Direct Format Usage for PMBus Data Transfer

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Introduction

System Management Interface Forum

Contents

- Data Format Review
- VOUT_MODE Command
- Format Comparison
- Format Limitations
- System Examples
- Linear Format Examples
- Direct Format Examples

The DIRECT format

- simple
- intuitive to use
- simplifying choices

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Data Format Review

- **Linear11 (Called Literal Format in tutorials)**
- **Linear16 (May be signed or unsigned)**
- **Direct**
- **IEEE Half Precision Floating Point**
- **IEEE Single Precision Floating Point**

This talk will focus on Linear and Direct formats only

LINEAR11 Format

LINEAR11 format is used for non-output voltage (See PMBus Part II, Section 7.3)

$$X = Y \cdot 2^{N}$$

Where

- **X is the real world value**
- **Y is a signed 11 bit 2's complement integer**
- **N is a signed 5 bit 2's complement integer**

The values N and Y form a 16-bit value sent over the bus as {N, Y}

LINEAR16 Format

LINEAR16 format is used for output voltage only (See PMBus Part II, Section 8.4.1)

$$\text{Voltage} = V \cdot 2^{N}$$

Where

- **Voltage is the value in Volts**
- **V is a 16 bit integer (unsigned for LINEAR16 signed for SLINEAR16) sent over bus**
- **N is a signed 5 bit 2's complement integer from the VOUT_MODE Parameter**

DIRECT Format

DIRECT format is used for any value (See PMBus Part II, Section 7.4)

$$X = 1/m \cdot (Y \cdot 10^{-R} - b)$$

Where

- **X is the real world value**
- **Y is a two byte 2's complement integer sent over bus**
- **m is the slope coefficient, a two byte 2's complement integer**
- **b is the offset, a two byte 2's complement integer**
- **R is the exponent, a one byte 2's complement integer**

Coefficients m, b, and R are read using the COEFFICIENTS command or obtained from the device literature

VOUT_MODE Command

VOUT_MODE is an 8-bit value {Mode, Parameter}

- **Upper 3 bits define the Mode**
- **Lower 5 bits define the Parameter**

Two cases of interest

- **LINEAR16 - Mode = 0, the Parameter is the 2's complement exponent**
- **DIRECT - Mode = 2, the Parameter is zero**

Typical usage – Read-Only

Format Comparison

All data formats have a restriction on range and resolution

Range

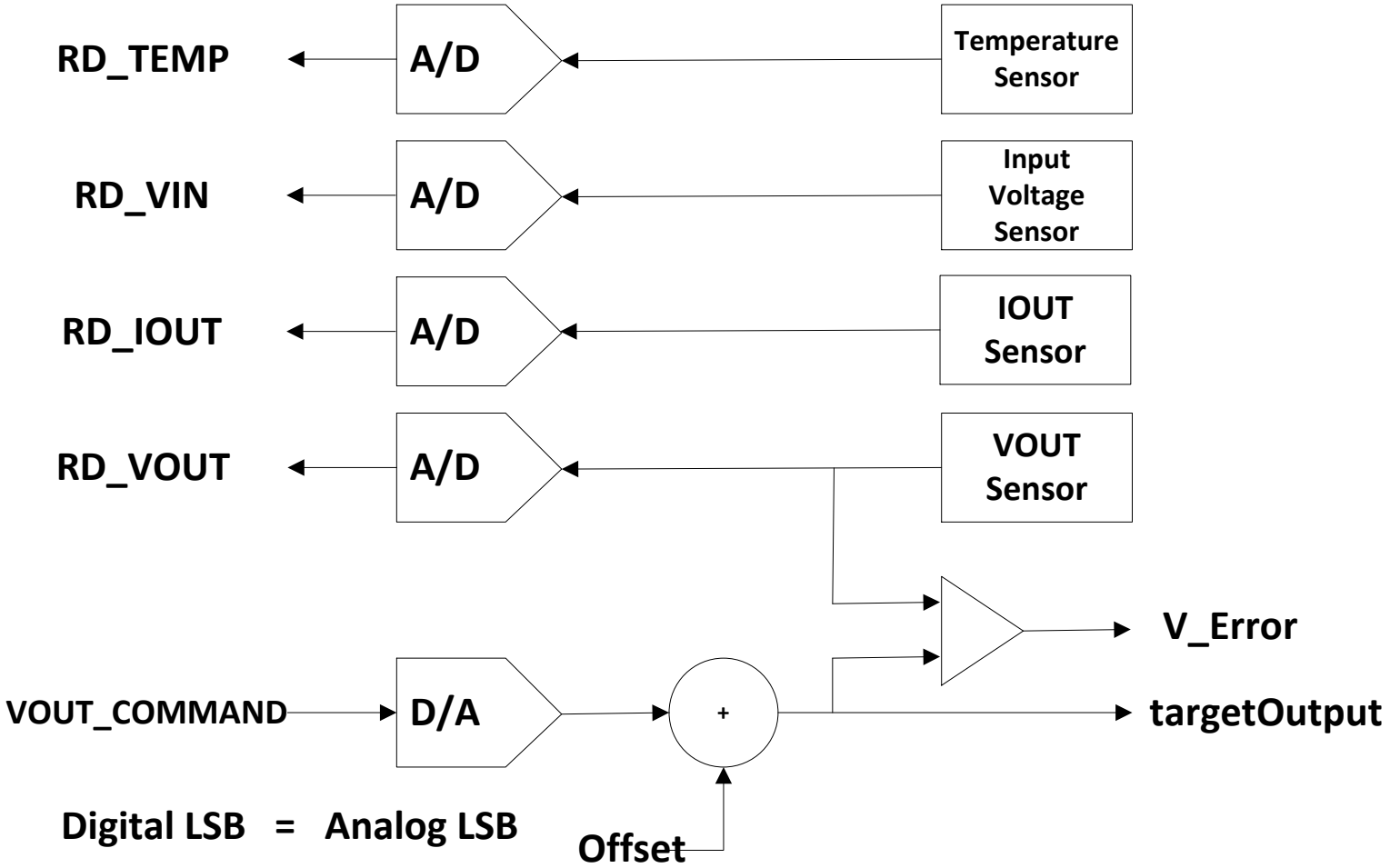
- **LINEAR11 has only 1024 steps**
- **LINEAR16 has 32768 steps signed or 65536 unsigned**

Resolution

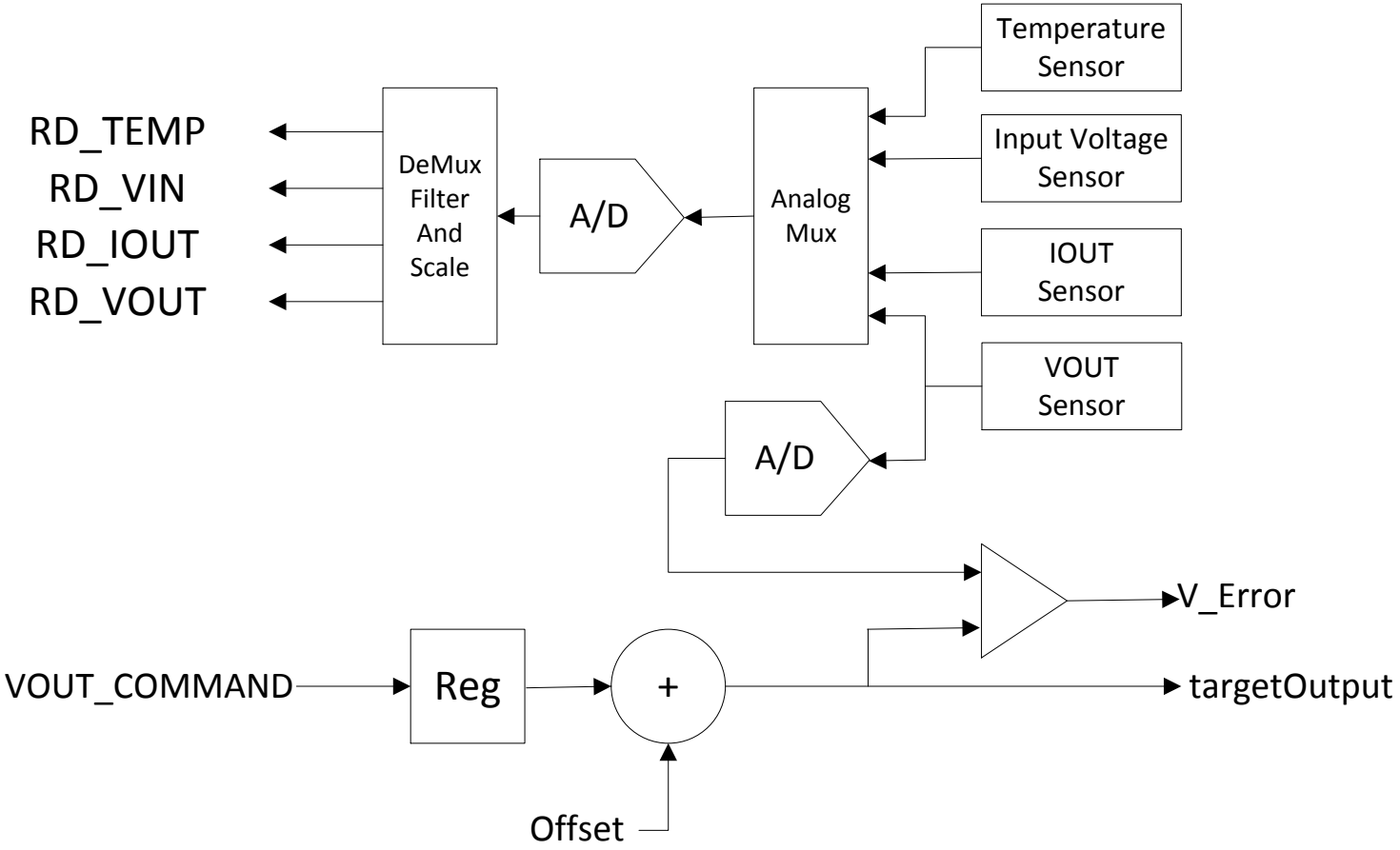
- **LINEAR11 and LINEAR16 formats have resolution that is a power of 2**
- **DIRECT format has resolution that is 1/m times a power of 10**

Which has better fit for overall accuracy? Ease of use?

Analog System



Digital System



Need for Better Resolution

- **VOUT positioning resolution versus absolute precision available with LINEAR16 and DIRECT are basically equivalent – difference is power of 2 versus power of 10.**

- **Telemetry data is a different story – 11-bits for LINEAR11 versus 16-bits for DIRECT.**

LINEAR16 Format Examples

Choose exponent N to be -10

$$X = Y \cdot 2^{-10}$$ **which gives 0.977 mV LSB size with +/-32 V range**

Choose exponent N to be -12

$$X = Y \cdot 2^{-12}$$ **which gives 0.244 mV LSB size with +/-8 V range**

Unfriendly values in base 2 radix

Direct Format Examples

Simplify the DIRECT Format to use m=1 and b=0:

$$X = Y \cdot 10^{-R}$$

With R = 3, the LSB size is 1mV with 32.7V range

With R = 2, the LSB size is 10mV with 327V range

Nice user friendly values in base 10 radix

Conclusion

- Direct Format is simple to use with wise coefficient choice
- Can represent wide range with decimal radix
- Data read back is exactly the setting value
- Exact voltage positioning relative to specifications
- Telemetry data is readable real world units
- Simplified debug – convert to decimal then move decimal point

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The End

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