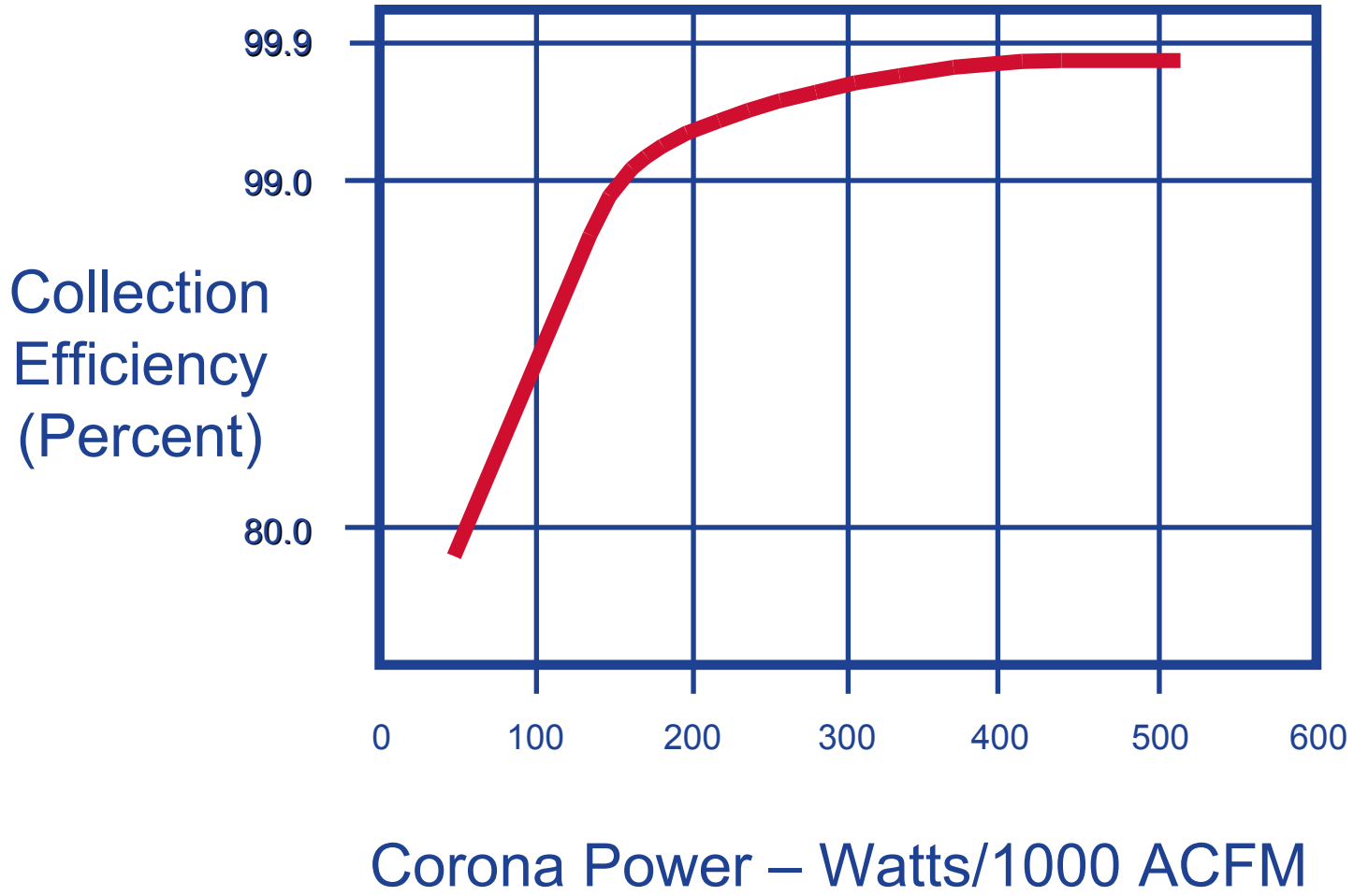
WPCA – AMEREN ESP SEMINAR

Understanding ESP Controls

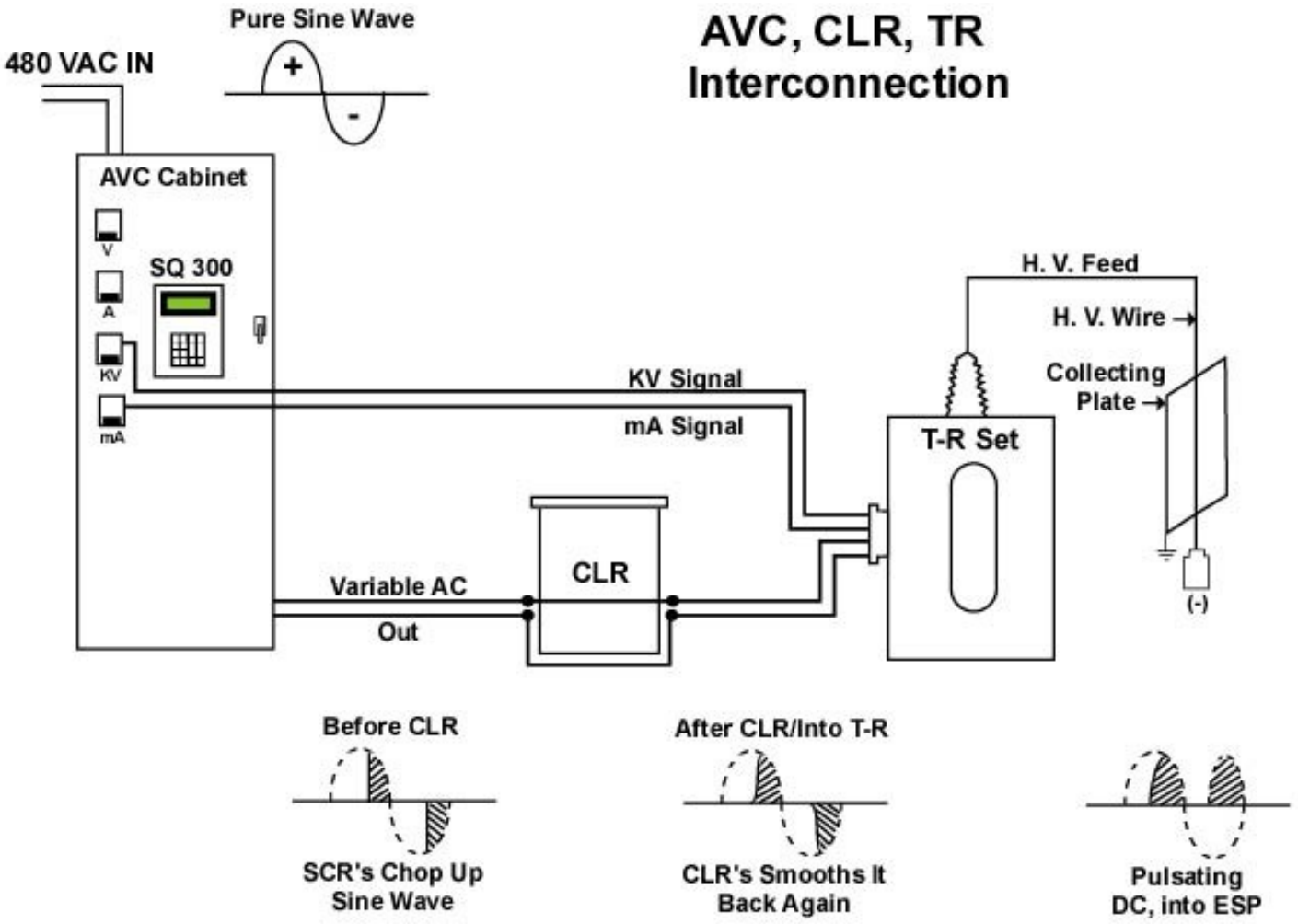
By John Knapik

Efficiency vs. Specific Corona Power

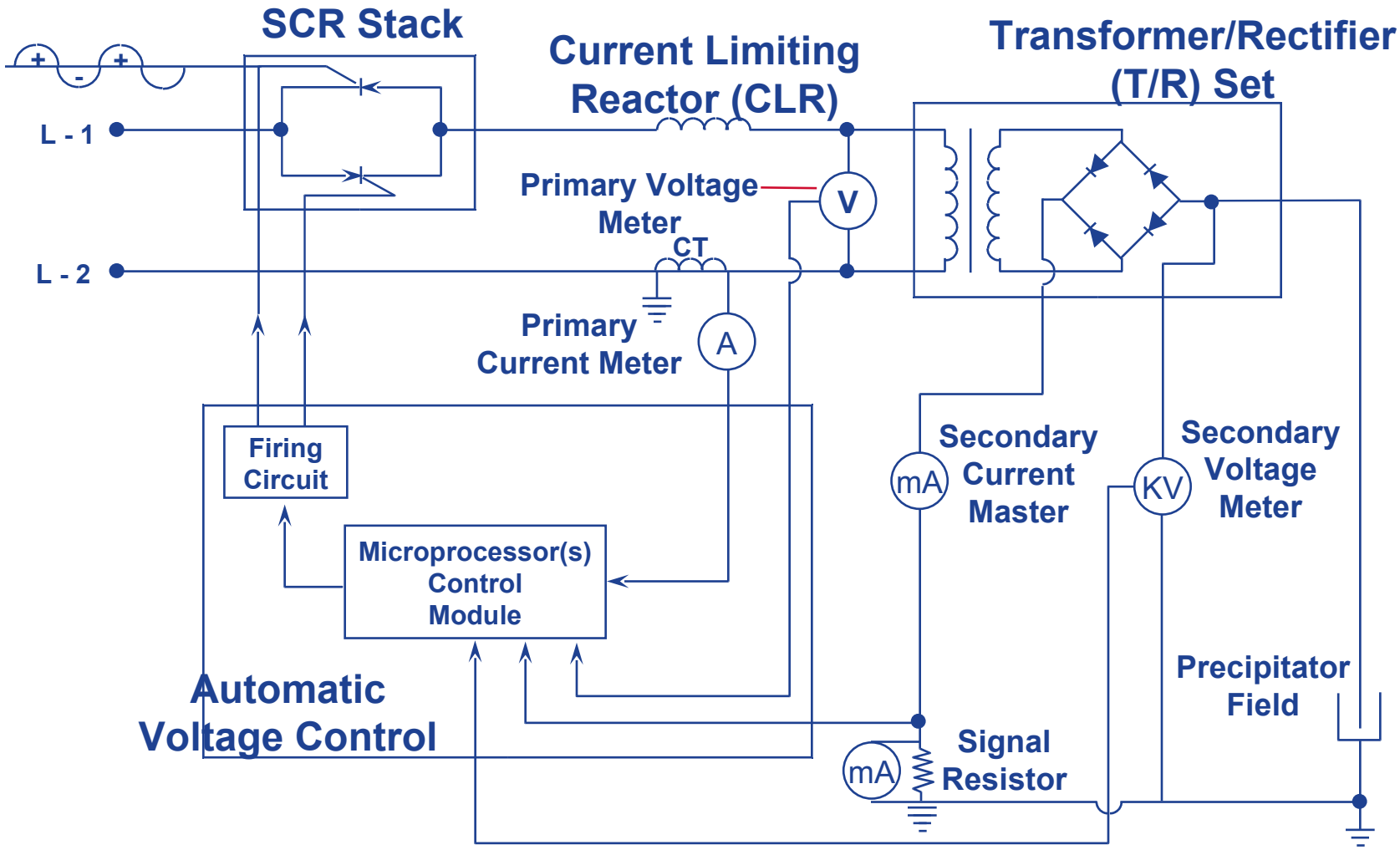
KNOW WHERE YOUR ESP RUNS ON THE CURVE



AVC Cabinet, CLR & T/R Set



Typical SCR-CLR Electrical System



Just Remember, the Primary of a T-R Set is Rated in Units of RMS, the Secondary is in Average

- 400 V AC RMS
- 120 A AC RMS
- 45 KV DC Average
- 750 mA DC Average

Therefore use an RMS Reading Meter to Calibrate the Primary Meters

Note! How Do You Tell The Difference?

Iron Vane Movement

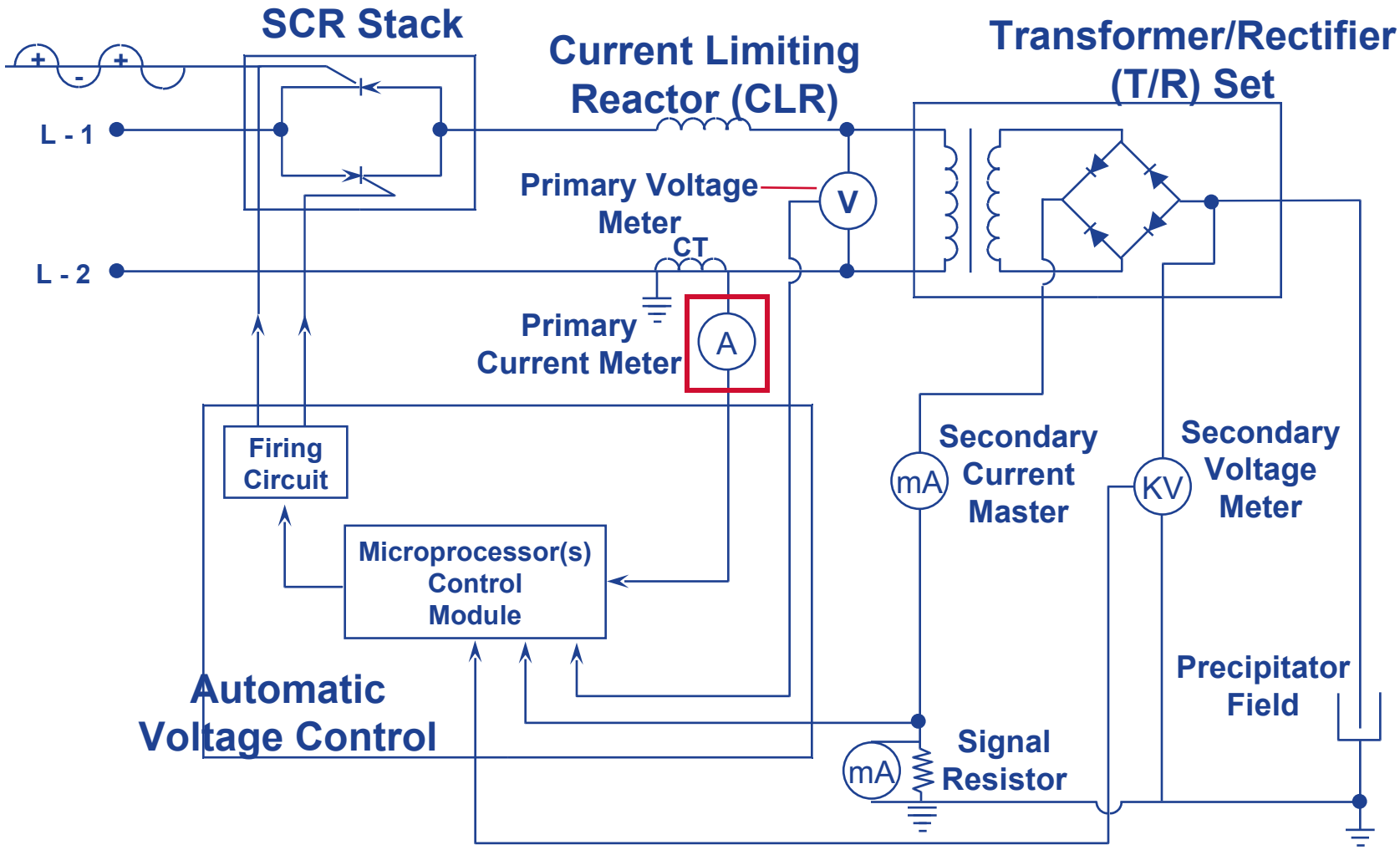
D'Arsonval

Average

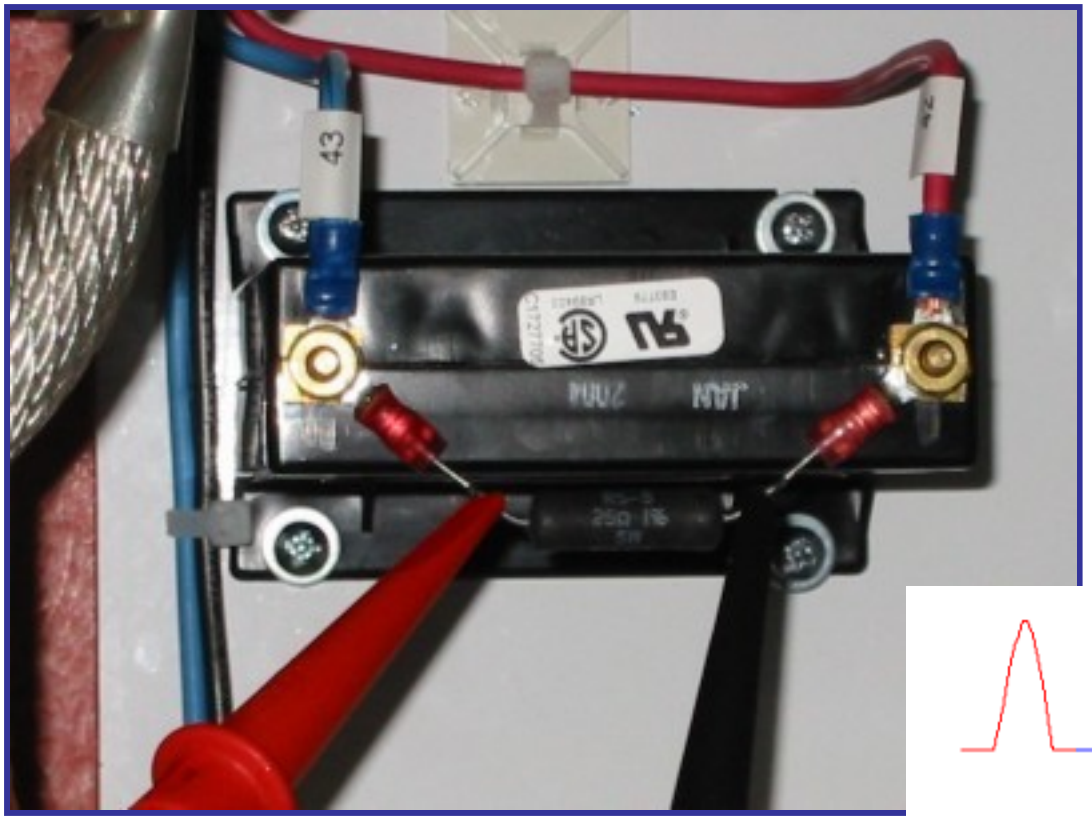
RMS

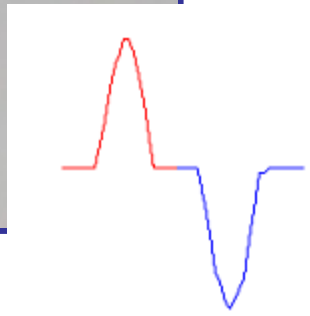
The Meter Scale Distance is not the Same on the RMS Meter.

Primary Current Meter

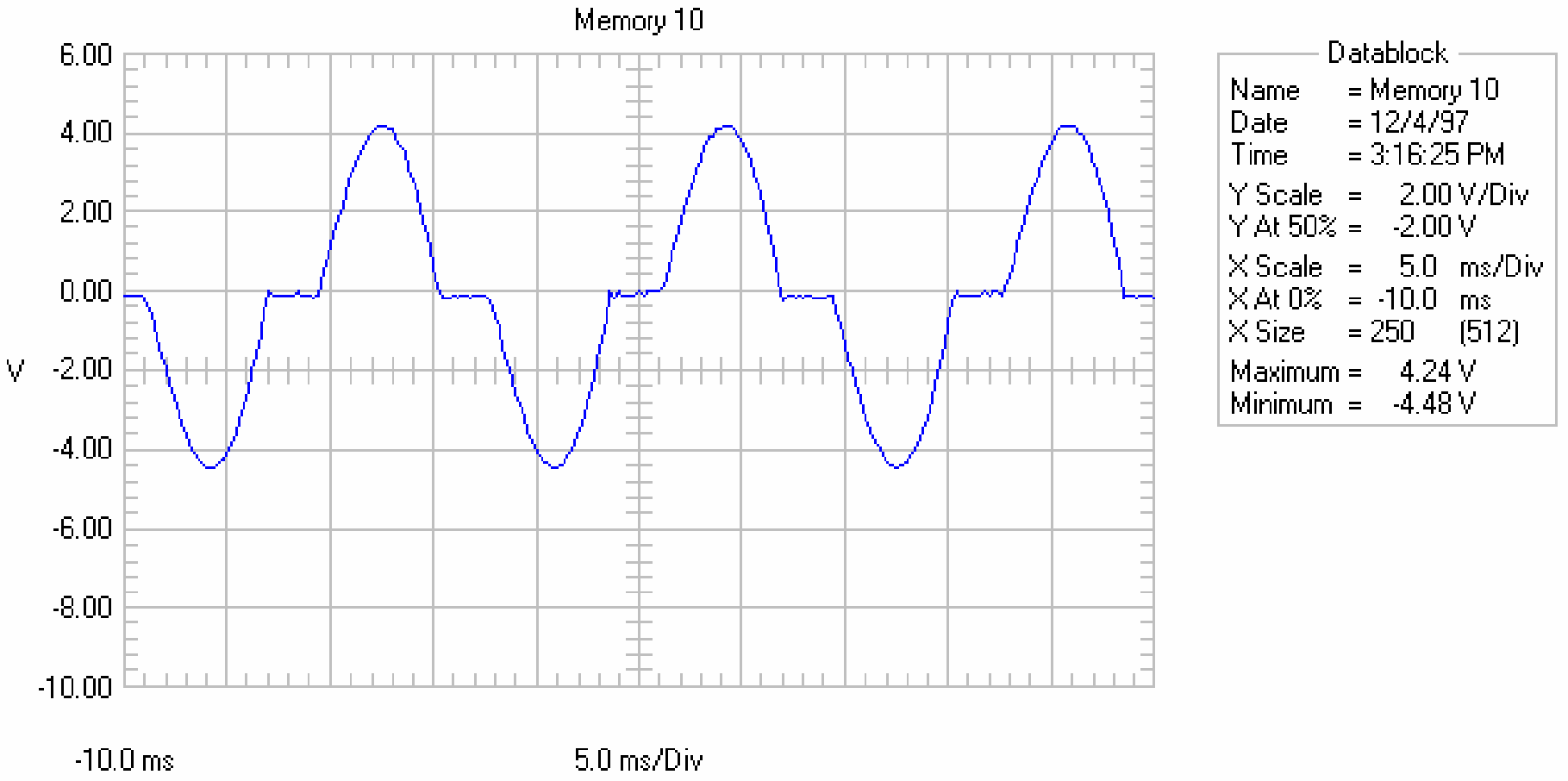


Finding the Primary Current Waveform

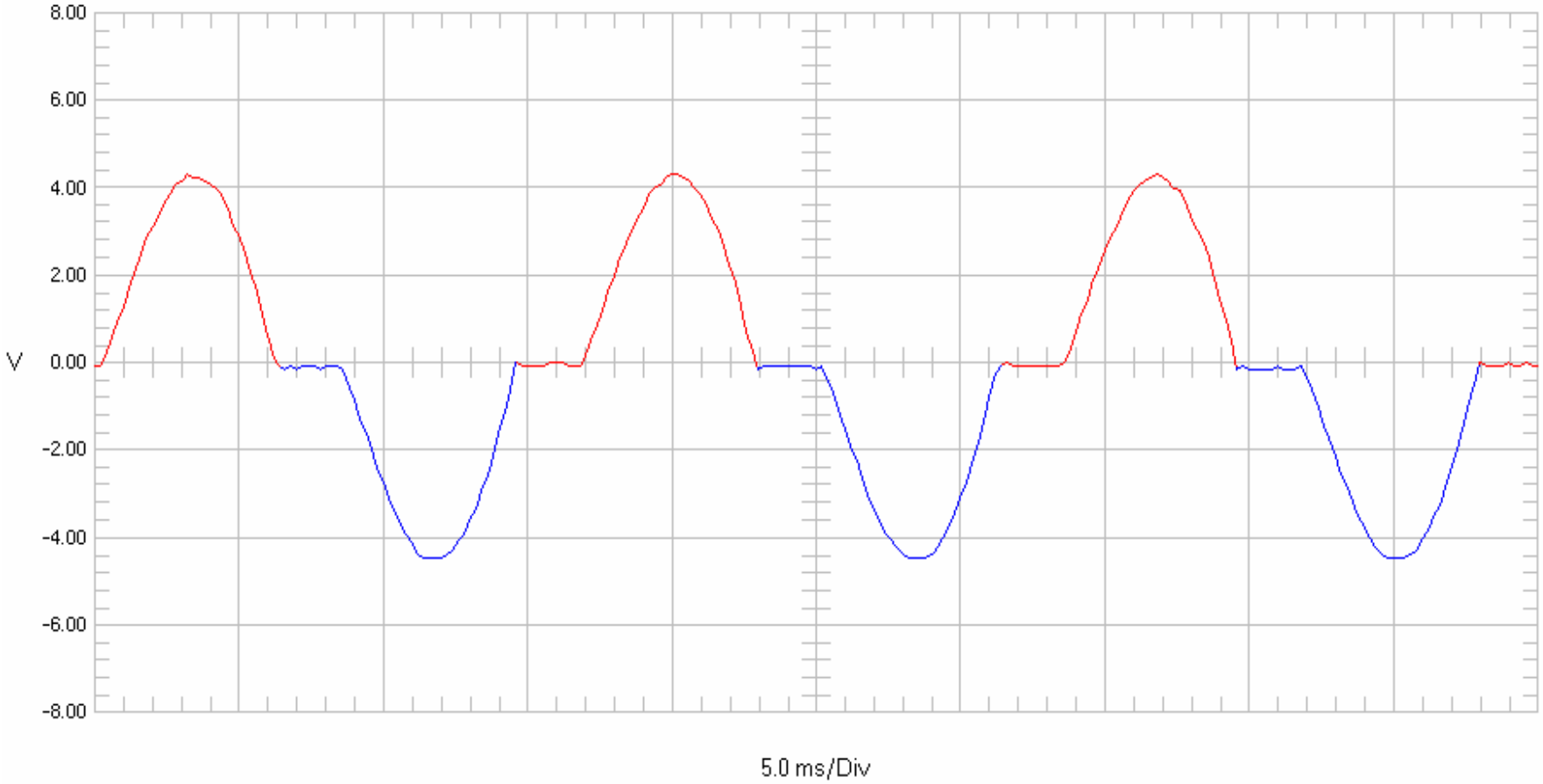




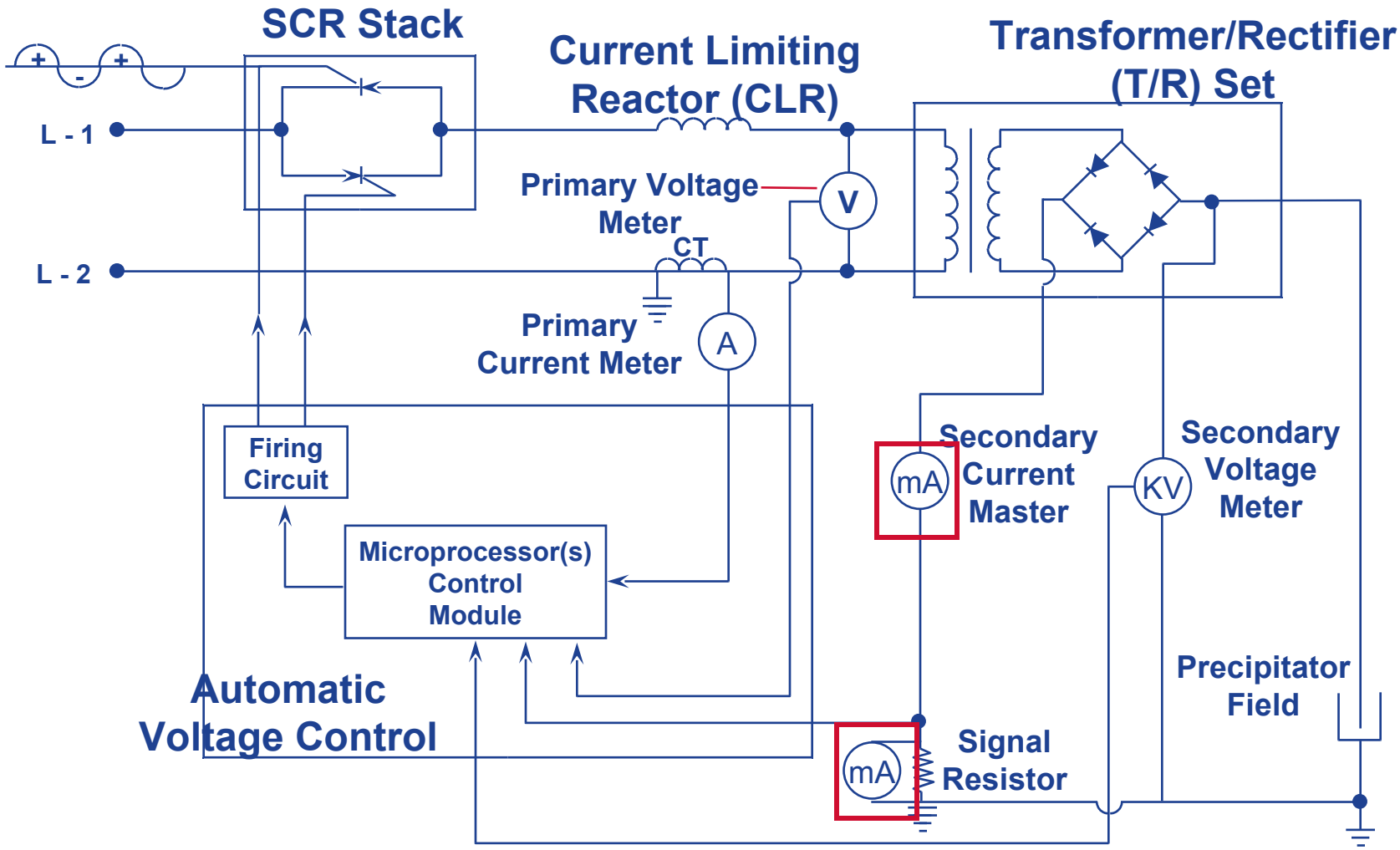
Primary Current – A Chopped Sine Wave



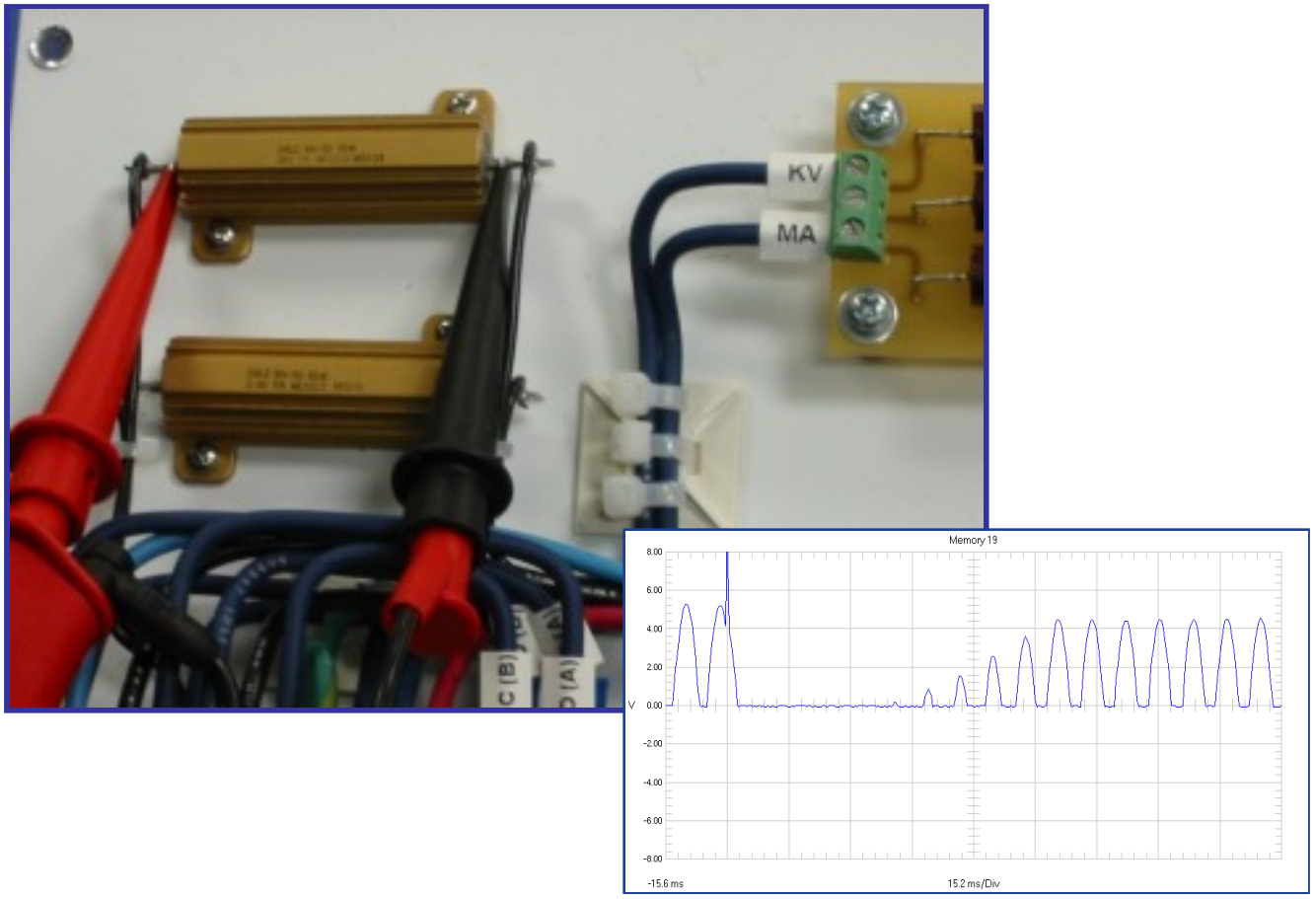
Primary Current Waveform - Positive and Negative Half-Cycles = SCR 1 and SCR 2



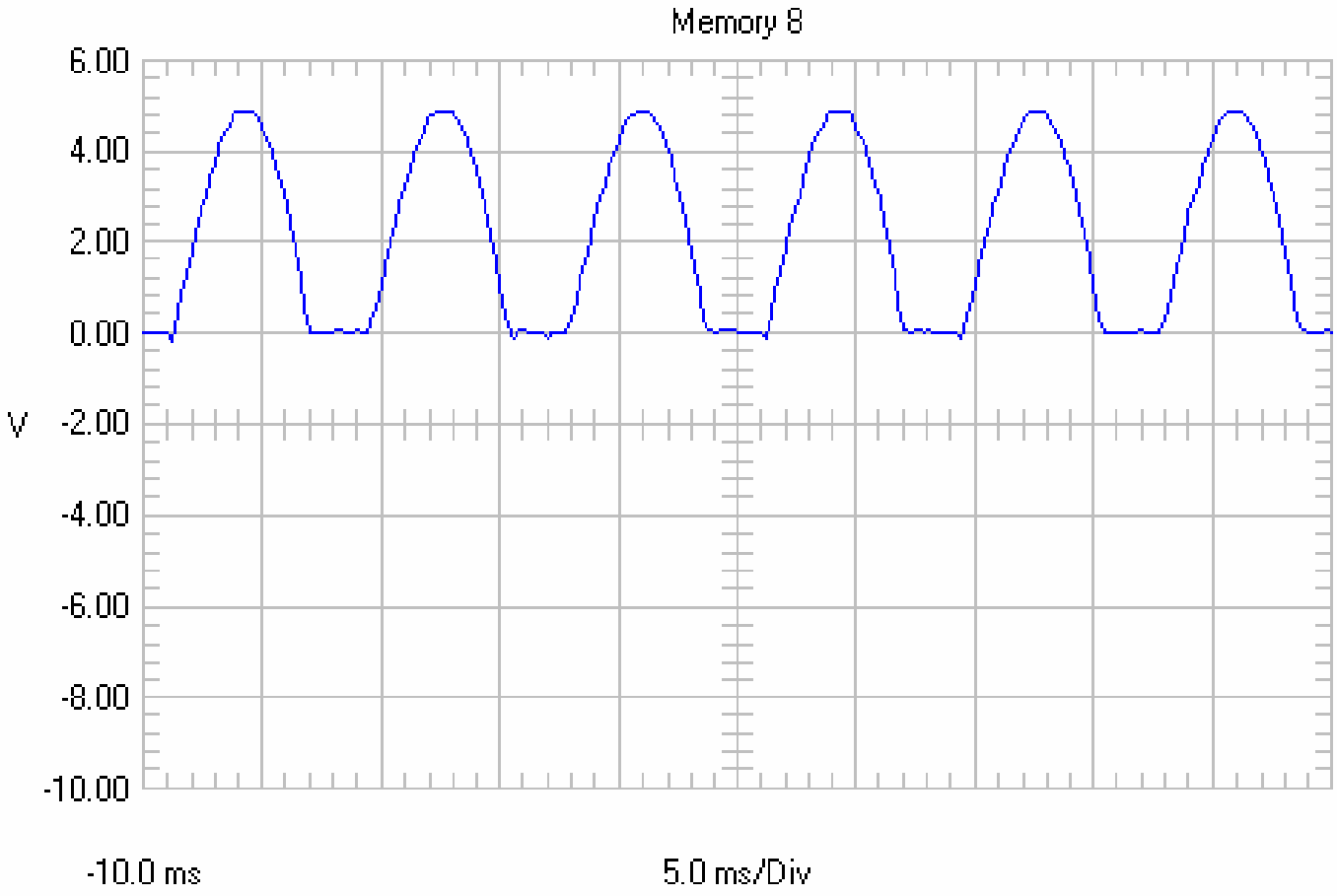
Secondary Current Meter



Finding the mA Signal



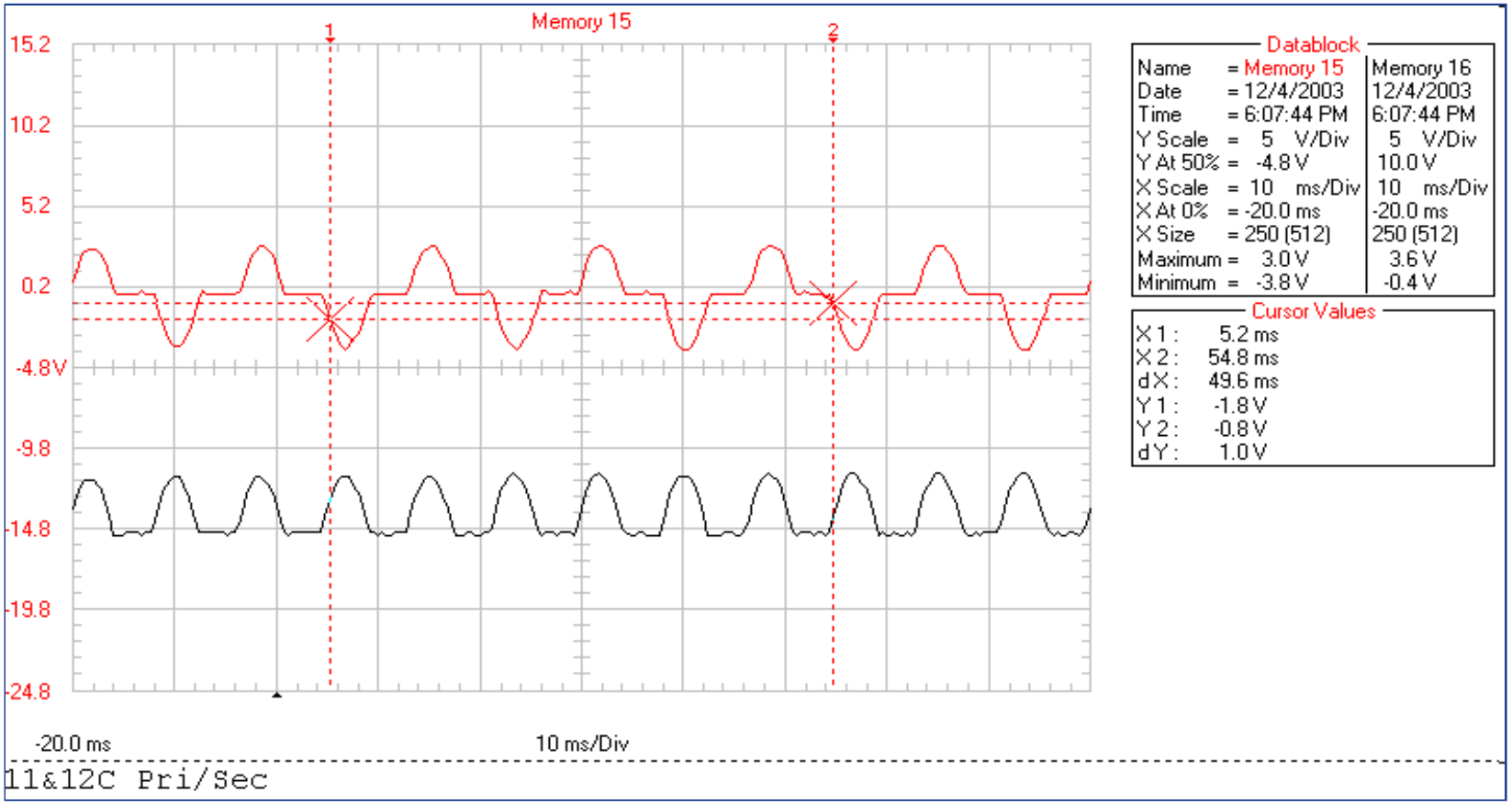
Secondary Current – Pulsating DC



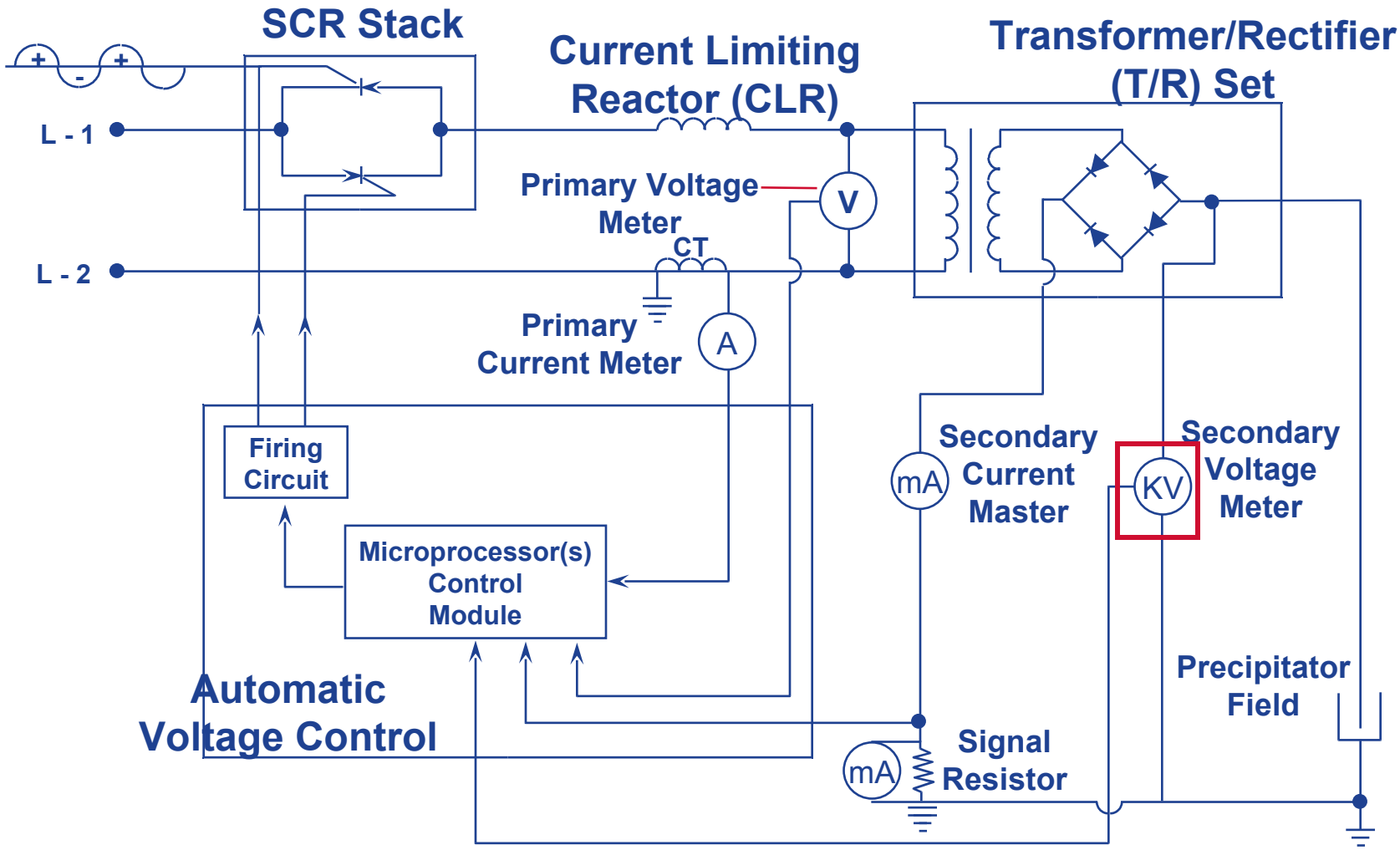
Datablock

Name	= Memory 8	
Date	= 12/4/97	
Time	= 3:16:23 PM	
Y Scale	= 2.00	V/Div
Y At 50%	= -2.00	V
X Scale	= 5.0	ms/Div
X At 0%	= -10.0	ms
X Size	= 250	(512)
Maximum	= 4.88	V
Minimum	= -0.16	V

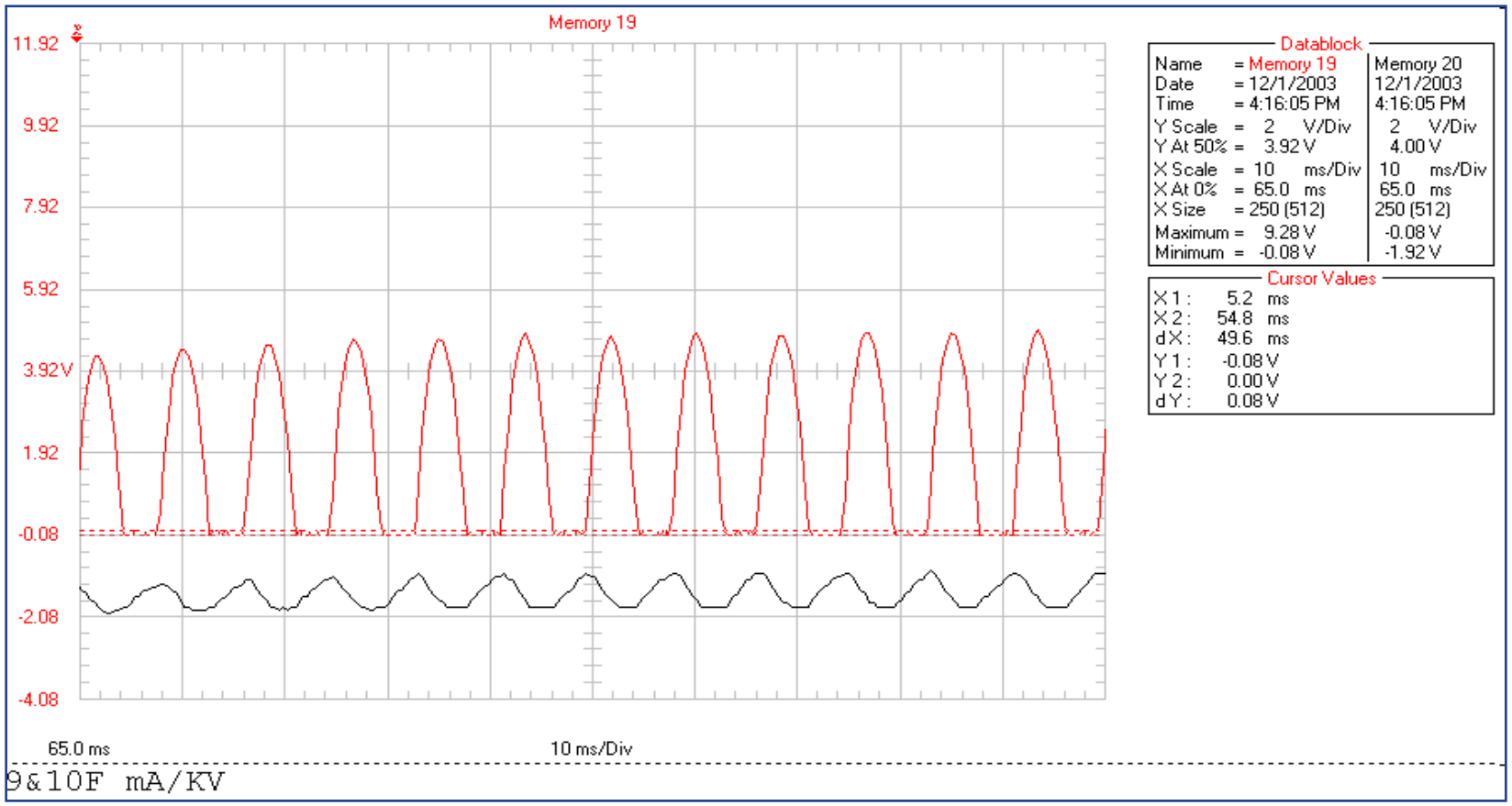
Typical Primary and Secondary Current



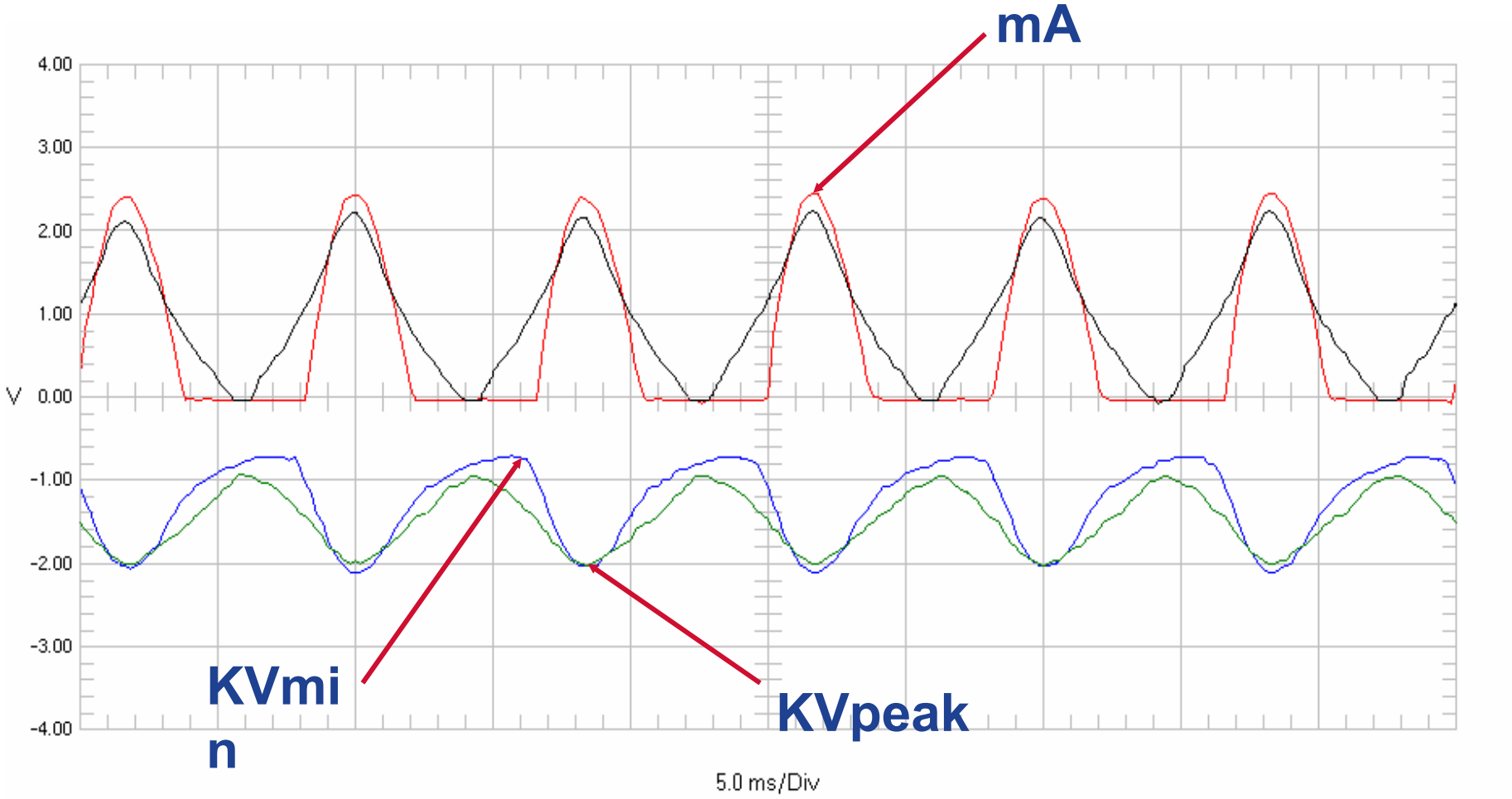
Secondary Voltage Meter



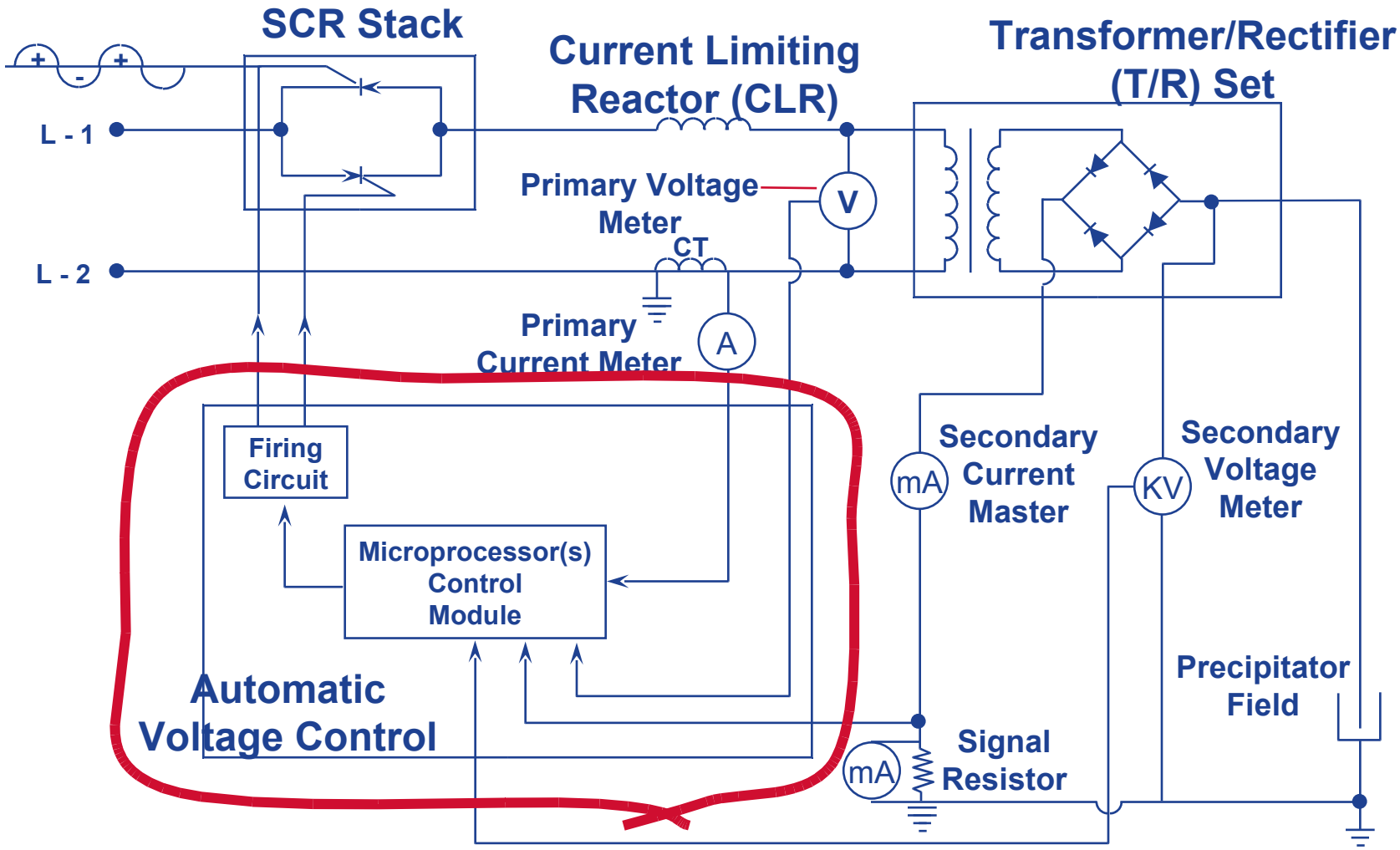
Current Limit - mA & KV



Secondary Voltage Waveforms – True Negative



Next – The Automatic Voltage Control



The **AVC**

is the **BRAINS**

of the ESP

Older Analog AVC

Microprocessor Based AVC

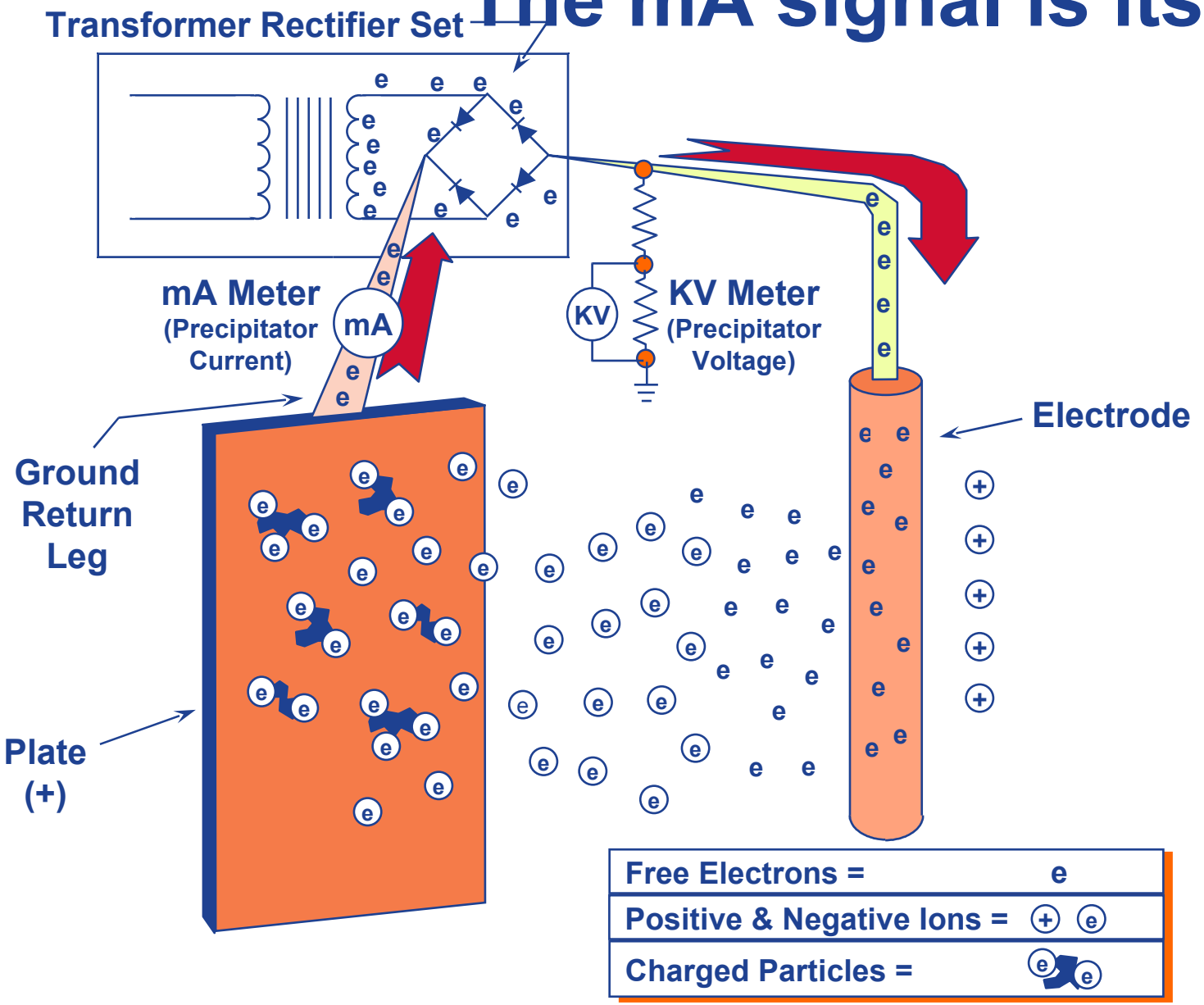
The AVC has 2 Jobs to Execute

- Control the amount of sparking in the ESP.
- If a T/R set is not sparking, then its AVC should be pushing that T/R set to one of its pre-set, healthy limits (volts, amps, KV, ma, or firing angle).
- I'll explain what is meant by "healthy" in a minute

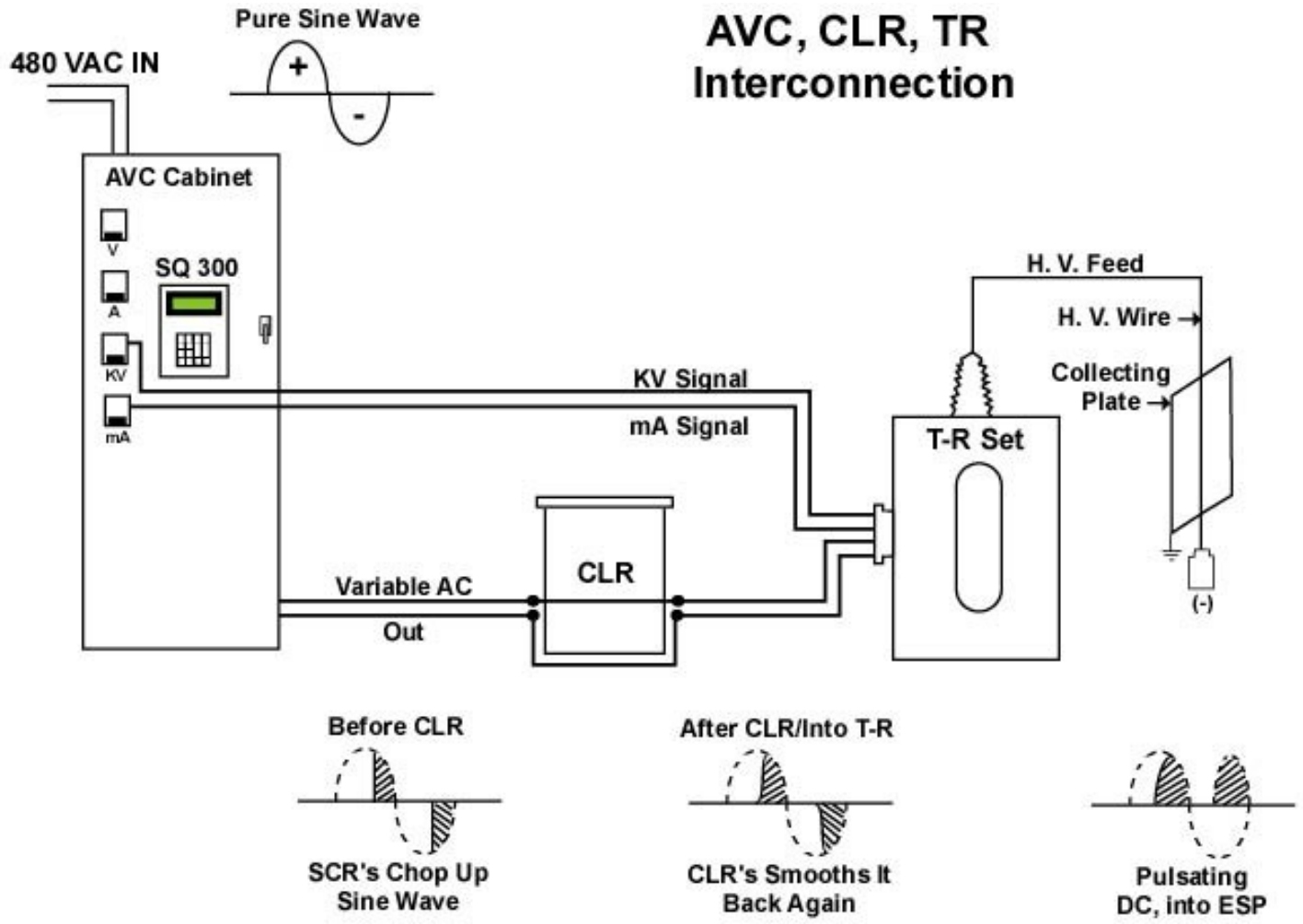
The AVC has 2 Jobs to Execute…

But how does the AVC know what's happening in the ESP?

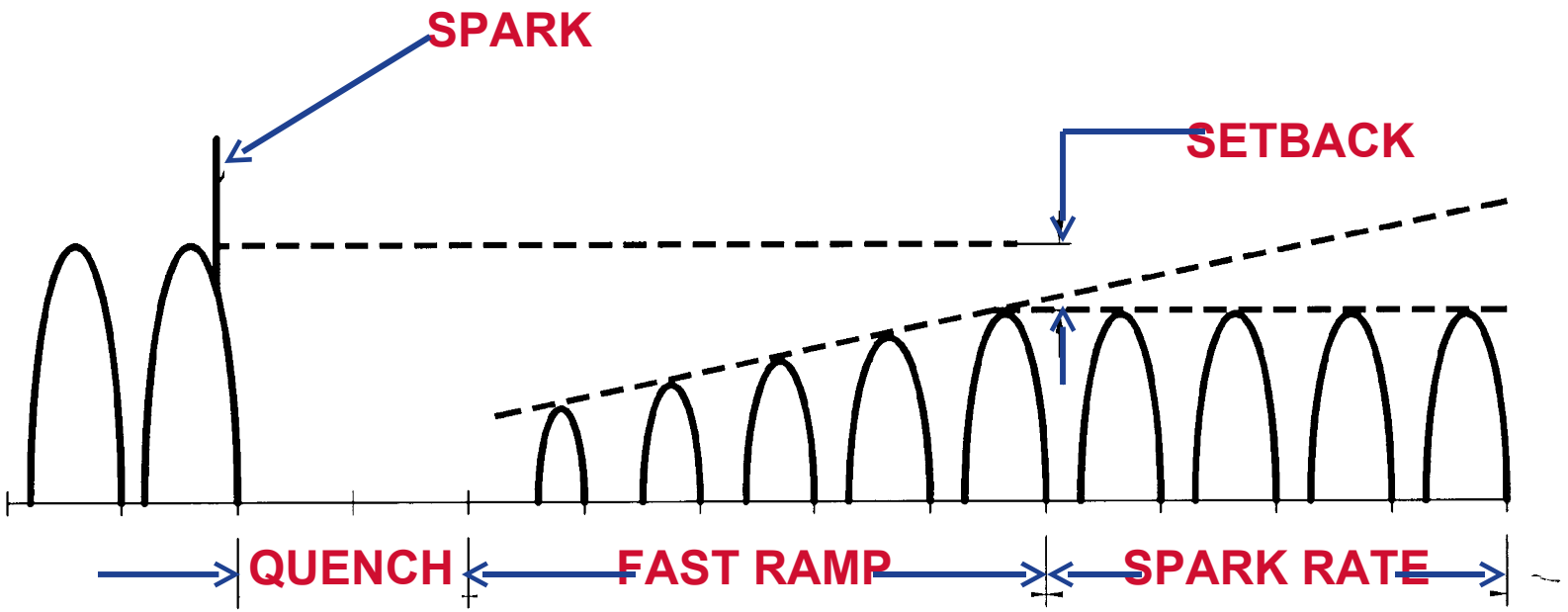
The mA signal is its eyes!



AVC Cabinet, CLR & T/R Set



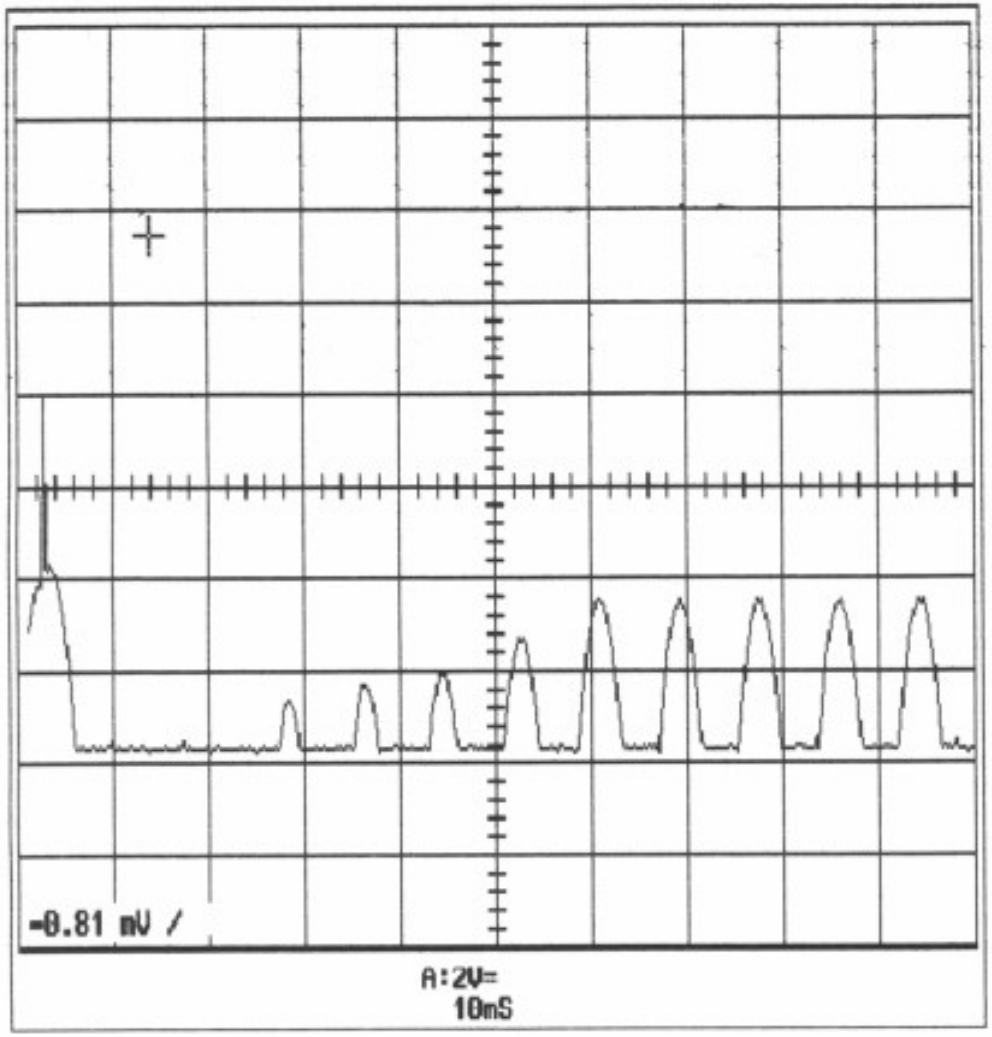
AVC Spark Response



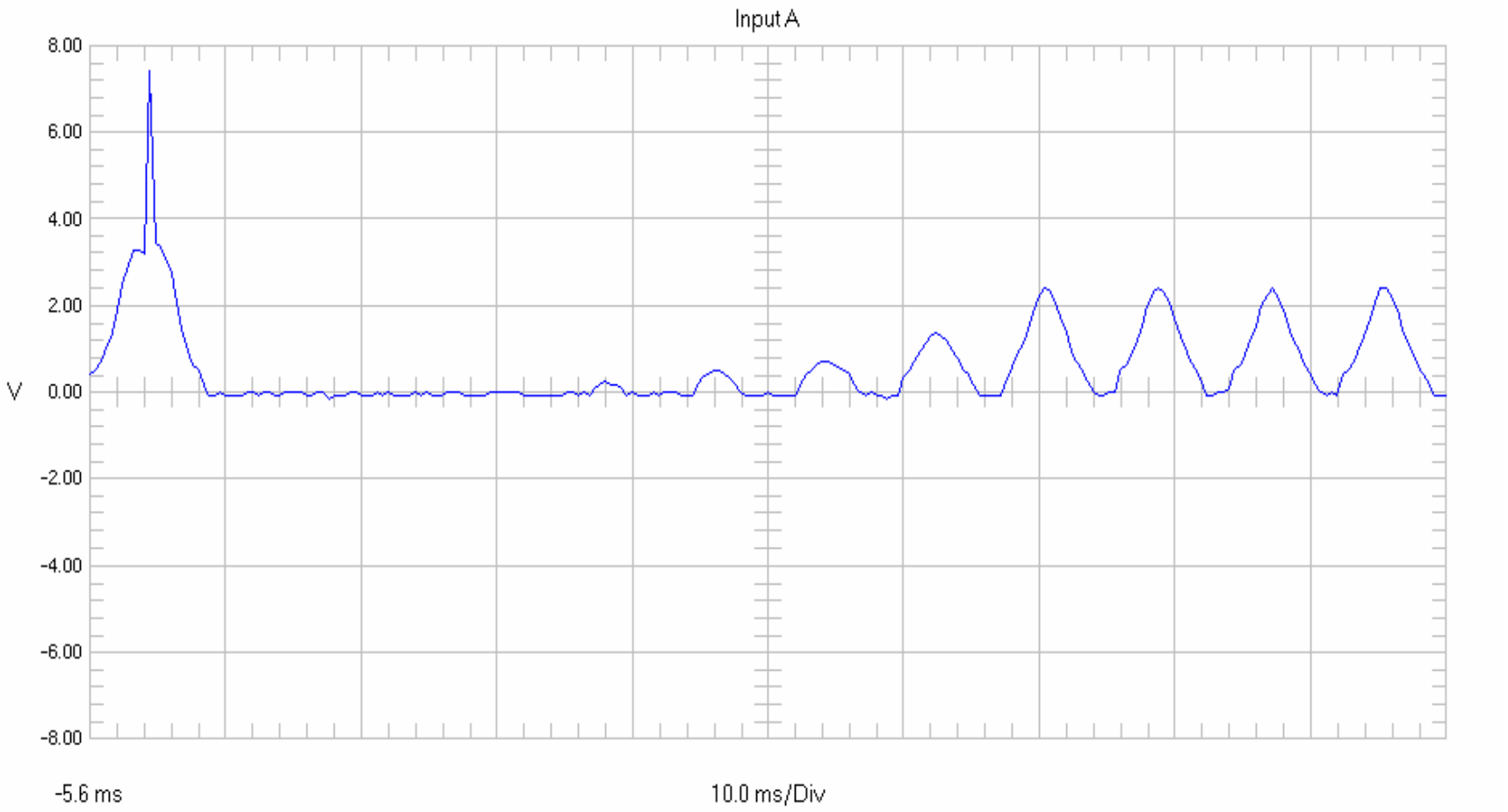
Good Initial Settings for an AVC

1. Quench = 1 Full Cycle
2. Fast Ramp = 5 or 6 Half Cycles
3. Setback = 15 to 20%
4. Spark Rate = 30SPM

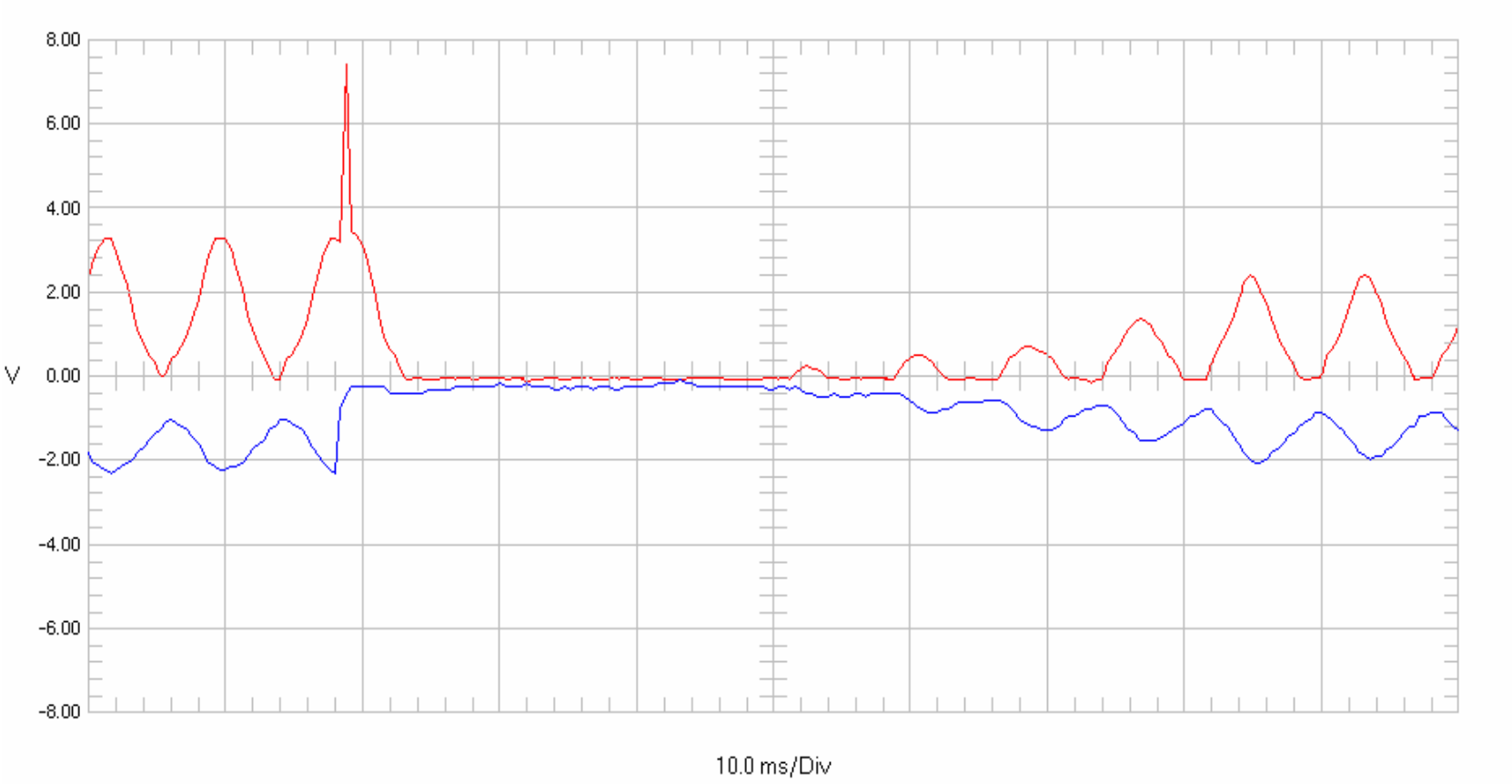
Proper AVC Response to Sparking



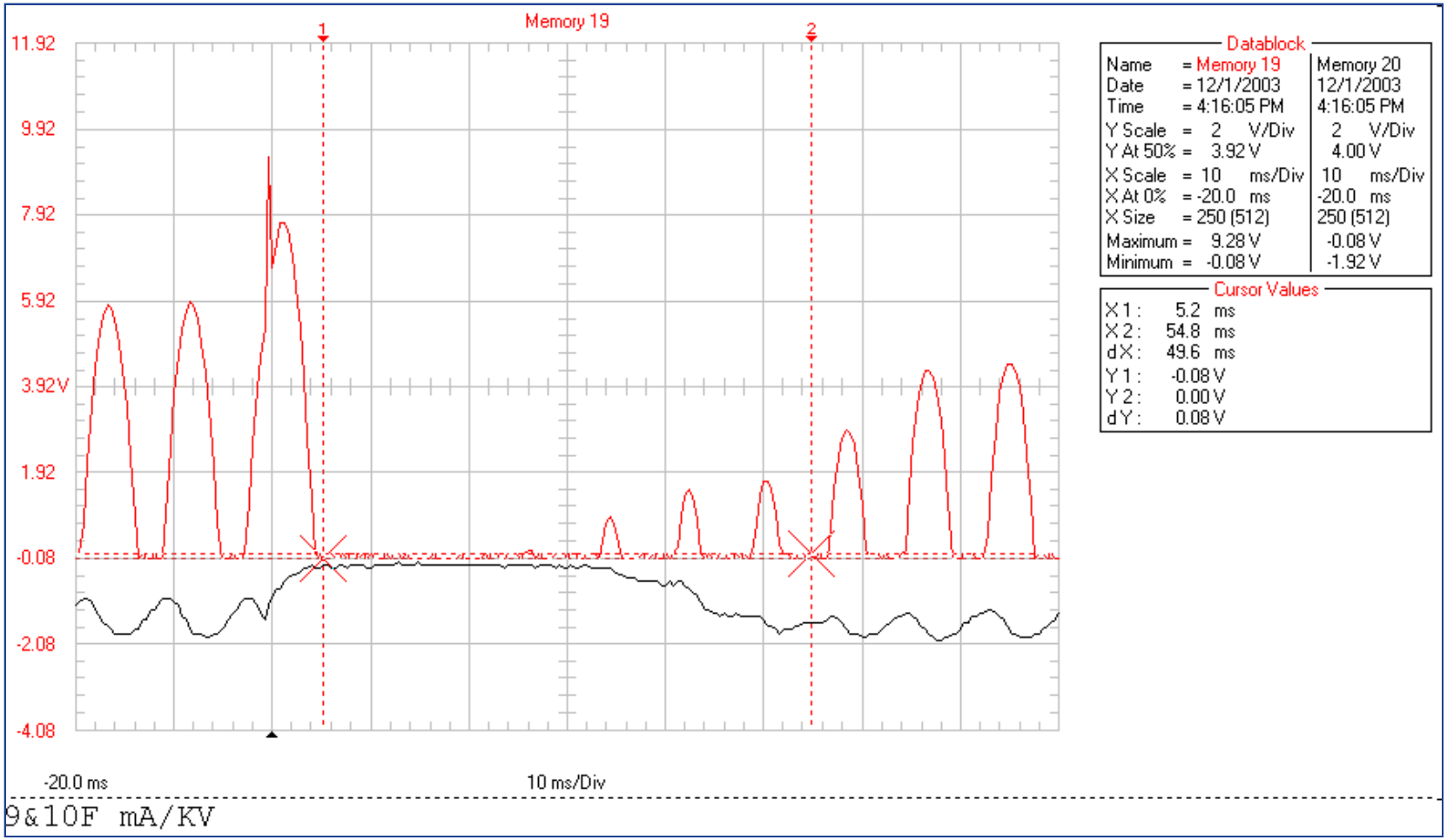
Spark Response - Secondary Current Waveform



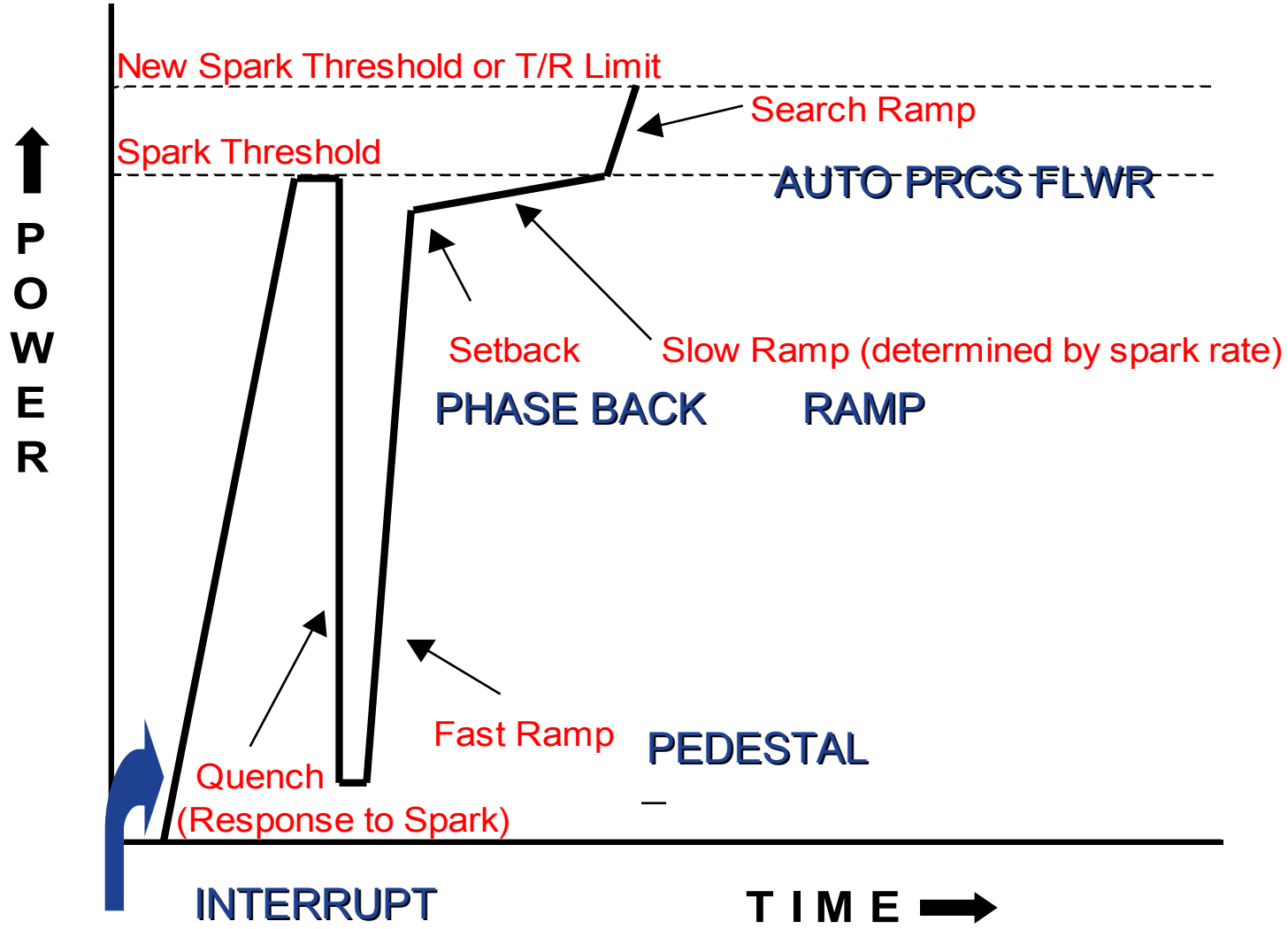
Spark Response - Secondary Current and Voltage Waveforms



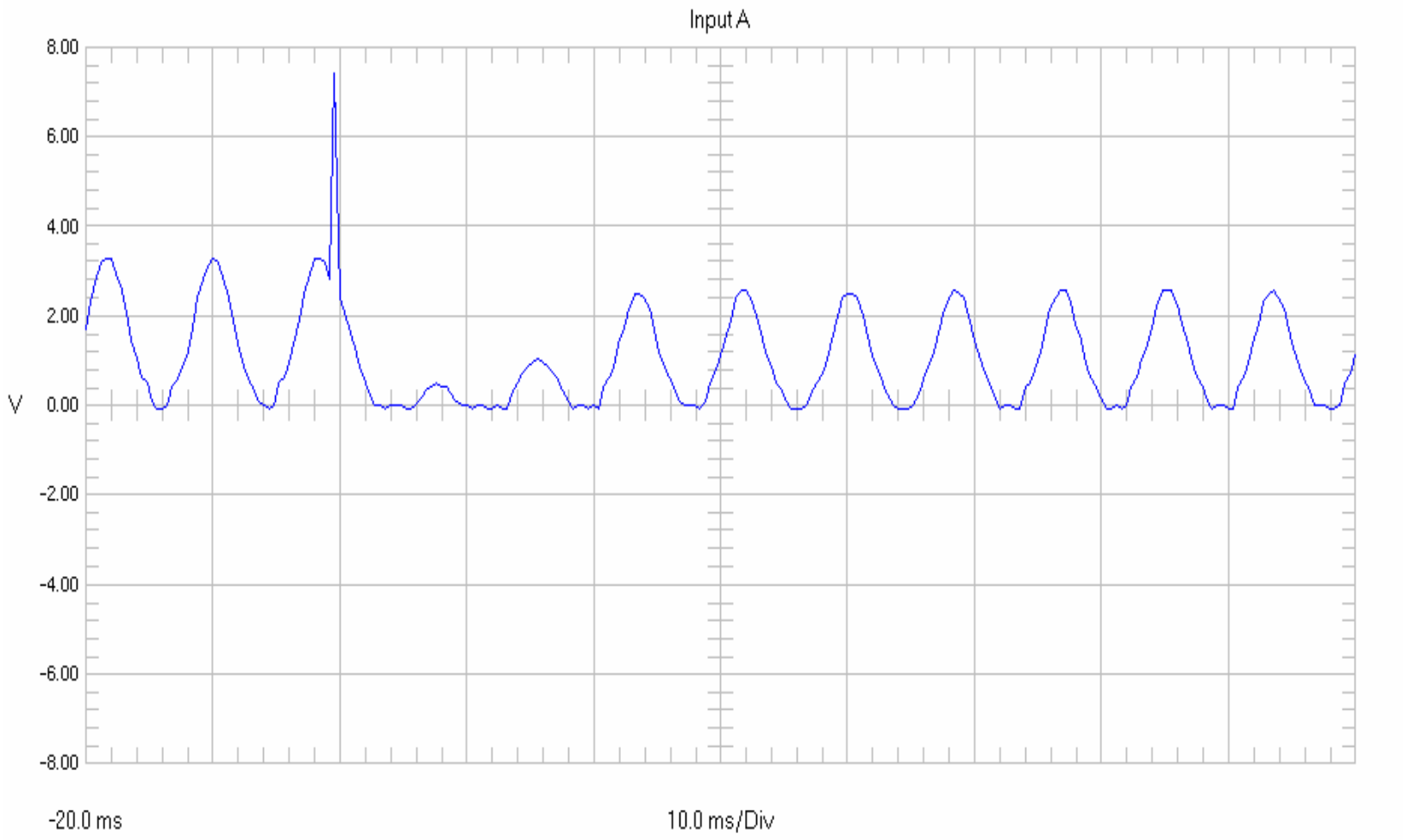
Typical Spark Response - mA & KV



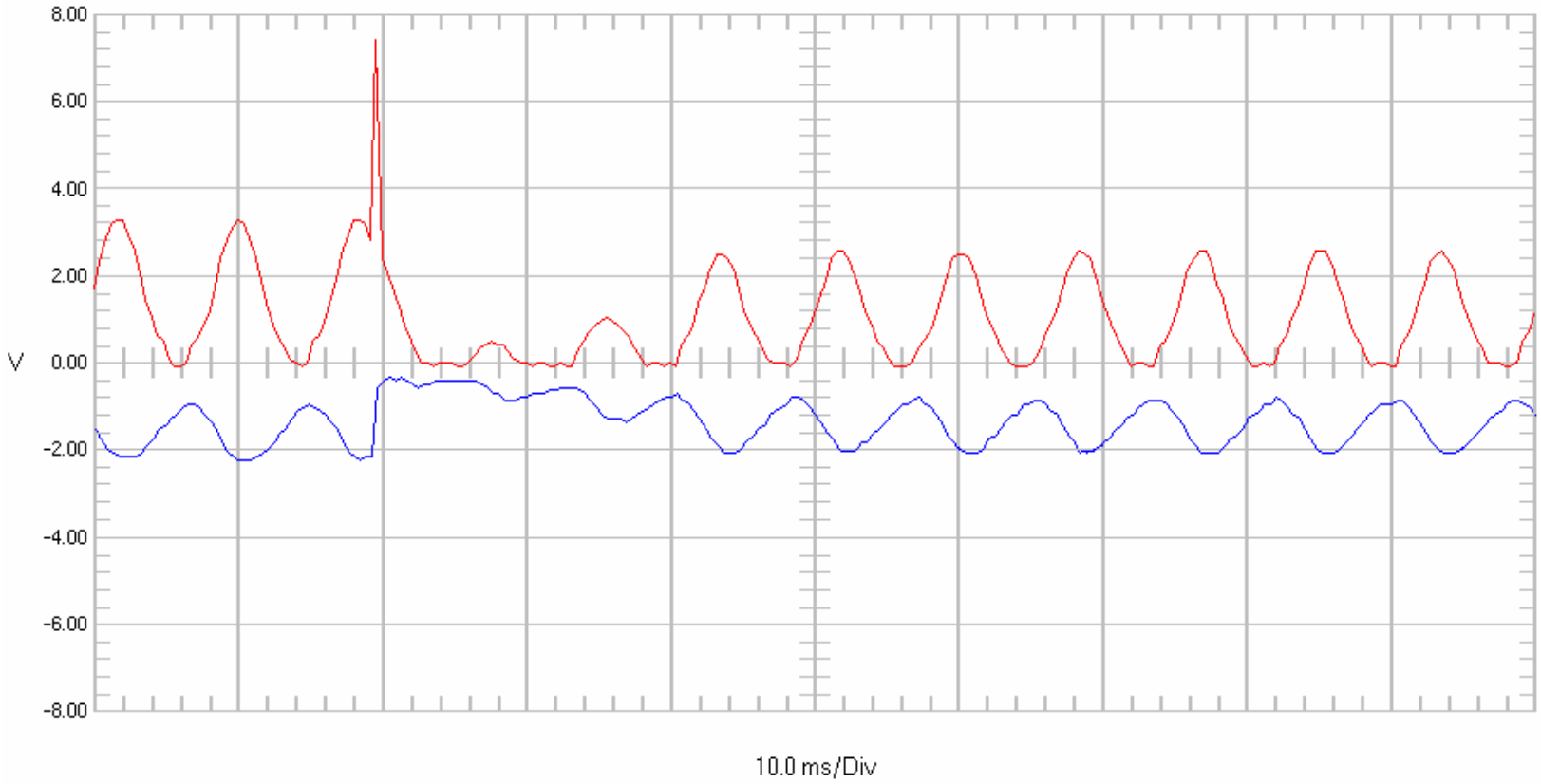
Further Control – A Search Ramp Rate



Spit Spark Response (mA)



Spit Spark Response - Secondary Current and Voltage Waveforms

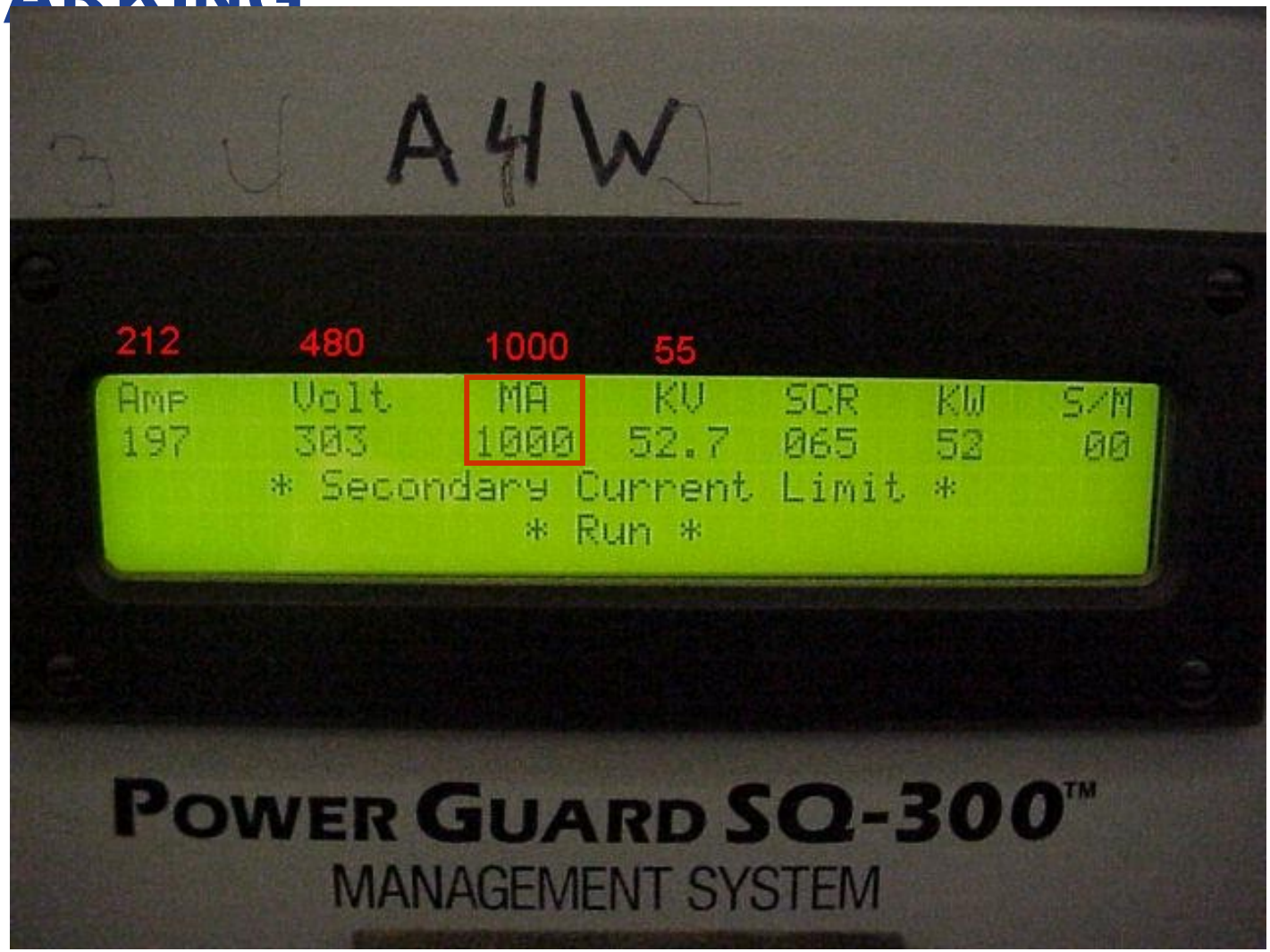


Examples of AVC ‘s at a Limit

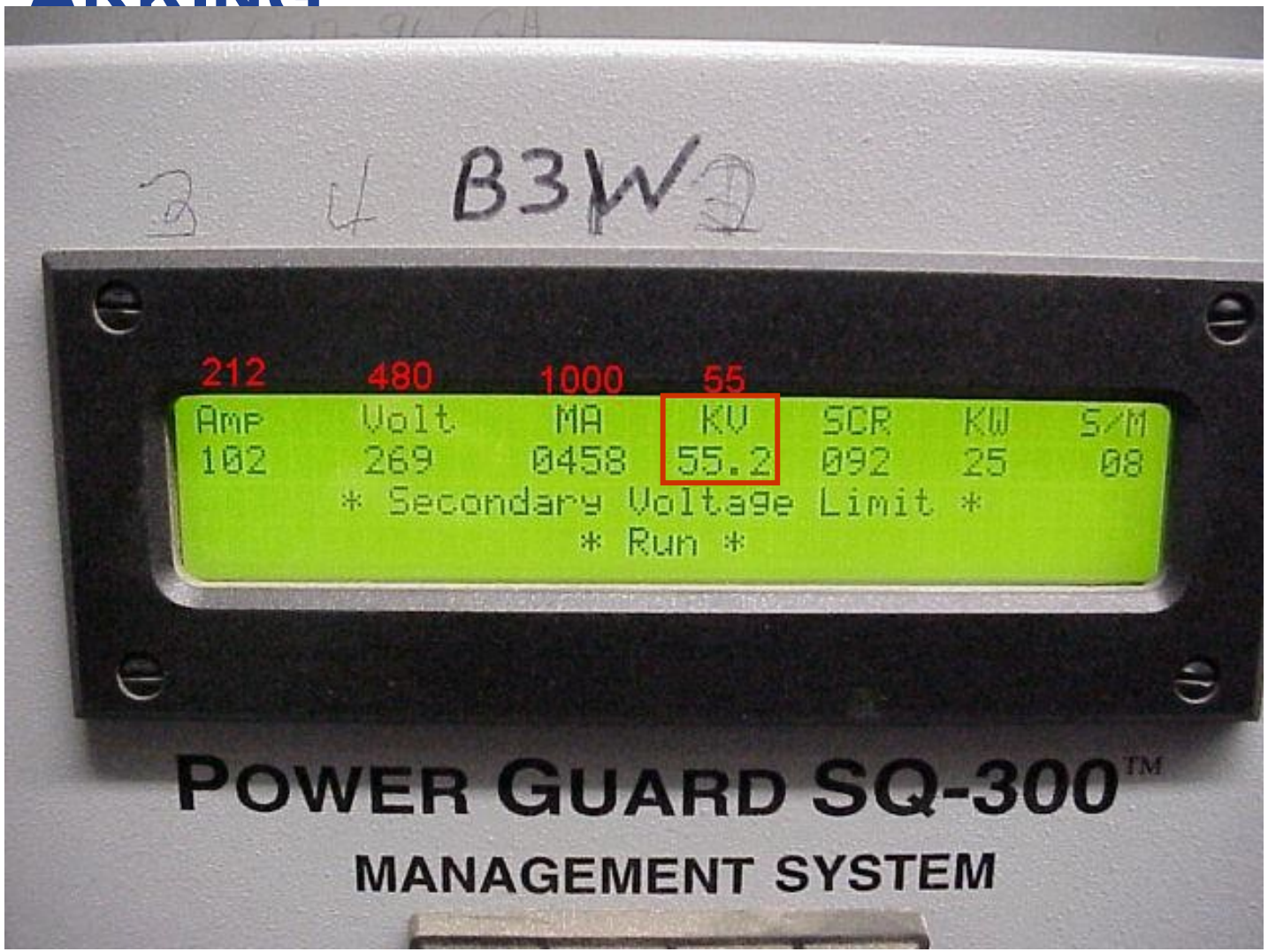
AVC SPARK LIMITED – DOING IT'S JOB

T/R Current Limited with Sparking

T-R CURRENT LIMITED WITHOUT SPARKING



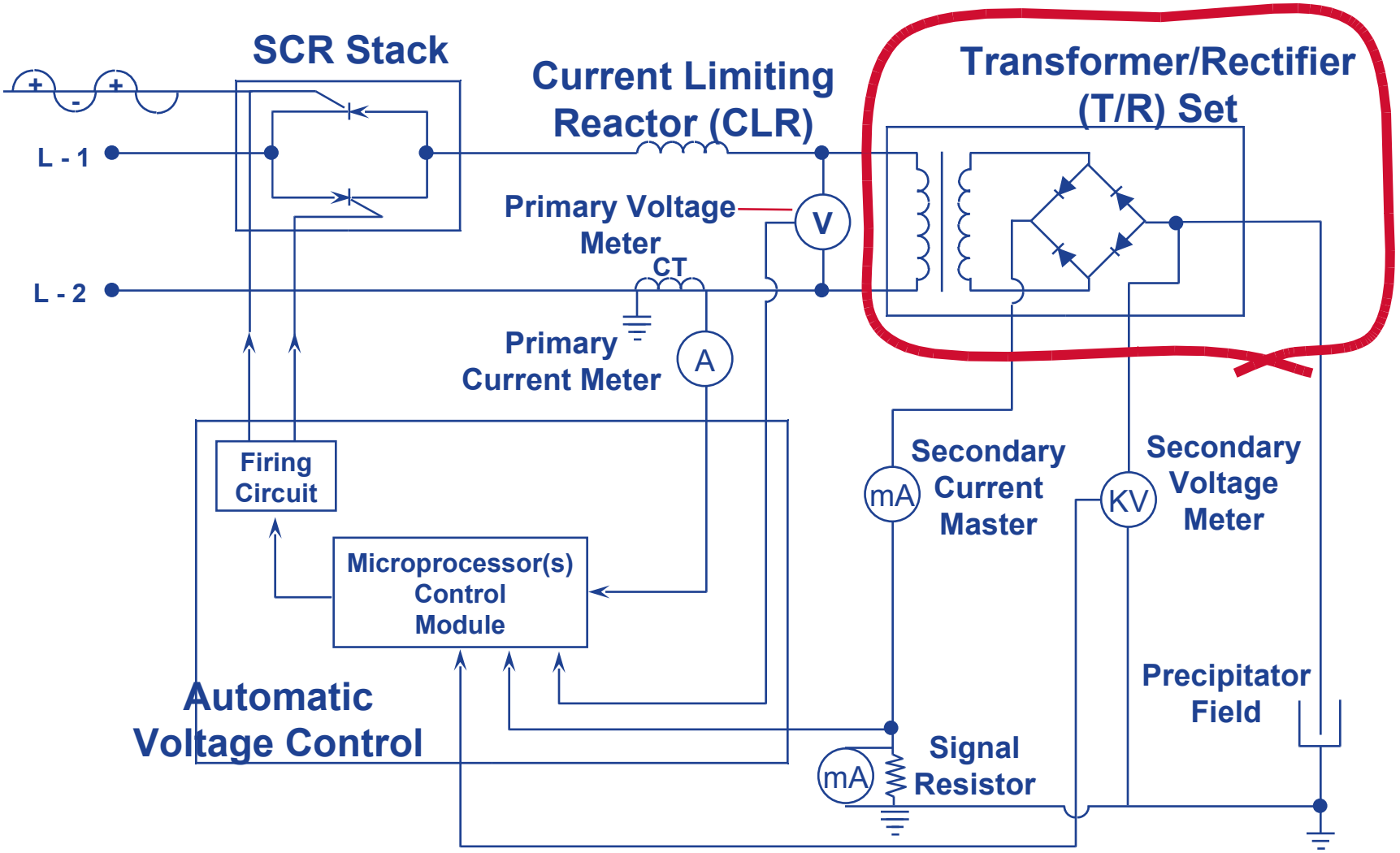
T-R VOLTAGE LIMITED WITH SPARKING



What is meant by “Healthy Limits?”

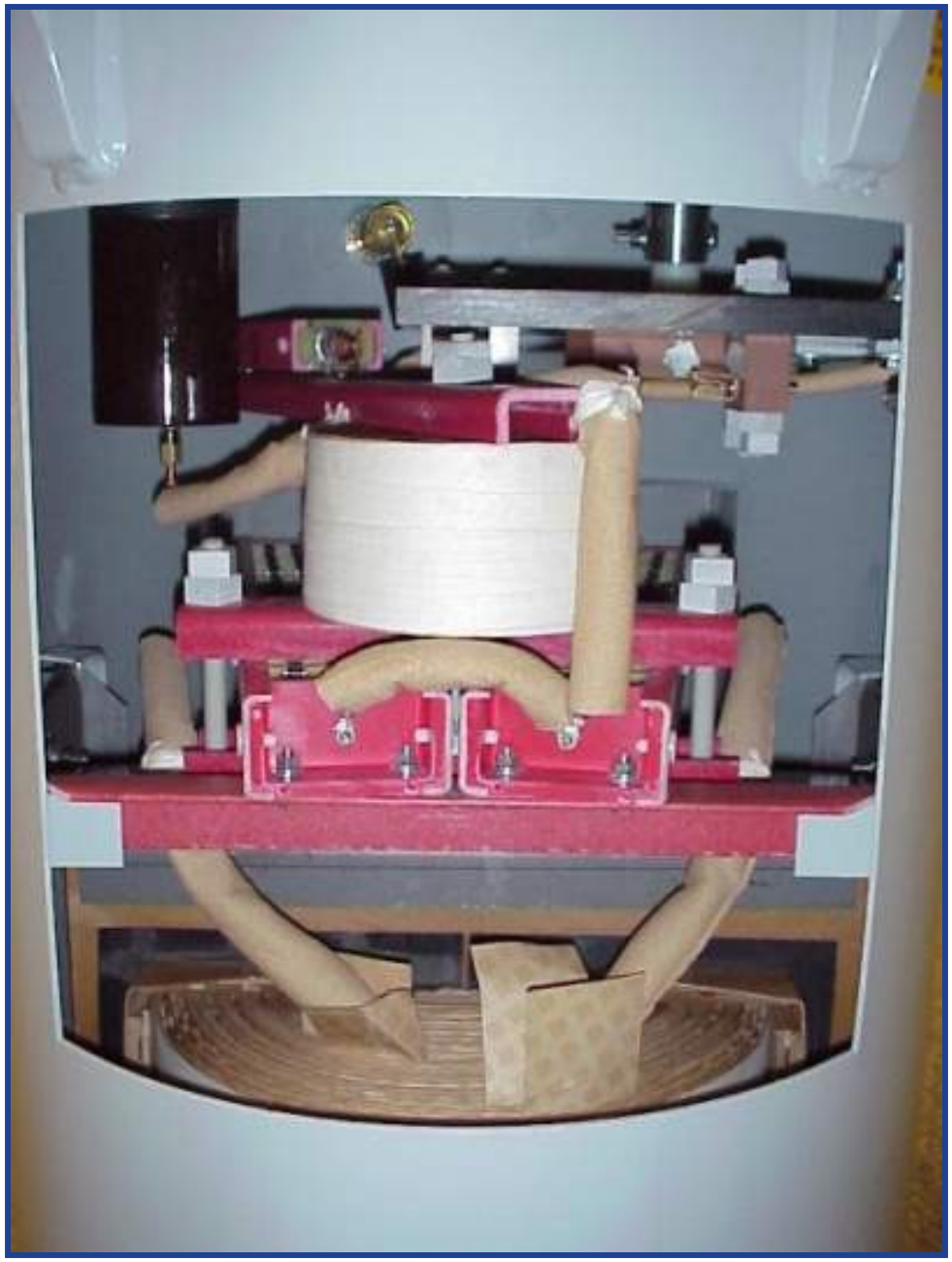
- Primary or Secondary Limit is not healthy when accompanied by a Primary Voltage level < 90 VAC or a Secondary level < 12KV. It usually indicates a short circuit.
- Secondary Voltage Limit is not healthy when there is very little Secondary Current. It usually indicates an open circuit.
- Neither condition is aiding in particle capture

The T-R Set


SCR Stack
Current Limiting Reactor (CLR)
Transformer/Rectifier (T/R) Set
L - 1
L - 2
Primary Voltage Meter
V
CT
Primary Current Meter
A
Firing Circuit
Microprocessor(s) Control Module
Automatic Voltage Control
mA
Secondary Current Master
KV
Secondary Voltage Meter
Precipitator Field
mA
Signal Resistor

Transformer Rectifier (T/R) Set

Inside T/R Tank



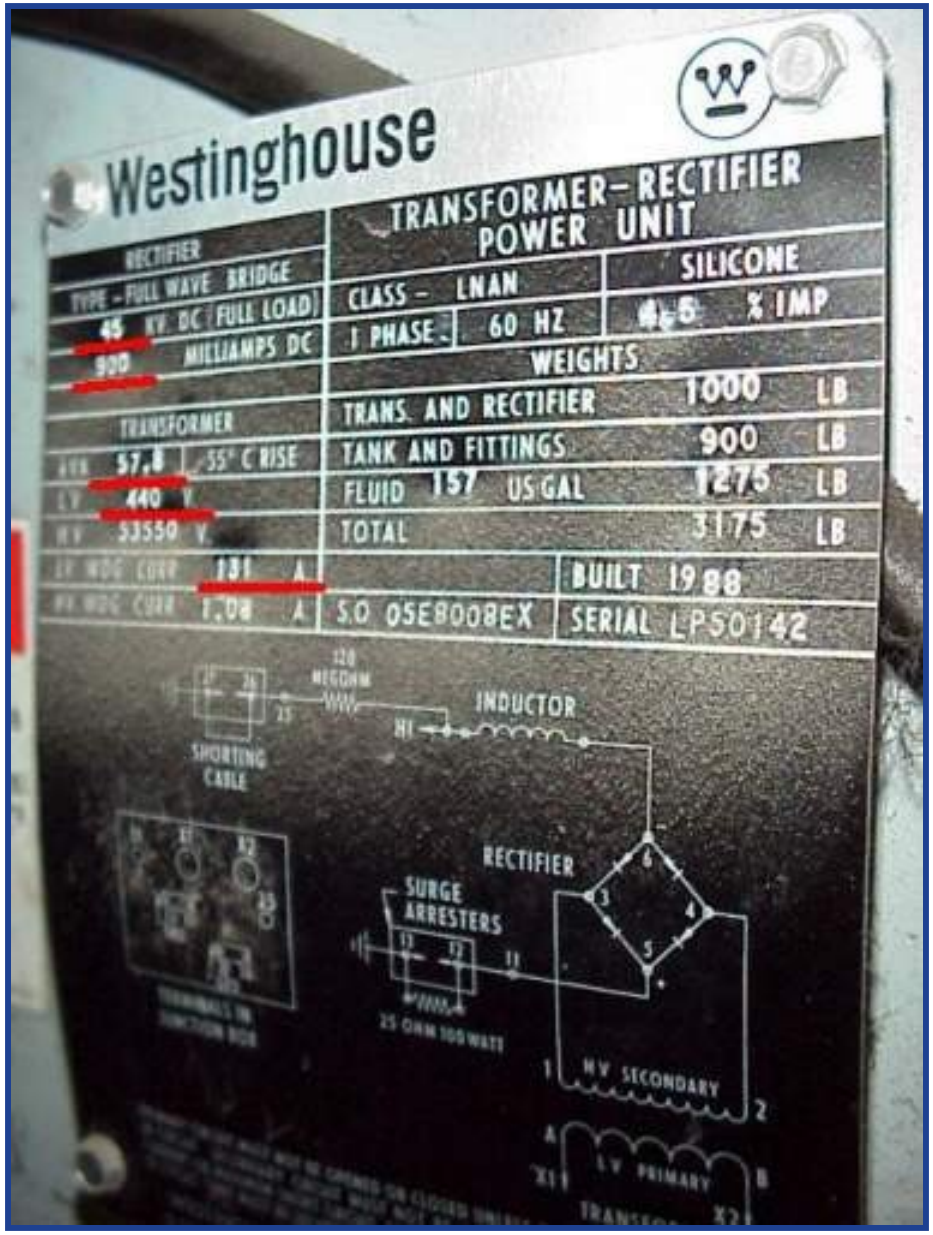
High Voltage Transformer

Diode Stack

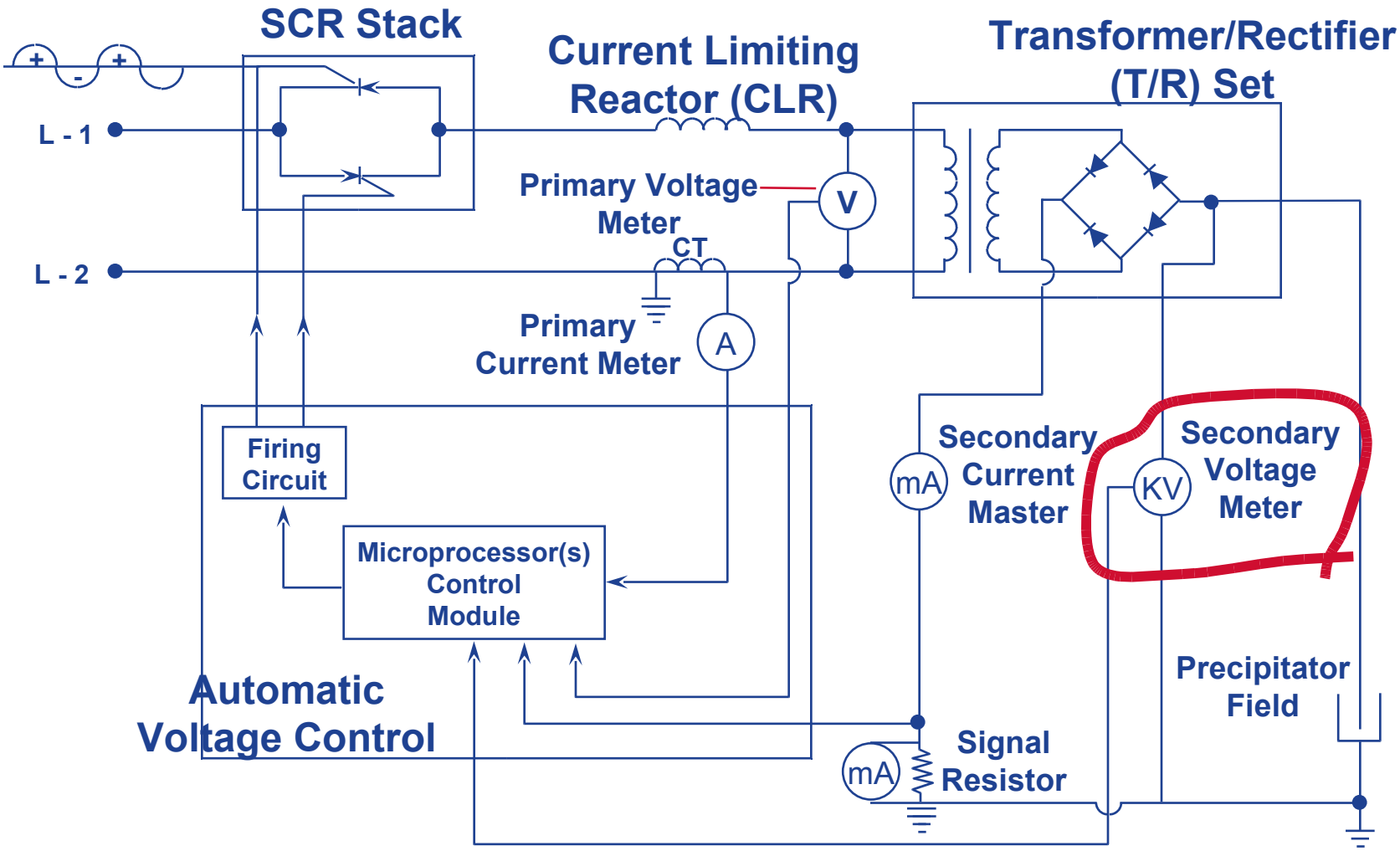
T/R Set - Low Voltage Junction Box

Low Voltage Junction Box

T/R Nameplate



The KV Meter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Secondary Voltage Meter
KV
Signal Resistor
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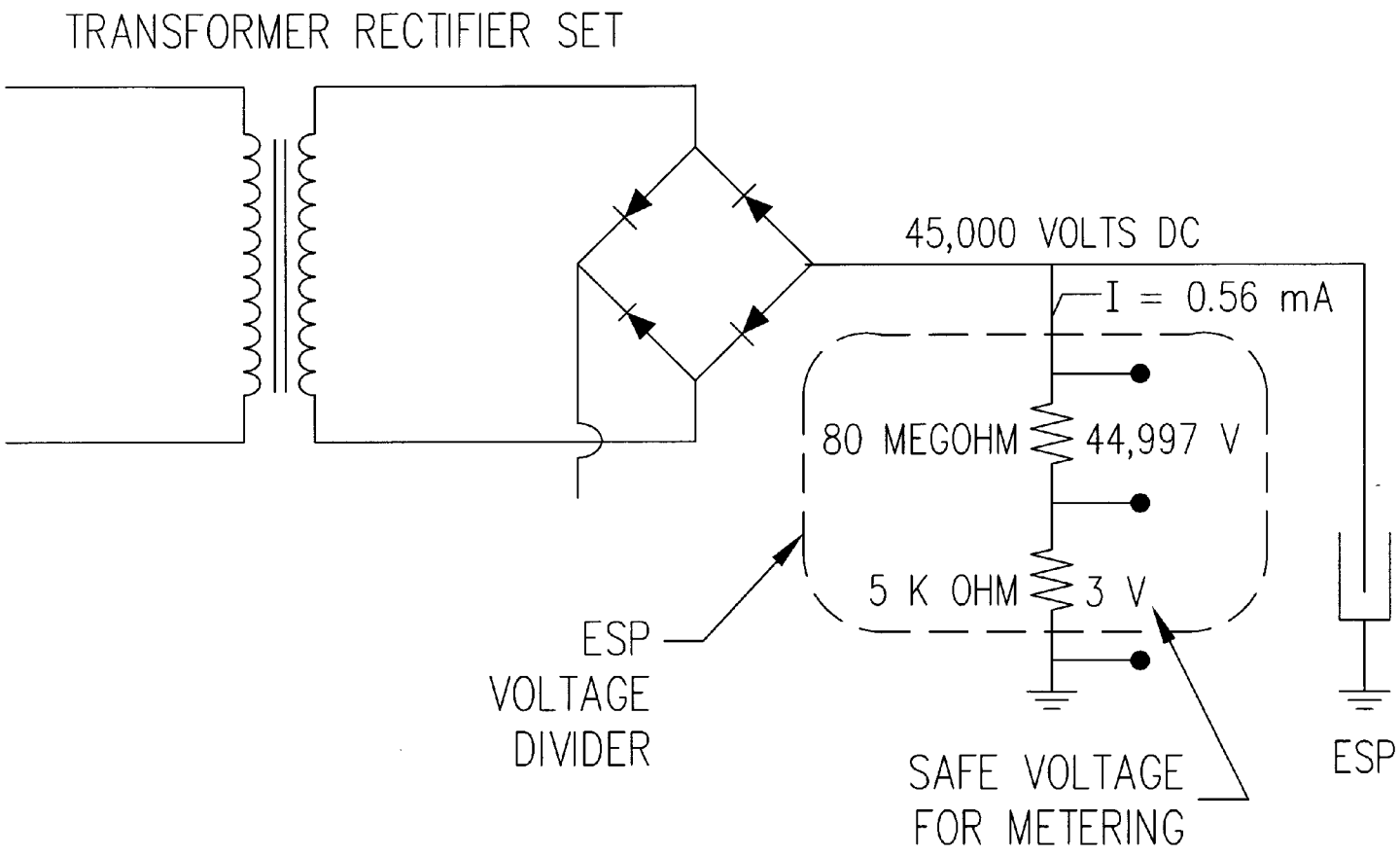
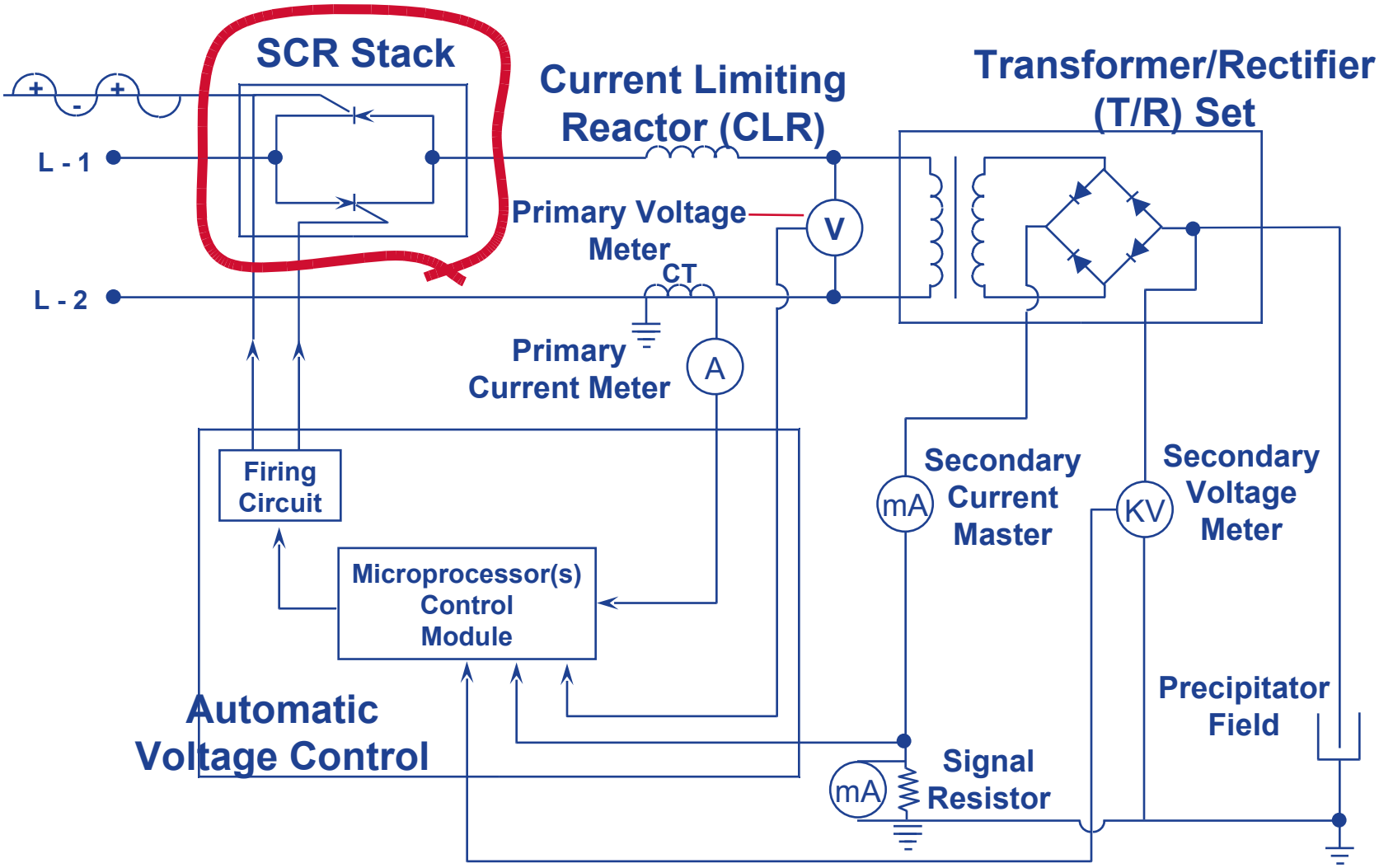
Precipitator Field

Voltage Divider



SCR'S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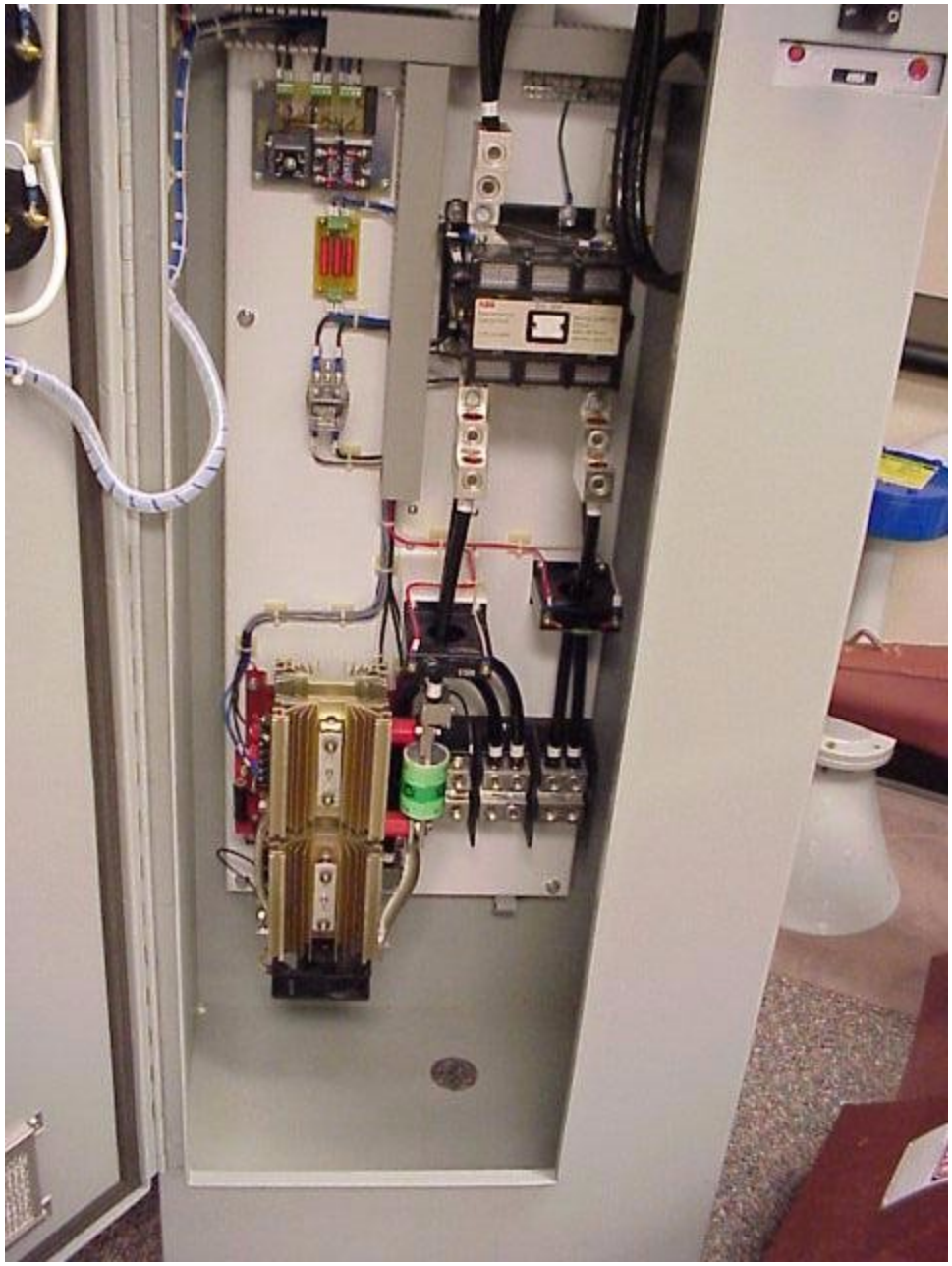
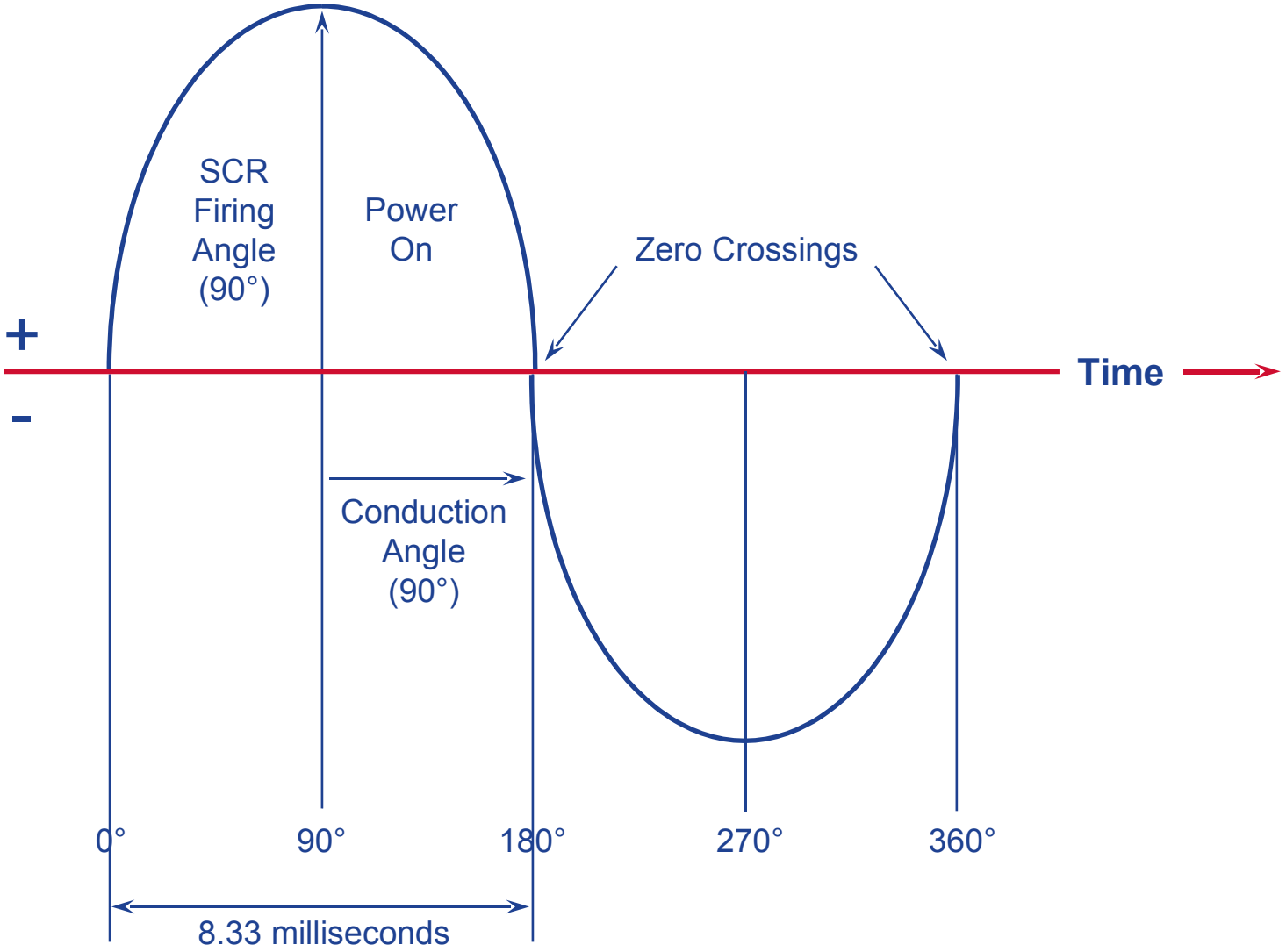
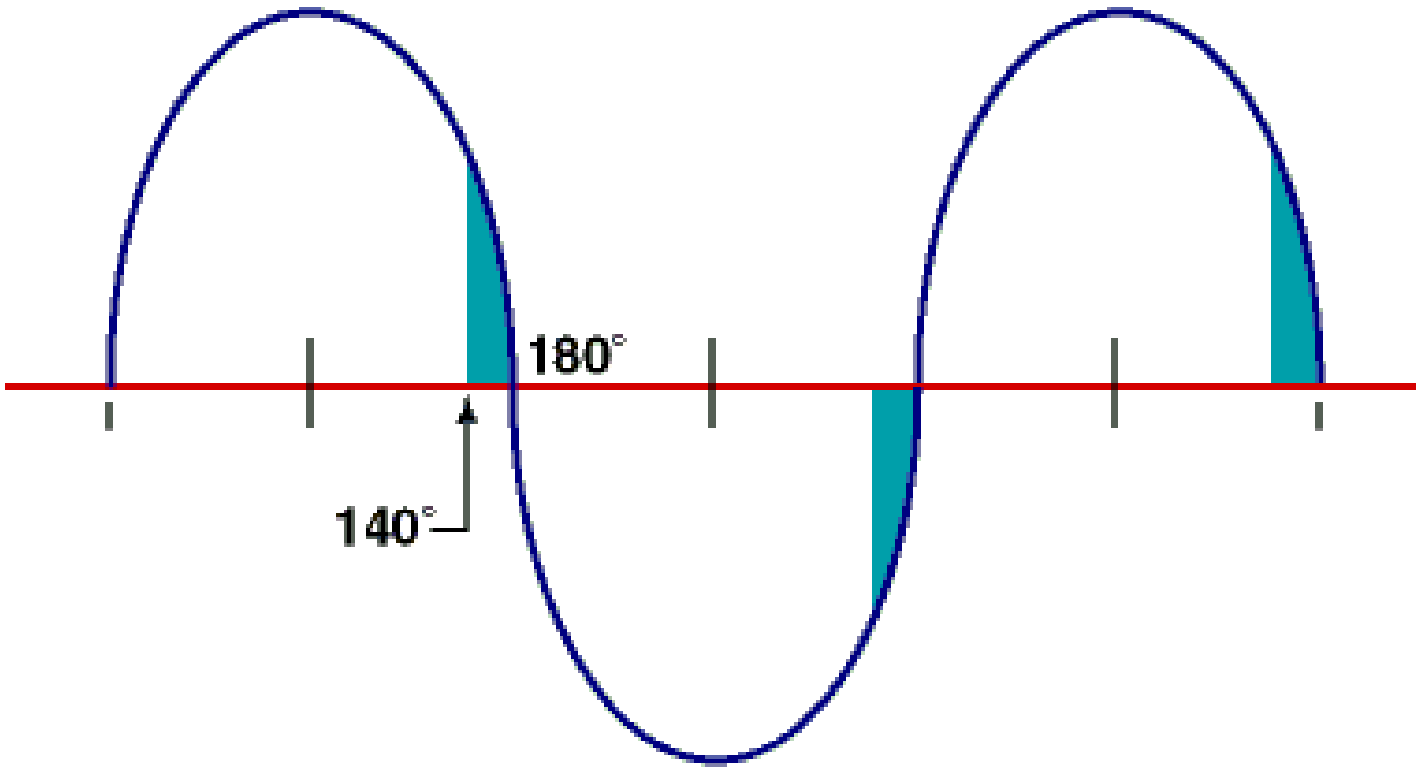
SCR



Typical Sine Wave

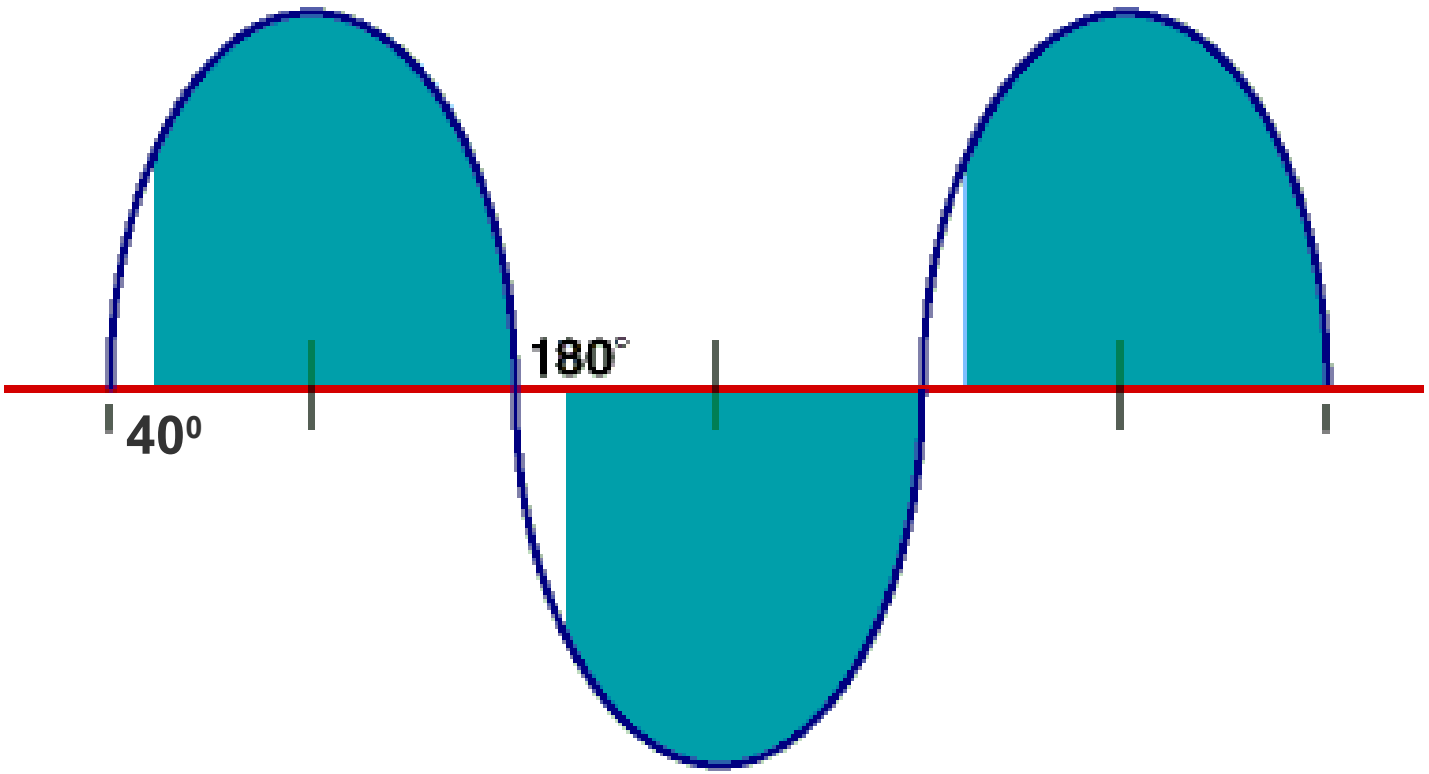


SCR: Low Voltage to T-R Set



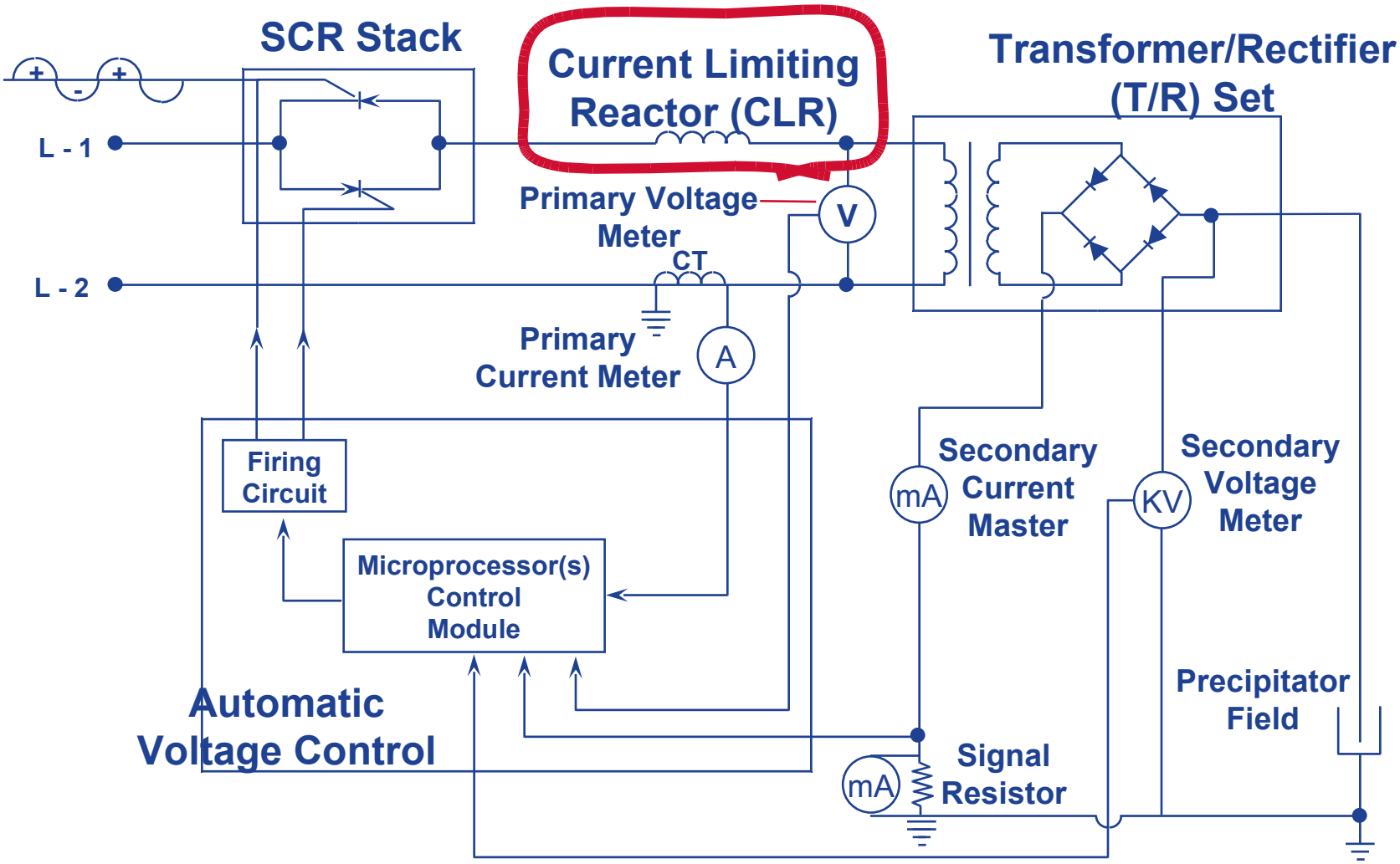
Firing Angle 140°
Conduction angle 40°

SCR: High Power to T-R Set



Firing Angle 40°
Conduction angle 140°

The CLR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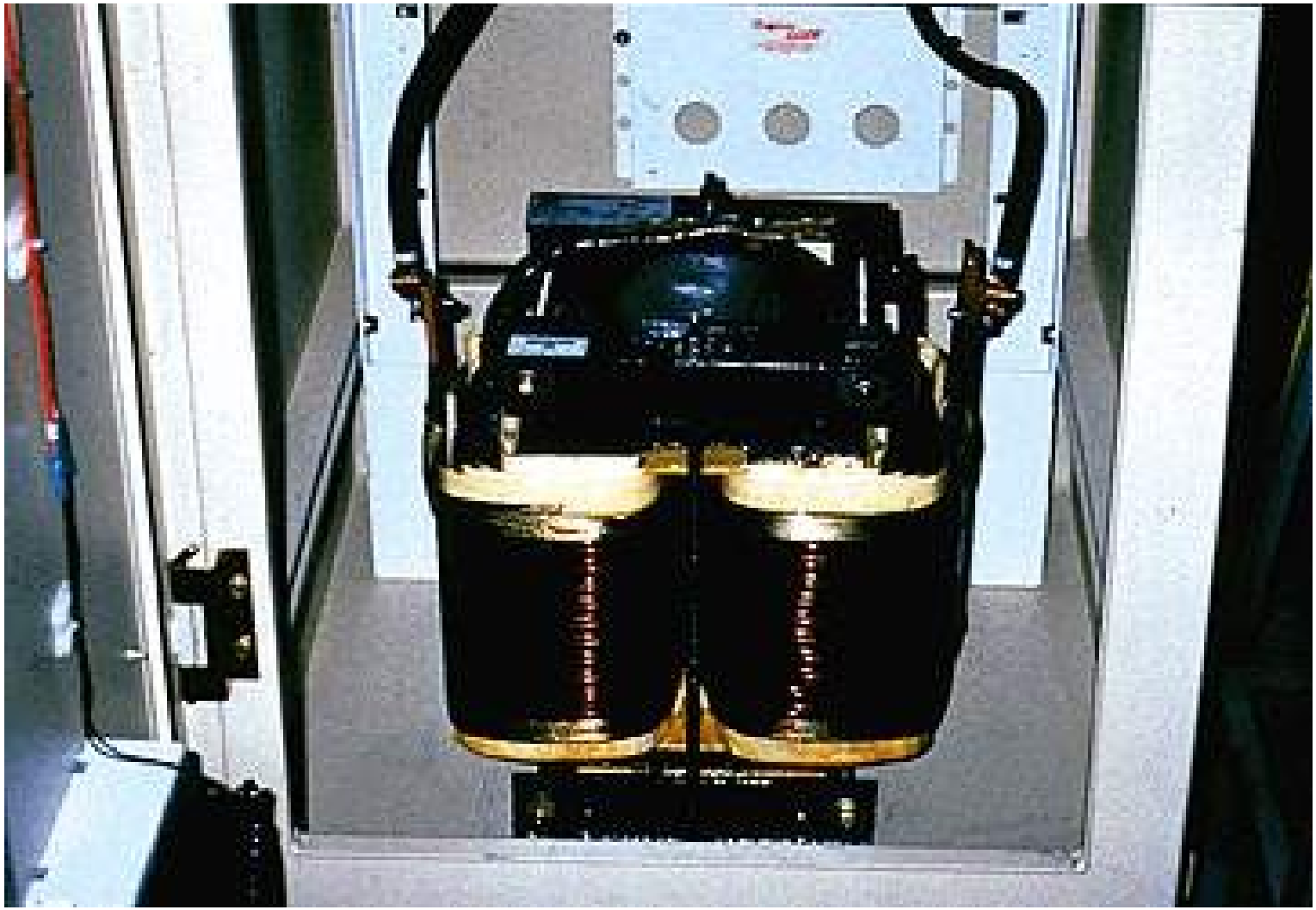
Current Limiting Reactor (CLR)

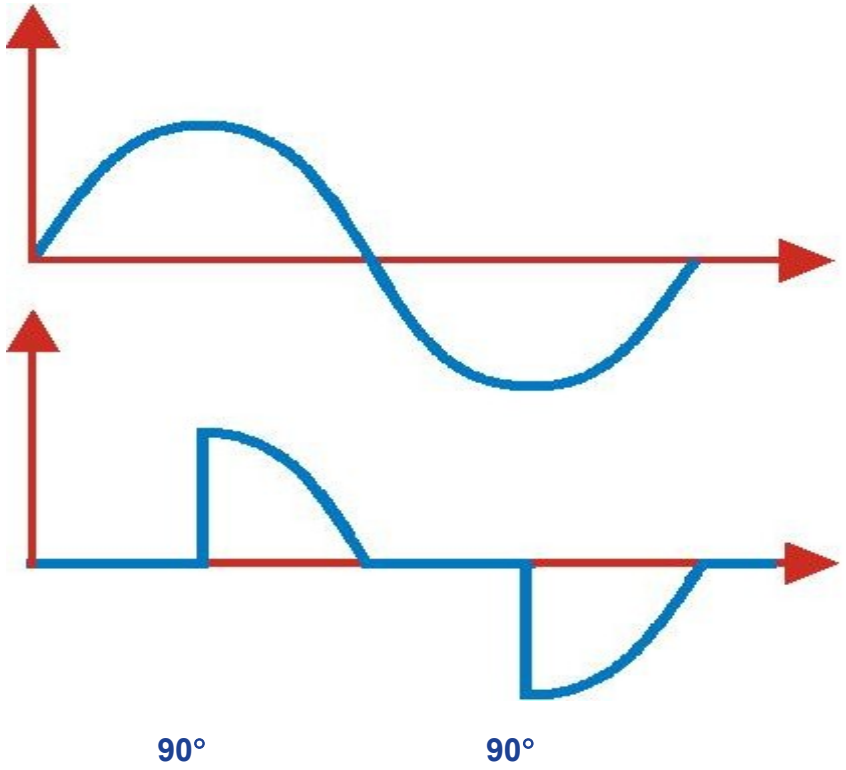


Current Limiting Reactor

Current Limiting Reactor at T-R Set

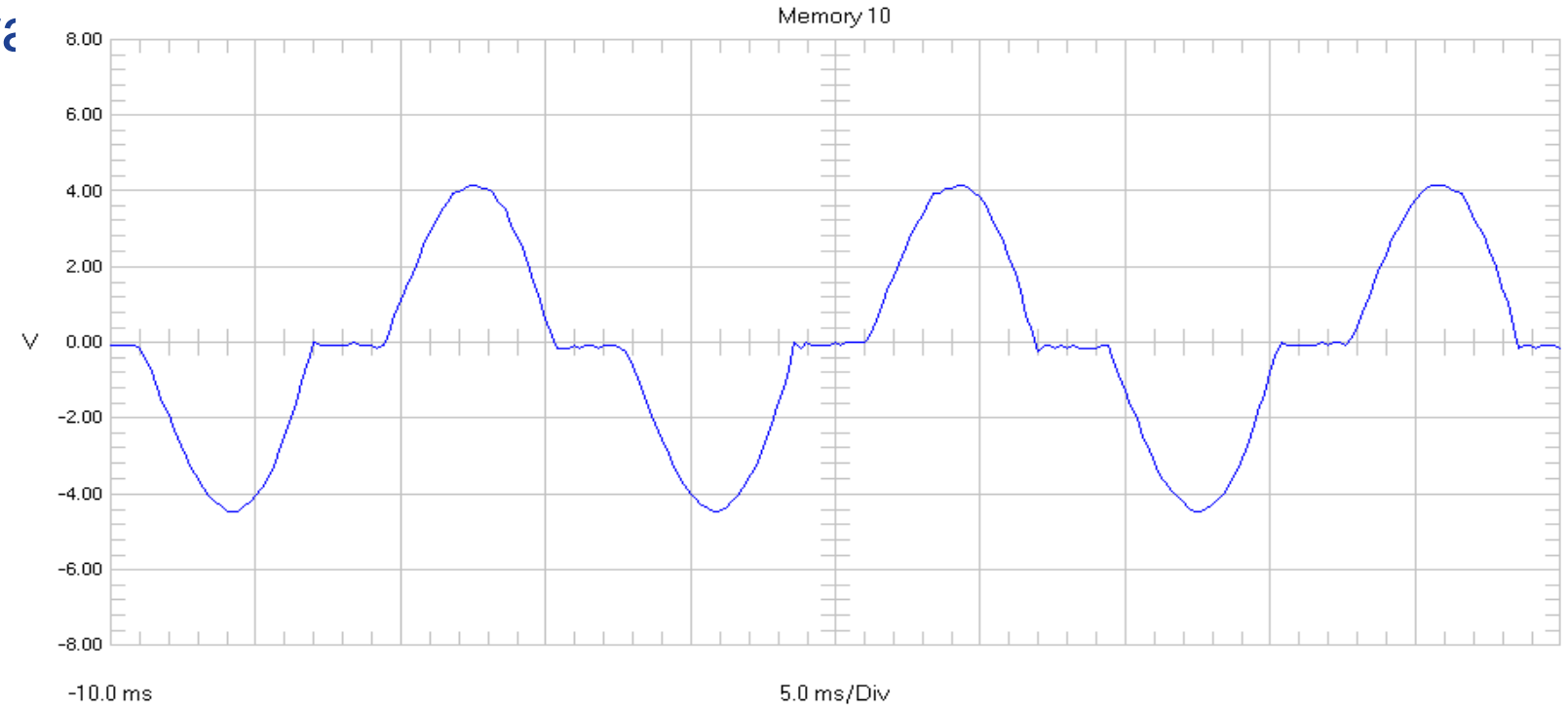
SCR's are why CLR's are Needed

- The diagram would represent the waveform with the SCRs turning on at 90°.
- If this waveform were applied to the T/R set, very inefficient operation would occur.
- Output power from the T/R set would be greatly reduced.



Electrical Basics: CLR

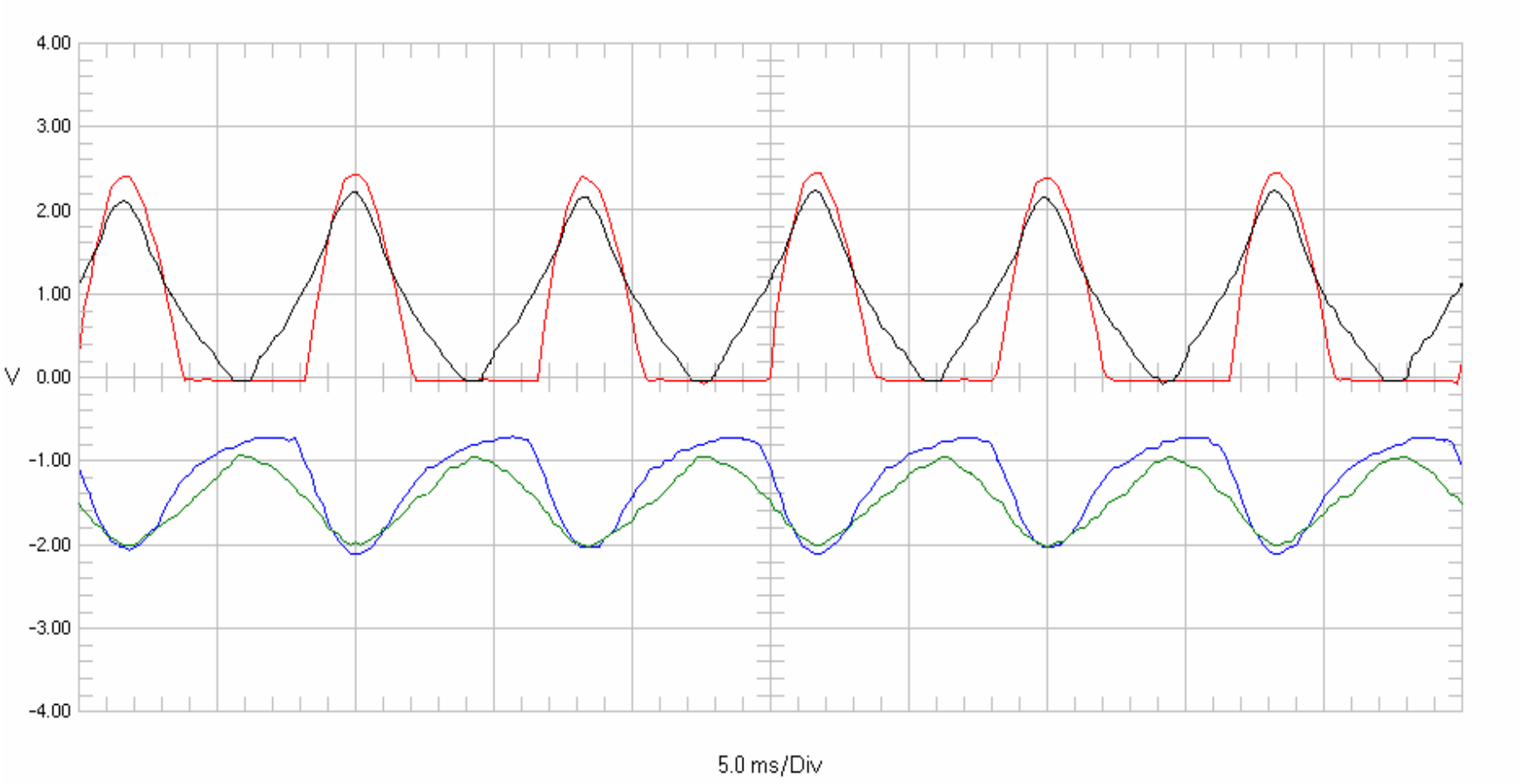
To increase the efficiency of the T/R set, a device called a CLR (current limiting reactor) is used. A CLR is an inductor. Recall that the property of an inductor is to oppose a change in current. Because of this property, the shape of the current waveform is changed and it starts looking more like a sine wa



CLR Function

- Limit short circuit current
- Shape T/R secondary wave to be more sinusoidal
- Provide proper form factor
- Protect SCRs and T/R diodes from steep current rise
- Increase precipitator voltage and current
- Not to be confused with air core reactor

CLR – Waveform Changes with Impedance



Proper CLR Sizes for Common T/R Sets

All T/R primaries are rated at 400V

PRI Current (Amps)	Sec. Current (mA)	Minimum (mH)
40	250	13.0
80	500	6.6
120	750	4.4
160	1000	3.3
200	1250	2.6
240	1500	2.2

Basic Troubleshooting

GE Energy

imagination at work

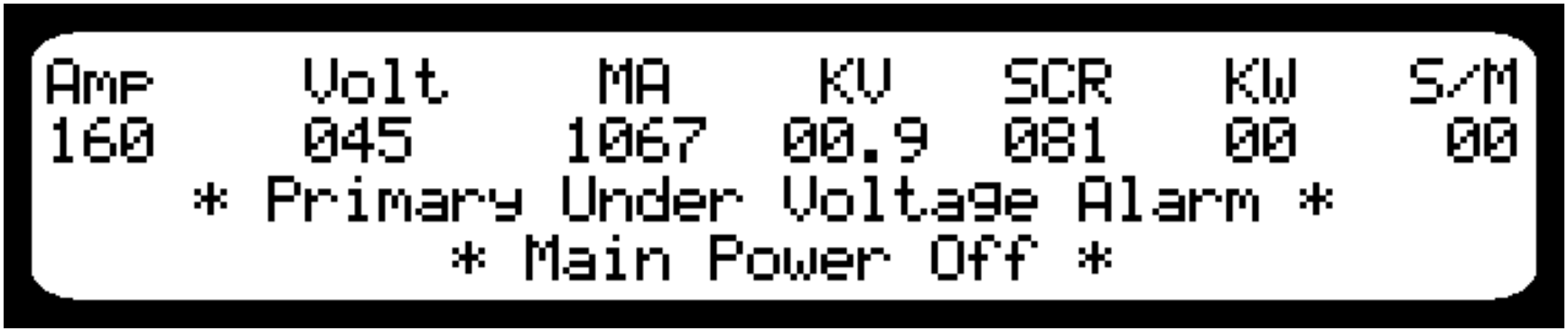
TR Nameplate Values (For this exercise)

Primary Current	160 Amps
Primary Voltage	480 Volts
Secondary Current	1200 mA
Secondary Voltage	45 kV

First Indication

160 480 1200 45

Second Indication



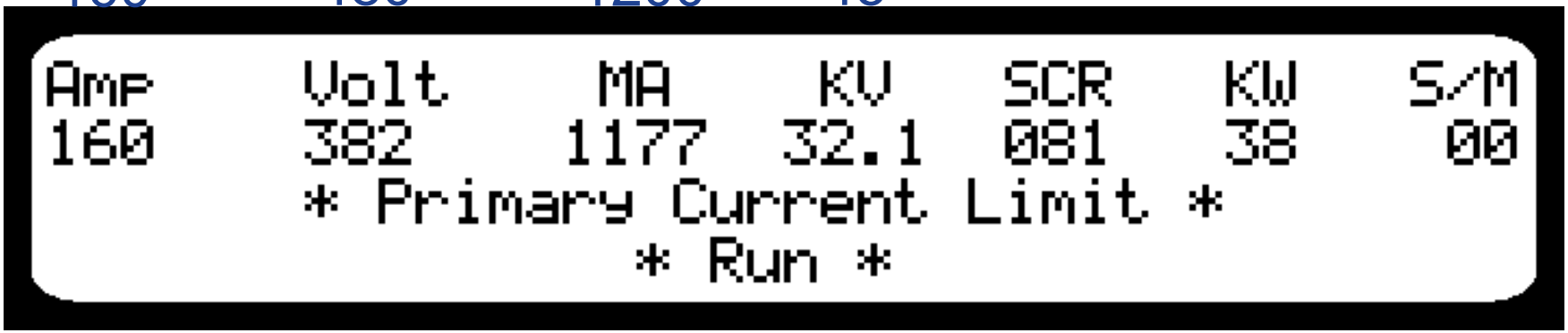
Short

Close Clearance

160 480 1200 45

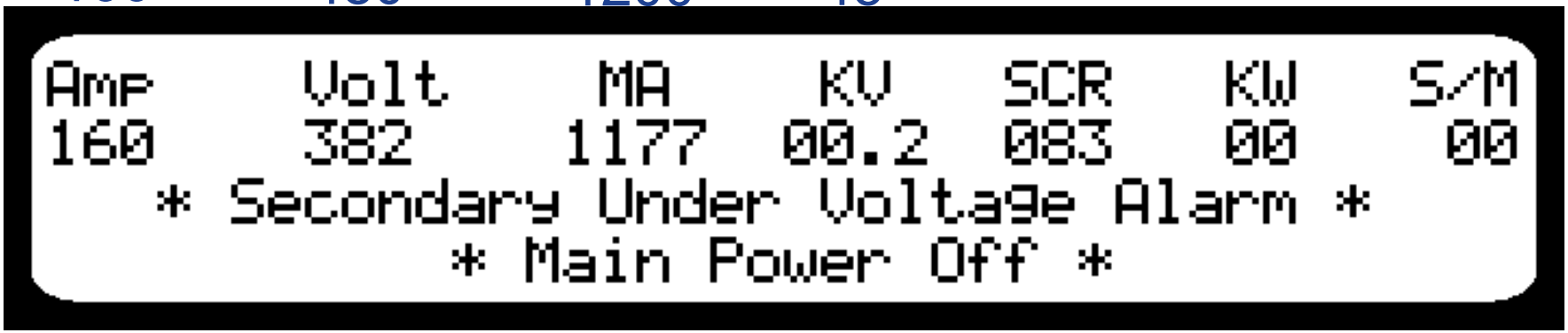
Conductive Dust, Outlet Field

160 480 1200 45



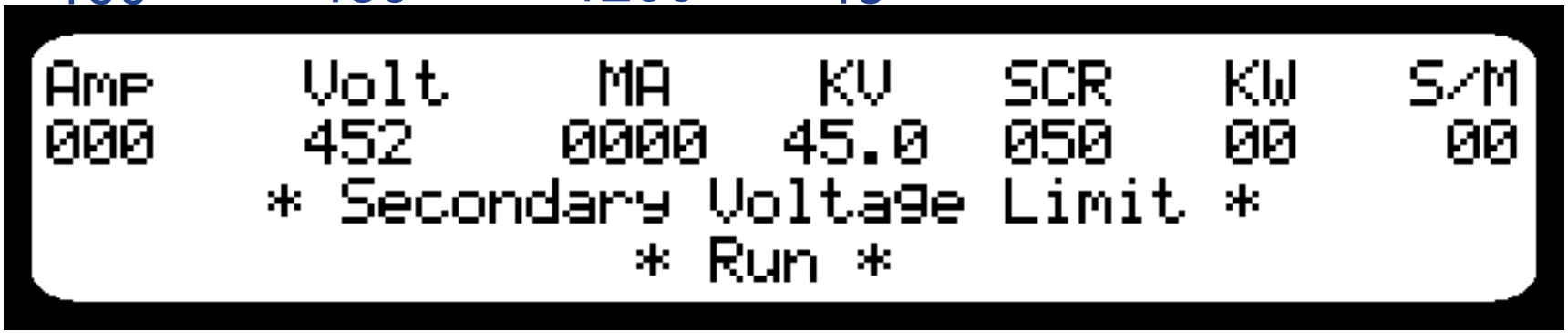
Bad KV Return

160 480 1200 45



Open

160 480 1200 45

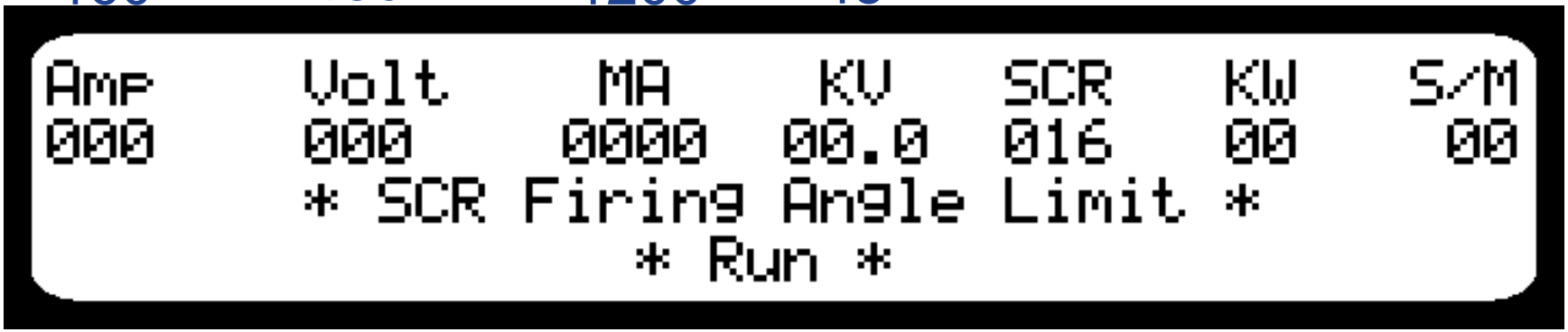


Normal Running Condition

160 480 1200 45

SCRs Not Firing

160 480 1200 45



Questions?

Thank You.

imagination at work