Senseg

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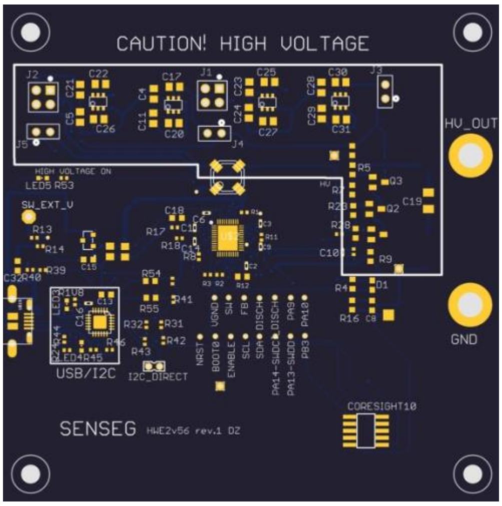
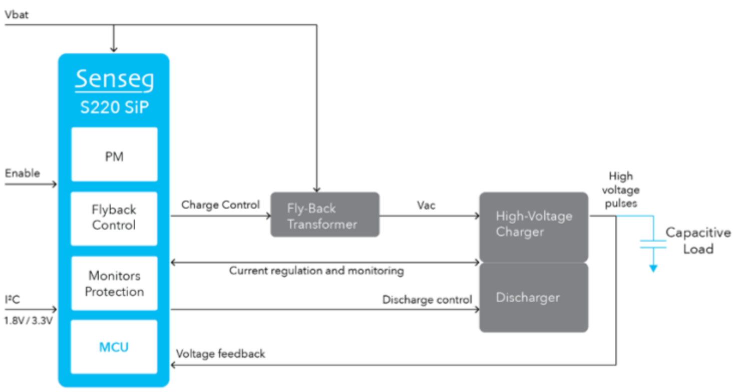
HIGH VOLTAGE DRIVER - E1

Senseg high voltage driver E1 is an evaluation board for Senseg proprietary S220 SiP (system-in-package). It uses flyback topology to generate high voltage, and the S220 has been specifically designed for implementing the high voltage driver using minimal number of external components. With the selection of externals, the maximum output voltage can be set to anything from a few hundred volts up to 2.5 kV. Depending on application needs, board area of only 20x10 mm with 2 mm height can be achieved.



For ease of use, the E1 high voltage driver board has I2C to USB converter inbuilt. After software installation the system is plug and play via USB connection, which also provides power for the system. Senseg software allows real-time control of the output signal. The requested signal waveform is written by the user in a high-level custom description language (example waveforms are provided), which S220 executes and maps to the non-linear properties of the high voltage part of the electronics.

Block Diagram



When driving larger loads with high frequency signals it is recommended to use a USB port capable of at least 900 mA. This evaluation board has an option to supply switch externally trough SW_EXT_V pad to avoid USB-related blackouts/brownouts. Please note that due to flyback topology features, the voltage over internal switch of S220 (60 V maximum, may be further limited by firmware) is not equal to the DC voltage supplied through SW_EXT_V. <u>Warning: If increasing switch voltage above 5V, the actual AC voltage across the switch must be monitored (SW test pad) to avoid the SiP damage.</u>

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The system operation can be divided into two major processes: 1) load *charging* through flyback circuit and a cascade of voltage multipliers (upslope part of the signal), and 2) load *discharging* through "transistor ladder" discharger (downslope part of the signal). During both stages, S220 continuously compares the actual output voltage with the intended one and introduces corrections to charge/discharge rate if needed.

EVALUATION BOARD FEATURES

E1 is designed to allow the user to explore the whole range of Senseg S220 performance capabilities and to examine which external components will be required to implement desired characteristics.

Voltage multipliers

The board has series of HV multipliers divided into three stages (no multiplication, 1st stage, and 2nd stage; set with jumpers). This feature allows to adjust the maximum output voltage approximately in the range of 600 V to 2500 V (depending on the transformer used). Output voltage increase due to multiplication is not linear as the capacitors involved in Cockcroft–Walton topology add up to secondary capacitance of the flyback transformer therefore limiting the initial high voltage. At the same time, if operating on the brink of transformer power capabilities (in the default design the flyback transformer is the bottleneck: S220 can drive notably larger transformers), multiplying high voltage will result in decrease in current delivery.

High voltage flyback transformer

E1 evaluation board is equipped with compact, low profile custom flyback transformer by Coilcraft. The default transformer is optimal for driving capacitive loads in the range of 500 pF (up to 500 Hz) to 20 nF (up to 50 Hz). S220 has potential of driving more powerful transformers. This requires changes to the charging algorithm which can be provided according to customer needs.

Senseg S220

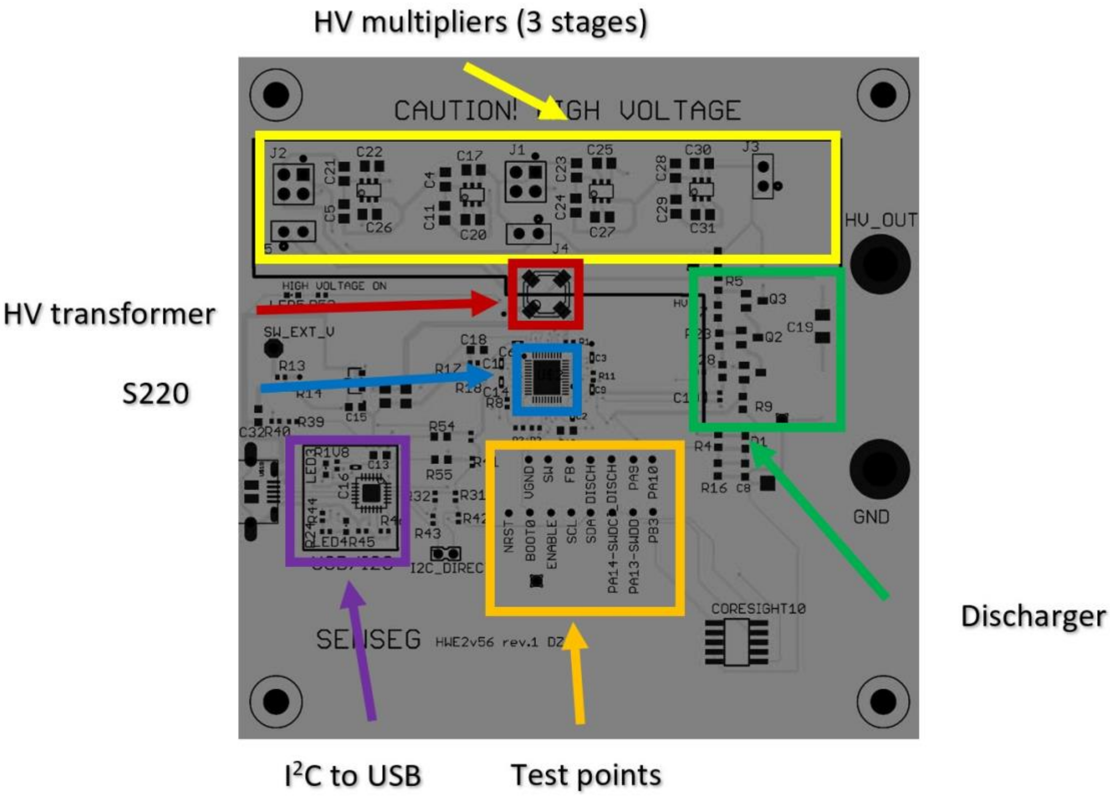
The SiP features broad customization possibilities through firmware modification. Changes in charging algorithm, flyback operation scenarios, and feedback loops optimizes S220 performance for a specified task. S220 has five free GPIOs which can be dedicated to various purposes. The SiP uses I^2C for communication with host. The I^2C to USB circuit can be bypassed using I2C_direct headers. To prevent overheating due to extreme operation S220 has built-in thermal protection and external NTC resistor to protect the transformer.

Discharger

Typically does not require any modifications, when operating under maximum ratings.

Test points

These provide access to the main analogue and digital signals: I^2C, NRST, ENABLE, SWD, current and voltage feedback, free GPIOs



POWER REQUIREMENTS AND MAXIMUM RATINGS

	MIN	MAX	UNIT
Supply voltage	3.3	5	V
Switch external supply	3.3	5*	V
Output power		1	W_{RMS}
Output voltage @500 Hz, 470 pF		1200	V_{peak}
Output voltage @125 Hz, 11 nF		1100	V_{peak}
Output voltage @50 Hz, 28 nF		950	V_{peak}
Frequency		1500	Hz
Maximum output voltage		2500	V_{peak}
Load		50	nF

***actual voltage across the switch to be monitored**

FEATURES

- Cost-efficient pricing vs. performance at high volumes
- Plug and play via USB
- Voltage range from 0 V up to +2.5 kV* (depending on the HW version)
- Maximum load up to 50 nF*
- Maximum frequency up to 1500 Hz*
- Continuous use capability due to minor heat emission
- Complete control of the waveform by easy-to-use custom description language
- Converter efficiency around 25%
- SiP in VFQFPN 5x6 mm 44 leads 0.4 mm pitch
- FW and HW safety features
- Sheathed output connectors

*There is a natural tradeoff between the output signal amplitude, frequency and the load driven. If one of the parameters is maximized, the other two are not able to reach their maximum. NOTE: It is also possible to make high voltage driver versions with higher power output by changing the transformer and tuning the flyback operation.

APPLICATIONS

- Dedicated HV driver for ELFIAC
- Compact laboratory HV source
- Electroactive polymers
- Piezos with high voltage but low current requirements (typically below 50nF load)
- Electrovibration
- MEMS devices
- Electrostatic chucks
- Electrophoresis

For more information:
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