HV892

Inductorless Liquid Lens Driver

Features

- Drives Capacitive Loads up to 200 pF
- Programmable Drive Amplitude (Compatible with 40 V_{RMS} to 60 V_{RMS} lenses)
- On-chip Boost Converter
- No External Inductor
- I^2C Interface
- Low Operating Current (≤ 20 mA)
- Low Standby Current (≤1 µA)
- Reduced EMI with Controlled Drive Edge
- 10-lead 4 x 4mm DFN package

Applications

- Cellphone Cameras
- PDA and Ultracompact Cameras
- Bar Code Readers
- Web and Laptop Cameras

General Description

The HV892 liquid lens driver is controlled via an I^2C interface. It is capable of driving capacitive loads of up to 200 pF and is compatible with 40 V_{RMS} to 60 V_{RMS} lenses.

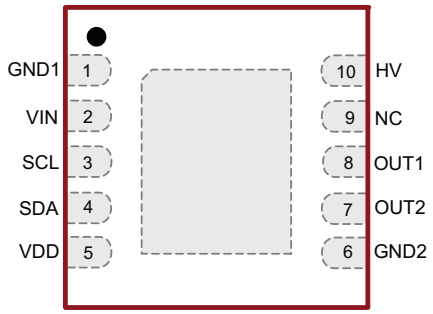
A single byte (AMP) written to the HV892 controls the operation of the driver. Setting AMP = 01h to FFh controls output amplitude in 255 monotonic steps. Setting AMP = 00h causes the HV892 to go into low-power Standby mode, consuming less than 1 µA. When active, the HV892 draws less than 20 mA.

A charge pump boost converter integrated on-chip provides the high voltage necessary for driving the lens. No external inductors or diodes are needed. Two ceramic chip capacitors are the only external components required for a complete lens driver circuit.

An H-bridge output stage provides AC drive to the lens, allowing the use of a single high-voltage boost converter while providing alternating polarity to the lens. Controlled rising and falling edges on the drive waveform reduce EMI.

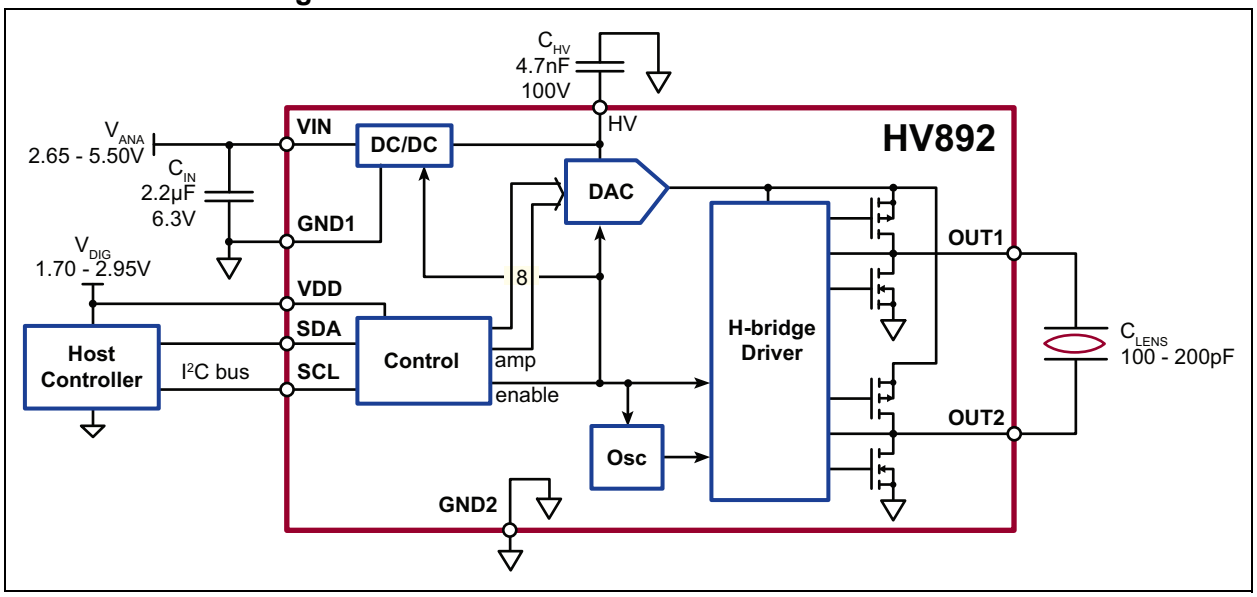
Package Type

10-lead DFN
(Top view)

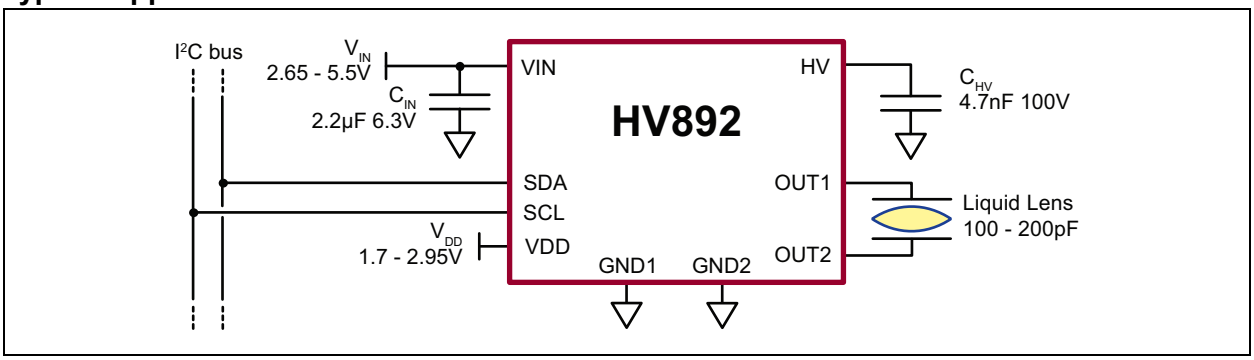


Pads are at the bottom of the package. Center heat slug is at ground potential. See Table 2-1 for pin information.

Functional Block Diagram



Typical Application Circuit



1.0 ELECTRICAL CHARACTERISTICS

Absolute Maximum Ratings †

V_{IN}, V_{DD} ..... –0.5V to +6.5V
SDA, SCL ..... –0.5V to +6.5V
Operating Ambient Temperature, T_A ..... –40°C to +85°C
Storage Temperature, T_S ..... –65°C to +150°C
ESD Rating (**Note 1**) ..... ESD Sensitive

† 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.

Note 1: Device is ESD sensitive. Handling precautions are recommended.

RECOMMENDED OPERATING CONDITIONS

Parameter	Sym.	Min.	Typ.	Max.	Unit	Conditions
Supply Voltage	V_{IN}	2.65	—	5.5	V	
I^2C Logic-level Reference	V_{DD}	1.7	—	2.95	V	
Time for V_{IN} to Ramp to 90%	t_{VIN}	—	—	2	ms	**Note 1**
Supply Bypass Capacitor	C_{IN}	—	2.2	—	µF	
High-voltage Storage Capacitor	C_{HV}	24	—	—	x C_{LOAD}	100V rating
Load (Lens) Capacitance	C_{LOAD}	100	150	200	pF	
I^2C Clock	f_{SCL}	—	—	400	kHz	
Operating Ambient Temperature	T_A	–25	—	+85	°C	

Note 1: To assure the driver powers up in Standby state. No damage will occur if ramped up slower.

ELECTRICAL CHARACTERISTICS

Electrical Specifications: Over recommended operating conditions at T_A = 25°C unless otherwise specified.

Parameter	Sym.	Min.	Typ.	Max.	Unit	Conditions
V_{IN} Supply Current	I_{IN}	—	—	500	nA	AMP = 00h, SDA = V_{DD}, SCL = V_{DD}
		—	8	20	mA	AMP = FFh, SDA = V_{DD}, SCL = V_{DD}
V_{DD} Supply Current	I_{DD}	—	—	500	nA	AMP = 00h, SDA = V_{DD}, SCL = V_{DD}
		—	9	12	µA	AMP = FFh, SDA = V_{DD}, SCL = V_{DD}
Output Voltage of Internal Boost Converter	HV	—	75	79	V	C_{LOAD} = 0 pF
AC Output Voltage	$V_{OUT(AC)}$	—	0	—	V_{RMS}	AMP = 00h
		9	10	11		AMP = 01h
		58.5	62	65.5		AMP = FFh
DC Output Offset Voltage	$V_{OUT(DC)}$	–2	0	+2	V	
Differential Non-linearity (Guaranteed Monotonic)	DNL	–1	—	+1	LSB	
Output Frequency	f_{OUT}	1	1.5	2	kHz	

Note 1: Measured from the rising edge of the I^2C acknowledge bit that terminates transmission of the AMP data byte

ELECTRICAL CHARACTERISTICS (CONTINUED)

Electrical Specifications: Over recommended operating conditions at T_A = 25°C unless otherwise specified.

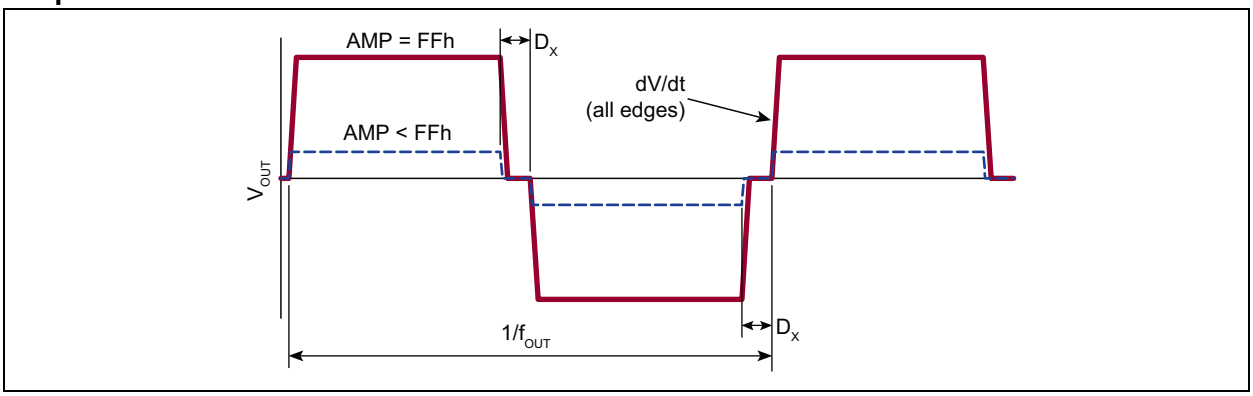
Parameter	Sym.	Min.	Typ.	Max.	Unit	Conditions
Transition Time (Fraction of Period)	D_X	—	4.7	—	%	
Output Slope	dV/dt	—	4.7	—	V/µs	C_{LOAD} = 150 pF, V_{IN} = 3.8V
Startup Time to 90% Amplitude	t_{SU}	—	—	20	ms	AMP = 00h → FFh, C_{HV} = 4.7 nF (**Note 1**)
Amplitude Response Time	t_A	—	—	5	ms	Over any one-step AMP increment or decrement (except 00h) (**Note 1**)
Logic Low Input Voltage	V_{IL}	—	—	0.3	x V_{DD}	
Logic High Input Voltage	V_{IH}	0.7	—	—	x V_{DD}	
Logic Low Output Voltage	V_{OL}	—	—	0.2	x V_{DD}	I_{LOAD} = 3 mA
Logic Low Input Current	I_L	—	—	10	µA	V_{DD} = 1.7V–2.95V
Logic High Input Current	I_H	—	—	10	µA	V_{DD} = 1.7V–2.95V
Logic Input Capacitance	C_{LI}	—	—	10	pF	V_{DD} = 1.7V–2.95V, grounded or open

Note 1: Measured from the rising edge of the I^2C acknowledge bit that terminates transmission of the AMP data byte

TEMPERATURE SPECIFICATIONS

Parameter	Sym.	Min.	Typ.	Max.	Unit	Conditions
TEMPERATURE RANGE						
Operating Ambient Temperature	T_A	–25	—	+85	°C	
Storage Temperature	T_S	–65	—	+150	°C	
PACKAGE THERMAL RESISTANCE						
10-lead DFN	θ_{JA}	—	44	—	°C/W	

Output Waveform



2.0 PIN DESCRIPTION

Table 2-1 details the description of pins in HV892.
Refer to **Package Type** for the location of pins.

TABLE 2-1: PIN FUNCTION TABLE

Pin Number	Pin Name	Description
1	GND1	Ground for the DC–DC converter. Connect GND1 and GND2 close to the IC.
2	VIN	Input voltage. Bypass with a 2.2 µF capacitor to GND1.
3	SCL	Clock for the I^2C interface. The HV892 is a Fast mode device ($f_{SCL} \leq 400$ kHz).
4	SDA	Serial data for the I^2C interface. The HV892 is a write-only device with a single 8-bit command byte. (Refer to Table 3-1.)
5	VDD	Externally supplied reference voltage for the I^2C logic levels. Connect to the I^2C bus supply.
6	GND2	Ground for the IC, except the DC-DC converter. Connect GND1 and GND2 close to the IC.
7	OUT2	Outputs of the H-bridge driver. The liquid lens connect these two pins. When disabled (AMP = 00h), both of these outputs are held at ground.
8	OUT1	
9	NC	Not connected
10	HV	High-voltage DC output of the internal boost converter. Connect a 4.7 nF 100V ceramic capacitor to ground close to the IC.

Note 1: Exposed backside pad is at ground potential and should be connected to circuit ground.

3.0 APPLICATION INFORMATION

3.1 I²C

The HV892 is a write-only Fast mode I²C device. Logic voltages are referenced to V_{DD}.

3.2 Address

The HV892 recognizes a 7-bit address. The device is pre-programmed with an I²C address of 0100011b.

3.3 Data

A single byte written to the HV892 controls the operation of the lens driver. See Table 3-1. The MSB is clocked in first.

TABLE 3-1: COMMAND TABLE

AMP	Description
00h	Low-power Standby mode. When in Standby mode, the internal boost converter and H-bridge oscillator are shut down, and the OUT pins are held at ground. Any AMP value other than 00h brings the HV892 out of Standby mode. The time it takes the HV892 to exit Standby mode and achieve full output amplitude is less than 20 ms with a 4.7 nF capacitor on the HV pin. Faster startup times may be achieved by lowering C_{HV} at the expense of possible waveform distortion.
01h–FFh	Controls output amplitude according to: $V_{OUT(RMS)} = 9.8_{RMS} + AMP \times 205mV_{RMS}$

3.4 Supplies

V_{IN} should be ramped up in less than 2 ms to assure the driver starts up in Standby mode. If brought up slower, the driver may not start up in Standby mode with output amplitude at an indeterminate level. In this case, writing AMP = 00h brings the driver to Standby mode. No damage will occur if V_{IN} is ramped up slower than 2 ms.

4.0 PACKAGING INFORMATION

4.1 Package Marking Information

10-lead DFN

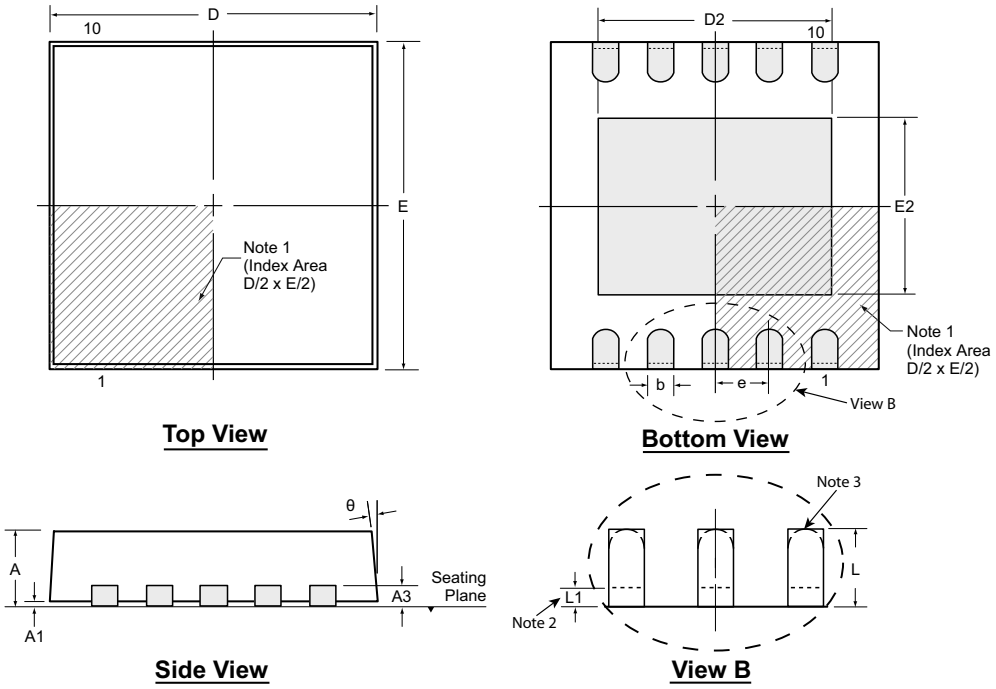
Example

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.

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 product code or customer-specific information. Package may or not include the corporate logo.

10-Lead DFN Package Outline (K7)

4.00x4.00mm body, 0.80mm height (max), 0.65mm pitch



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

Notes:

1. *A Pin 1 identifier must be located in the index area indicated. The Pin 1 identifier can be: a molded mark/identifier; an embedded metal marker; or a printed indicator.*
2. *Depending on the method of manufacturing, a maximum of 0.15mm pullback (L1) may be present.*
3. *The inner tip of the lead may be either rounded or square.*

Symbol		A	A1	A3	b	D	D2	E	E2	e	L	L1	θ
Dimension (mm)	MIN	0.70	0.00	0.20 REF	0.25	3.85*	2.80	3.85*	2.30	0.65 BSC	0.30	0.00*	0°
	NOM	0.75	0.02		0.30	4.00	-	4.00	-		0.40	-	-
	MAX	0.80	0.05		0.35	4.15*	3.50	4.15*	2.80		0.50	0.15	14°

JEDEC Registration MO-229, Variation WGGC, Issue C, Aug. 2003.
** This dimension is not specified in the JEDEC drawing.*
Drawings not to scale.

APPENDIX A: REVISION HISTORY

Revision A (September 2022)

- Converted Supertex Doc# DSFP-HV892 to Microchip DS20005712A
- Removed the minimum value of the Output Voltage of Internal Boost Converter (HV)
- Changed the packaging quantity of the K7 package from 3000/Reel to 3300/Reel to align packaging specifications with the actual BQM
- Made minor text changes throughout the document

PRODUCT IDENTIFICATION SYSTEM

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

PART NO.	XX	-	X	-	X
Device	Package Options		Environmental		Media Type

Device:	HV892	=	Inductorless Liquid Lens Driver
Package:	K7	=	10-lead WDFN
Environmental:	G	=	Lead (Pb)-free/RoHS-compliant Package
Media Type:	(blank)	=	3300/Reel for a K7 Package

Example:

a) HV892K7-G: Inductorless Liquid Lens Driver, 10-lead WDFN Package, 3300/Reel

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