Optical Flasher Operating Modes

Narrow pulse mode

15 nsec wide (FWHM) or shorter

**10^3-10^9 photons per pulse (Variable in 32 steps or more)

(** See discussion on next page)

Wide pulse mode

Rise time < 30 nsec, fall time < 50 nsec

Pulse width 800±10 nsec

Intensity $1x10^2$ – $2x10^4$ photons per nsec (variable in ? steps)

DC mode

Intensity	?
Maximum duration	?

Update after the 12/18/02 conference call:

- Wide pulse mode and DC mode will be removed from the Flasher Board requirement.
- An arbitrary wave light source external to the OM will be used for lab calibration of the PMT (rather than using the wide pulse mode).

The Maximum Narrow Pulse Intensity Requirement

- The combined output of all the LEDs fired at once and striking the photocathode without loss of photons shall produce **$M=1x10^9$** photoelectrons in the PMT with a quantum efficiency times collection efficiency of η=0.23 (bialkali photocathode, λ=400nm).
- If N LEDs are to be fired at once, each LED shall produce (M/N) photoelectrons per shot, *regardless* of the orientation of the LED.

Explanation

Since the mean-free path of the photons in ice is on the order of ~20m, the directionality of the LED beam pattern is lost over the inter-string distances. At large distances the photon flux appears to be a result of spherically outward diffusion of all the photons deposited at origin.

S: Number of photons deposited at origin
R: Distance to the OM from origin
A: Photon capture area of the OM
K: Transmission over the distance R in ice
G: Transmission through glass surfaces and gel
η: Quantum efficiency x collection efficiency of the PMT

Let R = 200m, A = 400cm^2, G = $(0.95)^2$, η = 0.23, K = ??

$$S \frac{A}{4\pi R^2} K G \eta = 1 \quad \Rightarrow S = 6 \times 10^7 / ??$$

In the laboratory, we can eliminate the geometrical factor and the effects of ice and glass. Thus we obtain the required number:

$$M = S \eta \quad \Rightarrow M =$$

How to Meet the Requirements

Assuming that all the light coming out of the tube hit the PMT photocathode, we have

$$M_p = S\, K_a\, K_t\, \eta$$

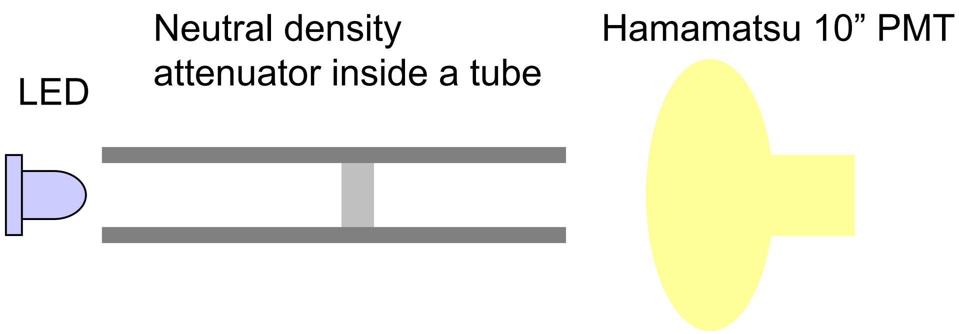
Since we must have $M = 1\times10^9$ photoelectrons per pulse in the absence of the effects of ice, glass and the spreading over distance,

$$M = S\, \eta$$

Therefore, the number of photoelectrons to be observed per pulse in the lab setup is

$$\boxed{M_p = K_a\, K_t\, M}$$

For a cosine source profile, K_t~0.0044 (Tube length of 5.7" and 0.75" aperture diameter)



S: Number of photons produced by the LED per pulse
K_a: Fraction transmitted through the neutral density attenuator
K_t: Fraction of light transmitted through the tube without the attenuator
M_p: Number of photoelectrons produced per pulse

Functions

Fast trigger from DOMMB
DOMMB sends “get ready” signal

Every other OM’s have horizontal beams
The rest of the OM’s have beams pointing 48degrees upward.
(Simulates 42degree Cherenkov angle)

Optical Flasher Operating Sequence

1. DOMMB checks to see if Flasher is READY
2. DOMMB selects one of the Flasher modes
3. DOMMB sets up parameters for the selected mode
4. DOMMB issues a trigger
5. Flasher fires
6. Flasher sends a timing pulse to the DOMMB for time stamping
7. Flasher writes a status code to an on-board register

Requirements

One of the bits of the **status register** indicates Flasher readiness

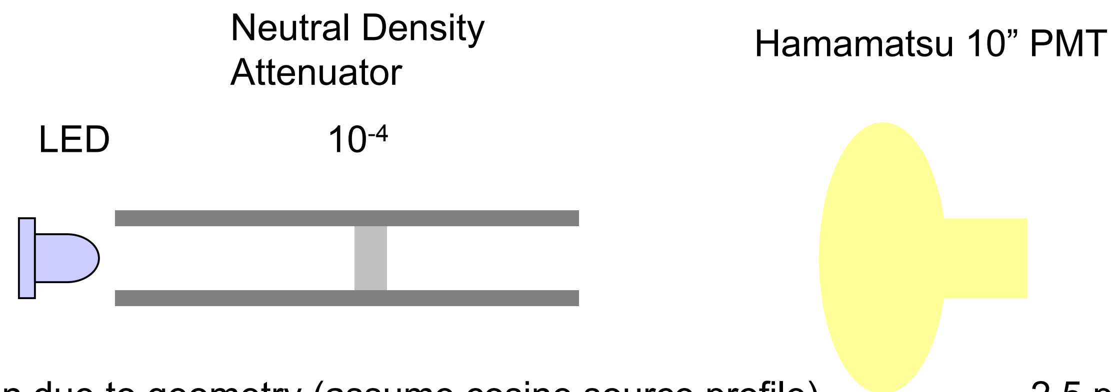
The cycle time for the above sequence is 1kHz

Alternative:

The set up parameters include the number of repetitions and the repetition intervals. Thus the above sequence does not have to be repeated as often as 1kHz.

Achieving a Narrow, High-Intensity Pulse
(Status of development by D. Wahl, UW-PSL)

Pulse intensity in excess of 1 pe at 200m has been achieved.



0.4% transmission due to geometry (assume cosine source profile) 2.5 pe / pulse

10^{-4} attenuation simulates 10^{-1} per 50 m of ice attenuation over 200 m. (WRONG)

To do: Insert OM glass and gel in the optical path.
Operate at low T.

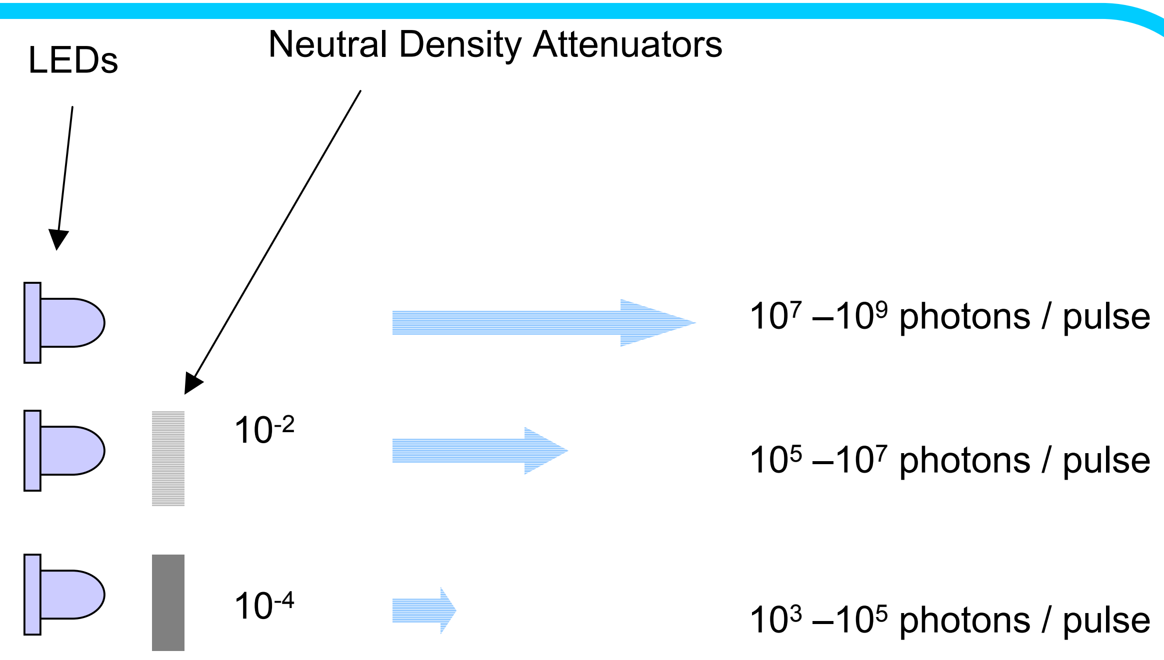
Achieving Six Decades of Pulse Intensity Adjustment
(Status of development by D. Wahl, UW-PSL)

- Producing a fast, high-intensity pulse is *not* a problem (done).

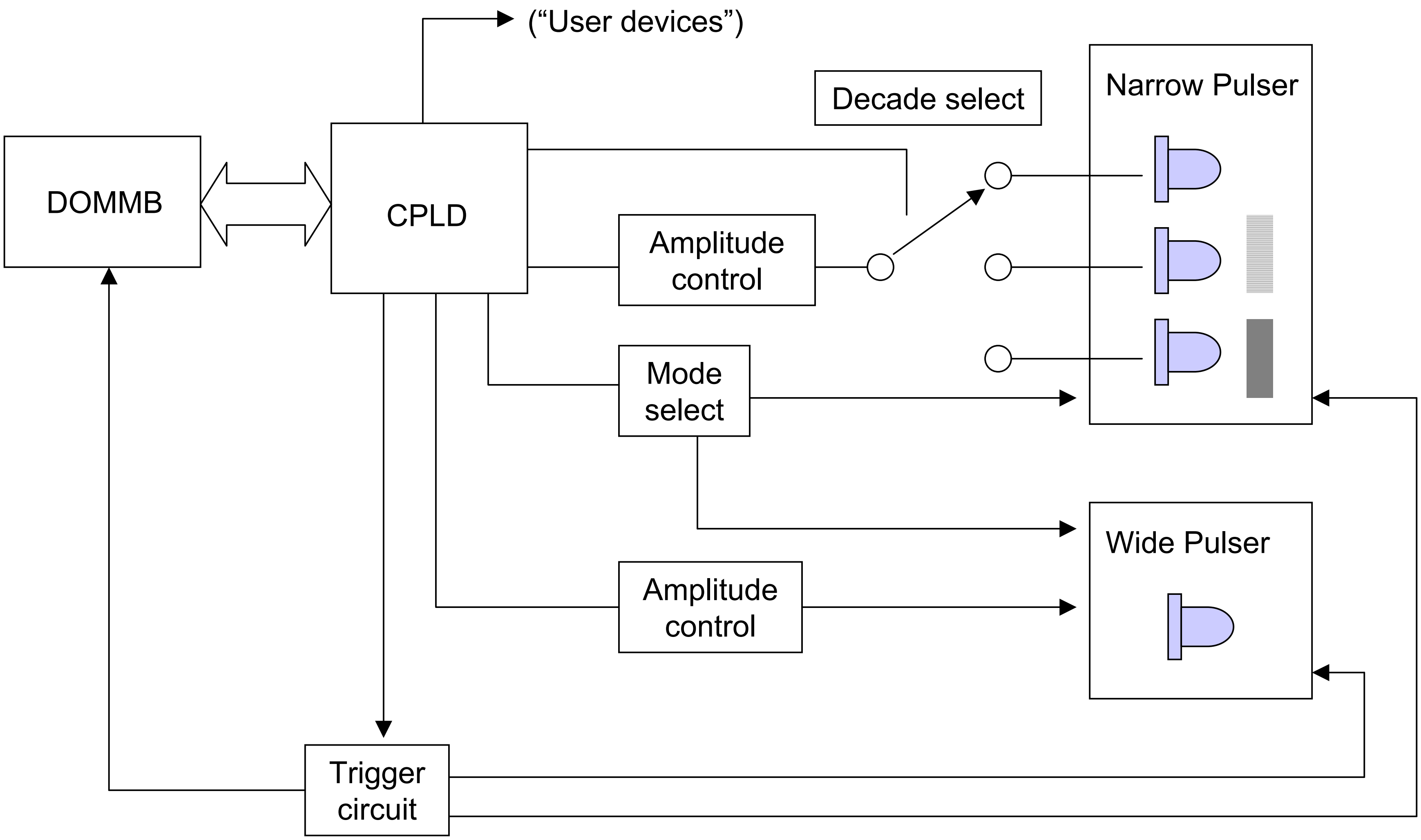
- Two decades of intensity adjustment is electronically achievable without sacrificing the temporal profile of the pulse.

- Six decades of intensity adjustment may be achieved by the scheme shown below, without sacrificing the pulse shape.

The intensity of the individual LEDs is adjustable over two decades.



Optical Flasher Design Concept



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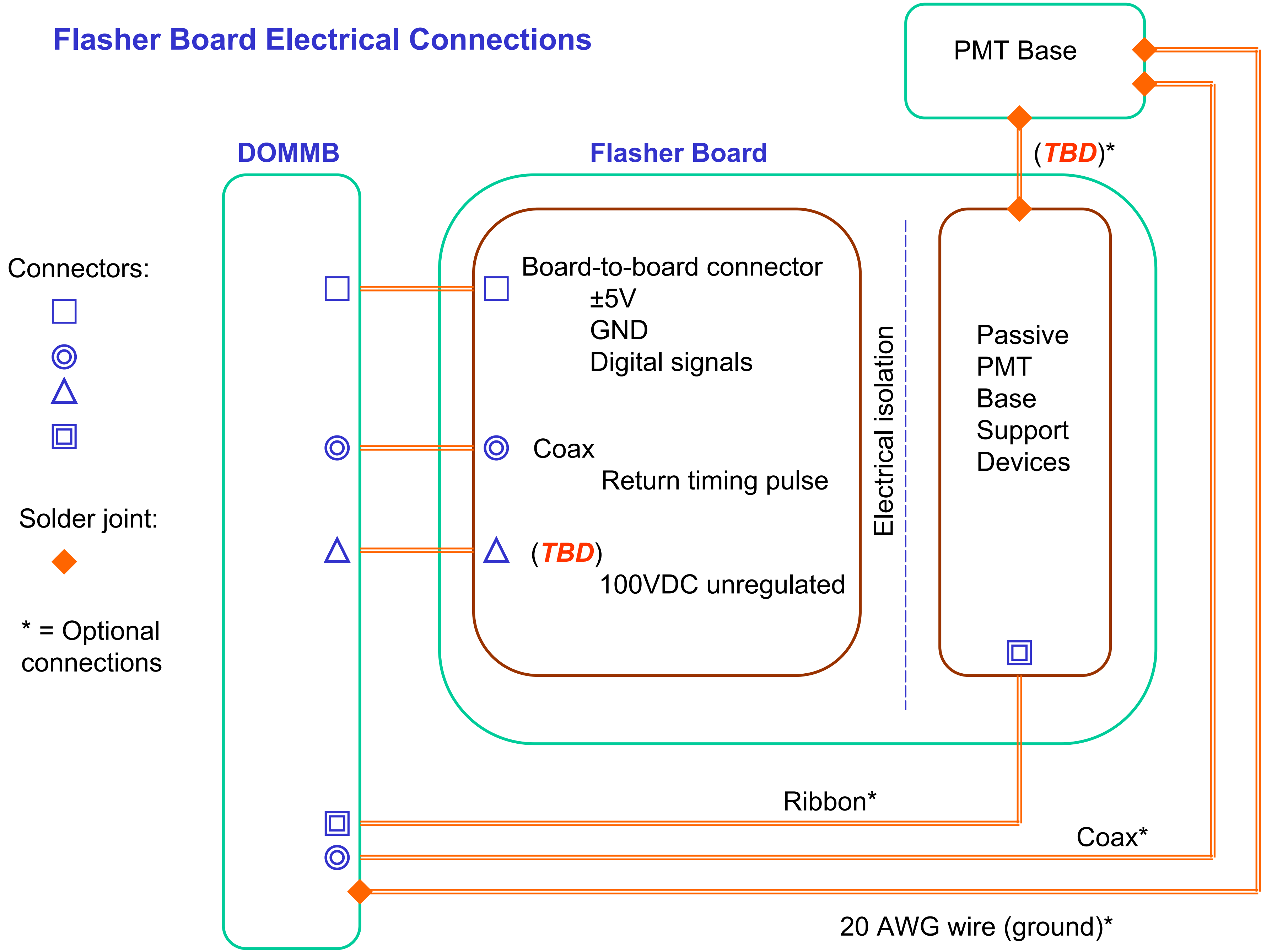
Flasher Board Electrical Connections



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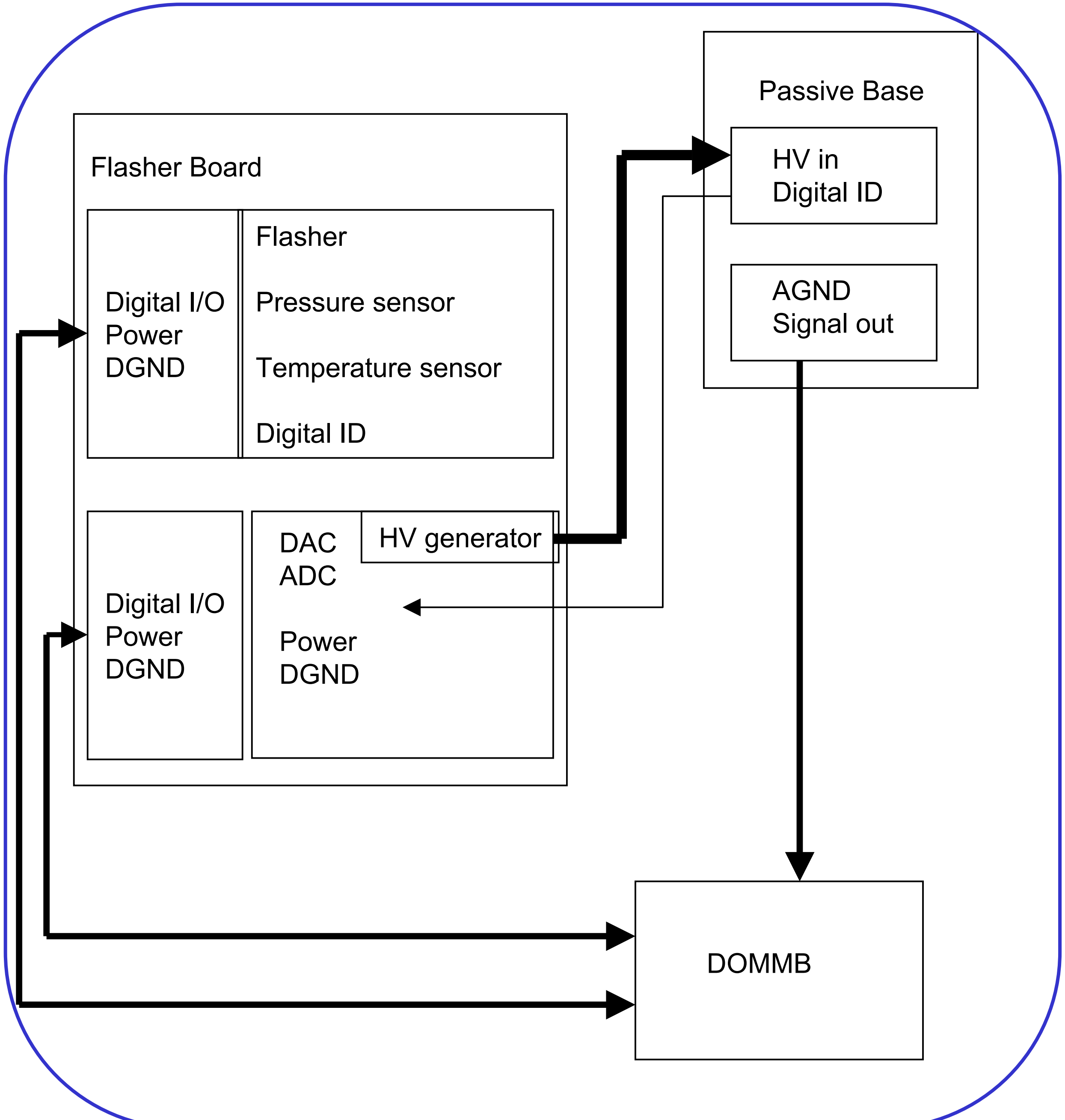
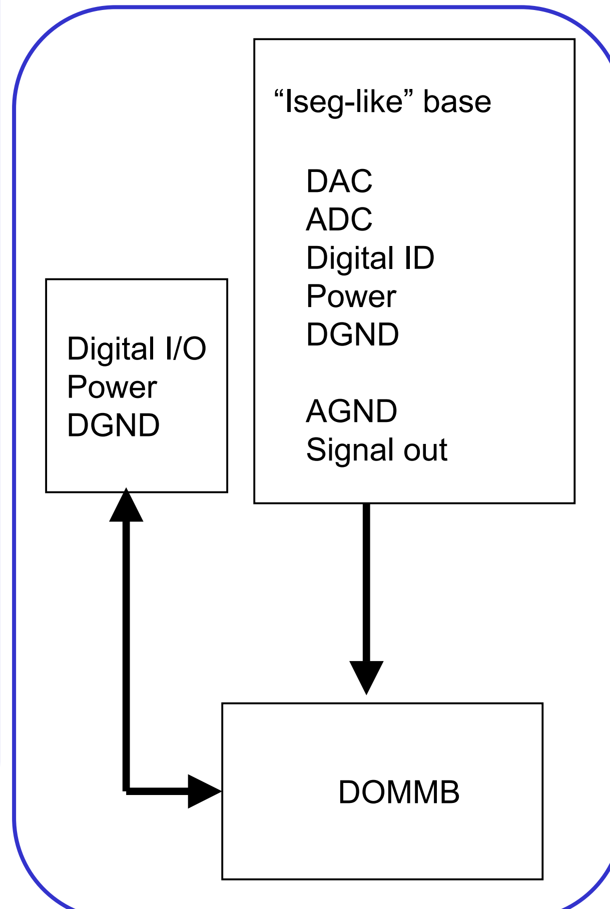
Locating the Passive PMT HV Base without Changing the Interface to DOMMB





10/22/02 N. Kitamura