



Advanced Specctra DO File Techniques to Complete Difficult BGA Boards

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Hugh Allen

CopperCAD
Design

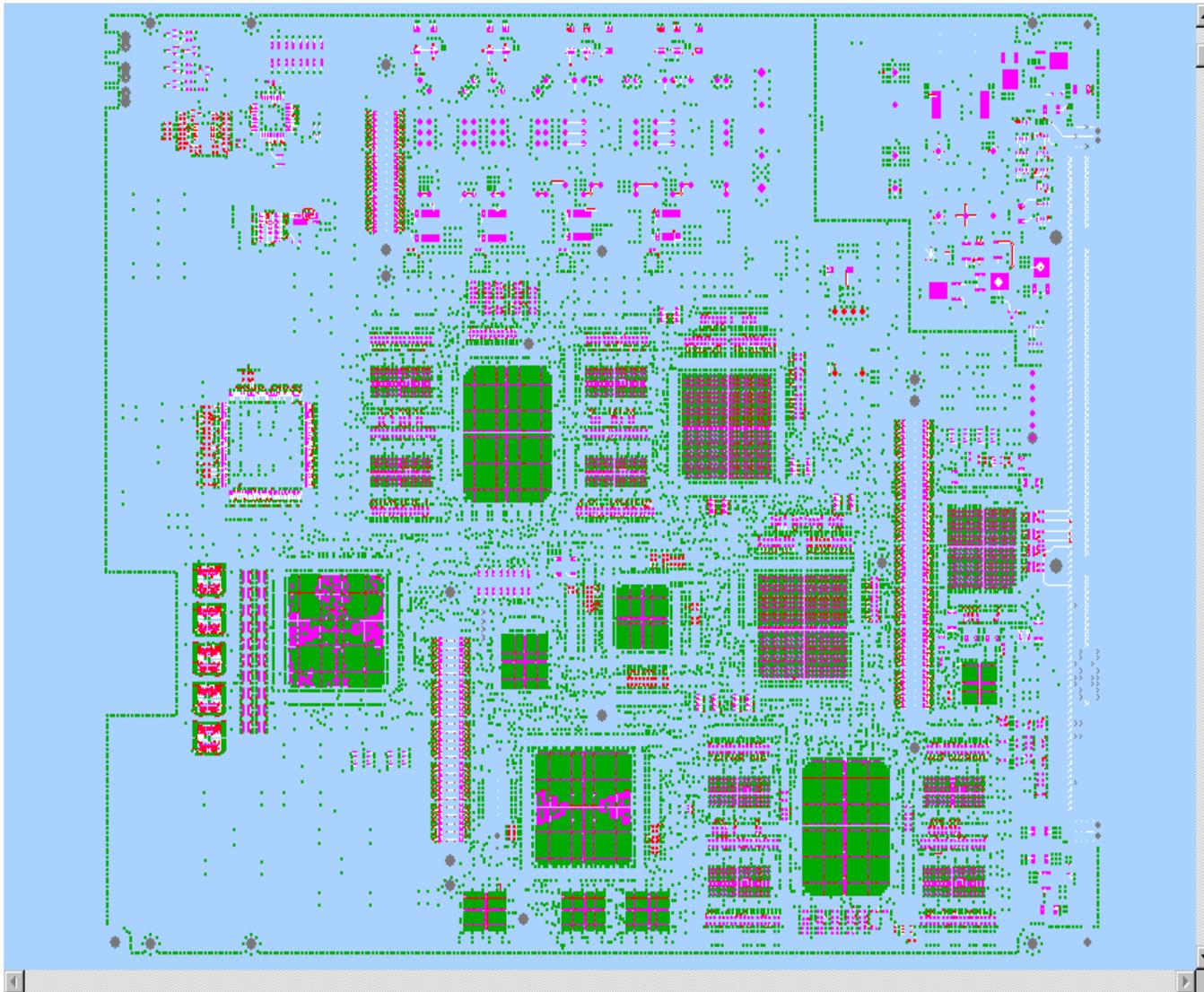
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OVERVIEW



- A look at what Specetra does in default mode
- Removing unnecessary regions impact
- Getting rid of the unconnects
- Finding convergence failure causes and solutions.
- Routing until improvement stops
- What tax for Crosses and Squeeze to use.
- Which Sort sequence works best
- The Wringer Produces convergence by making it shorter.
- Try to get rid of the last few conflicts.
- Miter as short as possible

The Design



- 7 large BGAS
- 19 small ones
- 17959 pins
- 12997 Connections
- 3223Nets
- 10 routing layers
- 22 layers total
- 11 in. x 14 in

DEFAULTS FOR EVERYTHING ROUTE 25 16

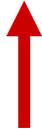


```

ROUTING HISTORY =====
|   Pass   | Conflicts |   |   |   |   |   |   |   |   |   |   |   |   |
|  Name   | No. | Cross | Clear | Fail | Unrte | Vias | XTalk | Len. | % | Pass | CPU Time | Total |
|-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
| Route   | 1 | 15867 | 1855 | 88 | 88 | 17729 | 93 | 524 | 0 | 0:08:38 | 0:08:38 |
| Route   | 2 | 12225 | 1501 | 16 | 6 | 17748 | 78 | 537 | 22 | 0:09:28 | 0:18:06 |
| Route   | 3 | 8712 | 1211 | 9 | 0 | 17823 | 65 | 533 | 27 | 0:08:39 | 0:26:45 |
| Route   | 4 | 6275 | 944 | 4 | 0 | 17900 | 64 | 213 | 27 | 0:08:12 | 0:34:57 |
  
```

```

| Clean   | 756 | 28 | 9 | 366 | 3 | 18808 | 41 | 45 |   | 0:04:22 | 25:46:28 |
  
```



Routed length=10790651.711

Ratio Actual / Manhattan= 1.1496

Unconnected length= 9897.150

THERE ARE A BUNCH OF REGIONS ON THE BOARD THAT ARE UNNECESSARY



- Put in to accommodate pad to via spacing top/bottom
- But they appear on all layers and besides the BGA's are fanned out and the fanouts are protected.
- **delete all regions**
 - COMMAND ADDED TO DO FILE

REGIONS DELETED EVERYTHING ELSE DEFAULT - ROUTE 25 16



ROUTING HISTORY =====												
Pass	Conflicts								Red	CPU Time		
Name	No.	Cross	Clear	Fail	Unrte	Vias	XTalk	Len.	%	Pass	Total	
-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----												
Delete	0	0	0	0	9913	16880	40	0		0:00:05	0:00:05	
Route	1	14856	1166	105	105	17675	109	525	0	0:07:23	0:07:28	
Route	2	11743	1143	15	7	17725	81	535	19	0:07:27	0:14:55	
Route	3	8251	927	6	1	17834	78	540	28	0:07:00	0:21:55	
Route	755	33	8	64	3	18741	42	47	10	0:00:52	18:43:25	
Clean	756	32	8	416	3	18741	45	54		0:03:37	18:47:02	

Routed length=10725117.698

Ratio Actual / Manhattan= 1.1406

Unconnected length=13934.620

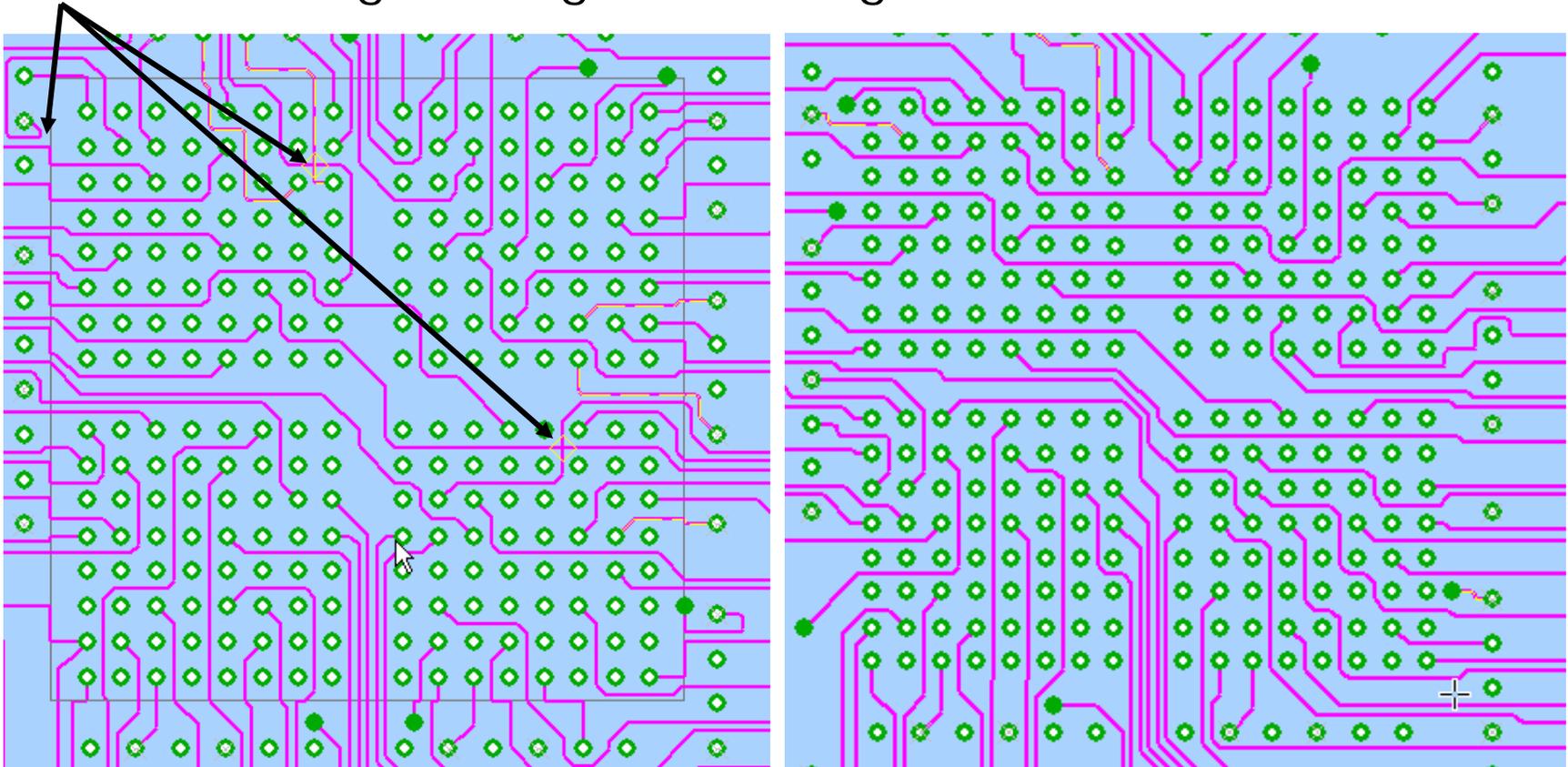
saved 7 hours on run



Strange Bends and flow disruption



- Accidental regions degrade routing, miter, and trombones!



Getting rid of the unconnects 1



- There is an undocumented set command that Specctra says it does not recognize.
- "# <<WARNING: >> Unknown set option <auto_remove>"
- On this Specctra is Untruthful. Specctra knows what it means and respects it.
- **set auto_remove off**
- I always use it, in every do file.

Getting rid of the unconnects 1



- It stops Specctra increasing the number of unconnects, if the going gets tough.
- It stops taking traces out and never putting them back.
- Give me a trace with conflicts, at the end, so I can see what Specctra did. Usually I can fix it much more easily than fixing a guide (RAT) .
- I have found that the completion rate is higher and happens faster, if I use this command.

Getting rid of the unconnects 2



- In addition I have a DO FILE sequence included in the DO FILE FRAMEMTS .txt file associated with this presentation.
- I generally include it after 10 or 25 passes depending on the design complexity.
- If it cannot connect all the wires, I determine why not, and fix the problem before proceeding.
- Keepouts, off board, peroute blockage, etc.

Getting rid of the unconnects 2



- It operates as follows:
 - Identifies the unconnects creating a group of the fromto's that are not connected.
 - Writes out a wire file containing the connected fromto's (wires).
 - Deletes all wires.
 - Selects and routes the unconnected fromto's on the otherwise empty design.
 - Reads the previously routed wires on top
 - and runs route passes to clear the resulting conflicts (messy but effective).

Getting rid of the unconnects 2



- **Identifying trapped unconnects early**

- At the end of this an unconnect report shows those that will not route on an empty board therefore must be trapped.

```
##DO FILE SEQUENCE
```

```
#try to connect unconnects
```

```
## report trapped &stonewalled situations
```

```
vset system Unroute on
```

```
if (unconnect_wire > 0)
```

```
then (
```

```
report unconnects $/pre_try_connect.txt
```

```
mode select guide; unsel all routing
```

```
#set co-ordinates to suit the units and full area of the design
```

```
select area guide 13110 -210 -360 12480
```

Getting rid of the unconnects 2



```
define (group uncon__gr (selected))
unsel all routing;      mode measure
write wire $/pre_force_conn.w;      delete all wires
select group uncon__gr;      route 25 1;      clean 2
#workaround for poly duplicating bug
unsel all routing;select all poly_wires;      unprotect selected
poly_wires
delete all poly_wires;      unselect all poly_wires
read wire $/pre_force_conn.w
report unconnects $/post_try_connect_trapped_connections.txt
route 10 16
)
#end try to connect unconnects & report trapped & stonewalled
situations
```

Getting rid of the unconnects 2



post_try_connect_trapped_connections.txt

Note: If this report contains connections You should stop and determine why at this early stage in the process.

One way to figure out why, is to go into Spectra interactive mode and try to connect them.

If this fails (probably will) then turn checking off and connect and see what errors appear and what the underlying problems are with the rules in effect.

Getting rid of the unconnects 3



Even with “set auto_remove off” on occasion you will see a few unconnects creep in.

1. Some times they are fixed almost immediately.
2. On other occasions they persist. I am convinced that they are the result of a database problem.

Because writing out a wires file, deleting all wires, then reading the wires file in clears the problem, usually in the next couple of route passes.

This is more common on Windows machines than Unix.

Included in the DO_FILE_FRAGMENTS.txt file

There is something wrong with this picture.



Layer	Direct	Pins	Vias	TJs	Conflicts	Length
TOP	Off	1016418667	163	0	537104.627	
SIG1	Vert	46818667	4	1	719720.403	
SIG2	Horz	46818667	11	4	1375735.365	
SIG3	Vert	46818667	18	4	1173525.050	
SIG4	Horz	46818667	9	5	1201317.745	
SIG5	Horz	46818667	6	39	1113067.598	
SIG6	Vert	46818667	2	1	1203051.029	
SIG7	Horz	46818667	9	3	1166561.458	
SIG8	Vert	46818667	11	6	1093008.042	
SIG9	Horz	46818667	3	1	772694.574	
BOTTOM	Off	617618749	186	0	425160.015	

Too many conflicts on Sig5

What is wrong with this picture.



- Turned out that we had a class defined that could only use layer Sig 5.
- A significant number of those nets had 2 or 3 connections to the pins on one large BGA.
- **Impossible** to route without crosses on one layer.
- **Solution: Route the other nets on one less layer.**
- Create another gnd plane layer to allow that class 2 layers to route on (without adding to total layers).
- Routing bit little more congested but it worked with no layer increase.

Routing until improvement stops.



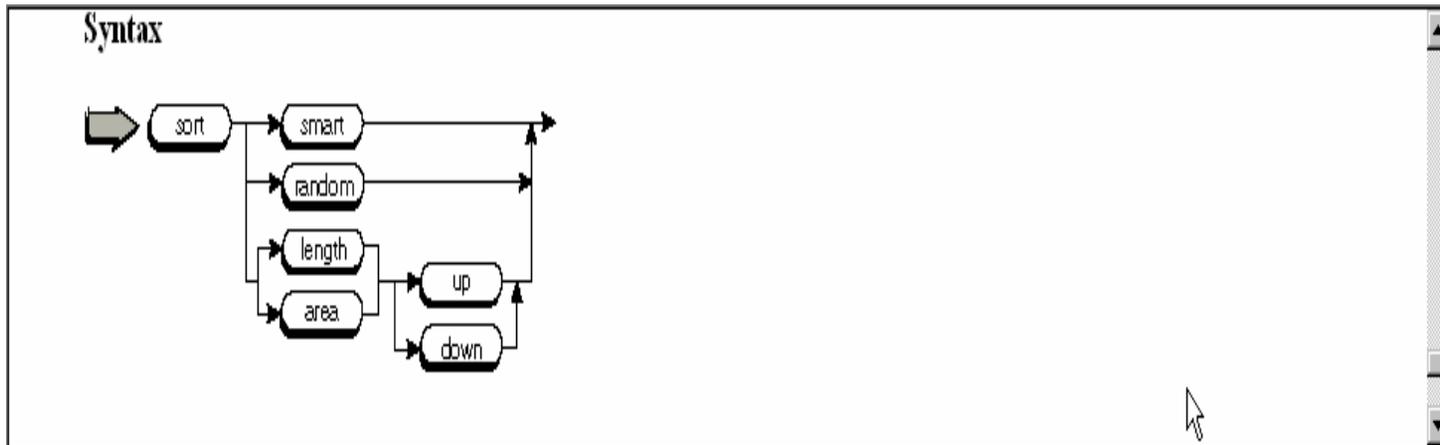
- On this or any design for that matter, we want to keep doing route 25 16 until convergence stops, then do something else.
- A do file sequence for this is included in **the DO_FILE_FRAGMENTS.txt file**.
- It looks at the bestsave file before and after each route 25 16 and stops when they are the same.
- In addition it cleans the bestsave results after each 25 16, not necessarily the 25th pass.
- This sequence was used in my evaluation of costs and sorts etc. as well as on all difficult boards.

What tax for Crosses and Squeeze to use.



- After Hundreds of hours of testing gradual variations from the tax of 1 for both cross and squeeze I concluded that the **default value of 1 is as good as it gets for them both.**
- Note this was only tested on BGA boards so it may be different on non heavy BGA boards.**
- An interesting side effect detected is that specifically setting the both to 1.0 produces a very minor insignificant variation in the results as compared with taking the default.

Which Sort sequence works best.



•Tested

- Smart
- Length up and length down
- Area up and Area down
- The default is smart (areas of dense routing first)

Which Sort sequence works best.



- After Hundreds of hours of testing:
- The most effective (based on unconnects left, conflicts left, final actual to manhattan ratio, and overall routing time, turned out to be:
 - Sort area up !!! (Better on all parameters)
- The lease effective turned out to be:
- Sort smart
- With length up and down and area down falling in between.

The Wringer



- Now you have done the “get rid of Unconnects thing” -- so there are none.
- And you have routed 25 16 until convergence stops but there are still a lot of crosses and clearance conflicts and a poor actual to manhattan ratio.
- What now -- more layers??
- No --- Try the Wringer!!

The Wringer on the board with reduced layer for routing



crosses	clear	ratio	routed	length	time	reduction
1st 27 passes						
306	55	1.1515	10813	in.	1:00:22	
pre wringer 162 passes convergence stopped						
29	12	1.1460	10747	in.	3:19:27	
wringer1						
14	5	1.1020	10335	in.	12:07:31	412 in.
wringer2						
11	3	1.0924	10244	in.	19:35:05	91 in.
cleaned to 0 0 0 in 3 hours						

What is The Wringer?



- It is a sequence of do file command that:
- Starts out with a loose ratio rule applied to all fromto's like 3.0 and routes a bit then tightens the ratio rule gradually down to 1.05.
- Then it gradually slackens it off until it takes length rule off all together.
- This sequence takes a while to run but it improves the ratio dramatically and gets rid of conflicts.

Where is The Wringer?



- It is in the `DO_FILE_FRAGMENTS.txt` file.

Try to get rid of the last few conflicts



- It is a sequence of do file command that:
- Works if there are a few conflicts left sometimes.
- It saves the wires then deletes the wires with conflicts.
- Then cleans the good wires and then tries to route the deleted conflict wires in the changed landscape created by the clean passes.
- If it gains on one iteration it saves the wires and repeats up to 10 times.

Try to get rid of the last few conflicts



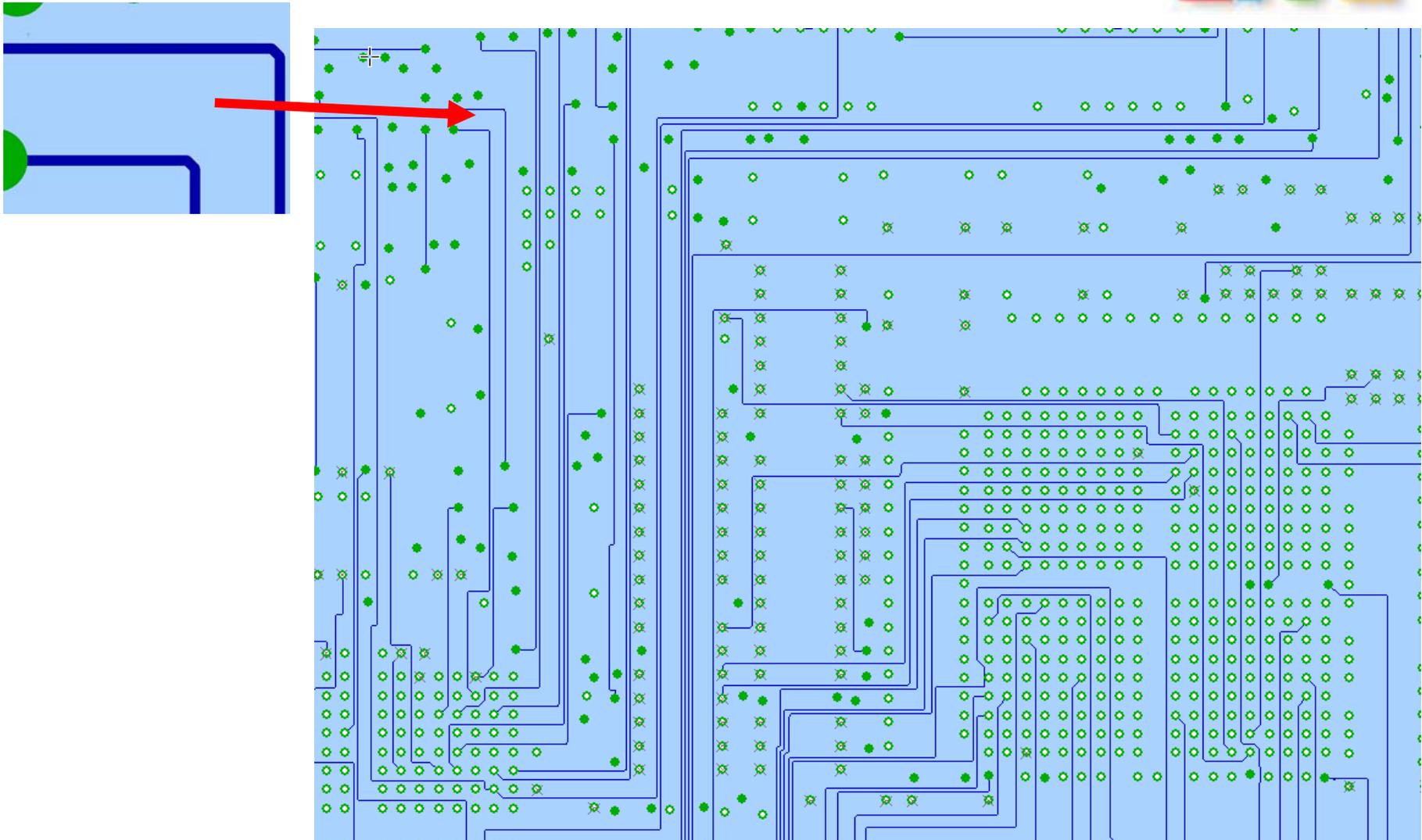
- If the number of unconnects increases or the number of conflicts increases it goes back to the saved wires so nothing is lost by trying it.
- It didn't help on the particular design we were looking at but has worked well on many others.
- **It is in the DO_FILE_FRAGMEMTS.txt file.**

Miter as short as possible

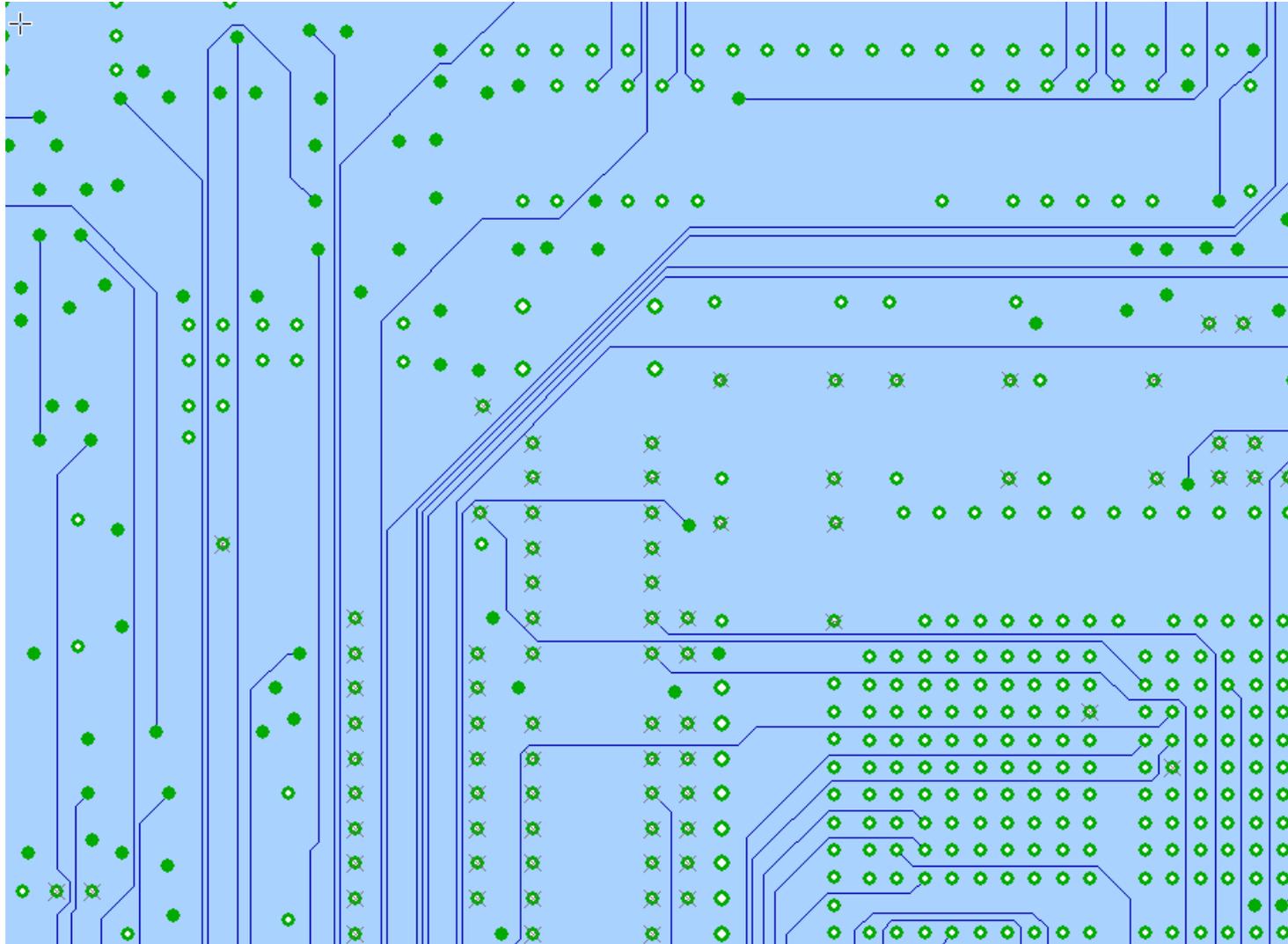


- In Rel 10.2 they made a change to miter that improves its performance. You can now miter (passes) and it stops if no progress is made.
- There is a little problem with it, in that if a min. length rule applies to a net, it only puts a very small miter in, even if the net far exceeds the max length rule.
- This can be overcome by delaying the introduction of any min rules (or implied min rules like matched are relative) until after the miter.

Miter NOT as short as possible



Miter as short as possible



Miter as short as possible



•It is in the `DO_FILE_FRAGMENTS.txt` file.

Bye

If no more questions then



ME