

Best Practices: Working with Backdrilling

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Backdrilling

Today's high-speed serial I/O technology handling 5 Gbps or higher presents new challenges for hardware engineers. Transitioning these high-frequency signals between layers greatly affects signal integrity when a portion of plated through-hole (PTH) is left unused, forming a stub. By definition, these stubs are the unused section of the barrel where the signal is not required to travel. This can be controlled in the design space by using the full length of the barrel for signal layer transitions thus keeping stubs to a minimum or with the use of buried or blind vias. If these options are not available, stubs can be removed through a board-fabrication process called backdrilling, sometimes referred to as controlled depth counter-boring.

Note: Backdrilling is not possible on the blind side of a mirrored via.

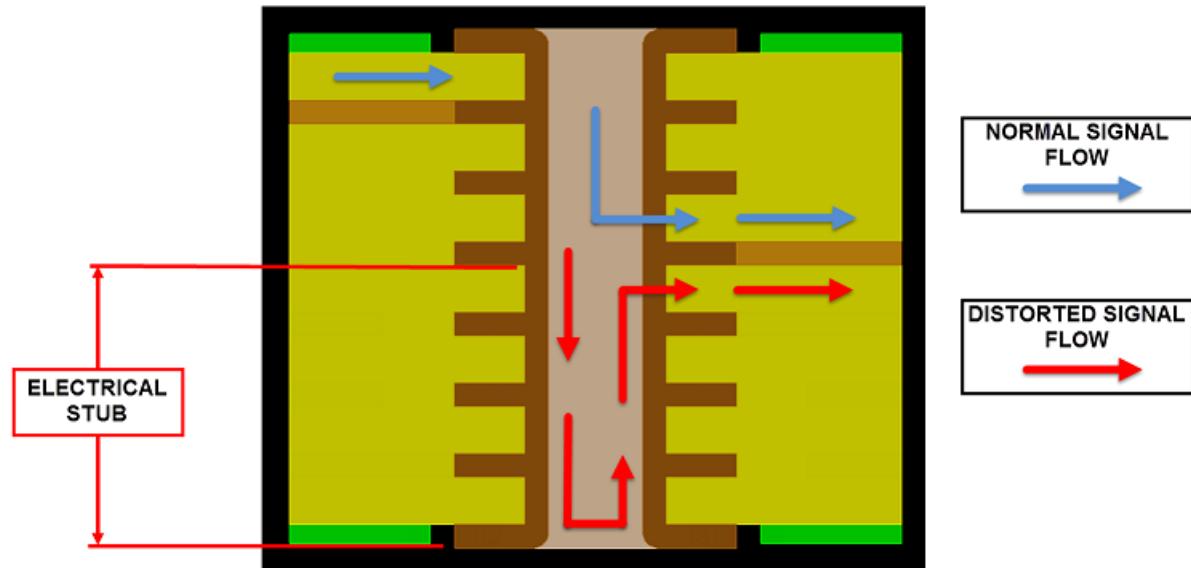
Introduction

Backdrilling is a board fabrication process that removes the unused section of plated-through holes; typically connector pins and signal vias. Secondary, controlled depth-drilling passes remove all electro-deposited plating material in the PTH ensuring signal stubs are minimized. Stubs are the source of impedance discontinuities and signal reflections, which become more critical as data rates increase. Backdrilling can be performed from either side of the PCB and to multiple depths. Drill sizes used for backdrilling are typically 6 to 10 mils larger than the original tooling. Fabricators must be careful not to drill beyond (over drill) the calculated depths as also not to under drill, leaving unacceptable stubs. Tradeoffs between signal quality

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and manufacturing costs must be considered as well as the tradeoff between signal integrity and board testability.

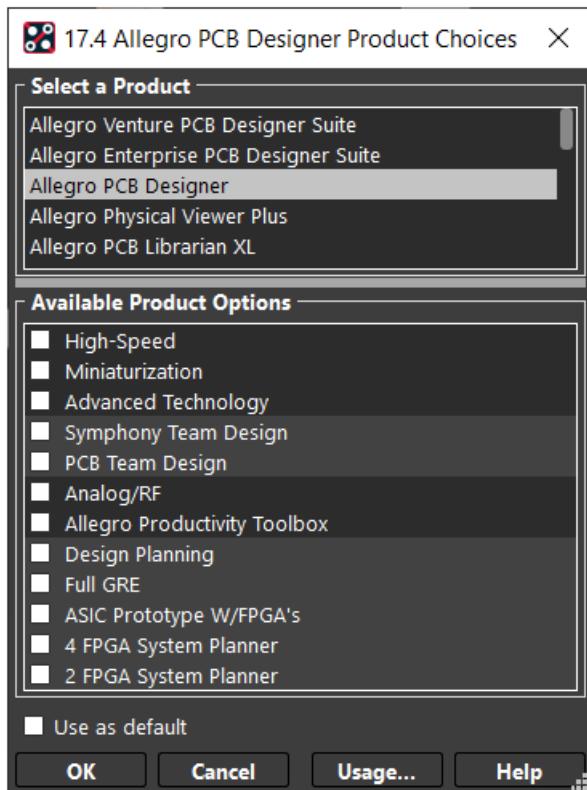


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Licensing

Backdrilling is available in the base Allegro PCB Designer license.



Prerequisites

Cross-section must contain material thickness for both conductor and dielectric layers.

Backdrill Commands, Properties, Parameters, and Subclasses

Menu Location	<i>Manufacturing – NC – Backdrill Setup and Analysis</i>
Command	<code>backdrill setup</code>

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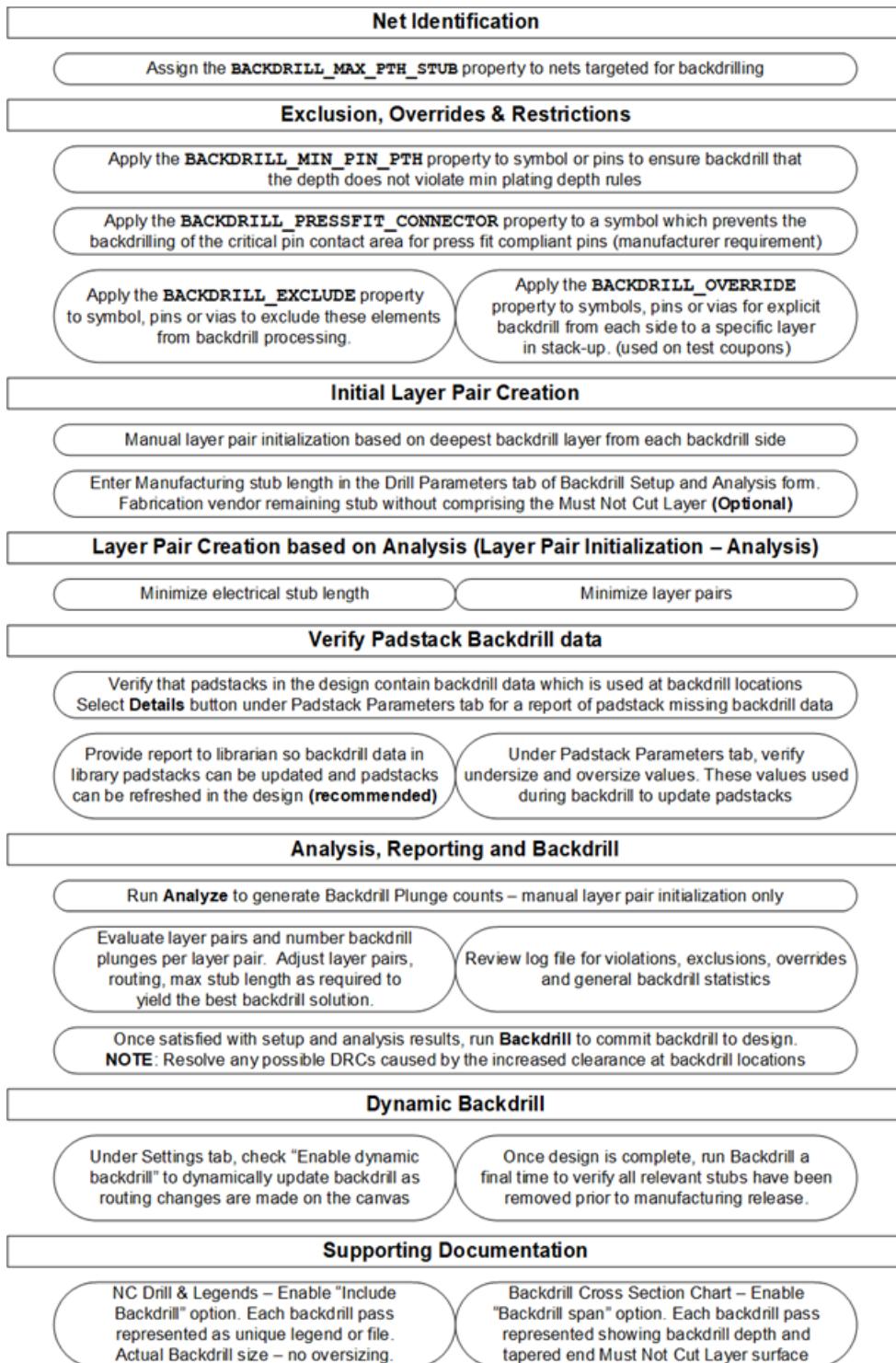
Backdrilling

Relevant Properties	BACKDRILL_MAX_PTH_STUB (net) BACKDRILL_EXCLUDE (symbol, pin, via) BACKDRILL_MIN_PIN_PTH (symbol, pin) BACKDRILL_OVERRIDE (symbol, pin, via) BACKDRILL_PRESSFIT_CONNECTOR (symbol) BACKDRILL_COMP_SIDE_ALLOWED (symbol, pin, via)
Relevant Parameters	Drill Legend (<i>Include Backdrill</i>) NC Drill (<i>Include Backdrill</i>) Cross Section Chart (<i>Backdrill Span</i>) IPC-D-356 (<i>Ignore Backdrill</i>)
Associative Manufacturing Subclasses	BACKDRILL-FLAG-TOP (Top side violation flags) BACKDRILL-FLAG-BOT (Bottom side violation flags) BACKDRILL-FLAG-ANY (Internal layer violation flags) NCBACKDRILL-<LAYER>-<LAYER> (Backdrill legends)

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Figure 1-1 Backdrill Flow in Allegro PCB Editor



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Terminology

The following terms are associated with backdrilling.

Backdrill	Secondary drilling process that removes the unused section of plated through holes
Counter-bore	Alternative term for backdrilling
Gbps	Giga Bits per Second
PTH	Plated through-hole
Press fit	Connector whose pins are forced (spring loaded) in PCB, not soldered
Stub	Unused section of a plated through hole resulting in signal quality issues (reflections, impedance discontinuity)

Net Identification

The first step in the backdrill application is the identification of nets targeted for potential backdrilling. The word potential is used, as ultimately backdrilling only affects pins and vias on nets that violate the maximum stub rule. Although a net is identified, it may be omitted from backdrilling if a required layer pair does not exist and the stub lengths are within margin. The net level property BACKDRILL_MAX_PTH_STUB can be applied at the schematic level, Cadence or third party, Allegro canvas using edit property command (*Edit – Properties*) or within Allegro Constraint Manager. The value of this property is the maximum allowable PTH stub and is restricted to length in database units.

Applying the BACKDRILL_MAX_PTH_STUB Property in Constraint Manager

The BACKDRILL_MAX_PTH_STUB property can be easily assigned to nets in Constraint Manager as follows:

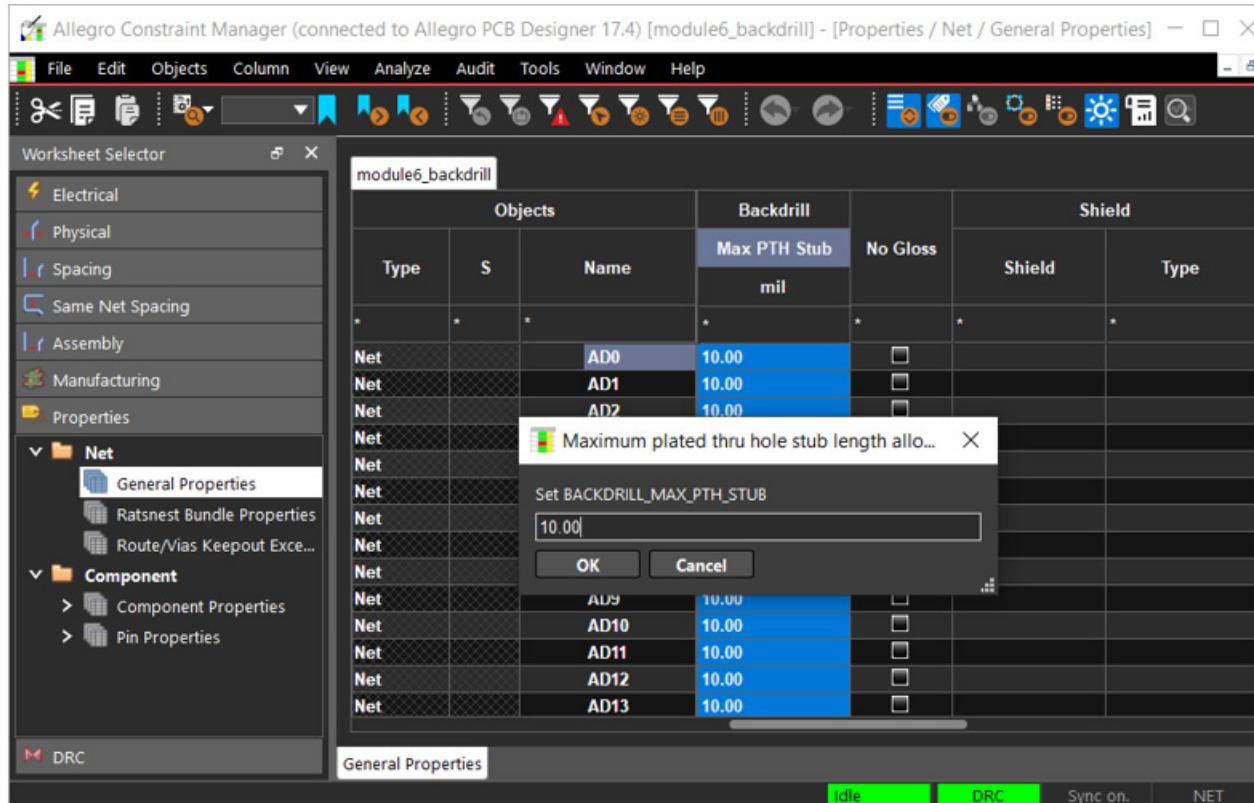
1. Open the *General Properties* worksheet located in the *Net Workbook*.
2. Scroll across the worksheet to the *Backdrill* column.
3. Select relevant cells where backdrill property is to be applied.
4. Right-click and choose *Change*.

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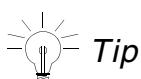
Backdrilling

5. Enter the maximum stub value, or enter 0 if no stub is allowed.
6. Click *OK*.

Figure 1-2 Applying BACKDRILL_MAX_PTH_STUB property in Constraint Manager



Property	BACKDRILL_MAX_PTH_STUB
Purpose	Identification of nets targeted for backdrilling
Usage	Required
Value	Max allowable stub in length (database units)
Objects	Nets
Backdrill analysis flag	S



All backdrill application properties begin with the BACKDRILL prefix.

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Applying the BACKDRILL_MAX_PTH_STUB property to pins and vias act as an override to the property value added to the associated net.

Note: The BACKDRILL_MAX_PTH_STUB property applied to pins and vias is ignored by the backdrill process if their associated net does not have the BACKDRILL_MAX_PTH_STUB property.

Stub Calculation

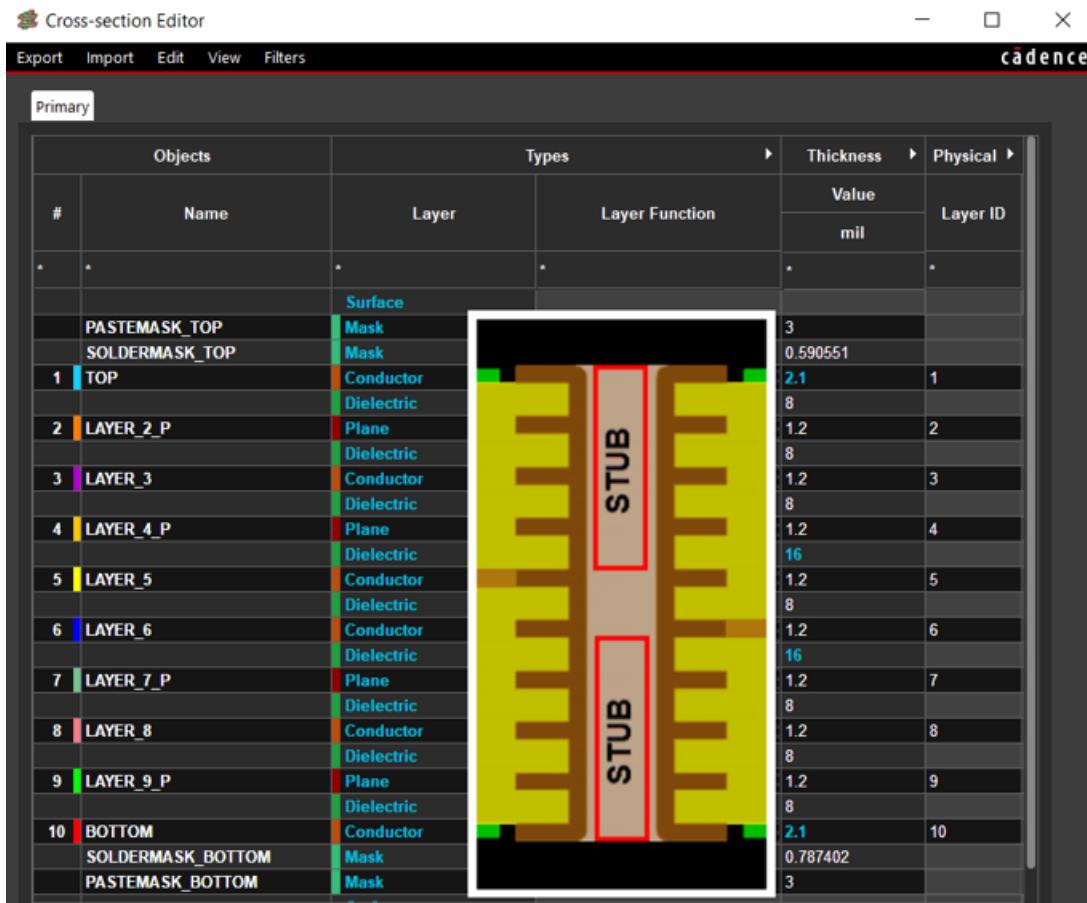
A stub is calculated from either the top or bottom side of the board to the adjacent dielectric layer of where the trace enters the PTH. It is a prerequisite that all information pertaining to conductor and dielectric thickness are to be entered in the Cross-section form to perform stub analysis. The following example illustrates how a stub is calculated in Allegro PCB Editor.

A trace enters a pin on LAYER_5 and exits on LAYER_6, resulting in a stub from both the top and bottom side. The top side stub includes the conductor and dielectric thickness from layer TOP to the surface of layer LAYER_5. The bottom side stub includes the conductor and dielectric thickness from layer BOTTOM to the surface of layer LAYER_6. Each side-based stub, not the accumulated total, is compared individually against the BACKDRILL_MAX_PTH_STUB property value.

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Figure 1-3 Calculating Stub Value



Pin Plating Restrictions

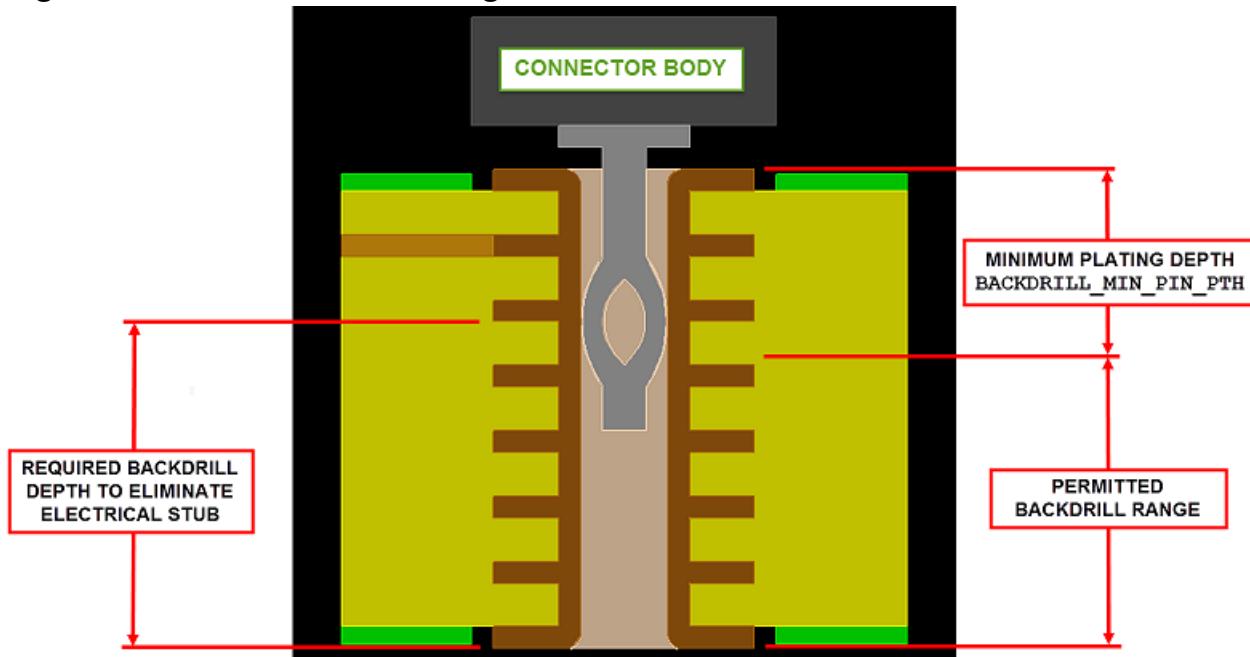
The manufacturer of a connector may specify a minimum plating depth from the mounting side to ensure its pins are fastened to the PCB properly. If pins on a connector with this restriction are to be backdrilled, the minimum pin plating depth would take precedence over resolving the stub violation.

For example, a trace connects two pins on LAYER_2. An electrical stub is present from the BOTTOM layer up to the surface of LAYER_2 because there is no other connections made below LAYER_2. Backdrilling from the bottom side of the PCB, removes the stub by drilling beyond LAYER_3 and stopping in the dielectric material before hitting LAYER_2 to meet the electrical stub requirements. Doing this violates the manufacturing minimum plating depth requirement and the connector pin is no longer have a reliable connection to the plated through-hole.

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Figure 1-4 Minimum Pin Plating



Applying the Minimum Pin Plating Property

The BACKDRILL_MIN_PTH property can be applied to symbols or pins using *Edit – Properties*. It prevents backdrill passes from removing a stub based on the relation between the and the *Must Not Cut Layer* using the following criteria:

- If the lower surface of the *Must Not Cut Layer* (Connection Layer) is outside the minimum pin plating depth, backdrilling will occur to eliminate the stub. Else the layer pair will be shifted down one layer so backdrilling could occur.
- If the remaining stub after the layer pair shift violates BACKDRILL_MAX_PTH_STUB property for the net then the pin will be flagged with a “P” symbol indicating a stub exists but the pin could not be backdrilled due to the plating restriction.

Allegro PCB Editor, when assessing P code violations, is advised to:

- Consider rerouting the signals on other layers to reduce the stub length while maintaining minimum pin plating requirements.
- Consult with engineering and discuss the possibility of increasing the value of the BACKDRILL_MAX_PTH_STUB property on the affected nets.
- Create a new backdrill pass set to accommodate the targeted layer to backdrill to.

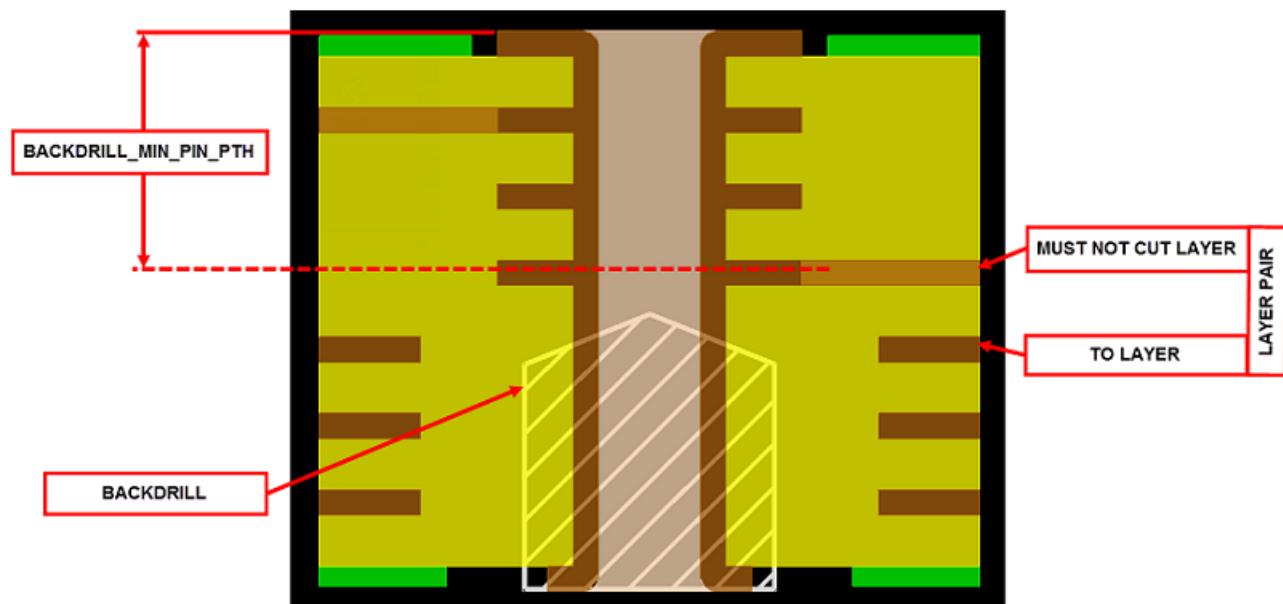
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- Apply the BACKDRILL_OVERRIDE property to a layer that satisfies the min pin plating requirement; treat stub violations as acceptable.

Property	BACKDRILL_MIN_PIN_PTH
Purpose	Ensures minimum pin plating depth is not compromised
Usage	Optional
Value	Depth from side component is placed (database units)
Objects	Symbols, pins
Backdrill analysis flag	P

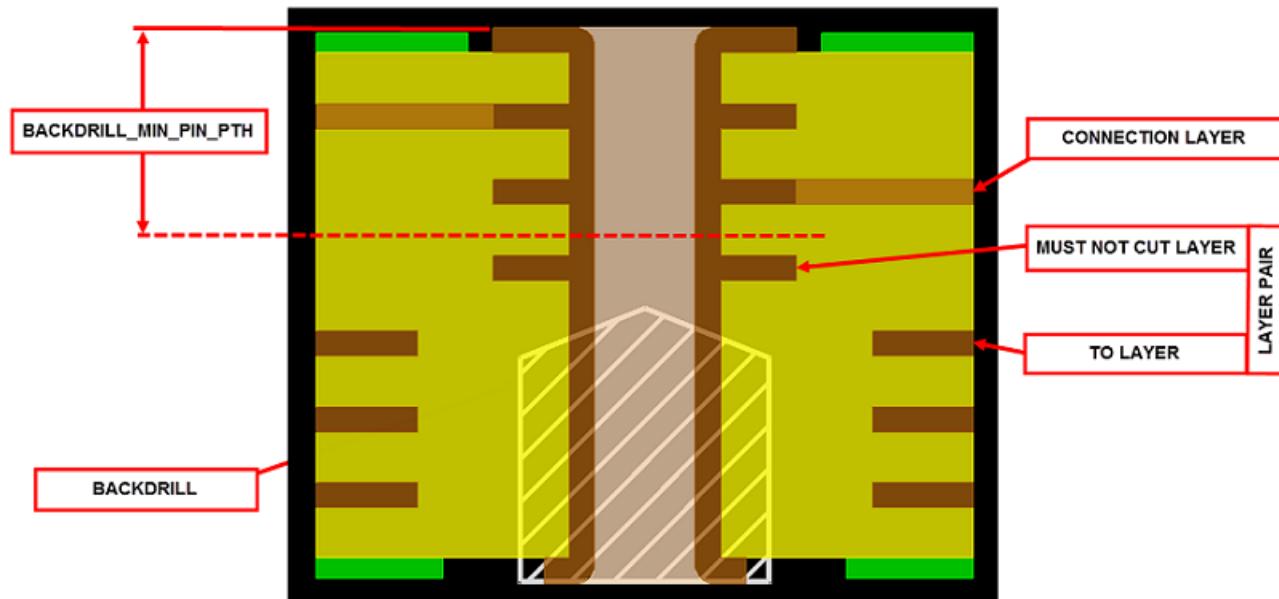
Figure 1-5 Must Not Cut Layer surface outside minimum pin plating depth



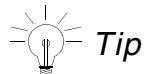
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Figure 1-6 Must Not Cut Layer surface inside minimum pin plating depth



Automatic layer pair shift allows backdrill outside min pin plating depth.

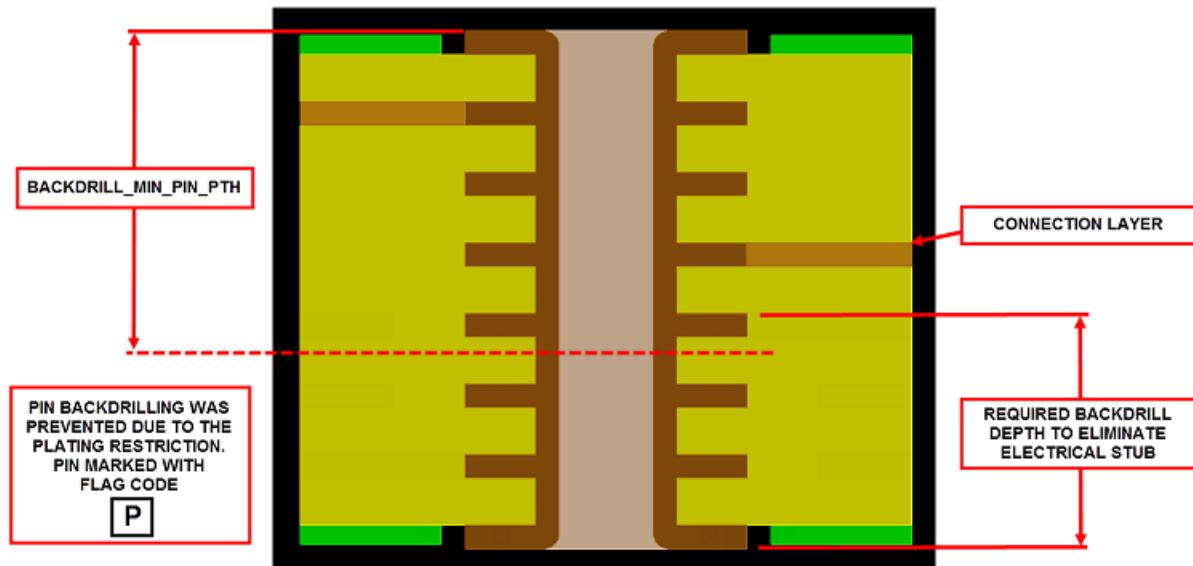


Tip
The backdrill code stops the backdrill at the layer before the *Must Not Cut Layer* (Connection Layer) called the *To Layer* preserving the adjacent dielectric layer. Fabrication vendor could backdrill further into the adjacent dielectric layer to remove as much electrical stub as possible, without compromising the *Must Not Cut Layer*.

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Figure 1-7 Must Not Cut Layer within the minimum pin plating depth



Backdrill passes are prevented from removing a stub and a flag code is reported.

Pressfit Connectors

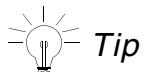
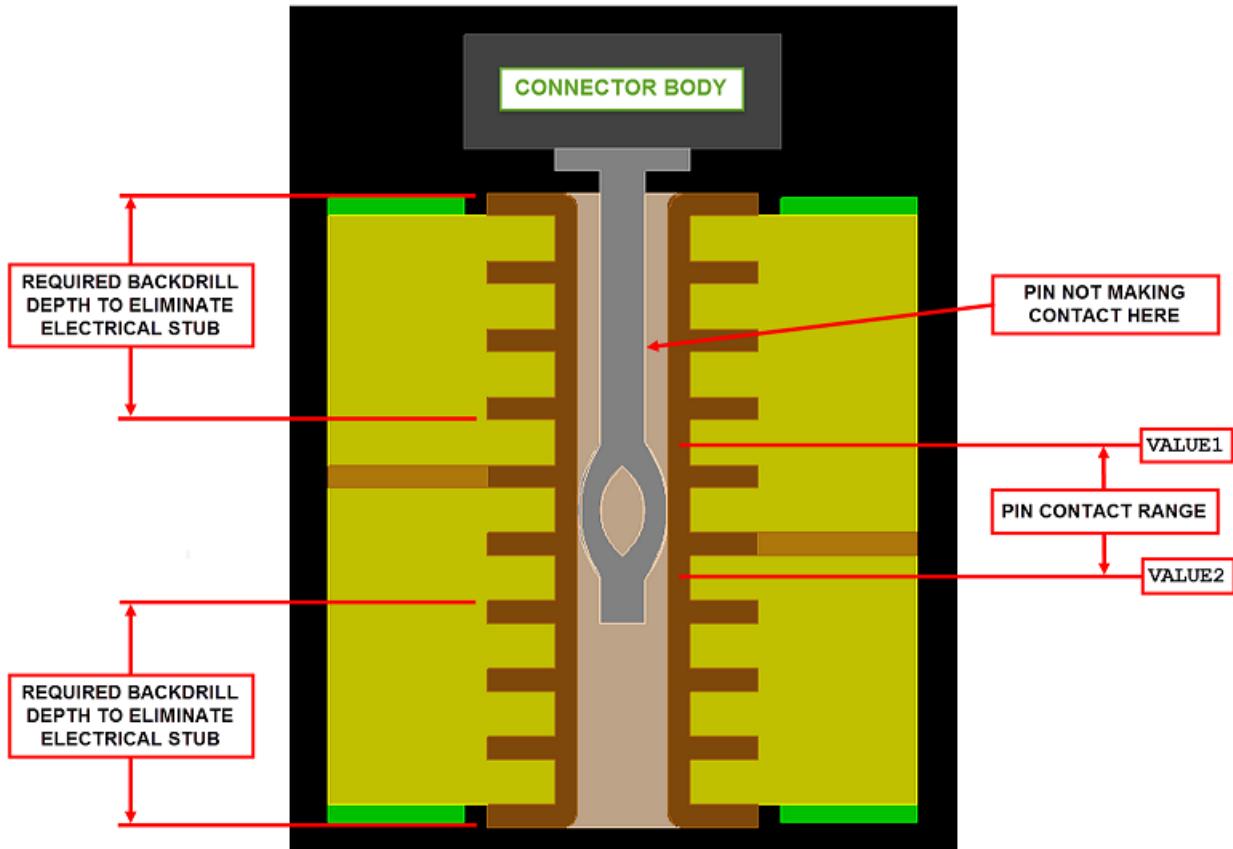
The backdrill code under normal circumstances does not backdrill pins from the same side a connector is placed on. The exception to this rule may apply to pressfit connectors. Pressfit connector pins are spring loaded or forced into the PCB making contact with the barrel of the hole in a specific range. A stub can result from both sides of the board up to but not including either the trace and/or the contact range.

The following illustration shows an actual pressfit pin and how a trace entering just above the contact range results in stubs from both the top and bottom side of the PCB.

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Figure 1-8 Pressfit Connector



Tip
The backdrilling is required on both side of the PCB on press fit connectors the BACKDRILL_PRESSFIT_CONNECTOR property must be applied to the symbol.

Note: The contact ranges for press fit compliant pins may not be specified on the actual connector specifications or even readily available. Inquiries to the manufacturer may be required to obtain this information.

Property	BACKDRILL_PRESSFIT_CONNECTOR
Purpose	Use on pressfit connectors to permit backdrilling from both sides of the board. Backdrill depth will not protrude into contact range as defined by the property string.
Usage	Optional

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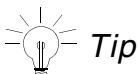
Backdrilling

Value	<VALUE1:VALUE2> values measured from the side the component is placed and defined the pin contact range (database units); this value must be obtained from manufacturer
Objects	Symbols
Backdrill analysis flag	n/a

Backdrill Exclusions

It may be necessary to exclude certain objects from backdrilling even though stub violations are present. The BACKDRILL_EXCLUDE property can be applied to symbols, pins or vias at both the library and design level using *Edit – Properties*. Common examples might include solder tail connectors or a dense pin escape pattern in BGA areas. The PCB Editor should consult with a manufacturing engineer before assuming all pin/via objects are suitable for backdrilling.

Property	BACKDRILL_EXCLUDE
Purpose	Excludes objects from backdrilling even though stub may be present
Usage	Optional
Value	EXCLUDE_TOP EXCLUDE_BOTTOM EXCLUDE_BOTH
Objects	Symbols, pins, vias
Backdrill analysis flag	X



Tip
Develop a plan to incorporate the following properties at the library level:
BACKDRILL_MIN_PIN_PTH, BACKDRILL_EXCLUDE, and
BACKDRILL_PRESSFIT_CONNECTOR.

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User Overrides

In most cases, the backdrill layer ranges defined in the Backdrill Setup and Analysis user interface satisfy your requirements to manage stubs. The BACKDRILL_OVERRIDE property allows user-specified control of layer ranges for any pin or via and from either side of the board or both. This is done regardless of violations that may result, such as testpoint conflicts or backdrilling through a connection. The override property was considered for the design of test coupons where the OEM wishes to evaluate the performance of the board fabricator with respect to the adherence of depth ranges. The designer may override the "to" layer to effectively drill out the layer where the trace connects the pin/via. The expected usage of this property is limited; please exercise caution to prevent accidental over-drilling.

Property	BACKDRILL_OVERRIDE
Purpose	User-specified backdrill range
Usage	Optional – special circumstances
Value	TOP:< <i>layer_name</i> >:BOTTOM:< <i>layer_name</i> >
Objects	Symbols, Pins, Vias
Backdrill analysis flag	O or W (warning)

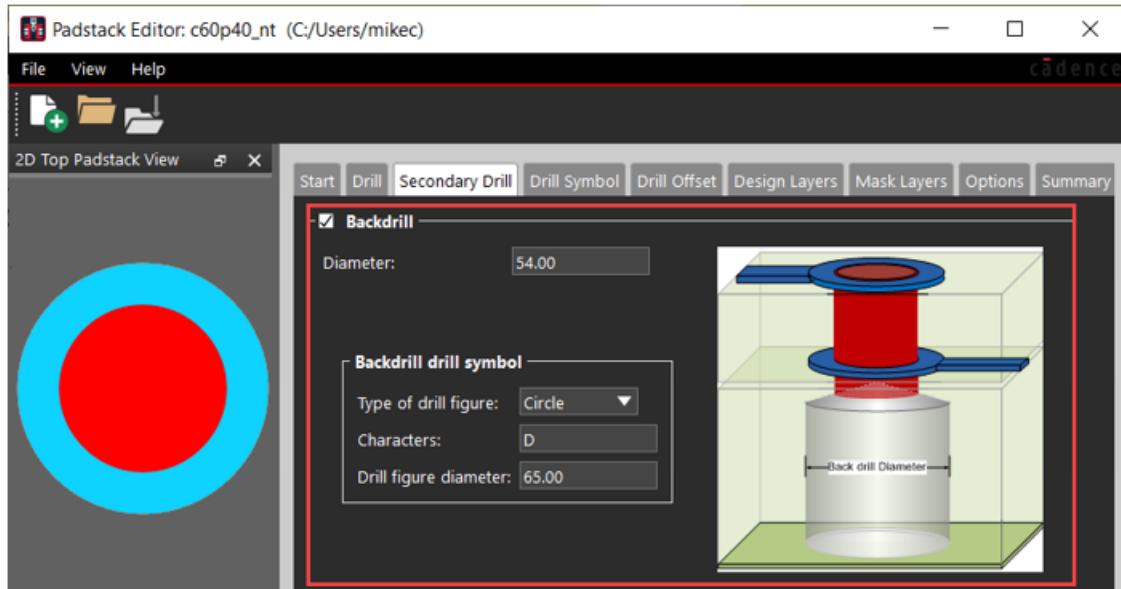
Padstack Editor Backdrill Data Support

Padstacks now support the definition of backdrill specific data which is used at backdrill locations. No need to generate special padstacks or keepouts to maintain design integrity. Fabrication vendor can provide backdrill requirements to assist in padstack updates.

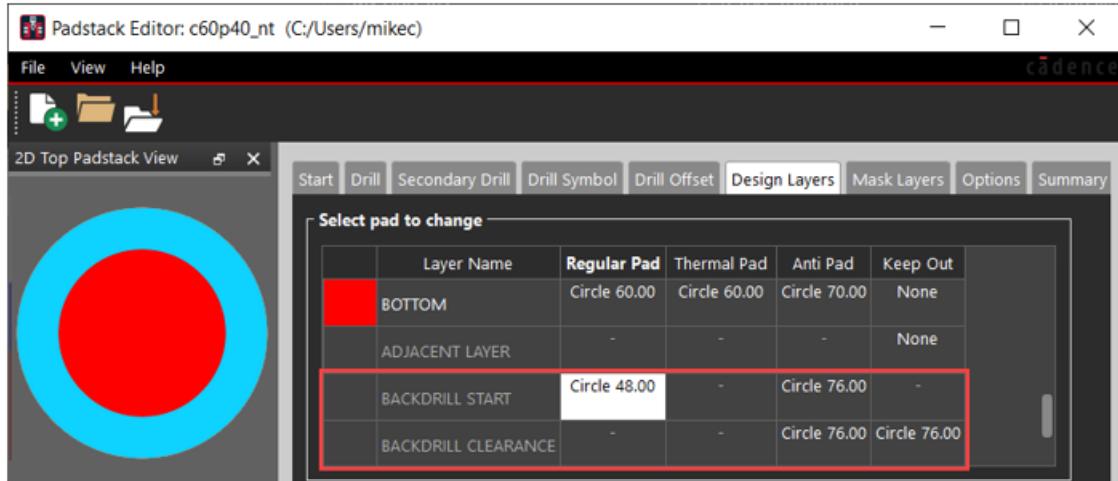
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- Backdrill diameter size and special drill legend figure



- Backdrill start layer copper pad, clearance anti-pad and route keepouts



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- Backdrill start layer solder mask geometries

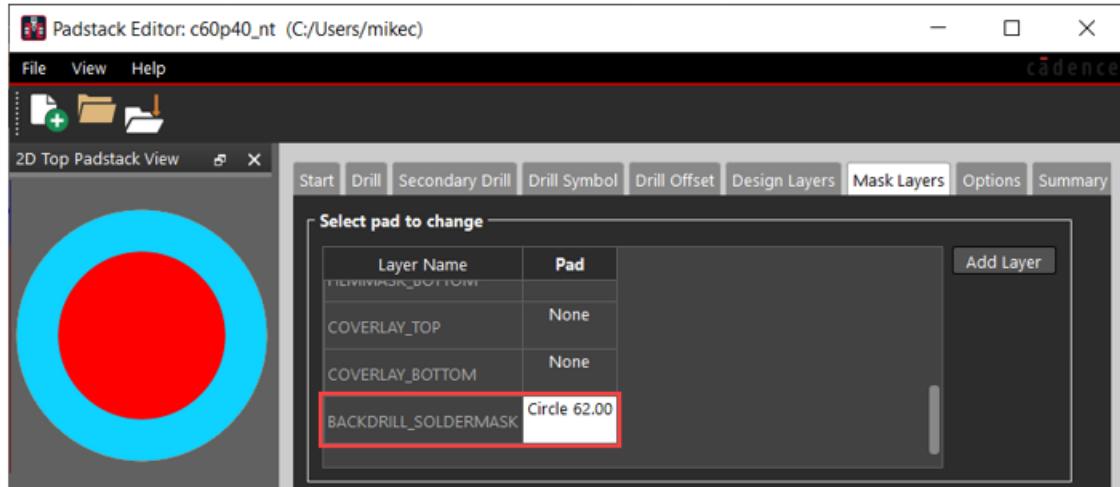
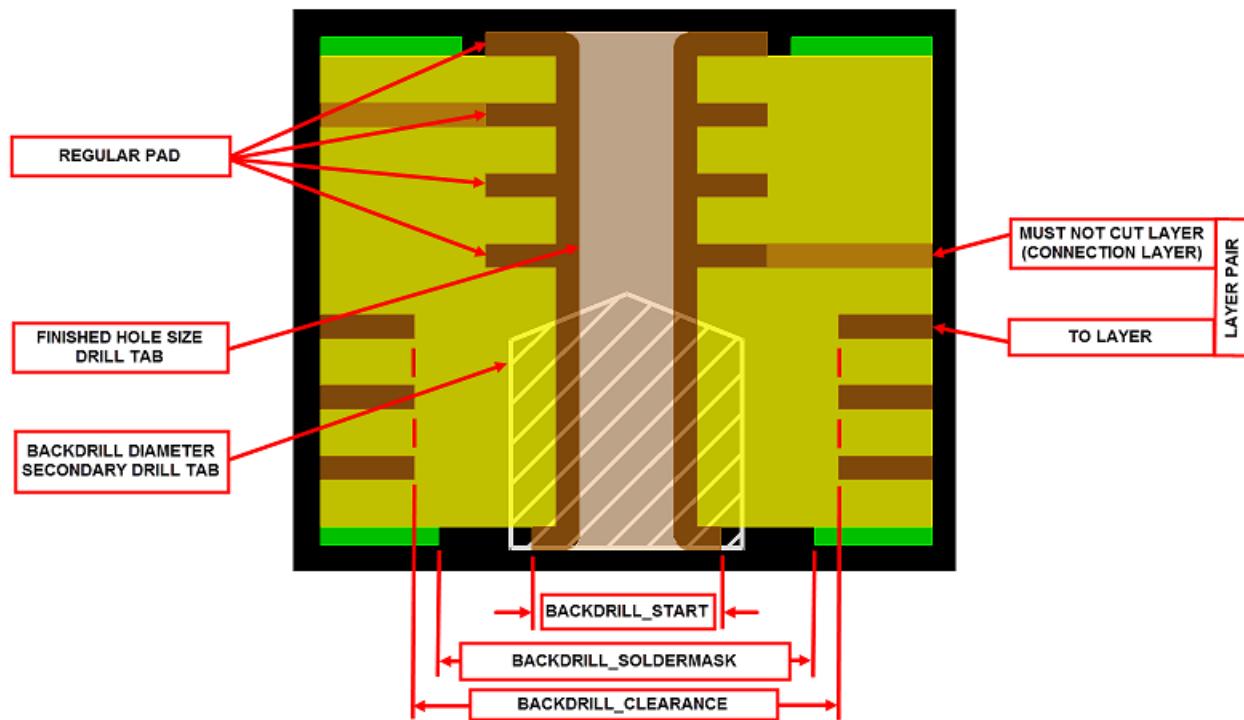


Figure 1-9 Typical backdrill location



Fabrication Vendor Backdrill requirements (Reference Only)

- Backdrill size is normally 6 – 10 mils over the primary drill.
- Clearance to backdrill path is normally 16 mils over the backdrill size

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- Inner layer pads in the backdrill path should be removed.
- Outer layer backdrill entry pad is normally reduced so it is slightly larger than the primary drill with would be drilled away by the backdrill. (Primary Drill + 5 mils)
- Outer layer backdrill solder mask opening is normally 6 – 10 mils over the backdrill size

Note: Consultation from a fabrication vendor is advised to determine which rules are going to work best. The library padstacks are required to be updated so that each design have consistent backdrill rules.

With the backdrill data being stored in the padstack this allows the information to be updated at the library and design level to take full advantages of this enhanced backdrill functionality. No special scripts and SKILL routines to maintain design integrity.



Tip

Although the backdrill data can be entered in the padstack at either the library or the design levels, it is recommended to maintain the backdrill data at the library level for a consistent set of backdrill rules and guidelines.

Setup and Analysis User Interface

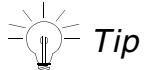
The heart of the backdrill application is the Backdrill Setup and Analysis user interface located in the *Manufacturing – NC* menu of Allegro PCB Editor. This form controls the side of the board to be backdrilled from, object types, and number of passes per side. Analysis in the form of graphical violations and a detail log file is provided when the *Analyze* button is selected. The form facilitates experimentation by editing pass sets and reviewing backdrill plunges per layer pair to eliminate underutilized backdrill layer pairs. Multiple analysis runs can be performed for fine tuning and backdrill results selecting the *Backdrill* button to commit

Initially Launching the Backdrill Setup and Analysis Dialog Box

Upon invocation, the Backdrill Pairs Question dialog is displayed. It can be used to produce a similar result to the Cadence default passes of previous versions with some fine tuning by defining the layer pairs based on the deepest backdrill layer by side and have them automatically generated.

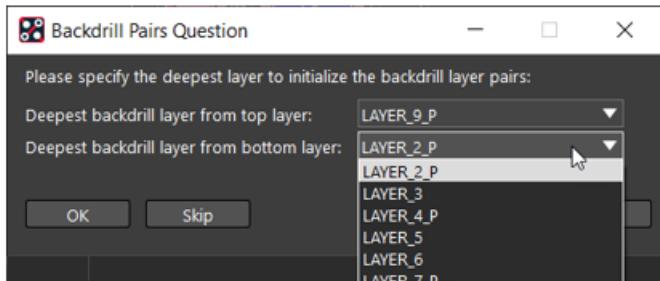
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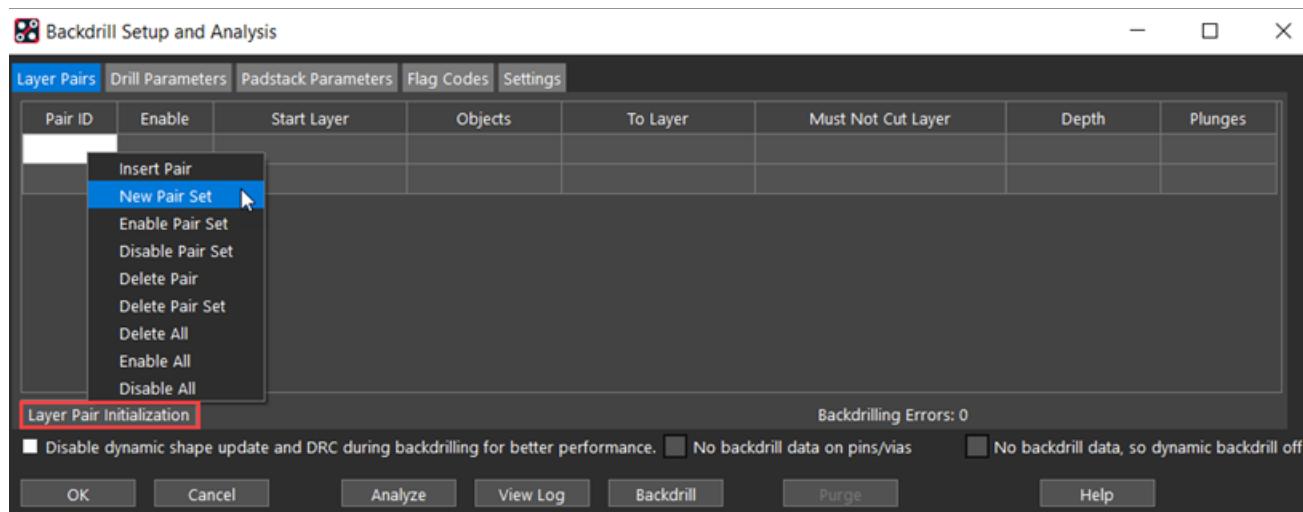
Tip

Defining the layer pairs manually could result in stub violations due to missing layer pair definition that should be included in the backdrill operation. Clicking the *Skip* button from this initial dialog allows you to begin backdrill setup with an opportunity to generate the backdrill layer pairs based on design analysis.



The Backdrill Setup and Analysis form gives you the ability to generate backdrill layer pairs manually using the right-click pop-up menu on a layer pair row, as in previous releases, or automatically using the *Layer Pair Initialization* button.

Figure 1-10 Backdrill Setup and Analysis Dialog Box



Backdrill Layer Pair Initialization dialog is separated into two sections:

1. Create layer pairs by the deepest backdrill layers (*Initialization*):

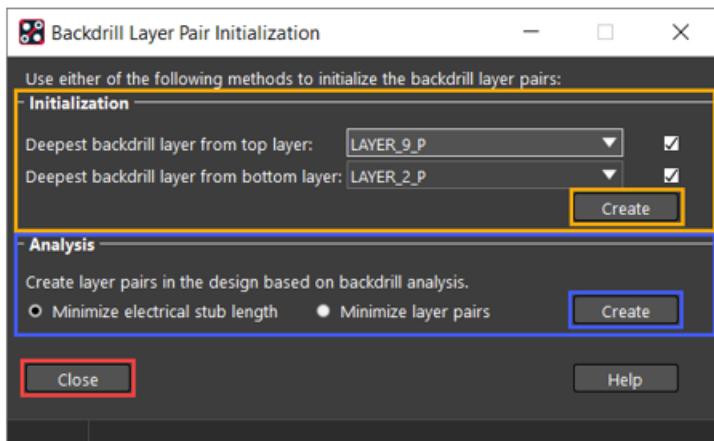
Select the deepest layers for each side, enable checkboxes on the right to generate layer pairs for **TOP** and **BOTTOM** or check both the checkboxes and select the *Create* button

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in the *Initialization* section to create the backdrill layer pairs. Click the *Close* button to see the layer pairs.

Note: This section performs the same layer pair creation as the Backdrill Pairs Question dialog presented when Backdrill and Analysis form was first opened.



2. Create layer pairs based on Design Backdrill Analysis (Analysis):

Enable *Minimize electrical stub length* or *Minimize layer pairs* and select the *Create* button in the section to create the backdrill layer pairs based on the backdrill analysis of the design. Click the *Close* button to see the layer pairs.

Figure 1-11 Generate layer pairs based on Analysis – Minimize electrical stub length

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Figure 1-12 Generate layer pairs based on Analysis – Minimize layer pairs

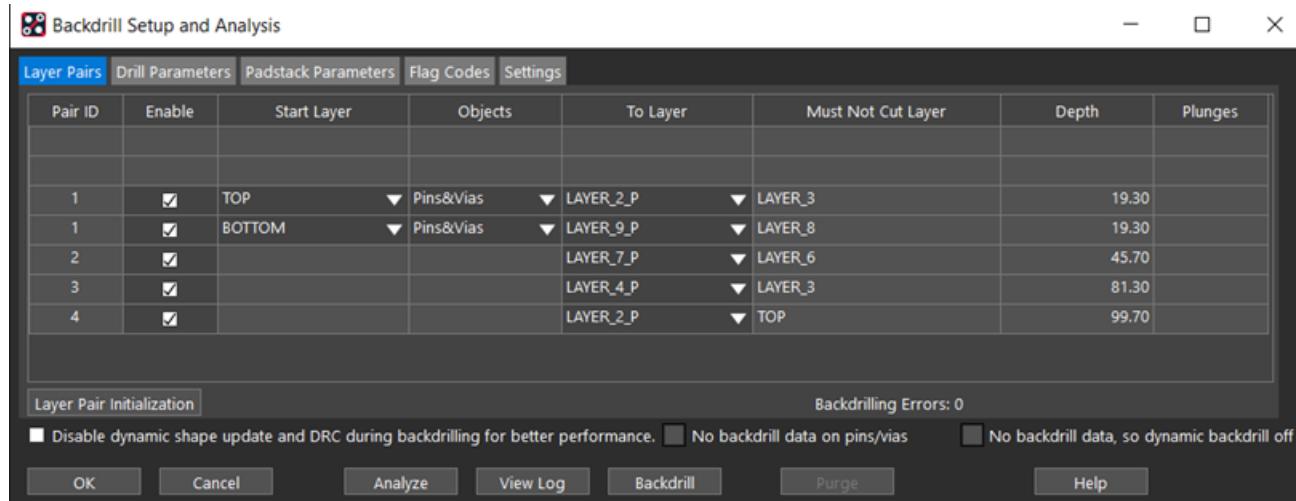
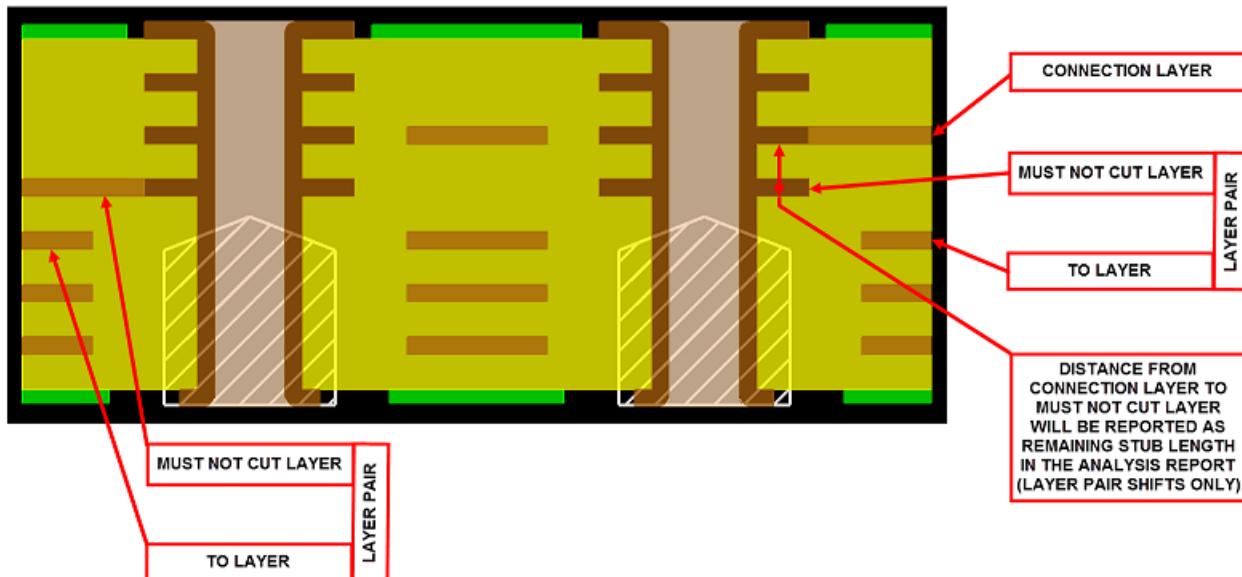


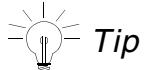
Figure 1-13 Minimize layer pairs



Combine backdrill layer pairs based on analysis while meeting Max Electrical Stub requirements (BACKDRILL_MAX_PTH_STUB).

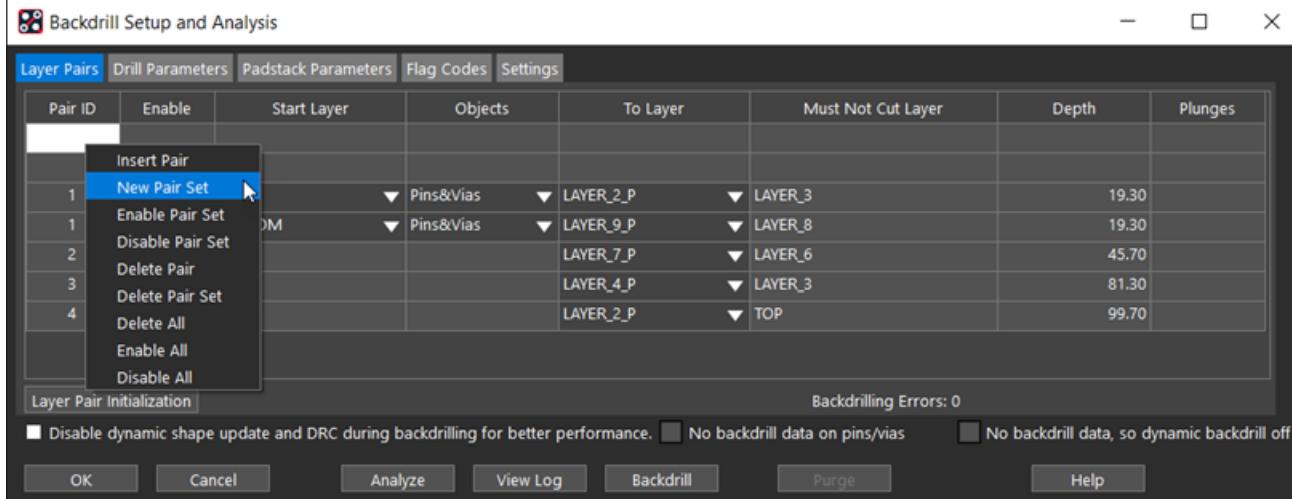
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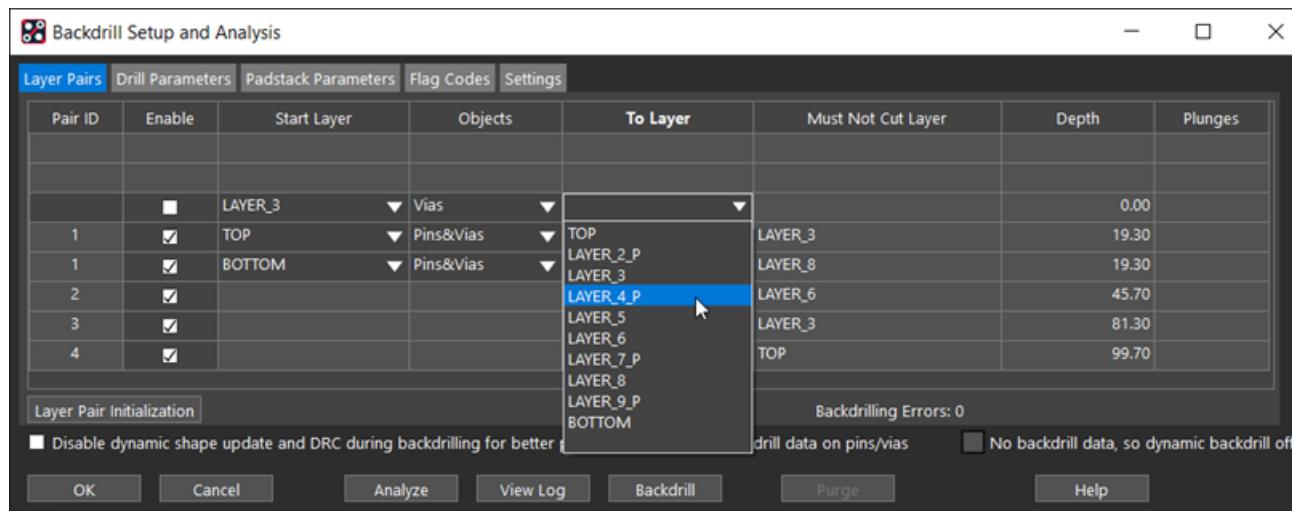
Tip

On sequential lamination designs, using blind and buried via technology, you can backdrill from an internal layer by creating a *New Pair Set* and inserting additional layer pairs using *Insert Pair* pop-up menu options.



Select the objects to backdrill and to which layers *To Layer* you wish to backdrill.

Note: Changing the Pair ID Number at this stage adds additional layer pair rows.

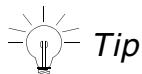
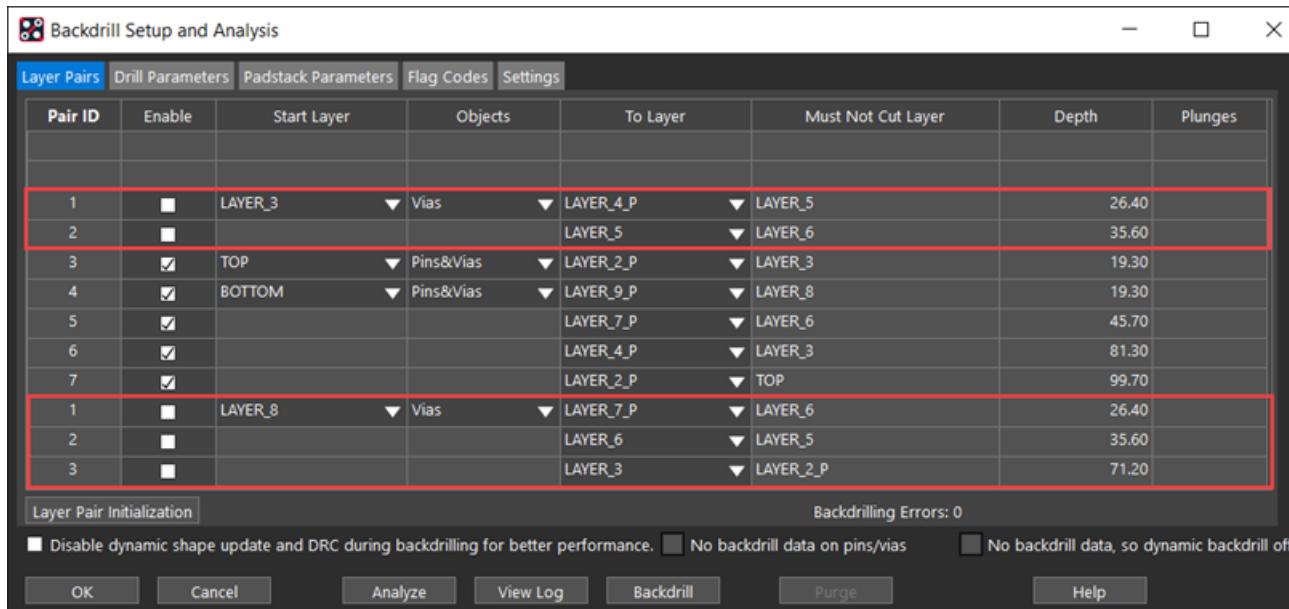


Insert new layer pairs as needed and make sure to enable them to be included in backdrill.

Working with Backdrilling

Backdrilling

Note: Plunges column remains blank on newly added layer pairs and requires *Analyze* or *Backdrill* to be ran for the information to be updated.



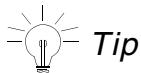
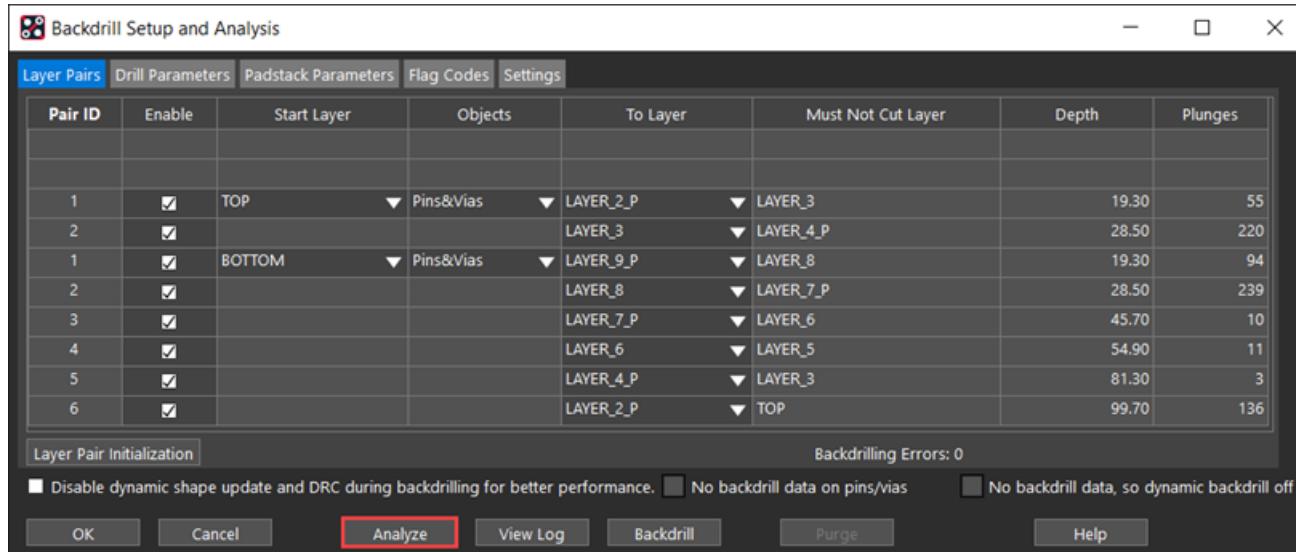
Tip

It is recommended to generate the backdrill layer pairs based on backdrill analysis of the design to ensure that all necessary backdrill layer pairs are generated. Layer pairs based on analysis attempt to completely remove the entire stub regardless of the value assigned to the BACKDRILL_MAX_PTH_STUB as long as a layer pair exists to do so.

Working with Backdrilling

Backdrilling

Once analysis runs the number of Plunges (backdrill candidates) are generated.



Tip

Backdrill layer pairs can be excluded from the backdrill process under the *Enable* column. Backdrill candidates on disabled or missing layer pairs will be reported as backdrill errors (stub violations) in the report and generate a canvas Flag Code figure.

Disabling underutilized layer pairs to isolate the backdrill plunges location that need to be reviewed and to possibly eliminate the layer pair after some routing tweaks.

Working with Backdrilling

Backdrilling

Figure 1-14 Disable backdrill layer pair for underutilized plunges

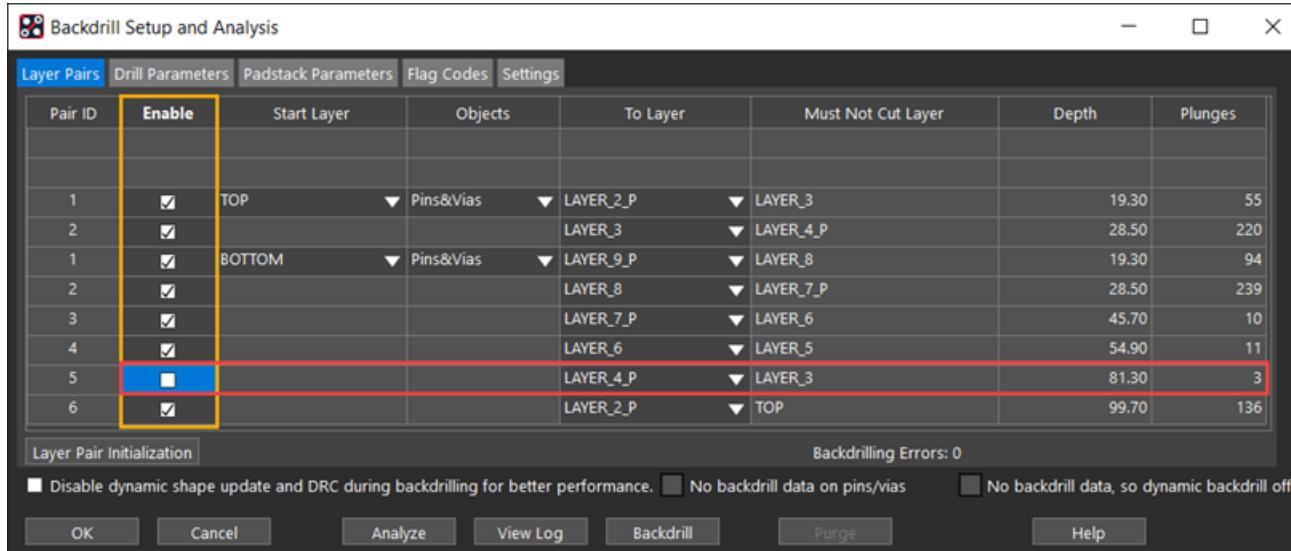


Figure 1-15 Backdrill Analysis report - shows stub violations from disabled layer pair

```

Total backdrill errors ... 3

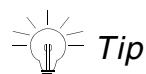
Maximum stub length violation      SQUARE + 'S' ... 3
Minimum pin PTH length violation  SQUARE + 'P' ... 0
Minimum MFG stub violation       SQUARE + 'M' ... 0

NOTE: The indicated "SQUARE + 'character'" above for each error
or exclusion is the backdrill flag figure that will appear
for it on the BACKDRILL-FLAG-TOP and/or -BOT subclasses.

Other flags that may appear:
Pin/via has BACKDRILL_OVERRIDE    SQUARE + 'O'
Pin/via has override with warning SQUARE + 'W'

=====
| Backdrilling errors ...
| Net Name | Object | Location           | Error
|-----|-----|-----|-----|
| P66 IRQ_L4 | Via   | (2835.00 576.00) | Maximum PTH stub length 10.00 < Actual stub length 17.20 TOP->LAYER_3 |
| P66 IRQ_L5 | Via   | (2784.00 579.00) | Maximum PTH stub length 10.00 < Actual stub length 17.20 TOP->LAYER_3 |
| P66 REQ_L0  | Via   | (1455.00 4305.00)| Maximum PTH stub length 10.00 < Actual stub length 17.20 TOP->LAYER_3 |
|-----|

```

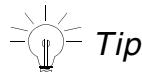


The *Plunges* column can be used to determine which backdrill layer pairs are underutilized and the Backdrill Analysis report displays the Net Name, Object, X-Y locations, and so on so that they can be investigated.

Working with Backdrilling

Backdrilling

Reviewing the routing at the backdrill site to assess if there is an opportunity to reroute the connection to eliminate the underutilized backdrill layer pair and to avoid the extra backdrill process at the fabrication vendor. You could also disable the layer pair to isolate the locations on the underutilized layer pairs and have them reported as errors.



After revising routing to reduce the number of backdrill layer pairs run analysis again from the Backdrill Setup and Analysis to review the backdrill results. Disabled layer pairs can be deleted using right-click option *Delete Pair* over the disabled row.

Figure 1-16 Review backdrill plunges by layer pair for underutilized layer pairs

Pair ID	Enable	Start Layer	Objects	To Layer	Must Not Cut Layer	Depth	Plunges
1	<input checked="" type="checkbox"/>	TOP	Pins&Vias	LAYER_2_P	LAYER_3	19.30	55
2	<input checked="" type="checkbox"/>			LAYER_3	LAYER_4_P	28.50	220
1	<input checked="" type="checkbox"/>	BOTTOM	Pins&Vias	LAYER_9_P	LAYER_8	19.30	94
2	<input checked="" type="checkbox"/>			LAYER_8	LAYER_7_P	28.50	239
3	<input checked="" type="checkbox"/>			LAYER_7_P	LAYER_6	45.70	10
4	<input checked="" type="checkbox"/>			LAYER_6	LAYER_5	54.90	11
5	<input checked="" type="checkbox"/>			LAYER_4_P	LAYER_3	81.30	3
6	<input checked="" type="checkbox"/>			LAYER_2_P	TOP	99.70	136

Layer Pair Initialization Backdrilling Errors: 0

Disable dynamic shape update and DRC during backdrilling for better performance. No backdrill data on pins/vias No backdrill data, so dynamic backdrill off

OK Cancel Analyze View Log Backdrill Purge Help

Figure 1-17 Backdrill locations from start layer BOTTOM to Must Not Cut Layer LAYER3

Working with Backdrilling

Backdrilling

View of file: backdrill_analysis

Backdrilling from layer BOTTOM

NOTES: An '*' preceding the object indicates that the backdrill was the result of a BACKDRILL_OVERRIDE.

A remaining stub length of '*****' indicates an override that created an etch violation.

Net Name	Object	Location	Finished Hole Size	Backdrill Hole Size	To Layer	Must Not Cut Layer	Maximum Depth	Maximum PTH Stub	Remaining Stub Len
P66 IRQ_L0	Via	(2664.00 580.00)	14.00	28.00	LAYER_2_P	TOP	99.70	10.00	0.00
P66 IRQ_L1	Via	(2614.00 580.00)	14.00	28.00	LAYER_2_P	TOP	99.70	10.00	0.00
P66 IRQ_L2	Via	(2664.00 630.00)	14.00	28.00	LAYER_2_P	TOP	99.70	10.00	0.00
P66 IRQ_L3	Via	(2614.00 630.00)	14.00	28.00	LAYER_4_P	LAYER_3	81.30	10.00	0.00
P66 IRQ_L4	Via	(2561.00 630.00)	14.00	28.00	LAYER_4_P	LAYER_3	81.30	10.00	0.00
P66 IRQ_L5	Via	(2614.00 730.00)	14.00	28.00	LAYER_4_P	LAYER_3	81.30	10.00	0.00

The *Depth* column in the Backdrill Setup and Analysis form and the analysis report provides maximum backdrill depths based on the layout cross-section.



Working with Backdrilling

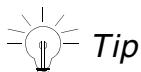
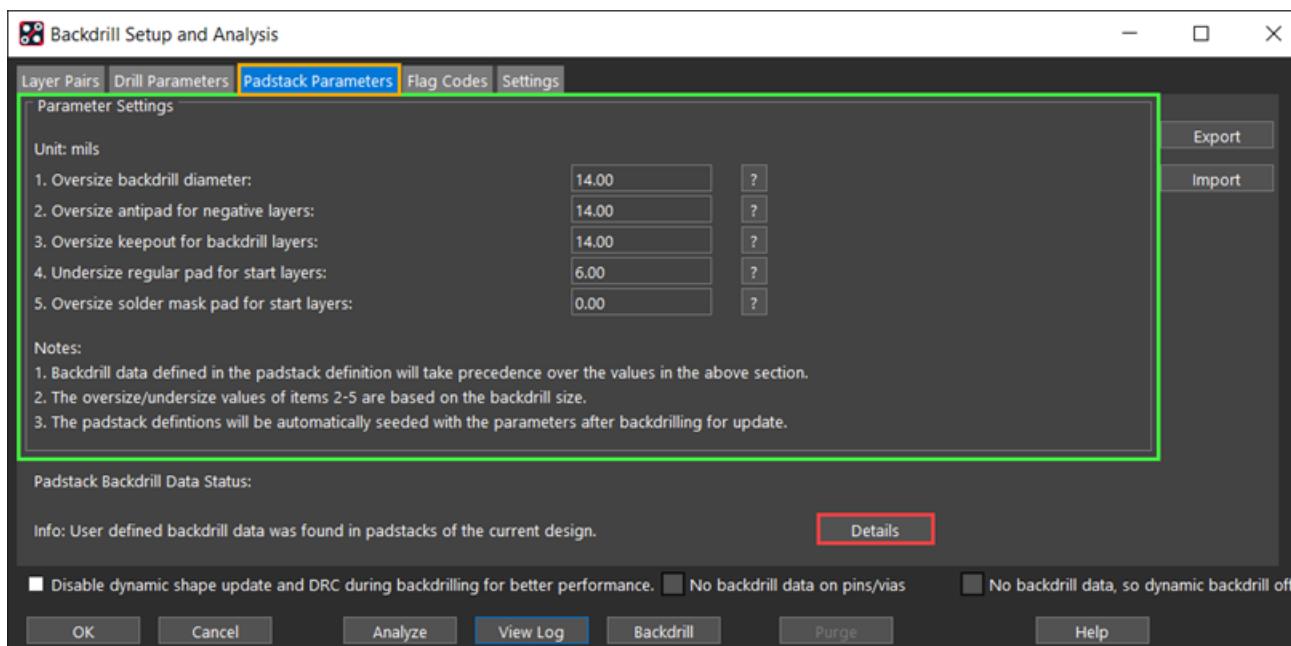
Backdrilling

Prior to executing Backdrill

The final step is to ensure that all of your padstacks contain backdrill information that can be used at each backdrill location.

Padstack Parameters Tab of the Backdrill Setup and Analysis Form

Padstacks which do not have backdrill data are automatically updated based on the criteria in this tab. Padstacks with user-defined backdrill data, from the library or manually entered in the design padstacks, will be used during the backdrill process and will not be updated based on this criteria.

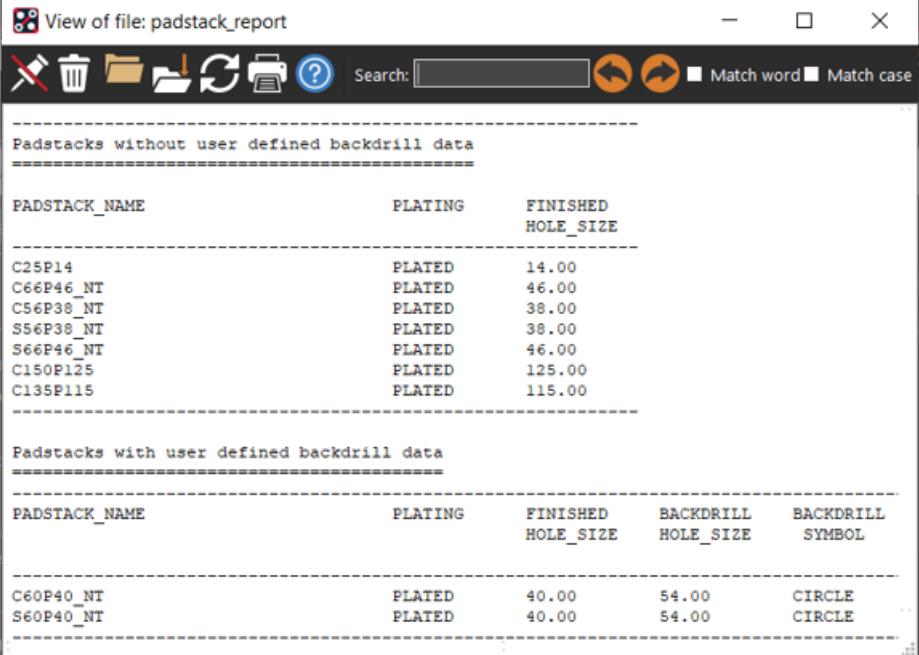


Tip
The question ? button next to each of the fill-in fields describes and assists in value entry to achieve the desired result.

Working with Backdrilling

Backdrilling

The *Details* button generates a list of all padstacks in the design and identify the padstacks which have user-defined backdrill information.



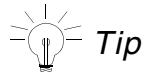
The screenshot shows a software interface with a title bar 'View of file: padstack_report'. Below the title bar is a toolbar with icons for file operations like Open, Save, Print, and Help, along with a search bar and checkboxes for 'Match word' and 'Match case'. The main content area contains two tables of padstack data.

Padstacks without user defined backdrill data

PADSTACK_NAME	PLATING	FINISHED HOLE_SIZE
C25P14	PLATED	14.00
C66P46_NT	PLATED	46.00
C56P38_NT	PLATED	38.00
S56P38_NT	PLATED	38.00
S66P46_NT	PLATED	46.00
C150P125	PLATED	125.00
C135P115	PLATED	115.00

Padstacks with user defined backdrill data

PADSTACK_NAME	PLATING	FINISHED HOLE_SIZE	BACKDRILL HOLE_SIZE	BACKDRILL SYMBOL
C60P40_NT	PLATED	40.00	54.00	CIRCLE
S60P40_NT	PLATED	40.00	54.00	CIRCLE



Tip
Adjust some of the values under the Padstack Parameters tab. When backdrill is executed the padstacks, without pre-existing backdrill data, will be updated.

Note: Only padstacks which do not have any backdrill data will be updated using the Padstack Parameters, all other padstacks with user defined backdrill data entered in the design or in the library will remain unchanged.

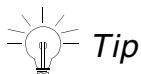
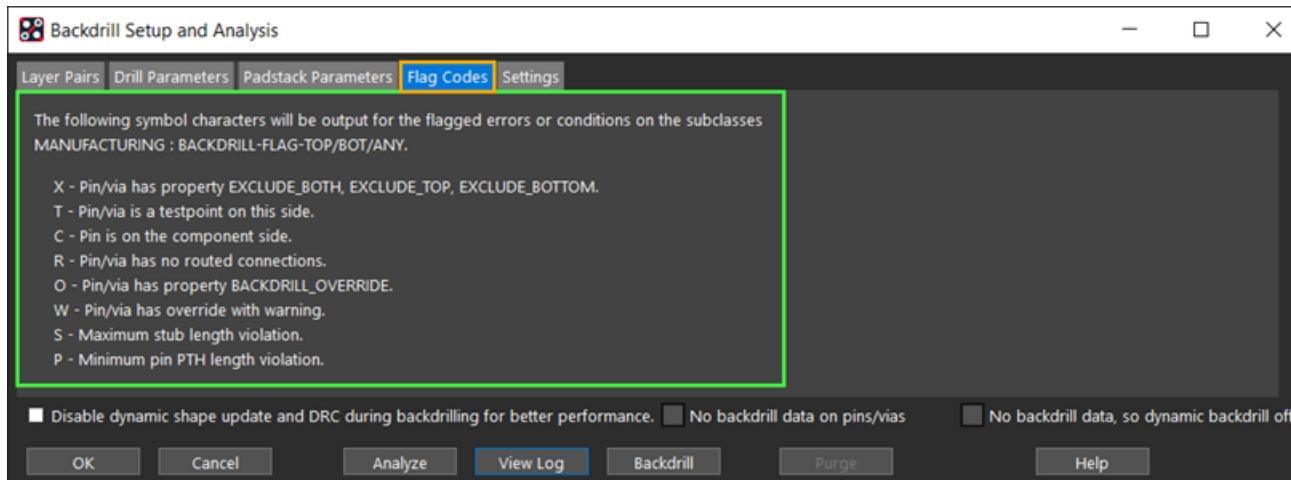
Note: It is recommended to enter the backdrill data in the library padstacks to ensure a consistent result when backdrill is executed from design to design.

Working with Backdrilling

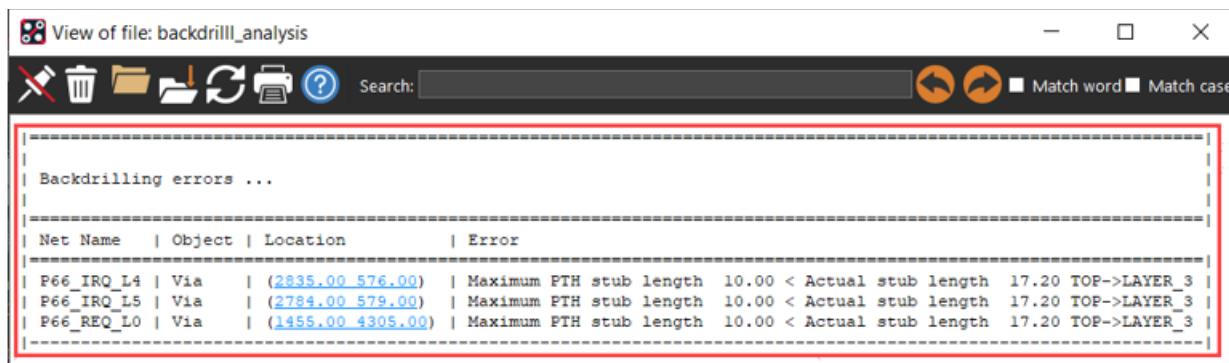
Backdrilling

Flag Codes tab of the Backdrill Setup and Analysis form

During Backdrill and Analysis a detailed report is generated with an errors flagged on the canvas using a set of pre-defined Flag Code figures



You can easily center on these Flag Code figures by clicking on the X-Y coordinate in the Backdrill and Analysis report file.



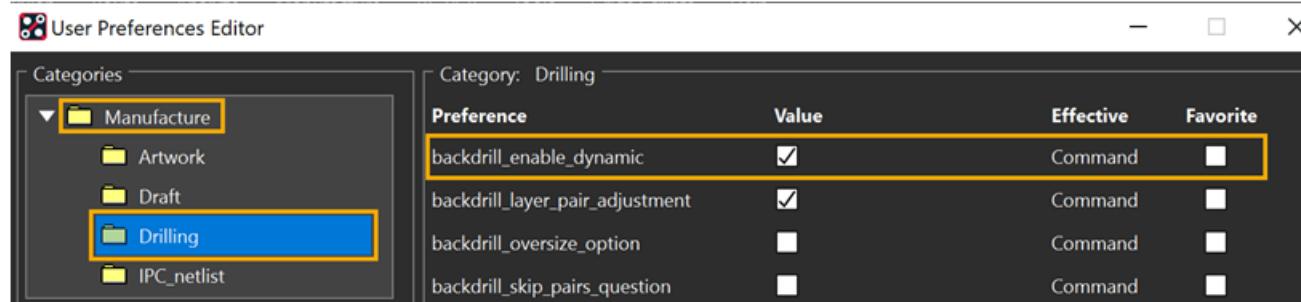
Enable Dynamic Backdrill from Setup tab of the Backdrill Setup and Analysis form

Achieving backdrill results in real-time, maintaining appropriate backdrill clearance and depth as updates are made is possible by enabling dynamic backdrill mode. To enable this mode,

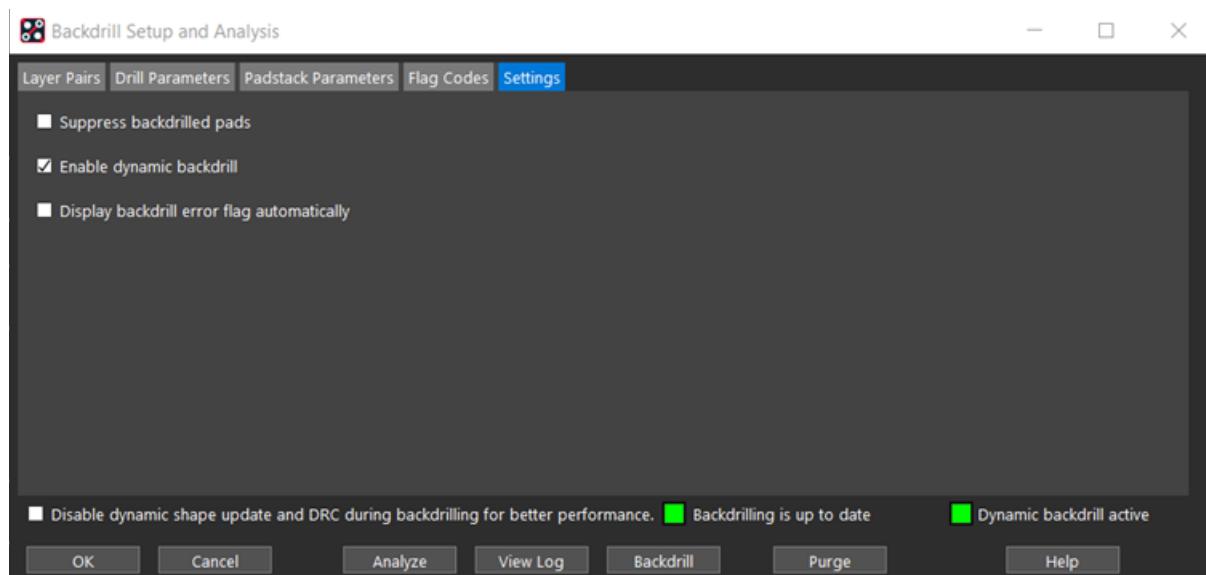
Working with Backdrilling

Backdrilling

set `backdrill_enable_dynamic` in User Preferences Editor under the *Manufacturing – Drilling* category.



The Settings tab of the Backdrill Setup and Analysis dialog starts showing the *Enable dynamic backdrill* option. Select this option to enable dynamic backdrill mode.



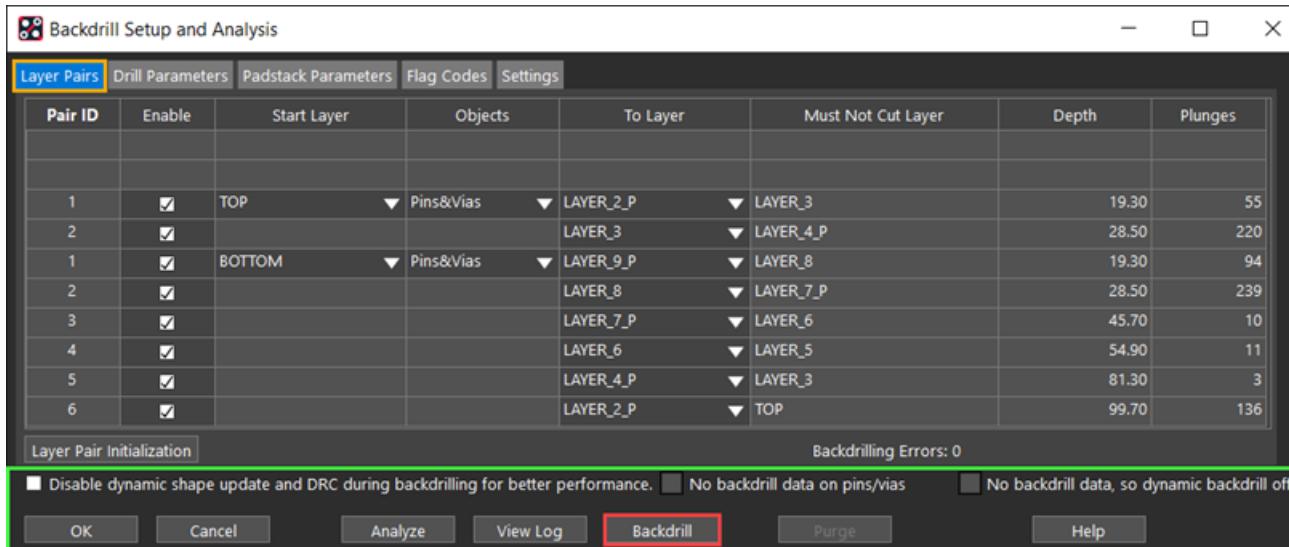
With dynamic backdrill enabled, when you slide vias, move components, or change connection layers, the tool selectively maintains and updates backdrill without any need of running multiple full backdrill executions.

Note: You must rerun backdrill prior to manufacturing release to verify all relevant stubs have been removed.

Working with Backdrilling

Backdrilling

Final Backdrill Steps – Executing Backdrill



Disable Dynamic shape update during backdrill – When backdrill is executed route keepouts are added to all backdrill locations to maintain backdrill hole clearance. On designs with a lot of dynamic shapes could see a performance impact during backdrill so this setting allows you to disable dynamic shape update.

Backdrill status

- Red – Backdrill data are out of date, select the *Backdrill* button to update.
- Green – Backdrill data on pins/vias are in sync
- Grey – No backdrill data saved on pins/vias yet
-

OK Closes form and saves settings with no Backdrill data generated

Cancel Closes form and discards updated settings

Analyze Analyzes design only and reports backdrill information but do not add backdrill data on pins/vias or update padstack backdrill values

ViewLog Displays the last generated Backdrill and Analysis report

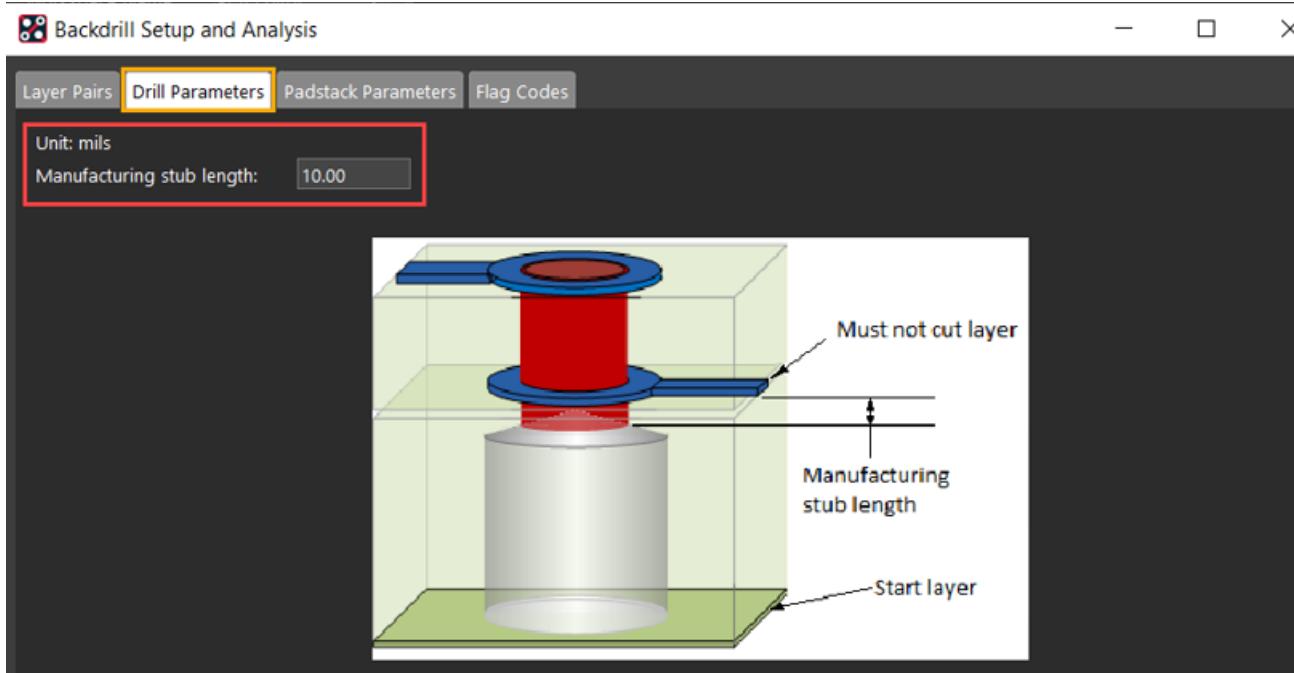
Working with Backdrilling

Backdrilling

Backdrill	Analyzes and generates backdrill data on pins/vias in the design. Padstacks which do not have any backdrill data are updated using the Padstack Parameters tab. All other padstacks with user-defined backdrill data entered in the design or in the library remain unchanged.
Purge	Removes backdrill data on pins/vias and from design padstacks which were updated based on the criteria under the Padstack Parameter tab.

Manufacturing Stub Length Analysis (Drill Parameters Tab)

There is an advanced setup for Backdrill and Analysis to verify that the remaining stub length after backdrill is manufacturable by specifying a manufacturing stub length. This is a fabrication vendor driven value and should not be confused with the minimum Electrical Stub requirements which is defined using the BACKDRILL_MAX_PTH_STUB Property. It is the remaining stub that can be reliably manufactured without comprising the Must Not Cut Layer.



The default value of manufacturing stub length is 0 . 00 which disables the advanced analysis and reporting. Entering the stub value provided by the fabricator turns on the advanced analysis and layer pair violation reporting to influence your backdrill decisions. This value is also reported in the Backdrill Analysis log file and in the Backdrill Drill Legends.

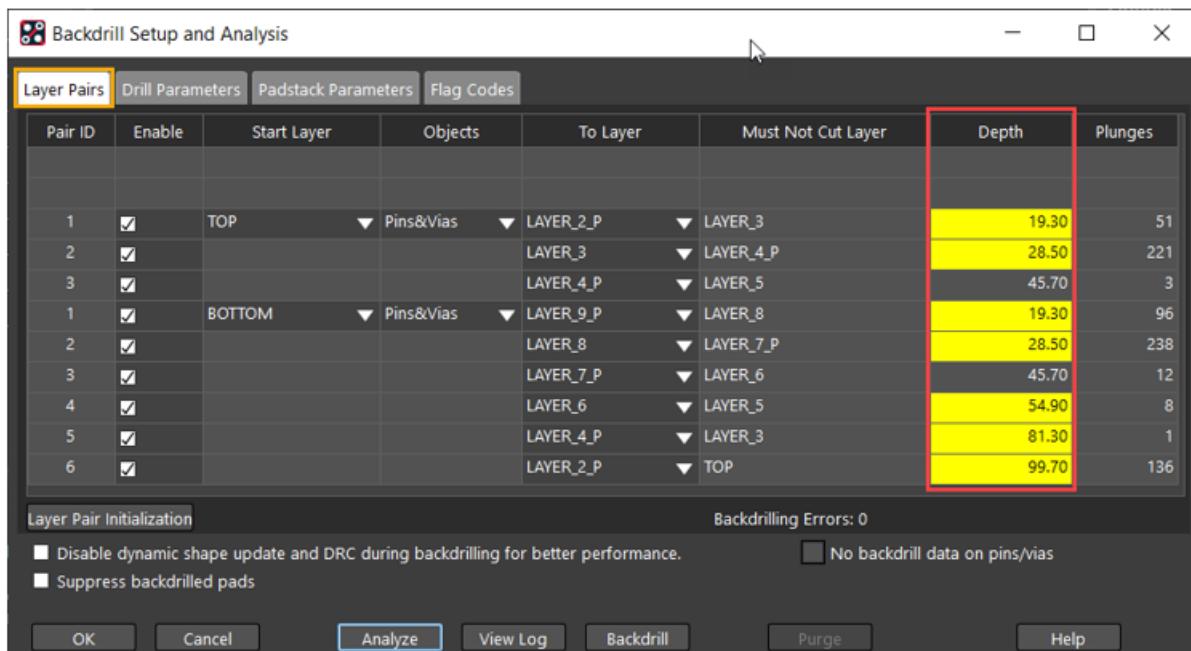
Working with Backdrilling

Backdrilling

Effects of Setting a Manufacturing Stub Length:

- The Layer Pairs Tab reports a yellow cell under the depth column where the total thickness of the *To Layer + Dielectric* is less than the entered stub value.
- When this violation exists the fabricator may have a difficult time backdrilling because just stopping at the To Layer (layer before the Must Not Cut Layer) needs to backed off from the To Layer to meet their manufacturing limitations.
- You can leave it up to the fabricator to adjust the drill depth or have the layer pairs adjusted during Layer Pair Initialization analysis.
 - The environmental variable *BACKDRILL_LAYER_PAIR_ADJUSTMENT* automatically shifts the layer pair for a given backdrill candidate to meet the fabricator minimum manufacturing stub length.

Layer Pairs tab feedback – Depth column yellow cells:



Pair ID	Enable	Start Layer	Objects	To Layer	Must Not Cut Layer	Depth	Plunges
1	<input checked="" type="checkbox"/>	TOP	Pins&Vias	LAYER_2_P	LAYER_3	19.30	51
2	<input checked="" type="checkbox"/>			LAYER_3	LAYER_4_P	28.50	221
3	<input checked="" type="checkbox"/>			LAYER_4_P	LAYER_5	45.70	3
1	<input checked="" type="checkbox"/>	BOTTOM	Pins&Vias	LAYER_9_P	LAYER_8	19.30	96
2	<input checked="" type="checkbox"/>			LAYER_8	LAYER_7_P	28.50	238
3	<input checked="" type="checkbox"/>			LAYER_7_P	LAYER_6	45.70	12
4	<input checked="" type="checkbox"/>			LAYER_6	LAYER_5	54.90	8
5	<input checked="" type="checkbox"/>			LAYER_4_P	LAYER_3	81.30	1
6	<input checked="" type="checkbox"/>			LAYER_2_P	TOP	99.70	136

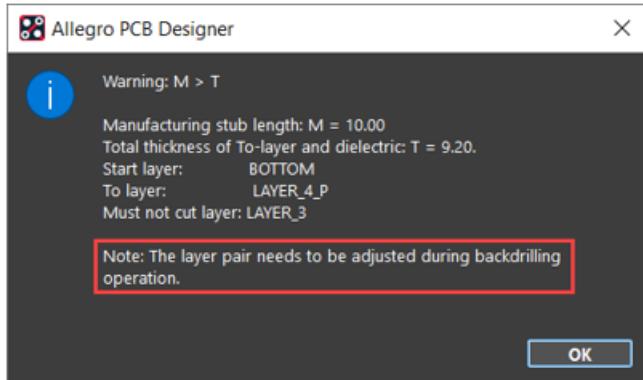
The layer pair rows for TOP to LAYER_4_P and BOTTOM to LAYER_7_P is not being reported as an issue because the minimum stub length after backdrill can be achieved, for example:

- To Layer (1.20 mils) + Dielectric (16.00 mils) = 17.20 mils
- Total Thickness is 17.20 mils, which is greater than 10.00 mils stub length.

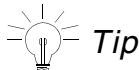
Working with Backdrilling

Backdrilling

Selecting the yellow cell on the layer pair row from BOTTOM to LAYER_4_P opens a dialog to explain the violation:



Note: The fabrication vendor can adjust the *To Layer* to meet their minimum stub length after backdrill which would result in them moving it to LAYER_5 with the stub spanning two layers. All Backdrill data will still be generated, even when these Warnings exist.



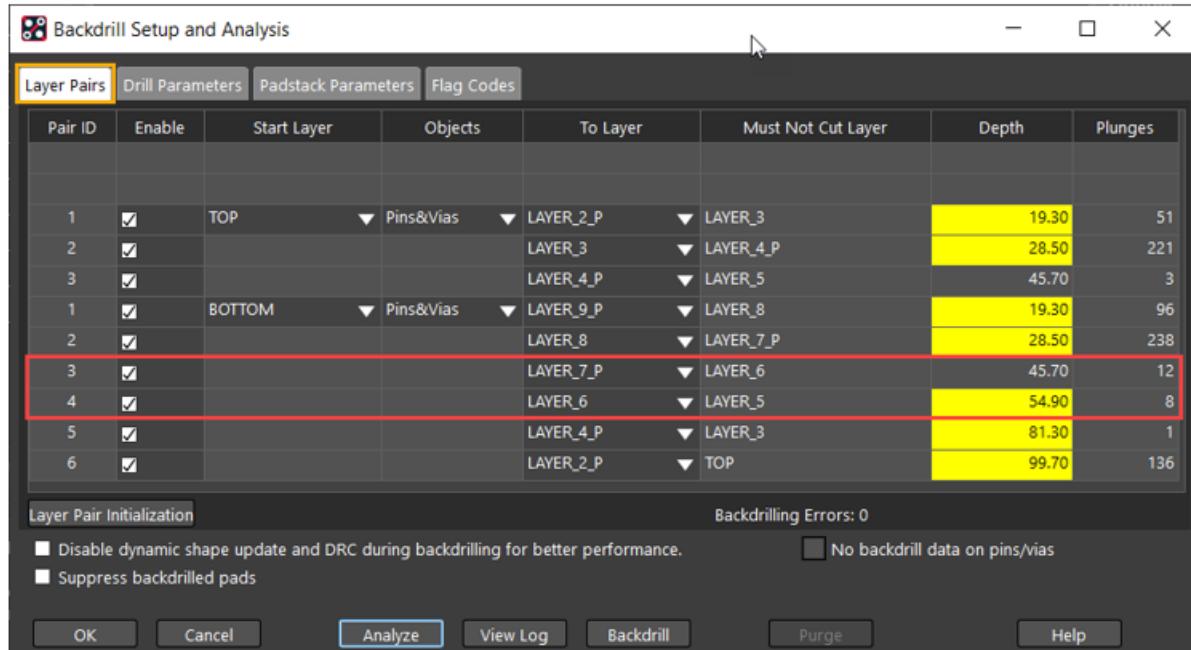
Backdrill Analysis can take into consideration the specified Manufacturing Stub Length and make adjustments during layer pair creation by setting a special environmental variable.

- Set the environmental variable `BACKDRILL_LAYER_PAIR_ADJUSTMENT`
- Select *Layer Pair Initialization* button in the *Layer Pairs* tab

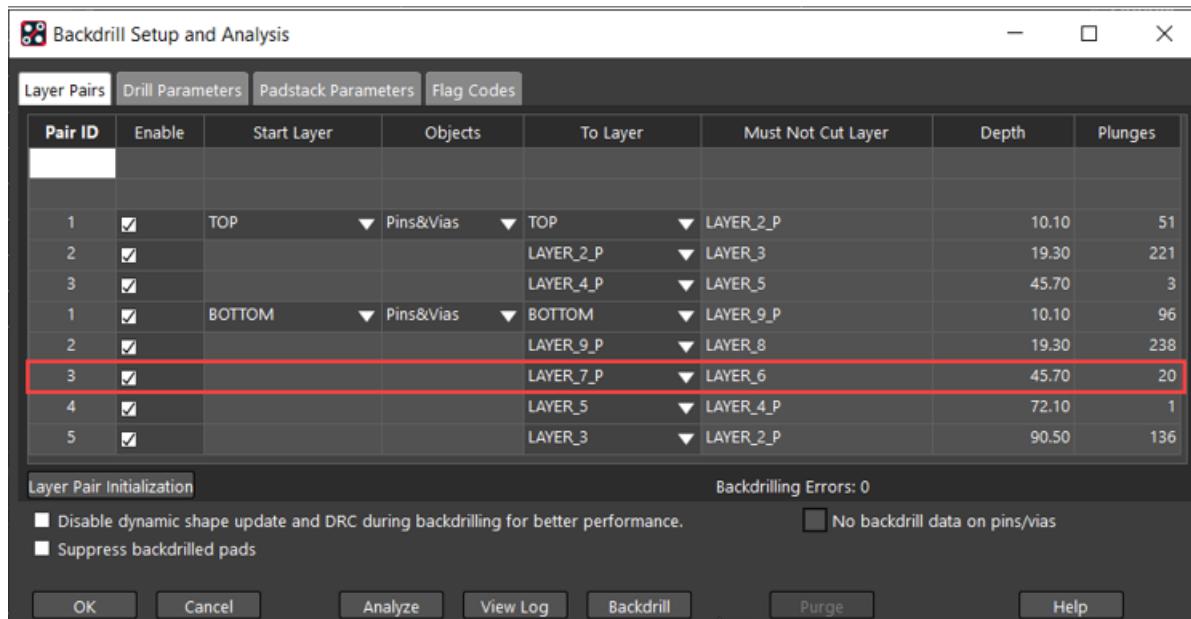
Working with Backdrilling

Backdrilling

FROM:



TO:

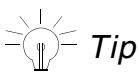


Note: The layer pair shift resulted in a couple bottom side backdrill layer pairs to be combined with all others shifting up or down one layer depending on the backdrill side.

Working with Backdrilling

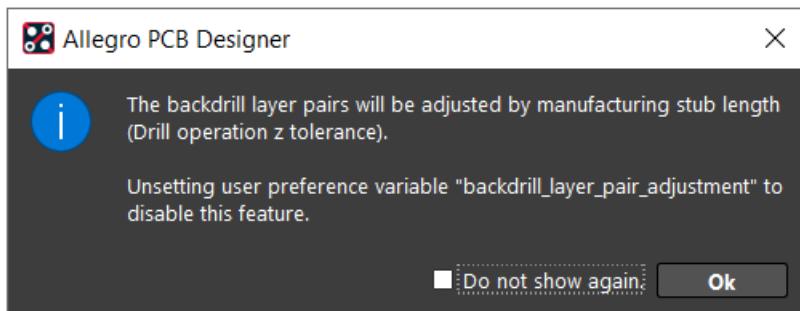
Backdrilling

To Layer	Must Not Cut Layer	Plunges	To Layer	Must Not Cut Layer	Plunges
LAYER_7_P	LAYER_6	10	LAYER_7_P	LAYER_6	21
LAYER_6	LAYER_5	11			



Once the layers pairs are regenerated backdrill will be out of date. Select the *Backdrill* button to regenerate backdrill data for pins/vias using the new layer pairs.

- With the *BACKDRILL_LAYER_PAIR_ADJUSTMENT* environment variable set, the following message is displayed. Select the *OK* button to continue.



Reviewing the backdrill analysis log, the *Remaining Stub Len* column reports the distance from the shifted *Must Not Cut Layer* to the actual connection layer.

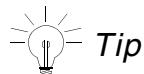
The screenshot shows a text editor window titled "View of file: backdrill_analysis.reduce". The content of the log file is as follows:

```
Backdrilling from layer BOTTOM
NOTES: An '*' preceding the object indicates that the backdrill was the result of a BACKDRILL_OVERRIDE.
A remaining stub length of ***** indicates an override that created an etch violation.

Net Name | Object | Location | Finished | Backdrill | Must Not | Maximum | Maximum PTH Stub | Remaining Stub Len
Net Name | Object | Location | Hole Size | Hole Size | To Layer | Cut Layer | Depth
P66_AD40 | Via | (1916.00 580.00) | 14.00 | 28.00 | LAYER_7_P | LAYER_6 | 45.70 | 10.00 | 9.20
P66_AD44 | Via | (1916.00 630.00) | 14.00 | 28.00 | LAYER_7_P | LAYER_6 | 45.70 | 10.00 | 9.20
P66_IRQ_L10 | Via | (2981.00 579.00) | 14.00 | 28.00 | LAYER_7_P | LAYER_6 | 45.70 | 10.00 | 0.00
P66_IRQ_L6 | Via | (2930.00 578.00) | 14.00 | 28.00 | LAYER_7_P | LAYER_6 | 45.70 | 10.00 | 0.00
```

Working with Backdrilling

Backdrilling



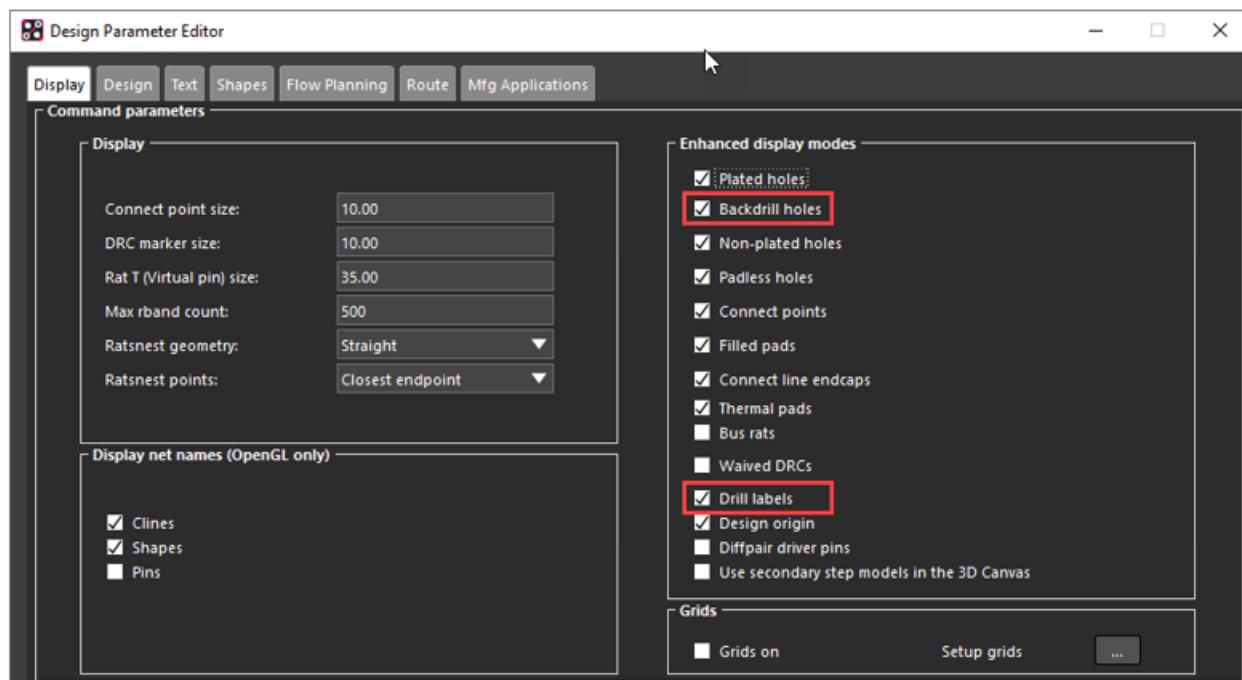
Tip

Remaining Stub Len column is the distance from the shifted *Must Not Cut Layer* to the actual connection layer. (To Layer + Dielectric thickness)

Maximum PTH Stub column is the Electrical Stub defined on the net using the BACKDRILL_MAX_PTH_STUB Property.

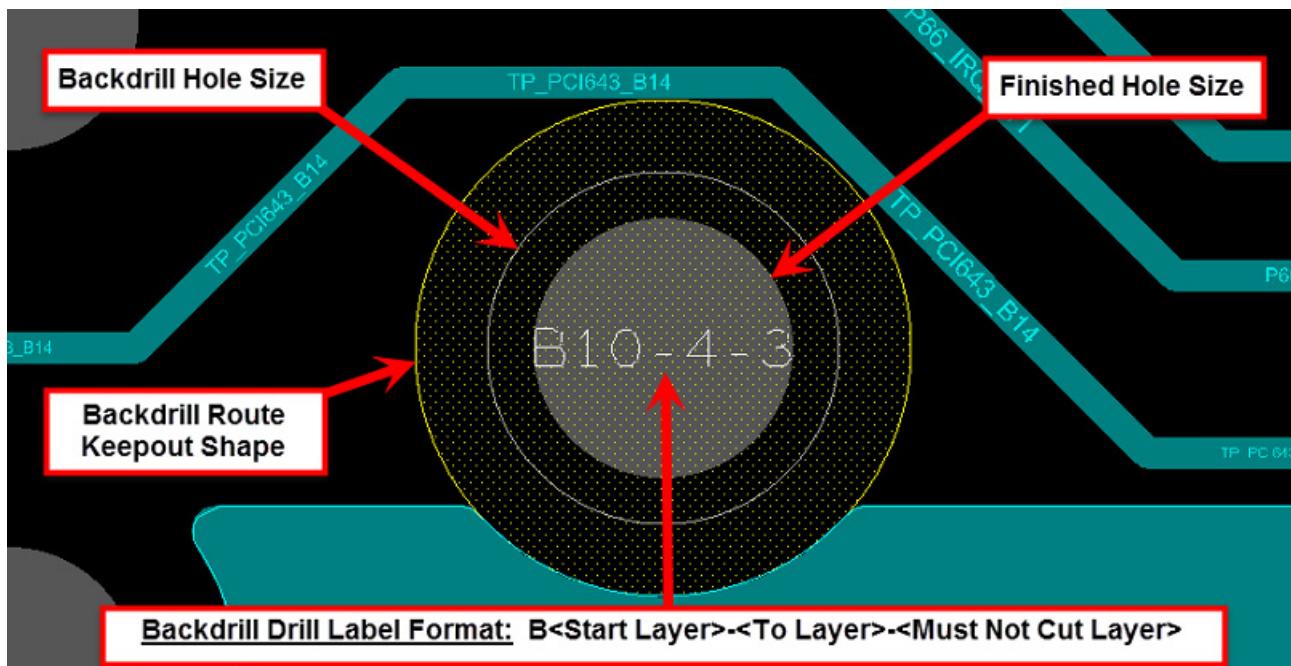
Backdrill Canvas Display Controls

Setup – Design Parameters – Display tab



Working with Backdrilling

Backdrilling

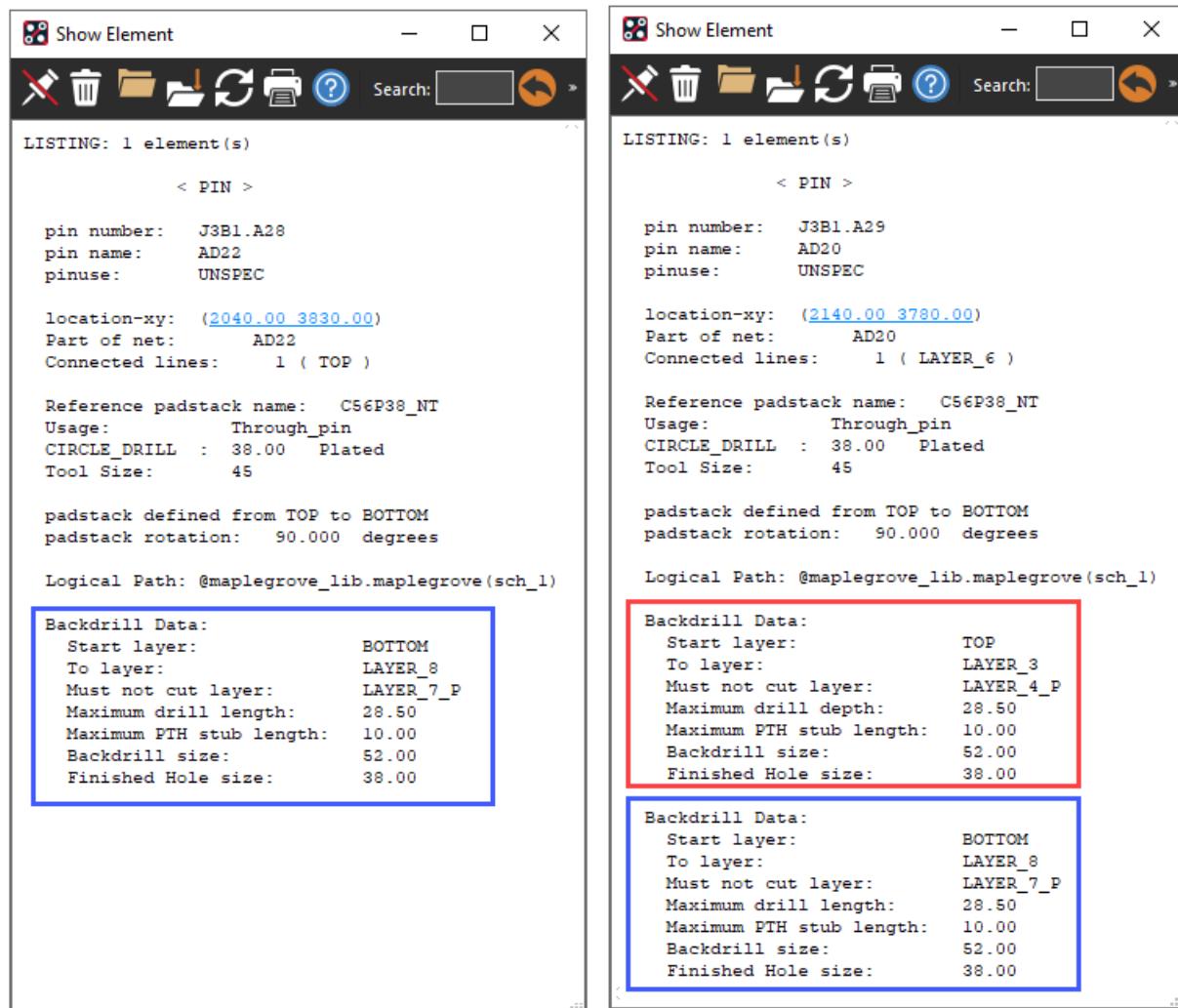


Working with Backdrilling

Backdrilling

Backdrill Data Show Element visibility (Pins/Vias)

Backdrill data is reported on pins/vias at the bottom of the show element information window.



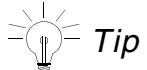
DRC and Shape Voiding

Internal design layers have route keepout shapes generated using the BACKDRILL_CLEARANCE KEEP OUT geometry definition in the padstack to maintain clearance from the backdrill hole to all copper features.

Negative planes utilize BACKDRILL_CLEARANCE ANTI PAD definition in the padstack to maintain clearance to backdrill.

Working with Backdrilling

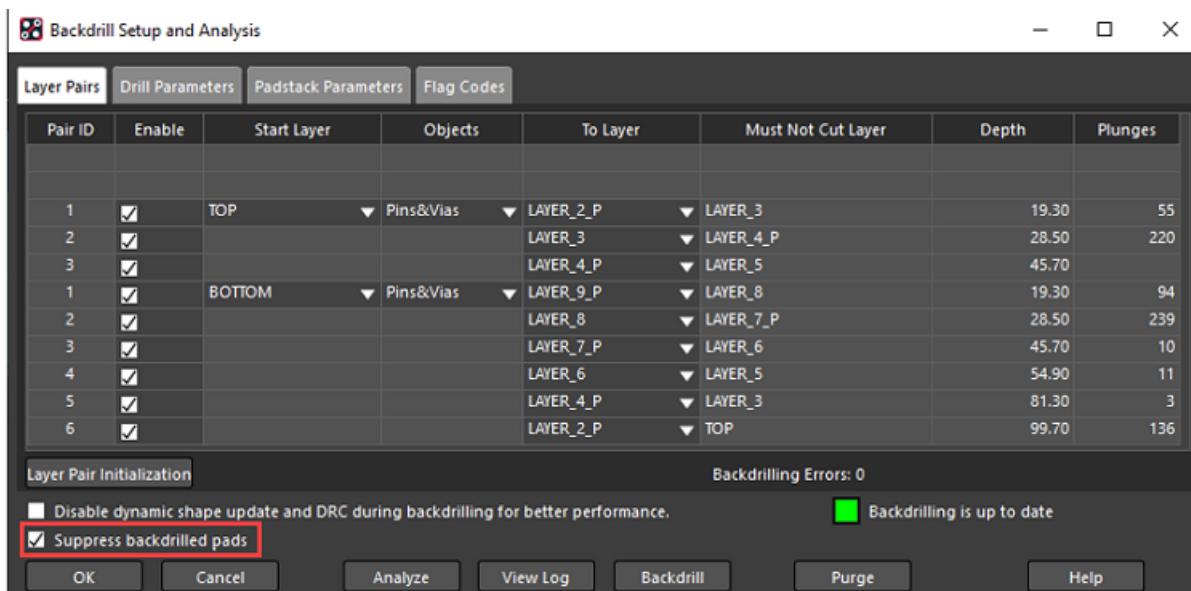
Backdrilling



Tip

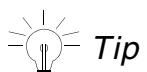
It is recommended to enable *Suppress backdrilled pads* in the Backdrill Setup and Analysis form to avoid a larger than expected clearance at backdrill locations based on the pin/via to copper spacing constraints and to prevent an internal pad being present during manufacturing output.

One of the common fabrication vendor requirements is that the internal layer pads at the backdrill locations are removed in the manufacturing output.



Board Testability

The decision to backdrill may impact your in-circuit test strategy. Any pin or via tagged as a test point is not backdrilled from that side. This could cause a significant reduction in test coverage as most test points are placed on pin and via objects. You can take advantage of adding test points directly on outer layer traces wherever it is feasible to do so.



Automatic and manual test point generation are backdrill aware so there is no chance of marking a pad as a test point which will be backdrilled during fabrication.

Working with Backdrilling

Backdrilling

Figure 1-18 Pins marked as Test Points (Triangle Figures)

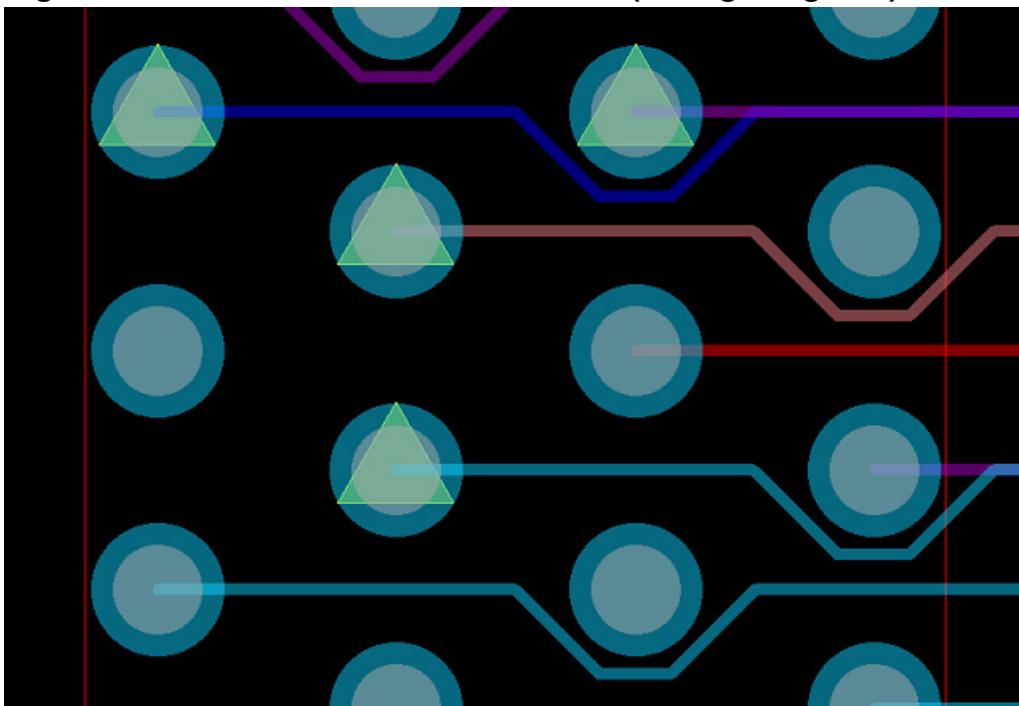
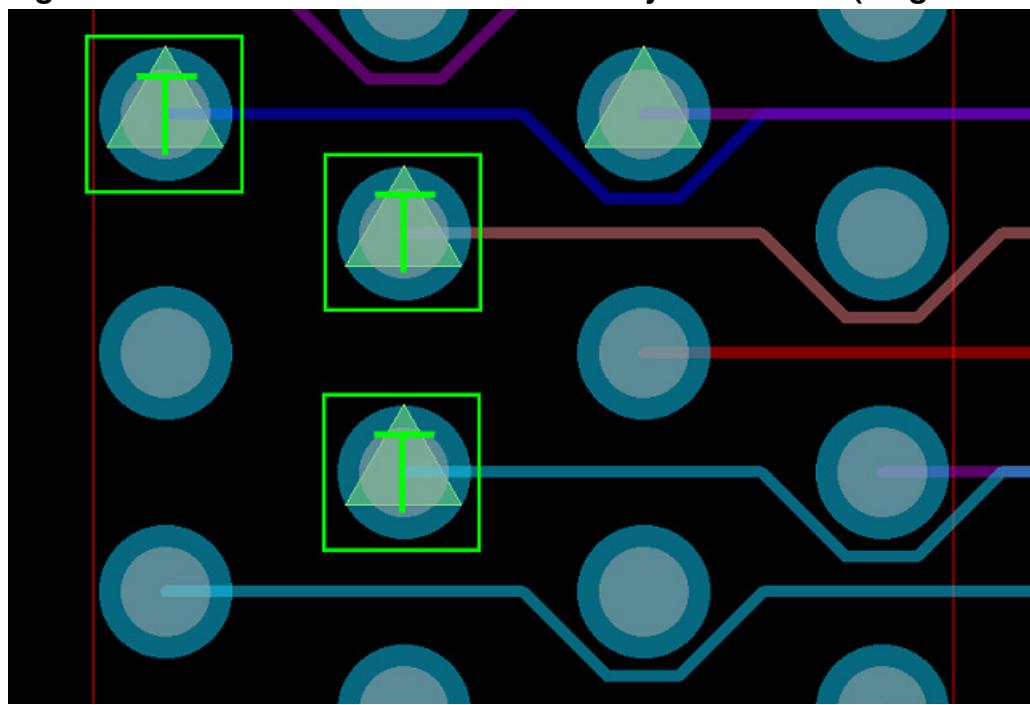


Figure 1-19 Backdrill candidates currently Test Points (Flag Code: Square with T character)



character)

Working with Backdrilling

Backdrilling

Figure 1-20 Test Point additions after backdrill locations has been identified

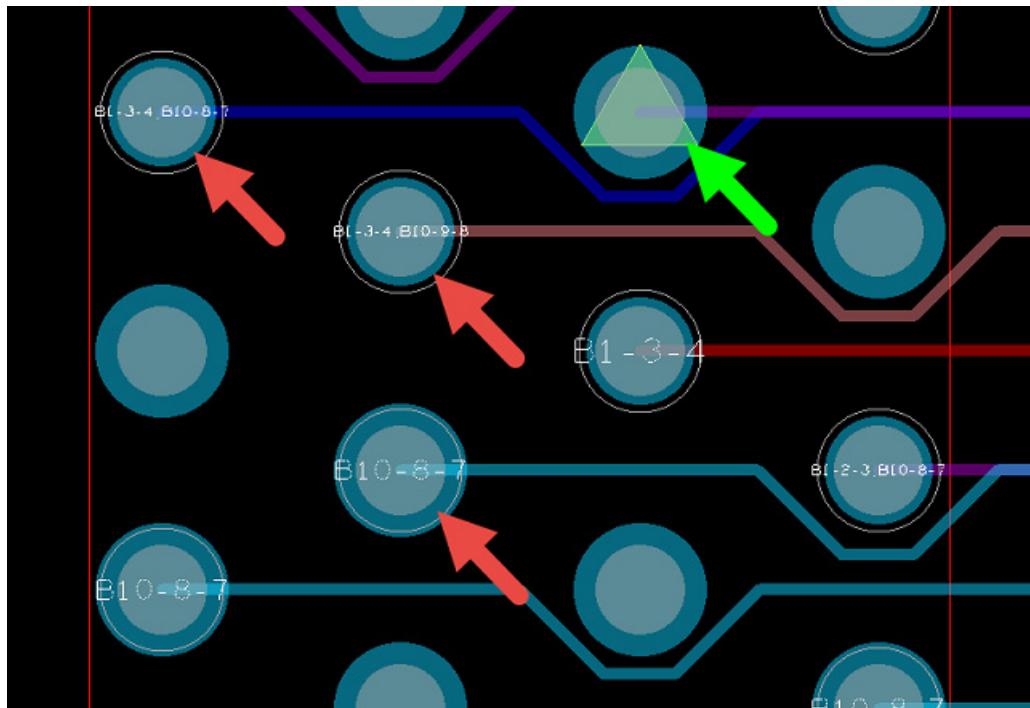


Figure 1-21 Feedback messages on the Allegro Command window

```
Command
Pick pin/via/trace to test ...
last pick: 1942.00 3877.00
(SPMHMF-416): Cannot add testpoint due to existing backdrill data. ←
last pick: 2049.00 3827.00
(SPMHMF-416): Cannot add testpoint due to existing backdrill data. ←
last pick: 2140.00 3785.00
(SPMHMF-416): Cannot add testpoint due to existing backdrill data. ←
last pick: 2040.00 3928.00
Pin probed from BOTTOM with probe type 100 (Net: TP_PCI1_A26) ←
Pick pulldown DONE/NEXT or next pin/via/line to accept.
```

Command >

Ready testprep manual

NC Drill and Legend Output

The output of backdrill data can be compared to the way buried/blind via data is output. Separate legends and NC Drill files are created for each backdrill pass. While dielectric layers are used in analysis calculations, the NC Drill output is based on conductor layers only.

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The fabrication vendor controls the stop depth somewhere in the dielectric layer adjacent to the conductor layer listed in the NC output. The Drill Legends reports the actual backdrill sizes as well as the *Must Not Cut Layer* and maximum depth to *Must Not Cut Layer* surface.

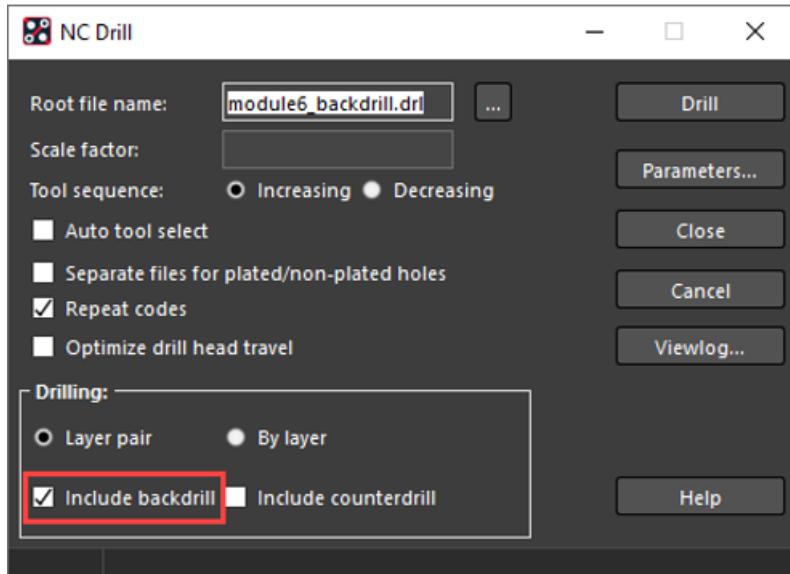
Working with Backdrilling

Backdrilling

Enabling Backdrill Output

The output of backdrill data is controlled by the parameter *Include backdrill* which is available in both the NC Drill and NC Legend forms.

Figure 1-22 NC Drill dialog



The screenshot shows the 'View of file: ncdrl' window. The title bar says 'View of file: ncdrl'. The main area displays the generated NC code:

```
'module6_backdrill-bd-10-9.drl' created for backdrilling of holes from layer BOTTOM to layer LAYER_9_P
-----
      Num      Size      +/- Tolerance      Plating      Quantity
      1.    28.0000    0.0000/ 0.0000  NON_PLATED          5
      2.    52.0000    0.0000/ 0.0000  NON_PLATED         48
      3.    54.0000    0.0000/ 0.0000  NON_PLATED         41
      ---- Total holes:                               94
      ---- Total head travel:           3.75 feet (1.14 meters)
```

NC Backdrill Legends

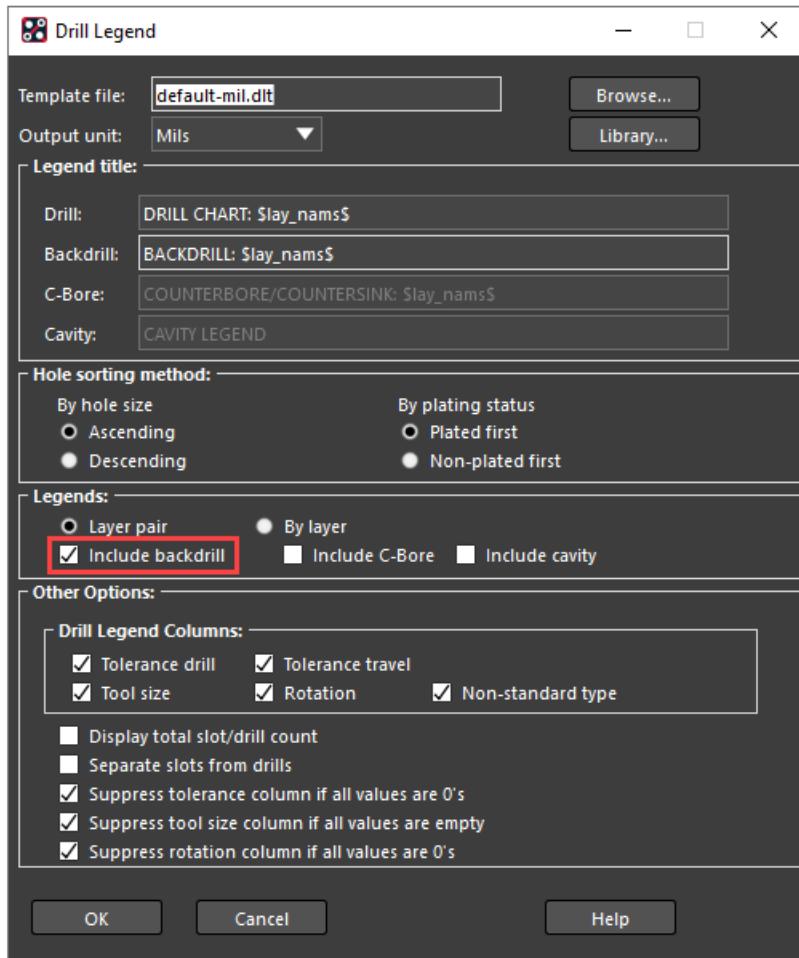
Similar to the standard NC Legend, the backdrill legend provides a symbolic representation of the sites to be backdrilled. The legend table lists oversized backdrill sizes used during the backdrill process.

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Backdrilling

- Drill sizes listed in legend are the actual backdrill size
- Must Not Cut Layer and depth to the surface of the Must Not Cut Layer
- Legend does not specify depth into adjacent dielectric layer. It is controlled by fabrication vendor

Figure 1-23 NC Drill Legend Dialog

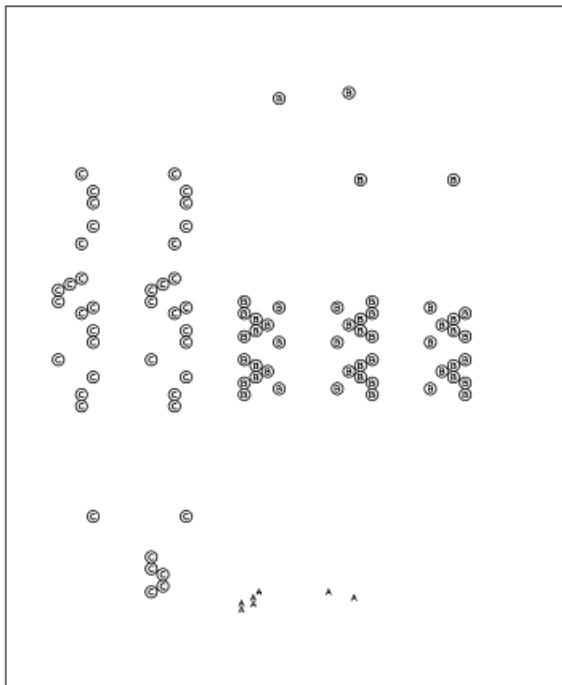


In the following figure, the NC Drill legend accounts for all sites to be backdrilled from the layer BOTTOM through layer LAYER_9_P into the dielectric layer between LAYER_9_P and LAYER_8. The actual depth range into the dielectric material may vary from vendor to vendor as there are many fabrication tolerances to consider. Hence Cadence makes no effort to supply controlled depth data but provides depth to the surface of the *Must Not Cut Layer* for reference.

Working with Backdrilling

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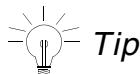
Figure 1-24 Backdrill Legend Output



BACKDRILL: BOTTOM to LAYER_9_P					
ALL UNITS ARE IN MILS					
FIGURE	BD_SIZE	MNC_LAYER	MAX_DEPTH	MFG_STUB	QTY
*	28.0	LAYER_8	19.3	-	7
@	52.0	LAYER_8	19.3	-	48
@	54.0	LAYER_8	19.3	-	41

NOTES:

- MNC_LAYER: MUST-NOT-CUT-LAYER
- MAX_DEPTH: DEPTH FROM START LAYER TO THE SURFACE OF MUST-NOT-CUT-LAYER
- MFG_STUB : MANUFACTURING STUB LENGTH



To support the new enhanced backdrill functionality, the backdrill legend format has been enhanced and required an update to the NC Drill Legend template file (*.dlt) You may find new column definitions, backdrill notes, and so on.

If you are using a local copy of the template file from a previous release it is recommended to retrieve the latest copy of the DLT files from the installation hierarchy in order to fully support the software enhancements for this release. You can find the DLT file at the following location:
`<Installation_directory>\share\pcb\text\nclegend`

Working with Backdrilling

Backdrilling

Legend Customization

Following are the updated sections to support the new backdrill functionality.

Figure 1-25 Backdrill Column Definitions

```
; ?ColumnDefinitionsBackdrill
; -----
;
?ColumnDefinitionsBackdrill '(
    ("Figure"      "FIGURE"          7)
    ("BD_Size"     "BD_SIZE"        10)
    ("MNCLayer"    "MNC_LAYER"      16)
    ("MaxDepth"    "MAX_DEPTH"      10)
    ("MfgDepth"    "MFG_STUB"       10)
    ("Quantity"    "QTY"            6)
)
```

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Figure 1-26 Backdrill Notes

```
;;
?DrillNotes
-----
?SlotNotes
-----
?BackdrillNotes
-----
?CavityNotes
-----

Lines of notes that are to appear below the legend table rectangle for
each drill legend that is generated. ?DrillNotes are for 'Layer pair' and
'By layer' legends, while ?BackdrillNotes are for 'Backdrill' legends.
?SlotNotes will be used for the slot hole legend when ?SeparateSlotHoleLegend is 'yes'.
Note text is allowed to be in upper and/or lower text, and there is no explicit
limit on the number of lines of text. The note text is specified as:

  (
    "<line 1 of text>"
    "<line 2 of text>"
    .
    .
    .
    "<line n of text>"
  )

The default for each is ""()"" which indicates there are no notes.

?DrillNotes      '()
?SlotNotes       '()

?BackdrillNotes '(
  "NOTES:"
  "- MMC_LAYER: MUST-NOT-CUT-LAYER"
  "- MAX_DEPTH: DEPTH FROM START LAYER TO THE"
  "             SURFACE OF MUST-NOT-CUT-LAYER"
  "- MFG_STUB : MANUFACTURING STUB LENGTH"
)

?CavityNotes     '(
  "NOTES:"
  "- U: BODY_UP"
  "- D: BODY_DOWN"
  "- P: PROTRUDING_ALLOWED"
)
```

222,1

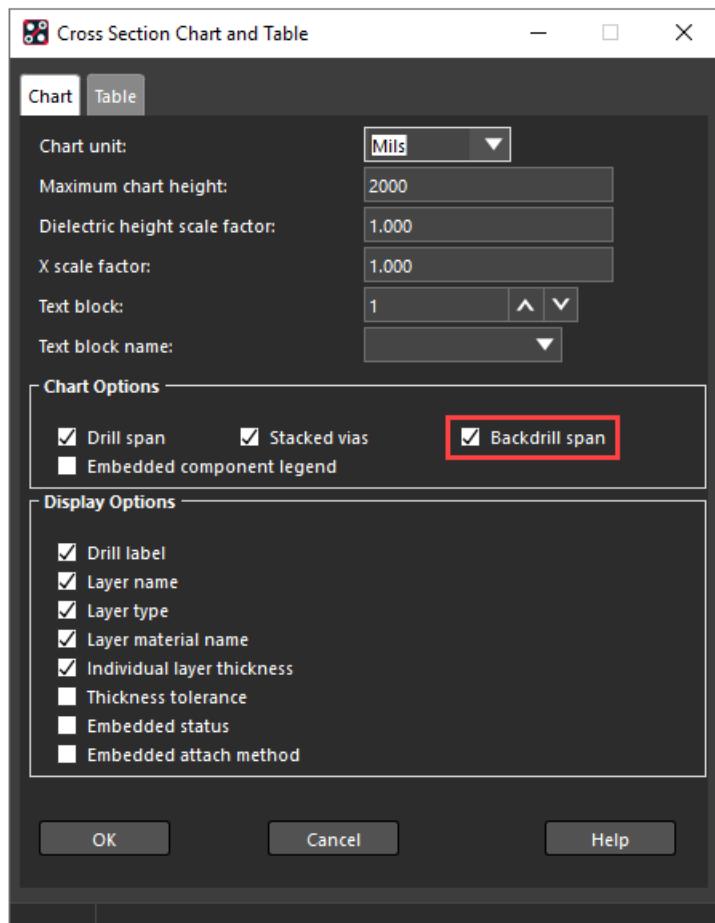
64%

Working with Backdrilling

Backdrilling

Backdrill Cross Section Chart Display

Enabling *Backdrill span* in Cross Section Chart dialog displays each backdrill span in the detail with a tapered end at the surface of the *Must Not Cut Layer*.



Working with Backdrilling

Backdrilling

