Aphos 32 Operating Manual

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1 Overview of the Aphos 32 Strobe light

The Aphos 32 Strobe light (strobe) is a pulsed only high intensity LED light designed for subsea operation. It consists of a subsea bottle and an LED panel. The bottle contains the control and interface electronics along with the energy storage capacitor banks and charging circuits. For reliability, the strobe consists of four independent channels each with their own charging, monitoring and storage circuits.

Figure 1 - Photo of the Aphos 32 Strobe light

The LED panel consists of 4 channels each with 8 high Power LED's connected in series. Each channel is routed back to its associated channel in the bottle. The LED panels come in wide angle and controlled angle variants.

To trigger the light, a TTL level trigger is applied to the Trigger +/- inputs via the rear bulkhead connector. The trigger input circuit is optically isolated. The light uses its own internal timing register to determine how long to fire for. This register is controllable over the RS485 interface.

To aid in quick deployment of the light, each Aphos 32 is programmed to automatically charge on power up. This means that the light can be strobed by applying a trigger signal, there is no software control required. Table 2 details the lights default factory setup.

The light can be further controlled and configured via the RS485 interface on pins 3 and 4 of the rear bulkhead connector. The Strobe light has a full set of control registers and details of these are provided in the Serial communications section. The internal microcontroller in the light is equipped with a data EEPROM so the light will retain any settings that are programmed into its registers over the serial interface.

Performance	
Light Power Output:	Up to 150,000 Lumens (depending on application)
Light Colour Temperature:	5,700°K Standard Colour Temperature
Colour:	White
Beam Angle/Shape:	80° beam angle flood
Strobe Capability:	0.1Hz to 10Hz
Pulse Width:	0.25 to 10ms
Frequency:	0.1 to 10Hz
Trigger Voltage:	3V to 15V DC optically isolated in the light
Minimum Trigger width:	250µsec
Trigger Type:	Rising or Falling edge (Factory set as Rising edge)
Control Options: RS485	Controlled from Cathx Stills Camera via RS485 or from serial terminal

Table 1-1 Aphos 32 performance specifications

1.1 Triggering the Aphos 32

As stated above, the strobe light is configured to Auto charge by default. This means that as soon as power is applied to the Strobe light, it will begin charging. The initial (cold) charge time will vary slightly from unit to unit, but will be complete within one minute from power on. The purpose of the auto-charge control is to allow a user to operate the light without having to configure it via the RS485 interface. It is possible to change the lights setup so that it does not auto charge.

Once the cold charge is complete the light is then ready to operate. If at this point a trigger signal is present at the lights trigger + / - pin's then the light will begin to strobe.

The light will continue to strobe so long as a trigger signal is detected on the lights trigger in pins. The Strobe can operate at frame rates up to 30Hz – but be aware that the light output will diminish with increasing frame rate. Table 1 below provides as guideline on the input range of the trigger signal that can be applied to the light.

Aphos 32 Strobe Input Trigger electrical specifications			
Trigger +/- input voltage level	Minimum	Typical	Maximum
	2.5VDC	5.0VDC	15VDC
Trigger input frequency[1]	Minimum	Typical	Maximum
	1/12Hz	5Hz	30Hz
Trigger signal pulse duration[2]	Minimum	Typical	Maximum
	200usec	1msec	---
Trigger mode	Rising / Falling Edge	Software configurable	

Table 1-2 Aphos 32 Trigger input specifics

[1] *The frequency of operation will be a factor in determining the amount of light than the strobe can produce. Higher frequencies afford shorter recharge times for the capacitor banks*

[2] *The Strobe light is edge triggered, and can be triggered by an active high or active low signal. Also, note that the trigger input circuit is optically isolated and inverts the incoming TTL signal as it is processed. The 200usec time is defined as a safe tested minimum. Operation with smaller trigger widths is possible but has not been tested.*

1.2 Modes of operation

The Aphos 32 has two distinct modes of operation available these are; Continuous pulse mode and Single shot mode.

Continuous pulse mode is the default mode of operation, in this mode the light will emit a pulse of light for every input trigger it receives. This is the normal operational mode of the light and would be the typical mode of operation for the light.

Single shot mode is a secondary mode of operation designed for use in stationary undersea systems that would not be taking images continuously. This mode of operation allow for very long light pulses to be generated in the light (up to 200msec), but the pulse repetition rate is much lower than in continuous mode, approx 1 image every 10 seconds.

The Aphos 32 ships in Continuous pulse mode as default unless specified. The lights mode can be changed via the serial interface and the mode is a saved setting in the lights Eeprom.

1.3 Factory settings

The strobe light is factory configured with some default operational settings. For the most part the factory settings can be used as good defaults throughout the products life. However there are some parameters that may require tuning depending on the application. Table 2 details the factory default register load out.

Aphos 32 Strobe Default Operational Settings				
LED pulse duration	Minimum	Typical	Maximum	Factory set
	200µsec		10000µsec[1]	3500µsec
RS485 Address	Minimum	Typical	Maximum	Factory set
	1		254	2[2]
Automatic charge	Enabled	Disabled		Factory Set
	1 or 2	0		2
LED current limit	Minimum	Typical	Maximum	Factory set
	1000mA	25000mA	27000mA	25000mA[3]

Table 1-3 Snapshot of factory set registers

[1] *The LED pulse duration is the time that the LED's are on once the pulse has been detected. The larger this number is the longer the LED pulse is, and consequently the larger the power demand from the capacitor banks.*

[2] *The RS485 address will be set to 2 if the light is shipping in a quantity of 1. If however there is more than one light in the order, then the serial number of the light will determine the RS485 address.*

[3] *The LED target current is used by the Lights PID control algorithm to set and maintain the peak current output from the light. As with point [1] a large figure here will require more power than a smaller figure. To achieve an output of 100000 Lumen at 5Hz, it is recommended to put this number to 18000.*

1.4 Strobe operation

The strobe light contains an internal microcontroller that controls how the capacitor banks are charged and also monitors the LED channel current to maintain output stability over a range of trigger frequencies and pulse durations.

When pulsing the Strobe light is effectively a finite state machine. Note here that during the pulse, the light electrically disconnects itself from the vehicles power system to prevent the vehicle 'seeing' a spike in power demand during the pulse duration. Table 3 shows how the light changes state when strobing.

DELAY	PULSE	CHARGE 1	CHARGE 2	CHARGE 3	CHARGE 4	TRICKLE
CH1 OFF	**CH1 PULSE**	**CH1 FAST**	CH1_OFF	CH1_OFF	CH1_OFF	**CH1 TRICKLE**
CH2 OFF	**CH2 PULSE**	CH2_OFF	**CH2 FAST**	CH2_OFF	CH2_OFF	**CH2 TRICKLE**
CH3 OFF	**CH3 PULSE**	CH3_OFF	CH3_OFF	**CH3 FAST**	CH3_OFF	**CH3 TRICKLE**
CH4 OFF	**CH4 PULSE**	CH4_OFF	CH4_OFF	CH4_OFF	**CH 4 FAST**	**CH4 TRICKLE**

Table 1-4 Strobe light pulse operation

There are seven different stages (states) to the lights trigger operation, as follows;

1.4.1 Delay

This is a configurable state, it is entered whenever the microcontroller detects the incoming trigger and acts as delay from trigger acquisition to actual light output. This is used when the light is being operated in a multi spectral imaging setup. The length of this delay is configurable via a serial command. Refer to the API for details on this. There is a 22usec fixed internal delay that is due to the control architecture in the light. The delay register adds to this.

1.4.2 Pulse

This is the state where the lights actually fire. It occurs once the delay state has elapsed and its length is user configurable. It's the state where the light is on. On the Cathx Configuration software, this state is controlled via the Pulse Duration slider as illustrated in figure 2.

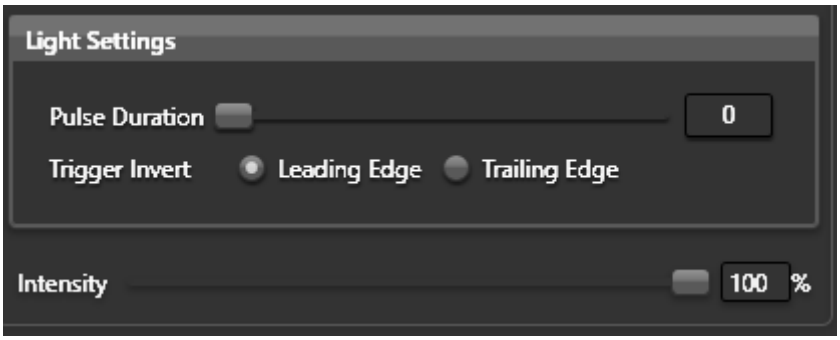

Figure 2 - Strobe light setting box in the Cathx Configuration software

1.4.3 Charge 1 – 4

These states are the channel fast charge states. The named channel is fast charged during these states. Only one channel is fast charged at a time. The fast charge current is set by the LED current control PID algorithm. The duration of the each charge interval has a limit of 56msec. The duration is calculated by the microcontrollers frame rate reading function.

1.4.4 Trickle

This state is only entered if there is enough time in the interval between pulses. During this state all channels are charged at a minimum effort. This is used to top off the channels during low frame rate operations.

2 Serial Communications Setup

The light is equipped with an RS485 half-duplex serial interface. The default baud rate used to communicate with the lights is 57600. It is possible to change the baud rate to one of a fixed number of speeds. The data format used is 8 data bits, no parity and 1 stop bit (8N1).

The communications architecture is a master/slave system in the light. The light will never send data onto the RS485 bus unless it is asked to do so by the host.

2.1 Packet structure Host to Aphos

Figure 3 below illustrates the packet structure for querying or commanding the light.

1	2	3	4	5	6	7	8	9	10	11	12
<	C	,	Address	,	Register	,	Value 1	Value 2	*	Checksum	>

Figure 3 - Host to Aphos 32 packet structure

When sending a query or command to a light the packet fields are broken down as shown in table 2-1.;

Field	Value	Description
1	"<"	Packet start delimiter
2	"C"	Command or Query from Host to light.
3	","	comma - internal field delimiter
4	"address"	Number from 1 to 255. This is the address of the light on the wire
5	","	comma - internal field delimiter
6	"register"	Register you want to access
7	","	comma - internal field delimiter
8	"value 1"	Command specific value (LED Channel identifier)
9	"value 2"	Command specific value
10	"*"	Internal field delimiter to indicate that the following field is a checksum
11	"Checksum"	The checksum can be calculated at the host and sent down. It is a 16 number. Alternatively, by sending "ZZZZ" in place of the checksum, the command will still be executed by the light.
12	">"	Packet end delimiter

Table 2-1 Host to Aphos 32 packet format

Note here that Field 9 is optional. Many commands will have only a single parameter. Also when reading data from the light, you do not send anything in Field 8 or 9. The light will interpret the lack of parameters as a 'Get' command and return the relevant data to the Host. If a parameter is present in Field 8 (9) then the light will interpret this command as a 'Set' command.

2.2 Packet structure Aphos to Host

Figure 4 below illustrates the packet structure used by the light when responding to the host. The packet below is a single character response packet. In this case field 6 is the value returned from the light. Some queries from the light will result in more than one character being returned.

1	2	3	4	5	6	7	8	9
<	R	,	Address	,	value	*	Checksum	>

Figure 4 - Aphos 32 to Host packet structure

Field	Value	Description
1	"<"	Packet start delimiter
2	"R"	Response from Host to light.
3	","	comma - internal field delimiter
4	"address"	Number from 1 to 255. This is the address of the light on the wire
5	","	comma - internal field delimiter
6	"register"	Register you want to access
7	","	comma - internal field delimiter
8	"value 1"	Command specific value
9	"*"	Internal field delimiter to indicate that the following field is a checksum
10	"Checksum"	The Aphos will always return a checksum
11	">"	Packet end delimiter

Table 2-2 Aphos 32 to Host packet structure

3 Operating the light

When the light leaves the factory it is setup in a ready to operate configuration. The light will simply need power and a valid trigger to begin firing. There is no requirement to control the light via the RS485 interface unless you wish to adjust parameters such as trigger duration and light intensity.

The light is relatively simple to control and for most operations the only parameters that will need adjustment are the pulse duration and the light intensity.

3.1 Adjusting the pulse duration

The commands below can be used change the length of time that the light will turn on for when a trigger is received. The command is detailed in Table 3-1. Refer to the Command reference section for a list of all commands, their format and the expected reply.

Command (Host to Aphos)	Response (Aphos to Host)	Details
<C,2,s_pulse 3000*ZZZZ>	None	This sets the pulse duration to 3000 usec
<C,2,s_pulse*ZZZZ>	<R,2,3000*ZZZZ>	This command asks the light to send back its pulse duration

Table 3-1 Setting the light pulse duration

3.2 Adjusting the LED intensity

The LED intensity will increase or decrease the LED power emitted from the panel. Be aware that the amount intensity of the panel will diminish as the frame rate increases. This is due to the fact that at high frame rates there is less time available for the capacitor banks to charge.

Command (Host to Aphos)	Response (Aphos to Host)	Details
<C,2,c_level 0 84*ZZZZ>	None	This sets the LED intensity to 84%

Table 3-2 Setting the LED intensity level

4 Command reference

The following commands can be used to communicate with the lights. For this table the lights RS485 address is assumed to be 2.

Command	Type	Packet	Response	Details
c_level	W	<C,2,c_level 0 80*ZZZZ>	None	Set the light level to 80%. Range is 0 to 100.
s_trigger	R/W	<C,2,s_trigger 1*ZZZZ>	None	Set strobe to trigger on rising edge (Default)
		<C,2,s_trigger 0*ZZZZ>	None	Set strobe to trigger on falling edge
		<C,2,s_trigger*ZZZZ>	<R,2,0*0171>	Light response, strobe is falling edge triggered
s_delay	R/W	<C,2,s_delay 100*ZZZZ>	None	Set light to wait 100usec after trigger is detected to power on the LED's
		<C,2,s_delay*ZZZZ>	<R,2,100*1234>	Light response, strobe delay is 100usec
s_pulse	R/W	<C,2,s_pulse 2500*ZZZZ>	None	Set strobe duration to 2500usec (Max duration is 10000usec)
		<C,2,s_pulse*ZZZZ>	<R,2,2500*123>	Light response, strobe duration is 2500usec
s_shot	R/W	<C,2,s_shot 100*ZZZZ>	None	Set the lights single shot duration to 100msec
s_mode	R/W	<C,2,s_mode 0*ZZZZ>	None	Set the light into pulsed mode (Default)
		<C,2,s_mode 1*ZZZZ>	None	Set the light into single shot mode
version	R	<C,2,version*ZZZZ>	<R,2,136*1234>	Light response, firmware version is 136
auto_en	R/W	<C,2,auto_en 1*ZZZZ>	None	Set the light to sequential auto charge at power on.
		<C,2,auto_en 2*ZZZZ>	None	Set the light to concurrent auto charge at power on. (Default)
		<C,2,auto_en 0*ZZZZ>	None	Disable auto charge, Requires power cycle.
s_no	R	<C,2,s_no*ZZZZ>	<R,2,999*1234>	Light response, light serial number is 999
s_enable	R/W	<C,2,s_enable 0*ZZZZ>	None	Disable light. Light will not respond to external trigger
		<C,2,s_enable 1*ZZZZ>	None	Enable light. Light will respond to external trigger. (Default)
d_address	R/W	<C,2,d_address 4*ZZZZ>	None	Change light address from 2 to 4
		<C,2,d_address*ZZZZ>	<R,2,2*0172>	Light response, RS485 address is 2

Table 4-1 Command reference