Record of Letter Ballot Review by TC Chapter for Procedural Review

Region/Locale: North America
Global Technical Committee: Flexible Hybrid Electronics
TC Chapter Cochairs: Randy Parker / DISCO, Ahmed Busnaina / Northeastern University
Standards Staff: Laura Nguyen

	Scheduled in Background Statement	Actual
Date	02/24/2026	02/24/2026
Location	The Wigwam Resort, Litchfield Park, Arizona/USA	The Wigwam Resort, Litchfield Park, Arizona/USA
Reason for Change of Date and/or Location (if changed)		

Note: Refer to *Regulations* ¶ 9.5 Exceptions for allowable reason to change.

I. Document Number and Title

Document Number	Document Title
7193B	New Standard: Guide for Substrate Design of Flexible Hybrid Electronics Based on Additive Printing Methods

II. Tally

Voting Tally: As-cast tally after close of voting period

Note: A minimum of 60% of the Voting Interests that have TC Members within the global technical committee that issued the Letter Ballot must return Votes. (*Regulations* ¶ 9.6.2.1.1)

Note: Refer to *Regulations* § 3.2.1 for definition of Voting Interest.

Voting Interest:	Returned Votes		Distribution		Return Rate	
Letter Ballot	25	÷	40	=	62.50%	≥60%
Intercommittee Ballot	47					
Voting Interest Reject(s)	10		Total Voters with Rejects			11
Voting Interest Accept(s)	34					

III. Rejects

Voting Interest Reject 1 (Voting Interest Name: Self)
Voter Reject 1 (Voter: Ryoichi Watanabe / Self)

Negative 1

Negative	Referenced Section/ Paragraph	Section 8			
	Negative Text	Chapter 8 describes best practices for FHE, which is still an emerging and rapidly evolving field. Chapter 8 shall be moved to an Appendix			
	Withdrawal (check one)	X	No Negative withdrawal made by Voter.	GO TO "Related" subsection	
Related	Motion and Reason (check one)	X	'Related' is mutually agreed upon. (Needs no motion.)	GO TO "Persuasive" subsection	
Persuasive	Motion and Reason (check one)	X	Negative is related and not persuasive. (Needs ≥2/3 votes to pass.)		
			Reason	FHE technology may change over time as it matures, in which case, the document can be revised at that time. This negative was also addressed in a previous comment by Tadahiro Furukawa Negative #8 where Section 8 title was updated from "FHE Design Best Practices" to "FHE Design Guidelines".	
	Motion by/ 2nd by	By: Randall Parker (DISCO) Second: Stephen Gonya (Binghamton University (SUNY))			
	Discussion	None			
	Result of Vote (check one)	6 Y 0 N; Motion passed			
		X	90% ≤ [Negative is related and not persuasive.]	GO TO "Not Significant Finding Option" subsection	
Not Significant	This option can be used only "if the TC Chapter finds a Negative not persuasive by a vote equal to or greater than 90% of the persons voting on the action". (*Regulations* ¶ 9.6.1.4.5.2)				
	Use of "Not significant finding option" (check one)	X	It is mutually agreed upon to term the Negative "not significant".	GO TO "Final" subsection → (D)	
Final		X	(D)	Not significant (counted under j in disposition)	

Negative 2

Negative	Referenced Section/ Paragraph	Figures 5, 9		
	Negative Text	Negative 2 The labels in Figures 5 and 9 shall be revised to indicate a ranked order of options rather than judgments implying requirements for a guide standard.		
	Withdrawal (check one)	X	No Negative withdrawal made by Voter.	GO TO "Related" subsection

Related	Motion and Reason (check one)	X	'Related' is mutually agreed upon. (Needs no motion.)					GO TO "Persuasive" subsection
Persuasive	Motion and Reason (check one)	X	Negative is related and persuasive. (Needs >1/3 votes to pass.)					
	Motion by/ 2nd by	By: Stephen Gonya (Binghamton University (SUNY)) Second: Deepak Trivedi (GE Research)						
	Discussion	None						
	Result of Vote (check one)	3 Y 0 N; Motion passed.						
		X	[Negative is related and persuasive.] > 1/3	Is a technical change recommended? (check one)	X	Y		GO TO "Address by Technical Change Option" subsection

Address by Technical Change Option

Technical Change Recommendations

Original section/paragraph number and at least one full sentence are required in "FROM" and "TO" fields.

Technical Changes

1

FROM: Section/Paragraph Fig 5

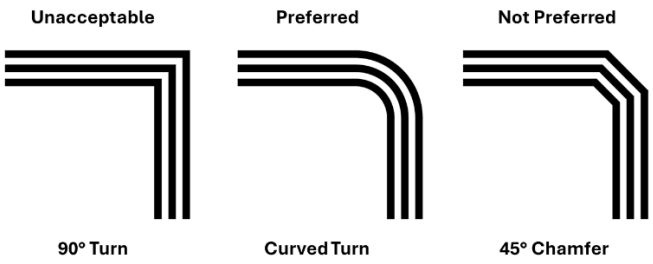


Figure 5
Trace Routing Options for Turns

TO: Section/Paragraph Fig 5

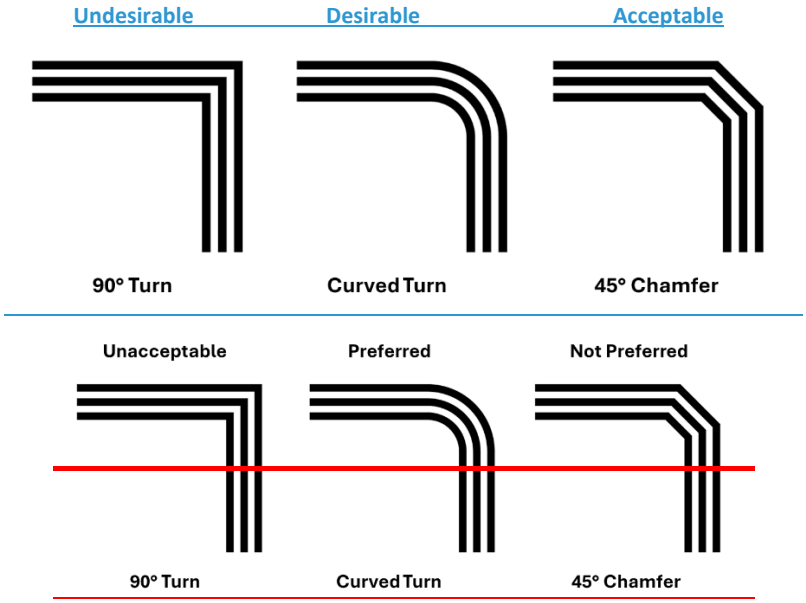


Figure 5
Trace Routing Options for Turns

Justification (If necessary)
The use of rating expressions 'preferred' and 'unacceptable' were not considered appropriate by reviewer for a design guideline. Figure ranking text was changed to more appropriate terms for a Guide.

FROM: Section/Paragraph Fig 6

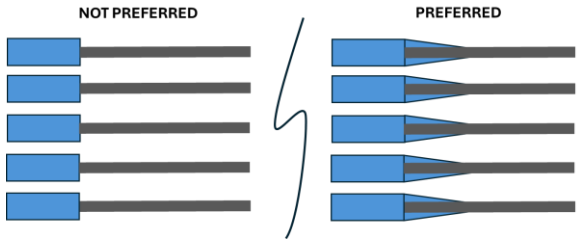


Figure 6
Use of Teardrop Fillets for Trace Connection to Pads

2

TO: Section/Paragraph Fig 6

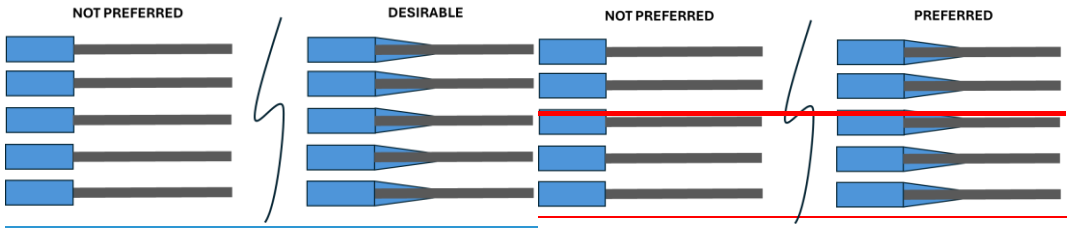
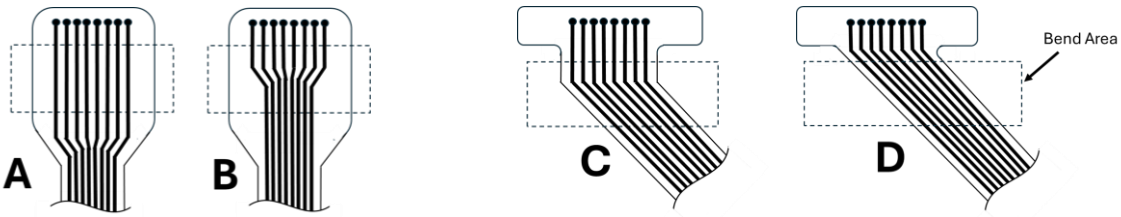


Figure 6
Use of Teardrop Fillets for Trace Connection to Pads

Justification (If necessary)
The use of rating expressions 'preferred' and 'unacceptable' were not considered appropriate by reviewer for a design guideline. Figure ranking text was changed to more appropriate terms for a Guide. This affected other figures in the Guide. Revise similar wording throughout for consistency

FROM: Section/Paragraph Fig 9

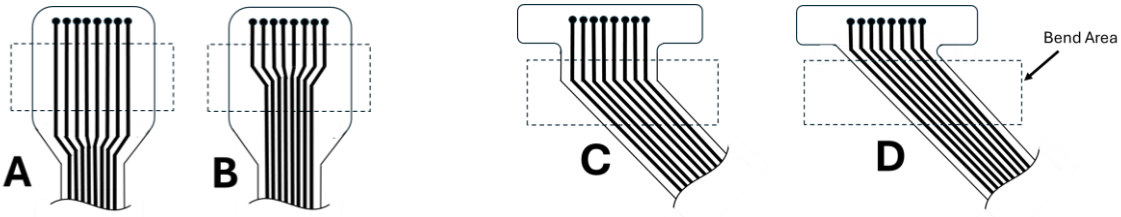


#1 A – preferred, B – acceptable, C – not preferred, D – unacceptable

Figure 9
Trace Routing in Bend Area

3

TO: Section/Paragraph Fig 9



#2 A – ~~preferred~~desirable, B – acceptable, C – not preferred, D – undesirable~~unacceptable~~

Figure 9
Trace Routing in Bend Area

		Justification (If necessary) The use of rating expressions 'preferred' and 'unacceptable' were not considered appropriate by reviewer for a design guideline. Figure ranking text was changed to more appropriate terms for a Guide. This affected other figures in the Guide. Revise similar wording throughout for consistency			
	Motion	Negative is addressed by the technical change(s).			
	Motion by/2nd by	**By:** Deepak Trivedi (GE Research) **Second:** Stephen Gonya (Binghamton University (SUNY))			
	Discussion	None			
	Result of Vote (check one)	3 **Y** 0 **N**; Motion passed.			
		X	2/3 ≤ [Negative is addressed by the technical change(s).]	**GO TO "Incorporation of the Technical Change" subsection**	
Incorporation of the Technical Change	**Motion**	To incorporate the technical change(s).			
	Motion by/2nd by	**By:** Deepak Trivedi (GE Research) **Second:** Stephen Gonya (Binghamton University (SUNY))			
	Discussion	None			
	Result of Vote (check one)	3 **Y** 0 **N**; Motion passed.			
		X	90% ≤ [Agree to incorporate.]	**GO TO "Final" subsection → (F)**	
Final	**(check if applicable)**	**X**	**(F)**	Addressed by technical change **(counted under k disposition)**	

Disposition of Voting Interest Reject 1

2	Original number (#) of Negatives			**(g)**
0	Number of Negatives withdrawn			**(h)**
0	Number of Negatives found not related			**(i)**
1	Number of Negatives found not significant			**(j)**
1	Number of Negatives addressed by technical change **(Negative becomes not significant)**			**(k)**
Final	**X**	**g - (h + i +j + k) = 0**	**Reject is Not Valid and is not included in the denominator of § VI. *Approval Conditions Check***	
		g - (h + i +j + k) >0	**Reject is included in the denominator of § VI. *Approval Conditions Check***	
		Reject without a Negative	**Not Valid**	

This table is needed for each Voting Interest Reject.

Note: If all of the Negatives included with a Reject Vote are withdrawn, determined to be not related, or determined to be not significant, the Reject Vote is not valid. (*Regulations* ¶ 9.4.3.3)
Note: A Negative addressed by a technical change is automatically considered to be not significant. (*Regulations* ¶ 9.6.1.4.5.2)

Voting Interest Reject 2 (Voting Interest Name: Hiroshima City University)

Voter Reject 1 (Voter: Satoshi Maeda / Hiroshima City University)

Negative 1

Negative	Referenced Section/ Paragraph	Entire document				
	Negative Text	First, the use of the important keyword "substrate" is inconsistent throughout the document. "Substrate," as explained in Section 7, refers to the plate or film that forms the base of a wiring board. However, in the title and most of this document, "substrate" refers to the package substrate or interposer. For example, replacing "substrate" in the title with "circuit board" and checking for consistency in terminology throughout the document might solve much of this problem. However, doing so would make it difficult to differentiate this document from the IPC standard. –				
Withdrawal (check one)		X	No Negative withdrawal made by Voter.			GO TO "Related" subsection
Related	Motion and Reason (check one)	X	'Related' is mutually agreed upon. (Needs no motion.)			GO TO "Persuasive" subsection
Persuasive	Motion and Reason (check one)	X	Negative is related and persuasive. (Needs >1/3 votes to pass.)			
	Motion by/ 2nd by	By: Stephen Gonya (Binghamton University (SUNY)) Second: Deepak Trivedi (GE Research)				
	Discussion	None				
	Result of Vote (check one)	3 Y 0 N; Motion passed.				
		X	[Negative is related and persuasive.] > 1/3	Is a technical change recommended? (check one)	X	Y	GO TO "Address by Technical Change Option" subsection

Technical Change Recommendations
Original section/paragraph number and at least one full sentence are required in "FROM" and "TO" fields.

Technical Changes	1	**FROM: Section/Paragraph 5.2.6** << to save space, only the "TO:" are shown with track changes >>

TO: Section/Paragraph 5.2.6

5.2 *Definitions*

5.2.1 *aerosol printing* — a noncontact printing process that converts ink into an aerosol mist and uses aerodynamic focusing to concentrate ink into a fine stream to precisely deposit onto a surface~~substrate~~.

…

5.2.9 *flexographic printing* — a contact printing process which uses a soft flexible convex plate wrapped around a cylinder to transfer ink to a surface~~the substrate~~.

5.2.10 *gravure printing* — a printing process that transfers ink to a surface~~substrate~~ from a concave printing plate (intaglio). The reverse of the image to be transferred is engraved and etched into the printing plate.

5.2.11 *inkjet printing* — a non-contact printing process that recreates a defined image by propelling minute droplets of ink onto a surface~~substrate~~.

…

NOTE 8: Stretchable conductive lines are normally printed or coated onto a stretchable ~~insulating~~ substrate.

…

5.2.27 *stretchable substrate* — a substrate that can recover its original size and shape immediately after removing the elongation force that causes deformation.
NOTE 10: "Immediately" refers to a short recovery time.

5.2.28 *substrate* — base structure~~material~~ containing the~~on or in which the devices or~~ circuit elements needed for electronic fabrication~~will be fabricated~~.

Justification (If necessary)

All uses of the word 'substrate' in this document were reviewed and edited, if necessary, to be consistent with the 5.2.28 definition. Else, the word 'surface' was substituted for 'substrate' where appropriate. Minor grammatical changes made throughout and NOTE 10 was also added to clarify the definition of "stretchable substrate"

Definition of "substrate" was also revised to be consistent with Japan Doc 6906.

2

FROM: Section/Paragraph 5.2.6
<< to save space, only the "TO:" are shown with track changes >>

TO: Section/Paragraph 5.2.6

7.6 *Thermoplastic Polyurethanes (TPU)* — Limited in use cases with electronics but offer the ability to print stretchable electronics and stretchable "traces" using stretchable inks. TPU's are a great supporting material for encapsulation, and specialized TPUs integrated with hot melt adhesives allow for easy integration of FHE to things like textiles. TPU handles like other films but provides rubber texture and characteristics. Most TPU films are provided on a support carrier to reduce stretching during manufacturing. Silicone rubber is sometimes used as a stretchable substrate material alternative to TPU.

…

7.11 *Substrate Surface Preparation* — Any type of substrate surface coating or surface modification needed for improved print quality or ink adhesion. Different surface preparations include cleaning, plasma, ozone, corona, abrasion, and application of levelers and adhesion promoters. These surface treatments are designed to improve the wettability and adhesion to~~of~~ the surface~~substrate~~.

Justification (If necessary)

All uses of the word 'substrate' in this document were reviewed and edited, if necessary, to be consistent with the 5.2.28 definition. Else, the word 'surface' was substituted for 'substrate', design', material', etc., where appropriate. Minor grammatical changes were also made throughout.

3

FROM: Section/Paragraph 5.2.6

<< to save space, only the "TO:" are shown with track changes >>

TO: Section/Paragraph 5.2.6

Table 1 Laser Drilling Via Formation for Various Substrates

Substrate Material	*Minimum Feature Diameter – UV (µm)*	*Minimum Feature Diameter – CO_2 (µm)*	*Remarks*
Polyimide (PI)	20–30	60–100	UV yields cleaner edges and less thermal str Common in microelectronics.
Polyethylene Terephthalate (PET)	30–50	80–125	UV cuts with less melting. CO_2 may induce distortion.
Thermoplastic Polyurethane (TPU)	~25	~75	TPU is stretchable; UV preserves mechanica flexibility better.
Polyethylene Naphthalate (PEN)	25–40	70–100	UV suitable for fine features; CO_2 used for larger clearance cuts.
Liquid Crystal Polymer (LCP)	20–50	70–120	UV preferred vias formation due to LCP's lo moisture absorption.
Flexible Glass	~10	Not suitable	UV (deep UV) allows precise micro-cutting; CO_2 generally cannot process glass.

Justification (If necessary)

All uses of the word 'substrate' in this document were reviewed and edited, if necessary, to be consistent with the 5.2.28 definition. Else, the word 'surface' was substituted for 'substrate', design', material', etc., where appropriate. Minor grammatical changes were also made throughout.

4

FROM: Section/Paragraph 5.2.6

<< to save space, only the "TO:" are shown with track changes >>

TO: Section/Paragraph 5.2.6

13.2 *Printed Inductors* — Inductors are typically printed with the same conductive ink used to print the circuit traces. Often this is an ink designed for the specific substrate surface, printing method, and temperature limitations. The following parameters should be defined on the master drawing for each inductor: 1) Nominal inductance, 2) Inductance tolerance, 3) Maximum DC resistance (DCR), with an optional parameter for 4) Geometry of inductor element. Typical printed inductor patterns consist of planar spirals that can be circular, square, hexagonal, or octagonal as shown in **Error! Reference source not found.**.

…

13.3 *Printed Capacitators* — Printed capacitors are typically of the parallel-plate version where there is a top and bottom electrode area and a thin dielectric layer in-between. Electrodes are usually printed with the same conductive ink used to print the conductive circuit traces. Often this is an ink designed for a specific substrate surface, printing method, and temperature limitations. …

Justification (If necessary)

All uses of the word 'substrate' in this document were reviewed and edited, if necessary, to be consistent with the 5.2.28 definition. Else, the word 'surface' was substituted for 'substrate' where appropriate. Minor grammatical changes were also made throughout.

FROM: Section/Paragraph 5.2.6

<< to save space, only the "TO:" are shown with track changes >>

TO: Section/Paragraph 5.2.6

5

16.4 *Preliminary Substrate Geometry Based on Closed-Form Analytical Solutions* — Consider flexural rigidity (modulus of elasticity and the moment of inertia of the cross-section), presence of stress concentrations, aspect ratio, possibility of wrinkling, buckling, creasing, etc. to identify preliminary geometry (such as thickness) of the substrate. Thinner substrates provide enhanced flexibility, whereas thicker substrates offer improved load-bearing capacity. This necessitates a trade-off between flexibility and structural robustness. Perform preliminary stress analyses using simplified closed-form equations applicable to beams, plates, and films. Evaluate whether any candidate designs~~substrates~~ can be excluded based on these initial calculations, particularly if they fail to simultaneously satisfy both flexibility and strength requirements.

Justification (If necessary)

All uses of the word 'substrate' in this document were reviewed and edited, if necessary, to be consistent with the 5.2.28 definition. Else, the word 'surface' was substituted for 'substrate', design', material', etc., where appropriate. Minor grammatical changes were also made throughout.

FROM: Section/Paragraph 5.2.6

<< to save space, only the "TO:" are shown with track changes >>

TO: Section/Paragraph 5.2.6

6

APPENDIX 1

A1-1 Introduction

A1-1.1 Printing methods for FHE are split into two broad categories; contact printing and non-contact printing. It is a contact method when the print device meets the surface~~substrate~~ being printed on, while it is non-contact when the device does not meet the surface~~substrate~~ during the printing process.

A1-2 Stencil Printing

A1-2.1 Stencil printing is a contact printing process in which paste is forced by a squeegee through apertures in a metal sheet onto the surface~~substrate~~. The typical material for making stencils is often stainless steel or polyimide film with laser cut, or blade cut, apertures because it ensures precise material deposition. Stencil printing is typically used for conductive or nonconductive adhesive depositions onto planar surfaces~~substrates~~ for SMT processes. Stencil printing is generally not suitable for circuity as the excessive cutout material needed for a circuit layer creates metal islands and degrades stencil planarity.

A1-3 Screen Printing

A1-3.1 Screen printing is a contact process where ink is transferred onto a surface~~substrate~~ via a fine meshed screen (**Error! Reference source not found.**). In the ink transfer process, a squeegee moving across the screen applies pressure on the ink forcing it through the holes in the mesh. The pattern printed is defined by the photocurable emulsion blocking parts of the mesh on the screen. The screen is held in tension by frames. Depending on the desired print resolution and surface~~substrate~~, one may choose the screen mesh material (polyurethane, steel) and mesh count. Typical screen printable paste is highly viscous (500 to 10000 cP), has low vapor pressure and is thixotropic. Multilayer fabrications using screen printing require the following: 1) fiducials for alignment and 2) heat treatment of the substrate to minimize ~~substrate~~ shrinkage.

…

A1-4 Dispense Printing

A1-4.1 Dispense printing is a contact direct write process that is based on the extrusion of highly viscous fluids from a syringe onto a target surface~~substrate~~ (**Error! Reference source not found.**).

…

A1-5 Gravure Printing

A1-5.1 Gravure printing is a contact printing method that uses a rotary press to transfer ink from a cylinder unto a surfac~~substrat~~e~~e~~ (**Error! Reference source not found.**). The pattern to be printed is intaglio engraved on the cylinder and the ink from the reservoir fills the engraving cells which is then transferred to the surface~~substrate~~. A flexible doctor blade wipes the surface of the cylinder prior to printing, leaving only inks in the cell. Typical ink viscosity is 20 cP to 100 cP. Minimum achievable line and spacing for printed electronics is 75µm.

…

A1-7 Flexography Printing

A1-7.1 This is a R2R contact printing method in which soft flexible photopolymer plate (~~F~~flexo plate) wrapped around a cylinder is used to transfer ink to the surface~~substrate~~ (**Error! Reference source not found.**). In this process, ink collected from the ink reservoir (ink tray) is transferred to the ~~A~~anilox cylinder where a doctor blade ensures uniform distribution of ink which is then transferred to the ~~F~~flexo plate which then transfers the ink pattern to the substrate surface which is pressed against the impression cylinder. Flexible or rigid plates may be printed on them. Ink viscosity ranges from 20 cP to 2500 cP.

…

A1-8 Inkjet Printing

A1-8.1 Inkjet printing is a digital non-contact direct write printing process in which low viscosity inks (1 cP to 35 cP) are jetted from a cartridge through nozzles onto a target surface~~substrate~~. Inkjet systems may be either drop on demand (DoD) or continuous inkjet (CIJ). In the CIJ system, a continuous stream of droplets is jetted out of the nozzle in response to a continuous actuating signal, and a deflector uses an electric field to direct target droplets to the surface~~substrate~~ while other droplets are recycled back to the reservoir (**Error! Reference source not found.**).

…

A1-9 Aerosol Printing

A1-9.1 A non-contact direct write printing method in which aerosolized ink particles are jetted out of the nozzle onto a target surface~~substrate~~ (**Error! Reference source not found.**). To form the aerosol, ink particles are atomized into droplets about 5 µm in diameter to form a mist above the fluid in the atomizing jar. This ink mist is mixed with an inert gas (typically nitrogen), which is then transported as a stream of aerosol onto the surface~~substrate~~. The transported aerosol stream is collimated by an inert sheath gas introduced at the deposition head which accelerates the aerosol through the nozzle and reduces the feature size. Feature size can be as small as 10 µm. The deposition mechanism allows for deposition on planar, non-planar, soft substrates or 3D objects. In addition, because of the collimated jet of ink, the nozzle can be up to 10 mm above the surface~~substrate~~ and still print satisfactory.

…

A1-10 Electrohydrodynamic (EHD) Printing

A1-10.1 This non-contact process uses an electric field to draw material from the nozzle tip onto the substrate surface (**Error! Reference source not found.**). The electric field is generated by a high voltage (in *kV*) between the nozzle and the surface~~substrate~~. In cases of a conductive substrate, the surface~~substrate~~ becomes the second terminal where the nozzle is the first terminal. …

…

A1-11 Plasma Jet Printing (PJP)

A1-11.1 …These can be tuned to thermally and chemically modify the ink as it is being printed as well as activate the surface~~substrate~~. …

…

A1-12 Dry Additive Nano Manufacturing (Dry ANM)

A1-12.1 This is an inkless non-contact printing method that in-situ directly sinters dry nanomaterials generated from laser ablation onto the intended surface~~substrate~~ (**Error! Reference source not found.**). In this process, an ablation laser coupled to a galvo scanner is directed towards a target material to generate a plasma plume. The Plasma plume which is a mixture of superheated clouds of ionized vapor, electrons and neutral particles ejected from the target material condense when they interact with the argon gas in the chamber to form nano particles. The argon gas flow transports the nanoparticles to the nozzle from which the particles are jetted onto the surface

~~of the intended substrate~~. The generated and subsequently transported particles are sintered in-situ on the surface with a sintering laser.

…

Table A1-1 Summary of Printing Methods

Printing Methods	*Principle*	*Ink Viscosity*	*Smallest Features Size*	*Surface~~bstrate~~ Configuration*
Stencil	Ink is forced through opening in stencil plate by squeegee	500-100000 cP	200 µm	Planar ~~surfaces~~ (2D)
Screen	Ink is forced through meshed screen by squeegee	500-100000 cP	75 µm	Planar ~~surface~~ (2D)
Dispense	Ink is extruded through a nozzle	500-28000 cP	20 µm	non-planar (2.5D)
Gravure	Ink transfer by cells in a rotary cylinder	20-100 cP	75 µm	Planar (flexible)
Offset Gravure	Ink is doctored into the cells of the gravure cylinder which is transferred to a roller and then a~~the~~ surface~~bstrate~~.	50-200 cP	10 µm	Planar, flexible, rigid

…

APPENDIX 2

A2-3 Conductive Ink Selection

A2-3 … Other considerations include; the cost to achieve a target sheet resistance ($ per Ω·square); printed trace resolution requirements (minimum width/spacing or pitch); surface roughness requirements (low Ra, low Rz, etc.); adhesion requirements to surface~~substrate~~ (cross hatch tape, die shear, etc.);…

…

A2-5 Post-Print Ink Processing

A2-5.1 After the ink is printed on a surface~~substrate~~, the solvent or water is evaporated, resulting in a dried or cured ink bonded to the surface~~substrate~~.

…

A2-5.1.2 Photonic sintering uses high intensity xenon bulbs flashed at rapid speed to only generate heat on the surface of the substrate. By optimizing the conditions, it is possible to generate temperatures at the surface of the ink about 500°C while keeping the substrate below 200°C. This allows low-temperature substrate materials~~s~~ to utilize inks that require higher temperature sintering.

…

A2-7 Ink Compatibility

A2-7.1 Inks are formulated both for the end-use properties and the printing process used. For example, inkjet uses extremely low-viscosity inks while screen printing uses high-viscosity pastes. Inks should be compatible with the substrate surface to achieve good printing and desired adhesion. Surface energy/tension compatibility is of primary importance. The ~~S~~substrate surface should have a surface energy that exceeds the fluid's surface tension to achieve proper wetting (contact angle). …

…

A2-10 Ink-to-Substrate Compatibility

A2-10.1 Basic ASTM D3359 tape test for ink adhesion to the substrate surface would be applicable.

…

Justification (If necessary) All uses of the word 'substrate' in this document were reviewed and edited, if necessary, to be consistent with the 5.2.28 definition. Else, the word 'surface' was substituted for 'substrate', design', material', etc., where appropriate. Minor grammatical changes were also made throughout.

	Motion		Negative is addressed by the technical change(s).		
	Motion by/2nd by		**By:** Deepak Trivedi (GE Research) **Second:** Stephen Gonya (Binghamton University (SUNY))		
	Discussion		None		
	Result of Vote (check one)		3 **Y** 0 **N**; Motion passed.		
		X	2/3 ≤ [Negative is addressed by the technical change(s).]	**GO TO "Incorporation of the Technical Change" subsection**	
	Incorporation of the Technical Change **Motion**		To incorporate the technical change(s).		
	Motion by/2nd by		**By:** Deepak Trivedi (GE Research) **Second:** Stephen Gonya (Binghamton University (SUNY))		
	Discussion		None		
	Result of Vote (check one)		3 **Y** 0 **N**; Motion passed.		
		X	90% ≤ [Agree to incorporate.]	**GO TO "Final" subsection → (F)**	
Final	**(check if applicable)**	**X**	**(F)**	Addressed by technical change **(counted under k disposition)**	

Negative 2

Negative	**Referenced Section/ Paragraph**		Appendix reference		
	Negative Text		The appendix is not mentioned at all in the main body of the document. At the very least, a description referencing the appendix is needed		
	Withdrawal (check one)	**X**	No Negative withdrawal made by Voter.	**GO TO "Related" subsection**	
Related	**Motion and Reason (check one)**	**X**	'Related' is mutually agreed upon. **(Needs no motion.)**	**GO TO "Persuasive" subsection**	
Persuasive	**Motion and Reason (check one)**	**X**	Negative is related and not persuasive. **(Needs ≥2/3 votes to pass.)**		
			Reason	Addressed by Takanobu Nakagawa Neg #4	
	Motion by/ 2nd by		**By:** Randall Parker (DISCO) **Second:** Stephen Gonya (Binghamton University (SUNY))		
	Discussion		None		
	Result of Vote (check one)		6 **Y** 0 **N**; Motion passed		
		X	90% ≤ [Negative is related and not persuasive.]	**GO TO "Not Significant Finding Option" subsection**	
Not Significant	**This option can be used only "if the TC Chapter finds a Negative not persuasive by a vote equal to or greater than 90% of the persons voting on the action". (*Regulations* ¶ 9.6.1.4.5.2)**				
	Use of "Not significant finding option" (check one)	**X**	It is mutually agreed upon to term the Negative "not significant".	**GO TO "Final" subsection → (D)**	

Final		**X**	**(D)**	Not significant **(counted under j in disposition)**

Negative 3

Negative	**Referenced Section/ Paragraph**	5.1.7			
	Negative Text	"5.1.7 Df" appears to be an abbreviation for "Dielectric loss factor."			
	Withdrawal (check one)	**X**	No Negative withdrawal made by Voter.		**GO TO "Related" subsection**
Related	**Motion and Reason (check one)**	**X**	'Related' is mutually agreed upon. **(Needs no motion.)**		**GO TO "Persuasive" subsection**
Persuasive	**Motion and Reason (check one)**	**X**	Negative is related and not persuasive. **(Needs ≥2/3 votes to pass.)**		
			Reason	Correct spelling of Df abbreviation. Editorial change to add "factor" to "dielectric loss factor"	
	Motion by/ 2nd by	**By:** Stephen Gonya (Binghamton University (SUNY) **Second:** Randall Parker (DISCO)			
	Discussion	None			
	Result of Vote (check one)	4 **Y** 0 **N**; Motion passed			
		X	90% ≤ [Negative is related and not persuasive.]	**GO TO "Not Significant Finding Option" subsection**	
Not Significant	**This option can be used only "if the TC Chapter finds a Negative not persuasive by a vote equal to or greater than 90% of the persons voting on the action". (*Regulations* ¶ 9.6.1.4.5.2)**				
	Use of "Not significant finding option" (check one)	**X**	It is mutually agreed upon to term the Negative "not significant".		**GO TO "Final" subsection → (D)**
Final		**X**	**(D)**	Not significant **(counted under j in disposition)**	
	(check if applicable)	**X**	*Comment generated.* ***Refer to Section V-(ii) Comment #*** *NC-1.*		

Negative 4

Negative	**Referenced Section/ Paragraph**	10.13.8

	Negative Text	The explanation for "10.13.8 Sheet Resistance" is inappropriate. Furthermore, among the many sheet resistance measurement methods available, ASTM F390 is a method developed for non-destructive measurement of the sheet resistance of infinitely flat planer (or at least large, planar) materials. On the other hand, with printed electronics, conductors can be arranged in any shape, making ASTM F390 unnecessary and difficult to apply. A more appropriate explanation of sheet resistance is as follows: "Sheet resistance is the resistance between two opposing sides of a square film. It is independent of the square's size. When non-destructive testing is required, sheet resistance can be measured using the 4-point probe method. Sheet resistance can also be calculated by dividing volume resistivity by thickness, assuming that the thickness is constant. Sheet resistance can also be applied to materials that cannot be measured in thickness, such as conductive fabric. The unit of sheet resistance is Ω, but it is written as Ωsq to compare it with surface resistivity (which is the resistance of a square film with no thickness)."					
	Withdrawal (check one)	**X**	No Negative withdrawal made by Voter.				**GO TO "Related" subsection**
Related	**Motion and Reason (check one)**	**X**	'Related' is mutually agreed upon. **(Needs no motion.)**				**GO TO "Persuasive" subsection**
Persuasive	**Motion and Reason**	**X**	Negative is related and persuasive. **(Needs >1/3 votes to pass.)**				
	Motion by/ 2nd by	**By:** Stephen Gonya (Binghamton University (SUNY)) **Second:** Deepak Trivedi (GE Research)					
	Discussion	None					
	Result of Vote (check one)	3 **Y** 0 **N**; Motion passed.					
		X	[Negative is related and persuasive.] > 1/3	**Is a technical change recommended?**	**X**	**Y**	**GO TO "Address by Technical Change Option" subsection**

Address by Technical Change Option

Technical Change Recommendations

Technical Changes — **1**

FROM: Section/Paragraph 10.13.8

10.13.8 *Sheet Resistance* — Sheet Resistance is a common electrical property used to characterize thin films of conducting materials using a 4-point probe measurement through a thin square of material, with units of ohms per square (refer to ASTM F390). Sheet resistance (Rs) is defined as the material resistivity (ρ) divided by its thickness (t). For example, the sheet resistance of 1 oz copper is 0.0005 Ω/sq. Typical sheet resistance range for silver ink film is 0.01-0.04 Ω/sq, although the best conductive ink for an application will depend on multiple variables including sheet resistance, thickness, substrate, cure temperature, deposition method, etc.

TO: Section/Paragraph 10.13.8

10.13.8 *Sheet Resistance* — Sheet Resistance is a common electrical property used to characterize thin films of conducting materials using a 4-point probe measurement through a thin square of material, with units of ohms per square (Ω/sq) and is independent of the sample size. ~~(refer to ASTM F390).~~ Sheet resistance (*Rs*) is defined as the material resistivity (*ρ or Ω-m*) divided by its thickness (*t*), assuming the thickness is constant. The Rs units of Ω/sq are used to differentiate it from surface resistance with units of Ω. For example, the sheet resistance of 1 oz copper foil (35 µm thick) is 0.0005 Ω/sq. Typical sheet resistance range for a Ag-~~silver~~ ink film is 0.01-0.04 Ω/sq~~,~~. ~~although the best conductive ink for an application will depend on multiple variables including sheet resistance, thickness, substrate, cure temperature, deposition method, etc.~~

Justification (If necessary)
Rewrote section 10.13.8 Sheet Resistance to accommodate reviewer's comments on variations in test method procedures in industry. The reference to ASTM F390 was removed from 10.13.8 for this reason.

Motion	Negative is addressed by the technical change(s).
Motion by/2nd by	**By:** Deepak Trivedi (GE Research) **Second:** Stephen Gonya (Binghamton University (SUNY))
Discussion	None
Result of Vote	3 **Y** 0 **N**; Motion passed.

	(check one)		X	2/3 ≤ [Negative is addressed by the technical change(s).]		GO TO "Incorporation of the Technical Change" subsection
	Incorporation of the Technical Change	Motion		To incorporate the technical change(s).		
		Motion by/2nd by		**By:** Deepak Trivedi (GE Research) **Second:** Stephen Gonya (Binghamton University (SUNY))		
		Discussion		None		
		Result of Vote (check one)		3 **Y** 0 **N**; Motion passed.		
			X	90% ≤ [Agree to incorporate.]		GO TO "Final" subsection → (F)
Final	(check if applicable)		X	(F)	Addressed by technical change (counted under k disposition)	

Negative 5

Negative	Referenced Section/ Paragraph		Section 11			
	Negative Text		Section 11 discusses single-sided, multilayer circuit boards, but creating such boards with printed electronics presents significant challenges. However, simple double-sided circuits are not discussed. The discussion of multilayer circuit boards needs to be restructured			
	Withdrawal (check one)	X	No Negative withdrawal made by Voter.			GO TO "Related" subsection
Related	Motion and Reason (check one)	X	'Related' is mutually agreed upon. (Needs no motion.)			GO TO "Persuasive" subsection
Persuasive	Motion and Reason (check one)	X	Negative is related and persuasive. (Needs >1/3 votes to pass.)			
	Motion by/ 2nd by		**By:** Stephen Gonya (Binghamton University (SUNY)) **Second:** Deepak Trivedi (GE Research)			
	Discussion		None			
	Result of Vote (check one)		3 **Y** 0 **N**; Motion passed.			
		X	[Negative is related and persuasive.] > 1/3	Is a technical change recommended? (check one)	X Y	GO TO "Address by Technical Change Option" subsection
Address	**Technical Change Recommendations** **Original section/paragraph number and at least one full sentence are required in "FROM" and "TO" fields.**					

Technical Changes

1

FROM: Section/Paragraph 11.1

11 Interconnects and Vias

11.1 *Interconnects and Vias* — Vias in a flexible substrate serve to connect multiple layers of circuitry or reroute signals to aid circuit wiring. Vias may be either though-hole, blind, or buried. Figure 12 shows a schematic drawing of the different via types in a multilayer substrate cross-section. Blind vias 12(a) stop within the substrate, being open on only one side. Though-hole vias 12(b) go through the substrate layers and are open on both sides of the substrate. Buried vias 12(c) are layer-to-layer connections within the substrate and are not open on either side. Vias may have either solid conductive ink fill 12(a-c) or coated walls 12(d) for the layer-to-layer connections. Via holes in flexible substrates are typically made by two methods. First, by laser drilling a hole in the dielectric layer and then filling or coating the hole with conductive ink to form the layer-to-layer connections. A second method common when printing the dielectric layer is to leave an isolated area uncoated to create a gap in the dielectric over a pad that is subsequently filled with a conductive ink when the next circuit layer is printed 12(e). Solid fill is typically done for higher aspect ratio vias where the hole is laser drilled. Via wall coating is typically done for larger diameter holes with a low aspect ratio (larger diameter that depth) or with dielectric gap type vias.

TO: Section/Paragraph 11.1

11 Interconnects and Vias

11.1 *Interconnects and Vias* — Vias in a flexible substrate serve to connect multiple layers of circuitry, or connect top and bottom layers in a double-sided board~~or reroute signals to aid circuit wiring~~. Vias may be either through-hole, blind, or buried. **Error! Reference source not found.** shows a schematic drawing of the different via types in a multilayer substrate cross-section. Blind vias 12(a) stop within the substrate, being open on only one side. Through-hole vias 12(b) go through the substrate layers and are open on both sides of the substrate. Buried vias 12(c) are layer-to-layer connections within the substrate and are not open on either side. Vias may have either solid conductive ink fill 12(a-c) or coated walls 12(d) for the layer-to-layer connections. Via holes in flexible substrates are typically made by two methods. First, by laser drilling a hole in the dielectric layer and then filling or coating the hole with conductive ink to form the layer-to-layer connections. A second method common when printing the dielectric layer is to leave an isolated area uncoated to create a gap in the dielectric over a pad that is subsequently filled with a conductive ink when the next circuit layer is printed 12(e). Solid fill is typically done for higher aspect ratio vias where the hole is laser drilled. Via wall coating is typically done for larger diameter holes with a low aspect ratio (larger diameter that depth) or with dielectric gap type vias.

Justification (If necessary)

Section 11 is mostly generic in regard to via formation as either double-sided or mulit-layer. Section 11.1 was edited to make it clear that double-sided boards are included. Flexible multi-layer printed circuits are becoming more mainstream using equipment and methods from multimaterial inkjet printing and multistep roll-to-roll printing.

Motion	Negative is addressed by the technical change(s).		
Motion by/2nd by	**By:** Deepak Trivedi (GE Research) **Second:** Stephen Gonya (Binghamton University (SUNY))		
Discussion	None		
Result of Vote (check one)	3 **Y** 0 **N**; Motion passed.		
	X	2/3 ≤ [Negative is addressed by the technical change(s).]	**GO TO "Incorporation of the Technical Change" subsection**

Incorporation of the Technical Change

Motion	To incorporate the technical change(s).		
Motion by/2nd by	**By:** Deepak Trivedi (GE Research) **Second:** Stephen Gonya (Binghamton University (SUNY))		
Discussion	None		
Result of Vote (check one)	3 **Y** 0 **N**; Motion passed.		
	X	90% ≤ [Agree to incorporate.]	**GO TO "Final" subsection → (F)**

Final	**(check if applicable)**	**X**	**(F)**	Addressed by technical change **(counted under k disposition)**

Disposition of Voting Interest Reject 2

5	Original number (#) of Negatives			**(g)**
2	Number of Negatives found not significant			**(j)**
3	Number of Negatives addressed by technical change **(Negative becomes not significant)**			**(k)**
Final	**X**	**g - (h + i +j + k) = 0**	**Reject is Not Valid and is not included in the denominator of § VI. *Approval Conditions Check***	

Voting Interest Reject 3 (Voting Interest Name: Yamagata University)
Voter Reject 1 (Voter: Tadahiro Furukawa / Yamagata University)

Negative 1

Negative	**Referenced Section/ Paragraph**	5.1.7			
	Negative Text	5.1.7 Df — dielectric loss → dielectric loss factor			
Withdrawal (check one)		**X**	No Negative withdrawal made by Voter.		**GO TO "Related" subsection**
Related	**Motion and Reason (check one)**	**X**	'Related' is mutually agreed upon. **(Needs no motion.)**		**GO TO "Persuasive" subsection**
Persuasive	**Motion and Reason (check one)**	**X**	Negative is related and not persuasive. **(Needs ≥2/3 votes to pass.)**		
			Reason	Addressed by Satoshi Maeda Neg #3.	
	Motion by/ 2nd by	**By:** Stephen Gonya (Binghamton University (SUNY) **Second:** Randall Parker (DISCO)			
	Discussion	None			
	Result of Vote (check one)	4 **Y** 0 **N**; Motion passed			
		X	90% ≤ [Negative is related and not persuasive.]	**GO TO "Not Significant Finding Option" subsection**	
Not Significant	**This option can be used only "if the TC Chapter finds a Negative not persuasive by a vote equal to or greater than 90% of the persons voting on the action". (*Regulations* ¶ 9.6.1.4.5.2)**				
	Use of "Not significant finding option" (check one)	**X**	It is mutually agreed upon to term the Negative "not significant".		**GO TO "Final" subsection → (D)**
Final		**X**	**(D)**	Not significant **(counted under j in disposition)**	

Negative 2

Negative	Referenced Section/ Paragraph	5.2.2		
	Negative Text	5.2.2 bending — deformation of printed electronics caused by external stress that induces curvature perpendicular to the original surface of the specimen. → deformation ~~of printed electronics~~ caused by external stress that induces curvature perpendicular to the original surface of the specimen.		
Withdrawal (check one)		X	No Negative withdrawal made by Voter.	GO TO "Related" subsection
Related	Motion and Reason (check one)	X	'Related' is mutually agreed upon. (Needs no motion.)	GO TO "Persuasive" subsection
Persuasive	Motion and Reason (check one)	X	Negative is related and not persuasive. (Needs ≥2/3 votes to pass.)	
			Reason: Editorial to remove text "of printed electronics" from definition to comply to style manual guidelines for definitions.	
	Motion by/ 2nd by	By: Stephen Gonya (Binghamton University (SUNY)) Second: Randall Parker (DISCO)		
	Discussion	None		
	Result of Vote (check one)	4 Y 0 N; Motion passed		
		X	90% ≤ [Negative is related and not persuasive.]	GO TO "Not Significant Finding Option" subsection
Not Significant	This option can be used only "if the TC Chapter finds a Negative not persuasive by a vote equal to or greater than 90% of the persons voting on the action". (*Regulations* ¶ 9.6.1.4.5.2)			
	Use of "Not significant finding option" (check one)	X	It is mutually agreed upon to term the Negative "not significant".	GO TO "Final" subsection → (D)
Final		X	(D)	Not significant (counted under j in disposition)
	(check if applicable)	X	*Comment generated. Refer to Section V-(ii) Comment # NC-2.*	

Negative 3

Negative	Referenced Section/ Paragraph	5.2.6		
	Negative Text	5.2.6 flexible electronics — electronic components on or in a flexible substrate. This wording should be aligned with the terminology standards developed in Japan. Or, sections 5.2.6 and 5.2.7 should be deleted. Reason 1 : It is not good for the most fundamental definitions to differ. Reason 2 : Using this definition, there are terms that are not classified as FHE. Using the Japanese definition, these are classified as FHE. For example : 5.2.12, 9.5, 9.5.1		
Withdrawal (check one)		X	No Negative withdrawal made by Voter.	GO TO "Related" subsection

Related	**Motion and Reason (check one)**	**X**	‘Related’ is mutually agreed upon. **(Needs no motion.)**				**GO TO “Persuasive” subsection**
Persuasive	**Motion and Reason (check one)**	**X**	Negative is related and persuasive. **(Needs >1/3 votes to pass.)**				
	Motion by/ 2nd by	**By:** Stephen Gonya (Binghamton University (SUNY)) **Second:** Deepak Trivedi (GE Research)					
	Discussion	None					
	Result of Vote (check one)	3 **Y** 0 **N**; Motion passed.					
		X	[Negative is related and persuasive.] > 1/3	**Is a technical change recommended? (check one)**	**X**	**Y**	**GO TO “Address by Technical Change Option” subsection**

Address by Technical Change Option

Technical Change Recommendations
Original section/paragraph number and at least one full sentence are required in “FROM” and “TO” fields.

Technical Changes — **1**

FROM: Section/Paragraph 5.2.6

5.2.6 *flexible electronics* — electronic components on or in a flexible substrate.
NOTE 3: The concept of flexibility includes not only being bendable but also being shearable, twistable, and stretchable.

TO: Section/Paragraph 5.2.6

5.2.6 *flexible electronics* — ~~electronic components on or in a flexible substrate.~~electronic components on or in a flexible substrate that includes not only electronic components that are flexible in the product itself, but also those that are flexible during/before processing of the product.

NOTE 3: The concept of flexibility includes not only being bendable but also being shearable, twistable, and stretchable.

Justification (If necessary)
changed definition to be consistent with Japan document 6906

Motion	Negative is addressed by the technical change(s).				
Motion by/2nd by	**By:** Deepak Trivedi (GE Research) **Second:** Stephen Gonya (Binghamton University (SUNY))				
Discussion	None				
Result of Vote (check one)	3 **Y** 0 **N**; Motion passed.				
	X	2/3 ≤ [Negative is addressed by the technical change(s).]			**GO TO “Incorporation of the Technical Change” subsection**

Incorporation of the Technical Change

Motion	To incorporate the technical change(s).				
Motion by/2nd by	**By:** Deepak Trivedi (GE Research) **Second:** Stephen Gonya (Binghamton University (SUNY))				
Discussion	None				
Result of Vote (check one)	3 **Y** 0 **N**; Motion passed.				
	X	90% ≤ [Agree to incorporate.]			**GO TO “Final” subsection → (F)**

Final	**(check if applicable)**	**X**	**(F)**	Addressed by technical change **(counted under k disposition)**

Negative 4

Negative	Referenced Section/ Paragraph	5.2.12					
	Negative Text	5.2.12 in-mold electronics — a manufacturing method that integrate electronics into a molded plastic part. "In-mold electronics" is not "manufacturing method."					
	Withdrawal (check one)	X	No Negative withdrawal made by Voter.				GO TO "Related" subsection
Related	Motion and Reason (check one)	X	'Related' is mutually agreed upon. (Needs no motion.)				GO TO "Persuasive" subsection
Persuasive	Motion and Reason	X	Negative is related and persuasive. (Needs >1/3 votes to pass.)				
	Motion by/ 2nd by	By: Stephen Gonya (Binghamton University (SUNY)) Second: Deepak Trivedi (GE Research)					
	Discussion	None					
	Result of Vote (check one)	3 Y 0 N; Motion passed.					
		X	[Negative is related and persuasive.] > 1/3	Is a technical change recommended? (check one)	X	Y	GO TO "Address by Technical Change Option" subsection

Address by Technical Change Option

Technical Change Recommendations
Original section/paragraph number and at least one full sentence are required in "FROM" and "TO" fields.

Technical Changes — 1

FROM: Section/Paragraph 5.2.12

5.2.12 *in-mold electronics* — a manufacturing method that integrate electronics into a molded plastic part.

NOTE 5: In-mold electronics is an extension of in-mold decoration technology, in which electronic components and electrodes are embedded inside the product in a three-dimensional shape.

TO: Section/Paragraph 5.2.12

5.2.12 *in-mold electronics* — electronic circuitry that is fabricated in the planar ~~flat~~ condition and then~~a manufacturing method that integrate electronics into thermal a~~ molded into shape such that the circuitry becomes integrated with the ~~plastic~~ molded part~~plastic part~~.

~~NOTE 5: In-mold electronics is an extension of in-mold decoration technology, in which electronic components and electrodes are embedded inside the product in a three-dimensional shape.~~

Justification (If necessary)
Clarified definition of in-mold electronics to eliminated the inference of a manufacturing method.

Motion	Negative is addressed by the technical change(s).				
Motion by/2nd by	By: Deepak Trivedi (GE Research) Second: Stephen Gonya (Binghamton University (SUNY))				
Discussion	None				
Result of Vote (check one)	3 Y 0 N; Motion passed.				
	X	2/3 ≤ [Negative is addressed by the technical change(s).]			GO TO "Incorporation of the Technical Change" subsection
n – Motion	To incorporate the technical change(s).				

		Motion by/2nd by	**By:** Deepak Trivedi (GE Research) **Second:** Stephen Gonya (Binghamton University (SUNY))		
		Discussion	None		
		Result of Vote **(check one)**	3 **Y** 0 **N**; Motion passed.		
			X	90% ≤ [Agree to incorporate.]	**GO TO "Final" subsection → (F)**
Final	**(check if applicable)**	**X**	**(F)**	Addressed by technical change **(counted under k disposition)**	

Negative 5

Negative	**Referenced Section/ Paragraph**	5.2.16		
	Negative Text	5.2.16 offset gravure printing — a variation of gravure printing where ink is doctored into the cells of a printing cylinder (intaglio) and transferred to a second roller cylinder (blanket) and then transferred to the substrate. 1 : “Gravure offset printing” is commonly used. 2: “printing cylinder” Add “or printing plate” Flat plate is important! I'll post photos of the printing machines. The Figures for Various Printing Machines in APPENDIX 1 are also not good. I recommend requesting Figures from Komori Corporation that can be used as standard. (only printing machines that use plates) Komori Corporation is a printing machine manufacturer and a member of the FHE Technical Committee. 		
	Withdrawal (check one)	X	No Negative withdrawal made by Voter.	**GO TO “Related” subsection**
Related	**Motion and Reason (check one)**	X	‘Related’ is mutually agreed upon. **(Needs no motion.)**	**GO TO “Persuasive” subsection**
	Motion and Reason (check one)	X	Negative is related and persuasive. **(Needs >1/3 votes to pass.)**	

Persuasive	**Motion by/ 2nd by**	**By:** Stephen Gonya (Binghamton University (SUNY)) **Second:** Deepak Trivedi (GE Research)					
	Discussion	None					
	Result of Vote (check one)	3 **Y** 0 **N**; Motion passed.					
		X	[Negative is related and persuasive.] > 1/3	**Is a technical change recommended? (check one)**	**X**	**Y**	**GO TO "Address by Technical Change Option" subsection**

Address by Technical Change Option

Technical Change Recommendations
Original section/paragraph number and at least one full sentence are required in "FROM" and "TO" fields.

Technical Changes

1

FROM: Section/Paragraph 5.2.16

5.2.16 *offset gravure printing* — a variation of gravure printing where ink is doctored into the cells of a printing cylinder (intaglio) and transferred to a second roller cylinder (blanket) and then transferred to the substrate.

TO: Section/Paragraph 5.2.16

5.2.16 *gravure offset ~~gravure~~ printing* — a variation of gravure printing where ink is doctored into the cells of a printing cylinder or printing plate (intaglio) and transferred to a second roller cylinder (blanket) and then transferred to a surface~~the substrate~~.

Justification (If necessary)

Clarified definition of gravure offset printing to include "or printing plate" in definition to include gravure offset printing machines that use flat intaglio plates.

2

FROM: Section/Paragraph A1-6

A1-6 Offset Gravure Printing

A1-6.1 Offset Gravure is a variation of Gravure printing where the ink is doctored into the cells of the printing cylinder which is then transferred to a roller and then transferred to the flexible substrate. This printing process is shown in 0. Ink from the ink fountain is collated into the cells in the printing cylinder, where the excess outside the cell is removed by a doctor blade. In the same rolling process, the ink in the cells is transferred onto a blanket cylinder which is then transferred onto the substrate with the printing pressure applied by the impression cylinder from the reverse side of the substrate. The common material for the blanket cylinder is polydimethylsiloxane (PDMS). The minimum functional lines and space achievable is 10 µm.

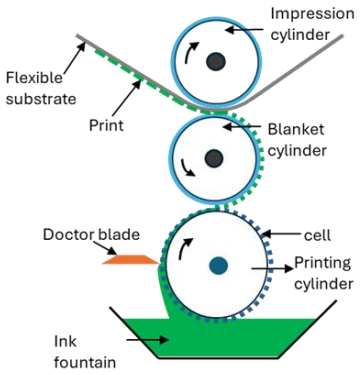


Figure A1-4
Offset Gravure Printing

TO: Section/Paragraph A1-6

A1-6 Gravure Offset ~~Gravure~~ Printing

A1-6.1 Gravure Offset ~~Gravure~~ is a variation of Gravure printing where the ink is doctored into the cells of the printing cylinder or printing plate which is then transferred to a roller and then transferred to the flexible surface~~substrate~~. This printing process is shown in 0, which is shown using cylinders for printing. Ink from the ink fountain is collated into the cells in the printing cylinder, where the excess outside the cell is removed by a doctor blade. In the same rolling process, the ink in the cells is transferred onto a softer blanket cylinder which is then transferred onto the surface~~substrate~~ with the printing pressure applied by the impression cylinder from the reverse side of the sheet~~substrate~~ material. ~~The common material for the blanket cylinder is polydimethylsiloxane (PDMS). The minimum functional lines and space achievable is 10 µm.~~

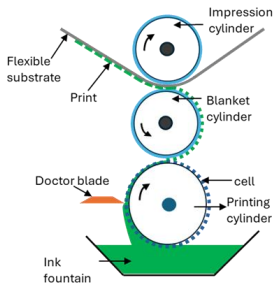


Figure A1-4
Gravure Offset ~~Gravure~~ Printing

Justification (If necessary)
Revised A1-6 to be consistent with the change in 5.2.16

3

FROM: Section/Paragraph 5.1.30

5.1.30 *PDMS* — polydimethylsiloxane

TO: Section/Paragraph 5.1.30

~~5.1.30 *PDMS* — polydimethylsiloxane~~

Justification (If necessary)
PDMS was deleted in the change to A1-6.1 to be consistent with the change in 5.2.16, and therefore should be removed from the *Abbreviations & Acronyms* section per *Style Manual*

Motion			Negative is addressed by the technical change(s).	
Motion by/2nd by			**By:** Deepak Trivedi (GE Research) **Second:** Stephen Gonya (Binghamton University (SUNY))	
Discussion			None	
Result of Vote (check one)			3 **Y** 0 **N**; Motion passed.	
		X	2/3 ≤ [Negative is addressed by the technical change(s).]	**GO TO "Incorporation of the Technical Change" subsection**
Incorporation of the Technical	**Motion**		To incorporate the technical change(s).	
	Motion by/2nd by		**By:** Deepak Trivedi (GE Research) **Second:** Stephen Gonya (Binghamton University (SUNY))	
	Discussion		None	
	Result of Vote (check one)		3 **Y** 0 **N**; Motion passed.	
		X	90% ≤ [Agree to incorporate.]	**GO TO "Final" subsection → (F)**
Final	**(check if applicable)**	**X**	**(F)**	Addressed by technical change **(counted under k disposition)**

Negative 6

Negative	**Referenced Section/ Paragraph**	5.2.26			
	Negative Text	5.2.26 stretchable ink — a conductive ink that can recover its original size and shape immediately after removing the elongation force that causes deformation. This description is a definition of the pattern or layer made from the ink.			
	Withdrawal (check one)	**X**	No Negative withdrawal made by Voter.		**GO TO "Related" subsection**
Related	**Motion and Reason (check one)**	**X**	'Related' is mutually agreed upon. **(Needs no motion.)**		**GO TO "Persuasive" subsection**
Persuasive	**Motion and Reason (check one)**	**X**	Negative is related and not persuasive. **(Needs ≥2/3 votes to pass.)**		
			Reason	Stretchable Ink definition is already consistent with Japan Doc 6906 sections 5.2.2, 5.2.5, and 5.3.3.	
	Motion by/ 2nd by	**By:** Randall Parker (DISCO) **Second:** Stephen Gonya (Binghamton University (SUNY))			
	Discussion	None			
	Result of Vote (check one)	6 **Y** 0 **N**; Motion passed			
		X	90% ≤ [Negative is related and not persuasive.]	**GO TO "Not Significant Finding Option" subsection**	
Not Significant	**This option can be used only "if the TC Chapter finds a Negative not persuasive by a vote equal to or greater than 90% of the persons voting on the action". (*Regulations* ¶ 9.6.1.4.5.2)**				
	Use of "Not significant finding option" (check one)	**X**	It is mutually agreed upon to term the Negative "not significant".	**GO TO "Final" subsection → (D)**	
Final		**X**	**(D)**	Not significant **(counted under j in disposition)**	

Negative 7

Negative	**Referenced Section/ Paragraph**	Entire Document		
	Negative Text	7.3 Polyimide (PI) — Traditionally used in flex electronics when needing a higher temperature and better chemical stability than either PET or PEN. Excellent dielectric properties as well as thermal characteristics, used for soldering surface mount devices (SMD) and wet etching fabrication. PI has an amber coloration and is optically translucent in thinner films. It is a more expensive option but allows for a wider range of circuit applications. From this point onward, "flexible" and "flex" are used. It should be unified to "flexible".		
	Withdrawal (check one)	**X**	No Negative withdrawal made by Voter.	**GO TO "Related" subsection**

Related	**Motion and Reason (check one)**	**X**	'Related' is mutually agreed upon. **(Needs no motion.)**				**GO TO "Persuasive" subsection**
Persuasive	**Motion and Reason (check one)**	**X**	Negative is related and persuasive. **(Needs >1/3 votes to pass.)**				
	Motion by/ 2nd by	**By:** Stephen Gonya (Binghamton University (SUNY)) **Second:** Deepak Trivedi (GE Research)					
	Discussion	None					
	Result of Vote (check one)	3 **Y** 0 **N**; Motion passed.					
		X	[Negative is related and persuasive.] > 1/3	**Is a technical change recommended? (check one)**	**X**	**Y**	**GO TO "Address by Technical Change Option" subsection**

Address by Technical Change Option

Technical Change Recommendations
Original section/paragraph number and at least one full sentence are required in "FROM" and "TO" fields.

Technical Changes — **1**

FROM: Section/Paragraph XXX

<< to save space, only the "TO:" are shown with track changes >>

TO: Section/Paragraph xxx

2 Scope

…

2.1.1 *Design for Flexible Substrates* — Substrate material considerations and guidelines for flexible circuit design, electrical performance, reliability, and flexural bending/shaping.

…

5.2.6 *flexible electronics* — electronic components on or in a flexible substrate.

NOTE 3: The concept of flexibility includes not only being bendable but also being shearable, twistable, and stretchable.

NOTE 4: "Flex" in this Guide is used as a verb and noun. "Flexible" is used as an adjective.

…

7.3 *Polyimide (PI)* — Traditionally used in flexible electronics when needing a higher temperature and better chemical stability than either PET or PEN. …

…

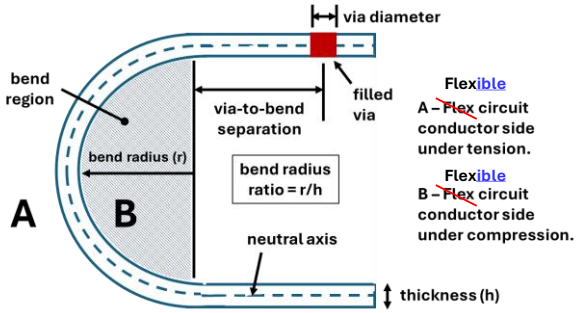
8.2 *Minimum Radius for Tear Resistance* — The minimum radius on inside corners of a flexible substrate outline should be at least 1.5 mm (0.059 in.) to minimize stress concentration and increase tear resistance; however, larger radii will make a more reliable part and be more resistant to tearing (0). Additional materials may be added to the inside radii to provide increased tear resistance (**Error! Reference source not found.**). These tear guard materials reinforce the flexible material and prevent tear propagation. To evaluate tear resistance for propagation of mechanical damage, refer to ASTM D624.

Figure 2
Use Larger Radii on Inside Corners of Flexible Substrate

TO: Section/Paragraph xxx

8.3 *Stiffeners* — Specific areas of a flexible circuit can be stiffened by adding localized rigid material called stiffeners. PET, PI or FR4 materials are commonly used for stiffeners. These materials can be attached with thermally cured adhesive or pressure-sensitive adhesive (PSA). Connector locations are a common area to use stiffeners to prevent excessive substrate flexing when plugging and unplugging connector.

…



#1 Neutral axis shown along center of substrate. Tension side A and compression side B.

Figure 8
Via-to-Bend Separation Distance

8.14 *Multiple Layers* — If the number of conductors required becomes too high for the allowed width of the substrate, or if multiple circuit cross-overs are required, then a double-sided flexible layer may be considered. This may also occur if, for example, the impedance needs dictate an embedded microstrip configuration wherein one of the conductive layers is a reference plane.

8.15 *Outline Cutting* — Laser depanelization is recommended for cutting the flexible circuit outline. However, cutting can also be done by blade, routing, punching, stamping, or hand scalpel.

…

9 Flexural Design Considerations

9.1 *Flexural Design* — The specific flex application and requirements will drive the substrate design and define what materials and design features need to be incorporated. For example, a static flexible circuit that is formed-to-fit with very few bending cycles, such as a flexible circuit formed to the contours of an enclosure, will require different attributes than a dynamic flex application that undergoes continuously bending throughout its operational life, such as a flexible circuit spanning a knee-joint. In addition, there are many hybrid applications that undergo continuous flexing but with mild bending requirements where the bend radius is loose or the number of cycles is small, such as a wearable apparel patch or a container lid that is opened infrequently.

9.2 *Bend Radius* — The minimum bend radius ratio for reliability of a single-sided static flex circuit is 6× the radius (*r*) divided by the flex thickness (*h*), stated as 6/1 or 6:1 (refer to 0). The minimum bend radius for a double-sided flexible circuit is 12× the flex thickness (12:1). The minimum bend radius for a dynamic flexible circuit is 100× the flex thickness (100:1). Bend radius ratio and its reliability impact is addressed in IPC-2223.

NOTE 15: Bend radius is measured from inside surface of flex bend.

NOTE 16: Static Flex (or bend-to-install) is flexed less than 100 times in its lifetime.

NOT 17: Dynamic Flex is regularly flexed during its operational lifetime.

NOTE 18: The bend radius criteria were taken from IPC-2223 which was created for copper foil clad laminate flexible circuits. The actual band radius of an additively printed flexible circuit may be different depending on flexible materials and its construction.

…

9.3.9 Using cross-hatch planes in bend areas increases flexibility. Typically, a 50% conductor fill is used in a cross-hatch pattern. For additively printed ground planes, it can be cost effective to utilize hatched planes instead of solid ones so less conductive ink is used and yield faster layer print times. Hatched ground planes are also more flexible compared to solid plane layers and may be advantageous in flexible regions of substrate. Note that hatched ground planes may not be suitable for higher frequency RF application where a solid return path is desired.

…

9.5 *Molded Shape* — As an alternative approach for single-sided flexible circuits, the bare substrate can be formed into shape with severe bend geometries, and then the circuit can be conformally printed onto the 3D shaped surfaces. This often requires a 3+ axis printing system to achieve the desired shape printing. This method can also be used to print circuitry onto rigid 3D articles where the final shape is molded and the 3D print pattern conforms to a CAD model design.

…

16.2 *Define Flexibility and Bending Requirements and Constraints* — Identify required bending radius (*R*), bend angle (Θ), twist loads (*Mx* and *My*), axial loads (*Fa*), volumetric/pressure loads (*p*), loads due to gravity (*g*), flex cycles, temperature and pressure cycles, frequency of loading/unloading cycles, etc. (0). Identify whether the application is displacement-controlled or force-controlled.

…

Figure 22
Typical Loads on a Flexible Substrate

…

Table A1-1 Summary of Printing Methods

Printing Methods	*Principle*	*Ink Viscosity*	*Smallest Features Size*	*Surface Configuration*
Stencil	Ink is forced through opening in stencil plate by squeegee	500-100000 cP	200 µm	Planar surfaces (2D)
Screen	Ink is forced through meshed screen by squeegee	500-100000 cP	75 µm	Planar surface (2D)
Dispense	Ink is extruded through a nozzle	500-28000 cP	20 µm	non-planar (2.5D)
Gravure	Ink transfer by cells in a rotary cylinder	20-100 cP	75 µm	Planar (flexible)
Offset Gravure	Ink is doctored into the cells of the gravure cylinder which is transferred to a roller then the substrate.	50-200 cP	10 µm	Planar~~,~~ (flexible, rigid)
Flexography	Ink is transferred by relief plates	20-2500 cP	7 µm	Planar (flexible)

…

Justification (If necessary)

Document 7193 text was reviewed and all word usages of "flex" were changed to "flexible", except where 'flex' is used as a verb. NOTE 4 was added to explain this for clarity. Minor grammatical changes were also made throughout.

Motion	Negative is addressed by the technical change(s).		
Motion by/2nd by	**By:** Deepak Trivedi (GE Research) **Second:** Stephen Gonya (Binghamton University (SUNY))		
Discussion	None		
Result of Vote (check one)	3 **Y** 0 **N**; Motion passed.		
	X	2/3 ≤ [Negative is addressed by the technical change(s).]	**GO TO "Incorporation of the Technical Change" subsection**

	Incorporation of the Technical Change	Motion	To incorporate the technical change(s).			
		Motion by/2nd by	**By:** Deepak Trivedi (GE Research) **Second:** Stephen Gonya (Binghamton University (SUNY))			
		Discussion	None			
		Result of Vote (check one)	3 **Y** 0 **N**; Motion passed.			
			X	90% ≤ [Agree to incorporate.]	**GO TO "Final" subsection → (F)**	
Final	(check if applicable)	**X**	**(F)**	Addressed by technical change **(counted under k disposition)**		

Negative 8

Negative	**Referenced Section/ Paragraph**	Section 8				
	Negative Text	8 FHE Design Best Practices FHE Design Best Practices Many FHE products do not use this design rule, so "Best Practices" is too strong term.				
	Withdrawal (check one)	**X**	No Negative withdrawal made by Voter.		**GO TO "Related" subsection**	
Related	**Motion and Reason**	**X**	'Related' is mutually agreed upon. **(Needs no motion.)**		**GO TO "Persuasive" subsection**	
Persuasive	**Motion and Reason**	**X**	Negative is related and persuasive. **(Needs >1/3 votes to pass.)**			
	Motion by/ 2nd by	**By:** Stephen Gonya (Binghamton University (SUNY)) **Second:** Deepak Trivedi (GE Research)				
	Discussion	None				
	Result of Vote (check one)	3 **Y** 0 **N**; Motion passed.				
		X	[Negative is related and persuasive.] > 1/3	**Is a technical change recommended?**	**X** **Y**	**GO TO "Address by Technical Change Option" subsection**
Address by Technical Change Option	**Technical Change Recommendations** **Original section/paragraph number and at least one full sentence are required in "FROM" and "TO" fields.**					
	Technical Changes 1	**FROM: Section/Paragraph 8** **8 FHE Design Best Practices**				
		TO: Section/Paragraph 8 **8 FHE Design ~~Best~~ Guidelines~~Practices~~**				
		Justification (If necessary) Section 8 title changed from "FHE Design Best Practices" to "FHE Design Guidelines" to be less rule-like in meaning.				
	Motion	Negative is addressed by the technical change(s).				
	Motion by/2nd by	**By:** Deepak Trivedi (GE Research) **Second:** Stephen Gonya (Binghamton University (SUNY))				

	Discussion		None		
	Result of Vote (check one)		3 **Y** 0 **N**; Motion passed.		
		X	2/3 ≤ [Negative is addressed by the technical change(s).]	**GO TO "Incorporation of the Technical Change" subsection**	
	Incorporation of the Technical Change	**Motion**	To incorporate the technical change(s).		
		Motion by/2nd by	**By:** Deepak Trivedi (GE Research) **Second:** Stephen Gonya (Binghamton University (SUNY))		
		Discussion	None		
		Result of Vote (check one)	3 **Y** 0 **N**; Motion passed.		
		X	90% ≤ [Agree to incorporate.]	**GO TO "Final" subsection → (F)**	
Final	**(check if applicable)**	**X**	**(F)**	Addressed by technical change **(counted under k disposition)**	

Negative 9

Negative	**Referenced Section/ Paragraph**	Figure 9		
	Negative Text	A – preferred, B – acceptable, C – not preferred, D – unacceptable Figure 9 Trace Routing in Bend Area The expressions A to D are not appropriate as guide standards. Please change to desirable, undesirable, or ranked order.		
	Withdrawal (check one)	**X**	No Negative withdrawal made by Voter.	**GO TO "Related" subsection**
Related	**Motion and Reason (check one)**	**X**	'Related' is mutually agreed upon. **(Needs no motion.)**	**GO TO "Persuasive" subsection**
Persuasive	**Motion and Reason (check one)**	**X**	Negative is related and not persuasive. **(Needs ≥2/3 votes to pass.)**	
			Reason	Addressed by Ryoichi Watanabe Negative #2.
	Motion by/ 2nd by	**By:** Randall Parker (DISCO) **Second:** Stephen Gonya (Binghamton University (SUNY))		
	Discussion	None		
	Result of Vote (check one)	6 **Y** 0 **N**; Motion passed		
		X	90% ≤ [Negative is related and not persuasive.]	**GO TO "Not Significant Finding Option" subsection**
Not Significant	**This option can be used only "if the TC Chapter finds a Negative not persuasive by a vote equal to or greater than 90% of the persons voting on the action". (*Regulations* ¶ 9.6.1.4.5.2)**			
	Use of "Not significant finding option" (check one)	**X**	It is mutually agreed upon to term the Negative "not significant".	**GO TO "Final" subsection → (D)**
Final		**X**	**(D)**	Not significant **(counted under j in disposition)**

Negative 10

Negative	Referenced Section/ Paragraph	9.3.4					
	Negative Text	9.3.4 Conductive traces in double-sided circuits of bend area should not be placed directly over each other, which produces an "I" beam effect. Route double-sided circuit traces staggered top to bottom, refer to Figure 10. Please explain the "I-beam effect."					
	Withdrawal (check one)	X	No Negative withdrawal made by Voter.				GO TO "Related" subsection
Related	Motion and Reason	X	'Related' is mutually agreed upon. (Needs no motion.)				GO TO "Persuasive" subsection
Persuasive	Motion and Reason	X	Negative is related and persuasive. (Needs >1/3 votes to pass.)				
	Motion by/ 2nd by	By: Stephen Gonya (Binghamton University (SUNY)) Second: Deepak Trivedi (GE Research)					
	Discussion	None					
	Result of Vote (check one)	3 Y 0 N; Motion passed.					
		X	[Negative is related and persuasive.] > 1/3	Is a technical change recommended?	X	Y	GO TO "Address by Technical Change Option" subsection

Address by Technical Change Option

Technical Change Recommendations
Original section/paragraph number and at least one full sentence are required in "FROM" and "TO" fields.

Technical Changes

1

FROM: Section/Paragraph 9.3.4

9.3.4 Conductive traces in double-sided circuits of bend area should not be placed directly over each other, which produces an "I" beam effect. Route double-sided circuit traces staggered top to bottom, refer to Figure 10.

TO: Section/Paragraph 9.3.4

9.3.4 ~~Conductive traces in double-sided circuits of bend area should not be~~Consider placement of double-sided circuits in the bend area regarding the overall stiffness. Traces placed directly over each other ~~, which produces~~ a rigid beam-like structure and can result in higher bending stiffness~~an "I" beam effect~~. Routing~~e~~ double-sided circuit traces staggered top to bottom will result in lower bending stiffness, refer to 0.

Justification (If necessary)
Reworded I-beam effect for clarity.

2

FROM: Section/Paragraph Figure 10

#1 Correct – staggered Incorrect – stacked

Figure 10
Double-Side Trace Routing in Bend Area

			TO: Section/Paragraph Figure 10  #1 ~~Correct~~ Lower bending stiffness – staggered ~~Incorrect~~ Higher bending stiffness – stacked **Figure 10** **Double-Side Trace Routing in Bend Area**		
			Justification (If necessary) Changes made to Figure 10, to be consistent with revisions made in 9.3.4.		
	Motion		Negative is addressed by the technical change(s).		
	Motion by/2nd by		**By:** Deepak Trivedi (GE Research) **Second:** Stephen Gonya (Binghamton University (SUNY))		
	Discussion		None		
	Result of Vote (check one)		3 **Y** 0 **N**; Motion passed.		
		X	2/3 ≤ [Negative is addressed by the technical change(s).]		**GO TO "Incorporation of the Technical Change" subsection**
	Incorporation of the Technical Change	**Motion**	To incorporate the technical change(s).		
		Motion by/2nd by	**By:** Deepak Trivedi (GE Research) **Second:** Stephen Gonya (Binghamton University (SUNY))		
		Discussion	None		
		Result of Vote (check one)	3 **Y** 0 **N**; Motion passed.		
		X	90% ≤ [Agree to incorporate.]		**GO TO "Final" subsection → (F)**
Final	**(check if applicable)**	**X**	**(F)**	Addressed by technical change **(counted under k disposition)**	

Negative 11

Negative	**Referenced Section/ Paragraph**	9.5		
	Negative Text	9.5 Molded Shape — As an alternative approach for single-sided flex circuits, the bare substrate can be formed into shape with severe bend geometries, and then the circuit can be conformally printed onto the 3D shaped surfaces. This often requires a 3+ axis printing system to achieve the desired shape printing. This method can also be used to print circuitry onto rigid 3D articles where the final shape is molded and the 3D print pattern conforms to a CAD model design. The title does not match the content. It's not just a 3+ axis printing system. Pad printing is also possible.		
Withdrawal (check one)		**X**	No Negative withdrawal made by Voter.	**GO TO "Related" subsection**
Related	**Motion and Reason**	**X**	'Related' is mutually agreed upon. **(Needs no motion.)**	**GO TO "Persuasive" subsection**

Persuasive

Motion and Reason	X	Negative is related and persuasive. **(Needs >1/3 votes to pass.)**					
Motion by/ 2nd by	**By:** Stephen Gonya (Binghamton University (SUNY)) **Second:** Deepak Trivedi (GE Research)						
Discussion	None						
Result of Vote (check one)	3 **Y** 0 **N**; Motion passed.						
	X	[Negative is related and persuasive.] > 1/3	**Is a technical change recommended?**	X	Y	**GO TO "Address by Technical Change Option" subsection**	

0Address by Technical Change Option

Technical Change Recommendations
Original section/paragraph number and at least one full sentence are required in "FROM" and "TO" fields.

Technical Changes — **1**

FROM: Section/Paragraph 9.5

9.5 *Molded Shape* — As an alternative approach for single-sided flex circuits, the bare substrate can be formed into shape with severe bend geometries, and then the circuit can be conformally printed onto the 3D shaped surfaces. This often requires a 3+ axis printing system to achieve the desired shape printing. This method can also be used to print circuitry onto rigid 3D articles where the final shape is molded and the 3D print pattern conforms to a CAD model design.

TO: Section/Paragraph 9.5

9.5 *Conformal Electronics* ~~*Molded Shape*~~ — As an alternative approach for single-sided flexible circuits, the bare substrate can be formed into shape with severe bend geometries, and then the circuit can be conformally printed onto the 3D shaped surfaces. This often requires a 3+ axis printing system to achieve complex ~~the desired~~ shape printing. This method can also be used to print circuitry onto rigid 3D articles where the final shape is molded and the 3D print pattern conforms to a CAD model design.

Justification (If necessary)
'Molded Shape' title for section 9.5 was not consistent with the stated definition. 9.5 title changed to 'Conformal Electronics' and made minor revisions to be consistent with the change.

Motion	Negative is addressed by the technical change(s).			
Motion by/2nd by	**By:** Deepak Trivedi (GE Research) **Second:** Stephen Gonya (Binghamton University (SUNY))			
Discussion	None			
Result of Vote (check one)	3 **Y** 0 **N**; Motion passed.			
	X	2/3 ≤ [Negative is addressed by the technical change(s).]	**GO TO "Incorporation of the Technical Change" subsection**	

Incorporation of the Technical Change

Motion	To incorporate the technical change(s).		
Motion by/2nd by	**By:** Deepak Trivedi (GE Research) **Second:** Stephen Gonya (Binghamton University (SUNY))		
Discussion	None		
Result of Vote (check one)	3 **Y** 0 **N**; Motion passed.		
	X	90% ≤ [Agree to incorporate.]	**GO TO "Final" subsection → (F)**

Final

(check if applicable)	X	**(F)**	Addressed by technical change **(counted under k disposition)**

Negative 12

Negative	Referenced Section/ Paragraph	9.5.1					
	Negative Text	9.5.1 In-Mold Electronics — A variation of 3D electronics where the circuitry (and sometimes assembly) is fabricated in the flat condition and then the entire device is thermal molded into shape. The electronics are integrated directly into a plastic part prior to the molding process. The content differs from "5.2.12". I am investigating this technology, and I call "9.5" and "9.5.1" three-dimensional shape electronics.					
	Withdrawal (check one)	X	No Negative withdrawal made by Voter.				GO TO "Related" subsection
Relate	Motion and Reason	X	'Related' is mutually agreed upon. (Needs no motion.)				GO TO "Persuasive" subsection
Persuasive	Motion and Reason	X	Negative is related and persuasive. (Needs >1/3 votes to pass.)				
	Motion by/ 2nd by	By: Stephen Gonya (Binghamton University (SUNY)) Second: Deepak Trivedi (GE Research)					
	Discussion	None					
	Result of Vote (check one)	3 Y 0 N; Motion passed.					
		X	[Negative is related and persuasive.] > 1/3	Is a technical change recommended?	X	Y	GO TO "Address by Technical Change Option" subsection

0Address by Technical Change Option

Technical Change Recommendations

Technical Changes — **1**

FROM: Section/Paragraph 9.5.1

9.5.1 *In-Mold Electronics* — A variation of 3D electronics where the circuitry (and sometimes assembly) is fabricated in the flat condition and then the entire device is thermal molded into shape. The electronics are integrated directly into a plastic part prior to the molding process.

TO: Section/Paragraph 9.5.1

9.5.1 *In-Mold Electronics* — A variation of 3D electronics where the circuitry (and sometimes assembly) is fabricated in the ~~flat~~ planar condition and then the ~~entire~~ device is ~~thermal~~ molded into shape often using a thermal process. The circuitry becomes~~electronics are~~ integrated with the~~directly into a plastic~~ molded part ~~duringprior to the the molding process~~.

Justification (If necessary)

Inconsistent content between 9.5.1 and 5.2.12 for In-Mold Electronics. Updated 9.5.1. to match 5.2.12 from the change that was addressed in Tadahiro Furukawa Neg #4.

Motion	Negative is addressed by the technical change(s).			
Motion by/2nd by	By: Deepak Trivedi (GE Research) Second: Stephen Gonya (Binghamton University (SUNY))			
Discussion	None			
Result of Vote (check one)	3 Y 0 N; Motion passed.			
	X	2/3 ≤ [Negative is addressed by the technical change(s).]		GO TO "Incorporation of the Technical Change" subsection

	Incorporation of the Technical Change	**Motion**	To incorporate the technical change(s).		
		Motion by/2nd by	**By:** Deepak Trivedi (GE Research) **Second:** Stephen Gonya (Binghamton University (SUNY))		
		Discussion	None		
		Result of Vote (check one)	3 **Y** 0 **N**; Motion passed.		
			X	90% ≤ [Agree to incorporate.]	**GO TO "Final" subsection → (F)**
Final	**(check if applicable)**	**X**	**(F)**	Addressed by technical change **(counted under k disposition)**	

Negative 13

Negative	**Referenced Section/ Paragraph**	10.13.8		
	Negative Text	10.13.8 Sheet Resistance — Sheet Resistance is a common electrical property used to characterize thin films of conducting materials using a 4-point probe measurement through a thin square of material, with units of ohms per square (refer to ASTM F390). Sheet resistance (Rs) is defined as the material resistivity (ρ) divided by its thickness (t). For example, the sheet resistance of 1 oz copper is 0.0005 Ω/sq. Typical sheet resistance range for silver ink film is 0.01-0.04 Ω/sq, although the best conductive ink for an application will depend on multiple variables including sheet resistance, thickness, substrate, cure temperature, deposition method, etc. 1 oz copper -→ 35-micrometer-thick copper foil silver ink -→ All others use Ag-ink.		
Withdrawal (check one)		**X**	No Negative withdrawal made by Voter.	**GO TO "Related" subsection**
Related	**Motion and Reason (check one)**	**X**	'Related' is mutually agreed upon. **(Needs no motion.)**	**GO TO "Persuasive" subsection**
Persuasive	**Motion and Reason (check one)**	**X**	Negative is related and not persuasive. **(Needs ≥2/3 votes to pass.)**	
			Reason	Addressed by Satoshi Maeda Neg #4
	Motion by/ 2nd by	**By:** Randall Parker (DISCO) **Second:** Stephen Gonya (Binghamton University (SUNY))		
	Discussion	None		
	Result of Vote (check one)	6 **Y** 0 **N**; Motion passed		
		X	90% ≤ [Negative is related and not persuasive.]	**GO TO "Not Significant Finding Option" subsection**
Not Significant	**This option can be used only "if the TC Chapter finds a Negative not persuasive by a vote equal to or greater than 90% of the persons voting on the action". (*Regulations* ¶ 9.6.1.4.5.2)**			
	Use of "Not significant finding option" (check one)	**X**	It is mutually agreed upon to term the Negative "not significant".	**GO TO "Final" subsection → (D)**
Final		**X**	**(D)**	Not significant **(counted under j in disposition)**

Negative 14

Negative	Referenced Section/ Paragraph	Figure 16					
	Negative Text	Figure 16 Simulation Design of a Circular Printed Inductor I don't understand what the simulation model is trying to show. It would be better to either write the parameters or remove the figure. What is Ansys 2022 in the upper right of the figure? Is the copyright okay?					
	Withdrawal (check one)	X	No Negative withdrawal made by Voter.				GO TO "Related" subsection
Related	Motion and Reason	X	'Related' is mutually agreed upon. (Needs no motion.)				GO TO "Persuasive" subsection
Persuasive	Motion and Reason	X	Negative is related and persuasive. (Needs >1/3 votes to pass.)				
	Motion by/ 2nd by	By: Stephen Gonya (Binghamton University (SUNY)) Second: Deepak Trivedi (GE Research)					
	Discussion	None					
	Result of Vote (check one)	3 Y 0 N; Motion passed.					
		X	[Negative is related and persuasive.] > 1/3	Is a technical change recommended?	X	Y	GO TO "Address by Technical Change Option" subsection

Address by Technical Change Option

Technical Change Recommendations
Original section/paragraph number and at least one full sentence are required in "FROM" and "TO" fields.

Technical Changes — **1**

FROM: Section/Paragraph Figure 16

13.2 *Printed Inductors* — … There are several online planar spiral coil inductance calculators that can aid in designing the spiral coil dimensions and include variables for the type of coil, trace width, trace spacing, number of turns, inner diameter, outer diameter, and conductor resistivity. A simulation model of a circular spiral inductor is shown in 0. Common to all printed planar spirals is a dielectric bridge printed across the coils to provide a pathway to the center contact. This dielectric material is electrically insulative and often used in other areas of a circuit design. For high-frequency applications, the *Dk* and *Df* of the dielectric should be considered, with the goal of using a material with the lowest dielectric constant and lowest dielectric loss. Some designs use a center via for the center connection with the bridge trace printed on the substrate opposite side.

…

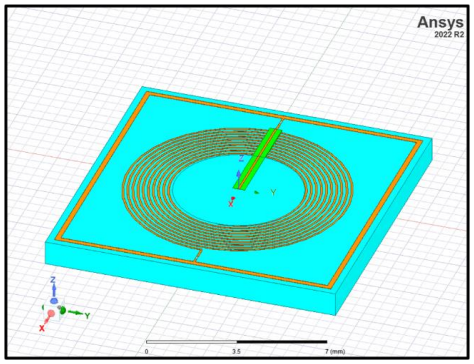


Figure 16
Simulation Design of a Circular Printed Inductor

.

TO: Section/Paragraph Figure 16

13.2 *Printed Inductors* — … There are several online planar spiral coil inductance calculators that can aid in designing the spiral coil dimensions and include variables for the type of coil, trace width, trace spacing, number of turns, inner diameter, outer diameter, and conductor resistivity. A simulation model example of a circular spiral inductor is shown in 0. Common to all printed planar spirals is a dielectric bridge printed across the coils to provide a pathway to the center contact. This dielectric material is electrically insulative and often used in other areas of a circuit design. For high-frequency applications, the *Dk* and *Df* of the dielectric should be considered, with the goal of using a material with the lowest dielectric constant and lowest dielectric loss. Some designs use a center via for the center connection with the bridge trace printed on the substrate opposite side.

…

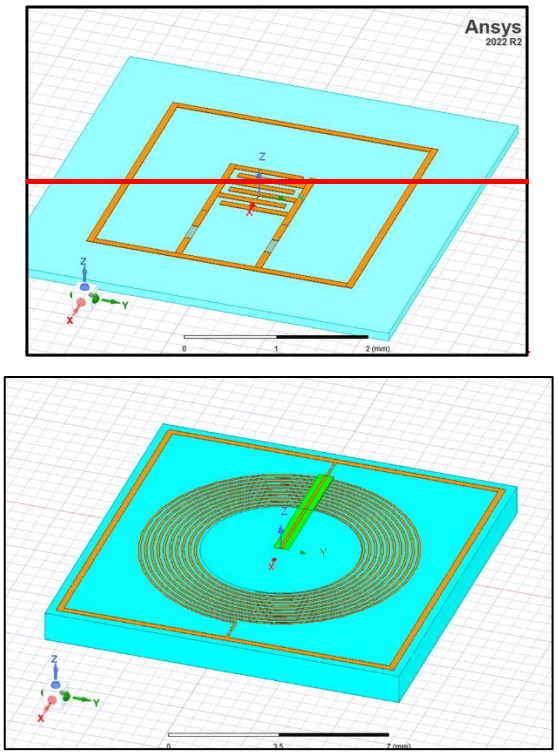


Figure 16
Example ~~Simulation Design~~ of a Circular Printed Inductor

Justification (If necessary)

Similar to CAD drawings, the image was created by the author, so company logo was removed and some of the text and Figure captions were revised to better explain the image.

2

FROM: Section/Paragraph Figure 18

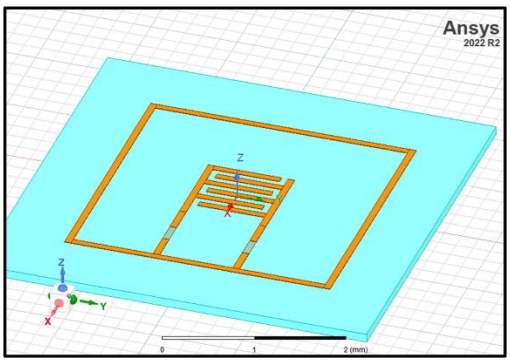
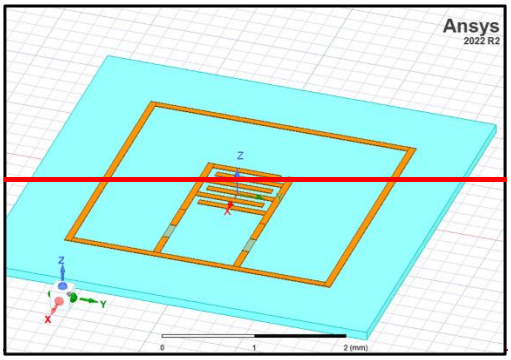


Figure 18
Co-Planar Interdigital Capacitor

TO: Section/Paragraph Figure 18



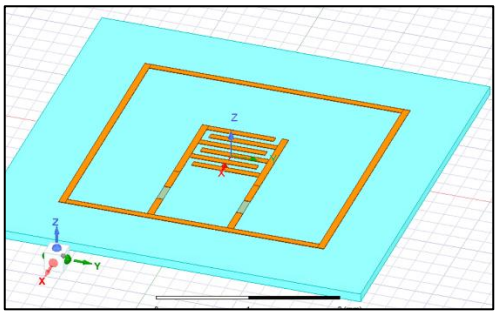


Figure 18
Example of a Co-Planar Interdigital Capacitor

Justification (If necessary)
Changes made to Figure 18 were made to be consistent with revisions to Figure 16 and related text.

Motion			Negative is addressed by the technical change(s).	
Motion by/2nd by			**By:** Deepak Trivedi (GE Research) **Second:** Stephen Gonya (Binghamton University (SUNY))	
Discussion			None	
Result of Vote (check one)			3 **Y** 0 **N**; Motion passed.	
		X	2/3 ≤ [Negative is addressed by the technical change(s).]	**GO TO "Incorporation of the Technical Change" subsection**
Incorporation of the Technical Change	**Motion**		To incorporate the technical change(s).	
	Motion by/2nd by		**By:** Deepak Trivedi (GE Research) **Second:** Stephen Gonya (Binghamton University (SUNY))	
	Discussion		None	
	Result of Vote (check one)		3 **Y** 0 **N**; Motion passed.	
		X	90% ≤ [Agree to incorporate.]	**GO TO "Final" subsection → (F)**
Final	**(check if applicable)**	**X**	**(F)**	Addressed by technical change **(counted under k disposition)**

Negative 15

Negative	**Referenced Section/ Paragraph**	13.2.1					
	Negative Text	13.2.1 In some cases, non-planar spiral inductors can be printed that involve 3D additive manufacturing techniques to build a cylinder or conical structures to print the coil windings onto. These devices are more complex and difficult to fabricate but can offer reduced spiral outer dimension to save board real estate, or are able to operate over a broader frequency band using a conical design. "3D additive manufacturing techniques" requires explanation.					
	Withdrawal (check one)	**X**	No Negative withdrawal made by Voter.				**GO TO "Related" subsection**
Related	**Motion and Reason**	**X**	'Related' is mutually agreed upon. **(Needs no motion.)**				**GO TO "Persuasive" subsection**
Persuasive	**Motion and Reason**	**X**	Negative is related and persuasive. **(Needs >1/3 votes to pass.)**				
	Motion by/ 2nd by	**By:** Stephen Gonya (Binghamton University (SUNY)) **Second:** Deepak Trivedi (GE Research)					
	Discussion	None					
	Result of Vote (check one)	3 **Y** 0 **N**; Motion passed.					
		X	[Negative is related and persuasive.] > 1/3	**Is a technical change recommended?**	**X**	**Y**	**GO TO "Address by Technical Change Option" subsection**

0Address by Technical Change Option

Technical Change Recommendations
Original section/paragraph number and at least one full sentence are required in "FROM" and "TO" fields.

Technical Changes — **1**

FROM: Section/Paragraph 13.2.1

13.2.1 In some cases, non-planar spiral inductors can be printed that involve 3D additive manufacturing techniques to build a cylinder or conical structures to print the coil windings onto. These devices are more complex and difficult to fabricate but can offer reduced spiral outer dimension to save board real estate, or are able to operate over a broader frequency band using a conical design.

TO: Section/Paragraph 13.2.1

13.2.1 In some cases, non-planar spiral inductors can be printed by~~that involve 3D~~ additive manufacturing techniques to build a 3D cylinder or conical structure~~s~~ in which to print the coil windings onto. These devices are more complex and difficult to fabricate but can offer reduced size~~spiral outer dimension~~ to save board real estate, or are able to operate over a broader frequency band~~ using a conical design~~.

Justification (If necessary)

Inconsistent content between 9.5.1 and 5.2.12 for In-Mold Electronics. Updated 9.5.1. to match 5.2.12 from the change that was addressed in Tadahiro Furukawa Neg #4.

Motion	Negative is addressed by the technical change(s).
Motion by/2nd by	**By:** Deepak Trivedi (GE Research) **Second:** Stephen Gonya (Binghamton University (SUNY))
Discussion	None
Result of Vote	3 **Y** 0 **N**; Motion passed.

	(check one)		X	2/3 ≤ [Negative is addressed by the technical change(s).]	GO TO "Incorporation of the Technical Change" subsection
	Incorporation of the Technical Change	Motion	To incorporate the technical change(s).		
		Motion by/2nd by	**By:** Deepak Trivedi (GE Research) **Second:** Stephen Gonya (Binghamton University (SUNY))		
		Discussion	None		
		Result of Vote (check one)	3 **Y** 0 **N**; Motion passed.		
			X	90% ≤ [Agree to incorporate.]	GO TO "Final" subsection → (F)
Final	(check if applicable)	X	(F)	Addressed by technical change (counted under k disposition)	

Negative 16

Negative	Referenced Section/ Paragraph	13.4					
	Negative Text	13.4 Printed Active Components — Printed active devices are defined as printed semiconductor devices on a planar flexible surface. These devices are challenging to fabricate and require extensive empirical testing to validate. The specific type and geometry of active components (including materials and layer structure) should be defined on the master drawing. As of the publication date of this document, printed active component technology is not considered mature enough for commercial implementation. Please delete					
Withdrawal (check one)		X	No Negative withdrawal made by Voter.				GO TO "Related" subsection
Related	Motion and Reason	X	'Related' is mutually agreed upon. (Needs no motion.)				GO TO "Persuasive" subsection
Persuasive	Motion and Reason	X	Negative is related and persuasive. (Needs >1/3 votes to pass.)				
	Motion by/ 2nd by	**By:** Stephen Gonya (Binghamton University (SUNY)) **Second:** Deepak Trivedi (GE Research)					
	Discussion	None					
	Result of Vote (check one)	3 **Y** 0 **N**; Motion passed.					
		X	[Negative is related and persuasive.] > 1/3	**Is a technical change recommended?**	X	Y	GO TO "Address by Technical Change Option" subsection
0Address by Technical Change	**Technical Change Recommendations** **Original section/paragraph number and at least one full sentence are required in "FROM" and "TO" fields.**						
	Technical Changes	1	**FROM: Section/Paragraph 13.4**13.4 *Printed Active Components* — Printed active devices are defined as printed semiconductor devices on a planar flexible surface. These devices are challenging to fabricate and require extensive empirical testing to validate. The specific type and geometry of active components (including materials and layer structure) should be defined on the master drawing. As of the publication date of this document, printed active component technology is not considered mature enough for commercial implementation.				

			TO: Section/Paragraph 13.4 13.4 *Printed Active Components* — Printed active devices are defined as printed semiconductor devices on a planar flexible surface. These devices are challenging to fabricate and require extensive empirical testing to validate. The specific type and geometry of active components (including materials and layer structure) should be defined on the master drawing. ~~As of the publication date of this document, printed active component technology is not considered mature enough for commercial implementation.~~		
			Justification (If necessary) Deleted last sentence of section 13.4 text per reviewer's suggestion.		
	Motion		Negative is addressed by the technical change(s).		
	Motion by/2nd by		**By:** Deepak Trivedi (GE Research) **Second:** Stephen Gonya (Binghamton University (SUNY))		
	Discussion		None		
	Result of Vote (check one)		3 **Y** 0 **N**; Motion passed.		
		X	2/3 ≤ [Negative is addressed by the technical change(s).]		**GO TO "Incorporation of the Technical Change" subsection**
	Incorporation of the Technical Change	**Motion**	To incorporate the technical change(s).		
		Motion by/2nd by	**By:** Deepak Trivedi (GE Research) **Second:** Stephen Gonya (Binghamton University (SUNY))		
		Discussion	None		
		Result of Vote (check one)	3 **Y** 0 **N**; Motion passed.		
		X	90% ≤ [Agree to incorporate.]		**GO TO "Final" subsection → (F)**
Final	**(check if applicable)**	**X**	**(F)**	Addressed by technical change **(counted under k disposition)**	

Negative 17

Negative	**Referenced Section/ Paragraph**	13.6		
	Negative Text	13.6 Printed Antennas — Lower frequency antennas (<10 GHz) can be printed with conductive ink (Figure 19) and have similar RF performance to that of traditional copper foil antennas. Ink conductivity, feature resolution, dimensional tolerance, and surface roughness become more critical at higher frequencies. Above 10 GHz, the RF performance of printed antennas start to underperform a comparable copper foil antenna. Attention should be given to printed antenna low-loss connections and impedance transitions between antenna, cabling, and circuitry. Since inductors and capacitors have been described, the 13.56 MHz antenna should also be included.		
Withdrawal (check one)		**X**	No Negative withdrawal made by Voter.	**GO TO "Related" subsection**
Related	**Motion and Reason**	**X**	'Related' is mutually agreed upon. **(Needs no motion.)**	**GO TO "Persuasive" subsection**
	Motion and Reason	**X**	Negative is related and persuasive. **(Needs >1/3 votes to pass.)**	

Persuasive

Motion by/ 2nd by	**By:** Stephen Gonya (Binghamton University (SUNY)) **Second:** Deepak Trivedi (GE Research)					
Discussion	None					
Result of Vote (check one)	3 **Y** 0 **N**; Motion passed.					
	X	[Negative is related and persuasive.] > 1/3	**Is a technical change recommended?**	**X**	**Y**	**GO TO "Address by Technical Change Option" subsection**

0Address by Technical Change Option

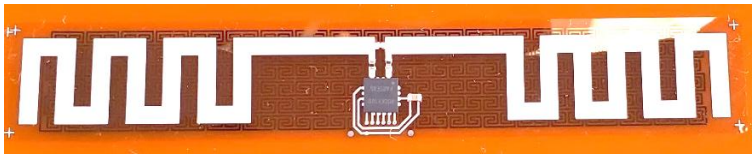
Technical Change Recommendations

Original section/paragraph number and at least one full sentence are required in "FROM" and "TO" fields.

Technical Changes — **1**

FROM: Section/Paragraph 13.6

13.6 *Printed Antennas* — Lower frequency antennas (<10 GHz) can be printed with conductive ink (0) and have similar RF performance to that of traditional copper foil antennas. Ink conductivity, feature resolution, dimensional tolerance, and surface roughness become more critical at higher frequencies. Above 10 GHz, the RF performance of printed antennas start to underperform a comparable copper foil antenna. Attention should be given to printed antenna low-loss connections and impedance transitions between antenna, cabling, and circuitry.



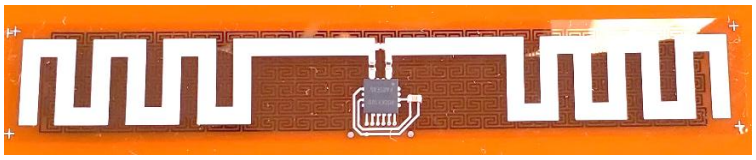
#1 Operational frequency of 915 MHz.

#2 Capacitor and inductor components were used for antenna impedance matching.

Figure 19
Passive RFID Tag with Ag-ink Printed Dipole Meander Antenna

TO: Section/Paragraph 13.6

13.6 *Printed Antennas* — Lower frequency antennas (<10 GHz) can be printed with conductive ink ~~(Figure 19)~~ and have similar RF performance to that of traditional copper foil antennas. Figure 19 shows an example of an RFID tag with a printed meander dipole antenna operating at 915 MHz. Ink conductivity, feature resolution, dimensional tolerance, and surface roughness become more critical at higher frequencies. Above 10 GHz, the RF performance of printed antennas may start to underperform a comparable copper foil antenna. Attention should be given to printed antenna low-loss connections and impedance transitions between antenna, feed network, cabling, and support circuitry.



~~Operational frequency of 915 MHz.~~

~~#3 Capacitor and inductor components were used for antenna impedance matching.~~

Figure 19
Passive RFID Tag with Ag-ink Printed Dipole Meander Antenna

Justification (If necessary)

Moved figure notes within text to clarify Reviewer's concern with reference to inductors and capacitors in Figure 19 figure notes.

Motion	Negative is addressed by the technical change(s).
Motion by/2nd by	**By:** Deepak Trivedi (GE Research) **Second:** Stephen Gonya (Binghamton University (SUNY))

	Discussion		None		
	Result of Vote (check one)		3 **Y** 0 **N**; Motion passed.		
		X	2/3 ≤ [Negative is addressed by the technical change(s).]	**GO TO "Incorporation of the Technical Change" subsection**	
	Incorporation of the Technical Change	**Motion**	To incorporate the technical change(s).		
		Motion by/2nd by	**By:** Deepak Trivedi (GE Research) **Second:** Stephen Gonya (Binghamton University (SUNY))		
		Discussion	None		
		Result of Vote (check one)	3 **Y** 0 **N**; Motion passed.		
			X	90% ≤ [Agree to incorporate.]	**GO TO "Final" subsection → (F)**
Final	**(check if applicable)**	**X**	**(F)**	Addressed by technical change **(counted under k disposition)**	

Negative 18

Negative	**Referenced Section/ Paragraph**	A1-6, A1-6.1		
	Negative Text	A1-6 Offset Gravure Printing A1-6.1 Offset Gravure is a variation of Gravure printing where the ink is doctored into the cells of the printing cylinder Same as noted in 5.2.16		
	Withdrawal (check one)	**X**	No Negative withdrawal made by Voter.	**GO TO "Related" subsection**
Related	**Motion and Reason (check one)**	**X**	'Related' is mutually agreed upon. **(Needs no motion.)**	**GO TO "Persuasive" subsection**
Persuasive	**Motion and Reason (check one)**	**X**	Negative is related and not persuasive. **(Needs ≥2/3 votes to pass.)**	
			Reason	Addressed by Tadahiro Furukawa Negative #5
	Motion by/ 2nd by	**By:** Randall Parker (DISCO) **Second:** Stephen Gonya (Binghamton University (SUNY))		
	Discussion	None		
	Result of Vote (check one)	6 **Y** 0 **N**; Motion passed		
		X	90% ≤ [Negative is related and not persuasive.]	**GO TO "Not Significant Finding Option" subsection**
Not Significant	**This option can be used only "if the TC Chapter finds a Negative not persuasive by a vote equal to or greater than 90% of the persons voting on the action". (*Regulations* ¶ 9.6.1.4.5.2)**			
	Use of "Not significant finding option" (check one)	**X**	It is mutually agreed upon to term the Negative "not significant".	**GO TO "Final" subsection → (D)**
Final		**X**	**(D)**	Not significant **(counted under j in disposition)**

Disposition of Voting Interest Reject 3

18	Original number (#) of Negatives			**(g)**
0	Number of Negatives withdrawn			**(h)**
0	Number of Negatives found not related			**(i)**
6	Number of Negatives found not significant			**(j)**
12	Number of Negatives addressed by technical change **(Negative becomes not significant)**			**(k)**
Final	**X**	**g - (h + i +j + k) = 0**	**Reject is Not Valid and is not included in the denominator of § VI. *Approval Conditions Check***	
		g - (h + i +j + k) >0	**Reject is included in the denominator of § VI. *Approval Conditions Check***	
		Reject without a Negative	**Not Valid**	

Voting Interest Reject 4 (Voting Interest Name: InnoLux Corporation)
Voter Reject 1 (Voter: Takanobu Nakagawa / InnoLux Corporation)

Negative 1

Negative	**Referenced Section/ Paragraph**	Section 5			
	Negative Text	Chapter 5 must be in line with FHE Terminology Standard which will soon be released from Japan.			
Withdrawal (check one)		**X**	No Negative withdrawal made by Voter.	**GO TO "Related" subsection**	
Related	**Motion and Reason (check one)**	**X**	'Related' is mutually agreed upon. **(Needs no motion.)**	**GO TO "Persuasive" subsection**	
Persuasive	**Motion and Reason (check one)**	**X**	Negative is related and not persuasive. **(Needs ≥2/3 votes to pass.)**		
			Reason	TF reviewed Terminology Doc 6906 against 7193 and changes were made throughout that have been addressed by other negatives. Unfortunately, since 6906 is not yet a published standard, 7193 cannot align with 6906 and will be revised via Line-Item ballot after publications.	
	Motion by/ 2nd by	**By:** Stephen Gonya (Binghamton University (SUNY)) **Second:** Randall Parker (DISCO)			
	Discussion	None			
	Result of Vote (check one)	4 **Y** 0 **N**; Motion passed			
		X	90% ≤ [Negative is related and not persuasive.]	**GO TO "Not Significant Finding Option" subsection**	
Final		**X**	**(C)**	Related and not persuasive (significant)	

This table is needed for each Negative.

Negative 2

Negative	Referenced Section/ Paragraph	Section 6			
	Negative Text	Chapter 6 : This structure is not suitable in consideration with current FHE progress. All of FHE related does not know whether described picture will be a future structure.			
	Withdrawal (check one)	X	No Negative withdrawal made by Voter.		GO TO "Related" subsection
Related	Motion and Reason (check one)	X	'Related' is mutually agreed upon. (Needs no motion.)		GO TO "Persuasive" subsection
Persuasive	Motion and Reason (check one)	X	Negative is related and not persuasive. (Needs ≥2/3 votes to pass.)		
			Reason	Editorial to remove ambiguity of the Figure and include text in 6.1 and Figure 1 that states "examples of possible FHE design elements". This text does not constrain 6.1 and Figure 1 image to only use current and near-future FHE structures.	
	Motion by/ 2nd by	By: Stephen Gonya (Binghamton University (SUNY)) Second: Randall Parker (DISCO)			
	Discussion	None			
	Result of Vote (check one)	4 Y 0 N; Motion passed			
		X	90% ≤ [Negative is related and not persuasive.]	GO TO "Not Significant Finding Option" subsection	
Final		X	(C)	Related and not persuasive (significant)	
	(check if applicable)	X	*Comment generated.* ***Refer to Section V-(ii) Comment #*** *NC-3.*		

Negative 3

Negative	Referenced Section/ Paragraph	Section 8-20			
	Negative Text	Chapter 8:~20 : These are just copy and paste from FPC design guide line. Because FHE design is still unmature for describing like chapter 8~20, from global FHE business point of view.			
	Withdrawal (check one)	X	No Negative withdrawal made by Voter.		GO TO "Related" subsection
Related	Motion and Reason (check one)	X	'Related' is mutually agreed upon. (Needs no motion.)		GO TO "Persuasive" subsection
Persuasive	Motion and Reason (check one)	X	Negative is related and not persuasive. (Needs ≥2/3 votes to pass.)		
			Reason	There are similarities between FHE (flexible printed electronics) and FPC (flexible printed circuits). Section 1.1 describes the difference between FHE and FPC and sections 8-20 detail design guidelines with consideration for differences of FHE compared to FPC.	
	Motion by/ 2nd by	By: Randall Parker (DISCO) Second: Stephen Gonya (Binghamton University (SUNY))			
	Discussion	None			
	Result of Vote (check one)	6 Y 0 N; Motion passed			
		X	90% ≤ [Negative is related and not persuasive.]	GO TO "Not Significant Finding Option" subsection	

Not Significan	This option can be used only "if the TC Chapter finds a Negative not persuasive by a vote equal to or greater than 90% of the persons voting on the action". (*Regulations* ¶ 9.6.1.4.5.2)				
	Use of "Not significant finding option"	**X**	It is mutually agreed upon to term the Negative "not significant".		**GO TO "Final" subsection → (D)**
Final		**X**	**(D)**	Not significant **(counted under j in disposition)**	

Negative 4

Negative	**Referenced Section/ Paragraph**	Main body			
	Negative Text	Appendix: It is not mentioned in the main body about the relationship between main body and appendix. For example, "See AppendixA1-1" in the main body..			
Withdrawal (check one)		**X**	No Negative withdrawal made by Voter.		**GO TO "Related" subsection**
Related	**Motion and Reason (check one)**	**X**	'Related' is mutually agreed upon. **(Needs no motion.)**		**GO TO "Persuasive" subsection**
Persuasive	**Motion and Reason (check one)**	**X**	Negative is related and not persuasive. **(Needs ≥2/3 votes to pass.)**		
			Reason	The Appendix is referenced in the main body in paragraphs 6.2, 6.2.15, and in 6.2.16.	
	Motion by/ 2nd by	**By:** Randall Parker (DISCO) **Second:** Stephen Gonya (Binghamton University (SUNY)			
	Discussion	None			
	Result of Vote (check one)	6 **Y** 0 **N**; Motion passed			
		X	90% ≤ [Negative is related and not persuasive.]	**GO TO "Not Significant Finding Option" subsection**	
Not Significant	This option can be used only "if the TC Chapter finds a Negative not persuasive by a vote equal to or greater than 90% of the persons voting on the action". (*Regulations* ¶ 9.6.1.4.5.2)				
	Use of "Not significant finding option" (check one)	**X**	It is mutually agreed upon to term the Negative "not significant".		**GO TO "Final" subsection → (D)**
Final		**X**	**(D)**	Not significant **(counted under j in disposition)**	

Disposition of Voting Interest Reject 4

4	Original number (#) of Negatives		**(g)**
2	Number of Negatives found not significant		**(j)**
0	Number of Negatives addressed by technical change **(Negative becomes not significant)**		**(k)**
Final	**X**	**g - (h + i +j + k)** >0	**Reject is included in the denominator of § VI. *Approval Conditions Check***

Voting Interest Reject 5 (Voting Interest Name: FUJIKURA KASEI)
Voter Reject 1 (Voter: Katsutomo Wakabayashi / FUJIKURA KASEI)

Negative 1

Negative	Referenced Section/ Paragraph	Entire document			
	Negative Text	If you are using flex as an abbreviation for flexible, I think it would be better to use flexible as it is a document.			
Withdrawal (check one)		X	No Negative withdrawal made by Voter.		GO TO "Related" subsection
Related	Motion and Reason (check one)	X	'Related' is mutually agreed upon. (Needs no motion.)		GO TO "Persuasive" subsection
Persuasive	Motion and Reason (check one)	X	Negative is related and not persuasive. (Needs ≥2/3 votes to pass.)		
			Reason	Addressed by Yamagata University Negative #7	
	Motion by/ 2nd by	By: Randall Parker (DISCO) Second: Stephen Gonya (Binghamton University (SUNY))			
	Discussion	None			
	Result of Vote (check one)	6 Y 0 N; Motion passed			
		X	90% ≤ [Negative is related and not persuasive.]	GO TO "Not Significant Finding Option" subsection	
Not Significant	This option can be used only "if the TC Chapter finds a Negative not persuasive by a vote equal to or greater than 90% of the persons voting on the action". (*Regulations* ¶ 9.6.1.4.5.2)				
	Use of "Not significant finding option" (check one)	X	It is mutually agreed upon to term the Negative "not significant".		GO TO "Final" subsection → (D)
Final		X	(D)	Not significant (counted under j in disposition)	

Disposition of Voting Interest Reject 5

1	Original number (#) of Negatives			(g)
0	Number of Negatives withdrawn			(h)
0	Number of Negatives found not related			(i)
1	Number of Negatives found not significant			(j)
0	Number of Negatives addressed by technical change (Negative becomes not significant)			(k)
Final		X	g - (h + i +j + k) = 0	Reject is Not Valid and is not included in the denominator of § VI. *Approval Conditions Check*
			g - (h + i +j + k) >0	Reject is included in the denominator of § VI. *Approval Conditions Check*
			Reject without a Negative	Not Valid

Voting Interest Reject 6 (Voting Interest Name: ITRI)
Voter Reject 1 (Voter: Bao-Jen Pong / ITRI)

Negative 1

Negative	Referenced Section/ Paragraph	NOTE 1		
	Negative Text	Negatives : [3.2 This Guide does not contain information on e-textiles. NOTE 1: E-textiles, or electronic textiles, are fabrics that incorporate electronics.] However, [5.2.27 stretchable substrate – a substrate that can recover its original size and shape immediately after removing the elongation force that causes deformation.] Some e-textile can be incorporate with stretchable substrates that mentioned in this draft. Hence, it should be clarified in this draft why e-textile should exclude in this draft ?		
	Withdrawal (check one)	X	No Negative withdrawal made by Voter.	GO TO "Related" subsection
Related	Motion and Reason (check one)	X	'Related' is mutually agreed upon. (Needs no motion.)	GO TO "Persuasive" subsection
Persuasive	Motion and Reason (check one)	X	Negative is related and not persuasive. (Needs ≥2/3 votes to pass.)	
			Reason	Reviewer concern for not stating reason for not including e-textile in document. Editorial to change wording in the Note of section 3.2 to include reason.
	Motion by/ 2nd by	By: Stephen Gonya (Binghamton University (SUNY)) Second: Randall Parker (DISCO)		
	Discussion	None		
	Result of Vote (check one)	4 Y 0 N; Motion passed		
		X	90% ≤ [Negative is related and not persuasive.]	GO TO "Not Significant Finding Option" subsection
Not Significant	This option can be used only "if the TC Chapter finds a Negative not persuasive by a vote equal to or greater than 90% of the persons voting on the action". (*Regulations* ¶ 9.6.1.4.5.2)			
	Use of "Not significant finding option" (check one)	X	It is mutually agreed upon to term the Negative "not significant".	GO TO "Final" subsection → (D)
Final		X	(D)	Not significant (counted under j in disposition)
	(check if applicable)	X	*Comment generated. Refer to Section V-(ii) Comment # NC-4.*	

Disposition of Voting Interest Reject 6

1	Original number (#) of Negatives		(g)
0	Number of Negatives withdrawn		(h)
0	Number of Negatives addressed by technical change (Negative becomes not significant)		(k)
Final		g - (h + i +j + k) = 0	Reject is Not Valid and is not included in the denominator of § VI. *Approval Conditions Check*
	X	g - (h + i +j + k) >0	Reject is included in the denominator of § VI. *Approval Conditions Check*
		Reject without a Negative	Not Valid

Voting Interest Reject 7 (Voting Interest Name: **Mega Stream Technology Co., Ltd.**)

Voter Reject 1 (Voter: **Steve Huang / Mega Stream Technology Co., Ltd.**)

Negative 1

Negative	**Referenced Section/ Paragraph**	3.2			
	Negative Text	Regarding 3.2 We know unstable substrates like fabrics can cause circuit cracking or deformation, resulting in open circuits or impedance changes that affect signal transmission. We anticipate that other flexible substrates may have the same problems. I suggest we only need to establish one standard for all flexible electronic substrates. As long as e-textiles meet this requirement, they can be used in industrial applications. Excluding e-textiles will hinder the development of this field.			
Withdrawal (check one)		X	No Negative withdrawal made by Voter.		**GO TO "Related" subsection**
Related	**Motion and Reason (check one)**	X	'Related' is mutually agreed upon. **(Needs no motion.)**		**GO TO "Persuasive" subsection**
Persuasive	**Motion and Reason (check one)**	X	Negative is related and not persuasive. **(Needs ≥2/3 votes to pass.)**		
			Reason	E-textiles use fabric type substrate materials that are significantly different than other sheet or film type substrates referred to in this document. This was clarified in NOTE 1, addressed by ITRI Negative #1.	
	Motion by/ 2nd by	**By:** Randall Parker (DISCO) **Second:** Stephen Gonya (Binghamton University (SUNY))			
	Discussion	None			
	Result of Vote (check one)	6 **Y** 0 **N**; Motion passed			
		X	90% ≤ [Negative is related and not persuasive.]	**GO TO "Not Significant Finding Option" subsection**	
Not Significant	**This option can be used only "if the TC Chapter finds a Negative not persuasive by a vote equal to or greater than 90% of the persons voting on the action". (*Regulations* ¶ 9.6.1.4.5.2)**				
	Use of "Not significant finding option" (check one)	X	It is mutually agreed upon to term the Negative "not significant".	**GO TO "Final" subsection → (D)**	
Final		X	**(D)**	Not significant **(counted under j in disposition)**	

Disposition of Voting Interest Reject 7

1	Original number (#) of Negatives		**(g)**
1	Number of Negatives found not significant		**(j)**
0	Number of Negatives addressed by technical change **(Negative becomes not significant)**		**(k)**
Final	X	**g - (h + i +j + k) = 0**	**Reject is Not Valid and is not included in the denominator of § VI. *Approval Conditions Check***

Voting Interest Reject 8 (Voting Interest Name: Roocare Corp)
Voter Reject 1 (Voter: Ys Teng / Roocare Corp)

Negative 1

Negative	Referenced Section/ Paragraph	Section 7			
	Negative Text	Chapter 7 describes multiple substrate materials, including paper-based substrates and resin-coated fabrics. Given that the same processing techniques may be applicable to fiber-based materials, it may be worth reconsidering the exclusion of fabrics in Section 3.2.			
Withdrawal (check one)		X	No Negative withdrawal made by Voter.		GO TO "Related" subsection
Related	Motion and Reason (check one)	X	'Related' is mutually agreed upon. (Needs no motion.)		GO TO "Persuasive" subsection
Persuasive	Motion and Reason (check one)	X	Negative is related and not persuasive. (Needs ≥2/3 votes to pass.)		
			Reason	Although paper-based and resin-coated fabrics are addressed in section 7, they are categories of substrate materials that can be printed on. Integrating electronics into fabrics and textiles (e-textiles) using conductive threads, stitching, functional fibers, rivets, eyelets, snaps, fasteners, and specialized coatings is not within the scope of this document. This was clarified in NOTE 1, addressed by ITRI Negative #1.	
	Motion by/ 2nd by	By: Randall Parker (DISCO) Second: Stephen Gonya (Binghamton University (SUNY))			
	Discussion	None			
	Result of Vote (check one)	6 Y 0 N; Motion passed			
		X	90% ≤ [Negative is related and not persuasive.]	GO TO "Not Significant Finding Option" subsection	
Not Significant	This option can be used only "if the TC Chapter finds a Negative not persuasive by a vote equal to or greater than 90% of the persons voting on the action". (*Regulations* ¶ 9.6.1.4.5.2)				
	Use of "Not significant finding option" (check one)	X	It is mutually agreed upon to term the Negative "not significant".		GO TO "Final" subsection → (D)
Final		X	(D)	Not significant (counted under j in disposition)	

Voting Interest Reject 8 - Voter Reject 2 (Voter: JC Lin / Roocare Corp)

Negative 1

Negative	Referenced Section/ Paragraph	Section 7		
	Negative Text	Chapter 7 describes multiple substrate materials, including paper-based substrates and resin-coated fabrics. Given that the same processing techniques may be applicable to fiber-based materials, it may be worth reconsidering the exclusion of fabrics in Section 3.2.		
Withdrawal (check one)		X	No Negative withdrawal made by Voter.	GO TO "Related" subsection

Related	**Motion and Reason (check one)**	**X**	'Related' is mutually agreed upon. **(Needs no motion.)**		**GO TO "Persuasive" subsection**
Persuasive	**Motion and Reason (check one)**	**X**	Negative is related and not persuasive. **(Needs ≥2/3 votes to pass.)**		
			Reason	Same negative from same company. Addressed by YS Teng / Roocare Corp Negative #1	
	Motion by/ 2nd by	**By:** Randall Parker (DISCO) **Second:** Stephen Gonya (Binghamton University (SUNY))			
	Discussion	None			
	Result of Vote (check one)	6 **Y** 0 **N**; Motion passed			
		X	90% ≤ [Negative is related and not persuasive.]	**GO TO "Not Significant Finding Option" subsection**	
Not Significant	**This option can be used only "if the TC Chapter finds a Negative not persuasive by a vote equal to or greater than 90% of the persons voting on the action". (*Regulations* ¶ 9.6.1.4.5.2)**				
	Use of "Not significant finding option" (check one)	**X**	It is mutually agreed upon to term the Negative "not significant".		**GO TO "Final" subsection → (D)**
Final		**X**	**(D)**	Not significant **(counted under j in disposition)**	

Disposition of Voting Interest Reject 8

2	Original number (#) of Negatives			**(g)**
0	Number of Negatives withdrawn			**(h)**
0	Number of Negatives found not related			**(i)**
2	Number of Negatives found not significant			**(j)**
0	Number of Negatives addressed by technical change **(Negative becomes not significant)**			**(k)**
Final	**X**	**g** - (**h** + **i** +**j** + **k**) = 0	**Reject is Not Valid and is not included in the denominator of § VI. *Approval Conditions Check***	
		g - (**h** + **i** +**j** + **k**) >0	**Reject is included in the denominator of § VI. *Approval Conditions Check***	
		Reject without a Negative	**Not Valid**	

Voting Interest Reject 9 (Voting Interest Name: KOMORI CORPORATION)

Voter Reject 1 (Voter: Hideki Ikeda / KOMORI CORPORATION)

Negative 1

Negative	Referenced Section/ Paragraph	A1-6		
	Negative Text	There are two printing methods: sheet type and web type, but this is limited to the web type. In particular, the sheet method is more common for A1-6 gravure offset printing. Also, "gravure offset printing" is more appropriate than "offset gravure printing."		
Withdrawal (check one)		X	No Negative withdrawal made by Voter.	GO TO "Related" subsection
Related	Motion and Reason (check one)	X	'Related' is mutually agreed upon. (Needs no motion.)	GO TO "Persuasive" subsection
Persuasive	Motion and Reason (check one)	X	Negative is related and not persuasive. (Needs ≥2/3 votes to pass.)	
			Reason	Same negative from same company. Addressed by Tadahiro Furukawa Negative #5
	Motion by/ 2nd by	By: Randall Parker (DISCO) Second: Stephen Gonya (Binghamton University (SUNY))		
	Discussion	None		
	Result of Vote (check one)	6 Y 0 N; Motion passed		
		X	90% ≤ [Negative is related and not persuasive.]	GO TO "Not Significant Finding Option" subsection
Not Significant	This option can be used only "if the TC Chapter finds a Negative not persuasive by a vote equal to or greater than 90% of the persons voting on the action". (*Regulations* ¶ 9.6.1.4.5.2)			
	Use of "Not significant finding option" (check one)	X	It is mutually agreed upon to term the Negative "not significant".	GO TO "Final" subsection → (D)
Final		X	(D)	Not significant (counted under j in disposition)

Disposition of Voting Interest Reject 9

1	Original number (#) of Negatives			(g)
1	Number of Negatives found not significant			(j)
0	Number of Negatives addressed by technical change (Negative becomes not significant)			(k)
Final		X	g - (h + i +j + k) = 0	Reject is Not Valid and is not included in the denominator of § VI. *Approval Conditions Check*
			g - (h + i +j + k) >0	Reject is included in the denominator of § VI. *Approval Conditions Check*
			Reject without a Negative	Not Valid

Voting Interest Reject 10 (Voting Interest Name: **Kobe University**)
Voter Reject 1 (Voter: **Mari Inoue / Kobe University**)

Negative 1

Negative	**Referenced Section/ Paragraph**	Entire document		
	Negative Text	To begin with, the usage of the key term “substrate” is inconsistent throughout the document. In Section 7, “substrate” is defined as the plate or film that serves as the foundation of a wiring board. However, in the title and in most other sections, the term is used to mean a package substrate or an interposer. One possible solution would be to replace “substrate” in the title with “circuit board” and then ensure consistent terminology across the document. Yet doing so may make it harder to distinguish this document from the IPC standard.		
Withdrawal (check one)		X	No Negative withdrawal made by Voter.	**GO TO “Related” subsection**
Related	**Motion and Reason (check one)**	X	‘Related’ is mutually agreed upon. **(Needs no motion.)**	**GO TO “Persuasive” subsection**
Persuasive	**Motion and Reason (check one)**	X	Negative is related and not persuasive. **(Needs ≥2/3 votes to pass.)**	
			Reason	Same negative from same company. Addressed by Satoshi Maeda Negative #1.
	Motion by/ 2nd by	**By:** Randall Parker (DISCO) **Second:** Stephen Gonya (Binghamton University (SUNY))		
	Discussion	None		
	Result of Vote (check one)	6 **Y** 0 **N**; Motion passed		
		X	90% ≤ [Negative is related and not persuasive.]	**GO TO “Not Significant Finding Option” subsection**
Not Significant	**This option can be used only “if the TC Chapter finds a Negative not persuasive by a vote equal to or greater than 90% of the persons voting on the action”. (*Regulations* ¶ 9.6.1.4.5.2)**			
	Use of “Not significant finding option” (check one)	X	It is mutually agreed upon to term the Negative “not significant”.	**GO TO “Final” subsection → (D)**
Final		X	**(D)**	Not significant **(counted under j in disposition)**

Negative 2

Negative	**Referenced Section/ Paragraph**	Main body		
	Negative Text	Additionally, the appendix is never referenced in the main text. At minimum, the document should include a statement that directs readers to the appendix.		
Withdrawal (check one)		X	No Negative withdrawal made by Voter.	**GO TO “Related” subsection**
Related	**Motion and Reason (check one)**	X	‘Related’ is mutually agreed upon. **(Needs no motion.)**	**GO TO “Persuasive” subsection**

Persuasive	**Motion and Reason (check one)**	**X**	Negative is related and not persuasive. **(Needs ≥2/3 votes to pass.)**		
			Reason	Same negative from above. Addressed by Satoshi Maeda Negative #3, and Tadahiro Furukawa Negative #1	
	Motion by/ 2nd by	**By:** Randall Parker (DISCO) **Second:** Stephen Gonya (Binghamton University (SUNY))			
	Discussion	None			
	Result of Vote (check one)	6 **Y** 0 **N**; Motion passed			
		X	90% ≤ [Negative is related and not persuasive.]	**GO TO "Not Significant Finding Option" subsection**	
Not Significant	**This option can be used only "if the TC Chapter finds a Negative not persuasive by a vote equal to or greater than 90% of the persons voting on the action". (*Regulations* ¶ 9.6.1.4.5.2)**				
	Use of "Not significant finding option" (check one)	**X**	It is mutually agreed upon to term the Negative "not significant".	**GO TO "Final" subsection → (D)**	
Final		**X**	**(D)**	Not significant **(counted under j in disposition)**	

Negative 3

Negative	**Referenced Section/ Paragraph**	5.1.7			
	Negative Text	The notation "5.1.7 Df" seems to represent "Dielectric loss factor."			
Withdrawal (check one)		**X**	No Negative withdrawal made by Voter.	**GO TO "Related" subsection**	
Related	**Motion and Reason (check one)**	**X**	'Related' is mutually agreed upon. **(Needs no motion.)**	**GO TO "Persuasive" subsection**	
Persuasive	**Motion and Reason (check one)**	**X**	Negative is related and not persuasive. **(Needs ≥2/3 votes to pass.)**		
			Reason	Same negative from above. Addressed by Satoshi Maeda Negative #3, and Tadahiro Furukawa negative #5	
	Motion by/ 2nd by	**By:** Randall Parker (DISCO) **Second:** Stephen Gonya (Binghamton University (SUNY))			
	Discussion	None			
	Result of Vote (check one)	6 **Y** 0 **N**; Motion passed			
		X	90% ≤ [Negative is related and not persuasive.]	**GO TO "Not Significant Finding Option" subsection**	
Not Significant	**This option can be used only "if the TC Chapter finds a Negative not persuasive by a vote equal to or greater than 90% of the persons voting on the action". (*Regulations* ¶ 9.6.1.4.5.2)**				
	Use of "Not significant finding option" (check one)	**X**	It is mutually agreed upon to term the Negative "not significant".	**GO TO "Final" subsection → (D)**	
Final		**X**	**(D)**	Not significant **(counted under j in disposition)**	

Negative 4

Negative	**Referenced Section/ Paragraph**	10.13.8			
	Negative Text	The explanation provided for "10.13.8 Sheet Resistance" is inadequate. Moreover, although numerous methods exist for measuring sheet resistance, ASTM F390 was developed specifically for non-destructive measurement of sheet resistance on infinitely flat (or at least large, planar) materials. In contrast, printed electronics allow conductors to be formed in arbitrary shapes, making ASTM F390 both unnecessary and impractical to apply. A more suitable explanation of sheet resistance would be: "Sheet resistance refers to the resistance measured between two opposite sides of a square film and does not depend on the size of the square. When non-destructive evaluation is required, it can be measured using the four-point probe method. It may also be calculated by dividing volume resistivity by thickness, assuming uniform thickness. Sheet resistance is applicable even to materials whose thickness cannot be measured, such as conductive fabrics. Although its unit is Ω, it is written as Ω/sq to distinguish it from surface resistivity, which represents the resistance of a square film with no thickness."			
Withdrawal (check one)		**X**	No Negative withdrawal made by Voter.		**GO TO "Related" subsection**
Related	**Motion and Reason (check one)**	**X**	'Related' is mutually agreed upon. **(Needs no motion.)**		**GO TO "Persuasive" subsection**
Persuasive	**Motion and Reason (check one)**	**X**	Negative is related and not persuasive. **(Needs ≥2/3 votes to pass.)**		
			Reason	Same negative from above. Addressed by Satoshi Maeda Negative #4	
	Motion by/ 2nd by	**By:** Randall Parker (DISCO) **Second:** Stephen Gonya (Binghamton University (SUNY))			
	Discussion	None			
	Result of Vote (check one)	6 **Y** 0 **N**; Motion passed			
		X	90% ≤ [Negative is related and not persuasive.]	**GO TO "Not Significant Finding Option" subsection**	
Not Significant	**This option can be used only "if the TC Chapter finds a Negative not persuasive by a vote equal to or greater than 90% of the persons voting on the action". (*Regulations* ¶ 9.6.1.4.5.2)**				
	Use of "Not significant finding option" (check one)	**X**	It is mutually agreed upon to term the Negative "not significant".	**GO TO "Final" subsection → (D)**	
Final		**X**	**(D)**	Not significant **(counted under j in disposition)**	

Negative 5

Negative	**Referenced Section/ Paragraph**	Section 11
	Negative Text	Section 11 addresses single-sided, multilayer circuit boards, yet manufacturing such boards using printed electronics is highly challenging. At the same time, simple double-sided circuits are not covered at all. The discussion of multilayer circuit boards therefore requires reorganization.

Withdrawal (check one)		**X**	No Negative withdrawal made by Voter.		**GO TO "Related" subsection**
Related	**Motion and Reason (check one)**	**X**	'Related' is mutually agreed upon. **(Needs no motion.)**		**GO TO "Persuasive" subsection**
Persuasive	**Motion and Reason (check one)**	**X**	Negative is related and not persuasive. **(Needs ≥2/3 votes to pass.)**		
			Reason	Same negative from above. Addressed by Satoshi Maeda Negative #5	
	Motion by/ 2nd by	**By:** Randall Parker (DISCO) **Second:** Stephen Gonya (Binghamton University (SUNY))			
	Discussion	None			
	Result of Vote (check one)	6 **Y** 0 **N**; Motion passed			
		X	90% ≤ [Negative is related and not persuasive.]	**GO TO "Not Significant Finding Option" subsection**	
Not Significant	**This option can be used only "if the TC Chapter finds a Negative not persuasive by a vote equal to or greater than 90% of the persons voting on the action". (*Regulations* ¶ 9.6.1.4.5.2)**				
	Use of "Not significant finding option" (check one)	**X**	It is mutually agreed upon to term the Negative "not significant".		**GO TO "Final" subsection → (D)**
Final		**X**	**(D)**	Not significant **(counted under j in disposition)**	

Disposition of Voting Interest Reject 10

5	Original number (#) of Negatives			**(g)**
0	Number of Negatives withdrawn			**(h)**
0	Number of Negatives found not related			**(i)**
5	Number of Negatives found not significant			**(j)**
0	Number of Negatives addressed by technical change **(Negative becomes not significant)**			**(k)**
Final	**X**	**g** - (**h** + **i** +**j** + **k**) = 0	**Reject is Not Valid and is not included in the denominator of § VI. *Approval Conditions Check***	
		g - (**h** + **i** +**j** + **k**) >0	**Reject is included in the denominator of § VI. *Approval Conditions Check***	
		Reject without a Negative	**Not Valid**	

IV. Other Technical Issues
None

V. Comments
V- (i) Voters' Comments

Commenter 1 (Randall Parker / DISCO) - Comment 1

Comment	*TF/TC Chapter to fill in section/paragraph #, if necessary.		
	Upon reviewing the Design Ballot Draft (#7193B), I just happened to find two very minor typos: 5.1.45 SR — silicon resin (should be "silicone resin") "Silicone resin" is referenced in A2-14, while there is no reference to "silicon resin". A2-13: ... Stretchable coverlay sheets are often silicon or TPU materials. (should be "silicone")		
Action	The TC Chapter agreed to do one of the following actions.		
	X	Editorial Change	
	Options for editorial change (check one)		Case 1: No vote in this section:
			To be included and voted on as a group in § VI. *Editorial Changes Other than Those Voted on in § V.*
		X	Case 2: Voted in this section:
			Original section number and at least one full sentence are required in "FROM" and "TO" fields.
Editorial Changes	1	FROM: Section/Paragraph 5.1.45	
		5.1.45 *SR* — silicon resin	
		TO: Section/Paragraph 5.1.45	
		5.1.45 *SR* — silicone resin	
		Justification (If necessary) Editorial Change - Corrected spelling from "silicon" to "silicone".	
	2	FROM: Section/Paragraph A2-13.1	
		A2-13.1 A cover lay is a solid sheet or film that is laminated to the device surface and becomes a permanent protective layer. Lamination may be done by applying heat, pressure, vacuum, or combination thereof. The layer provides water resistance and environmental protection. Stretchable coverlay sheets are often silicon or TPU materials.	
		TO: Section/Paragraph A2-13.1	
		A2-13.1 A cover lay is a solid sheet or film that is laminated to the device surface and becomes a permanent protective layer. Lamination may be done by applying heat, pressure, vacuum, or combination thereof. The layer provides water resistance and environmental protection. Stretchable coverlay sheets are often silicone or TPU materials.	
		Justification (If necessary) Editorial Change - Corrected spelling from "silicon" to "silicone".	

Motion	To approve above editorial change(s)
Motion by/2nd by	**By:** Deepak Trivedi (GE Research) **Second:** Stephen Gonya (Binghamton University (SUNY))
Discussion	None
Vote	3 **Y** 0 **N**; Motion passed.

This table is needed for each Comment accompanied a Vote

Commenter 2 (Manabu Ito / Toppan) - Comment 1

Comment	***TF/TC Chapter to fill in section/paragraph #, if necessary.**
	5.2.16 offset gravure printing / A1-6 Offset Gravure Printing "offset gravure printing" is not a correct technical term. It should be "gravure offset printing".
Action	**The TC Chapter agreed to do one of the following actions.**
	***No motion is required in this step.**
	X Already addressed by Commenter Tadahiro Furukawa, Comment #5

V-(ii) Comments Created by Handling Negative

Comment (Created by Handling Negative) NC – 1

Comment	"5.1.7 Df" appears to be an abbreviation for "Dielectric loss factor."		
Action	**The TC Chapter agreed to do one of the following actions.**		
	***No motion is required in this step.**		
	X Editorial change		
	Options for editorial change **(check one)**		**Case 1: No vote in this section:**
			To be included and voted on as a group in § VI. Editorial Changes Other than Those Voted on in § V.
		X	**Case 2: Voted in this section:**
			Original section number and at least one full sentence are required in "FROM" and "TO" fields.
Editorial Changes	**1**	**FROM: Section/Paragraph 5.1.7** 5.1.7 *Df* — dielectric loss	
		TO: Section/Paragraph 5.1.7 5.1.7 *Df* — dielectric loss factor	
		Justification (If necessary) Correct spelling of Df abbreviation. Editorial change to add "factor" to "dielectric loss factor"	

Motion	To approve above editorial change(s)
Motion by/2nd by	**By:** Randall Parker (DISCO) **Second:** Deepak Trivedi (GE Research)
Discussion	None
Vote	4 **Y** 0 **N**; Motion passed.

This table is needed for each Comment created by handling Negative.

Comment (Created by Handling Negative) NC – 2

Comment	5.2.2 bending — deformation of printed electronics caused by external stress that induces curvature perpendicular to the original surface of the specimen. → deformation ~~of printed electronics~~ caused by external stress that induces curvature perpendicular to the original surface of the specimen.		
Action	**The TC Chapter agreed to do one of the following actions.**		
	***No motion is required in this step.**		
		Already addressed by Commenter #, Comment #	
		No further action was taken by the TC Chapter.	
		Refer to the TF for more consideration.	
		New business	
	X	Editorial change	
	Options for editorial change **(check one)**		**Case 1: No vote in this section:**
			To be included and voted on as a group in § VI. Editorial Changes Other than Those Voted on in § V.
		X	**Case 2: Voted in this section:**
			Original section number and at least one full sentence are required in "FROM" and "TO" fields.
Editorial Changes	1	**FROM: Section/Paragraph 5.2.2** 5.2.2 *bending* — deformation of printed electronics caused by external stress that induces curvature perpendicular to the original surface of the specimen.	
		TO: Section/Paragraph 5.2.2 5.2.2 *bending* — deformation ~~of printed electronics~~ caused by external stress that induces curvature perpendicular to the original surface of the specimen.	
		Justification (If necessary) Editorial to remove text "of printed electronics" from definition to comply with Style Manual guidelines for definitions.	

Motion	To approve above editorial change(s)
Motion by/2nd by	**By:** Randall Parker (DISCO) **Second:** Deepak Trivedi (GE Research)
Discussion	None
Vote	4 **Y** 0 **N**; Motion passed.

Comment (Created by Handling Negative) NC – 3

Comment

Chapter 6 : This structure is not suitable in consideration with current FHE progress. All of FHE related does not know whether described picture will be a future structure.

Action

The TC Chapter agreed to do one of the following actions.

*No motion is required in this step.

	Already addressed by Commenter #, Comment #
	No further action was taken by the TC Chapter.
	Refer to the TF for more consideration.
	New business
X	Editorial change

Options for editorial change (check one)		
		Case 1: No vote in this section:
		To be included and voted on as a group in § VI. Editorial Changes Other than Those Voted on in § V.
	X	**Case 2: Voted in this section:**
		Original section number and at least one full sentence are required in "FROM" and "TO" fields.

Editorial Changes

1

FROM: Section/Paragraph 6.1, Figure 1

6 Printed Electronic Design Overview

6.1 The printed electronic design example shown in **Error! Reference source not found.** has multiple printed and nonprinted elements incorporated within the substrate design that include a) substrate dielectric layer, b) printed conductive material, c) printed dielectric material, d) vias through the substrate connecting top and bottom conductive elements, f) buried vias for interlayer connections, g) embedded die, h) printed discrete elements, i) connections to components utilizing printed conductive and dielectric materials.

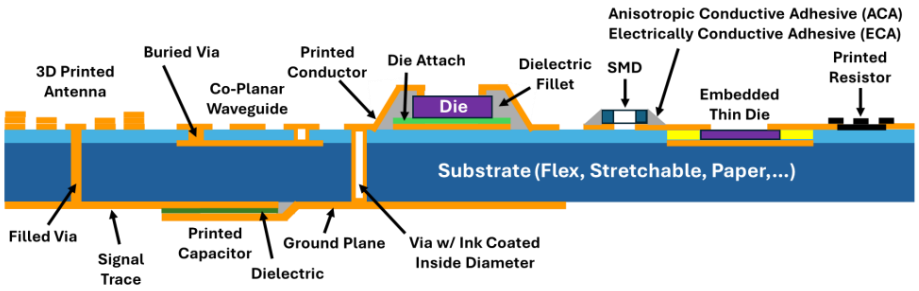


Figure 1
Design Elements of a FHE Substrate with Various Printed Interconnects

TO: Section/Paragraph 6.1, Figure 1

6 Printed Electronic Design Overview

6.1 The printed electronic design ~~example shown~~ in **Error! Reference source not found.** shows ~~has~~ multiple examples of possible FHE printed and nonprinted elements incorporated within the substrate design that includes a) substrate dielectric layer, b) printed conductive material, c) printed dielectric material, d) vias through the substrate connecting top and bottom conductive elements, f) buried vias for interlayer connections, g) embedded die, h) printed discrete elements, i) connections to components utilizing printed conductive and dielectric materials.

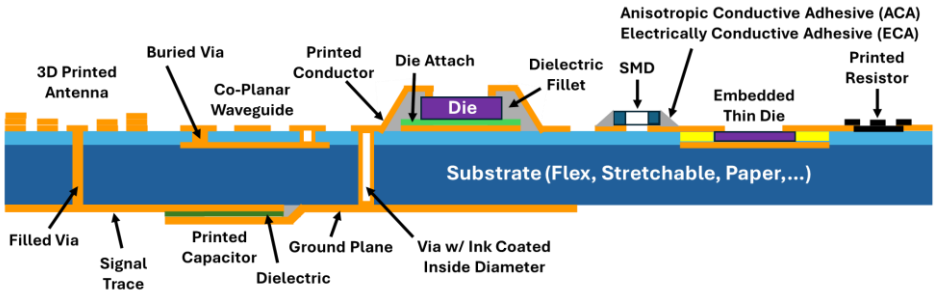


Figure 1
Possible Design Elements of ~~a~~ FHE Substrate with Various Printed Interconnect

Justification (If necessary)
Editorial to remove ambiguity of the Figure and include text in 6.1 and Figure 1 that states "examples of possible FHE design elements" for consistency. This text does not constrain 6.1 and Figure 1 image to only use current and near-future FHE structures.

Motion	To approve above editorial change(s)
Motion by/2nd by	**By:** Randall Parker (DISCO) **Second:** Deepak Trivedi (GE Research)
Discussion	None
Vote	4 **Y** 0 **N**; Motion passed.

Comment (Created by Handling Negative) NC – 4

Comment	Negatives : [3.2 This Guide does not contain information on e-textiles. NOTE 1: E-textiles, or electronic textiles, are fabrics that incorporate electronics.] However, [5.2.27 stretchable substrate – a substrate that can recover its original size and shape immediately after removing the elongation force that causes deformation.] Some e-textile can be incorporate with stretchable substrates that mentioned in this draft. Hence, it should be clarified in this draft why e-textile should exclude in this draft ?		
Action	**The TC Chapter agreed to do one of the following actions.**		
	***No motion is required in this step.**		
	X	Editorial change	
	Options for editorial change **(check one)**		**Case 1: No vote in this section:**
			To be included and voted on as a group in § VI. Editorial Changes Other than Those Voted on in § V.
		X	**Case 2: Voted in this section:**
			Original section number and at least one full sentence are required in "FROM" and "TO" fields.

Editorial Changes	1	**FROM: Section/Paragraph NOTE 1** 3.2 This Guide does not contain information on e-textiles. NOTE 1: E-textiles, or electronic textiles, are fabrics that incorporate electronics.
		TO: Section/Paragraph NOTE 1 3.2 This Guide does not contain information on e-textiles. NOTE 1: E-textiles, or electronic textiles, are fabrics that incorporate electronics. Fabric based substrates have anisotropic surface properties that would require different design considerations not within the scope of this Guide.
		Justification (If necessary) Voter concern for not stating reason for not including e-textile in document. Wording in NOTE 1 was revised to add clarity to the voter's concern.

Motion	To approve above editorial change(s)
Motion by/2nd by	**By:** Randall Parker (DISCO) **Second:** Deepak Trivedi (GE Research)
Discussion	None
Vote	4 **Y** 0 **N**; Motion passed.

VI. Editorial Changes Other than Those Voted on in § V
None

VII. Approval Conditions Check
VII. - (i). Approval Rate

APPROVAL CONDITION 1: All Negatives have been discussed and were withdrawn, found not related, found not persuasive, or addressed by a technical change. (*Regulations* ¶ 9.6.2.1.2)

APPROVAL CONDITION 2: At least 90% of the sum of valid Voting Interest Accept and Voting Interest Reject Votes must be Accept. (*Regulations* ¶ 9.6.2.1.3)

Note: If both approval conditions are not satisfied, the Document fails.

		Accepts	(Accepts + Valid Rejects)		
Approval Rate	=	34	36	= 94%	≥90%

VII. – (ii) Approval Level (check one)
Note: Refer to *Regulations* § 9.6.2 for further information.

X **Need a Ratification Ballot:**
The Letter Ballot meets the Letter Ballot approval conditions for the TC Chapter and a Ratification Ballot will be issued to validate technical changes.

VIII. Safety Check

Note: Refer to *Regulations* § 15 for further information.

Motion	X	**This is not a Safety Document**, when all safety-related information is removed, the Document is still technically sound and complete. (*Regulations* ¶ 8.7.1)
		This is a Safety Document, when all safety-related information is removed, the Document is not technically sound and complete. (*Regulations* ¶ 8.7.2)
		Safety Checklist (*Regulations* ¶ 15.3) is complete and has been included with the Document throughout the balloting process. (*Regulations* ¶ 15.1.2)
Motion by/2nd by		**By:** Deepak Trivedi (GE Research) **Second:** Stephen Gonya (Binghamton University (SUNY))
Discussion		None
Vote		3 **Y** 0 **N**; Motion passed

IX. Intellectual Property (IP) Check

Note: This Letter Ballot may cover all or part of a Standard or Safety Guideline. Regardless of the coverage, this IP check applies to the entire Standard or Safety Guideline*. Refer to *Regulations* § 16 for further information.

X	The TC Chapter meeting chair asked those participating, if they were aware of any patented technology that might be relevant (refer to *Regulations* ¶ 16.3.1.1) to the Standard or Safety Guideline; or, any copyrighted items or trademarks that are used/reproduced (refer to *Regulations* ¶ 16.4.1.2) in the Standard or Safety Guideline. (Also refer to *Regulations* § 8.8)		
	X	The question is NOT answered in affirmative (No potentially material patented technology or use/reproduction of copyrighted items/trademarks is known.)	**GO TO SECTION X.**

X. Action for This Document

Motion	X	This Document passed TC Chapter review with technical changes and with or without editorial changes and will be forwarded to the ISC A&R SC for procedural review. A Ratification Ballot will be issued to verify the technical changes.	
Motion by/ 2nd by		**By:** Stephen Gonya (Binghamton University (SUNY)) **Second:** Deepak Trivedi (GE Research)	
Discussion		None	
Vote		3 **Y** 0 **N**	
Final Action	X	Motion passed	
		Motion failed	

Note: If the use of PMPT or copyrighted item is justified by the TC Chapter, LOA or release form must be received before publication can proceed.