System Specifications

$R_{shunt} := 10 \cdot 10^{-3} \Omega$

$I_{load\_max} := 2.5A \qquad I_{load\_min} := -2.5A$

$V_{shunt\_max} := R_{shunt} \cdot I_{load\_max} = 25 \times 10^{-3} V$

$V_{shunt\_min} := R_{shunt} \cdot I_{load\_min} = -25 \times 10^{-3} V$

$FSR := V_{shunt\_max} - V_{shunt\_min} = 50 \times 10^{-3} V$

$T_{ambient} := 25C$

$T_{max} := 125C$

$\Delta T := T_{max} - T_{ambient} = 100 \times 10^{0} C$

Conversions

$dB(x) := \frac{1}{10^{\frac{x}{20}}} \frac{V}{V}$

$ppm := \frac{1}{1000000}$

Shunt Resistor Errors

Accuracy

$E_{shunt\_tol} := \alpha_{shunt\_tol} = 1 \times 10^{3} \cdot ppm$

Drift

$E_{shunt\_drift} := \Delta T \cdot \delta_{shunt\_drift} = 1.5 \times 10^{3} \cdot ppm$

Shunt Specifications

$\alpha_{shunt\_tol} := 0.1\%$

$\delta_{shunt\_drift} := 15 \frac{ppm}{C}$

INA213 Errors

INA Accuracy Specifications

$V_{os\_INA} := 5 \cdot \mu V$ $V_{s\_INA\_spec} := 5V$ $V_{s\_INA\_sys} := 3V$

$V_{os\_INA\_PSRR} := 0.1 \cdot \frac{\mu V}{V}$ $\alpha_{INA\_GE} := 0.02\%$

$V_{cm\_INA\_spec} := 12V$ $V_{cm\_sys} := 0V$ $V_{os\_INA\_CMRR} := dB(120) = 1 \times 10^{0} \cdot \frac{\mu V}{V}$

Accuracy

$$E_{INA\_Vos} := \frac{V_{os\_INA}}{FSR} = 100 \times 10^{0} \cdot ppm$$

$$E_{INA\_PSRR} := \frac{\left(V_{s\_INA\_spec} - V_{s\_INA\_sys}\right) \cdot V_{os\_INA\_PSRR}}{FSR} = 4 \times 10^{0} \cdot ppm$$

$$E_{INA\_GE} := \alpha_{INA\_GE} = 200 \times 10^{0} \cdot ppm$$

$$E_{INA\_CMRR} := \frac{\left(V_{cm\_INA\_spec} - V_{cm\_sys}\right) \cdot V_{os\_INA\_CMRR}}{FSR} = 240 \times 10^{0} \cdot ppm$$

Drift

$$E_{INA\_drift\_GE} := \Delta T \cdot \delta_{INA\_drift\_GE} = 300 \times 10^{0} \cdot ppm$$

$$E_{INA\_drift\_Vos} := \frac{V_{os\_INA\_drift}}{FSR} \cdot \Delta T = 200 \times 10^{0} \cdot ppm$$

INA Drift Specifications

$\delta_{INA\_drift\_GE} := 3 \frac{ppm}{C}$

$V_{os\_INA\_drift} := 0.1 \cdot \frac{\mu V}{C}$

REF2030 Errors

Accuracy

$$E_{REF\_output} := \alpha_{REF\_output} = 500 \times 10^{0} \cdot ppm$$

REF Accuracy Specifications

$$\alpha_{REF\_output} := 0.05\%$$

Drift

$$E_{REF\_drift} := (165C) \cdot \delta_{REF\_drift\_output} = 495 \times 10^{0} \cdot ppm$$

REF Drift Specifications

$$\delta_{REF\_drift\_output} := 3 \frac{ppm}{C}$$

System Error

Accuracy

$$E_{accuracy\_RSS} := \sqrt{\begin{pmatrix} E_{REF\_output}^{2} + E_{INA\_CMRR}^{2} \ldots \\ + E_{INA\_GE}^{2} + E_{INA\_PSRR}^{2} \ldots \\ + E_{INA\_Vos}^{2} + E_{shunt\_tol}^{2} \end{pmatrix}} = 1.165 \times 10^{3} \cdot ppm$$

$$E_{accuracy\_total} := \begin{matrix} E_{REF\_output} + E_{INA\_CMRR} + E_{INA\_GE} \ldots \\ + E_{INA\_PSRR} + E_{INA\_Vos} + E_{shunt\_tol} \end{matrix} = 2.044 \times 10^{3} \cdot ppm$$

Drift

$$E_{drift\_RSS} := \sqrt{\begin{matrix} E_{REF\_drift}^{2} + E_{INA\_drift\_Vos}^{2} \ldots \\ + E_{INA\_drift\_GE}^{2} + E_{shunt\_drift}^{2} \end{matrix}} = 1.62 \times 10^{3} \cdot ppm$$

$$E_{drift\_total} := E_{REF\_drift} + E_{INA\_drift\_Vos} + E_{INA\_drift\_GE} + E_{shunt\_drift} = 2.495 \times 10^{3} \cdot ppm$$

Total

$$E_{total\_RSS} := \sqrt{E_{accuracy\_RSS}^{2} + E_{drift\_RSS}^{2}} = 1.996 \times 10^{3} \cdot ppm$$

$$E_{total} := E_{accuracy\_total} + E_{drift\_total} = 4.539 \times 10^{3} \cdot ppm$$

System Errors as Percentages

$E_{accuracy\_RSS} = 116.517 \times 10^{-3} \cdot \%$

$E_{accuracy\_total} = 204.4 \times 10^{-3} \cdot \%$

$E_{drift\_RSS} = 162.019 \times 10^{-3} \cdot \%$

$E_{drift\_total} = 249.5 \times 10^{-3} \cdot \%$

$E_{total\_RSS} = 199.566 \times 10^{-3} \cdot \%$

$E_{total} = 453.9 \times 10^{-3} \cdot \%$