Neoway 有方

Neoway GPRS Module
ADC Function Description

Version 1.0

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Notice

This description is applicable to Neoway M660, M680, and M590E R2.

This document is intended for system engineers (SEs), development engineers, and test engineers.

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Revision Record			
Issue	Changes	Author	Date
V1.0	Initial draft	Qiao	2014-08-08

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1 ADC Function Description

Neoway GPRS modules supports Analog-to-Digital Converter (ADC) function. They can detect analog voltage signals that range from 0 to 2.8 V and then convert the detected voltage signal into 10-bit or 12-bit digital signals. The modules can read data through UART. This function is applicable to control or display circuit.

2 Recommended ADC Scheme

The ADC function GPRS modules can be used to detect analog voltage of temperature or pressure. You can send **AT+READADC=<0,1,2>** to UART to read the ADC value after channel converting and use it to your circuit.

This document will provides a complete design scheme of temperature detecting for reference.

Thermistors and analog temperature sensor chipsets are commonly used in temperature detecting schemes.

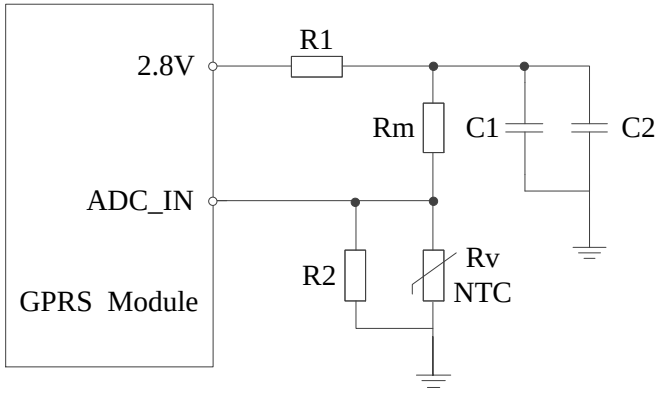
- Thermistors: cost-effective, but poor linearity and low temperature precision
- Temperature sensor: costly, but better linearity and high temperature precision.

ADC design using negative temperature coefficient (NTC) thermistor is recommended. With this design, you can send **AT+ADCTEMP=0** to the UART to read temperature and voltage value directly.

2.1 Recommended ADC Hardware Design

The recommended ADC design use NTC thermistors. NTC thermistor is a semiconductor made from a sintered metal oxide. It works in temperature detecting, temperature compensation, and temperature control circuits because raising the temperature of a semiconductor decreases the resistance.

Figure 2-1 Recommended ADC circuit



In Figure 2-1, R1, C1, and C2 forms a filter circuit to provide stable reference voltage source. NTC Rv and fixed Rm forms a resistive voltage divider, which provides voltage as measure voltage input. The Rv value changes as temperature varies, resulting in the voltage change. The built-in ADC of the module detects the voltage changes and converts it into digital signals. Then you can read it by sending AT commands to the UART.

The resistance of NTC thermistor can change from 200 KΩ in temperature -40℃ to 2 KΩ in temperature 85℃. R2 that has great resistance is paralleled to correct voltage value (the curve of temperature to resistance), especially at low temperature. In this manner, the voltage of ADC_IN will not be too high at low temperature or reach full scale in short term. Moreover, R2 does not have great impact on the measure precision.

R1=100Ω C1=0.1μF C2=100pF

You can use multi-layer ceramic capacitors at C1 and C2. Select multi-layer ceramic capacitor with 1% precision for Rm (18 KΩ) and R2 (47.5 KΩ).

Parameters of NTC thermistor:

- R_{25}: zero-power resistance value in ambient temperature 25℃
- R_T: zero-power resistance value in ambient temperature
- B-constant
- Packaging

The resistance vs. temperature curve of an NTC thermistor will be varied with B-constant. The resistance of the NTC thermistor has great change range as temperature changes.

It is recommended that you select NTC thermistor with a B-constant 3380K, packaging 0603, and R_{25} 10K. For example, SDNT1608X103F3380TF from Sunlord and NCP18XH103F03RB from Mutara.

2.2 ADC Voltage Collecting and Temperature

After you select the module of NTC thermistor, the resistance is varied with temperature, resulting in different voltages. If the resistance in different temperatures has been known, you can calculate the ambient temperature after getting the voltage at the ADC_IN pin.

The following table lists the resistance at each degree when the temperature ranges from -40℃ to 95℃ and the ADC voltage collected adopting circuit in Figure 2-1. After collecting voltage on the ADC_IN pin, the module can obtain the ambient temperature by checking the table. Then you can run AT commands to send the result to external CPU for display or other operations.

The following table uses SDNT1608X103F3380TF from Sunlord as the reference design.

NTC Resistance KΩ	Ambient Temperature ℃	ADC Voltage mV	NTC Resistance KΩ	Ambient Temperature ℃	ADC Voltage mV
208.15	-40	1896	8.93	28	831
196.57	-39	1890	8.61	29	813
185.71	-38	1883	8.30	30	795
175.52	-37	1876	8.00	31	777
165.96	-36	1869	7.71	32	760
156.97	-35	1861	7.43	33	743
148.53	-34	1853	7.17	34	726
140.60	-33	1845	6.92	35	709
133.14	-32	1837	6.67	36	693
126.12	-31	1828	6.44	37	677
119.52	-30	1819	6.22	38	661
113.30	-29	1809	6.00	39	646
107.45	-28	1799	5.80	40	630
101.93	-27	1789	5.60	41	615
96.73	-26	1778	5.41	42	601
91.83	-25	1767	5.23	43	586
87.21	-24	1756	5.05	44	572
82.85	-23	1744	4.88	45	559
78.73	-22	1732	4.72	46	545

74.85	-21	1720	4.57	47	532
71.18	-20	1707	4.42	48	519
67.71	-19	1694	4.27	49	506
64.43	-18	1681	4.13	50	494
61.33	-17	1667	4.00	51	482
58.40	-16	1652	3.87	52	470
55.62	-15	1638	3.75	53	458
53.00	-14	1623	3.63	54	447
50.51	-13	1608	3.51	55	436
48.16	-12	1592	3.40	56	425
45.93	-11	1576	3.30	57	414
43.81	-10	1560	3.19	58	404
41.81	-9	1543	3.09	59	394
39.91	-8	1526	3.00	60	384
38.11	-7	1509	2.91	61	375
36.40	-6	1491	2.82	62	365
34.77	-5	1474	2.73	63	356
33.23	-4	1455	2.65	64	347
31.77	-3	1437	2.57	65	338
30.38	-2	1419	2.49	66	330
29.05	-1	1400	2.42	67	322
27.80	0	1381	2.35	68	314
26.60	1	1362	2.28	69	306
25.46	2	1342	2.21	70	298
24.38	3	1323	2.15	71	291
23.35	4	1303	2.09	72	284
22.37	5	1283	2.03	73	277
21.44	6	1263	1.97	74	270
20.55	7	1243	1.91	75	263
19.70	8	1223	1.86	76	257
18.90	9	1203	1.80	77	250

18.13	10	1183	1.75	78	244
17.39	11	1163	1.70	79	238
16.69	12	1142	1.66	80	232
16.02	13	1122	1.61	81	226
15.39	14	1102	1.57	82	221
14.78	15	1082	1.52	83	215
14.20	16	1062	1.48	84	210
13.64	17	1042	1.44	85	205
13.11	18	1022	1.40	86	200
12.61	19	1002	1.37	87	195
12.12	20	982	1.33	88	190
11.66	21	963	1.29	89	186
11.22	22	943	1.26	90	181
10.79	23	924	1.23	91	177
10.39	24	905	1.19	92	173
10.00	25	886	1.16	93	169
9.63	26	867	1.13	94	165
9.27	27	849	1.10	95	161

You can read the current voltage and temperature by running AT command, which is described in the following table.

Description	To check the temperature from the external temperature sensor and the corresponding voltage
Format	AT+ADCTEMP=<mode><CR>
Parameter	<mode>: the specified sensor mode to read temperature and voltage. The units for the return value are ℃ and mV. 0: NTC thermistor mode 1: Integrated temperature sensor iii (not supported) 2: Integrated temperature sensor jjj (not supported)
Return Value	<CR><LF>+ADCTEMP: <temp>,<volt><CR><LF> <CR><LF>OK<CR><LF> <temp>: temperature, unit ℃

	<volt>: Voltage, unit mV <CR><LF>+ADCTEMP: <alarm><CR><LF> <CR><LF>OK<CR><LF> <alarm>: The temperature exceeds the range. OVL: the temperature is lower than -40℃. OVH: the temperature is higher than 95℃.	
Example	AT+ADCTEMP=0 +ADCTEMP: -5,1474 OK	Query the temperature from the NTC thermistor. The return value is -5℃,1474mV.
	AT+ADCTEMP=0 +ADCTEMP: 10,1183 OK	Query the temperature from the NTC thermistor. The return value is 10℃0.1183mV.
	AT+ADCTEMP=0 +ADCTEMP: OVL OK	Query the temperature from the NTC thermistor. The temperature is lower than -40℃.
	AT+ADCTEMP=1 ERROR	Query the temperature from the integrated temperature sensor iii. The mode is not supported. ERROR is returned.