User guide of watermeter DEMO

1. Structure of the watermeter DEMO

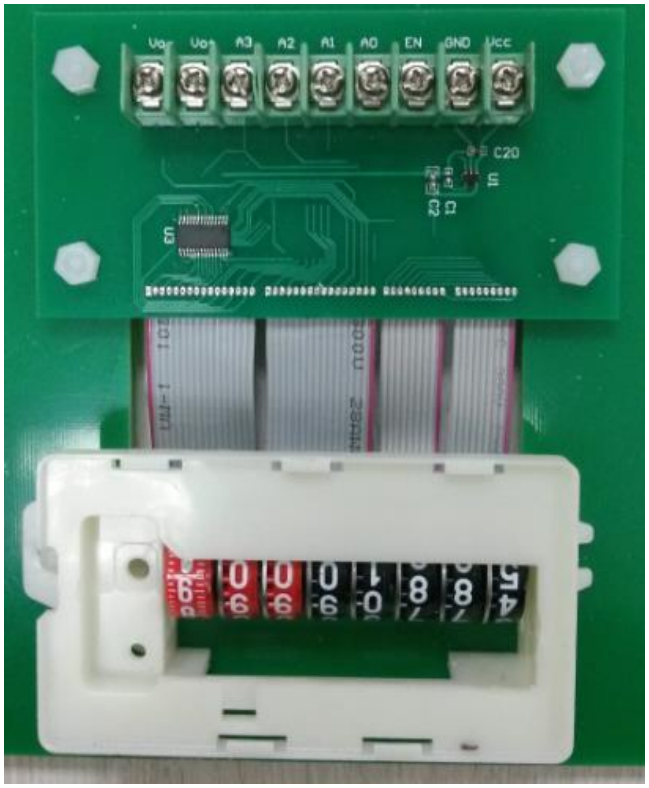


Fig1 picture of watermeter DEMO

Within the white housing, there are sensors sensitive to the magnet in the printed wheel. Sensors' signal output via terminals Vo- and Vo+ on the PCB at the right side.

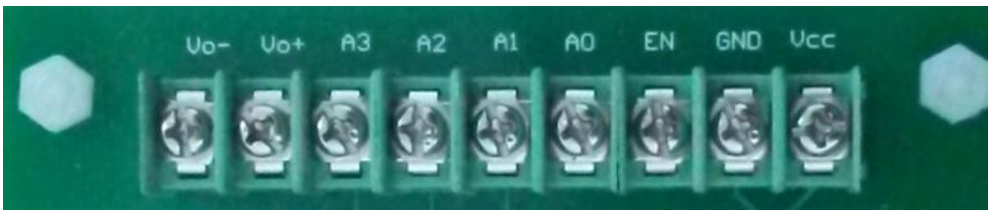


Fig2 terminals of watermeter DEMO

2. Power supply of the DEMO

Vcc: 2.6~16V

Enable: 1.6~Vcc, disable: 0~0.55V

Bus voltage of the watermeter is 2.5 volts powered by a LDO connecting seriously to the Vcc. 2 batteries can be the power source of the watermeter DEMO.

If Enable pin is not used, it should tied to Vcc.

3. Selecting pins

A0, A1, A2, A3 are the selecting logic input pins, with high state voltage of 2.5V and low state voltage of 0. There are 16 sensors locate as below figure detecting the 8 wheels, in which X1, X2,…,X8 are sensing X-axis field component and Y1,Y2,…,Y8 sensing Y-axis field component. A MUX is used to determine which sensor works at a single time. Truth table is as below, wherein differential output can be monitored by terminals Vo- and Vo+:

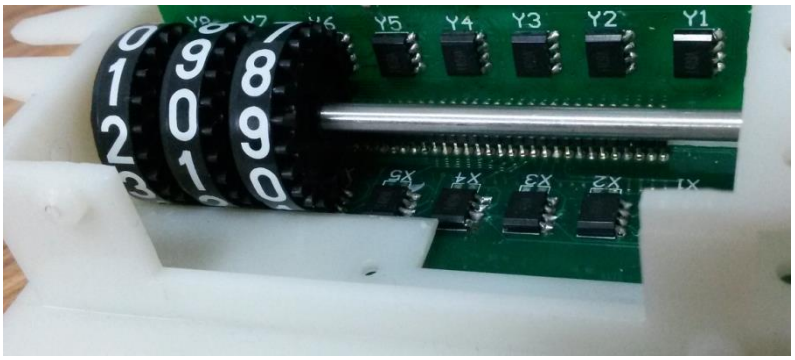


Fig3 X-sensor and Y sensor are assembled perpendicularly

Table 1 truth table of the system

A3	A2	A1	A0	selected sensor (differential voltage output)
0	0	0	0	X1
0	0	0	1	Y1
0	0	1	0	X2
0	0	1	1	Y2
0	1	0	0	X3
0	1	0	1	Y3
0	1	1	0	X4
0	1	1	1	Y4
1	0	0	0	X5
1	0	0	1	Y5
1	0	1	0	X6
1	0	1	1	Y6
1	1	0	0	X7
1	1	0	1	Y7
1	1	1	0	X8
1	1	1	1	Y8

4. Calculation of printed number of wheel

For a 8-wheels meter with 10 numbers on each wheel, there are 100000000 different possibilities of number, they are 0000001, 00000002, … ,99999999. It takes huge of time to rotate and test every number possibility for every different design. So Worst case measurement is taken.

Worst case happens when one wheels is being measured while other 7 wheels are aligned such that magnetic moment of the other magnet in said other 7 wheels are pointing to the same direction which gives biggest influence to the wheel being tested. If the system works in the worst case, it works in all 100000000 possibilities.

There are 10 small black points near each red number 0~9 which represent the 10 numbers of the print wheel. Thus, there are 100 worst case test points in each print number, meaning 800 worst case test points in 8 print wheels totally. Below shows the 100 worst cases on print wheel #1.

Table 2 100 worst cases on print wheel #1

Number of print wheel #1	Number of other 7 print wheels			
0	0000000	1111111	…	9999999
1	0000000	1111111	…	9999999
…	…	…	…	…
9	0000000	1111111	…	9999999

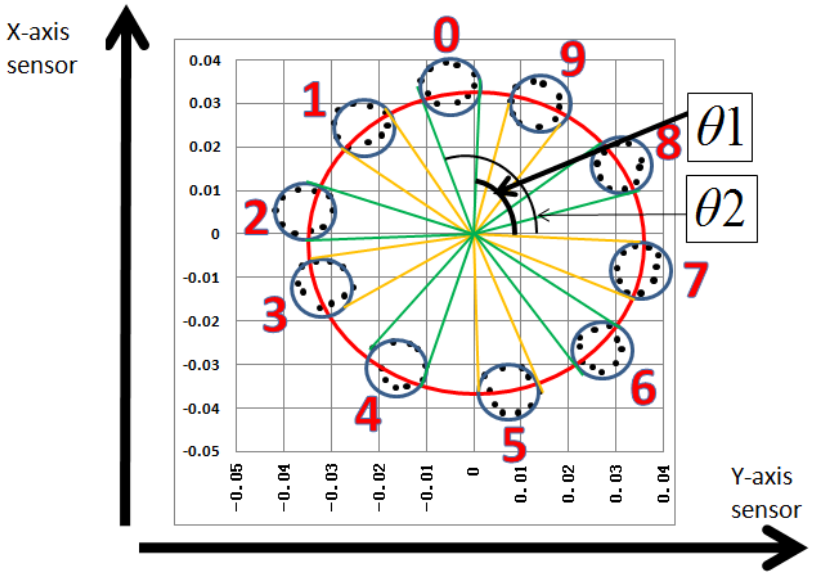


Fig 4 worst case result of print wheel #1

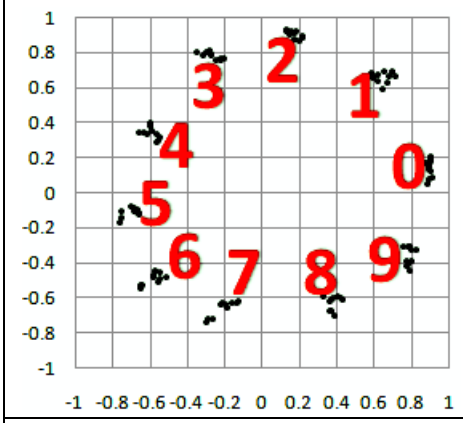
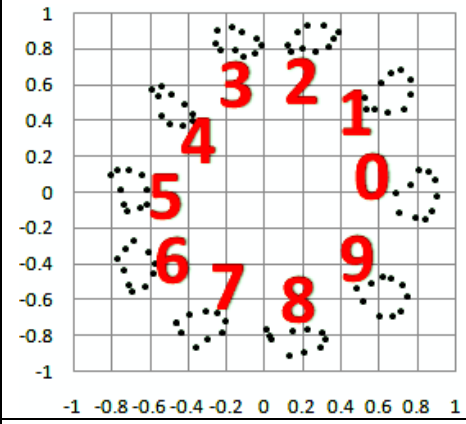
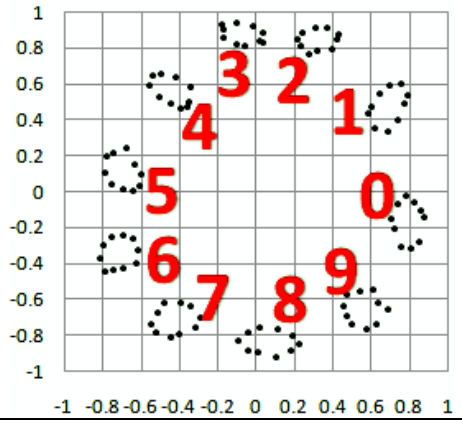
Worst case testing result of a printed wheel shows in Fig 4 in which the 2 vertically assembled sensor (we call them as Y-axis sensor and X-axis sensor) testing result is plot. Within the blue circle near red number 0, there are 10 small black points represent 10 worst cases while print wheel #1 is fixed in NUMBER 0 respectively. Be calculated by arc-tangent function, the angle of number 0 is between θ 1 and θ 2. For print number 0 of this wheel, calculated angle possibilities other than the 10 worst case should within the blue circle, which means angle should be between θ 1 and θ 2. The most important parameter of watermeter is neighboring interference which could be represented by the overlap of blue circle in above figure. We can see easily that in the above figure, there is no overlap between all neighboring blue circles, which means we can easily tell the number of the print wheel.

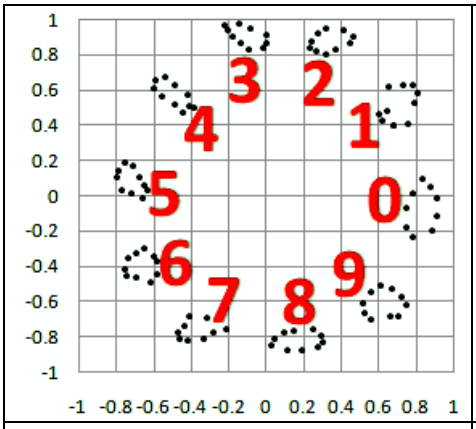
5. Testing data

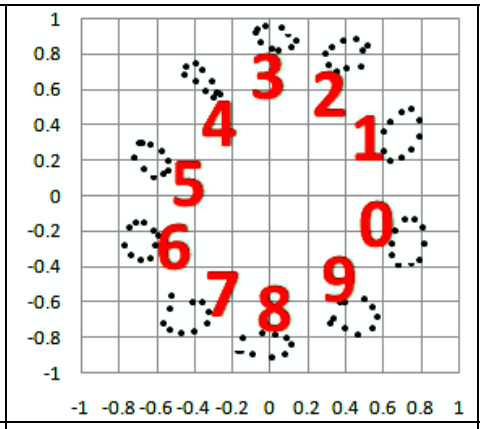
Testing data of all 8 wheels are shown in table 3, no overlap can be found. It means through calculation, the printed number of each wheel could be read.

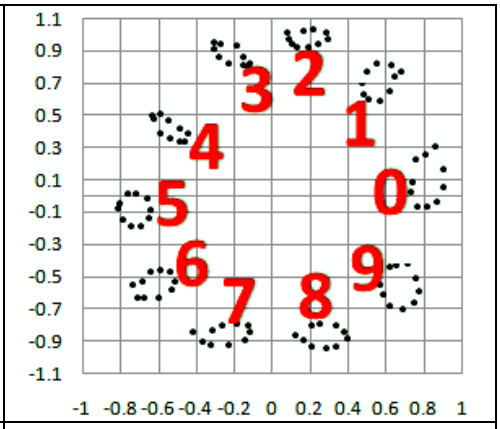
In order to reduce calculation complexity, sensor with low offset should be used.

Table 3 worst case data of the watermeter DEMO

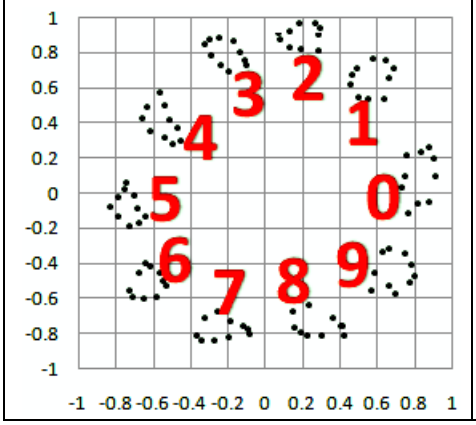
Wheel 1 	Wheel 2 	Wheel 3 
Wheel 4	Wheel 5	Wheel 6



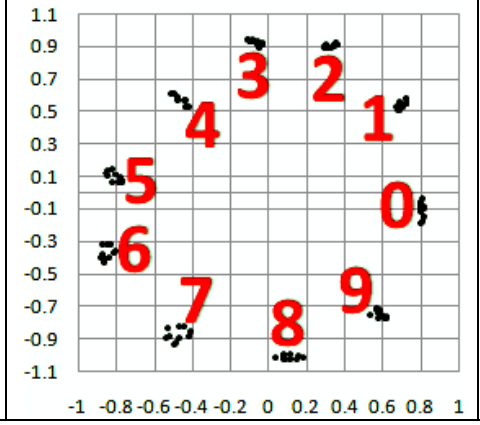




Wheel 7



Wheel 8



6. note

A).The value of output capacitors connected between Vo+/GND and Vo-/GND should be no greater than 0.1uF. A higher value of these capacitors would severely degrade readout speed of the metering device.

B). The decoder (74HC238) is optional. It is used to reduce the current of the device by limiting the number of sensors that are simultaneously powered during the read cycle. Removing this component can slighlty reduce system cost, but removing it increases the supply current by about 20uA during the read cycle. If the decoder is not used, the Vcc pins of all TMR sensors should be connected in parallel between the output terminal of LDO and GND.

C). The position of the sensors, permanent magnets, and the PCBs in this DEMO is not controlled to highest practically achievable accuracy that could result from mass production. The data in this testing report threfore does not show the best possible performance of this metering concept.