This is because switching between gain chains A and B may introduce transient signals, noise, or glitches resulting from "warming up" or initiating use of the equipment dedicated to measuring over the transitioned-to range.

[0008] Discontinuity D results in two types of ranging error. These errors occur when two ranges (e.g., r1 and r2) have different configured amplifier profiles (A and B, respectively). In the first type of error, the amplifier profile mismatch causes unwanted amplitude discontinuities or jogs (ΔV) in measured output voltage. In the second type, temporal data discontinuity, data flow can be cut off during a range to range transition. In FIG. 1, this manifests in the data gap in the time period from t_{TR} to t_B. Temporal data discontinuity happens when changing ranges involves "warming up" or engaging new electronics, specifically the amplifiers associated with profile B. Collecting data is inaccurate or impossible until these transients dissipate. Transients from the cooling down or shutting off of amplifiers associated with amplifier profile A may also cause delays or glitches in the measurement system.

[0009] Configuring setups like 120 to eliminate discontinuity D is difficult or impossible. The configuration is limited by the simplicity and lack of variability of the components (G_A, ADC A, G_B, and ADC B). Therefore, there is a critical need for new and improved solutions for providing robust, high quality, low noise source or measurement signals even as measured signals vary over decades or orders of magnitude. There is a critical need for flexible solutions to provide smoother transitions between ranges that dimmish or eliminate such discontinuities as shown in FIG. 1.

SUMMARY

[0010] In a first aspect, the present disclosure provides a measurement system comprising a gain chain configured to amplify an analog input signal, a range selector configured to select a gain between the analog input signal and a plurality of analog-to-digital converter (ADC) outputs from a plurality of ADCs, wherein each ADC output has a path, and a gain of each output path may be made up of a plurality of gain stages in the gain chain, and a mixer configured to combine the plurality of ADC outputs into a single mixed output. The plurality of ADCs may comprise a first ADC and a second ADC. The combining the plurality of ADC outputs may be performed in accordance to: mixed output = $\alpha E_{first} + (1 - \alpha)E_{second}$,

where: E_{first} may be the output of the first ADC, E_{second} may be the output of the second ADC, and α may be a mixing parameter that varies from one to zero.

[0010a] In a second aspect, the present disclosure provides a measurement system comprising: a gain chain configured to amplify an analog input signal; a range selector configured to select a gain between the analog input signal and a plurality of analog-to-digital converter (ADC) outputs from a plurality of ADCs, wherein each ADC output has a path, and a gain of each output path is made up of a plurality of gain stages in the gain chain; and a mixer configured to: when the input signal is in a first range, select an output from a first ADC as a single mixed output; when the input signal is in a second range, select an output from a second ADC as the single mixed output; and when the input signal is in between the first and second ranges, select a mix of the outputs from the first and second ADCs as the single mixed output.

[0010b] In a third aspect, the present disclosure provides a measurement system comprising: a gain chain configured to amplify an analog input signal; a range selector configured to select a gain between the analog input signal and a plurality of analog-to-digital converter (ADC) outputs from a plurality of ADCs, wherein each ADC output has a path, and a gain of each output path is made up of a plurality of gain stages in the gain chain; and a mixer configured to combine the plurality of ADC outputs into a single mixed output, wherein the plurality of ADC output paths comprises: two ADC output paths that can independently be configured into a high range and a low range path; the low range path having a first gain for converting the analog input signal; the high range path having a second gain for converting the analog input signal, the second gain being lower than the first gain; a mixing device configured to combine an output of the lower range with an output of the higher range; and a device configured to vary an amount of gain combined from the low range path and the high range path.

[0011] The system may comprise two or more ADCs. A first portion of the gain chain may be connected to a first one of the plurality of ADCs and a second portion of the gain chain may be connected to a second one of the plurality of ADCs. The range selector may select a gain for the first one of the plurality of ADCs from the first portion of the gain chain and may select a gain for the second one of the plurality of ADCs from the second portion of the gain chain. Each of the gain stages in the gain chain may be connected to each of the plurality of ADCs via one or more switch banks. The range selector may select a first portion of the shared gain stages for a first one of the plurality of ADCs and a second portion of the shared gain stages for a second one of the plurality of ADCs by setting switches in the one or more switch banks. The range selector may comprise a first and second multiplexer. The first multiplexer may select the first portion of the shared gain stages. The second multiplexer may select the second portion of the shared gain stages.

[0012] Selection of the first portion of the shared gain stages may comprise configuring a gain for the first one of the plurality of ADCs and selection of the second portion of the shared gain stages may comprise configuring a gain for the second one of the plurality of ADCs. The configuring a gain for the first and second one of the plurality of ADCs may comprise configuring the gains according to at least one range of the input signal. The mixer may be configured to, when the input signal may be in a first range, select an output from a first ADC as the single mixed output. The mixer may be configured to, when the input signal may be in a second range, select an output from a second ADC as the single mixed output. The mixer may be configured to, when the input signal may be in between the first and second ranges, select a mix of the outputs from the first and second ADCs as the single mixed output.

[0013] The system may maintain the second ADC online during a first transition period when the input signal may be in the first range. The system may maintain the first ADC online during a second period when the input signal may be in the second range. The range selector may be configured to configure a gain for at least one of the first ADC and second ADC based on an anticipated range of the input signal. During a hysteresis period, the system may maintain the first ADC offline. The system may maintain the second ADC online. The system may maintain a gain of the second

ADC constant. The hysteresis period may be between the first transition period and the second transition period.

[0014] The plurality of ADC output paths may comprise two ADC output paths that can independently be configured into a high range and a low range path. The low range path may have a first gain for converting the analog input signal. The high range path may have a second gain for converting the analog input signal. The second gain may be lower than the first gain. The paths may comprise a mixing device configured to combine an output of the lower range with an output of the higher range. The system may comprise a device configured to vary an amount of gain combined from the low range path and the high range path. The high range path may be connected to a first gain chain and the low range path may be connected to a second gain chain. The system may comprise a selector to select gain stages of the first gain chain for the first gain and to select gain stages of the second gain chain for the second gain. Each of the first and second gains may comprise gain stages in a gain chain common to the low range path and the high range path. A gain of each output path may be substantially the same. The mixer may average the outputs from each path to reduce noise in the single output.

[0015] In a fourth aspect, the present disclosure provides a method comprising amplifying an analog input signal using a gain chain, selecting a gain between the analog input signal and a plurality of analog-to-digital converter (ADC) outputs from a plurality of ADCs, wherein each ADC output has a path, and a gain of each output path may be made up of gain stages in the gain chain, and combining the plurality of ADC outputs into a single mixed output, wherein each of the gain stages in the gain chain is connected to each of the plurality of ADCs via one or more switch banks.

[0016] A first portion of the gain chain may be connected to a first one of the plurality of ADCs and a second portion of the gain chain may be connected to a second one of the plurality of ADCs. Each of the gain stages in the gain chain may be connected to each of the plurality of ADCs via one or more switch banks. The method may further comprise configuring two ADC output paths independently into a high range and a low range path. The method may comprise applying a first gain from the low range path to convert the analog input signal. The method may comprise applying a second gain from the high range path to convert the analog input

signal, the second gain being lower than the first gain. The method may comprise combining an output of the lower range with an output of the higher range. The

We claim:

1. A measurement system comprising:

a gain chain configured to amplify an analog input signal;

a range selector configured to select a gain between the analog input signal and a plurality of analog-to-digital converter (ADC) outputs from a plurality of ADCs, wherein each ADC output has a path, and a gain of each output path is made up of a plurality of gain stages in the gain chain; and

a mixer configured to combine the plurality of ADC outputs into a single mixed output, and wherein:

the plurality of ADCs comprises a first ADC and a second ADC; and

the combining the plurality of ADC outputs is performed in accordance to:

$$\text{mixed output} = \alpha E_{\text{first}} + (1 - \alpha) E_{\text{second}}$$

where:

E_{first} is the output of the first ADC;

E_{second} is the output of the second ADC; and

α is a mixing parameter that varies from one to zero.

2. The system of claim 1 comprising three or more ADCs.

3. The system of claim 1, wherein at least one of:

a first portion of the gain chain is connected to a first one of the plurality of ADCs and a second portion of the gain chain is connected to a second one of the plurality of ADCs; and

the plurality of ADCs comprises at least two types of ADCs.

4. The system of claim 3, wherein the range selector selects a gain for the first one of the plurality of ADCs from the first portion of the gain chain and selects a gain for the second one of the plurality of ADCs from the second portion of the gain chain.

5. The system of claim 1, wherein each of the gain stages in the gain chain is connected to each of the plurality of ADCs via one or more switch banks.

6. The system of claim 5, wherein the range selector selects a first portion of the shared gain stages for a first one of the plurality of ADCs and a second portion of the shared gain stages for a second one of the plurality of ADCs by setting switches in the one or more switch banks.

7. The system of claim 5, wherein the range selector comprises a first and second multiplexer and,

wherein the first multiplexer selects the first portion of the shared gain stages; and the second multiplexer selects the second portion of the shared gain stages.

8. The system of claim 7, wherein selection of the first portion of the shared gain stages comprises configuring a gain for the first one of the plurality of ADCs and selection of the second portion of the shared gain stages comprises configuring a gain for the second one of the plurality of ADCs.

9. The system of claim 8, wherein the configuring a gain for the first and second one of the plurality of ADCs comprises configuring the gains according to at least one range of the input signal.

10. The system of claim 1, wherein:

the gain of each output path is substantially the same; and
the mixer averages the outputs from each path to reduce noise in the single output.

11. A measurement system comprising:

a gain chain configured to amplify an analog input signal;

a range selector configured to select a gain between the analog input signal and a plurality of analog-to-digital converter (ADC) outputs from a

plurality of ADCs, wherein each ADC output has a path, and a gain of each output path is made up of a plurality of gain stages in the gain chain; and

a mixer configured to:

when the input signal is in a first range, select an output from a first ADC as a single mixed output;

when the input signal is in a second range, select an output from a second ADC as the single mixed output; and

when the input signal is in between the first and second ranges, select a mix of the outputs from the first and second ADCs as the single mixed output.

12. The system of claim 11, wherein the system:

maintains the second ADC online during a first transition period when the input signal is in the first range; and

maintains the first ADC online during a second period when the input signal is in the second range.

13. The system of claim 12, wherein the range selector is configured to configure a gain for at least one of the first ADC and second ADC based on an anticipated range of the input signal.

14. The system of claim 12, wherein, during a hysteresis period, the system:

maintains the first ADC offline;

maintains the second ADC online; and

maintains a gain of the second ADC constant.

15. The system of claim 14, wherein the hysteresis period is between the first transition period and the second transition period.

16. A measurement system comprising:

a gain chain configured to amplify an analog input signal;

a range selector configured to select a gain between the analog input signal and a plurality of analog-to-digital converter (ADC) outputs from a plurality of ADCs, wherein each ADC output has a path, and a gain of each output path is made up of a plurality of gain stages in the gain chain; and

a mixer configured to combine the plurality of ADC outputs into a single mixed output, wherein the plurality of ADC output paths comprises:

two ADC output paths that can independently be configured into a high range and a low range path;

the low range path having a first gain for converting the analog input signal;

the high range path having a second gain for converting the analog input signal, the second gain being lower than the first gain;

a mixing device configured to combine an output of the lower range with an output of the higher range; and

a device configured to vary an amount of gain combined from the low range path and the high range path.

17. The system of claim 16, wherein the high range path is connected to a first gain chain and the low range path is connected to a second gain chain.

18. The system of claim 16, further comprising a selector to select gain stages of the first gain chain for the first gain and to select gain stages of the second gain chain for the second gain.

19. The system of claim 16, wherein each of the first and second gains comprises gain stages in a gain chain common to the low range path and the high range path.

20. A method comprising:

amplifying an analog input signal using a gain chain;

selecting a gain between the analog input signal and a plurality of analog-to-digital converter (ADC) outputs from a plurality of ADCs, wherein

each ADC output has a path, and a gain of each output path is made up of gain stages in the gain chain; and

combining the plurality of ADC outputs into a single mixed output,

wherein each of the gain stages in the gain chain is connected to each of the plurality of ADCs via one or more switch banks.

21. The method of claim 20, wherein a first portion of the gain chain is connected to a first one of the plurality of ADCs and a second portion of the gain chain is connected to a second one of the plurality of ADCs.

22. The method of claim 20 further comprising:

configuring two ADC output paths independently into a high range and a low range path;

applying a first gain from the low range path to convert the analog input signal;

applying a second gain from the high range path to convert the analog input signal, the second gain being lower than the first gain;

combining an output of the lower range with an output of the higher range; and

varying an amount of gain combined from the high range path and the low range path.