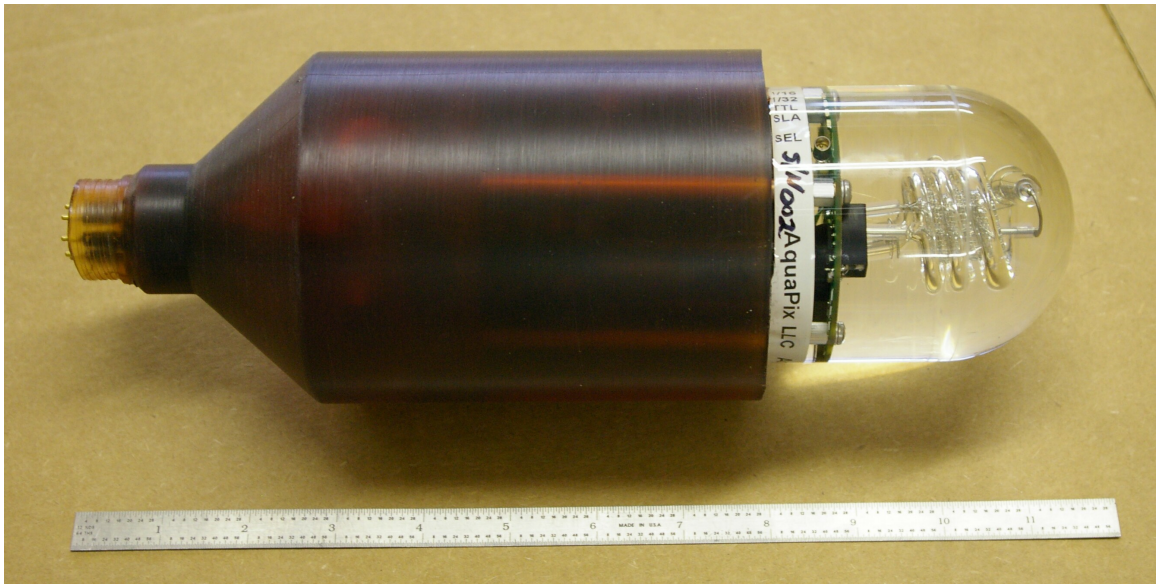
AquaFlash

User's Guide - PRELIMINARY



(Zoom in!)

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AquaFlash Design

The AquaFlash is a photographic strobe intended for use in deep underwater environments. The strobe is a modern design, and is not dedicated to any particular camera system.

Mechanical

The AquaFlash pressure housing is based on heavy walled borosilicate glass tubing, using formed and annealed dome ends. The cylinder is closed using a simple glass-to-glass interface, sealed using fiberglass tape and flexible epoxy.

The electrical connector penetration is o-ring sealed against a small glass flat through one of the dome ends. Cable connections are mechanically attached to the polyurethane covers to mitigate stress transfer to the glass penetration. The covers are held in place with an acrylic ring epoxied to the outside of the glass cylinder, again to minimize mechanical stresses.

The implodable volume of the unit is minimized by filling the interior with inert silicone oil. This also provides mechanical damping to the internal components, as well as heat transfer and useful dielectric properties for the electronics. A small sealed internal air cell provides expansion/compression space to isolate the electronics from pressure changes. Note that the silicone oil is non-toxic, non-reactive, etc… an MSDS is available upon request. There may be a small air bubble present in the oil.

The internal flash tube is a widely used commercial model, operated well below it's maximum rating, maximizing the reliability and life of this highly stressed component. The flash tube is located in the center of the cylindrical tube, allowing use with either end or side oriented reflectors.

Surrounding the cylindrical glass housing is a thick, very tough, semi-rigid polyurethane cover. The polyurethane is cast directly against the glass and adheres extremely well, allowing it to serve as the mechanical structure for mounts and reflectors, as well as providing excellent protection against bumps and mounting stresses.

Electrical

The AquaFlash is designed using the latest high efficiency charging technology. Reliability and volumetric efficiency are maximized by using an array of capacitors for energy storage. Flash duration (intensity) control is handled using IGBT switching, again maximizing efficiency, and greatly reducing recycle times at lower power outputs. The AquaFlash operation is controlled via microcontroller, reducing costs and greatly increasing flexibility and reliability.

The internal capacitors may retain their 650 volt charge for a fairly long time after power is removed. Given that the AquaFlash is a sealed unit, with no serviceable items, this does not pose a safety concern.

Reflectors

The design of the AquaFlash allows use of an end-style reflector, such as a parabolic dish for long range narrow beam, a general hemispherical dish for wide angle use, or a side-looking reflector, as might be used on an ROV.

Specifications (without connector, reflector)

Length:	Tip–Tip: 11.6 inches	Glass Envelope: 9.5 inches
Diameter:	Cover: 4 inches	Glass Envelope: 3.15 inches
Weight in Air	2.5 kg, 5.5 lbs	
Weight in seawater	TBD	
Exposed Materials:	Borosilicate Glass, Polyurethane	
Tested Pressure:	TBD (10,000 PSI anticipated)	
Flash Pulse Energy	275 watt-seconds (joules) typical, full power	
Flash Pulse Duration	4 mS typical, full power	
Anticipated Life:	>250,000 full power flashes	
Charge Voltage	650V	
Capacitance	1350uF	
Recycle time	15 seconds max	
Flash Interval	15 seconds at full power setting	
	Approx 4 flashes per second at lowest power setting	
Input Power	12V nominal (16V absolute maximum), 3A Peak	

Status indicators

Upon application of power, the LEDs will quickly flash sequentially, four times in a row. This indicates that the strobe has power, and is functioning.

In order to save power, the AquaFlash will shut down to a low power state after 10 idle seconds. The unit will not immediately lose charge however, and can re-awaken instantly. When the unit is automatically re-awakened via any input signal, the LEDs will flash again, indicating that it is ready to respond to inputs.

The currently configured operating mode is indicated by one of the green or yellow LEDs, per the table below. The Red LED flashes when charging, and will be solidly lit when the AquaFlash is fully charged.

LED	Color	Mode	Description
1	Red	Charge State (RDY)	Fully charged (solid), or charging (flashes). Off if AquaFlash is not Enabled.
2	Green	Manual: Full	Full Power flash, ignores Quench
3	Green	Manual: ½ Power	1/2 Power flash, ignores Quench
4	Green	Manual: ¼ Power	¼ Power flash, ignores Quench
5	Green	Manual: 1/8 Power	1/8 Power flash, ignores Quench
6	Green	Manual: 1/16 Power	1/16 Power flash, ignores Quench

7	Green	Manual: 1/32 Power	1/32 Power flash, ignores Quench
8	Yellow	TTL	Trigger Line Start, Quench Line stop
9	Yellow	Electrical Slave	Start & Stop per Trigger line, ignores Quench

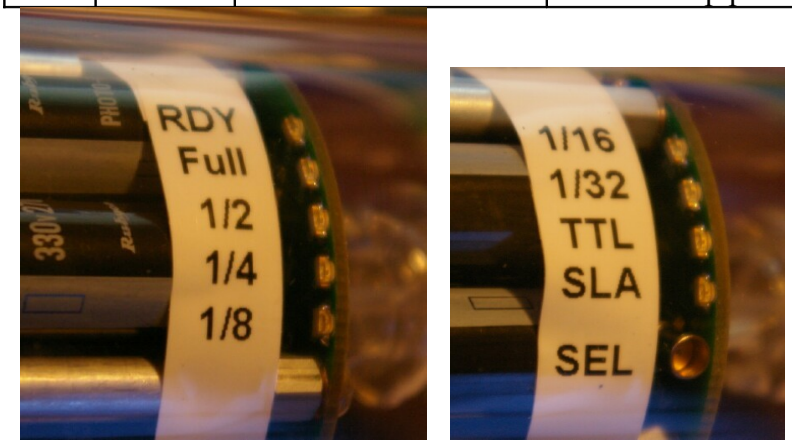


Figure 1 - Status Indicators & Flashlight Sensor

Operating Mode

The AquaFlash output intensity can be configured for one of six presets, TTL operation, or slaved to an external signal.

The six manual presets are designed with full f-stop increments. An internal optical integrator is used along with a self-calibration process to ensure repeatability, even when not fully charged. When set to any of the manual modes, the flash is started via the electrical Trigger signal.

TTL operation uses both the Trigger and the Quench signals to control the flash intensity. This scheme was originated by Nikon many decades ago, and is standard among many cameras. Many of the newer digital cameras use more sophisticated (i.e. proprietary) TTL schemes, which the AquaFlash will not support.

Slave operation is also provided, whereby the AquaFlash output will follow the pulses on the Trigger signal. In some cases this can be used with newer digital camera TTL systems. This mode will also be useful when configuring multiple strobe systems, where the camera controls one strobe, and other strobes are slaved via accessory sensors.

Selecting the Operating Mode

The operating mode can be configured through the electrical cable, or by use of a flashlight. Pulsing the Mode Select line or flashing a strong light on the sensor near the flash tube both provide an input to the strobe, allowing configuration. The light sensor (SEL) is next to the LEDs (see Figure 3).

These options allow for configuration via a number of method. The optional 'Deck Box' is useful for off-line testing and configuration. Once installed in a system, the strobe can be configured by an intelligent camera system controller (i.e. in-situ), or simply by flashlight on deck.

To start the mode selection process, provide three quick pulses/flashes within a 1 second period of time. The AquaFlash is designed to ignore patterns other than those needed to configure it. It may take a few minutes to get the hang of it by hand, so feel free to 'play'. When the correct sequence is recognized, all active LEDs will flash. If nothing else is signaled within 10 seconds, the AquaFlash will revert to idle operation.

Once the LEDs are flashing, indicating it's ready for selection, you may enter another pulse sequence to change states, according to the following table.

Pulses in 1 Second Period	Action
1	Select the next Mode
2	Reset Operating Mode to Manual, Full intensity.
4	Calibrate Manual Intensity

Once the selection process is done, the selected operating mode is saved, and will be retained even when disconnected from power.

Calibration

When the AquaFlash performs a calibration, it charges up and outputs a full intensity flash. This flash is monitored internally, and the resulting feedback information is saved. Calibration may only be required when changing reflectors. The LEDs will flash during this time, providing some status information, which is used at the factory. Once calibration is completed, the AquaFlash returns to it's idle state.

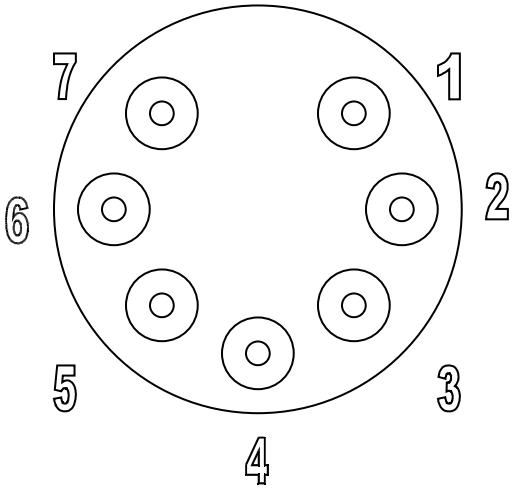
Connector

The AquaFlash uses a 7 pin interface connector, the MBH-7-MP from Impulse. An optional 2 ft mating cable with locking sleeve is available for sale with the AquaFlash for splicing into a camera system. Longer cables are available upon request, or directly from Impulse. The AquaFlash incorporates cast threads to mate with the mating cable retainer. Note that this threaded section is thin, and is not intended to handle great stresses.

The following table details the connections.

Pin	Name	Description
1	Mode Select	Pull low to activate. Internal 82K resistor to 5V
2	Supply	Nominal 12VDC: 9V-15V allowable range. 16V Absolute Maximum! Peak current draw is about 3 amps.
3	Quench	Pull low to stop flash, in TTL mode. Internal 82K resistor to 5V
4	Enable	Pull low to enable charging and flash output. Internal 82K

		resistor to 5V.
5	Trigger	Pull low to initiate flash. Internal 82K resistor to 5V. In slave mode, flash will be terminated when Trigger goes high.
6	Ground	Signal & Power common.
7	Ready	Charge Status: 1K to Supply when charged, Open if not active, and toggling if charging.



Pinout: Looking at pins on end of AquaFlash

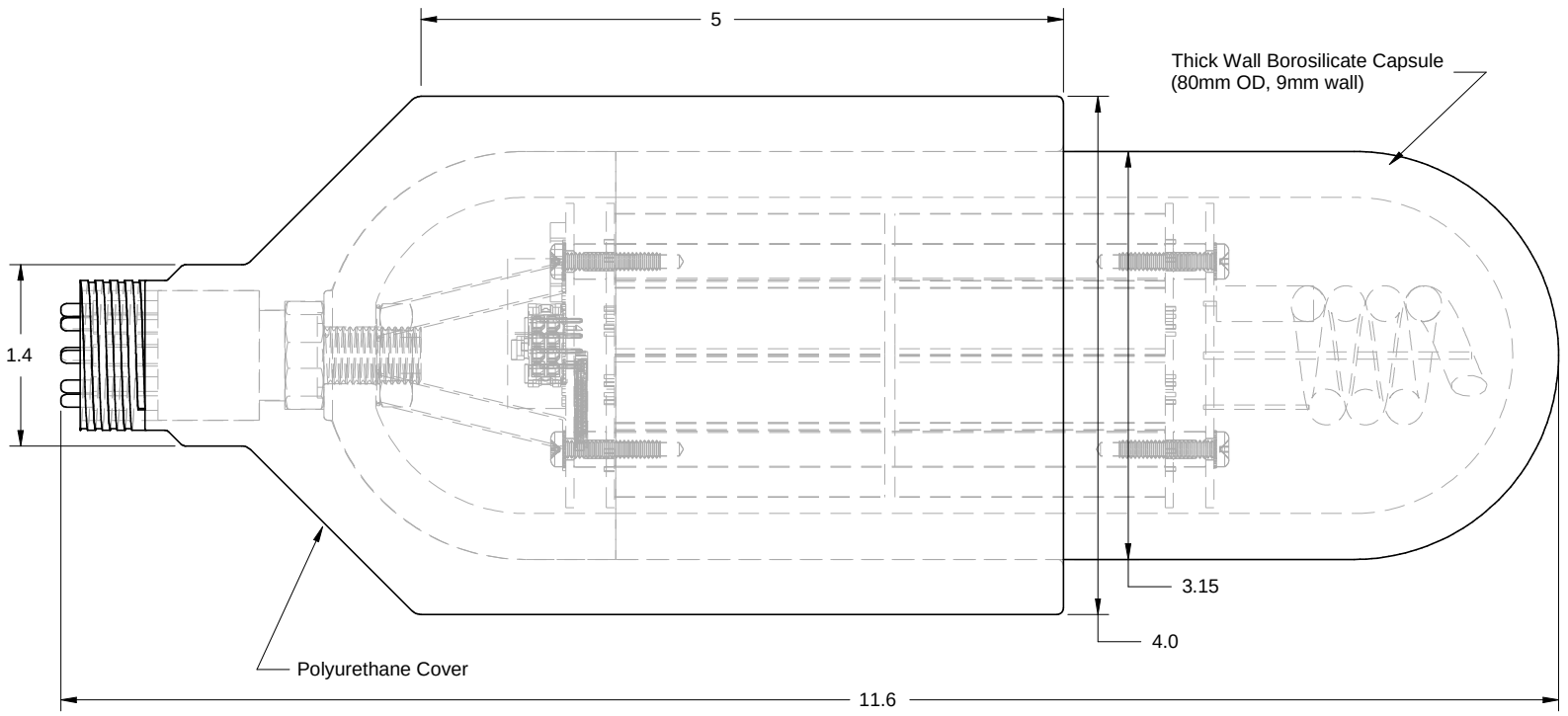
Application

The vast majority of deep water flash photography is performed using the camera set to a fixed shutter speed and iris, and the flash intensity set manually to yield correct exposure given the intended distance to target. Many of the newer camera systems are based on off-the-shelf digital cameras. Camera light sensors are frequently often occluded by the camera housings making auto exposure impossible, and many other cameras use proprietary pre-flash processes to establish TTL exposures. While it may be possible to use the slave mode of the AquaFlash with these pre-flash systems, the process is somewhat time-intensive, and is often inappropriate for many applications.

Setting the correct flash intensity has generally be a trial & error process, performed in a pool or sometimes, in the field. Flash intensity has historically been controlled via physical switches inside or on the pressure housing, making adjustment a time-consuming process, particularly in the field. Technology has progressed to the point where digital cameras are often able to upload images in-situ, so the AquaFlash has been designed to allow manual intensity control in-situ as well. If the mission parameters change during deployment, the AquaFlash intensity can be adjusted as needed! The Mode Select line can be pulsed to change settings (i.e. via a remote switch, under microcontroller control, etc.). Pulse the line three times in a 1 second period, and the unit will allow changes. Click it twice more in a second to reset the flash intensity to full manual, and then click it once per second to step through the other modes. A few seconds later, the selection mode will automatically exit, and another picture can be taken, and reviewed for exposure.

The typical flash operation is as follows. Apply power via the Supply and Ground lines. The power may be left connected at all times. To charge the AquaFlash, pull the Enable line low, and wait for the Ready line to go solid high. At this point, if desired, the Enable line may be brought low, ensuring that the AquaFlash does not draw further power. The flash can be triggered by bringing the Trigger line low, regardless of the Enable line state, presuming that the capacitors are charged. When the flash is triggered, the capacitors will immediately start to recharge if the Enable line is still active.

While a full complement of signals are available for status and control, note that only three wires are actually required for minimum connection… Supply, Trigger and Ground. The Enable line can be shorted to ground at the cable connector, and the other signals left un-connected.



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