

## Features and Benefits

- Low cost
- High sensitivity Hall Sensor
- Locked rotor protection and auto-restart
- Power-efficient CMOS and power MOSFETs
- Built-in output protection clamping diode
- Integrated tachometer (US62) or alarm (US63) signal protected output
- 2-coil fan driver with FG/RD output in 4-pin VK package RoHS Compliant

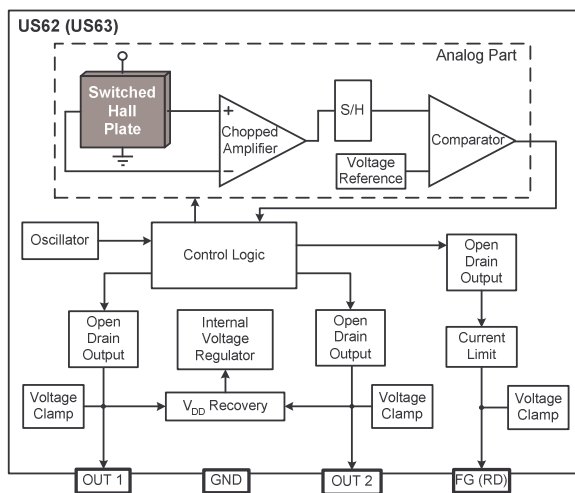
## Application Examples

- 5/12V fans
- Peak current up to 400mA

## Ordering Information

Part No.	Temperature Code	Package Code
US62	E (-40°C to 85°C)	VK (4-pin TO-92)
US63	E (-40°C to 85°C)	VK (4-pin TO-92)

## 1 Functional Diagram



## 2 General Description

The US62/63 is a one-chip solution for driving two-coil brushless DC cooling fans.

Based on the advanced Melexis CMOS process, the IC contains a Hall-effect sensor, dynamic offset correction and low side output drivers.

Frequency Generator or Rotation Detection is available. The open-drain output makes easier the connectivity with any external interface such as hardware monitoring or Super I/O IC.

These features are combined with the Melexis patented no- $V_{DD}$  design to fit the IC in a small 4-pin VK package.

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### 3 Glossary of Terms

Two-coil fan	A fan with two-coil windings where current alternates from 1 coil to the other depending on the direction of the magnetic field.
MilliTesla (mT), Gauss	Units of magnetic flux density : 1mT = 10 Gauss
V <sub>DD</sub>	Voltage on the common point of the fan coils.
I <sub>DD</sub>	Current supplying the chip which flows through the coil connected to the switched off output driver.
Peak output current	The current flowing in the coil at start-up, only limited by the coil resistance R <sub>COIL</sub> and the output driver resistance R <sub>DSON</sub> .
Continuous output current	The current flowing in the coil when the fan is spinning normally.
Locked rotor	The state when the fan stopped spinning due to mechanical blockage.
FG	Frequency generator or tachometer output
RD	Rotation detection or alarm output
LFPM	Linear Feet Per Minute – Unit of airflow velocity

### 4 Absolute Maximum Ratings

Parameter	Symbol	Value	Units
Fan Supply Voltage	V <sub>DD</sub>	18	V
Peak Output Current	I <sub>OUTP</sub>	400	mA
Continuous Output Current	I <sub>OUTC</sub>	250	mA
Operating Temperature Range	T <sub>A</sub>	-40 to 85	°C
Junction Temperature	T <sub>J</sub>	125	°C
Storage Temperature Range	T <sub>S</sub>	-55 to 150	°C
Magnetic Flux Density	B	Unlimited	mT
ESD Sensitivity (AEC Q100 002)	-	2	kV

Table 1: Absolute maximum ratings

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

### 5 Pin Definitions and Descriptions



Pin Name	Pin number	Function
FG (RD)	1	Frequency Generator (Rotation Detection) open drain output signal
OUT1	2	Open Drain Coil Driver 1
OUT2	3	Open Drain Coil Driver 2
GND	4	Ground pin

Table 2: Pin definitions and descriptions US62 (US63)

### 6 General Electrical Specifications

DC Operating Parameters  $T_A = 25^\circ\text{C}$ ,  $V_{DD} = 5\text{V to } 12\text{V}$  (unless otherwise specified)

Parameter	Symbol	Test Conditions	Min	Typ	Max	Units
Fan Supply Voltage	$V_{DD}$	Operating – $R_{COIL} = 50\Omega$	3.2 <sup>(1)</sup>		18	V
Supply Current	$I_{DD}$			2	4	mA
OUT1, OUT2 ON Resistance	$R_{DSON\ 1,2}$	$V_{DD} = 5\text{V}$		3.5		$\Omega$
OUT1, OUT2 ON Resistance	$R_{DSON\ 1,2}$	$V_{DD} = 12\text{V}$		2.5		$\Omega$
OUT1, OUT2 Output Clamp Voltage	$V_{OUT1,2}$		36			V
FG / RD Output Low Voltage	$V_{OL}$	$I_{OL} = 10\text{mA}$		250	500	mV
FG / RD Output Clamp Voltage	$V_{CLMP}$		18			V
FG / RD Output Leakage Current	$I_{LEAK}$	$V_{FG}(V_{RD}) = 18\text{V}$			10	$\mu\text{A}$
FG / RD Output Current Limit	$I_{FGLIM}$	$V_{FG}(V_{RD}) = 12\text{V}$		20		mA
Package Thermal Resistance	$R_{TH}$	One-sided PCB, zero LFPM		200		$^\circ\text{C/Watt}$
Locked Rotor Period	$T_{ON}$			0.22		S
Locked Rotor Period	$T_{OFF}$			1.3		S
Output Switching Delay	$T_{DELAY}$	"Dead time" when both drivers are off		100		us

Table 3: Electrical specifications

Note 1: The minimal value of  $V_{DD}$  should be determined using the following equation:

$$V_{DD} = 3\text{V} + R_{COIL} * I_{DD}$$

### 7 Magnetic Characteristics

DC Operating Parameters  $T_A = 25^\circ\text{C}$ ,  $V_{DD} = 12\text{V}$  (unless otherwise specified)

Parameter	Symbol	Test Conditions	Min	Typ	Max	Units
Operate point	$B_{OP}$			3	6	mT
Release point	$B_{RP}$		-6	-3		mT
Hysteresis	$B_{HYST}$		2	6		mT

Table 4: Magnetic specifications

### 8 Driver Output vs Magnetic Pole

Parameter	Test Conditions	OUT1	OUT2
North pole	$B < B_{RP}$	High	Low
South pole	$B > B_{OP}$	Low	High

Table 5: Driver output vs magnetic pole

Note 1: The magnetic pole is applied facing the branded side of the package

## 9 Detailed General Description

The US62/63 is a one-chip solution for driving two-coil brushless DC fans. Based on advanced Melexis CMOS process, the IC contains a Hall-effect sensor, dynamic offset correction and low side output drivers.

The output drivers OUT1 and OUT2 are fully protected against switching transients. So there is no need for an external zener diode to cut the high voltage spikes induced by the fan coils.

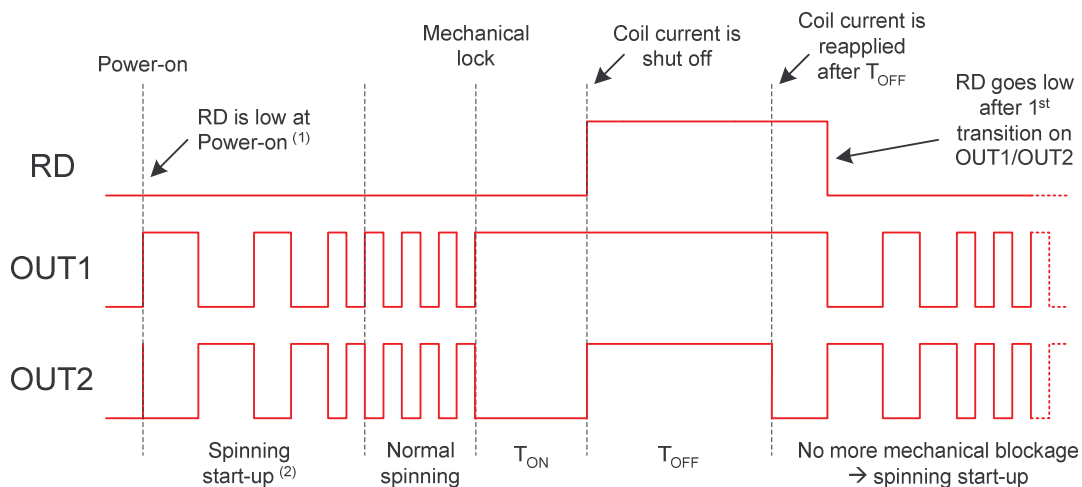
The US62 has an open-drain integrated tachometer FG output that follows the Hall signal. In the US63, the open-drain rotation detection output RD is active low during normal spinning of the motor. It goes high when the flux switching frequency becomes too low, which means the motor is blocked.

## 10 Unique Features

The FG/RD output driver provides an over current protection limiting the current flowing in the FG/RD driver while switched ON. It can occur if a too small pull-up resistor is used or if this resistor is short connected. This protection helps avoid EOS damage on the FG/RD driver.

The absence of a  $V_{DD}$  pin enables the two low side output drivers and FG/RD signal output to fit in a four-pin VK package. The lack of a  $V_{DD}$  pin decreases also the probability to damage the chip due to reverse voltage connection, using the coil resistance to limit the reverse current. In this condition, the total reverse current is twice the peak current value of the fan used.

The built-in locked-rotor protection automatically shuts off the coil current when the rotor is mechanically blocked, or the rotational speed becomes too low. The fan tries to restart every 1.3 seconds until the rotation of the shaft is allowed again. The On / Off cycling reduces the average current to 1/7 normal. It is enough to prevent overheating or damage to most fans.



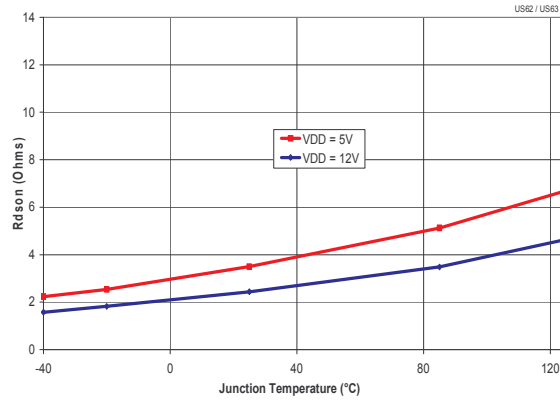
Note 1 : At Power-on, RD is low. If no transition occurs on OUT1/OUT2 before  $T_{ON}$  time, RD goes high.

Note 2 : The spinning start-up is the ramp between the zero speed and maximal speed. It depends on the motor characteristics.

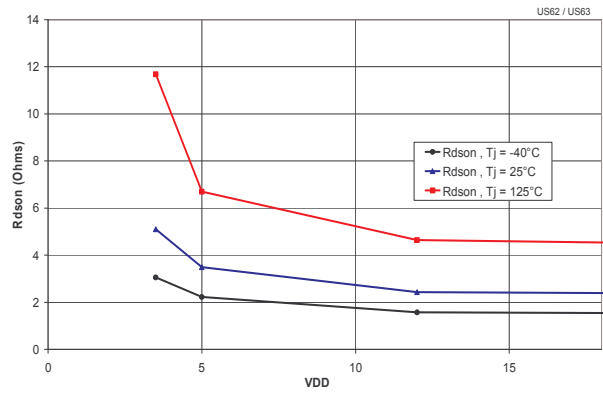
Note 3 : This graph does not represent the EMF effect.

## 11 Performance Graphs

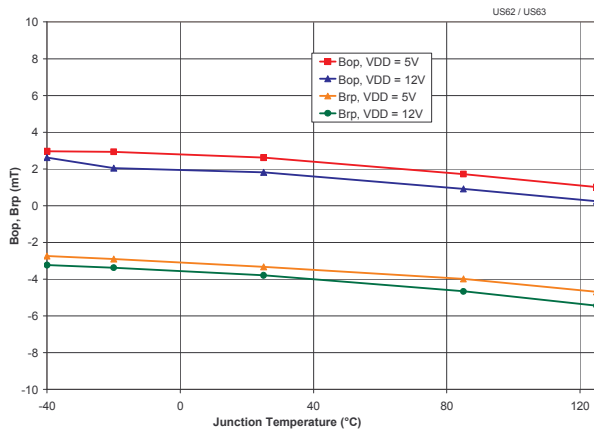
### 11.1 $R_{DS(ON)}$ vs $T_J$



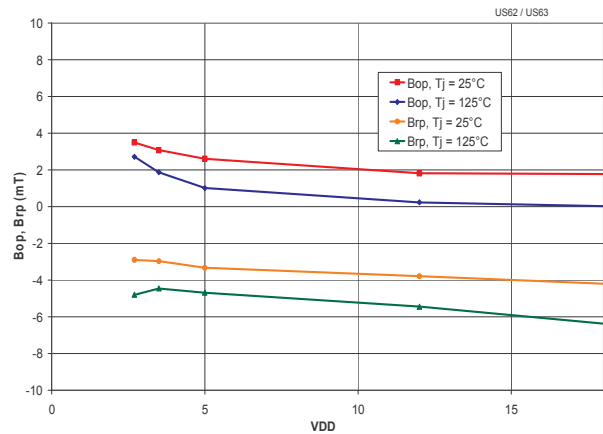
### 11.2 $R_{DS(ON)}$ vs $V_{DD}$



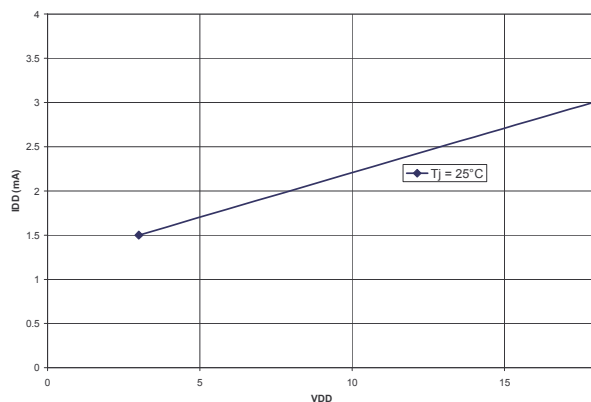
### 11.3 Magnetic Parameters vs $T_J$



### 11.4 Magnetic Parameters vs $V_{DD}$

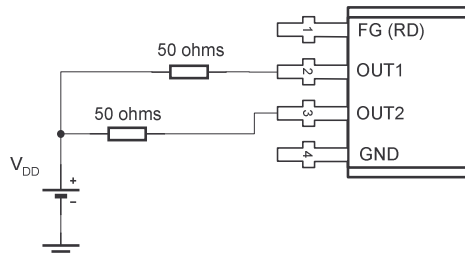


### 11.5 $I_{DD}$ vs $V_{DD}$



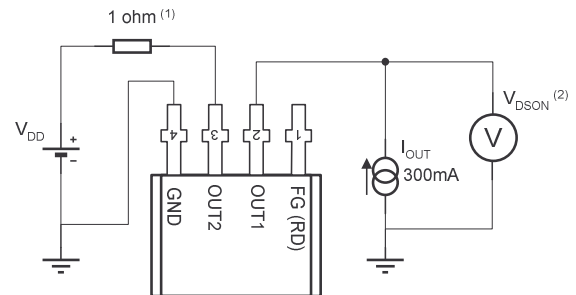
## 12 Test conditions

### 12.1 $V_{DD}$ – operating



Note 1 - "Operating" states the condition when all the chip functions are working normally

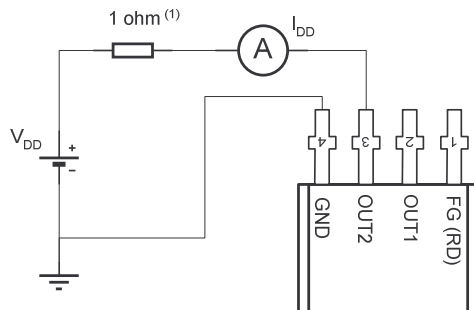
### 12.2 $R_{DS(on)}$



Note 1 - The chip is triggered to have OUT2 = high and OUT1 = low. A small resistor value is used to have  $V_{DD}$  equal to  $V_{OUT2}$

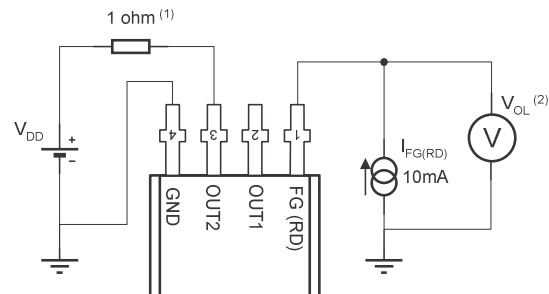
Note 2 - The output driver resistance  $R_{DS(on)}$  is calculated via the relation:  
 $R_{DS(on)} = V_{DS(on)} / I_{OUT}$

### 12.3 $I_{DD}$



Note 1 - The chip is triggered to have OUT2 = high and OUT1 = low. A small resistor value is used to have  $V_{DD}$  equal to  $V_{OUT2}$

### 12.4 FG/RD Output Low Voltage

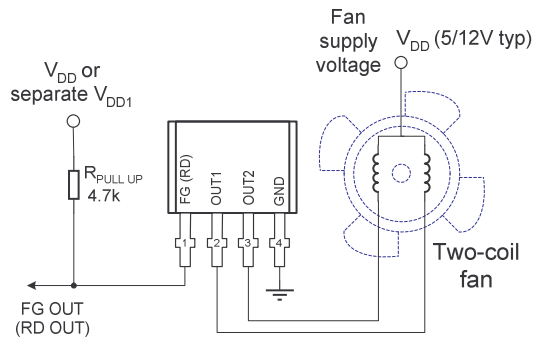


Note 1 - The chip is triggered to have OUT2 = high and OUT1 = low. A small resistor value is used to have  $V_{DD}$  equal to  $V_{OUT2}$

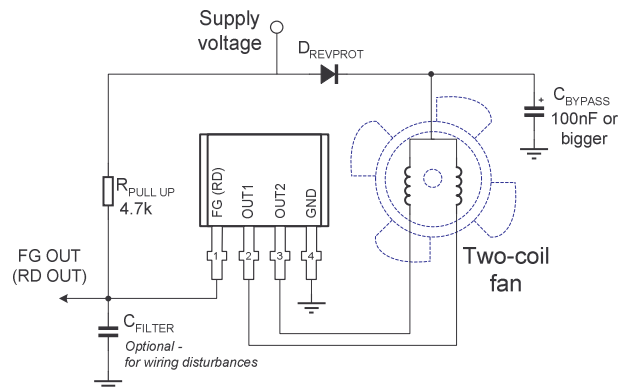
Note 2 - The FG/RD output low voltage is measured during the first  $T_{ON}$  period at the power-on event.

## 13 Application Information

### 13.1 Typical application with pull-up resistor



### 13.2 Configuration for reverse voltage / ground hot-switch protection



## 14 Application Comments

Figure 13.2 shows the application including several external protections.

The diode  $D_{REVPROT}$  best protects the chip and fan coils for reverse voltage condition.

The capacitor  $C_{BYPASS}$  is recommended if the supply ground may be disconnected while running even though the positive supply point is still connected. This capacitor provides a path to ground for the remaining energy in the coil which has to be evacuated. Without it, the energy can flow from OUT1/OUT2 to the FG/RD driver, without any limitation and may cause EOS damage.

Its value has to be tuned depending on the coils characteristics. Bigger inductance requires bigger capacitor.

The optional capacitor  $C_{FILTER}$  suppresses wire disturbances on the FG/RD output line.



## **15 Standard information regarding manufacturability of Melexis products with different soldering processes**

Our products are classified and qualified regarding soldering technology, solderability and moisture sensitivity level according to following test methods:

### **Reflow Soldering SMD's (Surface Mount Developments)**

- IPC/JEDEC J-STD-020  
Moisture/Reflow Sensitivity Classification for Nonhermetic Solid State Surface Mount Devices (classification reflow profiles according to table 5-2)
- EIA/JEDEC JESD22-A113  
Preconditioning of Nonhermetic Surface Mount Devices Prior to Reliability Testing (reflow profiles according to table 2)
- Melexis Working Instruction 341901308

### **Wave Soldering SMD's (Surface Mount Developments) and THD's (Through Hole Developments)**

- EN60749-20  
Resistance of plastic- encapsulated SMD's to combined effect of moisture and soldering heat
- EIA/JEDEC JESD22-B106 and EN60749-15  
Resistance to soldering temperature for through-hole mounted devices
- Melexis Working Instruction 341901309

### **Iron Soldering THD's (Through Hole Developments)**

- EN60749-15  
Resistance to soldering temperature for through-hole mounted devices
- Melexis Working Instruction 341901309

### **Solderability SMD's (Surface Mount Developments) and THD's (Through Hole Developments)**

- EIA/JEDEC JESD22-B102 and EN60749-21  
Solderability
- Melexis Working Instruction 3304312

For all soldering technologies deviating from above mentioned standard conditions (regarding peak temperature, temperature gradient, temperature profile etc) additional classification and qualification tests have to be agreed upon with Melexis.

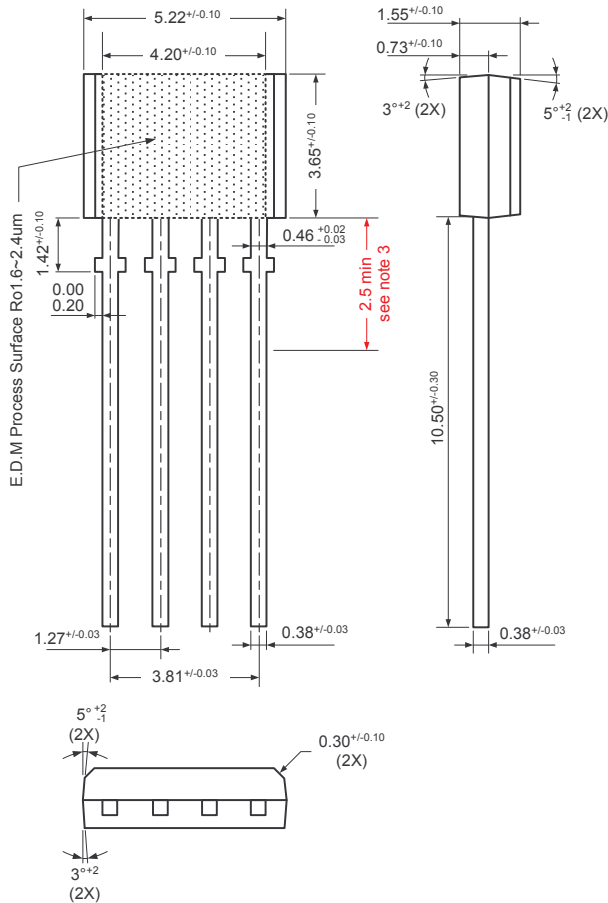
The application of Wave Soldering for SMD's is allowed only after consulting Melexis regarding assurance of adhesive strength between device and board.

For more information on the lead free topic please see quality page at our website:  
<http://www.melexis.com/quality.asp>

## **16 ESD Precautions**

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

**17 VK Package Information (4-pin TO-92)**



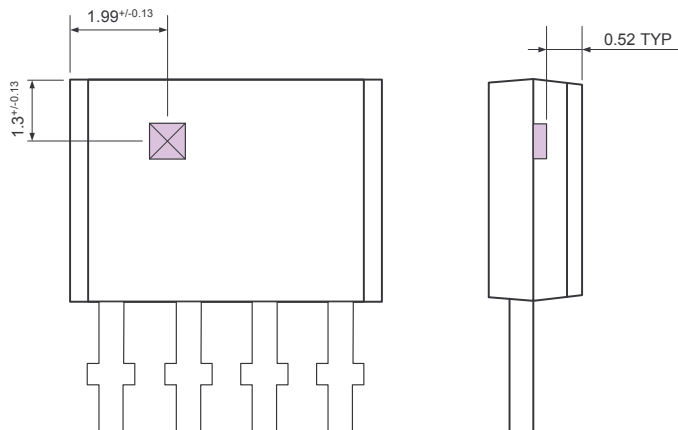
**Notes:**

1. All dimensions are in millimeters
2. Package dimension exclude molding flash. Mold flash shall not exceed 0.127mm.
3. To preserve reliability, it is recommended to have total lead length equal to 2.5mm minimum, measured from the package line.
4. VK package is a pin through-hole package, hence adapted for wave soldering process. A reflow soldering process is not recommended with VK package as it may seriously affect device reliability.

**Marking:**

- 1<sup>st</sup> Line : US62 (US63) - Name of the device
- 2<sup>nd</sup> Line : xxxxx - the last 5 digits of lot number

**Hall plate location**



**Notes:**

1. All dimensions are in millimeters

## **18 Disclaimer**

Devices sold by Melexis are covered by the warranty and patent indemnification provisions appearing in its Term of Sale. Melexis makes no warranty, express, statutory, implied, or by description regarding the information set forth herein or regarding the freedom of the described devices from patent infringement. Melexis reserves the right to change specifications and prices at any time and without notice. Therefore, prior to designing this product into a system, it is necessary to check with Melexis for current information. This product is intended for use in normal commercial applications. Applications requiring extended temperature range, unusual environmental requirements, or high reliability applications, such as military, medical life-support or life-sustaining equipment are specifically not recommended without additional processing by Melexis for each application.

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Or for additional information contact Melexis Direct:

Europe and Japan:  
Phone: +32 1367 0495  
E-mail: [sales\\_europe@melexis.com](mailto:sales_europe@melexis.com)

All other locations:  
Phone: +1 603 223 2362  
E-mail: [sales\\_usa@melexis.com](mailto:sales_usa@melexis.com)

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