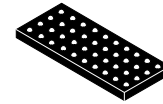


# Summary of Specification for OIS & CL-AF Control LSI

## LC898129DP1XHTBG



WLCSP40, 1.60x4.15x0.33  
CASE 567XS

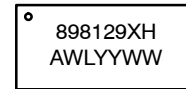
### Overview

LC898129DP1XHTBG is a system LSI integrating an on-chip 32 bit DSP, a FLASH ROM and peripherals including analog circuits for OIS (Optical Image Stabilization) / Closed Loop-AF (Auto Focus) control and drivers.

### Features

- On-chip 32 bit DSP
  - ◆ Built-in Software for Digital Servo Filter
  - ◆ Built-in Software for Gyro Filter
- Memory
  - ◆ Flash Memory
  - ◆ Program ROM
  - ◆ Program SRAM
  - ◆ Data SRAM
- Peripherals
  - ◆ AD Converter
  - ◆ DA Converter
  - ◆ 2-wire Serial I/F Circuit (The Communication Protocol is Compatible with I<sup>2</sup>C)
  - ◆ Hall Bias Circuit
  - ◆ Hall Amp
  - ◆ OSC (Oscillator)
  - ◆ LDO (Low Drop-Out Regulator)
  - ◆ Digital Gyro I/F (SPI)
  - ◆ Interrupt I/F
- Driver
  - ◆ OIS  
Linear Driver (x2ch, I<sub>full</sub> = 200 mA)
  - ◆ CL-AF (bi-direction)  
Linear Driver (x1ch, I<sub>full</sub> = 150 mA)
- Power Supply Voltage
  - ◆ AD/DA/VGA/LDO/OSC/Flash: AVDD30 = 2.7 V to 3.3 V
  - ◆ Driver: VM = 1.8 V to 3.3 V
  - ◆ 1.8 V I/O: IOVDD = 1.7 V to 3.3 V
  - ◆ Core Logic: Generated by On-chip LDO  
Connect 1 μF Capacitor to LDPO pin
- Package
  - ◆ WLCSP40 (4 x 10 Pin) Thickness Max. 0.35 mm, with Back Coat
- These Devices are Pb-Free, Halogen Free/BFR Free and are RoHS Compliant

### MARKING DIAGRAM



898129XH = Specific Device Code  
 A = Assembly Location  
 WL = Wafer Lot  
 YY = Year of Production  
 WW = Work Week

### ORDERING INFORMATION

See detailed ordering and shipping information on page 8 of this data sheet.

# LC898129DP1XHTBG

## BLOCK DIAGRAM

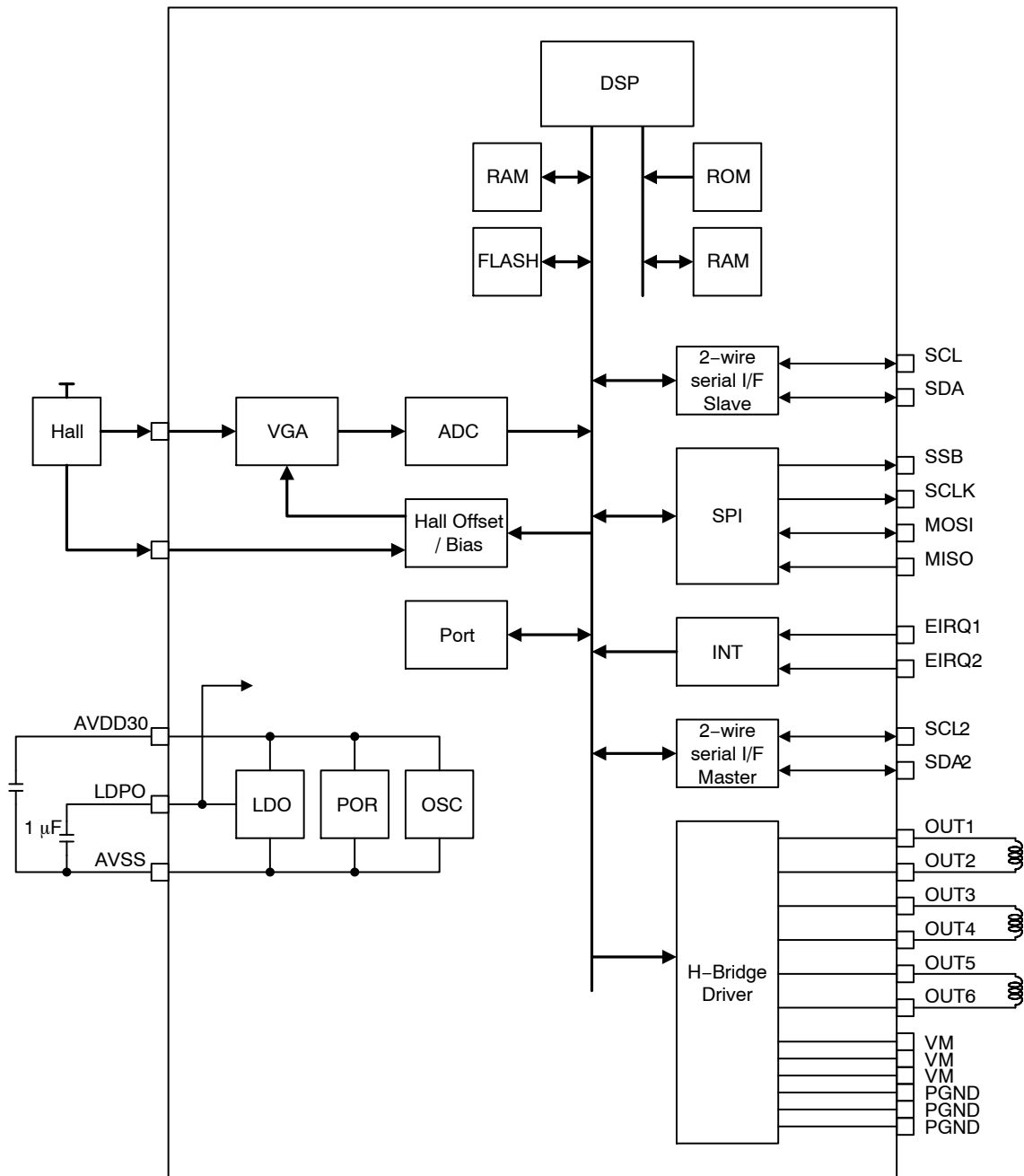


Figure 1. Block Diagram

# LC898129DP1XHTBG

## PIN LAYOUT

|   | 1    | 2    | 3      | 4      | 5      | 6     | 7      | 8     | 9    | 10    |
|---|------|------|--------|--------|--------|-------|--------|-------|------|-------|
| D | OUT1 | VM   | OUT5   | OUT6   | VM     | HLBO2 | HLBO3  | EIRQ1 | SSB  | SCL   |
| C | OUT2 | PGND | PGND   | HLBO1  | AVSS   | MON1  | SCL2   | EIRQ2 | SCLK | SDA   |
| B | OUT3 | PGND | OPINM1 | OPINM2 | OPINM3 | MON2  | SDA2   | AVSS  | MOSI | MISO  |
| A | OUT4 | VM   | OPINP1 | OPINP2 | OPINP3 | AVSS  | AVDD30 | LDPO  | AVSS | IOVDD |

|  |                     |
|--|---------------------|
|  | Driver              |
|  | VDD/VSS             |
|  | Internal VDD Output |
|  | 1.8 V I/O           |

Figure 2. Pin Layout (Bottom View)

Table 1. PIN DESCRIPTION

| No. | Pin    | I/O | I/O Pwr | Function                                                                                           | Init |
|-----|--------|-----|---------|----------------------------------------------------------------------------------------------------|------|
| 1   | MON1   | B   | AVDD30  | Servo Monitor Analog In/Out                                                                        | Z    |
| 2   | MON2   | B   | AVDD30  | Servo Monitor Analog In/Out                                                                        | Z    |
| 3   | SCL    | B   | IOVDD   | 2-wire serial HOST I/F Clock Slave                                                                 | Z    |
| 4   | SDA    | B   | IOVDD   | 2-wire serial HOST I/F Data Slave                                                                  | Z    |
| 5   | IOVDD  | P   |         | I/O Power (1.7 V to 3.3 V)                                                                         | -    |
| 6   | SSB    | B   | IOVDD   | Digital Gyro Data I/F Chip Select Out (3/4-wire Master)                                            | Z    |
| 7   | SCLK   | B   | IOVDD   | Digital Gyro Data I/F Clock Out (3/4-wire Master)                                                  | Z    |
| 8   | MOSI   | B   | IOVDD   | Digital Gyro Data I/F Data InOut (3-wire Master)<br>Digital Gyro Data I/F Data Out (4-wire Master) | Z    |
| 9   | MISO   | B   | IOVDD   | Digital Gyro Data I/F Data In (4-wire Master)                                                      | U    |
| 10  | EIRQ1  | B   | IOVDD   | Interrupt Input 1                                                                                  | Z    |
| 11  | EIRQ2  | B   | IOVDD   | Interrupt Input 2                                                                                  | Z    |
| 12  | SCL2   | B   | AVDD30  | 2-wire serial I/F Clock Master                                                                     | Z    |
| 13  | SDA2   | B   | AVDD30  | 2-wire serial I/F Data Master                                                                      | Z    |
| 14  | HLBO1  | O   | AVDD30  | Hall Bias Output 1                                                                                 | Z    |
| 15  | HLBO2  | O   | AVDD30  | Hall Bias Output 2                                                                                 | Z    |
| 16  | HLBO3  | O   | AVDD30  | Hall Bias Output 3                                                                                 | Z    |
| 17  | OPINM1 | I   | AVDD30  | Hall Opamp Input Minus 1                                                                           | -    |

# LC898129DP1XHTBG

**Table 1. PIN DESCRIPTION** (continued)

| No. | Pin    | I/O | I/O Pwr | Function                         | Init |
|-----|--------|-----|---------|----------------------------------|------|
| 18  | OPINP1 | I   | AVDD30  | Hall Opamp Input Plus 1          | –    |
| 19  | OPINM2 | I   | AVDD30  | Hall Opamp Input Minus 2         | –    |
| 20  | OPINP2 | I   | AVDD30  | Hall Opamp Input Plus 2          | –    |
| 21  | OPINM3 | I   | AVDD30  | Hall Opamp Input Minus 3         | –    |
| 22  | OPINP3 | I   | AVDD30  | Hall Opamp Input Plus 3          | –    |
| 23  | OUT1   | O   | VM      | OIS Driver Output                | Z    |
| 24  | OUT2   | O   | VM      | OIS Driver Output                | Z    |
| 25  | OUT3   | O   | VM      | OIS Driver Output                | Z    |
| 26  | OUT4   | O   | VM      | OIS Driver Output                | Z    |
| 27  | OUT5   | O   | VM      | CL–AF Driver Output              | Z    |
| 28  | OUT6   | O   | VM      | CL–AF Driver Output              | Z    |
| 29  | AVDD30 | P   |         | Analog Power (2.7 V to 3.3 V)    | –    |
| 30  | AVSS   | P   |         | Analog GND                       | –    |
| 31  | VM     | P   |         | Driver Power (1.8 V to 3.3 V)    | –    |
| 32  | VM     | P   |         | Driver Power (1.8 V to 3.3 V)    | –    |
| 33  | VM     | P   |         | Driver Power (1.8 V to 3.3 V)    | –    |
| 34  | PGND   | P   |         | Driver GND                       | –    |
| 35  | LDPO   | P   |         | Internal 1.38 V LDO Power Output | –    |
| 36  | AVSS   | P   |         | Analog GND                       |      |
| 37  | AVSS   | P   |         | Analog GND                       |      |
| 38  | AVSS   | P   |         | Analog GND                       |      |
| 39  | PGND   | P   |         | Driver GND                       |      |
| 40  | PGND   | P   |         | Driver GND                       |      |

\*Process when pins are not used

PIN TYPE “O” – Ensure that it is set to OPEN.

PIN TYPE “I” – OPEN is inhibited. Ensure that it is connected to the  $V_{DD}$  or  $V_{SS}$  even when it is unused.

(Please contact **onsemi** for more information about selection of  $V_{DD}$  or  $V_{SS}$ .)

PIN TYPE “B” – If you are unsure about processing method on the pin description of pin layout table, please contact us.

Note that incorrect processing of unused pins may result in defects.

# LC898129DP1XHTBG

## ELECTRICAL CHARACTERISTICS

**Table 2. ABSOLUTE MAXIMUM RATINGS** (AVSS = 0 V, PGND = 0 V)

| Parameter            | Symbol                                | Conditions            | Ratings                         | Unit |
|----------------------|---------------------------------------|-----------------------|---------------------------------|------|
| Power supply voltage | V <sub>AD30</sub> max                 | T <sub>a</sub> ≤ 25°C | –0.3 to 4.6                     | V    |
|                      | V <sub>M</sub> max                    | T <sub>a</sub> ≤ 25°C | –0.3 to 4.6                     |      |
|                      | V <sub>IO</sub> max                   | T <sub>a</sub> ≤ 25°C | –0.3 to 4.6                     |      |
| Input/Output voltage | V <sub>AI30</sub> , V <sub>AO30</sub> | T <sub>a</sub> ≤ 25°C | –0.3 to V <sub>AD30</sub> + 0.3 | V    |
|                      | V <sub>MI</sub> , V <sub>MO</sub>     | T <sub>a</sub> ≤ 25°C | –0.3 to V <sub>M</sub> + 0.3    |      |
|                      | V <sub>II</sub> , V <sub>IOO</sub>    | T <sub>a</sub> ≤ 25°C | –0.3 to V <sub>IO</sub> + 0.3   |      |
| Storage temperature  | T <sub>stg</sub>                      |                       | –55 to 125                      | °C   |

Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

**Table 3. ALLOWABLE OPERATING RATINGS** (T<sub>a</sub> = –30 to 85°C, AVSS = 0 V, PGND = 0 V)

| Parameter                               | Symbol            | Min | Typ | Max               | Unit |
|-----------------------------------------|-------------------|-----|-----|-------------------|------|
| <b>3.0 V POWER SUPPLY (AVDD30)</b>      |                   |     |     |                   |      |
| Power supply voltage                    | V <sub>AD30</sub> | 2.7 | 2.8 | 3.3               | V    |
| Input voltage range                     | V <sub>INA</sub>  | 0   | –   | V <sub>AD30</sub> | V    |
| <b>3.0 V POWER SUPPLY (VM) (Note 1)</b> |                   |     |     |                   |      |
| Power supply voltage                    | V <sub>M</sub>    | 1.8 | 2.8 | 3.3               | V    |
| Input voltage range                     | V <sub>INM</sub>  | 0   | –   | V <sub>M</sub>    | V    |
| <b>1.8 V POWER SUPPLY (IOVDD)</b>       |                   |     |     |                   |      |
| Power supply voltage                    | V <sub>IO</sub>   | 1.7 | 1.8 | 3.3               | V    |
| Input voltage range                     | V <sub>INI</sub>  | 0   | –   | V <sub>IO</sub>   | V    |

Functional operation above the stresses listed in the Recommended Operating Ranges is not implied. Extended exposure to stresses beyond the Recommended Operating Ranges limits may affect device reliability.

1. Three VM pins should be connected.

# LC898129DP1XHTBG

**Table 4. D.C. CHARACTERISTICS: INPUT/OUTPUT**

(Ta = -30 to 85°C, AVSS = 0 V, PGND = 0 V, AVDD30 = 2.7 to 3.3 V, IOVDD = 1.7 to 3.3 V)

| Parameter                 | Symbol | Conditions   | Min          | Typ | Max        | Unit | Applicable Pins                                             |
|---------------------------|--------|--------------|--------------|-----|------------|------|-------------------------------------------------------------|
| High-level input voltage  | VIH    | CMOS schmitt | 0.7 IOVDD    | –   | –          | V    | SCL, SDA, SSB, SCLK, MOSI, MISO, EIRQ1, EIRQ2               |
| Low-level input voltage   | VIL    |              | –            | –   | 0.3 IOVDD  | V    |                                                             |
| High-level input voltage  | VIH    | CMOS schmitt | 1.4          | –   | –          | V    | SCL2, SDA2                                                  |
| Low-level input voltage   | VIL    |              | –            | –   | 0.4        | V    |                                                             |
| High-level input voltage  | VIH    | CMOS schmitt | 0.7 AVDD30   | –   | –          | V    | MON1, MON2                                                  |
| Low-level input voltage   | VIL    |              | –            | –   | 0.3 AVDD30 | V    |                                                             |
| High-level output voltage | VOH    | IOH = -3 mA  | IOVDD - 0.2  | –   | –          | V    | SDA, SSB, SCLK, MOSI, MISO, EIRQ1, EIRQ2                    |
| Low-level output voltage  | VOL    | IOL = 3 mA   | –            | –   | 0.2        | V    | SCL, SDA, SSB, SCLK, MOSI, MISO, EIRQ1, EIRQ2               |
| High-level output voltage | VOH    | IOH = -3 mA  | AVDD30 - 0.2 | –   | –          | V    | SCL2, SDA2                                                  |
| Low-level output voltage  | VOL    | IOL = 3 mA   | –            | –   | 0.2        | V    |                                                             |
| High-level output voltage | VOH    | IOH = -2 mA  | AVDD30 - 0.2 | –   | –          | V    | MON1, MON2                                                  |
| Low-level output voltage  | VOL    | IOL = 2 mA   | –            | –   | 0.2        | V    |                                                             |
| Analog input voltage      | VAI    |              | AVSS         | –   | AVDD30     | V    | MON1, MON2, OPINP1, OPINM1, OPINP2, OPINM2, OPINP3, OPINM3  |
| Pull Up resistor          | Rup    |              | 20           | –   | 250        | kΩ   | SSB, SCLK, MOSI, MISO, EIRQ1, EIRQ2, MON1, MON2, SCL2, SDA2 |
| Pull Down resistor        | Rdn    |              | 20           | –   | 250        | kΩ   |                                                             |

**Table 5. DRIVER OUTPUT** (Ta = 25°C, AVSS = 0 V, PGND = 0 V, AVDD30 = VM = 2.8 V)

| Parameter                 | Symbol | Condition                      | Min   | Typ | Max   | Unit |
|---------------------------|--------|--------------------------------|-------|-----|-------|------|
| Output Current OUT1~OUT4  | Ifull  | Full code                      | 190   | 200 | 210   | mA   |
| Output Current OUT5, OUT6 |        | Full code, OP-AF (bidirection) | 142.5 | 150 | 157.5 | mA   |

**Table 6. NON-VOLATILE MEMORY CHARACTERISTICS**

|                       |       |                           |                 |    |
|-----------------------|-------|---------------------------|-----------------|----|
| Operating temperature | Topr1 | Read for FLASH            | -30~85          | °C |
|                       | Topr2 | Program & Erase for FLASH | -10~65 (Note 2) | °C |

| Item           | Symbol | Condition | Min | Typ | Max  | Unit   | Applicable Circuit |
|----------------|--------|-----------|-----|-----|------|--------|--------------------|
| Endurance      | EN     |           | –   | –   | 1000 | Cycles | Flash Memory       |
| Data retention | RT     |           | 10  | –   | –    | Years  |                    |
| Write time     | tWT    |           | –   | –   | 3    | ms     |                    |

Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.

2. All drivers must be in the standby state.

# LC898129DP1XHTBG

## AC CHARACTERISTICS

### Power Supply Timing

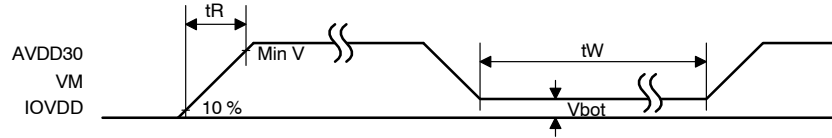


Figure 3. V<sub>DD</sub> Supply Timing

Table 7.

| Item           | Symbol           | Min | Typ | Max | Units |
|----------------|------------------|-----|-----|-----|-------|
| Rise time      | t <sub>R</sub>   | –   | –   | 3   | ms    |
| Wait time      | t <sub>W</sub>   | 100 | –   | –   | ms    |
| Bottom Voltage | V <sub>bot</sub> | –   | –   | 0.2 | V     |

Injection order between AVDD30, VM and IOVDD is below.

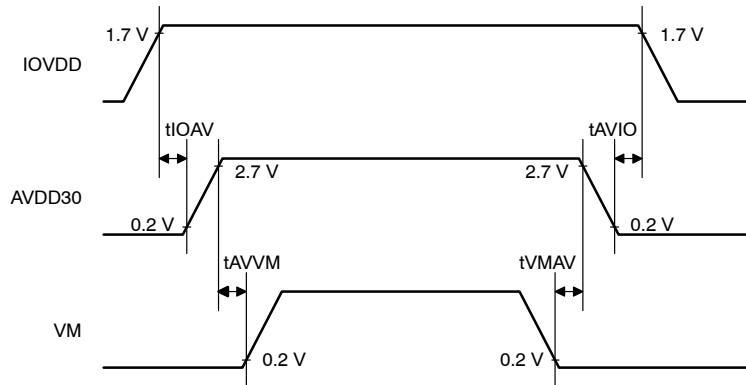


Figure 4.

Table 8.

| Item                    | Symbol            | Min | Typ | Max | Units |
|-------------------------|-------------------|-----|-----|-----|-------|
| IOVDD ON to AVDD30 ON   | t <sub>IOAV</sub> | 0   | –   | –   | ms    |
| AVDD30 ON to VM ON      | t <sub>AVVM</sub> | 0   | –   | –   | ms    |
| VM OFF to AVDD30 OFF    | t <sub>VMAV</sub> | 0   | –   | –   | ms    |
| AVDD30 OFF to IOVDD OFF | t <sub>AVIO</sub> | 0   | –   | *   | ms    |

SDA, SCL, SSB, SCLK, MOSI, MISO, EIRQ1 and EIRQ2 tolerate 3 V input at the time of IOVDD power off.

SCL2 and SDA2 tolerate 3 V input at the time of AVDD30 power off.

The data in the Flash memory may be rewritten unintentionally if you do not keep specifications.

And it is forbidden to power off during Flash memory access. The data in the Flash memory may be rewritten unintentionally.

OIS,AF driver is recommended to set standby before VM power off.

\*Please make IOPRSTB(D0\_0064h, bit0) = 0 before turning OFF AVDD30 when AVDD30 is turned off with keeping IOVDD on.

# LC898129DP1XHTBG

## 2-wire Serial Interface Timing

The 2-wire serial interface timing definition and electric characteristics are shown below. The communication protocol is compatible with I<sup>2</sup>C. This circuit has clock stretch function.

Static Address : 7'b0100100

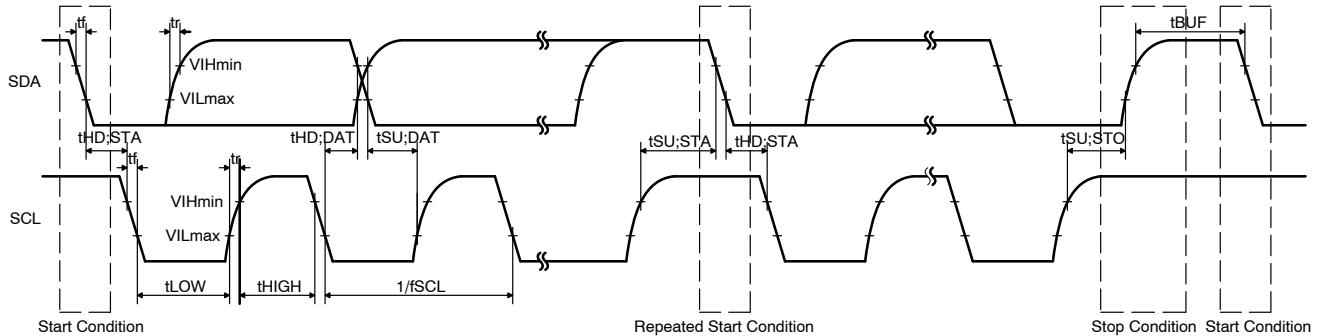


Figure 5.

Table 9.

| Item                                      | Symbol  | Standard-mode |      | Fast-mode     |     | Fast-mode Plus |      | Units |
|-------------------------------------------|---------|---------------|------|---------------|-----|----------------|------|-------|
|                                           |         | Min           | Max  | Min           | Max | Min            | Max  |       |
| SCL clock frequency                       | fSCL    | –             | 100  | –             | 400 | –              | 1000 | kHz   |
| START condition hold time                 | tHD;STA | 4.0           | –    | 0.6           | –   | 0.26           | –    | μs    |
| SCL clock Low period                      | tLOW    | 4.7           | –    | 1.3           | –   | 0.5            | –    | μs    |
| SCL clock High period                     | tHIGH   | 4.0           | –    | 0.6           | –   | 0.26           | –    | μs    |
| Setup time for repetition START condition | tSU;STA | 4.7           | –    | 0.6           | –   | 0.26           | –    | μs    |
| Data hold time                            | tHD;DAT | 0<br>(Note 3) | 3.45 | 0<br>(Note 3) | 0.9 | 0<br>(Note 3)  | 0.45 | μs    |
| Data setup time                           | tSU;DAT | 250           | –    | 100           | –   | 50             | –    | ns    |
| SDA, SCL rising time                      | tr      | –             | 1000 | –             | 300 | –              | 120  | ns    |
| SDA, SCL falling time                     | tf      | –             | 300  | –             | 300 | –              | 120  | ns    |
| STOP condition setup time                 | tSU;STO | 4.0           | –    | 0.6           | –   | 0.26           | –    | μs    |
| Bus free time between STOP and START      | tBUF    | 4.7           | –    | 1.3           | –   | 0.5            | –    | μs    |

3. Although the I<sup>2</sup>C specification defines a condition that 300 ns of hold time is required internally, this LSI is designed for a condition with typ. 25 ns of hold time. If SDA signal is unstable around falling point of SCL signal, please implement an appropriate treatment on board, such as inserting a resistor.

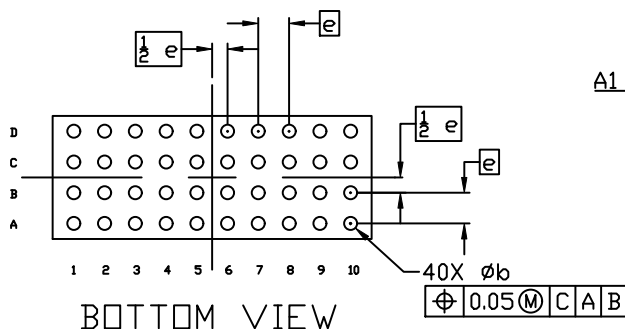
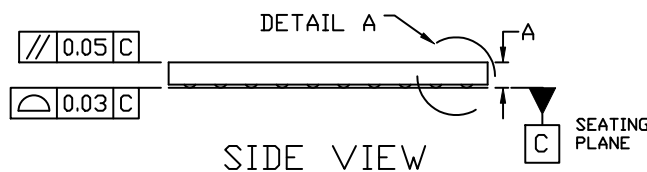
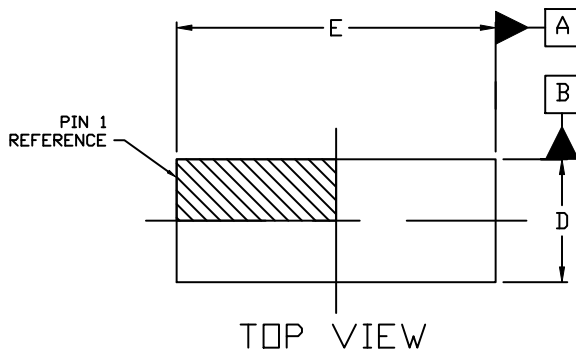
## ORDERING INFORMATION

| Part Number      | Package                            | Shipping <sup>†</sup> |
|------------------|------------------------------------|-----------------------|
| LC898129DP1XHTBG | WLCSP40<br>(Pb-Free, Halogen-Free) | 4000 / Tape & Reel    |

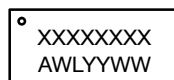
<sup>†</sup>For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D

### WLCSP40 1.60x4.15x0.33 CASE 567XS ISSUE O

DATE 12 APR 2019



#### GENERIC MARKING DIAGRAM\*



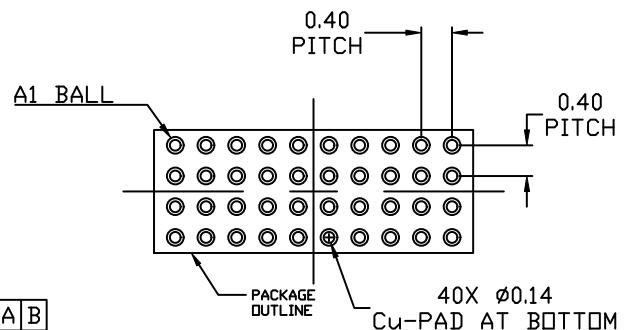
XXX = Specific Device Code  
A = Assembly Location  
WL = Wafer Lot  
YY = Year  
WW = Work Week

\*This information is generic. Please refer to device data sheet for actual part marking. Pb-Free indicator, "G" or microdot "▪", may or may not be present. Some products may not follow the Generic Marking.

#### NOTES:

1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. CONTROLLING DIMENSION: MILLIMETERS
3. DATUM C, THE SEATING PLANE, IS DEFINED BY THE SPHERICAL CROWNS OF THE CONTACT BALLS.
4. COPLANARITY APPLIES TO THE SPHERICAL CROWNS OF THE CONTACT BALLS.
5. DIMENSION b IS MEASURED AT THE MAXIMUM CONTACT BALL DIAMETER PARALLEL TO DATUM C.

| DIM | MILLIMETERS |        |        |
|-----|-------------|--------|--------|
|     | MIN.        | NOM.   | MAX.   |
| A   | 0.31        | 0.33   | 0.35   |
| A1  | 0.034       | 0.040  | 0.046  |
| A2  | 0.2525      | 0.2650 | 0.2775 |
| A3  | 0.020       | 0.025  | 0.030  |
| b   | 0.15        | 0.17   | 0.19   |
| D   | 1.575       | 1.600  | 1.625  |
| E   | 4.125       | 4.150  | 4.175  |
| e   | 0.40 BSC    |        |        |



#### RECOMMENDED MOUNTING FOOTPRINT\* NSMD TYPE

\* For additional information on our Pb-Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

|                  |                        |                                                                                                                                                                                  |
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| DESCRIPTION:     | WLCSP40 1.60x4.15x0.33 | PAGE 1 OF 1                                                                                                                                                                      |

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