GreenPAK™ AND GreenFET IN MEDICAL APPLICATIONS

A DIVE INTO CAPABILITIES

GreenPAK is a broad family (**HVPAK**, **AnalogPAK**, other **GreenPAKs**) of cost-effective non-volatile memory (NVM) configurable hardware devices which enables innovators to integrate many system functions while minimizing component count, board space, and power consumption. Using GreenPAK Designer software and GreenPAK Development Kit, designers can create and program a custom circuit in minutes.

GreenFET family of high-performance robust load switches are designed and optimized for all high-side power rail control applications from 0.25 V to 25.2 V where the load currents range from 1 A to 9 A. Using proprietary MOSFET design, all GreenFET load switches achieve ultra-stable RDS_{ON} across wide input and supply voltage ranges.

GreenPAK and GreenFET are suitable solutions for:

- ✓ Low Power Consumption and Small Form Factor
- ✓ Signal Processing
- ✓ Sensors and Actuators Integration
- ✓ Low Latency
- ✓ Security and Reliability
- ✓ Compatibility
- ✓ High-performance Low RDS_{ON} nFET & pFET MOSFETs
- ✓ Internal Protection
- ✓ Active HIGH ON-OFF control
- ✓ Open-drain power good signaling

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GreenPAK Application Notes

GreenFET Application Notes

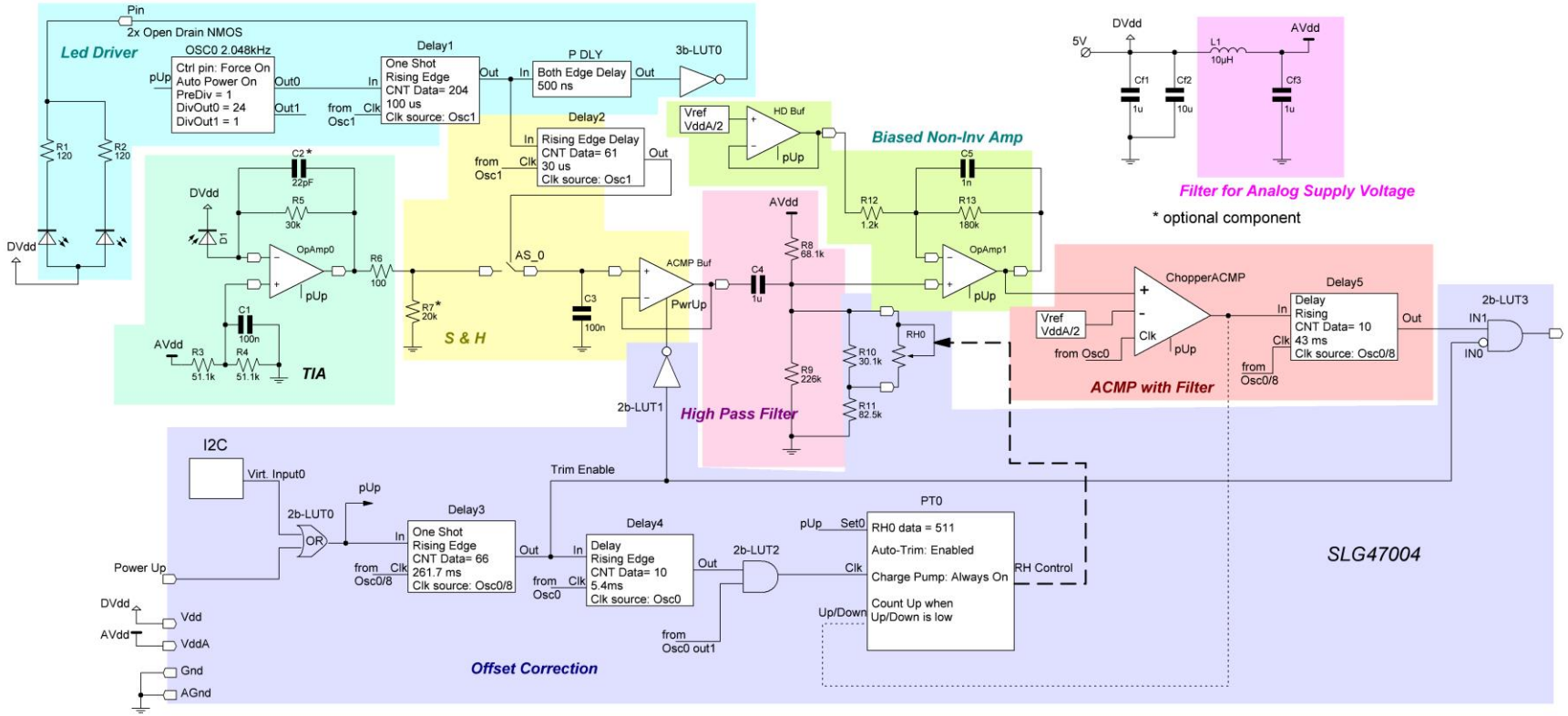
White Paper: Medical Applications with Renesas GreenPAK and AnalogPAK

RENESAS

ANALOGPAK™ IN MEDICAL APPLICATIONS

ANALOG FRONT END FOR HEART RATE MONITOR

The circuit utilizes a commonly used technique of measuring the green light reflected from skin. A unique Auto-Trim feature of the **AnalogPAK SLG47004** allows achieving stable circuit operation in various conditions.



The circuit consists of:

- LED driver
- transimpedance amplifier (TIA)
- sample and hold circuit
- high pass filter
- offset correction circuit
- biased non-inverting amplifier
- analog comparator with digital filter
- analog power supply filter

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Application Note: Analog Front End for Heart Rate Monitor

Datasheet SLG47004

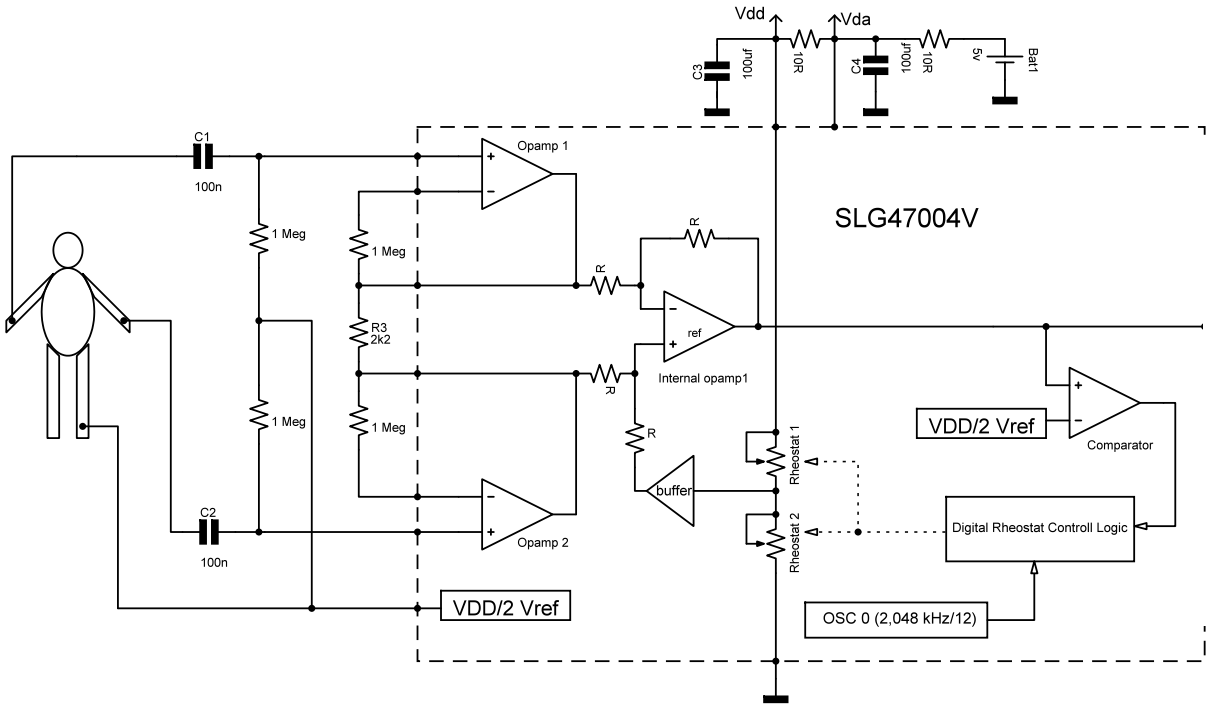
Design File

AnalogPAK IN MEDICAL APPLICATIONS

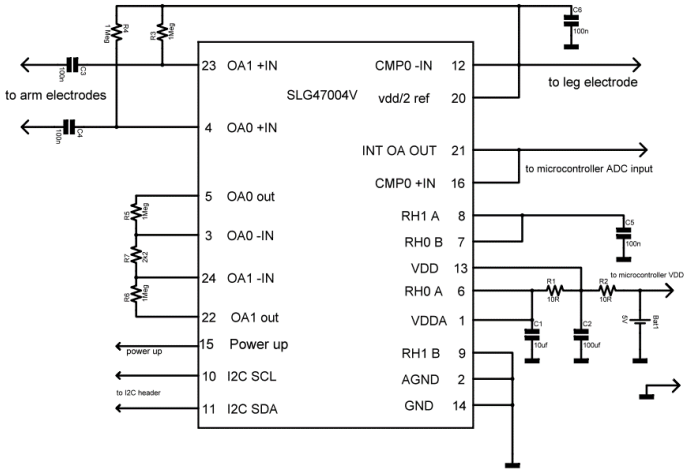
ANALOG FRONT-END FOR ELECTROCARDIOGRAM MONITOR

The circuit utilizes the commonly used technique of measuring electrical heart activity using three electrodes applied to the arms and legs. These electrodes detect the small electrical signal that results from cardiac muscle contraction (the heartbeat). The unique auto-trim feature of the **AnalogPAK SLG47004** enables output signal level stabilization in conditions of interference and baseline drift.

Structure of Electrocardiogram Analog Front-End



Electrical Schematic of Analog Front-End



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Application Note: Analog Front-End for Electrocardiogram Monitor

Design File

Datasheet SLG47004

ANALOGPAK IN MEDICAL APPLICATIONS

PH PROBE

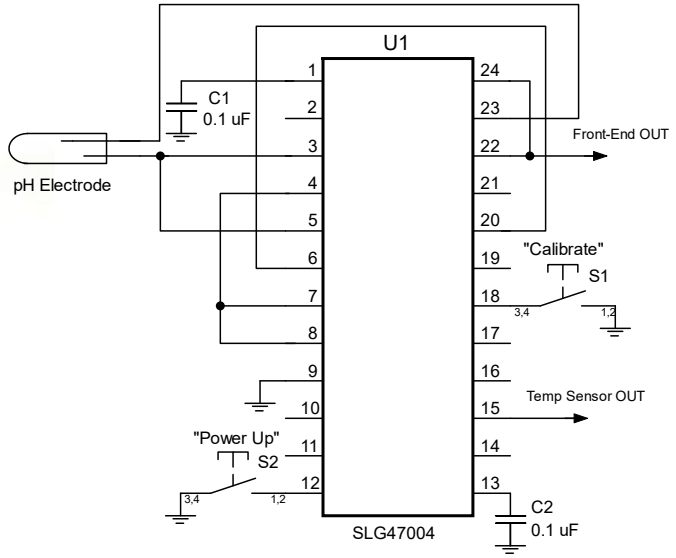
The **AnalogPAK SLG47004** can perfectly cope with pH probe interfacing challenges. In this application, a 250 MΩ pH electrode is used. As a rule, operational amplifiers with a tiny bias current (about tens of femtoamperes or even less) are used as buffer amplifiers for such sensors. However, such precise amplifiers come at a price. The **SLG47004**'s unique Auto-Trim function allows to eliminate the offset error caused by bias current at a reasonable price.

AnalogPAK-based pH Probe benefits:

- Small size
- Cost-effective
- Auto-trim function
- Built-in temperature sensor
- In-system programmability

pH Electrode

General Schematic of Analog Front-End for pH Probe Based on SLG47004



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Application Note: Analog Front-End for pH Probe

Design File

Datasheet SLG47004

GREENPAK IN MEDICAL APPLICATIONS

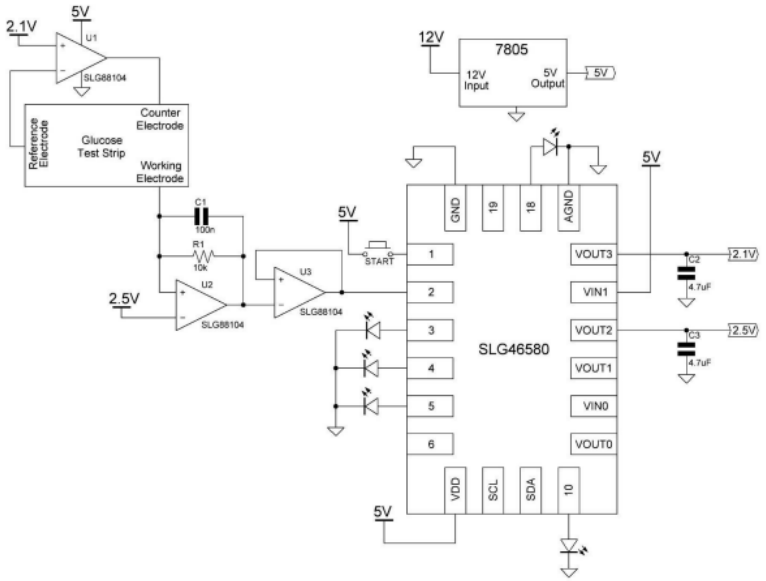
GLUCOSE SENSOR AND MONITOR

The **GreenPAK SLG46580V** and **SLG88104V** are used to develop a custom glucometer. The design uses the analog voltage signal generated by a blood drop on a customized Glucometer strip to measure glucose levels. The signal is amplified and fed into a GreenPAK SLG46580V IC. The GreenPAK decodes the voltage signal and compares it with preset thresholds to determine the glucose level.

The glucometer blood test strip used in this design is a typical one available on the market. The GreenPAK design can be easily modified to adjust the threshold levels of different glucose ranges. Reset and Start functions are included to make the design more reliable.

GreenPAK-based Glucometer benefits:

- Small size
- Cost-effective
- Energy efficient
- Could be easily modified for patients with Type-1 or Type-2 diabetes



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Application Note: Customized Glucometer using GreenPAK

Design File

Datasheet SLG88104

Datasheet SLG46580

Winning Combo: Continuous Glucose Monitoring (CGM) for Closed Loop Operation with Insulin Pump

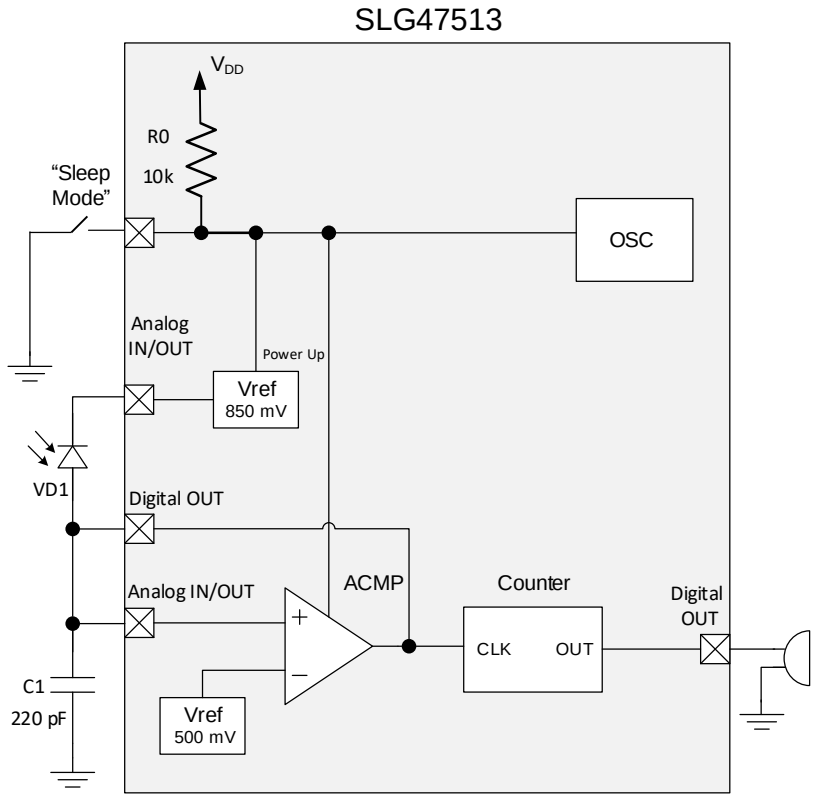
GREENPAK IN MEDICAL APPLICATIONS

SUNTAN MONITOR

The **GreenPAK SLG47513** is used to implement a suntan monitor to control ultraviolet radiation and prevent its negative effect. Its main feature is a low operation voltage (from 1.0 V to 1.65 V) that allows to power a project from a 1.5 V battery or even a solar cell. Furthermore, the measured current consumption of the device is maximum 30 µA, which ensures the long-term operation from the battery.

GreenPAK-based Suntan Monitor benefits:

- Small size
- Cost-effective
- Energy efficient
- Operates with a 1.5 V battery or a solar cell



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Application Note: Suntan Monitor

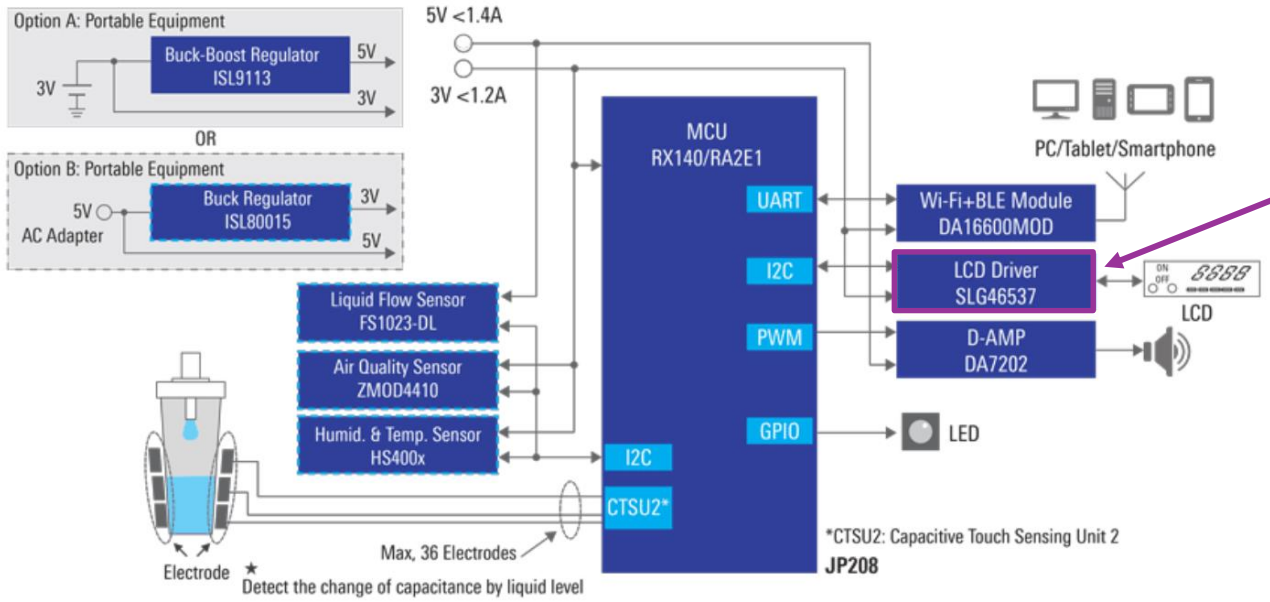
Design File

Datasheet SLG47513

GREENPAK IN MEDICAL APPLICATIONS

INFUSION LEVEL MONITOR USING CAPACITIVE TOUCH SENSING

The **GreenPAK SLG46537** provides a small, low power component for commonly used mixed-signal functions. The user creates their circuit design by programming the one-time Non-Volatile Memory (NVM) to configure the interconnect logic, the I/O Pins and the macro cells of the SLG46537V/M. This highly versatile device allows a wide variety of mixed-signal functions to be designed within a very small, low power single integrated circuit.



SLG46537

GreenPAK System Benefits:

- I²C-controlled LCD driver
- Low current consumption

Datasheet SLG46537

GreenPAK Application Notes

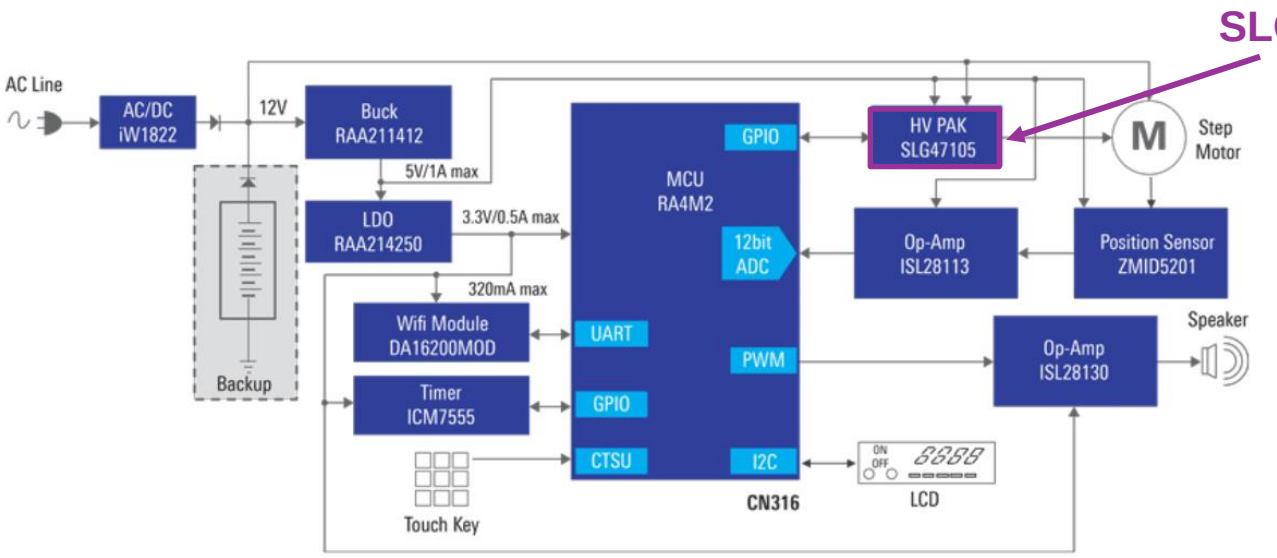
Winning Combo: Infusion Level Monitor Using Capacitive Touch Sensing

HVPAK™ IN MEDICAL APPLICATIONS

INFUSION PUMP

The **HVPAK (up to 26.4 V and 3 A per OUT)** takes its roots from the **GreenPAK family** featuring its configurability and free GUI-based **software** to design the circuit without any programming language needed. It combines mixed-signal logic and **high-voltage H-/Half-bridge** functionality in **a tiny 2 mm x 3 mm QFN package**.

The HVPAK incorporates advanced PWM macrocells, enabling the simultaneous control of multiple motors with varying PWM frequencies and duty cycles. Its compact size and low idle current consumption make it highly versatile, expanding its range of potential applications. This tiny and thermally-efficient IC provides an ideal platform for designing mixed-signal functions alongside its high-voltage capabilities.



HVPAK System Benefits:

- Ability to meet exact customer requirements
- Highly configurable
- Works as a standalone device
- Custom protections
- Current limit – motor/shaft stuck protection

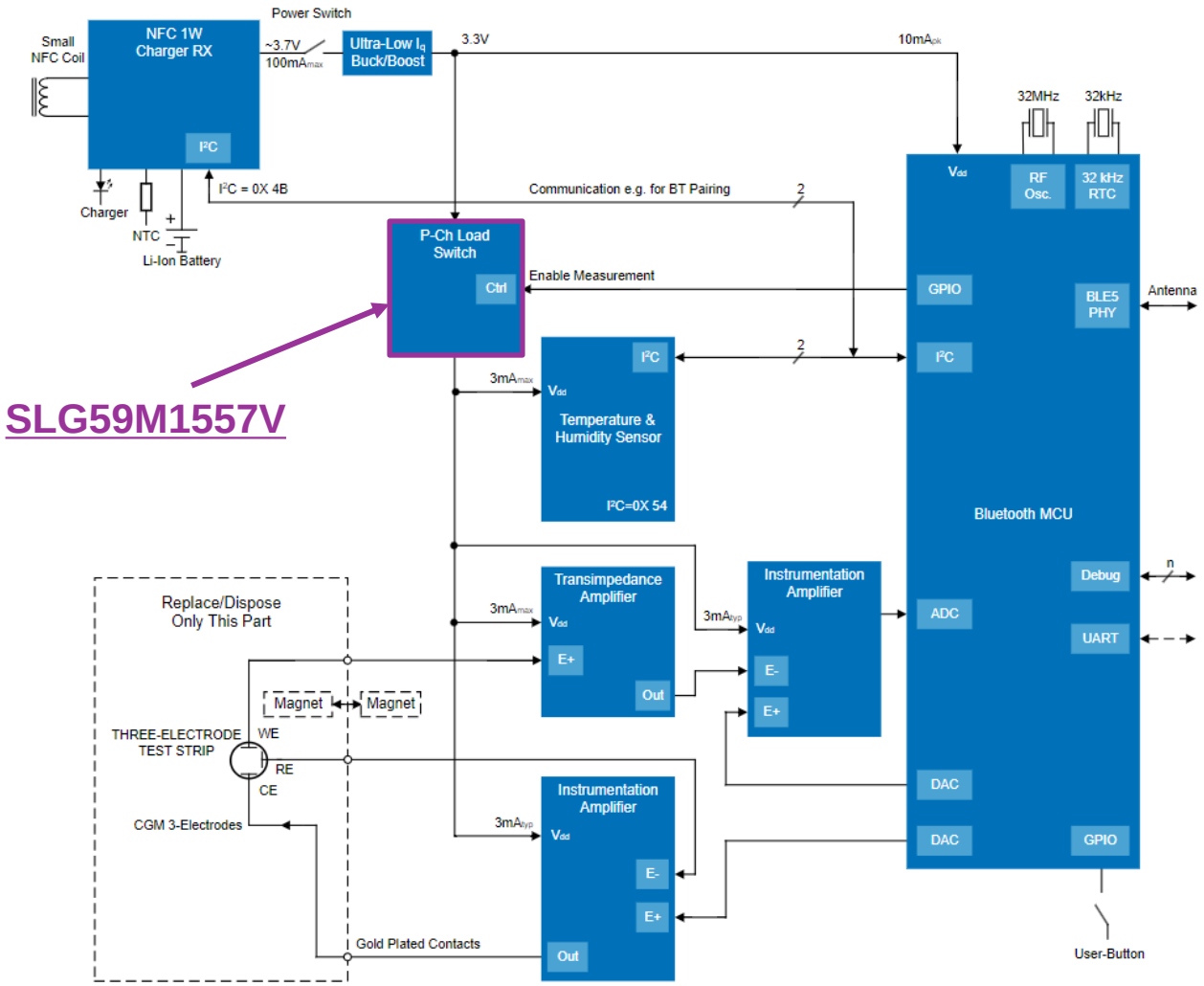
Datasheet SLG47105

HVPAK Application Notes

Winning Combo: Infusion Pump

GREENFET IN MEDICAL APPLICATIONS

CONTINUOUS GLUCOSE MONITORING (CGM) FOR CLOSED LOOP OPERATION WITH INSULIN PUMP



The **GreenFET SLG59M1557V** is designed for load switching applications with ultra low quiescent current. The part comes with one 28.5 mΩ, 1.0 A rated P-channel MOSFET controlled by a single ON control pin.

The product is packaged in an ultra-small 1.0 mm x 1.0 mm package.

GreenFET System Benefits:

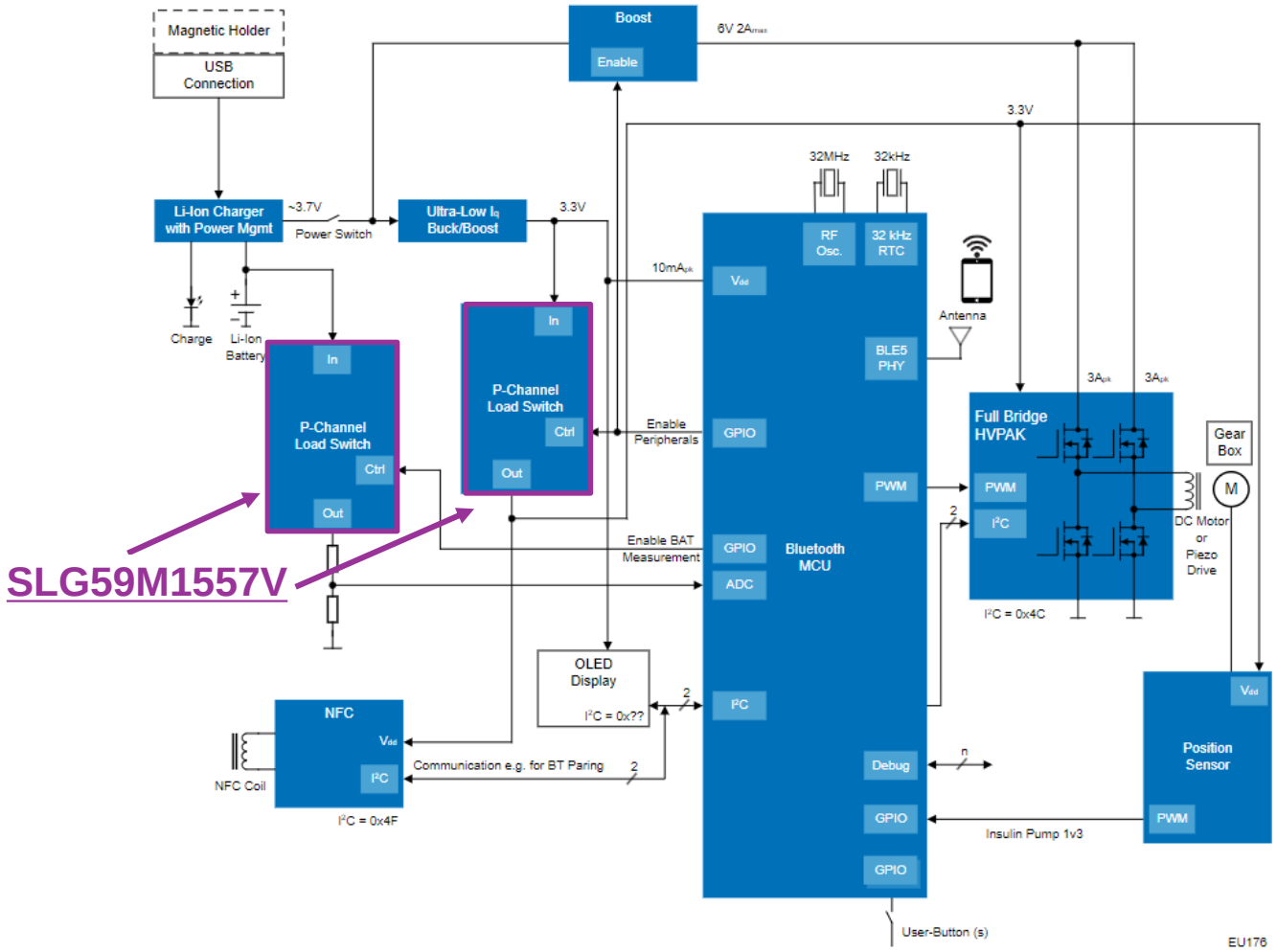
- Helps monitoring the battery voltage and save energy

Datasheet SLG59M1557V

Winning Combo: CGM for Closed Loop Operation with Insulin Pump

GREENFET IN MEDICAL APPLICATIONS

INSULIN PUMP WITH CLOSED LOOP OPERATION FOR CONTINUOUS GLUCOSE MONITORING (CGM)



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The product is packaged in an ultra-small 1.0 mm x 1.0 mm package.

GreenFET System Benefits:

- Helps to extend battery life by disabling peripherals when not used
- Helps monitoring the battery voltage and save energy

Datasheet SLG59M1557V

Winning Combo: Insulin Pump with Closed Loop Operation for Continuous Glucose Monitoring

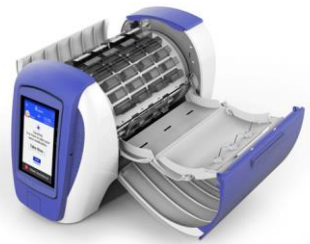
GreenPAK™ AND GreenFET IN MEDICAL APPLICATIONS

UNIQUE FUNCTIONS & FEATURES ALL-IN-ONE PACKAGE

Renesas **GreenPAK** devices are useful resources for innovative developments in medical applications. They integrate highly configurable analog and digital components in their different variants, where analog comparators (ACMPs), operational amplifiers (OPAMPs), PWM modules, rheostats, Look-Up tables (LUTs), clocks, counter/delays, DFFs, Asynchronous State Machines (ASM) etc. can be applied.

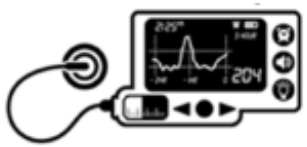
Analog

- Analog switch
- Battery charge indicator
- Comparators
- Current sense/limiter
- LDOs
- Low voltage indicator
- Logic (Mux, gates, etc.)
- OpAmp
- Over-temp detection
- Potentiometer
- Rheostat
- Voltage level detection
- Wake/sleep function
- ADC
- DAC
- and More



Digital

- Control
- Deserialization/serialization
- Frequency detection
- Frequency divider
- GPIOs (6-28)
- H-/Half-Bridge
- I^2C expansion
- Interrupt
- LED driving/pattern
- Digital comparator
- Math operations
- Level shifting
- Motor driving
- Pattern generator
- PWM generation
- Sequencer
- SPI or I^2C Communication
- System reset
- Watchdog timer
- and More



PFAS-free parts are available

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GreenPAK Application Notes

GreenFET Application Notes

White Paper: Medical Applications with Renesas GreenPAK and AnalogPAK

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