

DRAFT-DRAFT-DRAFT
Tiedowns
COMMUNICATIONS PROTOCOL

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The VME to slave micro controller communications goes through a gateway called the master micro controller. The communications between the VME and the master micro controller consists of a RS-232 link with an eight byte frame header. The communications between the master micro controller and the slave micro controllers is based on RS-485 with Opto 22 format.

First the VME sends the packet to the master micro controller and the VME task waits for a reply from the master before sending another packet on the same link (or a link timeout occurs). The master micro controller will in turn send the `com_msg` to the slave and wait for a response. If the response from the slave is not received within *50 milliseconds*, it times out and sends a time out reply to the VME.

The slave micro controller will receive `com_msg` and reply with a `rep_msg`. The master micro controller will receive the response from the slave and will send the `rep_msg` to the VME.

The formats for these packets are as follows:

1. VME to Master Micro Controller

The VME to master micro controller protocol consists of an eight bytes frame header plus the command message as follows:

[[f_header] [master_cmd] [485_addr] [com_msg_len] [msg_id] [b_header]] [com_msg]

<code>f_header</code>	2 bytes containing 0xaa55.
<code>master_cmd</code>	1 byte defined in Table 1.
<code>485_addr</code>	1 byte containing the address of the device on the 485 network. The master address is 0.
<code>com_msg_len</code>	1 byte containing the length of the <code>com_msg</code> to be sent to the slave.
<code>msg_id</code>	1 byte identifying the message and will be repeated back to the VME by the slave and/or master.
<code>b_header</code>	2 bytes containing 0x55aa.
<code>com_msg</code>	The message that will be sent to the slave (<code>485_addr</code>) micro controller.

MASTER_CMD		
Command	Opcode	Comment
CMD_TO_MICROS	0x1	Send the cmd_msg to the slave micro controller
CMD_ECHO	0x3	Do not send to slave! Echo the entire packet back to the VME

TABLE 1. VME to master micro controller commands.

2. Master Micro Controller to Slave Micro Controller

The master micro controller to slave micro controller protocol consists of a five bytes frame plus the com_msg as follows:

[485_addr] [cmd_msg_len] [msg_id] [com_msg] [crc hi] [crc lo]

485_addr	1 byte containing the address of the device on the 485 network.
cmd_msg_len	1 byte containing the length of the com_msg + 3.
msg_id	1 byte identifying the message and will be repeated back to the VME by the slave and/or master.
com_msg	The message that will be sent to the slave micro controller.
crc hi	The high byte of a 16 bit cyclic redundant code.
crc lo	The low byte of a 16 bit cyclic redundant code.

The com_msg is further formatted as follows:

[slave_cmd] [data_index] [optional_data]

slave_cmd	1 byte containing the opcode command to the slave as defined in Table 2.
data_index	1 byte requesting the slave which data to sent back in the data field as defined in Table 3.
optional_data	Data needed by the slave to carry out the command as defined in Table 2.

The maximum RS485 packet length is 255 bytes, therefore the maximum length of the com_msg is 250 bytes.

SLAVE_CMD				
Command	Opcode	Optional Data	Data Bytes	Comment
Nop	0x0		0	No Operation
Reset	0x1		0	Resets the control cabinet safety relay
Fbuffer	0x2	Time, Pos1..5	24	Writes time (ms) and 5 positions (enc. count) to buffer
Stop	0x3		0	Stops tracking or slewing motion
Track	0x4		0	Follows the pos @ time commands in buffer
Slew	0x5	Pos	4	Slews to a particular position (enc. count)
Get Status	0x6		0	Requests that the slave sends a complete status dump
Get Param	0x7	Param#	1	Requests that the slave sends the parameter Param#
Set Param	0x8	Value, Param#	3	Sets parameter Param# to value (if in allowed range)
Purge buffer	0xa		0	Purges the pos @ time buffer
Set Time	0xd	Time	4	Sets the MsCounter to Time at the next 1 sec tick
Get Time	0xe		0	Requests slave sends its MsCounter at last 1 sec tick
Power On	0xf		0	Turns the contactor for amplifier power ON
Power Off	0x10		0	Turns the contactor for amplifier power OFF
Get Log	0x11		0	Requests slave to send its fault log buffer
Set Clock	0x12		4	Set the time in the internal Toshiba clock time ¹
Get Clock	0x13		0	Requests slave sends its internal Toshiba clock time ¹
Purge Log	0x14		0	Purges the log faults buffer

¹ Seconds since January 1, 1980.

SLAVE_CMD				
Command	Opcode	Optional Data	Data Bytes	Comment
Get Free Pos	0x15		0	Requests the free available space in the Position Ring Buffer
Set FeedBack	0x16	FeedBack	1	Close the feedback loop with FeedBack
Set Maintenance Mode	0x17	Mode	1	Enter/Exit to/from Maintenance Mode

TABLE 2. Master micro controller to slave micro controller commands. *value?*

The data_index indicates which word (2 bytes) of memory to request. The memory is mapped as shown below.

Data Index	Name	Description
0	P24	+24 Vdc monitor (0.008 Volts/bit)
1	N24	-24 Vdc monitor (0.016 Volts/bit)
2	B24	Brakes +24Vdc (0.008 Volts/bit)
3	Encoder_Monitor	Encoder +5 Vdc (0.0025 Volts/bit)
4	V_FB	Velocity Command Feedback (0.008 Volts/bit) (0.01472 Deg./Sec.)
5	I_Monitor	Drive Current Monitor (0.00305 Amps/bit)
6	Speed_Monitor	Speed Monitor (4.8828 Mtr. RPMs/bit) (0.01797 Deg./Sec.)
7	Load_Cell_1	Load Cell 1
8	Load_Cell_2	Load Cell 2
9	Accelerometer	Reserved for future use. (0x0000)
10	RATE_PCU	Rate PCU
11	VEL_CMD	Velocity Commanded
12	LS-DI	Little Star Discrete Inputs
13	UIO1-DI	Universal I/O #1 Discrete Inputs
14	UIO2-DI	Universal I/O #2 Discrete Inputs
15	NOT IN USE	NOT IN USE - 0x0000
16	LS-DO & UIO1-DO	Little Start and Universal I/O #1 Discrete Outputs
17	UIO2 & 0x00	Universal I/O #2 and 0x00
18	DrvState & DrvStatus	Drive State and Drive Status
19	NOT IN USE	0x0000

0	Safety_Status	Safety Status, Limit Status, 0, Axis Status
21	Fault_Status	Fault Status

TABLE 3. Data Index

The Discrete Inputs (DATA_INDEX 12 thru 15), Discrete Outputs (DATA_INDEX 16 and 17), and the Status Variables (DATA_INDEX 18 thru 21) are defined in detail in *Appendix A*.

Fbuffer command use the following optional data:

[TIME] [Pos1] [Pos2] [Pos3] [Pos4] [Pos5]

TIME 4 bytes containing time in unsigned long format. Time is represented in milliseconds from midnight.

Pos1 4 bytes containing position to be applied at the time specified.

Pos2 4 bytes containing position to be applied at the time specified plus 40 msec.

Pos3 4 bytes containing position to be applied at the time specified plus 80 msec.

Pos4 4 bytes containing position to be applied at the time specified plus 120 msec.

Pos5 4 bytes containing position to be applied at the time specified plus 160 msec.

Note: All positions are in encoder counts in unsigned long format.

Set Param command, `slave_cmd` use the following data:

[Param#] [Value]

Param# 1 byte containing the parameter number as defined in Appendix B.

Value 2 bytes value of parameter Param# (unsigned int)

Set FeedBack command, `slave_cmd` use the following data:

[FEEDBACK]

FEEDBACK 1 byte containing:

0: to use the average of Load Cell 1 and 2

1: to use Load Cell 1 only

2: to use Load Cell 2 only

3: to use the Encoder

Set Maintenance Mode command, `slave_cmd` use the following data:

[MODE]

MODE 1 byte containing:

0: to EXIT Maintenance mode, and stop

1: to ENTER to Maintenance mode

3. Slave Microcontroller to Master Microcontroller

The slave micro controller to master micro controller protocol consists of a four bytes frame plus the `rep_msg` as follows:

[`rep_msg_len`] [`msg_id`][`slave_rep`] [`rep_msg`] [`crc hi`] [`crc lo`]

Force reply to /TW

- ⊙ `rep_msg_len` 1 byte containing the length of the `rep_msg` from the slave.
- 1 `msg_id` 1 byte that will be repeated back to the VME by the slave.
- 2 `slave_rep` 1 byte defined in Table 4.
- `rep_msg` The reply message from the slave micro controller to the VME.
- `crc hi` The high byte of a 16 bit cyclic redundant code
- `crc lo` The low byte of a 16 bit cyclic redundant code

SLAVE_REP		
Reply	Opcode	Comment
S_OK	0x0	Command received OK
S_INV_CMD	0x4	Slave received an invalid command from master
S_BCRC	0x5	Slave received a packet from master with bad CRC
S_OUT_OF_RANGE	0x6	Data received with command is out of range, ignored
S_OVERFLOW	0xA	Buffer overflow
S_PARAM_NOT_SAVED	0x8	Unable to save system eeprom parameter
S_INDEX_OUT_OF_RANGE	0x9	System Parameter Index out of range

TABLE 4. Slave micro controller to master micro controller replies.

The maximum RS485 packet length is 255 bytes, therefore the maximum length of the `rep_msg` is 251 bytes. The `rep_msg` is further formatted as follows:

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[Time_Stamp] [Position][LC1][LC2] [GeneralStatus] [Data] [Optional_Data]

3	Time_Stamp	4 bytes containing time at last 100 msec (time is in msec from midnight).
7	Position	4 bytes containing the position at Time_Stamp in encoder counts.
11	LC1	4 bytes containing the tension of Load Cell 1 at Time_Stamp
15	LC2	4 bytes containing the tension of Load Cell 2 at Time_Stamp
19	GeneralStatus	2 bytes of general status as defined below.
21	Data	2 bytes of data as requested by data_index (see com_msg).
23	Optional_Data	Data responding to some commands as described below.

The General Status is a two byte word returned on every communication packet to the VME containing detailed status information. The bits are defined as follows:

Bit # Definition

- 0 Safety Open - A 1 indicates that the safety relay is not energized. The power to the motor amplifiers is removed.
- 1 Axis Fault - A 1 indicates a failure which will inhibit axis motion.
- 2 Drive 1 Fault - A 1 indicates a failure which will inhibit drive 1 to be used.

3 NOT IN USE

- 4 Warning - A 1 indicates that something is out of nominal value, but does not inhibit motion.
- 5 Tracking Fault - A 1 indicates that tracking accuracy may be affected, but motion is allowed.

6,7 FeedBack in Use - A 0 indicates that the average of Load Cell 1 and Load Cell 2 is in use, a 1 indicates that Load Cell 1 only is in use, a 2 indicates that Load Cell 2 only is in use, and 3 that the encoder is in use.

- 8 Power On - A 1 Indicates that the power amplifiers have power applied to them.
- 9 Drive Enabled - A 1 Indicates that the amplifiers are enabled and system may be moving accordingly.
- A Remote Control Location Selected - A 1 indicates that the system can be commanded remotely.
- B Brakes Released - A 1 indicates that the brakes are released (not applied).

C,D DRIVE MODE - A 0 indicates that we are in STOP_MODE, a 1 in TRACK_MODE, a 2 in SLEW_MODE, and a 3 in MAINT_MODE.

E → *rebooted.*
F → *DATA IN TRACKING Buffer.*

The following commands expect the slave to send **optional_data** back to the VME as part of the response:

Get Status - The slave sends a complete status dump as described above (See Table #3).

Get Param - The slave returns 2 bytes (unsigned int) representing the value of the parameter working value param#. (See **SET_PARAM** command)

Get Time - The slave returns 4 bytes representing the time in ms from midnight at the previous 1-sec tick.

Get Clock - The slave returns 4 bytes representing the current hardware clock time (seconds since January 1, 1980).

?
• **Get Log** - The slave returns the fault log buffer which consists of the last 7 faults detected by the system and the number of occurrences each one had. The fault numbers and the meaning of each is described in *Appendix B*.

Get Free Pos - The slave returns the free available space in the Position Ring Buffer in integer format (2 bytes).

4. Master Micro controller to VME

The master micro controller to VME protocol consists of an eight bytes frame plus the reply message from the slave as follows:

[[f_header] [comm_stat] [485_addr] [rep_msg_len] [msg_id] [b_header]] [rep_msg]

f_header 2 byte containing 0xaa55.
 comm_stat 1 byte defined in Table 8.
 485_addr 1 byte containing the address of the device on the 485 network.
 rep_msg_len 1 byte containing the length of the rep_msg from the device.
 msg_id 1 byte that will be repeated back to the VME by the master (from slave).
 b_header 2 byte containing 0x55aa.

 rep_msg The reply message from the slave micro controller to the VME.

COMM_STAT		
Status.	Opcode	Comment
M_COM_STAT_OK	0x0	Communications OK
M_COM_STAT_SLV_TMOUT	0x1	Slave did not reply within expected time

COMM_STAT		
Status	Opcode	Comment
M_COM_STAT_BCRC	0x2	Master received a packet from slave with bad CRC
M_COM_STAT_BSTAT	0x3	Master's send function returned an unrecognized status
M_COM_STAT_BCMD	0x7	Master received an invalid command from VME
S_INV_CMD	0x4	Slave received an invalid command from master
S_BCRC	0x5	Slave received a packet from master with bad CRC
S_OUT_OF_RANGE	0x6	Data received with command is out of range, ignored
S_OVERFLOW	0xA	Buffer overflow
S_PARAM_NOT_SAVED	0x8	Unable to save system eeprom parameter
S_INDEX_OUT_OF_RANGE	0x9	System Parameter Index out of range

TABLE 8. Master micro controller to VME replies.