DSA400

Configurable Four Output, Low Jitter Clock Generator for Automotive

Features

- AEC-Q100 Automotive Qualified
- Low RMS Phase Jitter: <1 ps (typ.)
- Complies with PCIe Gen1/2/3/4 Common Clock Spec
- High Stability: ±25 ppm, ±50 ppm
- Wide Temperature Range:
  - Automotive Grade 2: –40°C to +105°C
  - Automotive Grade 3: –40°C to +85°C
- High Supply Noise Rejection: –50 dBc
- Four Format-Configurable Outputs:
  - LVPECL, LVDS, HCSL, LVCMOS
- Available Pin-Selectable Frequency Table
  - 1 Pin per Bank for 2 Frequency Sets
- Wide Frequency Range:
  - 2.3 MHz – 460 MHz
- 20-Pin QFN Footprint (5.0 mm x 3.2 mm)
- Excellent Shock and Vibration Immunity
- High Reliability
  - 20x better MTF than quartz-based devices
- Wide Supply Range of 2.25V to 3.6V
- Lead Free and RoHS-Compliant

Applications

- Automotive Infotainment
- Automotive ADAS
- Autonomous Driving
- In-Vehicle Network

General Description

The DSA400 is a four output clock generator. It utilizes proven PureSilicon™ MEMS technology to provide excellent jitter and stability while incorporating additional device functionality.

The nominal frequencies of the outputs can be identical or independently derived from common PLLs.

The four output DSA400 MEMS oscillators are excellent choices for use as clock references in automotive applications in which small size, low power consumption, and long-term reliability are paramount. The DSA400 is AEC-Q100 qualified.

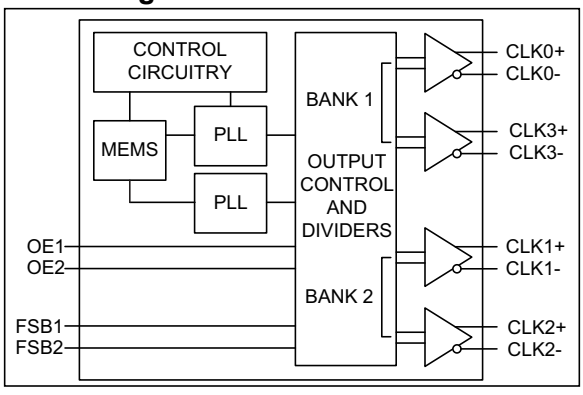
Each output may be configured independently to support a single-ended LVCMOS interface or a differential interface. Differential options include LVPECL, LVDS, or HCSL.

The DSA400 provides two independent select lines for choosing between two sets of pre-configured frequencies per bank. It also has two OE pins to allow for enabling and disabling outputs.

The DSA400 is packaged in a 20-pin QFN (5 mm x 3.2 mm) and is available in extended commercial and industrial temperature grades.

The DSA400 is a highly configurable device and is factory programmed to meet the customer's needs. Microchip's ClockWorks Configurator must be used to choose the necessary options, create the final part number, data sheet, and order samples.

Block Diagram



1.0 ELECTRICAL CHARACTERISTICS

Absolute Maximum Ratings †

Supply Voltage ..... –0.3V to +4.0V
Input Voltage ..... –0.3V to V_{DD}+0.3V
ESD Protection (HBM) ..... 4 kV
ESD Protection (MM) 400V
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.

ELECTRICAL CHARACTERISTICS

Electrical Charcteristics: V_{DD} = 3.3V; T_A = +25°C unless otherwise specified.

Parameters	Symbol	Min.	Typ.	Max.	Units	Conditions
Supply Voltage (Note 1)	V_{DD}	2.25	—	3.6	V	—
Core Supply Current (Note 2)	I_{DDCORE}	—	40	44	mA	OE(1:2) = 0. All outputs disabled.
Frequency Stability	Δf	—	—	±25	ppm	All temperature and V_{DD} ranges.
		—	—	±50		
Aging - First Year	Δf_{Y1}	—	—	±5	ppm	One year at +25°C
Aging - After First Year	Δf_{Y2}+	—	—	<±1	ppm/yr	Year two and beyond at +25°C
Start-up Time (Note 3)	t_{SU}	—	—	5	ms	T = +25°C
Input Logic Levels	V_{IH}	0.75 x V_{DD}	—	—	V	Input logic high
	V_{IL}	—	—	0.25 x V_{DD}		Input logic low
Output Disable Time (Note 4)	t_{DA}	—	—	5	ns	OE(1:2) transition from 1 to 0
Output Enable Time (Note 4)	t_{EN}	—	—	20	ns	OE(1:2) transition from 0 to 1
Pull-Up Resistor	R_{PU}	—	40	—	kΩ	All input pins have an internal pull-up

Note 1: V_{DD} pins should be filtered with a 0.1 µF capacitor connected between V_{DD} and V_{SS}.
2: The addition of I_{DDCORE} and I_{DDIO} provides the total current consumption of the device.
3: t_{SU} is time to 100 ppm stable output frequency after V_{DD} is applied and outputs are enabled.
4: See the Output Waveform section for more information.

TEMPERATURE SPECIFICATIONS (Note 1)

Parameters	Symbol	Min.	Typ.	Max.	Units	Conditions
Temperature Ranges						
Operating Temperature Range (T)	T_A	–40	—	+105	°C	Ordering Option L
	T_A	–40	—	+85	°C	Ordering Option I
Junction Temperature	T_J	—	—	+150	°C	—
Storage Temperature Range	T_S	–40	—	+150	°C	—
Soldering Temperature	—	—	—	+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, θ_{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

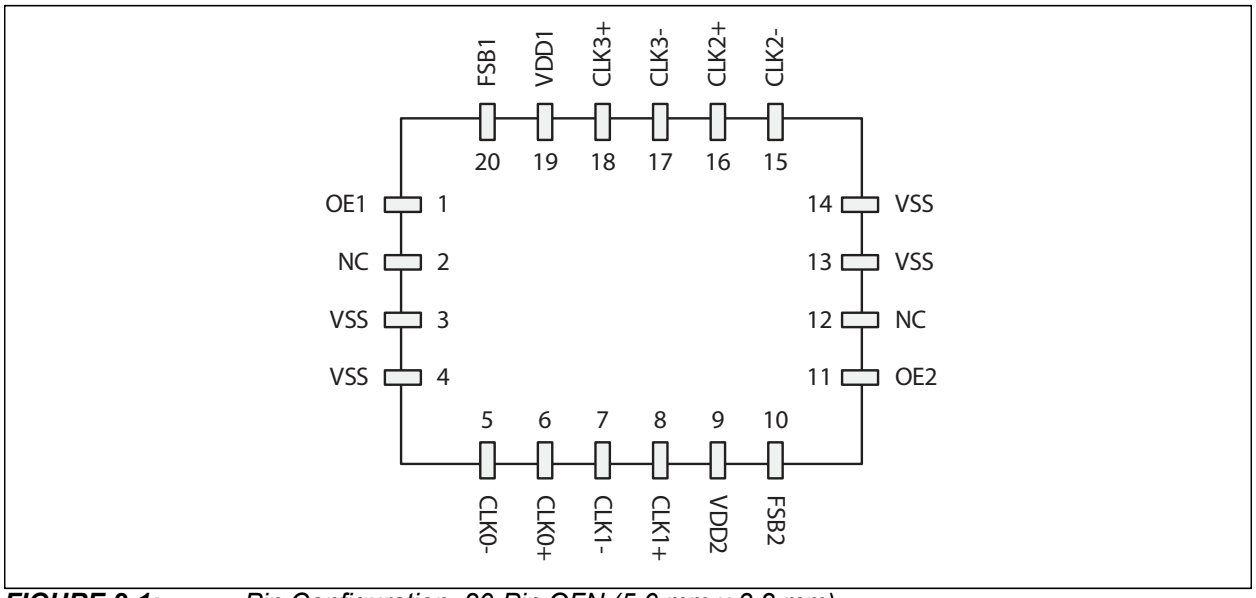


FIGURE 2-1: *Pin Configuration, 20-Pin QFN (5.0 mm x 3.2 mm)*

The descriptions of the pins are listed in Table 2-1.

TABLE 2-1: PIN FUNCTION TABLE

Pin Number	Pin Name	Pin Type	Description
1	OE1	I	Output Enable for Bank1 (CLK0 and CLK3); Active-High. See Table 3-1.
2	NC	N/A	Leave unconnected or connect to ground.
3	V_{SS}	PWR	Ground.
4	V_{SS}	PWR	Ground.
5	CLK0–	O	Complement output of differential pair 0 (off when in LVCMOS format).
6	CLK0+	O	True output of differential pair 0 or LVCMOS output 0.
7	CLK1–	O	Complement output of differential pair 1 (off when in LVCMOS format).
8	CLK1+	O	True output of differential pair 1 or LVCMOS output 1.
9	V_{DD2}	PWR	Power Supply for Bank2 (CLK1 and CLK2).
10	FSB2	I	Input for selecting pre-configured frequencies on Bank2 (CLK1 and CLK2).
11	OE2	I	Output Enable for Bank2 (CLK1 and CLK2); Active-High. See Table 3-1.
12	NC	N/A	Leave unconnected or connect to ground.
13	V_{SS}	PWR	Ground.
14	V_{SS}	PWR	Ground.
15	CLK2–	O	Complement output of differential pair 2 (off when in LVCMOS format).
16	CLK2+	O	True output of differential pair 2 or LVCMOS output 2.
17	CLK3–	O	Complement output of differential pair 3 (off when in LVCMOS format).
18	CLK3+	O	True output of differential pair 3 or LVCMOS output 3.
19	V_{DD1}	PWR	Power Supply for Bank1 (CLK0 and CLK3).
20	FSB1	I	Input for selecting pre-configured frequencies on Bank1 (CLK0 and CLK3).

3.0 OPERATIONAL DESCRIPTION

The DSA400 is a clock generator. Unlike older clock generators in the industry, it does not require an external crystal to operate; it relies on the integrated MEMS resonator that interfaces with internal PLLs. This technology enhances performance and reliability by allowing tighter frequency stability over a far wider temperature range. In addition, the higher resistance to shock and vibration decreases the aging rate to allow for much improved product life in the system.

3.1 Inputs

There are four input signals in the device. Each has an internal (40 kΩ) pull-up to default the selection to a high (1). Inputs can be controlled through hardware strapping method with a resistor to ground to assert the input low (0). Inputs may also be controlled by other components' GPIOs

In case more than one frequency set is desired, FSB1 and FSB2 are used to independently select one of two sets per bank. FSB1 selects the pre-configured set on Bank1 (CLK0 and CLK3) and FSB2 selects the pre-configured set on Bank2 (CLK1 and CLK2), as shown in Table 0-1 in the Product Identification System section.

If there is a requirement to disable outputs, the inputs OE1 and OE2 are used in conjunction to disable the banks of outputs. Outputs are disabled in tri-state (Hi-Z) mode. See Table 3-1 for more information.

TABLE 3-1: OUTPUT ENABLE SELECTION TABLE

OE1	OE2	Bank 1 (CLK0 & CLK3)	Bank 2 (CLK1 & CLK2)
0	0	Hi-Z	Hi-Z
0	1	Hi-Z	Running
1	0	Running	Hi-Z
1	1	Running	Running

3.2 Outputs

The four outputs are grouped into two banks. Each bank is supplied by an independent V_{DD} to allow for optimized noise isolation between the two banks. Each bank provides two synchronous outputs generated by a common PLL:

- Bank1 is composed of outputs CLK0 and CLK3.
- Bank2 is composed of outputs CLK1 and CLK2.

Each output may be pre-configured independently to be one of the following formats: LVCMOS, LVDS, LVPECL or HCSL. In case the output is configured to be single-ended LVCMOS, the frequency is generated on the true output (CLKx+) and the complement output (CLKx–) is shut off in a low state. Frequencies can be chosen from 2.3 MHz to 460 MHz for differential outputs and from 2.3 MHz to 170 MHz on LVCMOS outputs.

3.3 Power

V_{DD1} and V_{DD2} supply the power to banks 1 and 2 respectively. Each V_{DD} may have a different supply voltage from the other as long as it is within the 2.25V to 3.6V range. Each V_{DD} pin should have a 0.1 µF capacitor to filter high-frequency noise. V_{SS} is common to the entire device.

4.0 TERMINATION SCHEMES

4.1 LVPECL

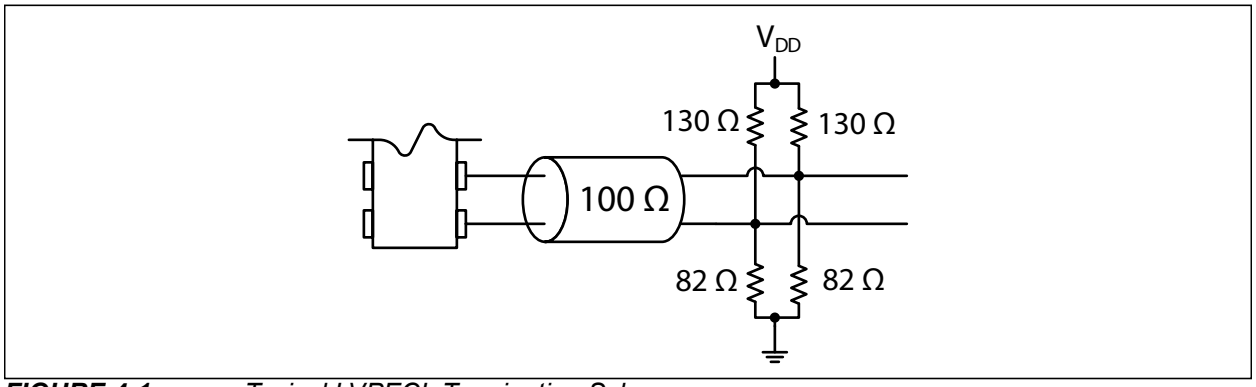


FIGURE 4-1: *Typical LVPECL Termination Scheme.*

TABLE 4-1: LVPECL OUTPUTS (Note 1)

Parameter	Symbol	Min.	Typ.	Max.	Units	Condition
Output Logic Levels	V_{OH}	V_{DD} – 1.08	—	—	V	Output Logic High, R_L = 50Ω to V_{DD}–2V
	V_{OL}	—	—	V_{DD} – 1.55		Output Logic Low, R_L = 50Ω to V_{DD}–2V
Peak-to-Peak Output Swing	—	—	800	—	mV	Single-Ended
Output Transition Time (Note 2)	t_R	—	250	—	ps	Rise Time. 20% to 80%; R_L = 50Ω to V_{DD}–2V
	t_F	—	250	—		Fall Time. 20% to 80%; R_L = 50Ω to V_{DD}–2V
Frequency	f_0	2.3	—	460	MHz	Single Frequency
Output Duty Cycle	SYM	48	—	52	%	Differential
IO Supply Current (Note 3)	I_{DDIO}	—	35	38	mA	Per Output at 125 MHz
Period Jitter (Note 4)	J_{PER}	—	2.5	—	ps_{RMS}	CLK(0:3) = 156.25 MHz
Integrated Phase Noise	J_{PH}	—	0.25	—	ps_{RMS}	200 kHz to 20 MHz @ 156.25 MHz
		—	0.38	—		100 kHz to 20 MHz @ 156.25 MHz
		—	1.7	2		12 kHz to 20 MHz @ 156.25 MHz

Note 1: LVPECL applicable to automotive Grade 3 temperature only.

2: See the Output Waveform section for more information.

3: The addition of I_{DDCORE} and I_{DDIO} provides the total current consumption of the device.

4: Period jitter includes crosstalk from adjacent output.

4.2 LVDS

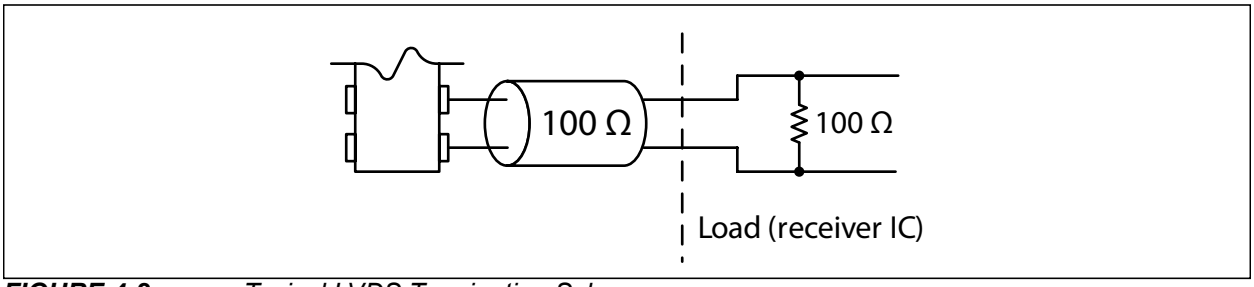


FIGURE 4-2: *Typical LVDS Termination Scheme.*

If the 100Ω clamping resistor does not exist inside the receiving device, it should be added externally on the PCB and placed as close as possible to the receiver.

TABLE 4-2: LVDS OUTPUTS

Parameter	Symbol	Min.	Typ.	Max.	Units	Condition
Output Offset Voltage	V_{OS}	1.125	—	1.46	V	R = 100Ω Differential
Delta Offset Voltage	ΔV_{OS}	—	—	100	mV	—
Peak-to-Peak Output Swing	V_{PP}	—	350	—	mV	Single-Ended
Output Transition Time (Note 1)	t_R	—	200	—	ps	Rise Time, 20% to 80%, R_L= 50Ω, C_L= 2 pF
	t_F	—	200	—		Fall Time, 20% to 80%, R_L= 50Ω, C_L= 2 pF
Frequency	f_0	2.3	—	460	MHz	Single Frequency
Output Duty Cycle	SYM	48	—	52	%	Differential
IO Supply Current (Note 2)	I_{DDIO}	—	9	12	mA	Per Output at 125 MHz
Period Jitter	J_{PER}	—	2.5	—	ps_{RMS}	—
Integrated Phase Noise	J_{PH}	—	0.28	—	ps_{RMS}	200 kHz to 20 MHz @ 156.25 MHz
		—	0.4	—		100 kHz to 20 MHz @ 156.25 MHz
		—	1.7	2.0		12 kHz to 20 MHz @156.25 MHz

Note 1: See the Output Waveform section for more information.

2: The addition of I_{DDCORE} and I_{DDIO} provides the total current consumption of the device.

4.3 HCSL

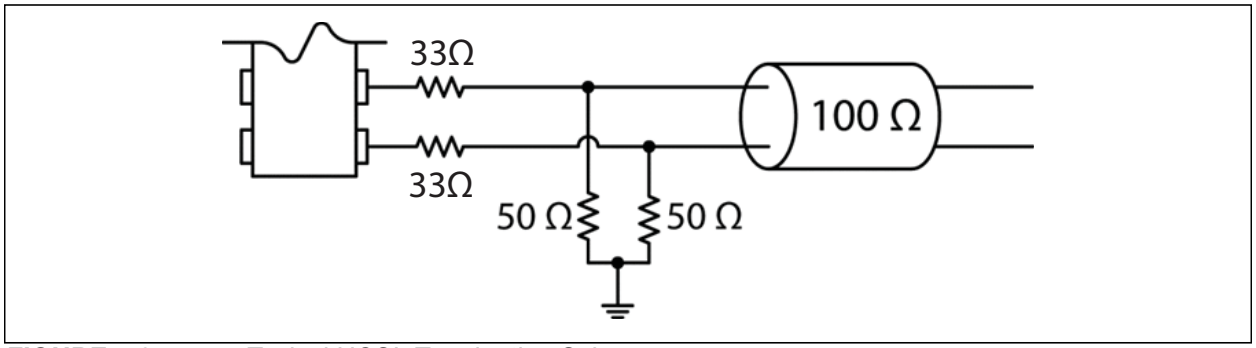


FIGURE 4-3: *Typical HCSL Termination Scheme.*

The 33Ω series resistors are needed to avoid excessive ringing.

TABLE 4-3: HCSL OUTPUTS

Parameter	Symbol	Min.	Typ.	Max.	Units	Condition
Output Logic Levels	V_{OH}	0.725	—	—	V	Output Logic High, R_L = 50Ω
	V_{OL}	—	—	0.1		Output Logic Low, R_L = 50Ω
Peak-to-Peak Output Swing	—	—	750	—	mV	Single-Ended
Output Transition Time (Note 1)	t_R	200	—	400	ps	Rise Time, 20% to 80%, R_L= 50Ω, C_L= 2 pF
	t_F	200	—	400		Fall Time, 20% to 80%, R_L= 50Ω, C_L= 2 pF
Frequency	f_0	2.3	—	460	MHz	Single Frequency
Output Duty Cycle	SYM	48	—	52	%	Differential
IO Supply Current (Note 2)	I_{DDIO}	—	20	22	mA	Per Output at 125 MHz.
Period Jitter	J_{PER}	—	2.5	—	ps_{RMS}	—
Integrated Phase Noise	J_{PH}	—	0.25	—	ps_{RMS}	200 kHz to 20 MHz @ 156.25 MHz
		—	0.37	—		100 kHz to 20 MHz @ 156.25 MHz
		—	1.7	2.0		12 kHz to 20 MHz @156.25 MHz

Note 1: See the Output Waveform section for more information.

2: The addition of I_{DDCORE} and I_{DDIO} provides the total current consumption of the device.

4.4 LVCMOS

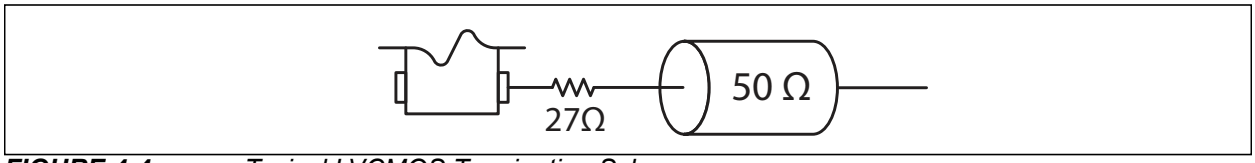


FIGURE 4-4: *Typical LVCMOS Termination Scheme.*

The 27Ω Series resistor complements the output impedance of about 23Ω to 50Ω impedance to match the line 50Ω characteristic impedance to prevent reflections from the driver back to the receiver.

TABLE 4-4: LVCMOS OUTPUTS

Parameter	Symbol	Min.	Typ.	Max.	Units	Condition
Output Logic Levels	V_{OH}	0.9 x V_{DD}	—	—	V	Output Logic High, I = ±6 mA
	V_{OL}	—	—	0.1 x V_{DD}		Output Logic Low, I = ±6 mA
Output Transition Time (Note 1)	t_R	—	1.1	2.0	ns	Rise Time, 20% to 80%, C_L= 15 pF
	t_F	—	1.3	2.0		Fall Time, 20% to 80%, C_L= 15 pF
Frequency	f_0	—	—	100	MHz	—
Output Duty Cycle	SYM	44	—	55	%	—
IO Supply Current (Note 2)	I_{DDIO}	—	11	14	mA	Per Output at 125 MHz, C_L = 15 pF
Period Jitter	J_{PER}	—	3	—	ps_{RMS}	CLK(0:3) = 125 MHz
Integrated Phase Noise	J_{PH}	—	0.3	—	ps_{RMS}	200 kHz to 20 MHz @ 125 MHz
		—	0.38	—		100 kHz to 20 MHz @ 125 MHz
		—	1.7	2.0		12 kHz to 20 MHz @125 MHz

Note 1: See the Output Waveform section for more information.

2: The addition of I_{DDCORE} and I_{DDIO} provides the total current consumption of the device.

5.0 OUTPUT WAVEFORM

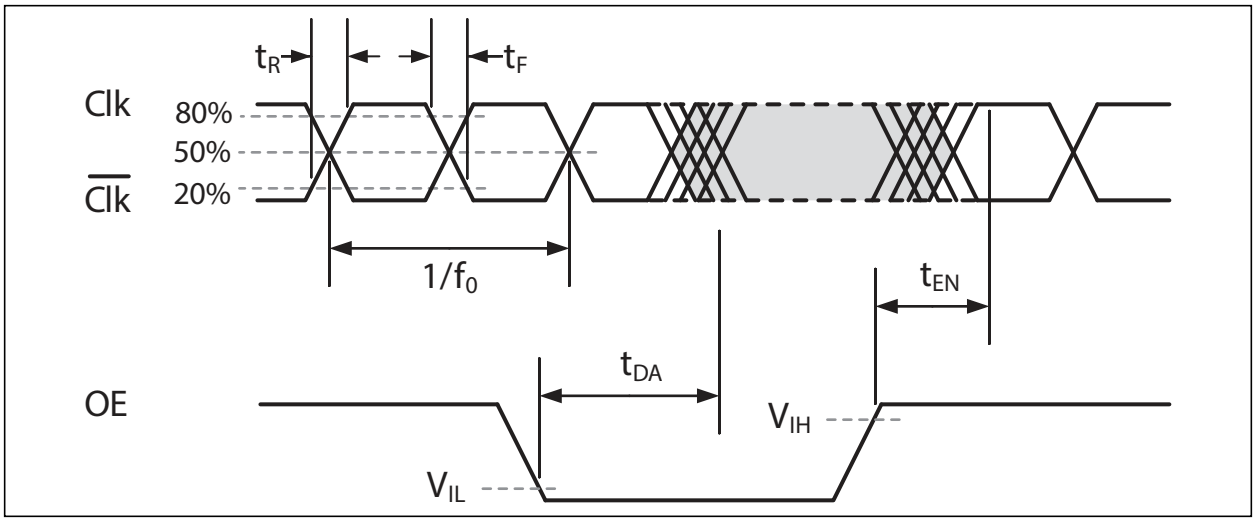


FIGURE 5-1: *Differential Output (LVDS, LVPECL, HCSL).*

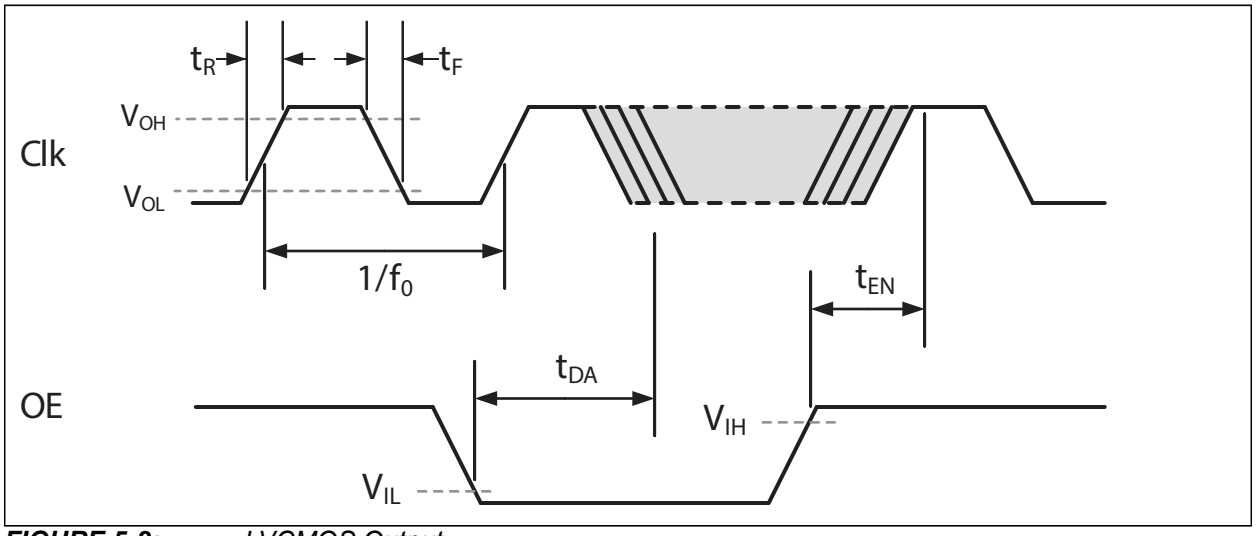


FIGURE 5-2: *LVCMOS Output.*

6.0 CONNECTION DIAGRAM

The connection diagram below includes recommended capacitors to be placed on each V_{DD} for noise filtering.

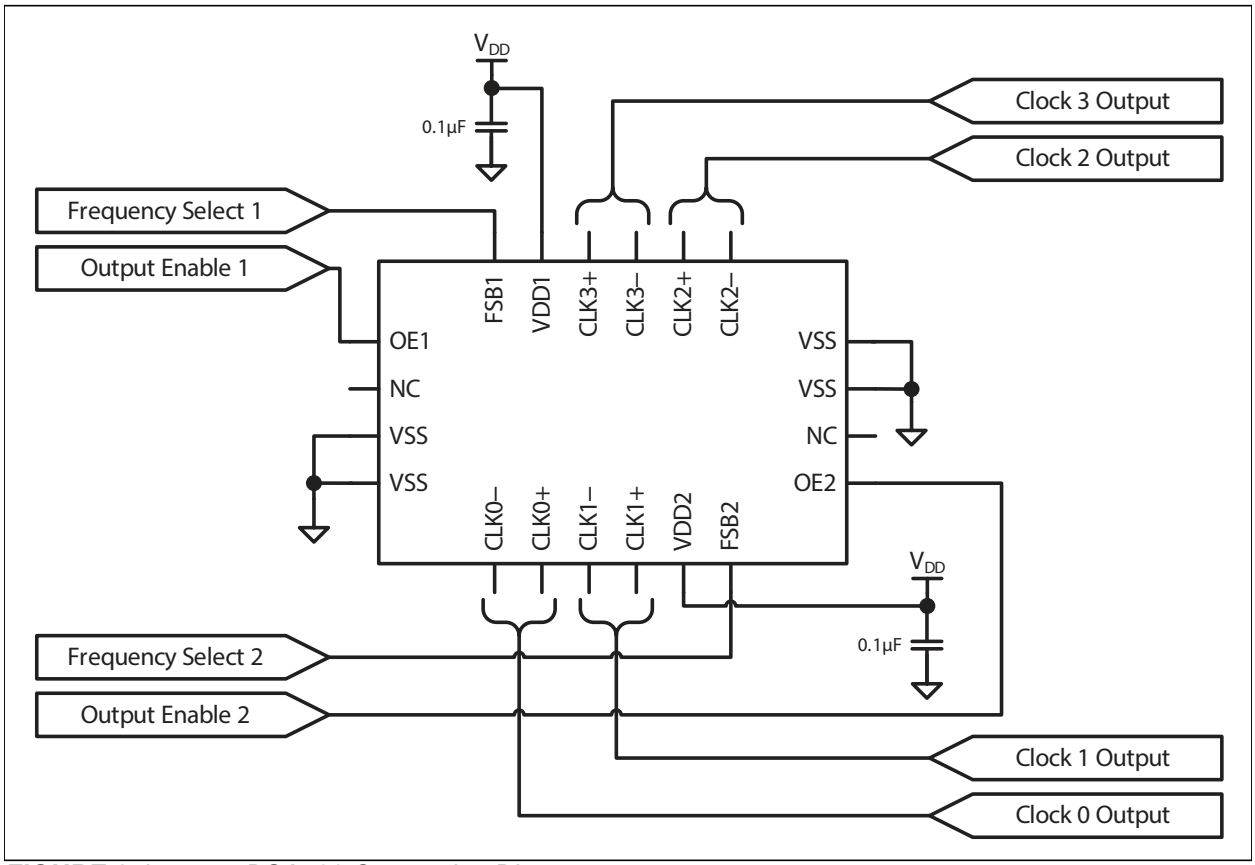
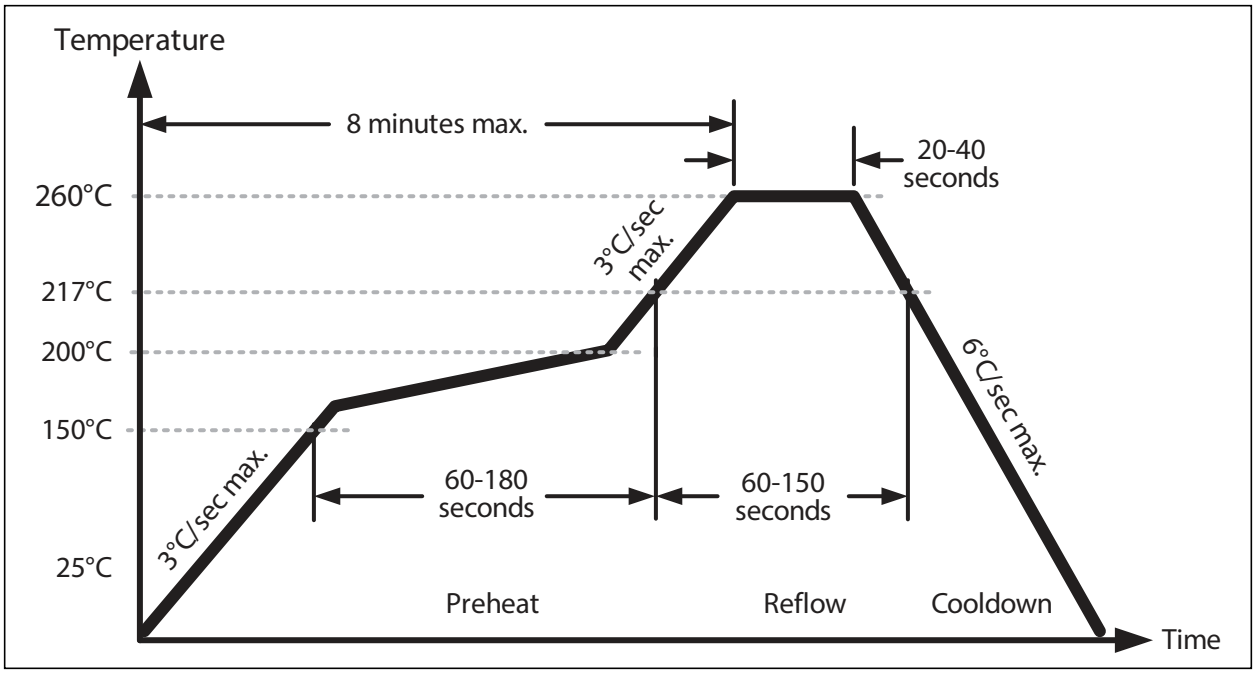


FIGURE 6-1: *DSA400 Connection Diagram.*

7.0 SOLDER REFLOW PROFILE

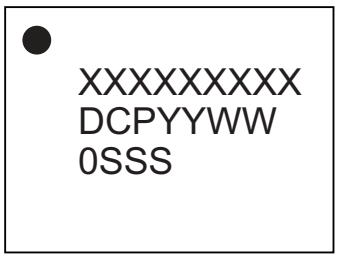


MSL 1 @ 260°C refer to JSTD-020C	
Ramp-Up Rate (200°C to Peak Temp)	3°C/sec. max.
Preheat Time 150°C to 200°C	60-180 sec.
Time Maintained above 217°C	60-150 sec.
Peak Temperature	255°C to 260°C
Time within 5°C of Actual Peak	20-40 sec.
Ramp-Down Rate	6°C/sec. max.
Time 25°C to Peak Temperature	8 minutes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

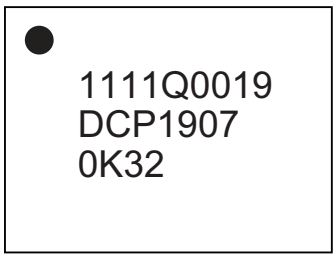
8.0 PACKAGING INFORMATION

8.1 Package Marking Information

20-Lead QFN*
(5.0 mm x 3.2 mm)



Example

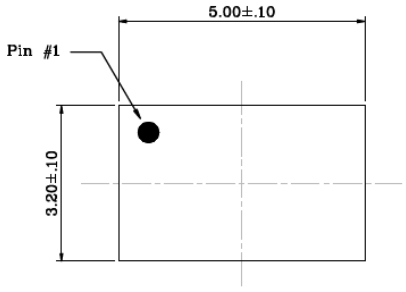


Legend:	XX...X	Product code or customer-specific information
	Y	Year code (last digit of calendar year)
	YY	Year code (last 2 digits of calendar year)
	WW	Week code (week of January 1 is week ‘01’)
	NNN	Alphanumeric traceability code
	(e3)	Pb-free JEDEC® designator for Matte Tin (Sn)
	*	This package 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).
Note:	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.	

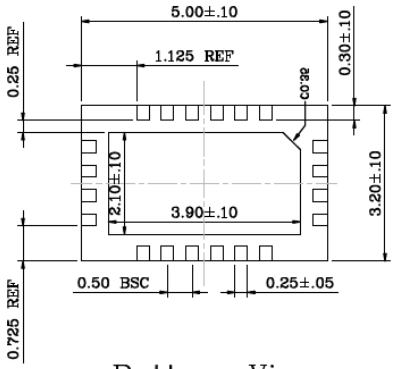
20-Lead QFN 5.0 mm x 3.2 mm Package Outline and Recommended Land Pattern

TITLE
20 LEAD QFN 5.0x3.2mm PACKAGE OUTLINE & RECOMMENDED LAND PATTERN

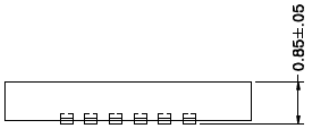
DRAWING #	QFN5032-20LD-PL-1	UNIT	MM



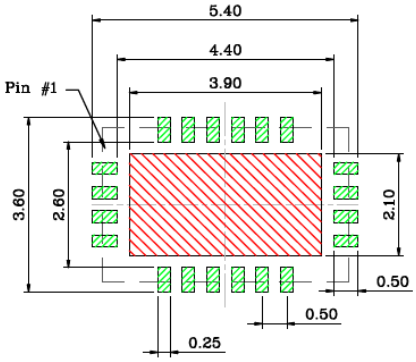
Top View



Bottom View



Side View



Recommended Land Pattern

NOTE:
1. Green shaded rectangles in Recommended Land Pattern are solder stencil opening.
2. Red shaded rectangle in Recommended Land Pattern is keep-out area.

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

APPENDIX A: REVISION HISTORY

Revision A (June 2020)

- Initial release of DSA400 as Microchip data sheet DS20006356A.

NOTES:

PRODUCT IDENTIFICATION SYSTEM

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

PART NO.	X	X	X	X	Qxxxx	X	X	X	X	XXX
Device	CLK3 Output Format	CLK2 Output Format	CLK1 Output Format	CLK0 Output Format	Freq. Code	Package	Temp. Range	Stability	Packing	Automotive Suffix

Device:	DSA400:		Configurable Four Output, Low Jitter Clock Generator
CLK3 Output Format:	0	=	OFF
	1	=	LVCMOS
	2	=	LVPECL
	3	=	LVDS
	4	=	HCSL
CLK2 Output Format:	1	=	LVCMOS
	2	=	LVPECL
	3	=	LVDS
	4	=	HCSL
CLK1 Output Format:	0	=	OFF
	1	=	LVCMOS
	2	=	LVPECL
	3	=	LVDS
	4	=	HCSL
CLK0 Output Format:	1	=	LVCMOS
	2	=	LVPECL
	3	=	LVDS
	4	=	HCSL
Frequency Code:	Qxxxx	=	This code is assigned by the factory. See Table 0-1 in this section for more information.
Package:	K	=	20-Pin QFN
Temperature Range:	L	=	–40°C to +105°C (Automotive Grade 2)
	I	=	–40°C to +85°C (Automotive Grade 3)
Stability:	1	=	±50 ppm
	2	=	±25 ppm
Packing:	Blank	=	72/Tube
	T	=	1,000/Reel
Automotive Suffix:	VXX = Automotive Suffix in which “XX” is assigned by Microchip. Default value is “AO” for standard automotive part		

Examples:

a) DSA400-2143QxxxxKI1VAO:
Configurable Four Output, Low Jitter Clock Generator; LVPECL CLK3; LVCMOS CLK2; HCSL CLK1; LVDS CLK0; Frequency Code; 20-Pin QFN; –40°C to +85°C Temp. Range; ±50 ppm Stability; 72/Tube; Standard automotive

b) DSA400-4132QxxxKI2TVAO:
Configurable Four Output, Low Jitter Clock Generator; HCSL CLK3; LVCMOS CLK2; LVDS CLK1; LVPECL CLK0; Frequency Code; 20-Pin QFN; –40°C to +85°C Temp. Range; ±25 ppm Stability; 1,000/Reel; Standard automotive

c) DSA400-0303QxxxxKL2VAO:
Configurable Four Output, Low Jitter Clock Generator; OFF CLK3; LVDS CLK2; OFF CLK1; LVDS CLK0; Frequency Code; 20-Pin QFN; –40°C to +105°C Temp. Range; ±25 ppm Stability; 72/Tube; Standard automotive

d) DSA400-1111QxxxxKL1TVAO:
Configurable Four Output, Low Jitter Clock Generator; LVCMOS CLK3 through CLK0; Frequency Code; 20-Pin QFN; –40°C to +105°C Temp. Range; ±50 ppm Stability; 1,000/Reel; Standard automotive

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.

Factory Configuration Code Assignment of Qxxxx

The DSC400 is meant for customers to define their own frequency requirements at the four available outputs using ClockWorks Configurator. The Qxxxx number identifies these specific customer requirements and is assigned by the factory.

TABLE 0-1: EXAMPLE OF HOW FSB1 & FSB2 ARE APPLIED & THE QXXXX ASSIGNMENT

Bank1	**Outputs**	**FSB1**		**Qxxxx Number**
		1 (default)	0	Q1234
	CLK0	125 MHz	150 MHz	
	CLK3	50 MHz	25 MHz	
Bank2	**Outputs**	**FSB2**		
		1 (default)	0	
	CLK1	156.25 MHz	100 MHz	
	CLK2	156.25 MHz	100 MHz	

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