

# ON Semiconductor

## Is Now



To learn more about onsemi™, please visit our website at  
[www.onsemi.com](http://www.onsemi.com)

onsemi and onsemi. and other names, marks, and brands are registered and/or common law trademarks of Semiconductor Components Industries, LLC dba "onsemi" or its affiliates and/or subsidiaries in the United States and/or other countries. onsemi owns the rights to a number of patents, trademarks, copyrights, trade secrets, and other intellectual property. A listing of onsemi product/patent coverage may be accessed at [www.onsemi.com/site/pdf/Patent-Marking.pdf](http://www.onsemi.com/site/pdf/Patent-Marking.pdf). onsemi reserves the right to make changes at any time to any products or information herein, without notice. The information herein is provided "as-is" and onsemi makes no warranty, representation or guarantee regarding the accuracy of the information, product features, availability, functionality, or suitability of its products for any particular purpose, nor does onsemi assume any liability arising out of the application or use of any product or circuit, and specifically disclaims any and all liability, including without limitation special, consequential or incidental damages. Buyer is responsible for its products and applications using onsemi products, including compliance with all laws, regulations and safety requirements or standards, regardless of any support or applications information provided by onsemi. "Typical" parameters which may be provided in onsemi data sheets and/or specifications can and do vary in different applications and actual performance may vary over time. All operating parameters, including "Typicals" must be validated for each customer application by customer's technical experts. onsemi does not convey any license under any of its intellectual property rights nor the rights of others. onsemi products are not designed, intended, or authorized for use as a critical component in life support systems or any FDA Class 3 medical devices or medical devices with a same or similar classification in a foreign jurisdiction or any devices intended for implantation in the human body. Should Buyer purchase or use onsemi products for any such unintended or unauthorized application, Buyer shall indemnify and hold onsemi and its officers, employees, subsidiaries, affiliates, and distributors harmless against all claims, costs, damages, and expenses, and reasonable attorney fees arising out of, directly or indirectly, any claim of personal injury or death associated with such unintended or unauthorized use, even if such claim alleges that onsemi was negligent regarding the design or manufacture of the part. onsemi is an Equal Opportunity/Affirmative Action Employer. This literature is subject to all applicable copyright laws and is not for resale in any manner. Other names and brands may be claimed as the property of others.

# LC898123F40XC

## Optical Image Stabilization (OIS) / Auto Focus (AF) Controller & Driver with 40 kB Flash Memory



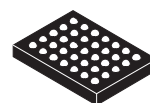
**ON Semiconductor®**

www.onsemi.com

### 1. Overview

LC898123F40XC is a system solution integrating an ultra-low-power 32-bit DSP, Flash Memory, and analog peripherals for OIS (Optical Image Stabilization) /AF (Auto Focus) control, H-bridge, and linear drivers.

Available in a tiny 3.22 mm × 2.30 mm chip-scale package, this device's 40 kB Flash memory enables high level commands and user data for greater system flexibility.



WLCSP35, 3.22x2.3

### 2. Features

#### ■ On-chip ultra-low-power 32-bit DSP

- Built-in software digital servo filter
- Built-in software Gyro filter

#### ■ Flash Memory

- 40 kByte Flash memory to store data and DSP software

#### ■ Peripherals

- Built-in Hall op amp with internal 5×, 10×, 13×, 20×, 40×, and 60× adjustable gain
- 4-channel, 14-bit A/D converter for Hall input
- 3-channel, 3-bit D/A converter for Hall offset setting
- 3-channel, 8-bit D/A converter for Hall bias setting
- Built-in 1-MHz 2-wire serial interface with clock stretch function
- Digital Gyro interface for various types of gyro (SPI Bus)
- Built-in 41-MHz oscillator
- Built-in LDO (Low Drop-Out regulator)

#### ■ Package

- WLP35 (35-bump chip-scale)
- 3.22 mm × 2.30 mm, 0.45 mm thick
- 0.4 mm bump pitch
- Pb-Free and Halogen Free

#### ■ Motor Driver

- OIS
  - 2-channel constant current linear driver ( $I_{full} = 200 \text{ mA}$ )
  - 2-channel H-bridge PWM driver ( $I_{omax} = 220 \text{ mA}$ )
- OP-AF (unidirection)
  - 1-channel constant current linear driver ( $I_{full} = 150 \text{ mA}$ )
- OP-AF (bidirection)
  - 1-channel constant current linear driver ( $I_{full} = 150 \text{ mA}$ )
- CL-AF
  - 1-channel constant current linear driver ( $I_{full} = 150 \text{ mA}$ )
  - 1-channel H-bridge PWM driver ( $I_{omax} = 150 \text{ mA}$ )

#### ■ Power supply voltage

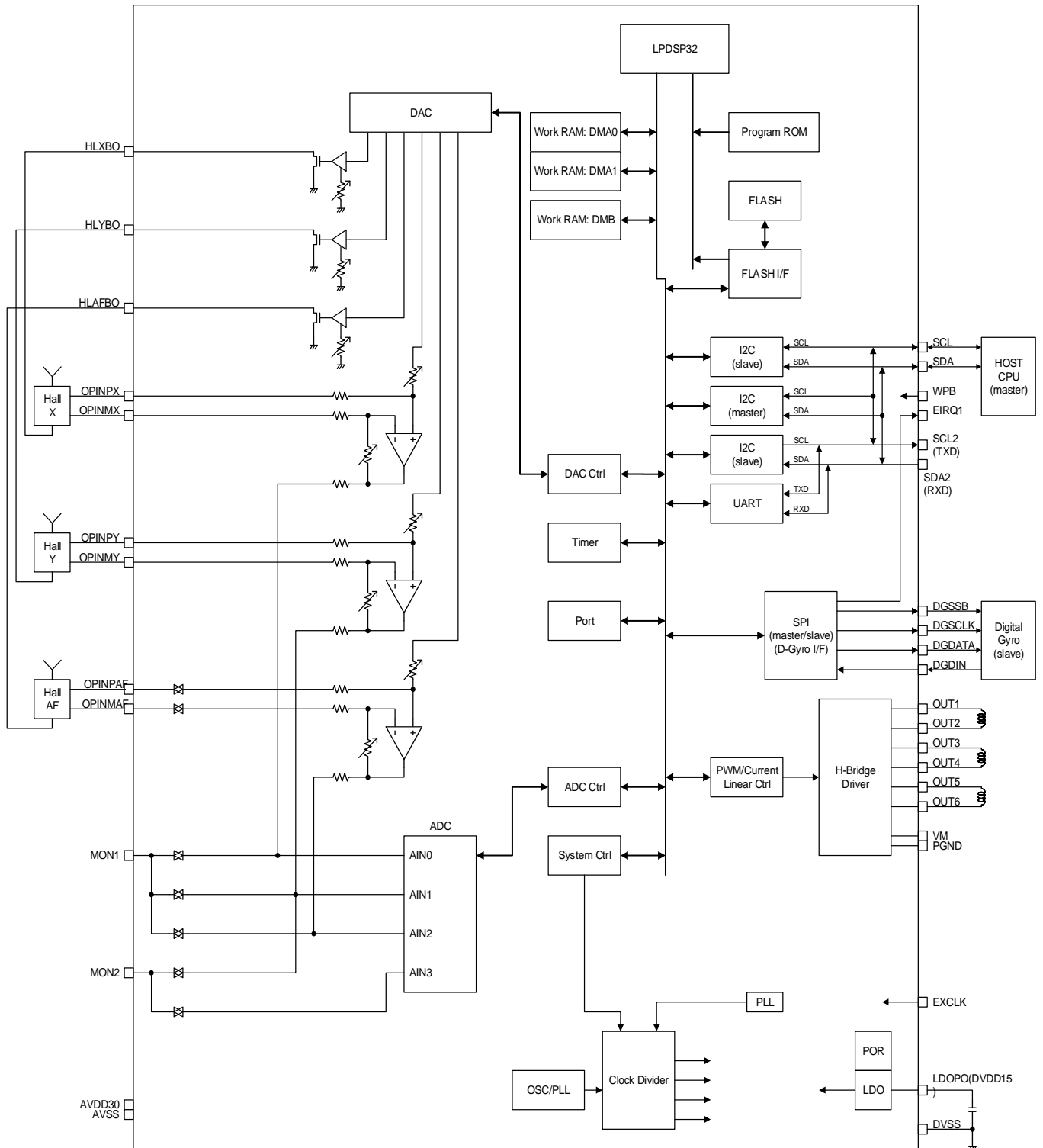
- AD/DA/VGA/LDO/OSC :  
AVDD30 = 2.6 to 3.3 V
- Digital I/O (except Gyro I/F) :  
AVDD30 = 2.6 to 3.3 V
- Driver :  
VM = Constant current : 1.75 to 3.3 V  
H Bridge PWM : 2.6 to 3.3 V
- Core Logic / Gyro interface I/O generated by internal LDO :  
DVDD15 = 1.55 V output (typ)

### ORDERING INFORMATION

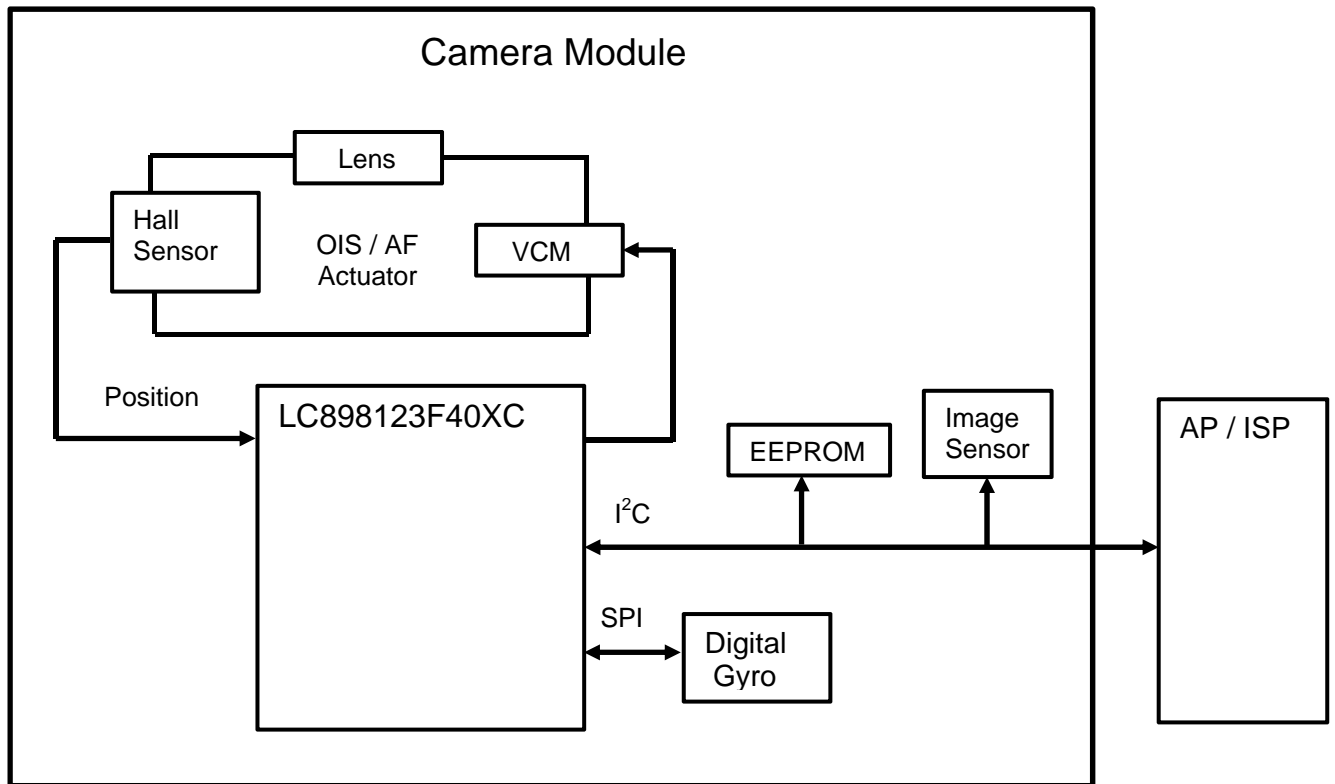
See detailed ordering and shipping information on page 11 of this data sheet.

# LC898123F40XC

## 3. Block Diagram



#### 4. Application Diagram



**LC898123F40XC**

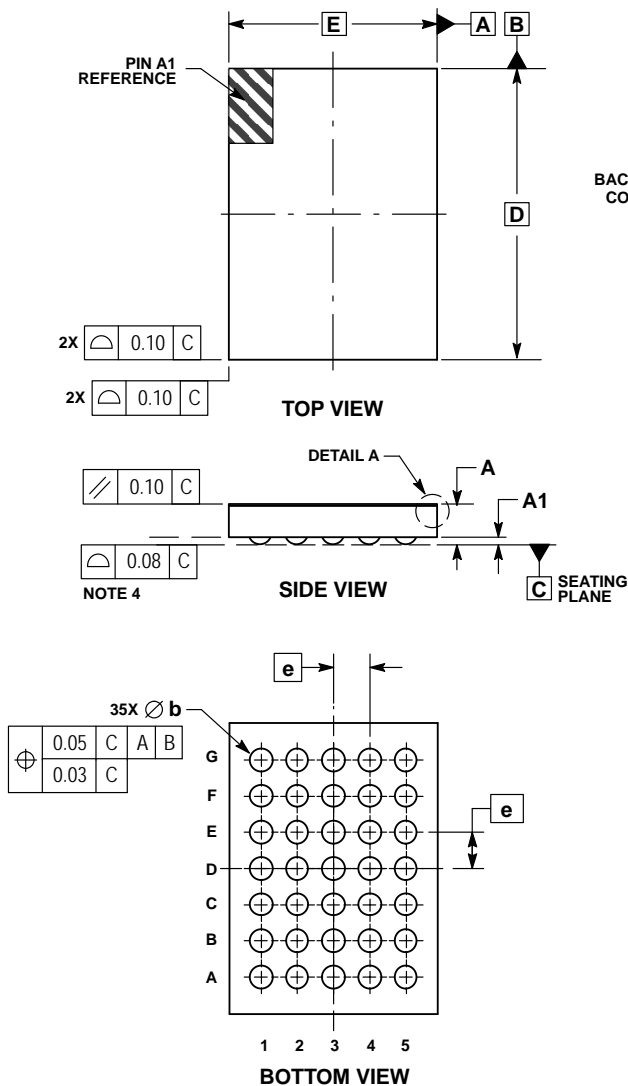
## 5. Package Dimensions

unit : mm

**WLCSP35, 3.22x2.3**

CASE 567LJ

## ISSUE B

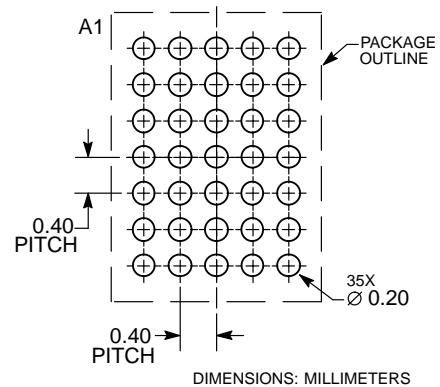


NOTES:

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 SOLDER BALLS.
4. COPLANARITY APPLIES TO SPHERICAL CROWNS OF SOLDER BALLS.

DIM	MILLIMETERS	
	MIN	MAX
A	0.35	0.45
A1	0.03	0.13
A3	0.025 REF	
b	0.15	0.25
D	3.22 BSC	
E	2.30 BSC	
e	0.40 BSC	

### RECOMMENDED SOLDERING FOOTPRINT\*



DIMENSIONS: MILLIMETERS

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

# LC898123F40XC

## 6. Pin Assign

		OUT4	OUT3	OUT2	OUT1	VM
G						
	F	MON1	SDA2 (RXD)	WPB	PGND	OUT6
	E	MON2	SCL2 (TXD)	DVSS	EXCLK	OUT5
	D	DVDD15	EIRQ1	AVSS	SDA	SCL
	C	AVDD30	HLAFBO	AVSS	HLYBO	HLXBO
	B	DGDATA	DGSSB	OPINMAF	OPINMY	OPINMX
	A	DGCLK	DGDIN	OPINPAF	OPINPY	OPINPX
		1	2	3	4	5

BOTTOM VIEW

	Driver output		Analog V <sub>DD</sub>
	Driver V <sub>DD</sub>		Analog GND
	Driver GND		Digital GND
			Logic Core V <sub>DD</sub> (Output)

# LC898123F40XC

## 7. Pin Descriptions

Pin Num	Pin	I/O Atr	I/O Pwr (V)	Primary Function (just after Reset)	Sub Functions	Init
A1	DGSCLK	B	1.55	Digital Gyro I/F Clock Input	Digital Gyro Clock Output	Z
				Digital Gyro I/F Clock Output	Internal Signal Monitor	
A2	DGDIN	B	1.55	Digital Gyro Data Input (4 Wired)	I <sup>2</sup> C Data I/O for DAC Monitor	Z
					Internal Signal Monitor	
A3	OPINPAF	I	2.8	AF Hall Opamp Input Plus	–	–
A4	OPINPY	I	2.8	OIS Hall Y Opamp Input Plus	–	–
A5	OPINPX	I	2.8	OIS Hall X Opamp Input Plus	–	–
B1	DGDATA	B	1.55	GPIO Input	Digital Gyro I/F Data Output (4 Wired)	Z
					Digital Gyro I/F Data I/O (3 Wired)	
					Internal Signal Monitor	
B2	DGSSB	B	1.55	Digital Gyro I/F Chip Select Input	Digital Gyro I/F Chip Select Output	Z
				Digital Gyro I/F Chip Select Output	Internal Signal Monitor	
B3	OPINMAF	I	2.8	AF Hall OpAmp Input Minus	–	–
B4	OPINMY	I	2.8	OIS Hall Y Opamp Input Minus	–	–
B5	OPINMX	I	2.8	OIS Hall X Opamp Input Minus	–	–
C1	AVDD30	P	–	Analog Power (2.6 to 3.3 V)	–	–
C2	HLAFBO	O	2.8	AF Hall Bias Output	–	–
C3	AVSS	P	–	Analog GND	–	–
C4	HLXBO	O	2.8	OIS Hall Y Bias Output	–	–
C5	HLXBO	O	2.8	OIS Hall X Bias Output	–	–
D1	DVDD15	P	–	Internal LDO Power Output	–	–
D2	EIRQ1	B	2.8	External IRQ1	I <sup>2</sup> C Data I/O for DAC Monitor	D
					UART Data Output (TXD)	
				External Clock Input	SPI I/F Chip Select Output	
					Internal Signal Monitor	
D3	AVSS	P	–	Analog GND	–	–
D4	SDA	B	2.8	I <sup>2</sup> C Data	–	Z
D5	SCL	B	2.8	I <sup>2</sup> C Clock	–	Z
E1	MON2	B	2.8	(Debugger Data Input)	I <sup>2</sup> C Data I/O for DAC Monitor	Z
					UART Data Input (RXD)	
					Servo Monitor Analog Out	
					Internal Signal Monitor	
E2	SCL2 (TXD)	B	2.8	I <sup>2</sup> C Clock for 2nd I <sup>2</sup> C	I <sup>2</sup> C Data I/O for DAC Monitor	Z
					UART Data Output	
					Internal Signal Monitor	
E3	DVSS	P	–	Logic GND	–	–
E4	EXCLK	B	2.8	External Clock Input	I <sup>2</sup> C Data I/O for DAC Monitor	D
				External IRQ1	Internal Signal Monitor	
E5	OUT5	O	2.8	AF Driver Output (H-Bridge, Linear)	–	–
F1	MON1	B	2.8	(Debugger Data Output)	I <sup>2</sup> C Data I/O for DAC Monitor	L
					UART Data Output (TXD)	
					Servo Monitor Analog Out	
					Internal Signal Monitor	
F2	SDA2 (RXD)	B	2.8	I <sup>2</sup> C Data for 2nd I <sup>2</sup> C	I <sup>2</sup> C Data I/O for DAC Monitor	Z
					UART Data Input	
					Internal Signal Monitor	
F3	WPB	I	2.8	Write Protect for Flash	–	D
F4	PGND	P	–	Driver GND	–	–
F5	OUT6	O	2.8	AF Driver Output (H-Bridge, Linear)	–	–
G1	OUT4	O	2.8	OIS Driver Output	–	–
G2	OUT3	O	2.8	OIS Driver Output	–	–
G3	OUT2	O	2.8	OIS Driver Output	–	–
G4	OUT1	O	2.8	OIS Driver Output	–	–
G5	VM	P	–	Driver Power (2.6 to 3.3 V)	–	–

# LC898123F40XC

## 8. Electrical Characteristics

**Absolute Maximum Rating** at AVSS = 0 V, DVSS = 0 V, PGND = 0 V

Parameter	Symbol	Conditions	Ratings	Unit
Power supply voltage	V <sub>AD30</sub> max	Ta ≤ 25°C	−0.3 to +4.6	V
	V <sub>M</sub> max	Ta ≤ 25°C	−0.3 to +4.6	V
Input voltage (Except DGDATA, DGSSB, DGSCCLK, DGDIN)	V <sub>AI30</sub>	Ta ≤ 25°C	−0.3 to V <sub>AI30</sub> +0.3	V
Input voltage (DGDATA, DGSSB, DGSCCLK, DGDIN)	V <sub>LDO18</sub>	Ta = −30 to +85°C	−0.3 to +1.872	V
Storage temperature	Tstg		−55 to +125	°C
Operating temperature	Topr		−30 to +85	°C
Output continuous current	Iomax	OUT1 to 4	210	mA
		OUT5, OUT6	157.5	mA

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.

**Allowable Operating Ratings** at Ta = −30 to +85°C, AVSS = 0 V, DVSS = 0 V, PGND = 0 V

3.0 V Power Supply (AVDD30)

Parameter	Symbol	Min	Typ	Max	Unit
Power supply voltage	V <sub>AD30</sub>	2.6	2.8	3.3	V
Input voltage range	V <sub>IN</sub>	0	–	V <sub>AD30</sub>	V

3.0 V Power Supply (VM)

Parameter	Symbol	Min	Typ	Max	Unit
Power supply voltage (H-Bridge PWM)	V <sub>M30</sub>	2.6	2.8	3.3	V
Power supply voltage (Constant current)		1.75	2.8	3.3	V
Input voltage range	V <sub>INM</sub>	0	–	V <sub>M30</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.



## LC898123F40XC

**DC Characteristics** : Input/Output level at AVSS = 0 V, DVSS = 0 V, PGND = 0 V, V<sub>DD</sub> = 2.6 to 3.6 V, Ta = –30 to +85°C

Parameter	Symbol	Conditions	Min	Typ	Max	Unit	Applicable Pin
High-level input voltage	VIH	CMOS schmitt	1.36			V	SCL2(TXD), SDA2(RXD), EXCLK
Low-level input voltage	VIL				0.39	V	
High-level input voltage	VIH	CMOS schmitt	1.26			V	DGDIN, DGSSB, DGSCCLK, DGDATA
Low-level input voltage	VIL				0.35		
High-level input voltage	VIH	CMOS schmitt	1.40				SCL, SDA
Low-level input voltage	VIL				0.40	V	
High-level input voltage	VIH	CMOS schmitt	1.48				EIRQ1, WPB
Low-level input voltage	VIL				0.37		
High-level input voltage	VIH	CMOS supported	1.40				MON1, MON2
Low-level input voltage	VIL				0.51		
High-level output voltage	VOH	IOH = –2 mA	AVDD30 –0.4			V	SCL2(TXD), SDA2(RXD), EXCLK, EIRQ1, MON1, MON2
High-level output voltage	VOH	IOH = –0.1 mA	1.32			V	DGDIN, DGSSB, DGSCCLK, DGDATA
Low-level output voltage	VOL	IOL = 2 mA			0.2	V	SCL2(TXD), SDA2(RXD), DGDIN, DGSSB, DGSCCLK, DGDATA, EXCLK, SDA, SCL
Low-level output voltage	VOL	IOL = 2 mA			0.4	V	MON1, MON2, EIRQ1
Analog input voltage	VAI		AVSS		AVDD30	V	OPINPX, OPINPY, OPINPAF, OPINMX, OPINMY, OPINMAF
PullUp resistor	Rup		50		200	kΩ	MON1, MON2, EIRQ1, SCL2(TXD), SD2(RXD)
PullUp resistor	Rup		180		800	kΩ	DGDATA, DGDIN, DGSSB, DGSCCLK
PullDown resistor	Rdn		50		220	kΩ	MON1, MON2, EIRQ1, SCL2(TXD), SDA2(RXD), EXCLK, WPB
PullDown resistor	Rdn		120		500	kΩ	DGDATA, DGDIN, DGSSB, DGSCCLK

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.

**Driver output** at Ta = –30 to +85°C, AVSS = 0 V, DVSS = 0 V, PGND = 0 V

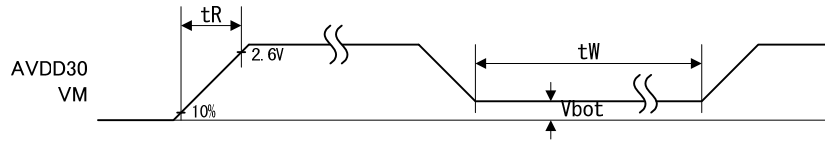
Parameter	Symbol	Condition	Min	Typ	Max	Unit
Output Current OUT1 to OUT4	I <sub>full</sub>	Full code		200		mA
Output Current OUT5, OUT6		Full Code OP-AF (bidirection / unidirection) CL-AF		150		mA

### Non-volatile Memory Characteristics

Parameter	Symbol	Condition	Min	Typ	Max	Unit
Endurance	EN				1000	Cycles
Data retention	RT		10			Years

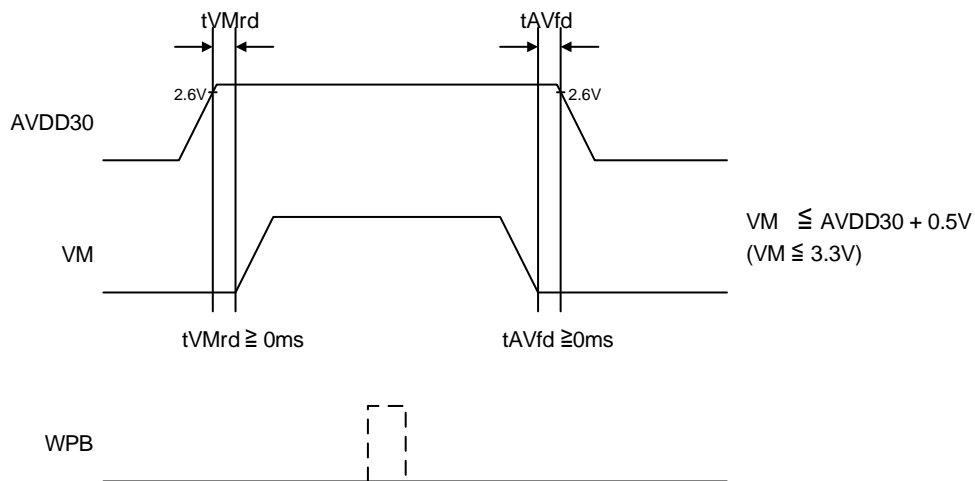
## 9. AC Characteristics

### 9-1 Power Sequence



Item	Symbol	Min	Typ	Max	Units
Rise time	$t_R$			3	ms
Wait time	$t_W$	100			ms
Bottom Voltage	$V_{bot}$			0.2	V

Injection order between AVDD30 and VM is below.



WPB must be open or pulled down normally. When Flash is erased or programmed, WPB must be held High.

SDA, SCL, EXCLK, and WPB will tolerate 3 V input at the time of power off.

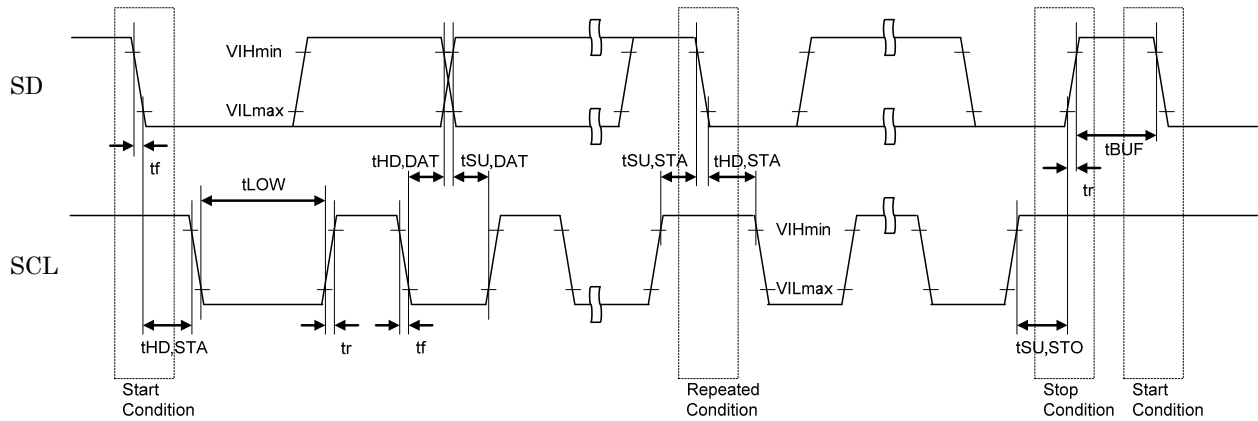
Power must remain applied to the device during flash access in order to prevent unintentional rewriting of the flash memory.

Data in flash memory may be rewritten unintentionally if the specified power sequencing techniques are not kept.

## LC898123F40XC

### 9-2 Two Wire Serial Interface Timing

The device's communication protocol is compatible with I<sup>2</sup>C (Fast mode Plus). This circuit has clock stretch function.



Item	Symbol	Pin name	Min	Typ	Max	Units
SCL clock frequency	Fscl	SCL			1000	kHz
START condition hold time	tHD,STA	SCL SDA	0.26			μs
SCL clock Low period	tLOW	SCL	0.5			μs
SCL clock High period	tHIGH	SCL	0.26			μs
Setup time for repetition START condition	tSU,STA	SCL SDA	0.26			μs
Data hold time	tHD,DAT	SCL SDA	0 (*1)		0.9	μs
Data setup time	tSU,DAT	SCL SDA	50			ns
SDA, SCL rising time	tr	SCL SDA			120	ns
SDA, SCL falling time	tf	SCL SDA			120	ns
STOP condition setup time	tSU,STO	SCL SDA	0.26			μs
Bus free time between STOP and START	tBUF	SCL SDA	0.5			μs

(\*1) Although the I<sup>2</sup>C specification defines a condition that 300 ns of hold time is required internally, LC898123F40XC is designed for a condition with typ. 40 ns of hold time. If SDA signal is unstable around falling point of SCL signal, please implement an appropriate countermeasure on board, such as inserting a resistor.

## LC898123F40XC

### ORDERING INFORMATION

Device	Package	Shipping (Qty / Packing)
LC898123F40XC-VH	WLCSP35, 3.22x2.3 (Pb-Free / Halogen Free)	4000 / Tape & Reel

† 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. [http://www.onsemi.com/pub\\_link/Collateral/BRD8011-D.PDF](http://www.onsemi.com/pub_link/Collateral/BRD8011-D.PDF)

ON Semiconductor and the ON Semiconductor logo are trademarks of Semiconductor Components Industries, LLC dba ON Semiconductor or its subsidiaries in the United States and/or other countries. ON Semiconductor owns the rights to a number of patents, trademarks, copyrights, trade secrets, and other intellectual property. A listing of ON Semiconductor's product/patent coverage may be accessed at [www.onsemi.com/site/pdf/Patent-Marking.pdf](http://www.onsemi.com/site/pdf/Patent-Marking.pdf). ON Semiconductor reserves the right to make changes without further notice to any products herein. ON Semiconductor makes no warranty, representation or guarantee regarding the suitability of its products for any particular purpose, nor does ON Semiconductor assume any liability arising out of the application or use of any product or circuit, and specifically disclaims any and all liability, including without limitation special, consequential or incidental damages. Buyer is responsible for its products and applications using ON Semiconductor products, including compliance with all laws, regulations and safety requirements or standards, regardless of any support or applications information provided by ON Semiconductor. "Typical" parameters which may be provided in ON Semiconductor data sheets and/or specifications can and do vary in different applications and actual performance may vary over time. All operating parameters, including "Typicals" must be validated for each customer application by customer's technical experts. ON Semiconductor does not convey any license under its patent rights nor the rights of others. ON Semiconductor products are not designed, intended, or authorized for use as a critical component in life support systems or any FDA Class 3 medical devices or medical devices with a same or similar classification in a foreign jurisdiction or any devices intended for implantation in the human body. Should Buyer purchase or use ON Semiconductor products for any such unintended or unauthorized application, Buyer shall indemnify and hold ON Semiconductor and its officers, employees, subsidiaries, affiliates, and distributors harmless against all claims, costs, damages, and expenses, and reasonable attorney fees arising out of, directly or indirectly, any claim of personal injury or death associated with such unintended or unauthorized use, even if such claim alleges that ON Semiconductor was negligent regarding the design or manufacture of the part. ON Semiconductor is an Equal Opportunity/Affirmative Action Employer. This literature is subject to all applicable copyright laws and is not for resale in any manner.