Configurable Reverse Telemetry Protocol for Retinal Prosthesis

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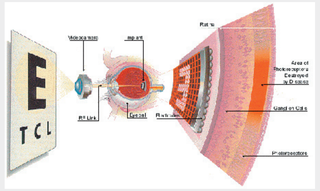
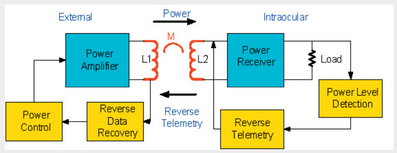
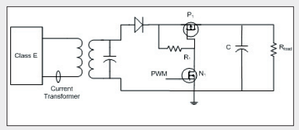


Overview

Retinal Prosthesis aims to provide vision for 33 million people suffering from lost vision caused by Age-related Macular Degeneration (AMD) or Retinitis Pigmentosa (RP). The prosthetic device includes the external unit which sends image data to the intraocular unit. The intraocular unit controls the microelectorde array which delivers current pulses for retinal stimulation.



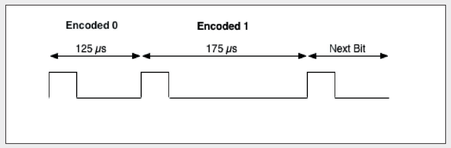


Reverse Telemetry

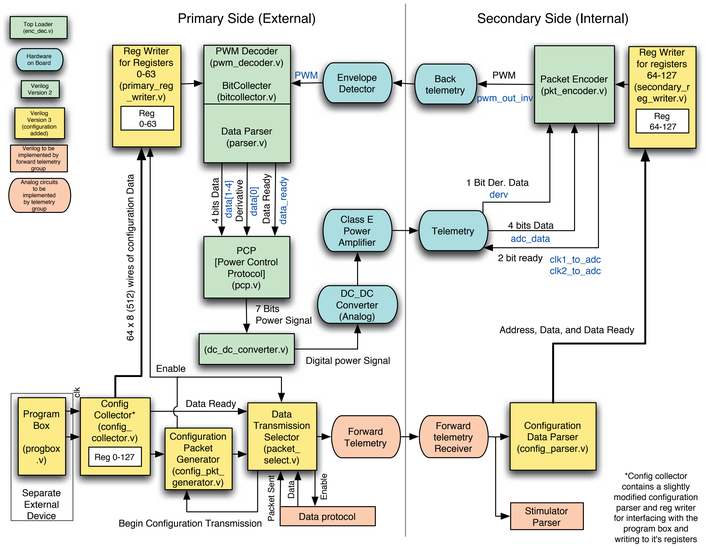
The intraocular unit receives power from the external unit using coils. Changes in coil separation and eye movement can induce a variation in the power being received. To compensate for these instantaneous changes in power, Reverse Telemetry is used as a part of closed-loop feedback system. It is also used to transmit information such as electrode impedance, temperature, and pH level in the eye.

Encoding

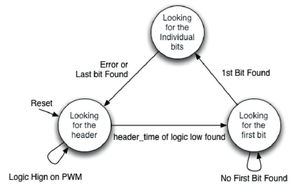
- A packet contains 16 bits
- Variable Width Bits
  - 1 is 175us
  - 0 is 125us
- Packet length varies from 3.2ms to 4ms



Header	pH,Temp,Impedance			D_3	D_2	P_1	D_1	D_0	Deriv	P_2
1.2ms silence	0	1	...	D_3	D_2	D_3+D_2	D_1	D_0	Deriv	D_1+D_0

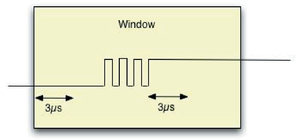


Decoding



- Recognizes a header by looking for a certain duration of low
- Recognizes first bit by looking for a low to high transition after header
- Searches for other bits using windows

- A Bit is found when a transition occurs inside the window
- To compensate for noise a transition is: 3us of low followed by 3us of high



Configuration

Reverse Telemetry protocol uses parameters shown in the table below for encoding and decoding. To configure these parameters, the external to intraocular data link called Forward Telemetry is used.

Parameter	Description	Default
pulse_dur_0	Time between pulses for a 0 (encoding/decoding)	125
pulse_dur_1	Time between pulses for a 1 (encoding/decoding)	175
pulse_width	The width in µs for a pulse (encoding)	7
header_length	Length in µs for the header (encoding)	1200
nbits_pkt	Number of Bits in one packet (encoding/decoding)	16
window_width	Width of the window (decoding)	10
header_threshold_time	Number of Bits in one packet (decoding)	255
level_threshold	Amount of time logic level must be constant to be ascertained	3

Sync Word	Type	Address	Data	Parity	Address	Data	Parity
30bits (11...0)	1bit	6bits	8bits	1bit	8bits	8bits	1bit

The packet is structured so that Sync Word can uniquely indicate the beginning of the packet.

Results & Future Work

Shown below are signal waveforms from verilog simulation of Back Telemetry protocol. Configuration Protocol is tested using a testbench which sends configuration packets from an input file to the decoder and compares the output of the decoder to the input file. In future, Back and Forward Telemetry protocols, along with other analog and digital components will be synthesized to a mixed signal chip in .18um process.