

User Manual for Channel sounding of HM-BT2401DA

Refer to the document 《HM-BT2401DA User Manual》 Use two HM-BT2401DA modules. Configure one of the modules as the initiator and the other as the reflector. The following AT commands are required:

AT+CSROLE、

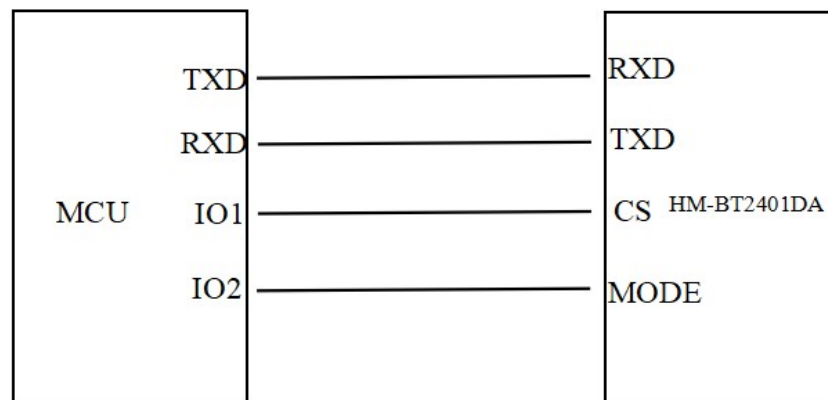
AT+SCANSA、

AT+SCANSO、

AT+CONN、

AT+CSEN

1. Configure the module's pin levels: CS=0, MODE=1, to enter AT command mode.



2. When the BLE device is in AT mode, use the AT+CSROLE command to query and set the CS ranging role, where 0 represents the initiator and 1 represents the reflector.

Log example:

```
[14:32:41.830]发→◇AT+CSROLE?  
[14:32:41.861]收←◆+CSROLE:0  
[14:32:46.161]发→◇AT+CSROLE=1,0  
[14:32:46.191]收←◆+CSROLE:OK  
[14:32:46.749]收←◆V1.0,1,HM-BT2401DA,HopeRF
```

3. It is necessary to ensure that the reflector device is in the broadcasting state.

The initiator device scans and connects to the reflector device. After the connection is successful, the serial port will report prompt information similar to [BLE]: Connected, 1.

Log example:

```
[14:17:55.156]发→◇AT+CSROLE?  
[14:17:55.188]收←◆+CSROLE:0  
[14:18:15.369]发→◇AT+SCANSA  
[14:18:15.414]收←◆+SCANSA:OK  
[SCAN]:1,3,1,75:50:FD:60:65:14,-68  
[SCAN]:2,3,1,53:6C:08:62:A1:75,-78  
[14:18:15.439]收←◆[SCAN]:3,3,1,6E:40:49:DC:51:5C,-100  
[SCAN]:4,3,1,49:2C:00:27:70:57,-66  
.  
.  
.  
[14:18:16.281]收←◆18:79:F5:47,-83,Lck1_8E3B1879F547  
[SCAN]:32,3,1,5C:8E:A0:F2:A9:F5,-95  
[14:18:17.039]发→◇AT+SCANSO  
[14:18:17.064]收←◆+SCANSO:OK  
[14:18:51.422]发→◇AT+CONN=1,1,7CC6B6D0865B  
收←◆[BLE]:Connected,1  
[MAC]:7C:C6:B6:D0:86:5B
```

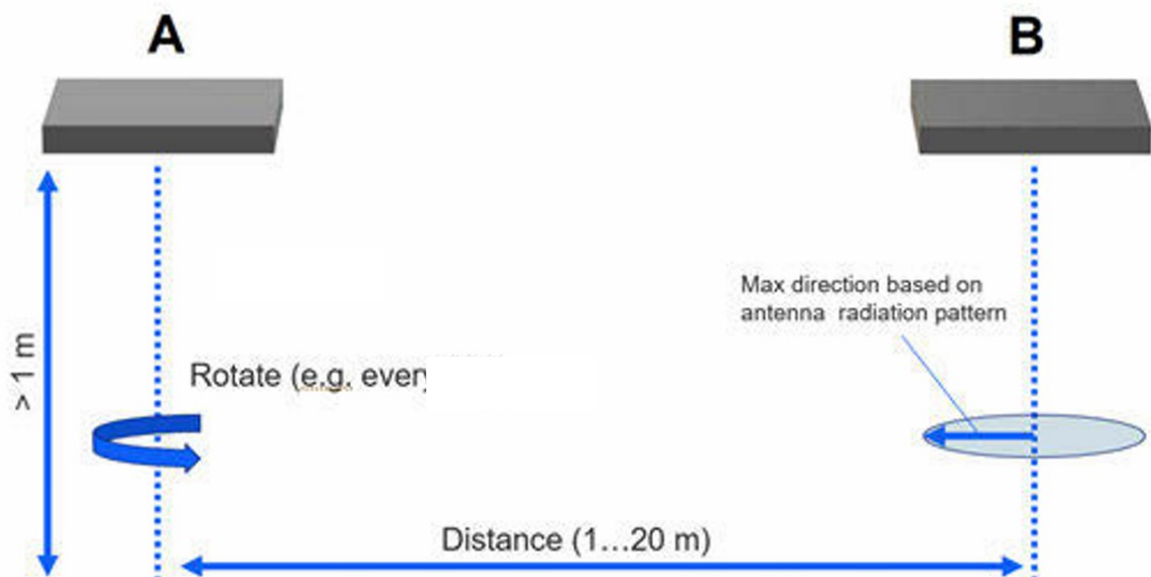
4. Enable the reporting of ranging results. The ranging results are reported by the initiator device (unit: **mm**).

Log example:

```
[14:26:43.926]发→◇AT+CSEN?  
[14:26:43.941]收←◆+CSEN:0  
[14:26:49.061]发→◇AT+CSEN=1,1  
[14:26:49.093]收←◆+CSEN:OK  
[14:26:58.672]发→◇AT+CSEN?  
[14:26:58.688]收←◆+CSEN:1  
[14:27:00.954]收←◆[CSRESULT]:112  
[14:27:03.256]收←◆[CSRESULT]:112  
[14:27:03.719]收←◆[CSRESULT]:112  
[14:27:04.166]收←◆[CSRESULT]:112  
[14:27:04.614]收←◆[CSRESULT]:150  
[14:27:05.045]收←◆[CSRESULT]:188  
[14:27:05.493]收←◆[CSRESULT]:226  
[14:27:05.956]收←◆[CSRESULT]:256  
[14:27:06.419]收←◆[CSRESULT]:256  
[14:27:06.899]收←◆[CSRESULT]:218  
[14:27:07.346]收←◆[CSRESULT]:180  
[14:27:07.809]收←◆[CSRESULT]:143  
[14:27:08.272]收←◆[CSRESULT]:112
```

5. Test environment setup

- ① Tests were performed in an unobstructed outdoor environment at 1m/3m/6m/9m/12m/15m/18m.
- ② Devices are elevated $\geq 1\text{m}$ above ground level, with Device A as initiator and Device B as reflector.
- ③ At the same distance, keep Device B stationary. Rotate Device A successively by 90 degrees in the direction of the arrow as shown in the figure to change its orientation, so as to measure the distance in 4 orientations.
- ④ Record 300 distance values at each position, calculate the average, maximum, minimum values, and the deviation from the actual distance, The results are presented in the following table.



unit:mm

	1m, 0°	1m, 90°	1m, 180°	1m, 270°	3m, 0°	3m, 90°	3m, 180°	3m, 270°
avg:	991.12219	980.9177	1105.63	974.7412141	2805.81	2574.22689	2889.04571	3045.966197
diff:	-9	-19	105	26	-195	-426	-111	46
min:	865	891	806	719	2698	2395	2342	2867
diff:	-135	-109	-194	-281	-302	-605	-658	-133
max:	1079	1075	1339	1116	2898	2773	3066	3236
diff:	79	75	339	116	-102	-227	66	236

	6m, 0°	6m, 90°	6m, 180°	6m, 270°	9m, 0°	9m, 90°	9m, 180°	9m, 270°
avg:	6071	5862.854	5718.4	5777.255952	9161.91	8808.90789	8760.49245	8879.5526
diff:	71	-138	-282	-223	161	-191	-240	-121
min:	5557	5385	5260	5592	8973	8622	8628	8626
diff:	-443	-615	-740	-408	-27	-378	-372	-374
max:	6236	6460	6013	6382	9240	9375	9087	9047
diff:	236	460	13	382	240	375	87	47

	12m, 0°	12m, 90°	12m, 180°	12m, 270°	15m, 0°	15m, 90°	15m, 180°	15m, 270°
avg:	12076.31	12009.77	11749	11770.8123	15097.2	14802.1099	15128.3855	14952.7006
diff:	76	10	-251	-230	97	-198	128	-48
min:	11846	11727	11542	11501	14783	14641	14856	14791
diff:	-154	-273	-458	-499	-217	-359	-144	-219
max:	12301	12200	11902	11900	15186	14955	16114	15144
diff:	301	200	-98	-100	186	-45	1114	144

	18m, 0°	18m, 90°	18m, 180°	18m, 270°
avg:	19082.776	18047.51	19071.4	18041.57778
diff:	1082	48	1071	41
min:	18149	16401	17944	16913
diff:	149	-1599	-56	-1083
max:	19903	18400	20135	18268
diff:	1903	400	20135	268

As shown in the above table, the ranging results are as follows:

- ① At distances from 1 m to 15 m, the ranging error accuracy of the average value is less than ± 0.3 m.
- ② At distances from 1 m to 15 m, the ranging error accuracy of the maximum and minimum values is less than ± 0.5 m.
- ③ The error at 18 m is about 1 m.