From Dan Edmunds <edmunds@pa.msu.edu>
Sent Tuesday, June 23, 2009 9:15 am
To Stephen Pordes <stephen@fnal.gov>
Cc "Bromberg, Carl" <Bromberg@pa.msu.edu>
Bcc
Subject Re: components for a PMT base ..

On Mon, 22 Jun 2009, Stephen Pordes wrote:

> Hi Dan,
>
> I apologize for bothering you but I have been asked suddenly
> to make a PMT base to be used in liquid argon (for darkmatter
> colleagues) and I wonder if you have recommended components
> (resistors, capacitors and material of PC board).
>
> many thanks ..
>
> Stephen

Hello Stephen,

Resistors:

The resistors that I know of that have been used in operating LArTPCs and do not appear to cause problems are:

Ohmite Slim-Mox 102
Ohmite Slim-Mox 104
Dale RN55D CMF <-- (and presumably the higher Wattage RM CMF types are OK)

Basically any real "metal film" resistor will hold its value OK at LAr temperature. The main things that you need to check are that the resistor does not contaminate the LAr and that it does not physically fall apart when it gets cold.

Capacitors:

The only capacitors that I have used in an operating LArTPC are Polypropylene Film capacitors specifically 0.01 uFd 1600 Volt from ICC (Illinois Capacitor Company) type PPB.

The Polypropylene Film capacitors do not change value when

they get cold because the dielectric constant of the film is not high to begin with. There have been no problems that I know of so far with the ICC type PPB capacitors falling apart when they get cold or with LAr contamination.

You can not use normal ceramic capacitors e.g. Z5U or X7R type ceramics. Their value when cold is only a few percent of their room temp value. You can use NP0 or C0G type ceramic and Mica capacitors if you test them for physical problems when cold and for LAr contamination.

For a number of reasons it is best to be conservative in the voltage rating of the capacitors when they are cold.

PC Board Material:

The concern with normal FR4 pcb material is that it contains bromine based fire retardant that will get into and contaminate the LAr. There are a number of pcb materials that do not contain halogen fire retardants. These include:

company name Taconic their material type TacLam TLG
company name Rogers some their materials 4000 series
company name Hitachi their material type MCL-HE-679G

These materials are designed for making pcbs that have microwave frequency signals.

Johnny Green is the person at Fermi who has investigated these pcb materials. Use of these special materials requires some special processing steps by the pcb vendor. Johnny knows a company near Fermi that can correctly handle making the raw pcbs from these special materials. I used Hughes Electronics Products near Detroit to make cards using the Taconic TLG material for T962.

Notes:

It appears that the pcb cards can hold a lot of water which is also a contaminate for the LAr. It may be a good idea to design the pcb card so that it can be cooked at 60 deg C or something like that to dry it before it is installed.

Designing the card to use components with wire through hole

leads (vs surface mount) eliminates a lot of the concern about matching coefficients of expansion of components vs the pcb material. IPC standards for assembly of the through hole components require a solder fillet on both sides of the card which reduces/eliminates problems with breaks in via conductivity when the card is cold on double sided cards. Multiple redundant vias is another way to reduce the risk of this problem.

Walter Jaskierny has knowledge and information about components for building cold electronics.

Please let me know is there is some additional information that I can help with.

Dan