Using Ceramic Resonators with the ADS1255/6

ABSTRACT

The ADS1255 and ADS1256 each have an onboard clock generator designed to use an external crystal to create the system clock. External ceramic resonators can also be used, since resonators operate with a similar clock generator circuit. Compared with quartz crystals, resonators typically are less accurate and have lower Q, and must be carefully evaluated before being used with either the ADS1255 or ADS1256.

Murata Corporation evaluated three of their ceramic resonators suitable for use with the ADS1256. The details of their evaluation method along with their final reports are included in this application note.

Contents

Appendices

1 Introduction

The ADS1255 and ADS1256 (together referred to as the ADS1255/6) share the same crystal oscillator clock generator. The external quartz crystal connects between pins XTAL1/CLKIN and XTAL2, as shown in Figure 1; see the ADS1255/6 data sheet for more details. In addition to crystals, ceramic resonators can also be used with the ADS1255/6 because they use the same oscillator circuit topology; simply replace the crystal with a ceramic resonator. Before making such a substitution, however, the ceramic resonator must be carefully considered.

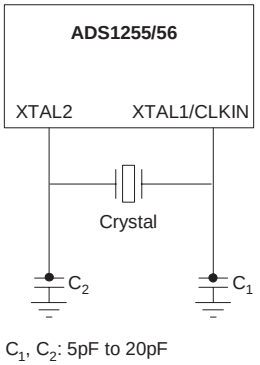

Figure 1. ADS1255/6 Oscillator

Ceramic resonators use the mechanical resonance of piezoelectric ceramics to enable oscillation. Compared with quartz crystals, these resonators typically have lower Q and require larger C_1 and C_2 capacitances. These differences, in turn, affect the oscillation conditions. Circuits designed for crystals, such as the ADS1255/6, should be thoroughly evaluated before use with a ceramic resonator to ensure proper device operation. The operating conditions of the ADS1255/6 help determine the scope needed for such an evaluation. Pay special attention to the required temperature and digital supply voltage ranges. For a robust design, make sure there is an adequate margin of safety between the operating range of the oscillator and the operating range that the ADS1255/6 will experience.

It is important to note that the tolerance of the oscillating frequency is typically significantly higher for resonators than it is for crystals. If the frequency response of the ADS1255/6 is critical (for example, 50Hz and/or 60Hz signals need to be removed by the digital filter), make sure to carefully review the resonator's oscillating frequency tolerance.

2 Murata Evaluation

Murata Corporation (www.murata.com.jp) offers the CERALOCK® family of low-profile surface-mount resonators. Murata performed a series of evaluation studies on the ADS1256 with the following CERALOCK resonators; the nominal frequency is shown in parenthesis:

CSTCR4M00G53 (4.00MHz)

CSTCR7M68G53 (7.68MHz)

CSTCE8M00G52 (8.00MHz)

The six evaluations listed below were performed on each resonator. The Murata test reports with the measured data are included as appendices at the end of this application note. The test circuit used to evaluate each resonator is shown at the beginning of each report. **V_{SET}** in the Murata test setup connects to the ADS1256 DVDD supply; **V'_{SET}** in the test setup connects to the AVDD supply.

Temperature Characteristics of Oscillating Frequency

This test measured the percentage change in frequency over temperature relative to the frequency at 25°C.

Temperature Characteristics of Oscillating Voltage

This test measured the amplitude of the oscillation at the resonator terminals:

V_{IH} = maximum value on XTAL1/CLKIN

V_{IL} = minimum value on XTAL1/CLKIN

V_{2H} = maximum value on XTAL2

V_{2L} = minimum value of XTAL2

Rise Time vs. V_{SET} Characteristics

This test measured the rise time (or *start-up time*) for the oscillator after power is applied. The time was measured from when power was applied to the point where the amplitude of oscillations reached 90% of the final value. Note from the reports that the start-up time for resonators is shorter than that of crystals.

Oscillating Frequency vs. V_{SET} Characteristics

This test measured the percentage change in oscillation frequency over DVDD voltage (V_{SET}). The supply voltage where oscillations began is indicated as the **Starting Voltage**

Oscillating Voltage vs. Vset Characteristics

This test measures the amplitude of the oscillation, similar to the Temperature Characteristics of Oscillating Voltage, as a function of DVDD voltage (V_{SET}).

Frequency Correlation Data

This table compares the frequency of oscillation between the ADS1256 EVM board and Murata's standard oscillator circuit. Five resonators were measured, with the average values listed as $\overline{X}$.

3 Summary

All three resonators evaluated by Murata worked successfully with the ADS1256. Murata used an extended temperature range (−55°C to +125°C) and DVDD range (1.5V to 4.25V) in their evaluations. This stable, conservative technique ensures adequate device safety. However, be sure to stay within the maximum operating temperature range and DVDD voltage range when operating the ADS1255/6 in the end application, as specified in the datasheet.

The ADS1255/6 oscillator circuit was designed to be used with crystals, but works well with some resonators, in particular the three resonators evaluated by Murata in their reports shown in this application note. Should a different resonator be considered for use with the ADS1255/6, be sure to perform a similar evaluation to ensure proper operation.

References

ADS1255/56 Datasheet (SBAS288C)

To obtain a copy of the referenced document, visit the Texas Instruments web site at www.ti.com. The last letter of the literature number (shown in parentheses) indicates the current revision letter for the document.

Appendix A. Murata Part Number CSTCE8M00G52−R0

Technical Data of Ceramic Resonator

MURATA Part No.: CSTCE8M00G52−R0

Applied to ADS1256IDB/29Z3575

Note: Suffix indicates packaging style.

·Lead type
- −A0 : Flat pack package(Ho=18mm)
- −B0 : Bulk

·SMD type
- −R0 : Plastic tape package(!=180mm)
- −B0 : Bulk

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Piezoelectric Components Group

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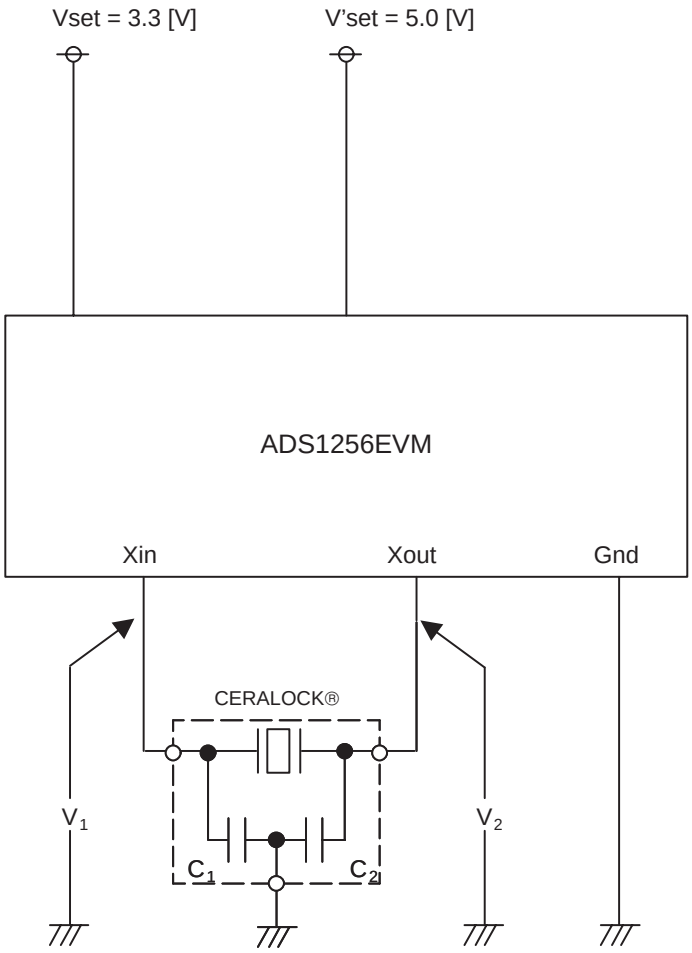
K.Kuramoto	K.Maruno	K.Masaki	K.Tagata	Mar 17, 2003	TCD−03−0466

Murata Manufacturing Co., Ltd.

Test Circuit



Xin : 19

Xout: 18

Recommended Value

CERALOCK® : CSTCE8M00G52−R0

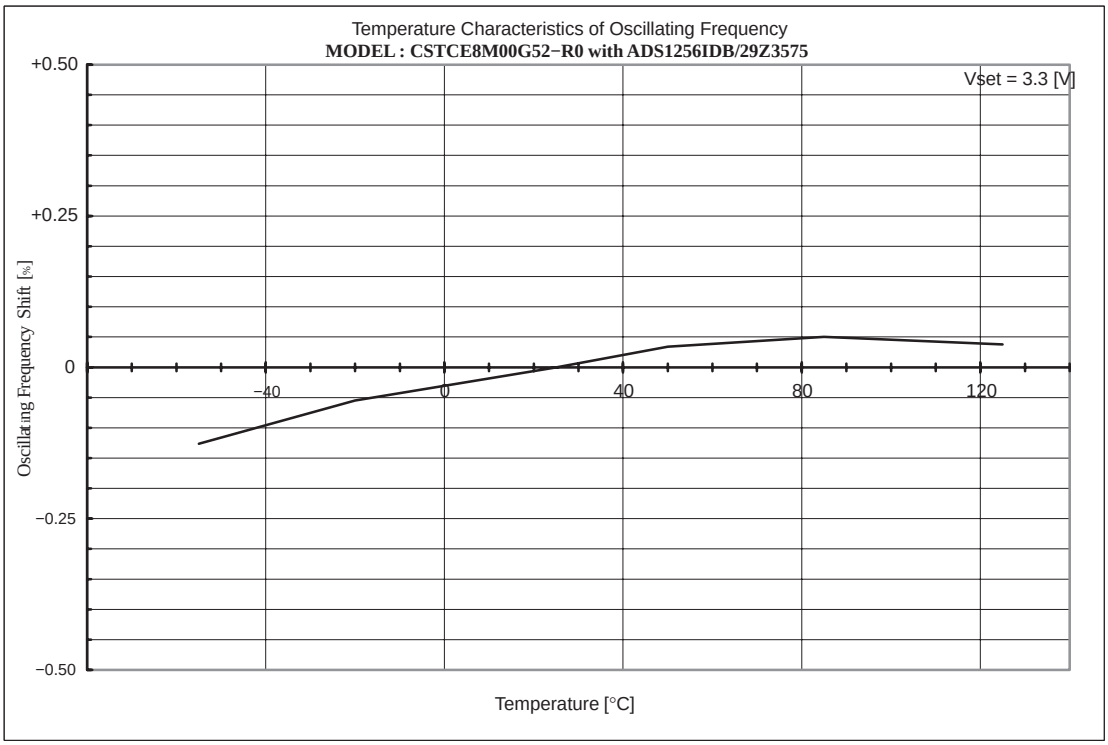
Vset = 1.6 to 3.6 [V]

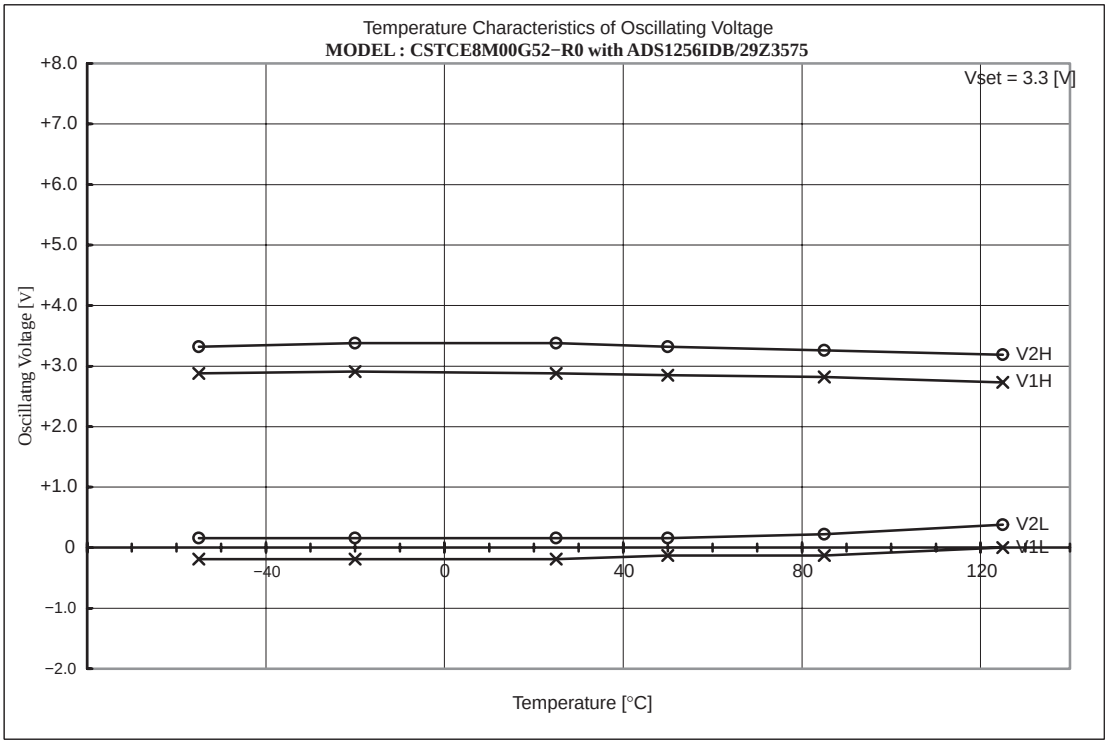
C1 = 10 [pF] (Typ.)

C2 = 10 [pF] (Typ.)

Ta = −40 to 85 [°C]

Murata Manufacturing Co., Ltd.





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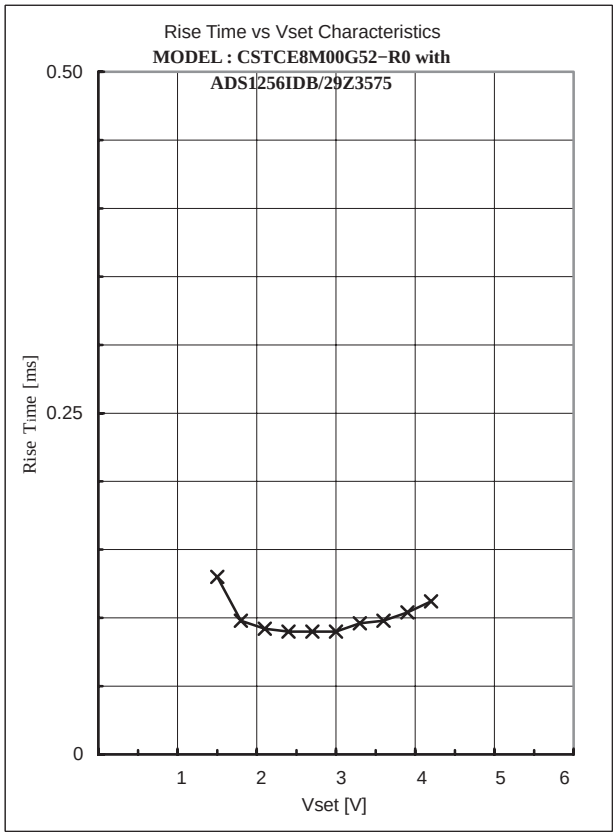
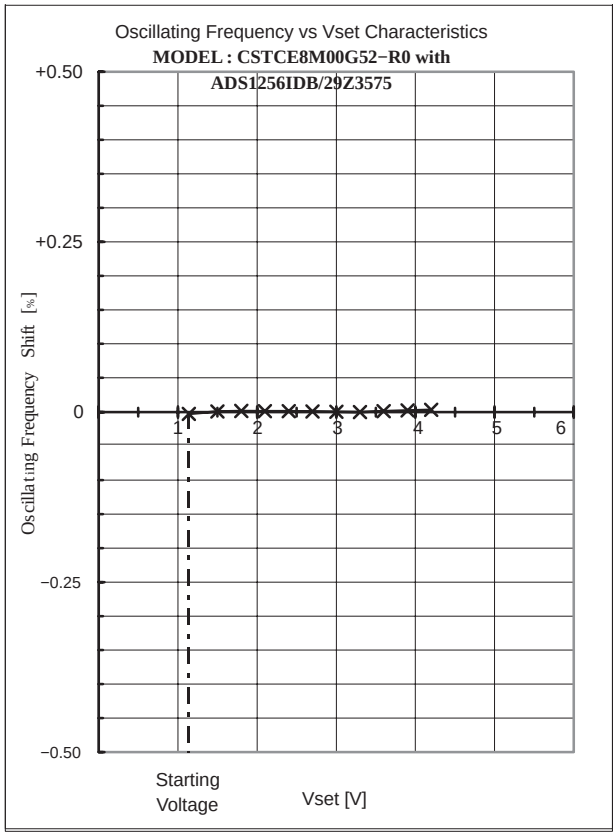
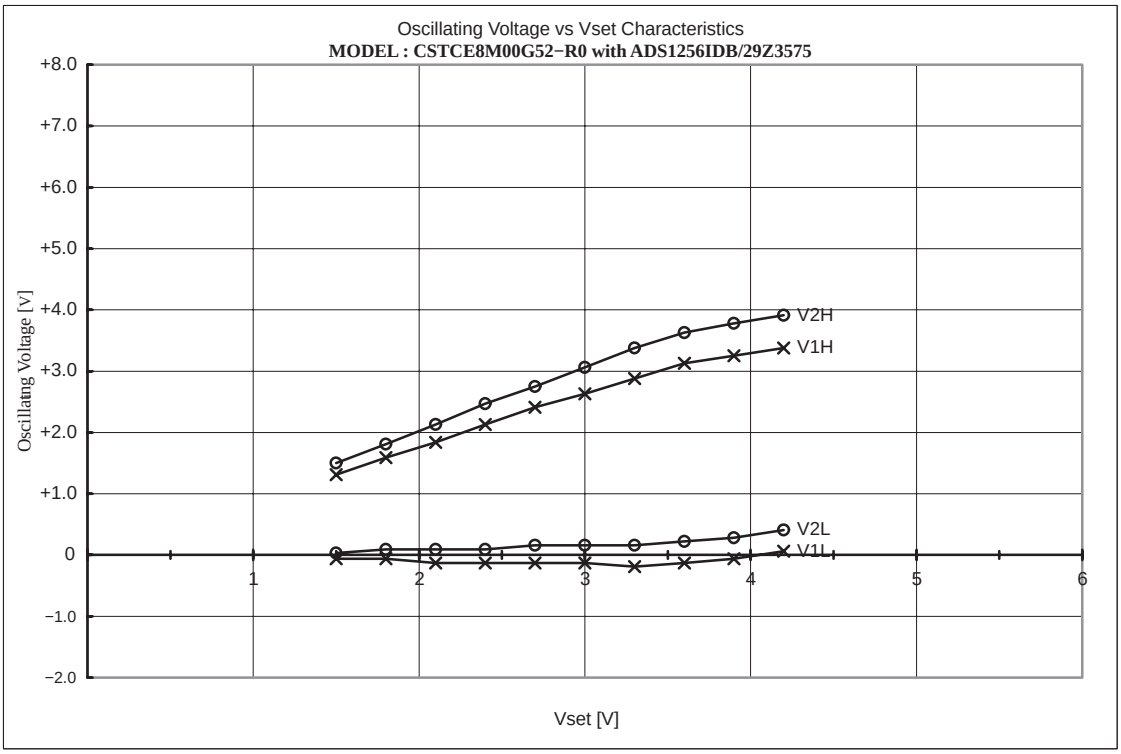




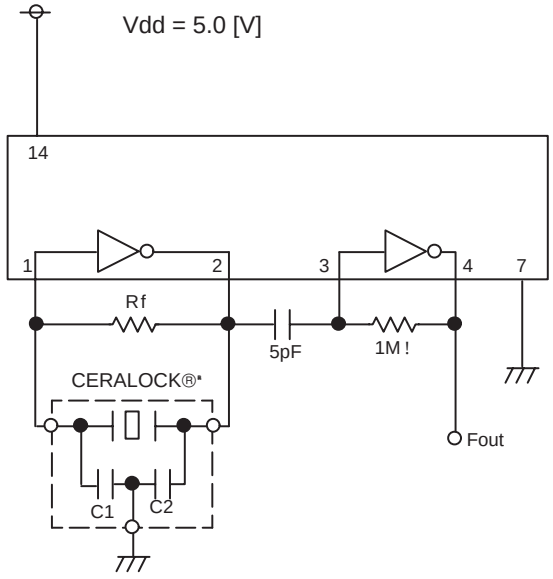


Murata Manufacturing Co., Ltd.

Frequency Correlation Data

Sample No.	ADS1256EVM Fosc [kHz]	Murata Standard Circuit Fosc [kHz]	Shift [%]
1	8049.594	8021.200	0.3540
2	8046.693	8019.200	0.3428
3	8048.569	8020.100	0.3550
4	8040.226	8012.400	0.3473
5	8049.746	8021.200	0.3559
$\bar{X}$	8046.966	8018.820	0.3510

muRata Standard Circuit



CERALOCK® : CSTCE8M00G52−R0
C1 = 10 [pF]
C2 = 10 [pF]
Rf = 1 [Mohm]

Murata Manufacturing Co., Ltd.

Appendix B. Murata Part Number CSTCR7M68G53−R0

Technical Data of Ceramic Resonator

MURATA Part No.: CSTCR7M68G53−R0

Applied to ADS1256IDB/29Z3575

Note: Suffix indicates packaging style.

·Lead type
- −A0 : Flat pack package(Ho=18mm)
- −B0 : Bulk

·SMD type
- −R0 : Plastic tape package(！=180mm)
- −B0 : Bulk

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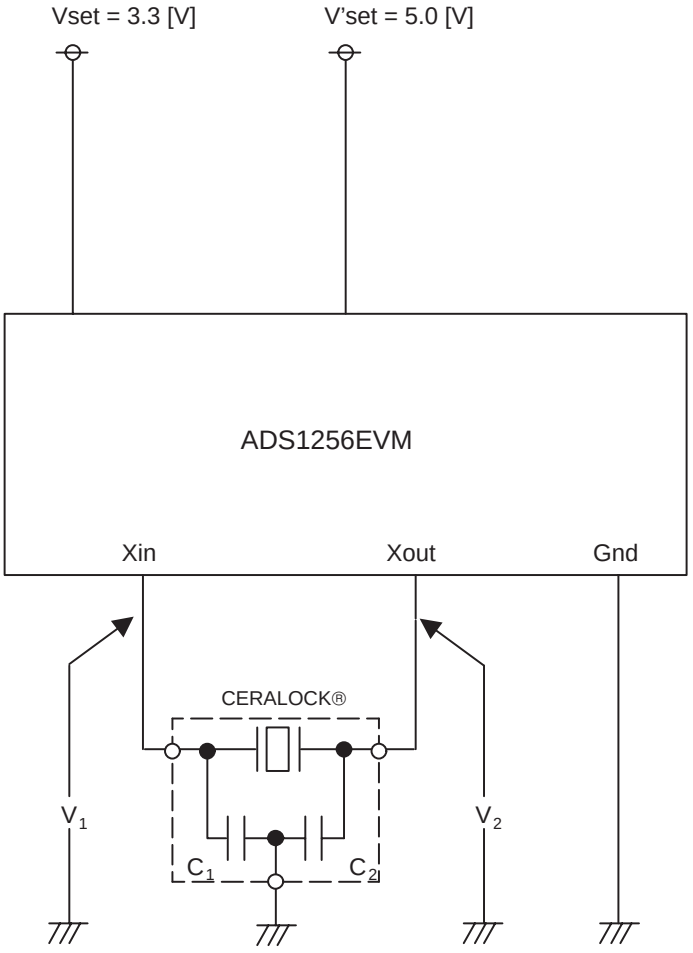
Murata Manufacturing Co., Ltd.

Test Circuit



Xin : 19

Xout: 18

Recommended Value

CERALOCK® : CSTCR7M68G53−R0

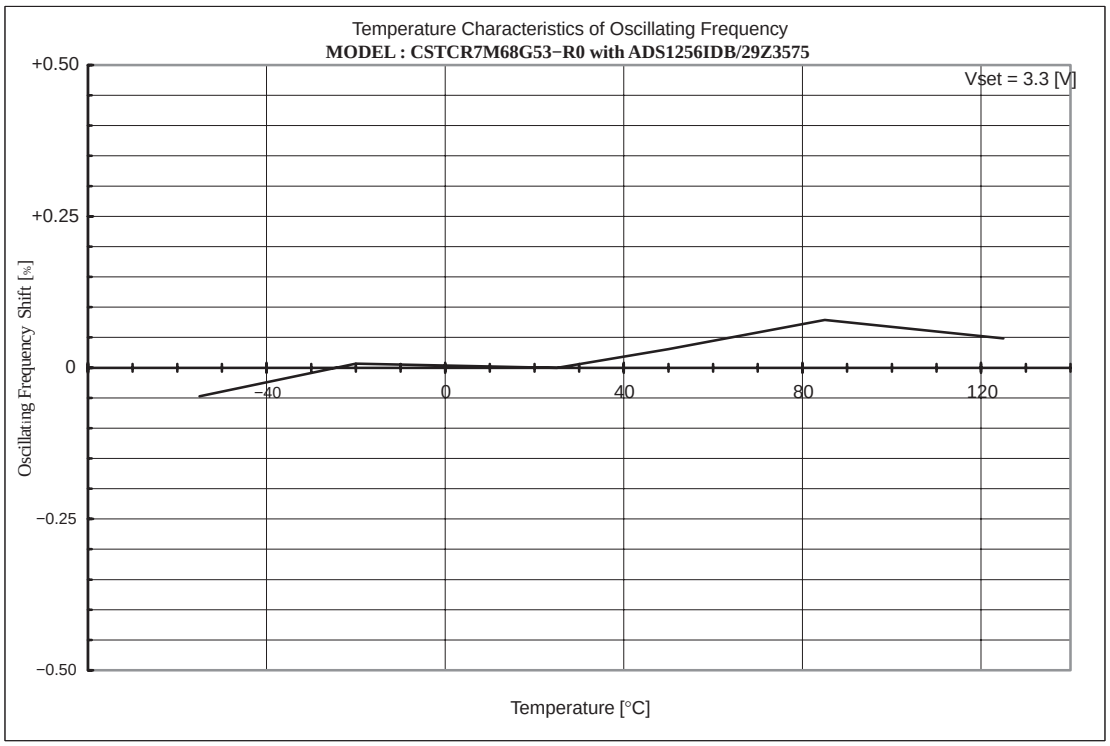
Vset = 2.3 to 3.6 [V]

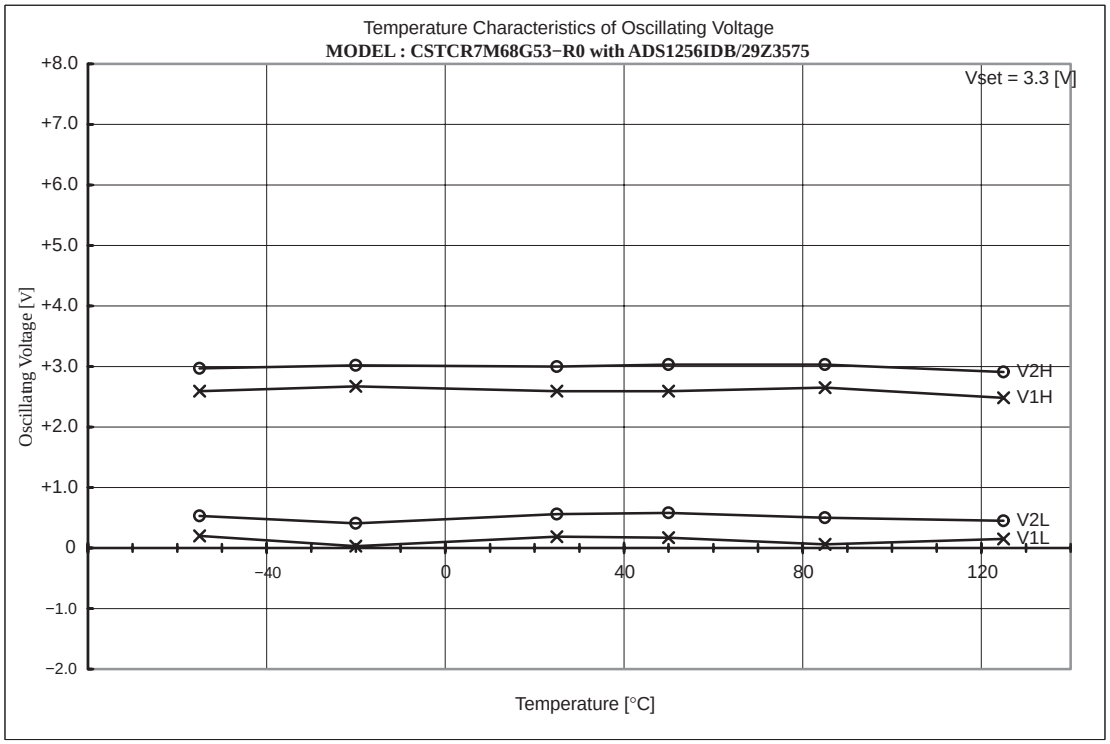
C1 = 15 [pF] (Typ.)

C2 = 15 [pF] (Typ.)

Ta = −40 to 85 [°C]

Murata Manufacturing Co., Ltd.





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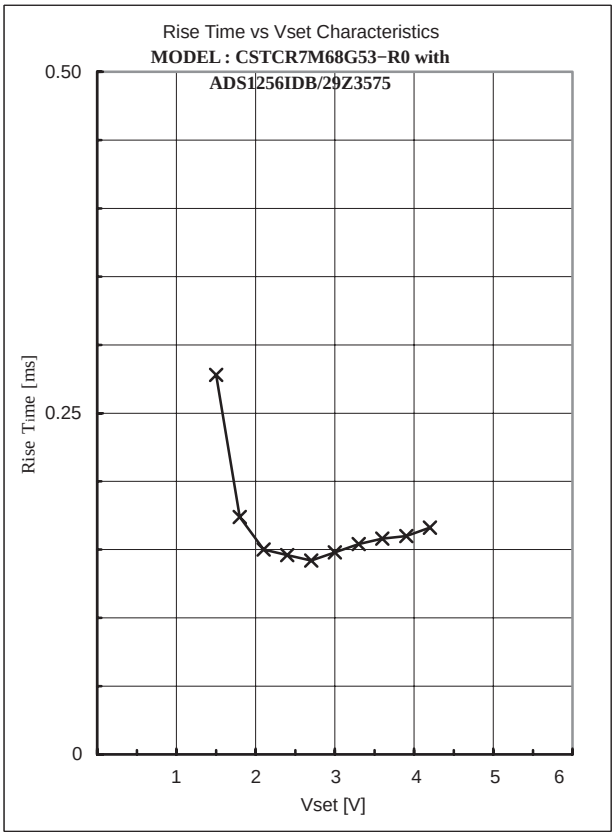
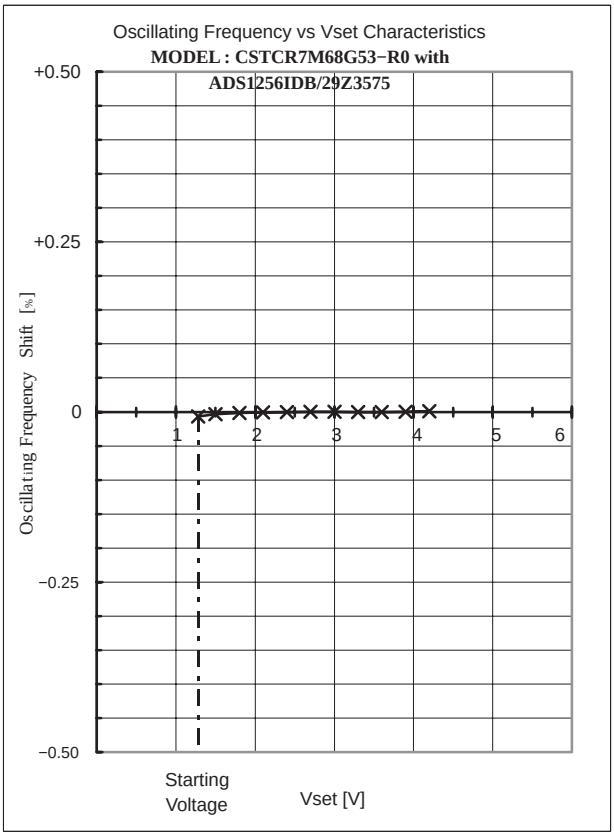
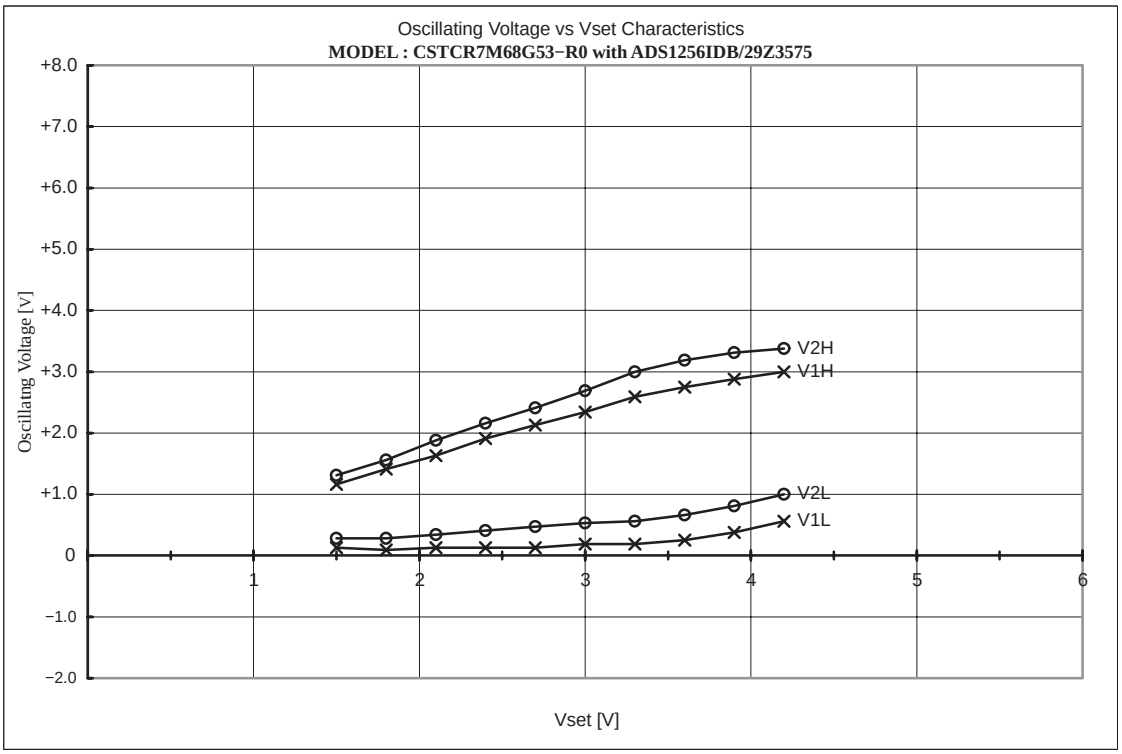




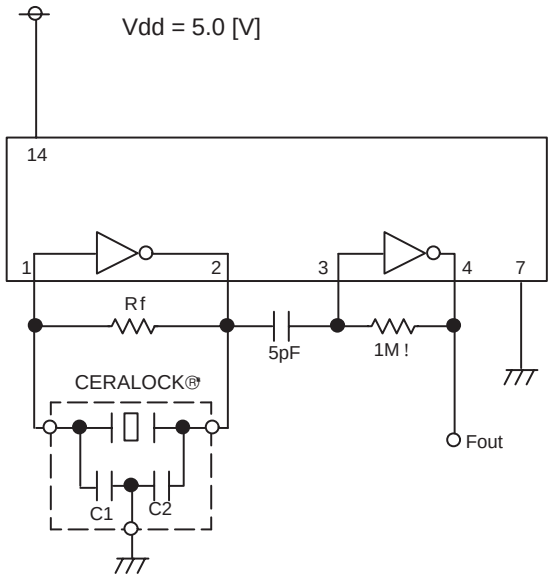


Murata Manufacturing Co., Ltd.

Frequency Correlation Data

Sample No.	ADS1256EVM Fosc [kHz]	Murata Standard Circuit Fosc [kHz]	Shift [%]
1	7013.597	6992.451	0.3024
2	7009.183	6988.824	0.2913
3	7014.502	6992.919	0.3087
4	7023.055	7002.287	0.2966
5	7016.344	6993.645	0.3246
$\bar{X}$	7015.336	6994.025	0.3047

muRata Standard Circuit



CERALOCK®: CSTCR7M00G53−R0

C1 = 15 [pF]

C2 = 15 [pF]

Rf = 1 [Mohm]

Murata Manufacturing Co., Ltd.

Appendix C. Murata Part Number CSTCR4M00G53−R0

Technical Data of Ceramic Resonator

MURATA Part No.: CSTCR4M00G53−R0

Applied to ADS1256IDB/29Z3575

Note: Suffix indicates packaging style.

·Lead type
- −A0 : Flat pack package(Ho=18mm)
- −B0 : Bulk

·SMD type
- −R0 : Plastic tape package(!=180mm)
- −B0 : Bulk

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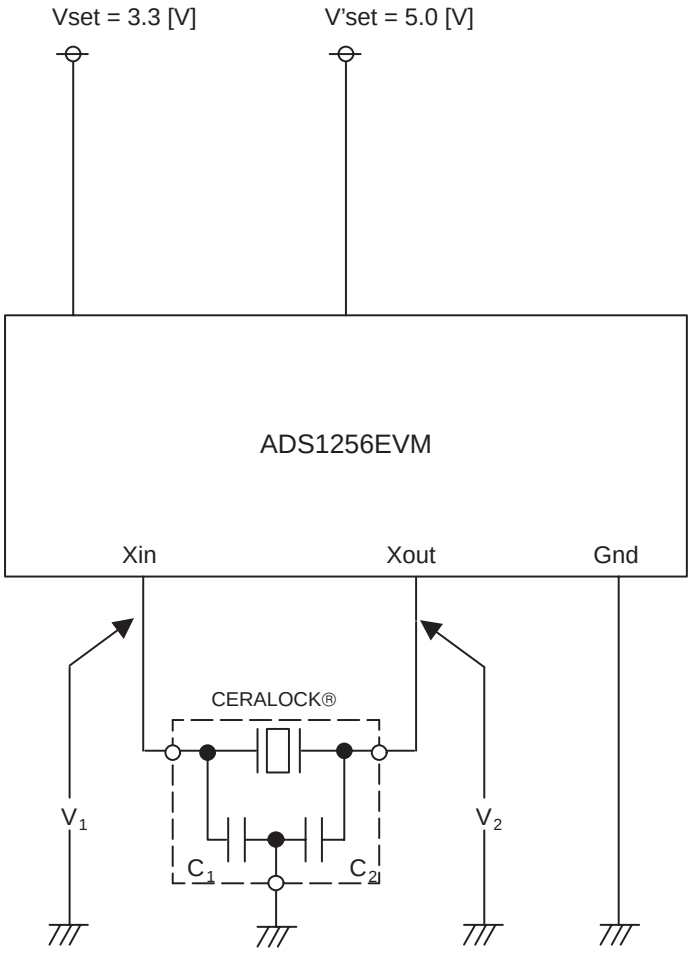
K.Kuramoto	K.Maruno	K.Masaki	K.Tagata	Mar 17, 2003	TCD−03−0464

Murata Manufacturing Co., Ltd.

Test Circuit



Xin : 19

Xout: 18

Recommended Value

CERALOCK® : CSTCR4M00G53−R0

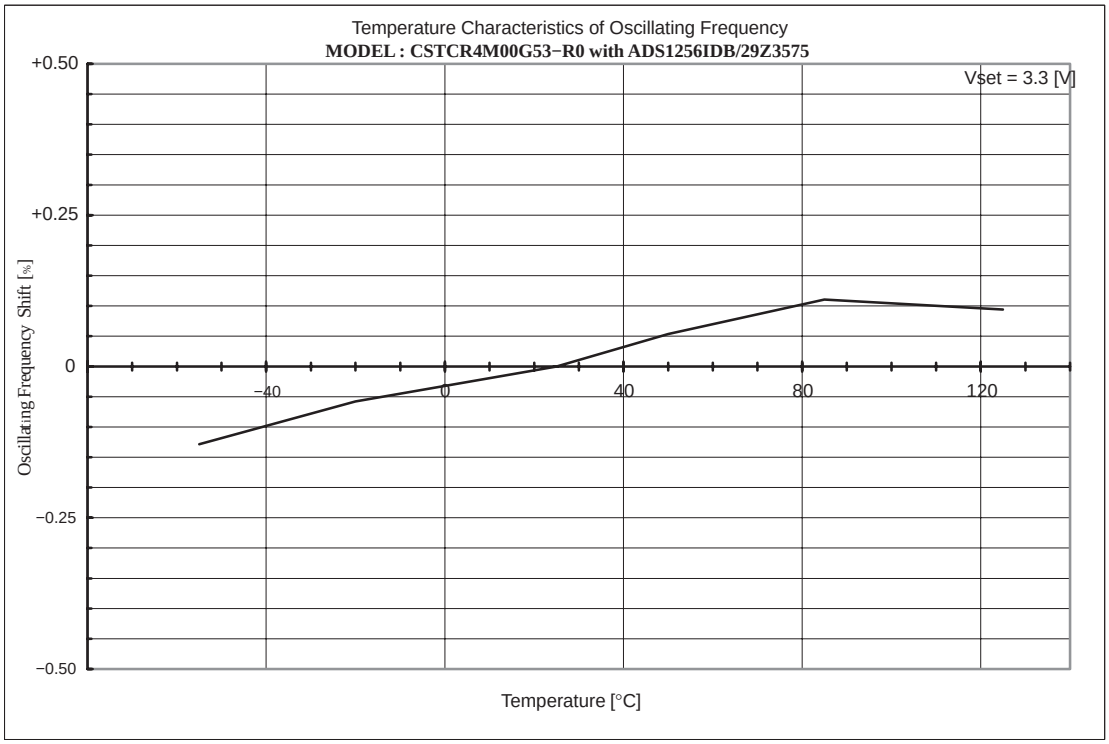
Vset = 1.5 to 3.6 [V]

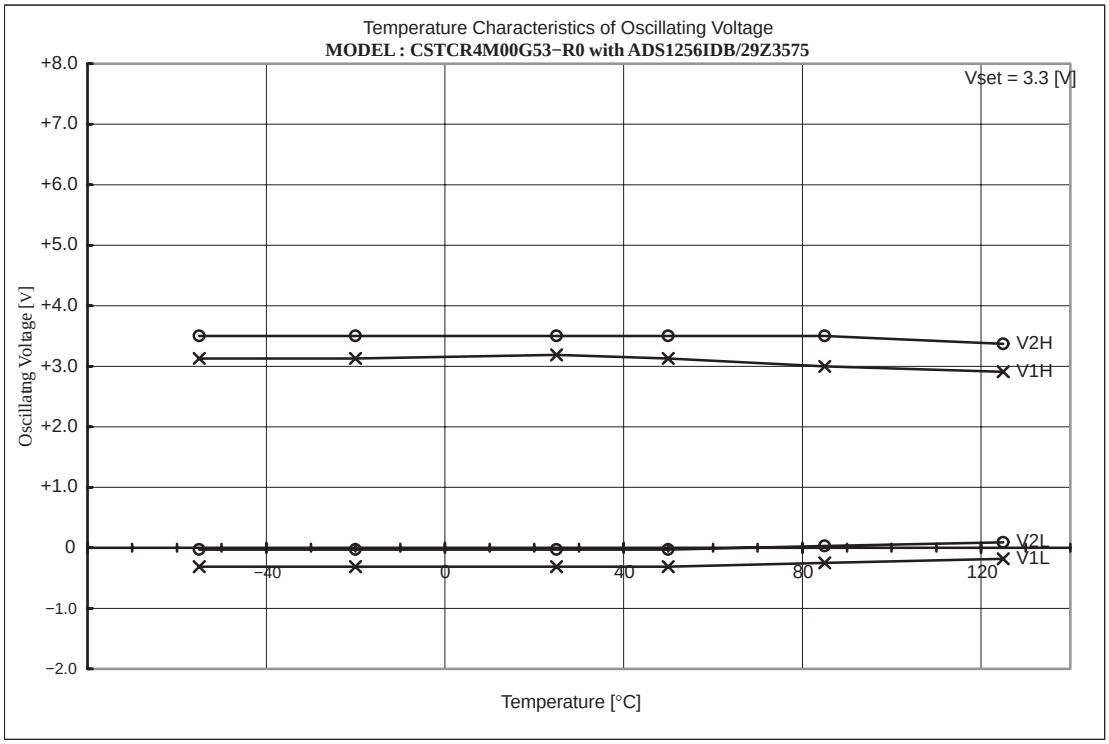
C1 = 15 [pF] (Typ.)

C2 = 15 [pF] (Typ.)

Ta = −40 to 85 [°C]

Murata Manufacturing Co., Ltd.





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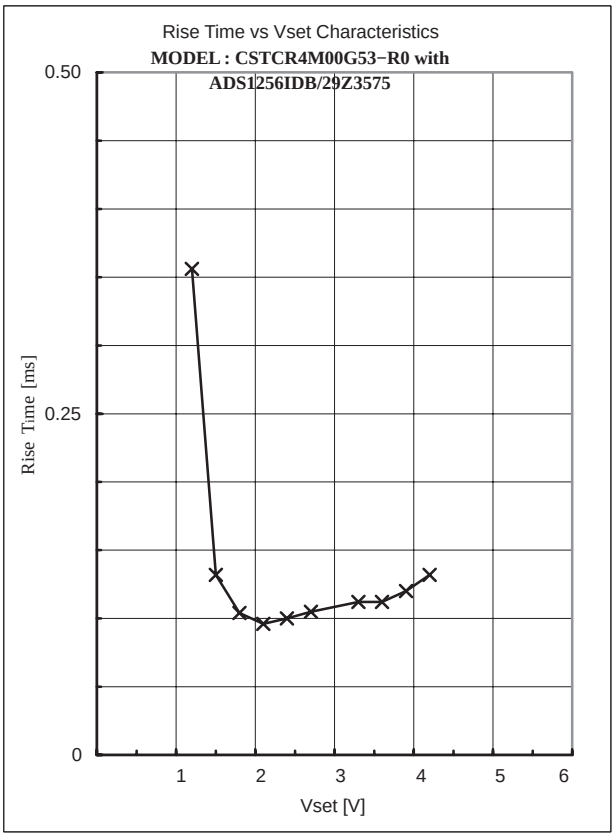
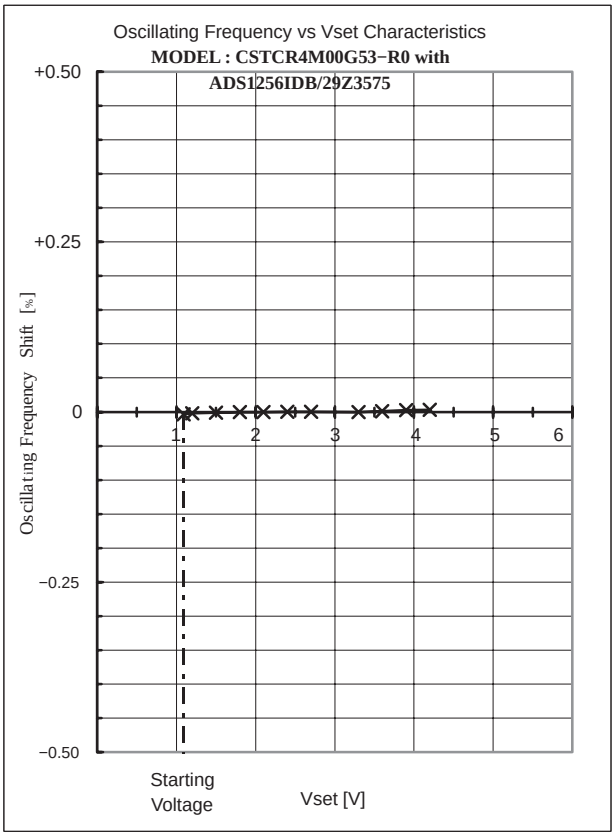
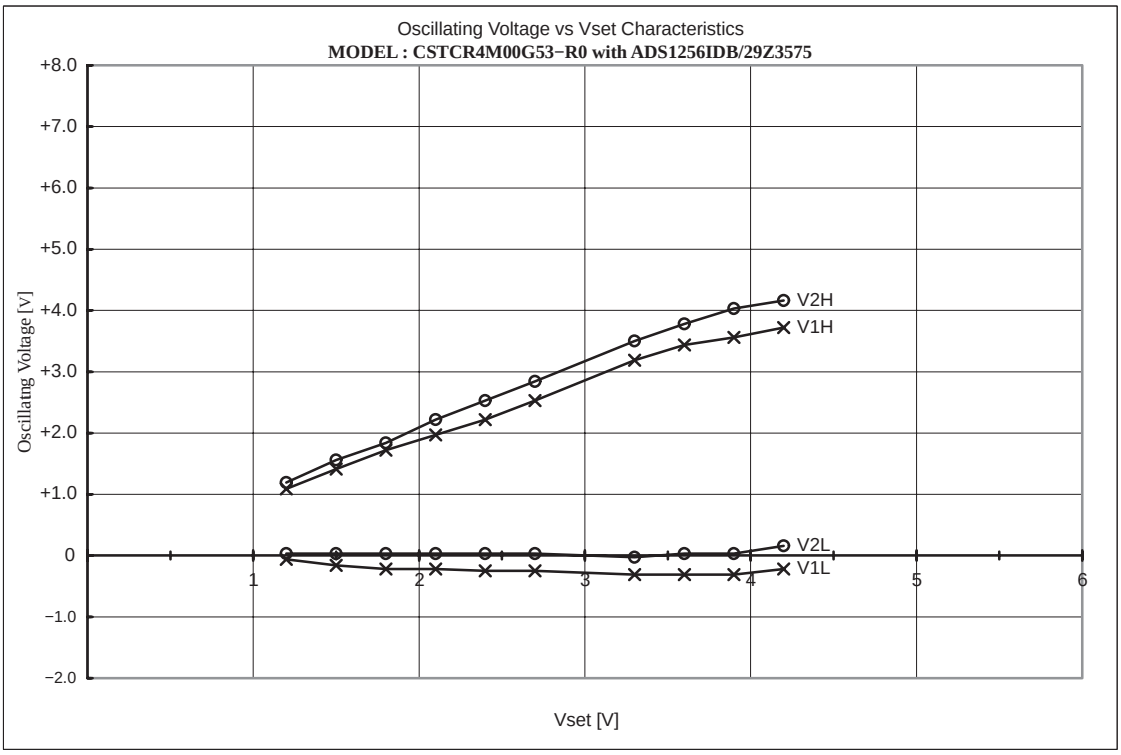




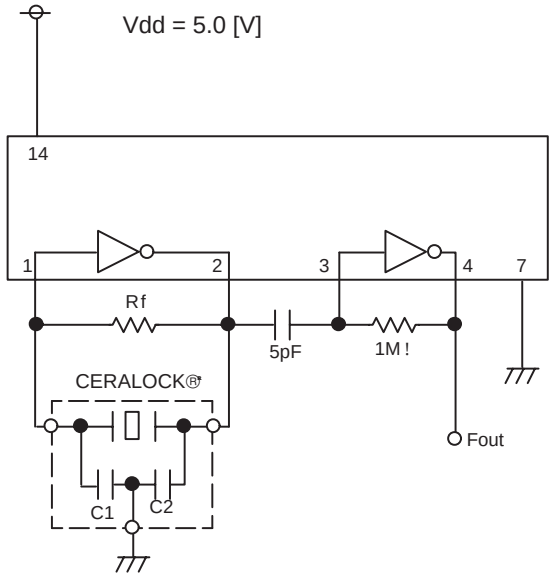


Murata Manufacturing Co., Ltd.

Frequency Correlation Data

Sample No.	ADS1256EVM Fosc [kHz]	Murata Standard Circuit Fosc [kHz]	Shift [%]
1	4004.829	3996.586	0.2063
2	4006.660	3997.551	0.2279
3	4010.776	4003.215	0.1889
4	4014.137	4007.093	0.1758
5	4009.408	4003.091	0.1578
$\bar{X}$	4009.162	4001.507	0.1913

muRata Standard Circuit



CERALOCK®: CSTCR4M00G53−R0

C1 = 15 [pF]

C2 = 15 [pF]

Rf = 1 [Mohm]

Murata Manufacturing Co., Ltd.

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