

Features and Benefits

- Supply voltage up to 12 V
- Interface directly with 5 V CMOS logic MCUs
- Serial link
- Can drive two 360° actuators & three 90° actuators simultaneously
- Open circuit / short-circuit detection of the drivers outputs
- Small size (SO24 package)
- Real Time Angle Tracking

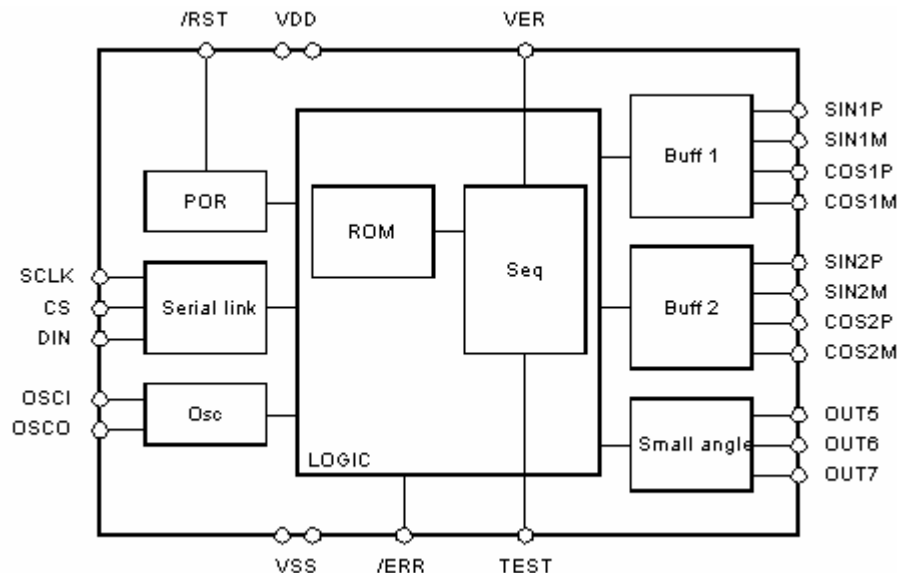
Applications

- Logometer Driver Dashboard
- Industrial Metering

Ordering Information

| Part No. | Temperature Suffix | Package | Option Code |
|----------|--------------------|-------------|-------------|
| MLX10407 | E (-40°C to 85°C) | DF (SOIC24) | CA |

Functional Diagram



Description

The 10407 is a MCU peripheral for logometers control using SIN/COS PWM commands. The circuit controls two independent sets of CMOS power bridges. A ten-bit angle is displayed with a 9 bit per quadrant resolution PWM whose frequency is set by a crystal oscillator. A power-on self test detects open or short-circuit outputs for each logometer and a real time angle tracking avoids display errors.

The 10407 can also drive three small angle logometers (90°). A three wire serial link allows bidirectional communication with the MCU.

DC Electrical Characteristics

Tamb = -40 to 85°C, VDD = 4.5 V to 12 V unless otherwise specified.

| Characteristics | Test Conditions | Symbol | Limits | | | Unit |
|---|---|--------|--------|-----|---------|------|
| | | | Min | Typ | Max | |
| Supply current | Inputs at VDD or VSS, No loads on outputs | ICC | | | 5.5 | mA |
| Maximum power dissipation | | PDmax | | | 620 | mW |
| Inputs | | | | | | |
| Input capacitance | | Cin | | | 10 | pF |
| Pin 11 | | | | | | |
| Pull-down resistance | | Rpd | 125 | | 750 | kOhm |
| Input voltage LOW | | VIL | -0.3 | | 1 | V |
| Input voltage HIGH | | VIH | 4 | | VDD+0.3 | V |
| Hysteresis | VDD = 8.5 V | VHYS | 0.5 | | 2.5 | V |
| Leakage current | pin at VDD or VSS | IL | -1 | | 1 | µA |
| Pin 12, 13, 14, 15, 17 | | | | | | |
| Input voltage LOW | | VIL | -0.3 | | 1 | V |
| Input voltage HIGH | | VIH | 4 | | VDD+0.3 | V |
| Hysteresis | VDD = 8.5 V | VHYS | 0.5 | | 2.5 | V |
| Leakage current (pin 12, 15, 17) | pin at VDD or VSS | IL | -1 | | 1 | µA |
| Pull-down resistance (pin 14) | | Rpd | 0.8 | | 1.5 | kOhm |
| Outputs | | | | | | |
| Pin 16 | | | | | | |
| Low level output voltage | IOUT < 500 µA | VOL | | | 0.3 | V |
| High level output leakage current | VOUT=VDD | ILKG | | | 10 | µA |
| Pin 2, 3, 5, 6, 20, 21, 23, 24 | | | | | | |
| Drop-out voltage for each pair of buffers | VDD = 8.5V, Tamb = 25°C, Icoil = 30 mA | Vd | | | 1.6 | V |
| Mismatch of drop-out voltage | | D Vd | | | ± 50 | mV |
| Pin 7, 8, 9 | | | | | | |
| Output voltage low | VDD = 8.5V, Tamb= 25°C, Isink = 40mA | VOL | | 0.3 | 0.6 | V |
| Output voltage high | VDD = 8.5V, Tamb= 25°C, Isource = 40mA | VOH | 6.8 | 7.8 | | V |
| Oscillator | | | | | | |
| Pin 18,19 | | | | | | |
| Input pin capacitance | | Cin | | 10 | 20 | pF |

ABSOLUTE MAXIMUM RATINGS

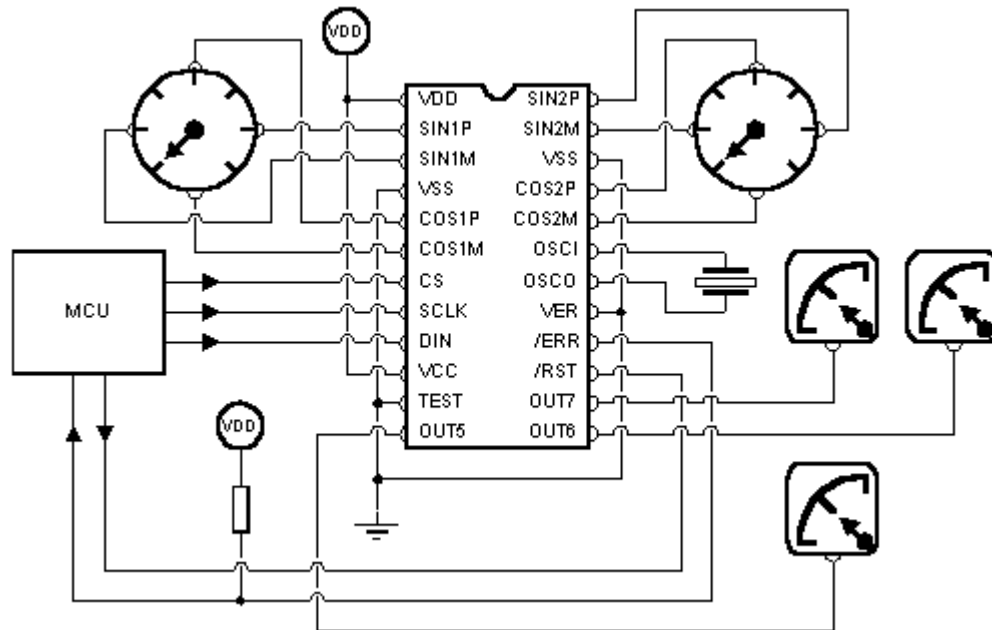
| Parameter | Symbol | Value | | Unit |
|-----------------------------|--------|-------|----------|------|
| | | Min | Max | |
| Storage Temperature Range | Tstg | -40 | +150 | °C |
| Operating Temperature Range | Tamb | -40 | +85 | °C |
| Supply Voltage Range | VDD | -0.3 | 14.0 | V |
| Input Voltage Range | Vi | -0.3 | VDD +0.3 | V |

AC Electrical Characteristics

Tamb = -40 to 85°C, VDD = 4.5 V to 12 V unless otherwise specified.

| Characteristics | Test Conditions | Symbol | Limits | | | Unit |
|----------------------------------|-----------------|--------|--------|-----|-----|------|
| | | | Min | Typ | Max | |
| Oscillator | | | 0.95 | | 8.4 | MHz |
| Clock frequency | | Fclk | | 8 | | MHz |
| Serial communication | | | | | | |
| Serial data clock frequency | | Fsclk | | 500 | | kHz |
| Time for DIN stable to SCLK rise | | | | 100 | | ns |
| Hold time for DIN | | | 100 | | | ns |

Typical application



Notes

- The chip integrates its oscillator load capacitors.
- The quartz frequency is 8MHz

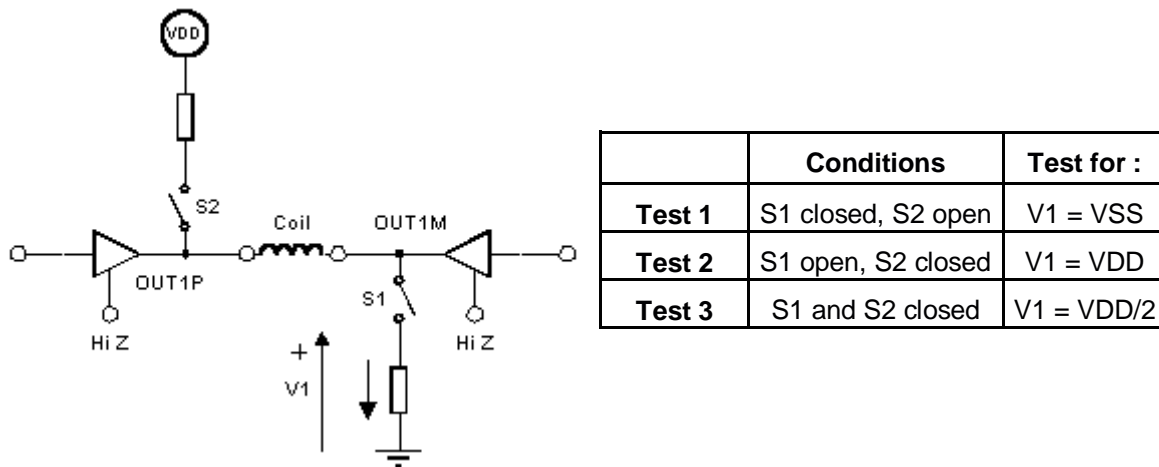
Operation

1) 360° logometers

Immediately following a reset, the IC checks if there is any short-circuit or open circuit on each buffer driver output (This test is not performed for outputs 5, 6 and 7). During this test, each buffer is held in a high impedance state and large value internal resistors (100kOhm) are sequentially connected on each pair of buffers (note : actuator coils must be connected on bridges).

Three tests are performed according to the following figure and table.

Test for short and open circuits

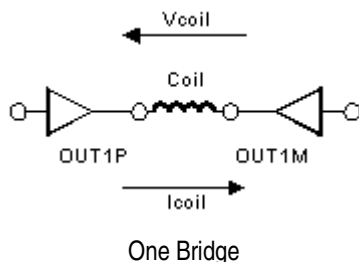


During the tests the pin ERRB (16) is at logic level 0. After completing the tests, ERRB remains low if one (or more) test failed. ERRB returns to high impedance if everything is OK.

These tests last approximately 4 ms with an oscillator clock frequency of 8 MHz.

After testing, all buffers are at VSS. The chip then waits for the MCU to send an angle/quadrant value to output the PWM signals for each buffer. Every logometer coil is connected in a bridge, so the current I_{coil} can be either positive or negative.

The total drop-out of a bridge is : $V_d = |V_{CC} - V_{coil}|$



2) 90° logometers

In addition to driving (2) 360° logometers the MLX10407 has a push-pull stage so it is possible to drive (3) additional 90° coils connected to GND or VDD respectively.

Serial Link

The MCU outputs the serial communication clock SCLK, the chip select CS, the data DIP, and reads the ERRB error status.

The data sent by the MCU is latched by the 10407 on the rising edge of SCLK.
The 10407 outputs the ERRB signal on the falling edge of SCLK

When CS = "0" the serial interface of the 10407 is inactive. When CS goes HIGH, the 10407 waits for a START BIT and then reads the following 15 bits transmitted by the MCU.

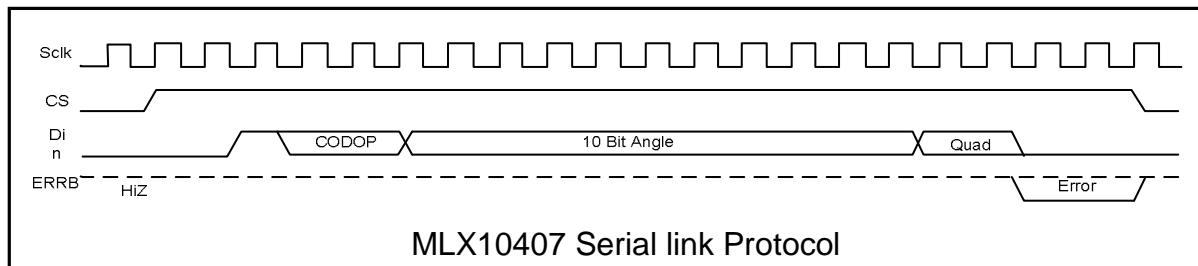
The START BIT (D0) must be "1".

| D1 | D2 | D3 | Instruction |
|----|----|----|-----------------------|
| 0 | 0 | 0 | Unused |
| 0 | 0 | 1 | Writing request LOGO1 |
| 0 | 1 | 0 | Unused |
| 0 | 1 | 1 | Writing request LOGO2 |
| 1 | 0 | 0 | Writing request LOGO3 |
| 1 | 0 | 1 | Writing request LOGO5 |
| 1 | 1 | 0 | Writing request LOGO4 |
| 1 | 1 | 1 | Unused |

The following 10 bits (D4, D5, D6, D7, D8, D9, D10, D11, D12, D13) set the angle value (D13 =lsb, D4 =msb).

The two remaining bits (D14D15) represent the quadrant (D14=msb). Note: for Logo1 & 2 only.

Serial Link



The 10407 outputs an error status on pin ERRB on the falling edge of SCLK immediately following the transmission of the quadrant lsb.

The pin 16 (ERRB) of the 10407 is driven low if there is no continuity between two consecutive quadrant values sent (for logo1 or logo2). The data is valid till CS is high, then when CS goes low ERRB returns to high impedance state and the error status is lost.

If the MCU has detected an error, it is possible to send data again : the first data bit set to "1" will initiate a new transmission of 15 data bits.

On the HIGH to LOW transition of CS the angle and quadrant values are stored into the internal registers of the 10407 if the following conditions are met:

- The MCU sent the appropriate writing request
- No quadrant error was detected by the 10407.

Otherwise new angle and quadrant values are discarded by the 10407 and the previous values are kept. The MCU will have to initialize a new transmission to the 10407.

If VER (pin 17) is connected to VDD then the 10407 does *not* store values of angles and quadrant in case of an error. It is however possible to make the 10407 store all angles and quadrant values even if there is an error, by connecting VER (pin 17) to GND.

PWM Generation

1) Logometers 360° (Logo 1 and Logo 2):

From the angle value received from the MCU (range [0° - 89.8°]), the 10407 generates two PWM signals (9 bit resolution) :

- The first one represents the sine PWMSIN,
- The second one is the cosine PWMCOS.

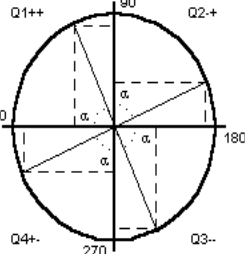
The 10407 uses a 512x9 ROM containing the sine of all angular values in the range [0° -89.8°] (note that the lsb value of the angle is not used).

An angle value greater than 90° is obtained using different quadrant values :

- Q1 (D14D15 = 00) > 0° =< a < 90°
- Q2 (D14D15 = 01) > 90° =< a < 180°
- Q3 (D14D15 = 10) > 180° =< a < 270°
- Q4 (D14D15 = 11) > 270° =< a < 360°

a is the angle value

The PWM are switched to the outputs depending on the value of the quadrant :

|  | QUADRANT | SIN1M | SIN1P | COS1M | COS1P | |
|---|----------|-------|--------|--------|--------|--------|
| | D14 | D15 | | | | |
| | 0 | 0 | 0 | PWMSIN | 0 | PWMCOS |
| | 0 | 1 | 0 | PWMCOS | PWMSIN | 0 |
| | 1 | 0 | PWMSIN | 0 | PWMCOS | 0 |
| | 1 | 1 | PWMCOS | 0 | 0 | PWMSIN |

- Logometer 1 is driven by outputs SIN1M/P COS1M/P,
- Logometer 2 is driven by outputs SIN2M/P COS2M/P.

The PWM frequency is given by :

$$F_{PWM} = F_{OSC} / 512 \quad (F_{OSC} = \text{Crystal oscillator frequency})$$

2) Logometers 90°

- There are three separate PWM outputs for Logo 3, Logo 4 and Logo 5.

Pin Out

| Pin | Symbol | Description |
|-----|--------|--|
| 1 | VDD | |
| 2 | SIN1P | Output buffer (coil 1 Logo1) |
| 3 | SIN1M | Output buffer (coil 1 Logo1) |
| 4 | VSS | |
| 5 | COS1P | Output buffer (coil 2 Logo1) |
| 6 | COS1M | Output buffer (coil 2 Logo1) |
| 7 | OUT5 | Output buffer (Logo 3) |
| 8 | OUT6 | Output buffer (Logo 4) |
| 9 | OUT7 | Output buffer (Logo 5) |
| 10 | VDD | |
| 11 | CS | Chip select (Schmitt trigger with 300kOhm pull-down) |
| 12 | SCLK | Serial clock (Schmitt trigger) |
| 13 | DIN | Data IN (Schmitt trigger) |
| 14 | TEST | TEST input.(1K pull-down) |
| 15 | RSTB | External reset (Schmitt trigger) |
| 16 | ERRB | Quadrant error output (Open drain) |
| 17 | VER | Quadrant verification inhibit |
| 18 | OSCO | Crystal oscillator output |
| 19 | OSCI | Crystal oscillator input |
| 20 | COS2M | Output buffer (coil 2 Logo2) |
| 21 | COS2P | Output buffer (coil 2 Logo2) |
| 22 | VSS | |
| 23 | SIN2M | Output buffer (coil 1 Logo2) |
| 24 | SIN2P | Output buffer (coil 1 Logo2) |

Reliability Information

Melexis devices are classified and qualified regarding suitability for infrared, vapor phase and wave soldering with usual (63/37 SnPb-) solder (melting point at 183degC).

The following test methods are applied:

- IPC/JEDEC J-STD-020A (issue April 1999)
Moisture/Reflow Sensitivity Classification For Nonhermetic Solid State Surface Mount Devices
- CECC00802 (issue 1994)
Standard Method For The Specification of Surface Mounting Components (SMDs) of Assessed Quality
- MIL 883 Method 2003 / JEDEC-STD-22 Test Method B102
Solderability

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 manufacturability/solderability see quality page at our website:
<http://www.melexis.com/>

ESD Precautions

Electronic semiconductor products are sensitive to Electro Static Discharge (ESD).

Always observe Electro Static Discharge control procedures whenever handling semiconductor products

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.

The information furnished by Melexis is believed to be correct and accurate. However, Melexis shall not be liable to recipient or any third party for any damages, including but not limited to personal injury, property damage, loss of profits, loss of use, interrupt of business or indirect, special incidental or consequential damages, of any kind, in connection with or arising out of the furnishing, performance or use of the technical data herein. No obligation or liability to recipient or any third party shall arise or flow out of Melexis' rendering of technical or other services.

© 2002 Melexis NV. All rights reserved.

For the latest version of this document, go to our website at:

www.melexis.com

Or for additional information contact Melexis Direct:

Europe and Japan:

Phone: +32 13 670495
E-mail: sales_europe@melexis.com

All other locations:

Phone: +1 603 223 2362
E-mail: sales_usa@melexis.com

QS9000, VDA6.1 and ISO14001 Certified