DIGISENSOR CO., LTD

MBA-1000 BAROMETER MODULE

- Pressure range: 300 – 1100 mbar.
- Integrated pressure and temperature sensor
- Integrated two additional 14-bit ADC channels.
- Integrated low power 8-bit MCU.
- 3-wire synchronous serial interface.
- Integrated software for pressure and temperature calculation.
- Low power, low voltage.
- Small dimension: 10 x 10 x 6mm

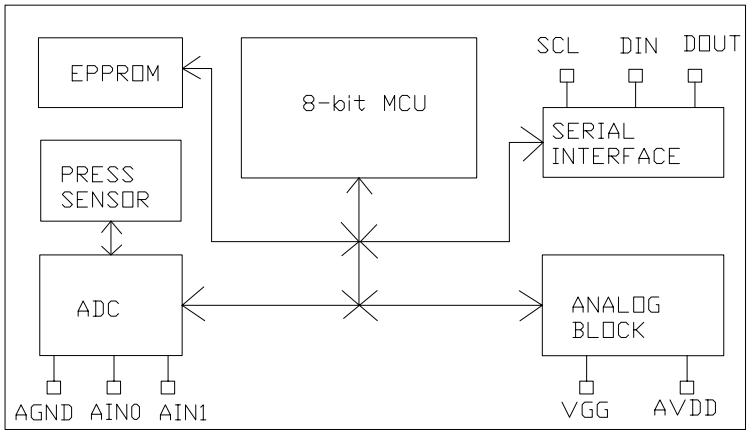
Description

The MBA-1000 is an SMD module including a piezoresistive pressure sensor, a 2K-bit EEPROM and an 8-bit MCU with integrated 14-bit ADC. With integrated firmware and calibrated pressure sensor, this module supplies to designers all processed information such as temperature, and atmospheric pressure. This high integration level allows an easy access to sensor technology without any background in it.
The MBA-1000, low power and voltage device, could communicate with a low cost 4-bit MCU on three wires synchronous interface. Two additional 14-bit AD channels are available for other use.
The small size of this module (10 x 10 x 6 mm) easies its integration in all watch applications.

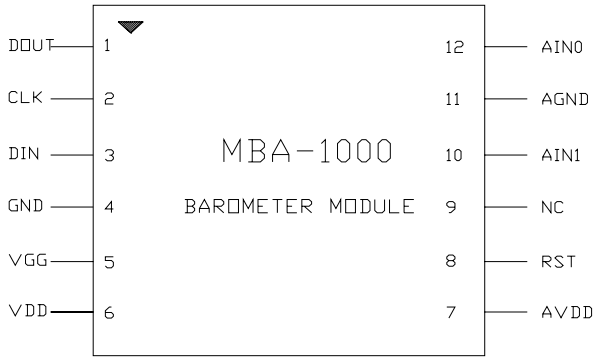
Application

- Barometer
- Weather forecast station
- Electronics compass and altimeter devices.

Block Diagram



Pin Configuration



Pin Descriptions

Name	In/Out	Pin No	Description
DOUT	I/O	1	Synchronous Serial Interface Data Output
CLK	I/O	2	Synchronous Serial Interface Clock Input
DIN	I/O	3	Synchronous Serial Interface Data Input
GND	I	4	Negative Power Supply (Ground)
VGG	O	5	Charge Pump Voltage (1)
VDD	I	6	Positive Power Supply
AVDD	O	7	Analog power output voltage (2)
RST	I	8	CPU Reset
NC		9	No connect
AIN1	I	10	Analog Input Channel 1 (4)
AGND	O	11	Analog Ground (3)
AIN0	I	12	Analog Input Channel 0 (4)

1. The voltage at VGG to GND is about twice more than VDD, used for flip circuit in compass application.
2. The voltage at AVDD pin is regulated at 3.6V to GND. There should be a 100K resistor connected between AVDD and GND.
3. AGND is the reference for analog input signal. Its voltage is regulated at 1.8V to GND.
4. The input voltage applied to AIN0 or AIN1 must be around AGND ± 0.45V

Absolute Maximum Ratings

Parameter	Rating	Unit
Supply Voltage	-0.3 to 3.6	V
Applied I/O Voltage	-0.3 to VDD+0.3	V
Operating Temperature	-10 to +60	^{o}C
Storage Temperature	-20 to +100	^{o}C
Maximum overpressure	5	Bar

DC Characteristic (Unless otherwise specified VDD=3V, Ta=25°C)

Parameter	Symbol	Conditions	Min	Typical	Max	Unit
Recommended Operation Power Voltage	VDD		2.5	3.0	3.3	V
Supply Current		V_{DD} = 3V				
Temperature Mode Average (1)	I_{avgT}			150		μA
Pressure Mode Average (1)	I_{avgP}			200		μA
Sleep Mode	I_{slp}			2	3	μA
ADC Ch0/Ch1 Mode	I_{ADEX}			2.5		mA
Conversion Time		VDD=3V				
Temperature mode	T_cvT			70	100	ms
Pressure mode	T_cvP			90	120	ms
ADC Ch0/Ch1 mode(2)	T_cv		25		105	ms
AGND output voltage	V_{AGND}			1.8		V
AVDD output voltage	V_{AVDD}			3.6		V
VGG voltage	V_{GG}			2x VDD		V
Operating pressure range	P		300		1100	mbar
Operating temperature range	T_a		-10°C		+60	°C
Synchronous serial clock	Sclk				5	KHz

Notes:

1. Averaged current consumptions are calculated for 1 reading per second.
2. T_cv is depending on ADC Ch0/Ch1 settings (refer to section “AD channel 0 and AD channel 1 settings” on page 6 for more detail)

Pressure and Temperature Output Characteristics

Parameter	Test conditions	Min	Typ.	Max	Unit	Note
Pressure resolution			0.1		mbar	1
Absolute pressure accuracy	P = 300 ... 1000mbar T=30°C	-3.0		+3.0	mbar	2
Relative pressure accuracy	P = 300 ... 1000 mbar	- 1		+ 1	mbar	
Pressure resolution	P = 300 ... 1000 mbar		0.1		mbar	
Maximum pressure error over temperature	Ta = 0 ... + 50°C	-3		+3	mbar	
Maximum error over supply voltage	VDD = 2.6V ... 3.3V	-1		+1	mbar	
Temperature accuracy	T= 0°C … + 50°C	-1		+1	°C	
Temperature resolution	T= 0°C … + 50°C		0.1		°C	

Notes :

1. Obtained by software filter.
2. Maximum error of pressure reading over the pressure range after offset adjustment at one pressure point.

Serial Communication Commands

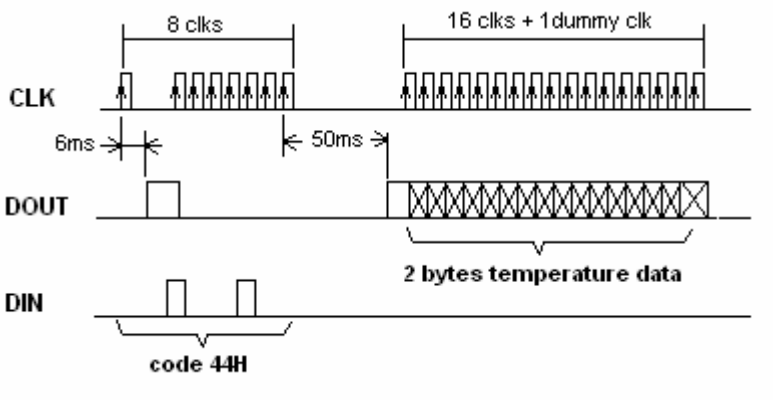
- For each byte, MSB is sent first and LSB at the end. Data is in hexadecimal format, negative number is in 2's complement.
- The module will enter sleep mode after executing a command or expiring time out in communication.
- In Sleep Mode, the oscillator stops, all internal registers and RAM keep values before Sleep Mode.
- To wake up the module from sleep mode, the host MCU just writes the first clock to the CLK pin. The module will wake up automatically and DOUT will go high after maximum 6 ms. The host MCU can then send out the new command.
- Data returned from MBA-1000 are separated into 2 bytes group, the host MCU has to send 17 pulse CLK (16 pulse clk to read 2 bytes data, the last pulse is dummy clk) to read 2 bytes data.

  The information supplied by MBA-1000 module could be sent to the host MCU on request. Hereunder, the list of commands issued by the host MCU to the barometer module.

Commands name	Code	Host MCU	MBA-1000
Communication testing	40H	Send 1 byte code and 4 bytes data	Send 4 bytes data
TEMP in C degree	44h	Send 1 byte code	Send 2 bytes temperature data
PRESSURE in mbar	45h	Send 1 byte code	Send 4 bytes pressure data
AD setting of channel 0 and 1 setting	4Ah	Send 1 byte code and 2 bytes data	Send 4Ah
ADC count of channel 0	43h	Send 1 byte code	Send 2 bytes data
ADC count of channel 1	47h	Send 1 byte code	Send 2 bytes data
ADC count of channel 0 & 1	48h	Send 1 byte code	Send 4 bytes data

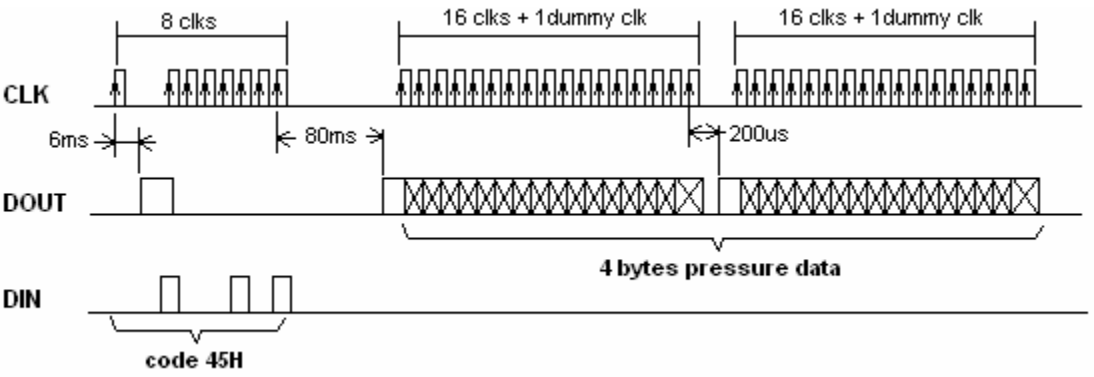
Important note: After a command related to AD conversion, such as Temperature reading, Pressure reading, AD channel 0, AD channel 1 reading, MBA-1000 needs about 300ms for the capacitors discharging. Thus, the host MCU has to delay 300ms from the end of one command to the start of the next command.

Temperature reading in C degree



- To read temperature from MBA-1000, the host MCU sends code 44H and waits for DOUT turn high (about 50ms) to read 2 bytes data return from MBA-1000. Data must be divided by 10 to get the real temperature.
- Temperature range is from –10°C to 60°C and resolution is 0.1°C.

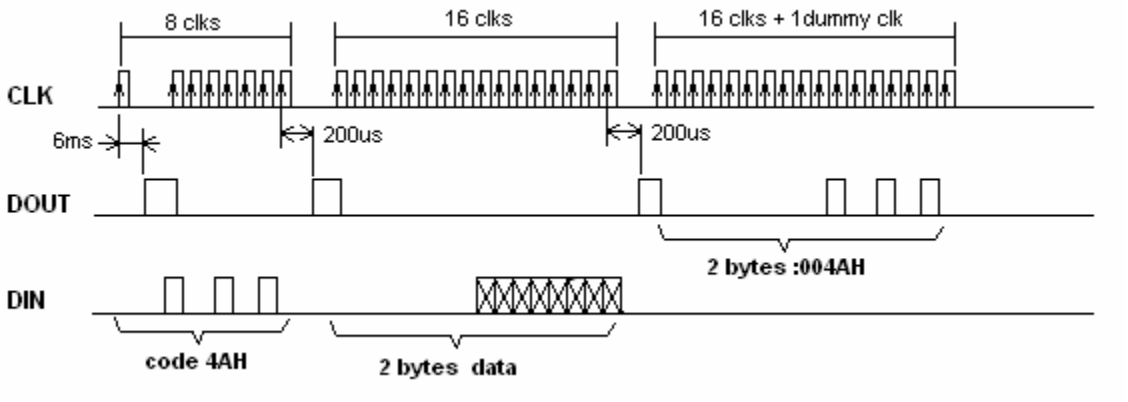
Pressure reading in mbar



- To read pressure from MBA-1000, the host MCU sends code 45h and waits for DOUT turn high (about 80ms) to read 4 bytes data return from MBA-1000. Data must be divided by 100 to get the real pressure.
- Pressure range is from 300mbar to 1100mbar and resolution is 0.1mbar.
- The pressure calculation uses the last reading temperature for compensation. Therefore, to have the correct pressure, the temperature has to be updated before reading pressure.

AD Channel 0 and Channel1 reading

AD channel 0 and AD channel 1 settings:



- The external AD channels should be configured on Power-on and each time resetting MBA-1000.
- To configure the setting of AD channel 0 and 1, the host MCU sends code 4Ah and 2 bytes data.
- Hereunder is the data formation for setting channel 0 and channel 1:

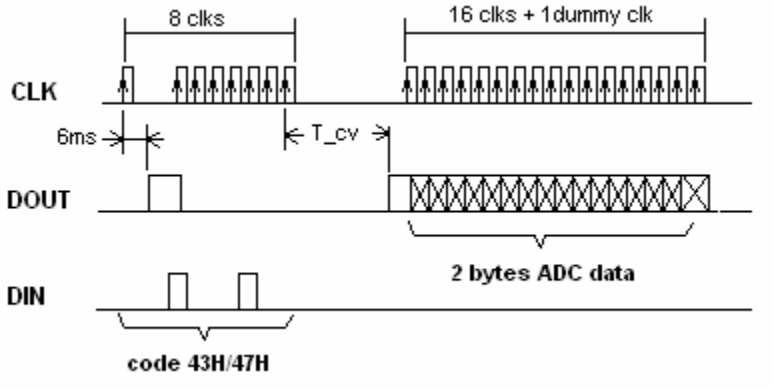
Byte1								Byte2					
MSB						LSB		MSB					LSB
0	0	0	0	0	0	0	0	0	0	ADG0		ADG1	ADF

- ADF: AD conversion time for both 2 channels.
  T_cv = AD conversion time
  In detail:
  00: 25ms 01: 30ms 10: 50ms 11: 90ms
  The longer of T_cv, the more stable of ADC, the typical ADF value is 10

- ADGx: Internal Gain for each channel
  00: 2/3 01: 1 10: 2 11: 2 1/3

- The AD reference voltage is 450 mV to AGND (1.8V to GND). The input different voltage after multiplying gain must change within ±450mV around AGND. The AD output range is from 15625 to -15625.
- AD output = (Vin-AGND)mV * 15625 / 450mV

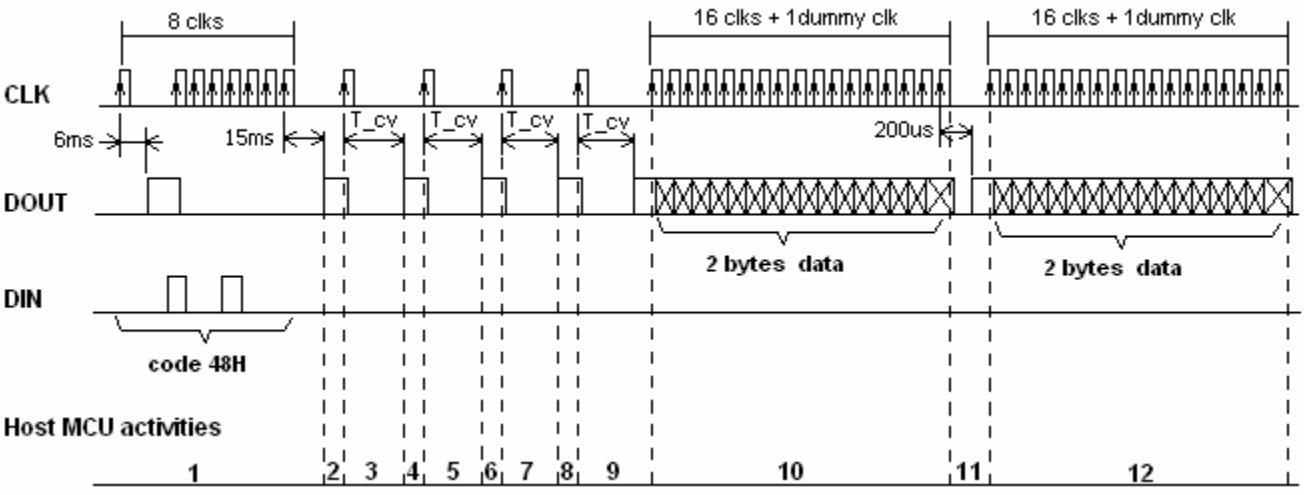
AD channel 0 (or AD channel 1) reading:



- To read the ADC channel 0 (or channel 1), the host MCU sends code 43h (or 47h) and receives 2 bytes data ADC returned from MBA-1000. Data is in hexadecimal format, negative number is in 2's complement. Data range is from -15625 to +15625.

AD channel 0 and channel 1 reading:

- This mode is designed for compass reading, which 2 channels must be read continuously on positive flip phase and then negative flip phase. If using separated AD0 and AD1 reading, it costs much time because of 300ms delay time between 2 readings. By using this code, two channels are read continuously without any delay between conversions, so reducing either delay time or power consumption.

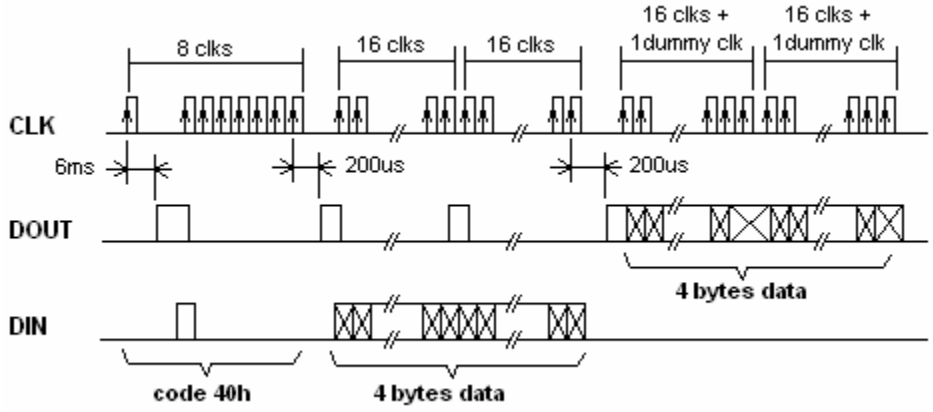


T_cv: conversion time (refer to the previous section: "AD channel 0 and AD channel 1 settings" for more detail)

1. Send code 48H and wait 15ms, check for DOUT=1
2. Set PFC=1, power on X sensor, send a CLK to start converting Positive ADCX.
3. Delay 30ms, check for DOUT=1

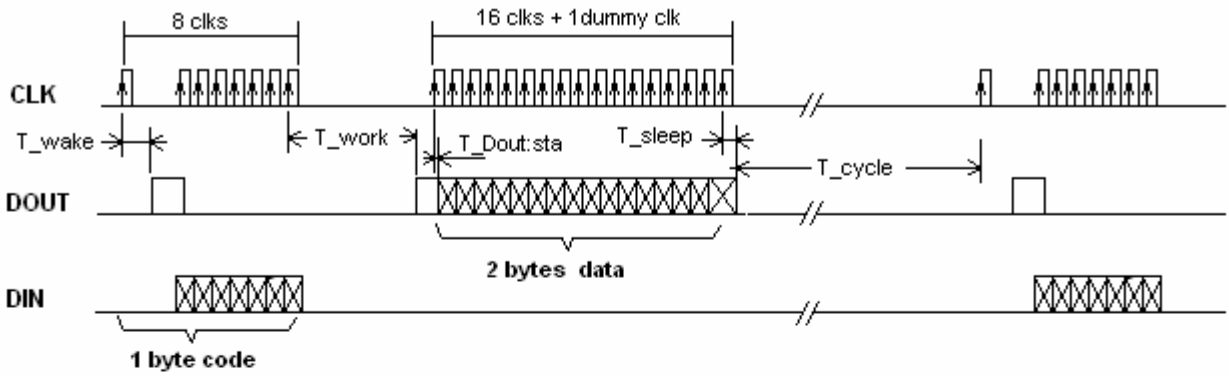
4. Set PFC=0, power off X sensor (set PW X to HiZ), power on Y sensor, send a CLK to start converting Positive ADCY.
5. Delay 30ms, check for DOUT=1
6. Set NFC=1, send a CLK to start converting Negative ADCY.
7. Delay 30ms, check for DOUT=1
8. Set NFC=0, Power off Y sensor (set PW Y to HiZ), power on X sensor, send a CLK to start converting Negative ADCX.
9. Delay 30ms, check for DOUT=1
10. Power off X sensor (set PWX to HiZ).
11. Read 2 bytes ADCX data return from MBA-1000
    ADCX = (Negative ADCX – Positive ADCX).
12. Read 2 bytes ADCY data return from MBA-1000
    ADCY = (Negative ADCY – Positive ADCY).

Communication Testing

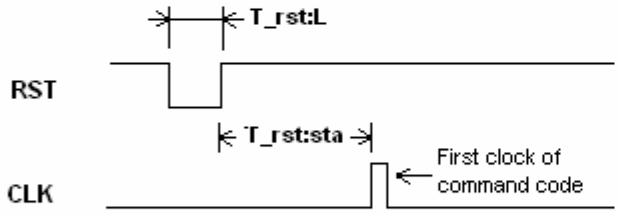


To test communication with MBA-1000, the host MCU sends code 40H following with 4 bytes data, then reads the return data from the module and compares them.

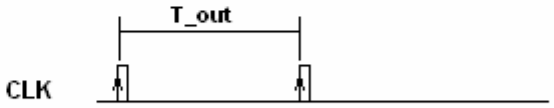
Timing diagram



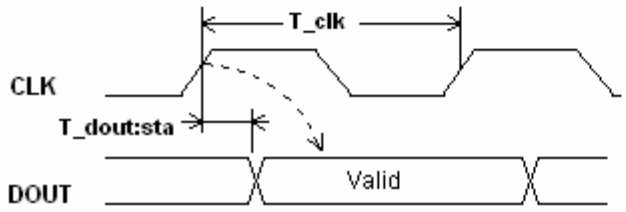
RESET TIMING



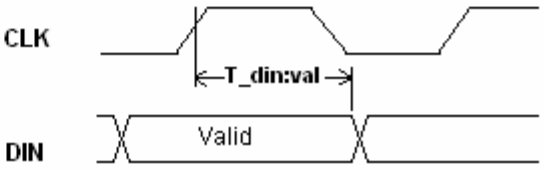
TIME OUT



DATA OUT TIMING



DATA IN TIMING



Symbol	Descriptions	Notes	Min	Typical	Max	Units
T_rst:L	Active low reset time		2			ms
T_rst:sta	Stable time after reset				300	ms
T_clk	Clock cycle	1	0.2		1000	ms
T_out	Communication time out	1	900	1000	1100	ms
T_din:val	Hold time for valid input data from rising edge of clk	2	100			μs
T_dout:sta	Output valid from rising edge of clk	3			100	μs
T_wake	Wake up time from sleep mode	4			6	ms
T_work	Delay time for executing a command	5		150	200	μs
	Pressure reading			90	150	ms
	Temperature reading			70	100	ms
	ADC channel 0 and channel 1 reading					
	ADF = 00			25	35	ms
	ADF = 01			30	40	ms
	ADF = 10			50	60	ms
	ADF = 11			90	105	ms
T_sleep	Hold time for the module return to sleep mode	6			200	μs
T_cycle	Hold time for between 2 readings	7	300			ms

Notes:

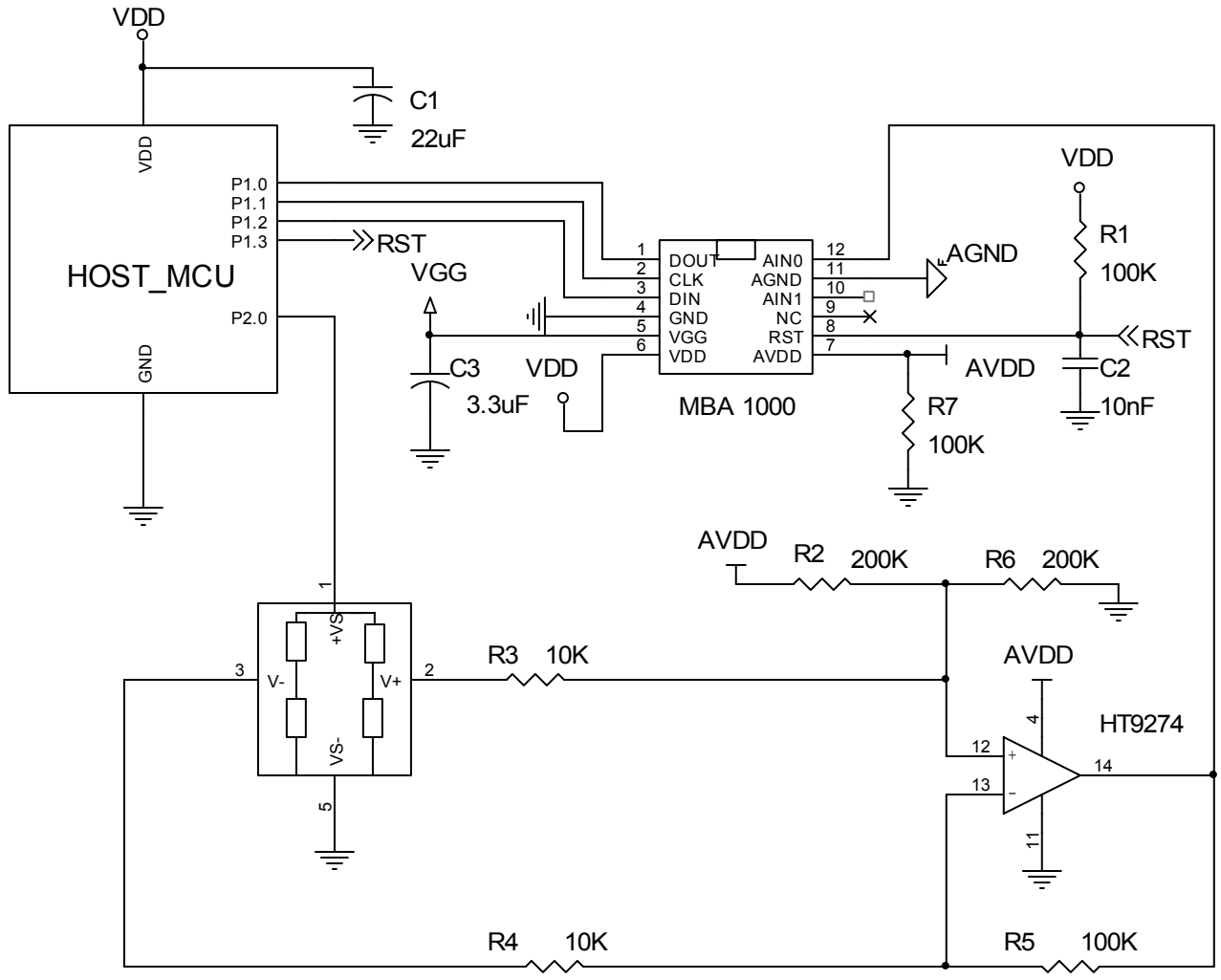
1. The maximum clock cycle is 1s; it is the Time-out of clock. If the interval between 2 clocks is more than 1s, the module will return to sleep mode and reset its entire serial interface, the host MCU has to restart the communication.
2. DIN should be set before rising edge of clock and hold at least 100 μs since this rising edge.
3. DOUT have to be read at least 100 μs after the rising edge of clock. For safety, the host MCU could read it at the falling edge of clock.
4. After sending the first clock of code, the host MCU waits T_wake for the module waking up from sleep mode and check Dout high before sending the next clocks.
5. The host MCU waits for DOUT high before processing the next step of communication test command. Dout will go high within T_work after the last clock of code.
6. After finishing a command, the module needs 200 μs to return to sleep mode. The host MCU has to delay T_sleep since the last clock of the previous command before sending new code.
7. After finishing a command related to AD reading (such as Pressure reading, Temperature reading, AD channel 0 & 1reading), the module need 300ms for discharged the capacitors. For the best accuracy output, the host MCU has to delay this interval before start a new command related AD reading.

Sleep mode settings

- After executing a command, the module goes to sleep mode automatically. In order to save the power, the host MCU ports have to be set compatible with the settings of the module's ports.

Name of port	Module MBA-1000	Recommended settings for host MCU
DIN	Input HiZ	Output low
DOUT	Output low	Output low or input HiZ
CLK	Input HiZ	Output low
RST	Input HiZ	Output high

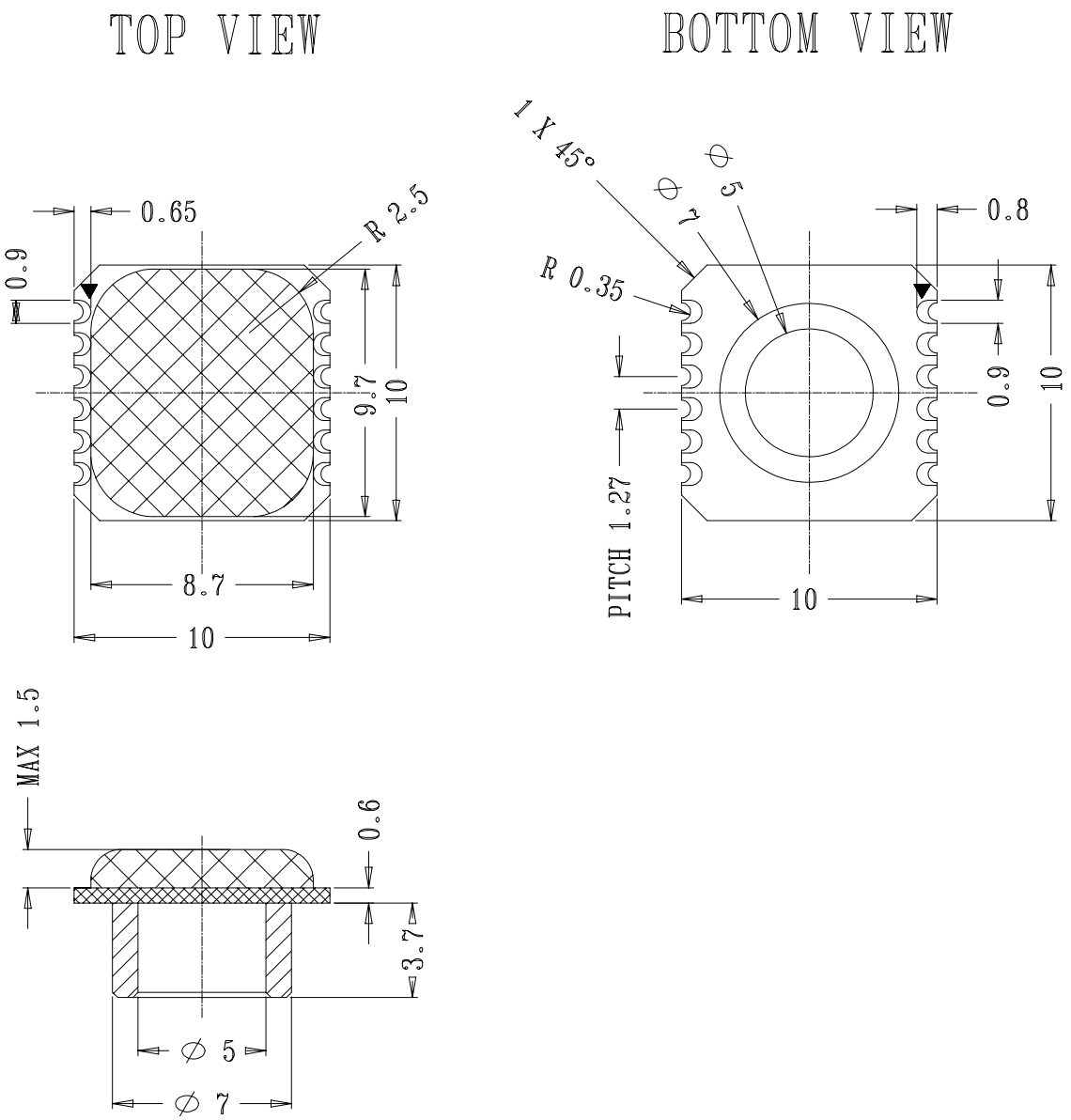
Application Schematics:



Assembling Recommendations

- **The module MBAW-1000 could not be soldered by reflow**. Hand soldering is recommended. The temperature of the solder tip must be lower than 300 ^{o}C.
- The pressure sensor used is very light sensitive. For a correct pressure reading, it must be well protected from light.
- Take all necessary ESD protection when handling this device.

Package Dimensions



ORDERING INFORMATION:

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REVISION HISTORY

- **Rev 3.7:** 10th Dec 2007
  - Change conversion time T_work:
    - From 70ms to 100ms max for Temperature reading.
    - From 90ms to 150ms max for Pressure reading.
  - Change application schematic, add R7=100k to pin VDDA
- **Rev 3.8:** 31st Jan 2008
  - Update company's address