System Power Simplification Utilizing PMBus™ Zone Capabilities

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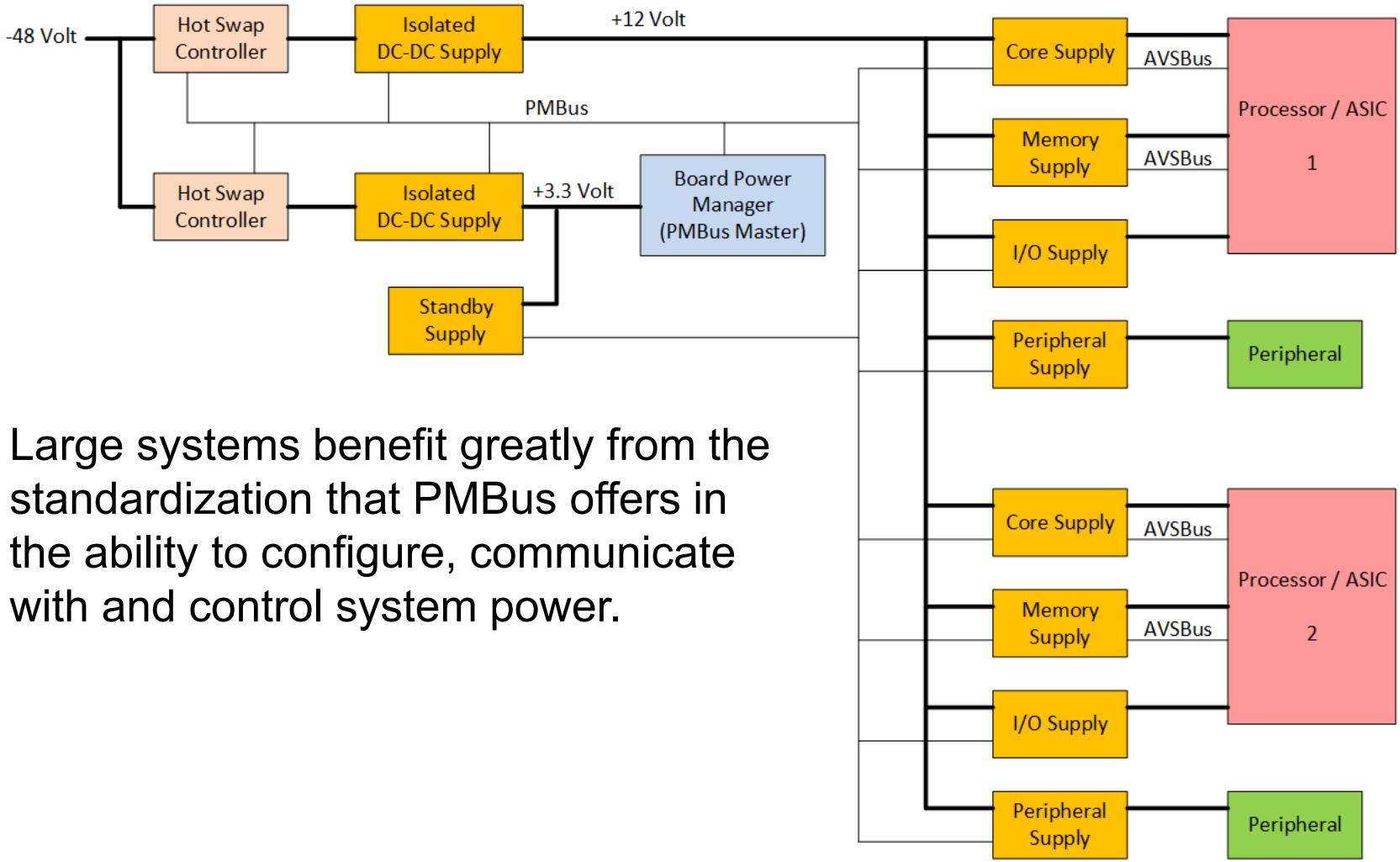
Presentation Overview

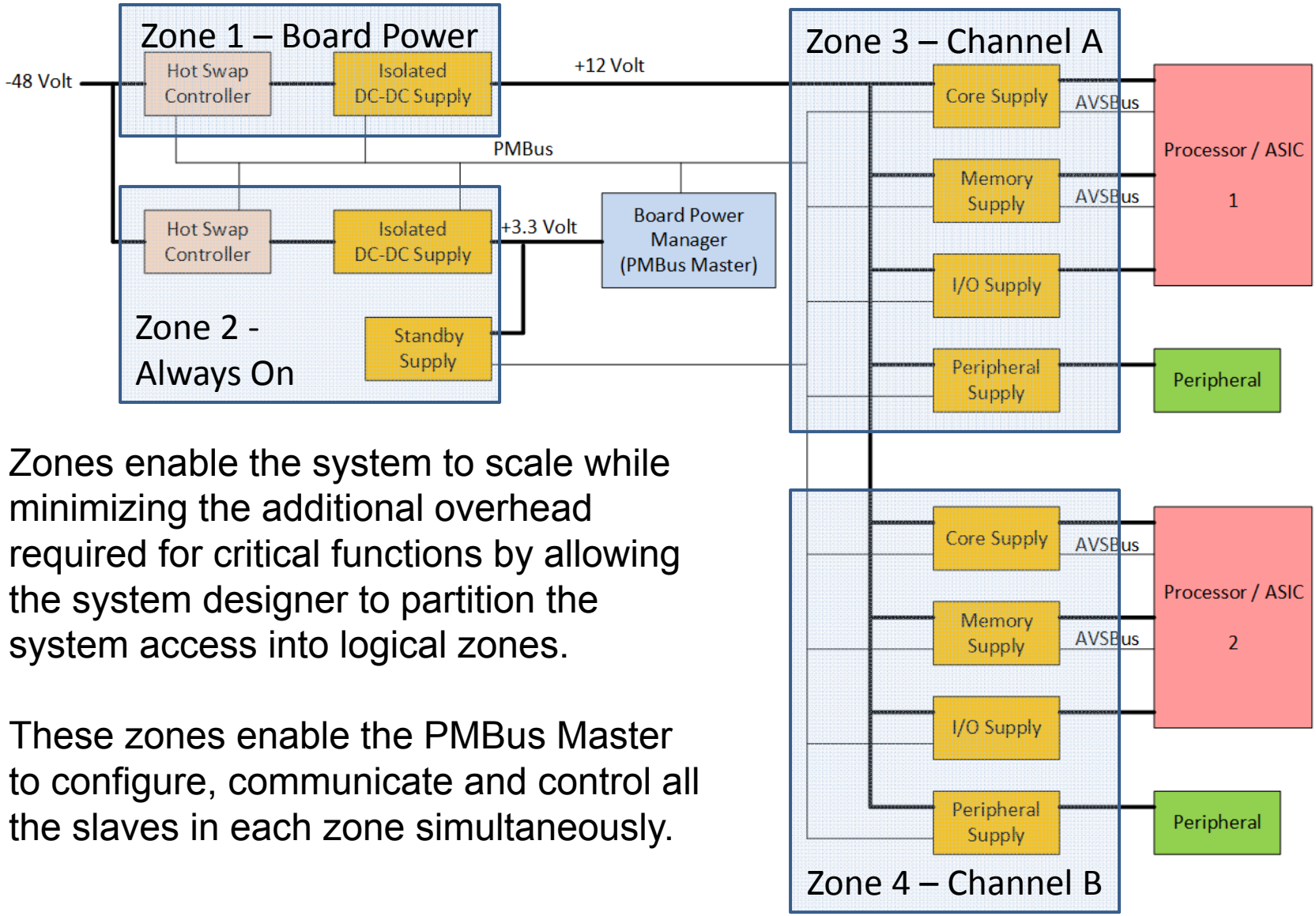
- The Idea of Zoned System Power
- The Infrastructure of Zones in PMBus
- The Implementation of Zones
  - Zone Config
  - Zone Active
  - Zone Read
  - Zone Write
  - Examples

The Idea of Zoned System Power



Large systems benefit greatly from the standardization that PMBus offers in the ability to configure, communicate with and control system power.

The Idea of Zoned System Power



Zones enable the system to scale while minimizing the additional overhead required for critical functions by allowing the system designer to partition the system access into logical zones.

These zones enable the PMBus Master to configure, communicate and control all the slaves in each zone simultaneously.

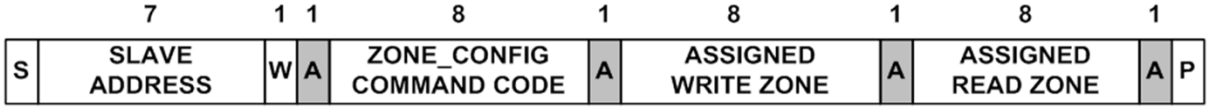
The Infrastructure of Zones

- PMBus 1.3
  - Version 1.3 (18 March 2014) introduced the Zone protocol
    - Part 1 Section 5.6.3 (ZONE_READ and ZONE_WRITE protocols)
    - Part II Section 11.16 (ZONE_CONFIG and ZONE_ACTIVE commands
  - Version 1.3.1 (13 March 2015*)clarified the Zone protocol.
    - Additional verbiage greater clarity.
    - ZONE_CONFIG was simplified for consistency.
- SMBus 3.0 (20 December 2014*)
  - ZONE READ and ZONE WRITE were added to the address space.
- AN001 - *Using The ZONE_READ and ZONE_WRITE Protocols (7 January 2016*)*

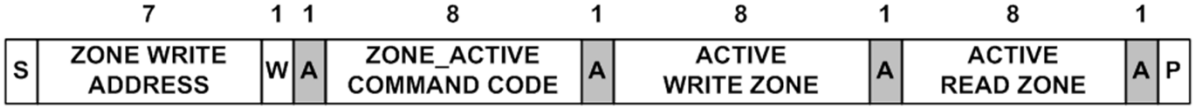
** Current releases*

The Implementation of Zones

- Before a system can utilize the zone protocols:
  - *Every slave in the system must be configured as a member of a zone for reading and a zone for writing using the ZONE_CONFIG command.*



  - *All slaves must be notified as to which zone is "active" using the ZONE_ACTIVE command.*



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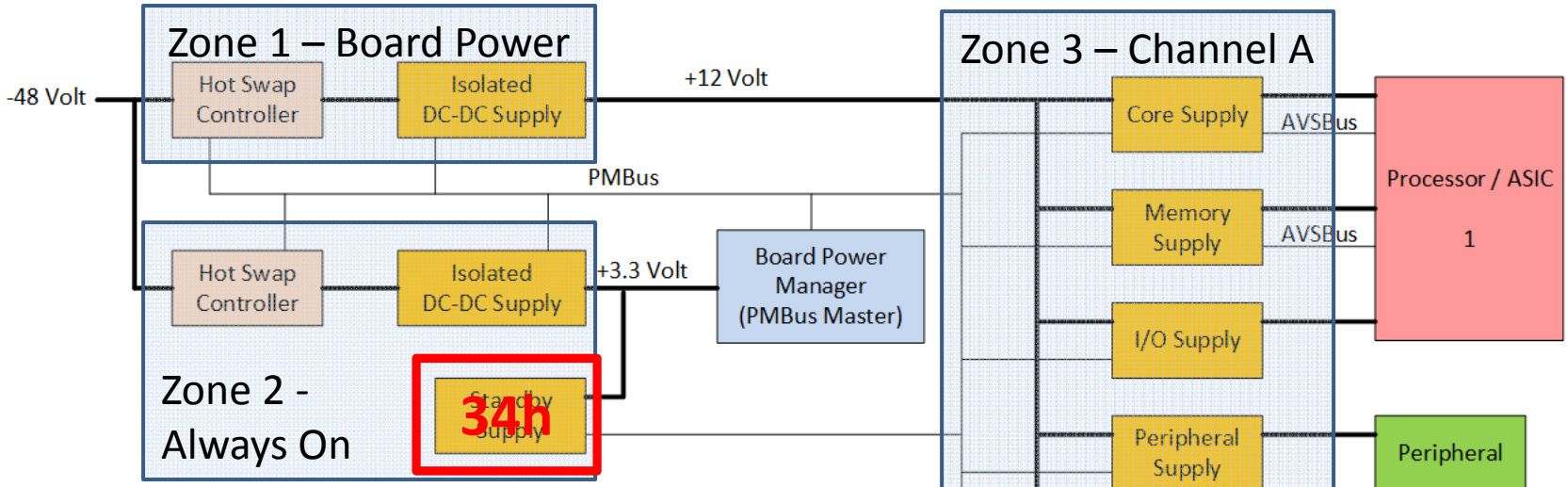
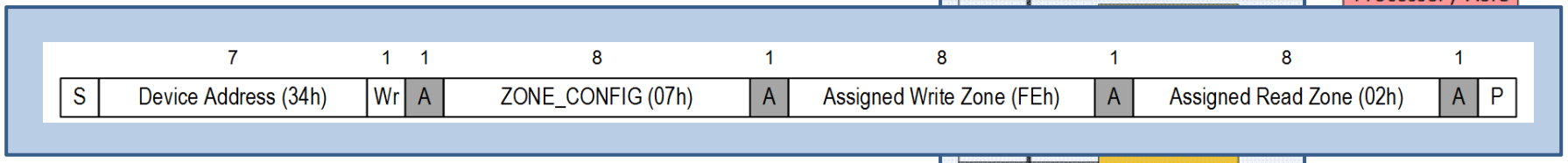
The Implementation of Zones

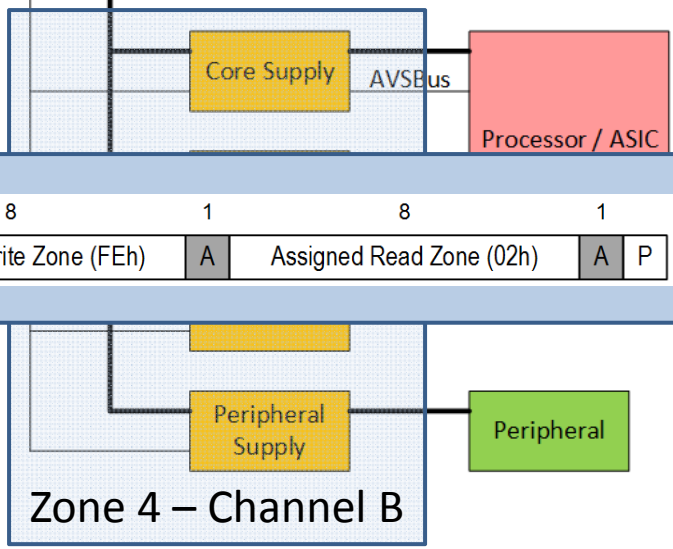


ZONE_CONFIG

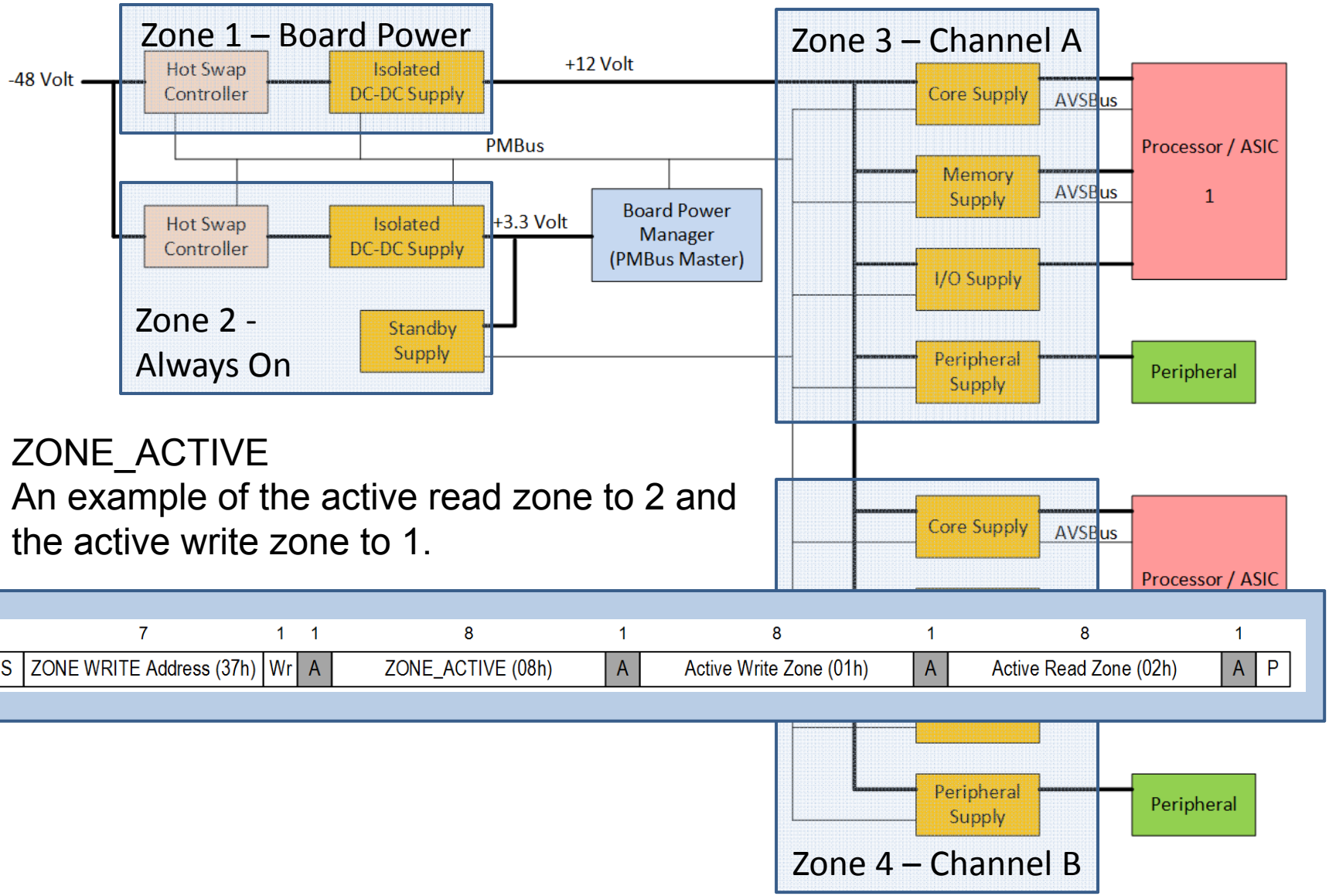
An example of configuring the slave standby supply that is located at PMBus address 34h.



FEh is a special ‘No Zone’ which excludes the slave from all zone operations.



The Implementation of Zones

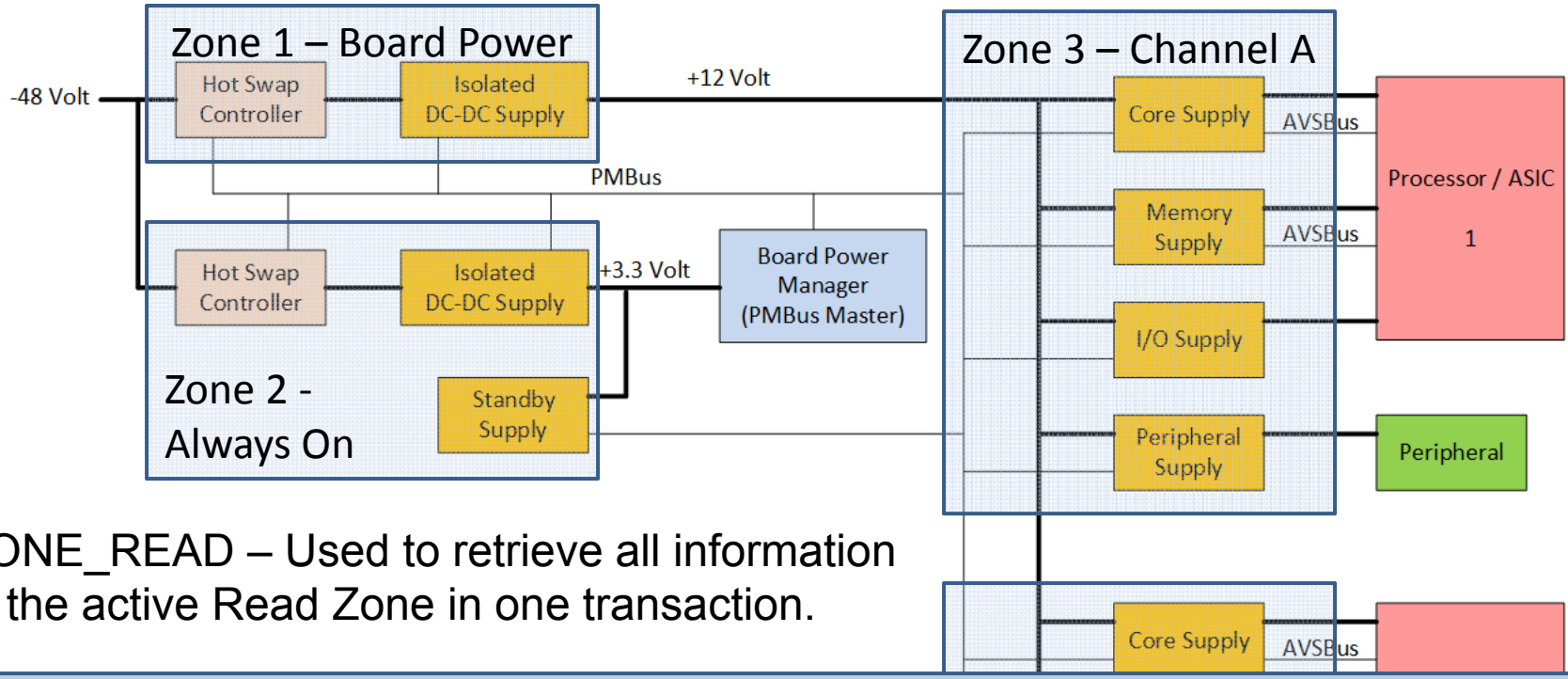


ZONE_ACTIVE

An example of the active read zone to 2 and the active write zone to 1.

7	1	1	8	1	8	1	8	1
S	ZONE WRITE Address (37h)	Wr	A	ZONE_ACTIVE (08h)	A	Active Write Zone (01h)	A	Active Read Zone (02h)	A	P

The Implementation of Zones



ZONE_READ – Used to retrieve all information in the active Read Zone in one transaction.

Start The Zone Read Operation With The Preamble:

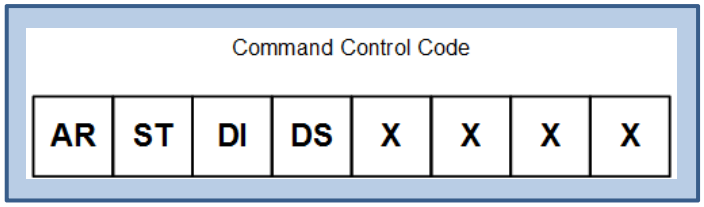
7	1	1	8	1	8	1	
S	ZONE READ Address (28h)	Wr	A	COMMAND CONTROL CODE	A	STATUS MASK or COMMAND	A	...

Continue The Zone Read Operation By Getting Data, Address, And PAGE Number From The First Device To Respond Without Losing Arbitration:

7	1	1	8	1	7	1	1	7	1	1	
Sr	ZONE READ Address (28h)	Wr	A	STATUS or DATA	A	SLAVE ADDRESS	1	A	SLAVE PAGE NUMBER	1	A	...

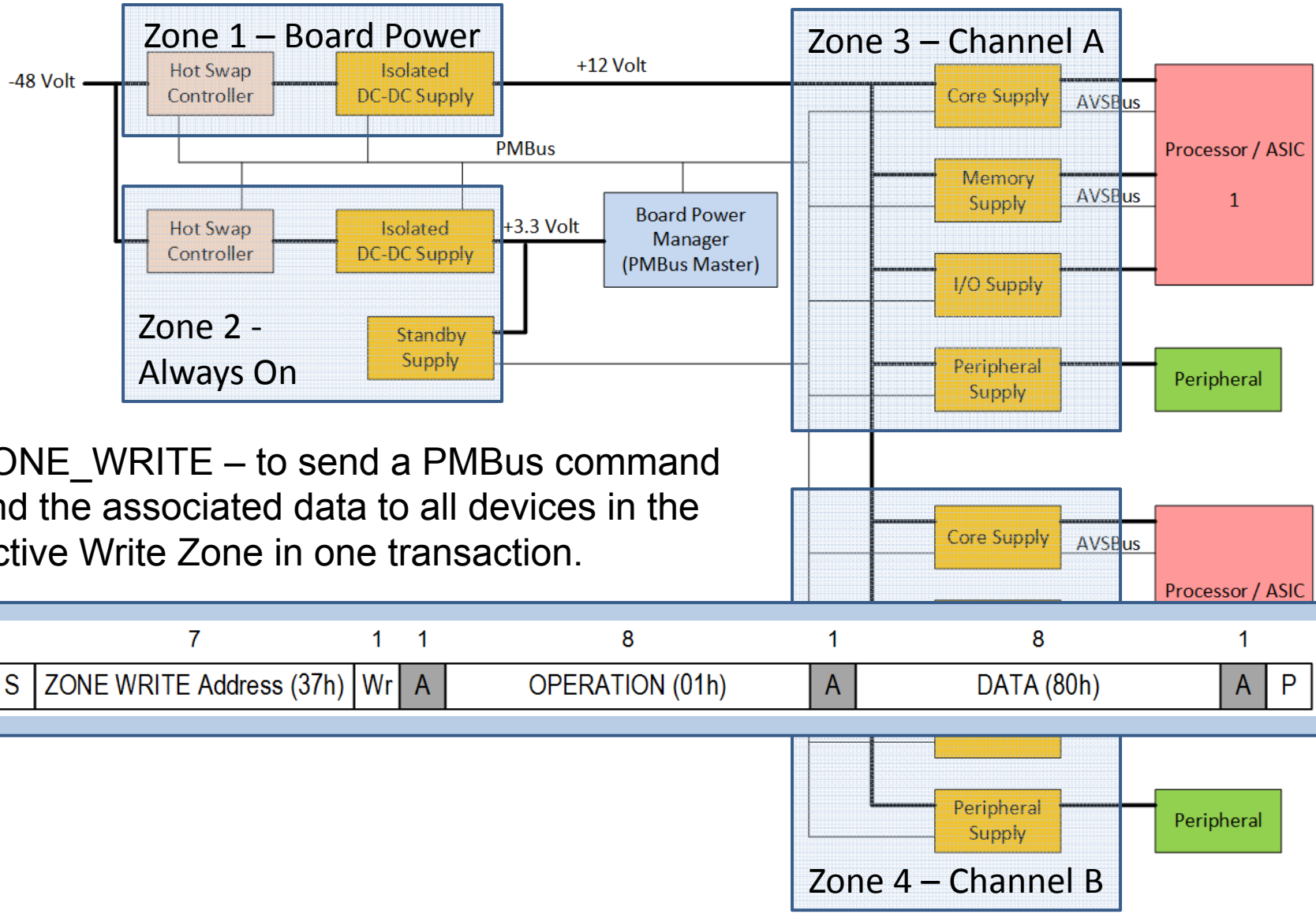
The Implementation of Zones

ZONE_READ – The power of the Command Control Code



- AR: All Respond
  - AR = 0 – All devices respond ONCE with their data and address, but only one will win the bit-wise arbitration.
  - AR = 1 – All devices respond with their data and address to every read to the ZONE_READ address (28h) until they are successful in sending information to the system host or the host sends a STOP.
- ST: Status, governing whether status information or response to a PMBus command is being requested.
- DI: Data Inversion, governing whether the bits in the returned data are bit-wise inverted or not.
- DS: Data Swap/byte order, governing whether data bytes are returned in the SMBus standard least significant byte first or with the most significant byte first.

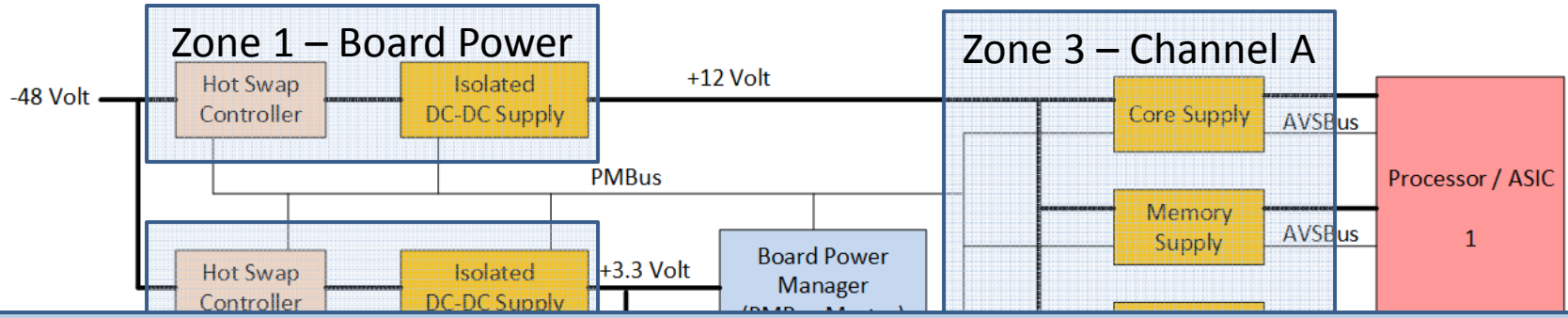
The Implementation of Zones



ZONE_WRITE – to send a PMBus command and the associated data to all devices in the Active Write Zone in one transaction.

7	1	1	8	1	8	1
S	ZONE WRITE Address (37h)	Wr	A	OPERATION (01h)	A	DATA (80h)	A	P

Example - Discovery



Discover the address of all the zone capable devices in the system.

Start The Discovery Process By Setting The Active Read Zone To The All Zone (FFh)

	7	1	1	8	1	8	1	8	1	
S	ZONE WRITE Address (37h)	Wr	A	ZONE_ACTIVE (08h)	A	Active Write Zone (FFh)	A	Active Read Zone (FFh)	A	P

Use The ZONE_READ Command To Get The Address, Page Number, And Status Of All Zone Capable Devices

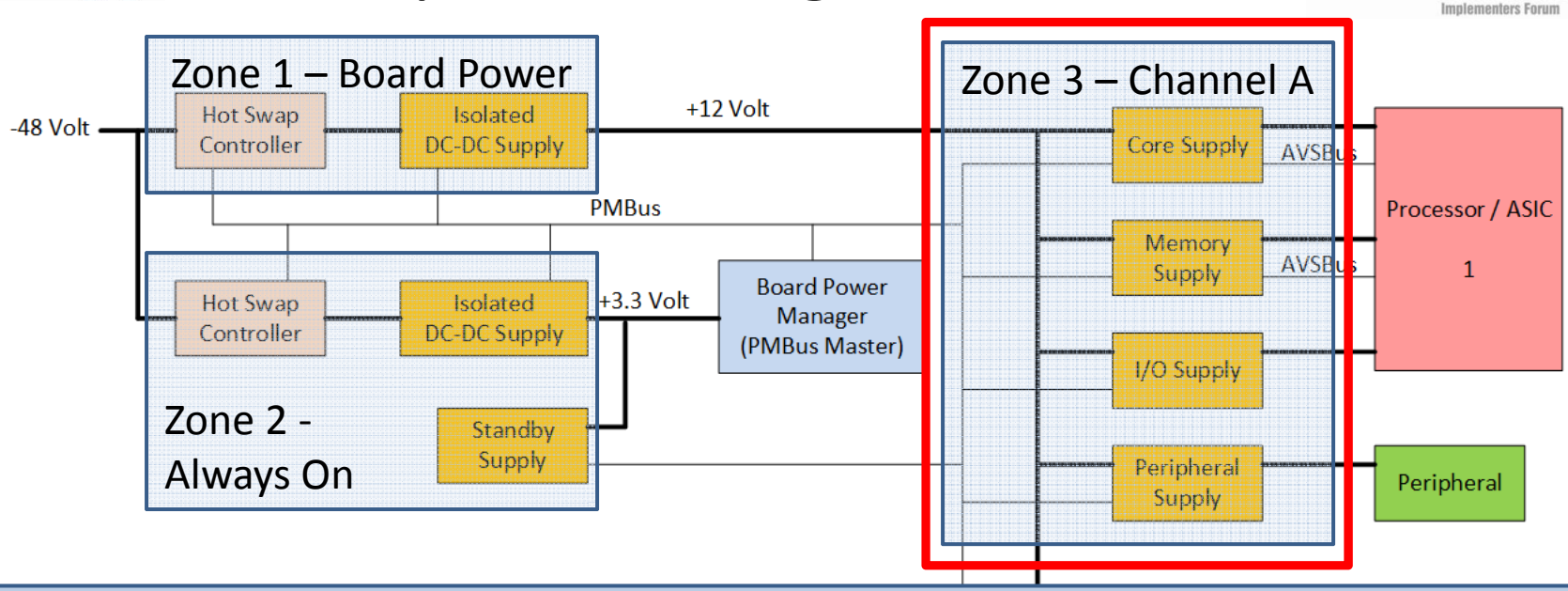
	7	1	1	8	1	8	1	
S	ZONE READ Address (28h)	Wr	A	COMMAND CONTROL CODE (C0h)	A	STATUS MASK (FFh)	A	…

	7	1	1	8	1	7	1	1	
Sr	ZONE READ Address (28h)	R	A	STATUS_WORD[15:8] (00h)	A	SLAVE ADDRESS (27h)	0	A	…

The host continues to issue repeated starts until there is no response.

	7	1	1	
Sr	ZONE READ Address (28h)	R	N	P

Example – Turning on Channel A



Set The Active Write Zone To Channel A (Zone 3 (03h))

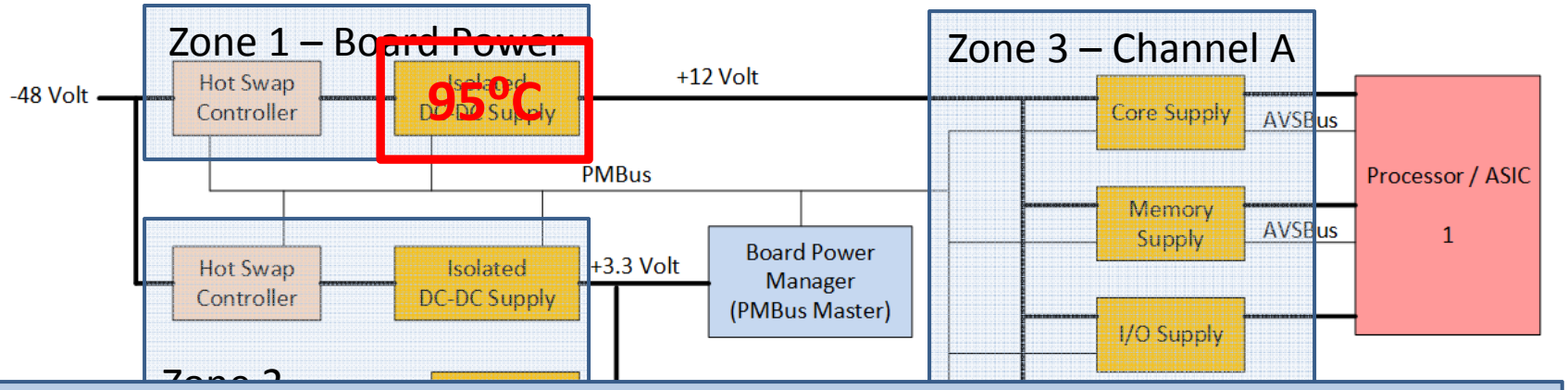
7	1	1	8	1	8	1	8	1	
S	ZONE WRITE Address (37h)	Wr	A	ZONE_ACTIVE (08h)	A	Active Write Zone (03h)	A	Active Read Zone (FFh)	A	P

Use The ZONE_WRITE Command To Set OPERATION to 80h For All Devices In The Active Zone

7	1	1	8	1	8	1	
S	ZONE WRITE Address (37h)	Wr	A	OPERATION (01h)	A	DATA (80h)	A	P

Power On Sequencing Begins With The STOP

Example – Finding the Hottest



Start The Process By Setting The Active Read Zone To The All Zone (FFh)

7	1	1	8	1	8	1	8	1	
S	ZONE WRITE Address (37h)	Wr	A	ZONE_ACTIVE (08h)	A	Active Write Zone (FFh)	A	Active Read Zone (FFh)	A	P

ZONE_READ with CCC set to AR=0;ST=0;DI=1;DS=1 and Issuing READ_TEMPERATURE_1

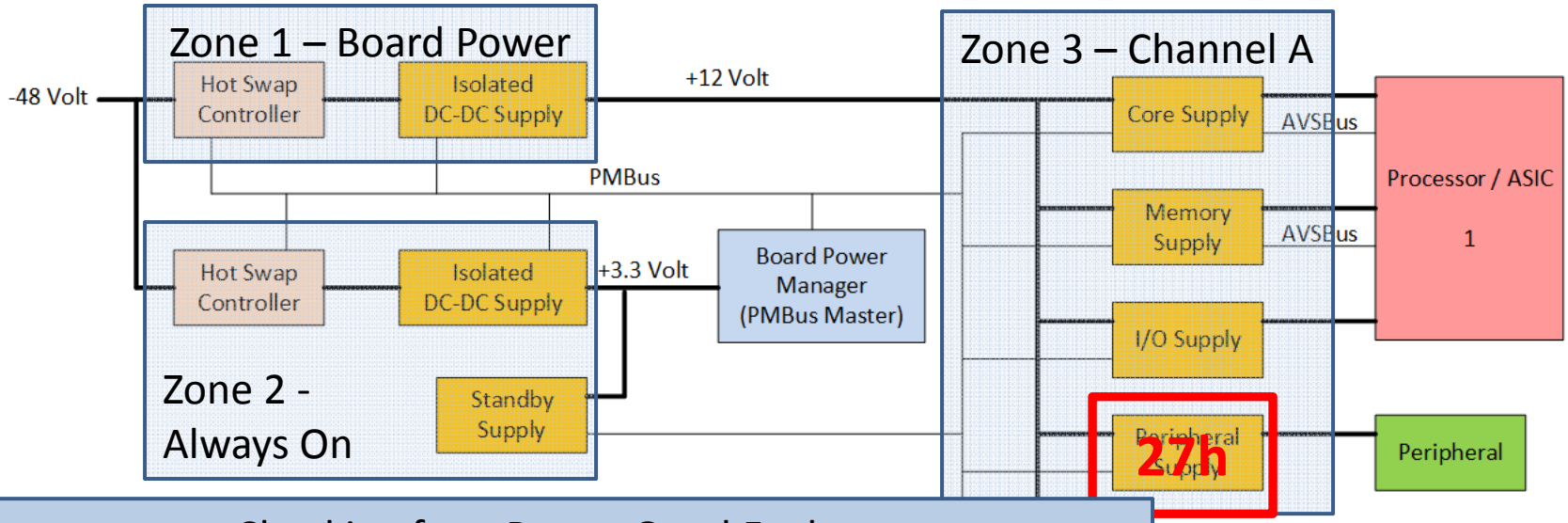
7	1	1	8	1	8	1	
S	ZONE READ Address (28h)	Wr	A	COMMAND CONTROL CODE (30h)	A	READ_TEMPERATURE_1 PMBUS COMMAND CODE (8Dh)	A	...

Read Back The Temperature And Address Of The Highest Temperature in the System

7	1	1	8	1	8	1	
Sr	ZONE READ Address (28h)	R	A	READ_TEMPERATURE_1[15:8] (15h)	A	READ_TEMPERATURE_1[7:0] (07h)	A	...

7	1	1	8	1	
SLAVE ADDRESS (35h)	1	A	SLAVE PAGE NUMBER (00h)	A	P

Example – Finding A Specific Fault



Checking for a Power Good Fault

Assuming the ZONE_READ is set to Channel A (Zone 3 (03h), Start the Zone Read operation masking all but the OFF bit in STATUS_BYTE

7	1	1	8	1	8	1
S	ZONE READ Address (28h)	Wr	A	COMMAND CONTROL CODE (F0h)	A	STATUS MASK (BFh)	A

During the data return the Peripheral Supply (27h) in Zone 3 wins the arbitration

7	1	1	8	1	7	1	1
Sr	ZONE READ Address (28h)	R	A	STATUS_BYTE[7:0] Inverted Data: 10111111b (BFh)	A	SLAVE ADDRESS (27h)	0	A

During the next data read all data bits are 1 so the master knows there are no more devices with bits set in the STATUS_BYTE so it ends the Zone Read with a STOP condition

7	1	1	8	1	7	1	1	
Sr	ZONE READ Address (28h)	R	A	STATUS_WORD[15:8] Inverted Data: 11111111b (FFh)	A	SLAVE ADDRESS (38h)	0	A	P

More Information

- PMBus™ Power System Management Protocol, Parts I & II, Command Language, System Management Interface Forum, Revision 1.3.1, March 2015. *Available at PMBus.org*
- System Management Bus (SMBus) Specification, System Management Interface Forum, Version 3.0, 21 December 2014. *Available at PMBus.org*
- I^2C-bus specification and user manual, Revision 6, NXP Semiconductors, April 2014
- PMBus Application Note AN001 - Using The ZONE_READ and ZONE_WRITE Protocols, January 2016. *Available at PMBus.org*
- *APEC 2016 Professional Education Seminar, PMBus: Review and New Capabilities Session presented by Robert White, Embedded Power Labs*

Thank You For Your Time And Attention

Special thanks to the members of the PMBus Specification Working Group and their work to evolve the PMBus interface.

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