SENSOR PLATFORMS

SSP1495

Remote Measurement Unit

Implantable Blood Analysis Sensor Interface

Implantable blood analysis chip set

The SSP1496 and SSP1495 work together to simplify intracardiac and intravenous blood parameter measurement. The SSP1496 and SSP1495 function in a master / slave relationship, where the SSP1496 resides inside an implantable medical device (IMD) and issues commands to the SSP1495, while the SSP1495 resides remotely, driving sensors, calibrating the measurement and reporting the results. The SSP1496 is the intelligent half of the chip set, containing an onboard microcontroller, digital SPI bus and specialized measurement processing firmware, while the SSP1495 is designed to be small, simple and low-power.

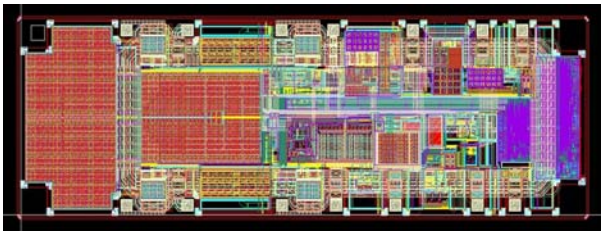


Diagram #2: The SSP1495 is the in-situ part of the chip set. It resides in an intravenous or intracardiac catheter for local pressure and SV02 measurements. It reports measurements back to the 1496 by a two-wire power/data bus.

The Remote Measurement Unit

The SSP1495 is directed at low power medical applications intended for measuring: blood pressure (either capacitive pressure sensor or resistive bridge pressure sensor), blood temperature, venous hemoglobin oxygen saturation (SVO2), hematocrit (Hct), carboxyhemogloben, glucose, or creatine (for renal function assessment). The SSP1495 is designed as an implantable device, with the bare silicon die measuring only 1mm x 3mm. Up to two SSP1495's can be connected in parallel. When used in this manner, one SSP1495 configures itself to measure SVO2 and blood temperature, while the other SSP1495 is configured to measure blood pressure and blood temperature. Both SSP1495's utilize the TWINS™ power/data bus (Two Wire Implantable INterface for Sensors). This bus allows power, commands and results to be transmitted over two wires. Diagram #1 above illustrates the system.

Operation

A measurement begins when the IMD host micro processor issues a request to the SSP1496 Command Unit for measurements to be taken either singly or at given intervals. The SSP1496 then instructs one of the SSP1495 Remote Measurement Units to wake

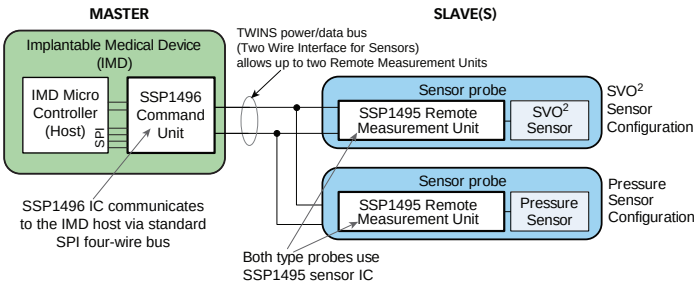


Diagram #1: Block diagram of the SSP1496 "Master" controlling a pair of SSP1495 "Slave" chips. The SSP1496 could reside in pacemaker module, while the SSP1495 would be intravenous.

up from its low power sleep mode and to make one measurement. Upon completion of this command, the SSP1495 uses its internally stored calibration coefficients to correct the measurement, and it then reports the results back to the SSP1496 Command Unit via the TWINS bus. Following this, the SSP1495 then returns to low-power sleep mode, awaiting the next instruction.

SVO2 Sensor Configuration

The SSP1495 can drive up to 6 external LEDs (one at a time) with a maximum current of 3.5 mA in 50 uA steps (see Diagram #3). Light from these LEDs passes though the blood and is detected on an external photo diode sensor. The photo diode charge is integrated and then digitized with an on chip 10 bit A2D converter. Photo diode dark current is also measured, digitized and subtracted from the SVO2 measurement. The SSP1495 also has a second photo diode input used to measure a calibration signal from the LEDs. The calibration signal does not pass though the blood. The on chip integration capacitance is programmable up to a maximum of 500pf. Also programmable is the integration time.

Pressure Sensor Configuration

The SSP1495 supports two different types of pressure sensors: capacitive and resistive bridge. As a capacitive pressure sensor (see Diagram #3), the SSP1495 can resolve 0.25mmHG in the absolute range of 560mmHG to 960mmG. Pressure data can be continuously streamed to the SSP1496 up to a 285Hz rate. The SSP1496 allows

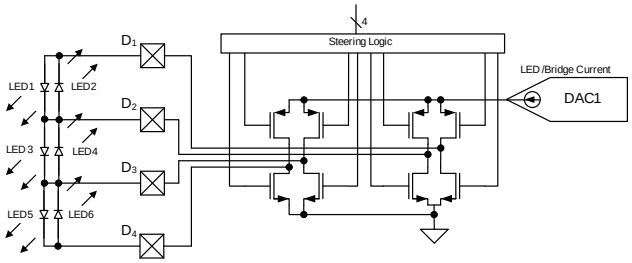
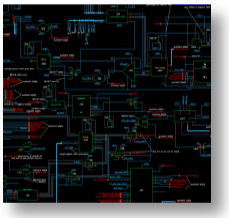


Diagram #3: SV02 Sensor configuration for the SSP1495.



SSP1495

Remote Measurement Unit

Implantable blood analysis Sensor Interface

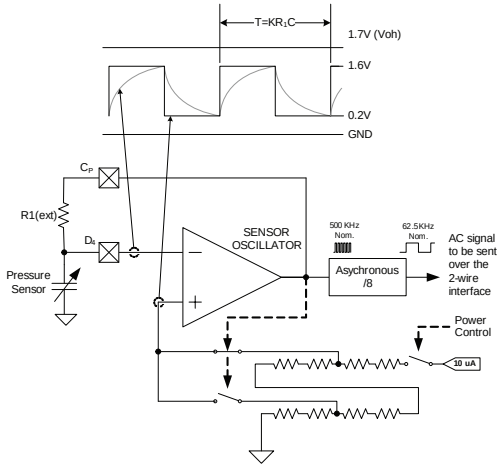


Diagram #5: Capacitive pressure configuration.

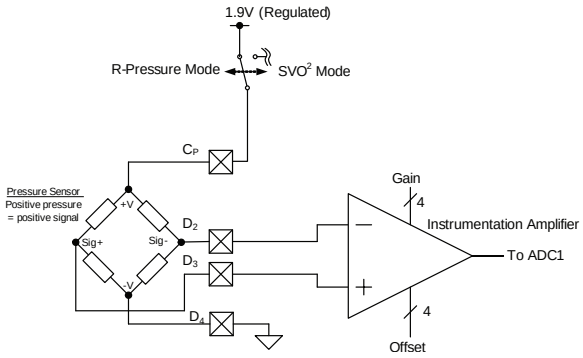


Diagram #4: Resistive pressure sensor configuration.

temperature data to be interleaved with pressure data.

As a resistive pressure sensor (see Diagram #4), the SSP1495 supports a 5Kohm external resistive bridge which connects to the input of an on chip instrumentation amplifier. The programmable gain and offset instrumentation amplifier drives a programmable low pass filtered input to an 11 bit on chip A2D converter. The programmable low pass filter allows for tradeoffs between pressure capture rate and noise free usable bits of resolution of the digitized signal. When used in "stream mode", pressure data can be taken up to a maximum rate of 340Hz.

Temperature Sensor

Temperature can be measured in either configuration of the SSP1495 (i.e. SVO2 or pressure). The temperature sensor has a range of 36 to 46 degrees C with .1 degree accuracy (after a 3rd order fit) and .02 degrees of resolution.

Local NVM

The sensor type configuration (i.e. SVO2 or Pressure) is stored in off-chip Non-Volatile-Memory. NVM also stores calibration coefficients and other important settings specific to each SSP1495. In a pacemaker application, where the SSP1495 is part of a lead system connecting to a central pacing unit, having localized NVM allows leads and SSP1495 Remote Measurement Unit to be replaced without the need to reprogram the correction coefficients within the SSP1496 (i.e. the correction coefficients specific to the SSP1495 are read from the NVM associated with the SSP1495).

Sensor Platforms, Inc.

SPI is a fabless semiconductor company, located in San Jose, California, that provides standard and custom mixed signal IC solutions to sensor manufacturers and system integrators. We are unique because we understand the needs of the interface IC not only from a mixed signal IC perspective, but also from the level of the system and the sensor. Our unique combination of expertise in mixed-signal analog IC design, sensor knowledge, and system level application requirements enable us to add value at each stage of sensor application deployment, from sensor specific analog blocks to DSP and algorithm engines to embedded firmware.

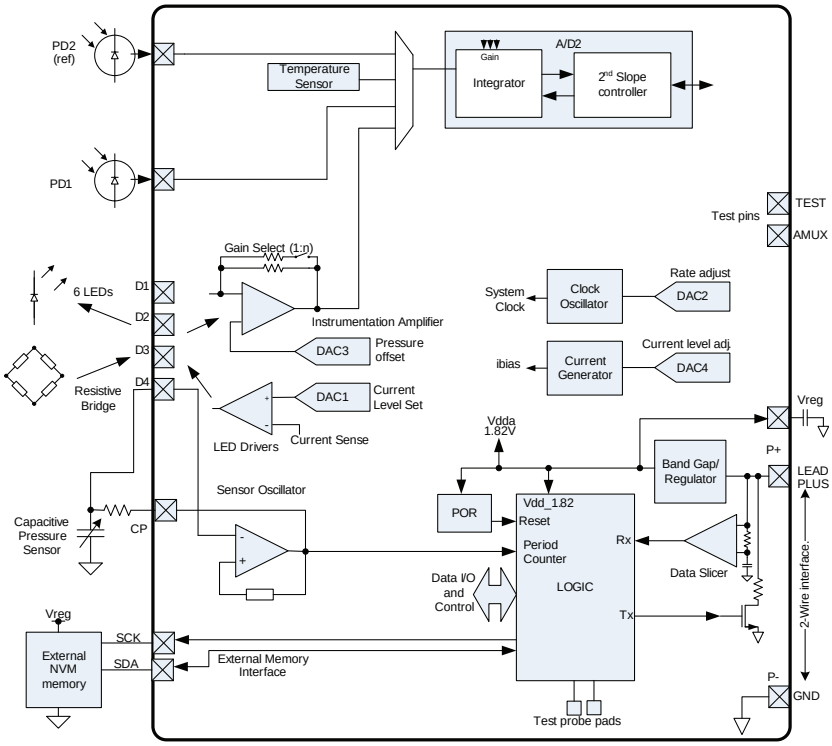


Diagram #6: Functional diagram of the SSP1495.

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