LOW POWER PRECISION DATA CONVERSION WITH INDUSTRY'S LOWEST-IQ VOLTAGE REFERENCE

New Product

Update

Agenda

- Understanding voltage reference specifications

- Introducing REF35

- Applications examples

- TI's voltage references portfolio

- Conclusion and wrap up

Understanding voltage reference specifications

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Voltage reference in data converter applications

- Data converters and sensors are the most common ways of interfacing with the real world.

- These devices require a precision voltage reference for accurate and repeatable measurement.

- A change in the output of the voltage reference will impact the static and dynamic performance of the data converter and its ENOB (effective number of bits).

- Precision voltage references are designed to be stable over variation in input voltage, temperature, aging and other factors.

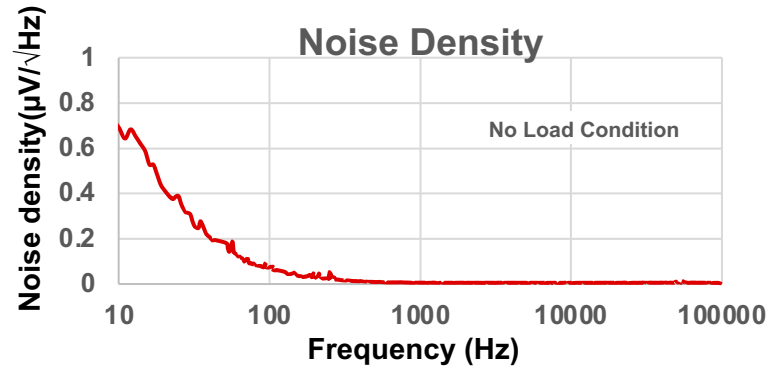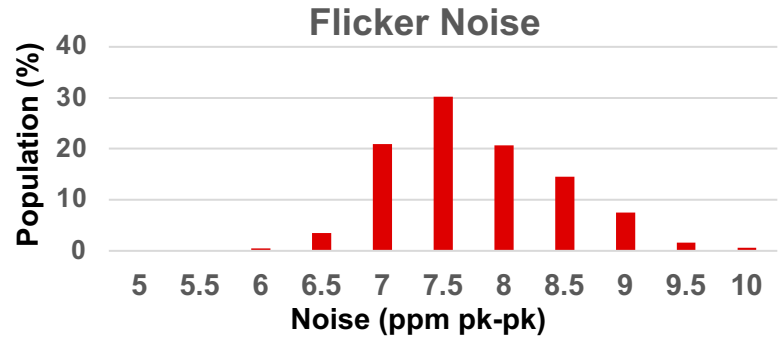- Let's look at some key specs next.

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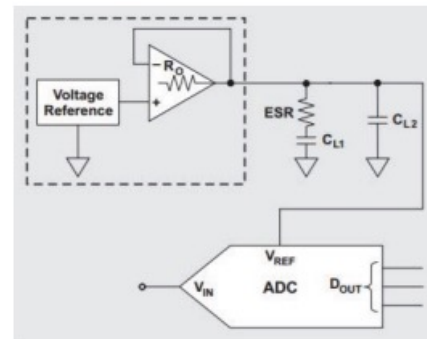
Temperature drift

- Temperature Drift (also referred to as temperature coefficient) is the change in reference voltage over temperature.

- Temperature drift impact the gain error of data converter thus impacting system accuracy.

- We specify this parameter using "BOX method" as shown. Provides max variation expected across temperature.

- REF35 provides a very low drift of 12 ppm/°C (−40°C to 105°C).

Box Method

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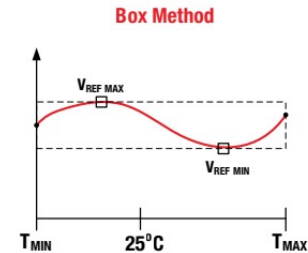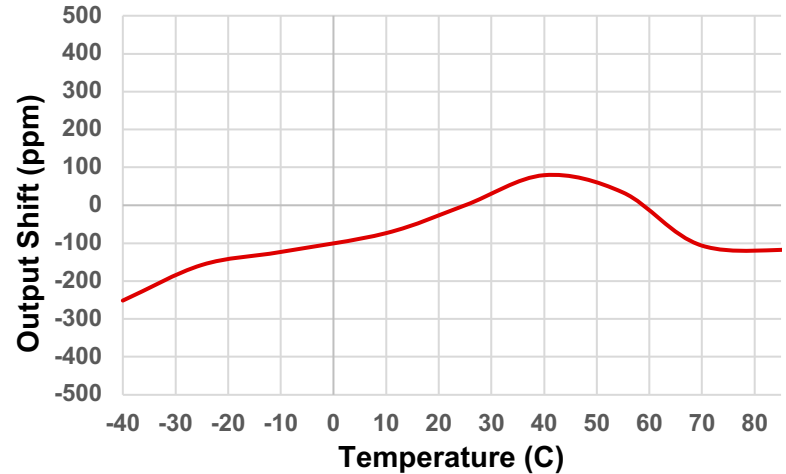
Flicker and broadband noise

- The internal noise of a voltage reference causes a dynamic error that degrades the signal-to-noise ratio (SNR) of a data converter and its ENOB.

- Flicker noise (0.1 Hz to 10 Hz) is specified as peak-to-peak value in 10-second time window. Noise density is used to specify broadband noise (10 Hz to 10 kHz).

- REF35 has exceptionally low noise but also offers a noise reduction (NR) pin to further minimize any error in the system.

Flicker Noise

Population (%) vs Noise (ppm pk-pk)

Noise Density

Noise density (µV/√Hz) vs Frequency (Hz)

No Load Condition

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Long-term stability

- Long-term stability (or drift) describes the shift in VREF after 1000 hours (6 weeks) of continuous operation under nominal conditions.

- This is an important parameter as it provides the designer data on stability of the reference voltage over the life of the application.

- REF35 provides an excellent long-term stability of 40 ppm after 1000 hours of operation.

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Introducing REF35

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REF35 Ultra-nano-power voltage precision reference

Key Specifications

Ultra-low supply current: 650 nA

Initial accuracy: ± 0.05%

Low Drift over temperature (max): 12 ppm/°C
(-40°C to 105°C)

Low flicker noise 0.1Hz to 10Hz : 3.3 ppm$_{P-P}$

Output voltage options: 1.024 V, 1.2 V, 1.25 V, 1.6 V, 1.8V, 2.048 V, 2.5 V, 3.0 V, 3.3 V, 4.096 V, 5.0 V

**Package:** Small 6-Pin SOT−23

Applications

- Sensor nodes for Internet of Things (IoT)
- Medical patches and wearables
- Portable test and measurements
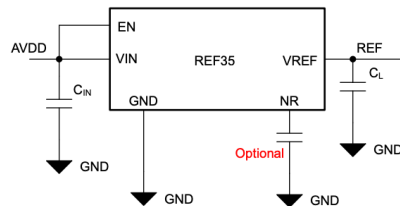- Automotive HV DCDC
- LiDAR

System Benefits

- Extended operating and battery life
- Low temperature coefficient increases accuracy of system
- High initial accuracy eliminates need for calibration
- Low drift with time and low–noise enables use in high precision systems
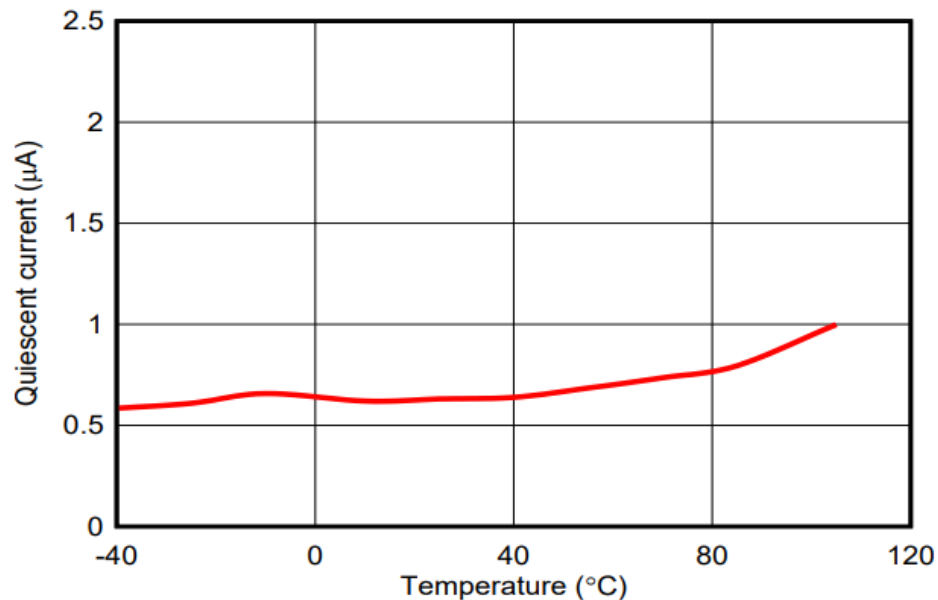
Attach to our data converters

- ADC34/35/36

5mm^2

TI.com/REF35

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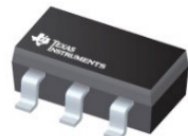
REF35 – power consumption (I_Q)

REF35 offers 650-nA typical current making it ideal for low for power applications

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REF35 – best-in-class performance

Key Spec	REF35	Competitor #1	Competitor #2
Available voltage options	10 options from 1 V to 5 V	7 options from 1.25 V to 5 V	7 Options from 1.25 V to 5 V
Supply current	650 nA	1.5 uA	18 uA
Temperature drift	12 ppm/ºC	10 ppm/ºC*	10 ppm/ºC
Noise	8 ppm pp	30 ppm pp	4.5 ppm pp

11

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Application examples

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REF35 – target applications

Medical

- Electrocardiogram
- Insulin pump
- Blood glucose monitor
- CT & PET scanner
- Infusion pump
- Multiparameter patient monitor
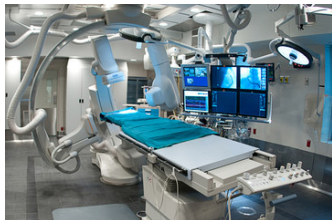
Factory automation & control

- Flow transmitters
- Gas transmitters
- Pressure transmitters
- Temperature transmitters
- Level transmitters
- Analog IO module
- Mix module (AI, AO, DI, DO)

Grid

- Fault indicators
- Smart meter
- String inverter

Automotive

- HEV/EV battery management
- Automotive camera
- Passive safety solutions

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Medical sensor patches

Low power for continuous monitoring of vital signals

Environment
- High accurate sensor measurement
- Low power consumption
- Rated for -40 C to 85 C

Key care-about specifications
- Nano power
- Temperature drift
- Noise

Voltages of interest
- 1.2 V and 2.5 V

Companion data converters
- AFE4960, AFE4300, ADS1292, ADS1191

Select a subsystem for: Multiparameter patch

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Electrocardiogram

Low power for longer battery life

Environment
- High accurate sensor measurement
- Low power consumption
- Rated for -40 C to 85 C

Key care-about specifications
- Nano power
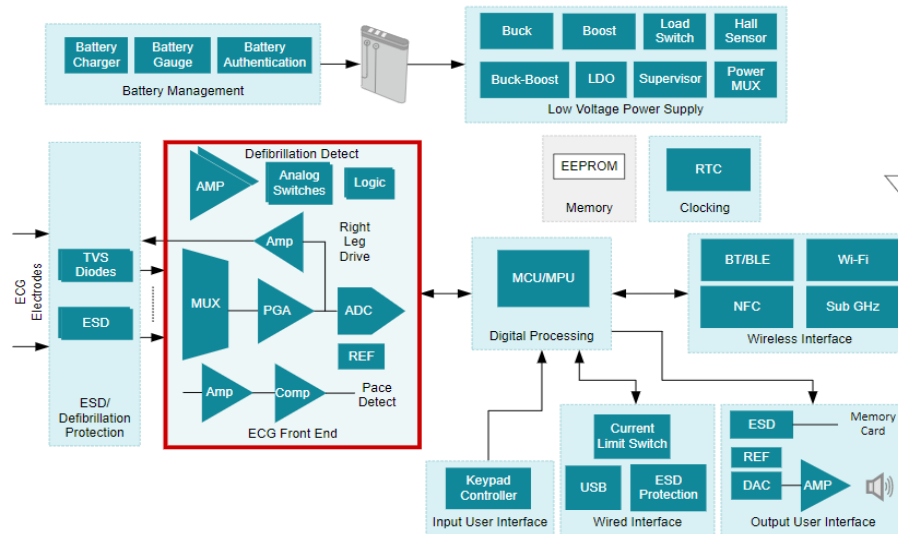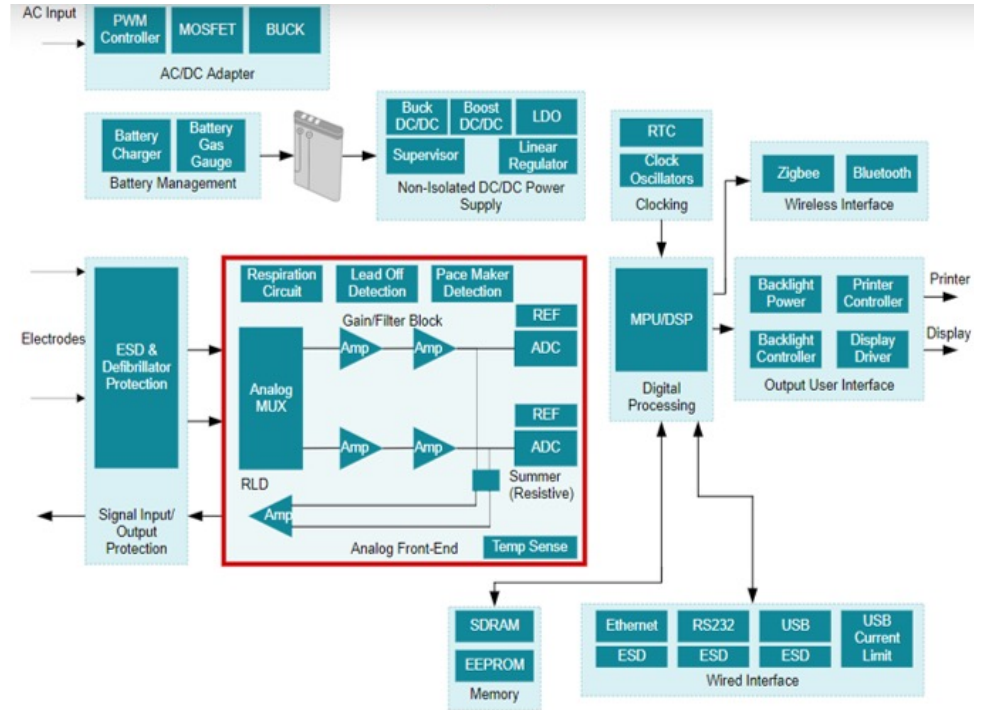- Temperature drift
- Noise

Voltages of interest
- 2.5 V, 3.0 V, 3.3V, 4 V

Companion ADCs
- ADS1292R, ADS1292, ADS1298

Insulin pump

Offer long battery life and high accuracy for handheld pump

Environment
- Small footprint
- Battery powered
- Rated for -40 C to 85 C
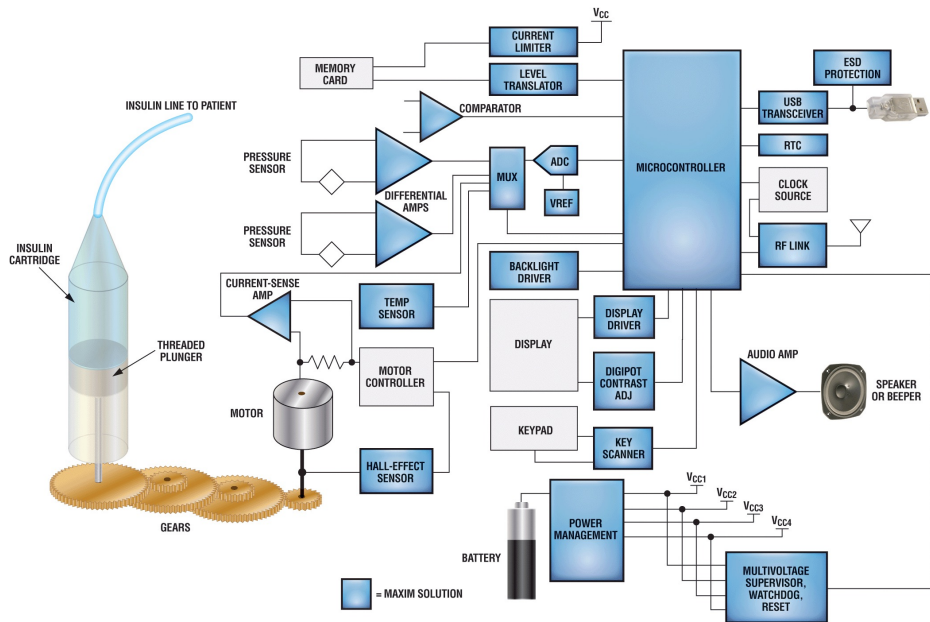
Key care-about specifications
- Sub 1-uA I_Q
- Temperature drift

Voltages of interest
- 3.0 V and 3.3 V

Companion data converters
- AFE4960, AFE4300, ADS1292, ADS1191

Fault indicators

Provide a low voltage bias to 1.2V for DAC and MCU ADC

Environment
- Power by backup battery
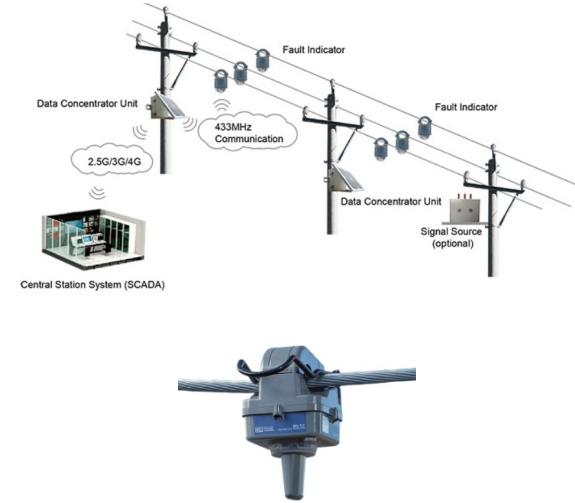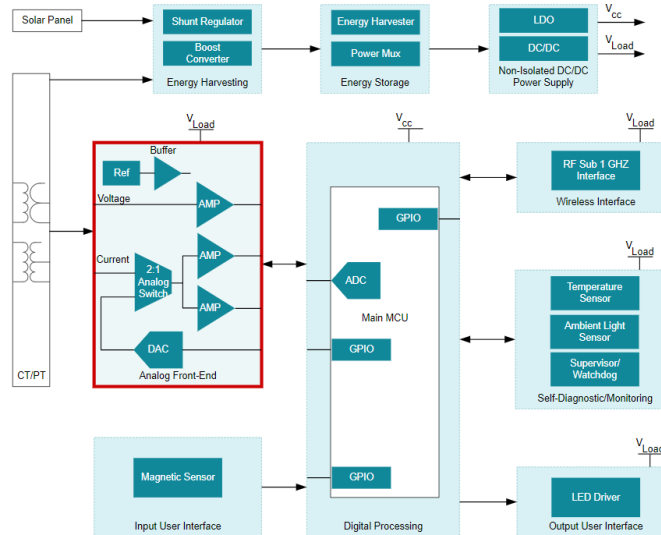- Rated for -40 C to 125 C

Key care-about specifications
- Long battery life
- Low voltage at 1.2 V
- Noise immunity

Voltages of interest
- 1.2 V, 2.5 V, 30 V

Companion data converters
- DAC101C081

Field transmitter

Excellent ADC at lowest power consumption

Environment
- Precision signal chain for sensing
- Rated for -55 C to 125 C

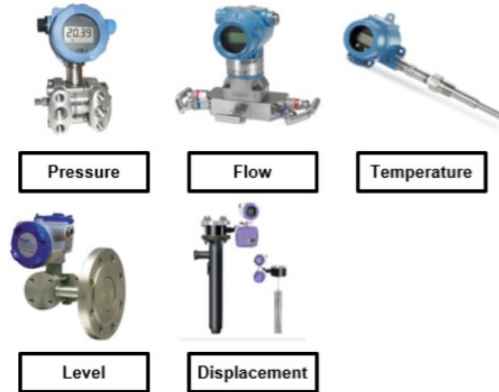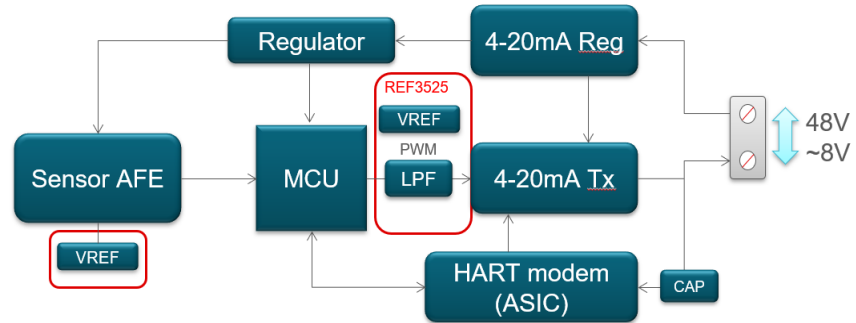**Key care-about specifications**
- Temperature drift
- Noise
- Nano Power

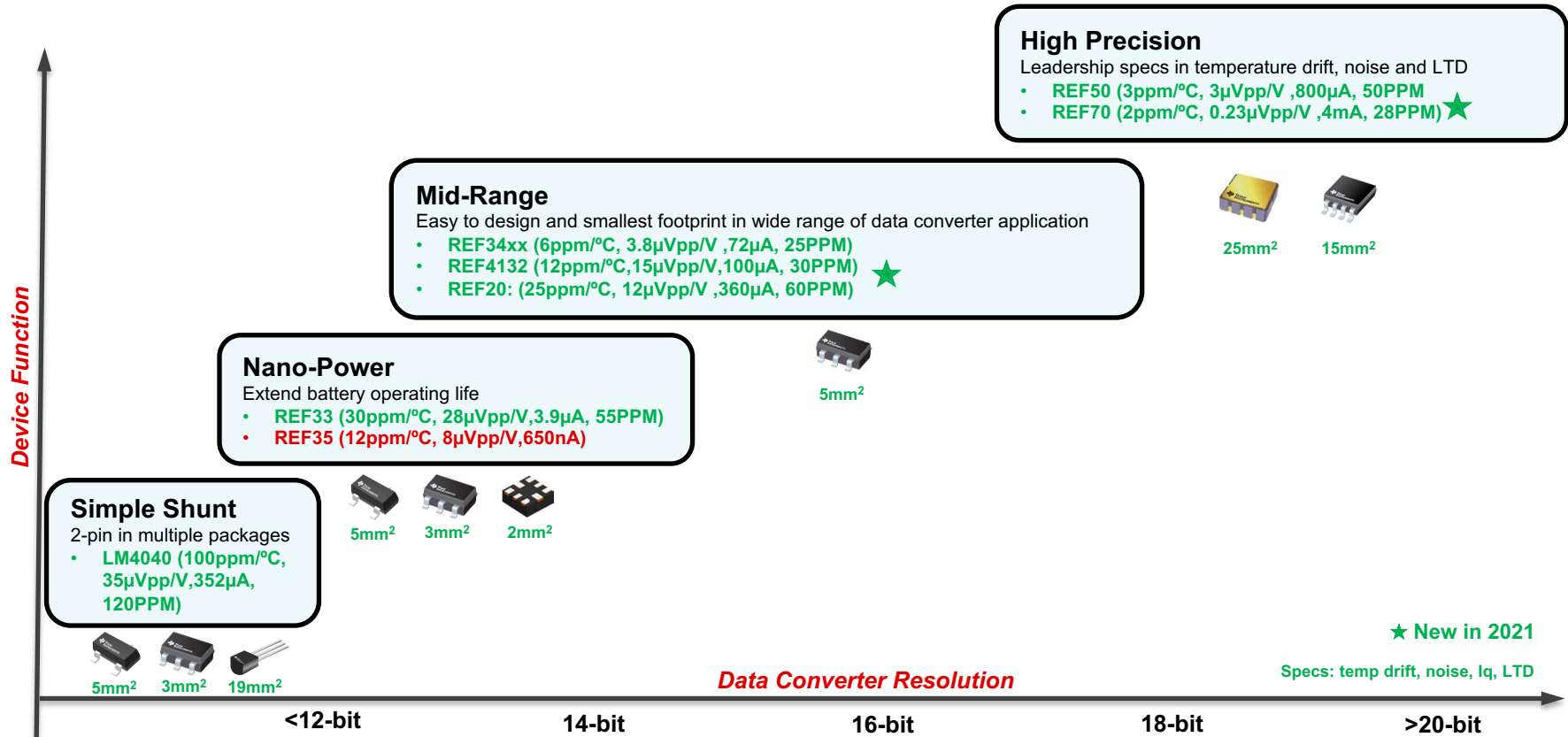**Voltages of interest**
- 3 V and 2.5 V

Companion ADCs
- ADS7052, ADS1219, ADS1259, ADS7142, ADS131A04

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TI's voltage references portfolio

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TI's voltage references portfolio for data converters

Device Function ↑ → **Data Converter Resolution**

High Precision
Leadership specs in temperature drift, noise and LTD
- REF50 (3ppm/ºC, 3µVpp/V ,800µA, 50PPM)
- REF70 (2ppm/ºC, 0.23µVpp/V ,4mA, 28PPM) ★

25mm²   15mm²

Mid-Range
Easy to design and smallest footprint in wide range of data converter application
- REF34xx (6ppm/ºC, 3.8µVpp/V ,72µA, 25PPM)
- REF4132 (12ppm/ºC,15µVpp/V,100µA, 30PPM) ★
- REF20: (25ppm/ºC, 12µVpp/V ,360µA, 60PPM)

5mm²

Nano-Power
Extend battery operating life
- REF33 (30ppm/ºC, 28µVpp/V,3.9µA, 55PPM)
- REF35 (12ppm/ºC, 8µVpp/V,650nA)

5mm²   3mm²   2mm²

Simple Shunt
2-pin in multiple packages
- LM4040 (100ppm/ºC, 35µVpp/V,352µA, 120PPM)

5mm²   3mm²   19mm²

★ **New in 2021**

Specs: temp drift, noise, Iq, LTD

| <12-bit | 14-bit | 16-bit | 18-bit | >20-bit |

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Getting started

You can start evaluating this device leveraging the following:

Content type	Content title	Link to content or more details
Product folder	REF35 Product Information	https://www.ti.com/product/REF35
Reference design	GaN-based, 6.6-kW, bidirectional, onboard charger reference design	PMP22650 reference design	TI.com
Technical blog content or white paper	Accurately measure vital signs with low Iq and a small form factor	https://e2e.ti.com/blogs_/b/powerhouse/posts/accurately-measure-vital-signs-with-low-iq-and-a-small-form-factor
Development tool or evaluation kit	REF35 Evaluation Platform	REF35EVM Evaluation board	TI.com

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Learn more at ti.com/REF35

- Precision voltage references are:
  - Essential in any data converter application
  - Designed to be stable over variation in input voltage, temperature, aging and other factors

- In low power applications, the quiescent current of the voltage reference directly impacts the overall power consumption of the system.

- REF35 provides:
  - Industry's lowest power consumption at 650 nA
  - ± 0.05% initial accuracy and 12 ppm/°C temperature drift
  - 10 voltage options to support any data converter

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Visit www.ti.com/npu

For more information on the New Product Update series, calendar and archived recordings

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