Technology Advancements in Board Level Shields for EMI Mitigation

Not Your Daddy’s Metal Can

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APPENDIX

• Fixing the CAUSE of the problem is always better and less expensive than fixing the SYMPTOM

A Board Level Shield (BLS) is the most efficient and least expensive shielding solution and is used closest to the source of the problem.
Cost of Shielding

There is a cost hierarchy to shielding which makes it commercially very important to consider shielding early in the design process. Shields may be fitted around:

(Resolution Pricing – Not True Values)

<table>
<thead>
<tr>
<th>Shield Type</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Individual ICs</td>
<td>$0.25</td>
</tr>
<tr>
<td>Segregated areas of PCB circuitry</td>
<td>$1.00</td>
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<tr>
<td>Whole PCBs</td>
<td>$10.00</td>
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<tr>
<td>Sub-assemblies and modules</td>
<td>$15.00</td>
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<tr>
<td>Complete products</td>
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<tr>
<td>Assemblies (e.g. industrial control and instrumentation cubicles)</td>
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<tr>
<td>Rooms</td>
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<tr>
<td>Buildings</td>
<td>$100,000</td>
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</table>
PC Board Shielding
Original Product Overview
Board Level Shielding

Increasing Cost

Single Piece  EZ Peel™  Un-Assembled  Pre-Assembled

Top peeled for access

After repair

Increasing Access to Components for Repair

Innovative Technology for a Connected World
Materials used for BLS

- Tin Plated Cold Rolled Steel (CRS) – Cheapest option
- Nickel Silver (Cu Ni Zn)
- Stainless Steel
- Tin Plated Phosphorous Bronze

- ALL materials are RoHs compliant
One Piece Shield

- **Holes**
  - Max. hole size is 3 mm [for RF reasons]
  - Min. hole size is 1 mm
  - Holes improve heat dissipation and allow access to test points.
  - Number of holes impacts tooling price.

- **Critical Dimensions**
  - Length, Width
  - Height
  - Co-planarity
2 Piece Shield: Pre-Assembled

• Cover is assembled onto frame at LT, placed in carrier tape and shipped to customer.
• Pick-up area not needed.
• 1.2 mm minimum assembled height is possible.
• Automation tooling requires about a million parts to be cost effective. We have some new assembly methods reducing this to about 250,000.
2 Piece Shield: Shield Frame

- Castellations
  - 3 mm x 0.5 mm
- Cross members are desired for support on lengths > 30 mm.
- Min. width of lip 1.00 mm. [prefer 1.50 mm].
- Lip can be 0.80 mm over distances less than 5 mm.
2 Piece Shield: Shield Assembly

• Frame is placed automatically and cover is hand placed (typically).
• Minimum total height [currently in production] is 1.2 mm.
• Typically allow 0.5 mm between bottom edge of cover and PCB surface.
D-Snap in cross section

- Two options are available depending on access requirements.
2 Piece Shield: Shield Cover

- Snaps into frame with dimple locking into slot.
- Typically we want any draw height to be less than 3 times material thickness.
- Dimples can be on cover [preferred] or frame. Dimple on the cover allows lower minimum height. We have a 1.2 mm total assembled height in production.
2 Piece Shield: Pick-Up Area

- Used for automatic placement on PCB.
- 6 mm diameter is preferred (We can go smaller, but this can impact package speeds and cost).
- Center of part is preferred.
EZ Removable Pick & Place Bridge

ReCover attachment mechanism applied to the pick and place bridge of a BLS frame to allow for easy, toolless, removal of the bridge after the frame is soldered to the PCB. Ease of removal along with reliable and consistent removal force will allow for automated removal.
BLS Frame with Cover

Releasably attached pick and place bridge
Low Z Height Option

- Offset / Raised Bridge allows for clearance over PCB components during PCB placement and reflow.
- Allows for overall reduction in final Z height since the frame height, after bridge removal, no longer needs to account for the component heights prior to reflow. (Difference between PCB component placement height before and after solder reflow.)
- Additional Parameters (in addition to basic Re-Movable bridge design)
  - Minimum height: 1.0 mm.
  - Offset Distance: 0.6 mm
  - Flange width: 1.0 mm
  - Bridge Requires removal after reflow. (Non-raised bridge does not.)
Low Z Height Application

Typical BLS with Pickup Bridge
- PCB Assembly Before Reflow
- Typical BLS Shield
  - PCB Component (BGA)
  - Solder Balls
  - Solder Paste
- PCB

After Reflow
- PCB Component (BGA)
- Solder Balls
- Solder Paste

Low Z Height, Removable Raised Pickup Bridge
- PCB Assembly Before Reflow
- Raised Bridge Height
  - PCB Component (BGA)
  - Solder Balls
  - Solder Paste
- PCB

After Reflow
- Frame Height After Bridge Removal
  - PCB Component (BGA)
- Solder Balls
- Solder Paste
- PCB

Advantages:
- Lower installed height of PCB / BLS assembly. (Solder Paste / Solder Ball settling height.)
- Greater clearance of BLS pickup bridge to PCB components
- Easy, tool less or automated removal of pickup bridge.
Multi-Compartment BLS

- Internal walls provide multiple shielded compartments
- Best solution for circuits boards with multiple circuit groups that needs shielding.
EZ Peel Removable Lid PC Board Shielding

- Easy removal of scored lid area
- Simple replacement technique for lid
- No impact on shielding effectiveness
- Used on surface mount or through hole applications
- Lid removal requires no special tools
- Only 1.5 lbs. force for lid removal
- Meets EIA and JEDEC specifications
- Can be packaged in tape and reel for SMT and pick and place applications
- Shield retains all physical properties after PCMCIA/JEIDA testing for shock, bending, torque, drop, and vibration
- Custom sized configurations are available
Example of EZ Peel®
EZ Peel Removable Lid
PC Board Shielding

Original EZ Peel Can

Snap-in Lid Application
After removal of scored section and application of snap-in lid

Dish Lid Application
After removal of scored section and application of dish lid
Ruble Corner Detail

- An LT innovation!
- Reduced corner seam reduces nesting during packaging.
- Two or more tabs used depending on height and minimum gap.
- Used on corners over 2.50 mm.
- Available on frames and single piece shields.
Developed as a next generation BLS product.

• The product addresses a way to increase S.E. at the board level due to fewer and smaller apertures such as the corners.
Design Comments – Rigid Corner

Traditional Formed Corner

Traditional Drawn Shield with Flange Lip

Rigid Corner Technology

PATENT PENDING
RIGID CORNER BOARD-LEVEL SHIELD

The rigid corner board-level shield incorporates a corner design that optimizes component rigidity for increased part and printed circuit board (PCB) firmness. As PCB designers are increasingly using thinner substrates, a rigid frame reinforces this assembly, thereby improving overall ruggedness and performance. The shield has improved solder joint reliability and resistance to solder joint fracture, especially in drop testing performance with thin PCBs.

The rigid corner shield is stronger and more robust than traditional drawn shields, which results in cohesiveness improvement of the solder connections. The shield can tolerate more deflection (i.e., more handling) without plastic deformation. Elimination of drawn flange reduces the space needed on the PCB for shielding trace width by potentially ~0.3 mm, allowing for the shield to be more closely placed on the PCB. Elimination of draft allows for more undershield space and improved component clearance.

The partially drawn corner is located near the top portion of the shield, resulting in improved torsional rigidity with no drawn lip and no draft. For parts over 2 mm, the corner is both drawn and formed with an interlocking multi-radius corner, which provides superior EMI shielding effectiveness. The interlocking corner can be meshed and closed in during the forming and drawing process for additional improved rigidity for parts taller than 2 mm. For parts under 2 mm, this entire corner is drawn without an interlocking corner.

FEATURES
• Corner openings are reduced.
• Improving shielding performance.
• Partly drawn corner located near the top portion of the corner combined with 80° straight forming of wall sections for improved torsional rigidity.
• U.S. Patent No. 7,486,902

BENEFITS
• Shield can tolerate more deflection (handling) without plastic deformation.
• Shield provides increased stiffness to the PCB.
• Tooling costs are not impacted.
• Elimination of draft allows for more undershield space and component clearance.

MARKETS
• Computing.
• Telecommunications.
• Data Transfer and Information Technology.
• Automotive.
• Consumer Electronics.
• Aerospace / Defense.
• Medical.
• Portability.
• Industrial & Instrumentation.
• Public Utilities.

Rigid Corner
Board-Level Shield

SEdB = 100 - 20 log(w/IMH) + 20 log[(14ln(w/H)) + 30 (in)]
where w is length of side and w/ H and ln = Λ/2 is wavelength in meter; IMH is frequency in MHz.

The longest dimension of the aperture limits or dominates the BLS shielding effectiveness.
Shielding Effectiveness Test
Shielding Effectiveness

Shielding Effectiveness Per IEEE-299 (Modified)

- SNG-PCS_NO_HOLES+CAST
- SNG-PCS_NO_HOLES+CAST (plotted data against 24 inch hole)

Frequency (Hz)

Shielding Effectiveness (dB)
Shielding Effectiveness

![Shielding Effectiveness Per IEEE-299(Modified)](image_url)

- **Shielding Effectiveness (dB)**
- **Frequency (Hz)**

- **SNG-PCS_NO_HOLES+NO_CAST**
- **SNG-PCS_NO_HOLES+NO_CAST (plotted data against 24inch hole)**
New Generation of Board Level Shields
ReCovr – Corner and retention detail

- Side walls are tied together in the corners via Rigid Corner feature.
- In the side wall, the combination of blanking and shearing patterns, result in a snap retention feature which allows for removal and subsequent re-assembly of the top cover.
- When removed, the vertical sides remain allowing for maximum access to board components for rework requirements.
Details on side profile cuts to create snap in feature.

- Snap in feature profile may be altered but will maintain snap in or locking feature.

- Pattern between snap features can be varied and is necessary to prevent long length slots counterproductive to EMI suppression.
New BLS Product Discussion:
Single Piece Removable Replaceable [Re-Cover] Board Level Shielding

- Shield as manufactured and installed
- Shield walls remaining attached w/ Shield removed
- Shield aligned for snap-in

PATENT PENDING
Additional Notes

- **Key Feature is the snap in feature on side walls**
  - Created in a stamping tool process
  - Created in a manner that will allow for part to stay intact throughout manufacturing, packaging, shipping, customer installation and solder reflow.
  - Minimum height limited to ~1.5 mm.
  - Internal walls are NOT an option.

- **Other part features may include:**
  - Partially drawn corner (Rigid Corner BLS)
  - Other Typical BLS Features
    - Ventilation Holes, Side Cutouts, Embossing, Marking, Multi-levels

- **Methods involve typical sheet metal stamping and forming operations.**
Cool Shield II
Cool Shield II

EXPLODED VIEW SCALE 3:1

COOLING DEVICE

SHIELDING FENCE

THERMAL PAD

HEAT SENSITIVE COMPONENT

Laird TECHNOLOGIES™

Innovative Technology for a Connected World
One piece shield

- One piece design for simplicity
- Pins for locating shield on board
- Holes for ventilation
Standard design

- Standard 2 piece design
- Standard interlocking corners
- Standard locking and contact dimples
- Array of holes for ventilation
Larger standard

- Standard design with contact and locking dimples
- Large frames require extra cross braces for additional rigidity
Cover with D-Snaps
D-Snap – 2 Options

• The use of D-snaps provides options with a direction locking system.
Shield for Home Automation

- Custom design shield with locating pins
- Frame and cover with standard contact and locking dimples
Low profile shield

- Low height design frame of 1.65mm
- Half drawn corners for extra rigidity
- Standard contact and locking dimples
Multi compartment shield

- 97-2000 Design style
- Multiple internal wall for EMI isolation
- One piece spring finger type cover
Half drawn interlocking corners

- Patented half drawn interlocking corners
- Standard locking dimples for cover retention
- Array of holes on cover for ventilation

Corner Detail
Tape and Reel

For accurate placement and volume production
Shielding Can Features

- Square or rectangular.
- Tin plated steel, optional nickel silver.
- Optional cooling holes
- Optional crenellated edges.
DVB (set top box)

- BLS used to shield Antenna input
- Both Cable and Satellite Set-top boxes
- Also used in wireless connections
Wireless Network Systems

- Used to Shield TX / RX
- Usually large in size
- Using 900 MHz to 5 GHz
Cellular Handsets

• Shielding of various functions
RF “Modules”

- RF Industry standards
- Protects the processors
- Others include IEEE 802
- IEEE 801.11
Wireless Networking

- Signal processing of Rx and Tx protected
- Shields usually surface mount, thin gauge
- 801.11 a, b, g
- WiMax
Wireless Networking

- Shielding of the processor due to small area
- Tx / Rx shielding
- Exterior case can also be used
Industrial Wireless

- Protection for the wireless protocol chipsets
- Rx / Tx
Medical Products

- Protects sensitive measurement chip sets
- Wireless connectivity

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Automotive GPS Systems

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- Protection of FM signals
Automotive – Satellite Radio

- Isolation of the FM link
- Channel / Source decoding
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- Fingerstock & Board Level Shields
- 3D files of most of Laird standard parts are available
- Download 2D drawings
- Configure your own cut-to-length fingerstock part
New catalog available

http://www.lairdtech.com/WorkArea/linkit.aspx?LinkIdentifier=id&ItemID=3282

BOARD LEVEL SHIELDS
PRODUCT SELECTION GUIDE
THANK YOU