

ADI Environmental Monitoring Solution

— For Electrochemistry Method

MACNICA

2021/9/15

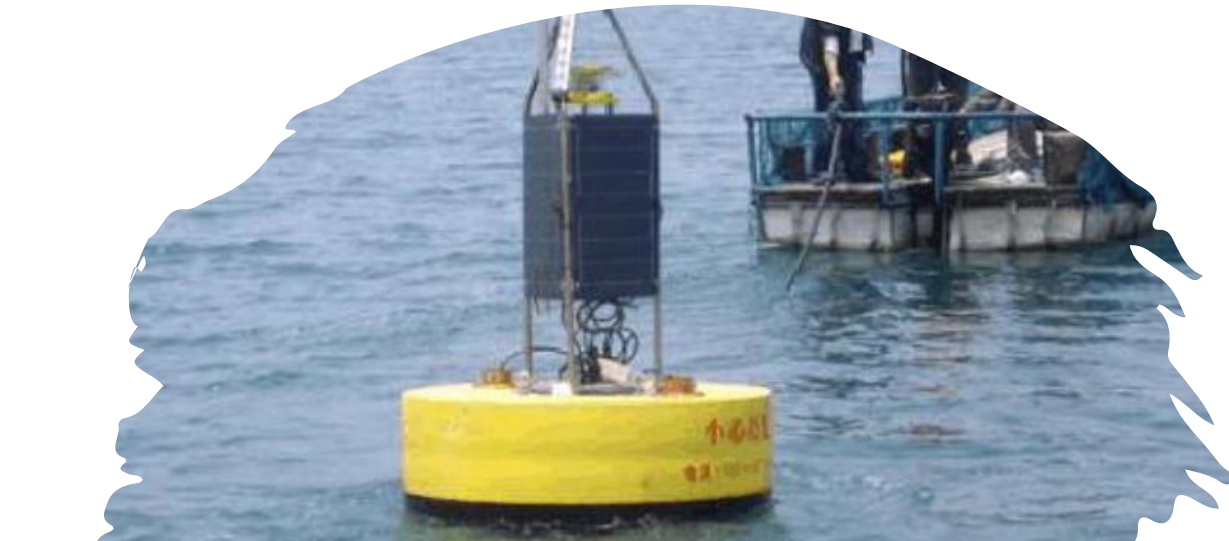
Boris Wang

DFAE for ADI



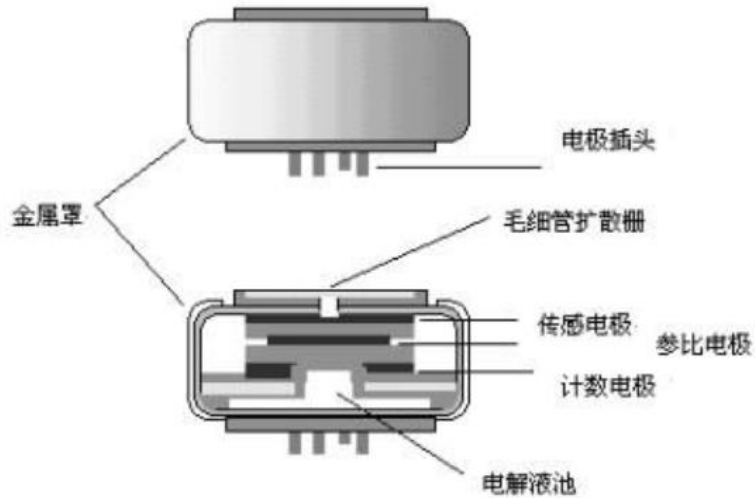
Environmental Monitor Instruments

- **Air Quality**
(CO/O₃/SO₂/NO_x/PM_{2.5}/PM₁₀/VOCs)
- **Gas Detection** (CO₂/H₂S/NH₃/CH₄.....)

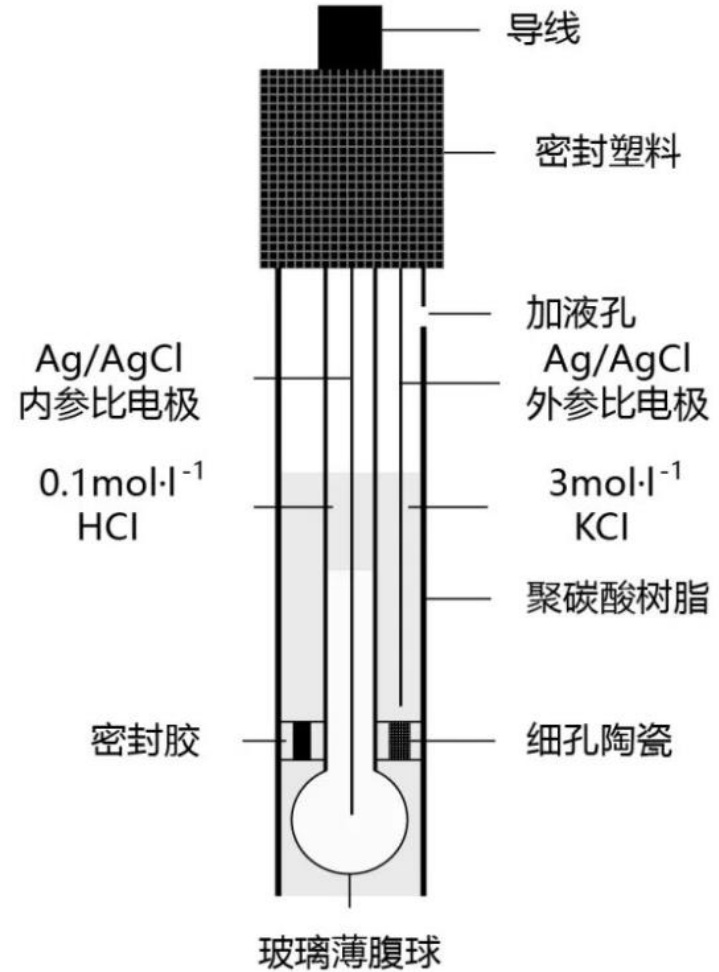


- **Water Quality**
- (Conductivity/PH/ORP/Dissolved Oxygen/Turbidity/Temp)

Structure of EC Sensors

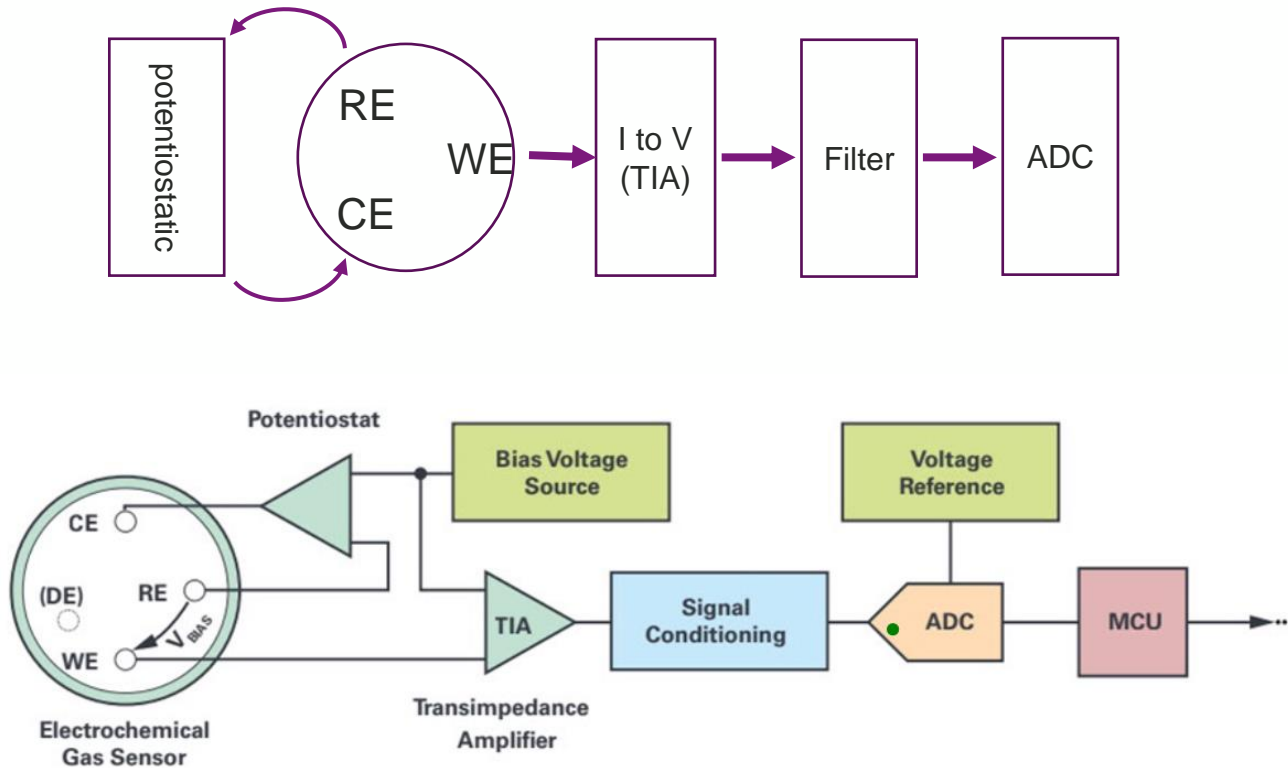


● Gas Sensor

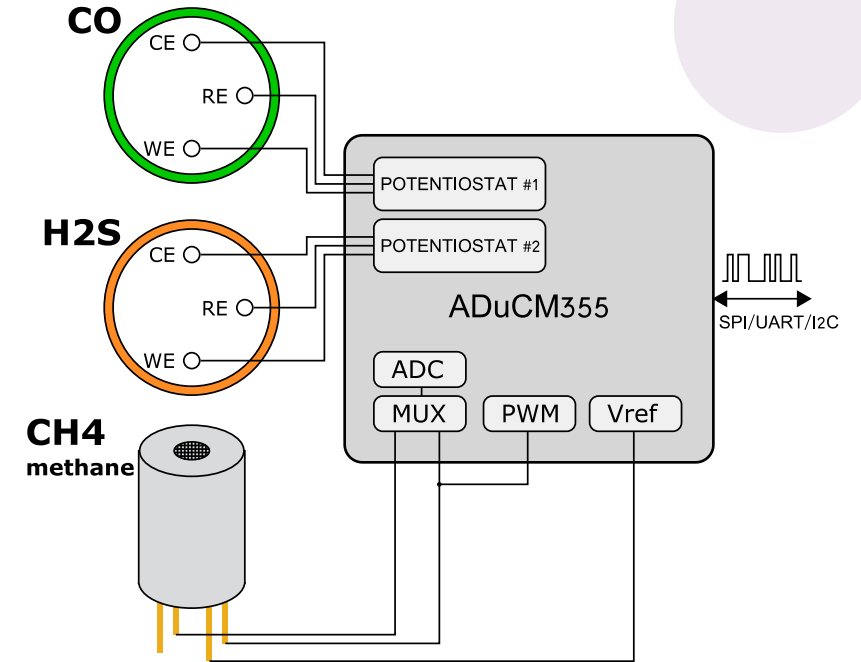


● pH Probe

Usage of Gas EC Sensors

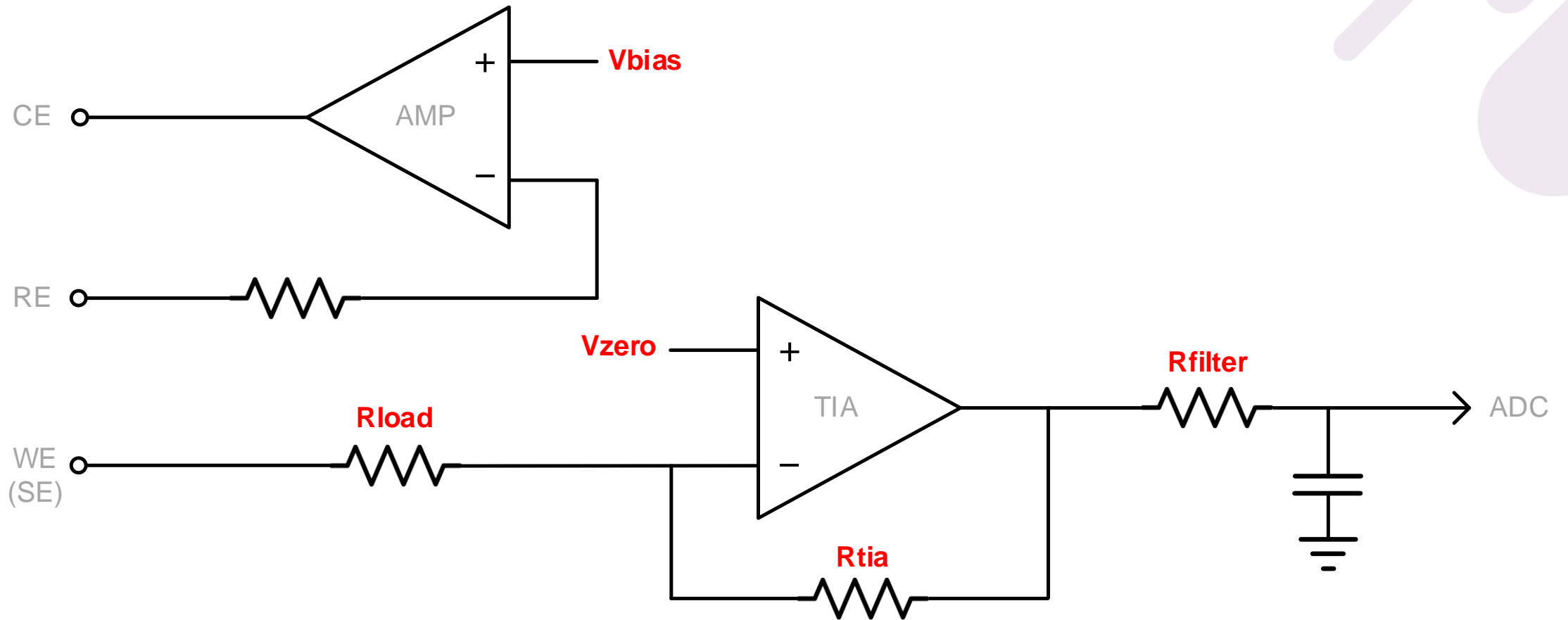


- Discrete device Solution



- Single Chip Solution

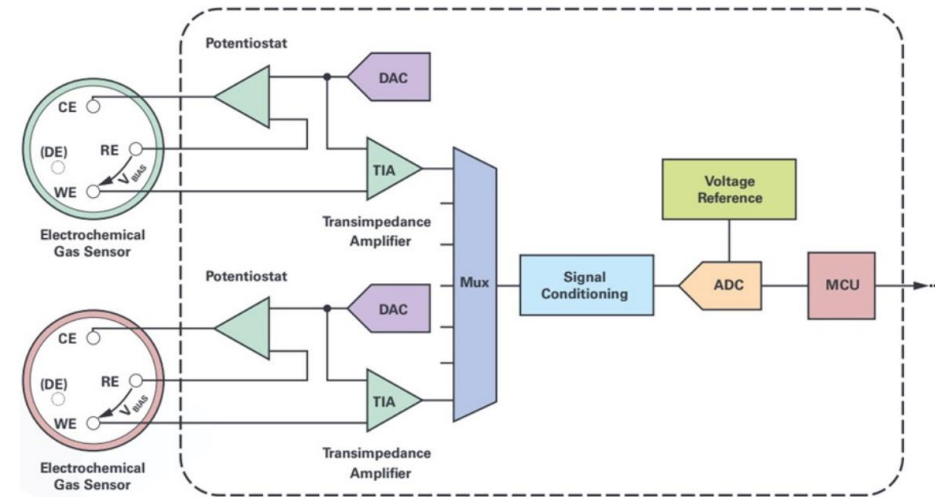
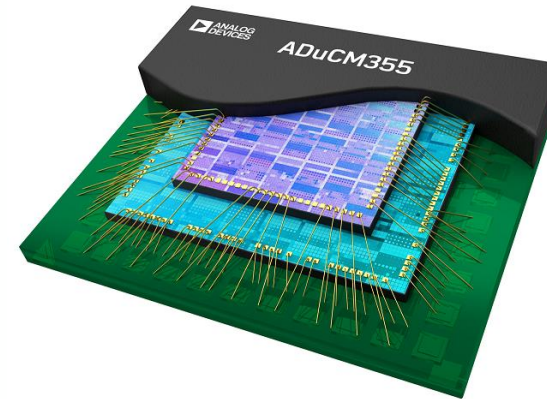
ADuCM355 Intelligent Sensor Platform



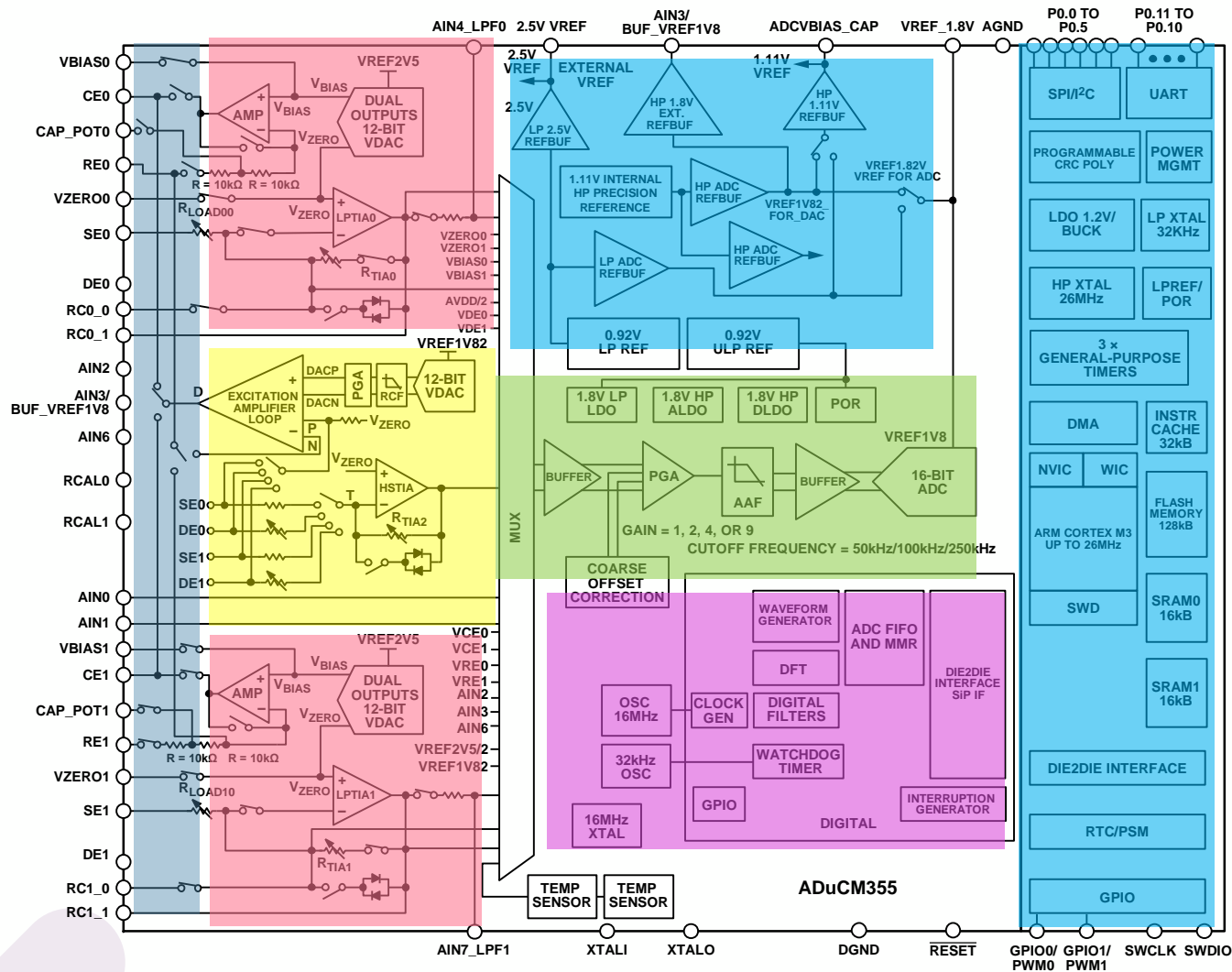
- **Software Configured !**

ADuCM355 Intelligent Sensor Platform

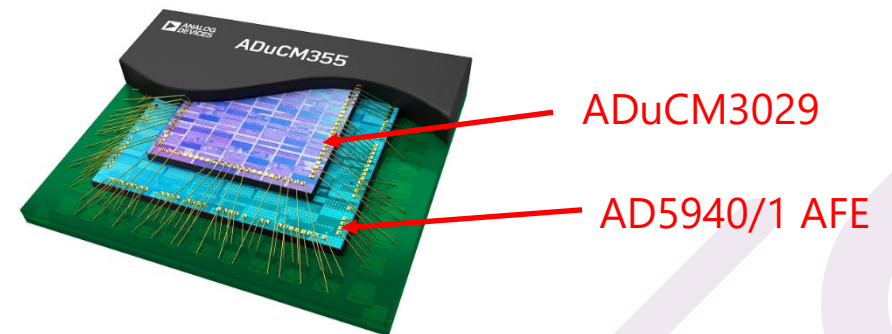
- **ULP Cortex Processor:**
 - Ultra Low Power Sensor-Hub Core
 - 26MHz Cortex-M3 ADuCM3029
 - 128kByte Flash / 64kByte SRAM
- **Electrochemical & Impedance AFE:**
 - Current, Voltage & Impedance Measurement Channels.
 - 2 X Ultra-Low Noise Always On Potentiostat Loops
 - Up to 200kHz Precision Impedance Spectroscopy Loop
 - Switch Matrix / Flexible 16-Bit Receive Channel



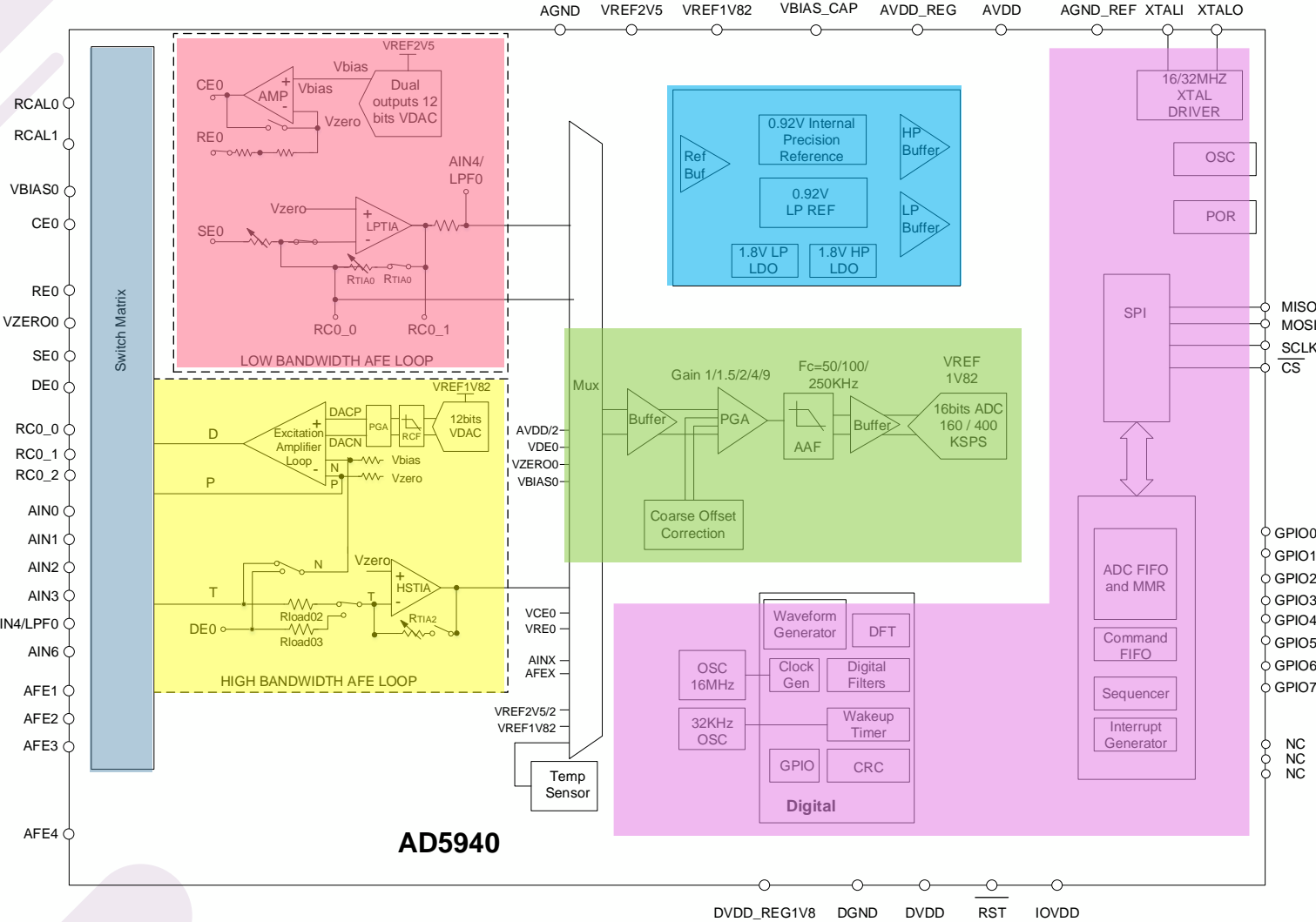
ADuCM355 Block Diagram



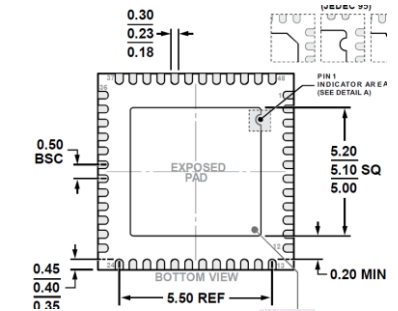
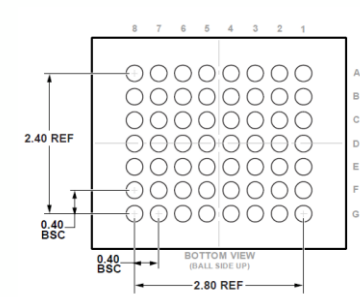
- Switch Matrix
- 2 Low power channels
- 1 High bandwidth loop
- Precision ADC
- References
- Digital blocks
- Cortem-M3 Microcontroller



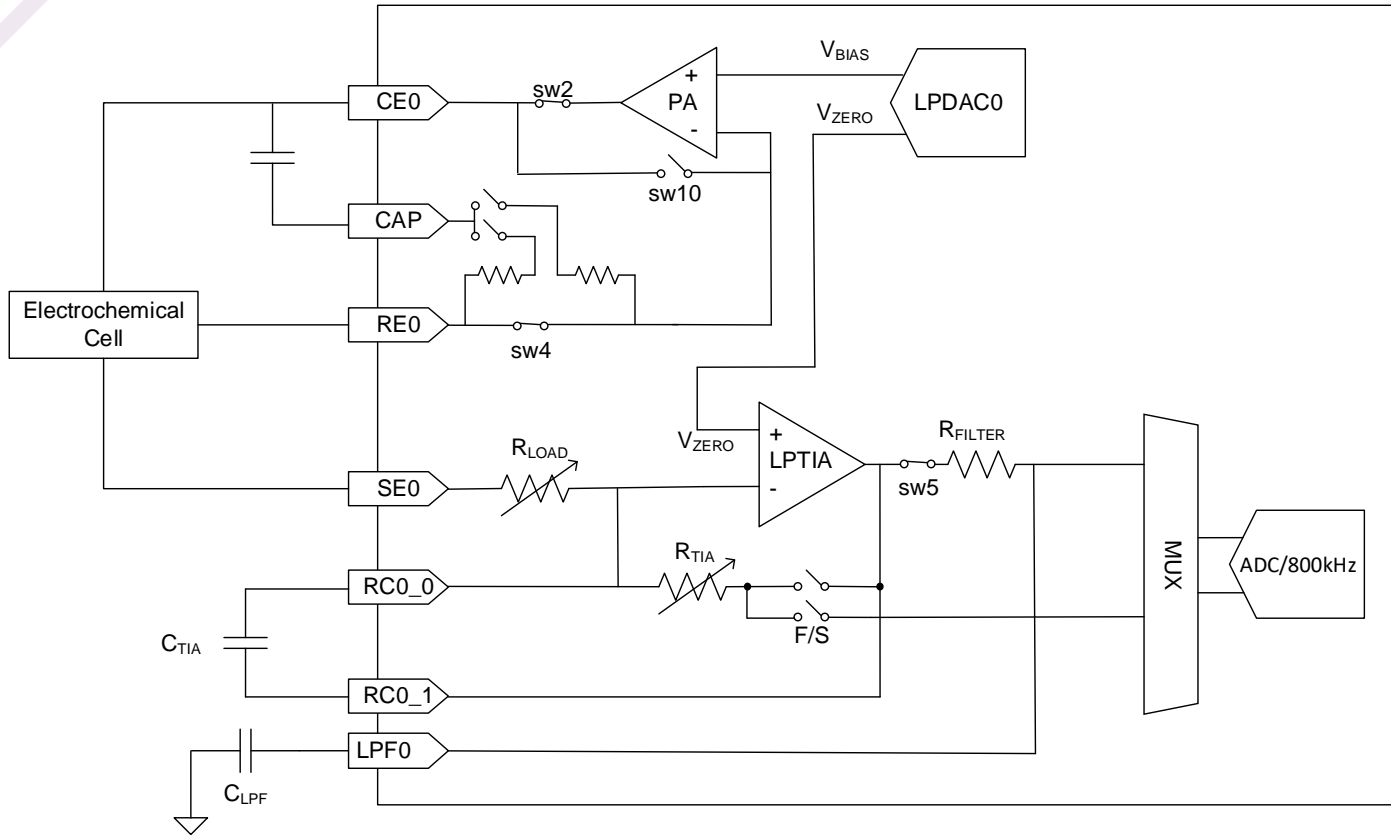
AD594x Block Diagram



- Switch Matrix
- Low Power Block
- High Bandwidth Block
- Precision SAR ADC
- Internal Voltage References
- Digital Blocks

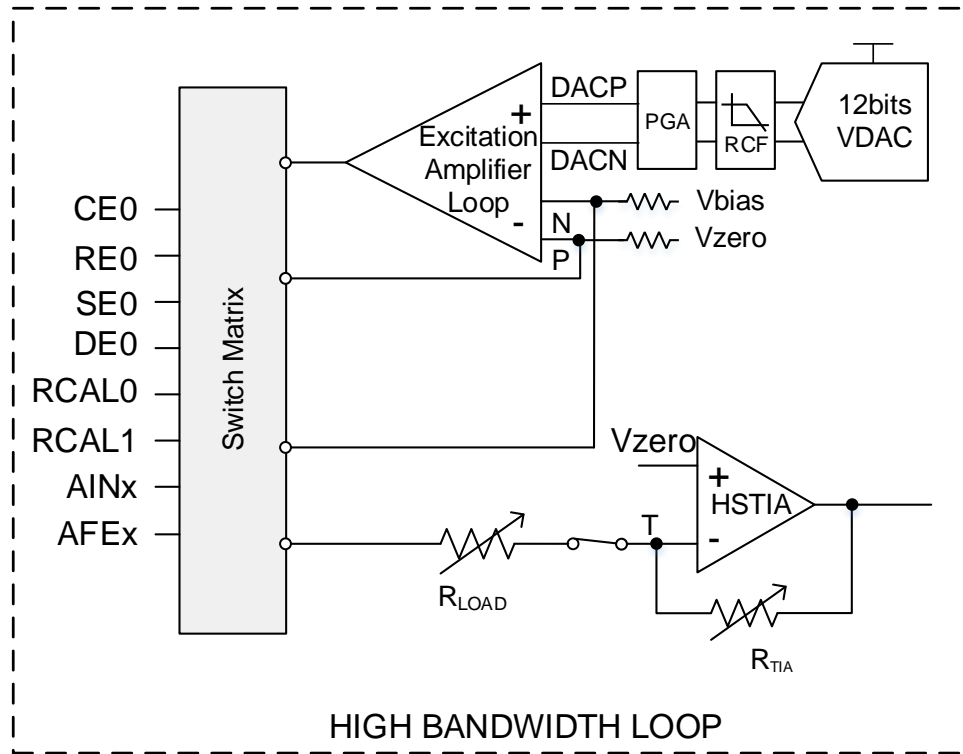


Low Power Potentiostat Block



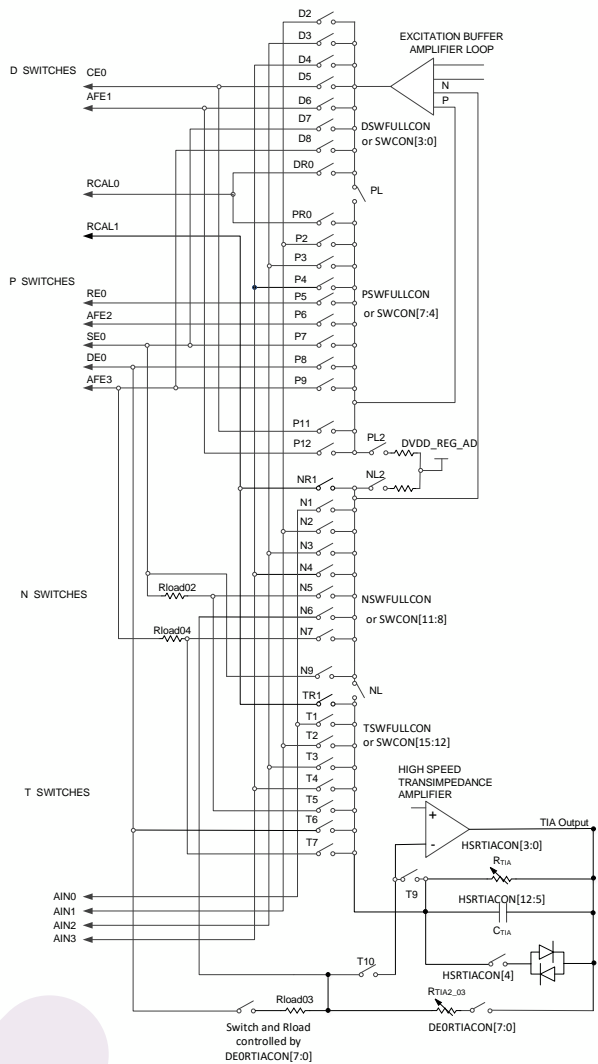
- **Ultra-low Bias currents for both amplifiers**
- **PA = 20pA**
- **LPTIA = 50pA**
- **Configurable load and gain resistor on LPTIA - 200 – 512k**
- **These can be calibrated**
- **DAC Update rate of 2kHz**
- **Radiated immunity**

High Bandwidth Impedance Measurement Block



- **Designed for high bandwidth signals up to 200kHz**
- **Programmable gain resistor – 1k -160k – can be calibrated**
- **Programmable load resistor – can be calibrated**
- **Switch matrix adds flexibility and allows connection of various inputs.**

Programmable Switch Matrix

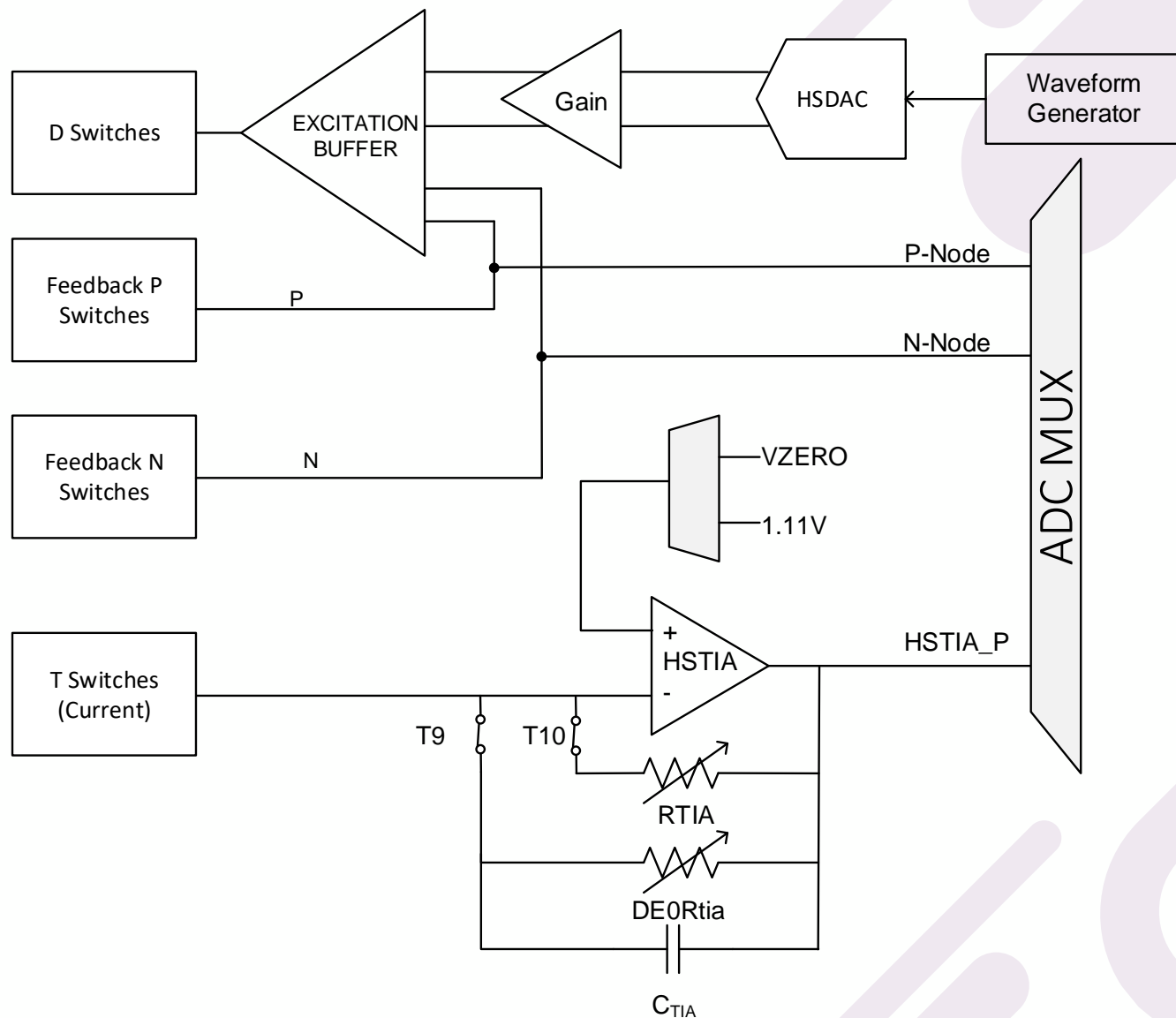


To CE0, RCAL0, AFE1, AFE3, SE0 AIN0-AIN3

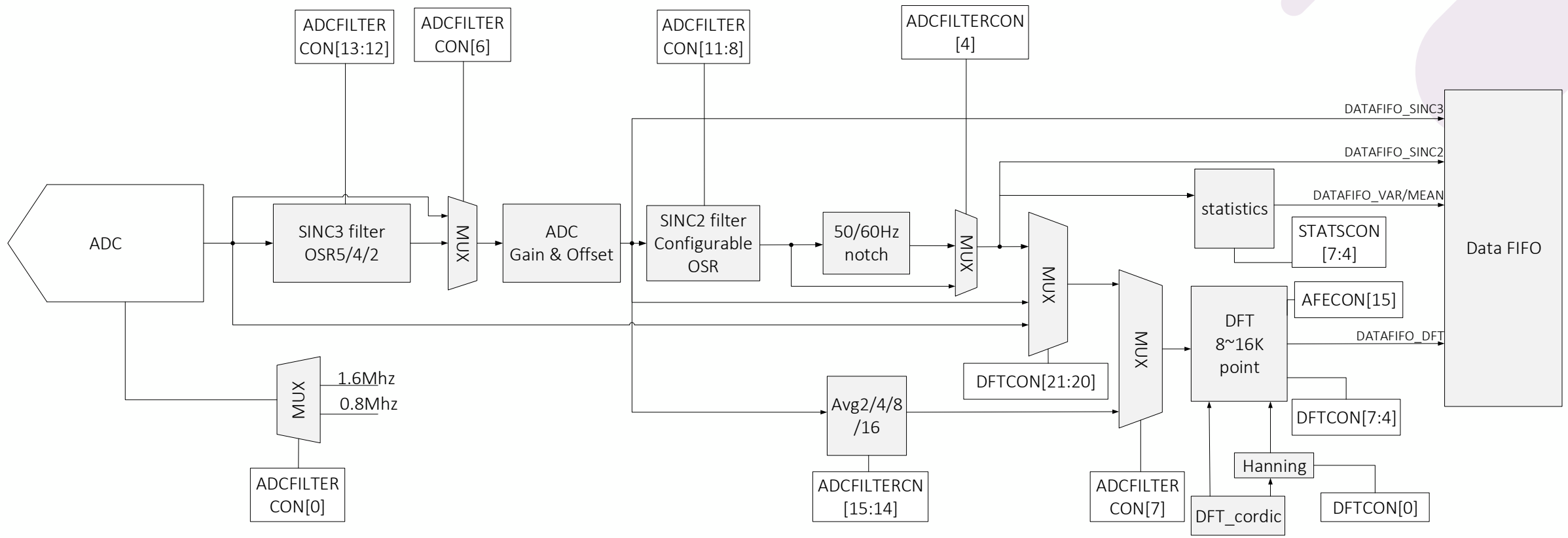
From RCAL0, CE0, SE0, DE0, RE0, AFE1, AFE2, AFE3, AIN0-AIN3

From RCAL1, SE0, AFE3, AIN0-AIN3

From RCAL1, AIN0-AIN3, SE0Load, DE0, AFE3Load, DE0Load



16-Bit SAR ADC

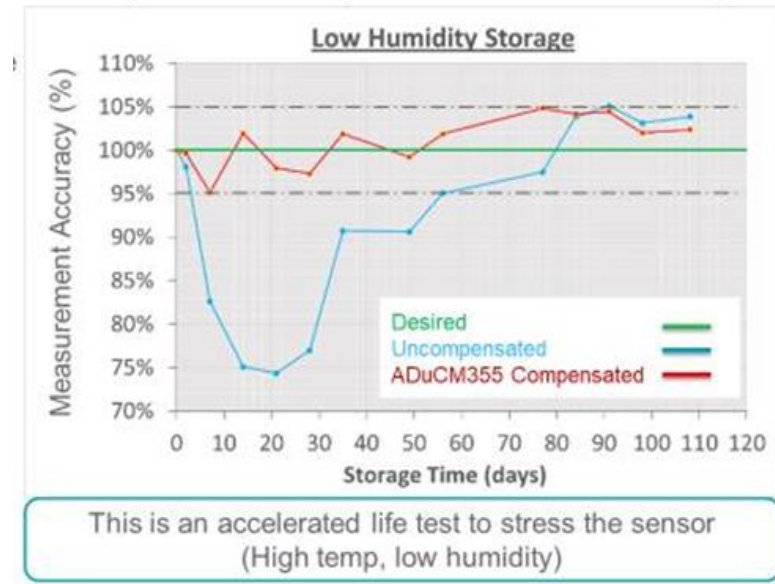
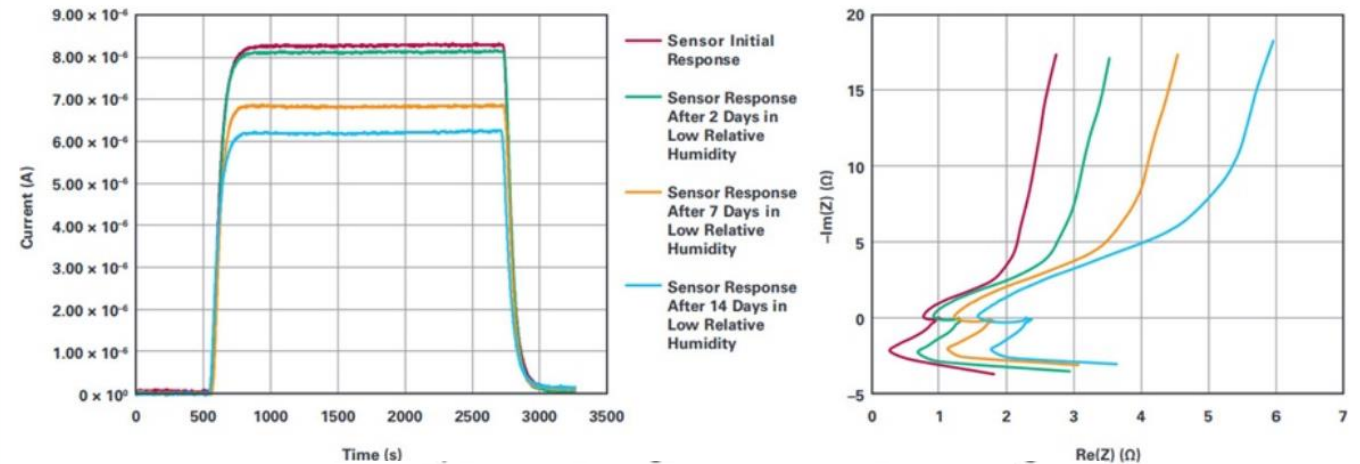


Life forecast of EC Sensor

```

Sensor0 EIS result:
Frequency , MAG , PHASE
100, 229.4785, -0.3502
1000, 12.7629, -7.6206
5000, 9.7078, -13.6187
10000, 8.6085, -9.6210
20000, 8.3971, -4.5410
30000, 8.3732, -0.1754
40000, 8.3011, -1.8179
50000, 8.1075, -7.8443
60000, 8.1827, -14.6273
70000, 8.4572, -23.0025
90000, 19.7686, 64.6958
160000, 29.4020, 96.8658
200000, 36.4791, 110.8103
  
```

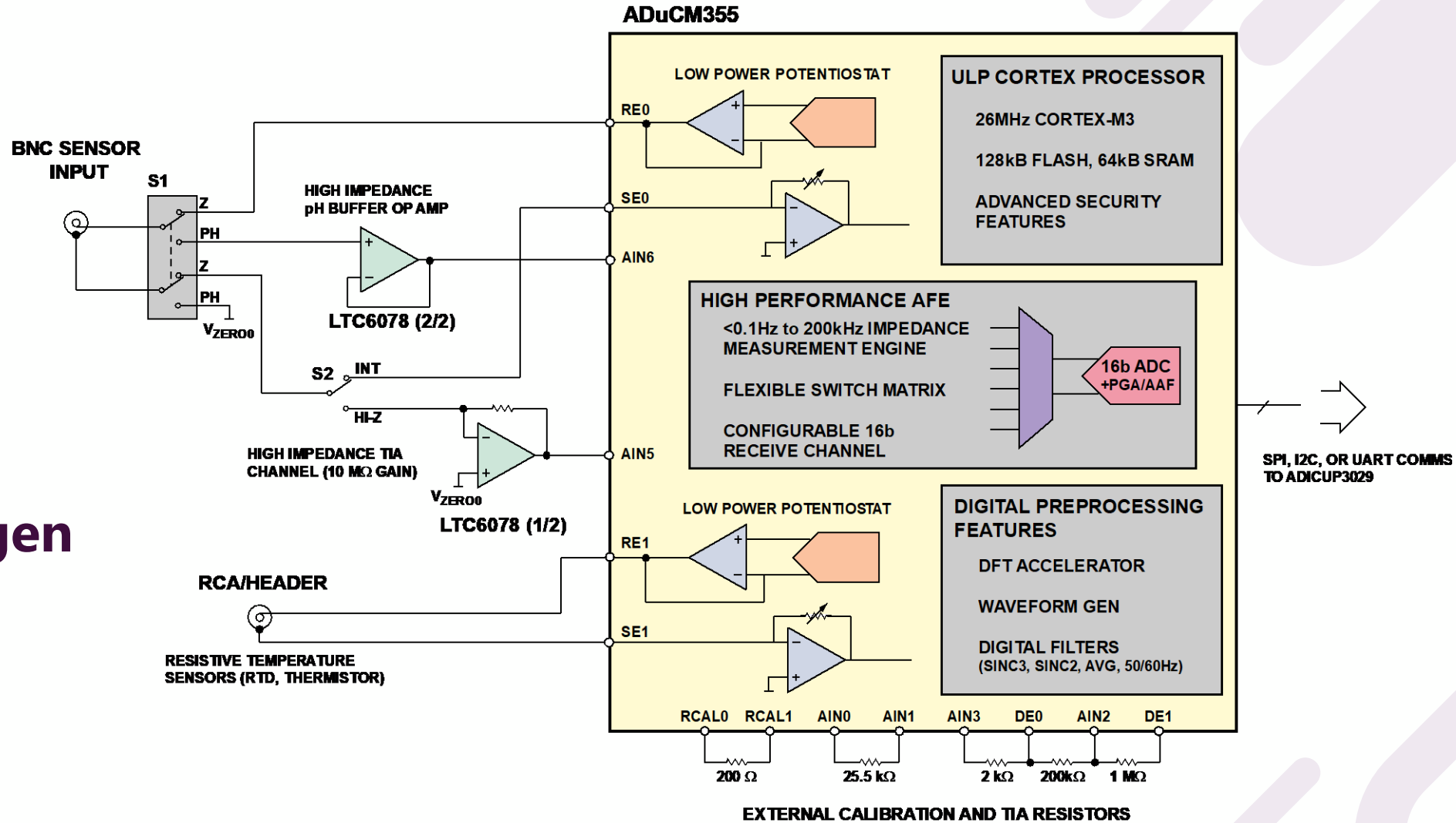
- EIS Results



- Compensation with EIS

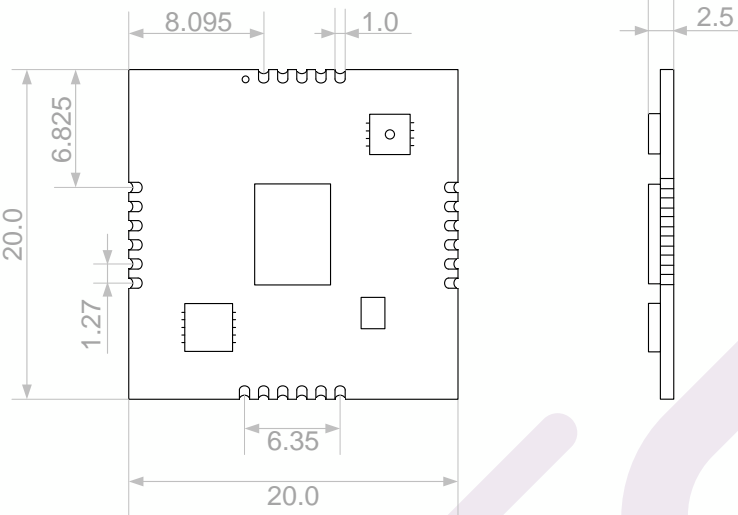
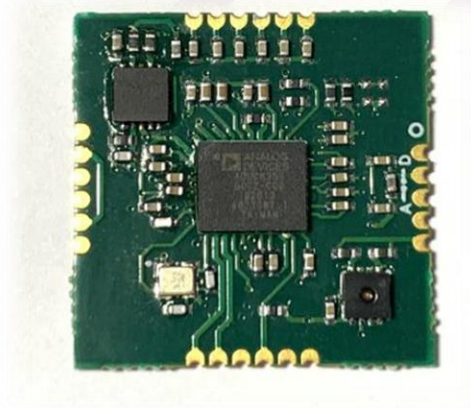
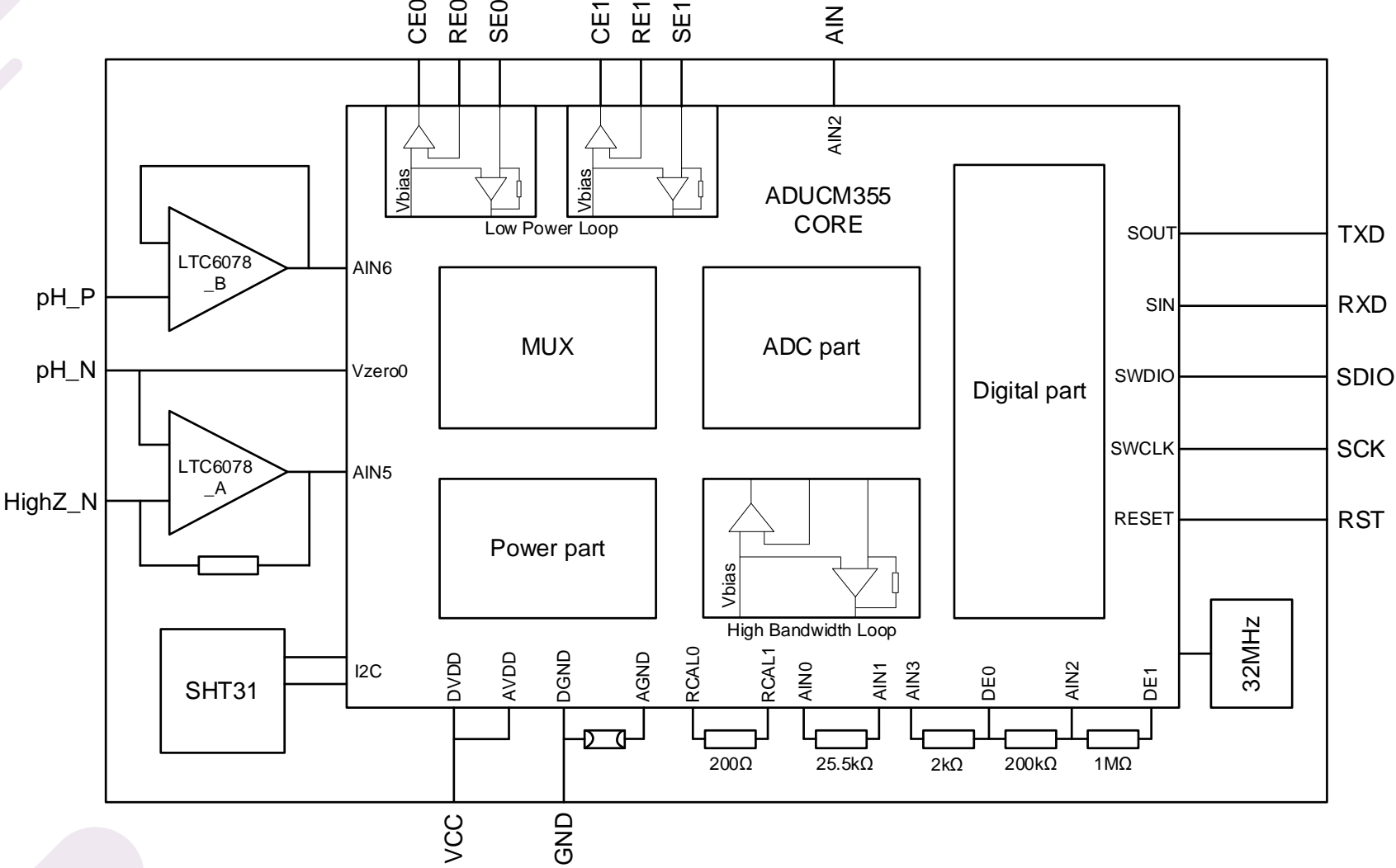
Water Quality Measurement

- pH / ORP
- Conductivity
- Temperature
- Dissolved Oxygen



- Compensation with EIS

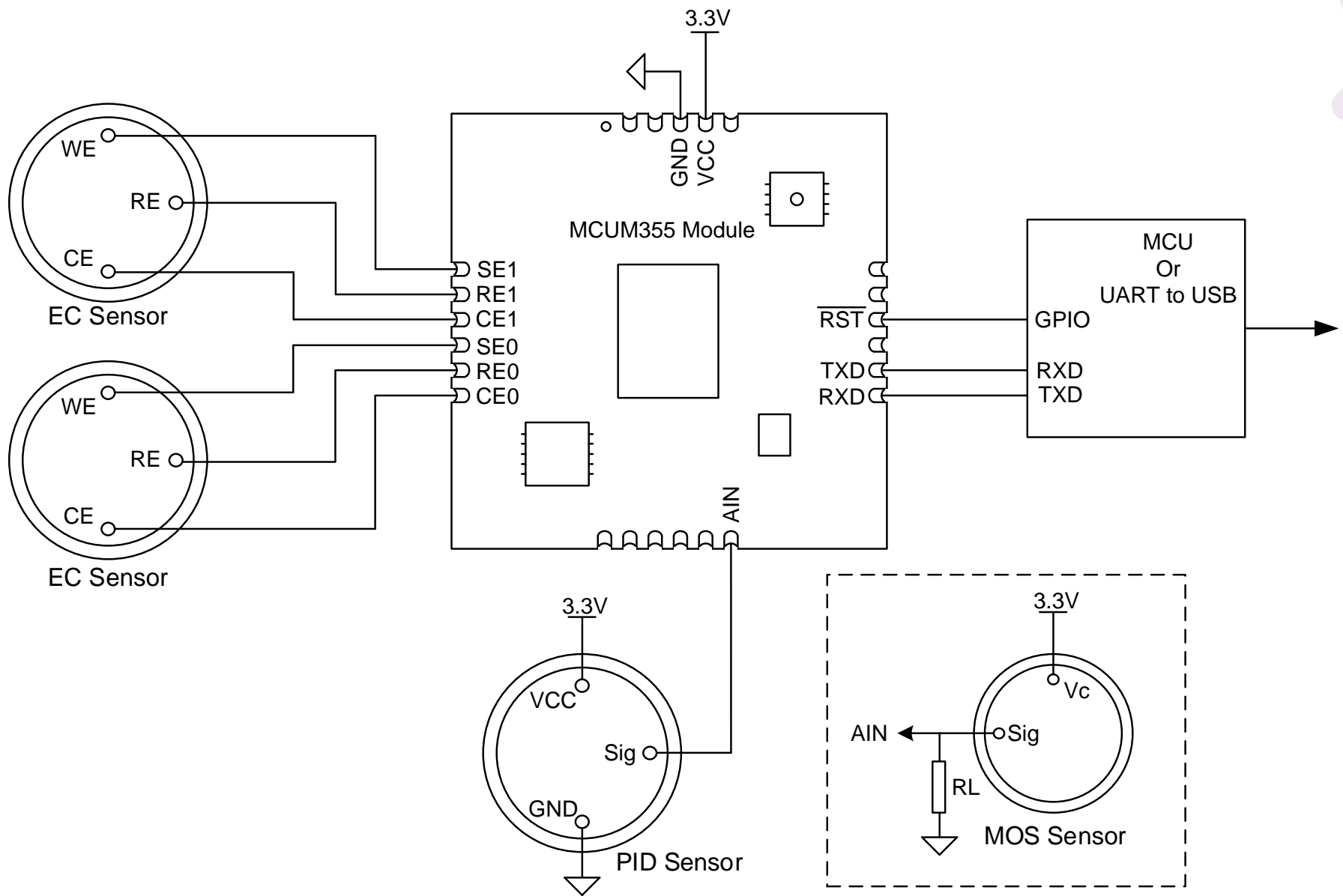
Quick Module — MCUM355



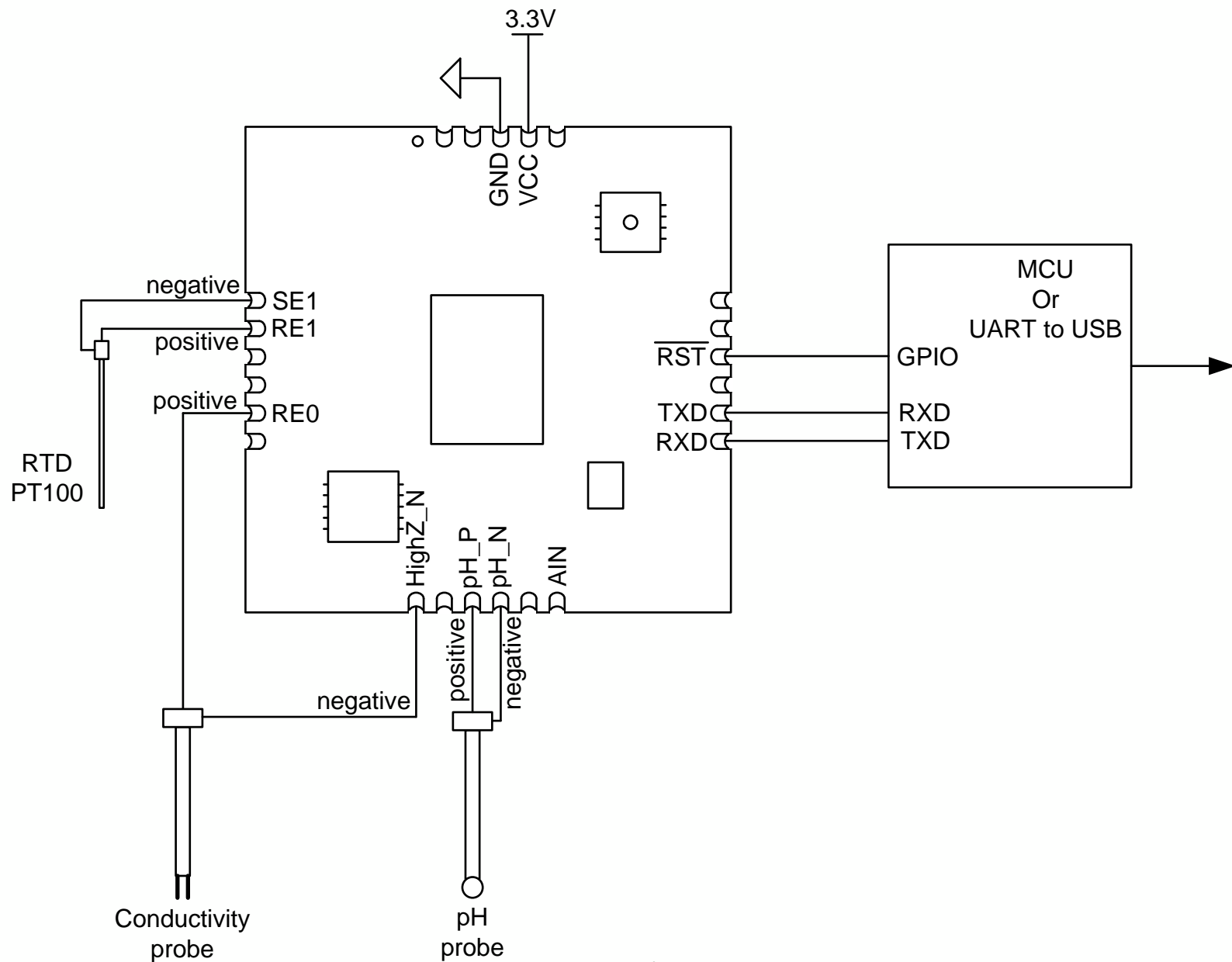
Quick Module — MCUM355

基本参数		硬件资源	
模块尺寸	20mm*20mm*2.5mm	主控芯片	ADUCM355 (ADI)
供电接口	3.3V@30mA (峰值)	高阻运放	LTC6078 (ADI)
通信接口	3.3V TTL 串口 / 波特率 9600	温湿度传感	SHT31 (Sensirion)
功能接口	电化学接口*2 / 阻抗测量*2 / pH电极*1 / 电导率*1 / 模拟电压*1	阻抗谱范围	200Hz~200kHz / 默认 13 档步进
其他接口	SWD 调试接口	电导率范围	200kΩ~100MΩ (对应阻值)

Gas Detection — Based on MCUM355



Water Quality — Based on MCUM355



UART Command — Based on MCUM355

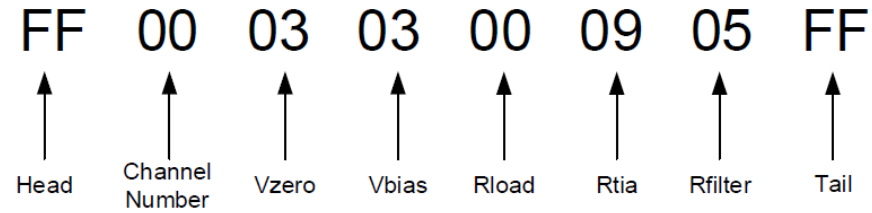


Figure 4: Definition of every byte in Config update command

After sending 'Config update command'. MCUM355 will stop Sensor measurements process and feedback new configuration information as shown in Fig.5. New parameters will be saved in Flash. You should RESET(or power-off and power-on again) the MCUM355.

```
Sensor Channel 0 Config Updated!
---Configuration Information---
Sensor Channel 0:
Vzero-> 600 mV
Vbias-> 500 mV
Rload-> 50 Ohm
Rtia -> 3 kOhm
Rflt -> 200 kOhm

Sensor Channel 1:
Vzero-> 500 mV
Vbias-> 500 mV
Rload-> 50 Ohm
Rtia -> 3 kOhm
Rflt -> 200 kOhm

Please RESET the System!
```



MCUM355
User Guide

Rload		
Parameter Value		Set Number
(Min) 10 Ohm		0x00
30 Ohm		0x01
50 Ohm		0x02
100 Ohm		0x03
1600 Ohm		0x04
3100 Ohm		0x05
(Max) 3600 Ohm		0x06

Rtia		
Parameter Value		Set Number
(Min) 1 kOhm		0x00
2 kOhm		0x01
3 kOhm		0x02
6 kOhm		0x03
8 kOhm		0x04
10 kOhm		0x05
12 kOhm		0x06
20 kOhm		0x07
24 kOhm		0x08
30 kOhm		0x09
32 kOhm		0x0A
40 kOhm		0x0B
48 kOhm		0x0C
64 kOhm		0x0D
85 kOhm		0x0E
96 kOhm		0x0F
100 kOhm		0x10
120 kOhm		0x11
128 kOhm		0x12

Demo Show



MACNICA

- **Boris Wang**
- **182-2286-9125**
- **boriswang@macnica.com**