



Apple iPhone 6s

Complementary Teardown Report with Additional Commentary



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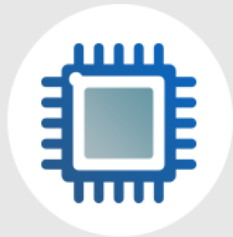
About Chipworks



Founded in 1992 to provide technical analysis capabilities to companies seeking to grow the potential of their IP and understand their competitors



Headquartered in Ottawa, Canada with over 112 employees – offices in Canada, USA, Europe, Japan, Korea and Taiwan



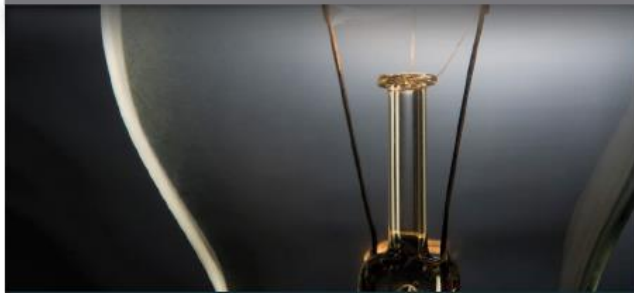
Provide solutions to over 200 global technology, semiconductor and electronics companies



Five in-house laboratories with advanced tools and equipment for in-depth, world-class analysis

Foundation of our products and services are built on

Patent Knowledge



- 60K patents read
- Our engineers read patents every day across a variety of technology areas
- Hire engineers out of their specific industry sector and teach them how to evaluate patents and speak to lawyers

Technology Expertise



- Wide spectrum of technology analysis expertise from semiconductor process and design techniques to electronics and software
- 80+ engineering projects going at any one time

Market Understanding



- Broad view of important industries – deep understanding of the key players, their products and revenue
- Proactively analyze 5 to 10 products a week
- Monitor current and future product trends to assess licensing potential

Two complementary business units



PATENT INTELLIGENCE SERVICES

Unrivalled Ability to Match Patents to Products

We provide insightful, customized solutions to help IP teams identify and fully leverage their best patents, protect their competitive position, prepare for litigation, and develop successful IP strategies.

COMPETITIVE TECHNICAL INTELLIGENCE

The Most Accurate Analysis of High Volume Consumer Devices

We provide timely, high-quality, and independent competitive technical analysis on which products are winning and why.



Specifications



- Manufacturer: Apple Inc.
- Product name: iPhone 6s
- Model number: A1688
- Size: 67.1 mm x 138.3 mm x 7.1 mm
- System: OS iOS 9

Specifications

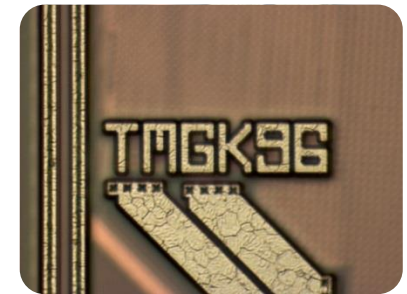
BASIC	Product Name	iPhone 6s, A1688					
	Manufacturer	Apple Inc.					
	Minimum Size (mm)	67.1 x 138.3 x 7.1					
	Weight (g)	143					
BATTERY TIME	Standby (hours)	3.9G: FDD-LTE: –	3.9G: TD-LTE: –	3G: WCDMA: 240	3G: CDMA: –	3G: TD-SCDMA: –	2G: GSM: –
	Voice Call (minutes)	3.9G: FDD-LTE: –	3.9G: TD-LTE: –	3G: WCDMA: 840	3G: CDMA: –	3G: TD-SCDMA: –	2G: GSM: –
	Video Call (minutes)	n/a					
	Digital TV (minutes)	n/a					
	Other	n/a					
	Battery (size in mm)	Li-ion polymer, 3.82 V, 1,715 mAh (38.17 x 95.03 x 2.87)					
SYSTEM	OS	iOS 9					
	CPU / ROM / RAM	CPU: Apple A9, dual-core, 1.8 GHz, embedded M9 motion co-processor ROM: 16 GByte RAM: 2 GByte					
DISPLAY	Main Display	4.7-inch, 16,777,216 colors, 750 x 1334 dot, Retina HD, IPS LCD					
	Sub Display	n/a					
COMMUNICATION	Protocol (MHz)	3.9G: FDD-LTE: 700, 800, 850, 900, 1700, 1800, 1900, 2100, 2100, 2600 3.9G: TD-LTE: n/a 3G: WCDMA: 850, 900, 1700, 1900, 2100 3G: CDMA: 800, 1700, 1900, 2100 3G: TD-SCDMA: n/a 2G: GSM: 850, 900, 1800, 1900					
	HSDPA/HSUPA (Mbps)	3G: 42.2/5.76			LTE: 300/50		
	Wireless LAN	802.11 a/b/g/n/ac					
	Bluetooth	4.2					
	GPS	Yes					
	Infrared	n/a					
	RFID/NFC	NFC					
CAMERA	Main Camera	12.0 MP CMOS with auto-focus, LED flash					
	Sub Camera	5.0 MP CMOS					
SENSOR	Motion	Accelerometer: Yes	Digital Compass: Yes	Gyroscope: Yes	Barometer: Yes		
		Gesture Recognition: n/a	-	-	-		
	Ambient	Light Sensor: Yes	Proximity Sensor: Yes	Temperature Sensor: n/a	Humidity Sensor: n/a		
	Security	Fingerprint Sensor: Yes	-	-	-		
	Healthcare	Heart Rate Monitor: n/a					
	Touch Panel	Capacitive, multi touch, 3D					
OTHER	HDMI	n/a					
	MicroSD (max. capacity)	n/a					
	Waterproof/Anti-shock	n/a					

Apple iPhone 6s Smartphone

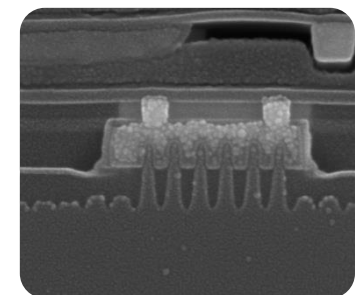
Application Processors – Dual Sourced

- Apple has dual sourced its A9 Application Processor from Samsung (14 nm FinFET) and TSMC (16 nm FinFET). Chipworks will be doing deep structural analysis of the TSMC process.
- Chipworks is working to confirm if the process is TSMC 16FF or 16FF+. We will be able to differentiate between these two processes once we understand the standard cell architecture and BEOL integration, where major differences are expected. Stay tuned!
- **Preliminary SEM and TEM images will be available to report pre-purchasers**

Chipworks Reports – TSMC 16 nm FinFET Process		Date
Basic Functional Analysis Report (FAR-1509-803) \$7,500		~Late October
<ul style="list-style-type: none">• Package photos/xrays• Metal 1 or polysilicon die photo• Die size measurements	<ul style="list-style-type: none">• Digital, analog, and memory are annotated• Node assessment• IC cost estimate	
Advance CMOS Essentials Project (ACE-1509-801) \$12,000		~Early December
<ul style="list-style-type: none">• Concise analyst's summary of critical device metrics, TEM-EDS results, and salient features supported by the following image folders:<ul style="list-style-type: none">• SEM bevel: logic region and SRAM with SEM cross-section of the general device structure, metals, dielectrics, and detail of the FEOL structures• TEM cross-sections: parallel and perpendicular to the transistor gates		
Structural Analysis Report (SAR-1504-802) \$24,500		~Late November
<ul style="list-style-type: none">• TSMC FinFET process• Top-down layer-by-layer analysis of the back end processing• Analysis of the front end processing including SEM and TEM imaging	<ul style="list-style-type: none">• Memory cell analysis• Layout – detailed SEM and optical plan-view images	
Related Reports <ul style="list-style-type: none">• Samsung 14 nm FinFET suite of reports• Intel 14 nm FinFET Cherry Trail suite of reports• Intel 14 nm FinFET Broadwell suite of reports		

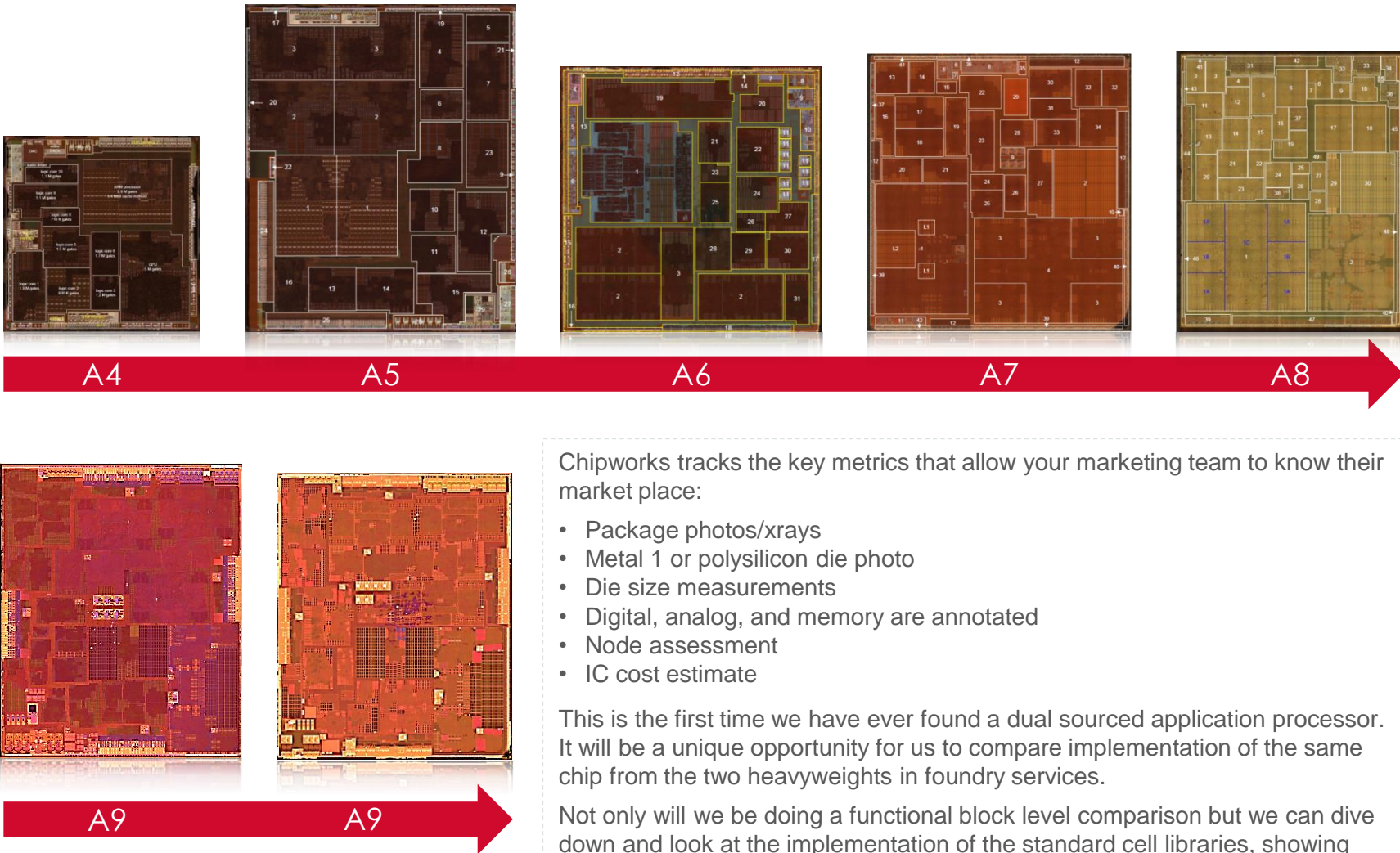


APL1022 Die Mark



TSMC 16 nm FinFET

Application Processors – Dual Sourced



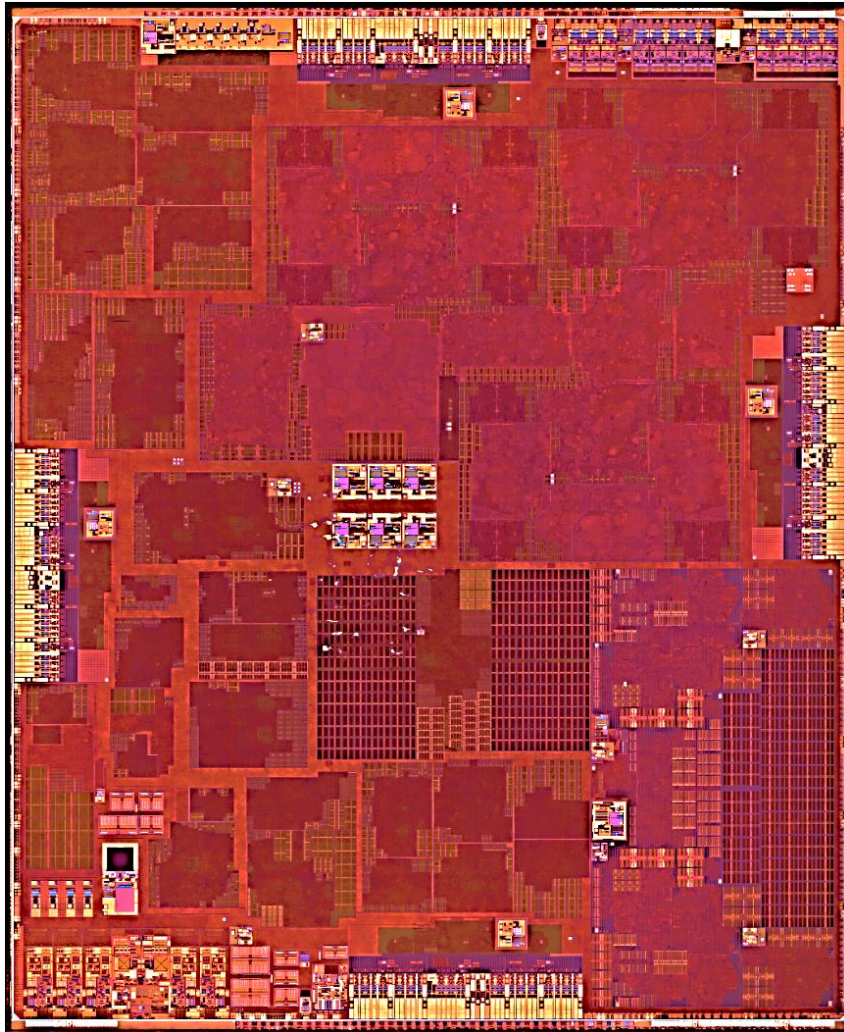
Chipworks tracks the key metrics that allow your marketing team to know their market place:

- Package photos/xrays
- Metal 1 or polysilicon die photo
- Die size measurements
- Digital, analog, and memory are annotated
- Node assessment
- IC cost estimate

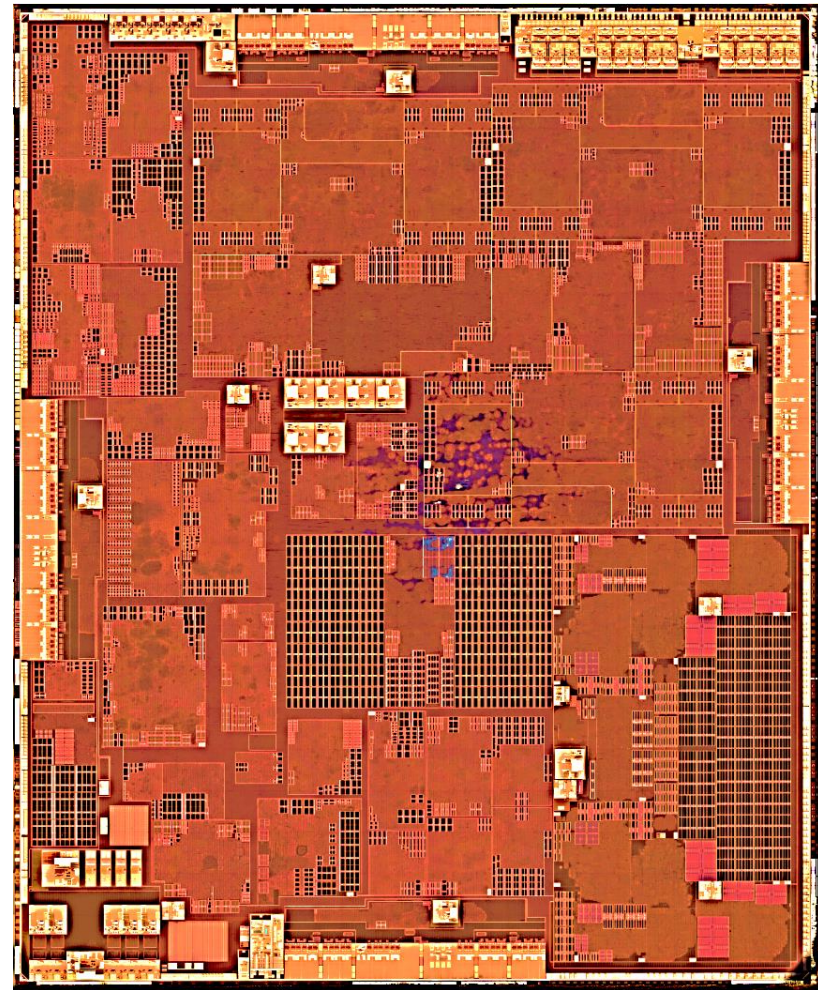
This is the first time we have ever found a dual sourced application processor. It will be a unique opportunity for us to compare implementation of the same chip from the two heavyweights in foundry services.

Not only will we be doing a functional block level comparison but we can dive down and look at the implementation of the standard cell libraries, showing cell layout and comparing routing efficiencies.

Application Processors – Sneak Peak, as promised!



APL1022 TSMC 16 nm FinFET

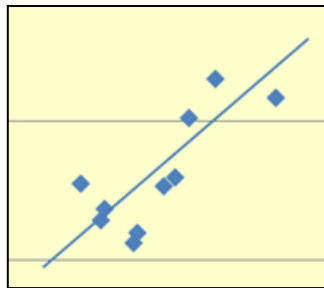


APL0898 Samsung 14 nm FinFET

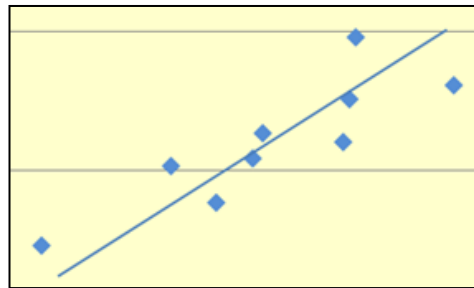
NOTE: False color and image sharpening has been applied to the photos for the purposes of this article. High resolution images in Chipworks reports are not retouched.

Transistor Characterization Reports - compare reality to foundry targets and publications.

Chipworks recently completed transistor characterization of the Samsung 14 nm FinFET process (logic). Chipworks provides universal transistor curves that will allow you to easily compare between foundries.



NMOS Universal Curve

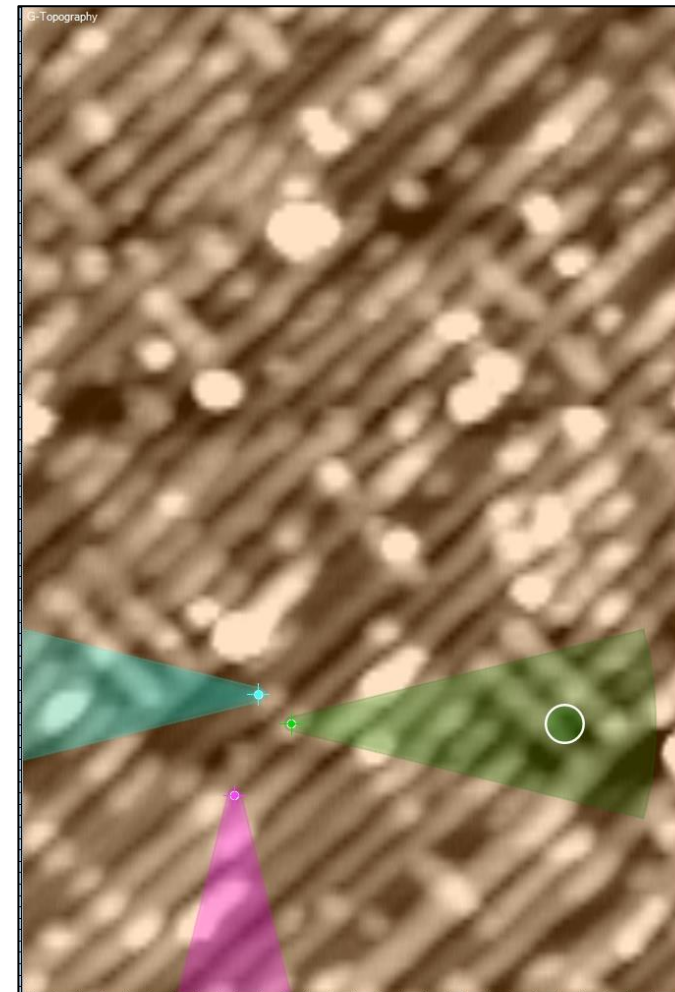


PMOS Universal Curve

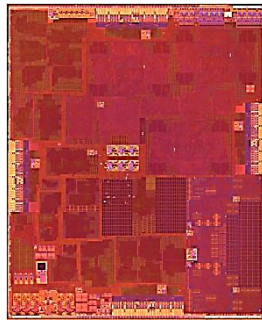
Measurements include:

- AFP Image of the Measurement Area for NMOS Transistor 1
- Transfer Characteristics ($V_{DS} = 0.7 \text{ V}$)
- Extrapolated Linear V_T ($V_{DS} = 0.05 \text{ V}$)
- Transconductance (g_m) ($V_{DS} = 0.7 \text{ V}$)
- Subthreshold Swing (S) ($V_{DS} = 0.7 \text{ V}$)
- Transfer Characteristics Versus V_{DS}
- DIBL ($\Delta V_{GS}/\Delta V_{DS}$)

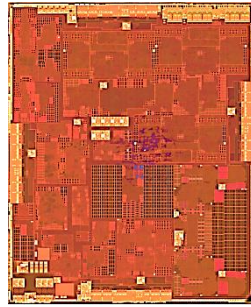
Related Transistor Reports	Report Code
TSMC 16 nm FinFET (logic)	Under consideration
Samsung 14 nm FinFET (logic)	TCR-1504-801
Intel 14 nm FinFET (SRAM)	TCR-1409-801



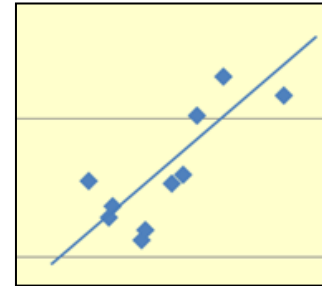
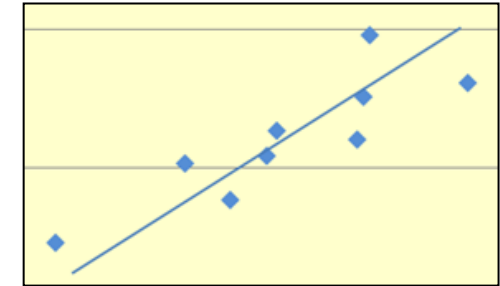
AFP image showing the probe locations for NMOS transistor CPU logic



A9(TSMC)



A9(SEC)

AreaNMOS Universal
CurvePMOS Universal
Curve**Perf/Power**

In-Depth Technology Benchmarking

- Based on phone-level benchmarks, the otherwise identical iPhone 6s are not the same
<https://m.youtube.com/watch?v=0bAeJ5fJ1M0>
- Apple's Dual-Source of the A9 applications processor allows Chipworks a unique opportunity to directly benchmark two technologies in the exact same design
 - Process analysis and costing
 - Standard cell implementation and routing efficiency
 - Transistor characterization and capacitance modeling
 - Block-level power measurements
- Perf/Power/Area metric would indicate Samsung should have the lead in battery life based on area. However, our measurement of the 14LPE process on Exynos has shown a weak NMOS, can this be the cause of the power difference between TSMC and Samsung A9s?

Product Information



Teardown

display, touch panel,
and FPC #3



center panel



Li-ion polymer
battery



PCB #1



rear cover

FPC #2



FPC #1

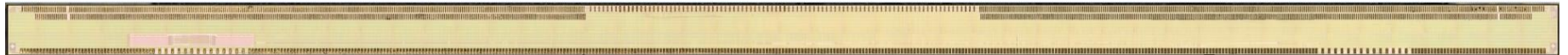
Display Driver Win for Synaptics

Synaptics' Q3 2014 acquisition of Renesas let them reap the rewards of the Renesas design win in the iPhone 6 and 6 plus, and Synaptics repeats this year with the design win for the iPhone 6s and 6s plus DDI.

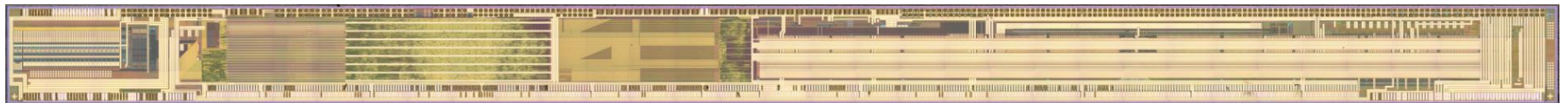
Looking forward Synaptics may be able to leverage this design win to move Apple towards a touch screen controller and display driver integrated solution. Chipworks first catalogued this disruptive design in the ZTE Q7 S6 Lux..

According to Synaptics there are a number of key benefits to TDDI:

- **Best-in-Class Performance** – synchronizes touch sensing and display driving to virtually eliminate display noise and offer best-in-class capacitive touch performance.
- **Thinner Form Factors** – Integration of the touch sensor into the display results in thinner form factors.
- **Brighter Displays** – Fewer layers in the touchscreen results in a brighter display, or longer battery life for the same brightness.
- **Lower System Cost** – Reducing the number of components, eliminating lamination steps and increasing manufacturing yield lowers overall system cost for OEMs.



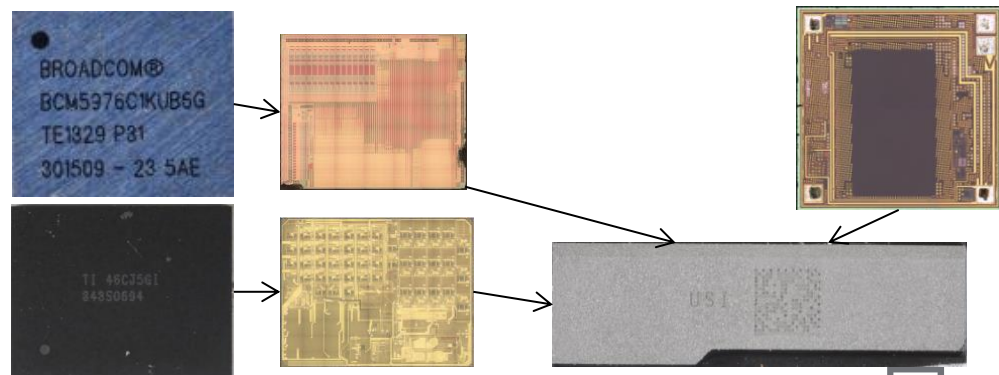
Synaptics iPhone 6S Display Driver IC R63318 (DDI)



Synaptics Touch and Display Driver Integration (TDDI) first generation, ZTE Q7 S6 Lux. Currently sampling second generation.

Touch Screen Controller

The touch screen controller was comprised of a two chip solution in the iPhone 6, this socket was held by Broadcom and Texas Instruments. In the iPhone 6S these two chips were combined into a single package with a third unknown chip. The next evolutionary step would be to move to an integrated touch and display driver solution.



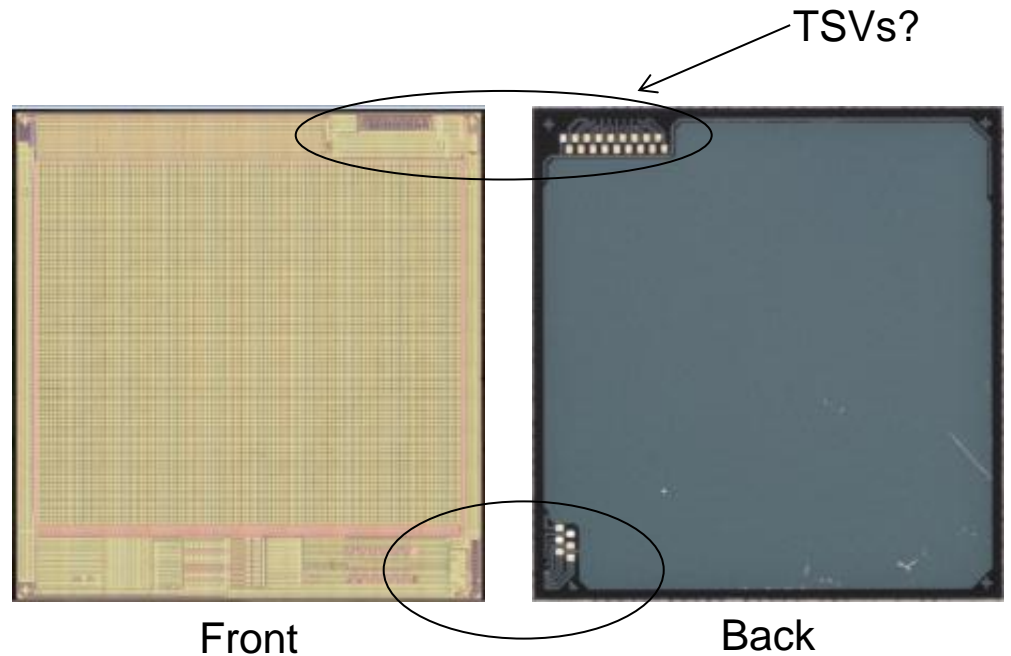
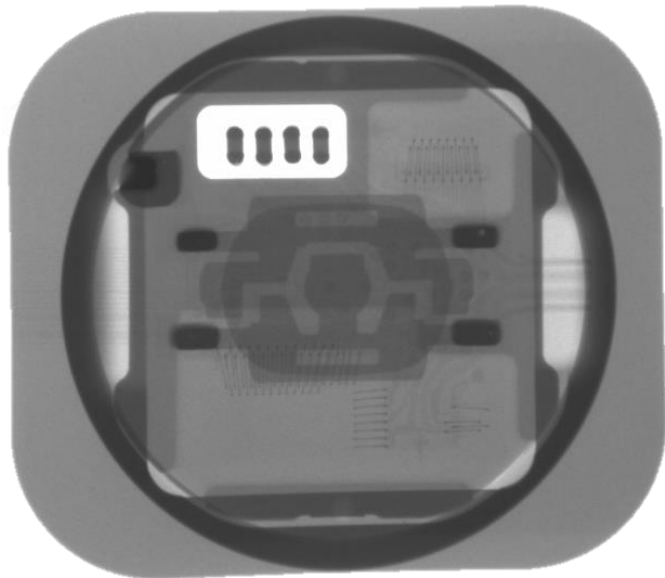
NOTE: Chips are not scaled.

Fingerprint Sensor – 2nd Generation

The last three generations of the iPhone (5, 5s, 6) have contained the same fingerprint sensor. Apple is now releasing their 2nd generation fingerprint sensor. We were excited to find contacts going from the front to the back of the die. Could this be TSMC’s first demonstration of TSVs?

We have already launched two reports on this new fingerprint sensor and are considering deep circuit analysis.

Related Fingerprint Sensor Reports	Report Code
Apple iPhone 6S Fingerprint Sensor Basic Functional Analysis Report	FAR-1510-802 Analysis Underway
Apple iPhone 6S Fingerprint Sensor Package Report	PKG-1510-801 Analysis Underway
Apple iPhone 6S Fingerprint Sensor Circuit Analysis Report	Under consideration Please contact us

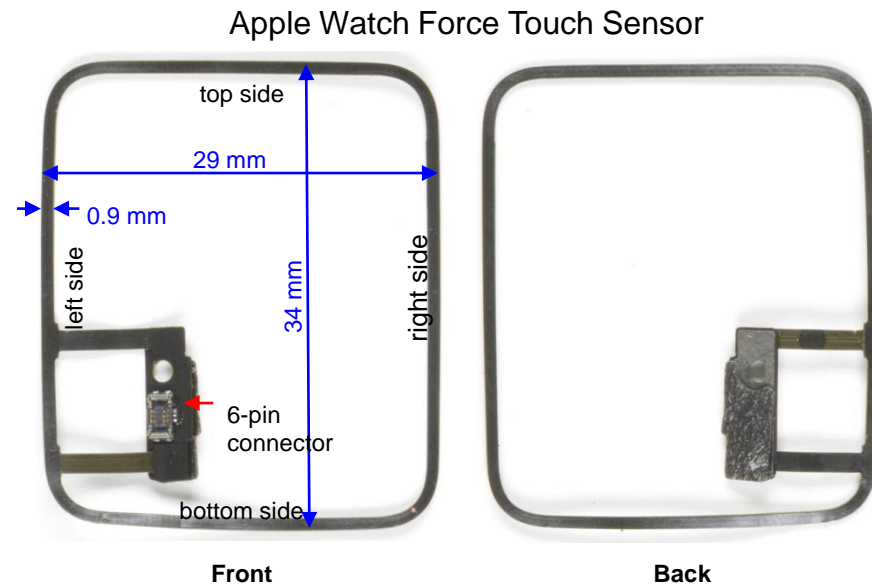


3D Touch

Apple has been improving its user interface across its product lines by adding a force-based touch features to the Macbook, Apple Watch and iPhone 6S.

Chipworks recently completed systems analysis of the Apple Watch Force Touch sensor. This report examines market adoption and penetration for force-based touch, intellectual landscape, and the technology behind the Apple Watch Force Touch. It includes findings about the construction, connectivity, and operation.

We have just begun system analysis of the iPhone 6S 3D Touch. Contact us to find out more!



Related Fingerprint Sensor Reports	Report Code
Apple iPhone 6S Force Touch Exploratory Report	EXR-1510-801 Analysis Underway
Apple Watch Force Touch Sensor Exploratory Report	EXR-1507-801

3D Touch – Apple’s adoption and what it may mean to the OEM World

An intellectual property perspective

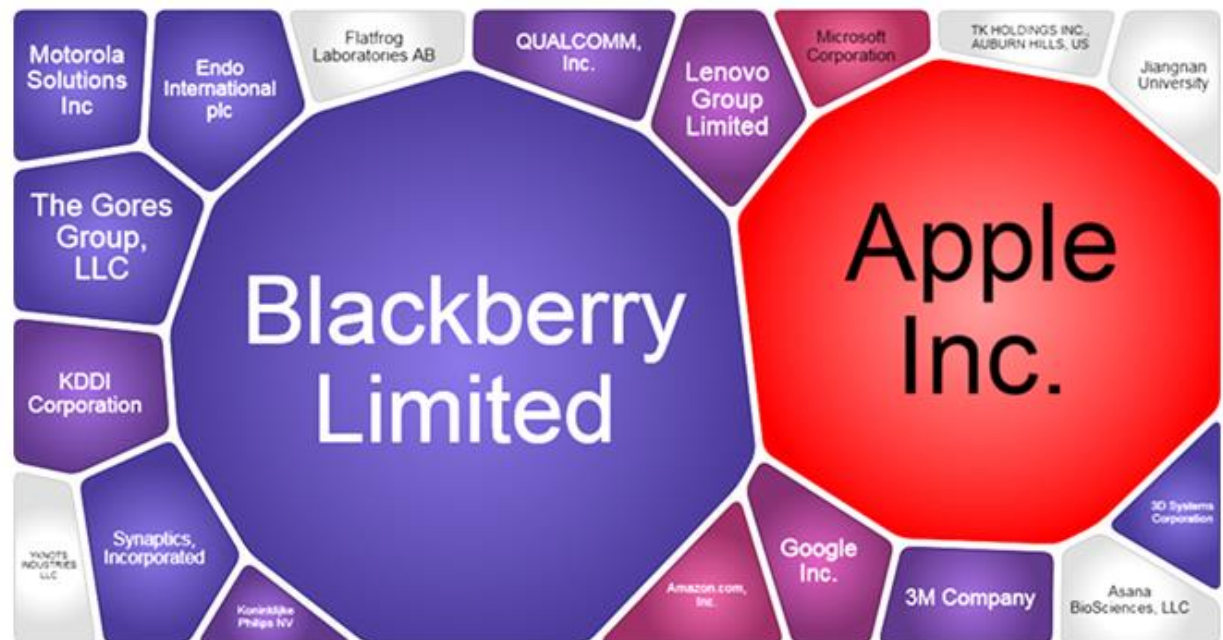
On September 2, just a couple of days before Apple’s iPhone 6s announcement, Huawei announced its own Android-based smartphone, the Mate S, with a Force Touch-inspired pressure sensitive screen.

It seems Force Touch technology applications are going to get crowded rather quickly. We decided to investigate who is patenting in the area. In other words, who would be interested in and prepared for potential licensing and litigation? We also wanted to find patents possibly applicable to Apple’s existing and future Force Touch products.

There are already some reports on BlackBerry (then RIM) patenting in the area (US9092057) at the time of their Storm smartphone release in 2008. This report, however, missed the point, since the patents discussed relate more to haptic feedback than to the force touch applied in Apple products.

A quick keyword search shows us the filing companies.

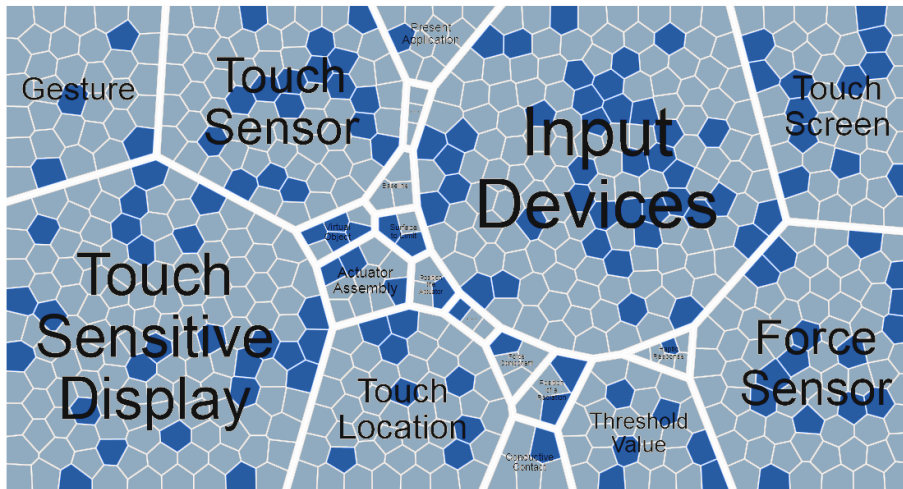
One glaring omission seems to be Huawei. This is odd, as one would expect they will become one of the preferred targets in any potential war. Expect Huawei to go after patent acquisitions.



Created using 2015 Innography, Inc.

3D Touch – Apple’s adoption and what it may mean to the OEM World An intellectual property perspective

What are patented topics?



Created using 2015 Innography, Inc.

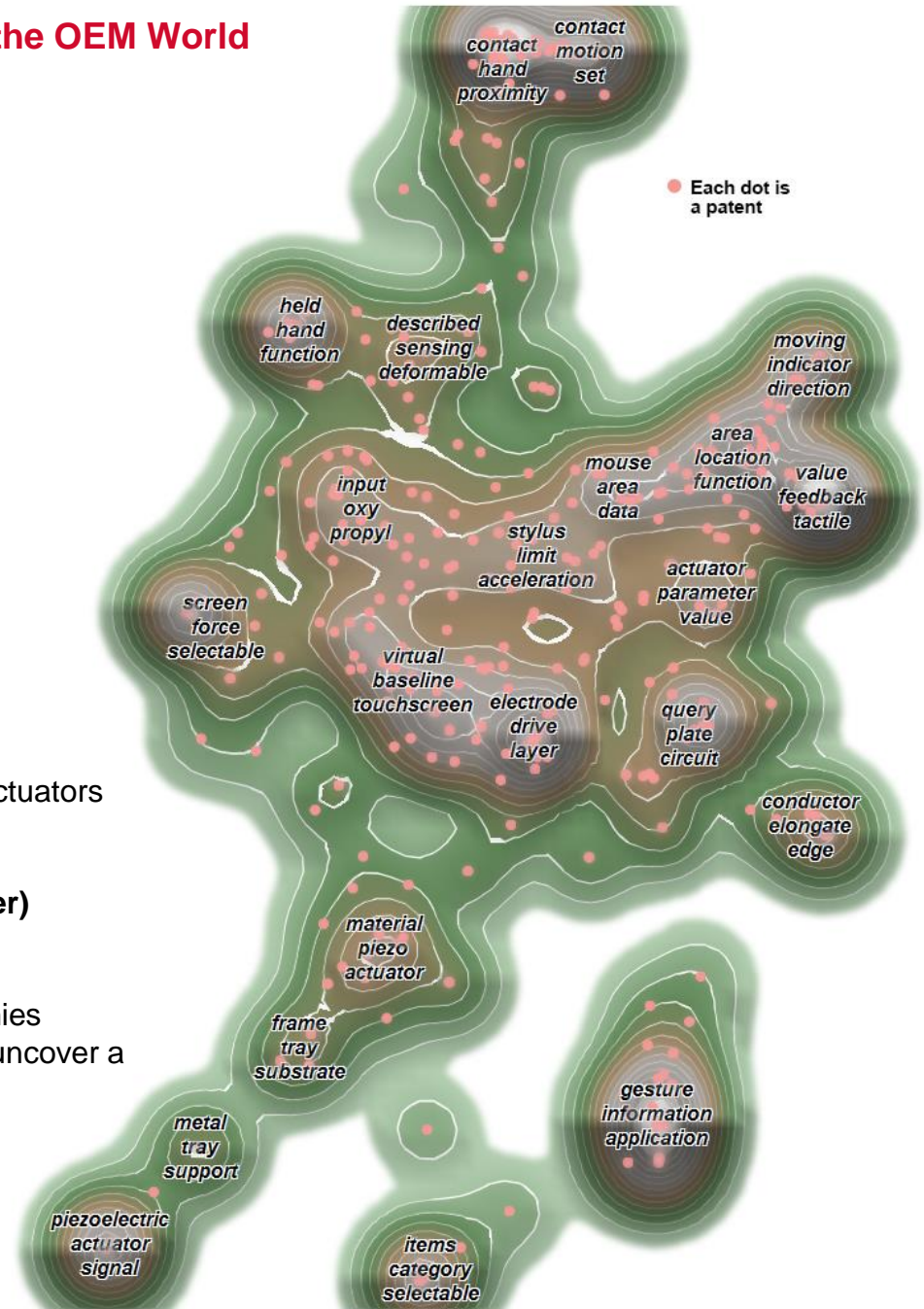
■ Grants ■ Applications

It is obvious that Force Touch, touch sensors, threshold value, and actuators dominate the filings.

Which patents are potentially applicable against Apple (and other) products?

Analyzing patenting companies and patents themselves, two companies appear in the forefront: BlackBerry and Qualcomm. We managed to uncover a couple of examples that we feel are applicable to Apple products.

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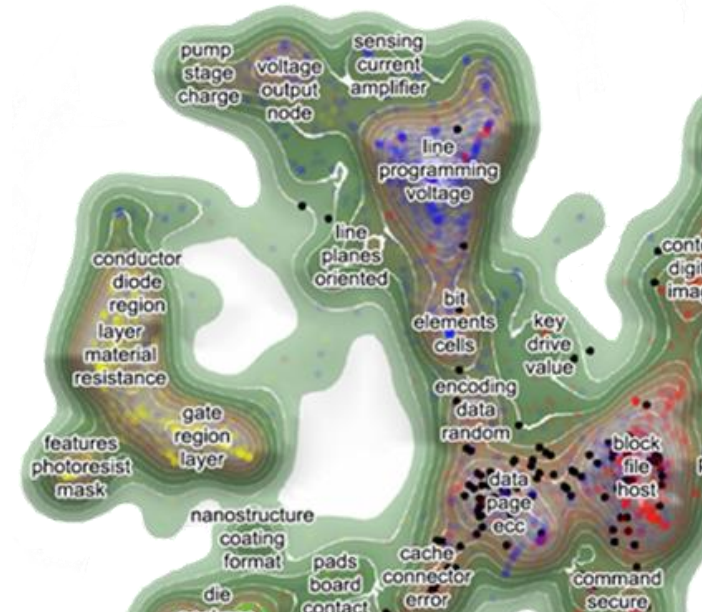
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- ✓ Analyze and understand large patent portfolios
- ✓ See changes in portfolios due to M&As
- ✓ Map competitor portfolios to your own
- ✓ Find relevant patents of value, faster
- ✓ Get an instant perspective for better IP decision making

LEARN MORE

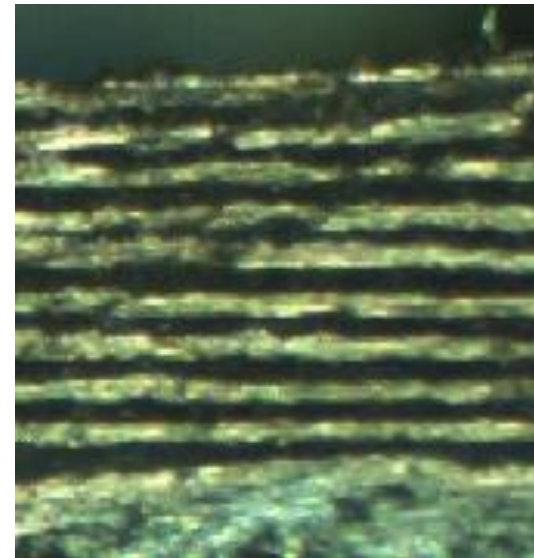
The Chipworks Patent Analytics solution, powered by KMX, has been specifically developed and trained to meet the needs of IP professionals who process thousands of patents in the semiconductor and electronics markets every day. You get a quick, accurate perspective so that you can make informed IP decisions, faster without being dependent on specialized technical expertise.



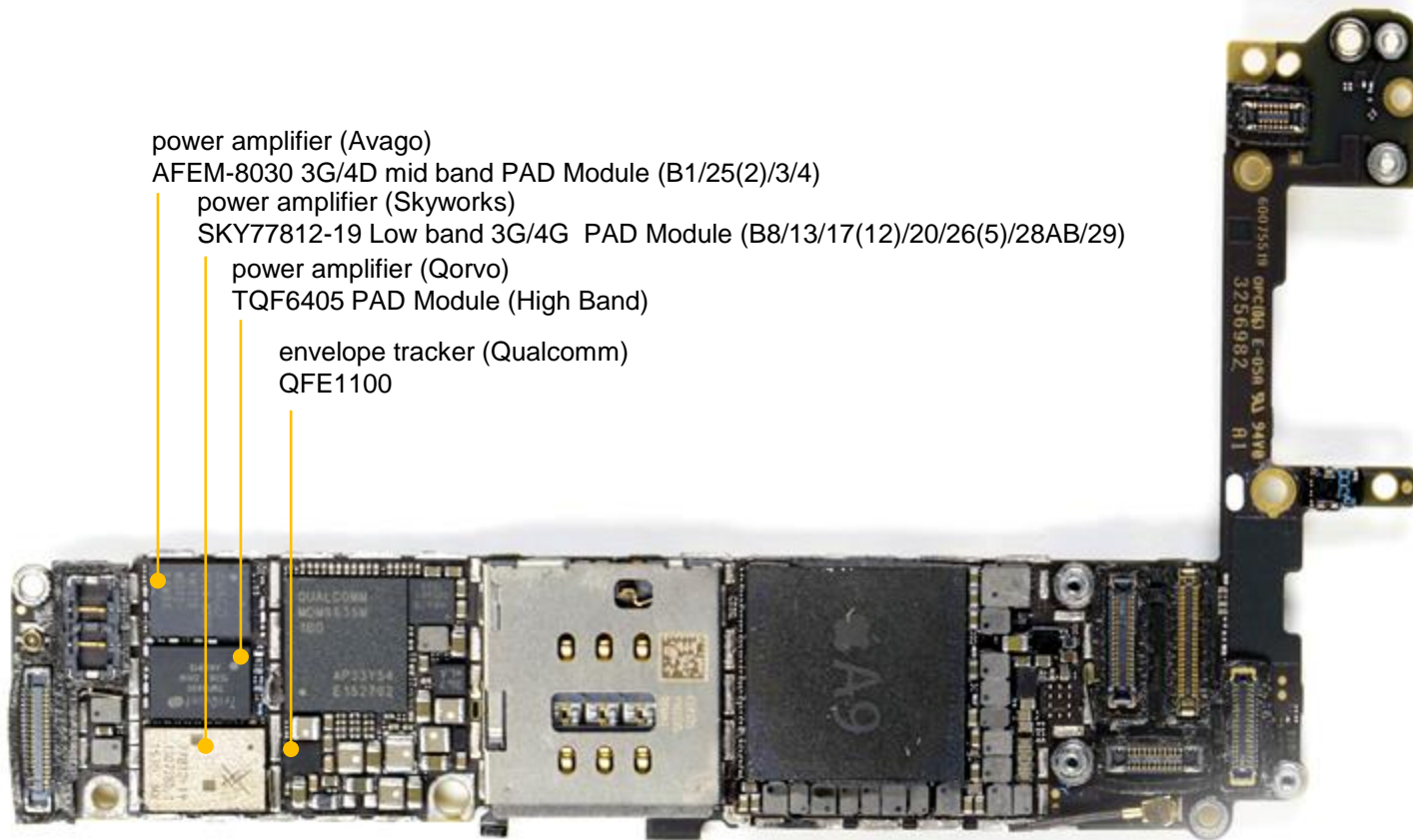
PCB Dimensions and Markings



	PCB #1
Manufacturer	OPC
Dimension	57.25 mm x 96.54 mm x 0.84 mm
Layer	10
Connector (pin)	0
Connector (socket)	13
Connector (ACF)	0



PCB #1 Display Side – Cellular

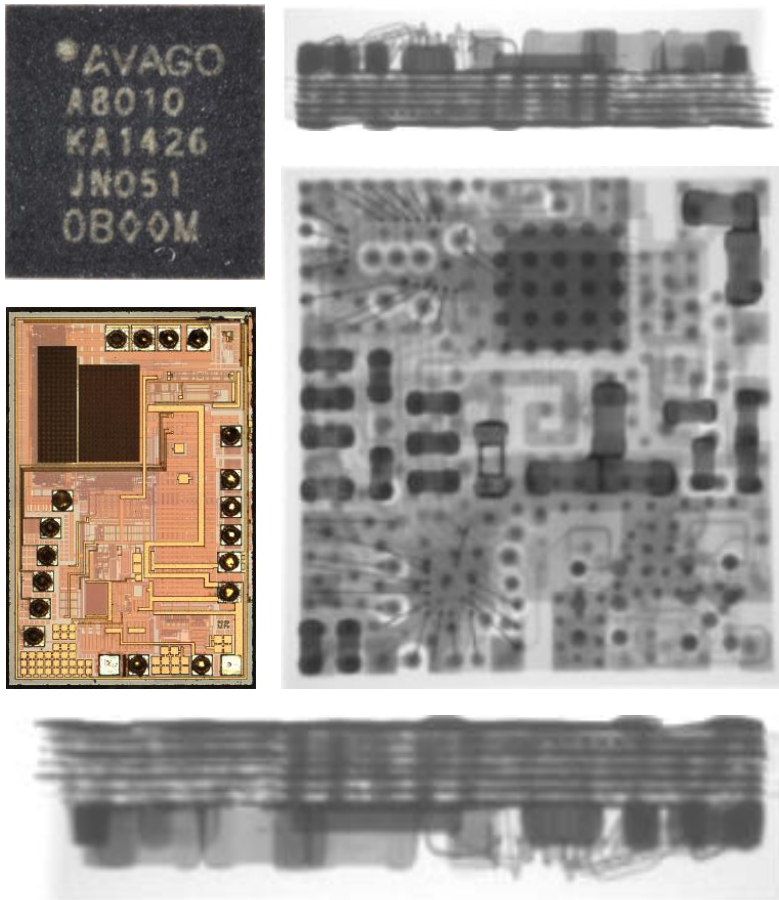


- power amplifier (Avago)
AFEM-8030 3G/4D mid band PAD Module (B1/25(2)/3/4)
- power amplifier (Skyworks)
SKY77812-19 Low band 3G/4G PAD Module (B8/13/17(12)/20/26(5)/28AB/29)
- power amplifier (Qorvo)
TQF6405 PAD Module (High Band)
- envelope tracker (Qualcomm)
QFE1100

Power Amplifier

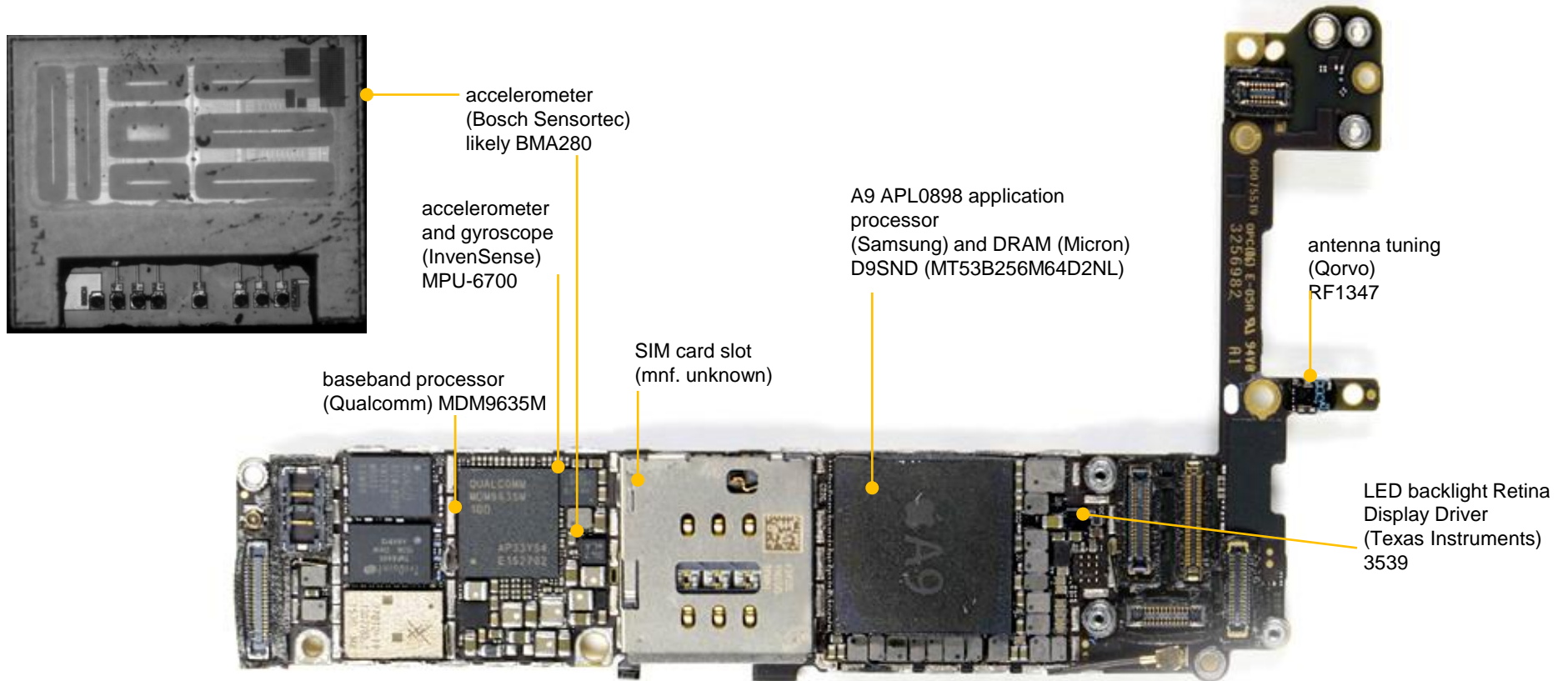
Chipworks has extensive circuit analysis available on leading edge power amplifier manufacturers. The number of components in these modules is astounding, in the Avago ACPM-8010 (below) Chipworks has catalogued 23 die!

This is a hotly contested space and it is not uncommon to find several manufacturers winning in the same phone.



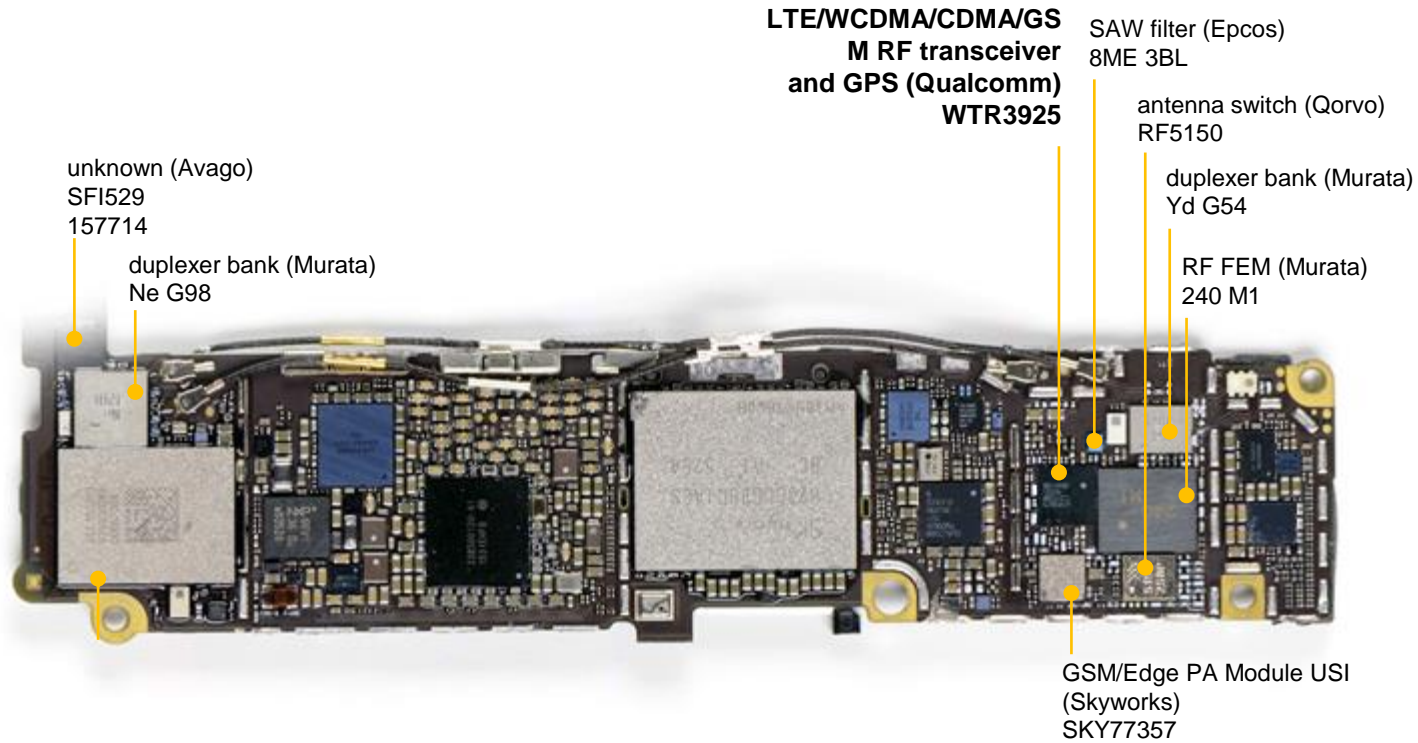
Related Power Amplifier Circuit Analysis Reports	Report Code
AVAGO ACPM-8010 Power Amplifier Circuit Analysis Reports	CAR-1507-201 <i>Analysis Underway</i>
Qualcomm QFE2320 RF Power Amplifier with Antenna Switch Circuit Analysis	CAR-1406-802
Qualcomm QFE2340 RF Power Amplifier with Tx-Rx Switch Circuit Analysis	CAR-1406-803
Avago ACPM-7600 Power Amplifier Circuit Analysis Reports	CAR-1311-902
Skyworks SKY85303 Power Amplifier Circuit Analysis Report	CAR-1307-901
Skyworks SKY85707 Power Amplifier Circuit Analysis Reports	CAR-1307-902

PCB #1 Display Side – Key Components



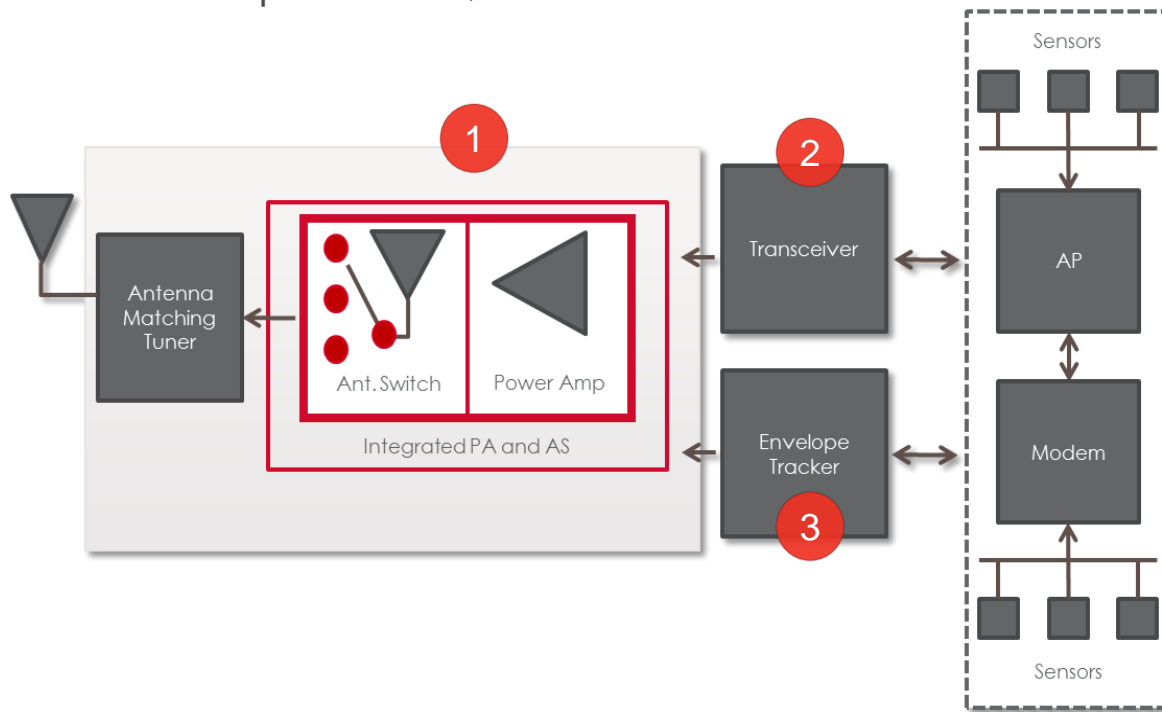
Accelerometer and Gyroscope Reports	Report Code
Bosch BMI160 Circuit Analysis Report	CAR-1510-901
Invensense MPU-6500/6515 ASIC Full Analog Circuit Analysis Report	CAR-1405-901
Bosch Triaxial Gyroscope ASIC from BMI055/BMG160 Circuit Analysis Report	CAR-1402-901
Maxim Integrated MAX21000 3-Axis Digital Output Gyroscope ASIC Circuit Analysis Report	CAR-1308-901

PCB #1 Battery Side – Cellular



Qualcomm RF Front End Circuit Analysis

- RF Transceiver WTR3925 (in Galaxy S6 Verizon)
- LTE Modem MDM9635M (in Galaxy S6 Verizon)
- Power Management PMD9635 (in Galaxy S6 Verizon)
- Envelope Tracker QFE1100



We have deep circuit analysis on the following devices:

- 1 **QFE2320**: Multi-mode Multi-band Power Amplifier with Integrated Antenna Switch
- 1 **QFE2340**: High Band Multi-mode Multi-band Power Amplifier with Integrated Transmitter/Receiver mode switch
- 2 **WTR-xxxx Transceivers**:
 - [WTR3925](#)
 - [WTR1625L](#)
 - [WTR1605L](#)
- 3 **QFE1100**: Envelope Tracker

INQUIRE ABOUT OUR RF ANALYSIS

WHAT'S A CIRCUIT ANALYSIS REPORT?

Qualcomm RF Front End Circuit Analysis

The Qualcomm WTR1605 RF Transceiver chip has been a fabulous winner for Qualcomm. It has been used in at least three different families of Qualcomm components. These components have in turn been found in a total of 89 different products from 24 different manufacturers (some are highlighted in the image on the right).

This type of component/product information is tracked in Chipworks' **Design Win Tracker (DWT)**.

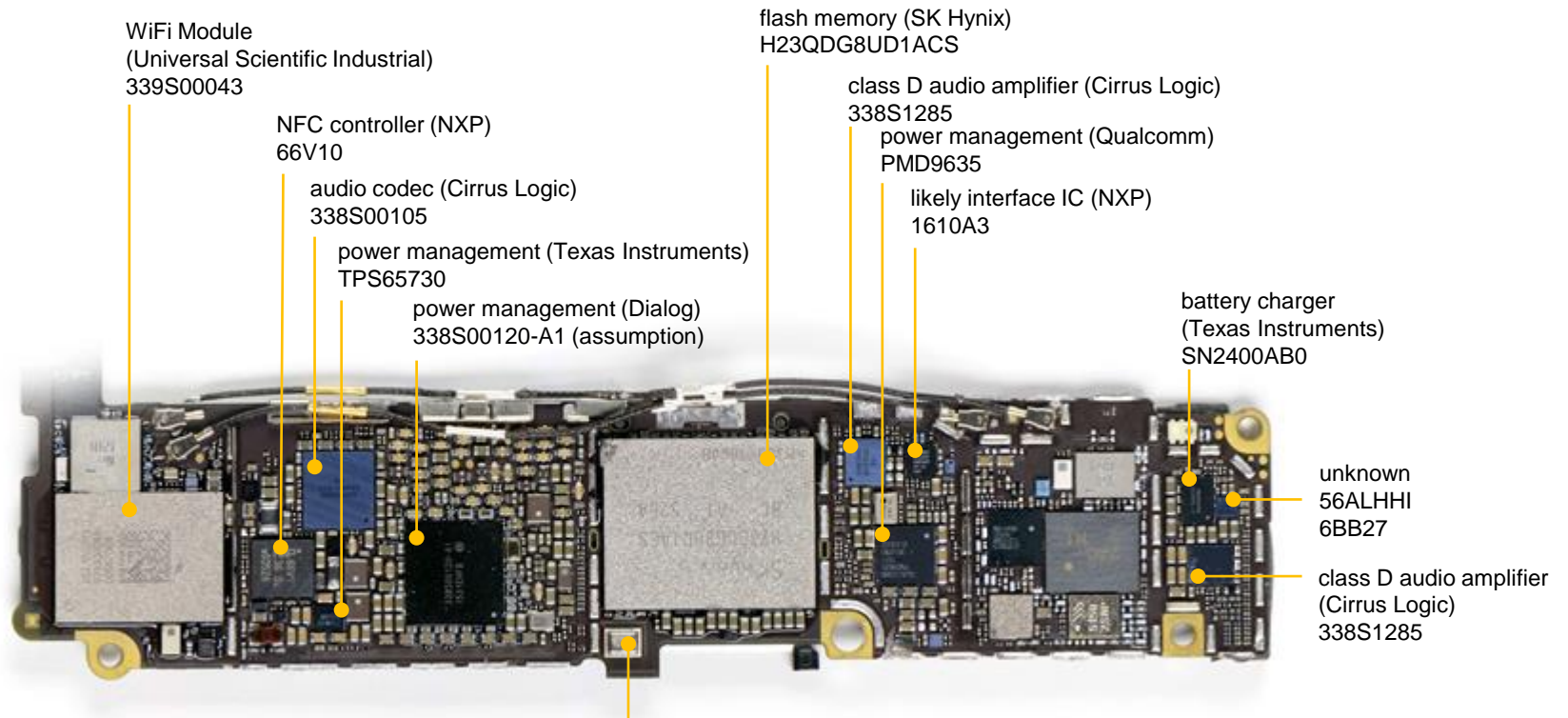
DWT is an annual, customizable subscription-based service with an exclusive focus on the integrated circuit (IC) design wins and losses in the highest volume phones and tablets.

Design Win Tracker addresses the number one problem faced by decision makers in the semiconductor industry: getting accurate, timely, and reliable information on the nature of design wins and losses.



[LEARN MORE](#)

PCB #1 Battery Side – Key Components

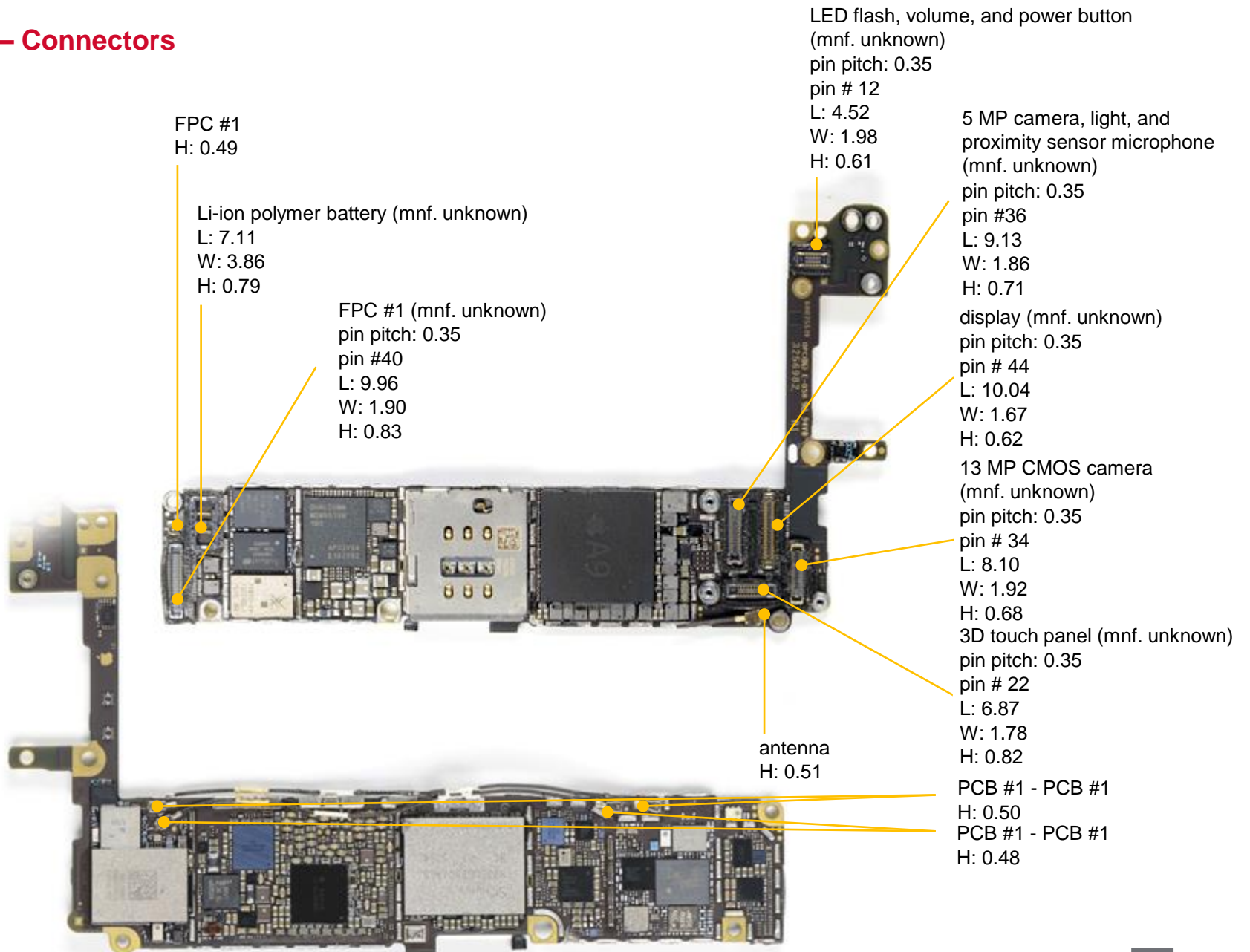


**barometer (Bosch Sensortec)
likely BMP280**



Barometer Circuit Analysis	Report Code
Bosch BMP280	CAR-1405-902

PCB #1 – Connectors



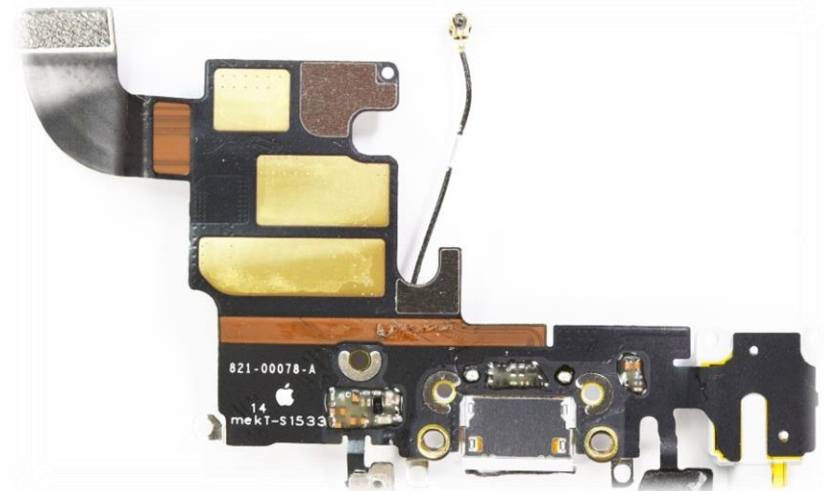
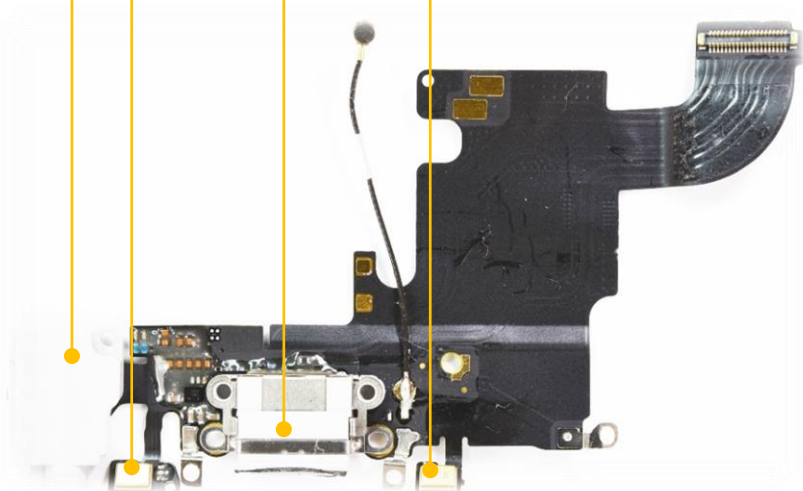
FPC #1 – Key Components

headphone port (mnf. unknown)

microphone (Knowles)
5280 KSM2

lightning connector (mnf. unknown)

microphone (Knowles)
5280 KSM2

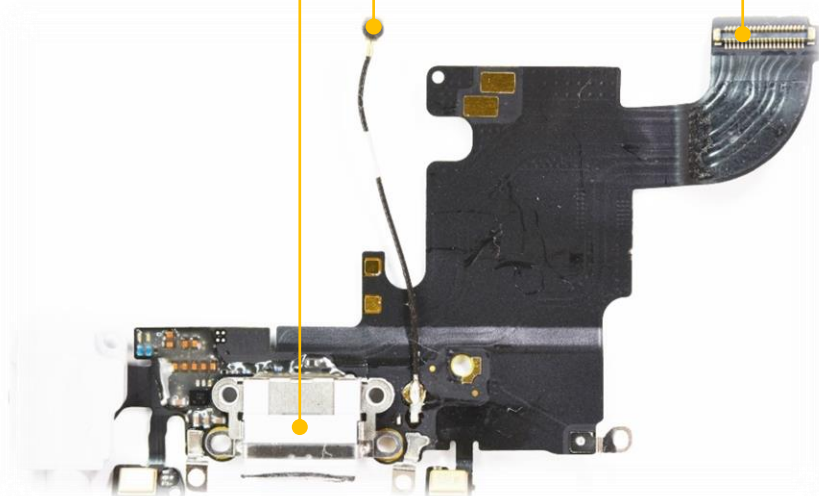


FPC #1 – Connectors

lightning connector (mnf. unknown)
pin pitch: 0.635
pin # 8
L: 8.84
W: 15.87
H: 3.27

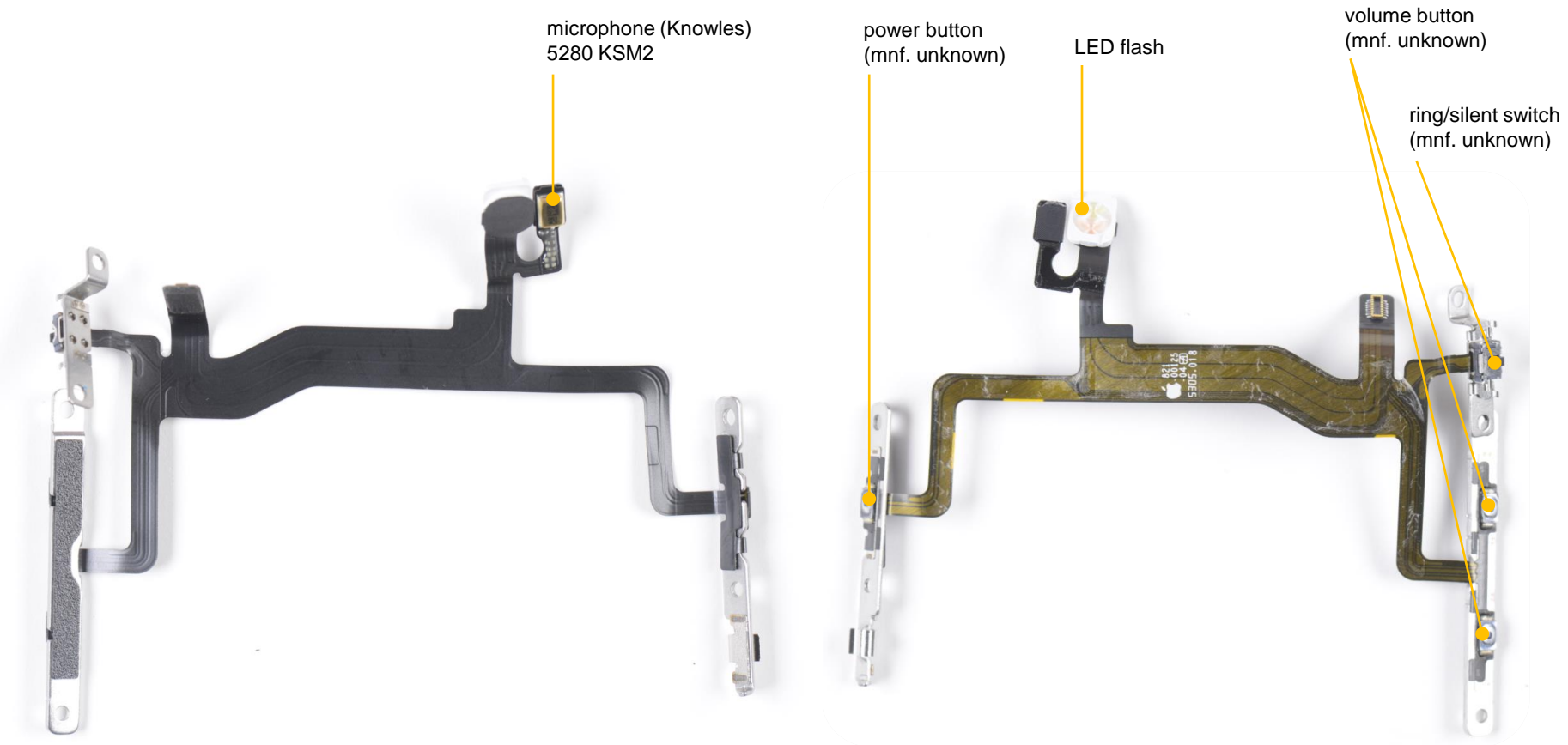
PCB #1
H: 0.90

PCB #1 (mnf. unknown)
pin pitch: 0.35
pin # 40
L: 8.79
W: 1.20
H: 0.72



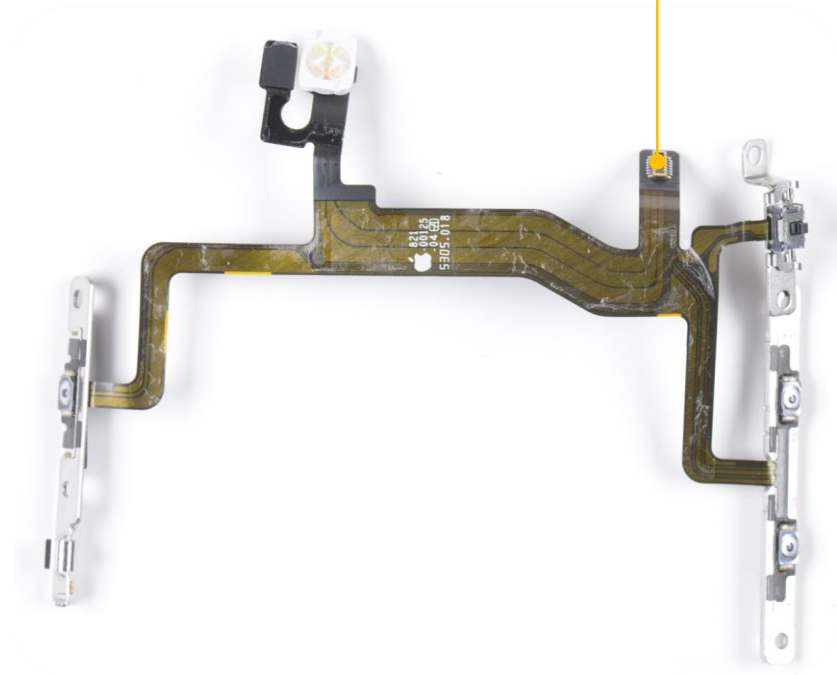
Measurement Unit: millimeters (mm)

FPC #2 – Key Components



FPC #2 – Connectors

PCB #1
(mnf. unknown)
pin pitch: 0.35
pin # 12
L: 3.40
W: 1.24
H: 0.48



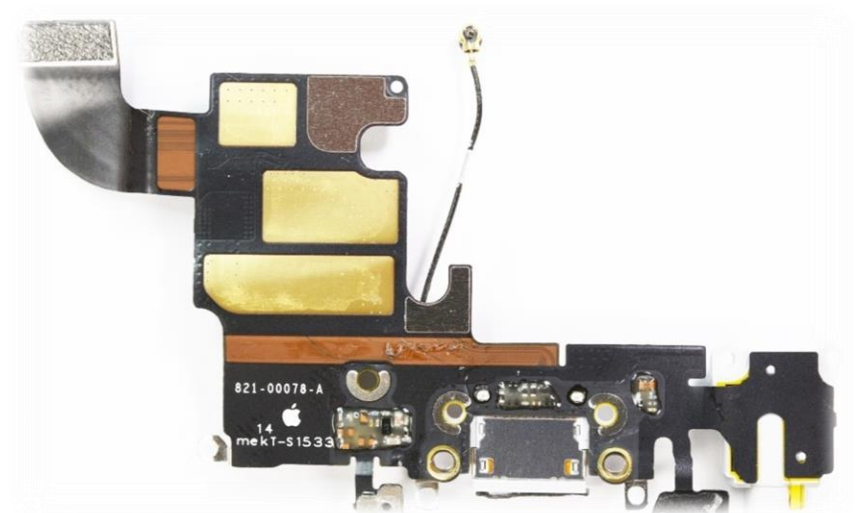
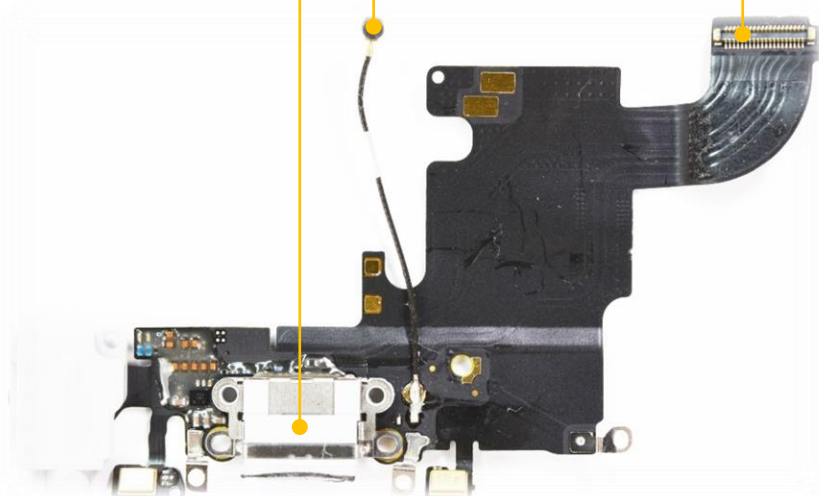
Measurement Unit: millimeters (mm)

FPC #1 – Connectors

lightning connector (mnf. unknown)
pin pitch: 0.635
pin # 8
L: 8.84
W: 15.87
H: 3.27

PCB #1
H: 0.90

PCB #1 (mnf. unknown)
pin pitch: 0.35
pin # 40
L: 8.79
W: 1.20
H: 0.72



Measurement Unit: millimeters (mm)

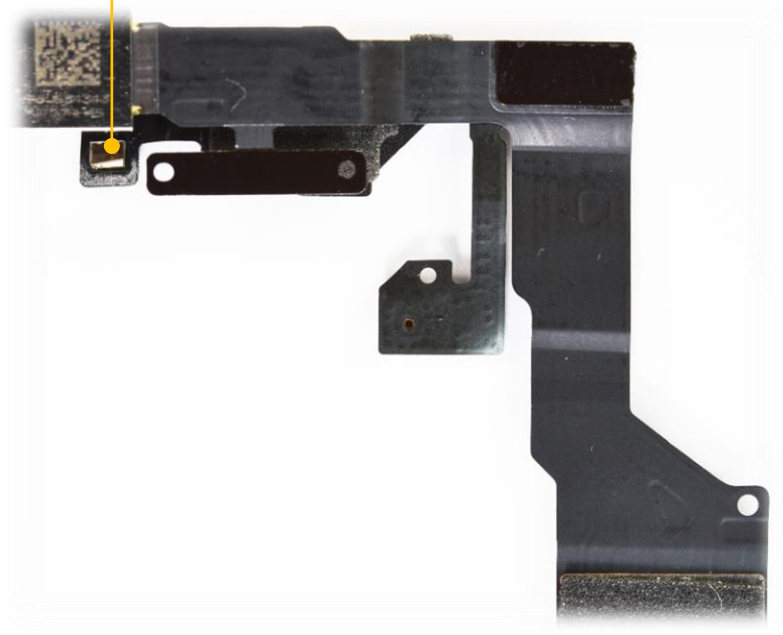
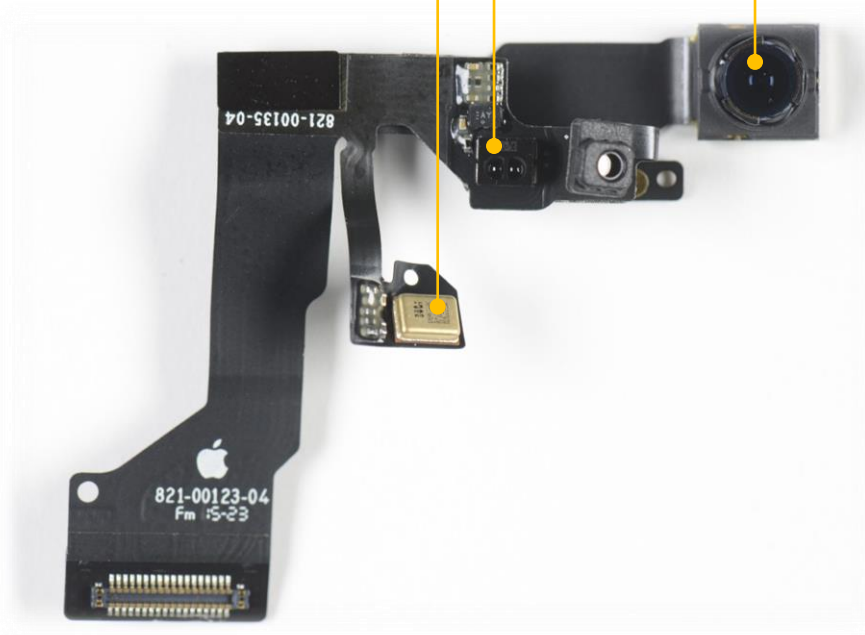
FPC #3 – Key Components

microphone (GoerTek)
529 GWM1

proximity sensor (mnf. unknown)

5 MP CMOS camera (mnf. unknown)

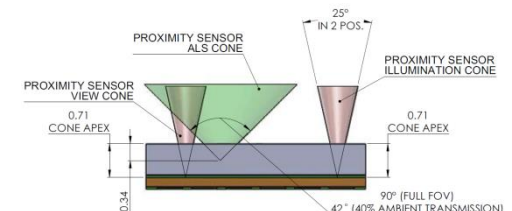
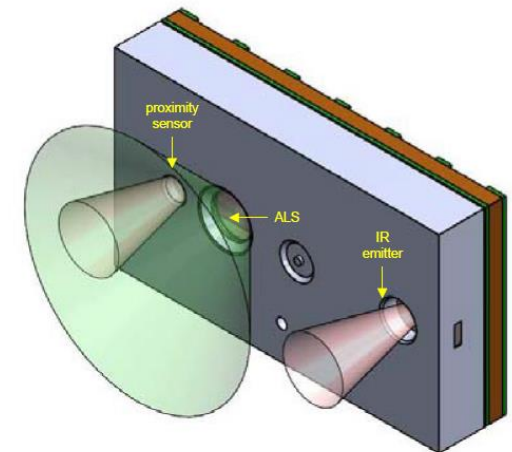
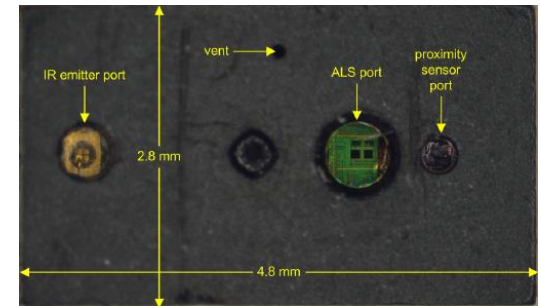
light sensor (mnf. unknown)



Time of Flight Sensor – A better solution to proximity detection

STMicroelectronics VL6180 Time of Flight Sensor

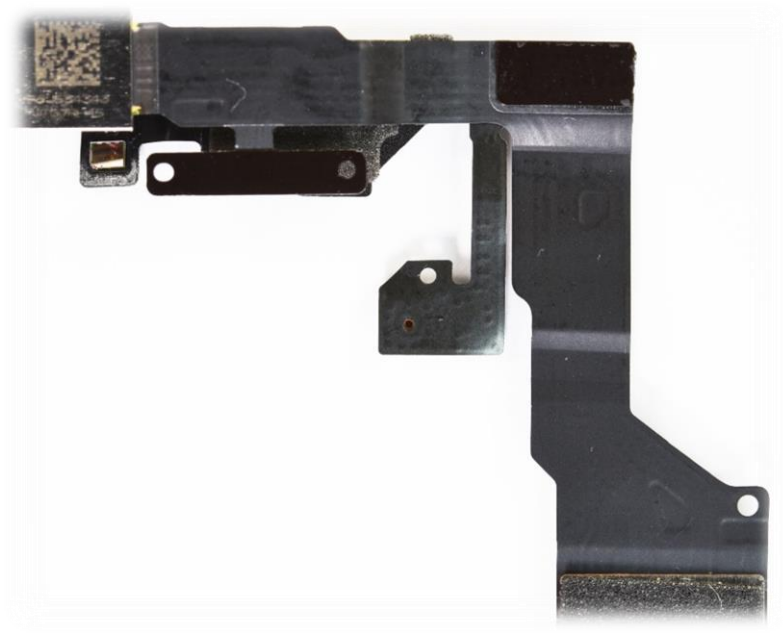
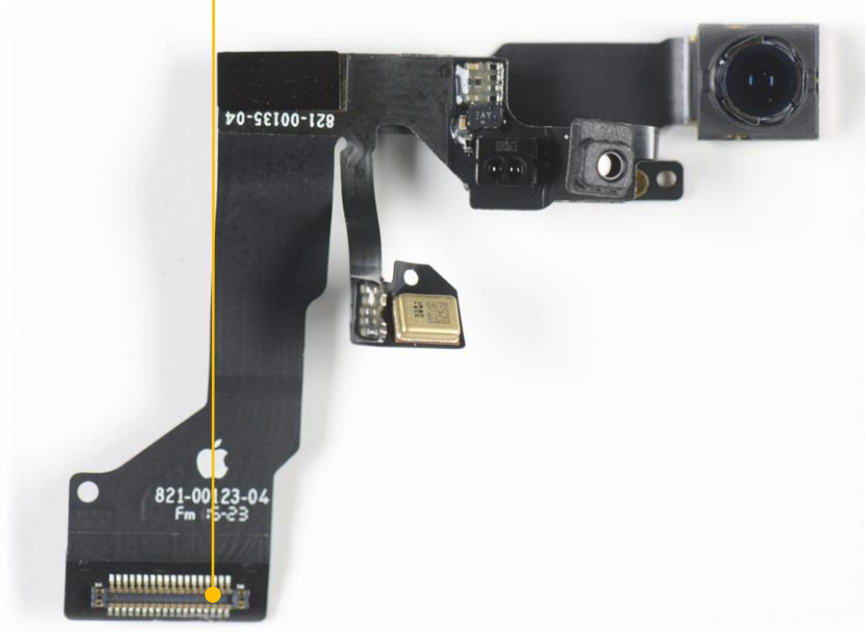
- Chipworks' first recorded design win of the VL6180 occurred in the BlackBerry Passport. We have since found the VL6180 in 5 different LGE smartphones.
- The primary application of the VL6180 is the replacement of existing proximity detection technology. Proximity sensors are used in nearly all smartphones to detect the user's head during a phone call. Unfortunately, the amplitude of the reflected light varies according to the distance but also with the reflectance level of the target, which can be as low as 3 percent for dark black hair. This can lead to ambiguous results - quite frustrating to some users.
- The VL6180 allows absolute distance to be measured independent of target reflectance. Instead of estimating the distance by measuring the amount of light reflected back from the object, the VL6180C precisely measures the time the light takes to travel to the nearest object and reflect back to the sensor.
- Was used in the LG G3 as the laser autofocus for the rear facing camera
- The integration of the SPAD, IR emitter and Ambient Light Sensor is an impressive engineering feat. We expect to find many more design wins for this disruptive technology!
- Fabled in STMicroelectronics BCD9 Process.



LEARN MORE

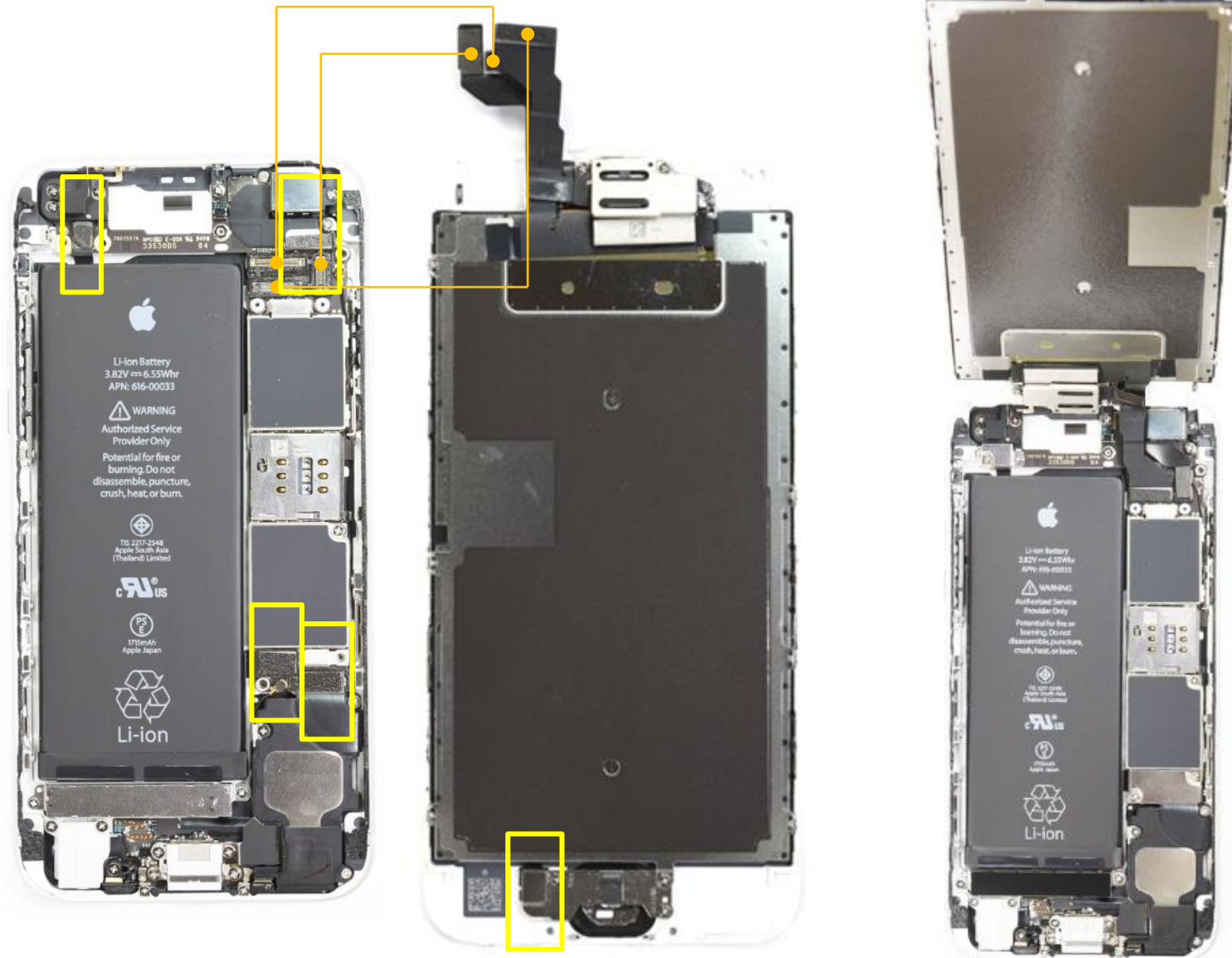
FPC #3 – Connectors

PCB #1 (mnf. unknown)
pin pitch: 0.35
pin # 36
L: 8.04
W: 1.42
H: 0.54

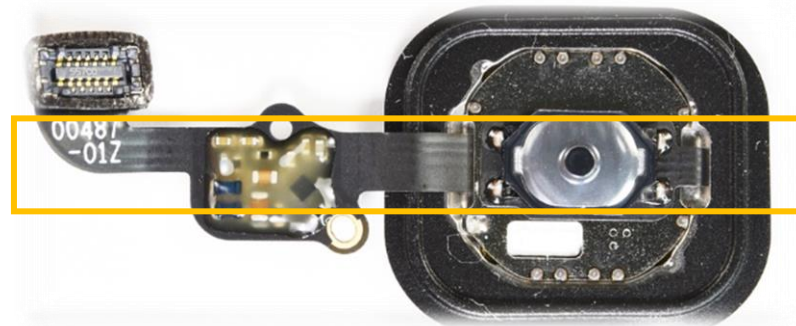


Measurement Unit: millimeters (mm)

PCB #1, FPC#1, FPC #2, and FPC #3 – Connectors Plugged



Others – Fingerprint Sensor



Others

speaker



speaker



vibrator (taptic engine)



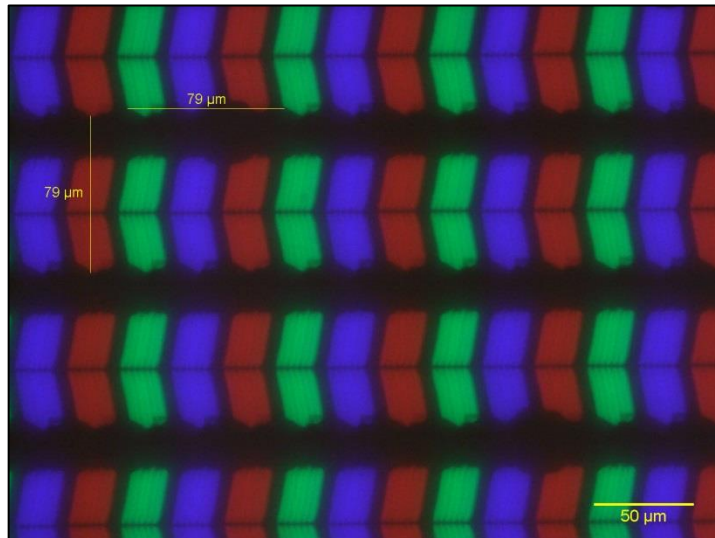
Main Display Dimensions

Display Module Size		61.17 x 110.46 x n/a (stack-on-glass)
Display Marking (location)		C3F5353E4HQQ873L7-A3MEQ298Q2K54 (bottom metal plate)
Display Panel Manufacturer		JDI
Display Diagonal Size (inch)		4.7
Display Mode (alignment)		IPS (stripe alignment)
Pixel Count (dot)		750 x 1334, Retina HD
Resolution (pixel per inch)		326
Peripheral Margin (from reverse side)	Left	1.31
	Top	1.34
	Right	1.33
	Bottom – up	0.08
	Bottom – low	5.00
Seal marking: Y/N (length in mm)		No
Display Component Thickness	1a: LCD Top Polarizer	n/a (stack-on-touch-panel)
	1b: LCD Panel	n/a (stack-on-touch-panel)
	1c: LCD Lower Polarizer and Reflector	0.08
	2: Diffuser	n/a
	3: Brightness Enhancement Film	0.05
	4: Brightness Enhancement Film	0.05
	5: Diffuser	0.03
	6: Light Guide	0.30
	7: Reflector	0.07
	Display Component Total Thickness (clearance)	n/a (stack-on-glass)
Display Back Light LED Count (size)		12 (2.86 x 0.80 x 0.48)
Display Cable Width/Pin Pitch/Pin Count		10.49 (socket)/0.35 x 44

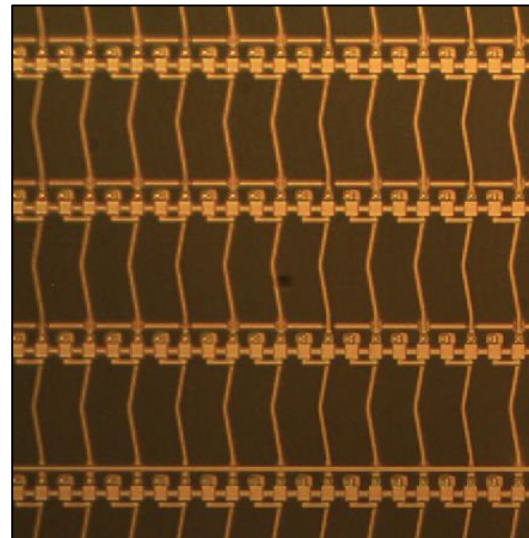
Measurement unit: millimeter (mm)

Main Display Detail – Pixel

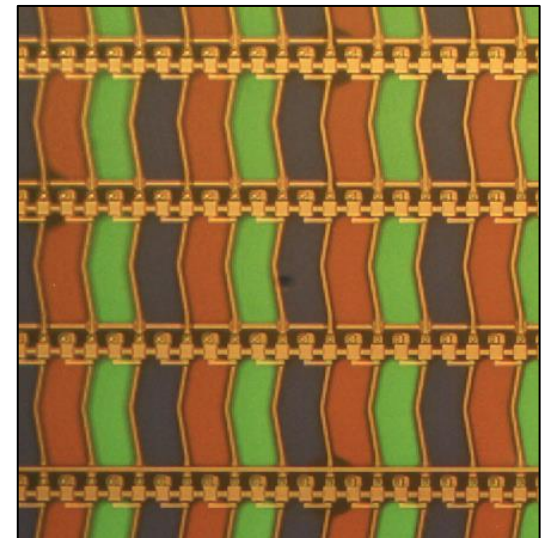
back light: ON
front light: OFF



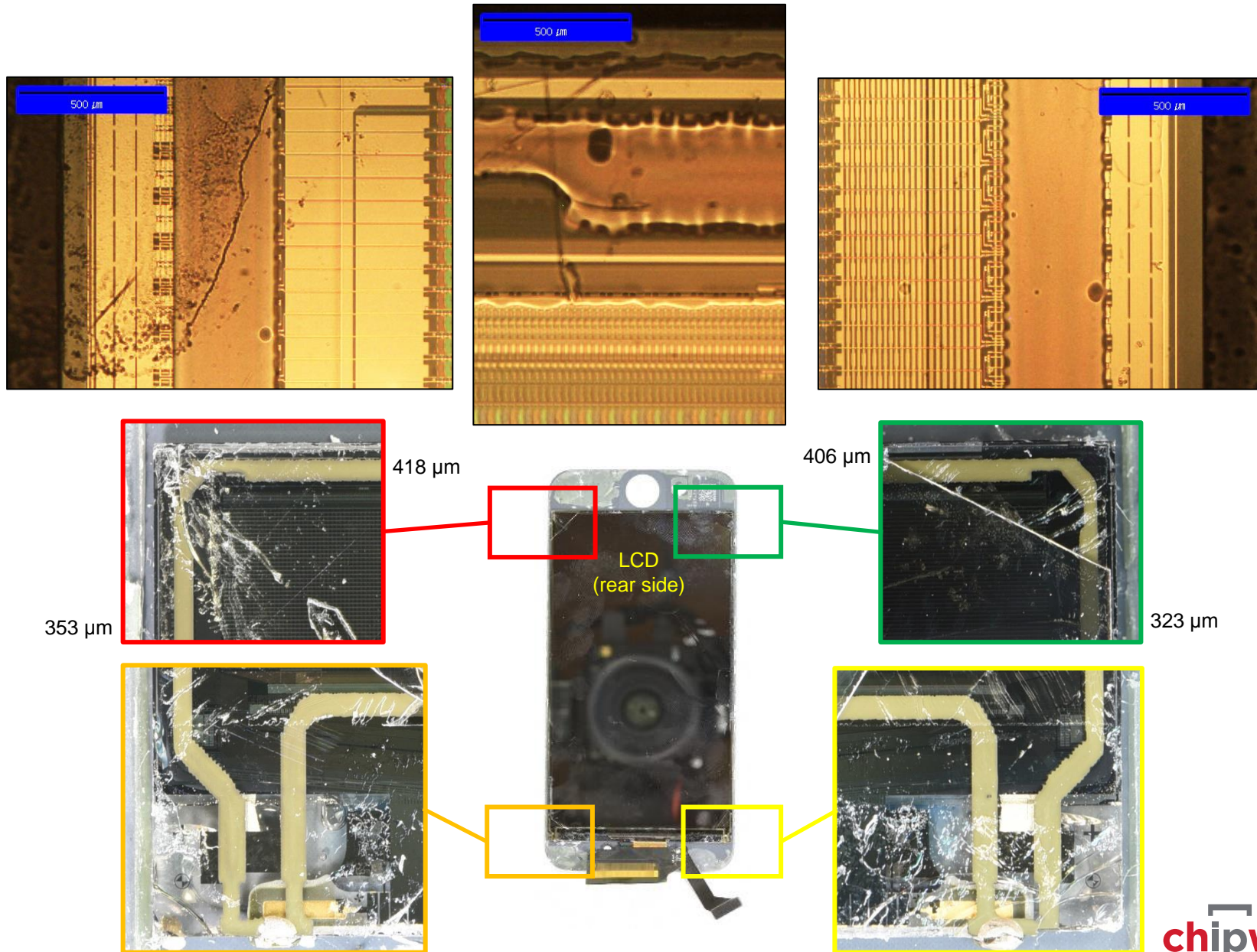
back light: OFF
front light: ON



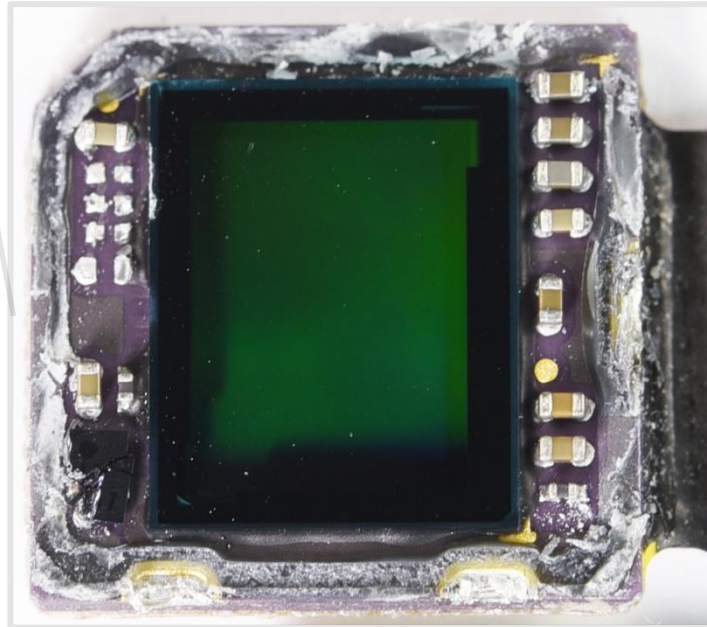
back light: ON
front light: ON



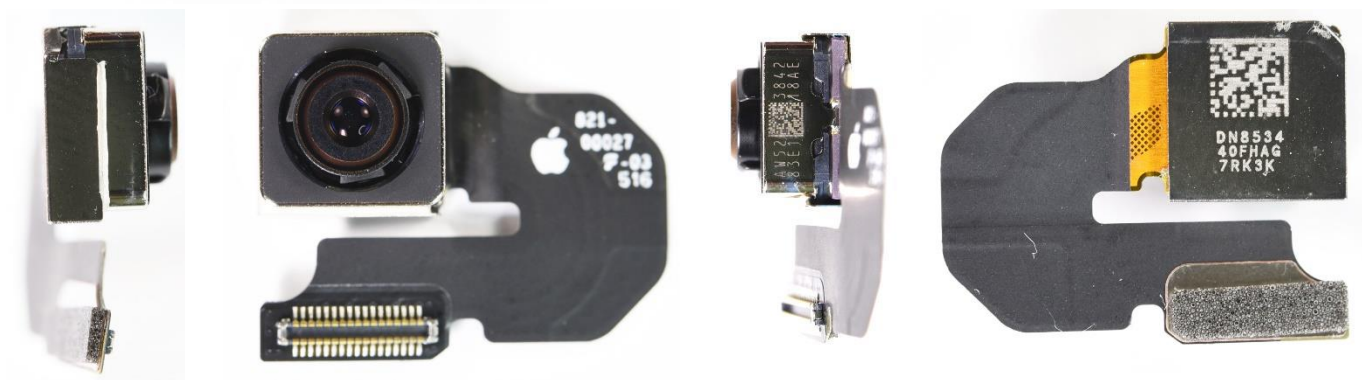
Main Display Detail – Peripheral



12 MP CMOS Camera

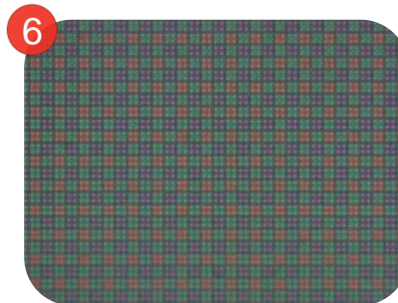
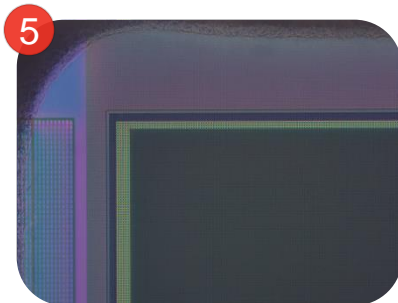
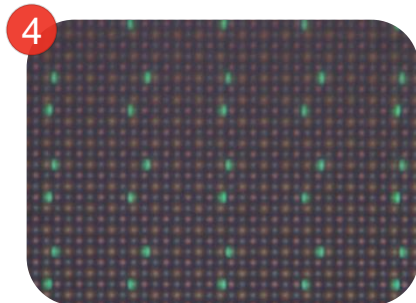
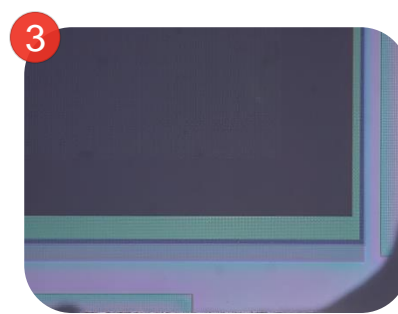
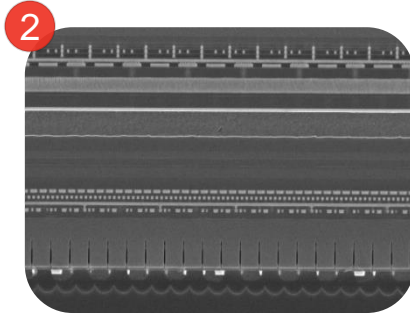
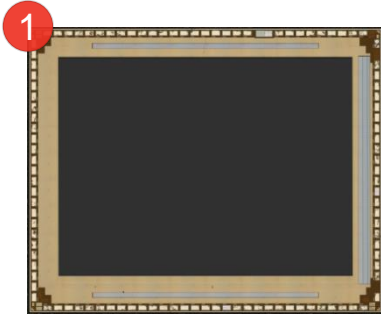


camera module size: 8.45 mm x 8.31 mm x 5.61 mm
camera module marking: AW52 3842
83E1 18AE
sensor diagonal size: 6.01 mm
sensor manufacturer: unknown
sensor board thickness: 0.88 mm



iSight and FaceTime Camera Overview and Reports

	iPhone 6s iSight Camera	iPhone 6s FaceTime Camera
Resolution (MP)	12	5
Pixel size (µm)	1.22	1.12 (2.24 µm color filter pitch)
Aperture	f/2.2	
Configuration	Stacked back-illuminated CMOS image sensor	
Imaging chip supplier	Sony	
Autofocus	On-chip phase-detection autofocus (PDAF)	–
Report Code	DEF-1509-803	DEF-1509-804



- 1 iSight Die Photo, Color Filters Removed
- 2 iSight Stacked CIS Cross-Section
- 3 iSight CIS Array Corner
- 4 iSight Phase Pixels
- 5 FaceTime CIS Array Corner
- 6 FaceTime Pixels

CHIPSELECT IMAGE SENSORS

Regular, Succinct Analysis of High-Volume Imaging Applications

For leaders who want to separate road maps from reality and understand what's really cooking under the hood of state-of-the-art imaging devices, ChipSelect Image Sensors is the ideal solution.

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- Automotive and security
- Specialty devices (gaming and industrial)
- Emerging growth areas

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Unlimited, 24/7 online access to package photos, die photos, and poly die photos



Image Sensor Design Wins Tracking spreadsheet (monthly)



Unlimited, 24/7 online access to Chipworks' Device Essentials Image Set and Summary deliverables



Recent Analysis Summary from Chipworks Senior Technology Analysts (tri-annually)



Annual onsite seminar delivered by Chipworks' Image Sensor Sector Analyst – an important opportunity to ask an unlimited number of questions

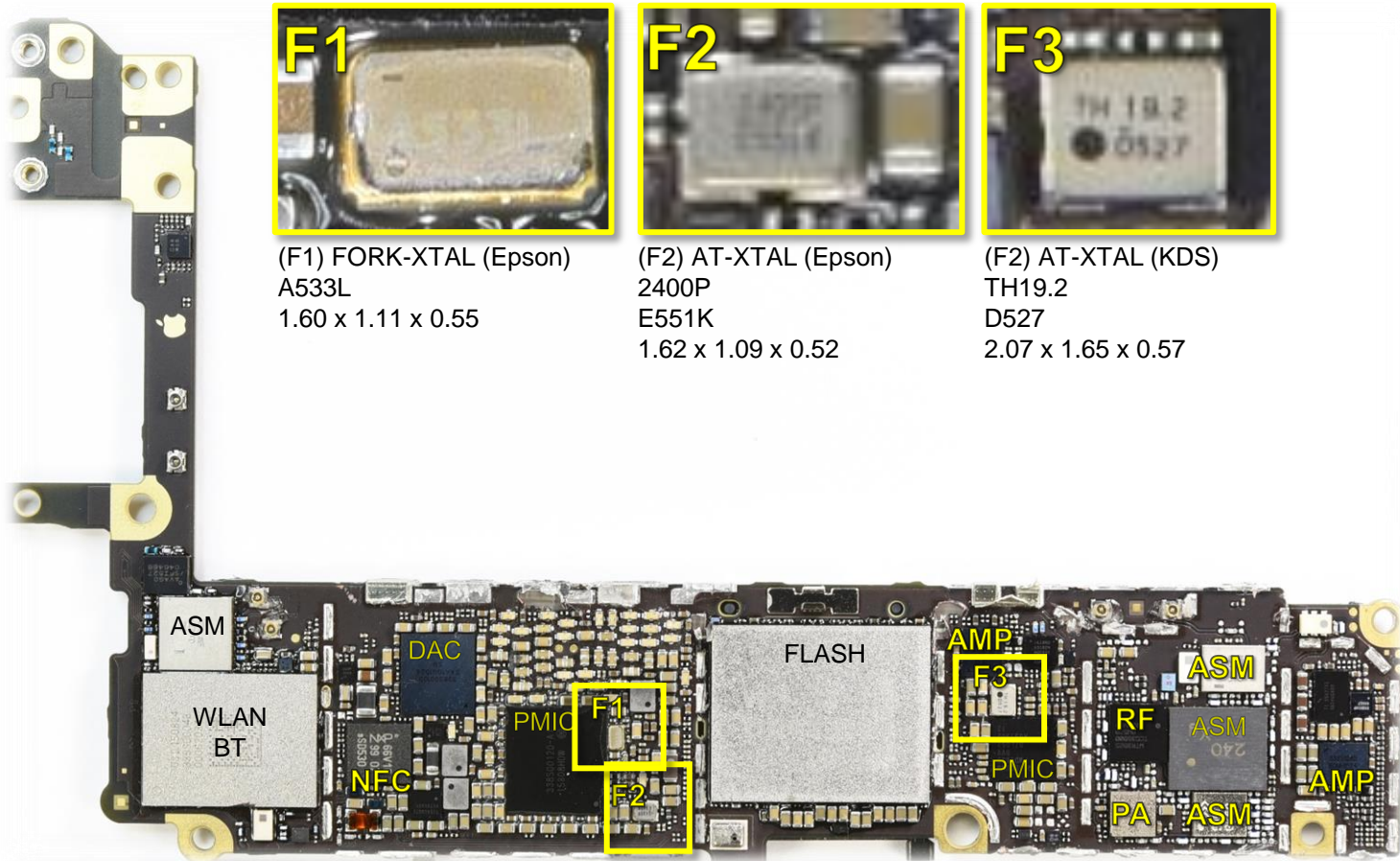


Noteworthy Patents Summary (tri-annually)

[LEARN MORE](#)



Quartz – PCB #1 Battery Side



(F1) FORK-XTAL (Epson)
A533L
1.60 x 1.11 x 0.55



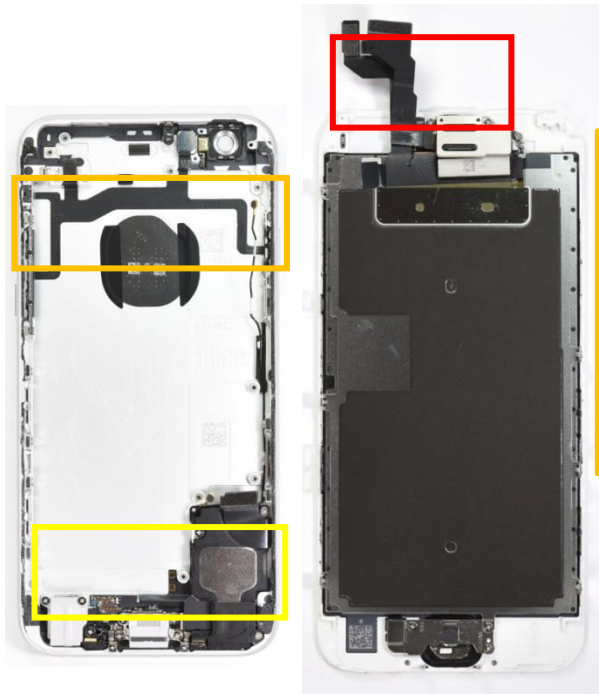
(F2) AT-XTAL (Epson)
2400P
E551K
1.62 x 1.09 x 0.52



(F2) AT-XTAL (KDS)
TH19.2
D527
2.07 x 1.65 x 0.57

Measurement unit: millimeters (mm)

Silicon Audio (Microphone)



microphone (Knowles)
5280 KSM2



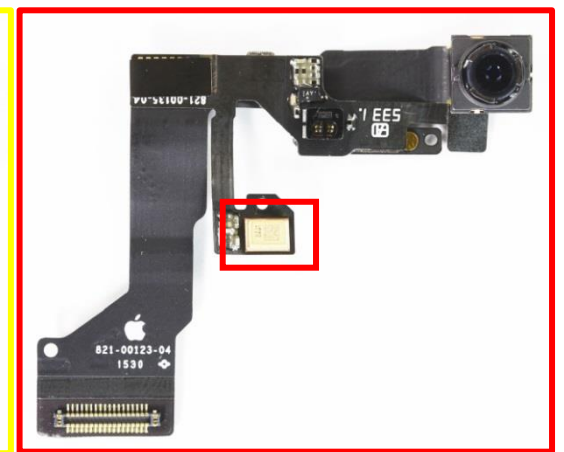
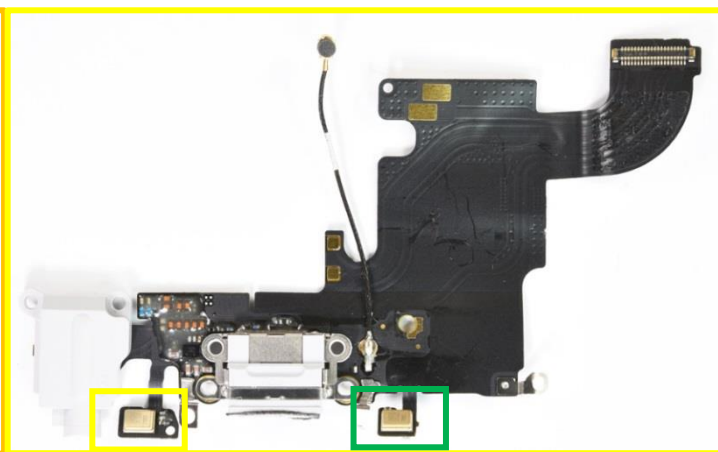
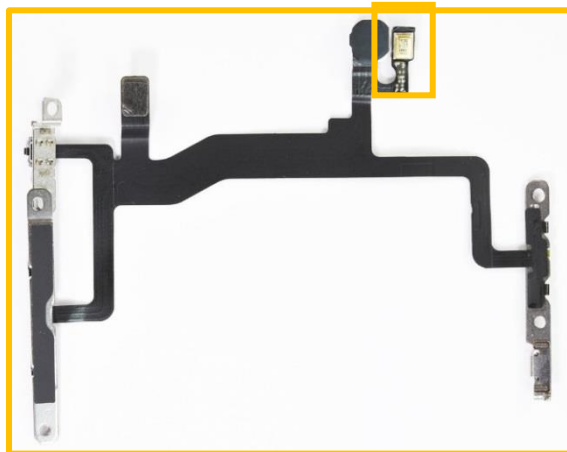
microphone (Knowles)
5280 KSM2



microphone (Knowles)
5280 KSM2

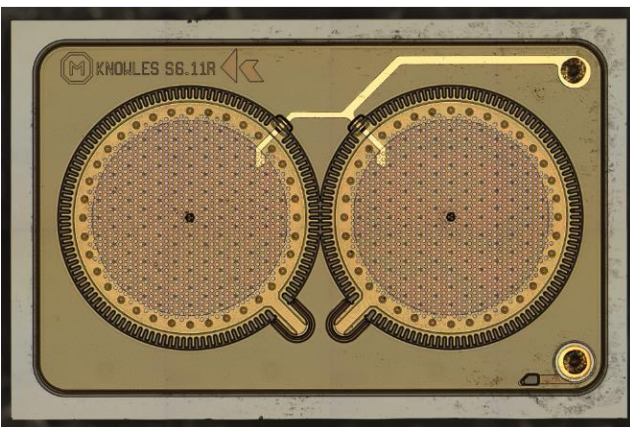
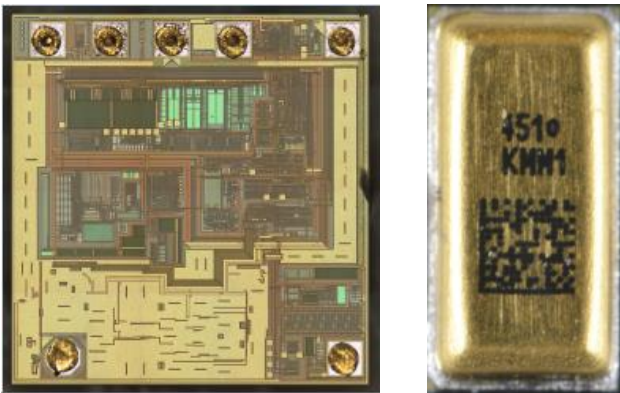


microphone (GoerTek)
529 GWM1

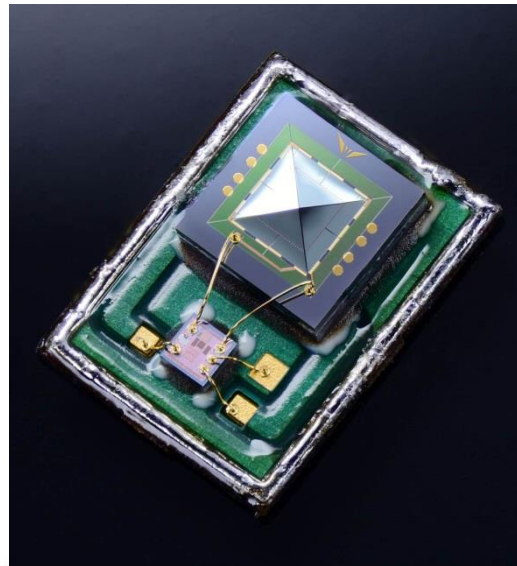


Knowles Microphone Design Win

Our teardown of the iPhone 6S was big news for Knowles showing a total of 3 out of 4 microphone design wins with their 5280 KSM2.



Knowles Microphone from MacBook



Commentary

Looking forward, we are hoping to find microphone design wins from newcomer Vesper MEMS. They are producing the first piezoelectric MEMS microphone, it's also waterproof and dust proof.

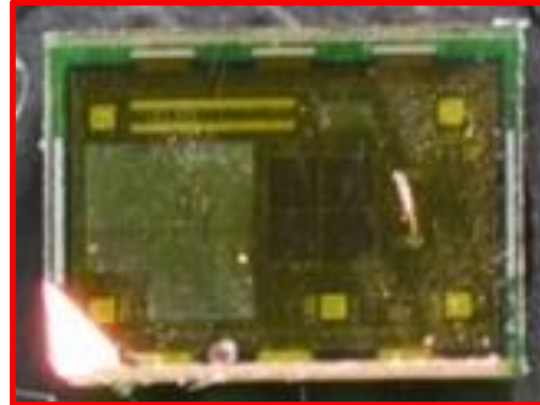
Read more about this disruptive design in an article from [tom's Hardware](#)

Related Microphone Reports	Report
Knowles Microphone ASIC die mark 19380 from MacBook Circuit Analysis (Analysis underway)	CAR-1510-903
Infineon E2150C MEMS Microphone from AAC Technologies SDM0102B-263-M02 Basic Device Overview Report	CWR-1410-901
AAC Technologies SDM0102B Omnidirectional MEMS Microphone Circuit Analysis Reports	CAR-1408-902
Knowles S1129 XCO18 Microphone ASIC Circuit Analysis Reports	CAR-1403-901
AAC Technologies M1729D Microphone ASIC (from iPhone 5) Full Analog Circuit Analysis Reports	CAR-1301-902

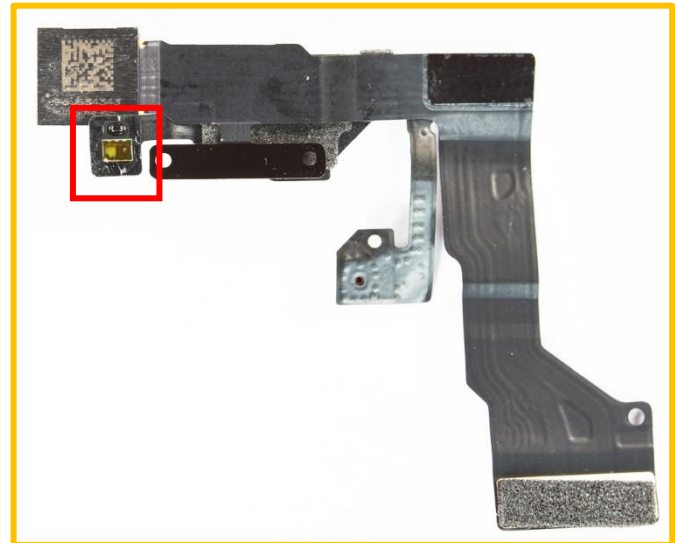
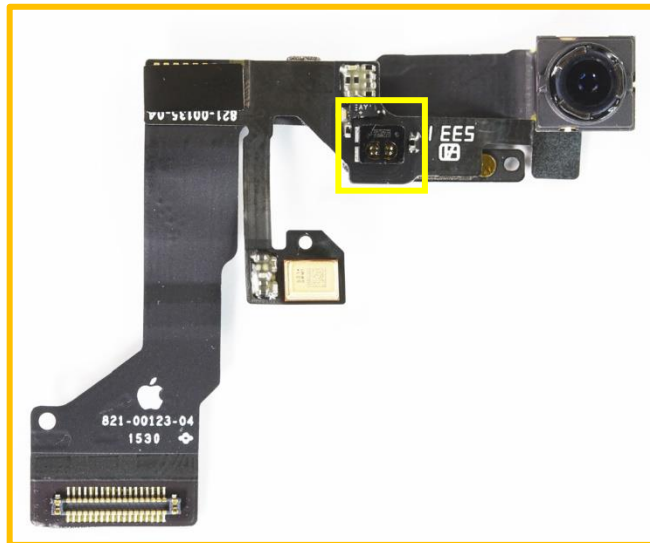
Ambient Sensor



proximity sensor (mnf. unknown)
2.78 mm x 2.38 mm x 1.28 mm



light sensor (mnf. unknown)
1.85 mm x 1.30 mm x 0.50 mm



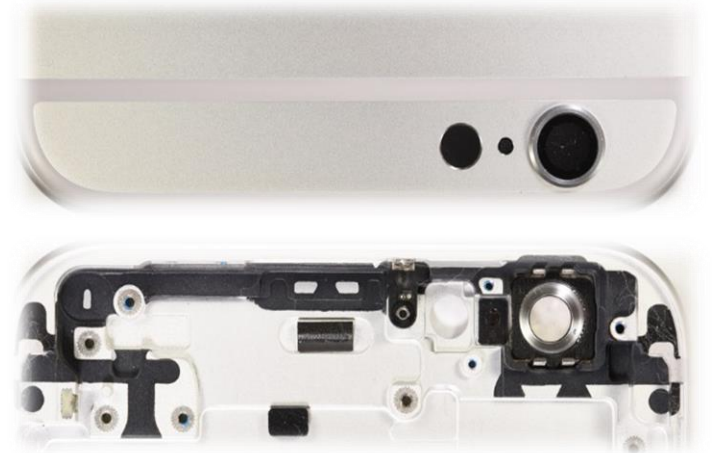
Antenna

WLAN/BT/GPS

cellular



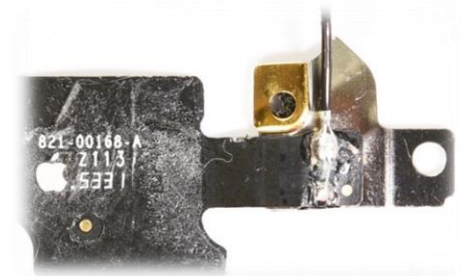
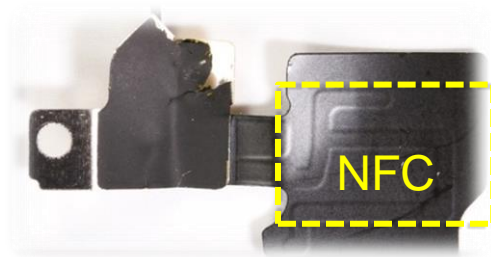
WLAN/Bluetooth/GPS



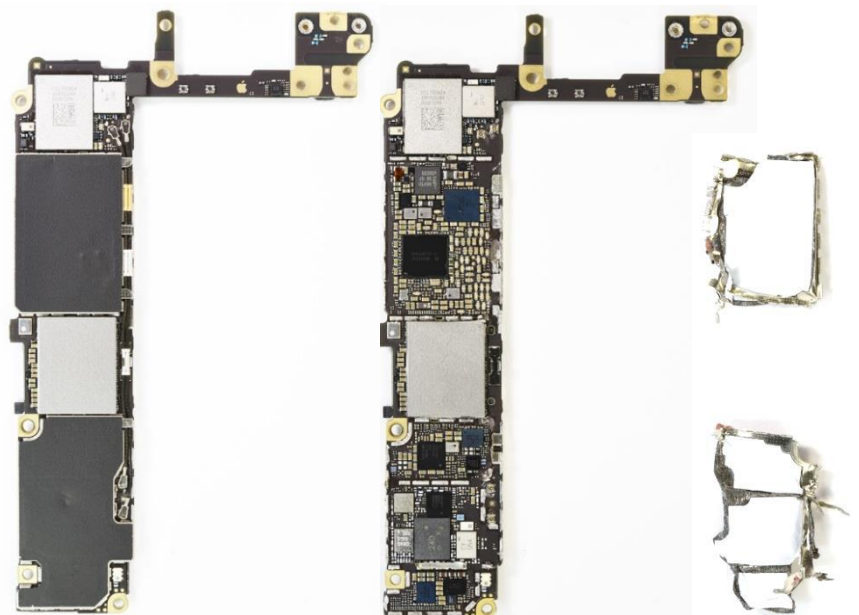
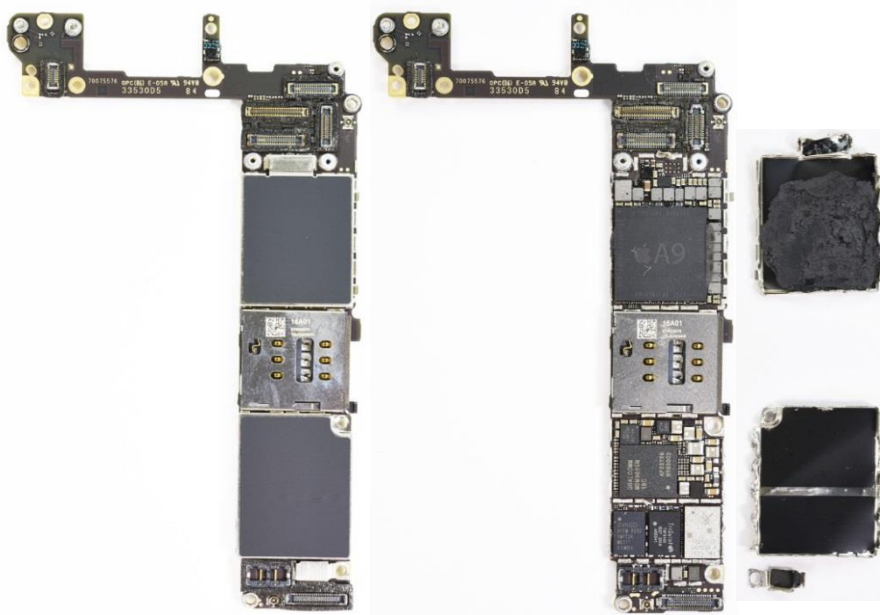
cellular

Antennas built-in, details unknown

Antenna



PCB EMI



Touch Panel

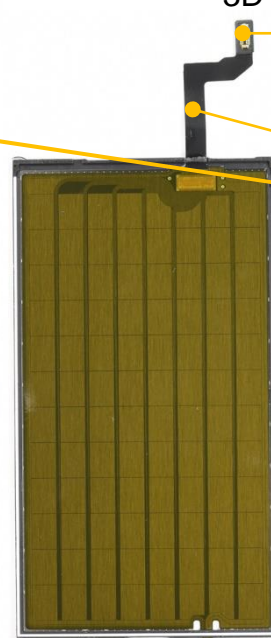
Surface glass, display, and touch panel thickness	2.04
Adhesion	Air gap
Touch panel material	Unknown

PCB #1
(mnf. unknown)
pin pitch: 0.35
pin # 44
L: 9.50
W: 1.28
H: 0.43

display

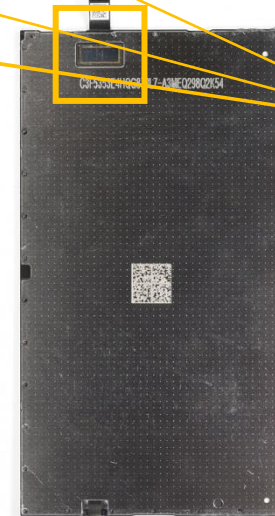


3D touch



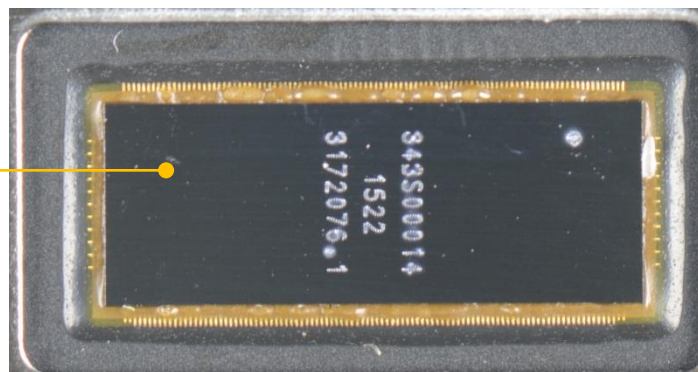
PCB #1 (mnf. unknown)
pin pitch: 0.35
pin # 22
L: 5.68
W: 1.09
H: 0.59

EMI shield film



fingerprint sensor (mnf. unknown)
pin pitch: 0.35
pin # 10
L: 3.19
W: 1.10
H: 0.53

3D touch panel controller
(Analog Devices)
343S00014
1522
3172076.1

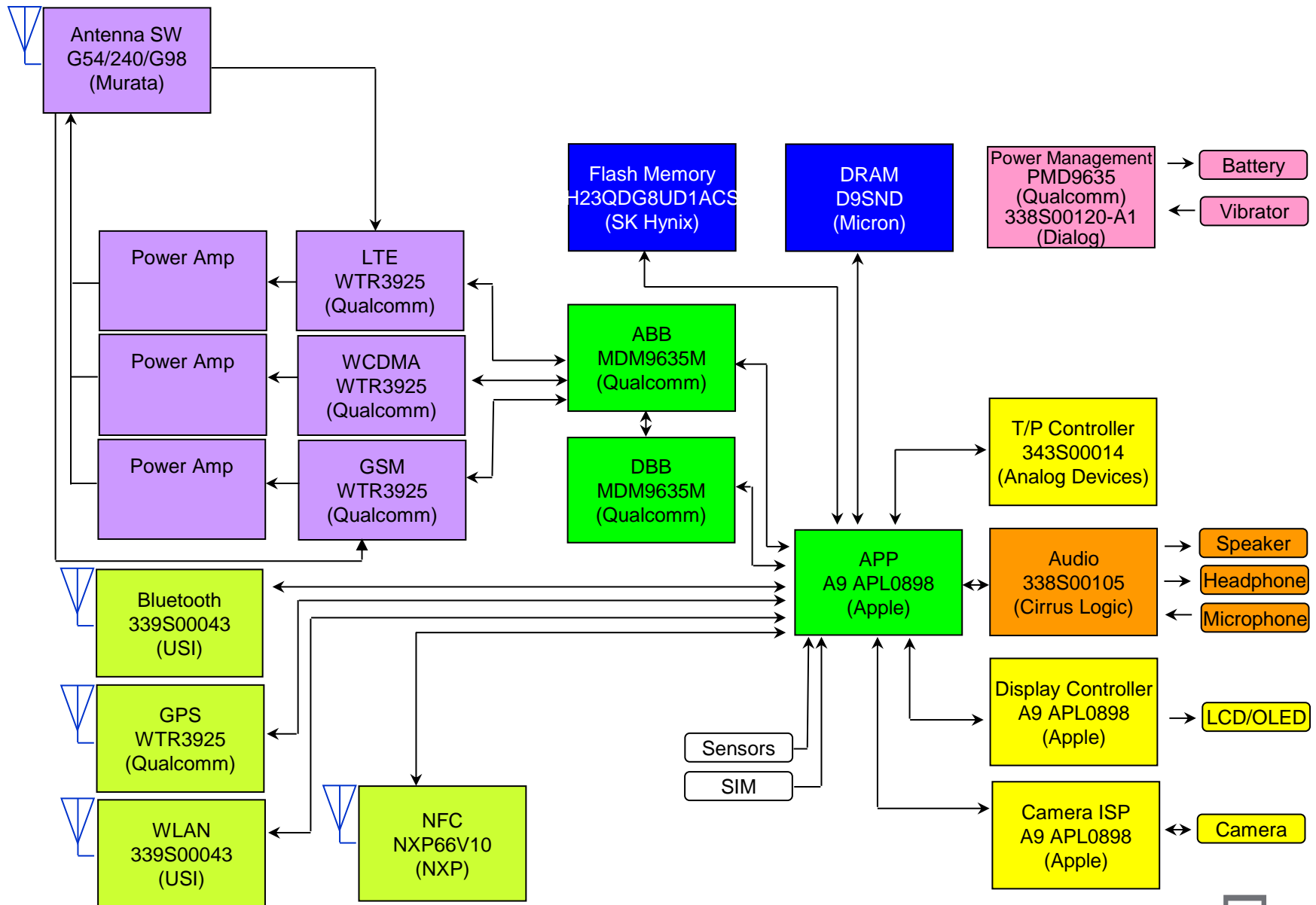


Measurement unit: millimeters (mm)

Power Source – Charger/Holder

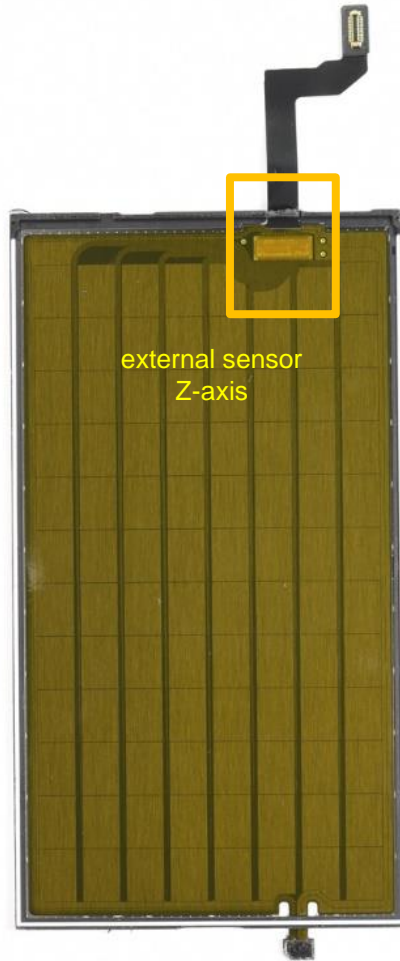


Block Diagram

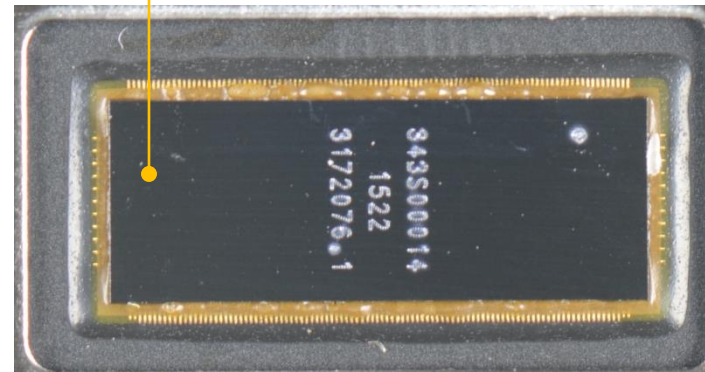


Technical Note

Unique/positive	3D touch	X/Y-axis touch sensing by in-cell touch panel. Z-axis touch sensing by indent sensing sheet.
Negative	-	-
Other	-	-



3D touch panel controller (Analog Devices)
 343S00014
 1522
 3172076.1



Key Component List

CATEGORY	FUNCTION	MARKING	PACKAGE SIZE (mm)	MNF	REMARK
CELLULAR	WCDMA TRANSCEIVER	WTR3925 TCG411000 AW521 203VV08	3.93 X 3.88 X 0.53	QUALCOMM	
	CDMA TRANSCEIVER	WTR3925 TCG411000 AW521 203VV08	3.93 X 3.88 X 0.53	QUALCOMM	
	LTE TRANSCEIVER	WTR3925 TCG411000 AW521 203VV08	3.93 X 3.88 X 0.53	QUALCOMM	
	WIMAX TRANSCEIVER	–	–	–	
	GSM TRANSCEIVER	WTR3925 TCG411000 AW521 203VV08	3.93 X 3.88 X 0.53	QUALCOMM	
	POWER AMPLIFIER	AVAGO AFEM-8030 KM1528 MB065 OOMBO	4.80 X 6.72 X 0.96	AVAGO	
	POWER AMPLIFIER	TriQuint TQF6405 1526 CHIN AR4912	6.71 X 4.80 X 0.90	QORVO	
	POWER AMPLIFIER	(LOGO) 77812-19 1307380.1 1530 MX	5.62 X 8.19 X 0.94	SKYWORKS	
	POWER AMPLIFIER	(LOGO) 77357-8 5128.1P 1529 MX	3.01 X 3.00 X 0.79	SKYWORKS	

Key Component List

CATEGORY	FUNCTION	MARKING	PACKAGE SIZE (mm)	MNF	REMARK
WIRELESS COMM	DIGITAL TV	-	-	-	
	WLAN	USI 150824 339S00043 00557068	8.97 X 11.76 X 0.80	UNIVERSAL SCIENTIFIC INDUSTRIAL	
	BLUETOOTH	USI 150824 339S00043 00557068	8.97 X 11.76 X 0.80	UNIVERSAL SCIENTIFIC INDUSTRIAL	
	GPS	WTR3925 TCG411000 AW521 203VV08	3.93 X 3.88 X 0.53	QUALCOMM	
	RFID	-	-	-	
	NFC	NXP 66V10 36 02 SD528	3.96 X 4.25 X 0.64	NXP	
	INFRARED PORT/CTRL	-	-	-	

Key Component List

CATEGORY	FUNCTION	MARKING	PACKAGE SIZE (mm)	MNF	REMARK
CONTROLLER	ANALOG BASEBAND	QUALCOMM MDM9635M 1BD AP33Y54 E152702	8.26 X 9.02 X 0.65	QUALCOMM	
	DIGITAL BASEBAND	QUALCOMM MDM9635M 1BD AP33Y66 E152702	8.26 X 9.02 X 0.65	QUALCOMM	
	APPLICATION PROCESSOR	A9 APL0898 339S00113 ON 155 1525 D9SND N91BFM111Z 1531	14.45 X 14.91 X 0.97	APPLE	DRAM POP
	IMAGE PROCESSOR	A9 APL0898 339S00113 ON 155 1525 D9SND N91BFM111Z 1531	14.45 X 14.91 X 0.97	APPLE	DRAM POP
	AUDIO PROCESSOR	338S00105 SAA1EF1525 SG	4.71 X 5.33 X 0.52	CIRRUS LOGIC	
	USB CONTROLLER	UNKNOWN	UNKNOWN	UNKNOWN	
	POWER MANAGEMENT	QUALCOMM PMD9635 0VV 3R51081 BU51502 19	4.16 X 4.10 X 0.54		
	POWER MANAGEMENT	338S00120-A1 1531EHFB	6.76 X 6.80 X 0.56	DIALOG	
	BATTERY MANAGEMENT	TI 56AX531 SN2400AB0	3.30 X 2.28 X 0.53	TEXAS INSTRUMENTS	

Key Component List

CATEGORY	FUNCTION	MARKING	PACKAGE SIZE (mm)	MNF	REMARK
CONTROLLER	DISPLAY CONTROLLER	A9 APL0898 339S00113 ON 155 1525 D9SND N91BFM111Z 1531	14.45 X 14.91 X 0.97	APPLE	DRAM POP
	LED CONTROLLER/DRIVER	UNKNOWN	UNKNOWN	UNKNOWN	

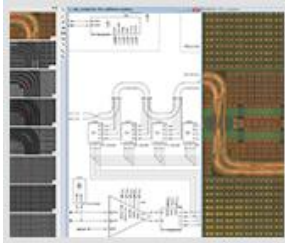
Key Component List

CATEGORY	FUNCTION	MARKING	PACKAGE SIZE (mm)	MNF	REMARK
AUDIO	MICROPHONE	5280 KSM2	2.53 X 3.35 X 1.04	KNOWLES	
	MICROPHONE	5280 KSM2	2.53 X 3.37 X 1.08	KNOWLES	
	MICROPHONE	529 GWM1	2.54 X 3.36 X 1.06	GOERTEK	
	MICROPHONE	5280 KSM2	2.53 X 3.42 X 1.05	KNOWLES	
	SPEAKER	CTH5355B 3FXG7T4AC	16.71 X 9.49 X 4.05	UNKNOWN	
	SPEAKER	CTH5343H CCGGLCKAX	20.10 X 36.01 X 4.68	UNKNOWN	
MOTOR	VIBRATOR	62J53648ECCGRGM15	41.37 X 5.98 X 2.85	UNKNOWN	TAPTIC ENGINE
SENSOR	ACCELEROMETER	MP67B 165AB1 1523	3.00 X 3.06 X 0.72	INVENSENSE	
	ACCELEROMETER	367 LA	2.01 X 2.00 X 1.03	BOSCH SENSORTEC	
	DIGITAL-COMPASS	UNKNOWN	UNKNOWN	UNKNOWN	
	GYROSCOPE	MP67B 165AB1 1523	3.00 X 3.06 X 0.72	INVENSENSE	
	BAROMETER	7HY YP	3.04 X 2.03 X 0.70	BOSCH SENSORTEC	
	TOUCH PANEL	343S00014 1522 3172076.1	8.55 X 3.19 X 0.50	ANALOG DEVICES	
MEMORY	DRAM	A9 APL0898 339S00113 ON 155 1525 D9SND N91BFM111Z 1531	14.45 X 14.91 X 0.97	MICRON	APP POP
	FLASH MEMORY	SK hynix H23QDG8UD1ACS BC A1 526A M18VR986QB	14.76 X 11.86 X 0.86	SK HYNIX	

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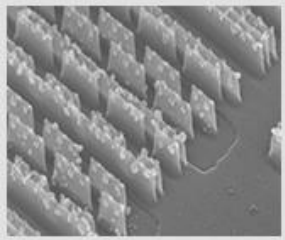
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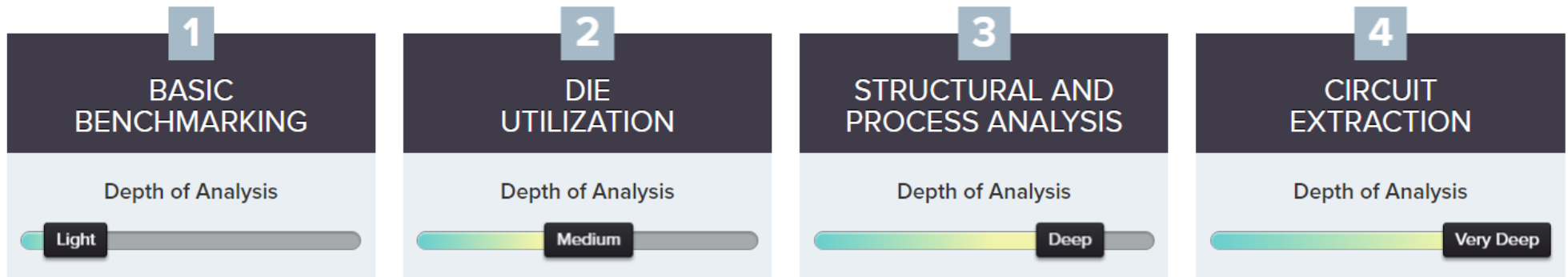
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