

# iC-LFS

## 32x1 LINEAR IMAGE SENSOR

preliminary



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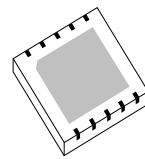
### FEATURES

- ◆ 32 active photo pixels of 56  $\mu\text{m}$  at a gap and distortion free pitch of 63.5  $\mu\text{m}$  (400 DPI)
- ◆ Integrating L-V conversion followed by a sample & hold circuit
- ◆ High sensitivity and uniformity over wavelength
- ◆ High clock rates of up to 5 MHz
- ◆ Only 32 clocks required for readout
- ◆ Shutter function enables flexible integration times
- ◆ Glitch-free analogue output
- ◆ Push-pull output amplifier
- ◆ 5 V single supply operation

### APPLICATIONS

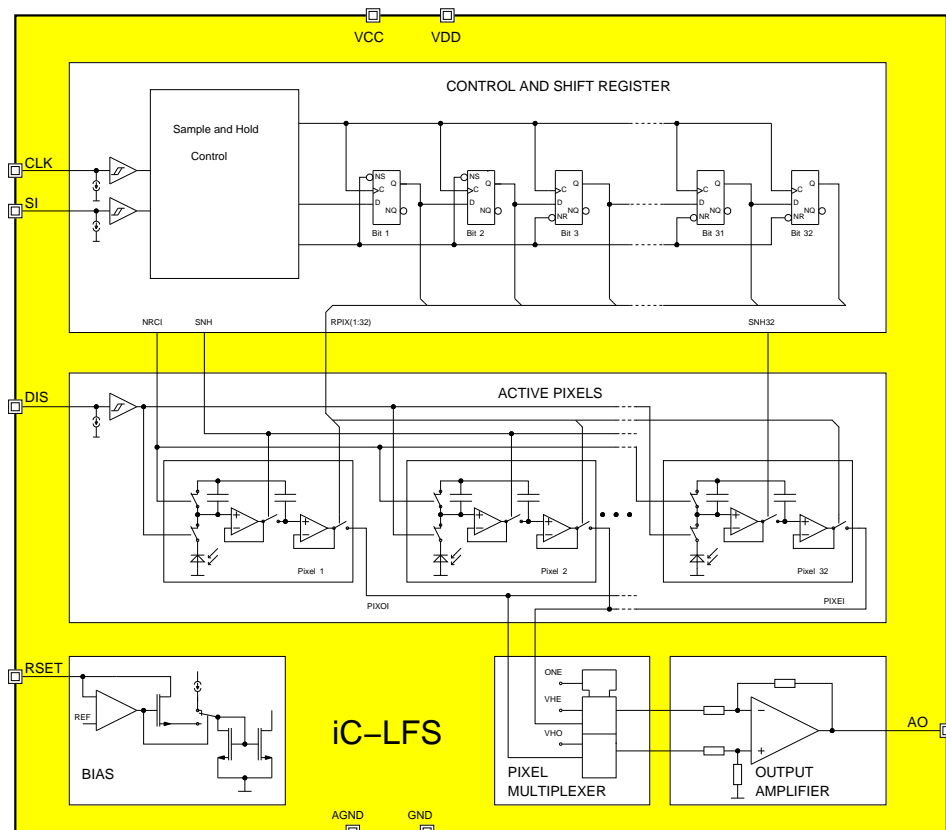
- ◆ Optical line sensors
- ◆ CCD substitute

### PACKAGES



cDFN10

### BLOCK DIAGRAM



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### DESCRIPTION

iC-LFS is an integrating light-to-voltage converter with a single line of 32 pixels pitched at  $63.5\mu\text{m}$  (center-to-center distance). Each pixel consists of a  $56.4\mu\text{m} \times 200\mu\text{m}$  photodiode, an integration capacitor and a sample and hold circuit.

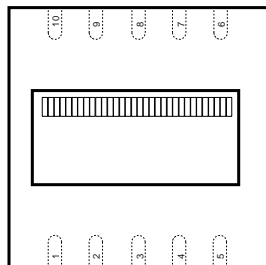
The integrated control logic makes operation very simple, with only a start and clock signal necessary. A third control input enables the integration period to be paused at any time (electronic shutter).

With the start signal the hold mode is activated for all pixels simultaneously with the next rising clock edge; starting with pixel 1 the hold voltages are switched in sequence to the push-pull output amplifier. The second clock pulse deletes all integration capacitors and the integration period starts again in the background during the output phase. A run is complete after 32 clock pulses.

iC-LFS is suitable for high clock rates of up to 5 MHz. If this is not required the supply current can be reduced via the external bias setting.

### PACKAGES cDFN10 4 mm x 4 mm

#### PIN CONFIGURATION cDFN10 4 mm x 4 mm



#### PIN FUNCTIONS

##### No. Name Function

1	SI	Start Integration Input
2	CLK	Clock Input
3	AO	Analogue Output
4	VDD	+5 V Digital Supply Voltage
5	VCC	+5 V Analogue Supply Voltage
6	RSET	Bias Current (resistor from VCC to RSET; when connected to GND the internal bias setting is activated)
7	n.c.	
8	AGND	Analogue Ground
9	GND	Digital Ground
10	DIS	Shutter control

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### ABSOLUTE MAXIMUM RATINGS

Beyond these values damage may occur; device operation is not guaranteed.

Item No.	Symbol	Parameter	Conditions	Min. / Max.		Unit
				Min.	Max.	
G001	VDD	Digital Supply Voltage		-0.3	6	V
G002	VCC	Analogue Supply Voltage		-0.3	6	V
G003	V()	Voltage at SI, CLK, DIS, RSET, AO		-0.3	VCC + 0.3	V
G004	I()	Current in RSET, AO		-10	10	mA
G005	Vd()	ESD Susceptibility at all pins	HBM, 100 pF/1.5 kΩ		4	kV
G006	Tj	Operating Junction Temperature		-40	125	°C

All voltages are referenced to ground unless otherwise stated.

All currents into the device pins are positive; all currents out of the device pins are negative.

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### ELECTRICAL CHARACTERISTICS

Operating Conditions: VCC = VDD = 5 V ±10%, RSET = GND, Tj = -25...85 °C unless otherwise noted

Item No.	Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
<b>Total Device</b>							
001	VDD	Digital Supply Voltage Range		4.5		5.5	V
002	VCC	Analogue Supply Voltage Range		4.5		5.5	V
003	I(VDD)	Supply Current in VDD	f(CLK) = 1 MHz f(CLK) = 5 MHz		tbd tbd		mA mA
004	I(VCC)	Supply Current in VCC			tbd		mA
005	Vc(hi)	Clamp Voltage hi at SI, CLK, DIS, RSET	Vc(hi) = V() – VCC; I() = 1 mA	0.3		1.8	V
006	Vc(lo)	Clamp Voltage lo at SI, CLK, DIS, RSET	Vc(hi) = V() – V(AGND); I() = -1 mA	-1.5		0.3	V
007	Vc(hi)	Clamp Voltage hi at AO	Vc(hi) = V(AO) – VCC; I(AO) = 1 mA	0.3		1.5	V
008	Vc(lo)	Clamp Voltage lo at AO, VCC, VDD, GND	Vc(lo) = V() – V(AGND); I() = -1 mA	-1.5		-0.3	V
<b>Photodiode Array</b>							
201	A()	Radiant Sensitive Area	200 μm x 56.40 μm per Pixel		0.01128		mm <sup>2</sup>
202	S(λ)max	Spectral Sensitivity	λ = 680 nm (see Fig. 1)		0.5		A/W
203	λ <sub>ar</sub>	Spectral Application Range	S(λ <sub>ar</sub> ) = 0.25 x S(λ)max (see Fig. 1)	400		980	nm
<b>Analogue Output AO</b>							
301	Vs(lo)	Saturation Voltage lo	I() = 1 mA			0.5	V
302	Vs(hi)	Saturation Voltage hi	Vs(hi) = VCC – V(), I() = -1 mA			1	V
303	K	Sensitivity	λ = 680 nm		2.88		V/pWs
304	V0()	Offset Voltage	integration time 1 ms, no illumination		400	800	mV
305	ΔV0()	Offset Voltage Deviation during integration mode	ΔV0() = V(AO)t1 – V(AO)t2, Δt = t2 – t1 = 1 ms	-250		50	mV
306	ΔV()	Signal Deviation during hold mode	ΔV0() = V(AO)t1 – V(AO)t2, Δt = t2 – t1 = 1 ms	-150		150	mV
307	tp(CLK-AO)	Settling Time	CI(AO) = 10 pF, CLK lo → hi until V(AO) = 0.98 x V(VCC)			200	ns
<b>Power-On-Reset</b>							
801	VCCon	Power-On Release by VCC				4.4	V
802	VCCoff	Power-Down Reset by VCC		1			V
803	VCChys	Hysteresis	VCChys = VCCon – VCCoff	0.4	1	2	V
<b>Bias Current Adjust RSET</b>							
901	Ibias()	Permissible External Bias Current		20		100	μA
902	Vref	Reference Voltage	I(RSET) = I <sub>bias</sub>	2.5	3	3.5	V
<b>Input Interface SI, CLK, DIS</b>							
B01	Vt(hi)	Threshold Voltage hi		1.4		1.8	V
B02	Vt(lo)	Threshold Voltage lo		0.9		1.2	V
B03	Vt(hys)	Hysteresis	Vt(hys) = Vt(hi) – Vt(lo)	300		800	mV
B04	I()	Pull-Down Current		10	30	50	μA
B05	fclk	Permissible Clock Frequency				5	MHz

### OPTICAL CHARACTERISTICS: Diagrams

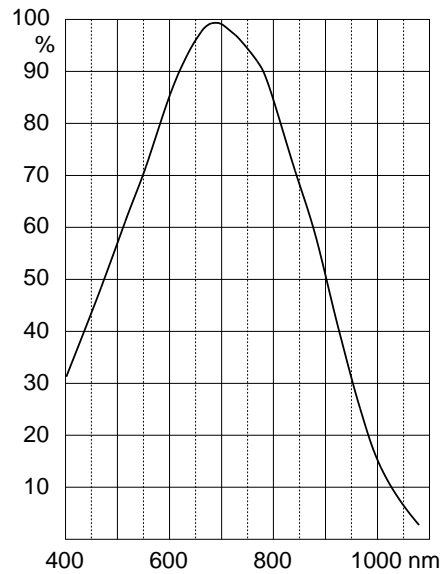


Figure 1: Relative spectral sensitivity

### OPERATING REQUIREMENTS: Logic

Operating Conditions:  $V_{CC} = V_{DD} = 5V \pm 10\%$ ,  $T_j = -25 \dots 85^\circ C$   
 input levels  $lo = 0 \dots 0.45V$ ,  $hi = 2.4V \dots V_{CC}$ , see Fig. 2 for reference levels

Item No.	Symbol	Parameter	Conditions	Limits		Unit
				Min.	Max.	
I001	tset	Setup Time: SI stable before CLK lo $\rightarrow$ hi	see Fig. 3	50		ns
I002	thold	Hold Time: SI stable after CLK lo $\rightarrow$ hi	see Fig. 3	50		ns

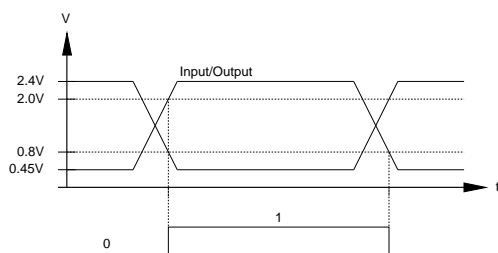


Figure 2: Reference levels

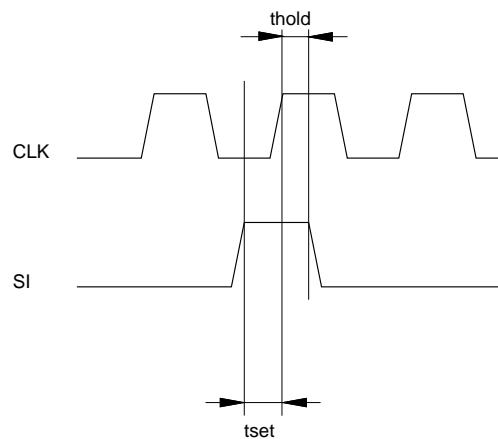


Figure 3: Timing diagram

**DESCRIPTION OF FUNCTIONS**

**Normal operation**

Following an internal power-on reset the integration and hold capacitors are discharged and the sample and hold circuit is set to sample mode. A high signal at SI and a rising edge at CLK triggers a readout cycle and with it a new integration cycle.

In this process the hold capacitors of pixels 1 to 31 are switched to hold mode immediately (SNH = 1), with

pixel 32 (SNH32 = 1) following suit one clock pulse later. This special procedure allows all pixels to be read out with just 32 clock pulses. The integration capacitors are discharged by a one clock long reset signal (NRCI = 0) which occurs between the 2<sup>nd</sup> and 3<sup>rd</sup> falling edge of the readout clock pulse (cf. Figure 4). After the 31 pixels have been read out these are again set to sample mode (SNH = 0), likewise for pixel 32 one clock pulse later (SNH32 = 0).

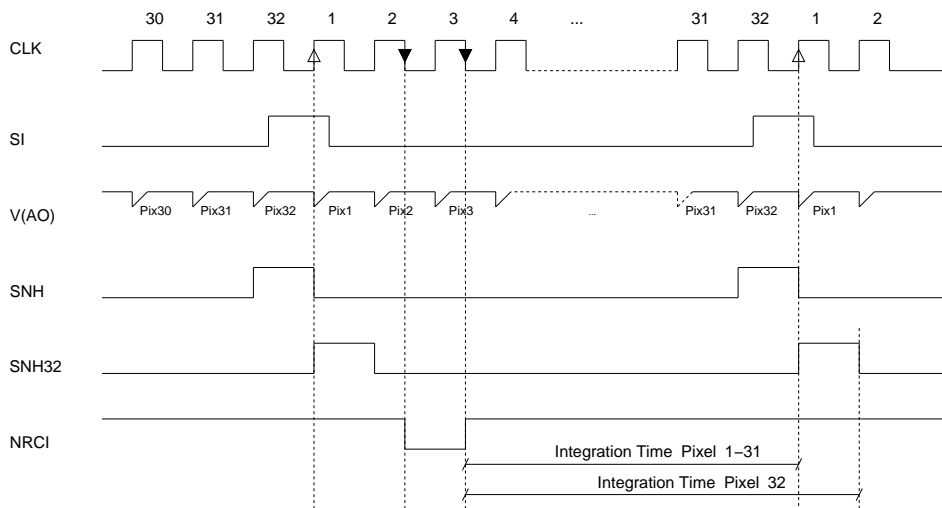


Figure 4: Readout cycle and integration sequence

If prior to the 32<sup>th</sup> clock pulse a high signal occurs at SI the present readout is halted and immediately reinitiated with pixel 1. In this instance the hold ca-

pacitors retain their old value i.e. hold mode prevails (SNH/SNH32 = 0).

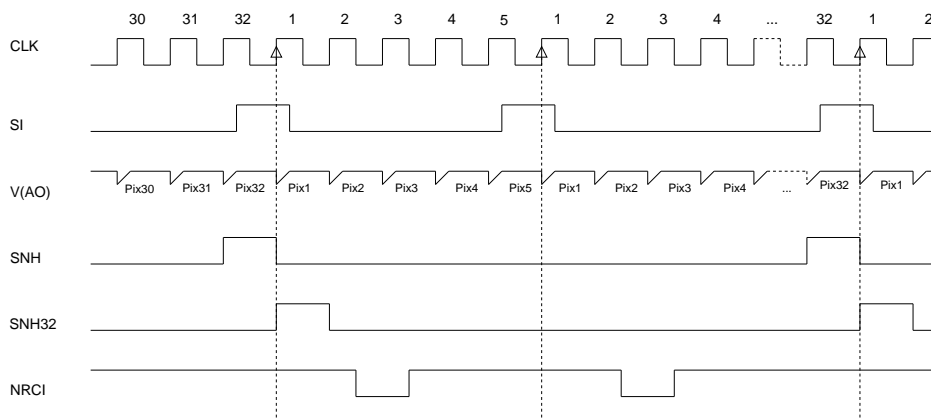


Figure 5: Restarting a readout cycle

With more than 32 clock pulses until the next SI signal, pixel 1 is output without entering hold mode; the out-

put voltage tracks the voltage of the pixel 1 integration capacitor.

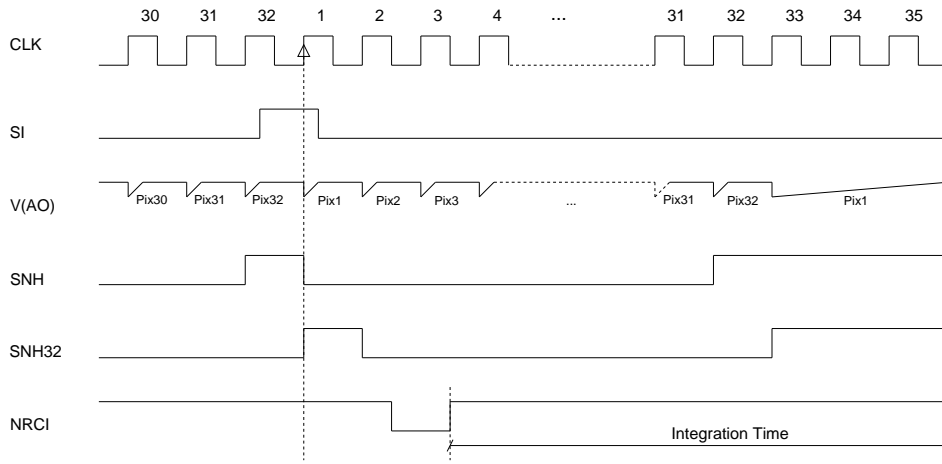


Figure 6: Clock pulse continued without giving a new integration start signal

**Operation with the shutter function**

Integration can be halted at any time via pin DIS, i.e. the photodiodes are disconnected from their corresponding integration capacitor when DIS is high and

the current integration capacitor voltages are maintained. If this pin is open or switched to GND the pixel photocurrents are summed up by the integration capacitors until the next successive SI signal follows.

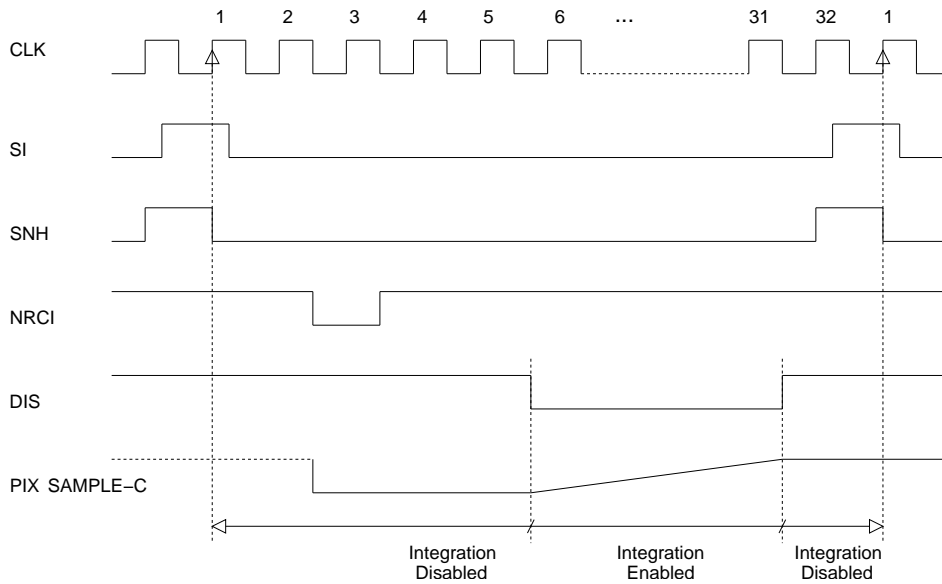


Figure 7: Defining the integration time via shutter input DIS

**External bias current setting**

In order to reduce the power consumption of the device an external reference current can be supplied to pin RSET which reduces the maximum readout frequency,

however. To this end a resistor must be connected from VCC to RSET. If this pin is not used, it should be connected to GND.

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## ORDERING INFORMATION

Type	Package	Order Designation
iC-LFS	clearDFN10 -	iC-LFS cDFN10 iC-LFS Chip

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