Electronic Systems Division
Toyota Technical Center

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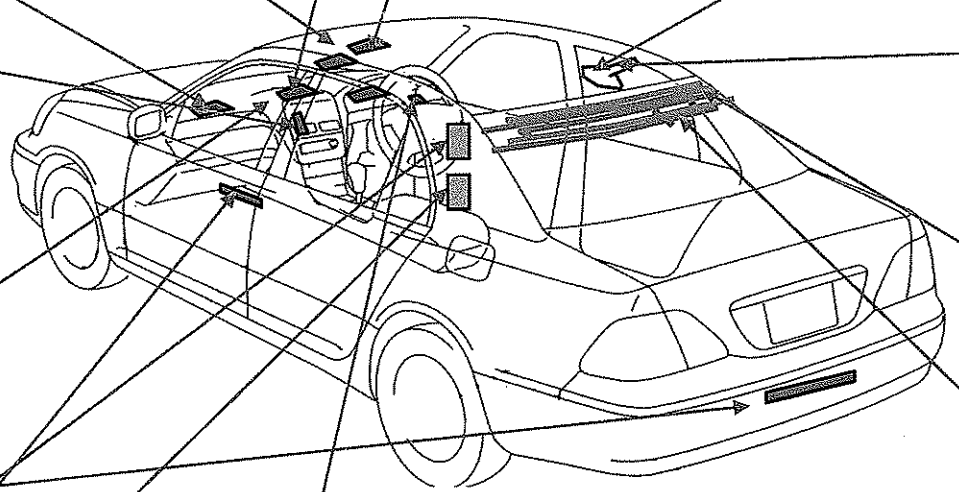
09-6-4

Introduction

Many radio waves systems exist on vehicles which have the potential to be impacted by the current draft Cool Car rule



Solar light sensor
IR 850nm

Night vision
IR 850nm

GPS
1.5GHz

ETC
915MHz

ITS
5.8GHz,3-5GHz
Future application

Mobile Phone
800MHz, 1.9GHz

Bluetooth
Wi-Fi(wireless LAN)
2.4GHz , 5.2GHz

Satellite digital radio
2.6GHz band

Communication module coupled with GPS using mobile phone
800MHz , 1.5GHz

TV (digital)
Future application

AM / FM

Remote Keyless Entry
312MHz , 134kHz

Garage Door Opener
300MHz band

Tire Pressure Monitoring
315MHz

Immobilizer
134.2kHz

Bold indicates areas of Toyota concern

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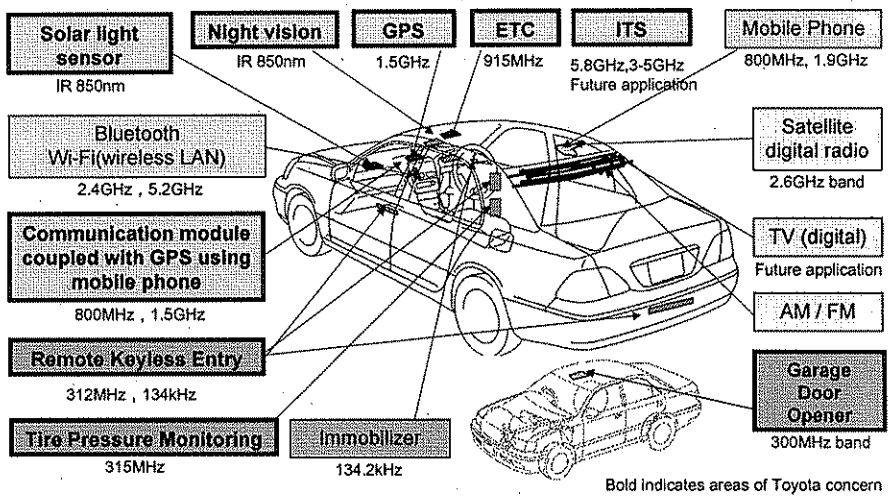

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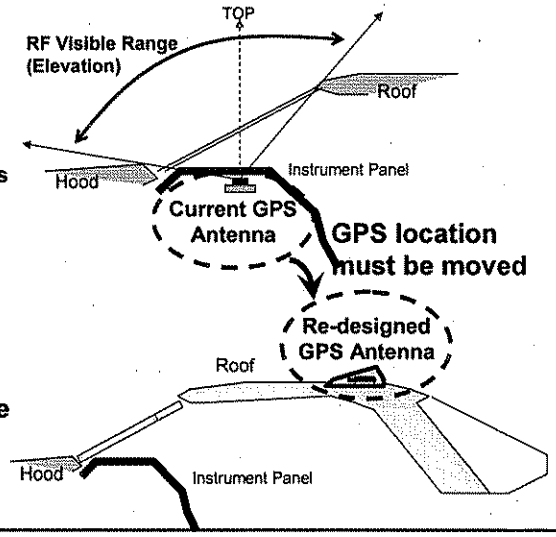
GPS Antenna Redesign

If present technology solar reflective glass is required on windshield the GPS antenna must be redesigned, even if deletion area is allowed

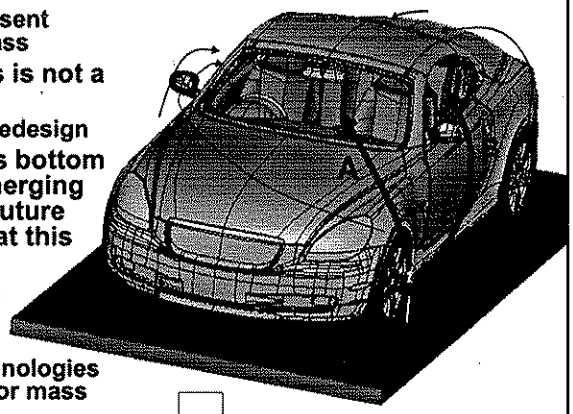
- **Examples of redesign impact**
  - **Cable between receiver and antenna must be rerouted**
    - **Longer cable attenuates signal, so receiver sensitivity may need to be improved**
  - **Hole through roof for mounting**
    - **Must verify body structural design and water intrusion**
- **Redesign is major change and requires adequate lead time**



Tire Pressure Monitoring System (TPMS)

An effective method to meet both the TPMS NHTSA regulation and currently drafted Cool Car rule with present technology is not clear

- **A dominant propagation route for front tire is through windshield**
  - **Signal attenuated by present technology reflective glass**
- **Adding multiple antennas is not a feasible option**
  - **Cost prohibitive, major redesign**
- **Wide area deletion across bottom of windshield or other emerging technologies could be a future solution but not feasible at this time**
  - **Wide area mask deletion would exceed 10% area**
  - **Wide area laser deletion and other emerging technologies are currently not ready for mass production**



Conclusion

Many technical issues still exist in implementing the current draft Cool Car rule with technology that is presently ready for mass production

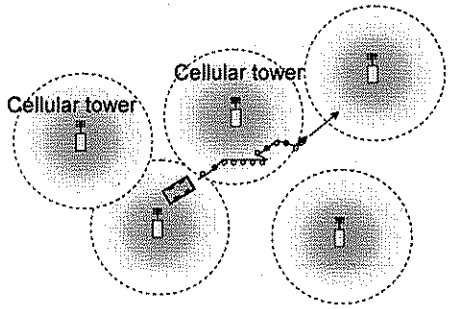
- **Toyota's Front Windshield Opinion**
  - Solar absorbing glass (Tts<=60%) should be allowed
    - Prevents potential radio wave interference, customer choice and mass production issues
  - Phase in: 30% at 12MY, 60% at 13MY, 100% at 14MY
  - Higher performance standard beginning in 15MY
    - Allows sufficient lead time to develop mass production technologies and address radio wave interference concerns

Appendix

Mobile Phone Interference

Potential situation of restricted connection power and reduction in cell numbers when driving in a cellular fringe area

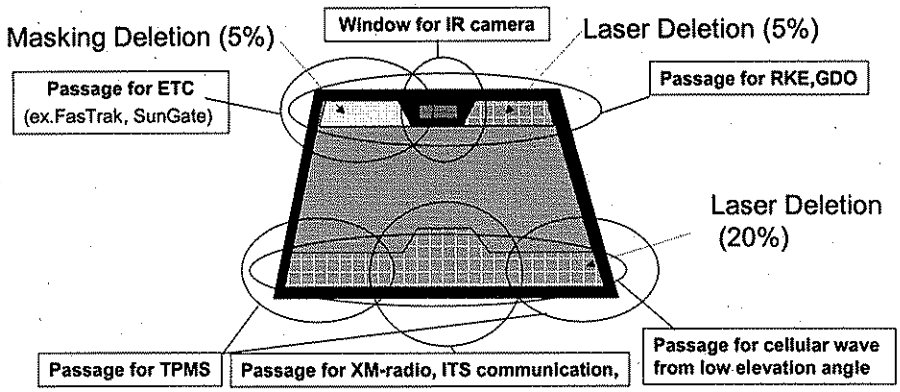
- **Particular concern is situation when driving toward cellular tower**
  - **Concern because primary path for radio wave propagation is through front windshield**



Necessary Deletion Pattern

The necessary deletion pattern to meet current draft Cool Car rule with present technology reflective glass is not currently feasible

- **Wide area laser deletion production ability is not established**
- **Potential technical concerns include visibility, warping and distortion**
- **No clear prospect that all glass suppliers can provide at 12MY on mass production level**



Future Application Impact

For future ITS technology implementation, the instrument panel is the best mounting location