



Oscillation Circuit Matching Test Report

Customer	Foxconn
Model No.	T99X171T00
Circuit Board No.	T99X171 REV.0 GP803263
Report No.	H190514-G01

Crystal No.	HOSONIC P/N	Customer P/N	Conclusion
Y401	E3SB24E00005JE		No modify
Y801	E3SB25.0000F12NGY		No modify
Y1001	E2SB20E00000XE		No modify

Approved	Prepared	Tested	Date
Bryant Wang	C.L.LEE	C.L.LEE	2019/5/14

Circuit Board



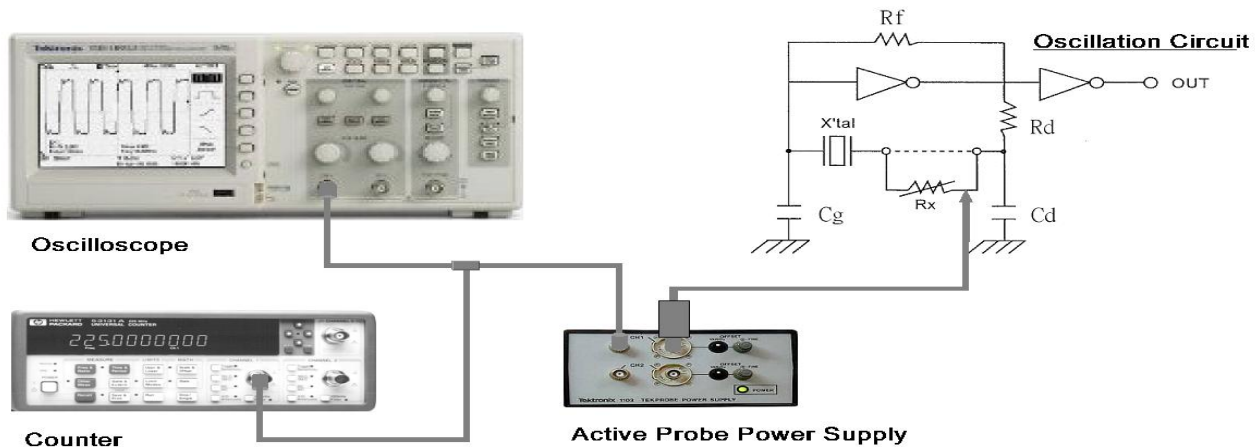
I.) Test Equipment :

Measurment Instrument	Maker	Model Number
Network Analyzer	S&A	250B
Oscilloscope with active probe (1.5GHz)	Tektronix	TDS 7104
		P6245
Oscilloscope	Tektronix	TDS 3052
AC Current probe		CT-1
Universal Counter	HP	53131A
Multimeter	HP	34401A
Capacitance Meter	HP	4278A

II.) Crystal and Oscillation Circuit Matching test :

- Crystal characteristic test (at room temp.)
- Crystal on board test : check Waveform and Frequency accuracy
- Negative Resistance : check the Negative Resistance(-R) value of Chip set
- Drive Level : check the Drive Level of Crystal on PCBA
- Oscillation circuit modification : modify the Cg , Cd , Rf , Rd etc.
- Hosonic recommendations for the crystal spec. and the load capacitance of oscillation circuit base on the tests above.

Measurement method of Negative Resistance(-R)



- 1.) Connect the Variable Resistor (Rx) to the circuit in series with the crystal unit.
- 2.) Place the Rx at 0ohm and increase the value of Rx till the crystal stops oscillating, measure current Rx value (Pack up -R value)
- 3.) Place the Rx at max value (i.e.1Kohm) and decrease the value of Rx till the crystal starts oscillating, measure current Rx value (Start up -R value)
- 4.) Pick the smaller Rx value in 2.) and 3.) as the Negative Resistance

$$\text{Negative Resistance } | -R | = R_x + R_L$$

$$R_L = R_r * (1 + C_o / C_L)^2$$

R_L = load resistance

C_o = shunt capacitance

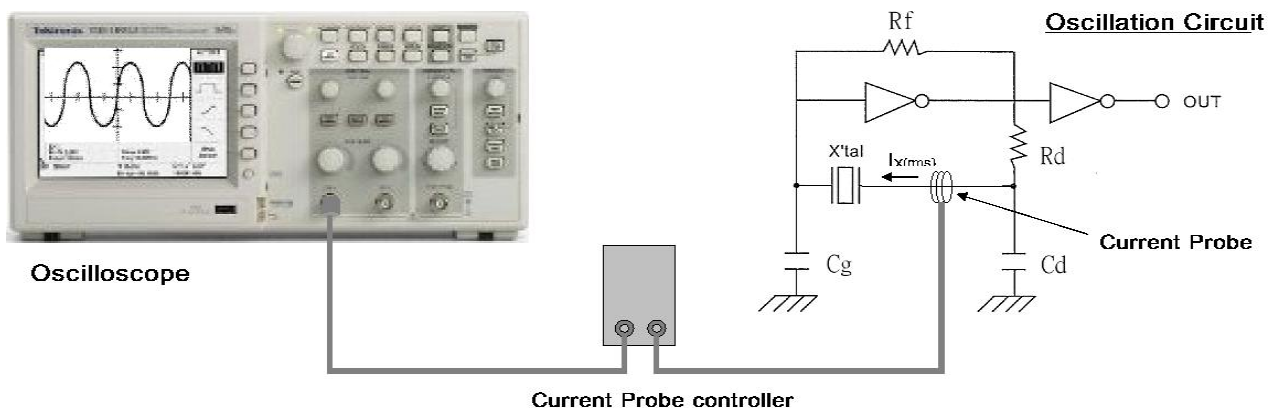
R_r = Equivalent Series Resistance(ESR)

C_L = load capacitance

※ Oscillation circuit should follow the rule of Negative Resistance $\geq 3 \sim 5 * \text{Max. ESR}(R_r)$
(Oscillation margin : ratio $\geq 3 \sim 5$ times)

At least 3 * Max.ESR the crystal unit can work stably.

Measurement method of Drive Level



- 1.) Drive level denotes electronic power required to oscillate a crystal unit , which can be calculated using the following formula.

$$\text{Drive level}(P) = I_x(\text{rms})^2 * R$$

I_x = electronic current value through the ci

- 2.) If the Drive level exceeds the specified level , the oscillation frequency could shift.

This occurs because an excessive level of power causes stress on the crystal and result in temperature rising. If excessive drive level of power continuously applies to the crystal unit, this may deteriorate or damage the characteristics.

Oscillation Circuit test result

Location : Y401

1. Specifications :

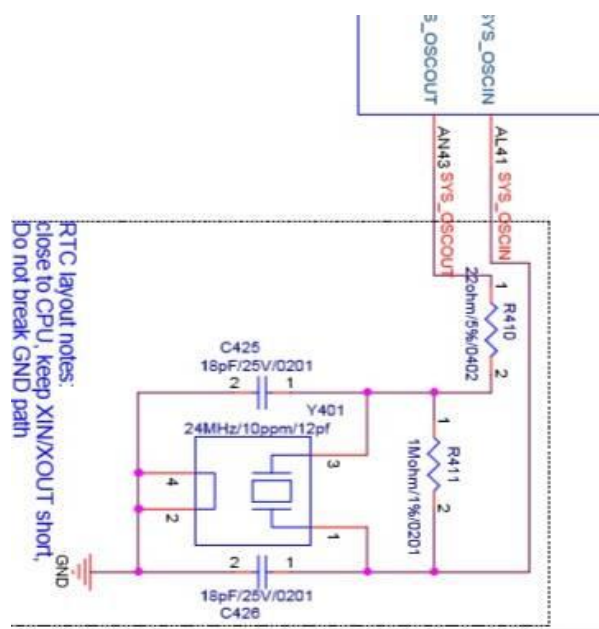
1-1. Crystal unit spec. :

Hosonic P/N	E3SB24E00005JE	
Customer P/N		
Nominal Frequency	24.000000	MHz
Load Capacitance (CL)	12	pF
Freq. Tolerance (at 25°C±3°C)	± 10	ppm
Freq. Stability (Ref. to 25°C)	± 20	ppm
Max. ESR	30	Ω
Drive Level	100	μw Typ.
Mode of Vibrator	Fundamental	

1-2. Crystal unit characteristic data :

Vendor	FL (ppm)	Rr(Ohms)	C0(pF)	C1(fF)	TS(ppm/pF)
HOSONIC	1.67	7.54	0.99	3.11	9.21
OTHER	5.75	10.69	0.89	2.82	8.49

2. Oscillation circuit :



IC Maker	
IC Model No.	S905X2

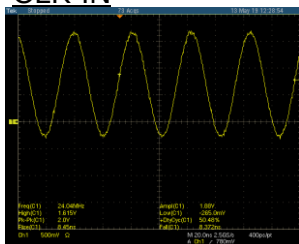
3. Crystal on board test :

Matching Test Item	unit	Original Circuit	
Circuit Parameter		HOSONIC	OTHER
		C425=C426=18pF	C425=C426=18pF
Output Frequency (Crystal on board)	MHz	24.00019700	24.00029516
	ppm	8.21	12.30
Negative Resistance	Ω	720	720
Drive Level	μ w	49.41	66.27
Frequency shift of PCB board	ppm	6.54	6.55

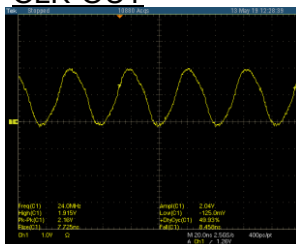
Frequency shift of PCB board(ΔF) = Output frequency - FL.

Oscillation Waveform : HOSONIC (original)

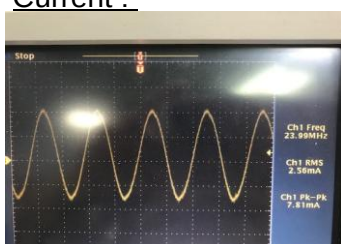
CLK-IN



CLK-OUT



Current :

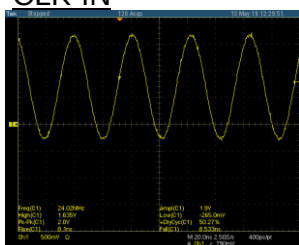


Frequency :

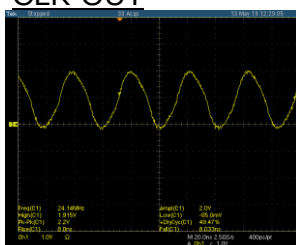


OTHER (original)

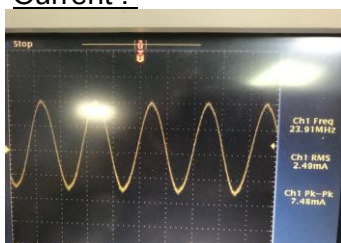
CLK-IN



CLK-OUT



Current :



Frequency :



4. Conclusion :

Location : Y401	X'tal CL	Circuit Parameter	ΔF (ppm)	DL (μW) Typ. 100	Oscillation margin Ratio: ≥ 3 (Times)
Current	12 pF	C425=C426=18pF	6.54	49.41	Ratio: 24 Times

It is recommended to maintain the circuit and crystal CL, the frequency deviation is within the allowable range and the negative resistance is also sufficient to meet the stable oscillation conditions, so it can provide a stable frequency output

Oscillation Circuit test result

Location : Y801

1. Specifications :

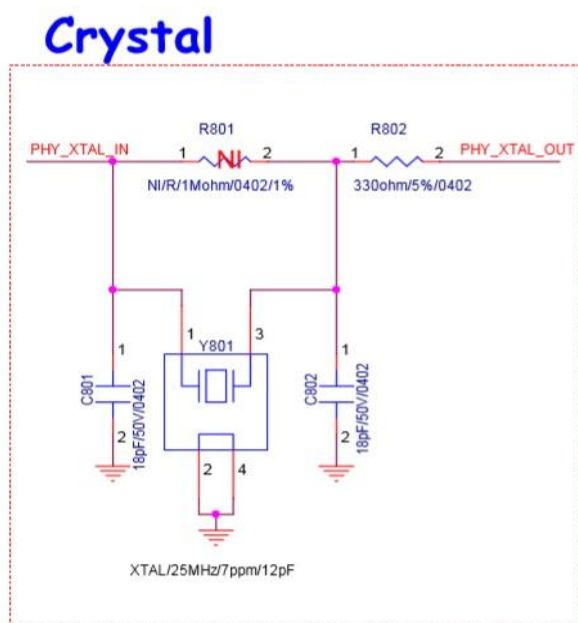
1-1. Crystal unit spec. :

Hosonic P/N	E3SB25.0000F12NGY
Customer P/N	
Nominal Frequency	25.000000 MHz
Load Capacitance (CL)	12 pF
Freq. Tolerance (at 25°C±3°C)	± 7 ppm
Freq. Stability (Ref. to 25°C)	± 15 ppm
Max. ESR	50 Ω
Drive Level	200 μw Max.
Mode of Vibraton	Fundamental

1-2. Crystal unit characteristic data :

Vendor	FL (ppm)	Rr(Ohms)	C0(pF)	C1(fF)	TS(ppm/pF)
HOSONIC	5.50	8.47	1.03	3.15	9.26

2. Oscillation circuit :



IC Maker	
IC Model No.	RTL8211F

3. Crystal on board test :

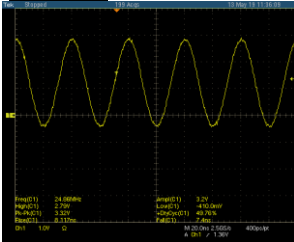
Matching Test Item	unit	Original Circuit
Circuit Parameter		HOSONIC
		C801=C802=18pF R802=330Ω
Output Frequency (Crystal on board)	MHz	25.00021253
	ppm	8.50
Negative Resistance	Ω	534
Drive Level	μw	150.12
Frequency shift of PCB board	ppm	3.00

Frequency shift of PCB board(ΔF) = Output frequency - FL.

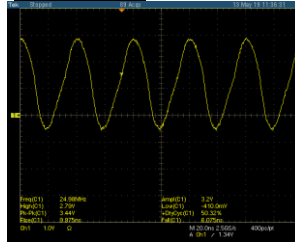
Oscillation Waveform :

HOSONIC (original)

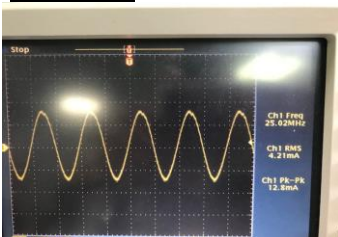
CLK-IN



CLK-OUT



Current :



Frequency :



4. Conclusion :

Location : Y801	X'tal CL	Circuit Parameter	ΔF (ppm)	DL (μW) ≤ 200	Oscillation margin Ratio: ≥ 3 (Times)
Current	12 pF	C801=C802=18pF R802=330 Ω	3.00	150.12	Ratio: 11 Times

It is recommended to maintain the circuit and crystal CL, the frequency deviation is within the allowable range and the negative resistance is also sufficient to meet the stable oscillation conditions, so it can provide a stable frequency output

Oscillation Circuit test result

Location : Y1001

1. Specifications :

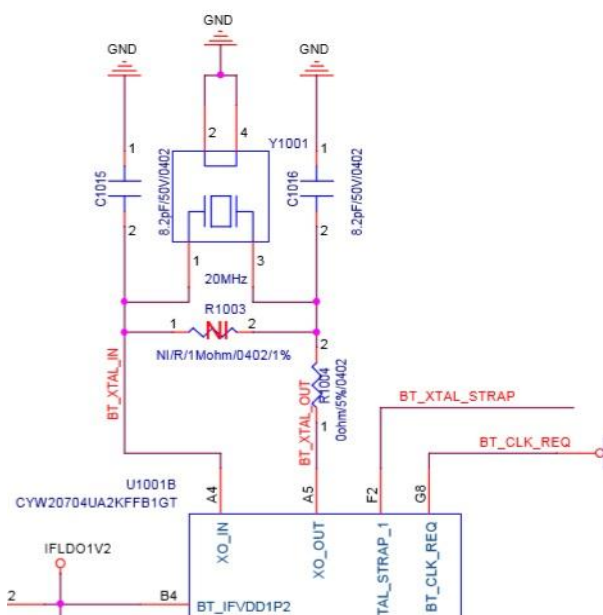
1-1. Crystal unit spec. :

Hosonic P/N	E2SB20E00000XE	
Customer P/N		
Nominal Frequency	20.000000	MHz
Load Capacitance (CL)	8	pF
Freq. Tolerance (at 25°C±3°C)	± 20	ppm
Freq. Stability (Ref. to 25°C)		
Max. ESR	50	Ω
Drive Level	300	μw Max.
Mode of Vibrator	Fundamental	

1-2. Crystal unit characteristic data :

Vendor	FL (ppm)	Rr(Ohms)	C0(pF)	C1(fF)	TS(ppm/pF)
HOSONIC	-0.68	20.52	0.69	1.71	11.33
OTHER	2.12	28.62	0.64	1.94	12.99

2. Oscillation circuit :



IC Maker	
IC Model No.	CYW2

3. Crystal on board test :

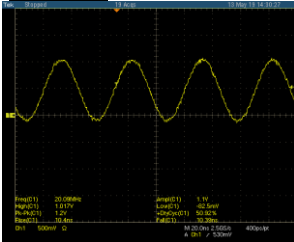
Matching Test Item	unit	Original Circuit	
Circuit Parameter		HOSONIC	OTHER
		C1015=C1016=8.2pF	C1015=C1016=8.2pF
Output Frequency (Crystal on board)	MHz	20.00010846	20.00018242
	ppm	5.42	9.12
Negative Resistance	Ω	860	860
Drive Level	μ w	13.66	17.45
Frequency shift of PCB board	ppm	6.10	7.00

Frequency shift of PCB board(ΔF) = Output frequency - FL.

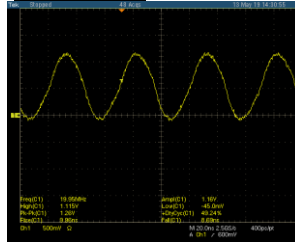
Oscillation Waveform :

HOSONIC (original)

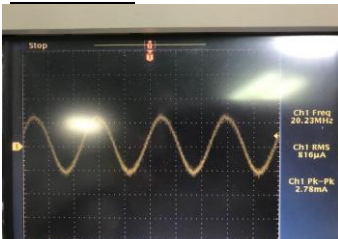
CLK-IN



CLK-OUT



Current :

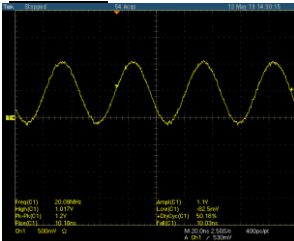


Frequency :

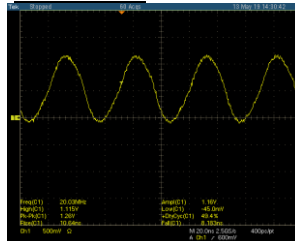


OTHER (original)

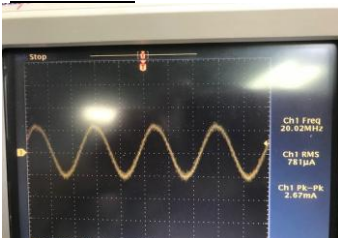
CLK-IN



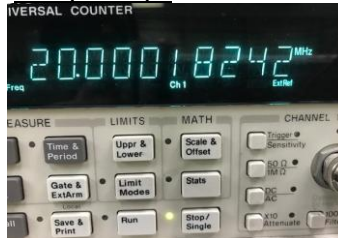
CLK-OUT



Current :



Frequency :



4. Conclusion :

Location : Y1001	X'tal CL	Circuit Parameter	ΔF (ppm)	DL (μW) ≤ 300	Oscillation margin Ratio: ≥ 3 (Times)
Current	8 pF	C1015=C1016=8.2pF	6.10	13.66	Ratio: 17.2 Times

It is recommended to maintain the circuit and crystal CL, the frequency deviation is within the allowable range and the negative resistance is also sufficient to meet the stable oscillation conditions, so it can provide a stable frequency output

Note :

- 1). If negative resistance can't fulfill the oscillate circuit, then start-up time may increase. ($< 3 * \text{Max.ESR}$) furthermore, it may stop oscillating. In order to avoid this problem. It must provides adequate negative resistance in the circuit design.
- 2). Applying excessive Drive Level to the crystal unit may cause deterioration of characteristics. Circuit design must be maintained in a proper Drive Level .
- 3). If frequency shift too much higher or lower , it may cause IC working abnormally.
- 4). Oscillation margin :

$$\text{Ratio} = | -R | / \text{Max. ESR}$$

Above recommendations need to be validated to make sure well system performance.