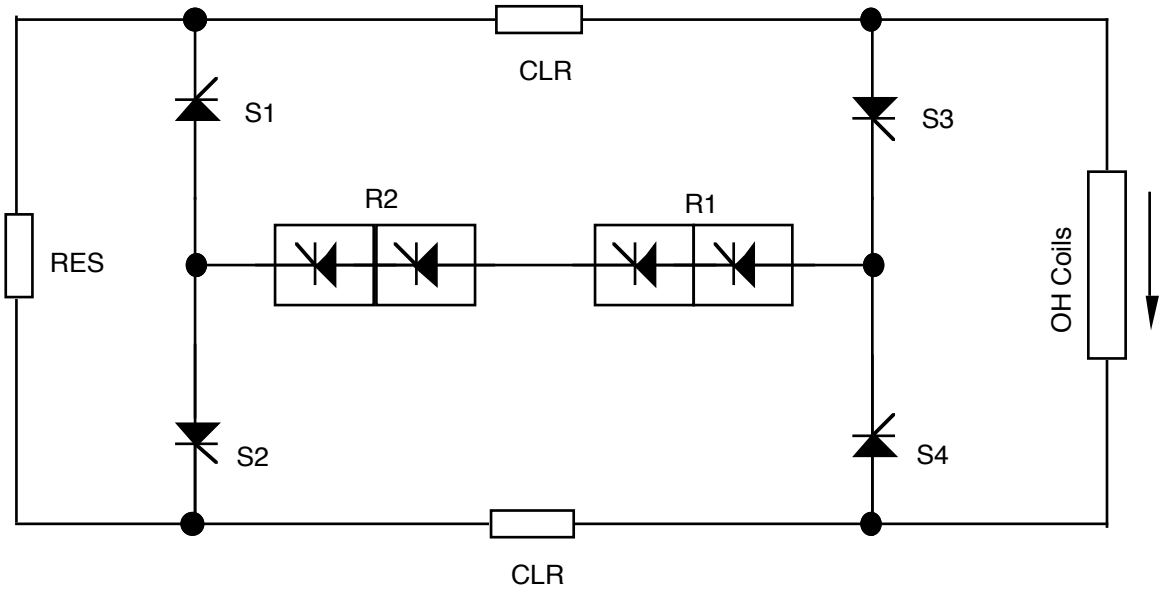
53-960605-CLN-01

TO: DISTRIBUTION
FROM: C NEUMEYER
SUBJECT: OH THYRISTOR SWITCH CONCEPT DESIGN & COST ESTIMATE

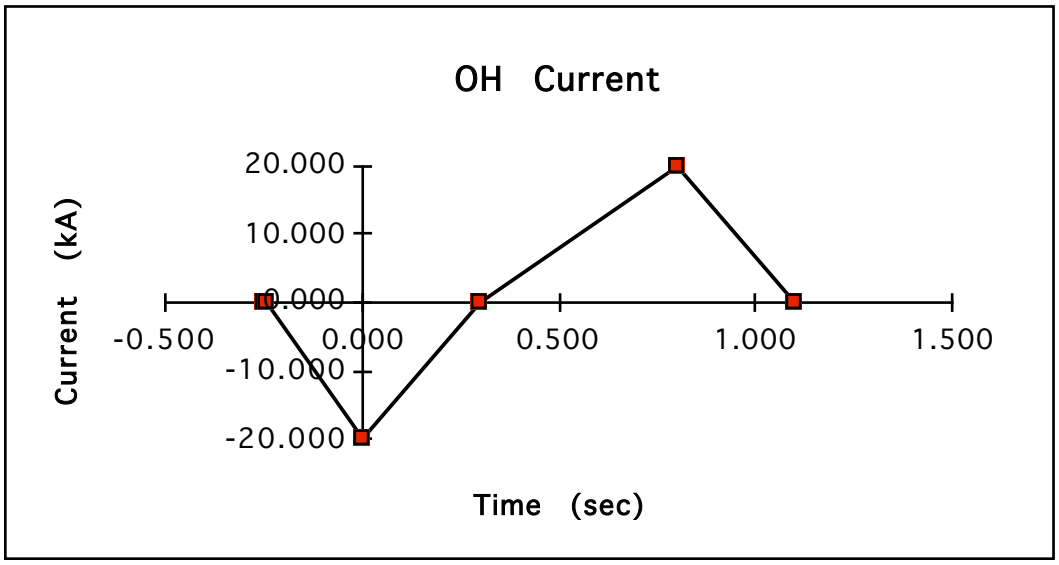
Reference:

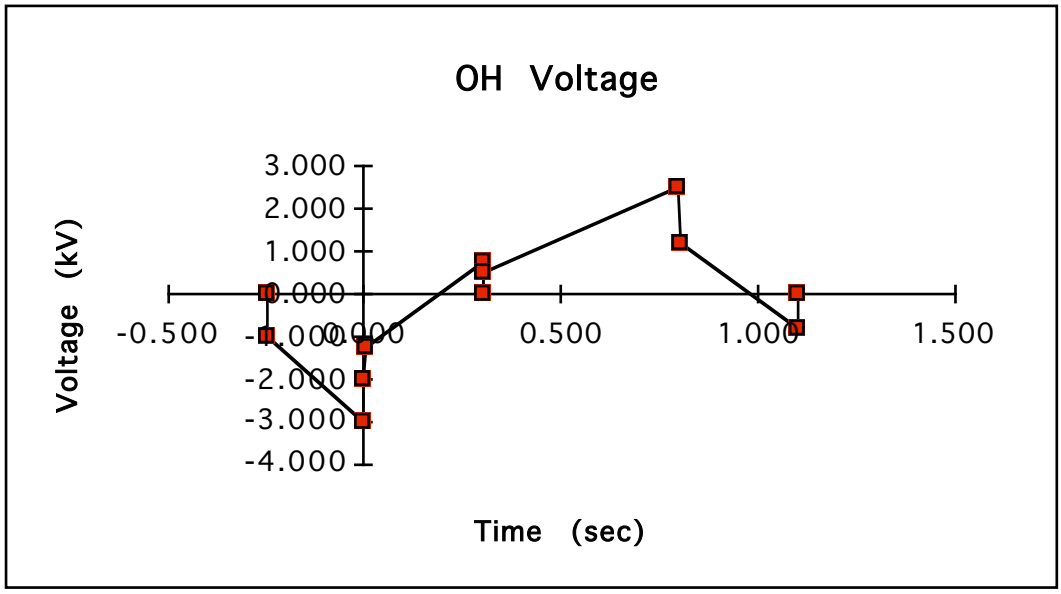
(1) 53-960522-CLN-01, "OPTIONS FOR NSTX OH POWER SUPPLY"

The purpose of this memo is to describe a conceptual design for thyristor switches used to provide bipolar OH operation. The switches in question are S1 through S4 in the following figure.



Coil current and terminal voltage waveforms are depicted in the following figures.



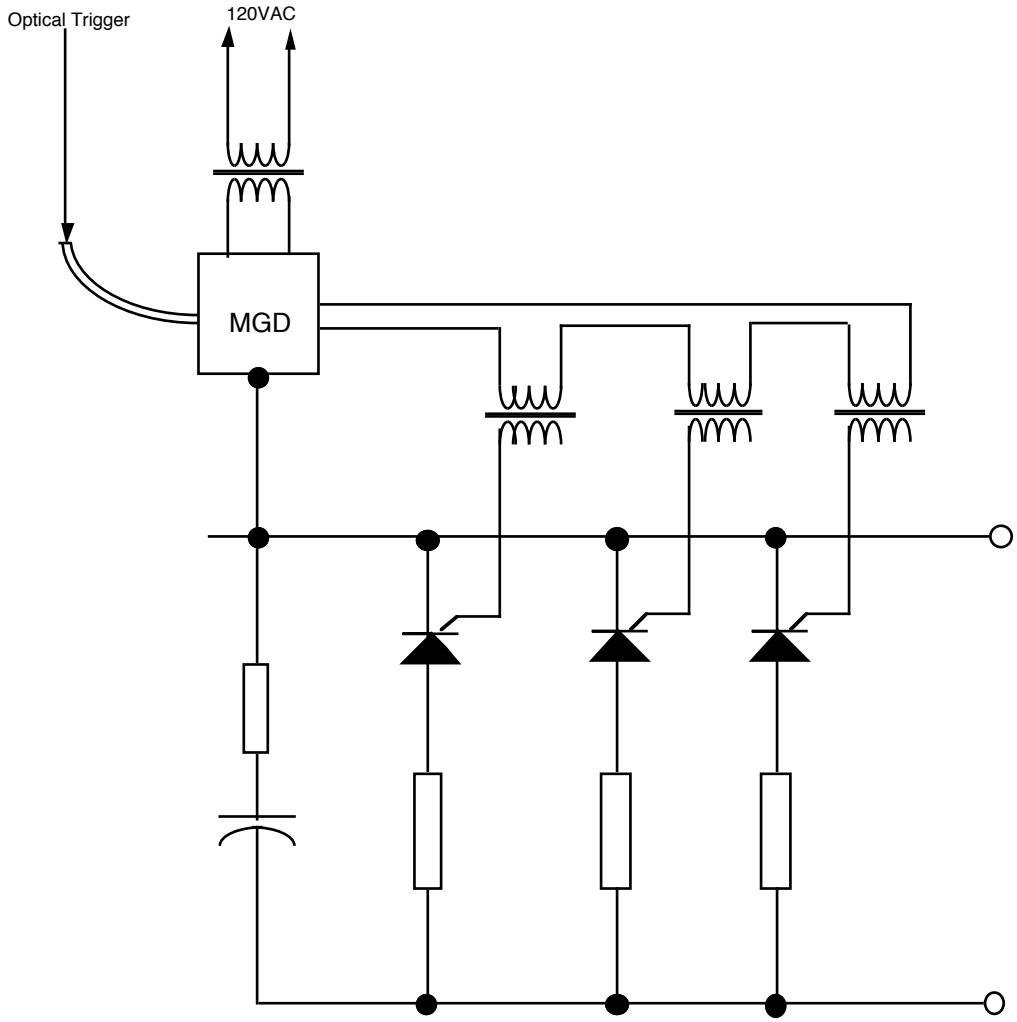


Current flow is initiated in the path S4, R1, R2, S1. Switches S2 and S3 are blocking. A small parasitic current flows in the resistor. Once the OH coils are precharged, the rectifiers are inverted, and Ioh heads toward zero. Near zero current the rectifiers are fully inverted, and at a current < V_{inv}/R, where R is the ohmic value of RES, the current in the rectifiers is extinguished and all of the load current flows in RES. S1 and S4 are now blocking. Next, S2 and S3 are fired, and the rectifiers are set to produce a (+) voltage, which further drives Ioh through zero and then in the opposite direction.

To design the switch, a current rating of 20kA/0.5 seconds, once per 900 seconds, and a maximum blocking voltage of 4kV, are assumed. In addition, the prospective fault current from the rectifier is assumed to be 80kA. The rectifier fault current should be suppressed in roughly 1/2 cycle if gate blocking is

successful and limited to a peak value on the order of 40kA; otherwise it will persist until the opening of the AC feeder breaker (3 cycles) and reach a peak value on the order of 80kA.

A concept design for the switch is shown in the following figure.



The switch uses several parallel thyristors, each in series with a resistor for current sharing. An RC snubber is connected in shunt. AC power for the gate driver is provided via an isolation transformer. The gate drive is triggered via a fiber optic cable. The gate pulse is delivered simultaneously to the parallel thyristors through pulse transformers with series connnected primary windings.

In terms of construction, it is envisioned that the parallel thyristors would each be clamped to a copper bus bar on the cathode side, perhaps with a copper block under the clamp on the anode side to act a transient heat sink and means of attachment to the resistor. The resistors would be implemented using stainless steel. They would be in the form of S shaped ribbons to provide strain relief between the clamed thyristor anode sides and the (-) bus. The (+) and (-) copper

collector bus bars could be water cooled if required to remove, between pulses, the modest heat generated during the pulse.

Design and cost estimate calculations are given on the attached spreadsheet.

cc:

D Mc Bride S Ramakrishnan NSTX File