User Manual – Software & Configuration

Intrinsic Safety Interface

Series 3000

PEPPERL+FUCHS ELCON

Worldwide Headquarters – Pepperl+Fuchs GmbH – Königsberger Allee 87 – 68307 Mannheim - Germany
Phone +49 621776-0 - Fax +49 621776-10 00 – http://www.pepperl-fuchs.com - Email: info@de.pepperl-fuchs.com
USA Headquarters - Pepperl+Fuchs Inc. – 1600 Enterprise Parkway Twinsburg – Ohio 44087 – Cleveland - USA
Phone +330 4253555 - Fax +330 4254607
Asia Pacific Headquarters - Pepperl+Fuchs Pte Ltd – P+F Building –18 Ayer Rajah Crescent – Singapore 139942
Phone +65 7799091 - Fax +65 8731637
Italy Headquarters - Pepperl+Fuchs Elcon – Via delle Industrie 4 – 20050 Mezzago (MI) - Italy
Phone +39 039 62921 - Fax +39 039 6292240 - Email: info@it.pepperl-fuchs.com

TABLE OF CONTENTS

1 INTRODUCTION

1.1 HiD 3000 overview

An HiD 3000 I/O station consists of a Communication Gateway (CG) and up to 16 I/O modules, located on a single plug-in Termination Board (TB). The I/O stations are connected to the Host Device by an industrial-standard fieldbus communication channel. The Host Device acts as the fieldbus “master”.

For each specific fieldbus, a specific Communication Gateway is required. Currently, you con select either a Modbus or Profibus CG. Clearly, an Host Device must be available that is compatible with the selected gateway.

An I/O station, in order to operate, requires a set of configuration data and parameter, which are related both to the desired operating mode and to the signal treatment that is locally performed on the I/O station. In order to simplify the configuration activity, Pepperl+Fuchs Elcon provides a PC-based software tool called HMI (Human Machine Interface) that, when required, can be locally connected to the I/O station by an RS-232 serial line.

In addition to the basic configuration activities, the HMI tool can also be used as an aid to project engineering, commissioning and maintenance for all type of HiD 3000 slave stations. The HMI acts as local monitor and allows the user to exercise the I/O Station without the need of an operating Host Device. The HMI tool can also be used, when desired, to “record” the I/O Module configuration for documentation purposes and later transfer to the Host Device. Note: the HMI tool is optional as for Profibus configuration but mandatory as Modbus usage.

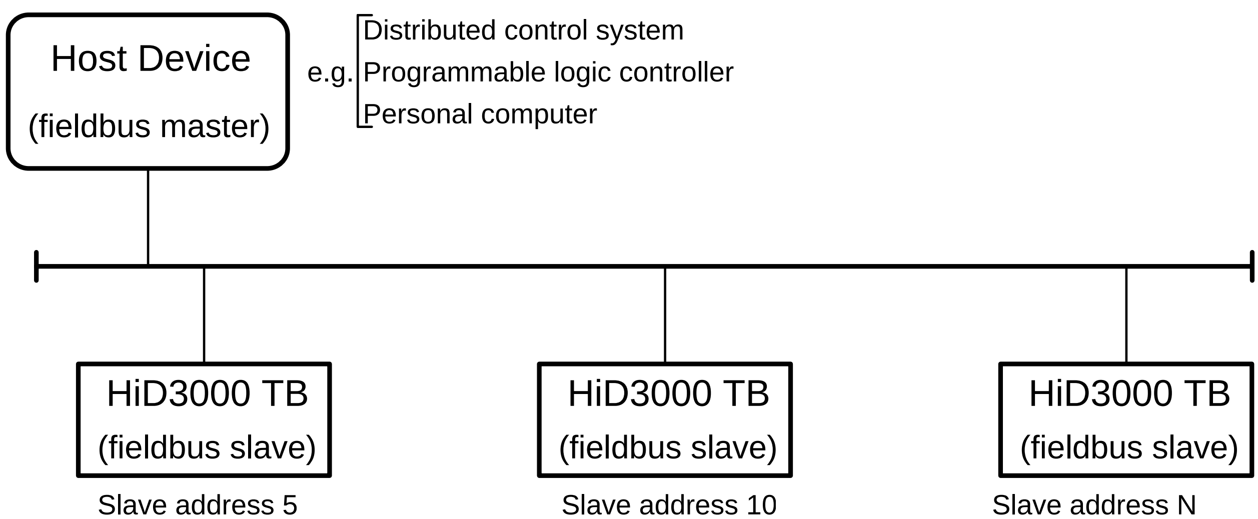

Figure 1: HiD3000 application configuration

1.2 Gateways overview

The Profibus gateway provides many convenient features that can be effectively implemented at the Host Device level, where they can be easily managed in an unified way, without need to connect a local configuration tool. Moreover there is no need to store locally on the HiD 3000 slave station any non-volatile configuration value, with the benefit of an increased reliability.

The Modbus gateway doesn’t support a remote configuration option, so the usage of the locally connected HMI tool is mandatory. In this case, it is necessary to store the configuration parameters within the gateway non volatile memory.

The selection of gateway type – Profibus or Modbus – generally depends on many issues, like the available Host Device, the application requirements and the available fieldbus experience. Profibus provides higher communication speed, full remote configuration capability and a completely standardised solution. Modbus can be cheaper at the Host Device level, it is less sophisticated (and so easier to use) and more flexible in implementing “special” configurations. Note: Modbus is a trademark of Modicon Inc.

2 I/O MODULES FUNCTIONS AND CONFIGURATION

The HiD 3000 series was designed to be as easy as possible to set-up and maintain. The available configuration options were therefore carefully selected to make set-up straightforward, avoiding rarely used and cumbersome operating modes.

In the following, the configuration options associated with each HiD 3000 module are described in detail.

2.1 HiD 3010 2-channel Analog I/O module

The HiD 3010 is a 2-channel analog module, intended to interface with – and power – both input and output 4/20 mA field devices. You can set-up the unit in three different modes:

- both channels behave as analog inputs;
- both channels behave as analog outputs;
- 1st channel behaves as analog input, 2nd channel behaves as analog output.

This is a ***circuit set-up*** (and not a software configuration option) and can be obtained by DIP-switches setting at the module level. In fact, at the software configuration level (and at the Fieldbus communication level) it looks like you have 3 distinct HiD 3010 types:

- HiD 3010 - input mode;
- HiD 3010 - output mode;
- HiD 3010 - mixed mode.

You can easily select the desired HiD 3010 type by the using the following set-up table:

Operating mode	DIP-1	DIP-2
HiD 3010 - input mode	ON	ON
HiD 3010 - output mode	OFF	OFF
HiD 3010 - mixed mode	ON	OFF

Table 2: HiD 3010 HW set-up

The HiD 3010 can detect either a short-circuit or an open-circuit fault on the field-device connection cables (N.B. when the channel is configured as an AO, the short-circuit fault can not be detected).

As for AI, this is obtained by detecting a too low or too high analog value at the current loop level (the check is made at the Communication Gateway level, with fixed thresholds). When a fault is detected, the associated diagnostic flag is set and the fault LED is switched on. As for AO, an out-of-compliance status of the output current generator is detected (i.e. a too high output voltage is measured).

When you wish to disable the fault-detection capability on a given channel, you can use the ***Mask fault*** configuration option, which disable both the diagnostic flag and the LED indication. This can be useful when you have unused channels or when you want to get a 0-20 mA – rather than 4-20 mA – range, and you don't want to get a fault indication when going near to 0 mA.

For all output modules, the HiD 3000 series allows for a "safe output" operating mode. This is active when the HiD 3000 slave station is not able to communicate with the central Host Device, either for a communication cable problem or for any other type of fault. In this case, it is either convenient to set the output channels in a predefined status – or to "freeze" them in the current one – up to when the communication is recovered.

By the ***Freeze output*** configuration option, you can activate the "freeze" operating mode. When this mode is not active, you can also use the ***Safe AO*** configuration option to select the desired "safe" output status (specified either as a mA or as a Hex value).

You should remember that the "safe output" operating mode is triggered by the "communication loss" watch-dog located at the Communication Gateway level, and that only when the watch-dog expires is the specified "safe" status set on the relevant outputs. You should therefore enable the "communication loss" watch-dog, and set it to the desired time interval in order to make the "safe output" mode active (this is a Host Device configuration option).

2.2 HiD 3040 4-channel Temperature Input module

The HiD3040 is a flexible 4-channel module for direct interface with all commonly used Thermocouple and RTD sensors. In addition, direct mV and Ohm measurement can be performed, as well as a potentiometer position measured.

The unit makes available 4 fully-isolated ***mV/TC*** channels, one of which can be used for Cold Junction compensation by directly connecting an RTD sensor provided with each unit. As for ***RTD*** measurements, two channels with a common point are supported, with the option of selecting a 2-wire, 3-wire or 4-wire connection.

A wide range of input sensor types is made available, all with a sensor-specific, high accuracy linearisation. Line fault management and CJC strategy is fully supported and configurable. All operating modes and functional options are fully managed under SW control (no DIP-switch or jumper required).

The HiD3040 can work in one out of four different operating modes, according to the selected sensor family:

- ***RTD*** operating mode (2 input channel, not isolated)
- ***Potentiometer*** operating mode (2 input channels, not isolated)
- ***TC/mV*** operating mode (4 input channels, fully isolated)
- ***TC/mV with CJC*** operating mode (3 + 1 input channels, fully isolated)

For each operating mode, one specific sensor type is to be selected among the available ones, as summarised in the following table:

RTD		Potentiometer	mV/TC with CJC	mV/TC without CJC
RJC Cu109		Potentiometer	B	B
DIN	Pt10	Potentiometer + C.T. (*)	E	E
	Pt50		J	J
	Pt100		K	K
	Pt1000		L	L
GOST	Pt10		N	N
	Pt50		R	R
	Pt100		S	S
	Pt1000		T	T
Ni100			100mV	100mV
Cu10			TC + C.T. (*)	TC + C.T. (*)
Cu50			100mV + C.T. (*)	100mV + C.T. (*)
Cu100				
R400				
R4000				
R400 + C.T. (*)				
R4000 + C.T. (*)				

(*) for future implementation, C.T. = custom table

Table 3: HiD3040 operating modes and sensor types

For each operating mode, apart from the sensor type selection, a set of additional configuration option are made available, that are shortly described in the following (see also Appendix A.):

- **Channel fault:** (available in all operating modes)

– enable

– disable

You can disable the line fault detection on each single input channel. This disable both the fault LED indication and the Gateway fault indication.

- **Fault strategy:** (available in all operating modes)

– freeze input

– set input High

– set input Low

When a line fault is detected in an input channel, you have the choice either to freeze the input measurement to the last valid value or to force to the upper or lower limit of the measuring range for the selected sensor.

- **Burn-out test:** (available in the *TC/mV* and *TC/mV with CJC* operating modes)

– enable

– disable

You have the option to disable the sense current that is periodically injected in the TC input to check for a possible "burn-out" (i.e. open circuit) condition. When you disable the burn-out current, a TC line fault will no more be detected.

- **CJC style:** (available in the *TC/mV* and *TC/mV with CJC* operating modes)

– disable

– fixed

– internal // module number

When interfacing with Thermocouples, you need to use a Cold Junction Compensation sensor. The CJC can be connected to the first channel of the module (TC/mV with CJC operating mode), reducing the available channels to 3. Alternatively, you can decide to obtain the CJC by using the temperature measured on the first channel of another HiD3040 module located on the same TB, making 4 channels available.

With the first approach, that we can call *local CJC*, you get a better temperature tracking; with the second approach – *remote CJC* – you increase the channel numbers when many HiD3040 are present on the same TB (up to 63 thermocouples channels on a single 16-position termination board.

When you wish to operate in the *local CJC* mode, you must set "*TC/mV with CJC"* mode and then select the *internal* CJC configuration option.

When you wish to operate in the *remote CJC* mode, you must set the *TC/mV* operating mode and then specify the *module number* from which you wish to get the CJC temperature measurement.

Finally, you have always the option to fully disable any CJC activity or to set a fixed temperature value which will substitute the measured CJC value.

2.3 HiD 3824 4-channel Digital Input module

The HiD 3824 can interface with up to 4 NAMUR proximity sensors or voltage-free contacts. In both cases, an input voltage level near to 0 volts is translated into a 0 digital bit. In some situations it is however convenient to associate a “0” input voltage with a “1” digital bit. This could be useful, for example, when your goal is to always associate a digital “1” to the “active” status of the input sensor.

When this is required, you can use the ***Invert input*** configuration option to get the desired behaviour on each specific channel. You should however remember that you only invert the digital bit value and not the HW input status. This means that a 0 input-voltage level is always associated with a “switched-on” channel status LED on the module itself.

The HiD 3824 is able to detect both short-circuit and open-circuit faults on the input sensor connection cables (when a NAMUR-compliant sensor is not used, you need two externally connected resistors to get this function). When a fault is detected, the associated diagnostic flag is set and the fault LED is switched on.

When you wish to disable the fault-detection capability on a given channel, you can use the ***Mask fault*** configuration option, which disables both the diagnostic flag and the LED indication. This can be useful either when you have unused channels or when you wish to connect a voltage-free contact with no external resistors.

2.4 HiD 3878 2-channel Digital Output module

The HiD 3878 is a 2-channel solenoid-driver unit, intended to interface with valves, alarm sounders, or displays. When a digital “1” bit is sent to the unit, the field-device is energised and the status LED switched on.

The HiD 3878 can detect either a short-circuit or an open-circuit fault on the field-device connection cables. When a fault is detected, the associated diagnostic flag is set and the fault LED is switched on.

When you wish to disable the fault-detection capability on a given channel, you can use the ***Mask fault*** configuration option, which disables both the diagnostic flag and the LED indication. This can be useful when you have unused channels or when you wish to connect some very special field devices, whose voltage and current levels would result in a wrong fault indication.

For all output modules, the HiD 3000 series allows for a “safe output” operating mode. This is active when the HiD 3000 slave station is not able to communicate with the central Host Device, either for a communication cable problem or for any other type of fault. In this case, it is either convenient to set the output channels in a predefined status – or to “freeze” them in the current one – up to when the communication is recovered.

By the ***Freeze output*** configuration option, you can activate the “freeze” operating mode. When this mode is not active, you can also use the ***Safe DO*** configuration option to select the desired “safe” output status (“energised” or “not energised”).

You should remember that the “safe output” operating mode is triggered by the “communication loss” watch-dog located at the Communication Gateway level, and that only when the watch-dog expires is the specified “safe” status set on the relevant outputs. You should therefore enable the “communication loss” watch-dog, and set it to the desired time interval in order to make the “safe output” mode active (this is a Host Device configuration option).

2.5 HiD 3891 1-channel Frequency Input module

The HiD3891 unit is a single channel module that, in addition to all HiD3824 features, is able to measure the input frequency over a wide integration range, including a pure counter option. Beside the NAMUR input interface – as on HiD3824 – the HiD3891 is also able to interface – on different input terminals – with a Vortex type voltage output sensor.

For the frequency measure capability, the HiD 3891 provides a frequency measurement – in Hz unit – in a 16 bit integer word updated each second.

In parallel, a programmable integration time measurement is provided in a 31 bit integer word, which counts the input pulses for the specified integration time. The value is updated at the completion of each integration time cycle, and the most significant bit – the 32^{nd} one – is used as a toggle indicator.

The time period during which input pulses are counted – Integration Time – is configurable at the GSD file level by a 16 bit word in units of 1 s. If the integration counter is set to zero then the function provided is that of an integrating counter.

3 HiD PBDP1 Profibus DP Communication Gateway

3.1 Overview

The HiD PBDP1 is a Profibus DP compliant communication gateway able to work up to the highest DP-specified communication speed (12 MB, on an RS-485 channel).The gateway acts as a link between the HiD 3000 I/O modules located on the Termination Board (TB) and the external DP line.

The typical TB can house up to 16 HiD 3000 modules and up to 2 HiD PBDP1 gateways. By using 2 gateways, you can get a high-integrity, redundant hardware configuration with no single-point of failure (see section 3.3).

By the HiD PBDP1, a HiD 3000 I/O station can be Profibus connected as a fully compliant, modular DP Slave, according to the EN 50 170 standard (vol. 2). The station “slave address” can easily set by DIP-switches located on the top of the Communication Gateway unit. The allowed addressing range is from 0 to 126, but to connect more than 32 devices to the RS-485 channel, suitable repeaters are required.

HiD 3000 I/O station was designed as a modular DP slave because this is the easiest way to manage all the different I/O Module configuration that the station makes possible to implement.

As a Profibus DP slave node, the HiD PBDP1 implements all the relevant configuration, parameterisation and diagnostic capabilities as specified by the applicable Profibus standards. These manifold capabilities are best described when discussing the structure of the HiD PBDP1 GSD file. The GSD file, to be associated with each Profibus slave, can be thought of as an “electronic” data-sheet for the fieldbus-connected device, and in fact it lists, among other things, all the available configuration options, including the previously described module-specific ones.

In the following, we will describe only the few HiD PBDP1 configuration options that are specific to the HiD 3000 implementation.

3.2 Functions and Configuration

The HiD PBDP1 gateway is able to internally monitor the main 24V input supply connected to the HiD 3000 Termination Board. When the input voltage goes below around 20.5 V, an associated diagnostic flag can be set and a related fault LED can be switched on. You should remember, however, that below 20V the I/O modules are no longer guaranteed to operate within specification (while the gateway typically operate down to 18V).

By using the ***Mask 24V power fail*** option, you can enable or disable the previously described voltage-monitoring capability.

For all output modules, the HiD 3000 series allows for a “safe output” operating mode. This is useful when the HiD 3000 slave station is no longer able to communicate with the central Host Device, either for a communication cable problem or for any other type of fault. In this case, it can be desirable to set the output channels in a predefined status/value – or to “freeze” them in the current one – up to when the communication is recovered.

The transition to the “safe output” status is controlled by the “communication loss” watch-dog timer, located on the Profibus Slave. The applicable time-out value is loaded in this timer by the Profibus Master, which calculate it taking into account the number of connected slave and the applicable communication speed.

The ***Disable fail safe*** selection provides a “general disable” option for the modules “safe output” operation, which bypass any “safe output mode” enable at the module configuration level. This can be useful in the commissioning phase, when you can not guarantee a continuous Profibus Master communication and you want to avoid to disable the “safe output” mode on each single output module.

Another situation in which it can be useful to disable the “safe output” mode at the gateway level, is when you connect the HMI commissioning tool to the HiD 3000 I/O station and no Profibus communication is running. In this case the “safe output” mode – when enabled at the module level would be immediately triggered.

When you have selected the “disable fail safe”, anyway, the HMI tool allow you to simulate the “loss of communication” event by a suitable menu command. In this way, it is possible to verify that the relevant output channels are in fact de-energised in a fail condition.

As a final note about “safe output” behaviour it is important to know that when, due to some type of fault, the Communication Gateway is not able to communicate with an I/O module for more than around 2 seconds, the module outputs are automatically set to the “not energised” status by the intervention of a dedicated watch-dog timer, local to the module.

3.3 Redundant Configuration

3.3.1 Overview

On the typical HiD3000 TB, 2 HiD PBDP1 gateways can be inserted to get a redundant configuration. The gateway nearer to the I/O modules is called *primary,* the other one *secondary*. The primary and secondary gateways must be always set to the same slave address, and each of them is associated with a dedicated serial Service Port (RS-232, DB-9 male connector) and Profibus Interface Port (RS-485, DB-9 female connector).

The only functional difference between *primary,* and the *secondary* gateway is that, when you power-up with both gateways inserted, the *primary* goes *operating* while the *secondary* goes *standby*. Apart from this, the two TB slots are equivalent and – when working with a single gateway, you can either insert it in the primary or in the secondary slot (by using the secondary slot you get slightly better configuration as for power dissipation).

When you wish to take the greatest benefit from the redundant configuration option, you should consider the usage of a redundant Profibus communication line (i.e. two independent RS-485 lines). This is the most reliable configuration, but asks for a redundant Profibus Master device or for an automatic line-switch device to feed the two communication lines to a single Profibus Master.

As an easier solution, you can connect a single Profibus communication line to both gateways (you have to use both Profibus connectors and set-up the communication line as if you were connecting to two distinct Profibus slave units). In this way, you still have a relevant reliability benefit, because you get an I/O station with no single point of failure. In addition, it is easy for the Host Device to manage the redundancy. In fact, a gateway commutation is equivalent to the momentary communication loss, exactly as resulting from a momentary supply removal.

In any case, you should remember that you can set-up a Profibus communication only with one of the two redundant gateways at a time, that is to say, you can not set-up a full Profibus communication with the “standby” gateway (cold back-up configuration).

3.3.2 Basic operation

The redundant-mode gateway operation is shortly described in the following:

- In normal operation, one gateway is “operating” while the other is in “standby”, and the “standby” gateway only activity is to monitor the “operating” gateway status.
- The “operating” gateway is able to detect a wide set of fault conditions, as Profibus communication loss, I/O modules (Local Bus) communication loss, software hang-up situations and supply related-disturbances.
- When the “operating” gateway detects an unrecoverable fault condition (including Profibus communication loss) it performs a self-reset action and disconnects itself – via internal mechanical relays – from both the Local Bus and the Profibus communication channels.
- When the “standby” gateway detects the “operating” gateway self-reset condition, it disables it and takes its place. The “standby” gateway now becomes the “operating” one and executes all the normal “power-up” operation associated with a Profibus slave, with the only exception that the I/O modules lines are not put into the “de-energised” status but kept in the original status.
- The Profibus Master has now up to 20 seconds to re-establish the communication according to the Profibus rules. If this is not the case, the I/O modules output lines are “de-energised” for safety reasons. It is up to the Host Device to manage this situation and avoid, when required any output commutations at restart-time.
- You should not confuse the – fixed – 20 s time-out (applicable after a redundancy-commutation) with the “communication loss” watch-dog time, which is calculated by the Profibus Master.

3.3.3 Additional information

To complete the redundant operation description, a few other issues have to be considered:

- The local gateway commutation time is typically less then 2 seconds. After this time, the new “operating” gateway restart the I/O modules polling on the Local Bus – so to refresh the modules watch-dog and preserve their output status –and waits for the fieldbus line messages required to re-establish the normal data-exchange mode.

- The time required to re-establish the data-exchange mode when a gateway commutation takes place can not be precisely specified because it is related with many Profibus Master parameters, like the communication speed and the number of slaves. However, this time is typically much lower than the max allowed 20 seconds interval.
- Both the ***Freeze output*** and the ***Safe output*** options are not available when in a redundant configuration. This is because an equivalent safe behaviour is better ensured by the redundant configuration on its own.
- At power-up – or after a commutation – a gateway waits for up to 20 seconds to get some Profibus message, and then switch to the other gateway (when available). This means that when two gateways are present but no Profibus communication can be established (e.g., due to a missing or faulty communication line) the two gateways keep switching at an around 20-second period. This has no negative effect – the relay life-time is very long – and ensure that, when the communication channel is restored, a gateway is immediately available to operate.
- Any message exchanged on the serial Service Port (RS-232 line) effectively restart the previously discussed 20 seconds period from 0. This allows to connect the HMI tool to – any of – the two redundant gateways and avoid the continuous switching when no Profibus Master is connected (the HMI tool keeps sending some periodic message also when no user action is taken).
- When two gateways are present, but one has a permanent hardware fault – as detected during the power-up self-test sequence – the other gateway is able to identify the situation and no commutation does ever take place. In this case, the operation is exactly as in the single-gateway situation.
- Don’t forget that an external connection of both gateways to a Profibus line is mandatory (there is no internal connection between the two gateway’s Modbus channels on the board).
- When a redundant switch takes place, the input data-base of the “new” gateway is generally aligned with the current input status before going into the data-exchange mode. As for the HiD3891 & HiD3040, however, there is an intrinsic delay of a few seconds before the availability of a new input value after a redundant commutation. During this period, an input value of 0 will appear in the data-base.

3.4 Self-Test and Diagnostic

3.4.1 Power-up self-test

At power-up time – or after a self-reset – the HiD PBDP1 performs a series of self-test verifications, and enters the normal operating mode only after having passed all the tests.

When a test is not passed, the relevant LEDs – see the following Table – a goes blinking for around 10 seconds, than a self-reset is performed (FAULT led goes momentary ON) and the unit restart as from a power-up. If the error is permanent, the unit keeps performing a self-reset – with the related fault indication – until it is powered down.

BUS 232TX	PWR LOW	CONF ERR	*Diagnostic test*
off	off	*blinking*	HC11 RAM self-test error detected
off	*blinking*	off	WSI RAM self-test error detected
blinking	off	off	SPC3 RAM self-test error detected
blinking	*blinking*	*blinking*	WSI ROM checksum error detected
blinking	off	*blinking*	Profibus read-back error detected
off	*blinking*	*blinking*	Local Bus read-back error detected

Table 4: PBDP1 power-up self-test LED indications

You should note that the BUS (yellow) LEDs are always “off” during the self-test phase, showing that the communication-lines relays are in hr de-energised status (the communication lines relay are used to support the redundant configuration.

3.4.2 Normal operating mode self-test

After having completed the power-up self-test phase, the HiD PBDP1 goes into the normal operating mode, and the LEDs indications are as described in the following table.

In a typical operating system, BUS INT, BUS EXT and BUS DEX are fixed on.

LED	Description	Colour	ON indication
PWR ON	Power ON	Green	24 V input supply present
FAULT	Module fault	Red	Microprocessor section is in the reset status
BUS INT	Local Bus connection status	Yellow	Local Bus channel connected, communication relay energised
BUS EXT	Profibus connection status	Yellow	Profibus channel connected, communication relay energised
BUS DEX	Profibus data exchange	Yellow	Profibus channel is in the “data-exchange” mode.
BUS 232TX	RS232 line transmission	Yellow	The Gateway is transmitting on the RS-232 Service serial line
PWR LOW	Low supply indication	Red	Low-level 24V input supply detected (disable option available)
CONF ERR	Configuration error	Red	Profibus “configuration” or “parametrisation” error detected

Table 5: PBDP1 normal operating mode LED indications

When in normal operating mode, both the Local Bus and the Profibus communication channels are also verified, as summarised in the following table.

Communication channel	Diagnostic test	Indication	Action
Local Bus	Checks for loss of communication on the Local Bus channel.	Profibus diagnostic message (no direct led indication)	When a redundant Gateway is present, the unit is disconnected from the relevant channel by the communication relay.
Profibus	Checks for loss of communication on the Profibus channel.	BUS DEX led goes off	When a redundant Gateway is present, the unit is disconnected from the relevant channel by the communication relay.

Table 6: PBDP1 communication channels LED indications

3.4.3 Internal diagnostic details

A voltage supervisor circuit continuously monitors the internal +5V supply and reset the microprocessor when a problem is detected. In addition, a watch-dog circuit, re-triggered under software control, is able to reset and restart the microprocessor when a program hang-up is detected.

When the input voltage goes below the specified limit, the “PWR LOW” LED is switched ON and a Profibus diagnostic message is generated. When the voltage returns at a normal level, the LED is switched OFF, and another Profibus diagnostic message is generated. Apart from the Profibus and LED indications, no other action is taken and the unit keep working normally. A configuration option is available to disable the input supply check.

4 HiD MBRT Modbus RTU Communication Gateway

4.1 Overview

The HiD MBRT is an Modbus RTU compliant communication gateway able to work up to 115.2 Kbit/s on an RS-485 channel. The gateway acts as a link between the HiD 3000 I/O modules located on the Termination Board (TB) and the external Modbus line.

The typical TB can house up to 16 HiD 3000 modules and up to 2 HiD MBRT gateways. By using 2 gateways, you can get an high-integrity, redundant hardware configuration with no single-point of failure (see next section).

By means of the HiD MBRT, the HiD 3000 I/O station can be Modbus connected as a compliant modular Modbus Slave, in compliance with the “Modicon Protocol” (PI-MBUS-300).

The station “slave address” can be easily set by the – hexadecimal – rotary-switches located on the top of the gateway enclosure. The allowed addressing range is from 0 to 126, but to connect more than 32 devices to the RS-485 channel, suitable repeaters are required. The default address value (manufacturing configuration) is 1.

The communication line parameters (speed, parity and stop bit) can be selected by the dip-switches located on the side part of module. The default configuration (manufacturing configuration) is as in the following: 38.8 Kbit/s, even parity, 1 stop bit.

HiD 3000 I/O station was designed as a modular Modbus slave because this is the easiest way to manage all the different I/O Modules configuration that the station makes possible to implement.

In the following, we will describe only the few HiD MBRT configuration options that are specific to the HiD 3000 implementation.

4.2 Functions and Configuration

The HiD MBRT gateway is able to internally monitor the main 24V input supply connected to the HiD 3000 Termination Board. When the input voltage goes below around 20.5 V, an associated diagnostic flag can be set and a related fault LED can be switched on. You should remember, however, that below 20V the I/O modules are no more guaranteed to operate within specification (while the gateway typically operate down to 18V).

By using the ***Mask 24V power fail*** option, you can enable or disable the previously described voltage-monitoring capability.

For all output modules, the HiD 3000 series allows for a “safe output” operating mode. This is useful when the HiD 3000 slave station is no longer able to communicate with the central Host Device, either for a communication cable problem or for any other type of Modbus fault. In this case, it can be desirable to set the output channels in a predefined status/value – or to “freeze” them in the current one – up to when the communication is recovered.

The transition to the “safe output” status is controlled by the “communication loss” watch-dog timer, located on the Profibus Slave. By the HMI tool, the user can select the desired time-out value (from 1 ms to 160 s) for the watch-dog timer, when you select 0, you disable the watch-dog timer operation. The time-out value is stored within the gateway non-volatile memory (EEPROM). The watch-dog timer is active both as for an “operating” and for a “standby” gateway, and is re-triggered whenever a message with the right address (i.e. the gateway address) is correctly received.

At power-up, the Modbus Communication Gateway sets the module configuration status according to the parameters stored within the internal non-volatile memory (EEPROM), and sets the module outputs according to the safe parameters values. If the option ***freeze*** was chosen (via the HMI tool) the power-up outputs status will be the de-energised one.

The ***Disable fail safe*** selection provides a “general disable” option for the modules “safe output” operation, which bypass any “safe output mode” enable at the module configuration level. This can be useful in the commissioning phase, when you can not guarantee a continuous Modbus Master communication and you want to avoid to disable the “safe output” mode on each single output module.

Another situation in which it can be useful to disable the “safe output” mode at the gateway level, is when you connect the HMI commissioning tool to the HiD 3000 I/O station and no Modbus communication is running. In this case the “safe output” mode – when enabled at the module level, would be immediately triggered.

When you have selected the “disable fail safe”, anyway, the HMI tool allow you to simulate the “loss of communication” event by a suitable menu command. In this way, it is possible to verify that the relevant output channels are in fact de-energised in a fail condition.

As a final note about “safe output” behaviour it is important to know that when, due to some type of fault, the Communication Gateway is not able to communicate with an I/O module for more than around 2 seconds, the module outputs are automatically set to the “not energised” status by the intervention of a dedicated watch-dog timer, local to the module.

4.3 Redundant Configuration

4.3.1 General issues

On the typical HiD3000 TB, 2 HiD MBRT gateways can be inserted to get a redundant configuration. The gateway nearer to the I/O modules is called *primary,* the other one *secondary*. Each gateway (primary and secondary) is associated with a dedicated serial Service Port (RS-232, DB-9 male connector) and Profibus Interface Port (RS-485, DB-9 female connector).

The only functional difference between *primary,* and the *secondary* gateway is that, when you power-up with both gateways inserted, the *primary* goes *operating* while the *secondary* goes *standby*. Apart from this, the two TB slots are <u>equivalent</u> and – when working with a single gateway, you can either insert it in the primary or in the secondary slot (by using the secondary slot you get slightly better configuration as for power dissipation).

When you wish to take the greatest benefit from the redundant configuration option, you should consider the usage of a redundant Modbus communication line (i.e. two independent RS-485 lines). This is the most reliable configuration, but asks for a redundant (or duplicated) Modbus Master device or for an automatic line-switch device to feed the two communication lines to a single Modbus Master.

As an easier solution, you can connect a single Modbus communication line to both gateways (you have to use both Modbus connectors and set-up the communication line as if you were connecting to two distinct Modbus slave units). In this way, you still have a relevant reliability benefit, because you get an I/O station with no single point of failure. In addition, it is easy for the Host Device to manage the redundancy. In fact, a gateway commutation is equivalent to the momentary communication loss, exactly as resulting from a momentary supply removal.

4.3.2 Communication issues

With a Modbus redundant configuration, you can decide to set the two gateways of an I/O station <u>either with the same or with a different slave address</u>. However, when you connect the two gateways to the same communication line, and you wish to set them to the same address, you clearly don’t want to get an answer from both of them. To avoid this problem, a side-located dip-switch (switch 8) is available which, when set to OFF, disable the answer from the “standby” gateway (but the received command is anyway executed, unless it includes a communication error).

With a Modbus redundant configuration, you can – when required – exchange information with both gateways at the same time. This means that an <u>hot back-up</u> configuration can be implemented. You are not allowed to send any “diagnostic” or “input value” request to the “standby” gateway. When you would do so, you would receive “ Slave device Busy” exception (code 06).

The easiest way to implement an hot back-up configuration is to set both gateways to the same address, and to use a <u>single Modbus Master</u> (that is to say, either a single communication line or two communication lines with an automatic line-switch device connected at the master side). In this case, an aligned output data-base is automatically obtained, and the communication time-out is also re-triggered on both gateways. The only caveat is about possible communication errors as for write massages to the “standby” gateway, for which you have no feedback (this is not a problem, however, when the Modbus Master continuously refresh the output status, as generally done).

When using a <u>dual Modbus Master</u> configuration it is up to the Modbus Master to keep updated the “output” data-base section of the “standby” gateway so that, in case of a commutation, the applicable output status is immediately available.

4.3.3 Basic operation

The redundant-mode gateway operation is shortly described in the following:

- In normal operation, one gateway is “operating” while the other is in “standby”. The “standby” gateway always monitor the “operating” gateway status, to check if a commutation is required.
- The “standby” gateway doesn’t communicate with the I/O modules but is able to receive “write” commands (including read-output ones), which are stored into the internal data-base. You must take care that the “standby” periodically receives some message, to re-trigger its internal watchdog timer (if the watchdog timer of the “stand-by” gateway is not re-triggered, <u>the redundancy commutation will not take place</u>).
- The “operating” gateway is able to detect a wide set of fault conditions, as Modbus communication loss, I/O modules (Local Bus) communication loss, software hang-up situations and supply related-disturbances. When such a fault condition takes place, the gateway disconnects itself – via an internal mechanical relay – from the Local Bus channel and – only in case of an HW fault – also from the Modbus channel.
- When the “standby” gateway detects the “operating” gateway fault condition, it takes its place. The “standby” gateway now becomes the “operating” one and executes all the normal “start-up” operation associated with a Modbus slave.
- The Modbus Master can now up re-establish the communication; if this is doesn’t happen within the expected time, the “communication loss” <u>watch-dog timer</u> expires an the I/O modules output lines will go into the “safe” status.
- With Modbus, the watchdog timer delay is applicable both to a “communication loss” situation and to the “communication recovery” situation after a redundancy-commutation.

4.3.4 Additional information

To complete the redundant operation description, a few other issues have to be considered:

- The local gateway-commutation time is typically less then 2 seconds. After this time, the new “operating” gateway restarts the I/O modules polling on the Local Bus – so to refresh the modules watch-dog and preserve their output status – and it waits for any Modbus message on the communication line. The time required for a Modbus master to restart the proper communication with a gateway after a redundant commutation is difficult to estimate because it is related with many communication parameters, like the communication speed and the number of slaves.
- As for an “<u>operating gateway</u>”, when a communication watch-dog time-out takes place, a redundancy commutation is activated (provided that the other gateway – the “standby” one – is available, working properly and with no communication watchdog time-out). As for the “<u>standby gateway</u>”, when a communication watch-dog time-out takes place, an indication is sent to the “operating” gateway (by an internal TB connection). This is in turn available as a diagnostic flag within the “operating” gateway data-base.
- When two gateways are present, but one of them has a permanent hardware fault – as detected during the power-up self-test sequence – the other gateway is able to identify the situation and no redundancy commutation does takes place. In this case, the operation is exactly as in the single-gateway situation.
- It is recommended to define an identical configuration as for the redundant gateways. To do this, please use always the same HMI-generated configuration file to configure both gateways.
- To obtain a more reliable hot-back-up redundancy, it is generally recommended to update periodically (and not only on change) the output database of both gateways
- An output channel with the “freeze value” option set is always in the “de-energised” status after a power-up or a reset. This is also true when a gateway goes from the “standby” to the “operating” status and the relevant output channel status had never been written in its the data-base.
- Don’t forget that an external connection of both gateways to a Modbus line is <u>mandatory</u> (there is no internal connection between the two gateway’s Modbus channels on the board).
- When a redundant switch takes place, the input data-base of the “new” gateway is generally aligned with the current input status before going into the data-communication mode. As for the HiD3891, however, there is an intrinsic delay of a few seconds before the availability of a new input value after a redundant commutation. During this period, an input value of 0 will appear in the data-base.

4.4 Self-Test and Diagnostic

4.4.1 Power-up self-test

At power-up time – or after a self-reset – the HiD MBRT performs a series of self-test verifications, and enters the normal operating mode only after having passed all the tests.

When a test is not passed, the relevant LEDs – see the following Table – start blinking for around 10 seconds, then a self-reset is performed (FAULT led goes momentary ON) and the unit restart as from a power-up. If the error is permanent, the unit keeps performing a self-reset – with the related fault indication – until it is powered down.

BUS 232TX	PWR LOW	CONF ERR	*Diagnostic test*
off	Off	*Blinking*	HC12 RAM self-test error detected
off	*Blinking*	Off	External RAM self-test error detected
blinking	*Blinking*	*Blinking*	External FLASH checksum error detected
blinking	off	*Blinking*	Modbus read-back error detected
off	*blinking*	*Blinking*	Local Bus read-back error detected

Table 7: MBRT power-up self-test LED indications

You should note that the BUS (yellow) LEDs are always “off” during the self-test phase, showing that the communication-lines relays are in the de-energised state (the communication lines relay are used to support the redundant configuration.

4.4.2 Normal operating mode self-test

After having completed the power-up self-test phase, the HiD MBRT goes into the normal operating mode, and the LEDs indications are as described in the following table.

In a typical operating system, BUS INT, BUS EXT and BUS DEX are fixed on.

LED	Description	Colour	ON indication
PWR ON	Power ON	Green	24 V input supply present
FAULT	Module fault	Red	Microprocessor section is in the reset status
BUS INT	Local Bus connection status	Yellow	Local Bus channel connected, communication relay energised
BUS EXT	Modbus connection status	Yellow	Modbus channel connected, communication relay energised
BUS 485Tx	Modbus line transmission	Yellow	Modbus channel is in transmitting mode on the RS-485 line.
BUS 232TX	RS232 line transmission	Yellow	The Gateway is in transmitting on the RS-232 Service serial line
PWR LOW	Low supply indication	Red	Low-level 24V input supply detected (disable option available)
CONF ERR	Configuration error	Red	Modbus “configuration” error detected

Table 8: MBRT normal operating mode LED indications

When in normal operating mode, both the Local Bus and the Modbus communication channels are also verified, as summarised in the following table.

<table>
<tr><th>Communication channel</th><th>Diagnostic test</th><th>Indication</th><th>Action</th></tr>
<tr><td>Local Bus</td><td>Checks for loss of communication on the Local Bus channel.</td><td>Modbus diagnostic message (no direct led indication)</td><td rowspan="2">When a redundant Gateway is present, the unit is disconnected from the relevant channel by the communication relay.</td></tr>
<tr><td>Modbus</td><td>Checks for loss of communication on the Modbus channel.</td><td>BUS 485Tx led goes off</td></tr>
</table>

Table 9: MBRT communication channels LED indications

4.4.3 Internal diagnostic details

A voltage supervisor circuit continuously monitors the internal +5V supply and reset the microprocessor when a problem is detected. In addition, a watch-dog circuit, re-triggered under software control, is able to reset and restart the microprocessor when a program hang-up is detected.

When the input voltage goes below the specified limit, the “PWR LOW” LED is switched ON and a diagnostic flag alarm is setter on database Modbus. When the voltage returns at a normal level, the LED is switched OFF, and the alarm flag in database is reset. Apart from the Modbus and LED indications, no other action is taken and the unit keep working normally. A configuration option is available to disable the input supply check.

5 HiD 3000 HMI Commissioning Tool

5.1 Overview

The HMI (Human Machine Interface) commissioning tool is a PC software package intended to support the installation, configuration and maintenance of the typical HiD 3000 system. The HMI package runs on any Win95/98 and NT PC, with minimal HW and SW requirements, and makes available an user-friendly, graphical oriented interface.

The HMI commissioning tool can operate in one of three different modes:

- the Configuration mode
- the Data Exchange mode (no fieldbus communication)
- the Data Exchange mode (active fieldbus communication)

The Configuration operating mode is intended for "off-line" usage, that is to say on a stand-alone PC, while in the Data Exchange mode you need to connect a PC RS-232 serial line to the local, serial Service Port located on the HiD 3000 Termination Board. When you use the Data Exchange mode while the fieldbus link is active (ongoing communication) you are basically in a monitoring mode, and you can not change any configuration parameter or output status value.

In the following, both Installation and basic Operating guidelines are provided, while you should refer to the Commissioning Guidelines section for a more specific discussion about the HiD 3000 HMI usage to get a fast set-up of a typical HiD 3000 system.

5.2 HMI Software Installation and Set-up

To connect a PC with the HiD 3000 I/O station, you need a "null-modem" RS-232 cable (only the RX, TX and GND signals are required) with a DB-9 male connector at the Station side and either a DB-9 or a DB-25 male connector at the PC side.

You need to locate the applicable DB-9 connector on the Termination Board. The HiD 3000 I/O station can in fact support 2 Communication Gateways, so you find on the TB two distinct Service Port connectors. Be sure to identify the one related to the specific Gateway with which you want to interface.

To load the software on your PC, you simply need to run the applicable ***set-up*** file, and you will be guided in all required operations. To start to communicate with the I/O Station you have finally to select the "Data Exchange" mode.

The serial Service Port pin allocation is shown in Table:

Signals Name	DB-9 Terminals (I/O Station side)	Connect to (PC side)
TX	3	RX
RX	2	TX
GND	5	GND

Table 10: serial Service Port pin allocation

To start the HMI program, you simply select from the Windows start menu. When requested, you have then to select the desired operating mode. When you wish to use the Data Exchange mode, be sure you are connected with the right cable to the right connector of a powered Termination Board (clearly, a gateway must also be present and plugged in the right slot).

If, after starting the HMI program and selecting the Data exchange mode, you get the message "*Serial link communication fault*", you should first restart the program in the Configuration mode and then use the ***Commands / Options Commands / Options*** / ***Serial link*** menu command to open the serial link configuration panel. You can now check that the COM1 selection is for 14400 baud, 8 data bits, no parity and one stop bit (when the COM1 port is not available on your PC, you can select another port).

If, after having selected the Data exchange mode (use ***Commands***) you still get the message "*Serial link communication fault"*, the possible reasons are:

- the Communication Gateway is faulty or not powered;
- the RS-232 communication cable is wrong;
- the RS-232 communication cable is connected to the wrong PC connector;
- the RS-232 communication cable is connected to the wrong Termination Board connector.

5.3 On-line Help and General Guidelines.

Once you have started the HMI program, you can click with the mouse on the "question mark" icon to activate the "context-sensitive" help mode. You can now click on most graphical objects to get a comprehensive description of the associated function.

The same end result can be also obtained when you position the mouse pointer on a graphical object and press the F1 key.

Finally, for some key graphical items, a "tool-tip" automatic help is also provided. When you simply stop the mouse pointer for a few seconds on the relevant item, a short text message is automatically displayed which describes the purpose of that particular function.

The HMI software is based on a multi-window organisation. By using the ***Windows*** menu command you can open a new window or select one of the already open windows. You can also cascade/tile the open windows in three different ways.

5.4 Configuration Mode

When using the off-line configuration mode, you typically start with allocating the desired I/O modules on the specific Termination Board "plug-in" slots. To do this, you simply drag the desired module from the ***Modules bar*** box and drop it in the desired location. When you make an error or when you wish to remove a unit, you simply drag the module and drop it in the "waste bin" located on the upper-right side of the Termination Board graphic windows.

To properly identify them, all slots on the TB are numbered. In addition, you can use the Gateway module location and the "blue" terminal block strip position to clearly identify the TB orientation.

Once you have installed all of the desired modules, you can double click on any of them to open the associated windows. Each of the I/O modules windows comprises a ***Channel*** section, showing both the status and the diagnostic information, and a ***Parameters*** section, summarising all available configuration options.

The ***Channel*** section is not used in the Configuration mode, but it becomes active in the Data Exchange mode where it reflects in real-time the current I/O status, including fault conditions ("Integrity" indication).

The ***Parameters*** section makes it possible to directly and easily set all the available configuration parameters, including the gateway ones.

When you open for the first time a new-module window, the configuration values are always set to the default status.

At any time, you can use the ***File*** menu to save the existing configuration status or to load a previously saved configuration file. You can also use the ***File*** menu to reset the current configuration to the start-up condition (default configuration values and no installed I/O module) by using the "new configuration" command.

When you save a configuration file, you can select between two different formats:

- the .HiD format (Profibus and Modbus generic HiD 3000 configuration file),
- the .GSD format (Profibus specific "GSD" device description file).

Both formats are based on simple "text" ASCII files that you can examine or print, when required, with any general-purpose text editor or word-processor. Any manual file modification should be avoided, because both formats are based on a proprietary syntax.

5.4.1 Profibus Master configuration

When configuring a Profibus Master, you must use the .GSD format, but when your purpose is simply to record or archive HiD 3000 configuration information for future use, you can in principle use either format. However, the .HiD format is likely to be more readable, because it was specifically conceived to record HiD 3000 information while the .GSD format syntax is of a more general nature.

5.4.2 Modbus system configuration

No GSD-like “description file” will be generated for a Modbus Master, because a transfer mechanism of configuration data between Master and Slave via Modbus is not implemented (and in any case, not standardised).

With Modbus, – unlike Profibus – the modules configuration and parameters are locally stored within the gateway non-volatile memory (EEPROM). To download the desired configuration to the gateway, the HMI toll is to be locally connected to the gateway RS-232 service port.

The procedure is as in the following:

- Within the HMI – working in “configuration” mode – you can define the desired configuration in an off-line mode.
- Always from within the “configuration” mode, a configuration file must be saved to disk, the .HiD format must be used, because Modbus doesn’t support the .GSD format.
- You have now to enter the HMI “data-exchange”, reload the previously save configuration file and finally download it to the serial-line connected gateway.

5.5 Data Exchange Mode – no fieldbus link

As soon as you select the Data Exchange mode, the HMI SW tries to establish communication with the relevant Communication Gateway, by means of the RS-232 Service Port located on the Termination Board. Via the gateway, the HMI tool can also access the relevant I/O modules information.

When there is no communication problem, you will see the same screen layout (i.e. graphic TB) as for the Configuration mode, with the only difference of the lack of the ***Modules bar*** box.

- With the Profibus Gateway the HMI tool is able to detect which is the specific module currently installed in each slot, so you will immediately get an “image” of the real TB module configuration.
- With the Modbus Gateway, the HMI is not able to detect the modules currently installed on the termination board, but it is only able to read the latest modules configuration (as stored within the gateway).

When the communication is established, the current configuration parameters setting for each module is also loaded.

- At power-up, the Profibus Gateway set the modules into a default configuration status, and all output are de-energised.
- The Modbus Gateway, instead, sets the modules configuration status according to the non-volatile values stored within its internal EEPROM memory. The modules outputs will be set according to the programmed “safe” status. If the freeze option was chosen, all the modules outputs will be set to the energised status.

You can now open each specific module window as in the Configuration mode.

In the ***Parameters*** section, you can access all the available configuration parameters. When you change them, however, on Profibus Gateway they take immediate effect on what you see within the ***Channel*** section(Except the HiD3040 Model that needs to reboot), which is now updated in real-time. On the Modbus Gateway the parameters will be modified after having pressed the purpose button. The I/O module fault LED status can also change when you act on the Status section.

Basically, by accessing the ***Channel*** section of each I/O module you can read the current status of each input channel, set the desired status of each output channel and verify the Integrity status (i.e. the possible presence of a fault condition) for each I/O loop.

- When in the Data Exchange mode with the Profibus Gateway, you can load and save the configuration files as in the Configuration mode. However, you can load a configuration file only when it specifies the same module configuration (i.e. the same module type in each slot position) as the currently installed one.

- When in the Data Exchange mode with the Modbus Gateway, you can load configuration file also if it is different from that currently installed one, and the loaded file will supersede the previous configuration.

5.6 Data Exchange Mode – active fieldbus link

You can work in the Data Exchange mode also when main fieldbus link is active. When the HMI SW detects, via the Service serial line, that the fieldbus link is active and communicating in the right way, an "*Active link*" message is shown on the screen.

When the fieldbus link is active, you are in a monitor-only mode. In fact, it is no longer possible to change any output value or configuration parameter, but only to look at their current status.

Only in case of the Profibus Gateway, as soon as the fieldbus link goes active, you will likely see some change within the ***Parameters*** sections content, because the gateway is now receiving the applicable parameter information directly via the fieldbus link. In fact, HiD 3000 Profibus station is fully fieldbus configurable.

Whenever the fieldbus link is terminated (e.g., by removing the fieldbus cable) the HMI tools automatically returns into the "no fieldbus link" mode after a short period of time.

5.7 Communication Watch-dog

The communication watch-dog is the maximum time between two consecutive messages before a "redundancy switch" (if a second gateway is present) or before the outputs transition to the "safe state" (if a single gateway is available).

- As for the Modbus Gateway, the desired watch-dog time can be set from within the "watch-dog" window. The value can go from 100ms to 160 seconds, in step of 2.5ms, and should be set in function of field bus speed. If the value is set to 0 the watch-dog is disabled (i.e. infinite time).
- As for the Profibus Gateway, the applicable watch-dog time
- You should not confuse the – fixed – 20 s time-out (applicable after a redundancy-commutation) with the "communication loss" watch-dog time, which is calculated by the Profibus Master – and sent to the Slave before going into the data-exchange mode (please refer to the applicable Profibus documentation as for more details about the "communication loss" watch-dog time calculation).

5.8 HiD3010 Analog Values Format

When you open the HiD3010 panel, you can access the relevant, analogue I/O values ether in a "mA" or in an "H" (hexadecimal) format. The allowed "mA" range is from 0 to 24 mA (over-range included), with two decimal points, resulting in a 10 μA resolution. The associated "H" range goes from 0 to 16383 (14 bits), with an effective resolution of 1,465 μA.

When looking at the "H" format, the HMI tool shows the digital value exactly as exchanged with the internal AD/DA 14-bit converters. This is useful at the commissioning phase, to easily check the stability of the input reading or to simplify any accuracy or linearity check.

However, you should remember that the fieldbus-level "H" format is different from the HMI one. This is because, in this case, the common practice is to align the most significant bit of the AD/DA word with the most significant bit of the protocol word. In our case, this results in an "apparent" 15-bits resolution at the protocol level (but really, the less significant protocol bit is always 0).

- N.B: as a result of the previous discussion, the HMI hexadecimal value looks like "half" of the fieldbus protocol hexadecimal value.

6 COMMISSIONING GUIDELINES

6.1 Set-up Sequence

The set up of a fully-working HiD 3000 system is typically achieved by the following steps:

- **Off-line configuration:**

– Start the HMI commissioning tool in the Configuration mode.

– Select bus type

– Graphically define the desired modules type and their location on the TB (slot position).

– For each module, use the HMI tool to set the desired value for each configuration parameter.

– Save the Configuration file (in both formats as for Profibus, in .HiD3 format only as for Modbus) and print the .HiD file for reference purposes.

- **Stand-alone station set-up:**

– Get a Termination Board and install the required I/O modules (and a gateway).

– Power the termination board, carefully checking the supply voltage.

– Connect the PC with the HMI SW to the TB Service serial line port of the relevant gateway.

– Start the HMI commissioning tool in the Data Exchange mode to communicate with the gateway.

– Verify all the installed I/O modules are shown on the graphic TB (otherwise, they could be faulty).

– Load the previously saved Configuration, mandatory on the Modbus Gateway.

– When there is no message error, you are sure that you have put the right module in the right slot.

– In case of error, install the right modules or goes to Configuration mode to generate a new file.

- **Field-devices commissioning:**

– Interface the required field devices to the TB terminal blocks.

– By the HMI tool, verify that all field devices – and I/O modules are working properly.

– When required, you can change the values of the modules configuration parameters.

– Save the final versions of the Configuration files (print the .HiD one for reference purposes).

- **Communication line check-up:**

– If you have a Profibus Gateway load the generated .GSD file on a PC-based Profibus Master simulator, else if you have a Modbus Gateway configure manually the Modbus Master simulator.

– At the central location, use the Master simulator to verify the fieldbus communication line.

– With the Master simulator, you can also verify the slave address of all connected stations.

- **Profibus Host Device start-up:**

– Load the .GSD file on the specific Profibus Configurator associated with the Host Device.

– Use the Profibus Configurator to define the remaining Profibus DP Master and general parameters.

– Download the binary configuration file generated by the Configurator to the Host Device.

– Start the Profibus Master and verify that it is able to communicate with the slaves.

- **Modbus Host Device start-up:**

  – Use the specific Modbus Configurator associated with the Host Device for define the memory area for data exchange.

  – Download the binary configuration file generated by the Configurator to the Host Device.

  – Start the Modbus Master and verify that it is able to communicate with the slaves.

- **Monitoring and maintenance:**

  – When required, connect the HMI tool to the HiD 3000 stations to monitor the situation.

  – You can also use the HMI tool to log the I/O data to get more confidence about proper operation.

7 APPENDIX A – HID3040 CONFIGURATIONS OPTIONS

7.1 “RTD” operating mode

RTD mode (2 channels)	Configuration options		Comments
RTD connection type:	2 wire		Both channels will share the same configuration.
	3 wire		
	4 wire		
Fault:	Enable		Each of the two channels can be individually configured.
	Disable		
RTD sensor type:	RJC Cu109		Each of the two channels can be individually configured. “RJC Cu109” is the Elcon provided sensor intended for CJC usage. “R400” and “R4000” are to be used for direct, non-linearised resistance measurement (0-400Ω and 0-4000Ω ranges).
	DIN	Pt10	
		Pt50	
		Pt100	
		Pt100	
	GOST	Pt10	
		Pt50	
		Pt100	
		Pt1000	
	Ni100		
	Cu10		
	Cu50		
	Cu100		
	R400		
	R4000		
	R400 with custom table (*)		
	R4000 with custom table (*)		
Fault strategy:	Freeze input		Each of the two channels can be individually configured.
	Set input High		
	Set input Low		

(*) for future implementation

Table 11: “RTD” operating mode configuration options.

7.2 “Potentiometer” operating mode

Potentiometer mode (2 channels)	Configuration options	Comments
Fault:	Enable	Each of the two channels can be individually configured.
	Disable	
Sensor type:	Potentiometer	Each of the two channels can be individually configured.
	Potent. with custom table (*)	
Fault strategy:	Freeze input	Each of the two channels can be individually configured.
	Set input High	
	Set input Low	

(*) for future implementation

Table 12: “Potentiometer” operating mode configuration options.

7.3 “TC/mV” operating mode

mV/TC mode (4 channels)	Configuration options	Comments
Cold junction Compensation style:	Disable	the channel 1 temperature measurement of a different module can be used for CJC.
	Fixed	
	Module number	
Fault:	Enable	Channel 2, 3 and 4 can be individually configured.
	Disable	
Sensor type:	B	Channel 1, 2, 3 and 4 can be individually configured.
	E	
	J	
	K	
	L	
	N	
	R	
	S	
	T	
	100mV	
	TC with custom table (*)	
	100mV with custom table (*)	
Fault Strategy:	Freeze input	Channel 1, 2, 3 and 4 can be individually configured.
	Set input High	
	Set input Low	
Burnout test:	Enable	Channel 2, 3 and 4 can be individually configured.
	Disable	

(*) for future implementation

Table 13: “TC/mV” operating mode configuration options.

7.4 "TC/mV + CJC" operating mode

mV/TC with CJC mode (3+1 channels)	Configuration options	Comments
Cold junction compensation style:	Disable	When "internal" is selected, the channel 1 temperature measurement is used for CJC.
	Fixed	
	Internal	
Channel 1 Fault:	Enable	Channel 1 is dedicated to the CJC function.
	Disable	
Channel 1 Sensor type:	sensor type list as for RTD mode	An RTD device is to be used as CJC sensor.
Channel 1 Fault strategy:	Freeze input	The "freeze input" strategy is recommended as for the RTD CJC sensor.
	Set input High	
	Set input Low	
Fault:	Enable	Channel 2, 3 and 4 can be individually configured.
	Disable	
Sensor type:	B	Channel 2, 3 and 4 can be individually configured.
	E	
	J	
	K	
	L	
	N	
	R	
	S	
	T	
	100mV	
	TC with custom table (*)	
	100mV with custom table (*)	
Fault Strategy:	Freeze input	Channel 2, 3 and 4 can be individually configured.
	Set input High	
	Set input Low	
Burnout test:	Enable	Channel 2, 3 and 4 can be individually configured.
	Disable	

(*) for future implementation

Table 14: "TC/mV + CJC" operating mode configuration options.

8 APPENDIX B – PROFIBUS DATA FORMATS

8.1 Introduction

This section describes the communication messages, memory map allocation and the key data formats applicable to a HiD 3000 I/O station system when used with Profibus DP communication gateway. The selected formats are fully compatible with the applicable EN 50170 standard (vol. 2), and thereby guarantee full interoperability with any generic, Profibus compliant Host Device. This description is tightly related with the parameters specified in the standard HiD 3000 Profibus GSD specification file.

On Profibus DP, the communications memory is divided into the following areas:

- Diagnostics information area
- User parameters area
- Input / Output area

In the following sections, the contents of the various areas will be described in detail.

8.2 Diagnostics Area

8.2.1 Diagnostics area content & definitions

07	06	05	04	03	02	01	00	Decimal bit
Station_status_1								diagn. byte 1
Station_status_2								diagn. byte 2
Station_status_3								diagn. byte 3
Master_Add								diagn. byte 4
Slave_Ident_Number_High								diagn. byte 5
Slave_Ident_Number_Low								diagn. byte 6
Device_Diagnostic_Header								diagn. byte 7
NF	Not used – set to 0				RGP	SG	PG	diagn. byte 8
Not used – set to 0							PSL	diagn. byte 9
M8F	M7F	M6F	M5F	M4F	M3F	M2F	M1F	diagn. byte 10
M16F	M15F	M14F	M13F	M12F	M11F	M10F	M9F	diagn. byte 11
M8E	M7E	M6E	M5E	M4E	M3E	M2E	M1E	diagn. byte 12
M16E	M15E	M14E	M13E	M12E	M11E	M10E	M9E	diagn. byte 13
Not used – set to 0				CD1.4	CD1.3	CD1.2	CD1.1	diagn. byte 14
Not used – set to 0				CD2.4	CD2.3	CD2.2	CD2.1	diagn. byte 15
Not used – set to 0				CD3.4	CD3.3	CD3.2	CD3.1	diagn. byte 16
Not used – set to 0				CD4.4	CD4.3	CD4.2	CD4.1	diagn. byte 17
Not used – set to 0				CD5.4	CD5.3	CD5.2	CD5.1	diagn. byte 18
Not used – set to 0				CD6.4	CD6.3	CD6.2	CD6.1	diagn. byte 19
Not used – set to 0				CD7.4	CD7.3	CD7.2	CD7.1	diagn. byte 20
Not used – set to 0				CD8.4	CD8.3	CD8.2	CD8.1	diagn. byte 21
Not used – set to 0				CD9.4	CD9.3	CD9.2	CD9.1	diagn. byte 22
Not used – set to 0				CD10.4	CD10.3	CD10.2	CD10.1	diagn. byte 23
Not used – set to 0				CD11.4	CD11.3	CD11.2	CD11.1	diagn. byte 24
Not used – set to 0				CD12.4	CD12.3	CD12.2	CD12.1	diagn. byte 25
Not used – set to 0				CD13.4	CD13.3	CD13.2	CD13.1	diagn. byte 26
Not used – set to 0				CD14.4	CD14.3	CD14.2	CD14.1	diagn. byte 27
Not used – set to 0				CD15.4	CD15.3	CD15.2	CD15.1	diagn. byte 28
Not used – set to 0				CD16.4	CD16.3	CD16.2	CD16.1	diagn. byte 29
Not used – set to 0								diagn. byte 30
Not used – set to 0								diagn. byte 31
Not used – set to 0								diagn. byte 32

Table 15: Diagnostics area content.

Abbreviation	Name	Values
PG	Primary Gateway	0=Not primary gateway 1=Primary gateway
SG	Secondary Gateway	0=Not secondary gateway 1=Secondary gateway
RGP	Redundant Gateway Present	0=Not present 1=Present
NF	No Fault	0= Faults present 1=No fault present
PSL	Power Supply Low	0=Power supply not low 1=Power supply low
M#F	Module # Fault	0=Fault not present 1=Fault present
M#E	Module # Error	0=Error not present 1=Error present
CD#.1	Ch. 1 of Mod. # Fault	0=Fault not present 1=Fault present
CD#.2	Ch. 2 of Mod. # Fault	0=Fault not present 1=Fault present
CD#.3	Ch. 3 of Mod. # Fault	0=Fault not present 1=Fault present
CD#.4	Ch. 4 of Mod. # Fault	0=Fault not present 1=Fault present

Table 16: Diagnostics definitions.

8.3 User Parameters Area

The parameter area defines the behaviour of the Communication Gateway(CG) and of each I/O module.

Parameter bytes 1 to 7 (the first seven rows in the table) are specified by the Profibus DP standard, next follows parameters 8 to 15 which are directed to CG. After these follows parameters for all installed modules. Module parameters consist of module type, mask fault flags and configuration data specific for each module.

8.3.1 Parameters area content

07	06	05	04	03	02	01	00	Decimal bit
Station_status								Param byte 1
Watch-dog_Factor_1								Param byte 2
Watch-dog_Factor_2								Param byte 3
Minimum_Station_Delay_Responder								Param byte 4
Slave_Ident_Number_High								Param byte 5
Slave_Ident_Number_Low								Param byte 6
Group_Ident.								Param byte 7
CG parameter 1								Param byte 8
CG parameter 2								Param byte 9
CG parameter 3								Param byte 10
CG parameter 4								Param byte 11
CG parameter 5								Param byte 12
CG parameter 6								Param byte 13
CG parameter 7								Param byte 14
CG parameter 8								Param byte 15
Module Type 1								Param byte 16
Mask Fault Flags 1								Param byte 17
Other parameters module 1								Param byte 18
								Param byte …
Module Type 16								Param byte …
Mask Fault Flags 16								Param byte …
Other parameters module 16								Param byte …
Last parameter module 16								Param byte 143

Table 17: Parameter area content.

8.4 Input / Output Area – values coding

The following sections summarise the process values coding as used for the various type of I/O information.

8.4.1 Analog 4-20 mA values coding

Nominal range		Min. under range		Max. over range	
Physical	16 bit integer	Physical	16 bit integer	Physical	16 bit integer
0…20mA	0…27306 (0…100%)	None (0mA)	0 (0%)	24mA	32767 (120%)
4…20mA	5461…27306 (0…100%)	None (-4mA)	0 (-25%)	24mA	32767 (125%)

Table 18: Analog values coding.

8.4.2 Digital "ON-OFF" values coding

Input values		Output values	
Digital value	Input status	Digital value	Output status
1	high impedance	1	energised
0	low impedance	0	de-energised

Table 19: Digital values coding.

8.4.3 Analog RTD input values coding

RTD	Nominal range		Min. under range		Max. over range	
Sensor	Physical	16 bit integer	Physical	16 bit integer	Physical	16 bit integer
Pt10, Pt50, Pt100 (a=0.3850)	-200.0 C +850.0 C	-2000 +8500	< -200.0 C	< -2000	> +850.0 C	> 8500
Pt1000 (a=0.3850)	-200.0 C +850.0 C	-2000 +8500	< -200.0 C	< -2000	> +850.0 C	> 8500
Pt10, Pt50, Pt100 (a=0.39100)	-200.0 C +850.0 C	-2000 +8500	< -200.0 C	< -2000	> +850.0 C	> 8500
Pt1000 (a=0.39100)	-200.0 C +1100.0 C	-2000 +11000	< -200.0 C	< -2000	> +850.0 C	> 8500
Ni100	-60.0 C +180.0 C	-600 +1800	< -60.0 C	< -600	> +180.0 C	> 1800
Cu10, Cu50, Cu100 (a=0.2480)	-200.0 C +200.0 C	-2000 +2000	< -200.0 C	< -2000	> +200.0 C	> 2000
R 400	0 Ohm 400 Ohm	0 400	< 0 Ohm	< 0	> 400 Ohm	> 4000
R 4000	0 Ohm 4000 Ohm	0 4000	< 0 Ohm	< 0	> 4000 Ohm	> 4000
R 400 + custom table	0 Ohm… 400 Ohm	0 400	Programmable		Programmable	
R 4000 + custom table	0 Ohm… 4000 Ohm	0 4000	Programmable		Programmable	

Table 20: Analog RTD values.

8.4.4 Analog Potentiometer input values coding

Potentiometer	Nominal range		Min. under range		Max. over range	
Sensor	Physical	16 bit integer	Physical	16 bit integer	Physical	16 bit integer
Potentiometer	0…100%	0…32767 (0…100%)	0<	0 (0%)	>100%	32767 (100%)
Potentiometer + custom table	0…100%	5461…27306 (0…100%)	Programmable		Programmable	

Table 21: Potentiometer values.

8.4.5 Analog Thermocouple input values coding

Thermocouple	Nominal range		Min. under range		Max. over range	
Sensor	Physical	16 bit integer	Physical	16 bit integer	Physical	16 bit integer
S	-50.0 C +1750.0 C	-500 +1750	< -200.0 C	< -2000	> +1750.0C	> 17500
R	-50.0 C +1750.0 C	-500 +1750	<-200.0 C	< -2000	> +1750.0 C	> 17500
B	-0.0 C +1800.0 C	0 +18000	<0.0 C	< -0	> +1800.0 C	> 18000
E	-200.0 C +1000.0 C	-2000 +10000	<-200.0 C	< -2000	> +1000.0 C	> 10000
J	-200.0 C +750.0 C	-2000 +7500	<-200.0 C	< -2000	> +750.0 C	> 7500
K	-200.0 C +1300.0 C	-2000 +13000	<-200.0 C	< -2000	> +1300.0 C	> 13000
T	-200.0 C +400.0 C	-2000 +4000	<-200.0 C	< -2000	> +400.0 C	> 4000
N	-200.0 C +1300.0 C	-2000 +13000	<-200.0 C	< -2000	> +1300.0 C	> 13000
L	-200.0 C +800.0 C	-2000 +8000	<-200.0 C	< -2000	> +800.0 C	> 8000
mV	-100 mV +100 mV	-32769 +32767	-100 mV	< -32769	+100 mV	> 32767
mV + custom table	-100 mV +100 mV	-32769 +32767	Programmable		Programmable	
Thermocouple. + custom table	-200.0 C… +1800.0 C	-32769 +32767	Programmable		Programmable	

Table 22: Analog Thermocouple values

8.5 HiD PBDP1 Profibus DP Gateway

The PBDP1 Communication Gateway (CG) is an intelligent communication interface between a Host Device via Profibus DP and the I/O modules via the Local-bus. At start-up, the user parameters bytes are sent to the CG by the controller.

07	06	05	04	03	02	01	00	Decimal bit
Not used – set to 0					WD_Base	D_SP	D_ST	Param byte 1
Not used – set to 0								Param byte 2
Not used – set to 0								Param byte 3
Not used – set to 0						TUS	M24VF	Param byte 4
Fixed Cold Junction Value High Byte								Param byte 5
Fixed Cold Junction Value Low Byte								Param byte 6
Not used – set to 0								Param byte 7
Not used – set to 0								Param byte 8

Table 23: CG user parameters.

Abbreviation	Name	Values
D_ST	Disable Start-bit monitoring	0= start bit monitoring enabled 1= start bit monitoring disabled
D_SP	Disable Stop-bit monitoring	0= stop bit monitoring enabled 1= stop bit monitoring disabled
WD_Base	Watch-dog Base time	0=10 mS 1=1 mS
M24VF	Mask 24V fault	0=not mask fault 1=mask fault
TUS	Temperature Unit Selection	0=Celsius 1=Fahrenheit

Table 24: CG definitions

8.6 HiD 3010 Analog I/O module

8.6.1 "Input" operating mode (2 input channels)

07	06	05	04	03	02	01	00	Decimal bit
Module Type								Param byte 1
Not used – set to 0						MC2F	MC1F	Param byte 2
Not used – set to 0								Param byte 3
Not used – set to 0								Param byte 4
Not used – set to 0								Param byte 5
Not used – set to 0								Param byte 6
Not used – set to 0								Param byte 7
Not used – set to 0								Param byte 8

Table 25: 3010 user parameters.

15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00	Decimal bit
0F	0E	0D	0C	0B	0A	09	08	07	06	05	04	03	02	01	00	Hex bit
Analog input value channel 0																Read word 1
Analog input value channel 1																Read word 2

Table 26: 3010 memory map.

Abbreviation	Name	Values
-	Module Type	0x07
MC#F	Mask Ch.# Fault	0=not mask fault 1=mask fault

Table 27: 3010 definitions.

8.6.2 "Output" operating mode (2 output channels)

07	06	05	04	03	02	01	00	Decimal bit
Module Type								Param byte 1
Not used – set to 0						MC2F	MC1F	Param byte 2
Not used – set to 0						C2FAO	C1FAO	Param byte 3
Ch.1 Fail Safe Analog Output High Byte								Param byte 4
Ch.1 Fail Safe Analog Output Low Byte								Param byte 5
Ch.2 Fail Safe Analog Output High Byte								Param byte 6
Ch.2 Fail Safe Analog Output Low Byte								Param byte 7
Not used – set to 0								Param byte 8

Table 28: 3010 user parameters.

15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00	Decimal bit
0F	0E	0D	0C	0B	0A	09	08	07	06	05	04	03	02	01	00	Hex bit
Analog output value channel 0																Write word 1
Analog output value channel 1																Write word 2

Table 29: 3010 definitions.

Abbreviation	Name	Values
-	Module Type	0x04
MC#F	Mask Ch.# Fault	0=not mask fault 1=mask fault
C#FAO	Ch.# Freeze Analog Output	0=not freeze the output in case of fail safe 1= freeze the output in case of fail safe
-	Ch.# Fail Safe Analog Output value	0-0x7FFF (0-24mA)

Table 30: 3010 memory map.

8.6.3 “Mixed” operating mode (1st channel in, 2nd channel out)

07	06	05	04	03	02	01	00	Decimal bit
Module Type								Param byte 1
Not used – set to 0						MC2F	MC1F	Param byte 2
Not used – set to 0						C2FAO	Not used (set to 0)	Param byte 3
Ch.2 Fail Safe Analog Output High Byte								Param byte 4
Ch.2 Fail Safe Analog Output Low Byte								Param byte 5
Not used – set to 0								Param byte 6
Not used – set to 0								Param byte 7
Not used – set to 0								Param byte 8

Table 31: 3010 user parameters.

15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00	Decimal bit
0F	0E	0D	0C	0B	0A	09	08	07	06	05	04	03	02	01	00	Hex bit
Analog input value channel 0																Read word 1
Analog output value channel 1																Write word 1

Table 32: 3010 memory map.

Abbreviation	Name	Values
-	Module Type	0x05
MC#F	Mask Ch.# Fault	0=not mask fault 1=mask fault
C2FAO	Ch.2Freeze Analog Output	0=not freeze the output in case of fail safe. 1= freeze the output in case of fail safe.
-	Ch.2 Fail Safe Analog Output value	0-0x7FFF (0-24mA)

Table 33: 3010 definitions.

8.7 HiD3040 Temperature Input module

8.7.1 "RTD" operating mode (2 channels)

07	06	05	04	03	02	01	00	Decimal bit
Module Type								Param byte 1
SS			Not used – set to 0			MC2F	MC1F	Param byte 2
Not used – set to 0								Param byte 3
NU	FSC1		Ch.1 Sensor Type					Param byte 4
NU	FSC2		Ch.2 Sensor Type					Param byte 5
Not used – set to 0								Param byte 6
Not used – set to 0								Param byte 7
Not used – set to 0								Param byte 8

Table 34: 3040 user parameters

15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00	Decimal bit
0F	0E	0D	0C	0B	0A	09	08	07	06	05	04	03	02	01	00	Hex bit
Analog input value channel 1																Read word 1
Analog input value channel 2																Read word 2
Not used – set to 0																Read word 2
Not used – set to 0																Read word 2

Table 35: 3040 memory map.

Abbreviation	Name	Values
-	Module Type	0x10
MC#F	Mask Ch. # Fault	0=not mask fault 1=mask fault
FSC#	Fault Strategy Channel #	0=freeze value 1=set high 2=set low
SS	Sensor Set	0=RTD 2 wire 1=RTD 3 wire 2=RTD 4 wire
-	Ch. # Sensor Type	0=RJC (Cu109 @23C) 1=Pt10 2=Pt50 3=Pt100 4=Pt1000 5=Pt10 6=Pt50 7=Pt100 8=Pt1000 9=Ni100 10=Cu10 11=Cu50 12=Cu100 28=RTD 400 Ω 29=RTD 4000 Ω 30=RTD 400 Ω + custom table 31=RTD 4000 Ω + custom table

Table 36: 3040 definitions.

8.7.2 “Potentiometer” operating mode (2 channels)

07	06	05	04	03	02	01	00	Decimal bit
Module Type								Param byte 1
SS			Not used – set to 0			MC2F	MC1F	Param byte 2
Not used – set to 0								Param byte 3
NU	FSC1		Ch.1 Sensor Type					Param byte 4
NU	FSC2		Ch.2 Sensor Type					Param byte 5
Not used – set to 0								Param byte 6
Not used – set to 0								Param byte 7
Not used – set to 0								Param byte 8

Table 37: 3040 user parameters.

15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00	Decimal bit
0F	0E	0D	0C	0B	0A	09	08	07	06	05	04	03	02	01	00	Hex bit
Analog input value channel 1																Read word 1
Analog input value channel 2																Read word 2
Not used – set to 0																Read word 2
Not used – set to 0																Read word 2

Table 38: 3040 memory map.

Abbreviation	Name	Values
-	Module Type	0x10
NU	Not Used	0
MC#F	Mask Ch. # Fault	0=not mask fault 1=mask fault
FSC#	Fault Strategy Channel #	0=freeze value 1=set high 2=set low
SS	Sensor Set	3=Potentiometer
-	Ch. # Sensor Type	0=absolute value 31=with custom table

Table 39: 3040 definitions.

8.7.3 "TC/mV" operating mode (4 channels)

07	06	05	04	03	02	01	00	Decimal bit
Module Type								Param byte 1
SS			NU	MC4F	MC3F	MC2F	MC1F	Param byte 2
NU	Cold Junction Selection							Param byte 3
DBC1	FSC1		Ch.1 Sensor Type					Param byte 4
DBC2	FSC2		Ch.2 Sensor Type					Param byte 5
DBC3	FSC3		Ch.3 Sensor Type					Param byte 6
DBC4	FSC4		Ch.4 Sensor Type					Param byte 7
Not used – set to 0								Param byte 8

Table 40: 3040 user parameters.

15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00	Decimal bit
0F	0E	0D	0C	0B	0A	09	08	07	06	05	04	03	02	01	00	Hex bit
Analog input value channel 1																Read word 1
Analog input value channel 2																Read word 2
Analog input value channel 3																Read word 2
Analog input value channel 4																Read word 2

Table 41: 3040 memory map.

Abbreviation	Name	Values
-	Module Type	0x10
NU	Not Used	0
MC#F	Mask Ch. # Fault	0=not mask fault 1=mask fault
FSC#	Fault Strategy Channel #	0=freeze value 1=set high 2=set low
DBC#	Disable Burnout test Ch. #	0=not disable burnout test 1=disable burnout test
SS	Sensor Set	5=4 TC with external Cold Junction compensation
-	Cold Junction Selection	0=disabled 16=fixed 48 to 63=external from module 1 to 16
-	Ch. # Sensor Type	0=B 1=E 2=J 3=K 4=L 5=N 6=R 7=S 8=T 29=+/-100mV 30=TC + custom table 31=+/-100mV + custom table

Table 42: 3040 definitions.

8.7.4 "TC/mV + CJC" operating mode (3 + 1 channels)

07	06	05	04	03	02	01	00	Decimal bit
Module Type								Param byte 1
SS			NU	MC4F	MC3F	MC2F	MC1F	Param byte 2
NU	Cold Junction Selection							Param byte 3
DBC1	FSC1		Ch.1 Sensor Type					Param byte 4
DBC2	FSC2		Ch.2 Sensor Type					Param byte 5
DBC3	FSC3		Ch.3 Sensor Type					Param byte 6
DBC4	FSC4		Ch.4 Sensor Type					Param byte 7
Not used – set to 0								Param byte 8

Table 43: 3040 user parameters.

15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00	Decimal bit
0F	0E	0D	0C	0B	0A	09	08	07	06	05	04	03	02	01	00	Hex bit
Analog input value channel 1																Read word 1
Analog input value channel 2																Read word 2
Analog input value channel 3																Read word 2
Analog input value channel 4																Read word 2

Table 44: 3040 memory map.

Abbreviation	Name	Values
-	Module Type	0x10
NU	Not Used	0
MC#F	Mask Ch. # Fault	0=not mask fault 1=mask fault
FSC#	Fault Strategy Channel #	0=freeze value 1=set high 2=set low
DBC#	Disable Burnout test Ch. #	0=not disable burnout test 1=disable burnout test
SS	Sensor Set	6=3 TC with internal Cold Juction compensation RTD
-	Cold Junction Selection	0=disabled 16=fixed 64=internal CJ
-	Ch. 1 Sensor Type	0=RJC (Cu109 @23C) 1=Pt10 2=Pt50 3=Pt100 4=Pt1000 5=Pt10 6=Pt50 7=Pt100 8=Pt1000 9=Ni100 10=Cu10 11=Cu50 12=Cu100 28=RTD 400 Ohm 29=RTD 4000 Ohm 30=RTD 400 Ohm + custom table 31=RTD 4000 Ohm + custom table
-	Ch. 2,3,4 Sensor Type	0=B 1=E 2=J 3=K 4=L 5=N 6=R 7=S 8=T 29=+/-100mV 30=TC + custom table 31=+/-100mV + custom table

Table 45: 3040 definitions.

8.8 HiD 3824 Digital Input module

07	06	05	04	03	02	01	00	Decimal bit
Module Type								Param byte 1
Not used – set to 0				MC4F	MC3F	MC2F	MC1F	Param byte 2
Not used – set to 0				IC4DI	IC3DI	IC2DI	IC1DI	Param byte 3
Not used – set to 0								Param byte 4
Not used – set to 0								Param byte 5
Not used – set to 0								Param byte 6
Not used – set to 0								Param byte 7
Not used – set to 0								Param byte 8

Table 46: DI-3824 user parameters.

08	07	06	05	04	03	02	01	00	Decimal bit
Not used – set to 0					DI4	DI3	DI2	DI1	Read word 1

Table 47: DI-3824 memory map.

Abbreviation	Name	Values
-	Module Type	0x01
MC#F	Mask Ch.# Fault	0=not mask fault 1=mask fault
IC#DI	Invert Ch.# Digital Input	0=not invert 1=invert
DI#	Ch.# Digital Input	if ICiDI=0 0=input open 1=input close if ICiDI=1 0=input close 1=input open

Table 48: DI-3824 definitions.

8.9 HiD 3891 Frequency Input module

07	06	05	04	03	02	01	00	Decimal bit
Module Type								Param byte 1
Not used – set to 0							MC1F	Param byte 2
Reload Time Counter High Value								Param byte 3
Reload Time Counter Low Value								Param byte 4
Not used – set to 0								Param byte 5
Not used – set to 0								Param byte 6
Not used – set to 0								Param byte 7
Not used – set to 0								Param byte 8

Table 49 3891 user parameters.

08	07	06	05	04	03	02	01	00	Decimal bit
Frequency Value									Read word 1
NV/MSB	Counter-Accumulator High Word								Read word 2
Counter-Accumulator Low Word									Read word 3

Table 50 3891 memory map.

Abbreviation	Name	Values
-	Module Type	0x03
MC#F	Mask Ch.# Fault	0=not mask fault 1=mask fault
NV/MSB	New Value / Most Significant Bit	If Reload Time Counter = 0 MSB Else New Value indicator
	Reload Time Counter	If = 0 the 32 bits Counter Accumulator continues to accumulate values Else it sets the number of seconds the values are accumulated

Table 51 3891 definitions.

8.10 HiD 3878 Digital Output module

07	06	05	04	03	02	01	00	Decimal bit
Module Type								Param byte 1
Not used – set to 0						MC2F	MC1F	Param byte 2
Not used – set to 0						C2FDO	C1FDO	Param byte 3
Not used – set to 0						C2FSDO	C1FSDO	Param byte 4
Not used – set to 0								Param byte 5
Not used – set to 0								Param byte 6
Not used – set to 0								Param byte 7
Not used – set to 0								Param byte 8

Table 52: 3878 user parameters.

07	06	05	04	03	02	01	00	Decimal bit
Not used – set to 0						DO2	DO1	Write word 1

Table 53: 3878 memory map.

Abbreviation	Name	Values
-	Module Type	0x02
MC#F	Mask Ch.# Fault	0=not mask fault 1=mask fault
C#FDO	Ch.# Freeze Digital Output	0=not freeze the output in case of fail safe. 1= freeze the output in case of fail safe.
C#FSDO	Ch.# Fail Safe Digital Output	0=not energised 1=energised
DO#	Ch.# Digital Output	0=not energised 1=energised

Table 54: 3878 definitions.

8.11 Empty module

Empty slots are identified by the empty module type.

07	06	05	04	03	02	01	00	Decimal bit
Module Type								Param byte 1
Not used – set to 0								Param byte 2
Not used – set to 0								Param byte 3
Not used – set to 0								Param byte 4
Not used – set to 0								Param byte 5
Not used – set to 0								Param byte 6
Not used – set to 0								Param byte 7
Not used – set to 0								Param byte 8

Table 55: Empty module user parameters.

Abbreviation	Name	Values
-	Module Type	0xFF

Table 56: Empty module definitions.

8.12 Module Types summary

Allocated module types allocation is summarised in the following table.

Module name	Module type
2 channel Analog Input (HiD 3010)	0x07
2 channel Analog Output (HiD 3010)	0x04
2 channel Analog Input/Output (HiD 3010)	0x05
Temperature & Low-level Input (HiD 3040)	0x10
4 channel Digital Input (HiD 3824)	0x01
1 channel Frequency Input (HiD 3891)	0x03
2 channel Digital Output (HiD 3878)	0x02
Empty module	0xFF

Table 57: Modules type allocation.

9 APPENDIX C – HID 3000 STANDARD GSD FILE

9.1 Overview

In the following, a print-out copy of the Standard Profibus GSD file for the HiD 3000 series is presented. This is relevant when the HiD 3000 remote units are equipped with the HiD PBDP1 Profibus DP gateway.

The Standard HiD 3000 GSD file is a Modular GSD file which list all available I/O modules type (along with the associated configuration options) <u>but doesn't specify</u> which type of I/O module is present in each slot position.

The Standard GSD files is intended to be loaded by a Profibus Master Configurator, generally a vendor-specific software tool provided by each Profibus Master manufacturer. By means of the Profibus Master Configurator you can, among other things, specify which module type is to be found in each slot of each connected, modular Profibus DP Slave.

The print-out presented in the following is intended as a "tutorial" aid and is not necessarily updated with the latest GSD revision. Please always use the GSD files as available in electronic format for any real application.

9.2 Content

```
;===========================================================================
;    Device description file according to DIN 19245 Part 3 (PROFIBUS-DP)
;===========================================================================
;
; FILENAME          : ELCO00BA.GSD
;---------------------------------------------------------------------------
; DEVICENAME        : PROFIBUS-DP/FMS 12MBaud
;---------------------------------------------------------------------------
; DEVICEFAMILY      : HID 3000
;---------------------------------------------------------------------------
; PROTOCOL          : PROFIBUS-DP (Slave)
;---------------------------------------------------------------------------
; VENDOR            : Elcon Instruments
;                     via delle industrie 4
;                     Mezzago (MI).
;                     Italy
;                     Phone: 039 / 62921
;                     Fax  : 039 / 6292240
;---------------------------------------------------------------------------
; ORDER-NO          :
;---------------------------------------------------------------------------
; CONTACT           : R&D
;                     Phone: 039 / 62921
;                     Fax  : 039 / 6292240
;---------------------------------------------------------------------------
; FILE VERSION      : 1.3
;---------------------------------------------------------------------------
; DATE              : 26.05.2000
;---------------------------------------------------------------------------
; MODIFICATIONS     :
; 1.0 : First release
; 1.1 : Added 'Empty Module' definition
;       Extended module parametrization from 3 to 8 bytes per module
; 1.2 : Changed Analog module parameters
; 1.3 : Added Temperature module and increased input buffer to 128 bytes,
;       added Frequency module definition,
;       added Fahrenheit selection
;===========================================================================
#Profibus_DP
PrmText = 1
Text(0) = "ENABLE"
Text(1) = "DISABLE"
EndPrmText

PrmText = 2
Text(0) = "DISABLE"
Text(1) = "ENABLE"
EndPrmText

PrmText = 5
Text(0) = "NORMAL"
Text(1) = "REVERSE"
EndPrmText

PrmText = 6
Text(0) = "NOT ENERGISED"
Text(1) = "ENERGISED"
EndPrmText

PrmText = 7
Text(0) = "RTD 2 wire"
Text(1) = "RTD 3 wire"
Text(2) = "RTD 4 wire"
EndPrmText
```

```
PrmText  = 8
Text(0)  = "RJC (Cu109 @23C ELCON)   "
Text(1)  = "Pt10    a=1.3850         "
Text(2)  = "Pt50    a=1.3850         "
Text(3)  = "Pt100   a=1.3850         "
Text(4)  = "Pt1000  a=1.3850         "
Text(5)  = "Pt10    a=1.3910         "
Text(6)  = "Pt50    a=1.3910         "
Text(7)  = "Pt100   a=1.3910         "
Text(8)  = "Pt1000  a=1.3910         "
Text(9)  = "Ni100   a=1.6170         "
Text(10) = "Cu10    a=1.4280         "
Text(11) = "Cu50    a=1.4280         "
Text(12) = "Cu100   a=1.4280         "
Text(28) = "RTD  400 ohm             "
Text(29) = "RTD 4000 ohm             "
Text(30) = "RTD  400 ohm custom table"
Text(31) = "RTD 4000 ohm custom table"
EndPrmText

PrmText  = 9
Text(0)  = "Potentiometer                  "
Text(31) = "Potentiometer with custom table"
EndPrmText

PrmText  = 10
Text(0)  = "B                           "
Text(1)  = "E                           "
Text(2)  = "J                           "
Text(3)  = "K                           "
Text(4)  = "L                           "
Text(5)  = "N                           "
Text(6)  = "R                           "
Text(7)  = "S                           "
Text(8)  = "T                           "
Text(29) = "+/- 100 mV                  "
Text(30) = "Tc with custom table        "
Text(31) = "+/- 100 mV with custom table"
EndPrmText

PrmText  = 11
Text(0)  = "Celsius    "
Text(1)  = "Fahrenheit "
EndPrmText

PrmText  = 13
Text(0)  = "Freeze input                "
Text(1)  = "Set input high              "
Text(2)  = "Set input low               "
EndPrmText

PrmText  = 14
Text(0)  = "Disable cold junction comp.    "
Text(16) = "Fixed cold junction comp.      "
;Text(32) = "Internal cold junction comp.  " ; Made by temperature module
Text(64) = "Internal cold junction comp.   "  ; Sent back by gateway
EndPrmText

PrmText  = 15
Text(0)  = "Disable cold junction comp.    "
Text(16) = "Fixed cold junction comp.      "
Text(48) = "Ext. cold junction comp. mod. 1"
Text(49) = "Ext. cold junction comp. mod. 2"
Text(50) = "Ext. cold junction comp. mod. 3"
Text(51) = "Ext. cold junction comp. mod. 4"
Text(52) = "Ext. cold junction comp. mod. 5"
```

```
Text(53) = "Ext. cold junction comp. mod. 6"
Text(54) = "Ext. cold junction comp. mod. 7"
Text(55) = "Ext. cold junction comp. mod. 8"
Text(56) = "Ext. cold junction comp. mod. 9"
Text(57) = "Ext. cold junction comp. mod.10"
Text(58) = "Ext. cold junction comp. mod.11"
Text(59) = "Ext. cold junction comp. mod.12"
Text(60) = "Ext. cold junction comp. mod.13"
Text(61) = "Ext. cold junction comp. mod.14"
Text(62) = "Ext. cold junction comp. mod.15"
Text(63) = "Ext. cold junction comp. mod.16"
EndPrmText

ExtUserPrmData = 1 "Alarm 24V Power Fail"
Bit(0) 0 0-1; Default = 0, Min = 0, Max = 1
Prm_Text_Ref = 1
EndExtUserPrmData

ExtUserPrmData = 2 "Temperature unit "
Bit(1) 0 0-1; Default = 0, Min = 0, Max = 1
Prm_Text_Ref = 11
EndExtUserPrmData

ExtUserPrmData = 3 "Fixed Cold Junction"
Signed16 0 -200-2000 ; Default = 0, Min = -20.0, Max = 200.0
EndExtUserPrmData

ExtUserPrmData = 6 "Channel 1 Fault"
Bit(0) 0 0-1; Default = 0, Min = 0, Max = 1
Prm_Text_Ref = 1
EndExtUserPrmData

ExtUserPrmData = 7 "Channel 2 Fault"
Bit(1) 0 0-1; Default = 0, Min = 0, Max = 1
Prm_Text_Ref = 1
EndExtUserPrmData

ExtUserPrmData = 8 "Channel 3 Fault"
Bit(2) 0 0-1; Default = 0, Min = 0, Max = 1
Prm_Text_Ref = 1
EndExtUserPrmData

ExtUserPrmData = 9 "Channel 4 Fault"
Bit(3) 0 0-1; Default = 0, Min = 0, Max = 1
Prm_Text_Ref = 1
EndExtUserPrmData

ExtUserPrmData = 10 "Channel 1 Input"
Bit(0) 0 0-1; Default = 0, Min = 0, Max = 1
Prm_Text_Ref = 5
EndExtUserPrmData

ExtUserPrmData = 11 "Channel 2 Input"
Bit(1) 0 0-1; Default = 0, Min = 0, Max = 1
Prm_Text_Ref = 5
EndExtUserPrmData

ExtUserPrmData = 12 "Channel 3 Input"
Bit(2) 0 0-1; Default = 0, Min = 0, Max = 1
Prm_Text_Ref = 5
EndExtUserPrmData

ExtUserPrmData = 13 "Channel 4 Input"
Bit(3) 0 0-1; Default = 0, Min = 0, Max = 1
Prm_Text_Ref = 5
EndExtUserPrmData
```

```
ExtUserPrmData = 20 "Ch. 1 freeze Output"
Bit(0) 0 0-1; Default = 0, Min = 0, Max = 1
Prm_Text_Ref = 2
EndExtUserPrmData

ExtUserPrmData = 21 "Ch. 2 freeze Output"
Bit(1) 0 0-1; Default = 0, Min = 0, Max = 1
Prm_Text_Ref = 2
EndExtUserPrmData

ExtUserPrmData = 22 "Ch. 3 freeze Output"
Bit(2) 0 0-1; Default = 0, Min = 0, Max = 1
Prm_Text_Ref = 2
EndExtUserPrmData

ExtUserPrmData = 23 "Ch. 4 freeze Output"
Bit(3) 0 0-1; Default = 0, Min = 0, Max = 1
Prm_Text_Ref = 2
EndExtUserPrmData

ExtUserPrmData = 30 "Ch. 1 Safe Digital Output"
Bit(0) 0 0-1; Default = 0, Min = 0, Max = 1
Prm_Text_Ref = 6
EndExtUserPrmData

ExtUserPrmData = 31 "Ch. 2 Safe Digital Output"
Bit(1) 0 0-1; Default = 0, Min = 0, Max = 1
Prm_Text_Ref = 6
EndExtUserPrmData

ExtUserPrmData = 32 "Ch. 3 Safe Digital Output"
Bit(2) 0 0-1; Default = 0, Min = 0, Max = 1
Prm_Text_Ref = 6
EndExtUserPrmData

ExtUserPrmData = 33 "Ch. 4 Safe Digital Output"
Bit(3) 0 0-1; Default = 0, Min = 0, Max = 1
Prm_Text_Ref = 6
EndExtUserPrmData

ExtUserPrmData = 40 "Ch. 1 Safe Analog Output"
Unsigned16 0 0-0x7FFF; Default = 0, Min = 0, Max = 7FFF
EndExtUserPrmData

ExtUserPrmData = 41 "Ch. 2 Safe Analog Output"
Unsigned16 0 0-0x7FFF; Default = 0, Min = 0, Max = 7FFF
EndExtUserPrmData

ExtUserPrmData = 42 "Ch. 3 Safe Analog Output"
Unsigned16 0 0-0x7FFF; Default = 0, Min = 0, Max = 7FFF
EndExtUserPrmData

ExtUserPrmData = 43 "Ch. 4 Safe Analog Output"
Unsigned16 0 0-0x7FFF; Default = 0, Min = 0, Max = 7FFF
EndExtUserPrmData

ExtUserPrmData = 50 "RTD connection mode"
BitArea(5-7) 1 0-2   ; Default = 1 (3 wire), Min = 0, Max = 2
Prm_Text_Ref = 7
EndExtUserPrmData

ExtUserPrmData = 51 "Ch. 1 RTD sensor type"
BitArea(0-4) 3 0-31  ; Default = 3 (Pt100)
Prm_Text_Ref = 8
EndExtUserPrmData

ExtUserPrmData = 52 "Ch. 2 RTD sensor type"
```

```
BitArea(0-4) 3 0-31  ; Default = 3 (Pt100)
Prm_Text_Ref = 8
EndExtUserPrmData

ExtUserPrmData = 53 "Ch. 1 fault strategy "
BitArea(5-6) 0 0-2   ; Default = 1 (Freeze), Min = 0, Max = 2
Prm_Text_Ref = 13
EndExtUserPrmData

ExtUserPrmData = 54 "Ch. 2 fault strategy "
BitArea(5-6) 0 0-2   ; Default = 1 (Freeze), Min = 0, Max = 2
Prm_Text_Ref = 13
EndExtUserPrmData

ExtUserPrmData = 55 "Ch. 3 fault strategy "
BitArea(5-6) 0 0-2   ; Default = 1 (Freeze), Min = 0, Max = 2
Prm_Text_Ref = 13
EndExtUserPrmData

ExtUserPrmData = 56 "Ch. 4 fault strategy "
BitArea(5-6) 0 0-2   ; Default = 1 (Freeze), Min = 0, Max = 2
Prm_Text_Ref = 13
EndExtUserPrmData

ExtUserPrmData = 60 "Ch. 1 Potentiometer type"
BitArea(0-4) 0 0,31  ; Default = 0 (ohm)
Prm_Text_Ref = 9
EndExtUserPrmData

ExtUserPrmData = 61 "Ch. 2 Potentiometer type"
BitArea(0-4) 0 0-31  ; Default = 0 (ohm)
Prm_Text_Ref = 9
EndExtUserPrmData

ExtUserPrmData = 71 "Ch. 1 TC/mv sensor type"
BitArea(0-4) 2 0-31  ; Default = 2 (Tc J)
Prm_Text_Ref = 10
EndExtUserPrmData

ExtUserPrmData = 72 "Ch. 2 TC/mv sensor type"
BitArea(0-4) 2 0-31  ; Default = 2 (Tc J)
Prm_Text_Ref = 10
EndExtUserPrmData

ExtUserPrmData = 73 "Ch. 3 TC/mv sensor type"
BitArea(0-4) 2 0-31  ; Default = 2 (Tc J)
Prm_Text_Ref = 10
EndExtUserPrmData

ExtUserPrmData = 74 "Ch. 4 TC/mv sensor type"
BitArea(0-4) 2 0-31  ; Default = 2 (Tc J)
Prm_Text_Ref = 10
EndExtUserPrmData

ExtUserPrmData = 75 "Ch. 1 burnout test"
Bit(7)       0 0,1   ; Default = 0 (Enabled), Min = 0, Max = 1
Prm_Text_Ref = 1
EndExtUserPrmData

ExtUserPrmData = 76 "Ch. 2 burnout test"
Bit(7)       0 0,1   ; Default = 0 (Enabled), Min = 0, Max = 1
Prm_Text_Ref = 1
EndExtUserPrmData

ExtUserPrmData = 77 "Ch. 3 burnout test"
Bit(7)       0 0,1   ; Default = 0 (Enabled), Min = 0, Max = 1
Prm_Text_Ref = 1
```

```
EndExtUserPrmData

ExtUserPrmData = 78 "Ch. 4 burnout test"
Bit(7)       0 0,1   ; Default = 0 (Enabled), Min = 0, Max = 1
Prm_Text_Ref = 1
EndExtUserPrmData

ExtUserPrmData = 79 "Cold Junction mode"     ; for module with internal CJ
BitArea(0-6) 64 0-64 ; Default = 64 (Internal sentback)
Prm_Text_Ref = 14
EndExtUserPrmData

ExtUserPrmData = 80 "Cold Junction mode"     ; for module without CJ
BitArea(0-6) 16 0-64 ; Default = 16 (Fixed temperature)
Prm_Text_Ref = 15
EndExtUserPrmData

ExtUserPrmData = 90 "Reload time counter"
Unsigned16 0 0-65535 ; Default = 0, Min = 0, Max = 65535
EndExtUserPrmData

GSD_Revision        = 1
Vendor_Name         = "Elcon Instruments"
Model_Name          = "HID 3000"
Revision            = "1.3"
Ident_Number        = 0x00BA
Protocol_Ident      = 0                      ; 0 = Profibus DP
Station_Type        = 0                      ; 0 = DP-Slave
FMS_supp            = 0                      ; 0 = false
Hardware_Release    = "A1"
Software_Release    = "1.00"

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
MaxTsdr_9.6         = 60
MaxTsdr_19.2        = 60
MaxTsdr_45.45       = 60
MaxTsdr_93.75       = 60
MaxTsdr_187.5       = 60
MaxTsdr_500         = 100
MaxTsdr_1.5M        = 150
MaxTsdr_3M          = 250
MaxTsdr_6M          = 450
MaxTsdr_12M         = 800

Redundancy          = 0                      ; 0 = no Profibus Redundancy
Repeater_Ctrl_Sig   = 0                      ;
24V_Pins            = 0
Implementation_Type = "SPC3-ASIC"
Bitmap_Device       = "Elconf_n"
;Bitmap_Diag         = ""
Freeze_Mode_supp    = 0
Sync_Mode_supp      = 0
Auto_Baud_supp      = 1
Set_Slave_Add_supp  = 0
Min_Slave_Intervall = 1                      ; time base = 100 uS
Modular_Station     = 1
Max_Module          = 16
Max_Input_Len       = 128
```

```
Max_Output_Len      = 64
Max_Data_Len        = 192
Modul_Offset        = 1
User_Prm_Data_Len   = 8
User_Prm_Data       = 0x00,0x00,0x00,0x00,\
                      0x00,0x00,0x00,0x00

;Fail_Safe           = 1
Slave_Family        = 3@TdF@Elcon
Max_Diag_Data_Len   = 32
Unit_Diag_Bit(0)    = "Primary Gateway"
Unit_Diag_Bit(1)    = "Secondary Gateway"
Unit_Diag_Bit(2)    = "Redundant Gateway present"
Unit_Diag_Bit(7)    = "No Fault"
Unit_Diag_Bit(8)    = "Power supply low"
Unit_Diag_Bit(16)   = "Module  1 Fault"
Unit_Diag_Bit(17)   = "Module  2 Fault"
Unit_Diag_Bit(18)   = "Module  3 Fault"
Unit_Diag_Bit(19)   = "Module  4 Fault"
Unit_Diag_Bit(20)   = "Module  5 Fault"
Unit_Diag_Bit(21)   = "Module  6 Fault"
Unit_Diag_Bit(22)   = "Module  7 Fault"
Unit_Diag_Bit(23)   = "Module  8 Fault"
Unit_Diag_Bit(24)   = "Module  9 Fault"
Unit_Diag_Bit(25)   = "Module 10 Fault"
Unit_Diag_Bit(26)   = "Module 11 Fault"
Unit_Diag_Bit(27)   = "Module 12 Fault"
Unit_Diag_Bit(28)   = "Module 13 Fault"
Unit_Diag_Bit(29)   = "Module 14 Fault"
Unit_Diag_Bit(30)   = "Module 15 Fault"
Unit_Diag_Bit(31)   = "Module 16 Fault"
Unit_Diag_Bit(32)   = "Module  1 Error"
Unit_Diag_Bit(33)   = "Module  2 Error"
Unit_Diag_Bit(34)   = "Module  3 Error"
Unit_Diag_Bit(35)   = "Module  4 Error"
Unit_Diag_Bit(36)   = "Module  5 Error"
Unit_Diag_Bit(37)   = "Module  6 Error"
Unit_Diag_Bit(38)   = "Module  7 Error"
Unit_Diag_Bit(39)   = "Module  8 Error"
Unit_Diag_Bit(40)   = "Module  9 Error"
Unit_Diag_Bit(41)   = "Module 10 Error"
Unit_Diag_Bit(42)   = "Module 11 Error"
Unit_Diag_Bit(43)   = "Module 12 Error"
Unit_Diag_Bit(44)   = "Module 13 Error"
Unit_Diag_Bit(45)   = "Module 14 Error"
Unit_Diag_Bit(46)   = "Module 15 Error"
Unit_Diag_Bit(47)   = "Module 16 Error"
Unit_Diag_Bit(48)   = "Ch. 1 of Mod. 1 Fault"
Unit_Diag_Bit(49)   = "Ch. 2 of Mod. 1 Fault"
Unit_Diag_Bit(50)   = "Ch. 3 of Mod. 1 Fault"
Unit_Diag_Bit(51)   = "Ch. 4 of Mod. 1 Fault"
Unit_Diag_Bit(56)   = "Ch. 1 of Mod. 2 Fault"
Unit_Diag_Bit(57)   = "Ch. 2 of Mod. 2 Fault"
Unit_Diag_Bit(58)   = "Ch. 3 of Mod. 2 Fault"
Unit_Diag_Bit(59)   = "Ch. 4 of Mod. 2 Fault"
Unit_Diag_Bit(64)   = "Ch. 1 of Mod. 3 Fault"
Unit_Diag_Bit(65)   = "Ch. 2 of Mod. 3 Fault"
Unit_Diag_Bit(66)   = "Ch. 3 of Mod. 3 Fault"
Unit_Diag_Bit(67)   = "Ch. 4 of Mod. 3 Fault"
Unit_Diag_Bit(72)   = "Ch. 1 of Mod. 4 Fault"
Unit_Diag_Bit(73)   = "Ch. 2 of Mod. 4 Fault"
Unit_Diag_Bit(74)   = "Ch. 3 of Mod. 4 Fault"
Unit_Diag_Bit(75)   = "Ch. 4 of Mod. 4 Fault"
Unit_Diag_Bit(80)   = "Ch. 1 of Mod. 5 Fault"
Unit_Diag_Bit(81)   = "Ch. 2 of Mod. 5 Fault"
Unit_Diag_Bit(82)   = "Ch. 3 of Mod. 5 Fault"
Unit_Diag_Bit(83)   = "Ch. 4 of Mod. 5 Fault"
```

```
Unit_Diag_Bit(88)   = "Ch. 1 of Mod. 6 Fault"
Unit_Diag_Bit(89)   = "Ch. 2 of Mod. 6 Fault"
Unit_Diag_Bit(90)   = "Ch. 3 of Mod. 6 Fault"
Unit_Diag_Bit(91)   = "Ch. 4 of Mod. 6 Fault"
Unit_Diag_Bit(96)   = "Ch. 1 of Mod. 7 Fault"
Unit_Diag_Bit(97)   = "Ch. 2 of Mod. 7 Fault"
Unit_Diag_Bit(98)   = "Ch. 3 of Mod. 7 Fault"
Unit_Diag_Bit(99)   = "Ch. 4 of Mod. 7 Fault"
Unit_Diag_Bit(104)  = "Ch. 1 of Mod. 8 Fault"
Unit_Diag_Bit(105)  = "Ch. 2 of Mod. 8 Fault"
Unit_Diag_Bit(106)  = "Ch. 3 of Mod. 8 Fault"
Unit_Diag_Bit(107)  = "Ch. 4 of Mod. 8 Fault"
Unit_Diag_Bit(112)  = "Ch. 1 of Mod. 9 Fault"
Unit_Diag_Bit(113)  = "Ch. 2 of Mod. 9 Fault"
Unit_Diag_Bit(114)  = "Ch. 3 of Mod. 9 Fault"
Unit_Diag_Bit(115)  = "Ch. 4 of Mod. 9 Fault"
Unit_Diag_Bit(120)  = "Ch. 1 of Mod. 10 Fault"
Unit_Diag_Bit(121)  = "Ch. 2 of Mod. 10 Fault"
Unit_Diag_Bit(122)  = "Ch. 3 of Mod. 10 Fault"
Unit_Diag_Bit(123)  = "Ch. 4 of Mod. 10 Fault"
Unit_Diag_Bit(128)  = "Ch. 1 of Mod. 11 Fault"
Unit_Diag_Bit(129)  = "Ch. 2 of Mod. 11 Fault"
Unit_Diag_Bit(130)  = "Ch. 3 of Mod. 11 Fault"
Unit_Diag_Bit(131)  = "Ch. 4 of Mod. 11 Fault"
Unit_Diag_Bit(136)  = "Ch. 1 of Mod. 12 Fault"
Unit_Diag_Bit(137)  = "Ch. 2 of Mod. 12 Fault"
Unit_Diag_Bit(138)  = "Ch. 3 of Mod. 12 Fault"
Unit_Diag_Bit(139)  = "Ch. 4 of Mod. 12 Fault"
Unit_Diag_Bit(144)  = "Ch. 1 of Mod. 13 Fault"
Unit_Diag_Bit(145)  = "Ch. 2 of Mod. 13 Fault"
Unit_Diag_Bit(146)  = "Ch. 3 of Mod. 13 Fault"
Unit_Diag_Bit(147)  = "Ch. 4 of Mod. 13 Fault"
Unit_Diag_Bit(152)  = "Ch. 1 of Mod. 14 Fault"
Unit_Diag_Bit(153)  = "Ch. 2 of Mod. 14 Fault"
Unit_Diag_Bit(154)  = "Ch. 3 of Mod. 14 Fault"
Unit_Diag_Bit(155)  = "Ch. 4 of Mod. 14 Fault"
Unit_Diag_Bit(160)  = "Ch. 1 of Mod. 15 Fault"
Unit_Diag_Bit(161)  = "Ch. 2 of Mod. 15 Fault"
Unit_Diag_Bit(162)  = "Ch. 3 of Mod. 15 Fault"
Unit_Diag_Bit(163)  = "Ch. 4 of Mod. 15 Fault"
Unit_Diag_Bit(168)  = "Ch. 1 of Mod. 16 Fault"
Unit_Diag_Bit(169)  = "Ch. 2 of Mod. 16 Fault"
Unit_Diag_Bit(170)  = "Ch. 3 of Mod. 16 Fault"
Unit_Diag_Bit(171)  = "Ch. 4 of Mod. 16 Fault"

Max_User_Prm_Data_Len      = 136
Ext_User_Prm_Data_Const(0) = 0x00,0x00,0x00,0x00,\
                             0x00,0x00,0x00,0x00

Ext_User_Prm_Data_Ref(3) = 1                 ; Disable 24V fail
Ext_User_Prm_Data_Ref(3) = 2                 ; Farenheit temperature unit
Ext_User_Prm_Data_Ref(4) = 3                 ; Fixed Cold Junction Value

Module = "Module 3824 DI 4xDC24V" 0x10       ; 1 byte in
Ext_Module_Prm_Data_Len = 8
Ext_User_Prm_Data_Const(0) = 0x01            ; Module Type
Ext_User_Prm_Data_Ref(1) = 6
Ext_User_Prm_Data_Ref(1) = 7
Ext_User_Prm_Data_Ref(1) = 8
Ext_User_Prm_Data_Ref(1) = 9
Ext_User_Prm_Data_Ref(2) = 10
Ext_User_Prm_Data_Ref(2) = 11
Ext_User_Prm_Data_Ref(2) = 12
Ext_User_Prm_Data_Ref(2) = 13
Ext_User_Prm_Data_Const(3) = 0x00,0x00,0x00,0x00,0x00
EndModule
;
```

```
Module = "Module 3878 DO 2xDC24V" 0x20       ; 1 byte out
Ext_Module_Prm_Data_Len = 8
Ext_User_Prm_Data_Const(0) = 0x02            ; Module Type
Ext_User_Prm_Data_Ref(1) = 6
Ext_User_Prm_Data_Ref(1) = 7
Ext_User_Prm_Data_Ref(2) = 20
Ext_User_Prm_Data_Ref(2) = 21
Ext_User_Prm_Data_Ref(3) = 30
Ext_User_Prm_Data_Ref(3) = 31
Ext_User_Prm_Data_Const(4) = 0x00,0x00,0x00,0x00
EndModule
;
Module = "Module 3010 AI 2x14BIT" 0x51       ; 2 words in
Ext_Module_Prm_Data_Len = 8
Ext_User_Prm_Data_Const(0) = 0x07            ; Module Type
Ext_User_Prm_Data_Ref(1) = 6
Ext_User_Prm_Data_Ref(1) = 7
Ext_User_Prm_Data_Const(2) = 0x00,0x00,0x00,0x00,0x00,0x00
EndModule
;
Module = "Module 3010 AI/AO 1+1x14BIT" 0x70  ; 1 word in, 1 word out
Ext_Module_Prm_Data_Len = 8
Ext_User_Prm_Data_Const(0) = 0x05            ; Module Type
Ext_User_Prm_Data_Ref(1) = 6
Ext_User_Prm_Data_Ref(1) = 7
Ext_User_Prm_Data_Ref(2) = 21
Ext_User_Prm_Data_Ref(3) = 41
Ext_User_Prm_Data_Const(5) = 0x00,0x00,0x00
EndModule
;
Module = "Module 3010 AO 2x14BIT" 0x61       ; 2 words out
Ext_Module_Prm_Data_Len = 8
Ext_User_Prm_Data_Const(0) = 0x04            ; Module Type
Ext_User_Prm_Data_Ref(1) = 6
Ext_User_Prm_Data_Ref(1) = 7
Ext_User_Prm_Data_Ref(2) = 20
Ext_User_Prm_Data_Ref(2) = 21
Ext_User_Prm_Data_Ref(3) = 40
Ext_User_Prm_Data_Ref(5) = 41
Ext_User_Prm_Data_Const(7) = 0x00
EndModule
;
Module = "Module 3040 RTD2,3,4 2x16BIT" 0x53 ; 4 words in
Ext_Module_Prm_Data_Len = 8
Ext_User_Prm_Data_Const(0) = 0x10            ; Module Type
Ext_User_Prm_Data_Ref(1) = 6                 ; disable fault Ch1
Ext_User_Prm_Data_Ref(1) = 7                 ; disable fault Ch2
Ext_User_Prm_Data_Ref(1) = 50                ; RTD connection type
Ext_User_Prm_Data_Const(2) = 0x00            ; no CJ selection
Ext_User_Prm_Data_Ref(3) = 51                ; RTD sensor type Ch1
Ext_User_Prm_Data_Ref(3) = 53                ; fault strategy  Ch1
Ext_User_Prm_Data_Ref(4) = 52                ; RTD sensor type Ch2
Ext_User_Prm_Data_Ref(4) = 54                ; fault strategy  Ch2
Ext_User_Prm_Data_Const(5) = 0x00
Ext_User_Prm_Data_Const(6) = 0x00
Ext_User_Prm_Data_Const(7) = 0x00            ; maxv!
EndModule
;
Module = "Module 3040 POT. 2x16BIT" 0x53     ; 4 words in
Ext_Module_Prm_Data_Len = 8
Ext_User_Prm_Data_Const(0) = 0x10            ; Module Type
Ext_User_Prm_Data_Const(1) = 0x60            ; Potentiometer mode
Ext_User_Prm_Data_Ref(1) = 6                 ; disable fault Ch1
Ext_User_Prm_Data_Ref(1) = 7                 ; disable fault Ch2
Ext_User_Prm_Data_Const(2) = 0x00            ; no CJ selection
Ext_User_Prm_Data_Ref(3) = 60                ; Pot. sensor type Ch1
Ext_User_Prm_Data_Ref(3) = 53                ; fault strategy  Ch1
```

```
Ext_User_Prm_Data_Ref(4) = 61                   ; Pot. sensor type Ch2
Ext_User_Prm_Data_Ref(4) = 54                   ; fault strategy  Ch2
Ext_User_Prm_Data_Const(5) = 0x00
Ext_User_Prm_Data_Const(6) = 0x00
Ext_User_Prm_Data_Const(7) = 0x00               ; maxv!
EndModule
;
Module = "Module 3040 TC/mV w. CJ 4x16BIT" 0x53 ; 4 words in
Ext_Module_Prm_Data_Len = 8
Ext_User_Prm_Data_Const(0) = 0x10               ; Module Type
Ext_User_Prm_Data_Const(1) = 0xC0               ; TC/mV with CJ
Ext_User_Prm_Data_Ref(1) = 6                    ; disable fault Ch1
Ext_User_Prm_Data_Ref(1) = 7                    ; disable fault Ch2
Ext_User_Prm_Data_Ref(1) = 8                    ; disable fault Ch3
Ext_User_Prm_Data_Ref(1) = 9                    ; disable fault Ch4
Ext_User_Prm_Data_Ref(2) = 79                   ; CJ mode with int.
Ext_User_Prm_Data_Ref(3) = 51                   ; RTD sensor type Ch1
Ext_User_Prm_Data_Ref(3) = 53                   ; fault strategy  Ch1
Ext_User_Prm_Data_Ref(4) = 72                   ; Tc/mV sensor type Ch2
Ext_User_Prm_Data_Ref(4) = 54                   ; fault strategy  Ch2
Ext_User_Prm_Data_Ref(4) = 76                   ; disable burnout test Ch2
Ext_User_Prm_Data_Ref(5) = 73                   ; Tc/mV sensor type Ch3
Ext_User_Prm_Data_Ref(5) = 55                   ; fault strategy  Ch3
Ext_User_Prm_Data_Ref(5) = 77                   ; disable burnout test Ch3
Ext_User_Prm_Data_Ref(6) = 74                   ; Tc/mV sensor type Ch4
Ext_User_Prm_Data_Ref(6) = 56                   ; fault strategy  Ch4
Ext_User_Prm_Data_Ref(6) = 78                   ; disable burnout test Ch4
Ext_User_Prm_Data_Const(7) = 0x00               ; maxv!
EndModule
;
Module = "Module 3040 TC/mV 4x16BIT" 0x53       ; 4 words in
Ext_Module_Prm_Data_Len = 8
Ext_User_Prm_Data_Const(0) = 0x10               ; Module Type
Ext_User_Prm_Data_Const(1) = 0xA0               ; TC/mV without CJ
Ext_User_Prm_Data_Ref(1) = 6                    ; disable fault Ch1
Ext_User_Prm_Data_Ref(1) = 7                    ; disable fault Ch2
Ext_User_Prm_Data_Ref(1) = 8                    ; disable fault Ch3
Ext_User_Prm_Data_Ref(1) = 9                    ; disable fault Ch4
Ext_User_Prm_Data_Ref(2) = 80                   ; CJ mode without int.
Ext_User_Prm_Data_Ref(3) = 71                   ; Tc/mV sensor type Ch1
Ext_User_Prm_Data_Ref(3) = 53                   ; fault strategy  Ch1
Ext_User_Prm_Data_Ref(3) = 75                   ; disable burnout test Ch1
Ext_User_Prm_Data_Ref(4) = 72                   ; Tc/mV sensor type Ch2
Ext_User_Prm_Data_Ref(4) = 54                   ; fault strategy  Ch2
Ext_User_Prm_Data_Ref(4) = 76                   ; disable burnout test Ch2
Ext_User_Prm_Data_Ref(5) = 73                   ; Tc/mV sensor type Ch3
Ext_User_Prm_Data_Ref(5) = 55                   ; fault strategy  Ch3
Ext_User_Prm_Data_Ref(5) = 77                   ; disable burnout test Ch3
Ext_User_Prm_Data_Ref(6) = 74                   ; Tc/mV sensor type Ch4
Ext_User_Prm_Data_Ref(6) = 56                   ; fault strategy  Ch4
Ext_User_Prm_Data_Ref(6) = 78                   ; disable burnout test Ch4
Ext_User_Prm_Data_Const(7) = 0x00               ; maxv!
EndModule
;
Module = "Module 3891 FREQ. 1x16+1x32BIT" 0x52 ; 3 words in, cons. word
Ext_Module_Prm_Data_Len = 8
Ext_User_Prm_Data_Const(0) = 0x03               ; Module Type
Ext_User_Prm_Data_Ref(1) = 6
Ext_User_Prm_Data_Ref(2) = 90
Ext_User_Prm_Data_Const(4) = 0x00,0x00,0x00,0x00
EndModule
;
Module = "Empty Module" 0x00
Ext_Module_Prm_Data_Len = 8
Ext_User_Prm_Data_Const(0) = 0xFF,0x00,0x00,0x00,0x00,0x00,0x00,0x00
EndModule
```

10 APPENDIX D – HID 3000 PROCESSED GSD FILE

10.1 Overview

In the following, some information about the "Processed" Profibus GSD file for the HiD 3000 series is presented.

The "processed" GSD file is the one generated by the HiD 3000 HMI Commissioning Tool when you select the .GSD format. This file is similar but not identical to the Standard HiD 3000 GSD file. The main difference is that the Profibus HiD 3000 station is described as a "compact" slave instead of a "modular" slave (as in the Standard GSD file).

In this way, it is possible to include in the Processed GSD file both the specific module configuration (i.e. which I/O module type is present in each slot) and the specific modules parameters (i.e. the specific modules configuration options selected by the user via HMI SW tool), including the gateway related ones.

In summary, the Standard GSD file is a fully generic slave description (and in fact there is a single GSD file of this type) while the Processed GSD is a specific description of a given slave configuration.

In the following, only the Processed GSD file sections that are different from the Standard GSD file ones have been inserted.

Italic identifies elements that were eliminated – or commented-out – with respect to the Standard GSD file, while ***bold*** shows what has been added. The .GSD file sections with no change were not inserted.

N.B. This is a template file referring to an empty (no modules) HiD3000 I/O Station with default configuration values.

10.2 Content

```
#Profibus_DP          ; GSD FILE VERSION    : 1.1
;S.1 – S.2  =================================================================
;All these sections (S.1 to S.2) were eliminated (i.e. commented-out)
;These sections contained all parameter-associated text strings.
;S.5  =======================================================================
;Max_Module          = 16
;User_Prm_Data_Len   = 8
;User_Prm_Data       = 0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00
User_Prm_Data_Len   = 136
;S.7  =======================================================================
Max_User_Prm_Data_Len      = 136
;Ext_User_Prm_Data_Const(0) = 0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00
;Ext_User_Prm_Data_Ref(3) = 1                 ; Disable 24V fail
;S.8 – S.13  ================================================================
;All these sections (S.8 to S.13) were eliminated (i.e. commented-out)
;These sections contained all Modules description information.
;S.14  ======================================================================
;A fully new section (S.14) was added
Max_Module = 1
;Parameters,  first line: unit paramteters, next  lines: one line for each slot
User_Prm_Data  =\
0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,\
0xFF,0x00,0x00,0x00,0x00,0x00,0x00,0x00,\
0xFF,0x00,0x00,0x00,0x00,0x00,0x00,0x00,\
0xFF,0x00,0x00,0x00,0x00,0x00,0x00,0x00,\
0xFF,0x00,0x00,0x00,0x00,0x00,0x00,0x00,\
```

```
0x01,0x00,0x00,0x00,0x00,0x00,0x00,0x00,\
0x02,0x00,0x00,0x00,0x00,0x00,0x00,0x00,\
0xFF,0x00,0x00,0x00,0x00,0x00,0x00,0x00,\
0xFF,0x00,0x00,0x00,0x00,0x00,0x00,0x00,\
0xFF,0x00,0x00,0x00,0x00,0x00,0x00,0x00,\
0xFF,0x00,0x00,0x00,0x00,0x00,0x00,0x00,\
0xFF,0x00,0x00,0x00,0x00,0x00,0x00,0x00,\
0xFF,0x00,0x00,0x00,0x00,0x00,0x00,0x00,\
0xFF,0x00,0x00,0x00,0x00,0x00,0x00,0x00,\
0xFF,0x00,0x00,0x00,0x00,0x00,0x00,0x00,\
0xFF,0x00,0x00,0x00,0x00,0x00,0x00,0x00,\
0xFF,0x00,0x00,0x00,0x00,0x00,0x00,0x00

;S.15  ======================================================================

;A fully new section (S.15) was added

Module= "Installation "

0x00,0x00,0x00,0x00,0x10,0x20,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00

EndModule
```

11 APPENDIX E – MODBUS CONCEPT

The communication system consists of a single master and up to 32 slaves. All devices are connected using two-wire RS-485 network hardware. If the master does not have an RS-485 port, a RS-232 to RS-485 converter is required. The electrical characteristics of RS485 limit the number of devices on a network to 32; however, buffering by repeaters increases this number.

The RS485 mode determines the way that the network is connected together. The 2-wire arrangement has both transmit and receive signals sharing the same wires. Although this makes most efficient use of the connections and makes wiring simpler, correct operation depends upon critical timing within the Master device.

RS485 requires that the extreme ends of a network be terminated with 120 Ohm resistors. If the MBRT Gateway is the last device on the network, the terminating resistor must be incorporated within the connector pod.

Modbus is a Master-Slave based communications protocol that means that all messages may only be initiated by the Master device. In general the Master will communicate with one Slave device at a time; it is possible under certain circumstances for the Master to broadcast to the entire network.

Message synchronisation is accomplished by detection of an idle communication line. The communication line is considered idle when no communication exists for an equivalent delay of 4 characters. The first byte received after idle-line detection is interpreted as the address byte of the next message. Message bytes must be transmitted in a continuous stream until the complete message has been sent. If a delay of more than 4 characters exists within the message, the message is discarded.

Response messages from the Slave are delayed by at least 4 character delays.

The basic Modbus RTU protocol format for both Master and Slaves is as follows:

Address	Function Code	Data	CRC 16

Each Slave unit requires a unique address to be programmed. If two or more units have the same address on the network, both or all will respond when this address is accessed by the Master device and a data corruption will result. Possible addresses range from 1-255; however, Modbus defines a maximum address number of 247.

The Function code defines the type of operation to execute on the message..

The Data field is Function code dependent and is detailed in the following sections.

Modbus RTU uses a 16-bit cyclic redundancy check (CRC). The error check includes all of the message bytes, starting with the first address byte when a CRC error is detected in the Master transmission, the message is discarded and there will be no response from the slave. If the CRC check is correct but the internal data in the message is not correct, the Slave will respond with one of two exception responses listed later

For further information the Modbus RTU protocol is described in the Modicon Modbus Reference Guide, Publication PI-MBUS-300 Rev. B.

11.1 Command Supported

The data type in a Modbus system is controlled by Function Code (FC n)

11.1.1 Function Code

The following functions are used for exchange data in bit format:

FC 01 Read Coil Status,

FC 02 Read Input Status,

FC 05 Force Single Coil,

FC 15 Force Multiple Coils.

The following functions are used for exchange data in Register format:

FC 03 Read Holding Registers,

FC 04 Read Input Registers,

FC 06 Preset Single Register,

FC 16 Preset Multiple Registers.

The following function with 4 sub-code (SC) is used for diagnostic test

FC 08 Diagnostic

SC 00 Loop-back

SC 01÷03 Message Counter

11.1.2 Data & Address Representation

Function Code	Data	Data Type		Access Type	User Level Address
01, 05, 15	Coil Status	Bit	Output	Read/Write	**0**xxxx
02	Input Status	Bit	Input	Read Only	**1**xxxx
04	Input Register	16 Bit	Input Registers	Read Only	**3**xxxx
03, 06, 16	Holding Registers	16 Bit	Output Registers	Read/Write	**4**xxxx

Table 58: Data Definition

In the Modbus User Level the address are counted beginning with **1**, instead in the string message the address are always referenced to **0**.

11.2 Message Format

Below are reported all the Modbus function supported by the MBRT; the function code 01, 02, 05, 15 are used for read or set single and multiple BIT, the function code 03, 04, 06, 16 are used for read or set single or multiple registers (16 Bit size), the function code 08 with its sub-function for execute diagnostic test.

11.2.1 Read Input Registers

ADDRESS	04	Registers Address Start		Number Registers		CRC 16
		Byte High	Byte Low	Byte High	Byte Low	

Table 59: Master message

ADDRESS	04	Byte Count	Data Register 1		Data Registers n		CRC 16
			Byte High	Byte Low	Byte High	Byte Low	

Table 60: Response message

11.2.2 Read Holding Registers

ADDRESS	03	Registers Address Start		Number Registers		CRC 16
		Byte High	Byte Low	Byte High	Byte Low	

Table 61: Master Message

ADDRESS	03	Byte Count	Register Value 1		Registers Value n		CRC 16
			Byte High	Byte Low	Byte High	Byte Low	

Table 62: Response Message

11.2.3 Preset single Register message

ADDRESS	06	Registers Address Start		Registers Value		CRC 16
		Byte High	Byte Low	Byte High	Byte Low	

Table 63: Master Message

ADDRESS	06	Registers Address Start		Registers Value		CRC 16
		Byte High	Byte Low	Byte High	Byte Low	

Table 64: Response Message

11.2.4 Preset Multiple Registers message syntax

Address	16	Register Address Start		Register Number		Byte Count	Register Value 1		Register Value n		CRC 16
		Byte High	Byte Low	Byte High	Byte Low		Byte High	Byte Low	Byte High	Byte Low	

Table 65: Master Message

Address	16	Register Address Start		Register Number		CRC 16
		Byte High	Byte Low	Byte High	Byte Low	

Table 66: Response Message

11.2.5 Read Input Status

ADDRESS	02	Bit Address Start		Number Bit		CRC 16
		Byte High	Byte Low	Byte High	Byte Low	

Table 67: Master Message

ADDRESS	02	Bit Address Start		Number Bit		CRC 16
		Byte High	Byte Low	Byte High	Byte Low	

Table 68: Response Message

11.2.6 Read Coils Status

ADDRESS	01	Coil Address Start		Number Coils		CRC 16
		Byte High	Byte Low	Byte High	Byte Low	

Table 69: Master Message

ADDRESS	01	Byte Count	Coils Value 1÷8	Coils Value n÷n+8	CRC 16
			Byte 1	Byte n/8	

Table 70: Response Message

11.2.7 Force single Coil

ADDRESS	05	Coil Address Start		Coil Value ON/OFF	Coil Value 0	CRC 16
		Byte High	Byte Low	Byte	Byte	

Table 71: Master Message

ADDRESS	05	Coil Address Start		Coil Value ON/OFF	Coil Value 0	CRC 16
		Byte High	Byte Low	Byte	Byte	

Table 72: Response Message

11.2.8 Force Multiple Coils

Address	15	Coil Address start		Coils Number		Byte Count	Coil Value 1÷8	Coil Value n÷n+8	CRC 16
		Byte High	Byte Low	Byte High	Byte Low		Byte 1	Byte n/8	

Table 73: Master Message

Address	15	Coil Address Start		Coils Number		CRC 16
		Byte High	Byte Low	Byte High	Byte Low	

Table 74: Response Message

11.2.9 Diagnostics Message

The purpose of the Loop-back Test is to test the communication system, the function code is 08 with supported sub function 00, 10, 12, 13 and 14. The message is composed by 2 Byte of Sub-function Code followed by 2 Byte to designate the action to be taken.

11.2.9.1 Supported Sub Function

Sub Code	Sub code Detail	Sub code Description
00	Loop-back Comunication	Return in the field data the whole message
10	Reset Counter	Reset All the counter below
12	Return Bus CRC	Return in field data the Bus CRC error count
13	Return Bus Exception	Return in field data the Bus exception error count
14	Return Slave Message	Return in field data Slave Message Count

Table 75: Loop-back sub function

11.2.9.2 Message Syntax

ADDRESS	08	Sub Function Code	Data	CRC 16

Table 76: Message Request

The Data field for the function with sub code 10, 12, 13, 14 must be 00.

ADDRESS	08	Sub Function Code	Data	CRC 16

Table 77: Message Response

11.2.10 Exception Response

It is possible that some function transmitted from the master are not supported by the slave (Code 01) or the address range is not valid (Code 02); in this case the slave will respond with format below.

11.2.10.1 Illegal Function

ADDRESS	128 + X	01	CRC 16

Table 78: Message Response

11.2.10.2 Illegal Data Address

ADDRESS	128 + X	02	CRC 16

Table 79: Message Response

11.2.10.3 Slave Device Busy

ADDRESS	128 + X	06	CRC 16

Table 80: Message Response

N.B. X is the function code of transmission message

12 APPENDIX F – MODBUS DATABASE AREA

12.1 Introduction

This section describes the memory map allocation and the key data formats applicable to a HiD 3000 I/O station system when used with Modbus RTU communication gateway. The selected formats are fully compatible with the "Modicon Modbus Protocol Reference Guide" PI-MBUS-300 Rev. j, and thereby guarantee full interoperability with any generic Modbus compliant Host Device.

On Modbus RTU communications memory is divided into the following areas:

- Diagnostics information area
- User parameters area
- Input / Output area

In the following sections, the contents of the various areas will be described in detail.

Further Information about the Modbus protocol, and the reference guide identified can be found at www.modicon.com which is part of the Schneider Electric web site.

Additional Information about Modbus and Modbus users can be found at www.Modbus.org

12.2 Diagnostic Information Area

The Diagnostic Area is accessible through the Function Code 04 (Read Input Registers) or Function Code 02 (Read Input Status). The diagnostic section is composed of one Gateway diagnostic register (32601), one General diagnostic register (32602), one summary Modules fault register (32603) and one summary Modules configuration error register. They are accessible as bit or as word, in the table below are indicated the address for access bit or access word, and the fault description.

12.2.1 Address Map & Contents

Module Position	Decimal Address		Register Content Description															
	Input Register	Input Status	0F	0E	0D	0C	0B	0A	09	08	07	06	05	04	03	02	01	00
			15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
Gateway	32601	11616÷11601									NF					RG	SG	PG
	32602	10632÷10617														SF		PF
	32603	10648÷10633	MF	MF	MF	MF	MF	MF	MF	MF	MF	MF	MF	MF	MF	MF	MF	MF
	32604	10664÷10649	ME	ME	ME	ME	ME	ME	ME	ME	ME	ME	ME	ME	ME	ME	ME	ME
1	32605	10680÷10665													CF	CF	CF	CF
2	32606	10696÷10681													CF	CF	CF	CF
3	32607	10712÷10697													CF	CF	CF	CF
4	32608	10728÷10713													CF	CF	CF	CF
5	32609	10744÷10729													CF	CF	CF	CF
6	32610	10760÷10745													CF	CF	CF	CF
7	32611	10776÷10761													CF	CF	CF	CF
8	32612	10792÷10777													CF	CF	CF	CF
9	32613	10808÷10793													CF	CF	CF	CF
10	32614	10824÷10809													CF	CF	CF	CF
11	32615	10840÷10825													CF	CF	CF	CF
12	32616	10856÷10841													CF	CF	CF	CF
13	32617	10872÷10857													CF	CF	CF	CF
14	32618	10888÷10873													CF	CF	CF	CF
15	32619	10904÷10889													CF	CF	CF	CF
16	32620	10920÷10905													CF	CF	CF	CF

Table 81: Diagnostic Area Definition

Bit Set (Abbreviation)	Name	Description
PG	Primary Gateway	The gateway is inserted on the primary connector
SG	Secondary Gateway	The gateway is inserted on the secondary connector
RG	Redundancy Gateway	The Redundancy Gateway is present
NF	No Fault	No Module Fault or Module error
PF	Power Failure	The power supply is under 20.4V
SF	Secondary Fault	The stand by gateway is in fault
MF	Module Fault	Module not respond, or parameter error
ME	Module Error	Module Configuration Error
CF	Channel Fault	Module channel fault

Table 82: Abbreviation name description.

12.2.2 Fault Bit Address Calculate

The formula below calculates the channel fault memory location knowing the position of the module and the channel number.

Channel Fault = **1**0000 + (**Mp***16+**Cn**+648)

Module Fault = **Bp** + 1

Module Error = **Bp** + 1

Mp: Module position

Bp: Bit position

Cn: Channel number

Example: Fault channel 3 in position 5

Address **= 1**0000 + (**5***16+**3**+648) = **1**0731

12.3 Analog Input Area

For every Input module four registers are reserved in the Modbus database. The address locations are fixed to the Modules positions on the termination board. The Modules that reference this area are HiD 3010, HiD 3040 and HiD 3891. This Area is accessible through the Function Code 04

12.3.1 Address Map & Contents

Module	Register Decimal Address	Register Content Description
	30001	Reserved
1	30002	HiD 3010 Channel 1
		HiD 3040 Channel 1
	30003	HiD 3010 Channel 2 (when switched as input)
		HiD 3040 Channel 2
		HiD 3891 Frequency Value
	30004	
		HiD 3040 Channel 3
		HiD 3891 Counter High Value
	30005	
		HiD 3040 Channel 4
		HiD 3891 Counter Low Value
2	30006	HiD 3010 Channel 1
		HiD 3040 Channel 1
	30007	HiD 3010 Channel 2 (when switched as input)
		HiD 3040 Channel 2
		HiD 3891 Frequency Value
	30008	
		HiD 3040 Channel 3
		HiD 3891 Counter High Value
	30009	
		HiD 3040 Channel 4
		HiD 3891 Counter Low Value
16	30062	HiD 3010 Channel 1
		HiD 3040 Channel
	30063	HiD 3010 Channel 2 (when switched as input)
		HiD 3040 Channel 2
		HiD 3891 Frequency Value
	30064	
		HiD 3040 Channel 2
		HiD 3891 Counter High Value
	30065	
		HiD 3040 Channel 2
		HiD 3891 Counter Low Value

Table 83: Input registers area definition.

Module Type	Input Channel	Register position In Module	Data Format	Note
HiD 3010	1	1	16 Bit Unsigned	
	2	2	16 Bit Unsigned	When used as Input
		3	Not Used	
		4	Not Used	
HiD 3891	1	1	Not Used	
		2	32 Bit Unsigned	Counter
		3		
		4	16 Bit Unsigned	Frequency
HiD 3040	1	1	16 Bit Signed	
	2	2	16 Bit Signed	
	3	3	16 Bit Signed	
	4	4	16 Bit Signed	

Table 84: Module registers map

12.3.2 Registers Address Calculate

The formulas below calculate the register memory location knowing the position of the module and the channel number.

HiD 3010 Channel = **3**0000 + (4***Pm**+**Cn**-3)

HiD 3040 Channel = **3**0000 + (4***Pm**+**Cn**-3)

HiD 3891 Frequency = **3**0000 + (4***Pm**-1)

HiD 3891 Counter High = 30000 + (4***Pm**)

HiD 3891 Counter Low = 30000 + (4***Pm**+1)

Pm: Position Module

Cn: Channel number

Example (HiD 3040): Module in position 7, input channel 2

Address **= 3**0000 + (4***7**+**2-**3) = **3**0027

Example (HiD 3891): Module in position 7

Address **= 3**0000 + (4***7-**1) = **3**0027

12.3.3 HiD 3010 Analog Input data format

Nominal range		Min. under range		Max. over range	
Physical	16 bit integer	Physical	16 bit integer	Physical	16 bit integer
0…20mA	0…27306 (0…100%)	None (0mA)	0 (0%)	24mA	32767 (120%)
4…20mA	5461…27306 (0…100%)	None (-4mA)	0 (-25%)	24mA	32767 (125%)

Table 85: Analog Input range for every single channel

12.3.4 HiD 3040 Temperature Input data format

RTD	Nominal range		Min. under range		Max. over range	
Sensor	Physical	16 bit integer	Physical	16 bit integer	Physical	16 bit integer
Pt10, Pt50, Pt100 (a=0.3850)	-200.0 C +850.0 C	-2000 +8500	< -200.0 C	< -2000	> +850.0 C	> 8500
Pt1000 (a=0.3850)	-200.0 C +850.0 C	-2000 +8500	< -200.0 C	< -2000	> +850.0 C	> 8500
Pt10, Pt50, Pt100 (a=0.39100)	-200.0 C +850.0 C	-2000 +8500	< -200.0 C	< -2000	> +850.0 C	> 8500
Pt1000 (a=0.39100)	-200.0 C +1100.0 C	-2000 +11000	< -200.0 C	< -2000	> +1100.0 C	> 11000
Ni100	-60.0 C +180.0 C	-600 +1800	< -60.0 C	< -600	> +180.0 C	> 1800
Cu10, Cu50, Cu100 (a=0.2480)	-200.0 C +200.0 C	-2000 +2000	< -200.0 C	< -2000	> +200.0 C	> 2000
R 400	0 Ohm 400 Ohm	0 400	< 0 Ohm	< 0	> 400 Ohm	> 4000
R 4000	0 Ohm 4000 Ohm	0 4000	< 0 Ohm	< 0	> 4000 Ohm	> 4000
R 400 + custom table	0 Ohm… 400 Ohm	0 400	Programmable		Programmable	
R 4000 + custom table	0 Ohm… 4000 Ohm	0 4000	Programmable		Programmable	

Table 86: Analog RTD values.

Potentiometer	Nominal range		Min. under range		Max. over range	
Sensor	Physical	16 bit integer	Physical	16 bit integer	Physical	16 bit integer
Potentiometer	0…100%	0…32767 (0…100%)	0<	0 (0%)	>100%	32767 (100%)
Potentiometer + custom table	0…100%	5461…27306 (0…100%)	Programmable		Programmable	

Table 87: Potentiometer values.

Thermocouple	Nominal range		Min. under range		Max. over range	
Sensor	Physical	16 bit integer	Physical	16 bit integer	Physical	16 bit integer
S	-50.0 C +1750.0 C	-500 +1750	< -200.0 C	< -2000	> +1750.0C	> 17500
R	-50.0 C +1750.0 C	-500 +1750	<-200.0 C	< -2000	> +1750.0 C	> 17500
B	-0.0 C +1800.0 C	0 +18000	<0.0 C	< -0	> +1800.0 C	> 18000
E	-200.0 C +1000.0 C	-2000 +10000	<-200.0 C	< -2000	> +1000.0 C	> 10000
J	-200.0 C +750.0 C	-2000 +7500	<-200.0 C	< -2000	> +750.0 C	> 7500
K	-200.0 C +1300.0 C	-2000 +13000	<-200.0 C	< -2000	> +1300.0 C	> 13000
T	-200.0 C +400.0 C	-2000 +4000	<-200.0 C	< -2000	> +400.0 C	> 4000
N	-200.0 C +1300.0 C	-2000 +13000	<-200.0 C	< -2000	> +1300.0 C	> 13000
L	-200.0 C +800.0 C	-2000 +8000	<-200.0 C	< -2000	> +800.0 C	> 8000
MV	-100 mV +100 mV	-32769 +32767	-100 mV	< -32769	+100 mV	> 32767
MV + custom table	-100 mV +100 mV	-32769 +32767	Programmable		Programmable	
Thermocouple. + custom table	-200.0 C… +1800.0 C	-32769 +32767	Programmable		Programmable	

Table 88: Analog Thermocouple values

12.3.5 HiD 3891 Pulse Input data format

Measure	Integration	Nominal range		Register	
Type	Time	Physical	Numeric	Cover	Format
Counter	-	0 - 4294967295	0 - 4294967295	2	Unsigned Long (32 Bit)
Frequency	1s..	0 - 2000	0 - 2000	1	Unsigned Int (16 Bit)
	10s	0 - 2000	0 - 20000		

Table 89: Analog values range for single channel

12.4 Analog Output Area

For every Output module four registers are reserved in the Modbus database. The address locations are fixed to the Modules positions on the termination board. The Module that reference this area for the moment is HiD 3010 when at least one channel is configured as output. This Area is accessible through the Function Code 03

12.4.1 Address Map & Contents

Module Position	Register Decimal Address	Register Content Description
	40001	Reserved
1	40002	HiD 3010 Channel 1 (when switched as Output)
	40003	HiD 3010 Channel 2
	40004	Not Used
	40005	Not Used
2	40006	HiD 3010 Channel 2 (when switched as Output)
	40007	HiD 3010 Channel 1
	40008	Not Used
	40009	Not Used
16	40062	HiD 3010 Channel 1 (when switched as Output)
	40063	HiD 3010 Channel 2
	40064	Not Used
	40065	Not Used

Table 90: Output Registers area definition.

Module Type	Input Channel	Register position In Module	Data Format	Note
HiD 3010	1	1	16 Bit Unsigned	When used as Output
	2	2	16 Bit Unsigned	
		3	Not Used	
		4	Not Used	

Table 91: Output Registers data format

12.4.2 Registers Address Calculate

The formula below allow to calculate the register address knowing the position of the module and the channel number.

HiD 3010 Channel = **4**0000 + (**Pm***4+**Cn**-3)

Pm: Position Module

Cn: Channel number

Example: Module in position 15, output channel 1

Address **= 4**0000 + (4***15**+**1-**3) = **4**0058

12.4.3 HiD 3010 Analog Output Data Format

Nominal range		Min. under range		Max. over range	
Physical	16 bit integer	Physical	16 bit integer	Physical	16 bit integer
0…20mA	0…27306 (0…100%)	None (0mA)	0 (0%)	24mA	32767 (120%)
4…20mA	5461…27306 (0…100%)	None (-4mA)	0 (-25%)	24mA	32767 (125%)

Table 92: Analog Output range for every single channel

12.5 Digital Input Area

The Digital Input Area is accessible through the Function Code 04 (Read Input Registers) or Function Code 02 (Read Input Status).

12.5.1 Address Map & Contents

Module Position	Decimal Address		Register Content Description															
	Input Register	Input Status	0F	0E	0D	0C	0B	0A	09	08	07	06	05	04	03	02	01	00
			15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
-	32501	10016 ÷ 10001	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
1	32502	10032 ÷ 10017													C4	C3	C2	C1
2	32503	10048 ÷ 10033													C4	C3	C2	C1
3	32504	10064 ÷ 10049													C4	C3	C2	C1
4	32505	10080 ÷ 10065													C4	C3	C2	C1
5	32506	10096 ÷ 10081													C4	C3	C2	C1
6	32507	10112 ÷ 10097													C4	C3	C2	C1
7	32508	10128 ÷ 10113													C4	C3	C2	C1
8	32509	10144 ÷ 10129													C4	C3	C2	C1
9	32510	10160 ÷ 10145													C4	C3	C2	C1
10	32511	10176 ÷ 10161													C4	C3	C2	C1
11	32512	10192 ÷ 10177													C4	C3	C2	C1
12	32513	10208 ÷ 10193													C4	C3	C2	C1
13	32514	10224 ÷ 10209													C4	C3	C2	C1
14	32515	10240 ÷ 10225													C4	C3	C2	C1
15	32516	10256 ÷ 10241													C4	C3	C2	C1
16	32517	10272 ÷ 10257													C4	C3	C2	C1

Table 93: Input registers area definition

Bit Set (Abbreviation)	Description	Input Values	
		Digital Value	Input Status
Cn (n=1..4)	Channel n Input	1	high impedance
		0	low impedance
R	Reserved	-	

Table 94: Digital values coding.

12.5.2 Bit Address Calculate

The formula below calculates the Channel input memory location knowing the position of the module and the channel number, its valid only for input status.

HiD 3824 Channel = **1**0000 + (**Mp***16+**Cn**)

Cn: Channel Number

Mp: Module position

Example: Module in position 3, input channel 4

Address **= 1**0000 + (**3***16+**4**) = **1**0052

12.6 Digital Output Area

The Digital Output Area is accessible through the Function Code 06 and 16 (Write Holding Registers), or Function Code 05 and 15 (Write Output Coil Status). It is possible to read the output variables through the Function Code 03 (Read Holding Registers) or 01 (Read Coils Status);

12.6.1 Address Map & Contents

Module Position	Decimal Address		Register Content Description															
	Holding Register	Coils Status	0F	0E	0D	0C	0B	0A	09	08	07	06	05	04	03	02	01	00
			15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
-	**4**0201	**0**0016 ÷ **0**0001	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
1	**4**0202	**0**0032 ÷ **0**0017															C2	C1
2	**4**0203	**0**0048 ÷ **0**0033															C2	C1
3	**4**0204	**0**0064 ÷ **0**0049															C2	C1
4	**4**0205	**0**0080 ÷ **0**0065															C2	C1
5	**4**0206	**0**0096 ÷ **0**0081															C2	C1
6	**4**0207	**0**0112 ÷ **0**0097															C2	C1
7	**4**0208	**0**0128 ÷ **0**0113															C2	C1
8	**4**0209	**0**0144 ÷ **0**0129															C2	C1
9	**4**0210	**0**0160 ÷ **0**0145															C2	C1
10	**4**0211	**0**0176 ÷ **0**0161															C2	C1
11	**4**0212	**0**0192 ÷ **0**0177															C2	C1
12	**4**0213	**0**0208 ÷ **0**0193															C2	C1
13	**4**0214	**0**0224 ÷ **0**0209															C2	C1
14	**4**0215	**0**0240 ÷ **0**0225															C2	C1
15	**4**0216	**0**0256 ÷ **0**0241															C2	C1
16	**4**0217	**0**0272 ÷ **0**0257															C2	C1

Table 95: Digital output area definition

Bit Set (Abbreviation)	Description	Output Values	
		Digital Value	Output Status
Cn (n=1, 2)	Channel n Input	1	Energised
		0	De-Energised
R	Reserved	-	

Table 96: Digital values coding.

12.6.2 Bit Address Calculate

The formula below calculates the Channel Output memory location knowing the position of the module and the channel number, its valid only for coils status.

Channel Output Address = **0**0000 + (**Mp***16+**Cn**)

Cn: Channel Number

Mp: Module position

Example: Module in position 9, output channel 1

Address **= 0**0000 + (**9***16+**1**) = **0**0145

13 APPENDIX G – GLOSSARY

Local bus:	Elcon proprietary communication channel, local to the Termination Board
PBDP1:	Profibus DP Communication Gateway
MBRT:	Modbus RTU Communication Gateway
GSD:	Gerät Stamm Datei, Profibus device description file
I/O Station:	Communication Gateway plus HiD3000 I/O modules
CG:	Communication Gateway
CJC:	Cold Junction Compensation
TB:	Termination Board
Host device:	Central control system typically including a Profibus Master section.
NAMUR:	German industry association which originally defined the standard as for proximity sensors interface

14 APPENDIX H – HID 3891 ACCURACY ANALYSIS

14.1 Measurement technique

To measure the input frequency, the HiD3891 does simply count the input pulses number over a fixed period of time, called ***integration time***. As a result, you get a new input measurement (that is to say, a new digital value) only immediately after the completion of each integration time period. During the integration time, you will always get the same digital value when you try to read it repeatedly via the Profibus (or Modbus) communication channel.

For the highest flexibility, the HiD3891 performs the input frequency measurement by managing in parallel both a **1 second** and a **10 second** integration time. This means that when you read the frequency value via Profibus (or Modbus), you get two independent digital values, one associated with an integration time of **1 s** and the other associated with an integration time of **10 s**.

So you have either the option of accessing a low-resolution but frequently updated measurement (1 s integration time) or an higher resolution but less frequently updated value (10 s integration time). The ***digital value*** is always presented as a 16 bit integer word representing the number of pulses counted during the integration time. In this way, with a 1 s integration time you directly get the input frequency measurement in Hz, while with a 10 s integration time you get it as a “tenth of Hz” figure.

14.2 Accuracy specifications

When you deal with the digital measurement of an analog information, the overall measurement precision is limited both by the "analog" accuracy and by the "digital" resolution errors. In summary:

Overall accuracy error = Accuracy error + Resolution error

The HiD3891 resolution error is specified as **< ± 1 LSB** (less significant bit) of the ***digital value***. This results in a frequency resolution error of **< ± 1 Hz** (1 s integration time) or **< ± 0.1 Hz** (10 s integration time).

The HiD3891 accuracy error is specified as **< 0.01 %** of the ***input frequency***. This is specified over the operating temperature range, and it is mainly related with the integration time precision and stability.

14.3 Accuracy tables

The overall accuracy error, specified as a percentage of the input frequency, can therefore be summarised as in the following two tables (the digital measurement value is also shown):

14.3.1 1 second integration time

Input Frequency	Resolution error	Accuracy error	Overall accuracy error	Digital measurement
2 Hz	± 50.00 %	± 0.01 %	± 50.01 %	2
5 Hz	± 20.00 %	± 0.01 %	± 20.01 %	5
10 Hz	± 10.00	± 0.01 %	± 10.01 %	10
20 Hz	± 5.00 %	± 0.01 %	± 5.01 %	20
50 Hz	± 2.00 %	± 0.01 %	± 2.01 %	50
100 Hz	± 1.00 %	± 0.01 %	± 1.01 %	100
200 Hz	± 0.50 %	± 0.01 %	± 0.51 %	200
500 Hz	± 0.20 %	± 0.01 %	± 0.21 %	500
1000 Hz	± 0.10 %	± 0.01 %	± 0.11 %	1000
2000 Hz	± 0.05 %	± 0.01 %	± 0.06 %	2000

Table 97: 1 second integration time accuracy analysis.

14.3.2 10 second integration time

Input Frequency	Resolution error	Accuracy error	Overall accuracy error	Digital measurement
2 Hz	± 5.00 %	± 0.01 %	± 5.01 %	20
5 Hz	± 2.00 %	± 0.01 %	± 2.01 %	50
10 Hz	± 1.00 %	± 0.01 %	± 1.01 %	100
20 Hz	± 0.50 %	± 0.01 %	± 0.51 %	200
50 Hz	± 0.20 %	± 0.01 %	± 0.21 %	500
100 Hz	± 0.10 %	± 0.01 %	± 0.11 %	1000
200 Hz	± 0.05 %	± 0.01 %	± 0.06 %	2000
500 Hz	± 0.02 %	± 0.01 %	± 0.03 %	5000
1000 Hz	± 0.01 %	± 0.01 %	± 0.02 %	10000
2000 Hz	± 0.005 %	± 0.01 %	± 0.015 %	20000

Table 98: 10 second integration time accuracy analysis.

14.4 Conclusions

To summarise the results from both tables, it should be note that in both cases the dominant error is the Resolution one (only with a 10 second integration time and F > 500 Hz the Accuracy error start to have some relevance).

The resolution error, however, can be easily expressed as an input frequency error, and namely:

- Resolution error: < **± 1.0 Hz** (integration time = **1s)**
- Resolution error: < **± 0.1 Hz** (integration time = **10s)**

These figures, therefore, can be easily used as a good approximation of the overall measurement accuracy.