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2070 PROFINET MODULE

Status and weight transfer using PROFINET

Applies for:

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1) Contents

2) Introduction

2.1 Introduction

This document describes the use of a 2070 PROFINET module from Eilersen Electric, when it is equipped with the program listed on the front page.

With the program specified on the front page, the 2070 PROFINET module is capable of transmitting weight and status for up to 4 loadcells in a single telegram. Each loadcell is connected to the PROFINET module through a loadcell interface module.

It is possible to connect the 2070 PROFINET module to a PROFINET network, where it will act as a slave. It will then be possible from the PROFINET master to read status and weight for each of the connected loadcells. Functions as zeroing, calibration and calculation of system weight(s) must be implemented **outside** the 2070 in the PROFINET master.

By use of DIP-switches it is possible to select measurement time and include one of 15 different FIR filters, which will be used to filter the loadcell signals, as well as selecting the desired scaling of the loadcell signals.

Exchange of data between master and slave takes place as described in the following.

2.2 ATEX (Ex) specification

IMPORTANT: Load cell modules and instrumentation <u>must be placed outside the hazardous zone</u> if the load cells are used in hazardous ATEX (Ex) area. Furthermore, only ATEX certified load cells and instrumentation can be used in ATEX applications.

3) Data Exchange

3.1 PROFINET communication

PROFINET communication with the 2070 PROFINET module uses a data module containing 26 input bytes (from the 2070) and 2 output bytes (to the 2070) as specified in the GSDML file.

NOTE: Please note that the 2 output bytes from the PROFINET master to the 2070 PROFINET module are NOT used in this application, and are reserved for future use. Only the 26 input bytes from the 2070 PROFINET module are used.

The 26 input data bytes (from the 2070 module) are structured like this:

Lc Register		**Lc Status(0)**		**Lc Signal(0)**					**Lc Status(3)**		**Lc Signal(3)**			
0	1	2	3	4	5	6	7		20	21	22	23	24	25

The byte order for the individual parts of the telegram is MSB first. In the following bit 0 will represent the least significant bit in a register.

LcRegister is a word (two bytes) that constitutes a bit register for indication of expected loadcells. Hence, bit 0-3 will be ON, if the corresponding loadcell (address) was expected to be connected. **LcRegister** is always transferred in **16 bit unsigned integer** format.

Furthermore bit 15 will always be ON, while bit 14 will toggle ON and OFF with 1hz (500ms ON, 500ms OFF).

LcStatus(X) is a word (two bytes) that constitute a register containing the actual status for loadcell **X**. **LcStatus(X)** is always transferred in **16 bit unsigned integer** format. During normal operation, this register will be 0, but if an error occurs, some bits in the register will be set resulting in an error code. A description of the different error codes can be found in the chapter *STATUS CODES*.

LcSignal(X) is a double word (four bytes) constituting a register containing the actual weight signal from loadcell **X** in **32 bit signed integer** format. Note that the value is only valid if the corresponding **LcStatus(X)** register is 0 indicating no error present. The resolution of the loadcell signal is scaled as described below.

Since only status and weight for the loadcells are transmitted in the telegram, functions such as status handling, calculation of system weight(s), zeroing and calibration **must** be implemented on the PROFINET master. Please refer to the chapter *Data Processing* for an explanation on how this typically can be done.

3.2 Data formats

The PROFINET communication can transfer data in the following three data formats. Please refer to other literature for further information on these formats as it is outside the scope of this document.

3.2.1 Unsigned integer format (16 bit)

The following are examples of decimal numbers represented on 16 bit unsigned integer format:

Decimal	Hexadecimal	Binary (MSB first)
0	0x0000	00000000 00000000
1	0x0001	00000000 00000001
2	0x0002	00000000 00000010
200	0x00C8	00000000 11001000
2000	0x07D0	00000111 11010000
20000	0x4E20	01001110 00100000

3.2.2 Signed integer format (32 bit)

The following are examples of decimal numbers represented on 32 bit signed integer format:

Decimal	Hexadecimal	Binary (MSB first)
-20000000	0xFECED300	11111110 11001110 11010011 00000000
-2000000	0xFFE17B80	11111111 11100001 01111011 10000000
-200000	0xFFFCF2C0	11111111 11111100 11110010 11000000
-20000	0xFFFFB1E0	11111111 11111111 10110001 11100000
-2000	0xFFFFF830	11111111 11111111 11111000 00110000
-200	0xFFFFFF38	11111111 11111111 11111111 00111000
-2	0xFFFFFFFE	11111111 11111111 11111111 11111110
-1	0xFFFFFFFF	11111111 11111111 11111111 11111111
0	0x00000000	00000000 00000000 00000000 00000000
1	0x00000001	00000000 00000000 00000000 00000001
2	0x00000002	00000000 00000000 00000000 00000010
200	0x000000C8	00000000 00000000 00000000 11001000
2000	0x000007D0	00000000 00000000 00000111 11010000
20000	0x00004E20	00000000 00000000 01001110 00100000
200000	0x00030D40	00000000 00000011 00001101 01000000
2000000	0x001E8480	00000000 00011110 10000100 10000000
20000000	0x01312D00	00000001 00110001 00101101 00000000

3.3 Scaling

By use of a DIP-switch, it is possible to select the desired scaling of the weight signals. The scaling of the weight signals on the PROFINET is determined by **SW2**.7 – **SW2**.8 as follows, where the table shows how a given weight is represented on the PROFINET depending on switch settings:

Weight [gram]	**SW2.7 = OFF SW2.8 = OFF (1 gram)**	**SW2.7 = OFF SW2.8 = ON (1/10 gram)**	**SW2.7 = ON SW2.8 = OFF (1/100 gram)**	**SW2.7 = ON SW2.8 = ON (10 gram)**
1,0	1	10	100	0
123,4	123	1234	12340	12
12341	12341	123410	1234100	1234

3.4 Measurement time

By use of DIP-switches, it is possible to choose between four different measurement times. All loadcells are sampled/averaged over a measurement period determined by **SW2**.5 and **SW2**.6 as follows:

SW2.5	**SW2.6**	**Measurement time**
OFF	OFF	20 ms
OFF	ON	100 ms
ON	OFF	200 ms
ON	ON	400 ms

The hereby found loadcell signals (possibly filtered) are used on the PROFINET until new signals are achieved when the next sample period expires.

3.5 Filtering

By use of DIP-switches, it is possible to include one of 15 different FIR filters, which will be used to filter the loadcell signals. Thus it is possible, to send the unfiltered loadcell signals achieved over the selected measurement period through one of the following FIR filters, before the results are transmitted on the PROFINET:

SW2.4	SW2.3	SW2.2	SW2.1	No.	Taps	Frequency		Damping
						Tavg = 20ms	Tavg = 200ms	
OFF	OFF	OFF	OFF	0	-	-	-	-
ON	OFF	OFF	OFF	1	7	12.0 Hz	1.2 Hz	-60dB
OFF	ON	OFF	OFF	2	9	10.0 Hz	1.0 Hz	-60dB
ON	ON	OFF	OFF	3	9	12.0 Hz	1.2 Hz	-80dB
OFF	OFF	ON	OFF	4	12	8.0 Hz	0.8 Hz	-60dB
ON	OFF	ON	OFF	5	12	10.0 Hz	1.0 Hz	-80dB
OFF	ON	ON	OFF	6	15	8.0 Hz	0.8 Hz	-80dB
ON	ON	ON	OFF	7	17	6.0 Hz	0.6 Hz	-60dB
OFF	OFF	OFF	ON	8	21	6.0 Hz	0.6 Hz	-80dB
ON	OFF	OFF	ON	9	25	4.0 Hz	0.4 Hz	-60dB
OFF	ON	OFF	ON	10	32	4.0 Hz	0.4 Hz	-80dB
ON	ON	OFF	ON	11	50	2.0 Hz	0.2 Hz	-60dB
OFF	OFF	ON	ON	12	64	2.0 Hz	0.2 Hz	-80dB
ON	OFF	ON	ON	13	67	1.5 Hz	0.15 Hz	-60dB
OFF	ON	ON	ON	14	85	1.5 Hz	0.15 Hz	-80dB
ON	ON	ON	ON	15	100	1.0 Hz	0.10 Hz	-60dB

NOTE: With all switches OFF no filtering is performed.

4) Data Processing

4.1 Zeroing, calibration and weight calculation

Calculation of system weight(s) is done by addition of the weight registers for the loadcells belonging to the system. This is explained below. **Note** that the result is only valid if all status registers for the loadcells in question indicate <u>no</u> errors. It should also be noted that it is up to the master to ensure the usage of consistent loadcell data when calculating the system weight (the used data should come from the same telegram).

4.1.1 Zeroing of weighing system

Zeroing of a weighing system (all loadcells in the specific system) should be performed as follows, taking into account that no loadcell errors may be present during the zeroing procedure:

1) The weighing arrangement should be empty and clean.
2) The PROFINET master verifies that no loadcell errors are present, after which it reads and stores the actual weight signals for the loadcells of the actual system in corresponding zeroing registers:

```
LcZero[x]=LcSignal[x]
```

3) After this the uncalibrated gross weight for loadcell **X** can be calculated as:

```
LcGross[X] = LcSignal[X] - LcZero[X]
```

4.1.2 Corner calibration of weighing system

In systems where the load is not always placed symmetrically the same place (for example a platform weight where the load can be placed randomly on the platform when a weighing is to take place), a fine calibration of a systems corners can be made, so that the weight indicates the same independent of the position of the load. This is done as follows:

1) Check that the weighing arrangement is empty. Zero the weighing system.
2) Place a known load (`CalLoad`) directly above the loadcell that is to be corner calibrated.
3) Calculate the corner calibration factor that should be multiplied on the uncalibrated gross weight of the loadcell in order to achieve correct showing as:

```
CornerCalFactor[x] = (CalLoad)/(LcGross[x])
```

After this, the determined corner calibration factor is used to calculate the calibrated gross weight of the loadcell as follows:

```
LcGrossCal[x] = CornerCalFactor[x] * LcGross[x]
```

4.1.3 Calculation of uncalibrated system weight

Based on the loadcell gross values (`LcGross[x]` or `LcGrossCal[x]`), whether they are corner calibrated or not, an uncalibrated system weight can be calculated as either:

```
Gross = LcGross[X1] + LcGross[X2] + …
```

or:

```
Gross = LcGrossCal[X1] + LcGrossCal[X2] + …
```

4.1.4 System calibration of weighing system

Based on the uncalibrated system weight a system calibration can be made as follows:

1) Check that the weighing arrangement is empty. Zero the weighing system.
2) Place a known load (`CalLoad`) on the weighing arrangement. **NOTE:** In order to achieve a correct calibration of the system it is recommended, that the used calibration load is at least 50% of the system capacity.
3) Calculate the calibration factor that should be multiplied on the uncalibrated system weight in order to achieve correct showing as:

```
CalFactor = (CalLoad)/(Actual Gross)
```

After this, the determined calibration factor is used to calculate the calibrated system weight as follows:

```
GrossCal = CalFactor * Gross
```

If the determined calibration factor falls outside the interval 0.9 to 1.1, it is very likely that there is something wrong with the mechanical part of the system. This does not however apply to systems that do not have a loadcell under each supporting point. For example on a three legged tank with only one loadcell, you should get a calibration factor of approximately 3 because of the two “dummy” legs.

5) Installation of System

5.1 Checklist during installation

During installation of the system, the following should be checked:

1. All hardware connections are made as described below.
2. If necessary, the PROFINET master should be configured to communicate with the 2070 PROFINET module using the supplied GSDML file.
3. Set the number of loadcells connected by use of **SW1**.2 – **SW1**.4 as described later.
4. Set the scaling/resolution of the weight signal by use of **SW2**.7 – **SW2**.8 as described earlier.
5. Set the desired measurement time by use of **SW2**.5 – **SW2**.6 as described earlier.
6. Select the desired filter by use of **SW2**.1 – **SW2**.4 as described earlier.
7. The loadcells are mounted mechanically and connected to the 2070 PROFINET module using their corresponding loadcell interface module (MCE2010). The loadcell addresses are set using the DIP-switches on the loadcell interface modules, so that they forth running from address 0 (0-3).
8. The 2070 PROFINET module is connected to the PROFINET network using the PORT1 PROFINET connector (and possibly also PORT2) in the front of the 2070 module.
9. Power (24VDC) is applied at the 2 pole power connector in the front of the 2070 module as described in the hardware section, and the PROFINET communication is started.
10. Verify that the BF, SF, MT, ST and D1 lamps of the 2070 module end up OFF.
11. Verify that the RDY lamp ends up green.
12. Verify that the TxBB lamp (green) on the 2070 PROFINET module is lit (after 10 seconds) and that the TxBB lamps on all the loadcell interface modules are also lit (can flash slightly).
13. Verify that the 2070 PROFINET module has found the correct loadcells (LcRegister), and that no loadcell errors are indicated (LcStatus(x)).
14. Verify that every loadcell gives a signal (LcSignal(x)) by placing a load directly above each loadcell one after the other (possibly with a known load).

The system is now installed and a zero and fine calibration is made as described earlier. Finally verify that the weighing system(s) returns a value corresponding to a known actual load.

Note that in the above checklist no consideration has been made on which functions are implemented on the PROFINET master.

6) Hardware Description

6.1 2070 overview

The following figure is an overview of how a 2070 PROFINET system looks:

6.2 Connection of power (J2)

This chapter describes the connection of power supply to the 2070 PROFINET module.

The 2070 module is powered by applying +24VDC on the green two pole connector (J2) as specified on the front of the 2070 module. This powers the entire 2070 system including the loadcell interface modules and loadcells connected using the supplied ribbon cable described below.

The 2 pole connector (J2) on the 2070 PROFINET module has these connections:

J2 CONNECTER	FUNCTION
J2.1	+24VDC (Vin)
J2.2	0 VDC (GNDin)

IMPORTANT: The used power supply must be stable and free of transients. It may therefore be necessary to use a separate power supply dedicated to the weighing system, and not connected to any other equipment.

6.3 Connection of loadcells (J7)

This chapter describes the connection of loadcells to the 2070 PROFINET module.

The 10 pole connector (J7) on the 2070 module is connected to the 10 pole connectors on the loadcell interface modules using the supplied ribbon cable with mounted connectors. Through this RS485 bus cable connection of power supply to the individual modules is achieved and data can be transferred from the loadcell modules to the 2070 module.

The 10 pole connector (J7) on the 2070 PROFINET module has these connections:

J7 CONNECTER	FUNCTION
J7.1 – J7.2	RS485-B (DATA-)
J7.3 – J7.4	RS485-A (DATA+)
J7.5 – J7.6	0 VDC (GNDin)
J7.7 – J7.8	+24VDC (Vin)
J7.9 – J7.10	I/O line

6.4 PROFINET connectors

The front of the 2070 PROFINET module is equipped with two standard Ethernet RJ45 connectors (**PORT1** and **PORT2**) for PROFINET connection using Cat5 cables.

6.5 RS485 connector (J1)

The green 3 pole connector (J1) at the bottom of the 2070 PROFINET module contains the same RS485 bus that is available through the ribbon cable connector (J7), which is normally used for interfacing loadcells. This allows an alternate way of connecting loadcells to the 2070 module. In other applications where no loadcells are connected to the 2070 module, this connector may be used to interface different equipment to the 2070 module using RS485 communication.

The 3 pole connector (J1) on the 2070 PROFINET module has these connections:

J1 CONNECTER	FUNCTION
J1.1	RS485-B (DATA-)
J1.2	RS485-A (DATA+)
J1.3	0 VDC (GNDin)

6.5.1 DIP-switch settings

The 2070 PROFINET module is equipped with a 4 pole DIP switch block located in the front of the module. This DIP switch block is named **SW1** and has the following function:

SWITCH	FUNCTION
***SW1**.1*	*Reserved for future use*
SW1.2 – **SW1**.4	**Number of loadcells** Used to set the number of loadcells as shown below.

Sw1.4	Sw1.3	Sw1.2	Number of loadcells
OFF	OFF	OFF	1
ON	OFF	OFF	2
OFF	ON	OFF	3
ON	ON	OFF	4
OFF	OFF	ON	4
ON	OFF	ON	4
OFF	ON	ON	4
ON	ON	ON	4

The 2070 PROFINET module is also equipped with an 8 pole DIP switch block also located in the front of the module. This DIP switch block is named **SW2** and has the following function:

SWITCH	FUNCTION
SW2.1 – **SW2**.4	**Filtering** Used to select the desired filter as described above.
SW2.5 – **SW2**.6	**Measurement time** Used to select the desired measurement time as described above.
SW2.7 – **SW2**.8	**Scaling** Used to select the desired scaling as described above.

6.5.2 Light Emitting Diodes (LEDs)

The front of the 2070 PROFINET module is equipped with a number of status lamps (light emitting diodes). These have the following functionality:

LED	**FUNCTION**
PORT1 connector (Green) (RJ45)	**Link (PORT1)** PROFINET is connected.
PORT1 connector (Yellow) (RJ45)	**Activity (PORT1)** PROFINET data is received or transmitted.
PORT2 connector (Green) (RJ45)	**Link (PORT2)** PROFINET is connected.
PORT2 connector (Yellow) (RJ45)	**Activity (PORT2)** PROFINET data is received or transmitted.
TxBB (Green)	**2070 communication with loadcells** PROFINET module is communicating with loadcells.
BF (Red)	**Bus Fail LED** The 2070 Bus Fail LED can be lit/flashing depending on the status of the network. The function of the BF LED is given below.
SF (Red)	**System Fail LED** The 2070 System Fail LED can be lit/flashing depending on the status of the system. The function of the SF LED is given below.
MT (Yellow)	**MainTenance required LED** The 2070 MainTenance required LED can be lit/flashing depending on the status of the system. The function of the MT LED is given below.
RDY (Green)	**ReaDY LED** The 2070 device ReaDY LED can be lit/flashing depending on the status of the device. The function of the RDY LED is given below.
ST *(Red)*	***STatus LED*** The 2070 STatus LED can be lit/flashing depending on the status of the system. The function of the ST LED is given below.
D1 *(Green)*	*Reserved for future use*

The TXBB, BF, SF, MT, RDY, ST and D1 LED's display the status of the PROFINET device, and can in conjunction with the table below be used for error finding.

LED	Color	Status	Description
BF	Red		**Bus Fail:**
		ON	No link status available.
		Flashing	Link status ok. No communication link to a PROFINET IO controller.
		OFF	The PROFINET IO controller has an active communication link to this PROFINET IO device.
SF	Red		**System Fail:**
		ON	PROFINET diagnostic exists.
		Flashing	Reserved.
		OFF	No PROFINET diagnostic.
MT	Yellow		**Maintenance Required:**
		ON	Manufacturer specific - depends on the capabilities of the device.
		Flashing	
		OFF	
RDY	Green		**Device Ready:**
		ON	TPS-1 has started correctly.
		Flashing	TPS-1 is waiting for synchronization of the host CPU (firmware start is complete).
		OFF	TPS-1 has not started correctly.

The ST LED blinks red (on time 250ms; off time 250ms) a number of times corresponding to the error detected by the PROFINET device. If multiple errors are detected at the same time, the ST LED will cyclic blink the different errors as each error (flash sequence) is separated by a 2 second off period. The following errors can be indicated by the ST LED:

Number of blinks on ST LED (250 ms)	Description
0	No errors detected
1	Error detected on loadcell 1 (load cell address 0)
2	Error detected on loadcell 2 (load cell address 1)
3	Error detected on loadcell 3 (load cell address 2)
4	Error detected on loadcell 4 (load cell address 3)

6.6 Update times

The 2070 PROFINET module samples the loadcell signals over a period of 20, 100, 200 or 400 ms. The hereby found loadcell signals are used in the PROFINET communication until new signals are achieved when the next sample period expires. Update times across the PROFINET communication depends on the specific PROFINET configuration (switches, number of units, master scan times etc.) and are beyond the scope of this document.

7) Appendices

7.1 Appendix A – PROFINET Configuration tips

7.1.1 MAC addresses

The MAC addresses of the 2070 PROFINET module are noted on a label on the side of the 2070 module. The MAC addresses of the 2070 module are preset to unique values within the Eilersen Electric A/S range.

7.1.2 GSDML file

The supplied GSDML can be used to configure the PROFINET master to communicate with the 2070 PROFINET module.

Please note that on a Siemens SIMATIC STEP 7 software platform, once the GSDML file has been imported, the imported 2070 PROFINET module will normally be placed in the following location of the "Hardware catalog":

Other field devices \ PROFINET IO \ I/O \ Eilersen Electric \ 2x70 CONCTR_4

7.1.3 Factory settings

Upon delivery the 2070 PROFINET module contains the following default factory settings:

Device Name:	d2x70
IP Address:	192.168.1.199
Subnet Mask:	255.255.255.0
Default Gateway:	192.168.1.254
Vendor ID:	840 (0x348)
Device Type:	D2x70

7.1.4 Setting DeviceName, IP Address etc.

The default factory settings of the 2070 PROFINET module, such as device name (d2x70) and IP address (192.168.1.199) etc., must be changed according to the actual PROFINET configuration.

Please note that on a Siemens SIMATIC STEP 7 software platform (TiA Portal), this is normally done under "Online Access" where the different node parameters (MAC address, IP address, DeviceName etc.) can be viewed and possibly changed.

7.1.5 Data sizes

The amount of data exchanged between the PROFINET master and the 2070 PROFINET module is specified in the GSDML file. This application with the software specified on the front page of the manual uses 26 input bytes and 2 output bytes. Please note that in this application the 2 output bytes are actually NOT used.

NOTE: Please beware that the terms "input" and "output" may be confusing and are used differently from vendor to vendor. Throughout this manual, these terms are always from the PROFINET masters (PLC's) point of view. Therefore, the data from the 2070 module to the PLC are referred to as "input" data, while the data from the PLC to the 2070 module are referred to as "output" data.

7.2 Appendix B – Internal Features

7.2.1 Connectors

The 2070 PROFINET module is internally equipped with connectors (and pin rows). These connectors have the following function:

CONNECTORS	FUNCTION
J21	***STM32 JTAG connector (pin row)*** *Not used.*
J8	**STM32 UART1 connector (pin row)** This connector is used when downloading new software to the 2070 module using the JP12 jumper.
J9	***TPS-1 JTAG connector (pin row)*** *Not used.*
J6	***TPS-1 UART6 connector (pin row)*** *Not used.*

7.2.2 Jumper settings

The 2070 PROFINET module is internally equipped with 6 jumpers. These jumpers have the following function:

JUMPER	FUNCTION
JP11	**STM32 RESET** The jumper allows reset of the onboard STM32 microcontroller. OFF: Normal operation (normal setting from factory) ON: Reset of the 2070 on-board microcontroller
JP12	**STM32 BOOT0** The jumper is used when downloading new software to the 2070 module using the J8 serial connector. OFF: Normal power-up/operation (normal setting from factory) ON: Download operation possible
P2	***STM32 configuration jumper*** *(Reserved for future use)*
P3	***STM32 configuration jumper*** *(Reserved for future use)*
JP1	**TPS-1 RESET** Not used. Must be in OFF position.
JP2	**TPS-1 BOOT1** Not used. Must be in OFF position.

7.2.3 Light Emitting Diodes (LEDs)

The 2070 PROFINET module is internally equipped with 3 LEDs. These LEDs have the following functionality:

LED	FUNCTION
D4 (Yellow)	**RS485 RX** RS485 data is received.
D9 (Green)	**RS485 TX** RS485 data is transmitted.
D10 (Green)	**Power** 3.3 VDC internal power supply is on.

7.3 Appendix C – Status Codes

Status codes for the connected loadcells are shown as a 4 digit hex number. If more than one error condition is present, the error codes are OR’ed together.

CODE (Hex)	CAUSE
0001	**Invalid/missing ’sample’ ID** Bad connection between communication module and loadcell module.
0002	**Loadcell timeout** Check that the loadcell is connected to the loadcell module.
0004	**Loadcell not synchronized** Bad connection between loadcell and loadcell module.
0008	**Hardware synchronization error** Cable between loadcell modules shorted or disconnected.
0010	**Power failure** Supply voltage to loadcells is too low.
0020	**Overflow in weight calculation** Internal error in loadcell module.
0040	**Invalid/missing ’latch’ ID** Bad connection between communication module and loadcell module.
0080	**No answer from loadcell module** No data is received from this loadcell module. This can be caused by the removal of the loadcell module, no power to the module or that the connection between loadcell module and communication module is broken.
0100	*Reserved for future use*
0200	*Reserved for future use*
0400	*Reserved for future use*
0800	**No loadcell modules answer** Bad connection between communication module and loadcell module. Not all telegrams from communication module are received in loadcell module.
1000	*Reserved for future use*
2000	*Reserved for future use*
4000	*Reserved for future use*
8000	*Reserved for future use*