user can stop this automatic hang up procedure.








```
; Definitions of the symbols

Modem       EQU     SB 0            ; Modem send/receive
CALL        EQU     F 8100          ; CALL flag
CONNECT     EQU     F 8101          ; Indicate a valid connection
INC_CALL    EQU     F 8102          ; Indicate an incomming call
dcd_f       EQU     F 8103          ; Carrier detect flag
diag_f      EQU     F 8150          ; First of 8 diagnostic flags
xbsy        EQU     F 8156          ; Xbsy flag (must be diag_F + 6)
diag_f0     EQU     F 8160          ; Full S-Bus Diagnostic (8 flags)
xbsy_sb     EQU     F 8166          ; Full S-Bus Xbsy (=diag_f0+6)
diag_r      EQU     R 4090          ; Diagnostic register
diag_r0     EQU     R 4091          ; Full S-Bus Diagnostic
pcd_ident   EQU     R 4095          ; PCD Identification register
timer       EQU     T 0             ; Timer used by SB modem
rd_timer    EQU     T 1             ; Timer for redial
dialnb      EQU     TEXT 0          ; Dial number string
resmod      EQU     TEXT 1          ; Reset modem string
initmod     EQU     TEXT 2          ; Init modem string
sasioff     EQU     TEXT 3          ; SASI OFF
sasioffd    EQU     TEXT 4          ; SASI OFF with delay
sasidiag    EQU     TEXT 5          ; SASI diagnostic
sasisb      EQU     TEXT 6          ; SASI Slave S-Bus via modem
sasimc      EQU     TEXT 7          ; SASI Mode C
pcd_number  EQU     1               ; PCD number
smod        EQU     1               ; Serial channel for modem
dcd         EQU     2               ; Carrier detect signal
sec1        EQU     10              ; 1 sec delay
off_delay   EQU     15              ; Delay before SASI OFF (in sec)
sec3        EQU     30              ; 3 sec delay
CD_time     EQU     450             ; Maximum Carrer Detect wait time
redial_tim  EQU     600             ; Redial time out
commtime    EQU     1800            ; Maximum communication time
baud        EQU     2400            ; Speed in bps for modem connection
Main        EQU     COB 0           ; Main program


; Definitions of the Texts
; The following texts can be adapted for your modem.
; Number to dial
 TEXT dialnb "ATDT004137727111<CR>"
;-- Modem reset string--
  TEXT resmod "ATZ<CR>"
;-- Modem init string --
  TEXT initmod ""
; ----------------------The following texts do not need to be changed
;-- SASI OFF --
  TEXT sasioff "MODE:OFF;"
;-- SASI OFF delay --
  TEXT sasioffd "MODE:OFF,",off_delay,";"
;-- SASI DIAG --
  TEXT sasidiag "DIAG:",diag_f0.T,",",diag_r0.T,";"
;-- SASI S-Bus --
  TEXT sasisb "UART:",baud,";MODE:SS0;DIAG:",diag_f.T,",",diag_r.T,";"
;-- SASI Mode C --
  TEXT sasimc "UART:",baud,",8,N,1;MODE:MC0;DIAG:",diag_f.T,",",diag_r.T,";"
```

```
; Initial Step 0 ------------------------------------------
        ; The code starting here will be copied in XOB16
$init
                        SASI    smod            ; Declare diagnostic flags
                                sasidiag
$endinit
; TR 0 ----------------------------------------------------Call or Redial
                        SICL    smod            ; Read and store the CD signal
                                dcd
                        OUT     dcd_f
                        ;
                        STH     CALL            ; If request to initiate a call
                        ANL     rd_timer        ;    and time to redial
                        ANL     dcd_f           ;    and modem off hook
                        ANL     xbsy_sb         ;    and OK to perform a sasi OFF
; Macro Step Init Modem ------------------------------
; ST 21 ----------------------------------------------------
                        SASI    smod            ; De-assign serial channel
                                sasioff
; TR 21----------------------------------------------------Xbsy
                        STL     xbsy_sb         ; Wait until end of SASI OFF
; ST 22  ---------------------------------------------------Reset modem
                        SASI    smod            ; Enter MC mode
                                sasimc
                        ACC     H
                        SOCL    smod            ; Set RTS
                                0
                        SOCL    smod            ; Set DTR
                                1
                        STXT    smod            ; Send reset modem string
                                resmod
                        LD      timer           ; 1 sec delay
                                sec1
; TR 22  ---------------------------------------------------Time 1 sec
                        STL     timer           ; Wait until text transmitted
                        ANL     xbsy            ;      and timer finished
; ST 23  ---------------------------------------------------Init modem
                        STXT    smod            ; Send modem init string
                                initmod
                        LD      timer           ; 1 sec delay
                                sec1
;-------------------------------------------------------
; TR 1 ----------------------------------------------------Time (1s)
                        STL     xbsy            ; Text send completely
                        ANL     timer           ;     and timer elapsed
; ST 1 ----------------------------------------------------Dial Phone Number
                        STXT    smod            ; Send dialing command
                                dialnb
                        LD      timer           ; Load maximum time for CD detection
                                CD_time
; TR 2 ----------------------------------------------------Dial Timeout
                        SICL    smod            ; Read DCD signal
                                dcd
                        OUT     dcd_f           ;   and store it
                        STL     timer           ; Time elapsed ?
                        ANL     dcd_f
```

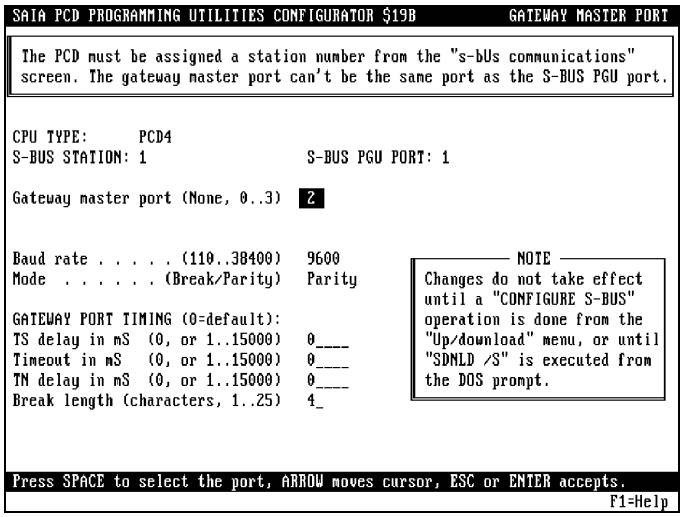
```
; ST 2----------------------------------------------------Load redial timer
                    LD      rd_timer        ; Load redial timer
                            redial_tim
                    SASI    smod            ; return to full S-Bus
                            sasioff
; TR 3 ----------------------------------------------------XBSY
                    STL     xbsy_sb
; ST 3 ----------------------------------------------------Full S-Bus
        ; To be sure that the SASI-OFF has been completly performed,  we need to wait 3 sec
                    LD      timer               ; Load 3 sec
                            sec3
                    RES     CONNECT         ; Reset the connect flag
                    RES     INC_CALL        ; Reset the incomming call flag
; TR 4 ----------------------------------------------------Time 3 sec
                    STL     timer
                    ANL     xbsy_sb

 ------------------------------------------------------------------------------------------------------------
; TR 5 ----------------------------------------------------Connection OK ?
                    STH     dcd_f           ; Connected ? (CD high)
;Macro Step Slave S-Bus ------------------------------
; ST 31  ----------------------------------------------------De-assign serial line
                    SASI    smod            ; De-assign serial channel
                            sasioff
; TR 31  ----------------------------------------------------Xbsy
                    STL     xbsy_sb         ; Wait until end of SASI OFF
; ST 32  ----------------------------------------------
                    SASI    smod            ; Re-assign serial channel
                            sasisb          ;       in mode SD0
                    SOCL    smod            ; Set DTR
                            0
                    SOCL    smod            ; Set RTS
                            1
; ----------------------------------------------------------
; TR 6 ----------------------------------------------------Empty
; ST 6 ----------------------------------------------------Connection active
                    LD      timer           ; load maximum communication time
                            commtime
                    SET     CONNECT         ; indicate the connection
; TR 7 ----------------------------------------------------Connection Loosed
                    SICL    smod            ; Wait until no DCD
                            dcd
                    ACC     C
```

```
; ST 7 ----------------------------------------------------Hang Up
        ; Hang up is not necessary, because we have already lost the line. But if it was not
        ; an incomming call it is necessary to return ; to Full S-Bus
                        STH     INC_CALL        ; If not an incomming call
                        JR      H end
                        SASI    smod            ;   Then return to FULL S-Bus
                                sasioff
        end:
; TR 8 ----------------------------------------------------Xbsy
                        STL     xbsy_sb         ; Wait until end of SASI OFF

 ------------------------------------------------------------------------------------------------------------
; TR 9 ----------------------------------------------------Time elapsed
                        STL     timer
; ST 9 ----------------------------------------------
        ; Perform a SASI OFF with delay to leave a chance to the PG3 console; to gain the control
        ; over  the program. Doing a SASI OFF will hang up.
                        SASI    smod            ; SASI OFF with delay
                                sasioffd
; TR 10----------------------------------------------------Xbsy
                        STL     xbsy_sb         ; Wait until end of SASI OFF

 ------------------------------------------------------------------------------------------------------------
; TR 11 ----------------------------------------------------Carrier detected ?
                        STH     dcd_f           ; DCD High ?
; ST 11 ----------------------------------------------------Incomming Call
                        SET     INC_CALL        ; indicate an incomming call
; TR 12 ----------------------------------------------------Empty
```

7.7 Configuration of a Gateway Master Port (GMP)

The master gateway port is configured using the "Gateway Master Port" menu in the configure menu of the PG3 utilities
The menu shows three predefined values :

- The CPU type, as defined in the "Hardware and memory" menu.
- The S-Bus station number as defined in the "S-Bus communications" menu.
- The S-Bus PGU port also defined in the "S-Bus communications" menu.



In the rest of the menu it is necessary to define eight essential parameters necessary for the initialisation of the Gateway.

Gateway master port (GMP)

This field specifies the port to be used for the Gateway Master Port. If "None" is chosen, no Gateway Master Port will be configured.

Port on CPU (PCD6 only)

This field is only for PCD6, it defines on which CPU the Gateway Master Port will be configured.

Baud rate

The transmission speed of the Gateway Master Port, this is selectable between 110 - 38400 bps as with any standard S-Bus communications protocol.

Mode

This defines whether the Gateway Master Port will use the break mode (mode 0), the parity mode (mode 1) or the data mode (mode 2).

TN delay

Turnaround time in milliseconds. This is the minimum time between the end of a response and transmission of the next telegram. It gives the remote station time to switch back to receive mode. The TN delay is particularly important if using the PCD7.T100 repeater or private line modems. If a zero is entered for the TN delay then the default value will be used. which can be found in the configure help index (Function key F1), in the S-Bus timing field and in the table below.

TS delay

Training sequence delay in milliseconds. This is the delay between setting RTS (Request To Send) and the transmission of the message and is principally for modems. If zero is entered for the TS delay then the default value will be used which can be found in the configure help index (Function key F1) , in the S-Bus timing field and in the table below.

Timeout

This time-out delay in milliseconds concerns the transmission between the Master Gateway Port and its connected slave(s). This defines the maximum time that the master will wait before transmitting a retry in the case of error. The table below lists the default time-out values in milliseconds to set in function of the baud-rate of the Master Gateway port. It may be necessary to adjust these values if the TN and TS delays differ from their default values. If zero is entered here then the default value will be used.

Baud rate	**110**	**150**	**300**	**600**	**1200**	**2400**	**4800**	**9600**	**19200**	**38400**
TN delay [ms]	27	20	20	5	3	2	2	1	1	1
TS delay [ms]	0	0	0	0	0	0	0	0	0	0
Timeout [ms] Br/Par	15000	9000	5000	3000	2000	1000	500	250	200	200
Timeout [ms] Data	15000	15000	7500	4500	3000	1500	750	375	300	300

Break length

This parameter specifies the number of break characters in break mode (mode 0). The default is 4.

Notes :

8. Appendixes

Appendix A Compatibility for using S-Bus at 38.4 Kbps

The baud rate 38.4 Kbps is supported as follows :

Firmware :	PCD1.M1x0	from version V001
	PCD2.M110/M120	from version V001
	PCD2.M150	from version V0A0
	PCD4.Mxx0	from version V003
	PCD4.Mxx5	from version V00B
	PCD4.M445	from version V00C (possibly V001)
	PCD6.M540	from version V002
	PCD6.M2x0	from version V007
	PCD6.M300	from version V001
Hardware :	PCD1.M1x0	all versions
	PCD2.M110/M120	from version A
	PCD2.M150	all versions
	PCD4.Mxx0	from version G
	PCD4.Mxx5	all versions
	PCD4.M445	all versions
	PCD6.M540	from version C
	PCD6.M2x0	all versions
	PCD6.M300	all versions

Interface types which can run at 38.4 Kbps :

RS 422 and RS 485	all
20mA current loop	none
RS 232	some, see list below

For the following RS 232 interfaces it is not possible to guarantee perfect operation at 38.4 Kbps because of the driver module used. However, it has been shown that in most cases these interfaces can also run at 38.4 Kbps.

PCD1.M1x0	interface 0 (PGU) or 1 *)
PCD2.M1x0	interface 0 (PGU) or 1 *)
PCD2.F520/F530	interface 2
PCD4.C120	interface 1
PCD4.C130	interface 3
PCD4.C340	all interfaces *)
PCD6.M540	interface 2
PCD6.M210	interfaces 0..3
PCD6.M220/M230	interfaces 2 and 3
PCD6.M300	all interfaces *)

*) with the interface module PCD7.F120

Appendix B S-Bus PGU interfaces and cables

The table below shows which of the PCD1, PCD2, PCD4 and PCD6 interfaces can be defined as S-Bus/PGU interfaces.

PCD type	**Interface**	**P8-PGU** Cable type PCD8. / baud rate	**S-Bus-PGU** Cable type / max. baud rate	**Converter** (optional)
PCD1.M1x0	0: RS 232 (PGU)	---	..K111 / 38.4 Kbps	..T120
	Optional:			
	1: RS 232 or	---	..K111 / 38.4 Kbps	..T120
	RS 422 / RS 485	---	Standard / 38.4 Kbps	---
PCD2.M110 /M120 or PCD2.M220	0: RS 232 (PGU)	..K100, K110 or K111 / 9.6 Kbps	..K111 / 19.2 Kbps	..T120
	or RS 485	---	Standard / 38.4 Kbps	---
	Optional:			
	1: RS 232 or	---	Standard / 38.4 Kbps	..T120
	RS 422 / RS 485	---	Standard / 38.4 Kbps	---
	2: RS 232	---	Standard / 19.2 Kbps	..T120
	3: RS 422 / RS 485	---	Standard / 38.4 Kbps	---
PCD2.M150 or PCD2.M250	0: RS 232 (PGU)	---	..K111 / 19.2 Kbps	..T120
	or RS 485	---	Standard / 38.4 Kbps	---
	Optional:			
	1: RS 232 or	---	Standard / 38.4 Kbps	..T120
	RS 422 / RS 485	---	Standard / 38.4 Kbps	---
	2: RS 232	---	Standard / 19.2 Kbps	..T120
	3: RS 422 / RS 485	---	Standard / 38.4 Kbps	---
PCD4.Mxxx with ..C100	0: RS 232 (PGU)	..K100, K110 or K111 / 9.6 Kbps	..K111 / 38.4 Kbps	..T120
PCD4.Mxxx with ..C110	0: RS 232 (PGU)	..K100, K110 or K111 / 9.6 Kbps	..K111 / 38.4K bps	..T120
	1: 20mA CL	---	---	---
PCD4.Mxxx with ..C120	0: RS 232 (PGU)	..K100, K110 or K111 / 9.6 Kbps	..K111 / 38.4 Kbps	..T120
	1: RS 232	---	Standard / 19.2 Kbps	..T120
	2: 20mA CL	---	---	---
	3: 20mA CL	---	---	---
PCD4.Mxxx with ..C130	0: RS 232 (PGU)	..K100, K110 or K111 / 9.6 Kbps	..K111 / 38.4 Kbps	..T120
	1: RS 422 / RS 485	---	Standard / 38.4 Kbps	---
	2: RS 422	---	Standard / 38.4 Kbps	..T140
	3: RS 232	---	Standard / 19.2 Kbps	..T120
PCD4.Mxxx with ..C340	0: RS232 (PGU)	..K100, K110 or K111 / 9.6 Kbps	..K111 / 38.4 Kbps	..T120
	1/2/3: RS 232	---	Standard / 38.4 Kbps	..T120
	1/2/3: RS 422/485	---	Standard / 38.4 Kbps	---
	1/2/3: 20mA CL	---	---	---
PCD6.M100	P8	..P800 / 9.6 Kbps	---	---
PCD6.M210	P8	..P800 / 9.6 Kbps	---	---
	0: RS 232	---	Standard / 19.2 Kbps	..T120
	1: RS 232	---	Standard / 19.2 Kbps	..T120
	2: RS 232	---	Standard / 19.2 Kbps	..T120
	3: RS 232	---	Standard / 19.2 Kbps	..T120

Remark : The programming cable PCD8.K101 replaces the old ..K100 which cannot be used for the PCD1 (see description on page 8-5)

Continuation on the next page

Continuation

PCD type	**Interface**	**P8-PGU** Cable type PCD8. / baud rate	**S-Bus-PGU** Cable type / max. baud rate	**Converter** (optional)
PCD6.M220	P8	..P800 / 9.6 Kbps	---	---
	0: RS 422 / RS 485	---	Standard / 38.4 Kbps	---
	1: RS 422	---	Standard / 38.4 Kbps	..T140
	2: RS 232	---	Standard / 19.2 Kbps	..T120
	3: RS 232	---	Standard / 19.2 Kbps	..T120
PCD6.M230	P8	..P800 / 9.6 Kbps	---	---
	0: 20mA CL	---	---	---
	1: 20mA CL	---	---	---
	2: RS 232	---	Standard / 19.2 Kbps	..T120
	3: RS 232	---	Standard / 19.2 Kbps	..T120
PCD6.M250	P8	..P800 / 9.6 Kbps	---	---
	0: 20mA CL	---	---	---
	1: 20mA CL	---	---	---
	2: 20mA CL	---	---	---
	3: 20mA CL	---	---	---
PCD6.M260	P8	..P800 / 9.6 Kbps	---	---
	0: RS 422 / RS 485	---	Standard / 38.4 Kbps	---
	1: RS 422 / RS 485	---	Standard / 38.4 Kbps	---
	2: RS 422 / RS 485	---	Standard / 38.4 Kbps	---
	3: RS 422 / RS 485	---	Standard / 38.4 Kbps	---
PCD6.M300	4: RS 232 (PGU)	---	..K111 / 38.4 Kbps	..T120
	Optional:			
	0: RS 232 or	---	..K111 / 38.4 Kbps	..T120
	20mA CL or	---	---	---
	RS 422 / RS 485	---	Standard / 38.4 Kbps	---
	1: RS 232 or	---	..K111 / 38.4 Kbps	..T120
	20mA CL or	---	---	---
	RS 422 / RS 485	---	Standard / 38.4 Kbps	---
	2: RS 232 or	---	..K111 / 38.4 Kbps	..T120
	20mA CL or	---	---	---
	RS 422 / RS 485	---	Standard / 38.4 Kbps	---
	3: RS 232 or	---	..K111 / 38.4 Kbps	..T120
	20mA CL or	---	---	---
	RS 422 / RS 485	---	Standard / 38.4 Kbps	---
PCD6.M540	0: RS 232 (PGU)	..K100, K110 or K111 / 9.6 Kbps	..K111 / 38.4 Kbps	..T120
	1: RS 422 / RS 485	---	Standard / 38.4 Kbps	---
	2: RS 232	---	Standard / 19.2 Kbps	..T120
	3: 20mA CL	---	---	---

P8-PGU : Programming interface with P8 protocol

S-Bus-PGU : Programming interface with S-Bus Protocol

Converter : Optional connection of a converter at the S-Bus interface is also possible, so that it matches the programming unit or network interface type.

Max. baud rate : Max. transmission speed for the programming interface. For the S-Bus protocol, the baud rate can be set between 110...38400 bps. For the P8 protocol, the baud rate is fixed at 9600 baud.

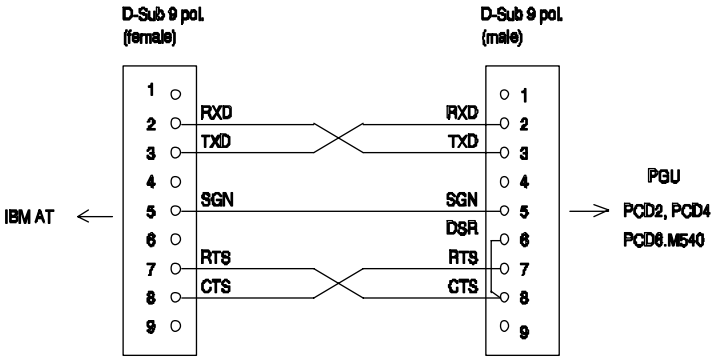
Cables for the programming interface

PCD8.P800

Interface processor for the programming unit with cable and 25-pole D-type connector. This device is used to connect the PG (via PGU interface) for PCD6.M1.. and ..M2.. processor modules. The processor supports the P8 protocol only. More information can be found in the PCD6 hardware manual.

PCD8.K110 (no longer available, replaced with PCD8.K111)

Programming cable with 9-pole D-type connector for connection of the programming unit (PC or PCD8.P100) with P8 protocol.



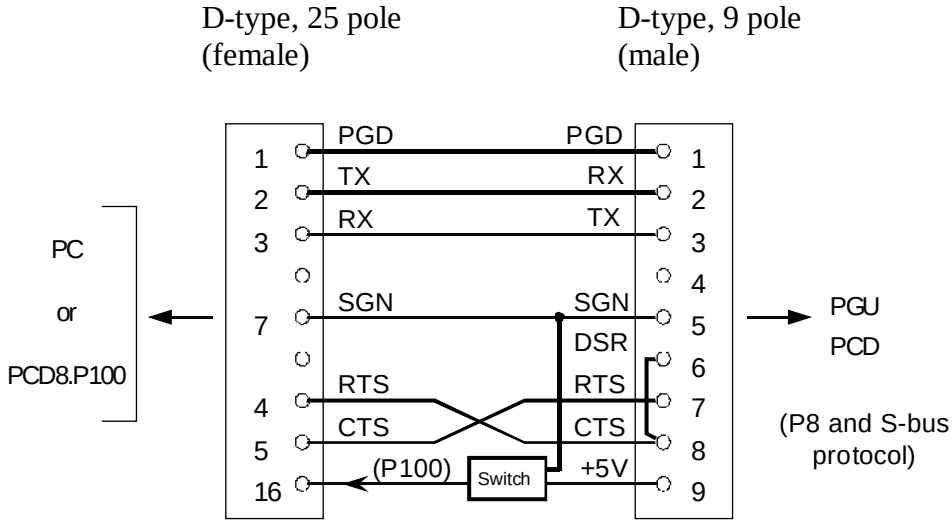
Use of cable as for PCD8.K111

This cable can only be used for the P8-PGU interface. When an "online" program is called (e.g. the debugger), the interface's RTS signal is set high by the programming unit. The PCD CPU recognises the programming unit by the wiring of pins 6 and 8 in the PGU connector and therefore automatically assigns the interface with the P8 protocol.

DSR = 1 PG connected, assignment with P8 protocol

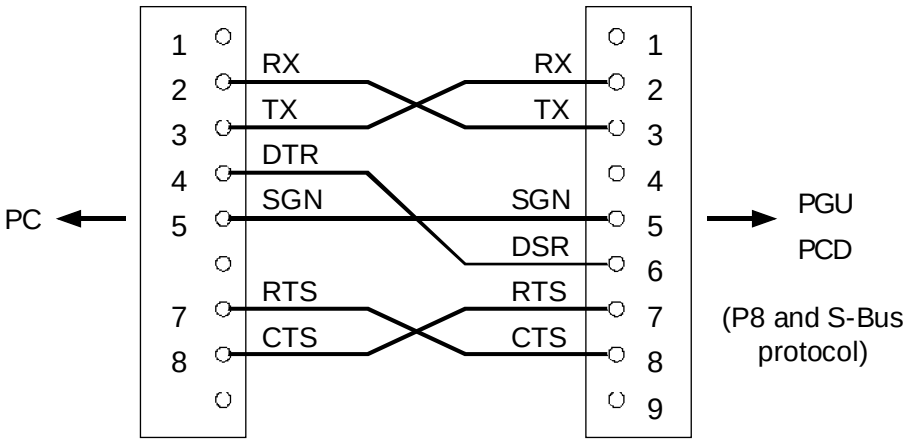
DSR = 0 no PG connected, so no assignment either

PCD8.K101 connecting cable (for P8 and S-bus protocol)
(as replacement for ..K100 which cannot be used for PCD1)



PCD8.K111

Programming cable with 9-pole D-type connector for connection of the programming unit with P8 or S-Bus protocol.



This cable can be used both for P8 and S-Bus PGU interfaces. When an online program is called, the Utilities (from version 1.7 for the PG3) enable the programming unit to control not only the RTS but also the DTR interface signals.

By evaluating the DSR signal, the PGU is automatically assigned with the appropriate protocol.

DSR = 1 P8 protocol

DSR = 0 S-Bus protocol, if interface has been configured for S-Bus, otherwise no assignment.

Compatibility and use of programming cable for PCD2, PCD4 and PCD6.M540

Cable PCD8..	Utility	Firmware	P8-PGU (port 0)	S-Bus PGU (port 0)	Notes
K111	new	new	yes	yes	Ideal case
K111	new	old	yes	no	S-Bus not supported by firmware.
K111	old	new	no	no	Cable not supported by utilities, no online connection possible.
K111	old	old	no	no	Cable not supported by utilities, no online connection possible.
K100, K110	new	new	yes	no	S-Bus not supported by cable, may not be set on PG.
K100, K110	new	old	yes	no	S-Bus not supported by firmware and cable.
K100, K110	old	new	yes	no	S-Bus not supported by utility and cable.
K100, K110	old	old	yes	no	P8 protocol only supported.

Utility version : new = from V1.7 (for the PG3)
Firmware version : new = from PCD2.M1x0 -V001
PCD4.Mxx0 -V003
PCD6.M540 -V002
PCD6.M1/M2 -V007

Standard cable (connection)

No special cable is required for connection of the programming unit. Terminal allocations and interface connection examples can be found in the PCD hardware manuals or in the manual “Installation components for RS 485 networks”.

Caution

When connecting non-SAIA devices to PCD interfaces RS422/485, special attention should be paid to signal polarity. SAIA identifies the signal lines with RX, /RX and TX, /TX. Non-SAIA devices often identify them differently, e.g. +RX, -RX and +TX, -TX, which can lead to confusion.

The following normally applies :

SAIA	Non-SAIA device	
RX	D	-RX
/RX	/D	+RX
TX	D	-TX
/TX	/D	+TX

Practical tip :
If connection is unsuccessful, even when the installation is supposedly correct, it is worth trying with transposed data lines.

Appendix C Firmware and software compatibility

Application level 2

Firmware version from which the support application level 2 is provided :

PCD1.M1x0	- V001
PCD2.M110/M120	- V001
PCD2.M150	- V0A0
PCD4.Mxx0	- V003
PCD4.Mxx5	- V00B
PCD6.M540	- V002
PCD6.M1/M2	- V007
PCD6.M300	- V001

RS232 and RTS signal

Firmware before :

PCD2.M1x0	- V002
PCD4.Mxx0	- V004
PCD6.M540	- V003
PCD6.M2x0	- V008

When the RS 232 PCD interface is assigned with the SASI instruction to SM2, SM1, SM0 or SS2, SS1, SS0 mode, the RTS control line status is set high. This would block communications, because the transmitters of all modems or converters (RS 232/485, RS 422/485) on the network would be switched on after initialisation.

In the user program, reset the RTS signal immediately after the SASI instruction by using SOCL.

Example :

```
XOB     16
SASI    3       ; Assign channel 3
        10      ; Definition text 10
ACC  L
SOCL    3       ; Channel 3
        0       ; Reset RTS
EXOB
```


S-Bus data mode

Firmware version from which the S-Bus data mode (SM2, SS2, GS2) is provided :

PCD1 firmware	from V002	(possibly Vß1C)
PCD2.M110/M120 firmware	from V005	(possibly V$45)
PCD2.M150	from V0A0	(since 1st version)
PCD4.xx5 firmware	from V00D	(possibly V$CA)
PCD6.M300 firmware	from V001	(possibly Vß09)

Software version from which the S-Bus data mode is provided :

PG3	from V 2.1
PG4	from V 1.4
SCOMM-DLL 32 bit	from V $114
SCOMM-DLL 16 bit	from V $14
C-Library 16 bit	from V $121
S-Bus Analyser	from V $007

S-BUS FIRMWARE COMPATIBILITY

Features	PCD1. M1x0		PCD2. M110/M120		PCD2. M150		PCD4. Mxx0		PCD4. Mxx5		PCD6. M540		PCD6. M1../M2..		PCD6. M300		Remarks
FW ≥ V.	FW	HW	FW	HW	FW	HW	FW	HW	FW	HW	FW	HW	FW	HW	FW	HW	
Level 1 (reduced protocol)	005	x	001	x	0A0	x	002	x	00B	x	001	x	007	x	001	x	
Level 2 up to 9'600 Bd	005	x	001	A	0A0	x	003	x	00B	x	002	x	007	x	001	x	PCD8.K111 required
Level 1 up to 38.4 KBd	005	x	001	A	0A0	x	003	G	00B	x	002	C	007	x	001	x	
Level 2 up to 38.4 KBd	005	x	001	A	0A0	x	003	G	00B	x	002	C	007	x	001	x	PCD8.K111 required
up to 38.4 KBd optimised	005	x	004	A	0A0	x	---	---	00C	x	---	---	---	---	001	x	major modif. to kernel
Broadcasting PCD as master	005	x	001	x	0A0	x	004	x	00B	x	003	x	008	x	001	x	
Broadcasting PC as master	001	x	003	x	0A0	x	004	x	00B	x	003	x	008	x	001	x	with the Debugger
Data Mode	005	x	005	x	0A0	x	---	---	00D	x	---	---	---	---	001	x	also with Gateway
Download Configuration	001	x	004	x	0A0	x	$52	x	00C	x	$41	x	---	---	001	x	new switches
Gateway	005	x	003	x	0A0	x	---	---	00C	x	---	---	009	x	001	x	
Gateway improved	070	x	080	x	0A0	x	---	---	0E0	x	---	---	---	---	030	x	transparent for telegr.
Modem : Private line	001	x	001	x	0A0	x	002	x	00B	x	001	x	007	x	001	x	
Public line	001	x	001	x	0A0	x	003	x	00B	x	002	x	007	x	001	x	
Reset/Init string	001	x	003	x	0A0	x	005	x	00B	x	004	x	009	x	001	x	
Modem +	001	x	003	x	0A0	x	005	x	00B	x	004	x	009	x	001	x	
Radio modem up to 4'800 Bd	001	x	003	x	0A0	x	005	x	00B	x	004	x	009	x	001	x	TFUL mechanism
RIO functionality	005	x	005	x	0A0	x	---	---	00D	x	---	---	---	---	001	x	activated with SASI
SRXM extension	005	x	003	x	0A0	x	005	x	00B	x	004	x	009	x	001	x	read system info slave
STXMI and SRXMI	005	x	003	x	0A0	x	005	x	00B	x	004	x	009	x	001	x	to transfer DB's
Write station number (Debug.)	001	x	004	x	0A0	x	005	x	00B	x	004	x	009	x	001	x	
XOB 17,18,19	001	x	003	x	0A0	x	005	x	00B	x	004	x	009	x	001	x	
S-Bus Master	005	x	001	x	0A0	x	003	x	00B	x	002	x	007	x	001	x	

--- not implemented in this PCD

X not depending of the hardware version.

1) PCD1 has been implemented with the slave protocol, from firmware V005 all S-Bus Master and Gateway functionalities are allowed.

2) PCD2 **version D, modification 1,** produced in July and August 1995 need a special firmware ($ version) to be able to use all the functionality of the S-BUS.

Notes :

S-BUS SOFTWARE COMPATIBILITY

Features	PCD1. Mx0		PCD2. M110/M120		PCD2. M150		PCD4. Mxx0		PCD4. Mxx5		PCD6. M540		PCD6. M1../M2..		PCD6. M300	
SW ≥ V.	PG3	PG4	PG3	PG4	PG3	PG4	PG3	PG4	PG3	PG4	PG3	PG4	PG3	PG4	PG3	PG4
Level 1 (reduced protocol)	2.0	1.3	1.7	1.21	$219	2.0.80	1.6	1.21	1.6	1.21	1.6	1.21	1.6	1.21	2.1	1.4
Level 2 up to 9'600 Bd	2.0	1.3	1.7	1.21	$219	2.0.80	1.7	1.21	1.7	1.21	1.7	1.21	1.7	1.21	2.1	1.4
Level 1 up to 38.4 KBd	2.0	1.3	1.7	1.21	$219	2.0.80	1.7	1.21	1.7	1.21	1.7	1.21	1.7	1.21	2.1	1.4
Level 2 up to 38.4 KBd	2.0	1.3	1.7	1.21	$219	2.0.80	1.7	1.21	1.7	1.21	1.7	1.21	1.7	1.21	2.1	1.4
up to 38.4 KBd optimised	2.0	1.3	1.7	1.21	$219	2.0.80	---	---	1.7	1.21	---	---	---	---	2.1	1.4
Broadcasting PCD as master	2.1	1.4	1.7	1.21	$219	2.0.80	1.6	1.21	1.6	1.21	1.6	1.21	1.6	1.21	2.1	1.4
Broadcasting PC as master	2.0	1.3	1.9	1.21	$219	2.0.80	1.9	1.21	1.9	1.21	1.9	1.21	1.9	1.21	2.1	1.4
Data Mode	2.1	1.4	2.1	1.4	$219	2.0.80	---	---	2.1	1.4	---	---	---	---	2.1	1.4
Download Configuration	2.0	1.4	2.0	1.4	$219	2.0.80	2.0	1.4	2.0	1.4	2.0	1.4	---	---	2.1	1.4
Gateway	2.1	1.4	1.9	1.3	$219	2.0.80	---	---	1.9	1.3	---	---	1.9	1.3	2.1	1.4
Gateway improved	2.1	1.4	1.9	1.3	$219	2.0.80	---	---	1.9	1.3	---	---	---	---	2.1	1.4
Modem : Private line	2.0	1.3	1.7	1.21	$219	2.0.80	1.7	1.21	1.7	1.21	1.7	1.21	1.7	1.21	2.1	1.4
Public line	2.0	1.3	1.7	1.3	$219	2.0.80	1.7	1.3	1.7	1.3	1.7	1.3	1.7	1.3	2.1	1.4
Reset/Init string	2.0	1.3	1.9	1.3	$219	2.0.80	1.9	1.3	1.9	1.3	1.9	1.3	1.9	1.3	2.1	1.4
Modem +	2.0	1.3	1.9	1.3	$219	2.0.80	1.9	1.3	1.9	1.3	1.9	1.3	1.9	1.3	2.1	1.4
Radio modem up to 4'800 Bd	2.0	1.3	1.9	1.21	$219	2.0.80	1.9	1.21	1.9	1.21	1.9	1.21	1.9	1.21	2.1	1.4
RIO functionality	2.0	1.3	2.0	1.3	$219	2.0.80	---	---	2.0	1.3	---	---	---	---	2.1	1.4
SRXM extension	2.0	1.4	1.9	1.4	$219	2.0.80	1.9	1.4	1.9	1.4	1.9	1.4	1.9	1.4	2.1	1.4
STXMI and SRXMI	2.0	1.4	1.9	1.4	$219	2.0.80	1.9	1.4	1.9	1.4	1.9	1.4	1.9	1.4	2.1	1.4
Write station number (Debug.)	2.0	1.3	1.9	1.21	$219	2.0.80	1.9	1.21	1.9	1.21	1.9	1.21	1.9	1.21	2.1	1.4
XOB 17,18,19	2.0	1.4	1.9	1.4	$219	2.0.80	1.9	1.4	1.9	1.4	1.9	1.4	1.9	1.4	2.1	1.4
S-Bus Master	2.1	1.4	1.7	1.21	$219	2.0.80	1.7	1.21	1.7	1.21	1.7	1.21	1.7	1.21	2.1	1.4

--- not implemented in this PCD

1) PCD1 has been implemented with the slave protocol, from firmware V005 all S-Bus Master and Gateway functionalities are allowed.
2) PCD2 **version D, modification 1,** produced in July and August 1995 need a special firmware ($ version) to be able to use all the functionality of the S-BUS.
3) used always the latest firmware version of the PCD8.P100 (V003 - June 1996)

Notes :

From :

Company :
Department :
Name :
Address :

Tel. :

Date :

Send back to :

SAIA-Burgess Electronics Ltd.
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BA : Electronic Controllers

SAIA® S-Bus for the PCD family

If you have any suggestions concerning the SAIA® PCD, or have found any errors in this manual, brief details would be appreciated.

Your suggestions :