PE43
UJT Relaxation Oscillator

Operating Manual

Ver.1.1

An ISO 9001 : 2000 company

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TÜV Rheinland Group

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PE43

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RoHS Compliance

Scientech Products are RoHS Complied.

RoHS Directive concerns with the restrictive use of Hazardous substances (Pb, Cd, Cr, Hg, Br compounds) in electric and electronic equipments.

Scientech products are “Lead Free” and “Environment Friendly”.

It is mandatory that service engineers use lead free solder wire and use the soldering irons upto (25 W) that reach a temperature of 450°C at the tip as the melting temperature of the unleaded solder is higher than the leaded solder.

Introduction

UJT Relaxation Oscillator PE43 is a compact, ready to use experiment board. This is helpful for students to have a study, how to generate the pulse using UJT with variable frequency to trigger the SCR and to understand the operation of it. If can be used with DC power supply.

Model	**Name**
PE01	UJT Characteristics
PE02	MOSFET Characteristics
PE03	SCR Characteristics
PE04	TRIAC Characteristics
PE05	DIAC Characteristics
PE06	IGBT Characteristics
PE07	PUT Characteristics
PE10	SCR Triggering (R, RC Full wave, RC Half wave)
PE11	SCR Triggering (UJT)
PE12	SCR Triggering (IC555)
PE13	SCR Triggering (IC74121)
PE14	Ramp and Pedestal Triggering
PE15	SCR Triggering (IC741)
PE16	SCR Triggering (PUT)
PE40	SCR Lamp Flasher
PE41	SCR Alarm Circuit
PE42	Series Inverter
PE44	Single Phase PWM Inverter
ST2701	IGBT Characteristics
ST2702	SCR Triggering (R, RC Half wave, RC Full wave)
ST2703	SCR Triggering Techniques
ST2704	Triggering of SCR using 74121 IC
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ST2707	Series Inverter
ST2708	Single Phase Controlled Rectifier (with Ramp Comparator Firing Scheme)
ST2709	Single Phase Controlled Rectifier (Cosine Firing Scheme)
ST2710	Single Phase Converter Firing Techniques (by TCA 785IC and Triangular Comparator)
ST2711	Lamp Dimmer
ST2712	Electronics Power Lab
ST2713	Single Phase Cyclo - Converter
ST2714	Speed Control of Universal Motor using SCR
ST2715	Speed Control of AC Motor using TRIAC

ST2716	Microcontroller Based Firing Circuit for Controlled Rectifier
ST2717	SCR Commutation Circuits
ST2718	Bedford & Parallel Inverter
ST2719	Step-Up Chopper
ST2720	Single Phase Bridge Inverter
ST2722	Step-Down Chopper
ST2723	AC Chopper

and many more..........

Theory

The UJT is often used as a trigger device for SCR's and TRIAC's. Other applications include non-sinusoidal oscillators; saw tooth generators, phase control, and timing circuits.

The most common UJT circuit in use today is the relaxation oscillator, which is shown below. Gate characteristics wide spread; pulses can be adjusted easily to suit such a wide spectrum of gate characteristics. The power level in pulse triggering is low as the gate drive is discontinuous; pulse triggering is therefore more efficient. The below Fig is called the relaxation oscillator. The resistor and capacitor connected to the emitter form an RC timing circuit. Normally, the value of capacitor is fixed and the value of resistor is of potentiometer type. The charging rate of the capacitor depends on the value of the resistor and since the resistor is variable the RC time constant can be controlled. When the voltage across the capacitor is equal to more than the peak voltage V_P of the UJT, it starts conducting. Since the UJT has a negative resistance, its voltage starts decreasing up to the valley voltage, and the capacitor discharges up to the valley voltage. This repetitive process produces a train of pulses at its output. From the output voltage waveform it is clear that the output pulses has a very small width and that a long relaxation time exits between the two pulses. Therefore it is said that the device is relaxed in this duration and is called the relaxation oscillator.

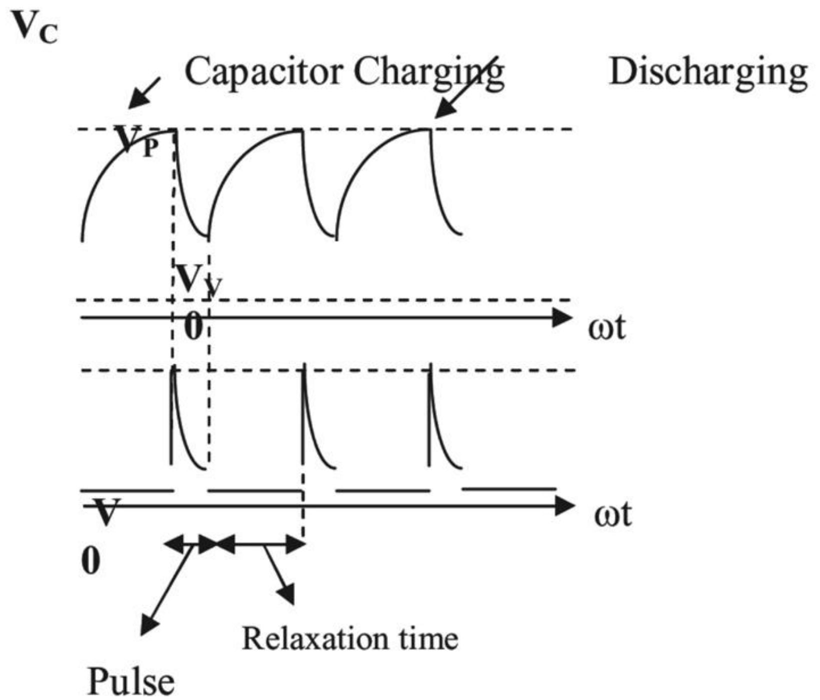
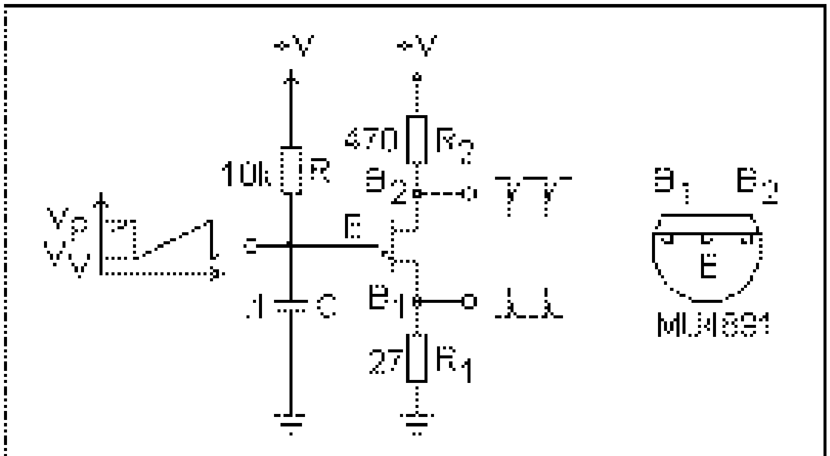


Figure 1



UJT Relaxation Oscillator

Figure 2

Show the circuit with UJT working in the oscillator mode. The external resistances R_1 and R_2 are small in comparison with the internal resistances R_{B1}, R_{B2} of UJT bases. The charging resistance R should be such that its load line intersects the device characteristics only in the negative resistance region.

In the figure, when source voltage V_{BB} is applied, capacitor C begins to charge through R exponentially towards V_{BB}. During this charging, emitter circuit of UJT is an open circuit. The capacitor voltage Vc, equal to emitter voltage Ve, is given by

$$Vc = Ve = V_{BB} (1-e^{t/RC})$$

The constant of the charge circuit is τ_1 = RC.

When this emitter voltage Ve reaches the peak point voltage Vp, the unijunction between E-B1 breaks down. As result, UJT turns on and capacitor C rapidly discharge through low resistance R1 with a time constant $\tau_2 = R_1C$. Here τ_2 is much smaller than τ_1. When the emitter voltage decays to the valley point voltage Vv, UJT turns off. The time T required for capacitor C to charge from initial voltage Vv to peak point voltage through large resistance R, can be obtained as under:

$$T = 1/f = RC \ln [1/ (1-\eta)]$$

The charging and discharging of the capacitor generate the Saw tooth wave at the emitter of UJT and if the output is taken from B_1, the result is a train of pulses occurring during the discharge of the capacitor through the UJT emitter. The voltage at B1during the UJT "off" time will be very small and determined by the voltage divider formed by R_1, R_{BB} and R_2 are :

$$V_{B1} (off) = [R_1/(R_1+ R_{BB}+ R_2)]\ E_{dc}$$

The rise time of the pulses is very short, but the fall time depends on the values of C and R_1. a larger value of C or R_1 will cause slower capacitor discharge and a longer fall time .if the out put is taken at B_2, a waveform of negative going pulses is obtained .

The frequency of oscillation is normally controlled by varying the charging time constant RC. There are however, limits on R. these limits are:

$$R_{min} = E_{dc} - Vv / Iv$$

$$R_{max} = E_{dc} - Vp / Ip$$

Keeping R between these limits will ensure oscillations. If R is greater than Rmax, the capacitor never reaches Vp since the current through R is not large enough to both charge the capacitor and supply Ip to the UJT the UJT will stay in the “off” state, and Vc will charge to a value just below Vp.

If R is than Rmin, the capacitor will reach Vp and discharge through the UJT but the UJT will not turn “off” since the current through R is greater than the Iv needed to hold the UJT “on”. The capacitor and V_{B1} waveform will consist of a single representing one charge and discharge interval. This single pulse operation is sometimes used in time delay applications.

Experiment

Objective :
Study of the UJT relaxation oscillator

Equipment Needed :

1. UJT relaxation oscillator board **PE43**

2. DC power supply +12V and GND.

3. Oscilloscope

4. 2 mm patch cords.

Circuit diagram :

Circuit diagram of UJT relaxation oscillator is given below :

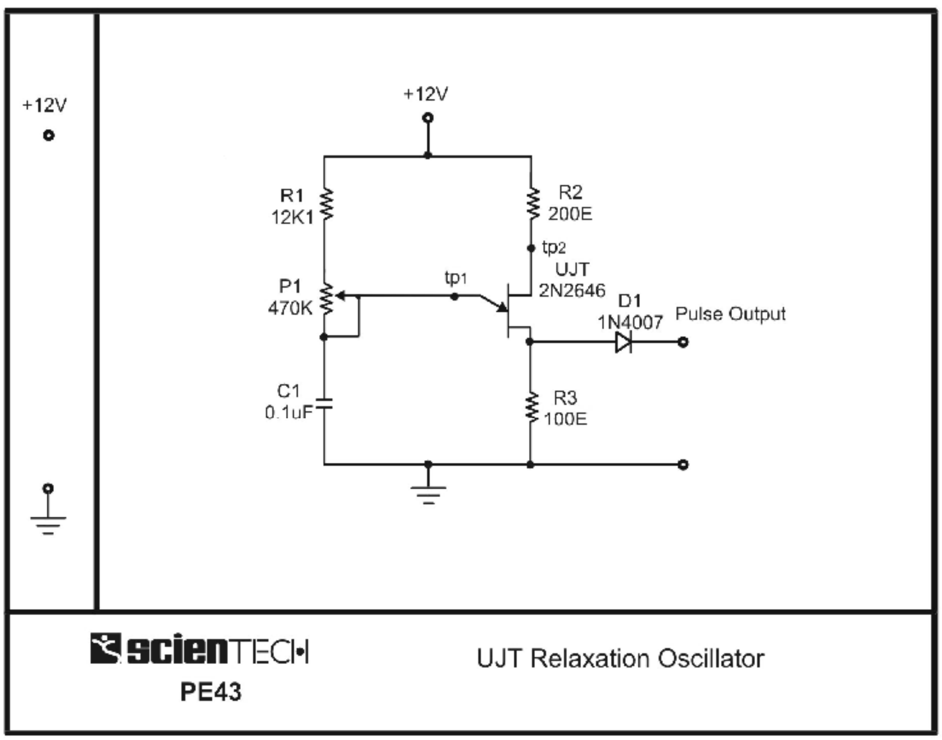


Figure 3

Procedure :

- Connect +12V dc power supply at their indicated position from external source.

1. Rotate the potentiometer P_1 fully in clockwise direction.

2. Switch ON the power supply.

3. Connect the oscilloscope CHI between output and ground and CHII between tp1 and ground and observe the waveform of pulse output and RC time constant.

4. Vary the potentiometer P_1 in clockwise direction so as to increase the frequency of the out put.

5. Sketch the waveforms on the paper.

Observation Table :

S. No.	Minimum Frequency	Maximum frequency

Datasheet

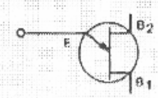
Boca Semiconductor Corp. (BSC)

PN Unijunction Transistors

Silicon PN Unijunction Transistors

2N2646
2N2647

PN UJTs



CASE 22A-01
STYLE 1

Designed for use In pulse and timing circuits, sensing circuits and thyristor trigger circuits. These devices feature:

1. Low Peak Point Current - 2μA (Max)
2. Low Emitter Reverse Current - 200nA (Max)
3. Passivated Surface for Reliability and Uniformity

Maximum Ratings (T_A = 25°C unless otherwise noted.)

Rating	Symbol	Value	Unit
Power Dissipation, Note 1	P_D	300	mW
RMS Emitter Current	$I_{E(RMS)}$	50	mA
Peak Pulse Emitter Current, Note 2	i_E	2	Amps
Emitter Reverse Voltage	V_{B2E}	30	Volts
Interbase Voltage	V_{B2B1}	35	Volts
Operating Junction Temperature Range	T_J	−65 to +125	°C
Storage Temperature Range	T_{stg}	−65 to +150	°C

"Indicates JEDEC Registered Date.

Notes :

1. Derate 3mW/°C increase In ambient temperature. The total Power dissipation (available power to Emitter and Base-Two) must be limited by the external circuitry.

2. Capacitor discharge - 10μF or loss, 30 volts or loss.

Characteristic		Symbol	Min	Typ	Max	Unit
Intrinsic Standoff Ratio (V_{B2B1} = 10 V), Note 1	2N2646 2N2647	η	0.56 0.68	— —	0.75 0.82	—
Interbase Resistance (V_{B2B1} = 3 V, I_E = 0)		r_{BB}	4.7	7	9.1	k ohms
Interbase Resistance Temperature Coefficient (V_{B2B1} = 3 V, I_E = 0, T_A = −55°C to +125°C)		α_{rBB}	0.1	—	0.9	%/°C
Emitter Saturation Voltage (V_{B2B1} = 10 V, I_E = 50 mA), Note 2		$V_{EB1(sat)}$	—	3.5	—	Volts
Modulated Interbase Current (V_{B2B1} = 10 V, I_E = 50 mA)		$I_{B2(mod)}$	—	15	—	mA
Emitter Reverse Current (V_{B2E} = 30 V, I_{B1} = 0)	2N2646 2N2647	I_{EB2O}	— —	0.005 0.005	12 0.2	μA
Peak Point Emitter Current (V_{B2B1} = 25 V)	2N2646 2N2647	I_P	— —	1 1	5 2	μA
Valley Point Current (V_{B2B1} = 20 V, R_{B2} = 100 ohms), Note 2	2N2646 2N2647	I_V	4 8	6 10	— 18	mA
Base-One Peak Pulse Voltage (Note 3, Figure 3)	2N2646 2N2647	V_{OB1}	3 6	5 7	— —	Volts

*Indicates JEDEC Registered Data.

Notes:

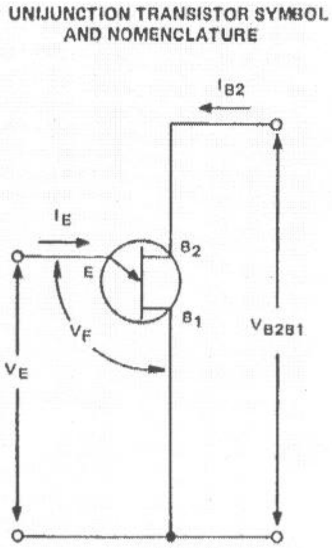
1. Intrinsic standoff ratio, η, is defined by equation:

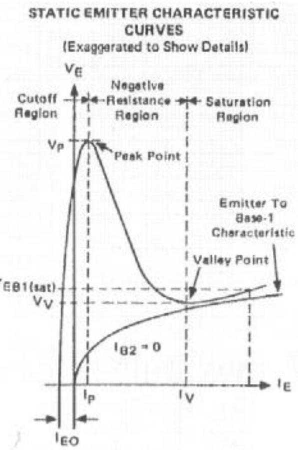
$$\eta = \frac{V_P - V_F}{V_{B2B1}}$$

Where V_P = Peak Point Emitter Voltage
V_{B2B1} = Interbase Voltage
V_F = Emitter to Base-One Junction Diode Drop (≈ 0.45 V @ 10 μA)

2. Use pulse techniques; PW ≈ 300 μs, duty cycle ≤ 2% to avoid internal heating due to interbase modulation which may result in erroneous readings.

3. Base-One Peak Pulse Voltage is measured in circuit of Figure 3. This specification is used to ensure minimum pulse amplitude for applications in SCR firing circuits and other types of pulse circuits.


UNIJUNCTION TRANSISTOR SYMBOL
AND NOMENCLATURE
IB2
IE
E
B2
B1
VF
VB2B1
VE


STATIC EMITTER CHARACTERISTIC
CURVES
(Exaggerated to Show Details)
VE
Cutoff
Region
Negative
Resistance
Region
Saturation
Region
VP
Peak Point
Emitter To
Base-1
Characteristic
Valley Point
VEB1(sat)
VV
IB2 = 0
IP
IV
IE
IEO

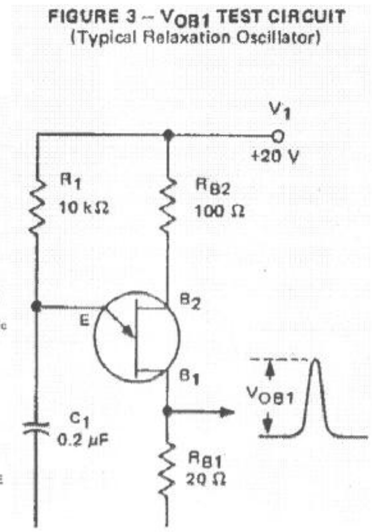


FIGURE 3 – VOB1 TEST CIRCUIT
(Typical Relaxation Oscillator)
V1
+20 V
R1
10 kΩ
RB2
100 Ω
B2
E
B1
VOB1
C1
0.2 µF
RB1
20 Ω