

Ticket #1269

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Create Date:	03/17/2016 4:19 pm	Phone:	(713) 501-2744
Field of Study:	Electrical Engineering		

Subject: **Yale University**
03/17/2016 4:19 pm Philip Piper

Hello,

Could you explain the difference between the over surface and through air values PCB trace separation in tables 10 and 15? I'm assuming over surface is for exposed conductors on a surface and through air (cut in board) is for traces under the silk screen. Which one applies to internal PCB layers?

Thanks,

Phil

03/17/2016 5:29 pm Philip Piper

After a bit more reading I think I understand the PCB trace separation rules, but I am a bit shocked (mind the pun) at how far traces need to be apart. For instance we specced wire to board connectors that are rated for 300V, but they don't have the 3/8" spacing required by the rules. Our linear regulator, which is rated up to 450V, is even further from the Hybrid rules specifications. This same problem occurred for almost every component on the HV side of the board, all of which are rated for the voltage they are used at.

When I first designed our HV control PCB I used the Hybrid rules for the HV to LV separation (3/8") and around IEC 60950 basic level creepage distance (~0.1") for HV to HV separation. When I looked up reinforced creepage distances, even that was about 2/3 of what Formula Hybrid requires! I'm not sure where to go from here, as I have a PCB that I think meets industry standards, but I'm not sure if I can get it to meet Formula Hybrid standards. I have attached a picture of it for reference.

Best,

Phil
HV PCB.jpg(296.3 kb)

03/20/2016 4:19 pm

Note that most for most TSV to TSV spacings, there are no requirements in the rules--you can use spacing as close as you'd like. There are only two situations where the rules specify minimum spacing. One is TSV to GLV separation. The other is for conductors inside the accumulator container.

Where is this board located, what does it do, what spacings on it are the concerns, and what is the scale for the image you provided?

03/21/2016 4:00 am Philip Piper

Ahh, very good. This board houses the precharge, discharge, TSMS resistors, DC-DC converters for TSVPs, linear regulators for accumulator prominent indicators, and some other bussing on the LV side. I have the LV-TS spacing at 3/8" which should satisfy the rules for our 300V system. Some of the TS spacings are quite close around the linear regulators

(surface mount on the mid-left), but that is due to the component packaging. The components are rated up to 450V and we are using the suggested land pattern, so I'm assuming we will be good based off of that. I'm going to double check with my faculty adviser first (suggestions are very welcome from here as well!). The linear regulator is an ON Semiconductor NCP785AH120T1GOSCT-ND. For reference, the inner diameter of the mounting hole at the bottom right is #10 (0.19").

Best,

Phil

03/21/2016 2:50 pm

Phil - we have been working on guidelines for HV spacing where conformal coat and / or current limiting fuses or resistors are used. We should have them to you shortly. I think that will help to resolve.

03/22/2016 3:24 am Philip Piper

Sounds good to me. Looking forward to it!

Phil

03/28/2016 12:24 pm

Phil - we discussed today and expect to have something out to you today or tomorrow.

03/28/2016 12:34 pm Philip Piper

Unfortunately our sponsor's pricing and lead time forced us to move forward with our current design. We plan to conformally coat the high voltage control (precharge, discharge, TSMP, DC-DC, etc...) and charging boards. We followed IEC 60950 for 300VDC reinforced with pollution degree 3 for HV-HV trace spacing (~150 thou). We followed Formula Hybrid rules for LV-HV trace spacing. Where we couldn't follow IEC 60950, we followed IPC-2221B for external spacing (50 thou). Where we couldn't follow IPC-2221B external, we followed IPC-2221B coated spacing (16 thou). The last case only occurred for the 300VDC-12VDC linear regulators that power the prominent accumulator indicators (they only come in surface mount packages).

Looking forward to hearing your guidelines in case we have to do a revision (expensive!).

Best,

Phil

03/30/2016 2:12 pm

Phil,

Your spacing is approved.

We'll be updating the rules for 2017. In the meantime, the inspectors have been advised to be somewhat lenient regarding these spacings.

Best regards,

-Doug F

03/31/2016 6:33 am

Phil,

With apologies, there were some caveats that should have been included with the approval I sent out yesterday. The rules

committee has not completely finished their discussions on this issue yet, but I will get you that information as soon as I can.

-Doug

03/31/2016 10:07 am

Phil,

I'm sorry for the confusion. Here's a copy of the draft 2017 rule for PCB spacing.

Our approval of your 2016 board is contingent on your meeting these requirements. Let me know if there are still any problems.

Thanks,

-Doug F

2017 PCB Spacing.pdf(208.8 kb)

03/31/2016 10:29 am Philip Piper

Doug,

Unfortunately the board we ordered does not meet that requirement. Our precharge and discharge circuitry has to run at a higher current than 250mA to meet Formula Hybrid rules and we used the IEC 60950 reinforced pollution degree 3 spacing (highest spacing requirement we could find) for these circuits which is less than 250 thou. For instance our discharge resistor is 1kOhm for a DC bus of 300V, resulting in a maximum current of 300mA. Of course the continuous current would be much lower than 250mA, but from what I can tell that spacing guide isn't referring to continuous current.

Our only other issue is that the DC-DC regulator land pattern spacing is about 50 thou. This pattern is suggested by the manufacturer who also states that the regulator is suitable for up to 450VDC. Aside from the regulator, every other trace and land pattern meets the spacing requirement.

Here is the link to the conformal coating we plan to use. It is aerosol based which should make application more consistent, and acrylic for the high dielectric strength.

<http://www.mouser.com/ProductDetail/MG-Chemicals/419C-340G/?qs=%2fha2pyFaduhJpKrAJozNrnN3FCTEPs8P5i64yuXDt%2fI9IOB1%2fBN5ww%3d%3d>

Best,

Phil

04/01/2016 7:44 am

Hello Phil,

You have clearly done due diligence on this design and we will approve it.

Thanks for your patience.

-Doug F

Please Wait!

Please wait... it will take a second!

