LocoMate Mirror™ | Rearview Mirror for DSRC V2X Connected Car

Key Benefits

Hardware
- Safety Device for V2X environment
- 5 Inch LCD Touch Screen
- Built in Forward Facing Camera
- Built in Rear-Facing Camera
- First mobile DSRC Rearview Mirror
- 802.11ac Wi-Fi Enabled for Internet Access
- Bluetooth 4.2.2. Infotainment Connect
- Sim Card for Cellular Connectivity
- External GPS Antenna
- Power Consumption < 3W
- FCC/CE/ROHS/USDOT Certified

Software
- WAVE Standards Support
  - IEEE 802.11p
  - IEEE 1609.2
  - IEEE 1609.3
  - IEEE 1609.4
  - SAE J2735
  - VAD/CAMP
- Fast channel switching capabilities
- Switching capability between control and service channels
- Multi-channel synchronization between service users
- Exclusive packet control
- TX power control per packet
- Data rate control per packet
- Remote application support
- Software development kit (SDK) for application development

WAVE Mode
- Support for 5.9 GHz spectrum with 10 MHz channel width
- Support for WAVE data and management frames
- Support for multi channel (control channel and service channel) using single radio
- <= 3 mS channel switch time irrespective of traffic conditions
- Can preempt messages in transmit queue
- Support for multiple priority queues
- Support for GPS-based synchronization

Product Highlights - The First DSRC Connected Vehicle Rearview Mirror

An integration of GPS, DSRC, and Bluetooth, LocoMate™ MIRROR is ideal for safety and V2X applications by allowing vehicles on the road to talk to each other or to another road side unit. It is fully compliant with Omni-Air’s certification and is used in worldwide deployments including the US Department of Transportation’s Safety Pilot in Ann Arbor, Michigan. Product applications include: Collision Avoidance, Emergency Vehicle Management, Train Crossing, Tolling, Commerce Applications ($), Truck Platooning, Taxi Management and Geo-Fencing.

LocoMate™ MIRROR communicates using DSRC Wi-Fi to receive traffic safety information from vehicles who have CONNECTED CAR technology and through Intersections (V2I). LocoMate™ comes integrated with GPS (LESS than 1 meter accuracy), Bluetooth and high-power 802.11 p radios.

Recommended Accessories: Development Board and USB Power Connector to Power (not included)
WAVE Protocols
- 802.11p (WAVE)
- IEEE 1609.2
- IEEE 1609.3
- IEEE 1609.4
- SAE J2735
- VAD/CAMP

Frequency
- 5.85 - 5.925 GHz
- 5.7 - 5.8 GHz (Europe)

DSRC Radio
- Integrated High-Power DSRC 5.9 GHz Radio
- Power: +24dBm at 16QAM, from -20°C-+85°C

GPS Device
- GPS with embedded RF antenna
- Accuracy Less Than <1 meter

Bluetooth
- Communicate to smart phones using bluetooth
- Communicate to CAN via Bluetooth

Multi-channel operation
- Consistent 3 ms channel switch time

Supplementary 802.11 MAC features
- Control Channel (CCH) and Service Channels coordination (SSH)
- 50 ms channel dwell time
- CCH for broadcast, high-priority and single-use safety messages and SCH for IP data

Power Supply
- Standard 5V Micro USB Charger

Channel Access
- Alternative, continuous

Channel Switching
- Consistent 3 ms switch time at every 50 ms
- Multichannel channel access and switching

Software Queuing
- Transmit queues per channel
- Prioritized channel access queues, with configurable channel access parameters

Database Configuration
- CLI
- Database file backup, restore

Platform
- Linux/Unix compatible
- SDK with C libraries
- Android support on smartphone applications

Interactive Communication
- ssh/telnet

IP Protocols
- ipv4 / ipv6

Network Configuration
- Wired and DSRC
- ipv4 configuration
- ipv6 configuration
- SIT Tunnel Support

US DOT VAD spec
- QPL vendor

GPS Applications
- Approx. 1m accuracy
- Path history implementation
- Path prediction implementation

Local Time Synchronization
- GPS along with PPS

Security
- Signing and verification of messages, encryption and decryption of messages
- Signing and verification of WSAs

Message Logging
- DSRC Transmit packets, DSRC Receive Packets, Ethernet packets
- System events
- Heartbeat messages with configuration (ipv4 or ipv6)
- Log offload configuration (ipv4 or ipv6)
- Wave Service Announcement configuration

LEDs
- DSRC packet transmission
- Bluetooth Activity
- GPS Fixed Achieved
- Power On

Human Machine Interface
- Smart phones HMI device w/ bluetooth interface

DSRC Channel Support
- 10 MHz Channels
- Frequency (MHz)

<table>
<thead>
<tr>
<th>Rate</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>3M</td>
<td>5860</td>
</tr>
<tr>
<td>4.5M</td>
<td>5870</td>
</tr>
<tr>
<td>6M</td>
<td>5880</td>
</tr>
<tr>
<td>9M</td>
<td>5890</td>
</tr>
<tr>
<td>12M</td>
<td>5900</td>
</tr>
<tr>
<td>18M</td>
<td>5910</td>
</tr>
<tr>
<td>24M</td>
<td>5920</td>
</tr>
</tbody>
</table>

- 20 MHz Channels
- Frequency (MHz)

<table>
<thead>
<tr>
<th>Rate</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>6M</td>
<td>5865</td>
</tr>
<tr>
<td>9M</td>
<td>5875</td>
</tr>
<tr>
<td>12M</td>
<td>5885</td>
</tr>
<tr>
<td>18M</td>
<td>5895</td>
</tr>
<tr>
<td>24M</td>
<td>5905</td>
</tr>
<tr>
<td>36M</td>
<td>5915</td>
</tr>
</tbody>
</table>

Throughput Traffic Test Results Half-Rates on Channel 172 (Mbps) Without Channel Switch

<table>
<thead>
<tr>
<th>Rates</th>
<th>TCP</th>
<th>UDP</th>
</tr>
</thead>
<tbody>
<tr>
<td>3M</td>
<td>2.36</td>
<td>2.38</td>
</tr>
<tr>
<td>4.5M</td>
<td>3.37</td>
<td>3.50</td>
</tr>
<tr>
<td>6M</td>
<td>4.34</td>
<td>4.37</td>
</tr>
<tr>
<td>9M</td>
<td>6.62</td>
<td>6.99</td>
</tr>
<tr>
<td>12M</td>
<td>7.97</td>
<td>9.00</td>
</tr>
<tr>
<td>18M</td>
<td>11.23</td>
<td>12.96</td>
</tr>
<tr>
<td>24M</td>
<td>13.54</td>
<td>15.81</td>
</tr>
<tr>
<td>27M</td>
<td>14.75</td>
<td>17.32</td>
</tr>
</tbody>
</table>

Throughput Traffic Test Results Full-Rates on Channel 175 (Mbps) Without Channel Switch

<table>
<thead>
<tr>
<th>Rates</th>
<th>TCP</th>
<th>UDP</th>
</tr>
</thead>
<tbody>
<tr>
<td>6M</td>
<td>4.7</td>
<td>5.0</td>
</tr>
<tr>
<td>9M</td>
<td>6.7</td>
<td>7.2</td>
</tr>
<tr>
<td>12M</td>
<td>9.8</td>
<td>10.5</td>
</tr>
<tr>
<td>18M</td>
<td>12.9</td>
<td>14.52</td>
</tr>
<tr>
<td>24M</td>
<td>16.6</td>
<td>18.661</td>
</tr>
<tr>
<td>36M</td>
<td>22.630</td>
<td>26.022</td>
</tr>
<tr>
<td>54M</td>
<td>27.782</td>
<td>32.231</td>
</tr>
</tbody>
</table>
## TCP/UDP Throughput in Different Channels

<table>
<thead>
<tr>
<th>WAVE operation</th>
<th>TCP (Mbps)</th>
<th>UDP (Mbps)</th>
</tr>
</thead>
<tbody>
<tr>
<td>20 MHz (max. phy rate=54 Mbps)</td>
<td>27.780</td>
<td>32.231</td>
</tr>
<tr>
<td>10 MHz (max. phy rate=27 Mbps)</td>
<td>14.75</td>
<td>17.32</td>
</tr>
<tr>
<td>10 MHz, with periodic channel switch</td>
<td>6.9</td>
<td>8.6</td>
</tr>
</tbody>
</table>

## Average per Packet Latency Values with Different Content Type Messages

<table>
<thead>
<tr>
<th>Test</th>
<th>Plain</th>
<th>Sign/Sign Verify</th>
<th>Encrypted/Decrypted</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average packet interval with 100 mS transmit periodicity</td>
<td>102 mS</td>
<td>112 mS</td>
<td>139 mS</td>
</tr>
<tr>
<td>Latency</td>
<td>2 mS</td>
<td>10 mS</td>
<td>35-40 mS</td>
</tr>
</tbody>
</table>

## 802.11p Radio Specifications

<table>
<thead>
<tr>
<th>Modulation</th>
<th>Data Rate</th>
<th>TX</th>
<th>RX</th>
</tr>
</thead>
<tbody>
<tr>
<td>BPSK</td>
<td>3 Mbps</td>
<td>24±1dBm</td>
<td>-95±2dBm</td>
</tr>
<tr>
<td>16QAM</td>
<td>18 Mbps</td>
<td>24±1dBm</td>
<td>-83±2dBm</td>
</tr>
<tr>
<td>64QAM</td>
<td>27 Mbps</td>
<td>21±1dBm</td>
<td>-77±2dBm</td>
</tr>
</tbody>
</table>

## Other Specifications

- **Operating Temperature**: -10°C to +55°C (output power specified over full temperature profile)
- **Channel Bandwidth**: 10 MHz, 20 MHz (FCC “Class C” Mask Compliant)

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**Ordering Information**

LocoMate Mirror™ Rearview Mirror Connected V2X
Part # OBU-212

For sales information please contact:
sales@aradasystems.com

**About Arada Systems**

Arada Systems is a leader in technologies meant for vehicle-based communication networks, particularly for applications such as toll collection, vehicle safety services, and commerce transactions via cars. LocoMate™ is being evaluated for real-time communication between vehicles and roadside access points or other vehicles creating a real-time public safety network.