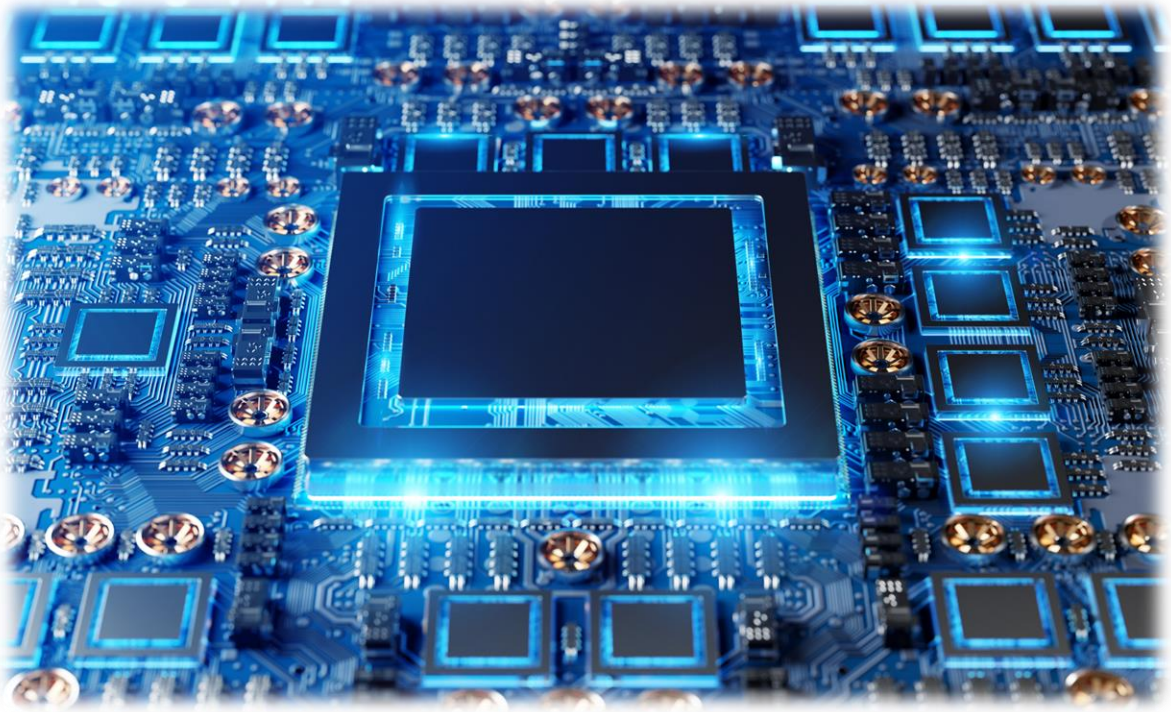
AIT Package Level EMI/RFI Conformal Shielding Solutions

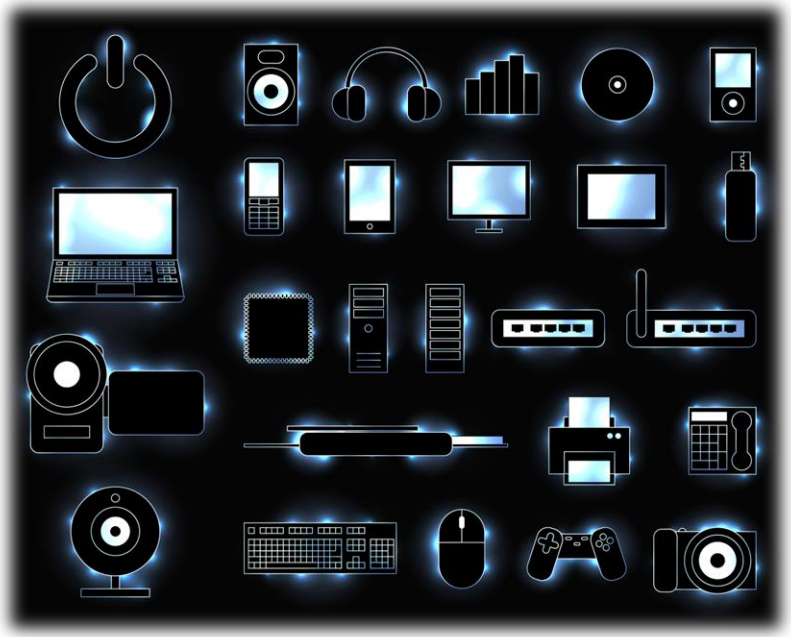
- **EMC8660 applied to component packages before soldering for proven performance of over 90 dB EMI/RFI shielding effectiveness from MHz to GHz**
  - **Heat releasing pad (HRP-500M) for protecting contacts of BGA packages during coating processes**
- **EMC8130 applied to onboard level component packages for proven performance of over 90 dB EMI/RFI shielding effectiveness from MHz to GHz**
  - **Onboard component package edge insulation protection moisture barrier seal (OBS7130)**
- **Jetting dispense spray component package level EMI/RFI shielding coating**
  - **Partnered jet-dispense spray equipment and tooling system and solution**

Wireless communication at higher frequencies from 3G to 5G demands the component packages to be in much closer proximity of and more interference between each other



High frequency mobile devices from 3G to 4G with components much closers and generating signals and electromagnetic radiation that affects each others processing or interference. With the advances of G5 and the coming 6G cellular and wireless Internet communication that operates at 6GHz and higher, the need of effective RF electromagnetic interference (RFI/EMI) shielding between the devices onboard of the cellular, computer and communication devices that have high shielding effectiveness, cost effective and spacing saving becomes more demanding.

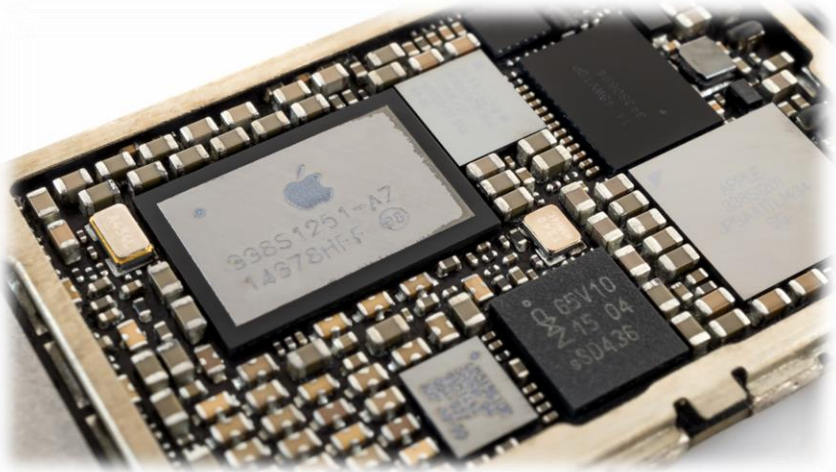
The demand for higher frequency operations also dictates much closer spacing between component packages and thus traditional solder metal cans shielding is not applicable or effective. The package level shielding becomes a necessity. Highly conductive coating on the components from the top to all sides other than the soldering contact interface have been proven to be the most reliable and cost-effective solution.



With over 35 years in providing EMI/RFI shielding coating and sealant to military electronics, AIT has one of the most extensive experience in providing these component package level shielding applications. Besides providing the necessary micron level coating (4-8 micron thickness) with more than 90 dB shielding effective and if necessary with thicker coating to 110dB shielding can be achieved with AIT package level conformal conductive coatings.

These coating while mostly used to coat the component packages before they are attached to the circuit board, AIT also provides shielding solution that can be directly applied on the solder component packages for shielding enhancement or as manufacturing process.

Traditional metal lid shield covering the component packages cannot be used in late 4G to 5G smartphones that demand the component packages to be in much closer proximity of and more interference between each other

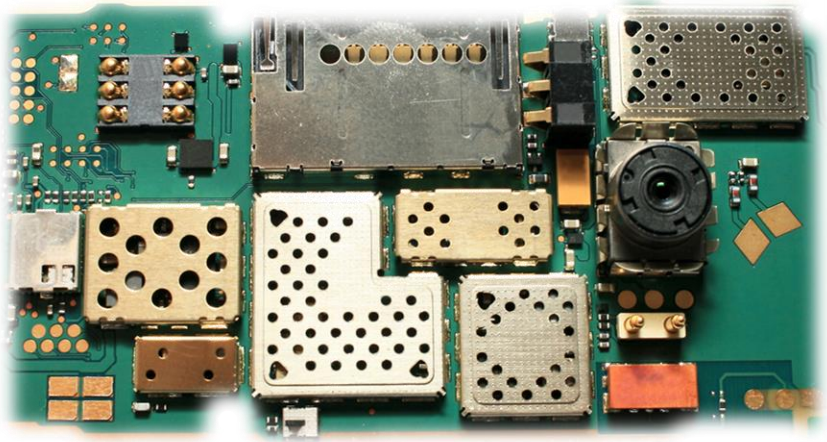


Component package conformal conductive shielding becomes a necessity for late 4G devices

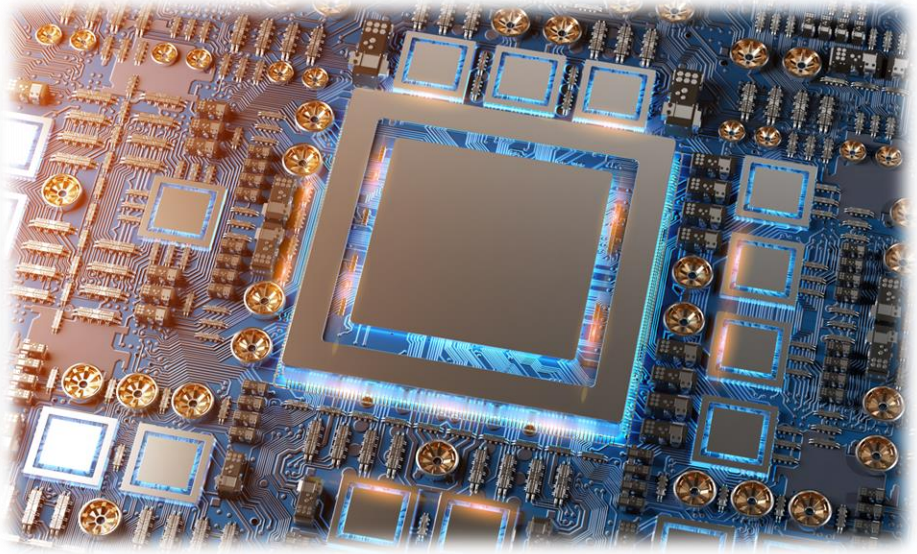
From 3G to 5G and the coming 6G cellular and wireless Internet communication that operates at 6GHz and higher, the need of effective RF electromagnetic interference (RFI/EMI) shielding between the devices onboard of the cellular, computer and communication devices that have high shielding effectiveness, cost effective and spacing saving becomes more demanding.

The move to higher frequency operations also dictates much closer spacing between component packages and thus traditional solder metal lid cans shielding is not applicable or effective.

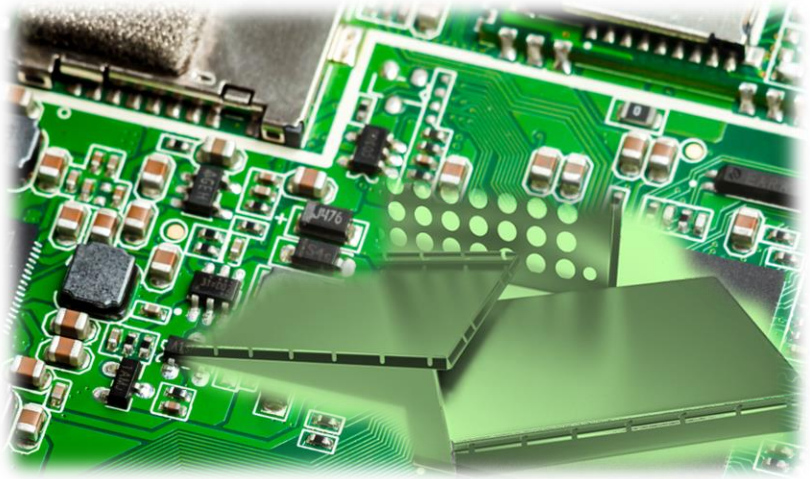
The package level shielding becomes a necessity. Highly conductive coating on the components from the top to all sides other than the soldering contact interface have been proven to be the most reliable and cost-effective solution.



Individual component package with metal lid shielding is cost effective and technically viable for 3G and early 4G devices



EMI/RFI Shielding Effectiveness on Component Package Level with Soldered Lids are Not as Effective for Ultra-High Frequency Devices

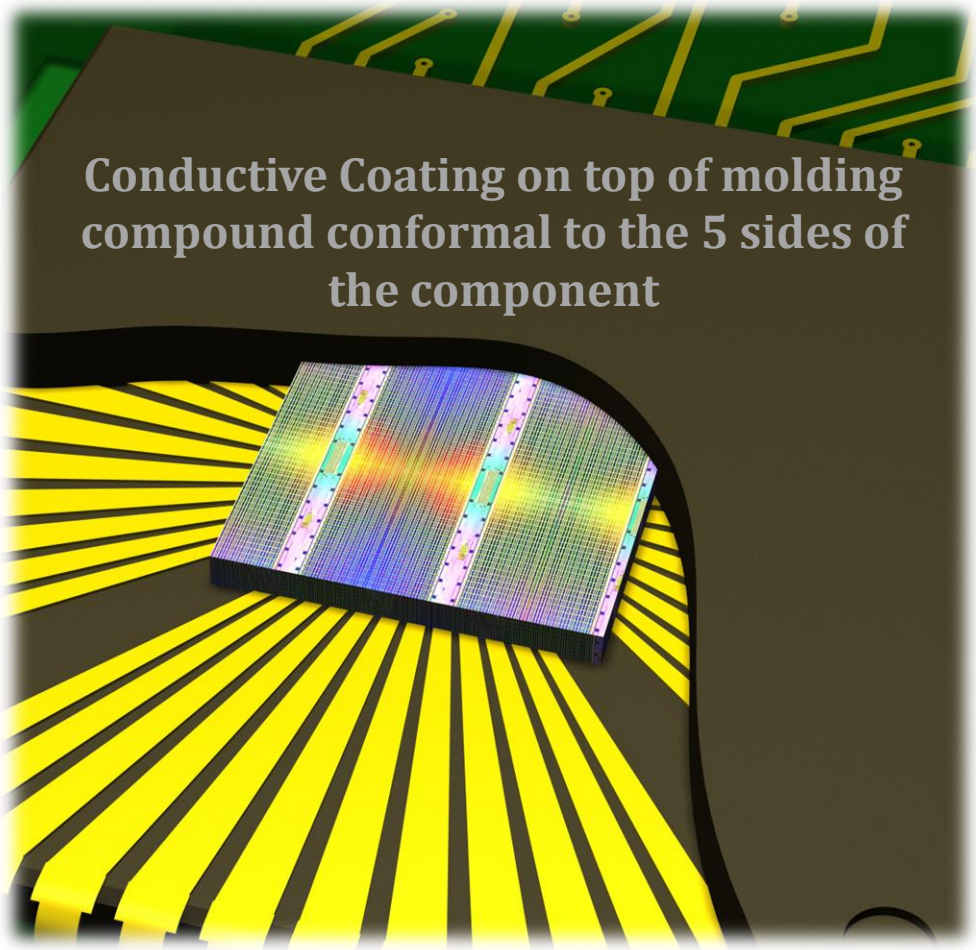


Comparative Technologies and Costs		
	Vacuum Metal Sputtering	Jet Spray Dispensing
Package Dimension	10mmx10mmx1.0mm	10mmx10mmx1.0mm
Relative Productivity	<10,000 units per hour	> 30,000 units per hour
Floor Space Requirement	15-30 sq meter	3-5 sq meter
Average Capital Investment	US$3-8 million	US$0.2-0.5 million
Estimated Cost Per Package	>>US$0.01	~US$0.01

With the advances of 5G that operates at 6GHz and higher, the need of effective RF electromagnetic interference (RFI/EMI) shielding between the devices onboard of the cellular, computer and communication devices becomes much more demanding.

- The demand for higher frequency operations also dictates much closer spacing between component packages and thus traditional soldered metal cans shielding is not applicable or effective. High vacuum sputtering deposition is much more expensive than jet spray dispensing.
  http://www.ultraspray.com/usi_advanced_adoption_of_emi_shielding/
- The package level shielding becomes a necessity. Highly conductive coating on the components from the top to all sides other than the soldering contact interface have been proven to be the most reliable and cost-effective solution.
- Conductive coating while mostly used to coat the component packages before they are attached to the circuit board, AIT also provides shielding solution that can be directly applied on the solder component packages for shielding enhancement or as manufacturing process.

EMI/RFI Shielding Effectiveness on Component Package Level with Direct Conductive Coating



Component package conductive coating must attached to the molding compound:

- To form thin conductive coating conformal to the molded component package
  - 4-8 micron coating for up to 90dB shielding effectiveness
  - 15-25 micron coating for up to 110dB and up for shielding effectiveness
- Covering all 5 sides without affecting contact interconnection interface surface
- Jet-spray coating on component package level, or judicial and selectively on radiating component package on board level

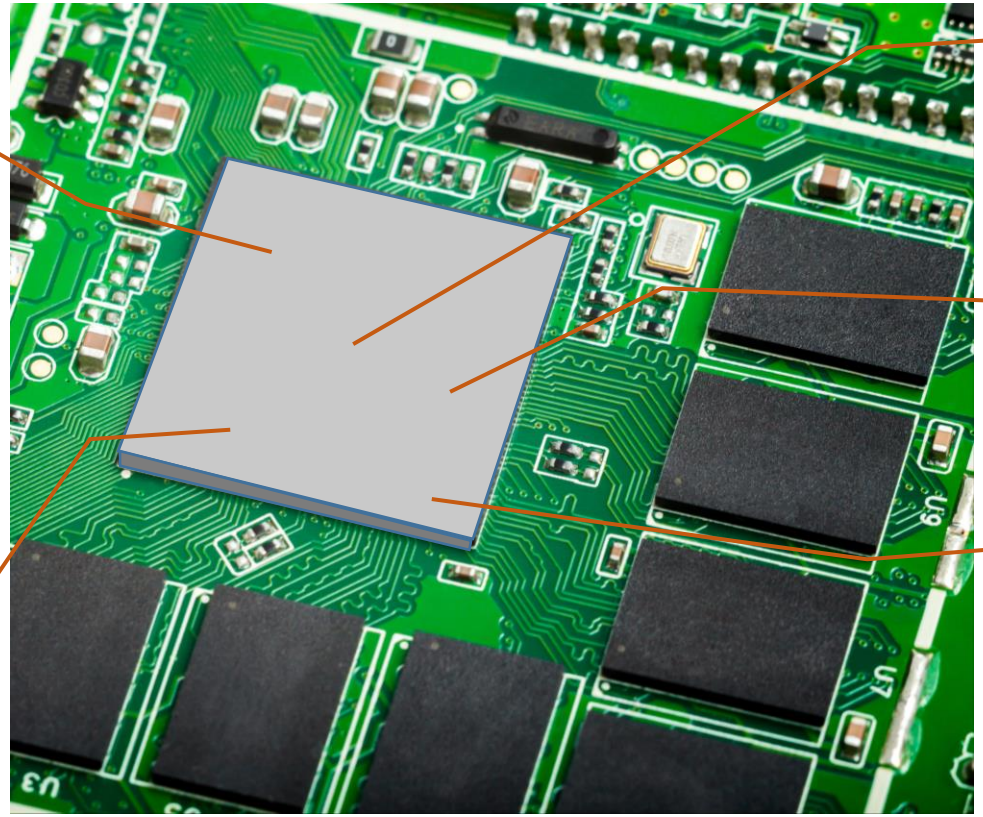
EMC8660 and EMC8130 Package Level Conductive Spray Coating with Unparalleled Performance

Rapid Low Temperature Curing for Low Stress and No Warpage:

- 150°C for 10-30 minutes, or
- 125°C for 45-60 minutes, or
- 100°C for 2+ hours
- Lower temperature curing for lower stress on packages and ultra low shrinkage

Molecular Structure Designed to Absorb Thermal Stresses:

- Outstanding thermal cycling compatibility from -65C to 150°C
- No Crack
- No Voids



Uniform Conductive Coating with Programmable Jet Spray:

- Outstanding Conductivity: < $2x10^{-5}$ Ω-cm Resistivity
- 4-10µ for >90 dB shielding effectiveness
- 15-25µ for >110 dB shielding effectiveness

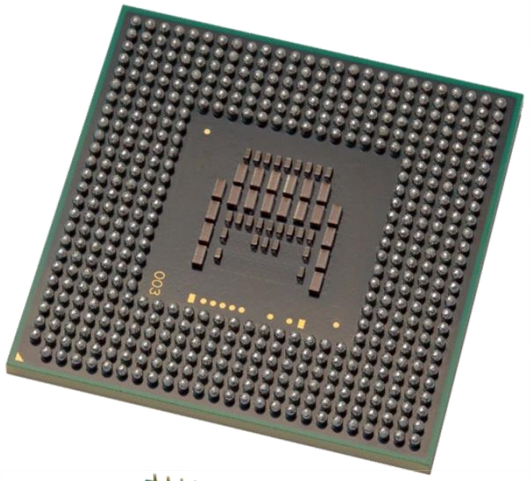
Fast Air Drying into Dry Film on Component Packages for Ease of Handling:

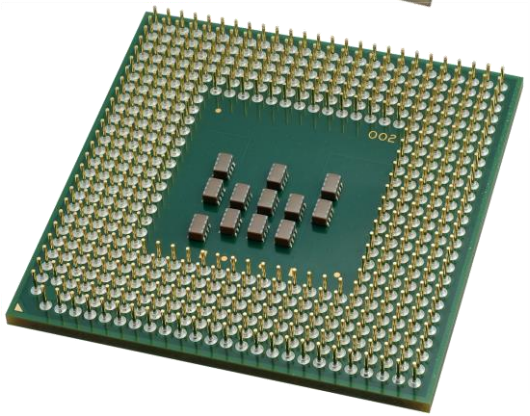
- Ambient drying as soon as spraying is finished
- Solid and dry film before curing

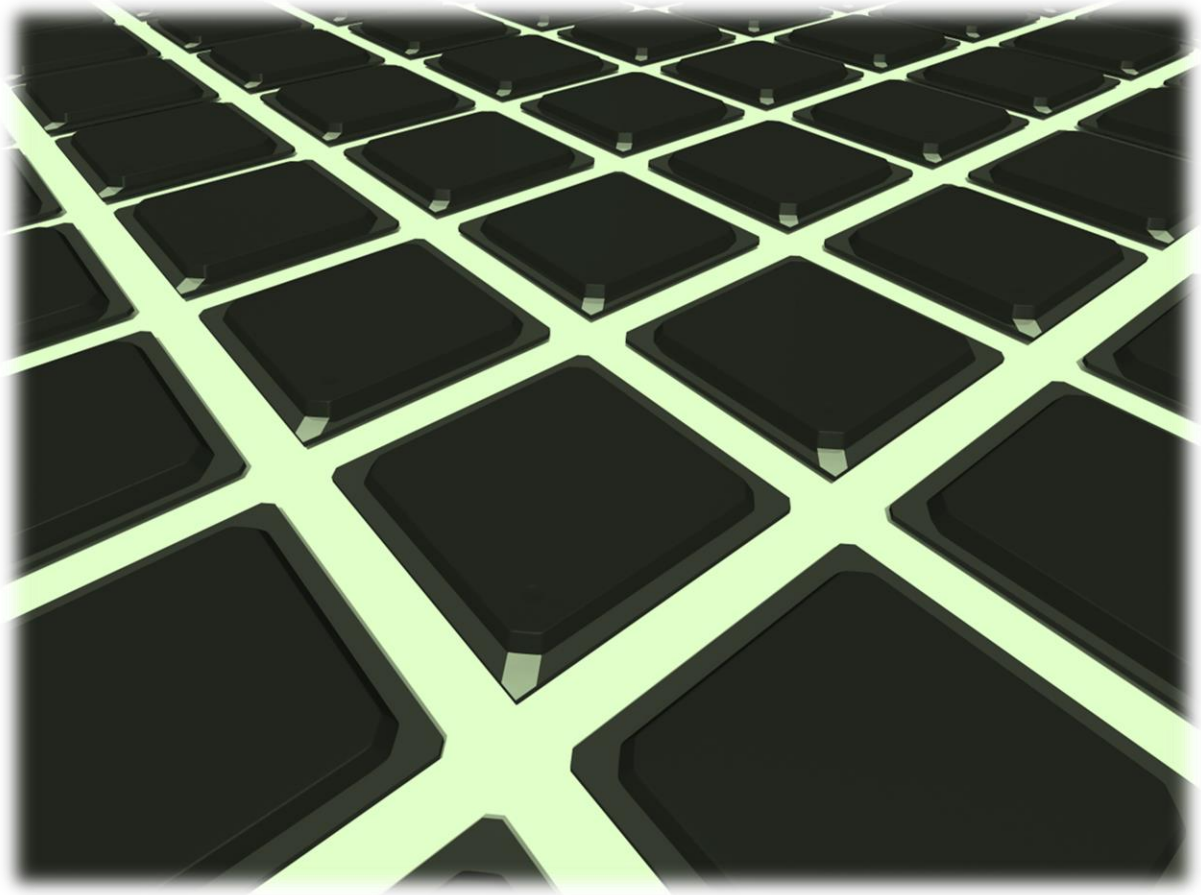
No Bleed Coating with Controlled Thixotropy for Defined Edge Flow:

- Outstanding adhesion onto molding compound surfaces
- Controlled flow for onboard direct application
- No bleeding onto neighboring board areas and underneath the component

Component Package Level Conductive Spray Coating Requires a Sealing Pad for Protection and Handling



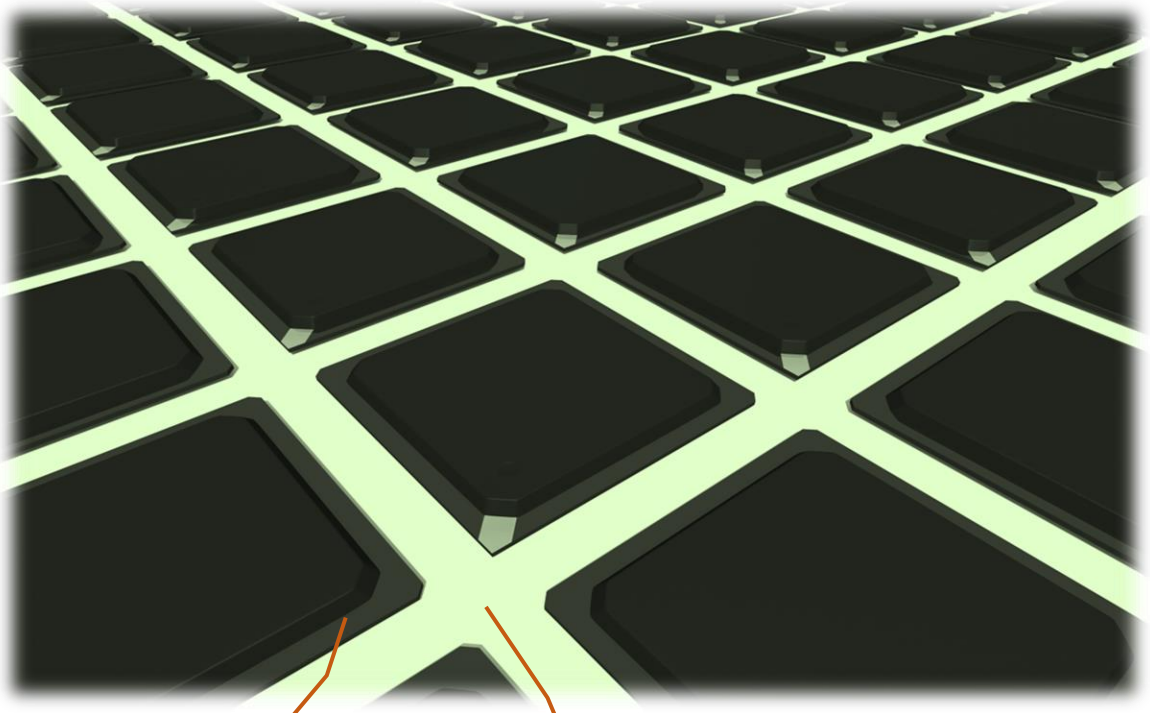




Jet-Spray conductive coating onto molding compound:

- Covering all 5 sides without affecting contact interconnection interface surface
- Solder balls and contact pins on interconnection interface side must be sealed off from jet-spray coating:
  - Needs a conformable sealing pad allowing the package solder balls and pins submerged. To withstand coating curing at temperature up to 175°C.
  - The component package must be easily picked for board attachment
  - Heat releasing pad (HRP-500M) for protecting contacts of BGA packages during coating processes

Component Package Level Conductive Spray Coating Requires a Sealing Pad for Protection and Handling



"Height" of Component Package should determines the Street" of Carrier Pad (Ability to Absorb the Solder Balls of BGA Packages)

"Street" of Carrier Pad (Ability to Absorb the Solder Balls of BGA Packages) Should be Spaced to Allow Adequate Coating of the Edges of the Component Package

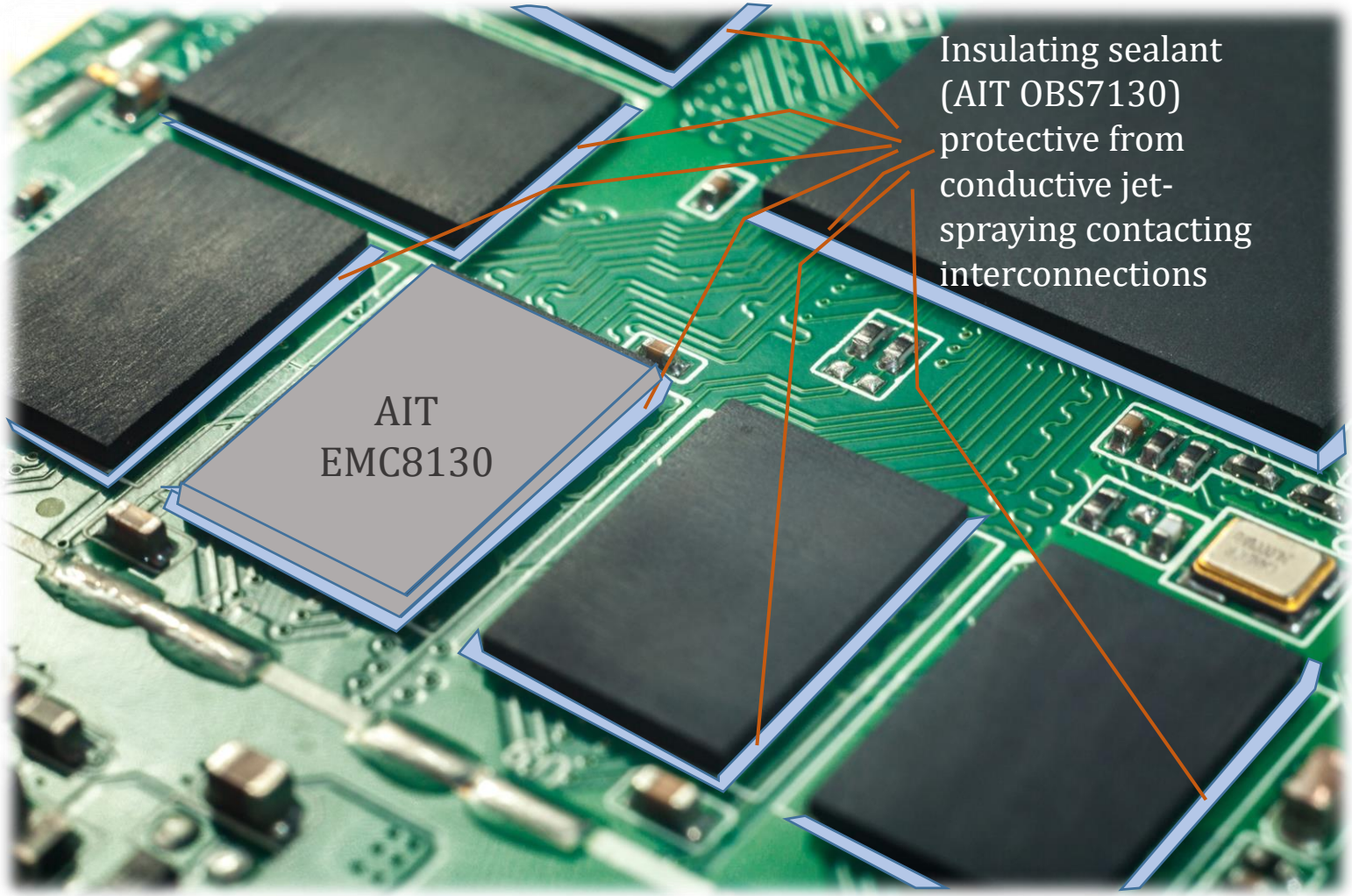
Conductive Coating Parameters and Properties	
Product Identification	AIT EMC8660
Material Technology	Electrically Hyper-conductive Coating
Application and Dispensing Method	Jet Spraying, Ultrasonic Spraying
Conductive Fillers	Proprietary sub-micron silver particulates
Volume (Bulk) Resistivity	$<2x10^{-5}$ Ω-cm
Recommended Coating Thickness for 90dB SE	4-10 micron
Recommended Coating Thickness for >110dB SE	15-25 micron
Viscosity at 5 rpm	300-500 cps
Thixotropic Index	~1.5
Curing Temperature and Condition	100°C(120 min.) to 150°C (<30 min.) circulating ai
Adhesion on Molding Compound and FR4	>5B (ASTM Cross Hatch Method)
Recommended "Street Width" to Package Height in Carrier Supporting Pad	1:1

Jet-Spray conductive coating onto molding compound:

- Covering all 5 sides without affecting contact interconnection interface surface
- Solder balls and contact pins on interconnection interface side must be sealed off from jet-spray coating:
  - Needs a conformable sealing pad allowing the package solder balls and pins submerged. To withstand coating curing at temperature up to 175°C.
  - The component package must be easily picked for board attachment
  - Heat releasing pad (GD-TR-100M for stud bumped chips, GD-TR-450M for solder-balled packages) for protecting contacts of packages during coating processes

http://www.dispensing.com.tw/?action=third&id=107

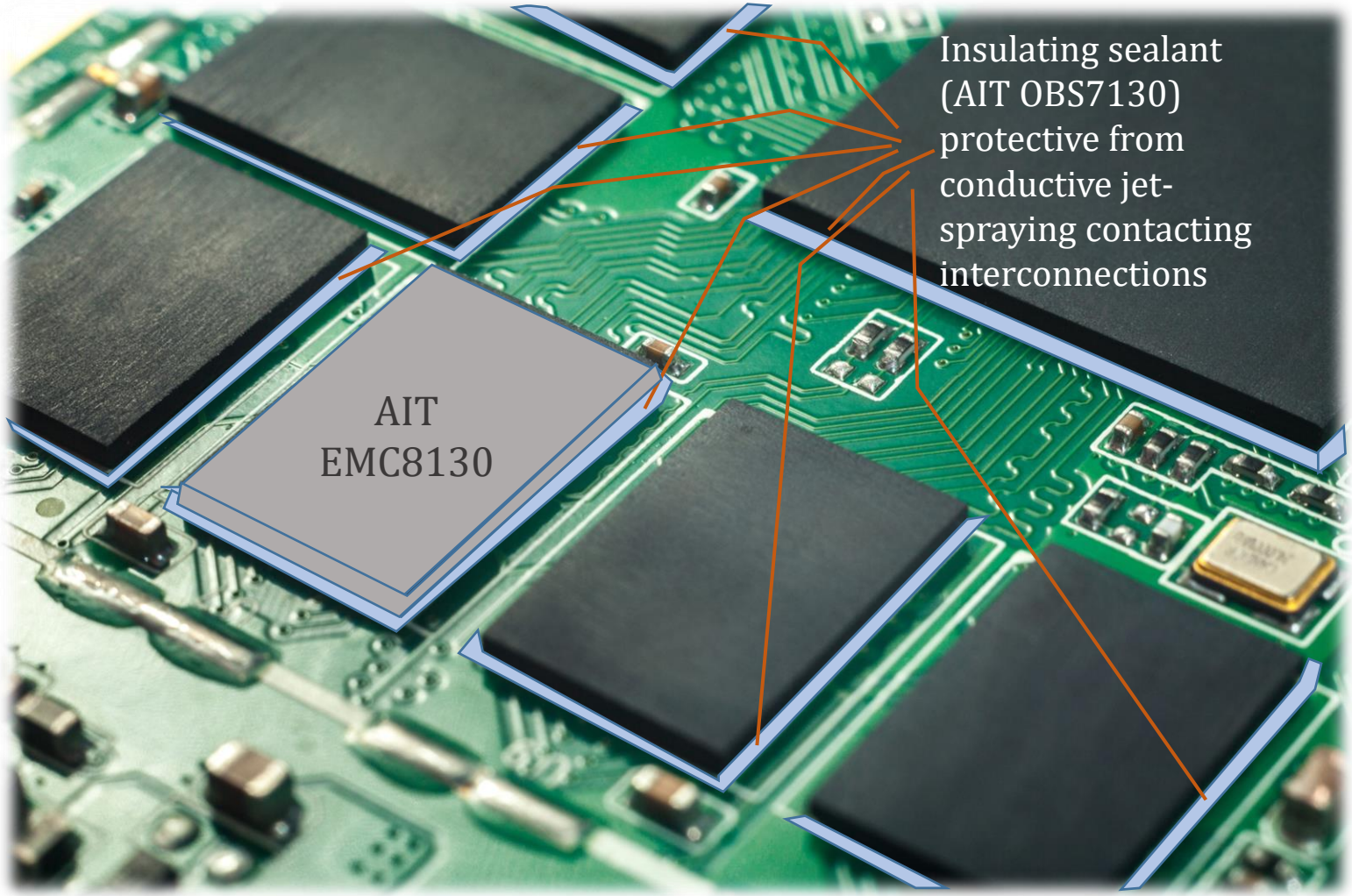
Board Level Component Conductive Spray Coating Requires a Sealant for Component Edges' Protection



Jet-Spray conductive coating onto onboard compound:

- Covering all 5 sides without affecting contact interconnection interface surface and nearby board areas
- Solder balls and contact pins on interconnection interface side must be sealed off from jet-spray coating:
  - Needs a dispensable sealant sealing all 4 sides component package edges from coating sipping into contacting with solder balls and pins.
  - Sealant capable to withstand all board level functional testing without negatively affecting its performance.
  - Sealant preferably enhances the protection against moisture, acid rain laden moisture, salt-fog moisture and other negative impact environment.
- **EMC8130 applied to onboard level component packages for proven performance of over 90 dB EMI/RFI shielding effectiveness from MHz to GHz**
  - Onboard component package edge insulation protection moisture barrier seal (OBS7130)

Board Level Component Conductive Spray Coating Requires a Sealant for Component Edges' Protection



Conductive Coating and Insulating Sealant Parameters and Properties		
Product Identification	AIT EMC8130	AIT OBS7130
Material Technology	Electrically Hyper-conductive Coating	Electrically Insulating Sealant
Application and Dispensing Method	Jet Spraying, Ultrasonic Spraying	Needle-Tip Dispensing
Conductive Fillers	Proprietary sub-micron silver	Insulating Moisture Barrier Sealant
Volume (Bulk)	$<2x10^{-5}$ Ω-cm	$>1x10^{14}$ Ω-cm
Recommended Coating Thickness for 90dB SE	4-10 micron	Apply to seal the edges of package to board interfaces
Recommended Coating Thickness for >110dB SE	15-25 micron	Apply to seal the edges of package to board interfaces
Viscosity at 5 rpm	300-500 cps	50,000 cps
Thixotropic Index	~1.5	~3.5
Curing Temperature and Condition	Ambient air drying	Ambient air drying
Adhesion on Molding Compound and FR4	>2B (ASTM Cross Hatch Method)	Seal and bond to molding compound and board surfaces

Summary of AIT Package-Level EMI/RFI Shielding Coatings and Solutions for 5G and Ultra High Frequency Devices:

- ❑ **EMC8660 applied to component packages before soldering for proven performance of over 90 dB EMI/RFI shielding effectiveness from MHz to GHz**
  - **Heat releasing pad (GD-TR-200M, GD-TR-450M) for protecting solder balls contacts of BGA packages during coating processes**
- ❑ **EMC8130 applied to onboard level component packages for proven performance of over 90 dB EMI/RFI shielding effectiveness from MHz to GHz**
  - **Onboard component package edge insulation protection moisture barrier on-board seal (OBS7130)**
- ❑ **AIT has more than 35 years of expertise in providing EMI/RFI shielding coating and sealant solutions**
- ❑ **Jetting dispense spray component package level EMI/RFI shielding coating**
  - **Partnered with jet-dispense spray equipment and tooling system and solution providers**