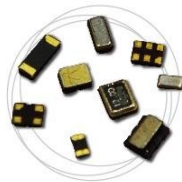


# Automotive Freq Components Introduction

Your Best Partner for Frequency Devices

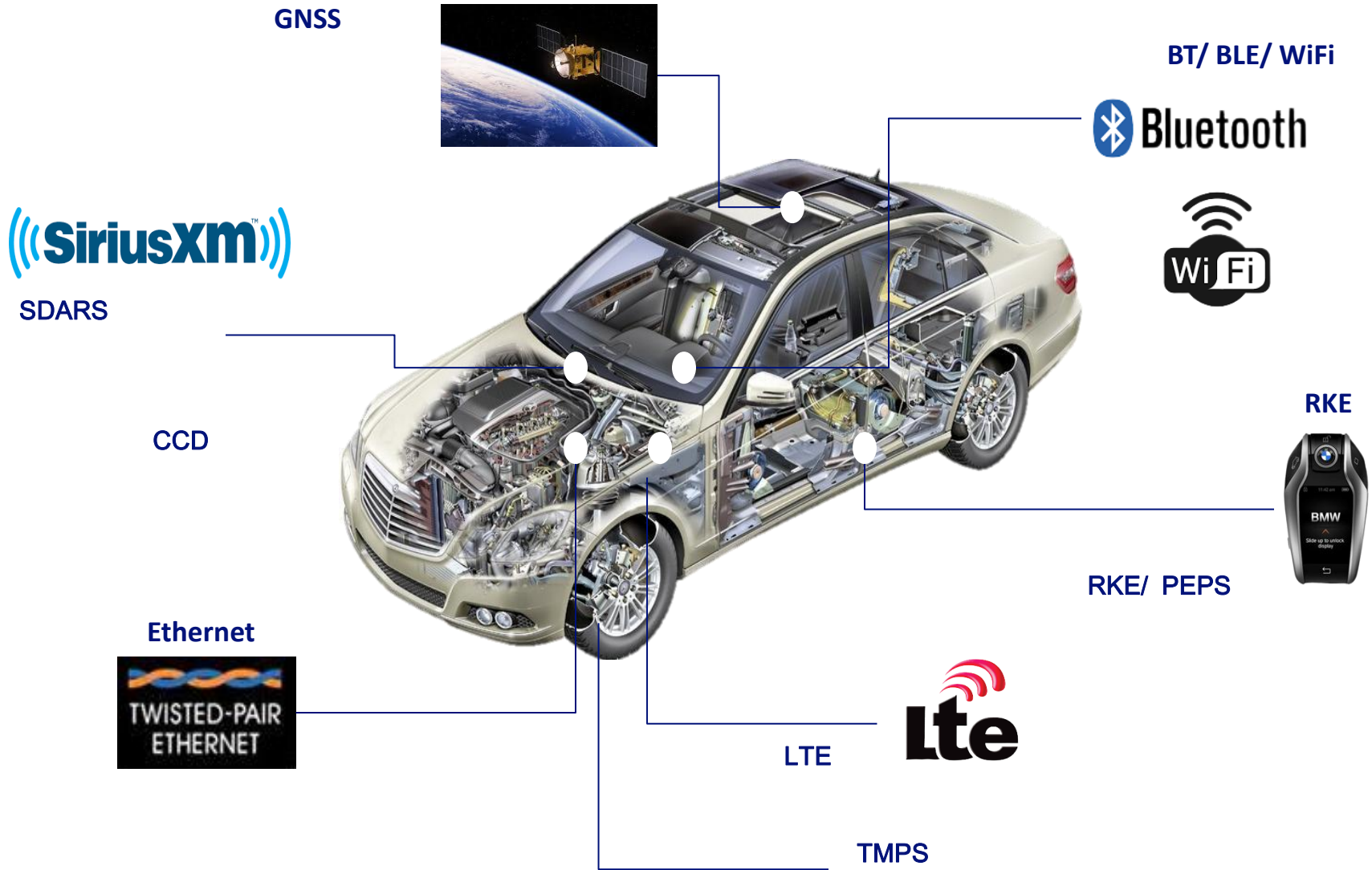


# Agenda



- HMI in Automotive Applications
- Roadmap
- Automotive Requirement

# HMI in Automotive Applications



# Automotive Applications



Smart  
Cockpit

- Digital cluster
- Surround view
- RSE
- IVI



Body &  
Comfort

- Ambient Light
- Power Seat ECU



Connectivity

- 5G V2X TBOX
- Zonal Gateway
- Ethernet Switch



Powertrain

- EV Power BMS
- Powertrain
- On Board Charger
- Charging Station



Software

- V2X SW stack
- OTA
- Cybersecurity



ADAS

- Forward/Reverse Parking Distance Warning System Automatic Parking System
- ADAS

# HMI in Automotive Application



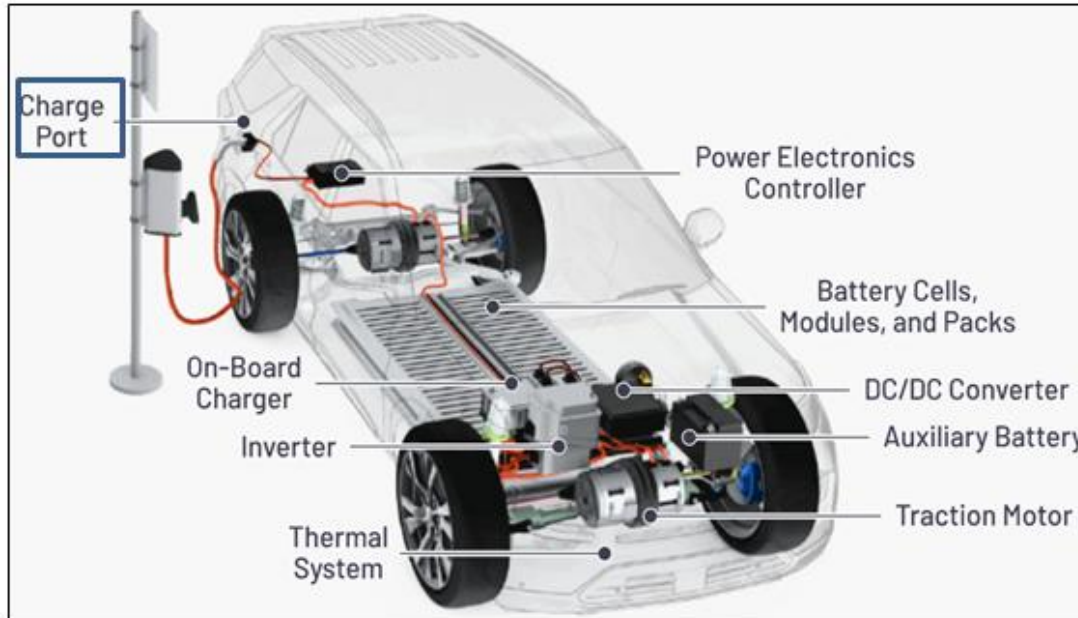
ADAS / Autonomous	Connected / Infotainment	Electric
Radar System	Telematics / C-V2X	Battery Management System (BMS) /
Camera System	In-Vehicle Infotainment (IVI), Car Audio, Navigation	Wireless BMS
Surround Camera System / LiDAR System	Head Up Display (HUD)	Motor (Traction Inverter)
Automotive Computer		Converter
Gateway (In-Vehicle Network)		Charger (from electrical grid)
Body	Safety	Powertrain
Remote Keyless Entry (RKE) / Tire Pressure Monitoring System (TPMS)	Antilock Brake System (ABS)	Engine Control
Front Lighting System	Electric Stability Control (ESC)	Transmission
Air Conditioner	Airbag	Electric Power Steering
Digital Mirror (Viewing System)		
Others		
Dashboard Camera (Dash cam)		
Driver Monitoring System (DMS)		
Child Presence Detection (CPD), DMS		

# Frequency for Automotive Application



<b>12.288, 18.432, 24.576, 55.46667M</b>	<b>25, 50, 125M</b>	<b>24, 27M</b>
In-Vehicle Infotainment (IVI), Car Audio, Navigation	Automotive Computer	Camera System
<b>125M, 156.25M</b>	Camera System	Digital Mirror (Viewing System)
Automotive Computer	Front Lighting System	Driver Monitoring System (DMS)
Front Lighting System	Gateway (In-Vehicle Network)	Front Lighting System
In-Vehicle Infotainment (IVI), Car Audio, Navigation	In-Vehicle Infotainment (IVI), Car Audio, Navigation	<b>25, 27, 50, 100, 125M</b>
<b>20 ~ 160M</b>	Telematics / C-V2X	Child Presence Detection (CPD), DMS
Child Presence Detection (CPD), DMS	<b>25, 27, 50, 100M</b>	Digital Mirror (Viewing System)
Radar System	Automotive Computer	Radar System
<b>24, 25, 33.33, 50M</b>	Camera System	<b>8 ~ 125M</b>
Automotive Computer	Gateway (In-Vehicle Network)	Camera System
Gateway (In-Vehicle Network)	In-Vehicle Infotainment (IVI), Car Audio, Navigation	Child Presence Detection (CPD), DMS
In-Vehicle Infotainment (IVI), Car Audio, Navigation	Surround Camera System / LiDAR System	Digital Mirror (Viewing System)
<b>25, 27, 50M</b>	<b>33.3333, 50, 100M</b>	Driver Monitoring System (DMS)
Telematics / C-V2X	Front Lighting System	Front Lighting System
<b>25, 50, 125, 156.25M</b>	<b>50, 100M</b>	
Surround Camera System / LiDAR System	Surround Camera System / LiDAR System	
<b>25, 50M</b>		
In-Vehicle Infotainment (IVI), Car Audio, Navigation		

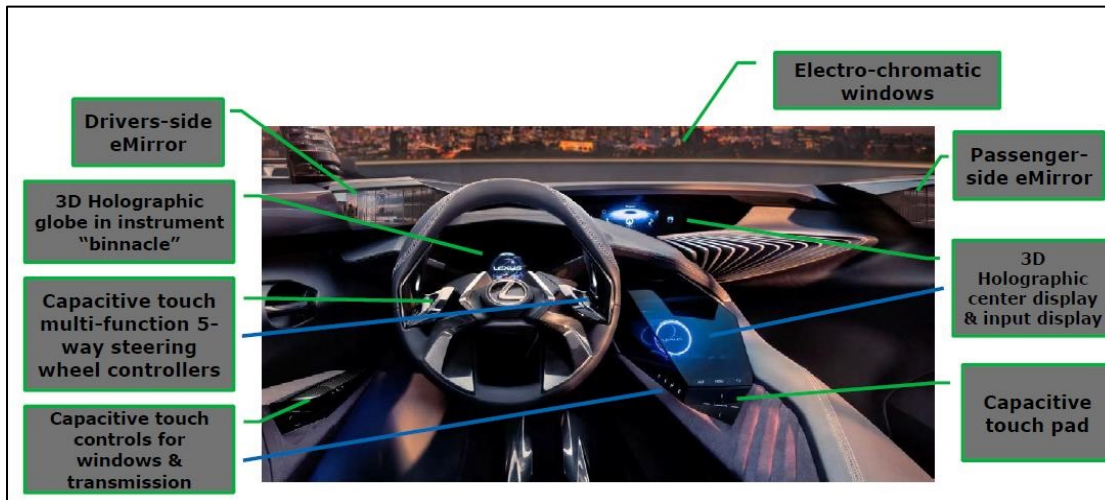
# EV Charger



Frequency	Type / Package
32.768 KHz	X21-X31 XTAL
8 MHz	X32 XTAL X25 XTAL X20 XTAL X16 XTAL
10 MHz	
12 MHz	
16 MHz	
20 MHz	
22 MHz	
24 MHz	
25 MHz	
26 MHz	
27 MHz	
40 MHz	
50 MHz	
19.2 MHz	SX3 OSCIL
38.4 MHz	SX2 OSCIL
26 MHz	SX2 TCXO



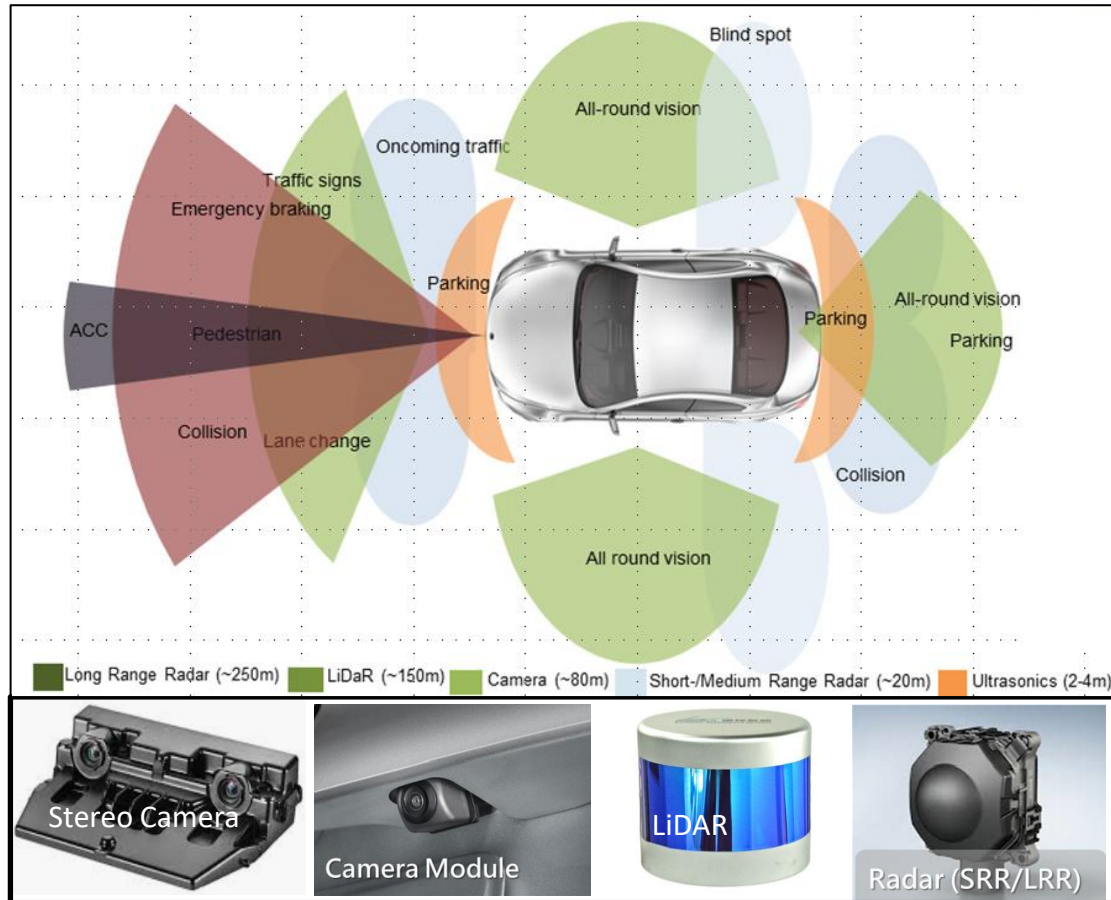
# Infotainment



Frequency	Type / Package
32.768 KHz	X31 XTAL SX1 , SX2 OSCIL
12.288 MHz 16 MHz 18.432MHz 20 MHz 22 MHz 24 MHz 24.576 MHz 25 MHz 26 MHz 27 MHz 30 MHz 40 MHz	X32 XTAL X25 XTAL X20 XTAL X16 XTAL
26 MHz	SX3 OSCIL SX2 OSCIL

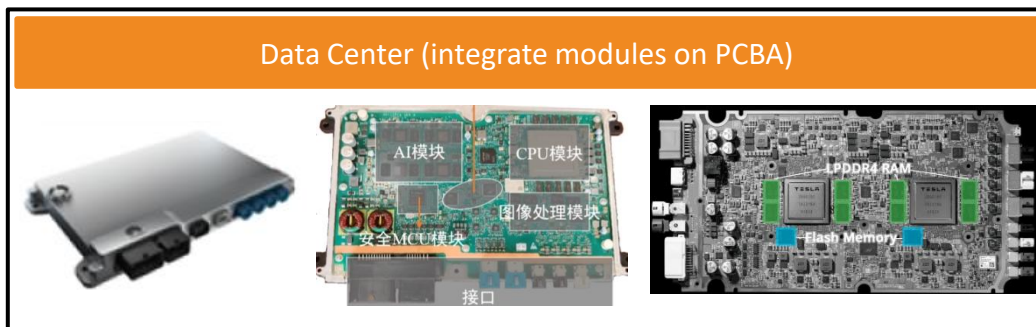


# Advanced Driver Assisted System (ADAS)



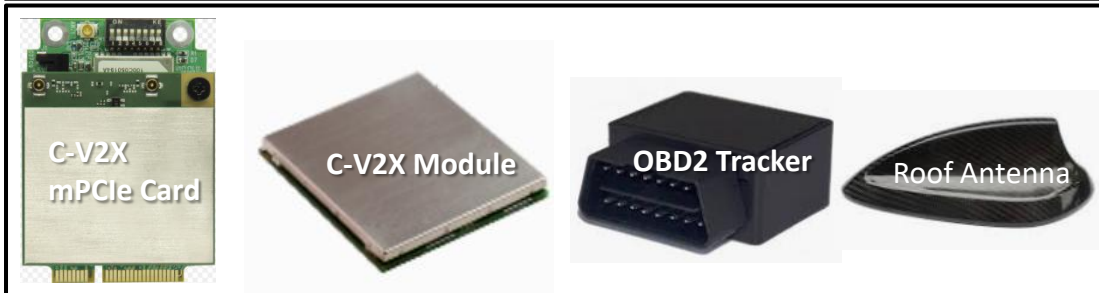
Frequency	Type / Package
32.768 KHz	X31 XTAL SX2 OSCIL
4 MHz 8 MHz	49S XTAL 49SM XTAL
4 MHz 10 MHz 16 MHz 20 MHz 22 MHz 25 MHz 26 MHz	X32 XTAL X20 XTAL
10 MHz 27 MHz 30 MHz	SX3 OSCIL SX2 OSCIL
20 MHz	SX2 TCXO

# Central Unit of Vehicle



Frequency	Type / Package
32.768 KHz	X31 XTAL
12MHz 14.31818MHz 19.2MHz 25MHz 26MHz 38.4MHz 48 MHz 50 MHz	X32 XTAL X20 XTAL
20MHz 25MHz 50MHz 100MHz 125 MHz 156.25 MHz	SX3 OSCIL SX2 OSCIL
19.2MHz 25MHz 26MHz 32MHz 38.4 MHz	SX1 TCXO SX2 TCXO

# Connected Car ( C-V2X )



Frequency	Type / Package
32.768 KHz	X31 XTAL
4 MHz 8 MHz	49S XTAL 49SM XTAL
16 MHz 19.2 MHz 26 MHz 38.4 MHz 96 MHz	X32 XTAL X20 XTAL
20 MHz 26 MHz 32 MHz 40 MHz 76.8 MHz 100 MHz	Crystal Filter SP2 TCXO

# Automotive Crystals – Camera & Radar



Specifications	Part number	Application
24/30/15/1.8/2.5x2.0	SX2C33F25E-24MHz	Camera
27/20/15/1.8/2.5x2.0	SX2C18F20E-27MHz	Camera
27/30/15/1.8/2.5x2.0	SX2C18F25E-27MHz	Camera
16/10/20/3.2x2.5	X32-1015K20F16MHz	Camera
27/10/8/2.0x1.6	X20-1050M8F27MHz	Camera
24/10/12/3.2x2.5	X32-1015K12F24MHz	Camera
27/20/20/3.2x2.5	X32-3020K20F27MHz	Camera
25/10/12/2.0x1.6	X20-1015L12F25MHz	Camera
32.768K/20/12.5/3.2x1.5	X31A-20-12.5 32K768	Camera
27/30/6.5/3.2x2.5	X32-3030K6.5F27MHz	Camera
27/10/7/2.0x1.6	X20-1020K7F27MHz	Camera

Specifications	Part number	Application
20/10/10/2.0x1.6	X20-1030L10F20MHz	Radar

# Automotive Crystals – Control & ETCS



Specifications	Part number	Application
2/50/15/5/3.2x2.5	SX3C50K50E-2MHz	Control
16/50/8/3.2x2.5	X32-1010D8F16MHz	Control
8/10/10/5.0x3.2	X53-1020H10F8MHz	Control
26/10/8/2.0x1.6	X20-1550M8F26MHz	Control
25/20/12/3.2x2.5	X32-2020H12F25MHz	Control

Specifications	Part number	Application
32.768/20/15/3.3/3.2x2.5	SX3C33H20E-32.768MHz	ETCS
16.384/1/2.5x2.0	SX2CT33L-3.0-E4P-16.384MHz	ETCS
32.768/20/15/3.3/2.0x1.6	SX1C33H20E-32.768MHz	ETCS

# Automotive Crystals – Infotainment




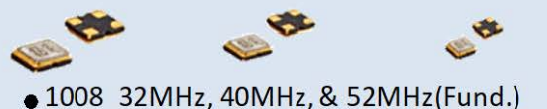
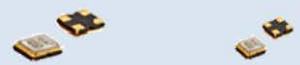
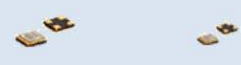

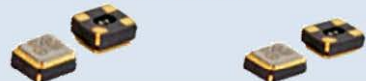




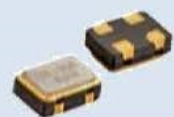




Specifications	Part number	Application
37.4/2/2.0x1.6	SX1ST1V3K-2.5-F4P-37.4MHz	Infotainment
48/1.5/2.0x1.6	SX1ST1V3L-2.5-F4P-48MHz	Infotainment
27/10/12/2.0x1.6	X20-1030K12F27MHz	Infotainment
24/8/12/3.2x2.5	X32-0825M12F24MHz	Infotainment
37.4/10/12/2.5x2.0	X25-1020K12F37.4MHz	Infotainment
28.63636/10/20/3.2x2.5	X32-2020K10F28.63636MHz	Infotainment
37.4/7/8/2.0x1.6	X20-0713K8F37.4MHz	Infotainment
48/8/10/2.5x2.0	X25-0825M10F48MHz	Infotainment
50/10/8/2.0x1.6	X20-1015K8F50MHz	Infotainment
48/8/10/2.0x1.6	X20-0825M10F48MHz	Infotainment
48/8/10/3.2x2.5	X32-0825M10F48MHz	Infotainment
40/5/7/2.0x1.6	X20-0517L7F40MHz	Infotainment
48/5/10/1.6x1.2	X16-0513K10F48MHz	Infotainment
40/10/10/1.6x1.2	X16-1020K10F40MHz	Infotainment

# Automotive Crystals – TPMS & Remote Control

Specifications	Part number	Application
26/10/8/2.0x1.6	X20-1050M8F26MHz	TPMS
48/10/7/2.0x1.6	X20-10100M7F48MHz	TPMS
26/10/8/3.2x2.5	X32-1050M8F26MHz	TPMS
26/10/8/2.0x1.6	X20-1050M8F26MHz	TPMS

Specifications	Part number	Application
27.6/10/10/3.2x2.5	X32-1020K10F27.6MHz	Remote Control
48/15/10/2.0x1.6	X20-1515K10F48MHz	Remote Control
16/10/8/3.2x2.5	X32-1030M8F16MHz	Remote Control
32/5/8/3.2x2.5	X32-0515K8F32MHz	Remote Control
24.305/15/8/3.2x2.5	X32-1040M8F24.305MHz	Remote Control

# Crystal Product Roadmap

	Available	2023	2024	2025	2026	
<b>Crystal</b>	<ul style="list-style-type: none"> <li>● 3225 8MHz</li> <li>● 2520 54MHz+/-3ppm</li> <li>● 2016 16~96MHz(Fund.)</li> </ul> 	<ul style="list-style-type: none"> <li>● 1612 24~96MHz(Fund.)</li> <li>● 1210 78.125MHz, 80MHz, 96MHz, 100MHz, &amp; 120MHz(Fund.)</li> <li>● 1008 32MHz, 40MHz, &amp; 52MHz(Fund.)</li> <li>● 1210 26MHz, 32MHz, 37.4MHz, 40MHz, 48MHz, 76.8MHz (Fund.)</li> </ul> 	<ul style="list-style-type: none"> <li>● 1008 48MHz, 76.8MHz, 80MHz(Fund.)</li> </ul> 	<ul style="list-style-type: none"> <li>● 1008 80MHz,96MHz(Fund.)</li> </ul> 		
<b>TCXO</b>	<ul style="list-style-type: none"> <li>● 2016 TCXO 19.2, 26, 52MHz 1.8~3.3V 0.5 &amp; 2 ppm</li> <li>● 3225 RTC TCXO 32.768K</li> </ul> 	<ul style="list-style-type: none"> <li>● 2520 /2016 TCXO 0.5 ppm -40C to +105C CS AEC-Q200</li> <li>● 2520 /2016 TCXO 2.5ppm -40C to +105C CS/CMOS Enable AEC-Q200</li> <li>● NPC 2520 /2016 TCXO 2.5 ppm -40C to +85C CS</li> <li>● 1612 TCXO</li> <li>● 2113 RTC TCXO 32.768K</li> </ul> 	<ul style="list-style-type: none"> <li>● 2520 /2016 TCXO 0.5 ppm -40C to +125C CS Enable AEC-Q200</li> <li>● 2520 /2016 TCXO 76.8MHz &amp; 96MHz 0.5 ppm -40C to +85C CS</li> </ul> 	<ul style="list-style-type: none"> <li>● 1612 TCXO -40C to +105C CS AEC-Q200</li> </ul> 	<ul style="list-style-type: none"> <li>● 1612 TCXO -40C to +125C CS AEC-Q200</li> </ul> 	<ul style="list-style-type: none"> <li>● 1612 TCXO -40C to +105C CS AEC-Q200</li> </ul> 
<b>XO</b>	<ul style="list-style-type: none"> <li>● 2016 XO 2~125MHz 1.8~3.3V</li> <li>● 2520XO 2~125MHz 1.8~3.3V</li> <li>● 3225 XO 2~125MHz 1.8~3.3V</li> </ul> 	<ul style="list-style-type: none"> <li>● 2016 /2520 Ultralow Low Current 32.76K XO</li> </ul> 	<ul style="list-style-type: none"> <li>● 2520 3225 200fs Jitter 25MHz~320MHz LVPECL/LVDS/HCSL</li> <li>● 2520 3225 50fs Jitter 25MHz~320MHz LVPECL/LVDS/HCSL</li> </ul> 	<ul style="list-style-type: none"> <li>● 2520 3225 200fs Jitter 25MHz~320MHz LVPECL/LVDS/HCSL</li> <li>● 2520 3225 50fs Jitter 25MHz~320MHz LVPECL/LVDS/HCSL</li> </ul> 	<ul style="list-style-type: none"> <li>● 2520 3225 200fs Jitter 25MHz~320MHz LVPECL/LVDS/HCSL</li> <li>● 2520 3225 50fs Jitter 25MHz~320MHz LVPECL/LVDS/HCSL</li> </ul> 	



# Automotive Requirements



Factory : TS16949(IATF 16949) & VDA 6.3

TS : Technical Specification

IATF : International Automotive Task Force

ISO : International Organization of Standard

PPAP: Product Parts Approval Process

Product : AEC-Q200/AEC-Q100

AEC: Automotive Electronics Council

# AEC-Q200 Grade Operation Temperature



GRADE	TEMPERATURE RANGE		PASSIVE COMPONENT TYPE Maximum capability unless otherwise specified and qualified	TYPICAL/EXAMPLE APPLICATION
	MINIMUM	MAXIMUM		
0	-50°C	+150°C	Flat chip ceramic resistors, X8R ceramic capacitors	All automotive
1	-40°C	+125°C	Capacitor Networks, Resistors, Inductors, Transformers, Thermistors, Resonators, Crystals and Varistors, all other ceramic and tantalum capacitors	Most underhood
2	-40°C	+105°C	Aluminum Electrolytic capacitors	Passenger compartment hot spots
3	-40°C	+85°C	Film capacitors, Ferrites, R/R-C Networks and Trimmer capacitors	Most passenger compartment
4	0°C	+70°C		Non-automotive

# AEC-Q200 Stress Test - I



TABLE 11 - TABLE OF METHODS REFERENCED QUARTZ CRYSTALS			
Stress	NO.	Reference	Additional Requirements
Pre- and Post-Stress Electrical Test	1	User spec.	Test is performed except as specified in the applicable stress reference and the additional requirements in Table 11.
High Temperature Exposure (Storage)	3	MIL-STD-202 Method 108	1000 hrs. at rated operating temperature (e.g. 85°C part can be stored for 1000 hrs at 85°C. Same applies for 125°C). Unpowered. Measurement at 24±4 hours after test conclusion.
Temperature Cycling	4	JESD22 Method JA-104	1000 cycles (-40°C to 125°C) Note: If 85°C part the 1000 cycles will be at that temperature rating. Measurement at 24±4 hours after test conclusion. 30min maximum dwell time at each temperature extreme. 1 min. maximum transition time.
Biased Humidity	7	MIL-STD-202 Method 103	1000 hours 85°C/85%RH. Rated V <sub>DD</sub> applied with 1 MΩ and inverter in parallel, 2X crystal C <sub>L</sub> capacitors between each crystal leg and GND. Measurement at 24±4 hours after test conclusion.
Operational Life	8	MIL-STD-202 Method 108	Note: 1000 hrs @ 125°C. If 85C part will be tested at that temperature. Rated V <sub>DD</sub> applied with 1 MΩ and inverter in parallel, 2X crystal C <sub>L</sub> capacitors between each crystal leg and GND. Measurement at 24±4 hours after test conclusion.
External Visual	9	MIL-STD-883 Method 2009	Inspect device construction, marking and workmanship. Electrical Test not required.
Physical Dimension	10	JESD22 Method JB-100	Verify physical dimensions to the applicable device detail specification. Note: User(s) and Suppliers spec. Electrical Test not required.
Terminal Strength (Leaded)	11	MIL-STD-202 Method 211	Test leaded device lead integrity only. Conditions: A (227 g), C (227 g).
Resistance to Solvents	12	MIL-STD-202 Method 215	Note: Also aqueous wash chemical - OKEM clean or equivalent. Do not use banned solvents.
Mechanical Shock	13	MIL-STD-202 Method 213	Figure 1 of Method 213. Condition C

AEC vs Standard  
 600 pcs vs 165 pcs  
 1000 Hours vs 168 Hours  
 1000 Hours vs 10 Cycles  
 1000 Hours vs 96 Hours  
 1000 Hours vs 168 Hours

# AEC-Q200 Stress Test - II



TABLE 11 - TABLE OF METHODS REFERENCED QUARTZ CRYSTALS			
Stress	NO.	Reference	Additional Requirements
Vibration	14	MIL-STD-202 Method 204	5g's for 20 minutes 12 cycles each of 3 orientations. Note: Use 8"X5" PCB .031" thick with 7 secure points on one 8" side and 2 secure points on corners of opposite sides. Parts mounted within 2" from any secure point. Test from 10-2000 Hz.
Resistance to Soldering Heat	15	MIL-STD-202 Method 210	Condition B No pre-heat of samples. Note: Single Wave solder - Procedure 1 with solder within 1.5 mm of device body for Leaded. Procedure 1 except 230°C and immerse only to level to cover terminals for SMD.
Solderability	18	J-STD-002	For both Leaded & SMD. Electrical Test not required. Magnification 50 X. Conditions: Leaded: Method A @ 235°C, category 3. SMD: a) Method B, 4 hrs @ 155°C dry heat @ 235°C b) Method B @ 215°C category 3. c) Method D category 3 @ 260°C.
Electrical Characterization	19	User Spec.	Parametrically test per lot and sample size requirements, summary to show Min, Max, Mean and Standard deviation at room as well as Min and Max operating temperatures.
Flammability	20	UL-94	V-0 or V-1 Acceptable
Board Flex	21	AEC Q200-005	60 sec minimum holding time.
Terminal Strength (SMD)	22	AEC Q200-006	

# Automotive Requirement



	<b>Commercial/Industrial</b>	<b>Automotive Grade</b>
Specs (Reliability)	Heat & Cold 168 Hours	Heat & Cold up to 1000 Hours
	Therma Shock 10 Cycles	Thermal Shock up to 1000 Cycles
Raw Material Selection	Standard	Grade A Supplier
Production Process	Standard	Dedicated Line & Machine
Testing Coverages	100%	200% if needed.
Quality assurance and control standards	Standard	100% Inspection
		High Sampling Rate
		Proactive Analysis or Monitor for Prevention
DPPM	<b>&lt;1000</b>	<b>&lt;10</b>