SCR Triggering Circuits
Scientech 2702

Learning Material
Ver 1.1

An ISO 9001:2008 company
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Certificate

Standard: **ISO 9001:2008**

Certificate Registr. No. **85 100 001 10182**

TÜV Rheinland India Pvt. Ltd.:

Certificate Holder: **Scientech Technologies Pvt. Ltd.**

Unit 1: 94 – 101, Electronics Complex, Pardeshi Pura,
Indore – 452 010, Madhya Pradesh, India

Unit 2: 90 – 91, Electronics Complex, Pardeshi Pura,
Indore – 452 010, Madhya Pradesh, India

Scope: **Design, Manufacture of Electronic Test & Measuring Instruments, Training Products for Electrical & Electronics Education and Providing Technology Training**

An audit was performed, Report No. 10182. Proof has been furnished that the requirements according to ISO 9001:2008 are fulfilled.

The due date for all future audits is 04-10 (dd.mm).

Validity: The certificate is valid from **2010-12-13 until 2013-12-12.**

Bangalore, 2010-12-20

The Certification Body of
TÜV Rheinland India Pvt. Ltd.

The validity of this certificate is subject to timely completion of Surveillance audits as agreed in the Contract. The Validity of the Certificate can be verified under www.tuv.com with the Identification No. 9105027653

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SCR Triggering Circuits

Scientech 2702

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Safety Instructions

Read the following safety instructions carefully before operating the instrument. To avoid any personal injury or damage to the instrument or any product connected to the instrument.

Do not operate the instrument if you suspect any damage within.

The instrument should be serviced by qualified personnel only.

For your safety:

Use proper Mains cord : Use only the mains cord designed for this instrument. Ensure that the mains cord is suitable for your country.

Ground the Instrument : This instrument is grounded through the protective earth conductor of the mains cord. To avoid electric shock the grounding conductor must be connected to the earth ground. Before making connections to the input terminals, ensure that the instrument is properly grounded.

Observe Terminal Ratings : To avoid fire or shock hazards, observe all ratings and marks on the instrument.

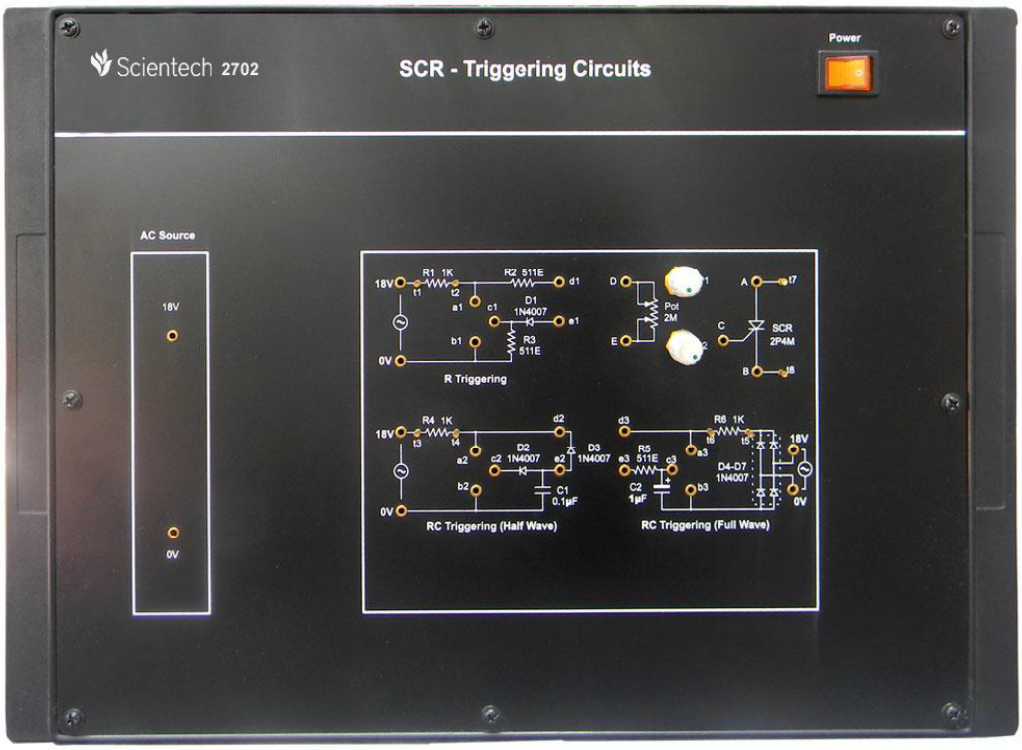
Use only the proper Fuse : Use the fuse type and rating specified for this instrument.

Use in proper Atmosphere : Please refer to operating conditions given in the manual.

1. **Do not operate in wet / damp conditions.**
2. **Do not operate in an explosive atmosphere.**
3. **Keep the product dust free, clean and dry.**

Introduction

Scientech 2702 is a platform which is very useful for Students to understand various thyristor firing methods like R, RC half wave, RC full wave. This platform is provided with in built power supply, sockets for making interconnection in the circuit & exhaustive learning material.



Features

- **In built Power Supply**
- **Easy to operate and understand**
- **Three firing circuits on single board**
- **Gradual firing angle control**
- **Test points for observe output of different circuits**
- **Sockets to make different connections**
- **On board AC sources of 18 V-0 V-18 V**

Technical Specifications

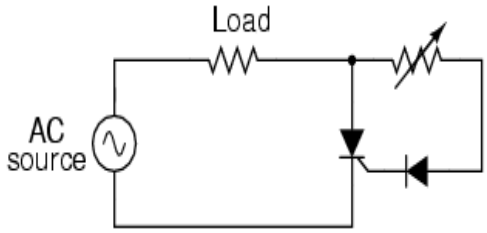
On board AC source	:	18 V - 0 V - 18 V
On board firing circuits	:	
R Triggering Circuit		
RC Half Wave Triggering Circuit		
RC Full Wave Triggering Circuit		
Interconnections	:	2 mm sockets (Gold plated)
Firing angle variation	:	Gradually variation using firing control POTS
SCR assembly	:	4 SCRs 2P4M, 400 V/2A
Test points	:	8 nos (Gold plated)
Dimensions (mm)	:	W 420 x D 255 x H 100
Power Supply (Mains)	:	110V - 260V AC, 50/60Hz
Weight	:	1 Kg. (approximately)
Operating Conditions	:	$0\text{-}40^{0}$ C, 80% RH
Learning material	:	CD (Theory, procedure, reference results, etc), Online (optional)

Theory

The most common, reliable and efficient method for controlling the conduction period of a Thyristors is by means of gate voltage control. The gate voltage control circuit is also called as the triggering circuit or Triggering circuit. Normally these circuits were used in low power semiconductor devices. The various triggering circuits are

a. Resistor Triggering:

A Diode-resistance combination circuit is the simplest way of obtaining the trigger pulse. The most basic method of obtaining the gate current from the main ac source is: whenever the anode is positive with respect to the cathode. When the thyristor has triggered in the positive half cycle of the input voltage, the anode-cathode voltage of the thyristor drops to the conduction value(≈1.5V) and the gate current decreases to zero(due to the availability of the low resistance path). The resistor R limits the peak gate current value, and the diode D prevents a reverse voltage during the negative half-cycle of the ac input. By varying the value of the resistance R1, the conduction period of the thyristor can be controlled. The value of the resistance R is such that the value of the gate current should not exceed the rated maximum value.



Circuit at minimum power setting

Figure 1

b. Resistor-capacitor Triggering:

The triggering angle control limitation of the diode resistance triggering circuit can be overcome by the diode-resistance-capacitance triggering circuit. The figure shows the RC-half wave trigger circuit. The conduction period can be controlled over the full 180° range. By varying the value of R1, the trigger can be controlled from 0 to Π. During the positive half cycle, the capacitor C charges to the trigger voltage of the thyristor in a time determined by the RC time constant and the applied anode voltage. During the negative half cycle, the capacitor charges to the peak supply voltage at $\omega t = (-\Pi/2)$. After this period, the supply voltage decreases and reaches zero at $\omega t = 0$.During this period the capacitor voltage becomes positive during the positive half cycle of the ac input, the capacitor begins to charge through the variable resistance R1, in the opposite direction and as soon as it charges to a positive voltage equal to the gate trigger voltage, the thyristor turns ON. Here the diode D1 is used to prevent the negative voltage between the gate and the cathode through the diode D2 during the negative half-cycle.

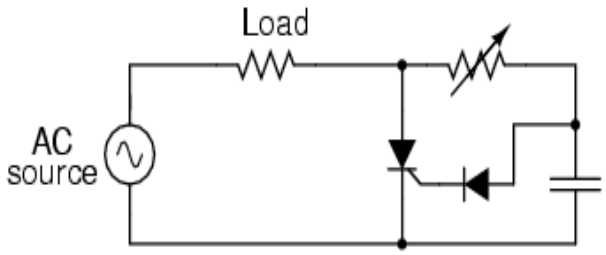
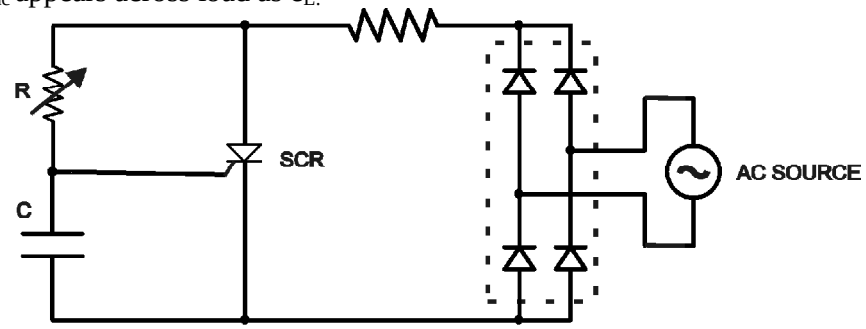


Figure 2

c. Resistor-Capacitor-Full wave triggering:

In the RC-half wave trigger circuit power can be delivered to the load only during the positive half cycle of e_s because the SCR conducts only when it is forward biased. This limitation can be overcome in several ways; here the ac line voltage is converted to pulsating dc by the full-wave diode bridge. This allows the SCR **to be triggered ON for both half cycle of the line voltage**, which doubles the available power to the load. The initial voltage, by which the capacitor C charges is almost zero. Capacitor C is set to this low positive voltage (upper plate positive) by the clamping action of the SCR gate. When the capacitor charges to a voltage equal to V_{gt}, SCR triggers and rectified voltage E_{dc} appears across load as $e_{L.}$



RC Triggering (Full Wave)

Figure 3

Experiment 1

Objective:

To study the Resistor Triggering Circuit

Equipments Needed:

1. Power Electronics Board **Scientech 2702.**
2. 2 mm patch cords.
3. Oscilloscope-Scientech 803/831, or equivalent

Circuit diagram:

The circuit diagram for SCR Triggering circuits is as follows:

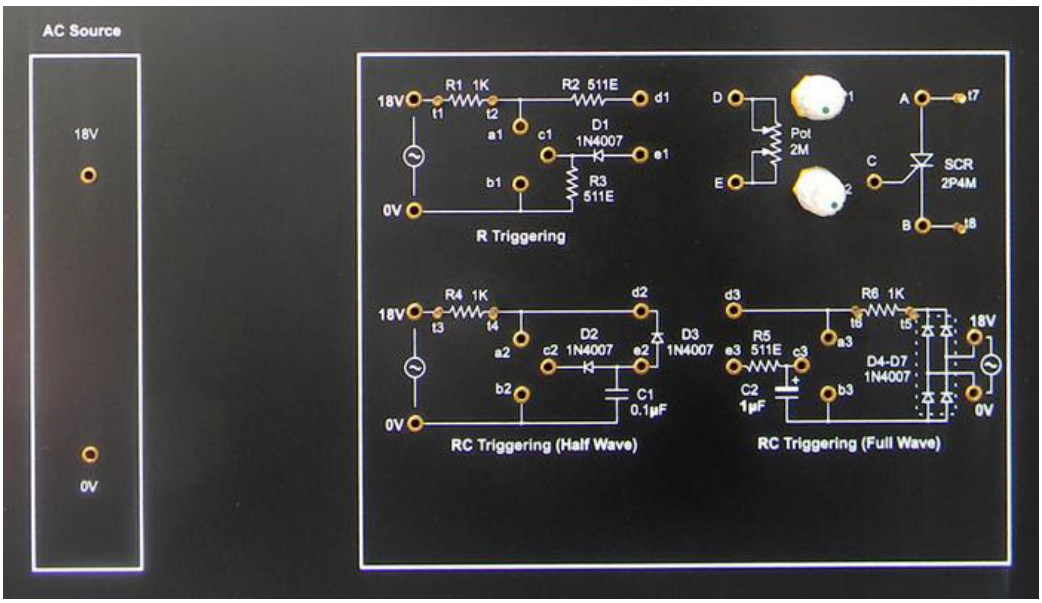


Figure 4

Procedure:

1. Connect the potentiometer points ‘D’ to point ‘d1’ and ‘E’ to point ‘e1’.
2. Connect the SCR points ‘A’ to point ‘a1’, ‘B’ to point ‘b1’ and ‘C’ to point ‘c1’.
3. Rotate the potentiometer ‘P1’ fully in clockwise direction.
4. Switch ‘On’ the power supply.
5. Connect the oscilloscope CH.I between the load test point ‘t1’ and ‘t2’ and observe the Phase angle and voltage.
6. Now, connect the oscilloscope probe across the thyristor and observe the waveform.
7. Vary the potentiometer slowly; you can see the phase angle variation.
8. Repeat the experiment from step 5 for various angles and plot the graphs.

Observation Table 1:

S. No.	Load voltage(V)	Phase Angle (α)
1.		
2.		
3.		
4.		
5.		
6.		

Experiment 2

Objective:

To study the Resistor-Capacitor Triggering Circuit (Half wave)

Equipments Needed:

1. Power Electronics Board **Scientech 2702.**
2. 2 mm patch cords.
3. Oscilloscope-Scientech 803/831, or equivalent

Circuit diagram:

The circuit diagram for SCR Triggering circuits is as follows:

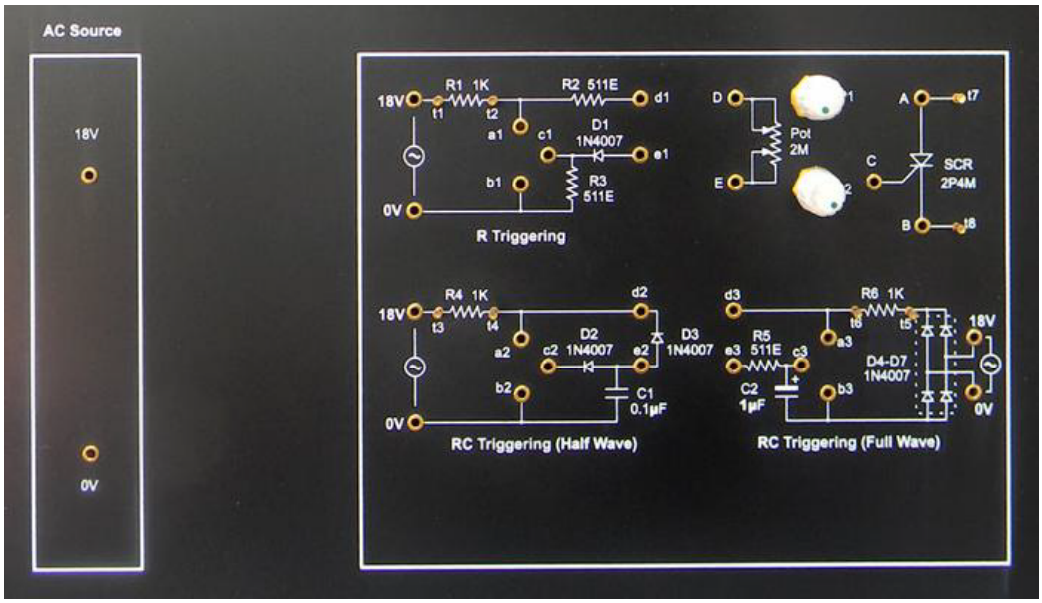


Figure 5

Procedure:

1. Connect the potentiometer points ‘D’ to point ‘d2’ and ‘E’ to point ‘e2’.
2. Connect the SCR points ‘A’ to point ‘a1’, ‘B’ to point ‘b2’ and ‘C’ to point ‘c2’.
3. Rotate the potentiometers ‘P1’ fully in the anticlockwise direction.
4. Switch ‘On’ the power supply.
5. Connect the oscilloscope probe between the load test point ‘t3’ and ‘t4’ and observe the Phase angle and voltage.
6. Now, connect the oscilloscope probe across the thyristor and observe the waveform.
7. Vary the potentiometer slowly; you can see the phase angle variation.
8. Repeat the experiment from step 5 for various angles and plot the graphs.

Observation Table 2:

S. No.	Load voltage(V)	Phase Angle (α)
1.		
2.		
3.		
4.		
5.		
6.		

Experiment 3

Objective:

To study the Resistor - Capacitor Triggering Circuit (Full Wave).

Equipments Needed:

1. Power Electronics Board **Scientech 2702.**
2. 2 mm patch cords.
3. Oscilloscope-Scientech 803/831, or equivalent

Circuit diagram:

The circuit diagram for SCR Triggering circuits is as follows:

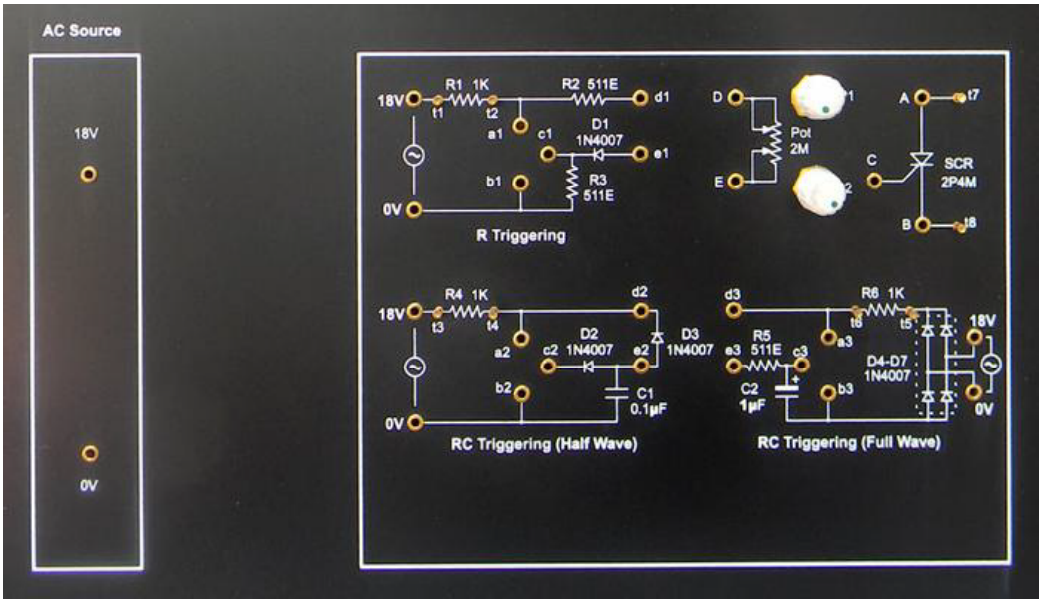


Figure 6

Procedure:

1. Connect the potentiometer points ‘D’ to point ‘d3’ and ‘E’ to point ‘e3’
2. Connect the SCR points ‘A’ to point ‘a1’, ‘B’ to point ‘b3’ and ‘C’ to point ‘c3’.
3. Rotate the potentiometers ‘P1’ fully in clockwise direction.
4. Switch ‘On’ the power supply.
5. Connect the oscilloscope probe between the load test point ‘t5’ and ‘t6’ and observe the Phase angle and voltage.
6. Now, connect the oscilloscope probe across the thyristor and observe the waveform.
7. Vary the potentiometer slowly; you can see the phase angle variation.
8. Repeat the experiment from step 5 for various angles and plot the graphs.

Observation Table 3:

S. No.	Load voltage (V)	Phase Angle (α)
1.		
2.		
3.		
4.		
5.		
6.		

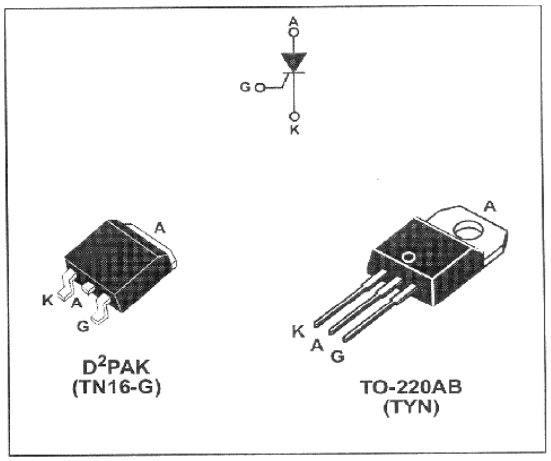
Datasheet

Standard

TN16 and TYNx16 Series
16A SCRs

Main features

Symbol	Value	Unit
$I_{T(RMS)}$	16	A
V_{DRM}/V_{RRM}	600 to 1000	V
I_{GT}	25	mA



Description**:**

The TYN / TN16 SCR Series is suitable for general purpose applications.

Using clip assembly technology, they provide a superior performance in surge current capabilities.

Absolute Ratings (limiting values)

Symbol	Parameter			Value	Unit
$I_{T(RMS)}$	RMS on-state current (180° conduction angle)		Tc = 110°C	16	A
$T_{(AV)}$	Average on-state current (180° conduction angle)		Tc = 110°C	10	A
I_{TSM}	Non repetitive surge peak on-state current	tp = 8.3 ms	Tj = 25°C	200	A
		tp = 10 ms		190	
I^2t	I^2t Value for fusing	tp = 10 ms	Tj = 25°C	180	A^2S
dI/dt	Critical rate of rise of on-state current $I_G = 2 \times I_{GT}$, tr ≤ 100 ns	F = 60 Hz	Tj = 125°C	50	A/µs
I_{GM}	Peak gate current	tp = 20 µs	Tj = 125°C	4	A
$P_{G(AV)}$	Average gate power dissipation		Tj = 125°C	1	W
T_{stg} Tj	Storage junction temperature range Operating junction temperature range			- 40 to + 150 - 40 to + 125	°C
V_{RGM}	Maximum peak reverse gate voltage			5	V