

IEEE Central Texas Consultants Network Meeting July 27, 2011

Product Teardown Analysis for Technical Marketing, Competitive Intelligence, and Intellectual Property Assertion

Presented by:
UBM TechInsights
Technical Intelligence

Ted Scardamalia
Don Stroud

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Apple iPhone 4 A1332

**Quad-band GSM + EDGE;
W-CDMA (850/900/1900/2100 MHz) + HSDPA/HSUPA
Report #11000-100629-CDd**

Handset Weight: 140.7 grams



Product Description:

Apple released their fourth-generation iPhone 4 (not to be confused as being 4G capable) in late June 2010, coinciding with their latest iOS upgrade to 4.0. Operating on quad-band GSM + EDGE and quad-band W-CDMA + HSDPA / HSUPA (850/900/1900/2100 MHz) networks, the iPhone 4 is enhanced with higher resolutions for both display (960 x 640 up from 480 x 320) and main camera (5MP up from 3MP) with HD video recording capability. Apple also introduced a front-facing VGA camera for making conference calls from iPhone-to-iPhone via their new FaceTime chat application. The 3.7V/1420mAh Li-polymer battery provides a claimed 14 hours of GSM talk time, but only 7 hours for W-CDMA; standby time is rated at 300 hours. Other features include WiFi 802.11b/g/n (802.11n is 2.4GHz only), Bluetooth 2.1 with EDR, and A-GPS with navigation.

Report Contents:

- Detailed external and internal photos
- Detailed step-by-step disassembly
- Power measurements
- Block Diagram
- Circuit board & packaging metrics
- Complete parts list & component count
- Manufacturing cost analysis
- Description of most interesting electronic features and packaging concepts

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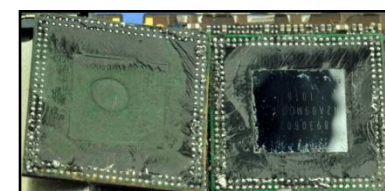
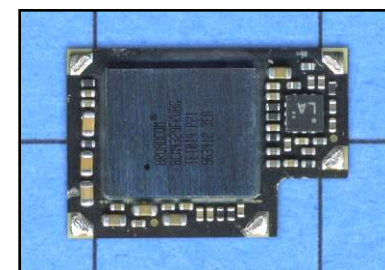
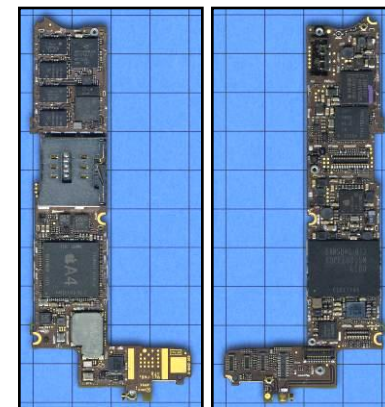
Executive Summary

While maintaining a similar form-factor and display size to preceding iPhone designs, the iPhone 4 introduces a much higher-resolution 960x640 LCD, improved camera with LED flash, additional video-call camera, and faster operation speed among other new features and the next-generation OS4. The case design implements a unique integrated antenna design, with co-molding used to create isolated sections of edge frame to enable radiation and reception for the Cellular, A-GPS, and WiFi/Bluetooth radios. Criticism swirled around the issues with loss of reception when the outer case was held in a way that interfered with the antenna, specifically when a hand or finger bridges the "launch point" of the cellular antenna with the grounded adjacent case. We performed RF power tests while bridging the problem portion of outer case and verified some aspects of the issue though a quantitative RF test to validate the magnitude of signal loss is beyond the scope of this report.

The iPhone 4 employs a 10-layer full-sequential buildup PCB for most of the electronics including the Apple-designed, Samsung-manufactured A4 / APL0398 applications processor with ARM A8 Cortex first seen in the Apple iPad family. In an upgrade from the iPad A4 implementation, applications memory has been doubled from 256MB to 512MB of Mobile DDR SDRAM (still using a x64 interface) in an Elpida-manufactured package-on-package (#ECK4265J1PB-50-F). The 32GB of MLC NAND Flash user memory is available in a 8-chip stacked package from Samsung (#K9PFG08U5M). A Micron (formerly Numonyx) MCP (#PF36MY1EF) with Intel-based 16MB NOR Flash and 16MB of Mobile DDR SDRAM Elpida forms the comms memory. Infineon is once again the supplier of the Digital Baseband, now with a more-integrated single-chip device (#X-GOLD 616 PMB9801). Likewise Infineon supplies a now-single-chip W-CDMA/GSM Transceiver (#PMB5703) as well as a quad-band W-CDMA LNA (#BGA748L16). Skyworks supplies not only the quad-band GSM power amplifier (#SKY77541, very similar to SKY77529) this time, but also two of the four W-CDMA power amplifiers as well (#SKY77459 for band V, and #SKY77452 for band VIII). TriQuint provides the remaining two W-CDMA power amplifiers (#TQM676091 for band I, and #TQM666092 for band II). All RF PA modules integrate the appropriate duplexers for the band supported. Dialog Semiconductor provides Power Management (#338S0867 / D1815A) which contains the same die seen in the iPad, as was the case for the Cirrus Logic audio CODEC (#338S0589 / CLI1495B0) which was also seen in the iPad. A slightly-revised version of the TI-manufactured Touch Screen Controller (#343S0499 / F761586G) seen in previous Apple products supports capacitive multi-touch in a single device. The 3-Axis Accelerometer (#LIS331DLH) and new 3-Axis Gyroscope (#L3G4200DH ?) are from STMicroelectronics, while the 3-Axis Electronic Compass is provided by AKM Semiconductor. Audience supplies the Voice processor (#A10C0 ?) capable of handling noise cancellation with two microphones. The upgraded 5MP autofocus camera employs OmniVision's #OV5650 while the new front-facing VGA Camera uses OmniVision's #OV7738 image sensor. Apple has upgraded to Broadcom's #BCM4329 for WiFi/Bluetooth implementation, while replacing Infineon for the A-GPS Receiver with Broadcom's BCM4750. The Battery Cell supplier is once again Sony Energy Devices (#US433481) and the 3.5" 960 x 640 TFT-LCD (chip-in-glass) display employs a Display Column Driver from Renesas SP Drivers (#R63303A0). The full block diagram can be found on pages 57-58.

iPhone 4 mechanical design follows the usual Apple formula of sophistication in materials and manufacturing. The highly-processed metal frame uses co-molded plastic to isolate the antennae segments and integrate a spanning metal support plate for the bonded display/touchscreen/cover-glass (topside) and battery/circuit-board/cover-glass (underside). Welded thread bosses line the inside perimeter of the frame for fastening the display assembly and small screw fasteners and tapes abound.

The estimated hardware cost-of-goods-sold (COGS) for the 32GB iPhone 4, assuming fully-scaled production, comes to \$[REDACTED]. Total COGS, including an estimated \$[REDACTED] for supporting materials is \$[REDACTED], against the August 2010 no-contract street price of \$[REDACTED]. This yields a COGS-to-price ratio of [REDACTED]%. The smaller-capacity 16GB model would have a total COGS of about \$[REDACTED] under a consistent assumption for NAND pricing as used in this report. Sleek, and profitable, the iPhone 4 does appear to have a nagging Achilles heel in the antenna implementation but Apple has offered free covers to ameliorate interference and attempt to soothe the angry masses. Despite these stumbles and a report that Consumer Reports is not recommending the iPhone 4, sales overall appear to be brisk and – it seems so far – that the iPhone franchise remains relatively intact.



Product Overview

| Product Description | | Protocols | |
|---------------------------|---|------------------------------------|--------------------|
| Product Type | Smartphone | Core Protocol | GSM & W-CDMA |
| Product Name | iPhone 4 (32GB - Model#A1332) | Data Protocol | EDGE & HSDPA/HSUPA |
| Brand | Apple | GSM | 850/900/1800/1900 |
| Official Release Date | 24-Jun-10 | W-CDMA | 850/900/1900/2100 |
| Origin | U.S. (design) / China (mfg.) | Complexity/Integration Metrics | |
| FCC ID Number | BCG-E2380A | | |
| Serial Number | 85022AVXA4T | | |
| Operating System (OS) | Apple iOS 4.0 | IC Package Count | 45 |
| Product Key Features | | Die Area (mm ²) | 1934.5 |
| | | Substrate Tiling Density (Main BD) | 0.98 |
| | | Cost Metrics | |
| Talk Time (Hours): | 3G = 7; 2G = 14 | Retail Price | \$699.00 |
| Standby Time (Hours): | 300 | Total Manufacturing Cost* | \$ 8 |
| HD (720p) Video Recording | FaceTime Video Conferencing (WiFi only) | Electronics Cost | \$ 7 |
| Multi-touch Touchscreen | Tap to Focus Video or Still Images | % Total Manufacturing Cost | |
| Bluetooth 2.1 + EDR | WiFi 802.11b/g/n (802.11n is 2.4GHz Only) | Integrated Circuits | 19% |
| Assisted GPS | iTunes Interface | Modules, Discretes & Connectors | 7% |
| microSIM Card | Music & Video Player | Substrates | 3% |
| 32GB Memory | Electronic Compass & 3-Axis Accelerometer | Component Insertion | 9% |
| 3-Axis Gyroscope | Proximity & Ambient Light Sensors | Card Test | 2% |
| System Footprint Metrics | | Display | 6% |
| | | Battery Pack | 9% |
| Weight (grams) | 140.7 | Cameras | 4% |
| Product Dimensions (mm) | 115.7 x 59.2 x 9.5 | WiFi/Bluetooth Module | 8% |
| Key Subsystems | | Non-Electronic Parts | 9% |
| | | Final Assembly & Test | 4% |
| Display | 3.5" TFT-LCD; 16.7M colors; 960 x 640 pixels; chip-in-glass | | |
| Battery | Li-Polymer, 3.7V, 1420mAh | | |
| Main Camera | 5MP CMOS w/ Autofocus & LED Flash | | |
| Secondary Camera | VGA CMOS | | |

*Note: The total manufacturing cost does not include the cost of the supporting materials shown on the following pages.

Supporting Materials



Packaging - \$[REDACTED]

Total Estimated Cost of
Supporting Materials = \$[REDACTED]00



Documentation & Decals - \$0.15



Headset - \$[REDACTED]

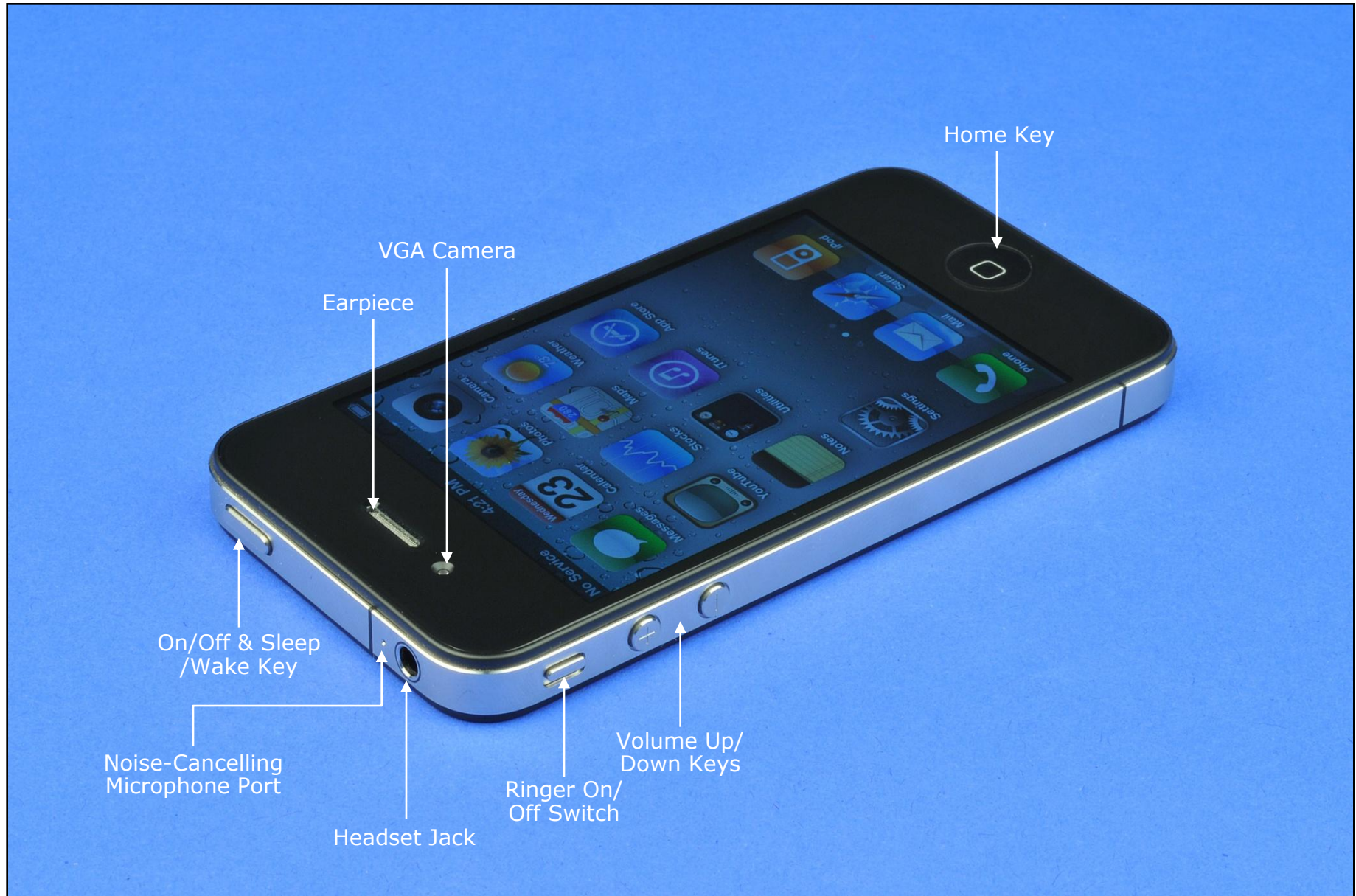


AC Adapter - \$[REDACTED]



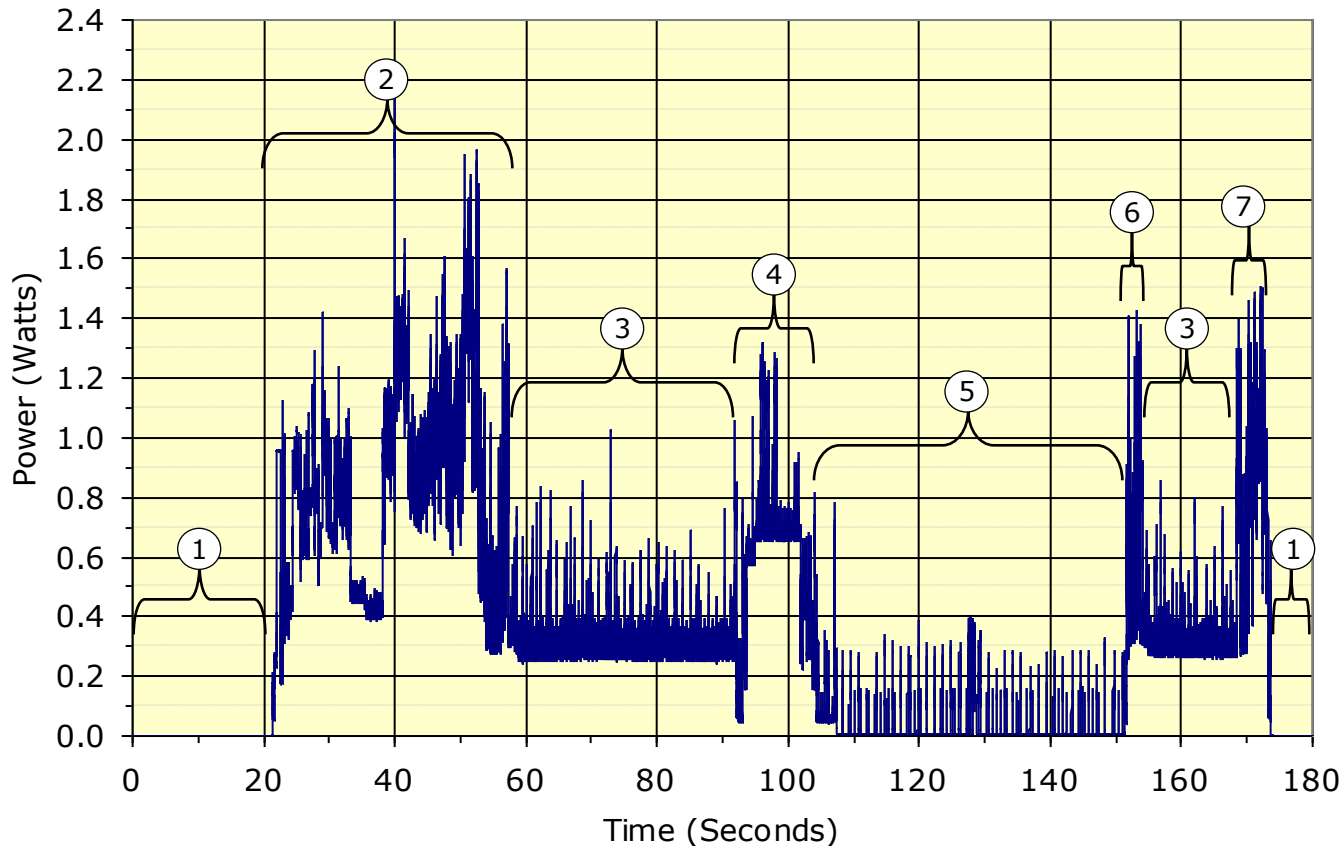
Multifunction Cable - \$[REDACTED]

Features & Dimensions (Front, Top, & Left)



Power Measurements

Power Up/Down (Flight Mode Off)



1. Phone powered off. ($0.00W$)
2. Phone powering on.
3. Sitting idle at home screen. ($0.31W$)
4. Putting the phone into sleep mode; the display turns off.
5. Sitting idle in sleep mode, power briefly at $0.06W$ then settles down to $0.02W$.
6. Waking up and unlocking phone.
7. Powering off phone.

Test Parameters

- Network Connection: AT&T 3G Network
- Radio Parameters: Flight Mode = Off; Bluetooth = Off; WiFi = Off; Location Services = Off
- Phone Parameters: Display Brightness = Min.; Volume Level = Mute
- Measurement Parameters: Period = 3ms; Integration Time = 1ms; 333 samples/second
- All measurements are averages unless otherwise specified.

Power Measurements

GSM 1900MHz - Voice

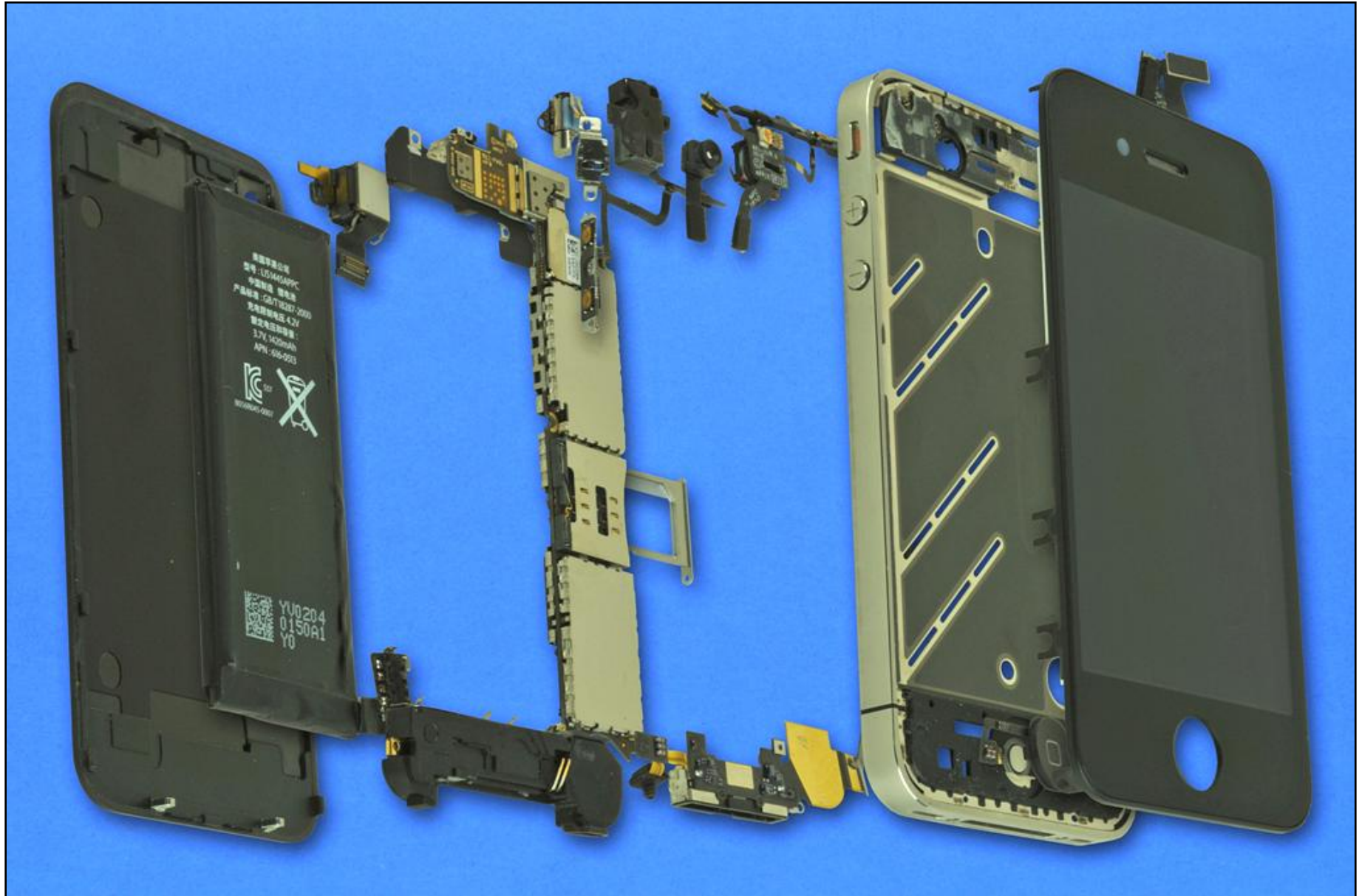
| | | | | |
|--------------|-----------------|------------|-------|-------|
| Voice | Protocol | GSM | | |
| | Frequency (MHz) | 1900 | | |
| | PA Setting | Low | Mid | High |
| | Minimum (Watts) | 0.426 | 0.404 | 0.417 |
| | Average (Watts) | 0.66 | 0.97 | 1.06 |
| | Maximum (Watts) | 1.34 | 2.82 | 3.36 |

GSM 1900MHz - Voice (w/ Area Covered by Finger)

| | | | | |
|--------------|-----------------|-----------------|-------|-------|
| Voice | Protocol | GSM | | |
| | Frequency (MHz) | 1900 | | |
| | PA Setting | Low | Mid | High |
| | Minimum (Watts) | Lost Connection | 0.408 | 0.429 |
| | Average (Watts) | | 0.89 | 0.93 |
| | Maximum (Watts) | | 2.61 | 2.93 |

Tests performed with an Agilent GS-8210 Wireless Handset Test system.

Component Arrangement



[Comments?](#)

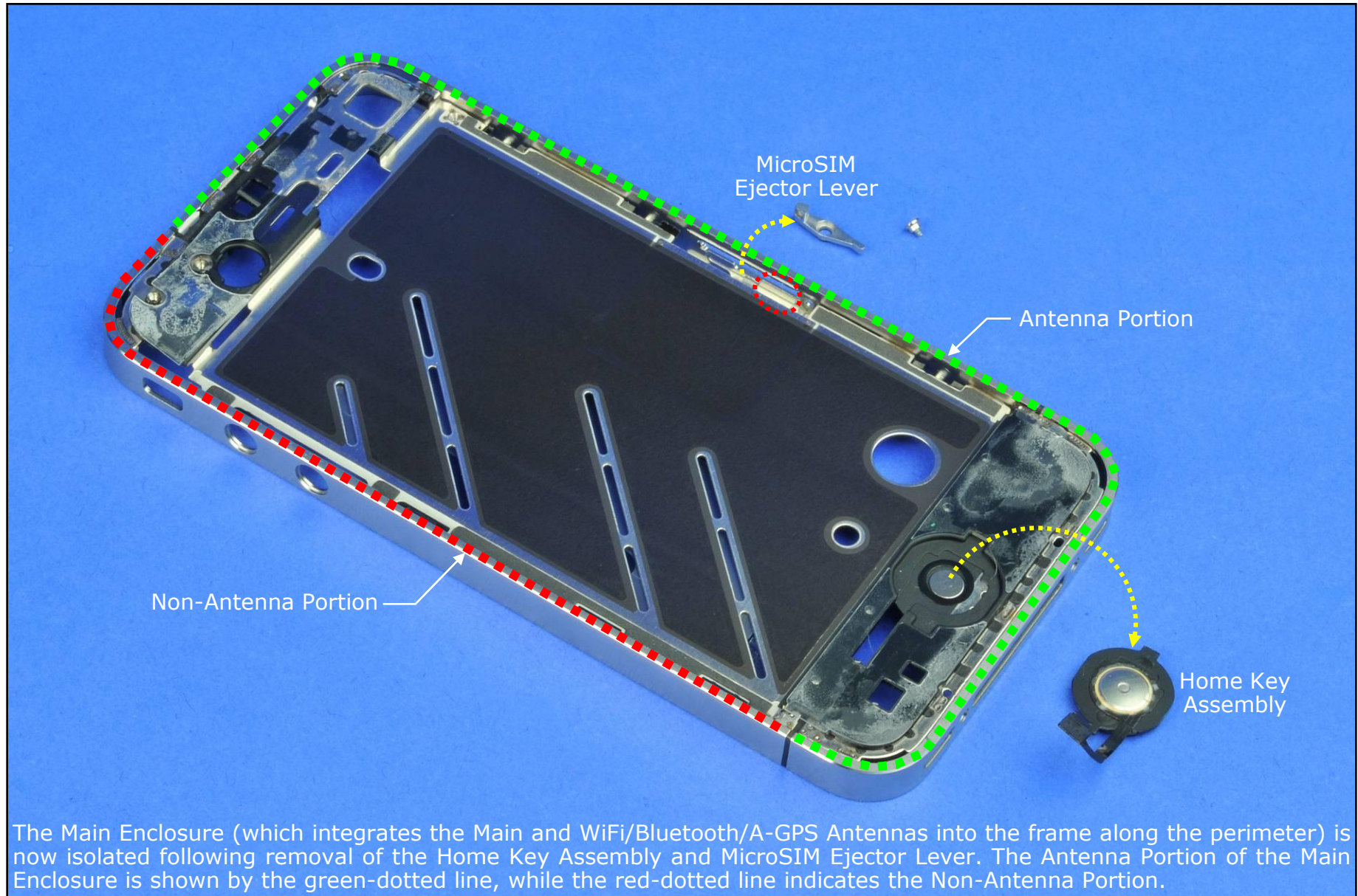
[Email us at feedback@teardown.com](mailto:feedback@teardown.com)

Teardown Sequence



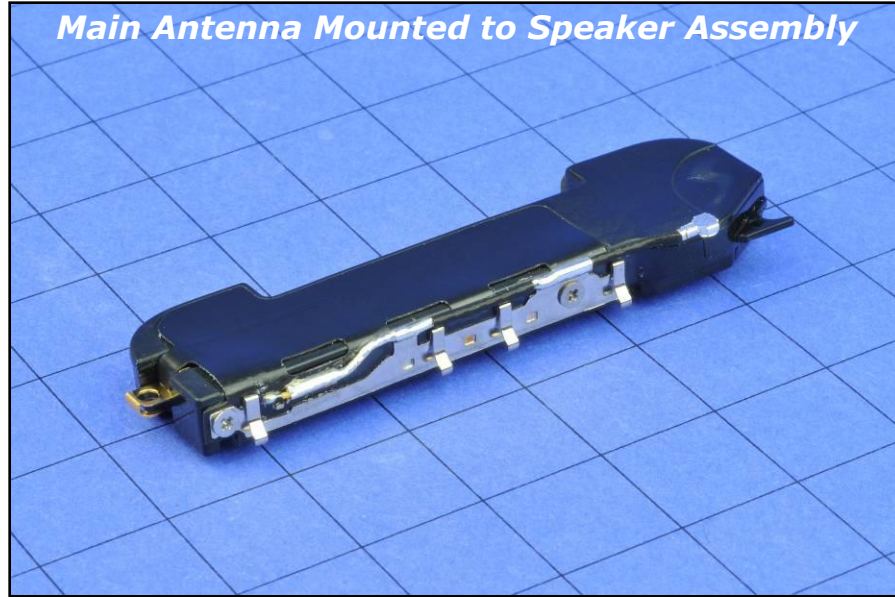
The Main Board is now lifted from the enclosure separating the Earpiece Connection. A spring contact on the Main Board is also separated from the Antenna that surrounds the outer band of the phone.

Teardown Sequence



Main Antenna

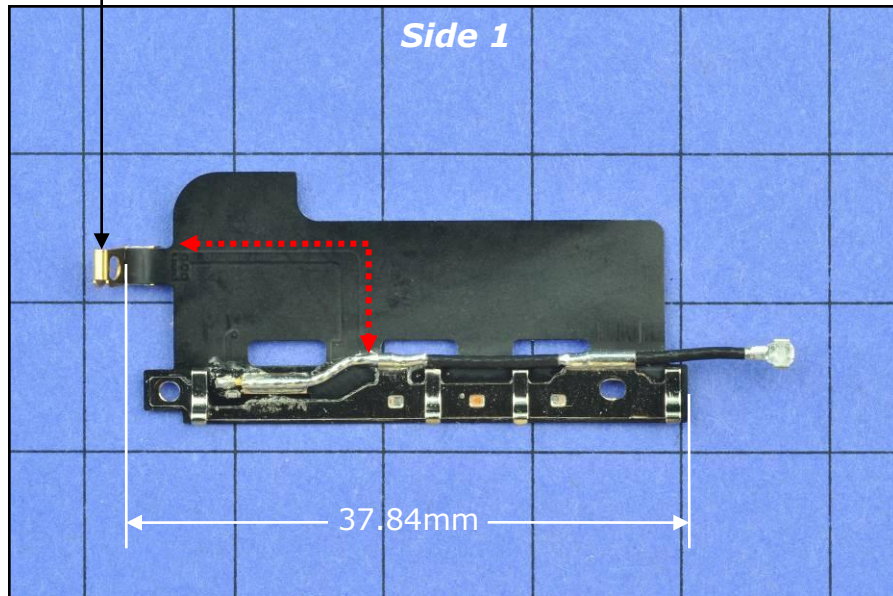
Main Antenna Mounted to Speaker Assembly



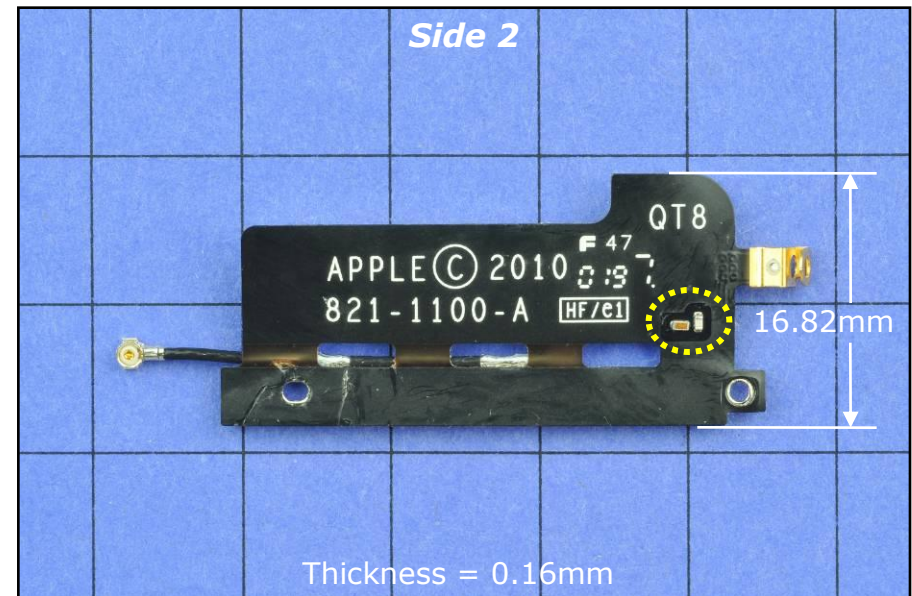
Note: Structure shown is mostly for distribution of antenna connection to frame attach point, with the frame serving as the prime radiative/receptive element. A series L-C circuit circled in yellow is placed between coax end-point and frame attach point. A $\sim 22\text{mm}$ long grounded stub (highlighted in red) is also seen at the frame attach point.

Frame attach point

Side 1

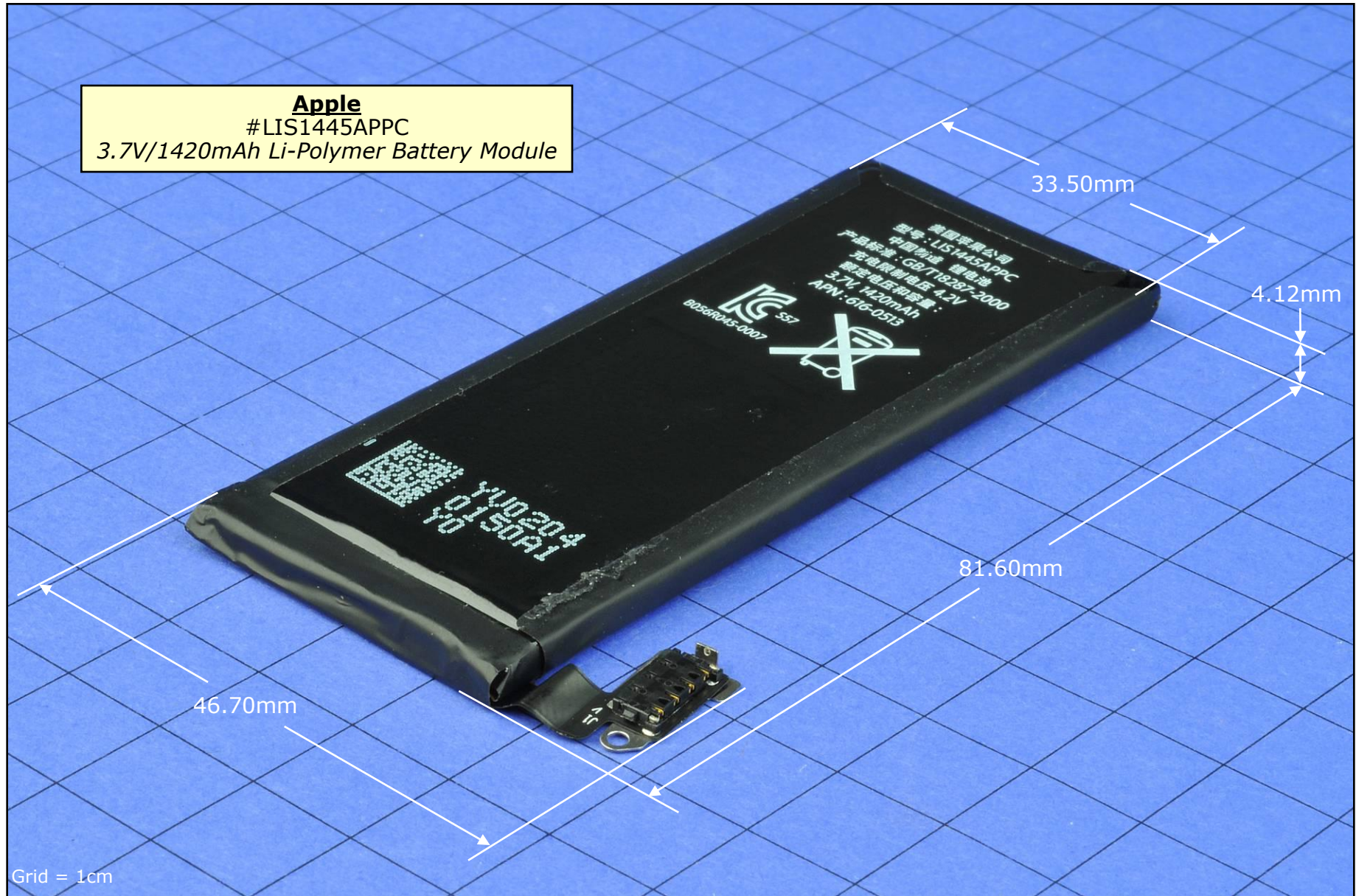


Side 2



Thickness = 0.16mm

Battery Module

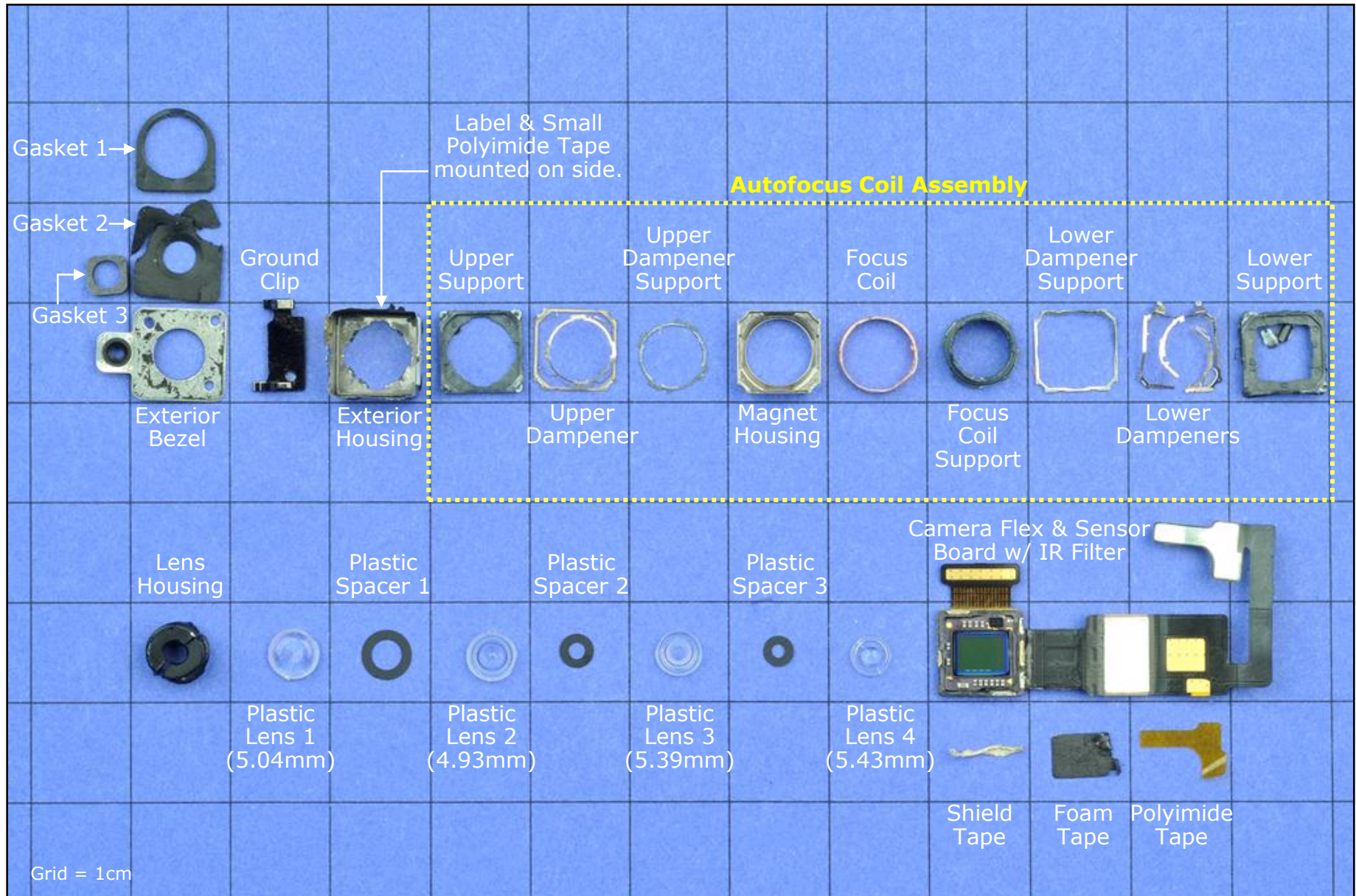


Estimated Battery Cost



| Battery Pack | | |
|--------------------------------|-----------------|---------------------|
| Pack Brand | | Apple Computer |
| Pack Part Number | | LIS1445APPC |
| Pack Voltage | | 3.7 |
| Cell Type | | Lithium Polymer |
| Pack Rating (mAHrs) | | 1420 |
| Pack Size (mm) | | 81.57 x 46.7 x 4.12 |
| Vol. Energy Density (mWHrs/cc) | | 334.8 |
| Pack Weight (grams) | | 27.0 |
| Wt. Energy Density (mWHrs/g) | | 194.6 |
| Cell Brand | | Sony Energy Devices |
| Estimated Costs | Cell | \$ |
| | Electronics | \$ |
| | Non-Electronics | \$ |
| | Assembly | \$ |
| | Test | \$ |
| | Margin | \$ |
| Estimated Pack Price | | \$ |

5MP Camera Disassembled



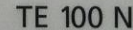
Camera Test Photos (Sunny, Far)



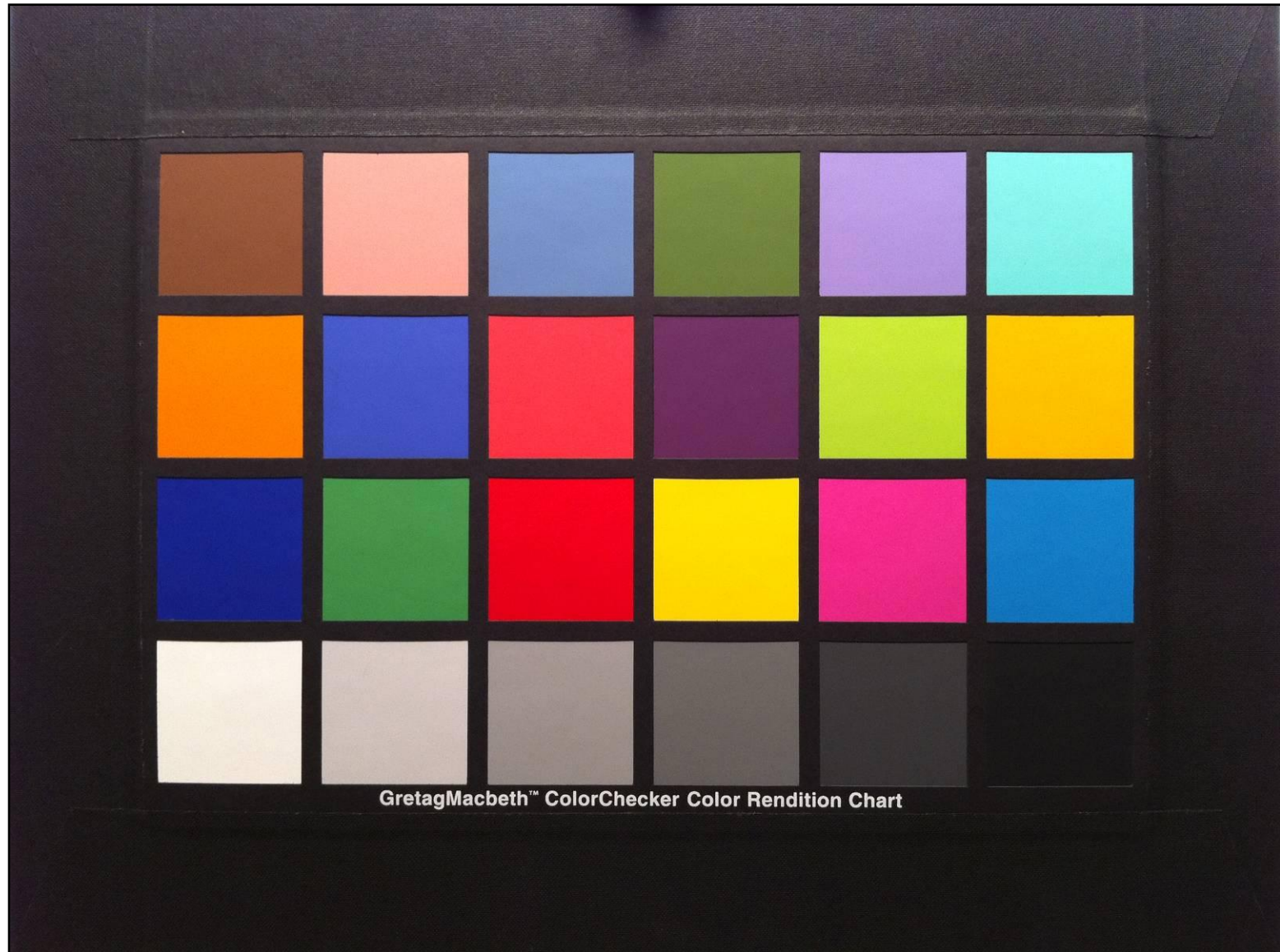
Photo taken outdoors with sunny lighting conditions.

[Comments?](#)

[Email us at feedback@teardown.com](mailto:feedback@teardown.com)



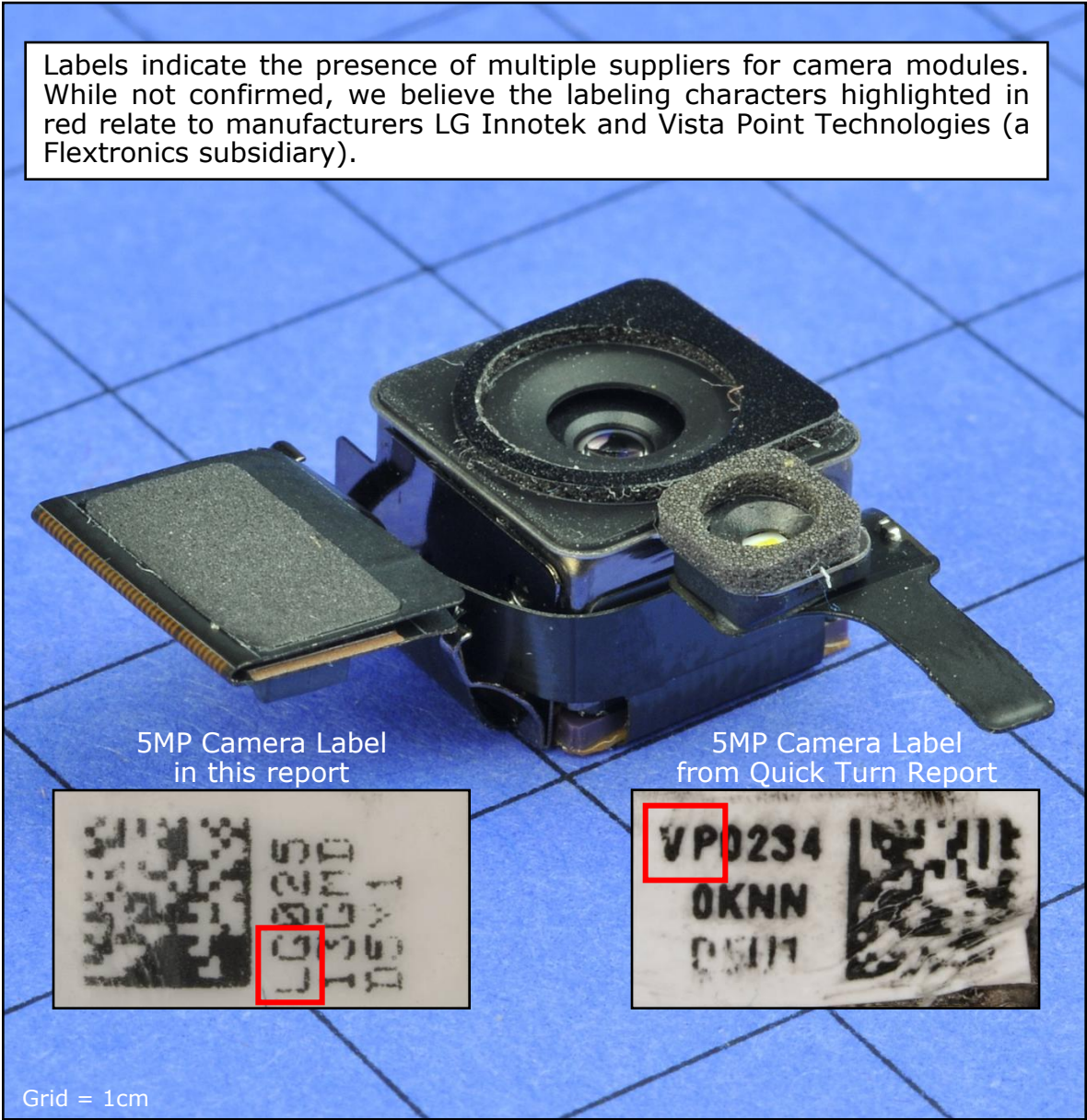
GretagMacbeth @ 320 LUX



5MP Camera Estimated Cost



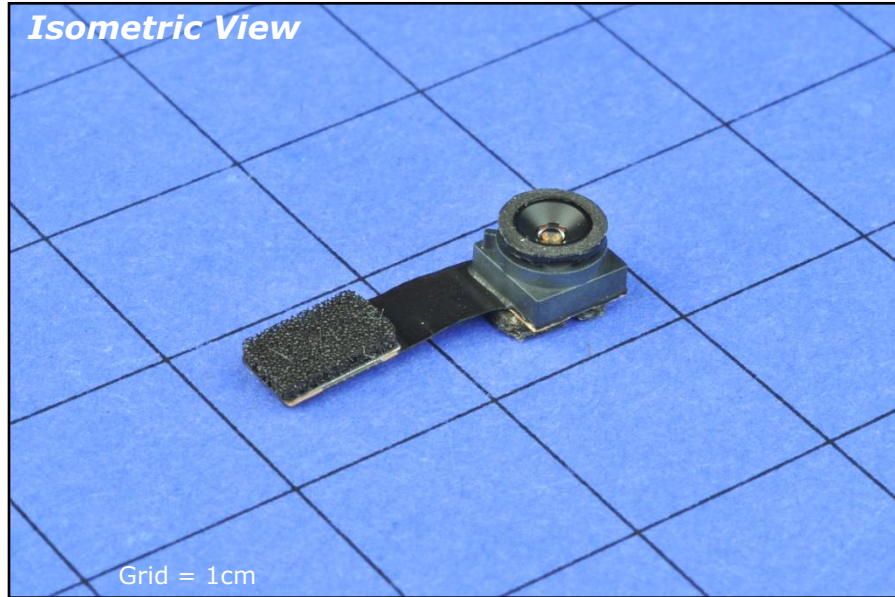
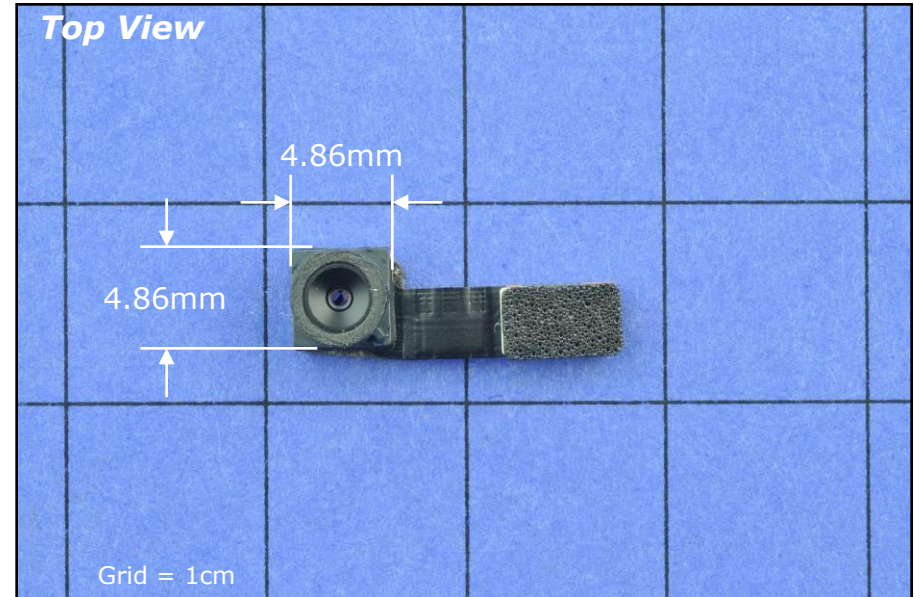
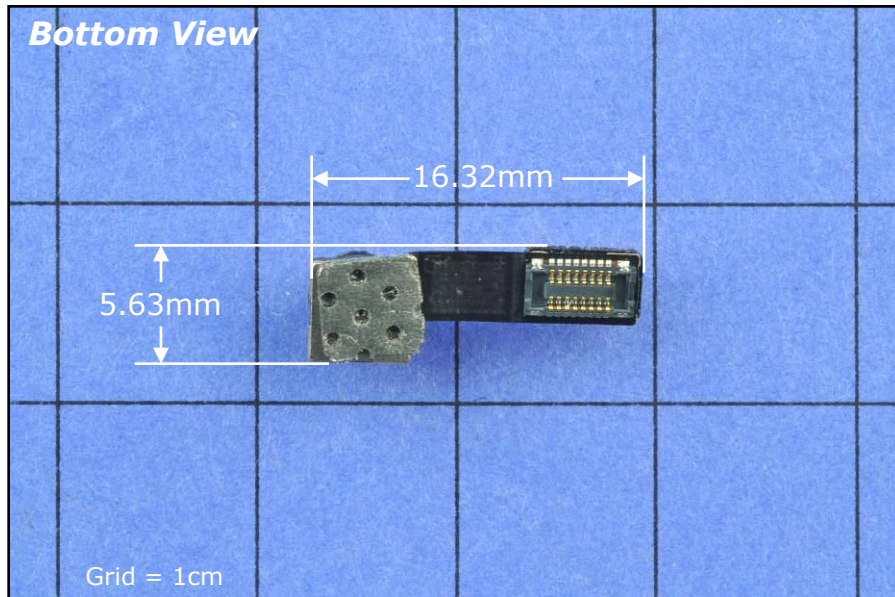
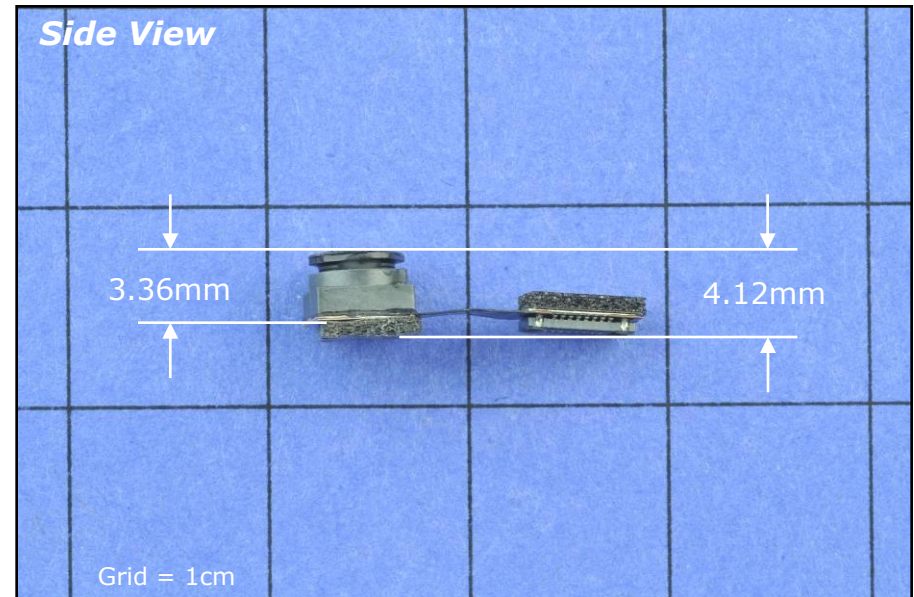
Labels indicate the presence of multiple suppliers for camera modules. While not confirmed, we believe the labeling characters highlighted in red relate to manufacturers LG Innotek and Vista Point Technologies (a Flextronics subsidiary).



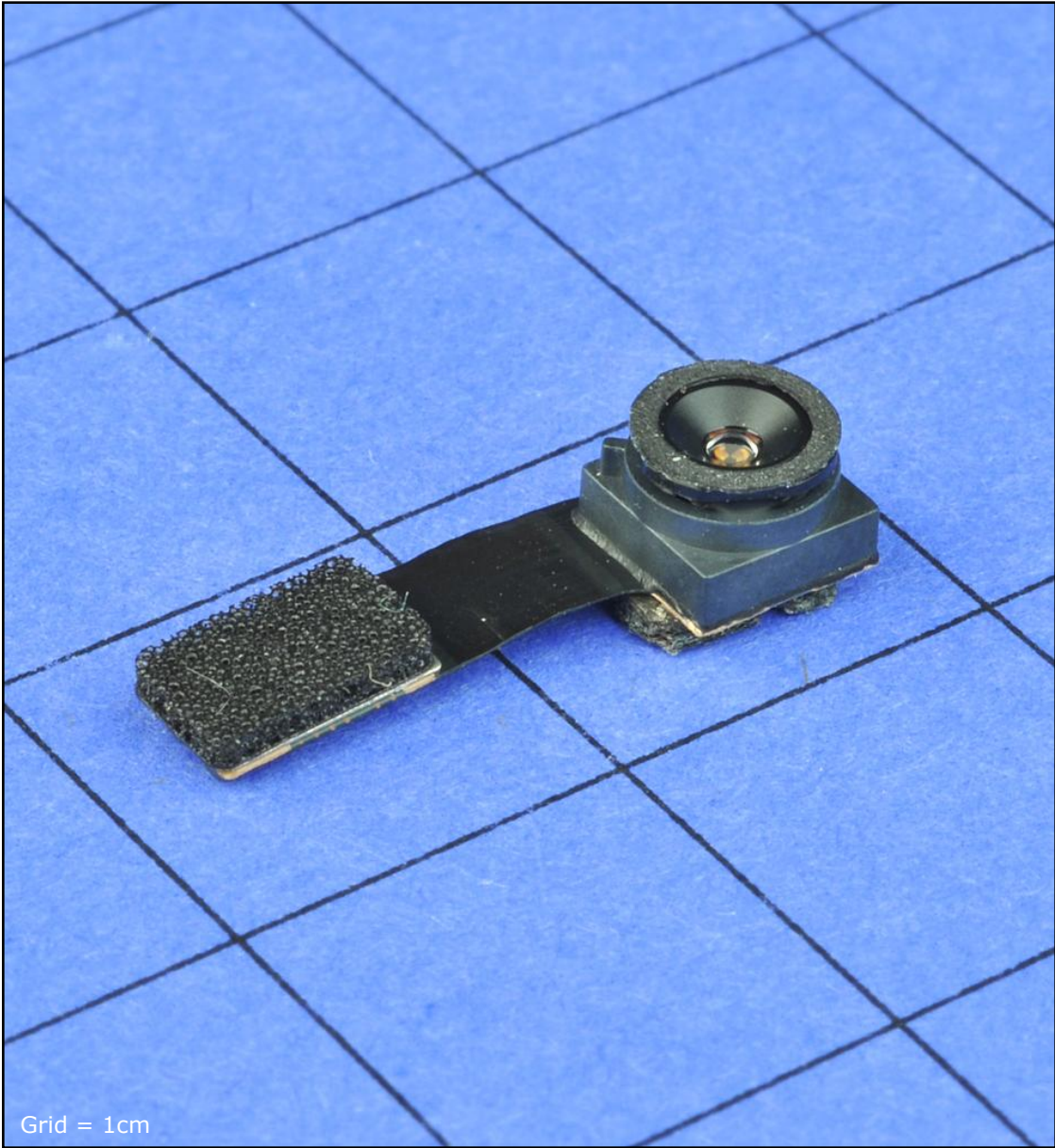
| 5MP Camera Module | | |
|--------------------------|----------------------|----|
| Brand | LG Innotek | |
| Part Number | LG025 ? | |
| Subsystem Size (mm) | 19.23 x 18.84 x 6.88 | |
| Camera Size (mm) | 8.75 x 8.75 x 5.93 | |
| Subsystem Weight (grams) | 1.3 | |
| Camera Weight (grams) | 1.0 | |
| Type | CMOS | |
| Resolution | 5 MP | |
| Optical Size | 1/3.2" | |
| Lens Elements | 4 | |
| Optical Zoom | 1 | |
| Estimated Costs | Electronics | \$ |
| | Non-Electronics | \$ |
| | Assembly | \$ |
| | Test | \$ |
| | Markup | \$ |
| Estimated Module Price | | \$ |

Grid = 1cm

VGA Camera Module

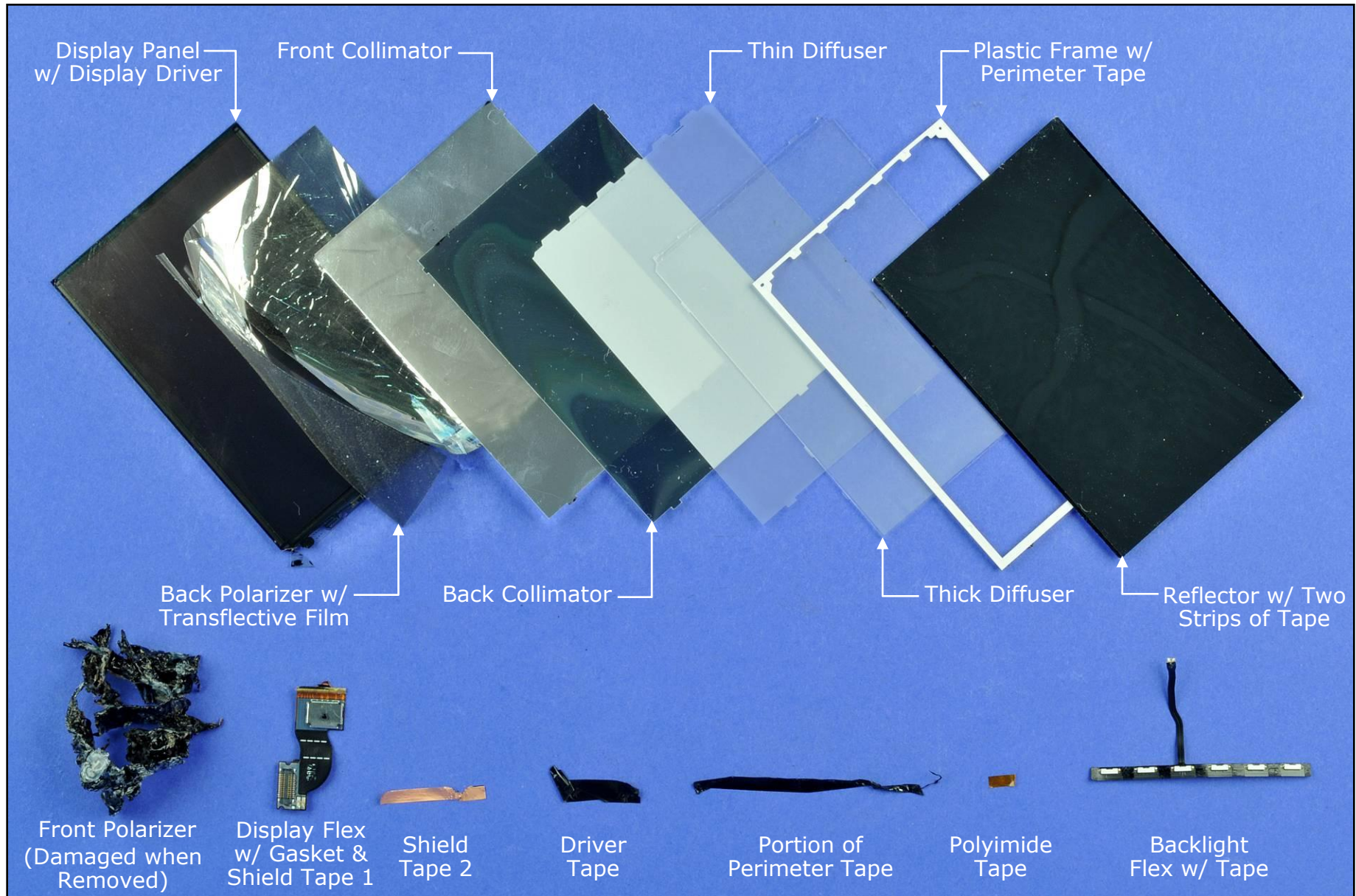
Isometric View*Top View**Bottom View**Side View*

VGA Camera Estimated Cost

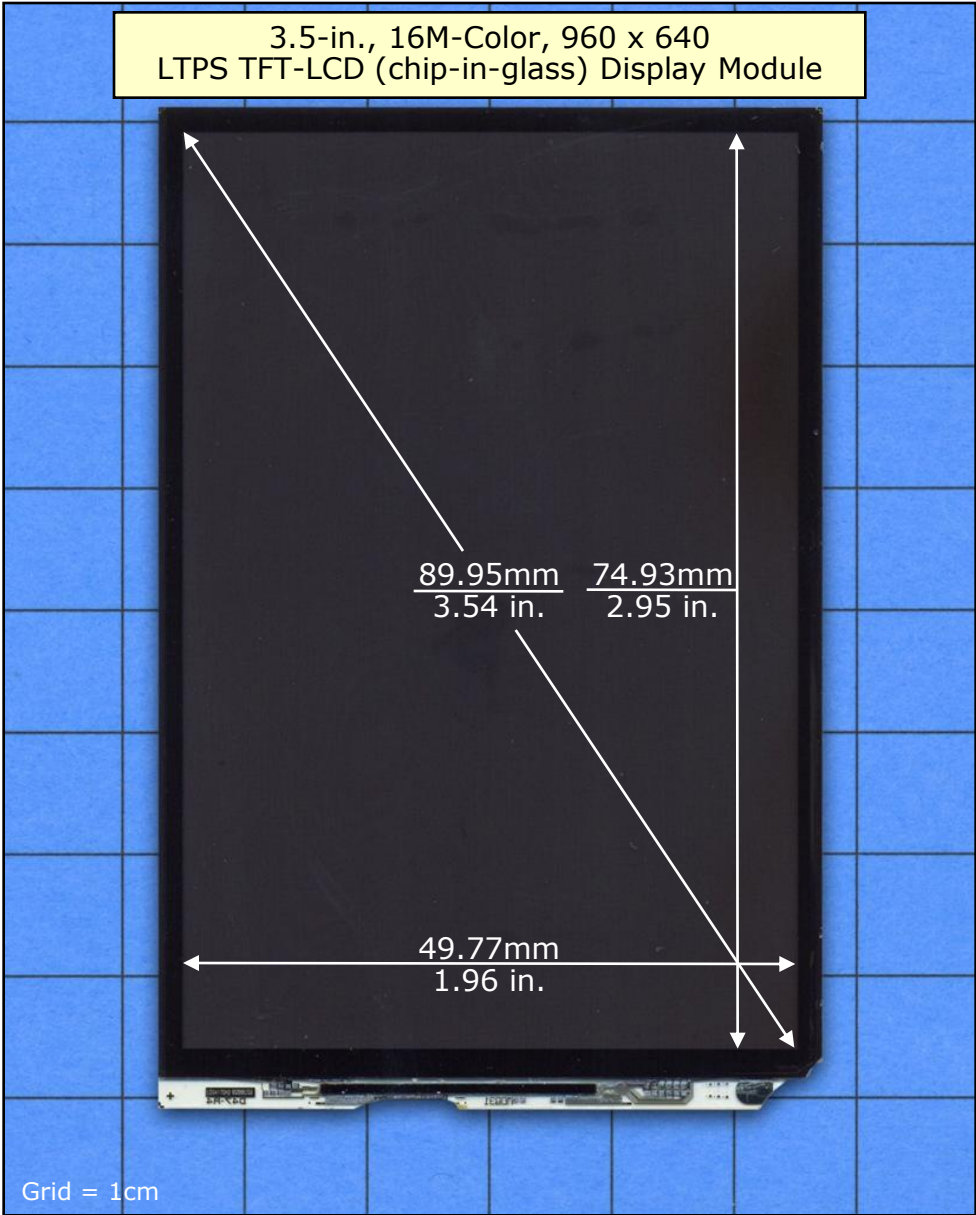


| VGA Camera Module | | |
|--------------------------|-----------------|---------------------|
| Brand | | Unknown |
| Part Number | | Unknown |
| Subsystem Size (mm) | | 16.32 x 5.63 x 4.12 |
| Camera Size (mm) | | 4.86 x 4.86 x 3.36 |
| Subsystem Weight (grams) | | 0.2 |
| Camera Weight (grams) | | 0.1 |
| Type | | CMOS |
| Resolution | | VGA |
| Optical Size | | 1/7.5" |
| Lens Elements | | 3 |
| Optical Zoom | | 1 |
| Estimated Costs | Electronics | \$ |
| | Non-Electronics | \$ |
| | Assembly | \$ |
| | Test | \$ |
| | Markup | \$ |
| Estimated Module Price | | \$ |

Display Module Disassembled



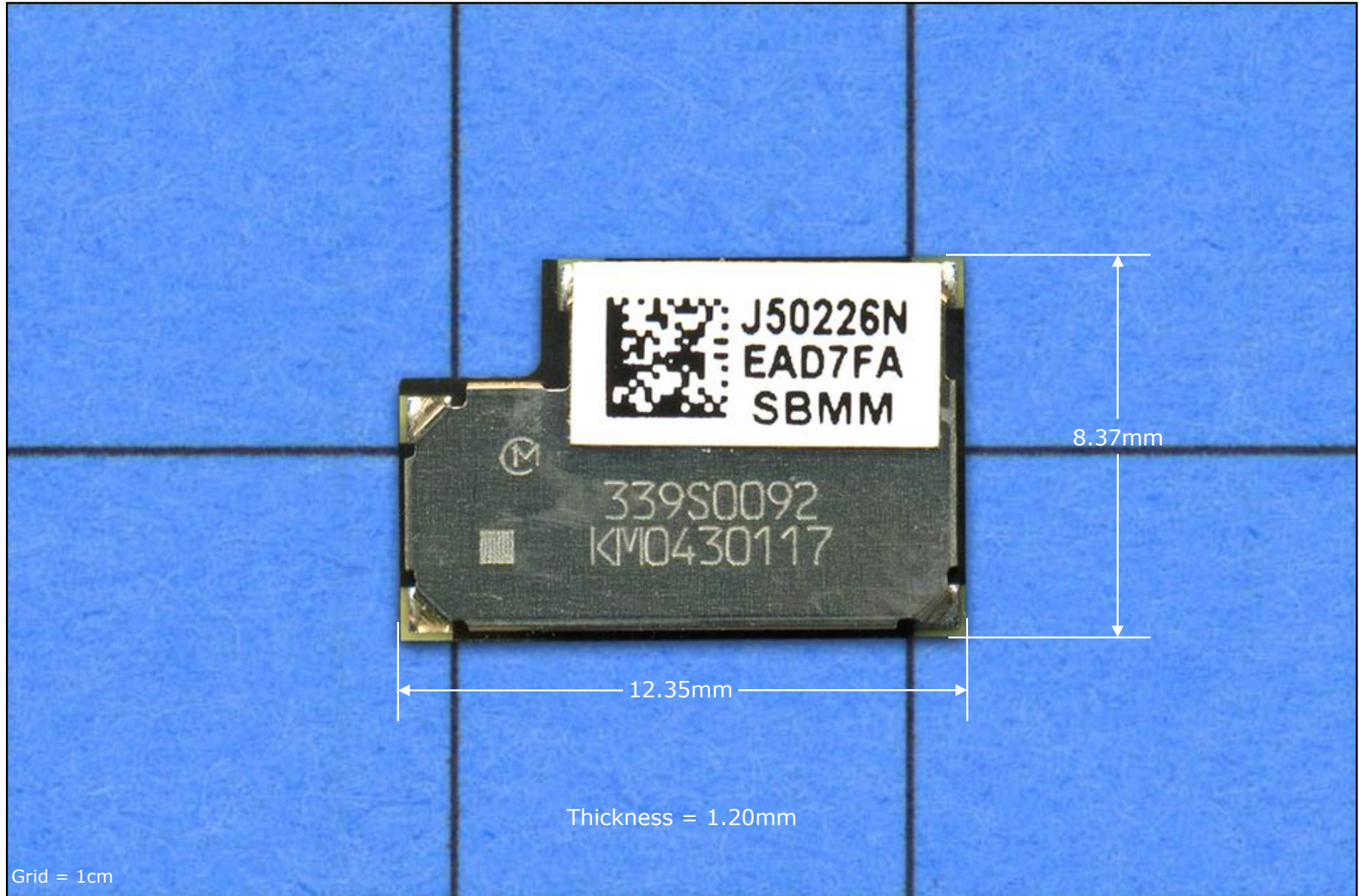
Estimated Display Cost



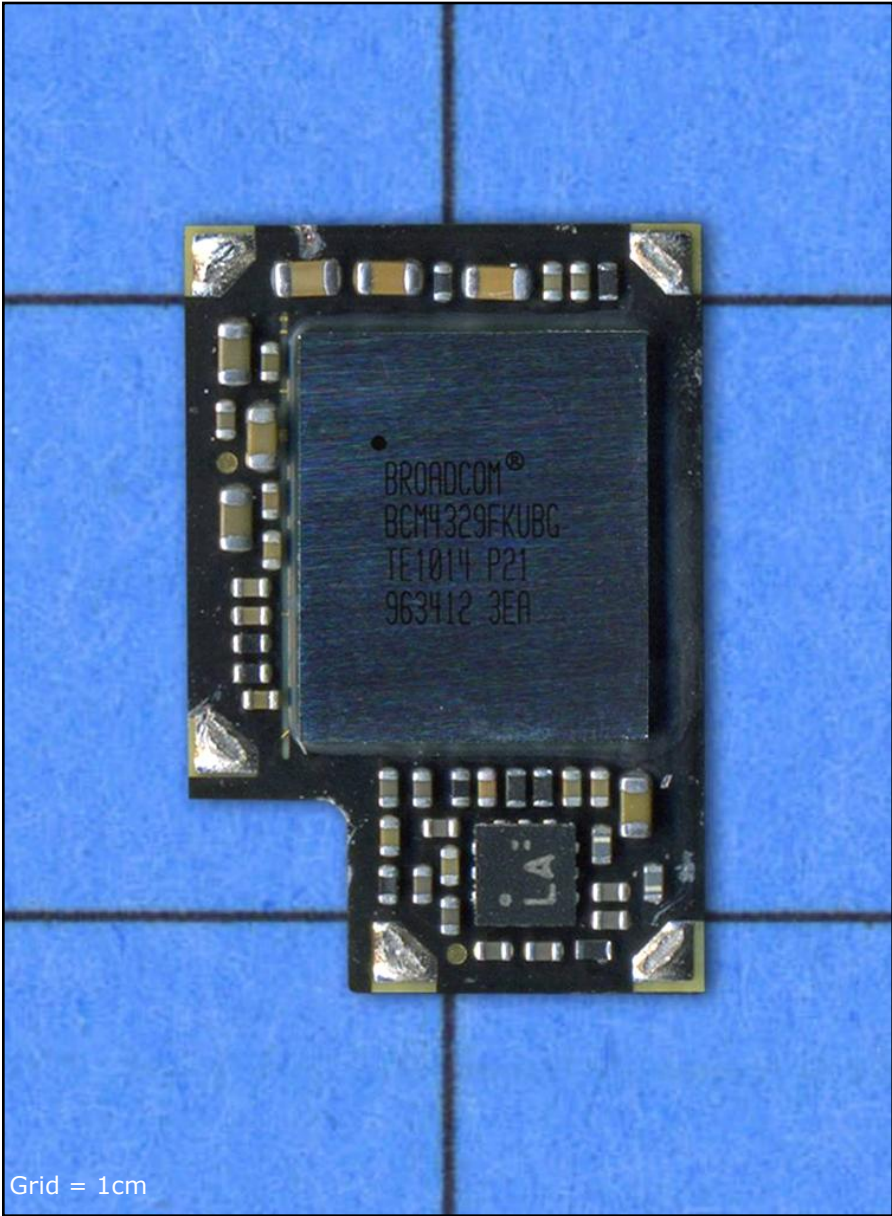
| Display Module | | |
|------------------------|---------------------|----------------------|
| Brand | | TMDisplay ? |
| Part Number | | 821-0695-A |
| Module Dimensions | | 82.85 x 54.88 x 2.14 |
| Weight (grams) | | 10.20 |
| Panel Metrics | View Size (mm) | 74.93 x 49.77 |
| | Type | TFT w/Chip-in-Glass |
| | Colors | 16777216 |
| | Rows / Columns | 960 / 640 |
| | Backlighting Scheme | Six White LEDs |
| Estimated Costs | Panel | \$ |
| | Electronics | \$ |
| | Circuit Assembly | \$ |
| | Non-Electronics | \$ |
| | Final Assembly | \$ |
| | Test | \$ |
| Markup | | \$ |
| Estimated Module Price | | \$ |

Display Panel Markings



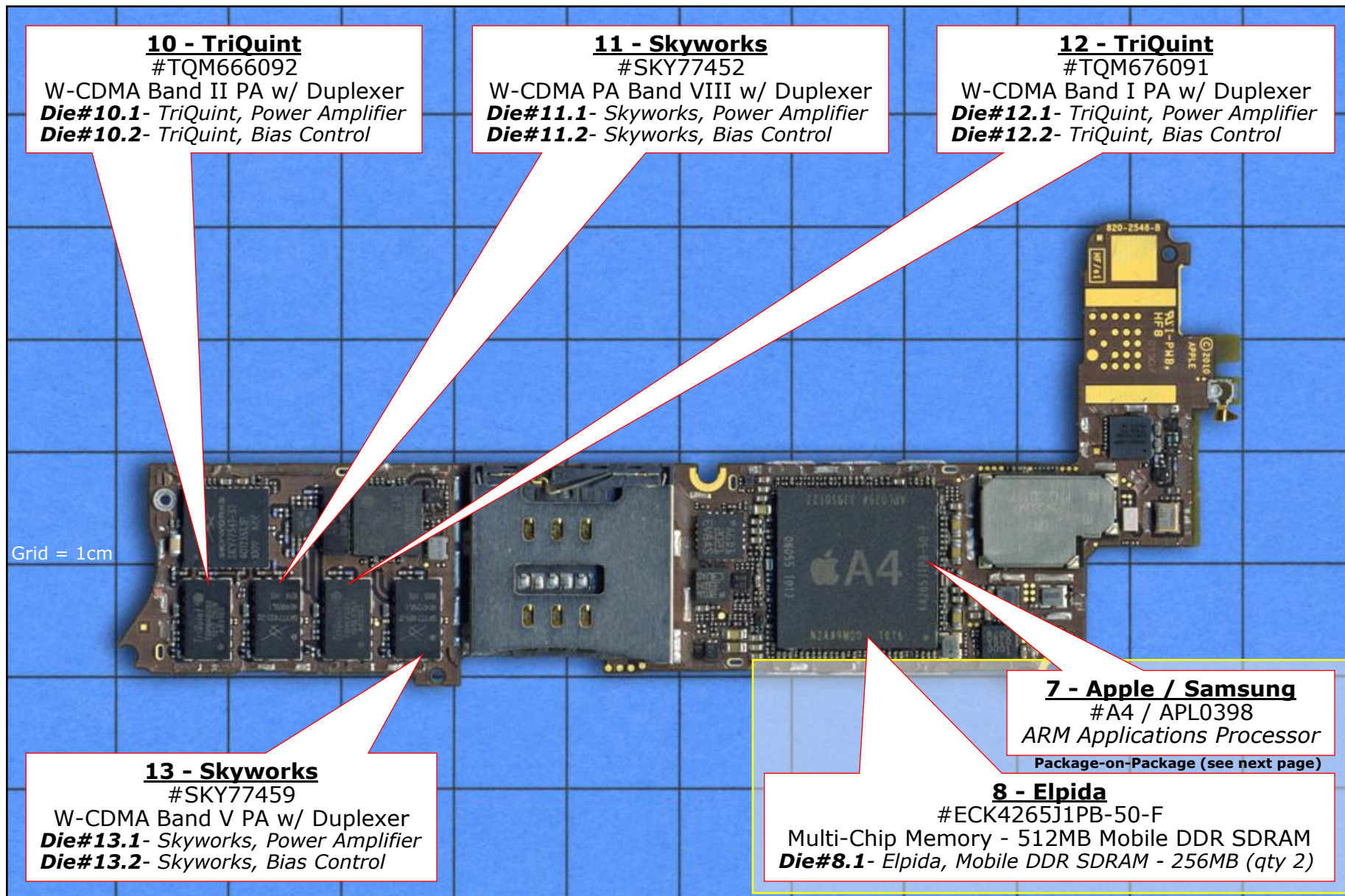


Estimated WiFi/Bluetooth Module Cost

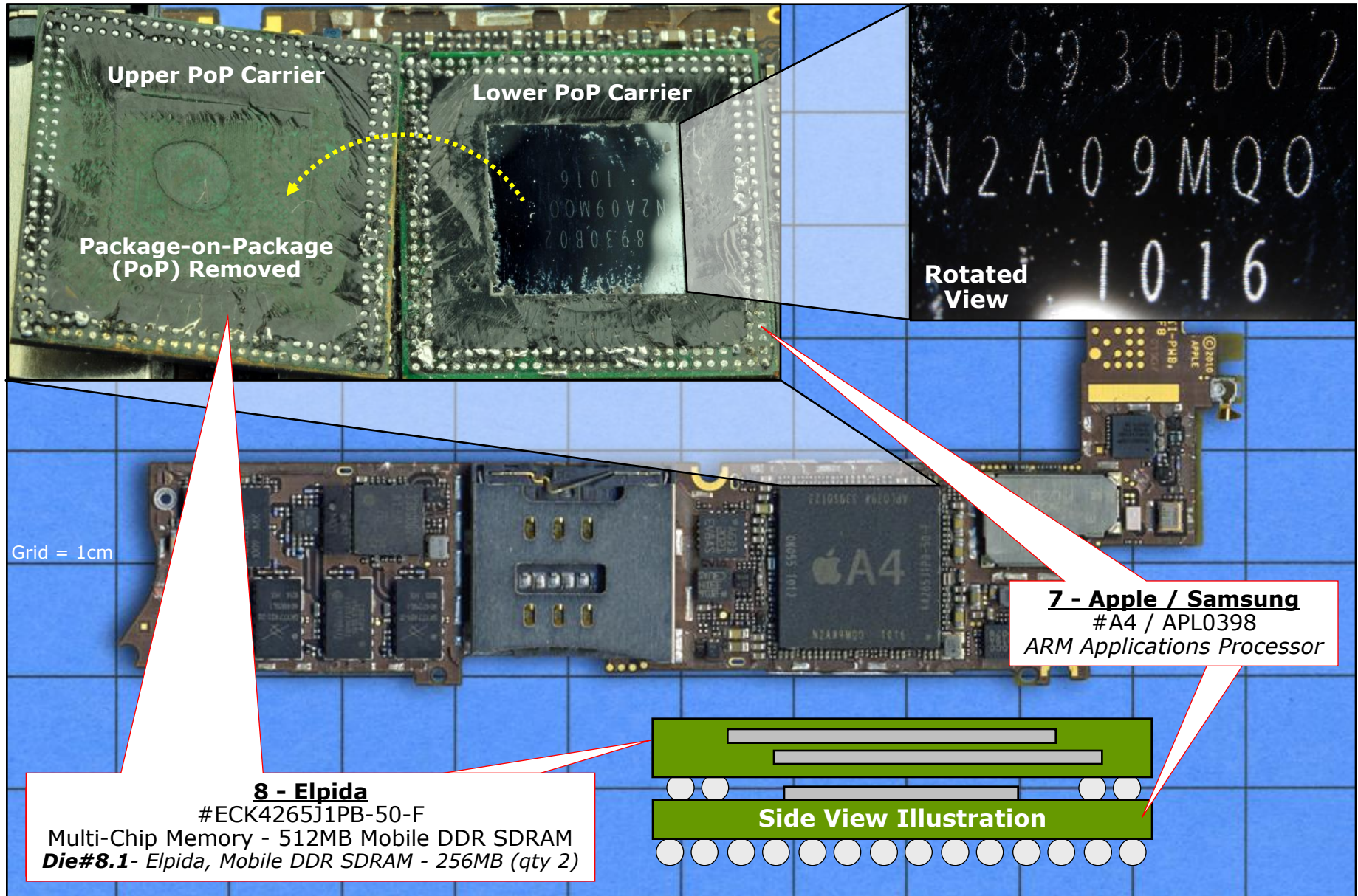


| WiFi/Bluetooth Module | | |
|------------------------|-----------------|--------------------|
| Brand | | Murata |
| Part Number | | 339S0092 |
| Module Dimensions | | 12.35 x 8.27 x 1.2 |
| Weight (grams) | | 0.30 |
| Estimated Costs | Electronics | \$ |
| | Non-Electronics | \$ |
| | Assembly | \$ |
| | Test | \$ |
| | Markup | \$ |
| Estimated Module Price | | \$5.56 |

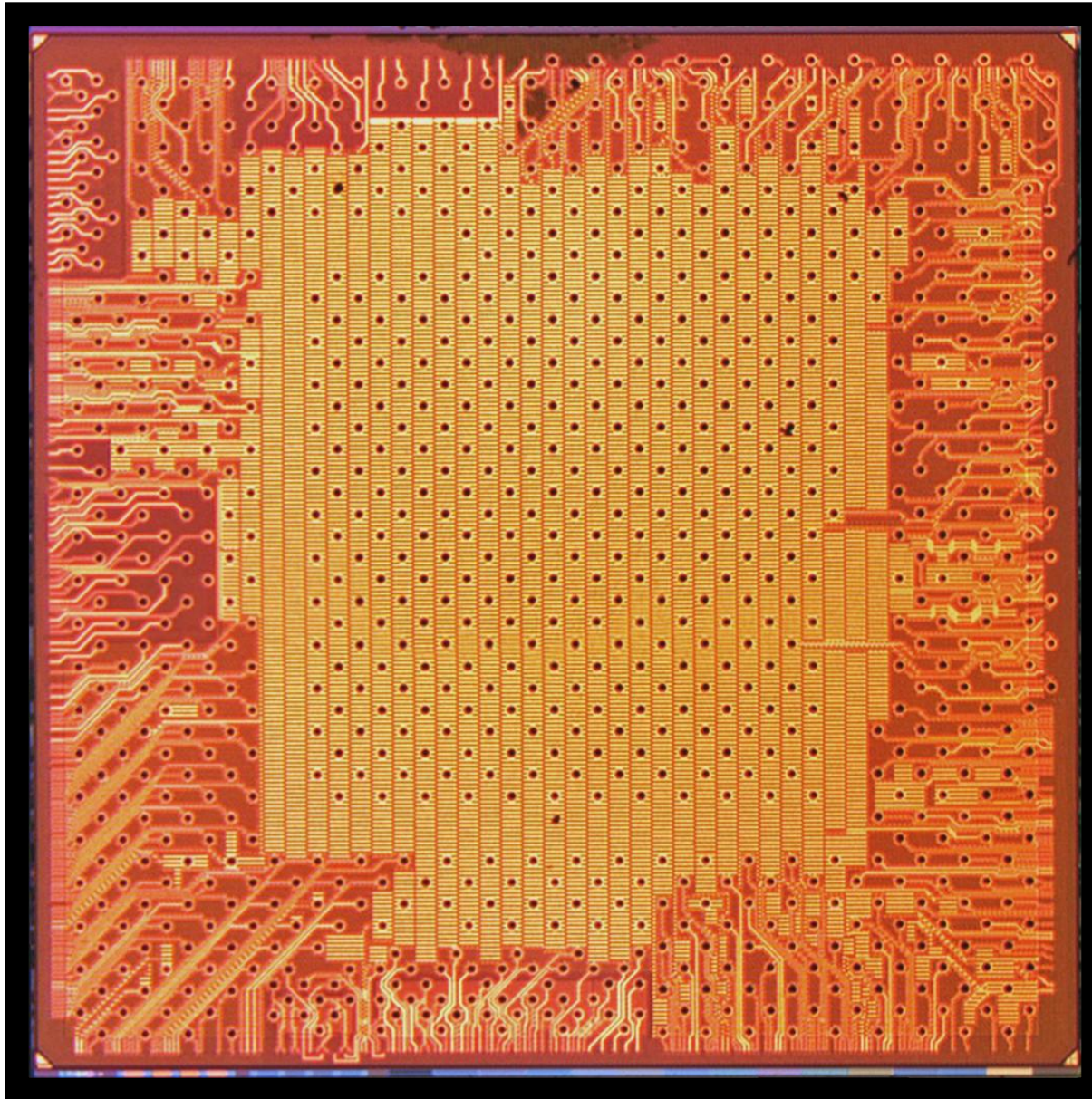
Main Board (Side 1 IC Identification)



Main Board (Side 1 IC Identification)



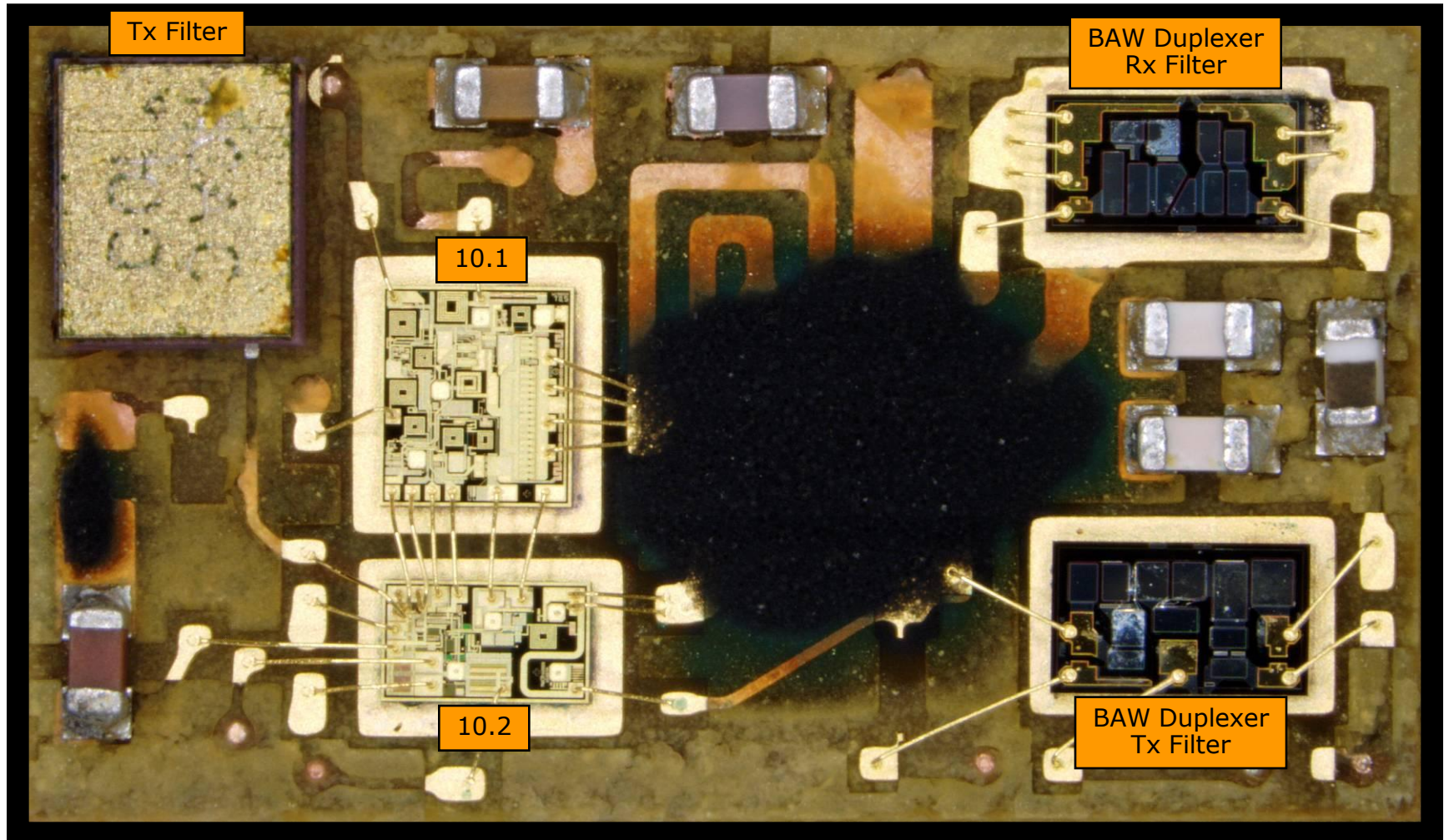
Main Board (Side 1 Die Photos)

**7 - Apple / Samsung**

#A4 / APL0398

*ARM Applications Processor**Die Size: 7.29 x 7.29 mm*

Main Board (Side 1 Die Photos)



10 - TriQuint

#TQM666092

W-CDMA Band II PA w/ Duplexer
Die#10.1- TriQuint, Power Amplifier

Die#10.2- TriQuint, Bias Control
Pkg. Size: 7.00 x 4.00 mm

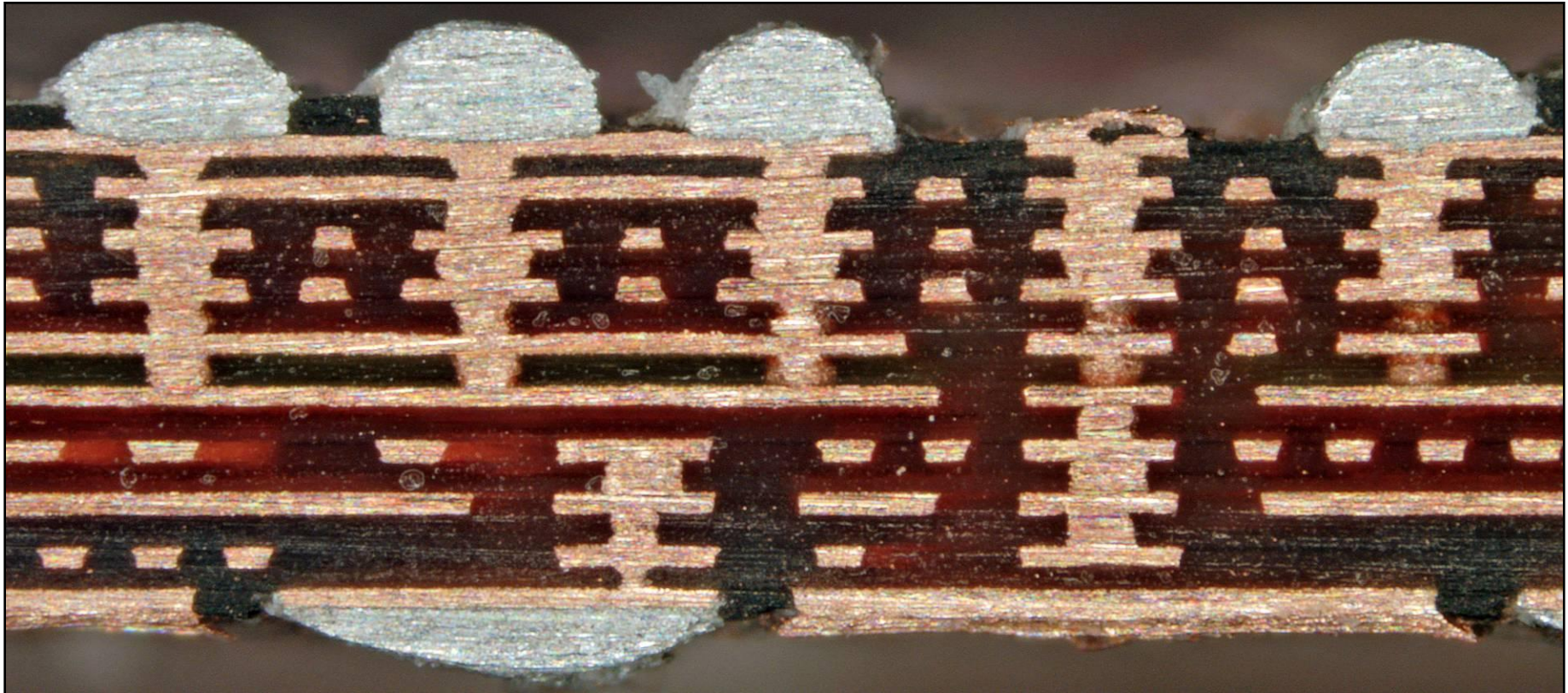
[Comments?](#)

[Email us at feedback@teardown.com](mailto:feedback@teardown.com)

Main Board Cross-Section

Construction: 4+2+4 Full Sequential Buildup

- Two-layer starting core fabrication followed by;
 - 4X sequential addition of (filled) microvia layers added top and bottom to form 10-layer PCB.
 - Via-in-pad construction
 - PCB Vendor: Ibiden
 - PCB Thickness: 0.75mm
 - Cross-Section Location: A4 Applications Processor + Memory PoP (top side) & 32GB NAND Flash Memory (bottom side)
- Process likely correlates to Ibiden's FVSS – see <http://www.ibiden.com/product/electronics/fvss.html>.
 - Unimicron also known to supply boards using their ELIC process – see <http://www.unimicron.com/en/product15.htm>



Integrated Circuit Components

| Functional Area | Location | Package Info | | | | | | | | | | | Die Info | | | | | | | | | | Estimated Costs | |
|-----------------|----------------------|--------------|---------|----------------------|----------------------|---|------------------------|-----------|------------|-------------|------------|-------------|-----------|---------|------------------------------|---------------------------|---|-------------|------------|-----------|-------|--|-----------------|--|
| | | Pkg Ref. # | Pkg Qty | Brand Name | Part Number | Pkg Description | Form | Pin Count | Pitch (mm) | Length (mm) | Width (mm) | Height (mm) | Die Ref # | Die Qty | Brand Name | Part Number | Description | Length (mm) | Width (mm) | Each | Total | | | |
| Analog | Main Board, Side 1 | 1 | 1 | STMicroelectronics | US331DLH | 3-Axis Accelerometer & MEMs Sensor | MCP - 3 Chips | 16 | 0.50 | 3.00 | 3.00 | 1.30 | 1.1 | 1 | STMicroelectronics | V583A | Accelerometer Signal Processor | 2.14 | 1.48 | \$ 0.320 | | | | |
| | | | | | | | | | | | | | 1.2 | 1 | Unknown | | MEMs Sensor - Upper | 2.23 | 2.03 | \$ 0.260 | | | | |
| | | | | | | | | | | | | | 1.3 | 1 | STMicroelectronics | CSL12B | MEMs Sensor - Lower | 2.23 | 2.03 | \$ 0.400 | | | | |
| | | 2 | 1 | STMicroelectronics | LG34200DH ? | 3-Axis Digital Gyroscope & MEMs Sensor | MCP - 3 Chips | 16 | 0.65 | 4.00 | 4.00 | 1.10 | 2.1 | 1 | STMicroelectronics | V564A | Gyro Signal Processor | 2.56 | 2.56 | \$ 0.680 | | | | |
| | | | | | | | | | | | | | 2.2 | 1 | STMicroelectronics | Unknown | MEMs Sensor - Upper | 3.14 | 3.14 | \$ 0.570 | | | | |
| | | | | | | | | | | | | | 2.3 | 1 | STMicroelectronics | GK10A | MEMs Sensor - Lower | 3.14 | 3.14 | \$ 1.180 | | | | |
| Logic | Main Board, Side 1 | 3 | 1 | Ricoh | RP106Z | 400mA LDO Regulator | Flip Chip, Solder | 4 | 0.40 | 0.68 | 0.68 | 0.60 | 3.1 | 1 | Ricoh | RP106Z | 400mA LDO Regulator | 0.68 | 0.68 | \$ 0.090 | | | | |
| | | 4 | 1 | TI | THS7319 | 3-Channel Video Amplifier | BGA | 9 | 0.50 | 1.50 | 2.00 | 4.1 | 1 | TI | THS7319 | 3-Channel Video Amplifier | 0.71 | 0.52 | \$ 0.150 | | | | | |
| | | 5 | 1 | Audience | A10020 ? | Voice Processor | BGA (UF) | 32 | 0.40 | 3.00 | 3.00 | 0.90 | 5.1 | 1 | Audience | A10020 ? | Voice Processor | 1.73 | 1.65 | \$ 0.610 | | | | |
| | | 6 | 1 | NXP Semiconductor | 74AUP1G07 | Non-Inverting Buffer | DFN | 6 | 0.35 | 1.00 | 1.00 | 0.50 | 6.1 | 1 | NXP Semiconductor | 74AUP1G07 | Non-Inverting Buffer | 0.41 | 0.36 | \$ 0.050 | | | | |
| | | 7 | 1 | Samsung | A4 / APL0398 | ARM Applications Processor | BGA (UF) | 531 | 0.50 | 14.00 | 14.00 | 0.61 | 7.1 | 1 | Samsung | A4 / APL0398 | ARM Applications Processor | 7.29 | 7.29 | \$ 16.000 | | | | |
| | | 8 | 1 | Elpida | EC9A265J1PB-50-F | Multi-Chip Memory - 512 MB Mobile DDR SDRAM | BGA Stacked 2 (UF) | 200 | 0.50 | 14.00 | 14.00 | 0.82 | 8.1 | 2 | Elpida | EC9A265J1PB-50-F | Mobile DDR SDRAM Memory - 256 MB | 10.64 | 8.24 | \$ 3.930 | | | | |
| Memory | Main Board, Side 1 | 9 | 1 | Infineon | BGA748L16 | Quad-Band W-CDMA LNA | QFN | 16 | 0.50 | 2.30 | 2.20 | 0.00 | 9.1 | 1 | Infineon | BGA748L16 | Quad-Band W-CDMA LNA | 1.13 | 1.12 | \$ 0.260 | | | | |
| | | 10 | 1 | TriQuint | TQM666092 | W-CDMA Band II PA w/ Duplexer | MCP - 2 Chips | 17 | 1.00 | 7.00 | 4.00 | 1.10 | 10.1 | 1 | TriQuint | W1886A | Power Amplifier | 1.08 | 0.96 | \$ 0.610 | | | | |
| | | | | | | | | | | | | | 10.2 | 1 | TriQuint | W1887A | Power Amplifier | 1.02 | 0.58 | \$ 0.290 | | | | |
| | | 11 | 1 | Skyworks | SKY77452 | W-CDMA Band VIII PA w/ Duplexer | MCP - 2 Chips | 17 | 1.00 | 7.00 | 4.00 | 1.10 | 11.1 | 1 | Skyworks | 64062-1 | Power Amplifier | 1.06 | 0.96 | \$ 0.580 | | | | |
| | | | | | | | | | | | | | 11.2 | 1 | Skyworks | 64019-14 | Power Amplifier | 0.60 | 0.39 | \$ 0.180 | | | | |
| | | 12 | 1 | TriQuint | TQM676091 | W-CDMA Band I PA w/ Duplexer | MCP - 2 Chips | 17 | 1.00 | 7.00 | 4.00 | 1.10 | 12.1 | 1 | TriQuint | W1883A | Power Amplifier | 1.09 | 0.93 | \$ 0.520 | | | | |
| RF Shared | Main Board, Side 1 | 13 | 1 | Skyworks | SKY77459 | W-CDMA Band V PA w/ Duplexer | MCP - 2 Chips | 17 | 1.00 | 7.00 | 4.00 | 1.10 | 13.1 | 1 | Skyworks | 64062-1 | Power Amplifier | 1.06 | 0.86 | \$ 0.580 | | | | |
| | | | | | | | | | | | | | 13.2 | 1 | Skyworks | 64019-14 | Power Amplifier | 0.58 | 0.39 | \$ 0.180 | | | | |
| | | | | | | | | | | | | | 14.1 | 1 | Skyworks | 31519 | Power Amplifier Controller | 1.99 | 1.31 | \$ 0.360 | | | | |
| | | | | | | | | | | | | | 14.2 | 1 | Skyworks | 64048_01 | Low Bands Power Amplifier | 0.86 | 0.76 | \$ 0.190 | | | | |
| | | | | | | | | | | | | | 14.3 | 1 | Skyworks | 64049-04 | High Bands Power Amplifier | 0.87 | 0.55 | \$ 0.150 | | | | |
| | | | | | | | | | | | | | 14.4 | 1 | Sony | A2801 | CMOS Decoder | 1.77 | 0.58 | \$ 0.160 | | | | |
| AGPS | Main Board, Side 1 | 14 | 1 | Skyworks | SKY77541 | Quad-Band GSM / EDGE PA w/ Antenna Switch | MCP - 5 Chips | 27 | 0.65 | 7.50 | 7.00 | 1.10 | 14.1 | 1 | Skyworks | 64048_01 | Low Bands Power Amplifier | 0.86 | 0.76 | \$ 0.190 | | | | |
| | | | | | | | | | | | | | 14.3 | 1 | Skyworks | 64049-04 | High Bands Power Amplifier | 0.87 | 0.55 | \$ 0.150 | | | | |
| | | | | | | | | | | | | | 14.4 | 1 | Sony | A2801 | CMOS Decoder | 1.77 | 0.58 | \$ 0.160 | | | | |
| | | | | | | | | | | | | | 14.5 | 1 | Sony | G1248 | SPST Antenna Switch | 1.98 | 0.92 | \$ 0.450 | | | | |
| | | 15 | 1 | Infineon | PMB5703 | GSM / W-CDMA Transceiver | BGA (UF) | 121 | 0.50 | 6.00 | 6.00 | 0.80 | 15.1 | 1 | Infineon | PMB5703 | GSM / W-CDMA Transceiver | 4.41 | 4.41 | \$ 2.910 | | | | |
| | | 16 | 1 | Infineon | BGS12AL7-6 | SPDT RF Switch | DFN | 6 | 0.50 | 1.40 | 1.30 | 0.60 | 16.1 | 1 | Infineon | BGS12AL7-6 | SPDT RF Switch | 0.77 | 0.51 | \$ 0.090 | | | | |
| Analog | Main Board, Side 2 | 17 | 1 | Broadcom | BCM4750 | Single-Chip A-GPS | Flip Chip, Solder (UF) | 47 | 0.40 | 3.56 | 3.56 | 0.40 | 17.1 | 1 | Broadcom | BCM4750 | Single-Chip A-GPS | 3.56 | 3.56 | \$ 1.440 | | | | |
| | | 18 | 1 | Unknown | H | GPS LNA | QFN | 6 | 0.50 | 1.00 | 1.00 | 0.70 | 18.1 | 1 | Unknown | H | GPS LNA | 0.38 | 0.38 | \$ 0.090 | | | | |
| | | 19 | 1 | Dialog Semiconductor | 338S0867 / D1815A | Power Management | BGA (UF) | 121 | 0.50 | 6.00 | 6.00 | 0.60 | 19.1 | 1 | Apple / Dialog Semiconductor | 338S0867 / D1815A | Power Management | 4.06 | 3.58 | \$ 1.620 | | | | |
| | | 20 | 1 | Cirrus Logic | 338S0869 / CLT149SB0 | Audio CODEC | Flip Chip, Solder (UF) | 86 | 0.40 | 4.85 | 3.80 | 0.60 | 20.1 | 1 | Apple / Cirrus Logic | 338S0869 / CLT149SB0 | Audio CODEC | 4.85 | 3.80 | \$ 1.360 | | | | |
| | | 21 | 1 | Maxim | MAX8834Y | Step-Up Converter w/ 1.5A Flash Driver | Flip Chip, Solder (UF) | 20 | 0.50 | 2.59 | 2.05 | 0.60 | 21.1 | 1 | Maxim | MAX8834Y | Step-Up Converter w/ 1.5A Flash Driver | 2.59 | 2.05 | \$ 0.420 | | | | |
| | | 22 | 1 | NXP Semiconductor | 74LVC1G07 | Non-Inverting Buffer | DFN | 6 | 0.35 | 1.00 | 1.00 | 0.60 | 22.1 | 1 | NXP Semiconductor | 74LVC1G07 | Non-Inverting Buffer | 0.40 | 0.32 | \$ 0.050 | | | | |
| Logic | Main Board, Side 2 | 23 | 1 | TI | CDPF3282 | Stereo Headphone Amplifier w/ Pop Suppression ? | Flip Chip, Solder (UF) | 12 | 0.40 | 1.57 | 1.17 | 0.50 | 23.1 | 1 | TI | CDPF3282 | Stereo Headphone Amplifier w/ Pop Suppression ? | 1.57 | 1.17 | \$ 0.220 | | | | |
| | | 24 | 1 | Maxim | MAX8839X | DC-DC Converter ? | Flip Chip, Solder (UF) | 16 | 0.50 | 2.07 | 2.07 | 0.60 | 24.1 | 1 | Maxim | MAX8839X | DC-DC Converter ? | 2.07 | 2.07 | \$ 0.310 | | | | |
| | | 25 | 2 | Intersil | ISL54200 | USB 2.0 Dual 2:1 Multiplexer | QFN | 10 | 0.50 | 2.10 | 1.50 | 0.50 | 25.1 | 1 | Intersil | ISL54200 | USB 2.0 Dual 2:1 Multiplexer | 1.08 | 0.94 | \$ 0.130 | | | | |
| | | 26 | 1 | Maxim | MAX9718 | Audio Power Amplifier | Flip Chip, Solder (UF) | 9 | 0.50 | 1.55 | 1.50 | 0.70 | 26.1 | 1 | Maxim | MAX9718 | Audio Power Amplifier | 1.55 | 1.50 | \$ 0.160 | | | | |
| | | 27 | 1 | AKM Semiconductor | AK8975 | 3-Axis Electronic Compass | BGA (UF) | 14 | 0.50 | 2.40 | 2.40 | 1.40 | 27.1 | 1 | AKM Semiconductor | AK8975 | 3-Axis Electronic Compass | 1.95 | 1.94 | \$ 0.920 | | | | |
| | | 28 | 1 | Infineon | X-GOLD 616 PMB9801 | GSM / W-CDMA Baseband | BGA (UF) | 316 | 0.40 | 8.50 | 8.50 | 0.80 | 28.1 | 1 | Infineon | X-GOLD 616 PMB9801 | GSM / W-CDMA Baseband | 6.97 | 6.96 | \$ 9.940 | | | | |
| Memory | Main Board, Side 2 | 29 | 1 | Micron | PF36M1Y1EF | Multi-Chip Memory - 16 MB NOR Flash, 16 MB Mobile DDR SDRAM | BGA Stacked 2 (UF) | 133 | 0.50 | 8.00 | 8.00 | 0.90 | 29.1 | 1 | Intel | W76M | NOR Flash Memory - 16 MB | 4.01 | 3.97 | \$ 0.840 | | | | |
| | | 30 | 1 | Samsung | K9PFG08U5M | Multi-Chip Memory - 32 GB MLC NAND Flash | BGA Stacked 8 (UF) | 52 | 1.50 | 18.00 | 14.00 | 0.90 | 30.1 | 8 | Elpida | EC41218CF | Mobile DDR SDRAM Memory - 16 MB | 4.80 | 3.87 | \$ 1.030 | | | | |
| | | 31 | 1 | TI | 343S0499 / F761586G | Touchscreen Controller | BGA (UF) | 64 | 0.50 | 4.50 | 4.50 | 0.60 | 31.1 | 1 | Samsung | K9GND08U5M | MLC NAND Flash - 4 GB | 13.55 | 13.55 | \$ 1.080 | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | |
| Analog | Sensor Flex, Side 1 | 32 | 1 | Taos | TS12771 | Ambient Light Sensor / Proximity Detect | DFN | 6 | 0.65 | 2.40 | 2.00 | 0.70 | 32.1 | 1 | Taos | TS12771 | Ambient Light Sensor / Proximity Detect | 1.85 | 1.12 | \$ 0.220 | | | | |
| Analog | Docking Flex, Side 1 | 33 | 3 | STMicroelectronics | USBULC6-2F3 | 2-Line USB ESD Protection | Flip Chip, Solder | 4 | 0.40 | 0.96 | 0.91 | 0.60 | 33.1 | 1 | STMicroelectronics | USBULC6-2F3 | 2-Line USB ESD Protection | 0.96 | 0.91 | \$ 0.040 | | | | |
| | | 34 | 1 | STMicroelectronics | HSMDIULC6-4F3 | 4-Line HDMI ESD Protection | Flip Chip, Solder | 10 | 0.40 | 1.59 | 1.08 | 0.60 | 34.1 | 1 | STMicroelectronics | HSMDIULC6-4F3 | 4-Line HDMI ESD Protection | 1.59 | 1.08 | \$ 0.060 | | | | |
| Totals | | 37 | | | | | | 1982 | | | | | 58 | | | | | | | | | | | |

(UF) = Underfilled

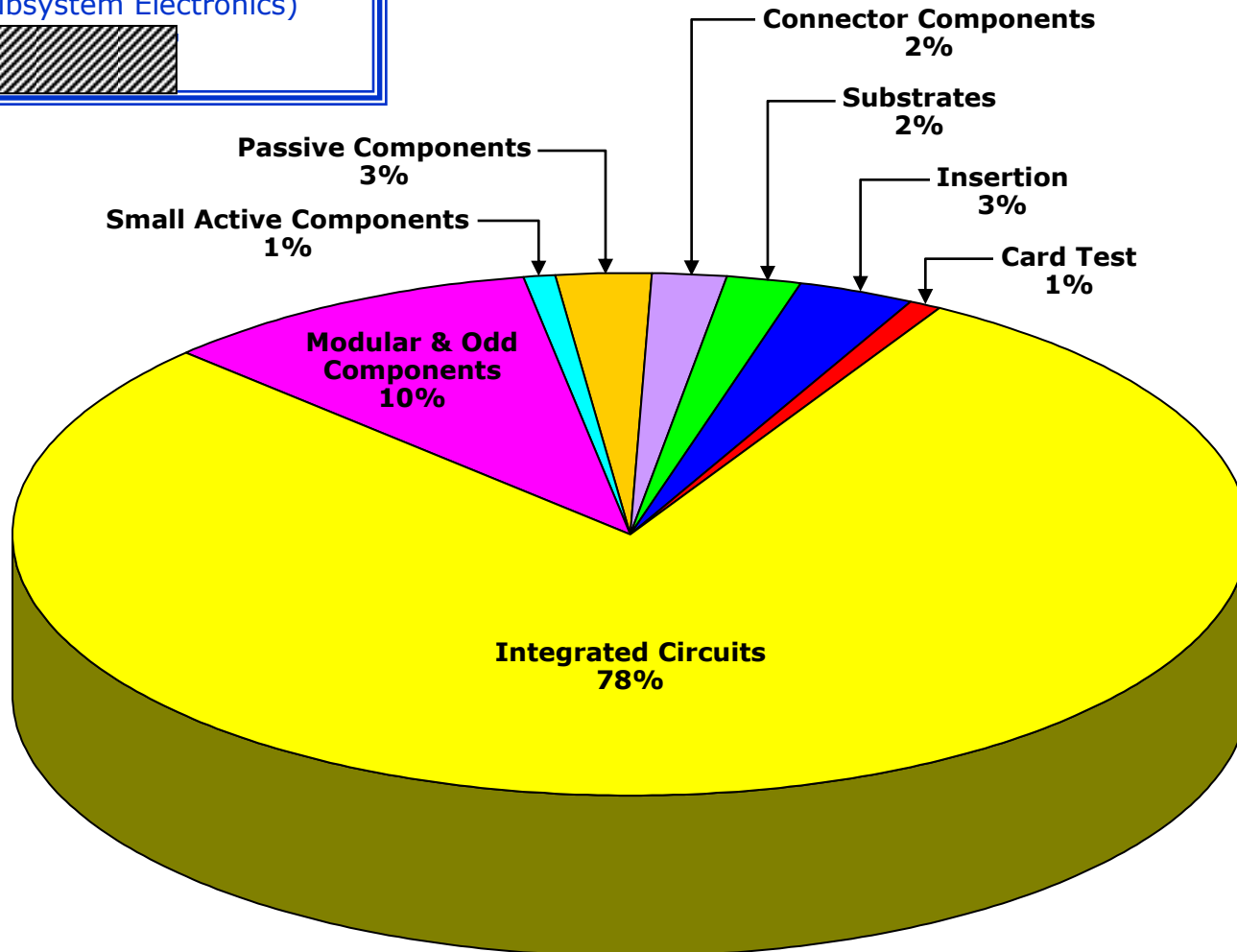
Note: Supplemental information such as IC package & die markings are included in the Excel Bill of Materials (BOM) Spreadsheet

Electronic Costs Break-Down

Estimated Cost of Electronics

(Includes Subsystem Electronics)

\$



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

[Comments?](#)

Email us at feedback@teardown.com

Cost Summary

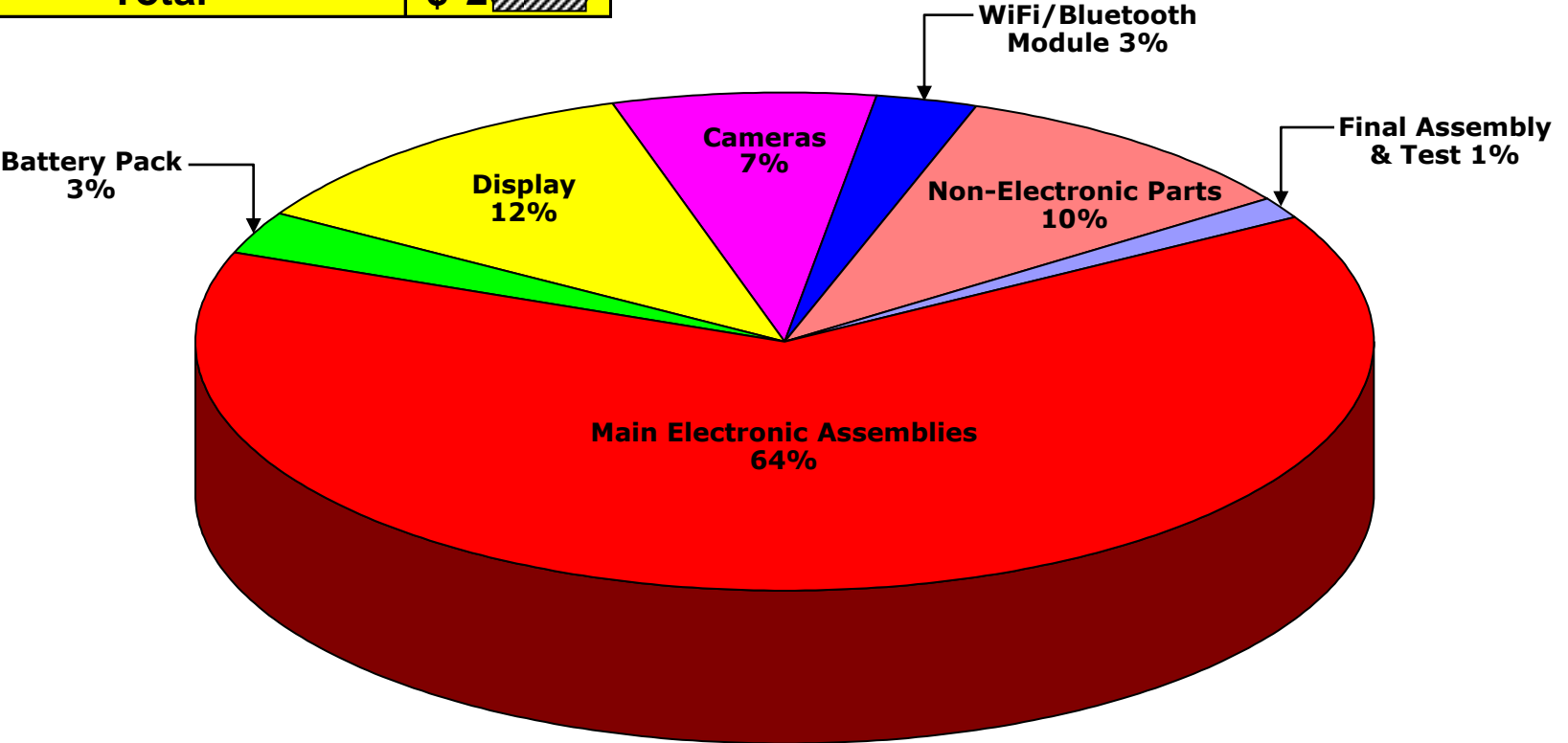
| Estimated Cost Totals | | |
|----------------------------|----|---|
| Main Electronic Assemblies | \$ | 9 |
| Battery Pack | \$ | 3 |
| Display | \$ | 2 |
| Cameras | \$ | 3 |
| WiFi/Bluetooth Module | \$ | 3 |
| Non-Electronic Parts | \$ | 7 |
| Final Assembly & Test | \$ | 3 |
| Total | \$ | 2 |

NOTE:
An Additional
Cost of
\$ [redacted]
for the
Supporting
Materials

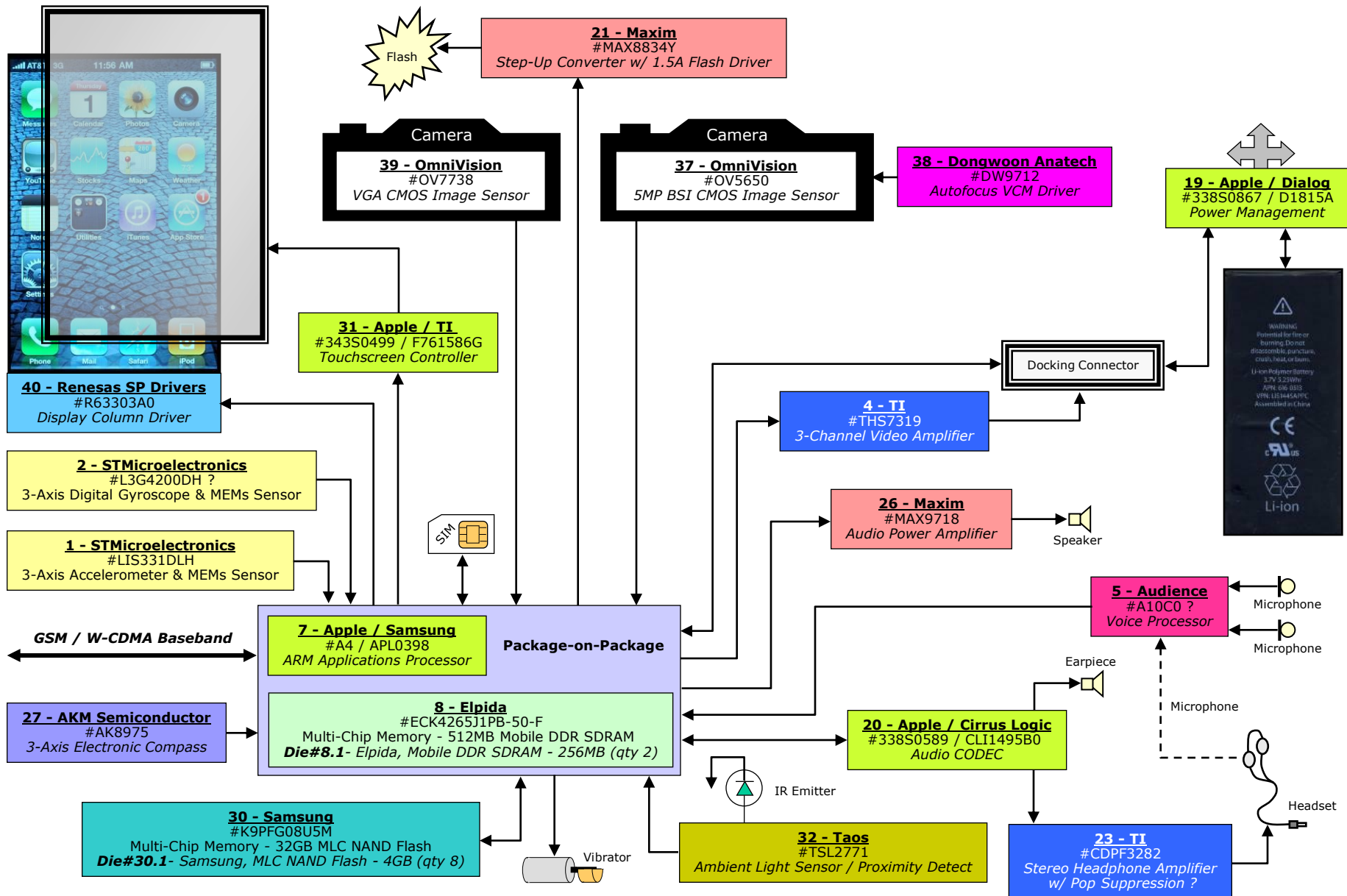
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Total Cost Notes

- 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



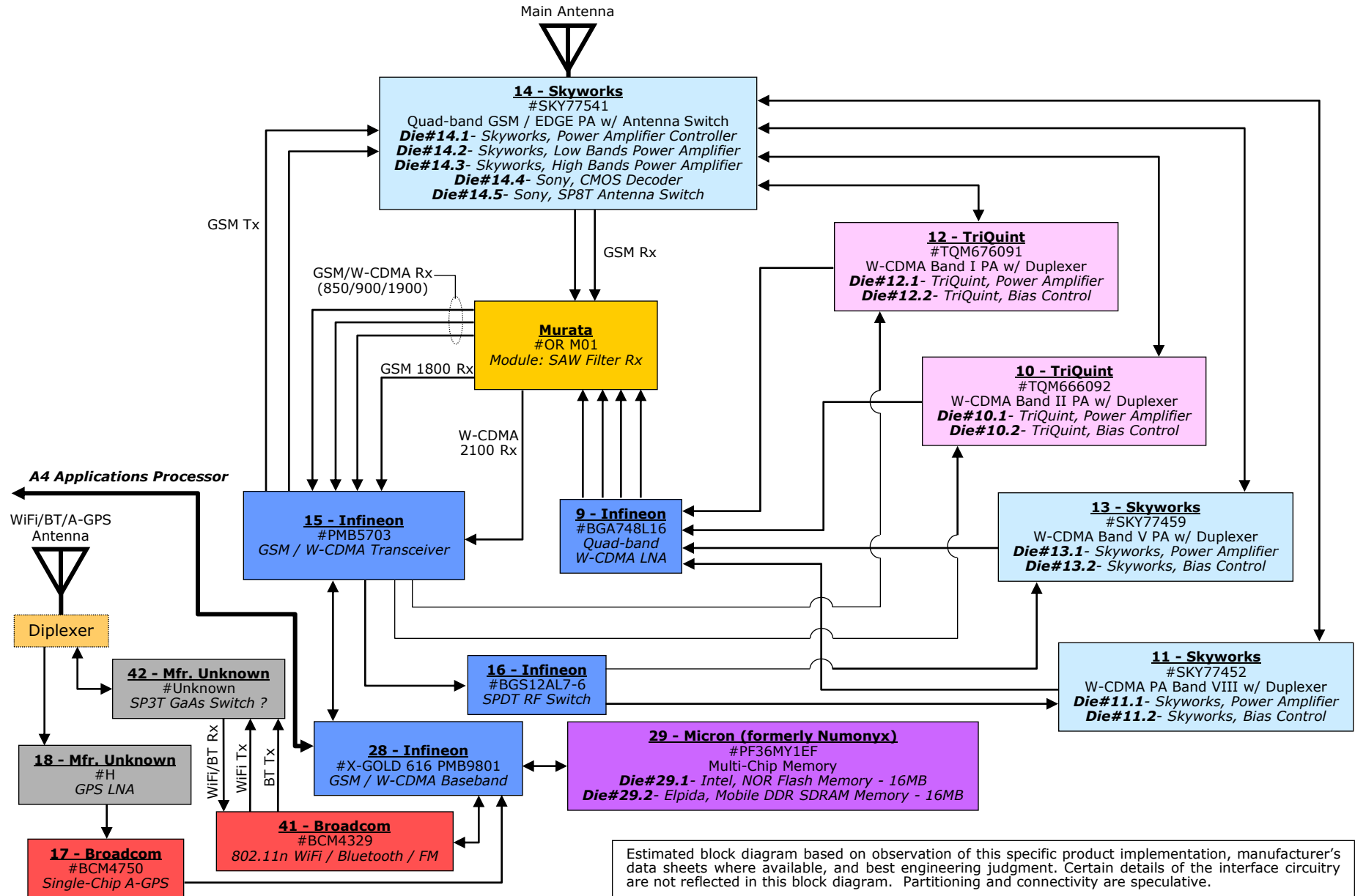
Block Diagram



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