



Teardown

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Report Information	
Report Publish Date	3/24/2022
ItemID / Report Code	393640/DDT-2112-803
Product Description	
Product Type	Smartphone
Brand	Sony
Device Name	Xperia 5 III
Device Model #	SO-53B
Official Release Date	11/12/2021
Country of Purchase	Japan
Retail Price	\$980.02
Weight (grams)	168.9 (Measured)
Device Dimensions (mm)	156.55 x 68.28 x 9.7 (Measured at Longest/Widest/Thickest Points)
Product Features	
Operating System	Android 11
Processor Spec	Qualcomm SM8350 Snapdragon 888 5G
RAM Support	8 GB Mobile LPDDR4X SDRAM
Communications	Quad-Band GSMEDGE, W-CDMA (800/850/2100 MHz), LTE (700/800/850/1500/1700/1800/2100/2600 MHz), TD-LTE (1900/2300/2500/2600/3500 MHz), 5G TD-NR (3500/4700 MHz)
Connectivity	Bluetooth 5.2, GPS/GLONASS, BeiDou, Galileo, A-GPS, Geotagging, QuickGPS, QZSS, NFC A, NFC B, FeliCa, WiFi 802.11 a/b/g/n/ac, Wi-Fi Direct, Wi-Fi Tethering, Wi-Fi Calling, Miracast, USB Type-C 3.1
User Interface	Multitouch Capacitive Touchscreen, Side Control Buttons
Storage	Internal: 128 GB 3D TLC External: microSD up to 1 TB
Sensors	3-Axis Electronic Compass, Ambient Light & Color Sensor, Ambient Light / Proximity Sensor, Hall Effect Sensor, 6-Axis MEMS Accelerometer & Gyroscope, Digital Barometric Pressure Sensor
Battery Type	3.87 V, 4380 mAh, Lithium Polymer
Battery Life (Hrs)	Use Time: 24h (3G Talk) ; Standby Time: 100h
Main Display	6.1 in, AMOLED - Y-OCTA, 2520 x 1080 pixels, 1073741824 colors
Display Refresh Rate	120 Hz
Front Camera	8 MP CMOS BSI, f/2.0
Rear Camera	12 MP CMOS BSI, Wide-Angle, f/1.7, AF, OIS; 12 MP CMOS BSI, Telephoto, f/2.3-2.8, AF, OIS, 3x/4.4x optical zoom; 12 MP CMOS BSI, Ultra-Wide-Angle, f/2.2, AF; LED Flash

Deep Dive Teardown

Device Analysis

Design Wins

Design Wins		
Function	Manufacturer	Part Number
Apps/Baseband Processor	Qualcomm	SM8350-103-AB
RAM	Samsung	K3LK7K70BM-BGCP
NAND Flash	Samsung	KLUDG4UHDB-B2E1
Power Management	Qualcomm	PM8350B-001
	Qualcomm	PM8350-004
	Qualcomm	PM8350C-004
	Qualcomm	PMR735A-005
Camera Power Management	Qualcomm	PM8008-0X0 (x2)
RF Transceiver + GPS	Qualcomm	SDR868-008
Accelerometer/Gyroscope	STMicroelectronics	LSM6DSO
Hall-Effect Sensor	Rohm	BU520xxxxx
Digital Barometric Pressure Sensor	Bosch Sensortec	BMP390
Audio CODEC	Qualcomm	WCD9385-000
Class-D Audio Amplifier	Cirrus Logic	CS35L41B (x2)
NFC & Secure Element Chip	NXP Semiconductors	SN100F
Touchscreen Controller	Samsung	S6SY79XA
WiFi / Bluetooth	Murata	Unknown
MB Rx/D Front-End Module	Qualcomm	QDM5631
HB/MB Front-End Module	Qualcomm	QPM5670-001
5G NR n78/n79 Front-End Module	Qualcomm	QPM5579-104
LB Front-End Module ?	Qualcomm	QPM6621-101
RxD Front-End Module	Qualcomm	Unknown
MB Rx/D Front-End Module	Qualcomm	QDM5631
MB/HB Rx/D Front-End Module	Qualcomm	QDM5670-004
LTE B21 Power Amplifier	Skyworks	SKY77771-11
Quad-Band GSM PA	Skyworks	SKY77365-11
MEMS Microphones	Knowles	SPH0655LM4H-1
	Hosiden	KRM5600

Qualcomm has the most design wins for the Sony Xperia 5 III SO-53B with 16 major ICs. Qualcomm provided the SM8350-103-AB Application Processor, RF Transceiver and GPS SDR868-008, Audio CODEC WCD9385-000, Camera Power Management, RF Front-End Modules, and four Power Management ICs.

Memory consists of 128 GB 3D TLC V-NAND Flash (KLUDG4UHDB-B2E1) and 8 GB Mobile LPDDR5 SDRAM (K3LK7K70BM-BGCP) from Samsung.

[Design Wins](#)
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[Cost Drivers](#)

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Device Analysis

Analysis Summary

Integrated Circuit Metrics		
IC Die Count**		129
IC Package Count**		93
Cost Metrics		
Retail Price		\$980.02
Total Manufacturing Cost*		\$456.19
Electronics Cost**		\$336.24
Manufacturing Cost Breakdown		
Integrated Circuits	\$228.27	50.0%
Modules, Discretes & Connectors	\$25.52	5.6%
Substrates	\$18.27	4.0%
Component Insertion	\$8.44	1.8%
Card Test	\$5.40	1.2%
Battery Subsystem	\$12.18	2.7%
Display/Touchscreen Subsystem	\$51.35	11.3%
Camera Subsystems	\$85.81	18.8%
Fingerprint Sensor Subsystem	\$2.19	0.5%
Non-Electronic Parts	\$15.91	3.5%
Final Assembly & Test	\$2.85	0.6%
Total	\$456.19	100.0%
*Excluding Supporting Materials' Cost		
**Including Subsystems		

The Sony Xperia 5 III is the successor to the [Sony Xperia 5 II](#).

It features a 6.1-inch, 4K (1644 x 2520 pixels) AMOLED display with 120 Hz refresh rate. The display panel was provided by Samsung.

The Xperia 5 III has one camera in the front (8 MP) and three rear 12 MP cameras: Wide Angle, Ultra-Wide Angle, and Telephoto. Image sensors were provided by Sony and Samsung.

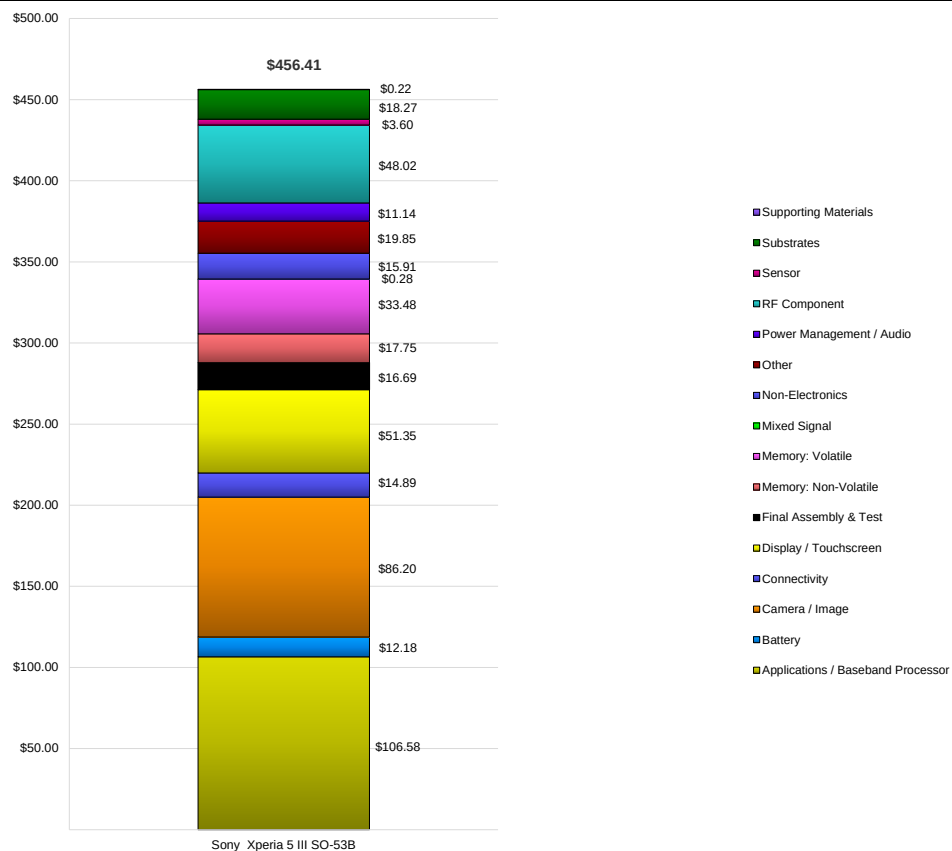
WiFi using two frequencies - 2.4 GHz and 5 GHz.

Security is provided by face recognition technology and a fingerprint sensor.

Device Analysis

Cost Drivers

Item	Function	Location	Component Category	Description	Pkg Form	Qty	Piece Cost	Extended Cost	Pin Count, Each*	Pin Count, Tot*	IC Ref #	Pkg Brand	Pkg PN	Category
1	Applications / Baseband	Main Board - Side 1	IC	Octa-Core Snapdragon 888 Applications / Baseband Processor	BGA-POP	1	\$106.5800	\$106.5800	1888	1888	Main - IC.1	Qualcomm	SM8350-103-AB	Applications / Baseband Processor
193	Subsystems			12 MP Dual Rear Camera Subsystem		1	\$53.0800	\$53.0800				Sony	PDX214	Camera / Image
182	Subsystems			120 Hz Display/Touchscreen Subsystem		1	\$51.3500	\$51.3500				Samsung	AMB609VP04	Display / Touchscreen
13	Memory: Volatile	Main Board - Side 1	IC	Multichip Memory - 8 GB Mobile LPDDR5 SDRAM	BGA-POP-4	1	\$33.4800	\$33.4800	496	496	Main - IC.2	Samsung	K3LK7K70BM-BGCP	Memory: Volatile
184	Subsystems			12 MP Telephoto Rear Camera Subsystem		1	\$27.8400	\$27.8400				Sony	C112MY800A	Camera / Image
12	Memory: Non-Volatile	Main Board - Side 1	IC	Multichip Memory - 128 GB 3D TLC V-NAND Flash, Memory Controller (UFS 3.1)	BGA Stacked 4+1	1	\$17.7500	\$17.7500	153	153	Main - IC.3	Samsung	KLUDG4JHDS-B2E1	Memory: Non-Volatile
155	RF Component	RF Board - Side 2	IC	RF Transceiver + GPS	BGA	1	\$17.5500	\$17.5500	486	486	Main - IC.59	Qualcomm	SDR888-008	RF Component
4	Connectivity	RF Board - Side 1	IC	WiFi 802.11a/b/g/n/ac/ax / Bluetooth 5.2 Module	MCP - 6 Chips	1	\$12.7500	\$12.7500	140	140	Main - IC.50	Murata	Unknown	Connectivity
181	Subsystems			Battery Subsystem		1	\$12.1800	\$12.1800				Ningde Amperex Technology Ltd	SNYSACS	Battery
222	Substrates	Main Board		12 Layer Buildup FR4 / HF		1	\$8.8000	\$8.8000				UMT		Substrates



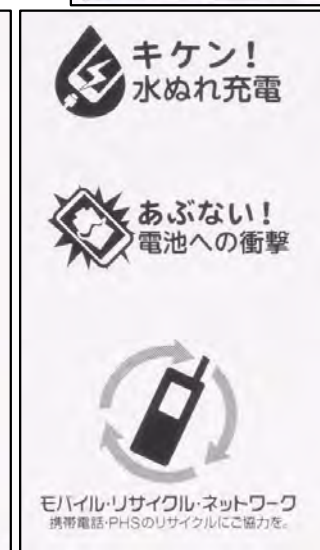
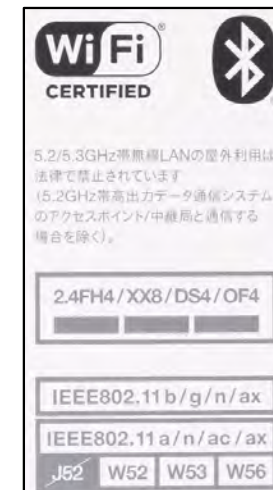
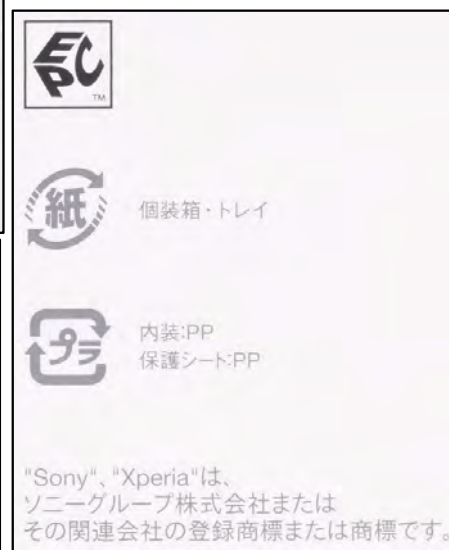
Design Wins

Analysis Summary

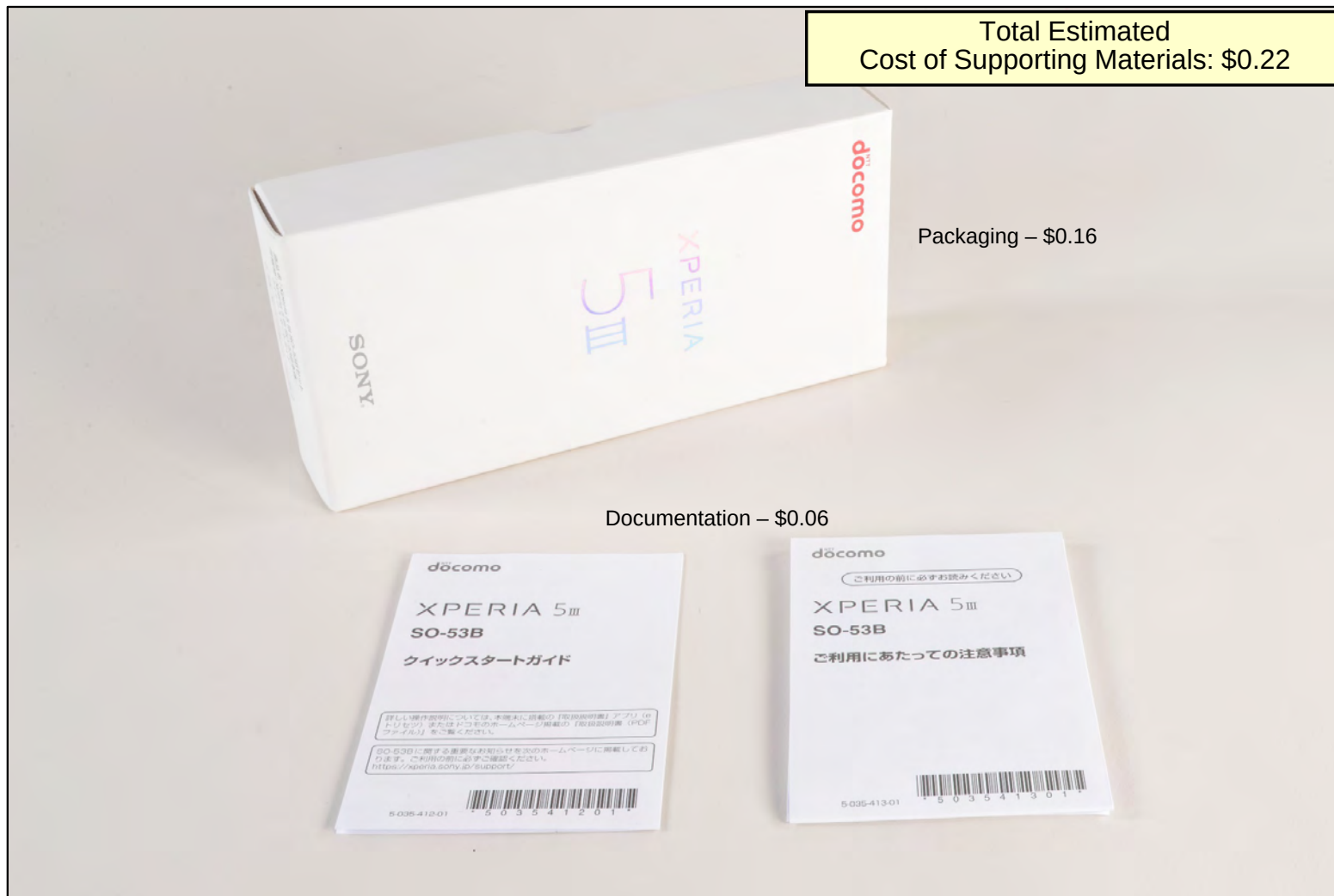
Cost Drivers

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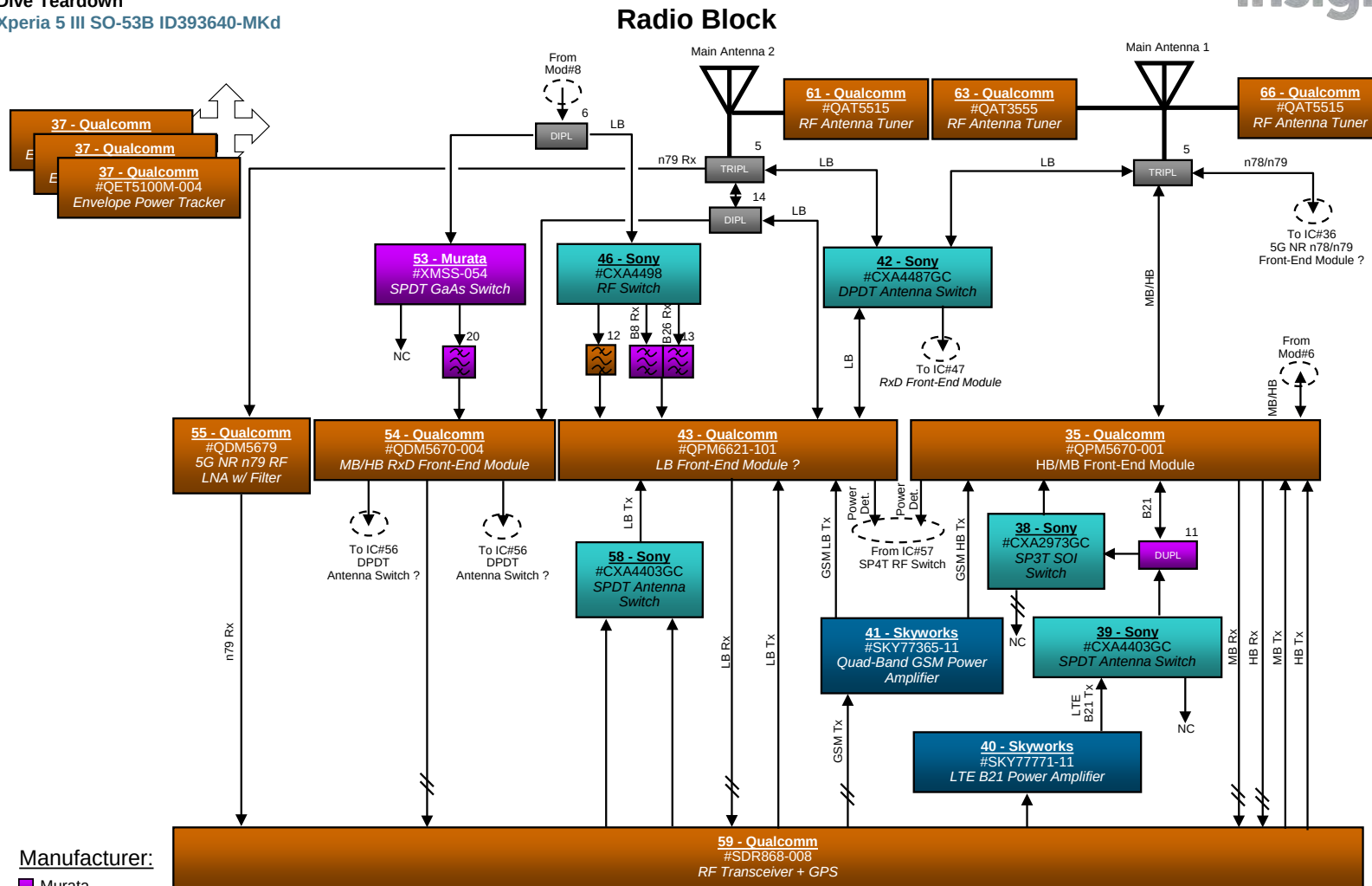
Product Labels



Supporting Materials



Block Diagram

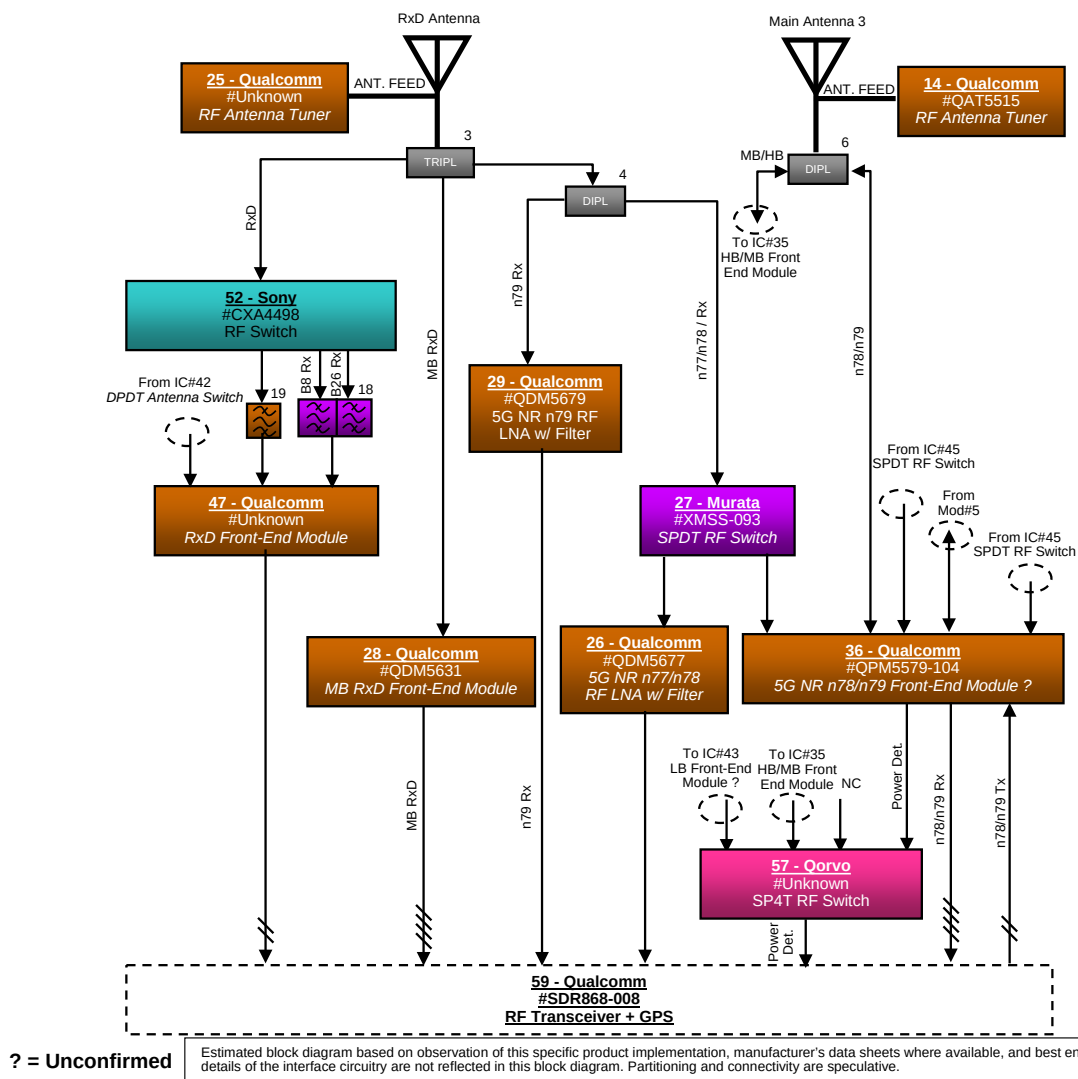


Block Diagram

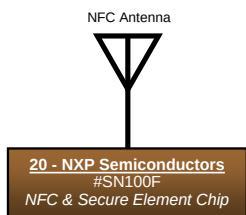
Radio Block

Manufacturer:

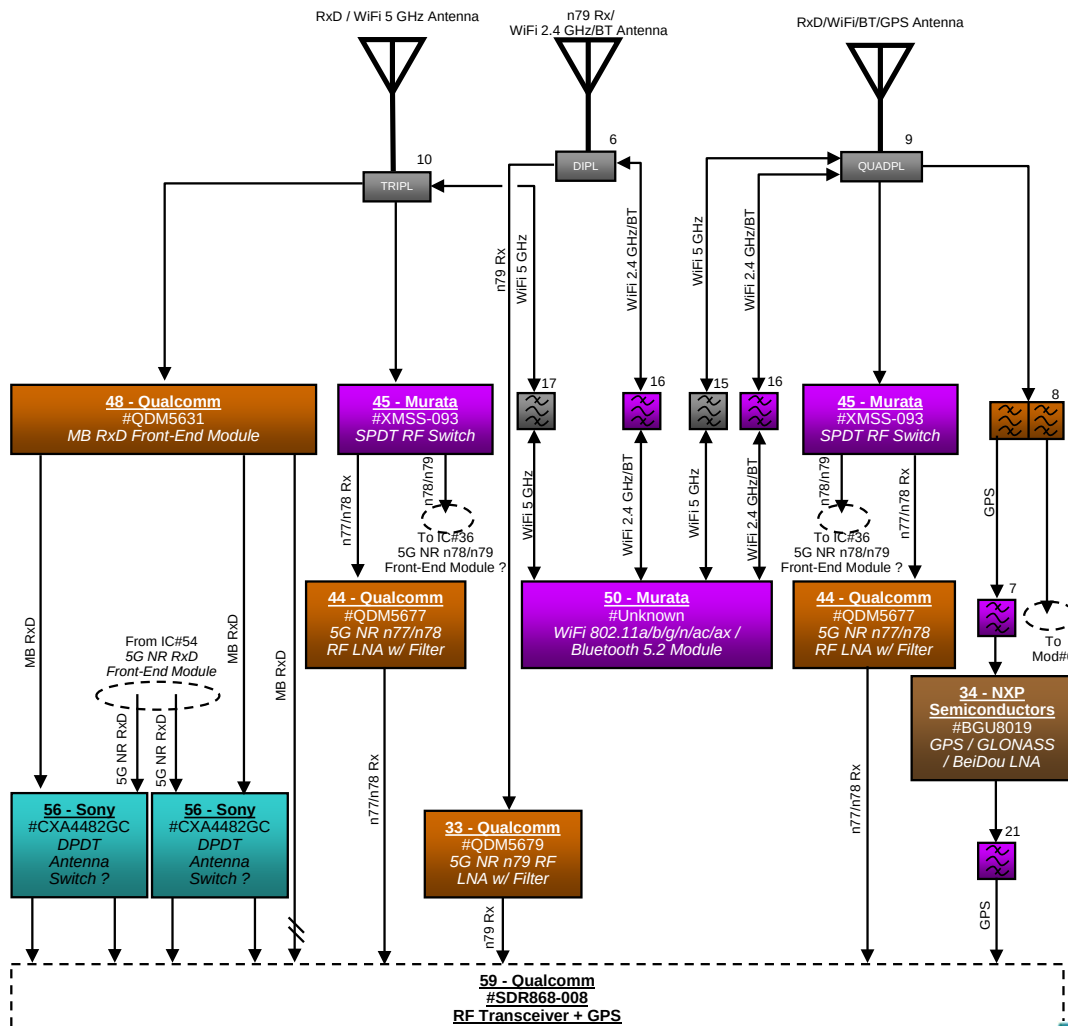
- Murata
- Qorvo
- Qualcomm
- Skyworks
- Sony
- Unknown



Block Diagram



Radio Block



Manufacturer:

- Murata
- NXP
- Qualcomm
- Skyworks
- Sony
- Unknown

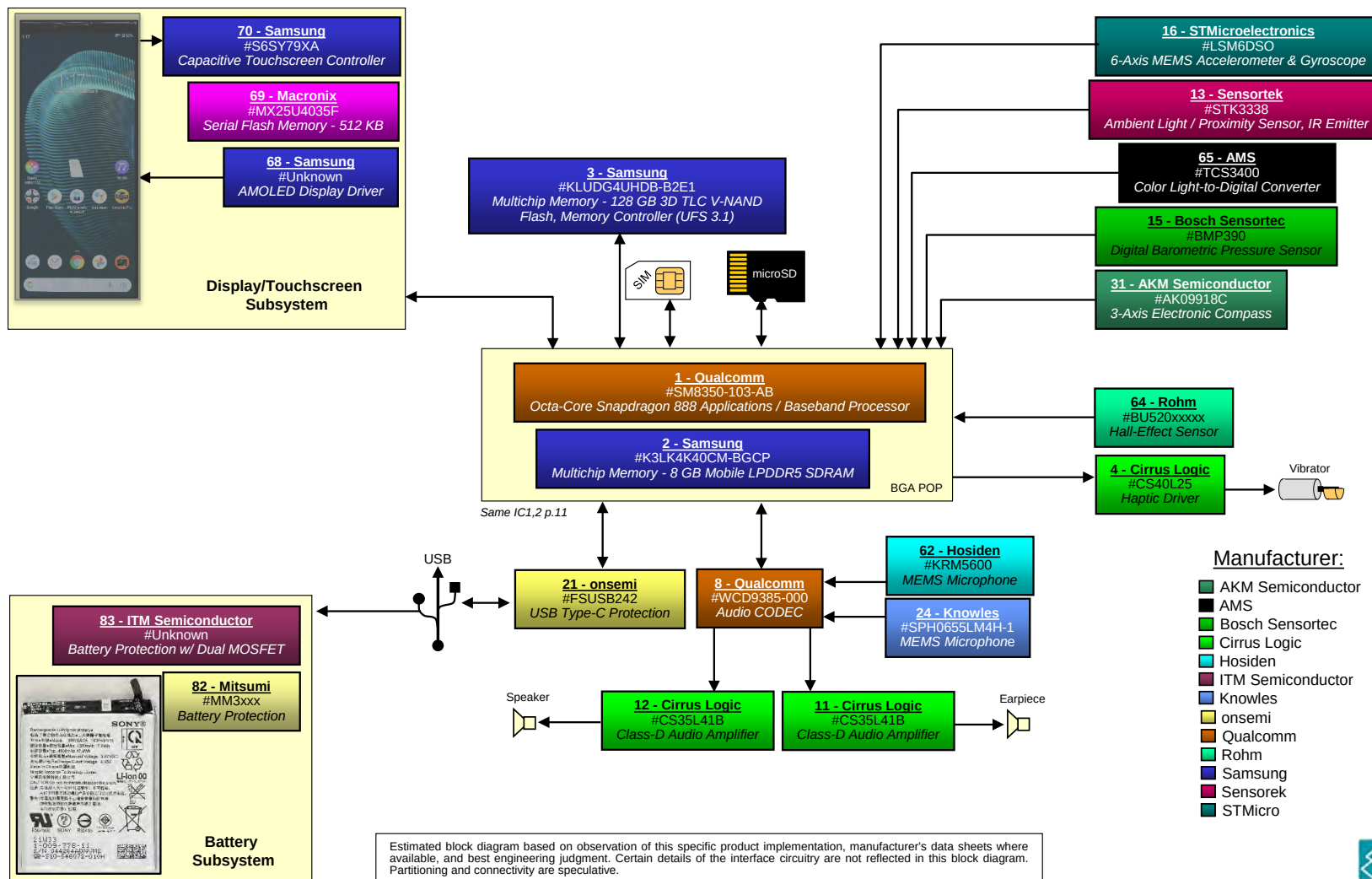
? = Unconfirmed

Estimated block diagram based on observation of this specific product implementation, manufacturer's data sheets where available, and best engineering judgment. Certain details of the interface circuitry are not reflected in this block diagram. Partitioning and connectivity are speculative.



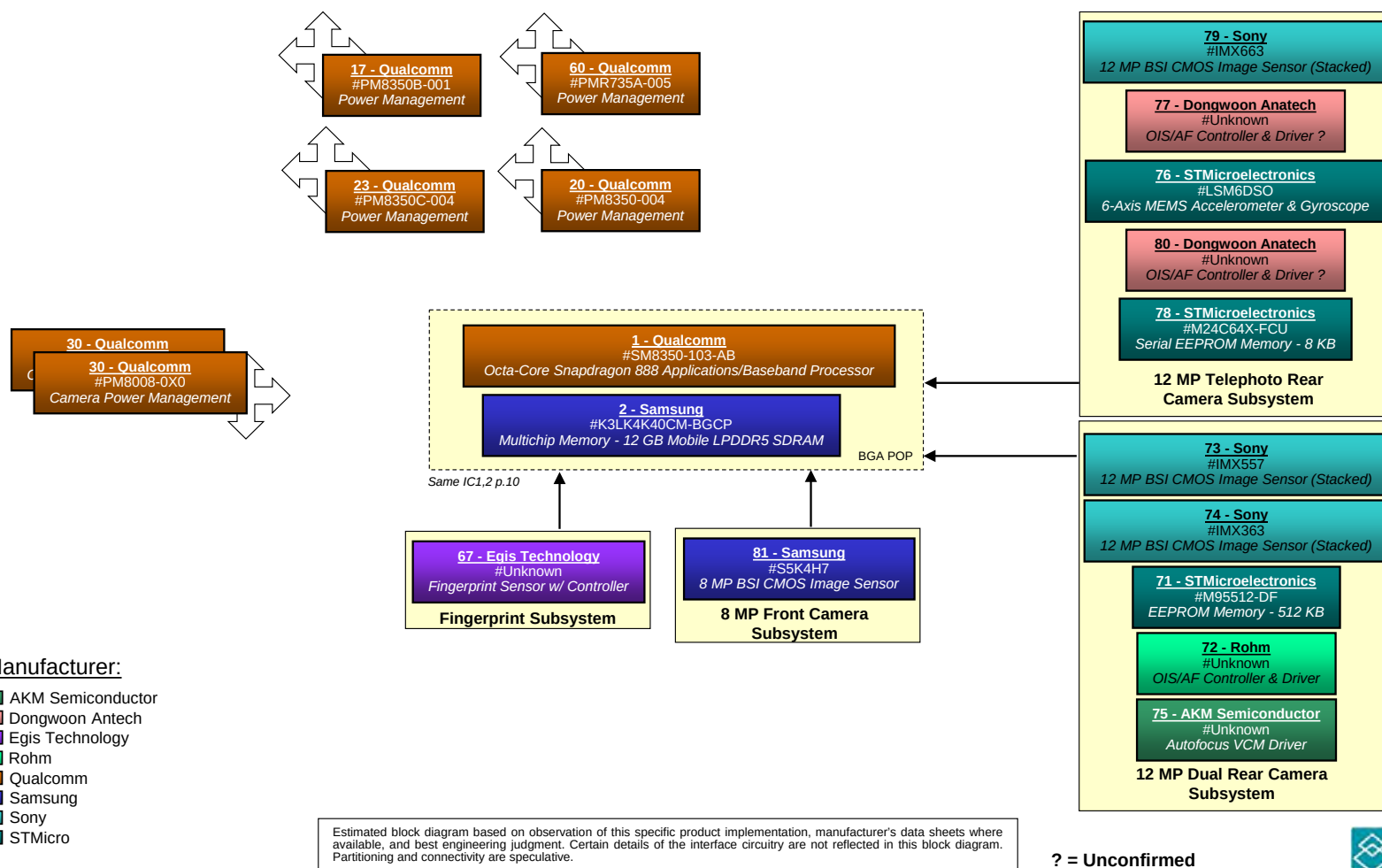
Block Diagram

System Block



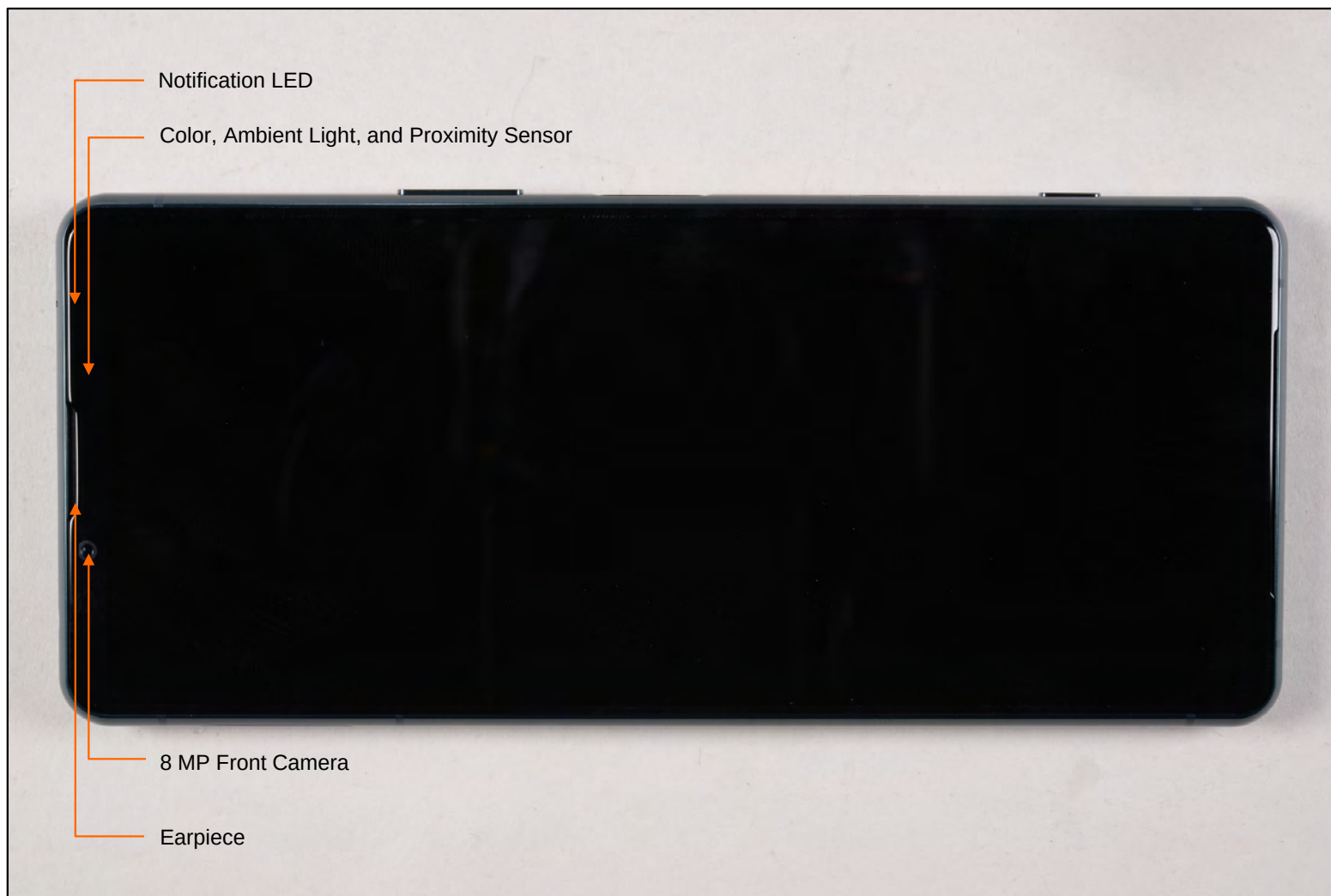
Block Diagram

System Block



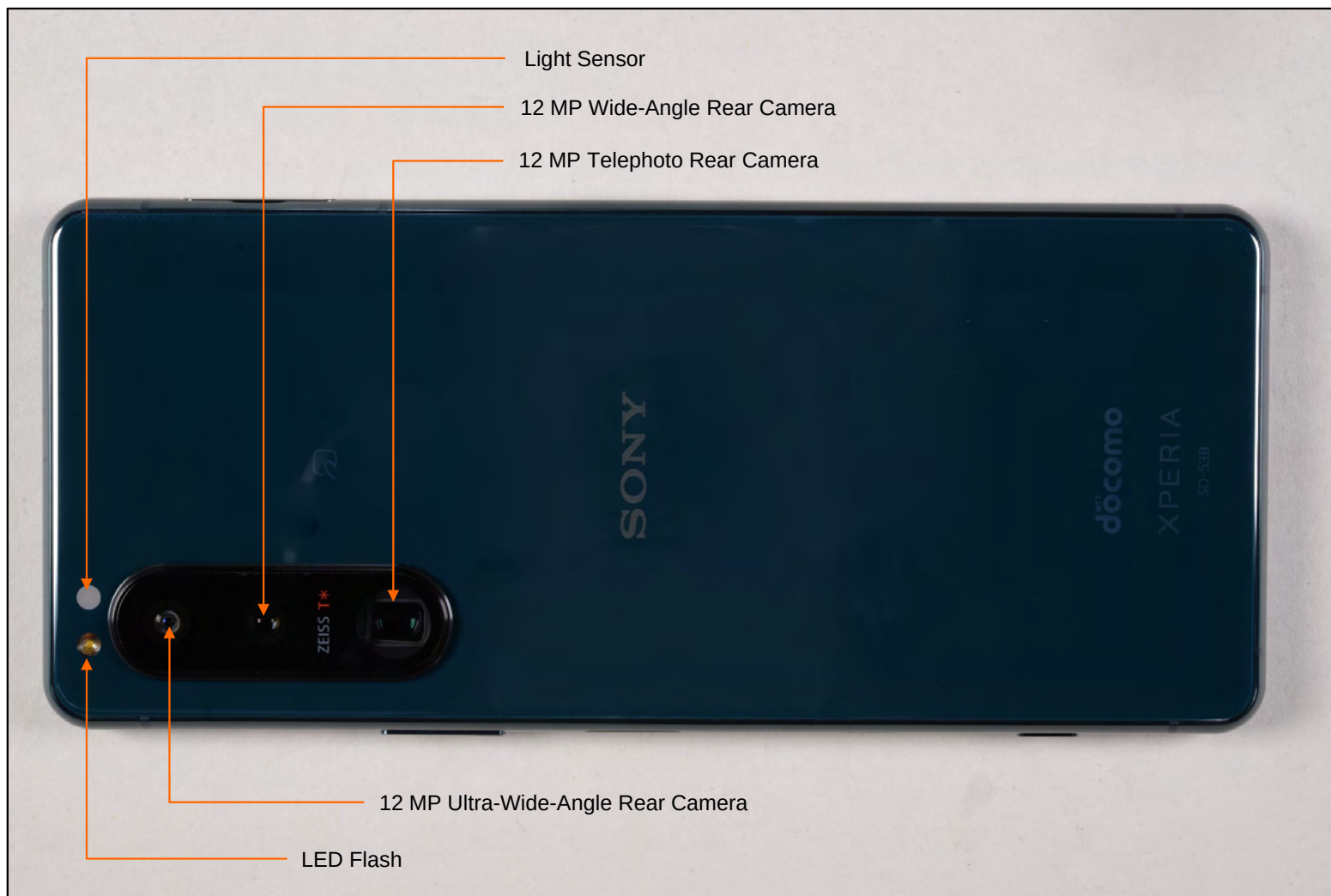
Features

Exterior Features



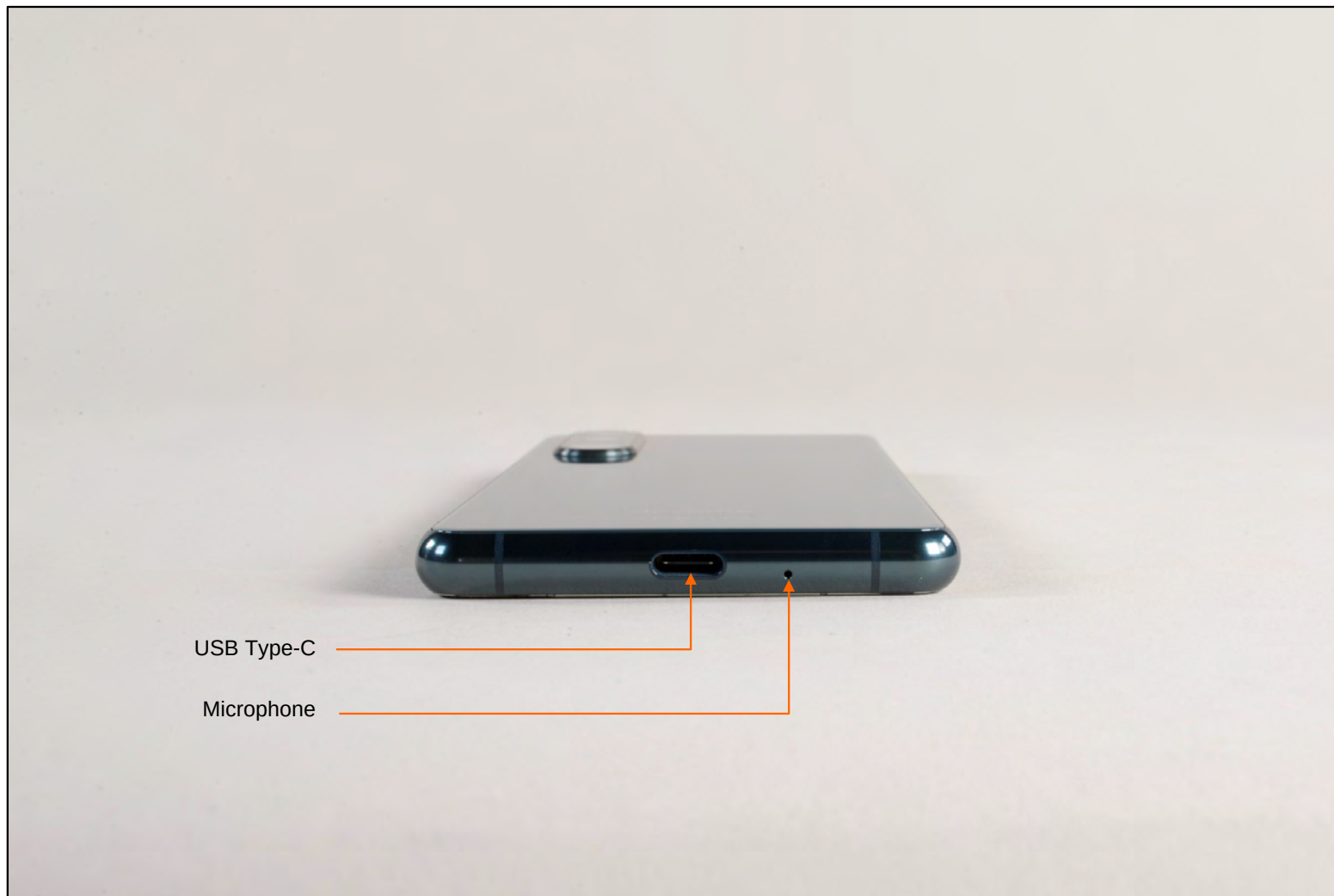
Features

Exterior Features



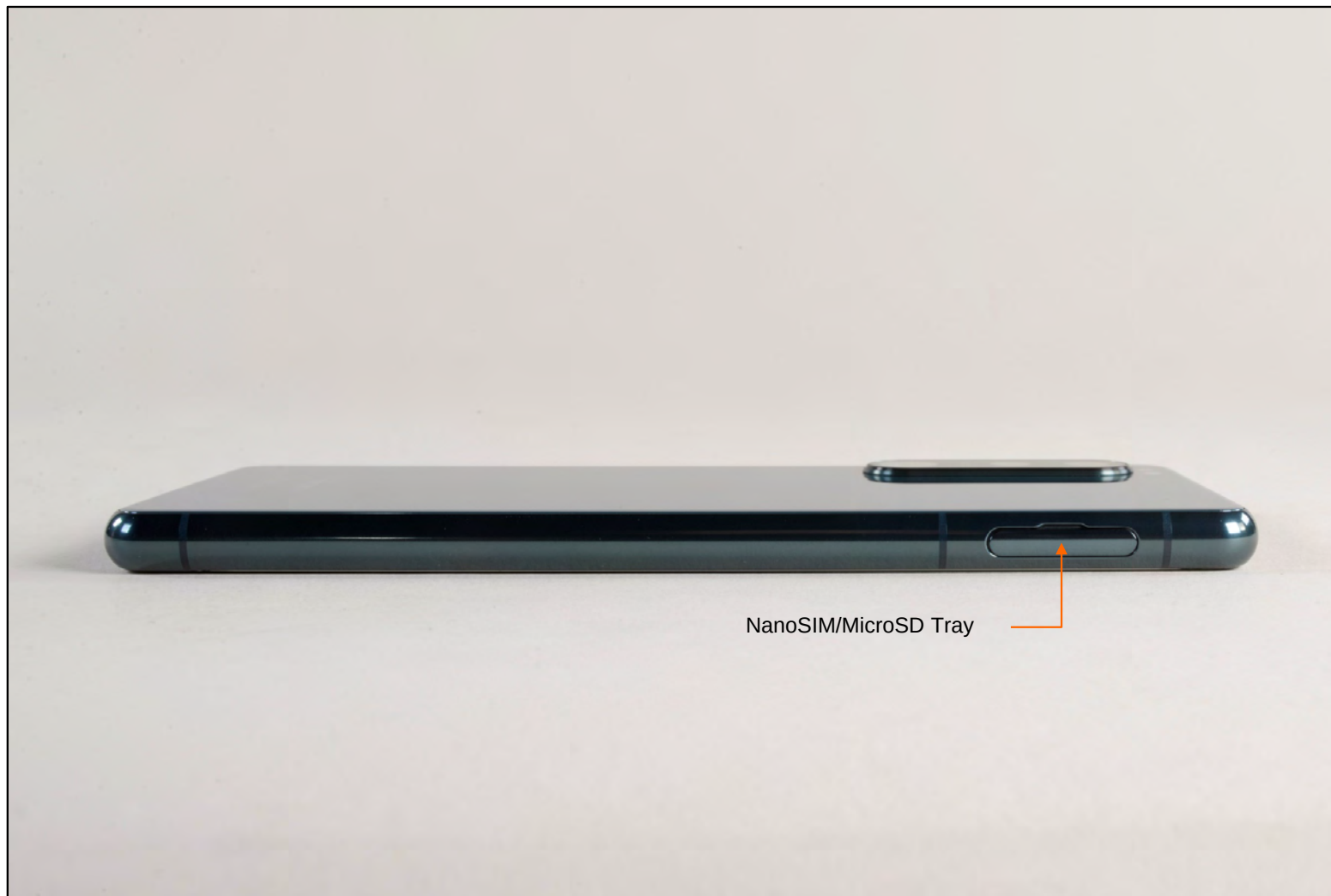
Features

Exterior Features



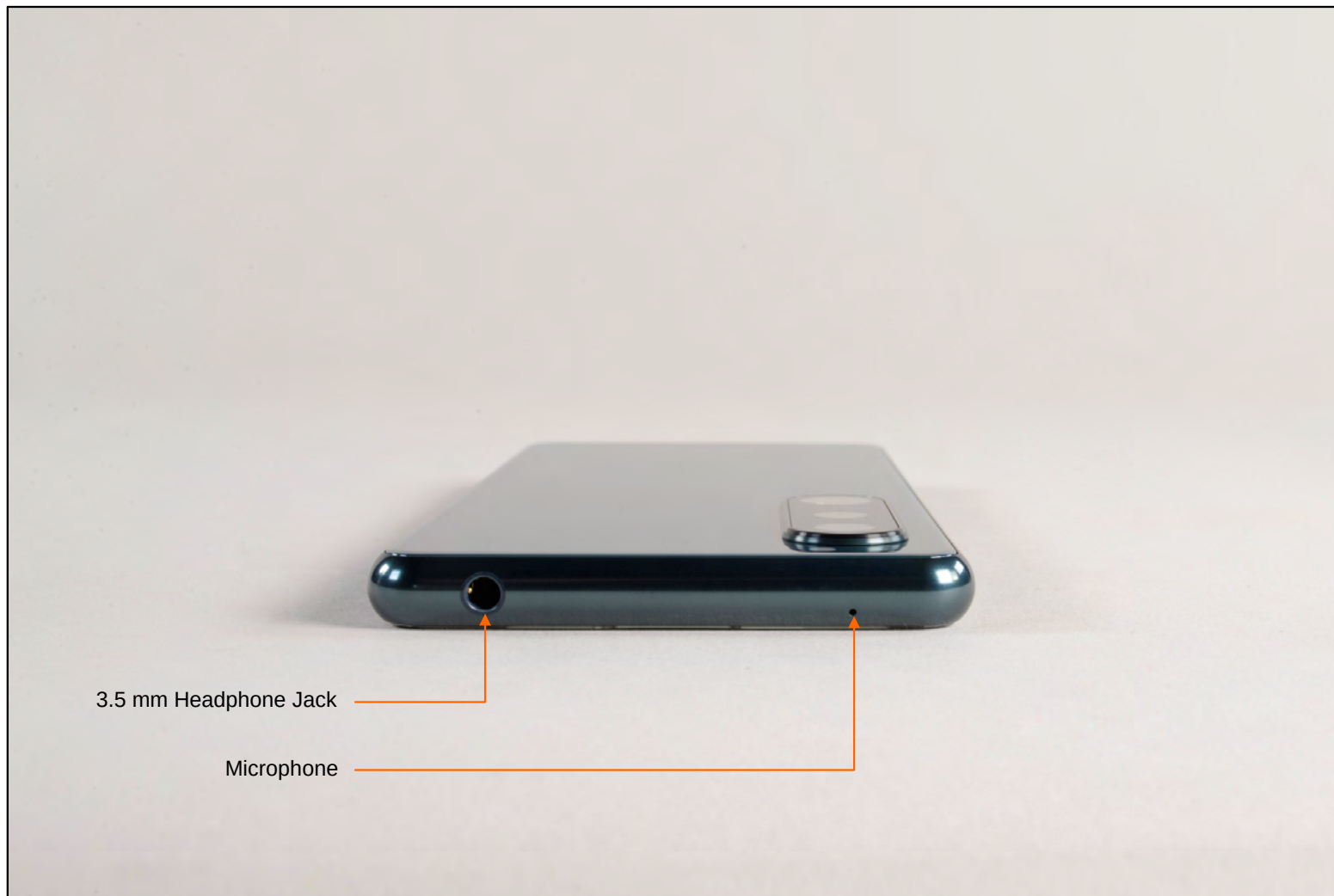
Features

Exterior Features



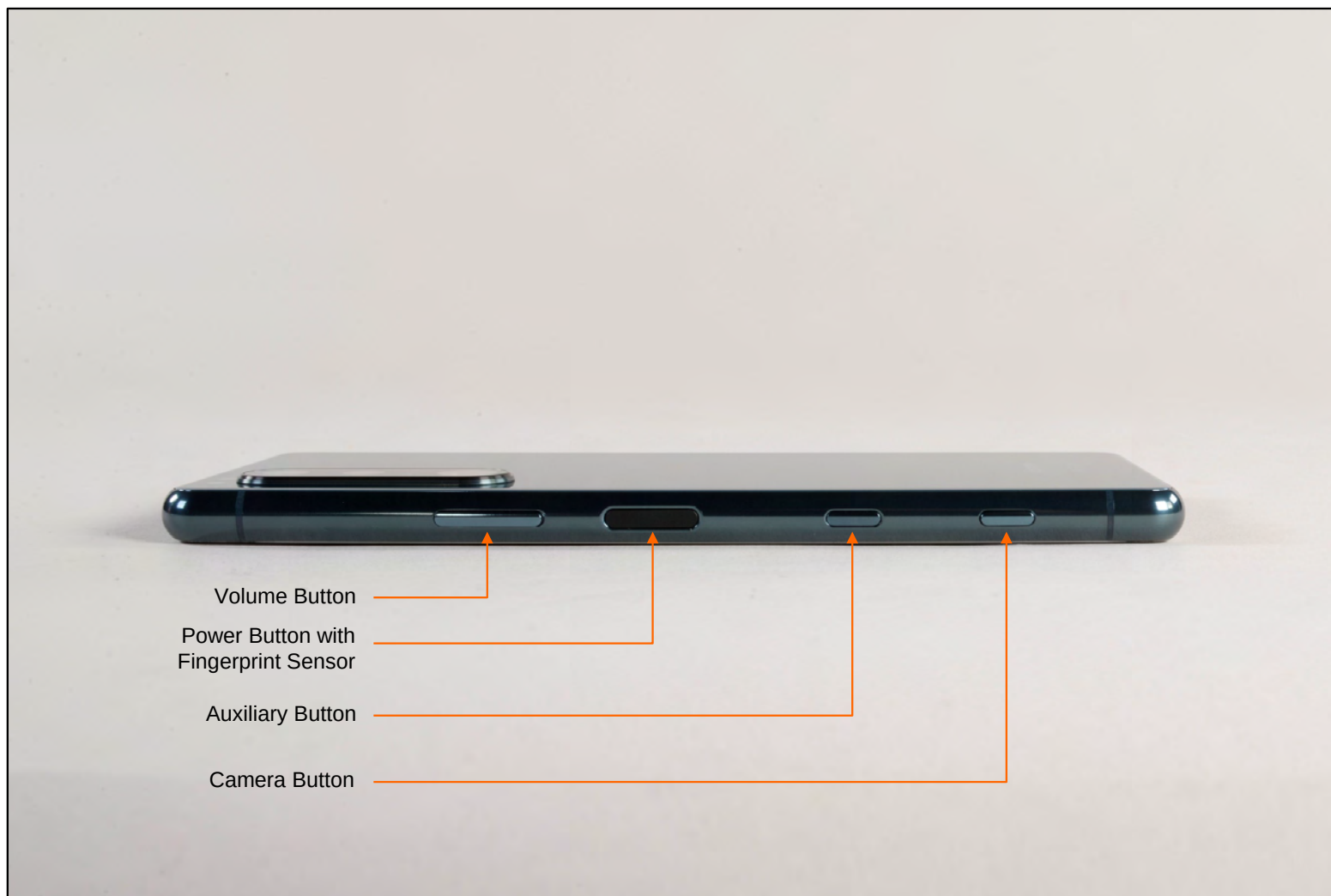
Features

Exterior Features



Features

Exterior Features



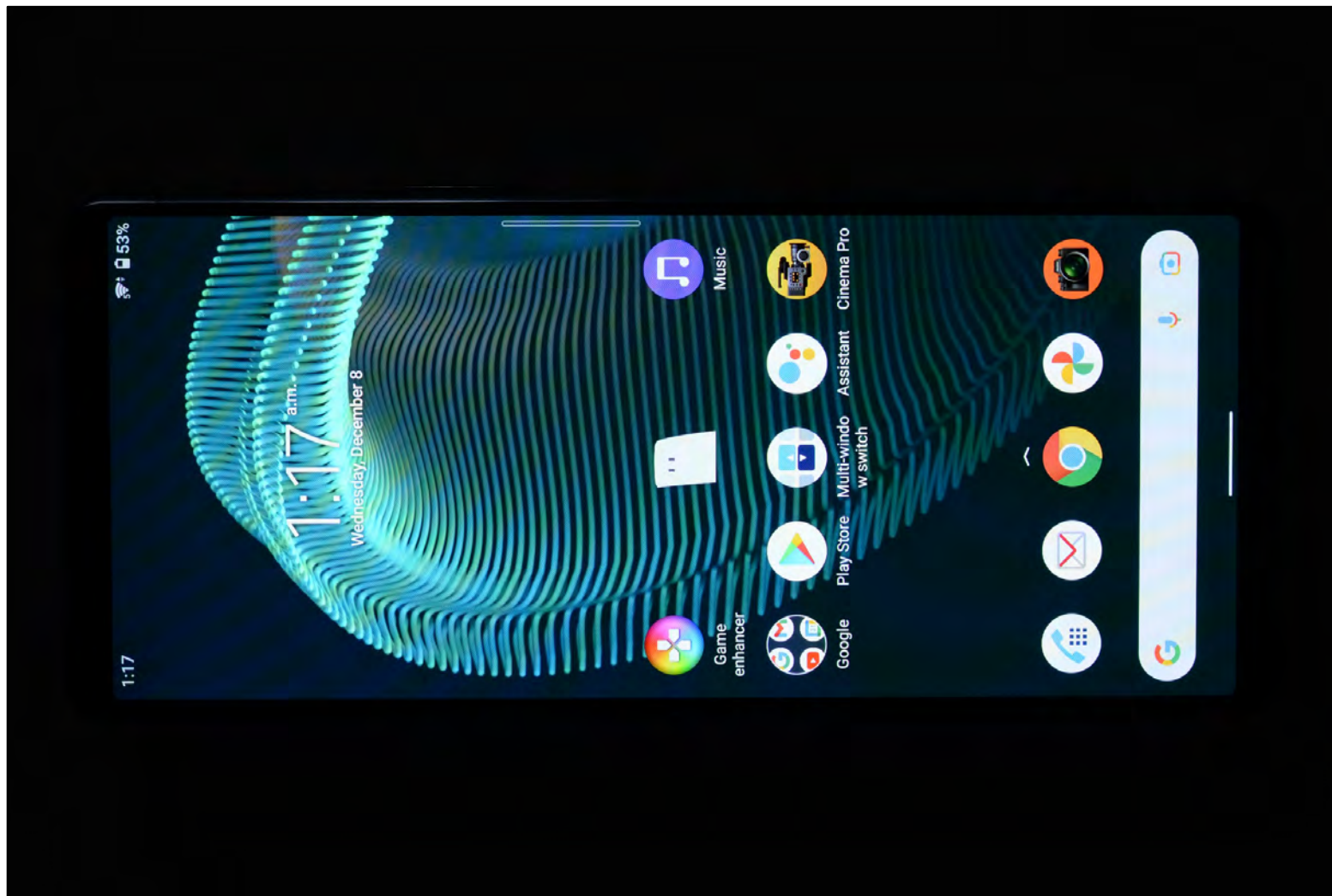
Features

Backlights

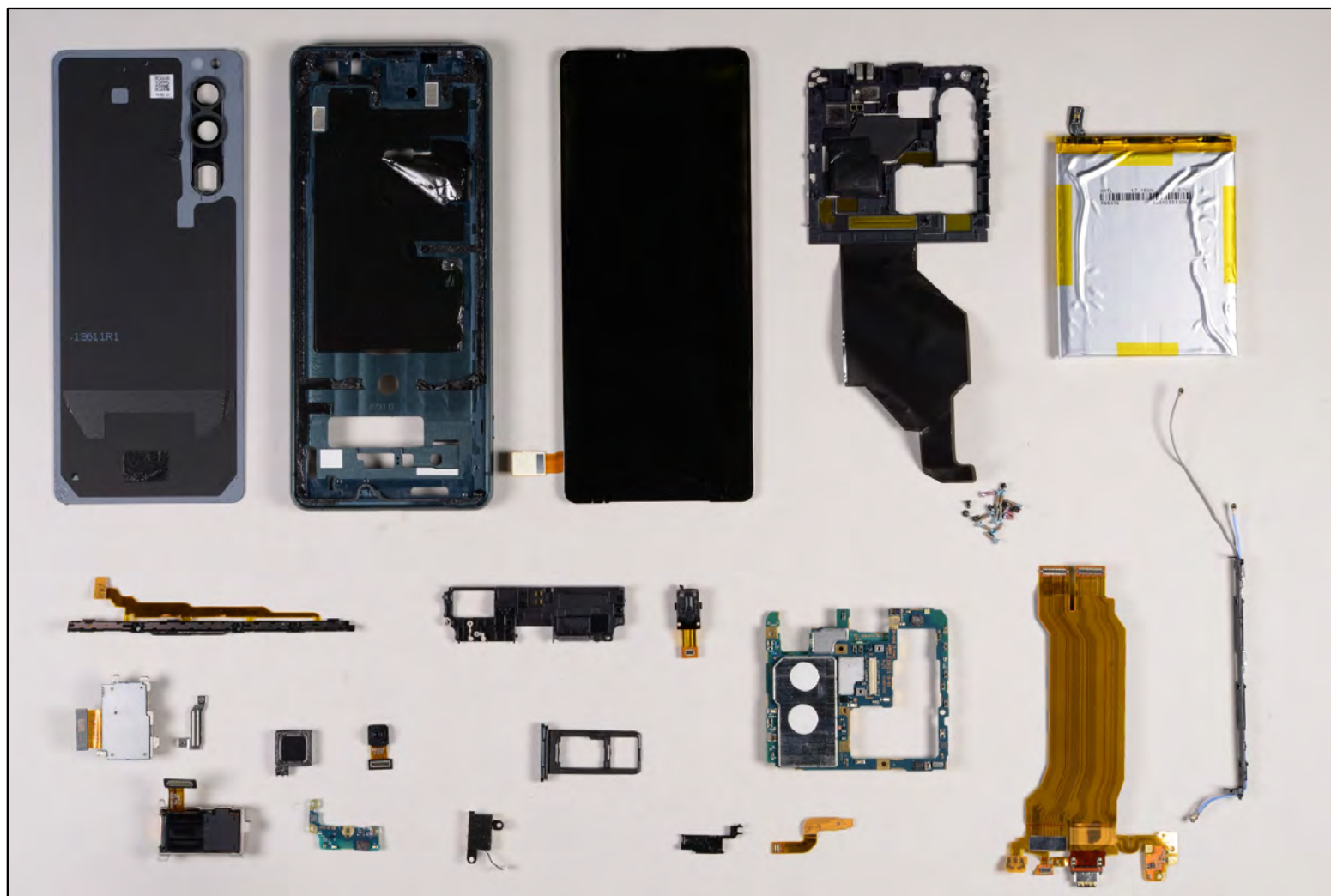


Features

Backlights



Major Components – Side 1



Components

Major Components – Side 2



Major Components

Main Enclosures

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Components

Main Enclosures – Side 1



NE #1 – Main Frame

NE #2 – Back Cover

Components

Main Enclosures – Side 2



NE #1 – Main Frame

NE #2 – Back Cover

Teardown



Teardown



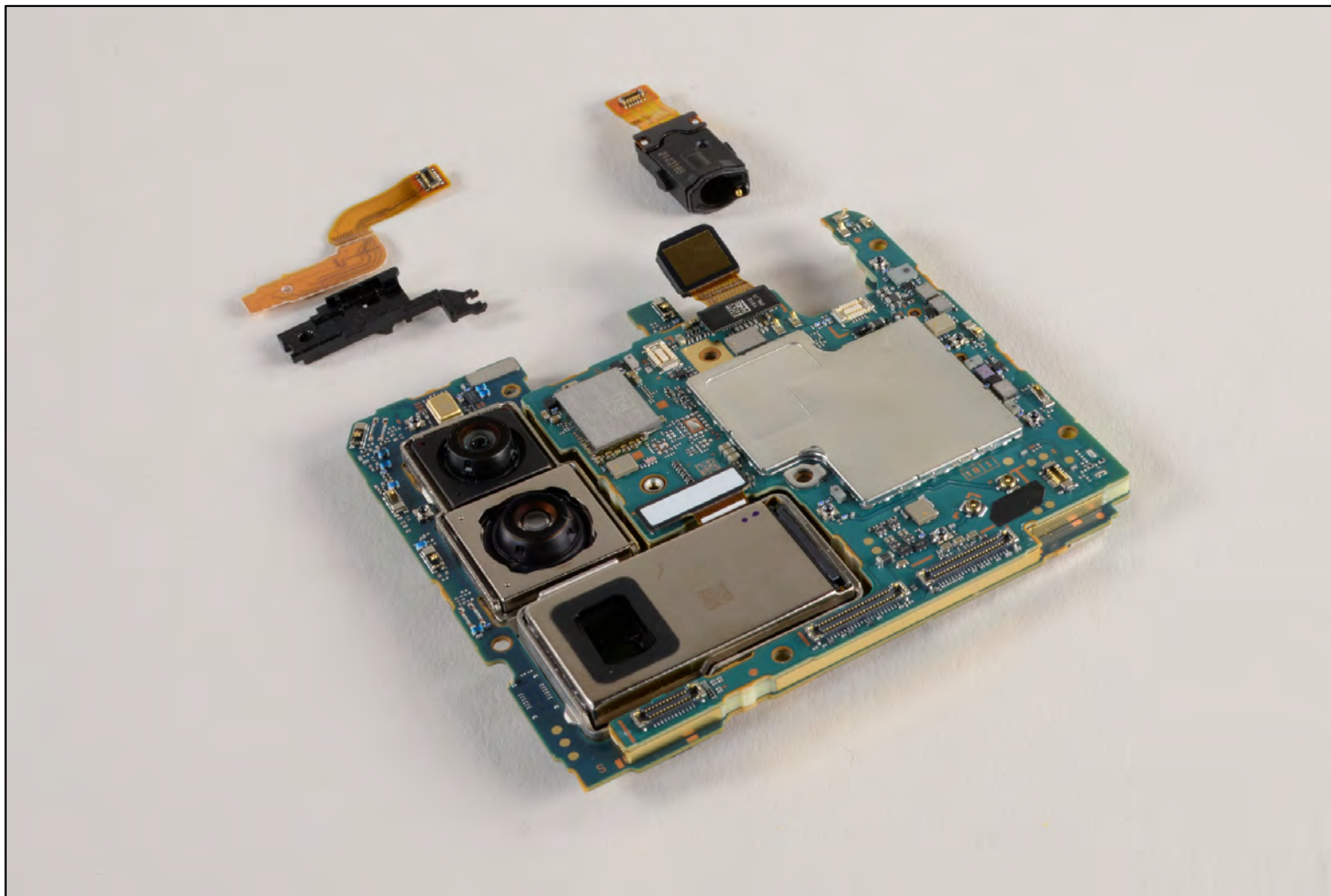
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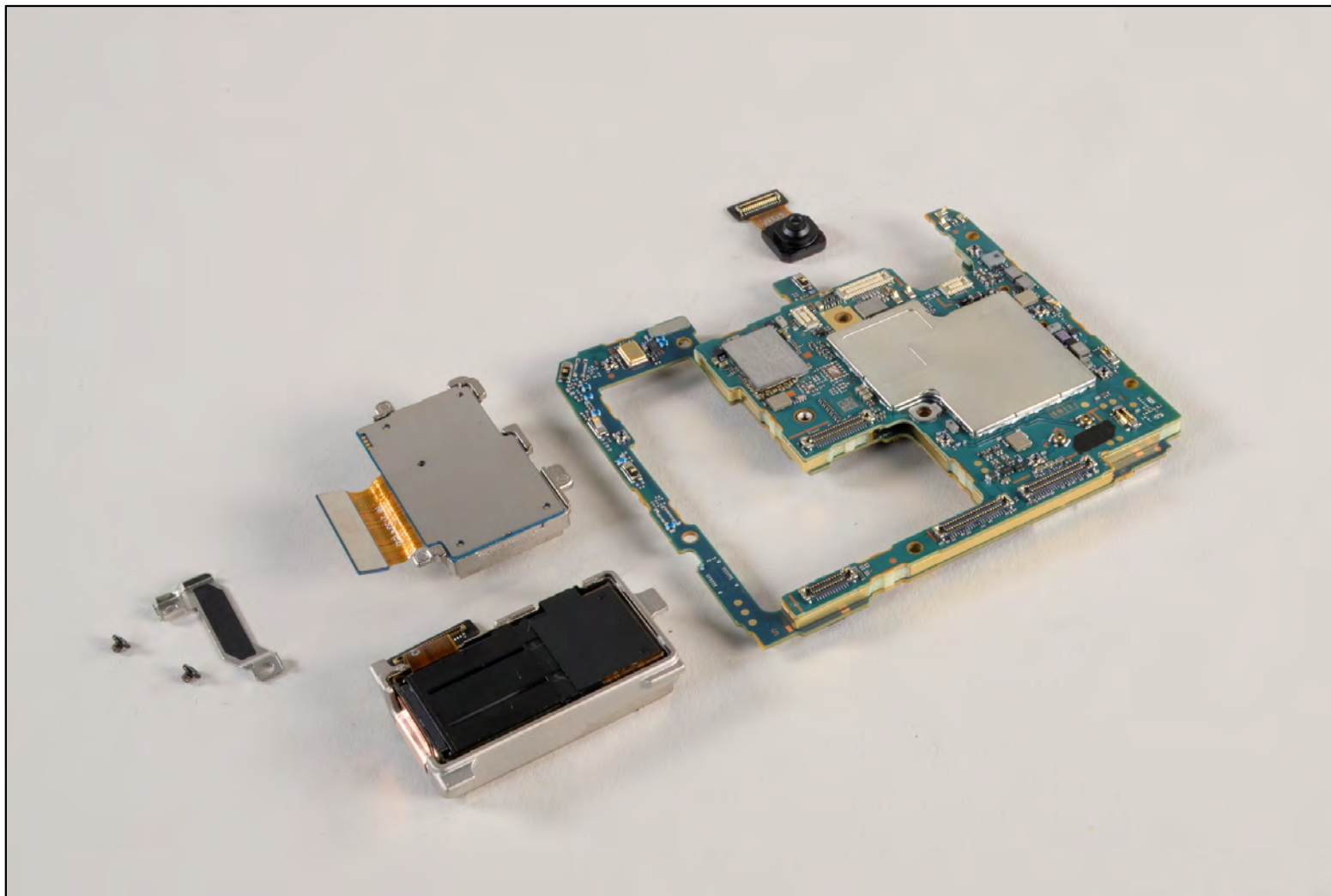
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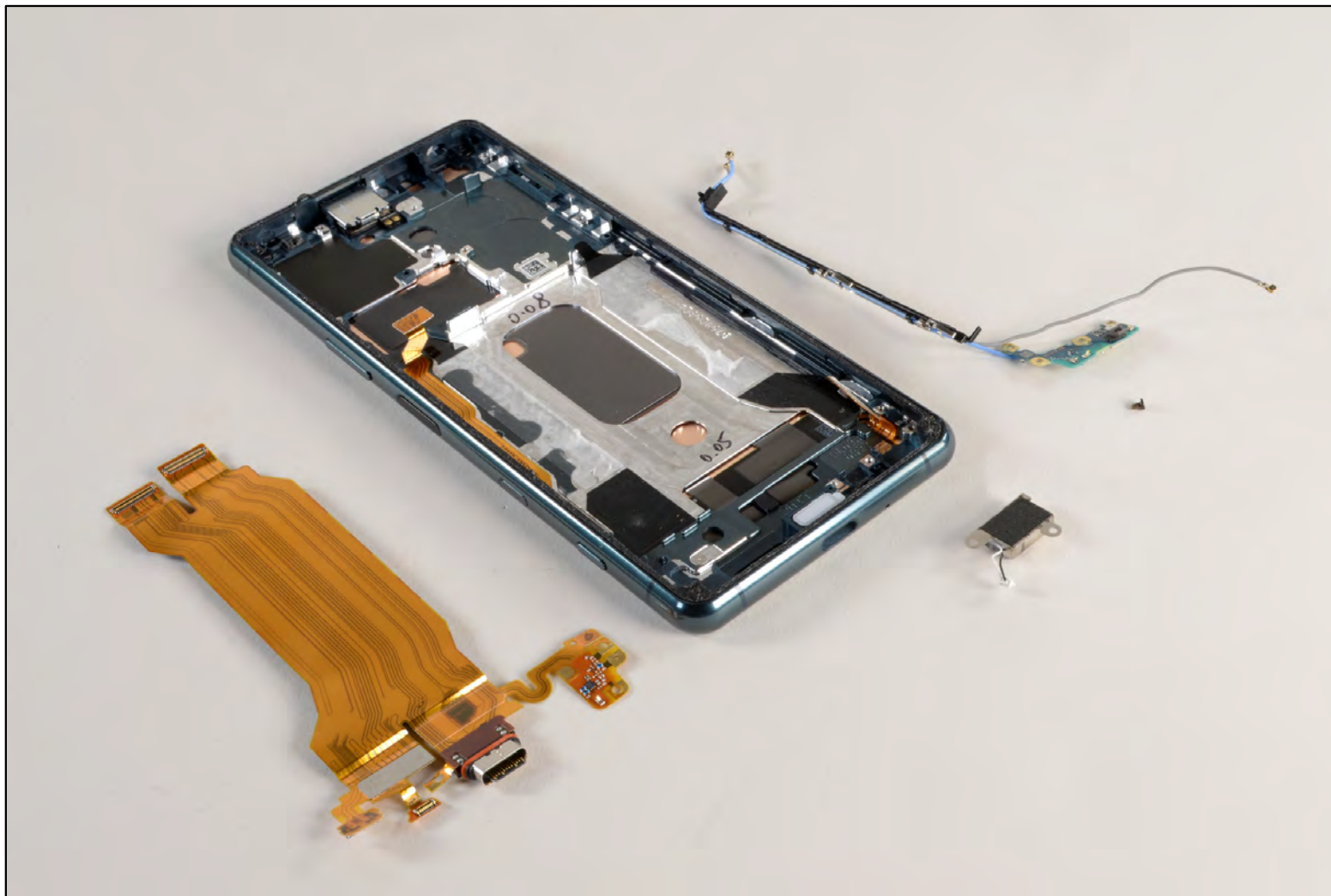
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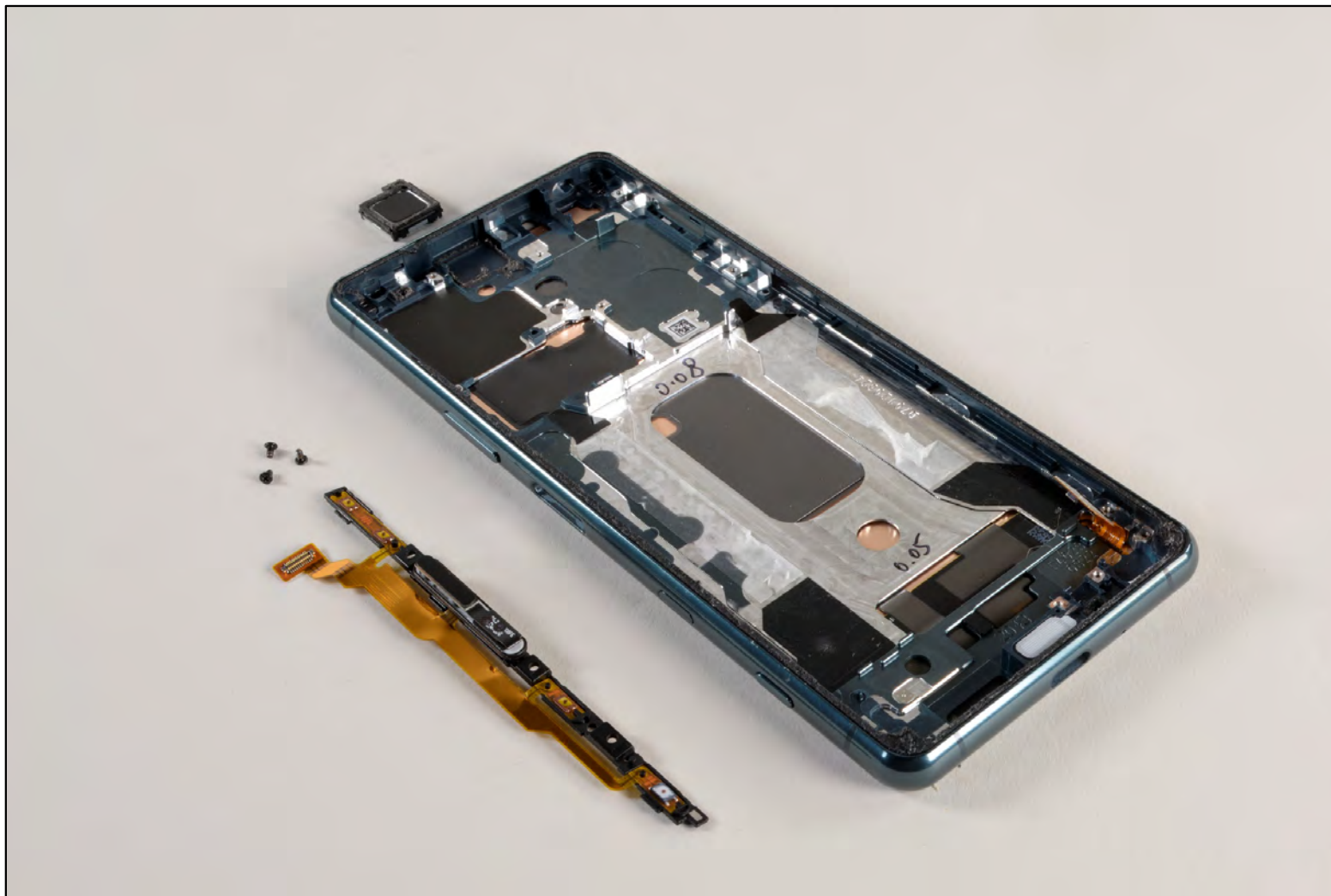
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Teardown



Teardown

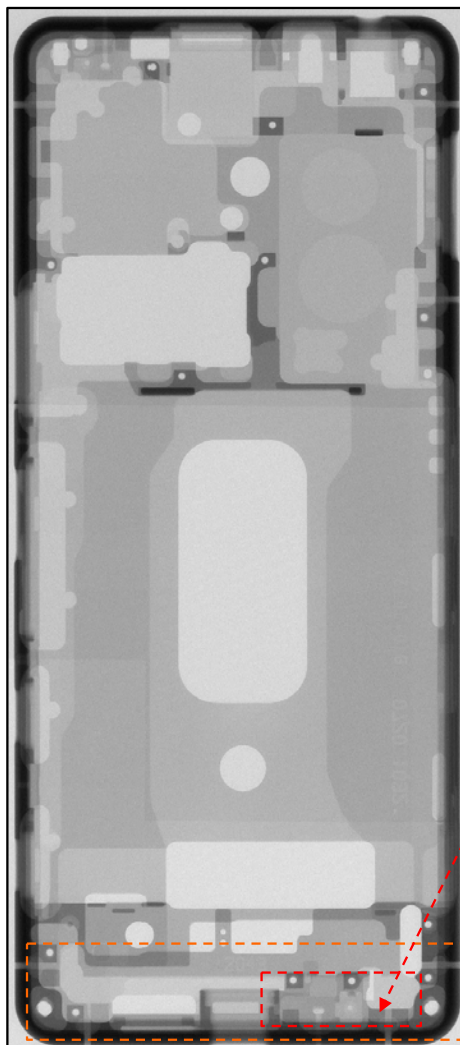


Teardown



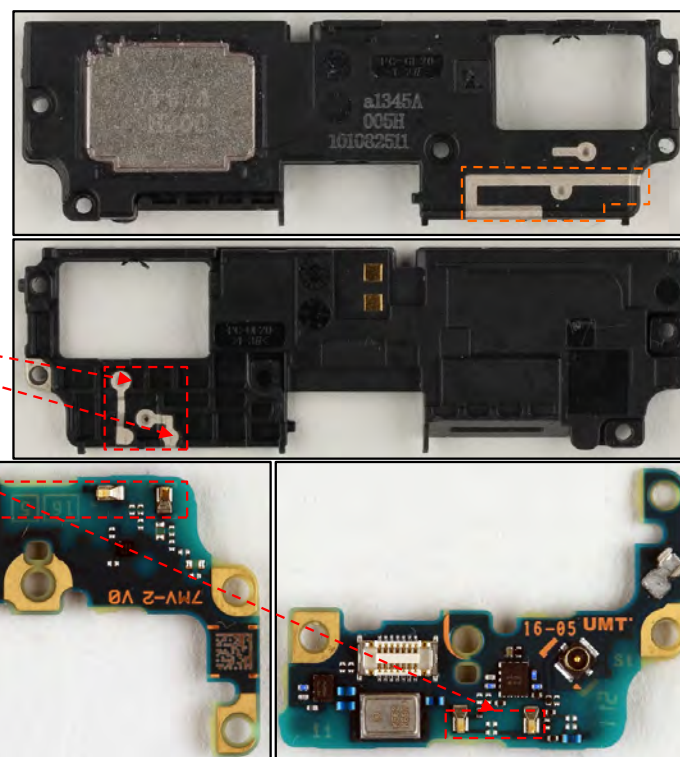
Antennas

Main 1 Antenna



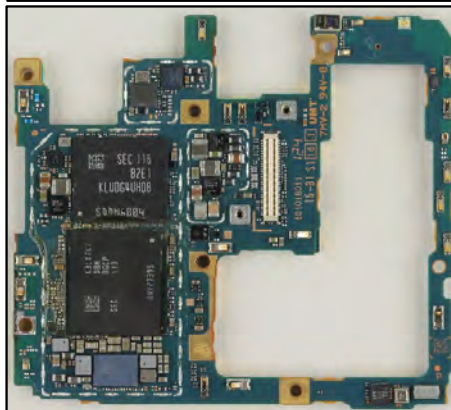
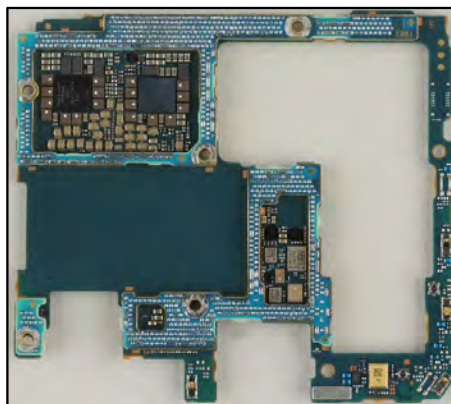
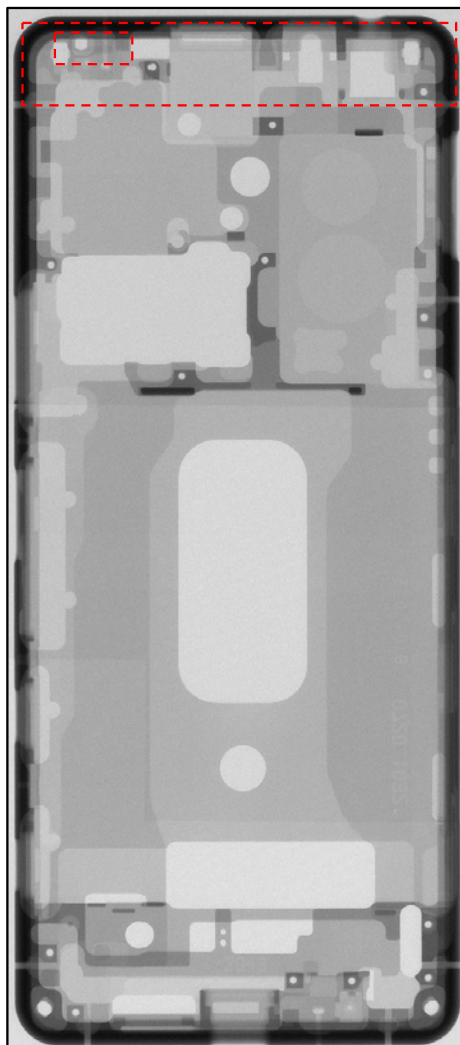
Feed Point

Main 1 Antenna Element		
Length	Width	Height
61.2 mm	16.2 mm	7.6 mm

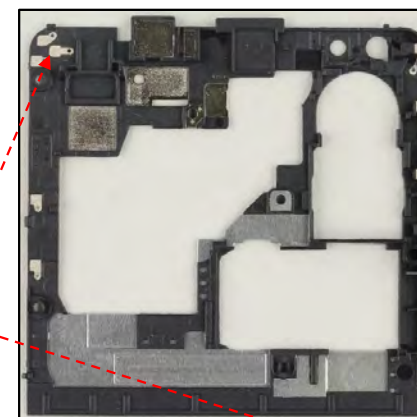


Antennas

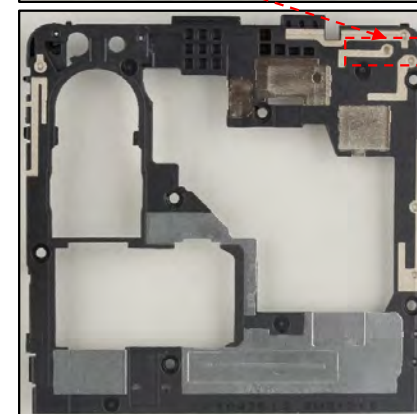
Main 2 Antenna



Main 2 Antenna Element		
Length	Width	Height
61.1 mm	11.1 mm	7.6 mm

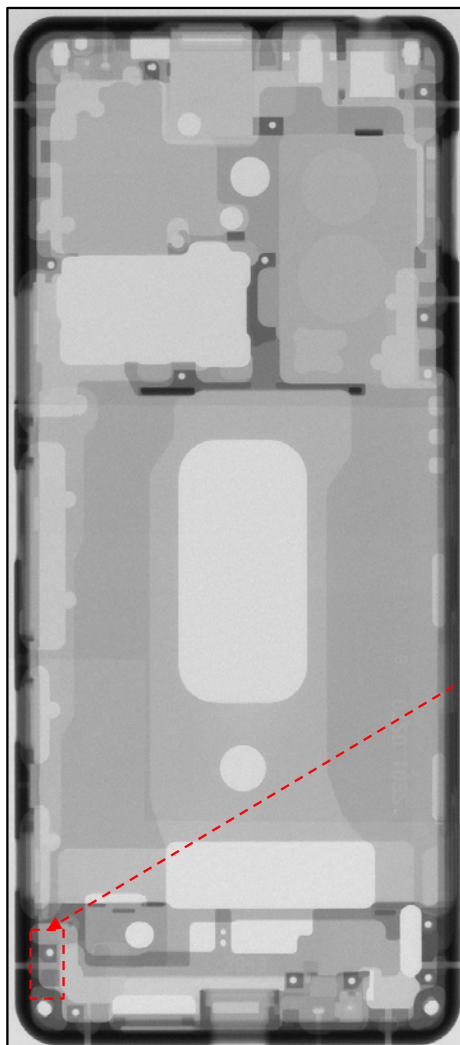


Feed Point



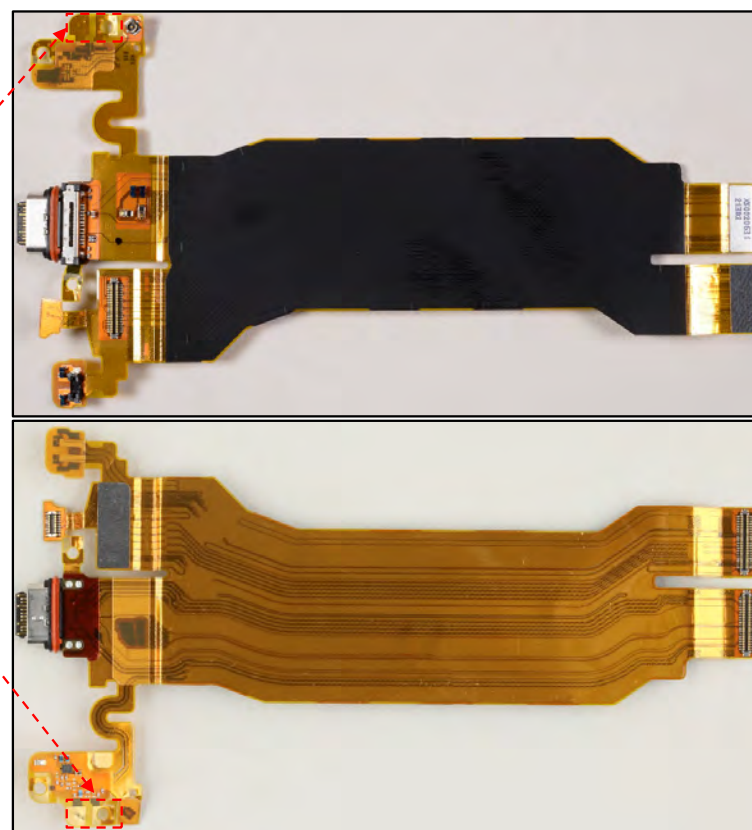
Antennas

Main 3 Antenna



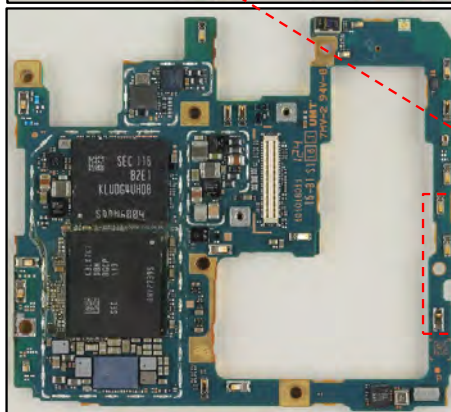
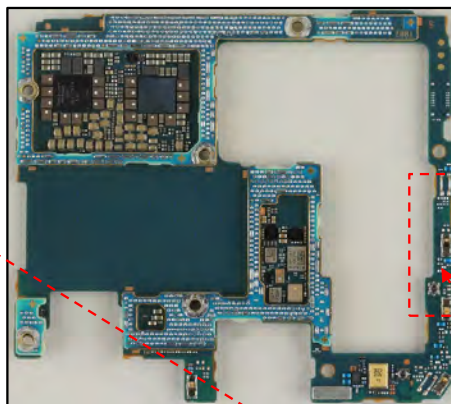
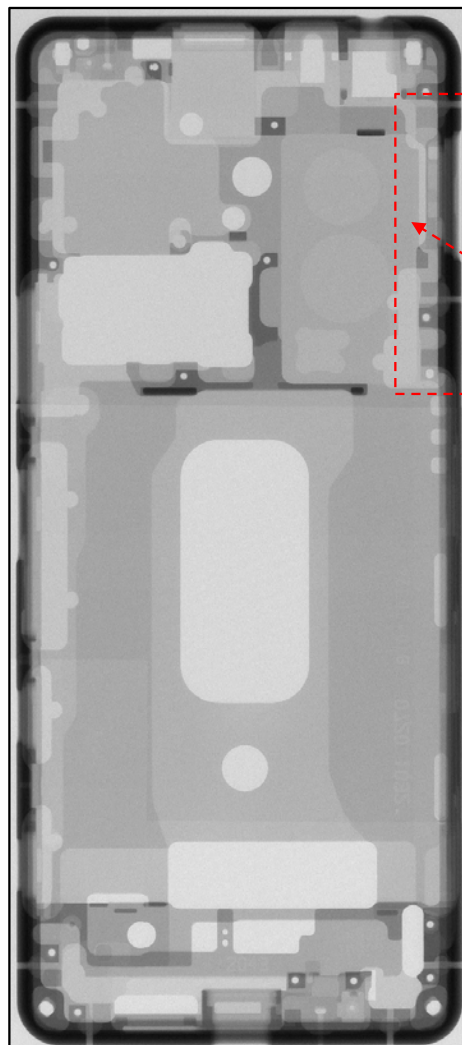
Feed Point

Main 3 Antenna Element		
Length	Width	Height
7.0 mm	4.6 mm	7.6 mm

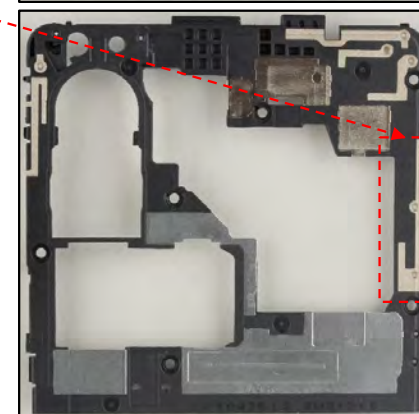
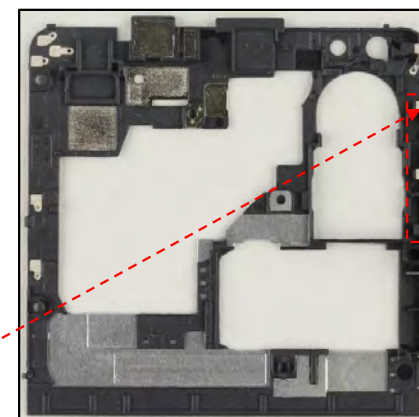


Antennas

RxD Antenna



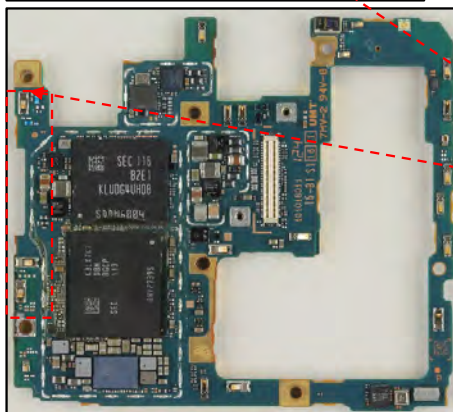
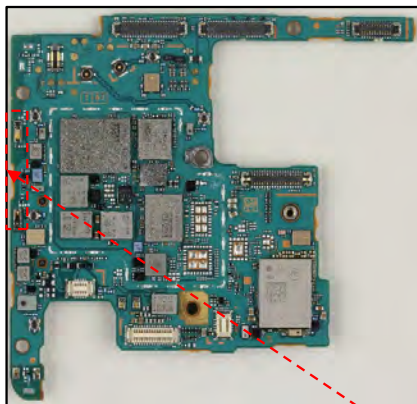
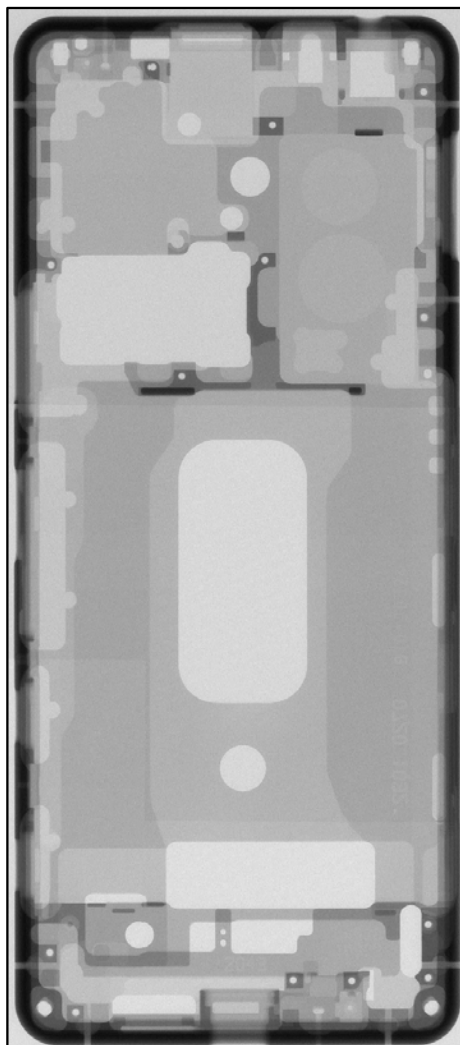
RxD Antenna Element		
Length	Width	Height
57.8 mm	14.1 mm	7.6 mm



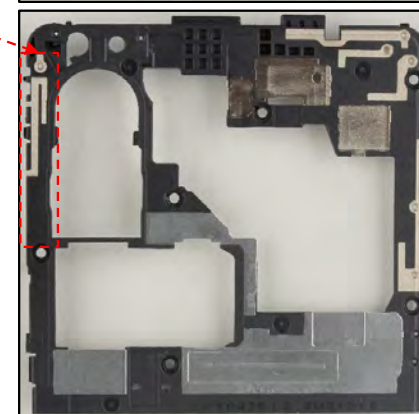
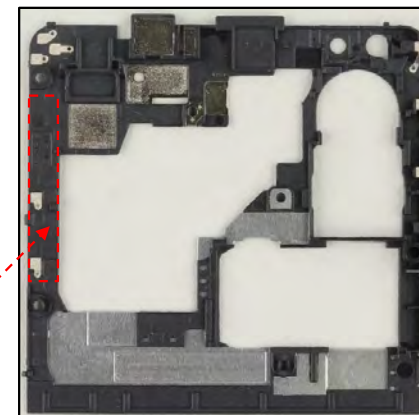
Feed Point

Antennas

n79 Rx/WiFi 2.4 GHz/BT Antenna



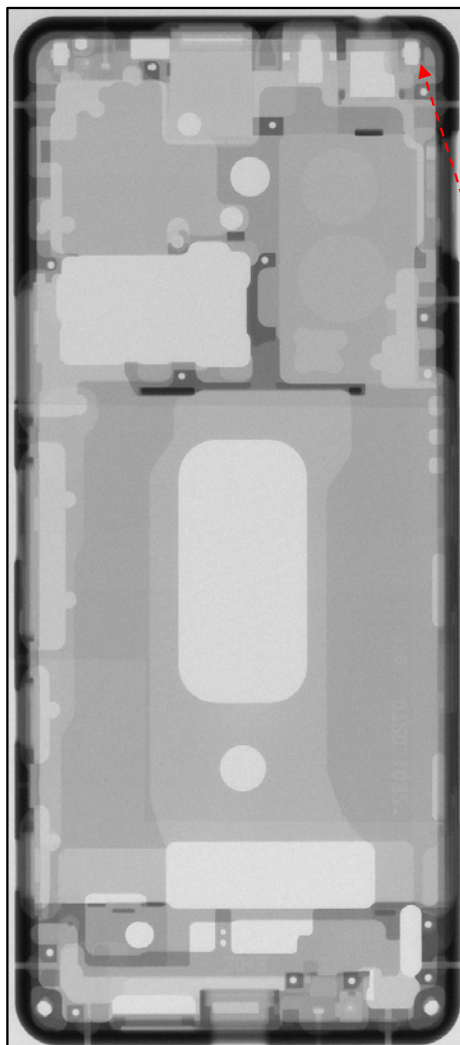
n79 Rx / WiFi 2.4 GHz/BT Antenna Element		
Length	Width	Height
21.2 mm	3.6 mm	7.6 mm



Feed Point

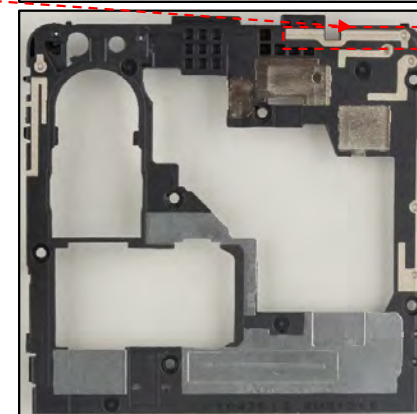
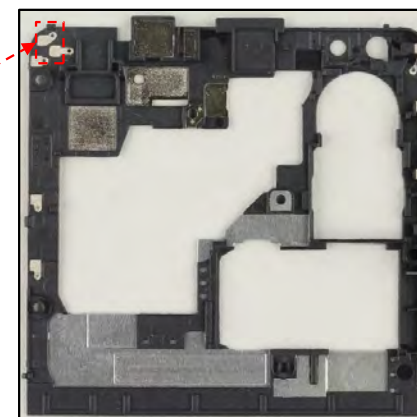
Antennas

RxD/WiFi 5 GHz Antenna



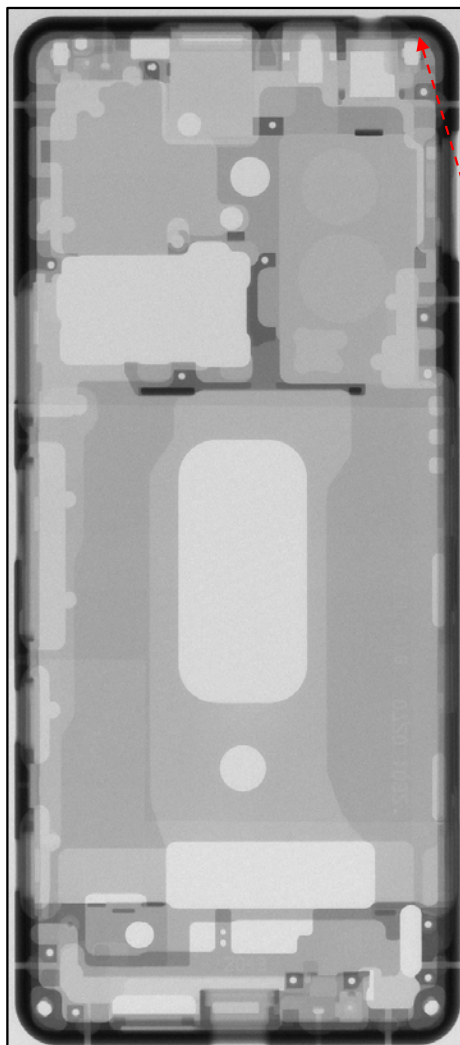
RxD / WiFi 5 GHz Antenna Element		
Length	Width	Height
18.9 mm	3.1 mm	2.4 mm

Feed Point

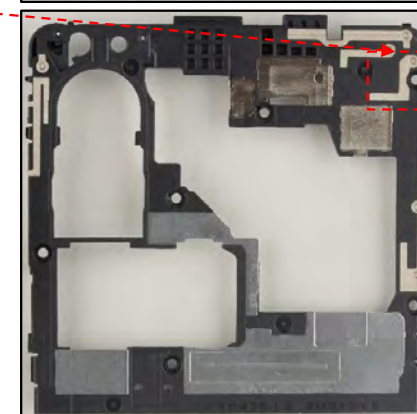
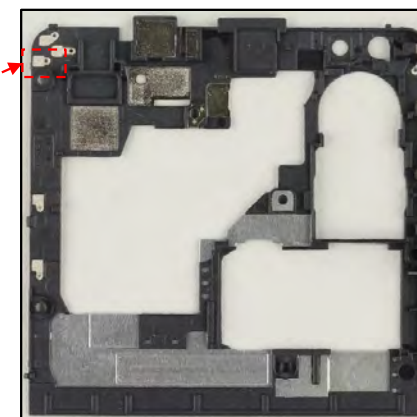


Antennas

RxD/WiFi/BT/GPS Antenna



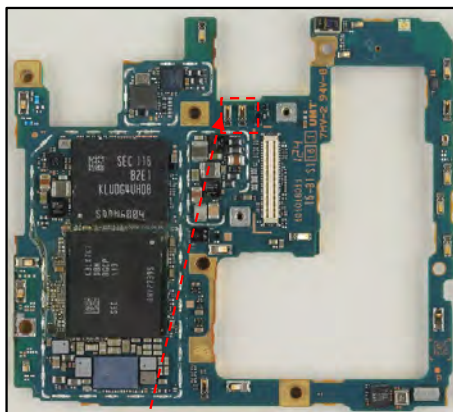
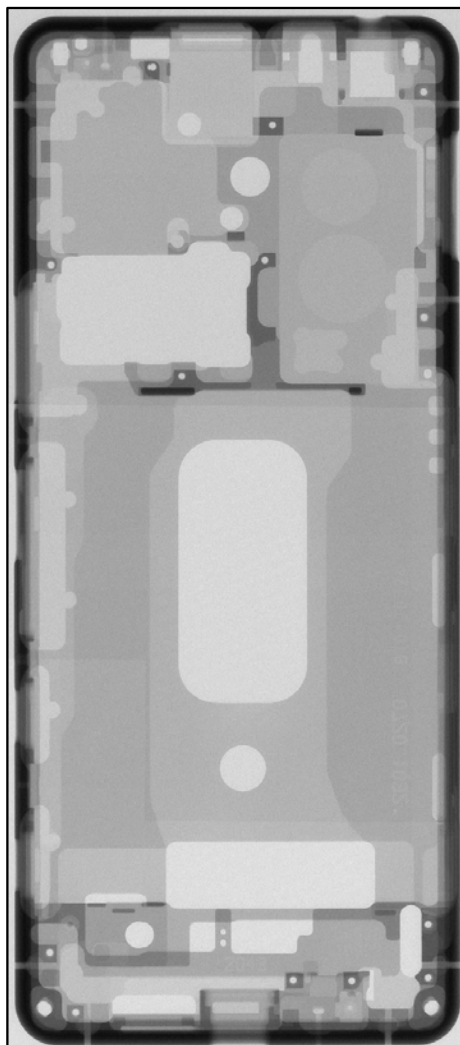
RxD / WiFi / BT / GPS Antenna Element		
Length	Width	Height
12.0 mm	8.6 mm	2.4 mm



Feed Point

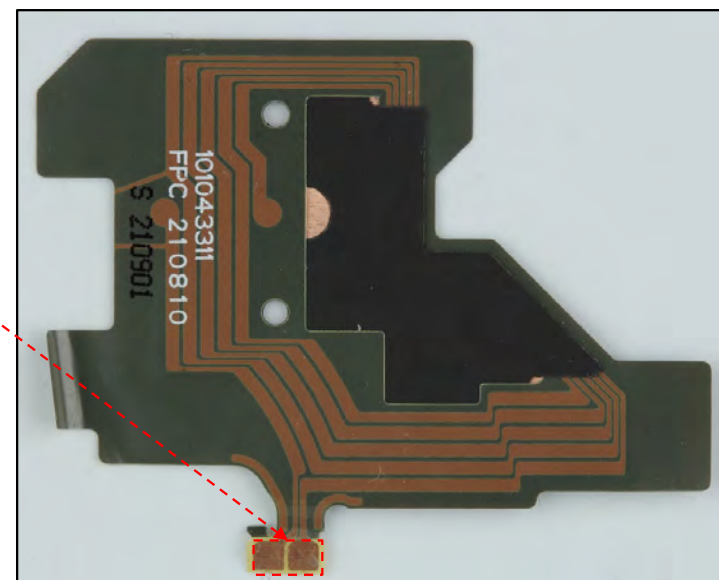
Antennas

NFC Antenna



Feed Point

NFC Antenna Element		
Length	Width	Height
38.8 mm	31.0 mm	3.1 mm



Component Function Guide

In both Deep Dive and Survey Plus reports, ICs and modules will be categorized by their function within the system.

These categories are in alignment with the high-level IC function categories currently found in the BOM Database. The categories will also be found in the updated Excel BOM workbooks which are included with each report.

Component Function	
Applications/Baseband Processor	Processors which are both Apps/BB Processors
Application Processor	Main Processor without cellular modem
Baseband Processor	Cellular Modem Processor
Camera / Image	Image Sensors, Video processors, Image co-processors, VGA Camera
Connectivity	Antennas, Bluetooth, GPS, USB, WiFi, ZigBee components
Display / Touchscreen	Display driver, Touchscreen controller, etc.
Logic	CPLD, FPGA, Programmable Logic Array/PLA, PLD
Memory: Mixed	Components with both non-volatile and volatile memory
Memory: Non-Volatile	NAND, NOR, EEPROMs, etc.
Memory: Volatile	RAM, SDRAM, etc.
Mixed Signal	DSPs, MCUs, Mixed-Signal Arrays, (non-audio, non-apps, non-baseband) Processors
Other	Small logic AND, OR gates, LDOs, Transistors, Regulators
Power Management / Audio	Audio CODECs, Envelope Tracking, MEMS Microphone, Power Management
RF Component	Diplexers, RF Antenna, RF antenna switches, RF Filters, RF Power Amplifiers, RF Receivers, RF Transceivers, etc.
Sensor	Accelerometer, Barometer, Compass, Gyroscope, Heart, Pressure, Temperature

Subsystems

Battery Summary



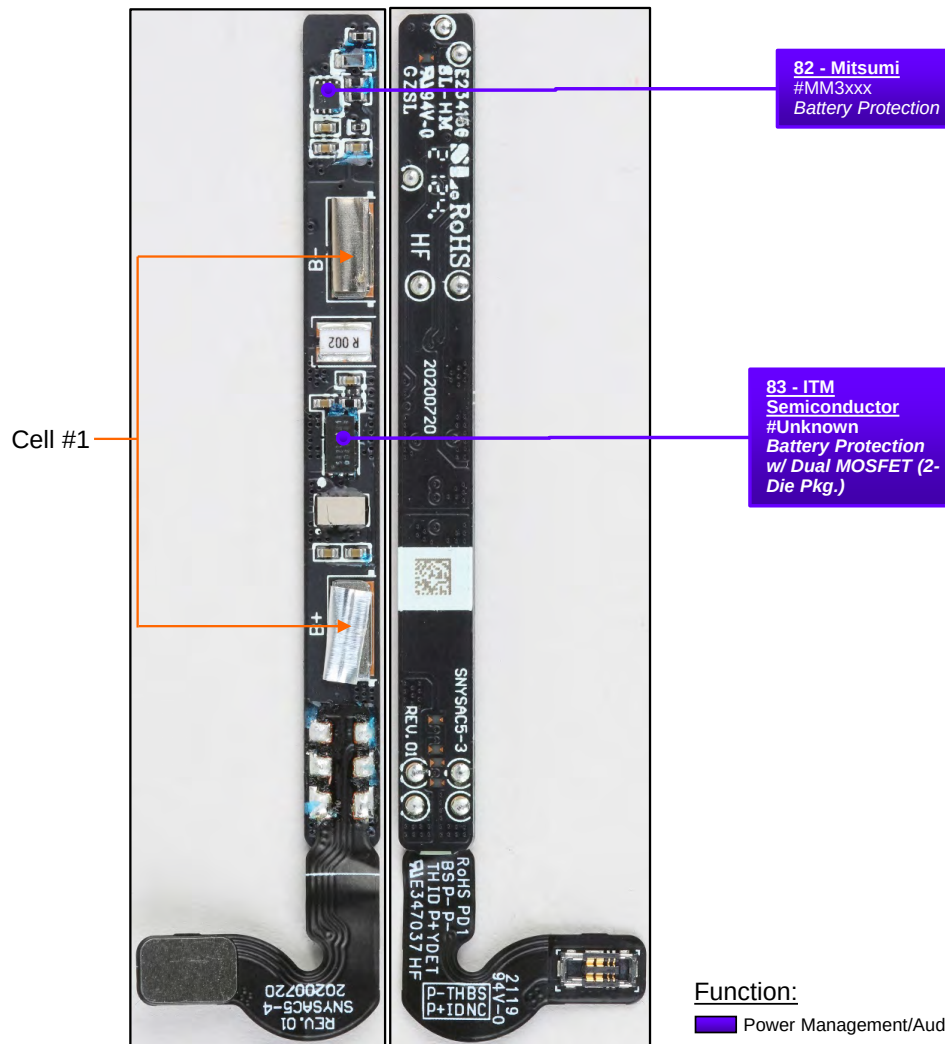
Battery Subsystem		
Pack Brand	Ningde Amperex Technology Limited	
Pack Part Number	SNYSAC5	
Pack Voltage	3.87	
Cell Type	Lithium Polymer	
Pack Rating (mAhrs)	4380	
Pack Size (mm)	73.15 x 59.85 x 5.32	
Vol. Energy Density (mWhrs/cc)	727.8	
Pack Weight (grams)	57.8	
Wt. Energy Density (mWhrs/g)	293.3	
Cell Brand	Amperex Technology Limited (ATL)	
Estimated Costs	Cell(s)	\$6.79
	Electronic Parts	\$0.73
	Non-electronic Parts	\$0.43
	Assembly	\$0.52
	Test	\$0.05
Gross Margin		\$3.65
Estimated Pack Price		\$12.18

A full Subsystem BOM is provided in the included BOM workbook.



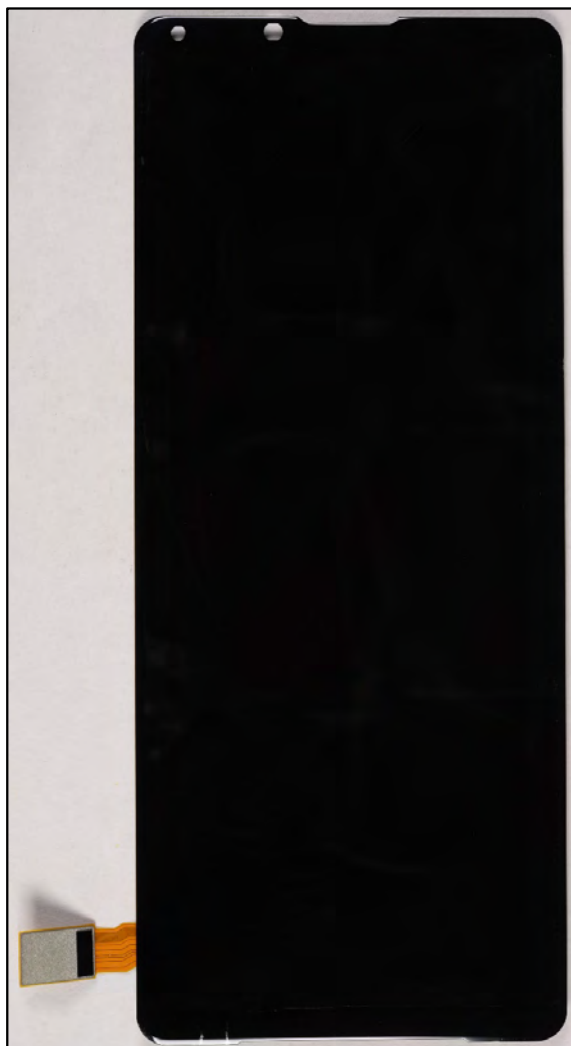
Subsystems

Battery IC Identification



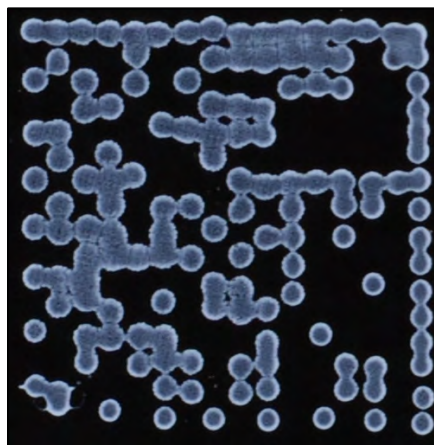
Subsystems

Display/Touchscreen Summary



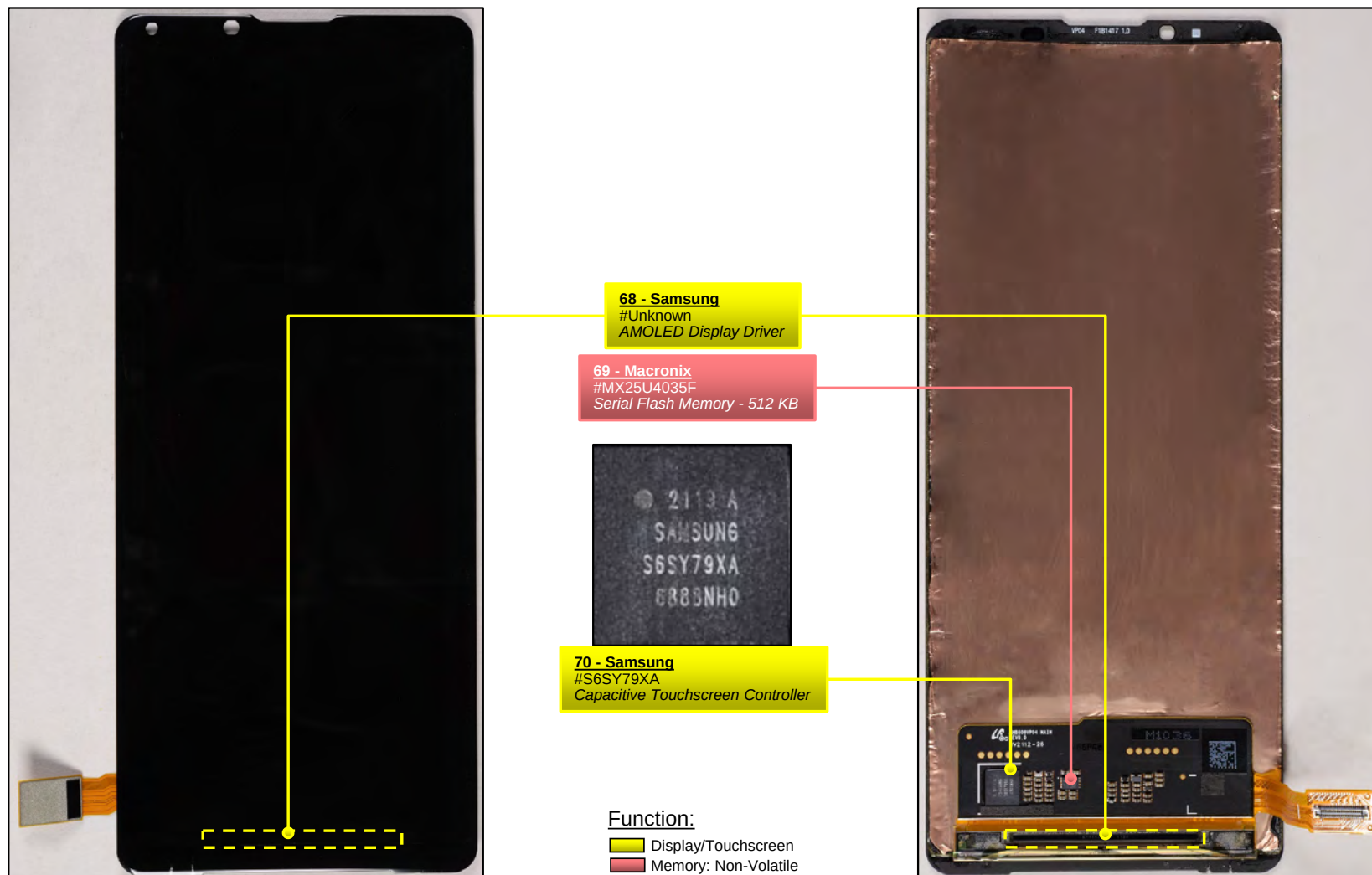
120 Hz Display/Touchscreen Subsystem		
Brand		Samsung
Part Number		AMB609VP04
Module Dimensions		152.26 x 63.74 x 1.25
Weight (grams)		24.04
Panel Metrics	View Size (mm)	142.97 x 61.64
	Type	AMOLED - Y-OCTA
	Colors	1073741824
	Rows / Columns	2520 / 1080
	Backlighting Scheme	OLED
Estimated Costs	Panel(s)	\$20.83
	Electronic Parts	\$6.29
	Circuit Assembly	\$0.35
	Non-Electronic Parts	\$5.34
	Final Assembly	\$0.22
	Test	\$0.35
	Gross Margin	\$17.97
Estimated Module Price		\$51.35

A full Subsystem BOM is provided in the included BOM workbook.



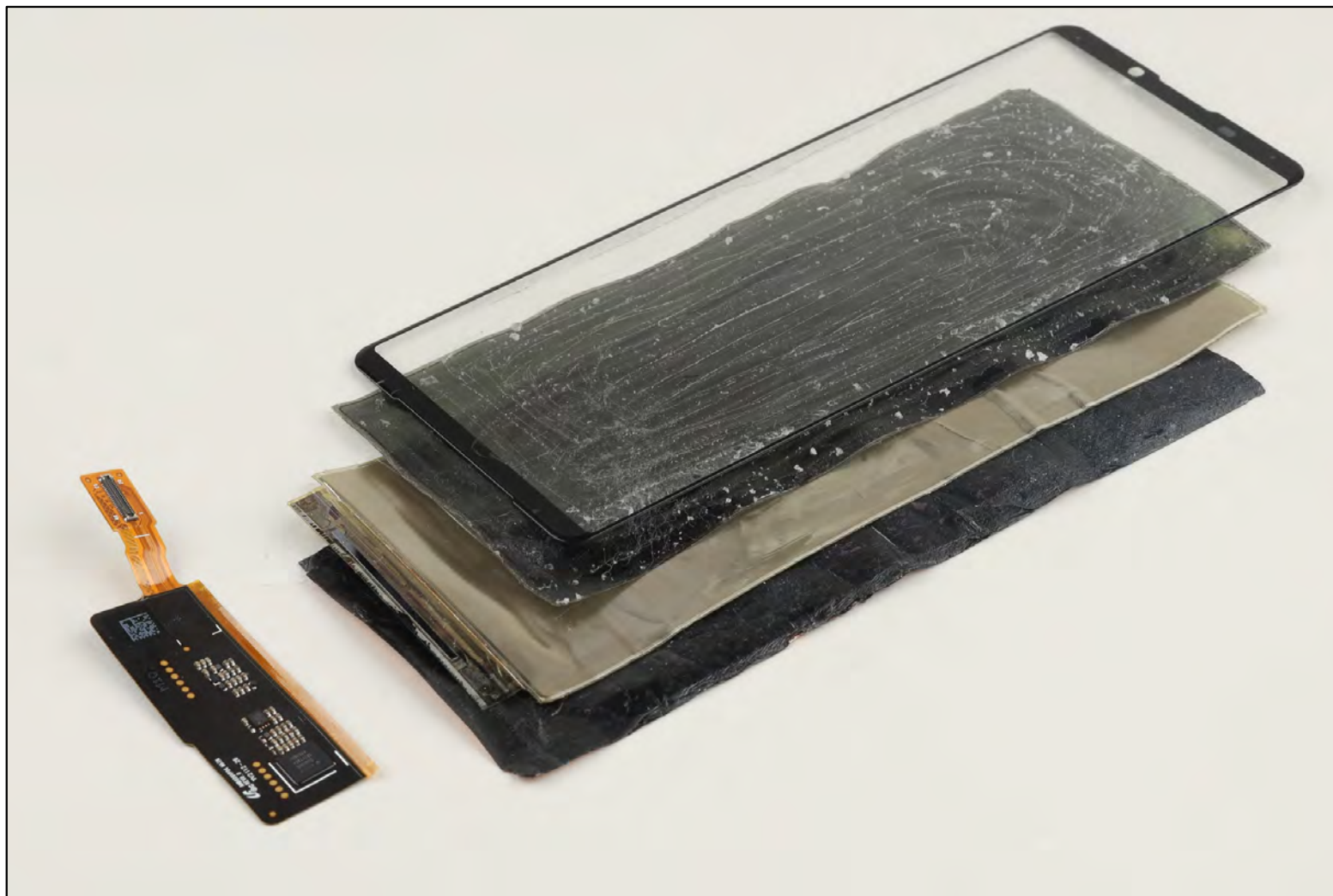
Subsystems

Display/Touchscreen IC Identification



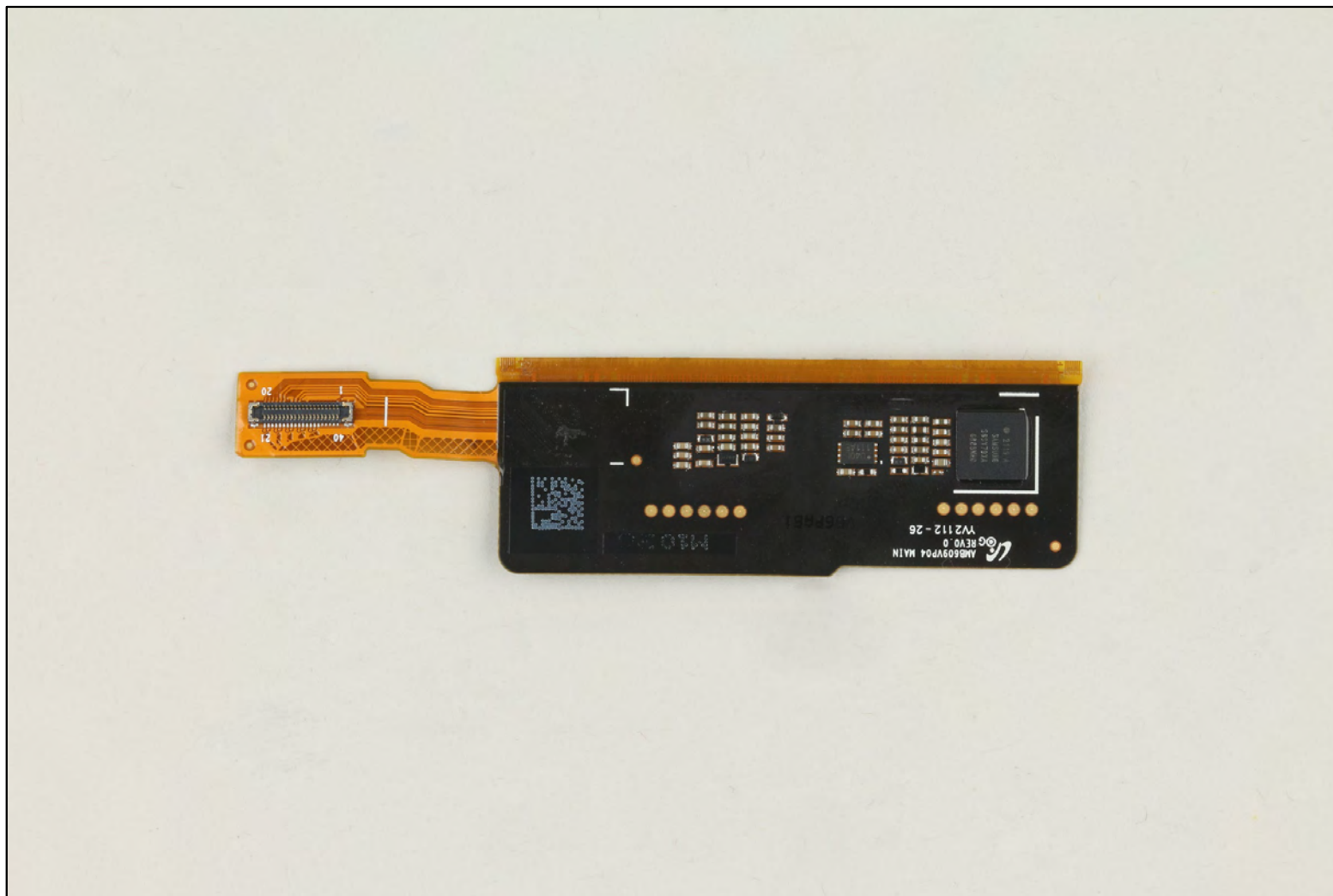
Subsystems

Display/Touchscreen Disassembly



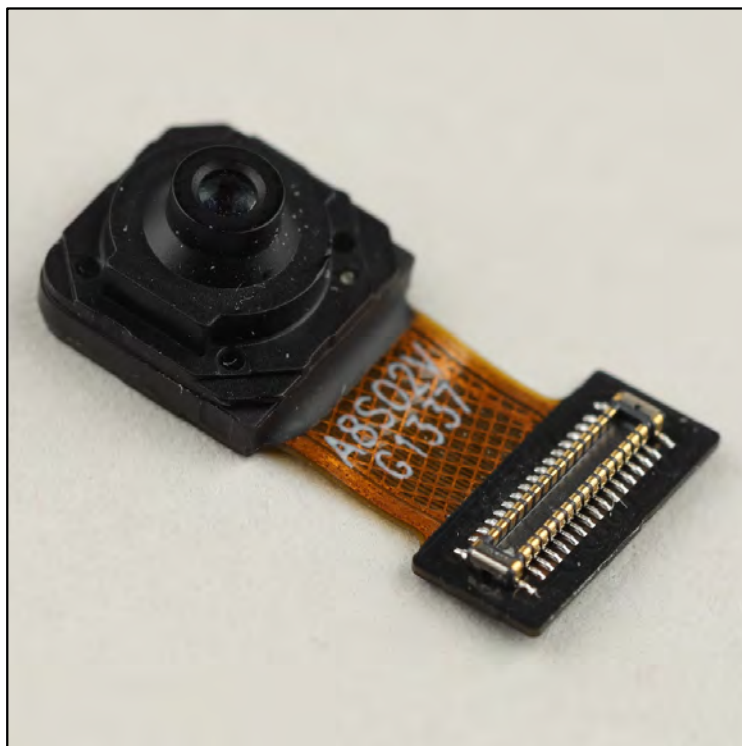
Subsystems

Display/Touchscreen Substrates



Subsystems

8 MP Front Camera Summary



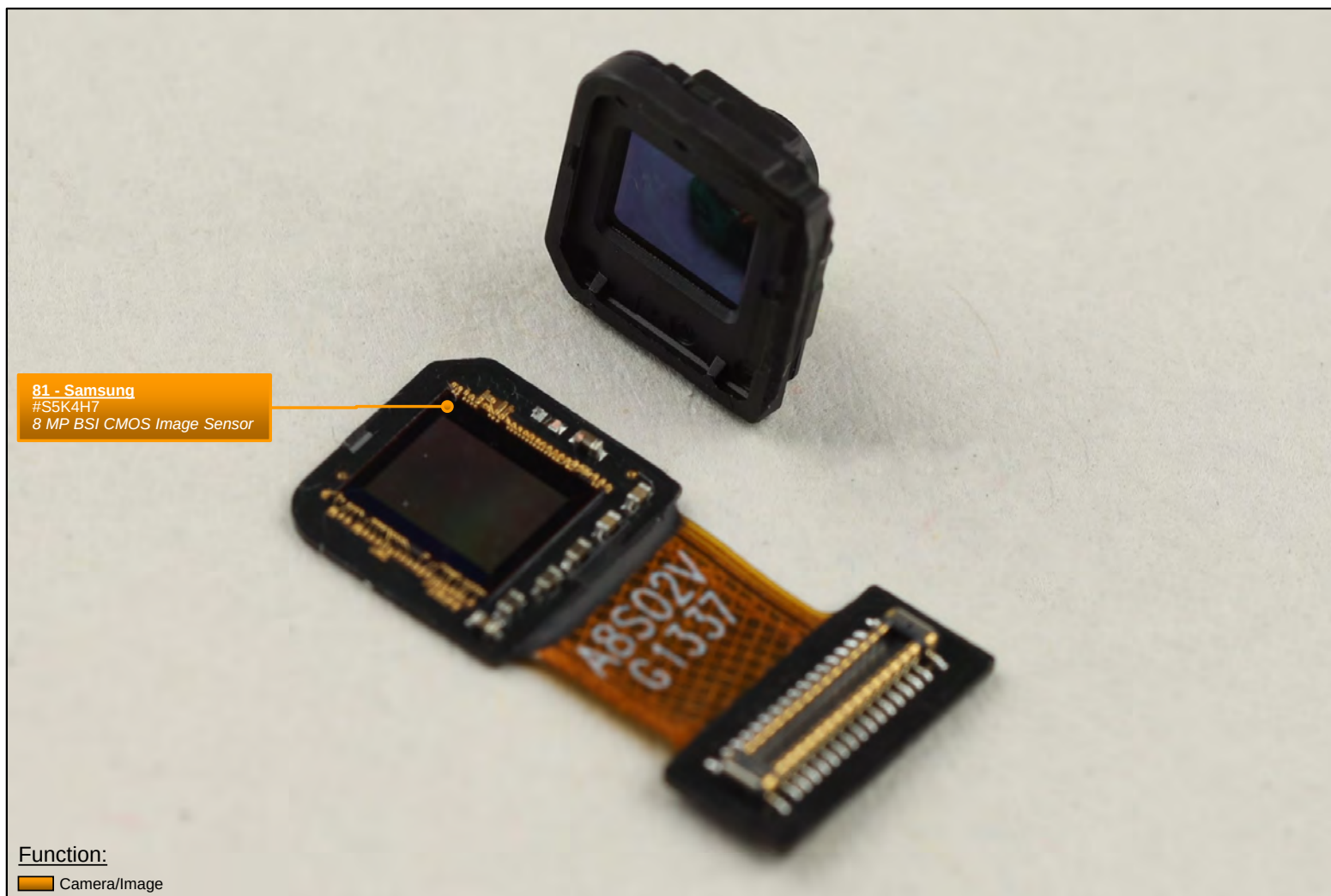
8 MP Front Camera Subsystem		
Brand	Unknown	
Part Number	A8S02V	
Subsystem Size (mm)	6.95 x 6.84 x 4.26	
Camera Size (mm)	6.95 x 6.84 x 4.26	
Subsystem Weight (grams)	0.2	
Camera Weight (grams)	0.2	
Type	CMOS BSI	
Resolution	8 MP	
Optical Size	1/4	
Lens Elements	4	
Optical Zoom	1	
Estimated Costs	Electronic Parts	\$1.89
	Non-Electronic Parts	\$1.02
	Assembly	\$0.36
	Test	\$0.15
	Gross Margin	\$1.47
Estimated Module Price		\$4.89

A full Subsystem BOM is provided in the included BOM workbook.

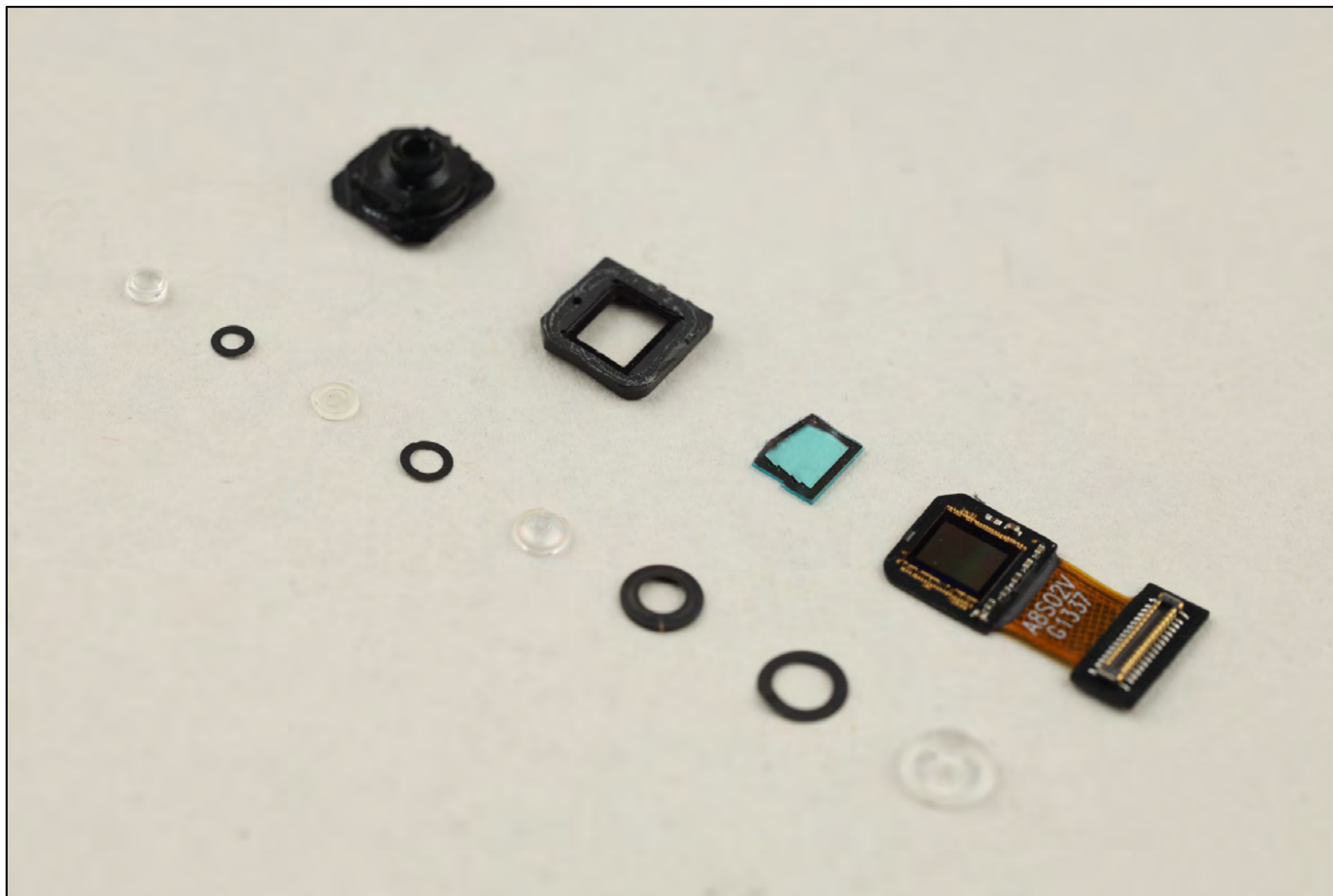


Subsystems

8 MP Front Camera IC Identification

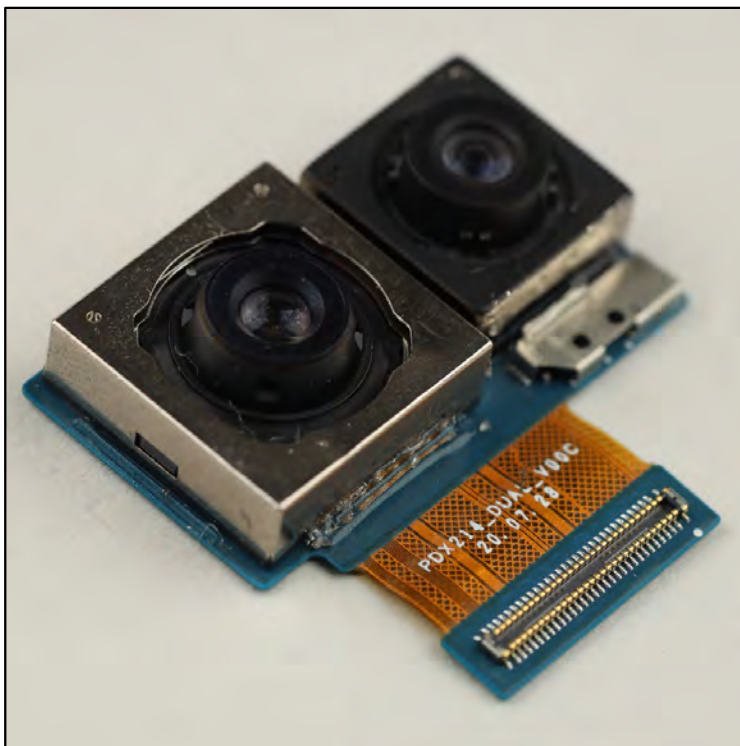


8 MP Front Camera Disassembly



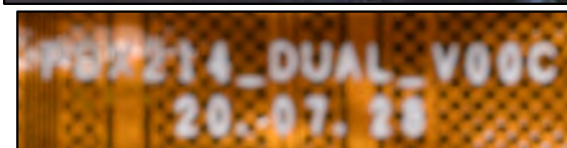
Subsystems

12 MP Dual Rear Camera Summary



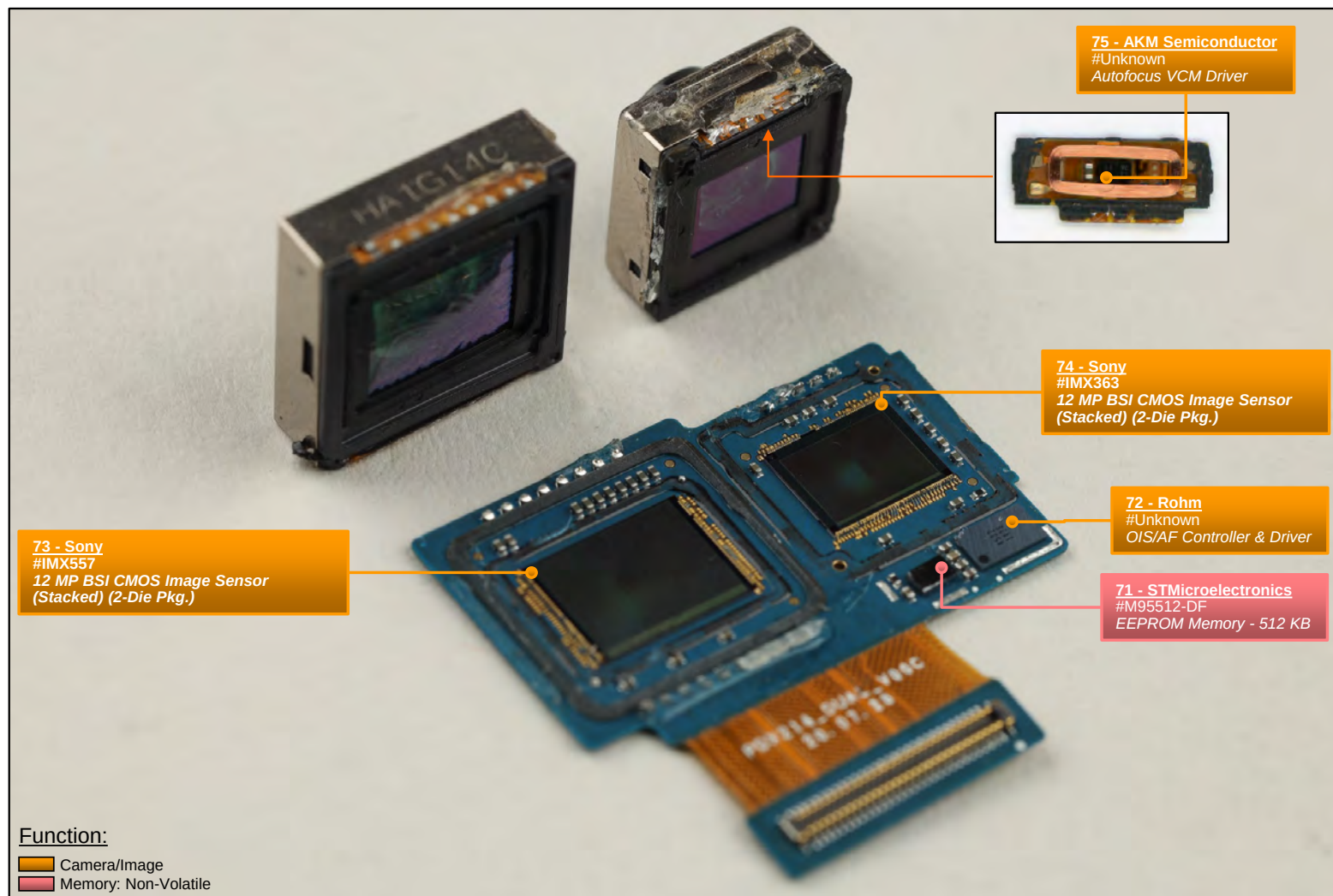
12 MP Dual Rear Camera Subsystem		
Brand	Sony	
Part Number	PDX214	
Subsystem Size (mm)	25.56 x 15.6 x 6.7	
Camera Size (mm)	25.56 x 15.6 x 6.7	
Subsystem Weight (grams)	3.1	
Camera Weight (grams)	3.1	
Type	CMOS BSI	
Resolution(Wide Angle)	12 MP	
Resolution(Ultra-Wide Angle)	12 MP	
Optical Size(Wide Angle)	1/1.7	
Optical Size(Ultra-Wide Angle)	1/2.6	
Lens Elements(Wide Angle)	7	
Lens Elements(Ultra-Wide Angle)	6	
Optical Zoom	1	
Estimated Costs	Electronic Parts	\$25.74
	Non-Electronic Parts	\$4.65
	Assembly	\$1.15
	Test	\$0.30
	Gross Margin	\$21.23
Estimated Module Price		\$53.08

A full Subsystem BOM is provided in the included BOM workbook.



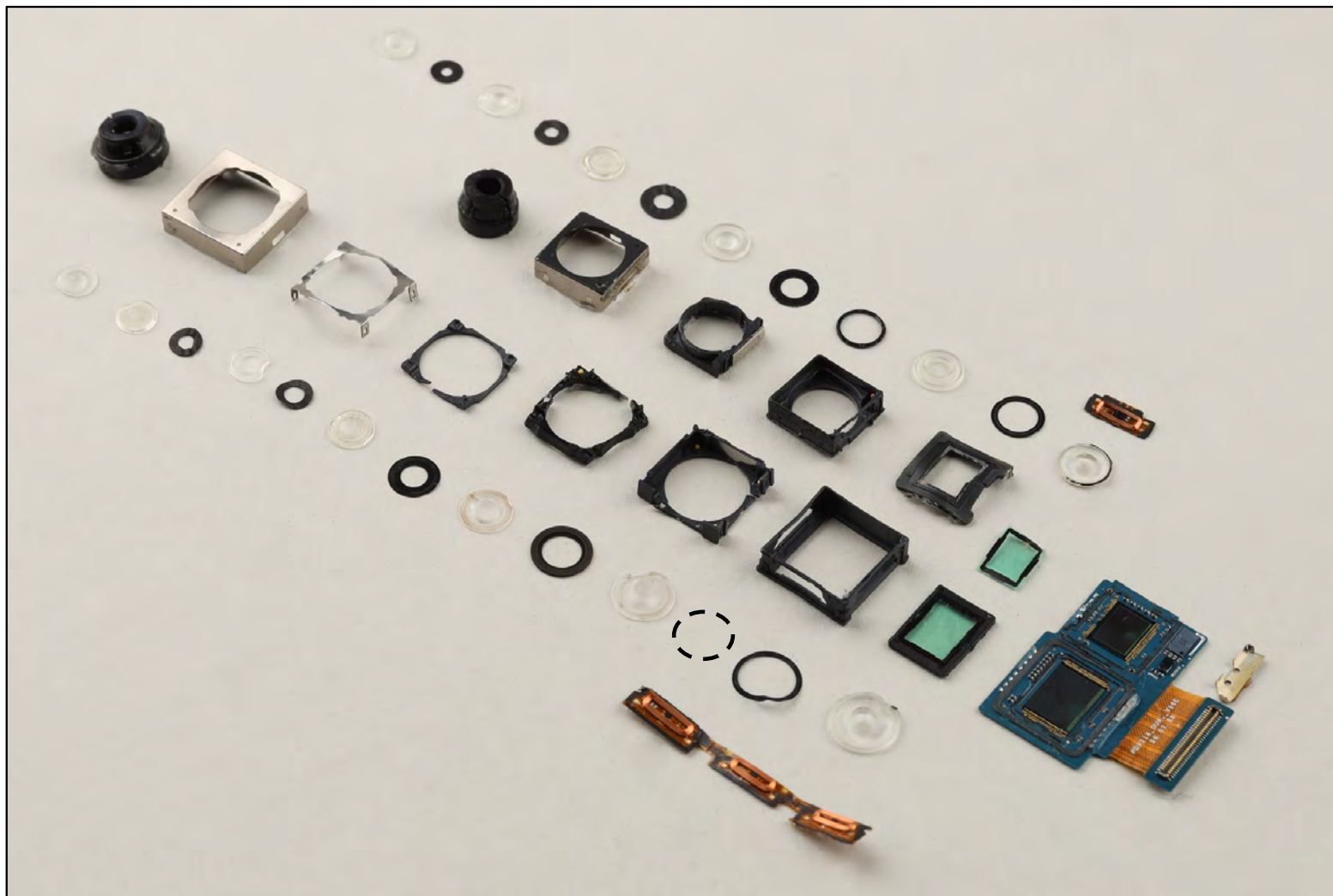
Subsystems

12 MP Dual Rear Camera IC Identification



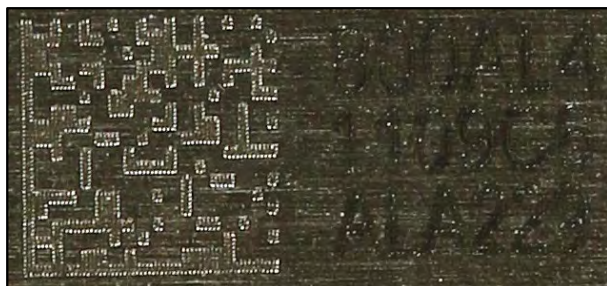
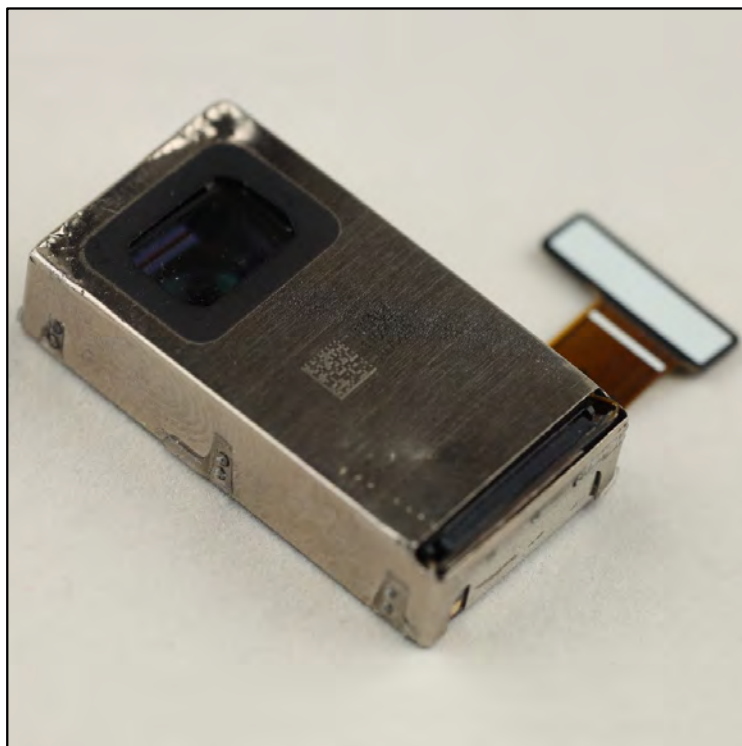
Subsystems

12 MP Dual Rear Camera Disassembly



Subsystems

12 MP Telephoto Rear Camera Summary



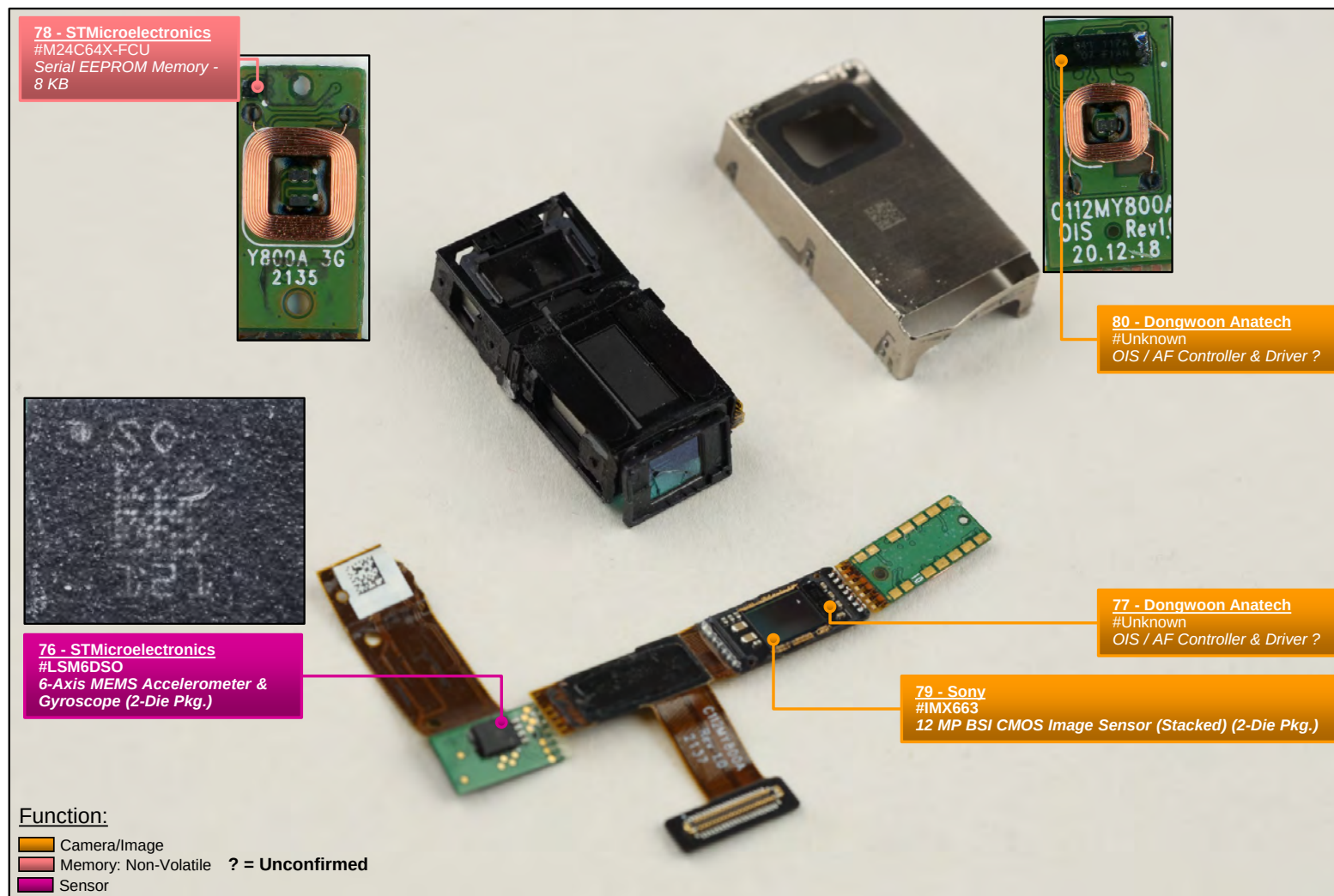
12 MP Telephoto Rear Camera Subsystem		
Brand	Sony	
Part Number	C112MY800A	
Subsystem Size (mm)	26.75 x 15 x 6.46	
Camera Size (mm)	26.75 x 15 x 6.46	
Subsystem Weight (grams)	3.8	
Camera Weight (grams)	3.8	
Type	CMOS BSI	
Resolution	12 MP	
Optical Size	1/2.8	
Lens Elements	7	
Optical Zoom	1	
Estimated Costs	Electronic Parts	\$12.00
	Non-Electronic Parts	\$3.85
	Assembly	\$0.70
	Test	\$0.15
	Gross Margin	\$11.14
Estimated Module Price		\$27.84

A full Subsystem BOM is provided in the included BOM workbook.



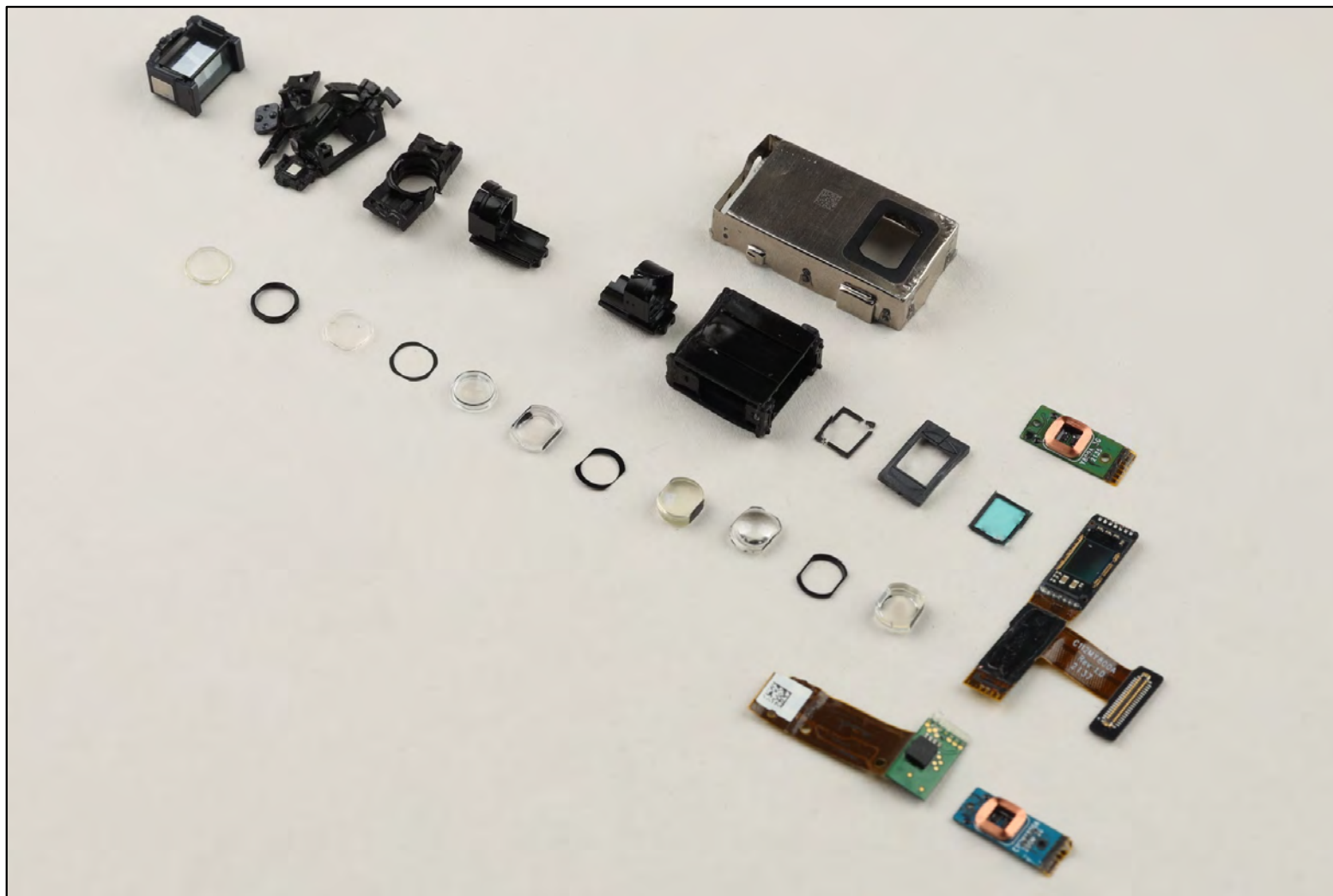
Subsystems

12 MP Telephoto Rear Camera IC Identification



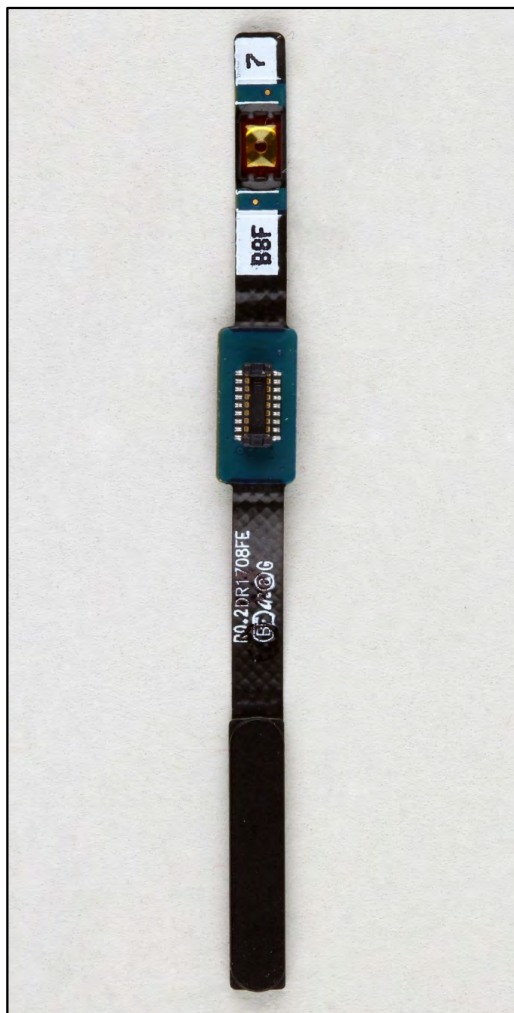
Subsystems

12 MP Telephoto Rear Camera Disassembly



Subsystems

Fingerprint Sensor Summary

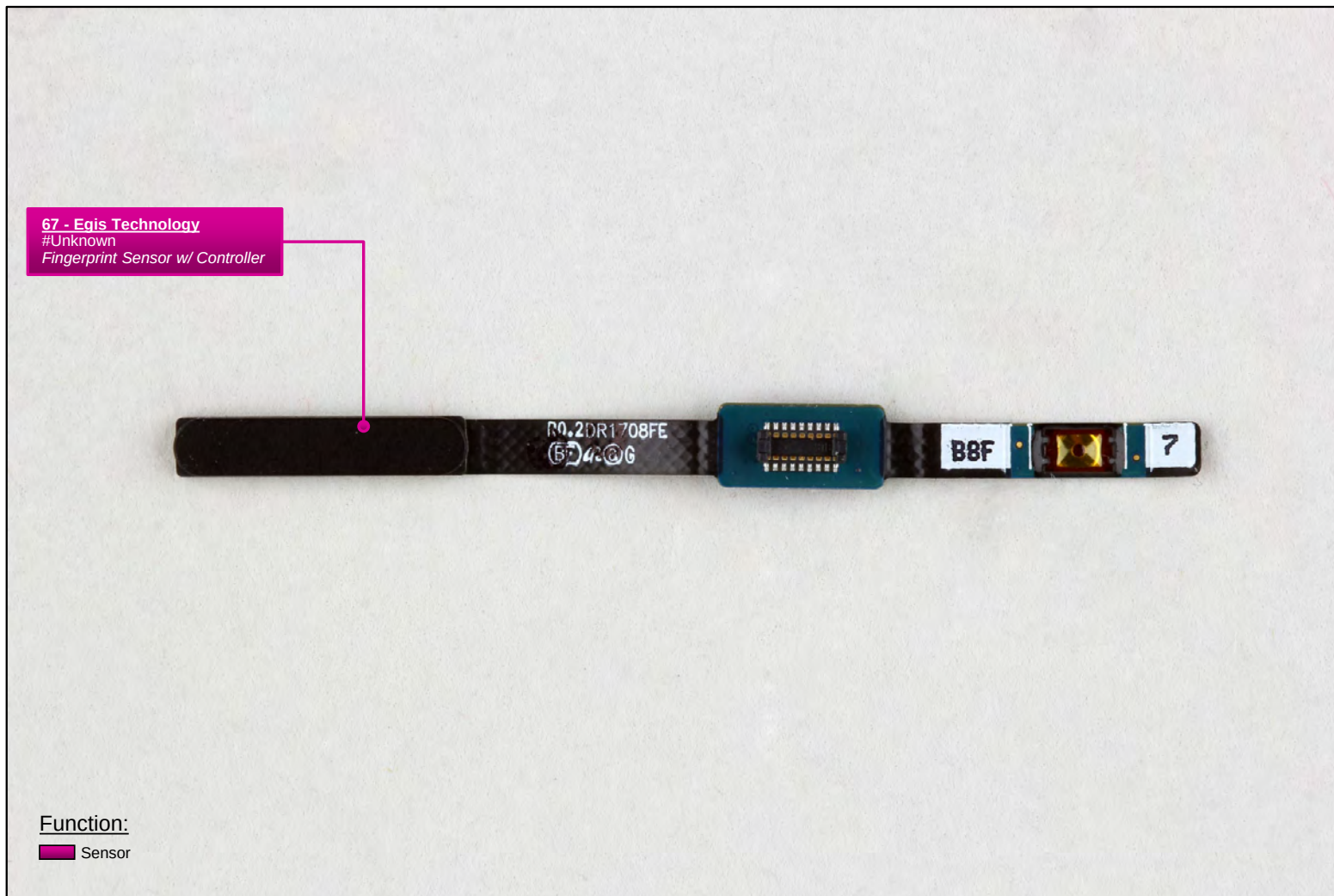


Fingerprint Sensor Subsystem		
Brand		Unknown
Part Number		Unknown
Module Dimensions		48.17 x 3.98 x 1.73
Weight (grams)		0.16
Estimated Costs	Electronic Parts	\$1.38
	Non-Electronic Parts	\$0.00
	Assembly	\$0.05
	Test	\$0.10
	Gross Margin	\$0.66
Estimated Module Price		\$2.19

A full Subsystem BOM is provided in the included BOM workbook.

Subsystems

Fingerprint Sensor IC Identification



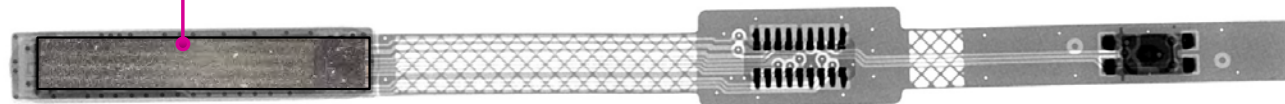


Subsystems

Fingerprint Sensor X-Ray and Die Photo

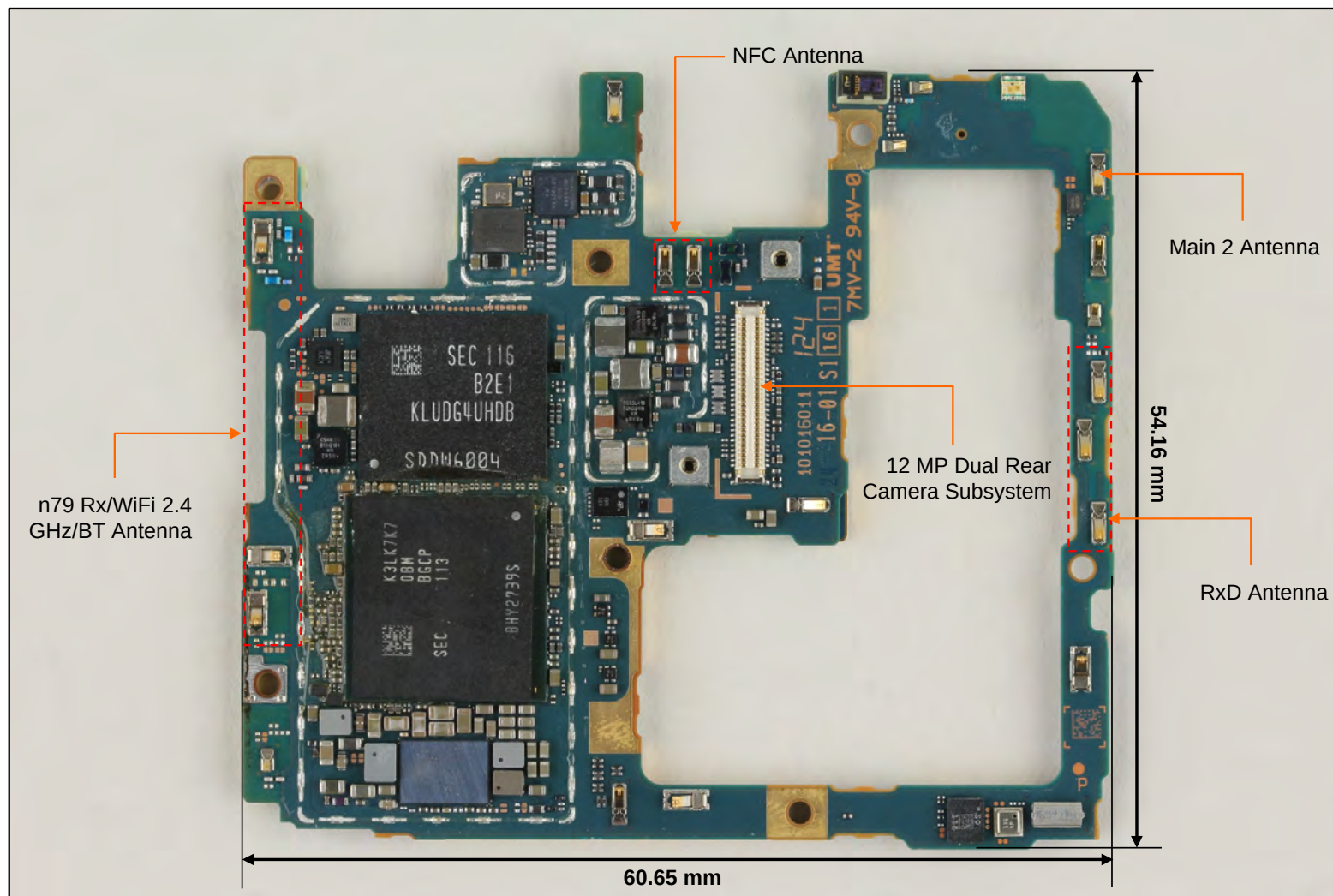
67 - Egis Technology
#Unknown
Fingerprint Sensor w/ Controller
Pkg Size: 13.78 x 2.79 mm

67.1 - Egis Technology
#ET608
Fingerprint Sensor w/ Controller
Die Size: 10.36 x 2.23 mm



Main Board

Side 1



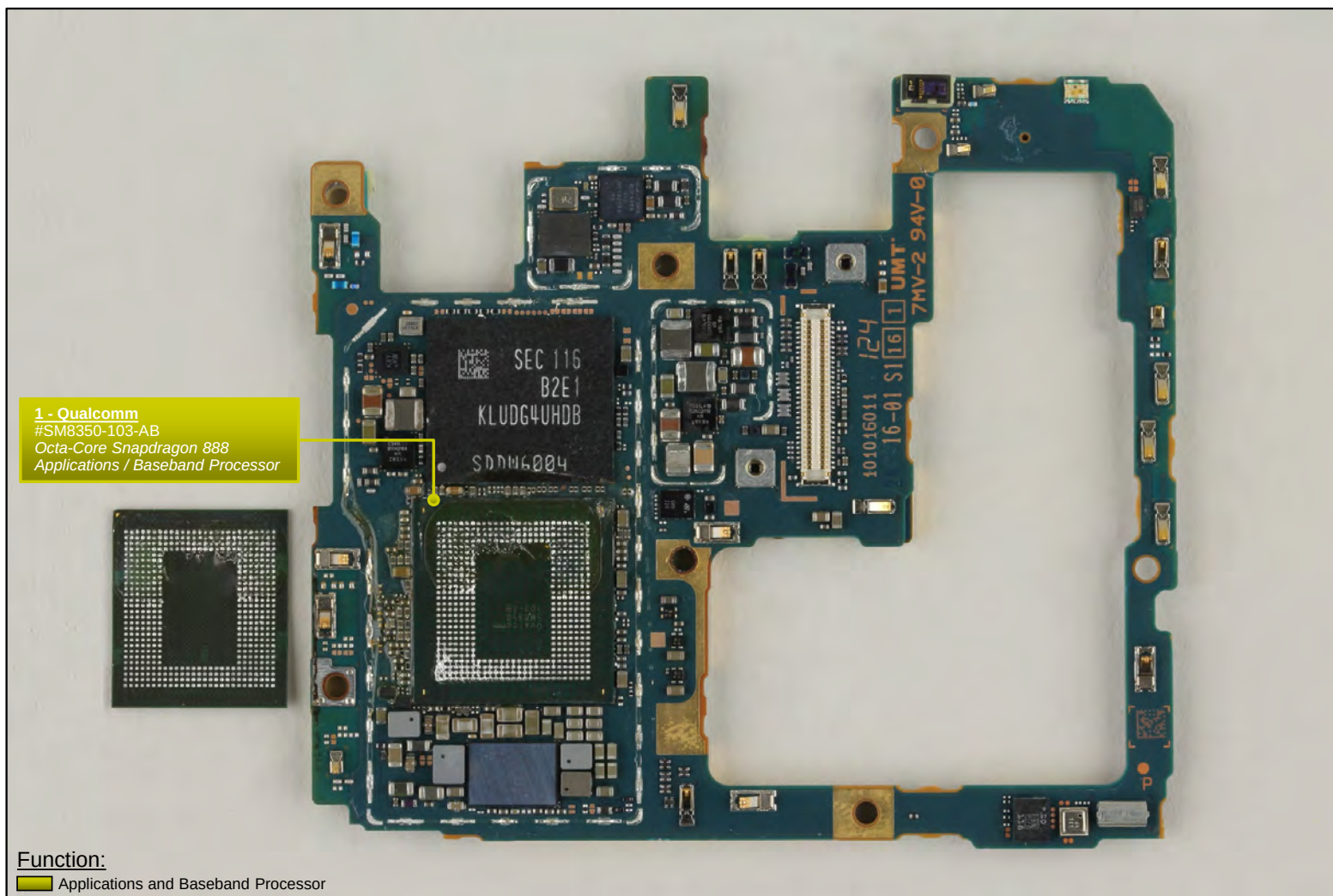
Assembly IC Identification Radio ICs Sensors X-Rays & Die Photos

Side 1 Side 2 Cross Section

Front Page Device Analysis Product Labels Supporting Materials Block Diagram Features Components Teardown Antennas Component Function Guide Subsystems Main Board Other Substrates Summaries Overview & Discussion

Main Board

Side 1 IC Identification



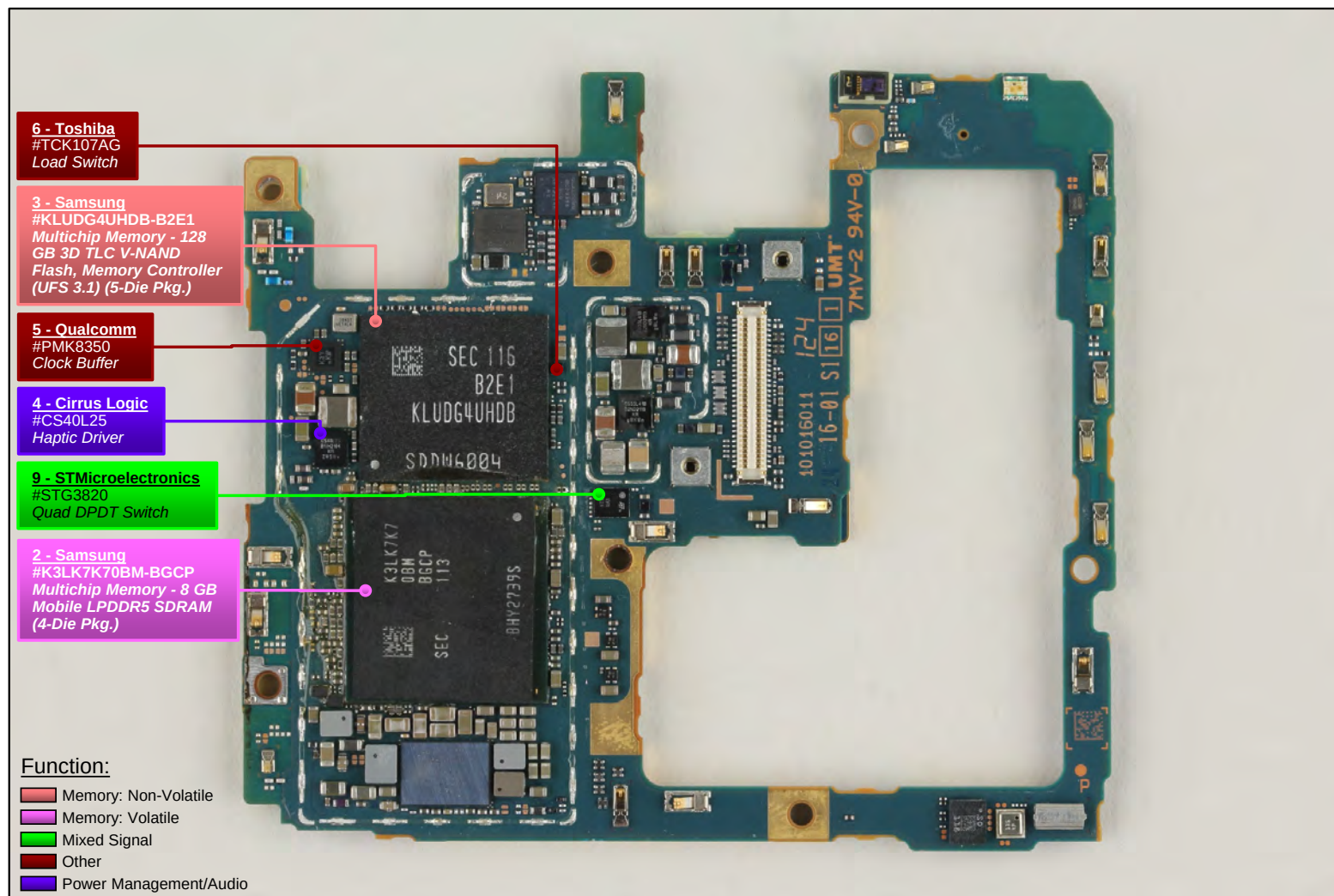
Assembly IC Identification Radio ICs Sensors X-Rays & Die Photos

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Front Page Device Analysis Product Labels Supporting Materials Block Diagram Features Components Teardown Antennas Component Function Guide Subsystems Main Board Other Substrates Summaries Overview & Discussion

Main Board

Side 1 IC Identification



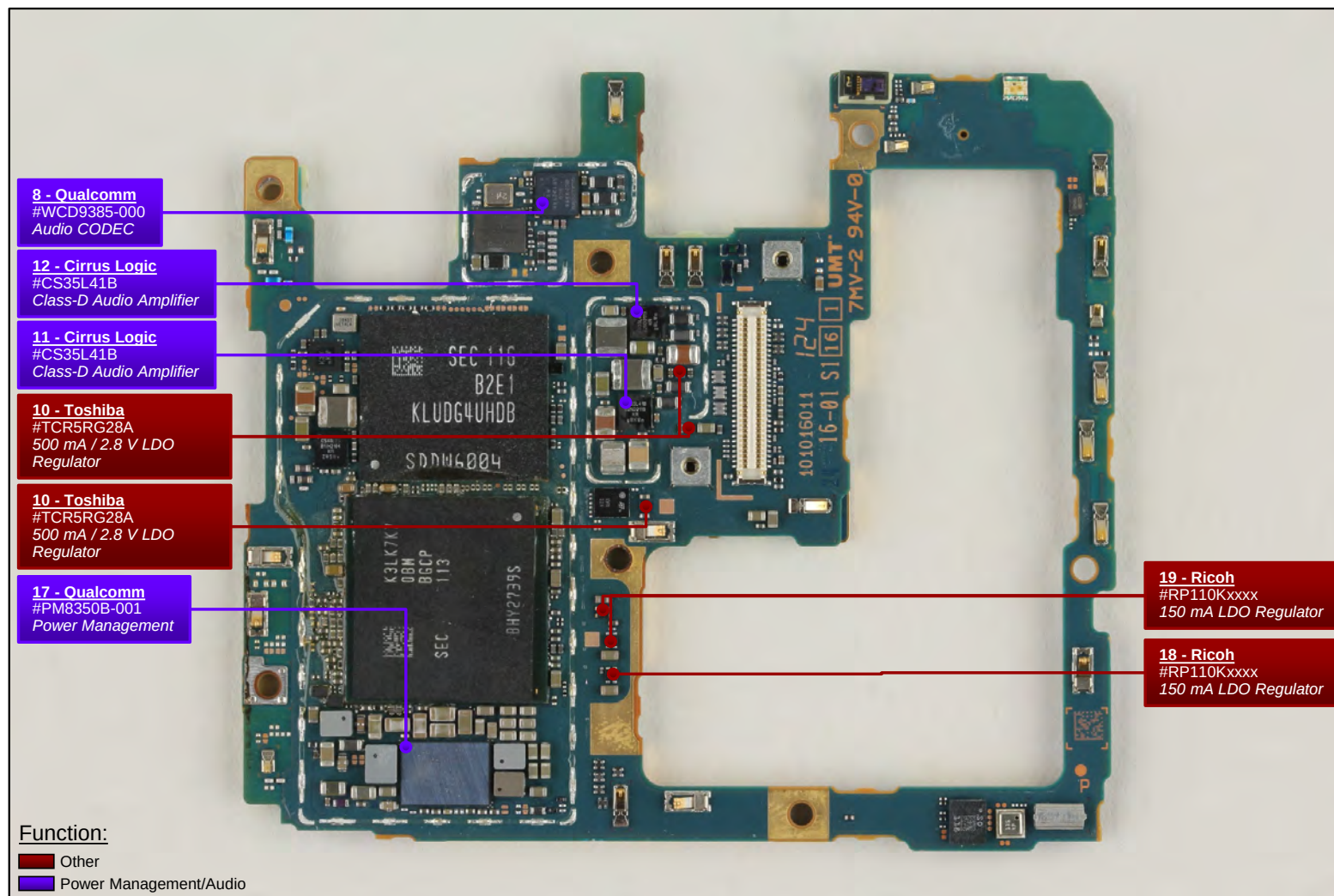
Assembly IC Identification Radio ICs Sensors X-Rays & Die Photos

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Side 1 IC Identification



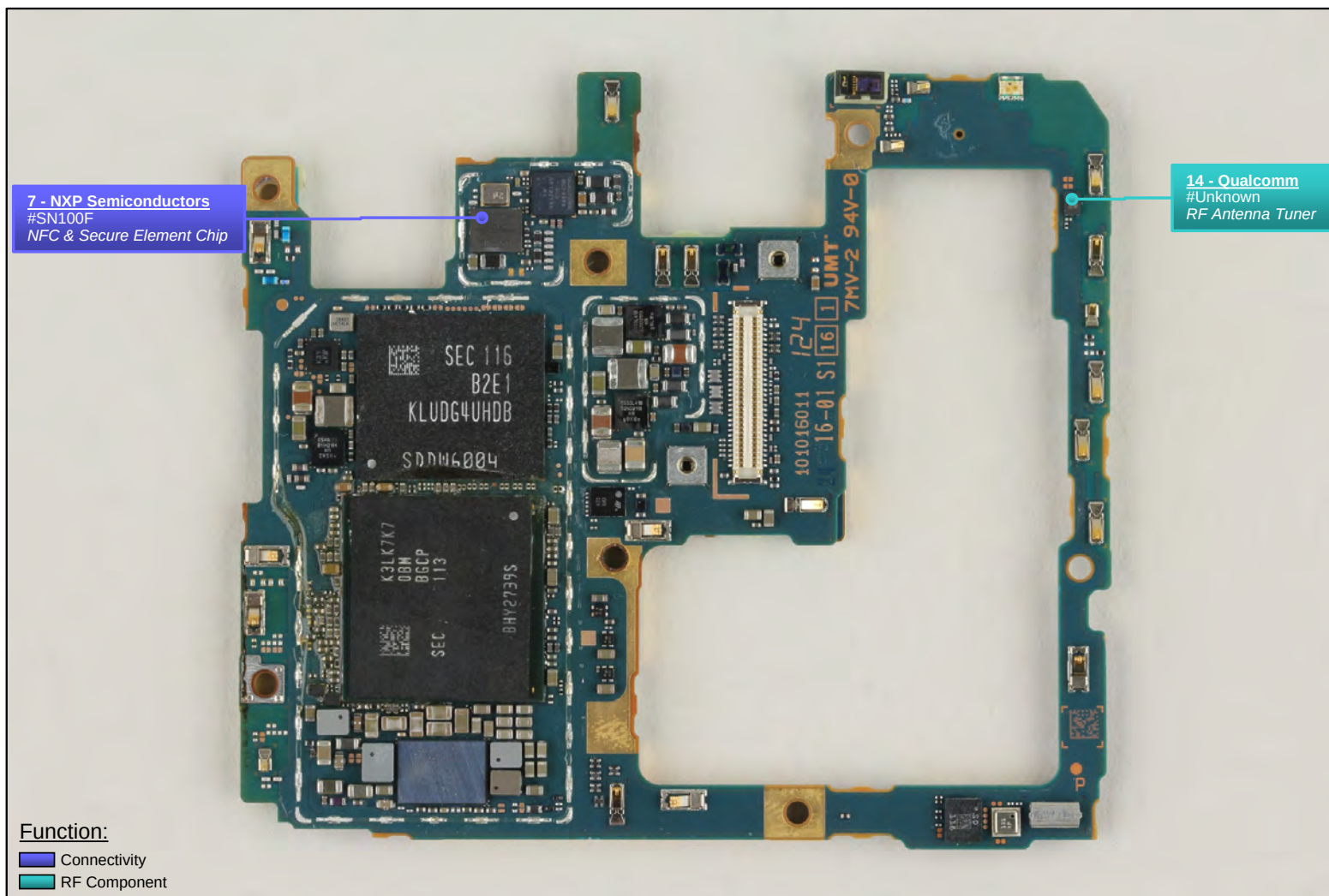
Assembly IC Identification Radio ICs Sensors X-Rays & Die Photos

Side 1 Side 2 Cross Section

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Main Board

Side 1 ICs – Radio



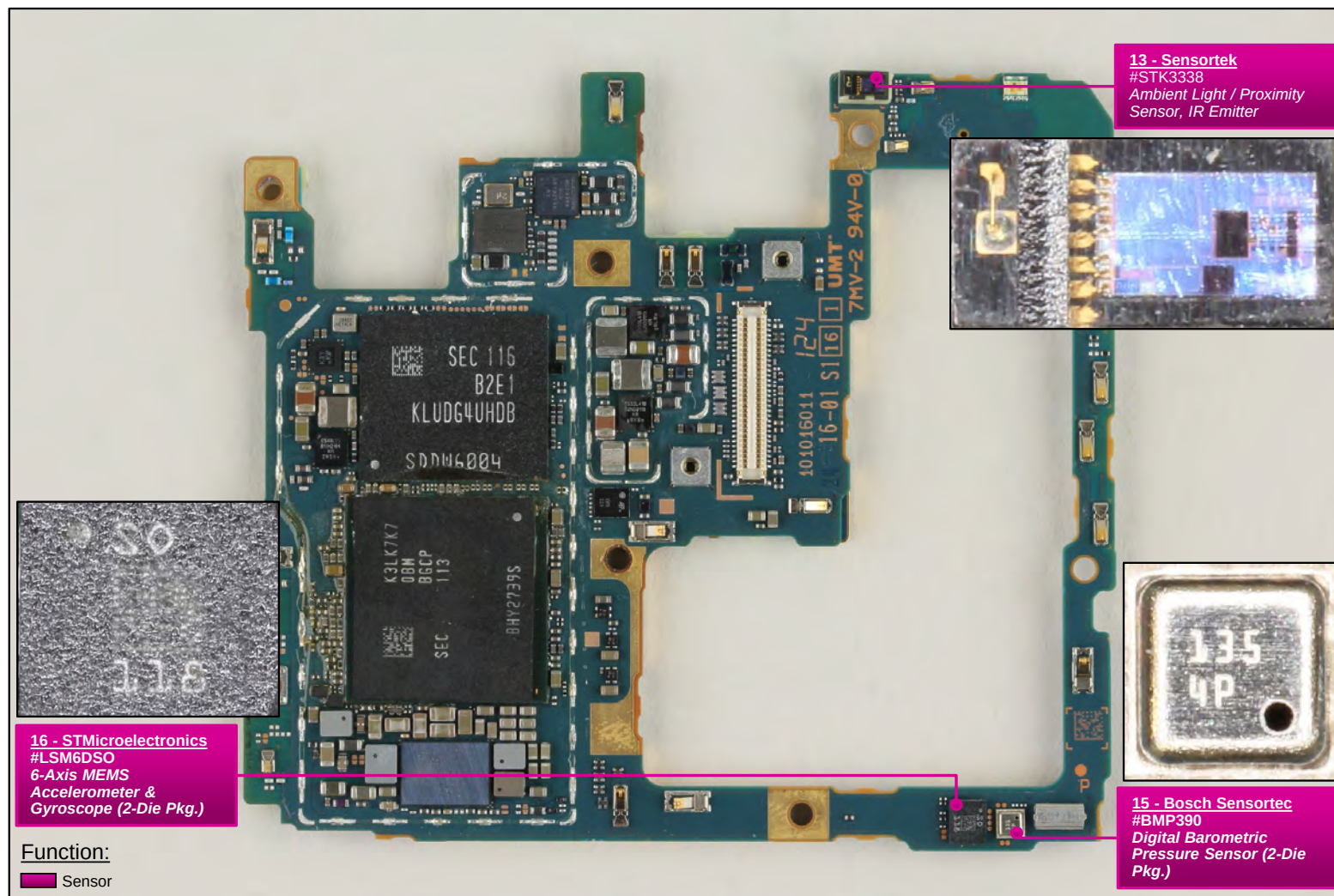
Assembly IC Identification Radio ICs Sensors X-Rays & Die Photos

Side 1 Side 2 Cross Section

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Main Board

Side 1 ICs – Sensors



Assembly IC Identification Radio ICs **Sensors** X-Rays & Die Photos

Side 1 Side 2 Cross Section

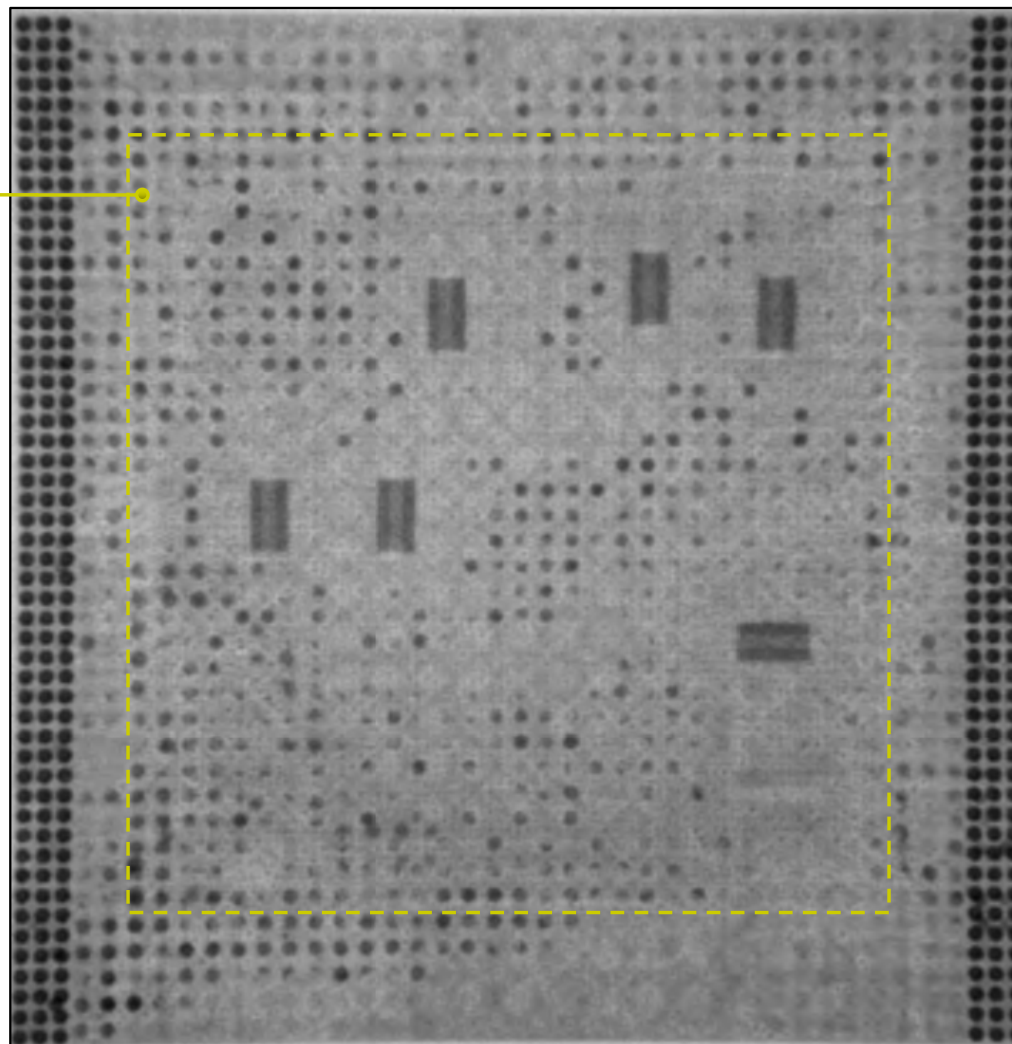
Front Page Device Analysis Product Labels Supporting Materials Block Diagram Features Components Teardown Antennas Component Function Guide Subsystems **Main Board** Other Substrates Summaries Overview & Discussion

Main Board

Side 1 X-Rays and Die Photos

1 - Qualcomm
#SM8350-103-AB
Octa-Core Snapdragon 888 Applications / Baseband Processor
Pkg Size: 14.32 x 14.03 mm

1.1 - Qualcomm
#HG11-PP133-200
Octa-Core Snapdragon 888 Applications / Baseband Processor
Die Size: 10.74 x 10.53 mm



Function:

Applications and Baseband Processor

Assembly IC Identification Radio ICs Sensors X-Rays & Die Photos

Side 1 Side 2 Cross Section

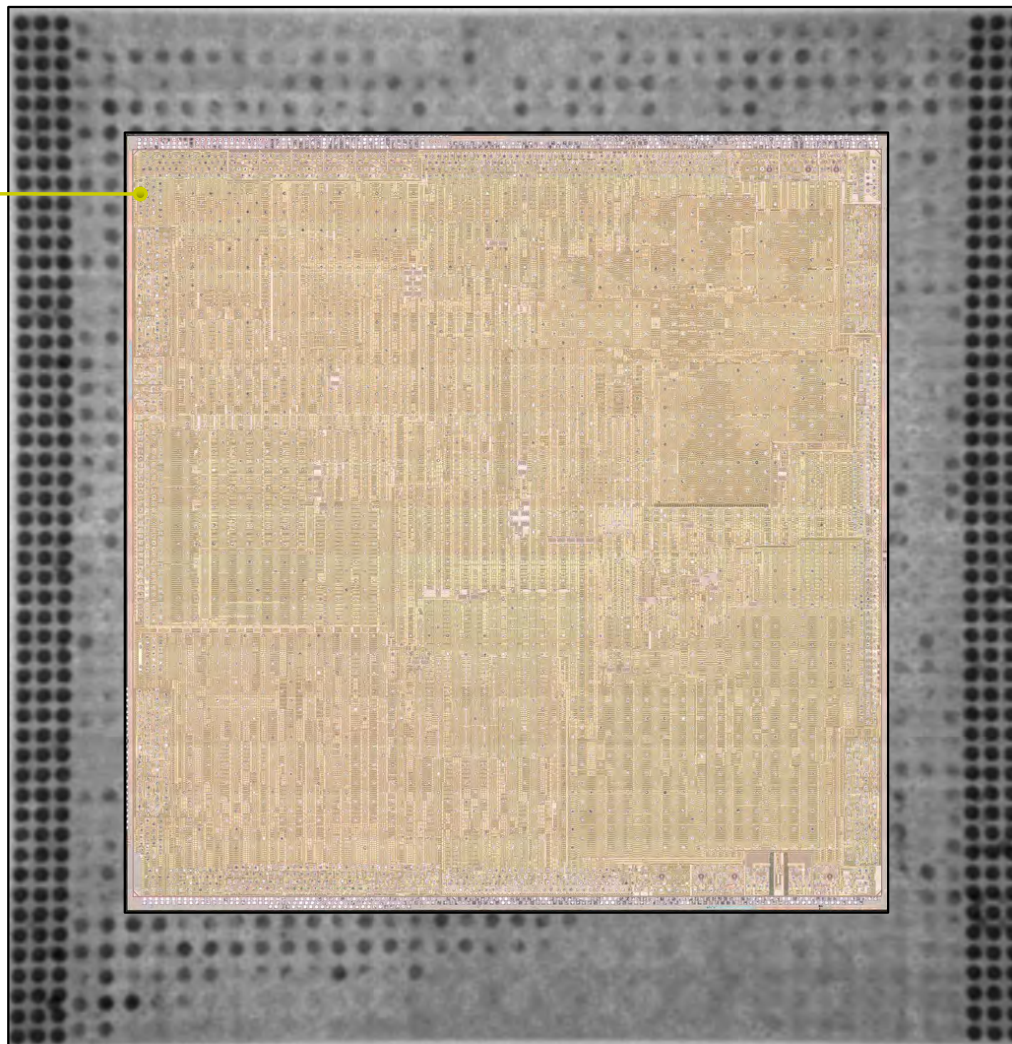
Front Page Device Analysis Product Labels Supporting Materials Block Diagram Features Components Teardown Antennas Component Function Guide Subsystems Main Board Other Substrates Summaries Overview & Discussion

Main Board

Side 1 X-Rays and Die Photos

1 - Qualcomm
#SM8350-103-AB
Octa-Core Snapdragon 888 Applications / Baseband Processor
Pkg Size: 14.32 x 14.03 mm

1.1 - Qualcomm
#HG11-PP133-200
Octa-Core Snapdragon 888 Applications / Baseband Processor
Die Size: 10.74 x 10.53 mm



Function:

Applications and Baseband Processor

Assembly IC Identification Radio ICs Sensors X-Rays & Die Photos

Side 1 Side 2 Cross Section

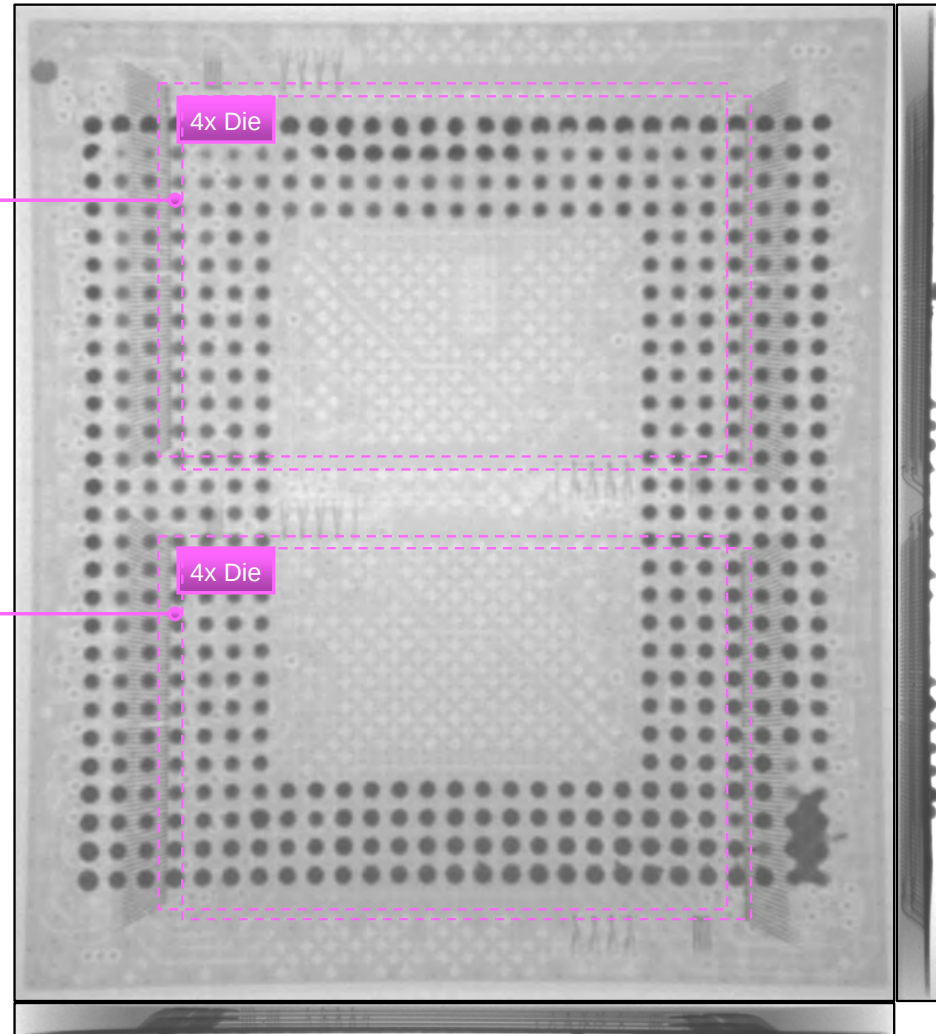
Front Page Device Analysis Product Labels Supporting Materials Block Diagram Features Components Teardown Antennas Component Function Guide Subsystems Main Board Other Substrates Summaries Overview & Discussion

Main Board

Side 1 X-Rays and Die Photos

2 - Samsung
#K3LK7K70BM-BGCP
Multichip Memory - 8 GB Mobile LPDDR5 SDRAM (4-Die Pkg.)
Pkg Size: 14 x 12.4 mm

2.1 - Samsung
#K4L6E165YB
Mobile LPDDR5 SDRAM Memory - 2 GB
Die Size: 10.91 x 5.66 mm



Function:

Memory: Volatile

Assembly IC Identification Radio ICs Sensors X-Rays & Die Photos

Side 1 Side 2 Cross Section

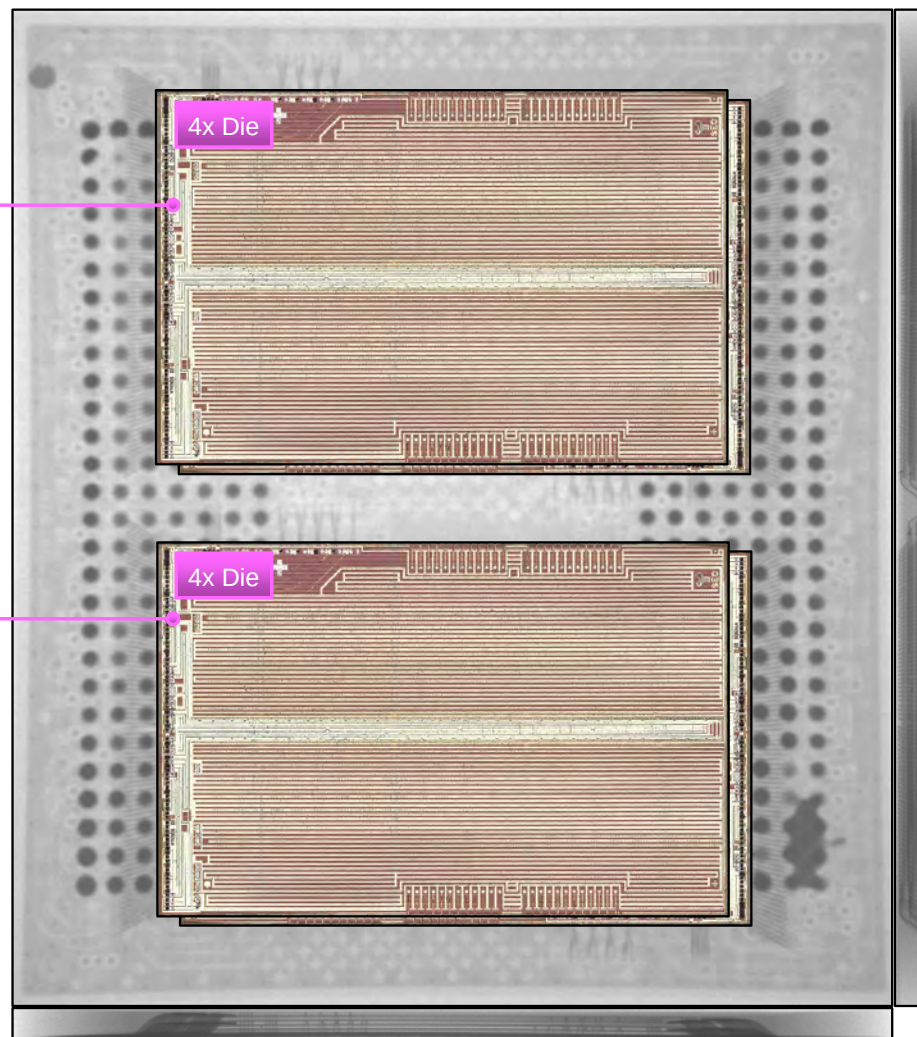
Front Page Device Analysis Product Labels Supporting Materials Block Diagram Features Components Teardown Antennas Component Function Guide Subsystems Main Board Other Substrates Summaries Overview & Discussion

Main Board

Side 1 X-Rays and Die Photos

2 - Samsung
#K3LK7K70BM-BGCP
Multichip Memory - 8 GB Mobile LPDDR5 SDRAM (4-Die Pkg.)
Pkg Size: 14 x 12.4 mm

2.1 - Samsung
#K4L6E165YB
Mobile LPDDR5 SDRAM Memory - 2 GB
Die Size: 10.91 x 5.66 mm



Function:

Memory: Volatile

Assembly IC Identification Radio ICs Sensors X-Rays & Die Photos

Side 1 Side 2 Cross Section

Front Page Device Analysis Product Labels Supporting Materials Block Diagram Features Components Teardown Antennas Component Function Guide Subsystems Main Board Other Substrates Summaries Overview & Discussion

Main Board

Side 1 X-Rays and Die Photos

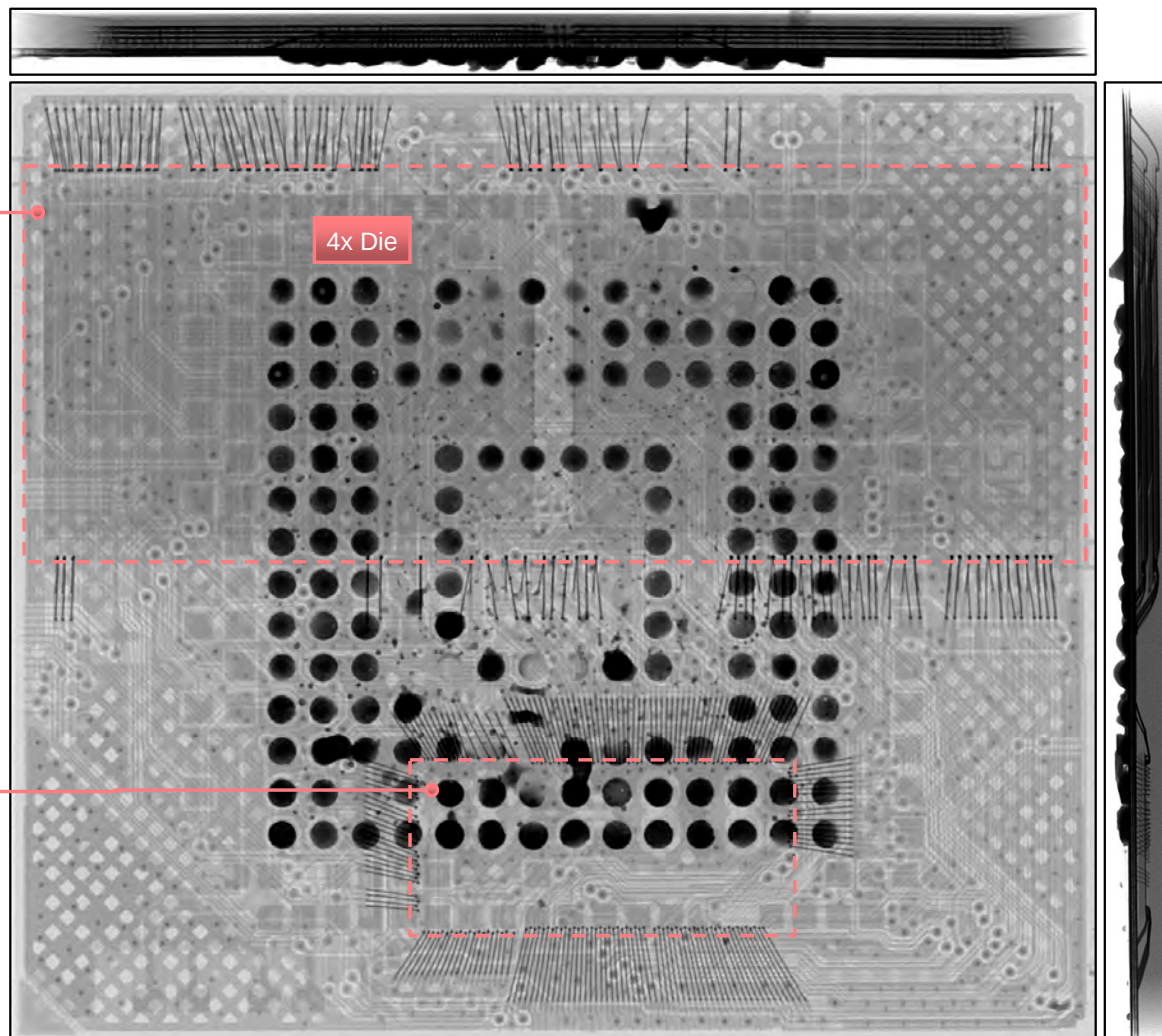
3 - Samsung
#KLUDG4UHDB-B2E1
Multichip Memory - 128 GB 3D TLC V-NAND
Flash, Memory Controller (UFS 3.1) (5-Die Pkg.)
Pkg Size: 13 x 11.5 mm

3.1 - Samsung
#K9AFGD8J08
3D TLC V-NAND Flash Memory - 32 GB
Die Size: 12.75 x 4.51 mm

3.2 - Samsung
#S4LR050
Memory Controller (UFS 3.1)
Die Size: 4.61 x 2.18 mm

Function:

Memory: Non-Volatile



Assembly IC Identification Radio ICs Sensors X-Rays & Die Photos

Side 1 Side 2 Cross Section

Front Page Device Analysis Product Labels Supporting Materials Block Diagram Features Components Teardown Antennas Component Function Guide Subsystems Main Board Other Substrates Summaries Overview & Discussion

Main Board

Side 1 X-Rays and Die Photos

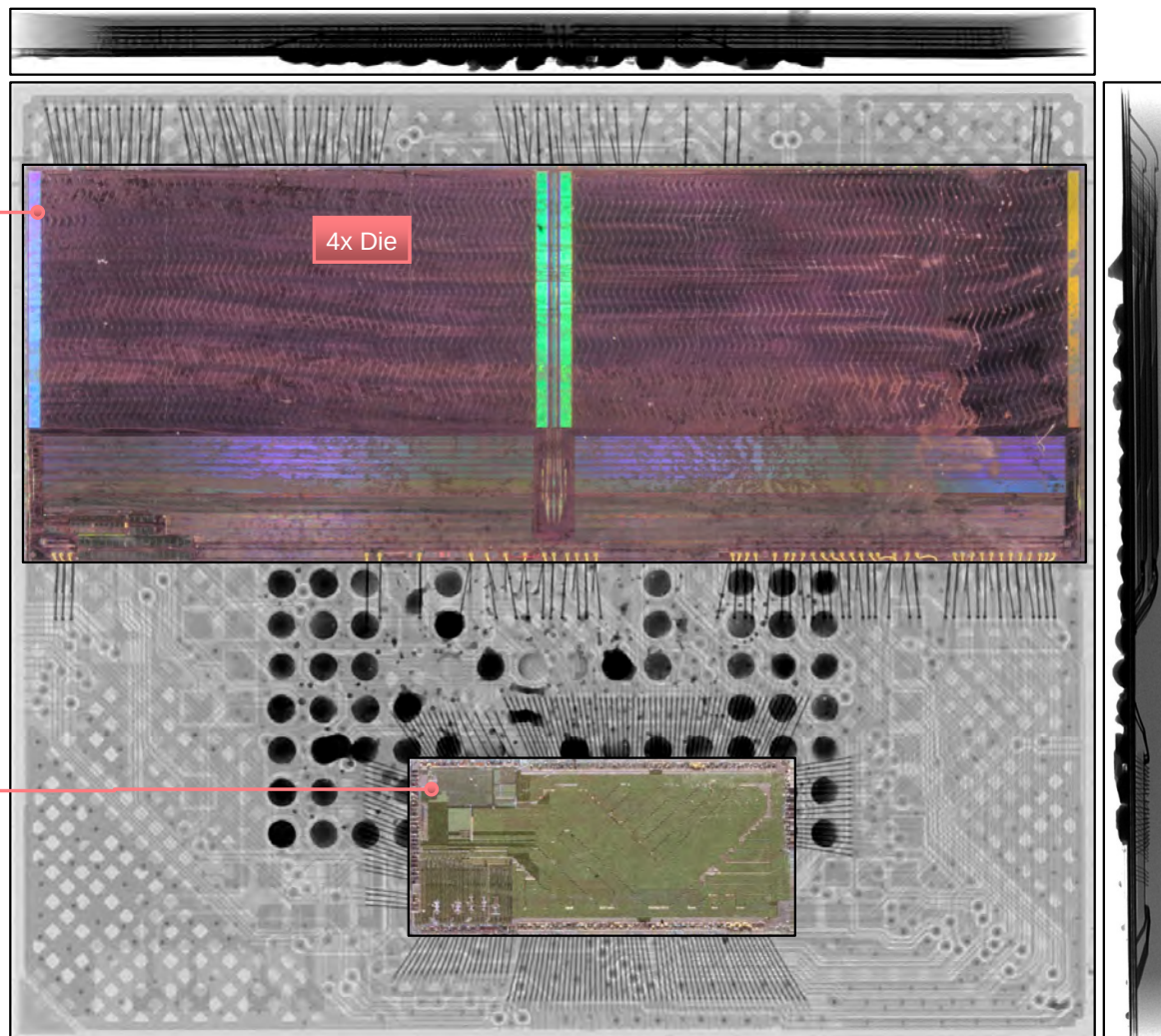
3 - Samsung
#KLUDG4UHDB-B2E1
Multichip Memory - 128 GB 3D TLC V-NAND
Flash, Memory Controller (UFS 3.1) (5-Die Pkg.)
Pkg Size: 13 x 11.5 mm

3.1 - Samsung
#K9AFGD8J08
3D TLC V-NAND Flash Memory - 32 GB
Die Size: 12.75 x 4.51 mm

3.2 - Samsung
#S4LR050
Memory Controller (UFS 3.1)
Die Size: 4.61 x 2.18 mm

Function:

Memory: Non-Volatile



Assembly IC Identification Radio ICs Sensors X-Rays & Die Photos

Side 1 Side 2 Cross Section

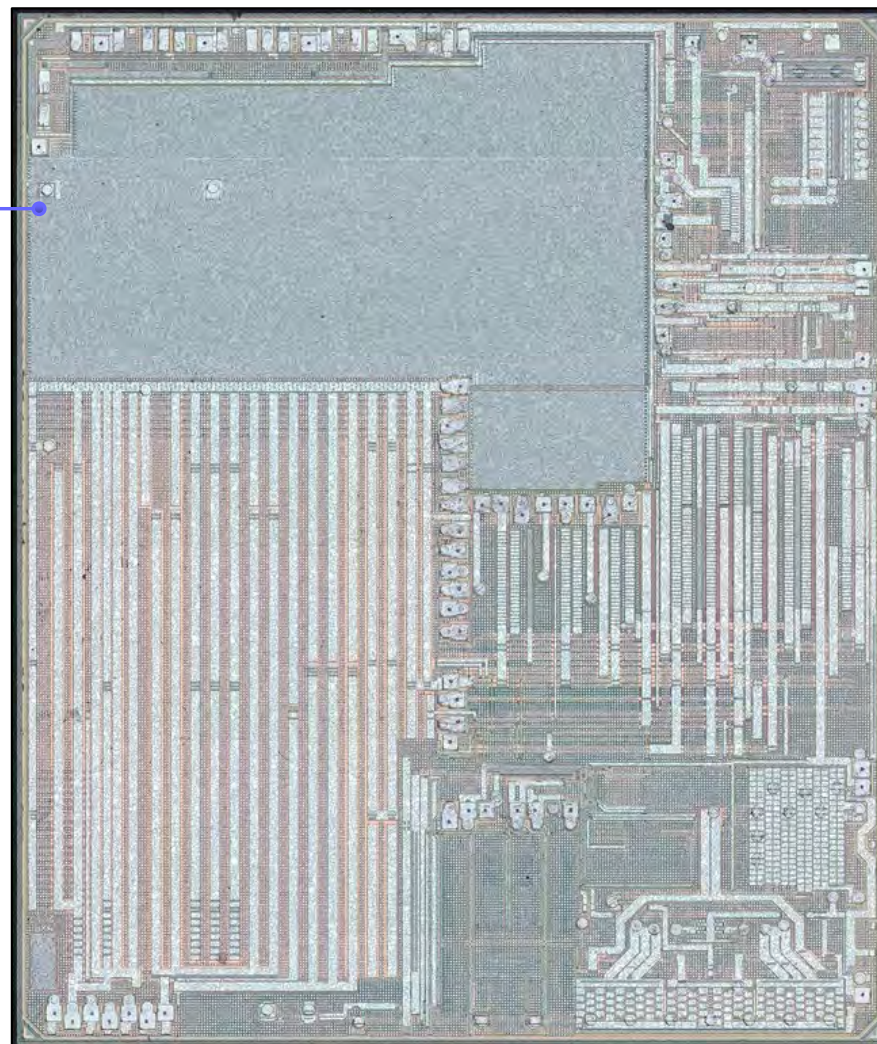
Front Page Device Analysis Product Labels Supporting Materials Block Diagram Features Components Teardown Antennas Component Function Guide Subsystems Main Board Other Substrates Summaries Overview & Discussion

Main Board

Side 1 X-Rays and Die Photos

7 - NXP Semiconductors
#SN100F
NFC & Secure Element Chip
Pkg Size: 3.54 x 3 mm

7.1 - NXP Semiconductors
#Unknown
NFC & Secure Element Chip
Die Size: 3.54 x 3 mm



Function:

Connectivity

Assembly IC Identification Radio ICs Sensors X-Rays & Die Photos

Side 1 Side 2 Cross Section

Front Page Device Analysis Product Labels Supporting Materials Block Diagram Features Components Teardown Antennas Component Function Guide Subsystems Main Board Other Substrates Summaries Overview & Discussion

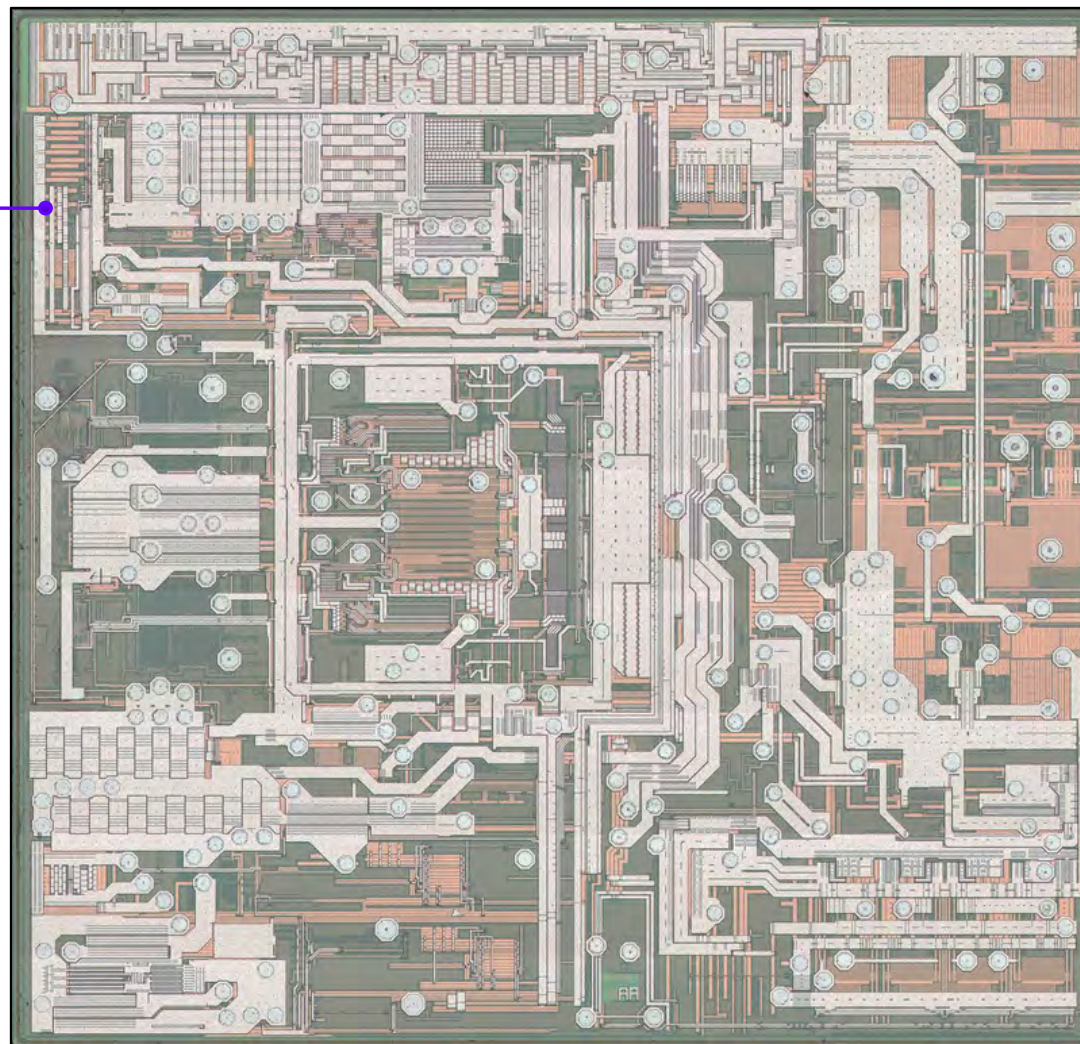
Main Board

Side 1 X-Rays and Die Photos

8 - Qualcomm
#WCD9385-000
Audio CODEC
Pkg Size: 3.12 x 3.01 mm

8.1 - Qualcomm
#HG11-PL093-100 ?
Audio CODEC
Die Size: 2.95 x 2.84 mm

Function: ? = Unconfirmed
■ Power Management/Audio



Assembly IC Identification Radio ICs Sensors X-Rays & Die Photos

Side 1 Side 2 Cross Section

Front Page Device Analysis Product Labels Supporting Materials Block Diagram Features Components Teardown Antennas Component Function Guide Subsystems Main Board Other Substrates Summaries Overview & Discussion

Main Board

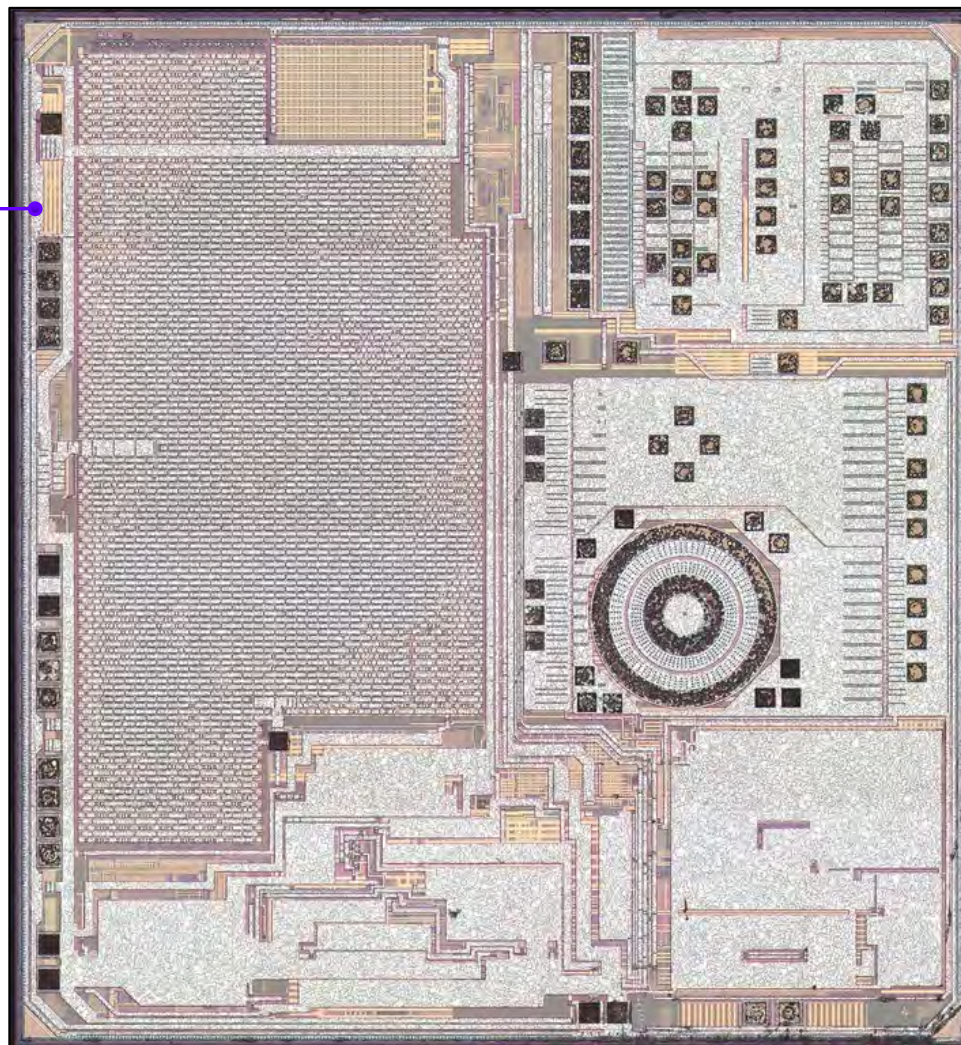
Side 1 X-Rays and Die Photos

11 - Cirrus Logic
#CS35L41B
Class-D Audio Amplifier
Pkg Size: 2.46 x 2.27 mm

11.1 - Cirrus Logic
#CLI1755B2
Class-D Audio Amplifier
Die Size: 2.46 x 2.27 mm

Function:

Power Management/Audio



Assembly IC Identification Radio ICs Sensors X-Rays & Die Photos

Side 1 Side 2 Cross Section

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Main Board

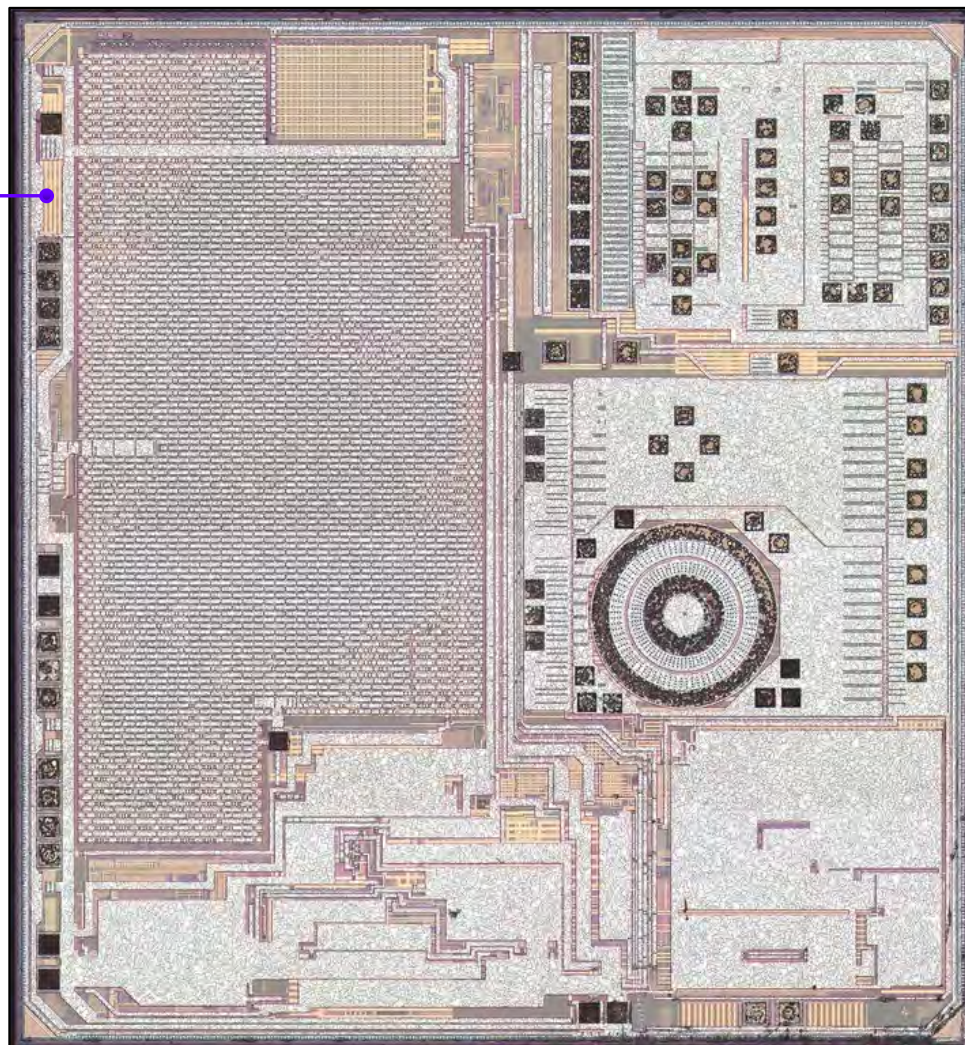
Side 1 X-Rays and Die Photos

12 - Cirrus Logic
#CS35L41B
Class-D Audio Amplifier
Pkg Size: 2.46 x 2.26 mm

12.1 - Cirrus Logic
#CL11755B2
Class-D Audio Amplifier
Die Size: 2.46 x 2.26 mm

Function:

Power Management/Audio



Assembly IC Identification Radio ICs Sensors X-Rays & Die Photos

Side 1 Side 2 Cross Section

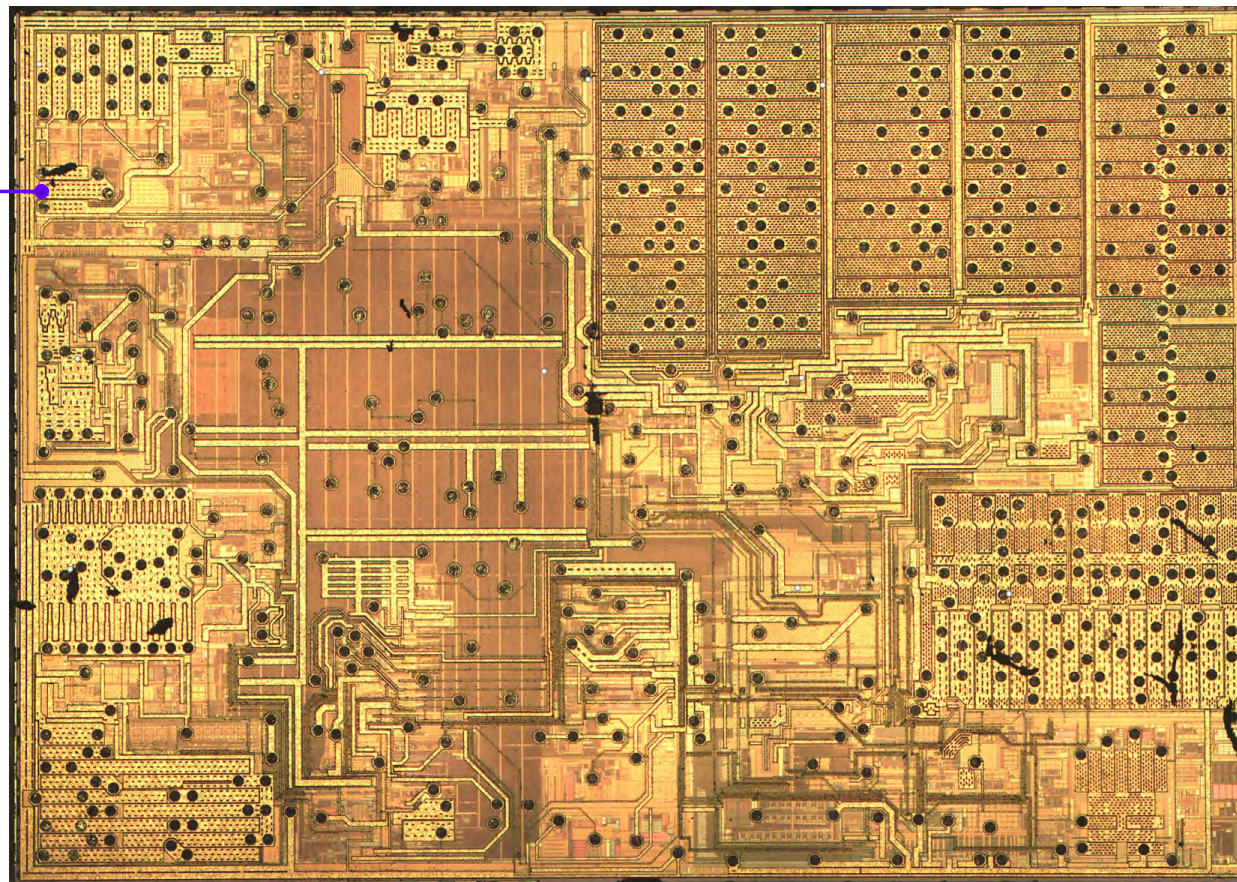
Front Page Device Analysis Product Labels Supporting Materials Block Diagram Features Components Teardown Antennas Component Function Guide Subsystems Main Board Other Substrates Summaries Overview & Discussion

Main Board

Side 1 X-Rays and Die Photos

17 - Qualcomm
#PM8350B-001
Power Management
Pkg Size: 6.25 x 4.44 mm

17.1 - Qualcomm
#HG11-PP475-200
Power Management
Die Size: 6.03 x 4.26 mm



Function:

Power Management/Audio

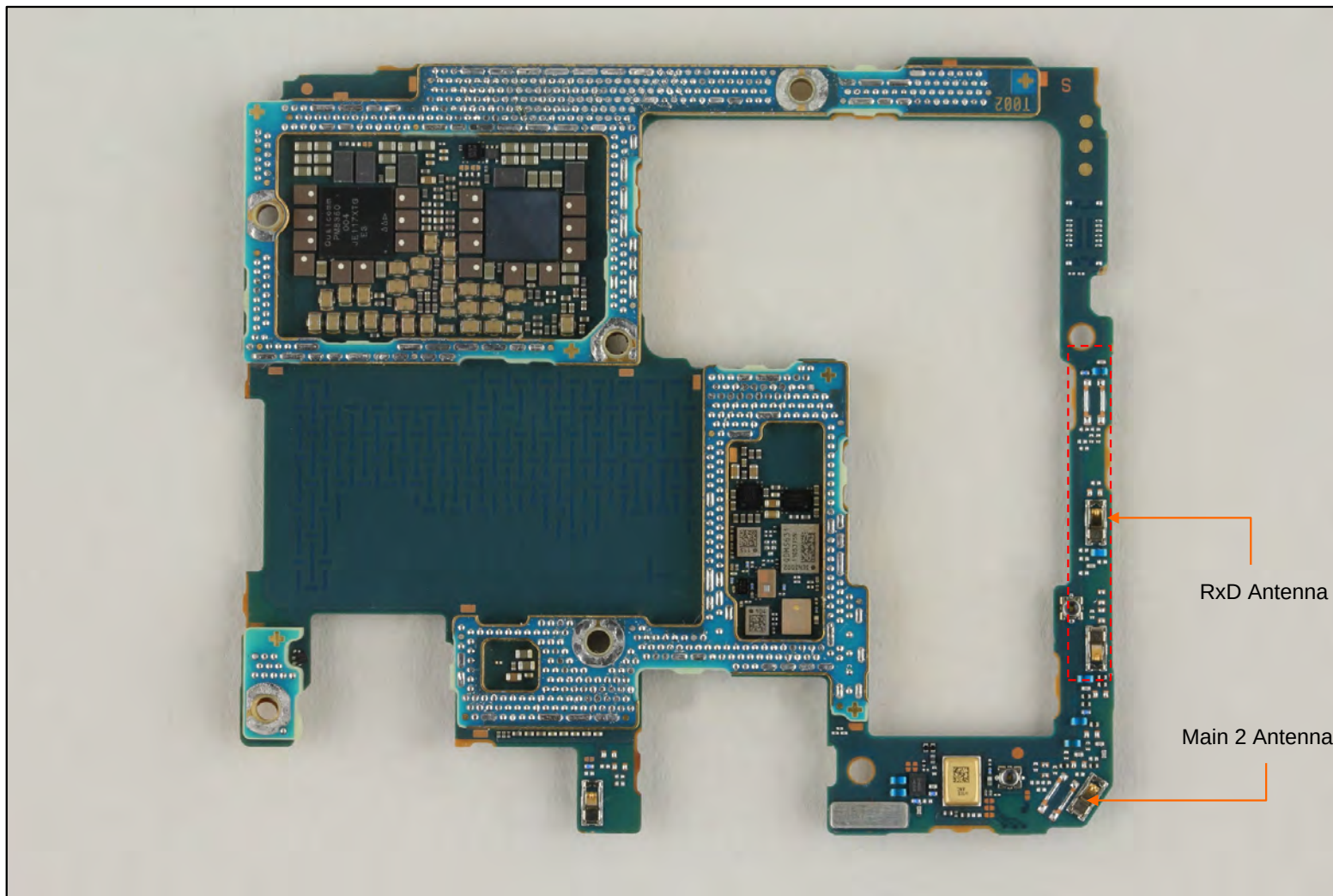
Assembly IC Identification Radio ICs Sensors X-Rays & Die Photos

Side 1 Side 2 Cross Section

Front Page Device Analysis Product Labels Supporting Materials Block Diagram Features Components Teardown Antennas Component Function Guide Subsystems Main Board Other Substrates Summaries Overview & Discussion

Main Board

Side 2



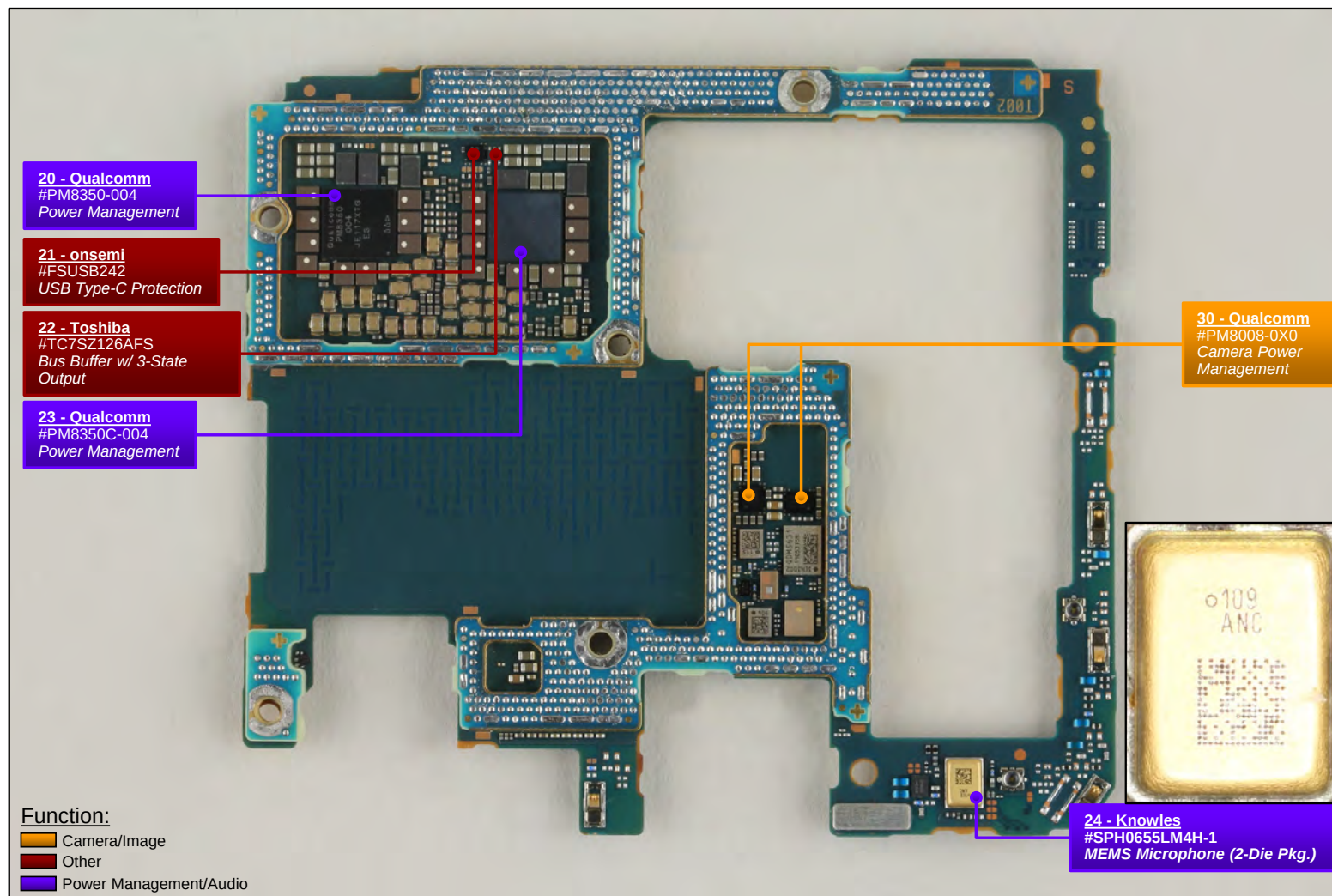
Assembly IC Identification Radio ICs Sensors X-Rays & Die Photos Radio Modules

Side 1 Side 2 Cross Section

Front Page Device Analysis Product Labels Supporting Materials Block Diagram Features Components Teardown Antennas Component Function Guide Subsystems Main Board Other Substrates Summaries Overview & Discussion

Main Board

Side 2 IC Identification



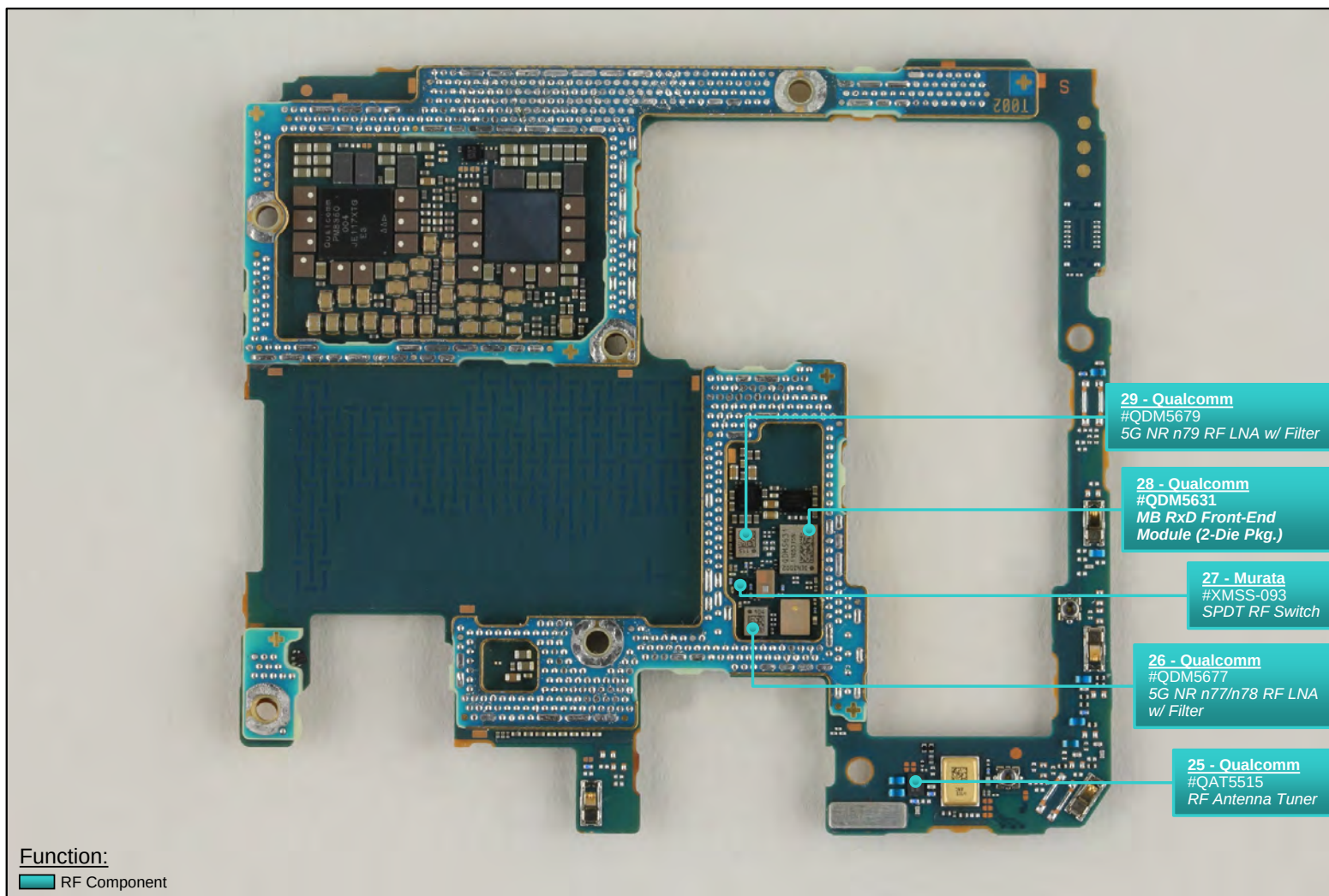
Assembly IC Identification Radio ICs Sensors X-Rays & Die Photos Radio Modules

Side 1 Side 2 Cross Section

Front Page Device Analysis Product Labels Supporting Materials Block Diagram Features Components Teardown Antennas Component Function Guide Subsystems Main Board Other Substrates Summaries Overview & Discussion

Main Board

Side 2 ICs – Radio



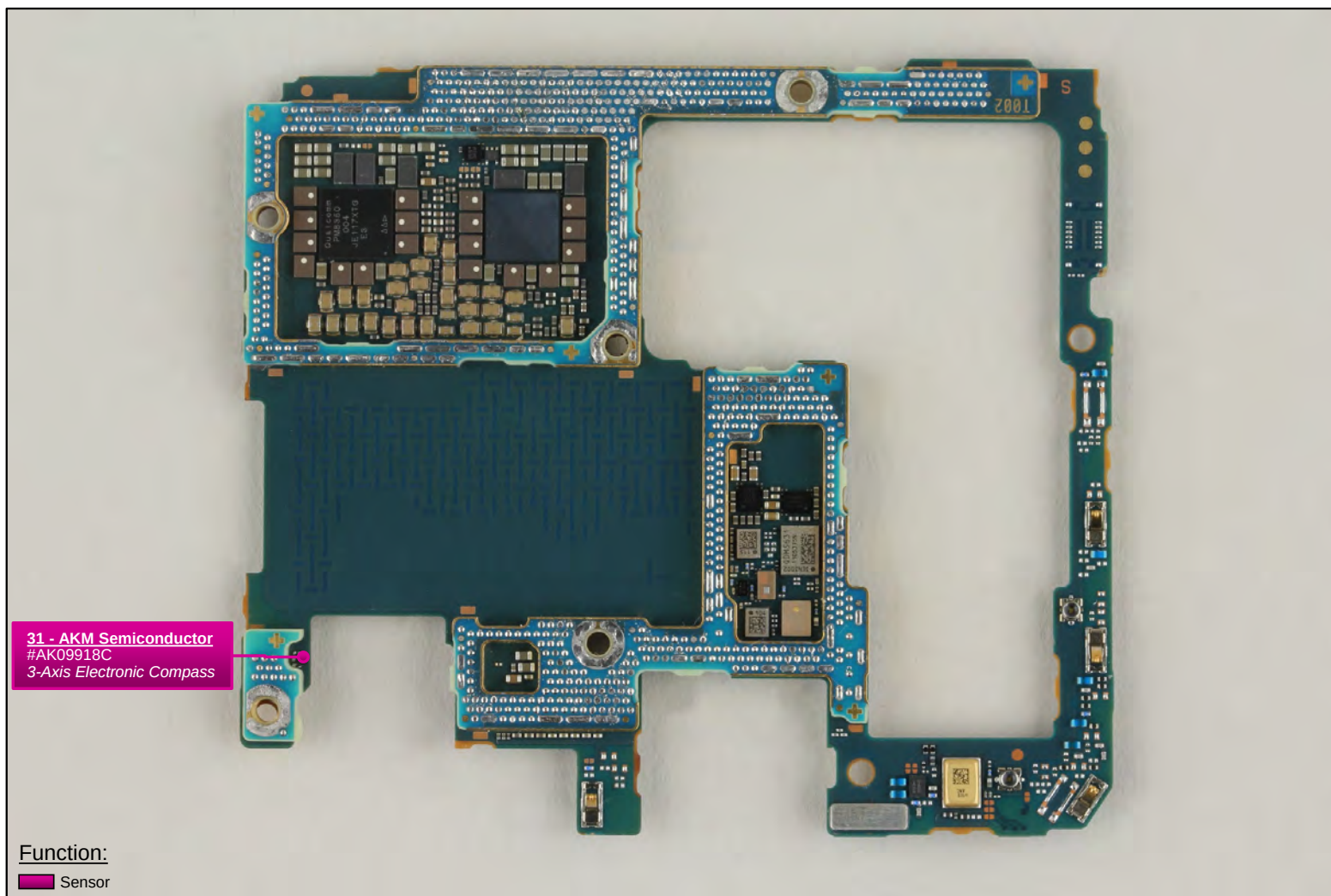
Assembly IC Identification Radio ICs Sensors X-Rays & Die Photos Radio Modules

Side 1 Side 2 Cross Section

Front Page Device Analysis Product Labels Supporting Materials Block Diagram Features Components Teardown Antennas Component Function Guide Subsystems Main Board Other Substrates Summaries Overview & Discussion

Main Board

Side 2 ICs – Sensors



Assembly IC Identification Radio ICs Sensors X-Rays & Die Photos Radio Modules

Side 1 Side 2 Cross Section

Front Page Device Analysis Product Labels Supporting Materials Block Diagram Features Components Teardown Antennas Component Function Guide Subsystems Main Board Other Substrates Summaries Overview & Discussion

Main Board

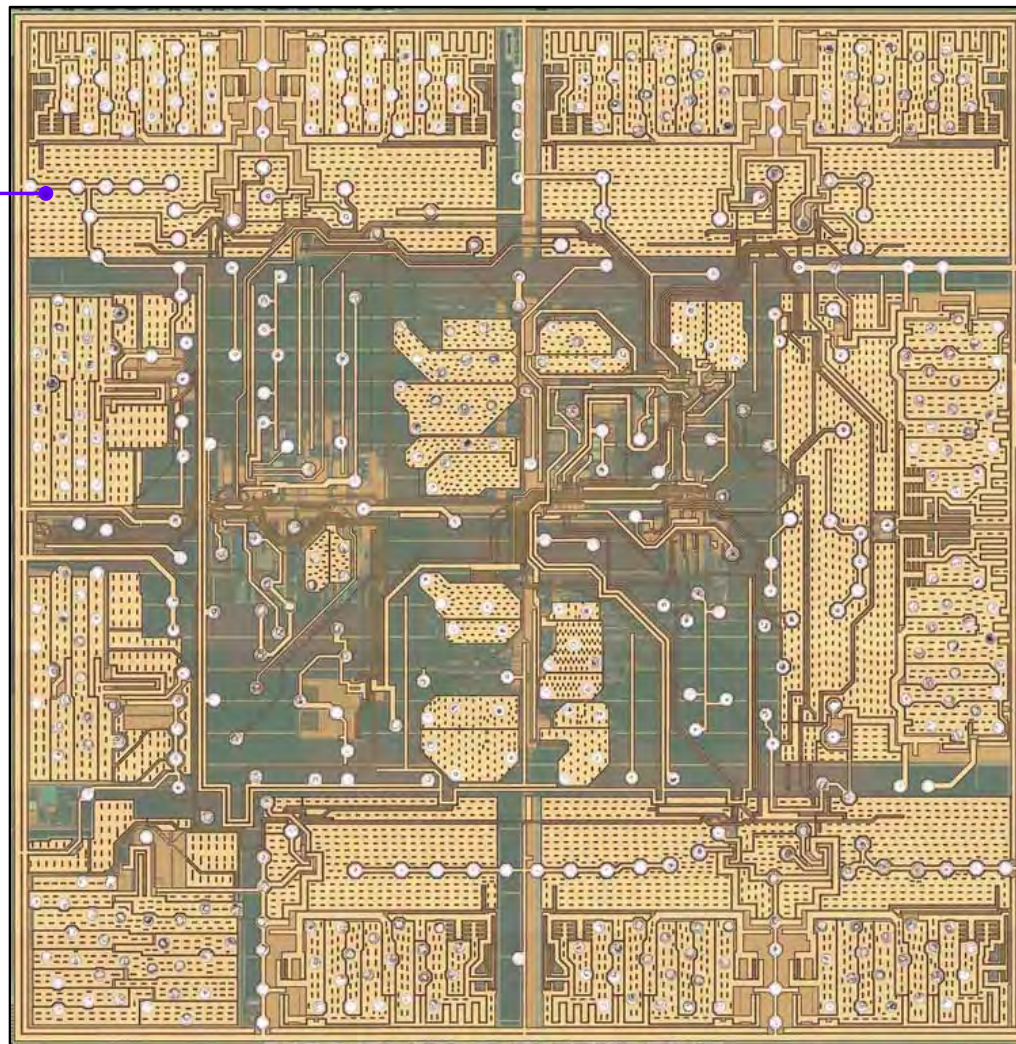
Side 2 X-Rays and Die Photos

20 - Qualcomm
#PM8350-004
Power Management
Pkg Size: 5.09 x 5.01 mm

20.1 - Qualcomm
#HG11-PP173-210
Power Management
Die Size: 4.89 x 4.78 mm

Function:

Power Management/Audio



Assembly IC Identification Radio ICs Sensors X-Rays & Die Photos Radio Modules

Side 1 Side 2 Cross Section

Front Page Device Analysis Product Labels Supporting Materials Block Diagram Features Components Teardown Antennas Component Function Guide Subsystems Main Board Other Substrates Summaries Overview & Discussion

Main Board

Side 2 X-Rays and Die Photos

23 - Qualcomm
#PM8350C-004
Power Management
Pkg Size: 5.17 x 4.85 mm

23.1 - Qualcomm
#HG11-PP455-210
Power Management
Die Size: 4.95 x 4.6 mm



Function:

Power Management/Audio

Assembly IC Identification Radio ICs Sensors X-Rays & Die Photos Radio Modules

Side 1 Side 2 Cross Section

Front Page Device Analysis Product Labels Supporting Materials Block Diagram Features Components Teardown Antennas Component Function Guide Subsystems Main Board Other Substrates Summaries Overview & Discussion

Main Board

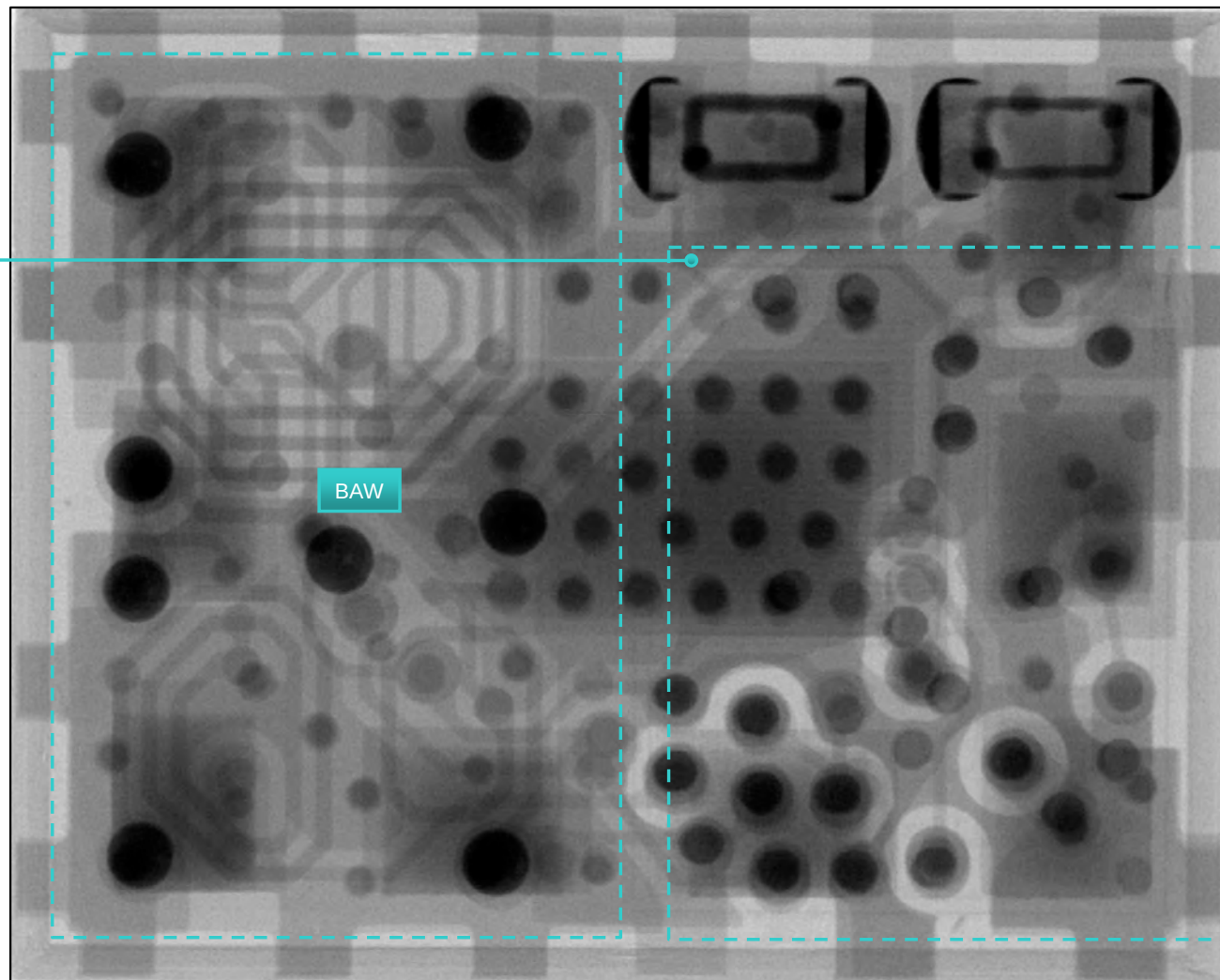
Side 2 X-Rays and Die Photos

26 - Qualcomm
#QDM5677
5G NR n77/n78 RF LNA w/ Filter
Pkg Size: 2 x 1.6 mm

26.1 - Qualcomm
#HG11-PL421-100
5G NR n77/n78 RF LNA
Die Size: 1.15 x 0.92 mm

BAW

Function:
RF Component



Assembly IC Identification Radio ICs Sensors X-Rays & Die Photos Radio Modules

Side 1 Side 2 Cross Section

Front Page Device Analysis Product Labels Supporting Materials Block Diagram Features Components Teardown Antennas Component Function Guide Subsystems Main Board Other Substrates Summaries Overview & Discussion

Main Board

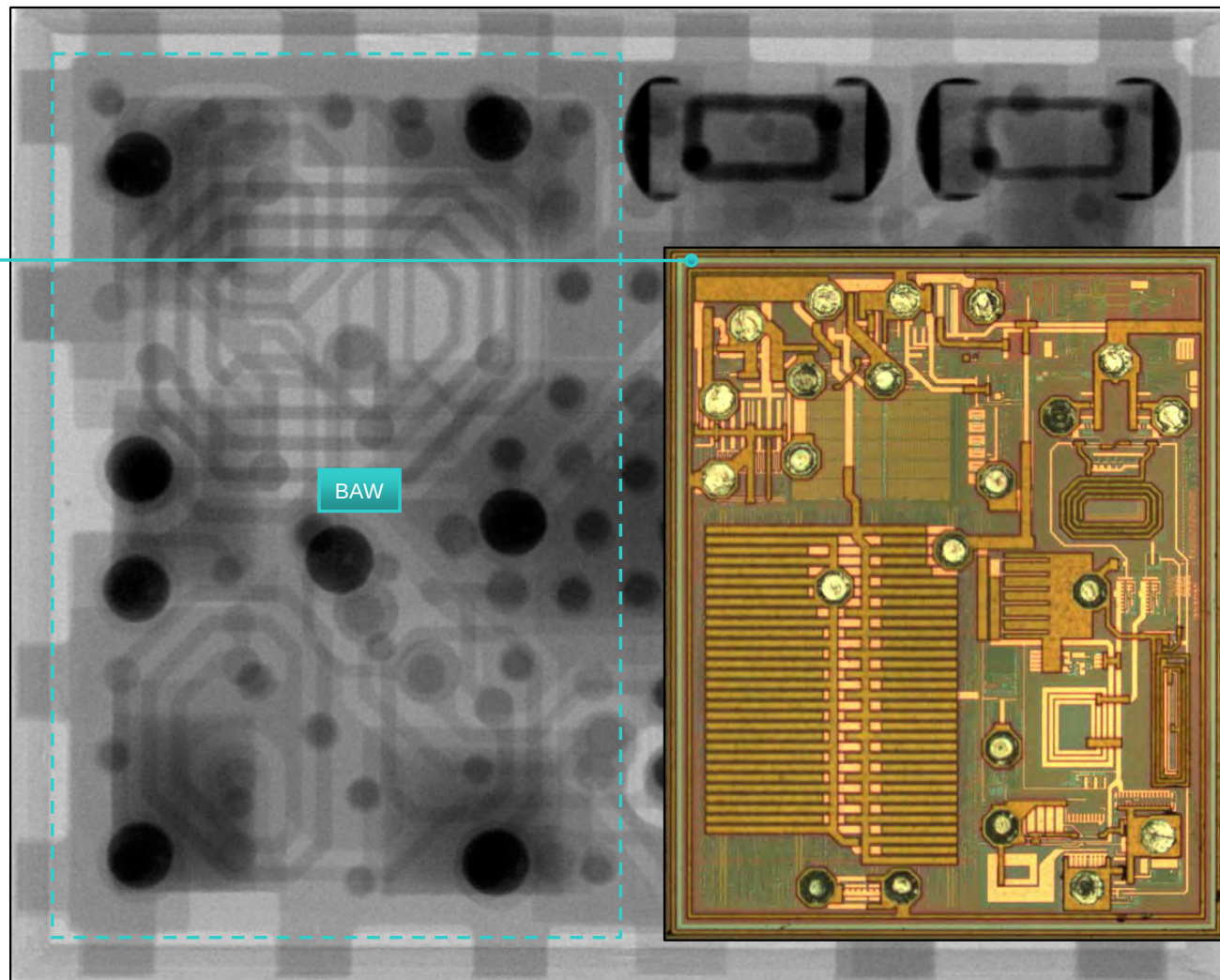
Side 2 X-Rays and Die Photos

26 - Qualcomm
#QDM5677
5G NR n77/n78 RF LNA w/ Filter
Pkg Size: 2 x 1.6 mm

26.1 - Qualcomm
#HG11-PL421-100
5G NR n77/n78 RF LNA
Die Size: 1.15 x 0.92 mm

BAW

Function:
RF Component



Assembly IC Identification Radio ICs Sensors X-Rays & Die Photos Radio Modules

Side 1 Side 2 Cross Section

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Main Board

Side 2 X-Rays and Die Photos

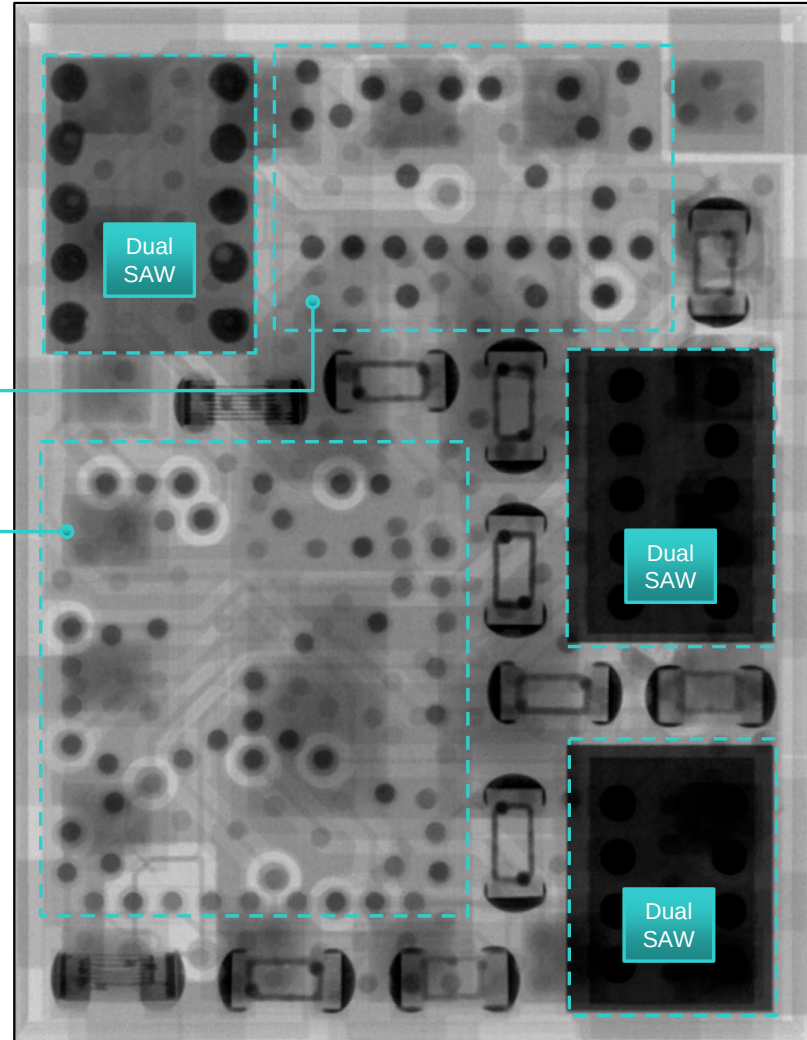
28 - Qualcomm
#QDM5631
MB Rx/D Front-End Module (2-Die Pkg.)
Pkg Size: 3.4 x 2.61 mm

28.1 - Qualcomm
#HG11-PM386_200
RF Switch
Die Size: 1.32 x 0.95 mm

28.2 - Qualcomm
#HG11-PJ018-200
RF LNA
Die Size: 1.55 x 1.41 mm

Function:

RF Component



Assembly IC Identification Radio ICs Sensors X-Rays & Die Photos Radio Modules

Side 1 Side 2 Cross Section

Front Page Device Analysis Product Labels Supporting Materials Block Diagram Features Components Teardown Antennas Component Function Guide Subsystems Main Board Other Substrates Summaries Overview & Discussion



Main Board

Side 2 X-Rays and Die Photos

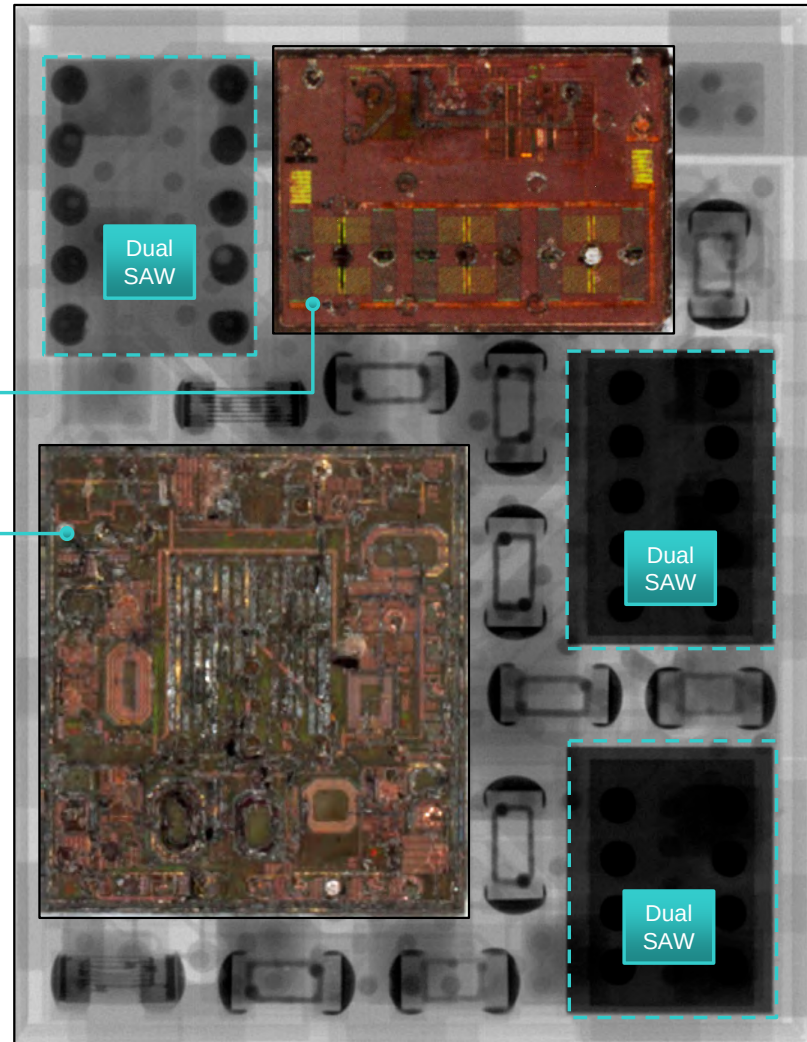
28 - Qualcomm
#QDM5631
MB Rx/D Front-End Module (2-Die Pkg.)
Pkg Size: 3.4 x 2.61 mm

28.1 - Qualcomm
#HG11-PM386_200
RF Switch
Die Size: 1.32 x 0.95 mm

28.2 - Qualcomm
#HG11-PJ018-200
RF LNA
Die Size: 1.55 x 1.41 mm

Function:

RF Component



Assembly IC Identification Radio ICs Sensors X-Rays & Die Photos Radio Modules

Side 1 Side 2 Cross Section

Front Page Device Analysis Product Labels Supporting Materials Block Diagram Features Components Teardown Antennas Component Function Guide Subsystems Main Board Other Substrates Summaries Overview & Discussion

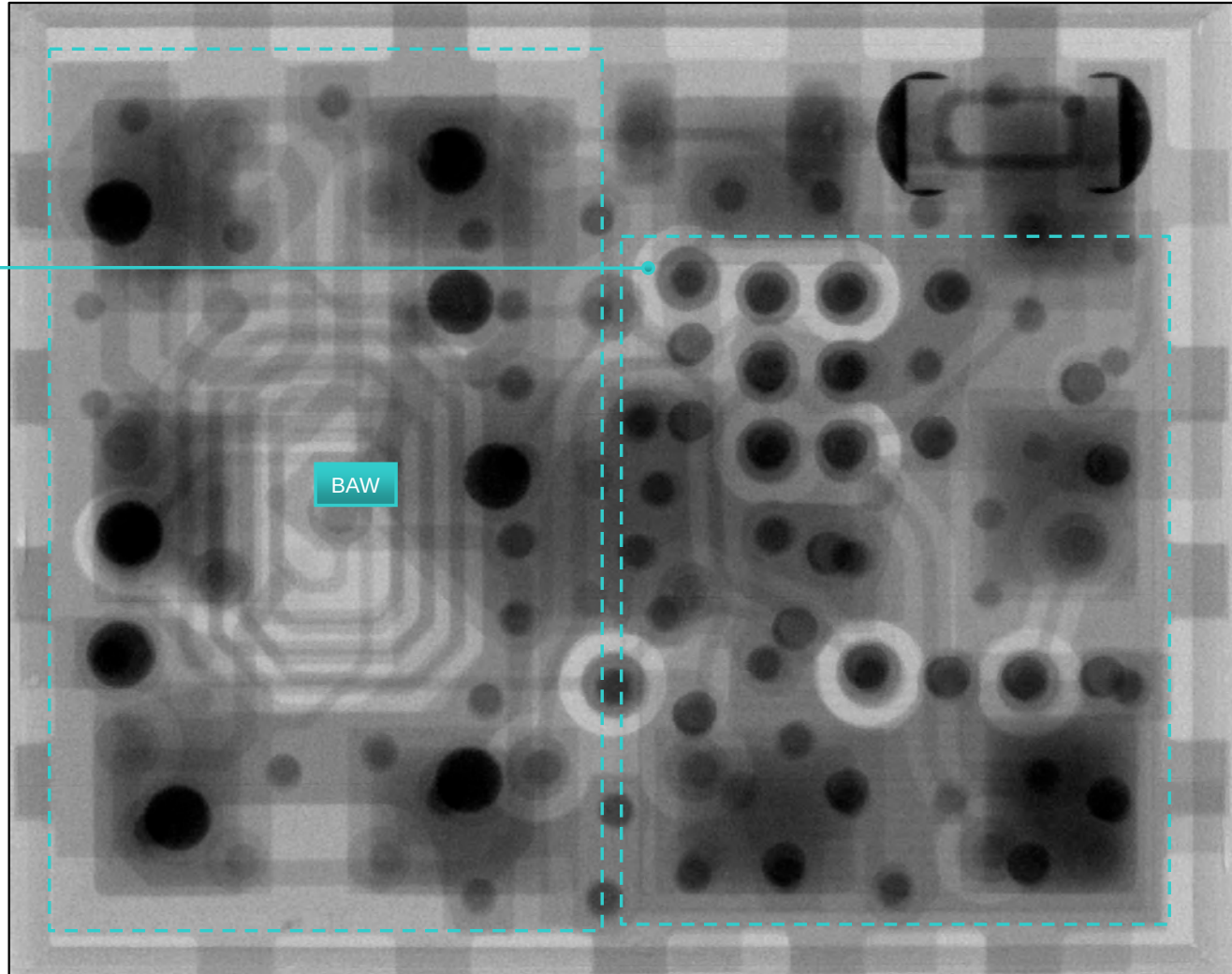


Main Board

Side 2 X-Rays and Die Photos

29 - Qualcomm
#QDM5679
5G NR n79 RF LNA w/ Filter
Pkg Size: 2.01 x 1.63 mm

29.1 - Qualcomm
#HG11-PL422-100
5G NR n79 RF LNA
Die Size: 1.14 x 0.91 mm



Function:
RF Component

Assembly IC Identification Radio ICs Sensors X-Rays & Die Photos Radio Modules

Side 1 Side 2 Cross Section

Front Page Device Analysis Product Labels Supporting Materials Block Diagram Features Components Teardown Antennas Component Function Guide Subsystems Main Board Other Substrates Summaries Overview & Discussion



Main Board

Side 2 X-Rays and Die Photos

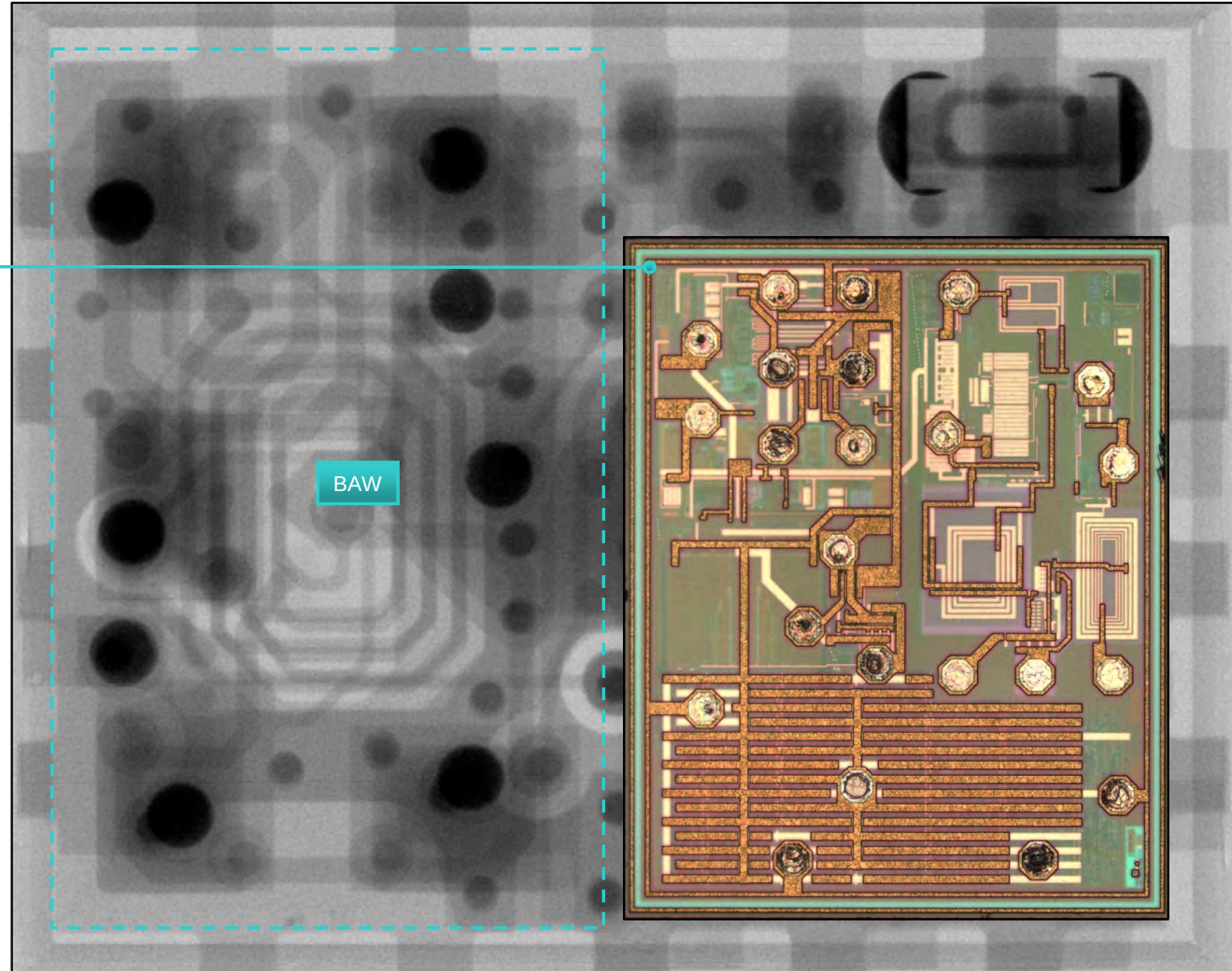
29 - Qualcomm
#QDM5679
5G NR n79 RF LNA w/ Filter
Pkg Size: 2.01 x 1.63 mm

29.1 - Qualcomm
#HG11-PL422-100
5G NR n79 RF LNA
Die Size: 1.14 x 0.91 mm

BAW

Function:

RF Component



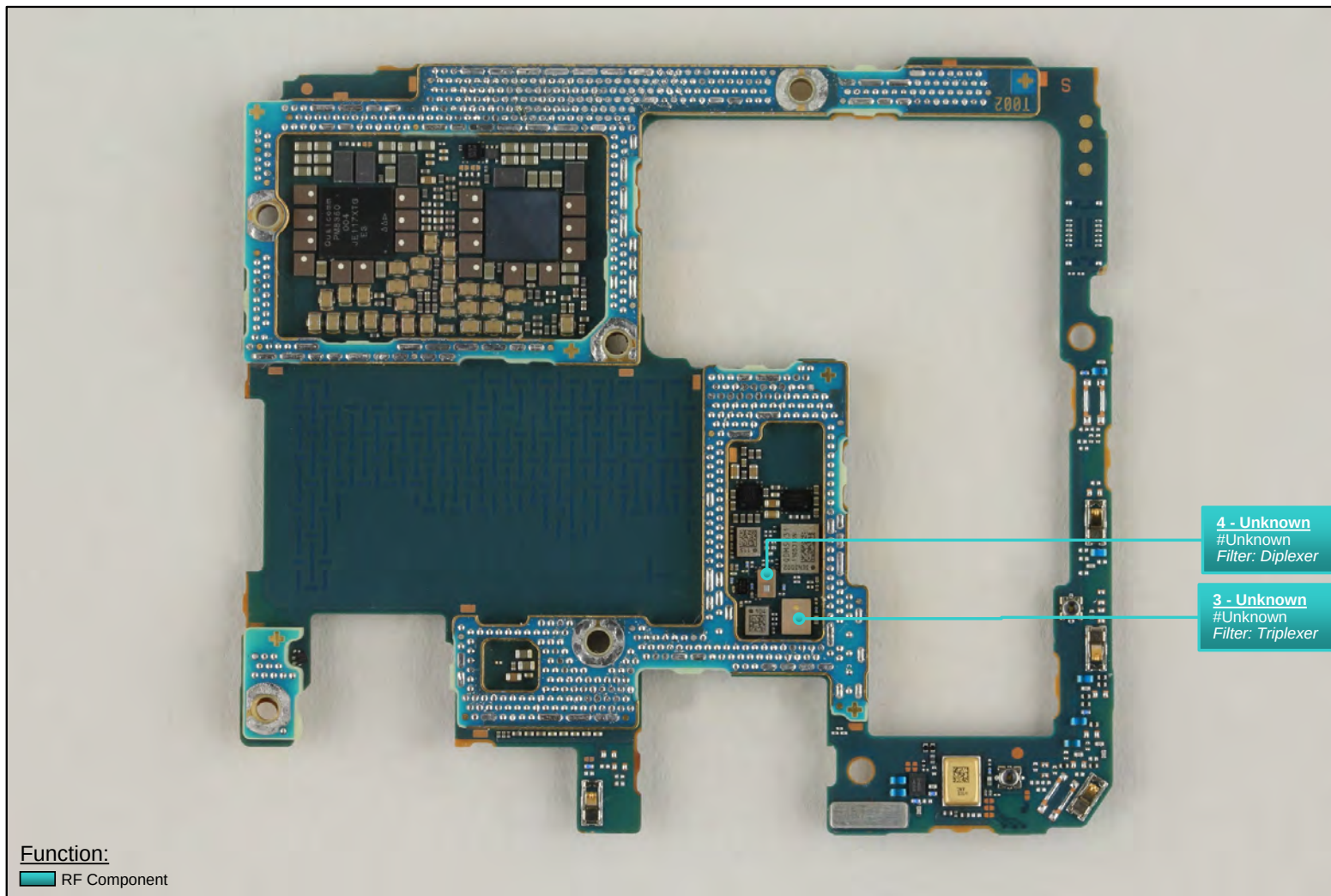
Assembly IC Identification Radio ICs Sensors X-Rays & Die Photos Radio Modules

Side 1 Side 2 Cross Section

Front Page Device Analysis Product Labels Supporting Materials Block Diagram Features Components Teardown Antennas Component Function Guide Subsystems Main Board Other Substrates Summaries Overview & Discussion

Main Board

Side 2 Modules – Radio



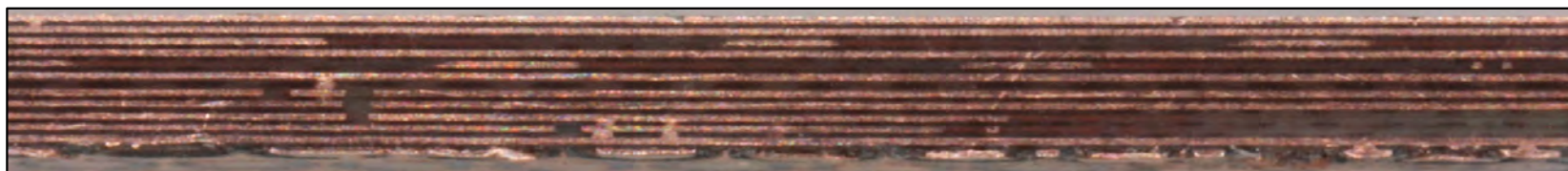
Assembly IC Identification Radio ICs Sensors X-Rays & Die Photos Radio Modules

Side 1 Side 2 Cross Section

Front Page Device Analysis Product Labels Supporting Materials Block Diagram Features Components Teardown Antennas Component Function Guide Subsystems Main Board Other Substrates Summaries Overview & Discussion

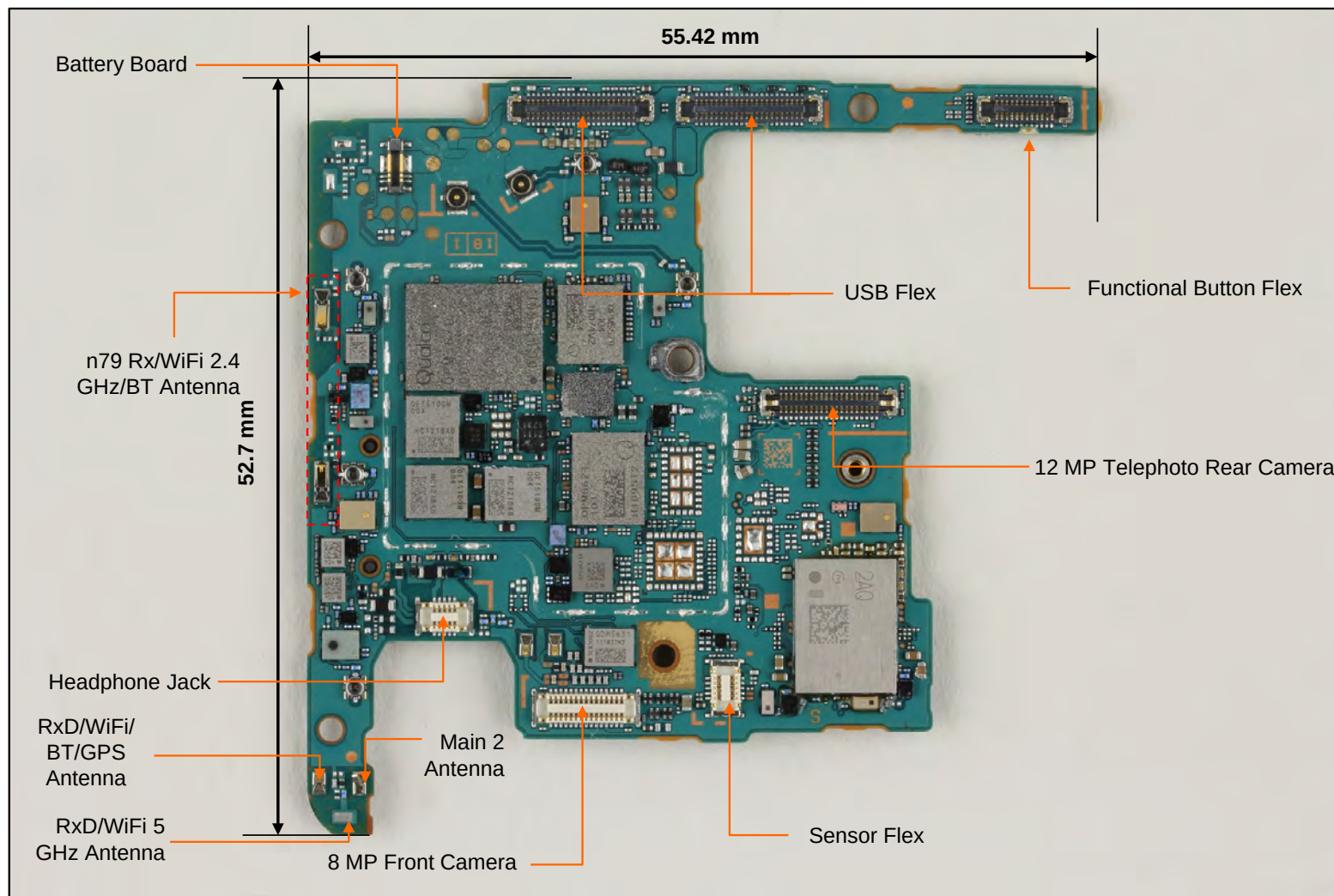
Main Board

Cross Section



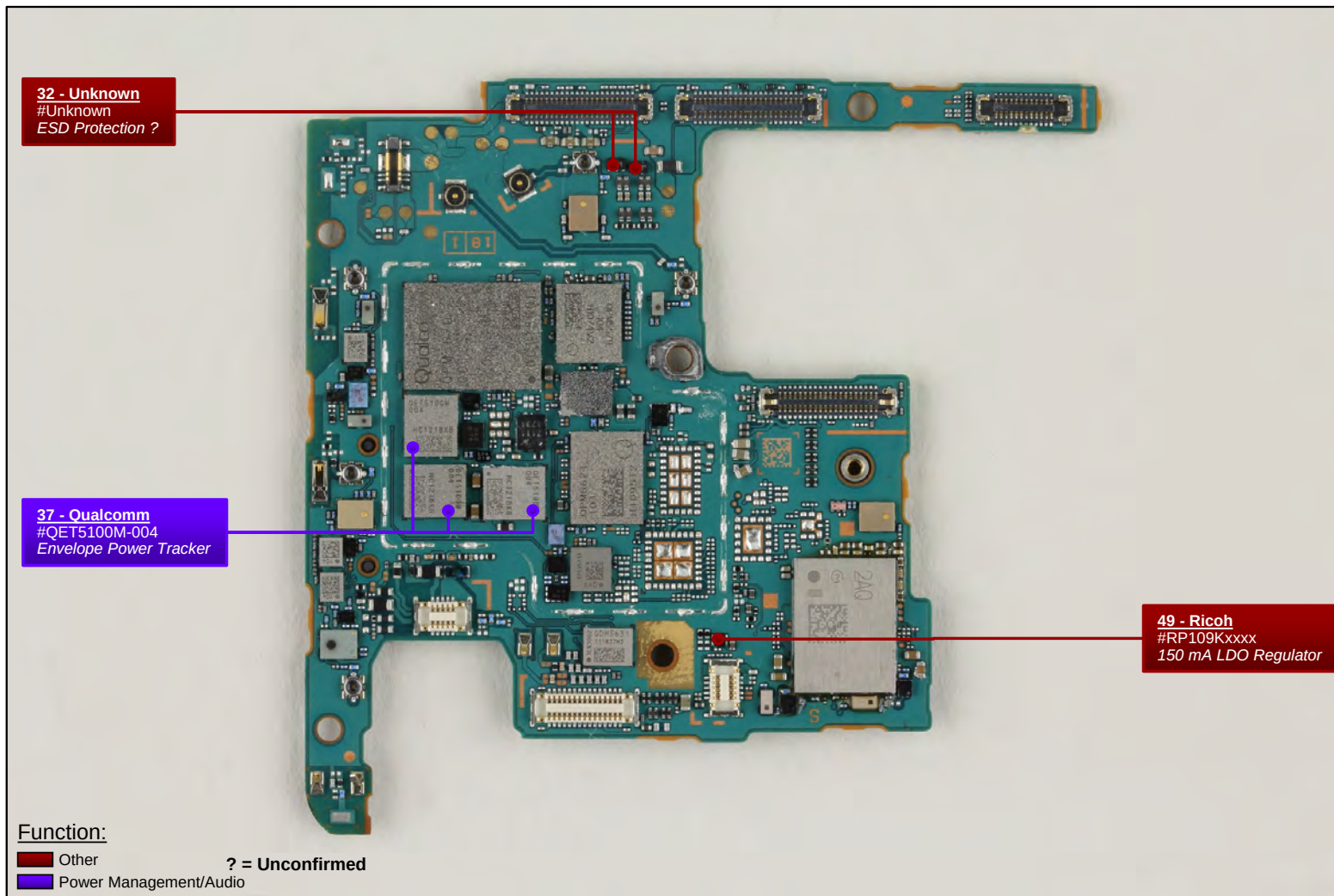
Other Substrates

RF Board – Side 1



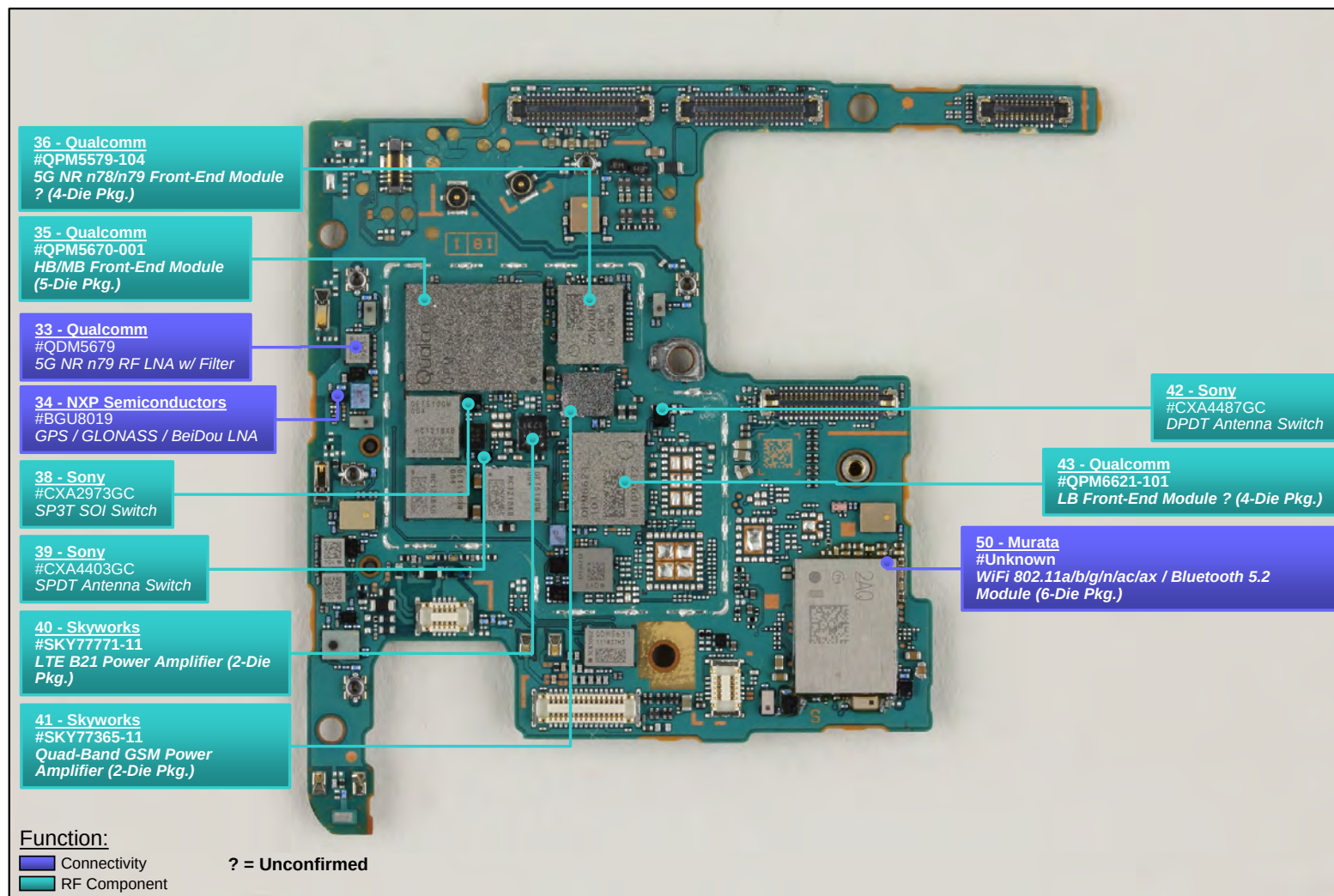
Other Substrates

RF Board – Side 1 IC Identification



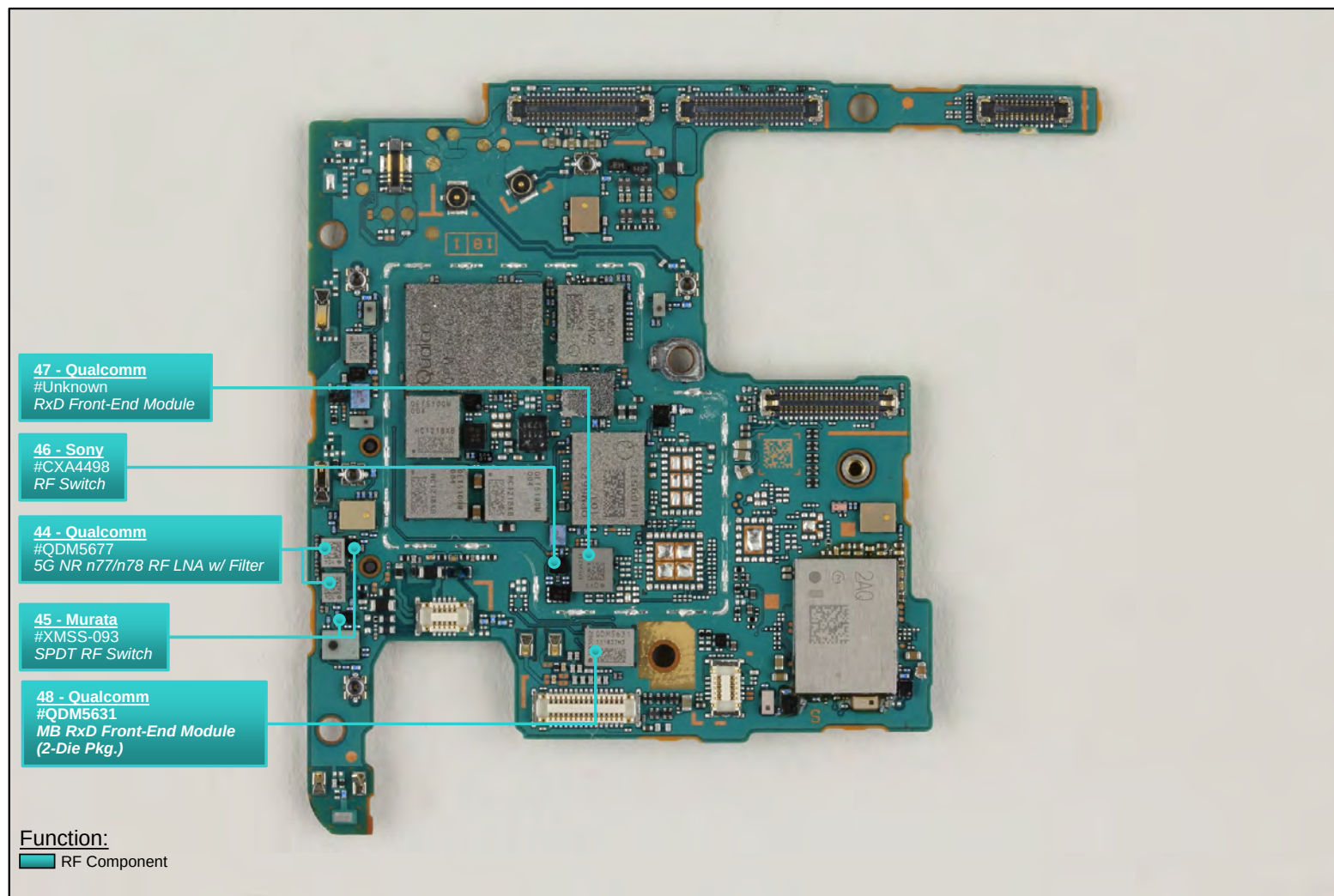
Other Substrates

RF Board – Side 1 IC Identification



Other Substrates

RF Board – Side 1 IC Identification

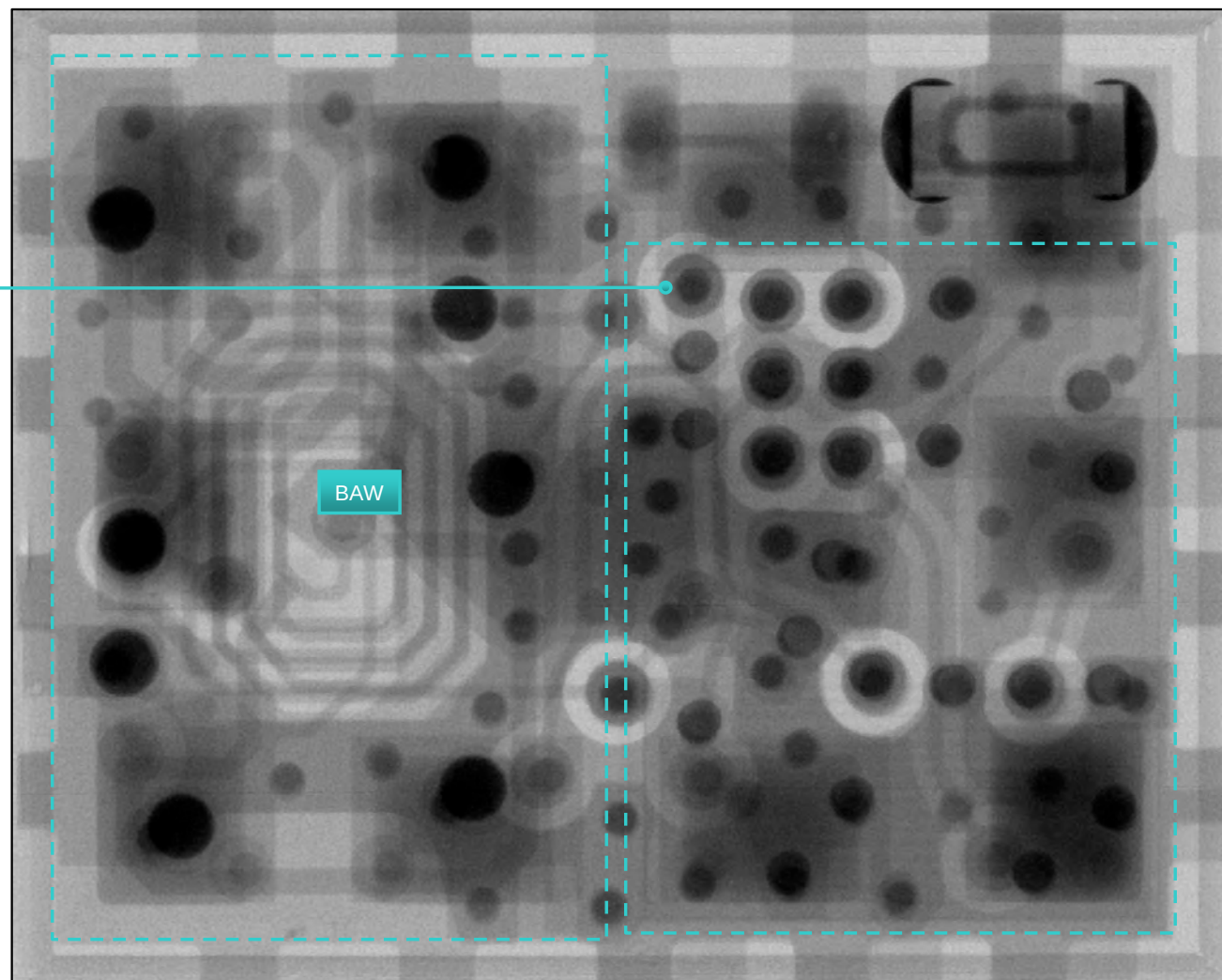


Other Substrates

RF Board – Side 1 X-Rays and Die Photos

33 - Qualcomm
#QDM5679
5G NR n79 RF LNA w/ Filter
Pkg Size: 2.01 x 1.61 mm

33.1 - Qualcomm
#HG11-PL422-100
5G NR n79 RF LNA
Die Size: 1.15 x 0.92 mm



Other Substrates

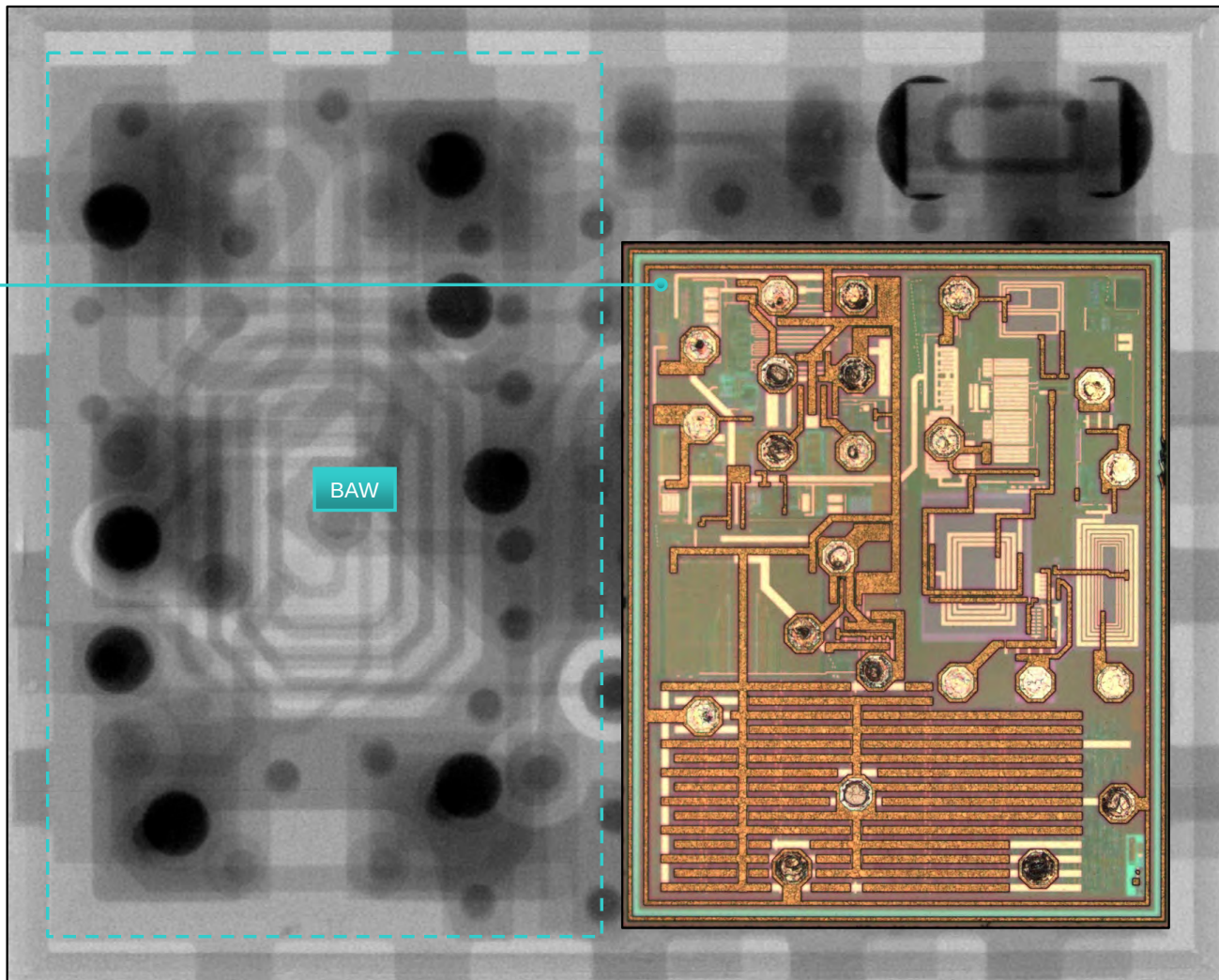
RF Board – Side 1 X-Rays and Die Photos

33 - Qualcomm
#QDM5679
5G NR n79 RF LNA w/ Filter
Pkg Size: 2.01 x 1.61 mm

33.1 - Qualcomm
#HG11-PL422-100
5G NR n79 RF LNA
Die Size: 1.15 x 0.92 mm

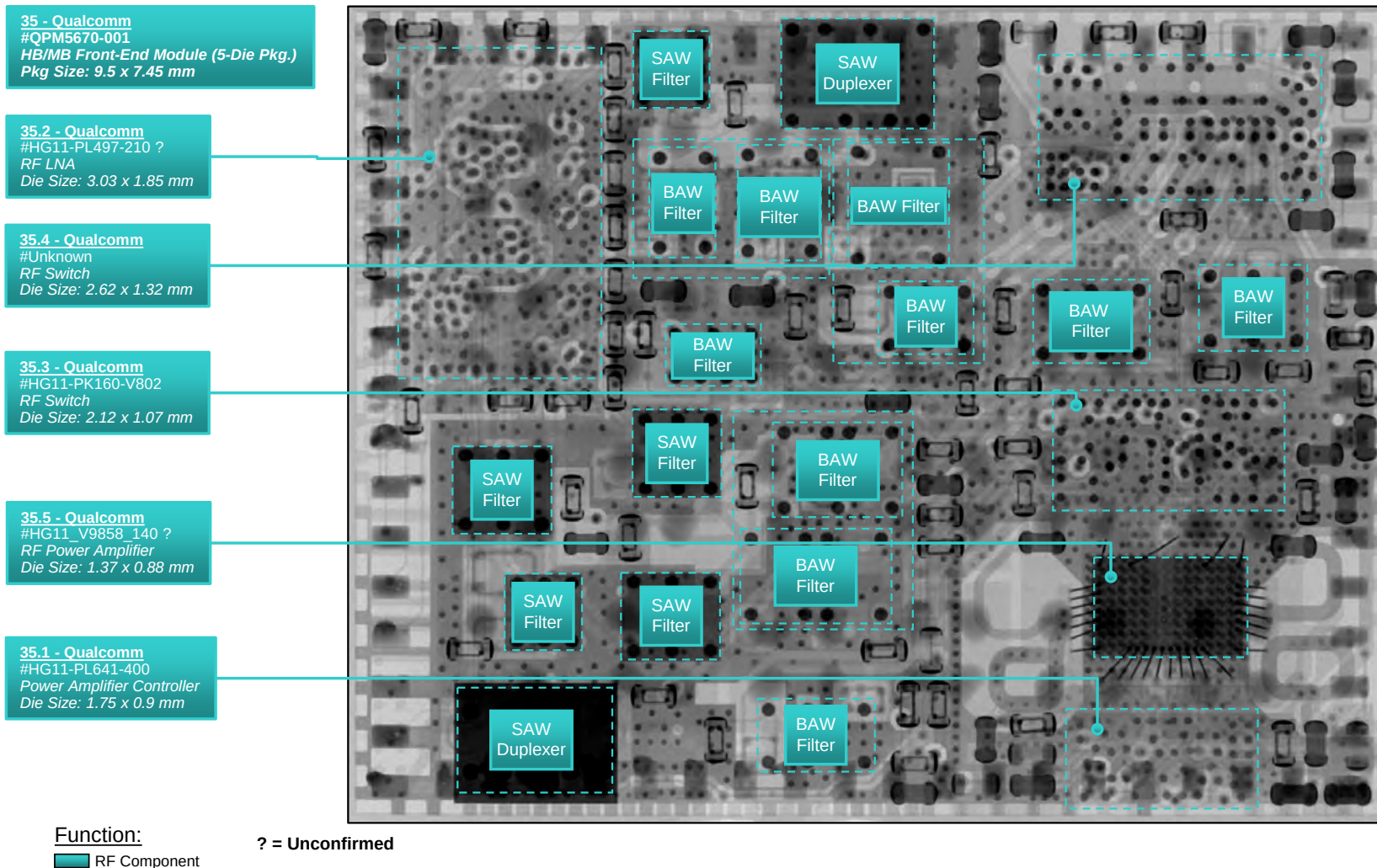
BAW

Function:
RF Component



Other Substrates

RF Board – Side 1 X-Rays and Die Photos



Other Substrates

RF Board – Side 1 X-Rays and Die Photos

35 - Qualcomm
#QPM5670-001
HB/MB Front-End Module (5-Die Pkg.)
Pkg Size: 9.5 x 7.45 mm

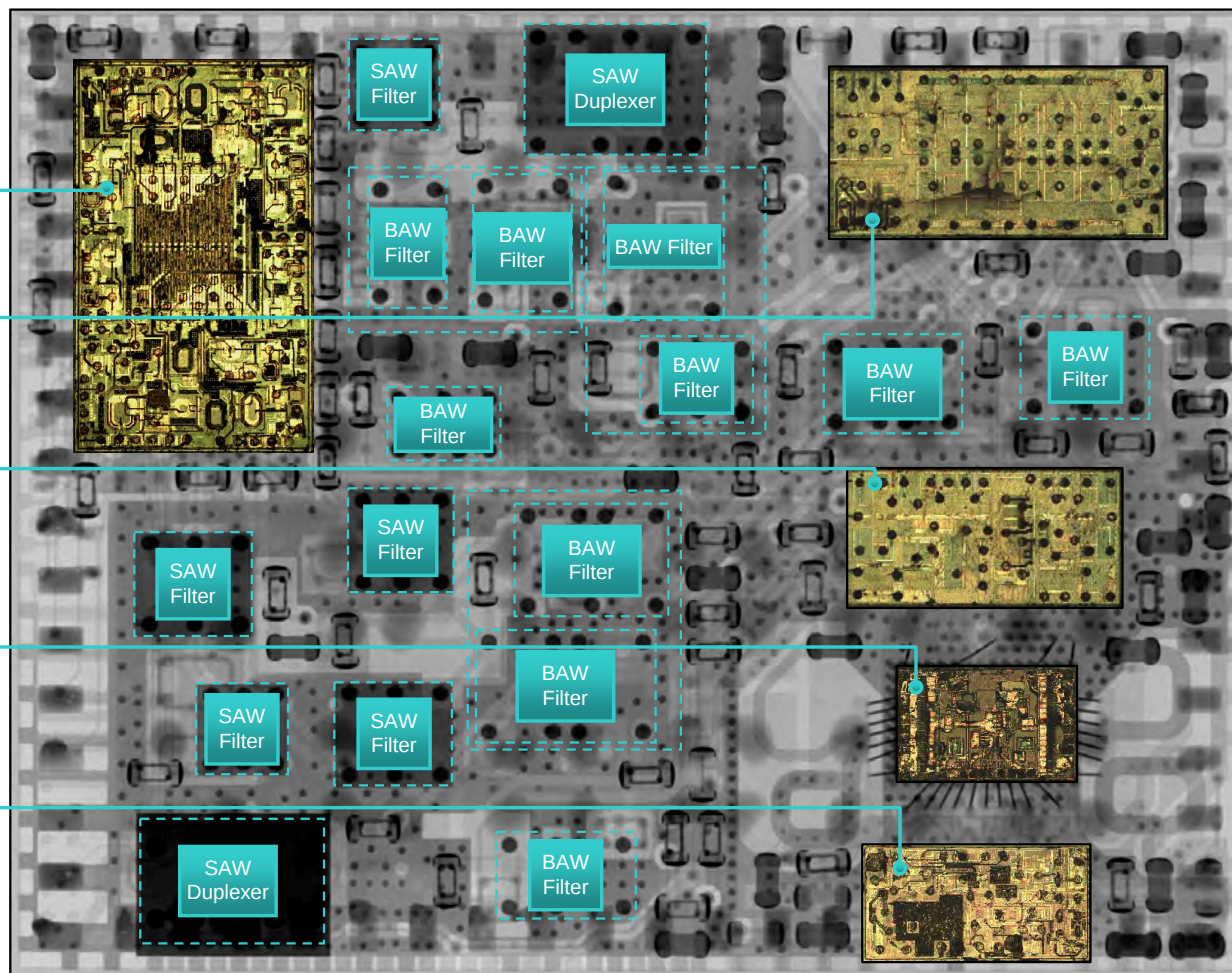
35.2 - Qualcomm
#HG11-PL497-210 ?
RF LNA
Die Size: 3.03 x 1.85 mm

35.4 - Qualcomm
#Unknown
RF Switch
Die Size: 2.62 x 1.32 mm

35.3 - Qualcomm
#HG11-PK160-V802
RF Switch
Die Size: 2.12 x 1.07 mm

35.5 - Qualcomm
#HG11_V9858_140 ?
RF Power Amplifier
Die Size: 1.37 x 0.88 mm

35.1 - Qualcomm
#HG11-PL641-400
Power Amplifier Controller
Die Size: 1.75 x 0.9 mm



Function:

RF Component

? = Unconfirmed

Other Substrates

RF Board – Side 1 X-Rays and Die Photos

36 - Qualcomm
#QPM5579-104
5G NR n78/n79 Front-End Module ?
(4-Die Pkg.)
Pkg Size: 5.56 x 4.52 mm

36.1 - Qualcomm
#LNA / RF Switch
HG11-PT131-110
Die Size: 2.3 x 1.69 mm

Band
Pass

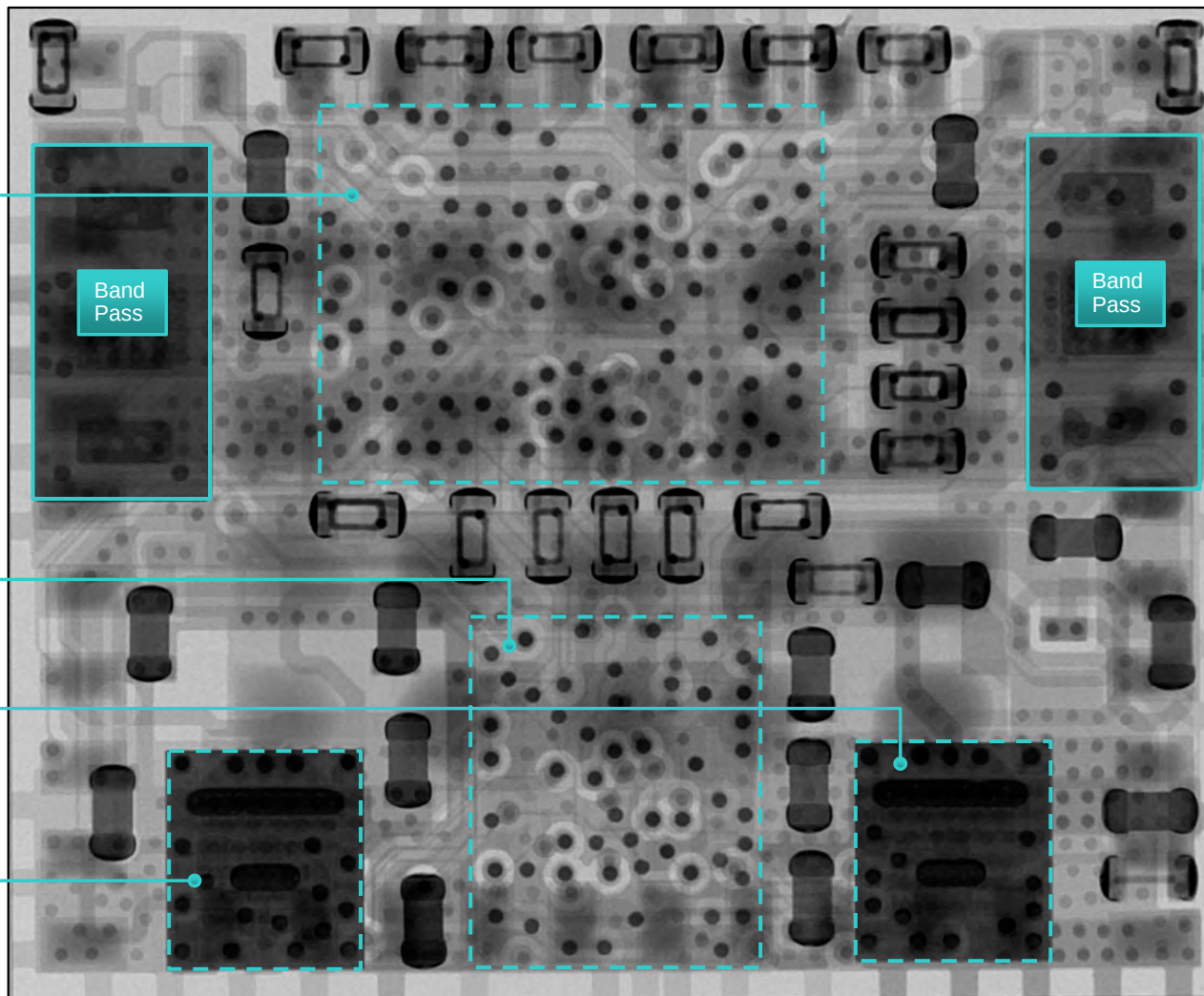
Band
Pass

36.2 - Qualcomm
#HG11-PT545-210
Power Amplifier Controller
Die Size: 1.66 x 1.35 mm

36.4 - Qualcomm
#HG11_PU460_142 ?
RF Power Amplifier
Die Size: 1 x 0.6 mm

36.3 - Qualcomm
#HG11_15852_700
RF Power Amplifier
Die Size: 0.96 x 0.86 mm

Function: ? = Unconfirmed
RF Component



Other Substrates

RF Board – Side 1 X-Rays and Die Photos

36 - Qualcomm
#QPM5579-104
5G NR n78/n79 Front-End Module ?
(4-Die Pkg.)
Pkg Size: 5.56 x 4.52 mm

36.1 - Qualcomm
#LNA / RF Switch
HG11-PT131-110
Die Size: 2.3 x 1.69 mm

Band
Pass

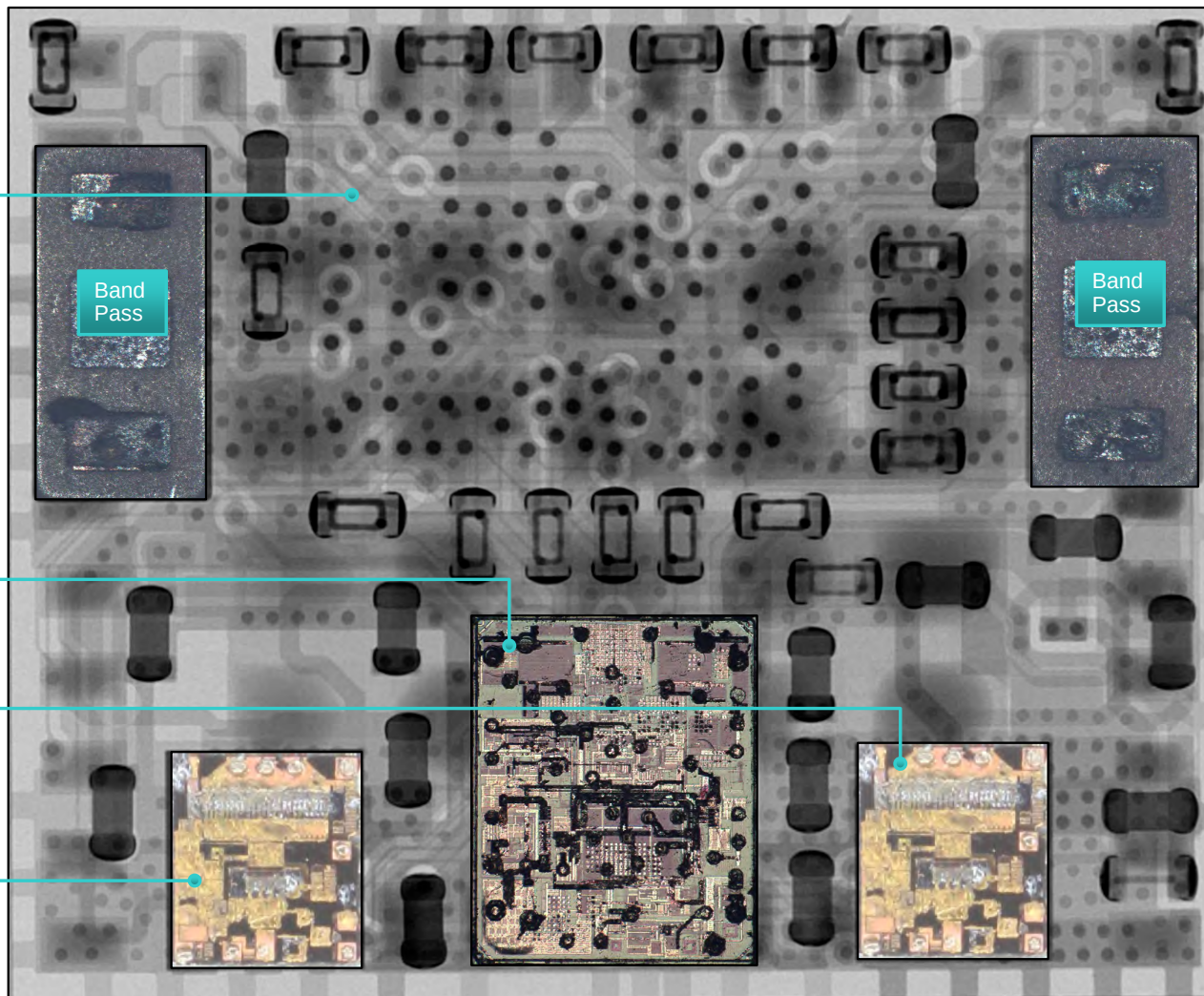
Band
Pass

36.2 - Qualcomm
#HG11-PT545-210
Power Amplifier Controller
Die Size: 1.66 x 1.35 mm

36.4 - Qualcomm
#HG11_PU460_142 ?
RF Power Amplifier
Die Size: 1 x 0.6 mm

36.3 - Qualcomm
#HG11_15852_700
RF Power Amplifier
Die Size: 0.96 x 0.86 mm

Function: ? = Unconfirmed
RF Component

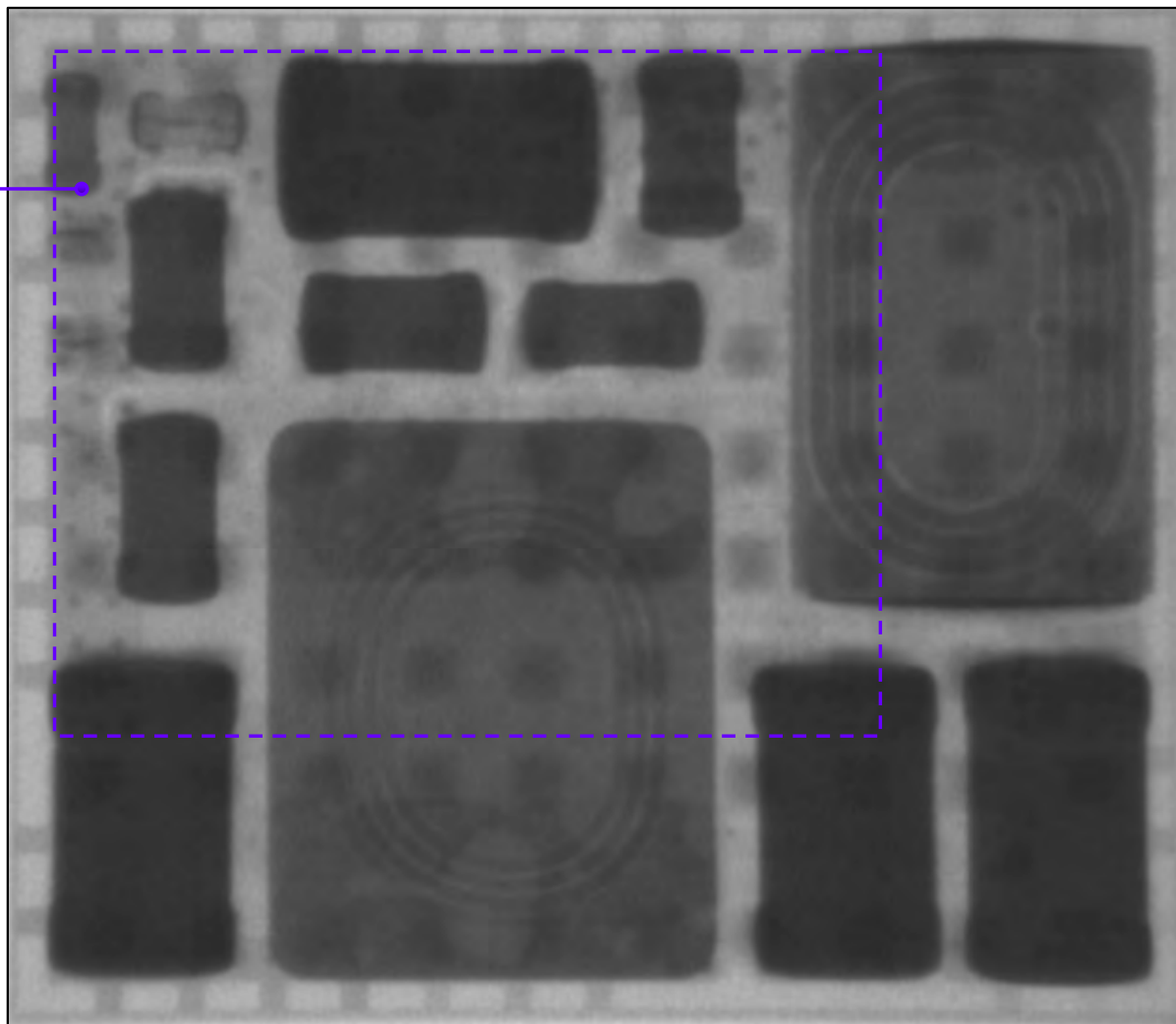


Other Substrates

RF Board – Side 1 X-Rays and Die Photos

37 - Qualcomm
#QET5100M-004
Envelope Power Tracker
Pkg Size: 4.28 x 3.68 mm

37.1 - Qualcomm
#HG11-P7850-220
Envelope Power Tracker
Die Size: 2.91 x 2.43 mm



Function:

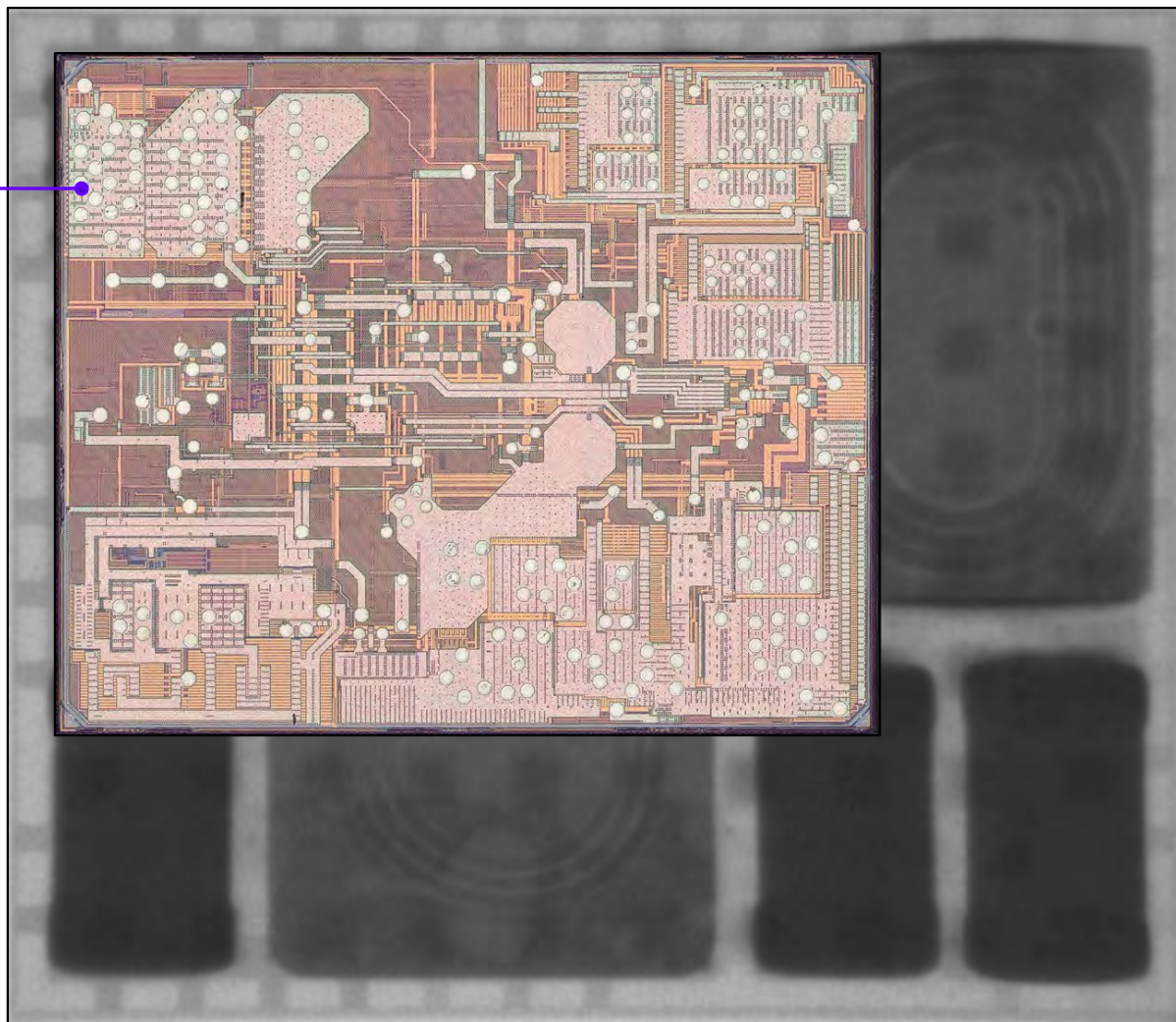
Power Management/Audio

Other Substrates

RF Board – Side 1 X-Rays and Die Photos

37 - Qualcomm
#QET5100M-004
Envelope Power Tracker
Pkg Size: 4.28 x 3.68 mm

37.1 - Qualcomm
#HG11-P7850-220
Envelope Power Tracker
Die Size: 2.91 x 2.43 mm



Function:

Power Management/Audio

Other Substrates

RF Board – Side 1 X-Rays and Die Photos

40 - Skyworks
#SKY77771-11
LTE B21 Power Amplifier (2-Die
Pkg.)
Pkg Size: 2.5 x 1.99 mm

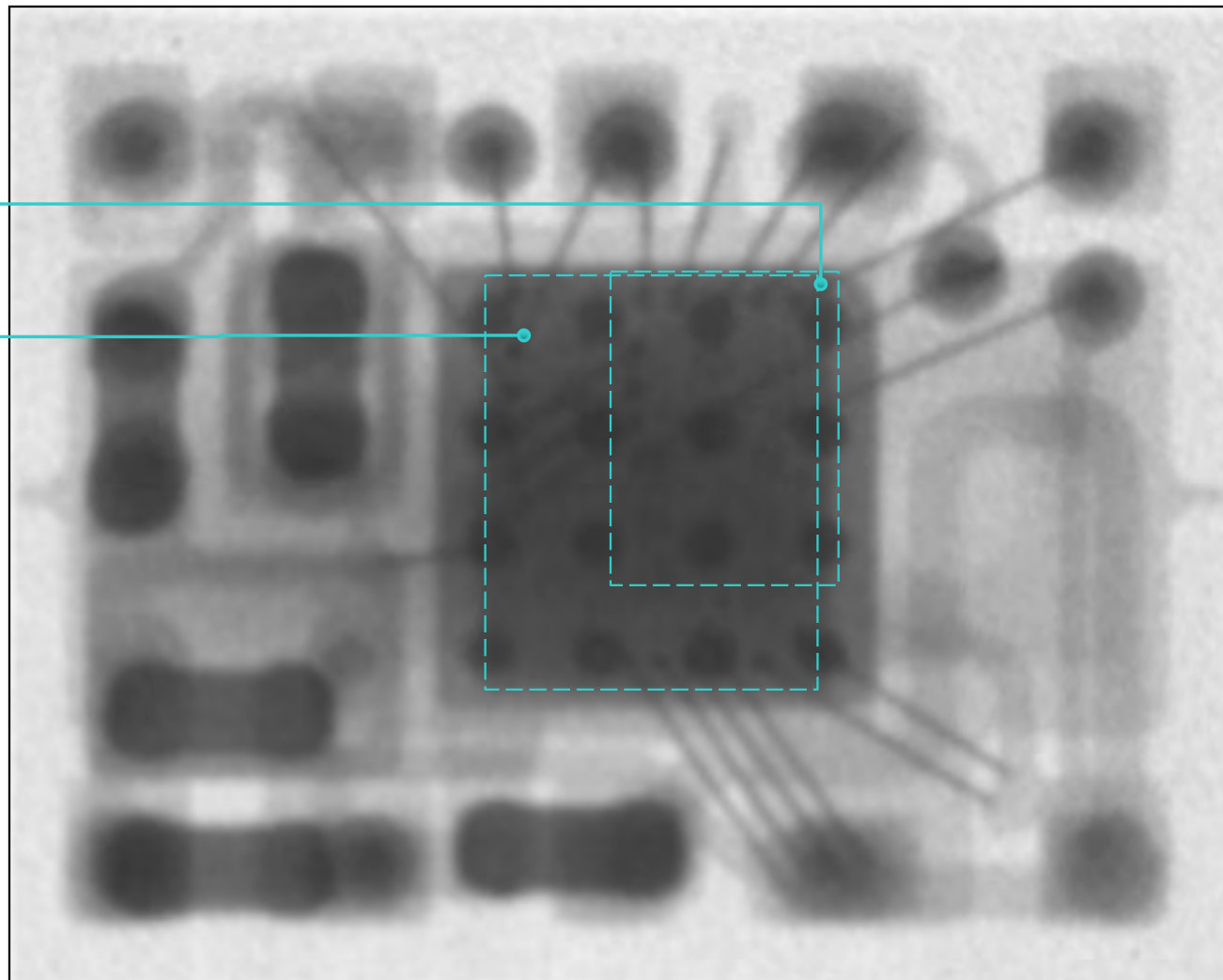
40.1 - Skyworks
#PK1021
Power Amplifier Controller
Die Size: 0.62 x 0.44 mm

40.2 - Skyworks
#ZG007_001 ?
RF Power Amplifier
Die Size: 0.84 x 0.69 mm

? = Unconfirmed

Function:

RF Component



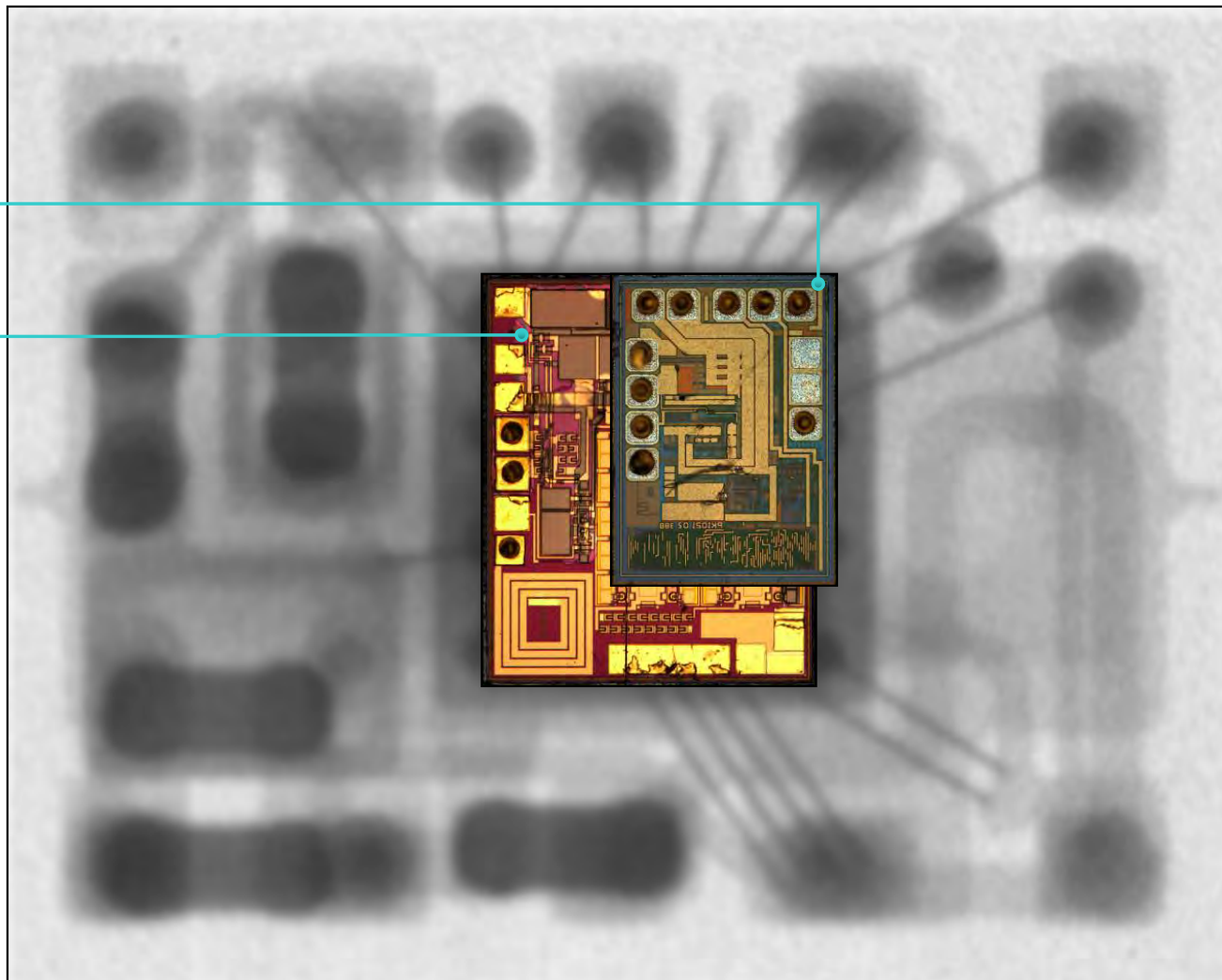
Other Substrates

RF Board – Side 1 X-Rays and Die Photos

40 - Skyworks
#SKY77771-11
LTE B21 Power Amplifier (2-Die
Pkg.)
Pkg Size: 2.5 x 1.99 mm

40.1 - Skyworks
#PK1021
Power Amplifier Controller
Die Size: 0.62 x 0.44 mm

40.2 - Skyworks
#ZG007_001 ?
RF Power Amplifier
Die Size: 0.84 x 0.69 mm



? = Unconfirmed

Function:

RF Component



Other Substrates

RF Board – Side 1 X-Rays and Die Photos

41 - Skyworks
#SKY77365-11
Quad-Band GSM Power Amplifier
(2-Die Pkg.)
Pkg Size: 3.51 x 3.01 mm

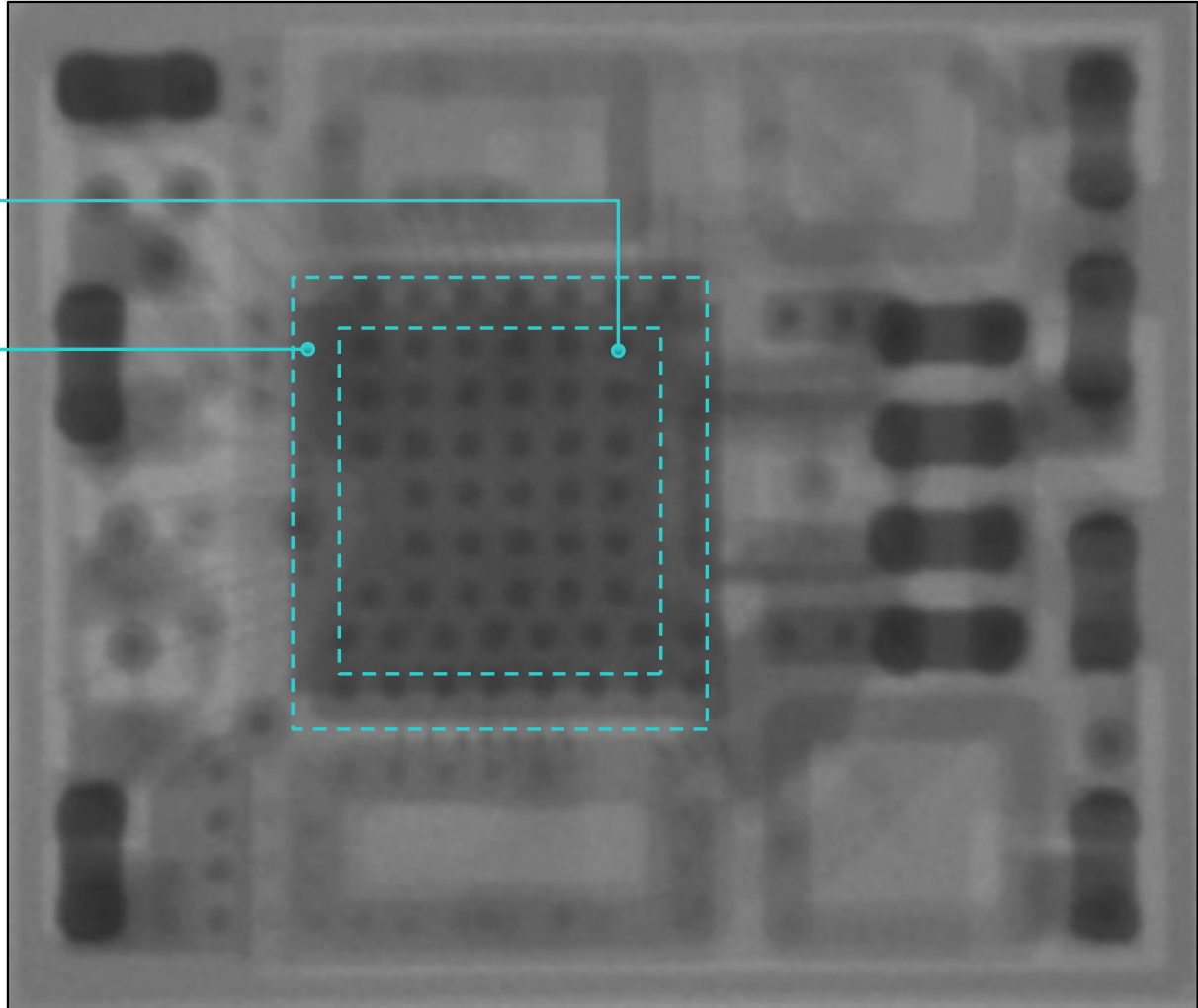
41.1 - Skyworks
#PK112603
Power Amplifier Controller
Die Size: 0.75 x 0.69 mm

41.2 - Skyworks
#ZP018-202 ?
RF Power Amplifier
Die Size: 1.3 x 1.15 mm

? = Unconfirmed

Function:

RF Component



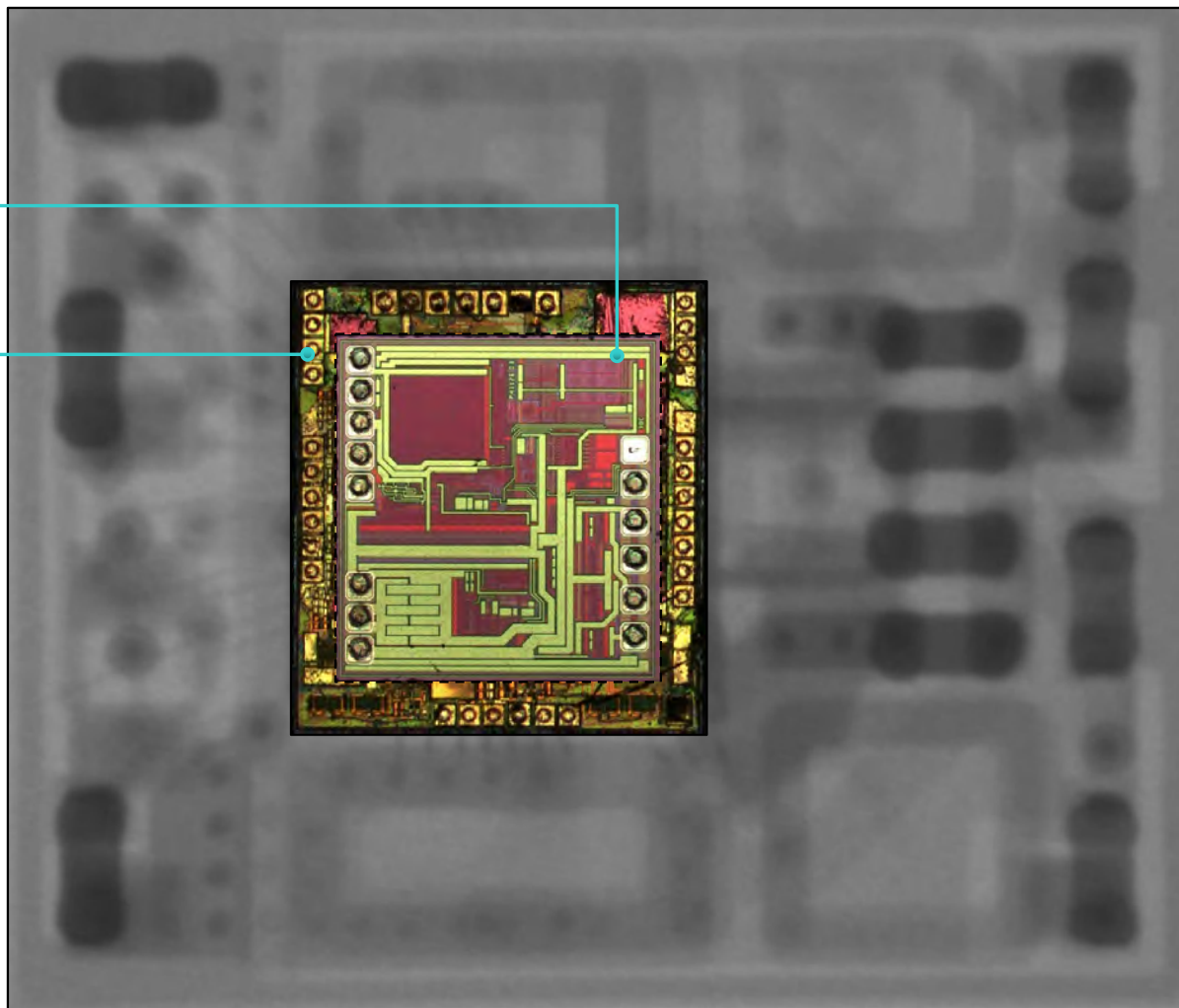
Other Substrates

RF Board – Side 1 X-Rays and Die Photos

41 - Skyworks
#SKY77365-11
Quad-Band GSM Power Amplifier
(2-Die Pkg.)
Pkg Size: 3.51 x 3.01 mm

41.1 - Skyworks
#PK112603
Power Amplifier Controller
Die Size: 0.75 x 0.69 mm

41.2 - Skyworks
#ZP018-202 ?
RF Power Amplifier
Die Size: 1.3 x 1.15 mm



? = Unconfirmed

Function:

RF Component

43 - Qualcomm
#QPM6621-101
LB Front-End Module ?
(4-Die Pkg.)
Pkg Size: 6.4 x 5.01 mm

43.1 - Qualcomm
#PU462-124
RF Power Amplifier
Die Size: 0.98 x 0.88 mm

43.4 - Qualcomm
#HG11-PM015-800
RF Switch / Controller ?
Die Size: 2 x 1.19 mm

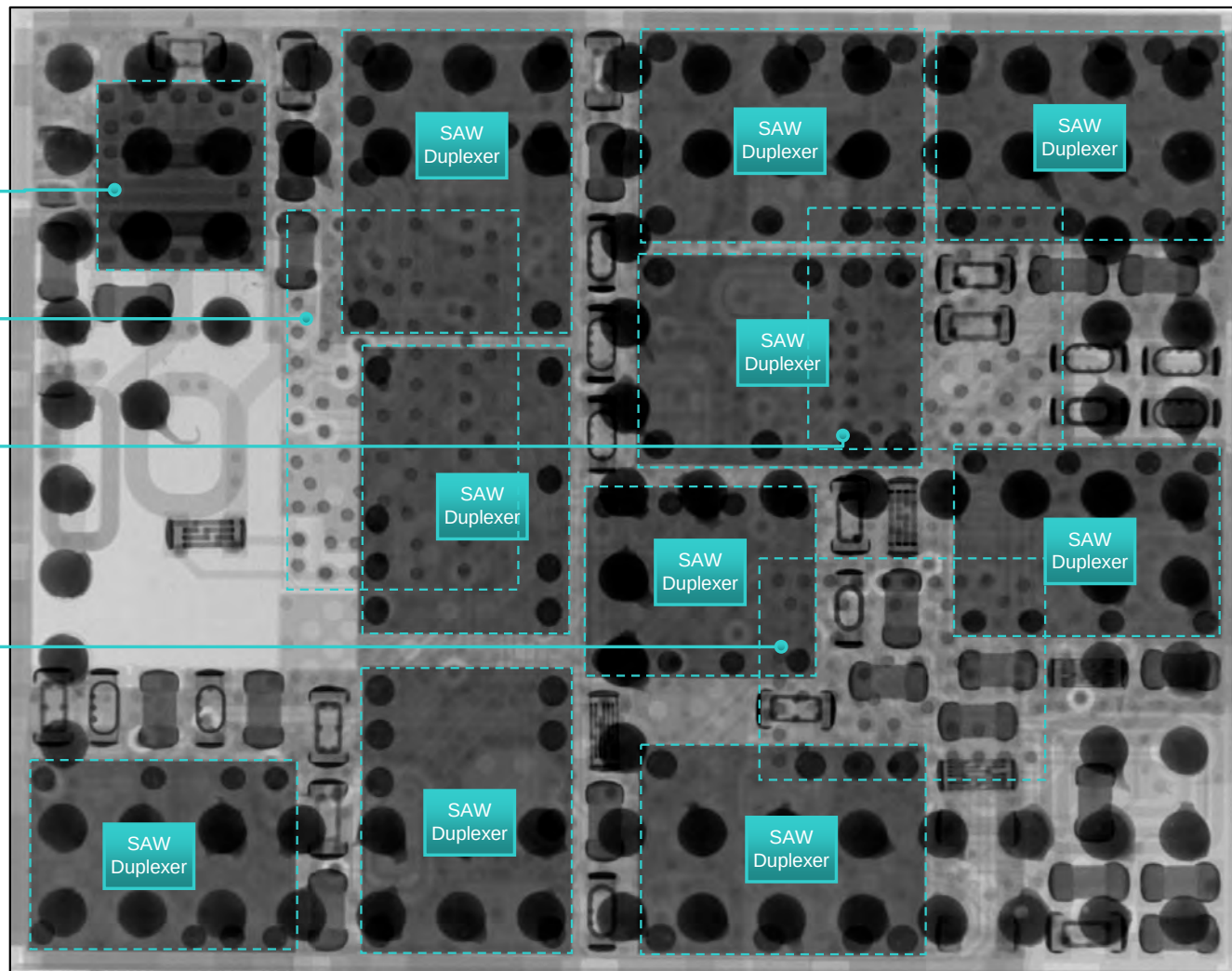
43.2 - Qualcomm
#HG11-PL498-300
RF LNA
Die Size: 1.25 x 1.23 mm

43.3 - Qualcomm
#HG11-PU265-102
RF Switch
Die Size: 1.52 x 1.13 mm

? = Unconfirmed

Function:

 RF Component



Other Substrates

RF Board – Side 1 X-Rays and Die Photos

43 - Qualcomm
#QPM6621-101
LB Front-End Module ?
(4-Die Pkg.)
Pkg Size: 6.4 x 5.01 mm

43.1 - Qualcomm
#PU462-124
RF Power Amplifier
Die Size: 0.98 x 0.88 mm

43.4 - Qualcomm
#HG11-PM015-800
RF Switch / Controller ?
Die Size: 2 x 1.19 mm

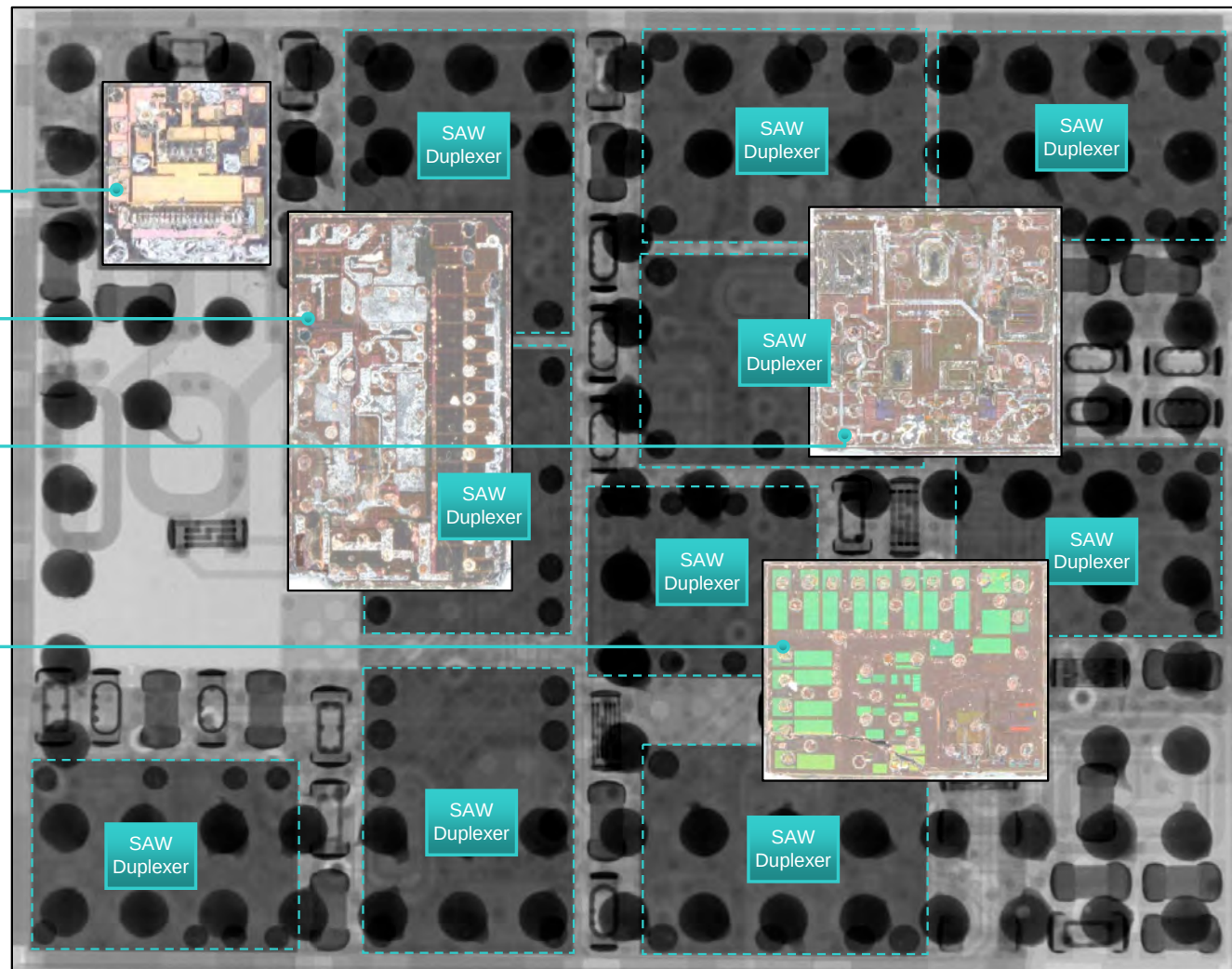
43.2 - Qualcomm
#HG11-PL498-300
RF LNA
Die Size: 1.25 x 1.23 mm

43.3 - Qualcomm
#HG11-PU265-102
RF Switch
Die Size: 1.52 x 1.13 mm

? = Unconfirmed

Function:

RF Component

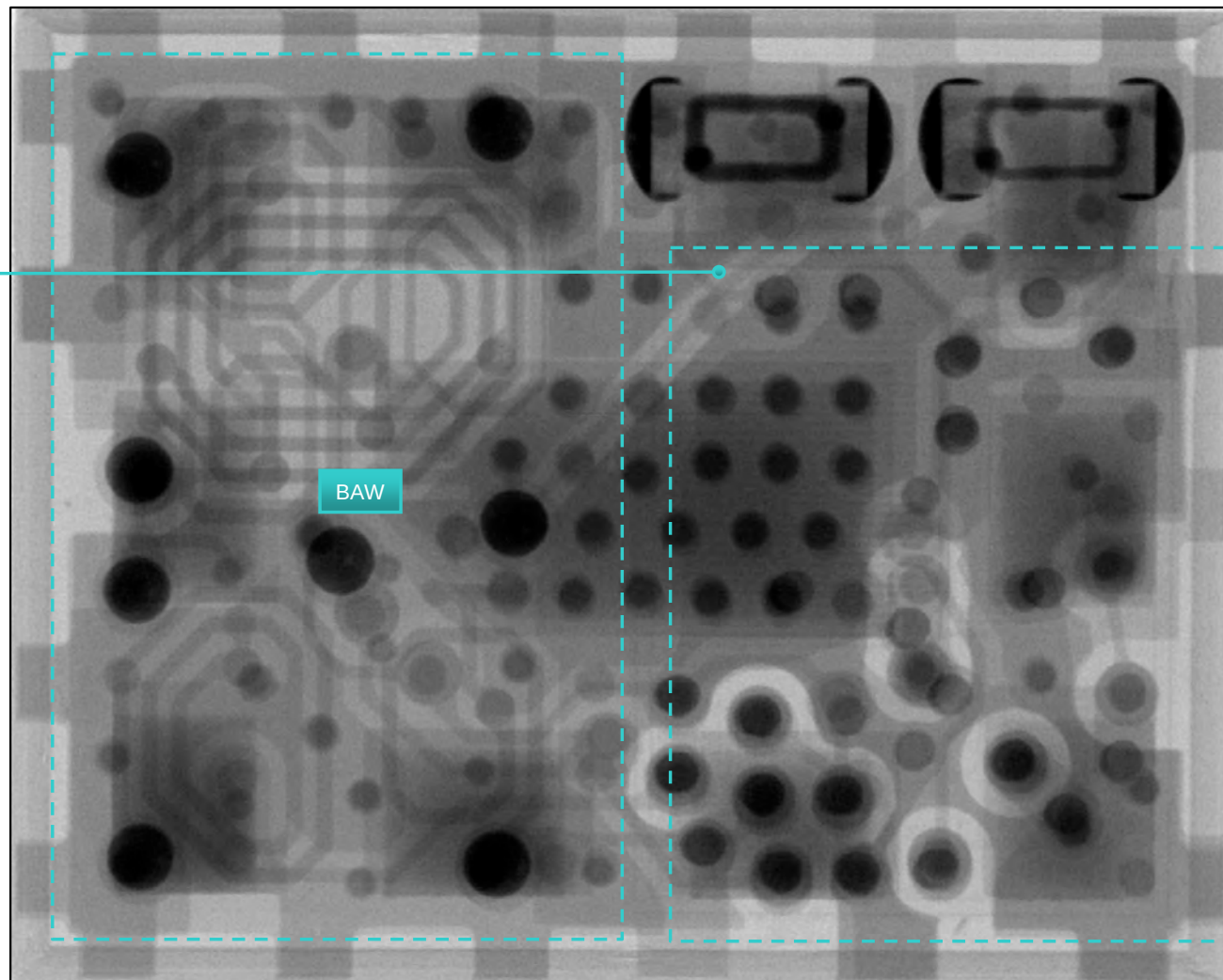


Other Substrates

RF Board – Side 1 X-Rays and Die Photos

44 - Qualcomm
#QDM5677
5G NR n77/n78 RF LNA w/ Filter
Pkg Size: 2.01 x 1.61 mm

44.1 - Qualcomm
#HG11-PL421-100
5G NR n77/n78 RF LNA
Die Size: 1.15 x 0.93 mm



Function:
RF Component

Other Substrates

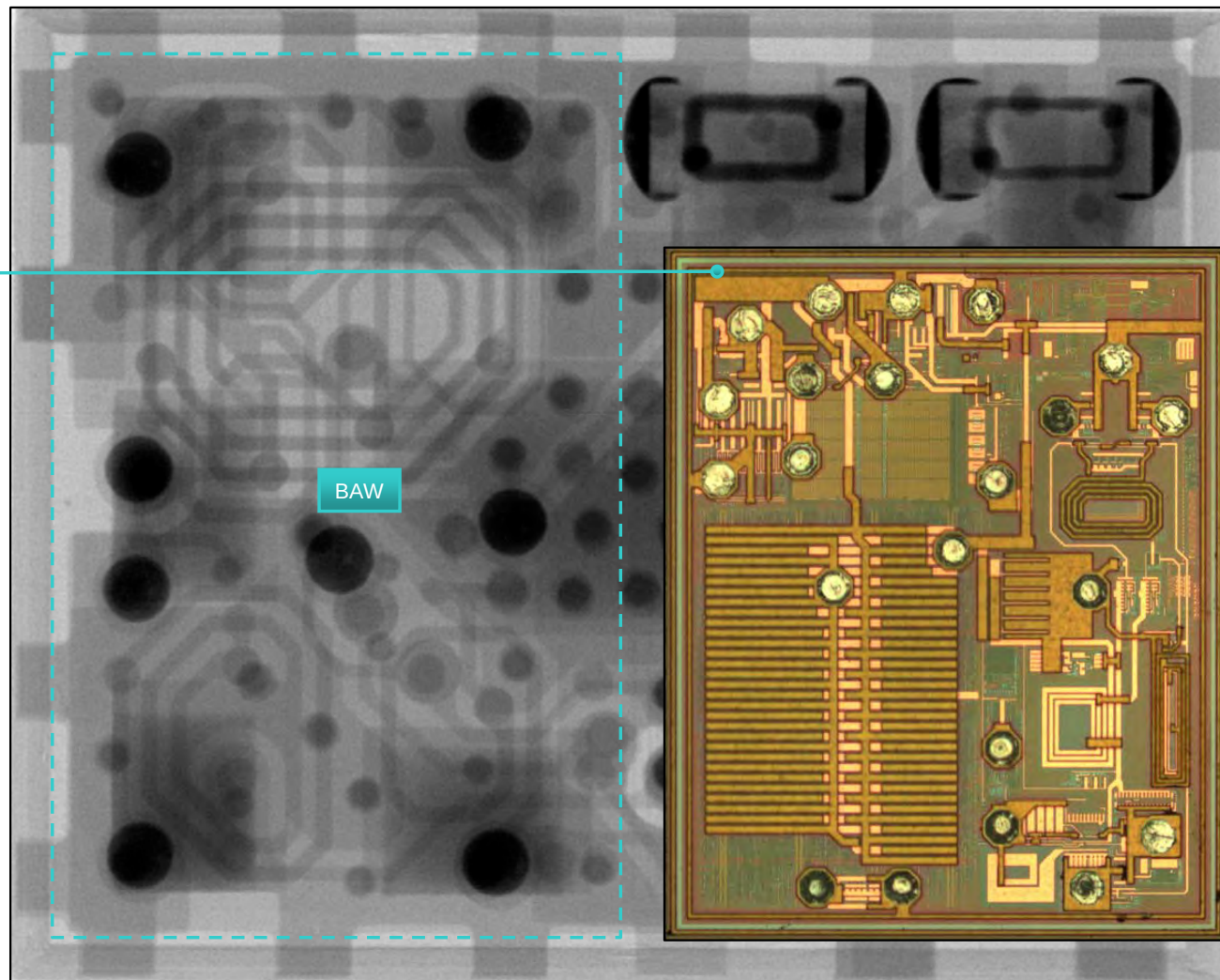
RF Board – Side 1 X-Rays and Die Photos

44 - Qualcomm
#QDM5677
5G NR n77/n78 RF LNA w/ Filter
Pkg Size: 2.01 x 1.61 mm

44.1 - Qualcomm
#HG11-PL421-100
5G NR n77/n78 RF LNA
Die Size: 1.15 x 0.93 mm

BAW

Function:
RF Component



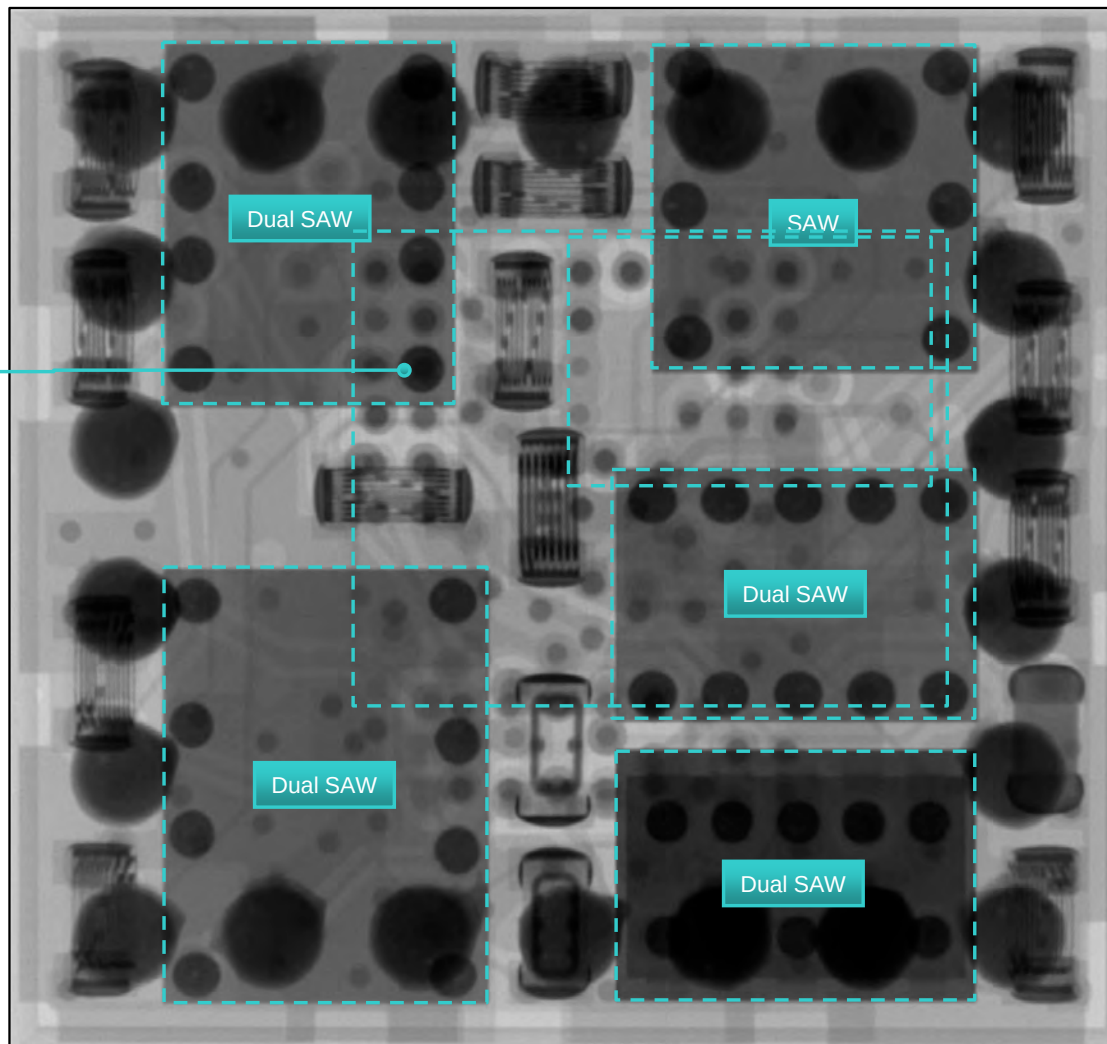
Other Substrates

RF Board – Side 1 X-Rays and Die Photos

47 - Qualcomm
#Unknown
Rx/D Front-End Module
Pkg Size: 3.02 x 2.8 mm

47.1 - Qualcomm
#Unknown
RF Switch / LNA
Die Size: 1.63 x 1.3 mm

Function:
RF Component



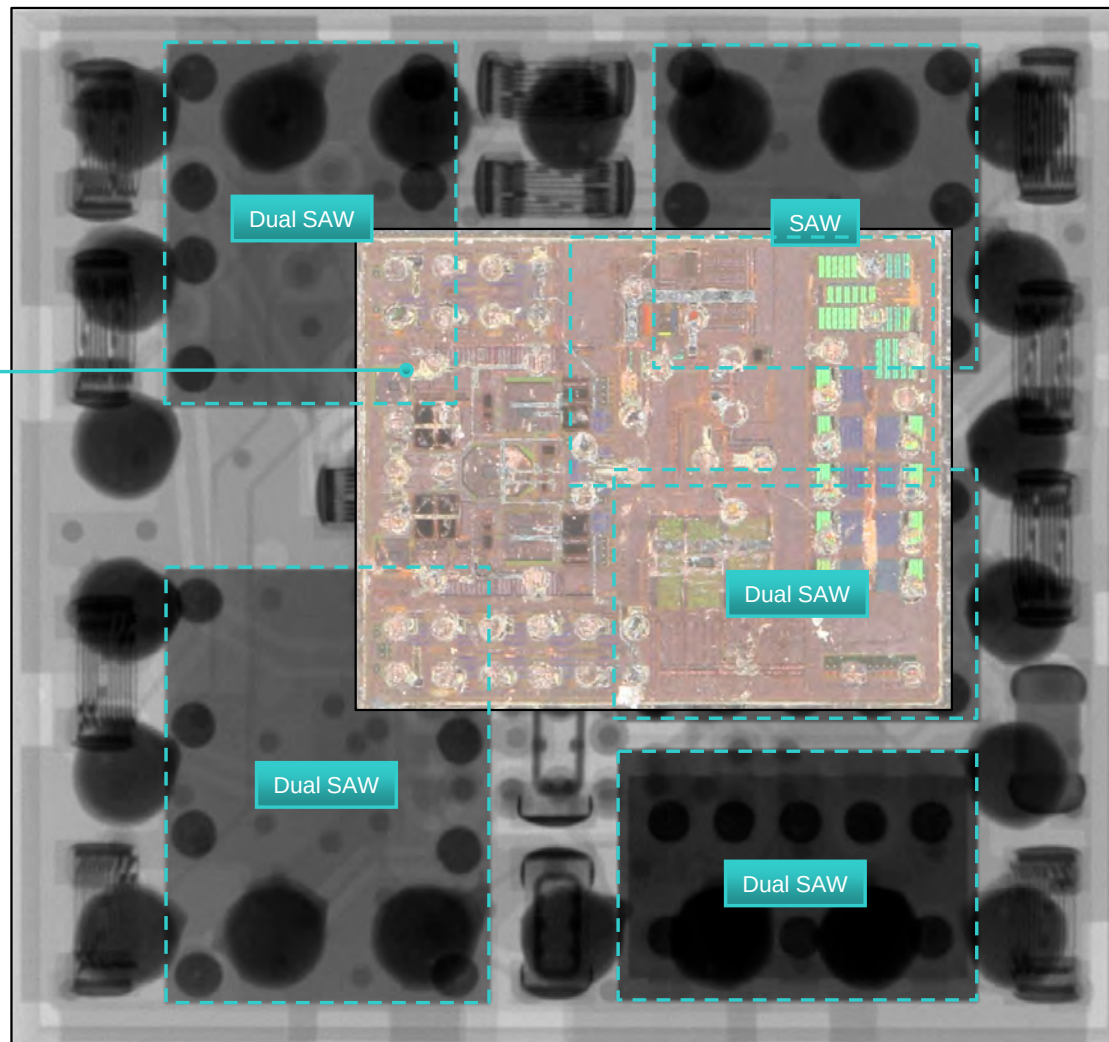
Other Substrates

RF Board – Side 1 X-Rays and Die Photos

47 - Qualcomm
#Unknown
RxD Front-End Module
Pkg Size: 3.02 x 2.8 mm

47.1 - Qualcomm
#Unknown
RF Switch / LNA
Die Size: 1.63 x 1.3 mm

Function:
RF Component



Other Substrates

RF Board – Side 1 X-Rays and Die Photos

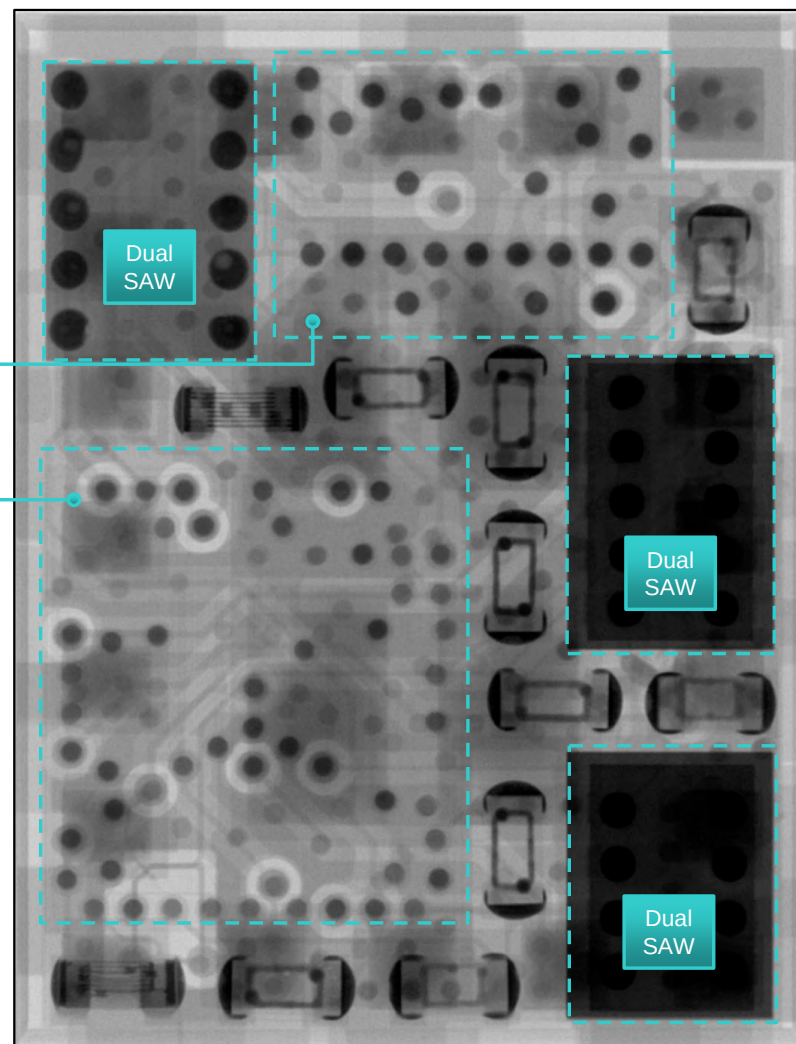
48 - Qualcomm
#QDM5631
MB Rx/D Front-End Module (2-Die Pkg.)
Pkg Size: 3.39 x 2.6 mm

48.2 - Qualcomm
#HG11-PM386_200
RF Switch
Die Size: 1.32 x 0.93 mm

48.1 - Qualcomm
#HG11-PJ018-200
RF LNA
Die Size: 1.57 x 1.43 mm

Function:

 RF Component



Other Substrates

RF Board – Side 1 X-Rays and Die Photos

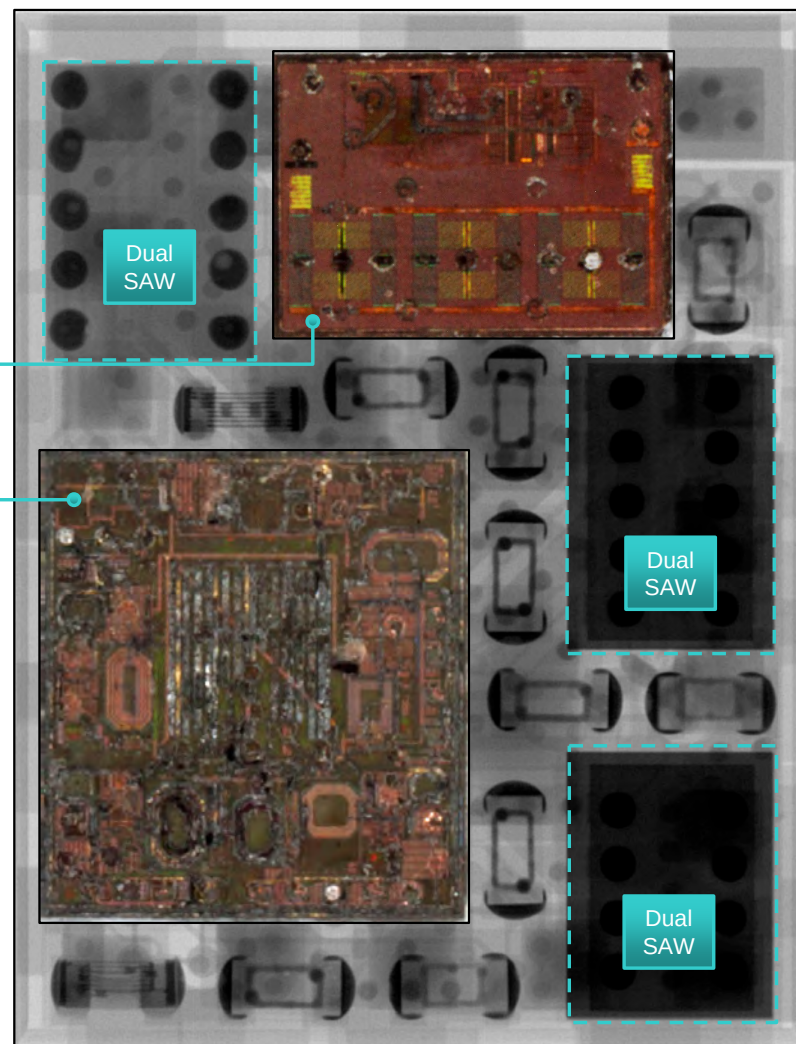
48 - Qualcomm
#QDM5631
MB Rx/D Front-End Module (2-Die Pkg.)
Pkg Size: 3.39 x 2.6 mm

48.2 - Qualcomm
#HG11-PM386_200
RF Switch
Die Size: 1.32 x 0.93 mm

48.1 - Qualcomm
#HG11-PJ018-200
RF LNA
Die Size: 1.57 x 1.43 mm

Function:

RF Component



Other Substrates

RF Board – Side 1 X-Rays and Die Photos

50 - Murata
#Unknown
WiFi 802.11a/b/g/n/ac/ax / Bluetooth 5.2
Module (6-Die Pkg.)
Pkg Size: 9.3 x 7.1 mm

50.2 - Qualcomm
#HG11-YC990-110
WiFi 802.11a/b/g/n/ac/ax / Bluetooth 5.2
Die Size: 6.31 x 6 mm

50.3 - NXP Semiconductors
#Unknown
WiFi 2.4 GHz Front-End Module?
Die Size: 1.82 x 1.6 mm

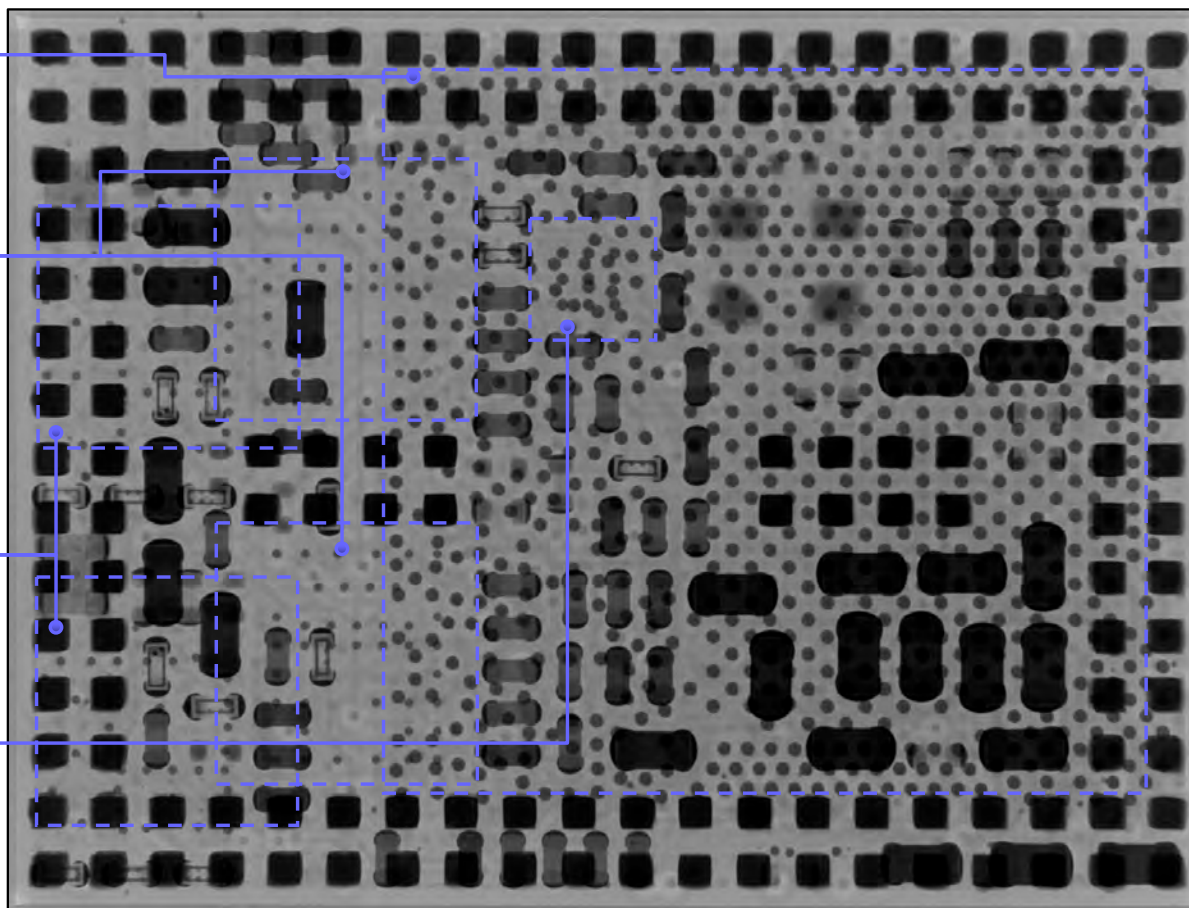
50.1 - NXP Semiconductors
#R1431c
WiFi 5 GHz Front-End Module
Die Size: 1.63 x 1.62 mm

50.4 - Unknown
#XMSS-095 ?
SP4T GaAs Switch ?
Die Size: 0.59 x 0.58 mm

? = Unconfirmed

Function:

Connectivity



Other Substrates

RF Board – Side 1 X-Rays and Die Photos

50 - Murata
#Unknown
WiFi 802.11a/b/g/n/ac/ax / Bluetooth 5.2
Module (6-Die Pkg.)
Pkg Size: 9.3 x 7.1 mm

50.2 - Qualcomm
#HG11-YC990-110
WiFi 802.11a/b/g/n/ac/ax / Bluetooth 5.2
Die Size: 6.31 x 6 mm

50.3 - NXP Semiconductors
#Unknown
WiFi 2.4 GHz Front-End Module?
Die Size: 1.82 x 1.6 mm

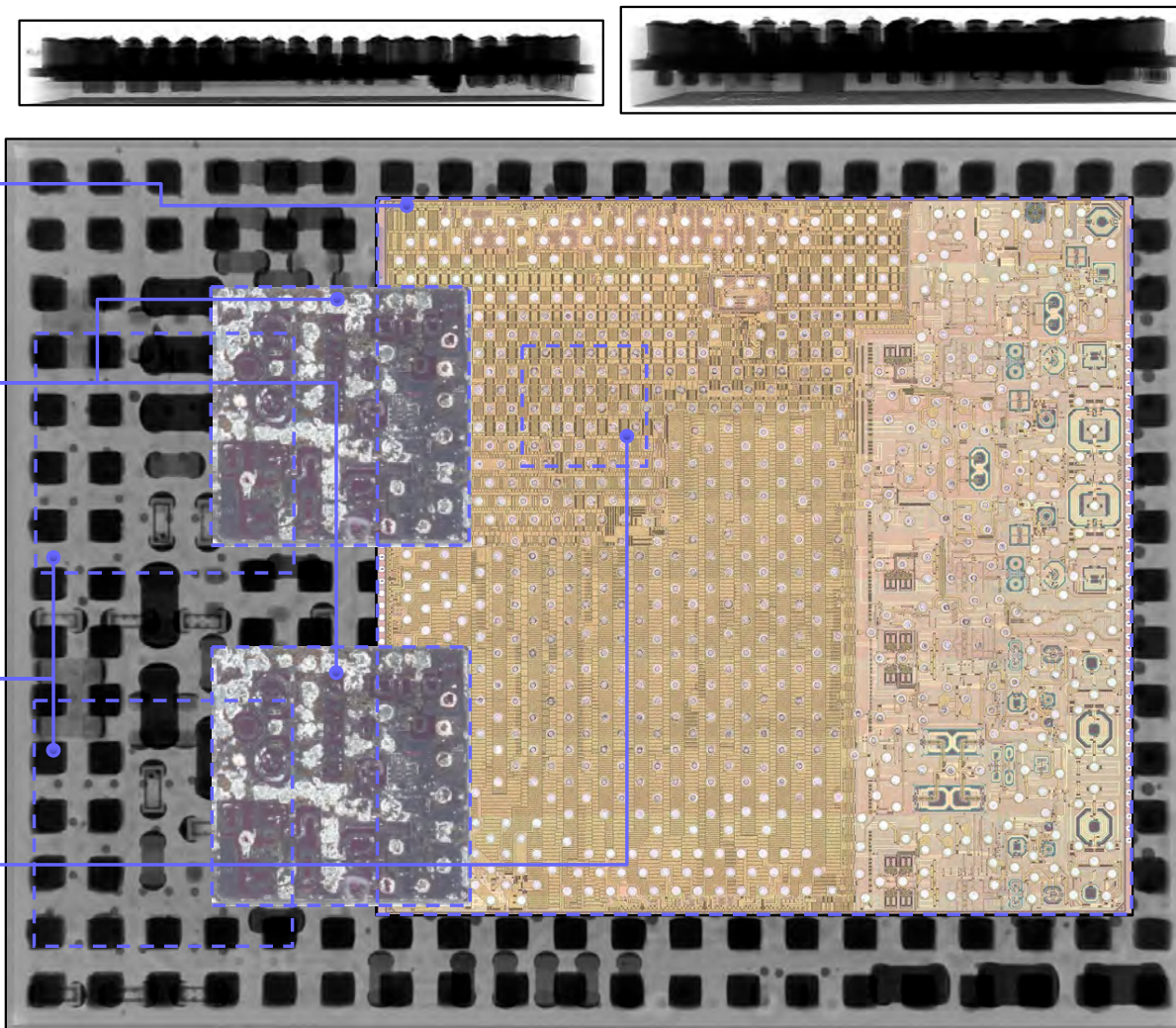
50.1 - NXP Semiconductors
#R1431c
WiFi 5 GHz Front-End Module
Die Size: 1.63 x 1.62 mm

50.4 - Unknown
#XMSS-095 ?
SP4T GaAs Switch ?
Die Size: 0.59 x 0.58 mm

? = Unconfirmed

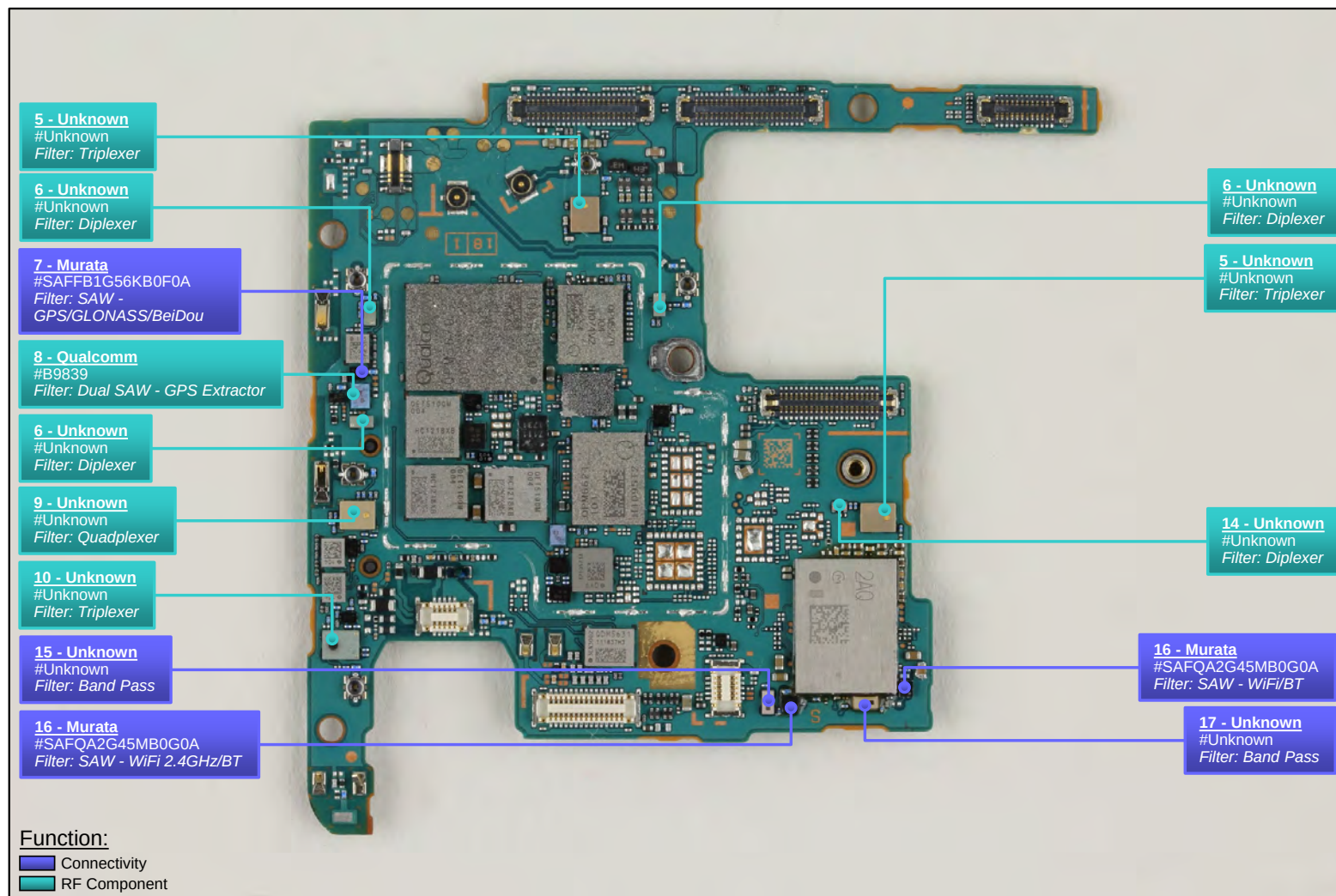
Function:

Connectivity



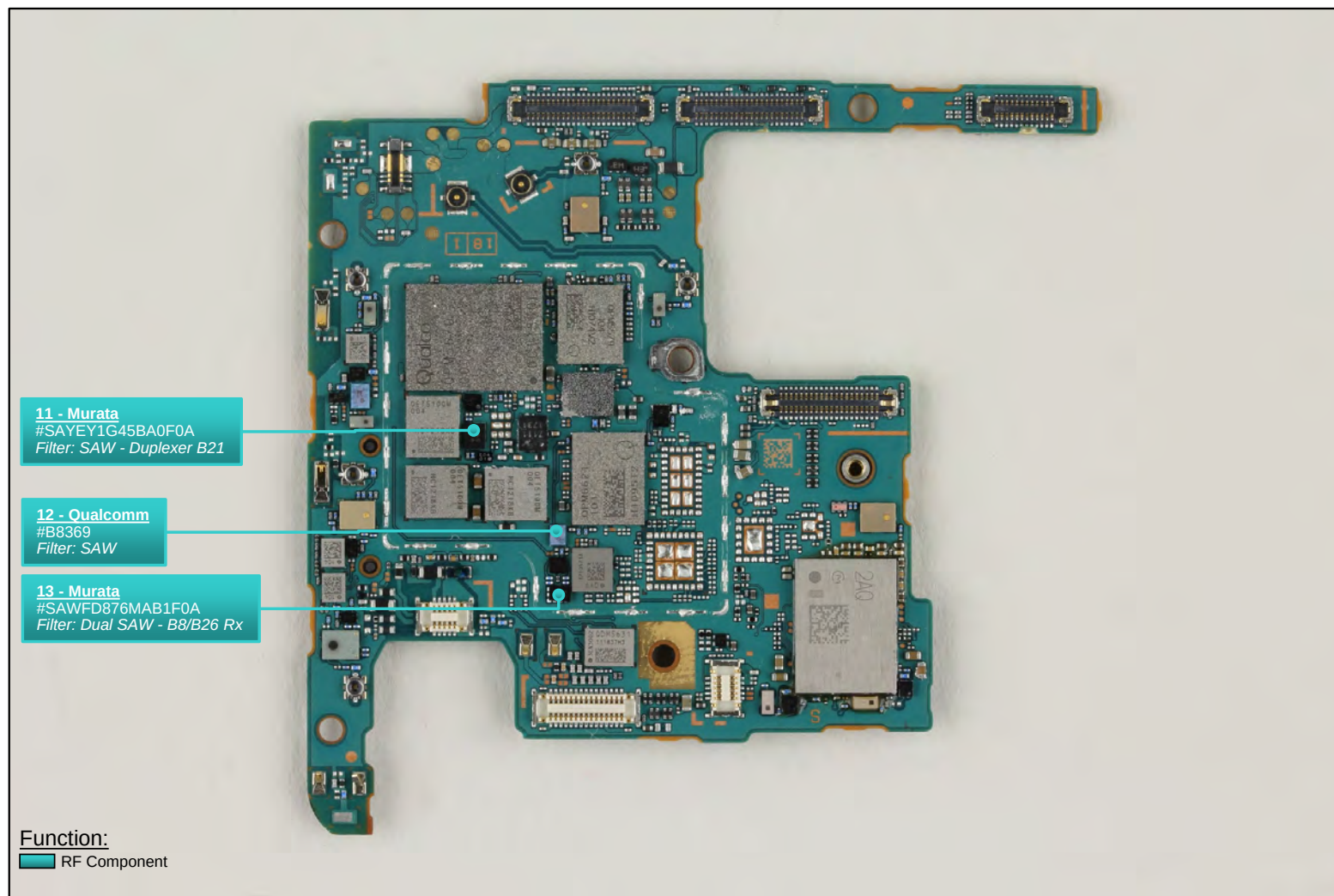
Other Substrates

RF Board – Side 1 IC Identification



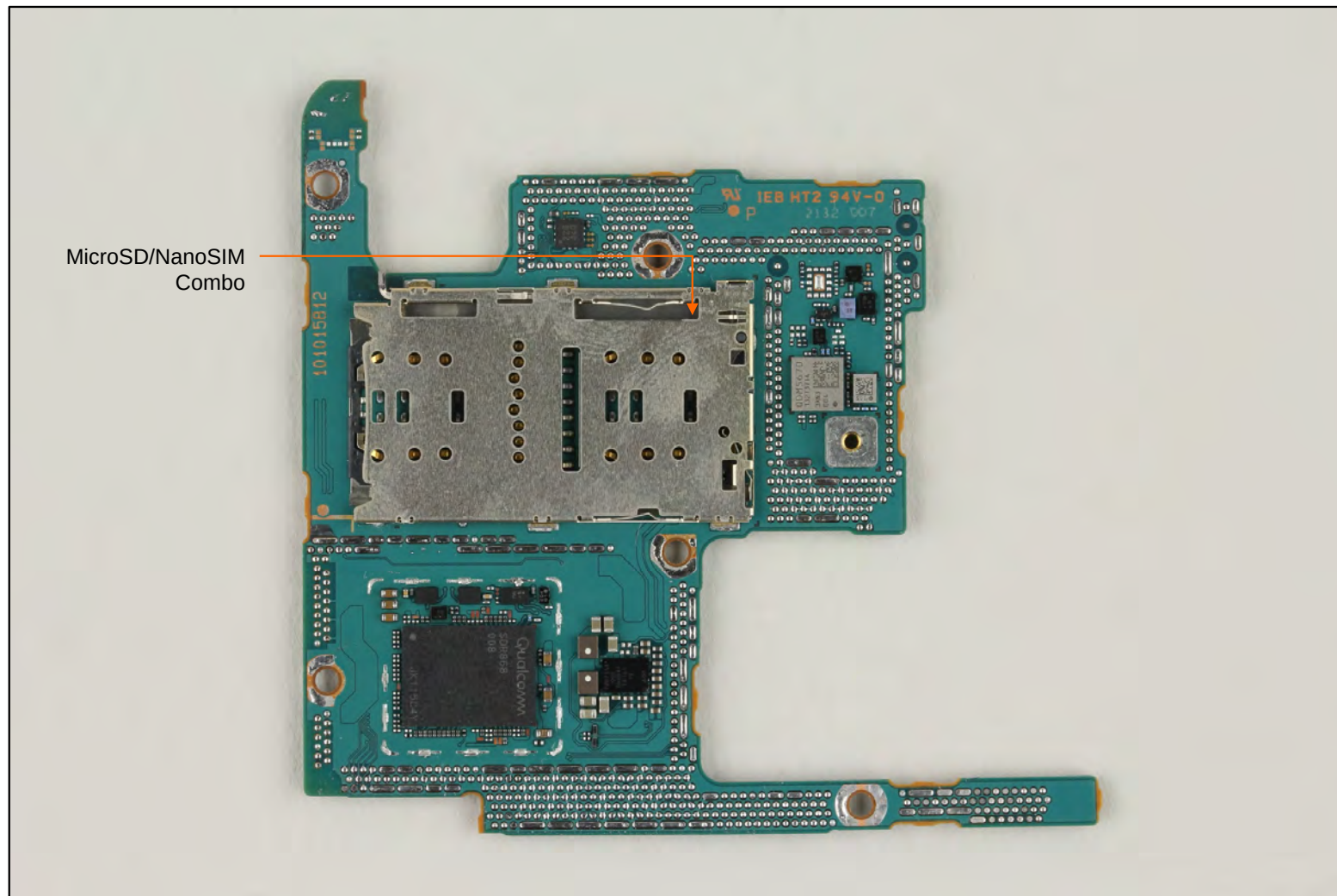
Other Substrates

RF Board – Side 1 IC Identification



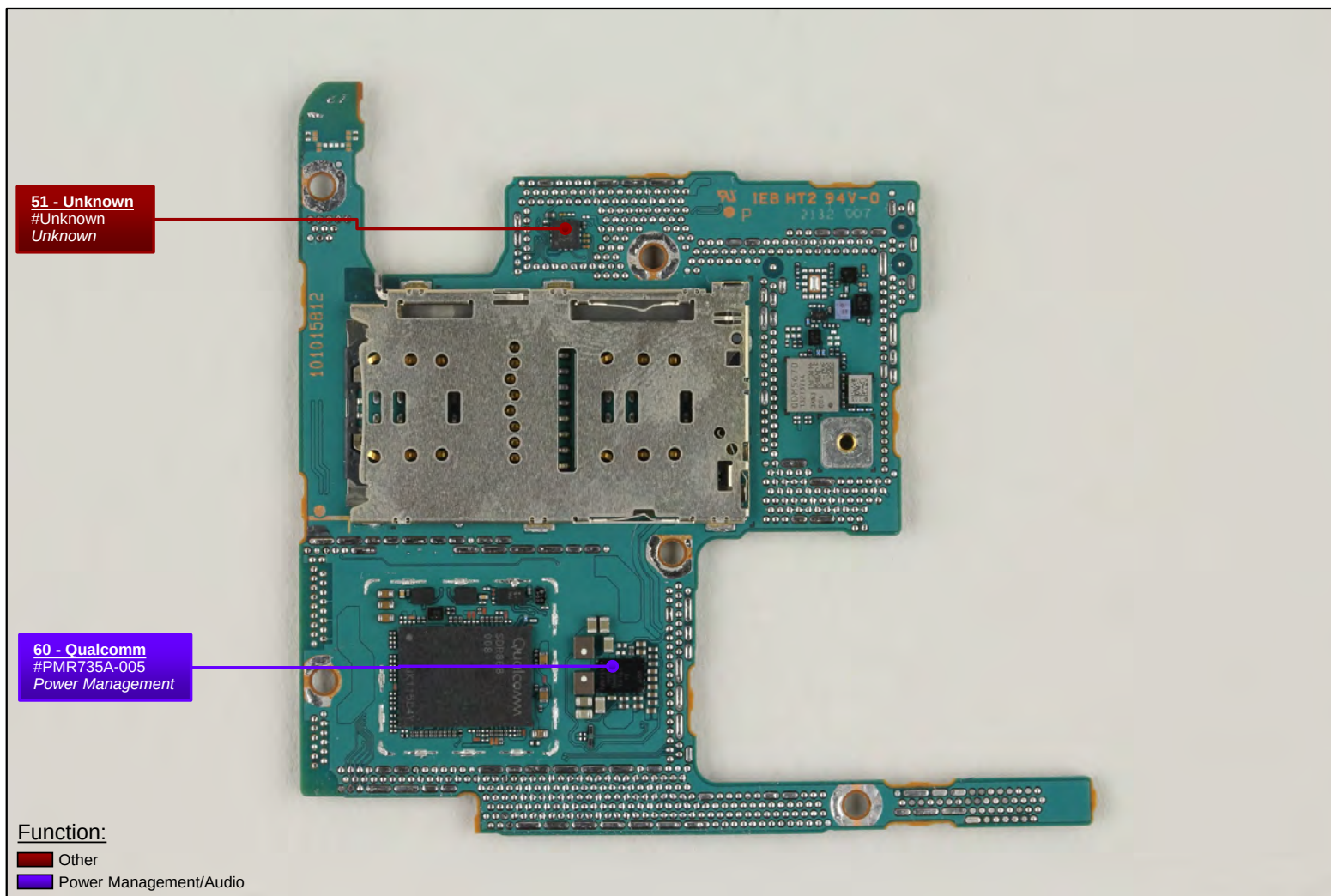
Other Substrates

RF Board – Side 2



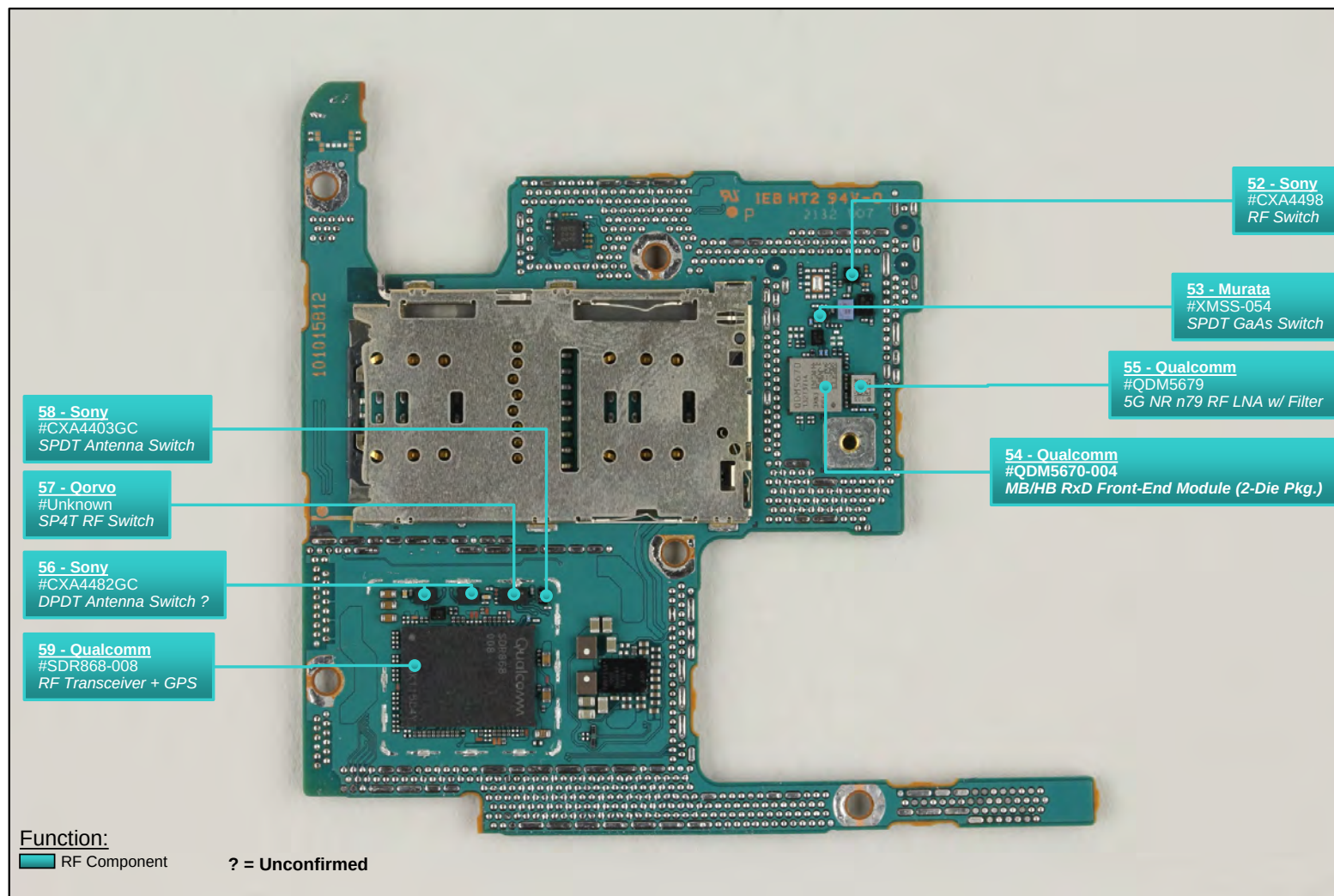
Other Substrates

RF Board – Side 2 IC Identification



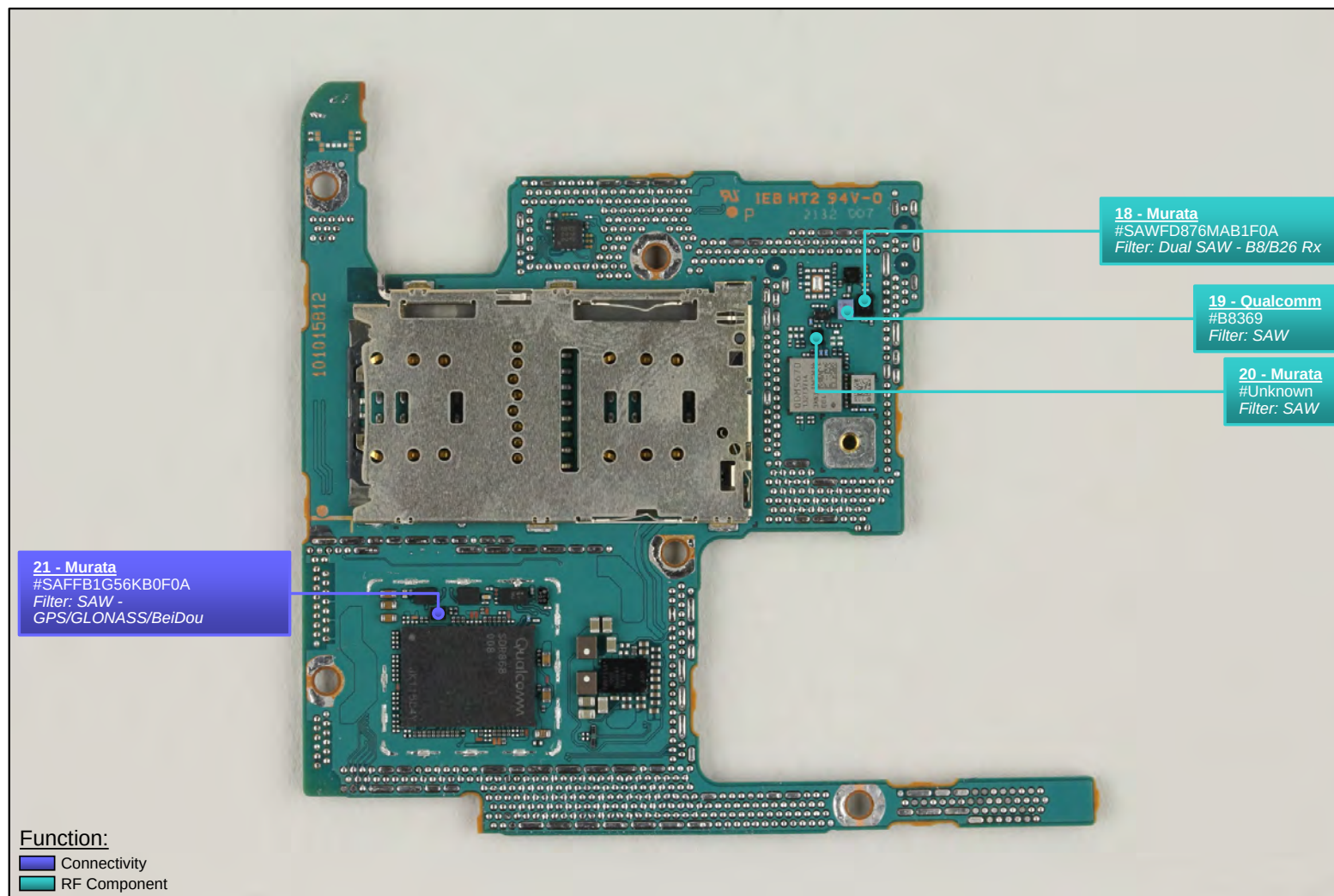
Other Substrates

RF Board – Side 2 IC Identification



Other Substrates

RF Board – Side 2 IC Identification



Other Substrates

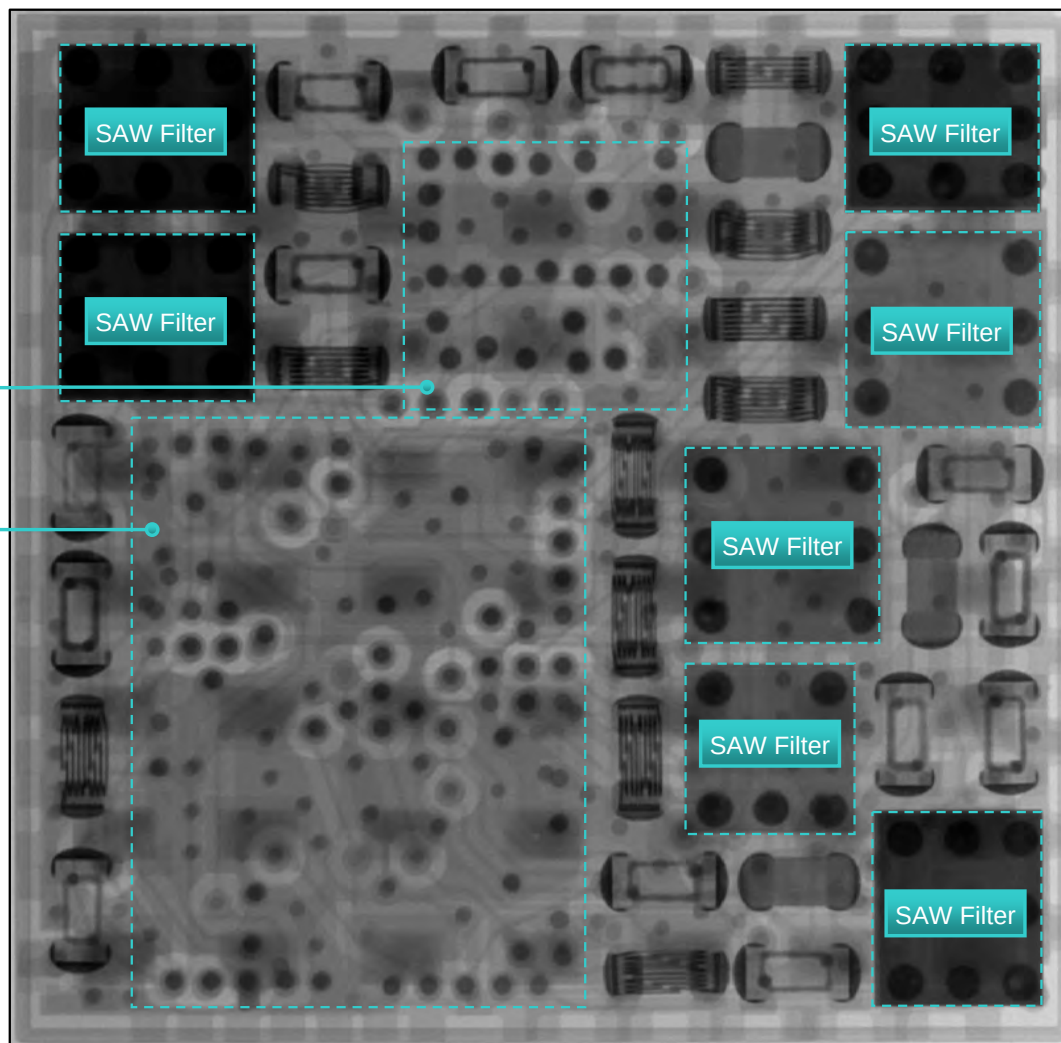
RF Board – Side 2 X-Rays and Die Photos

54 - Qualcomm
#QDM5670-004
MB/HB Rx/D Front-End Module (2-Die Pkg.)
Pkg Size: 3.73 x 3.61 mm

54.1 - Qualcomm
#PH785-410
RF Switch
Die Size: 1 x 0.93 mm

54.2 - Qualcomm
#HG11-PK871-201
LNA / RF Switch
Die Size: 2.1 x 1.62 mm

Function:
RF Component



Other Substrates

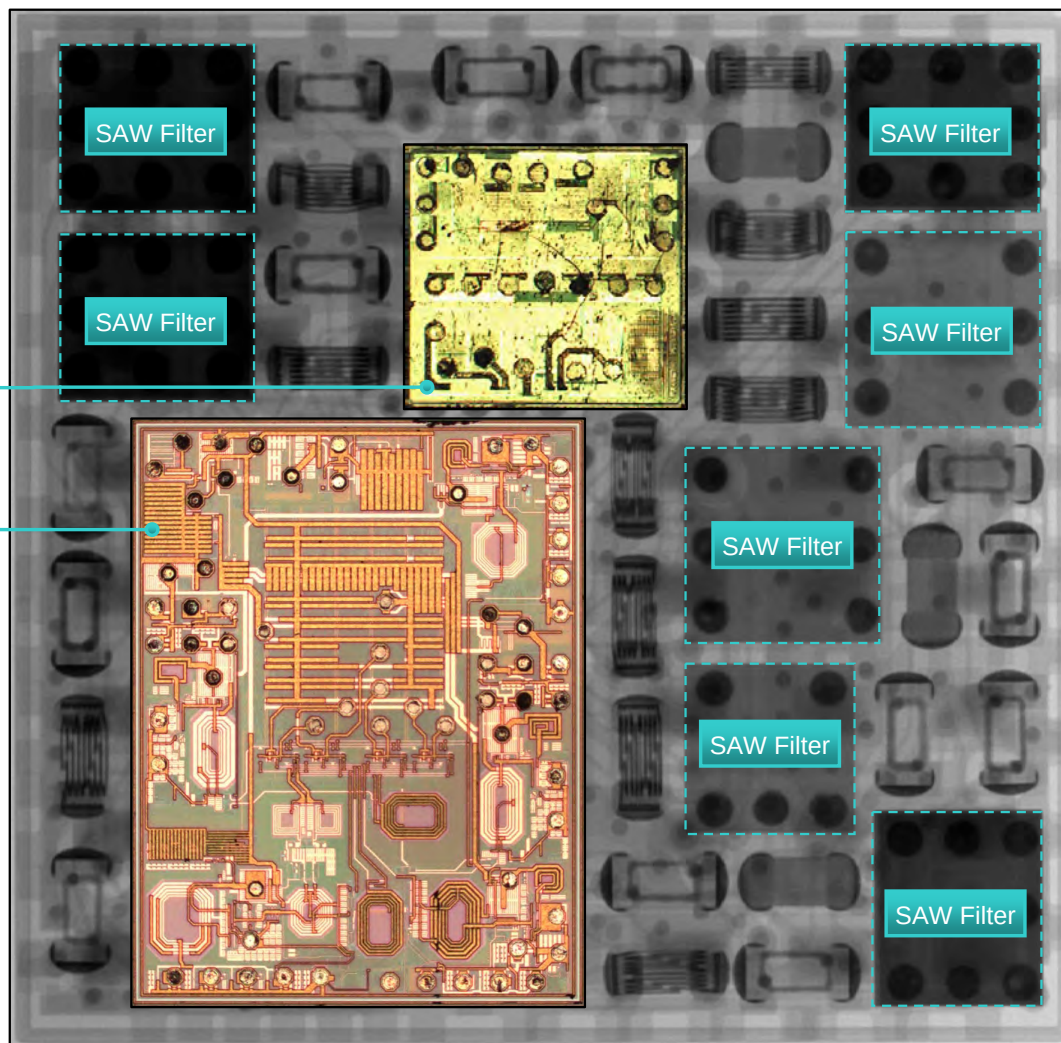
RF Board – Side 2 X-Rays and Die Photos

54 - Qualcomm
#QDM5670-004
MB/HB Rx/D Front-End Module (2-Die Pkg.)
Pkg Size: 3.73 x 3.61 mm

54.1 - Qualcomm
#PH785-410
RF Switch
Die Size: 1 x 0.93 mm

54.2 - Qualcomm
#HG11-PK871-201
LNA / RF Switch
Die Size: 2.1 x 1.62 mm

Function:
RF Component



Other Substrates

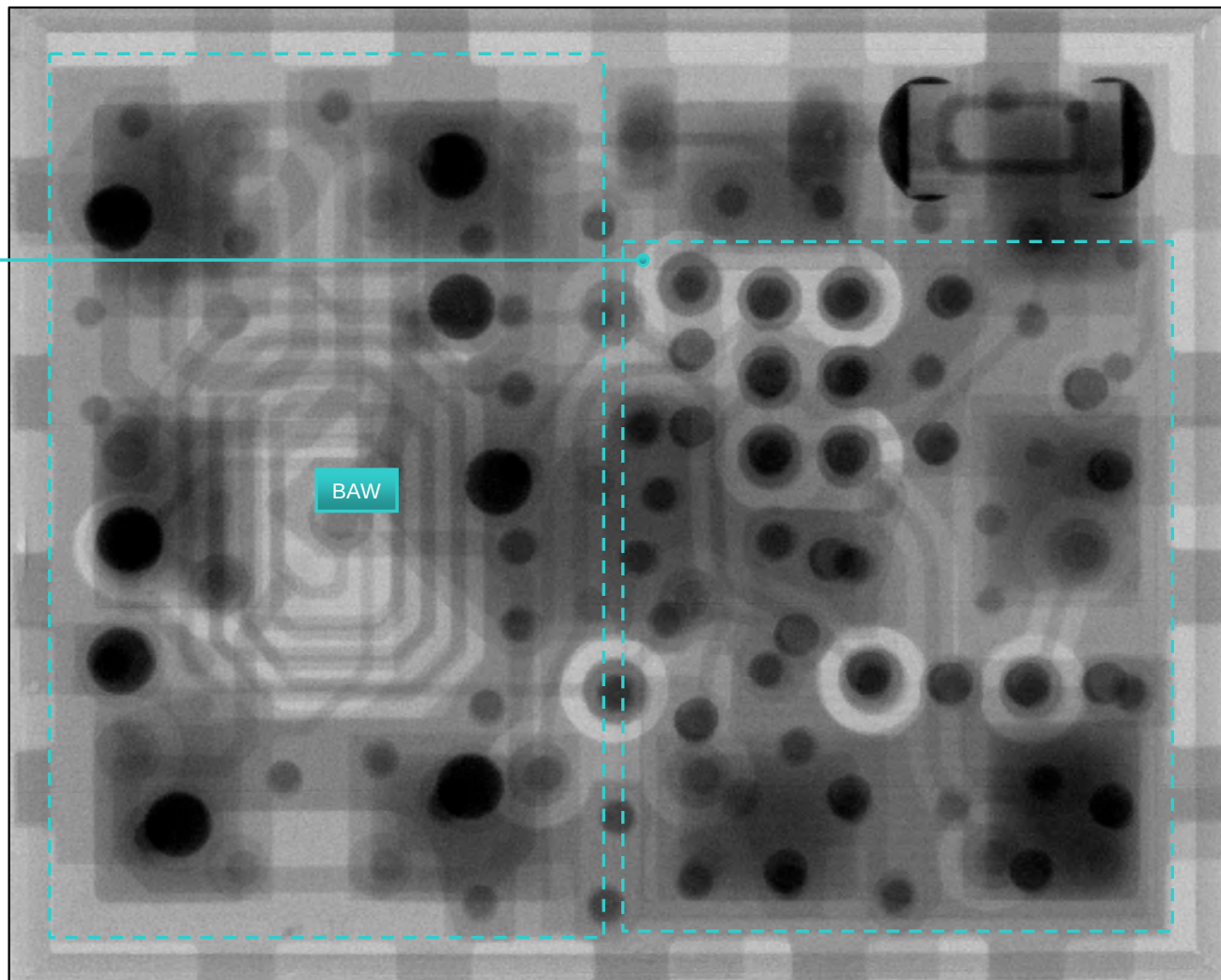
RF Board – Side 2 X-Rays and Die Photos

55 - Qualcomm
#QDM5679
5G NR n79 RF LNA w/ Filter
Pkg Size: 2 x 1.61 mm

55.1 - Qualcomm
#HG11-PL422-100
5G NR n79 RF LNA
Die Size: 1.15 x 0.91 mm

BAW

Function:
RF Component





Other Substrates

RF Board – Side 2 X-Rays and Die Photos

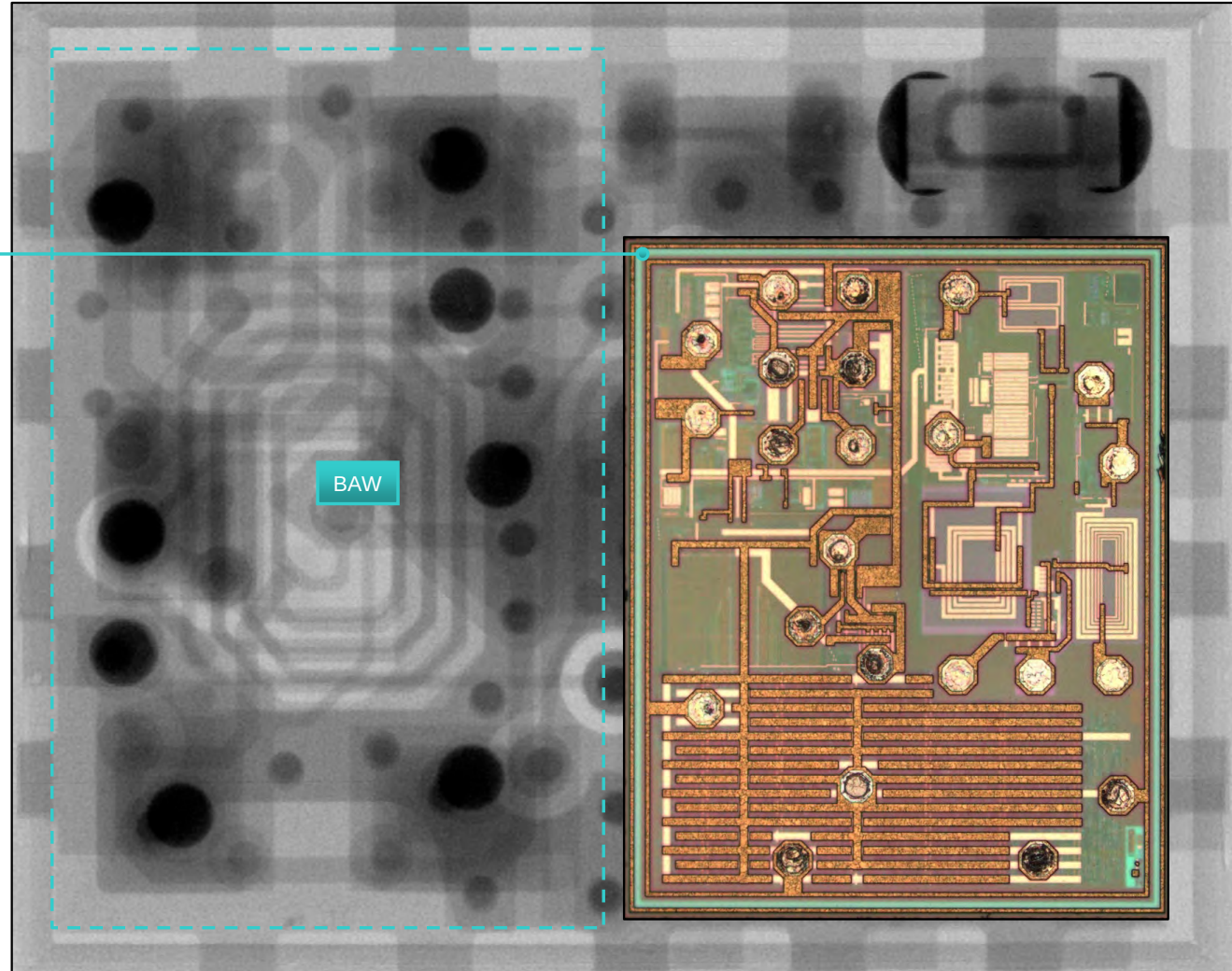
55 - Qualcomm
#QDM5679
5G NR n79 RF LNA w/ Filter
Pkg Size: 2 x 1.61 mm

55.1 - Qualcomm
#HG11-PL422-100
5G NR n79 RF LNA
Die Size: 1.15 x 0.91 mm

BAW

Function:

RF Component



Other Substrates

RF Board – Side 2 X-Rays and Die Photos

59 - Qualcomm
#SDR868-008
RF Transceiver + GPS
Pkg Size: 9.23 x 7.01 mm

59.1 - Qualcomm
#HG11-PD715-320 ?
RF Transceiver + GPS
Die Size: 7.88 x 6.5 mm



Function:

 RF Component

? = Unconfirmed

Other Substrates

RF Board – Side 2 X-Rays and Die Photos

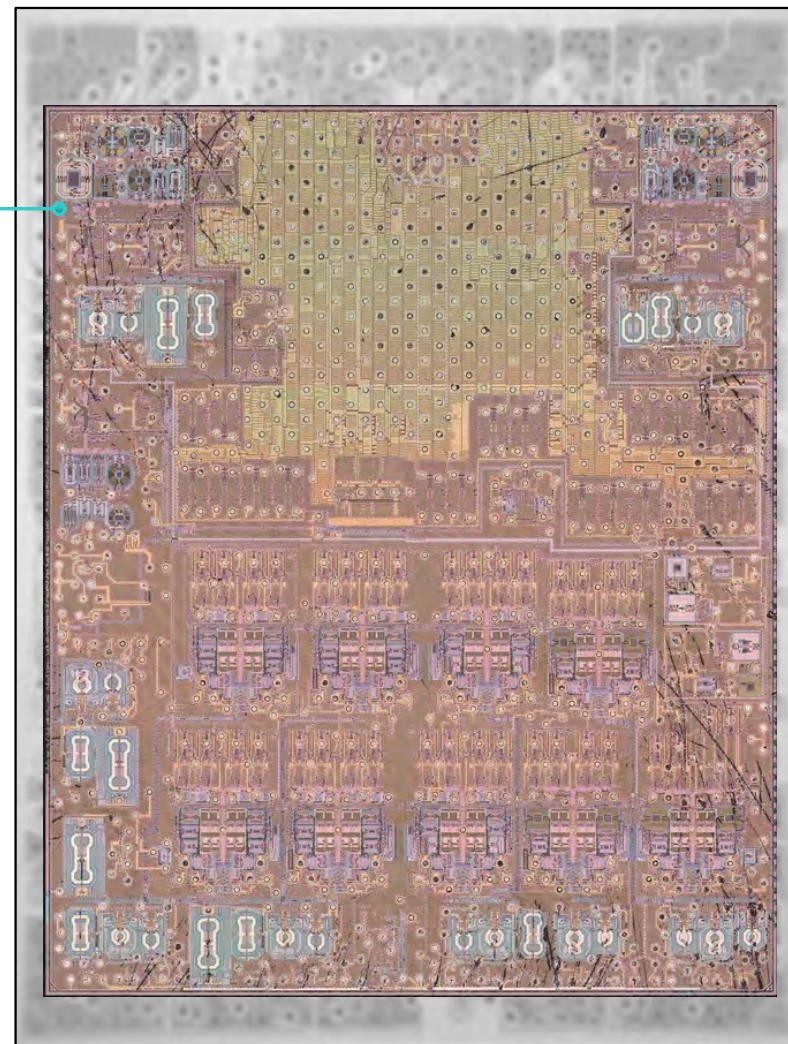
59 - Qualcomm
#SDR868-008
RF Transceiver + GPS
Pkg Size: 9.23 x 7.01 mm

59.1 - Qualcomm
#HG11-PD715-320 ?
RF Transceiver + GPS
Die Size: 7.88 x 6.5 mm

Function:

RF Component

? = Unconfirmed

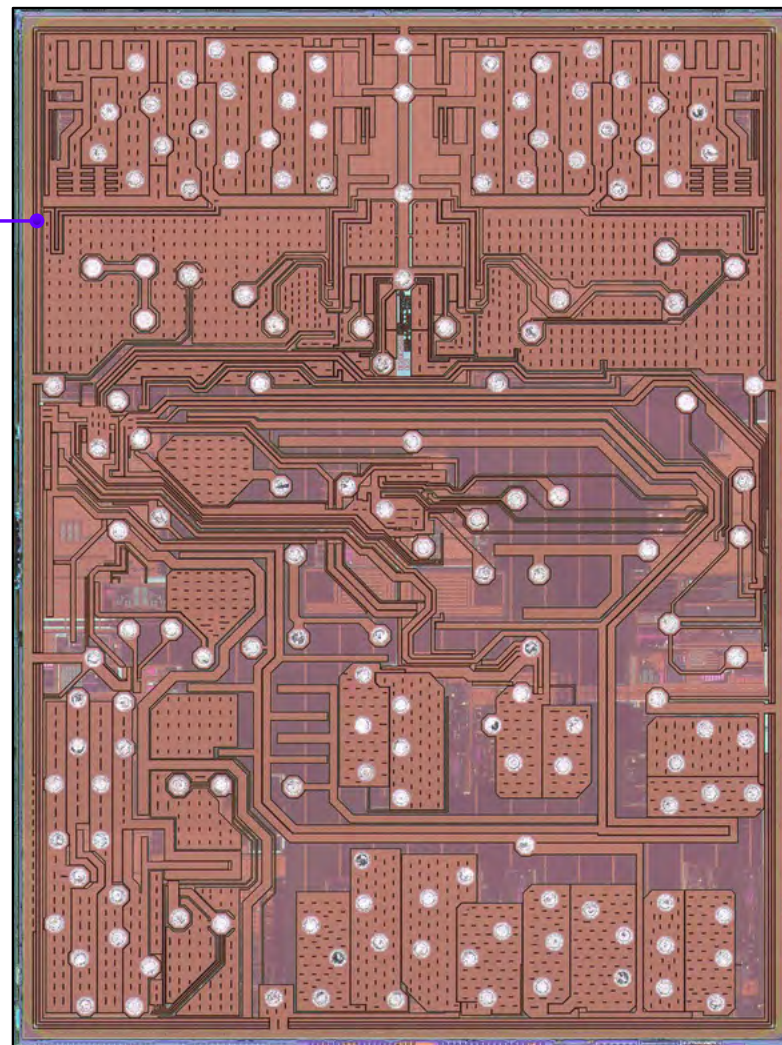


Other Substrates

RF Board – Side 2 X-Rays and Die Photos

60 - Qualcomm
#PMR735A-005
Power Management
Pkg Size: 3.22 x 2.42 mm

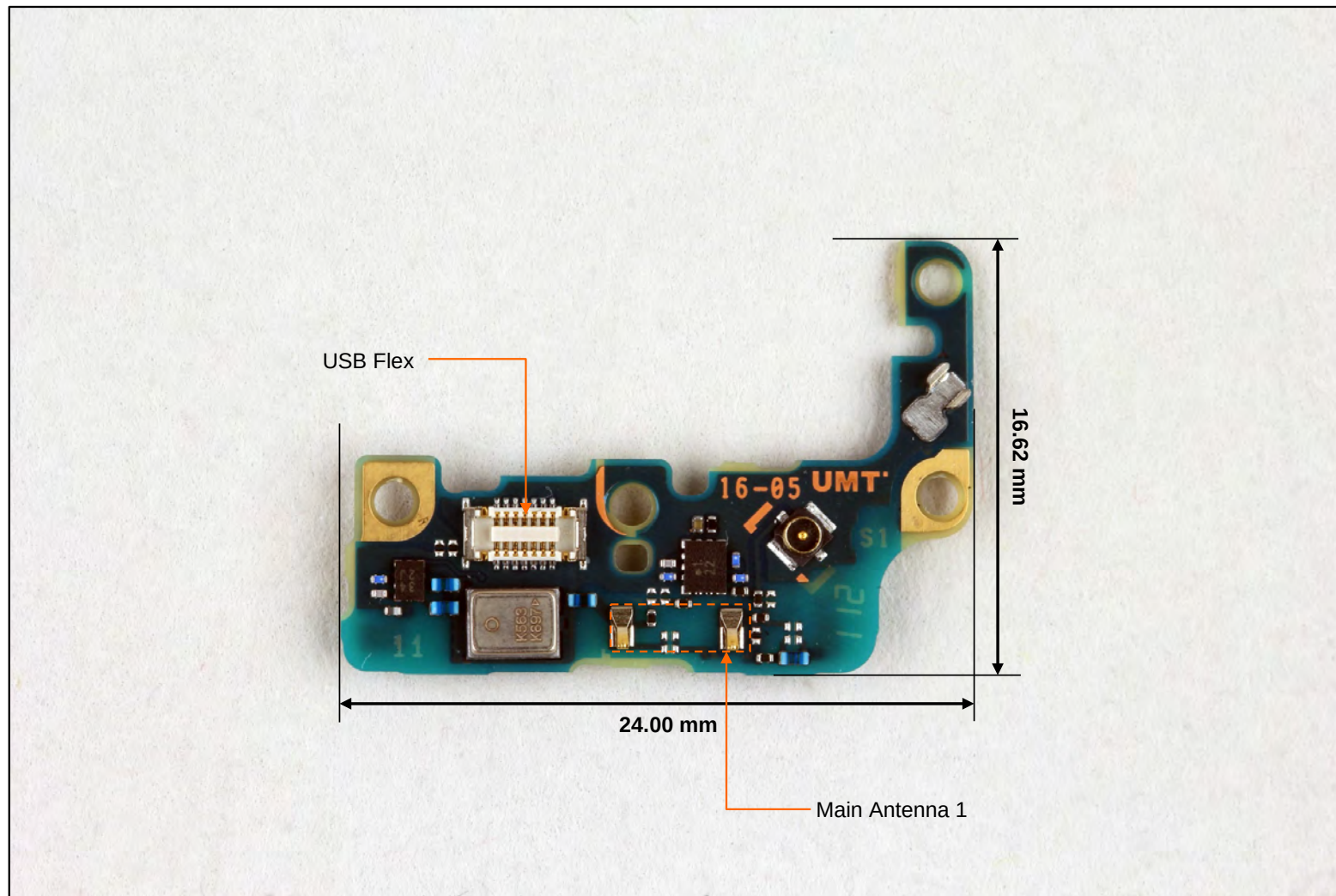
60.1 - Qualcomm
#HG11-PP364-220 ?
Power Management
Die Size: 3.2 x 2.4 mm



Function: ? = Unconfirmed
60.1 Power Management/Audio

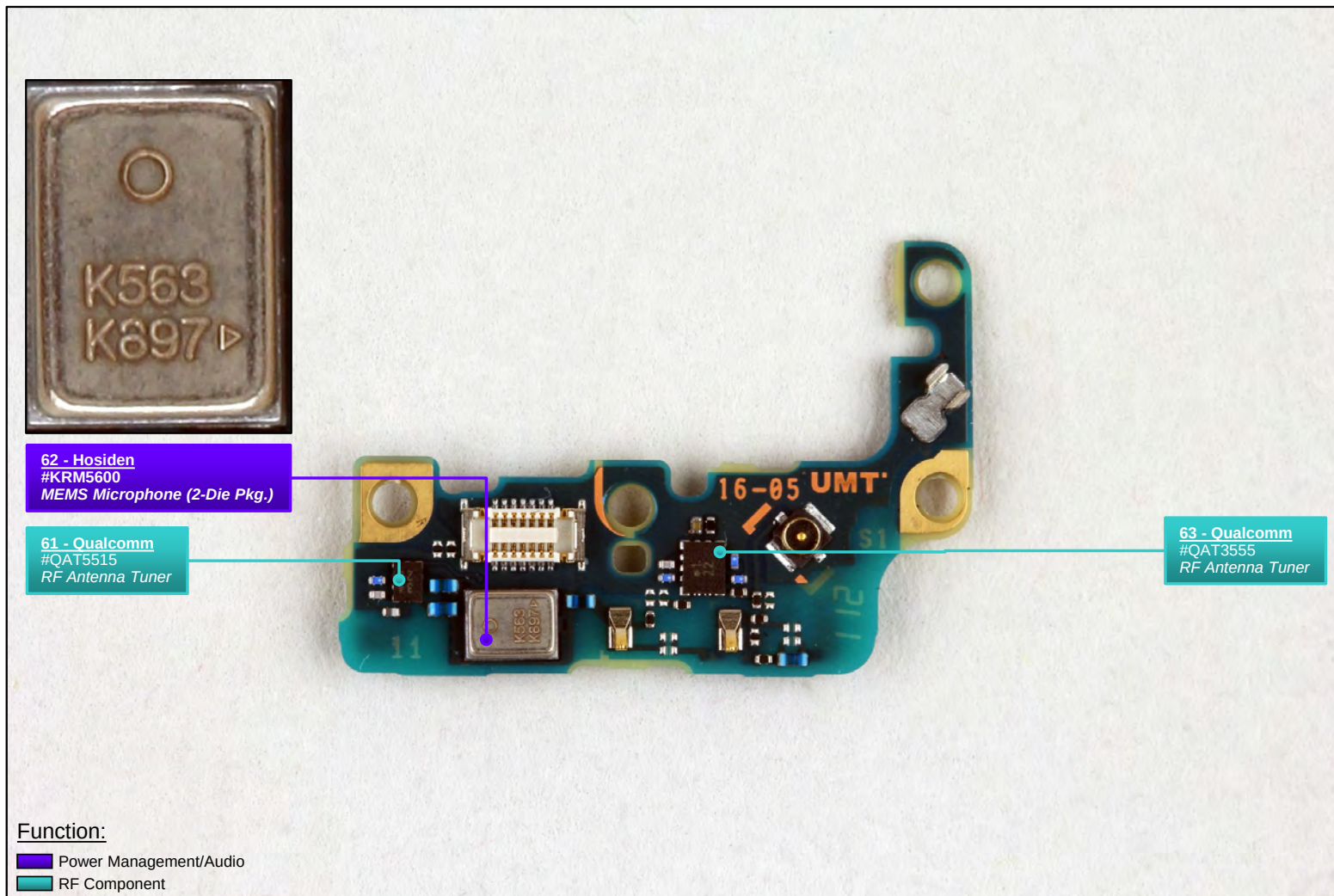
Other Substrates

Antenna Board – Side 1



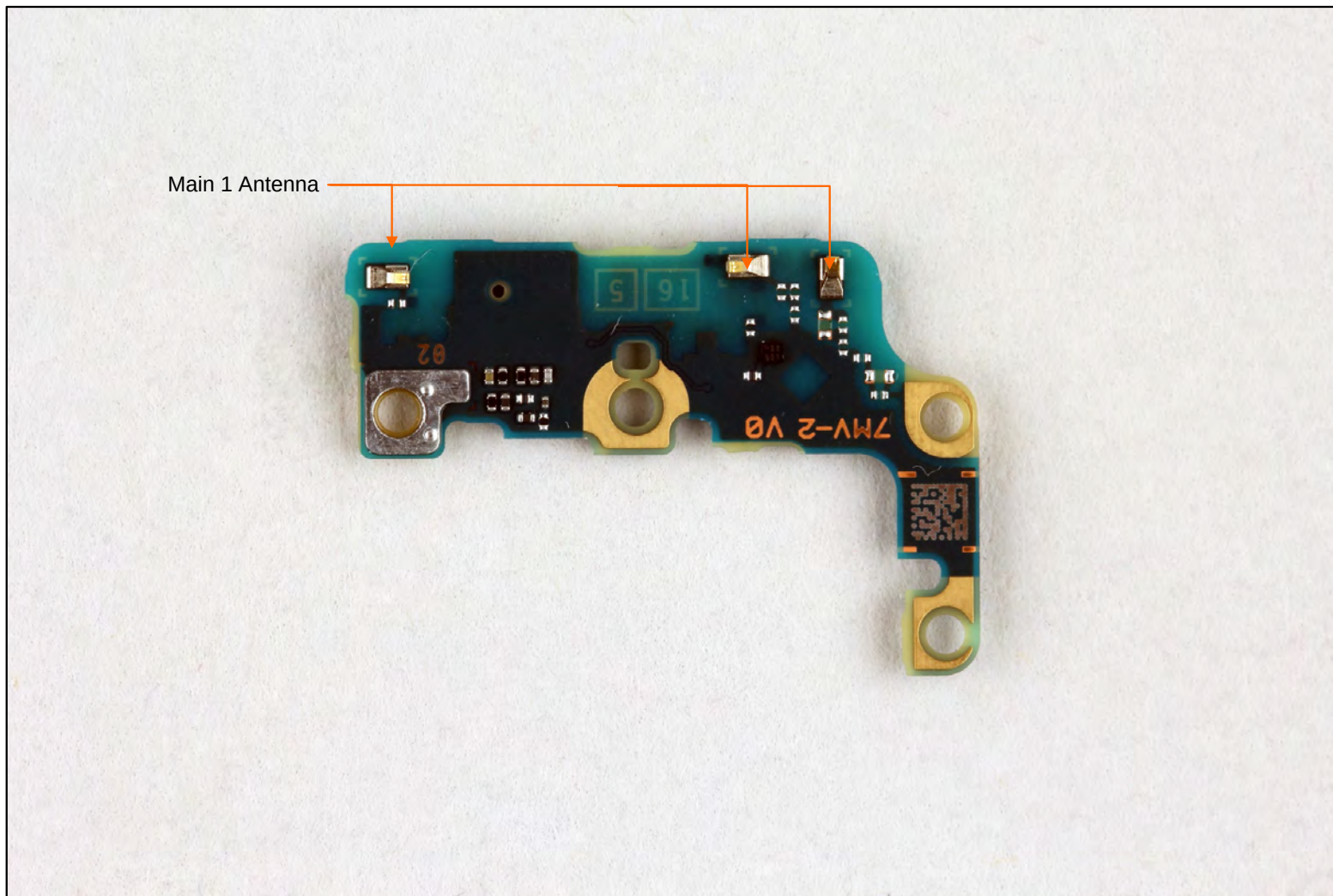
Other Substrates

Antenna Board – Side 1 IC Identification



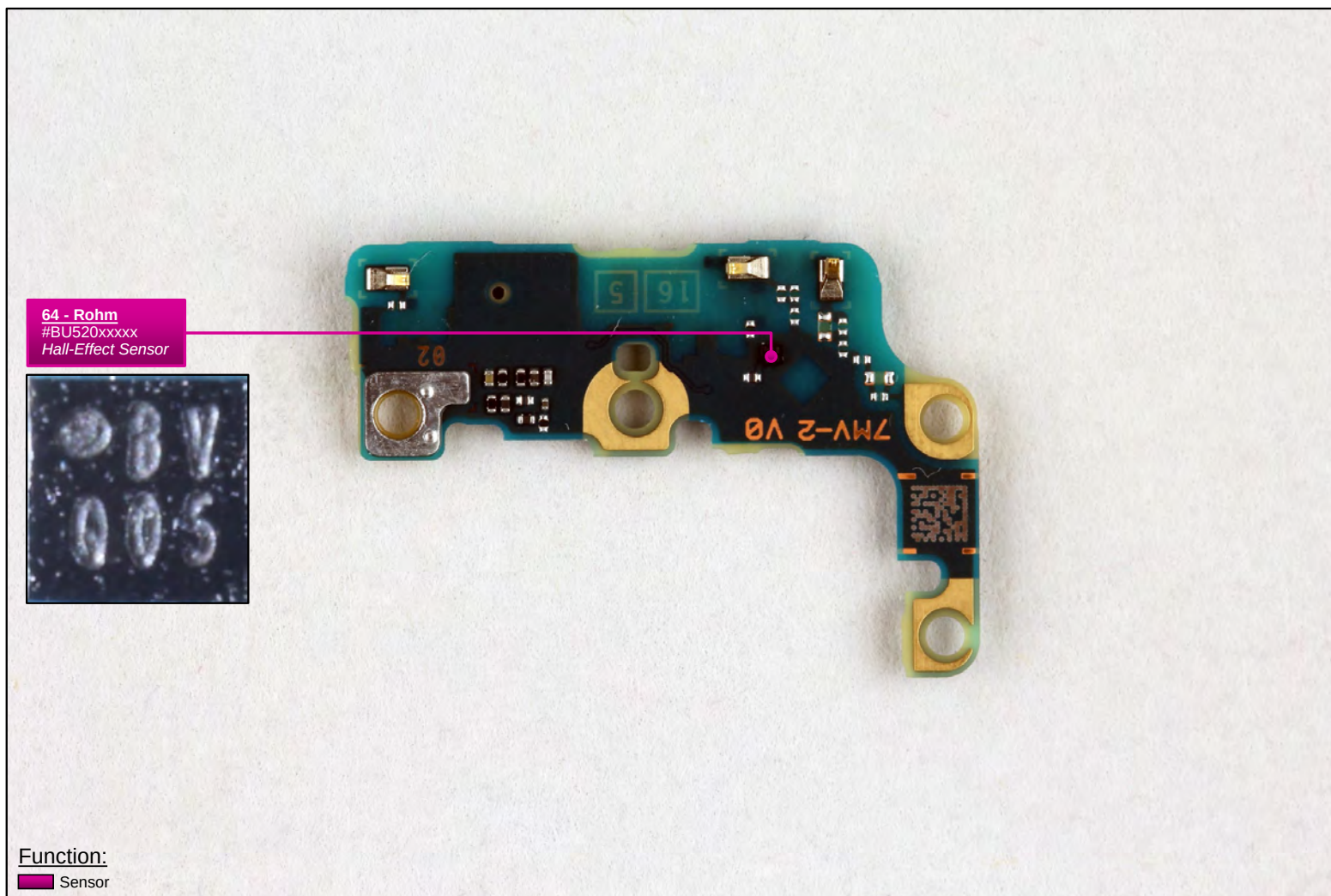
Other Substrates

Antenna Board – Side 2



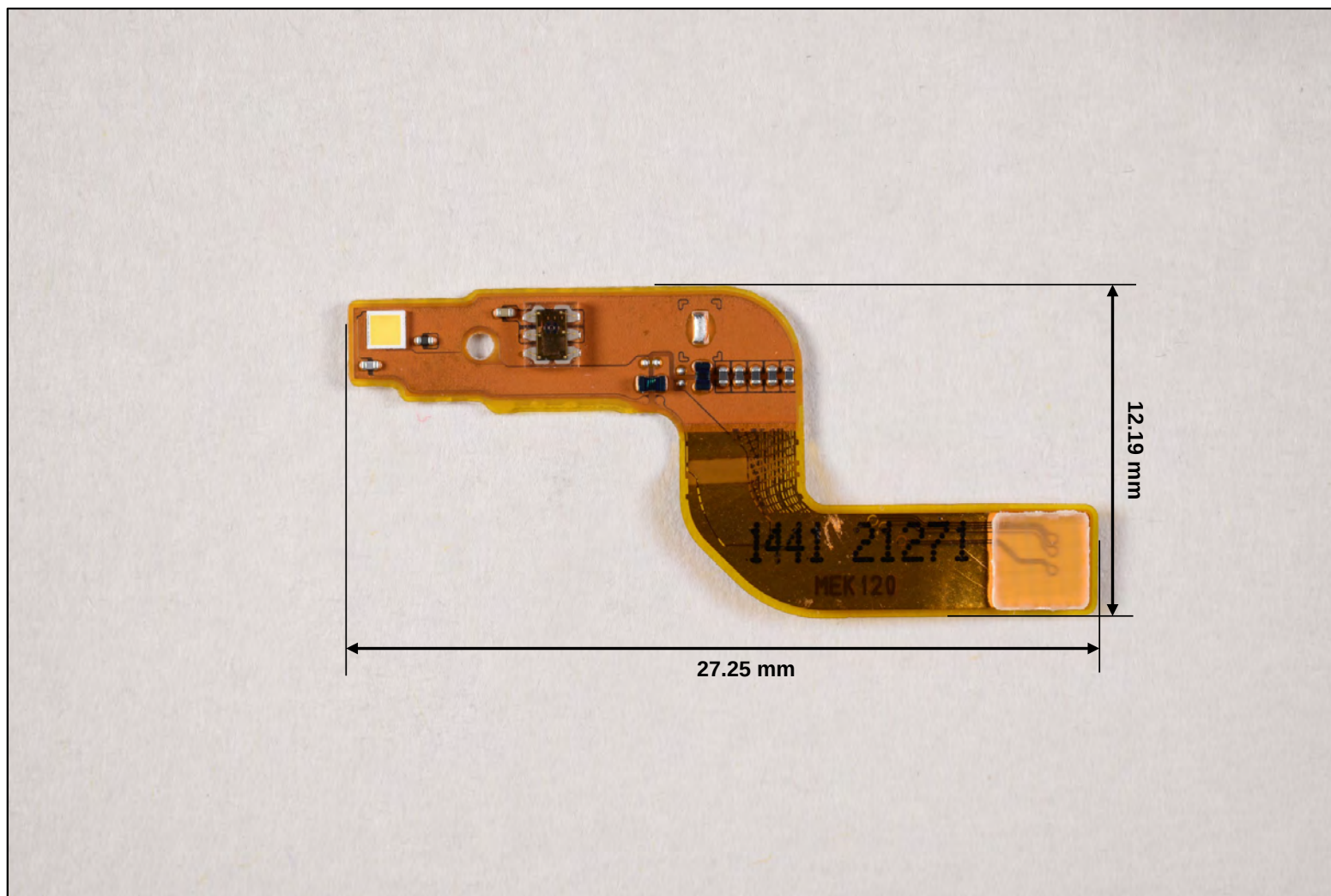
Other Substrates

Antenna Board – Side 2 IC Identification



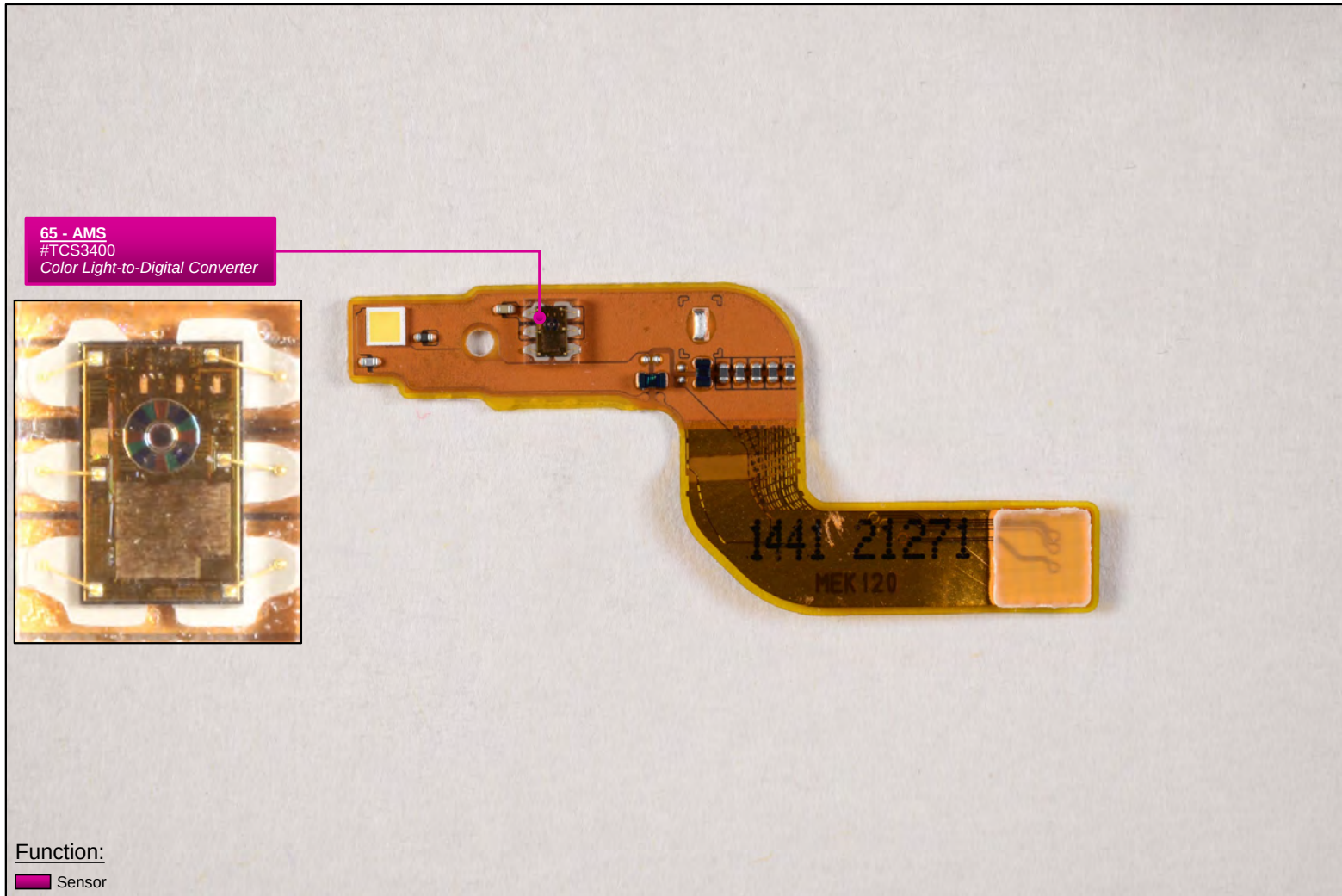
Other Substrates

Sensor Flex – Side 1



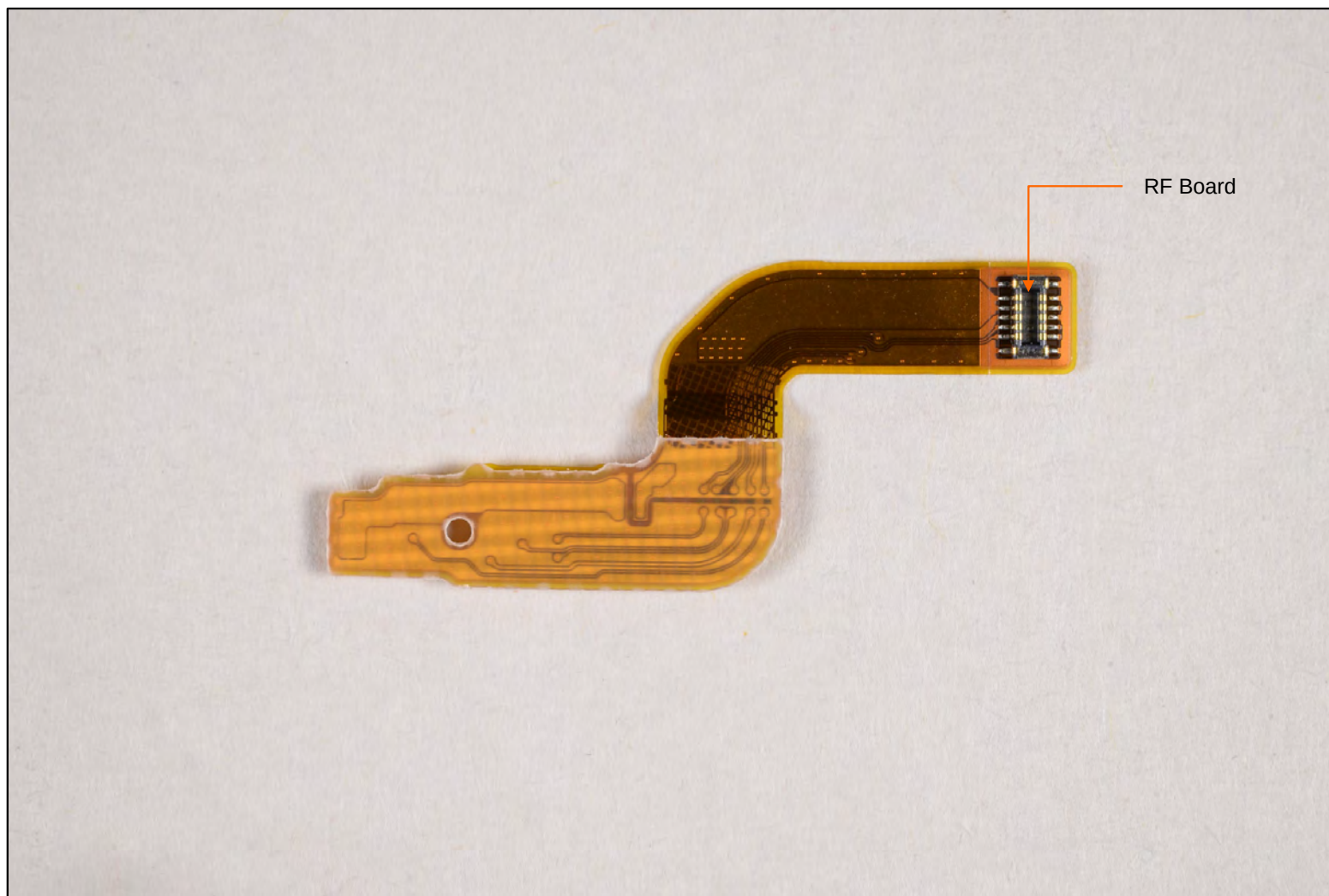
Other Substrates

Other Substrate – Side 1 IC Identification



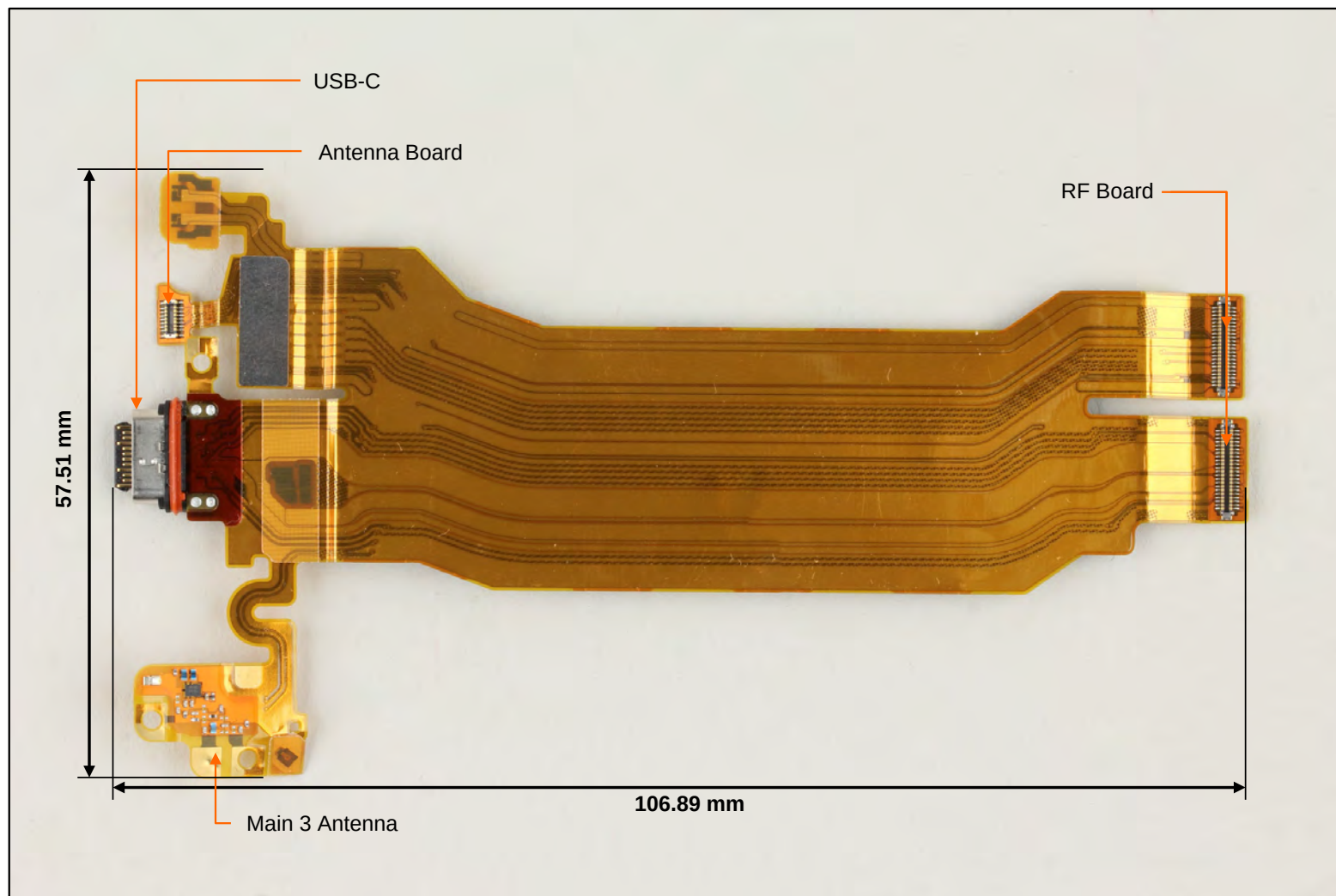
Other Substrates

Other Substrate – Side 2



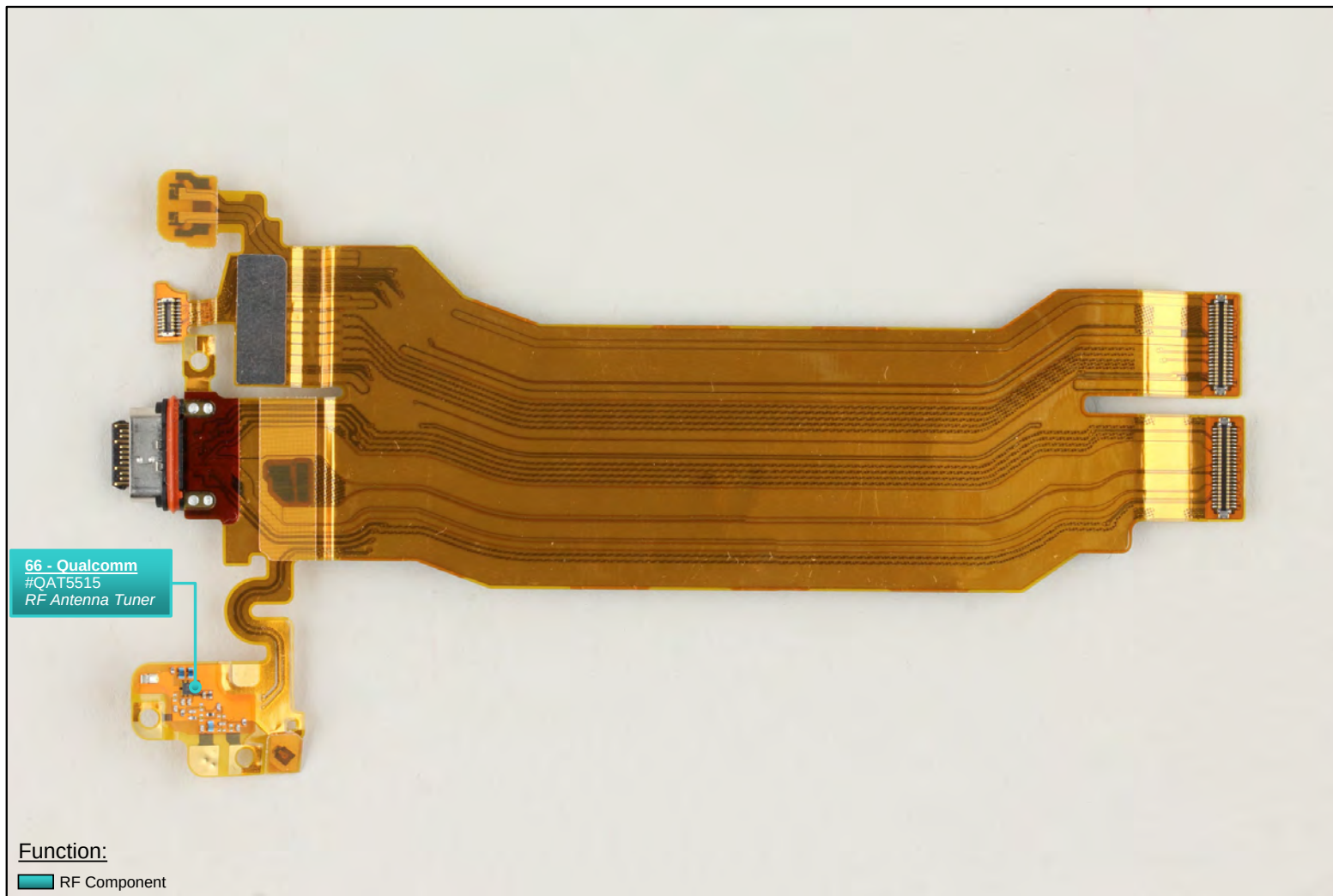
Other Substrates

USB Flex – Side 1



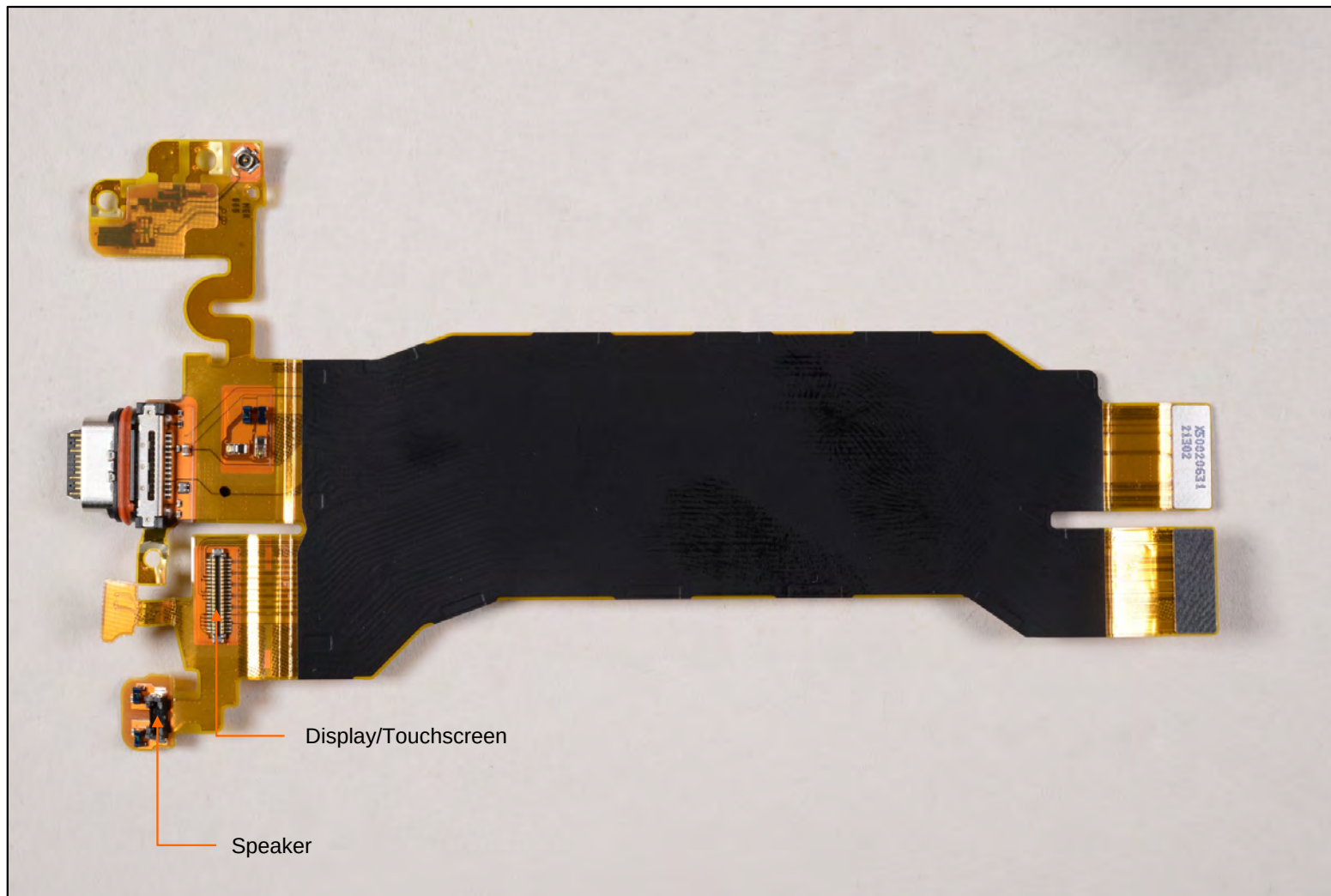
Other Substrates

USB Flex – Side 1 IC Identification



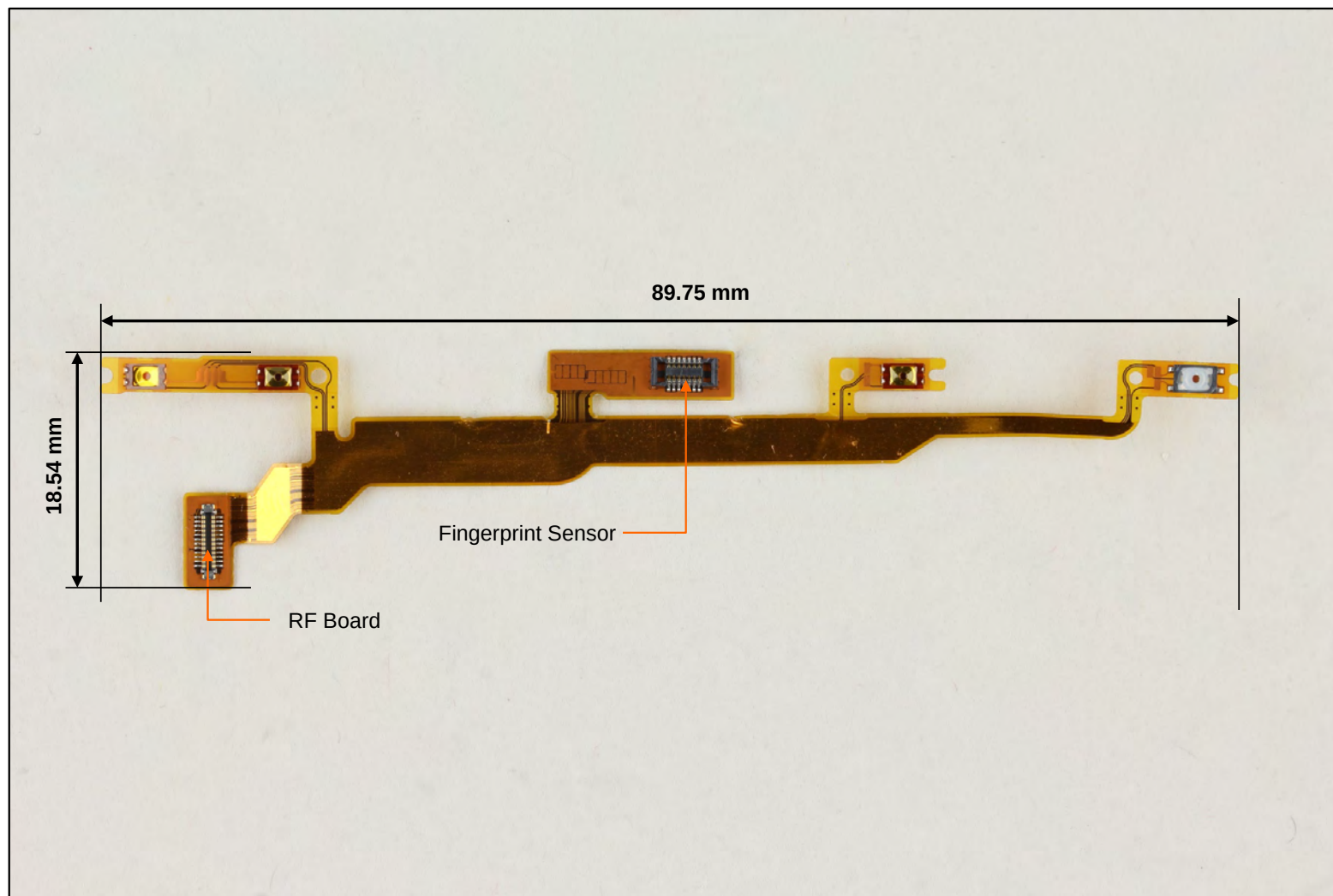
Other Substrates

USB Flex – Side 2



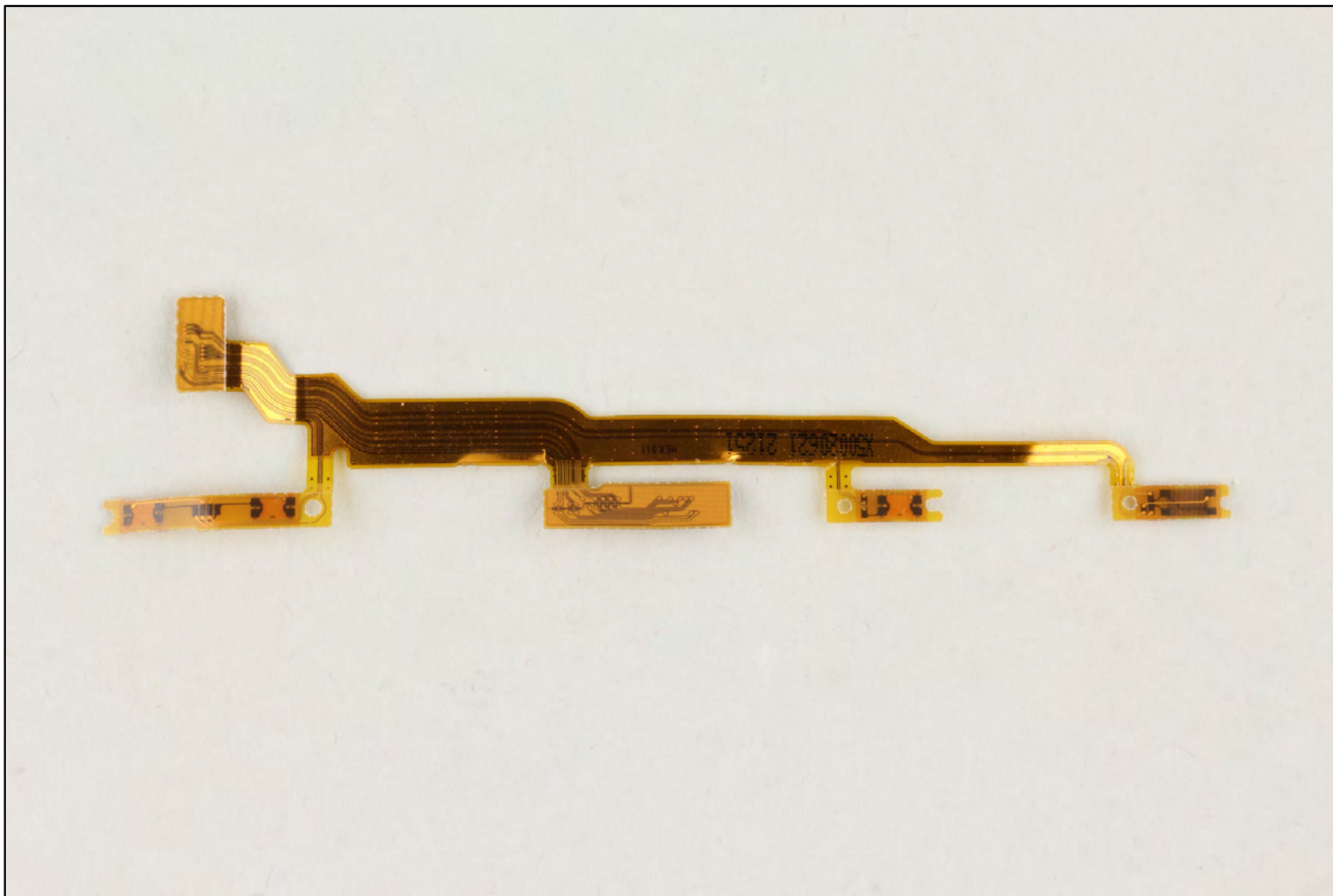
Other Substrates

Functional Buttons – Flex Side 1



Other Substrates

Functional Buttons – Flex Side 2



Summaries

Substrate Data

Substrates														
Assembly Name	Manufacturer	Core Material	Mfg. Technology	Layers	Area (cm²)	Min. Trace Pitch (mm)	Min. Trace Width (mm)	ThruVia Land Dia (mm)	ThruVia Hole Dia (mm)	BlindVia Land Dia (mm)	BlindVia Hole Dia (mm)	Thickness (mm)	Routing Density	Estimated Costs
Antenna Board	UMT	FR4	4 Layer Buildup FR4 / HF	4	1.9	0.00	0.08			0.24	0.09	0.5	39.3	\$ 0.16
Functional Button Flex	Unknown	Polyimide	2 Layer Flex w/Vias	2	4.9	0.09	0.06			0.26	0.13	0.1	29.8	\$ 0.79
Main Board	UMT	FR4	12 Layer Buildup FR4 / HF	12	27.6	0.11	0.05	0.50	0.13	0.15	0.07	0.6	120.2	\$ 8.80
RF Board	Ibiden	FR4	10 Layer Buildup FR4 / HF	10	16.4	0.10	0.03	0.45	0.13	0.16	0.04	0.5	87.5	\$ 3.81
Sensor Flex	Unknown	Polyimide	2 Layer Flex w/Vias	2	1.4	0.10	0.05			0.30	0.12	0.1	26.9	\$ 0.23
USB Flex	Unknown	Polyimide	2 Layer Flex w/Vias	2	27.7	0.10	0.05			0.33	0.13	0.2	21.6	\$ 4.48

Summaries

Electronic Assembly Metrics

Electronic Assembly Metrics by Assembly											
General Area	Assembly Name	Substrate Area (sq.cm)	Metal Layers	Circuit Area (sq.cm)	Routing Density (cm of routing per sq.cm of substrate)	Number of Components	Number of Connections	Component Density (Components/sq.cm)	Connection Density (Connections/sq.cm)	Avg. Pin Count	Assembly Weight (grams)
Main Electronics	Antenna Board	1.87	4	7.5	39.3	42	116	22.5	62.0	2.8	0.30
Main Electronics	Functional Button Flex	4.90	2	9.8	29.8	6	54	1.2	11.0	9.0	0.25
Main Electronics	Main Board	27.65	12	331.8	120.2	711	5620	25.7	203.3	7.9	10.66
Main Electronics	RF Board	16.40	10	164.0	87.5	638	2983	38.9	181.9	4.7	6.54
Main Electronics	Sensor Flex	1.38	2	2.8	26.9	13	38	9.4	27.5	2.9	0.10
Main Electronics	USB Flex	27.67	2	55.3	21.6	43	249	1.6	9.0	5.8	1.94
Main Electronics Totals		79.87	32	571.2		1453	9060	18.2	113.4	6.2	19.79
Subsystem Electronics	Battery Subsystem: Battery Board	2.55	4	10.2	25.4	21	62	8.2	24.3	3.0	1.08
Subsystem Electronics	120 Hz Display/Touchscreen Subsystem: Display/Touchscreen Flex	11.81	4	47.2	293.0	50	2374	4.2	201.0	47.5	1.31
Subsystem Electronics	8 MP Front Camera Subsystem: 8 MP Front Camera Flex	0.99	4	4.0	94.4	10	99	10.1	100.0	9.9	0.09
Subsystem Electronics	12 MP Dual Rear Camera Subsystem: 12 MP Dual Rear Camera Flex	4.91	4	19.6	83.9	38	382	7.7	77.8	10.1	1.17
Subsystem Electronics	12 MP Telephoto Rear Camera Subsystem: 12 MP Telephoto Rear Camera Flex	2.49	6	14.9	125.2	49	461	19.7	185.1	9.4	0.69
Subsystem Electronics	Fingerprint Sensor Subsystem: Fingerprint Sensor Flex	1.36	2	2.7	41.6	3	28	2.2	20.6	9.3	0.16
Subsystem Electronics Totals		24.11	24	98.7		171	3406	7.1	141.3	19.9	4.50
System Totals		104.0	56.0	669.9		1624	12466	15.6	119.9	7.7	24.29

NOTE: Occasional inconsistencies in totals may be present due to rounding error.

Summaries

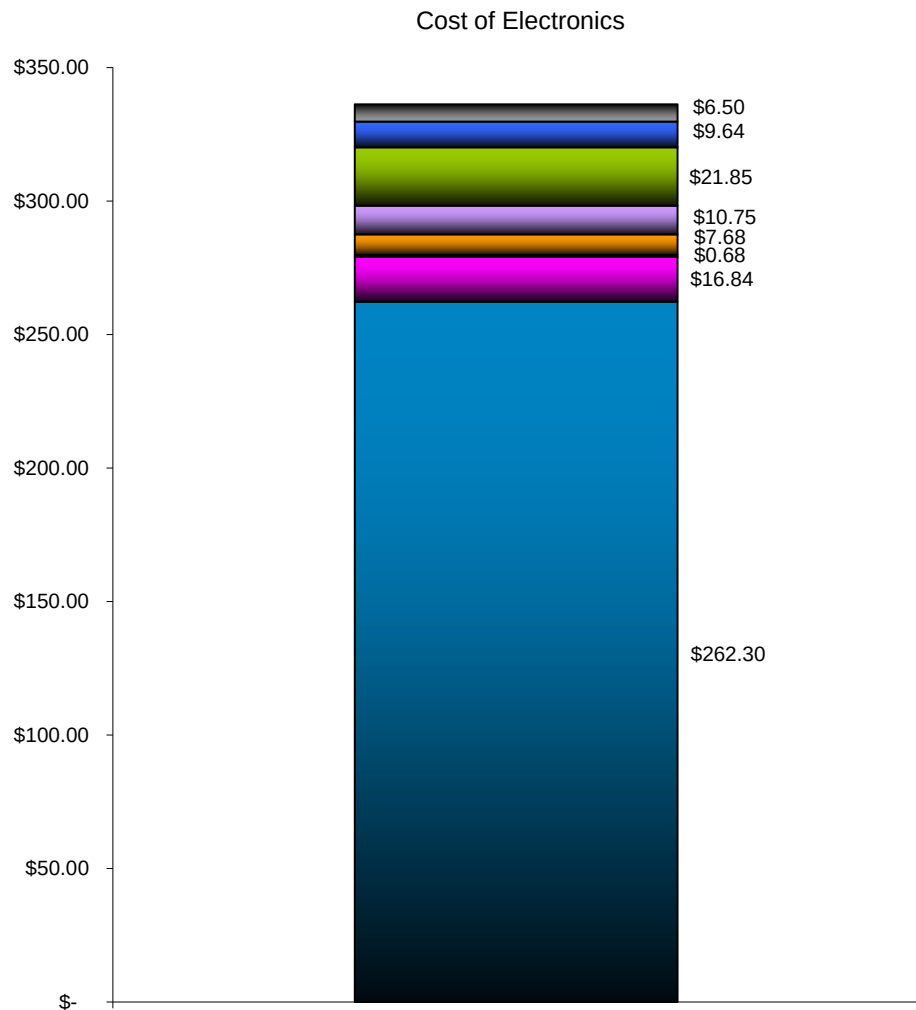
Electronic Cost by Assembly

Electronics Costs by Assembly										
General Area	Assembly Name	Total	Integrated Circuits	Modular & Odd Form Components	Small Active Components	Passive Components	Connector Components	Substrates	Insertion	Card Test
Main Electronics	Antenna Board	\$ 3.28	\$ 0.65	\$ 1.65	\$ -	\$ 0.15	\$ 0.32	\$ 0.16	\$ 0.27	\$ 0.08
Main Electronics	Functional Button Flex	\$ 1.60	\$ -	\$ 0.12	\$ -	\$ -	\$ 0.23	\$ 0.79	\$ 0.06	\$ 0.40
Main Electronics	Main Board	\$ 194.86	\$ 169.52	\$ 0.94	\$ 0.15	\$ 4.16	\$ 5.10	\$ 8.80	\$ 4.02	\$ 2.17
Main Electronics	RF Board	\$ 76.96	\$ 57.82	\$ 4.45	\$ 0.10	\$ 2.70	\$ 2.64	\$ 3.81	\$ 3.68	\$ 1.76
Main Electronics	Sensor Flex	\$ 0.94	\$ 0.15	\$ -	\$ 0.25	\$ 0.05	\$ 0.07	\$ 0.23	\$ 0.08	\$ 0.11
Main Electronics	USB Flex	\$ 8.26	\$ 0.13	\$ 1.12	\$ -	\$ 0.17	\$ 1.15	\$ 4.48	\$ 0.33	\$ 0.88
Main Electronics Totals		\$ 285.89	\$ 228.27	\$ 8.28	\$ 0.50	\$ 7.23	\$ 9.50	\$ 18.27	\$ 8.44	\$ 5.40
Subsystem Electronics	12 MP Dual Rear Camera Subsystem	\$ 26.37	\$ 20.28	\$ 4.00	\$ -	\$ 0.12	\$ 0.32	\$ 1.02	\$ 0.32	\$ 0.30
Subsystem Electronics	12 MP Telephoto Rear Camera Subsystem	\$ 12.38	\$ 6.57	\$ 4.53	\$ -	\$ 0.07	\$ 0.22	\$ 0.62	\$ 0.23	\$ 0.15
Subsystem Electronics	120 Hz Display/Touchscreen Subsystem	\$ 6.99	\$ 4.37	\$ -	\$ 0.09	\$ 0.16	\$ 0.22	\$ 1.45	\$ 0.35	\$ 0.35
Subsystem Electronics	8 MP Front Camera Subsystem	\$ 2.12	\$ 1.48	\$ -	\$ -	\$ 0.03	\$ 0.17	\$ 0.21	\$ 0.08	\$ 0.15
Subsystem Electronics	Battery Subsystem	\$ 0.96	\$ 0.25	\$ -	\$ 0.09	\$ 0.06	\$ 0.23	\$ 0.10	\$ 0.18	\$ 0.05
Subsystem Electronics	Fingerprint Sensor Subsystem	\$ 1.52	\$ 1.08	\$ 0.03	\$ -	\$ -	\$ 0.09	\$ 0.18	\$ 0.03	\$ 0.10
Subsystem Electronics Totals		\$ 50.34	\$ 34.03	\$ 8.56	\$ 0.18	\$ 0.44	\$ 1.25	\$ 3.58	\$ 1.20	\$ 1.10
System Totals		\$ 336.24	\$ 262.30	\$ 16.84	\$ 0.68	\$ 7.68	\$ 10.75	\$ 21.85	\$ 9.64	\$ 6.50

NOTE: Occasional inconsistencies in totals may be present due to rounding error.

Summaries

Electronic Component Costs



Estimated Cost of Electronics

(Includes Subsystem Electronics)

\$336.24

- Card Test
- Insertion
- Substrates
- Connector Components
- Passive Components
- Small Active Components
- Modular & Odd Form Components
- Integrated Circuits

Summaries

Electronic Counts by Assembly

Counts by Assembly													
General Area	Assembly Name	IC Package Count	IC Connections	Modular/Odd Form Components	Modular/Odd Form Component Connections	Small Active Components	Small Active Component Connections	Passive Components	Passive Component Connections	Connectors	Connector Connections	Subsystem I/Os	Opportunities
Main Electronics	Antenna Board	4	33	1	4	0	0	28	56	9	23	0	158
Main Electronics	Functional Button Flex	0	0	4	16	0	0	0	0	2	38	0	60
Main Electronics	Main Board	35	3466	8	27	5	14	629	1358	34	755	0	6331
Main Electronics	RF Board	35	1410	25	149	7	14	544	1124	27	286	0	3621
Main Electronics	Sensor Flex	1	6	0	0	1	2	10	20	1	10	0	51
Main Electronics	USB Flex	1	10	1	2	0	0	31	64	10	173	0	292
Main Electronics Totals		76	4925	39	198	13	30	1242	2622	83	1285	0	10513
Subsystem Electronics	12 MP Dual Rear Camera Subsystem	5	243	3	23	0	0	31	62	1	60	60	488
Subsystem Electronics	12 MP Telephoto Rear Camera Subsystem	5	143	1	21	0	0	17	34	1	40	40	302
Subsystem Electronics	120 Hz Display/Touchscreen Subsystem	3	2242	0	0	6	12	40	80	1	40	40	2464
Subsystem Electronics	8 MP Front Camera Subsystem	1	53	0	0	0	0	8	16	1	30	30	139
Subsystem Electronics	Battery Subsystem	2	18	0	0	1	6	15	30	3	8	6	89
Subsystem Electronics	Fingerprint Sensor Subsystem	1	10	1	4	0	0	0	0	1	14	14	45
Subsystem Electronics Totals		17	2709	5	48	7	18	111	222	8	192	190	3527
System Totals		93	7634	44	246	20	48	1353	2844	91	1477	190	14040

NOTE: Occasional inconsistencies in totals may be present due to rounding error.

Summaries

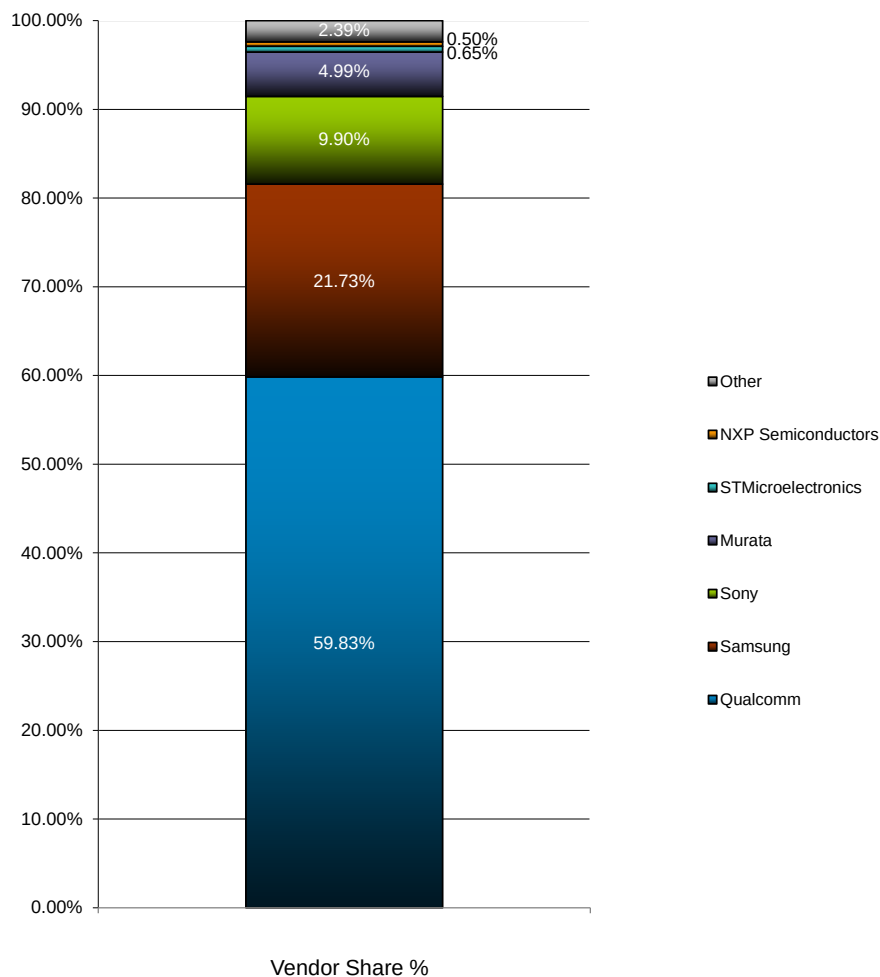
IC Metrics

IC Metrics											
General Area	Assembly Name	IC Die Count	IC Package Count	Number of Package Connections	Die Area (sq.mm)	Substrate Tiling Density (die area / substrate area)	Package Area (sq.mm)	Die Area/Package Area Ratio	Package Connections per sq.cm of Package Area	Volatile Memory (KBytes)	Non-Volatile Memory (KBytes)
Main Electronics	Antenna Board	5	4	33	6.1	0.03	14.8	0.41	222.8	0	0
Main Electronics	Main Board	46	35	3466	747.1	0.27	705.2	1.06	491.5	8388608	134217728
Main Electronics	RF Board	54	35	1410	189.2	0.12	395.0	0.48	357.0	0	0
Main Electronics	Sensor Flex	1	1	6	2.1	0.01	4.7	0.44	129.1	0	0
Main Electronics	USB Flex	1	1	10	1.2	0	1.6	0.74	621.4	0	0
Main Electronics Totals		107	76	4925	945.6		1121.3	0.84	439.2	8388608	134217728
Subsystems	12 MP Dual Rear Camera Subsystem	7	5	243	195.6		125.6	1.56	1.9	0	512
Subsystems	12 MP Telephoto Rear Camera Subsystem	7	5	143	68.1		48.3	1.41	3.0	0	8
Subsystems	120 Hz Display/Touchscreen Subsystem	3	3	2242	59.8		81.3	0.74	27.6	0	512
Subsystems	8 MP Front Camera Subsystem	1	1	53	19.6		26.9	0.73	2.0	0	0
Subsystems	Battery Subsystem	3	2	18	6.1		9.1	0.67	2.0	0	0
Subsystems	Fingerprint Sensor Subsystem	1	1	10	23.1		38.5	0.60	0.3	0	0
Subsystem Electronics Totals		22	17	2709	372.3		329.6	1.13	821.8	0	1032
System Totals		129	93	7634	1317.9		1450.9	0.91	526.2	8388608	134218760

NOTE: Occasional inconsistencies in totals may be present due to rounding error.

Summaries

IC Manufacturer Distribution



NOTE: Occasional inconsistencies in totals may be present due to rounding error.

Pkg. Brand	Cost
Qualcomm	\$156.94
Samsung	\$57.00
Sony	\$25.96
Murata	\$13.10
STMicroelectronics	\$1.71
NXP Semiconductors	\$1.30
Other	
Egis Technology	\$1.08
Cirrus Logic	\$1.03
Rohm	\$0.58
Skyworks	\$0.58
Dongwoon Anatech	\$0.55
Bosch Sensortec	\$0.30
Toshiba	\$0.27
Knowles	\$0.26
Hosiden	\$0.25
Sensortek	\$0.21
AKM Semiconductor	\$0.19
Unknown	\$0.18
ITM Semiconductor	\$0.16
AMS	\$0.15
Qorvo	\$0.12
onsemi	\$0.11
Ricoh	\$0.10
Mitsumi	\$0.09
Macronix	\$0.08

Summaries

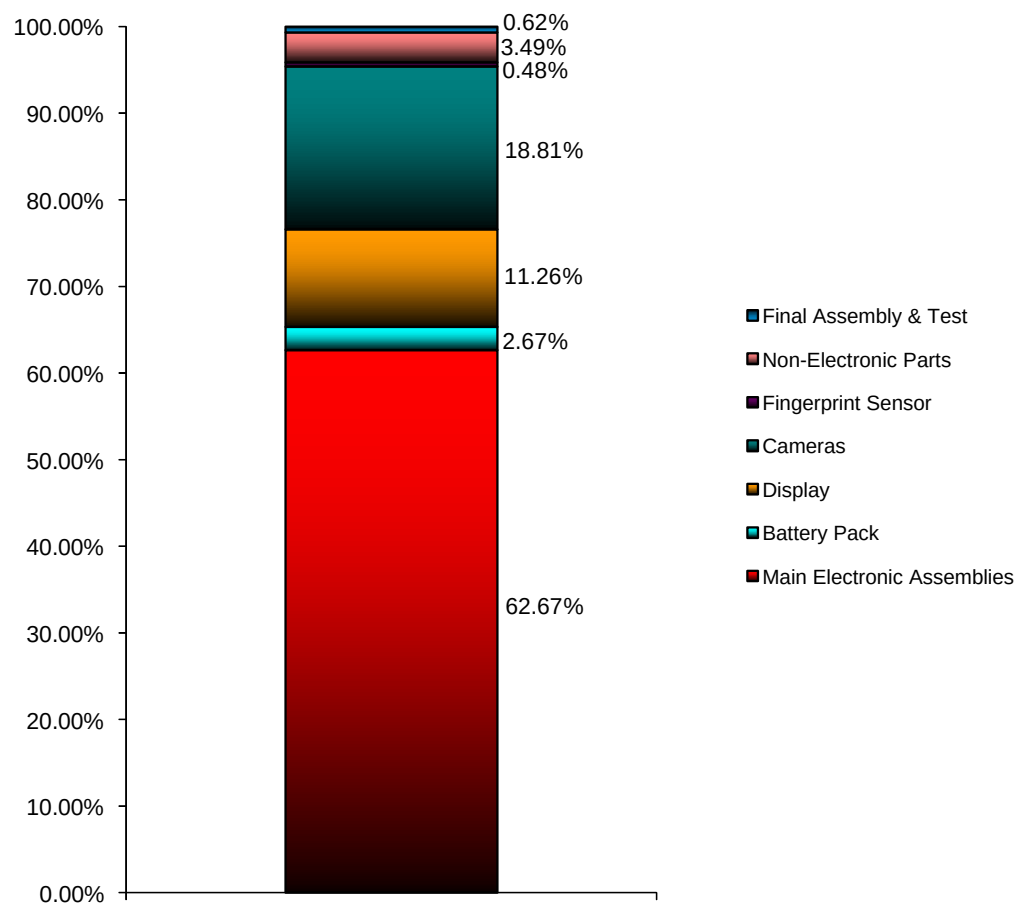
Non-Electronic Cost

Subsystem	Part ID No.	Qty	Description	Fabrication Process	Material	Dimensions (mm)	Total Weight (grams)	Est'd Cost Each	Est'd Extended Cost
Enclosures	1	1	Main Frame	Cast + Co-Molded + Machined + Tapped + Laser Printed + Spot-Welded + Pulls + Anodized	Aluminum + PBT+ GF40	156.55 x 68.25 x 7.59	26.15	\$7.890	\$7.890
	2	1	Back Cover	Molded+ Painted + Polished + Printed	Gorilla Glass	152.25 x 63.71 x 0.62	13.47	\$6.040	\$6.040
Miscellaneous	3	1	Back Cover Plastic Tape, Large	Die-Cut	Plastic + Adhesive	147.8 x 59.2 x 0.01	0.14	\$0.060	\$0.060
	4	1	Main Frame Foam Gasket	Die-Cut	Foam + Adhesive	147.8 x 59.2 x 0.2	0.62	\$0.060	\$0.060
	5	2	EMI Tape, Large	Die-Cut	Plastic + Metal + Adhesive	x	1.38	\$0.070	\$0.140
	6	17	Plastic Tape, Small	Die-Cut	Plastic + Adhesive	x	0.17	\$0.010	\$0.170
	7	1	Moisture Sensor	Die-Cut	Paper + Adhesive	2.52 x 1.08 x 0.05	0.01	\$0.010	\$0.010
	8	4	Conductive Tape w/ Foam, Small	Die-Cut	Metal + Foam + Adhesive	x	0.04	\$0.020	\$0.080
	9	1	Cooper Tape, Small	Die-Cut	Copper + Adhesive	7.61 x 4.72 x 0.06	0.01	\$0.020	\$0.020
	10	2	Plastic Label, Small	Die-Cut + Printed	Plastic + Adhesive	x	0.02	\$0.020	\$0.040
	11	9	Kapton Tape, Small	Die-Cut	Polyimide + Adhesive	x	0.09	\$0.020	\$0.180
	12	1	Gasket w/ Mesh	Co-Molded	Plastic + Rubber + Adhesive	x	0.03	\$0.020	\$0.020
	13	16	Foam Tape, Small	Die-Cut	Foam + Adhesive	x	0.16	\$0.010	\$0.160
	14	2	EMI Tape, Medium	Die-Cut	Plastic + Metal + Adhesive	x	0.52	\$0.040	\$0.080
	15	3	Thermal Pad	Die-Cut	Silicone	x	0.15	\$0.020	\$0.060
	16	19	Screw	Machined	Metal	x	11.40	\$0.010	\$0.190
	17	2	Button	Cast + Machined + Anodized + Painted	Aluminum	x	0.12	\$0.040	\$0.080
	18	1	NanoSIM/MicroSD Tray	Molded + Pulls + Printed	PC + GF10	31.21 x 14.7 x 2.35	0.16	\$0.060	\$0.060
	19	1	NanoSIM/MicroSD Handle	Cast + Painted	Aluminum + Plastic + Rubber	19.8 x 5.45 x 3.6	0.27	\$0.020	\$0.020
	20	1	LED Flash Window	Molded	Plastic	6.31 x 3.58 x 0.51	0.01	\$0.010	\$0.010
	21	1	Front Camera Rubber Support	Molded	Rubber	7.75 x 7.61 x 3.57	0.04	\$0.010	\$0.010
	22	1	Camera Frame	Cast + Anodized + Painted	Aluminum + Adhesive	43.45 x 14.91 x 1.88	1.00	\$0.120	\$0.120
	23	1	Camera Window	Molded + Polished + Painted	Glass	41.07 x 12.53 x 0.5	0.59	\$0.100	\$0.100
	24	4	Metal Part	Stamped + Formed	Metal	x	0.32	\$0.030	\$0.120
	25	1	Plastic Support #1	Molded	Plastic	80.42 x 8.25 x 4.08	0.25	\$0.010	\$0.010
	26	1	Plastic Support #2	Molded	Plastic	20.61 x 10.14 x 2.9	0.11	\$0.010	\$0.010
	27	1	Plastic Support #3	Molded	Plastic	12.32 x 12.04 x 1.7	0.02	\$0.010	\$0.010
	28	4	Plastic Support #4	Molded	Plastic	x	0.04	\$0.010	\$0.040
	29	1	Button Support #1	Co-Molded + Stamped + Pulls	Metal + PC + GF30	95.12 x 4.89 x 2.06	0.85	\$0.040	\$0.040
	30	1	Rubber Gasket #1	Co-Molded	Rubber + Plastic	27.05 x 4.51 x 1.23	0.09	\$0.010	\$0.010
	31	2	Rubber Gasket #2	Co-Molded	Rubber + Plastic	x	0.06	\$0.010	\$0.020
	32	1	Rear Camera Frame #1	Cast + Machined	Aluminum	31.04 x 20.36 x 6.2	0.71	\$0.020	\$0.020
	33	1	Rear Camera Frame #2	Cast + Machined	Aluminum	28.44 x 20.71 x 4.1	1.24	\$0.030	\$0.030
Total		106						Estimated Cost	\$15.91

Summaries

Assembly Cost Total

Total System Costs Percentage



Final Assembly & Test

Made in	Thailand
Number of parts	133
Est'd number of steps	479
Est'd time (seconds)	1821
Est'd final assembly cost	\$ 1.25
Est'd final test cost	\$ 1.60

Estimated Cost Totals

Main Electronic Assemblies	\$ 285.89
Battery Pack	\$ 12.18
Display	\$ 51.35
Cameras	\$ 85.81
Fingerprint Sensor	\$ 2.19
Non-Electronic Parts	\$ 15.91
Final Assembly & Test	\$ 2.85
Total	\$456.19

Note: An additional \$0.22 estimated for accessories and supporting materials

Cost Total Notes:

Estimated final assembly cost includes labor only.
Total cost does not include Non-recurring, R&D, G&A, IP licensing fees/royalties, software, sales & marketing, distribution.
Assumes fully scaled production.

Overview & Discussion

Cost Estimation Process

Cost modeling is tricky business. Multiple variables affect the actual production costs a manufacturer will experience, including development expenses, unit volumes, supply-and-demand in component markets, die yield-curve maturity, OEM purchasing power, and even variations in accounting practices. Different cost modeling methods employ different assumptions about how to handle these and other variables, but we can identify two basic approaches: that which seeks to track short-term variations in the inputs to the production process, and that which strives to maintain comparability of the output of the model across product families and over time.

TechInsights' philosophy in cost modeling is to emphasize consistency across products and comparability over time, rather than to track short-term fluctuations. During the past eight years, we have developed an estimation process that, while necessarily lacking an insider's knowledge of the cost factors that impact any one manufacturer, is reasonably accurate in its prediction of unit costs in high-volume production environments. We do not claim that the model will produce the "right" answer for your firm's environment. However, TechInsights does give customers a key analytical tool with a complete set of data in our Bill of Materials (BOM). The BOM allows readers to 1) scrutinize the assumptions behind our cost model and 2) modify the results based on substitution of their own component cost estimates where they have better information based on inside knowledge.

Our estimation process decomposes overall system cost into three major categories: Electronics, Mechanical, and Final Assembly. We begin by creating a complete electronics bill-of-materials (BOM). Each component from the largest ASIC to the smallest discrete resistor is entered into a BOM table with identifying attributes such as size, pitch, I/O count, package type, manufacturer, part number, estimated placement cost, and die size (if the component is an IC). Integrated circuit costs are calculated from measured die area. Using assumptions for wafer size, process type, number of die per wafer, defect density, and profit margin in combination with die area, an estimate of semiconductor cost is derived. Costs for discrete components and interconnect are derived from assumption tables which relate BOM line items to specific cost estimates by component type and estimates for part placement costs are included. For LCD display costs, we employ a model which tabulates expected cost from measurements of glass area, LCD type, and total pixel resolution. When market costs are available from alternative sources, LCD panel costs are taken from and referenced to these sources.

Costs of non-electronic components such as molded plastic enclosures and metallic components are measured in terms of weight, size, thickness, type of material, and complexity to arrive at their estimated cost. Other system items such as optics, antennas, batteries and displays are costed from a set of assumption tables derived from a combination of industry data, average high volume costs, and external sources. For final assembly, we re-build the torn-down product, tabulating stepwise assembly times as the reconstruction proceeds, to reach a total assembly time. Using a labor rate assumption for the country of origin, we then calculate final assembly cost.

The three major categories for system cost contributors can be broken down into the subcategories of ICs, other electronics parts, displays, batteries (as appropriate), camera modules, electronics assembly, non-electronic elements, and final assembly. By adding the cost estimates for each of these subcategories, an overall estimated cost is derived for the system under evaluation. Product packaging and accessories (CDs, cables, etc.) are also documented and estimated for their contribution to total cost as appropriate.

We believe our cost estimates generally fall within 15 percent of the "right answer," which itself can vary depending on the market and OEM-specific factors mentioned earlier. While the TechInsights cost model is imperfect, it yields important insights into technology and business dynamics along with good first-order contributions to system cost by component type. Additionally, the consistency of approach and gradual modification to assumptions (smoothing out frequently-shifting pricing factors) hopefully yields a credible, but user-modifiable, view of OEM high volume cost-to-produce.

Please feel free to contact us at support@techinsights.com with any comments, questions, or proposed corrections with respect to our cost estimates. We welcome your input.

Overview & Discussion

Metrics

In our product teardowns, we gather a series of metrics for product profiling and comparison. Some metrics focus on system characteristics such as total silicon area, total system semiconductor storage capacity, and total connection count. Other metrics reflect more subtle aspects of electronics assembly such as connection density, average component I/O count, and silicon tiling density. Taken as a whole, the metrics allow deeper comparison and benchmarking across multiple disciplines and multiple products. Key metrics we gather on products are described below along with their definitions and what they tend to say about the system under study. Most metrics can be used both in comparing similar products for benchmarking purposes or for quantifying differences in levels of complexity between dissimilar product types. Data fall into two categories; either “raw” measured data or ratios of these measured data sets.

Total Silicon Area: This metric describes the total area of silicon as measured from X-ray or direct measurement of ICs. The area is an expression of the enclosed bare die area and excludes packaging area. The aggregate silicon area is a good benchmark to show how integrated a design might be when making comparisons to similar systems. Total silicon area also reflects the major cost driver for most systems we examine.

Silicon Tiling Density: Ratio of Total Silicon Area to total printed circuit board “projected” area (i.e. the simple board area and not the cumulative surface area of both sides of the board). This metric directly reflects the level of efficiency and aggressiveness in integrated circuit packing and placement. Single digit Silicon Tiling Density is typical but silicon coverage of 10% - 20% has been seen in some of the most advanced products we have examined. Higher Tiling Densities often correspond with the use of chip scale packaging (CSPs) or other small form-factor IC packaging technologies. High density circuit boards are also often a supporting technology.

Number of Parts: Total component count including ICs, passives, modules, connectors, etc., each separated out in our reporting.

Number of Connections: The total number of connections corresponds to the total number of interconnects introduced by the aggregate component set and reflects any electrical connection observed (solder joints, adhesive interconnect, or connector terminal interfaces).

Opportunity Count: Opportunity Count is the total number of parts plus the total number of connections; the name reflects that each of these constituent elements represents an opportunity for failure. A high opportunity count means more complex and riskier electronics assembly.

Average Pin Count (APC): Ratio of total number of component terminals to total number of parts, at the system level. This metric reflects the ‘average’ terminal complexity of the components and often provide a signature of integration level and/or “digital-ness” of the overall product. Low APCs reflect a high number of discretes or other low-pincount devices often characteristic of analog circuitry. Conversely, high APCs are characteristic of highly integrated, high-pincount assemblies, often those composed largely of digital integrated circuits.

Connection Density: This metric is a ratio of the total Number of Connections to total printed circuit board assembly area, in units of connections per sq. inch. The metric provides data related to the Silicon Tiling Density above, but with an emphasis on complexity of I/O interconnect. For example, with a fixed Connection Density, high tiling density of low-pincount memory chips is more readily achieved than comparable silicon tiling of high pincount logic.

Part Density: This metric is a ratio of the total Number of Parts to total printed circuit board assembly area, in units of components per sq. inch. The metric provides data related to the Silicon Tiling Density and Connection Density as described above, but with an emphasis on density and complexity of component packing efficiency. For example, low Part Density of high-pincount devices can pose an equal challenge in Connection Density to high Part Density of low-pincount devices. High Part Density does reflect challenges in surface mount assembly in terms of (typically) precision of placement, number of placements, and engineering of part clearances.

Routing Density (heuristic estimate) = $3 \times (\text{Average Pin Count}) \times \sqrt{\text{Part Density}}$. The Routing Density metric is an empirically derived relationship that characterizes the wiring density of the interconnect used to support the interconnection of components in a planar electronic assembly (i.e. the circuit board). Architectural issues such as bussing or other factors affecting the regularity of wiring impact the actual Routing Density needed to support a given application, but the metric provides a ready measure of wiring complexity.

Overview & Discussion

Report Revisions

Periodically we will make revisions to these reports. In the event a revision is made, the information below may be referenced as a summary of the changes which were made.

Rev. D - Initial Release