

H-BRIDGE MODULES AS BOX-LEVEL PULSED POWER COMPONENTS



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Why Build an “H-Bridge Box”



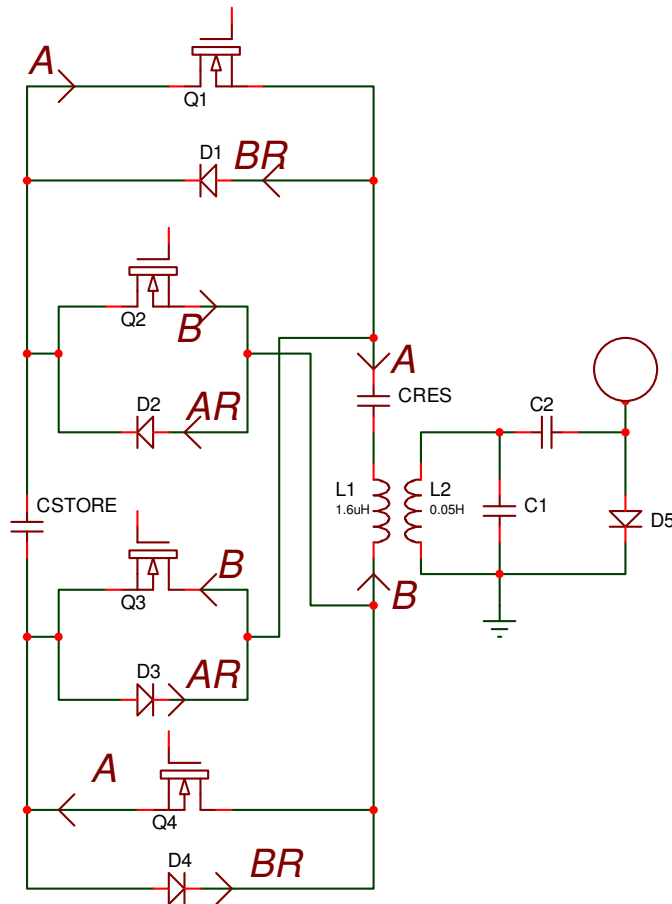
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- **Engineering of common components is the path to reducing pulsed power system cost**
 - **Common component base accumulates experience in performance which can improve reliability**
 - **H-bridges have unique properties**

Solid State H-Bridge Features



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- **Converts DC to symmetric AC**
 - **4-element H-bridge requires only a single power supply**
 - **Diodes provide for Energy recovery of inductive energy**

Inductive Load Performance



- Current goes through “A” path
- When transistors turn off current goes through “AR” (A return) path through diodes back to the energy source CStore
- Current goes through “B” path
- Current returns through “BR” at end of pulse

Series Resonant Performance

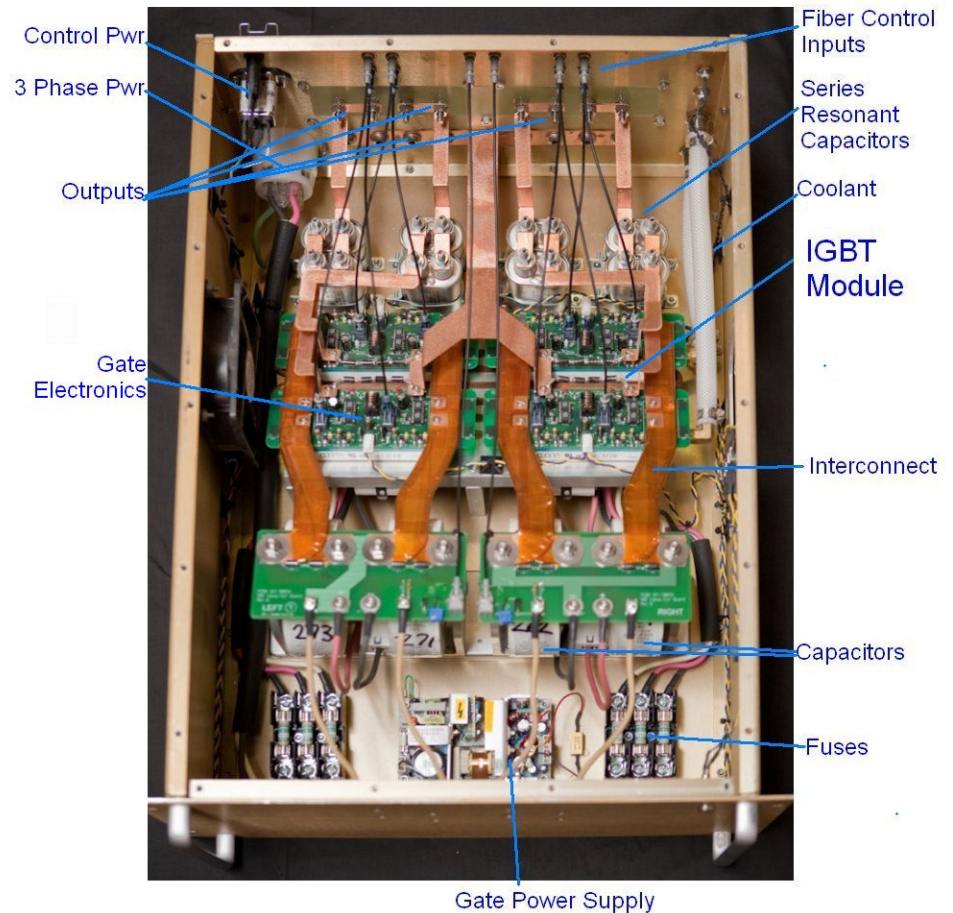


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- **Negative Attribute – 100 % of current goes through the IGBT each cycle**
 - **Positive Attribute – Significant voltage “gains” are possible (AC voltage/DC input > 20 are routine)**
 - Voltage gain simplifies transformer design or even eliminates the requirement for a transformer

Details 1

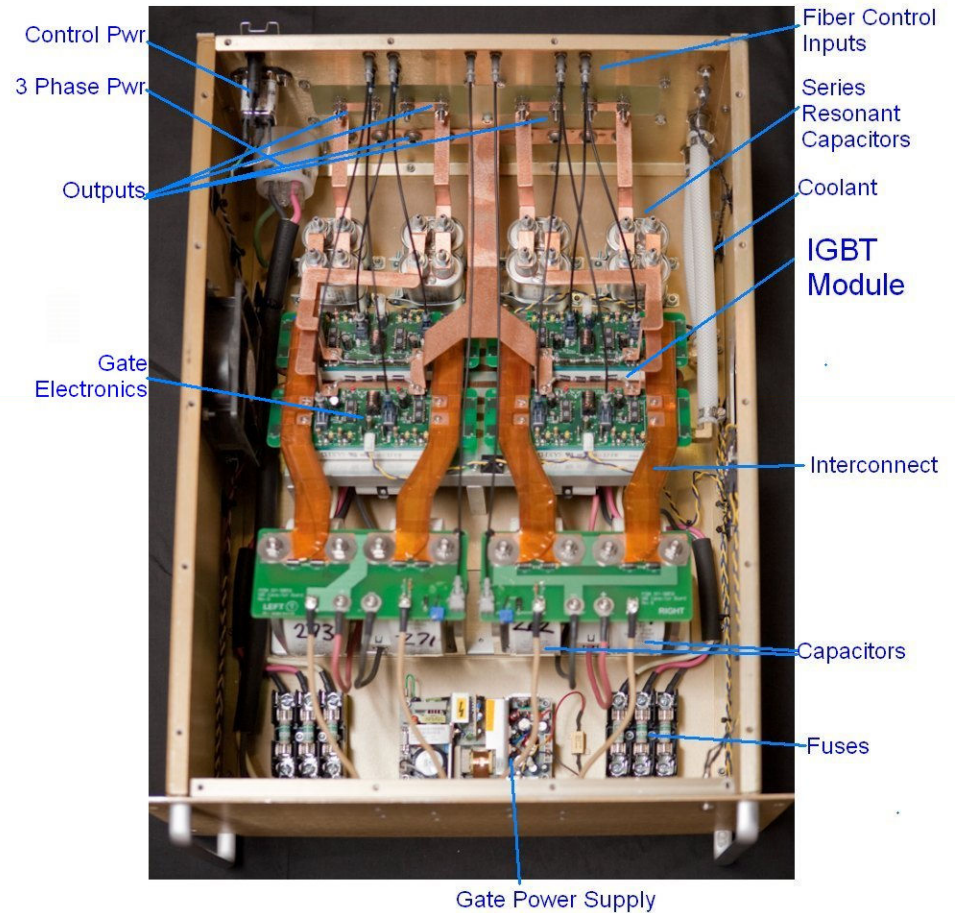


- Plastic fiber optic connections for ease of termination and troubleshooting
- Internal Series resonant capacitors tailored to the application
- Water or glycol based coolants with quick-connect lines



Details 2

- IXYS IGBT module with fast diodes
- Low inductance (3 nH) interconnects
- Low inductance (9 nh) capacitors
- Fused by half-box (promotes redundancy in multi-box systems)
- Fast transformer gate drives



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“Bypass” Capacitance



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- **“Bypass” capacitance is placed near a load to provide high compliance**
 - **H-bridge boxes are engineered so additional capacitance is not required for bypass**

Gate Drive

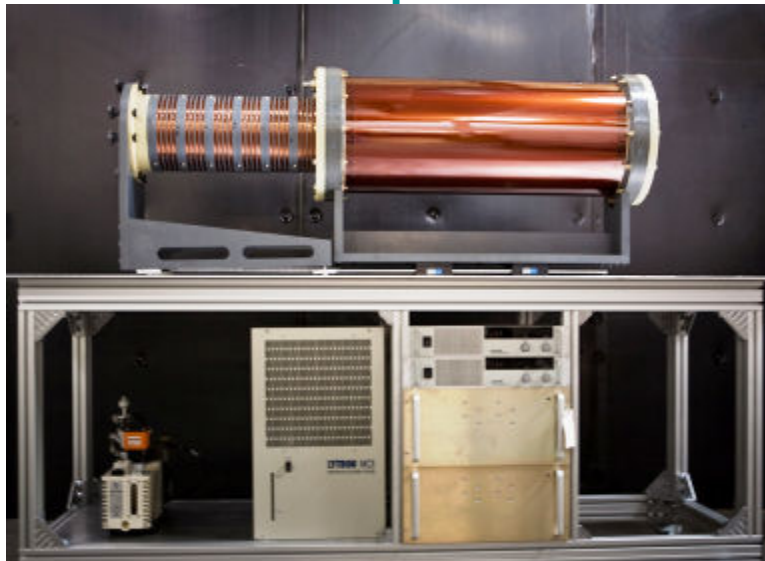


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- **Transformer based gate drives are “good enough**
 - **Transformer based gate drives prevent “Shoot through” faults in most cases**

NHVG (Nested DC Accelerator)



- Designed for moderate energy (0.25 – 1.5 MeV) DC applications
 - Medical parts' sterilization
 - Plastics' processing
 - X-ray Security
 - Ion Implantation

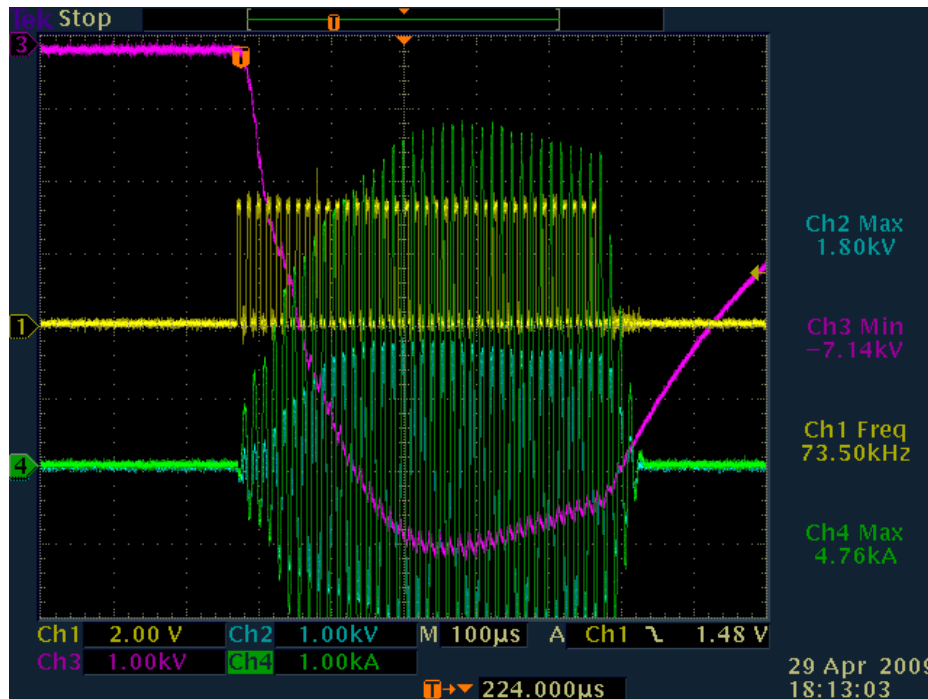


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NHVG Waveforms



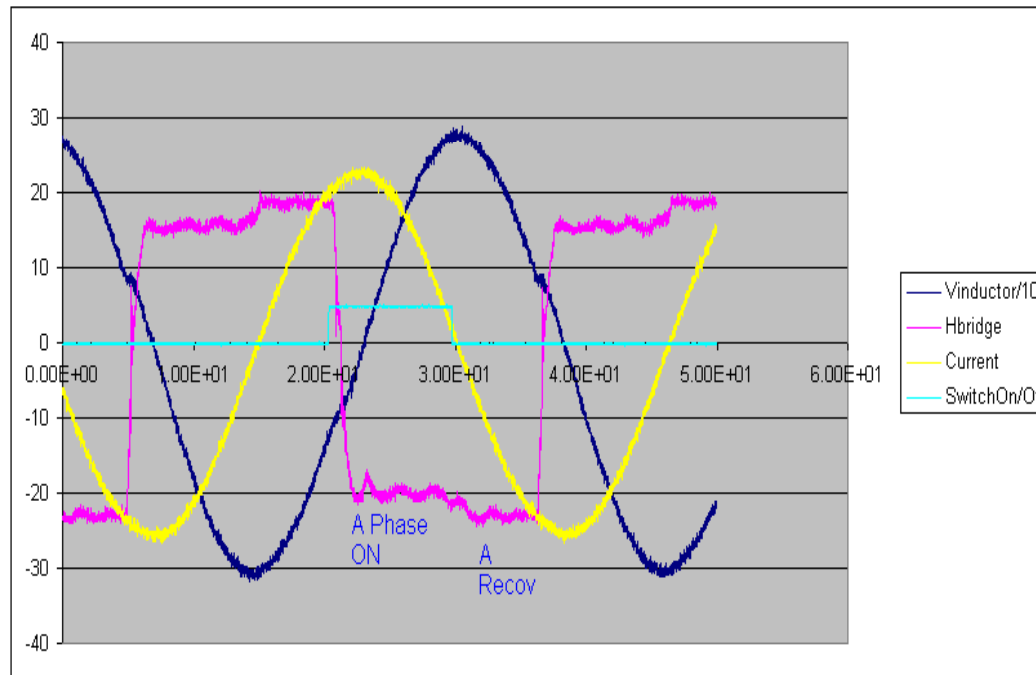
- Pulsed Version
 - 500 kW Peak (250 kV 2 A)



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Waveforms in Operation

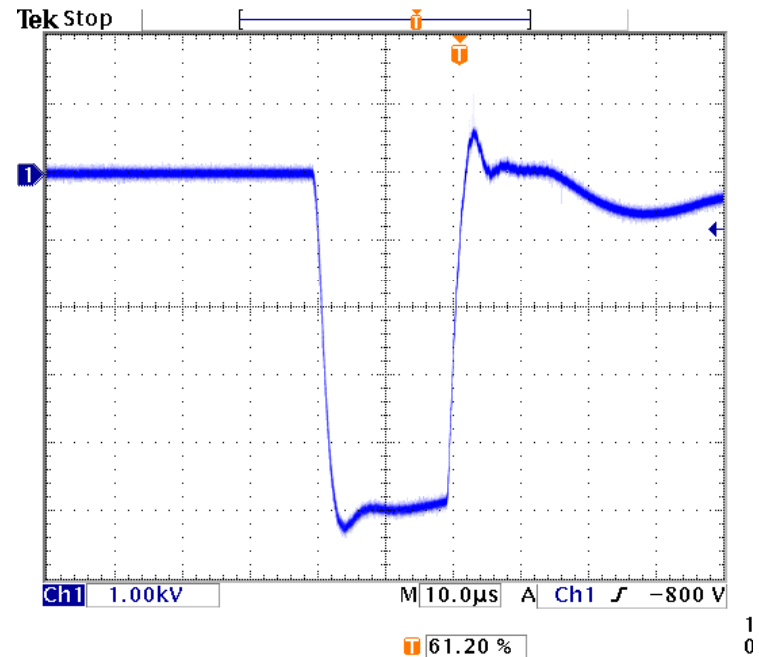
- Typical CW Settings
- Series resonant voltage $\sim 10 * DC$



Modulators Driven By H-Bridges



- For small and medium sized pulse generators the cost of the generator is primarily in the transformer
- Optimization of the transformer is more important than efficient use of the semiconductors



Laser Guided Energy (LGE)



- **Power Supplies for Laser Guided Discharges can be Tesla coils**
- **Long LGE discharge – electrically active laser discharge**



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Tesla Coils

- **Small LGE (Laser Guided Energy) Tesla coil**
- **10 Joules/pulse**
- **300 Hz**
- **300 kV**
- **24” high coil in air**
- **>90% efficient**
- **800 A peak input current**
- **Can be basic building block of unique power supplies**



Conclusions



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- **Component selections in the H-bridge boxes have been made to minimize component count**
 - **The H-bridge boxes have been robust and reliable in a variety of applications**
 - **A number of different devices can be built on this standard platform**
 - Resonant drivers (Series resonant)
 - Resonant drivers (Parallel resonant)
 - Pulsed system drivers with reset
 - **Over 200 boxes have been built in the last 3 years**

A few boxes more



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