

## Crystal-less™ Configurable Two-Output Clock Generator for Automotive

### Features

- Automotive AEC-Q100 Qualified
- Two Simultaneous CMOS Outputs
  - Output 1 Range: 2.3 MHz to 170 MHz
  - Output 2 Range: 2.3 MHz to 170 MHz
- Low RMS Phase Jitter: <1 ps (typ.)
- High Stability:  $\pm 20$  ppm,  $\pm 25$  ppm,  $\pm 50$  ppm
- Wide Temperature Range:
  - Automotive Grade 1:  $-40^{\circ}\text{C}$  to  $+125^{\circ}\text{C}$
  - Automotive Grade 2:  $-40^{\circ}\text{C}$  to  $+105^{\circ}\text{C}$
  - Automotive Grade 3:  $-40^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$
- High Supply Noise Rejection:  $-50$  dBc
- High Shock and Vibration Immunity
  - Qualified to MIL-STD-883
- High Reliability
  - 20x higher MTBF than crystal-based clock generator designs
- Supply Range of 2.25 to 3.63V
- Lead-Free and RoHS Compliant

### Applications

- Automotive Infotainment
- Automotive ADAS
- Automotive Camera Module
- Automotive LIDAR and RADAR

### Benefits

- Replace High Temperature Crystals and Quartz Oscillators

### General Description

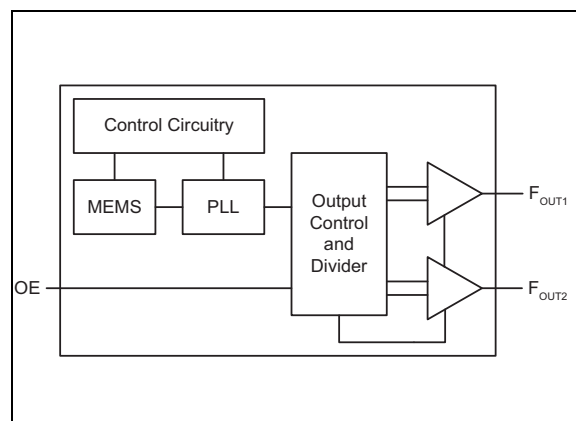
The DSA2311 is a crystal-less™ clock generator that is factory-configurable to simultaneously output two separate frequencies from 2.3 MHz to 170 MHz. The clock generator uses proven silicon MEMS technology to provide low jitter and high frequency stability across a wide range of supply voltages and temperatures. By eliminating the external quartz crystal, crystal-less clock generators significantly enhance reliability and accelerate product development, while meeting stringent clock performance criteria for a variety of consumer electronics, communications, and storage applications.

DSA2311 has an Output Enable/Disable feature that allows it to disable the outputs when OE is low. The device is available in a space-saving 6-pin 2.5 mm x 2.0 mm crystal-less VDFN package that uses only a single external bypass capacitor.

The two output frequencies can be customized by using Clockworks:

<http://clockworks.microchip.com/timing>

### Block Diagram



## 1.0 ELECTRICAL CHARACTERISTICS

### Absolute Maximum Ratings †

|                         |                              |
|-------------------------|------------------------------|
| Input Voltage, $V_{IN}$ | .....-0.3V to $V_{DD}$ +0.3V |
| Supply Voltage          | ..... -0.3V to + 4.0V        |
| ESD Protection (HBM)    | .....4 kV                    |
| ESD Protection (CDM)    | ..... 1.5 kV                 |

† **Notice:** Stresses above those listed under “Absolute Maximum Ratings” may cause permanent damage to the device. This is a stress rating only and functional operation of the device at those or any other conditions above those indicated in the operational sections of this specification is not intended. Exposure to maximum rating conditions for extended periods may affect device reliability.

**TABLE 1-1: ELECTRICAL CHARACTERISTICS**

| Parameters                   | Sym.       | Min.                 | Typ. | Max.                 | Units             | Conditions                                                                                     |
|------------------------------|------------|----------------------|------|----------------------|-------------------|------------------------------------------------------------------------------------------------|
| Supply Voltage (Note 1)      | $V_{DD}$   | 2.25                 | —    | 3.6                  | V                 | —                                                                                              |
| Supply Current (Note 2)      | $I_{DD}$   | —                    | 21   | 23                   | mA                | EN pin low. All outputs disabled.                                                              |
| Frequency Stability (Note 3) | $\Delta f$ | —                    | —    | $\pm 20$             | ppm               | Includes frequency variations due to initial tolerance, temperature, and power supply voltage. |
|                              |            | —                    | —    | $\pm 50$             |                   |                                                                                                |
| Aging                        | $\Delta f$ | —                    | —    | $\pm 5$              | ppm               | One year at +25°C                                                                              |
| Start-up Time (Note 4)       | $t_{SU}$   | —                    | —    | 5                    | ms                | T = +25°C                                                                                      |
| Input Logic Levels           | $V_{IH}$   | $0.75 \times V_{DD}$ | —    | —                    | V                 | Input logic high                                                                               |
|                              | $V_{IL}$   | —                    | —    | $0.25 \times V_{DD}$ |                   | Input logic low                                                                                |
| Output Disable Time          | $t_{DA}$   | —                    | —    | 5                    | ns                | —                                                                                              |
| Output Enable Time           | $t_{EN}$   | —                    | —    | 20                   | ns                | —                                                                                              |
| Pull-Up Resistor (Note 2)    | —          | —                    | 40   | —                    | k $\Omega$        | Pull-up exists on all digital IO                                                               |
| Output Logic Levels          | $V_{OH}$   | $0.9 \times V_{DD}$  | —    | —                    | V                 | Output logic high, I = $\pm 6$ mA                                                              |
|                              | $V_{OL}$   | —                    | —    | $0.1 \times V_{DD}$  |                   | Output logic low, I = $\pm 6$ mA                                                               |
| Output Transition Rise Time  | $t_R$      | —                    | 1.1  | 2.0                  | ns                | 20% to 80%; $C_L = 15$ pF                                                                      |
| Output Transition Rise Time  | $t_F$      | —                    | 1.4  | 2.0                  |                   | 20% to 80%; $C_L = 15$ pF                                                                      |
| Frequency                    | $f_0$      | 2.3                  | —    | 170                  | MHz               | Grade 3 temp. range                                                                            |
|                              |            | 3.3                  | —    | 100                  |                   | Grade 1 temp. range                                                                            |
|                              |            | 3.3                  | —    | 170                  |                   | Grade 2 temp. range                                                                            |
| Output Duty Cycle            | SYM        | 45                   | —    | 55                   | %                 | —                                                                                              |
| Period Jitter (Note 5)       | $J_{PER}$  | —                    | 3    | —                    | pS <sub>RMS</sub> | $F_{O1} = F_{O2} = 25$ MHz                                                                     |
| Integrated Phase Noise       | $J_{CC}$   | —                    | 0.3  | —                    | pS <sub>RMS</sub> | 200 kHz to 20 MHz @ 25 MHz                                                                     |
|                              |            | —                    | 0.38 | —                    |                   | 100 kHz to 20 MHz @ 25 MHz                                                                     |
|                              |            | —                    | 1.7  | 2                    |                   | 12 kHz to 20 MHz @ 25 MHz                                                                      |

- Note 1:** Pin 4  $V_{DD}$  should be filtered with a 0.01  $\mu$ F capacitor.
- Note 2:** Output is enabled if Enable pad is floated or not connected. Operating current = disabled current +  $\Delta I_{DD}$  from  $F_{OUT1}$  +  $\Delta I_{DD}$  from  $F_{OUT2}$ . See graph for more information.
- Note 3:** For other ppm stabilities, please contact the factory.
- Note 4:**  $t_{SU}$  is time to 100 ppm stable output frequency after  $V_{DD}$  is applied and outputs are enabled.
- Note 5:** Period jitter includes crosstalk from adjacent output.

## TEMPERATURE SPECIFICATIONS (Note 1)

| Parameters                      | Sym.  | Min. | Typ. | Max. | Units | Conditions        |
|---------------------------------|-------|------|------|------|-------|-------------------|
| <b>Temperature Ranges</b>       |       |      |      |      |       |                   |
| Operating Temperature Range (T) | $T_A$ | -40  | —    | +85  | °C    | Ordering Option I |
|                                 | $T_A$ | -40  | —    | +105 | °C    | Ordering Option L |
|                                 | $T_A$ | -40  | —    | +125 | °C    | Ordering Option A |
| Junction Operating Temperature  | $T_J$ | —    | —    | +150 | °C    | —                 |
| Storage Temperature Range       | $T_A$ | -40  | —    | +150 | °C    | —                 |
| Soldering Temperature Range     | $T_S$ | —    | —    | +260 | °C    | 40 sec. max.      |

**Note 1:** The maximum allowable power dissipation is a function of ambient temperature, the maximum allowable junction temperature and the thermal resistance from junction to air (i.e.,  $T_A$ ,  $T_J$ ,  $\theta_{JA}$ ). Exceeding the maximum allowable power dissipation will cause the device operating junction temperature to exceed the maximum +150°C rating. Sustained junction temperatures above +150°C can impact the device reliability.

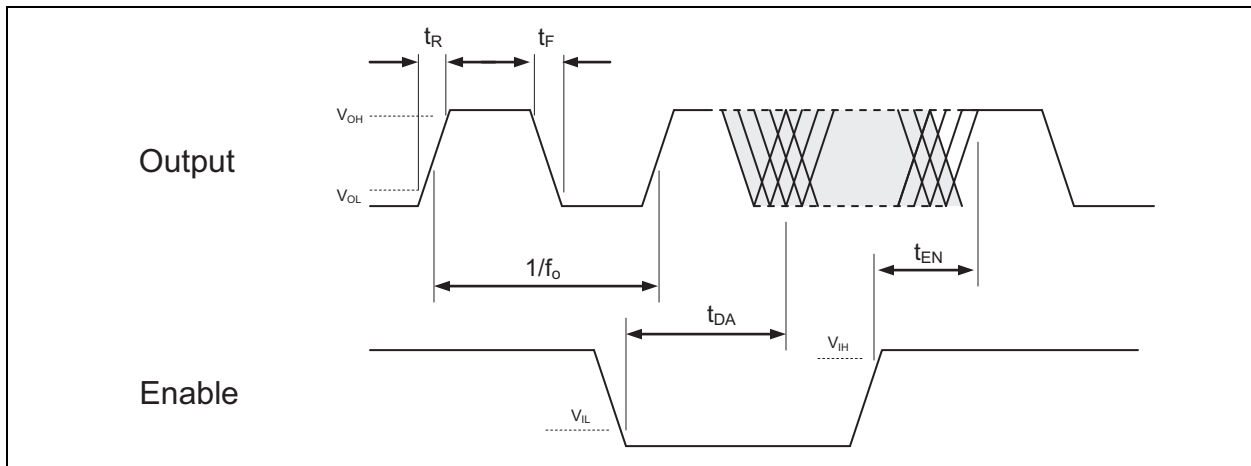
## 2.0 PIN DESCRIPTIONS

The descriptions of the pins are listed in [Table 2-1](#).

**TABLE 2-1: PIN FUNCTION TABLE**

| Pin Number | Pin Name | Description                           |
|------------|----------|---------------------------------------|
| 1          | ENABLE   | Output Enable for both CLK0 and CLK1. |
| 2          | N/C      | Do not connect.                       |
| 3          | GROUND   | Ground.                               |
| 4          | CLK0     | Clock Output 0 (CMOS).                |
| 5          | CLK1     | Clock Output 1 (CMOS).                |
| 6          | VDD      | Supply Voltage.                       |

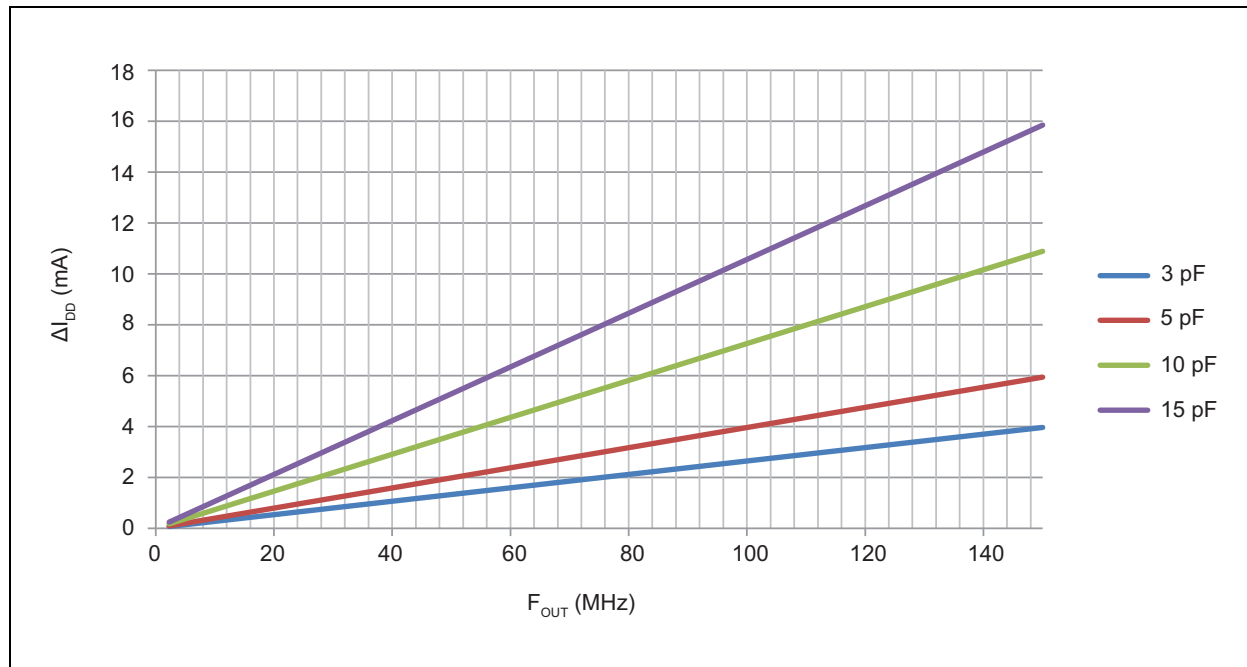
### 3.0 OUTPUT WAVEFORM



**FIGURE 3-1:** OE Function and Output Waveform: LVCMOS.

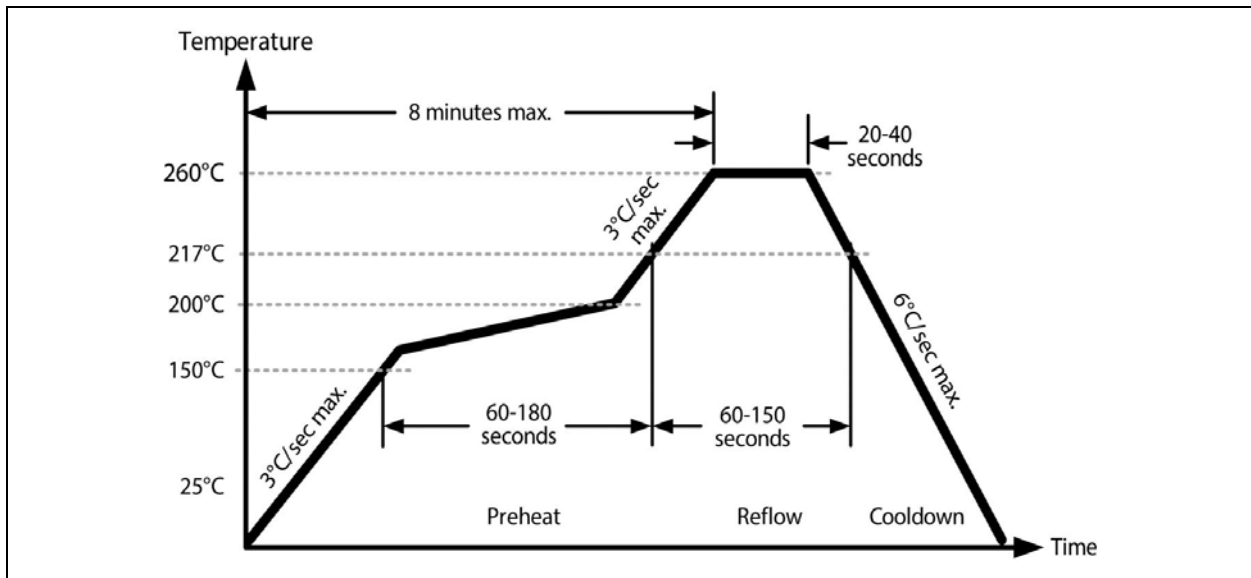
## 4.0 CURRENT CONSUMPTION

Total Current = Disabled Current +  $\Delta I_{DD} F_{OUT1}$  +  $\Delta I_{DD} F_{OUT2}$



**FIGURE 4-1:**  $\Delta I_{DD}$  / Output vs. Frequency and Load @ 3.3V  $V_{DD}$ .

## 5.0 SOLDER REFLOW PROFILE



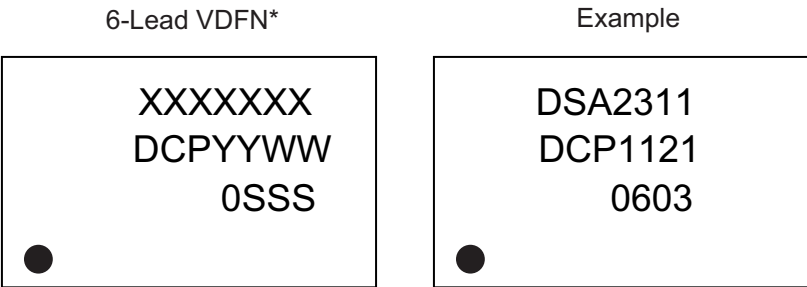
**FIGURE 5-1:** Solder Reflow Profile.

**TABLE 5-1: SOLDER REFLOW**

| MSL 1 @ 260°C Refer to JSTD-020C   |                |
|------------------------------------|----------------|
| Ramp-Up Rate (200°C to Peak Temp.) | 3°C/sec. max.  |
| Preheat Time 150°C to 200°C        | 60 to 180 sec. |
| Time Maintained above 217°C        | 60 to 150 sec. |
| Peak Temperature                   | 255°C to 260°C |
| Time within 5°C of Actual Peak     | 20 to 40 sec.  |
| Ramp-Down Rate                     | 6°C/sec. max.  |
| Time 25°C to Peak Temperature      | 8 minutes max. |

## 6.0 PACKAGING INFORMATION

### 6.1 Package Marking Information

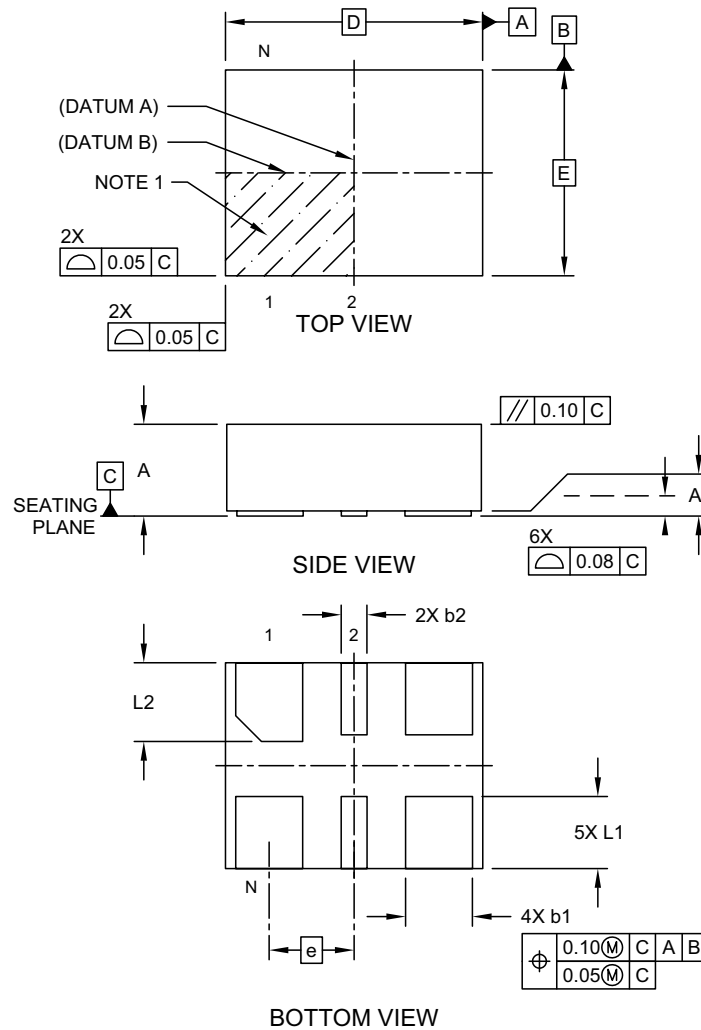


|                |                                                                                                                                                                                                                                                            |                                                                                                                    |
|----------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------|
| <b>Legend:</b> | XX...X                                                                                                                                                                                                                                                     | Product code, customer-specific information, or frequency in MHz without printed decimal point                     |
|                | Y                                                                                                                                                                                                                                                          | Year code (last digit of calendar year)                                                                            |
|                | YY                                                                                                                                                                                                                                                         | Year code (last 2 digits of calendar year)                                                                         |
|                | WW                                                                                                                                                                                                                                                         | Week code (week of January 1 is week '01')                                                                         |
|                | NNN                                                                                                                                                                                                                                                        | Alphanumeric traceability code                                                                                     |
|                | (e3)                                                                                                                                                                                                                                                       | Pb-free JEDEC® designator for Matte Tin (Sn)                                                                       |
|                | *                                                                                                                                                                                                                                                          | This package is Pb-free. The Pb-free JEDEC designator ((e3)) can be found on the outer packaging for this package. |
|                | •, ▲, ▼                                                                                                                                                                                                                                                    | Pin one index is identified by a dot, delta up, or delta down (triangle mark).                                     |
| <b>Note:</b>   | In the event the full Microchip part number cannot be marked on one line, it will be carried over to the next line, thus limiting the number of available characters for customer-specific information. Package may or may not include the corporate logo. |                                                                                                                    |
|                | Underbar ( _ ) and/or Overbar ( ¯ ) symbol may not be to scale.                                                                                                                                                                                            |                                                                                                                    |

## 6-Lead VDFN 2.5 mm x 2.0 mm Package Outline and Recommended Land Pattern

### 6-Lead Very Thin Dual Flatpack No-Leads (J7A) - 2.5x2.0 mm Body [VDFN]

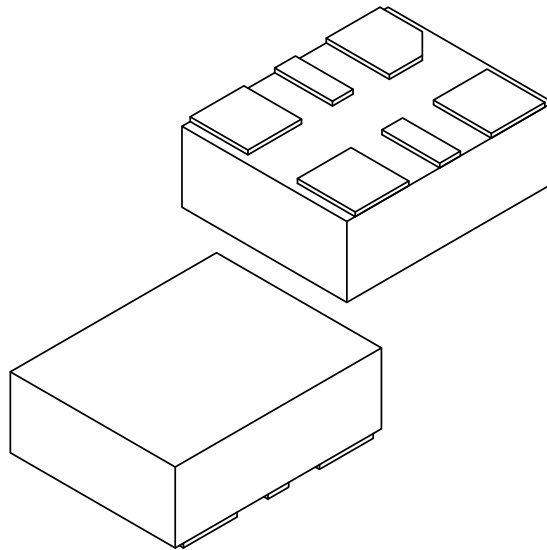
**Note:** For the most current package drawings, please see the Microchip Packaging Specification located at <http://www.microchip.com/packaging>



Microchip Technology Drawing C04-1005A Sheet 1 of 2

## 6-Lead Very Thin Dual Flatpack No-Leads (J7A) - 2.5x2.0 mm Body [VDFN]

**Note:** For the most current package drawings, please see the Microchip Packaging Specification located at <http://www.microchip.com/packaging>



| Units               |    | MILLIMETERS |       |       |
|---------------------|----|-------------|-------|-------|
| Dimension Limits    |    | MIN         | NOM   | MAX   |
| Number of Terminals | N  | 6           |       |       |
| Pitch               | e  | 0.825 BSC   |       |       |
| Overall Height      | A  | 0.80        | 0.85  | 0.90  |
| Standoff            | A1 | 0.00        | 0.02  | 0.05  |
| Overall Length      | D  | 2.50 BSC    |       |       |
| Overall Width       | E  | 2.00 BSC    |       |       |
| Terminal Width      | b1 | 0.60        | 0.65  | 0.70  |
| Terminal Width      | b2 | 0.20        | 0.25  | 0.30  |
| Terminal Length     | L1 | 0.60        | 0.70  | 0.80  |
| Terminal Length     | L2 | 0.665       | 0.765 | 0.865 |

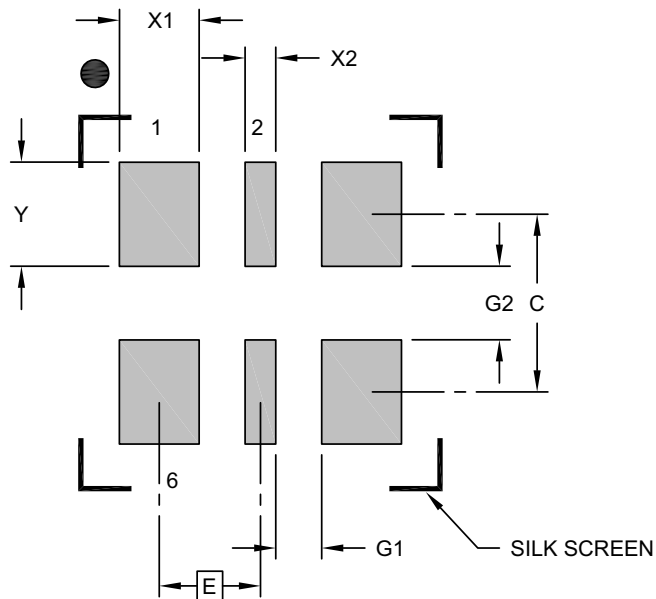
**Notes:**

- Pin 1 visual index feature may vary, but must be located within the hatched area.
- Package is saw singulated
- Dimensioning and tolerancing per ASME Y14.5M
  - BSC: Basic Dimension. Theoretically exact value shown without tolerances.
  - REF: Reference Dimension, usually without tolerance, for information purposes only.

Microchip Technology Drawing C04-1005A Sheet 2 of 2

## 6-Lead Very Thin Dual Flatpack No-Leads (J7A) - 2.5x2.0 mm Body [VDFN]

**Note:** For the most current package drawings, please see the Microchip Packaging Specification located at <http://www.microchip.com/packaging>



RECOMMENDED LAND PATTERN

| Dimension Limits            | Units | MILLIMETERS |           |      |
|-----------------------------|-------|-------------|-----------|------|
|                             |       | MIN         | NOM       | MAX  |
| Contact Pitch               | E     |             | 0.825 BSC |      |
| Contact Pad Width (X4)      | X1    |             |           | 0.65 |
| Contact Pad Width (X2)      | X2    |             |           | 0.25 |
| Contact Pad Length (X6)     | Y     |             |           | 0.85 |
| Contact Pad Spacing         | C     |             | 1.45      |      |
| Space Between Contacts (X4) | G1    | 0.38        |           |      |
| Space Between Contacts (X3) | G2    | 0.60        |           |      |

**Notes:**

- Dimensioning and tolerancing per ASME Y14.5M  
BSC: Basic Dimension. Theoretically exact value shown without tolerances.
- For best soldering results, thermal vias, if used, should be filled or tented to avoid solder loss during reflow process

Microchip Technology Drawing C04-3005A

NOTES:

## APPENDIX A: REVISION HISTORY

### Revision A (March 2018)

- Initial release of DSA2311 as Microchip data sheet DS20005893A.

NOTES:

## PRODUCT IDENTIFICATION SYSTEM

To order or obtain information, e.g., on pricing or delivery, contact your local Microchip representative or sales office.

| <u>PART NO.</u>           |  |  | <u>X</u> | <u>X</u>                                                            | <u>X</u>                    | <u>RXXXX</u> | <u>X</u>       |
|---------------------------|--|--|----------|---------------------------------------------------------------------|-----------------------------|--------------|----------------|
| Device                    |  |  | Package  | Temperature Range                                                   | Stability                   | Frequency    | Packing Option |
| <b>Device:</b>            |  |  | DSA2311: | Crystal-less Configurable Two-Output Clock Generator for Automotive |                             |              |                |
| <b>Package:</b>           |  |  | K        | =                                                                   | 6-LEAD 2.5 mm x 2.0 mm VDFN |              |                |
| <b>Temperature Range:</b> |  |  | A        | =                                                                   | -40°C to +125°C (Grade 1)   |              |                |
|                           |  |  | L        | =                                                                   | -40°C to +105°C (Grade 2)   |              |                |
|                           |  |  | I        | =                                                                   | -40°C to +85°C (Grade 3)    |              |                |
| <b>Stability:</b>         |  |  | 1        | =                                                                   | ±50 ppm                     |              |                |
|                           |  |  | 2        | =                                                                   | ±25 ppm                     |              |                |
|                           |  |  | 3        | =                                                                   | ±20 ppm                     |              |                |
| <b>Frequency:</b>         |  |  | Rxxxx    | =                                                                   | Custom Frequency Code       |              |                |
| <b>Packing Option:</b>    |  |  | <blank>  | =                                                                   | Tube                        |              |                |
|                           |  |  | T        | =                                                                   | Tape & Reel                 |              |                |

**Examples:**

a) DSA2311KL1-Rxxxx    Crystal-less Configurable Two-Output Clock Generator, 6-LD VDFN, Grade 2 Temp. Range, ±50 ppm Stability, Custom Frequency (F<sub>OUT1</sub> and F<sub>OUT2</sub>), Tube

b) DSA2311KI3-Rxxxx    Crystal-less Configurable Two-Output Clock Generator, 6-LD VDFN, Grade 3 Temp. Range, ±20 ppm Stability, Custom Frequency (F<sub>OUT1</sub> and F<sub>OUT2</sub>), Tube

**Note 1:**    Tape and Reel identifier only appears in the catalog part number description. This identifier is used for ordering purposes and is not printed on the device package. Check with your Microchip Sales Office for package availability with the Tape and Reel option.

**Output Clock Frequencies**

Output frequencies are factory-configured to individual customer and product requirements, subject to output control and divider limitations. Contact sales with your custom frequency needs.

<http://clockworks.microchip.com/timing/>

| Frequency Code | F <sub>OUT1</sub> (MHz) | F <sub>OUT2</sub> (MHz) |
|----------------|-------------------------|-------------------------|
| R0001          | 127                     | 127                     |
| R0002          | 25                      | 125                     |

NOTES:

---

**Note the following details of the code protection feature on Microchip devices:**

- Microchip products meet the specification contained in their particular Microchip Data Sheet.
- Microchip believes that its family of products is one of the most secure families of its kind on the market today, when used in the intended manner and under normal conditions.
- There are dishonest and possibly illegal methods used to breach the code protection feature. All of these methods, to our knowledge, require using the Microchip products in a manner outside the operating specifications contained in Microchip's Data Sheets. Most likely, the person doing so is engaged in theft of intellectual property.
- Microchip is willing to work with the customer who is concerned about the integrity of their code.
- Neither Microchip nor any other semiconductor manufacturer can guarantee the security of their code. Code protection does not mean that we are guaranteeing the product as "unbreakable."

Code protection is constantly evolving. We at Microchip are committed to continuously improving the code protection features of our products. Attempts to break Microchip's code protection feature may be a violation of the Digital Millennium Copyright Act. If such acts allow unauthorized access to your software or other copyrighted work, you may have a right to sue for relief under that Act.

---

Information contained in this publication regarding device applications and the like is provided only for your convenience and may be superseded by updates. It is your responsibility to ensure that your application meets with your specifications. MICROCHIP MAKES NO REPRESENTATIONS OR WARRANTIES OF ANY KIND WHETHER EXPRESS OR IMPLIED, WRITTEN OR ORAL, STATUTORY OR OTHERWISE, RELATED TO THE INFORMATION, INCLUDING BUT NOT LIMITED TO ITS CONDITION, QUALITY, PERFORMANCE, MERCHANTABILITY OR FITNESS FOR PURPOSE. Microchip disclaims all liability arising from this information and its use. Use of Microchip devices in life support and/or safety applications is entirely at the buyer's risk, and the buyer agrees to defend, indemnify and hold harmless Microchip from any and all damages, claims, suits, or expenses resulting from such use. No licenses are conveyed, implicitly or otherwise, under any Microchip intellectual property rights unless otherwise stated.

*Microchip received ISO/TS-16949:2009 certification for its worldwide headquarters, design and wafer fabrication facilities in Chandler and Tempe, Arizona; Gresham, Oregon and design centers in California and India. The Company's quality system processes and procedures are for its PIC® MCUs and dsPIC® DSCs, KEELOQ® code hopping devices, Serial EEPROMs, microperipherals, nonvolatile memory and analog products. In addition, Microchip's quality system for the design and manufacture of development systems is ISO 9001:2000 certified.*

**QUALITY MANAGEMENT SYSTEM**  
**CERTIFIED BY DNV**  
**== ISO/TS 16949 ==**

### Trademarks

The Microchip name and logo, the Microchip logo, AnyRate, AVR, AVR logo, AVR Freaks, BeaconThings, BitCloud, CryptoMemory, CryptoRF, dsPIC, FlashFlex, flexPWR, Helder, JukeBlox, KEELOQ, KEELOQ logo, Klear, LANCheck, LINK MD, maxStylus, maxTouch, MediaLB, megaAVR, MOST, MOST logo, MPLAB, OptoLyzer, PIC, picoPower, PICSTART, PIC32 logo, Prochip Designer, QTouch, RightTouch, SAM-BA, SpyNIC, SST, SST Logo, SuperFlash, tinyAVR, UNI/O, and XMEGA are registered trademarks of Microchip Technology Incorporated in the U.S.A. and other countries.

ClockWorks, The Embedded Control Solutions Company, EtherSynch, Hyper Speed Control, HyperLight Load, IntelliMOS, mTouch, Precision Edge, and Quiet-Wire are registered trademarks of Microchip Technology Incorporated in the U.S.A.

Adjacent Key Suppression, AKS, Analog-for-the-Digital Age, Any Capacitor, AnyIn, AnyOut, BodyCom, chipKIT, chipKIT logo, CodeGuard, CryptoAuthentication, CryptoCompanion, CryptoController, dsPICDEM, dsPICDEM.net, Dynamic Average Matching, DAM, ECAN, EtherGREEN, In-Circuit Serial Programming, ICSP, Inter-Chip Connectivity, JitterBlocker, KlearNet, KlearNet logo, Mindi, MiWi, motorBench, MPASM, MPF, MPLAB Certified logo, MPLIB, MPLINK, MultiTRAK, NetDetach, Omniscient Code Generation, PICDEM, PICDEM.net, PICKit, PICtail, PureSilicon, QMatrix, RightTouch logo, REAL ICE, Ripple Blocker, SAM-ICE, Serial Quad I/O, SMART-I.S., SQI, SuperSwitcher, SuperSwitcher II, Total Endurance, TSHARC, USBCheck, VariSense, ViewSpan, WiperLock, Wireless DNA, and ZENA are trademarks of Microchip Technology Incorporated in the U.S.A. and other countries.

SQTP is a service mark of Microchip Technology Incorporated in the U.S.A.

Silicon Storage Technology is a registered trademark of Microchip Technology Inc. in other countries.

GestIC is a registered trademark of Microchip Technology Germany II GmbH & Co. KG, a subsidiary of Microchip Technology Inc., in other countries.

All other trademarks mentioned herein are property of their respective companies.

© 2017, Microchip Technology Incorporated, All Rights Reserved.  
ISBN: 978-1-5224-2773-5

## Worldwide Sales and Service

### AMERICAS

**Corporate Office**  
2355 West Chandler Blvd.  
Chandler, AZ 85224-6199  
Tel: 480-792-7200  
Fax: 480-792-7277  
Technical Support:  
<http://www.microchip.com/support>  
Web Address:  
[www.microchip.com](http://www.microchip.com)

**Atlanta**  
Duluth, GA  
Tel: 678-957-9614  
Fax: 678-957-1455

**Austin, TX**  
Tel: 512-257-3370

**Boston**  
Westborough, MA  
Tel: 774-760-0087  
Fax: 774-760-0088

**Chicago**  
Itasca, IL  
Tel: 630-285-0071  
Fax: 630-285-0075

**Dallas**  
Addison, TX  
Tel: 972-818-7423  
Fax: 972-818-2924

**Detroit**  
Novi, MI  
Tel: 248-848-4000

**Houston, TX**  
Tel: 281-894-5983

**Indianapolis**  
Noblesville, IN  
Tel: 317-773-8323  
Fax: 317-773-5453  
Tel: 317-536-2380

**Los Angeles**  
Mission Viejo, CA  
Tel: 949-462-9523  
Fax: 949-462-9608  
Tel: 951-273-7800

**Raleigh, NC**  
Tel: 919-844-7510

**New York, NY**  
Tel: 631-435-6000

**San Jose, CA**  
Tel: 408-735-9110  
Tel: 408-436-4270

**Canada - Toronto**  
Tel: 905-695-1980  
Fax: 905-695-2078

### ASIA/PACIFIC

**Australia - Sydney**  
Tel: 61-2-9868-6733

**China - Beijing**  
Tel: 86-10-8569-7000

**China - Chengdu**  
Tel: 86-28-8665-5511

**China - Chongqing**  
Tel: 86-23-8980-9588

**China - Dongguan**  
Tel: 86-769-8702-9880

**China - Guangzhou**  
Tel: 86-20-8755-8029

**China - Hangzhou**  
Tel: 86-571-8792-8115

**China - Hong Kong SAR**  
Tel: 852-2943-5100

**China - Nanjing**  
Tel: 86-25-8473-2460

**China - Qingdao**  
Tel: 86-532-8502-7355

**China - Shanghai**  
Tel: 86-21-3326-8000

**China - Shenyang**  
Tel: 86-24-2334-2829

**China - Shenzhen**  
Tel: 86-755-8864-2200

**China - Suzhou**  
Tel: 86-186-6233-1526

**China - Wuhan**  
Tel: 86-27-5980-5300

**China - Xian**  
Tel: 86-29-8833-7252

**China - Xiamen**  
Tel: 86-592-2388138

**China - Zhuhai**  
Tel: 86-756-3210040

### ASIA/PACIFIC

**India - Bangalore**  
Tel: 91-80-3090-4444

**India - New Delhi**  
Tel: 91-11-4160-8631

**India - Pune**  
Tel: 91-20-4121-0141

**Japan - Osaka**  
Tel: 81-6-6152-7160

**Japan - Tokyo**  
Tel: 81-3-6880-3770

**Korea - Daegu**  
Tel: 82-53-744-4301

**Korea - Seoul**  
Tel: 82-2-554-7200

**Malaysia - Kuala Lumpur**  
Tel: 60-3-7651-7906

**Malaysia - Penang**  
Tel: 60-4-227-8870

**Philippines - Manila**  
Tel: 63-2-634-9065

**Singapore**  
Tel: 65-6334-8870

**Taiwan - Hsin Chu**  
Tel: 886-3-577-8366

**Taiwan - Kaohsiung**  
Tel: 886-7-213-7830

**Taiwan - Taipei**  
Tel: 886-2-2508-8600

**Thailand - Bangkok**  
Tel: 66-2-694-1351

**Vietnam - Ho Chi Minh**  
Tel: 84-28-5448-2100

### EUROPE

**Austria - Wels**  
Tel: 43-7242-2244-39  
Fax: 43-7242-2244-393

**Denmark - Copenhagen**  
Tel: 45-4450-2828  
Fax: 45-4485-2829

**Finland - Espoo**  
Tel: 358-9-4520-820

**France - Paris**  
Tel: 33-1-69-53-63-20  
Fax: 33-1-69-30-90-79

**Germany - Garching**  
Tel: 49-8931-9700

**Germany - Haan**  
Tel: 49-2129-3766400

**Germany - Heilbronn**  
Tel: 49-7131-67-3636

**Germany - Karlsruhe**  
Tel: 49-721-625370

**Germany - Munich**  
Tel: 49-89-627-144-0  
Fax: 49-89-627-144-44

**Germany - Rosenheim**  
Tel: 49-8031-354-560

**Israel - Ra'anana**  
Tel: 972-9-744-7705

**Italy - Milan**  
Tel: 39-0331-742611  
Fax: 39-0331-466781

**Italy - Padova**  
Tel: 39-049-7625286

**Netherlands - Drunen**  
Tel: 31-416-690399  
Fax: 31-416-690340

**Norway - Trondheim**  
Tel: 47-7289-7561

**Poland - Warsaw**  
Tel: 48-22-3325737

**Romania - Bucharest**  
Tel: 40-21-407-87-50

**Spain - Madrid**  
Tel: 34-91-708-08-90  
Fax: 34-91-708-08-91

**Sweden - Gothenberg**  
Tel: 46-31-704-60-40

**Sweden - Stockholm**  
Tel: 46-8-5090-4654

**UK - Wokingham**  
Tel: 44-118-921-5800  
Fax: 44-118-921-5820