HY313X
Configurations

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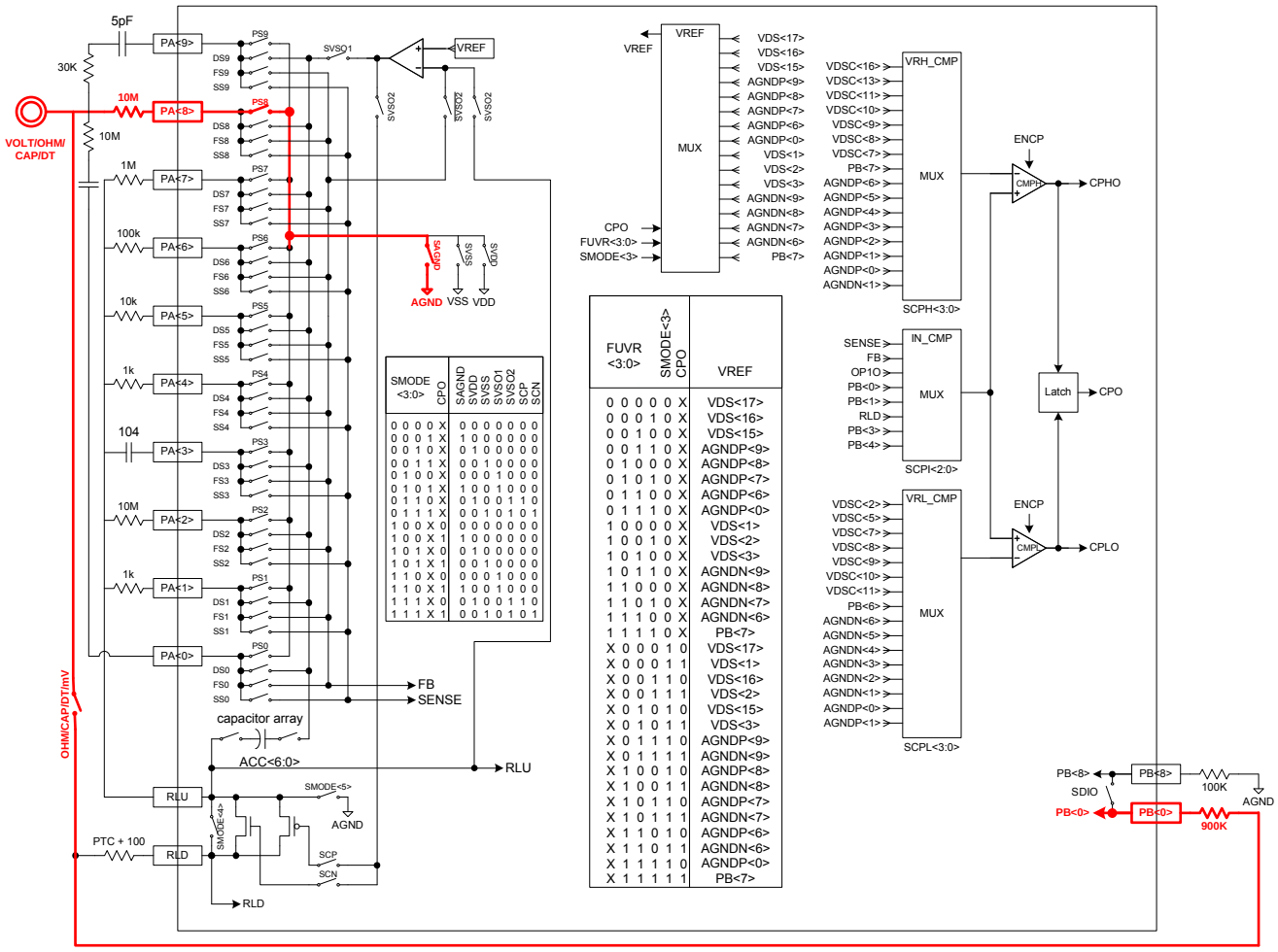
1. DCmV

Due to high ADC input impedance, it is easily to sense 50/60Hz signal of the air that leads to unstable reading value after the testing probe was connected. It is recommended to connect input10MΩ to ground to reduce input impedance of DMM mV range.

The network configuration of 50mV and 500mV is similar. When measuring 50mV, it uses built-in OPA to amplify signal for 10 times then processing it in ADC.

Main function of chopper is to reduce DC Offset. When OPA measures DC, it is advised to open ADC1 Pre-Filter.

1.1. Input Network Configuration



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1 0 1 0	0	X	VDS<3>
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1 1 0 0	0	X	AGNDN<8>
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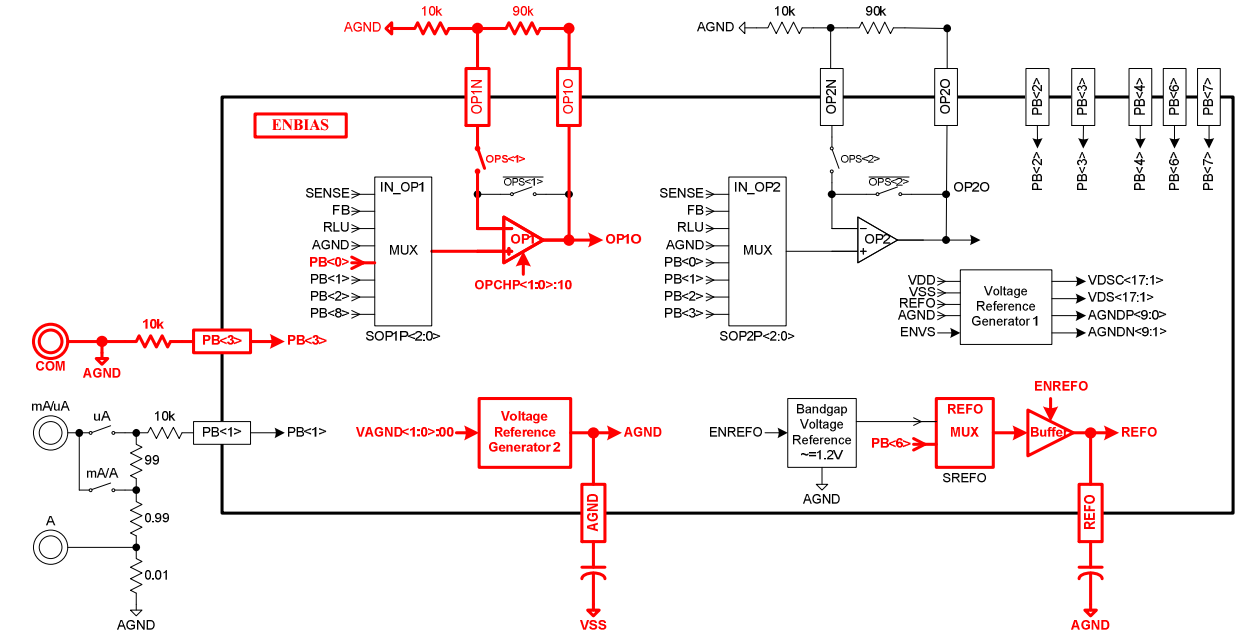
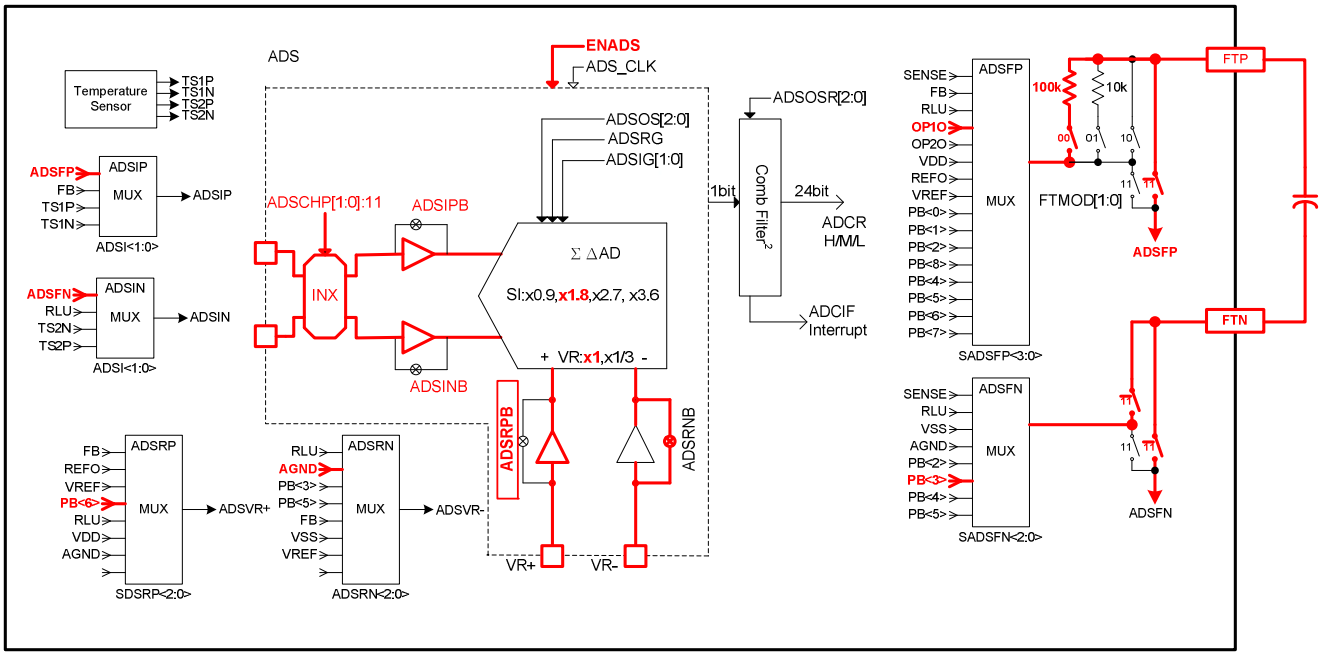
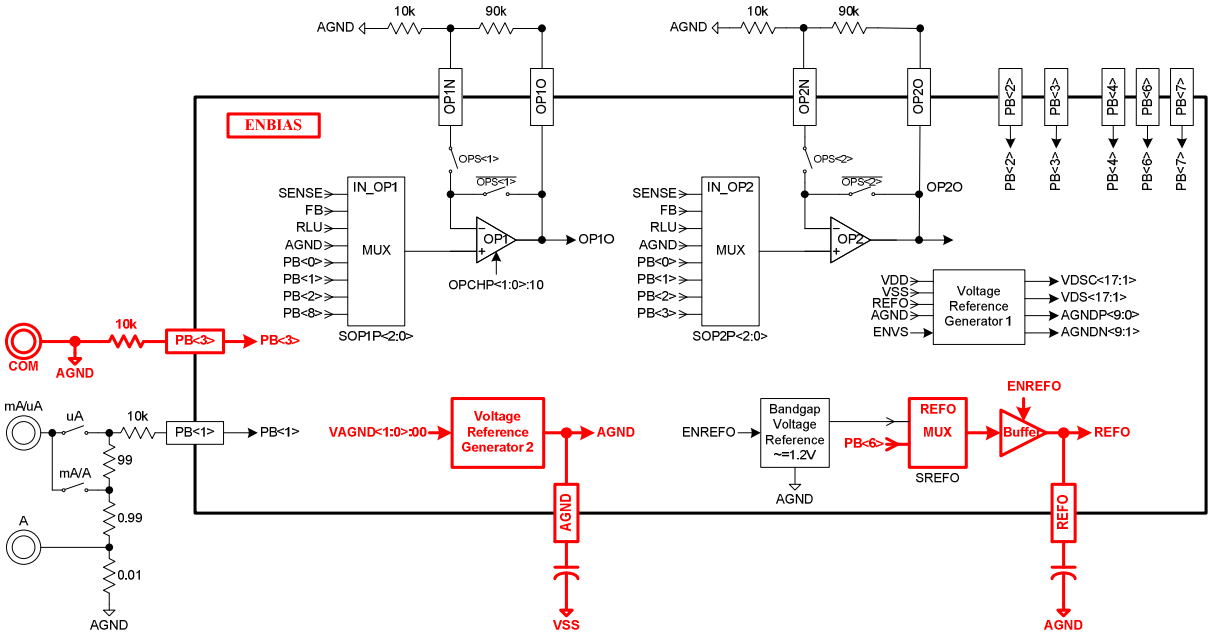
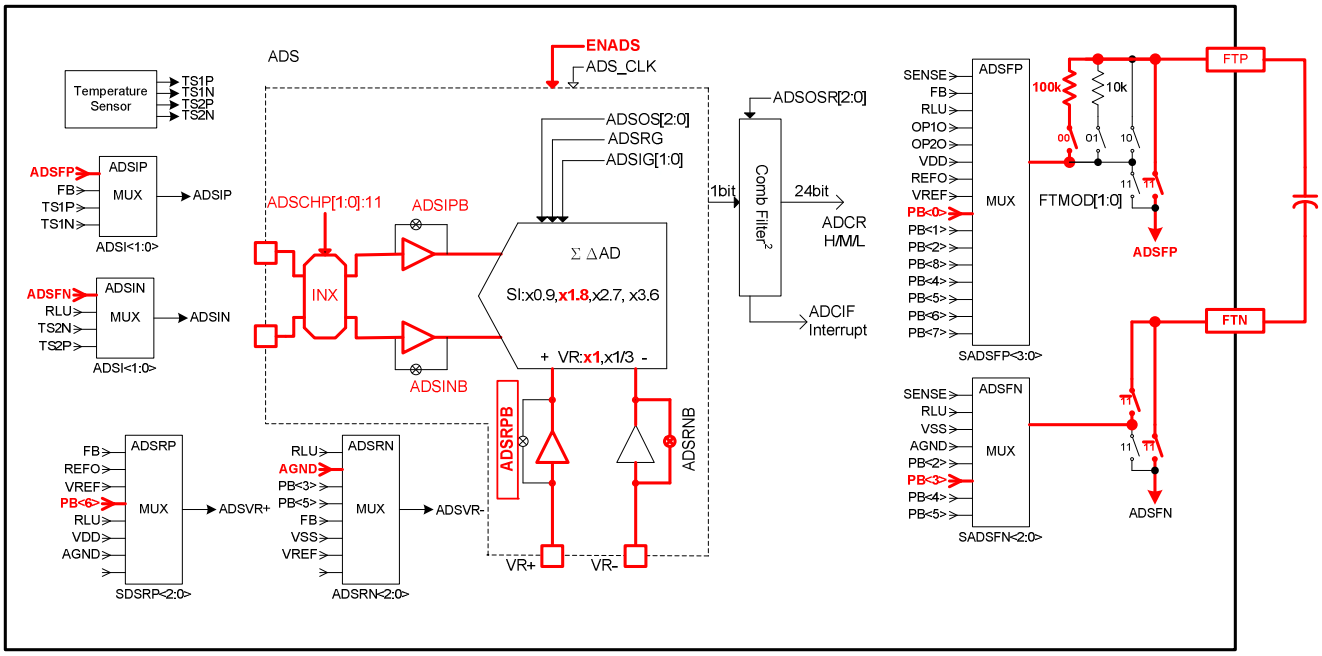
1.2. DC50mV Measurement Network Configuration





1.3. DC500mV Measurement Network Configuration



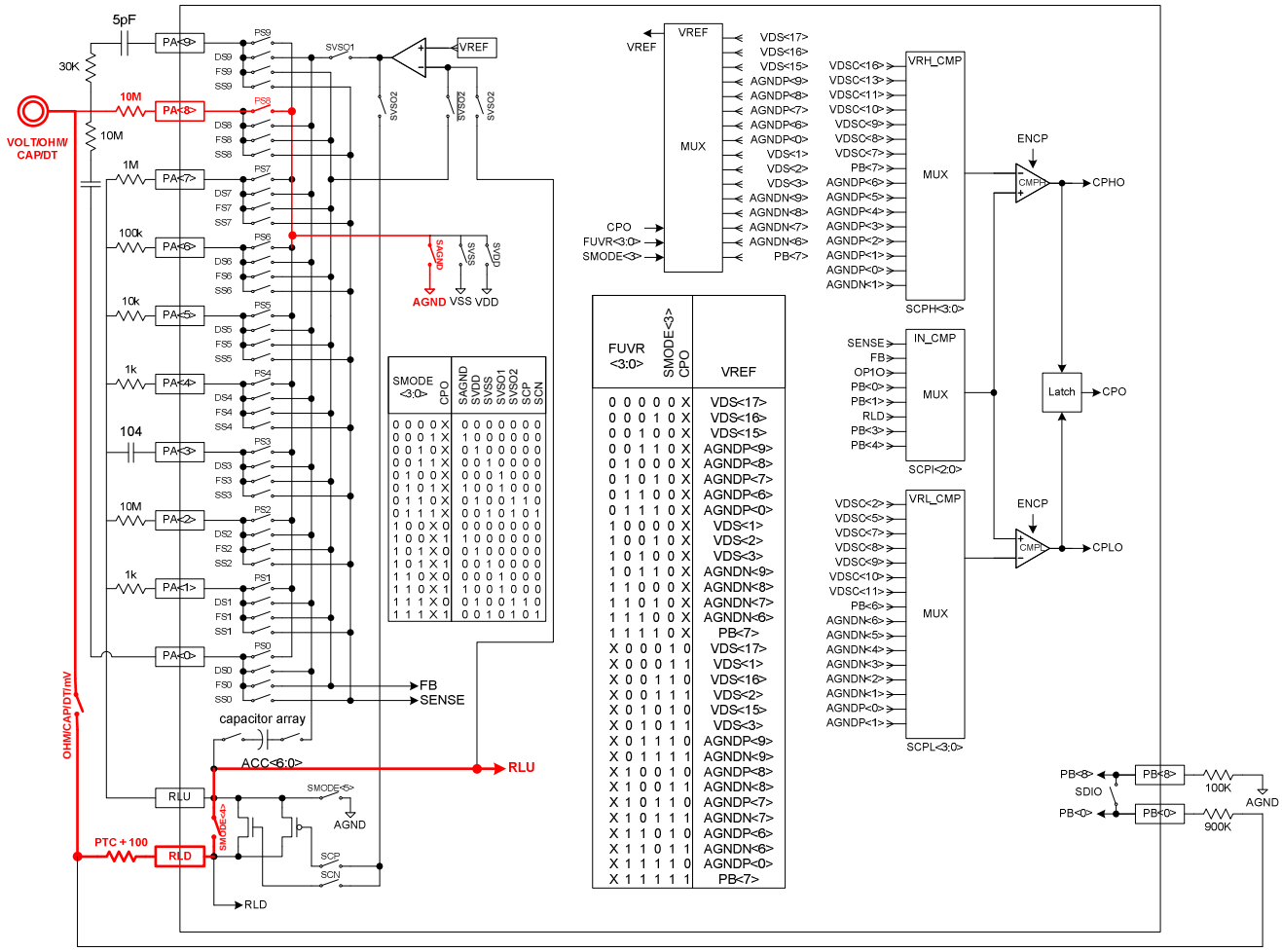


2. ACmV

Due to high ADC input impedance, it is easily to sense 50/60Hz signal of the air that leads to unstable reading value after the testing probe was connected. It is recommended to connect input10MΩ to ground to reduce input impedance of DMM mV range.

The network configuration of 50mV and 500mV is similar. When measuring 50mV, it uses built-in OPA to amplify signal for 10 times then processing it in ADC.

2.1. Input Network Configuration



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1 0 1 1	1	0	1	1	0	1	0	1
1 1 0 0	0	0	0	0	1	1	1	0
1 1 0 0	1	0	0	0	1	1	0	1
1 1 0 1	0	0	1	0	1	1	1	0
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0 1 0 0	0	X	AGNDP<8>
0 1 0 1	0	X	AGNDP<7>
0 1 1 0	0	X	AGNDP<6>
0 1 1 1	0	X	AGNDP<0>
1 0 0 0	0	X	VDS<1>
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1 0 1 0	0	X	VDS<3>
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X 0 0 1	1	0	VDS<16>
X 0 0 1	1	1	VDS<2>
X 0 1 0	1	0	VDS<15>
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X 1 1 0	1	0	AGNDP<6>
X 1 1 0	1	1	AGNDN<6>
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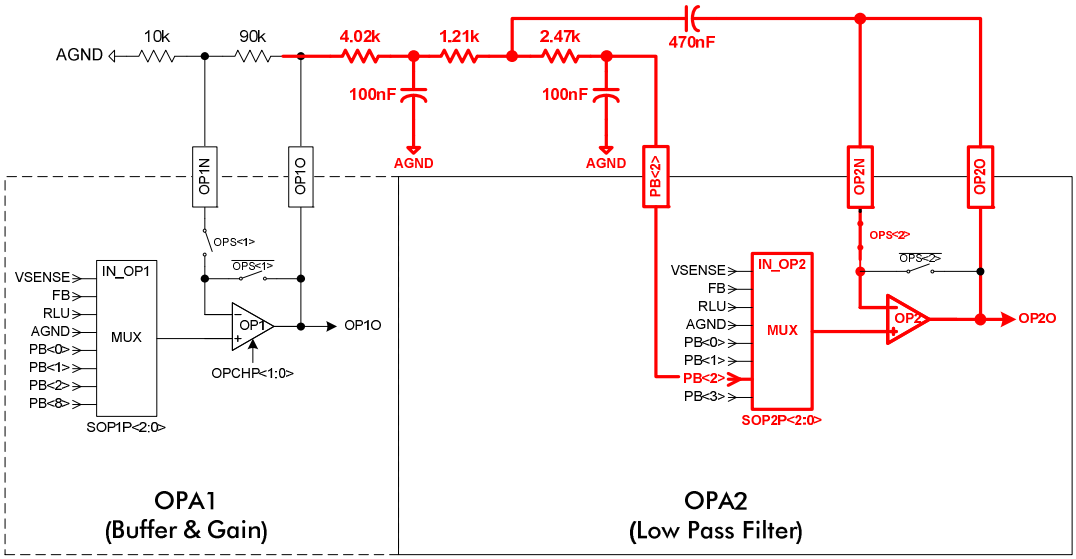
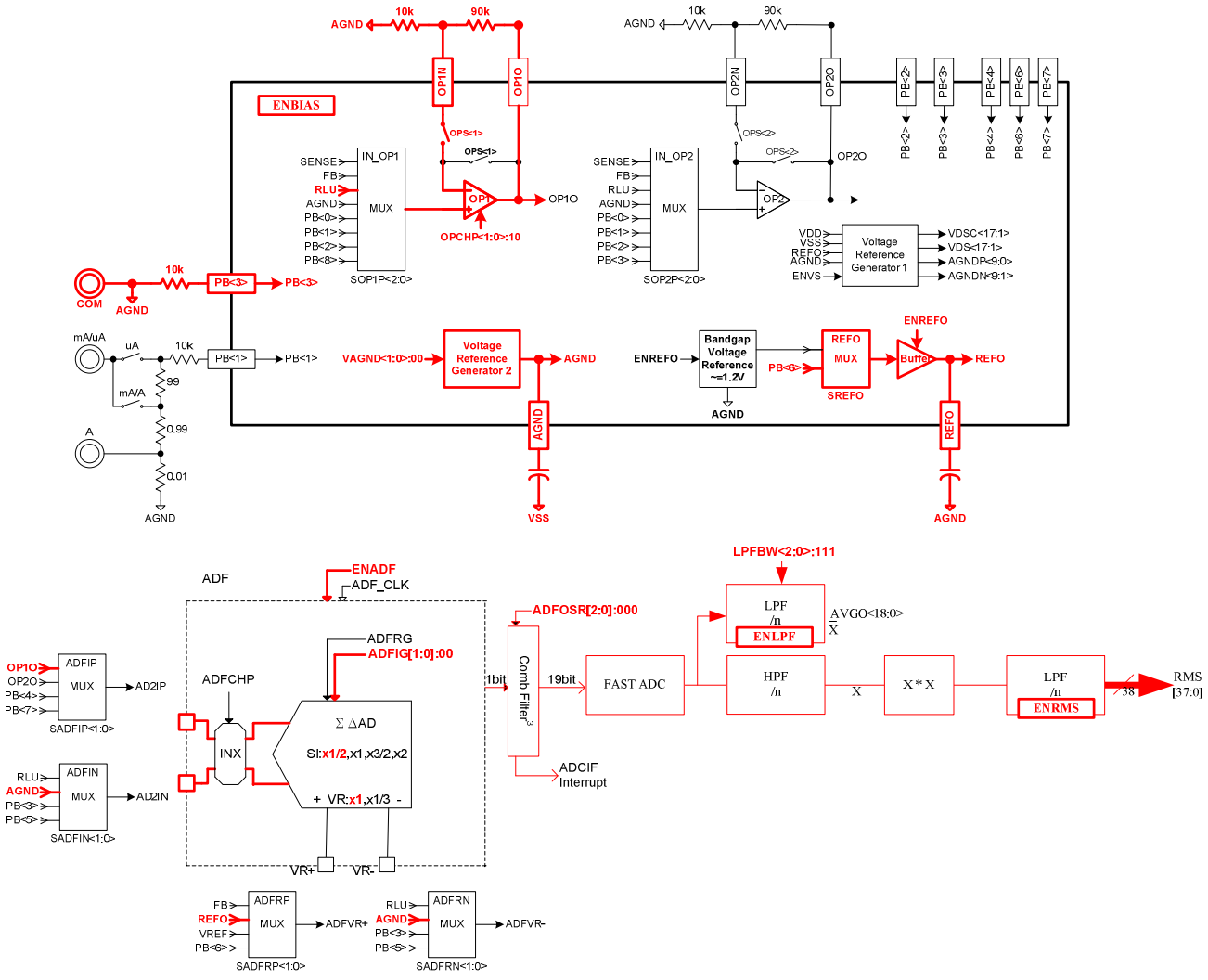
X 1 1 1	1	1	PB<7>

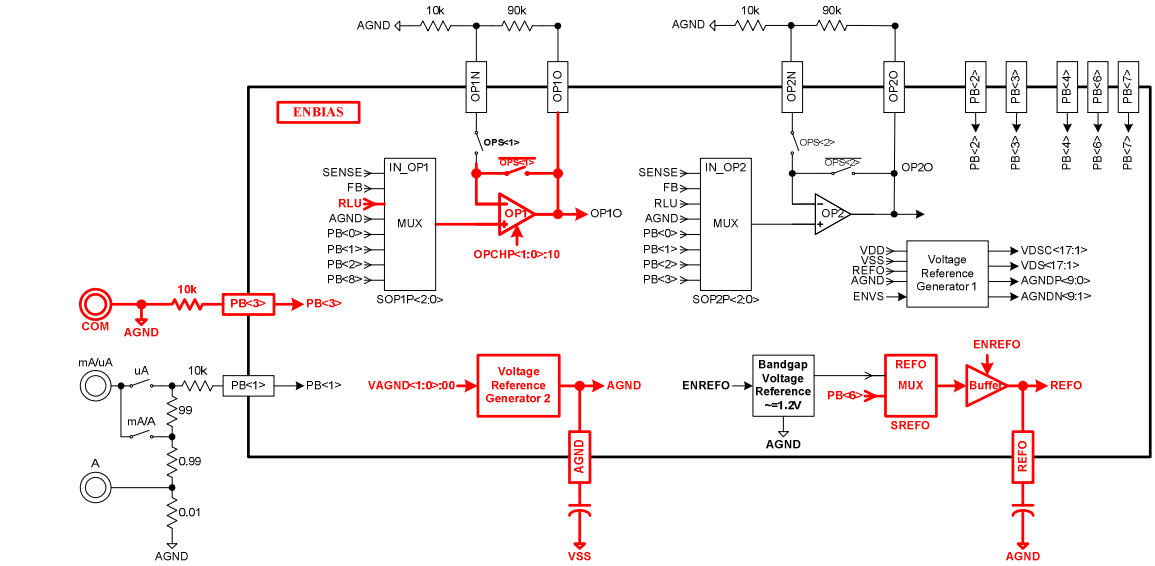
2.2. AC Low Pass Filter Measurement Network Configuration



2.3. AC50mV Measurement Network Configuration



2.4. AC500mV Measurement Network Configuration



3. DCV

30KΩ resistor and 5pF capacitor of the input end is for the use of ACV frequency compensation. When DCV is not in use, it is recommended to connect to ground and its input divider of voltage range is shown in below equation：

$$5V\_Range \Rightarrow V_{IN} \times \frac{1.111M\Omega}{10M\Omega + 1.111M\Omega} = \frac{V_{IN}}{10}$$

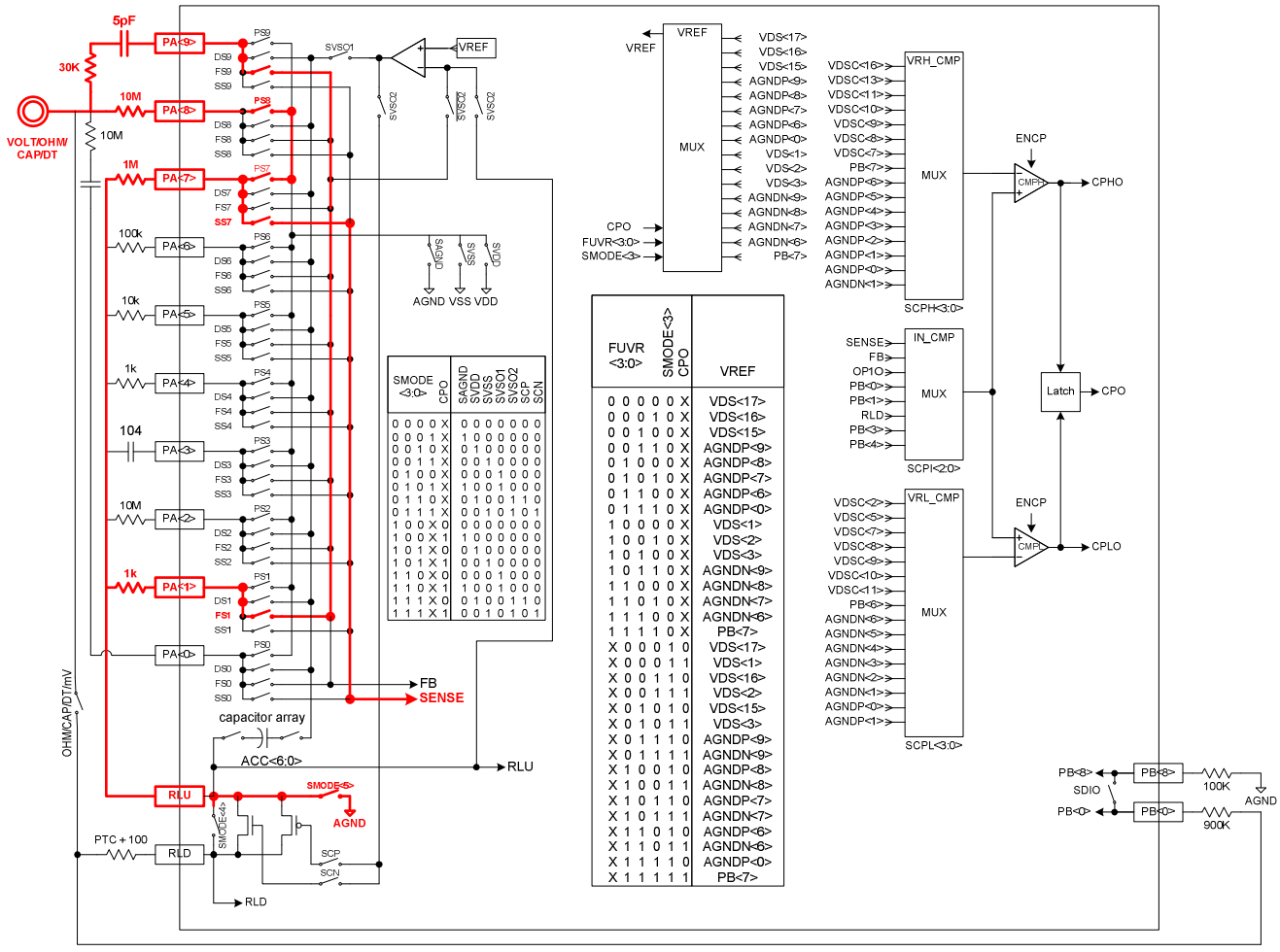
$$50V\_Range \Rightarrow V_{IN} \times \frac{101.01K\Omega}{10M\Omega + 101.01K\Omega} = \frac{V_{IN}}{100}$$

$$500V\_Range \Rightarrow V_{IN} \times \frac{10.01K\Omega}{10M\Omega + 10.01K\Omega} = \frac{V_{IN}}{1000}$$

$$1000V\_Range \Rightarrow V_{IN} \times \frac{1K\Omega}{10M\Omega + 1K\Omega} = \frac{V_{IN}}{10000}$$

HY313x has two sets OPA that can be used to amplify 10 times of signal, realizing 500mVmeasurement by collocating with 5V network configurations.

3.1. 5V Input Network Configuration



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0 0 0 1	X	1	0	0	0	0	0	0
0 0 1 0	X	0	1	0	0	0	0	0
0 0 1 1	X	0	0	1	0	0	0	0
0 1 0 0	X	0	0	0	1	0	0	0
0 1 0 1	X	1	0	0	1	0	0	0
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0 1 1 0	0	X	AGNDP<6>
0 1 1 1	0	X	AGNDP<0>
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1 1 1 0	0	X	AGNDN<6>
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X 0 0 1	1	0	VDS<16>
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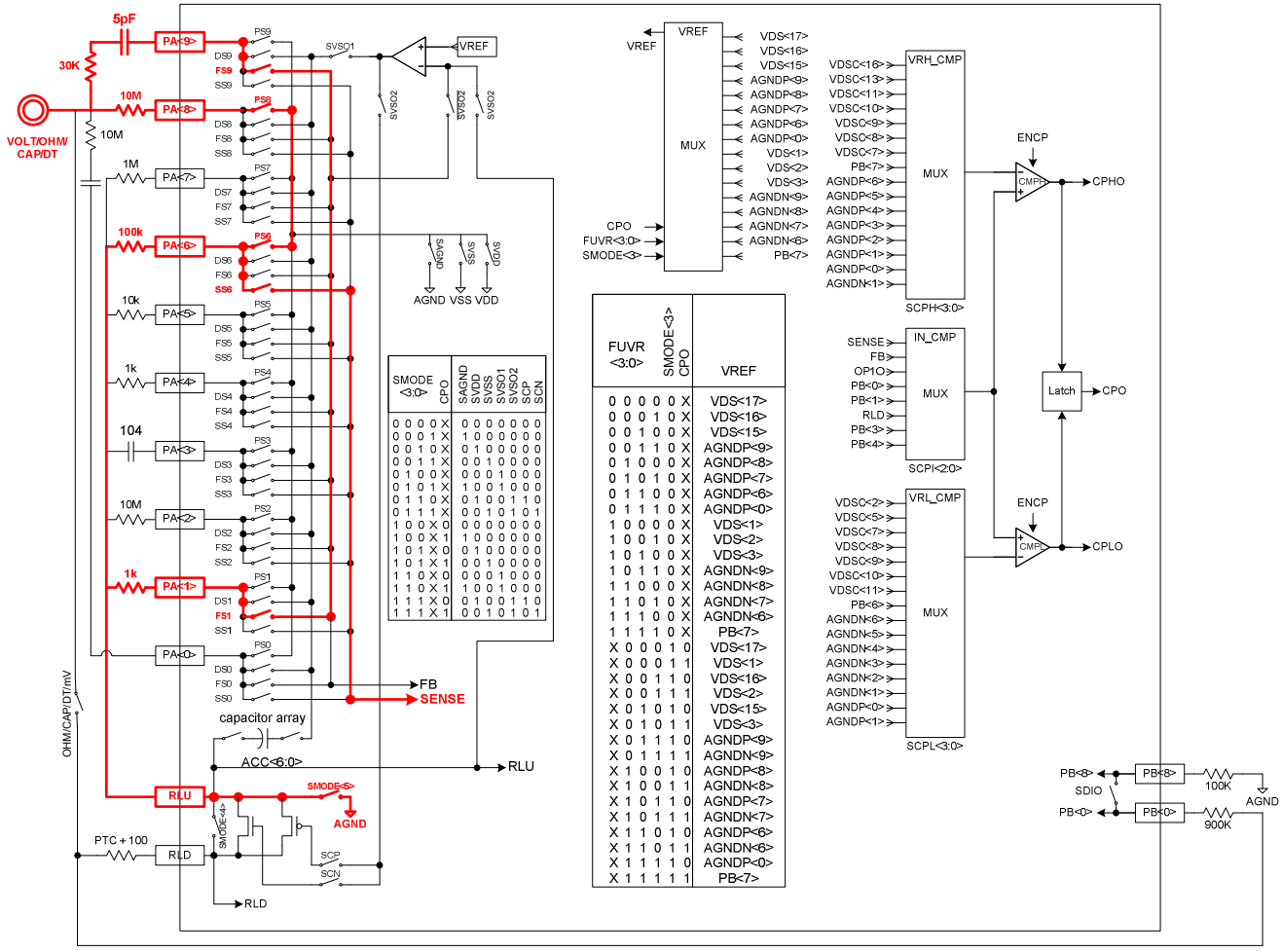
3.2. 50V Input Network Configuration



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0 0 1 0	0	X	VDS<15>
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0 1 0 0	0	X	AGNDP<8>
0 1 0 1	0	X	AGNDP<7>
0 1 1 0	0	X	AGNDP<6>
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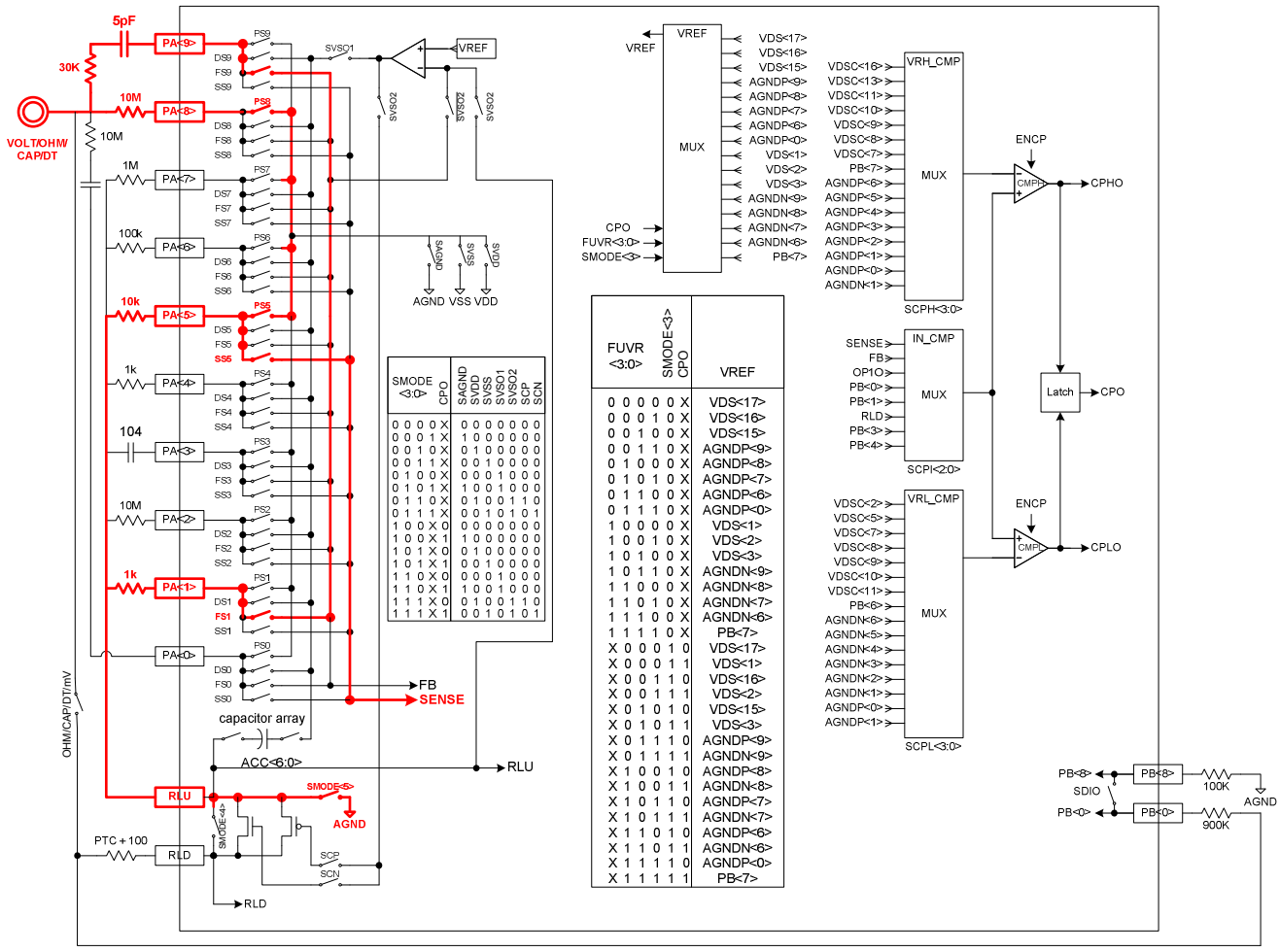
3.3. 500V Input Network Configuration



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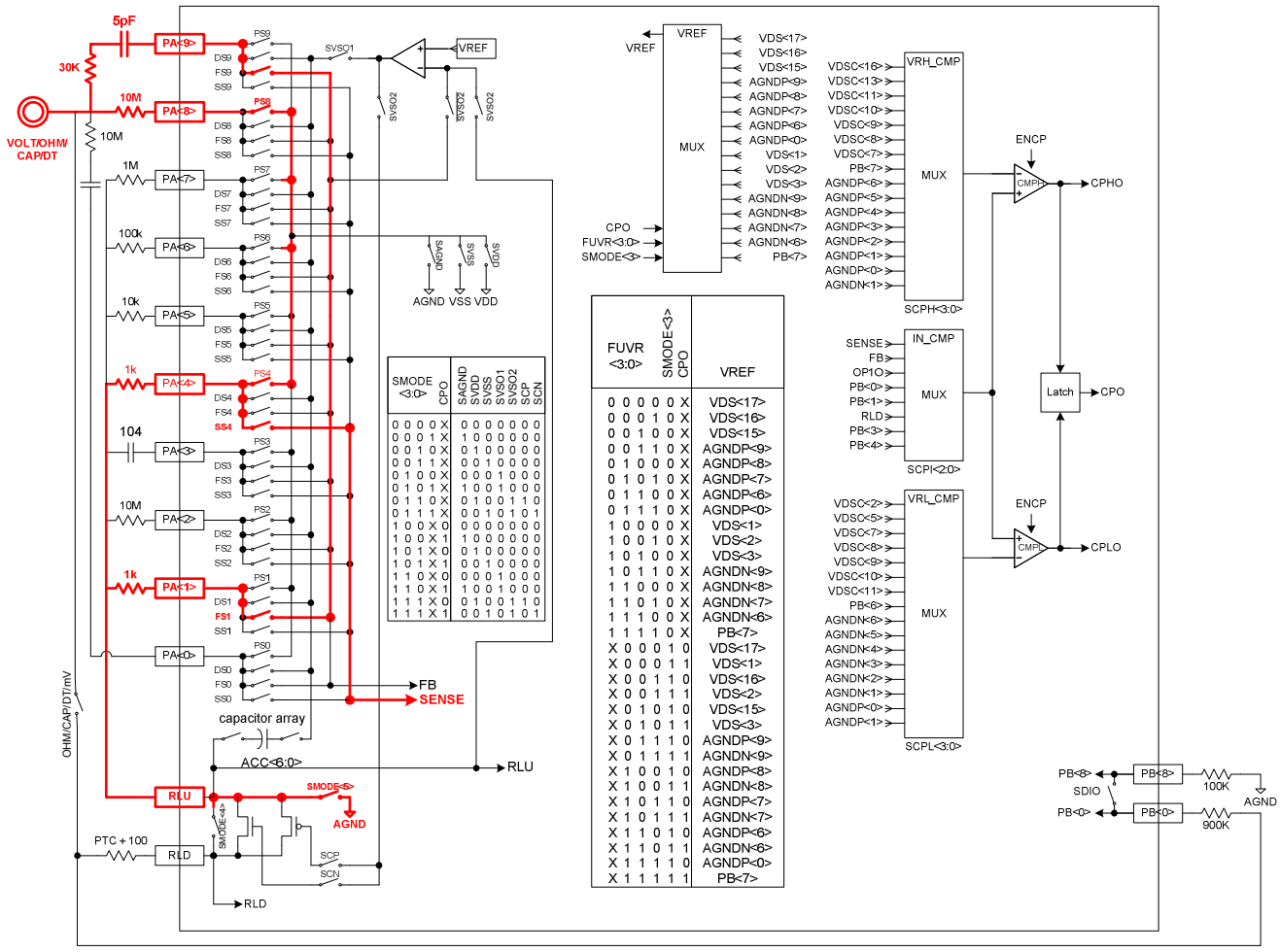
3.4. 1000V Input Network Configuration



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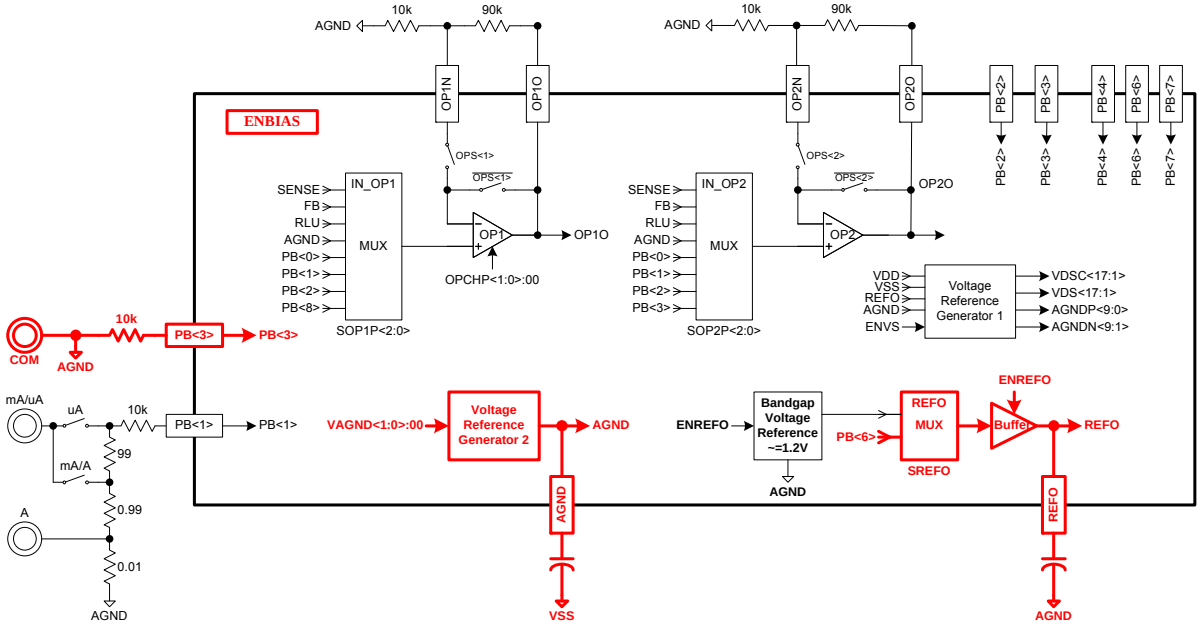
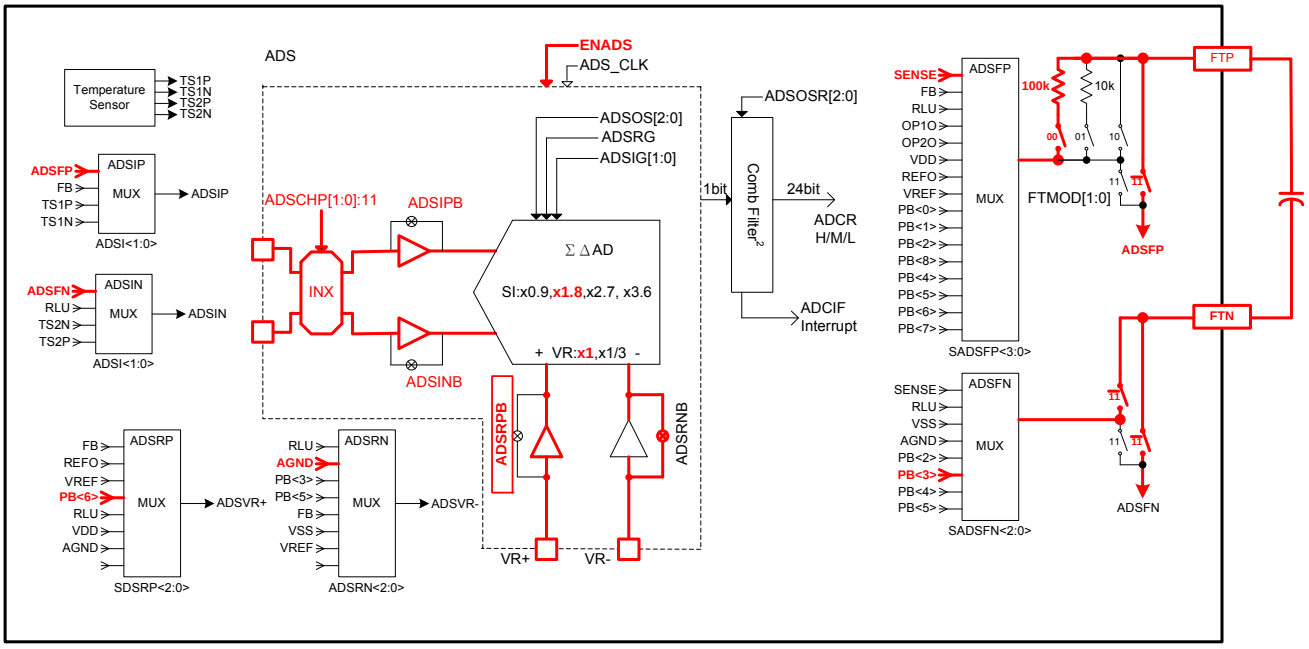
0 1 0 0	0	X	AGNDP<8>
0 1 0 1	0	X	AGNDP<7>
0 1 1 0	0	X	AGNDP<6>
0 1 1 1	0	X	AGNDP<0>
1 0 0 0	0	X	VDS<1>
1 0 0 1	0	X	VDS<2>
1 0 1 0	0	X	VDS<3>
1 0 1 1	0	X	AGNDN<9>
1 1 0 0	0	X	AGNDN<8>
1 1 0 1	0	X	AGNDN<7>
1 1 1 0	0	X	AGNDN<6>
1 1 1 1	0	X	PB<7>
X 0 0 0	1	0	VDS<17>
X 0 0 0	1	1	VDS<1>
X 0 0 1	1	0	VDS<16>
X 0 0 1	1	1	VDS<2>
X 0 1 0	1	0	VDS<15>
X 0 1 0	1	1	VDS<3>
X 0 1 1	1	0	AGNDP<9>
X 0 1 1	1	1	AGNDN<9>
X 1 0 0	1	0	AGNDP<8>
X 1 0 0	1	1	AGNDN<8>
X 1 0 1	1	0	AGNDP<7>
X 1 0 1	1	1	AGNDN<7>
X 1 1 0	1	0	AGNDP<6>
X 1 1 0	1	1	AGNDN<6>
X 1 1 1	1	0	AGNDP<0>
X 1 1 1	1	1	PB<7>

3.5. DC5V~1000V Measurement Network Configuration

Main function of Chopper is to reduce DC Offset.





4. ACV

30KΩ resistor and 5pF capacitor of the input end is to compensate ACV frequency. When a part of ranges are not in use, it is recommended to connect to ground and its input divider of voltage range is shown in below equation：

$$5V\_Range \Rightarrow V_{IN} \times \frac{1.111M\Omega}{10M\Omega + 1.111M\Omega} = \frac{V_{IN}}{10}$$

$$50V\_Range \Rightarrow V_{IN} \times \frac{101.01K\Omega}{10M\Omega + 101.01K\Omega} = \frac{V_{IN}}{100}$$

$$500V\_Range \Rightarrow V_{IN} \times \frac{10.01K\Omega}{10M\Omega + 10.01K\Omega} = \frac{V_{IN}}{1000}$$

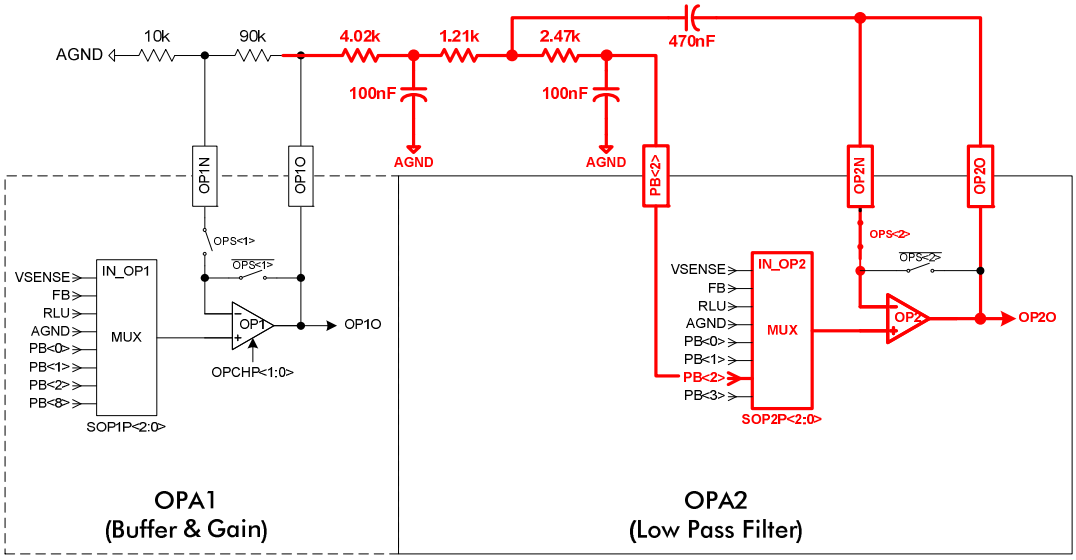
$$1000V\_Range \Rightarrow V_{IN} \times \frac{1K\Omega}{10M\Omega + 1K\Omega} = \frac{V_{IN}}{10000}$$

HY313x has two sets OPA that can be used to amplify 10 times of signal, realizing 500mVmeasurement by collocating with 5V network configurations.

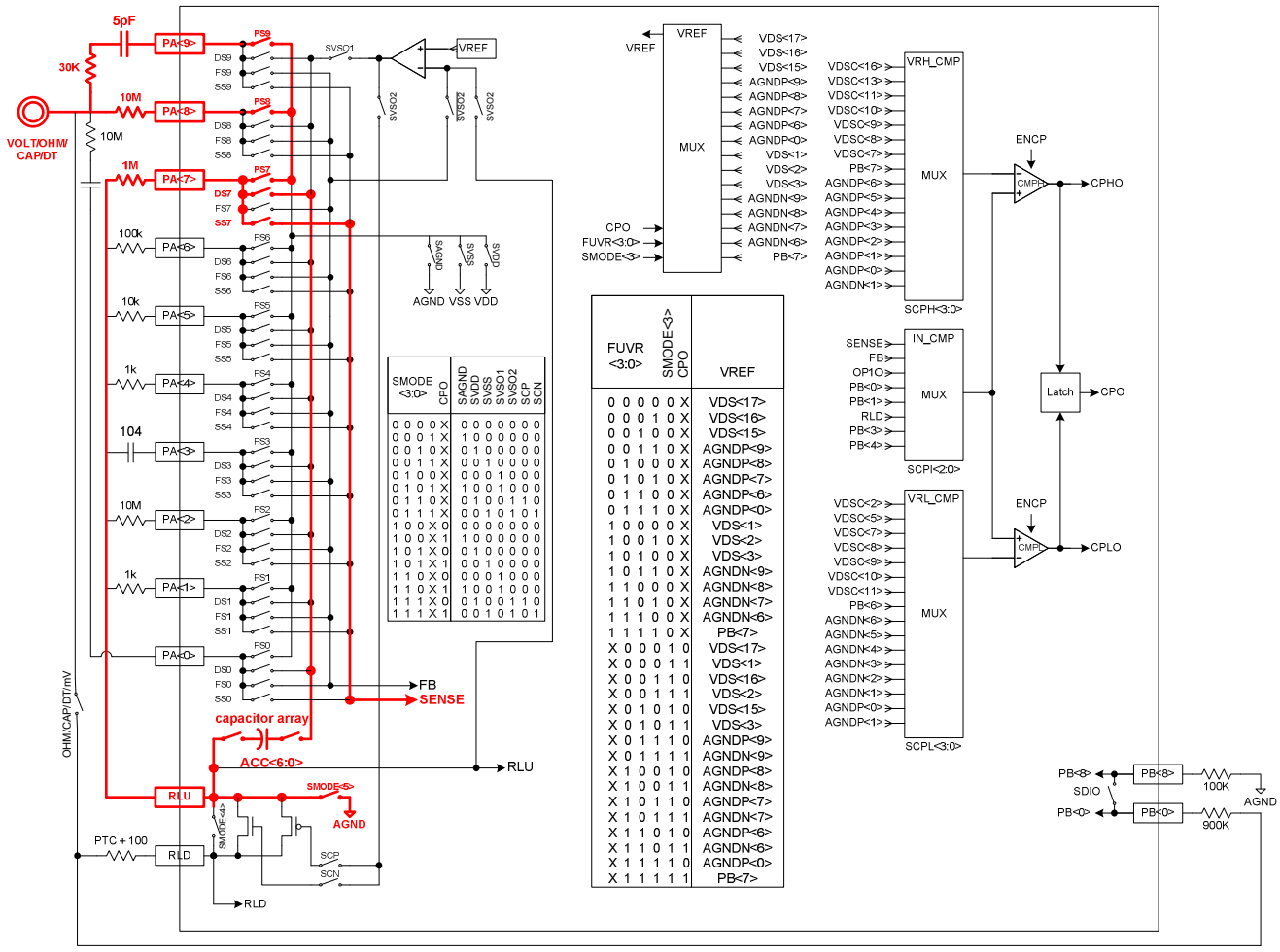
Digital ACV bandwidth compensation capacitor equation is as follows：

$$Capacitor\ array = \sum_{n=0}^{6} ACC < n > \times 2^n \times 0.2\,pF$$

4.1. AC Low Pass Filter Measurement Network Configuration



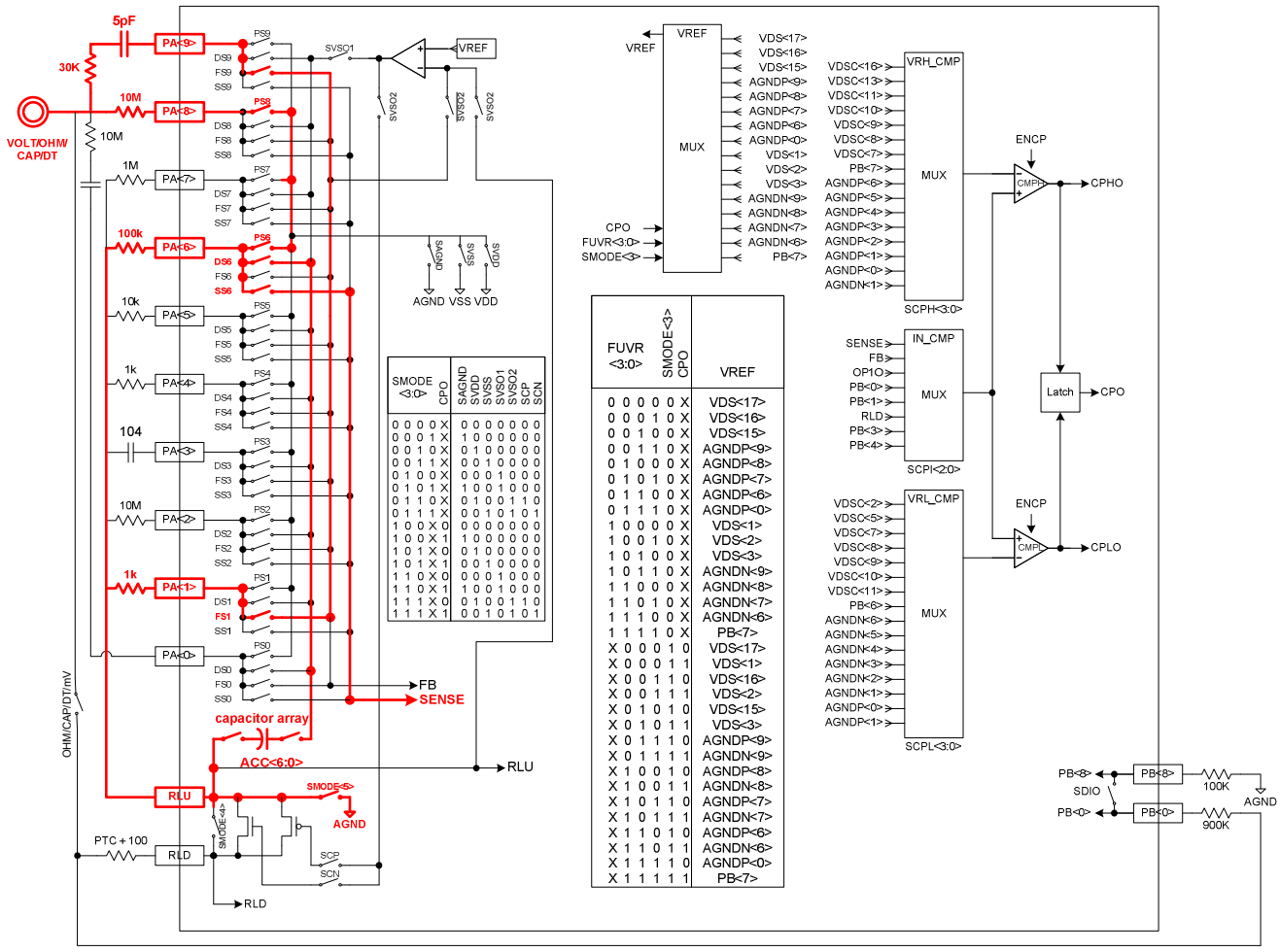
4.2. 5V Input Network Configuration



SMODE <3:0>	CPO	SAGND	SVDD	SVSS	SVSO1	SVSO2	SCP	SCN
0 0 0 0	X	0	0	0	0	0	0	0
0 0 0 1	X	1	0	0	0	0	0	0
0 0 1 0	X	0	1	0	0	0	0	0
0 0 1 1	X	0	0	1	0	0	0	0
0 1 0 0	X	0	0	0	1	0	0	0
0 1 0 1	X	1	0	0	1	0	0	0
0 1 1 0	X	0	1	0	1	0	0	0
0 1 1 1	X	0	0	1	0	1	0	1
1 0 0 0	0	0	0	0	0	0	0	0
1 0 0 0	1	1	0	0	0	0	0	0
1 0 0 1	X	1	0	0	0	0	0	0
1 0 1 0	0	0	1	0	0	0	0	0
1 0 1 0	1	0	0	1	0	0	0	0
1 0 1 1	X	0	0	0	1	0	0	0
1 1 0 0	0	0	0	1	0	0	0	0
1 1 0 0	1	1	0	0	1	0	0	0
1 1 0 1	X	0	1	0	1	0	0	0
1 1 1 0	0	0	0	1	0	1	0	1
1 1 1 0	1	0	1	0	1	0	1	0
1 1 1 1	X	0	0	1	0	1	0	1

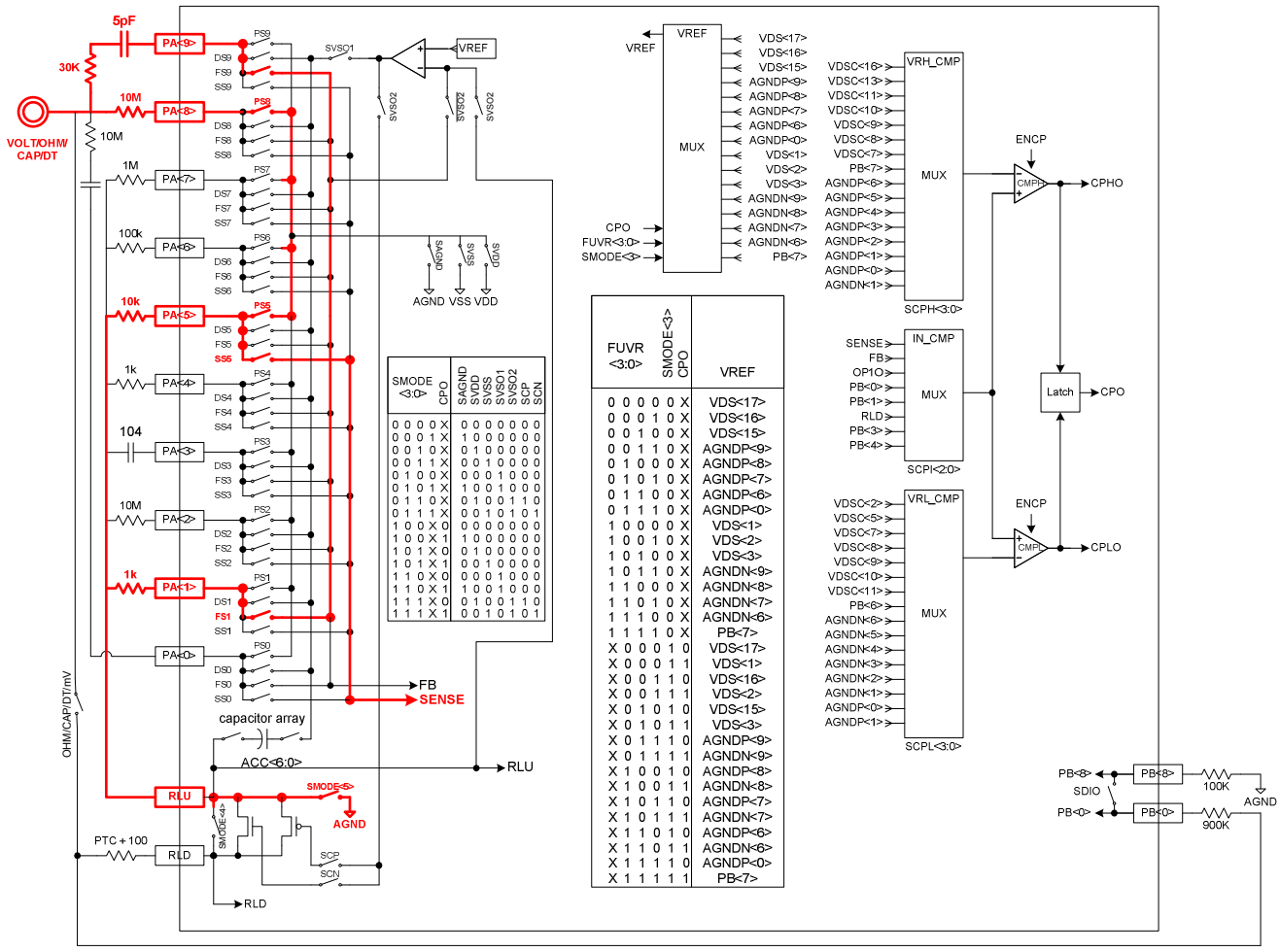
FUVR <3:0>	SMODE<3>	CPO	VREF
0 0 0 0	0	X	VDS<17>
0 0 0 1	0	X	VDS<16>
0 0 1 0	0	X	VDS<15>
0 0 1 1	0	X	AGNDP<9>
0 1 0 0	0	X	AGNDP<8>
0 1 0 1	0	X	AGNDP<7>
0 1 1 0	0	X	AGNDP<6>
0 1 1 1	0	X	AGNDP<0>
1 0 0 0	0	X	VDS<1>
1 0 0 1	0	X	VDS<2>
1 0 1 0	0	X	VDS<3>
1 0 1 1	0	X	AGNDN<9>
1 1 0 0	0	X	AGNDN<8>
1 1 0 1	0	X	AGNDN<7>
1 1 1 0	0	X	AGNDN<6>
1 1 1 1	0	X	PB<7>
X 0 0 0	1	0	VDS<17>
X 0 0 0	1	1	VDS<1>
X 0 0 1	1	0	VDS<16>
X 0 0 1	1	1	VDS<2>
X 0 1 0	1	0	VDS<15>
X 0 1 0	1	1	VDS<3>
X 0 1 1	1	0	AGNDP<9>
X 0 1 1	1	1	AGNDN<9>
X 1 0 0	1	0	AGNDP<8>
X 1 0 0	1	1	AGNDN<8>
X 1 0 1	1	0	AGNDP<7>
X 1 0 1	1	1	AGNDN<7>
X 1 1 0	1	0	AGNDP<6>
X 1 1 0	1	1	AGNDN<6>
X 1 1 1	1	0	AGNDP<0>
X 1 1 1	1	1	PB<7>

4.3. 50V Input Network Configuration



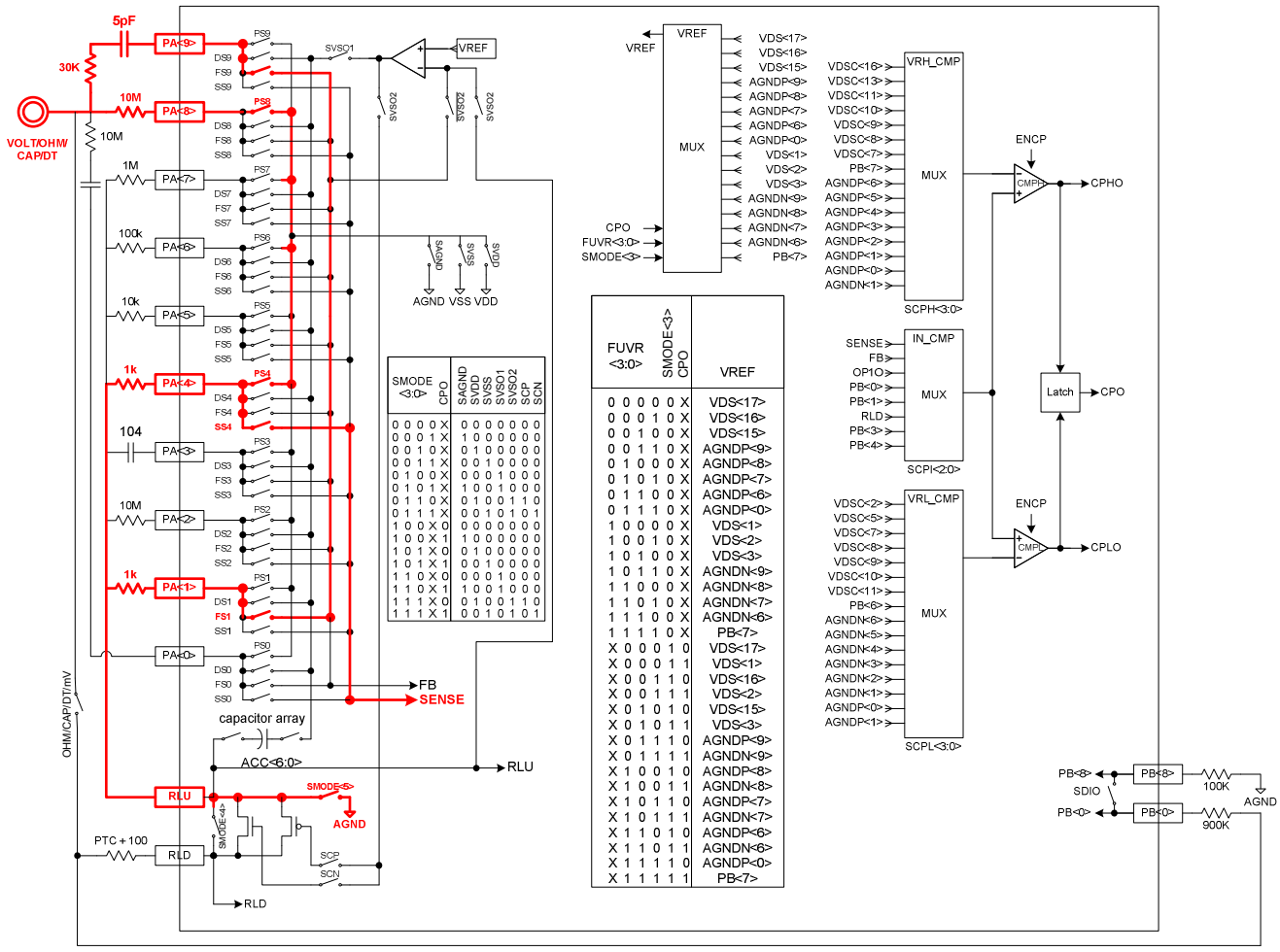
FUVR <3:0>	SMODE<3>	CPO	VREF
0 0 0 0	0	X	VDS<17>
0 0 0 1	0	X	VDS<16>
0 0 1 0	0	X	VDS<15>
0 0 1 1	0	X	AGNDP<9>
0 1 0 0	0	X	AGNDP<8>
0 1 0 1	0	X	AGNDP<7>
0 1 1 0	0	X	AGNDP<6>
0 1 1 1	0	X	AGNDP<0>
1 0 0 0	0	X	VDS<1>
1 0 0 1	0	X	VDS<2>
1 0 1 0	0	X	VDS<3>
1 0 1 1	0	X	AGNDN<9>
1 1 0 0	0	X	AGNDN<8>
1 1 0 1	0	X	AGNDN<7>
1 1 1 0	0	X	AGNDN<6>
1 1 1 1	0	X	PB<7>
X 0 0 0	1	0	VDS<17>
X 0 0 0	1	1	VDS<1>
X 0 0 1	1	0	VDS<16>
X 0 0 1	1	1	VDS<2>
X 0 1 0	1	0	VDS<15>
X 0 1 0	1	1	VDS<3>
X 0 1 1	1	0	AGNDP<9>
X 0 1 1	1	1	AGNDN<9>
X 1 0 0	1	0	AGNDP<8>
X 1 0 0	1	1	AGNDN<8>
X 1 0 1	1	0	AGNDP<7>
X 1 0 1	1	1	AGNDN<7>
X 1 1 0	1	0	AGNDP<6>
X 1 1 0	1	1	AGNDN<6>
X 1 1 1	1	0	AGNDP<0>
X 1 1 1	1	1	PB<7>

4.4. 500V Input Network Configuration



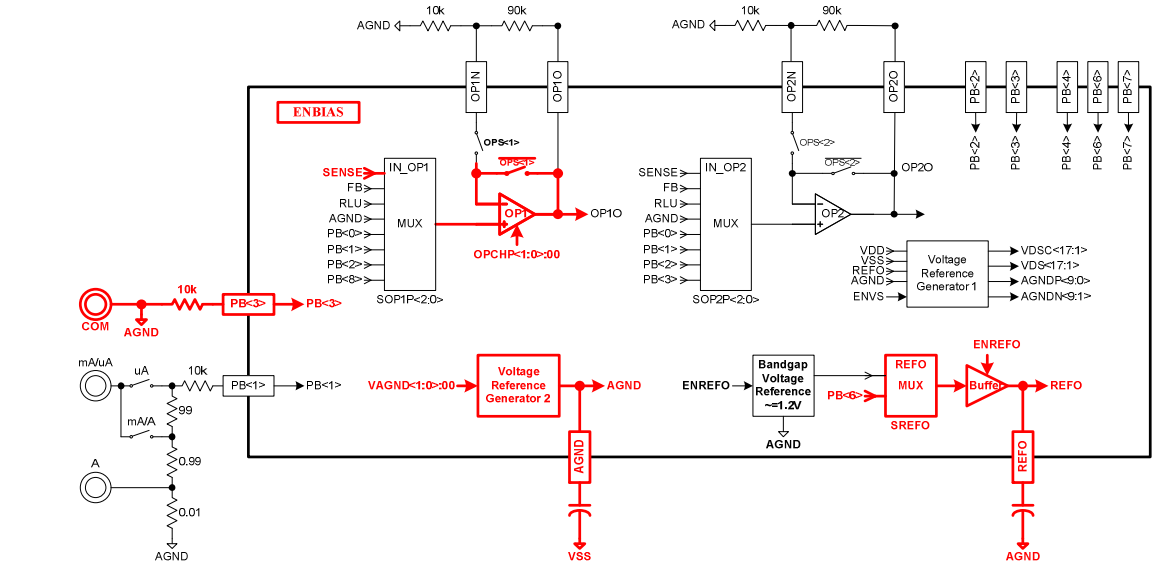
FUVR <3:0>	SMODE<3>	CPO	VREF
0 0 0 0	0	X	VDS<17>
0 0 0 1	0	X	VDS<16>
0 0 1 0	0	X	VDS<15>
0 0 1 1	0	X	AGNDP<9>
0 1 0 0	0	X	AGNDP<8>
0 1 0 1	0	X	AGNDP<7>
0 1 1 0	0	X	AGNDP<6>
0 1 1 1	0	X	AGNDP<0>
1 0 0 0	0	X	VDS<1>
1 0 0 1	0	X	VDS<2>
1 0 1 0	0	X	VDS<3>
1 0 1 1	0	X	AGNDN<9>
1 1 0 0	0	X	AGNDN<8>
1 1 0 1	0	X	AGNDN<7>
1 1 1 0	0	X	AGNDN<6>
1 1 1 1	0	X	PB<7>
X 0 0 0	1	0	VDS<17>
X 0 0 0	1	1	VDS<1>
X 0 0 1	1	0	VDS<16>
X 0 0 1	1	1	VDS<2>
X 0 1 0	1	0	VDS<15>
X 0 1 0	1	1	VDS<3>
X 0 1 1	1	0	AGNDP<9>
X 0 1 1	1	1	AGNDN<9>
X 1 0 0	1	0	AGNDP<8>
X 1 0 0	1	1	AGNDN<8>
X 1 0 1	1	0	AGNDP<7>
X 1 0 1	1	1	AGNDN<7>
X 1 1 0	1	0	AGNDP<6>
X 1 1 0	1	1	AGNDN<6>
X 1 1 1	1	0	AGNDP<0>
X 1 1 1	1	1	PB<7>

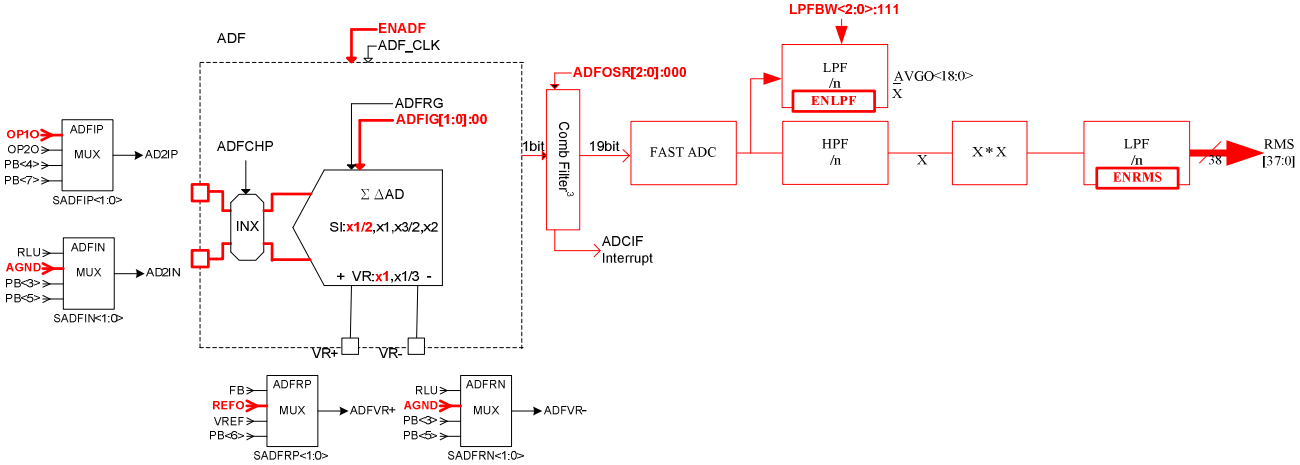
4.5. 1000V Input Network Configuration



FUVR <3:0>	SMODE<3>	CPO	VREF
0 0 0 0	0	X	VDS<17>
0 0 0 1	0	X	VDS<16>
0 0 1 0	0	X	VDS<15>
0 0 1 1	0	X	AGNDP<9>
0 1 0 0	0	X	AGNDP<8>
0 1 0 1	0	X	AGNDP<7>
0 1 1 0	0	X	AGNDP<6>
0 1 1 1	0	X	AGNDP<0>
1 0 0 0	0	X	VDS<1>
1 0 0 1	0	X	VDS<2>
1 0 1 0	0	X	VDS<3>
1 0 1 1	0	X	AGNDN<9>
1 1 0 0	0	X	AGNDN<8>
1 1 0 1	0	X	AGNDN<7>
1 1 1 0	0	X	AGNDN<6>
1 1 1 1	0	X	PB<7>
X 0 0 0	1	0	VDS<17>
X 0 0 0	1	1	VDS<1>
X 0 0 1	1	0	VDS<16>
X 0 0 1	1	1	VDS<2>
X 0 1 0	1	0	VDS<15>
X 0 1 0	1	1	VDS<3>
X 0 1 1	1	0	AGNDP<9>
X 0 1 1	1	1	AGNDN<9>
X 1 0 0	1	0	AGNDP<8>
X 1 0 0	1	1	AGNDN<8>
X 1 0 1	1	0	AGNDP<7>
X 1 0 1	1	1	AGNDN<7>
X 1 1 0	1	0	AGNDP<6>
X 1 1 0	1	1	AGNDN<6>
X 1 1 1	1	0	AGNDP<0>
X 1 1 1	1	1	PB<7>

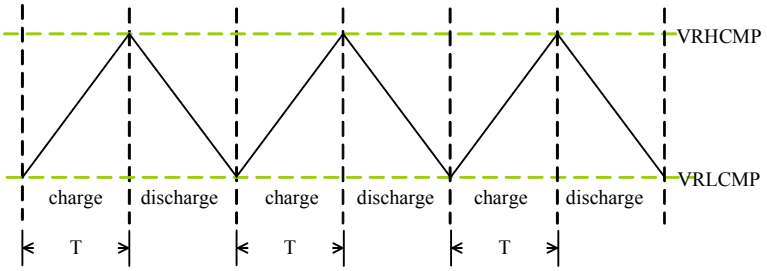
4.6. AC5V~1000V Measurement Network Configuration





5. Capacitor

There are two ways to measure capacitor, constant voltage and constant current output mode. Under low capacitor (<1 μF), users need to use constant voltage output mode for testing whereas using constant current output mode to test high capacitor (>1 μF). Capacitor measurement uses charge/discharge test cycle to gain the value.



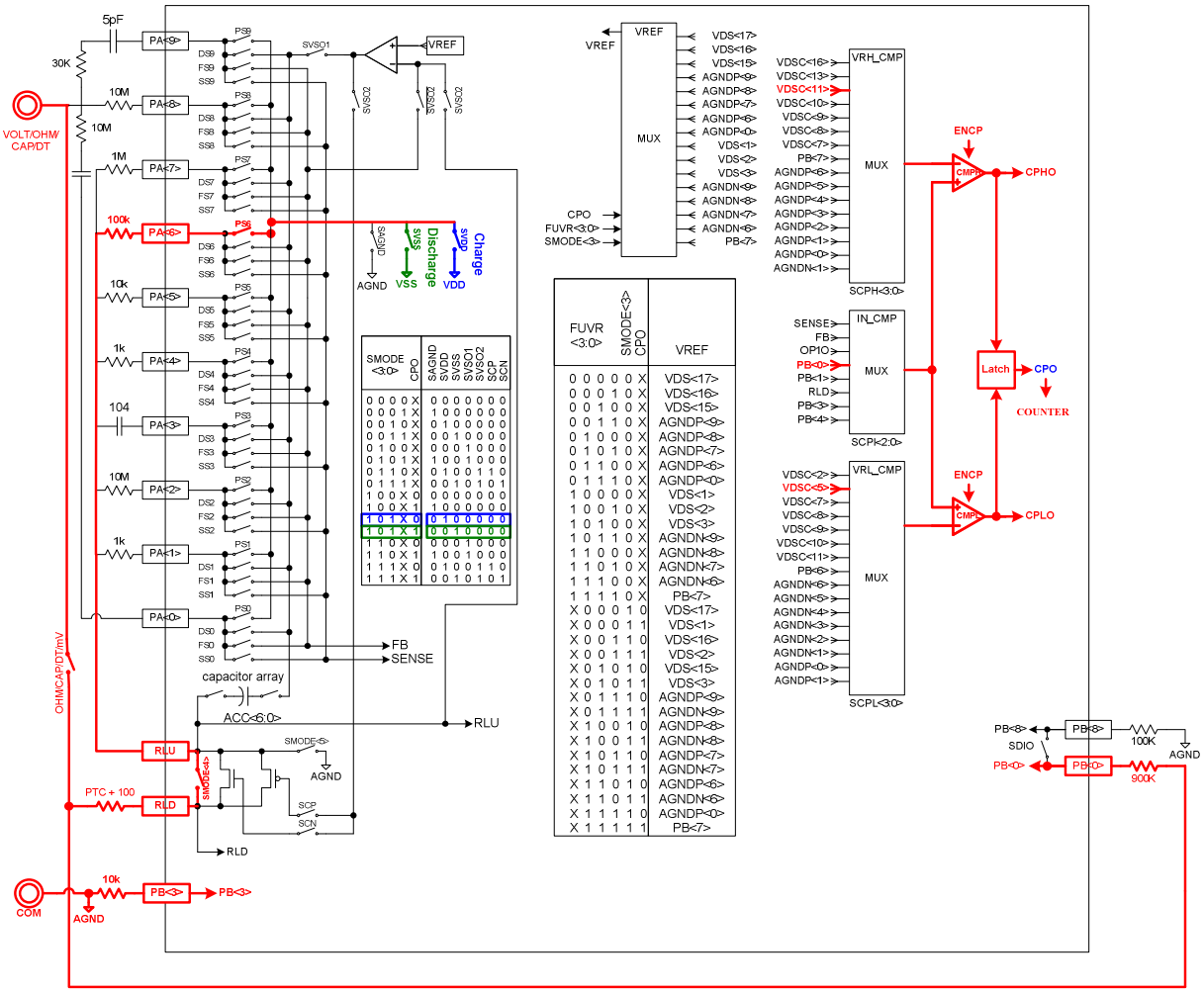
$$\Delta Q = I \times t = C \times \Delta V$$

$$C = \frac{Q}{V} = \frac{I \times \Delta t}{V}$$

Capacitor measurement test procedure：

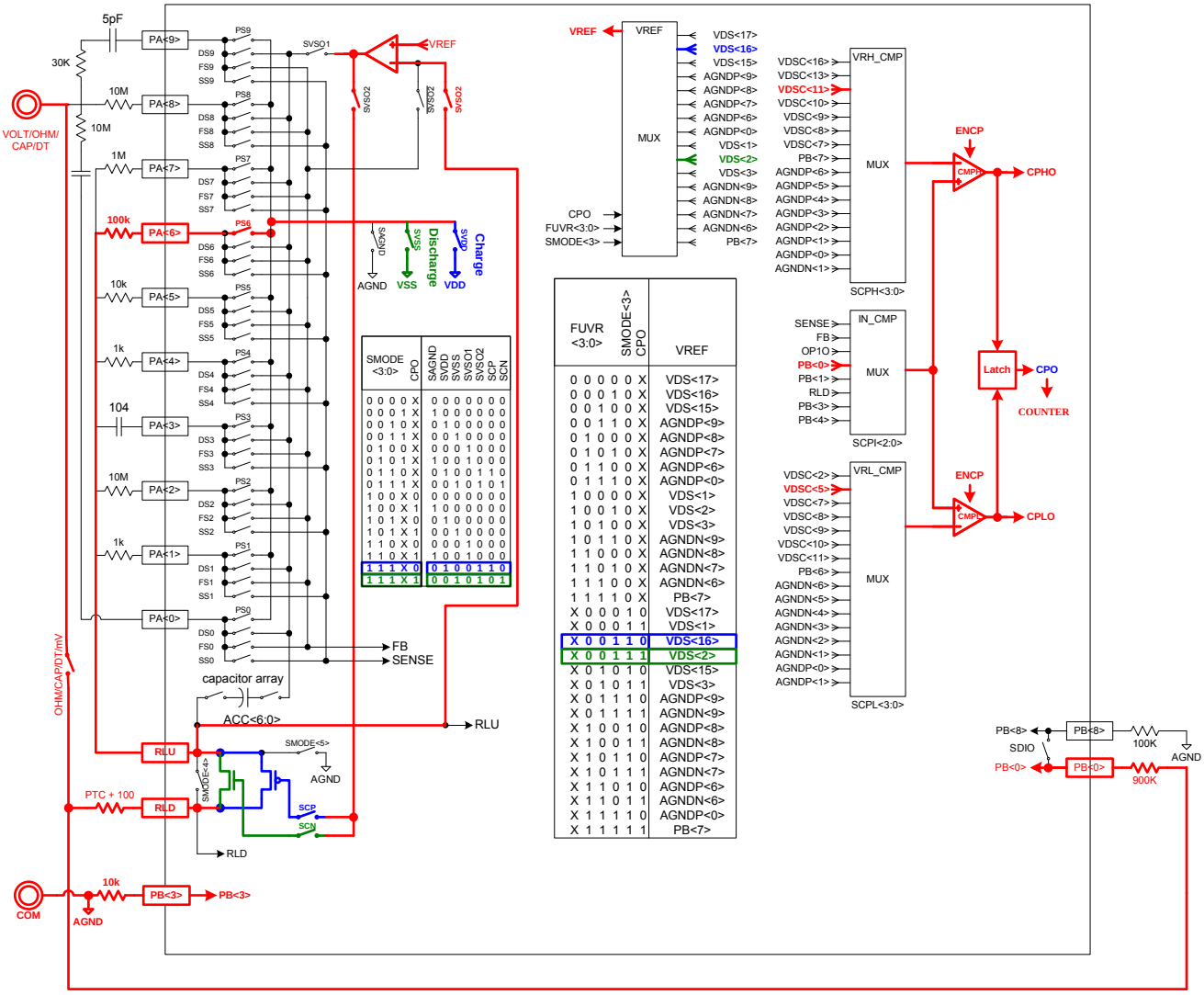
1. Select constant voltage (SMODE<7:0>=01110b) and constant current (SMODE<7:0>=11010b) test mode output.
2. Configure capacitor charge/discharge comparison voltage (VRHCMP、VRLCMP) and the actual charge/discharge of capacitor is decided by comparator, ACPO.
3. Configure CTA<23:8> initial value of Frequency Counter. When INTF2 register, CTF bit is 1, CTC<23:0> divided by CTB<23:0> to gain the cycle length.

5.1. 50-500nF (Constant Voltage Charge/Discharge Measurement)



FUVR <3:0>	SMODE<3> CPO	VREF
0 0 0 0	0 X	VDS<17>
0 0 0 1	0 X	VDS<16>
0 0 1 0	0 X	VDS<15>
0 0 1 1	0 X	AGNDP<9>
0 1 0 0	0 X	AGNDP<8>
0 1 0 1	0 X	AGNDP<7>
0 1 1 0	0 X	AGNDP<6>
0 1 1 1	0 X	AGNDP<0>
1 0 0 0	0 X	VDS<1>
1 0 0 1	0 X	VDS<2>
1 0 1 0	0 X	VDS<3>
1 0 1 1	0 X	AGNDN<9>
1 1 0 0	0 X	AGNDN<8>
1 1 0 1	0 X	AGNDN<7>
1 1 1 0	0 X	AGNDN<6>
1 1 1 1	0 X	PB<7>
X 0 0 0	1 0	VDS<17>
X 0 0 1	1 1	VDS<1>
X 0 1 1	1 0	VDS<16>
X 0 1 1	1 1	VDS<2>
X 1 0 1	1 0	VDS<15>
X 1 0 1	1 1	VDS<3>
X 0 1 1	1 0	AGNDP<9>
X 0 1 1	1 1	AGNDN<9>
X 1 0 0	1 0	AGNDP<8>
X 1 0 0	1 1	AGNDN<8>
X 1 0 1	1 0	AGNDP<7>
X 1 0 1	1 1	AGNDN<7>
X 1 1 0	1 0	AGNDP<6>
X 1 1 0	1 1	AGNDN<6>
X 1 1 1	1 0	AGNDP<0>
X 1 1 1	1 1	PB<7>

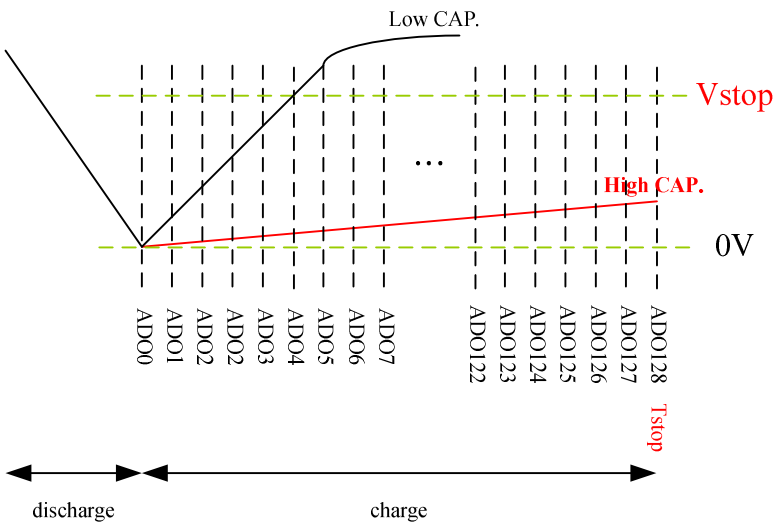
5.2. 5uF-50uF (Constant Current Charge/Discharge Measurement)



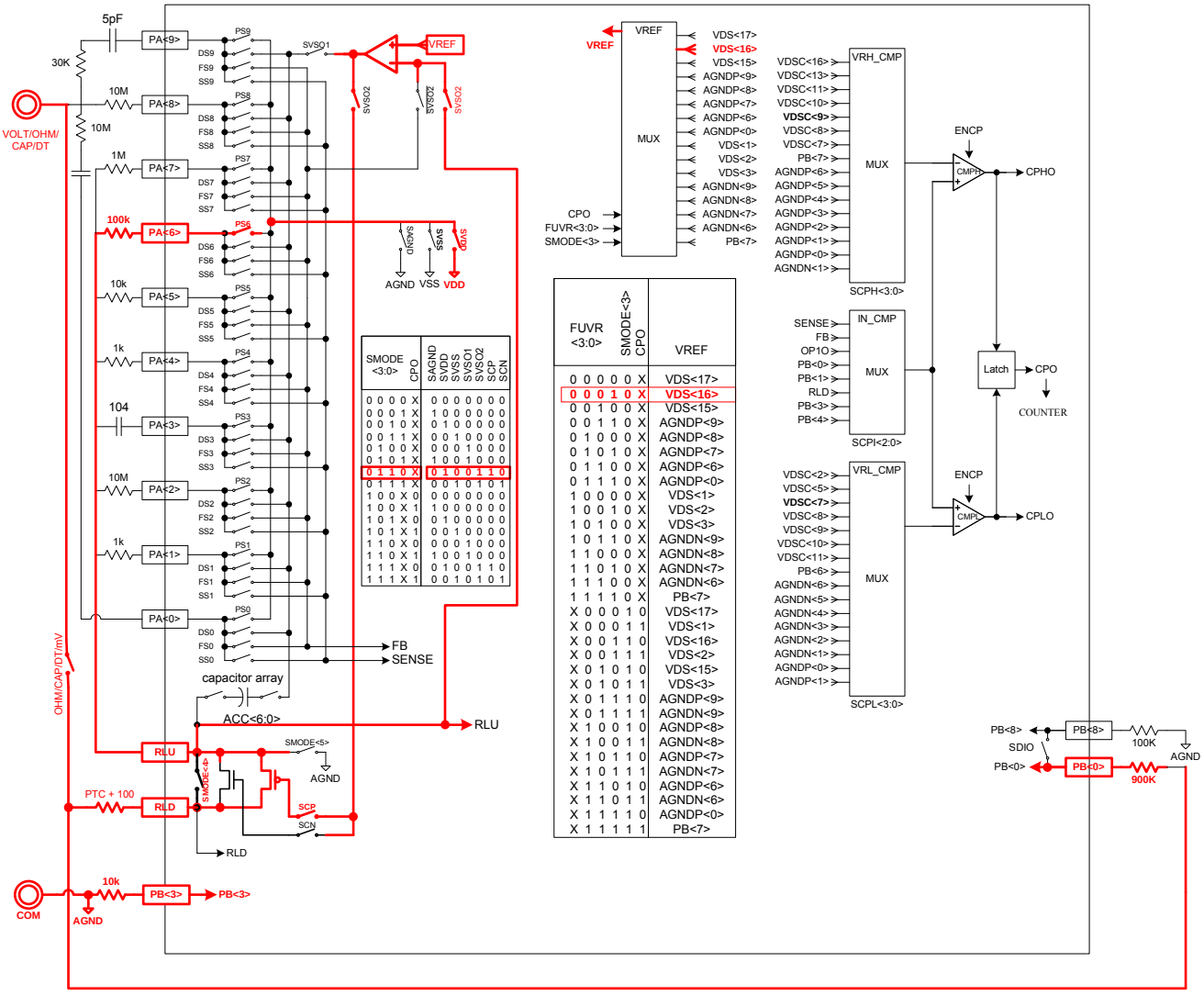
FUVR <3:0>	SMODE<3>	CPO	VREF
0 0 0 0	0	X	VDS<17>
0 0 0 1	0	X	VDS<16>
0 0 1 0	0	X	VDS<15>
0 0 1 1	0	X	AGNDP<9>
0 1 0 0	0	X	AGNDP<8>
0 1 0 1	0	X	AGNDP<7>
0 1 1 0	0	X	AGNDP<6>
0 1 1 1	0	X	AGNDP<0>
1 0 0 0	0	X	VDS<1>
1 0 0 1	0	X	VDS<2>
1 0 1 0	0	X	VDS<3>
1 0 1 1	0	X	AGNDN<9>
1 1 0 0	0	X	AGNDN<8>
1 1 0 1	0	X	AGNDN<7>
1 1 1 0	0	X	AGNDN<6>
1 1 1 1	0	X	PB<7>
X 0 0 0	1	0	VDS<17>
X 0 0 0	1	1	VDS<1>
X 0 0 1	1	0	VDS<16>
X 0 0 1	1	1	VDS<2>
X 0 1 0	1	0	VDS<15>
X 0 1 0	1	1	VDS<3>
X 0 1 1	1	0	AGNDP<9>
X 0 1 1	1	1	AGNDN<9>
X 1 0 0	1	0	AGNDP<8>
X 1 0 0	1	1	AGNDN<8>
X 1 0 1	1	0	AGNDP<7>
X 1 0 1	1	1	AGNDN<7>
X 1 1 0	1	0	AGNDP<6>
X 1 1 0	1	1	AGNDN<6>
X 1 1 1	1	0	AGNDP<0>
X 1 1 1	1	1	PB<7>

500uF~50mF capacitors require longer charge/discharge time, the only change of different ranges is the output current. Users can take the voltage difference under a fixed time (t) to gain capacitor value. The change of capacitor value and voltage value is an inverse ratio.

$$C = \frac{Q}{V} = I \times \frac{\Delta t}{\Delta V}$$



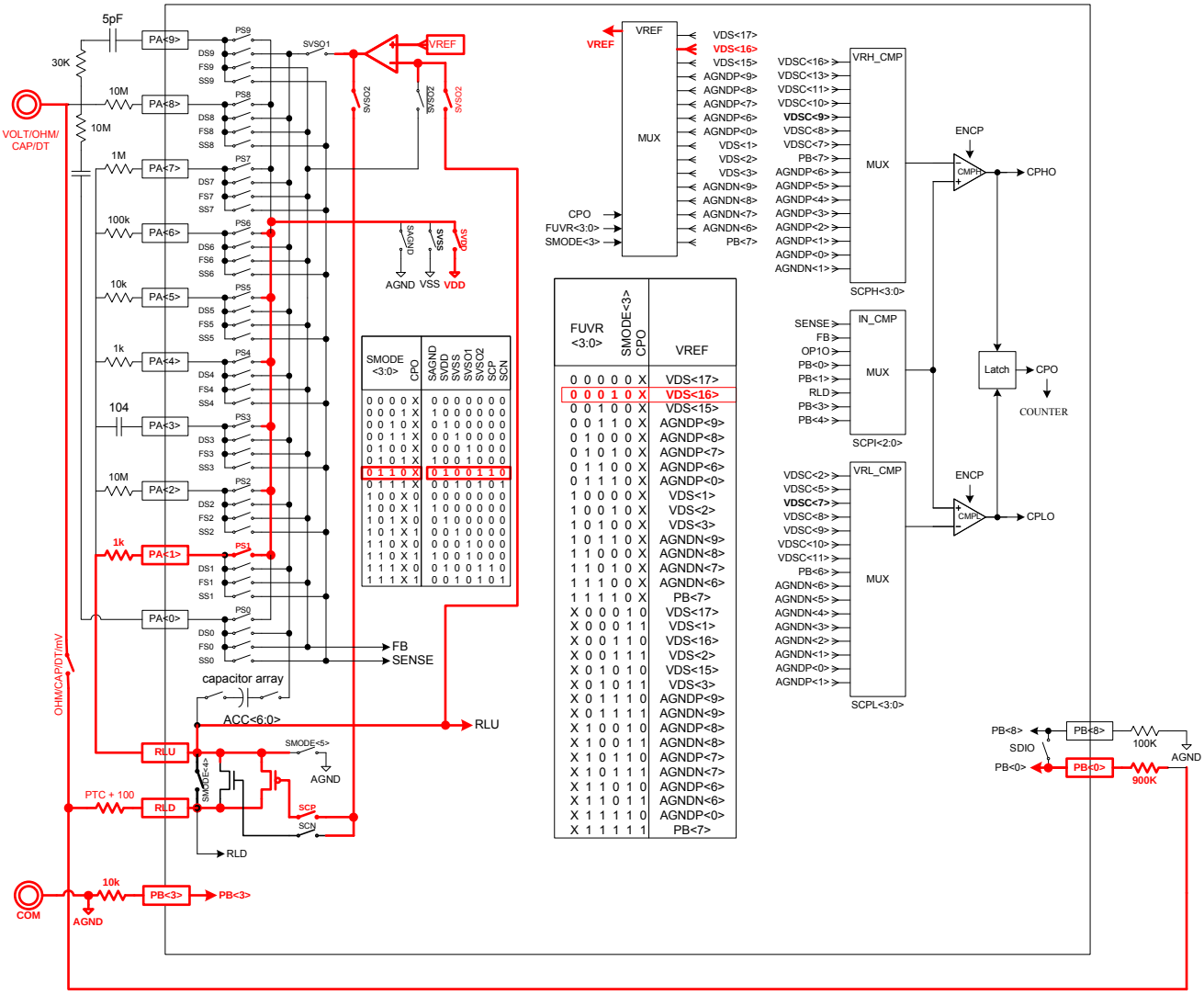
5.3. 500uF(Charge)



SMODE <3:0>	CPO	SAGND	SVDD	SVSS	SVSO1	SVSO2	SCP	SCN
0 0 0 0	X	0	0	0	0	0	0	0
0 0 0 1	X	1	0	0	0	0	0	0
0 0 1 0	X	0	1	0	0	0	0	0
0 0 1 1	X	0	0	1	0	0	0	0
0 1 0 0	X	0	0	0	1	0	0	0
0 1 0 1	X	1	0	0	0	1	0	0
0 1 1 0	X	0	1	0	0	1	0	1
0 1 1 1	X	0	0	1	0	1	0	1
1 0 0 X	0	0	0	0	0	0	0	0
1 0 0 X	1	1	0	0	0	0	0	0
1 0 1 X	0	0	1	0	0	0	0	0
1 0 1 X	1	0	0	1	0	0	0	0
1 1 0 X	0	0	0	0	1	0	0	0
1 1 0 X	1	1	0	0	0	1	0	0
1 1 1 X	0	0	1	0	0	1	1	0
1 1 1 X	1	0	0	1	0	1	0	1

FUVR <3:0>	SMODE<3>	CPO	VREF
0 0 0 0	0	X	VDS<17>
0 0 0 1	0	X	VDS<16>
0 0 1 0	0	X	VDS<15>
0 0 1 1	0	X	AGNDP<9>
0 1 0 0	0	X	AGNDP<8>
0 1 0 1	0	X	AGNDP<7>
0 1 1 0	0	X	AGNDP<6>
0 1 1 1	0	X	AGNDP<0>
1 0 0 0	0	X	VDS<1>
1 0 0 1	0	X	VDS<2>
1 0 1 0	0	X	VDS<3>
1 0 1 1	0	X	AGNDN<9>
1 1 0 0	0	X	AGNDN<8>
1 1 0 1	0	X	AGNDN<7>
1 1 1 0	0	X	AGNDN<6>
1 1 1 1	0	X	PB<7>
X 0 0 0	1	0	VDS<17>
X 0 0 0	1	1	VDS<1>
X 0 0 1	1	0	VDS<16>
X 0 0 1	1	1	VDS<2>
X 0 1 0	1	0	VDS<15>
X 0 1 0	1	1	VDS<3>
X 0 1 1	1	0	AGNDP<9>
X 0 1 1	1	1	AGNDN<9>
X 1 0 0	1	0	AGNDP<8>
X 1 0 0	1	1	AGNDN<8>
X 1 0 1	1	0	AGNDP<7>
X 1 0 1	1	1	AGNDN<7>
X 1 1 0	1	0	AGNDP<6>
X 1 1 0	1	1	AGNDN<6>
X 1 1 1	1	0	AGNDP<0>
X 1 1 1	1	1	PB<7>

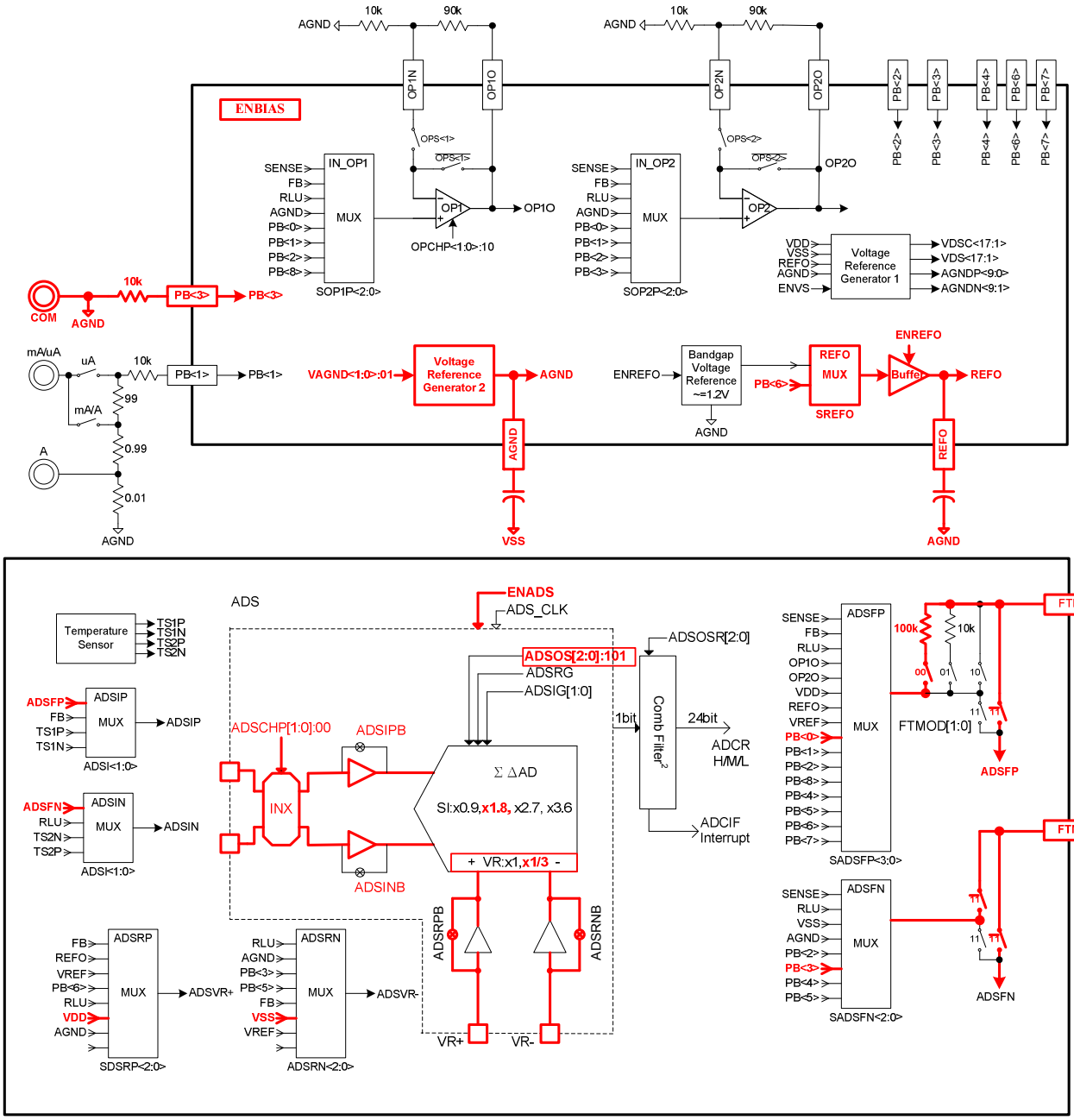
5.4. 5mF-50mF(Charge)



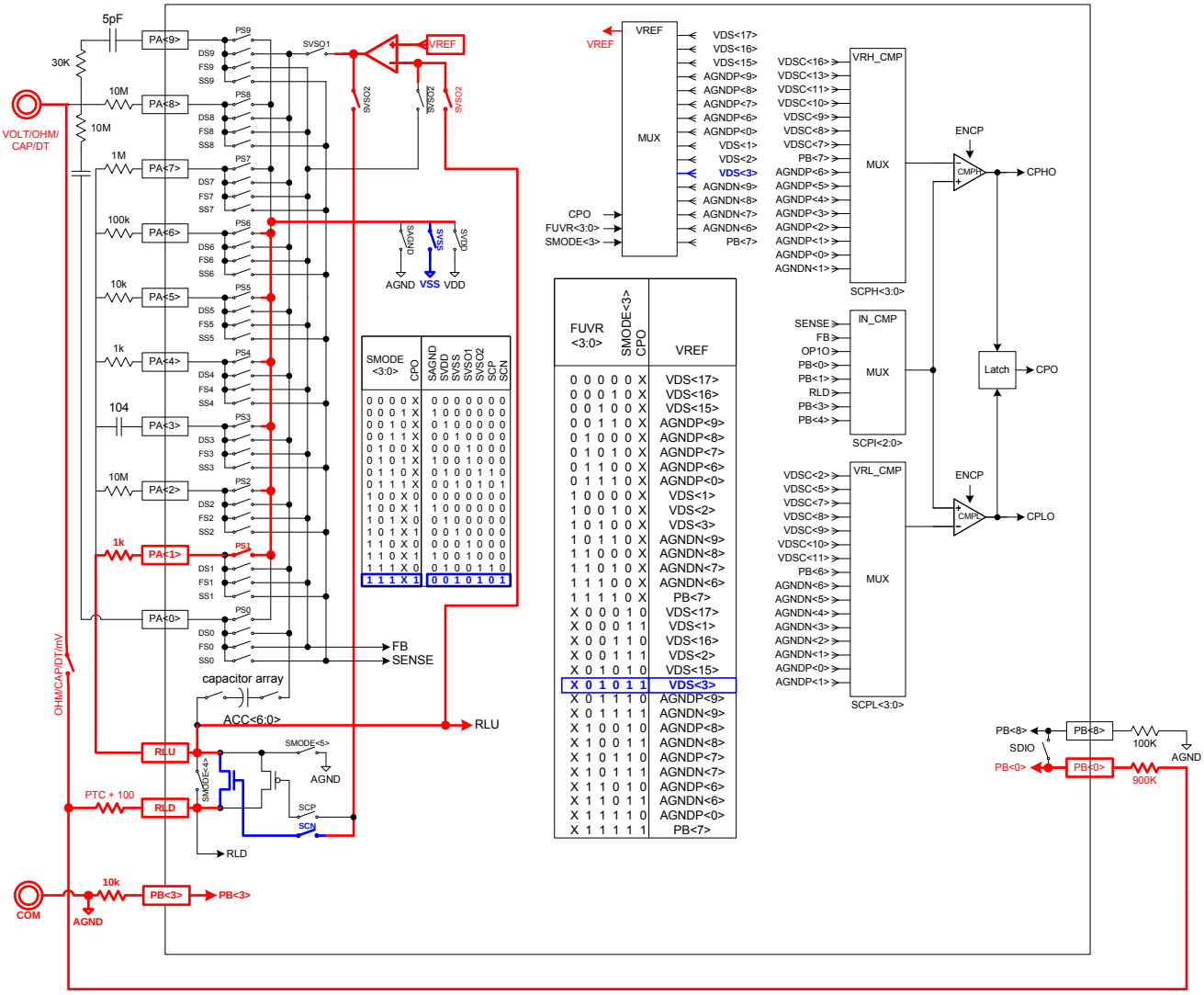
SMODE <3:0>	CPO	SAGND	SVDD	SVSS	SVSO1	SVSO2	SCP	SCN
0 0 0 0	X	0	0	0	0	0	0	0
0 0 0 1	X	1	0	0	0	0	0	0
0 0 1 0	X	0	1	0	0	0	0	0
0 0 1 1	X	0	0	1	0	0	0	0
0 1 0 0	X	0	0	0	1	0	0	0
0 1 0 1	X	1	0	0	1	0	0	0
0 1 1 0	X	0	1	0	1	0	0	0
0 1 1 1	X	0	0	1	1	0	0	0
1 0 0 0	X	0	0	0	0	1	0	0
1 0 0 1	X	1	0	0	0	1	0	0
1 0 1 0	X	0	1	0	0	1	0	0
1 0 1 1	X	0	0	1	0	1	0	0
1 1 0 0	X	0	0	0	1	1	0	0
1 1 0 1	X	1	0	0	1	1	0	0
1 1 1 0	0	0	1	0	1	1	0	1
1 1 1 1	1	0	0	1	0	1	0	1

FUVR <3:0>	SMODE<3>	CPO	VREF
0 0 0 0	0	X	VDS<17>
0 0 0 1	0	X	VDS<16>
0 0 1 0	0	X	VDS<15>
0 0 1 1	0	X	AGNDP<9>
0 1 0 0	0	X	AGNDP<8>
0 1 0 1	0	X	AGNDP<7>
0 1 1 0	0	X	AGNDP<6>
0 1 1 1	0	X	AGNDP<0>
1 0 0 0	0	X	VDS<1>
1 0 0 1	0	X	VDS<2>
1 0 1 0	0	X	VDS<3>
1 0 1 1	0	X	AGNDN<9>
1 1 0 0	0	X	AGNDN<8>
1 1 0 1	0	X	AGNDN<7>
1 1 1 0	0	X	AGNDN<6>
1 1 1 1	0	X	PB<7>
X 0 0 0	1	0	VDS<17>
X 0 0 0	1	1	VDS<1>
X 0 0 1	1	0	VDS<16>
X 0 0 1	1	1	VDS<2>
X 0 1 0	1	0	VDS<15>
X 0 1 0	1	1	VDS<3>
X 0 1 1	1	0	AGNDP<9>
X 0 1 1	1	1	AGNDN<9>
X 1 0 0	1	0	AGNDP<8>
X 1 0 0	1	1	AGNDN<8>
X 1 0 1	1	0	AGNDP<7>
X 1 0 1	1	1	AGNDN<7>
X 1 1 0	1	0	AGNDP<6>
X 1 1 0	1	1	AGNDN<6>
X 1 1 1	1	0	AGNDP<0>
X 1 1 1	1	1	PB<7>

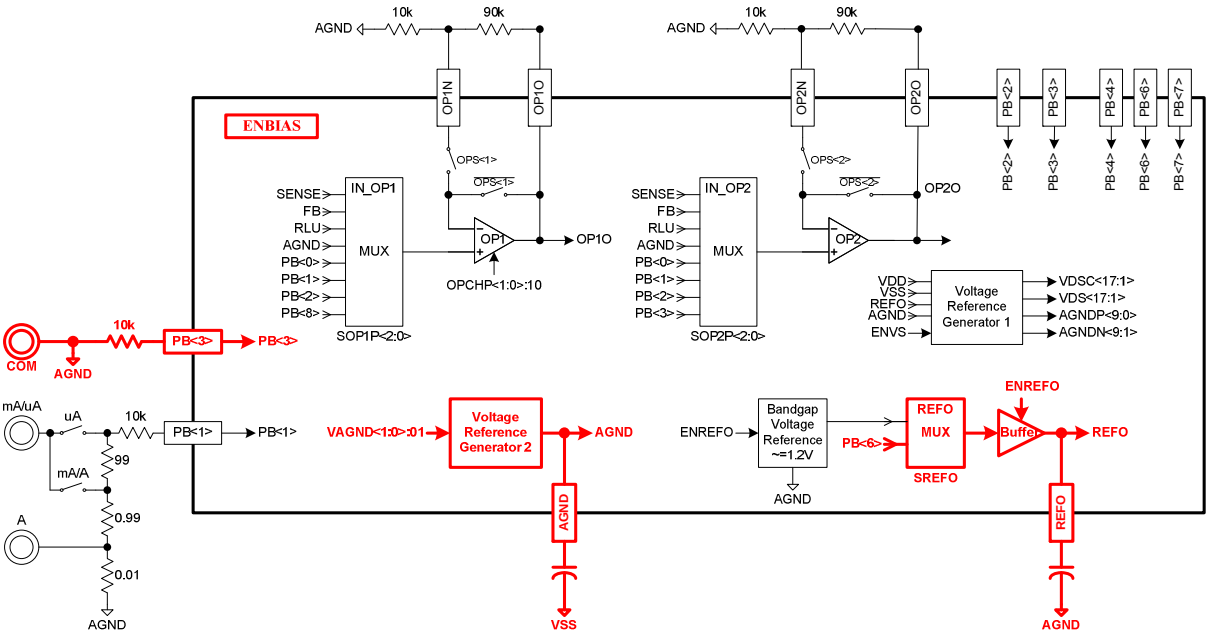
5.5. 500uF~50mF Measurement Network Configuration

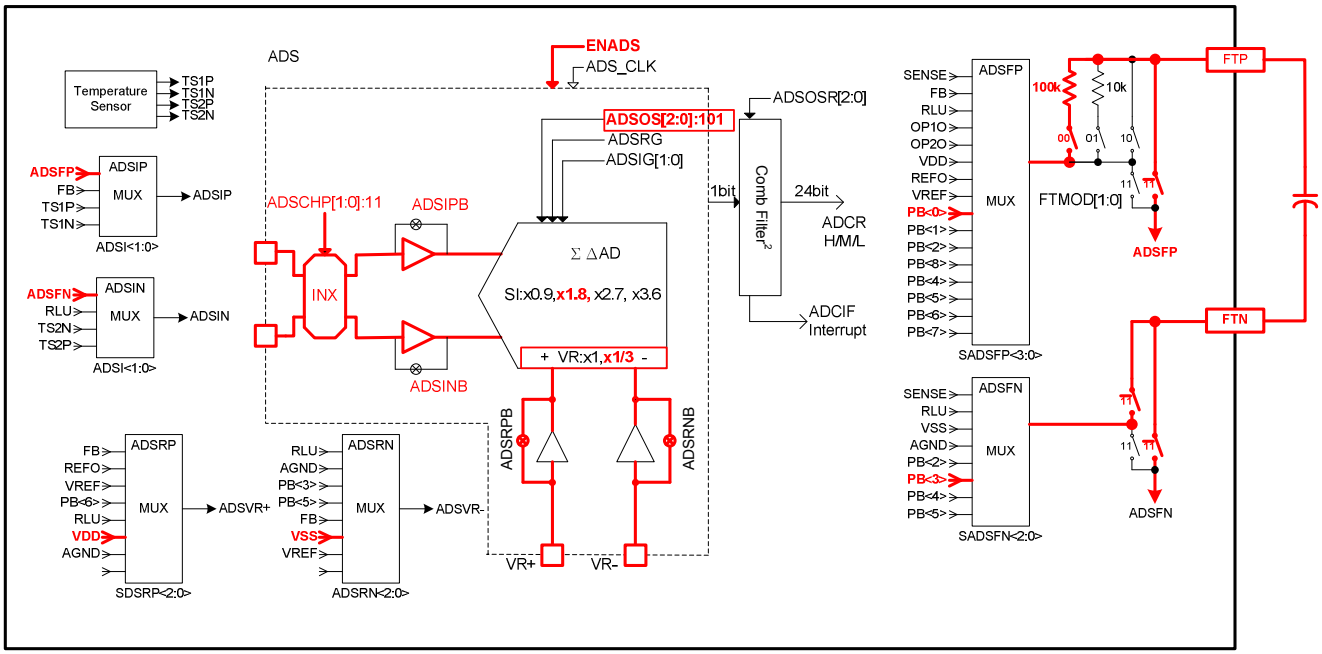


5.6. Discharge (500uF~50mF)



FUVR <3:0>	SMODE<3>	CPO	VREF
0 0 0 0	0	X	VDS<17>
0 0 0 1	0	X	VDS<16>
0 0 1 0	0	X	VDS<15>
0 0 1 1	0	X	AGNDP<9>
0 1 0 0	0	X	AGNDP<8>
0 1 0 1	0	X	AGNDP<7>
0 1 1 0	0	X	AGNDP<6>
0 1 1 1	0	X	AGNDP<0>
1 0 0 0	0	X	VDS<1>
1 0 0 1	0	X	VDS<2>
1 0 1 0	0	X	VDS<3>
1 0 1 1	0	X	AGNDN<9>
1 1 0 0	0	X	AGNDN<8>
1 1 0 1	0	X	AGNDN<7>
1 1 1 0	0	X	AGNDN<6>
1 1 1 1	0	X	PB<7>
X 0 0 0	1	0	VDS<17>
X 0 0 0	1	1	VDS<1>
X 0 0 1	1	0	VDS<16>
X 0 0 1	1	1	VDS<2>
X 0 1 0	1	0	VDS<15>
X 0 1 0 1 1			**VDS<3>**
X 0 1 1	1	0	AGNDP<9>
X 0 1 1	1	1	AGNDN<9>
X 1 0 0	1	0	AGNDP<8>
X 1 0 0	1	1	AGNDN<8>
X 1 0 1	1	0	AGNDP<7>
X 1 0 1	1	1	AGNDN<7>
X 1 1 0	1	0	AGNDP<6>
X 1 1 0	1	1	AGNDN<6>
X 1 1 1	1	0	AGNDP<0>
X 1 1 1	1	1	PB<7>

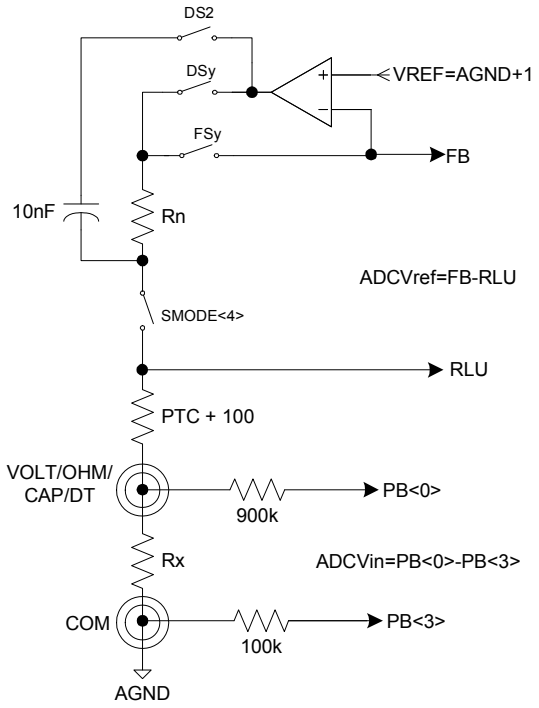

AGND
10k
90k
OP1N
OP1O
OP2N
OP2O
ENBIAS
OPS<1>
OPS<2>
SENSE
FB
RLU
AGND
PB<0>
PB<1>
PB<2>
PB<3>
PB<8>
IN_OP1
MUX
OP1
OPCHP<1:0>:10
SOP1P<2:0>
IN_OP2
SOP2P<2:0>
PB<2>
PB<3>
PB<4>
PB<6>
PB<7>
VDD
VSS
REFO
ENVS
Voltage Reference Generator 1
VDSC<17:1>
VDS<17:1>
AGNDP<9:0>
AGNDN<9:1>
COM
PB<3>
mA/uA
uA
mA/A
99
0.99
0.01
A
PB<1>
VAGND<1:0>:01
Voltage Reference Generator 2
VSS
ENREFO
Bandgap Voltage Reference ~=1.2V
REFO MUX
SREFO
Buffer
REFO


ADS
ENADS
ADS_CLK
Temperature Sensor
TS1P
TS1N
TS2P
TS2N
ADSOS[2:0]:101
ADSRG
ADSIG[1:0]
ADSOSR[2:0]
ADSFP
ADSIP
MUX
ADSI<1:0>
ADSCHP[1:0]:11
ADSIPB
INX
ΣΔAD
SI:x0.9,x1.8, x2.7, x3.6
+ VR:x1,x1/3 -
ADSINB
1bit
Comb Filter2
24bit
ADCR H/M/L
ADCIF Interrupt
ADSFN
ADSIN
ADSRP
ADSRN
ADSVR+
ADSVR-
ADSRPB
ADSRNB
VR+
VR-
SDSRP<2:0>
ADSRN<2:0>
100k
10k
FTP
FTN
FTMOD[1:0]
SADSFP<3:0>
SADSFN<2:0>

6. Resistor

The chip offers two ways to measure resistor, constant voltage and constant current measurement and different methods lead to diverse results.

Constant voltage or ratio resistor measurement design must input ADC signal and open reference voltage input buffer when measuring high resistor. 3MΩ parallel connection impedance will be generated if ADC input was not opened. It is suggested to use constant current resistor measurement when design 500kΩ to 50MΩ application. The measurement equation is given below：

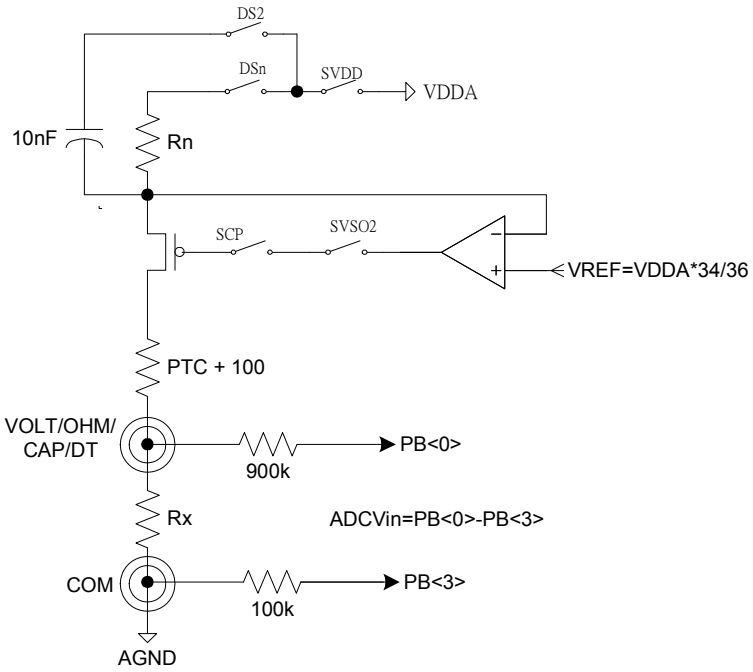


$$I_{Rx} = I_{Rn}$$

$$V_{Rx} = I_{Rx} \times Rx = \frac{V_{Rn}}{Rn} \times Rx$$

$$R_{READ} = \frac{V_{Rx}}{V_{Rn}} \times Full\ Scale = \frac{ADCV_{in}}{ADCV_{ref}} \times Full\ Scale$$

Constant current resistor measurement design has higher internal impedance of DSn and SVDD electrical switches; it will have parallel connection with Rn resistor and to cause output current deviation. It is recommended to use constant voltage resistor measurement when designing 500kΩ or below applications. The measurement equation is given below：

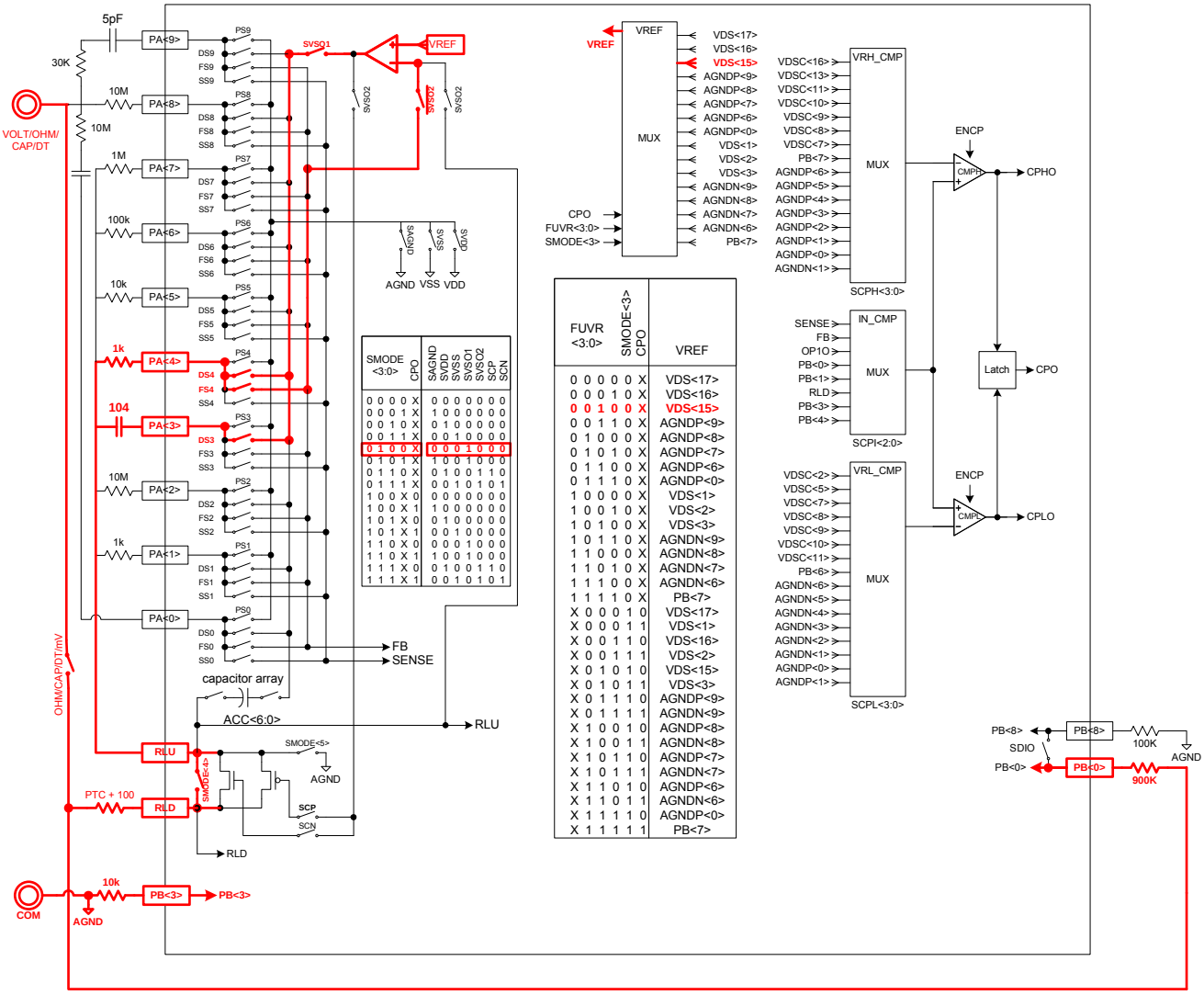


$$I_{Rx} = I_{Rn} = \frac{VDDA - VREF}{Rn}$$

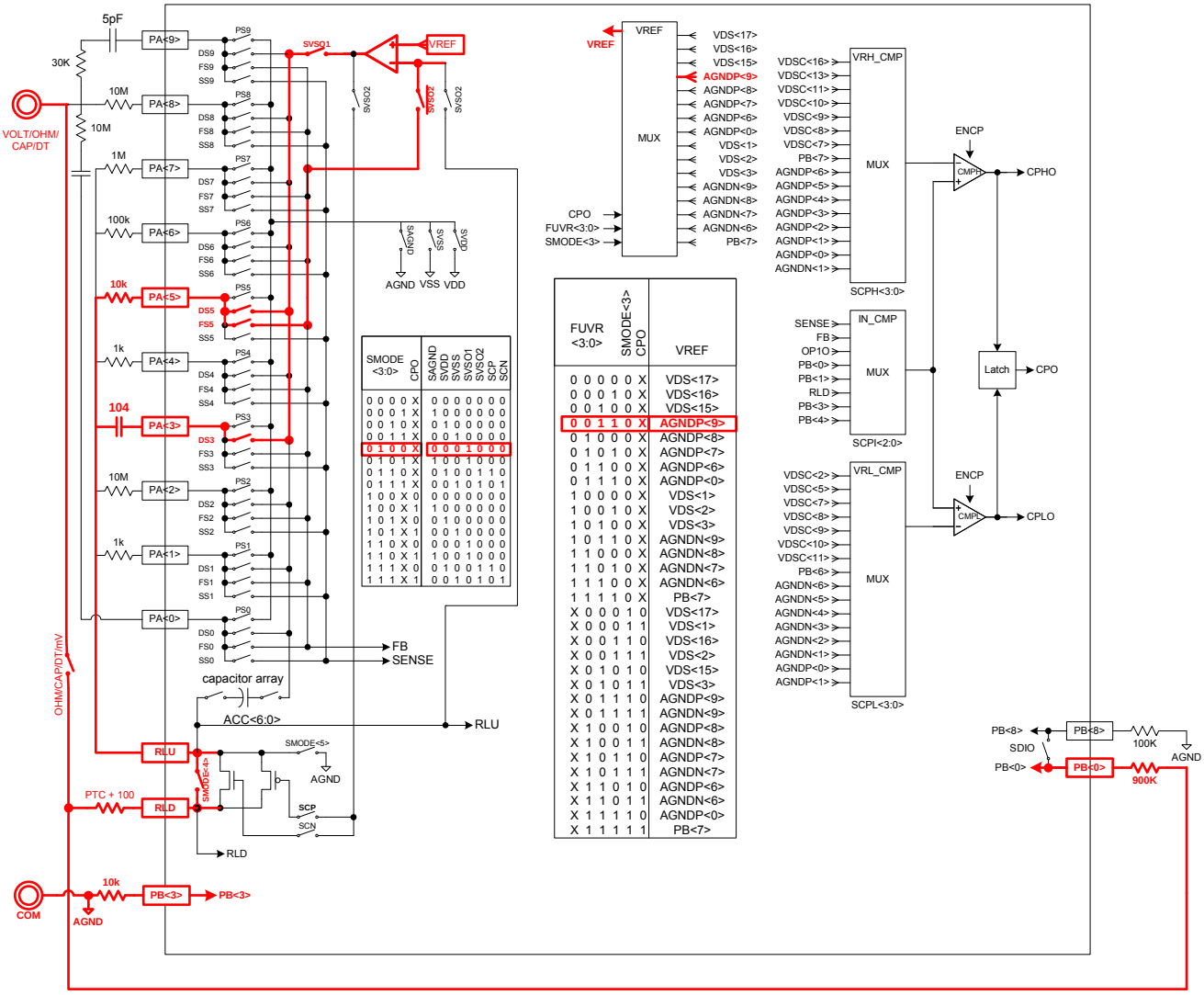
$$R_{READ} = \frac{ADCV_{in}}{ADCV_{ref}} \times Full\ Scale$$

$$R_{READ} = \frac{Rx \times I_{Rx}}{ADCV_{ref}} \times Full\ Scale$$

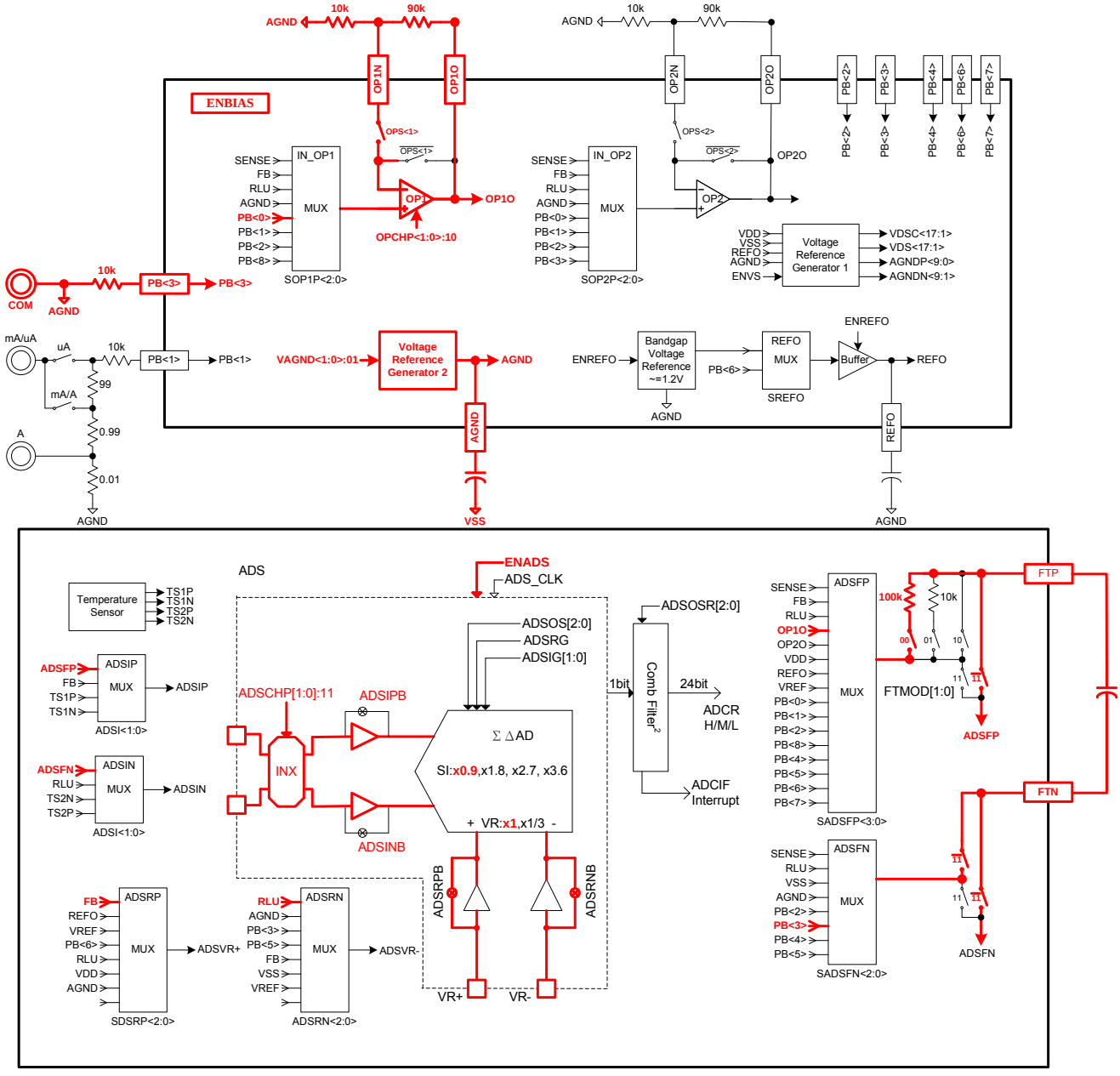
6.1. 50ohm/500ohm Input Network Configuration



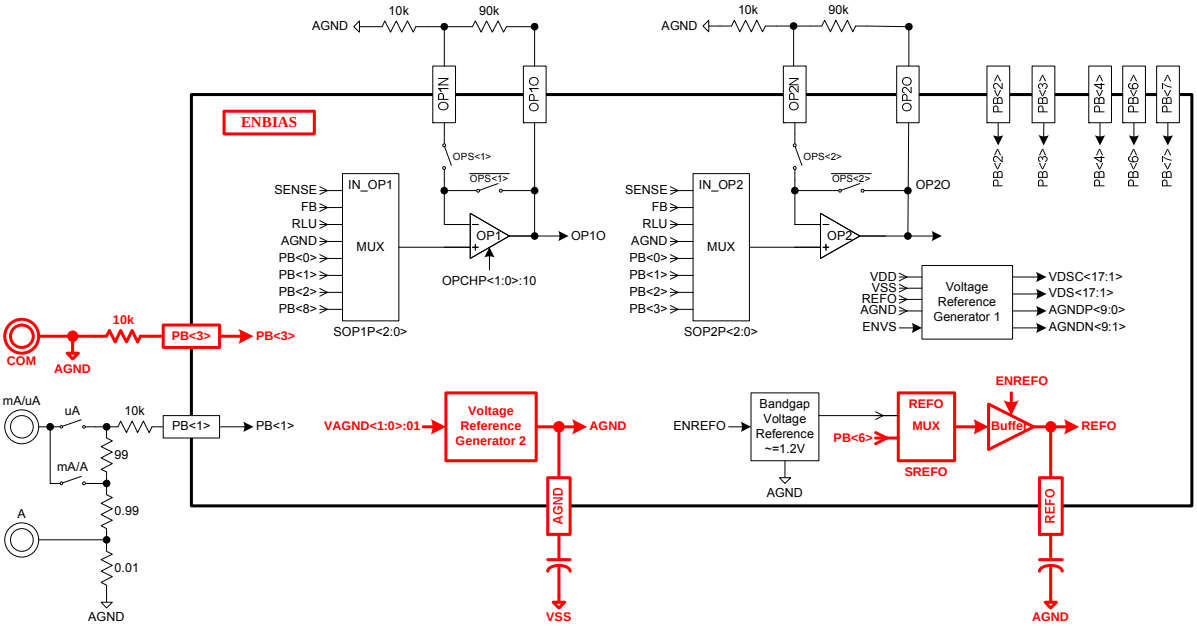
6.2. 5K ohm Input Network Configuration

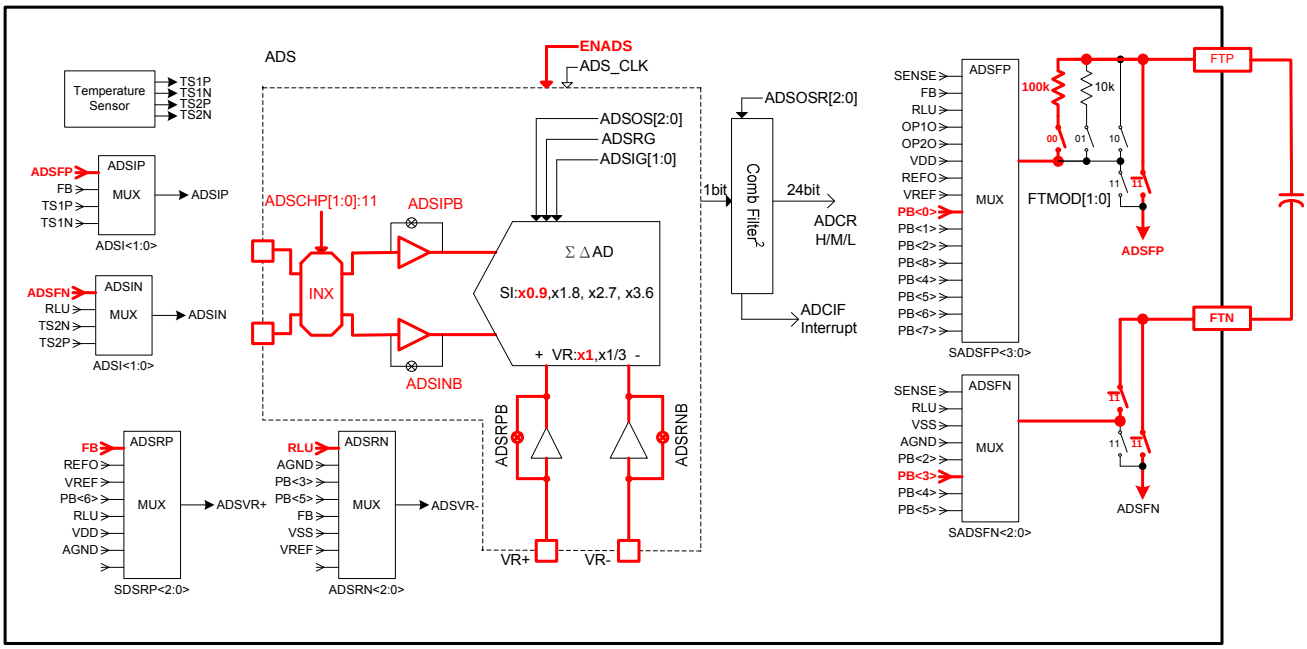


6.3. 50ohm Measurement Network Configuration

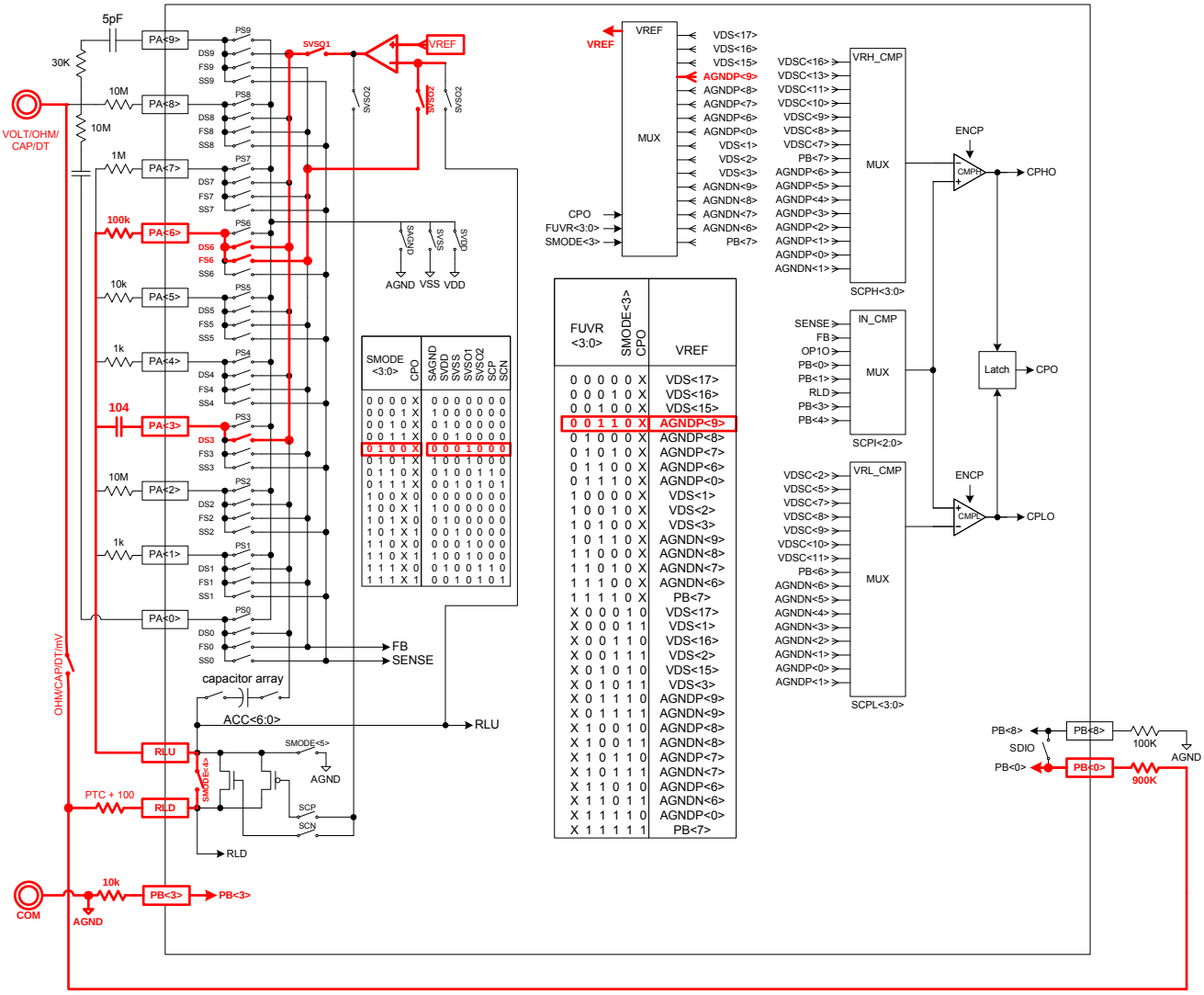


6.4. 500 ohm~50K ohm Measurement Network Configuration



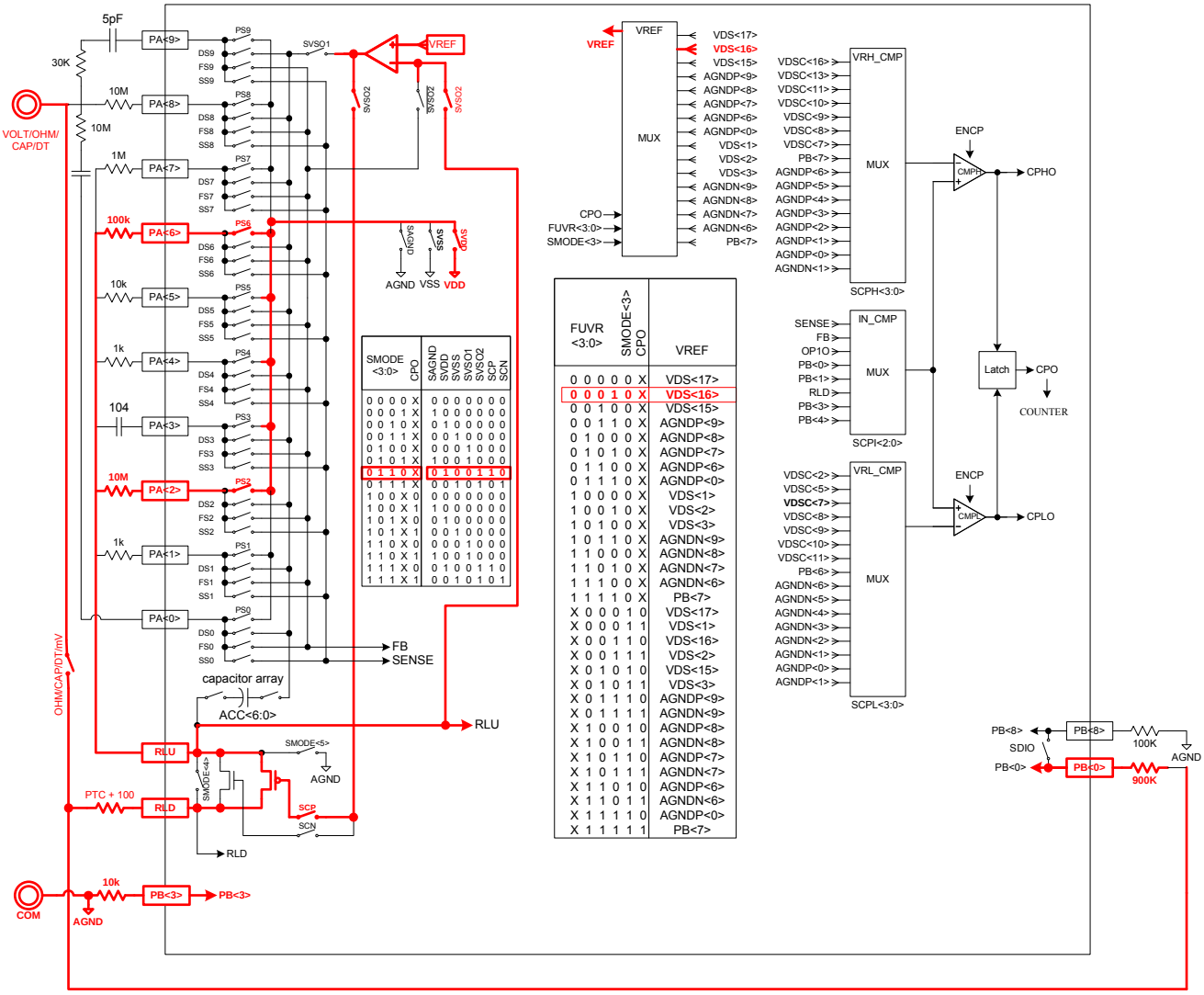


6.5. 50Kohm Input Network Configuration



FUVR <3:0>	SMODE<3>	CPO	VREF
0 0 0 0	0	X	VDS<17>
0 0 0 1	0	X	VDS<16>
0 0 1 0	0	X	VDS<15>
0 0 1 1	0	X	AGNDP<9>
0 1 0 0	0	X	AGNDP<8>
0 1 0 1	0	X	AGNDP<7>
0 1 1 0	0	X	AGNDP<6>
0 1 1 1	0	X	AGNDP<0>
1 0 0 0	0	X	VDS<1>
1 0 0 1	0	X	VDS<2>
1 0 1 0	0	X	VDS<3>
1 0 1 1	0	X	AGNDN<9>
1 1 0 0	0	X	AGNDN<8>
1 1 0 1	0	X	AGNDN<7>
1 1 1 0	0	X	AGNDN<6>
1 1 1 1	0	X	PB<7>
X 0 0 0	1	0	VDS<17>
X 0 0 0	1	1	VDS<1>
X 0 0 1	1	0	VDS<16>
X 0 0 1	1	1	VDS<2>
X 0 1 0	1	0	VDS<15>
X 0 1 0	1	1	VDS<3>
X 0 1 1	1	0	AGNDP<9>
X 0 1 1	1	1	AGNDN<9>
X 1 0 0	1	0	AGNDP<8>
X 1 0 0	1	1	AGNDN<8>
X 1 0 1	1	0	AGNDP<7>
X 1 0 1	1	1	AGNDN<7>
X 1 1 0	1	0	AGNDP<6>
X 1 1 0	1	1	AGNDN<6>
X 1 1 1	1	0	AGNDP<0>
X 1 1 1	1	1	PB<7>

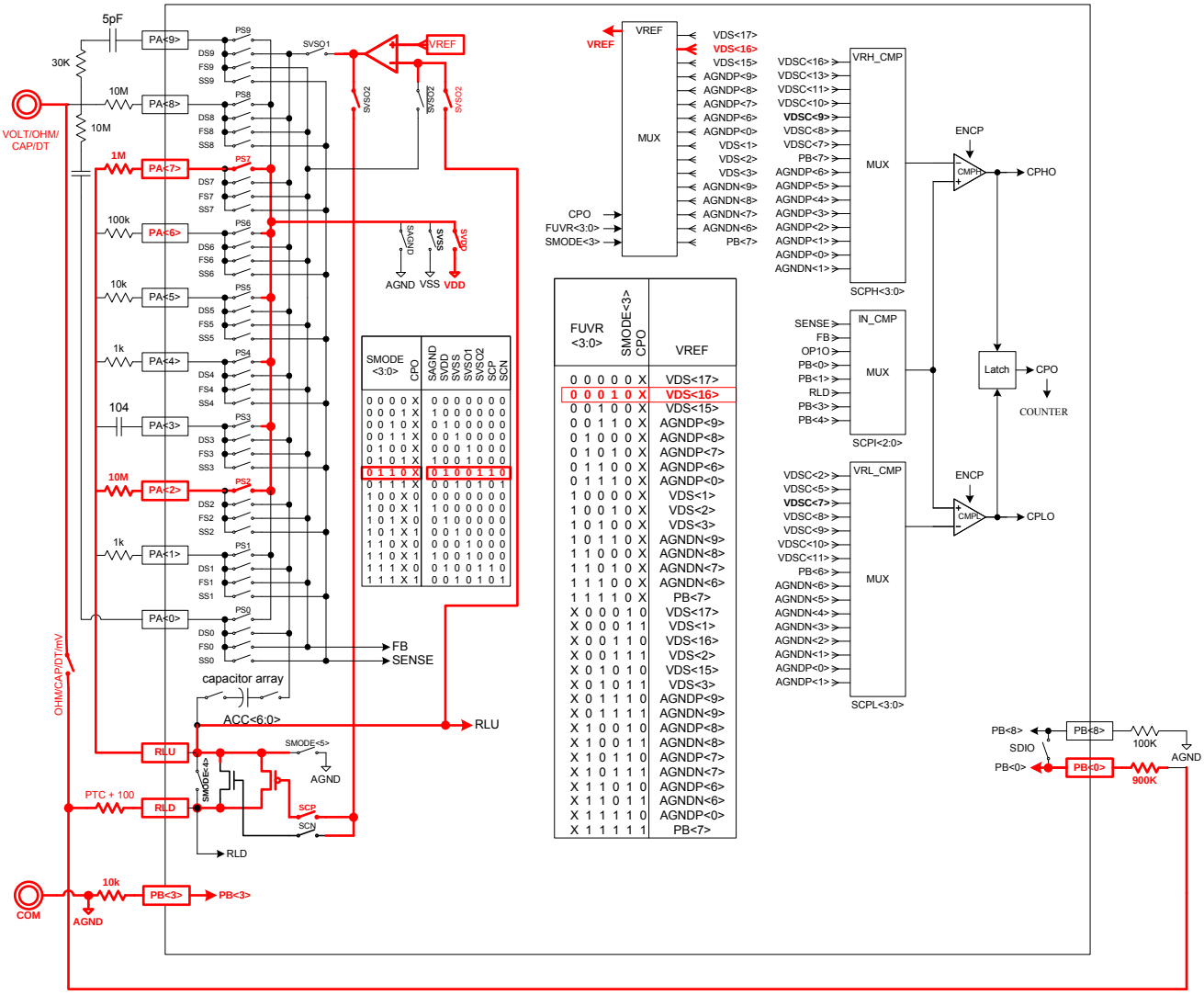
6.6. 500Kohm Input Network Configuration



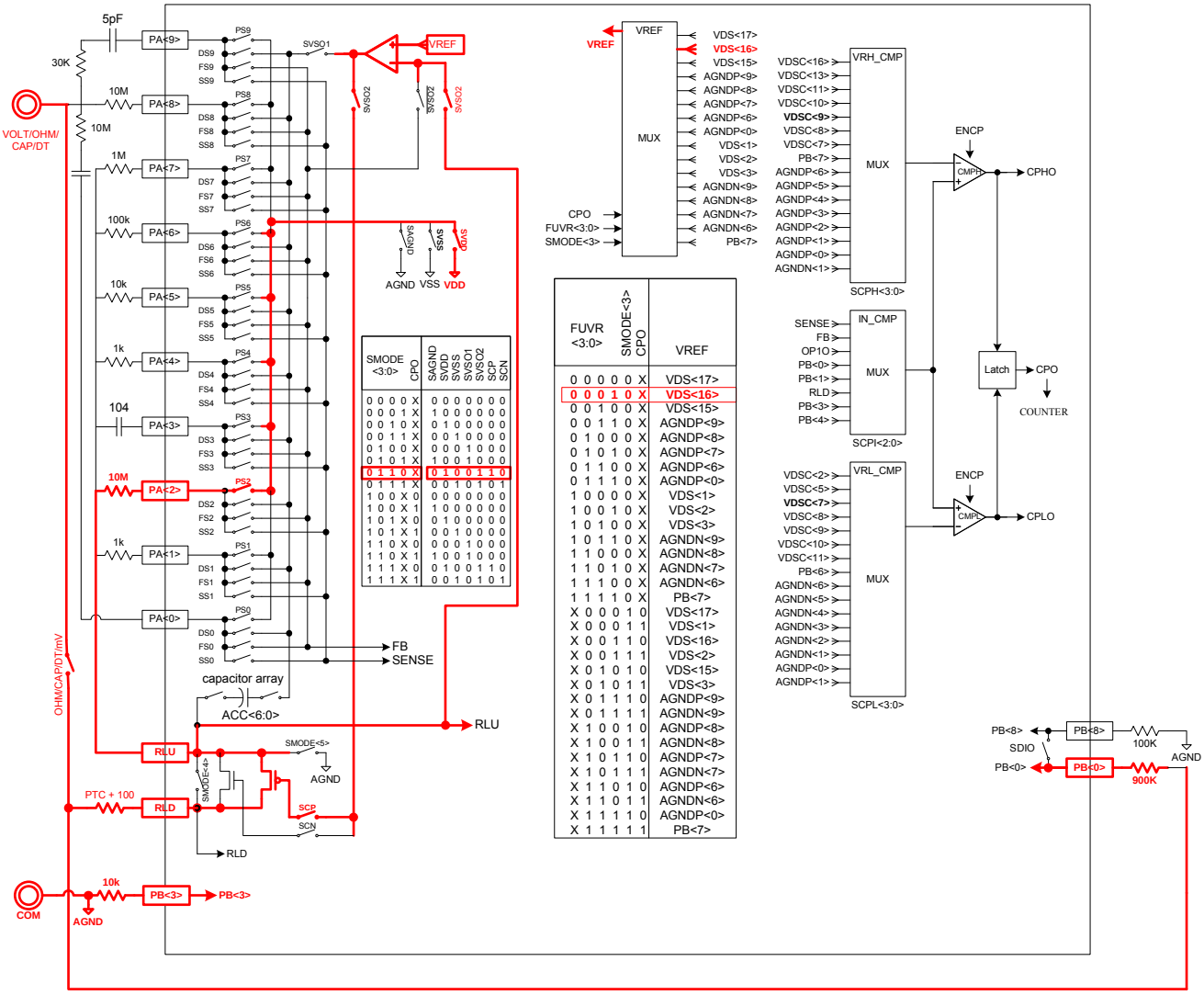
SMODE <3:0>	CPO	SAGND	SVDD	SVSS	SVSO1	SVSO2	SCP	SCN
0 0 0 0	X	0	0	0	0	0	0	0
0 0 0 1	X	1	0	0	0	0	0	0
0 0 1 0	X	0	1	0	0	0	0	0
0 0 1 1	X	0	0	1	0	0	0	0
0 1 0 0	X	0	0	0	1	0	0	0
0 1 0 1	X	1	0	0	1	0	0	0
0 1 1 0	X	0	1	0	1	0	1	0
0 1 1 1	X	0	0	1	0	1	0	1
1 0 0 X	0	0	0	0	0	0	0	0
1 0 0 X	1	1	0	0	0	0	0	0
1 0 1 X	0	0	1	0	0	0	0	0
1 0 1 X	1	0	0	1	0	0	0	0
1 1 0 X	0	0	0	0	1	0	0	0
1 1 0 X	1	1	0	0	1	0	0	0
1 1 1 X	0	0	1	0	1	0	1	0
1 1 1 X	1	0	0	1	0	1	0	1

FUVR <3:0>	SMODE<3>	CPO	VREF
0 0 0 0	0	X	VDS<17>
0 0 0 1	0	X	VDS<16>
0 0 1 0	0	X	VDS<15>
0 0 1 1	0	X	AGNDP<9>
0 1 0 0	0	X	AGNDP<8>
0 1 0 1	0	X	AGNDP<7>
0 1 1 0	0	X	AGNDP<6>
0 1 1 1	0	X	AGNDP<0>
1 0 0 0	0	X	VDS<1>
1 0 0 1	0	X	VDS<2>
1 0 1 0	0	X	VDS<3>
1 0 1 1	0	X	AGNDN<9>
1 1 0 0	0	X	AGNDN<8>
1 1 0 1	0	X	AGNDN<7>
1 1 1 0	0	X	AGNDN<6>
1 1 1 1	0	X	PB<7>
X 0 0 0	1	0	VDS<17>
X 0 0 0	1	1	VDS<1>
X 0 0 1	1	0	VDS<16>
X 0 0 1	1	1	VDS<2>
X 0 1 0	1	0	VDS<15>
X 0 1 0	1	1	VDS<3>
X 0 1 1	1	0	AGNDP<9>
X 0 1 1	1	1	AGNDN<9>
X 1 0 0	1	0	AGNDP<8>
X 1 0 0	1	1	AGNDN<8>
X 1 0 1	1	0	AGNDP<7>
X 1 0 1	1	1	AGNDN<7>
X 1 1 0	1	0	AGNDP<6>
X 1 1 0	1	1	AGNDN<6>
X 1 1 1	1	0	AGNDP<0>
X 1 1 1	1	1	PB<7>

6.7. 5M ohm Input Network Configuration



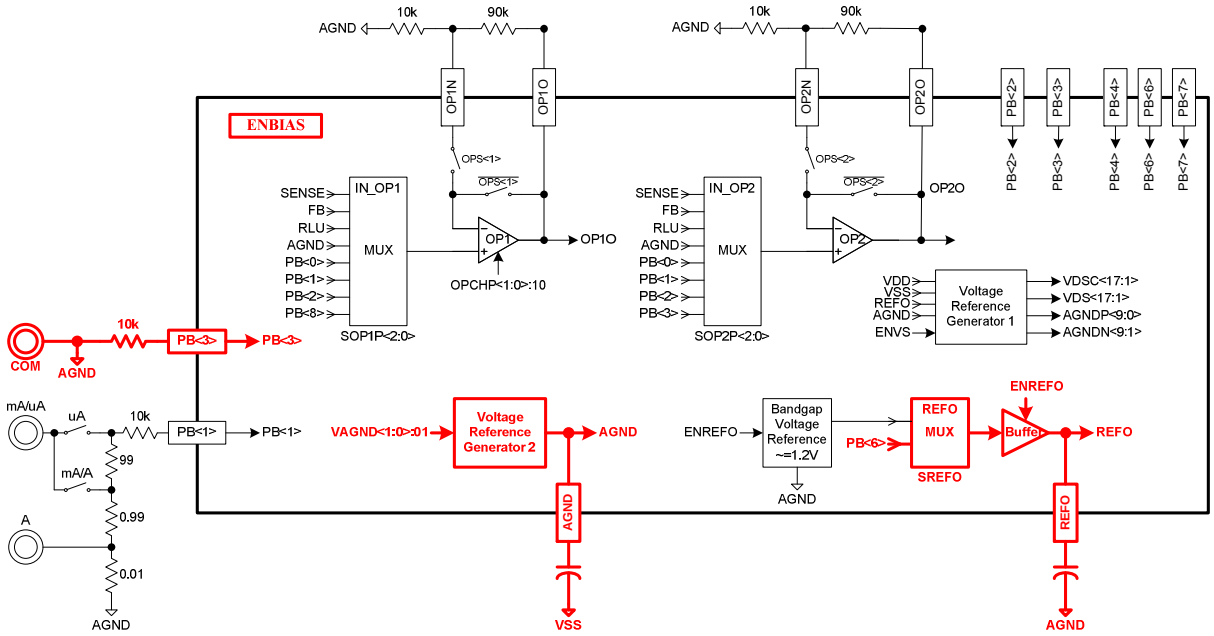
6.8. 50Mohm Input Network Configuration

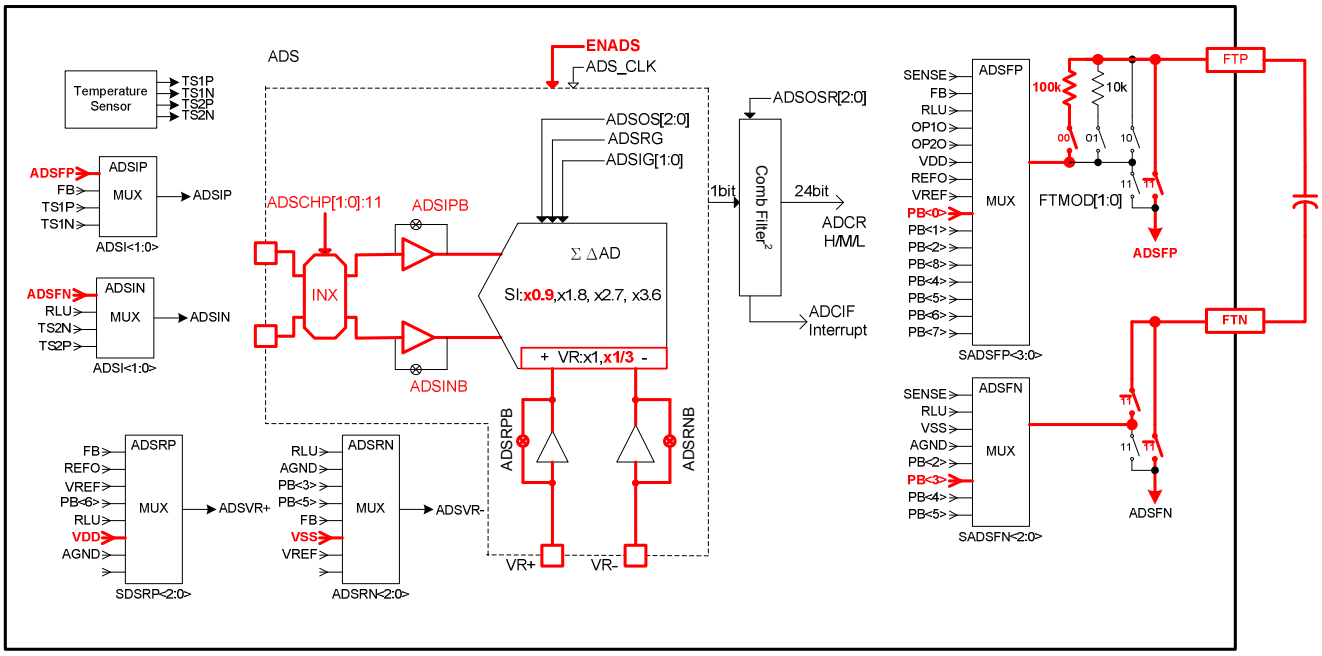


SMODE <3:0>	CPO	SAGND	SVDD	SVSS	SVSO1	SVSO2	SCP	SCN
0 0 0 0	X	0	0	0	0	0	0	0
0 0 0 1	X	1	0	0	0	0	0	0
0 0 1 0	X	0	1	0	0	0	0	0
0 0 1 1	X	0	0	1	0	0	0	0
0 1 0 0	X	0	0	0	1	0	0	0
0 1 0 1	X	1	0	0	1	0	0	0
0 1 1 0	X	0	1	0	1	0	1	0
0 1 1 1	X	0	0	1	0	1	0	1
1 0 0 X	0	0	0	0	0	0	0	0
1 0 0 X	1	1	0	0	0	0	0	0
1 0 1 X	0	0	1	0	0	0	0	0
1 0 1 X	1	0	0	1	0	0	0	0
1 1 0 X	0	0	0	0	1	0	0	0
1 1 0 X	1	1	0	0	1	0	0	0
1 1 1 X	0	0	1	0	1	0	1	0
1 1 1 X	1	0	0	1	0	1	0	1

FUVR <3:0>	SMODE<3>	CPO	VREF
0 0 0 0	0	X	VDS<17>
0 0 0 1	0	X	VDS<16>
0 0 1 0	0	X	VDS<15>
0 0 1 1	0	X	AGNDP<9>
0 1 0 0	0	X	AGNDP<8>
0 1 0 1	0	X	AGNDP<7>
0 1 1 0	0	X	AGNDP<6>
0 1 1 1	0	X	AGNDP<0>
1 0 0 0	0	X	VDS<1>
1 0 0 1	0	X	VDS<2>
1 0 1 0	0	X	VDS<3>
1 0 1 1	0	X	AGNDN<9>
1 1 0 0	0	X	AGNDN<8>
1 1 0 1	0	X	AGNDN<7>
1 1 1 0	0	X	AGNDN<6>
1 1 1 1	0	X	PB<7>
X 0 0 0	1	0	VDS<17>
X 0 0 0	1	1	VDS<1>
X 0 0 1	1	0	VDS<16>
X 0 0 1	1	1	VDS<2>
X 0 1 0	1	0	VDS<15>
X 0 1 0	1	1	VDS<3>
X 0 1 1	1	0	AGNDP<9>
X 0 1 1	1	1	AGNDN<9>
X 1 0 0	1	0	AGNDP<8>
X 1 0 0	1	1	AGNDN<8>
X 1 0 1	1	0	AGNDP<7>
X 1 0 1	1	1	AGNDN<7>
X 1 1 0	1	0	AGNDP<6>
X 1 1 0	1	1	AGNDN<6>
X 1 1 1	1	0	AGNDP<0>
X 1 1 1	1	1	PB<7>

6.9. 500Kohm~50Mohm Measurement Network Configuration



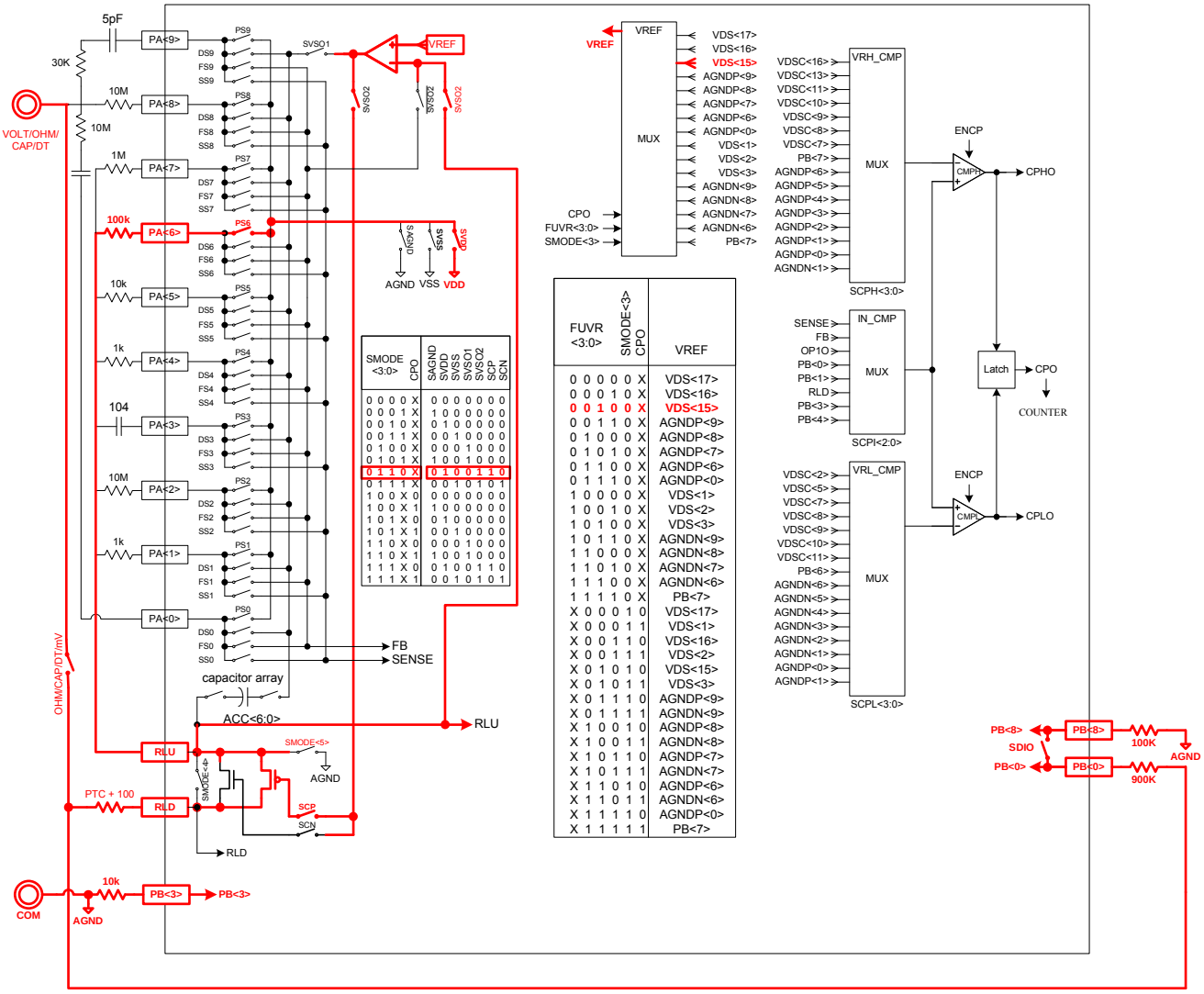


7. Diode

Diode function is to measure Forward Voltage or called PN Barrier Potential. This chip offers positive/negative constant current source or positive/negative constant voltage source measurement. This example illustrates positive constant current measurement.

When constant current passed through diode, both edges of component will have voltage difference. The voltage is around 0.2V~1.5V, to prevent exceeding full scale. Thus, taking 900kΩ and 100kΩ to form 10 times attenuation.

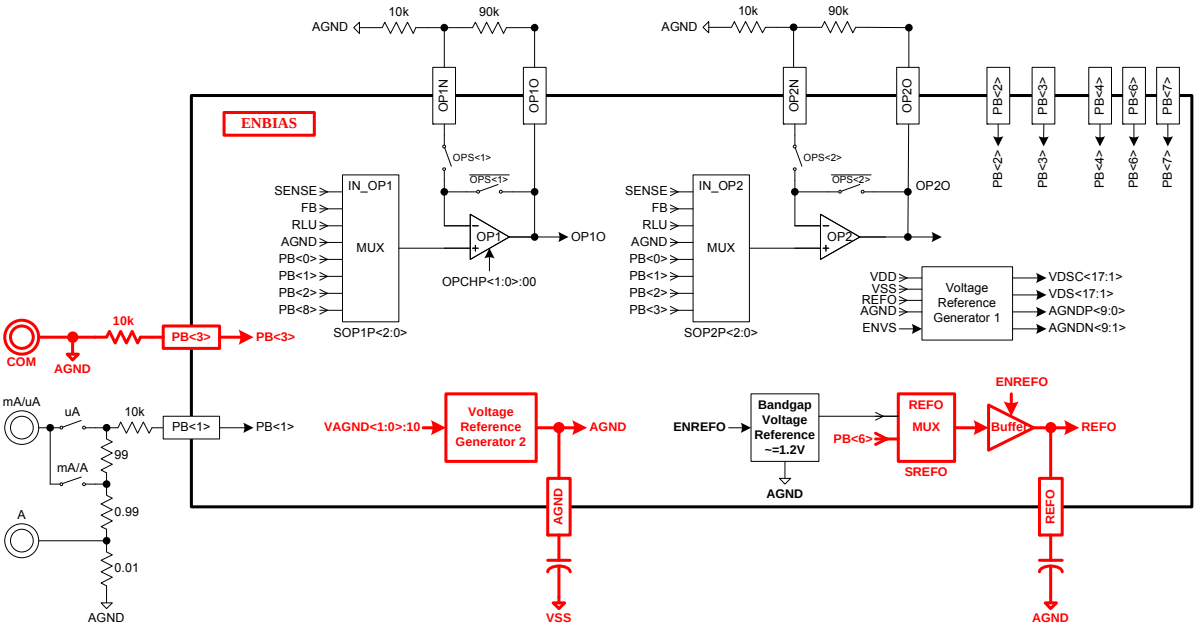
7.1. Diode Input Network Configuration

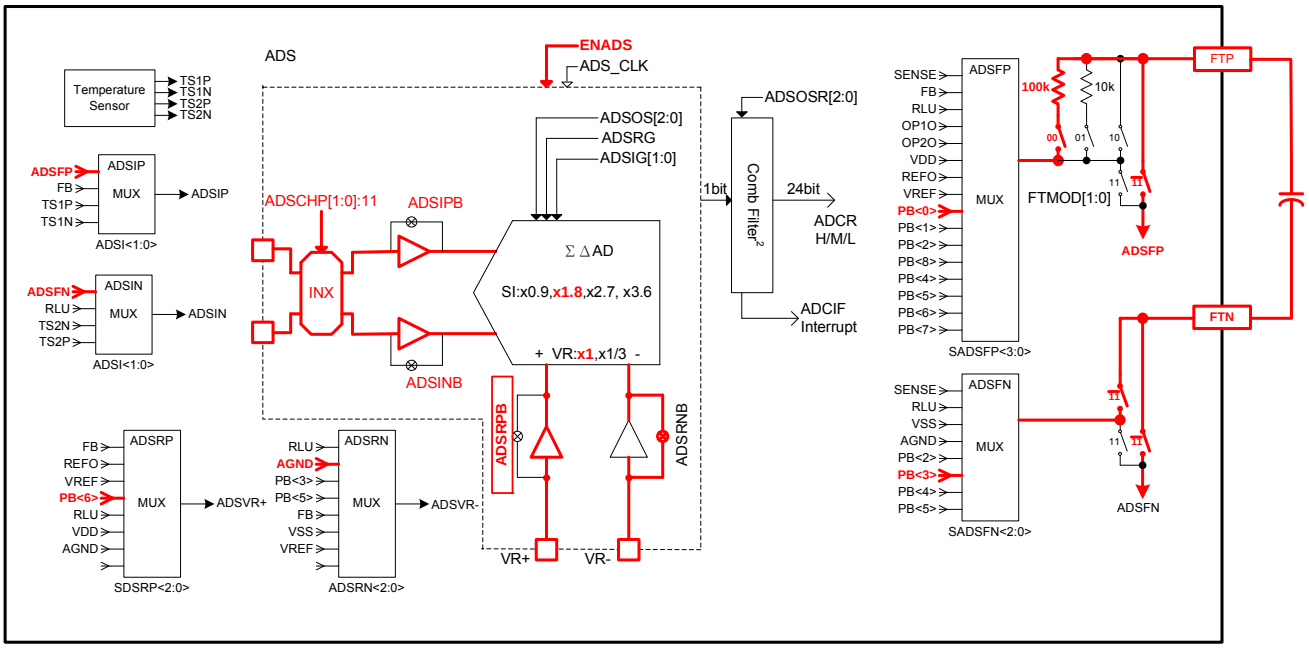


SMODE <3:0>	CPO	SAGND	SVDD	SVSS	SVSO1	SVSO2	SCP	SCN
0 0 0 0	X	0	0	0	0	0	0	0
0 0 0 1	X	1	0	0	0	0	0	0
0 0 1 0	X	0	1	0	0	0	0	0
0 0 1 1	X	0	0	1	0	0	0	0
0 1 0 0	X	0	0	0	1	0	0	0
0 1 0 1	X	1	0	0	1	0	0	0
0 1 1 0	X	0	1	0	0	1	0	0
0 1 1 1	X	0	0	1	0	1	0	0
1 0 0 X	0	0	0	0	0	0	1	0
1 0 0 X	1	1	0	0	0	0	1	0
1 0 1 X	0	0	1	0	0	0	1	0
1 0 1 X	1	0	0	1	0	0	1	0
1 1 0 X	0	0	0	0	1	0	1	0
1 1 0 X	1	1	0	0	1	0	1	0
1 1 1 X	0	0	1	0	0	1	1	0
1 1 1 X	1	0	0	1	0	1	1	0

FUVR <3:0>	SMODE<3>	CPO	VREF
0 0 0 0	0	X	VDS<17>
0 0 0 1	0	X	VDS<16>
0 0 1 0	0	X	VDS<15>
0 0 1 1	0	X	AGNDP<9>
0 1 0 0	0	X	AGNDP<8>
0 1 0 1	0	X	AGNDP<7>
0 1 1 0	0	X	AGNDP<6>
0 1 1 1	0	X	AGNDP<0>
1 0 0 0	0	X	VDS<1>
1 0 0 1	0	X	VDS<2>
1 0 1 0	0	X	VDS<3>
1 0 1 1	0	X	AGNDN<9>
1 1 0 0	0	X	AGNDN<8>
1 1 0 1	0	X	AGNDN<7>
1 1 1 0	0	X	AGNDN<6>
1 1 1 1	0	X	PB<7>
X 0 0 0	1	0	VDS<17>
X 0 0 0	1	1	VDS<1>
X 0 0 1	1	0	VDS<16>
X 0 0 1	1	1	VDS<2>
X 0 1 0	1	0	VDS<15>
X 0 1 0	1	1	VDS<3>
X 0 1 1	1	0	AGNDP<9>
X 0 1 1	1	1	AGNDN<9>
X 1 0 0	1	0	AGNDP<8>
X 1 0 0	1	1	AGNDN<8>
X 1 0 1	1	0	AGNDP<7>
X 1 0 1	1	1	AGNDN<7>
X 1 1 0	1	0	AGNDP<6>
X 1 1 0	1	1	AGNDN<6>
X 1 1 1	1	0	AGNDP<0>
X 1 1 1	1	1	PB<7>

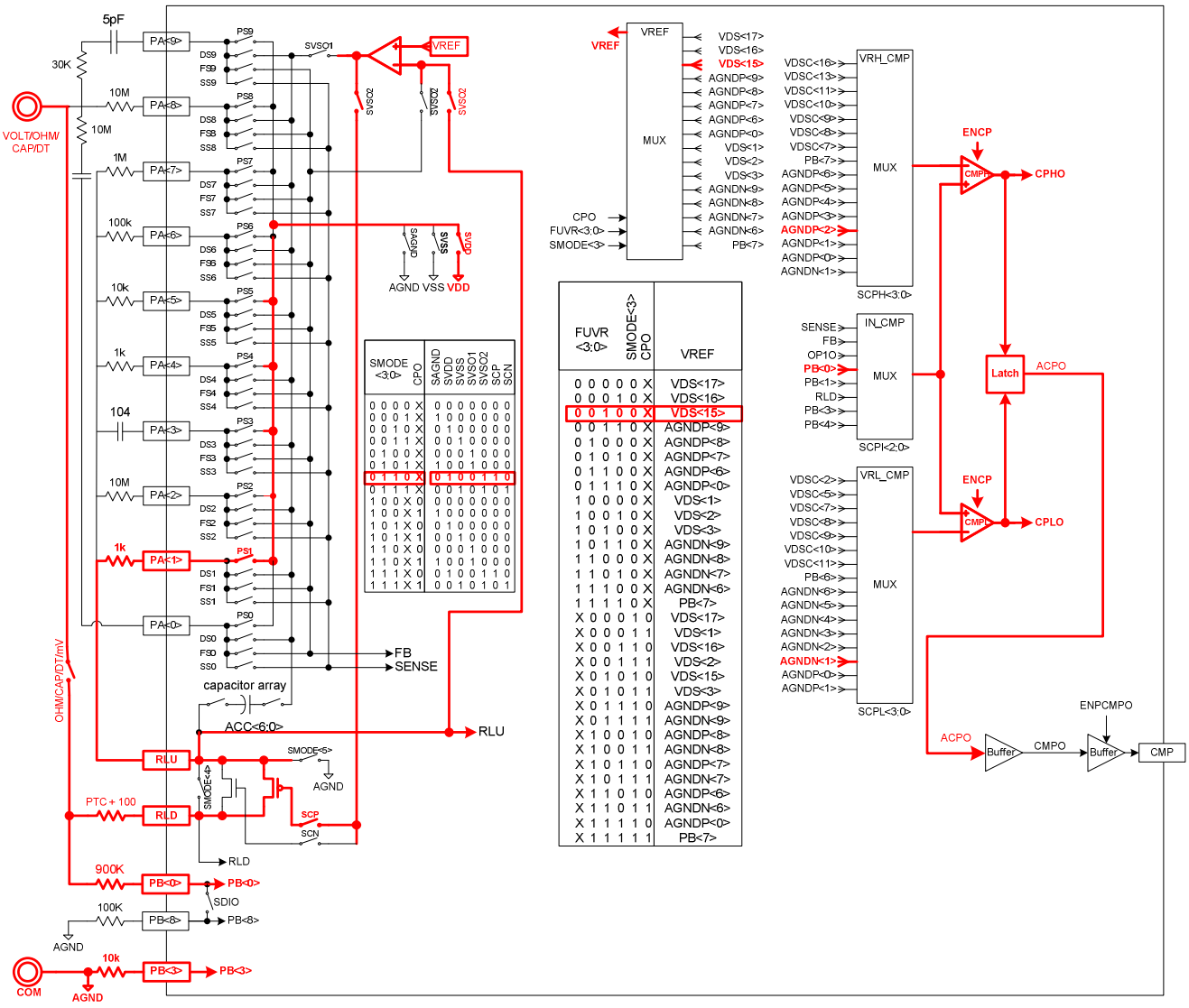
7.2. Diode Measurement Network Configuration





8. Continuity

This function can use constant current or constant voltage output measurements. This case is positive constant current output measurement.

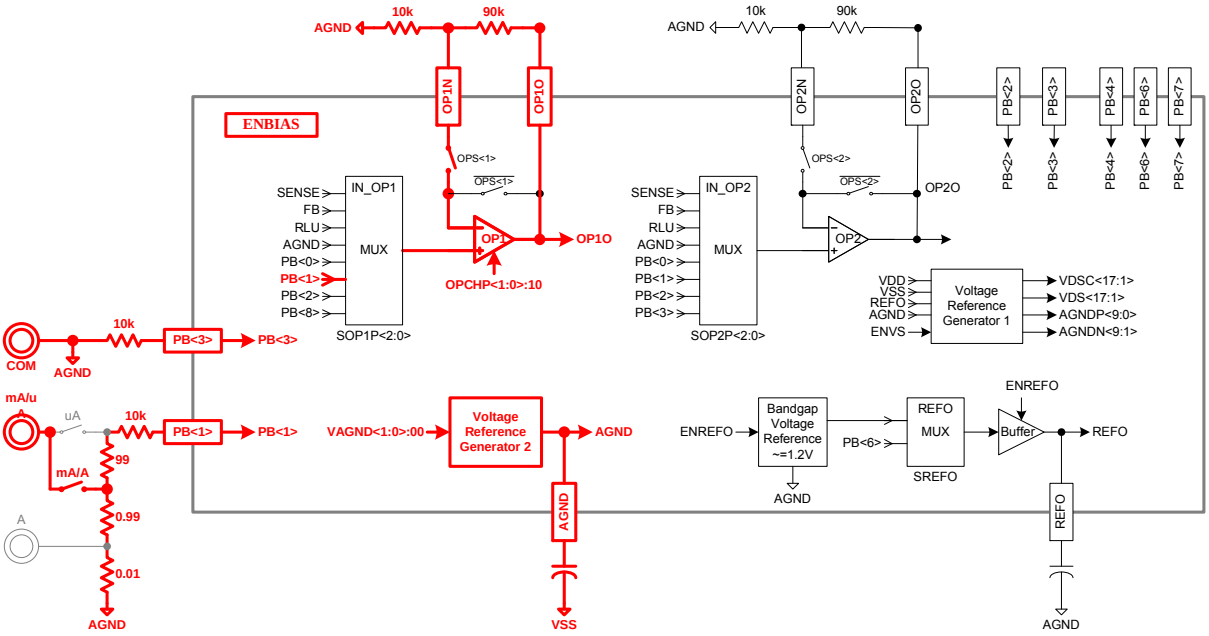


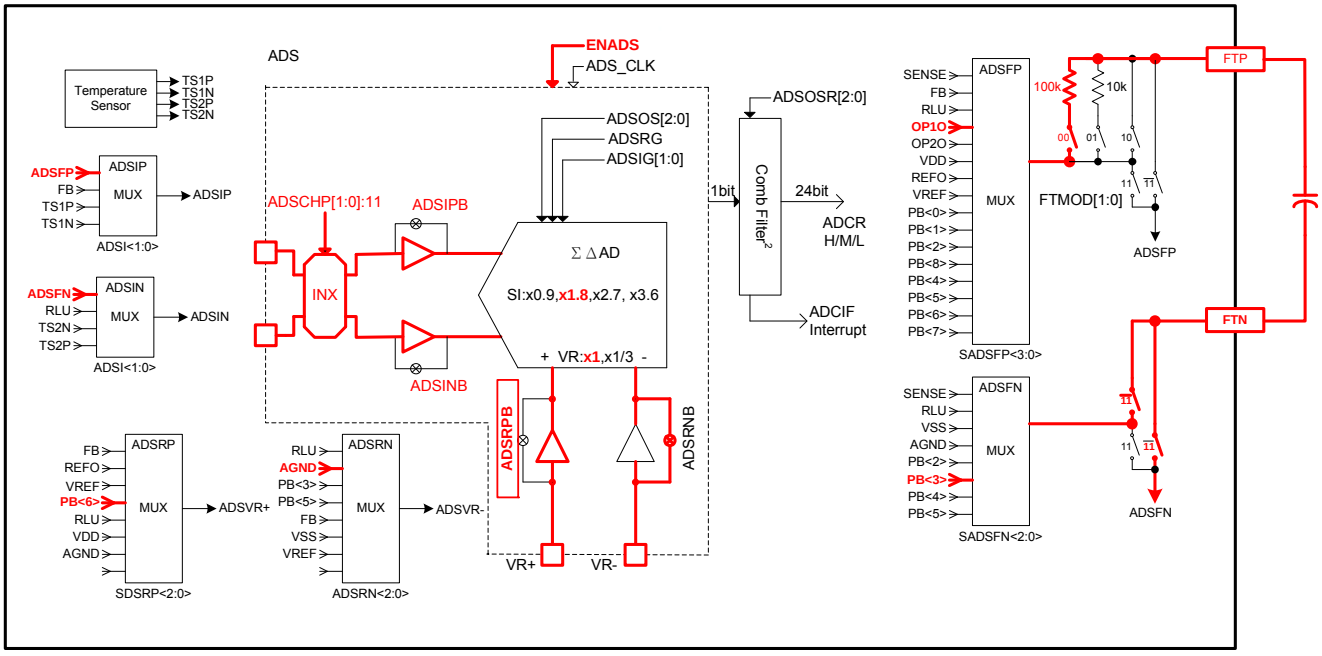
FUVR <3:0>	SMODE<3>	CPO	VREF
0 0 0 0	0	X	VDS<17>
0 0 0 1	0	X	VDS<16>
0 0 1 0	0	X	VDS<15>
0 0 1 1	0	X	AGNDP<9>
0 1 0 0	0	X	AGNDP<8>
0 1 0 1	0	X	AGNDP<7>
0 1 1 0	0	X	AGNDP<6>
0 1 1 1	0	X	AGNDP<0>
1 0 0 0	0	X	VDS<1>
1 0 0 1	0	X	VDS<2>
1 0 1 0	0	X	VDS<3>
1 0 1 1	0	X	AGNDN<9>
1 1 0 0	0	X	AGNDN<8>
1 1 0 1	0	X	AGNDN<7>
1 1 1 0	0	X	AGNDN<6>
1 1 1 1	0	X	PB<7>
X 0 0 0	1	0	VDS<17>
X 0 0 0	1	1	VDS<1>
X 0 0 1	1	0	VDS<16>
X 0 0 1	1	1	VDS<2>
X 0 1 0	1	0	VDS<15>
X 0 1 0	1	1	VDS<3>
X 0 1 1	1	0	AGNDP<9>
X 0 1 1	1	1	AGNDN<9>
X 1 0 0	1	0	AGNDP<8>
X 1 0 0	1	1	AGNDN<8>
X 1 0 1	1	0	AGNDP<7>
X 1 0 1	1	1	AGNDN<7>
X 1 1 0	1	0	AGNDP<6>
X 1 1 0	1	1	AGNDN<6>
X 1 1 1	1	0	AGNDP<0>
X 1 1 1	1	1	PB<7>

9. Current

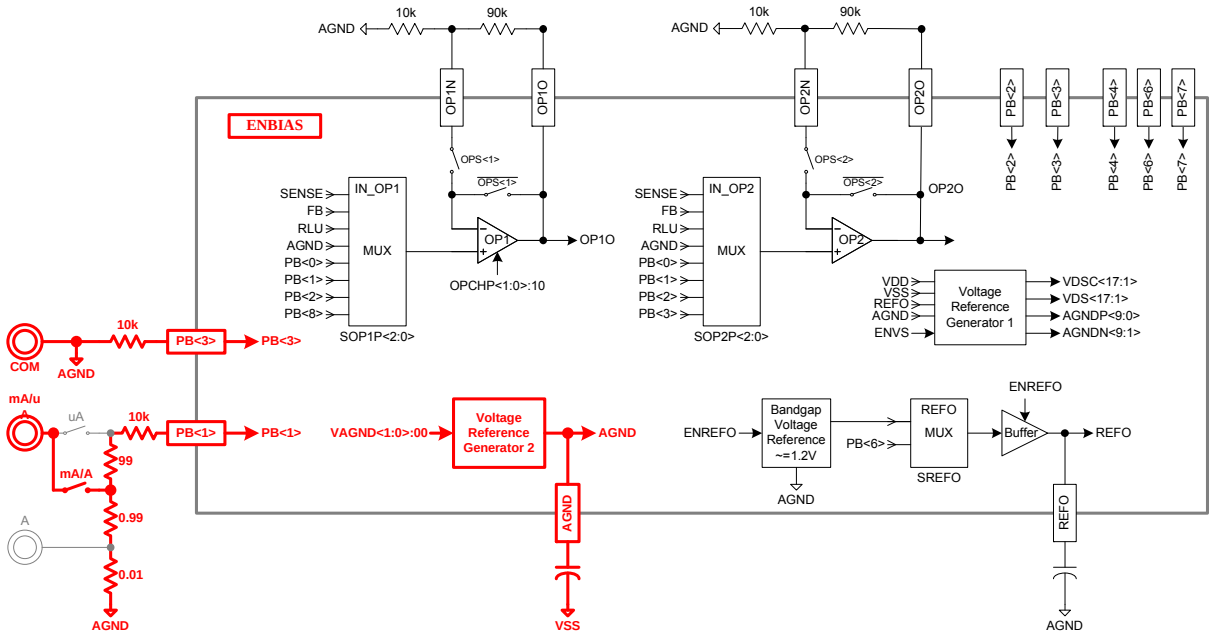
Current measurement is similar with that of measuring mV.

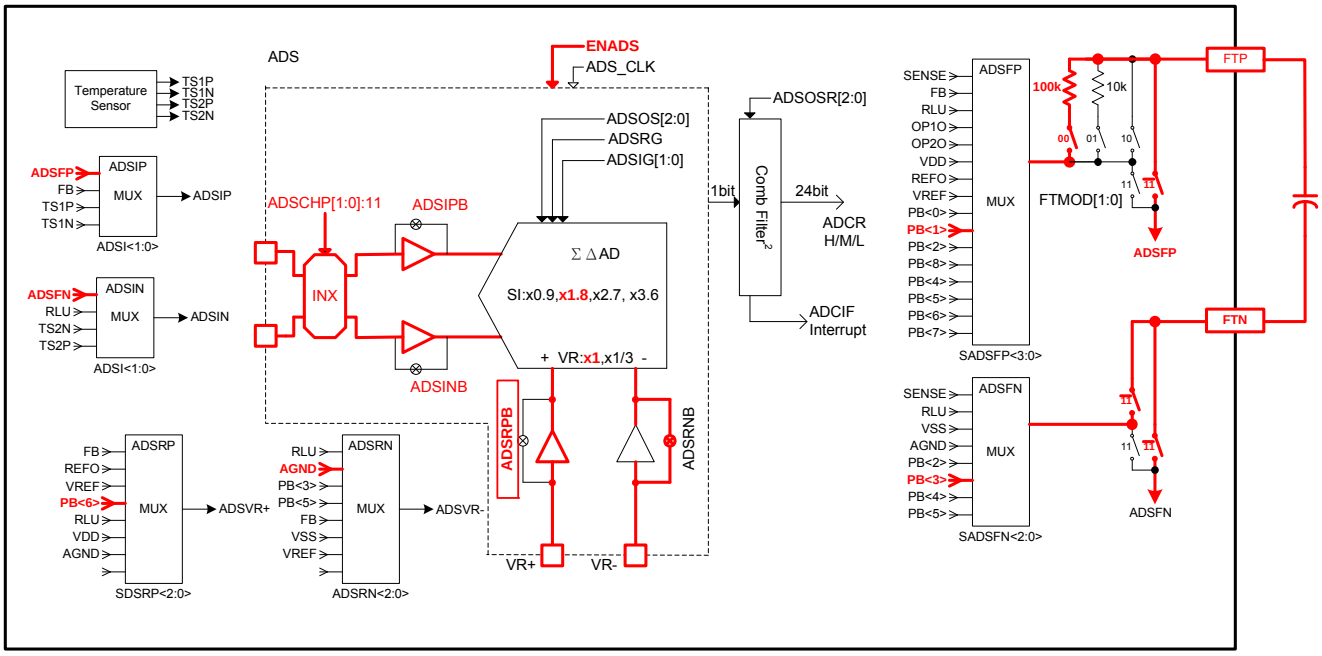
9.1. DC 50mA



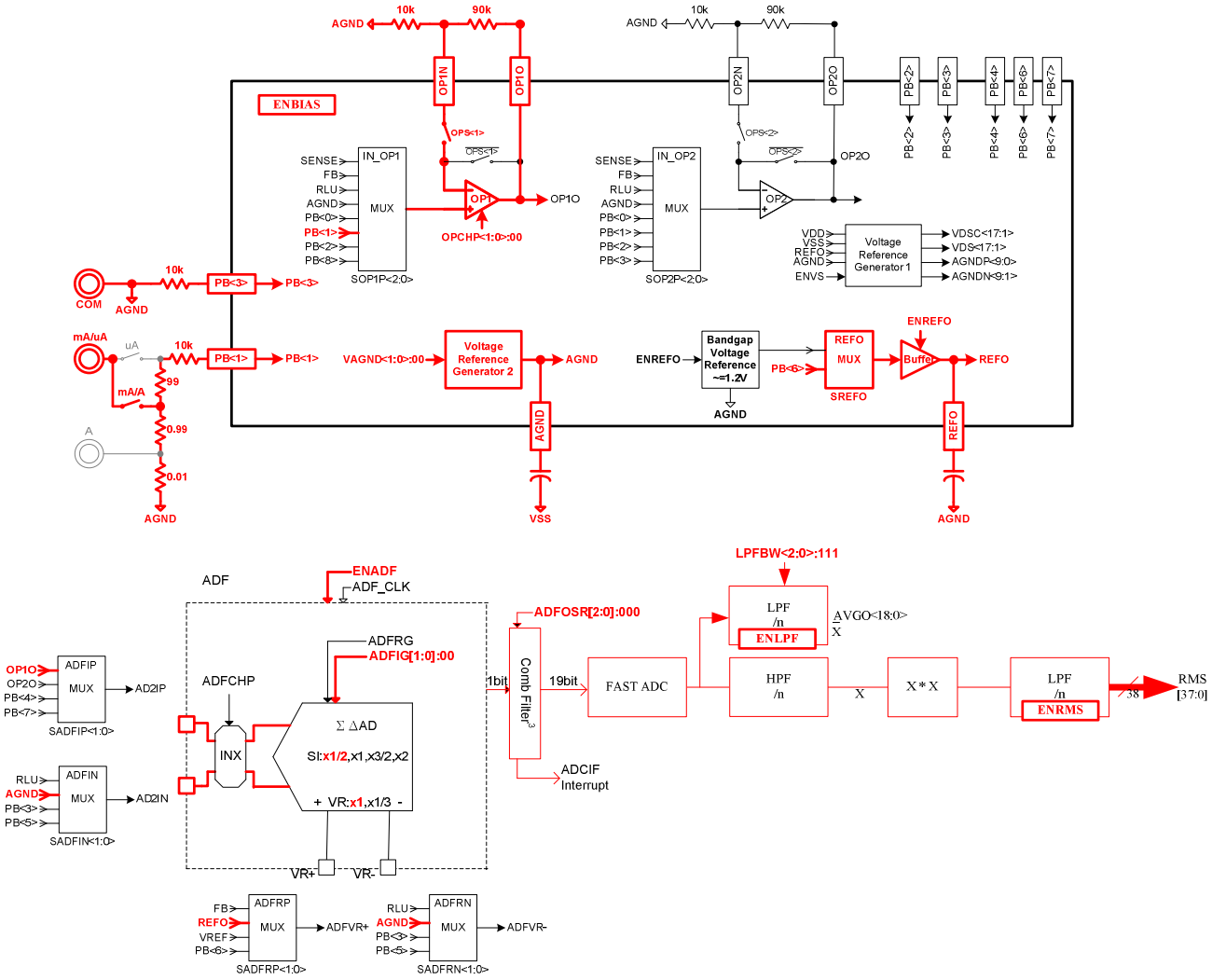


9.2. DC 500mA


AGND
10k
90k
ENBIAS
OP1N
OP1O
OP2N
OP2O
PB<2>
PB<3>
PB<4>
PB<6>
PB<7>
OPS<1>
OPS<2>
SENSE
FB
RLU
AGND
PB<0>
PB<1>
PB<2>
PB<8>
IN_OP1
MUX
SOP1P<2:0>
OP1
OP1O
OPCHP<1:0>:10
IN_OP2
SOP2P<2:0>
OP2
OP2O
VDD
VSS
REFO
ENVS
Voltage Reference Generator 1
VDSC<17:1>
VDS<17:1>
AGNDP<9:0>
AGNDN<9:1>
COM
PB<3>
mA/u
uA
mA/A
99
0.99
0.01
PB<1>
VAGND<1:0>:00
Voltage Reference Generator 2
VSS
ENREFO
Bandgap Voltage Reference ~=1.2V
REFO MUX
SREFO
Buffer
REFO

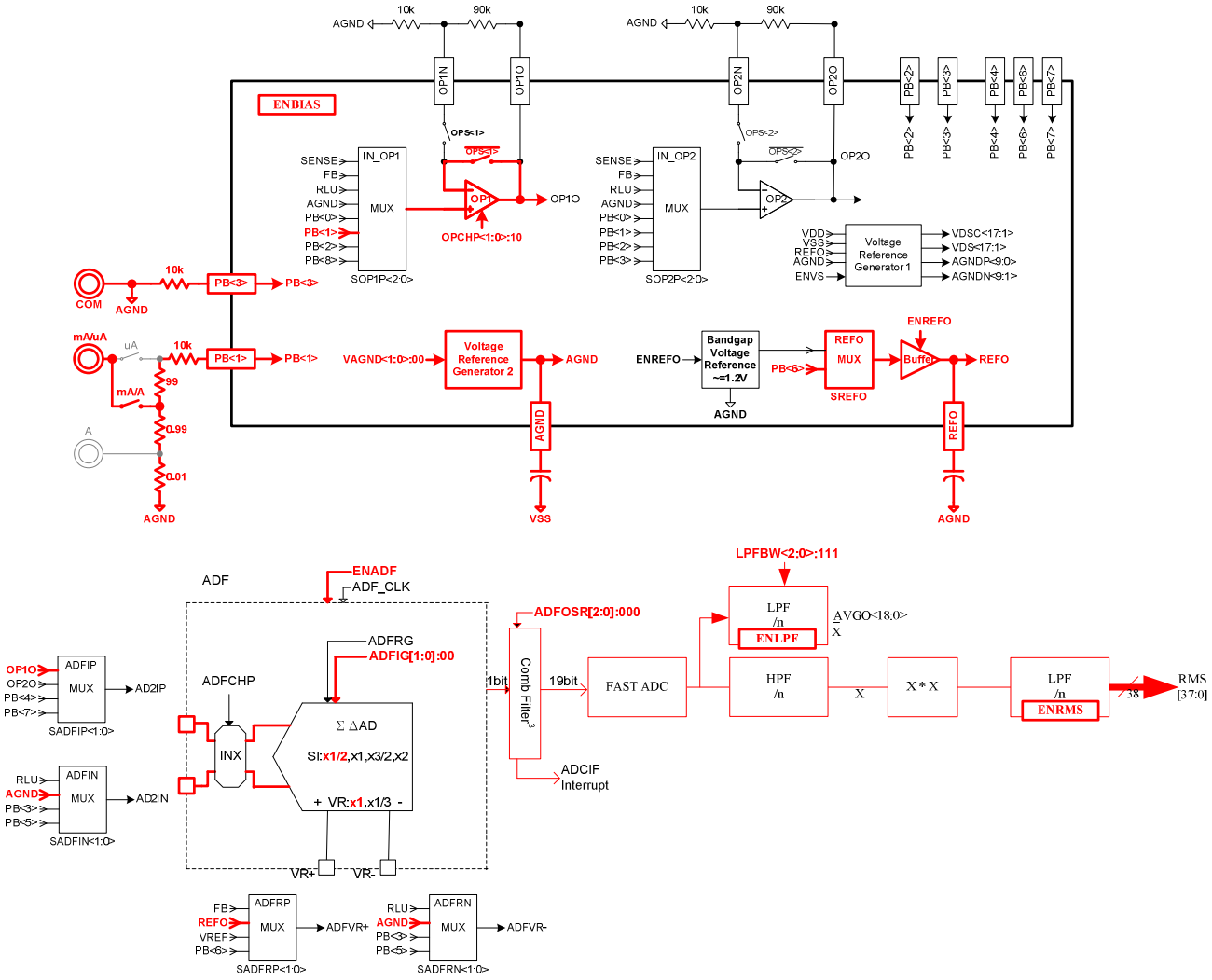

ADS
ENADS
ADS_CLK
Temperature Sensor
TS1P
TS1N
TS2P
TS2N
ADSFP
ADSIP
FB
TS1P
TS1N
MUX
ADSI<1:0>
ADSFN
ADSIN
RLU
TS2N
TS2P
ADSOS[2:0]
ADSRG
ADSIG[1:0]
ADSCHP[1:0]:11
ADSIPB
INX
ADSINB
Σ ΔAD
SI:x0.9,x1.8,x2.7, x3.6
+ VR:x1,x1/3 -
ADSOSR[2:0]
1bit
Comb Filter2
24bit
ADCR H/M/L
ADCIF Interrupt
ADSRP
REFO
VREF
PB<6>
VDD
AGND
SDSRP<2:0>
ADSVR+
ADSRN
PB<3>
PB<5>
VSS
SADSRN<2:0>
ADSVR-
ADSRPB
ADSRNB
VR+
VR-
SADSFP<3:0>
100k
10k
00
01
10
11
FTMOD[1:0]
FTP
FTN
SADSFN<2:0>

9.3. AC 50mA


AGND
10k
90k
OP1N
OP1O
ENBIAS
OPS<1>
SENSE
FB
RLU
AGND
PB<0>
PB<1>
PB<2>
PB<8>
IN_OP1
MUX
SOP1P<2:0>
OP1
OP1O
OPCHP<1:0>:00
OP2N
OP2O
OPS<2>
PB<2>
PB<3>
PB<4>
PB<6>
PB<7>
IN_OP2
SOP2P<2:0>
OP2
VDD
VSS
REFO
ENVS
Voltage Reference Generator 1
VDSC<17:1>
VDS<17:1>
AGNDP<9:0>
AGNDN<9:1>
COM
PB<3>
mA/uA
uA
mA/A
A
99
0.99
0.01
PB<1>
VAGND<1:0>:00
Voltage Reference Generator 2
VSS
ENREFO
Bandgap Voltage Reference ~=1.2V
PB<6>
REFO MUX
SREFO
Buffer
REFO

ADF
ENADF
ADF_CLK
ADFRG
ADFIG[1:0]:00
ADFCHP
INX
Σ ΔAD
SI:x1/2,x1,x3/2,x2
+ VR:x1,x1/3 -
VR+
VR-
OP1O
OP2O
PB<4>
PB<7>
ADFIP
MUX
AD2IP
SADFIP<1:0>
RLU
AGND
PB<3>
PB<5>
ADFIN
AD2IN
SADFIN<1:0>
FB
REFO
VREF
PB<6>
ADFRP
ADFVR+
SADFRP<1:0>
ADFRN
ADFVR-
SADFRN<1:0>
ADFOSR[2:0]:000
1bit
Comb Filter3
19bit
ADCIF
Interrupt
FAST ADC
LPFBW<2:0>:111
LPF
/n
ENLPF
AVGO<18:0>
HPF
X
X*X
ENRMS
38
RMS
[37:0]

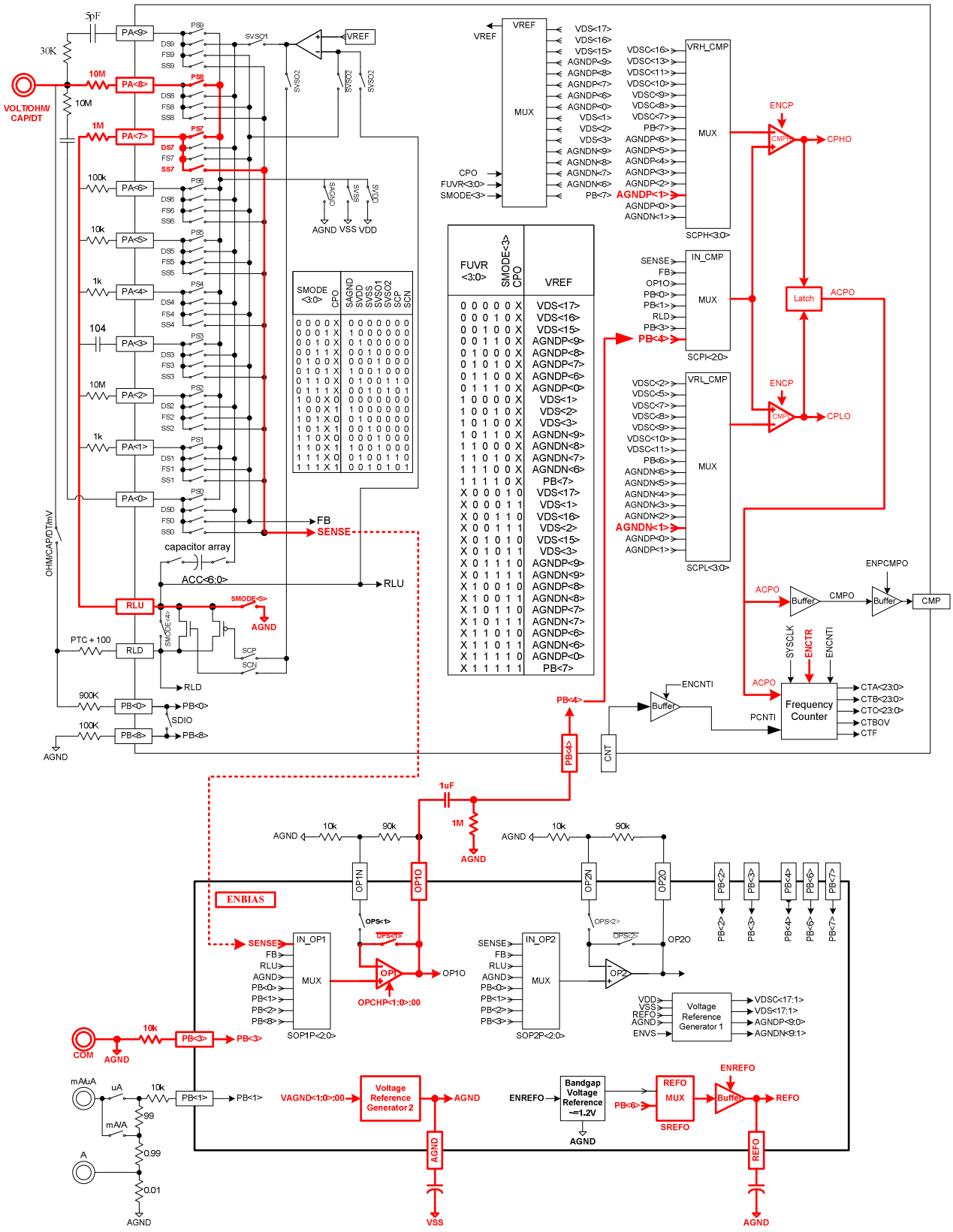
9.4. AC 500mA


AGND
10k
90k
OP1N
OP1O
OP2N
OP2O
ENBIAS
OPS<1>
OPS<2>
SENSE
FB
RLU
AGND
PB<0>
PB<1>
PB<2>
PB<3>
PB<8>
IN_OP1
MUX
SOP1P<2:0>
OP1
OPCHP<1:0>:10
IN_OP2
SOP2P<2:0>
OP2
PB<2>
PB<3>
PB<4>
PB<6>
PB<7>
VDD
VSS
REFO
ENVS
Voltage Reference Generator 1
VDSC<17:1>
VDS<17:1>
AGNDP<9:0>
AGNDN<9:1>
COM
mA/uA
uA
mA/A
A
99
0.99
0.01
VAGND<1:0>:00
Voltage Reference Generator 2
VSS
ENREFO
Bandgap Voltage Reference ~=1.2V
REFO MUX
SREFO
Buffer
REFO
ADF
ENADF
ADF_CLK
ADFRG
ADFIG[1:0]:00
ADFCHP
INX
Σ ΔAD
SI:x1/2,x1,x3/2,x2
+ VR:x1,x1/3 -
VR+
VR-
ADFIP
AD2IP
SADFIP<1:0>
ADFIN
AD2IN
SADFIN<1:0>
ADFRP
ADFVR+
SADFRP<1:0>
ADFRN
ADFVR-
SADFRN<1:0>
ADFOSR[2:0]:000
Comb Filter3
1bit
19bit
ADCIF
Interrupt
FAST ADC
LPFBW<2:0>:111
LPF /n
ENLPF
AVGO<18:0>
HPF /n
X
X*X
ENRMS
/38
RMS [37:0]

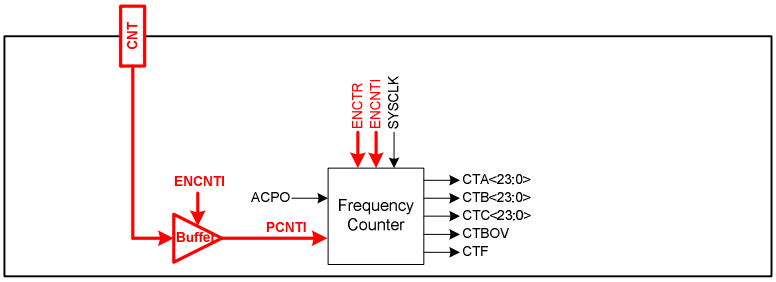
10. Frequency

10.1. Voltage input

When measured frequency, the signal is inputted by PA<n> and PB<n>. If the input contains DC, must be removed by AC Coupled capacitors.



10.2. CNT input



11. Revision History

Major differences are stated thereinafter:

Version	Page	Revision Summary
V01	All	First edition
V02	All	Revise all contents