MLX92362/MLX92361

Isolated output programmable Hall Effect Latch/Switch/Omnipolar switch
Datasheet

1. Features and Benefits

- Normal or lateral magnetic sensitivity options X,Y,Z
- Switch output – fully isolated from the supply voltage, OUTA/OUTB potentials can be below GND or above VDD
- Typical R_{ON} of 3Ω
- Output current up to 100mA (AMR 200mA)
- Programmable magnetic thresholds and threshold temperature coefficient
- Programmable magnetic Latch, Unipolar and Omnipolar Switch function
- Built-in daisy chain functionality to synchronize multiple devices
- Operating voltage range from 4.5V to 28V
- Low average supply current – 180µA typical
- Under-Voltage Reset protection
- Thermal protection
- Package RoHS compliant TSOT-6L

2. Application Examples

- Reed switch replacement
- Fluid level meter applications
- Push button
- Direct load driving
- HIGH/LOW side switch

3. Description

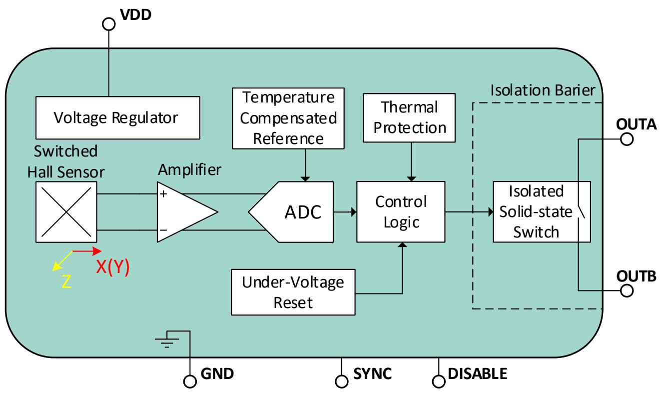
The MLX92362/61 is a monolithic sensor IC sensitive to normal or lateral magnetic field.

The MLX92362/61 has two output pins, OUTA and OUTB. They are connected to an integrated, electrically isolated switch. The MLX92362 can be programmed to output direct or inverted signal from one of the two sensitive axes – X(Y) or Z. The signal available on the output pins is result of comparison between the applied magnetic field and the pre-programmed magnetic thresholds B_{OP} and B_{RP} for the selected sensitive axis.

The MLX92362/61 can be programmed to act as magnetic latch, unipolar switch or omnipolar switch.

The MLX92362/61 can be used as general replacement of reed switches having the advantage of solid-state reliability. Note that a series of ICs can be connected in a single module, and synchronized via the same 3-wire interface thanks to the built-in daisy chain function.

Customers can benefit from the end-of-line (EoL) programming capability of the MLX92362 or alternatively, they can choose a pre-programmed MLX92361 device.



MLX92362 functional diagram

Contents

4. Ordering Information

Product	Temperature	Package	Option Code	Packing Form	Definition
MLX92362	L	SE	AAA-000	RE	Customer programmable Y/Z-axis sensitive device
MLX92362	L	SE	ABA-000	RE	Customer programmable X/Z-axis sensitive device
MLX92361	L	SE	ABC-001	RE	Pre-programmed X-axis sensitive device

Legend:

Temperature Code:	L: T_A from -40°C to 150°C
Package Code:	"SE" for TSOT-6L
Option Code:	AAA = Y/Z-axis Programmable sensor ABA = X/Z-axis Programmable sensor AAB = Pre-programmed sensor, Z-axis sensitive AAC = Pre-programmed sensor, Y-axis sensitive ABB = Pre-programmed sensor, Z-axis sensitive ABC = Pre-programmed sensor, X-axis sensitive
Packing Form:	RE: tape on reel
Ordering Example:	MLX92362LSE-AAA-000-RE

5. Glossary of Terms

Gauss (G), Tesla (T)	Units for the magnetic flux density – 1 mT = 10 G
TC	Temperature Coefficient of the magnetic threshold (in ppm/°C)
ADC	Analog-to-Digital Converter
B_{OP}	Operating magnetic threshold
B_{RP}	Release magnetic threshold

6. Absolute Maximum Ratings

Parameter	Symbol	Value	Unit
Supply voltage(1)	V_{DD}	32	V
Supply current(1,2, 3)	I_{DD}	20	mA
Reverse supply voltage(1)	V_{DDREV}	-0.5	V
Reverse supply current(1, 3, 4)	I_{DDREV}	-20	mA
Maximum voltage difference between any combination of VDD, GND, OUTA and OUTB pins(1)	V_{DIFF}	±32	V
Output pin current(1, 3, 4)	I_{OUTA}, I_{OUTB}	±20	mA
Output current(1, 3, 5)	I_{OUT}	±200	mA
DISABLE pin voltage(1)	V_{DIS}	6	V
DISABLE pin reverse voltage(1)	V_{DISREV}	-0.5	V
DISABLE pin current(1, 3, 4)	I_{DIS}	±20	mA
SYNC pin current(1, 3, 4)	I_{SYNC}	±20	mA
Maximum junction temperature(6)	T_J	+175	°C
ESD – HBM(7)	-	4	kV
ESD – CDM(8)	-	1000	V

Exceeding the absolute maximum ratings may cause permanent damage. Exposure to absolute maximum-rated conditions for extended periods may affect device reliability.

Note 1: For maximum 1 hour
Note 2: Including the current through the protection device
Note 3: The maximum junction temperature should not be exceeded
Note 4: Current through the protection device
Note 5: Current through the output switch
Note 6: Guaranteed by 1000 hours HTOL
Note 7: Human Body Model according AEC-Q100-002 or ANSI/ESDA/JEDEC JS-001 standard
Note 8: Charged Device Model according AEC-Q100-011 or ANSI/ESDA/JEDEC JS-002 standard

7. General Electrical and Timing Specifications

Operating conditions V_{DD} = 4.5V to 28V, T_A = -40°C to 150°C (unless otherwise specified)

Parameter	Symbol	Condition	Min	Typ(1)	Max	Unit
Under Voltage Reset threshold	V_{UVR}		–	–	4.2	V
Under Voltage Reset reaction time(2)	t_{UVR}	V_{DD} drop to 2V	–	0.4	–	µs
Output leakage	I_{OFF}	V_{OUTA} = 0V, V_{OUTB} = 28V or V_{OUTA} = 28V, V_{OUTB} = 0V	–	–	1	µA
Output turned-on resistance(3)	R_{ON}	I_{OUT} = 50mA T_A = -40..105°C	–	3	5	Ω
Output turned-on resistance	R_{ON}	I_{OUT} = 50mA T_A = -40..150°C	–	3	6	Ω
Output turned-off resistance(2)	R_{OFF}	V_{OUTA} = 5V, V_{OUTB} = 0V or V_{OUTA} = 0V, V_{OUTB} = 5V	–	>10	–	MΩ
Output isolation resistance to GND(2)	R_{ISO}	V_{OUTA} = V_{OUTB} = 5V	–	>10	–	MΩ
OUTA parasitic capacitance to GND(2)	C_{OUTA_GND}	V_{AC} = 1V, f = 50kHz Switch state = OFF, OUTB unconnected;	–	9	–	pF
OUTB parasitic capacitance to GND(2)	C_{OUTB_GND}	V_{AC} = 1V, f = 50kHz Switch state = OFF, OUTA unconnected;	–	9	–	pF
OUTA parasitic capacitance to OUTB(2)	C_{OUTA_OUTB}	V_{AC} = 1V, f = 50kHz Switch state = OFF;	–	4	–	pF
Output voltage operating range	V_{OUTA}, V_{OUTB}		V_{DD} - 28	–	28	V
Output voltage difference, V_{OUTA} - V_{OUTB}			-28	–	28	V
Output rise time(2,4)	t_R	R_{PU}=10kΩ, V_{DD}=12V, V_{PU}=5V, C_{LOAD}=50pF	3	8	20	µs
Output fall time(2,4)	t_F	R_{PU}=10kΩ, V_{DD}=12V, V_{PU}=5V, C_{LOAD}=50pF	3	8	20	µs
Power-On time(5,6)	t_{ON}	V_{DD}=12V $\Delta V_{DD}/\Delta t \geq 2V/\mu s$ DISABLE = 0	–	170	250	µs
Power-On state	–	Output state during t_{ON}		OFF		–
Average supply current	I_{DDAVG}	t_{SLEEP} = 50ms, DISABLE = 0 T_A = -40..150°C	162	180	212	µA
Average supply current(3)	I_{DDAVG}	t_{SLEEP} = 50ms, DISABLE = 0 T_A = -40..85°C	162	180	192	µA
Peak supply current, for peaks longer than 5µs	I_{DDPEAK}		–	1.5	2.2	mA
Output update period	T_{OU}	DISABLE = 0		$t_{PACT} + t_{ACT} + t_{SLEEP}$		–

Parameter	Symbol	Condition	Min	Typ[1]	Max	Unit
Pre-Active phase duration	t_{PACT}		96.9	102	107.1	µs
Active phase duration	t_{ACT}		49.4	52	54.6	µs
Programmable sleep phase duration	t_{SLEEP}	Typical range, DISABLE = 0	0.064	–	81.96	ms
Average Pre-Active phase supply current	I_{DDPACT}	T_A = -40..150°C	330	380	430	µA
Average Pre-Active phase supply current[3]	I_{DDPACT}	T_A = -40..85°C	330	380	410	µA
Average Active phase supply current	I_{DDACT}		1.3	1.4	1.5	mA
Sleep phase supply current	$I_{DDSLEEP}$	T_A = -40..150°C	160	180	210	µA
Sleep phase supply current[3]	$I_{DDSLEEP}$	T_A = -40..85°C	160	180	190	µA
DISABLE pin input low voltage	V_{DIS_IL}		1	1.2	1.4	V
DISABLE pin input high voltage	V_{DIS_IH}		1.5	1.8	2	V
DISABLE pin weak pull-down current	I_{DIS_WPD}		3	4	5.5	µA
DISABLE pin strong pull-down current	I_{DIS_SPD}		85	100	115	µA
Propagation delay – DISABLE falling edge to Output update[2]	t_{DIS_PD}		–	180	240	µs
DISABLE low state duration for successful Output update[2]	t_{DIS_LD}		20	–	–	µs
SYNC pin output low voltage	V_{SYNC_OL}	I_{LOAD} = 1mA	20	35	60	mV
SYNC pin output high voltage	V_{SYNC_OH}	I_{LOAD} = 0.5mA	3.2	3.5	3.9	V
		I_{LOAD} = 0mA	3.5	3.8	4.3	V
SYNC low state pulse duration	t_{SYNC_LD}		45	48	51	µs
Thermal Protection	T_{PROT}		–	190	–	°C
SE package thermal resistance	R_{THJA}	Single layer PCB, JEDEC standard test boards, still air (LFPM=0)	–	250	–	°C/W

Note 1: Unless otherwise specified the typical values are defined at T_A = +25°C and V_{DD} = 12V
Note 2: Guaranteed by design and verified by characterization, not production tested
Note 3: Guaranteed by correlation with production test at T_A=150°C and verified by characterization
Note 4: Open drain application, one of the outputs connected to ground, the other connected to the pull-up resistor. R_{PU} and V_{PU} are respectively the external pull-up resistor and pull-up power supply
Note 5: The Power-On Time represents the time from reaching V_{DD} = 4.5V to the first refresh of output state
Note 6: Power-On Slew Rate is not critical for the proper device start-up.

8. Version specific parameters

8.1. MLX92362LSE-ABA-000-RE

Test Condition	Operating Point B_{OP} (mT)			Release Point B_{RP} (mT)			TC (ppm/°C)	Output polarity active pole	Sleep duration (ms)
	Min	Typ(1)	Max	Min	Typ(1)	Max	Typ(1)		
T_A = -40°C							0(2)	X-axis Direct Unipolar switch	50
T_A = 25°C		3			2				
T_A = 150°C									

8.2. MLX92361LSE-ABC-001-RE

Operating conditions V_{DD} = 4.5V to 28V, T_A = -40°C to 150°C (unless otherwise specified)

Test Condition	Operating Point B_{OP} (mT)			Release Point B_{RP} (mT)			TC (ppm/°C)	Output polarity active pole	Sleep duration (ms)
	Min	Typ(1)	Max	Min	Typ(1)	Max	Typ(1)		
T_A = -40°C							-2000(2)	X-axis Direct Omnipolar switch	81.96
T_A = 25°C		±3			±2				
T_A = 150°C									

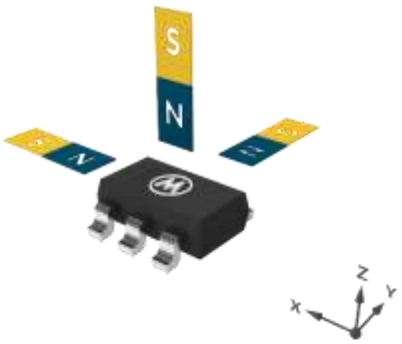
Note 1: Unless otherwise specified the typical values are defined at T_A = +25°C and V_{DD} = 12V
Note 2: The Temperature Coefficient is calculated using following formula:

$$TC = \frac{B_{XPTA2} - B_{XPTA1}}{B_{XPTA1} \times (T_{A2} - T_{A1})} \times 10^6, ppm/°C$$

where:
T_{A1} = 25°C, T_{A2} = 150°C
In case of magnetic Latch application: B_{XPTA1} (B_{XPTA2}) = B_{OP} - B_{RP} at T_{A1} (T_{A2})
In case of magnetic Unipolar Switch application: B_{XPTA1} (B_{XPTA2}) = B_{OP} or B_{RP} at T_{A1} (T_{A2})
In case of magnetic Omnipolar Switch application: B_{XPTA1} (B_{XPTA2}) = B_{OP_SOUTH} – B_{OP_NORTH} at T_{A1} (T_{A2})

9. Detailed Description

9.1. Active magnetic pole definition



SE package
North Pole Active for X,Y and Z axis

SE package
South Pole Active for X,Y and Z axis

9.2. Average supply current

MLX92362/61 operates in a Sleep-Active mode as long as the DISABLE pin is in low state. The chip is sequencing Sleep, Pre-Active and Active phases. In Sleep phase the chip is maintaining its output state and in Pre-Active phase it is preparing for Active phase. In Active phase the chip is detecting the magnetic field and updates its output state. Taking into account all of the defined operating phases with their corresponding currents and duration the average supply current of the chip can be calculated using the following formula:

$$I_{DDAVG} = \frac{I_{DDSLEEP} \times t_{SLEEP} + I_{DDPACT} \times t_{PACT} + I_{DDACT} \times t_{ACT}}{t_{SLEEP} + t_{PACT} + t_{ACT}}$$

Where $I_{DDSLEEP}$ is the supply current of the chip in sleep phase, t_{SLEEP} is the programmed sleep duration, I_{DDPACT} is the average supply current in pre-active phase, t_{PACT} is the duration of the pre-active phase, I_{DDACT} is the average supply current in active phase and t_{ACT} is the active phase duration.
When calculating the minimum and maximum average supply current only the minimum and maximum values of the $I_{DDSLEEP}$, I_{DDPACT} and I_{DDACT} should be used. The timing parameters should be always calculated as typical values since the timing parameters are derivate of the same clock source, making the ratio between them fixed. Therefore, the tolerance of the timing parameters is not affecting the average current consumption.

9.3. DISABLE pin function

The DISABLE pin is a 5V tolerant digital input with integrated pull-down current. The pin can be controlled by 3.3V or 5V logic outputs. The function of the pin is to disable the Active phase, preventing the output update. The pin is intended for on-demand output update. On the falling edge of the disable signal the chip wakes up, transitions to Pre-Active, then to Active phase and updates its output state. The time between the falling edge of the disable signal and the output update is t_{DIS_PD}.

If the pin is held in high state, the chip will transition periodically to Pre-Active phase with duration t_{PACT} and then back to sleep with duration:

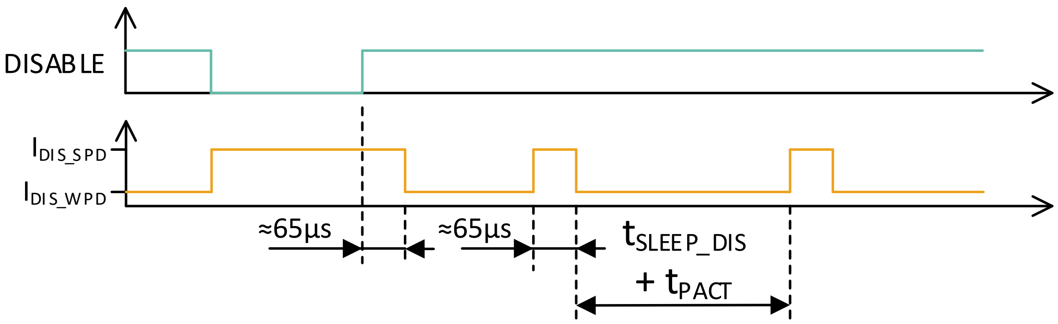
$$t_{SLEEP\_DIS} = 2 \times t_{SLEEP} - 108\mu s$$

This sequence of t_{SLEEP_DIS} and t_{PACT} is repeated as long as DISABLE pin is held high. In this mode the average current consumption can be calculated with the following formula:

$$I_{DDAVG} = \frac{I_{DDSLEEP} \times t_{SLEEP\_DIS} + I_{DDPACT} \times t_{PACT}}{t_{SLEEP\_DIS} + t_{PACT}}$$

If the DISABLE pin is held in low state the chip operates as described in "9.2 Average supply current".

The DISABLE pin has integrated pull-down current and it can be left unconnected if it is not used. The pull-down current has two values – strong (I_{DIS_SPD}) and weak (I_{DIS_WPD}). The strong pull-down current is always active while the DISABLE pin is in low state. The chip is switching to the weak pull-down current if the state of the pin is held in high state for more than ≈65µs. The chip is switching between the weak and the strong current each t_{SLEEP_DIS} + t_{PACT}, if the pin is held in high state.



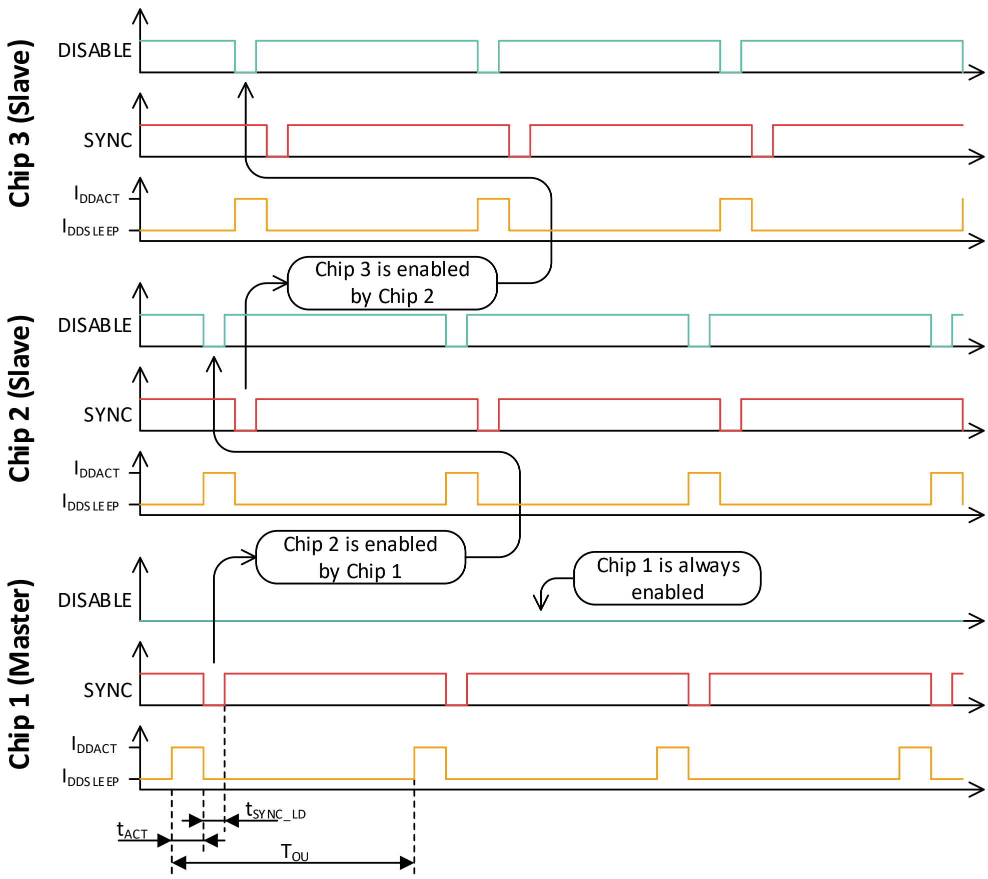
If the pin is not used, it can be left unconnected or it can be connected to GND.

9.4. SYNC pin function

The SYNC pin outputs an active low pulse at the end of each Active phase, indicating the output state is updated. The state of the output is valid 20µs after the rising edge of the SYNC pin.
If the pin is not used, it should be left unconnected.

9.5. Daisy chain operating mode

The daisy chain operating mode makes use of the SYNC and DISABLE pins for applications with more than one MLX92362/61 device. Such application is "12 Fluid level meter application schematic" where only three devices are used for simplicity, but practically tens or hundreds of devices can be used. The first chip in the chain (the one with DISABLE pin unconnected or connected to GND) is called master. Each of the subsequent devices is a slave. The master is initiating the update of the full chain, making the update behavior predictable and repeatable. First, the master is updating its output, then the slave next to the master and so on.
The figure below illustrates the function, in a simplified way with Pre-Active phase omitted.



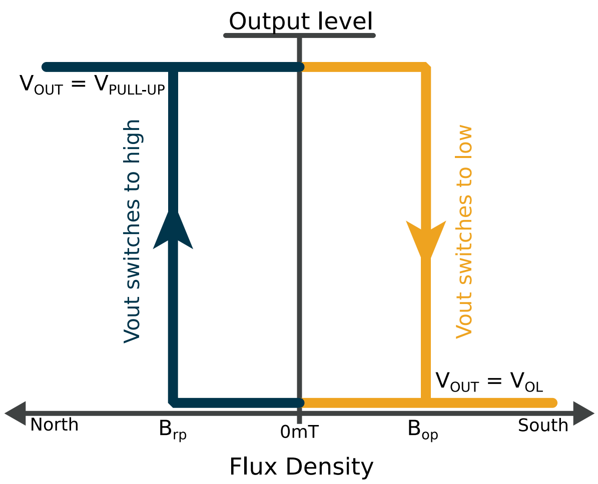
Other benefit of the daisy chain operating mode is reduced peak current consumption. The chip to chip synchronization ensures only one device will be in Active phase at a time as long as the total sum of Pre-Active and Active phases of all devices is less than the sleep time. In the opposite case two or more "waves" of enabled devices will exist, but the function will still exist and work correctly. The reduced peak current consumption enables the possibility to design a module with narrower PCB traces and less filtering capacitance near the chip. This makes practical the possibility to make a module with hundreds of devices with more than 1m length and operate it close to the minimum supply voltage (e.g. at 5V) without worrying that the last chip in the module will not be able to operate because of the too high voltage drop over the PCB traces.
In case the SYNC-DISABLE connection between any two slave devices is broken, a new master is automatically assigned (the chip with the floating DISABLE pin) and the module continues to operate with two masters, one for the half of the chain before the defect and one for the half of the chain after the defect. No power-cycling is required or manual intervention.
The average current consumption of a module operating in Daisy chain mode can be calculated using the following formula:

$$I_{DDAVG} = N \times I_{DDAVG\_SINGLE} + (N-1) \times \frac{(I_{DIS\_WPD} \times (t_{SLEEP} + t_{PACT} + t_{ACT} - 65\mu s) + I_{DIS\_SPD} \times 65\mu s)}{t_{SLEEP} + t_{PACT} + t_{ACT}}$$

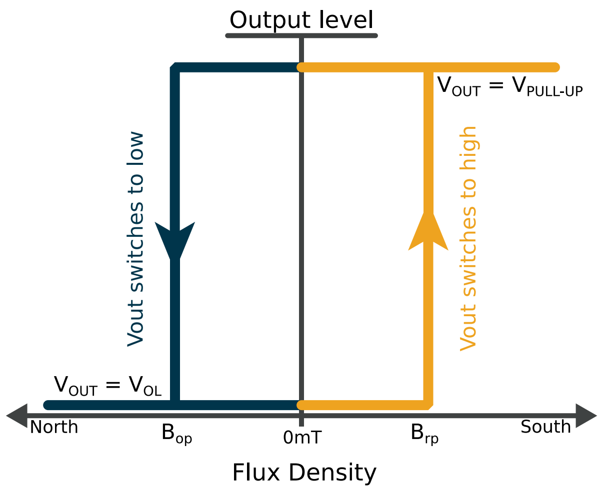
Where N is the number of devices in the Daisy chain, I_{DDAVG_SINGLE} is the average current consumption of a single chip calculated using the formula in "9.2 Average supply current", I_{DIS_WPD} is the weak pull down current of the DISABLE pin, I_{DIS_SPD} is the DISABLE pin strong pull-down current, t_{SLEEP} is the Sleep phase duration, t_{PACT} is the Pre-Active phase duration and t_{ACT} is the Active phase duration. Similar to the average current consumption of a single chip when minimum and maximum current consumption is calculated the timing tolerances should not be taken into account, only typical values should be used.

10. Magnetic Behavior

10.1. Latch Sensor

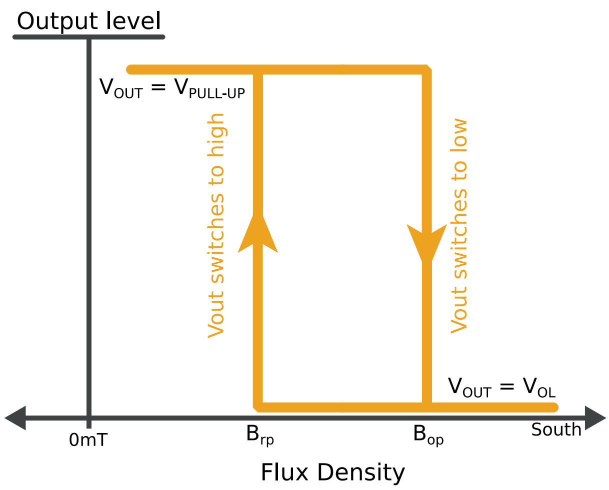


South Pole Active Latch

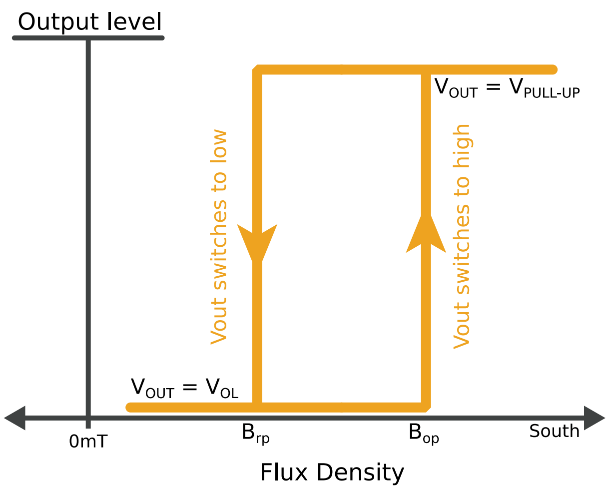


North Pole Active Latch

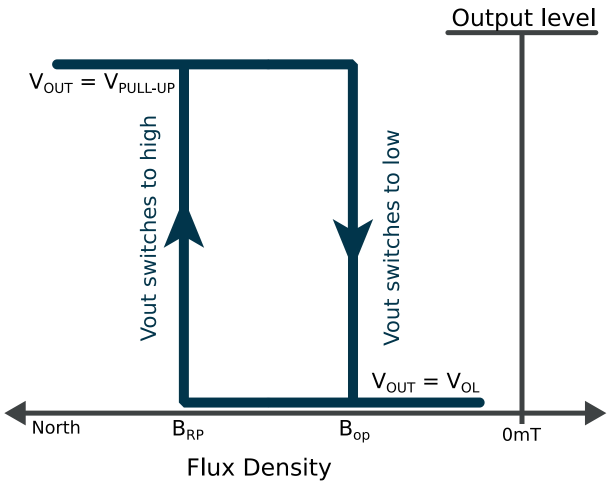
10.2. Unipolar Switch Sensor



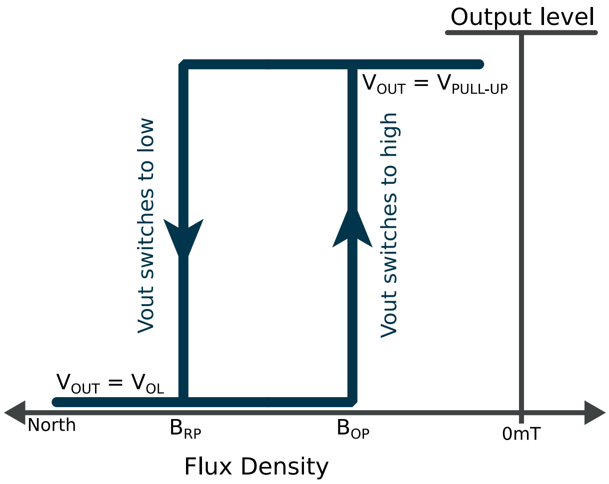
Direct South Pole Active Switch



Inverted South Pole Active Switch

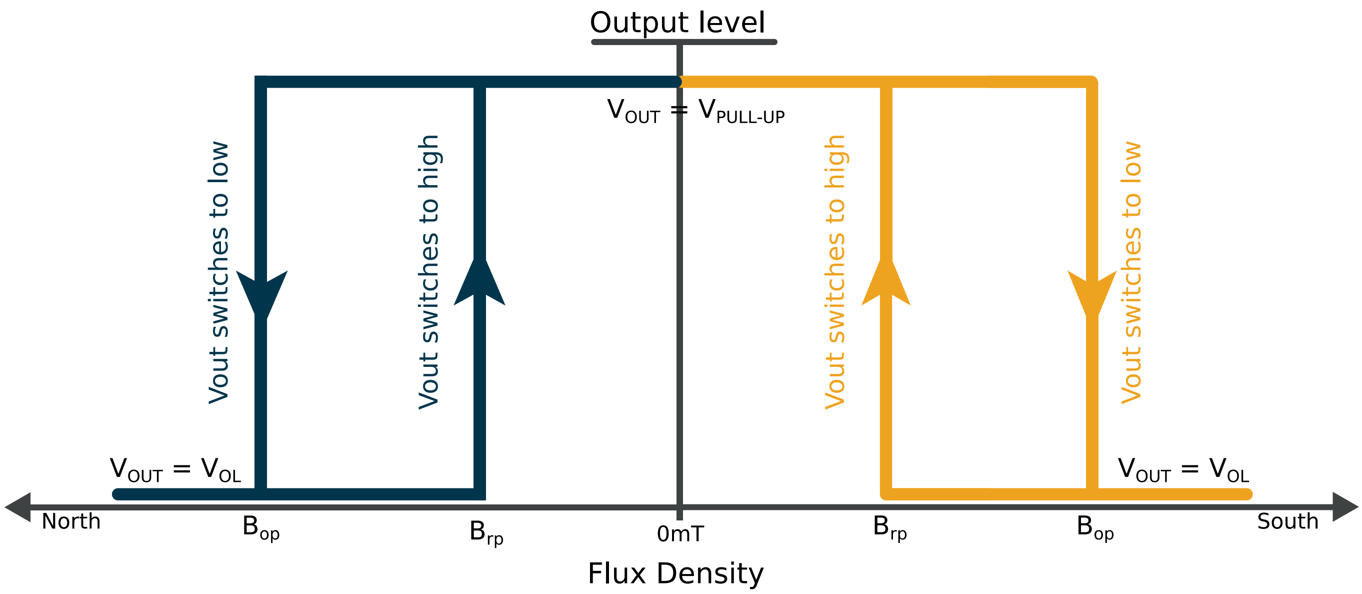


Direct North Pole Active Switch



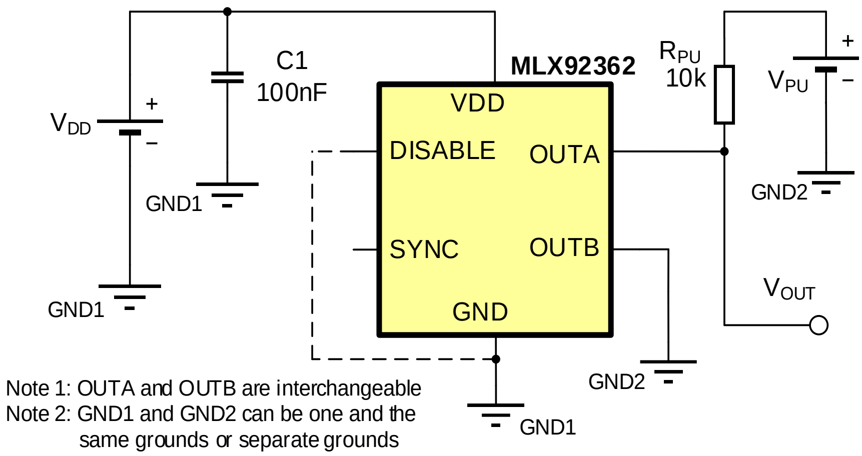
Inverted North Pole Active Switch

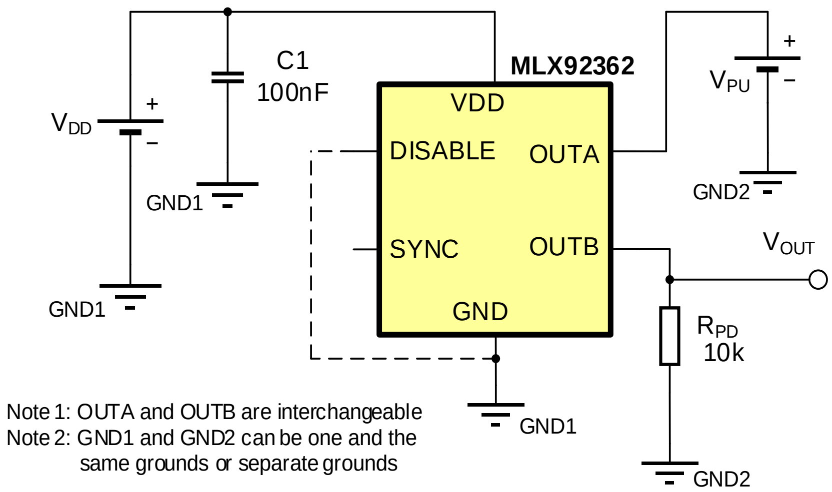
10.3. Omnipolar Switch Sensor



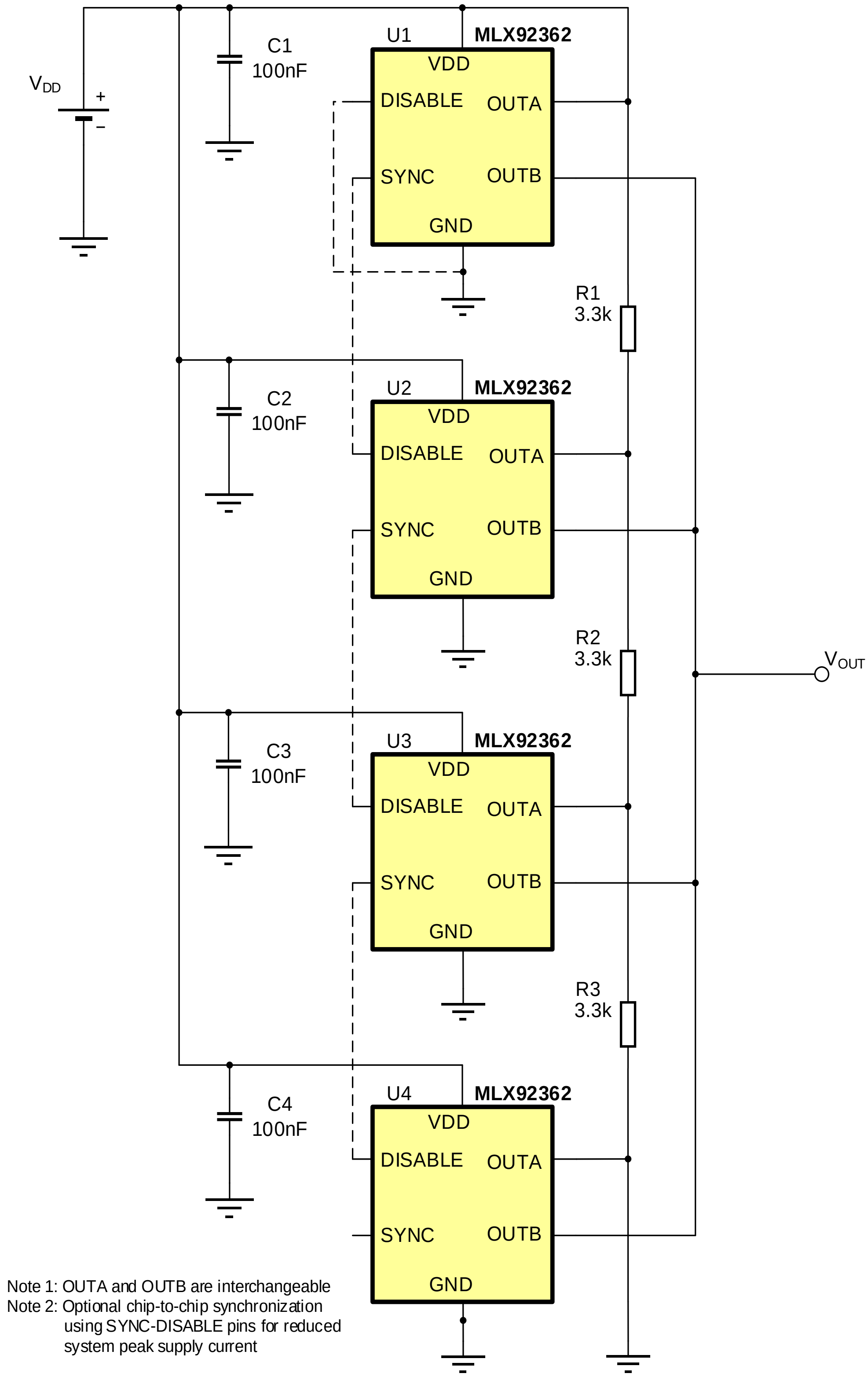
Direct omnipolar switch

11. Open drain application schematics – Low side and High side





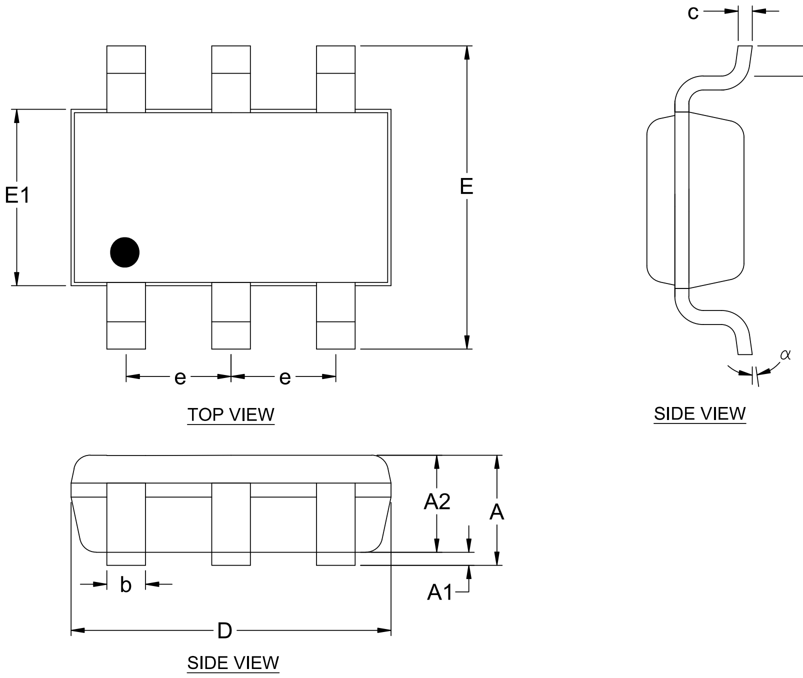
12. Fluid level meter application schematic



13. Package Information

13.1. TSOT-6L (SE Package)

13.1.1. TSOT-6L – Package dimensions

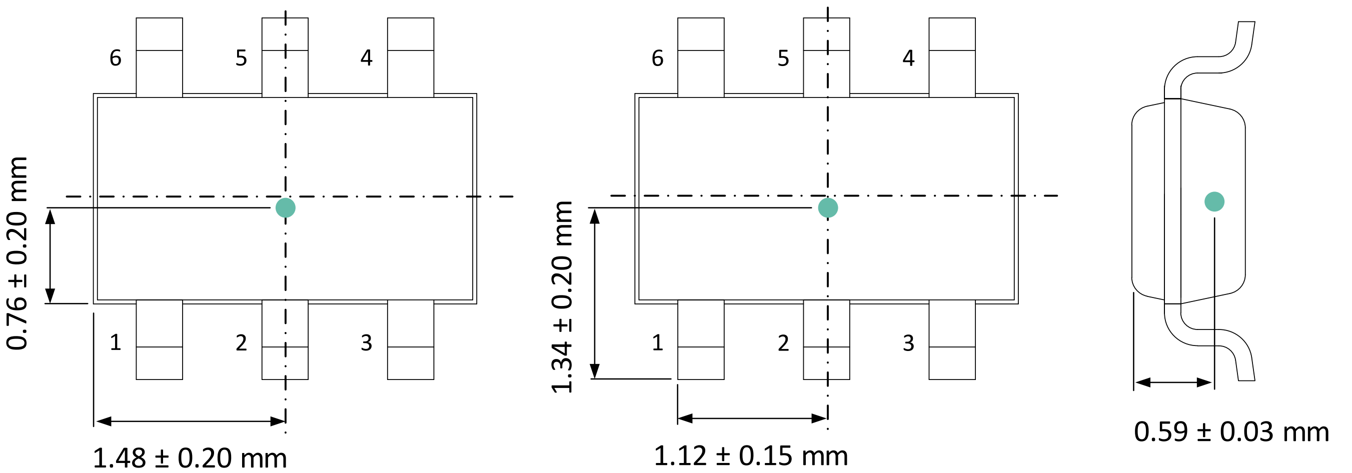


SYMBOL	MINIMUM	MAXIMUM
A	– – –	1.00
A1	0.025	0.10
A2	0.85	0.90
D	2.80	3.00
E	2.60	3.00
E1	1.50	1.70
L	0.30	0.50
b	0.30	0.45
c	0.10	0.20
e	0.95 BSC	
α	0°	8°

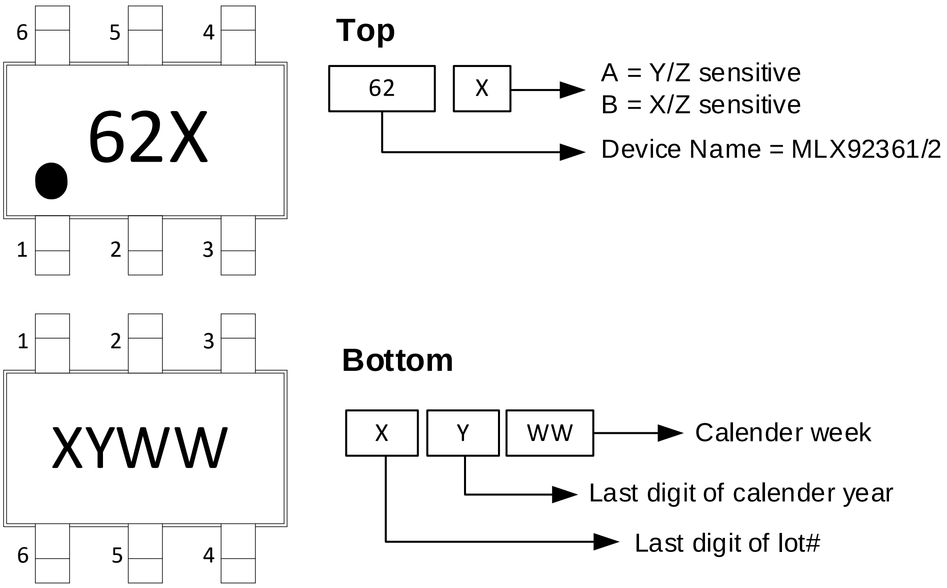
NOTE :

1. ALL DIMENSIONS IN MILLIMETERS (mm) UNLESS OTHERWISE STATED.
2. DIMENSION D DOES NOT INCLUDE MOLD FLASH OR PROTRUSIONS OF MAX 0.15 mm PER SIDE.
3. DIMENSION E DOES NOT INCLUDE MOLD FLASH OR PROTRUSIONS OF MAX 0.25 mm PER SIDE.
4. DIMENSION b DOES NOT INCLUDE DAMBAR PROTRUSION OF MAX 0.07 mm.
5. DIMENSION L IS THE LENGTH OF THE TERMINAL FOR SOLDERING TO A SUBTRATE.
6. FORMED LEAD SHALL BE PLANAR WITH RESPECT TO ONE ANOTHER WITH 0.076 mm SEATING PLANE.

13.1.2. TSOT-6L – Sensitive spot



13.1.3. TSOT-6L – Package marking/ Pin definition



Pin #	Name	Type	Function
1	DISABLE	Input	Chip disable input. Integrated pull-down
2	GND	Ground	Ground pin
3	SYNC	Output	Synchronization output, push-pull
4	OUTA	Output	Isolated switch pin A
5	OUTB	Output	Isolated switch pin B
6	VDD	Supply	Supply Voltage pin

Note: if the Disable pin is unused, connect to ground or leave unconnected.

14. Standard Information

Our products are classified and qualified regarding soldering technology, solderability and moisture sensitivity level according to standards in place in Semiconductor industry.

For further details about test method references and for compliance verification of selected soldering method for product integration, Melexis recommends reviewing on our web site the General Guidelines soldering recommendation. For all soldering technologies deviating from the one mentioned in above document (regarding peak temperature, temperature gradient, temperature profile etc), additional classification and qualification tests have to be agreed upon with Melexis.

For package technology embedding trim and form post-delivery capability, Melexis recommends to consult the dedicated trim&form recommendation application note: lead trimming and forming recommendations

Melexis is contributing to global environmental conservation by promoting **lead free** solutions. For more information on qualifications of **RoHS** compliant products (RoHS = European directive on the Restriction Of the use of certain Hazardous Substances) please visit the quality page on our website: http://www.melexis.com/en/quality-environment

15. ESD Precautions

Electronic semiconductor products are sensitive to Electro Static Discharge (ESD).
Always observe Electro Static Discharge control procedures whenever handling semiconductor products.

16. Contact

For the latest version of this document, go to our website at www.melexis.com.
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17. Disclaimer

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