FEATURES

* Supply voltage up to 12 V.
* Interface directly with 5 V CMOS logic µP.
* Serial link.
* can drive
  two actuators 360°
  three actuators 90°
* open circuit or short circuit detection of the drivers outputs.
* Small size (SO24 package).

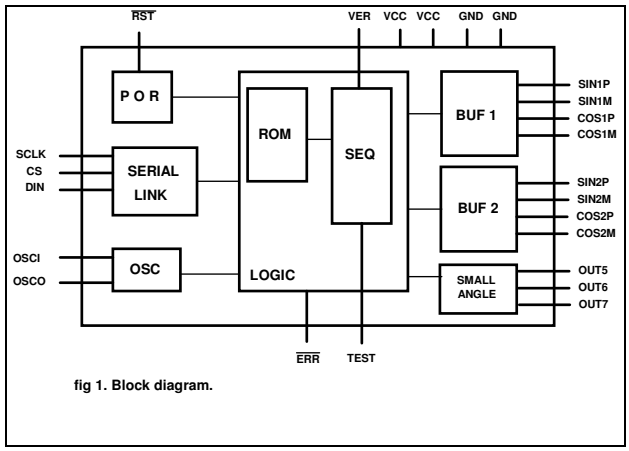

fig 1. Block diagram.

The 10407 is a µP peripheral for logometers control using SIN/COS PWM commands. The circuit controls two independant sets of CMOS power bridges. A ten bits angle is displayed with a 9 bits per quadrant resolution PWM whose frequency is set by a crystal oscillator. A power-on self test detects open or short-circuits outputs for each logometer and a real time angle tracking avoids display errors.
The 10407 can also drive three small angle logometers (90°).
The communication with the µP is done via a three wires serial link.
The 10407 outputs an error status on a special pin.

Ordering Code

Product Code	Temperature Code	Package Code	Option Code	Packing Form Code
MLX10407	E	DF	AAA-000	RE

Legend:

Temperature Code: E for Temperature Range -40°C to 85°C
Package Code: DF for SOIC300Mil
Packing Form: RE for Reel

Ordering example: MLX10407EDF-AAA-000-RE

PINNING.

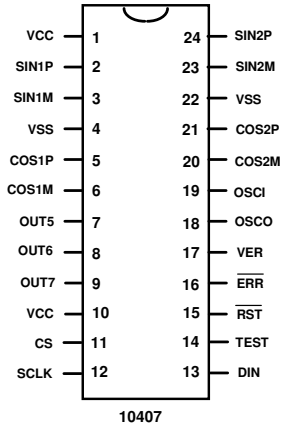

fig.2 Pinning diagram.

SO24 PACKAGE

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

OPERATION.

1) Logometers 360°

Immediately after a reset, the I.C. checks if there is any short-circuit or open circuit on each buffer driver output (This test is not made for outputs 5,6 7). For this test, each buffer is held in a high impedance state and large internal resistances (100kΩ) are sequentially connected on each pair of buffers (note : the actuator coil must be connected on each bridge).

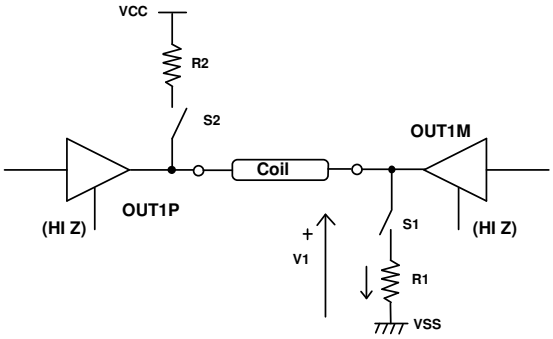

fig 3. Test for short-circuits and open circuits.

Three tests are done (see fig 3.)

	condition	test for :
Test 1	S1 closed, S2 open	V1 = VSS
Test 2	S1 closed, S2 closed	V1 = VCC/2
Test 3	S1 open, S2 closed	V1 = VCC

During the tests the pin ERRB (16) is at logic level 0. Then after the tests have been done ERRB stays at 0 if one (or more) test fails or changes to high impedance state if every thing is OK.
These tests last approximately 4 ms with an oscillator clock frequency of 8 Mhz.
After the test all buffers are at VSS. The I.C. waits for the µP to send an angle/quadrant value and then outputs a PWM signal on every buffer. Every logometer coil is connected in a bridge, so the current Icoil can be either positive or negative. The total drop-out of a bridge is :

$$V_d = | V_{CC} - V_{coil} |$$

The four bridges have the same drop-out for the same current I_{coil}.

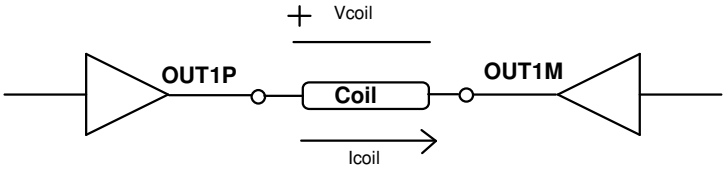

fig 4. One bridge.

2) Logometers 90°

There are three different PWM outputs for Logo 3, Logo 4, Logo 5.

SERIAL LINK.

The µP outputs the serial clock SCLK, the chip select CS, the data DIN, and receives from the I.C. the error status on pin ERRB(16).
The data sent by the µP are latched by the 10407 on the rising edge of SCLK.
The 10407 outputs an error status on pin ERRB (16) 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 µP (see fig 4.)

The START BIT (D_0) must be "1".
The following three bits ($D_1D_2D_3$) are the operation code for the 10407 :

$D_1D_2D_3 = 001 \Rightarrow$ Writing request LOGO1
$D_1D_2D_3 = 011 \Rightarrow$ Writing request LOGO2
$D_1D_2D_3 = 100 \Rightarrow$ Writing request LOGO3
$D_1D_2D_3 = 110 \Rightarrow$ Writing request LOGO4
$D_1D_2D_3 = 101 \Rightarrow$ Writing request LOGO5

Any other codes are reserved for test and will have no effect in normal operation mode.

The following 10 bits ($D_4D_5D_6D_7D_8D_9D_{10}D_{11}D_{12}D_{13}$) are the value of the angle (D_4 = MSB, D_{13} = LSB).
The following two bits ($D_{14}D_{15}$) represent the quadrant (D_{14}=MSB). Note : for Logo1 & 2 only.

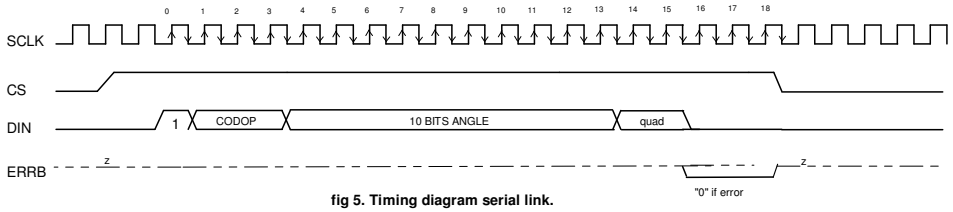

fig 5. Timing diagram serial link.

The 10407 outputs an error status on pin ERRB (16) 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 µP has detected an error, it is possible to send data again : the first bit "1" will initiate a new transmission of 15 data bits.

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

- The µP sent a writing request,
- No quadrant error was detected by the 10407.

Otherwise new values of angle and quadrant are not taken into account by the 10407 and the previous values are kept. The µP must initialize a new transmission with the 10407.

It is possible to make the 10407 store all values of angles and quadrant even if there is an error if the pin 17 (VER) is connected to GND.

PWM GENERATION.

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

From the angle value received from the µP (range [0° - 89.8°]) the 10407 generates two PWM (9 bits resolution) :
- the first one represents the sinus PWMSIN,
- the second one is the cosinus PWMCOS.

The 10407 uses a ROM 512x9 which contains the sinus of any angle in the range [0° - 89.8°] (note that the LSB value of the angle is not used).

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

Q1 ($D_{14}D_{15} = 00$) $\Rightarrow$ $0° \le \alpha < 90°$
Q2 ($D_{14}D_{15} = 01$) $\Rightarrow$ $90° \le \alpha < 180°$
Q3 ($D_{14}D_{15} = 10$) $\Rightarrow$ $180° \le \alpha < 270°$
Q4 ($D_{14}D_{15} = 11$) $\Rightarrow$ $270° \le \alpha < 360°$

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

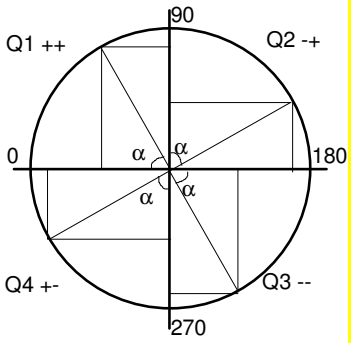

fig 6. Quadrants and PWM sign.

QUADRANT D_{14}	D_{15}	SIN1M	SIN1P	COS1M	COS1P
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 :

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

2) Logometers 90° (Logo1, Logo2, Logo3) :

The value transmitted by the µP is directly the PWM value ($D_4D_5D_6D_7D_8D_9D_{10}D_{11}D_{12}$), D4 is MSB and D12 LSB. D13 and Quad bits (D14,D15) are not used.

ABSOLUTE MAXIMUM RATINGS.

parameter	symbol	min.	max.	unit
Storage temperature range	T_{stg}	-40	+150	°C
Operating temperature range	T_{amb}	-40	+85	°C
Supply voltage range (pin 1)	V_{CC}	-0.3	14.0	V
Input voltage range	V_I	-0.3	V_{CC} + 0.3	V

ELECTRICAL CHARACTERISTICS.

Tamb = -40 to 85°C, VCC = 5 V to 12 V unless otherwise specified.

parameter	conditions	symbol	min.	typ.	max.	unit
Supply current	Inputs at VCC or VSS No loads on outputs VCC=8.5V T=25°C	I_{CC}			5.5	mA
Maximum power dissipation		P_{Dmax}			620	mW
Inputs						
Input capacitance		Cin			10	pF
Pin 11						
Pull-down resistance		R_{pd}	125		750	kΩ
input voltage LOW		V_{IL}	-0.3		1	V
input voltage HIGH		V_{IH}	4		V_{CC}+0.3	V
Hysteresis	VCC = 8.5 V	V_{HYS}	0.5		2.5	V
Leakage current	pin at V_{CC} or V_{SS}	I_L	-1		1	µA
Pin 12,13,14,15,17						
input voltage LOW		V_{IL}	-0.3		1	V
input voltage HIGH		V_{IH}	4		V_{CC}+0.3	V
Hysteresis	VCC = 8.5 V	V_{HYS}	0.5		2.5	V
Leakage current (p12,15,17)	pin at V_{CC} or V_{SS}	I_L	-1		1	µA
Pull-down resistance (p14)		R_{pd}	0.8		1.5	kΩ
Outputs						
Pin 16						
Low level output voltage	I_{OUT} < 500 µA	V_{OL}			0.3	V
High level output leakage current	V_{OUT} = V_{CC}	I_{LKG}			10	µA
Pin 2,3,5,6,20,21,23,24						
Drop-out voltage for each pair of buffers	V_{CC} = 8.5V, Tamb = 25°C I_{coil} = 30 mA, see fig. 4	Vd			1.6	V
Mismatch of drop-out voltage	V_{CC} = 8.5V, Tamb = 25°C I_{coil} = 30 mA, see fig. 4	ΔVd			± 50	mV
Pin 7,8,9						
Output voltage low	VCC = 8.5V, Tamb = 25°C I_{sink} = 40mA	V_{OL}		0.6	1.0	V
Output voltage high	VCC = 8.5V, Tamb=25°C I_{source} = 40mA	V_{OH}	6.8	7.8		V
Oscillator						
Pin 18,19						
input pin capacitance		Cin		10	20	pF

clock frequency		f_{clk}		8		MHz

AC ELECTRICAL CHARACTERISTICS.

Parameter	Value	unit
Maximum SCLK input frequency	500	kHz
Setup time DIN to SCLK rising	100	ns
Hold time DIN to SCLK rising	100	ns
Setup time CS high to SCLK rising	100	ns

APPLICATION SCHEMATIC.

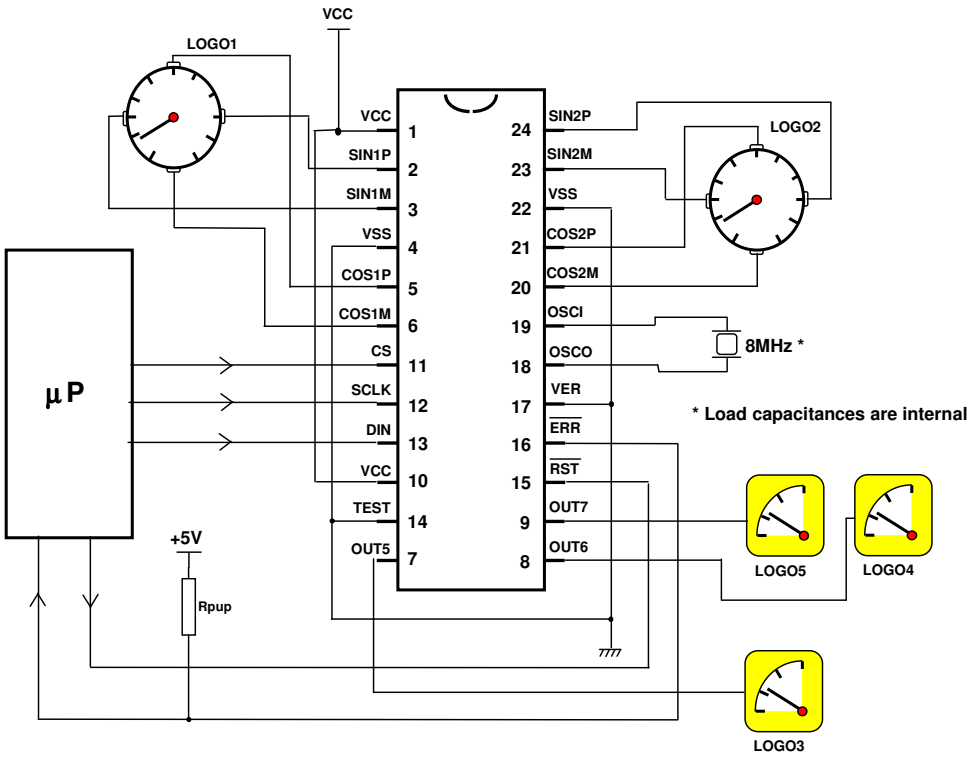

Fig 7. Typical application

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