



Oscillation Circuit Matching Test Report

Customer	Foxconn
Model No.	T99X171T00
Circuit Board No.	
Report No.	H190220-G01

Crystal No.	HOSONIC P/N	Customer P/N	Conclusion
Y401	E3SB24E00005JE		No modify
Y801	E3SB25.0000F12NGY		C801=C802=18pF R802=330Ω
Y1001	E2SB20E00000XE		C1015=C1016=8.2pF

Approved	Prepared	Tested	Date
Bryant Wang	C.L.LEE	C.L.LEE	2019/2/20

Circuit Board



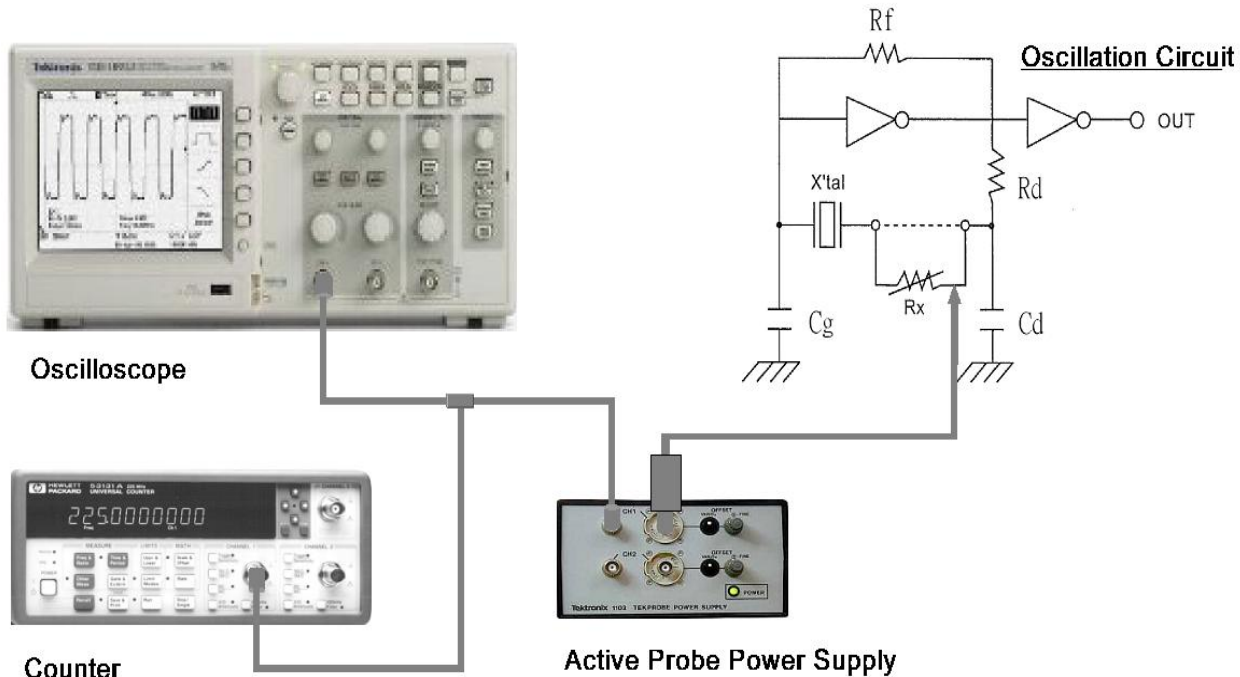
I.) Test Equipment :

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

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

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

R_L = load resistance

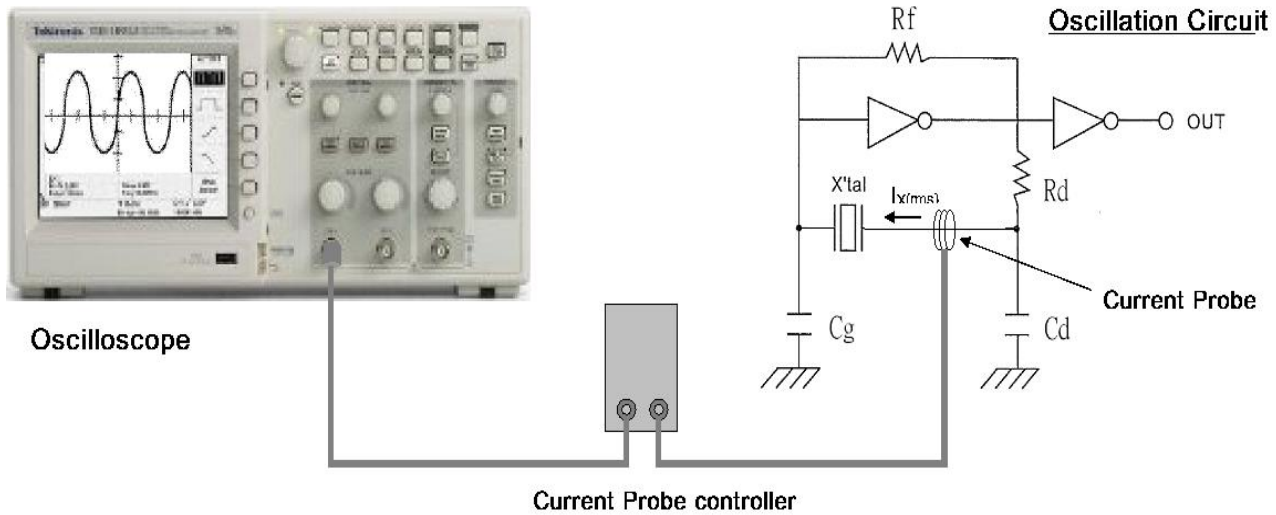
C_o = shunt capacitance

R_r = Equivalent Series Resistance(ESR)

C_L = load capacitance

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

$$\text{Drive level}(P)=I_{x(rms)}^2 * ESR$$

I_x = electronic current value through the crystal

- 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.

Y401: Oscillation Circuit test result

1. Specifications :

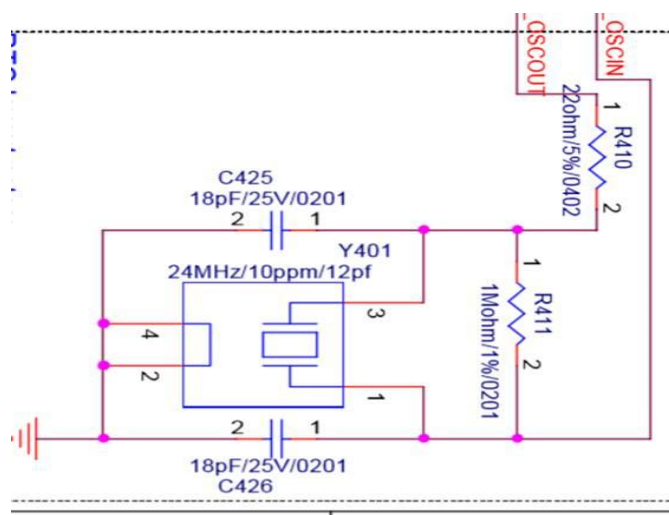
1-1. Crystal unit spec. :

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 :

X'tal Y401	FL (ppm)	Rr(Ohms)	C0(pF)	C1(fF)	TS(ppm/pF)
HOSONIC	4.97	8.00	0.98	3.10	9.20
OTHER	5.08	7.89	0.87	2.83	8.54

2. Oscillation circuit :



IC Maker	
IC Model No.	S905X2

	Original Design
Cg : C425	18 pF
Cd : C426	18 pF

3. Crystal on board test :

Matching Test Item	unit	Original Circuit	
Circuit Constants		HOSONIC	OTHER
		C425=C426=18pF	C425=C426=18pF
Output Frequency (Crystal on board)	MHz	24.00028625	24.00026605
	ppm	11.93	11.09
Negative Resistance	Ω	690	123
Drive Level	μ W	58.75	41.99
Frequency shift of PCB board	ppm	6.96	6.01

4. Conclusion :

4-1. The ground capacitance C425=C426=18pF, X'tal CL=12pF

4-1-1. The crystal on board oscillating frequency is +11.93ppm,
the frequency deviation between on board frequency and crystal FL is +6.96ppm.

4-1-2. The Negative Resistance (690 Ω) $\geq$ 90 Ω (basic requirement) .Therefore, the circuit can oscillate stable

4-1-3. The Drive Level (58.75 μ W) is matching the crystal spec.

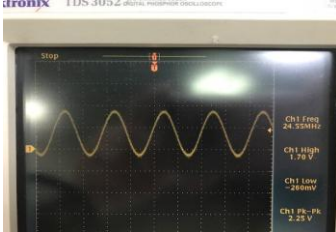
4-2. Suggestion :

The ground capacitance keep C425=C426=18pF and collocate with CL=12pF of crystal,
then it will satisfy the stable frequency output.

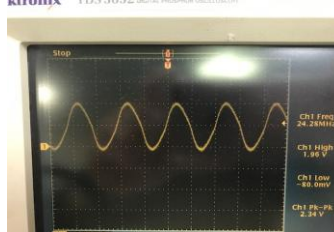
HOSONIC (original)

Waveform :

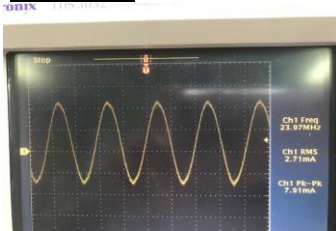
CLK-IN



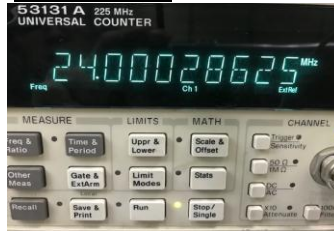
CLK-OUT



Current :



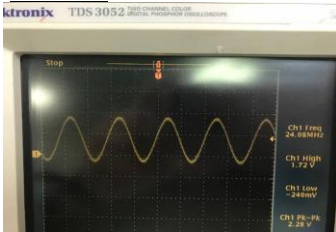
Frequency :



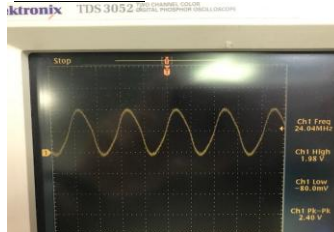
OTHER (original)

Waveform :

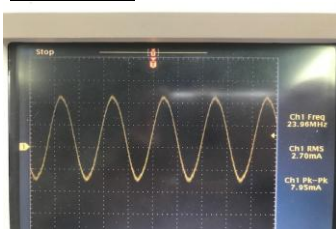
CLK-IN



CLK-OUT



Current :



Frequency :



Y801: Oscillation Circuit test result

1. Specifications :

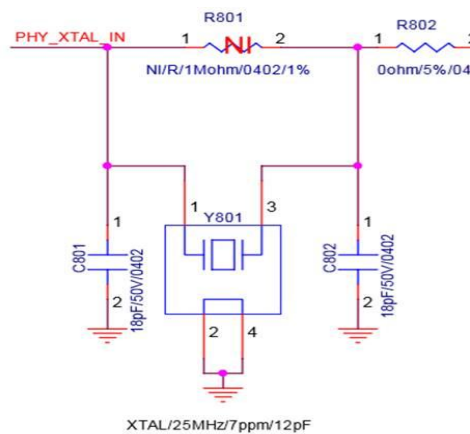
1-1. Crystal unit spec. :

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 Vibrator	Fundamental	

1-2. Crystal unit characteristic data :

X'tal Y801	FL (ppm)	Rr(Ohms)	C0(pF)	C1(fF)	TS(ppm/pF)
HOSONIC	2.77	9.78	1.02	3.20	9.44

2. Oscillation circuit :



IC Maker		
IC Model No.	RTL8211F	
	Original Design	Modified Design
Cg : C801	18 pF	18 pF
Cd : C802	18 pF	18 pF
Rd : R802	0 Ω	330 Ω

3. Crystal on board test :

Matching Test Item	unit	Original Circuit
Circuit Constants		HOSONIC
		C801=C802=18pF
		R802=0Ω
Output Frequency (Crystal on board)	MHz	24.99967338
	ppm	-13.06
Negative Resistance	Ω	652
Drive Level	μw	264.45
Frequency shift of PCB board	ppm	-15.83

Matching Test Item	unit	Original Circuit
Circuit Constants		HOSONIC
		C801=C802=18pF
		R802=330Ω
Output Frequency (Crystal on board)	MHz	25.00011795
	ppm	4.72
Negative Resistance	Ω	555
Drive Level	μw	174.16
Frequency shift of PCB board	ppm	1.95

4. Conclusion :

4-1. The ground capacitance C801=C802=18pF,R802=0Ω,X'tal CL=12pF

4-1-1. The crystal on board oscillating frequency is -13.06ppm,
the frequency deviation between on board frequency and crystal FL is -15.83ppm.

4-1-2. The Negative Resistance (652Ω) .>= 150Ω (basic requirement) .Therefore, the circuit can oscillate stab

4-1-3. The Drive Level (264.45μW) is matching the crystal spec.

4-2. The ground capacitanceC801=C802=18pF,R802=330Ω,X'tal CL=12pF

4-2-1. The crystal on board oscillating frequency is +4.72ppm,
the frequency deviation between on board frequency and crystal FL is +1.95ppm.

4-2-2. The Negative Resistance (555Ω) .>= 150Ω (basic requirement) .Therefore, the circuit can oscillate stab

4-2-3. The Drive Level (174.16μW) is matching the crystal spec.

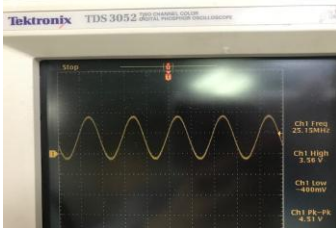
4-3. Suggestion :

The ground capacitance C801=C802=18pF,R802=0Ω change C801=C802=18pF,R802=330Ω
and collocate with CL=12pF of crystal, then it will satisfy the stable frequency output.

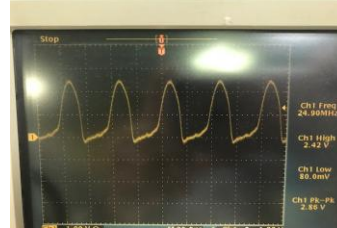
HOSONIC (original)

Waveform :

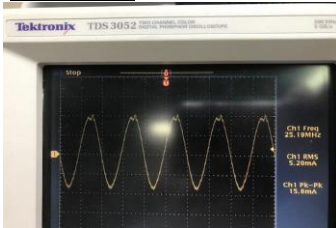
CLK-IN



CLK-OUT



Current :



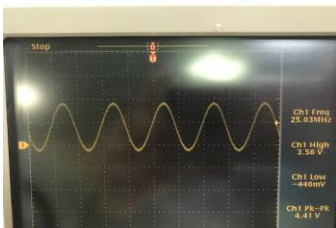
Frequency :



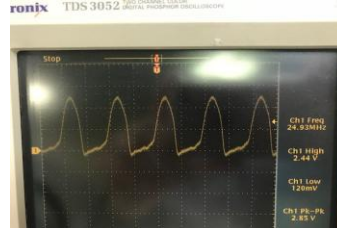
HOSONIC (Modified)

Waveform :

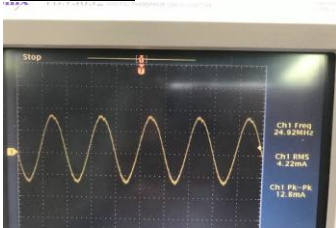
CLK-IN



CLK-OUT



Current :



Frequency :



Y1001: Oscillation Circuit test result

1. Specifications :

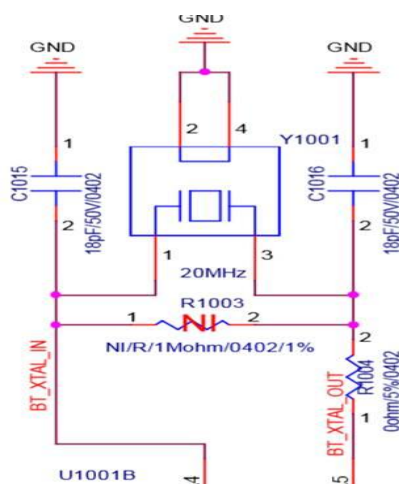
1-1. Crystal unit spec. :

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)		ppm
Max. ESR	50	Ω
Drive Level	300	μw Max.
Mode of Vibraton	Fundamental	

1-2. Crystal unit characteristic data :

X'tal Y1001	FL (ppm)	Rr(Ohms)	C0(pF)	C1(fF)	TS(ppm/pF)
HOSONIC	1.09	13.56	0.72	1.71	11.27
OTHER	4.14	23.46	0.67	1.98	13.20

2. Oscillation circuit :



IC Maker		
IC Model No.	0704UA2	
	Original Design	Modified Design
Cg : C1015	18 pF	8.2 pF
Cd : C1016	18 pF	8.2 pF

3. Crystal on board test :

Matching Test Item	unit	Original Circuit	
Circuit Constants		HOSONIC	OTHER
		C1015=C1016=18pF	C1015=C1016=18pF
Output Frequency (Crystal on board)	MHz	19.99934292	19.99930956
	ppm	-32.85	-34.52
Negative Resistance	Ω	321	321
Drive Level	μ w	22.21	29.95
Frequency shift of PCB board	ppm	-33.94	-38.66

Matching Test Item	unit	Original Circuit	
Circuit Constants		HOSONIC	OTHER
		C1015=C1016=8.2pF	C1015=C1016=8.2pF
Output Frequency (Crystal on board)	MHz	20.00013892	20.00024531
	ppm	6.95	12.27
Negative Resistance	Ω	911	911
Drive Level	μ w	10.45	15.96
Frequency shift of PCB board	ppm	5.86	8.13

4. Conclusion :

4-1. The ground capacitance C1015=C1016=18pF,X'tal CL=8pF

4-1-1. The crystal on board oscillating frequency is -32.85ppm,
the frequency deviation between on board frequency and crystal FL is -33.94ppm.

4-1-2. The Negative Resistance (321 Ω) .>= 150 Ω (basic requirement) .Therefore, the circuit can oscillate stab

4-1-3. The Drive Level (22.21 μ W) is matching the crystal spec.

4-2. The ground capacitance C1015=C1016=8.2pF,X'tal CL=8pF

4-2-1. The crystal on board oscillating frequency is +6.95ppm,
the frequency deviation between on board frequency and crystal FL is +5.86ppm.

4-2-2. The Negative Resistance (911 Ω) .>= 150 Ω (basic requirement) .Therefore, the circuit can oscillate stab

4-2-3. The Drive Level (15.96 μ W) is matching the crystal spec.

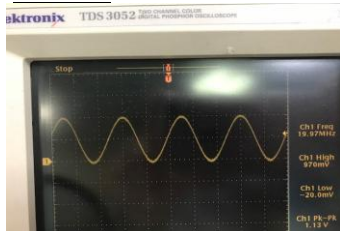
4-3. Suggestion :

The ground capacitance C1015=C1016=18pF change C1015=C1016=8.2pF
and collocate with CL=8pF of crystal, then it will satisfy the stable frequency output.

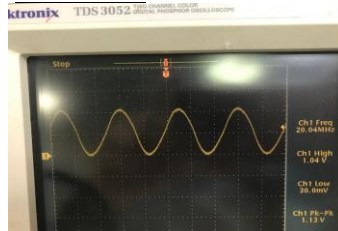
HOSONIC (original)

Waveform :

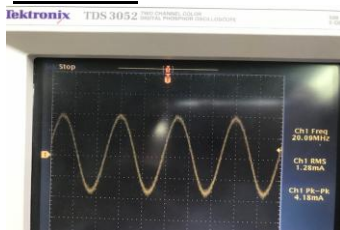
CLK-IN



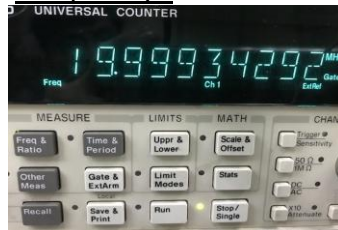
CLK-OUT



Current :



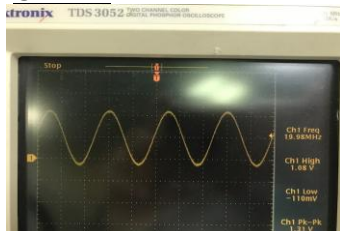
Frequency :



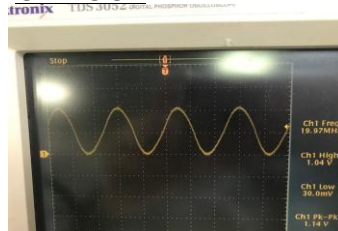
OTHER (original)

Waveform :

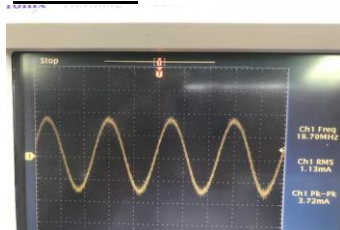
CLK-IN



CLK-OUT



Current :



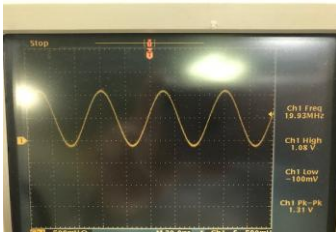
Frequency :



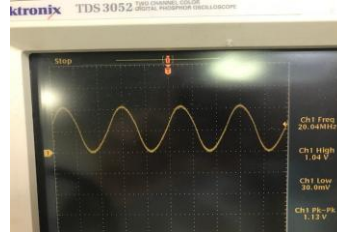
HOSONIC (Modified)

Waveform :

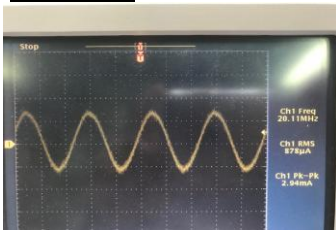
CLK-IN



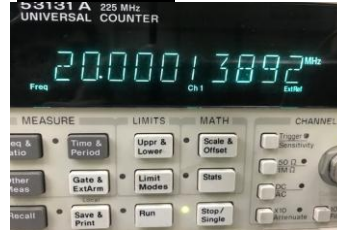
CLK-OUT



Current :



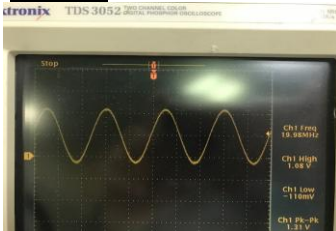
Frequency :



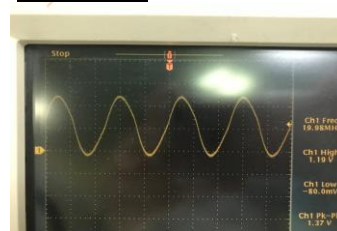
OTHER (Modified)

Waveform :

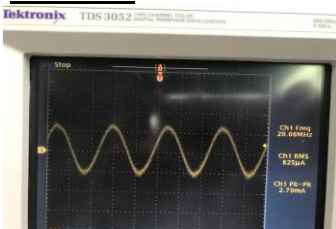
CLK-IN



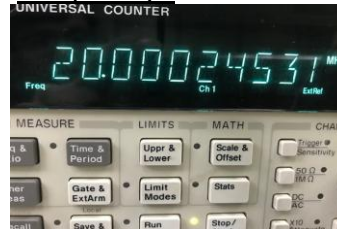
CLK-OUT



Current :



Frequency :





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