REINHOLD ENVIRONMENTAL Ltd.

2015 APC Round Table & Expo Presentation

July 13 & 14, 2015, in Atlanta, GA / Hosted by Southern Company

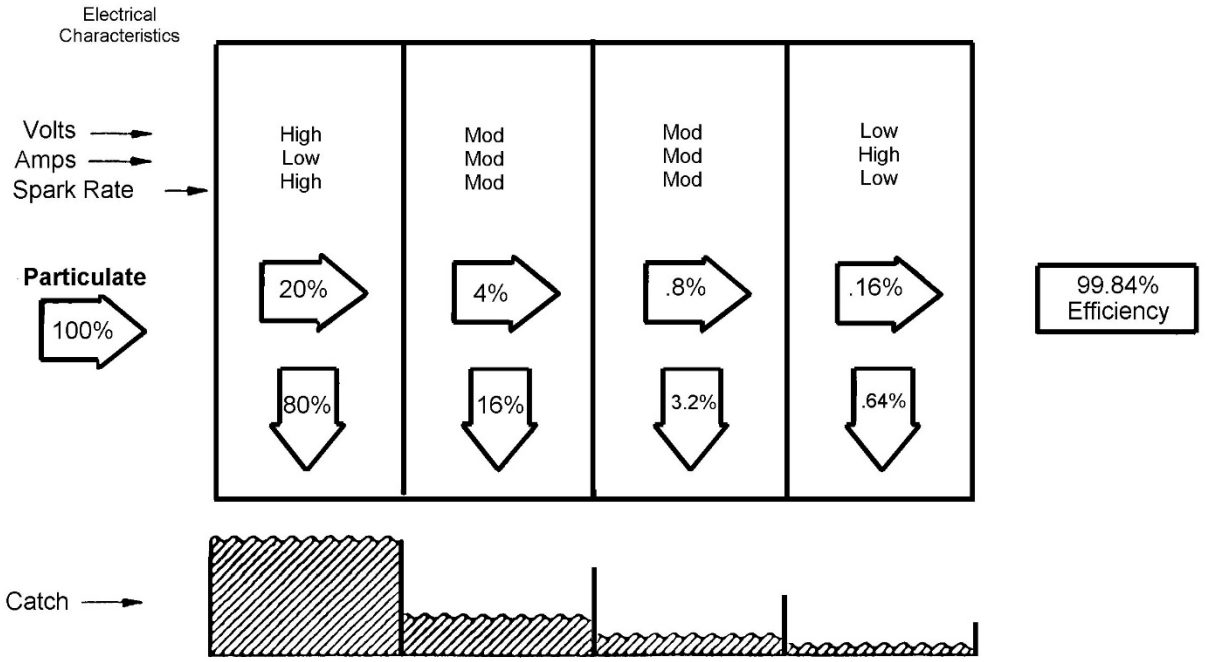
Transitioning from SCR to IGBT Controlled Power Supplies for ESP

Paul Ford

REDKOH INDUSTRIES

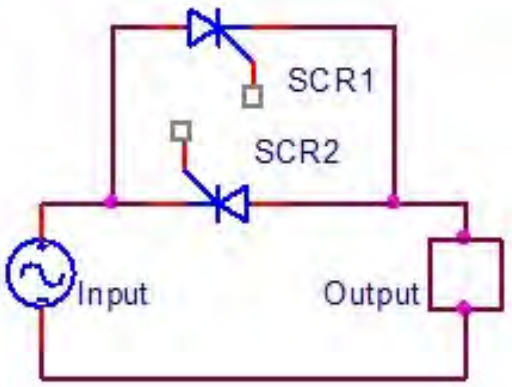
PARTICULATE COLLECTION

TYPICAL RELATIONSHIP BETWEEN ELECTRICAL READINGS AND PARTICULATE
CATCH NUMBERS ARE ONLY APPROXIMATIONS FOR ILLUSTRATION

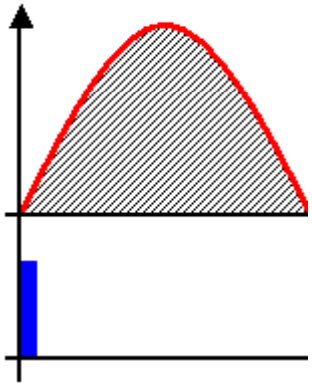


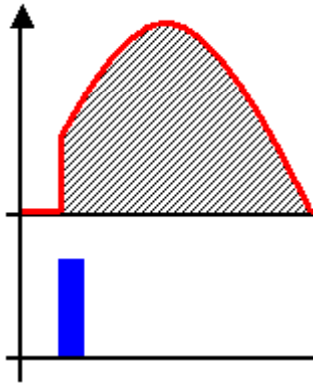
Current is the rate at which electric charge flows past a point in a circuit. **Voltage** is the electrical force that would drive an electric current between two points.

Comparison chart	**Current**	**Voltage**
Definition	Current is the rate at which electric charge flows past a point in a circuit. In other words, current is the rate of flow of electric charge.	Voltage, also called electromotive force, is the potential difference in charge between two points in an electrical field. In other words, voltage is the "energy per unit charge".
Symbol	I	V
Unit	A or amps or amperage	V or volts or voltage
SI Unit	1 ampere =1 coulomb/second.	1 volt = 1 joule/coulomb. (V=W/C)
Measuring Instrument	Ammeter	Voltmeter
Relationship	Current is the effect (voltage being the cause). Current cannot flow without Voltage.	Voltage is the cause and current is its effect. Voltage can exist without current.
Field created	A magnetic field	An electrostatic field
In series connection	Current is the same through all components connected in series.	Voltage gets distributed over components connected in series.
In a parallel connection	Current gets distributed over components connected in parallel.	Voltages are the same across all components connected in parallel.



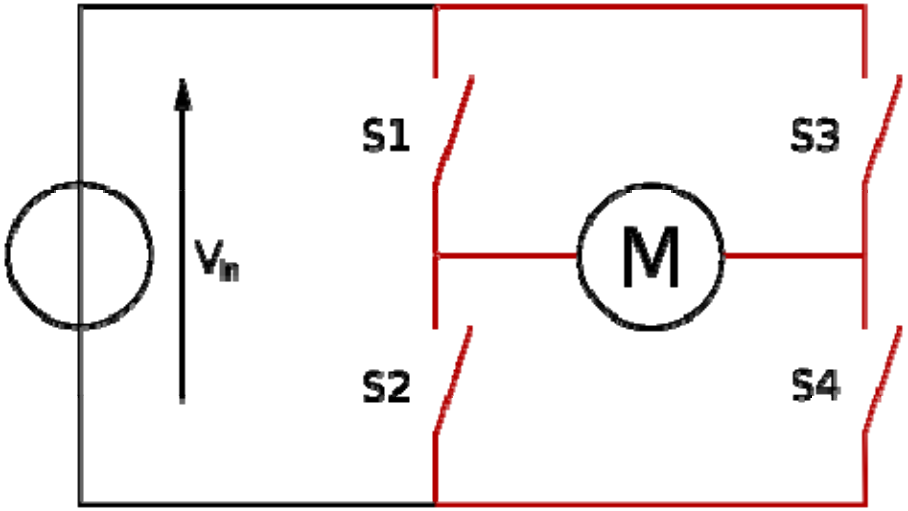
SCR SWITCH

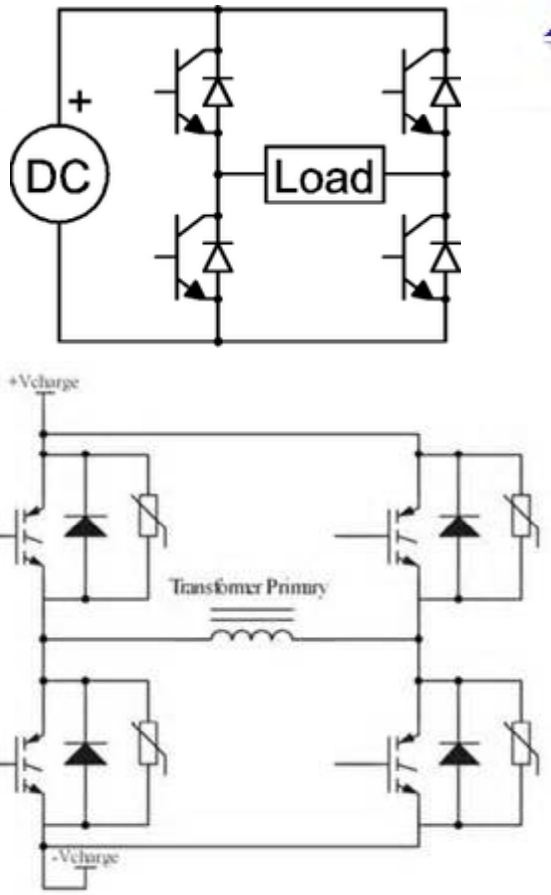




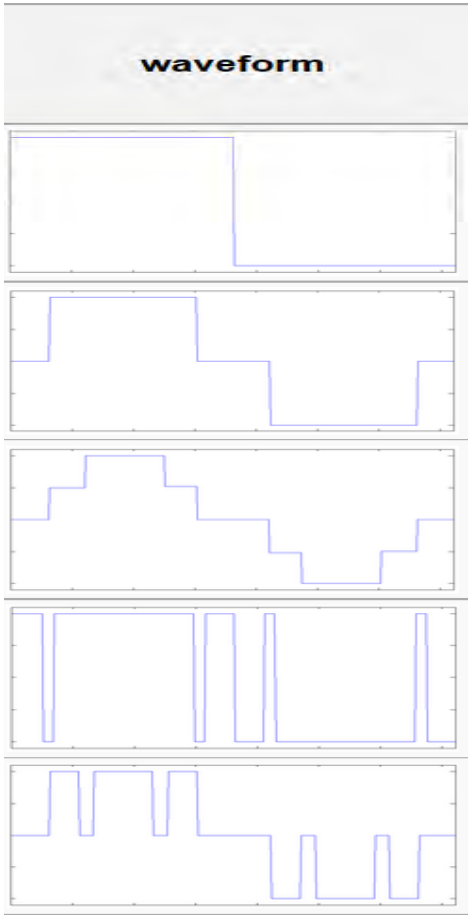
An H Bridge ☺

IGBT SWITCH





IGBT FLEXIBILITY



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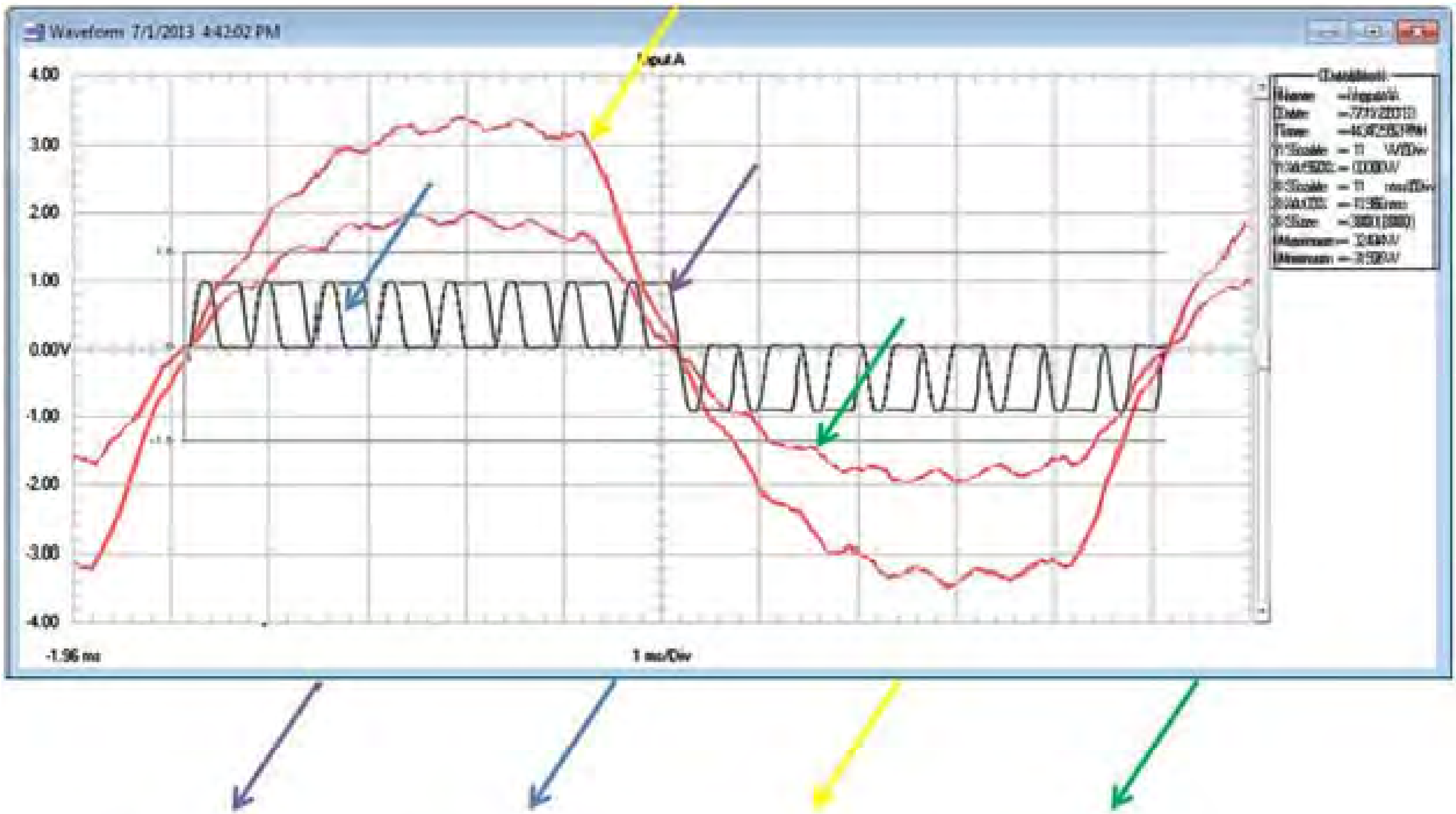

100 Hz, 60%
Duty Theoretical

100 Hz, 30%
Duty Theoretical

100 Hz, 60%
Duty Actual

100 Hz, 30%
Duty Theoretical

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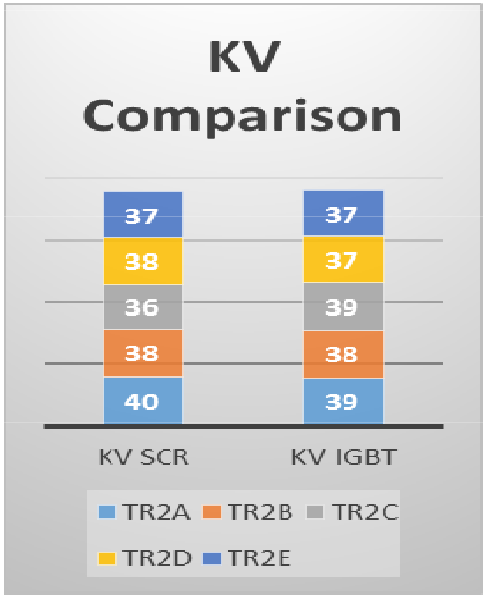
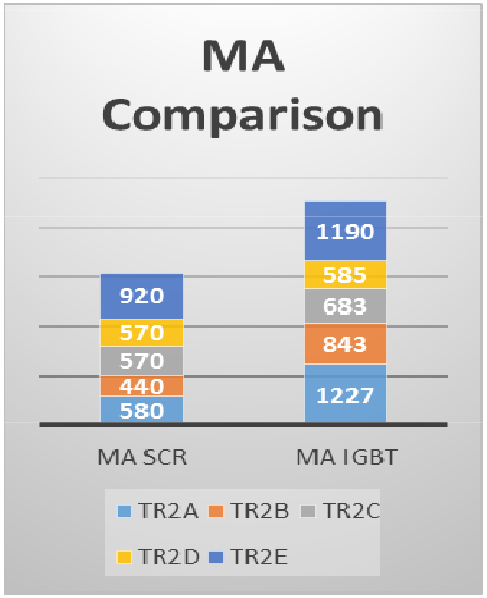
SAMPLE RESULTS

Unit 1	kV SCR	kV IGBT	MA SCR	MA IGBT
TR2A	40	39	580	1227
TR2B	38	38	440	843
TR2C	36	39	570	683
TR2D	38	37	570	585
TR2E	37	37	920	1190





THE UPGRADE PROCESS

- DETERMINE WHETHER SMPS IS RIGHT FOR YOU!
- CHANGE 2 POLE INCOMING POWER TO 3 POLE
  - Breaker and additional phase - cable

- REMOVE CHASSIS PLATE WITH ORIGINAL SCR CONTROLS
- INSTALL NEW IGBT CHASSIS PLATE
- POWER UP

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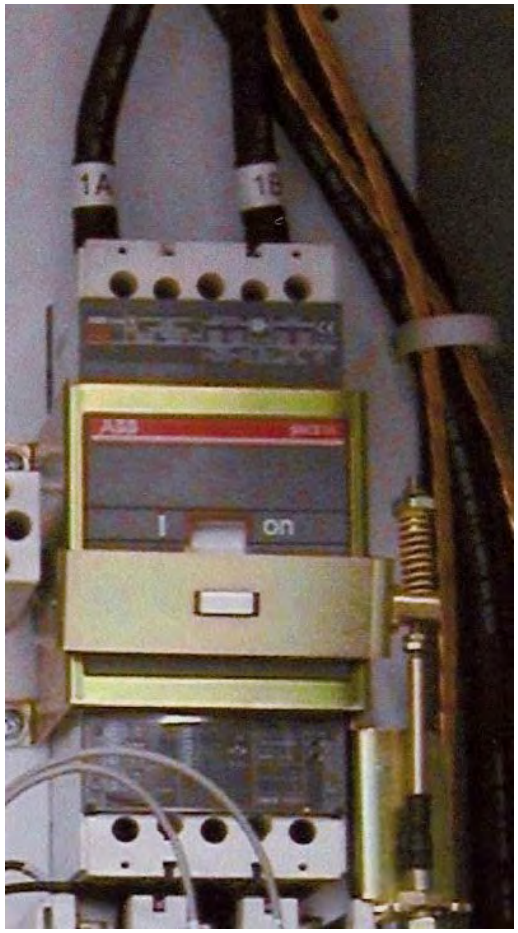

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Original SCR Control Cabinet

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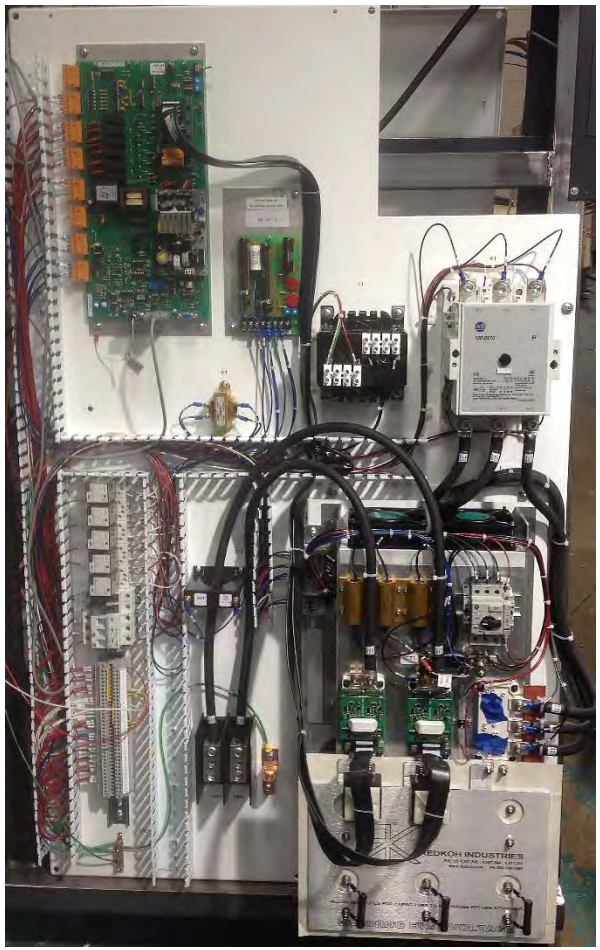
PRE-BUILT IGBT CHASSIS PLATE



Upgrading the Control Cabinet

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Upgraded Control Cabinet

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60Hz

SMPS

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The Conventional TR Set at 100 Hz modulated with 1.6 kHz

- **Benefits**
  - **Reduced ESP "ripple" provides improvements in ESP performance.**
  - **A lifetime of reliability.**
  - **Conservative designs**
  - **A wealth of knowledge and support.**
  - **A huge installed base.**
  - **Numerous companies manufacturing and re-building.**
  - **Known and reliable control and switching topologies.**
  - **Plant personnel supported.**
  - **Uses the same CLR**
  - **No de-rating of the TR set**

The 400Hz TR Set

- **Benefits**
  - **Possess all the benefits of the Transformers listed above**
  - **Significantly higher power capabilities as a result of conventional design techniques**
  - **Can be part of an ongoing TR replacement program**
  - **Size and shell matching – direct replacement**

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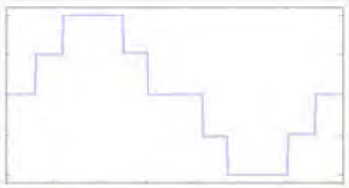
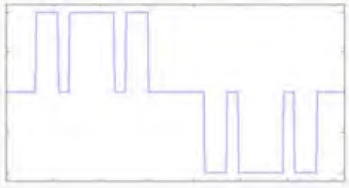
The 400Hz TR Set

Recognize these?
You should do....You are already using them!

Closing Arguments

- **Mid Frequency Switch Mode Power Supplies Provide:**
  - **Suitable waveform to the TR set in order to minimize ESP Ripple.**
  - **Increased average voltage to the ESP.**
  - **Increased current flow to the ESP.**
  - **Fast response times to events occurring in both the ESP and Power system.**
  - **Possess all the benefits of the tried and trusted transformer rectifier design**
  - **Significantly high power capabilities.**
  - **Improvement in power factor**
  - **Reuse of existing cabling, control rooms and Mechanical TR footprints**
  - **No Duct work modifications**
  - **Provides a solution rather than a one fits all product?**

waveform	signal transitions per period	harmonics eliminated	harmonics amplified	System Description	THD
	2	-	-	2-level square wave	~45%[7]
	4	3, 9, 27,...	-	3-level "modified square wave"	> 23.8%[7]
	8			5-level "modified square wave"	> 6.5%[7]
	10	3, 5, 9, 27	7, 11,...	2-level very slow PWM	
	12	3, 5, 9, 27	7, 11,...	3-level very slow PWM	