A NEW TYPE HIGH VOLTAGE FAST RISE/FALL TIME SOLID STATE MARX PULSE MODULATOR

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Stangenes Industries has developed a Fast Rise/Fall time dynamic waveform solid-State modulator base on the Marx Generator:

- Pulsed Voltage: 14kV
- Pulse Width total: 0.2 to 2µsec
- Pulse rise/fall time: <120 nSec
- Pulse rate: >25kHz
The present pulsed modulators such as hard tube modulator or Solid State equivalents or induction modulators have a number of limitation which can be overcome by use of the solid state Marx approach.

1) Dynamic Pulse width and Amplitude
2) Fast Rise time and fall time
3) High pulse voltage with low power supply voltage.
4) Capable of driving high capacitance load
Advantages of solid-state Marx for dynamic pulses

- **1) Rise time and fall time** The output impedance of a Marx is very low limited only by the capacitor and switch impedance on both rise and fall. Turn on and off time of the switch is the major limit to rise time.

- **2) The Marx allows for discrete dynamic amplitude control.** Depending on the number of stages the amplitude of the pulse can be time varying by discreet steps.
The Marx generator modulator has the advantage of **lower DC voltages and multiple stages**. Typically it used **inductor, resistor, or transformers** to supply the charging capacitors voltage and control power to the stages.
Replace resistor/inductors with solid state switch

Note: charging and auxiliary by way of diodes and switches

Modular design for Modulator and drivers
• A prototype, **14 stage multistage modulator** was fabricated and tested and supplied to Fermi Lab.

• Each stage was operated at a nominal one kilovolt with a producing a **14 kV pulse.** **Rise times was less than 150 nS with pulse width adjustable for 0.2 µS to 2 µS**.

• **Spark down testing** using spark gaps demonstrated its ability to recover from load break down.
14 stage Marx modulator
14 kV pulse Rise times < 120μS
Pulse width adjustable
Fiber optic trigged

Pulse Driver Stages
Mother board and trigger Driver
STANGENES INDUSTRIES, INC.

Stangenes Marx modulator driver

2.2kV IGBTs operating at 1 kV

Longer pulse

Short Pulse

IGBT limits Rise time
Adjustment flexibility of modulator

Short pulses 200 ns

Step Voltage Amplitude Pulses
A Second Generation Modulator has been designed and is under fabrication to 14kV, at 50 kHz with discrete dynamically adjustable output voltage. The new modulator will have improved cooling. It is capable of using high voltage FETs to improve the rise time and fall time of the modulator. The IGBT/FETs are water cooled to allow for greater than 50 kHz operation.
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Stangenes Marx modulator driver

Water cooled heat sink and modular stages
SUMMARY

• The Stangenes designed Solid-State Marx modulator has demonstrated that it can be used to provide a fast rise and fall time at high repetition rate. In addition, it can produce a dynamic amplitude and pulse duration at high voltages. With the improved cooling, it well is capable of higher repetition rates. If the IGBTs are replaced with FETs, the modulator can have a faster rise and fall time at a lower output voltage.