Profibus DP gateway
TOSPBDP001
for TOSHIBA frequency inverters

TOSPBDP001 gateway

user manual

CE ⓊL ⒮Ⓐ®

TOSPBDP001

Profibus DP Gateway for TOSHIBA frequency inverters
user manual revision 1.1 (02/2006)

Contents

Important notice:

This manual has been compiled with great care. However, No responsibility is undertaken for incorrect representation or unmentioned technical corelations. Especially, any liability for damages or injuries that result due to the use of this technical manual is not accepted.

The products and the functions described in this documentation may be modified to suit the latest technological development anytime without notice. The information given in this manual cannot be held valid contractually.

1. Description

The gateway TOSPBDP001 converts Profibus DP sequences to the TOSHIBA frequency inverter serial communication protocol on a 4-wire RS485/RS422 subnet.

Multiple TOSHIBA frequency inverters can be operated with one TOSPBDP001 gateway. The maximum inverter number and line length are limited by the data amount and local circumstances (typical: 5 inverters, 30m line length)

The TOSHIBA protocol data (in binary mode) are forwarded mainly unchanged as Profibus DP data. The TOSHIBA protocol allows access to all parameters and functions of the frequency inverter and provides many useful commands.

Checksum and header-byte of the TOSHIBA communication protocol are added automatically to the RS485 telegrams and removed on the Profibus.

Integrated automatic security functions assure that in case of communication disturbance either on the Profibus or the RS485 subnet the drive will be stopped within one second.

On the fieldbus side the gateway supports Profibus DP as slave:

Communication speed: 9600 bps bis 12Mbit/s.

9 byte input data

8 byte output data

On the RS485 subnet a 4-wire interface is provided:

Communication speed: 19.200 baud

Parity: even

Data bits: 8

Stop bits: 1

2. Terminals

A)   Profibus DP

B)   configuration port RJ-11

C)   subnet RS485 / RS422

D)   voltage supply

E)   DIN-rail mounting with common ground contact
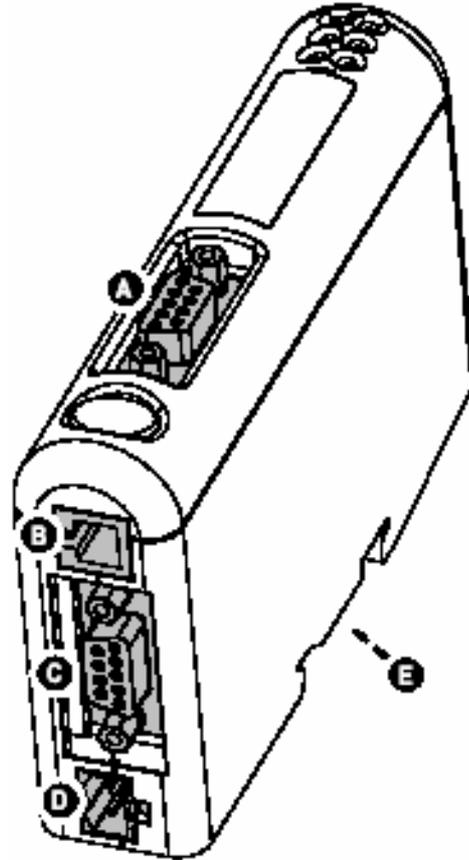
A) Profibus DP:

standard Profibus DP female D-SUB9 jack on the front

Pin	Signal	Description
Housing	Shield	Bus cable shield, connected to PE
1	-	-
2	-	-
3	B-Line	Positive RxD/TxD (RS485)
4	RTS[a]	Request To Send
5	GNDBUS[b]	Isolated GND from RS-485 side
6	+5V BUS[b]	Isolated +5V output from RS-485 side (80mA max)
7	-	-
8	A-Line	Negative RxD/TxD (RS485)
9	-	-
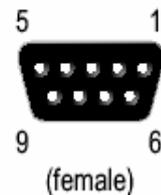
a) in some systems for choosing the sending direction. In most cases only the terminals A-Line, B-Line and Shield are used.

b) For termination. Some devices (optical transceivers RS485-to-Fiber) need a supply voltage of 5V DC at these terminals.

B) Configuration port:

RJ-11 jack (4/4) at the bottom to connect a configuration cable.

Do not use this connection during normal operation.

The gateways TOSPBDP001 are configured to communicate properly with TOSHIBA frequency inverters.

A change of the configuration (and the use of a configuration cable) is not recommended.

C) Subnet RS422/RS485:

D-SUB9 female jack at the bottom

Pin	Description		RS422
1	+5V Output(50mA max)		
2	Reserved - do not connect		
3	Reserved - do not connect		
4	Not connected		
5	Ground	(SG)	✓
6	RS422 Rx +	(RXA)	✓
7	RS422 Rx -	(RXB)	✓
8	RS485 + /RS422 Tx+	(TXA)	✓
9	RS485 - /RS422 Tx-	(TXB)	✓
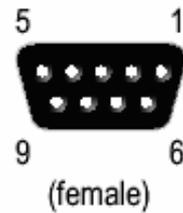
The pins 2 and 3 must not be used.

D) Voltage supply:

24 V ±10% DC voltage, typical consumption 100mA, maximum 280mA

Pin	Description
1	+24V DC
2	GND
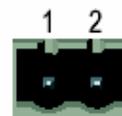
E) Common ground:

Inside the DIN-rail reception is a contact spring. It is connected to the ground of the connector housing of the Profibus DP and RS422/RS485 D-SUB jacks.

3. LEDs and switches

At the front there are six LEDs monitoring the gatway status.

LED Nummer	Zustand	Bedeutung
1 – fieldbus online	off	not online
	green	**online**
2 – fieldbus offline	**off**	**not offline**
	red	offline
3 – unused	-	-
4 – fieldbus diagnosis	**off**	**No Diagnosis**
	red blinking, 1Hz	configuration error
	red blinking, 2Hz	error: user parameter
	red blinking, 4Hz	initialisation fault
5 – subnetz-status	off	no power
	green, blinking	initialisation in progress
	green	**normal operation**
6 – device status	off	no power
	red	stopped, subnet-fault or timeout
	alternating red/green	invalid or missing configuration
	green	initialisation in progress
	green blinking	**normal operation**
	red blinking	contact manufacturer
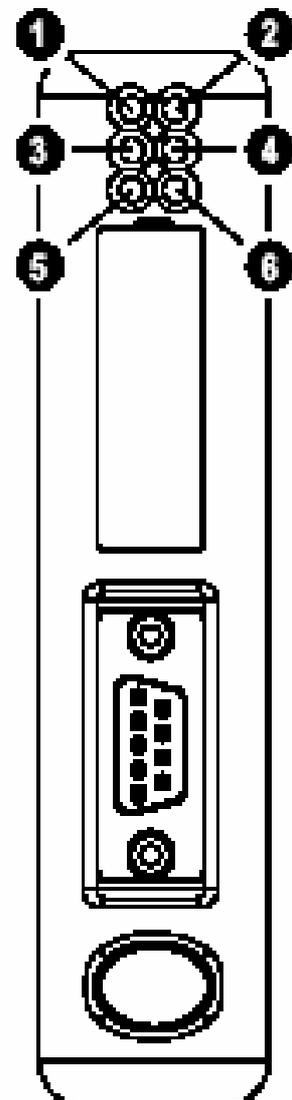
At the front there are two turndials
for configuration of the Profibus DP
slave address (behind the cover):

The Profibus address is combined
as follows:

**(switch B x 10) + (switch A)**

switch A: top
switch B: bottom

by default every gateway TOSPBDP001
is configured with Profibus address „02".
(switch A = 2, switch B = 0)
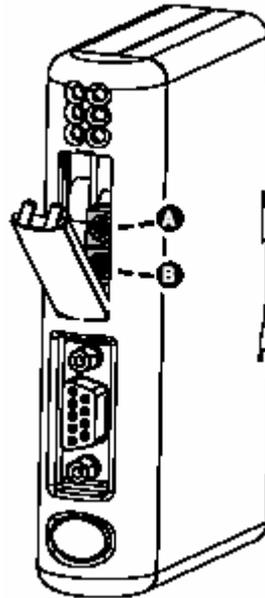
Changing the address will become effective after power-cycling the gateway.

4. DIN-rail mounting
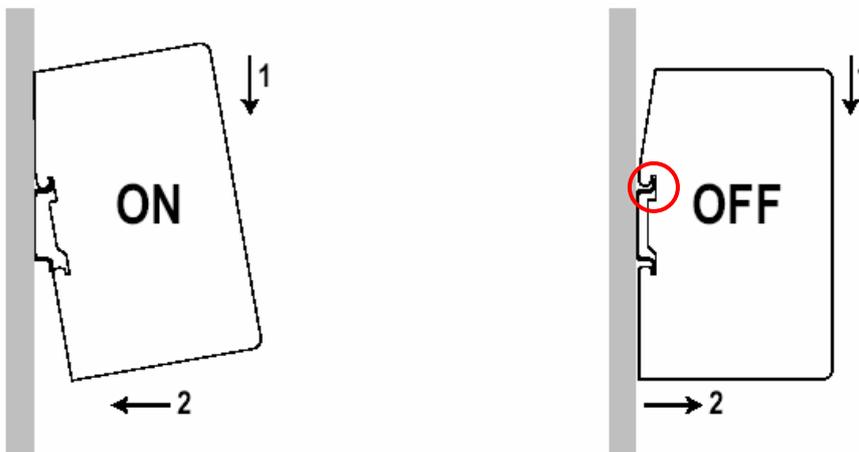
In the upper dent of the DIN-rail reception is a spiral spring for ground contact. It is connected with the ground of the D-SUB jacks.

5. RS485 wiring

Series VF-A7/P7 inverters can be connected using ordinary ethernet patch cables and ISDN Y-distributors:
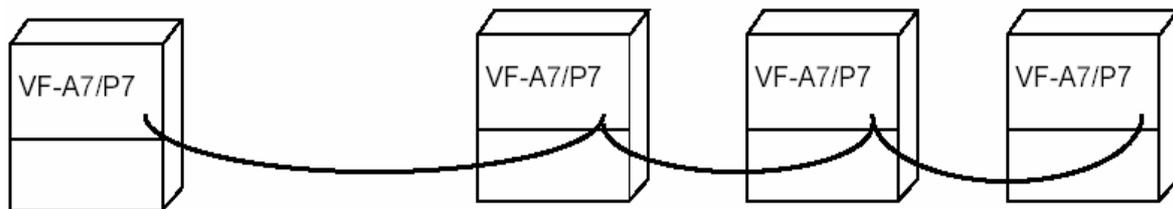
Series VF-S11 Inverters (with RS485 option board with screw terminals) can be connected likewise. Also a subnet with different series' inverters is possible.

Install the RS485 inverter subnet as follows:
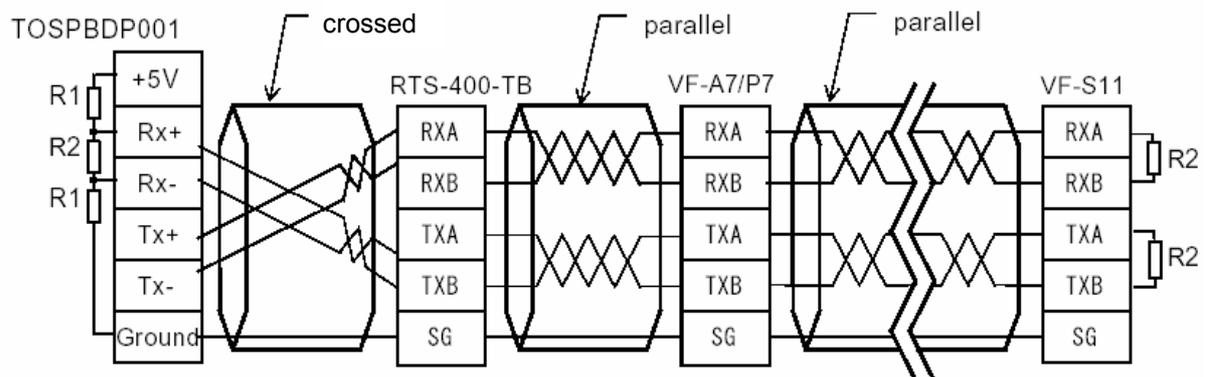
R1: BIAS-resistors   (500-700 Ω 1/2W)   R2: termination resistors (100-120 Ω 1/2W)

A cable CABTOSPB001 with integrated BIAS- and termination resistors for connecting the first TOSHIBA frequency inverter with the gateway TOSPBDP001 is available. Connecting further TOSHIBA frequency inverters can usually be done by using 8-wire Ethernet cable: CAT5, S-FTP, AWG 26 stranded, Z_0 = 100 Ω.

Inside the TOSHIBA frequency inverters series VF-S11 the termination resistors (110 Ω) can be switched on or off. Use ISDN terminators (100 Ω) and Y-adapters together with inverters series VF-A7 and VF-P7.

Use termination resistors only when using BIAS-resistors.

For simple applications (1-2 inverters, line length <2m) the BIAS- and termination resistors R1 and R2 can be left away. In this case the PLC programming has to contain a control procedure to assure that the data has been received correctly.

The timout function of the inverter should be deactivated then ($F803 = 0$, see chapter 6. parameters and chapter 7., security functions).

The following colour-to-signal assignment is valid for the cable CABTOSPB001:

RXA	blue		TXA	green-white
RXB	blue-white		TXB	green
SG	brown and orange		SHLD	shield
(P24)	(orange-white)		(P5)	(brown-white)

Do not use the contacts P24 or P5 of the communication interface!

A) Series VF-S11:   screw terminals on the option board RS4003Z
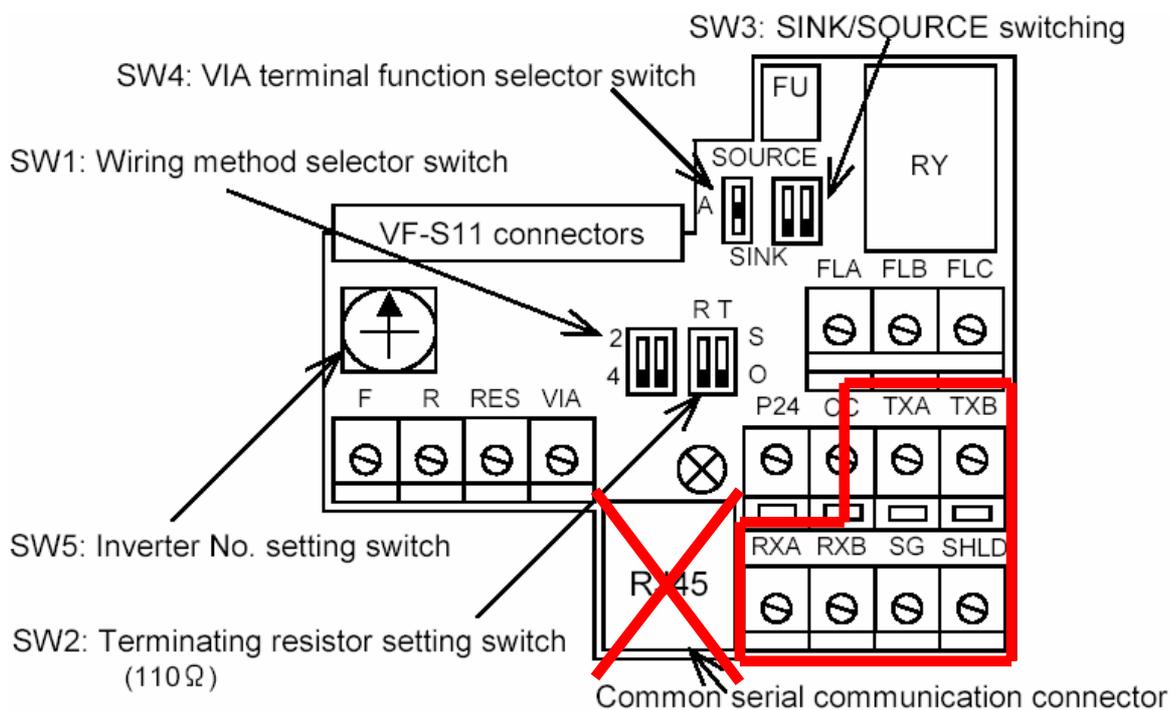
Do not use the TTL (RJ45) jack for RS485/RS422 signals!

All TOSHIBA frequency inverters series VF-S11 connected to one common subnet – except the one at the end of the line – must be configured as follows (SW1, SW2):

Only the TOSHIBA frequency inverters series VF-S11 at the end of the line must be configured as follows (SW1 and SW2):

B) Series VF-A7/-P7:   RS485 interface integrated as standard
                              (RJ-45 jack)

8-pin   1-pin
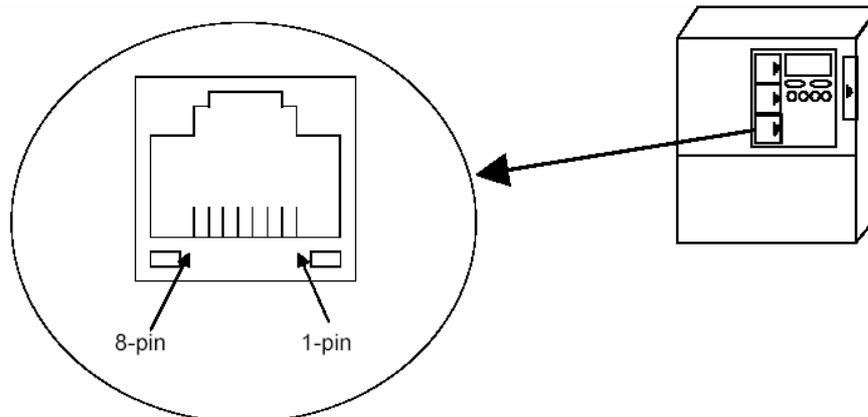
Signal name	Pin assignment	Purpose
RXA	4	In-phase receiving data (positive line)
RXB	5	Opposite-phase receiving data (negative line)
TXA	3	In-phase transmission data (positive line)
TXB	6	Opposite-phase transmission data (negative line)
SG	2 , 8	Ground of signal lines
P24	1	24V(Connection prohibited)
P5	7	5V(Connection prohibited)

Signal line seen from the inverter side (Ex. RXA is received at inverter side.)

C) Series VF-nC1/-S9:   TTL-to-RS485 converter option (e.g. RTS400 TB)

With the optional converter module RTS400 TB one ore two TOSHIBA frequency inverters with a TTL interface can be connected to the RS485 subnet.

The TTL interface at the TOSHIBA frequency inverters and at the RTS400 TB module is supplied by a RJ-45 jack. Therefore ordinary ethernet patch cables can be used for connection. The TTL cable length should as short as possible (<2m) to avoid signal distortion through radio interference. Additionally the cable shield can be grounded.
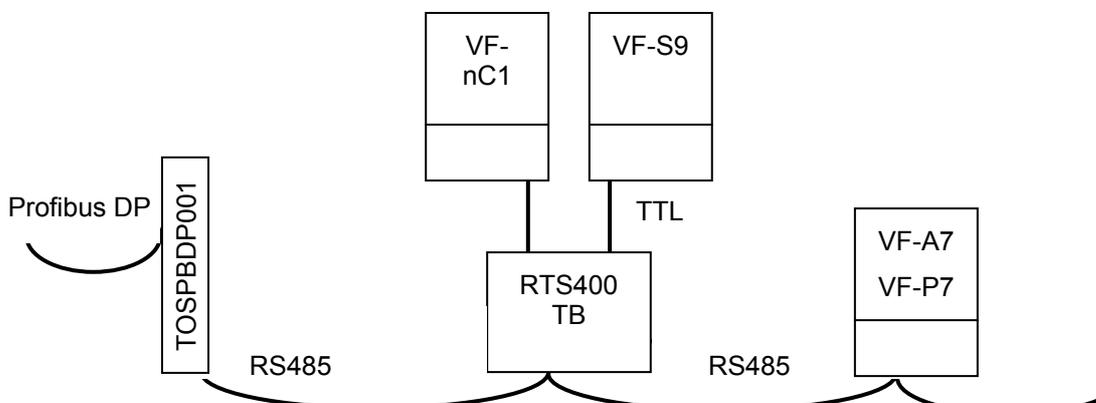
6. Parameter settings of the TOSHIBA frequency inverters

The following inverter parameters must be programmed for the communication to function:

VF-S9, VF-S11, VF-nC1:

F800	4	Communication speed (reset or power-cycle required!)
F801	1	Parity (reset or power-cycle required!)
F802	XX	Inverter identification number (INV-NO)
F803	1	timeout for communication errors

VF-A7, VF-P7:

F801	1	Parity (reset or power-cycle required!)
F802	XX	Inverter identification number (INV-NO)
F803	1	timeout for communication errors
F820	4	Communication speed (reset or power-cycle required!)

Note: A power-cycle has to be performed before the settings of the parameters F800, F801 und F820 become effective. The inverter has to stay switched off until the LED Display is darkk. At powering up the changes will be taken over.

The inverter identification numbers have to be unique to one common RS485 subnet.

At TOSHIBA frequency inverters series VF-S11 with RS485 option board (RS4003Z) the intetification numbers 0 to 15 can be choosen with the durndial SW5 (see chapter 5. passage A, wiring). Settings in parameter F802 (INV-NO) are only valid when SW5 is in position **0**. In all other positions of SW5 the setting of is F802 (INV-NO) irrelevant.

Setting parameter F803 **=** 1 (timeout for communication errors) causes the inverter to stop the drive, when no telegram (write command) is received within one second. This should be used with a subnet equipped with BIAS and termination resistors (see chapter 5., wiring and chapter 7., security functions).

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7. Security functions

For surveillance of the data connection and for protection against wire cut the gateway automatically sends a safety telegram every 500ms, that will be processed by all TOSHIBA frequency inverters.

When an fault occurs in the Profibus DP connection the gateway TOSPBDP001 stops sending these safety telegrams.

TOSHIBA frequency inverters that have set a timeout (parameter $F803$, unit is approximately one second) will trip with a communication error ($Err5$), when not receiving a security telegram or a write command within the set time.

The security telegrams will not be visible on the Profibus DB fieldbus.

The PLC programming is recommended to perform a cyclical status monitoring of all TOSHIBA frequency inverters. Register FC90 (see chapter 8 passage E, communication number) contains actual status information. During normal operation in ComNo FC90 is stored a 0000h. A key to the error codes can be found in one of the manuals for the serial communication: (e6581139.pdf, e6581222.pdf, e6581230.pdf, E6580793.pdf, e6581140.pdf).

If other frequency inverters have to be tripped automatically in case that one is tripped, connect the inverters as follows:

external trip switch (breaker)

last TOSHIBA frequency inverter
terminal connections:
RES   FLB   FLC   CC

inverted signal for external trip

inverted trip signal

first TOSHIBA frequency inverter
terminal connections:
RES   FLB   FLC   CC

PLC-input

24 V =
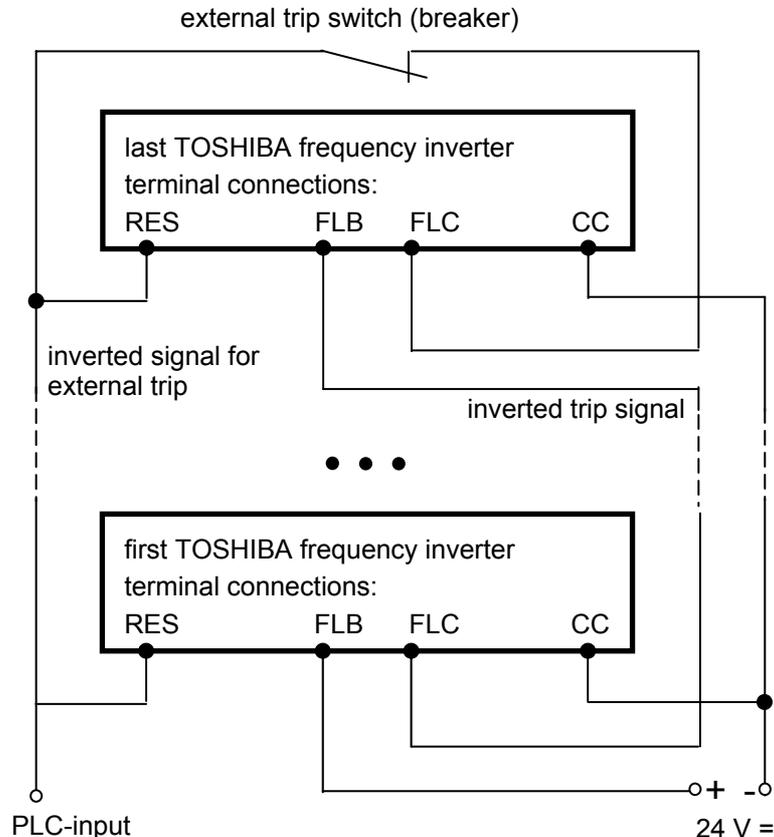
programming of the terminal parameters for this setup: see next page

Parameter setting for the above external trip circuit:

VF-S9/S11:   F113 = 45   input RES = function EXTN, inverted ext. trip stop
              F132 = 10   output FL = trip relais, default setting

VF-P7/A7:   F114 = 21   input RES = inverted external trip stop
              F132 = 10   output FL = trip relais, default setting

A trip can be cleared with an additional terminal signal or by communication:

Profibus DP sending data for a reset:								
control		trg	INV	CMD	ComNo.		DATA	
xx	xx	xx	FF	50	FA	00	20	00

8. Telegram structure

The communication is based on the TOSHIBA communication protocol (binary mode) for TOSHIBA frequency inverters like it is described in the manuals for serial communication:

series VF-S9:   e6581139.pdf

series VF-S11:   e6581222.pdf, e6581230.pdf

series VFP7/A7: E6580793.pdf

series VF-nC1:   e6581140.pdf

The gateway TOSPBDP001 automatically adds and removes the TOSHIBA header byte and the checksum byte on the RS485 subnet side. Additionally provided on the Profibus DP side are 2 bytes of status information and 2 bytes of control information and 1 trigger byte:

Profibus DP telegrams:

sending to the gateway:

BYTE 1	BYTE 2	BYTE 3	BYTE 4	BYTE 5	BYTE 6	BYTE 7	BYTE 8	BYTE 9
control		trigger	INV-NO	CMD	ComNo		DATA	

receiving from the gateway:

BYTE 1	BYTE 2	BYTE 3	BYTE 4	BYTE 5	BYTE 6	BYTE 7	BYTE 8
status		INV-NO	CMD	ComNo		DATA	

GSD – file

The GSD-file `ESCO1803.GSD` is also available in file format.

```
;================================================================
; Profibus Device Database of :
; HMS Industrial Networks Communicator
; Model : ANYBUS-C PDP Toshiba Inverter
; Description : ANYBUS-C Profibus Communicator Toshiba Inverter
; Language : English
; Date : 21 May 2001
; Author : HMS Industrial Networks AB
;
;
;================================================================
#Profibus_DP

GSD_Revision        = 2

; Device identification
Vendor_Name         = "HMS Industrial Networks AB"
Model_Name          = "ANYBUS-C PDP Toshiba Inverter"
Revision            = "Version 1.1"
Ident_Number        = 0x1803
Protocol_Ident      = 0                 ; DP protocol
Station_Type        = 0                 ; Slave device
FMS_supp            = 0                 ; FMS not supported
Hardware_Release    = "Version 1.4"
Software_Release    = "Version 1.1"

; Supported baudrates
9.6_supp            = 1
19.2_supp           = 1
45.45_supp          = 1
93.75_supp          = 1
187.5_supp          = 1
500_supp            = 1
1.5M_supp           = 1
3M_supp             = 1
6M_supp             = 1
12M_supp            = 1
```

```
; Maximum responder time for supported baudrates
MaxTsdr_9.6          = 60
MaxTsdr_19.2         = 60
MaxTsdr_45.45        = 250
MaxTsdr_93.75        = 60
MaxTsdr_187.5        = 60
MaxTsdr_500          = 100
MaxTsdr_1.5M         = 150
MaxTsdr_3M           = 250
MaxTsdr_6M           = 450
MaxTsdr_12M          = 800


; Supported hardware features
Redundancy           = 0          ; not supported
Repeater_Ctrl_Sig    = 2          ; TTL
24V_Pins             = 0          ; not connected
Implementation_Type  = "SPC3"


; Supported DP features
Freeze_Mode_supp     = 1          ; supported
Sync_Mode_supp       = 1          ; supported
Auto_Baud_supp       = 1          ; supported
Set_Slave_Add_supp   = 0          ; not supported


; Maximum polling frequency
Min_Slave_Intervall  = 1          ; 100 us


; Maximum supported sizes
Modular_Station      = 0; not modular
Modul_Offset         = 1


Fail_Safe            = 0          ; state CLEAR not accepted


Slave_Family         = 0
Max_Diag_Data_Len    = 6


; Definition of modules
Module = "Binary Mode" 0x30,0x30,0x20,0x30,0x30,0x70,0x20,0x70
EndModule
```

A) Control- and status word (byte 1 and 2):

Using the status- and the control word is optional, that means data is transmitted by the gateway independently. Their purpose is to provide a means to survey regular operation.

The gateway counts up byte 2 of the status word while receiving corrupted serial telegrams. Receiving the first valid telegram it sets back byte 2 to 00h.

After power-on the status wort is e.g. 9F00h (10011111 00000000 b).

Bit 14 and 15 serve as handshake:

- Receiving a control command the gateway takes over bit 14 of the control word into bit 14 of the status word.

  The gateway toggles bit 15 of the status word, when new status information is available.

- The PLC programming shall toggle bit 14 of the control word every time a new control command is issued. Otherwise the control command is not processed by the gateway (for example actualisation of the status information)

  After reading the status word the PLC programming should take over it 15 of the status word into bit 15 of the control word.

Bit No.	control byte 1	handshake	status byte 1
15	PLC takes over	⟵	gateway toggles
14	PLC toggles	⟶	gateway takes over

See also example in section G).

Bit 13 (Data Valid) is currently (07/2005) not used.

During regular operation the status words can therefor have four states:

Hex		Statusbyte 1								Statusbyte 2							
1	2	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
1F	00	0	0	0	1	1	1	1	1	0	0	0	0	0	0	0	0
5F	00	0	1	0	1	1	1	1	1	0	0	0	0	0	0	0	0
9F	00	1	0	0	1	1	1	1	1	0	0	0	0	0	0	0	0
DF	00	1	1	0	1	1	1	1	1	0	0	0	0	0	0	0	0

B) Trigger byte (byte 3):

Only after a change of byte 3 in the telegram sent to the gateway the data is for-warded to the TOSHIBA frequency inverter(s).

This allows for repetitive and asynchroneous transmission of telegrams, for example continous reading of the inverter status or value monitoring.

The state of byte 3 after power-on is 0x00.

Note: It is possible to program a counter inside the PLC to run from 01h to FFh cycli-cally for the trigger byte 3 or just to toggle one bit.

C) Inverter identification number (INV-NO):

See also chapter 6., parameter setting

The TOSHIBA frequency inverters only process telegrams that contain their identifi-cation nummer or **FF**.

Telegrams to the INV-NO **FF** are called braodcast, and will be processed by all re-ceiving inverters, but only answered by inverter number **0**.

Broadcasts allow to issue commands that will be executed by all TOSHIBA fre-quency inverters on the same RS485 subnet **simultaneously**.

Brodacasts are transmitted as normal telegrams but to the *virtual* frequency in-verter identification number (INV-NO) **FF**. No TOSHIBA frequency inverter can be set to have the identification number **FF** on his own.

All receiving frequency inverters (with all their INV-NOs) process these telegrams.

Only the inverter with the number **0** answers broadcasts.

Note:

The security functions are realised with a broadcast (in ASCII-mode). All receiving in-verters process these telegrams and restart their timeout counters (1 Second, pa-rameter F8ロヨ = 1). Only the inverter with the number **0** answers (heartbeat). Tele-grams in ASCII-mode are blocked by the gateway TOSPBP001 and are not for-warded to the Profibus DP.

D) Commands (CMD):

The following commands (Profibus DP sending byte 5) from the TOSHIBA frequency inverter serial communication protocol are supported:

Hexadezimal	ASCII	Explanation
50	P	Write to RAM. Data is retained until reset or power-cycle.
57	W	Write to EEPROM. Data is retained permanently. This command should not be used during normal operation because the EEPROM can perform only 10.000 writes in average.
53, 73	S, s	Write to RAM. Data is retained until reset or power-cycle. The inverter does not answer. Speed commands will be scaled, see passage E)
47	G	Read. The data in Profibus sending byte 8 und byte 9 are dummy data (Irrelevant for read commands.

E) Storage address (ComNo):

The communication number to each parameter acan be found in the english manuals in the parameter lists. More addresses can be found in the passage „Monitoring the operation status". This number is given as hexadecimal value.

Example: ᗄᑕᑕ (acceleration time)   ComNo: 0090h

         Pxxx (output voltage)   ComNo: FE05h

Besides parameters and monitor values there are special registers for data communication:

FA00 (FA04)   Start-, Stop-, Reset commands, change of direction and others

FA01 (FA05)   Frequency command

FC90   Inverter status

More addresses („Communication Numbers") and a detailed description of can be taken from the english manuals for the serial communication (e6581139.pdf, e6581222.pdf, e6581230.pdf, E6580793.pdf, e6581140.pdf). See also the example in passage E) in this chapter.

F) Data (DATA):

In the english product manuals in the parameter lists is given the resolution as „Minimum setting unit Communication" (use the figure right of the „/"). Calculate settings as follows:

Sending word = Hex(value / unit)

Example: FH   (maximum frequency)   = 50Hz
Sending word = 50 / 0.01 = 5000d = 1388h   byte 8 = 13, byte 9 = 88

Using the commands 53/73 („S"/"s") the frequency references are transmitted as prcetuel value of the maximum frequency (possible values are from 0000h to FFFFh).

Internally the references are scaled through the parameters FB11 to FB14 :
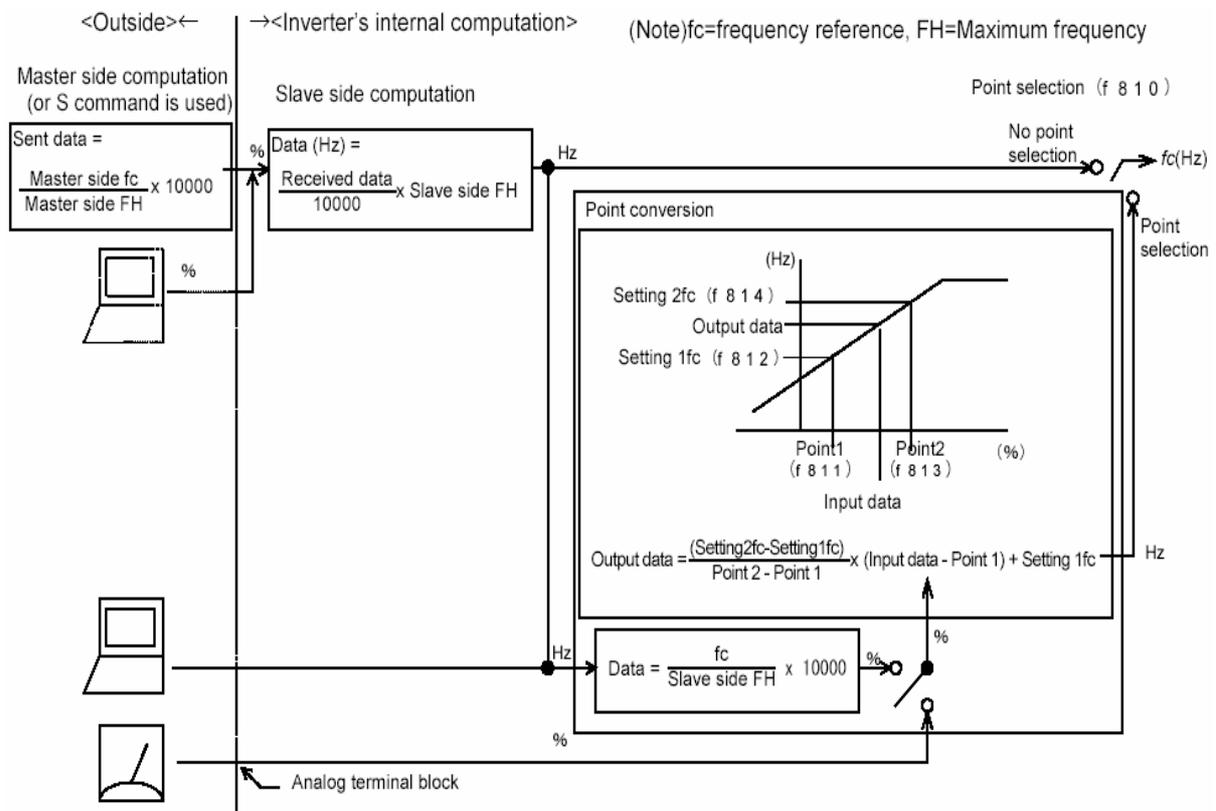
G) Communication example:

Inverter No. 11 shall run forward at 50Hz, the current be read and then be stopped:

sent telegrams:									received telegrams:							
control		trg	INV	CMD	ComNo.		DATA		status	trg	CMD	ComNo.		DATA		
E0	00	01	0B	50	FA	00	C4	00	DF	00	0B	50	FA	00	C4	00
A0	00	02	0B	50	FA	01	13	88	9F	00	0B	50	FA	01	13	88
E0	00	03	0B	47	FE	03	xx	xx	DF	00	0B	47	FE	03	10	E8
A0	00	04	0B	50	FA	00	C2	00	9F	00	0B	50	FA	00	C2	00

10E8h = 4328d - The current is 43,28 % of the inverters' rated current

For an explanation of the control- and status- bytes please see passage A.

9. Timing

Programming the PLC care should be taken for timing issues:

Use system functions for consistent writing and reading (e.g. SFC14, SFC15), when you need so send and receiva data several times during one PLC cycle. The process snapshot (PBA x, PBE x, PWA x, PWE x, etc.) is synchronised with the Profibus only once per PLC cycle.

Telegrams are answered by the inverters during the following answering times (the commands 53h und 73h will not be answeres, see passage C, commands):

VF-S11   max. 20ms

VF-A7/ P7   max. 15-20ms

VF-nC1   max. 78ms

Off course the gateway can send data only with the subnet data rate (19200 baud). Data inside the input buffer of the gateway that is not sent already will be overwritten by new Profibus telegrams. On the RS485 subnet there will be 8 byte data transmitte in either direction. With the default rate 19.200 baud transmission takes 5ms per telegram:

(1 starting bit + 8 data bits + 0…1 parity + 1…2 stop bits) * 8 byte / 19.200 = ~5ms

The gateway TOSPBDP001 needs an additional processing time of ca. 5ms in either direction.

Therefor the time between sending a command from the PLC and receiving the answer from one TOSHIBA frequency inverter series VF-S11 and VF-P7 will usually be roughly 30-40ms.

To avoid data collision on the subnet telegrams to different inverters on the same RS485 subnet (excepted commands 53h und 73h) must be delayed minimum by the answering time (VF-S11, VF-A7/P7: 20ms). Otherwise two inverters could be sending the same time and data loss may occur.

Commands 53h and 73h will not be answered by the addressed TOSHIBA frequency inverter and therefor no waiting tim is necessary.

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10.   Technical data

Type	TOSPBDP001
Protection	IP20
Dimensions	(L x W x H) 120 x 75 x 27 mm
Temperature during operation	-5°C...+55°C
Storage temperature	-55°C...+85°C
Humidity	0...95% (not condensing)
Cooling	passivly self cooling
Supply voltage	24V DC ± 10%
Consumption	typically 100 mA, maximum 300 mA
Certification	CE, UL (E214107)

Technical details may be changed without notice.