Apple U1
Ultra Wideband (UWB) Analysis

Product Brief – October 2019

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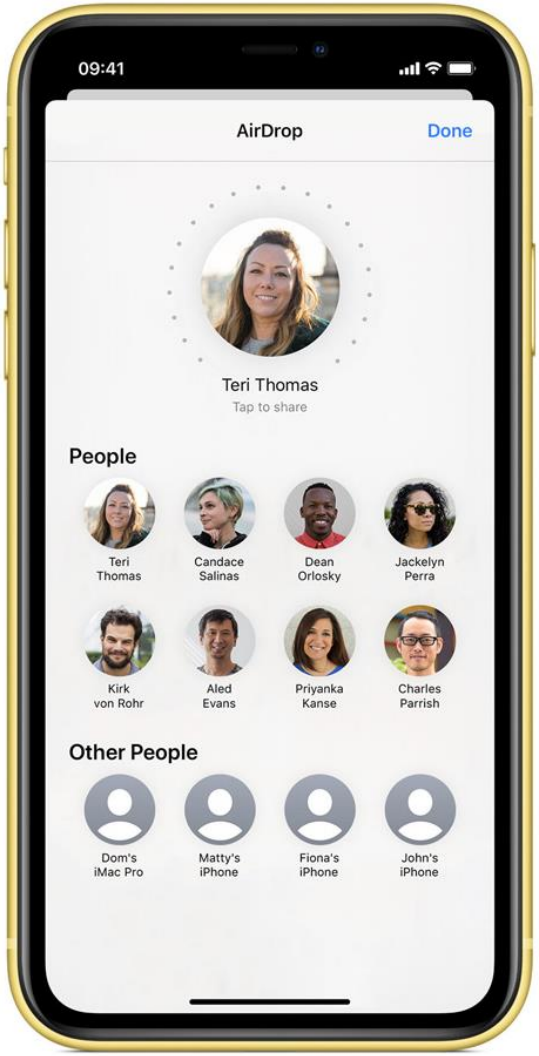
Markets	Devices	Scope
Consumer Electronics	DRAM Memory	Product Teardowns & Costing / BOM
Mobile Devices	NAND Flash Memory	Structural / Materials Analysis
Medical Devices	Microprocessors / Controllers	Packaging Analysis
Storage Devices	Wireless R/F	Circuit Extraction and Analysis
Automotive Electronics	Analog	Transistor Characterization
Internet of Things	Antennas	Waveform Analysis
Semiconductors	Power Management	Functional Testing
Wi-Fi	Sensors	Software Analysis
Clean-Tech Devices	Displays	
Optoelectronics		

Apple's U1 Marketing



Share. Find. Play. More precisely than ever.

Ultra Wideband technology comes to iPhone. The new Apple-designed U1 chip uses Ultra Wideband technology for spatial awareness — allowing iPhone 11 to precisely locate other U1-equipped Apple devices. Think GPS at the scale of your living room. So if you want to share a file with someone using AirDrop, just point your iPhone at theirs and they'll be first on the list.[3]

What is UWB (Ultra-Wideband)?

UWB (Ultra-wideband) is a short-range radio technology that precisely pinpoints and measures distance between other UWB equipped devices.

Similar to Bluetooth Low Energy, in that it requires low power to function, but different, as Bluetooth measures signal strength between devices, and UWB measures signal time between devices.

UWB-enabled devices exchange pulse shapes of information that improves the ranging accuracy and can be used for a future ranging exchange. The pulse shape information provides a time-zero index to a received ranging signal to develop timestamps for time-of-flight (TOF) calculations (similar to GPS technology). Distance is then calculated by assessing associated TOF data and exchanged pulse shape information.

UWB is not a new concept; the Estimote UWB comes equipped with Decawave UWB transceivers (DW1000 Radio IC).

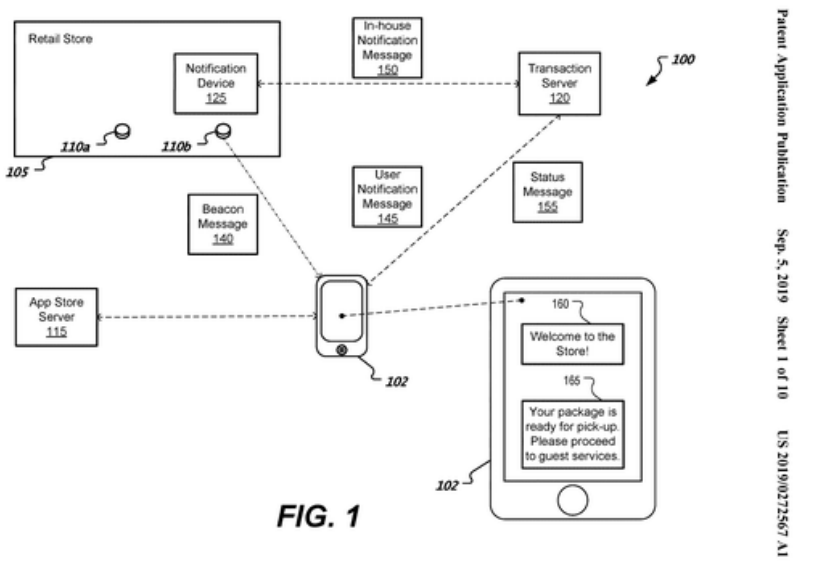
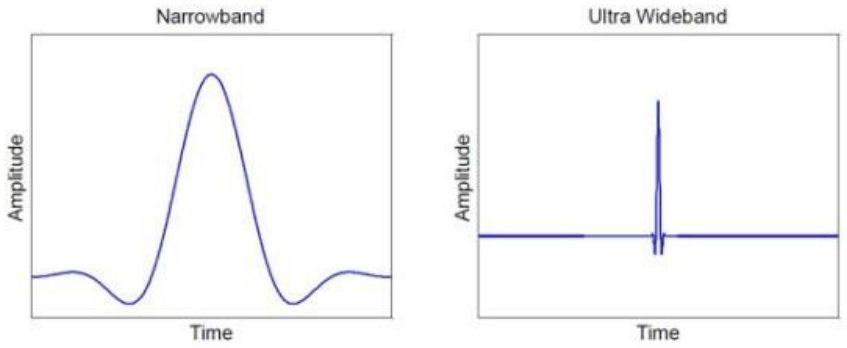


Image from Apple Inc. patent US20190272567A1



Apple iPhone 11 U1 (UWB)

- According to Apple, the U1 chip allows the iPhone 11 to accurately detect other U1-equipped Apple devices through spatial awareness technology.
- Apple is the first company to offer a UWB chip in a smartphone device.
- UWB in Apple iPhones transmit on two different frequencies – 6.24 GHz and 8.2368 GHz.
- U1 chip can only communicate with other U1 chips.

- Apple applied for an "Ultra-wideband radios for time-of-flight-ranging and network position estimation" patent in 2006 (prior to the first iPhone's release) and has since applied for at least 3 more UWB-centric patents to be utilized in their future product offerings.

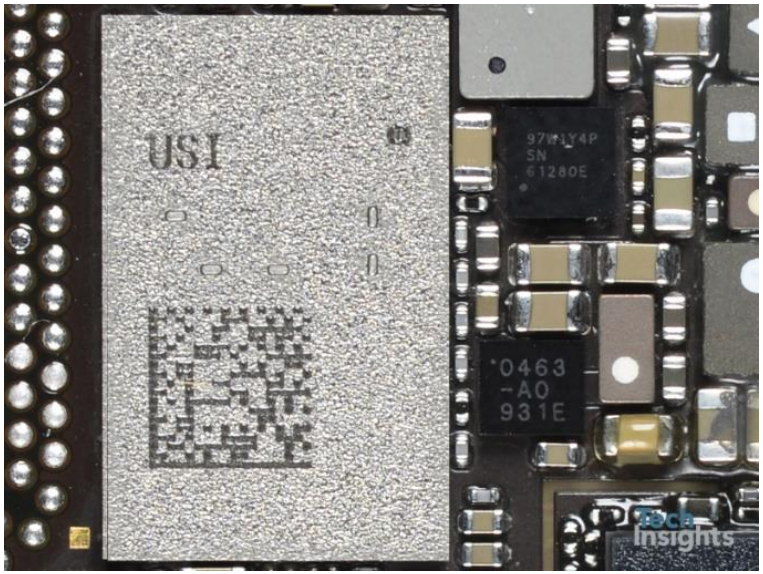
TechInsights Observes U1 Chip Location in Apple iPhone 11 Pro Max Teardown

The USI module shown here contains the Apple U1 chip.

The UWB in the Apple iPhones transmits on two different frequencies - 6.24 GHz and 8.2368 GHz.

The U1 chip can only communicate with other U1 chips. We expect to see the U1 in more Apple products, but note that we did not find it in the Apple Watch Series 5.

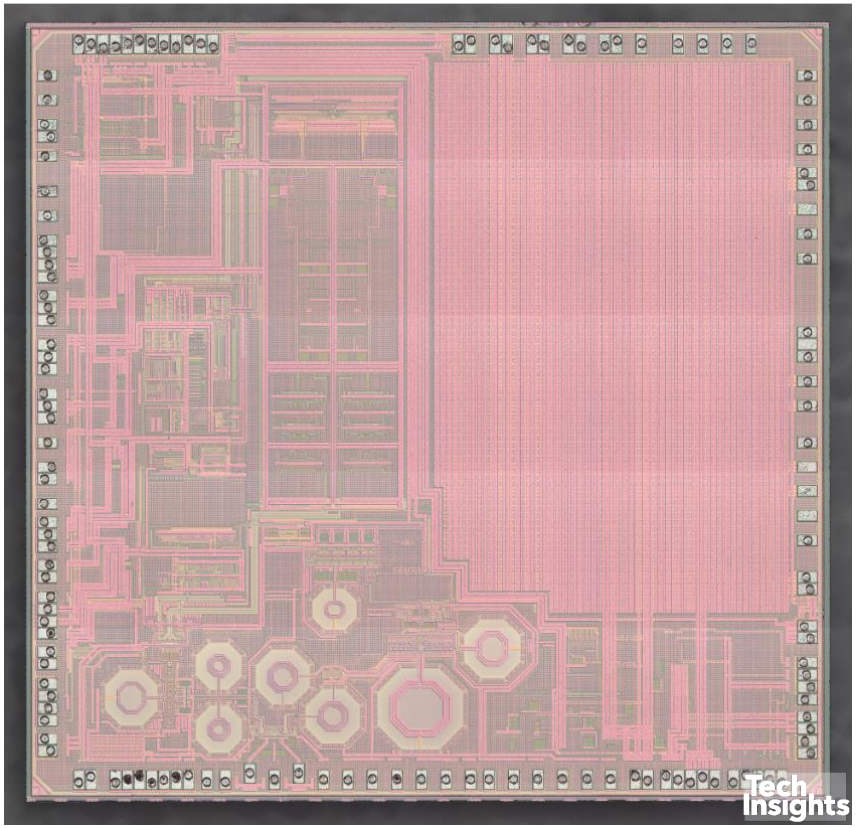
UWB and in-room tracking is not a new concept; it has been on Apple's agenda since before the first iPhone was released.



https://www.techinsights.com/blog/apple-iphone-11-pro-max-teardown

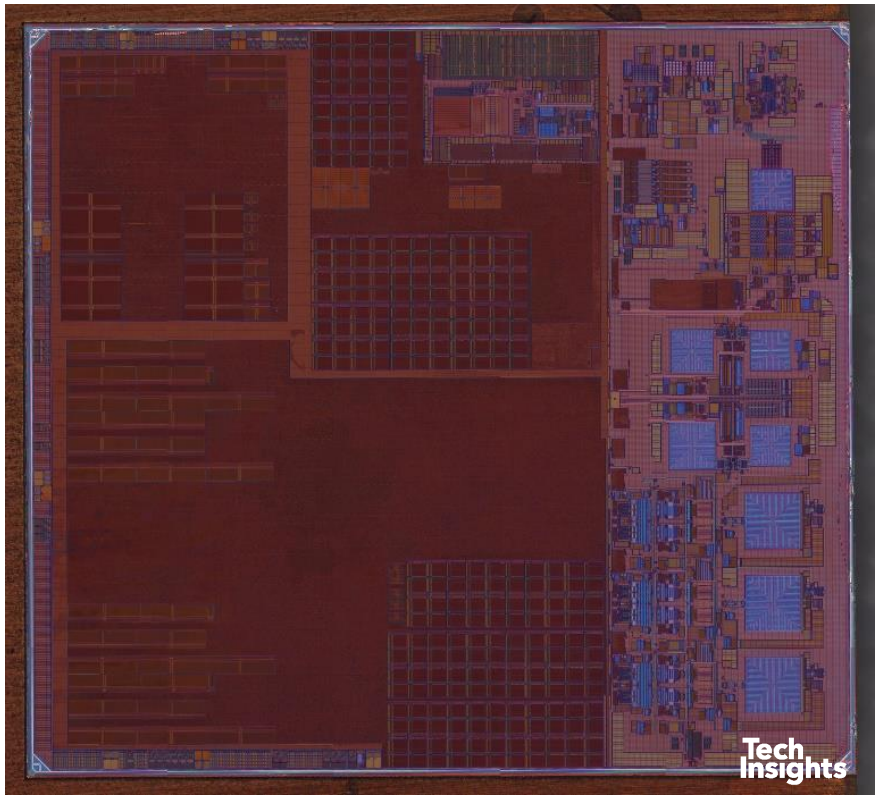
Decawave DW1000 and Apple U1

Decawave DW1000 die



Manufactured on TSMC's 90 nm process

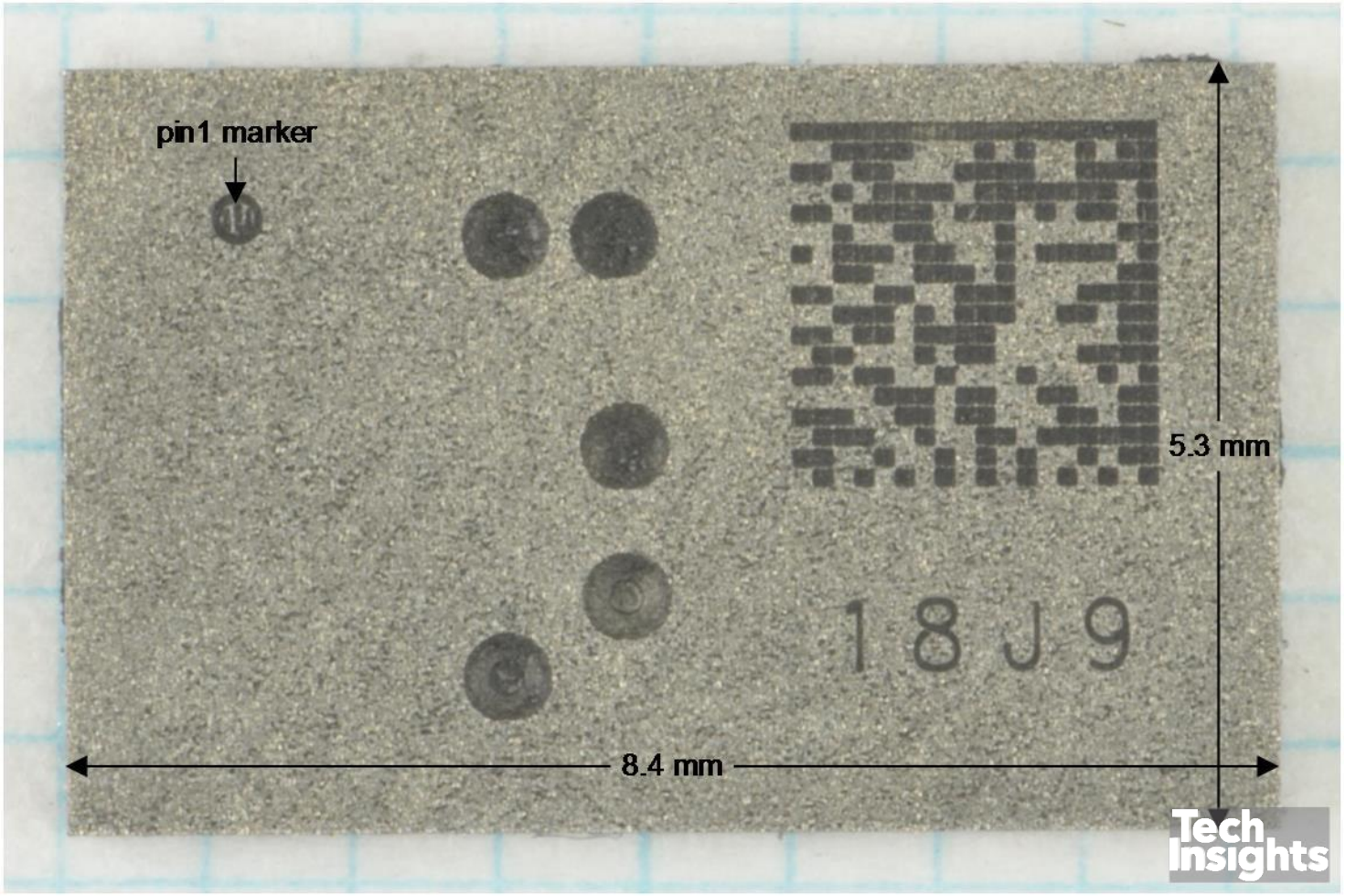
Apple U1 TMKA75 die



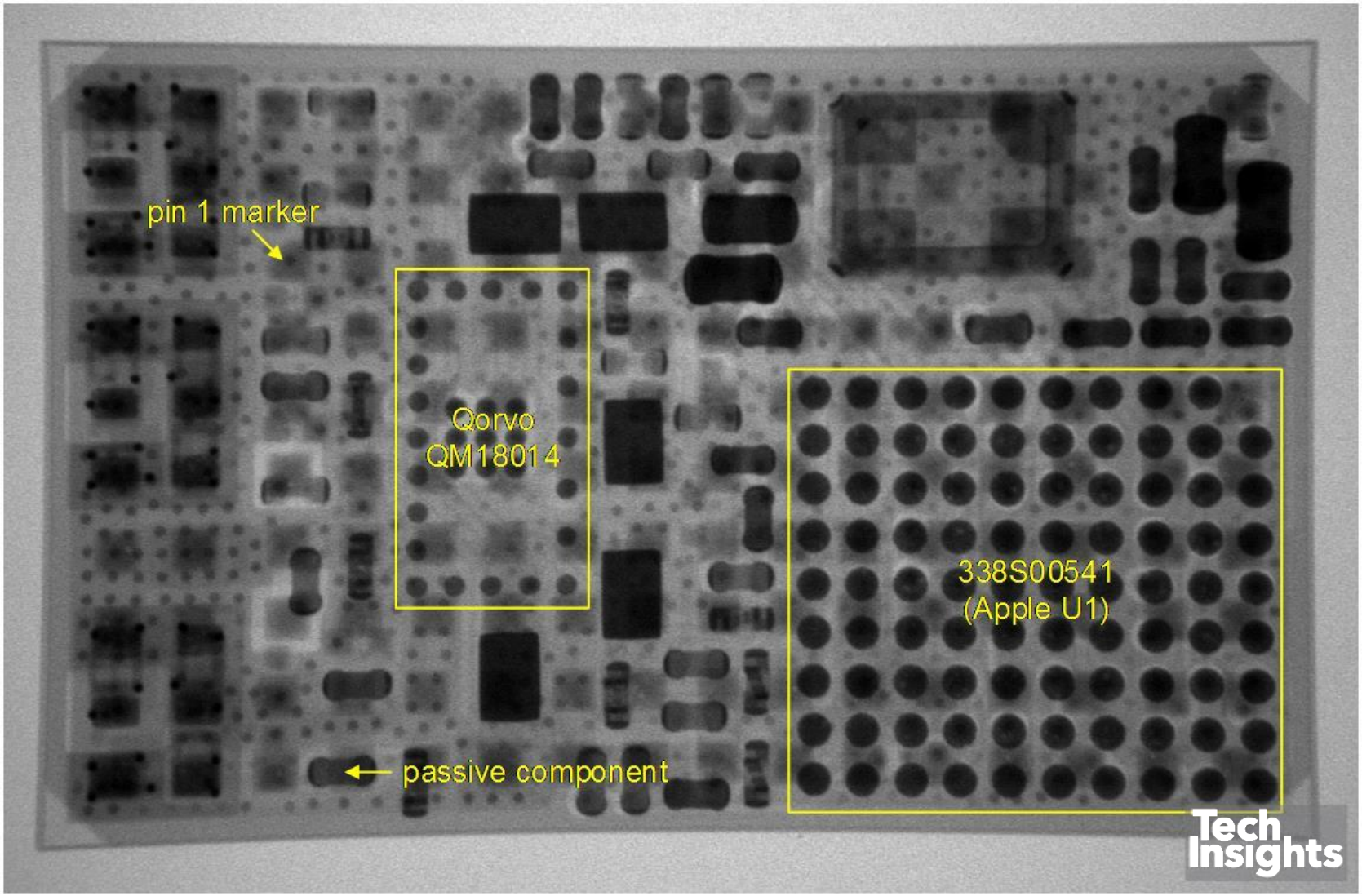
Die allocation: 33% memory, 33% digital, 33% analog

This was manufactured on TSMC's 16FF process

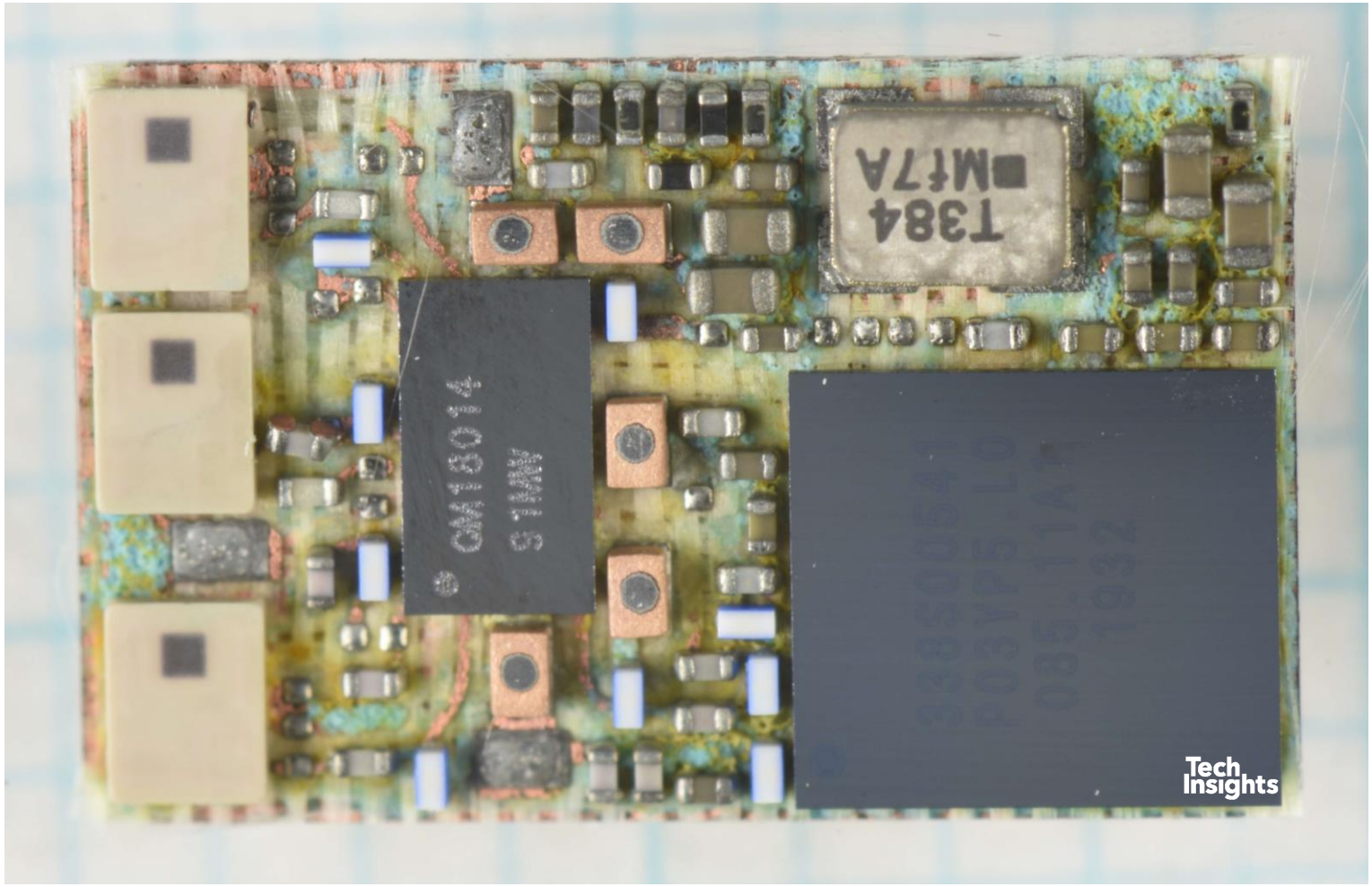
U1 Package



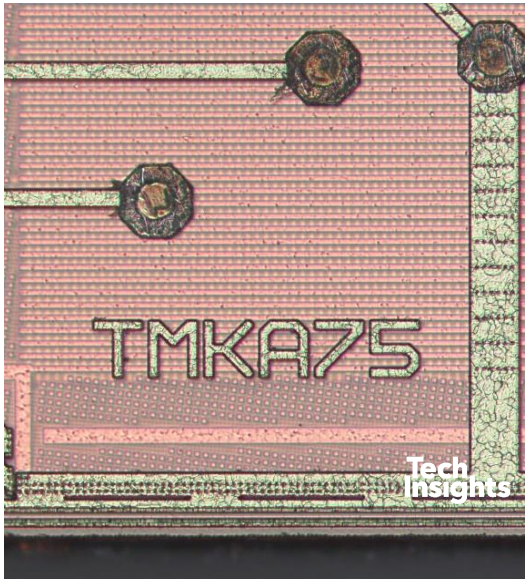
U1 Package X-Ray (Top)

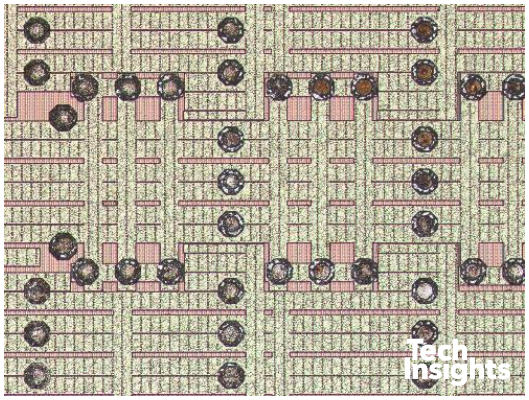


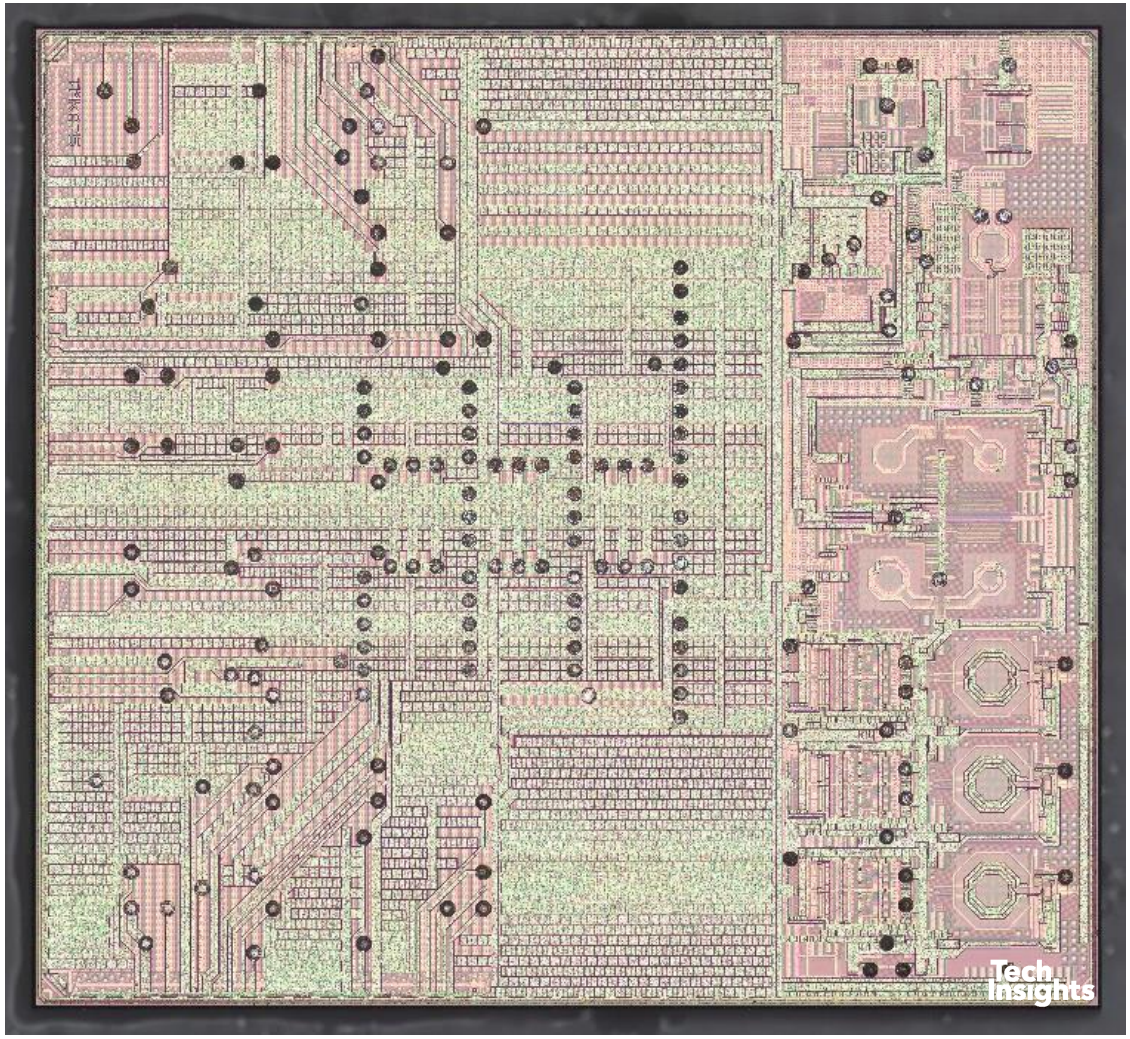
U1 Package Jet-Etched



U1 – Die Photo & Bond Pads





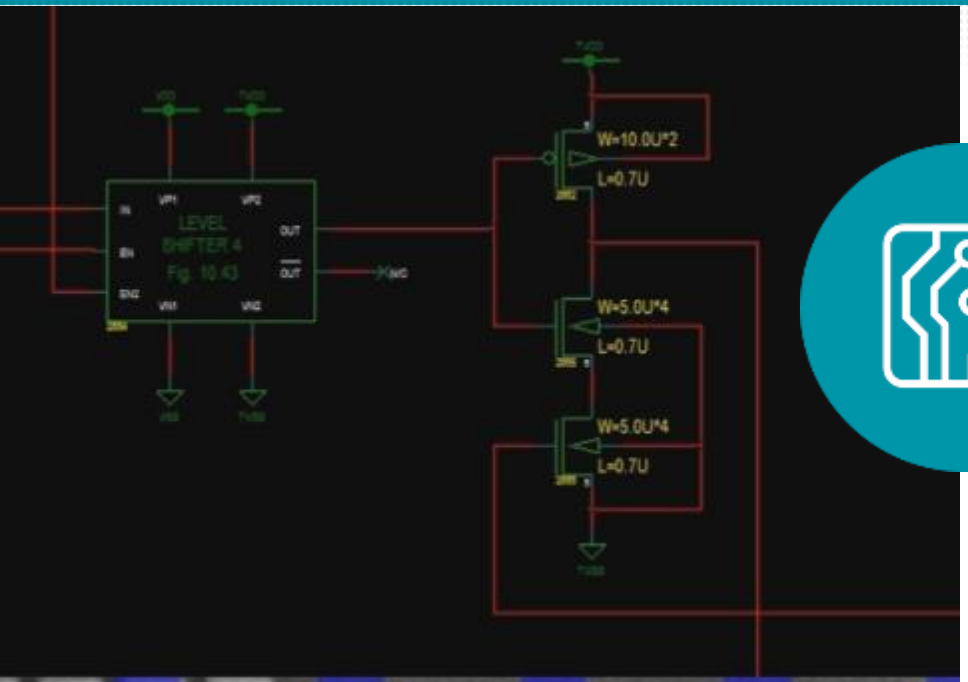


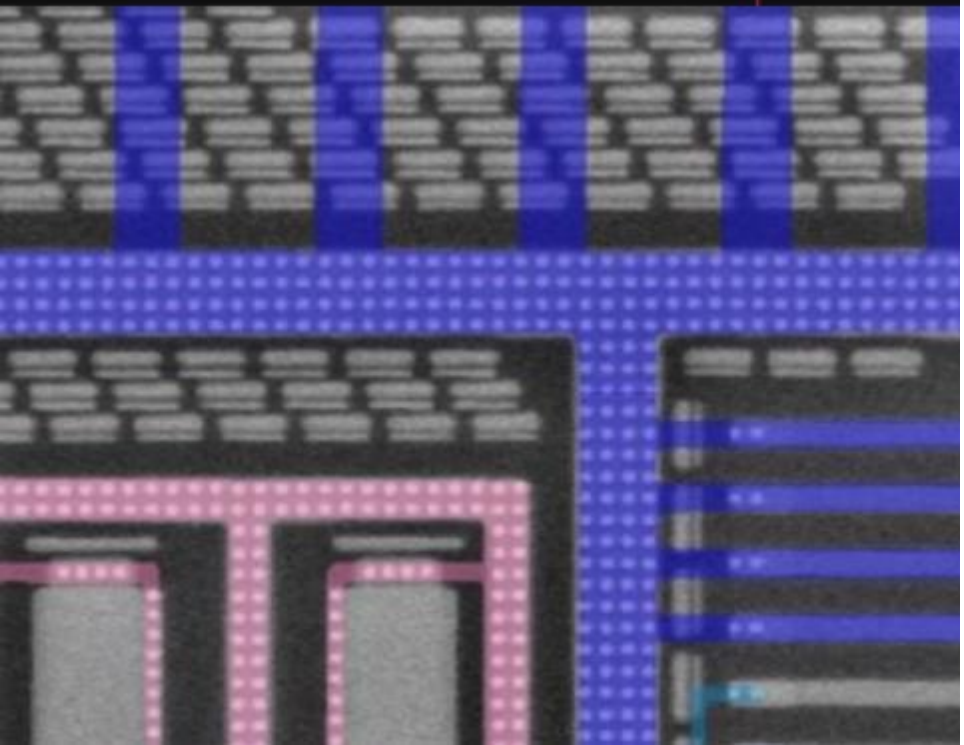
Potential Apple UWB Use Cases

- **Apple 'Tag1,1'**: The Apple Tag device will pair to the iPhone, utilizing UWB (among other locational technology such as NFC) and can be attached to any item. Will notify users of its whereabouts in proximity to the smartphone device in the event of misplacement. Apple Tag technology included in iOS 13 as 'Find My' app
- **Apple Products:** Future iterations of Apple Watch, AirPods, AirPod cases, Apple Glasses, MacBook Pro, etc.
- **IoT**: Some potential applications include – smart home technology, enhanced mobile payments, indoor navigation, gaming, augmented reality and keyless car entry.

http://apple.com/icloud/find-my/

Planned Analysis





Circuit Analysis

- Hierarchical schematics are recreated in a way that mirror a developer's design
- Sub 10 nm - From the block down to the gate level – all linked to the original layout, showing the extracted gates and associated interconnects
- All circuit reports are shipped with CircuitVision™, providing a highly interactive, easy to navigate view of circuit design including the physical implementation on the integrated circuit.

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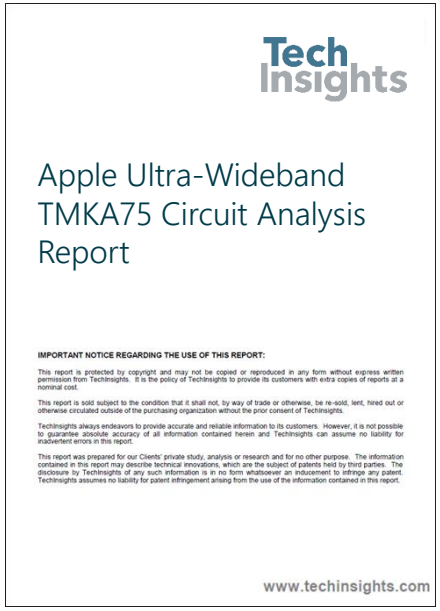
Apple U1 (TMKA75 die) Ultra-Wideband die (USI RF Module of the iPhone 11) Circuit Analysis: CAR-1910-801

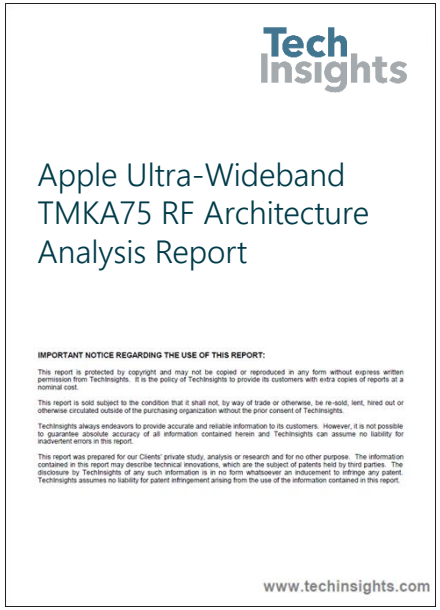
- Report Details:
  - Full Circuit Analysis on the Apple Ultra-Wideband TMKA75 die found in the USI RF Module of the iPhone 11
  - Interim deliverables available on request.



Apple Ultra-Wideband TMKA75 RF Architecture Analysis: ARC-1910-801

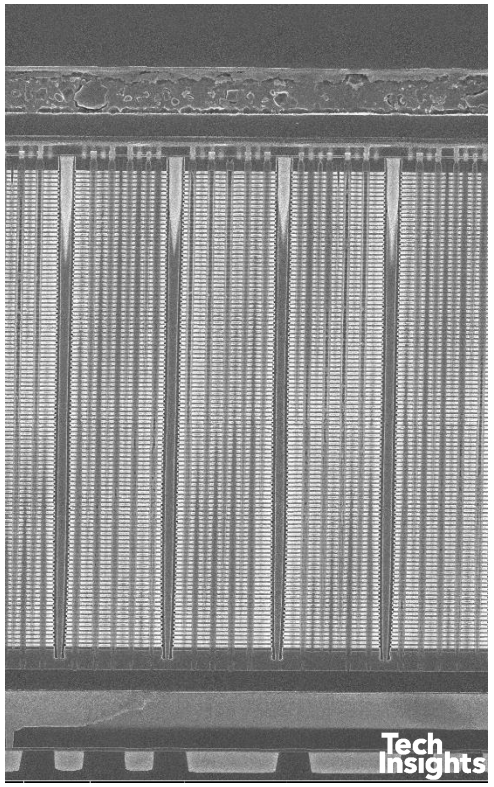
- Report Details:
  - Full RF Architecture Analysis on the Apple Ultra-Wideband
  - Interim deliverables available on request.

- Table of Contents:
  - Device Summary
  - Introduction
  - General Overview
  - RF Architecture



Floorplan and Teardown Reports

- BFR-1910-801
  - Apple U1 UWB SoC Basic Floorplan Analysis Report
- CUT-1910-901
  - iPhone 11 Block Diagram with U1 Poly Die Photo Teardown Analysis



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Broadcom wi-fi 6/BT 5.0 wireless Basic Functional Analysis Report	Broadcom	Floorplan	WiFi / BT SoC	BFR-1910-802	-	In Creation
NXP SN200 NFC Controller Basic Functional Analysis Report	NXP Semiconductors	Floorplan	NFC Controller	BFR-1910-803	-	In Creation
Intel WCSAX200 WiFi SOC Basic Functional Analysis	Intel	Floorplan	WiFi SoC	BFR-1908-803	-	In Creation
Nordic nRF52811 Basic Floorplan Analysis	Nordic	Floorplan	SoC (System-on-Chip)	BFR-1908-802	-	In Creation
Toshiba TC35681 Bluetooth SoC Basic Floorplan Analysis	Toshiba	Floorplan	RF Transceiver	BFR-1908-801		Published
Dialog Semiconductor DA14699 Bluetooth Basic Functional Analysis	Dialog Semiconductor	Floorplan	SoC (System-on-Chip)	BFR-1906-807		Published
Bestechnic BES2300 Bluetooth 5.0 Audio Chip Basic Floorplan Analysis	Bestechnic	Floorplan	Bluetooth	BFR-1907-801		Published
Apple H1 343S00290 Bluetooth SoC Architecture Analysis	Apple	Circuit	Bluetooth	BFR-1907-801		Published
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