

EMU Peripheral Crate Controller

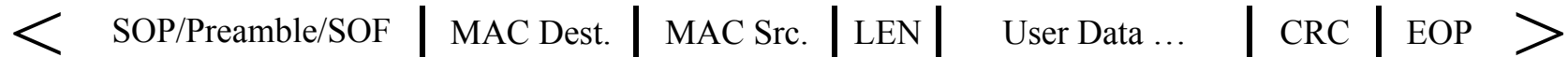
Data Formats

Warning: The contents of this document are preliminary and are subject to change without notice!

Rev. 1.09

Document		Firmware		Changes
Rev.	Date	Rev.	Date	
1.01	6/29/2005			Fixed typos in examples page (in VME control word).
1.02	7/8/2005	2.18	7/8/2005	Added new function codes and return data types corresponding to firmware version 2.18.
1.03	7/12/2005			Note that function codes 0x05 - 0x16, 0x21, and 0x23 are not yet implemented. Also return data header formats are not yet implemented as shown in this document.
1.04	9/29/2005	3.06	8/31/2005	Return data header format in firmware revision 3.06 and later now matches the format described in this document (except AK/Status codes are not yet implemented). Flash memory functions added (0x05 - 0x16). Separate path for spontaneous packets now implemented (Errors, Warnings, Info, and Interrupts) although interrupt handling is not yet implemented.
1.05	10/26/2005	3.06	8/31/2005	Configuration register bits specified; Restriction on MAC addresses detailed.
1.06	11/15/2005	3.09	11/1/2005	Added error handling in VME master for bus errors (BERR); Packet type codes for INFO/WARN/ERR and INTR has changed; defined a format for identifying INFO/WARN/ERR sources;
1.07	11/15/2005	3.11	11/8/2005	Added interrupt handler module; Changed VME_config register definitions and defaults.
1.08	11/16/2005	3.12	11/16/2005	Added functions for writing and reading serial numbers to/from FLASH
1.09	3/22/2006	3.55	3/8/2006	Improved error handling; Redefined INFO/WARN/ERR formats; Extensively tested and tweaked VME interface to make it less sensitive to backplane noise and glitches; Added Wrt_CR_ID (write Cnfg reg. based on ID) function; Redefined front panel switch 2; Added BOD (Beginning Of Data) marking in external FIFO to separate packets of VME data to facilitate error recovery; Changed slow clock generation method to utilize SRLs (area efficient); Optimized some areas of VME interface to improve timing issues.

Ethernet Packet Format



Mnemonic	Meaning	Size (bytes)	Code/Value
SOP	Start of Packet	1	0xFB
Preamble	Bit pattern for synchronization.	7	6(0x55)(0xD5)
SOF	Start of Frame (last byte of preamble)	1	0xD5
MAC Dest.	Destination MAC address	6	Hardware Defined
MAC Src.	Source MAC address	6	Hardware Defined
LEN	Length of User Data in bytes	2	2-9000
User Data	User specified data	46-9000	User defined
CRC	Cyclical Redundancy Check	4	Packet defined
EOP	End of Packet	1	0xFD

User Data Format

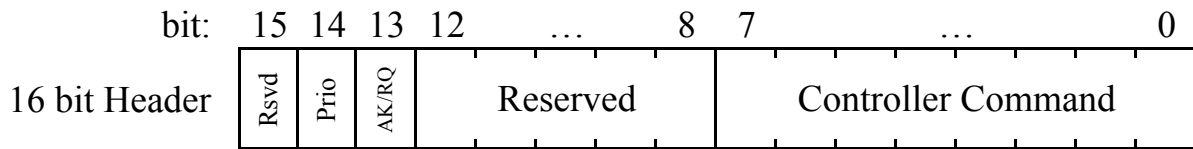
There are 3 general user data formats for the following 3 cases:

- 1) Packets sent to the controller.
- 2) Packets returning from the controller (with PROTOCOL disabled).
- 3) Packets returning from the controller (with PROTOCOL enabled).

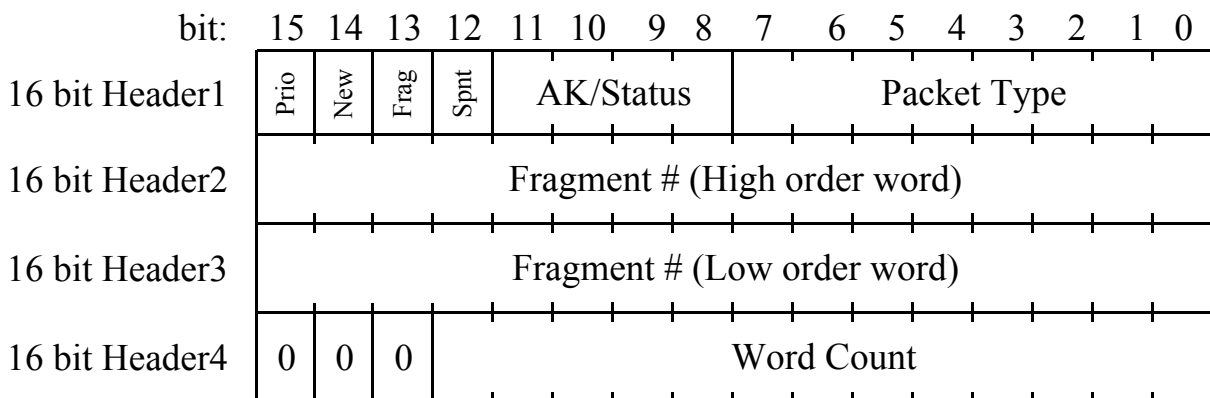
Sequence (16 bit words)	Sent to	Received from (PROTOCOL disabled)	Received from (PROTOCOL enabled)
0	< Header >	< Command Dependent Data >	< Header1 >
1	< Command Dependent Data >	< Command Dependent Data >	< Header2 >
2	< Command Dependent Data >	< Command Dependent Data >	< Header3 >
3	< Command Dependent Data >	< . >	< Header4 >
4	< . >	< . >	< Command Dependent Data >
5	< . >	< . >	< Command Dependent Data >
6	< . >	< . >	< Command Dependent Data >
.	< . >	< . >	< . >
.	< . >	< . >	< . >
.	< . >	< . >	< . >

Header Formats

For packets sent to the controller:



For packets retruned from the controller:



Definitions of labels and abbreviations

Rsvd. : Reserved.

Prio. : Priority packet. To be executed or returned out of sequence ASAP.

AK/RQ : Acknowledgement of command execution is requested.

Controller Command : Function code to be executed: Data format is dependent upon this code.

New : Indicates that this is the first packet in a series of 1 or more packets.

Frag. : Indicates that the amount of data exceeds the maximum packet size. This packet contains only a fragment of the requested data.

Spnt. : Indicates that this packet was spontaneously generated by the controller and was not in response to a request.

AK/Status : Acknowledgement status. Indicates disposition of the requested function.

Packet Type : Indicates the type of data contained in this packet. The data format is dependent upon this type.

Fragment # : A 32 bit number specifying this packets position in a sequence of packet fragments.

Word Count : The number of data words to follow the header.

Function Codes

Cat.	Mnemonic	OpCode	Functional Description	Data Format
Initialization/Configuration	Funcnt_NoOp	0x00	No action taken.	no data
	Set_FF_Test	0x01	Set test mode for external FIFO.	no data
	Set_FF_VME	0x02	Set VME mode for external FIFO.	no data
	ECC_enable	0x03	Enable Error Correcting Codes in external FIFO	no data
	ECC_disable	0x04	Disable Error Correcting Codes in external FIFO	no data
	Save_Cnfg_Num	0x05	Save current controller configuration as specified configuration number.	1 word
	Read_Cnfg_Num_Dir	0x06	Direct readback of specified stored configuration (raw data from Flash mem).	1 word
	Read_Cnfg_Num_Dcd	0x07	Decoded readback of specified stored configuration.	1 word
	Rstr_Cnfg_Num	0x08	Restore controller configuration to specified configuration.	1 word
	Set_Cnfg_Dflt	0x09	Set default controller configuration to specified number.	1 word
	Read_Cnfg_Dflt	0x0A	Readback the default configuration number.	no data
	Set_MACs	0x0B	Set MAC addresses.	MAC FMT ¹
	Read_MACs_Dir	0x0C	Direct readback of stored MAC addresses (raw data from Flash mem).	no data
	Read_MACs_Dcd	0x0D	Decoded readback of stored MAC addresses.	no data
	Read_CRs	0x0E	Readback configuration registers (CR's).	no data
	Wrt_Eth_CR	0x0F	Write Ethernet CR with specified data.	1 word
	Wrt_Ext_CR	0x10	Write External FIFO CR with specified data.	1 word
	Wrt_Rst_CR	0x11	Write reset enables CR with specified data.	1 word
	Wrt_VME_CR	0x12	Write VME CR with specified data.	1 longword ²
	Wrt_BTO_CR	0x13	Set VME Bus Timeout to specified data.	1 word
	Wrt_BGTO_CR	0x14	Set VME BusGrant Timeout to specified	1 word
	Wrt_All_CRs	0x15	Write all CR's and timeouts with specified	CR FMT ¹
	Set_Clr_CRs	0x16	Set or Clear individual bits of a CR.	Set Clr FMT ¹
	Set_Inj_Err	0x17	Enable error injecting into FIFO data bits	no data
	Rst_Inj_Err	0x18	Disable error injecting into FIFO data bits	no data
	Warn_On_Shdown	0x19	Enable warning packets prio to reloading.	no data
	No_Warn_On_Shdown	0x1A	Disable warning packet on shutdown.	no data
	Snd_Startup_Pkt	0x1B	Enables sending an INFO packet on start-up.	no data
	No_Startup_Pkt	0x1C	Disables sending start-up INFO packets.	no data
	Wrt_Ser_Num	0x1D	Write 24-bit PCB serial number.	1 longword ²
	Rd_Ser_Num	0x1E	Read 24-bit PCB serial number.	1 longword ²
	Wrt_CR_ID	0x1F	Write CR(s) and timeout(s) to reg. ID	CR ID FMT ¹

Function Codes Continued

Cat.	Mnemonic	OpCode	Functional Description	Data Format
VME functions	VME_Cmds	0x20	Specified data are VME commands and are sent through external FIFO.	VME_DAT_FMT ¹
		0x21	Undefined	
	VME_Dir_Cmds	0x22	Specified data are VME commands and are sent directly to VME interface (not yet implemented).	VME_DAT_FMT ¹
		0x23	Undefined	
		0x24	Undefined	--
		.	Undefined	--
		.	Undefined	--
		.	Undefined	--
		0x2F	Undefined	--
Undefined		0x30	Undefined	--
		.	Undefined	--
		.	Undefined	--
		.	Undefined	--
		0xDF	Undefined	--
External FIFO Testing and Programming	Wrt_Ext_FF	0xE0	Write specified data to external FIFO.	N words ³
	Prg_Ext_Off	0xE1	Program offsets for external FIFO. (18-bit full offset, then 18-bit empty offset)	2 longwords ^{2,4}
	Rdbk_Ext_Off	0xE2	Readback offsets from external FIFO.	no data
	PRst_Ext_FF	0xE3	Partial reset of external FIFO.	no data
	Rd_Ext_FF	0xE4	Read specified number of words from external FIFO.	1 longword ²
	RT_Ext_FF	0xE5	Retransmit specified number of words from external FIFO.	1 longword ²
	MRst_Ext_FF	0xE6	Master reset of external FIFO.	no data
	ST_MK_Ext_FF	0xE7	Set MARK at current read pointer location.	no data
	RST_MK_Ext_FF	0xE8	Reset MARK; restore normal operation	no data
	Rst_Ext_Err_Cnt	0xE9	Reset FIFO data bit error counters.	no data
	Rd_Ext_Err_Cnts	0xEA	Readback FIFO data bit error counters.	no data
		0xEB	Undefined	--
		.	Undefined	--
		0xEF	Undefined	--

Function Codes Continued

Cat.	Mnemonic	OpCode	Functional Description	Data Format
Test and Diagnostic		0xF0	Undefined	--
		.	Undefined	--
		.	Undefined	--
		0xF8	Undefined	--
	Force_Reload	0xF9	Force reprogramming the FPGA.	no data
	Read_Drop_Mem	0xFA	Read all words from logic analyzer circular buffer A.	no data
	Read_WSOP_Mem	0xFB	Read all words from logic analyzer circular buffer B.	no data
	Flash_R_W	0xFC	Read or Write Flash memory. Data contains commands for Flash interface.	FLASH_FMT ¹
	Send_N_Words	0xFD	Request specified number of words be sent from the controller.	1 longword ²
	Load_User_Reg	0xFE	Load the 32 bit LED user register with specified data.	1 longword ²
	Loopback	0xFF	Transmit the data in this packet back to sender as is.	N words ³

¹See section on "Function Specific Sub Formats" for details on specified data format.

²High order word sent first, with unused high order bits padded with zeros.

³The number of words are defined by LEN in the MAC frame header.

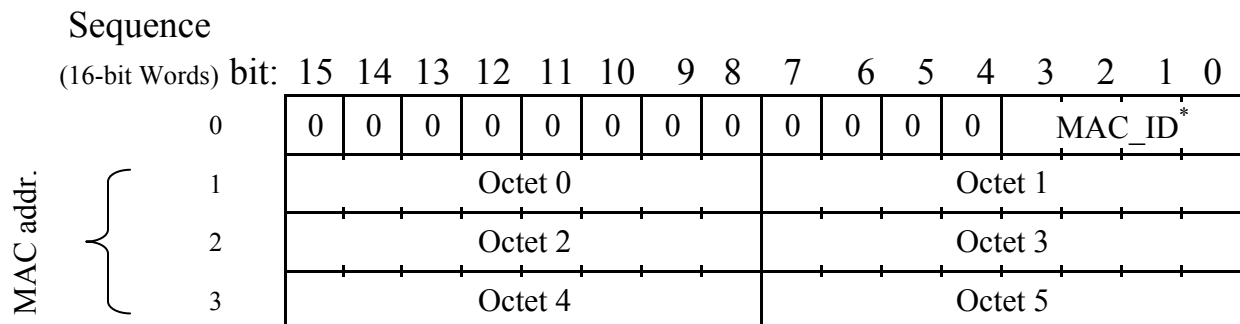
⁴Two words for the FULL offset come first followed by two words for the EMPTY offset.

Function Specific Sub Formats

(After Header)

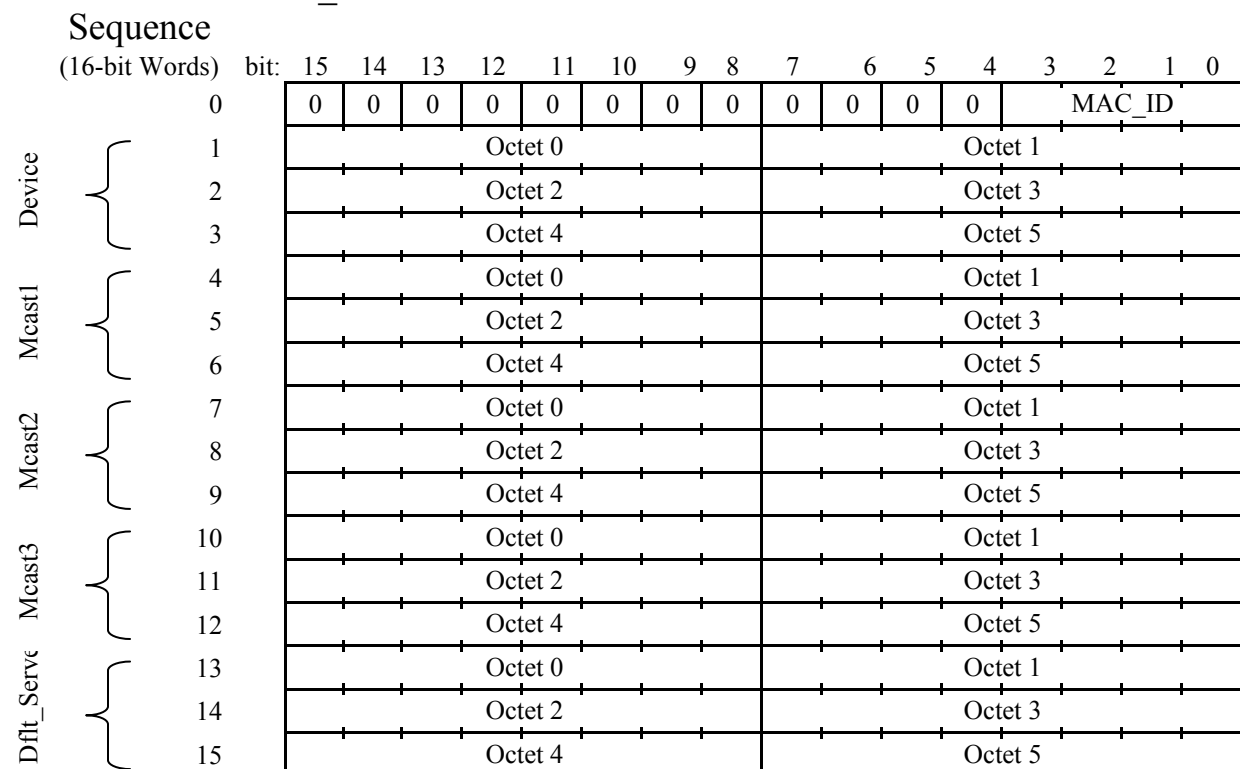
MAC_FMT (function: Set_MACs; OpCode 0x0B)

MAC_ID ≤ 4:



*MAC_ID	Name	Use
0	Device	MAC address of device being configured.
1	Mcast1	Group MAC address 1 for multicast packets.
2	Mcast2	Group MAC address 2 for multicast packets.
3	Mcast3	Group MAC address 3 for multicast packets.
4	Dflt_Server	MAC address of default server for spontaneous packets sent from the
5 - 7	-	Not defined.
8	All	Refers to all MAC registers.
9 - 15	-	Not defined.

MAC_ID = 8:



Function Specific Sub Formats (continued)

(After Header)

CR_FMT (function: Wrt_All_CRs; OpCode 0x15)

Sequence		15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
(16-bit Words)	bit:																
0		Ethernet CR [†]															
1		External FIFO CR [†]															
2		Reset Enable CR [†]															
3		VME CR(31:16) [†]															
4		VME CR(15:0) [†]															
5		Bus Timeout CR [†]															
6		Bus Grant Timeout CR [†]															

[†]See section on "Configuration Register Bits" for details on bit definitions.

Function Specific Sub Formats (continued)

(After Header)

CR_ID_FMT (function: Wrt_CR_ID; OpCode 0x1F)

CR_ID ≤ 5 (except CR_ID = 3):

Sequence

(16-bit Words)	bit:	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0		0	0	0	0	0	0	0	0	0	0	0	0	CR_ID [‡]			
1		CR															

CR_ID = 3:

Sequence

(16-bit Words)	bit:	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0		0	0	0	0	0	0	0	0	0	0	0	0	CR_ID [‡]			
1		VME CR(31:16)															
2		VME CR(15:0)															

[‡] CR_ID	CR Name	Use
0	Ethernet	Configuration bits for ethernet module.
1	Ext. FIFO	Configuration bits for external FIFO interface.
2	Reset Ena.	Reset sources and miscellaneous config. bits.
3	VME	Configuration bits for VME interface.
4	BTO	Bus TimeOut in 16 ns units.
5	BGTO	Bus Grant TimeOut in 16 ns units.
6,7	-	Not defined.
8	All	Refers to all CR registers.
9 - 15	-	Not defined.

CR_ID = 8:

Sequence

(16-bit Words)	bit:	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0		0	0	0	0	0	0	0	0	0	0	0					CR_ID
1		Ethernet CR															
2		External FIFO CR															
3		Reset Enable CR															
4		VME CR(31:16)															
5		VME CR(15:0)															
6		Bus Timeout CR															
7		Bus Grant Timeout CR															

Function Specific Sub Formats (continued)

(After Header)

Set_Clr_FMT (function: Set_Clr_CRs; OpCode 0x16)

CR_ID ≤ 2:

Sequence

(16-bit Words)	bit:	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0		0	0	0	0	0	0	0	Set/Clr	0	0	0	0	CR_ID			
1		Mask for CR															

CR_ID = 3:

Sequence

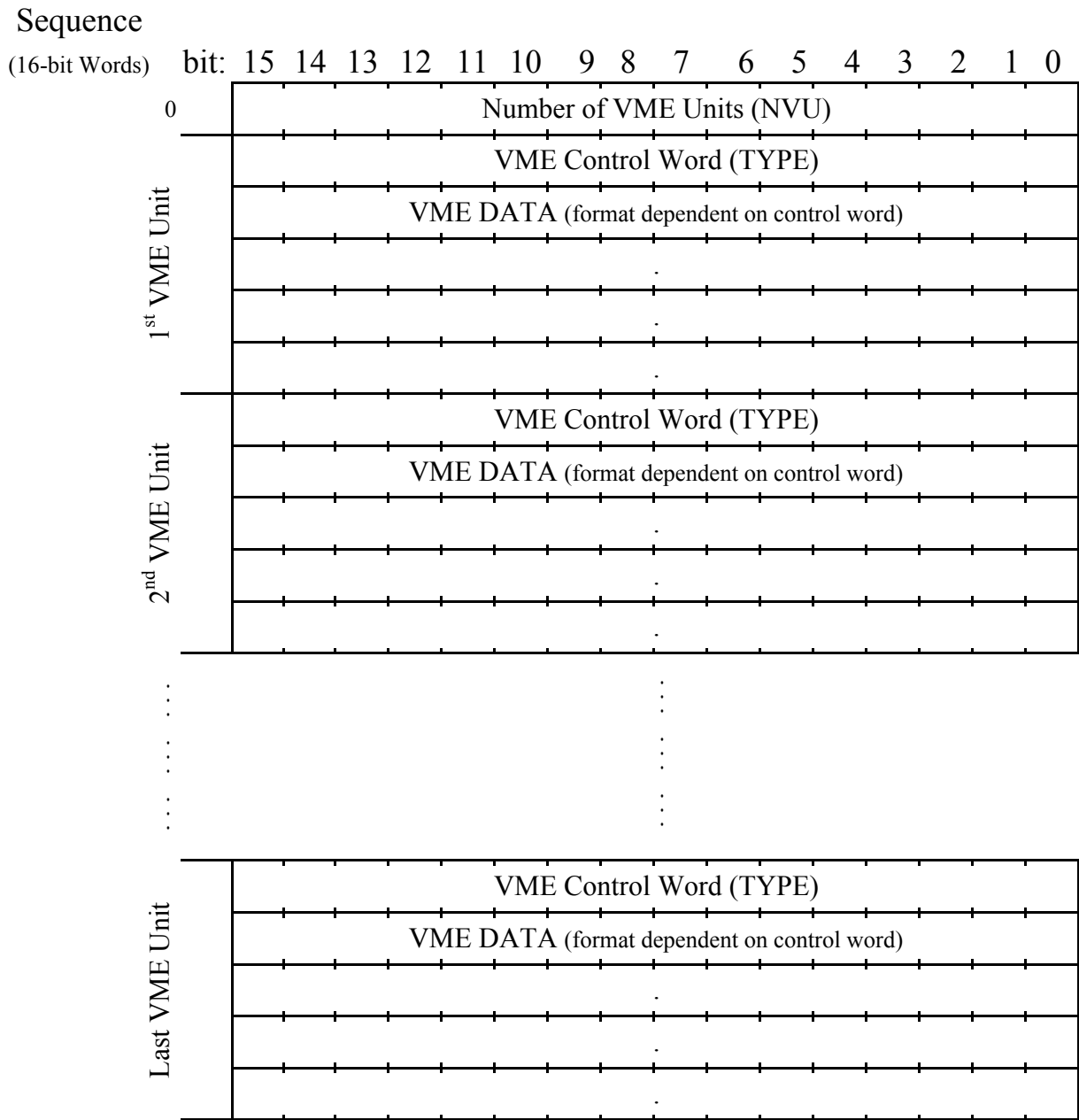
(16-bit Words)	bit:	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0		0	0	0	0	0	0	0	Set/Clr	0	0	0	0	CR_ID			
1		VME Mask(31:16)															
2		VME Mask(15:0)															

Set/Clr bit	Function
0	Mask is "ANDed" with the specified CR
1	Mask is "ORed" with the specified CR

Function Specific Sub Formats (continued)

(After Header)

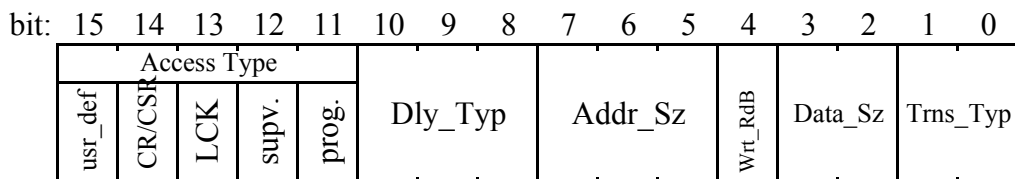
VME_DAT_FMT (function: VME_Cmds; OpCode 0x20)



Function Specific Sub Formats (continued)

(After Header)

VME Control Word



Transfer Types

Trns_Typ Code	Mnem.	Meaning
0	SNGL	Single transfer
1	BLOCK	Block transfer
2	RMW	Read Modify Write sequence
3	UNALG	Unaligned transfer (16-bits crossing word boundaries)

Data Sizes

Data_Sz Code	Mnem.	Size	Number of supplied/expected words
0	D08	8 bits	1
1	D16	16 bits	1
2	D32	32 bits	2
3	D64	64 bits	4

Write Control

Wrt_RdB Value	Meaning
0	Read data from specified VME address.
1	Write data to specified VME address

Address Sizes

Addr_Sz Code	Mnem.	Size	Number of supplied/expected words
0	-	-	undefined
1	A16	16 bits	1
2	A24	24 bits	2
3	A32	32 bits	2
4	A40	40 bits	3
5	A64	64 bits	4
6	-	-	undefined
7	-	-	undefined

Delay Types

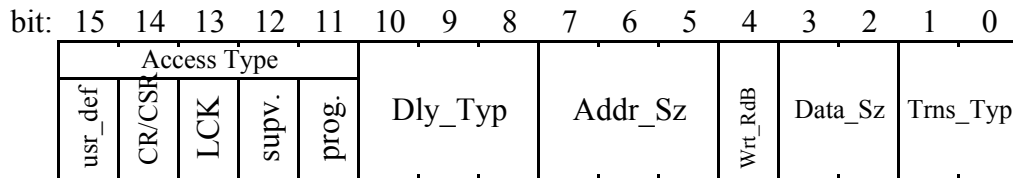
Dly_Typ Code	Mnem.	Clock Period	Num bits	Max Count	Max Delay	Comment
0	No_Dly	-	-	-	-	
1	D4nsX16	4 ns	16	65535	262,144 us	4 ns modes are disabled. If used, 2 bits are dropped and 16 ns clock is used.
2	D16nsX16	16 ns	16	65535	1.049 ms	
3	D16usX16	16.384 us	16	65535	1.074 s	
4	D4nsX32	4 ns	32	4.29E+09	17.18 s	4 ns modes are disabled. If used, 2 bits are dropped and 16 ns clock is used.
5	D16nsX32	16 ns	32	4.29E+09	68.72 s	
6	D16usX32	16.384 us	32	4.29E+09	1.95 hr	
7	undefined	undefined	-	undefined	undefined	

Note: The format of the data following the VME control word is dependent on the options specified in the control word. Please refer to the section on "VME Control Word Dependent Data Format" for the details.

Function Specific Sub Formats (continued)

(After Header)

VME Control Word (continued)



Access Types	Mnem.	Value	Meaning
	prog.	0	VME data access
		1	VME program access
	supv.	0	non-privileged access
		1	supervisory access
	LCK	0	normal transfer
		1	VME Lock command
	CR/CSR	0	normal transfer
		1	Config. ROM/Cntrl & Status Reg.
	usr_def	0	Standard address modifiers
		1	User defined Address Modifier (UAM)

Note: The format of the data following the VME control word is dependent on the options specified in the control word. Please refer to the section on "VME Control Word Dependent Data Format" for the details.

Function Specific Sub Formats (continued)

(After Header)

VME Control Word Dependent Data Format

General Format of VME Data:

Section / Order	Data Specified	Words	Conditions (data present when...)
Delay Section:	Delay	0,1-2 Words	Dly_Typ $\neq$ 0
Address Section:	Addr. Mod.	0,1 Words	Dly_Typ = 0 & usr_def = 1
	Address	0,1-4 Words	Dly_Typ = 0
Data Section:	Data Count:	0,1 Word (n)	Dly_Typ = 0 & Trns_Typ = BLOCK
	Data	0-4 Words n-times	Dly_Typ = 0 & Wrt_RdB = 1

Delay Section:

Delay:

Seq.	Dly_Typ	
	D4nsX16	D4nsX32
	D16nsX16	D16nsX32
	D16usX16	D16usX32
0	Delay(15:0)	Delay(31:16)
1	-	Delay(15:0)

Address Section:

Address Modifier: Specify a user defined address modifier in the range 0x10 to 0x1F;

Address:

Seq.	Addr_Sz				
	A16	A24	A32	A40	A64
0	Addr(15:0)	0x00Addr(23:16)	Addr(31:16)	0x00Addr(39:32)	Addr(63:48)
1	-	Addr(15:0)	Addr(15:0)	Addr(31:16)	Addr(47:32)
2	-	-	-	Addr(15:0)	Addr(31:16)
3	-	-	-	-	Addr(15:0)

Data Section:

Data Count: 16 bit word specifying the number of transfers in the block.

Data:

Seq.	Reads Wrt_RdB = 0	Data_Sz (for writes Wrt_RdB = 1)			
		D08	D16	D32	D64
0	-	0x00Data(7:0)	Data(15:0)	Data(31:16)	Data(63:48)
1	-	-	-	Data(15:0)	Data(47:32)
2	-	-	-	-	Data(31:16)
3	-	-	-	-	Data(15:0)

Function Specific Sub Formats (continued)

(After Header)

FLASH_FMT (function: Flash_R_W; OpCode 0xFC)

Sequence

(16-bit Words)

bit:	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	
0	0	0	0	0	0	0	0	0	Number of Pages (NP: 1-128)								
1	W^1	Page Number (0-127)							C^2	Number of Bytes (NB1: 1-64)							
2	0	0	Byte Address (0-63)							Data							
3	0	0	Byte Address (0-63)							Data							
4	0	0	Byte Address (0-63)							Data							
.	0	0															
.	0	0															
.	0	0															
(NB1+1)+1	W^1	Page Number (0-127)							C^2	Number of Bytes (NB2: 1-64)							
(NB1+1)+2	0	0	Byte Address (0-63)							Data							
(NB1+1)+3	0	0	Byte Address (0-63)							Data							
(NB1+1)+4	0	0	Byte Address (0-63)							Data							
.	0	0															
.	0	0															
.	0	0															
(NB2+1)+(NB1+1)+1	W^1	Page Number (0-127)							C^2	Number of Bytes (NB3: 1-64)							
(NB2+1)+(NB1+1)+2	0	0	Byte Address (0-63)							Data							
(NB2+1)+(NB1+1)+3	0	0	Byte Address (0-63)							Data							
(NB2+1)+(NB1+1)+4	0	0	Byte Address (0-63)							Data							
.	0	0															
.	0	0															
.	0	0															

First Page

Second Page

Third Page

¹W=1: write to specified page; W=0 : read from specified page.

²This bit is ignored on writes (W=1). When W=0; C=0 indicates that data readback is to be directed to the GbE transmitter; C=1 indicates that data readback is to be directed to the configuration registers.

Return Packet Types

Code	Packet Type		Words per Data Unit
0x00	No data		0
0x01	Loopback data		1
0x02	TX_N_Words requested data		1
0x03	External FIFO data or offsets		mixed ¹
0x04	VME D08 data	} Type = {01,Data_Sz} (4+Data_Sz)	1
0x05	VME D16 data		1
0x06	VME D32 data		2
0x07	VME D64 data		4
0x08			
0x09			
0x0A	Configuration Module data		mixed ²
0x0B	Flash readback data		variable ³
0x0C			
⋮			
0xF8	D08 Interrupt packet with 8-bit Status/ID		1
0xF9	D16 Interrupt packet with 16-bit Status/ID		1
0xFA	D32 Interrupt packet with 32-bit Status/ID		2
⋮			
0xFD	Information packet		variable ⁴
0xFE	Warning packet		variable ⁴
0xFF	Error packet		variable ⁴

¹Dependent on requested data: programed offset (two 18-bit words), error counts (two 32-bit words), or standart FIFO read data (n 16-bit words). (See following pages):

²Dependent on requested data: MAC, CR, Serial Num. Etc. (see following pages):

³Flash Readback Data Format (see following pages):

⁴For information, warning, and error packets the data format is dependent on the source of the data (see following pages for details):

Return Data Formats

External FIFO Data Format (Packet type 0x03):

Programmed offsets; Response to OpCode 0xE2 (Rdbk_Ext_Off):

Sequence

(16-bit Words)	bit:	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	b17	b16
1		Full Offset(15:0)															
2		0	0	0	0	0	0	0	0	0	0	0	0	0	0	b17	b16
3		Empty Offset(15:0)															

Bit error counts; Response to OpCode 0xEA (Rd_Ex_Err_Cnts):

Sequence

(16-bit Words)	bit:	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0		Count of uncorrected errors—high order word (31:16)															
1		Count of uncorrected errors—low order word (15:0)															
2		Count of corrected errors—high order word (31:16)															
3		Count of corrected errors—low order word (15:0)															

Normal FIFO data; Response to OpCodes 0xE4 or 0xE5 (Rd(T)_Ext_FF):

Sequence

(16-bit Words)	bit:	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0		FIFO contents 1 st word (15:0)															
1		FIFO contents 2 nd word (15:0)															
2		FIFO contents 3 rd word (15:0)															
⋮		⋮															

Return Data Formats (continued)

Configuration Data Readback Format: (Packet type 0x0A):

Direct read of stored configuration:

Response to OpCode 0x06 (Read_Cnfg_Num_Dir):

Sequence

(16-bit Words)	bit:	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	0					Page				0							Count = 30
1	0	0				Address							eth_cr(15:8)				
2	0	0				Address							eth_cr(7:0)				
3	0	0				Address							ext_ff_cr(15:8)				
4	0	0				Address							parity_A(11:4)				
5	0	0				Address				parity_A(3:0)			parity_B(11:8)				
6	0	0				Address							parity_B(7:0)				
7	0	0				Address							ext_ff_cr(7:0)				
8	0	0				Address							rst_cr(15:8)				
9	0	0				Address							rst_cr(7:0)				
10	0	0				Address							parity_A(11:4)				
11	0	0				Address				parity_A(3:0)			parity_B(11:8)				
12	0	0				Address							parity_B(7:0)				
13	0	0				Address							vme_cr(31:24)				
14	0	0				Address							vme_cr(23:16)				
15	0	0				Address							vme_cr(15:8)				
16	0	0				Address							parity_A(11:4)				
17	0	0				Address				parity_A(3:0)			parity_B(11:8)				
18	0	0				Address							parity_B(7:0)				
19	0	0				Address							vme_cr(7:0)				
20	0	0				Address							bto_cr(15:8)				
21	0	0				Address							bto_cr(7:0)				
22	0	0				Address							parity_A(11:4)				
23	0	0				Address				parity_A(3:0)			parity_B(11:8)				
24	0	0				Address							parity_B(7:0)				
25	0	0				Address							bgto_cr(15:8)				
26	0	0				Address							bgto_cr(7:0)				
27	0	0				Address							rsvd(15:8)				
28	0	0				Address							parity_A(11:4)				
29	0	0				Address				parity_A(3:0)			parity_B(11:8)				
30	0	0				Address							parity_B(7:0)				

Return Data Formats (continued)

Configuration Data Readback Format: (Packet type 0x0A):

Decoded read of stored configuration or current configuration:

Response to OpCode 0x07 or 0x0E (Read_Cnfg_Num_Dcd or Read_CRs):

Sequence

(16-bit Words)	bit:	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	Ethernet CR																
1	External FIFO CR																
2	Reset Enable CR																
3	VME CR(31:16)																
4	VME CR(15:0)																
5	Bus Timeout CR																
6	Bus Grant Timeout CR																

Read default configuration number:

Response to OpCode 0x0A (Read_Cnfg_Dflt):

Sequence

(16-bit Words)	bit:	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0		0	0	0	0	0	0	0	0	Default Configuration Number							

Read serial number:

Response to OpCode 0x1E (Rd_Ser_Num):

Sequence

(16-bit Words)	bit:	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0		0	0	0	0	0	0	0	0	SerNo(23:16)							
1		SerNo(15:0)															

Return Data Formats (continued)

Configuration Data Readback Format: (Packet type 0x0A):

Direct read of stored MAC addresses:

Response to OpCode 0x0C (Read_MACs_Dir):

Sequence

(16-bit Words)	bit:	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	0					Page				0					Count = 60		
1	0	0				Address								Octet 0 of Device MAC			
2	0	0				Address								Octet 1 of Device MAC			
3	0	0				Address								Octet 3 of Device MAC			
4	0	0				Address								parity_A(11:4)			
5	0	0				Address					parity_A(3:0)			parity_B(11:8)			
6	0	0				Address						parity_B(7:0)					
7	0	0				Address								Octet 4 of Device MAC			
8	0	0				Address								Octet 5 of Device MAC			
9	0	0				Address								Octet 6 of Device MAC			
10	0	0				Address								parity_A(11:4)			
11	0	0				Address					parity_A(3:0)			parity_B(11:8)			
12	0	0				Address						parity_B(7:0)					
13	0	0				Address								Octet 0 of Mcast1 MAC			
14	0	0				Address								Octet 1 of Mcast1 MAC			
15	0	0				Address								Octet 3 of Mcast1 MAC			
16	0	0				Address								parity_A(11:4)			
17	0	0				Address					parity_A(3:0)			parity_B(11:8)			
18	0	0				Address						parity_B(7:0)					
19	0	0				Address								Octet 4 of Mcast1 MAC			
20	0	0				Address								Octet 5 of Mcast1 MAC			
21	0	0				Address								Octet 6 of Mcast1 MAC			
22	0	0				Address								parity_A(11:4)			
23	0	0				Address					parity_A(3:0)			parity_B(11:8)			
24	0	0				Address						parity_B(7:0)					

⋮

Pattern repeats for remaining MAC addresses: Mcast2, Mcast3, and Dflt_Server.

Return Data Formats (continued)

Configuration Data Readback Format: (Packet type 0x0A):

Decoded read of stored MAC addresses:
 Response to OpCode 0x0D (Read_MACs _Dcd):

Sequence		bit: 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0																
(16-bit Words)																		
Device	{	0	Octet 0								Octet 1							
		1	Octet 2								Octet 3							
		2	Octet 4								Octet 5							
Mcast1	{	3	Octet 0								Octet 1							
		4	Octet 2								Octet 3							
		5	Octet 4								Octet 5							
Mcast2	{	6	Octet 0								Octet 1							
		7	Octet 2								Octet 3							
		8	Octet 4								Octet 5							
Mcast3	{	9	Octet 0								Octet 1							
		10	Octet 2								Octet 3							
		11	Octet 4								Octet 5							
Dflt_Server	{	12	Octet 0								Octet 1							
		13	Octet 2								Octet 3							
		14	Octet 4								Octet 5							

Return Data Formats (continued)

Flash Readback Data Format: (Packet type 0x0B):

Sequence

(16-bit Words)		bit:																15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0		
0	1 st Page Read	0		Page								0	Count																						
		0	0	Address								Data																							
		0	0	Address								Data																							
		0	0	.								.																							
		0	0	.								.																							
		0	0	.								.																							
1 st Count + 1	2 nd Page Read	0		Page								0	Count																						
		0	0	Address								Data																							
		0	0	Address								Data																							
		0	0	.								.																							
		0	0	.								.																							
		0	0	.								.																							
...																		:																	
n th Count + n	n th Page Read	0		Page								0	Count																						
		0	0	Address								Data																							
		0	0	Address								Data																							
		0	0	.								.																							
		0	0	.								.																							
		0	0	.								.																							

Return Data Formats (continued)

Data Format for ERR/WARN/INFO Packet Types

(Packet Types 0xFF, 0xFE, and 0xFD)

first data word after header	bit: 15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	Source ID				Source Dependent Code Word											

Table of Source ID's[†]

Code Word Format

Source ID	Mnemonic	bit:	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0				
0	Misc		0	0	0	0	Undefined															
1	VME_Ctrl	ERR	0 0 0 1				0 0 0 0				0 0 0 0				Ctrl. Error Type [‡]							
			Access Type					Dly_Typ				Addr_Sz				Wrt_RdB	Data_Sz	Trns_Typ				
			usr_def	CR/CSR	LCK	supv.	prog.															
2	VME_Master	Error packets	0 0 1 0				0 0 0 0				Not_Sup	BTO	BERR	MSTR_ST								
			0 0 0 0				0	AM(5:0)							Wrt_	Data_Sz	Trns_Typ					
			High order address word.																			
			Mid High address word.																			
			Mid Low address word.																			
			Low order address word.																			
3	VME_Rdbk		0	0	1	1	Undefined															
4	VME_IH	ERR	0 1 0 0				0 0 0 0				0 0		BTO	BERR	IH_ST							
			0 0 0 0				0 0 0 0				0	Addr			0	IRQ						
		WARN									msk_chg											
			0 1 0 0				0 0 0 0					IRQ Mask										
			0 0 0 0				0 0 0 0				0	Addr			0	IRQ						
5	VME_Slv		0	1	0	1	Undefined															
6	VME_Arb		0	1	1	0	Undefined															

[†]See the following pages for an explanation of the named fields in this table.

[‡]See the following pages for definitions of specific error types.

Return Data Formats (continued)

Data Format for ERR/WARN/INFO Packet Types

(Packet Types 0xFF, 0xFE, and 0xFD)

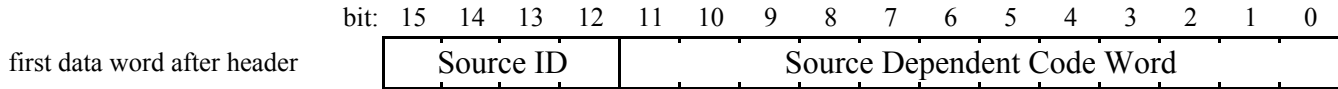


Table of Source ID's (continued)[†]

Source ID	Mnemonic	bit:	Code Word Format															
			15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
7	Ext_FIFO_mod	ERR	0	1	1	1	0	0	0	0	0	0	0	ff_wrt_err	ff_mk_err	ff_rt_err	ff_mt_err	ff_rd_err
8	Eth_Rcv		1	0	0	0	Undefined											
9	Eth_Trns		1	0	0	1	Undefined											
10	JTAG_mod		1	0	1	0	Undefined											
11	Flash_mod		1	0	1	1	Undefined											
12	Config_mod		1	1	0	0	Undefined											
13	BTC_mod	ERR	1	1	0	1	0	0	0	0	0	0	0	0	TC_ERRS [‡]			
14	Rst_Hndlr		1	1	1	0	Undefined											
15	Strtup_Shtdwn	WARN	1	1	1	1	0	0	0	0	0	0	0	0	TC_WARNINGS [‡]			
		INFO	1	1	1	1	0	0	0	0	0	0	0	0	TC_INFOS [‡]			

[†]See the following pages for an explanation of the named fields in this table.

[‡]See the following pages for definitions of specific error types.

Return Data Formats (continued)

Data Format for ERR/WARN/INFO Packet Types

(Packet Types 0xFF, 0xFE, and 0xFD)

Table of Source ID's (continued)

Explanation of Fields

Source	Field	Meaning
VME_Ctrl	Ctrl. Error Type	See Table on next page.
	2 nd Word	See "VME Control Word" format and definitions.
VME_Master	MSTR_ST	State of the VME master state mache at the time of the
	BERR	When BTO=0, BERR indicates a bus error reported by
	BTO	Indicates a bus time out.
	Not_Sup	Indicates that the attempted command is not supported.
	AM	Address Modifier used during the attempted command
VME_IH	IH_ST	State of the interrupt handler state mache at the time of
	BERR	When BTO=0, BERR indicates a bus error reported by
	BTO	Indicates a bus time out.
	IRQ	The IRQ level being responded to during the IACK cycle.
	Addr	Address used to specify the IRQ level during the IACK
	IRQ Mask	The current mask used to enable IRQ levels to respond to.
	msk_chg	Indicates that the IRQ Mask has changed.
Ext_FIFO_mod	ff_rd_err	FIFO went empty after a read sequence was started.
	ff_mt_err	FIFO was empty when a read was requested.
	ff_rt_err	Either FIFO was empty or MARK not set when a
	ff_mk_err	An attempt to set a MARK was made when the FIFO was
	ff_wrt_err	FIFO went full after a write sequence was started.
BTC_mod	TC_ERRS	See Table on next page.
Strtup_Shtdwn	TC_WARNs	See Table on next page.
	TC_INFOS	See Table on next page.

Return Data Formats (continued)

Data Format for ERR/WARN/INFO Packet Types

(Packet Types 0xFF, 0xFE, and 0xFD)

Table of Source ID's (continued)

Specific Error Types

Source	Code	Mnemonic	Meaning
Ctrl. Err Type	0	No_Cerr	No controller error.
	1	Unkn_Addr	The specified address size is not valid.
	2	Unkn_Dly	The specified delay type is not valid.
	3	Inc_Opt	The combination of options are incompatible.
	4	RdEr_Units	A FIFO read error occurred while attempting to read the number of VME units from the FIFO.
	5	RdEr_CtrlWrd	A FIFO read error occurred while attempting to read the control word from the FIFO.
	6	RdEr_Addr	A FIFO read error occurred while attempting to read the address from the FIFO.
	7	RdEr_Dcnt	A FIFO read error occurred while attempting to read the block transfer data count from the
	8	RdEr_Data	A FIFO read error occurred while attempting to read the data from the FIFO.
	9 - 15	not defined	Not yet assigned.
TC_ERRS	0	TC_No_Err	No error from traffic controller.
	1	TC_No_Data	The expected data was not present.
	2	TC_Not_Exc	The requested command was not executed.
	3	TC_Unk_Fnc	The requested command is not defined in the
	4 - 15	not defined	Not yet assigned.
TC_WARNINGS	0	SS_No_Warn	No warning from Strtup_Shtdwn.
	1	SS_Rld_Pndg	A reload signal was received a shutdown is
	2 - 15	not defined	Not yet assigned.
TC_INFOS	0	SS_No_Info	No information from Strtup_Shtdwn.
	1	SS_Start_up	A reload has just completed and the system is now operational.
	2 - 15	not defined	Not yet assigned.

Examples

Example 1: VME commands for 2 A24D16 single writes, a delay, and then an A24D16 single read.

		Sequence of 16 bit words (HEX)	Meaning
1 st VME Unit	Header	2020	Function is VME Comands with ackowlegment request
	NVU	0004	Number of VME units
	Control Word	0054	A24D16 Single Write
	Address	00A(23:16)	High order byte of VME address
		A(15:0)	Low order word of VME address
	Data	D(15:0)	Data word to write
2 nd VME Unit	Control Word	0034	A24D16 Single Write
	Address	00A(23:16)	High order byte of VME address
		A(15:0)	Low order word of VME address
	Data	D(15:0)	Data word to write
3 rd VME Unit	Control Word	05XX	16 ns by 32 bit delay
		Dly(31:16)	High order word of delay
	Data	Dly(15:0)	Low order word of delay
4 th VME Unit	Control Word	0044	A24D16 Single Read
	Address	00A(23:16)	High order byte of VME address
		A(15:0)	Low order word of VME address

Configuration Register Bits: (Definitions and Defaults)

Ethernet Configuration Register

bit:	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Bit definitions	reserved								switch control	spont. pkt ena	carrier extend	protocol enable	promisc.	passthru	tdis	tx inhibit
Firmware default	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0

(0x0050)

- switch control : **This has been disabled in the firmware. The switch now controls what signals are sent to the test ports for logic analyzer connections.**
- spont. pkt ena : Enables the controller to send spontaneous packets for errors, warnings, information, and interrupts, otherwise no packets will be sent that are not in response to a request for
- carrier extend : For use in half duplex mode at speeds above 100 Mb/s to ensure proper operation of the CSMA/CD protocol (1000 BASE-T).
- protocol enable : Specifies whether or not packets sent from the controller are sent with a header. When protocol is enabled, headers are included.
- promisc. : Puts controller in promiscuous mode. In this mode the controller accepts all MAC addresses.
- passthru : Puts controller in pass-thru mode. In this mode the controller returns the user data portion of all accepted packets received back to the sender without executing any instructions. A header is added if the protocol enable bit is set.
- tdis : Disables the transmit side of the optical transceiver. Any established link will be lost. It is suggested that this bit be kept set to zero. **This has been disabled.**
- tx inhibit : Disables the transmit side of the RocketIO™. This prevents Idles from being transmitted and therefore any established link will be lost. It is suggested that this bit be kept set to zero. **This has been disabled.**

External FIFO Configuration Register

bit:	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Bit definitions	reserved													Inject Errors	ECC enable	Test Mode
Firmware default	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0

(0x0002)

- Inject Errors : Injects errors into data written to the external FIFO for testing ECC function.
- ECC enable : Enables Error Correcting Codes to be used in the external FIFO.
- Test Mode : When set, enables reading the external FIFO. When not set, data in the FIFO will be read by the VME controller.

Configuration Register Bits: (Continued) (Definitions and Defaults)

Reset Enables/Misc. Configuration Register

bit:	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Bit definitions	reserved									Send Pkt on Strt	Warn on Shtdwn	JTAG	Hard Reset	SYSRST	Front Panel	Internal
Firmware default	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	1

(0x0013)

Send Pkt on Strt : Enables an INFO packet to be sent after power-up or reprogramming informing the server that the controller is ready.

Warn on Shtdwn : Enables a Warning packet to be sent informing the server of an impending shutdown/reprogram. The server should stop sending commands to the controller.

JTAG : Enables resets via the CF pin on the program PROM. Used when loading new

Hard Reset : Enables resets via the CMS/EMU Hard Reset line.

SYSRST : Enables resets via the VME backplane SYSRST signal.

Front Panel : Enables resets via the front panel push button switch.

Internal : Enables resets via a command sent in an Ethernet packet.

Configuration Register Bits: (Continued)

(Definitions and Defaults)

VME Configuration Register

		High Order															
bit:		31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
Bit definitions		SYSRST in ena.	SYSRST out ena.	IH_DT_SZ		IH Req. Level		IH Req. Type		upd_irq msk	Interrupt Levels						
Firmware default		0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
		Low Order															
bit:		15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Bit definitions		Force SYSRST	Ena. high order	Arbiter Type		Master Req. Level		Master Req. Type		User Defs	Interrupt Handler	Location Mon.	Slave enable	Arbiter enable	BTO enable	SYSCLK enable	Master enable
Firmware default		0	0	0	1	1	1	0	1	0	0	0	1	1	1	1	1
		(0xED1F)															

SYSRST in ena. : Enable monitoring SYSRESETs on the backplane.

SYSRST out ena. : Enable SYSRESETs out to backplane.

IH_DT_SZ : Specifies the data transfer capability of the Interrupt Handler (IH).

IH Req. Level : Specifies the bus request level for the Interrupt Handler's (IH) requester (0-3).

IH Req. Type : Specifies the bus requester type for the Interrupt Handler.

0: Release On Request (ROR)

1: Release When Done (RWD)

2: Fair ROR requester.

3: Fair RWD requester.

upd_irq_msk : Update IRQ mask - restores the mask to IH_LVL5 and auto resets itself to 0.

Interrupt Levels : Specifies the Interrupt ReQuest lines (IRQ's) that the IH services.

Force SYSRST : Force a SYSRESET

Ena. High order : Enable the high order bits of address and data busses.

Arbiter Type : Specifies the Arbiter type.

0: No arbitration (disabled).

1: SinGle Level arbiter (SGL), uses BR3.

2: PRIoritized arbiter (PRI).

3: Round Robin Select arbiter (RRS).

Master Req. Level : Specifies the bus request level for the VME Master's requester (0-3).

Master Req. Type : Specifies the bus requester type for the VME Master.

0: Release On Request (ROR)

1: Release When Done (RWD)

2: Fair ROR requester.

3: Fair RWD requester.

User Defs : Enables the user defined I/O buffers on J2 signals.

Interrupt Handler : Enables the Interrupt Handler. (not implemented yet)

Location Mon. : Enables the Location Monitor. (not implemented yet)

Slave enable : Enables the Slave. The slaves functions are currently only for testing purposes.

Arbiter enable : Enables the Arbiter.

BTO enable : Enables the Bus Timer. The time out value can be set by the user.

SYSCLK enable : Enables the VME SYSCLK on the backplane (16 MHz).

Master enable : Enables the VME Master.

Configuration Register Bits: (Continued)

(Definitions and Defaults)

VME Bus Timeout Register

Firmware default : 0x30D4 (200 μ sec. in 16 ns units)

VME Bus Grant Timeout Register

Firmware default : 0x0C35 (50 μ sec. in 16 ns units)

Assigning MAC Addresses

Notes on Representations:

Hexadecimal Representation:

MAC addresses are 48-bit addresses grouped into six octets. The standard representation of a MAC address is the hexadecimal representation (as defined by IEEE STD 802¹) which is a string of six octets (in Hex) separated by hyphens, for example: AC-DE-48-00-00-80.

The ordering of the octets is as follows: octet0-octet1-octet2-octet3-octet4-octet5.

Bit-reversed Representation:

An alternative representation that is sometimes used (in the context of IEEE 802.5) is the bit-reversed representation in which the bits in each octet are reversed. In this representation the octets are separated by colons. The MAC address for the example used above in bit-reversed representation is 35:7B:12:00:00:01.

The ordering of the octets is unchanged: octet0:octet1:octet2:octet3:octet4:octet5.

Beware! Source of Confusion:

Often, MAC address are written or displayed in the hexadecimal representation but the octets are separated by colons! One example of this is the Linux `/sbin/ifconfig` command. In documentation and software for the Gigabit Ethernet VME Controller, the hexadecimal representation will always be intended (and should be assumed) regardless of the separator actually used.

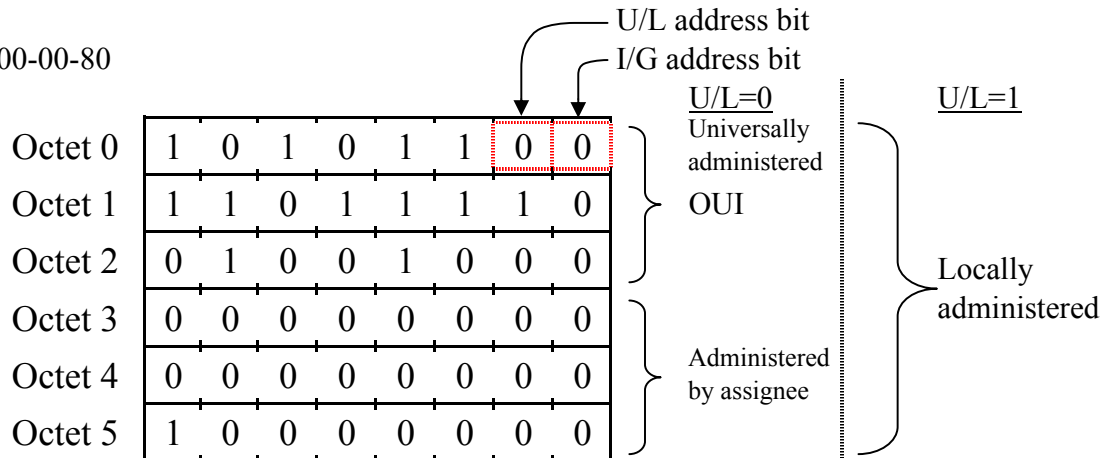
¹IEEE Standard for Local and Metropolitan Area Networks: Overview and Architecture, The Institute of Electrical and Electronics Engineers, Inc.; 2002. (Print: ISBN 0-7381-2940-2 SH94947; PDF: ISBN 0-7381-2941-0 SS94947)

Assigning MAC Addresses (continued)

Restrictions in MAC Address Assignments:

Structure of a MAC Address:

AC-DE-48-00-00-80



I/G: Individual or Group address. LSB of octet 0.

I/G=0 - Individual address.

I/G=1 - Group address.

U/L: Universally or Locally administered. Next to LSB of octet 0.

U/L=0 - Universally administered by IEEE.

U/L=1 - Locally administered.

OUI: Organizationally Unique Identifier.

Locally Assigned Addresses:

Locally assigned address must have the U/L bit set to 1.

Valid individual MAC addresses are: x2-xx-xx-xx-xx-xx
 x6-xx-xx-xx-xx-xx
 xA-xx-xx-xx-xx-xx
 xE-xx-xx-xx-xx-xx

Valid MAC group addresses are: x3-xx-xx-xx-xx-xx
 x7-xx-xx-xx-xx-xx
 xB-xx-xx-xx-xx-xx
 xF-xx-xx-xx-xx-xx

Where the x's can be assigned any value.