CAD Netlist Verification
Version 7.0

This process uses a netlist generated from a CAD program to check a gerber database for shorts and opens. To locate errors, it will be important to understand the netlist format. The document "IPCD356 Simplified" will help users get up to speed on our preferred format. To get information on CAD system specific netlist formats, check with the vendor of the product in question.

The Fast Method

This method uses a CAD ASCII database to generate an IPCD-356 netlist to be used for checking. Requires the following files and menu items.

- File: CAD DATABASE supported by CAM350/FabFactory
- Files: Gerber Database exported from CAD Database
- Menu Item: FILE | IMPORT | CAD DATA | <Appropriate CAD Import>
- Menu Item: FILE | EXPORT | NETLIST | IPCD-356
- Menu Item: FILE | IMPORT | NETLIST | IPCD-356
- Other menu items needed should be part of any configuration that allows for the above items.

If any of these menu items are grayed out, then your current product level is not appropriate for this process. The process is outline below.

1) FILE | IMPORT | CAD DATA | <correct CAD Source>. Click OK and select your saved CAD ASCII file.
2) After import is complete. FILE | EXPORT | NETLIST | IPCD-356 - IPCD-356 is a datum coordinate based format that keeps notes on pin numbers too. For more information on the IPCD-356 get the IPCD-356 document from Support.
3) Use Info | Query | Dcode on 2 locations on the board. Make sure that they are easy points to find visually (a boarder corner or a mounting hole perhaps). Write down the coordinates for these points.
4) You may want to save (FILE | SAVE AS) at this point. This will allow a quicker re-load of the data if you need to review later.
5) FILE | NEW.
6) Import the Gerber layers. FILE | IMPORT | AUTOIMPORT is recommend.
7) Click Tables | Layers or the "Y" hot key. Label the layers appropriately for type. Only electrical layers are looked at, so masks, pastes and graphic layers can be left as graphic. But the Top, Bottom, Internal, Positive and Negative planes must be labeled as the correct type. This step is critical, especially for internal planes. Photographically negative layers (layers in which the data represents a lack of copper) are tagged as negative.
8) Set the draw and flash layer colors to different colors for each layer. Setting the draw color different from the flash color makes identification of drawn pads much easier. Noticeably different colors are recommend. Click "OK" when finished with setting up Tables | Layers.

9) If plated drill data exists, make sure that was imported too. Use Edit | Layers | Align as needed.
10) Do draw-to-flash conversion as required. This step is required because Netlist extract defines the end of a net as where a draw ends at a flash. This is not as critical is there is a plated drill layer loaded, as version 5.0 and later will use the drill data to create vias.
11) Locate the objects that you made notes of in step 3. Make sure the coordinates match. If they don't, use EDIT | CHANGE | ORIGIN | DATUM COORDINATE to change to click on one of your objects and enter the correct location for that object. All other data gets moved relative.
12) Utilities | Netlist Extract. Use the default settings with none of the “Netlist extraction parameters” checked off” in most cases. CAD Netlists typically do not include nets without pads or single point nets, so you should not have CAM350 generate a Netlist with them. This process will deduce net connectivity based upon the previous steps. A small cross will be displayed on some pads to represent a through-hole padstack. These padstack markers can be turned off under Settings | View Options. No padstack marker means the pad was processed as SMT.
13) FILE | SAVE as a new PCB file. The saved PCB will be very helpful in Error Resolution. Also, if you make a mistake or want to review the data later you won’t have to do this all over again.
14) FILE | IMPORT | NETLIST | IPCD-356. Select the Netlist you created in step 2.
15) The import process will run a comparison of nets and produce an error report if it finds any problems. If it does, see below for methods of Netlist Verification Error Resolution.

The Slow Method

This method uses a netlist from a cad source to check against gerber data. It is a time consuming process as the gerber data must be reverse engineered to accept the pin based net information output by the CAD system. The following files and Menu items are required.

- File: CAD Netlist supported by CAM350/FabFactory
- Files: Gerber Database exported from CAD Database
- Menu Item: UTILITIES | QUICKPART
- Menu Item: FILE | IMPORT | NETLIST | IPCD-356
- Other menu items needed should be part of any configuration that allows for the above items.

If any of these menu items are grayed out, then your current product level is not appropriate for this process. The process is outlined below.

1) Import the Gerber layers.
2) Click Tables | Layers or the “Y” hot key. Label the layers appropriately for type. Only electrical layers are looked at, so masks, pastes and graphic layers can be left as graphic. But the Top, Bottom, Internal, Positive and Negative planes must be labeled as the correct type. This step is critical, especially for internal planes. Some internal planes are tagged as "Negative Plane" because the actual copper would be the opposite of what is displayed.
3) Set the draw and flash layer colors to different colors for each layer. Setting the draw color different from the flash color makes identification of drawn pads much easier. We recommend using noticeably different colors. Click “OK” once you are finished with setting up Tables | Layers.
4) If plated drill data exists, then import that too. Use Edit | Layers | Align as needed.
5) Do draw-to-flash conversion as required. This step is required because Netlist extract defines the end of a net as where a draw ends at a flash. This is not as critical is there is a plated drill layer loaded, as version 5.0 and later will use the drill data to create vias.
6) Utilities | Netlist Extract. Use the default settings with none of the “Netlist extraction parameters” checked off” in most cases. CAD Netlists typically do not include nets without pads or single point nets, so you should not have CAM350 generate a Netlist with them.

This process will deduce net connectivity based upon the previous steps. A small cross will be displayed on some pads to represent a through-hole padstack. These padstack markers can be turned off under Settings | View Options. No padstack marker means the pad was processed as SMT.

7) FILE | SAVE as a new PCB file. If you make a mistake or want to review the data later you won't have to do this all over again.
8) Run Utilities | Quickpart and identify all the parts in the database. Use silkscreen data to correctly identify parts.
9) FILE | IMPORT | NETLIST – select the correct CAD Netlist format and file.
10) The import process will run a comparison of nets and produce an error report if it finds any problems. If it does, see below for methods of Netlist Verification Error Resolution.

CAD Netlist Verification Error Resolution

Tracking down netlist errors can be difficult. Using the netlist error report locate problem nets and follow their path. This method is a bit time consuming, but it will yield results. The following section discusses this process in detail and offers some methods to speed up the process.

At this point, if there were any errors, you should have a netlist import error report. This report comes in the form of a notepad document. It will list Incoming nets and the nets they conflict with (pass through or that touch nothing). As the import process goes through a number of filters, there may be redundant reports of error if there are any at all. Typically the error report will be large, if there is one, but usually all errors can be traced to one source.

Sample Warning and Error messages
WARNING: Incoming net $Net48 not assigned - no coordinate match!
WARNING: (400.0:450.0) of incoming net $Net60 doesn't touch any net!
WARNING: (1600.0:450.0) of incoming net $Net60 doesn't touch any net!
ERROR: Incoming nets $Net11 and $Net3 both pass thru net $Net21!
ERROR: Incoming Net $Net60 passes thru nets $Net46 and $Net17!

These messages mean exactly what they say. If an incoming (imported) net does not touch any other net, then there is no net at the coordinates specified. If an incoming net passes though an existing net, it means the incoming net is shorting to another net. If an incoming net is not assigned that means that no match was found for the imported net. There are other messages, but they are generally understandable.

Typically if there is one error, there are many. As a result any problems typically produce a massive list of net import problems. But this should not be cause to worry, the source of multiple problems is typically the same source. So the best idea is to look at the first few errors and find the one that involves the one with the shortest net. Then, using a net trace method you can then go to each of the points listed in the net and see where the problem is occurring.

Net trace method
As most errors reports are due to a single error, if you start comparing coordinates in the CAM350 database vs. the Netlist, you will eventually find the problem. This is time consuming but it works. So it is best to choose the net you will trace wisely. For example, say the sample above were the first 5 lines of your netlist error report. Shorts are the best things to look for as they have artwork associated. In this case we have 3 short nets incoming $Net11, $Net3 and $Net60. Using search in notepad determine which one of these 3 nets has the fewest points. In this case it was $Net3.

317$Net3 VIA MD 200PA00X+ 15000Y+ 11300X 350Y S3
317$Net3 VIA MD 200PA00X+ 7000Y+ 12150X 350Y S3

```
317$Net3        VIA       D 280PA00X+ 15000Y+  4500X 350Y        S0
327$Net3        U1   -9   M     A01X+ 14750Y+  5750X 240Y 900    S2
327$Net3        U2   -9         A01X+ 14750Y+ 12250X 240Y 900    S2
327$Net3        U6   -3         A01X+  7000Y+ 11400X 240Y 740    S2
317$Net3        J1   -4   MD 280PA00X+ 15000Y+  4500X 550Y        S0
```

$Net3 is has only 7 points. $Net60 shorted to a power plane so it was huge. Using the coordinate box to you can jump from point looking for shorts and opens. First coordinate is 1.5 x 1.13 and should have a 35 mil aperture. Remember IPCD-356 format is a 2 integer, 4 decimal format.

Two Screen method.
This is only usable with the FAST method. Start Cam350 twice. In one window have the CAD Import, in the other window have the Gerber data processed up to a point PRIOR to the import of the IPCD-356 CAD Netlist. Now go over the list or error. Use INFO | FIND | NET to locate problem nets and highlight them. Do a Visual compare to find the problem. It is less accurate than the net trace but often worth it as it is a quick way to check.

Typical errors
Negative vs. Positive data. This is the number one preparation error. A POSITIVE Plane is an internal plane layer that will get plotted positive. This means that wherever there is data (color) there is conductive material. A NEGATIVE Plane is just the opposite. It is an internal plane layer that will get plotted negative. This means that wherever there is not data (black) inside the boarder, there is conductive material.

Drill data oversized from Anti-pads. Drill data is taken into account when extracting a Netlist. Check the Drill layer vs. any negative layers. If the Drill hits are larger than the anti-pads then those drills are making a short. Occasionally you'll find drill hits with no anti-pads. If the database has thermals then odds are these drills are not meant to be shorting.

2 Negative Planes with Thermals in the same spot. These are easy to find. Analysis | Negative Plane Thermal Conflicts will catch it. Alternatively just turn both negative layers on and make them the same color. You should not be able to see any thermals, as the Anti-Pads will block out the thermal on the other layer. If it does not, then you have found your short.

V 6.0 arc/circle bug. In version 6.0 a bug shorted positive planes to flashes that had the same centers as a circle or arc (that did not touch it). If you are getting a lot of shorts on a database with positive trace filled planes check the boarders for arcs and circles via query. If the database has them use EDIT | CHANGE | SECTORIZE on the entire affected layer and then re-extract the netlist.