- MODEL No: HMS5300 -

* Product Name: Hall Effect Measurement System in variable temperature from 80K to 350K by using AMP 55 Kit including SH80350K/
from RT to 573K by using AHT55T3 Kit.

- Manual version: ver 5.11-

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1. Hardware installation.

1) HMS5300 consists of.

HMS5300 system mainly consists of "Main body System", "Magnet for 80K-350K(AMP55T)", "Sample Holder(SH80350K)", "Magnet for RT-573K(AHT55T3)" and "software program"
2) Cable connections.

2-1) Testing on 80K-350K (Using AMP55T)

First of all, you need to connect many cables successfully as below images.

You need to take care ①, ②, ③ cable connectors are water-proof but the other side of ①, ②, ③ cable connectors are non-water proof. Water proof connectors are little longer than the other side connectors.

The reason why we use wafer-proof connectors for connecting to LN2 tank is for more safety issue. Because, LN2 tank surface will be dewy, whenever measuring in low temperature.
And, either USB or RS232 cable also must be connected between your computer and main body system’s back panel’s connector. And, “voltage rate switch” also must be selected as per your electrical environment.

2-2) Testing on RT-573K (Using AHT55T3)
First of all, you need to connect many cables with below AHT55T3
2-3) How to input the gas valve

Insert the pipe into ‘Gas In’ and ‘Gas Out’ with nut and ferrules as the below picture.

* When you finish the test of low temp with AMP55T Kit and then intend to measure high temp with AHT55T3, you can see the red bulb of ‘ERROR’ in front of Main Body. At this time, please push a button of ‘RESET’, so that it will be back to normal status.
3) Bolt screw in and out, to lock in and lock out magnet

As shown in above image, you have to screw bolt out, first of all, before you start to test. If not, magnet does not move at all and it causes noise sounds. If you meet this noise sounds, rush to push "power off" button and get rid of two bolts on both magnet sides, left and right.

< Pic#5, please remove two bolt screw pin on both sides magnet as shown above >
1. Pull to the end of left, and insert the 'long bolt pin'.
   Turn the long bolt pin to the right. (About 10~15 turns)

2. When you push the magnet to the middle, if you see the tool is located in middle as the left picture, you turn the bolt appropriately.

3. It is time to turn the right side.
   ① Again, move the magnet slightly to the left side.
   ② Push the bolt pin to be straight.

4. ① Pull the magnet slightly to the right side.
    ② When the bolt pin meets the hole, turn to the right.
5. You may need the 'Big L hexa wrench' to work these jobs.

<Pic#6. both sides bolt should be screw in to lock magnet movement>

Both of bolt must be screw in and firmly fixed, in order to prevent the magnet from moving on both sides out of control in a process of shipping. Please screw bolt in whenever you move magnet for long journey. If not, magnet move left and right sides out of control and it may be the reason of shorter magnet life time, and magnet may be broken or not operated by serious shockness.

And, if the magnet is not standing on initial position, push "RESET" button in the main body system's front panel. If so, magnet comes to initial position automatically. Magnet is ready to run successfully.
4) LN2 tank and sample board construction.

Above image is to show top view of LN2 tank with magnet kit. LN2 must be poured into "① LN2 tank" to test in variable temperature. And, it can make it possible to maintain LN2 temperature during test.

"② part of sample board" is top end of sample board. Sample board was made of "Oxygen-free bronze" shank and it was coated by gold. Oxygen-free bronze is very good to respond for temperature variation very fast. And, coated-gold can prevent sample board from getting rusty.

"③ motorizing controller" is to make it possible to move magnet left and right side automatically during test.

"⑤ LN2 tank lid" should be closed as above image right after pouring LN2, in order to keep LN2 for longer time. If not, LN2 does boil and evaporate faster.
“⑦ Funnel” is to make it possible to flow LN2 into square type LN2 tank which is centered on both round magnet.
Above images are to show sample board. And, those are not detachable each other. Please do not try to take it to pieces by force.
“Heater” was embedded in sample board inside. It can make it possible to raise the temperature goes up by getting signal from electrical power.

And, AMP55T: “sample board” is heated by heater and cooled down by LN2.

AHT55T3: “sample board” is only heated by heater.

“Temperature sensor” reads temperature currently on the real time basis, and send signal to main body system.

“sample” must be mounted on sample board successfully. It is very important process. If sample mounted on sample board loosely, connection between each probe tip and sample’s four point edge may be disconnected during test, esp in low temperature. So, please try to check each connection was successfully done.

If you finished all the cable connections, voltage rate switch selection, USB/RS232 connection and mounting sample on board, you can power main body system on.

When a tester uses AHT55T3, the tester should open and close the magnet lid and cap.
5) Sample holding kit supporter.

Sample holding kit can be put on supporting base as shown above. It makes easier and more convenient to mount sample on sample board and exchange samples.
2. S/W program installation.

Click "setup.exe" file to start HMS5300 installation program.

It automatically goes on as above.
Select the primary installation directory.

All software will be installed in the following location(s). To install software into a different location(s), click the Browse button and select another directory.

Target directory for application:

C:\Program Files\HMS-5300 Ver5.8

Target directory for National Instruments software:

C:\Program Files\National Instruments

Click "Next" button.

You must accept the license(s) displayed below to proceed.

Click "I accept the License Agreement(s)".
Click "Next" button.

Click "Next" button.
It is installing program files.

Click "Finish". Installation process was finished.

Click "Restart" and before that, please save the data in advance that is on operating.
3. How to measure

Start the program.

1) The first main page of hall effect measurement system

If all the hardware connections and s/w program was successfully installed, start to open measurement page.
Above pic#1) is to show initial measurement page.

(1) Input value

Pic#2 is to show selecting COM PORT by pull-down menu bar. It is automatically selected but if not, click COM3 except for COM1.
You can select "ROOM TEMP" or "VARIABLE TEMP" as per your test purpose.

"I" means input current value. You can fill it from 1nA to 20mA as per the sample’s electrical properties. If it is too high resistive sample, you will have to fill it lower, on the other hand, if it is high conductivity sample, input current must be 10mA or 15, or higher.

"D" is doped - sample thickness layer. You have to know it in advance by testing with your ellipsometer or other instruments.

"B" is magneto flux density. We usually offer 0.55Tesla magnet but it may be little stronger or little weaker. It will be range of 0.57T ~ 0.53T and we will test and label actual magneto flux density in magnet kit before shipment.
This is because our permanent magnet is very sensitive to air gap between both round magnet.

"INITIAL" and "FINAL" means variable temperature set-up range in which user likes to test. Limit temperature of AMP55T is 80K for "INITIAL" and 350K for "FINAL" temp, and temperature of AHT55T3 is upto 573K.
"STEP" means actual testing point. In Pic#4, we filled "11" and "INITIAL" temp is 300K and "FINAL" temp is 320K. If so, our system will measure at 300K, 302K, 304K, ..., 318K and 320K. It measures 11 number of point at each 2K interval variation.

![INPUT VALUE](image)

*Pic#5. complete input value*

(2) Open port

![RESULT DATA](image)

*Pic#6 click "OPEN PORT"

If you filled all menu in input value, you have to click "OPEN PORT" to see if connection is successful. Above Pic#6 is to show "connection success" and you can also see currently real-time temperature in progress. It now indicates 297K. If it reach to 300K, the system will start to run, after system wait 5 seconds of maintaining time at 300K.

If you see "connection fail", you need to check hardware(cable) connections. If you see "connection success", click "MEASURE" button, and it starts to run successfully.
(3) Measure

It is testing now and it reads and displays raw data, Vab, Vbc, Vac, Vcd, Vda, Vbd.

Now, magnet system is inserting magnet N to S automatically by motorizing system.
And then right after that, system reads and displays data of MAC and MBD.

Now magnet system is inserting magnet S to N automatically by motorizing system.
And then right after that, system reads and display data of -MAC and -MBD.

Measurement was finished and you can see below “MEASUREMENT DATA” in Pic#12.
“RESULT” in Pic#12.
(4) Raising temperature automatically by heating up sample board.

If the system finish measurement at the first step temperature, system raise temperature automatically by heating up bronze sample board to reach to next step temperature. The system starts to repeat measuring process when it goes on to the next goal temperature.

(5) Test results

Pic#12, "MEASUREMENT DATA". It is raw data

Pic# 12 is to show raw data and these values are based on calculating below “RESULT” values such as bulk concentration, mobility, resistivity and so on.

And, in the first row of black color box, system applied forward current. In the second row of gray color box, on the other hand, system applied reverse current.

And, you can also see whether ohmic contact is good or not, by taking a look at absolute values of each pair (forward and reverse value). Now in Pic#12, please see Vab. Each values are “-2.5416” and “2.5425”, and absolute values of each other are very similar. So you can see ohmic contact is good.
After final test, it displays
Bulk concentration,
Sheet concentration,
Resistivity, Conductivity,
Magneto-Resistance,
Mobility,
Average Hall Coefficient, A-C Cross Hall Coefficient, B-D Cross Hall Coefficient,
Ratio of Vertical/Horizontal

In Pic# 14. “RESULT DATA”, it shows Temp and Current as well as RESULT values in Pic# 13.

(6) SAVE the measured data.

If you finished all test process, click “SAVE” button below.
And, saved data can be transformed to excel file by opening saved data file (~_hall) in excel file.

(7) LOAD menu.

If you like to see existingly saved data in the first test page, click “LOAD” menu in Pic# 15.

(8) CALCUL menu.

If you made a mistake to fill incorrect D (doped sample thickness layer), or incorrect B(Magneto flux density), you don’t have to re-measure again. Please just fill actually correct D or B in input value, and then click “CALCUL” button. If so, system calculate it automatically.
2) The second page
(I/V, I/R measurement and graph plotting)

If you like to see I/V, I/R plotting graph, click "Go To I/V CURVE" as below.

< Pic# 1. Click "Go To I/V CURVE >

< Pic#2. I/V, I/R Curve Tracer page >
“CON.REF(%)” is percentage of the ratio between horizontal and vertical resistance values. If vertical resistance is 10ohm and horizontal resistance 20ohm, “CON.REF(%)” is 200%.

Limit is 1000%, and if actual tested percentage is higher than 1000%, the system says “contact fail” in “OPERATING DESCRIPTION”.

“STEP” in current above also can be set up as mentioned in “STEP” of temperature.

Click “MEASURE” button if you filled all in input value, temperature range and current in I/V, I/R page.

Or, if you just like to see measured data in the first main page, click “I-V curve” and click “ab − − −”. You can see each a to b plotting graph in variable temp.
And, you also can see plotting graph of “b to c”, “c to d” and “d to a” in variable temperature by just clicking “bc”, “cd”, “da” in above pictures.
<Pic#6. b to c plotting graph in variable temperature>

<Pic#7 c to d plotting graph in variable temperature>
If you like to save the data, click "SAVE" menu button. And, it saves in "~.temp". Extension name must be ".temp".
And, you also can see I/R plotting graph of "a to b", "b to c", "c to d" and "d to a" in variable temperature by just clicking "ab", "bc", "cd", "da" in above pictures.

And, if you'd like to save I/R tested data, click "SAVE" menu bar. It can save as below image.

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Click "DATA VIEW" menu. You can see all tested data in I/V, I/R page in text file.
3) The third page

(Graph plotting of temp versus carrier concentration, mobility, resistivity, conductivity, hall coefficient)

If you finished test in the first main page, click “Go To TEMP Chart” as below.

<Pic# 12. DATA VIEW window>

<Pic# 1. click “Go To TEMP Chart” menu button>
Click "Concentration" button in Pic#2 and graph plot as above.

Click "Mobility" button in Pic#3 and graph plot as above.
<Pic# 4. Temperature versus Resistivity graph>

<Pic# 5. Temperature versus Hall Coefficient graph>
4) Test in Low temperature by using Liquid Nitrogen (important)

(1) Pour Liquid Nitrogen into Funnel.
(2) Pour Liquid Nitrogen to be enough and close LN2 tank lid

(3) Click “COM PORT” before starting to measure.
In the first measurement page of s/w, click “COM PORT”. If it shows “connection success”, the system is trying to read currently temperature and it indicates currently temperature in “Progress (%)”,
You can see temperature goes down step by step in “Progress(%)”.

If you like to measure at very low temperature, for example, from 80K or 90K temperature, you have to pour about 100ml Liquid Nitrogen into funnel one time. And, you will have to repeatedly pour more than 2 to 3 times at one or two minutes interval.
It flows down into square LN2 tank which is centered on both round magnet.

This process is not only to reach to low goal temperature but also to keep not-dewy status in square LN2 tank.

And, these process of pouring LN2 is always substantially needed to measure at lower temperature than room temperature.
(4) Start to measure
If temperature of sample nearly reaches to goal, by above LN2 pouring process, click "MEASURE" button. It starts to measure sample at variable temperature.
For example, you would like to measure on 150K and the system is reading 270, 260, 250... 170, 160K arrived, you click the 'Measure' button, so the system will find 150 K temperatures and start the test.

** Starting on low temperature at 80 ~90K
If you want to start at 80K or 90K etc. which is very low temperature, it is very hard to reach and start the test at the first time.
In starting on low temperature at 80 ~90K, please wait for over 5 minutes, because the LN2 tank need a time to low itself also.
The thermocouple can read the low temperature by LN2 at first, but the low temperature can be read by reaching it to the sample board in the bottom of the LN2 tank.
Therefore, the user who want to test to start on 80~90K, please have a time to wait for a while.(over 5 minutes.)

(5) Tip (Important and take care ! )
i) Liquid Nitrogen may be dangerous if it is contacted to skin or clothes. So, please pay more attention to this during test.
   ii) When you like to quit testing process, during test performance, you have to click "STOP" button, first and then click "CLOSE" button and finally close button("X") in s/w test window.
   If you click directly close button ("X") in s/w test window , without clicking "STOP" button and "CLOSE" button, it may cause some system problem.
iii) When you try to change sample to measure another sample, you have to dry the sample board and sample. To do that, do not try to take out the sample board with magnet lid from square type LN2 tank. It will make the sample board with sample be dewy if taking it out of square LN2 tank. Without taking out sample board with sample, just set up 330K in initial and 330K in final and set up 3 steps and measure it. If so, then the system will raise the temperature and measure at 330K in three times for 1~3 minutes. After this test, you can see sample board with sample be dried.

iv) HMS5300 system can have 99 number of test results at one time test and therefore, if you like to test 2K interval such as 80K, 82K, 84K,..., temperature range set-up must be limited, i.e from 80K ~ 270K or 90K ~ 280K or 100K ~ 290K like this way. Or, if you like to test wider temperature range, you have to set up 3K or higher temperature interval.

v) We strongly recommend that you should not do other work on the computer that is measuring Hall Effect by HMS-5300. Other job will possibly interfere the measurement data and especially ‘Go To Temp Chart’ button cause the problem with buffering, so main data cannot receive the current and shows a wrong data result.

vi) Although there is no problem in common use, we provide fail-safe fuse of 2A for
purchasers who use 100-120 voltage, in case that the fuse 1A is sometimes disconnected in 100-120 volt circumstance. The disconnection problem seldom happens. This is fail-safe fuse, so you don't need to force to change if there is no problem. If you want to change the fuse, please follow the below process.

This is fuse case. Use flat device (ex. driver) to lift the case.

Lift the case by hand.

This is the current fuse. (for 220-240 volt, 1A)

We provide the fail-safe fuse. (for 100-120 volt, 2A)

— TECHNICAL SUPPORT —

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