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mod. IO-CB/AI-08HL-00

M.U. IO-CB/AI-08HL-2/07.07
Cod. J30-478-1AAI-08HL E

User manual

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CANopen I/O Module

8 Configurable Analogue Inputs mod. IO-CB/AI-08HL



8 inputs configurable for:

- mA, V linear inputs

APPLICABLE STANDARDS

The AI-08HL module is suited for the CiA DS301 protocol [1] and implements the CiA DS 401 standard Device Profile, as far as the Analogue Input Function Block is concerned [2].

Characteristics

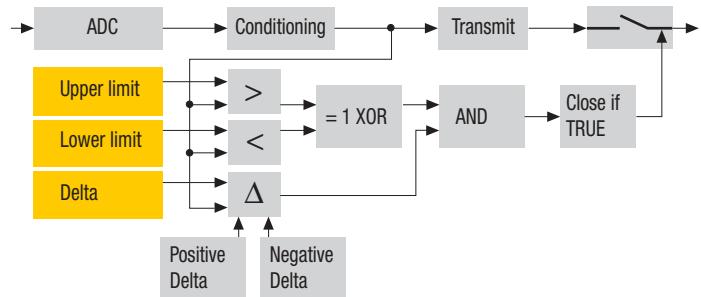
Technical data

Accuracy at 25°C	$\pm 0.1\%$ FS
Temperature coefficient	0.01% FS/K
Input impedance	mA < 300Ω V > 10kΩ
Digital resolution	16 bit
Conversion time	5 ms
Overshoot protection	30 V
CMRR	> 100 dB

WARNING

- 1) The product described in this manual should only be installed, operated and maintained by qualified application programmers and software engineers who are familiar with automation safety concepts and applicable national standards.
- 2) This product supports the Parameter defaults indicated by CiA standards, in addition, some parameters have a factory set (value present in the module when comes from the factory). The default values can be loaded with the restore command, but after the restore, factory set values are lost.

Functional Block Diagram



The analogue input function block describes, for each input channel, how field values are transmitted.

Every time one of the limit conditions is reached an asynchronous transmission takes place.

PDOs used by the module

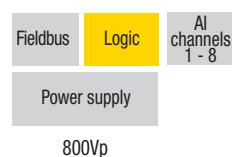
TPDO	Properties	Mapped objects	Index	Sub-index
TPDO 2	COBID: 280h + NodeID Transmission Type: 01h *	Read Analog Input ch 1	6401h	01h
		Read Analog Input ch 2	6401h	02h
		Read Analog Input ch 3	6401h	03h
		Read Analog Input ch 4	6401h	04h
TPDO 3	COBID: 380h + NodeID Transmission Type: 01h *	Read Analog Input ch 5	6401h	05h
		Read Analog Input ch 6	6401h	06h
		Read Analog Input ch 7	6401h	07h
		Read Analog Input ch 8	6401h	08h

Note: * The Transmission Type is configurable; **01h** is the factory set (value present in the modules when come from the factory), the default value is **FFh**.

General

3 way isolation	800 Vp
Power supply	24 Vdc; -15...+25%
Power consution	3 W
Dimensions	L: 76; H: 110; W: 65
Weight	220 g
Safety regulations EN61010-1	Isolation class II (50 Vrms) Installation category II Pollution degree 2
CE marking	EN61131-2

3 way isolation diagram

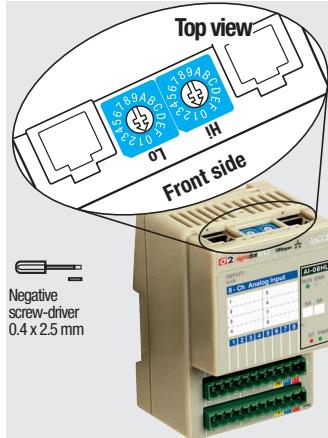


Environment

	Operating	Storage
Temperature	-10...+65°C	-40...+85°C
Relative Humidity	5...95% non condensing Appropriate measures must be taken against humidity >85%	5...95% non condensing For a short period, slight condensation may appear on the housing
Mounting	Vertical, free air	
Protection	IP20	
Vibrations (3 axes)	10...57Hz 0.0375mm 57...150Hz 0.5g	
Shock (3 axes)	15g, 11ms half sine	

Hardware Set-up

Hexadecimal rotary switches, service and I/O LEDs



LED	Status	Meaning
RUN	ON	Operational
	Blinking	Pre-operational (CANopen)
	Single flash	STOPPED
	OFF	Device in RESET state
ERR	ON	BUS OFF
	Single flash	Warning limit reached
	Double flash	Error Control Event
	Triple flash	Sync Error (CANopen)
ST	OFF	No error. Device working
	ON	DIAG Error
	Blinking	INIT and DIAG running
	Single flash	Baud rate setting
PWR	OFF	Module OK and ready
	ON	Module Power Supply ON
PWR	OFF	Module Power Supply OFF

Bit Rate and Node ID configuration

Bit rate

Lo switch	Baud rate kbps	Bus length m
1	20	2500
2	50	1000
3	100	500
4	125	500
5	250	250
6 *	500	100
7	800	50
8	1000	25

Notes: * Default value

Node ID

Hi switch	Lo switch	Valid ID Node
0	1	01h (address 1)
0	2	02h (address 2)
↓	↓	↓
7	F	7Fh (address 127D) *

Parameters setting

Index 2001h – Analogue Input Type

The n-th subindex (from 1 to 8) contains the configuration parameter of the n-th Analogue Input

Value	Input type	Condition
0x00	0...10 V	Default
0x01	0...20 mA	
0x02	4...20 mA	

Standard parameters

Index 6421h - Analog Input Interrupt Trigger Selection

This object determines, which events shall cause an interrupt for a specific channel. Bits set in the list below shall refer to ways in which interrupts may be triggered.

Bit number	Interrupt trigger
0	Upper limit exceeded
1	Input below lower limit
2	Input changed by more than delta
3	Input reduced by more than negative delta
4	Input increased by more than positive delta
5 to 7	reserved for future use

Index 6422h - Analog Input Interrupt Source

This object shall determine which channel has produced an interrupt. Bits set shall relate to the number of any channels that have produced interrupts. The bits shall be reset automatically after read by SDO or transmitted by means of a PDO.

1 = interrupt produced

0 = no interrupt produced.

Index 6423h - Analog Input Global Interrupt Enable

This object shall enable and disable globally the interrupt behaviour without changing the interrupt mask. By default, no analogue input activates an interrupt.

TRUE = global interrupt enabled

FALSE = global interrupt disabled

Index 6424h - Analog Input Interrupt Upper Limit Integer

If enabled (see 6423h object), an interrupt is triggered when the analogue input is equal or rises above the given value. The value shall be always left adjusted. As long as the trigger condition is met, every change of the analogue input data generates a new interrupt, if there is no additional trigger condition, e.g. an input interrupt delta (6426h).

Index 6425h - Analog Input Interrupt Lower Limit Integer

If enabled (see 6423h object), an interrupt is triggered when the analogue input is equal or rises above the given value. The value shall be always left adjusted. As long as the trigger condition is met, every change of the analogue input data generates a new interrupt, if there is no additional trigger condition, e.g. an input interrupt delta (6426h).

Parameter configuration

Module specific parameters

Index 2000h – Terminal Block Temperature

Ambient temperature, measured on the module's terminal block.

Not available through TPDO.

Index 3000h – Node Address

Current Module Node ID - Read only access

Index 3001h – Baudrate

Current Module Bit rate - Read only access

Index 6426h - AI Interrupt Delta Unsigned

This object shall set the delta value (rising or falling above or below the last communicated value) for interrupt-enabled analogue inputs (see 6423h object).

Index 6427h - AI Interrupt Negative Delta Unsigned

This object shall set the negative delta value (falling below the last communicated value) for interrupt-enabled analogue inputs (see 6423h object).

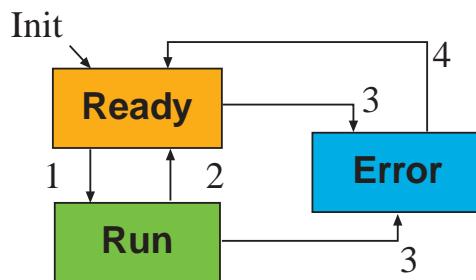
Index 6428h - AI Interrupt Positive Delta Unsigned

This object shall set the positive delta value (rising above the last communicated value) for interrupt-enabled analogue inputs (see 6423h object).

Commands

Index 200Ch – Operating mode

The device has its own internal state machine. It is possible to move through this by sending appropriate values to the Index 200Ch, following the table below.



Transition	Operating mode value	Behaviour
Init	-	At Power-Up, the Device is in the “ready” state. Transition 1 is also executed if Index 200Ch - Operating Mode contains the default value 1
1	01h (default)	Operating mode “RUN” is activated
2	00h	Return to the initialisation “ready” state. The transition is performed: <ul style="list-style-type: none">• following an operator’s command• after assigning the configuration parameter (2001h)
3	FFh	The “error” state is automatically assigned by the device (and the operating mode value is read only) when: <ul style="list-style-type: none">• an attempt is made to execute an unexpected command
4	00h	This value causes an exit from the “error” state, after the error condition is acknowledged. The only transition is to the “ready” state

Parameter Store/Restore

This module allows parameters to be saved in a non volatile memory. In order to avoid storing parameters by mistake, storage is only executed when a specific signature is written to the appropriate subindex. The signature is “save”.

Similarly, the default values of parameters, according to the communication or device profile, are restored. On receipt of the correct signature in the appropriate subindex, the device restores the default parameters and then confirms the SDO transmission. The signature is “load”.

The new configuration becomes active after a reset, i.e. after a “Power Down” or an NMT “Reset Node” message.

Byte	0	1	2	3	4	5	6	7
Store Parameter	22h	10h	10h	01h	73h	61h	76h	65h
	COB – ID = 600h + NodeID							
Restore Parameter	22h	11h	10h	01h	6Ch	6Fh	61h	64h
	COB – ID = 600h + NodeID							

SDO Messages

The entries of a device Object Dictionary are accessed trough SDO (Service Data Object) messages. The basic SDO messages are as follows, as based on the Client – Server request and response model:

Byte	0	1	2	3	4	5	6	7
Read request	40h	Index	Sub-Index					Reserved
	COB – ID = 600h + NodeID							
Read response	4xh *	Index	Sub-Index					Data
	COB – ID = 580h + NodeID							
Write request	22h	Index	Sub-Index					Data
	COB – ID = 600h + NodeID							
Write response	60h	Index	Sub-Index					Reserved
	COB – ID = 580h + NodeID							

* This code is type dependant.

Please refer to the CIA DS301 Profile for more details.

Emergency messages

The module automatically sends emergency messages including error codes. The communication errors are described in CIA DS301 [1].

The error codes are expressed as a DEVICE SPECIFIC ERROR type of code, one for each channel: 0xFF0n for channel n. The codes indicating a specific condition are also inserted, following the table below:

Error code	Error
0000000000	No error – This code is generated when exiting an error condition, to notify the end of one of the error states
0000000001	Error No Valid Calib – An attempt to change the state of an input channel not properly calibrated to “operating”
0000000002	Error No Config – An attempt to change the state of an input channel with a non valid Sensor Type to “operating”
0000000006	Error No Command – Invalid command received
0000000007	Error Wrong Command – An attempt to execute a command from an illegal state
0000000008	Error Wrong Assignment – An attempt to assign a parameter from an illegal state
Emergency message COB – ID = [entry 1014h] + NodeID	
Error code	

Reference documents

List of CIA documents to which the user should refer:

- [1] CiA DS301 - CANopen Application Layer and Communication Profile
- [2] CiA DS401 - CANopen Device Profile: Generic I/O Modules

Accessories, Spare Parts and Warranty

Power Supply 75W 24Vdc 3A	AP-S2/AL-DR75-24
Power Supply 120W 24Vdc 5A	AP-S2/AL-DR120-24
Additional Terminal Block 2x11	AP-S2/TB-211-1
Female Plug 11 Screw clamp	AP-S2/SPINA-V11
Female Plug 11 Spring clamp	AP-S2/SPINA-M11
RJ45 terminated cable 14cm	AP-S2/LOCAL-BUS76
RJ45 terminated cable 22cm	AP-S2/LOCAL-BUS152
CAN termination Adapter	AP-S2/TERM-CAN

Warranty: 3 years excluding defects due to improper use

Object Dictionary (with default values)

⚠ In order to configure the module, it is necessary to connect it to a PC with the CAN interface and the supervisory software installed. The configuration can be obtained by writing the desired values to the module's variables listed in the Object Dictionary.

Object Dictionary structure

Index (hex)	Sub Index	Object	Name	Default [hex]	Type	Acc. Attr.	MO
1000	VAR	Device Type	00040191	UNSigned32	RO	M	
1001	VAR	Error Register	00	UNSigned8	RO	M	
1003	ARRAY	Predefined error field	00000000	UNSigned32	RO	O	
1005	VAR	COB-ID SYNC	00000080	UNSigned32	RW	O	
1006	VAR	Communication cycle period	00000000	UNSigned32	RW	O	
1007	VAR	Synchronous window length	00000000	UNSigned32	RW	O	
1008	VAR	Manufacturer Device Name	"08HL"	Vis-String	const	O	
1009	VAR	Manufacturer Hardware Version	"1.00"	Vis-String	const	O	
100A	VAR	Manufacturer Software Version	"1.00"	Vis-String	const	O	
100C	VAR	Guard Time	0000	UNSigned16	RW	O	
100D	VAR	Life Time Factor	00	UNSigned8	RW	O	
1010	ARRAY	Store Parameters	00000000	UNSigned32	RW	O	
00h	VAR	Largest subindex supported	01	UNSigned8	RO		
01h	VAR	Save all parameters	03	UNSigned32	RW		
1011	ARRAY	Restore Default Parameters	00000000	UNSigned32	RW	O	

00h	VAR	Largest subindex supported	01	UNSigned8	RO		
01h	VAR	Restore all default parameters	01	UNSigned32	RW		
1014	VAR	COB-ID EMCY	80 + NodeID	UNSigned32	RW	O	
1015	VAR	Inhibit Time EMCY	0000	UNSigned16	RW	O	
1017	VAR	Producer heartbeat time	07D0	UNSigned16	RW	O	
1018	RECORD	Identity Object	Identity (23h)			M	
00h	VAR	Number of entries	01	UNSigned8	RO		
01h	VAR	Vendor ID	000000E9	UNSigned32	RO		
1200	RECORD	Server SDO parameter	SDO Parameter (22h)			O	
00h	VAR	Number of entries	02	UNSigned8	RO		
01h	VAR	COB-ID Client → Server (rx)	600+NodeID	UNSigned32	RO		
02h	VAR	COB-ID Server → Client (tx)	580+NodeID	UNSigned32	RO		
1800	RECORD	1 st Transmit PDO Comm Param.	PDO CommPar (20h)			M	
00h	VAR	Largest subindex supported	05	UNSigned8	RO		
01h	VAR	COB-ID used	380+NodeID	UNSigned32	RW		
02h	VAR	Transmission type	FF *	UNSigned8	RW		
03h	VAR	Inhibit time	0000	UNSigned16	RW		
04h	VAR	Reserved	0000	UNSigned8	RW		
05h	VAR	Event timer	0000	UNSigned16	RW		
1801	RECORD	2 nd Transmit PDO Comm Param.	PDO CommPar (20h)			M	
00h	VAR	Largest subindex supported	05	UNSigned8	RO		
01h	VAR	COB-ID used	280+NodeID	UNSigned32	RW		
02h	VAR	Transmission type	FF *	UNSigned8	RW		
03h	VAR	Inhibit time	0000	UNSigned16	RW		
04h	VAR	Reserved	0000	UNSigned8	RW		
05h	VAR	Event timer	0000	UNSigned16	RW		
1802	RECORD	3 rd Transmit PDO Comm Param.	PDO CommPar (20h)			M	

00h	VAR	Largest subindex supported	05	UNSigned8	RO		
01h	VAR	COB-ID used	380+NodeID	UNSigned32	RW		
02h	VAR	Transmission type	FF *	UNSigned8	RW		
03h	VAR	Inhibit time	0000	UNSigned16	RW		
04h	VAR	Reserved	0000	UNSigned8	RW		
05h	VAR	Event timer	0000	UNSigned16	RW		
1803	RECORD	4 th Transmit PDO Comm Param.	PDO CommPar (20h)			M	
00h	VAR	Largest subindex supported	05	UNSigned8	RO		
01h	VAR	COB-ID used	480+NodeID	UNSigned32	RW		
02h	VAR	Transmission type	FF *	UNSigned8	RW		
03h	VAR	Inhibit time	0000	UNSigned16	RW		
04h	VAR	Reserved	0000	UNSigned8	RW		
05h	VAR	Event timer	0000	UNSigned16	RW		
1A00	RECORD	1 st Transmit PDO Mapping	UNUSED	PDO Mapping (21h)		M	
00h	VAR	No. of mapped application obj.	00	UNSigned8	RO		
1A01	RECORD	2 nd Transmit PDO Mapping	PDO Mapping (21h)			M	
00h	VAR	No. of mapped application obj.	04	UNSigned8	RO		
01h	VAR	Read Analogue Input 16 bit - ch1	64010110	UNSigned32	RO		
02h	VAR	Read Analogue Input 16 bit - ch2	64010210	UNSigned32	RO		
03h	VAR	Read Analogue Input 16 bit - ch3	64010310	UNSigned32	RO		
04h	VAR	Read Analogue Input 16 bit - ch4	64010410	UNSigned32	RO		
1A02	RECORD	3 rd Transmit PDO Mapping	PDO Mapping (21h)			M	
00h	VAR	No. of mapped application obj.	04	UNSigned8	RO		
01h	VAR	Read Analogue Input 16 bit - ch5	64010510	UNSigned32	RO		
02h	VAR	Read Analogue Input 16 bit - ch6	64010610	UNSigned32	RO		
03h	VAR	Read Analogue Input 16 bit - ch7	64010710	UNSigned32	RO		
04h	VAR	Read Analogue Input 16 bit - ch8	64010810	UNSigned32	RO		

1A03	RECORD	4 th Transmit PDO Mapping	UNUSED	PDO Mapping (21h)		M	
00h	VAR	No. of mapped application obj.	00	UNSigned8	RO		
2000	ARRAY	Cold Junction Temperature	00000000	UNSigned32	RW	O	
00h	VAR	Number of entries	01	UNSigned8	RO		
01h	VAR	Cold Junction Measure	00000000	UNSigned32	RW	O	
2001	ARRAY	AI Input Type	00000000	UNSigned32	RW	O	
00h	VAR	Number of entries	08	UNSigned8	RO		
01h	VAR	AI Input Type ch1	00	UNSigned8	RW		
02h	VAR	AI Input Type ch2	00	UNSigned8	RW		
03h	VAR	AI Input Type ch3	00	UNSigned8	RW		
04h	VAR	AI Input Type ch4	00	UNSigned8	RW		
05h	VAR	AI Input Type ch5	00	UNSigned8	RW		
06h	VAR	AI Input Type ch6	00	UNSigned8	RW		
07h	VAR	AI Input Type ch7	00	UNSigned8	RW		
08h	VAR	AI Input Type ch8	00	UNSigned8	RW		

Index (hex)	Sub Index	Object	Name	Default [hex]	Type	Acc. Attr.	MO
200C	ARRAY	AI Operating Mode					
01h	VAR	Number of entries	08	UNSigned8	RO		
01h	VAR	AI Operating Mode ch1	01	UNSigned8	RW		
02h	VAR	AI Operating Mode ch2	01	UNSigned8	RW		
03h	VAR	AI Operating Mode ch3	01	UNSigned8	RW		
04h	VAR	AI Operating Mode ch4	01	UNSigned8	RW		
05h	VAR	AI Operating Mode ch5	01	UNSigned8	RW		
06h	VAR	AI Operating Mode ch6	01	UNSigned8	RW		
07h	VAR	AI Operating Mode ch7	01	UNSigned8	RW		
08h	VAR	AI Operating Mode ch8	01	UNSigned8	RW		
3000	VAR	Node Address	7F	UNSigned8	RO	O	
3001	VAR	Node Baurate	06	UNSigned8	RO	O	
6401	ARRAY	Read Analogue Input 16-bit					
00h	VAR	Number of entries	08	UNSigned8	RO		
01h	VAR	Read Analogue Input 16bit - ch1	00	INTEGER16	RO		

02h	VAR	Read Analogue Input 16bit - ch2	00	INTEGER16	RO		
03h	VAR	Read Analogue Input 16bit - ch3	00	INTEGER16	RO		
04h	VAR	Read Analogue Input 16bit - ch4	00	INTEGER16	RO		
05h	VAR	Read Analogue Input 16bit - ch5	00	INTEGER16	RO		
06h	VAR	Read Analogue Input 16bit - ch6	00	INTEGER16	RO		
07h	VAR	Read Analogue Input 16bit - ch7	00	INTEGER16	RO		
08h	VAR	Read Analogue Input 16bit - ch8	00	INTEGER16	RO		
6421	ARRAY	AI Interrupt Trigger Selection	00	UNSigned8	RO		
00h	VAR	Number of entries	08	UNSigned8	RO		
01h	VAR	AI Interrupt Trigger Selection - ch1	07	UNSigned8	RW		
02h	VAR	AI Interrupt Trigger Selection - ch2	07	UNSigned8	RW		
03h	VAR	AI Interrupt Trigger Selection - ch3	07	UNSigned8	RW		
04h	VAR	AI Interrupt Trigger Selection - ch4	07	UNSigned8	RW		
05h	VAR	AI Interrupt Trigger Selection - ch5	07	UNSigned8	RW		
06h	VAR	AI Interrupt Trigger Selection - ch6	07	UNSigned8	RW		
07h	VAR	AI Interrupt Trigger Selection - ch7	07	UNSigned8	RW		
08h	VAR	AI Interrupt Trigger Selection - ch8	07	UNSigned8	RW		
6422	ARRAY	AI Interrupt Source	00	UNSigned8	RO		
00h	VAR	Number of entries	01	UNSigned8	RO		
01h	VAR	AI Interrupt Source	00	UNSigned8	RO		
6423	VAR	AI Global Interrupt Enable	FALSE	BOOLEAN	RW	O	
6424	ARRAY	AI Interrupt Upper Limit Integer	00	UNSigned32	RO		
00h	VAR	Number of entries	08	UNSigned8	RO		
01h	VAR	AI Interrupt Upper Limit Integer - ch1	00	INTEGER32	RW		
02h	VAR	AI Interrupt Upper Limit Integer - ch2	00	INTEGER32	RW		
03h	VAR	AI Interrupt Upper Limit Integer - ch3	00	INTEGER32	RW		
04h	VAR	AI Interrupt Upper Limit Integer - ch4	00	INTEGER32	RW		
05h	VAR	AI Interrupt Upper Limit Integer - ch5	00	INTEGER32	RW		
06h	VAR	AI Interrupt Upper Limit Integer - ch6	00	INTEGER32	RW		
07h	VAR	AI Interrupt Upper Limit Integer - ch7	00	INTEGER32	RW		
08h	VAR	AI Interrupt Upper Limit Integer - ch8	00	INTEGER32	RW		

05h	VAR	AI Interrupt Upper Limit Integer - ch5	00	INTEGER32	RW		
06h	VAR	AI Interrupt Upper Limit Integer - ch6	00	INTEGER32	RW		
07h	VAR	AI Interrupt Upper Limit Integer - ch7	00	INTEGER32	RW		
08h	VAR	AI Interrupt Upper Limit Integer - ch8	00	INTEGER32	RW		
6425	ARRAY	AI Interrupt Lower Limit Integer	00	UNSigned8	RO		
00h	VAR	Number of entries	08	UNSigned8	RO		
01h	VAR	AI Interrupt Lower Limit Integer - ch1	00	INTEGER32	RW		
02h	VAR	AI Interrupt Lower Limit Integer - ch2	00	INTEGER32	RW		
03h	VAR	AI Interrupt Lower Limit Integer - ch3	00	INTEGER32	RW		
04h	VAR	AI Interrupt Lower Limit Integer - ch4	00	INTEGER32	RW		
05h	VAR	AI Interrupt Lower Limit Integer - ch5	00	INTEGER32	RW		
06h	VAR	AI Interrupt Lower Limit Integer - ch6	00	INTEGER32	RW		
07h	VAR	AI Interrupt Lower Limit Integer - ch7	00	INTEGER32	RW		
08h	VAR	AI Interrupt Lower Limit Integer - ch8	00	INTEGER32	RW		
6426	ARRAY	AI Interrupt Delta Unsigned	00	UNSigned8	RO		
00h	VAR	Number of entries	08	UNSigned8	RO		
01h	VAR	AI Interrupt Delta Unsigned - ch1	00	UNSigned32	RW		
02h	VAR	AI Interrupt Delta Unsigned - ch2	00	UNSigned32	RW		
03h	VAR	AI Interrupt Delta Unsigned - ch3	00	UNSigned32	RW		
04h	VAR	AI Interrupt Delta Unsigned - ch4	00	UNSigned32			