

Super CMDs

CMD_BUFFER_START

CMD[7:0]	CMDI[7:0]	Dummy
0xF1	0x00	0x0000 → return buffer carries length 0xhLLLL

CMD_BUFFER_END → not mirrored

CMD	CMDI[7:0]	Fill[7:0]	
0xF2	0x00	0x00	

REFERENCE_WORD

CMD[7:0]	CMDI[7:0]	Reference
0x01	0x01	0x0000

All read cmds go to CMD endpoint

READ_LOCAL

CMD	CMDI[7:0]	Address
0x01	0x02	Address[15:0]

READ_LOCAL_BLOCK

CMD	CMDI[7:0]	Address
0x01	0x03	Address[15:0]
Block_length , max 768 Words		

WRITE_LOCAL

CMD	CMDI[7:0]	Address
0x02	0x04	Address[15:0]
Data[31:0]		

WRITE_RESET (higest reset, resets everything)

CMD[7:0]	CMDI[7:0]	Fill
0x02	0x06	0x0000
Data[31:0]		

Flow Control

Write to UDP port 0x8002

WRITE_DELAY, without CMD frame. Expects only one 32 bit UDP word

CMD	CMDI[7:0]	Delay
0x02	0x07	Delay[15:0]

CMDs executed from stack

START_STACK → is mirrored as

CMD	endpoint	Dummy
0xF3	0x01; returns stack	0x0000; returns length

START_STACK_NODATA; Returns no data to data stack \$\$MBS

CMD	endpoint	Dummy
0xF3	0x02; Suppress data output	0x0000; returns length

Implementation for instruction “QUIET” required for TRIVA

Write D16/32-A24/32

CMD	AM	Argument
Write: 0x23	A16: 0x2D A24: 0x3D A32: 0x0D	Data Length: 0x0001 = 16 bit 0x0002 = 32 bit
Address[31:0] 16, 24 or 32 b its used by addressed module		
Data[31:0] 16 or 32 bits used by addressed module		

READ D16/32-A24/32

CMD	AM	Argument
Read: 0x12	A16: 0x2D A24: 0x3D A32: 0x0D	Data Length: 0x0001 = 16 bit 0x0002 = 32 bit
Address[31:0] 16, 24 or 32 b its used by addressed module		

Read BLT32-A32

CMD	AM	Argument
0x12	0x0F	Max cycles (64k max) 0xFFFF
Address[31:0]		

Read MBLT64-A32, swapped words at read

CMD	AM	Argument
-----	----	----------

0x13	0x0C	Max cycles (64k max) 0XXXXX
Address[31:0]		

Write Word to data

CMD	Fill[23:0]
0xC2	0x000000
WORD[31:0]	

STACK_END → not mirrored to data

CMD	Fill[23:0]	
0xF4	0x000000	

New control CMDs

Address_Inc_Mode → Memory read / FIFO read → OK

CMD	Fill
0xC3	0x000000 0= FIFO read, 1=memory_read

WAIT_CLK → ok

CMD	Fill
0xC4	0x000000; TIME[23:0] [clks]

SIGNAL_AKKU signal masked and shifted Accu → ok lower 16 bits of masked shifted Akku → pattern for 16 internal IRQs

CMD	Fill[23:0]
0xC6	0x00000000

Mask_Shift_Accu; first mask is applied, then rotated left Can be set and modified at any time

CMD	Shift bits +8 (8+1 = shift left, number multiplied by 2
0xC5	0x000000 after mask rotate left by up to 31 bits
And-Mask[31:0]	

Set_Accu

CMD	Fill
0xC8	0x000000
Set value[31:0]	

Read_to_Accu A32 D16/32

CMD	AM	Argument
0x14	A16: 0x2D A24: 0x3D A32: 0x0D	Data Length: 0x0001 = 16 bit 0x0002 = 32 bit
Address[31:0] 16, 24 or 32 bits used by addressed module		

BLT → loops for value of accu, max values = Argument

MBLT → loops for value of accu, max values = Argument

Cycle Dread when accu just set with accu argument

Comp_Loop_Accu (value) 0x12345678 (mode)

CMD	
0xC7	Compare mode: 0x0 =eq, 0x1 = lt, 0x2 = gt ; loop to previous “read_to_accu” if false

Compare value[31:0]

If Read to Accu or set_accu is before the read CMDs, the number of iterations in the Accu after masking and shifting is executed.

READ D16/32-A24/32

Removed:

SIGNAL_READ D16/32-A24/32 \$\$MBS

CMD	AM	Argument
Read: 0x16	A16: 0x2D A24: 0x3D A32: 0x0D	Data Length: 0x0001 = 16 bit 0x0002 = 32 bit
Address[31:0] 16, 24 or 32 b its used by addressed module		

Emits the lower 16 bits of read register to internal Signal array → connect to IRQs via register 0x7000 to 0x701C; required to handle TRIVA Trigger numbers from register.

Order of execution

- 1) Mask <compare><ROL><mask> → set mask for following Akku cmd
- 2) set Accu <Value> / load akku <Amode> <Dmode> <address>
- 3) MBLT
BLT
Dread_loop
Scan_Wait <compare_value> (compare with masked, shifted ACCU)

Write SPECIAL_WORD to data

CMD	Type[23:0]
0xC1	0x0 = time_stamp, 0x1 = accu[31:0],

Read 2eSST64-A32

CMD[7:0]	Rate[1:0]	AM[5:0]	Cycles[15:0]
Write: 0x12	0=160MB, 1=276MB, 2=300MB	0x21	Max cycles (64k max) 0XXXXX
Address[31:0]			

The controller can receive the maximum rate. The sender controls transfer rate and may send up to the maximum specified speed. So usually specify „2“ for maximum speed.

DATA Output FORMAT

Stack_Header {Number of Following Words[14:0]}

READ_CMD
Data[31:0]

BLT, MBLT, 2eSST

Header{ 15'd0,BERR_Flag,1'b1,Number of Following Words[14:0]}

Write Word

Word[31:0]

STACK header:

CMD[7:0]	ERR[3:0]	Stack_No[3:0]	CTR_ID[2:0]	Length [12:0]
0xF3 / 0xF9	Cnt,Syntax, Berr, timeout			0x0001

0xF9, Cnt = 1 → stack header of parts if events has parts

0xF3, Cnt = 0 → .stack header of last part of event or for non partial events
Carries the 3 error bits

Cnt : continue bit; Event is continued in next partial event

ERR {Cnt,Syntax, Berr, timeout}

Berr is only shown when Berr at Dread, or Dwrite.

“regular” Berr at block read is only shown in the Block read header

At read or write with Berr, an additional Berr Word 0xFFFFFFFF is placed.

CTR_ID: controller id in multi crate operation, 0..7

Length: max 8k for partial event

Block header

Stack execution is continued at time out errors.

CMD[7:0]	ERR[3:0]	Reserved[3:0]	Reserved[2:0]	Length[12:0]
0xF5	Cnt, 0, Berr, timeout	0000	000	0x0001

ERR {Cnt, 0, Berr, timeout}

Cnt = Block is continued in next partial event

Stack error messages on EP0, only when stack data goes to EP1

CMD[7:0]	ERR[3:0]	Stack_No[3:0]	Length
0xF7	0, Syntax, Berr, timeout		0x0001
{stack_number[15:0], stack_line_to_fail[15:0]}			

Rate of error messages limited to 2k/s

ERR {0, Syntax, Berr, timeout}

Communication Example

CMD send

```
0xF100 0000 # start of buffer ;
0x0101 0001 # place reference word
          0x0204 AAAA          # Write local
          0xDDDDDDDD          # Data
          0x0105 AAAA          # read local
0xF200 0000 #end of buffer
```

CMD return

----- Ethernet specific -----

```
{0x0110,reserved[3:0],frame number_cmd[11:0], reserved[3:0],data_words[11:0]}
{0x0111,header_pointer[10:0]==0}
```

```
0xF100 LLLL      # start of buffer , length of buffer;
0x0101 WWWW      # W=reference word
          0x0204 AAAA          # Write local
          0xDDDDDDDD          # Data
          0x0105 AAAA          # read local
          0xDDDDDDDD          # read dataF
```

Data return

----- Ethernet specific -----

```
{reserved[3:0],frame number_dat[11:0],reserved[3:0],data_words[11:0]}
{reserved[15:0],reserved[3:0],header_pointer[11:0] }
```

```
0xF3TS LLLL      # start of buffer : Stack number, length of buffer;
0xDDDDDDDD
0xF5010002        # BLT block, terminated with Berr
          0xDDDDDDDD          # BLT data
          0xDDDDDDDD
0xF3TS LLLL      # start of buffer : Stack number, length of buffer;
0xDDDDDDDD
0xDDDDDDDD
0xF3TS LLLL      # start of buffer : Stack number, length of buffer;
0xF5000003        # BLT regular termination
          0xDDDDDDDD          # 3 BLT data following
          0xDDDDDDDD
          0xDDDDDDDD
```

L = Number of following words

S = stack number

T = timeout at VME-bus (0x0 ok, 0x1 = timeout)

Wrapping UDP Data

Header0: {0,0,Chan[1:0], Packet_number[11:0], CTR_ID[2:0],number_of_datawords[12:0]}

Header1: {UDP_time_stamp[18:0],Header_pointer[12:0]}

UDP_time_stamp: increment in 1ms steps → runs 17.5 minutes

CTR_ID = controller ID

Chan[1:0]. 0 = command mirror;
 1= response from stack fifo EP0, (direct execution, errors)
 2= data from stack EP1 (event data)

number of data words: number of words to follow the two header words.

Header_pointer: position directly behind the header words is 0.

Communication with stack execution CMD:

CMD send data

```
{0x0100, bref[15:0]} # start of buffer , reference;
    {0x0101 000, stack[3:0]} # write stack
        0xC200 0000 # Write word to Stack (reference word to identify data packet)
        0x000000123
        0x230D 0002 # Write D16A32
        0x0000 000F # Write address = 0xF
        0x1234 5678 # Word to write
    0xF100 0000 # Stack end
    {0x0102, 0x000, EPoint, stack[3:0]} # execute stack , Endpoint to send
0x01FF 0000
```

CMD Return data = identical to send data: (To Check if UDP package has arrived)

```
{0x0110, frame number[15:0]}
    {0x0111, pointer_last_word[15:0]} = 3
    {0x0100, ref[15:0]} # start of buffer , reference ; // CMD-Marker
        {0x0101, 0x000, stack[3:0]} # write stack
            0xC200 0000 # Write word to Stack (reference word to identify data packet)
            0x000000123
            0x230D 0002 # Write D16A32
            0x0000 000F # Write address = 0xF
            0x1234 5678 # Word to write
        0xF100 0000 # Stack end
    {0x0102, 0x000, EPoint, stack[3:0]} # execute stack → Produces a data package
0x01FF 0000 #end of buffer
```

UDP associated data package

```
{0x0110, frame number[15:0]}
    {0x0111, pointer to last word[15:0]} = 3
    {0x0112, pointer to first event_header.[15:0]} (none → 0) = 1 // DATA Marker
        {ref[11:0], stack[3:0], data_length[15:0]} = 1
        0x00000123 #reference word written to stack
```

Register map

Registers from 1 to 0x5FFF are 32bit registers.

- * They can be accessed by super CMDs

- * They only allow **D32 read and write** access from stack.

0x0100 Synchronisation

0x0010 Master mode = 1;

0x0400 USB frame gap[15:0] multiples of 8ns;
Default 20000 = 250us;

Trigger IO

0x0200 Trigger-IO, Timer; Trigger area has D16 = 2 byte address increments

0x0200 select_address[9:0]; {level[1:0], xxx ,unit[4:0]} // only lower 32 units in present impl.
4 levels, 32 units per level

0x0204 Reset_register_mask[11:0]: {timer[3:0],counter[7:0]}

0x6090 resets according to mask

0x0300 ... 0x031E 32x registers[15:0] for unit

0x0340 ... 0x05

3E 32x connects[15:0] for unit 0...32,

//**0x0380**.....0x03EE Input connects: {con,level[1:0],unit[7:0],outputs[3:0]}

// Data: 14 bit connection coordinate;

//**0x03F0** connection level: lev_pattern[3:0];

Units:

Type = 1, Input with GG

Type = 2, output with GG

Type = 3 Timer

Type = 4

VME_IRQ_input 1...7

Stack_Busy 0...7

Soft_trigger 0...7

VME_mon: AS*,DS0*, Dtack*

Type = 5 receive_sync_triggers

Type = 8, Gate generator

GG:

A0= INF {inputs[3:0],outputs[3:0],Type[7:0]}

A1 = delay

A2 = width

A3 = holdoff

A4 = invert_input (bit[0])

Type = 16, Coincidence + Pattern unit

Type = 31 Stack_start

Type = 32 internal_IRQ_out

Type = 33 Send_sync_triggers, 4 inputs

Type = 64 Dig_Oszi, 8 inputs, trigger output for stack start

0x1000 Trigger statistics (1k words)
stamps, rates, counts

// Stack has D32 bit = 4 byte address increments

Stack execution triggers

0x1100	stack0		RW		{IMM,trigger_type[2:0],sub_trigger[4:0]}
0x1104	stack1		RW		
0x1108	stack2		RW		
0x110C	stack3		RW		
0x1110	stack4		RW		
0x1114	stack5		RW		
0x1118	stack6		RW		
0x111C	stack7		RW		

Trigger type[2:0]:

0 = no trigger

1= IRQ, sub_trigger = 0...6 for IRQ1...7 (ROAK)

2= IRQ without IACK (RORA)

3= external Trigger (via IO) from trigger network

4= Timer underrun trigger

IMM=1 immediately execute this stack

Stack address index page

0x1200	stack0		RW		Only lower 16 bits valid, point to stack start.
0x1204	stack1		RW		
0x1208	stack2		RW		
0x120C	stack3		RW		
0x1210	stack4		RW		
0x1214	stack5		RW		
0x1218	stack6		RW		
0x121C	stack7		RW		

Start / stop

0x1300	start	2	RW		Bit 0: start = 1; Bit 1= stacks active
0x1304	Controller_id	3	RW		Is transmitted in F3/F9 word and USB header0

Example: when setting start bit to 0: poll start register until bit1 gets 0. Then all trigger requests and last stack have been processed.

0x2000 2k *32-bit Words = 4k-bytes Memory available for Stacks

0x2000	stack_start		RW	0	Stack is 32 bit oriented, → lower 2 address bits are not significant.
0x2004					

0x4000 to 0x43FF MDIO, 10 bits

Adress[9] = 1 → internal MAC access; 0 → PHY access

IP configuration 0x4400

Addr		bits		Def.	
0x4400	IP_low	16	RW		Own IP low
0x4402	IP_high	16	RW		Own IP high
0x440C	ip-cmd_low	16	RW		Dest ip-cmd_low
0x440E	ip_cmd_high	16	RW		Dest ip_cmd_high
0x4410	ip-dat_low	16	RW		Dest ip-dat_low
0x4412	ip_dat_high	16	RW		Dest ip_dat_high
0x4414	cmd_mac0		R		
0x4416	cmd_mac1		R		
0x4418	cmd_mac2		R		
0x441A	cmd_dest_port		R		
0x441C	data_dest_port		R		
0x441E	data_mac0		R		
0x4420	data_mac1		R		
0x4422	data_mac2		R		
0x4430	jumbo_frame_on	1	RW	0	Switch on jumbo frames (8k)

Own IP can be set by UDP via register or by DHCP

CMD dest IP can be modified when when MVLC is accessed at port 8000

Data dest IP can be modified when when MVLC is accessed at port 8001

VME module registers, Emulates a standard VME module at address 0xFFFFxxxx

Registers starting from 0x6000 are 16 bit register.

They can be written and read from stack by addressing A=FFFFxxxx, Data width is automatic

Addressing by direct cmd is also possible. Only lower 16 bits of data word valid.

SUPPORTED AM codes

2D A16 supervisory access

29 A16 non privileged data access

3D A24 supervisory data access

39 A24 non privileged data access

0D A32 supervisory data access

09 A32 non privileged data access

21 2eSST

3B A24 non privileged block transfer (BLT)

3F A24 supervisory block transfer (BLT)

0F A32 supervisory block transfer (BLT)

0B A32 non privileged block transfer (BLT)

3C A24 supervisory 64-bit block transfer (MBLT)

38 A24 non privileged 64-bit block transfer (MBLT)

0C A32 supervisory 64-bit block transfer (MBLT)

08 A32 non privileged 64-bit block transfer (MBLT)

Wrapping events

Header: {stack, event_length} → max event length is 32k Words.
Data

further structure can be added by stack instructions. For example:
Trigger time stamp,
event number

Trigger registers:

Sends a status word

0x00 trigger counter_accept0

0x01 trigger counter_accept1

0x04 trigger counter_free0

0x05 trigger counter_free1

0x08 trigger time stamp0

0x09 trigger time stamp1

IRQ / Signaling concept:

V0018

IRQ 1...7 are VME IRQs (internal 0...6),
IRQ 8 to 15 (int 7..14) are internal IRQs
int(0..8) can be also connected to time stamper event FIFO
int(9) fixed DSO IRQ

V0019

IRQ 1...7 are VME IRQs (internal 0...6),
IRQ 8 to 15 (int 7..14) are internal IRQs
int(0..14) can be also connected to time stamper event FIFO
int(9) fixed DSO IRQ

Stack commands READ_SIGNAL and SIGNAL_WORD can emit a 16 bit internal signal

When not all 4 IRQ index registers are deactivated (== 0):

The pulsed signal is evaluated in 4 sets of 2 registers:

0x7000 IRQ index to be triggered (1...16) ; 0 means deactivated

0x7002 Compare signal. If equal, specified IRQ 0x7000 is emitted

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0x700C

0x700E

When all IRQ indices are == 0; the signal is interpreted as direct IRQ trigger: bit 0 = irq1, bit 15 = IRQ16; IRQ9 is reserved for the DSO, and has no effect when set.