TI Automotive mmWave Radar Solution

Automotive 76~81GHz mmWave sensor
Automotive Radar Applications

**CORNER RADAR**
- Single chip radar sensor solution
- Integrated DSP, Memory
- >130m Range using single chip
- ~170m using 2 chip

**IMAGING RADAR**
- Cascaded radar sensor solution
- >350m Range
- < 1 deg angular accuracy

**RADAR FOR PARKING**
- Antenna on package solution
- Multimodal/Multi functional
- High resolution and wide field of view

**Body & Incabin Sensing**
- Automatic Door opener
- Driver Vital Sign Detection
- Occupant Detection
- Gesture detection
TI introduce the first Single Chip mmWave IC

Discrete Multi-Chip mmWave Sensor
- Discrete solution – expensive
- Complex and critical signal routes
- Unconventional packaging
- Prone to noise
- Lack of system level observability
- Crude implementation of RF and Baseband safety

TI Single-Chip mmWave Sensor
- Smaller in size
- Simpler design
- Built in monitoring and calibration (ASIL)
- High Resolution, less false positives
- Programmable core
- Lower Power
Trend in Radar sensors

- 77 GHz LRR Micro + MMIC + Highly Automated Driving
- 77 GHz MRR Micro + MMIC
- 24 GHz SRR Micro + MMIC + NCAP, Surround Radar, Park Assist
- Cascaded 77 GHz (8+)RX (6+)TX Signal Processor
- Single Chip 76-81 GHz 4RX 3TX

Today 2021
Automotive radar roadmap

High performance front end

AWR1243
3TX / 4RX
CSI, SPI
4GHz RF, 15MHz IF
10.4 x 10.4 BGA

AWR1243P
3TX / 4RX
CSI, SPI
4GHz RF, 15MHz IF
3rd Tx, Phase Rotator
10.4 x 10.4 BGA

AWR1642
2TX / 4RX
1.5MB RAM
SPI, CAN, CANFD
4GHz RF, 5MHz IF
10.4 x 10.4 BGA
PPAP Ready

AWR1443
3TX / 4RX
576KB RAM
SPI, CAN
4GHz RF, 5MHz IF
10.4 x 10.4 BGA

Single chip

AWR1243P
3TX / 4RX
CSI, SPI
4GHz RF, 15MHz IF
3rd Tx, Phase Rotator
10.4 x 10.4 BGA

AWR1843
3TX / 4RX
2MB RAM
SPI, CAN, CANFD
4GHz RF, 10 MHz IF
10.4 x 10.4 BGA

AWR2xxx

2017
2018
2019
2020
Automotive mmWave Sensors

**AWR1243**
- Radar Sensor
  - Use Cases
    - Imaging Radar Sensor
      - 2x or 4x AWR12 (cascade) + External DSP
    - MRR and LRR
  - ASIL-B capable
  - PPAP/Production: Now

**AWR1642**
- Radar Sensor + DSP
  - Use Cases
    - SRR Single chip Radar
      - 100m Cross traffic Alert
    - Body sensing, Occupant sensing, Vital sign monitoring
  - ASIL-B capable
  - PPAP/Production: Now

**AWR1843**
- Radar Sensor + DSP
  - Use Cases
    - Parking w/ height measurement
    - MRR single chip radar
  - ASIL-B capable
  - Sampling: July 2018
  - PPAP/RTM: 2Q19
Sensor configuration with TI mmWave solutions

- **IMAGING**
  - AWR1243
  - Processor

- **CORNER/MRR**
  - AWR1243
  - Processor

- **LRR**
  - AWR1243

- **SRR**
  - AWR1642

- **USRR**
  - AWR1642

- **Proximity**
  - AWR1443

- **Satellite Configuration**
  - AWR1243

- **FPD**
  - Processor

- **Satellite Configuration**
  - AWR1243

- **Processor**
  - AWR1243

- **CANFD**
  - Processor
Delivering mmWave sensing solutions
## Hardware Platforms

<table>
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<tr>
<th>Platform</th>
<th>Description</th>
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<tr>
<td><strong>AWR1443/AWR1642</strong></td>
<td>Enables evaluation of single chip radar</td>
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<tr>
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<td>Proximity sensor demo on AWR1443 EVM</td>
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<td>SRR demo on AWR1642 EVM</td>
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<td></td>
<td>Environment: mmWave-SDK</td>
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<td><strong>AWR1x + DCA1000EVM</strong></td>
<td>Enables RF performance evaluation</td>
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<td></td>
<td>Raw ADC capture into PC and then post process</td>
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<td></td>
<td>mmWave Studio to visualize object range/velocity/angle</td>
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<tr>
<td></td>
<td>Environment: DFP and mmWave Studio</td>
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<tr>
<td><strong>AWR1243 + TDA3x</strong></td>
<td>Enables radar algorithm and MRR/LRR application development on TDA3x</td>
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<td></td>
<td>Enables vehicle validation/demonstration</td>
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<tr>
<td></td>
<td>Environment: DFP and TDA3x Radar SDK</td>
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<tr>
<td><strong>AWR1x sensor module</strong></td>
<td>Enables radar algorithm and proximity/SRR application development on AWR1443/AWR1642</td>
</tr>
<tr>
<td><strong>AWR1x starter kit</strong></td>
<td>Enables vehicle validation/demonstration</td>
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- **AWR1642-ODS EVM**: 85 x 65mm
- **AWR1243 + TDA3x**: 34 x 38mm
Short Range Radar Reference Design Using AWR1642 EVM: TIDEP-0092

Features

- Today:
  - Single chip solution with DSP integration and 1.5MB of on chip RAM for application programming.
  - Detected cloud point/objects up to 80m sent over UART interface to a PC for visualization using mmWave SDK
  - Clustering & Tracking of objects up to 100m+ at 40cm resolution, +/-60 deg FOV
  - Velocity resolution algorithm
  - Better detections and minimum memory configuration
  - Stream object data over Ethernet via a data capture card
  - Occupancy grid detection

Tools & Resources

- TI Design Link:
- Design Files: Schematics, BOM, Gerbers
- Software:

Benefits

- Single Chip solution with DSP integration excluding dependence on external processor.
- Small form factor and low power.
- High spatial and velocity resolution at 77GHz
- Cost optimized BOM
- Reference processing chain and higher layer algorithms

Target Applications

- Blind Spot detection
- Lane Change assistance
- Cross Traffic alert
- Parking Assistance

Device Documents

- www.ti.com/product/AWR1642

AWR1642

Data Capture Card

Ethernet
Automotive 77GHz Radar Module Reference Design: TIDA-01570

50mm x 71mm

TIDA-01570 block diagram

http://www.ti.com/tool/TIDA-01570
Corner Radar Using Single Chip Radar Sensor AWR1843

Key Features

- Single chip drives smallest form factor and lowest cost sensor
  - World’s first RFCMOS single chip sensor already in production, enabling processing at the edge
- High precision and accurate detection up to 150m
  - Ultra-wide bandwidth enables separation of objects as close as 4cm
  - Detection of 200+ objects with multi-mode
- mmWave-SDK, reference designs and system level learnings enable faster TTM
  - Safety monitoring, device calibration, optimized power architecture, reference algorithms
Enabling Level2+ automation with high performance cascade

77 GHz MMIC
MCU

Today
Resolution in 10s of m
Coarse Doppler resolution
100 km/h relative velocity

5cm resolution
Low Doppler ambiguity
300km/h relative velocity

High Performance LRR

+ beam steering
< 1° angular resolution

Curbs/Overhanging objects
Overhead bridges/tunnels
Dense urban scenarios

LRR

AWR1243
TDA3x

CORNER/MRR

4x angular resolution

AWR1243
TDA3x/
TDA2x

AWR1243
TDA2x

Texas Instruments
Adjacent Markets

Many sensing applications in and around car

Customer Value
- Accurate
- Easy
- Scalable

Collaborator Value
- Small modules
- Geographic advantage

Secondary Benefits
- Low power
- DSP programmable and reference designs

1 Hardware and Software platform
**Key market segments**

**Obstacle Detection Sensor**
- Car/Door Openers
- Park Assistance
- Suspension control
- Detection of ice/water on road

**Vehicle Occupant Detection**
- Child Left behind
- Intrusion detection
- Occupant classification (adult or child) for air bag deployment

**Driver Vital Sign Monitoring**
- Driver/Passenger Heart rate
- Driver sleep state detection
- Passenger ill/pass out

**Swipe/Kick to open**
- Kick to open tailgate
- HMI screen change
- Knob control
- Panes open/close
Near range 3D obstacle detection (Body & Chassis)

- Sense obstacle in the vicinity of car door to avoid collision and damage
- Single chip and small form factor that can go even "inside" a door-handle OR side-mirror OR door-cladding – Scalable to multiple locations
- Works under bright sunlight, pitch darkness, snow, fog
- Detection in elevation and azimuth directions with sub mm range accuracy
- Offers more range than any comparable sensing technology
- Easy algorithm implementation on single chip

Why 77GHz radar
Obstacle detection using AWR1642BOOST-ODS

Features
- Near range 3D obstacle detection
- Single chip solution with DSP integration and 1.5MB of on chip RAM for application programming.
- Parameters
  - Range: 4 cm - 15m
  - Resolution: 4 cm
  - FOV: +/-80 deg Azimuth, +/-80 deg Elevation

Target Applications
- Automotive
  - Obstacle detection around Car door/trunk
- Parking Assist

Benefits
- TI
  - Accurate, Low power single chip sensor for near range 3D obstacle detection applications against existing solutions

Customer Collateral
- HW/SW reference to jump start on the system design
- 3D Obstacle detection and elevation algorithm reference
- Processing chain reference

Tools & Resources
- Tool folder link
  EVM page available and code on TI Resource explorer
  Early software available for evaluation now
- Device datasheets links:
  - AWR1642BOOST-ODS – Available to order
Vehicle Occupant Detection Reference Design: TIDEP-01001

http://www.ti.com/tool/TIDEP-01001
TI Training – training.ti.com
Welcome to Resource Explorer
Examples, libraries, executables and documentation for your device and development board

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