已批准
Hanlin Lin 2019-03-13 4:01 pm

Release Note for AIC HA201 Expander

March 13, 2019

Changelog

03/13/2019 (fw3A6_v1.12.6.1 + mfg3A6.0_HA201_v1.6.0.6) - Part Number (B98-00HA21E0120601 + SEG-0006C006A01)

1. Initial revision

1. SES Pages

- 00h – List of supported diagnostic pages
- 01h – SES configuration
- 02h – SES enclosure control / enclosure status
- 04h – SES string out / string in
- 05h – SES threshold out / threshold in
- 07h – SES element descriptor
- 0Ah – SES additional element
- 0Eh – SES download microcode control / SES download microcode status
- 80h - Vendor specific diagnostic out / diagnostic in
- 81h – Vendor specific Bridge I2C out / Bridge I2C in
- 82h - Vendor specific chassis number out / chassis number in
- 8Ah – Vendor specific Expander PWM out / Expander PWM in

2. Implementation on SES Pages

2.1. SES string out / string in

2.1.1. SES string out

It can be used to control the following items.

- Change UUID

- Change temperature sensor settings on Backplane - T1 and T2
- Change two canister status LED
- Change Expander SAS address
- Reset I2C on local Bridge PIC, Backplane PIC, and all Backplane I2C slaves including PMBus
- Hard reset local Bridge PIC
- Force local Bridge PIC to stay in bootloader mode
- Hard reset Backplane PIC
- Force Backplane PIC to stay in bootloader mode
- Reset local Expander
- Reset remote Expander
- Configure Backplane PIC setting for Backplane bezel LED state and motherboard power-off mode for the enclosure power button
- Configure Backplane PIC power for powering off and +5V standby power cycling either canister
- Configure an additional blue LED per drive

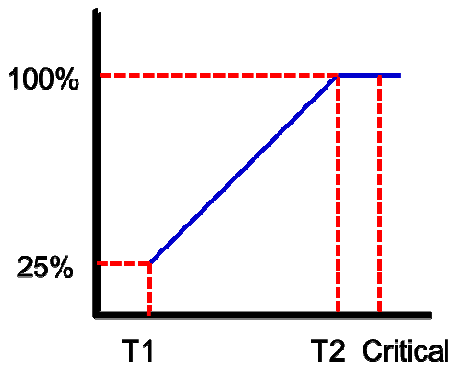
String out format

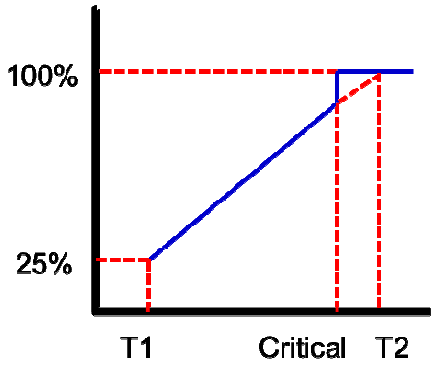
Byte0 ~ Byte7	Change Expander SAS address No change – all 0x0 The change will take effect after expander reset.
Byte8 ~ Byte11	Temperature0 parameters (in Celsius): T1, T2, warning threshold, critical threshold No change – all 0x0 The change will take effect after expander reset.
Byte12 ~ Byte15	Temperature1 parameters (in Celsius): T1, T2, warning threshold, critical threshold No change – all 0x0 The change will take effect after expander reset.
Byte16 ~ Byte19	Temperature2 parameters (in Celsius): T1, T2, warning threshold, critical threshold No change – all 0x0 The change will take effect after expander reset.
Byte20 ~ Byte20	Primary canister status LED – Green No change – 0xFF, Not control LED – 0x0, LED on – 0x1, LED off – 0x2, LED slow blink – 0x3, LED fast blink – 0x4 LED slow blink and LED fast blink might look similar due to the scheduling priority

Byte21 ~ Byte21	Primary canister status LED – Red No change – 0xFF, Not control LED – 0x0, LED on – 0x1, LED off – 0x2, LED slow blink – 0x3, LED fast blink – 0x4 LED slow blink and LED fast blink might look similar due to the scheduling priority
Byte22 ~ Byte22	Secondary canister status LED – Green No change – 0xFF, Not control LED – 0x0, LED on – 0x1, LED off – 0x2, LED slow blink – 0x3, LED fast blink – 0x4 LED slow blink and LED fast blink might look similar due to the scheduling priority
Byte23 ~ Byte23	Secondary canister status LED – Red No change – 0xFF, Not control LED – 0x0, LED on – 0x1, LED off – 0x2, LED slow blink – 0x3, LED fast blink – 0x4 LED slow blink and LED fast blink might look similar due to the scheduling priority
Byte24 ~ Byte39	Change UUID (Byte0 ~ Byte15 on Backplane EEPROM with I2C address: 0xA0) No change – all 0x0
Byte40 ~ Byte40	Reset I2C No change – 0x0, Reset – 0x1
Byte41 ~ Byte41	Reset Backplane PIC No change – 0x0, Reset – 0x1
Byte42 ~ Byte42	Force to stay in Backplane PIC bootloader It triggers “Reset I2C” also. No change – 0x0, Bootloader – 0x1
Byte43 ~ Byte43	Reset local Bridge PIC No change – 0x0, Reset – 0x1
Byte44 ~ Byte44	Force to stay in local Bridge PIC bootloader It triggers “Reset I2C” also. No change – 0x0, Bootloader – 0x1
Byte45 ~ Byte45	Reset remote Expander No change – 0x0, Reset – 0x1
Byte46 ~ Byte46	Reset local Expander No change – 0x0, Reset – 0x1
Byte47 ~ Byte47	Configure Backplane PIC setting No change – 0xFF Power button on force motherboard power-off mode – Bit1 = 0 Power button on non-force motherboard power-off mode – Bit1 = 1

	Turn on AC loss feature – Bit2 = 0 Turn off AC loss feature – Bit2 = 1 Turn on the bezel power (3.3V and 5V) – Bit5 = 1 Turn off the bezel power (3.3V and 5V) – Bit5 = 0
Byte48 ~ Byte48	Configure Backplane PIC power No change – 0x0 Power off the canister close to the power – Bit7 = 1 Power off the canister away from the power – Bit6 = 1 +5V standby power cycle the canister close to the power – Bit5 = 1 +5V standby power cycle the canister away from the power – Bit4 = 1 +5V standby power cycle duration – Bit3 ~ Bit0 (it ranges between 0.5 second and 8 seconds)
Byte49 ~ Byte49	Configure an additional blue LED per drive No change – Slot ID is invalid Bit1 ~ Bit0: LED pattern (On: 00, Off: 01, Slow blinking: 10, Fast blinking: 11) Bit7 ~ Bit2: Slot ID (Slot 0 ~ 23 for an individual slot are valid, and Slot24 for all slots is valid also)

Smart fan curves for Temperature0, Temperature1, and Temperature2 follow.





2.1.2. SES string in

It can provide status of the following items.

- Expander firmware revision

- Expander manufacture configuration revision
- Local Bridge PIC firmware revision
- Backplane PIC firmware revision
- Backplane UUID
- Canister slot id
- Two canister power state in Backplane PIC
- Two canister power status in Backplane PIC
- Two canister present status in Backplane PIC
- Synchronous GPIO status for the other Bridge PIC
- UART status for the other Bridge PIC
- Local Bridge PIC data valid indicator
- Local Bridge PIC healthy state
- Backplane PIC healthy state
- Backplane PIC setting for Backplane bezel LED state and motherboard power-off mode for the enclosure power button
- Unreadable Backplane I2C slave
- Temperature sensor settings on Backplane - T1 and T2
- Two canister status LED
- Expander SAS address
- Status of the additional blue LED per drive

String in format

Byte0 ~ Byte7	Expander SAS address
Byte8 ~ Byte11	Expander firmware revision
Byte12 ~ Byte15	Expander manufacture configuration revision
Byte16 ~ Byte19	Temperature0 parameters (in Celsius): T1, T2, warning threshold, critical threshold Each parameter is 0xFF while reading failure.
Byte20 ~ Byte23	Temperature1 parameters (in Celsius): T1, T2, warning threshold, critical threshold Each parameter is 0xFF while reading failure.
Byte24 ~ Byte27	Temperature2 parameters (in Celsius): T1, T2, warning threshold, critical threshold Each parameter is 0xFF while reading failure.
Byte28 ~ Byte28	Canister slot id 0: primary canister (the right canister or Canister-A) 1: secondary canister (the left canister or Canister-B)
Byte29 ~ Byte29	Local Bridge PIC healthy

	Healthy – 0x1, Not healthy – 0x0
Byte30 ~ Byte30	Local Bridge PIC data valid indicator Valid – 0x1, Invalid – 0x0
Byte31 ~ Byte31	Backplane PIC setting Power button on force motherboard power-off mode – Bit1 = 0 (default) Power button on non-force motherboard power-off mode – Bit1 = 1 Turn on AC loss feature – Bit2 = 0 Turn off AC loss feature – Bit2 = 1 (default) Turn on the bezel power (3.3V and 5V) – Bit5 = 1 Turn off the bezel power (3.3V and 5V) – Bit5 = 0 (default)
Byte32 ~ Byte32	Unreadable Backplane I2C slave Reading failure – 0xFF, None – 0x0, Temperature0 – 0x1, Temperature1 – 0x2, Temperature2 – 0x3, PCA9555_chip0_port0 – 0x4 or 0x5, PCA9555_chip0_port1 – 0x6 or 0x7, PCA9555_chip1_port0 – 0x8 or 0x9, PCA9555_chip1_port1 – 0xA or 0xB, EEPROM – 0xC, Backplane PIC – 0xD, PCA9552_chip_LS0 – 0xE, PCA9552_chip_LS1 – 0xF, PCA9552_chip_LS2 – 0x10, PCA9552_chip_LS3 – 0x11, PCA9551_chip_LS0 – 0x12, PCA9551_chip_LS1 – 0x13
Byte33 ~ Byte33	Sync GPIO healthy Reading failure – 0xFF, Healthy – 0x1, Not healthy – 0x0
Byte34 ~ Byte34	UART healthy Reading failure – 0xFF, Healthy – 0x1, Not healthy – 0x0
Byte35 ~ Byte35	Backplane PIC healthy Reading failure – 0xFF, Healthy – 0x1, Not healthy – 0x0
Byte36 ~ Byte36	Primary canister status LED – Green Reading failure – 0xFF Bit7 ~ Bit4 for the status: LED on – 0x1, LED off – 0x2 Bit3 ~ Bit0 for the setting: Not control LED – 0x0, LED on – 0x1, LED off – 0x2, LED slow blink – 0x3, LED fast blink – 0x4

	LED slow blink and LED fast blink might look similar due to the scheduling priority
Byte37 ~ Byte37	Primary canister status LED – Red Reading failure – 0xFF Bit7 ~ Bit4 for the status: LED on – 0x1, LED off – 0x2 Bit3 ~ Bit0 for the setting: Not control LED – 0x0, LED on – 0x1, LED off – 0x2, LED slow blink – 0x3, LED fast blink – 0x4 LED slow blink and LED fast blink might look similar due to the scheduling priority
Byte38 ~ Byte38	Secondary canister status LED – Green Reading failure – 0xFF Bit7 ~ Bit4 for the status: LED on – 0x1, LED off – 0x2 Bit3 ~ Bit0 for the setting: Not control LED – 0x0, LED on – 0x1, LED off – 0x2, LED slow blink – 0x3, LED fast blink – 0x4 LED slow blink and LED fast blink might look similar due to the scheduling priority
Byte39 ~ Byte39	Secondary canister status LED – Red Reading failure – 0xFF Bit7 ~ Bit4 for the status: LED on – 0x1, LED off – 0x2 Bit3 ~ Bit0 for the setting: Not control LED – 0x0, LED on – 0x1, LED off – 0x2, LED slow blink – 0x3, LED fast blink – 0x4 LED slow blink and LED fast blink might look similar due to the scheduling priority
Byte40 ~ Byte40	Primary canister present status Reading failure – 0xFF, Not present – 0x0, Present – 0x1
Byte41 ~ Byte41	Secondary canister present status Reading failure – 0xFF, Not present – 0x0, Present – 0x1

Byte42 ~ Byte42	Primary canister power status Reading failure – 0xFF, Power off – 0x0, Power on – 0x1
Byte43 ~ Byte43	Secondary canister power status Reading failure – 0xFF, Power off – 0x0, Power on – 0x1
Byte44 ~ Byte44	Primary canister power state Reading failure – 0xFF, Clean state – 0x0 Canister not present – 0x1, Canister present and off – 0x2 Canister present and on – 0x3 Canister present but failed to power on – 0x4
Byte45 ~ Byte45	Secondary canister power state Reading failure – 0xFF, Clean state – 0x0 Canister not present – 0x1, Canister present and off – 0x2 Canister present and on – 0x3 Canister present but failed to power on – 0x4
Byte46 ~ Byte61	Backplane UUID (Byte0 ~ Byte15 on Backplane EEPROM with I2C address: 0xA0)
Byte62 ~ Byte63	Reserved
Byte64 ~ Byte66	Backplane PIC firmware revision
Byte67 ~ Byte69	Bridge PIC firmware revision
Byte70 ~ Byte70	Additional blue LED Bit1 ~ Bit0: Slot 0 Bit3 ~ Bit2: Slot 1 Bit5 ~ Bit4: Slot 2 Bit7 ~ Bit6: Slot 3 LED on: 00, LED off: 01, LED slow blinking: 10, LED fast blinking: 11
Byte71 ~ Byte71	Additional blue LED Bit1 ~ Bit0: Slot 4 Bit3 ~ Bit2: Slot 5 Bit5 ~ Bit4: Slot 6 Bit7 ~ Bit6: Slot 7 LED on: 00, LED off: 01, LED slow blinking: 10, LED fast blinking: 11
Byte72 ~ Byte72	Additional blue LED Bit1 ~ Bit0: Slot 8 Bit3 ~ Bit2: Slot 9 Bit5 ~ Bit4: Slot 10 Bit7 ~ Bit6: Slot 11

	LED on: 00, LED off: 01, LED slow blinking: 10, LED fast blinking: 11
Byte73 ~ Byte73	Additional blue LED Bit1 ~ Bit0: Slot 12 Bit3 ~ Bit2: Slot 13 Bit5 ~ Bit4: Slot 14 Bit7 ~ Bit6: Slot 15 LED on: 00, LED off: 01, LED slow blinking: 10, LED fast blinking: 11
Byte74 ~ Byte74	Additional blue LED Bit1 ~ Bit0: Slot 16 Bit3 ~ Bit2: Slot 17 Bit5 ~ Bit4: Slot 18 Bit7 ~ Bit6: Slot 19 LED on: 00, LED off: 01, LED slow blinking: 10, LED fast blinking: 11
Byte75 ~ Byte75	Additional blue LED Bit1 ~ Bit0: Slot 20 Bit3 ~ Bit2: Slot 21 Bit5 ~ Bit4: Slot 22 Bit7 ~ Bit6: Slot 23 LED on: 00, LED off: 01, LED slow blinking: 10, LED fast blinking: 11

2.2. SES threshold out / threshold in

It includes only Temperature Sensor and Cooling elements.

Threshold control element format

BYTE/BIT	7	6	5	4	3	2	1	0
0	REQUESTED HIGH CRITICAL THRESHOLD							
1	REQUESTED HIGH WARNING THRESHOLD							
2	REQUESTED LOW WARNING THRESHOLD							
3	REQUESTED LOW CRITICAL THRESHOLD							

Threshold status element format

BYTE/BIT	7	6	5	4	3	2	1	0
0	HIGH CRITICAL THRESHOLD							

1	HIGH WARNING THRESHOLD
2	LOW WARNING THRESHOLD
3	LOW CRITICAL THRESHOLD

2.3. Vendor specific diagnostic out / diagnostic in

2.3.1. Vendor specific out / vendor specific in for I2C access on Backplane

It supports the following commands. Each “Send I2C access command” should be followed by a “Get I2C result”. While issuing another “Send I2C access command” after sending a “Send I2C access command”, you would get error reported. After sending a “Send I2C access command”, a “Cancel I2C access command” should be issued before sending another “Send I2C access command”.

(A) Send I2C access command (the vendor specific out)

(B) Get I2C result (the vendor specific in)

(C) Cancel I2C access command (the vendor specific out)

There are two Vendor specific in formats and two Vendor specific out formats.

Vendor specific in format-1

Byte0 ~ Byte0	Return code for success – 0x0
Byte1 ~ Byte1	read length in bytes
Byte(1+1)~Byte(1+1)	read data-1
…	…
Byte(1+N)~Byte(1+N)	read data-N N can be up to 128

Vendor specific in format-2

Byte0 ~ Byte0	Return code for failure local Bridge PIC failed to read from/write to the target device via I2C – 0x1 local Bridge PIC memory allocation failure – 0x2 Invalid data from local Bridge PIC – 0x3 Expander failed to read from local Bridge PIC via I2C excluding data timeout – 0x4 Expander memory allocation failure – 0x5 No I2C read command sent – 0x6 Data timeout from local Bridge PIC – 0x7

Vendor specific out format-1

Byte0 ~ Byte0	Send I2C access command – 0x0
Byte1 ~ Byte1	I2C slave address

Byte2 ~ Byte2	read length in bytes
Byte3 ~ Byte3	write length in bytes
Byte(3+1)~Byte(3+1)	write data-1
…	…
Byte(3+N)~Byte(3+N)	write data-N N can be up to 128

Vendor specific out format-2

Byte0 ~ Byte0	Cancel I2C access command – 0x1

Example:

Take PMBus for example. The I2C address of the PMBus power module is 0xB2. We try to read the input voltage of the power module. In the specification of the power module, the input voltage is output with a 2-byte format after being written one command byte "0x88" via I2C. The following data (read length = 2 and write length = 1) will be sent via the vendor specific out page.

00 B2 02 01 88

After the vendor specific out page, you can issue the vendor specific in page to get the following data. It's a successful command (0x00), length of data (0x02), and the output data (0x63 and 0xeb).

00 02 63 eb

2.3.2. I2C error / reset statistic

It supports up to 128-byte reading data for I2C error statistic and I2C interface reset count. Each I2C error count consists of 2 consecutive bytes repositioned for Little-endian machines (the low byte first, then the high byte).

Vendor specific in format-1

Byte0 ~ Byte0	Return code for success – 0x0
Byte1 ~ Byte1	0x80
Byte(1+1)~Byte(1+1)	read data-1
…	…
Byte(1+N)~Byte(1+N)	read data-N N is 128

The 5 error counts (writeI2C, readI2C, dataFormat, dataComparison, and

dataTimeout monitored by Expander) consist of the first 10 bytes. The 5 error counts monitored by Expander are described below.

(A) writeI2C: Fail to write I2C

(B) readI2C: Fail to read I2C

(C) dataFormat: Data format read from local Bridge PIC is incorrect

(D) dataComparison: Read local Bridge PIC twice, and compare both data

(E) dataTimeout: Data timeout from local Bridge PIC

The following 110 bytes monitored by Bridge PIC are divided by 11 groups (10 bytes each group). The 5 error counts (BusArbitration, MasterHardware, SlaveResponse, MemoryAllocation, and DataComparison) consist of each 10-byte group. The 11 groups are listed below in order.

Group 1: Backplane temperature sensor 0

Group 2: Backplane temperature sensor 1

Group 3: Backplane temperature sensor 2

Group 4: Backplane PCA9555-0

Group 5: Backplane PCA9555-1

Group 6: Backplane EEPROM

Group 7: Backplane PIC

Group 8: Backplane PMBus

Group 9: IPMB (from Bridge PIC I2C master to Motherboard IPMB I2C slave)

Group 10: Backplane PCA9552

Group 11: Backplane PCA9551

The 5 error counts monitored by Bridge PIC are described below.

(A) BusArbitration: It's nothing to do with the sync GPIO. The error is raised while Bridge PIC fails to start I2C sequence due to the I2C bus signal.

(B) MasterHardware: Error for the I2C master interface like the abnormal interface status after starting I2C sequence, interface transmitter never ready, …

(C) SlaveResponse: Can't get proper response from the I2C slave

(D) MemoryAllocation: Bridge PIC fails to allocate memory for processing I2C access

(E) DataComparison: Read the same I2C slave device twice, and compare both data

The last 8 bytes monitored by Bridge PIC are 4 interface reset counts (I2C master for Backplane, I2C slave for Expander, I2C master for local IPMB, and I2C slave for

remote IPMB).

Vendor specific out format-1

Byte0 ~ Byte0	Send I2C access command – 0x0
Byte1 ~ Byte1	0x0
Byte2 ~ Byte2	0x80
Byte3 ~ Byte3	0x0

Example:

To read I2C error statistic and I2C interface reset count, issue the vendor specific out page with the following data.

00 00 80 00

After the vendor specific out page, you can issue the vendor specific in page to get the following data. It's a successful command (0x00), 128 data bytes (0x80), and the output data.

00 80 00 00 00 00 00 00 00 00 00 00 00 00 00 00
00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
00 00

2.4. Vendor specific Bridge I2C out / Bridge I2C in

It supports the following commands. Each "Send I2C access command" should be followed by a "Get I2C result". While issuing another "Send I2C access command" after sending a "Send I2C access command", you would get error reported. After sending a "Send I2C access command", a "Cancel I2C access command" should be issued before sending another "Send I2C access command".

(A) Send I2C access command (the vendor specific out)

(B) Get I2C result (the vendor specific in)

(C) Cancel I2C access command (the vendor specific out)

There are two Vendor specific in formats and two Vendor specific out formats.

Vendor specific in format-1

Byte0 ~ Byte0	Return code for success – 0x0
Byte1 ~ Byte1	read length in bytes
Byte(1+1)~Byte(1+1)	read data-1
…	…
Byte(1+N)~Byte(1+N)	read data-N N can be up to 32

Vendor specific in format-2

Byte0 ~ Byte0	Return code for failure Expander failed to access Bridge I2C slave – 0x4 Expander memory allocation failure – 0x5 No I2C read command sent – 0x6

Vendor specific out format-1

Byte0 ~ Byte0	Send I2C access command – 0x0
Byte1 ~ Byte1	I2C slave address
Byte2 ~ Byte2	read length in bytes
Byte3 ~ Byte3	write length in bytes
Byte(3+1)~Byte(3+1)	write data-1
…	…
Byte(3+N)~Byte(3+N)	write data-N N can be up to 34

Vendor specific out format-2

Byte0 ~ Byte0	Cancel I2C access command – 0x1

Example:

Take Bridge EEPROM for example. The I2C address of Bridge EEPROM is 0xA0. We try to read 32 bytes from the address 0x0020 which is 2 bytes in Bridge EEPROM specification. The following data (read length = 4 and write length = 2) will be sent via the vendor specific out page.

00 A0 04 02 00 20

After the vendor specific out page, you can issue the vendor specific in page to get the following data. It's a successful command (0x00), length of data (0x04), and the 4-bytes output data.

00 04 30 31 32 33

2.5. Vendor specific chassis number out / chassis number in

The chassis number is kept on Byte256 ~ Byte511 of the EEPROM on the chassis backplane. The I2C address of the backplane EEPROM is 0xA0. The length of the chassis number is not more than 247 bytes.

The chassis number is the unit serial number in the VPD (Vital Product Data) page fetched with a SCSI INQUIRY command.

2.5.1. Vendor specific chassis number out

In order to update the chassis number on the backplane EEPROM, the length of the chassis number must be 1 ~ 247 bytes. To invalidate the chassis number, the length should be applied with 0.

Chassis number (0 ~ 247 bytes)

2.5.2. Vendor specific chassis number in

Byte0 ~ Byte0	Valid data: 0x0, invalid data: 0x1
Chassis number or none	Chassis number (1 ~ 247 bytes) for valid data, none for invalid data

2.6. Vendor specific Expander PWM out / Expander PWM in

2.6.1. Vendor specific Expander PWM out

It can be used to control the following items.

- Enable/disable Motherboard temperature reading for Bridge PIC's fan control
- Change CPU0 thermal margin settings - T1, T2, T3, and T4
- Change CPU1 thermal margin settings - T1, T2, T3, and T4
- Change DIMM thermal margin settings - T1, T2, T3, and T4
- Change local or remote PWM output manually (%)
- Change Expander on-die temperature settings - T1, T2, T3, and T4

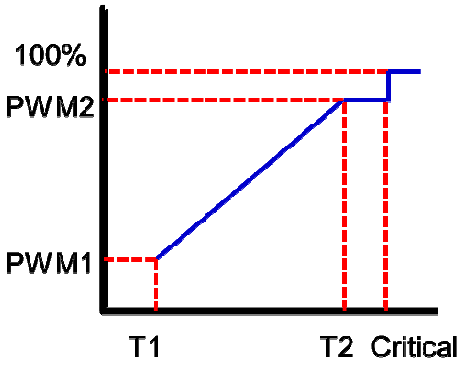
Expander PWM out format

Byte0 ~ Byte0	Enable/disable Motherboard temperature reading for Bridge PIC's fan control No change – other than 0x0 and 0x1

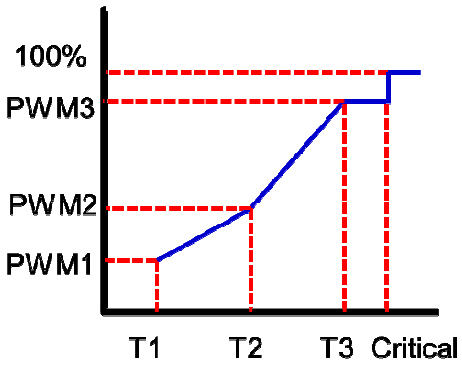
	Enable – 0x1 Disable – 0x0
Byte1 ~ Byte10	CPU0 thermal margin parameters (in Celsius): T1, T2, T3, T4, PWM1 (%), PWM2 (%), PWM3 (%), PWM4 (%), warning threshold, critical threshold No change – all 0x0 The change will take effect after expander reset.
Byte11 ~ Byte20	CPU1 thermal margin parameters (in Celsius): T1, T2, T3, T4, PWM1 (%), PWM2 (%), PWM3 (%), PWM4 (%), warning threshold, critical threshold No change – all 0x0 The change will take effect after expander reset.
Byte21 ~ Byte30	DIMM thermal margin parameters (in Celsius) shared by all DIMMs: T1, T2, T3, T4, PWM1 (%), PWM2 (%), PWM3 (%), PWM4 (%), warning threshold, critical threshold No change – all 0x0 The change will take effect after expander reset.
Byte31 ~ Byte31	Change local or remote PWM output manually (%) No change – 0xFF Local PWM control – Bit7 = 0 Remote PWM control – Bit7 = 1 Manual PWM output (%) – Bit6 ~ Bit0 (invalid if its value is more than 100)
Byte32 ~ Byte41	Expander on-die temperature parameters (in Celsius): T1, T2, T3, T4, PWM1 (%), PWM2 (%), PWM3 (%), PWM4 (%), warning threshold, critical threshold No change – all 0x0 The change will take effect after expander reset.

Smart fan curves below for expander and motherboard sensors are supported.

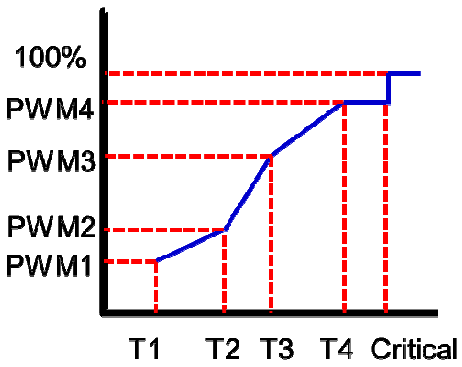
(1) Use T1, T2, PWM1 (%), and PWM2 (%) for the curve. The other settings include T3=0, T4=0, PWM3=0, and PWM4=0.



(2) Use T1, T2, T3, PWM1 (%), PWM2 (%), and PWM3 (%) for the curve. The other settings include T4=0 and PWM4=0.



(3) Use T1, T2, T3, T4, PWM1 (%), PWM2 (%), PWM3 (%), and PWM4 (%) for the curve.



2.6.2. Vendor specific Expander PWM in

It can provide status of the following items.

- Setting of Motherboard temperature reading for Bridge PIC's fan control

- Unsuccessful read count for CPU0, CPU1, and DIMM
- CPU0/CPU1/DIMM thermal margin reading and its status
- CPU0 thermal margin settings - T1, T2, T3, and T4
- CPU1 thermal margin settings - T1, T2, T3, and T4
- DIMM thermal margin settings - T1, T2, T3, and T4
- Current local PWM output (%)
- Expander on-die temperature settings - T1, T2, T3, and T4

Expander PWM in format

Byte0 ~ Byte0	Setting of Motherboard temperature reading for Bridge PIC's fan control Reading failure – 0xFF Enable – 0x1 Disable – 0x0
Byte1 ~ Byte1	Unsuccessful read count for CPU0, CPU1, and DIMM Reading failure – 0xFF Reported range: 0x0 ~ 0x64 If 0x64 is reported, the fan runs at full speed when Motherboard temperature reading for Bridge PIC's fan control is enabled.
Byte2 ~ Byte2	CPU0 thermal margin reading
Byte3 ~ Byte3	Status of CPU0 thermal margin reading No successful reading – 0xFF All BMC Event Messages disabled from this sensor – Bit7 = 0 Sensor scanning disabled – Bit6 = 0 Reading/state unavailable – Bit5 = 1
Byte4 ~ Byte4	CPU1 thermal margin reading
Byte5 ~ Byte5	Status of CPU1 thermal margin reading No successful reading – 0xFF All BMC Event Messages disabled from this sensor – Bit7 = 0 Sensor scanning disabled – Bit6 = 0 Reading/state unavailable – Bit5 = 1
Byte6 ~ Byte6	DIMM1 thermal margin reading
Byte7 ~ Byte7	Status of DIMM1 thermal margin reading No successful reading – 0xFF All BMC Event Messages disabled from this sensor – Bit7 = 0

	Sensor scanning disabled – Bit6 = 0 Reading/state unavailable – Bit5 = 1
Byte8 ~ Byte8	DIMM2 thermal margin reading
Byte9 ~ Byte9	Status of DIMM2 thermal margin reading No successful reading – 0xFF All BMC Event Messages disabled from this sensor – Bit7 = 0 Sensor scanning disabled – Bit6 = 0 Reading/state unavailable – Bit5 = 1
Byte10 ~ Byte10	DIMM3 thermal margin reading
Byte11 ~ Byte11	Status of DIMM3 thermal margin reading No successful reading – 0xFF All BMC Event Messages disabled from this sensor – Bit7 = 0 Sensor scanning disabled – Bit6 = 0 Reading/state unavailable – Bit5 = 1
Byte12 ~ Byte12	DIMM4 thermal margin reading
Byte13 ~ Byte13	Status of DIMM3 thermal margin reading No successful reading – 0xFF All BMC Event Messages disabled from this sensor – Bit7 = 0 Sensor scanning disabled – Bit6 = 0 Reading/state unavailable – Bit5 = 1
Byte14 ~ Byte23	CPU0 thermal margin parameters (in Celsius): T1, T2, T3, T4, PWM1 (%), PWM2 (%), PWM3 (%), PWM4 (%), warning threshold, critical threshold
Byte24 ~ Byte33	CPU1 thermal margin parameters (in Celsius): T1, T2, T3, T4, PWM1 (%), PWM2 (%), PWM3 (%), PWM4 (%), warning threshold, critical threshold
Byte34 ~ Byte43	DIMM thermal margin parameters (in Celsius) shared by all DIMMs: T1, T2, T3, T4, PWM1 (%), PWM2 (%), PWM3 (%), PWM4 (%), warning threshold, critical threshold
Byte44 ~ Byte44	Current local PWM output (%) Reading failure – 0xFF
Byte45 ~ Byte54	Expander on-die temperature parameters (in Celsius): T1, T2, T3, T4, PWM1 (%), PWM2 (%), PWM3 (%), PWM4 (%), warning threshold, critical threshold

2.7. Bezel I2C access through Backplane PIC

Use Vendor specific diagnostic in/diagnostic out formats to access Backplane PIC (0x30), and follow the formats below to access Bezel I2C. Please follow three steps below.

(1) Issue a Bezel I2C access command with the following format which supports I2C read command with up to 16 bytes, I2C write command with up to 16 bytes, and I2C write-read command with up to 16 bytes for read and 8 bytes for write.

Bezel I2C access command format

Backplane PIC address	Description
0x80	I2C command state If the "0xFF" (busy on processing the command) is reported, this field is not changeable. Command trigger – 0x0
0x81	I2C channel The channels supported are 0x3 and 0x4.
0x82	Bezel I2C 7-bit slave address
0x83	Read bytes (up to 16 bytes)
0x84	Write bytes Up to 16 bytes for I2C write command, and up to 8 bytes for I2C write-read command.
0x85 ~ 0x94	Write Data

(2) Get the status of the Bezel I2C access command issued.

Bezel I2C command status format

Backplane PIC address	Description
0x80	I2C command state Status reported: Format error – 0x33 Successful – 0x55 Error on processing the command – 0xAA I2C bus error – 0xCC

	Busy on processing the command – 0xFF

(3) Get the read data for I2C read command and I2C write-read command.

Bezel I2C read data format

Backplane PIC address	Description
0xA0 ~ 0xAF	Read Data

3. SES Elements

- 02h - Power Supply
  Number of possible elements: 2
- 03h - Cooling (it is not supported while the number of elements is 0)
  Number of possible elements: 0, 4, or 8 (it depends on the jumper setting of Bridge board)
- 04h - Temperature Sensor
  Number of possible elements: 4
- 0Eh - Enclosure
  Number of possible elements: 1
- 17h - Array Device
  Number of possible elements: 24

4. Implementation on SES Elements

Only the fields highlighted in green are supported.

4.1. Power Supply Element

4.1.1. Power Supply Control Element

BYTE/BIT	7	6	5	4	3	2	1	0
0	COMMON CONTROL							
	SELECT	PRDFAIL	DISABLE	RST SWAP	Reserved			
1	RQST IDENT	Reserved						
2	Reserved							
3	Reserved	RQST FAIL	RQST ON	Reserved				

4.1.2. Power Supply Status Element

BYTE/BIT	7	6	5	4	3	2	1	0
0	COMMON STATUS							
	Reserved	PRDFAIL	DISABLED	SWAP	ELEMENT STATUS CODE			
1	IDENT	Reserved						
2	Reserved				DC OVER VOLTAGE	DC UNDER VOLTAGE	DC OVER CURRENT	Reserved
3	HOT SWAP	FAIL	RQSTED ON	OFF	OVERTMP FAIL	TEMP WARN	AC FAIL	DC FAIL

Field	Value
ELEMENT STATUS CODE	OK: No failure or warning conditions detected CRITICAL: FAIL bit is set due to one or more failure condition UNKNOWN: Can't get information from Bridge MCU
FAIL	A failure condition is detected
AC FAIL	A failure condition is detected
DC FAIL	A failure condition is detected

4.2. Cooling Element

4.2.1. Cooling Control Element

BYTE/BIT	7	6	5	4	3	2	1	0
0	COMMON CONTROL							
	SELECT	PRDFAIL	DISABLE	RST SWAP	Reserved			
1	RQST IDENT	Reserved						
2	Reserved							
3	Reserved	RQST FAIL	RQST ON	Reserved		REQUESTED SPEED CODE		

Field	Value
RQST IDENT	Please refer to section "SES Element Control Functions" for details.
REQUESTED SPEED CODE	Please refer to section "SES Element Control Functions" for details.

4.2.2. Cooling Status Element

BYTE/BIT	7	6	5	4	3	2	1	0
0	COMMON STATUS							
	Reserved	PRDFAIL	DISABLED	SWAP	ELEMENT STATUS CODE			
1	IDENT	Reserved				ACTUAL FAN SPEED (MSB)		
2	ACTUAL FAN SPEED (LSB)							
3	HOT SWAP	FAIL	RQSTED ON	OFF	Reserved	ACTUAL SPEED CODE		

Field	Value
ELEMENT STATUS CODE	OK: Everything is Ok NON-CRITICAL: If either warning limit is exceeded CRITICAL: If either failure limit is exceeded UNKNOWN: Can't get information from Bridge MCU
IDENT	Applicable only for Cooling element 0 and Cooling element 4 0: Enable the smart fan function 1: Disable the smart fan function
ACTUAL FAN SPEED	Current fan RPM
FAIL	The fan RPM can't be detected or equal to 0
ACTUAL SPEED CODE	000b: Stopped. Current RPM $=$ 0 001b: Lowest speed. 0 $<$ Current RPM $\leqq$ 5000 010b: Second lowest speed. 5000 $<$ Current RPM $\leqq$ 7000 011b: Third lowest speed. 7000 $<$ Current RPM $\leqq$ 9000 100b: Intermediate speed. 9000 $<$ Current RPM $\leqq$ 11000 101b: Third highest speed. 11000 $<$ Current RPM $\leqq$ 13000 110b: Second highest speed. 13000 $<$ Current RPM $\leqq$ 15000 111b: Highest speed. 15000 $<$ Current RPM

4.3. Temperature Sensor Element

4.3.1. Temperature Sensor Control Element

BYTE/BIT	7	6	5	4	3	2	1	0
0	COMMON CONTROL							
	SELECT	PRDFAIL	DISABLE	RST SWAP	Reserved			
1	RQST IDENT	RQST FAIL	Reserved					
2	Reserved							
3	Reserved							

4.3.1. Temperature Sensor Status Element

BYTE/BIT	7	6	5	4	3	2	1	0
0	COMMON STATUS							
	Reserved	PRDFAIL	DISABLED	SWAP	ELEMENT STATUS CODE			
1	IDENT	FAIL	Reserved					
2	TEMPERATURE							
3	Reserved				OT FAILURE	OT WARNING	UT FAILURE	UT WARNING

Field	Value
ELEMENT STATUS CODE	OK: Everything is Ok NON-CRITICAL: If either warning limit is exceeded CRITICAL: If either failure limit is exceeded UNKNOWN: Can't get information from Bridge MCU
FAIL	A warning or failure condition is detected
TEMPERATURE	Temperature reading
OT FAILURE	Temperature has exceeded the failure high threshold value
OT WARNING	Temperature has exceeded the warning high threshold value
UT FAILURE	Temperature is below the failure low threshold value
UT WARNING	Temperature is below the warning low threshold value

4.4. Enclosure Element

4.4.1. Enclosure Control Element

BYTE/BIT	7	6	5	4	3	2	1	0
0	COMMON CONTROL							
	SELECT	PRDFAIL	DISABLE	RST SWAP	Reserved			
1	RQST IDENT	Reserved						
2	POWER CYCLE REQUEST	POWER CYCLE DELAY						
3	POWER OFF DURATION						REQUEST FAILURE	REQUEST WARNING

4.4.2. Enclosure Status Element

BYTE/BIT	7	6	5	4	3	2	1	0

0	COMMON STATUS						
	Reserved	PRDFAIL	DISABLED	SWAP	ELEMENT STATUS CODE		
1	IDENT	Reserved					
2	TIME UNTIL POWER CYCLE					FAILURE INDICATION	WARNING INDICATION
3	REQUEST POWER OFF DURATION					FAILURE REQUESTED	WARNING REQUESTED

Field	Value
ELEMENT STATUS CODE	OK

4.5. Array Device Element

4.5.1. Array Device Control Element

BYTE/BIT	7	6	5	4	3	2	1	0
0	COMMON CONTROL							
	SELECT	PRDFAIL	DISABLE	RST SWAP	Reserved			
1	RQST OK	RQST RSVD DEVICE	RQST HOT SPARE	RQST CONS CHECK	RQST IN CRIT ARRAY	RQST IN FAILED ARRAY	RQST REBULD/ REMAP	RQST R/R ABORT
2	RQST ACTIVE	DO NOT REMOVE	Reserved	RQST MISSING	RQST INSERT	RQST REMOVE	RQST IDENT	Reserved
3	Reserved		RQST FAULT	DEVICE OFF	ENABLE BYP A	ENABLE BYP B	Reserved	

Field	Value
PRDFAIL	Please refer to section “SES Element Control Functions” for details.
RQST OK	Please refer to section “SES Element Control Functions” for details.
RQST RSVD DEVICE	Please refer to section “SES Element Control Functions” for details.
RQST HOT SPARE	Please refer to section “SES Element Control Functions” for details.
RQST CONS CHECK	Please refer to section “SES Element Control Functions” for details.
RQST IN CRIT ARRAY	Please refer to section “SES Element Control Functions” for details.

RQST IN FAILED ARRAY	Please refer to section “SES Element Control Functions” for details.
RQST REBUILD/REMAP	Please refer to section “SES Element Control Functions” for details.
RQST R/R ABORT	Please refer to section “SES Element Control Functions” for details.
RQST ACTIVE	Please refer to section “SES Element Control Functions” for details.
DO NOT REMOVE	Please refer to section “SES Element Control Functions” for details.
RQST MISSING	Please refer to section “SES Element Control Functions” for details.
RQST INSERT	Please refer to section “SES Element Control Functions” for details.
RQST REMOVE	Please refer to section “SES Element Control Functions” for details.
RQST IDENT	Please refer to section “SES Element Control Functions” for details.
RQST FAULT	Please refer to section “SES Element Control Functions” for details.
DEVICE OFF	Please refer to section “SES Element Control Functions” for details.

4.5.2. Array Device Status Element

BYTE/BIT	7	6	5	4	3	2	1	0
0	COMMON STATUS							
	Reserved	PRDFAIL	DISABLED	SWAP	ELEMENT STATUS CODE			
1	OK	RSVD DEVICE	HOT SPARE	CONS CHK	IN CRIT ARRAY	IN FAILED ARRAY	REBUILD/ REMAP	R/R ABORT
2	APP CLIENT BYPASSED A	DO NOT REMOVE	ENCLOSURE BYPASSED A	ENCLOSURE BYPASSED B	READY TO INSERT	RMV	IDENT	REPORT
3	APP CLIENT BYPASSED B	FAULT SENSED	FAULT REQSTD	DEVICE OFF	BYPASSED A	BYPASSED B	DEVICE BYPASSED A	DEVICE BYPASSED B

Field	Value
PRDFAIL	Set by the PRDFAIL on Array Device Control Element

ELEMENT STATUS CODE	OK: A drive is detected in the slot NOT INSTALLED: No drive is installed in the slot
OK	Set by the RQST OK on Array Device Control Element
RSVD DEVICE	Set by the RQST RSVD DEVICE on Array Device Control Element
HOT SPARE	Set by the RQST HOT SPARE on Array Device Control Element
CONS CHK	Set by the RQST CONS CHECK on Array Device Control Element
IN CRIT ARRAY	Set by the RQST IN CRIT ARRAY on Array Device Control Element
IN FAILED ARRAY	Set by the RQST IN FAILED ARRAY on Array Device Control Element
REBUILD/REMAP	Set by the RQST REBUILD/REMAP on Array Device Control Element
R/R ABORT	Set by the RQST R/R ABORT on Array Device Control Element
DO NOT REMOVE	Set by the DO NOT REMOVE on Array Device Control Element
READY TO INSERT	Set by the RQST INSERT on Array Device Control Element
RMV	Set by the RQST REMOVE on Array Device Control Element
IDENT	Set by the RQST IDENT on Array Device Control Element
FAULT REQSTD	Set by the RQST FAULT on Array Device Control Element
DEVICE OFF	Set by the DEVICE OFF on Array Device Control Element

5. SES Element Control Functions

5.1. LED indicators (green and red) associated with an attached disk drive

Array Device Slot control element

BYTE/BIT	7	6	5	4	3	2	1	0
0	COMMON CONTROL							
	SELECT	PRDFAIL	DISABLE	RST SWAP	Reserved			
1	RQST OK	RQST RSVD DEVICE	RQST HOT SPARE	RQST CONS CHECK	RQST IN CRIT ARRAY	RQST IN FAILED ARRAY	RQST REBULD/ REMAP	RQST R/R ABORT
2	RQST ACTIVE	DO NOT REMOVE	Reserved	RQST MISSING	RQST INSERT	RQST REMOVE	RQST IDENT	Reserved
3	Reserved		RQST FAULT	DEVICE OFF	ENABLE BYP A	ENABLE BYP B	Reserved	

The default behavior for green LED is “LED is on when the disk is not busy, and off when the disk is executing a command”. When the “RQST IDENT” bit is set, the green LED overwrites its default behavior with a slow blink while the red LED is off. The green LED is set “Activity” for not overwriting its default behavior.

Slot Control Bit	Green LED	Red LED
RQST OK	Activity	OFF
RQST RSVD DEVICE	Activity	OFF
RQST HOT SPARE	Activity	OFF
RQST CONS CHECK	Activity	Fast blink
RQST IN CRIT ARRAY	Activity	Slow blink
RQST IN FAILED ARRAY	Activity	Slow blink
RQST REBUILD/REMAP	Activity	Fast blink
RQST R/R ABORT	Activity	Slow blink
RQST ACTIVE	Activity	OFF
DO NOT REMOVE	Activity	OFF
RQST MISSING	ON	ON
RQST INSERT	Activity	Slow blink
RQST REMOVE	Activity	Slow blink
RQST IDENT	Slow blink	OFF
RQST FAULT	ON	ON
DEVICE OFF	OFF	OFF
PRDFAIL	Activity	Slow blink

5.2. How to turn on/off the power of a drive slot

Array Device Slot control element

BYTE/BIT	7	6	5	4	3	2	1	0
0	COMMON CONTROL							
	SELECT	PRDFAIL	DISABLE	RST SWAP	Reserved			
1	RQST OK	RQST RSVD DEVICE	RQST HOT SPARE	RQST CONS CHECK	RQST IN CRIT ARRAY	RQST IN FAILED ARRAY	RQST REBULD/ REMAP	RQST R/R ABORT
2	RQST ACTIVE	DO NOT REMOVE	Reserved	RQST MISSING	RQST INSERT	RQST REMOVE	RQST IDENT	Reserved
3	Reserved		RQST FAULT	DEVICE OFF	ENABLE BYP A	ENABLE BYP B	Reserved	

The "DEVICE OFF" for a drive slot is defined in the bit4, byte3 of the "Array Device Slot control element" in the SES specification. Set the bit to turn off a slot power, and vice versa.

5.3. How to manually change fan speed for local or remote Cooling elements

Cooling control element

BYTE/BIT	7	6	5	4	3	2	1	0
0	COMMON CONTROL							
	SELECT	PRDFAIL	DISABLE	RST SWAP	Reserved			
1	RQST IDENT	Reserved						
2	Reserved							
3	Reserved	RQST FAIL	RQST ON	Reserved		REQUESTED SPEED CODE		

The "RQST IDENT" for Cooling is defined in the bit7, byte1 of the "Cooling control element" in the SES specification. Set "RQST IDENT" bit to disable the smart fan function, and then change fan speed with one of the two methods below. Clear "RQST IDENT" bit to enable the smart fan function again. Please disable the smart fan function before changing fan speed.

(A) The "REQUESTED SPEED CODE" is defined in the bit2 ~ 0, byte3 of the "Cooling control element" in the SES specification. The fan speed for local or remote Cooling elements can be manually changed by setting the "REQUESTED SPEED CODE" bits. Only the Cooling element 0 (for local) and the Cooling element 4 (for remote) support this feature.

REQUESTED SPEED CODE

Code	Description
000b	Leave fan at current speed
001b	Set cooling mechanism to lowest speed
010b	Set cooling mechanism to second lowest speed
011b	Set cooling mechanism to third lowest speed
100b	Set cooling mechanism to intermediate speed
101b	Set cooling mechanism to third highest speed
110b	Set cooling mechanism to second highest speed
111b	Set cooling mechanism to highest speed

(B) Through the Byte1 of the "Vendor specific Expander PWM out" page, the fan speed for local or remote Cooling elements can be changed manually.

6. Online Firmware Update

6.1. Expander firmware and MFG update

(1) Use the open source sg3_utils to perform firmware and MFG update via inband SAS. The sg3_utils is supported by Windows and Linux.

(2) Use LSI xtools, "xflash" to reset the expander chip to activate the new firmware and MFG. via inband SAS.

6.2. PIC firmware update

(1) Force local Bridge PIC to stay in the bootloader mode by sending the "String Out" page.

(2) Use Microchip PIC32 Bootloader Application – PIC32UBL to update firmware, and then run the new firmware. Microchip PIC32UBL is only supported by Windows. Users can develop PIC32 Bootloader Application for Linux based on Microchip PIC32UBL source.

7. Temperature sensor and cooling connector locations

Bridge Board		
Cooling 2/3		Cooling 0/1
Backplane Board		
Temp Sensor-0	Temp Sensor-1	Temp Sensor-2
Drive Bay		
24 Disk Drives		