

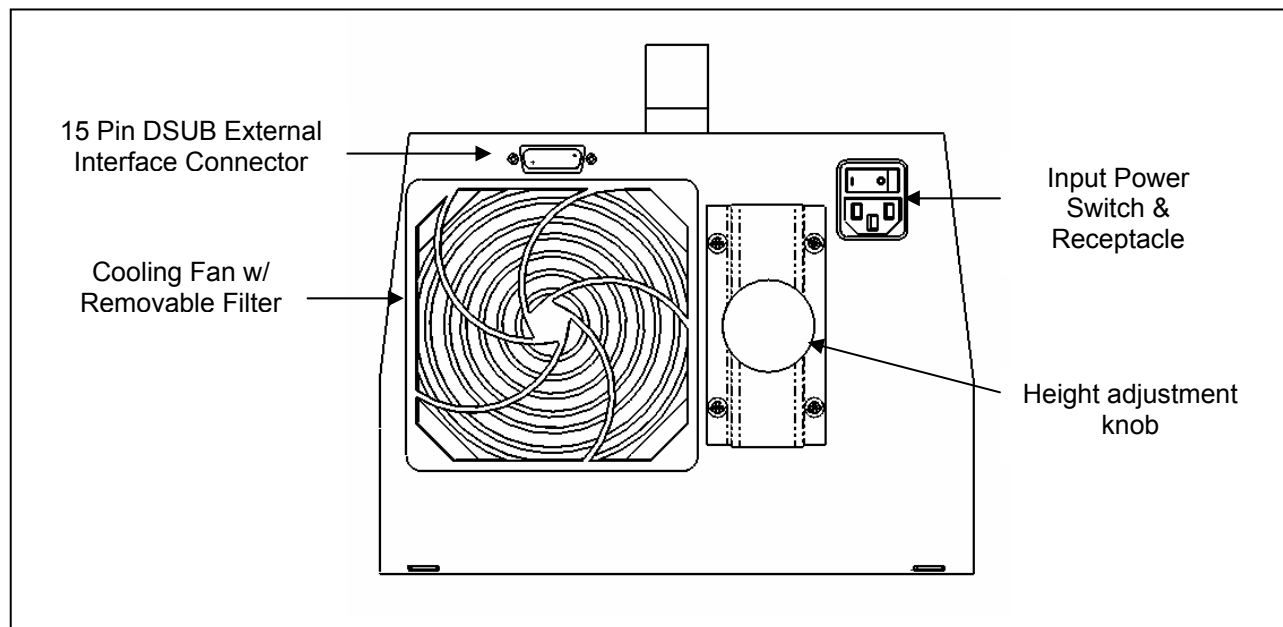
IntelliRay Serial Communication Protocol Description

Introduction

The Uvitron IntelliRay is a microprocessor-based light curing system, which features an RS232/RS485 serial port for applications requiring remote control of curing operations. This note describes the interface and protocol required to send a serial data stream to monitor and control the IntelliRay through the unit's rear panel 15 pin DSUB connector.

Network Description

The IntelliRay's internal controller can communicate on a network that consists of a single master (host computer or PLC) and a single or multiple slave lamp heads. The serial bus type can be selected at the IntelliRay front panel setup menu, and can be set as either RS232 or RS485 industry standard types. For more information regarding IntelliRay operation and menus, refer to sections 5 & 6 of the IntelliRay Instruction Manual. The system has one of each type of port available at the unit's rear panel 15 pin DSUB connector (see rear panel view below).



For connector pin-out and wiring information, refer to External Interface Wiring in Section 7 of the IntelliRay Instruction Manual.

For single lamp head communication, either RS232 or RS485 may be used. If multiple lamp heads are required, RS 485 can be used to control up to 8 units per network. The IntelliRay utilizes a Sipex SP310ECP RS232 converter, and a National Semiconductor DM75176BN RS485 Transceiver for serial communications. The IntelliRay's communication interface electrical parameters are therefore compliant with industry standard specifications for both RS232 and RS485 systems. Refer to the data sheet of either device for specific electrical information and specifications.

Communications Specifics

The IntelliRay communicates at a fixed serial baud rate of 19200 bps, with 1 start bit, 8 data bits, 1 stop bit and a programmable 9th bit used for multiprocessor communications. The ninth bit is sent by the bus master processor to signal all slave IntelliRay units to wake up and check if the current byte matches their Address (or unit ID) currently programmed in the setup menu at the control panel of each unit. If the byte matches the ID, the unit will continue to listen and receive the following message bytes which will not have their 9th bit set. If the ID does not match, the unit will ignore the subsequent bytes. This 9th bit wake-up minimizes unnecessary interruptions of the internal controller processing by communications between other slaves and the master computer. If no ninth bit setting is available at the port of the host processor, its parity bit can be set for the address byte to achieve the same function. This addressing scheme is used for both RS485 and RS232.

Message Packet Description

The IntelliRay message contains four header bytes, followed by a variable length data packet which is terminated by a two byte message checksum. This message format is used for both master processor transmission and slave lamp head responses. The validity of the header and checksum bytes as well as the quantity of data bytes should all be verified by the host processor in order to detect a corrupted message packet.

Format of IntelliRay message packet:

ADDR	MSG #	CLASS	BYTE CNT	PACKET DATA BYTES	CSUM HI	CSUM LO
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Address: Also called the Unit ID, identifies the particular slave destination of the message transmitted by the master (or host) processor. The addressed slave should respond with its own packet address to identify to the master which device is replying. This value may be in the range of 0 to 7.

Message #: This is a sequentially incrementing packet number which increases by one with each successful message transmission. If the master receives a negative acknowledge (NACK), no response or an invalid response to a given message, the master should retransmit with the same message number to signal to the slave that the subsequent message is a duplicate. This will permit the slave to identify the packet as a retransmission, allowing it to avoid processing a given command more than once if it already acted on an earlier message. The valid message number is 0 to 255, and the number should roll-over to zero after the max value has been reached.

Class: The message class identifies the category or type of message being transmitted. The valid range of class values is 1 to 10. Command class codes are as follows:

Class	Code	Description
POLL*	0x01	Poll command class
NORM_MODE	0x02	Normal mode command class
SERV_MODE	0x03	Service mode command class
DOWNLOAD_START *	0x04	Download command class
DOWNLOAD_DATA *	0x05	Download command class
DOWNLOAD_END *	0x06	Download command class
ACK	0x07	Program block norm response to message
NACK	0x08	Program block error response to message
DL_ACK *	0x09	Boot block norm response to message
DL_NACK *	0x0A	Boot block error response to message

(* Currently unsupported command classes, for internal use only)

Byte Count: This field identifies the number of bytes sent in the data field of the packet. The maximum number of bytes in the data field of the message received by the IntelliRay is 64, and the max number of bytes transmitted by the IntelliRay is 32.

Packet Data Bytes: The bytes transmitted in this variable length field contain the actual data to be transmitted by either the master or slave processor. The meaning of the individual byte values are a function of the specific command code and class, and are defined below.

Checksum High and Low bytes: The IntelliRay message packet includes a two byte message checksum, which is used to verify the overall integrity of the transmitted/received data. The transmitted message checksum is calculated by performing a 16 bit summation of all the header and data field bytes, complementing the total, and adding 1 to the result. The 16 bit value is then split into two bytes and appended as the last two bytes of the message packet, with the high order byte 1st, and the low order byte last.

The receiving processor will verify the received packet by summing all the incoming header and data field bytes into a 16 bit value. The high order byte of the message checksum is then weighted by multiplying it by 256 (0x100), and added to the checksum total. The low order byte of the checksum is added to the total directly without any weighting. The resulting total should be equal to zero for a valid message transmission. For non-zero checksums, the host processor should retransmit the original message to insure the message was received correctly by the slave. If several consecutive communication errors are detected, a message can be sent to the operator to notify him of a possible serial link fault.

Command Codes:

Commands are received by the IntelliRay from the host processor as the first byte of the Packet Data Bytes field portion of the message. The current list of supported command codes are shown below:

Normal Class Command Codes:

Command	Code	Description
SEND_UV_PARAMS	0x14	Xmit UV system params on serial line
SET_UV_PARAMS	0x15	Rcv UV param settings on serial line

Service Class Command Codes:

Command	Code	Description
SWITCH_LED	0x0D	turn specified LED on or off

Command Descriptions

Send UV Params: This Normal class command is sent by the host processor to read the IntelliRay's system parameters. The message Packet Data Bytes field consists of 30 bytes which contain all the current settings, measurements and status of the IntelliRay system. The IntelliRay can be polled on a regular basis with this command for status updates. The returned data bytes are as follows:

Byte #	Function	Description
0	Lamp Intensity	0 to 255, 0 = half power, 255 = full power
1, 2	Lamp Timer	In Auto mode, counts down secs. before shutter closes. In Manual, counts up secs. of shutter open duration.
3	Lamp Fader	Time remaining during fade of lamp (from current intensity to half power) that occurs when shutter is commanded closed.
4, 5	Lamp Hours	Elapsed hours (or current age) of arc lamp.
6	Shutter State	1 = Shutter open, 0 = shutter closed
7	Lamp Ready	1 = Ready, 0 = not ready or warm-up in progress
8	Lamp Standby	1 = Standby power shutter closed, 0 = lamp at power level of current intensity w/ shutter open.
9	Lamp Timer Mode	1 = AUTO (shutter timed), 0 = MANUAL (shutter open indefinitely).
10	Lamp On	1 = Lamp on (shutter open), 0 = lamp off (closed)
11	Door Open	1 = Door open (interlock active), 0 = Door closed
12	Head Over Temperature	1 = Lamp head over temp, 0 = normal
13	Oven Over Temperature	1 = Oven over temp, 0 = normal
14, 15	Analog Input #0	A to D channel 0, (with expander option only)
16, 17	Analog Input #1	A to D channel 1, (with expander option only)
18, 19	+5V Sense	Internal 5V, meas., (with expander option only)
20, 21	+12V Flash Voltage	Internal 5V, meas., (with expander option only)
22, 23	+24V Sense	Internal 5V, meas., (with expander option only)
24, 25	Oven Temperature	Optional extern temp measurement (not used)
26, 27	Head Temperature	IntelliRay lamp head internal temp (°F * 100)
28, 29	Sanity Reference	2.5V ref., used to check A to D operation (*100)

(NOTE: All two byte or 16 bit data values are sent high order byte 1st, low order byte last, all analogs are sent *100 to allow for decimals – divide by 100 when converting to floats.)

Set UV Params: This Normal class command writes to system parameters of the IntelliRay. In response to this command, the IntelliRay returns the same data as is returned by the Send UV Params command (refer to the table above). This allows normal polling data to be collected by the host regardless whether reading or writing occurs. The six parameters to be written in the Packets Data Bytes field of the message are as follows:

Byte #	Function	Description
0	Set Params Command	Command code = 0x15 (21 decimal)
1, 2	Lamp Timer Setting	Exposure time for internal shutter timing, (16 bit)
3	Lamp Intensity Setting	0 to 255, 0 = half power, 255 = full power
4	Timer Mode Setting	1 = AUTO, 0 = MANUAL. In Auto mode, timer counts down seconds before shutter closes. In Manual, counts up seconds while shutter open – shutter remains open indefinitely.
5	Exposure ON/OFF	Writing this byte to 1 toggles the shutter position from closed to open, or from open to closed.

Switch LED : This Service class command allows the LED I/O port of the IntelliRay to be written, to turn digital port signals on and off for testing purposes. The four parameters to be written in the Packets Data Bytes field of the message are as follows:

Command Code	Prefix 1	Prefix 2	Port Bit ID Code
0x0D	0x00	0x00	Select from the table below

Bit ID Code Name	Bit ID	Description
COM PORT RS485	0x00	Selects RS485 serial port mode
COM PORT RS232	0x01	Selects RS232 serial port mode
LAMP RDY LED ON	0x02	Turns on LAMP RDY LED
LAMP RDY LED OFF	0x03	Turns off LAMP RDY LED
SHUTT OPEN LED ON	0x04	Turns on SHUTTER OPEN LED
SHUTT OPEN LED OFF	0x05	Turns off SHUTTER OPEN LED
STANDBY LED ON	0x06	Turns on STANDBY LED
STANDBY LED OFF	0x07	Turns off STANDBY LED
ALARM LED ON	0x08	Turns on ALARM LED
ALARM LED OFF	0x09	Turns off ALARM LED
HEARTBEAT LED ON	0x0A	Turns on HEARTBEAT LED
HEARTBEAT LED OFF	0x0B	Turns off HEARTBEAT LED
BACKLIGHT ON	0x0C	Turns on LCD BACKLIGHT
BACKLIGHT OFF	0x0D	Turns off LCD BACKLIGHT
BEEPER ON	0x0E	Turns on ALARM BEEPER
BEEPER OFF	0x0F	Turns off ALARM BEEPER

Error Conditions and Codes:

For cases where communications errors or unexpected data is received by a slave lamp head, a Negative Acknowledge (or NACK) message will be returned to the master processor. This NACK class message will contain a single byte in the data field which will indicate the error condition detected. The NACK message format is shown below:

ADDR	MSG #	0x08	BYTE CNT	ISOLATION CODE	CSUM HI	CSUM LO
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Note that the 3rd (or class) byte is set to the constant signifying a NACK class message.

The NACK error isolation codes are as follows:

Isolation Code Name	Code	Description
REC TIMEOUT	0x02	Timeout waiting to receive byte
INVALID CHKSUM	0x03	Checksum not equal to zero
LOOPBACK TIMEOUT	0x05	Timeout waiting for loopback of RS485 transmit (possible bus collision condition)
LOOPBACK ERROR	0x06	Loopback character not equal to transmit character (possible bus collision condition)
XMIT INT TIMEOUT	0x07	Timeout waiting for transmit interrupt of stop bit
INV NUM PARAM	0x08	Invalid number of command parameters
INV POLL CMD	0x09	Invalid poll mode command
INV NORM CMD	0x0A	Invalid normal mode command
INV SERV CMD	0x0B	Invalid service mode command
CMD BUFFER FULL	0x0C	Command buffer full (excessive command rate)
INV CMD CLASS	0x0D	Invalid command class
RECEIVER BUSY	0x0E	Receiver busy, unable to respond (resend later)
INV BUFF CMD	0x0F	Invalid message in command buffer
TOO MANY INTS	0x10	Serial communications interrupts > max rate
INV CMD PARAM	0x11	Invalid command parameter

Duplicate Messages: If an IntelliRay slave receives a duplicate message (message number the same as the previous message), then the slave will retransmit its response to the previous message in case the master did not previously receive it.

Slave Message Reception Interruptions: Because the internal controller of the IntelliRay is performing real time process control of system functions, there may be occasions where the processor may be busy and unable to respond to the master's message. For cases where critical messages are being sent, the master should have the capability to retransmit if a response message is incomplete or if no response is received.

Communication Timing

The following table shows approximate timing parameters of the IntelliRay communications protocol:

Timing Parameter	Value	Description
MAX INT RATE	8	Max num of slave serial interrupts/sec
MAX REC BYTE WAIT	1 – 2 mS	Max time slave will wait to receive byte
MAX LOOPBACK WAIT	2.2 – 4.4 mS	Max time slave will wait to receive loopback
REMOTE COMM TIMEOUT	3 Secs	Delay before keypad lockout releases after communications with lamp head ceases.

Support

If any further assistance is required, contact Uvitron Customer support at the number shown below, and a representative will be glad to assist you.

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