



Automotive Crystals & Oscillators



ISO/TS 16949 certified since 2006



Automotive Crystal and Oscillator

Key Differences	Automotive	Consumer/Industrial
Identification	"A" product series Documents marked "ACAP"	Other than "A" product series
Engineer/Operators	Automotive training program with qualification level, dedicated full time	TXC standard training program
Production Line	Dedicated	Mix
Reliability	Automotive grade AEC-Q100 & AEC-Q200 + customer requirement	Consumer grade + customer requirement
New product design to manufacturing	Advance Product Quality Planning (APQP)	
Specification	-40 to 105C, 125C and 150C	-40 to 85C, 105C or by customer specification
Final test	100%	Based on customer requirement
Qualification process	PPAP, PSW (TXC PQSO)	TXC PQSO
Record retention	15 years	5 years
Quality Assurance system	ISO/TS16949, VDA6.3	QS9001, ISO/TS16949

Automotive High Reliability Solutions

High Mechanical Shock Resistance

5,000G, 0.3mSec., 3 times for all 6 directions
(Beyond AEC-Q standard)

High Thermal Shock Resistance

-55°C~150°C, dwell time 15min, transfer time 20Sec, all 1,000 cycles
(Beyond AEC-Q standard)

High Vibration Resistance

20G, 10~2000Hz~10Hz, 1.52mm, 3 direction; sweep 20min. for each cycle, 12 cycles for each direction
(Beyond AEC-Q standard)

High Moisture Resistance

Storage temperature 25°C to 65°C, relative humidity 80%RH to 100%RH, 24hrs per cycle, 20 cycles
(Beyond AEC-Q standard)

Wide Operating Temperature

Crystals: G0: -40~150°C, G1: -40~125°C
Crystals/Oscillators: G2: -40~105°C, G3: -40~85°C

Infotainment & Telematics



Bluetooth
AM/FM/DAB



Navigation



WiFi, Multimedia



Emergency
Call (eCall)

Common Frequency	Size	Grade
32.768kHz	AH (3215 TF)	G1
4MHz 8MHz	AS (HC49 S) AT (HC49 SMD)	G2
10MHz 12MHz 16MHz 20MHz 22MHz 26MHz	AV (3225 Glass) AY (2016 Seam)	G1 G1
27MHz 48MHz	AW (2520 XO)	G2
26MHz	AQ (3225 TCXO)	G2

Remote Keyless, Instrument Cluster



Start/Stop Engine



Cluster



Smart Key

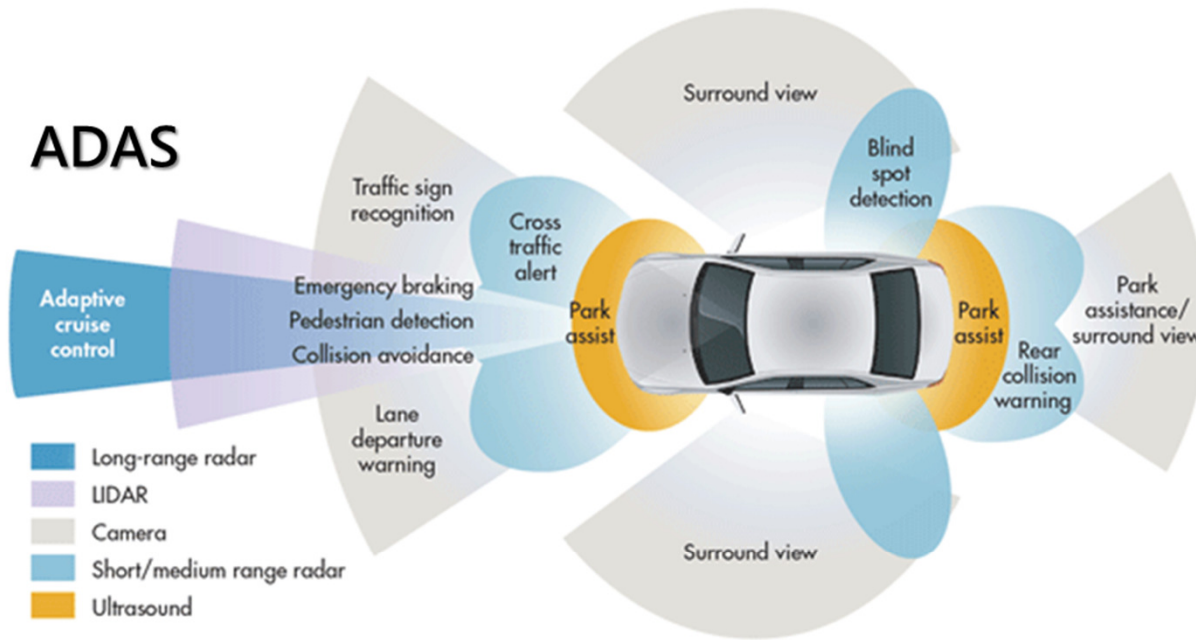
Common Frequency	Size	Grade
32.768kHz	AH (3215 TF)	G1
8MHz		
9.8MHz		
13.5MHz	AV (3225 Glass)	G1
16MHz	AM (3225 Seam)	G1
26MHz		
30MHz		

Tire Pressure Monitoring System (TPMS)



Common Frequency	Size	Grade
9.8437MHz		
9.8643MHz		
12MHz		
13.56MHz	AM (3225 Seam)	G1
18.08MHz	AY (2016 Seam)	G1
19.687MHz		
21.948MHz		
26MHz		
32MHz		

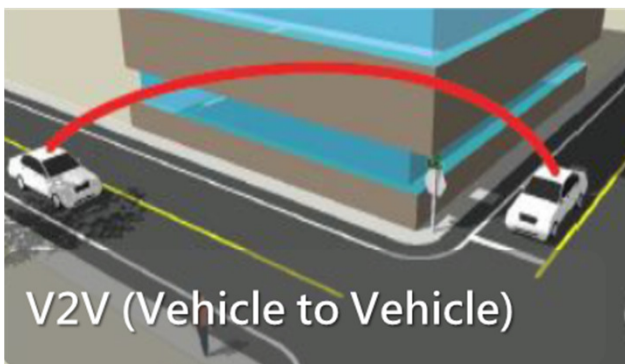
Advanced Driver Assisted System (ADAS)



Common Frequency	Size	Grade
32.768kHz	AH (3215 TF) ACZ (5032 XO)	G1 G2
4MHz 8MHz	AS (HC49 S) AT (HC49 SMD)	G2
4MHz 16MHz 20MHz 22MHz 26MHz	AV (3225 Glass) AY (2016 Seam)	G1 G1 G2
27MHz 30MHz	AW (2520 XO)	G2

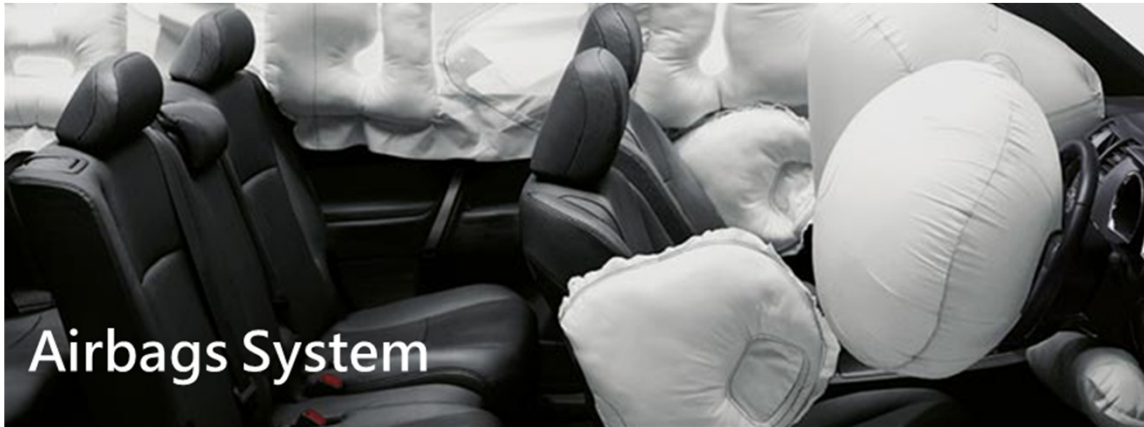
Connected Car, V2X

LTE, 802.11p



Common Frequency	Size	Grade
32.768kHz	AH (3215 TF)	G1
4MHz 8MHz	AS (HC49 S) AT (HC49 SMD)	G2
19.2MHz 26MHz	AY (2016 Seam)	G2
20MHz 40MHz	AQ (3225 TCXO)	G2

Airbags, ESC, ABS, EPS



Airbags System



Electronic Park System



Electronic Stability Control
Anti-Lock Braking







Common Frequency	Size	Grade
32.768kHz	AH (3215 TF) ACZ (5032 XO)	G1 G2
4MHz 8MHz	AX (8045 Glass)	G0
8MHz 10MHz 12MHz 20MHz 28MHz	AV (3225 Glass) AM (3225 Seam)	G1 G1

Automotive Crystal Overview

Crystal Product Series											
PN Series	AB	AM	AZ	AY	AX	AA	AV	AS	AT	AH	AE
Type	Seam				Glass		Glass	Metal CAN	Metal CAN	Seam TF	Seam TSX
	4 Pads				2 Pads		4 & 2 Pads	49S DIP	49S SMD	2 Pads	4 Pads
Size (mm)	5.0 X 3.2	3.2 X 2.5	2.5 X 2.0	2.0 X 1.6	8.0 X 4.5	5.0 X 3.2	3.2 X 2.5	11.4 X 4.8	11.4 X 4.8	3.2 X 1.5	2.5 X 2.0
Frequency Range (MHz)	8 50	9.8 50	12 74.1	16 50	4 40	7.2 48	8 62.4	4 62	4 62	32.768 KHZ	19.2
Operating Temp. Range	G1	G1	G1	G1	G1	G1	G1	G2	G2	G1	G2

Notes: G3: -40~85°C / G2: -40~105°C / G1: -40~125°C / G0: -40~150°C

Automotive Oscillator Overview

Oscillator Product Series						
PN Series	AC 	AU 	AW 	AN 	AQ 	AL 
Output Type	CMOS				Clipped Sinewave	
Size (mm)	5.0 X 3.2	3.2 X 2.5	2.5 X 2.0	2.0 X 1.6	3.2 X 2.5	2.5 X 2.0
Frequency Range (MHz)	1 70	1 70	4 54	4 54	16.369/ 26	
Operating Temp. Range	G2	G2	G2	G2	G2	G2

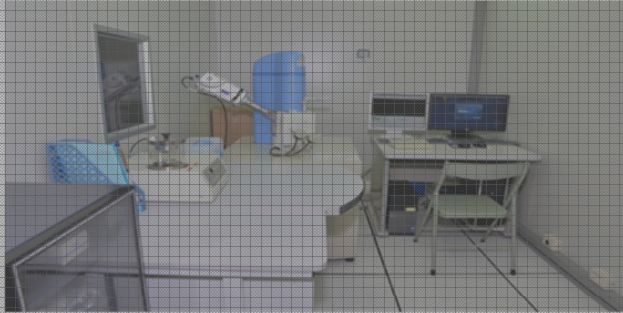
Notes: G3: -40~85°C / G2: -40~105°C / G1: -40~125°C / G0: -40~150°C



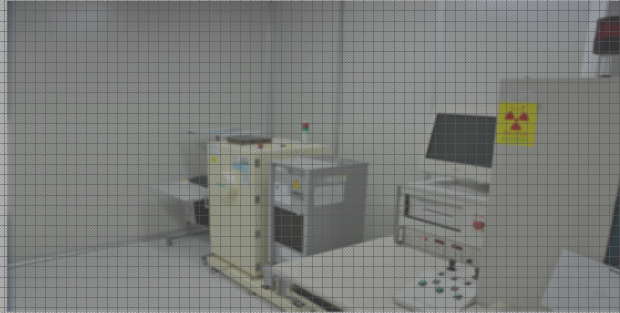
Automotive Product Series, Customized Specs is Available

Type	Product Series	Frequency Range	Temperature Range	Manufacturing
Crystal	AS (HC-49S)	4~62.4MHz	-40~+105°C	China
	AT (HC-49S/SMD)	4~62.4MHz	-40~+105°C	
	AX (8045 Glass)	6~40MHz	-40~+150°C	
	AA (5032 Glass)	8~48MHz	-40~+150°C	
	AV (3225 Glass)	9.84~62.4Mhz	-40~+125°C	
	AH (3215 Seam)	32.768kHz	-40~+125°C	
	Taiwan	AB (5032 Seam)	8~50MHz	-40~+125°C
		AM (3225 Seam)	10~50MHz	-40~+125°C
		AZ (2520 Seam)	16~80MHz	-40~+125°C
		AY (2016 Seam)	16~50MHz	-40~+125°C
XO (CMOS)	AC (5032 Seam)	1~70MHz	-40~+105°C	Taiwan
	AU (3225 Seam)	1~70MHz	-40~+125°C	
	AW (2520 Seam)	4~54MHz	-40~+125°C	
TCXO	AQ (3225Seam)	13~52MHz	-40~+105°C	
	AL(2520 Seam)	13~52MHz	-40~+105°C	
TSX	AE(2520 Seam)	19.2MHz	-40~+105°C	

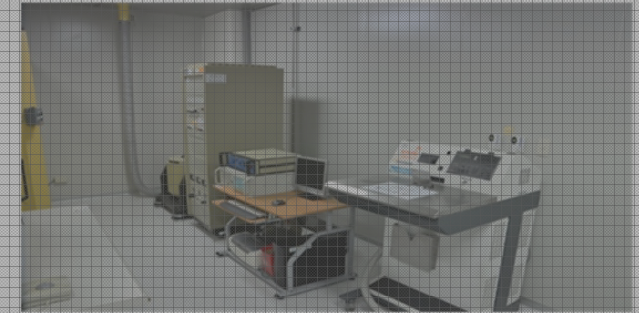
In-House Automotive RA and Circuit Matching Lab Service



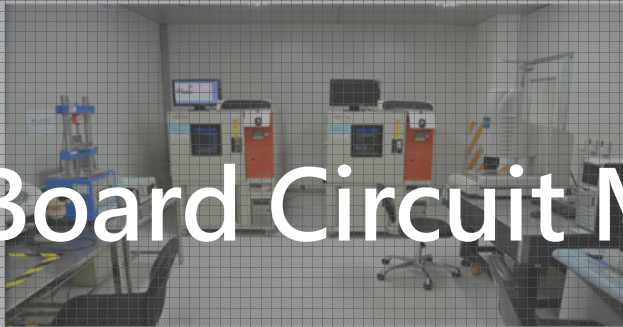
SEM / EDS



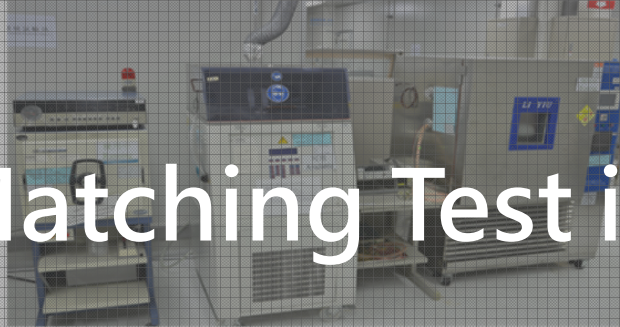
Centrifugal for TPMS



Vibration / leakage



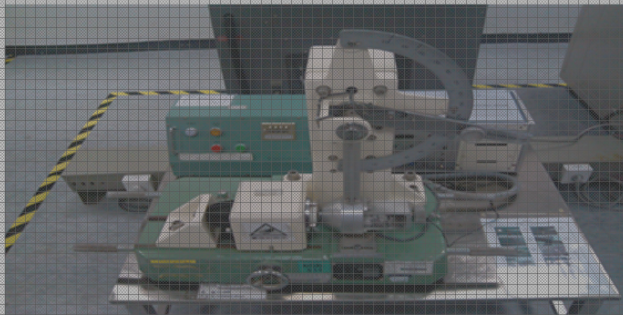
Bending / Dynamic aging



Humidity / L-L Thermal Shock



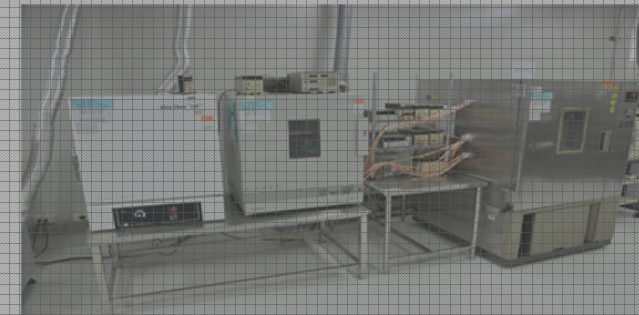
A-A Thermal / Drop / Mechanical



Mechanical Shock



Aging Ovens



High Temp / Low Temp Ovens

Board Circuit Matching Test is recommended

Appendix

Contents:

AECQ – What is AECQ?

PPAP – What is PPAP?

OTR – Why the need of wider Operating Temperature Range?

Automotive Record Retention – Why is longer time-frame?

RA – Why Reliability test more stringent?

Production – Why automotive has dedicated production line?

AECQ – What is AECQ?

AEC is an abbreviation of "Automotive Electronics Council." AEC is an industry organization that promotes the standardization of reliability or qualification standards for automotive electronic components, consisting of major auto manufacturers and major electronic component manufacturers in the USA. The AEC-Qxxx standards are widely adopted as standards for automotive electronic components, practically serving as the industry standards. These standards are classified into the following groups, according to the component category:

AEC-Q100: Integrated circuits (ICs)

AEC-Q200: Passive components (capacitors, inductors, etc.)

PPAP – What is PPAP?

Production Part Approval Process (PPAP) is a standardized process in the automotive and aerospace industries that helps manufacturers and suppliers communicate and approve production designs and processes before, during, and after manufacture.

OTR – Why the need of wider Operating Temperature Range?

An **operating temperature** is the temperature at which an electrical or mechanical device operates. The device will operate effectively within a specified temperature range which varies based on the device function and application context, and ranges from the **minimum operating temperature** to the **maximum operating temperature** (or peak operating temperature). Outside this range of safe operating temperatures the device may fail. Automotive generally operate over a broader temperature range than industrial devices; commercial-grade devices generally have the narrowest operating temperature range.

Please refer to the Automotive grading chart.

Automotive Record Retention – Why is longer time-frame?

Automotive Electronics suppliers are required to be certified under TS-16949 & ISO9001, under TS & ISO system there's a standard requirement for record retention set by OEM car manufacturers. Please refer to below record retention guidelines:

TABLE 1) OEM and Tier Records Availability Requirements

	RETENTION YEARS AFTER THE PRODUCTION PERIOD HAS ENDED	RETENTION YEARS AFTER A GIVEN DOCUMENT WAS CREATED	RETENTION YEARS AFTER A GIVEN DOCUMENT HAS EXPIRED
	Tooling records, PPAP's, P.O.'s and P.O. Amendments	Production records and test records	Internal audit records and records of management reviews
Core OEM (Example: GM, Ford, DCX, Delphi)	1	1	3
Tier Group 1 (Example: Visteon)	10	As long as 10	Same as OEM, although management review frequencies are not included.
Tier Group 2	15	As long as 10	Same as OEM, although management review frequencies are not included.
Tier Group 3 (Example: Bosch)	15+	Combination of highly specific document types with a blend of frequencies that "borrow" from those indicated in Groups 1 and 2 above.	
Tier Group 4 (Example: Dana)	Beyond those requirements shown in TS for records, neither years nor document types are specified.		

RA – Why Reliability test more stringent?

Standards are set in accordance to AEC (i.e. Q200) to confirm the high reliability of products, including high-temperature/high-humidity resistance, thermal shock resistance, and durability:

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

Production – Why automotive has dedicated production line?

Automotive Timing device is put into dedicated production line due to the fact that the quality standard differs from consumer applications. Automotive tier one customers uses “Zero Defect” concept (0ppm) to audit its suppliers, as well as mandating its suppliers to implement the same concept into its sub-tiers. Production control processes are more stringent than the ones producing consumer products.

Zero Defects (or **ZD**) was a management-led program to eliminate defects in industrial production that enjoyed brief popularity in American industry from 1964^[1] to the early 1970s. Quality expert [Philip Crosby](#) later incorporated it into his "Absolutes of Quality Management" and it enjoyed a renaissance in the American automobile industry.

Thank you