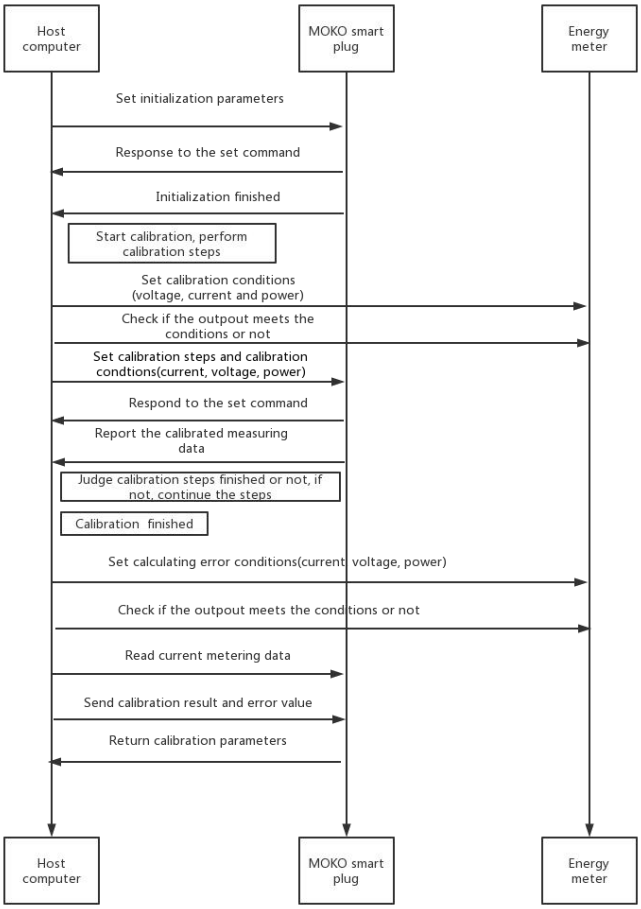
1. MOKO calibration system

The MOKO power metering SDK includes power metering and calibration functions. The custom firmware which integrates the SDK can directly work with the MOKO calibration system.

The MOKO calibration system includes a host computer and an energy meter. The host computer is MOKO calibration software, the calibration instrument is IPM8103 single phase energy meter (**the energy meter must have the accuracy of active and reactive power up to 0.5S**).
During the calibration, the host computer is the control center, it can control the energy meter output different load (voltage, current and power) to the MOKO smart plug device following the ***RN8209C calibration methods***, and send command to the smart plug device to implement the calibration steps.

2. MOKO calibration process

Please see the below picture to know the calibration process:



3. Calibration steps

There are six steps during the calibration:

1. HFConst and Kp calculation
2. Calibrate Kv,Ki,GPQA
3. Calibrate phase
4. Calibrate active power offset
5. Calibrate reactive phase offset
6. Calibrate active current offset

We can refer to the RN8209C user manual to get the calibration method details.

4. Communication protocol example

4.1 Reading commands

4.1.1 Inquire device information

Host computer send:

```
{
"inquire":1              //2 is inquire calibration deviation,3 is inquire current meter parameter
}
```

Device reply:

```
{
"inquire":1,
"id": "123132",           //mac address of the device
"type": "MK117",          // device type
"ver": "V1.0.7"           // firmware version
}
```

4.1.2 Inquire calibration error

Host computer send:

```
{
"inquire":2
```

}

Device reply:

{
"inquire":2,
“Deviation”:9999 //The measuring error after calibration, the value is compared with 10000. If value is 0, that means device is not calibrated.
}

4.1.3 Inquire current measuring data

Host computer send:

{
"inquire":3
}

Device reply:

{
"inquire":3,
"voltage":220000,
"current":50000,
"power":11000000
}

4.2 Set initialization parameters

Host computer send:

{
"set":1,
"power_start":4.4,
"EC":3200,
"KV":0.0005316, //The coefficient of the voltage that based on the hardware design
"R":2000 //The shunt resistance value
}

Device reply to the command

```
{
"set":1,
"resp": "ack"
}
```

Device reply the initialization result

```
{
"init_result":1
}
```

4.3 Set calibration steps

After the host computer receive the successful initialization result, it will send command to start the calibration steps.

4.3.1 Set calibration steps

Host computer send:

```
{
"set":2,
"step":1,       // The value in different calibration steps is different, there are 6 calibration steps.
"voltage":220000,
"current":50000,
"power":11000000
}
```

Device reply:

```
{
"set":2,
"resp": "ack"
}
```

Device return the measuring value after calibration:

{
"set":2,
"step":1,
"voltage":220022,
"current":50220,
"power":11010000
}

4.3.2 Send calibration result and deviation

After calibration, host computer will send the calibration result and deviation value to device.

{
"set":3,
"result":1,
"deviation":9999
}

Device will return calibration parameters:

{
"set":3,
"resp": "ack"
"GPQA":123,
"GPQB":123,
"PhsA":123,
"PhsB":123,
"Cst_QPhsCal":123,
"APOSA":324,
"APOSB":543,
"RPOSA":143,
"RPOSB":234,
"IARMSOS":234,
"IBRMSOS":234,
"IBGain":0,
"Ku":12343,
"Kia":123,
"Kib":0
}

4.3 Exit calibration mode

After the calibration is successfully done, the host computer will send a command to make the device exit calibration mode. Then the device will enter the next mode.

```
{
"set":4,
}
```

Device reply:

```
{
"set":4,
"resp": "ack"
}
```

5. Document version

Version	Editor	Date
V1.0	Weiguifen	2023.3.20