October, 2024

High Frequency Low Noise Differential Output Oscillator

REM-B / AEM-B / TEM-B / KEM-B

九州電通株式会社

KYUSHU DENTSU COMPANY LIMITED (KDK)

http://www.kdk-group.co.jp

Introduction

■ Communication Systems 5G toward 6G generation

- As communication volume increased, higher speed and capacities required

■ Market needs :

- Reference clock sources requiring higher frequency, lower noise and smaller size.

■ Develop new products to meet market needs

- Development of High-Frequency, **Ultra-Low-Noise, Low-Jitter, Differential Output**
- Output without multiplication up to **500MHz** available
- Realized by thinning process using proprietary plasma technology : **Inverted MESA blanks**
- AT-cut in small package 2520 up to 7050

Features

RoHS

- Differential output
- Size : 2520 / 3225 / 5032 / 7050
- Freq. range : 25MHz～500MHz
- Output : LVPECL / LVDS / HCSL
- Supply volt. : +2.5V / +3.3V
- Temp. range : -40～+125℃
- Phase jitter : 67fs typ. (@156.250MHz)

REM-B
(2.5x2.0x1.1mm)

AEM-B
(3.2x2.5x1.1mm)

TEM-B
(5.0x3.2x1.4mm)

KEM-B
(7.0x5.0x1.4mm)

Products

Target market / Application

- Data Center
- Optical Transmission Modules
- Network Equipments (Routers, Servers)
- Communication Base Stations
- Factory Automation Equipments
- Measuring Instruments

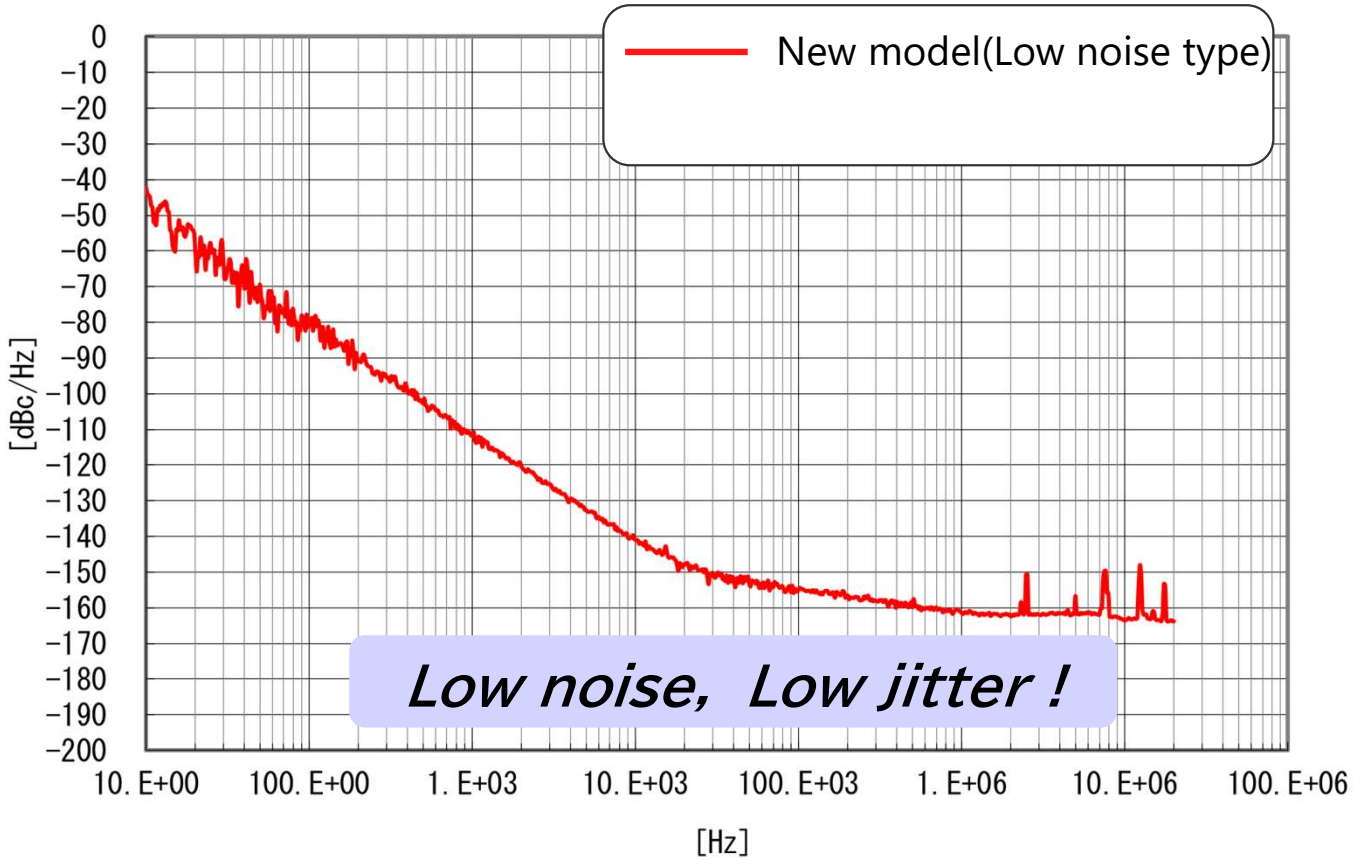
Electrical Characteristics

All sizes

特性項目	Parameters	Conditions 条件	LVPECL	LVDS	HCSL
供給電圧	Supply Voltage		+2.5V±5% +3.3V±5%		
動作温度範囲	Operating Temperature Range		-40～+85℃ -40～+105℃ -40～+125℃		
周波数範囲	Frequency Range		100～500MHz		
消費電流(max.)	Input Current	Frequency Range	70mA(25～320MHz) TBD(320+～500MHz)	35mA(25～320MHz) TBD(320+～500MHz)	45mA(100～320MHz) TBD(320+～500MHz)
周波数安定性(max.)	Frequency Stability	≦170MHz(-40～+85℃)	+ 25ppm		
		≦170MHz(-40～+125℃) >170MHz(-40～+85℃)	+ 50ppm		
		All Frequency(-40～+125℃)	+ 100ppm		
シンメトリー(max.)	Symmetry	At 0.5Vdd	45/55%		
出力電圧	Output Voltage	"0" Level(max.) "1" Level(min.)	Vcc-1.81～Vcc-1.62V Vcc-1.025～Vcc-0.880V	0.9V 1.6V	-0.15～0.15V 0.66～0.85V
差動出力電圧(min.)	Differential Output Voltage	Offset Voltage	-	0.4Vp-p (at 1.125～1.375V)	-
立上り/立下り時間(max.)	Rise/ Fall Time	At 20%～80%Vp-p	0.4ns	0.3ns	0.5ns
負荷	Load		Vtt=Vcc-2.0V Rt=50Ω	100Ω (OUT1-OUT2)	50Ω
E/D機能	E/D Function	#1 Open #1 ≧ 0.7Vdd #1 ≦ 0.3Vdd	#4,#5 Active #4,#5 Active #4,#5 High-Z		
スタンバイ電流(max.)	Stand-by Current	At "0"Level at #1	30μA max.		
位相ジッタ(typ.)	Phase jitter	Offset Frequency	67fs (12kHz～20MHz) @156.250MHz		

Phase Noise Data (typical)

Ex) @312.500MHz, LVDS

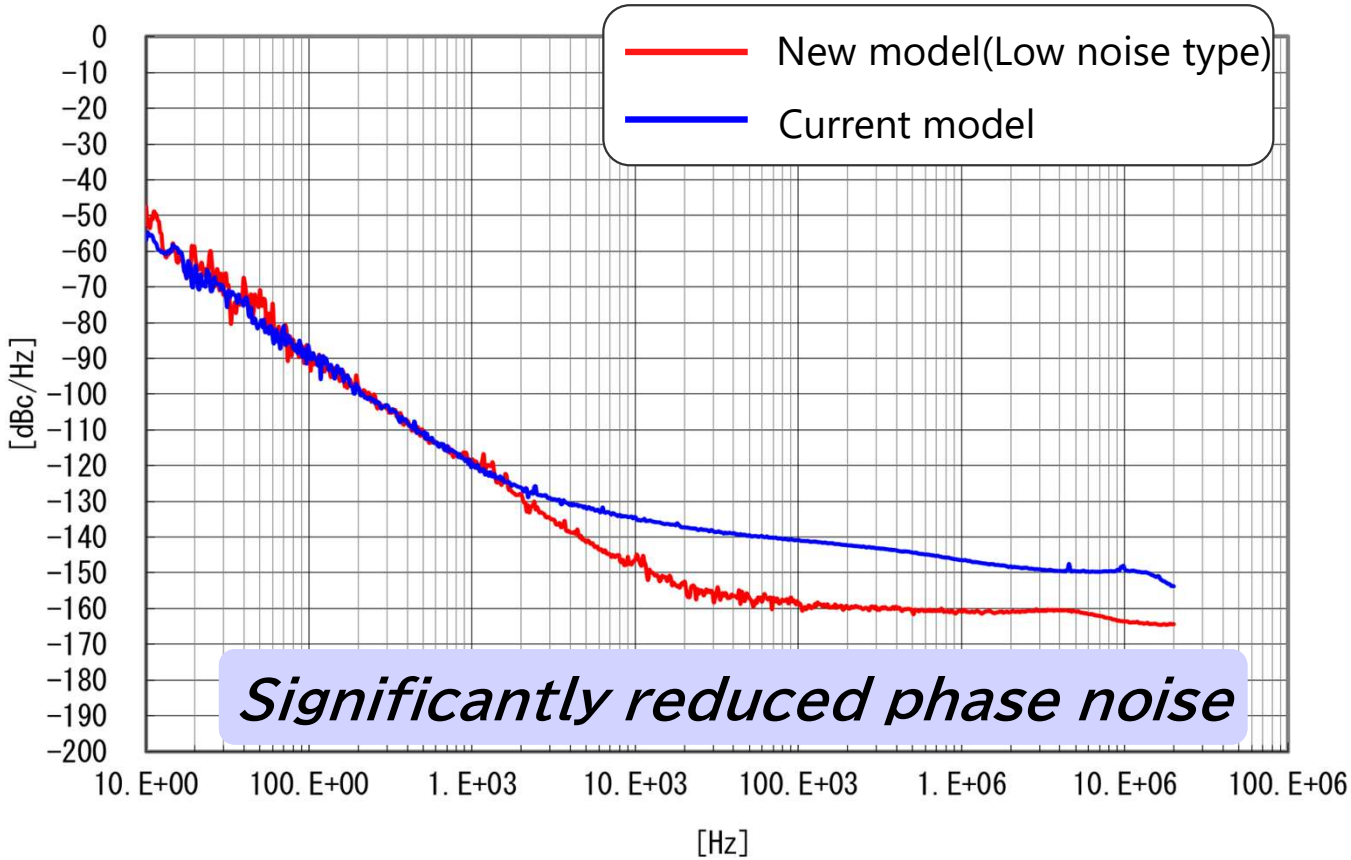


	10Hz	100Hz	1kHz	10kHz	100kHz	1MHz	10MHz	PHASE JITTER(ps)
New model	-42	-79	-112	-141	-155	-161	-164	0.026

Measured By "Agilent E5052B Signal Source Analyzer"

Phase Noise Data (typical)

Ex) @200.000MHz, LVDS

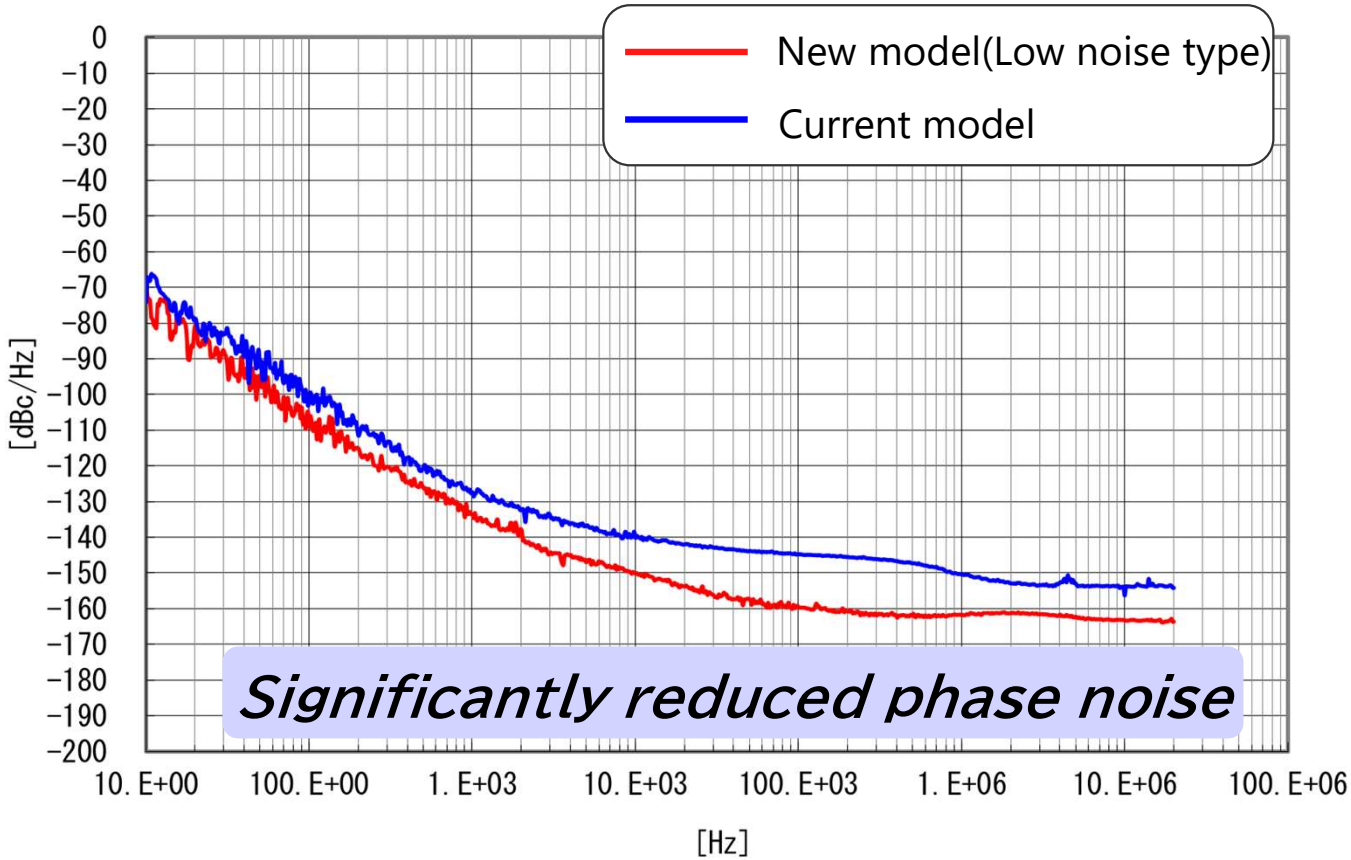


	10Hz	100Hz	1kHz	10kHz	100kHz	1MHz	10MHz	PHASE JITTER(ps)
New model	-47	-88	-118	-146	-159	-161	-164	0.037
Current model	-57	-88	-119	-134	-141	-146	-149	0.173

Measured By "Agilent E5052B Signal Source Analyzer"

Phase Noise Data (typical)

Ex) @100.000MHz, LVDS

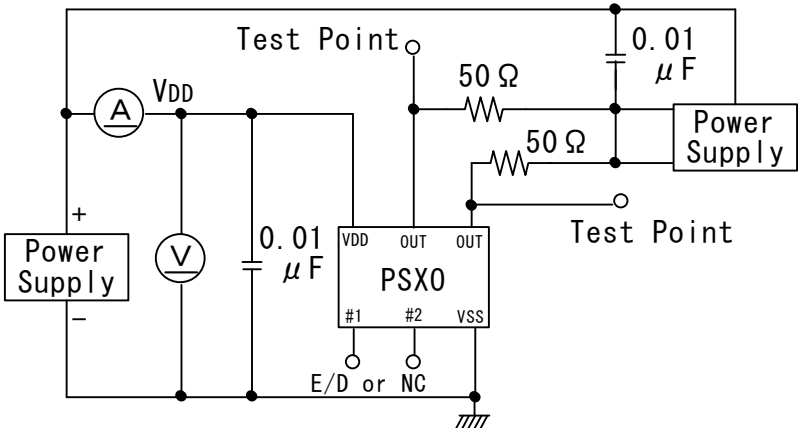


	10Hz	100Hz	1kHz	10kHz	100kHz	1MHz	10MHz	PHASE JITTER(ps)
New model	-69	-109	-134	-150	-160	-162	-163	0.072
Current model	-74	-101	-127	-140	-145	-150	-156	0.232

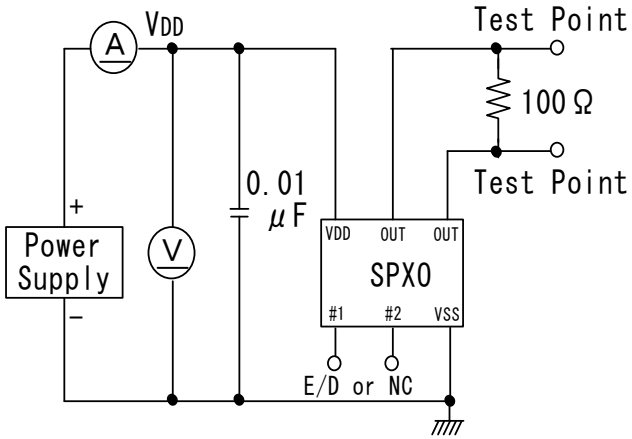
Measured By "Agilent E5052B Signal Source Analyzer"

Test Circuit & Output Wave

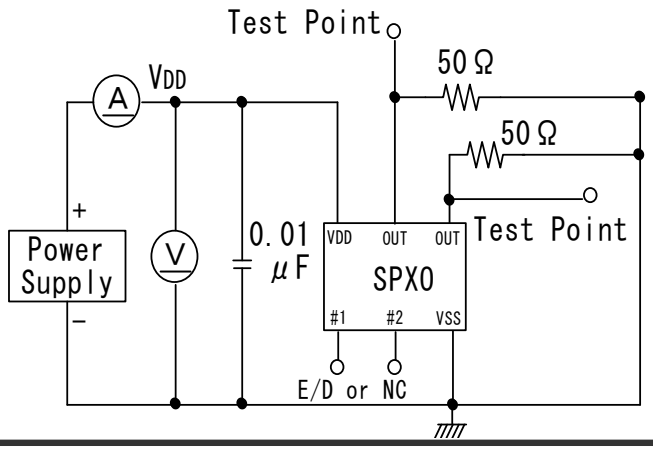
Test Circuit (LVPECL)



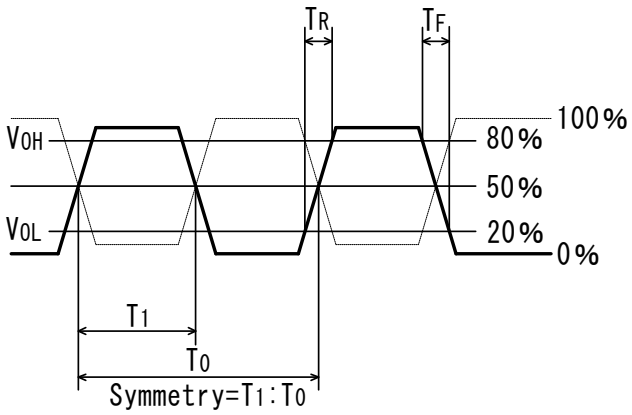
Test Circuit (LVDS)



Test Circuit (HCSL)



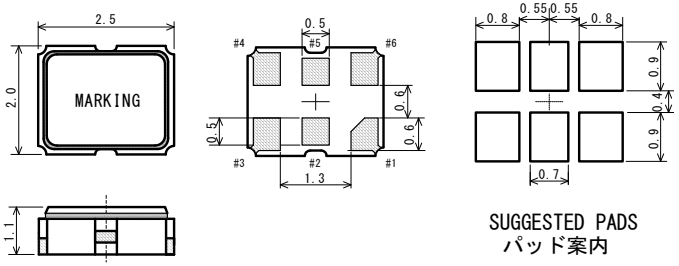
Output Wave (LVPECL / LVDS / HCSL)



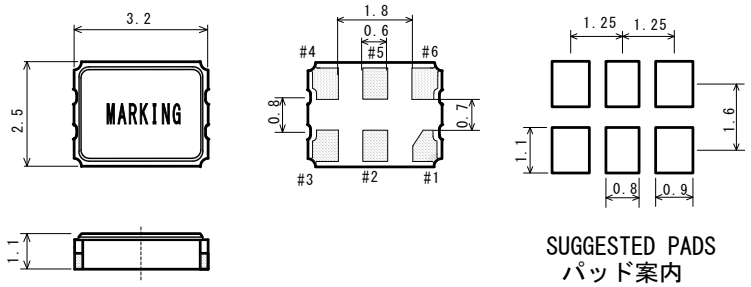
＊ When using, a bypass capacitor of about 0.01 μF or 0.1 μF should be placed between power supply (Vdd) and ground (Vss).

Dimensions / Pin connection

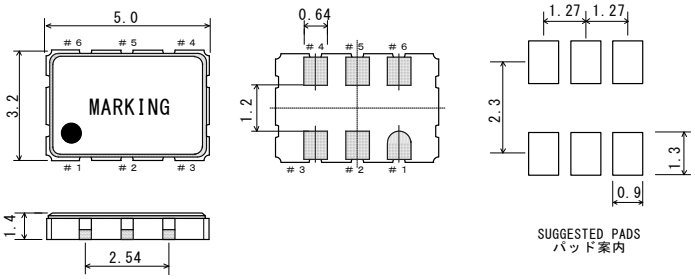
REM-B
2.5x2.0mm



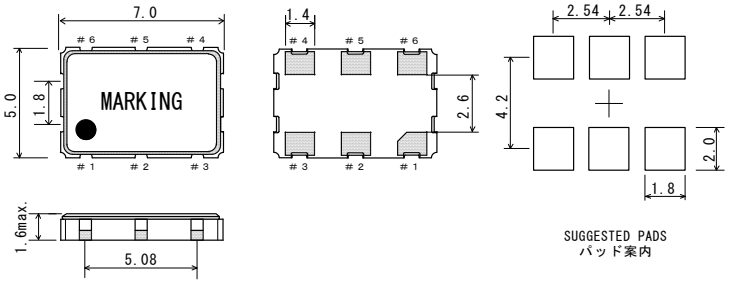
AEM-B
3.2x2.5mm



TEM-B
5.0x3.2mm



KEM-B
7.0x5.0mm



All sizes

PAD	Connections
#1	E/D
#2	NC
#3	GND
#4	OUT1
#5	OUT2
#6	Vcc

Nomenclature

Ex）	Size	:2.5㎜×2.0㎜
	Supply Voltage	:+2.5V
	Frequency Stability	:±50ppm max.
	Temperature Range	:-40℃～+105℃
	Output	:LVDS

REM 2 5 U T 5 −L B 312. 500MHz

Code→ ① ② ③ ④ ② ⑤ Frequency

B = Ultra Low Noise TYPE

Table1. MODEL

Code①	
REM	2.5x2.0mm
AEM	3.2x2.5mm
TEM	5.0x3.2mm
KEM	7.0x5.0mm

Table2. Supply Voltage

Code②⑤		Supply Voltage
2	5	+2.5 V
3	Blank	+3.3 V

Table3. Frequency Stability

Code③	Freq. Stability
2	±25 ppm max.
5	±50 ppm max.
0	±100 ppm max.

Table4. Temperature Range

Code④	Temp. Range
Z	-40℃～ +125℃
U	-40℃～ +105℃
F	- 40℃～ + 85℃
A	- 10℃～ + 70℃

Table5. Output

Code⑤	Output
Blank	LVPECL
−L	LVDS
−H	HCSL

Unique plasma processing technology 1

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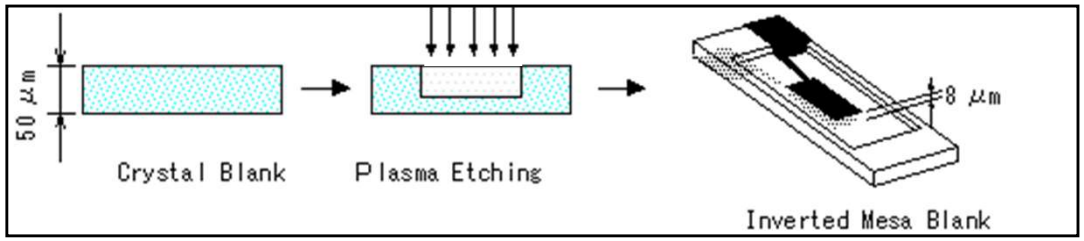
●Dry etching technology applied to crystal processing

Faster Signals → Higher frequency of crystal → Machining Limitations

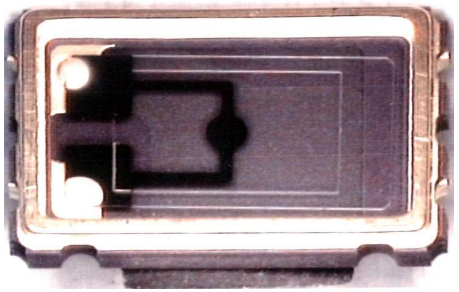
Thin quartz crystal sheets is achieved using proprietary plasma etching equipment

＊Patent No. 3492933

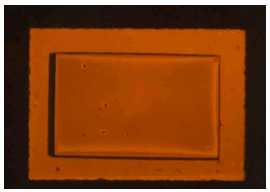


F0 = 1.67 x N ／T (AT-Cut)
F0 = Frequency (MHz)
N = 1,3,5,7 (Osc. mode)
T = thickness (mm)

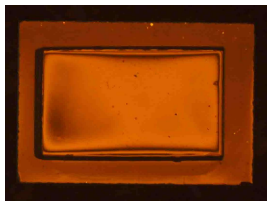
※Thinner Crystal = Higher Frequency



High frequency is realized by thinning only center of crystal plate.
Thickness remains on the periphery, thus preserving strength of the crystal plate.



70MHzRange
(t=22.3μm)



200MHzRange
(t=8.3μm)

Only center can be processed to a few μm level.

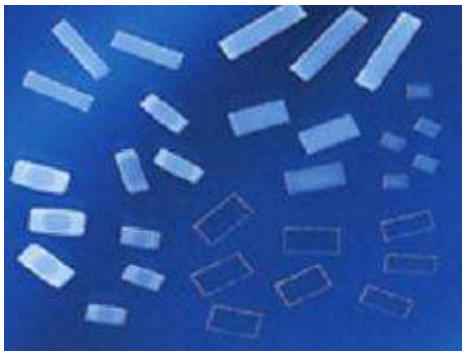
KDK's unique thin plate processing technology overcomes the limitations of conventional mechanical polishing.

Unique plasma processing technology 2

KDK KYUSHU DENTSU CO., LTD.

● High-frequency fundamental process using plasma equipment

blank

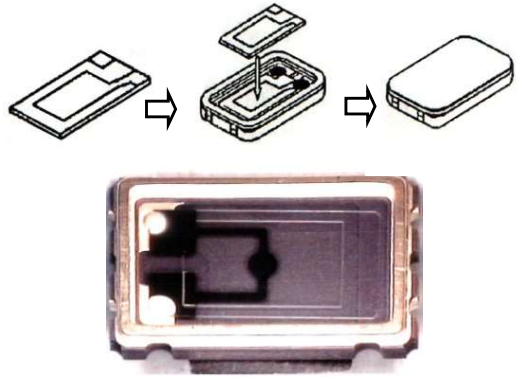


Crystal blank

MESA blank process

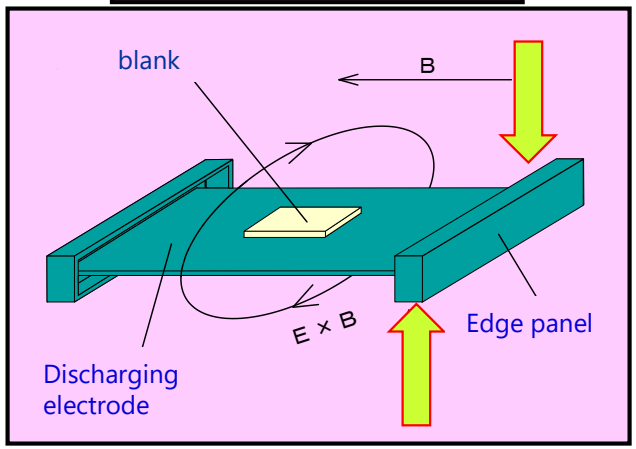
Plasma etching equipment

assembling



Oscillator, VCXO, Crystal

Vacuumed chamber



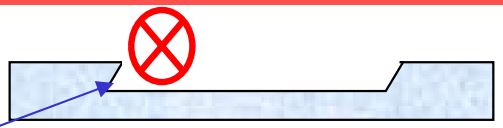
Introduce etching gas (CF4) and additive gases (Ar, O2) into the chamber to generate high-density uniform plasma to plane away quartz substrate (SiO2) thinly.

◂ Left : Image of dry etching with magnetron plasma

Unique plasma processing technology 3

● Advantages of Dry Etching Process with Plasma

Wet Processes by other company

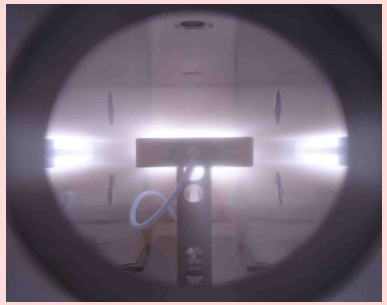


Chemical Mesa Blank

Risk of breakage of electrode at the side ＝ risk of oscillation stoppage

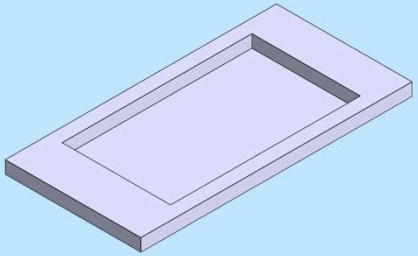
KDK Dry Process

KDK Mesa Blank
real straight



Fundamental up to 500MHz available

High frequencies that were not possible with conventional wet etching can be produced using KDK plasma dry etching.



Superior Microfabrication

Wet etching is processed in the crystal direction, so the edge is not vertical.
Plasma dry etching allows vertical processing, resulting in a good aspect ratio.

Environmentally friendly

Wet etching uses chemicals and requires waste liquid treatment.
Dry etching is an environ-mentally friendly process that does not produce waste liquid.