



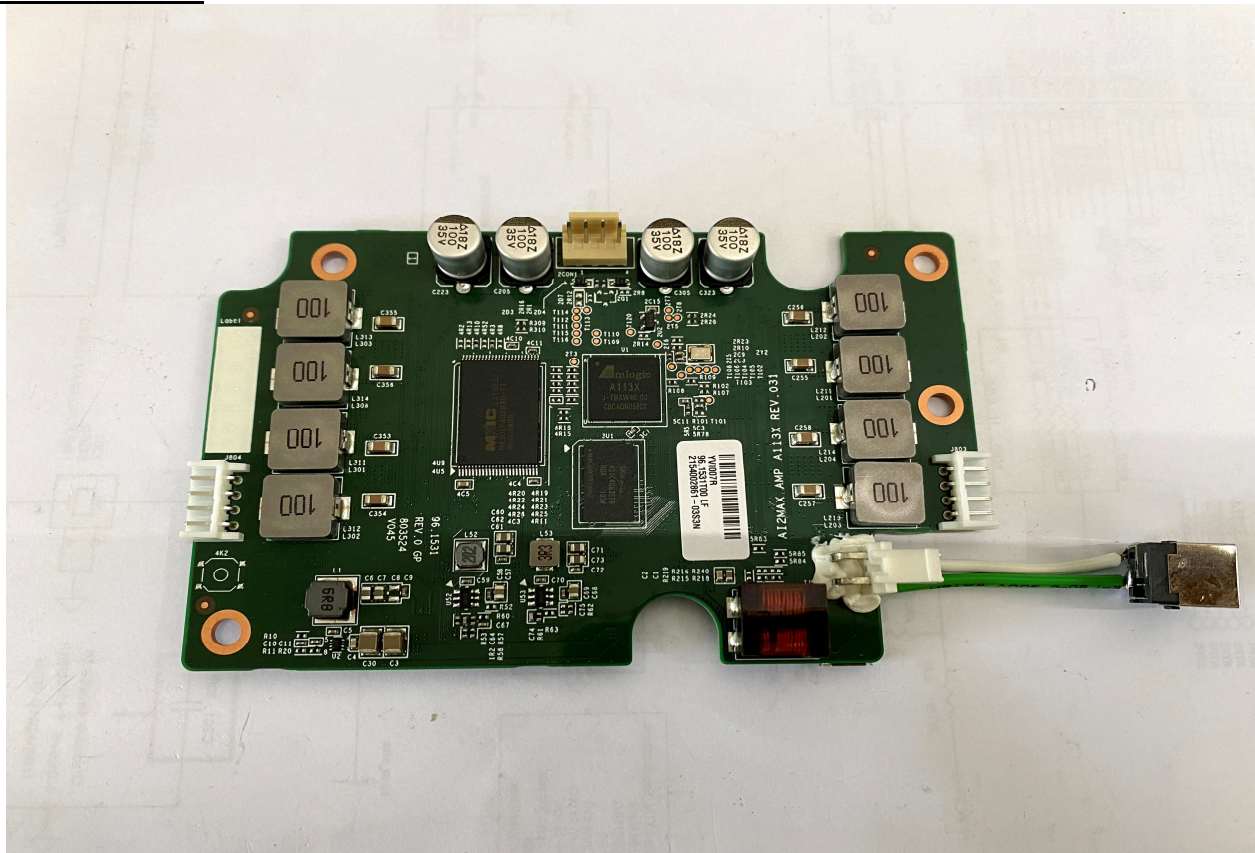
Oscillation Circuit Matching Test Report

Customer	Foxconn
Model No.	K18X001.00
Circuit Board No.	AI2MAX AMP A113X REV.031
Report No.	H210525-F03

Crystal No.	HOSONIC P/N	Customer P/N	Conclusion
2Y2	E3SB24E00005JE	-	2C3=2C9=15pF 2R10=22Ω

Approved	Prepared	Tested	Date
Bryant Wang	Ryan Chang	Ryan Chang	2021/5/25

Circuit Board



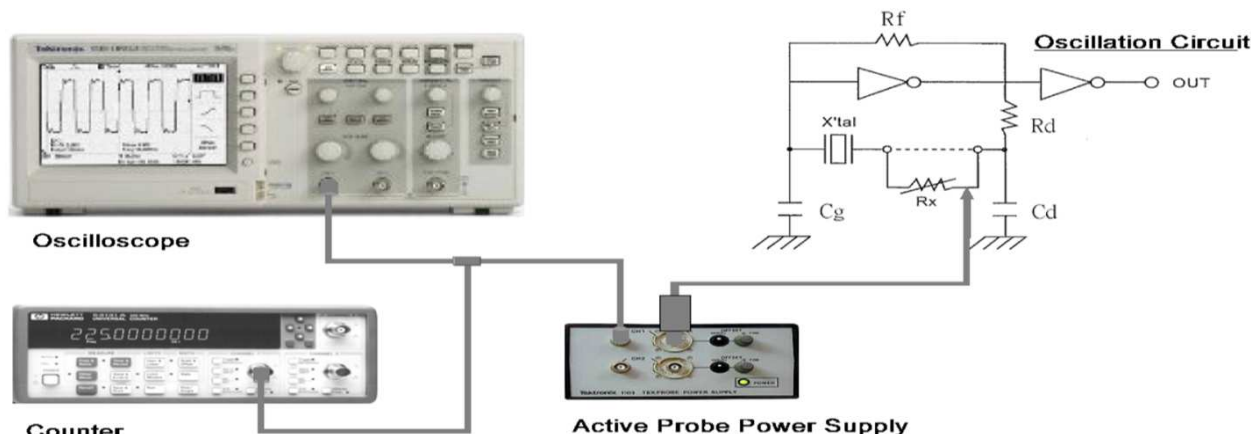
I.) Test Equipment :

Measurment Instrument	Maker	Model Number
Network Analyzer	S&A	250B
Oscilloscope with active probe (1.5GHz)	Tektronix	TDS 7104
		P6245
Oscilloscope AC Current probe	Tektronix	TDS 3052
		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 C_g , C_d , R_f , R_d 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

Negative Resistance | -R | = Rx + RL

$$RL = Rr * (1 + Co/CL)^2$$

RL= load resistance

Rr= Equivalent Series Resistance(ESR)

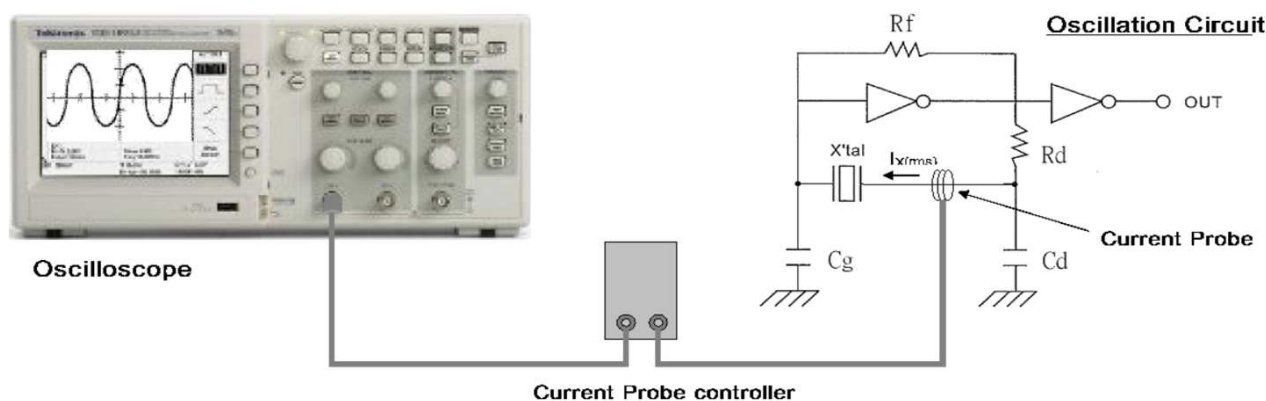
Co= shunt capacitance

CL= load capacitance

- ※ Oscillation circuit should follow the rule of Negative Resistance $\geq 3 \sim 5$ *Max. ESR(Rr)
(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.

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

I_x = electronic current value through the cr

- 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 : 2Y2

1. Specifications :

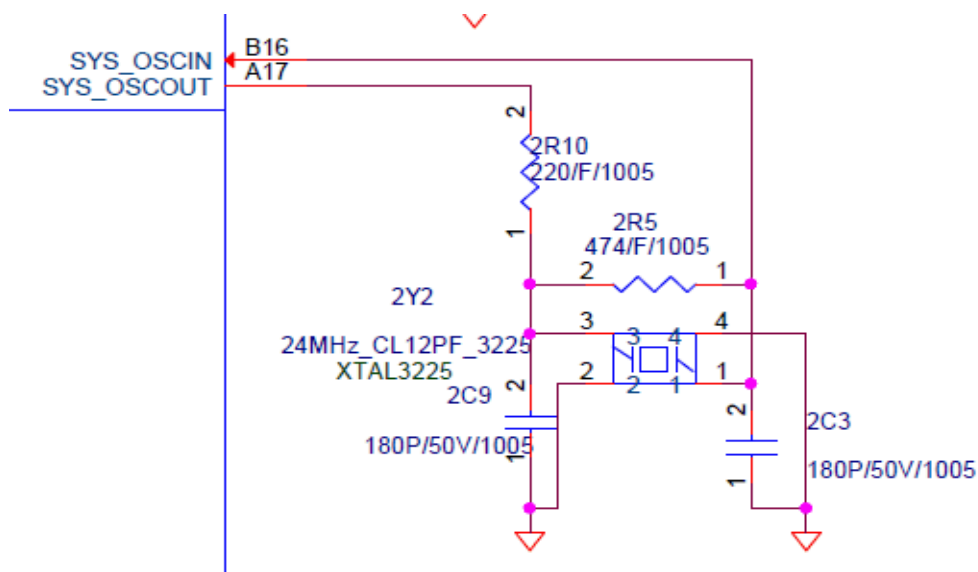
1-1. Crystal unit spec. :

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 Vibraton	Fundamental	

1-2. Crystal unit characteristic data :

Vendor	FL (ppm)	Rr(Ohms)	C0(pF)	C1(fF)	TS(ppm/pF)
HOSONIC	7.81	8.54	1.03	3.08	9.07

2. Oscillation circuit :



IC Maker	Amlogic
IC Model No.	A113X

3. Crystal on board test :

Matching Test Item	unit	Original Circuit
Circuit Parameter		HOSONIC
		2C3=2C9=18pF 2R10=22Ω
Output Frequency (Crystal on board)	MHz	23.99991028
	ppm	-3.74
Negative Resistance	Ω	> 1000
Drive Level	μw	99.30
Frequency shift of PCB board	ppm	-11.55

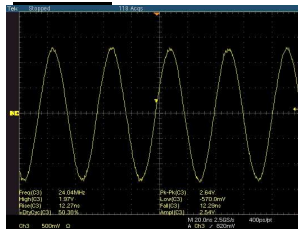
Matching Test Item	unit	Modified Circuit
Circuit Parameter		HOSONIC
		2C3=2C9=15pF 2R10=22Ω
Output Frequency (Crystal on board)	MHz	24.00020457
	ppm	8.52
Negative Resistance	Ω	> 1000
Drive Level	μw	80.49
Frequency shift of PCB board	ppm	0.71

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

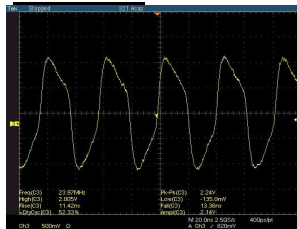
4. Oscillation Waveform :

HOSONIC (original)

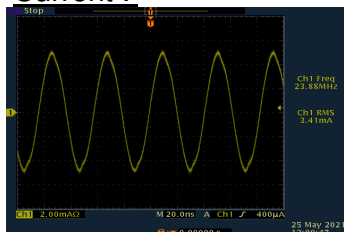
CLK-IN



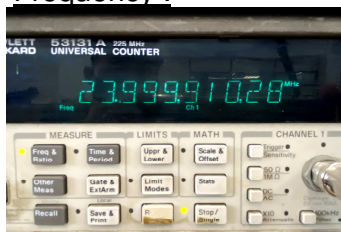
CLK-OUT



Current :

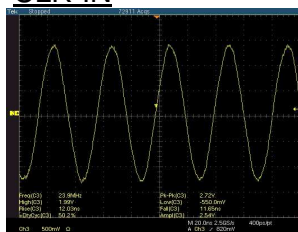


Frequency :

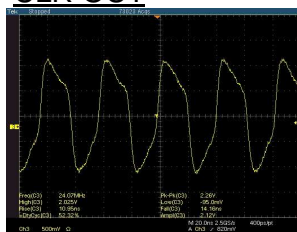


HOSONIC (modified)

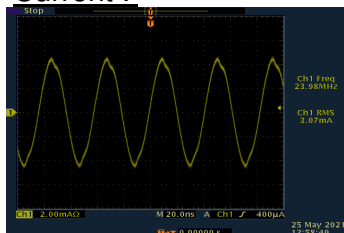
CLK-IN



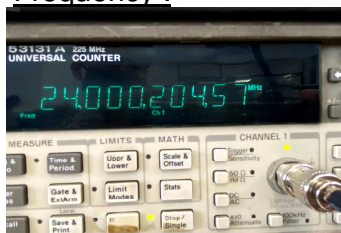
CLK-OUT



Current :



Frequency :



5. Conclusion :

Location : 2Y2	X'tal CL	Circuit Parameter	ΔF (ppm)	DL (μW) Typ. 100	Oscillation margin Ratio: ≥ 3 (Times)
Current	12 pF	2C3=2C9=18pF 2R10=22 Ω	-11.55	99.30	Ratio: 33.3 Times
Suggest	12 pF	2C3=2C9=15pF 2R10=22 Ω	0.71	80.49	Ratio: 33.3 Times

It is recommended to use the suggest 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). Frequency shift of PCB board = Output frequency - FL.

Above recommendations need to be validated to make sure well system performanc