Technical Specification

VM-110 UDP EG-Link Specification

Document No: TS-0006

REV	DATE	REASON FOR ISSUE	PREPARED BY	CHECKED BY	APPROVED BY
1	2017-08-29	Initial revision	OTE	JL	GAØ
2	2018-01-15	Updated the BU state, link status and RU state values.	OTE	JL	OTE
3	2020-06-12	Updated during implementation	JL	MS	GAØ

Table of Contents

1 Introduction 3
1.1 Purpose 3
1.2 System Overview 3
1.3 Definitions and Abbreviations 3
1.4 Revision History 4
2 General 5
2.1 Value encoding 5
2.2 Multicast configuration 5
3 Packet framing 5
3.1 Packet ID 5
3.2 Header 6
3.3 CRC 6
4 Packet payload 7
4.1 VRPI – VisionRemote Periodic Input 7
4.1.1 BU state 7
4.1.2 Link status 8
4.1.3 RU state 8
4.1.4 Joystick position 8
4.1.5 Switch state 9
4.2 VRPO – VisionRemote Periodic Output 9
4.3 VRCI - VisionRemote Command Input 10
4.4 VRAO – VisionRemote Acknowledge Output 10
4.5 VRCO - VisionRemote Command Output 10
4.6 VRAI – VisionRemote Acknowledge Input 11
5 Packet Flow 11
5.1 Packet handling 11
5.1.1 VRPI 11
5.1.2 VRPO 11
5.1.3 VRCI 12
5.1.4 VRCO 12
5.1.5 Illegal packets 12
5.2 Armed vs. Disarmed 12
5.3 G-Link fallback operation 12

1 Introduction

1.1 Purpose

This document specifies the UDP protocol used for the VisionRemote VM-110 EG-Link.

Please note that other protocols may be running simultaneously on the EG-Link. This is not specified in this document.

Also note that data presented on the RU graphical screen and commands entered on graphical screen are handled by the RU application. The RU application is adapted to suit the actual machine. This document specifies how to exchange this data over EG-Link, but the actual data content must be specified in a machine specific document.

1.2 System Overview

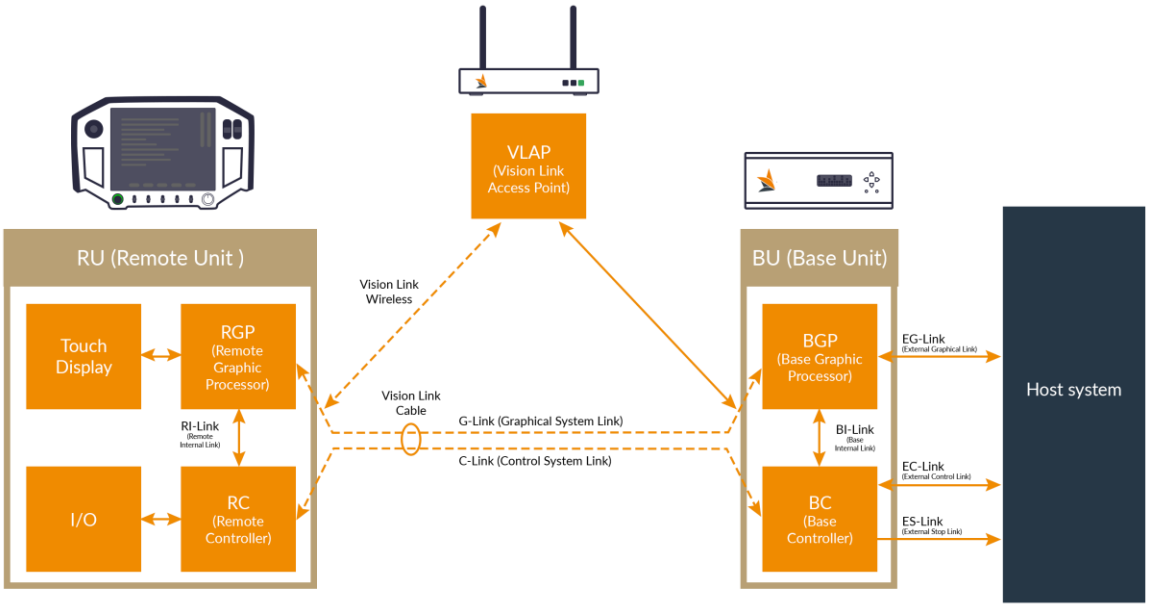


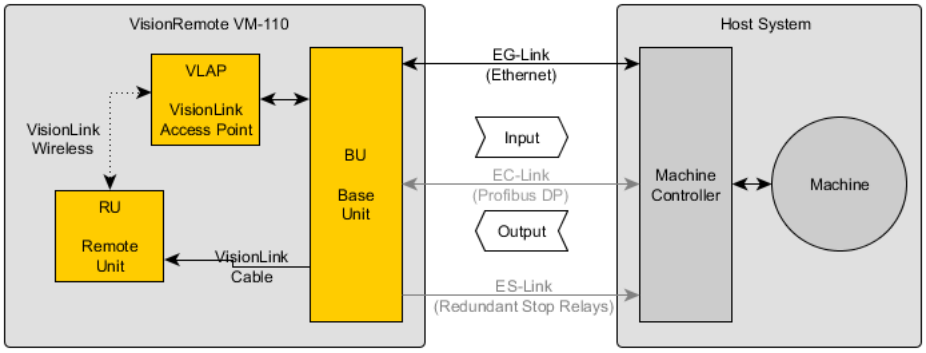
Figure 1 The Vision Remote system layout.

1.3 Definitions and Abbreviations

Machine controller is used for the computer or PLC that communicates with BU using the UDP protocol specified in this document.

The remote unit is abbreviated RU, and the base is abbreviated BU.

The term 'Input' is used for data sent from BU to machine controller. The term 'Output' is used for data sent from machine controller to BU. These terms are identical to PLC terms for dedicated peripheral units:



1.4 Revision History

Revision	Description
1	Initial revision
2	Updated the following sections: - 4.1.1 BU state. Changed description of value 0x04. - 4.1.2 Link status. Added value 5 & 6. Changed description of other values. - 4.1.3 RU state. Changed state names to match system specification. - 4.1.3 Joystick position. Added figures to increase clarity.
3	Updated the following sections: - 2.2 Multicast configuration. Changed output packet port default value and description.

2 General

2.1 Value encoding

All multi bytes values are encoded in little-endian format (least significant byte first).

All data specified in this document uses one of the following encodings:

- Unsigned integer with a length of 8, 16 or 32 bits.
- Signed integer with a length of 8, 16 or 32 bits using two's complement.
- ASCII values. Only values in range 0x20..0x7E are used.

All size values in this document are to be interpreted as bytes.

2.2 Multicast configuration

Default configuration is:

- Multicast address: 239.255.42.20
- Input packet port: 5825
- Output packet port: 5827
- Multicast TTL: 1

Multicast address and input packet port is configurable in the BU. The output packet port is always 2 higher than the input packet port.

3 Packet framing

All UDP packets have the same layout:

Field	Size	Description
Packet ID	4	Identifies the packet type. See section 3.1.
Header	12	Contains information about the packet. See section 3.2.
Payload	0..492	Packet payload. Varies with the different packets. See chapter 4.
CRC	4	Ensures data integrity of the packet. See section 3.3.

3.1 Packet ID

A magic code first in each packet identifies the packet type. The magic code is a 4 character ASCII string, and the following values are defined:

Value	Description
VRPI	VisionRemote Periodic Input. This packet is sent periodically by the BU. It contains VisionRemote operational status, and state of switches and joysticks on RU.
VRCI	VisionRemote Command Input. This packet is sent by BU when a command is issued by the operator in the RU application.
VRAI	VisionRemote Acknowledge Input. This packet is sent when RU application has processed a VRCO packet.
VRPO	VisionRemote Periodic Output. This packet should be sent periodically by the machine controller. It contains information to be presented on the graphical user interface.
VRCO	VisionRemote Command Output. This packet sends a command from the machine controller to RU application.
VRAO	VisionRemote Acknowledge Output. This packet should be sent when the machine controller has processed a VRCI packet.

The first 2 bytes, 'VR', identifies this as a VisionRemote packet. The 3rd byte identifies type of packet (Periodic, Command or Acknowledge). The 4th byte shows the direction (Input or Output).

3.2 Header

The packet header has the following layout:

Field	Size	Description
Revision	2	Payload revision number. Set to 0 to use the layout described in this document.
Origin	2	Unique ID of BU that sent the packet. To be set to 0 in packets from machine controller.
Serial	2	Packet serial number. The sender numbers all packets sent sequentially. Can be checked by receiver to detect packet loss and repeated packets.
Size	2	Size of packet payload in number of bytes.
Spare	4	Spare for future use. Set to 0 for now.

3.3 CRC

CRC is calculated on all packet data including Packet ID and header. CRC parameters are as follows:

- Initial value: 0xFFFFFFFF
- CRC polynomial: 0x04C11DB7
- Processing order: Sequential byte wise.

Polynomial and initial value is identical to STD-CRC-32 used by Ethernet end many other protocols, but uses byte wise processing and not DWORD processing that Ethernet uses.

4 Packet payload

4.1 VRPI – VisionRemote Periodic Input

Payload of VRPI packet is:

Field	Size	Description
BU state	1	State of BU. See section 4.1.1.
VLAPs	1	Number of VLAPs connected to BU. In range 0..3.
Unarmed RUs	1	Number of unarmed RUs communicating with this BU.
EG-Link status	1	State of EG-Link. See section 4.1.2.
EC-Link status	1	State of EC-Link. See section 4.1.2.
C-Link status	1	State of C-Link. See section 4.1.2.
Armed RU	2	Unique ID of RU that is currently armed. Set to 0 if no remote is currently armed. When 0, all the following fields are set to 0.
RU state	1	State of armed RU. See section 4.1.3
RU battery	1	Armed remote battery level in range 0..100 (%).
RU C-Link RSSI	1	RSSI level of C-Link in range 0..100 (%).
RU cable	1	Set to 0 if operating on wireless VisionLink. Set to 1 if operating on cable.
RU Docked	1	Set to 1 when RU is placed in docking station. Otherwise 0.
RU Disabled	1	Set to 0 if remote is enabled. Set to 1 if disabled due to tilting. Set to 2 if disabled due to inactivity.
RU Joystick 1 to 4	4 * 2	Position of joystick 1 to 4. See section 4.1.4.
RU Switch 1 to 8	8 * 2	State of switch 1 to 8. See section 4.1.5.
RU Encoder value	1	Encoder value. Is incremented and decremented as encoder is rotated. Wraps around freely, so machine controller must handle this if needed.
RU Encode switch	1	Set to 1 when encoder is pushed down. 0 if not.
Spare	6	Spare bytes for future use. Set to 0 for now.

4.1.1 BU state

The following BU state values are defined:

Value	Interpretation
0x00	Initial. BU is not fully operative yet.
0x01	Stopped. BU is armed against a specific RU, and RU signals that BU should stop.
0x02	External link error. Monitoring has detected an error in EC-Link or EG-Link.
0x03	Blocked. Communication is lost with an armed RU. Turn on RU and rearm to resume

	operation.
0x04	Failed. Self-diagnostics has discovered a fatal internal error in BU.
0x10	Disarmed. BU is not armed against a specific RU. Check 'Unarmed RUs' to see if any unarmed RUs are connected.
0x11	Armed. BU is armed against a specific RU.

The ES-Link relays will be open when BU state is less than 0x10.

4.1.2 Link status

The following link state values are defined:

Value	Interpretation
0	Unused. The link is not used in this system.
1	Operational. The link operates normally.
2	No Link. Link is not operational because no valid data has been received.
3	Link error. Configuration error in system causes link to be inoperative.
4	Interface Error. Error reported by link interface module.
5	Data error. Link is up, but there is an error in the exchanged data.
6	Passive. Link is not in use. Can only be reported on C-Link when no remote is armed.

4.1.3 RU state

The following RU state values are defined:

Value	Interpretation
0	Initial. No RU is armed yet.
1	Disarmed. Only used internally.
2	Armed. Remote is armed, but movements are disabled due to tilting or inactivity.
3	Enabled. Remote is armed and enabled. Movements are allowed.
4	Stopped. Armed remote has stopped causing ES-Link relay to open.

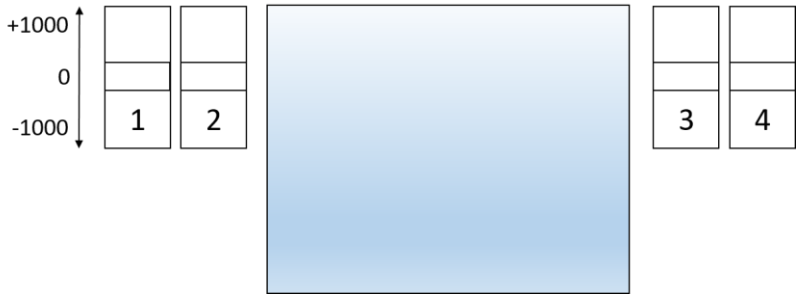
RU enters stopped state if one of the following happens while the RU is armed:

- Stop switch is activated
- Free fall or shock sensor is triggered
- A fatal error has occurred in RU

4.1.4 Joystick position

Joystick position as a signed integer in range +/- 1000. A passive joystick is reported as 0.

Single axis joysticks are oriented like this:



Dual axis joysticks are oriented like this:

4.1.5 Switch state

Note that the protocol and the electronics are prepared for up to 8 switch positions. The RU has room for 4 switches if it is equipped with a stop switch, and 5 if not. The switches are numbered from left to right.

The value reported in switch state varies with the fitted switch:

Equipment	**Value reported**
Pushbutton	1 if button is pushed. 0 if not.
2-position toggle switch	1 if switch is in upper/right position. 0 if not.
3-position toggle switch	0 in center position. 1 in upper/right position. -1 in lower/left position.
Potentiometer	0 in counter clockwise position, up to 1000 in clockwise most position.
Pushbutton with LED	0 means not pushed. 1 means pushed. Add 2 if LED is lit.
Dual color LED	0 means OFF. 1 means GREEN. 2 means RED. 3 means AMBER.

When fitted with LEDs, the LEDs are controlled by the RU application. If the machine controller shall control these LEDs, functionality must be implemented in RU application to forward this data to the LEDs.

4.2 VRPO – VisionRemote Periodic Output

Payload of VRPO packet is:

Field	Size	Description
Packet number	2	If the periodic data is configured to be larger than 488 bytes, then the packet will have to be split into several packets. This field will show the packet number. It shall be incremented by one for each packet.
Periodic data	0 - 488	Periodic process data from machine controller to BU.

Periodic process data typically contains machine state values and measurement parameters. It is up to the RU application and the machine controller to agree on the interpretation of this data.

The number of packets are known since this follows from the configuration. All packets shall be full, besides the last one, this doesn't need to be full.

4.3 VRCI - VisionRemote Command Input

Payload of VRCI packet is:

Field	Size	Description
Command ID	2	BU numbers all generated commands sequentially. Shall be used by machine controller to detect repeated commands and to acknowledge a command.
Spare	4	Reserved for future use. Set to 0 for now.
Command data	16	Command data from RU application to machine controller.

When a command packet is retransmitted (see section 5.1.3), the packet serial number in packet header will increase normally, but the Command ID will not be incremented.

Normally, most commands are only allowed on an armed remote. It is up to the RU application to disable blocked commands when unarmed. Also the machine controller should check RU state to ensure that the RU is armed before executing the command.

4.4 VRAO – VisionRemote Acknowledge Output

Payload of VRAO packet is:

Field	Size	Description
Command ID	2	ID of VRCI command that is acknowledged.

4.5 VRCO - VisionRemote Command Output

Payload of VRCO packet is:

Field	Size	Description
Command ID	2	The machine controller shall number all generated commands sequentially. Will be used by BU to detect repeated commands and to acknowledge a command.
Spare	4	Reserved for future use. Set to 0 for now.
Command data	16	Command data from machine controller to RU application.

4.6 VRAI – VisionRemote Acknowledge Input

Payload of VRAI packet is:

Field	Size	Description
Command ID	2	ID of VRCO command that is acknowledged.

5 Packet Flow

5.1 Packet handling

5.1.1 VRPI

BU sends a VRPI packet every 125 ms. There is no retransmission. If a packet is lost, the data will be received in the next packet.

The machine controller should flag an error if no VRPI packet has been received for a fixed time (e.g. 500ms), and handle the error accordingly.

5.1.2 VRPO

The machine controller should periodically send a VRPO packet. Recommended interval is 50 – 200ms. There is no retransmission. If a packet is lost, the data will be received in the next packet.

If the VRPO packet is split, the packets that make up one bunch of data shall be sent without delay between them. This bursts of packets shall be sent at the interval specified for the VRPO packet. The receiver is responsible for putting the packets together.

BU will flag an error if no VRPO packet has been received for 2000 ms. If this error occurs when an RU is armed, the ES-Link relays will open.

5.1.3 VRCI

The BU will resend the VRCI packet every 100 ms until an acknowledge (VRAO) is received. If no acknowledge is received within 2000 ms, an error will be flagged to the RU application that command execution has failed. The RU application should then inform the operator.

5.1.4 VRCO

The machine controller should resend the VRCO packet every 100 ms until an acknowledge (VRAI) is received. If no acknowledge is received within a reasonable timeout, the machine controller should detect this as an error and stop sending the command.

5.1.5 Illegal packets

Illegal packets should be silently ignored. This includes packet with unknown packet ID, illegal CRC or unsupported/unexpected header values.

5.2 Armed vs. Disarmed

The BU handles multiple connected RUs simultaneously, but only one of them can be armed.

Packet	When remote is armed	When remote is disarmed
VRPI	Data from remote is sent in packet.	No data from remote in packet, but number of remotes is reported in packet.
VRPO	Data from machine controller is sent to RU application.	Data from machine controller is sent to RU application.
VRCI	Commands from RU application are sent to machine controller.	Commands from RU application are sent to machine controller.
VRCO	Commands from machine controller are sent to RU application.	Commands from machine controller is sent to RU application.

5.3 G-Link fallback operation

Wireless G-Link is based on WiFi, so a limited operational range and occasional dropouts must be expected. When G-Link fails, the system will use C-Link instead. C-Link is more reliable, but has limited capacity. When operating on C-Link, data will be prioritized like this:

Priority	Packet	Description
1	VRPI	This data is important for machine control and system safety.
2	VRCI	Operator commands are more important than display updates.

3	VRCO	Critical alarms can be sent to RU application as commands to ensure priority over periodic data.
4	VRPO	Periodic update of graphical display data has lowest priority.

As seen by the operator, the system will be operative with a failing G-Link, but the response time on screen commands will be longer, and the periodic update of screen information will be slower.

When a RU is armed, fallback operation is limited to this RU. If no remote is armed, fallback will work on a single disarmed RU only.