iMP Series

I2C Programming

Technical Reference Note

Description:

The iMP Protocol is compliant with the PMbus Power System Management Protocol Specification Part I Revision 1.0, and the PMbus Power System Management Protocol Specification Part II Revision 1.0. Note that the PMbus is based on the System Management Bus (SMbus) Specification.

ARTESYN™
EMBEDDED TECHNOLOGIES

For supplementary information regarding the PMbus and SMbus specifications, these documents will be referred to, and are considered part of this protocol:

Ref#1   PMBus™ Power System Management Protocol Specification, Part I

– General Requirements, Transport And Electrical Interface, Revision 1.0

www.powerSIG.org

Ref#2   PMBus™ Power System Management Protocol Specification, Part II

– Command Language, Revision 1.0

www.powerSIG.org

Ref#3   System Management Bus Specification, Revision 1.1

www.sbs-forum.org

Ref#4   System Management Bus (SMBus) Specification, Version 2.0

www.sbs-forum.org

Ref#5   Astec PIC16F87xA I2C Bootloader Interfacing

Ref#6   Astec iMP Module UART Bootloader Interfacing

Ref#7   Astec iMP Case I2C Protocol Revision 16 - 20070130

Technical Reference Note

I2C COMMUNICATION TESTING OF CONFIGURED SMART CASE AND MODULE

Refer to reference document iMP Case I2C Protocol.

1. Turn-ON the power supply to be tested.

The power supply configuration should have **SMART MODULES** installed and given as follows:

SLOT NO.	Model	RATING	Vo	Module Firmware Version
1	73-551-0005i	210W	5V	v2.19
2	73-551-0012i	210W	12V	v2.19
3	73-551-0024i	210W	24V	v2.19
4	73-551-0005i	210W	5V	v2.19
5	73-551-0048i	210W	48V	v2.19
6	73-551-0012i	210W	12V	v2.19
7	73-551-0024i	210W	24V	v2.19

2. Issue UPDATE_WRITE_PROTECT BYTE (Enable All Commands):

Slave Address	: Based on A0, A1, AND A2 (0x3E by default)
Command Code	: 0x10
Data Byte	: 0x00
Transaction Type	: Write Byte

3. Issue VERIFY_WRITE_PROTECT BYTE command:

Slave Address	: Based on A0, A1, AND A2 (0x3E by default)
Command Code	: 0x10
Data Byte	: 0x00
Transaction Type	: Read Byte

Verify enabled commands

GO / NO GO

4. Issue MODULE_AUTO_DETECT command:

Slave Address	: Based on A0, A1, AND A2 (0x3E by default)
Command Code	: 0xD4
Data Byte	: 0x00
Transaction Type	: Send Byte

a. All smart modules inserted detected. GO / NO GO

(see smart module matrix for module details).

If smart modules are not detected, check if all modules are inserted properly and powering-up.

.

VP ELECTRONIQUE - 91300 MASSY - Tel: 01.69.20.08.69 - contact@vpelec.com - www.vpelec.com

Read Smart Modules Information

5. Read module slot (max 7 slots for iMP1, 6 slots for iMP8 and 5 slots for iMP4) information using page command.
Refer to Ref #2, 11.10

a. Issue PAGE 0 (slot 1) command (Supported PMBus Standard command):

Valid Range   : 0 to 7 (max 7 slots for iMP1, 6 slots for iMP8, 5 slots for iMP4)

The iMP PSU can support up to eight different outputs. An internal register serves as an index that can be used by many commands to distinguish between the Modules. This is the Page register, which can be accessed through the Page command. The valid values for the Page register are from zero to seven (0 to 7). At power-up, this value is zero.

b. Issue VERIFY_PAGE command:

Verify and read if PAGE was updated   GO / NO GO

6. Issue EXTRACT_MODULE VERSION command:

Slave Address   : Based on A0, A1, AND A2 (0x3E by default)

Command Code   : 0xDE

Data Byte   : 0x00

Transaction Type   : Send Byte

7. Wait for 40ms delay.

8. Issue READ_MODULE_VERSION command:

Slave Address   : Based on A0, A1, AND A2 (0x3E by default)

Command Code   : 0xDF

Data Byte   : 4 (including the Byte Count)

Transaction Type   : Read block

Data Format: : Byte1 is the Byte Count equal to 3,

                                    Byte2 is the Module Firmware Major Version,

                                    Byte3 is the Module Firmware Minor Version and Byte4 is the **MODULE_POWER_VOLTAGE_RANGE_CODE** (see iMP Case I2C Protocol)

MODULE_POWER_VOLTAGE_RANGE_CODE

This register is stored in the non-volatile memory of the module referenced by the Page, and contains information regarding the rated power of the said module as well as the voltage range of the output.

BIT	FLAG	R/W	DESCRIPTION
3-0	Voltage Range	R Only	These bits describe the range of the module's output voltage. 0000 – 2V to 5.5V 0001 – 6V to 12V 0010 – 14V to 20V 0011 – 24V to 36V 0100 – 42V to 60V
7-4	Power	R Only	These bits describe the rated power of the module. 0000 – 210W 0001 – 360W 0011 – 600W 0100 – 750W

Verify module version information if correct:

    a.   **Version** - module firmware version   GO / NO GO

        (Refer to procedure #1 of this section)

    b.   **Power** - power series type, 210W   GO / NO GO

    c.   **Vrange** - voltage series type   GO / NO GO

        (Refer to procedure #1 of this section)

9. Repeat procedure 5-8 for other slots (PAGE 1-6).   GO / NO GO

(max 7 slots for iMP1, 6 slots for iMP8 and 5 slots for iMP4)

10. Read module slot (max 7 slots for iMP1, 6 slots for iMP8 and 5 slots for iMP4) information using PAGE command. Refer to Ref #2, 11.10

    a.   **Issue PAGE 0 (slot 1) command (Supported PMBus Standard command).**

        Valid Range   : 0 to 7 (max 7 slots for iMP1, 6 slots for iMP8, 5 slots for iMP4)

    b.   **Issue VERIFY_PAGE command:**

        Verify and read if PAGE was updated   GO / NO GO

11. Issue MODULE_MONITOR command:

Slave Address   : Based on A0, A1, AND A2 (0x3E by default)

Command Code: : 0xEA

Transaction Type: : Read Block

Data Bytes: : 8 (including the Byte Count)

Data Format: : Byte1 is the Byte Count equal to 6, for the succeeding bytes,

                                  refer to iMP Case I2C Protocol on the formats of the individual reply data

Reply Format:

Reply Byte	Description	Reference Command
1	Byte Count = 8	
2-3	Output Voltage	READ_VOUT
4-5	Output Current	READ_IOUT
6-7	Module Temperature	READ_TEMPERATURE_3
8	MODULE_STATUS_FLAGS	MODULE_STATUS_FLAGS

READ_VOUT

Direct Data Format:　　　　　　m = 1, b = 0, R = -2 (10mV resolution)

This command returns the output voltage of the module referenced by the current Page.

READ_IOUT

Direct Data Format:　　　　　　m = 1, b = 0, R = -2 (10mA resolution)

This command returns the output current of the module referenced by the current Page.

READ_TEMPERATURE_3

Direct Data Format:　　　　　　m = 1, b = 0, R = 0 (1 degree Celsius resolution)

This command returns the temperature of the module referenced by the current Page.

MODULE_STATUS_FLAGS

This register contains status and fault flags with respect to the module referenced by the current Page.

Note that the flags here represent the real-time status, and therefore does not require a separate command to be reset.

BIT	FLAG	R/W	DESCRIPTION
0	Output Enabled	R Only	This flag reflects the state of the module's operation.
1	UVP Fault	R Only	Module Under voltage condition exists.
2	DC Ok	R Only	Module's output is not within regulation.
3	OCP Fault	R Only	Module Over current fault exists.
4	OTP Fault	R Only	Module Over Temperature condition exists.
5	OTP Warning	R Only	Module's Temperature is near the Temperature Limit.
6	OVP Fault	R Only	Module Over voltage fault detected.
7	System Fault	R Only	General module fault detected.

Verify module information if correct:

a.	**Vout** - measured output DC voltage,	GO / NO GO
	Should be within regulation	
	(Refer to procedure #1 of this section)	
b.	**Iout** - measured output DC current, 0A	GO / NO GO
c.	**Module Temp** - internal ambient temperature	GO / NO GO
d.	**DCOK** - status signal of output voltage within regulation	GO / NO GO

12. Repeat procedure 10-11 for other slots (PAGE 1-6).   GO / NO GO

(max 7 slots for iMP1, 6 slots for iMP8 and 5 slots for iMP4)

Read Smart Case Information

13. Issue CASE_FIRMWARE_VERSION command:

Slave Address	: Based on A0, A1, AND A2 (0x3E by default)
Command Code	: 0xD0
Transaction Type	: Read Block
Data Bytes	: 5
Data Format	: Byte1 is the Byte Count equal to 4
	Byte2 is the Primary Firmware Version
	Byte3 is the Secondary Firmware Major Version in Binary Coded Decimal format (BCD)
	Byte4 is the Secondary Firmware Minor Version in BCD
	Byte5 is the Secondary Firmware Version Branch in BCD

a.	**Primary FW Version** – Refer to Section 5.3 for latest firmware version	GO / NO GO
b.	**Secondary FW Version** - Refer to Section 5.3 for latest firmware version	GO / NO GO

14. Issue PSU_MONITOR command:

Slave Address	: Based on A0, A1, AND A2 (0x3E by default)
Command Code	: 0xE9
Transaction Type	: Read Block
Data Bytes	: 17 (including the Byte Count)
Data Format	: Byte1 is the Byte Count equal to 16, for the succeeding bytes,
	refer to iMP Case I2C Protocol on the formats of the individual reply data

This command will return all the commonly monitored Case data. All the individual data here can be read using separate commands, and has the same formats.

Reply Format:

Reply Byte	Description	Reference Command
1	Byte Count = 16	
2	STATUS_BYTE	STATUS_BYTE
3	CASE_STATUS_BYTE	CASE_STATUS_BYTE
4-5	Input Voltage	READ_VIN
6-7	Input Current	READ_IIN
8-9	TOTAL_POWER	TOTAL_POWER
10-11	PSU Case Temperature	READ_TEMPERATURE_1
12-13	PSU Case Primary Temperature	READ_TEMPERATURE_2
14-15	Fan1 Speed	READ_FAN_SPEED_1
16-17	Fan2 Speed	READ_FAN_SPEED_2

STATUS_BYTE

This device uses the PMbus standard STATUS_BYTE register and all applicable flags. This register reflects all the other faults.

CASE_STATUS_BYTE

Slave Address   : Based on A0, A1, AND A2 (0x3E by default)
Command Code   : 0xD8
Transaction Type: : Read Byte
Data Bytes   : 1
Data Format   : see previous discussion on the CASE_STATUS_BYTE

This register contains flags about the current status of the PSU. Note that the flags here represents the real-time status, and therefore does not require a separate command to be reset.

BIT	FLAG	R/W	DESCRIPTION
0	Inhibit_Enable_0	R Only	These flags mirrors the Control Signal Input state.
1	Inhibit_Enable_1	R Only	
2	AC Ok	R Only	This flag reflects the state of the AC input.
3	Bulk Ok	R Only	This flag reflects the state of the Bulk voltage.
4	Global DC Ok	R Only	This flag reflects the state of all module outputs.
5	Fan1 Ok	R Only	This flag reflects the state of the PSU Fan1.
6	Fan2 Ok	R Only	This flag reflects the state of the PSU Fan2.
7	PS ON	R Only	This flag reflects the state of the PSU operation.

READ_VIN

Direct Data Format   : m = 1, b = 0, R = -2 (10mV resolution)

This command returns the input AC RMS voltage of the PSU.

READ_IIN

Direct Data Format   : m = 1, b = 0, R = -2 (10mA resolution)

This command returns the input current of the PSU.

TOTAL_POWER

Slave Address   : Based on A0, A1, AND A2 (0x3E by default)

Command Code   : 0xD7

Transaction Type   : Read Word

Data Bytes   : 2

Direct Data Format   : m = 1, b = 0, R = 0 (1W resolution)

READ_TEMPERATURE_1

Data Format   : 0.25 degree Celsius resolution, 2's Complement

This command returns the temperature of the PSU Case.

READ_TEMPERATURE_2

Direct Data Format   : m = 1, b = 0, R = 0 (1 degree Celsius resolution)

This command returns the temperature of the PSU primary side.

READ_FAN_SPEED_1

Direct Data Format   : m = 10, b = 0, R = 0 (10 RPM resolution)

This command returns the speed of the PSU Case fan1.

READ_FAN_SPEED_2

Direct Data Format: m = 10, b = 0, R = 0 (10 RPM resolution)

This command returns the speed of the PSU Case fan2.

a.	**Read Primary Temperature (Temperature_2)** -temp in degC		GO / NOGO
b.	**Read Case Ambient Temp (Temperature_1)-**temp in degC		GO / NOGO
c.	**Read Fan Speed** (speed in RPM)		GO / NOGO
d.	**Read Input Voltage** - the input voltage source of the PSU		GO / NOGO
e.	Compare voltage readout versus actual DMM reading		± 5VAC
f.	**Read Input Current** - the input current drawn by the PSU		GO / NOGO
g.	**Read DCOK/ACOK** -status signals good (**GDCOK**)		GO / NOGO

15. Issue PSU_CONFIG command:

Slave Address : Based on A0, A1, AND A2 (0x3E by default)

Command Code : 0XD5

Transaction Type : R/W Byte

Data Bytes : 1

This register is stored in a non-volatile memory (User or Default Configuration Memory), and contains different configuration flags that controls the fan speed, external EEPROM access, and start-up state.

BIT	FLAG	R/W	DESCRIPTION
0	Fan Alarm Disabled	R/W	If this flag is set, fan fault detection is disabled (useful for PSU without fans).
1	Fan Off at Standby	R/W	At standby, fans operate at quiet mode by default. If this flag is set, the fans are turned off at standby mode instead.
2	Fan Direction Reversed	R/W	Fan speed is based on the hottest temperature reading, and reaches the maximum at 50 degrees Celsius. If this flag is set, reverse fan airflow is assumed and fan speed reaches the maximum at 40 degrees Celsius.
3	Full Speed Override*	R/W	If this flag is set, fan speed is set to maximum.
4	Half Speed Override*	R/W	If this flag is set, fan PWM duty is set to half.
5	Fan Voltage Override*	R Only	If this flag is set, fan speed is set according to a requested fan voltage. This flag can be controlled only by use of the **VFAN_1** command.
6	FRU EEPROM Write Enabled	R/W	If this flag is set, external write to the FRU EEPROM is allowed.
7	Startup Operation Mode On	R/W	If this flag is set, the initial value of the **OPERATION** register is set to ON mode.

Note: These fan overrides work in conjunction with the default temperature-based fan control. Whichever results to the highest fan speed will tale control of the fans

15.1 Issue Fan override command:

a.	**Set Fan speed to Half.**		GO / NO GO
	Slave Address : Based on A0, A1, AND A2 (0x3E by default)		
	Command Code : 0XD5		
	Transaction Type : R/W Byte		
	Data Bytes : 0xD0 (Fan speed set to half)		
b.	Issue READ_FAN_SPEED_1/ READ_FAN_SPEED_2	>6660 RPM	GO / NO GO
c.	**Set Fan speed to Full.**		GO / NO GO
	Slave Address : Based on A0, A1, AND A2 (0x3E by default)		
	Command Code : 0XD5		
	Transaction Type : R/W Byte		
	Data Bytes : 0xC8 (Fan speed set to full)		
d.	Issue READ_FAN_SPEED_1/ READ_FAN_SPEED_2	>7800 RPM	GO / NO GO
e.	**Set Fan speed to nominal.**		GO / NO GO
	Slave Address : Based on A0, A1, AND A2 (0x3E by default)		
	Command Code : 0XD5		
	Transaction Type : R/W Byte		
	Data Bytes : 0xC0 (Fan speed set to nominal)		
f.	Issue READ_FAN_SPEED_1/ READ_FAN_SPEED_2	>5760 RPM	GO / NO GO

15.2 Issue Fan Voltage Override command:

VFAN_1

Direct Data Format	: m = 1, b = 0, R = -2 (10mV resolution)
Valid Range	: 6.5 to 12 V, 0 V to disable

This command will set the Fan Override flag in the PSU_CONFIG register and overrides the PSU fan control with
 the requested fan voltage (only if this fan voltage is greater than the expected voltage of the fan control logic, which
is based on the temperature data). If the parameter is zero, the Fan Override flag is disabled.

Slave Address	: Based on A0, A1, AND A2 (0x3E by default)		
Command Code	: 0XD5		
Transaction Type	: R/W Byte		
Data Bytes	: 0xE0 (Enable Fan Voltage Override)		
a.	Issue **VFAN_1** command. Set fan voltage to 8V		GO / NO GO
b.	Issue **READ_FAN_SPEED_1/ READ_FAN_SPEED_2**	>6660 RPM	GO / NO GO
c.	Issue **VFAN_1** command. Set fan voltage to 12V		GO / NO GO
d.	Issue **READ_FAN_SPEED_1/ READ_FAN_SPEED_2**	>7800 RPM	GO / NO GO
e.	Issue **VFAN_1** command. Set fan voltage to 6.5V		GO / NO GO
f.	Issue **READ_FAN_SPEED_1/ READ_FAN_SPEED_2**	>5760 RPM	GO / NO GO

15.3 Issue OPERATION_OFF command (Supported PMBus Standard command):

This device uses only bit 7 of the PMBus standard OPERATION register. The other flags are disregarded.
Refer to Ref #2, 12.1

a.	All modules output voltage goes out of regulation.	GO / NO GO
b.	All modules DCOK reads "**DC FAIL**".	GO / NO GO
c.	All modules PSON status reads "**OFF**".	GO / NO GO
d.	Case DCOK LED blinking	GO / NO GO
e.	Issue **OPERATION_ON** command.	
f.	All modules output voltage within regulation.	

Load Module Pre-defined Settings

16. Read module slot (max 7 slots for iMP1, 6 slots for iMP8 and 5 slots for iMP4) information using PAGE command. Refer to Ref #2, 11.10

    a.   **Issue PAGE 0 (slot 1) command (Supported PMBus Standard command):**
    Valid Range   : 0 to 7 (max 7 slots for iMP1, 6 slots for iMP8, 5 slots for iMP4)

    b.   **Issue VERIFY_PAGE command:**
    Verify and read if PAGE was updated   GO / NO GO

17. Issue **LOAD_PREDEFINED_SETTING** command:

Command Code	: E5h
Transaction Type	: W Byte
Data Bytes	: 1
Data Format	: Parameter Byte is the index to the pre-defined setting stored in the module
Data Range	: refer to the module documentation for valid stored settings index

This command will load an indexed pre-defined setting stored in the module referenced by the current Page. Refer to respective module IPS for details.

    a.   Load Pre-defined Settings 1
    b.   Read Module output voltage   GO / NO GO
        (Should be same as set pre-defined setting)

18. Repeat procedure 17 for Pre-defined Settings 2-7 for same Page.   GO / NO GO

19. Load Pre-defined Default Settings
Read Module output voltage   GO / NO GO
(Should be same as set pre-defined DEFAULT setting - Refer to procedure #1 of this section)

20. Repeat procedure 16-19 for other slots (PAGE 1-6).   GO / NO GO
(max 7 slots for iMP1, 6 slots for iMP8 and 5 slots for iMP4)

21. Turn-off power supply.

Your Power House
VP ELECTRONIQUE