

TO: Microchip Corporation

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|-------------|------------------------|-----|
| Report No. | UKY1C-C3-16832-00(43)N | 1/4 |
| Date Issued | 25-Nov-16 | |

Crystal oscillation circuits report

Dear Sirs,

We are pleased to submit a report on the above subject as follows:

Yours faithfully

| | |
|------------------------------|-------------------------|
| Board name | SAME54 Xplained Pro kit |
| IC name | ATSAME54P20A |
| Specification | CX3225GB12000H0KPSC1 |
| Specification NO. | -- |
| Crystal unit type | CX3225GB |
| Frequency | 12000 kHz |
| Frequency tolerance | ±30 PPM |
| Temperature | -40~+85 °C |
| Temperature characteristic | ±50 PPM |
| Equivalent series resistance | 150 Ω |
| Load capacitance | 12 pF |
| Drive level | 100 uW |

Circuit examination history

2016.11.25 First edition UKY1C-C3-16832-00(43)N

| Crystal Units design section | | Crystal oscillation circuit evaluation section | | |
|------------------------------|------------|--|------------|------------|
| Approved by | Checked by | Approved by | Checked by | Prepared |
| T.Nitobe | - | A.Hisako | Y.Yuki | M.Tanigawa |

The reference about the above

KYOCERA Crystal Device Corporation Marketing Division
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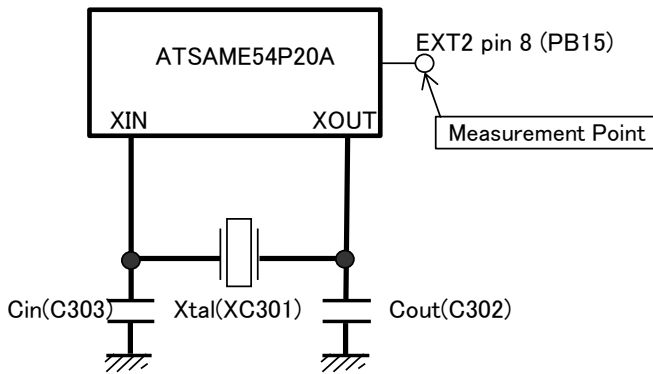
Tel:+81-237-43-5747 Fax:+81-237-43-5651

Note:The characteristics of crystal oscillating circuits vary according to a circuit constant, installed condition,etc.

Before use,please conlem matching of the crystal unit with the crystal oscillator circuits.Please also note that the results of reviewing the circuits may not meet the characteristics of your product.

○ Measurement Circuit Diagram

SAME54 Xplained Pro kit



IC: ATSAME54P20A

Vcc: USB (V)

: CX3225GB 12000kHz

CL= 12pF

| Measurement Item | Instrument |
|---------------------|---|
| Frequency | Anritsu MS2661C Spectrum Analyzer |
| Negative Resistance | Anritsu MS2661C Spectrum Analyzer |
| Drive Level | Tektronix Digital Oscilloscope TDS5052B |
| | Tektronix AC Current Probe P6022 |

○ Characteristics at Present Constants

CL= 12pF

| Circuit Constants | | Power Voltage (V) | Automatic Loop Control | Negative Resistance (Ω) | Circuit load Capacitance (pF) | Frequency Deviation (PPM) | Drive Level (μ W) | 3rd Negative Resistance (Ω) |
|-------------------|------------|-------------------|------------------------|-------------------------|-------------------------------|---------------------------|-------------------|-----------------------------|
| Cin(C303) | Cout(C302) | | | | | | | |
| 12pF | 12pF | USB | Enabled | -3865 | 10.45 | +8.33 | 7 | -410 |
| 12pF | 12pF | USB | Disabled | -3864 | 12.99 | -4.33 | 270 | -420 |

• Negative resistance

<Automatic loop control enabled>

The negative resistance for 12000kHz at the present circuit constants is -3865Ω , which is enough to assure stable operation of the circuits.

<Automatic loop control disabled>

The negative resistance for 12000kHz at the present circuit constants is -3864Ω , which is enough to assure stable operation of the circuits.

• Circuit load capacitance and Frequency tolerance

<Automatic loop control enabled>

The load capacitance of the oscillator circuit is 10.45pF with a frequency deviation of +8.33PPM. This is based on the fact that this quartz crystal has a frequency deviation of +/-0 by using a load capacitance of 12pF.

<Automatic loop control disabled>

The load capacitance of the oscillator circuit is 12.99pF with a frequency deviation of -4.33PPM. This is based on the fact that this quartz crystal has a frequency deviation of +/-0 by using a load capacitance of 12pF.

• Drive level

<Automatic loop control enabled>

The drive level of the oscillation circuit is $7\mu W$.

When a quartz crystal unit with 58.76Ω equivalent series resistance and 64.91Ω load resonance resistance is used. This is a good value without the possibility to cause trouble.

<Automatic loop control disabled>

The drive level of the oscillation circuit is $270\mu W$.

When a quartz crystal unit with 58.76Ω equivalent series resistance and 63.68Ω load resonance resistance is used. This value is large. This may become the problem.

• 3rd Over tone Negative resistance

<Automatic loop control enabled>

The 3rd over tone (= 36000kHz) negative resistance of the oscillation circuit is -410Ω .

The value is guaranteed to stable oscillation in the circuit.

<Automatic loop control disabled>

The 3rd over tone (= 36000kHz) negative resistance of the oscillation circuit is -420Ω .

The value is guaranteed to stable oscillation in the circuit.

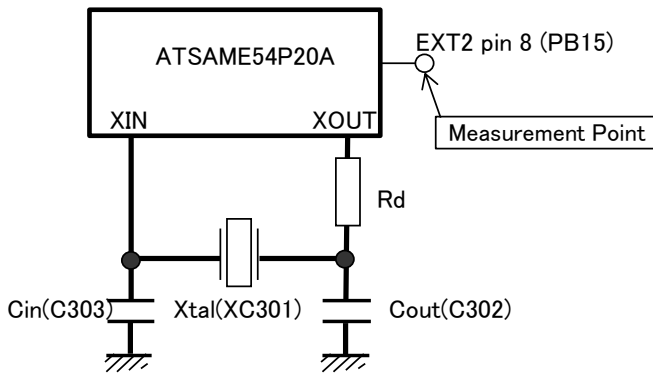
• Conclusion

Constant and Load Capacitance change is needed because drive level with automatic loop control disabled is large.

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○ Measurement Circuit Diagram

SAME54 Xplained Pro kit



IC: ATSAME54P20A

Vcc: USB (V)

: CX3225GB 12000kHz

CL= 12pF

| Measurement Item | Instrument |
|---------------------|---|
| Frequency | Anritsu MS2661C Spectrum Analyzer |
| Negative Resistance | Anritsu MS2661C Spectrum Analyzer |
| Drive Level | Tektronix Digital Oscilloscope TDS5052B |
| | Tektronix AC Current Probe P6022 |

○ Characteristics at Recommended Constants

CL= 12pF

| Circuit Constants | | | Power Voltage (V) | Automatic Loop Control | Negative Resistance (Ω) | Circuit load Capacitance (pF) | Frequency Deviation (PPM) | Drive Level (μ W) | 3rd Negative Resistance (Ω) |
|-------------------|-----------|------------|-------------------|------------------------|-------------------------|-------------------------------|---------------------------|-------------------|-----------------------------|
| Rd | Cin(C303) | Cout(C302) | | | | | | | |
| 1500Ω | 15pF | 15pF | USB | Enabled | -1764 | 12.04 | -0.17 | 9 | -20 |
| 1500Ω | 15pF | 15pF | USB | Disabled | -1765 | 11.14 | +4.33 | 95 | -20 |

• Negative resistance

<Automatic loop control enabled>

The negative resistance for 12000kHz at the present circuit constants is -1764Ω , which is enough to assure stable operation of the circuits.

<Automatic loop control disabled>

The negative resistance for 12000kHz at the present circuit constants is -1765Ω , which is enough to assure stable operation of the circuits.

• Circuit load capacitance and Frequency tolerance

<Automatic loop control enabled>

The load capacitance of the oscillator circuit is 12.04pF with a frequency deviation of -0.17PPM . This is based on the fact that this quartz crystal has a frequency deviation of ± 0 by using a load capacitance of 12pF.

<Automatic loop control disabled>

The load capacitance of the oscillator circuit is 11.14pF with a frequency deviation of $+4.33\text{PPM}$. This is based on the fact that this quartz crystal has a frequency deviation of ± 0 by using a load capacitance of 12pF.

• Drive level

<Automatic loop control enabled>

The drive level of the oscillation circuit is $9\mu\text{W}$.

When a quartz crystal unit with 58.76Ω equivalent series resistance and 64.08Ω load resonance resistance is used. This is a good value without the possibility to cause trouble.

<Automatic loop control disabled>

The drive level of the oscillation circuit is $95\mu\text{W}$.

When a quartz crystal unit with 58.76Ω equivalent series resistance and 64.52Ω load resonance resistance is used. This value is large. This may become the problem.

• 3rd Over tone Negative resistance

<Automatic loop control enabled>

The 3rd over tone (= 36000kHz) negative resistance of the oscillation circuit is -20Ω . The value is guaranteed to stable oscillation in the circuit.

<Automatic loop control disabled>

The 3rd over tone (= 36000kHz) negative resistance of the oscillation circuit is -20Ω . The value is guaranteed to stable oscillation in the circuit.

• Conclusion

We recommend use of the product at the present constants.

However, please check whether it is satisfactory enough in your company.

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○Temperature Characteristics at Recommended Constants

| Circuit Constants | | | Power Voltage (V) | Temperature (°C) | Automatic Loop Control | Negative Resistance (Ω) | Drive Level (μ W) | 3rd Negative Resistance (Ω) |
|-------------------|-----------|------------|-------------------|------------------|------------------------|-------------------------|-------------------|-----------------------------|
| Rd | Cin(C303) | Cout(C302) | | | | | | |
| 1500Ω | 15pF | 15pF | USB | -40 | Enabled | -1764 | 9 | -20 |
| 1500Ω | 15pF | 15pF | USB | -40 | Disabled | -1764 | 93 | -20 |
| 1500Ω | 15pF | 15pF | USB | +85 | Enabled | -1665 | 12 | -20 |
| 1500Ω | 15pF | 15pF | USB | +85 | Disabled | -1665 | 93 | -20 |

The results of testing the mounted board we borrowed from you this time are as described above. Please also check and review them on your side before use.

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