

U.S. Patent No. 9,253,925 (“’925 Patent”)

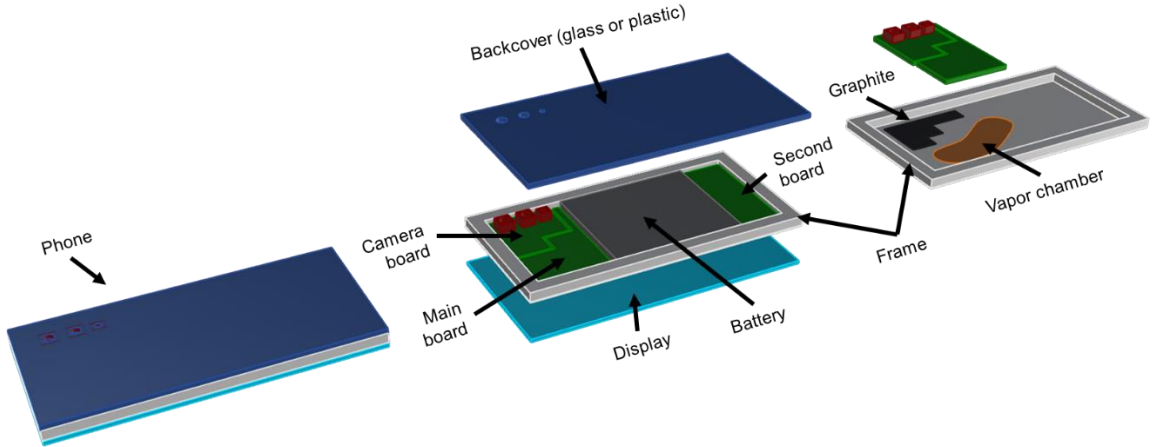
Accused Products

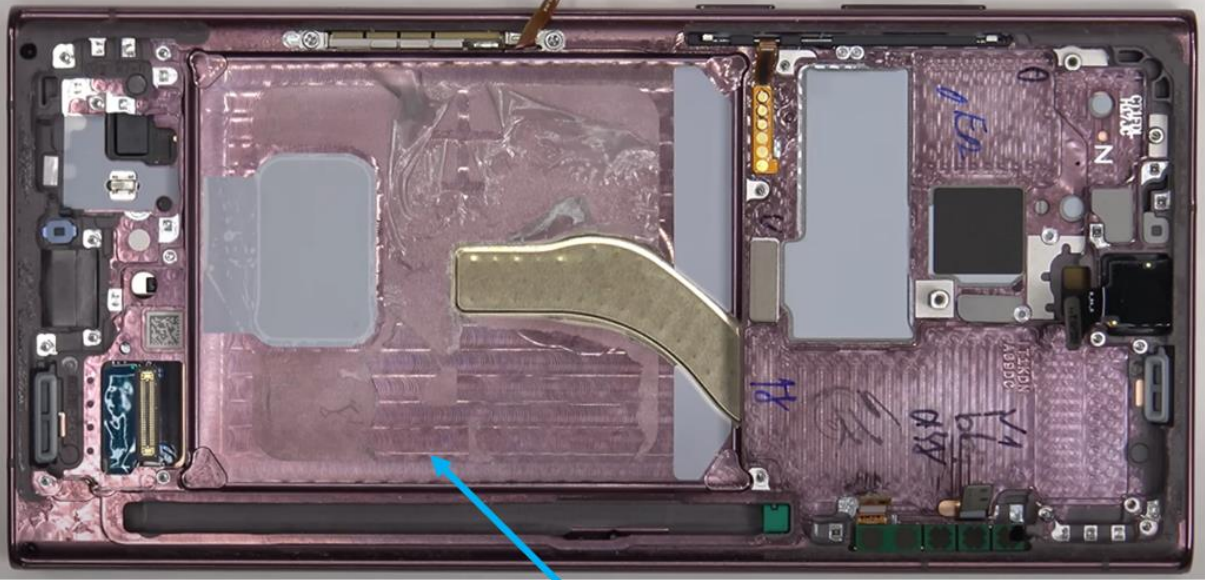
Samsung’s products comprising graphite and/or vapor chamber thermal conduction transfer panels, including without limitation the Samsung Galaxy S10, Galaxy S10e, Galaxy S10+, Galaxy S10 Lite, Galaxy S10 5G, Galaxy S20, Galaxy S20 5G, Galaxy S20+, Galaxy S20+ 5G, Galaxy S20 Ultra, Galaxy S20 FE, Galaxy S20 FE 5G, Galaxy S21, Galaxy S21+, Galaxy S21 Ultra, Galaxy S21 FE, Galaxy S22, Galaxy S22+, Galaxy S22 Ultra, Galaxy S23, Galaxy S23+, Galaxy S23 Ultra, Galaxy S23 FE, Galaxy S24, Galaxy S24+, Galaxy Note 20, Galaxy Note 20 5G, Galaxy Note 20 Ultra, and Galaxy Note 20 Ultra 5G.

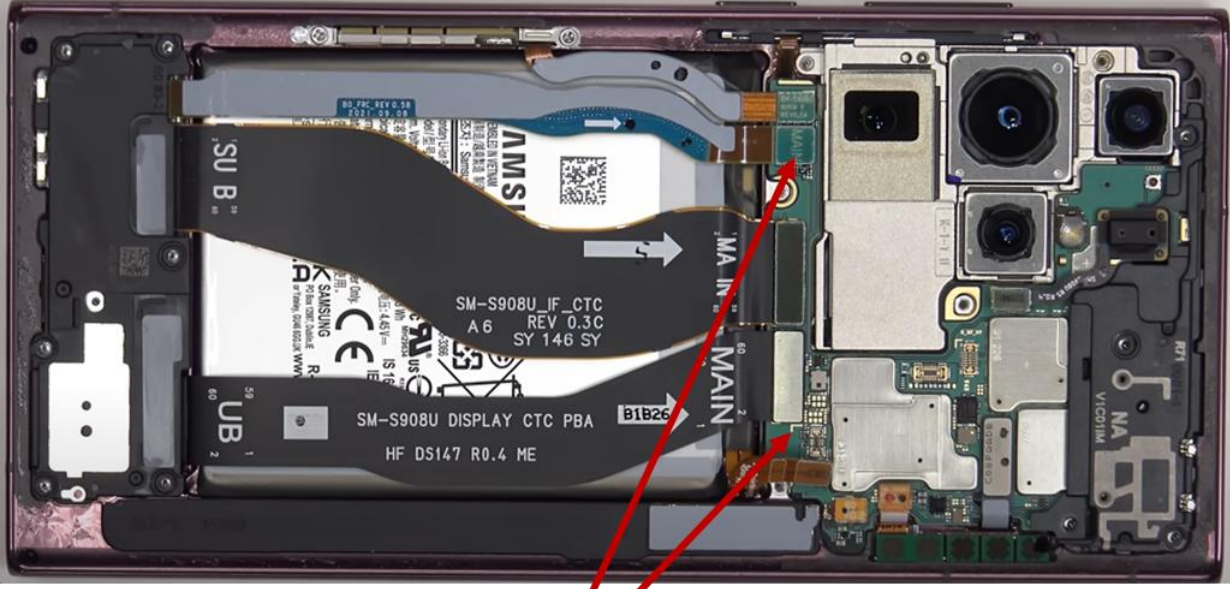
Each Accused Product infringes the claims in substantially the same way, and the evidence shown in this chart is similarly applicable to each Accused Product. For example, each Accused Product includes a graphite and/or vapor chamber thermal conduction transfer panel as shown and described in this chart. Thus, the descriptions and evidence below relating to the Galaxy S22 Ultra representative product is similarly applicable to the remaining Accused Products listed above . Each claim limitation is literally infringed by each Accused Product. However, to the extent any claim limitation is not met literally, it is nonetheless met under the doctrine of equivalents because the differences between the claim limitation and each Accused Product would be insubstantial, and each Accused Product performs substantially the same function, in substantially the same way, to achieve the same result as the claimed invention. Notably, Samsung has not yet articulated which, if any, particular claim limitations it believes are not met by the Accused Products.

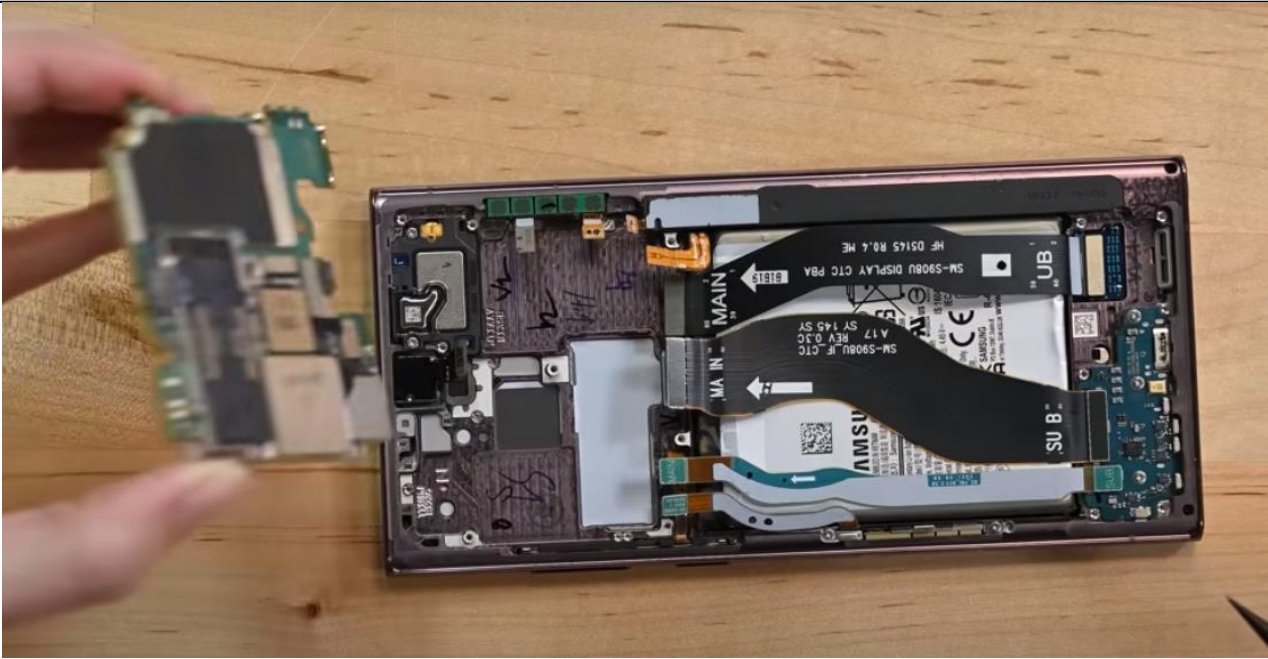
Claim 3

Claim 3	Accused Products
3. An electronic assembly comprising:	To the extent the preamble is limiting, each Accused Product is or comprises an electronic assembly. For example, the Galaxy S22 Ultra includes a frame, main PCB, and thermal conduction panel as described in the elements below. <i>See, e.g.:</i>

Claim 3	Accused Products
	 Illustration of Samsung phone construction
[3a] a support structure comprising walls enclosing a space;	Each Accused Product comprises a support structure comprising walls enclosing a space. For example, the Galaxy S22 Ultra includes a frame with side walls enclosing the space as shown below. <i>See, e.g.:</i>

Claim 3	Accused Products
	 A support structure comprising walls enclosing a space (the phone frame has walls extending from its major flat surface – the walls enclose a space) Annotated photograph of Galaxy S22 Ultra
[3b] a circuit substrate coupled to a first portion of said support structure, said circuit substrate comprising a mounting surface;	Each Accused Product comprises a circuit substrate coupled to a first portion of said support structure, said circuit substrate comprising a mounting surface. For example, the Galaxy S22 Ultra includes a main system board screwed to the phone frame, with a mounting surface. <i>See, e.g.:</i>

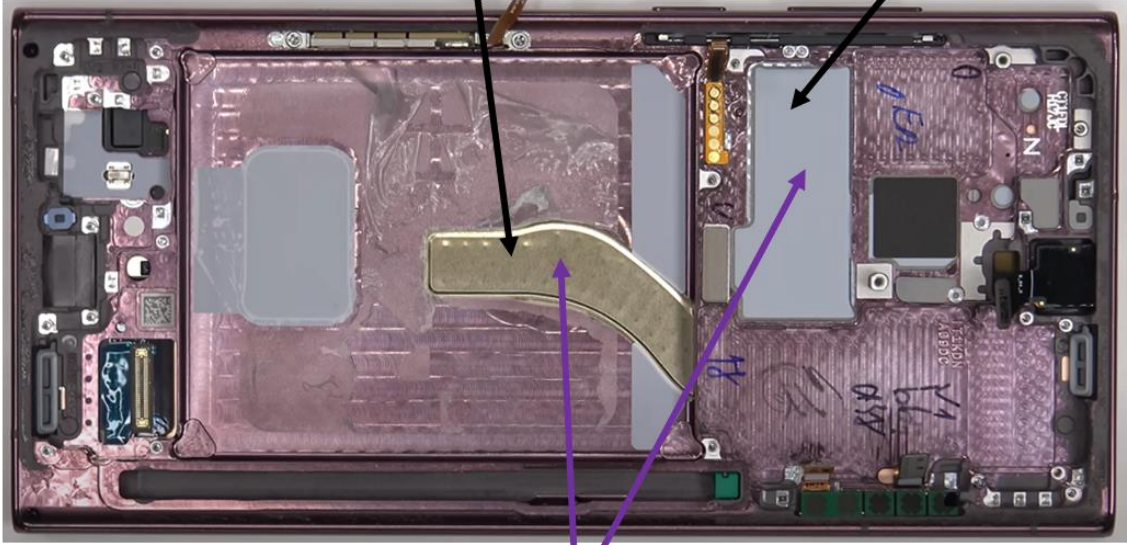
Claim 3	Accused Products
	 A circuit substrate coupled to a first portion of said support structure, said circuit substrate comprising a mounting surface (the main board and camera board mount to the frame with screws) Annotated photograph of Galaxy S22 Ultra, showing system board coupled to support structure. The mounting surface is not visible in this photograph.

Claim 3	Accused Products
	 Screen capture from https://www.ifixit.com/Teardown/Samsung+Galaxy+S22+Teardown/148710 at 1:16, showing system board (at left) of Galaxy S22 Ultra being flipped up from its mounting, showing electronic devices attached to the mounting surface of the circuit substrate.

Claim 3	Accused Products
	 Screen capture from https://www.ifixit.com/Teardown/Samsung+Galaxy+S22+Teardown/148710 at 1:17 showing electronic devices attached to mounting surface. The main system processor is at right (corresponding to the top of the previous image).
[3c] an electronic device attached to said mounting surface and disposed within said space; and	Each Accused Product comprises an electronic device attached to said mounting surface and disposed within said space. For example, numerous electronic devices are attached to the mounting surface in the Galaxy S22 Ultra, as shown below. <i>See, e.g.:</i>

Claim 3	Accused Products
	Screen capture from https://www.ifixit.com/Teardown/Samsung+Galaxy+S22+Teardown/148710 at 1:16, showing system board (at left) of Galaxy S22 Ultra being flipped up from its mounting, showing electronic devices attached to the mounting surface of the circuit substrate.

Claim 3	Accused Products
	 Screen capture from https://www.ifixit.com/Teardown/Samsung+Galaxy+S22+Teardown/148710 at 1:17 showing electronic devices attached to mounting surface. The main system processor is at right (corresponding to the top of the previous image).
[3d] a panel coupled to a second portion of said support structure, said panel comprising contiguous sections, each said section comprising an inner surface facing said mounting surface of said circuit substrate and oriented within twenty-five	Each Accused Product comprises a panel coupled to a second portion of said support structure, said panel comprising contiguous sections, each said section comprising an inner surface facing said mounting surface of said circuit substrate and oriented within twenty-five degrees of parallel to said mounting surface. For example, the Galaxy S22 Ultra contains a vapor chamber and a graphite sheet, each of which has an inner surface facing the mounting substrate and substantially parallel to it. <i>See, e.g.:</i>

Claim 3	Accused Products
degrees of parallel to said mounting surface,	Vapor Chamber Graphite  a panel coupled to a second portion of said support structure, said panel comprising contiguous sections, each said section comprising an inner surface facing said mounting surface of said circuit substrate and oriented within twenty-five degrees of parallel to said mounting surface (the graphite film, vapor chamber and boards are all oriented parallel to the plane of the frame flat surface – and likely within 1 degree of parallel to the mounting surface. The graphite is visible through holes in the flat surface of the frame and covers a larger area on the opposite side of the frame)) Annotated photograph of Galaxy S22 Ultra.

Claim 3	Accused Products
	 Graphite  Vapor Chamber (graphite film has been peeled back) (these are views from the opposite side of the frame – to better see how the vapor chamber and graphite film have contiguous sections) Annotated photographs of Galaxy S22 Ultra.

Claim 3

Accused Products



Screen capture from <https://www.ifixit.com/Teardown/Samsung+Galaxy+S22+Teardown/148710> at 4:09 showing vapor chamber removed from support structure. The inner surface facing the mounting surface is facing away from the camera in this image.

Claim 3	Accused Products
	copper heat pipes for heat diffusion. Instead, this teardown shows that Samsung is using a 3D graphite layer within the entry Galaxy S21 model to achieve better device thermals this year. https://9to5google.com/2021/01/18/samsung-galaxy-s21-teardown-shows-minor-internal-differences-from-s20-series/  https://www.sammobile.com/news/the-power-of-galaxy-s23-backed-by-larger-vapor-chambers/ According to Samsung, the Galaxy S24 has a 1.5x bigger vapor chamber than the Galaxy S23. The Galaxy S24+ has a 1.6x bigger vapor chamber system than the Galaxy S23+. The Galaxy S24 Ultra has a vapor chamber cooling system that's almost twice (1.9x) as big as the Galaxy S23 Ultra. That's a massive upgrade over the Galaxy S23 series. https://www.sammobile.com/news/galaxy-s24-sustain-performance-bigger-vapor-chamber/
[3e] wherein each said section has a first thermal conductivity substantially parallel to the inner surface of said section	In each Accused Product, each said section has a first thermal conductivity substantially parallel to the inner surface of said section and a second thermal conductivity substantially perpendicular to the inner surface of said section.

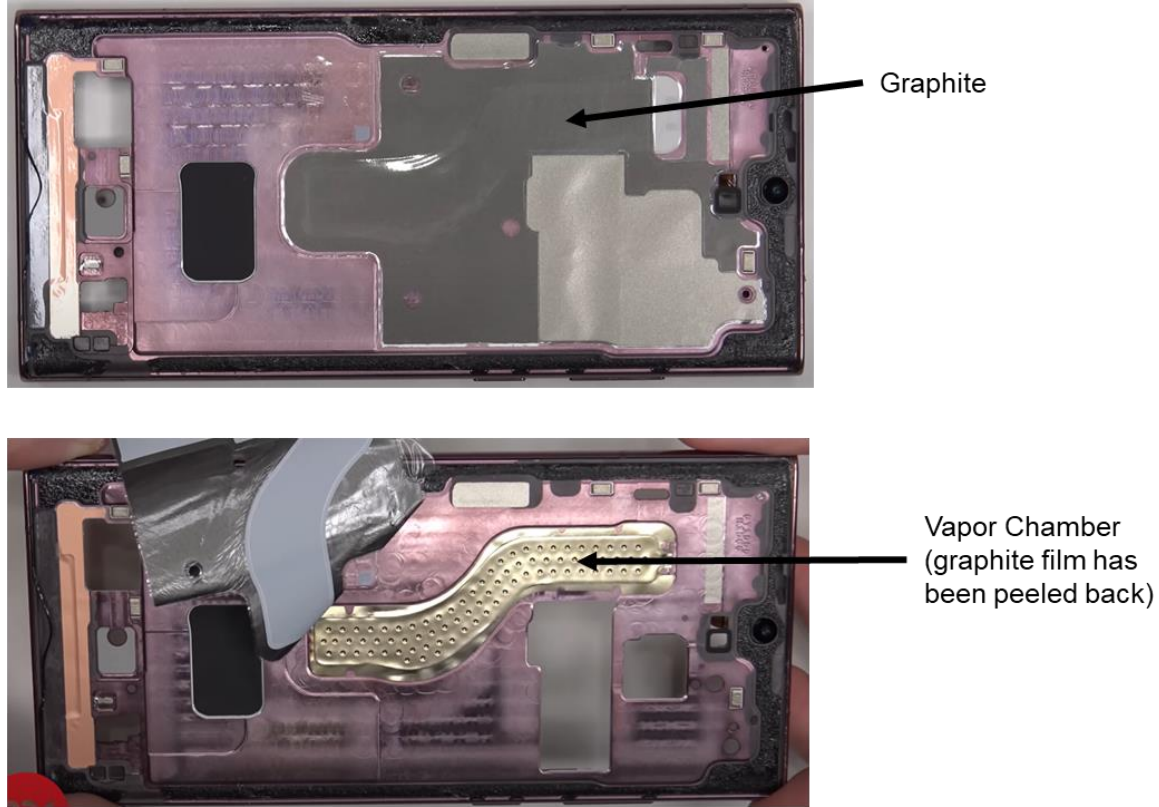
Claim 3	Accused Products																																				
and a second thermal conductivity substantially perpendicular to the inner surface of said section,	For example, the pyrolitic graphite used in the thermal transfer pads of the Galaxy S22 Ultra has a substantial difference in in-plane versus through-plane thermal conductivity, corresponding to the first and second thermal conductivities as claimed. For another example, on information and belief the vapor chambers used in the Galaxy S22 Ultra and other Samsung devices have a substantial difference in in-plane versus through-plane thermal conductivity, corresponding to the first and second thermal conductivities as claimed See, e.g.: Typical Properties of HPMS Pyrolytic Graphite <table><tr><th>Property</th><th>Unit</th><th>HGS-012</th><th>HGS-017</th><th>HGS-025</th><th>HGS-040</th></tr><tr><td>Color</td><td>-</td><td colspan="4">Silver gray</td></tr><tr><td>Thickness</td><td>mm</td><td>0.012</td><td>0.017</td><td>0.025</td><td>0.040</td></tr><tr><td>Density</td><td>g/cc</td><td>2.1</td><td>2.1</td><td>1.92</td><td>1.8</td></tr><tr><td>Typical Thermal Conductivity, In-Plane</td><td>W/m-K</td><td>1800</td><td>1800</td><td>1750</td><td>1400</td></tr><tr><td>Typical Thermal Conductivity, Through-Plane</td><td>W/m-K</td><td>10</td><td>11</td><td>18</td><td>20</td></tr></table> Exemplary summary of thermal properties of pyrolitic graphite, from https://hpmsggraphite.com/pyrolyticgraphitesheet?gclid=EA1aIQobChMI4vuVi_Lj_QIVMRTUAR3x6wlgEAAYASAAEgLQjfD_BwE	Property	Unit	HGS-012	HGS-017	HGS-025	HGS-040	Color	-	Silver gray				Thickness	mm	0.012	0.017	0.025	0.040	Density	g/cc	2.1	2.1	1.92	1.8	Typical Thermal Conductivity, In-Plane	W/m-K	1800	1800	1750	1400	Typical Thermal Conductivity, Through-Plane	W/m-K	10	11	18	20
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Claim 3	Accused Products
[3f] wherein for each said section, said first thermal conductivity is at least one-hundred times greater than said second thermal conductivity.	In each Accused Product, for each said section, said first thermal conductivity is at least one-hundred times greater than said second thermal conductivity. For example, the pyrolytic graphite used in the thermal transfer pads of the Galaxy S22 Ultra has a substantial difference in in-plane versus through-plane thermal conductivity, corresponding to the first and second thermal conductivities as claimed. In a typical example, corresponding to the properties of the Galaxy S22 Ultra, the in-plane conductivity is 180 times greater than the cross-plane conductivity. For another example, on information and belief the in-plane conductivity of the vapor chambers used in the Galaxy S22 Ultra and other Samsung devices is at least one-hundred times greater than the cross-plane conductivity. <i>See, e.g.:</i>

Claim 3	Accused Products																																				
	Typical Properties of HPMS Pyrolytic Graphite <table><tr><th>Property</th><th>Unit</th><th>HGS-012</th><th>HGS-017</th><th>HGS-025</th><th>HGS-040</th></tr><tr><td>Color</td><td>-</td><td colspan="4">Silver gray</td></tr><tr><td>Thickness</td><td>mm</td><td>0.012</td><td>0.017</td><td>0.025</td><td>0.040</td></tr><tr><td>Density</td><td>g/cc</td><td>2.1</td><td>2.1</td><td>1.92</td><td>1.8</td></tr><tr><td>Typical Thermal Conductivity, In-Plane</td><td>W/m-K</td><td>1800</td><td>1800</td><td>1750</td><td>1400</td></tr><tr><td>Typical Thermal Conductivity, Through-Plane</td><td>W/m-K</td><td>10</td><td>11</td><td>18</td><td>20</td></tr></table> Exemplary summary of thermal properties of pyrolytic graphite, from https://hpmsggraphite.com/pyrolyticgraphitesheet?gclid=EAIaIQobChMI4vuVi_Lj_QIVMRTUAR3x6wlgEAAYASAAEgLQjfd_BwE	Property	Unit	HGS-012	HGS-017	HGS-025	HGS-040	Color	-	Silver gray				Thickness	mm	0.012	0.017	0.025	0.040	Density	g/cc	2.1	2.1	1.92	1.8	Typical Thermal Conductivity, In-Plane	W/m-K	1800	1800	1750	1400	Typical Thermal Conductivity, Through-Plane	W/m-K	10	11	18	20
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Claim 4

Claim 4	Accused Products
4. The electronic assembly of claim [3], wherein:	Each Accused Product is or comprises the electronic assembly of claim 3, wherein said panel further comprises substantially parallel edges bounding said sections, and for each said section, said inner surface of said section is from one of said edges bounding said section to another of said edges bounding said section.

Claim 4	Accused Products
said panel further comprises substantially parallel edges bounding said sections, and for each said section, said inner surface of said section is from one of said edges bounding said section to another of said edges bounding said section.	For example, each section of the panel of the Galaxy S22 Ultra has at least two substantially parallel edges, and has a continuous inner surface from one edge to the other. <i>See, e.g.:</i>  (these are views from the opposite side of the frame – to better see how the vapor chamber and graphite film have contiguous sections) Annotated photographs of Galaxy S22 Ultra

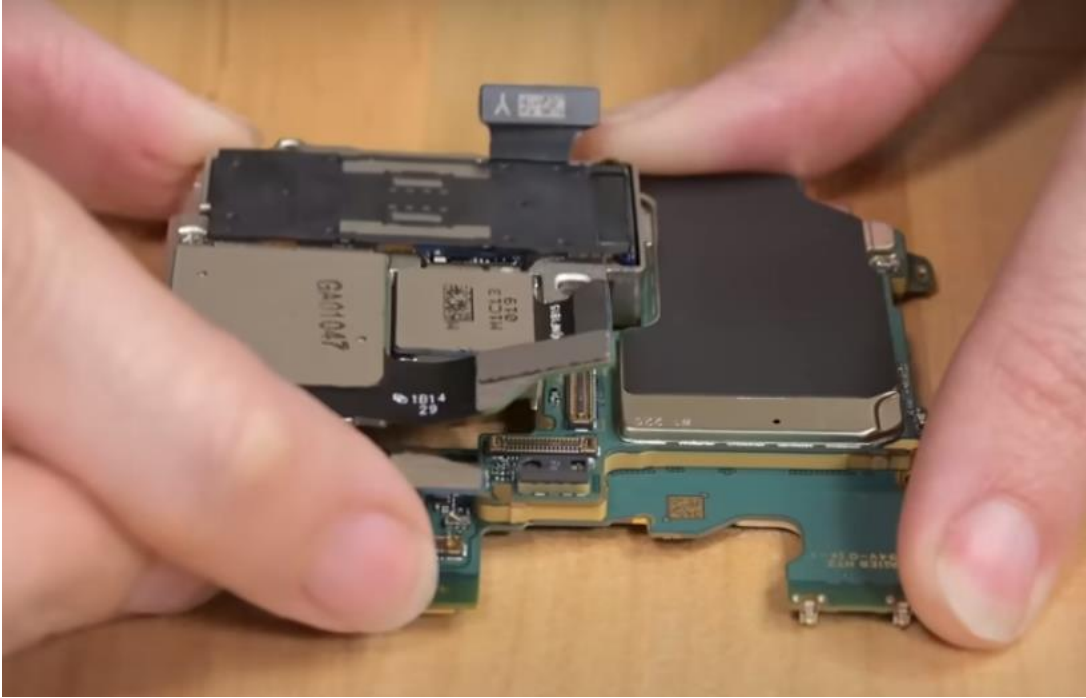
Claim 4

Accused Products



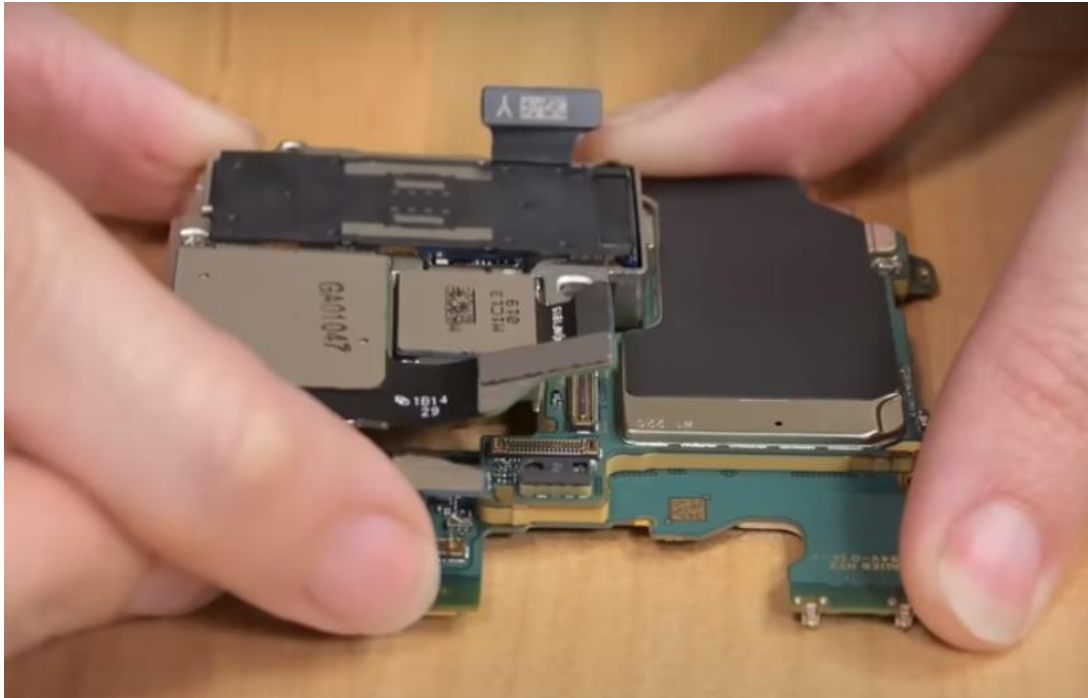
Screen capture from <https://www.ifixit.com/Teardown/Samsung+Galaxy+S22+Teardown/148710>
at 4:09

Claim 5

Claim 5	Accused Products
5. The electronic assembly of claim 4, wherein said mounting surface is substantially planar.	Each Accused Product is or comprises the electronic assembly of claim 4, wherein said mounting surface is substantially planar. For example, the mounting surface in the Galaxy S22 Ultra comprises one or more PCBs, each of which is substantially planar. Furthermore, the plurality of PCBs, as assembled, form a substantially planar mounting surface. <i>See, e.g.:</i>  Screen capture from https://www.ifixit.com/Teardown/Samsung+Galaxy+S22+Teardown/148710 at 1:17 showing electronic devices attached to mounting surface.

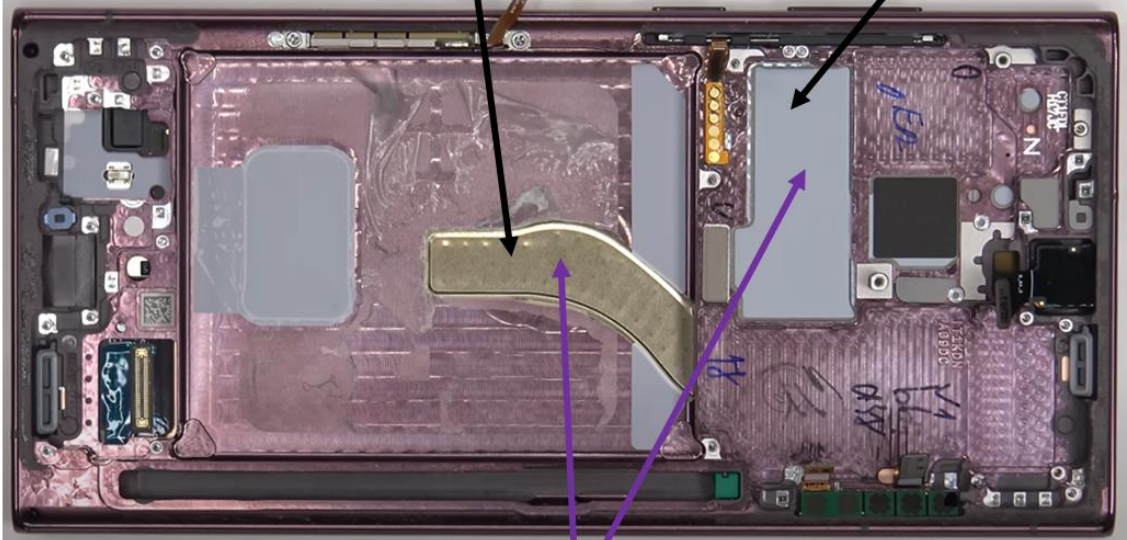
Claim 6

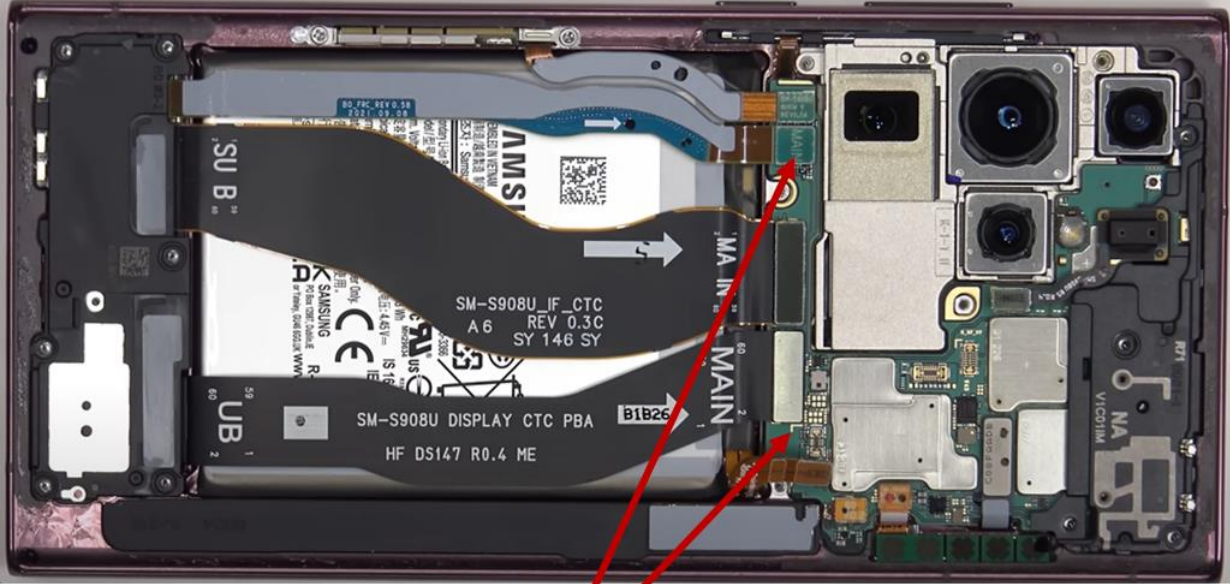
Claim 6	Accused Products
6. The electronic assembly of claim 5 further comprising thermally conductive material disposed between and physically contacting said electronic device and the inner surface of said first one of said sections of said panel.	Each Accused Product is or comprises the electronic assembly of claim 5 further comprising thermally conductive material disposed between and physically contacting said electronic device and the inner surface of said first one of said sections of said panel. For example, in the Galaxy S22 Ultra, individual electronic devices have internal heat spreaders and/or thermal conduction pads thermally connecting them to the panel. For another example, in the case of the Galaxy S22 Ultra CPU, there is thermally conductive metal material between the CPU and the vapor chamber. <i>See, e.g.:</i> 

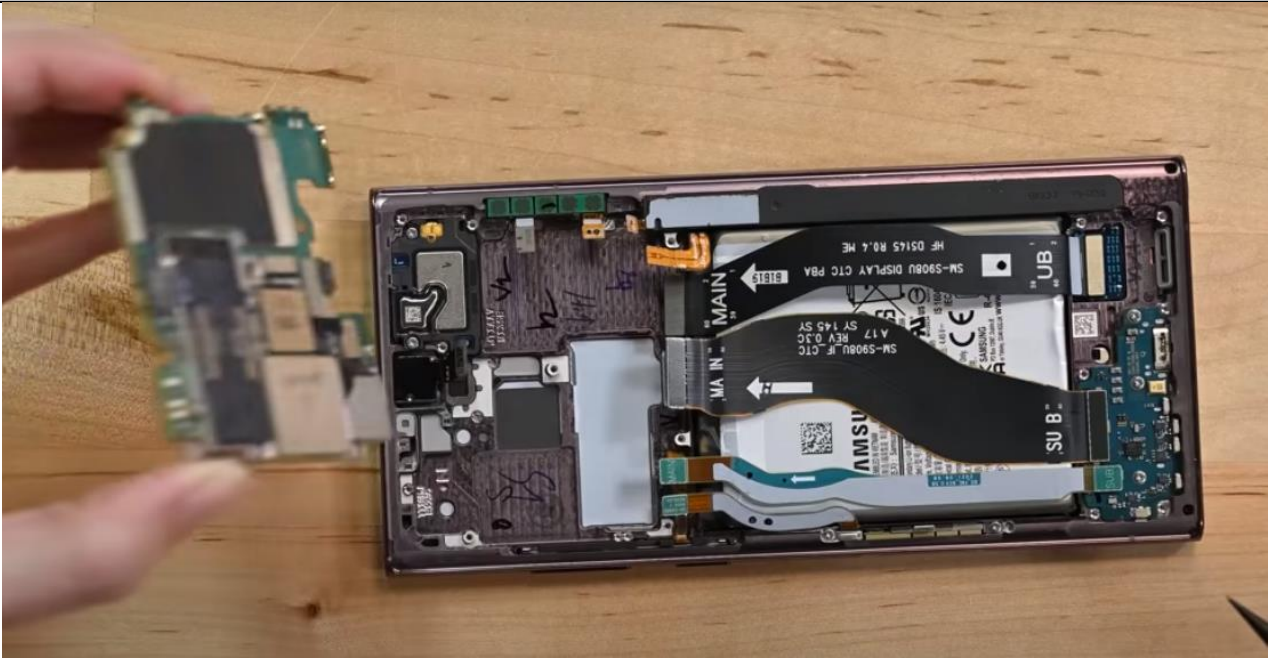
Claim 6	Accused Products
	Screen capture from https://www.ifixit.com/Teardown/Samsung+Galaxy+S22+Teardown/148710 at 1:16, showing system board (at left) being flipped up from its mounting, with system CPU at top of the system board, showing contact area between system CPU and thermally conductive metal connecting the system CPU to the vapor chamber.  Screen capture from https://www.ifixit.com/Teardown/Samsung+Galaxy+S22+Teardown/148710 at 1:17 showing thermally conductive material above system CPU

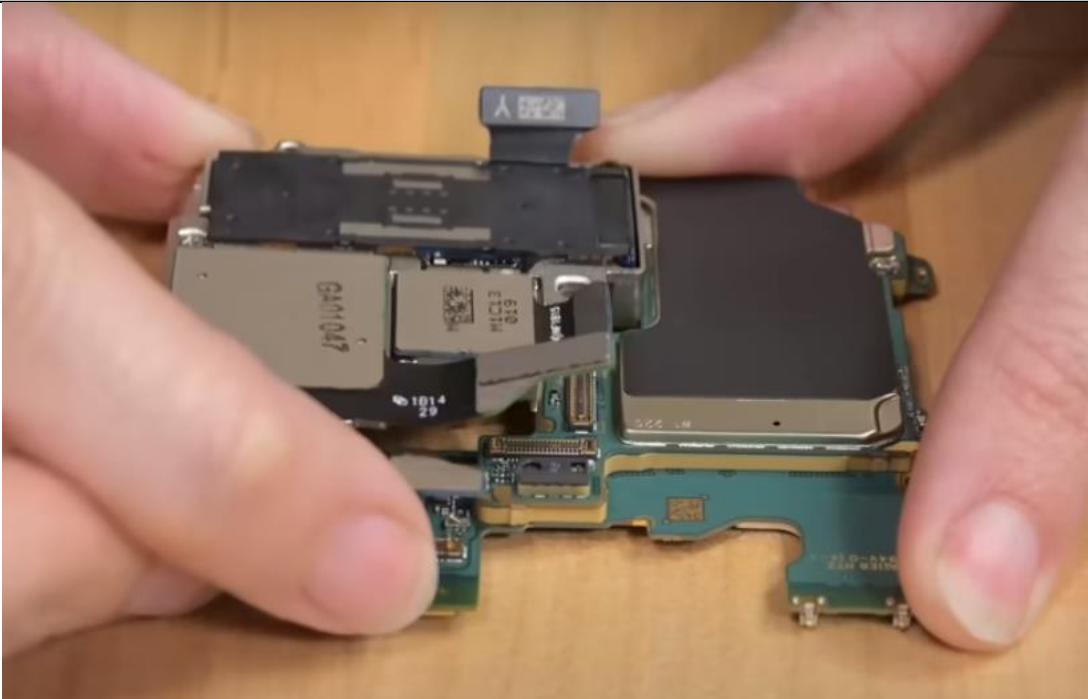
Claim 7

Claim 7	Accused Products
7. The electronic assembly of claim 6, wherein said inner surface of said first one of said sections is substantially parallel to said mounting surface.	Each Accused Product is or comprises electronic assembly of claim 6, wherein said inner surface of said first one of said sections is substantially parallel to said mounting surface. For example, in the Galaxy S22 Ultra the inner surfaces as claimed of both the vapor chamber and graphite heat spreaders are substantially parallel to the PCB, as enforced by the connections to the frame. This is shown generally in the photographs below, although because of the contact between the panel and the mounting surface it is impossible to actually see both parallel surfaces in the same image. <i>See, e.g.:</i>

Claim 7	Accused Products
	 a panel coupled to a second portion of said support structure, said panel comprising contiguous sections, each said section comprising an inner surface facing said mounting surface of said circuit substrate and oriented within twenty-five degrees of parallel to said mounting surface (the graphite film, vapor chamber and boards are all oriented parallel to the plane of the frame flat surface – and likely within 1 degree of parallel to the mounting surface. The graphite is visible through holes in the flat surface of the frame and covers a larger area on the opposite side of the frame)) Annotated photograph of Galaxy S22 Ultra.

Claim 7	Accused Products
	 A circuit substrate coupled to a first portion of said support structure, said circuit substrate comprising a mounting surface (the main board and camera board mount to the frame with screws) Annotated photograph of Galaxy S22 Ultra, showing system board coupled to support structure that enforces parallelism with panel.

Claim 7	Accused Products
	 Screen capture from https://www.ifixit.com/Teardown/Samsung+Galaxy+S22+Teardown/148710 at 1:16, showing mounting surface of system PCB (at left) being flipped up from its place parallel to the inner surface(s) of the graphite and vapor chamber panels (at right).

Claim 7	Accused Products
	 Screen capture from https://www.ifixit.com/Teardown/Samsung+Galaxy+S22+Teardown/148710 at 1:17 showing thermally conductive material