RS-422 Receiver

Communications Protocol

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RS-422 RECEIVER
STANDARD & EXTENDED COMMUNICATIONS PROTOCOL

Vicon's VPS line of CCTV control systems incorporate the EIA RS-422 standard for serial data communications for data command control of the VPS line of remote positioning devices such as the Surveyor Dome, V1310RB, V1200R-LM, etc. receivers.

Communications to and from the remote receivers occur at either 600bps or 4800bps with 1 Start bit, 8 data bits and 1 stop bit without parity checking. The selected baud rate is determined at both the CCTV control system and receiver by system configuration data, jumpers and/or DIP switches.

Communications are point-to-point with command/response loop throughs located at the receivers. In other words the controlling CPU transmits data to one receiver which in turn re-transmits the same data to the next receiver which in turn re-transmits the same data to the next receiver, etc. The maximum number of receivers on one communications "trunk" is 256 receivers. Status feedback from the commanded receiver occurs in the same manner, but in the opposite direction.

Receiver identification is provided by an eight bit DIP switch on individual receivers and all receiver communications are targeted to one specific receiver at any given time. In a standard configuration, one receiver address controls one pan and tilt drive which has one camera mounted on it. This one-to-one relationship between receivers, pan and tilt drives and cameras leads to the convention of using the receiver address as the camera number. Consequently, "Camera No. 1" refers to the receiver which has been set for address 1, the equipment that is connected to that receiver and the video signal which is connected to the video switcher input No. 1.

Receiver commands give the operator control of the pan and tilt drive, the motorized lens, and the auxiliary functions. The receiver has the ability to control concurrent tasks and consequently will accept multiple commands (e.g., the receiver can pan-left, tilt-up, zoom out and focus-far all at once). The keypad operator can use multiple commands by activating several of the controls simultaneously.

Whenever a receiver detects an input address as its own and assuming the receiver is configured for half-duplex communications, it will respond with one or more bytes. This response will contain status information pertaining to receiver type, basic receiver status and other detailed information pertaining to receiver functions.

The format of the receiver response is dependent upon a) receiver type, b) current command data input and c) prior command data input.

The user should refer to the specific manual that was supplied with their Dome/Receiver for information related to programming features such as bps rate and addressing.

A typical interchange of command and response data will occur as follows:

From CPU **From Receiver**

Two Command “Header” Bytes

One Status byte

Four Command Data Bytes

One Status byte

Or graphically:

Standard Command

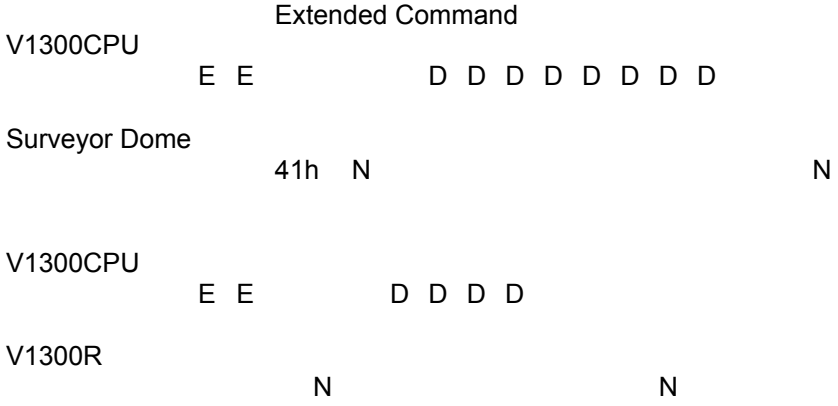
V1300CPU	C		D	D	D	D	
Surveyor Dome		N					N
V1300R		N					N

Where,
C represents **Normal Command Header,**
D represents **Command Data** and,
N represents **Normal Response Data.**

With recent features added to various receivers, this typical interchange required modification but needed modifications such that compatibility remained between older receivers and new receivers and older systems and newer systems.

Thus an “Identifier” byte was added as a preamble to the first standard status response. This identifier byte will only be transmitted through when an “Extended Command” data bit is set in the command header bytes. In older VPS systems, this extended command data bit will stay fixed at zero. Therefore, the receiver knows when the transmitting CPU is ***sending*** commands using newly added extended command data set and the CPU knows when it is communicating with a receiver that can ***accept*** the extended command data.

Now, the CPU/Receiver communications protocol can be significantly enhanced to add new features such as extended preset capability, variable speed pan& tilt control, etc. This modified command/response interchange may now be represented as:

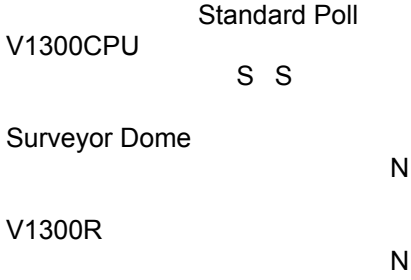


Where,

E represents **Normal Extended Command Header,**
D represents **Command Data** and,
N represents **Normal Response Data** and
41h represents the **Identifier** byte.

Note that in the figure above for V1300R receiver, even though the CPU transmitted the same Extended Header Bytes, it still only transmitted only 4 command data bytes. This is because the older V1300R receiver is not capable of transmitting the identifier byte and therefore not capable of accepting the 4 extra extended command data bytes.

At times, the CPU will have no command data to transmit but will simply want to “poll” the receiver to verify it is still operational and to obtain an updated status report. To accelerate communications time for receiver polling, the CPU need not transmit a complete set of command data. Rather, only the first two command header bytes are required for the receiver to respond to a poll. Graphically, the standard poll and response would appear as follows:



Where,

S is for **NO Command** (Status Only)
N is for **Normal Response Data**.

In addition to the standard poll/command response, one of the extended commands provides the ability to tailor this response to provide additional information. This additional information might include, current preset number, current sector or absolute position information. If the receiver response has been modified then the command/status interchange might appear as follows:

Extended Command with Modified Response

V1300CPU ……..
E E 8 Command Bytes
……..

Surveyor Dome ….
41h N 43h i N F DATA
….

Where,

E represents **Normal Extended Command Header,**
N represents **Normal Response Data,**
41h represents the **Identifier** byte,
43h indicates modified response to follow,
i indicates no. of bytes in extended command response,
F indicates what type of data in response and,
DATA in actual response data.

Typical modified response to a standard poll may then appear like:

Standard Poll with Modified Response

V1300CPU
S S

Surveyor Dome …..
43h i N F DATA
….

V1300R
N

Where,

S is for **No Command** (Status Only)
N represents **Normal Response Data,**
43h indicates modified response to follow,
i indicates no. of bytes in extended command response,
F indicates what type of data in response and,
DATA in actual response data.

Vicon's VPS video matrix switching systems perform a timeout check for expecting response data from the polled or commanded receiver. There should be no more than a 1-1/2 byte time delay for the CPU to wait for incoming data otherwise the CPU will assume the receiver is malfunctional and place it "offline."

Communications Data Format Description

Listed below are tables which describe the data format for each byte passed between the video switcher CPU and the addressed receiver. Refer to these tables to correctly format control data for remotely operating individual receivers.

SOURCE CPU RECEIVER COMMAND HEADER BYTES		
Bit #	**Header Byte 0**	**Header Byte 1**
7	1	0
6	0	Extended Command
5	0	Alarm Acknowledge
4	0	Normal Command
3	Receiver Address Bit 7	Receiver Address Bit 3
2	Receiver Address Bit 6	Receiver Address Bit 2
1	Receiver Address Bit 5	Receiver Address Bit 1
0	Receiver Address Bit 4	Receiver Address Bit 0

TABLE 1

As seen in Table 1, the CPU can target a message to any one receiver by transmitting the two header bytes with the corresponding receiver address. Further definition of the two header bytes allow the CPU to form a normal command header by setting bit 4 in Header Byte[2]. By also setting bit 6 in Header Byte[2], the CPU can further define an extended command header. If both of these bits are reset then the receiver will not process any commands and assume the header bytes are for a status poll request only and will respond accordingly. Bit 5 in Header Byte[2], the Alarm Acknowledge bit, will cause the receiver to no longer transmit an active alarm status until the alarm input for the associated receiver goes away and then reappears.

CONTROL SOURCE CPU STANDARD RECEIVER COMMAND DATA				
Bit #	**Command Data [1]**	**Command Data [2]**	**Command Data [3]**	**Command Data [4]**
7	0	0	0	0
6	Pan Left	Zoom Out	AUX 1”	Preset Enter
5	Pan Right	Zoom In	AUX2”	Preset Recall
4	Tilt Up	Focus Far	AUX3”	0
3	Tilt Down	Focus Near	AUX4”	Preset No. 3
2	Auto-Pan’	Iris Open	AUX5”	Preset No. 2
1	Auto-Iris’	Iris Close	AUX6”	Preset No. 1
0	0	LENS SPEED’	0	Preset No. 0

TABLE 2

Listed in Table 2 are all of the functions that form the standard command protocol. Control of these functions is different depending upon whether a particular function is defined as momentary or latching. Manual pan, tilt, zoom and focus functions are defined as momentary functions. Auto-Iris, Auto-Pan and Lens Speed are defined as latching functions. The auxiliary functions can be individually configured at the receiver to be either momentary or latching functions. Proper control of both momentary and latching

functions is further defined below in the Receiver Latching and Momentary Functions section.

Preset control for receivers that only accept normal commands is provided in the COMMAND DATA[4] byte. Preset control is limited to only 10 presets numbered 1 through 10. The preset number is binary coded in Preset No. bits 0 to 3. The command to perform either a preset store or preset recall is defined by setting one and only one of either the Preset Enter bit or the Preset Recall bit. Take note that if a preset command is transmitted using this format to a receiver that is capable of accepting the extended preset command then preset number 1 to 10 will be equivalent to extended preset number 90 to 99. Also, if a preset command is passed using this method and the extended command bit was set in the two header bytes then this preset command will be ignored.

SOURCE CPU EXTENDED RECEIVER SPEED CONTROL COMMAND DATA				
Bit #	**Command Data [5]**	**Command Data [6]**	**Command Data [7]**	**Command Data [8]**
7	0	0	0	0
6	0	PAN_SPEED.6	0	TILT_SPEED.6
5	0	PAN_SPEED.5	0	TILT_SPEED.5
4	0	PAN_SPEED.4	0	TILT_SPEED.4
3	PAN_SPEED.10	PAN_SPEED.3	TILT_SPEED.10	TILT_SPEED.3
2	PAN_SPEED.9	PAN_SPEED.2	TILT_SPEED.9	TILT_SPEED.2
1	PAN_SPEED.8	PAN_SPEED.1	TILT_SPEED.8	TILT_SPEED.1
0	PAN_SPEED.7	PAN_SPEED.0	TILT_SPEED.7	TILT_SPEED.0

TABLE 3

Control for variable speed pan and tilts such as the Surveyor Dome is provided by the extended speed control command detailed in Table 3. This command provides finite speed control for up to 1024 different speeds for both pan and tilt. Note, however, that this command provides for only a magnitude of speed control. Directional control is provided in the normal command data bytes using the Pan Right, Pan Left, Tilt Up and Tilt Down control bits.

SOURCE CPU EXTENDED RECEIVER PRESET COMMAND DATA				
Bit #	**Command Data [5]**	**Command Data [6]**	**Command Data [7]**	**Command Data [8]**
7	0	0	0	0
6	0	PRESET.6	PRESET_PAN_SPEED.6	PRESET_TILT_SPEED.6
5	0	PRESET.5	PRESET_PAN_SPEED.5	PRESET_TILT_SPEED.5
4	1	PRESET.4	PRESET_PAN_SPEED.4	PRESET_TILT_SPEED.4
3	0	PRESET.3	PRESET_PAN_SPEED.3	PRESET_TILT_SPEED.3
2	0	PRESET.2	PRESET_PAN_SPEED.2	PRESET_TILT_SPEED.2
1	0	PRESET.1	PRESET_PAN_SPEED.1	PRESET_TILT_SPEED.1
0	RECALL/RESTORE	PRESET.0	PRESET_PAN_SPEED.0	PRESET_TILT_SPEED.0

TABLE 4

For receivers that have preset capability for up to 99 presets, the extended preset command has been provided as an extension to the normal preset command that only provided preset capability for 10 presets. Using this command, the CPU can direct the receiver to store the current position for pan, tilt, zoom and focus to be returned to at some future time using the preset recall command. When a preset store is required, the preset number should be passed in COMMAND DATA[6] with COMMAND DATA[5] equal to 11 HEX. The preset store command ignores COMMAND DATA [7] and COMMAND DATA[8].

When COMMAND DATA[5] is passed equaling 10 HEX, the receiver will direct the pan, tilt, zoom and focus positions to a previously stored position. If the receiver and pan and tilt is capable of variable speed presets then COMMAND DATA[7] is used to define the maximum pan speed to approach the pan preset position and COMMAND DATA[8] is used to define the maximum tilt speed to approach the tilt preset position. If either is passed as 0 then the pan and/or tilt drive will allow maximum speed.

SOURCE CPU EXTENDED RECEIVER STATUS REPORT MODIFY COMMAND				
Bit #	**Command Data[5]**	**Command Data[6]**	**Command Data[7]**	**Command Data[8]**
7	0	0	0	0
6	0	0	0	0
5	0	0	0	0
4	1	0	0	0
3	0	EXTENDED ALARM STATUS	0	0
2	0	ABSOLUTE POSITION	0	0
1	1	CURRENT PRESET	0	0
0	STANDARD/ONCE	CURRENT SECTOR	0	0

TABLE 5

For some receivers the ability to tailor status feedback is provided for sector identification and current preset position feedback. Using the extended command outlined in TABLE 5, the CPU can command the receiver to transmit not only the normal status but the current pan sector and current preset position. If command data byte [5] is set to 0X13, then the extended status will be returned for every poll request. If command data byte [5] is set to 0X12, then the extended status will be returned only once.

SOURCE RECEIVER NORMAL STATUS RESPONSE	
Bit #	**Status Byte[1]**
7	Receiver Alarm
6	Preset Active
5	Aux 1
4	Aux 2
3	Aux 3
2	Aux 4
1	Auto-Iris
0	Auto-Pan

TABLE 6

The normal status response outlined in TABLE 6 provides the CPU the ability to determine the current on/off state of various latching functions. A bit set to 1 indicates that the function is currently active. Note that the Preset Active bit and Auto-Pan bit will never be set to 1 simultaneously as this would create the identifier byte.

SOURCE RECEIVER NORMAL STATUS RESPONSE WITH IDENTIFIER		
Bit #	**Status Byte[1]**	**Status Byte[2]**
7	0	Receiver Alarm
6	1	Preset Active
5	0	Aux 1
4	0	Aux 2
3	0	Aux 3
2	0	Aux 4
1	0	Auto-Iris
0	1	Auto-Pan

TABLE 7

The extended status response detailed in TABLE 7 provides the controlling CPU the ability to determine that the receiver is capable of handling extended commands. This extended status report will only be transmitted by the receiver after two extended command header bytes are received. The Status Byte[2] in TABLE 7 follows the same format as the normal status response detailed in TABLE 6.

SOURCE RECEIVER MODIFIED STATUS RESPONSE						
Bit #	**Status Byte[1]**	**Status Byte[2]**	**Status Byte[3]**	**Status Byte[4]**	**Status Byte[5]**	**Status Byte [6-?]**
7	0	Length. 7	Receiver Alarm	*Reserved*	Status Data as Defined by Status Byte[4]	Status Data as Defined by Status Byte[4]
6	1	Length.6	Preset Active	*Undefined*		
5	0	Length.5	Aux 1	*Undefined*		
4	0	Length.4	Aux 2	*Undefined*		
3	0	Length.3	Aux 3	Extended Alarm Status		
2	0	Length.2	Aux 4	Absolute Position Status		
1	1	Length.1	Auto-Iris	Current Preset		
0	1	Length.0	Auto-Pan	Current Sector		

TABLE 8

When status is transmitted using the modified status response, the additional status is transmitted in a certain order of priority. If multiple bits are set in Status Byte [4], the order of data transmission will be Current Sector, followed by Current Preset, followed by Absolute Position Status, followed by Extended Alarm Status. Status Byte[3] follows the same format as the normal status byte detailed in TABLE 6. Since future enhancements provide uncertainty with modified status reports, the length of the status response is specified using STATUS BYTE[2]. This length includes a count of 4 for STATUS BYTE[1] through STATUS BYTE[4]

SOURCE RECEIVER ABSOLUTE POSITION STATUS							
Bit #	**Status Byte [N]**	**Status Byte [N+1]**	**Status Byte [N+2]**	**Status Byte [N+3]**	**Status Byte [N+4]**	**Status Byte [N+5]**	**Status Byte [N+6]**
7	0	0	0	0	0	0	0
6	Pan.11	Pan.4	Tilt.5	Zoom.8	Zoom.1	Focus.13	Focus.6
5	Pan.10	Pan.3	Tilt.4	Zoom.7	Zoom.0	Focus.12	Focus.5
4	Pan.9	Pan.2	Tilt.3	Zoom.6	Pan.1	Focus.11	Focus.4
3	Pan.8	Tilt.9	Tilt.2	Zoom.5	Pan.0	Focus.10	Focus.3
2	Pan.7	Tilt.8	Tilt.1	Zoom.4	Tilt.0	Focus.9	Focus.2
1	Pan.6	Tilt.7	Zoom.10	Zoom.3	Focus.15	Focus.8	Focus.1
0	Pan.5	Tilt.6	Zoom.9	Zoom.2	Focus.14	Focus.7	Focus.0

TABLE 9

The pan position is in 8.3 format (lsb is 1/8 of a degree). The tilt position is in 6.3 format (lsb is 1/8 of a degree). The zoom position is in 6.3 format (lsb is 1/8x magnification). The focus is a register value that may be used to determine if autofocus has settled out. Surveyor2000 Domes will only provide resolution to 1/2 degree for pan or tilt and 0.5x magnification for zoom. For those domes, bits 1 and 0 will be set to 0. SurveyorVFT domes provide position resolution to 1/8 degree and zoom resolution to 1/8x.

SOURCE CPU ABSOLUTE POSITION SET COMMAND						
Bit #	**Command Data [5]**	**Command Data [6]**	**Command Data [7]**	**Command Data [8]**	**Command Data [9]**	**Command Data [10]**
7	0	0	0	0	0	0
6	0	Pan.11	Pan.4	Tilt.5	Zoom.8	Zoom.1
5	0	Pan.10	Pan.3	Tilt.4	Zoom.7	Zoom.0
4	1	Pan.9	Pan.2	Tilt.3	Zoom.6	Pan.1
3	0	Pan.8	Tilt.9	Tilt.2	Zoom.5	Pan.0
2	1	Pan.7	Tilt.8	Data[10]valid	Zoom.4	Tilt.1
1	1	Pan.6	Tilt.7	Zoom.10	Zoom.3	Tilt 0
0	1	Pan.5	Tilt.6	Zoom.9	Zoom.2	direction

TABLE 10

The pan position is 8.3 format (lsb is 1/8 of a degree). The tilt position is 6.3 format (lsb is 1/8 of a degree). The zoom position is 6.3 format (lsb is 1/8x magnification). The preset active bit in the receiver status response will be set while the absolute position is being solved. Surveyor2000 Domes will only provide resolution to 1/2 degree for pan or tilt and 0.5 x magnification for zoom. For those domes, bits 1 and 0 will be ignored and command data [10] will not be used. Surveyor VFT domes provide position resolution to 1/8 degree and zoom resolution of 1/8x. If Command Data [9], bit 2 is set to 1, then Command Data [10] will be issued. The Surveyor VFT, revision 1.0.5 and higher, will use Command Data [10] for the higher resolution bits and direction sense bit. If the direction sense bit is 0, then the direction will be to pan left with increasing numbers and tilt up with increasing numbers. This is the convention used by the Surveyor2000. If the direction sense bit is set to 1, then the direction will be the opposite. If the Data [10] valid bit is 0, then the direction sense will default to 0.

SOURCE CPU ABSOLUTE IRIS POSITION SET COMMAND				
Bit #	**Command Data [5]**	**Command Data [6]**	**Command Data [7]**	**Command Data [8]**
7	0	0	0	0
6	0	0	Iris.6	0
5	0	0	Iris.5	0
4	1	0	Iris.4	0
3	1	0	Iris.3	0
2	0	0	Iris.2	0
1	0	0	Iris.1	0
0	0	Iris.7	Iris.0	0

TABLE 11

To set the iris setting, issue the absolute iris position set command per Table 11. The range of iris settings is 0 x 00 (darkest) to 0 x FF (brightest).

Receiver Latching and Momentary Functions

At the receiver there exist what are commonly referred to as momentary functions and latching functions.

Momentary functions are functions that follow the commanded input exactly; a bit value of 1 turns the function on while a bit value of 0 turns the function off. Momentary functions include: Pan Right/Left, Tilt Up/Down, Zoom In/Out, Focus Near/Far.

Latching functions are turned on and off by a 0-to-1 transition by the associated command bit. Whenever the receiver senses the command bit change from 0 to 1 from one command input to the next, the receiver toggles the state (from on to off or from off to on) for the associated function. Latching functions include: Auto-Iris, Auto-Pan, Lens Speed.

Controlling V1300R-PVP and V1200R-PVP Variable Speed Receivers

The method for controlling speed for the V1200R-PVP receivers and the V1300R-PVP receivers differs from controlling the Surveyor Dome.

For the older PVP receivers, AUX 3 and AUX 4 are used for pan speed control and AUX 5 and AUX 6 for tilt speed control. This provides 4 speed levels for pan and 4 speed levels for tilt. Directional control is still provided by the Pan Right/Left and Tilt Up/Down control bits. The aux functions are only a means of providing a magnitude of speed control.

V1300R STANDARD RECEIVER CONTROL COMMAND						
Bit #	**Header (1)**	**Header (2)**	**Data (1)**	**Data (2)**	**Data (3)**	**Data (4)**
7	1	0	0	0	0	0
6	0	EXTENDED_CMD	PL	ZO	AUX1	PRESET ENTER
5	0	ALARM_ACK	PR	ZI	AUX2	PRESET RECALL
4	0	CMND_DATA	TU	FF	AUX3	0
3	RCVR_ADDR.7	RCVR_ADDR.3	TD	FN	AUX4	PRESET NO. 3
2	RCVR_ADDR.6	RCVR_ADDR.2	A/P	IO	AUX5	PRESET NO. 2
1	RCVR_ADDR.5	RCVR_ADDR.1	AI	IC	AUX6	PRESET NO. 1
0	RCVR_ADDR.4	RCVR_ADDR.0	HALF (SEIZE)	SPEED	0	PRESET NO. 0

SURVEYOR DOME EXTENDED VARIABLE SPEED COMMAND				
Bit #	**Data (5)**	**Data (6)**	**Data (7)**	**Data (8)**
7	0	0	0	0
6	0	PAN_SPEED.6	0	TILT_SPEED.6
5	0	PAN_SPEED.5	0	TILT_SPEED.5
4	0	PAN_SPEED.4	0	TILT_SPEED.4
3	PAN_SPEED.10	PAN_SPEED.3	TILT_SPEED.10	TILT_SPEED.3
2	PAN_SPEED.9	PAN_SPEED.2	TILT_SPEED.9	TILT_SPEED.2
1	PAN_SPEED.8	PAN_SPEED.1	TILT_SPEED.8	TILT_SPEED.1
0	PAN_SPEED.7	PAN_SPEED.0	TILT_SPEED.7	TILT_SPEED.0

SURVEYOR DOME EXTENDED PRESET COMMAND				
Bit #	**Data (5)**	**Data (6)**	**Data (7)**	**Data (8)**
7	0	0	0	0
6	0	PRESET.6	PRESET_PAN_SPEED.6	PRESET_TILT_SPEED.6
5	0	PRESET.5	PRESET_PAN_SPEED.5	PRESET_TILT_SPEED.5
4	1	PRESET.4	PRESET_PAN_SPEED.4	PRESET_TILT_SPEED.4
3	0	PRESET.3	PRESET_PAN_SPEED.3	PRESET_TILT_SPEED.3
2	0	PRESET.2	PRESET_PAN_SPEED.2	PRESET_TILT_SPEED.2
1	0	PRESET.1	PRESET_PAN_SPEED.1	PRESET_TILT_SPEED.1
0	RECALL/STORE	PRESET.0	PRESET_PAN_SPEED.0	PRESET_TILT_SPEED.0

*Note: In diagrams below:

S is for No Command (Status Only)
C is for Normal Command
E is for Extended Command
N is for Normal Response Data

Standard Poll

V1300CPU

S

Surveyor Dome

N

V1300R

N

Standard Command

V1300CPU

C

Surveyor Dome

N N

V1300R

N N

Extended Command

V1300CPU

E

Surveyor Dome

41h N N

V1300CPU

E

V1300R

N N

Standard Poll with Modified Response

V1300CPU

S

Surveyor Dome . . . .

43h F N DATA

V1300R N

Extended Command with Modified Response

V1300CPU . . . . . .

E 8 Command Bytes

. . . . . .

Surveyor Dome . . .

41h N 43h F N DATA

. . . .