Body Composition (BC) Calculations

Variables:

- Excitation Frequency
- Excitation Voltage
- Unknown Impedance
- Access Impedance
- Calibration Resistor (R_{CAL})
- TIA Resistor (R_{TIA})
- Instrumentation Amplifier Gain Resistor (R_G)

Excitation Frequency:
High frequency excitation is required for BC measurements. Good accuracy is achieved using 50 kHz.

Excitation Voltage:
Large excitation voltage used to achieve best SNR. 600 mV_{PEAK} recommended.

Unknown Impedance:
The impedance range of unknown impedance ($Z_{UNKNOWN}$) for BC applications (4 electrode, wrist worn BC solution) is typically 100 Ω - 5 kΩ (from left wrist to right finger).

Access Impedance:
Current limiting resistor (R_{LIMIT}) and DC blocking / isolating capacitors (C_{ISO1} and C_{ISO2}) are required to meet the IEC 60601 Standard. These components will contribute towards the total access impedance of the excitation leg ($Z_{ACCESS1}$) and measurement leg ($Z_{ACCESS2}$).
$Z_{ACCESS1} = R_{LIMIT} + C_{ISO1}$
$Z_{ACCESS2} = C_{ISO2}$

R_{LIMIT}:
IEC 60601 Standard limit for patient leakage at 50 kHz is 500 μA_{RMS}
500 μA_{RMS} = 707 μA_{PEAK}
600 mV_{PEAK} / 707 μA_{PEAK} = 848 Ω
Use 1 kΩ for additional safety margin.

C_{ISO}:
C_{ISO} should be large, but also needs to be cost effective. 47 nF should satisfy both metrics.

Calibration Resistor (R_{CAL}):
R_{CAL} should be set to be close to the minimum value of the expected unknown impedance. In this example, close to 100 Ω

TIA Resistor (R_{TIA}):
For R_{TIA} calculations use the minimum $Z_{UNKNOWN}$.
Minimum impedance seen by the TIA = $Z_{ACCESS1} + Z_{UNKNOWN} + Z_{ACCESS2}$ = 1108.31 Ω - 7.02°
600mV_{PEAK} / 1108.31 Ω = 541 μA_{PEAK}
Max ADC range = 750mV_{PEAK}
To avoid non-linearities at the ends of the range, use 80% of the total range = 600mV
600mV_{PEAK} / 541 µA = 1108 Ω
Use R_{TIA} = 1 kΩ

Instrumentation Amplifier (AD8226) Gain Resistor (RG):
Maximum impedance of $Z_{UNKNOWN}$ = 5 kΩ
Maximum current into TIA = 541 µA
Maximum voltage drop across R_{TIA} = 1 kΩ * 541 µA = 541 mV
ADuCM350 max ADC range = 750 mV_{PEAK}
Gain required = 750 mV / 541 mV = 1.386
AD8226 gain G = 1 + (49.4 kΩ / R_G) = 1.386 (see AD8226 datasheet for details)
R_G = 127.98 kΩ
Use R_G = 120 kΩ

Note if 2-Wire Relative Measurement Only:
Same maths apply for ADuCM350 – ignore AD8226 maths – part is not required.
RCAL measurement will need to be included so use the 2-Wire Impedance measurement example in SDK.