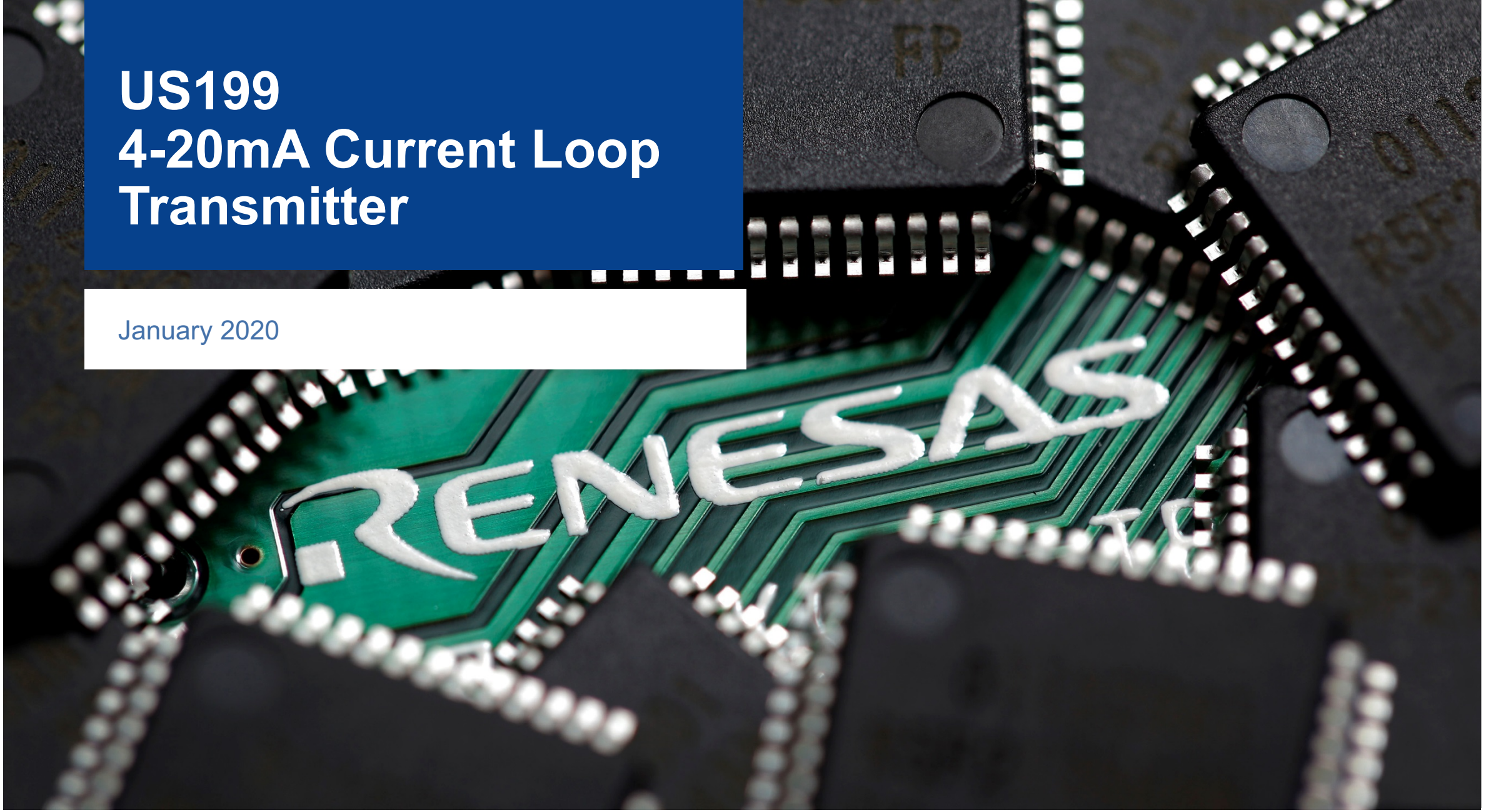
US199
4-20mA Current Loop Transmitter

January 2020



4-20mA Current Loop Transmitter

Overview

The 4-20mA current loop is the dominate standard for sensor systems in many industries. This is because it is the simplest option to configure and connect. However, it also uses less wiring and connections than other signals, therefore reducing the overall system cost. In large locations, it is better for traveling long distances since the current doesn't degrade (unlike the voltage).

This winning combination shows a possible transmitter solution with our precision digital power monitor (DPM), stable power source, and the low power, analog rich feature capabilities of our 16-bit RL78/I1D MCU.

System Benefits

- The RL78/I1D is an analog and ultra low power MCU for detector and sensor applications
- The ISL80410 is a high voltage, adjustable V_{OUT}, low quiescent current linear regulator suited for "always-on" applications
- Precision voltage from Renesas' ISL21080 Nanopower (310nA typical) voltage reference

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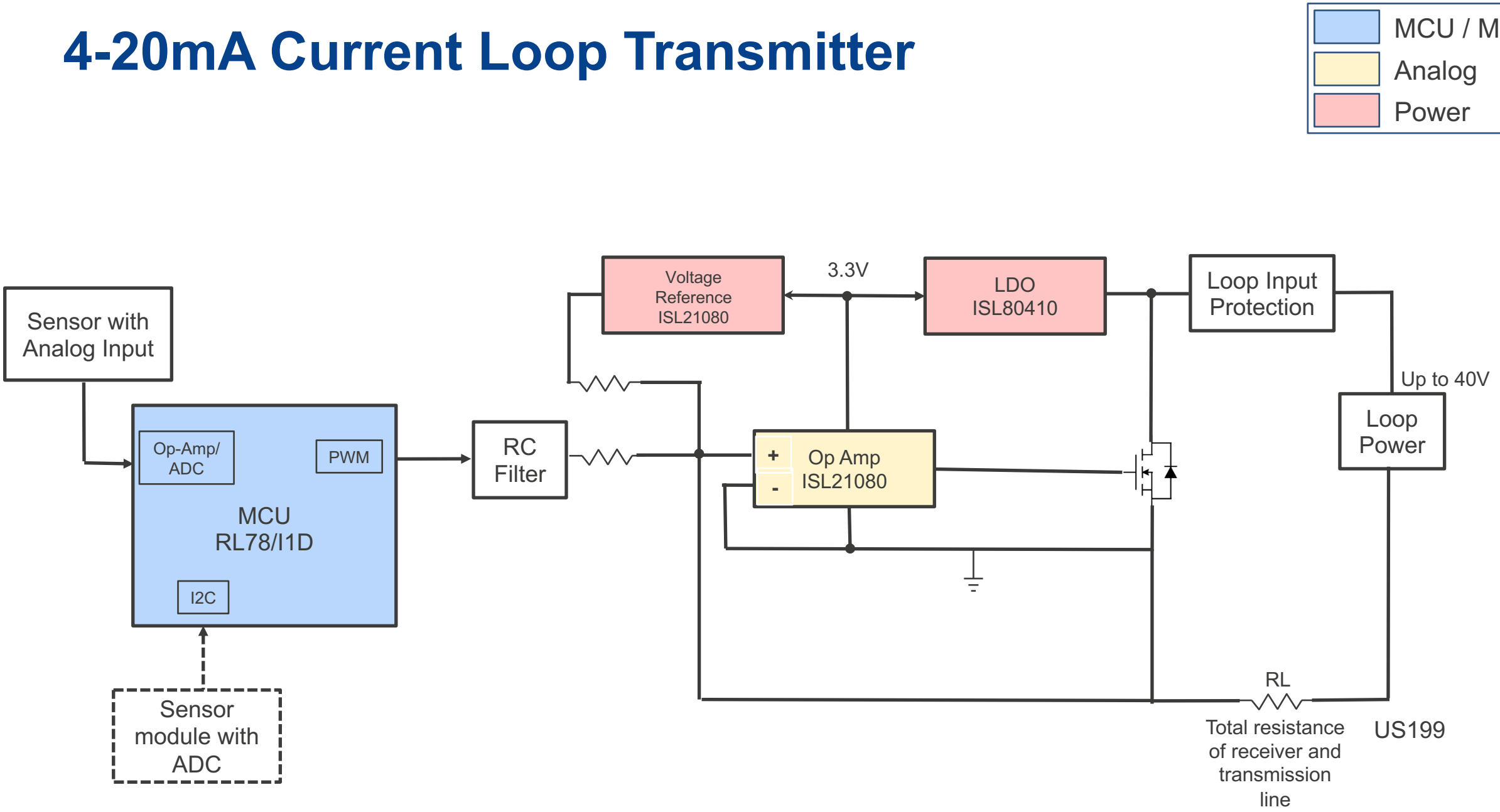
4-20mA Current Loop Transmitter



4-20mA Current Loop Transmitter

Device Category	P/N	Key Features
MCU	RL78/I1D	Low Power 16-bit MCU with enhanced analog functions such as operational amplifiers, 12-bit A/D converter and window comparators
Power	ISL21080	300nA NanoPower voltage references
	ISL80410	40V, low quiescent current, 150mA linear regulator
Analog	ISL28130	Low power operational amplifier for battery-powered devices

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RL78/I1D – Ultra-Low Power Analog MCU

Suitable for Detectors and Sensors Requiring Low Power and Analog Integration

Low Power Consumption for Extended Battery Life

- High-speed recovery from STOP mode in just 3.4 µs, and supply of operation current in 124 µA when operating at 1MHz
- Ability to operate peripheral circuits (sensor activation, signal amplification, obtaining A/D conversion results) without CPU intervention. Ability to determine whether it is necessary to activate the CPU based on A/D conversion results.
- VDD = single power supply voltage of 1.6 to 3.6 V

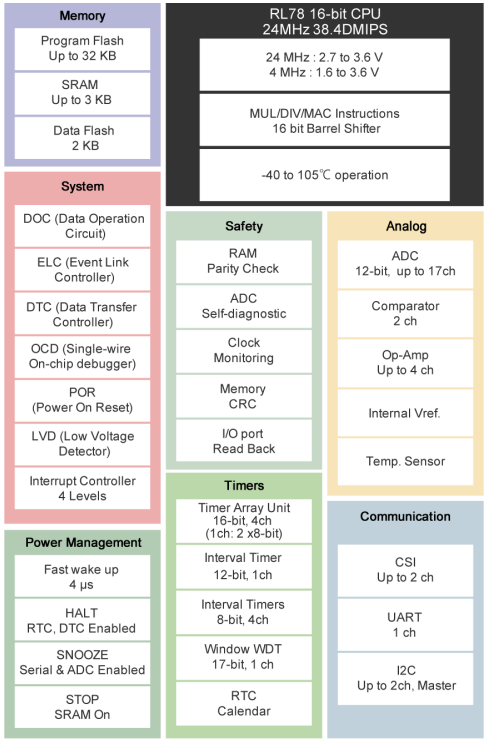
Rich Analog Functions

- On-chip ADC, 12-bit × 17 channels, conversion time: 3.375 µs
- Internal reference voltage (1.8 V)
- Op-amp × 4 channels (high-speed and low power modes)
- Comparator × 2 channels (window mode support)

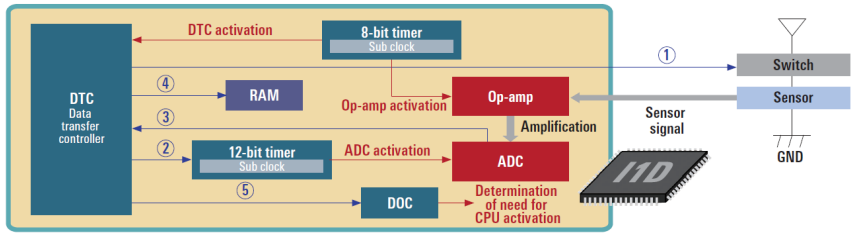
Safety and Small Package

- Compliant with European safety standard for household appliances (IEC/UL 60730)
- 4mm x 4mm small package line up

Part #	Flash ROM	RAM	12-bit ADC	OPA	Package
R5F1176xGxx	8-16 KB	0.7 ~ 2 KB	6ch	2ch	20-LSSOP(4.4 x 6.5mm 0.65 mm pitch)
R5F1177xGxx	8-16 KB	0.7 ~ 2 KB	6ch	2ch	24-HWQFN(4 x 4mm 0.5 mm pitch)
R5F1176AGxx	8-32KB	0.7 ~ 3KB	12ch	4ch	30-LSSOP(7.62mm 0.65 mm pitch)
R5F1176BGxx	16-32KB	2 ~ 3 KB	12ch	4ch	32-HVQFN(5 x 5mm 0.5 mm pitch) 32-LQFP(7 x 7mm 0.8 mm pitch)
R5F1176GGxx	16-32KB	2 ~ 3 KB	17ch	4ch	48-LQFP(7 x 7mm 0.5 mm pitch)



RL78/I1D Block Diagram



Snooze Mode Operation Example

BIG IDEAS FOR EVERY SPACE RENESAS

ISL21080 – 300nA NanoPower Voltage Reference

Micropower Voltage Reference for Energy Harvesting Applications, Portable Instrument

Wide Output Voltages and Small Package

- Reference output voltages: 0.900V, 1.024V, 1.250V, 1.500V, 2.048V, 2.500V, 3.000V, 3.300V, 4.096V, 5.000V
- Space-saving SOT-23 package

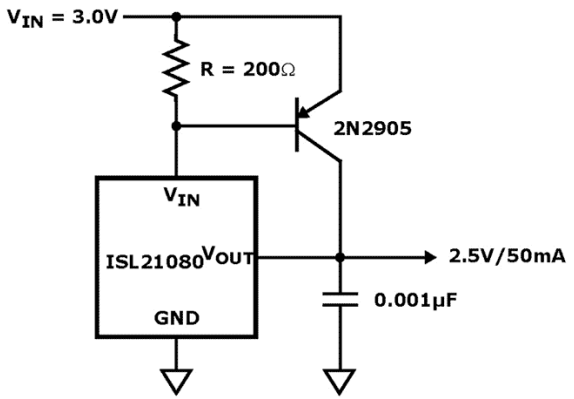
Flexible Supply Voltage

- Operates from a single 2.0V to 8V supply (minimum and maximum voltage is dependent on voltage option)
- Provides ±0.2% to ±0.7% accurate reference (dependent on voltage option)

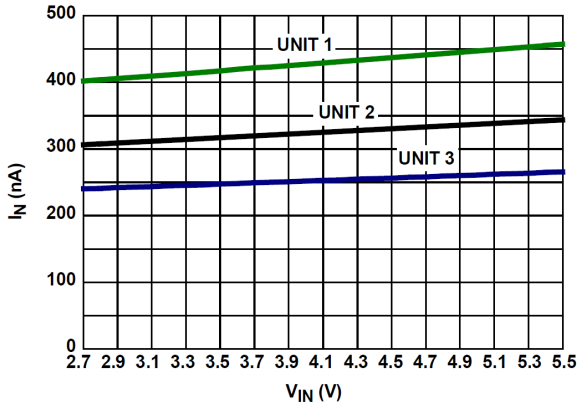
Output Features

- Output current capability : ±7mA
- Ultra-low supply current: 310nA (typical), 1.5µA(Maximum)
- Output voltage noise: 30µVP-P (0.1Hz to 10Hz)

Part #	Initial Accuracy(%)	V_{OUT} Option(V)
ISL21080DIH309/10	±0.7	0.900, 1.024
ISL21080DIH312	±0.6	1.25
ISL21080CIH315	±0.5	1.5
ISL21080CIH320/25	±0.3	2.048, 2.5
ISL21080CIH330/33/41/50	±0.2	3.0, 3.3, 4.096, 5.0



Typical Application Diagram



I_{IN} vs V_{IN}, Three Units

ISL21080xxEV1Z Evaluation Board

ISL80410 – High Voltage Adjustable V_{OUT} LDO

Low Quiescent Current and 40V/150mA Output

High Performance and Wide Input Range

- Wide V_{IN} range of 6V to 40V
- Adjustable output voltage from 2.5V to 12V
- Ensured 150mA output current
- ±1% accurate voltage reference (over temperature, load)

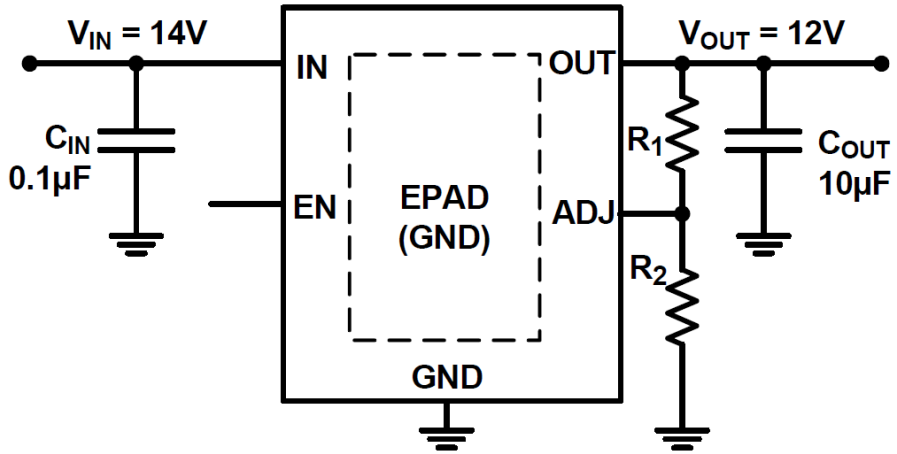
High Efficiency

- Ultra low 18µA typical quiescent current
- Low 2µA of typical shutdown current
- Low dropout voltage of 295mV at 150mA
- Low 26µVRMS noise

Excellent Safety

- 40V tolerant logic level (TTL/CMOS) enable input
- 5kV ESD HBM rated
- Thermal shutdown and current limit protection

Part #	V_{IN} Range(V)	V_{OUT} Range(V)	Enable Pin	Package
ISL80410IBEZ	6 to 40	ADJ	Yes	8 Ld EPSOIC
ISL80410IBEZ-T	6 to 40	ADJ	Yes	8 Ld EPSOIC
ISL80410IBEZ-T7A	6 to 40	ADJ	Yes	8 Ld EPSOIC



Typical Application Circuit

ISL80410EVAL1Z Evaluation Board

ISL28x30 – Low Power/Drift RRIO Operational Amplifier

Ideal Low Power Operational Amplifier for Battery-Powered Devices

Low Offset

- Low input offset voltage: 40µV, Max
- Low offset drift: 150nV/°C, Max.
- Input bias current: 250 pA, Max.

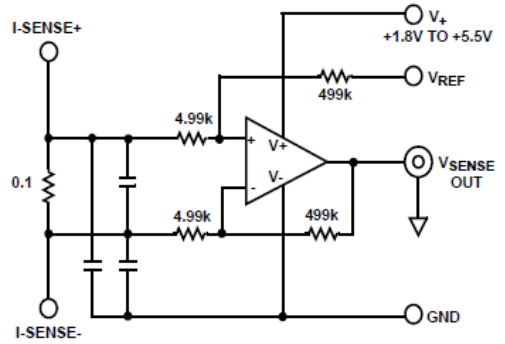
Good Dynamic Performance

- Low noise (0.01Hz to 10Hz): 1.1µVP-P, Typ.
- Rail-to-rail input and output

Low Power Design

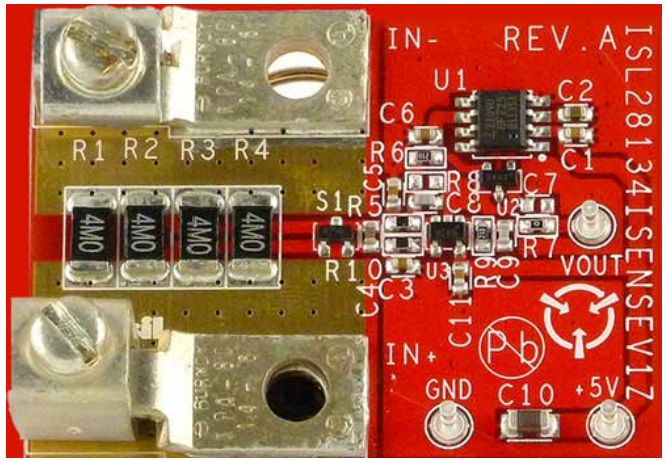
- Quiescent current (per amplifier): 20µA, Typ.
- Single supply range: +1.8V to +5.5V
- Dual supply range: ±0.9V to ±2.75V

Part #	Temp.	Package
ISL28130FHZ	-40 - 125°C	5 Ld SOT-23
ISL28130CEZ	0 - 70°C	5 Ld SC-70
ISL28230CUZ	0 - 70°C	8 Ld MSOP
ISL28230FRZ	-40 - 125°C	8 Ld 3x3 DFN
ISL28430CBZ	0 - 70°C	14 Ld SOIC
ISL28430FVZ	-40 - 125°C	14 Ld TSSOP



BI-DIRECTIONAL CURRENT SENSE AMPLIFIER

Typical Operating Circuit



ISL2813xxSENSEV1Z Precision Current Sense Op Amp

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