AB68
Hartley Oscillator

Operating Manual

Ver.1.1

An ISO 9001 : 2000 company

Innovative Technology Ecosystem

94-101, Electronic Complex Pardesipura,
Indore- 452010, India
Tel : 91-731- 2570301/02, 4211100
Fax: 91- 731- 2555643
e mail : info@scientech.bz
Website : www.scientech.bz
Toll free : 1800-103-5050

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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

AB68 is a compact, ready to use **Hartley Oscillator** experiment board. This is useful for students to understand functionality of Hartley oscillator. It can be used as stand alone unit with external DC Power Supply or can be used with **Scientech Analog Lab ST2612** which has built in DC Power Supply, AC Power Supply, function generator, modulation generator, continuity tester, toggle switches, and potentiometer.

List of Boards :

Model	Name
AB01	Diode characteristics (Si, Zener, LED)
AB02	Transistor characteristics (CB NPN)
AB03	Transistor characteristics (CB PNP)
AB04	Transistor characteristics (CE NPN)
AB05	Transistor characteristics (CE PNP)
AB06	Transistor characteristics (CC NPN)
AB07	Transistor characteristics (CC PNP)
AB08	FET characteristics
AB09	Rectifier Circuits
AB10	Wheatstone bridge
AB11	Maxwell's Bridge
AB12	De Sauty's Bridge
AB13	Schering Bridge
AB14	Darlington Pair
AB15	Common Emitter Amplifier
AB16	Common Collector Amplifier
AB17	Common Base Amplifier
AB18	RC-Coupled Amplifier
AB19	Cascode Amplifier
AB20	Direct Coupled Amplifier
AB21	Class A Amplifier
AB22	Class B Amplifier (push pull emitter follower)
AB23	Class C Tuned Amplifier
AB24	Transformer Coupled Amplifier
AB25	Phase Locked Loop (FM Demodulator & Frequency Divider / Multiplier)
AB26	FET Amplifier
AB27	Voltage Controlled Oscillator
AB28	Multivibrator (Mono stable/Astable)
AB29	F-V and V-F Converter
AB30	V-I and I-V Converter
AB31	Zener Voltage Regulator
AB32	Transistor Series Voltage Regulator
AB33	Transistor Shunt Voltage Regulator
AB35	DC Ammeter

AB37	DC Ammeter (0-2mA)
AB39	Instrumentation Amplifier
AB41	Differential Amplifier (Transistorized)
AB42	Operational Amplifier (Inverting / Non-inverting / Differentiator)
AB43	Operational Amplifier (Adder/Scalar)
AB44	Operational Amplifier (Integrator/ Differentiator)
AB45	Schmitt Trigger and Comparator
AB49	K Derived Filter
AB51	Active filters (Low Pass and High Pass)
AB52	Active Band Pass Filter
AB54	Tschebyscheff Filter
AB56	Fiber Optic Analog Link
AB57	Owen's Bridge
AB58	Anderson's Bridge
AB59	Maxwell's Inductance Bridge
AB64	RC – Coupled Amplifier with Feedback
AB66	Wien Bridge Oscillators
AB67	Colpitt Oscillator
AB80	RLC Series and RLC Parallel Resonance
AB82	Thevenin's and Maximum Power Transfer Theorem
AB83	Reciprocity and Superposition Theorem
AB84	Tellegen's Theorem
AB85	Norton's theorem
AB88	Diode Clipper
AB89	Diode Clampers
AB90	Two port network parameter
AB91	Optical Transducer (Photovoltaic cell)
AB92	Optical Transducer (Photoconductive cell/LDR)
AB93	Optical Transducer (Phototransistor)
AB96	Temperature Transducer (RTD & IC335)
AB97	Temperature Transducer (Thermocouple)
AB101	DSB Modulator and Demodulator
AB102	SSB Modulator and Demodulator
AB106	FM Modulator and Demodulator

and many more……

Theory

Oscillators are circuits that produce periodic waveforms without input other than perhaps a trigger. They generally use some form of active device, lamp, or crystal, surrounded by passive devices such as resistors, capacitors, and inductors, to generate the output.

There are two main classes of oscillator: Relaxation and Sinusoidal. Relaxation oscillators generate the triangular, sawtooth and other nonsinuoidal waveforms. Sinusoidal oscillators consist of amplifiers with external components used to generate oscillation, or crystals that internally generate the oscillation. The focus here is on sine wave oscillators, created using operational amplifiers Op-Amps. Sine wave oscillators are used as references or test waveforms by many circuits.

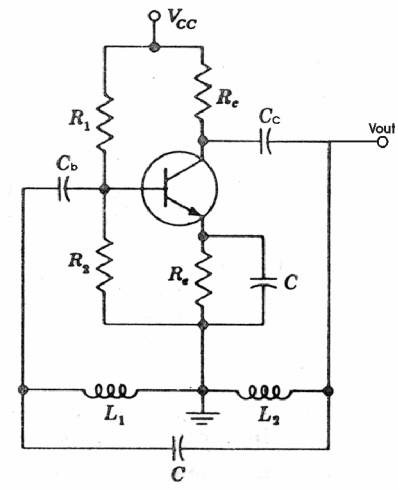
An oscillator is a type of feedback amplifier in which part of the output is fed back to the input via a feedback circuit. If the signal fed back is of proper magnitude and phase, the circuit produces alternating currents or voltages. Two requirements for oscillation are:

1. The magnitude of the loop gain A_VB must be at least 1, and

2. The total phase shift of the loop gain A_VB must be equal to 0° or 360°. If the amplifier causes a phase shift of 180°, the feedback circuit must provide an additional phase shift of 180° so that the total phase shift around the loop is 360°.

Hartley Oscillator :

The Hartley oscillator is one of the simplest and best known oscillators and is used extensively in circuits, which work at radio frequencies. Figure 1 shows the basic Hartley oscillator circuit configuration. The transistor is in voltage divider bias which sets up Q-point of the circuit. The output voltage is fed back to the base and sustains oscillations developed across the tank circuit, provided there is enough voltage gain at the oscillation frequency.



Hartley Oscillator **Figure 1**

The resonant frequency of the Hartley oscillator can be calculated from the tank circuit used. We can calculate the approximately resonant frequency as

$$F_r = \frac{1}{2p\sqrt{L_T C}} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (1)$$

Here, the Inductor used is the equivalent Inductance. In Hartley oscillator the circulating current passes through the series combination of L1 and L2. Therefore equivalent Inductance is,

$$L_T = L1 + L2 + 2\,M \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (2)$$

Where, M is the mutual inductance between two inductors.

$$M = K\sqrt{L_1 L_2} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (3)$$

Where, K is the coefficient of coupling, lies between 0 to 1.The coefficient of coupling gives the extent to which two inductors are couple.

Starting condition for oscillations is

$$AB > 1$$

Where,

B is approximately equal to L2/L1.

The feedback should be enough to start oscillations under all conditions as different transistor, temperature, voltage, etc. but it should not be much that you lose more output than necessary. The resonant frequency can be changed by either changing the value of inductor or changing the value of capacitor but the combination of the three components should satisfy the above given two conditions for oscillation.

Experiment

Objective :
Study of the operation of Hartley Oscillator

Equipments Needed :

1. Analog board of **AB68**.
2. DC power supplies +12V from external source or **ST2612 Analog Lab**.
3. Oscilloscope Caddo 802 or equivalent
4. 2 mm patch cords.

Circuit diagram :

Circuit used to study the operation of Hartley Oscillator is as shown in figure 2.

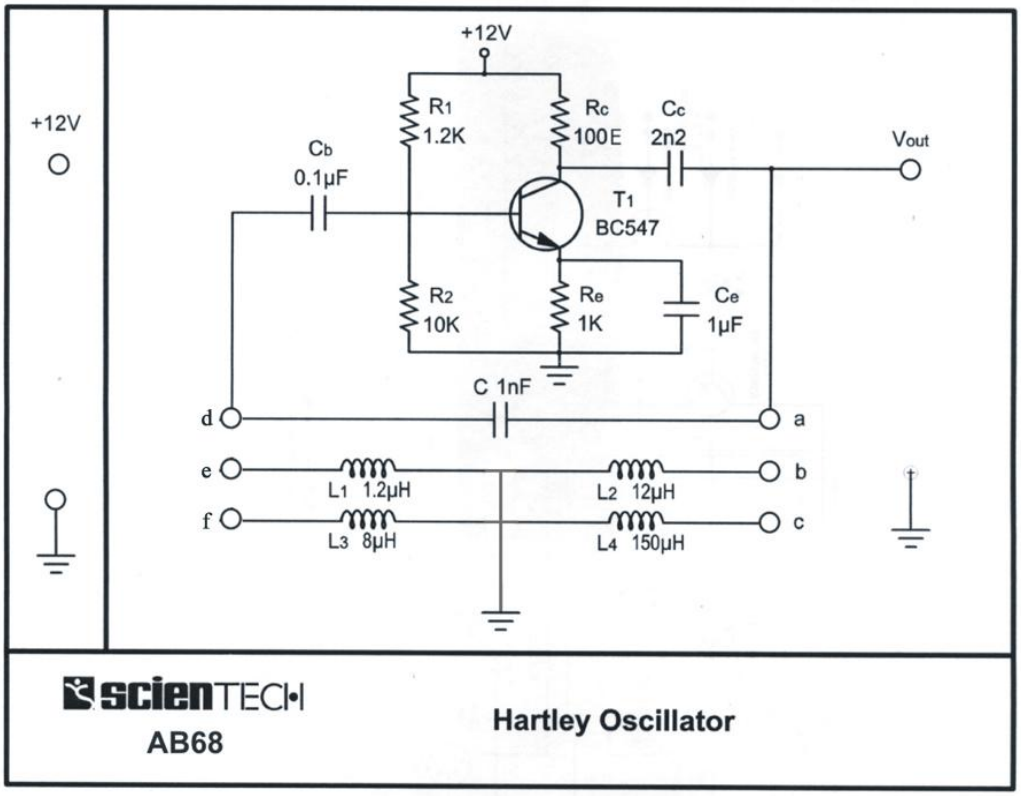


Figure 2

Procedure :

- Connect +12V DC power supplies at their indicated position from external source or **ST2612 Analog Lab**.

1. Connect a patch cord between points a and b and another patch cord between point d and e.

2. Switch on the Power Supply.

3. Connect Oscilloscope between Vout and ground on **AB68 board**.

4. Record the value of output frequency on oscilloscope.

5. Calculate the resonant frequency using equation 1.

6. Compare measured frequency with the theoretically calculated value.

7. Switch off the supply.

8. Remove the patch cord connected between points a and b and connect it between points a and c.

9. Remove the patch cord connected between points d and e and connect it between point d and f.

10. Follow the procedure from point 4 to 7.

Result :

- *When patch cord connected across a and b*

  Practically calculated Output frequency (on CRO): .....
  Theoretically calculated values

  L_T: …… (use equation 2)

  Resonant frequency (fr) : ……. (use equation l)

  Output voltage amplitude: ……... Vp-p

- *When patch cord connected across a and c*

  Practically calculated Output frequency (on CRO) : …….....
  Theoretically calculated values

  L_T: …… (use equation 2)

  Resonant frequency (fr) : ……. (use equation l)

  Output voltage amplitude: ……... Vp-p

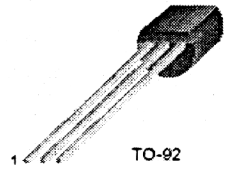
Data Sheet

FAIRCHILD
SEMICONDUCTOR®

BC546/547/548/549/550

Switching and Applications

- High Voltage: BC546, V_{CEO}=65V
- Low Noise: BC549, BC550
- Complement to BC556 ... BC560



TO-92

1. Collector 2. Base 3. Emitter

NPN Epitaxial Silicon Transistor

Absolute Maximum Ratings T_a=25°C unless otherwise noted

Symbol	Parameter	Value	Units
V_{CBO}	Collector-Base Voltage : BC546	80	V
	: BC547/550	50	V
	: BC548/549	30	V
V_{CEO}	Collector-Emitter Voltage : BC546	65	V
	: BC547/550	45	V
	: BC548/549	30	V
V_{EBO}	Emitter-Base Voltage : BC546/547	6	V
	: BC548/549/550	5	V
I_C	Collector Current (DC)	100	mA
P_C	Collector Power Dissipation	500	mW
T_J	Junction Temperature	150	°C
T_{STG}	Storage Temperature	-65 ~ 150	°C

Electrical Characteristics T_a=25°C unless otherwise noted

Symbol	Parameter	Test Condition	Min.	Typ.	Max.	Units
I_{CBO}	Collector Cut-off Current	V_{CB}=30V, I_E=0			15	nA
h_{FE}	DC Current Gain	V_{CE}=5V, I_C=2mA	110		800	
V_{CE} (sat)	Collector-Emitter Saturation Voltage	I_C=10mA, I_B=0.5mA		90	250	mV
		I_C=100mA, I_B=5mA		200	600	mV
V_{BE} (sat)	Base-Emitter Saturation Voltage	I_C=10mA, I_B=0.5mA		700		mV
		I_C=100mA, I_B=5mA		900		mV
V_{BE} (on)	Base-Emitter On Voltage	V_{CE}=5V, I_C=2mA	580	660	700	mV
		V_{CE}=5V, I_C=10mA			720	mV
f_T	Current Gain Bandwidth Product	V_{CE}=5V, I_C=10mA, f=100MHz		300		MHz
C_{ob}	Output Capacitance	V_{CB}=10V, I_E=0, f=1MHz		3.5	6	pF
C_{ib}	Input Capacitance	V_{EB}=0.5V, I_C=0, f=1MHz		9		pF
NF	Noise Figure : BC546/547/548	V_{CE}=5V, I_C=200μA		2	10	dB
	: BC549/550	f=1KHz, R_G=2KΩ		1.2	4	dB
	: BC549	V_{CE}=5V, I_C=200μA		1.4	4	dB
	: BC550	R_G=2KΩ, f=30~15000MHz		1.4	3	dB

h_{FE} Classification

Classification	A	B	C
h_{FE}	110 ~ 220	200 ~ 450	420 ~ 800

Rev. A2, August 2002

Typical Characteristics

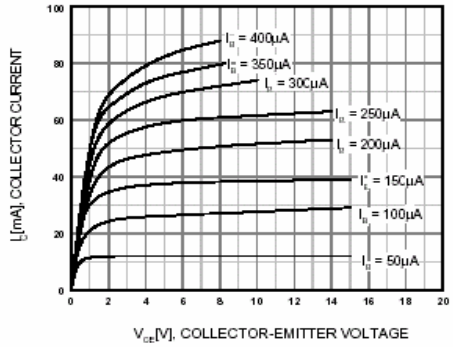


Figure 1. Static Characteristic

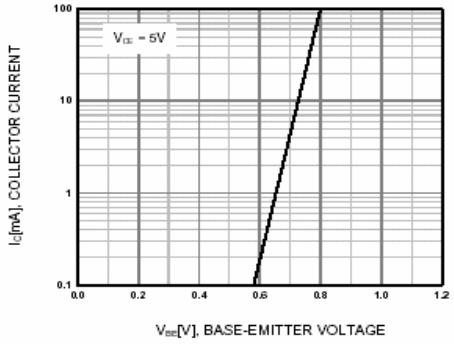


Figure 2. Transfer Characteristic

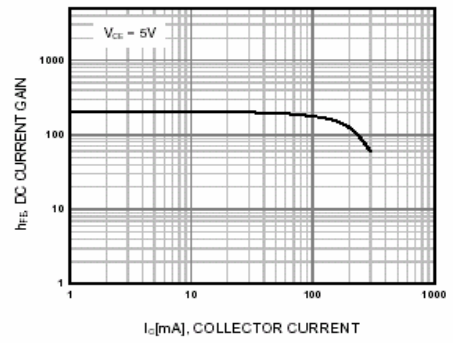


Figure 3. DC current Gain

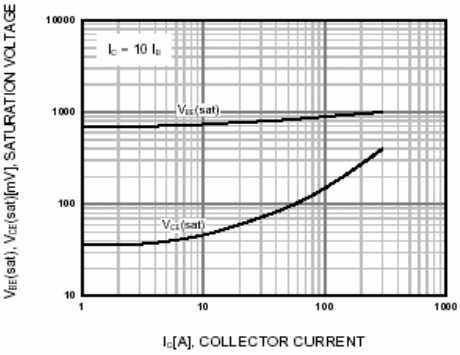


Figure 4. Base-Emitter Saturation Voltage
Collector-Emitter Saturation Voltage

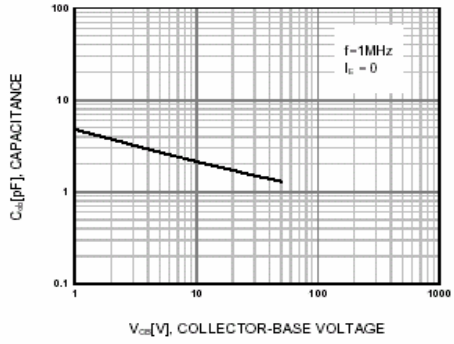


Figure 5. Output Capacitance

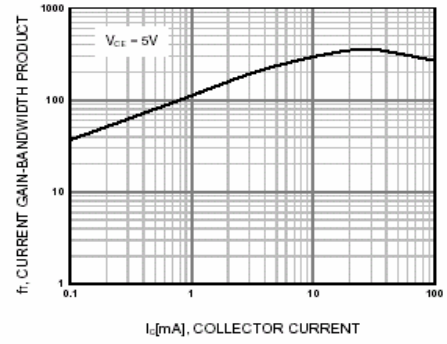


Figure 6. Current Gain Bandwidth Product

Warranty

1. We guarantee the product against all manufacturing defects for 24 months from the date of sale by us or through our dealers. Consumables like dry cell etc. are not covered under warranty.

2. The guarantee will become void, if

a) The product is not operated as per the instruction given in the operating manual.

b) The agreed payment terms and other conditions of sale are not followed.

c) The customer resells the instrument to another party.

d) Any attempt is made to service and modify the instrument.

3. The non-working of the product is to be communicated to us immediately giving full details of the complaints and defects noticed specifically mentioning the type, serial number of the product and date of purchase etc.

4. The repair work will be carried out, provided the product is dispatched securely packed and insured. The transportation charges shall be borne by the customer.

For any Technical Problem Please Contact us at **service@scientech.bz**

List of Accessories

1. 2 mm Patch Cords (Red) .....1 No.

2. 2 mm Patch Cord (Blue) ..... 2 Nos.

3. 2 mm Patch Cord (Black) ..... 3 Nos.

4. e-Manual.....1 No.

Updated 30-03-2009